



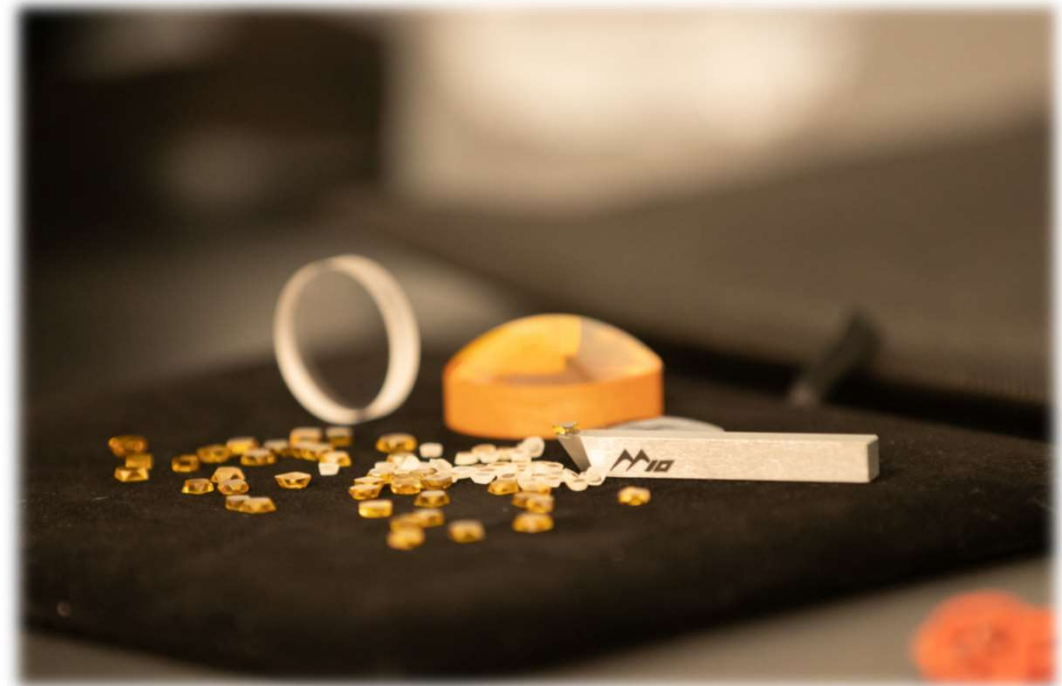
A Micro-LAM Company

# **M10 Edge, Ltd.**

## **Advanced Diamond Tooling**

# M10 Overview

- ❑ A Micro-LAM, Inc. Company
- ❑ M10 was founded in 2019 based on key core values:
  - ✓ Consistency in tool performance to improve production efficiency.
  - ✓ Using science to determine the optimal tool for each application.
  - ✓ Delivering on time.
  - ✓ Providing support beyond tool manufacturing.
- ❑ Collectively over 150 years in ultra-precision tooling experience.
- ❑ The exclusive manufacturer for the patented laser-assisted diamond turning tools.



# The Ecosystem



# Global Coverage



USA



UK (Headquarters)



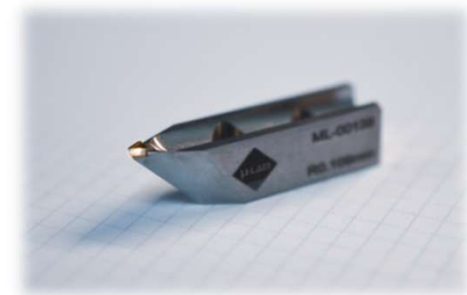
China (Repair Services)

Coming soon in 2021



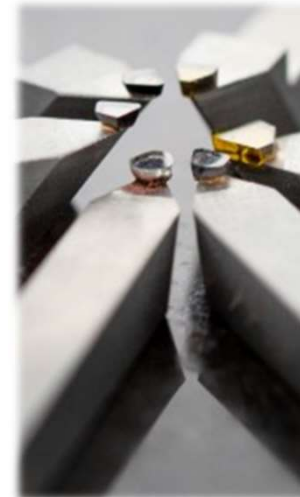
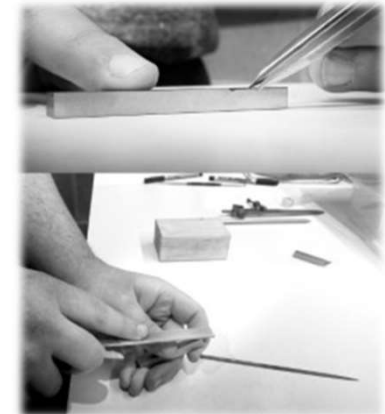
# Core Competencies

- ▶ Consistent tool performance
- ▶ Customer service & support is top priority
- ▶ Top quality relap ensuring minimal diamond removal
- ▶ R&D oriented team putting science to work
- ▶ The only diamond tool manufacturer with in-house diamond turning machines & metrology to support customer applications



# Consistent Tool Performance

- ▶ For years customers have seen “certain” tools outperform tools that are the same geometry
  - ▶ Customer quote: “We buy 10 tools 5 of them perform as expected, the other 5 perform more like a roughing tool”
- ▶ M10 Edge’s experience in diamond polishing sprinkled with the science of Micro-LAM ensures our customers of a tool that performs consistently.
- ▶ Quality control at every step:
  - ▶ Stone orientation QC
  - ▶ Brazing stability QC
  - ▶ In-depth waviness QC on diamond turning industry standard metrology
  - ▶ Chip-free cutting edges at 500x Nomarski with photos stored
- ▶ All of the above and more, ensure that our customers see a repeatable tool life, whether the tool is new or repaired.



# Customer Service

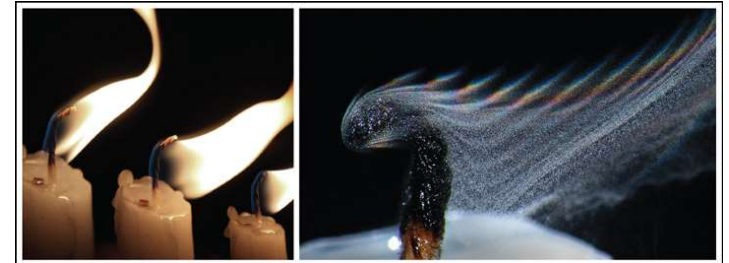
- ▶ New tools guaranteed to be dispatched within 4-6 weeks of order being placed.
- ▶ 1 Free Relap on every new tool we deliver late.
- ▶ Guaranteed 3 day on-site turn-around on relaps.
- ▶ Technical & R&D support for machining related challenges.
- ▶ Investing the time & resources to build partnerships with customers.
- ▶ Over 150 years of experience in tool selection, manufacturing & applications.



# Fun Facts on Diamonds

A candle flame contains millions of small diamonds

A professor of chemistry at St Andrews University found that 1.5 million diamond nanoparticles can be found in a candle's flame



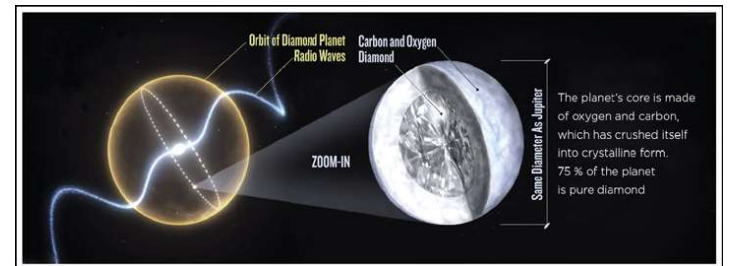
Diamond is one of the hardest substances on earth

According to researchers a diamond is 58x harder than anything else in nature, therefore the only object that can cut through a diamond is another diamond.



Lucy, the diamond in the sky

In 2007, the Harvard-Smithsonian Centre for Astrophysics announced the discovery of a 10 billion-trillion-trillion carat diamond in the sky. The star was named after the Beatles song, "Lucy in the Sky with Diamonds" and is located fifty light years from Earth.





# Types of Diamond

Monocrystalline Natural Diamond



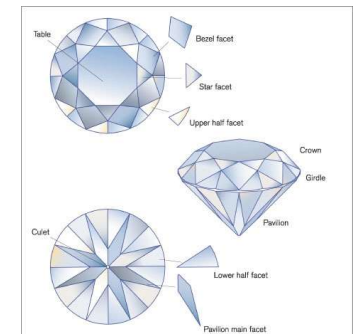
Monocrystalline Synthetic Diamond



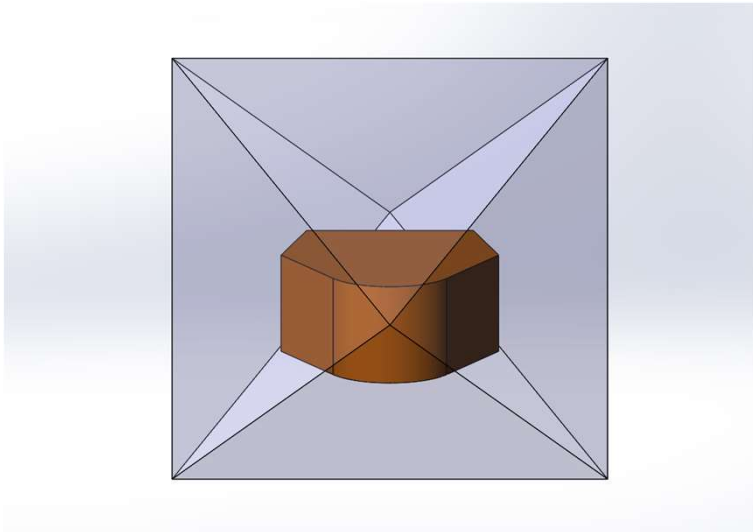
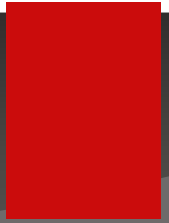
# Diamond Selection

4 key criteria carried detailed by M10 specialists during diamond selection (COSS):

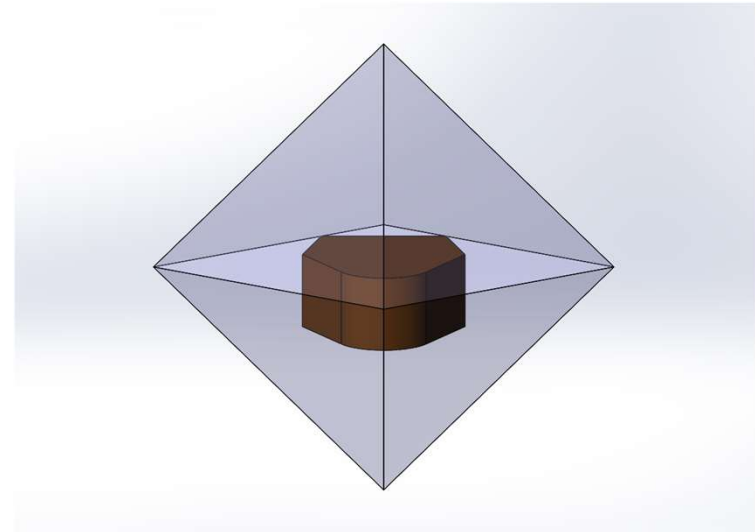
1. Colour of the stone
2. Orientation & grain structure of the stone
3. Size of the stone
4. Shape of the stone



# Diamond Orientation



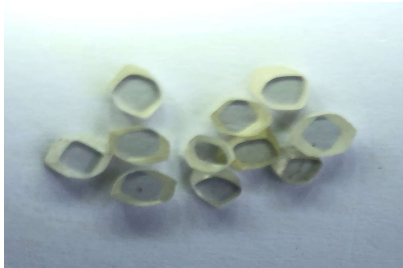
110/100 Dodec Orientation, 2-point



100/100 Cubic Orientation, 4-point



# Diamond Orientation Continued



## Diamonds in the **Dodec** Orientation

- Most resistant to abrasive wear
- Maximum controlled arc 120°
- Over 120° of arc is possible, outside of the central 120° you can't control waviness
- For tools with high clearances up to 20° as standard and up to 40° for tough parts
- Secondary clearances are possible up to 75°
- Positive or negative rake angle possible +65° down to -75°



## Diamonds in the **Cubic** Orientation

- Most resistant to chemical wear
- Up to 170° of controlled arc is possible
- 15° maximum clearance for controlled waviness tools
- 20° maximum clearance on standard waviness tools
- Secondary clearances are possible up to 75°
- +2½ down to -65° rake angles possible





# The 8-Point Inspection

## 1 Send us your problem tool.

1. Waviness
2. Remaining life
3. Top rake quality
4. Diamond quality
5. Crystal orientation
6. Crystal alignment quality
7. Braze area and quality
8. Shank material analysis

## 2

**Receive an honest  
assessment of your  
options.**

## 3

**Take advantage of a  
generous trade-in deal.**



# Combined Expertise Supporting Your M10 Tool

Ultra-Precision Tool Mfg.

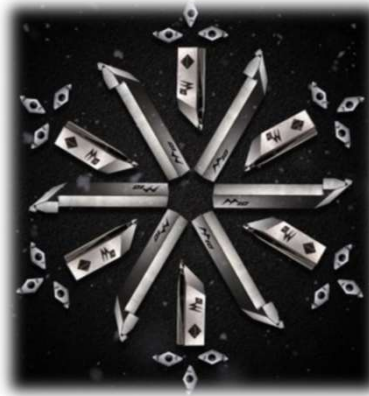
> 150 years

Precision Eng. & Metrology

> 40 years

Tooling Sales & Support

> 40 years



Diamond Turning

> 80 years

Tool Repair & QC

> 150 years

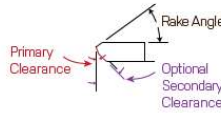
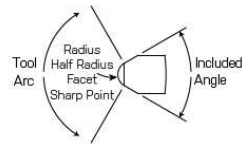
Tool Design & Selection

> 55 years



# M10 Tool Code

## M10 Edge Tool Configurator



### Tool Geometry Code

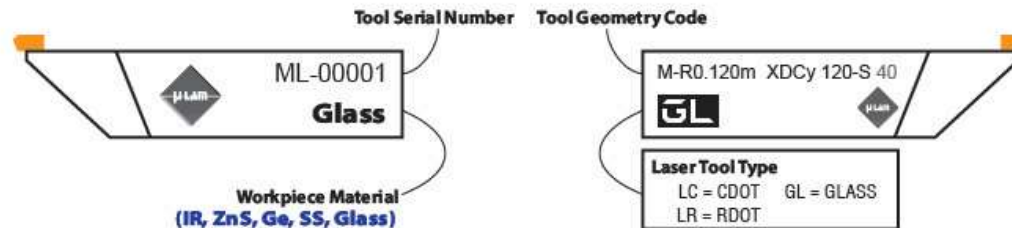
**N-R0.50m WFCy 100-C4 40 i**

<b>Diamond Type</b> <b>N</b> Natural <b>M</b> HPHT4 <b>H</b> HPHT2 <b>C</b> Clear CVD <b>B</b> Black CVD <b>S</b> Sumitomo <b>P</b> PCD	<b>Full Radius [R]</b> R - 0.120 mm	<b>Half Radius [H]</b> H - 0.120 mm	<b>Facet Tool [F]</b> F - 0.120 mm	<b>Sharp Point [P]</b> P	<b>Rake Angle</b> F = +20° X = -35° E = +10° B = -40° J = +5° Y = -45° K = +2.5° Z = -65° L = 0° M = -2.5° N = 5° O = -7.5° R = -10° T = -15° V = -20° W = -25° C = -30°	<b>Primary Clearance</b> J = 5° Z = 35° H = 7.5° I = 40° S = 8° C = 45° G = 10° F = 12.5° T = 14° E = 15° V = 16° X = 17° W = 18° D = 20° B = 25° A = 30°	<b>Clearance Type</b> Cy = Cylindrical Co = Conical	<b>Tool Arc</b> T' - 170°	<b>Waviness</b> S = < 2.00µm C1 = < 1.00µm C2 = < 0.75µm C3 = < 0.50µm C4 = < 0.25µm C5 = < 0.20µm C6 = < 0.15µm C7 = < 0.10µm C8 = < 0.05µm C9 = < 0.03µm	<b>Optional Secondary Clearance</b> 6° - 70°	<b>Optional Insert Tool Shank</b> i
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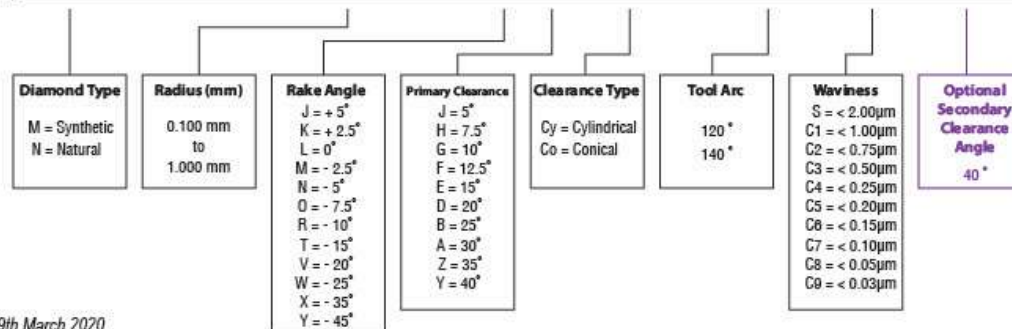


# Micro-LAM Tool Code

## Micro-LAM Tool Codes



**Tool Geometry Code**  
M-R0.120m XDCy 120-S 40

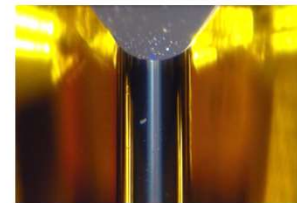


Rev 29th March 2020



# Laser Assisted Tooling Inspections

- ▶ M10 is an exclusive supplier for the only patented opto-mechanical cutting tool.
- ▶ M10 personnel trained by Micro-LAM.
- ▶ Opto-mechanical tool performance certification
- ▶ M10 is equipped with laser tooling inspection equipment to perform
  - ▶ IR transmission tests
  - ▶ Tool shank fit on tool post
  - ▶ Diamond clearance on cooling copper cap
  - ▶ Surface quality and clarity of laser entry surface



# Waviness Inspection & Re-radiusing

- ▶ Contact probe based ultra-precision measurement system with gage resolution of 0.3nm
- ▶ In-depth focus on the shape and transition zones within the tools waviness
- ▶ Peak to valley, Ra & Rq are measured
- ▶ Serial number, tool type and inspector detail provided
- ▶ Radius, front clearance angles, total arc, included angle, cutting height & rake angle all specified
- ▶ Re-radiusing on controlled or standard waviness tools if required
  - ▶ Turnaround on reradius tools is one working week



## Measurement Certificate

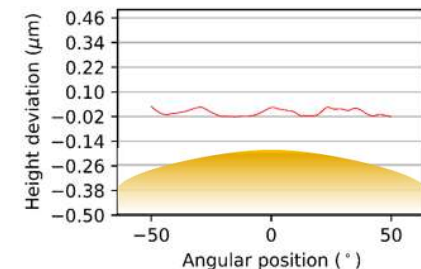
2/23/2021

		Parameter	Value	Units	
<b>Serial</b>	M10-00445	Radius	0.492	(mm)	
<b>Customer</b>	██████████	Primary Clearance	15.0	(DEG)	CYL
<b>Job Number</b>	R-ML00004	2nd Clearance	n/a	(DEG)	
<b>Tool Type</b>	N-R0.50m LECy 100-C4	Sweep Angle	100.0	(DEG)	
<b>Inspector</b>	<b>Simon Barlow</b>	Included Angle	60.0	(DEG)	
		Cut Height		(mm)	
		Rake	0°		

### Measured Parameters

PV 0.053 (μm) Rq 0.015 (μm) Ra 0.013 (μm)

### Waviness Profile




# Waviness Inspection & Re-radiusing

## (Opto-Mechanical Diamond Tool)

- ▶ Contact probe based ultra-precision measurement system with gage resolution of 0.3nm
- ▶ In-depth focus on the shape and transition zones within the tools waviness
- ▶ Peak to valley, Ra & Rq are measured
- ▶ Serial number, tool type and inspector detail provided
- ▶ Radius, front clearance angles, total arc, included angle, cutting height & rake angle all specified
- ▶ Re-radiusing on controlled or standard waviness tools if required
  - ▶ Turnaround on reradius tools is one working week
- ▶ OMDT Checks
  - ▶ Laser window inspection
  - ▶ Geometrical tolerances for diamond & shank
  - ▶ IR Laser transmissivity





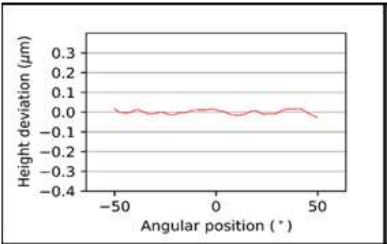
**Measurement Certificate** 21/01/2021

	Parameter	Value	Units	
Serial	ML-00724	Radius	0.210	(mm)
Customer	Micro-LAM Inc	Primary Clearance	17.0	(DEG) CYL
Job Number	N-ML00042	2nd Clearance	50.0	(DEG)
Tool Type	LC M RD 2m YKCV 120 C4 S	Sweep Angle	100.0	(DEG)
Inspector	Simon Barlow	Included Angle	60.0	(DEG)
		Cut Height	10.454	(mm)
		Rake Angle	-45	




**Measured Parameters**

PV 0.044 (μm)	Rq 0.010 (μm)	Ra 0.009 (μm)
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**Waviness Profile**



**Laser Window Inspection**

Front
Back
Exit

**Pass/Fail**

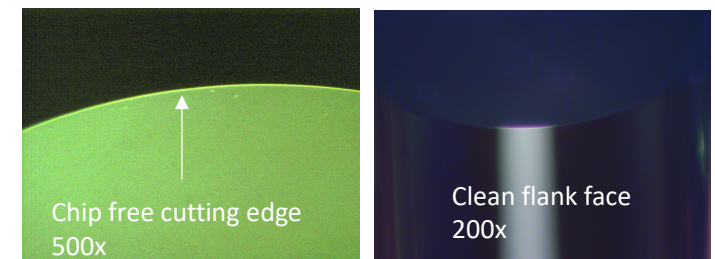
Tool Condition	FAIL <input type="checkbox"/>	PASS <input checked="" type="checkbox"/>
HeNe Throughput	FAIL <input type="checkbox"/>	PASS <input checked="" type="checkbox"/>
Crystal Status	FAIL <input type="checkbox"/>	PASS <input checked="" type="checkbox"/>
IR >8Watts	FAIL <input type="checkbox"/>	PASS <input checked="" type="checkbox"/>

# Relap Inspection

- ▶ Custom tool holders used for specific geometries to ensure consistency and geometrical tolerance maintained with each repair.
- ▶ Cutting edge inspected under a Nomarski microscope to ensure a chip-free edge at 500x.
- ▶ Inspection before and after each relap is carried out to ensure minimal diamond removed.
- ▶ Images of chip free cutting edges as new or repaired is saved and available on request.
- ▶ 3 day on-site turnaround for relaps.



Before Relap



After Relap



# M10's R&D Support

- ▶ 5 x PhD's with expertise in...
  - ▶ Precision Engineering
  - ▶ Materials Science
  - ▶ Tribology
  - ▶ Metrology
  - ▶ Optical Engineering



2 x Precitech N250 Ultra



JEOL SEM (with EDAX)



SIEMENS D5000 XRD



Precitech NanoX



Optimus T+1



KEYENCE Z450 Microscope



# M10's Applications Support



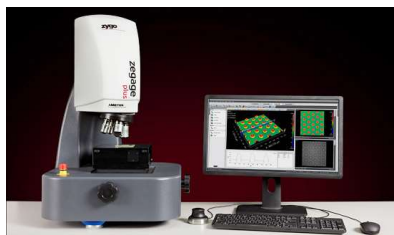
Precitech N700 Ultra



Nanotech 250 UPL



Talysurf PGI Optics



Zygo White Light Surface  
Profilometer



Zygo Fizeau Interferometer



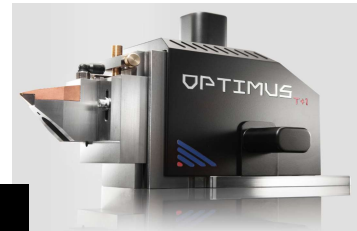
LuphoScan 260-HD



# PACE – Precision Advancement Center of Excellence (UK)



4-axis Ultra-Precision Lathe



Optimus T+1 & Optimus T2



Ultra-Precision Diamond Tools



White Light Interferometer (Surface Roughness)



PGI Optics (Surface Profile)



Luphoscan (Surface Figure)

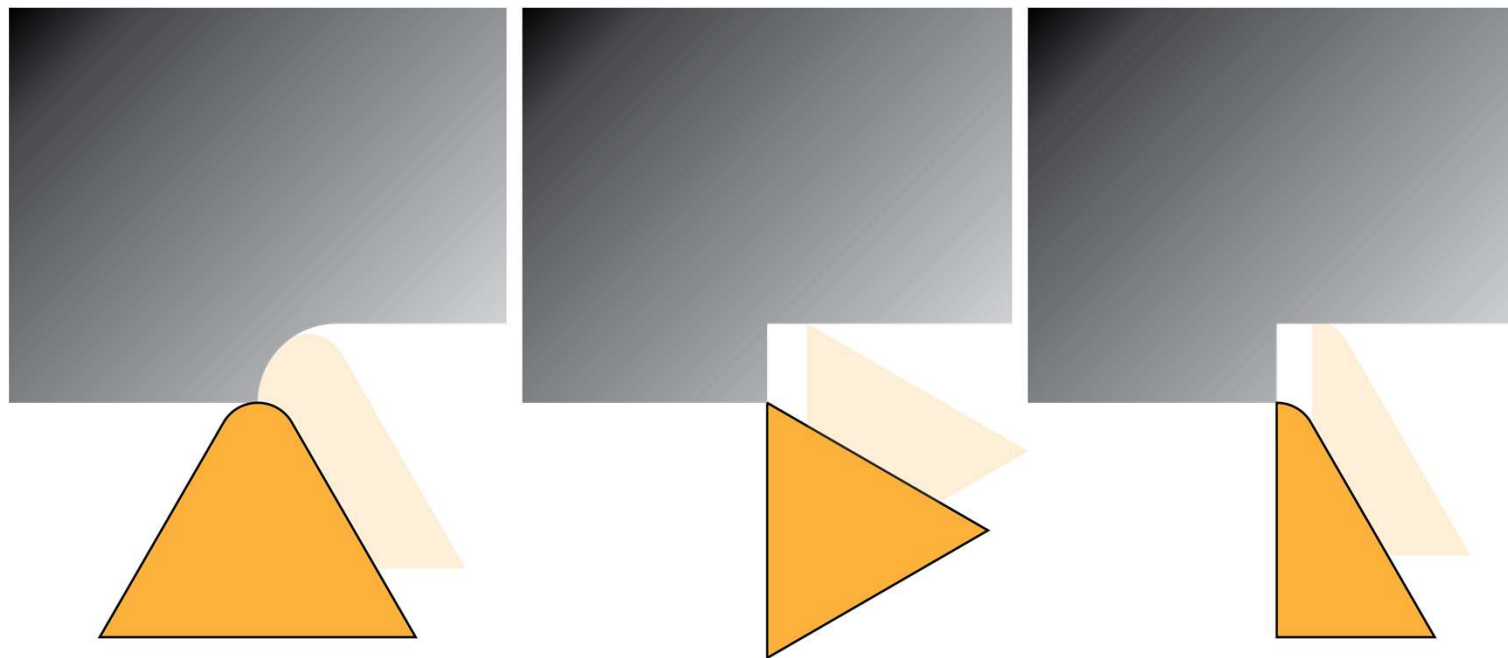


Jayesh Navare



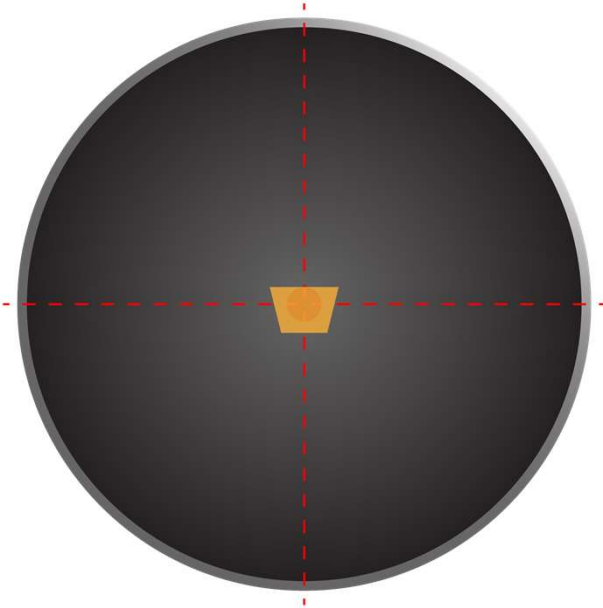
- Applications Engineer
- Micro-LAM & M10 Representative
- Masters in Mechanical Engineering
- Specialized in Precision Engineering

# Tooling for Diffractives & Fresnels

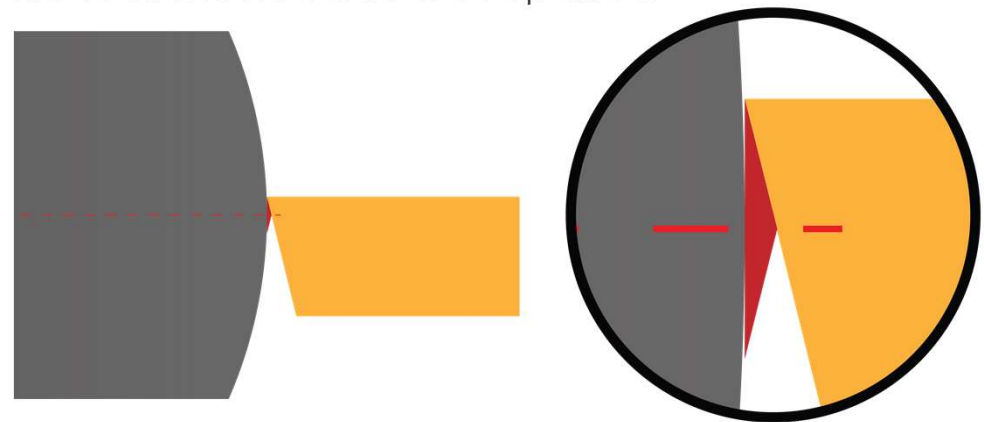




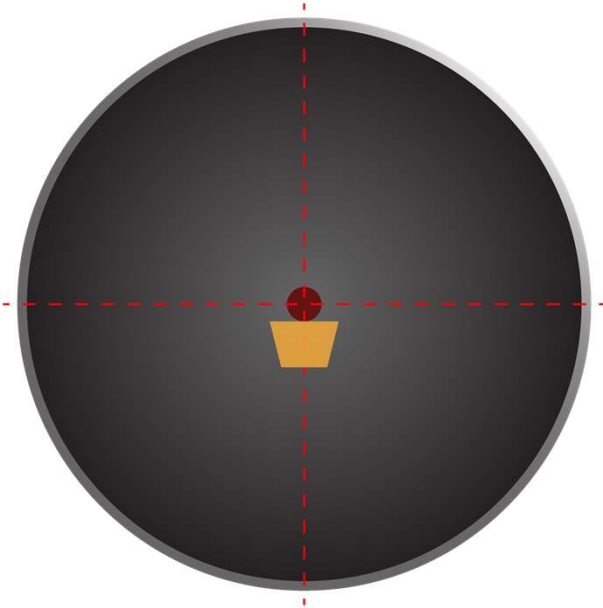
# Tool Setting – Y Axis Above Centre



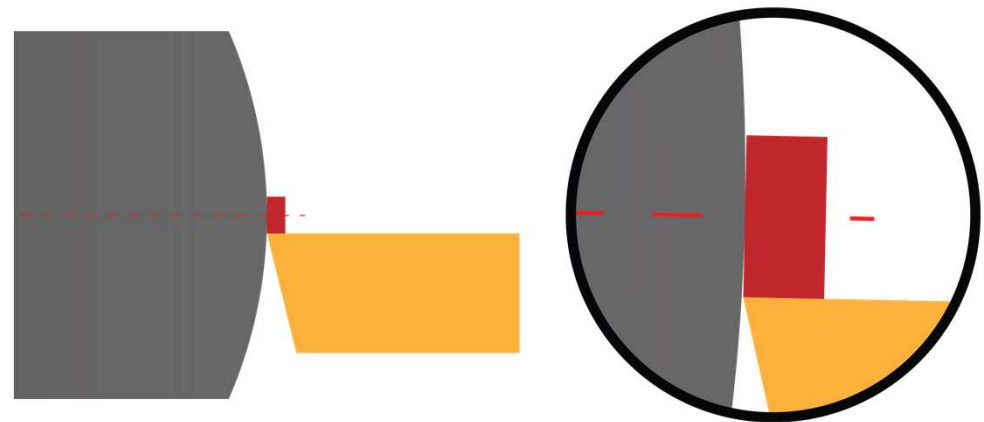
- ▶ Setting above centre will chip the tools cutting edge
- ▶ A cone shape will appear on your setup stud
- ▶ Material will come into contact below the tools cutting edge
- ▶ This will damage the tool
- ▶ The tool will need to be repaired



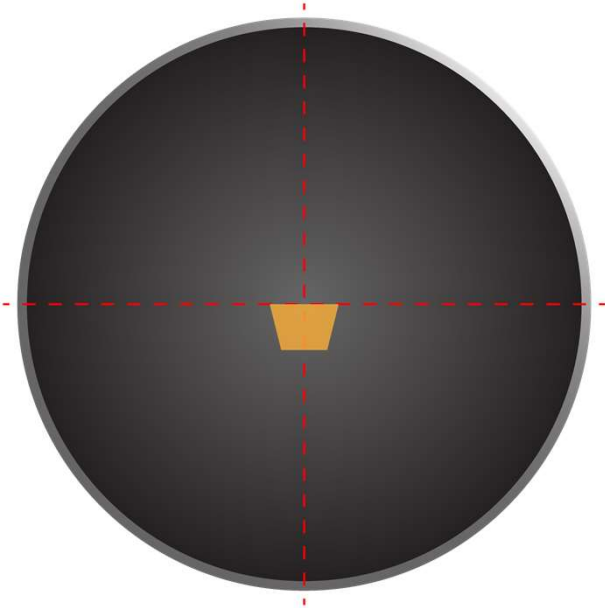
# Tool Setting – Y Axis Below Centre



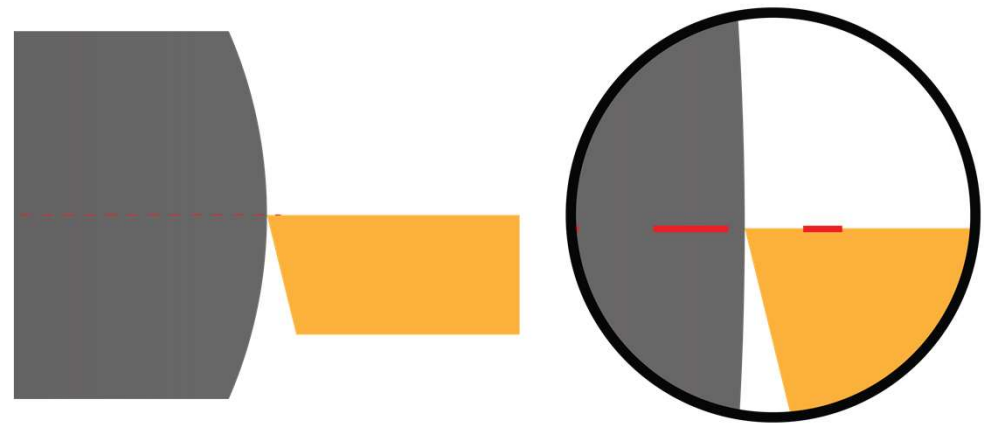
- ▶ Setting below centre will not damage the tool
- ▶ It is safer to start below centre and work up to centre
- ▶ The tools cutting edge will cut material as it is meant to
- ▶ A cylinder shape will appear on your part
- ▶ You can then move higher towards finding centre



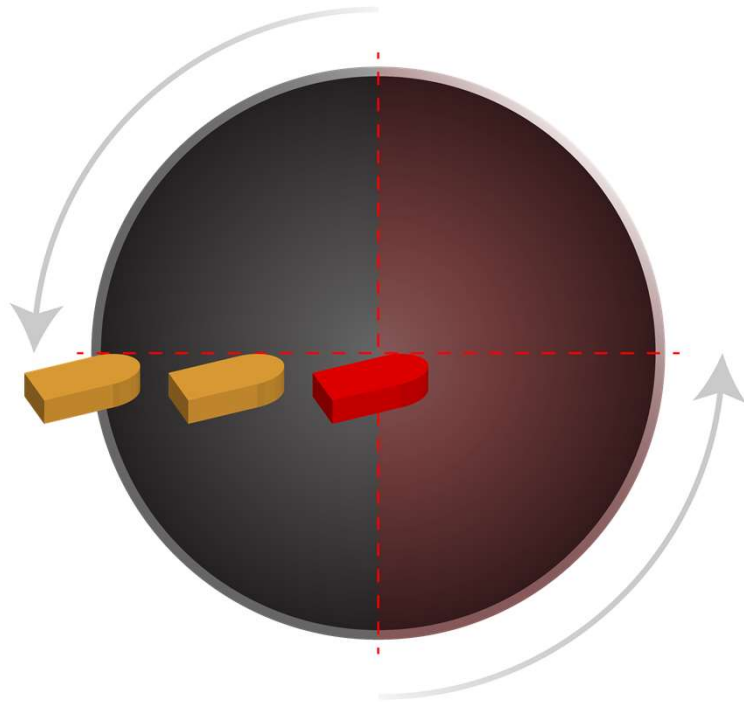
# Tool Setting – Y Axis Centered



- ▶ No cone or cylinder will be visible
- ▶ You're ready to start cutting parts



# Tool Setting – X Axis Past Centre



- ▶ Cutting past centre will chip your tool
- ▶ Material will come into contact below the tools cutting edge
- ▶ This will damage the tool
- ▶ The tool will need to be repaired

# Improve Your Diamond Turning Experience

VIOS



- ▶ Visual Inspection & Observation System
- ▶ Positional Indicators to Assist Tool Setting
- ▶ Clear View & Video of the Tool & Workpiece Whilst being Processed



HAWK-I



- ▶ Monitor Tool Performance with Hawk-I
- ▶ Check the Wear/Damage to Your Tool Whilst it's on the Machine
- ▶ The DT Technician Can Now Predict When He Needs to Change a Tool

# Let's Build a Partnership....

**Ben Smith-Ruddick**  
Global Sales Manager



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**M10 Edge, Ltd.**

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