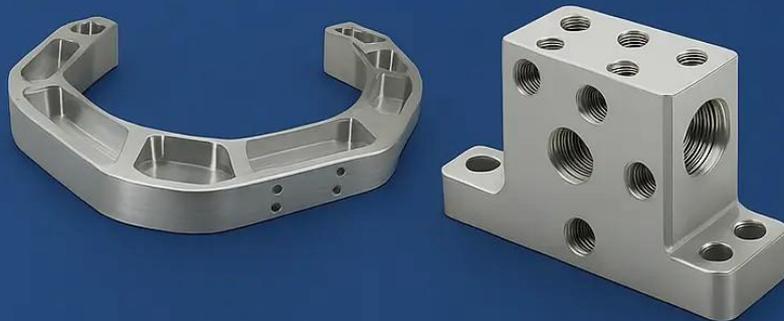




CNC MACHINING HANDBOOK



Medical Devices · Dental Equipment · Life Sciences
Robotics · Semiconductor · automation
Renewable Energy & Power Generation · Space Satellite



CNC Machining Handbook from Rollyu Precision

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Chapter 1: Introduction to CNC Machining

What is CNC Machining?

CNC machining (Computer Numerical Control machining) is a high-precision, subtractive manufacturing process that transforms digital designs into finished components by removing material from a solid workpiece. Using **automated, computer-controlled movements**, it delivers exceptional accuracy, repeatability, and speed—ideal for both prototyping and production runs.

At the heart of CNC machining are **G-code programs** derived from 3D CAD models. These codes guide the movement of cutting tools, controlling speed, feed, and depth to precisely shape the part.

The two primary CNC processes are:

- **CNC Milling** – where a rotating tool cuts material from a stationary block.
- **CNC Turning (Lathe)** – where the workpiece spins and a fixed cutting tool shapes it.

Advanced **multi-axis CNC machines** at Rollyu Precision combine both methods to handle complex geometries in a single setup—maximizing efficiency and part consistency.

CNC machining is compatible with a wide range of materials, including **aluminum, stainless steel, titanium, brass, PEEK, and ABS**, making it an ideal solution for **industries demanding tight tolerances**, such as **medical devices, aerospace, photonics, semiconductors, and robotics**.

Why Choose CNC Machining from Rollyu Precision?

- **Tight tolerance capability and micromachining**
- **Fast turnaround for prototypes and production**
- **ISO 9001:2015 & ISO 13485:2016 certified processes**
- **High material versatility and surface finish options**

At **Rollyu Precision**, CNC machining is more than a process—it's a promise of **accuracy, quality, and reliability** tailored to the needs of high-tech industries.

Evolution of CNC Technology

The evolution of **CNC (Computer Numerical Control) technology** reflects the broader advancement of automation, digital control, and precision manufacturing over the past century. CNC didn't roll out of bed in 2025 ready to dominate. **It's got old-school roots** — we're talking mid-20th-century military tech meets hole-punch tape and analog dials. But over the decades, CNC transformed from a glorified calculator to the ultra-precise, robot-integrated beast it is today. it is today.

1. Manual Machining Era (Pre-1940s)

Before CNC, machining was entirely manual. Skilled machinists operated lathes, mills, and grinders using handwheels, levers, and visual measurement. This limited complexity, consistency, and scalability.

2. Numerical Control (NC) – 1940s–1950s

The punch-tape pioneer era: Early numerical control (NC) machines used punched tape to tell machines what to do. It worked ... sort of. Precision was clunky, but for post-WWII aviation, it was still miles better than manual setups. Just imagine how far it's come. The first major leap came during World War II, when the U.S. Air Force commissioned the development of **Numerical Control (NC)** machines to produce complex aircraft parts. These machines were controlled by punch cards or paper tape—containing coordinate instructions—to automate tool paths.

3. CNC Emerges – 1960s

With the integration of **digital computers** in the 1960s, NC evolved into **CNC**. This shift eliminated the need for physical tapes and enabled more dynamic programming. Early CNC systems used basic programming languages and analog electronics, significantly improving repeatability and accuracy. Enter the “C” in Computer Numerical Control. Engineers began replacing tape decks with real-time computer processing. This shift gave birth to the first legit CNC systems — much faster, way more accurate, and programmable without scissors and tape splices. In the '60s, this shift also meant G-code started to become standardized.

4. CAD/CAM Integration – 1970s–1980s

The introduction of **CAD (Computer-Aided Design)** and **CAM (Computer-Aided Manufacturing)** allowed engineers to design parts digitally and generate machine code automatically. CNC machines became more accessible and flexible across industries. With CAD and CAM software hitting the scene, manufacturers could now design and generate toolpaths digitally. G-code became the universal language of machine tools. Suddenly, CNC was both efficient and scalable.

5. Multi-Axis and High-Speed Machining – 1990s

This era brought about **3-axis, 4-axis, and 5-axis** machines, enabling more complex geometries and tighter tolerances. **High-speed machining (HSM)** and better spindle technology improved cycle times and surface finishes.

6. Smart CNC – 2000s–2010s

Advancements in **microprocessors, sensors, and networking** gave rise to **smart CNC systems**. Machines became capable of real-time monitoring, adaptive control, and remote diagnostics. CAM software became more intuitive, reducing the skill barrier.

7. Industry 4.0 and Beyond – 2015–Today

Today's CNC machines are part of the **Industry 4.0** ecosystem. They are integrated with **IoT, AI, cloud-based data analytics, and digital twins**, enabling predictive maintenance, lights-out manufacturing, and closed-loop quality control. Now, CNC systems are loaded with sensors, linked to real-time analytics, and increasingly paired with robotic arms. Smart factories can tweak production in real time — and machine learning is starting to predict wear and optimize tool paths as things happen, instead of, “Oh, no, why did this break?”



8. Future Trends in CNC Machining and Automation

CNC machining is undergoing a significant transformation as Industry 4.0 continues to reshape advanced manufacturing. Once seen as the pinnacle of precision, CNC machines are now becoming smarter, more autonomous, and deeply integrated into digital ecosystems. The future lies in AI-powered adaptive machining, where real-time data on tool wear, spindle load, and vibration allows machines to adjust cutting parameters on the fly—enhancing tool life and product consistency. Automation is accelerating with robotic arms and collaborative robots (cobots) enabling lights-out manufacturing and safer, more efficient human-machine collaboration. Closed-loop control systems, equipped with sensors and encoders, now correct deviations in real time, ensuring higher accuracy and less waste. Digital twin technology allows manufacturers to simulate machining operations virtually before production begins, reducing setup time and avoiding costly trial runs. At the same time, sustainability is gaining ground through innovations like coolant recycling, dry machining, and efficient material nesting. Finally, cloud-based smart monitoring systems are turning CNC machines into fully connected assets—providing predictive maintenance, live performance dashboards, and actionable insights that improve uptime, traceability, and operational efficiency. The result is a new era of CNC machining: faster, greener, smarter, and more agile.

Benefits for high-precision industries

In today's manufacturing landscape, precision is no longer optional—it is essential. Industries such as aerospace, medical devices, semiconductors, robotics, and photonics depend on components with tight tolerances, exceptional material integrity, and consistent performance. CNC (Computer Numerical Control) precision machining has emerged as a cornerstone technology in these sectors, enabling manufacturers to meet demanding specifications with confidence.

1. Micron-Level Accuracy and Tight Tolerance Control

CNC machining provides unmatched dimensional precision, often achieving tolerances down to ± 0.005 mm (± 5 microns). This level of accuracy is critical in applications where even the smallest deviation can lead to system failure or inefficiency.

- **Medical:** Surgical implants and diagnostic equipment require sub-millimeter precision to ensure patient safety and functionality.
- **Semiconductor:** Wafer handling and cleanroom tooling demand ultra-tight tolerances to maintain alignment and minimize particle generation.
- **Photonics:** Optical mounts, housings, and fiber alignment systems must meet laser-grade flatness and positional accuracy.

By relying on software-controlled tool paths and repeatable machine logic, CNC systems virtually eliminate the variability of manual operations.

2. Continuous Production and Lights-Out Manufacturing

Once a CNC machine is programmed, it can run autonomously—day or night—with minimal operator intervention. This unlocks 24/7 production capacity, enabling:

- Rapid turnaround times for urgent jobs
- Efficient high-volume part production
- Increased uptime with fewer labor shifts

Rollyu Precision employs automation protocols such as tool changers, in-process sensors, and robotic loading to enable uninterrupted production for both prototyping and large-scale orders.

3. Scalable Manufacturing for Prototypes and Mass Production

CNC machining provides a seamless path from early design to full production:

- **Low-volume:** Ideal for validation units, engineering prototypes, and limited batch runs.
- **High-volume:** Repeatable precision allows economical manufacturing at scale, particularly when combined with DFM (Design for Manufacturability) principles.

This scalability reduces risk during new product introduction (NPI) and supports agile engineering workflows.

4. Geometric Complexity and Multi-Axis Capability

Modern CNC equipment—particularly 4-axis and 5-axis machines—supports the fabrication of highly complex geometries that would be difficult or impossible using traditional methods.

- Undercuts, helical channels, compound curves, and thin-wall features can be

machined with precision

- Simultaneous multi-axis motion reduces setups and errors associated with repositioning
- Tool libraries of up to 30+ instruments enable hybrid machining strategies (e.g., drilling, threading, engraving) in a single cycle

Rollyu Precision's equipment is optimized for complex part geometries commonly found in aerospace brackets, robotic joints, and high-density enclosures.

5. Reduced Material Waste and Greater Resource Efficiency

Subtractive manufacturing inherently generates waste, but CNC technology minimizes this by:

- Optimizing tool paths for minimal excess removal
- Utilizing software simulations to plan cuts before material is touched
- Eliminating overcuts and misalignment through rigid workholding and sensor feedback

Especially when working with premium materials such as titanium or PEEK, these efficiencies translate directly into cost savings.

6. Lower Overall Production Costs

While CNC machining may have higher up-front programming and setup costs, the long-term savings are substantial:

- Minimal rework due to high repeatability and low defect rates
- Lower labor costs per part thanks to automation
- Consolidation of multiple machining steps reduces lead times and logistical overhead

CNC machining is particularly cost-effective for high-precision, low-to-medium volume production, where tooling costs of casting or molding are unjustified.

7. Enhanced Workplace Safety and Reduced Human Error

Safety is a critical consideration in any manufacturing environment. CNC machining reduces operator exposure to high-risk conditions:

- Fully enclosed cutting environments with interlocks and emergency stops
- Programmable operations reduce repetitive stress injuries
- Real-time monitoring flags tool wear or misfeeds before failure occurs

At Rollyu Precision, operator safety is enhanced by proper training, remote machine control capabilities, and AI-powered error detection systems.

8. Broad Material Compatibility

One of CNC machining's greatest strengths is its versatility across materials:

- **Metals:** Aluminum, stainless steel, titanium, brass, copper, Inconel, magnesium
- **Plastics:** PEEK, PTFE, POM, PMMA, PA, PC
- **Composites and exotic alloys** for aerospace or energy applications

This makes CNC ideal for industries that require a mix of lightweight, corrosion-resistant, heat-tolerant, or biocompatible components.

9. Rapid Prototyping and Design Validation

CNC machining accelerates innovation by offering fast-turn prototyping:

- CAD-to-part conversion can be completed in as little as 48–72 hours
- Ideal for functional prototypes requiring tight tolerance or load testing
- Easy to iterate—just revise the CAD model and regenerate tool paths

This empowers design engineers to validate concepts early, test form/fit/function, and de-risk downstream production.

10. Consistent Quality and Process Traceability

With the rise of Industry 4.0 and medical/aerospace regulations, traceability and quality assurance are more important than ever. CNC machining supports:

- Digital documentation of every toolpath and material lot
- Integration with quality control systems (CMM, optical comparators, SPC)
- Compliance with ISO 9001:2015, ISO 13485:2016, and industry-specific standards

Rollyu Precision maintains full traceability from raw material to final inspection, with batch-level inspection reports available upon request.

In industries where performance, safety, and regulatory compliance are non-negotiable, CNC precision machining offers an ideal manufacturing foundation. The ability to produce highly complex, repeatable, and cost-effective components makes CNC technology indispensable for high-precision sectors.

At Rollyu Precision, our investment in advanced CNC equipment, quality systems, and engineering expertise ensures that your parts meet the most demanding requirements—on time, every time.

In addition to our CNC machining processes, we offer sheet metal fabrication, die casting services, rapid prototyping, and more. No matter what your plastic fabrication needs entail, we have the capabilities to create durable plastic products for your applications.

Chapter 2: Rollyu Precision Overview

Rollyu Precision Company Background

Founded with a mission to deliver uncompromising precision, **Rollyu Precision** is a leading manufacturer of high-tolerance CNC machined components and sheet metal fabricated parts for advanced industries worldwide. Headquartered in China and ISO 9001:2015 and ISO 13485:2016 certified, we specialize in serving high-performance sectors including **medical devices, dental equipment, semiconductors, robotics, photonics, life sciences, renewable , space & satellite, and automation systems.**

At Rollyu, we combine cutting-edge equipment—including 3-, 4-, and 5-axis CNC machines—with a skilled engineering team and rigorous quality control to produce components with tolerances as tight as ± 0.005 mm. Our manufacturing capabilities span across **CNC milling and turning, sheet metal fabrication, die casting, rapid prototyping, and custom finishing**—enabling end-to-end solutions from prototype to production.

What sets Rollyu apart is our ability to provide not only precision parts, but also responsive engineering support, fast lead times, and full traceability across the supply chain. Whether it's a complex surgical robot housing, a photonics alignment mount, or a semiconductor fixture, we bring your designs to life with precision, consistency, and care.

With a commitment to innovation, quality, and customer success, Rollyu Precision is more than a supplier—we are a manufacturing partner dedicated to driving excellence in every part we produce.



Certifications: ISO 9001:2015, ISO 13485:2016

At Rollyu Precision, quality is built into every part we manufacture. Our operations are governed by internationally recognized management systems to ensure product consistency, regulatory compliance, and customer satisfaction across all industries we serve. Rollyu Precision has achieved both ISO 9001:2015 and ISO 13485:2016 certifications, demonstrating its commitment to quality management and specifically to the requirements of the medical device industry.

ISO 9001:2015 – Quality Management System

Rollyu Precision is certified to **ISO 9001:2015**, the global standard for quality management. This certification demonstrates our ability to consistently provide products and services that meet customer and regulatory requirements. It ensures:

- Rigorous in-process and final inspection controls
- Continuous improvement in quality, delivery, and performance
- Documented procedures and full production traceability

This certification is essential for industries such as **semiconductors, photonics & quantum robotics, automation, renewable, space & satellite, and industrial equipment**.

ISO 13485:2016 – Medical Device Quality Management

In addition to general quality assurance, Rollyu Precision is also certified to **ISO 13485:2016**, the international standard for quality management specific to the **medical device and dental industries**. It ensures:

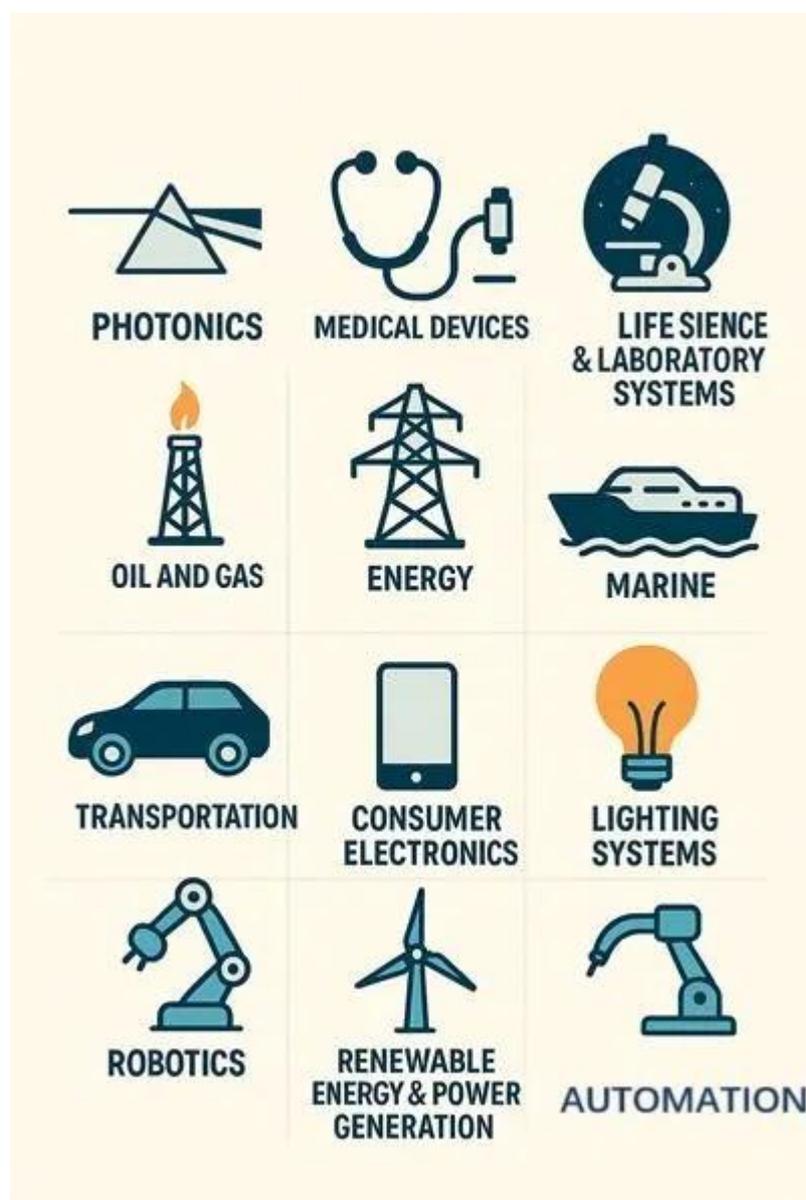
- Strict adherence to regulatory compliance (FDA, EU MDR, etc.)
- Risk-based product development and traceability
- Control over cleanliness, documentation, and process validation

This certification qualifies Rollyu as a trusted manufacturing partner for **surgical robotics, diagnostic systems, dental equipment, Life Sciences**, and other Class II, and III medical-grade parts.

Industry Focus: Medical, Dental, Semiconductor, Photonics, Robotics, Life sciences and More

At **Rollyu Precision**, we specialize in high-accuracy CNC machining and precision sheet metal fabrication, die-casting parts, rapid prototyping for industries where **failure is not an option** and tolerances are measured in microns. With ISO 9001:2015 and ISO 13485:2016 certifications, we serve a global base of innovators in **medical devices, dental technology, semiconductors, photonics, robotics, and life sciences**.

Each industry we serve is driven by advanced engineering, complex geometries, and strict compliance requirements. Rollyu delivers reliable, repeatable components that meet the highest standards of quality, cleanliness, and performance.



Medical Devices

Precision. Biocompatibility. Traceability.

We manufacture critical components for surgical robotics, diagnostic imaging, orthopedic implants, rehabilitation systems, and patient monitoring. Our materials expertise includes titanium, PEEK, stainless steel, and anodized aluminum—all machined to surgical-grade precision.

Common Applications:

- Robotic arm joints and end-effectors
- Implantable device casings
- Diagnostic sensor housings
- MRI/CT-compatible non-magnetic components

Dental Technology

Compact Design. Cleanability. Reliability.

Dental systems require compact, lightweight, corrosion-resistant components with smooth finishes. We manufacture precision parts for intraoral scanners, milling units, sterilizers, orthodontic tools, and implant planning systems.

Common Applications:

- Intraoral scanner brackets
- Machined trays for autoclave use
- Custom abutment fixtures
- Components for chairside CAD/CAM units

Semiconductor Manufacturing

Micron-Level Accuracy. Cleanroom Compliance. Material Purity.

We deliver tight-tolerance parts for semiconductor equipment, including wafer processing, lithography, and vacuum systems. All components meet high-purity, low-particulate, and flatness specifications critical for ultra-clean environments.

Common Applications:

- Wafer alignment systems
- Precision cooling plates
- Load ports and robotic handlers
- Chamber components and lift pins

Photonics & Optoelectronics

Laser Precision. Optical Alignment. Surface Integrity.

Photonics requires extreme precision in alignment and surface quality. We produce lens mounts, optical benches, beam-steering frames, and housing components with exacting tolerances and optical-grade finishes.

Common Applications:

- Optical mounting structures
- Diode housing assemblies
- Fiber optic alignment components
- Interferometer frames

Robotics & Automation

Motion Control. Lightweight Frames. Reliability Under Load.

We support robotics OEMs in industrial, surgical, and service sectors. From robotic arms and end-effectors to control housings and exoskeletons, we deliver parts that combine strength, precision, and repeatability.

Common Applications:

- Joint enclosures and gear housings
- Actuator mounts and load frames
- Lightweight sensor brackets
- Structural frames for AMRs/AGVs

Life Sciences & Laboratory Systems

Fluid Management. Sterile Surfaces. Tight Integration.

Our precision parts support automated lab platforms, diagnostic analyzers, and biotech instruments. We machine components from PEEK, PTFE, stainless steel, and high-purity polymers for use in clean, chemically inert environments.

Common Applications:

- Microfluidic interface blocks
- Automated liquid handling systems
- Sample processing and PCR modules
- Spectrometer mounts and fluid reservoirs

Other Industries: We also cater to a range of other industries, including:

- Space & Satellite
- Oil and Gas
- Energy and Power
- Marine
- Telecommunications
- Transportation
- Consumer Electronics
- Lighting Systems

Why choose Rollyu Precision?

Precision Beyond Expectation. Reliability Without Compromise.

When it comes to high-accuracy CNC machining, die-casting, rapid prototyping, and sheet metal fabrication, **Rollyu Precision** stands out as a trusted partner to innovation-driven industries. We deliver more than just parts — we deliver **confidence, consistency, and capability** across every project. Rollyu Precision stands out due to its focus on unmatched precision, fast production cycles, and efficient workflows. They offer high-quality packaging to ensure safe delivery of our CNC machined components, sheet metal fabrication, die casting, and rapid prototyping. Our expertise in precision engineering translates to reliable results, minimizing errors, and ensuring product quality.

Here's a more detailed look at why choosing Rollyu Precision is beneficial:

1. Ultra-Precision Manufacturing

We specialize in complex geometries and tight tolerances down to ± 0.005 mm, backed by 3-, 4-, and 5-axis CNC machining and advanced finishing. Whether for surgical robotics or photonics alignment systems, our parts meet the most demanding specifications — every time. Rollyu Precision's focus on precision ensures that our precision components meet specific engineering tolerances, which is crucial for many applications.

2. Certified Quality Systems

Our operations are governed by **ISO 9001:2015** and **ISO 13485:2016** certifications, ensuring traceability, repeatability, and full compliance with global medical and industrial standards. Every part undergoes rigorous inspection using calibrated tools and CMMs.

3. Industry-Focused Expertise

We understand the unique challenges of your sector — from cleanroom-compatible components for **semiconductors**, to lightweight frames for **robotics**, and biocompatible parts for **medical and dental devices**. Our engineering team speaks your language.

4. Full-Service Capabilities

Rollyu Precision's CNC machining capabilities are versatile. Rollyu provides a one-stop solution:

- CNC Milling & Turning
- Laser Cutting
- Sheet Metal Fabrication
- Die Casting & Finishing
- Rapid Prototyping
- 3D Printing
- Vacuum Casting
- Wire EDM (Electrical Discharge Machining)

- Assembly Support
This integrated model reduces lead times and streamlines quality control across your supply chain.
- Custom Finish
- Dimensions and cosmetics Inspection

5. Rapid Prototyping & Scalable Production

From proof-of-concept to full-volume runs, our agile production lines scale with your needs. Fast lead times, low MOQs, and production flexibility ensure you meet market demands without delay. Precision machining facilitates easier prototype testing, allowing businesses to refine their designs before moving into full-scale production.

6. Global Delivery with Local Support

We ship globally while offering dedicated, bilingual support. Whether you're based in the U.S., Europe, or Asia-Pacific, Rollyu Precision provides **engineering feedback, DFM consultation,** and responsive customer service to keep your projects on track.

7. Clean, Consistent, Ready-to-Use Parts

Every part we deliver is:

- Cleaned and deburred
- Dimensionally verified
- Functionally fit and packaging-ready

No surprises. No rework. Just precision you can rely on.

8. Reduced Lead Times:

Rollyu Precision's expertise in precision engineering improves overall operational efficiency, making it easier to manage and integrate with various systems. By streamlining workflows and improving efficiency, Rollyu Precision can offer reduced lead times, allowing businesses to receive our components faster, allowing clients' businesses to move into full-scale production more quickly.

9. High-Quality Packaging:

Rollyu Precision utilizes premium EPE foam and sturdy cartons to ensure safe delivery of customers' precision machined components.

Trusted by Leaders in

Medical Devices | Dental Equipment | Semiconductors | Photonics | Robotics | Life Sciences | Automation | Consumer Electronics | Space & Satellite | Renewable Energy

Rollyu Precision is not just a manufacturer. We are your **engineering ally**, production partner, and quality assurance team—delivering parts that power next-generation innovation.

Chapter 3: CNC Machining Capabilities

3-axis, 4-axis, and 5-axis machining

Fundamental Precision for Simple to Moderate Complexity Parts

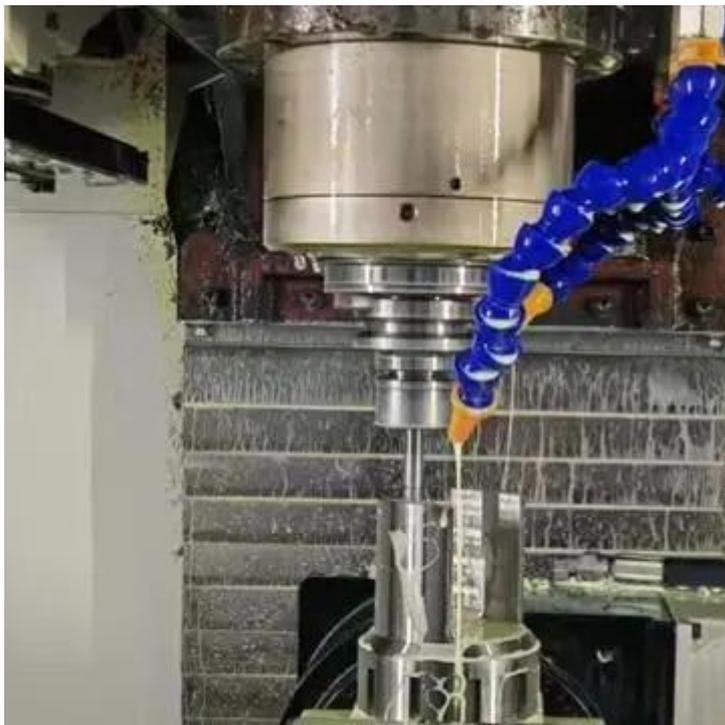
3-axis machining is the most common and widely used CNC configuration, where the cutting tool moves in three linear directions:

- **X-axis:** left to right
- **Y-axis:** front to back
- **Z-axis:** up and down

In this setup, the workpiece remains stationary on the machine bed while the cutting tool performs operations across these three axes. It is best suited for components that can be accessed from one side at a time and do not require rotation or tilting.

3-Axis Machining

- **Motion:** Moves along the X, Y, and Z axes (linear movement).
- **Capabilities:** Suitable for simple parts with flat or planar surfaces.
- **Limitations:** Difficult to machine complex geometries or angled features.
- **Applications:** Drilling, tapping holes, and machining flat surfaces.



3-axis, 4-axis, and 5-axis machining refer to the number of axes along which a CNC machine can move the cutting tool or workpiece. 3-axis machines offer simple linear movement, 4-axis adds rotational movement, and 5-axis includes both linear and rotational movement, allowing for greater complexity and precision.

At **Rollyu Precision**, we utilize a full range of CNC machining capabilities — including **3-axis, 4-axis, and 5-axis machining** — to meet the complex requirements of industries like medical devices, semiconductors, photonics, and robotics. Each axis configuration offers distinct advantages depending on part geometry, tolerance demands, and production efficiency.

Best for: Flat geometries, basic profiles, pockets, and contours

In 3-axis machining, the cutting tool moves along three linear axes: **X (left-right), Y (front-back), and Z (up-down)**. The workpiece remains stationary as the tool moves around it.

- Ideal for: Simple components, planar surfaces, and shallow cavities
- Common operations: Milling, drilling, facing, slotting
- Cost-effective and fast setup for low-complexity parts

Use Cases for 3-Axis Machining:

- Base plates
- Brackets
- Covers and enclosures
- Flat face components for medical and consumer electronics
- Heat sinks and mounting blocks
- Housings with planar features
- Simple enclosures for electronics or medical devices

Advantages for 3-Axis Machining:

- **Cost-Effective:** Lower machine cost and faster setup reduce unit prices for suitable parts
- **Reliable Accuracy:** Maintains high repeatability for 2.5D features and pockets
- **Quick Turnaround:** Efficient for rapid machining of large batches

4-Axis Machining

Increased Flexibility for Multi-Sided and Cylindrical Components

4-axis CNC machining builds upon the capabilities of 3-axis machining by introducing a rotational axis (A-axis), which rotates the workpiece around the X-axis. This additional degree of freedom allows the cutting tool to access multiple faces of the part without manual repositioning, enabling faster cycle times and more consistent accuracy for parts with features on multiple sides.

4-Axis Machining

- **Motion:** Adds a fourth axis (rotational) to the X, Y, and Z axes.
- **Capabilities:** Allows for machining complex arcs, angled features, and parts requiring rotation.

- **Applications:** Machining parts with angled features, such as cam lobes or helixes.



Key Capabilities of 4-Axis Machining

- Simultaneous or indexed rotation of the workpiece during milling
- Machining around cylindrical or tubular parts
- Milling slots, flats, grooves, and holes on multiple faces in one setup
- Improved accuracy over multiple re-fixturing setups in 3-axis systems

Best for: Cylindrical parts, features on multiple sides, and spiral patterns

4-axis machining adds **rotational movement around the X-axis (A-axis)**, allowing the part to be rotated during machining.

- Enables access to multiple faces without manual repositioning
- Increases accuracy and efficiency for parts with radial symmetry
- Ideal for components with holes, grooves, or profiles around a central axis
-

Use Cases for 4-Axis Machining

- Shafts and pins
- Connectors, bushings, and couplings with side-drilled features Rotated cavity milling (e.g., dental handpiece housings)
- Industrial automation components with features on multiple sides
- Shafts with flats, keyways, or cross-holes
- Turbine components, impellers, and screw-shaped parts
- Dental and surgical tool bodies with radial features

Advantages for 4-Axis Machining

- **Improved Efficiency:** Reduces the need for part repositioning between operations
- **Enhanced Precision:** Eliminates stacking errors from multiple setups
- **Better Surface Continuity:** Ideal for smoothly curved or rotational features
- **More Complex Geometry:** Enables partial wraparounds and multi-side access

Limitations

- Cannot machine complex undercuts or highly contoured 3D surfaces that require tilting along multiple axes
- Less suitable for organic shapes or aerospace-style freeform surfaces (requires 5-axis)
- Requires precise fixturing to optimize rotational balance

How Rollyu Precision Uses 4-Axis Machining

At **Rollyu Precision**, our 4-axis machining centers are deployed for high-efficiency production of multi-sided components — particularly in the **dental, robotics, automation, and semiconductor industries**. By rotating the workpiece during machining, we minimize human error, reduce total machining time, and maintain uniform quality across part features.

We routinely use 4-axis CNC for:

- Side hole arrays in robot joint housings
- Cross-hole drilling in automation connectors
- Flats and slots on precision shafts
- Radial grooves on semiconductor fixtures

Our 4-axis setups are fully integrated with tool changers, high-speed spindles, and CMM verification systems—ensuring that even your most geometrically demanding parts are delivered **on time, on spec, and on budget**.

5-Axis Machining

Unmatched Precision and Geometric Freedom for Complex, High-Value Parts

5-axis CNC machining represents the pinnacle of subtractive manufacturing technology. In addition to the linear movements along the **X, Y, and Z axes**, 5-axis machines add two rotational axes—**A (rotation around X)** and **B (rotation around Y)**—allowing the cutting tool to approach the part from virtually any angle.

This enables the production of complex, multi-surface geometries in a single setup, significantly reducing lead time, manual rework, and cumulative error. For industries such as **aerospace, medical devices, photonics, robotics, and semiconductors**, 5-axis machining is essential for achieving the tightest tolerances on intricate 3D parts.



5-Axis Machining

- **Motion:** Adds two rotational axes (A and B or A and C) in addition to the X, Y, and Z axes.
- **Capabilities:** Enables machining of highly complex geometries, including curved surfaces and intricate shapes.

Applications: Aerospace, medical, and other industries requiring high precision and complex designs.

Key Capabilities of 5-Axis Machining

- Simultaneous 5-axis interpolation for freeform surfaces and organic geometries
- Indexed 5-axis machining for multi-sided operations in a single clamping
- Machining of deep cavities, undercuts, compound angles, and complex contours
- Smoother surface finishes on curved profiles and critical alignment features

Types:

3+2: Can rotate two axes independently, but not simultaneously.

Fully Continuous: Can rotate two axes simultaneously.

Best for: Complex geometries, undercuts, angled surfaces, and aerospace/medical-grade parts

5-axis machining introduces two additional rotational axes: **A (rotation around X) and B (rotation around Y)**. This allows the tool to approach the part from virtually any angle.

- Minimizes setups — multiple faces machined in a single run
- Maintains tight tolerances on 3D contoured or organic shapes
- Reduces tool deflection and improves surface finish on deep features
- Critical for industries where microns matter

Use Cases for 5-Axis Machining:

- Surgical instrument bodies,
- housings with compound angles
- Robotic joint housings, Robotics gear housings and lightweight structural frames
- Photonics optical mounts requiring micron-level flatness and alignment
- Aerospace brackets with complex curves
- Semiconductor tooling with intersecting channels or compound angles
- Aerospace brackets and engine components with 3D contours
- Photonics mounts requiring micron-level flatness and alignment
- Semiconductor tooling with intersecting micro-channels and deep features

Advantages

- **One-Setup Machining:** Significantly reduces setup time and eliminates part repositioning
- **Higher Precision:** Maintains dimensional accuracy and alignment across multiple axes
- **Better Surface Finish:** Fewer tool entries = smoother surface continuity and fewer blend lines
- **More Complex Designs:** Freedom to machine any face, any angle, with minimal tool interference
- **Shorter Lead Times:** Less handling and faster production for high-mix, low-volume runs

Limitations

- Higher initial programming complexity and CAM requirements
- Greater machine investment and operator training needed
- May not be cost-effective for simple, flat components better suited to 3-axis

How Rollyu Precision Uses 5-Axis Machining

At **Rollyu Precision**, our 5-axis machining platforms are reserved for your most advanced and mission-critical parts. We routinely use simultaneous and indexed 5-axis operations to produce:

- **Surgical robotics components** with multi-directional interfaces
- **Precision optical assemblies** with tight concentricity and angular tolerances
- **Semiconductor process equipment** with intricate channel networks
- **Custom actuator housings** with undercuts, chamfers, and multi-level features

Each part is programmed using high-level CAM software with toolpath simulation and collision detection, followed by CMM validation and full QA documentation. This ensures **flawless quality, traceability, and compliance**—especially in regulated industries.

Axis Comparison Overview

Feature	3-Axis	4-Axis	5-Axis
Movement Axes	X, Y, Z	X, Y, Z + A	X, Y, Z + A, B
Setup Changes Needed	High	Moderate	Low
Geometric Complexity Support	Basic	Moderate	Advanced/Organic
Ideal For	Flat parts	Radial/cylindrical	Complex freeform geometries
Industries	Electronics	Dental, Automation	Medical, Photonics, Aerospace,

Rollyu Precision's 5-axis capabilities empower innovation. Whether you're developing high-precision surgical instruments or breakthrough quantum optics, we deliver the form, function, and finish your applications demand—with agility, accuracy, and accountability.

At **Rollyu Precision**, our engineering team will help determine the optimal machining strategy to balance cost, complexity, and performance — ensuring your parts are manufactured to exacting standards.

Choosing the Right Machining Axis for Your Project

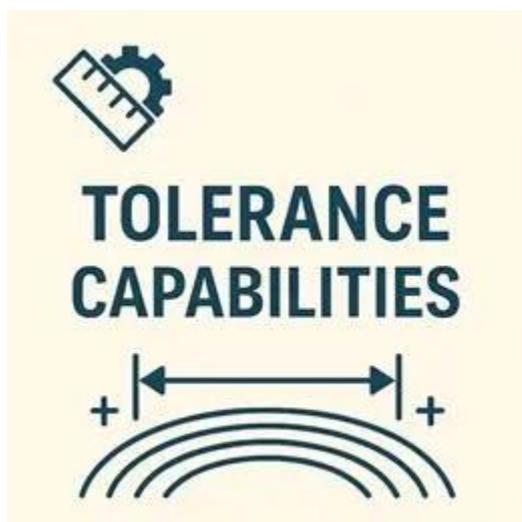
Machining Type	Axes	Complexity	Setup Time	Typical Use
3-Axis	X, Y, Z	Low–Medium	Low	Flat parts, simple pockets
4-Axis	X, Y, Z + A	Medium	Medium	Cylindrical parts, side features
5-Axis	X, Y, Z + A, B	High	High	Complex curves, multi-angle features

Tolerance Capabilities at Rollyu Precision

Micron-Level Precision. Guaranteed Repeatability.

Tolerance capabilities in manufacturing, like ± 0.005 mm, refer to the permissible variation in a manufactured part's dimensions. This indicates the maximum amount a feature can deviate from its intended design value and still be considered acceptable.

At **Rollyu Precision**, we understand that in high-performance industries, tolerances aren't just numbers — they define functionality, reliability, and safety. That's why we specialize in **tight-tolerance machining**, offering dimensional precision down to **± 0.005 mm (± 5 microns)** across a range of materials and part geometries.



What are tolerances?

Controlling Variation to Ensure Fit, Function, and Performance

In manufacturing, a **tolerance** refers to the **permissible limit or limits of variation** in a physical dimension or measured value of a part. It defines how much a feature—such as a hole diameter, slot width, or overall length—can deviate from its nominal (theoretical) dimension and still be considered acceptable.

For example, a shaft specified as **10.00 mm ± 0.01 mm** must fall between **9.99 mm and 10.01 mm** to pass inspection.

Why Tolerances Matter

Ensuring Functionality, Compatibility, and Manufacturability

Tolerances are essential to modern manufacturing because **no production process is perfect**—even the most advanced CNC machine introduces slight variations. Tolerances define the acceptable range of deviation from the nominal dimension, helping engineers and manufacturers ensure that parts perform reliably in real-world applications.

Tolerances are critical to:

- **Interchangeability:** Ensuring that parts from different production runs or suppliers fit and function correctly
- **Assembly Compatibility:** Avoiding interference or looseness between mating parts
- **Functional Performance:** Guaranteeing proper motion, sealing, alignment, or stress distribution
- **Quality Control:** Defining measurable criteria for acceptance or rejection
- **Cost Optimization:** Balancing manufacturing difficulty with design intent—tighter tolerances require more precision, tooling, and inspection, increasing cost

Types of Tolerances

- **Dimensional Tolerances:** Applied to linear dimensions (e.g., ± 0.01 mm)
- **Geometric Tolerances (GD&T):** Control form, orientation, position, and runout of features (e.g., flatness, concentricity, perpendicularity)
- **Limit Dimensions:** Instead of \pm variation, some drawings show upper and lower bounds directly (e.g., 19.95 / 20.05 mm)

Tolerance Example in Practice

If a medical device housing requires a sliding fit for an internal sensor module, the tolerance of both the slot width and sensor body must be tightly controlled to avoid binding or rattling. Even a 0.02 mm deviation may affect calibration or safety.

At **Rollyu Precision**, we work with customer-defined tolerances and offer machining capabilities down to **± 0.005 mm**, ensuring that every component we produce meets the required performance criteria—consistently and reliably.

How are tolerances expressed?

Defining Acceptable Variation for Precision Manufacturing

Tolerances are the allowable deviations from a nominal (target) dimension and are typically expressed as either a **\pm value** or **limit dimensions**. They provide a precise, measurable range within which a manufactured part is considered acceptable.

Tolerances are typically expressed as a range, such as ± 0.005 mm. This means that the dimension can be 0.005 mm smaller or larger than the specified value and still be considered within tolerance.

1. Plus/Minus Tolerances (\pm)

This is the most common format and is used when the acceptable variation is equal in both directions.

Example:

Nominal Dimension: **10.000 mm**

Tolerance: **± 0.005 mm**

Acceptable Range: **9.995 mm to 10.005 mm**

This means the final measurement can be up to 0.005 mm larger or smaller than the nominal value.

2. Limit Dimensions

Limit dimensions define the upper and lower acceptable values directly, without using a \pm symbol.

Example:

- Upper Limit: **10.005 mm**
- Lower Limit: **9.995 mm**

This expresses the same tolerance range as ± 0.005 mm, but makes the boundaries explicitly clear.

3. Asymmetric Tolerances

Sometimes, tighter control is needed in one direction (e.g., a hole cannot be too small but may be slightly oversized). These are expressed with **unequal upper and lower deviations**.

Example:

Nominal Dimension: **10.000 mm**

Tolerance: **+0.010 / -0.000 mm**

Acceptable Range: **10.000 mm to 10.010 mm**

This ensures the part never falls below 10.000 mm.

4. Geometric Tolerances (GD&T)

Beyond linear dimensions, tolerances may control **shape, orientation, or position** using **Geometric Dimensioning and Tolerancing (GD&T)** symbols. Examples include:

- Flatness: ≤ 0.01 mm
- Position: true position within a 0.02 mm diameter zone
- Concentricity, Perpendicularity, Runout, etc.

These are critical in assemblies where precise relationships between features are required.

Example:

If a part's intended dimension is 10 mm and the tolerance is ± 0.005 mm, the acceptable range is 9.995 mm to 10.005 mm.

Visual Example

Type	Format	Interprets As
\pm Tolerance	10.000 mm ± 0.005 mm	9.995 mm to 10.005 mm
Limit Dimensions	9.995 mm / 10.005 mm	Explicit upper and lower bounds
Asymmetric Tolerance	10.000 mm +0.010 / -0.000	10.000 mm to 10.010 mm (no undersize)

At **Rollyu Precision**, we work with all standard tolerance formats and apply them using advanced CAD/CAM software and inspection protocols. Whether you're specifying hole fits, angular alignment, or surface profiles, we manufacture to **your exact specifications—clearly, consistently, and accurately**.

Factors Affecting Tolerances

What Determines How Tight a Tolerance Can or Should Be?

Setting the right tolerance is a balance between functionality, manufacturability, and cost. While tighter tolerances improve precision and fit, they also increase complexity, lead time, and inspection requirements. Several technical and practical factors influence how tight a tolerance can be realistically achieved.

Tolerances are influenced by various factors, including the manufacturing process, the material being used, and the complexity of the part.

Tolerances, in various contexts, are affected by a range of factors. In manufacturing, these can include material properties, manufacturing processes, and environmental conditions. In biology, tolerance refers to an organism's ability to survive under specific environmental conditions, and this range can be influenced by time, place, situation, and culture. In drug use, tolerance is the body's adaptation to repeated exposure, leading to a need for higher doses.

1. Material Type

Different materials respond differently to machining forces and thermal conditions.

- **Hard metals (e.g., stainless steel, titanium):** Support tighter tolerances due to their stability.
- **Soft metals or plastics (e.g., aluminum, PEEK):** More prone to warping, deformation, or thermal expansion, which may limit how tight the tolerance can be held.

2. Part Geometry

The complexity and size of a part affect tolerance feasibility.

- **Simple geometries** are easier to hold to tight specs.
- **Thin walls, deep pockets, or long unsupported features** are more difficult to machine without deflection or vibration.
- **Symmetry and rigidity** improve machinability and dimensional stability.

3. Machining Process

Tolerance capability varies significantly by process:

- **3-axis machining:** Best for flat, planar features (± 0.01 – 0.005 mm typical).
- **5-axis machining or grinding:** Ideal for complex, tight-tolerance parts.
- **EDM:** Enables extremely fine tolerances (± 0.003 mm or better).
- **Sheet metal fabrication:** Typically looser (± 0.1 mm or more), depending on bending, welding, and material springback.

4. Thermal Expansion and Environmental Conditions

- **Machining heat** can cause parts to expand during production. Once cooled, shrinkage may bring dimensions out of spec.
- **Room temperature control** is critical when machining and measuring tight-tolerance components.

- Some materials (like plastics) have high coefficients of thermal expansion, which must be considered in both design and inspection.

5. Tooling and Fixturing

- **Tool wear** and incorrect tool geometry can cause deviation from nominal dimensions.
- **High-quality fixturing** ensures part stability during cutting, reducing the chance of movement that affects precision.
- **Tool deflection** becomes an issue on long-reach or high-speed machining jobs.

6. Inspection Capability

You can only reliably hold tolerances that you can measure.

- **CMMs (Coordinate Measuring Machines)**, optical comparators, and laser measurement systems are required for sub- ± 0.01 mm tolerances.
- Manual gauges are not suitable for ultra-tight precision.
- Proper calibration and environmental controls (e.g., temperature, vibration) are essential.

7. Cost vs. Functionality

- Tighter tolerances increase machining time, scrap risk, inspection effort, and price.
- Always **match the tolerance to the functional need**—not tighter than necessary.
- Collaborate with the manufacturer (like Rollyu Precision) during DFM (Design for Manufacturability) reviews to optimize tolerances for both performance and production efficiency.

At Rollyu Precision, we consider all these factors when planning a job. Whether your component needs ± 0.1 mm for a bracket or ± 0.005 mm for a semiconductor fixture, we apply the right process controls, tooling, and inspection protocols to ensure your tolerances are not just met — they're repeatable.

Importance of Specifying Tolerances

Defining Precision to Ensure Performance, Compatibility, and Cost-Efficiency

In precision manufacturing, simply defining a dimension is not enough. **Specifying tolerances** is essential to communicate how much variation is acceptable for a part to function correctly. Without clearly defined tolerances, manufacturers are forced to guess what's "good enough," which can lead to costly overengineering—or worse, part failure.

Specifying tolerances is crucial in manufacturing as it defines the acceptable variation in dimensions, ensuring proper fit, function, and quality of parts and assemblies. By establishing limits for dimensions, tolerances improve part compatibility, allow for manufacturing variations, and optimize production costs. They also play a vital role in quality control and inspection, ensuring that manufactured parts meet design specifications.

When designing a part, it is important to specify the appropriate tolerances for each dimension or feature. This ensures that the manufacturing process is properly controlled and that the finished part meets the required accuracy and fit.

Why Specifying Tolerances Matters

1. Ensures Functional Fit

Tolerances determine whether parts will **fit together properly** during assembly. Whether it's a press fit, slip fit, or sliding mechanism, the tolerance controls the degree of clearance or interference needed to ensure reliable operation.

Example: A shaft that's too large or a hole that's too small—even by a few microns—can result in binding, excess wear, or failure to assemble.

2. Guarantees Interchangeability

In mass production or modular systems, components must be **interchangeable** regardless of batch or supplier. Specifying tolerances ensures that each part produced conforms to the same acceptance criteria, supporting scalability and supply chain reliability.

3. Improves Inspection and Quality Control

Tolerances provide **measurable standards** for pass/fail decisions during inspection. Without tolerances, inspectors have no objective way to verify if a part meets design requirements.

With tolerance: "This shaft is 9.996 mm — acceptable."

Without tolerance: "Is this close enough? We can't be sure."

4. Prevents Over-Engineering

By clearly defining what level of precision is actually needed, engineers can avoid unnecessarily tight tolerances that increase cost and complexity without adding functional benefit. Overly strict tolerances drive:

- Higher machining time
- Increased tool wear
- More scrap and rework
- Costlier inspection processes

5. Supports Design for Manufacturability (DFM)

During the product development stage, specifying realistic and functional tolerances helps manufacturers choose the right materials, processes, and tools to balance **performance with production efficiency**.

6. Ensures Safety and Compliance

In regulated industries like **medical devices, aerospace, or robotics**, tolerances are critical to ensuring **reliable operation and user safety**. A poorly tolerated part can lead to mechanical failure, recalls, or legal liability.

Key Takeaway:

Every dimension must have a purpose. Every tolerance must reflect that purpose.

At **Rollyu Precision**, we work closely with design and engineering teams to review and optimize tolerances—ensuring your parts are not only functional and manufacturable, but also cost-effective and consistent.

Examples of CNC machining tolerances:

CNC machining can achieve tolerances as tight as ± 0.0005 inches (0.0127 mm) or ± 0.001 inches (0.0254 mm), according to ENZEMFG. In some cases, even tighter tolerances are possible, according to Rollyu Precision.

Standard Tolerance Capabilities

Process Type	Typical Tolerance Range
CNC Milling (3/4/5-axis)	± 0.01 mm to ± 0.005 mm
CNC Turning	± 0.01 mm to ± 0.005 mm
Wire EDM	± 0.003 mm to ± 0.005 mm
Sheet Metal Fabrication	± 0.1 mm (can be tighter depending on features)
Thread Accuracy	Up to ISO 4H/5H or ANSI class 3B

For ultra-high precision or inspection-critical components, we collaborate closely with customers to define tolerance stacks, GD&T requirements, and inspection protocols.

Applications Requiring Tight Tolerances

Where Precision is Non-Negotiable

In high-precision industries, tight tolerances—typically in the range of **± 0.005 mm or tighter**—are not just design preferences; they are functional requirements. Whether for ensuring perfect assembly fit, optical alignment, leak-free sealing, or load-bearing reliability, these applications depend on flawless dimensional control to meet performance, safety, and regulatory expectations.

Tight tolerances, or very small permissible variations in a part's dimensions, are crucial in many applications where precision and accuracy are paramount, particularly in industries like aerospace, medical, and automotive. They ensure components fit together correctly, function as intended, and maintain safety and reliability.

Our ± 0.005 mm tolerance capability is critical in industries where fit, sealing, or motion alignment are mission-critical:

- **Medical Devices:** Implantable parts, robotic surgical tools, sensor housings
- **Semiconductors:** Wafer fixtures, vacuum chamber flanges, alignment plates
- **Photonics:** Optical mounts, fiber alignment blocks, beam path structures
- **Robotics:** Gear housings, actuator brackets, moving mechanical assemblies
- **Life Sciences:** Microfluidic manifolds, precision fluid connectors, instrument calibration pins

1. Medical Devices

Tight tolerances are essential for ensuring compatibility between components in surgical, diagnostic, and implantable medical systems. Even micron-level deviations can compromise patient safety or device functionality.

Examples:

- Surgical robotic joints
- Titanium implant components
- Sensor alignment brackets
- MRI/CT-compatible housings

2. Dental Equipment

Dental tools and machines are compact, handheld, and often involve precise mechanical movements. High tolerances ensure smooth function, reduced vibration, and patient comfort.

Examples:

- Intraoral scanner modules
- Endodontic tool holders
- Autoclavable enclosures
- CAD/CAM milling units

3. Semiconductor Equipment

In semiconductor fabrication, tolerances are measured in microns—or even nanometers. Tight control ensures positional accuracy, flatness, and cleanliness in environments where particles and misalignment can cause yield loss or product failure.

Examples:

- Wafer chucks and vacuum stages
- Test sockets and contact probes
- Chamber flanges and alignment tools
- Precision cooling or mounting plates

4. Photonics & Optoelectronics

Photonics systems require exact positioning of lenses, fibers, and mirrors. Sub-micron tolerances ensure optimal alignment for beam steering, signal integrity, and optical isolation.

Examples:

- Lens mounts and beam splitters
- Fiber optic alignment fixtures
- Diode housing and thermoelectric platforms
- Optical benches and positioning blocks

5. Robotics & Automation

Robotic systems, both industrial and surgical, rely on high-precision components to maintain consistent movement, torque transfer, and positional feedback.

Examples:

- Gearbox housings
- Encoder brackets
- Servo mounts
- Lightweight arm structures with tight mechanical clearances

6. Life Sciences & Laboratory Instruments

In biotech, fluid handling, and analytical instruments, tight tolerances are required to ensure proper sealing, microfluidic flow control, and reproducible results in sensitive experiments.

Examples:

- Microfluidic cartridges and manifolds
- Lab automation grippers and guides
- PCR tray holders
- Sample testing stage plates

7. Aerospace & Defense

Aerospace components are often subjected to extreme stresses, temperatures, and operational conditions. Dimensional integrity ensures mission success, safety, and structural reliability.

Examples:

- Precision airframe brackets
- Fuel system components
- Satellite sensor mounts
- Missile guidance system housings

Summary: When Are Tight Tolerances Needed?

Application Type	Why Tight Tolerances Matter
Assembly Fit	Ensures interference, clearance, or transition fits
Motion & Alignment	Maintains repeatable, accurate mechanical movement
Sealing & Flow Control	Prevents leaks, enables precise fluid handling
Optical or Thermal Control	Aligns components to light paths or cooling zones
Regulatory Compliance	Required for FDA, ISO 13485, aerospace standards

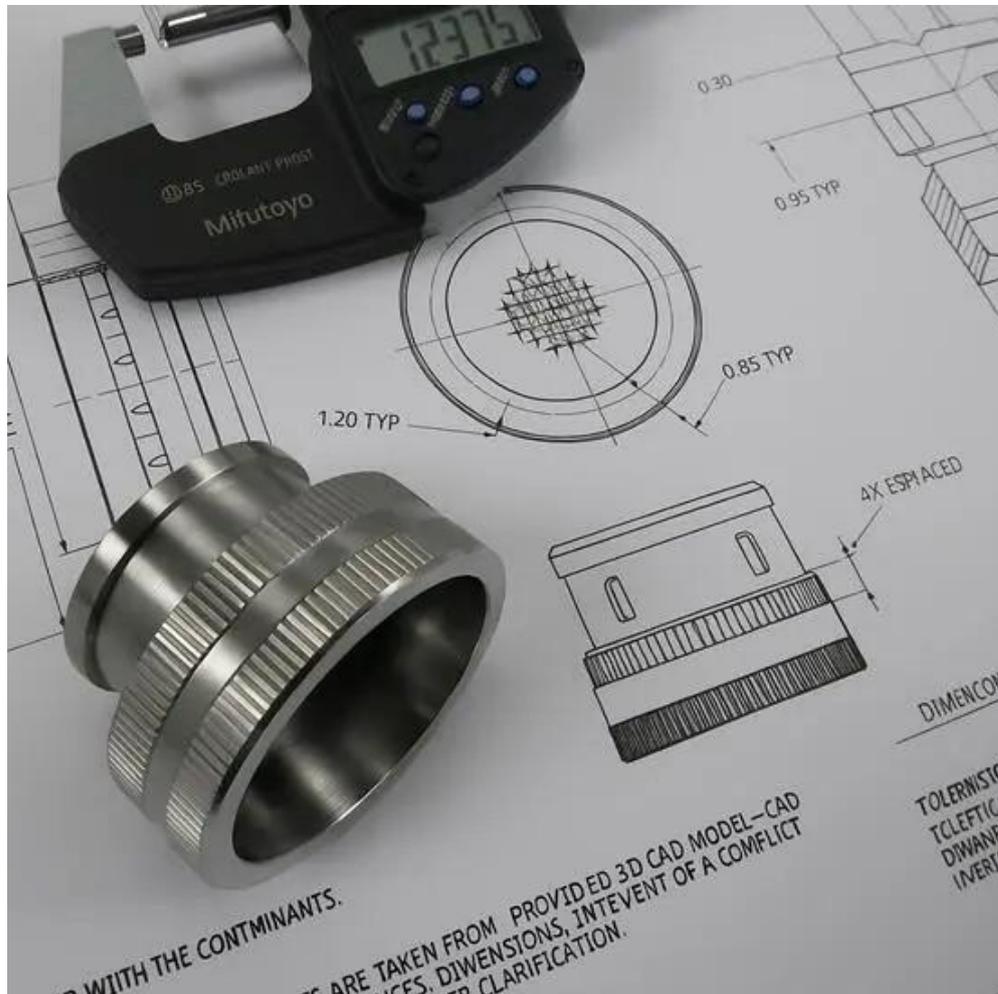
At **Rollyu Precision**, we specialize in the production of critical components for these applications. Our advanced CNC machining, multi-axis capabilities, and inspection systems allow us to consistently deliver parts with **±0.005 mm or tighter** tolerances—ensuring performance, quality, and confidence in every industry we serve.

How We Ensure Tolerance Integrity

To ensure tolerance and integrity, individuals, groups, and societies should focus on fostering respect, empathy, and understanding for diverse perspectives and backgrounds. This can be achieved through active listening, open communication, and challenging stereotypes while promoting inclusivity and celebrating individuality.

At Rollyu Precision, tolerance integrity isn't just a quality metric — it's the foundation of every

precision component we deliver. From dental implants to semiconductor fixtures, maintaining tight dimensional tolerances ensures proper fit, reliable function, and long-term performance in your assemblies.



- **Engineering-Driven DFM Reviews:**

Before production begins, our engineering team conducts **Design for Manufacturability (DFM)** analysis to validate:

- Feasibility of critical tolerance zones
- Appropriate machining strategies
- Required toolpaths for 3-axis, 4-axis, and 5-axis operations
- Stack-up implications in multi-part assemblies

This proactive approach prevents deviation risks and ensures that specifications are both realistic and repeatable.

- **Precision Machining Equipment:**

We operate high-performance CNC machines with closed-loop control systems and temperature-stabilized spindles to hold tolerances down to:

- **±0.005 mm (±0.0002")** for precision features
- **±0.01 mm (±0.0004")** for tight-fit mating components

Machines are calibrated regularly and run in controlled environments to minimize thermal drift and mechanical variation.

- **In-Process Monitoring & Tool Compensation:**

During machining, we utilize:

- **Touch probes** for real-time part zero validation
- **Tool wear monitoring** and compensation protocols
- **In-process measurement cycles** to auto-correct deviations before final pass

This reduces the chance of rework or scrap, even on complex geometries.

- **Metrology-Grade Inspection:**

We enforce a strict quality control regime using calibrated instruments such as:

- **CMMs (Coordinate Measuring Machines)** for multi-axis precision measurement
- **Micrometers, bore gauges, and pin gauges** for critical internal dimensions
- **Surface roughness testers** for Ra validation (down to 0.4µm if required)

All inspections follow **ISO 9001:2015** and **ISO 13485:2016** standards and are documented with traceable results.

- **Statistical Process Control (SPC):**

For production runs, we implement SPC to monitor:

- Dimensional trends
- Cp/Cpk values for key characteristics
- Root cause tracing for out-of-tolerance data

This ensures we not only meet tolerance — we control it systematically.

- **CAD/CAM Integration:** Full digital workflow from 3D model to toolpath
- **Tooling Calibration:** Regular inspection and replacement of cutting tools
- **Environmental Controls:** Stable temperature and humidity in high-precision machining zones
- **Advanced Inspection:** Coordinate Measuring Machines (CMMs), laser scanners, optical comparators, and SPC (Statistical Process Control) systems
- **In-Process Validation:** Real-time monitoring of spindle loads, tool wear, and positional accuracy on closed-loop systems

- **Feedback Loop for Continuous Improvement:**

Post-inspection data is analyzed and fed back to:

- CAM programming for optimized offsets
- Fixturing refinement and toolpath smoothing
- Material supplier feedback (for flatness, grain, or internal stress issues)

This loop drives ongoing improvements across batches and customer projects.

- **Inspection Documentation & Traceability:**

- First Article Inspection (FAI) reports
- Full dimensional inspection reports with CMM data
- Material and process traceability (ISO 13485 / ISO 9001 compliant)
- PPAP or FAIR support for regulated industries

Your Precision Partner

Whether you need micro-level fits, leak-tight seals, or perfectly aligned optical paths, **Rollyu Precision** delivers the tolerances your application demands—with consistency, scalability, and full quality traceability.

Supported Materials

At **Rollyu Precision**, we specialize in CNC machining and sheet metal fabrication using a broad spectrum of **engineering-grade materials**, tailored to meet the stringent demands of **medical, aerospace, semiconductor, photonics, industrial, and food processing** sectors.

Aluminum (6061, 7075, 2024-T81, 6063, 6082, etc.)

Lightweight, corrosion-resistant, and high-strength — ideal for enclosures, thermal management, automation frames, and food-grade components.

Stainless Steel (304, 316, 17-4PH)

Durable, biocompatible, and corrosion-resistant — widely used in **surgical tools, cleanroom equipment, and FDA-compliant food machinery**.

Titanium (Grade 2, Grade 5)

Exceptional strength-to-weight ratio and chemical inertness — perfect for **orthopedic implants, robotic arms, and aerospace components**.

PEEK (Polyether ether ketone)

A high-performance thermoplastic offering **excellent chemical resistance, heat stability, and biocompatibility** — ideal for **semiconductor tooling, medical implants, and analytical equipment**.

Brass

Outstanding machinability, conductivity, and wear resistance — ideal for **valves, electrical contacts, and low-friction bushings**.

Copper (C110, C145, etc.)

Outstanding **thermal and electrical conductivity** — ideal for **heat sinks, electrical busbars, RF shielding, and semiconductor tooling**. Offers excellent machinability and antimicrobial properties for select medical and food-safe applications.

Tool Steels (O1, A1, D1, SKD11, etc.)

High-wear resistance and dimensional stability — ideal for **molds, dies, punches, cutting tools, and precision fixtures**.

- **O1 (Oil-Hardening)** – Excellent dimensional stability for general-purpose tooling
- **A1 (Air-Hardening)** – Good machinability and toughness
- **D1 (High Carbon, High Chromium)** – Outstanding wear resistance
- **SKD11 (JIS equivalent to D2)** – High hardness and excellent abrasion resistance, suitable for cold-working applications
- **Invar 36 (Fe-Ni Alloy)** Ultra-low thermal expansion — critical for aerospace fixtures, optical mounts, and semiconductor tooling where dimensional stability is essential across temperature ranges.
- **Kovar (Fe-Ni-Co Alloy)** Matched thermal expansion for glass and ceramic sealing —

critical for hermetic packages, photonics, microwave systems, and vacuum assemblies.



High-Performance Plastics & Specialty Materials

- **Delrin® (White & Black Acetal)** – Low-friction, high-stiffness plastic used in **bushings, gears, and medical-grade moving parts.**
- **PEI (Ultem®)** – High heat resistance and sterilization compatibility — preferred for **aerospace and surgical devices.**
- **PC (Polycarbonate)** – Tough, transparent plastic used in **optical parts, shields, and sensor housings.**
- **PTFE (Teflon®)** – Chemically inert and non-stick — ideal for **fluid systems, valve seats, and food-grade seals.**
- **Ceramics (Macor, Alumina, AL2O3, Zirconia)** – Used in **non-conductive, wear-resistant, or high-temperature** electronic and medical applications.
- **G10 (FR4 Composite)** Fiberglass-reinforced epoxy laminate — electrically insulating and mechanically strong, used in electronic, medical, and structural applications where non-conductivity and moisture resistance are critical.



Special Material Grades & Certifications

We support:

- **Medical-grade** plastics and metals (ISO 13485)
- **Food-grade** stainless steel and PTFE (FDA-compliant)
- **Marine-grade** alloys for saltwater resistance
- **Tool & die steel** with heat treatment options (annealed, hardened, tempered)
- **Aerospace & semiconductor-qualified materials** with full material traceability

Precision with Purpose

All materials are processed with meticulous attention to:

- **Material traceability**
- **Surface finish requirements**
- **Functional and regulatory compliance**

Whether it's rapid prototyping, short-run production, or high-volume manufacturing, **Rollyu Precision** guarantees consistent quality backed by ISO 9001 and ISO 13485 certification.

Surface Finish Options

Surface finishing provides a protective and/or aesthetic coating to metal surfaces, enhancing their durability and appearance. Common surface finish options include anodizing, polishing, powder coating, and various plating methods.

At **Rollyu Precision**, we offer a wide range of surface finishing services to enhance the **appearance, functionality, and corrosion resistance** of your precision-machined and fabricated parts. Finishes are selected based on your material, application, and regulatory requirements.

Metal Finishing Options

- **Anodizing (Clear, Black, Hardcoat)**
Ideal for aluminum parts — improves corrosion resistance, wear resistance, and aesthetics. Type II and Type III anodizing available.
- **Polishing / Buffing**
Provides a smooth or mirror-like surface for medical, cosmetic, and aesthetic parts — available in roughness grades (Ra) as low as 0.2 μm .
- **Powder Coating**
Durable and uniform finish for aluminum, steel, and brass parts — available in a variety of colors and textures. Ideal for outdoor or high-wear environments.
- **Bead Blasting / Sandblasting**
Creates a uniform matte or satin finish — ideal as a pre-treatment or standalone aesthetic option.
- **Electropolishing**
Smooths and passivates stainless steel surfaces — widely used in medical, food-grade, and semiconductor applications.
- **Passivation**
Enhances corrosion resistance of stainless steel by removing free iron — compliant with ASTM A967 and ISO standards.
- **Zinc Plating / Chromate Conversion (Alodine)**
Used for steel or aluminum parts — provides conductive, corrosion-resistant, and RoHS-compliant protection.
- **Brushing**
Creates a uniform, directional grain finish — common for enclosures and aesthetic panels.

METAL FINISHING OPTIONS



ANODIZING
(CLEAR, BLACK, HARDCOAT)

Ideal for aluminum parts – improves corrosion resistance, wear resistance, and aesthetics. Type II and Type III anodizing available.



POLISHING / BUFFING

Provides a smooth or mirror-like surface for medical, cosmetic, and aesthetic parts – available in roughness grades (Ra) as low as 9.2 µm.



POWDER COATING

Durable and uniform finish for aluminum, steel, and brass parts – available in a variety of colors and textures, ideal for outdoor or high-wear environments.



BEAD BLASTING / SANDBLASTING

Creates a uniform matte or satin finish – ideal as a pre-treatment or standalone aesthetic option.



ELECTROPOLISHING

Smooths and passivates stainless steel surfaces – widely used in medical, food-grade, and semiconductor



PASSIVATION

Enhances corrosion resistance of stainless steel by removing free iron – compliant with ASTM A967 and ISO standards



ZINC PLATING / CHROMATE CONVERSION (ALODINE)

Used for steel or aluminum parts – provides conductive, corrosion-resistant, and RoHS-



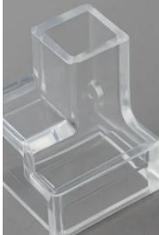
BRUSHING

Creates a uniform, directional grain finish – common for enclosures and aesthetic pa-

Plastic & Composite Finishing

- **Vapor Polishing** – For polycarbonate or acrylic parts requiring optical clarity
- **Ultrasonic Cleaning** – Used for PEEK, PTFE, or medical components requiring contamination-free handling
- **Laser Engraving** – For marking logos, barcodes, and serial numbers on plastic and composite parts

PLASTIC & COMPOSITE FINISHING



VAPOR POLISHING



ULTRASONIC CLEANING



LASER ENGRAVING

Application-Specific Finishing Support

We support finishing requirements for:

- **Medical-grade** (ISO 13485 compliant, electropolished, passivated, ultrasonic-cleaned)
- **Aerospace-grade** (MIL-spec anodizing, conversion coating, chromate-treated)
- **Semiconductor and photonics** (low-particulate, non-contaminating finishes, polished ceramic)
- **Food-grade** (polished stainless steel, passivated welds, FDA-compliant coatings)



Precision Inside and Out

Our finishing processes are tightly integrated into the production workflow to ensure:

- Surface roughness, gloss, and color match specifications
- Adhesion quality and durability
- Cleanroom-ready packaging where required

Let us help you choose the right finish based on performance, compliance, and visual requirements.

Chapter 4: Process Flow

Quoting → DFM analysis → Programming → Machining → QC → Delivery

Precision Manufacturing Process Flow

At **Rollyu Precision**, we follow a structured and quality-driven process to ensure every part meets your exact specifications — from initial quote to final delivery.

The sequence "Quoting → DFM analysis → Programming → Machining → QC → Delivery" outlines the typical steps involved in the manufacturing process of a custom part, especially in CNC machining. Let's break down each of these stages:

1. Quoting

This initial phase involves a customer submitting a design (typically a CAD model) to a manufacturer for a price and lead time estimate. We evaluate your 2D/3D files, materials, quantities, and tolerances to provide accurate, timely, and cost-effective quotations.

2. DFM Analysis (Design for Manufacturability)

DFM is a crucial step where the design is evaluated to ensure it can be efficiently and cost-effectively manufactured. This analysis identifies potential issues like thin walls, sharp internal corners, or difficult-to-machine features. Our engineering team reviews your design for manufacturability, identifying potential risk areas and recommending adjustments to improve production efficiency and reduce costs.

3. CNC Programming

Once the design is finalized, a CNC programmer creates the instructions (G-code) that the CNC machine will follow to manufacture the part. This step requires expertise in CNC programming and a deep understanding of the machining process. Rollyu Precision uses advanced CAM software, we generate optimized toolpaths based on your CAD models, considering geometry, tolerance zones, and material behavior.

4. Precision Machining

This is the stage where the actual manufacturing takes place. The CNC machine, guided by the G-code, removes material from a block of raw material (the workpiece) to create the desired part. Different machining processes, such as milling, turning, and drilling, may be used depending on the part's design and material. Rollyu Precision executes machining on 3-axis, 4-axis, or 5-axis CNC machines with tight tolerance control, using industry-grade metals and high-performance plastics. CNC machinists play a crucial role in setting up the machine, selecting the right tools, and monitoring the machining process.

5. Quality Control (QC)

After machining, the part undergoes quality control to ensure it meets the specified dimensions, tolerances, and surface finish requirements. This may involve visual inspection, dimensional measurements using precision instruments, and non-destructive testing

methods. Every critical feature is inspected using calibrated tools, including CMMs, micrometers, and surface testers. Rollyu Precision provides full dimensional reports upon request and adhere to ISO 9001 & ISO 13485 standards. If the part fails QC, it may need to be reworked or scrapped.

6. Packaging & Delivery

The final stage involves packaging and shipping the finished part to the customer. Proper packaging is essential to protect the part during transit. Parts from Rollyu Precision are cleaned, finished, and securely packaged based on industry and customer-specific standards. Global delivery with on-time shipment is guaranteed. Delivery time depends on factors like the manufacturing process, part complexity, and shipping distance.

Each of these steps is interconnected and contributes to the overall success of the manufacturing process. Effective communication and collaboration between teams responsible for each step are essential for ensuring a smooth and efficient workflow, ultimately leading to high-quality products and satisfied customers. By following these steps, Rollyu Precision efficiently produce high-quality custom parts that meet the specific needs of our customers.

Why It Matters

At Rollyu Precision, we don't just manufacture parts — we ensure reliability, repeatability, and results. Our structured process flow—**from quoting and DFM to machining, inspection, and delivery**—is designed to reduce risks, improve lead times, and deliver parts that meet the most demanding application requirements.

This streamlined process ensures:

- Fast turnaround without compromising precision
- Full traceability and inspection-backed quality
- Engineering feedback to reduce lead times and avoid design rework
-

Here's why it makes a difference:

- **Faster Turnaround**
Early DFM analysis eliminates rework and streamlines production, reducing delays from design to delivery.
- **Tighter Tolerances, Fewer Surprises**
Advanced programming and high-precision machining deliver consistent results, even for complex geometries or tight fits.
- **Certifiable Quality**
Every part goes through rigorous QC backed by ISO 9001:2015 and ISO 13485:2016 standards — ensuring traceability and reliability.
- **Application-Ready Components**
Whether for surgical robots, semiconductor tools, or aerospace fixtures, your parts arrive **clean, compliant, and ready for integration.**

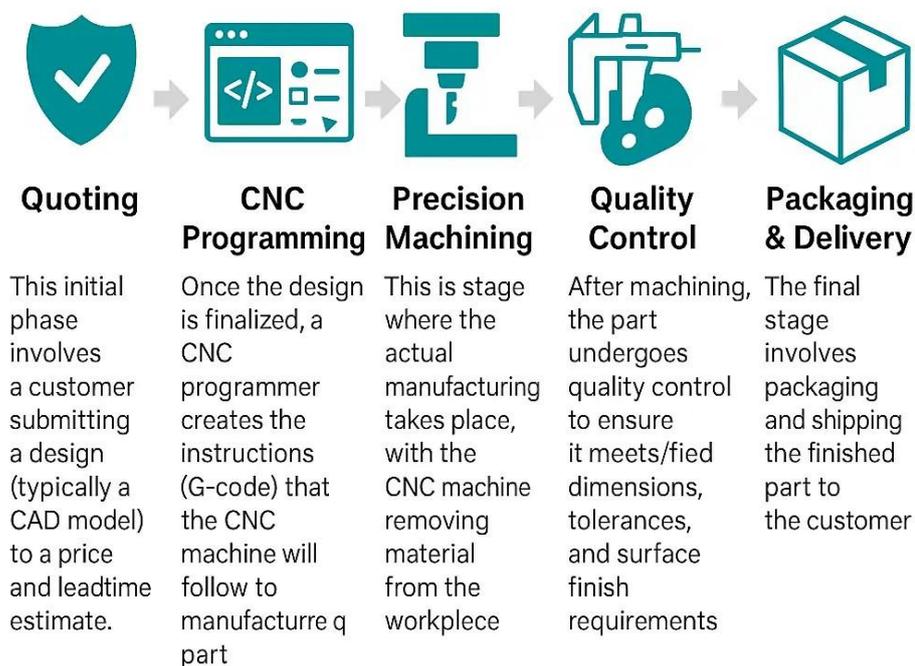
- **Responsive Support**

From engineering feedback to packaging optimization, we're with you at every step — ensuring confidence from prototyping to full-scale production.

Precision is not just a process — it's a promise. That's why industry leaders trust Rollyu Precision for mission-critical components.

Precision Manufacturing Process Flow

At Rollyu Precision, we follow a structured and quality-driven process to ensure every part meets your exact specifications —



In-Process Inspections & Final Verification

When it comes to **CNC precision machining**, quality isn't an afterthought — it's built into every step of our manufacturing process. At **Rollyu Precision**, we serve industries where failure is not an option: **medical devices, semiconductor tooling, aerospace components, robotics, and photonics**. That's why we implement rigorous **in-process inspections** and **final dimensional verification** to ensure every part we ship is **100% production-ready**. At **Rollyu Precision**, quality is built into every step — not just checked at the end. We integrate both **in-process inspections** and **final dimensional verification** to ensure every part meets your exact specifications.

In-Process Inspections

In-process inspection and final verification are distinct but important quality control measures in manufacturing. In-process inspection (also known as during production inspection or in-line inspection) checks products at various stages of the production process, allowing for prompt identification and correction of defects. Final verification, on the other hand, occurs before the product is shipped or distributed, ensuring overall quality compliance and readiness for market.

In-process inspection refers to quality checks performed during the machining or fabrication process — not just at the end. This is especially critical in **tight tolerance CNC machining**, where even minor tool wear or setup deviation can lead to non-conforming parts. During machining, our operators and engineers perform real-time quality checks to catch deviations early and prevent downstream issues:

- **Toolpath validation** and probe-based part zeroing
- **On-machine measurements** for critical dimensions and features
- **Tool wear monitoring** and automatic offsets for high-consistency runs
- **Operator sign-offs** at defined production checkpoints
-

This allows us to control tight tolerances and reduce non-conformances before parts even reach the inspection room. This layered approach ensures that potential deviations are corrected **before final machining passes**, saving time, reducing scrap, and increasing yield — all while maintaining tight dimensional control.

Final Verification

After parts are machined and cleaned, we perform **final inspections** to validate that each component conforms to customer specifications, industry standards, and regulatory requirements such as **ISO 9001:2015** and **ISO 13485:2016**. After machining and finishing, each part undergoes a comprehensive quality check:

- **CMM inspection** for tight-tolerance geometries

- **Caliper, micrometer, and bore gauge measurement** for key dimensions
- **Thread, fit, and surface finish validation**
- **First Article Inspection (FAI)** and full dimensional reports available upon request
- **Visual and cosmetic inspection** under proper lighting to ensure aesthetics meet customer standards

These inspection protocols are particularly critical for **medical CNC machining**, **aerospace-grade parts**, and **semiconductor components**, where **dimensional accuracy**, **repeatability**, and **cleanroom compliance** are mandatory. All inspections are conducted under our **ISO 9001:2015** and **ISO 13485:2016** certified quality system, with full material and process traceability.

Every part that leaves Rollyu Precision is fully verified, production-ready, and meets your most demanding engineering and regulatory requirements.

In-Process Inspections & Final Verification



When it comes to CNC precision machining, quality isn't an afterthought—it's built into every step of our manufacturing process.



In-Process Inspections

In-process inspections

In-process inspections—quality checks performed during machining or fabrication—not just at the end

This is inspections, early and ongoing

- Toolpath validation and probe-based part zeroing
- On-machine measurements for critical dimensions and features
- Tool wear monitoring and automatic offsets for high-consistency runs
- Operator sign-offs at defined production checkpoints

Final Verification

After parts are machined and cleaned, we perform final inspections to validate that each component meets customer specifications, industry standards, and regulatory requirements

Every part that leaves Rollyu Precision is fully verified, production-ready, and meets your most demanding engineering and regulatory requirements.

Project Lifecycle Case Study:

CNC Machined Frame for a Surgical Robotics Platform

Client Industry: Medical Device – Surgical Robotics

Project Type: Tight-tolerance aluminum and stainless steel CNC assemblies

Project Duration: 5 weeks (Prototype to First Production Batch)

Certifications Required: ISO 13485, ISO 9001, RoHS compliance

Key Services: DFM review, 5-axis CNC machining, surface finishing, CMM inspection, lot traceability

Phase 1: Initial Inquiry & Quoting

A U.S.-based surgical robotics company approached Rollyu Precision with a request for a **lightweight yet rigid structural chassis** made of **6061-T6 aluminum** and **17-4PH stainless steel**. Requirements included:

- ± 0.005 mm tolerances
- Burr-free edges
- Cleanroom-compatible finishing
- Full traceability documentation (C of C, material certs, inspection reports)

Within **48 hours**, our sales and engineering team delivered a **detailed quotation** with DFM suggestions, lead times, finish specs, and certification scope.

Phase 2: Engineering & DFM Review

Before machining began, our engineering team conducted a **Design for Manufacturability (DFM) analysis**, focusing on:

- Reducing deep pocket chatter with revised radii
- Optimizing setup for reduced tool changes
- Aligning slot tolerances with standard cutter availability
- Proposing **hard anodizing** instead of painting for better biocompatibility

After client approval of the updated drawings, we finalized **CAM programming** using Fusion 360 and Mastercam for both 3-axis and 5-axis setups.

Phase 3: Machining & In-Process Inspection

The parts were machined using:

- **5-axis CNC centers** for the main chassis
- **4-axis horizontal mills** for repeatable side-feature production
- **Tapping, reaming, and deburring stations**

During machining, our team performed **in-process inspections** using:

- On-machine probing
- Micrometers for ID/OD control
- Real-time tool wear monitoring

This approach minimized scrap and ensured parts stayed within tolerance throughout the run.

Phase 4: Final QC & Documentation

Post-machining, each part underwent:

- **CMM inspection** against GD&T requirements
- **Surface finish testing** (Ra < 0.8 µm for mating faces)
- **Visual inspection** under 5x magnification
- **Lot serialization** and laser engraving

We delivered a **complete inspection report, material certs,** and a **Certificate of Conformance**—aligned with **ISO 13485** requirements.

Phase 5: Finishing, Packaging & Delivery

Finishing included:

- Type III black **hard anodizing** (Class 2, non-dyed for internal parts)
- Passivation for stainless steel inserts
- Ultrasonic cleaning and vacuum-sealed packaging

Parts were shipped via **DHL Express**, and the client received them **3 days ahead of schedule**.

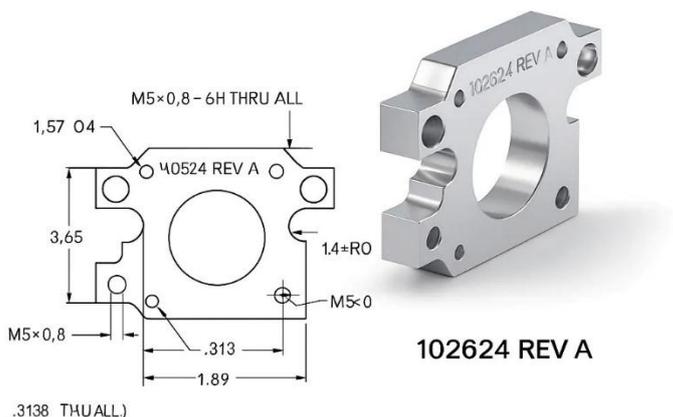
Project Outcome

- 100% dimensional compliance
- 0 NCRs in first 3 batches
- Client approved Rollyu Precision as a **long-term strategic vendor**
- Follow-up: Client awarded additional projects for titanium subcomponents and robotic end-effectors

Client Feedback

“Rollyu delivered parts that passed our internal QC the first time — a rare feat. Our team’s DFM input and quality consistency made our launch window possible. We now consider them a key supplier for high-precision robotic components.”

— Lead Mechanical Engineer, Surgical Robotics OEM



ENGRAVE PN			BOTTOM MOTOR MOUNT		
ZONE	REV	DESCRIBE	REVISKENS	6061 Alloy	CLEAR IRIDITE
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SCALE X = .2 XX = .25 X4X = 005 AG = .3°				REV.	102624 REV A 2:1

Chapter 5: Quality Control at Rollyu Precision

Inspection Tools: CMMs, micrometers, gauges

For inspecting CNC machined parts, a variety of tools are used to ensure accuracy and precision. These include Coordinate Measuring Machines (CMMs), height gauges, micrometers, and thread gauges, among others. CMMs are used for complex shape evaluation and confirming that parts meet both dimensional and geometric standards. Height gauges are used for measuring vertical distances, while micrometers provide highly precise measurements of small dimensions. Thread gauges verify thread quality, and other tools like calipers and needle gauges are used for various inspections.

At Rollyu Precision, quality is never assumed — it's measured, verified, and documented. To meet the rigorous demands of industries like medical devices, robotics, photonics, and semiconductors, we use a comprehensive suite of **inspection tools** to validate every CNC machined component.

Here's a look at the tools we rely on:

Core Inspection Tools for CNC Machining:

- ◆ **CMM (Coordinate Measuring Machine)**
 - For complex 3D part geometries and GD&T features
 - Capable of sub-micron accuracy
 - Fully programmable and ideal for first article and final inspection
- ◆ **Height Gauges (TESA-Hite)**
 - Used for measuring vertical dimensions, depths, and step heights
 - Suitable for both production and QA labs
- ◆ **Digital Micrometers**
 - For highly precise outer diameter (OD), thickness, and step measurements
 - Resolution: ± 0.001 mm
 - Commonly used for tight tolerance features
- ◆ **Thread Gauges (Plug & Ring Types)**
 - Go/No-Go verification of internal and external thread fit
 - Ensures compliance with ISO/ANSI thread standards
- ◆ **Calipers and Bore Gauges**
 - Quick, repeatable dimensional checks
 - Useful for mid-process and in-process inspection
- ◆ **2D Optical Projector (VMS)**
 - Ideal for visual edge profiling, angles, and contours
 - Non-contact inspection for delicate or small parts
- ◆ **Hardness Testers (Rockwell, Vickers)**
 - Confirm material heat treatment status
 - Required for aerospace, surgical, and defense components



Where Tolerances Are Respected, and Compliance Is Guaranteed

At **Rollyu Precision**, quality is not a checkpoint — it's a culture. Every part we deliver, from prototyping to high-volume production, undergoes a multi-layered quality control process tailored to meet the strictest international standards across **medical devices**, **semiconductors**, **robotics**, **dental devices**, **aerospace**, and **industrial automation**.

We are **ISO 9001:2015** and **ISO 13485:2016** certified, ensuring full traceability, risk mitigation, and regulatory compliance from raw material to final inspection.

Multi-Stage Quality Control Process

1. Incoming Material Inspection

At **Rollyu Precision**, quality begins long before the first cut. Our **Incoming Material Inspection** process ensures that every batch of raw material—whether aluminum, stainless steel, titanium, PEEK, or tool steel—is verified for **compliance, consistency, and suitability** before entering production.

This is the foundation of our **ISO 9001:2015** and **ISO 13485:2016** certified quality control system.



INCOMING MATERIAL INSPECTION

Ensuring Every Piece Meets Our Standards

- Verification of raw materials
- Review of material certificates
- Initial quality checks

Every batch of material is verified for:

- Chemical composition (certified mill test reports)
- Mechanical properties
- Heat lot traceability
- Dimensions and flatness
- Surface condition and grain direction
- RoHS and REACH compliance
- Country of origin (when required)
- Dimensional & Visual Checks

Sheet and bar **thickness, flatness, and length tolerance**

Barstock concentricity or squareness (for turning or milling)

Surface condition for scratches, oxidation, dents, or lamination defects

Consistency in grain direction (important for bending or anodizing)

- Material Identification & Segregation

All incoming materials are:

- **Labeled with internal part numbers and lot IDs**
- **Segregated by material type, alloy, and certification level**
- Stored in a **controlled inventory area** to prevent mix-ups or cross-contamination

For sensitive applications (e.g., **medical or semiconductor machining**), we apply special handling procedures including anti-static storage and contamination control.

- Additional Testing (When Required)

For critical projects, we coordinate or perform:

- **Hardness testing (Rockwell, Brinell)**
- **Ultrasonic flaw detection (NDT)**

- Third-party lab chemical analysis
- RoHS/REACH compliance screening

These services are documented and provided with the shipment to meet your compliance or audit needs.

INCOMING MATERIAL INSPECTION

MATERIAL CERTIFICATION

Verify mill test report (MTR)
for chemical and mechanical prop



DIMENSIONAL & VISUAL CHECKS

Inspect materials for
surface, and dimension



MATERIAL IDENTIFICATION

Labeling with part numbers lot IDs



MATERIAL SEGREGATION

Store by alloy and certification level



ADDITIONAL TESTING

Perform hardness, NDT, or RoHS

ROLLYU
PRECISION

2. In-Process Inspection

What Is In-Process Inspection?

In-process inspection refers to the **continuous measurement and validation** of parts **during machining** — not just at the end. This ensures that even as conditions change (tool wear, material behavior, machine heat), **precision and consistency are maintained**.

Involves checking the parts at various stages of the manufacturing process to identify and rectify defects promptly. This proactive approach ensures that defects are caught early, preventing costly rework or waste.

At **Rollyu Precision**, we don't just inspect parts after they're made — we ensure they're right while they're being made. Our **In-Process Inspection** strategy is designed to prevent defects before they happen, especially when producing **tight-tolerance CNC components** for the **medical, robotics, semiconductor, and aerospace** sectors.



Rollyu Precision embed real-time inspection checkpoints throughout the machining process:

- **Probing and tool offset compensation** on CNC machines
- **Critical-to-quality dimensions** verified by operators with calibrated micrometers, bore gauges, and indicators
- **Tool wear monitoring** and automatic feed adjustment
- **Lot traveler documentation** for traceability

Equipment We Use for In-Process Inspection

- Digital Micrometers
- Dial Indicators
- Thread Plug Gauges
- Height Gauges

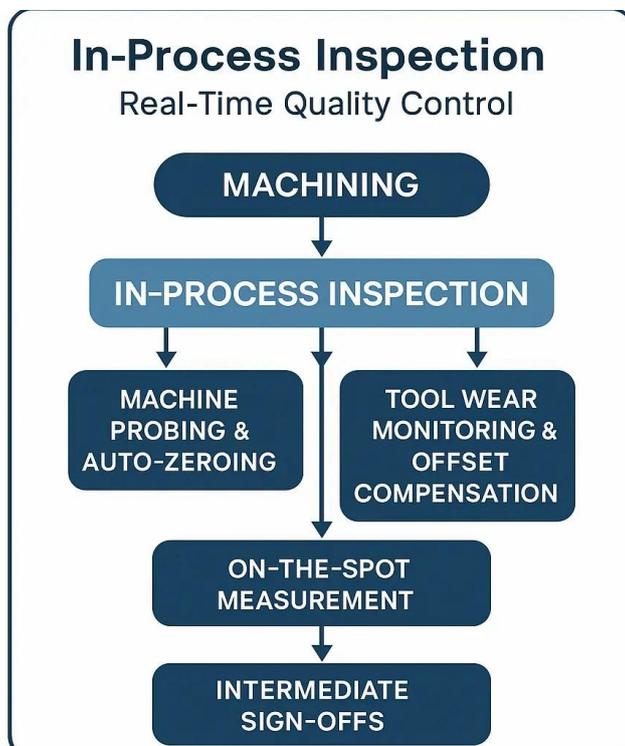
- Real-time spindle feedback systems
- Integrated probing on 3-axis, 4-axis, and 5-axis CNC machines

Our In-Process QC Methods Include:

- **Machine Probing & Auto-Zeroing**
Ensures accurate part setup before cutting, preventing fixture misalignment.
- **Tool Wear Monitoring & Offset Compensation**
Our CNC machines adjust in real time to maintain dimensions within ± 0.005 mm.
- **On-the-Spot Measurement with Calibrated Gauges**
Technicians use micrometers, bore gauges, and height indicators to verify dimensions mid-process.
- **Intermediate Sign-Offs**
Complex or high-mix parts are checked at key machining stages for CTQ (critical-to-quality) features.

Why It Matters

- **Reduces rework and scrap**, especially for high-value materials like titanium, PEEK, and Invar
- Maintains **tolerance integrity** throughout production
- Detects and corrects deviations **before they become defects**
- Supports consistent results for **medical-grade**, **aerospace-certified**, and **semiconductor-clean** components



3. Final Dimensional Inspection

A final dimensional inspection ensures a manufactured part meets the precise specifications outlined in the design phase, verifying its accuracy and functionality. This process involves measuring various parameters like length, width, height, and geometric characteristics to confirm adherence to tolerances and requirements.

Where Precision Is Verified Before Delivery

At **Rollyu Precision**, every component undergoes **final dimensional inspection** before leaving our facility — ensuring it meets not just blueprint specifications, but also the functional demands of your application. Whether you're in **medical devices**, **aerospace**, **semiconductors**, or **robotics**, our inspection protocols are designed to deliver certified, production-ready results. Our inspection team uses advanced metrology tools to ensure parts meet all print requirements:



Key Inspection Tools & Capabilities

- **Coordinate Measuring Machines (CMMs)** for complex 3D geometry
Used for verifying complex geometries, tight-tolerance profiles, and GD&T (Geometric Dimensioning & Tolerancing) callouts. CMMs ensure micron-level accuracy, especially for high-value parts like **implant housings**, **optical mounts**, and **alignment blocks**.
- **Height Gauges & Digital Micrometers**
Used for measuring critical linear dimensions, flatness, thickness, and step depths.
- **Pin Gauges, Thread Gauges, Bore Gauges**
Applied for fit-checking mating components, tapped holes, internal diameters, and

fine-pitch threads.

- **Surface Roughness Testers**

Ensuring Ra values meet required cosmetic and functional thresholds (e.g., $Ra \leq 0.8 \mu\text{m}$ for sealing surfaces in medical or vacuum parts).

- **Optical comparators and height gauges** for profile and contour checks
- **Full dimensional reports (FAI / FAIR / PPAP)** available upon request



Full Documentation (As Required)

We support industry-specific documentation, including:

- **FAI (First Article Inspection Reports)**
- **PPAP (Production Part Approval Process)** for aerospace/automotive
- **FAIR reports** for regulated or defense-related programs
- **Certificate of Conformance (C of C)**
- **Lot and serial traceability** for medical and semiconductor applications

All results are stored, traceable, and available for customer review or audit.

Certified for Compliance

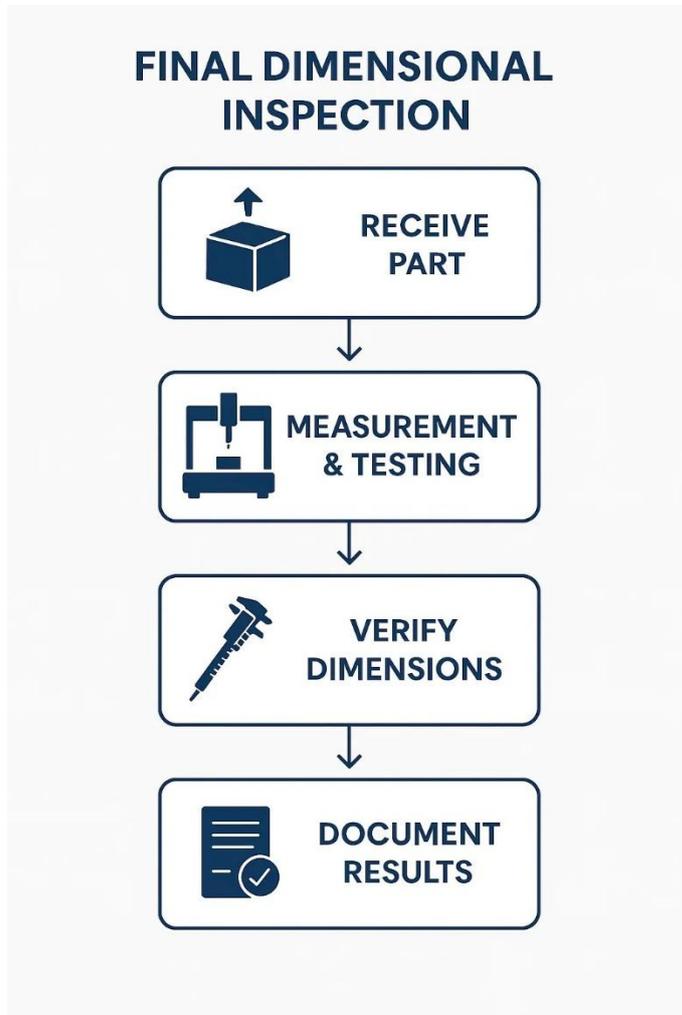
Our final inspection workflow is fully compliant with:

- **ISO 9001:2015**
- **ISO 13485:2016 (medical device manufacturing)**
- **Customer-specific quality standards**

Why It Matters

Final dimensional inspection ensures:

- Your parts meet **all tolerances, threads, and surface finish specs**
- Every shipment passes **functionality and fit validation**
- There are **no surprises during your incoming QA or assembly**
- Your critical components are **ready for integration**, not rework



4. Surface Finish & Cosmetic Inspection

Surface finish and cosmetic inspection involve evaluating the visual and tactile characteristics of a product's surface, ensuring it meets aesthetic and functional requirements. This includes checking for surface defects like scratches, dents, and unevenness, as well as measuring surface texture parameters like roughness and waviness. Automated visual inspection systems are often used to detect these defects efficiently.

Where Precision Meets Aesthetics

At **Rollyu Precision**, we know that quality isn't just about dimensions — it's also about how the part looks and feels. From **medical device enclosures** to **semiconductor fixtures** and **robotic frames**, we apply strict **surface finish and cosmetic inspection** standards to ensure your parts look as precise as they perform.

What We Inspect

We conduct comprehensive checks on:

- **Surface Finish (Ra Value)**

Using calibrated surface roughness testers, we verify that critical areas meet required Ra specifications — as low as **0.2 μm** for sealing faces or medical-grade surfaces.

- **Deburring & Edge Quality**

All parts are inspected under magnification to confirm edges are clean, consistent, and burr-free. We apply defined chamfer/radius standards based on your print.

- **Cosmetic Uniformity**

We inspect for:

- Scratches, dents, oxidation, watermarks
- Color variation on anodized or powder-coated surfaces
- Brushed pattern consistency (for aluminum and stainless)

- **Anodizing, Polishing, Powder Coating, and More**

Each finished part is verified for proper coating thickness, adhesion, and surface evenness, especially for **Class A surfaces** in visible or end-user-facing applications.

Tools We Use

- Surface roughness testers (Mitutoyo SJ series or equivalent)
- Inspection lighting booths with neutral backgrounds
- Magnifiers (5x and 10x) for edge and corner checks
- Color reference swatches (for anodized or painted parts)

Every finished part is checked for:

- Burr-free edges and chamfers
- Surface finish (as-machined, anodized, passivated, polished, etc.)
- Cosmetic consistency under inspection lighting
- Contamination-free cleaning for medical or semiconductor use

SURFACE FINISH & COSMETIC INSPECTION



Surface Roughness
Measurement



Deburring &
Edge Quality



Cosmetic
Uniformity



Coating & Surface
Treatments

5. Documentation & Certification

Proof of Precision, Backed by Standards

At **Rollyu Precision**, we understand that delivering a high-quality part isn't enough — you also need the right documentation to prove it. Whether you're manufacturing **ISO 13485-compliant medical devices**, **semiconductor tooling**, or **aerospace-grade assemblies**, our **documentation and certification system** ensures full transparency, traceability, and compliance.

Standard Quality Documentation We Provide

- **Certificate of Conformance (C of C)**
Confirms part compliance with customer drawings, specifications, and referenced standards.

- **Material Test Reports (MTRs)**
Include heat lot number, chemical composition, and mechanical properties from certified mills.
- **First Article Inspection Report (FAI / FAIR)**
Provided for new part numbers or revised designs, verifying all critical dimensions, features, and finishes.
- **Full Dimensional Inspection Reports**
Generated via CMM and manual measurements, covering GD&T requirements and critical-to-function dimensions.
- **RoHS / REACH Declarations**
Available upon request for compliance with environmental and regulatory directives.
- **Serialization / Lot Traceability**
Laser-engraved part numbers, batch codes, and internal route history to support cleanroom or regulated industries.

Certifications That Build Confidence

Rollyu Precision is certified under:

-  **ISO 9001:2015** – General quality management
-  **ISO 13485:2016** – Medical device component manufacturing
-  **RoHS & REACH compliant processes**
-  Customer-specific audit compliance

Why Documentation Matters

- **Shortens your incoming QC time**
- **Facilitates regulatory filing and traceability**
- **Builds supplier trust and audit readiness**
- **Saves engineering time during part qualification**

We provide full QA documentation based on your needs:

- **Material certs (MTRs)**
- **Certificate of Conformance (C of C)**
- **Inspection reports and dimensional data**
- **Serialization and lot traceability**
- **Regulatory compliance (FDA, CE, ISO, RoHS)**

Industry Compliance You Can Trust

Our QC system is built to support:

- **Medical device manufacturing (ISO 13485)**
- **Cleanroom and vacuum-compatible parts (semiconductors, photonics)**
- **High-reliability aerospace components (AS-level expectations)**
- **Food-grade and RoHS-compliant products**

We welcome quality audits, customer inspections, and third-party verification as part of long-term supply partnerships.

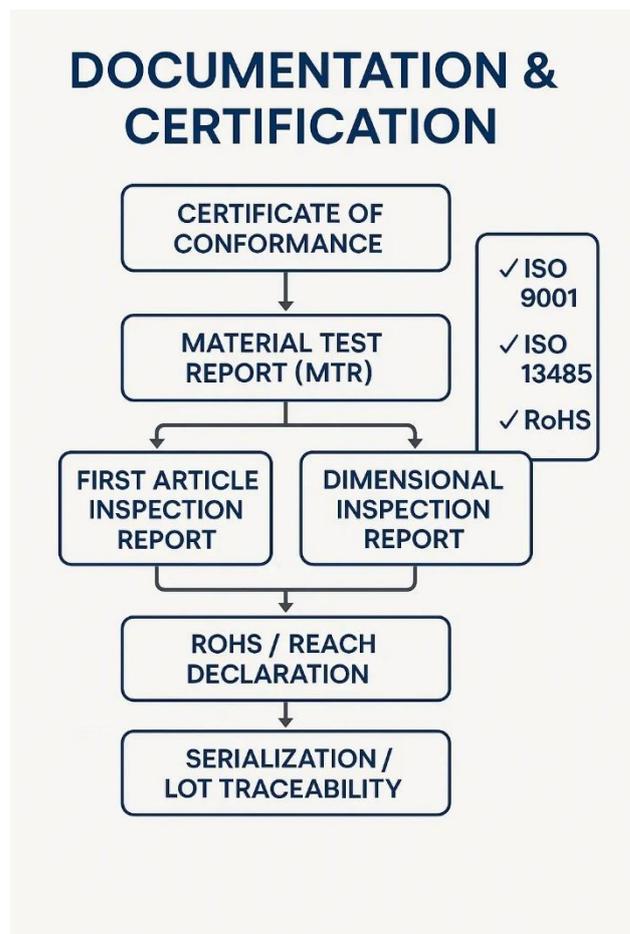
Final Inspection Means Final Confidence

Every component that leaves our facility has been:

- ✓ Machined to spec
- ✓ Inspected for function and finish
- ✓ Packaged to prevent damage
- ✓ Documented for compliance

This is **Quality Control at Rollyu Precision** — where we deliver more than parts.

We deliver **precision, documentation, and peace of mind.**



Inspection Tools at Rollyu Precision

Precision-Grade Equipment for Precision-Machined Parts

At Rollyu Precision, we rely on a suite of **calibrated metrology tools** to ensure that every CNC-machined component meets your most demanding dimensional, geometric, and surface finish requirements. From **tight-tolerance aerospace parts** to **medical device enclosures**, our inspection equipment delivers **measurement you can trust** — and document.



Core Metrology Equipment We Use

1. Coordinate Measuring Machines (CMMs)

- Used for verifying complex geometries, multi-axis features, and GD&T callouts
- Ideal for 3D profiles, true position, concentricity, flatness, and perpendicularity checks
- CMM reports available for every lot or First Article Inspection (FAI)

2. Micrometers (Digital & Analog)

- For measuring precise outside diameters (OD), inside diameters (ID), and step thicknesses
- Used in-process and post-machining to control features down to ± 0.001 mm
- Calibrated in accordance with ISO 9001 quality systems

3. Precision Gauges

- **Thread gauges** (GO/NO-GO) for internal and external threads
- **Pin gauges** for accurate hole diameter validation
- **Bore gauges** for roundness and tolerance verification
- **Height gauges** and granite surface plates for 2D layout inspection

Supporting Tools

- Surface roughness testers (Ra verification for sealing faces or sliding surfaces)
- Calipers, dial indicators, and depth micrometers
- Visual inspection stations with 5x–10x magnification and neutral lighting
- QR code scanners and serialization tools for traceability and documentation

Why It Matters

Whether you're delivering a **medical implant frame**, **robotic end-effector**, or **photonics fixture**, our inspection tools ensure:

- Conformance to GD&T tolerances
- Full material and dimensional traceability
- Faster production approval and easier customer acceptance
- Confidence in every shipment

Traceability System for CNC Machining

Full Lot-Level Control from Raw Stock to Finished Part

A CNC traceability system in machining involves tracking a part's journey from raw material to finished product, capturing information about the process, including which machines, operators, and programs were used. This data can be used for internal shop tracking, and for chain traceability, where information is maintained across multiple businesses to the end user.

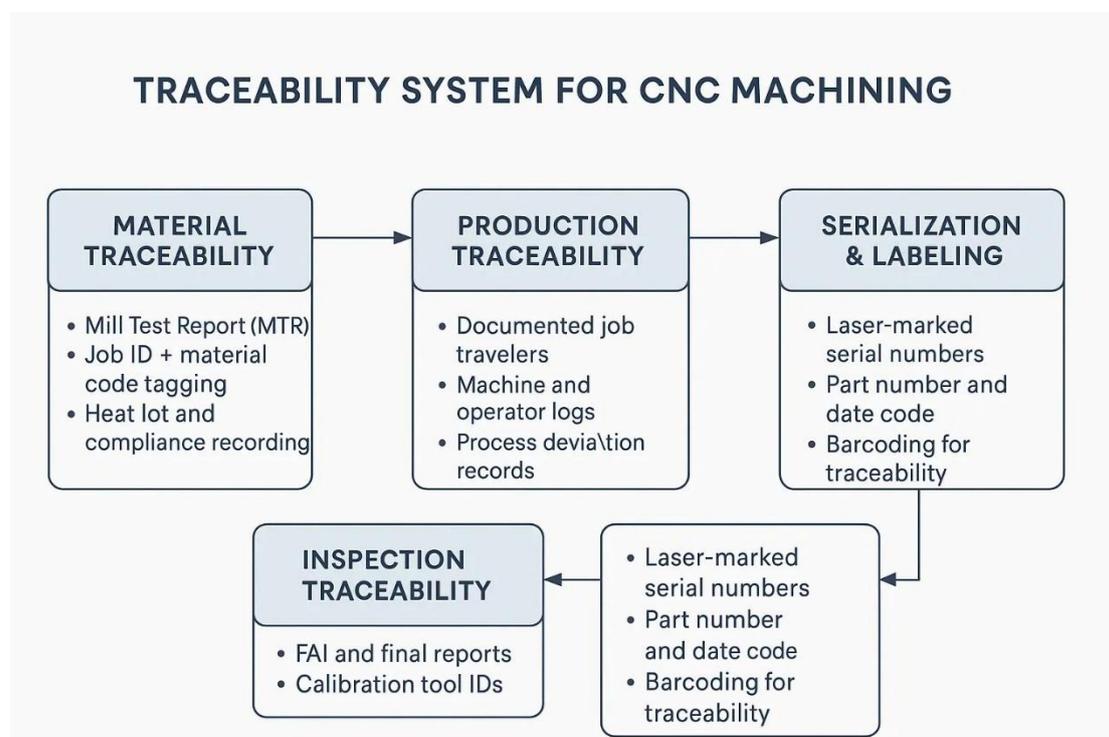
At **Rollyu Precision**, we operate a robust **traceability system** that ensures every CNC machined part is fully traceable — from incoming material to final delivery. Whether you're producing **medical-grade implants**, **semiconductor equipment parts**, or **aerospace components**, our system supports compliance, audit-readiness, and full accountability.

What Is CNC Traceability?

Traceability in CNC machining refers to the ability to track and record:

- The **origin** and **certification** of raw materials
- Every **manufacturing step** the part undergoes
- The **tools, machines, and operators** involved
- The **final inspection results** and packaging

This enables full **lot-level or even serial-level history**, aligned with **ISO 9001:2015** and **ISO 13485:2016** requirements.



Our Traceability System Includes:

1. Material Traceability

- Every material batch is linked to a **Mill Test Report (MTR)**
- Materials are tagged with internal **job ID + material code**
- Heat lot, supplier origin, RoHS/REACH compliance recorded

2. Production Traceability

- CNC job travelers document machine ID, operator, and process parameters
- Setup sheets, tool lists, and CAM file revisions are logged
- Rework or deviation is recorded with reason + corrective action

3. Inspection Traceability

- FAI and final inspection reports are tied to lot and drawing revision
- Tool calibration IDs are recorded on inspection sheets
- Dimensional reports are saved per lot and referenced by part serial or batch

4. Serialization & Labeling

- Parts can be laser marked with:
 - Unique serial numbers
 - Part number + revision
 - Manufacturing date code
- Barcoding or QR coding available for packaging traceability

Why Traceability Matters

- **Regulatory Compliance** – ISO 13485, CE, FDA, AS9100 audits
- **Root Cause Analysis** – Quickly isolate process errors or field issues
- **Customer Confidence** – Cleanroom, medical, aerospace and defense readiness
- **Inventory Control** – Batch separation for high-mix, low-volume parts

Defect Prevention Methods in CNC Machining

Proactive Quality Strategies That Eliminate Errors Before They Occur

To prevent defects in CNC machining, focus on preventative maintenance, proper tool selection and usage, optimizing cutting parameters, and implementing robust quality control measures. This includes regular machine maintenance, tool condition monitoring, and on-machine inspection.

At **Rollyu Precision**, we believe that the best way to ensure quality is to **prevent defects before they happen** — not just detect them after the fact. That's why we implement a multilayered defect prevention system across all CNC machining stages, from DFM analysis to final packaging.

1. Design for Manufacturability (DFM) Review

Before machining begins, our engineering team reviews all drawings for:

- Unmachinable or conflict features
- Unnecessary tight tolerances
- Improper hole depths or thread specs
- Material selection and surface finish compatibility

✅ Benefit: Prevents scrap due to unrealistic specs or misaligned tolerancing.

2. Process Standardization

We create detailed **setup sheets**, **tooling lists**, and **G-code simulations** before production begins. This ensures:

- Repeatable setups for multi-batch production
- Optimal feeds/speeds based on material and geometry
- Reduced risk of operator error or tool failure

✅ Benefit: Minimizes variation between operators, shifts, and machines.

3. In-Process Quality Monitoring

Using real-time probing, on-machine measurement, and manual gauges, we control critical dimensions during machining:

- Tool wear compensation
- Auto-zero part alignment
- Intermediate dimensional checks

✅ Benefit: Catches dimensional drift before it results in rejects.

4. First Article Inspection (FAI) & SPC

- First piece of every lot is fully verified
- SPC (Statistical Process Control) is applied to key features

- Non-conformance root causes are logged and fed back to process control

✅ Benefit: Prevents entire batch issues; supports consistent quality.

5. Tool and Machine Maintenance

- Predictive replacement cycles for inserts and drills
- Machine leveling, backlash checks, and spindle calibration
- Chip management and coolant monitoring

✅ Benefit: Prevents errors caused by mechanical instability or wear.

6. Handling, Finishing & Packaging Controls

- Burr control at deburring stations
- Visual inspection under magnification
- Foam or vacuum packaging for sensitive parts
- Barcode labeling for part identification

✅ Benefit: Reduces defects from handling, contamination, or shipping damage.

Bottom Line: Quality by Design

With these proactive methods, Rollyu Precision:

- Reduces scrap and rework
- Speeds up QA approval
- Improves on-time delivery
- Supports zero-defect strategies in regulated industries

By focusing on these methods, CNC machining facilities can significantly reduce defects, improve part quality, and increase overall efficiency.

Sample Quality Control Checklist for CNC Machining

Part Number: 0000034635

Drawing Revision: 02

Material: 300 Series Stainless Steel (Passivated)

Order Quantity: 20 pieces

Inspector: Juan Lee

Date: 2025-03-25

1. Incoming Material Verification

Item	Requirement	Verified	Comments
Mill Test Report (MTR) present	Yes / No	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-
Correct alloy / grade	Match PO / Drawing	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-
RoHS/REACH compliant (if required)	Yes	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-
No visible damage or warpage	Clean surface	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-

- Tool offset monitored and adjusted
- Bore diameters checked after each setup
- Thread depth confirmed via depth gauge
- Reamed holes verified using plug gauges (H7 tolerance)

2. In-Process Inspection

In-process inspection refers to the quality checks and dimensional verifications performed **during the machining process**, rather than only after the part is completed. It ensures that **critical features** meet specified tolerances **in real time**, preventing costly rework and scrap.

Item	Method	Frequency	Verified
Critical dimensions	Micrometer / Caliper / CMM	Every 5 pcs	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>
Tapped hole depth & threads	Thread plug gauge	Every 10 pcs	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>
Flatness / perpendicularity	Indicator / CMM	Random sample	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>
Tool wear monitoring	Machine offset check	Shift start / alarm	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>

3. Final Dimensional Inspection

Item	Method	Frequency	Verified
Critical dimensions	Micrometer / Caliper / CMM	Every 5 pcs	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>
Tapped hole depth & threads	Thread plug gauge	Every 10 pcs	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>
Flatness / perpendicularity	Indicator / CMM	Random sample	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>
Tool wear monitoring	Machine offset check	Shift start / alarm	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>

Refer to drawing features such as:

- Ø0.0985 H7 reamed hole (tolerance $\pm 0.0004''$)
- 3/8-24 and M9x0.5 threaded features
- Surface finish ≤ 63 Ra
- 0.015 x 15° chamfer

Use CMM for position, perpendicularity, and depth validations.

4. Surface Finish & Appearance

Surface finish refers to the texture, smoothness, and overall appearance of a machined part's surface after manufacturing. It directly impacts **aesthetics, functionality, wear resistance, and fit**—especially for mating parts or components used in medical, optical, or consumer-facing applications.

Common CNC Surface Finishes

Finish Type	Process	Typical Ra	Notes
As-Machined	Directly off the tool	3.2 – 6.3 μm	Minor tool marks visible
Bead Blasting	Abrasive media	1.6 – 3.2 μm	Matte, uniform texture
Anodizing (Type II/III)	Electrochemical oxide layer	N/A	Protective & decorative for aluminum
Brushing	Directional sanding	0.8 – 1.6 μm	Creates linear grain
Polishing	Mechanical buffing	< 0.4 μm	Glossy or mirror finish
Powder Coating	Dry sprayed & baked paint	N/A	Durable, colored surface
Electropolishing	Electrochemical smoothing	< 0.4 μm	Ideal for stainless steel, medical use

Key Surface Finish Metrics

Parameter	Description
Ra (Roughness Average)	Measures average height deviation from a mean line; lower = smoother
Rz (Mean Roughness Depth)	Average peak-to-valley distance across sampling lengths
Visual Grade	Based on visual clarity, gloss, and uniformity (e.g., matte, satin, mirror)

Item	Spec	Verified	Comments
Anodizing color uniformity	Class 2 Black, No blotches	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-
Deburring	No burrs or sharp edges	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-
Cleanliness	No oil, dust, or scratches	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-
Laser marking legibility	QR + Part #	<input checked="" type="checkbox"/> / <input checked="" type="checkbox"/>	-

- Confirm all features are deburred and chamfered
- Visual inspection under light for scratches or tool marks
- Check passivated surface for discoloration or non-uniform finish

5. Packaging & Identification

Item	Requirement	Verified	Comments
Foam or vacuum packed	Yes	☑ / ✗	-
Labeled with Part # and Lot #	Yes	☑ / ✗	-
Certificate of Conformance included	Yes	☑ / ✗	-
Inspection report attached	Yes	☑ / ✗	-

- Parts vacuum packed or foam wrapped
- Lot number labeled on bag or tray
- C of C and inspection report enclosed

☑ Final Approval

Inspector Name Signature Date

Sample Quality Control Checklist for CNC Machining

3/8-74 0.836 0.313 0.138 0.415 0.230 1.295 1.324 -A 0.78 0.137 6.77 0.281 0.208 0.116 DTEA U 5.2 SECTION B-B SECTION E E 0.15

SPROCKET BODY
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PREPARED: Prepared dchimed PROCESSING Cleanin boud	SAMPLE QUALITY CONTROL FOR 136	RECEPTION EJE FEV
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Chapter 6: Design for Manufacturability (DFM) Tips

Design for Manufacturability (DFM) for CNC machining focuses on optimizing designs for efficient and cost-effective production. Key DFM tips include avoiding thin walls, deep narrow pockets, and unnecessary features, as well as specifying realistic tolerances and adding radii to internal edges. Additionally, designing around standard stock materials and minimizing material removal can significantly reduce machining time and costs.

Reduce Cost, Improve Precision, Accelerate Production

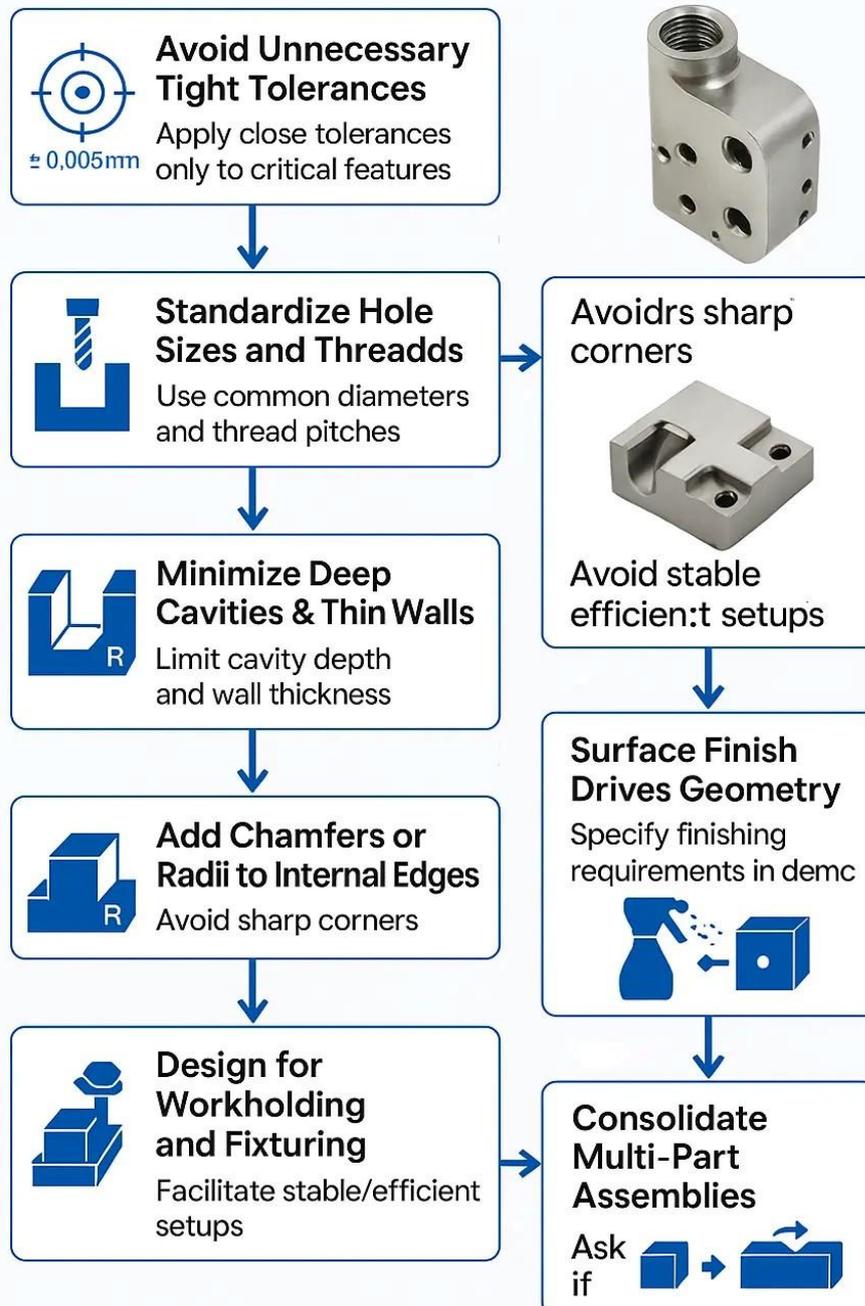
At **Rollyu Precision**, DFM is not just a value-added service — it's how we help engineers and sourcing teams build better, more efficient, and cost-effective CNC parts. Whether you're in **medical devices**, **semiconductors**, **aerospace**, or **robotics**, the earlier we get involved in your design, the more optimized your part will be.

Why DFM Matters in CNC Machining

A well-designed part:

- Lowers machining time and tool changes
- Reduces tolerance stack-up risks
- Minimizes rework and scrap
- Improves lead time and surface finish
- Cuts costs — especially in low to mid volumes

Design for Manufacturability (DFM) Tips for CNC Machining



Key DFM Tips for Precision CNC Machining

1. Avoid Unnecessary Tight Tolerances

Not every feature needs ± 0.01 mm. Apply **tight tolerances only to critical fits** (e.g., sealing surfaces, mating shafts). Loosening non-critical dimensions helps reduce inspection time, tool wear, and cost.

2. Standardize Hole Sizes and Threads

Stick to:

- Standard drill diameters ($\varnothing 3$, $\varnothing 6$, $\varnothing 10$...)
- Unified (UNC/UNF) or ISO (M) threads
- Avoid deep blind holes or small tapped holes (e.g., M2 in stainless)

3. Minimize Deep Cavities & Thin Walls

Cavities deeper than $4 \times$ diameter or walls thinner than 1.5 mm are hard to machine and easy to deform. Use radiused pockets and allow tool relief whenever possible.

4. Add Chamfers or Radii to Internal Edges

Sharp internal corners are difficult for end mills. Design with **minimum internal radii \geq tool radius** (typically R0.5–R2.0 mm). Chamfers also help reduce burrs and improve cosmetic finish.

5. Design for Workholding and Fixturing

Flat bottoms, datum surfaces, and clamping flats make setups easier and more stable. If symmetry isn't required, design a base face that aligns with machine bed orientation.

6. Surface Finish Drives Geometry

Surface finishes like anodizing, passivation, or bead blasting can **affect critical fit dimensions**. Always specify if the finish is **before or after final machining**.

7. Consolidate Multi-Part Assemblies

Ask if two mated parts can be combined into one CNC body. We often help customers reduce assembly steps and tolerance stack-up by redesigning separate parts into a unified block.

Bonus: Ask for DFM Review with Your RFQ

Rollyu offers **free DFM feedback** during quoting. Send us your 2D/3D files, and we'll advise on:

- Machining risks
- Cost-saving changes
- Finish and fit guidance
- Tool access issues

Ready to Optimize Your CNC Part Design?

Talk to our engineering team.

Submit your drawing to engineering@rymaching.com → Get DFM advice in 48 hours.

Optimal Tolerances & GD&T Practices in CNC Machining

For optimal tolerances and GD&T practices in CNC machining, focus on specifying tolerances that are functionally necessary and realistic for the machine's capabilities. Use GD&T to control geometric variations, ensuring features are correctly aligned and positioned, crucial for complex assemblies.

Balance Precision, Manufacturability, and Cost

In CNC machining, **tolerance decisions can make or break a project**. Over-specifying tolerances leads to excessive costs and delays; under-specifying results in poor fit or functional failure. At **Rollyu Precision**, we help customers apply **optimal tolerances** and smart **GD&T (Geometric Dimensioning & Tolerancing)** practices that align with real-world manufacturing and inspection capability.

1. Start with Functional Requirements

Not every dimension needs ± 0.01 mm.

- ◆ Apply **tight tolerances only to critical mating, sealing, or alignment features**
- ◆ For non-functional surfaces or overall lengths, consider ± 0.1 mm or looser
- ◆ Avoid default tolerancing; tailor specs based on part function

2. Use GD&T to Control Form, Not Just Size

GD&T offers more control over how parts function in the real world:

- **True Position (TP)** – Best for locating holes, slots, or boss features
- **Flatness, Parallelism, Perpendicularity** – Ensures surface consistency without over-constraining size
- **Profile of a Surface** – Controls 3D form for contoured surfaces or freeforms
- **Runout / Concentricity** – For rotating components like shafts, bushings, or seats

Use **datum-based GD&T schemes** to ensure consistent inspection and reduce rejection risk.

3. Match Tolerances to Manufacturing Capability

At Rollyu Precision, typical machining capability:

Feature	Tolerance Capability
Bore Diameters	± 0.005 mm (± 0.0002 ")
Linear Dimensions	± 0.01 mm typical
Thread Depth & Fit	Checked with GO/NO-GO gauges
Surface Finish	$Ra \leq 1.6 \mu\text{m}$, $Ra \leq 0.8 \mu\text{m}$, $Ra \leq 0.4 \mu\text{m}$, down to $Ra \leq 0.2 \mu\text{m}$ (polished)

Important: Tight tolerances require tighter process control \rightarrow higher cost. Always evaluate the trade-off.

4. Inspection Strategy Should Match Tolerance Level

- High-tolerance dimensions \rightarrow CMM measurement with traceable certs
- Medium-tolerance features \rightarrow calipers, height gauges
- Threads \rightarrow plug gauges (GO/NO-GO), thread mic
- Surface finish \rightarrow profilometer or visual standard (e.g. Ra, SPI)

Bonus: Engineering Tips

- Avoid \pm tolerances on large distances (e.g. ± 0.02 mm over 100 mm is rarely necessary)
- Use **limit dimensions** when form control isn't needed
- Add **chamfer callouts** to avoid sharp-edge inspection disputes
- Use "**non-critical**" or "**reference only**" tags for visual but non-functional features

Why It Matters

Optimizing your tolerancing strategy improves:

- Production success rate
- Machining cost and lead time
- CMM and FAI pass rate
- Long-term supplier consistency

At Rollyu, we don't just machine parts — we engineer success by helping you spec it right, measure it right, and deliver it right.

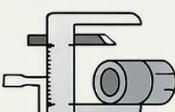
Want a free DFM + tolerance review on your next part?

Send us your drawing to engineering@rymaching.com. Let's make it inspection-ready.

OPTIMAL TOLERANCES & GD&T PRACTICES IN CNC MACHINING

1. START WITH FUNCTIONAL REQUIREMENTS

- Apply tight tolerances only to clearance or sealing features
- Consider ± 0.1 mm for non-critical dimensions



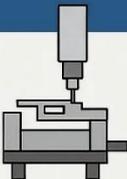
2. USE GD&T TO CONTROL FORM, NOT JUST SIZE

- True Position (TP)
- Flatness
- Profile of a Surface
- Runout / Concentricity

○ | 0.2

3. MATCH TOLERANCES TO MANUFACTURING CAPABILITY

FEATURE	TOLERANCE CAPABILITY
Bore diameters	± 0.005 mm ($\pm 0.0002^*$)
Linear dimen	± 0.01 mm typical
Thread depth & fit	Checked with GO/NO-GO gau
Surface finish	$Ra \leq 0.8 \mu\text{m}$, $Ra \leq 0.2 \mu\text{m}$ (polished)



4. INSPECTION STRATEGY SHOULD MATCH TOLERANCE LEVEL

- Tight tolerances: use CMM or ga

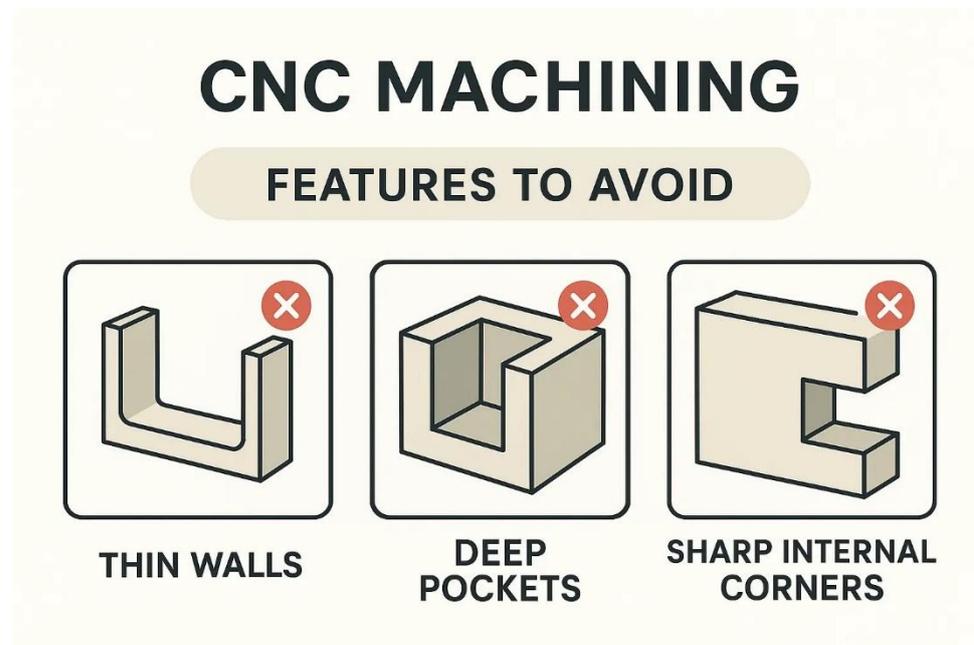


BONUS: IMPROVES SUCCESS RATE, LEAD TIME- CONSISTENCY

CNC Machining DFM Alert: Features to Avoid

Thin Walls, Deep Pockets & Sharp Internal Corners

In CNC machining, it's advantageous to avoid designing features like thin walls, deep pockets with sharp corners, and sharp internal corners. Thin walls can lead to breakage or warping, while deep pockets and sharp corners increase machining time and cost.



At Rollyu Precision, we often help customers optimize their 3D models before machining begins. And the same three problems come up again and again:

1. Thin Walls

Thin walls are prone to breakage, chatter, and warping during machining, especially in metals. For plastics, softening can also occur. To avoid this, consider beefing up walls or exploring alternative design approaches.

Why it's risky:

- Thin walls (< 1.0 mm for metal, < 2.0 mm for plastics) are prone to **vibration, chatter, deflection, and warping** during cutting.
- Hard to hold dimensionally consistent, especially with **thermal expansion** or **coolant flow**.

DFM Tip:

- ✓ Aim for wall thickness $\geq 1.5 \times$ tool diameter
- ✓ Use ribs or gussets if strength is needed
- ✓ Avoid tall, unsupported features in vertical orientation

2. Deep Pockets

Deep, narrow pockets with sharp corners can be difficult to machine, requiring long, fragile

tools and increasing machining time and cost. Consider using a larger tool diameter for deeper pockets, or avoid them altogether if possible.

Why it's risky:

- Pockets deeper than **4× their width** increase tool deflection, poor surface finish, and long cycle times.
- Chip evacuation becomes difficult, especially for blind cavities.

DFM Tip:

- ✓ Limit pocket depth to $\leq 3 \times$ width
- ✓ Add relief holes or access slots for multi-face access
- ✓ Consider multi-piece assemblies if geometry is too extreme

3. Sharp Internal Corners

Sharp internal corners are difficult to machine accurately due to the limitations of round-cutting tools. It's best to incorporate a radius on internal corners to facilitate machining and improve surface finish.

Why it's risky:

- End mills are round — sharp inside corners can't be cut without overcutting.
- Increases tool stress, burrs, and post-machining hand finishing.

DFM Tip:

- ✓ Add internal radii \geq tool radius (usually R0.5 mm or more)
- ✓ Use 2D fillets, not zero-radius transitions
- ✓ If tight inside corners are needed, consider EDM

Considerations for all features:

Wall Thickness: Aim for a minimum wall thickness of at least 0.030 inches for metals and 0.06 inches for plastics.

Tool Diameter: The maximum depth of drilling should generally be no more than 12 times the bit diameter.

Machining Time: Deep pockets, thin walls, and sharp corners can significantly increase machining time

By understanding these design considerations, Rollyu Precision engineers can create parts that are more easily and efficiently machined, leading to lower costs and improved quality.

Pro Tip: Let's DFM It Together

Before you issue a PO, send us your drawing or model.

We'll suggest improvements that reduce cost, tooling complexity, and inspection risk — without compromising function.

Contact Rollyu Precision for a free DFM review.

CNC Machining Material Selection Guide

When selecting materials for CNC machining, consider factors like application, operating environment, machinability, and cost. Popular materials include aluminum, steel, stainless steel, brass, copper, and various plastics. Each material offers unique properties and suitability for specific applications.

CNC machining offers unmatched flexibility when it comes to material options. From metals like aluminum and stainless steel to high-performance plastics such as PEEK and Delrin, nearly any machinable material can be shaped with precision and speed.

But this flexibility also presents a challenge: **How do you choose the right material for your specific application?**

The answer lies in understanding each material's unique **mechanical properties, thermal behavior, machinability, cost, and ideal applications**. The wrong choice can lead to part failure, unnecessary costs, or performance limitations. The right one can optimize performance, reduce machining time, and improve product reliability.

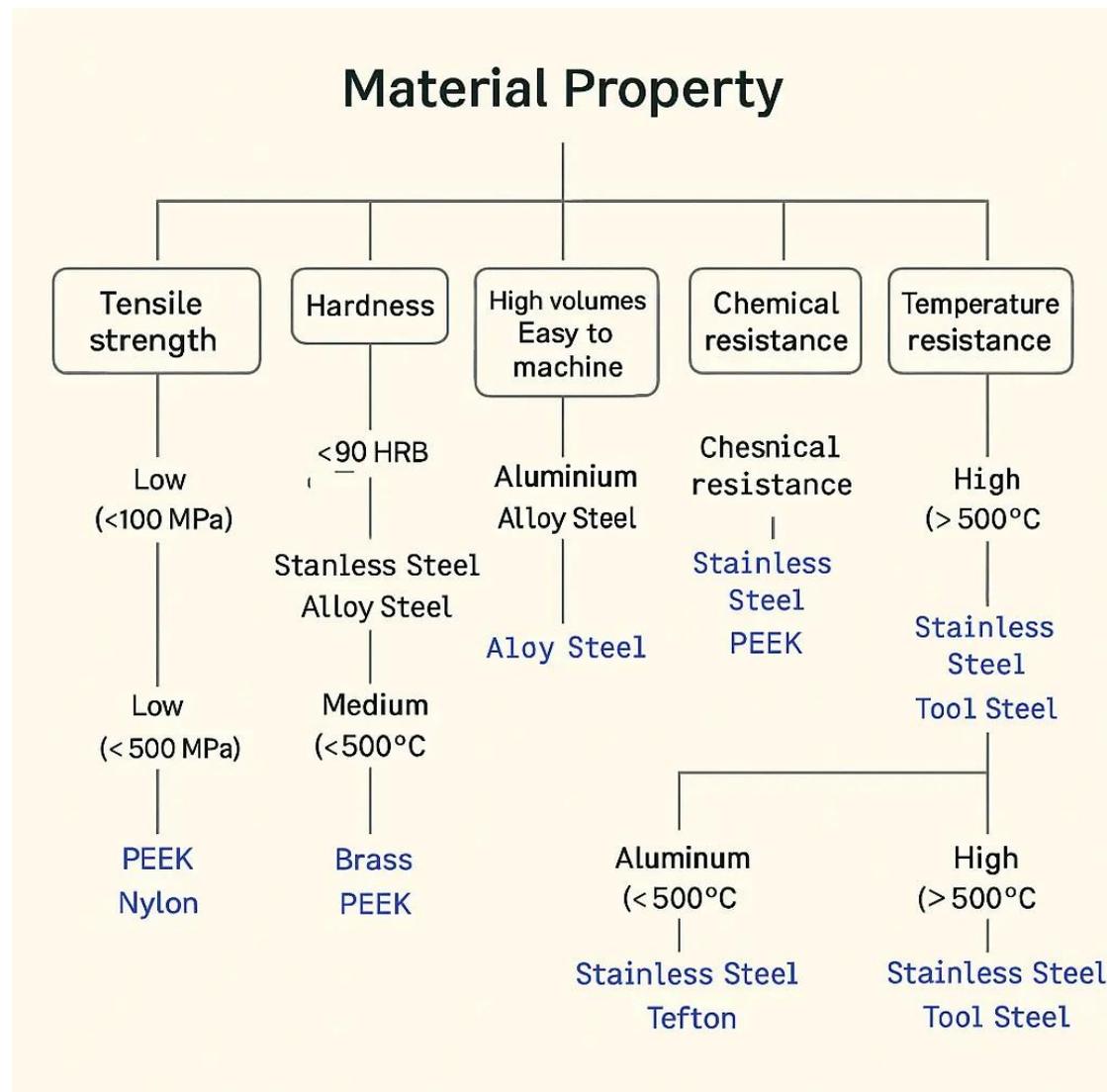


Material	Type	Key Properties	Common Applications
Aluminum 6061	Metal	Lightweight, corrosion-resistant, easy to machine	Aerospace, enclosures, medical fixtures
Aluminum 7075	Metal	High strength, lower corrosion resistance	Aerospace, automotive, tooling
Stainless Steel 304	Metal	Corrosion-resistant, strong, hygienic	Food processing, medical devices
Stainless Steel 316	Metal	Superior corrosion resistance, biocompatible	Marine, surgical tools
Brass C360	Metal	Excellent machinability, low friction, attractive finish	Valves, fittings, electronics
Titanium Grade 2 / 5	Metal	Strong, lightweight, biocompatible, corrosion-resistant	Medical implants, aerospace, defense
Mild Steel (1018, 1045)	Metal	Cost-effective, strong, easy to weld	Structural parts, shafts, gears
Tool Steel (D2, A2, H13)	Metal	Extremely hard, wear-resistant	Dies, punches, cutting tools
Delrin (Acetal)	Plastic	Low friction, high stiffness, machinable	Gears, bushings, medical components
Nylon (PA)	Plastic	Tough, impact-resistant, wear-resistant	Bearings, wear pads, insulators
PEEK	Plastic	High temperature, chemical resistance, biocompatible	Surgical tools, semiconductor parts
PTFE (Teflon)	Plastic	Chemical-resistant, low friction	Seals, gaskets, medical devices
ABS	Plastic	Rigid, cost-effective, good dimensional stability	Prototypes, consumer products
Polycarbonate	Plastic	Impact-resistant, transparent	Enclosures, lenses, guards

Selection Tips:

- **Function First:** Choose materials based on mechanical, thermal, and chemical requirements.
- **Finish Requirements:** Metals polish well; plastics vary.
- **Tight Tolerances:** Metals like aluminum and steel are more stable than plastics.
- **Cost Consideration:** Plastics are cheaper to machine; titanium is more expensive but stronger.

Whether you're an engineer prototyping a new design or a procurement specialist evaluating manufacturing options, Rollyu Precision will help you **make informed material decisions**—ensuring your parts perform as expected while keeping costs under control.



Cost vs complexity trade-offs

In CNC machining, cost and complexity are intertwined. Simpler parts with looser tolerances and common materials are generally less expensive, while complex geometries, tight tolerances, and specialized materials require more advanced machinery, tooling, and skilled labor, leading to higher costs. Balancing design complexity with budget constraints is crucial for optimizing CNC machining projects.

In CNC machining, **cost and design complexity** are directly linked. While CNC offers excellent precision and versatility, increasing complexity typically leads to higher costs due to extended machining time, more toolpaths, and custom setups.

Design Factor	Cost Impact	Why It Matters
Tight Tolerances	↑ High	Slower feeds, specialized inspection required
Thin Walls	↑ High	Risk of deflection, slower passes
Deep Cavities	↑ High	Requires long-reach tools, slower speeds
Undercuts / Side Features	↑ High	May require custom tools or 5-axis machining
High Surface Finish	↑ Moderate-High	Secondary finishing or slower cuts
Complex 3D Geometry	↑ Very High	Increases CAM programming and multi-axis machining
Low Volumes	↑ Per-part cost ↑	Setup time is spread over fewer parts

CNC Machining Cost Optimization Strategies – Comparison Table

Strategy	Description	Benefit
Simpler Designs	Eliminate unnecessary features; focus on functional geometry	Reduced machining time & complexity
Material Selection	Choose cost-effective and machinable materials like aluminum or POM	Lower raw material and tooling cost
Tolerance Optimization	Apply tight tolerances only where functionally required	Minimizes inspection and precision costs
Standard Tooling	Use standard drills, mills, and inserts instead of custom cutters	Saves setup time and reduces tooling costs
Optimized Fixturing	Use modular or reusable fixtures for setup flexibility	Faster changeovers and fewer setups
Production Run Optimization	Increase lot size to amortize setup time across more units	Lower per-part cost for larger quantities
Alternative Processes	Consider molding or 3D printing for high-volume or complex geometries	Can significantly reduce total cost

By understanding the factors that influence CNC machining costs and implementing cost-optimization strategies, Rollyu Precision engineers and designers can make informed decisions that balance complexity with budget. Strategies for Cost Optimization.

Chapter 7: Specialized Machining Services

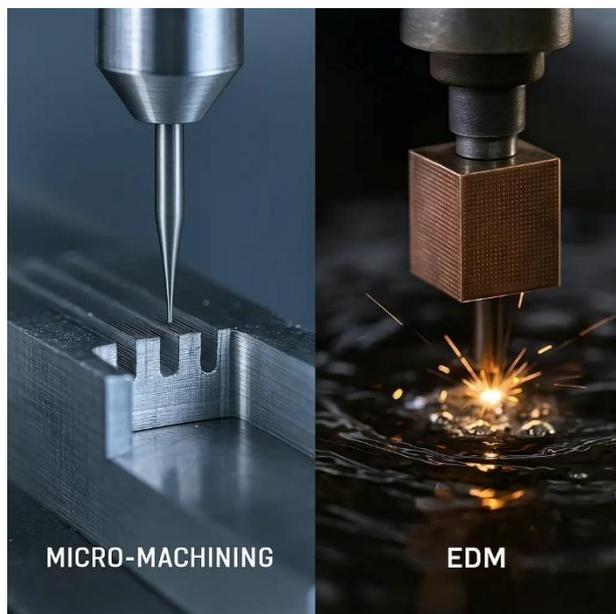
Micro-machining and Electrical Discharge Machining (EDM)

Micro-machining and Electrical Discharge Machining (EDM) are closely related, with micro-EDM being a specialized form of EDM used for creating micro-scale features and intricate shapes in difficult-to-machine materials. EDM uses electrical discharges to remove material through melting and vaporization, while micro-EDM adapts this process for smaller features and higher precision.

At Rollyu Precision, both micro-machining and EDM are advanced CNC technologies used when **tight tolerances**, **fine features**, and **difficult materials** are involved. They're essential in industries like **medical devices**, **aerospace**, **semiconductors**, dental equipment, and **watchmaking**.

Micro-Machining: Precision at the Micron Scale and What It Is:

Micro-machining involves using extremely small tools (often <1 mm in diameter) to machine intricate geometries or tight features with ultra-high precision. It's used to manufacture microcomponents, micro-dies, micro-molds, and other micro-devices. Micro-machining techniques include mechanical methods like drilling and milling, as well as non-mechanical methods like EDM.



Key Features:

- Tool sizes down to 0.1 mm or smaller
- Tolerances as tight as $\pm 1 \mu\text{m}$
- Compatible with metals and plastics
- Typically performed using high-speed spindles and advanced CNC mills

Used For:

- Micro-holes and channels
- Medical implants and stents

- Micro-electronics components

EDM (Electrical Discharge Machining): No-Contact Material Removal

What It Is:

EDM removes material using **electrical discharges (sparks)** between a tool electrode and the workpiece, ideal for very hard or fragile materials. The process involves a spark between an electrode and the workpiece, generating intense heat that melts and vaporizes the material. EDM is commonly used for hard-to-machine materials like hardened steels and alloys.

Key Types:

- **Wire EDM:** Uses a thin wire to cut through the part (like a bandsaw)
- **Sinker EDM:** Uses shaped electrodes to erode cavities

Advantages:

- Can machine extremely hard materials (tool steels, titanium, Inconel)
- Produces complex internal features and sharp corners
- No mechanical stress during machining

Used For:

- Mold cavities and dies
- Aerospace turbine components
- Medical surgical tools

What is Micro-EDM?

Micro-EDM is a specialized form of EDM tailored for micro-scale machining. It allows for the creation of very small holes, intricate shapes, and high-precision features. Micro-EDM is particularly useful for creating features on difficult-to-machine materials, such as those used in electronics, medical devices, and aerospace applications.

How Micro-EDM Works

Micro-EDM utilizes tiny electrical discharges to remove material.

The size of the plasma channel (the area where the spark occurs) is smaller in micro-EDM compared to traditional EDM.

This allows for the creation of finer details and higher precision.

Micro-machining and EDM Comparison Snapshot

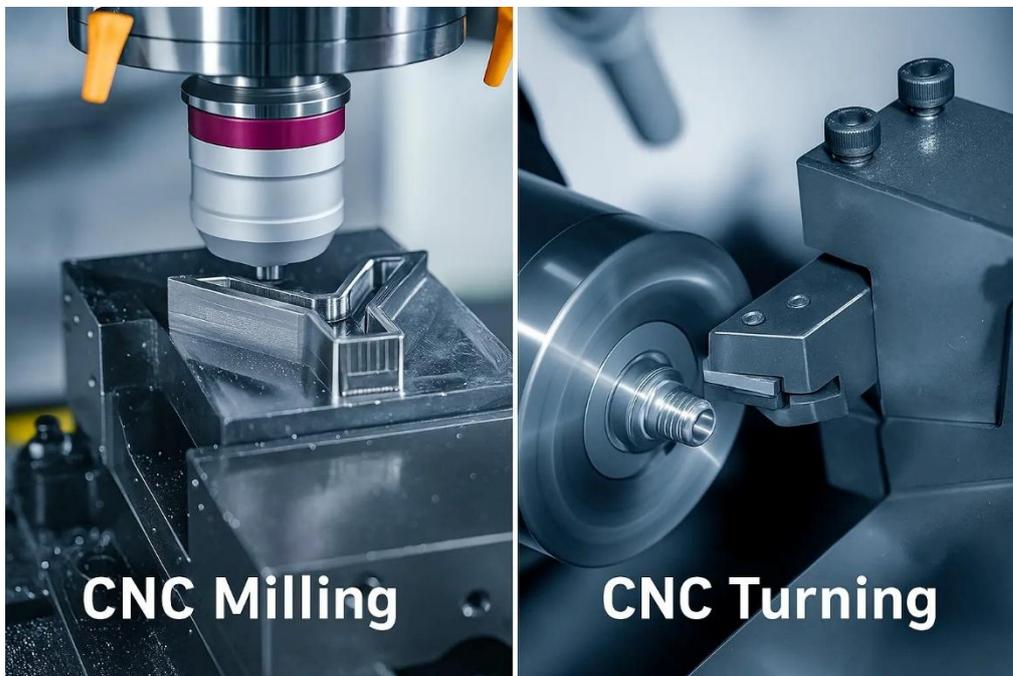
Feature	Micro-Machining	EDM
Material Contact	Yes (cutting tools)	No (electrical erosion)
Best For	Tiny geometries, tight tolerances	Complex profiles in hard metals
Speed	Fast for soft materials	Slower but highly precise
Surface Finish	Good (with polishing)	Very good, low stress
Tool Wear	High	Low (non-contact)

In summary, Micro-machining and EDM are valuable tools for micro-machining, offering high precision, the ability to machine difficult materials, and the creation of complex shapes. It plays a crucial role in various industries, from medical devices to electronics, and continues to advance with new technologies and applications.

CNC Turning vs. CNC Milling: What's the Difference?

CNC turning and milling are two primary methods in subtractive manufacturing, each utilizing computer-controlled machines to shape material. The key difference lies in how the cutting tool and workpiece interact. In CNC turning, the workpiece rotates while the tool remains stationary, making it ideal for cylindrical and rotational parts. CNC milling, on the other hand, involves a rotating tool moving across a stationary workpiece, allowing for complex, irregular shapes and flat surfaces. Both CNC turning and CNC milling are subtractive manufacturing processes, but they differ in how the cutting tool and workpiece interact.

At Rollyu Precision, CNC turning and milling offer distinct approaches to precision machining, each with its own advantages. CNC turning is best for cylindrical parts, offering faster and more affordable production for shapes like shafts, rods, and bushings. CNC milling excels at creating complex geometries, flat surfaces, and irregular shapes, making it suitable for parts with detailed features on multiple surfaces.



CNC Turning

CNC Turning is a subtractive manufacturing process where a **cutting tool removes material from a rotating workpiece** to create cylindrical parts. It's one of the most efficient methods for producing round components with tight tolerances and excellent surface finishes.

Process: The workpiece rotates while a single-point cutting tool removes material.

It's commonly used in industries like automotive, aerospace, and medical to produce precise components. The process is controlled by a computer program (G-code) that directs the tool's movement.

How CNC Turning Works

- The **workpiece rotates** rapidly while the cutting tool moves linearly along the X and Z axes.
- CNC lathes and turning centers may include features like live tooling, automatic bar feeders, and multi-axis capabilities

Common CNC Turned Parts

Suitable for: Cylindrical parts, cones, disks, polygons, and hexagons.

Examples: Knobs, screws, shafts, and threaded components.

- Shafts & axles
- Threaded connectors
- Spacers & bushings
- Housings & cylindrical enclosures
- Medical implants & bone screws
- Fluid handling components (fittings, nozzles)

Advantages: Faster production, more affordable than milling for certain applications, and well-suited for cylindrical features.

Benefit	Explanation
High Precision	Ideal for concentricity and tight dimensional tolerances
Efficient for Round Parts	Faster than milling for symmetrical geometry
Excellent Surface Finish	Achieves smooth surfaces with minimal post-processing
Cost-Effective for High Volumes	Especially with bar feeding and automated turning centers

Typical Materials

- **Metals:** Aluminum, stainless steel, brass, titanium, tool steels
- **Plastics:** POM (Delrin), PTFE (Teflon), Nylon, PEEK

Workpiece rotates, tool stays still (or moves linearly)

- **Used For:** Cylindrical or symmetrical parts
- **Typical Machines:** CNC lathes, turning centers
- **Key Features:**
 - Excellent for shafts, pins, bushings, threads
 - Fast material removal for round parts
 - Ideal for concentric tolerances
- **Common Parts:**
Sleeves, rods, nozzles, connectors, bearing housings

CNC Milling

CNC milling is a subtractive machining process where a **rotating cutting tool moves across a stationary or moving workpiece**, removing material to produce flat surfaces, pockets, slots, curves, and complex 3D geometries. The workpiece is rigidly mounted to a table, and this table moves or rotates on different planes so the tool can work at many angles. Sophisticated CNC milling machines can have 5 or more axes of independent motion to make more complex shapes or to avoid having to move the workpiece to a separate machine.

How CNC Milling Works

- The cutting tool rotates and moves along multiple axes (typically X, Y, and Z).
- The workpiece is fixed to the machine bed or mounted on a moving platform.
- Milling machines range from **3-axis** to **5-axis** systems depending on part complexity.

Tool rotates, workpiece remains stationary (or moves in X/Y/Z)

- **Used For:** Prismatic, flat, or complex 3D shapes
- **Typical Machines:** 3-axis, 4-axis, 5-axis milling machines
- **Key Features:**
 - Produces pockets, slots, holes, contours
 - More versatile for complex geometries
 - Can handle flat and irregular surfaces

Common CNC Milled Parts

- Brackets & housings
- Heat sinks
- Precision plates
- Custom enclosures
- Jigs & fixtures
- Optical and robotic components
- Brackets
- Tooling plates

Common Materials

- **Metals:** Aluminum, stainless steel, titanium, copper
- **Plastics:** POM, ABS, Nylon, PTFE, PEEK
- **Others:** Carbon fiber composites, machinable wax

Benefit	Explanation
High Precision	Ideal for concentricity and tight dimensional tolerances
Efficient for Round Parts	Faster than milling for symmetrical geometry
Excellent Surface Finish	Achieves smooth surfaces with minimal post-processing
Cost-Effective for High Volumes	Especially with bar feeding and automated turning centers

Rollyu Precision, a manufacturer in Shenzhen, China likely utilizes both CNC turning and milling services based on its industry and customer needs. Our services would likely cater to the specific requirements of various parts, from cylindrical components to complex 3D shapes. We would likely offer both processes to meet the diverse needs of our clients.

Feature	CNC Turning	CNC Milling
Rotation	Workpiece rotates	Tool rotates
Best For	Round/symmetrical parts	Flat or complex shapes
Axes Typically Used	2 (X, Z)	3–5 (X, Y, Z + rotation/tilt)
Speed for Simple Parts	Very fast	Moderate
Setup Time	Short	Longer for complex fixtures
Machining Examples	Shafts, screws, bushings	Brackets, panels, mechanical housings



Post-processing and Assembly

Post-processing and assembly are crucial final steps in CNC machining, ensuring parts meet specifications and can be used or assembled correctly. Post-processing involves finishing techniques like deburring, polishing, or coating to refine the final product. Assembly involves bringing together various machined components to create a functional product.

Post-processing aims to improve the aesthetic and functional aspects of CNC-machined parts after the machining process.

After CNC machining, parts often require **additional steps** to meet final specifications in terms of surface finish, dimensional accuracy, or functional integration. These steps fall into two categories:

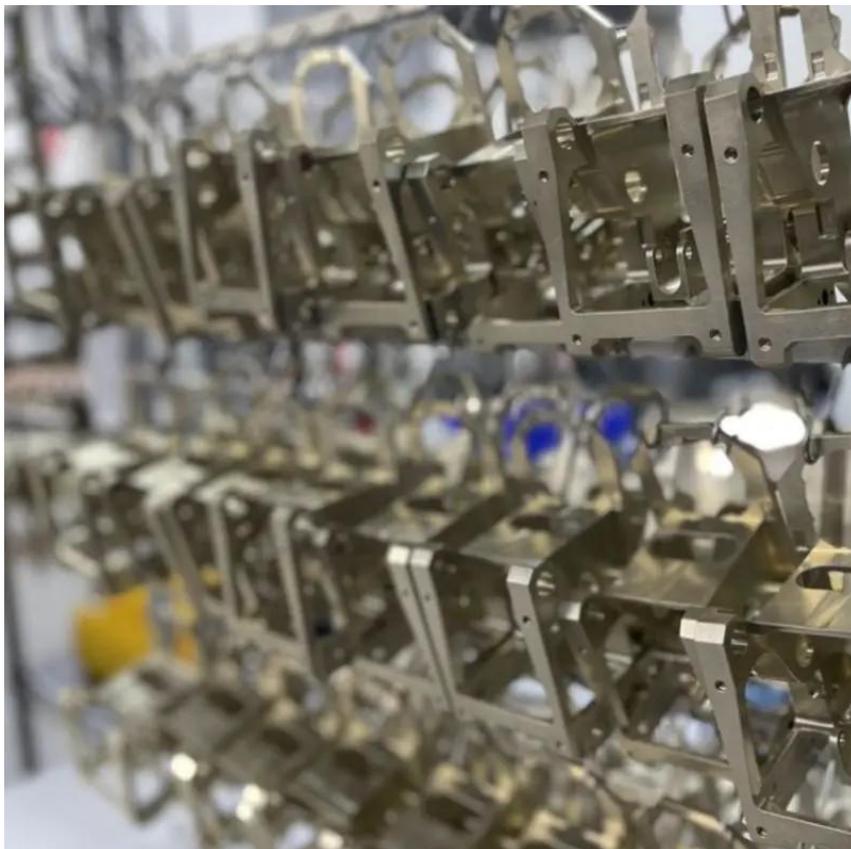
Common Techniques:

Deburring: Removing sharp edges and burrs created by the cutting process to ensure safety and improve appearance.

Polishing: Smoothing surfaces to achieve a specific finish or desired appearance.

Coating: Applying protective or decorative coatings like powder coating, painting, or plating.

Surface Finishing: A broader category encompassing various techniques like blasting, heat treatment, and anodizing to achieve specific surface characteristics.



Process	Purpose	Common Applications
Deburring	Remove sharp edges, burrs, and small chips	All machined parts
Surface Finishing	Improve texture, gloss, or protection	Cosmetic components, visual parts
Anodizing	Add corrosion resistance and color to aluminum	Enclosures, heat sinks
Passivation	Improve corrosion resistance of stainless steel	Medical devices, surgical instruments
Heat Treatment	Enhance mechanical properties like hardness and strength	Tooling, aerospace components
Polishing/Brushing	Refine surface appearance	Consumer products, optical components
Painting/Coating	Aesthetic or functional layers (e.g., powder coat, PTFE)	Outdoor components, electronics
Laser Engraving	Add logos, text, part numbers	Branded parts, traceability in medical/defense

Assembly:

Definition: Assembly involves combining multiple machined components into a complete product.

Importance: Allows for the creation of complex mechanisms and finished products.

Assembly Techniques: Can involve various methods, including:

Bolting/Screw Fastening: Using bolts and screws to connect parts.

Soldering: Joining parts using solder.

Welding: Joining parts by fusing them together.

Adhesive Bonding: Using adhesives to join parts.



Assembly Type	Details
Mechanical Assembly	Screws, nuts, press-fits, snap-fits
Adhesive Bonding	Epoxy, UV cure adhesives
Threaded Inserts	Helicoils or brass inserts for durable threads
Multi-Part Assembly	Precision alignment of subcomponents
Final Testing	Functional fit, torque specs, alignment, leak test etc.

Why Choose Rollyu for Post-Processing & Assembly?

- ISO 9001 & ISO 13485 certified quality management
- One-stop service from raw part to ready-to-install unit
- Tight control over finishing tolerances and cosmetic standards
- Reduced lead times through integrated processes

In summary, post-processing refines CNC-machined parts to meet specific requirements, while assembly combines these parts to create a functional product.

Prototyping vs. Production Runs in CNC Machining

Understanding the distinction between prototyping and production runs is critical for **cost efficiency**, **lead time planning**, and **design validation**. Both serve different stages of a product's lifecycle—and require tailored strategies.

CNC (Computer Numerical Control) machining is a popular method for creating prototypes due to its precision, speed, and ability to produce complex shapes with tight tolerances. It's a subtractive manufacturing process where a digital design is used to control a machine that removes material from a raw workpiece, resulting in a physical prototype.

Prototyping

Purpose:

To validate design, fit, function, and manufacturability before mass production. Prototyping is more flexible and allows for easy design changes, while production focuses on consistent, repeatable results.

Aspect	Details
Volume	1–20 parts (typically)
Speed	Fast turnaround prioritized over cost
Setup	Minimal setup, may use soft tooling or temporary fixturing
Flexibility	Design changes are expected and easily implemented
Inspection	Often includes full dimensional reports or CMM checks
Cost per Part	Higher (due to setup not being amortized)
Ideal For	Engineering validation, fit testing, proof-of-concept

Production Runs

Purpose:

CNC production runs involve using Computer Numerical Control machines to manufacture parts or components in large quantities. This process relies on computer-controlled machines and pre-programmed instructions to achieve high precision, consistency, and efficiency in the production of parts.



Aspect	Details
Volume	50–10,000+ parts
Speed	Optimized for cost and consistency
Setup	Full production tooling and jigs; automated workholding
Flexibility	Design changes costly; tight version control required
Inspection	Sampling-based QC (SPC, visual, in-line)
Cost per Part	Lower (setup costs spread across parts)
Ideal For	Market release, inventory, commercial deployment

Key Takeaway

Prototyping is about speed and feedback.

Production is about repeatability and efficiency.

Using both strategically ensures faster development cycles and reliable part delivery.

In summary, CNC machining provides a versatile and accurate method for both prototyping and production, with the choice depending on the specific needs of the project and the stage of product development.

Chapter 8: Applications by Industry

Medical: implants, enclosures, surgical devices

At **Rollyu Precision**, we provide high-accuracy **CNC machining**, **die casting**, **rapid prototyping** and **sheet metal fabrication** services for advanced industries that demand uncompromising quality and consistency. Our ISO 9001 and ISO 13485-certified capabilities support both rapid prototyping and volume production of tight-tolerance components. We work with leading companies across **medical devices**, **dental equipment**, **life sciences**, **robotics**, **semiconductor manufacturing**, **industrial automation**, **renewable energy**, and **aerospace sectors**. Whether you're developing surgical instruments, semiconductor tooling, lab automation systems, or lightweight satellite structures, Rollyu delivers precision-machined parts with full traceability, material control, and process reliability — every time.

Precision CNC Machining for Medical Components – Rollyu Precision

In the medical industry, precision is not a luxury—it is a necessity. Rollyu Precision is a dedicated CNC machining company serving the medical sector with exceptional accuracy and unwavering reliability. From intricate surgical components to robust laboratory fixtures, we machine critical medical parts that meet the most rigorous functional and regulatory requirements.

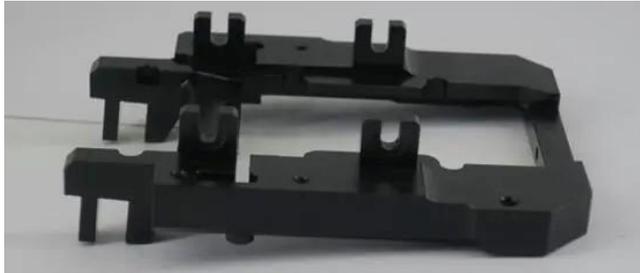


A Full Range of CNC-Machined Medical Components

At Rollyu Precision, we manufacture an extensive portfolio of medical components, including but not limited to:

Structural & Support Parts:

Gripper brackets, door frames, monitor arms, HMI mounting tubes, connection plates, and enclosures—all essential for the assembly and operation of medical systems.



Fluid & Pneumatic Control Components:

Manifold blocks, valve bodies, short valve spools, valve holders, valve caps, vacuum tubes, cylinder nuts, and coupling assemblies for fluid regulation systems.



Motion & Adjustment Mechanisms:

Lead screw clamps, adjusting knobs, sensor brackets, motor mounts, pivoting plates, stopper brackets, shuttle motor adapter plates, and motor bases—all machined with tight tolerances to ensure accurate motion control.



Micromachined and High-Precision Items:

Modified needle pins, ejector pins, rolling pins, needle heads, mixer blade housings, and calibration pins—often used in surgical or diagnostic applications requiring micron-level accuracy.



Advanced Assemblies & Prototypes:

We support low-volume production runs for wearable devices, implantable prototypes, cartridges, housings, and lab components—machined, inspected, and ready for final integration.



Excellence in Surgical Device Manufacturing

Surgical procedures demand the highest quality components—there is zero room for compromise. Rollyu Precision delivers micro-scale surgical tools and implant components machined from materials like titanium and stainless steel, using 5-axis CNC machining and EDM technologies.

Our facility produces precision parts for:

- LASIK equipment
- Cardiac devices and miniature gears
- Orthopedic titanium implants
- Implantable medical devices
- Custom surgical instruments

Each component is crafted under tightly controlled conditions to ensure sterility, dimensional accuracy, and flawless function in the operating room.

Laboratory and Diagnostic Equipment Manufacturing

Our clients in the diagnostic and life sciences sectors rely on us to deliver high-performance components used in laboratory automation and DNA analysis. We manufacture insertion tools, sample handling fixtures, and structural supports used in sensitive testing environments where accuracy is critical.

Parts like MRI table components, collimators for CT scanners, and X-ray anodes are engineered to operate reliably even in mobile or high-radiation environments.



Radiology-Grade Micromachining & EDM Services

Radiologists and imaging engineers depend on precision-machined parts that function in real-time during procedures. Our EDM machining services are ideal for complex geometries, heat-sensitive alloys, and miniature components used in:

- MRI systems
- CT scanners
- X-ray and fluoroscopy machines

We ensure dimensional integrity, electrical conductivity where needed, and component reliability under repeated use.



Why Medical Clients Choose Rollyu Precision

Speed: Rapid prototyping, bridge tooling, and low-volume production with turnaround times as fast as 1–3 days.

Accuracy: Sub-millimeter and micron-level tolerances on complex geometries.

Materials: Experience with high-temperature plastics (PEEK, PEI), titanium, stainless steel, Inconel, and medical-grade aluminum.

Certifications: ISO 9001:2015 certified facility with full traceability and documentation.

Customization: DFM support, surface finishing (anodizing, passivation, plating), and packaging options tailored to medical environments.

Materials We Machine for Medical Applications

Rollyu's expertise spans a wide range of materials suitable for critical medical applications:

- **Titanium & Inconel:** Lightweight, corrosion-resistant, ideal for orthopedic and implantable components.
- **Stainless Steel:** Durable and sterilization-ready for surgical tools and lab equipment.
- **Aluminum:** Lightweight and cost-effective, often used in housings and structural supports.
- **PEEK & PEI (Ultem):** High-performance thermoplastics for components exposed to heat, pressure, and chemical sterilization.

Applications We Serve

From concept to production, we support medical engineers, R&D teams, and OEMs across a variety of applications:

- Surgical instruments
- Handheld diagnostic tools
- Ventilators and respiratory systems
- Wearables and prosthetics
- Implantable prototypes
- Cartridge and housing systems
- Dental Equipment

We Machine the Impossible

Many shops hesitate to take on complex or unconventional designs. At Rollyu Precision, those are the projects we specialize in. Whether you're designing the next breakthrough in minimally invasive surgery or need ultra-precise components for a wearable health device, we're here to make it real.

Our experienced engineers thrive on solving difficult challenges, iterating prototypes, and achieving what others consider impossible. We don't just deliver parts—we deliver possibilities.

Partner with Rollyu Precision

We invite you to collaborate with our team for your next medical machining project. With speed, precision, and uncompromising quality, Rollyu helps accelerate your innovation from idea to reality.

 Contact us today for a quote or technical consultation at:

 +86 (0) 152 19497088

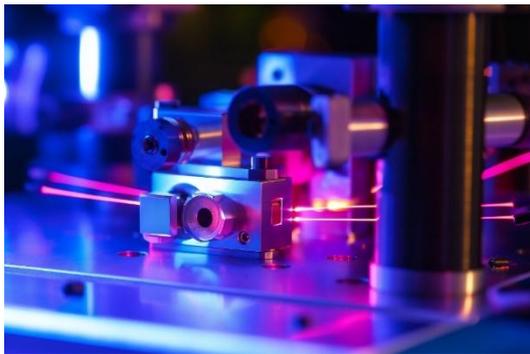
 info@rymachining.com

 www.rollyu.com

Photonics CNC Machining Parts – Advanced Components for Optical Innovation

Photonics systems demand components with nanometer-level accuracy. Whether you're developing lidar sensors, quantum modules, high-speed fiber optics, or laser diagnostic systems, precision mechanical components are the foundation. At **Rollyu Precision**, we specialize in high-tolerance CNC machining for photonics OEMs—producing over **1,000 distinct components**, from **gripper brackets** to **alignment jigs, lens holders, diode nests**, and **custom stage carriages**.

Our components are found in systems for laser steering, fiber coupling, light detection, and optical alignment—enabling breakthroughs in telecom, life sciences, aerospace, and AI sensing.



Photonics Hardware Demands Precision CNC Parts

Photonics components often serve optical paths, thermal management, or structural alignment—any imperfection affects performance. Rollyu delivers photonics CNC parts with:

- **Tight tolerances:** ± 0.005 mm or better
- **Mirror-finish surfaces:** $R_a < 0.2$ μm
- **Thermal and vibration stability**
- **Consistent fit for optomechanical systems**

We routinely machine complex assemblies such as **lens pods, collimator tubes, fiber clamp bases, optic head rings**, and **gonio stages**, built to exacting tolerances in a temperature-controlled environment.

What We Machine for the Photonics Industry

We've delivered thousands of precision parts including:

► Optomechanical Assemblies

- **Lens holders, camera holders, diode holders, mirror brackets, mask holders, phosphor holders, LED ring supports**
- **Collimator tubes, vortex holders, beam steering brackets, filter carriers, mirror glue links, laser diode holders**



► Precision Positioning and Stages

- Stage carriages, XY holder bases, gonio plates, eccentric shafts, pivot hubs, cleaver holders, scanner supports, alignment plates
- Micrometer tips, mirror turrets, setup blocks, positioner mounts, gluing jigs, alignment pins, pneumatic cylinder supports

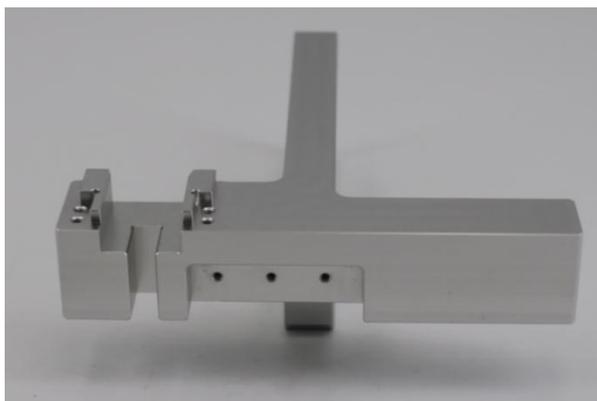


► Fiber Optics & Coupling Systems

- Fiber holders, fiber fan-outs, fiber guides, fiber clamp bases, fiber gripper flexures, 230um/460um gripper jaws, loose tube adapters
- Stripper base plates, fiber hook nests, lateral fiber guides, gripper columns, APD gripper assemblies.

► Mounts & Structural Supports

- Manifolds, light supports, sensor housings, motor mounts, controller brackets, robot bases, inspection blocks, stage link braces
- T-foot brackets, base gussets, angle supports, hinge shims, turret housings, microscope holders, clamp floors



► Laser System Parts

- Laser clamps, cooling plates for life test lasers, laser hoods, beam delivery arms, excitation section covers, calibration blocks, induction plates

► Custom Fixtures & Carriers

- Carrier thumbscrews, spool rack bases, demo lens jigs, prototype handles, glue brackets, mounting plates, mirror levelers, sensor flags

We also supply **valve mounting plates, spring pushers, torch tips, cam rods, jaw holders, lock plates, pivoting screws, magnet holders**, and more—supporting highly integrated assemblies where precision matters.



Materials Engineered for Optical Environments

We regularly machine:

- **Aluminum (6061, 7075)** – black anodized for low reflectivity
- **Copper and BeCu** – for heat transfer in diode modules
- **Titanium Grade 5 (Ti-6Al-4V)** – ideal for weight-sensitive optical platforms
- **Stainless steels (304, 316, 17-4PH)** – for structural rigidity
- **Plastics (PEEK, Ultem, Delrin, PTFE)** – for electrical isolation, cleanroom compliance

Surface treatments include passivation, electropolishing, matte black anodizing, bead blasting, and optical masking for laser alignment protection.

Built-in Optical Precision Quality Control

To meet photonics-grade tolerances, Rollyu uses:

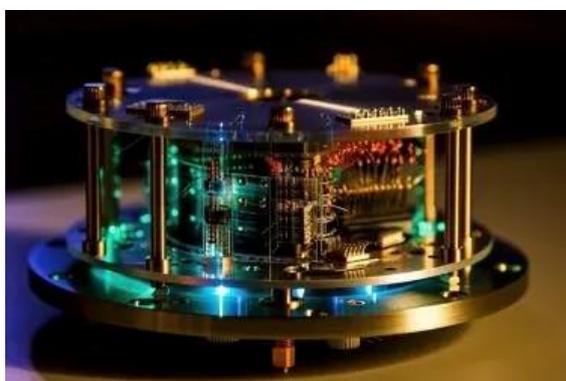
- **CMMs and laser interferometry** for dimensional verification
- **Roughness testers** for optical path components
- **Optical alignment validation** for holders and plates
- **Thread and pin gauge certification** for mounting interfaces
- **Material traceability & ISO 9001:2015 documentation**

We support first article inspections (FAI), full batch certification, and customer-defined inspection protocols.

Who We Serve

Our components are used by:

- **Photonics startups** developing laser-based diagnostics
- **Medical OEMs** building diagnostic imaging systems
- **Lab and R&D groups** prototyping custom mounts and optomechanics
- **Telecommunications** – Fiber alignment tools, amplifier modules, scaling fiber optic networks, and couplers
- **Medical Imaging & Diagnostics** – Optical housings, fiber heads, and sensor mounts
- **Lidar and 3D Sensing** – Compact enclosures and scanning modules
- **Laser Processing Systems** – Beam collimators, alignment stages, and cooling blocks
- **Quantum & Semiconductor Photonics** – Precision frames and cavity parts for vacuum environments



Whether it's a **gripper support arm**, **carrier platform**, **microscope link**, or **prism holder**, our team delivers high-mix, low-volume, and high-precision machining with short lead times.

Let's Machine the Future of Light—Together

Your photonics hardware deserves more than generic machining. At Rollyu Precision, we specialize in the kind of parts others won't touch: eccentric geometries, ultra-tight fits, and mission-critical assemblies.

Whether you need a **diode jig**, **turret drive**, **sensor cradle**, or an entire **fiber optic subassembly**, we are ready to collaborate—from CAD to cleanroom.

Contact us today info@rymachining.com to quote your project, review tolerances, or begin prototyping. Rollyu Precision—Where photonics meets perfection.

✉ Contact us today for a quote or technical consultation at:

☎ +86 (0) 152 19497088

✉ info@rymachining.com

🌐 www.rollyu.com

Robotics CNC Machining Parts – Built for Precision, Motion & Reliability

Robots don't tolerate misalignment. Neither do we.

At Rollyu Precision, we specialize in high-accuracy CNC machining tailored for the robotics industry. From lightweight robotic arms and joint housings to end-effector components and sensor mounts, our CNC machining capabilities support industrial, surgical, autonomous, and service robotics. We deliver complex, high-precision parts that perform in high-speed, high-demand environments where failure is not an option.

CNC Robotics Machining Capabilities at Rollyu

- 3-axis, 4-axis, and 5-axis CNC machining for multi-face complexity
- Accuracy up to ± 0.005 mm for consistent, repeatable performance
- Precision machining of arms, pivot blocks, housings, camera mounts, grippers
- Materials: Aluminum, Titanium, Stainless Steel, Engineering Plastics (e.g., PEEK, Delrin)
- Post-processing: anodizing, bead blasting, laser engraving, thread inserts
- ISO 9001:2015 & ISO 13485 certified workflows

Commonly Machined Robotic Components

- Motor brackets and gear housings
- End-effector frames, probes, and gripper jaws
- Chassis plates and structural frames
- Camera holders, cable brackets, and mounting arms
- Sensor enclosures and actuator plates
- Joints, bearings, bushings, V-blocks, robotic base mounts

These parts are essential in enabling motion, sensing, and control in robotic systems. Whether for surgical instruments or factory automation, we ensure that every part meets strict geometric tolerances and performance standards.



Why CNC Machining is Critical to Robotics

1. Precision and Repeatability

Our CNC equipment achieves tolerances down to ± 0.0002 inches, ensuring perfectly aligned parts for smooth robotic movements.

2. Complex Designs

Robotics requires compact, multifunctional parts. CNC machining allows creation of intricate geometries, thin walls, internal channels, and multi-axis contours.

3. Versatility Across Materials

We work with metals, polymers, and composites depending on strength, weight, and environmental exposure requirements.

4. Cost-Efficiency

Optimized tool paths, minimized waste, and reduced human labor enable affordable high-volume production.

5. Reliability and Durability

Precision-machined components last longer and withstand mechanical stress, vibration, and heat exposure without degradation.

Examples of CNC-Produced Robotic Parts

- Joints with rotational accuracy
- Helical gears and planetary gearboxes
- Load cell brackets and camera enclosures
- Custom mounting adapters and automation-ready fasteners
- End-effector brackets, grippers, and claws

From Prototypes to Production

Rollyu Precision supports the full lifecycle of robotic component development:

- DFM support and prototype validation
- Custom fixturing and gauge development
- Rapid prototyping with 3D-printed jigs
- Short-run bridge tooling for pilot builds
- Full-scale production to support high-volume automation lines

Our in-house team and advanced equipment make this transition seamless, ensuring scalability without sacrificing quality.

Advanced Machining and Welding Services

5-Axis Precision Machining

Used to create high-complexity robotic components like end effectors, probe heads, and precision linkages. Supports intricate multi-surface features.

Vertical & Horizontal CNC Milling

Ideal for chassis parts, motor housings, sensor mounts, and large structural frames.

Swiss CNC Machining

Delivers high volumes of small, high-precision components like shafts, miniature bushings, and sensor pins.

Laser Welding

Enables precision joining of components with minimal distortion. Especially suitable for actuator enclosures, sensor assemblies, and modular frames.

Quality Assurance

Our quality system is certified to **ISO 9001:2015** and **AS9100D**, ensuring full traceability, documentation, and inspection for every part:

- First Article Inspection Reports (FAIR)
- In-process SPC
- Automated CMM with CAD model inspection
- Final dimensional verification
- Lot traceability and raw material certification

Our QMS ensures:

- Process consistency
- Risk mitigation
- Regulatory compliance
- Continuous improvement across all projects



CNC Machining for Robotics Applications

We serve multiple robotics segments including:

Industrial Robotics: robot arms, end-of-arm tooling, joints, mounting systems

Medical & Surgical Robotics: titanium tools, articulated joints, micro-scale actuators

Autonomous Vehicles: camera mounts, control system brackets, drivetrain elements

Automation & Packaging Systems: sensor mounts, conveyor pulleys, robotic grippers

R&D & Prototype Labs: testing rigs, frame adapters, cable guides



Our Competitive Edge

Precision: Tolerances down to ± 0.0001 inches ensure critical alignment.

Complexity: We reduce setups with multi-axis machining, optimizing efficiency and geometric accuracy.

Material Range: We machine aluminum, stainless, titanium, PEEK, nylon, carbon fiber, and more.

Fast Turnarounds: Rapid prototyping and short lead times supported by digital workflows and in-house capabilities.

Sustainability: Waste recycling, energy-efficient machining, and sustainable material sourcing.

Industry 4.0 Integration: Smart data-driven machining, digital twins, and in-line QC feedback systems.

Applications in Automation Systems

Robotic Arm Components: Base plates, wrist joints, shoulder gears, and end-of-arm effectors.

Conveyor System Parts: Drive shafts, pulleys, guide rails, modular brackets, rollers, and support structures.

Sensor Mounts: Protective housings, adjustable vision brackets, precision optical trays, alignment jigs.

Control System Integration: PLC mounting panels, thermal management components, EMI-shielded housings.

Innovation in Action

Our machining innovation supports lightweight designs, low-backlash motion, EMI shielding, and thermal management. We're constantly adopting new materials, tighter tolerances, and more advanced inspection to stay ahead.

Partner with Rollyu Precision

If you're designing the future of robotics, you need a manufacturing partner who can match your pace, quality expectations, and engineering complexity.

Let Rollyu Precision support your journey—from prototyping to production, from end-effector design to chassis machining.

Contact us today to quote your next robotics component, info@rymachining.com

 Contact us today for a quote or technical consultation at:

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 www.rollyu.com

Semiconductor CNC Machining Parts Ultra-Precision for a Nanometer World

In today's high-tech manufacturing ecosystem, few industries demand the same level of precision, cleanliness, and material control as the semiconductor industry. As chips continue to shrink and wafer technology advances into the realm of sub-10 nm and beyond, the parts used to fabricate these devices must meet uncompromising standards. At Rollyu Precision, we manufacture CNC machined components that stand up to these demands—delivering ultra-tight tolerances, zero-defect quality, and reliable long-term performance in vacuum, high-heat, and cleanroom environments.

The Importance of CNC Machining in Semiconductor Manufacturing

CNC machining plays a pivotal role in the fabrication and support infrastructure of semiconductor production lines. From wafer handling to lithography, etching, deposition, metrology, and packaging, CNC-machined parts are used in critical assemblies and subsystems.

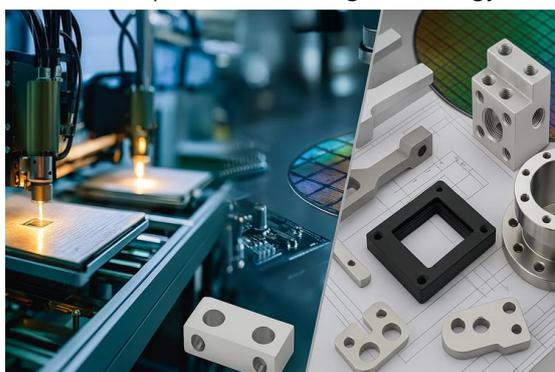
Precision is everything. Even microscopic misalignment can lead to particle generation, surface contamination, or part failure—potentially compromising millions of dollars' worth of wafers. That's why semiconductor OEMs and Tier-1 suppliers rely on machining partners like Rollyu Precision for consistent, repeatable, and scalable parts that meet exact engineering specifications.

Components We Commonly Manufacture for Semiconductor Equipment

Our customers in the semiconductor sector rely on us for an extensive range of machined parts, including:

- Wafer lift arms and robotic end-effectors
- Vacuum chamber bodies and isolation flanges
- Gas delivery manifolds and flow plates, gas distribution blocks
- Sensor mounts and photonics housings
- Rotary drive collars and spindle shafts
- Precision alignment blocks, standoffs, and brackets
- Electrostatic chuck components and base frames
- Ceramic-to-metal interface fixtures
- Lithography bracket

These parts support tools used in wafer processing (etch, CVD, ALD, PVD), photolithography, CMP, ion implantation, dicing, metrology, and backend packaging.



Machining Capabilities Tailored for the Semiconductor Sector

1. Ultra-Tight Tolerances

We consistently hold tolerances as tight as ± 0.002 mm on critical dimensions. Complex geometries with multiple datums and tight GD&T callouts are our daily work. Whether machining sealing surfaces, microbores, counterbores, or cooling channels, we ensure parts meet exacting specs.

2. Multiaxis Machining & Swiss Turning

With 3-axis, 4-axis, and 5-axis vertical/horizontal CNC milling centers, as well as Swiss screw machines, we can produce both large structural frames and miniature internal features with equal confidence. This versatility supports semiconductor toolmakers who require assemblies with mixed-scale components.

3. Micro-Machining & EDM

We utilize wire and sinker EDM for ultra-fine feature resolution, tight corner radii, and sharp internal geometries. Micro-machining capabilities enable the production of miniature alignment tools, sensor nests, and high-density mounting plates.

Materials Expertise

Semiconductor machining isn't just about dimensions—it's about material purity, finish quality, and contamination control. At Rollyu Precision, we have deep experience with industry-critical materials:

- **Aluminum 6061, 7075, 2024 (vacuum compatible, anodizable)**
- **Stainless Steel 304, 316L (SEMIF20 vacuum re-melt grades)**
- **Titanium Grade 5, Grade 2 (non-magnetic, corrosion-resistant)**
- **PEEK, Ultem, and other high-performance polymers**
- **Ceramics: Macor, Alumina, Aluminum Nitride**
- **Hastelloy C-22/C-276 and Invar 36 (for thermal stability)**
- **Silicon and Gallium-based substrates (on request)**

We maintain clean segregation during material handling and machining to prevent cross-contamination, a requirement for vacuum chamber and wafer-facing parts.

Surface Treatments & Finishing Capabilities

We offer specialized post-processing options that ensure optimal cleanliness, corrosion resistance, and vacuum performance:

- **Citric acid passivation (ASTM A967) for stainless steel**
- **Bead blasting and mechanical polishing to $Ra < 0.2 \mu\text{m}$**
- **Anodizing (Type II, Type III, Hard Anodize) for aluminum parts**
- **Nickel, gold, and electroless nickel plating**
- **Electropolishing and ultrasonic cleaning (cleanroom-ready)**
- **Laser engraving for traceability and part identification**

Every surface finish is validated per SEMI standards and tailored to the customer's process environment.

Quality Control – Built for Cleanroom & Critical Tolerance Applications

Semiconductor CNC parts require not just dimensional accuracy, but verifiable documentation and statistical process control. At Rollyu Precision, our QMS meets ISO 9001:2015 and ISO 13485 standards. Every part is manufactured, inspected, and certified under a controlled workflow:

- 100% traceability from raw material to finished part
- Lot-based inspection records and inspection reports (FAIR, PPAP)
- CMM inspection with direct-model programming
- Coordinate measurement reports with ± 0.001 mm resolution
- Particle inspection, packaging, and Class 100/1000 cleanroom compliance (upon request)

Application Segments We Serve

We serve customers across every major segment of the semiconductor value chain:

- **Front-End (Wafer Fabrication):**

Etch chambers, lithography systems, deposition platforms, gas distribution blocks, plasma tools.

- **Back-End (Assembly, Test, Packaging):**

Lead frame alignment, die placement guides, vacuum chambers, inspection nests.

- **Photonics & Quantum Technology:**

High-stability mirror holders, beam alignment fixtures, precision mounts.

- **Wafer Handling and Automation:**

Robotic wafer grippers, lift arms, sensor flags, and actuator brackets.

- **Advanced Packaging (3D IC, FOWLP):**

Precision tooling for micro-bumps, solder balls, thermal management.

Case Studies: How CNC Machining Supports Semiconductor Innovation

Case 1: Wafer Chuck Frame for a Vacuum Etch Tool

Client required an aluminum 6061 chuck frame machined to ± 0.005 mm flatness, anodized and cleaned for vacuum. Rollyu produced 300 units over 6 months with zero non-conformances.



Industry: Semiconductor Equipment

Component: Wafer Chuck Frame

Material: Aluminum 6061

Tolerance: ± 0.005 mm flatness

Surface Finish: Anodized and vacuum-cleaned

Volume: 300 units over 6 months

Challenge:

A leading semiconductor equipment manufacturer required a precision-machined chuck frame used in a vacuum etch tool. The part needed to maintain an ultra-flat surface with a tight flatness tolerance of ± 0.005 mm to ensure even wafer support and gas flow uniformity. Additionally, the component had to be anodized for corrosion resistance and thoroughly cleaned for vacuum chamber compatibility.

Solution by Rollyu Precision:

Rollyu deployed 5-axis CNC machining and precision lapping techniques to achieve the required flatness across a complex geometry. Each part underwent full dimensional inspection using a calibrated CMM, followed by Type II anodizing and ISO 14644-compliant cleaning to remove microscopic contaminants.

Outcome:

- **300 units delivered** on schedule over a 6-month period
- **Zero non-conformances** reported by the customer
- Achieved **100% vacuum integrity compliance** during tool integration
- Enabled the client's tool to pass beta site evaluations with no mechanical revisions

Client Feedback:

"Rollyu's precision machining and clean handling were instrumental in getting our etch tool qualified for high-volume semiconductor fabs. Their consistency and responsiveness made them a strategic partner."

Case 2: Sensor Block for Optical Alignment System

PEEK block with micro-tapped holes (M1.6) and pocketed sensor nest, machined using custom fixtures and inspected via CMM. Full RoHS and REACH compliance.

Industry: Semiconductor Metrology

Component: Sensor Mounting Block

Material: PEEK (Polyether ether ketone)

Features: M1.6 micro-tapped holes, precision pocket for sensor seating

Compliance: RoHS & REACH compliant

Inspection: CMM dimensional verification

Challenge:

A client developing an optical alignment system required a non-metallic sensor block with extreme dimensional stability and chemical resistance. The part featured micro-threaded M1.6 holes and a custom pocket profile for precise sensor seating—tolerances were tight due to the optical calibration requirements. Due to the softness and thermal sensitivity of PEEK, the machining approach had to avoid material stress and deformation.



Solution by Rollyu Precision:

Rollyu engineered custom soft-jaw fixtures to secure the part without inducing clamping distortion. A high-speed spindle and micro-tooling setup were used to achieve burr-free micro-taps and tight pocket tolerances. Full dimensional inspection was performed using a CMM, and all materials were traced to certified RoHS and REACH compliant sources.

Outcome:

- Delivered **precision-milled PEEK components** with micro-tap threading success rate >99%
- Maintained **<0.01 mm tolerance** across the critical sensor nest region
- Verified **100% compliance** with EU RoHS and REACH standards
- Enabled accurate, repeatable sensor alignment in cleanroom optical systems

Client Feedback:

"PEEK is notoriously difficult to machine, but Rollyu delivered flawless parts with exceptional attention to detail. The precision of the sensor nest exceeded our expectations."

Stain

Case 3: Manifold Assembly Plate

Stainless steel 316L, post-machined with electropolishing and passivation. Threads held to class 3A tolerance. Designed for cleanroom fluid delivery systems.

Industry: Semiconductor Process Equipment

Component: Fluid Manifold Assembly Plate

Material: Stainless Steel 316L

Post-Processing: Electropolished + Passivated

Thread Spec: ASME Class 3A Tolerance

Application: Cleanroom fluid distribution system

Challenge:

A semiconductor OEM required a manifold plate capable of precise fluid routing in a Class 100 cleanroom environment. The part was made from corrosion-resistant 316L stainless steel and needed tight-tolerance threads (Class 3A) to ensure reliable, leak-free connections under pressure. Surface integrity was critical—requiring both electropolishing for roughness control and passivation for enhanced corrosion resistance.

Solution by Rollyu Precision:

Rollyu implemented a multi-step approach: precision CNC milling and tapping were followed by in-house thread gauging to ensure Class 3A conformity. Post-machining, parts were electropolished to achieve a smooth, contamination-resistant finish and then passivated per ASTM A967 standards. Each part underwent 100% visual and dimensional QC, including surface Ra testing.

Outcome:

- Achieved **Ra < 0.2 μm** surface finish for fluid-contact surfaces
- **Thread concentricity and pitch** held within 0.02 mm
- Delivered components with **no visible particulate** under 10x magnification
- Fully compliant with **semiconductor cleanroom standards**

Client Feedback:

"The manifold plates from Rollyu passed our internal audit without issue. The polished finish and tight threading were exactly what we needed for leak-free fluid handling in our advanced process modules."



Why Leading OEMs Trust Rollyu Precision

We're not just a job shop—we're a strategic manufacturing partner trusted by top-tier semiconductor equipment manufacturers. Why?

- **Responsiveness:** Fast prototyping, NPI ramp-up, and quick-turn engineering changes
- **Capacity:** Scalable production from 1 to 10,000 parts
- **Cleanliness:** Dedicated clean packaging area for ISO 14644-compatible shipments
- **Collaboration:** Our engineers work hand-in-hand with your design team
- **Cost Control:** Lean manufacturing and design-for-manufacturability reviews

Future of Semiconductor Machining – Our Perspective

As the semiconductor industry trends toward 2 nm nodes, EUV lithography, 3D packaging, and quantum integration, component complexity and criticality will continue to increase. This means tighter tolerances, exotic materials, and more demanding traceability and cleanliness requirements.

At Rollyu, we're investing in:

- **Closed-loop machine control and Industry 4.0 integration**
- **Tool wear prediction using AI and sensor fusion**
- **Diamond tooling for ultra-fine surface finishes**
- **Ceramic hybrid machining technologies**
- **Real-time SPC dashboards for process stability**

Our mission is to stay ahead of the curve—ensuring our customers receive parts that are not just precise, but engineered for tomorrow's semiconductor breakthroughs.

Let's Build the Future of Semiconductors—Together

From prototypes to production, from vacuum chambers to optical sensor mounts—Rollyu Precision delivers CNC machined parts that enable the semiconductor industry to push the boundaries of nanotechnology.

Whether you're designing a new EUV platform, automating your wafer handling system, or building the next generation of quantum chips, we're here to support you with expert machining, responsive service, and zero-defect quality.

✉ Contact us today for a quote or technical consultation at:

☎ +86 (0) 152 19497088

✉ info@rymachining.com

🌐 www.rollyu.com

From semiconductor tools and medical devices to aerospace structures, to robotics, and photonics, and renewable energy systems, precision matters. At Rollyu Precision, we understand the critical role every component plays in your product's performance and safety. That's why we combine advanced manufacturing technologies with rigorous quality control — delivering consistent, ISO-certified results across medical, dental, life sciences, robotics, semiconductor, automation, renewable energy, and aerospace industries. When failure is not an option, trust Rollyu to deliver the parts that power innovation.

Chapter 9: Case Studies & Testimonials

Case Studies & Testimonials

At Rollyu Precision, we don't just machine parts — we help our clients solve critical engineering challenges. Our case studies demonstrate how precision manufacturing directly contributes to product innovation, functional reliability, and speed-to-market across industries like **medical devices, dental equipment, life sciences, robotics, semiconductor manufacturing, industrial automation, renewable energy, and aerospace.**

From ± 0.005 mm flatness on wafer chucks to micro-threaded sensor blocks in high-performance polymers, our work speaks for itself. But so do our clients.

What Our Clients Say

"Rollyu's quality and responsiveness exceeded our expectations. Their machining precision and cleanroom readiness helped us qualify new equipment faster than planned."

— Senior Engineer, Semiconductor Equipment Manufacturer

"The attention to detail on our orthopedic components was outstanding. Rollyu's consistency across batches gave our QA team total confidence."

— Director of Supply Chain, Medical Device OEM

"When it came to sourcing complex brackets for our autonomous robotics platform, Rollyu delivered tight tolerances and full documentation — on time, every time."

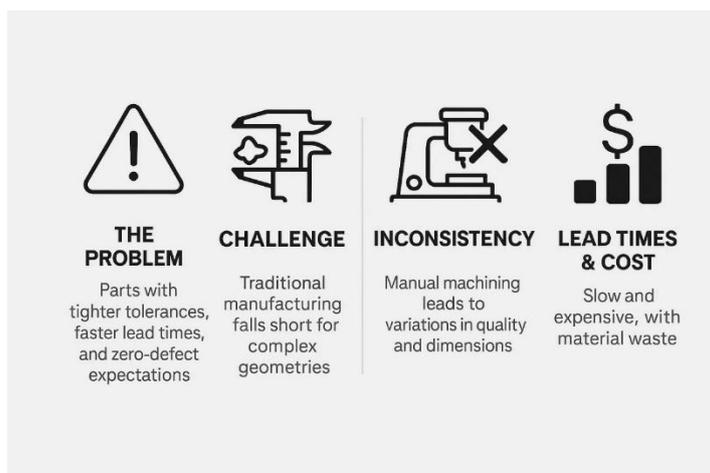
— Mechanical Design Lead, Robotics Startup

Problem-Solution-Benefit

The Problem

In high-tech industries like **semiconductor, medical devices, robotics, and aerospace**, engineers face relentless pressure to design parts with tighter tolerances, faster lead times, and zero-defect expectations. Many suppliers struggle to keep up — delivering inconsistent quality, limited material traceability, and delays in both prototyping and production. These issues can delay regulatory approvals, compromise performance, and increase risk.

- **Challenge:** Many industries require high-precision, custom-made parts, but traditional manufacturing methods often fall short in terms of accuracy, repeatability, and cost-effectiveness, especially for complex geometries.
- **Inconsistency:** Manual machining processes are prone to human error, leading to variations in part quality and dimensions, making it difficult to ensure consistent product performance.
- **Lead Times & Cost:** Traditional manufacturing can be slow and expensive, particularly when producing intricate parts or dealing with frequent design iterations.
- **Material Waste:** In traditional machining, material waste is a concern, increasing costs and impacting sustainability.



The Solution

Rollyu Precision offers **ISO 9001:2015 and ISO 13485:2016 certified** CNC machining services that meet the exacting demands of mission-critical applications. Our 3-, 4-, and 5-axis machining centers handle tight-tolerance features (down to ± 0.005 mm) in materials like **Aluminum, Stainless Steel, Titanium, Invar, and PEEK**. We integrate full traceability, in-process inspection (CMM, optical, thread gauges), and strict quality protocols across every stage — from **rapid prototyping** to **production scaling**.

- **Precision CNC Machining:** Rollyu Precision utilizes advanced Computer Numerical Control (CNC) machining to produce parts with exceptional accuracy and tight tolerances, often within ± 0.001 inches.
- **Multi-Axis Capabilities:** Rollyu Precision can handle complex part geometries with 3-

axis, 4-axis, and 5-axis CNC machines, enabling intricate designs that are difficult or impossible to achieve with manual machining.

- **Material Versatility:** Rollyu Precision works with a wide range of materials, including metals (aluminum, stainless steel, etc.), plastics, and composites, catering to various industry needs.
- **Automation and Programming:** Rollyu Precision leverages automated processes and advanced programming to enhance machining efficiency, reduce lead times, and minimize the potential for errors.



The Benefit

With Rollyu as your CNC machining partner, you gain unmatched precision for critical tolerances and complex geometries, along with faster prototyping-to-production timelines backed by repeatable accuracy. We provide full documentation and material traceability to meet the demands of regulated industries, helping you improve design confidence, reduce rework, and lower total lifecycle costs. Our trusted quality spans across medical, dental, life sciences, robotics, semiconductor, industrial automation, renewable energy, and aerospace sectors — ensuring your parts perform exactly as intended, every time.

- **High Accuracy and Precision:** Rollyu Precision delivers parts that meet the most demanding specifications, ensuring optimal performance and reliability.
- **Consistent Quality:** CNC machining ensures repeatability, guaranteeing consistent part quality across production runs, which is crucial for applications where interchangeability and reliability are critical.
- **Reduced Costs & Lead Times:** Rollyu Precision's efficient CNC machining processes minimize material waste, reduce labor costs, and shorten production times, resulting in cost-effective solutions and faster time-to-market.
- **Design Flexibility:** CNC machining offers flexibility in accommodating design changes and customization, allowing for rapid prototyping and iterative product development.
- **Scalability:** Rollyu Precision can handle projects ranging from prototypes and low-volume production to large-scale manufacturing, adapting to different production needs.
- **Improved Efficiency:** By automating the machining process, Rollyu Precision frees up engineers and technicians to focus on design and innovation rather than manual part

fabrication



Rollyu Precision offers a solution to the challenges of traditional manufacturing by leveraging the power of CNC machining to deliver high-precision, high-quality parts efficiently and cost-effectively, enabling its clients to achieve their goals and improve their product performance.

From surgical instruments to vacuum chamber components, Rollyu delivers parts that perform — in the lab, in the field, and in orbit.



Highlight Customer Pain Points and How Rollyu Solved Them

Solving Real-World Challenges with CNC Precision

How Rollyu Precision Delivers Results That Matter

Customer Pain Point #1: Inconsistent Tolerances in Critical Semiconductor Components

Rollyu Precision addresses customer pain points related to high cost and low productivity in the precision machining industry by offering affordable, high-quality custom parts and leveraging automation for efficiency. We also provide excellent customer service and support,

The Challenge: A leading semiconductor equipment manufacturer struggled with poor flatness and inconsistent thread quality in wafer chuck frames from previous suppliers — leading to vacuum leaks and costly downtime during chamber integration.

Rollyu's Solution: We implemented high-precision 5-axis CNC milling and advanced lapping processes to achieve **±0.005 mm flatness**, verified with CMM inspection. Thread gauges ensured 100% compliance to Class 3A specs.

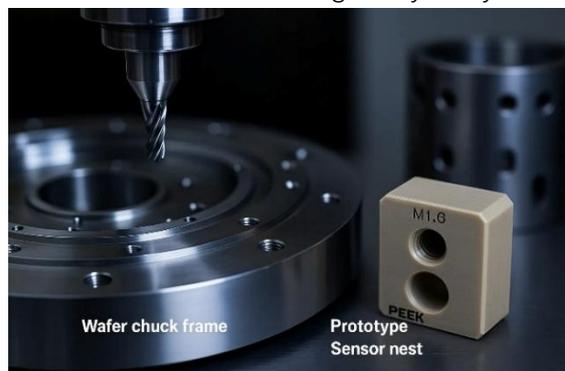
The Result: Over 300 units delivered with **zero non-conformances**, improving tool qualification speed and reducing assembly rework.

Customer Pain Point #2: Fragile Micro-Features in Medical Device Prototyping

The Challenge: A medical device OEM needed quick-turn prototypes with micro-threaded holes (M1.6) in soft materials like PEEK. Previous vendors caused deformation, poor thread engagement, and burr issues.

Rollyu's Solution: Using custom workholding and micro-tooling strategies, we produced burr-free threads and tight-tolerance sensor nests with no surface distortion. All components were RoHS and REACH compliant.

The Result: Prototypes passed functional testing on the first try — accelerating regulatory submissions and minimizing costly delays.



Customer Pain Point #3: Long Lead Times for Custom Automation Brackets

The Challenge: An industrial automation customer required CNC-milled aluminum and stainless brackets with complex geometries and short timelines. Previous suppliers couldn't

meet the lead time without sacrificing inspection documentation.

Solution: With in-house CNC capacity and lean scheduling, we machined and inspected critical brackets within **10 days**, providing full dimensional reports and material certs.

The Result: The client met their build deadline and standardized on Rollyu for future orders — citing **speed, consistency, and quality documentation**.

Customer Pain Point #4: Cosmetic and Functional Defects in Aerospace Parts

The Challenge: A NewSpace aerospace company faced cosmetic scratches and inconsistent chamfering on aluminum satellite structures that impacted thermal coating and fit-up.

Rollyu's Solution: We introduced fixture-based fixturing for repeatable part orientation and applied post-machining hand finishing and anodizing control per aerospace cosmetic standards.

The Result: The client reported a **98% yield improvement** and now relies on Rollyu for critical external structural components.



With Rollyu as your CNC machining partner, you gain unmatched precision for critical tolerances and complex geometries — including features as tight as ± 0.002 mm, micro-threaded holes, thin-wall structures, and multi-axis contours. We overcome technical challenges such as machining heat-sensitive polymers like PEEK without deformation, maintaining flatness in large aluminum components, and producing defect-free Class 3A threads in stainless steel. Our agile processes enable faster prototyping-to-production timelines with consistent accuracy. Backed by full documentation and material traceability, we help regulated industries improve design confidence, reduce rework, and lower total lifecycle costs. From medical and dental devices to robotics, semiconductors, industrial automation, renewable energy, and aerospace, Rollyu delivers parts that meet your highest standards — every time.

Chapter 10: CNC Machining FAQs

This section addresses some of the most frequently asked questions from engineers, buyers, and project managers working with Rollyu Precision for CNC machining services. It covers lead times, order volumes, surface finish expectations, and documentation standards to help customers plan and manage their projects efficiently.

1. What are the typical lead times for CNC machining projects?

Lead times depend on part complexity, material availability, quantity, and post-processing requirements.

- **Rapid prototypes:** 5–10 business days
- **Small to mid-volume production:** 10–20 business days
- **High-volume runs or parts requiring anodizing, heat treatment, or electropolishing:** 20–30 business days

Expedited services are available upon request. All delivery schedules are confirmed during quotation based on actual capacity and supply chain conditions.

2. What is your minimum order quantity (MOQ)?

Rollyu Precision supports a range of order sizes:

- **Prototypes and single-piece machining:** Accepted
- **Low-volume production:** From 5 to 100 units
- **Full-scale production:** 100+ units, with pricing tiers based on quantity

We work closely with startups, R&D teams, and OEMs — no MOQ is required for initial development or validation builds.

3. What surface finish standards can Rollyu achieve?

Surface finish depends on the machining process, material, and any post-processing treatments applied:

- **As-machined:** Ra 1.6–3.2 μm typical (63–125 μin)
- **Polished:** Ra 0.4–0.8 μm (16–32 μin)
- **Electropolished / Chemically polished:** Ra < 0.2 μm for critical applications
- **Anodized / Bead-blasted / Powder-coated:** Available per customer spec
- **Cosmetic surfaces:** We follow industry-specific standards, including ASTM, ISO 1302, or customer-defined appearance criteria

All finishes are visually inspected and, if specified, verified using surface roughness testers (profilometers).

4. Do you provide material certifications?

Yes. Rollyu Precision offers full traceability and certification for all materials used:

- **Material Test Reports (MTRs) / Mill Certificates**
- **RoHS & REACH compliance declarations**
- **Biocompatibility certification** for medical-grade materials (e.g., Titanium Grade 5, 316L Stainless Steel, PEEK)

- **DFARS-compliant or domestic source documentation**, if required

Certifications are included upon request and form part of our standard quality documentation package for regulated industries such as medical, dental, robotics, aerospace, and semiconductor.

Getting a Quote for CNC Machining Services

Choosing the right CNC machining partner is a critical step in your manufacturing process. At **Rollyu Precision**, we make the quoting process for CNC machining simple, accurate, and highly responsive — whether you're sourcing prototypes, low-volume production, or high-precision, high-volume components for regulated industries.



What Information Do We Need for an Accurate CNC Quote?

Providing complete and accurate information up front ensures we deliver a fast and reliable quote tailored to your specific project. Here's what we recommend submitting:

1 Engineering Drawings & 3D Models

- 2D Technical Drawings (PDF, DWG, DXF)
- 3D Models (STEP, IGES, SolidWorks, Parasolid)
- Include:
 - Tolerances (especially for critical dimensions)
 - Surface finish requirements
 - Material callouts
 - Thread specifications
 - Geometric tolerances (GD&T)

2 Material Requirements

- Metals (Aluminum, Stainless Steel, Titanium, Brass, Copper, Tool Steels, etc.)
- Plastics (POM, PEEK, PTFE, PEI, PC, Nylon, Ultem, etc.)
- Specialty Alloys or Customer-Supplied Material

3 Quantity & Production Volume

- Prototype or single-piece sample
- Small batch production
- Full production volumes

- Forecast demand for blanket orders or KanBan programs

4 Surface Finishing Requirements

- Anodizing (Type II, Type III)
- Passivation
- Electropolishing
- Bead Blasting
- Powder Coating
- Plating (Nickel, Zinc, Gold, etc.)
- Custom Coatings

5 Certification & Compliance Needs

- ISO 9001 or ISO 13485 certification
- Material traceability / RoHS / REACH
- PPAP, FAI, CMM inspection reports
- Cleanroom packaging or export compliance (if applicable)

6 Delivery Requirements

- Lead time expectations
- Delivery destination (domestic or global)
- Special packaging or kitting requests

Our CNC Quoting Process

Here's how your RFQ moves through our team at Rollyu Precision:

1 DFM Review (Design for Manufacturability):

Our engineers analyze your part geometry to ensure manufacturability, recommend optimizations, and identify potential cost-saving adjustments.

2 Process Planning:

We determine optimal machining strategies (5-axis, 3-axis, turning, EDM, grinding, etc.) to meet your tolerances, surface finishes, and functional requirements.

3 Material & Process Sourcing:

We confirm raw material availability and select the most efficient machining, finishing, and inspection workflows.

4 Detailed Quotation:

We provide:

- Unit pricing
- Tooling (if applicable)
- Lead time
- Shipping & delivery terms
- Optional value-add recommendations

Quote Turnaround Time

- **Standard Projects:** 1–3 business days
- **Complex Multi-Part Assemblies:** 3–5 business days
- **Large BOM Programs:** Custom schedule upon project review

What If You Don't Have Full CAD Files?

No problem. Our engineering team can assist in converting sketches, samples, or legacy drawings into full 3D models and manufacturing packages. We regularly support customers during product development stages.

Why Choose Rollyu Precision for CNC Machining?

-  3-Axis, 4-Axis & 5-Axis CNC Machining
-  Precision CNC Turning & Swiss Turning
-  Tight Tolerances ($\pm 0.005\text{mm}$ capability)
-  Full In-House Surface Finishing
-  ISO 9001 & ISO 13485 Certified
-  CMM Inspection & Full Traceability
-  Prototyping to Production Scaling
-  Global Export Experience

Ready to Request a CNC Machining Quote?

 **Email your RFQ to:** info@rymaching.com

 **Visit us online at:** www.rymaching.com