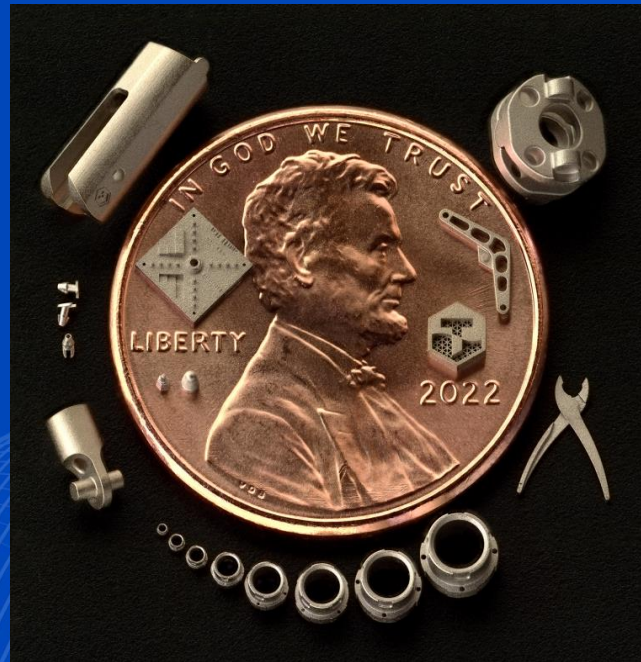




TRIO LABS

Micro Metal Manufacturing

Precision components for
next-generation medical devices





About Trio Labs

Improving patients' lives by enabling critical healthcare innovation



Trio Labs manufactures precision micro-scale metal components for the medical device industry. Our proprietary RIPL technology delivers CNC-equivalent quality at scales conventional manufacturing cannot reach.

Morrisville, NC

ISO 13485 Certified

**73+ Companies
Served**



Resin Infused Powder Lithography (RIPL®)

Breaking New Ground In Micro Metal Additive Manufacturing



Achieve CNC-Level Precision

Gold standard for micro metals. Matches CNC surface finish & tolerances. Ultra-high precision (5-micron resolution).

With MIM Materials

Standard metal injection molding powders. Standard MIM sintering furnaces. Access to broad portfolio of materials.

In a 3D Printing Process

Outperforms existing 3D tech. Scales easily to high-volume production. Handles complexity better than MIM.



The Applications We Serve



Robot-Assisted Surgical Solutions

Instruments, end effectors, articulating joints, housings, and structural components for robotic systems



Catheter-Deployed Interventional

Electrodes, tips, housings, and delivery system components for high-performance catheters



Where Manufacturing Hits Its Limits

CNC / EDM / ECM

- Tools <0.25mm diameter fracture easily
- Walls <0.2mm are impacted by tool deflection
- Cannot create enclosed curved channels
- <1mm parts: "consider other processes"

Hard limit: ~0.1-0.2mm features

Metal Injection Molding

- 15-25% shrinkage unpredictable at micro scale
- Walls <0.3mm: 10-18% breakage rate
- \$30-50K+ tooling, months per geometry
- Hinders rapid prototyping

Hard limit: ~0.2-0.5mm walls

<THE GAP>

No production-ready
solution for complex metal parts
at sub-millimeter scale

Semiconductor Alternatives

Electrochemical deposition, LIGA, and wafer fabrication operate at sub-mm resolution — but from the wrong paradigm:

- 2.5D structures, not solid 3D metal parts
- Nickel and silicon, not biocompatible SS
- \$20B fabs or synchrotron facilities
- Economics require millions of units
- Wrong regulatory framework for medtech

Wrong paradigm for medical devices

**Medtech demands rapid iteration of solid metal parts in biocompatible alloys
at volumes of several to several hundred thousand, all managed in ISO 13485 standards**



RIPL[®]: Built for the Gap

Standard Binder Jetting

50-100 μm layers

RIPL Today



5 μm layers

10-20x finer

RIPL Roadmap



2 μm layers

25-50x finer

Solid 3D Metal Parts

17-4PH and 316L stainless steel. Dense, structural, load-bearing. Not thin films or shells.

Complex Internal Geometry

No tooling constraints. Enclosed channels, lattices, and features CNC tools cannot reach.

Prototype to Production

Same process, same parameters, same qualification from first part to full production run.

The only production-ready process that extends precision manufacturing into territory CNC and MIM cannot reach.



Resin Infused Powder Lithography (RIPL®)

Additive manufacturing with the precision of CNC



Fabricate Green Parts

- Standard MIM metal powder
- Blend with photopolymer resin
- UV cure one layer at a time



Remove Excess Material

- Excess material supports build
- No complex supports
- Washes away easily



Sinter Green Parts

- Standard MIM sintering furnace
- Polymer binder burns away
- Metal fuses, dense part remains



Net-Shape Part Ready

- Tolerances as tight as $\pm 0.0006''$
- CNC-quality surface finish
- High density, repeatable properties

Borrowing the best of MIM

Materials, metallurgy, qualifications are similar to MIM — low barrier to proving quality.

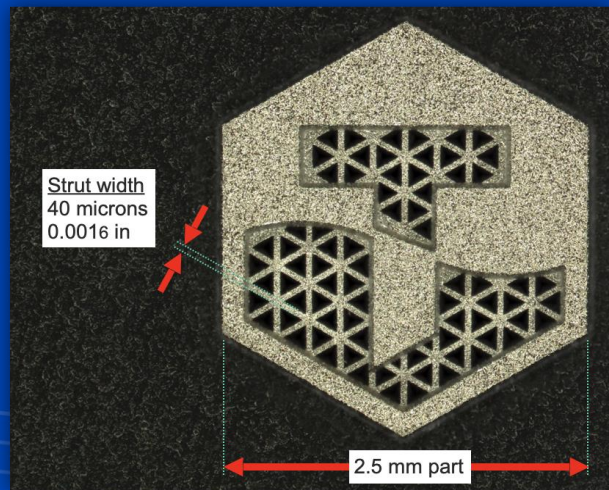
Not 3D printing as you know it

More scalable, greater precision, fewer defects than SLS, DMLS.



RIPL[®] Performance Characteristics

5-Micron Resolution



Tolerance

± 0.0006 " (15 microns) or 1.5% of nominal, whichever is larger.

Tighter tolerances achieved in many cases.

Surface Finish

Ra32 (0.8 micron) average native surface finish.

Secondary processing often not required. Electro- or vibratory polishing optional.

Repeatability

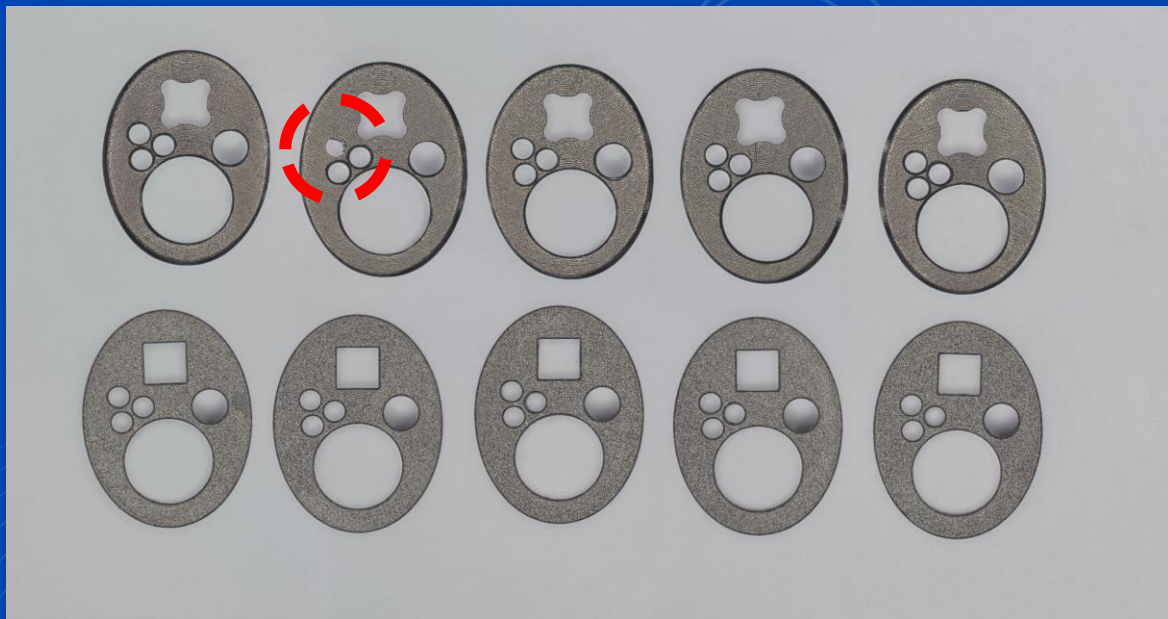
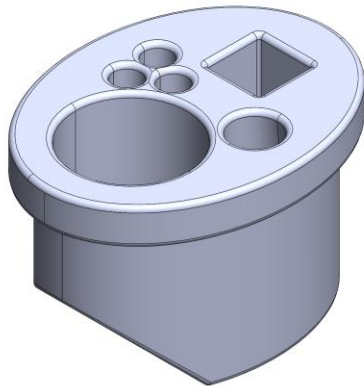
Tap density, isotropic green parts.

High degree of repeatability for both print and sinter processes.



Direct Comparison

Machining vs RIPL[®]

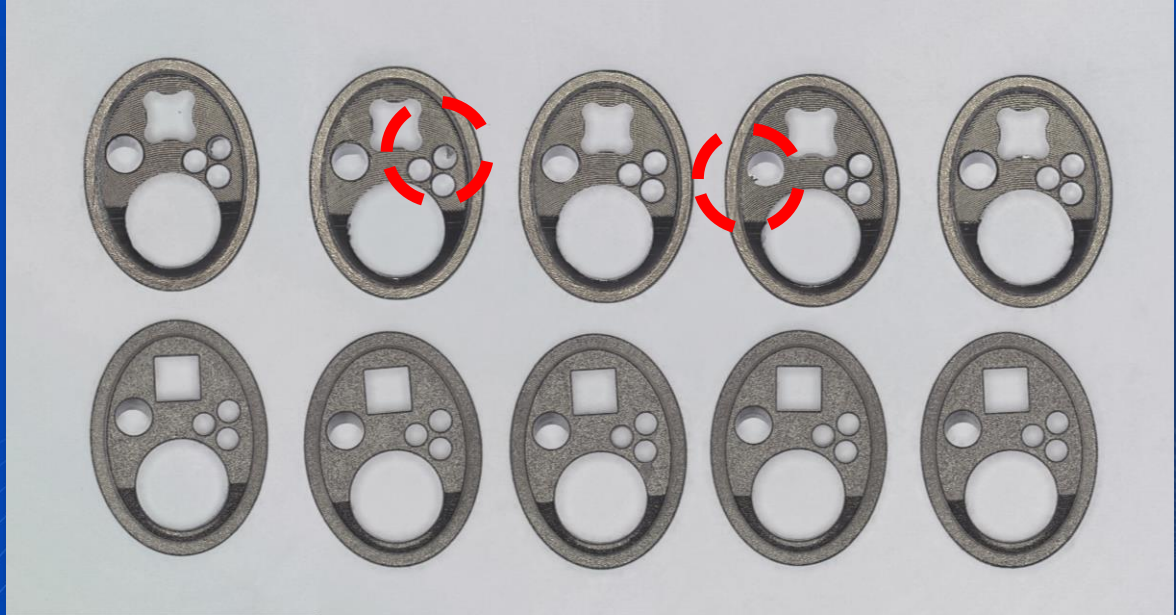
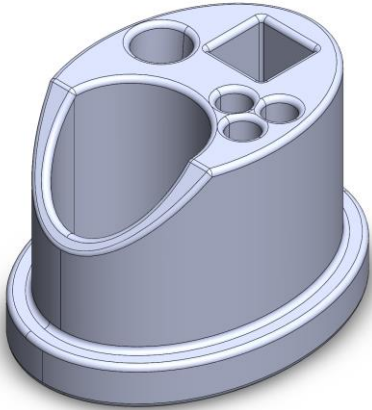


RIPL is a burr-free process with greater fidelity to CAD



Direct Comparison

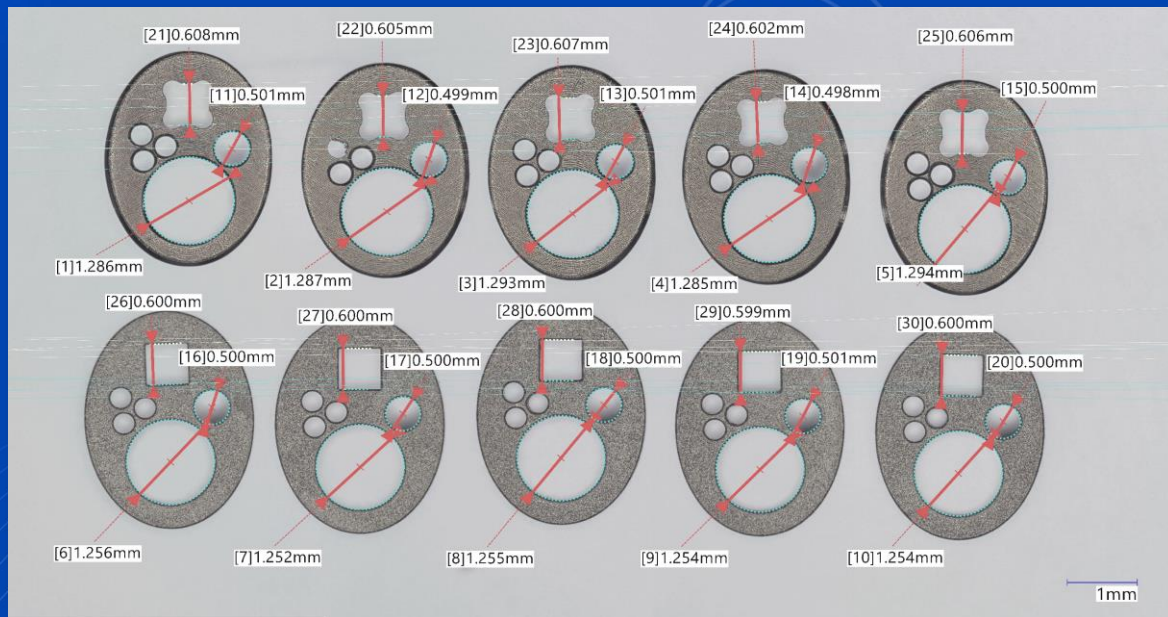
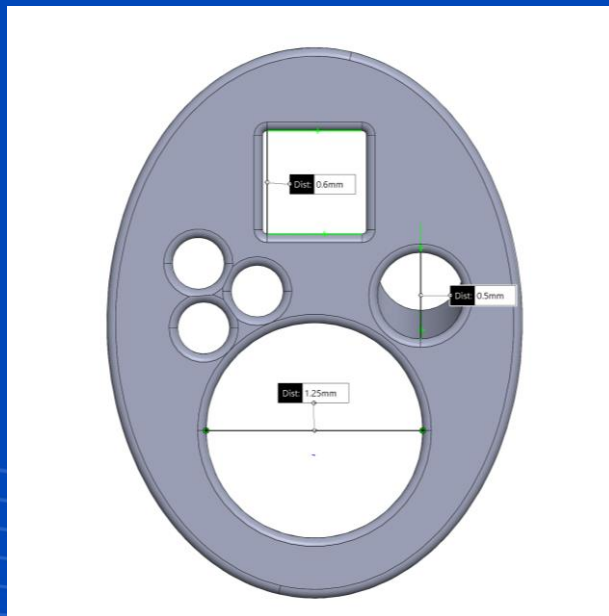
Machining vs RIPL[®]





Direct Comparison

Machining vs RIPL[®]





Direct Comparison: 17-4PH, 316L

MIM vs RIPL® vs Wrought

Property	Standard	Trio Labs 17-4PH as sintered	Trio Labs 17-4PH H900	Comparative Reference Values		
				MIM As- Sintered ¹	MIM H900 ¹	Wrought H900 ²
Tensile Strength	Micro tensile testing based on ASTM E8, adjusted for sample size	1158 MPa	1371 MPa	900 MPa	1190 MPa	1310 MPa
0.2% Yield Strength		952 MPa	1166 MPa	730 MPa	1090 MPa	1170 MPa
Elongation at Break		13.2 %	15.4 %	6 %	6 %	10 %
Hardness	ASTM E18	35 HRC	41 HRC	27 HRC	35 HRC	40 HRC
Relative Density	ASTM B311	97 %	97 %	96 %	96 %	100 %
Corrosion testing	ASTM F1089	Pass	Pass	Pass	Pass	Pass

Property	Trio Labs 316L As-Sintered	Comparative Reference Values	
		MPIF 35* As-Sintered	ASTM A240 Wrought
Tensile Strength	544 MPa	520 MPa	482 MPa
0.2% Yield Strength	175 MPa	175 MPa	172 MPa
Elongation at Break	90 %	50 %	40 %
Hardness	75 HRB	67 HRB	95 HRB max
Relative Density	97 %	95 %	-



Key Capabilities

Part Size

Ideal Range

2mm to 5mm

Maximum

12.2 x 7.6 x ~5mm

- Some flex in Z direction
- Larger parts available 2026Q3

Feature Size

5-micron volumetric pixels (voxels)
Walls down to 25 microns

Materials

Now

17-4 Stainless Steel
316L Stainless Steel

In consideration

304L Stainless Steel

In pipeline

Titanium / Ti64

Future possibilities (please share your thoughts!)

F75, Nitinol, Tungsten, Ceramics

Production

Total Medtech focus

ISO 13485 Certified

Scalable to

Tens to hundreds of thousands
(and beyond) in annual volumes

Production-ready infrastructure

Capacity to support quick turn
prototyping AND high volume
production



Part of Your MedTech Toolkit

No single technology is an all-purpose solution

OPTIMAL USE CASE	MICRO MANUFACTURING TECHNOLOGY		
	CNC, EDM, ECM	MIM	RIPL®
Superior precision & tolerances	✓		✓
High complexity	✓		✓
Low cost for complexity		✓	✓
High volume		✓	✓
High mix	✓		✓
Design flexibility			✓
Scalability (proto to production)			✓
Fastest lead time			✓
Fastest production speed		✓	
Millimeter Part Size	✓	✓	✓
Centimeter Part Size	✓	✓	
Larger Part Size	✓		
Metal stock	✓		
Metal powder		✓	✓

RIPL® shines best with:

- Smaller parts with high complexity
- Quick prototyping turn times
- Seamless transition to high volume production



Working With Trio

Meet With Trio Engineers

- Technology primer (if needed)
- Go over project needs
- Review CAD and drawings
- Discuss DFM, clarify critical tolerances

Request for Quote

- Submit in STEP file format
- 50-micron fillets on sharp edges where design allows
- Provide drawings (optional), indicate critical tolerances

Quote Response: ~24 Hours

Delivery: ~2-4 Weeks

sales@triolabs.com | www.triolabs.com



TRIO LABS

**IMPROVING PATIENTS' LIVES BY ENABLING
CRITICAL HEALTHCARE INNOVATION**

133 Southcenter Ct., Suite 900, Morrisville NC 27560
252-899-2573 | sales@triolabs.com | www.triolabs.com

LinkedIn: Trio Labs Inc.



RIPL[®] Design Guide

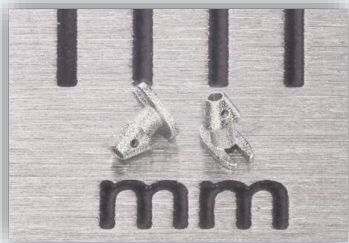
All tolerances are subject to review based on specific designs

Parameter	Specification
Materials	17-4PH SS, 316L
Min Feature Size	0.002" [50µm] posts, 0.0016" [40µm] walls
Hole Sizes	Blind 3:1, Through 5:1 aspect ratio
Edges	5-7µm radii, 25-50µm fillets recommended
Surface Finish	Ra32µin [Ra 0.8µm]
Max Part Size	7.6mm x 12.2mm x 5mm
Layer Thickness	0.0002" [5µm]
Tolerances	±1.5% or ±0.0006" [15µm]

Additional MedTech Applications

Ophthalmic

Glaucoma Shunts
Instrumentation



Orthodontic

Alignment Brackets



Microneedles

Drug Delivery

