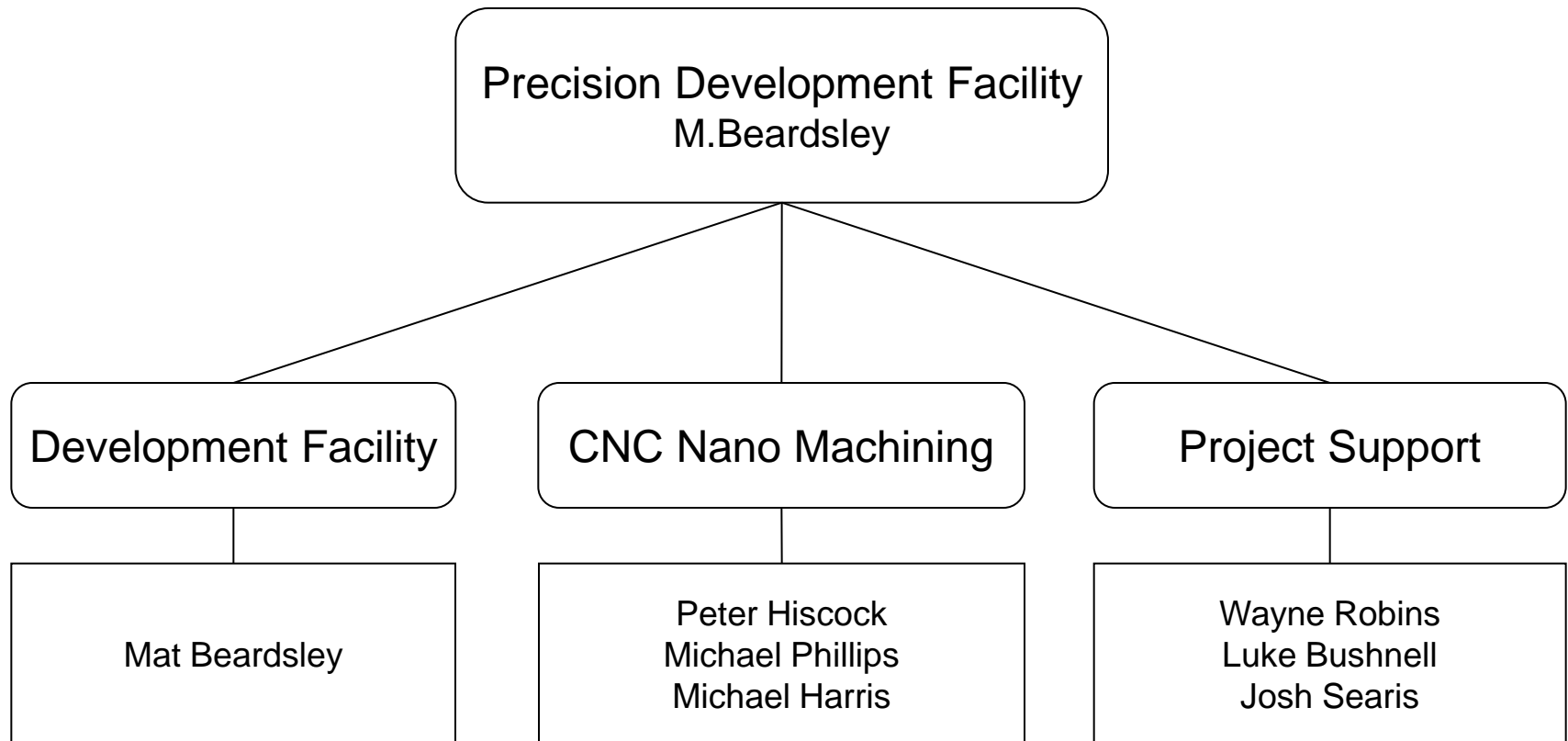


# Engineering Approaches to Miniaturisation

M.Beardsley



# PDF Organogram



# Development Facility



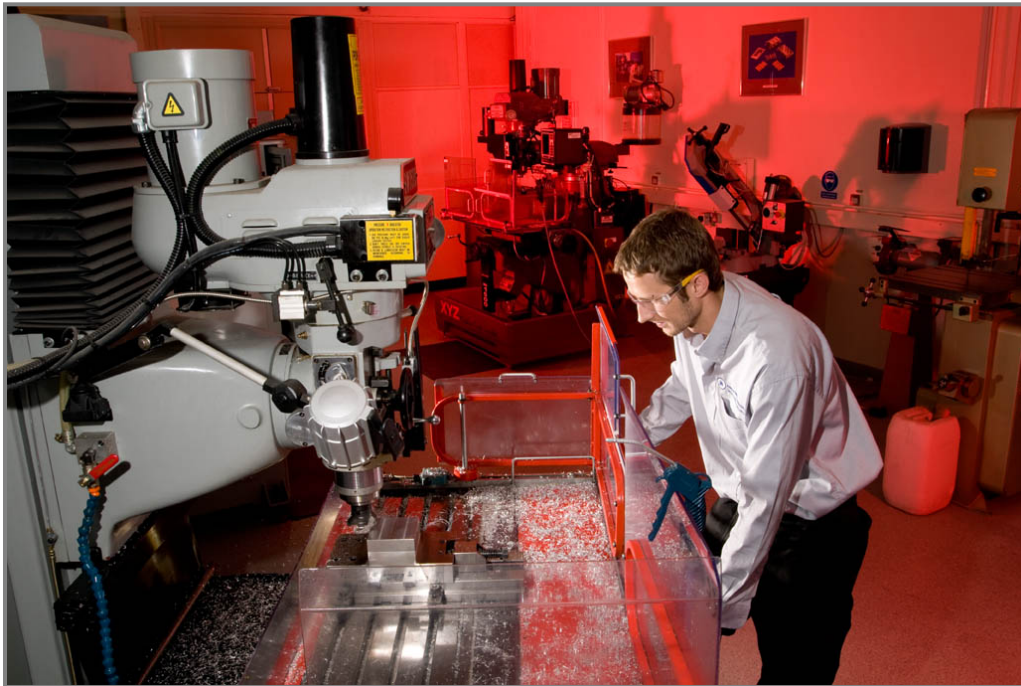
- Temperature controlled
- Two mini jig borers
- Micro machining mill
- Three precision lathes
- CNC Wire EDM
- Non contact measuring
- Electroplating Facility
- Grid Winding Facility

# CNC Nano Machining



- Temperature controlled
- KERN Micro with 5-axis unit
- KERN Pyramid Nano
- Hardinge GT Super Precision CNC Lathe

# Project Support



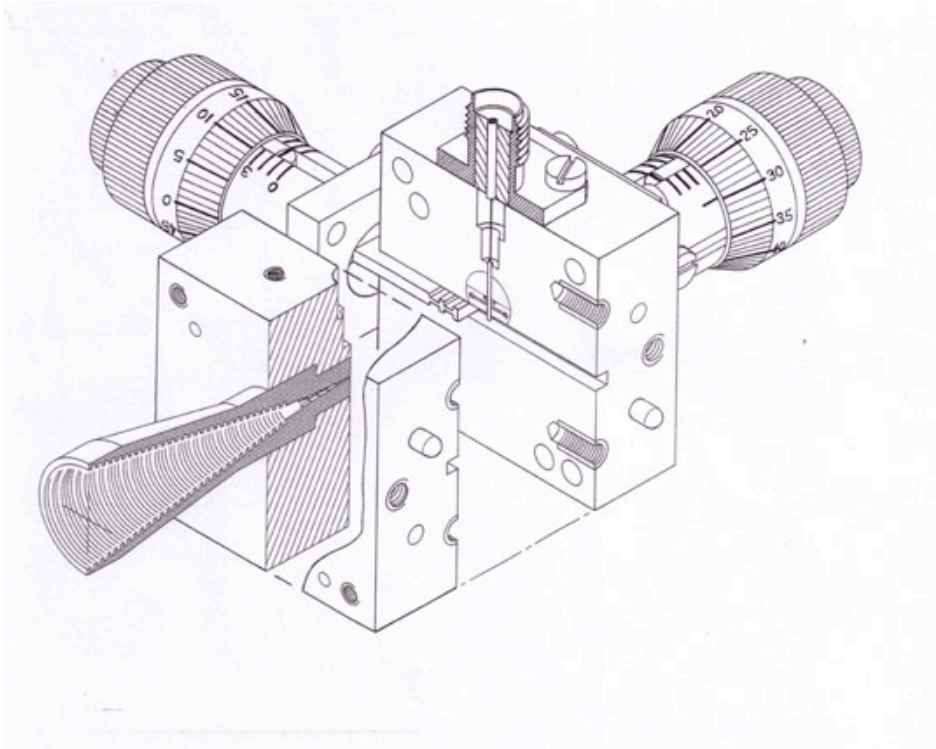
- Temperature controlled
- Two full 5-axis CNC Milling machines
- Two HAAS Super Mini Mills
- HURCO VMX30 CNC Milling machine

# Objectives of the Facility

- **Primarily developing and manufacturing devices operating in the microwave frequency range.**
- **Close support role for other Departments at the Rutherford Laboratory and commercial companies**  
Laser, ISIS, OXSENSIS, QinetiQ

Development of novel machining techniques.  
Production of miniature components

# Sub millimetre wave instrumentation



Millimetre Wave Mixer  
Device

Typically 25 mm cubed  
in size

Support manufacture  
of components  
between 95 GHz – 2.5  
THz

# Feedhorn mandrels

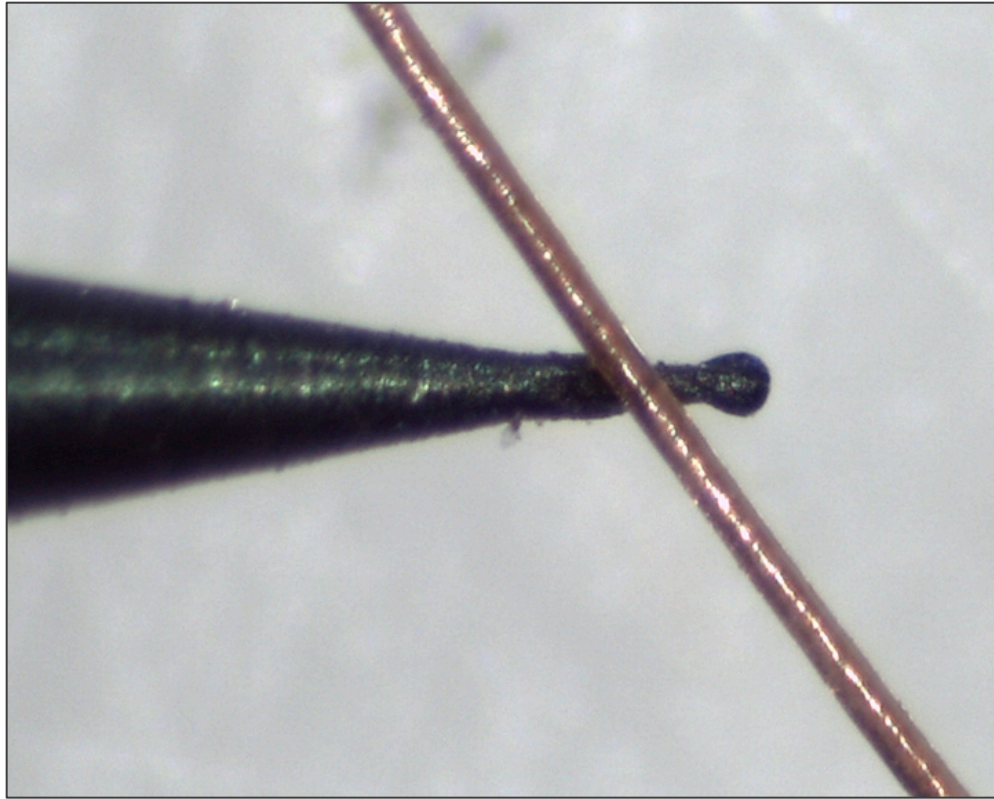


## Tooling

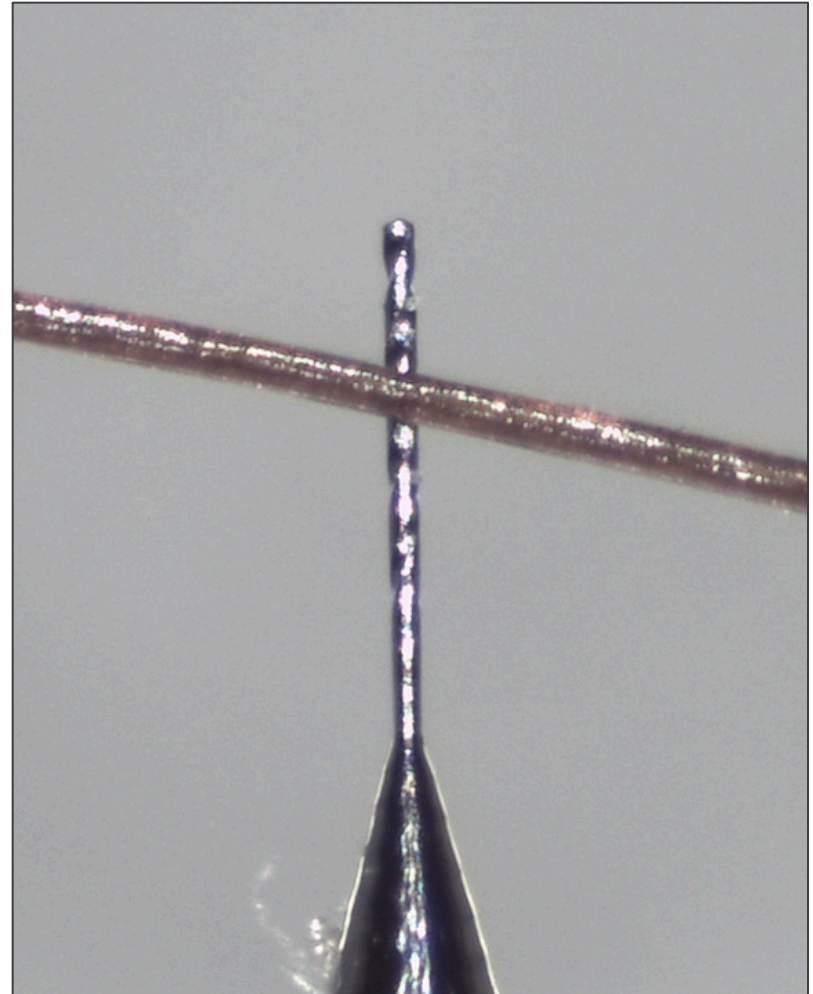
- 0.026 mm width
- High Speed Steel
- Polished Cutting Edge



# Miniaturisation of tooling

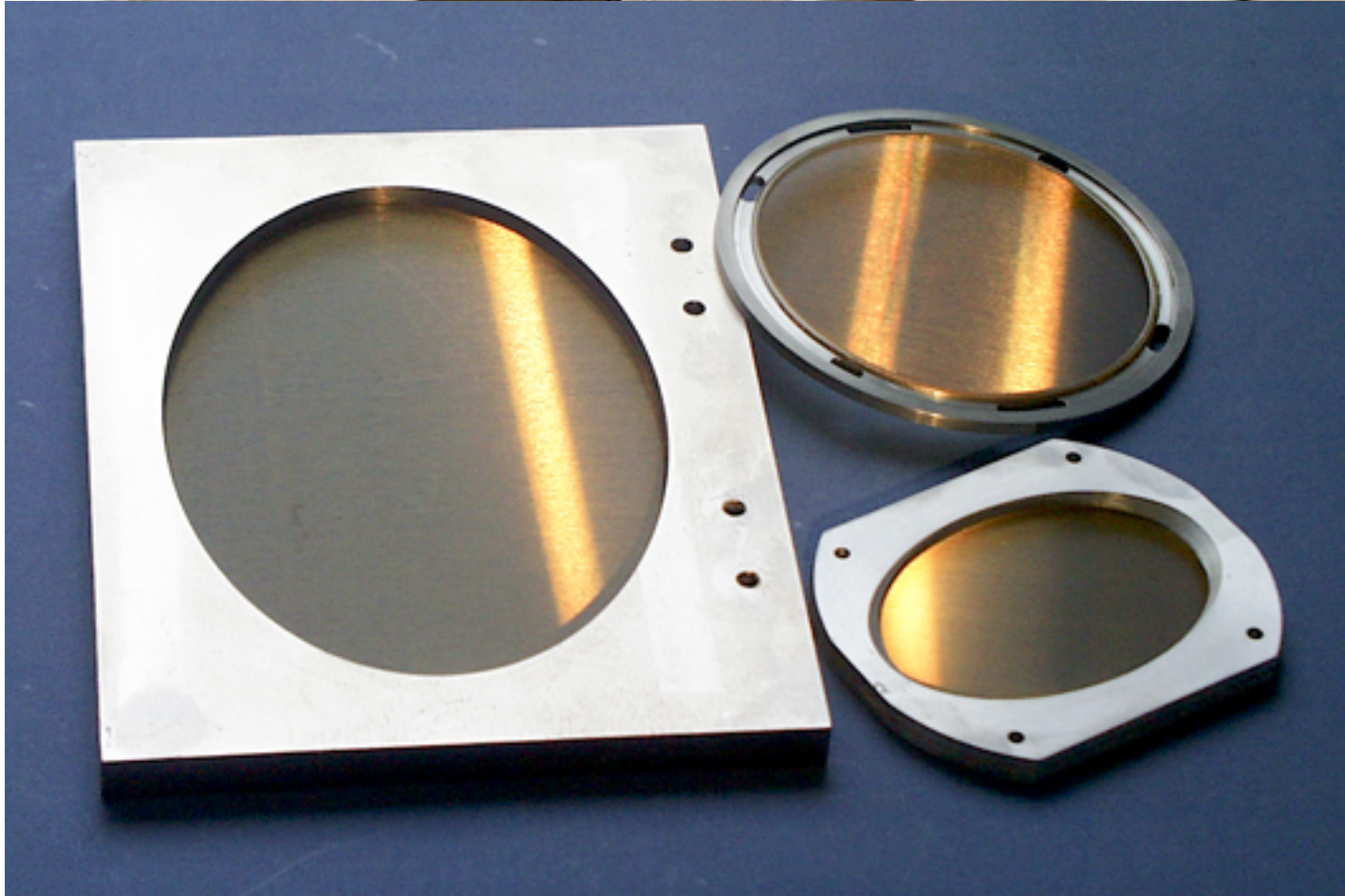


0.1mm tungsten carbide ball nose milling cutter

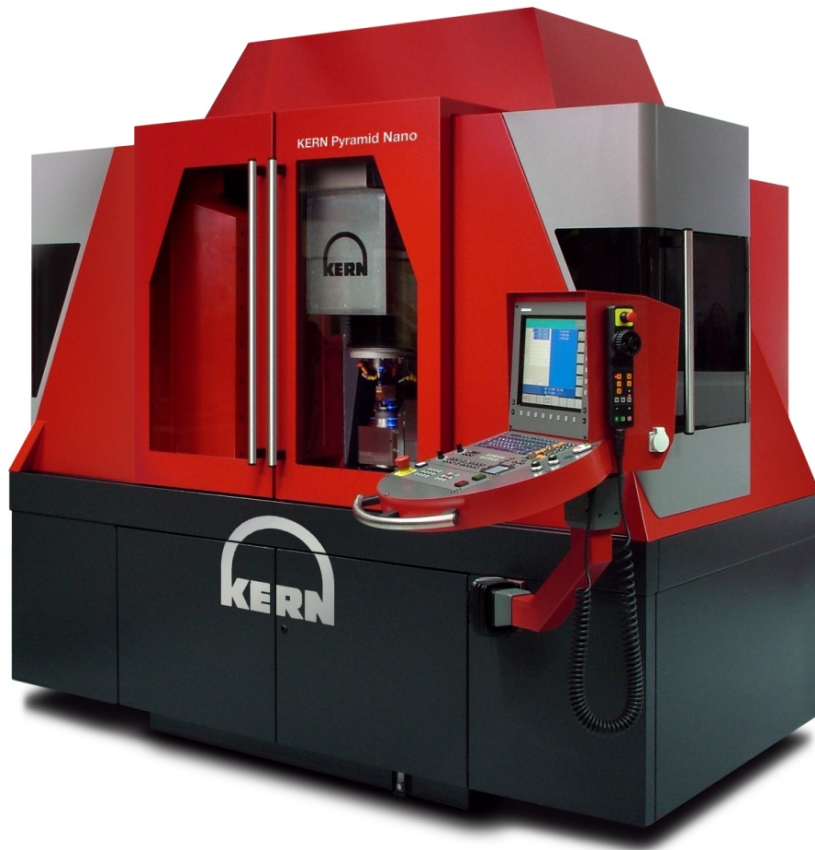


0.05 mm HSS drill

# Loads, blocks and grids



# Enhanced development using KERN Pyramid Nano



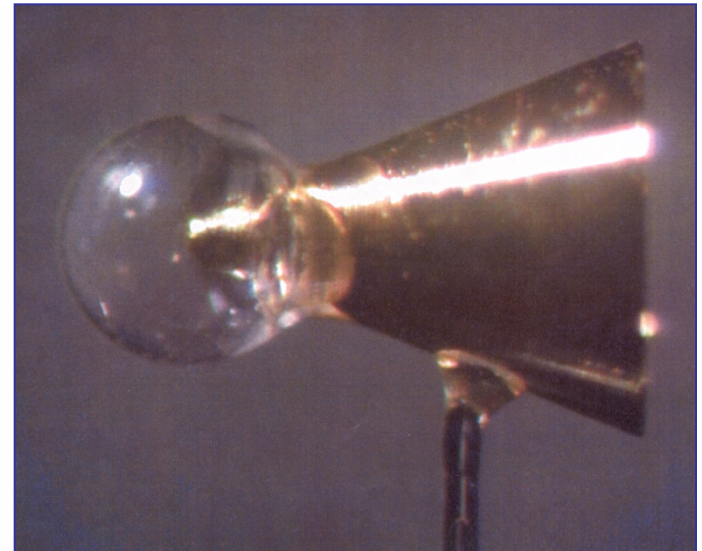
## Factors to consider when machining at the micron level.

- Environmental- temperature, vibration.
- Operator- skilled technicians.
- Work holding- bespoke novel jigs and fixtures.
- Tool path strategies- high performance CAM software.

# CLF Target Manufacture

## Example geometry for nuclear fusion

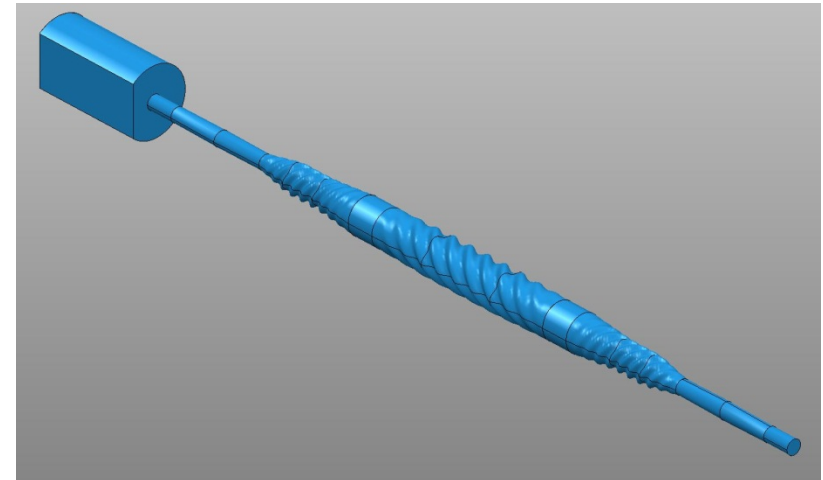
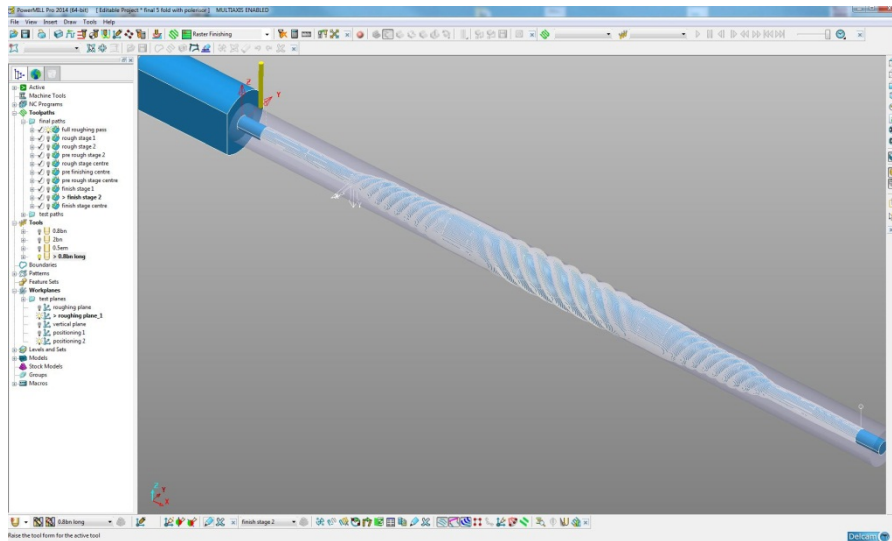
- Conical shape
- Pure gold
- Base 950 $\mu\text{m}$  diameter
- 1mm high
- Wall thickness at tip 10 $\mu\text{m}$  or less



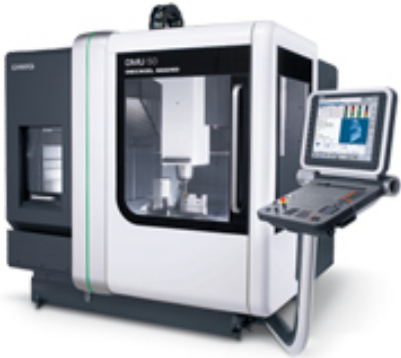
# High Performance CAM

## Design to finished product

- Commercially available.
- Allows the programming of complex 3D machining of novel geometries.
- Surfacer module - powerful tool for refining and modifying surfaces.
- Process still relies on skill of PDF technicians to design and manufacture bespoke precision work holding jigs and fixtures.
- Requires a wealth of experience to devise a suitable machining strategy to achieve the form accuracy and surface finish on the part.



# 5-Axis machining

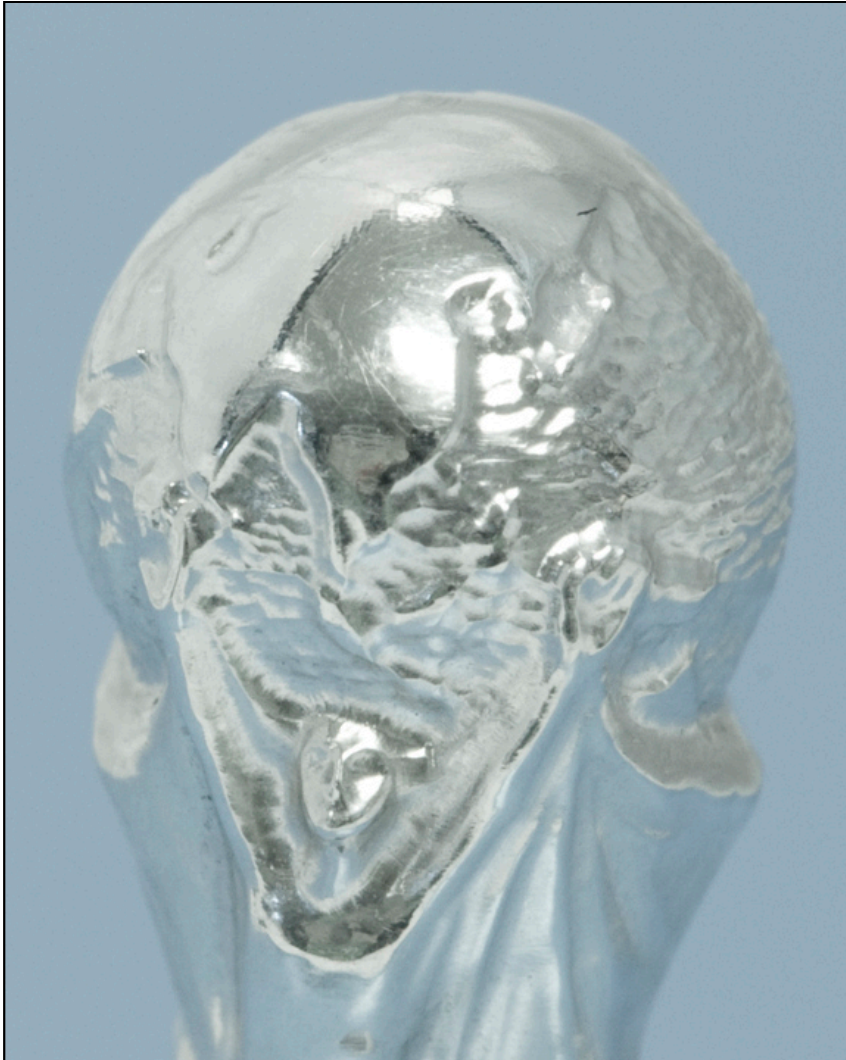


- Push towards single set up machining.
- Reduced lead times, labour costs.
- Better tool life, improved quality of the part
- 30 auto tool changer
- Spindle speed 18k RPM

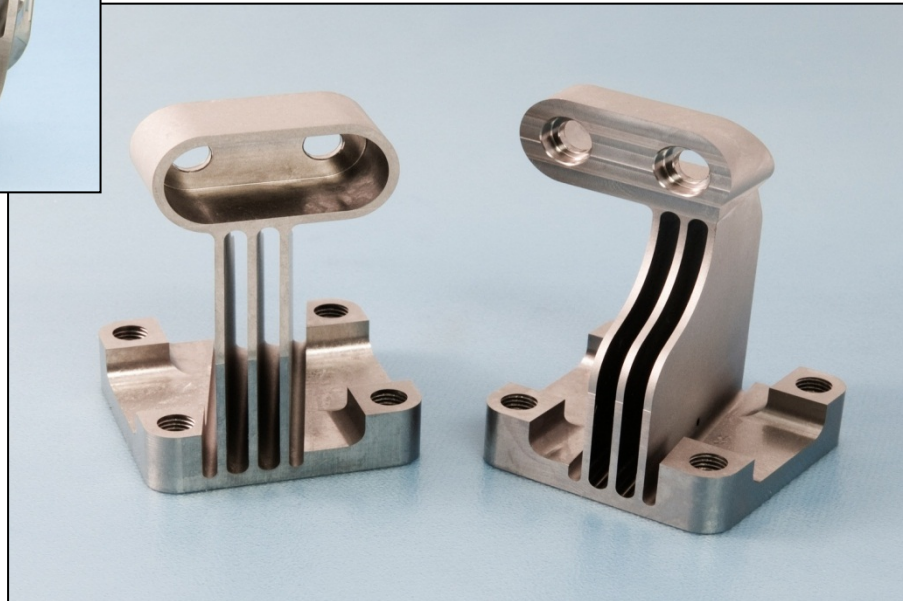


# 5-axis machining (Full)

- Full 5-axis kinematics.
- 2" stock diameter.
- 2.5 hours machining time.
  
- Full 5-axis on KERN Micro.
- 12 mm stock diameter.
- Approximately 24 hours machining time.



# 5-axis machining (3+2)

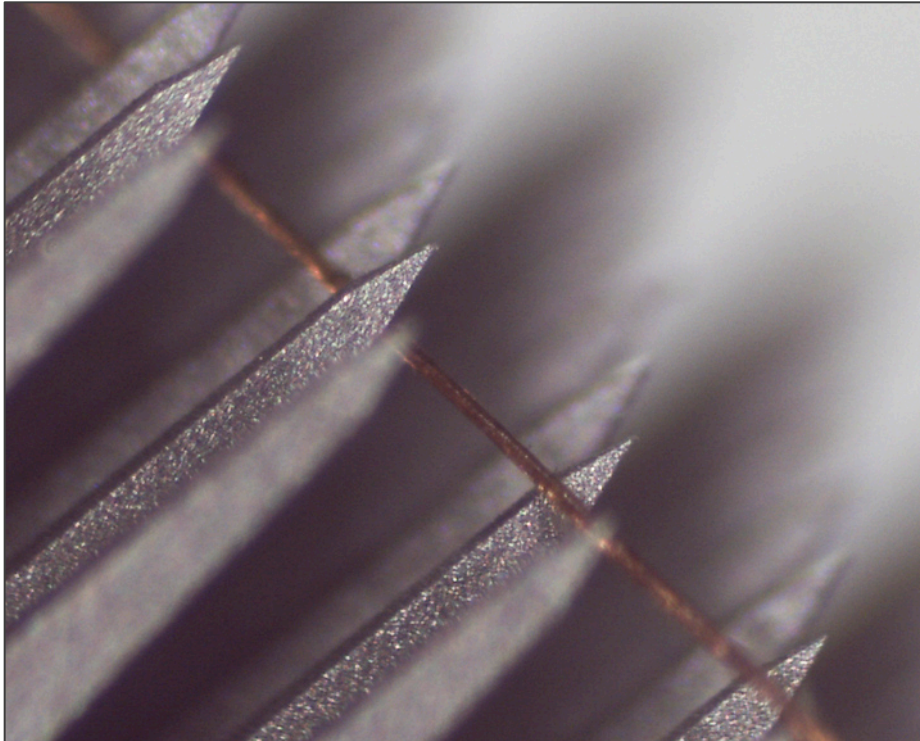


- Reduces manufacturing time.
- Increase accuracy of the part.
- Modular work holding fixtures allow part to be set up on other machines without loss of original datum.

Examples of schedule critical flight hardware.



# CNC Wire EDM



Manufacturing of intricate parts in conductive materials.

Very good at machining refractory metals such as tungsten, tantalum.

Conventional diameter of wire is 250 $\mu$ m, high end machines can use wire 50 $\mu$ m in diameter.

# ISIS Facility Target Manufacture



## TS2 Target

- Tantalum clad tungsten core
- 300 mm in length
- 30kg
- £100k
- PDF developed novel machining strategies to machine these refractory metals

# Contact Details

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