

The Development of RF Structures & Diagnostic Tools for Ultrashort Bunches



Ultrafast Beams and Applications, 02-05 July 2019

CANDLE SRI, Armenia

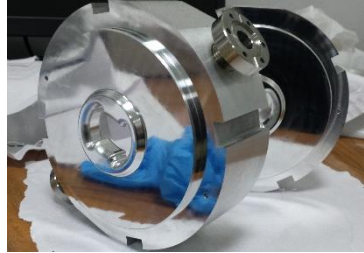
Vahe Danielyan

Scientific Production Division

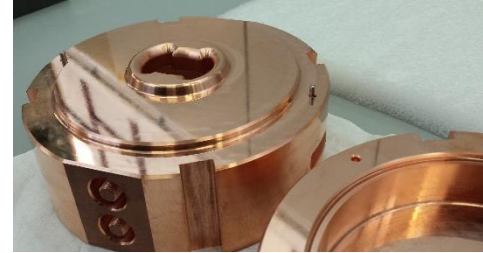


Introduction

- Historical review



TDC Al. Prototype



TDC Copper Cells

- Ongoing researches



S-Band A. Structure Prototype

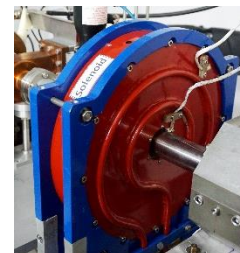


Quadrupole Magnets

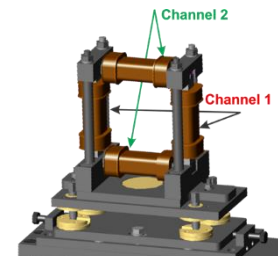
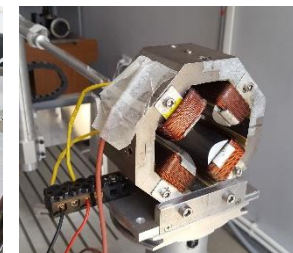
- Future developments



S-Band A. Structure



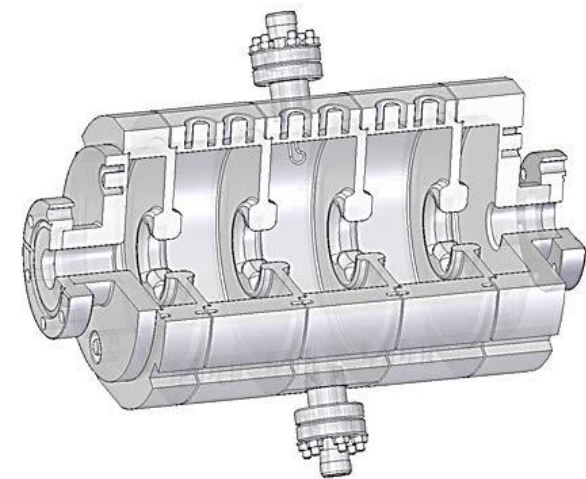
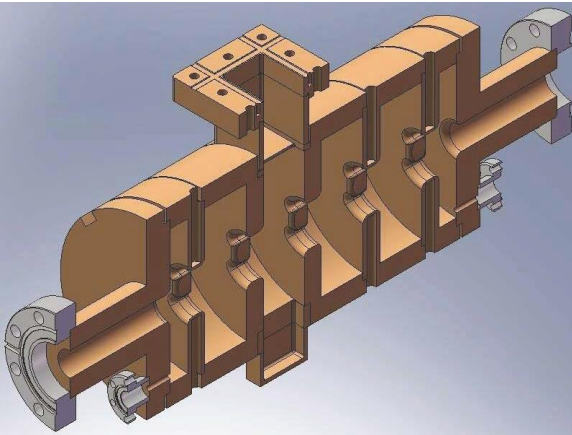
Magnets (Solenoid, quadrupole, Dipole & Corrector)



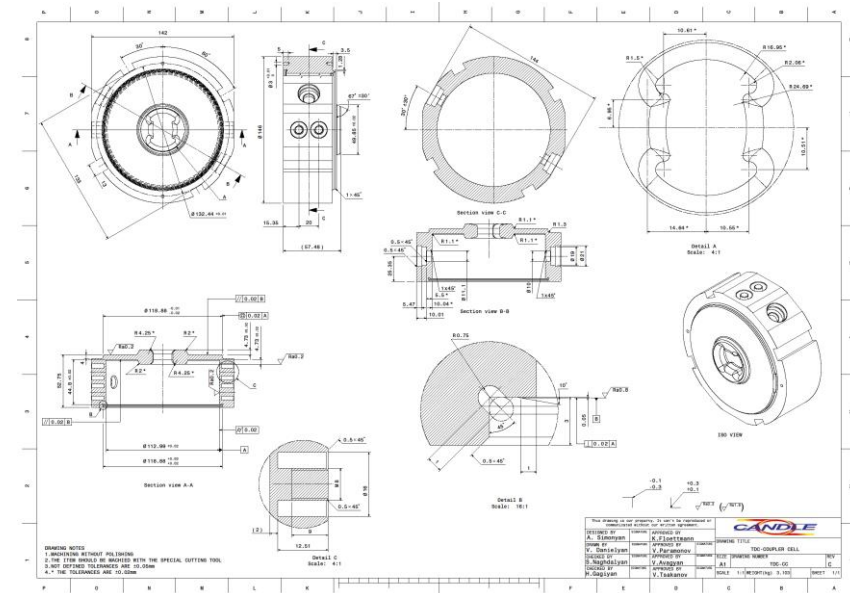
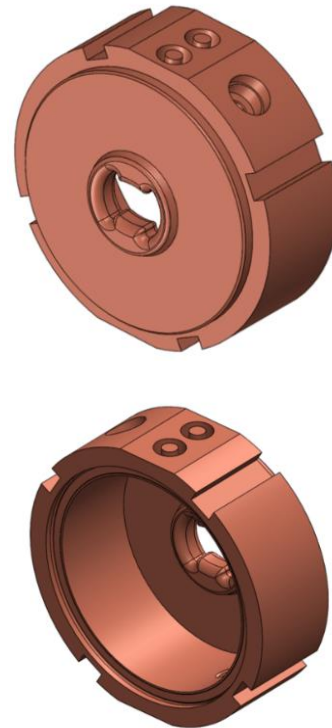
Transverse Deflecting Cavities

REGAE, DESY

Design



Engineering Design & Technical Drawings



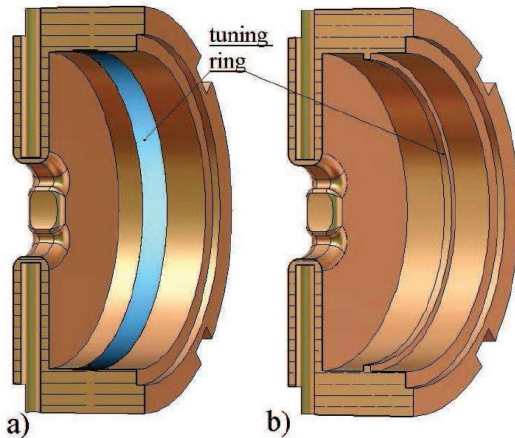
Main Requirements:

- **Material – Oxygen Free Copper**
- **Tolerances - $\pm 20\mu$**
- **Surface Roughness - $Ra0.2\mu$**
- **Tuning Tools - Push & Pull**
- **Machine without polishing**

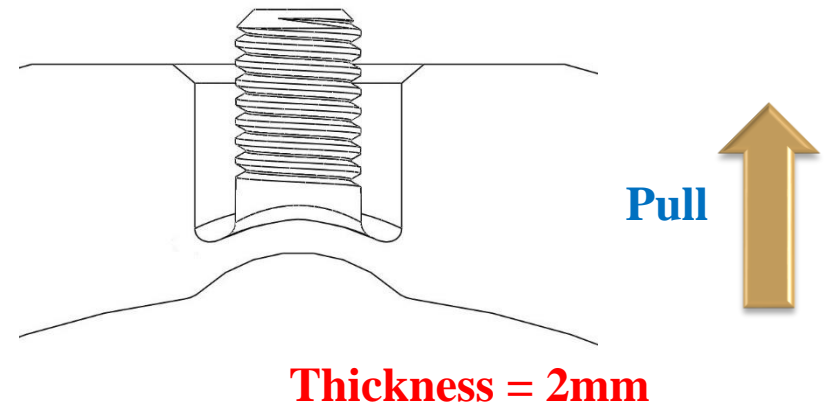
Transverse Deflecting Cavities

REGAE, DESY

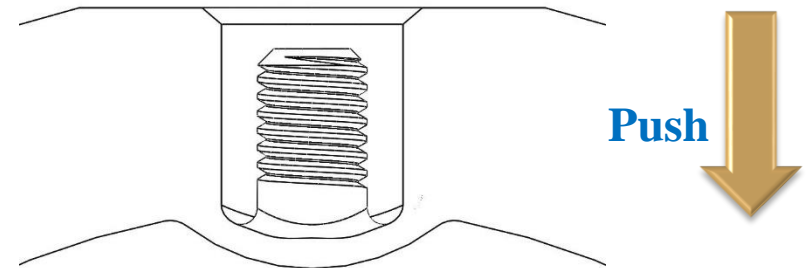
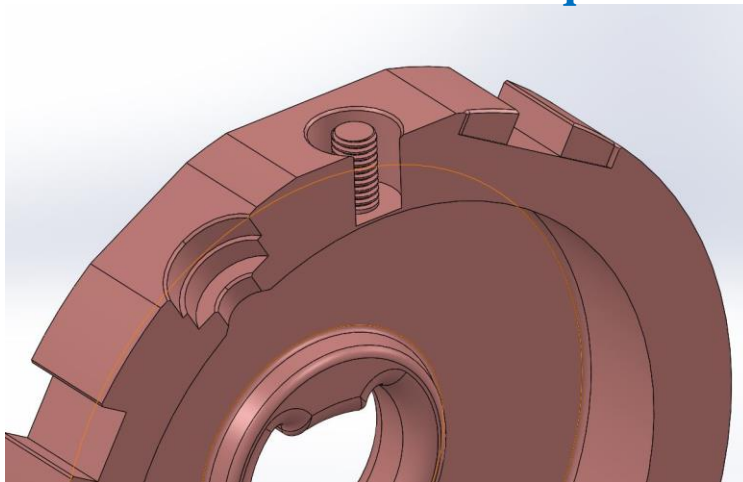
Tuning Tools



Push & Pull Technique



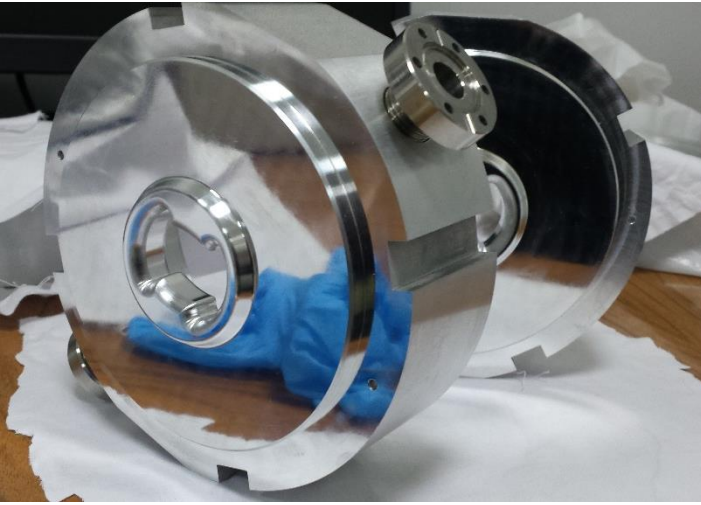
Push & Pull Technique



Transverse Deflecting Cavities

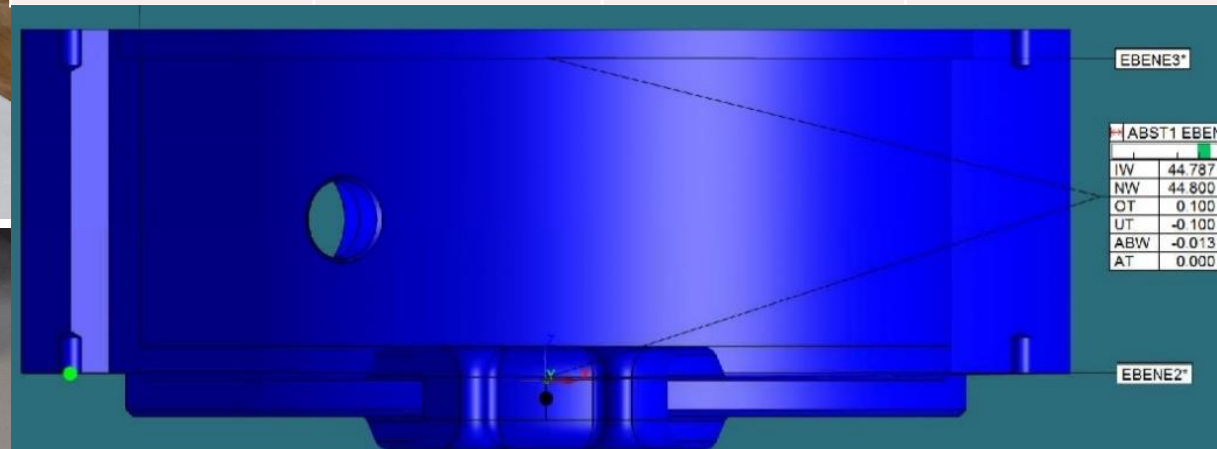
REGAE, DESY

TDC Al. Prototype



Mechanical & RF Measurements at DESY

Coupler Cell	Design	Measured	Deviation
ID depth	44.8 mm	44.787 mm	-13 μ
ID	112.88mm	112.888 mm	+ 8 μ



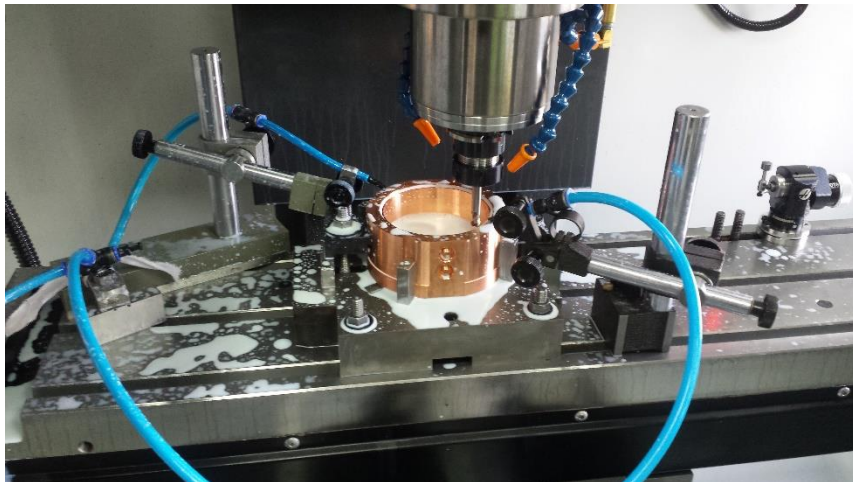
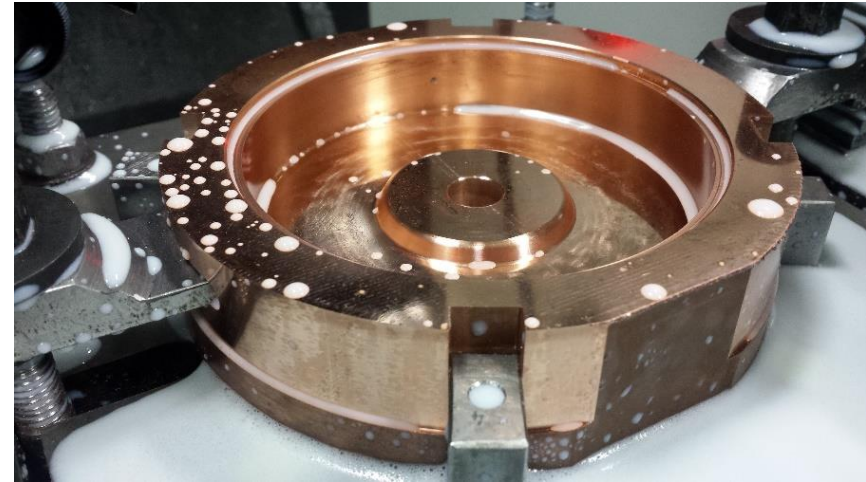
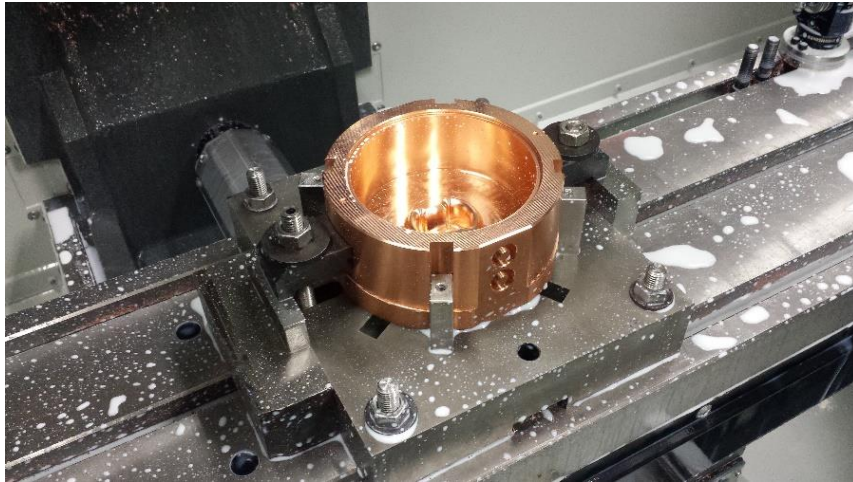
CNC Machine Accuracy $\pm 10\mu$

- Mechanical CMM Measurements – in tolerances
- Measured Frequency – **3001.9 MHz**
- RF Measurements – ID should be **increased 110 μ**
112.88 mm to 112.99 mm

Transverse Deflecting Cavities

REGAE, DESY

TDC Copper Cells' Production

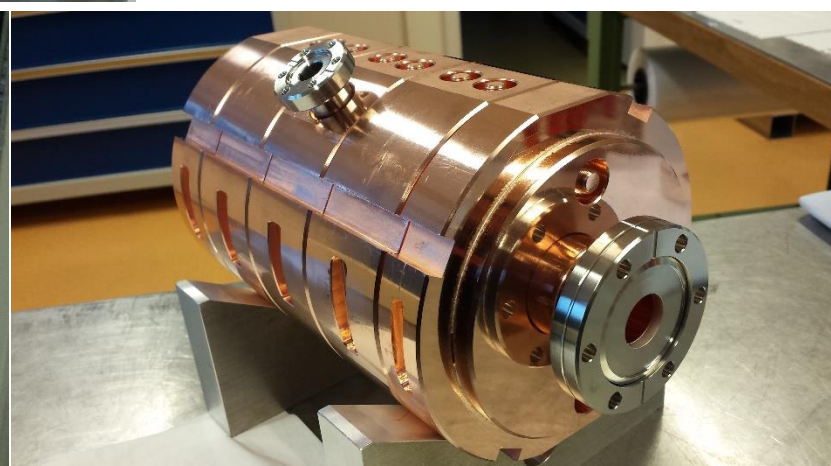
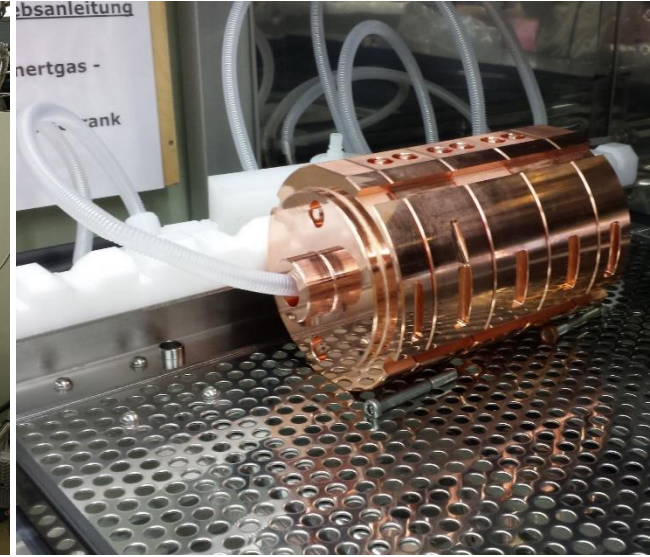
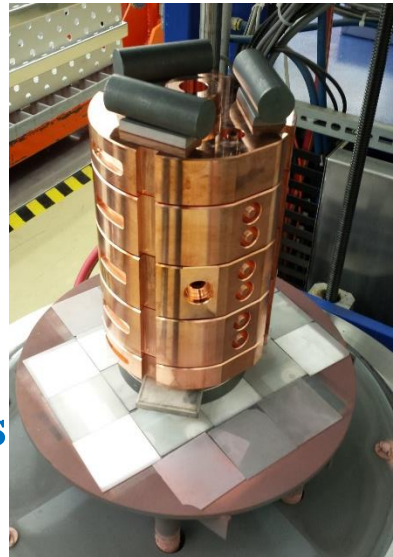


Transverse Deflecting Cavities

REGAE, DESY

Final Production Processes of TDC at DESY

- Vacuum Brazing
- Leak Detection
- RF Measurements
- RF Tuning
- Leak Detection
- Cleaning
- Brazing cooling tubes
- Commissioning

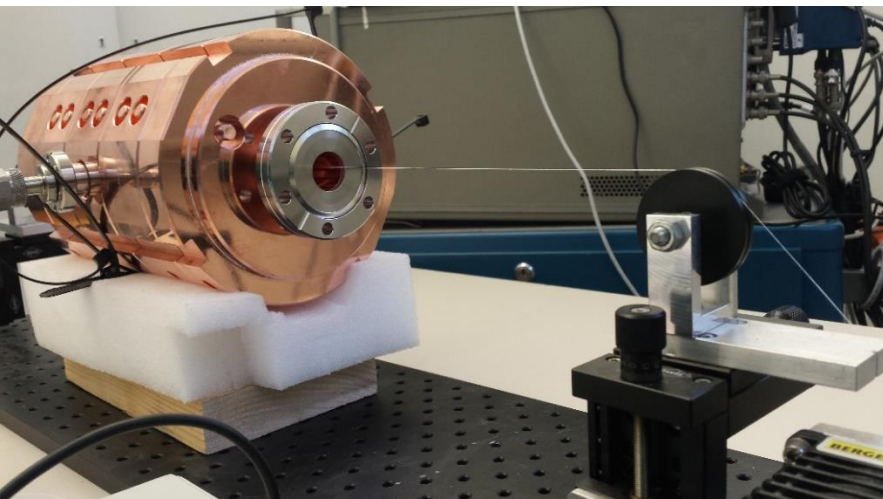


Transverse Deflecting Cavities

REGAE, DESY

TDC RF Tuning at DESY

Measurements



≈ 3 mm
Pulling

Deformed material around Tuning Studs



- Measured Frequency – 3001.5 MHz (+3.5 MHz)
- Operating Frequency – 2997,925 MHz
- No leaks after RF Tuning

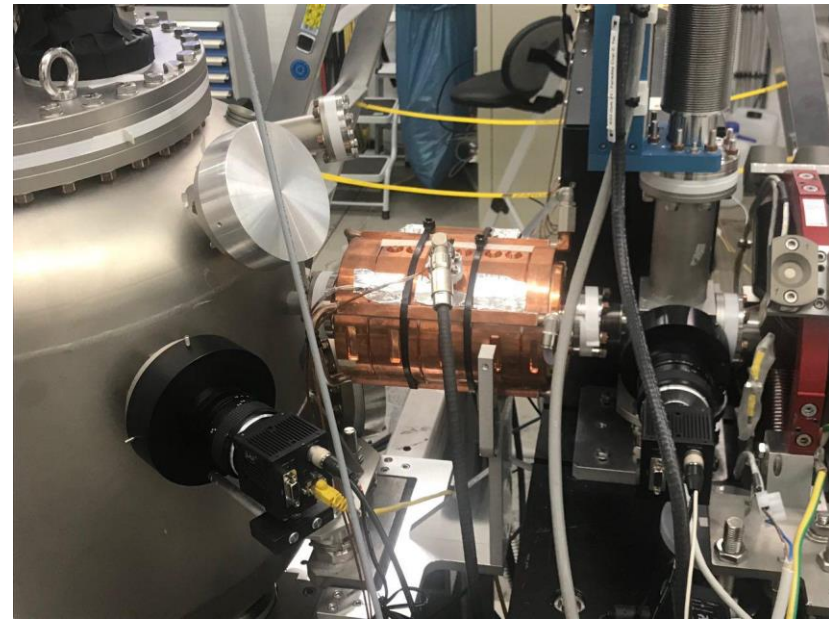
Transverse Deflecting Cavities

REGAE, DESY

Collaborating Team



TDC On REGAE Machine

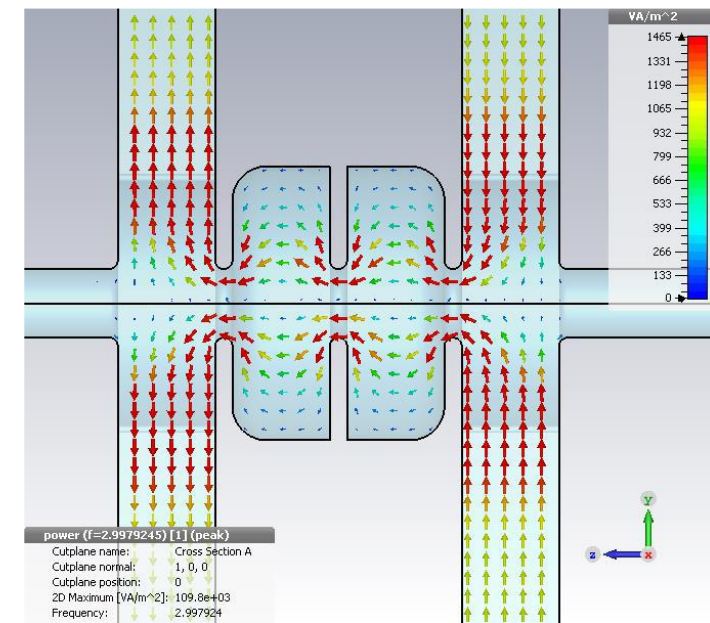
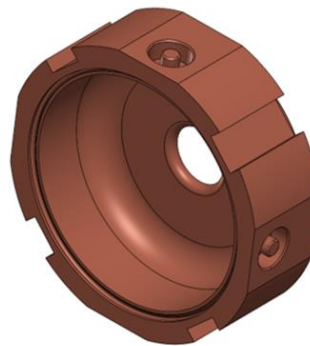
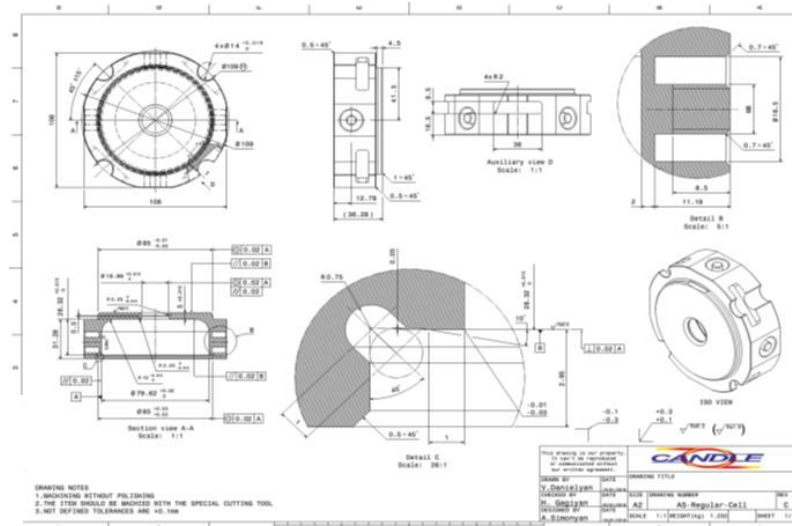
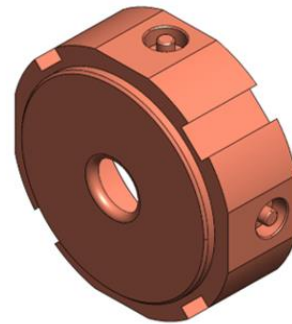
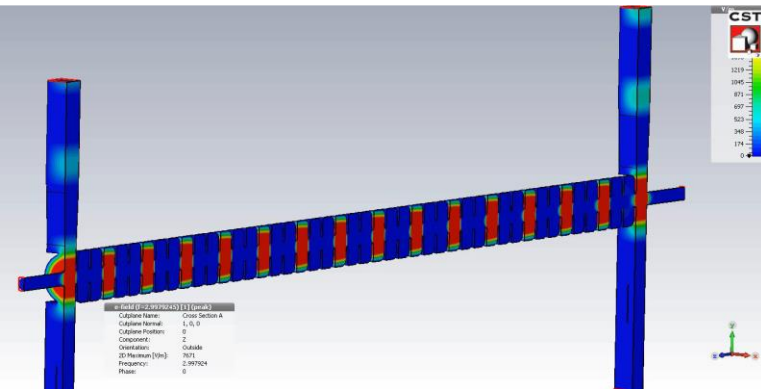


S-Band Accelerating Structure

AREAL, CANDLE

Design

Engineering Design & Technical Drawings



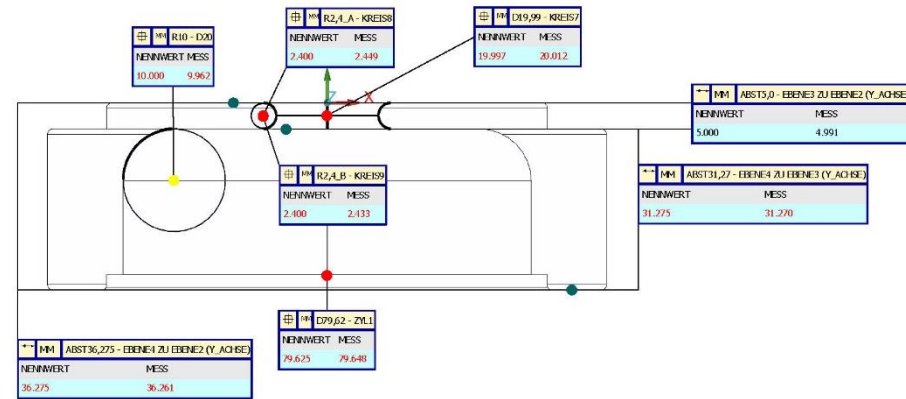
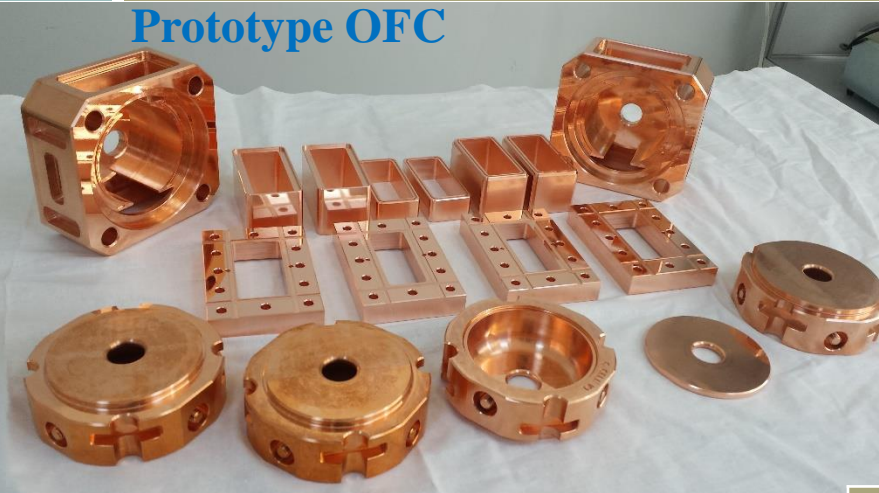
Main Requirements:

- **Material – Oxygen Free Copper**
- **Tolerances - $\pm 15\mu$**
- **Surface Roughness - Ra0.2 μ**
- **Tuning Tools - Push & Pull**
- **Machine without polishing**

S-Band Accelerating Structure

AREAL, CANDLE

Prototype OFC



Mechanical Measurements at DESY



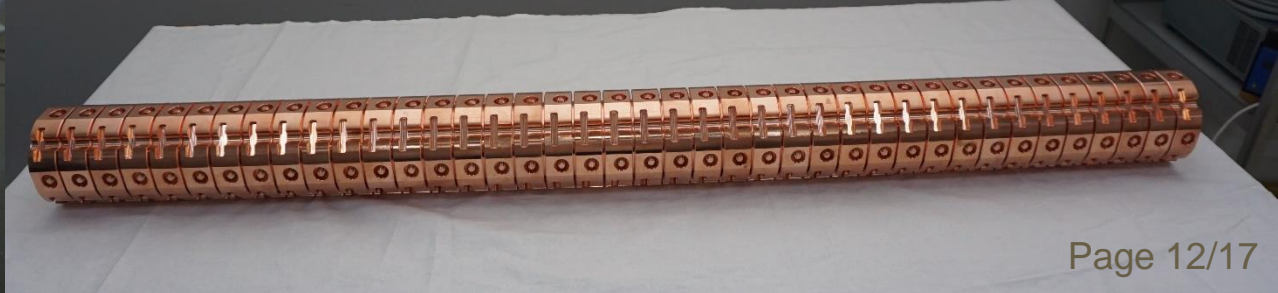
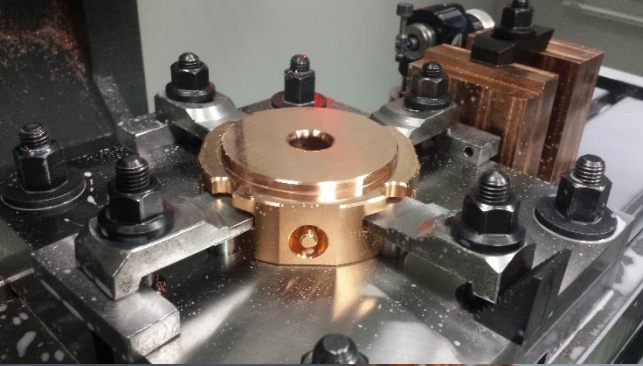
R. Cell №3	Design	Measured	Deviation
ID depth	31.275 mm	31.270 mm	- 5 μ
ID	79.625 mm	79.648 mm	+ 23 μ
Iris Diameter	19.997 mm	20.012 mm	+ 15 μ
R. Cell №5	Design	Measured	Deviation
ID depth	31.275 mm	31.269 mm	- 6 μ
ID	79.625 mm	79.648 mm	+ 23 μ
Iris Diameter	19.997 mm	20.011 mm	+ 14 μ

Repeatability Less Than 3 μ

S-Band Accelerating Structure

AREAL, CANDLE

First S-Band A. Structure for AREAL Upgrade



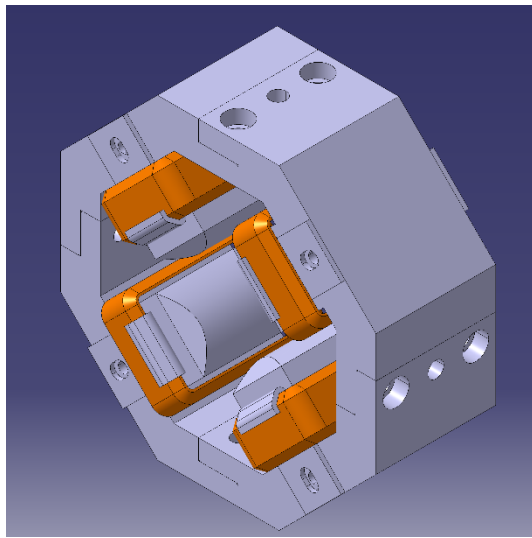
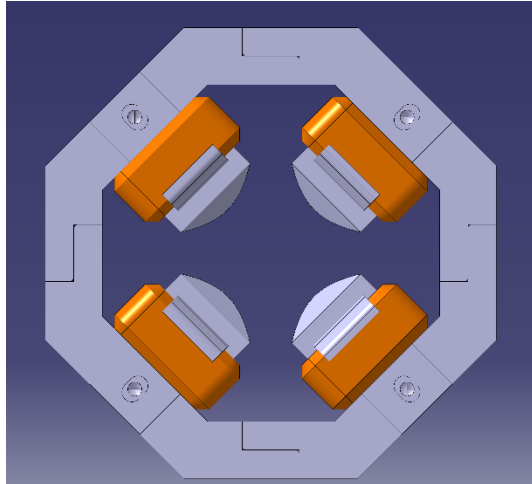
Quadrupole Magnets

AREAL, CANDLE

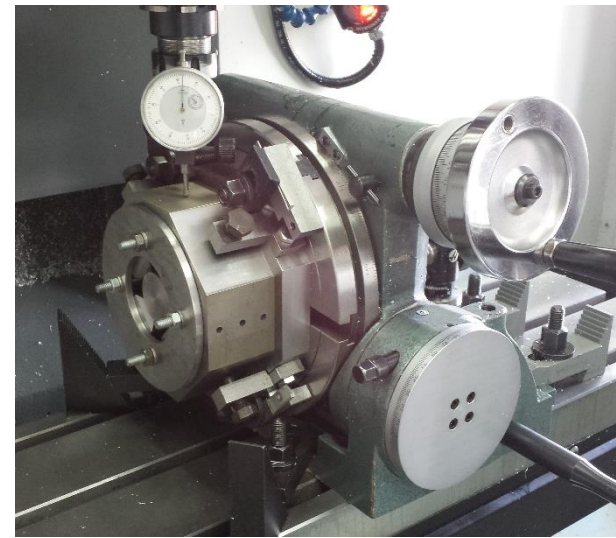
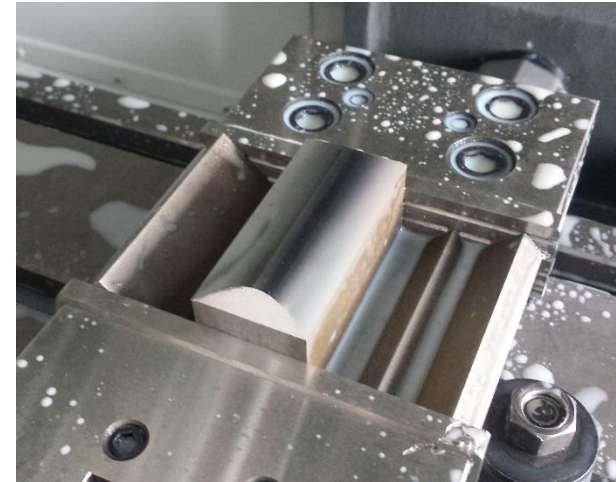
Design Parameters

Parameters	
Doublet length	165 mm
Magnet length	60 mm
Magnet bore diameter	43 mm
Field gradient	0.6 T/m
Wire diameter	1 mm
Wire cross section	0.785 mm ²
Winding numbers	100
Max. voltage per Magnet	4.2 V
Maximal current	2.36 A

Engineering Design



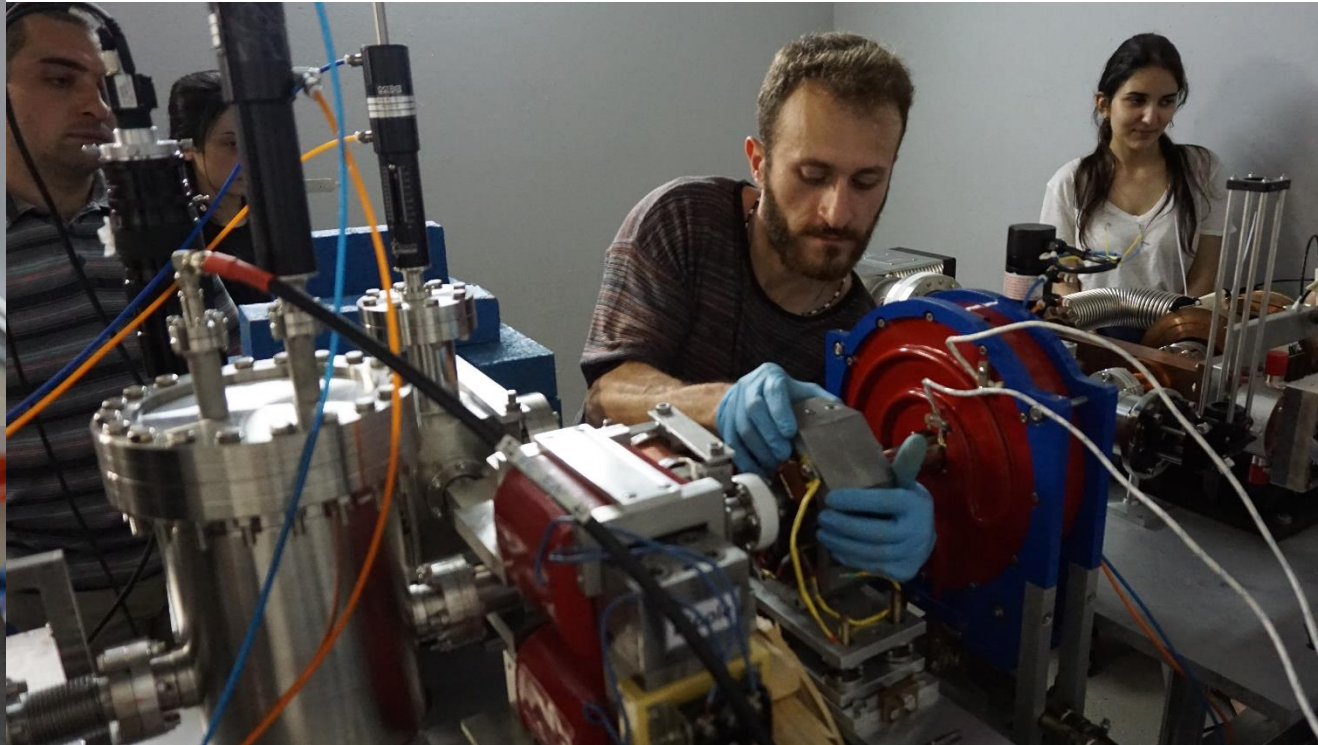
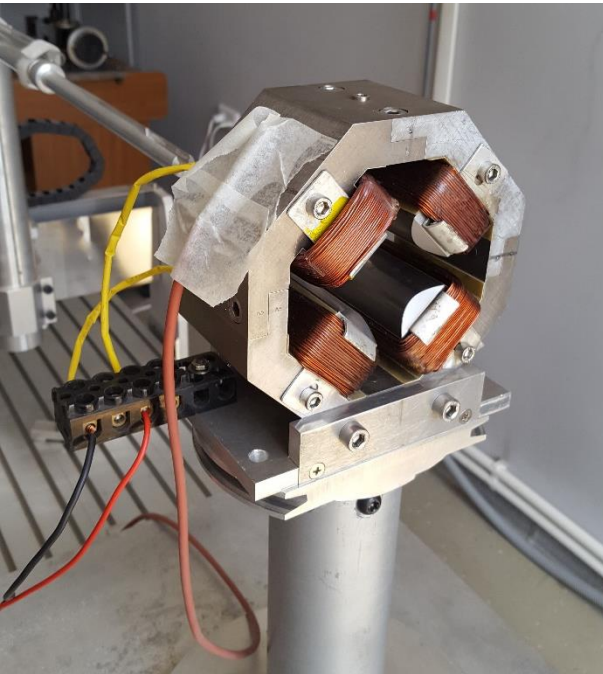
Fabrication



Quadrupole Magnets

AREAL, CANDLE

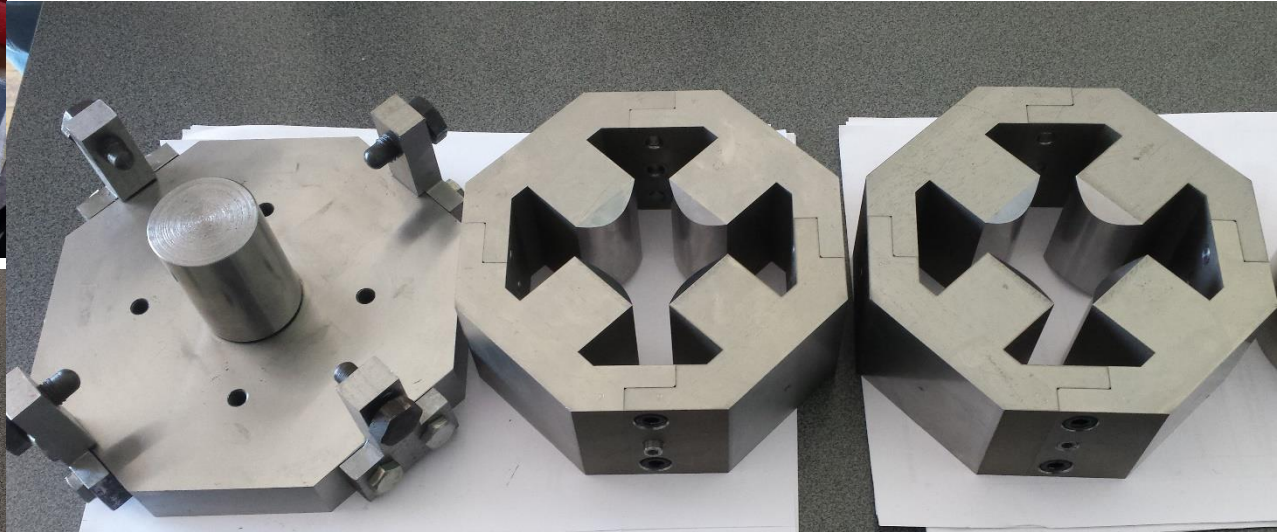
Magnetic Measurements & Installation on AREAL



Quadrupole Magnets

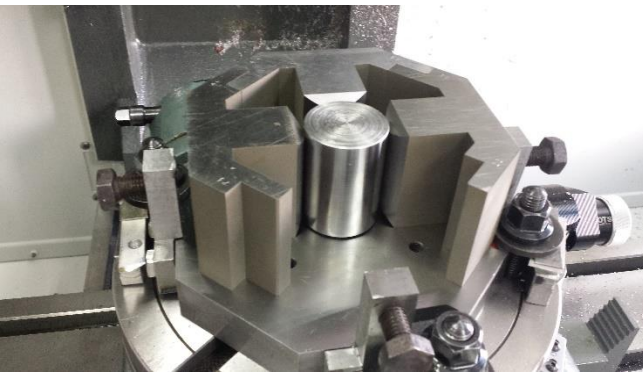
AREAL, CANDLE

After Successful Prototyping 2 Quadrupoles are in Production Stage



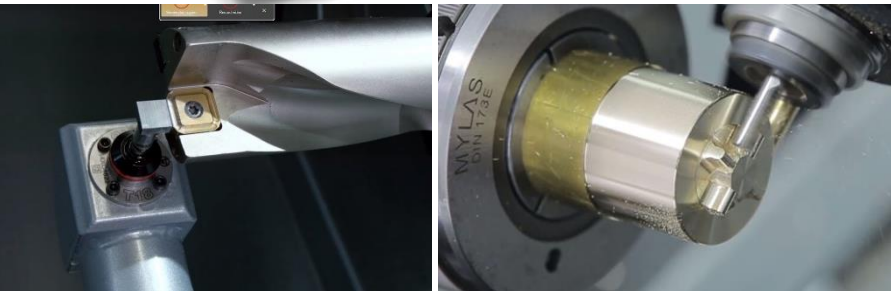
New Projects (AREAL upgrade)

- Second S-Band Accelerating Structure
- 5 Quadrupole Magnets
- 2 Dipoles Magnets
- 4 Corrector Magnets
- Solenoid Magnets
- ≈ 15 Supporting Systems for New Girders



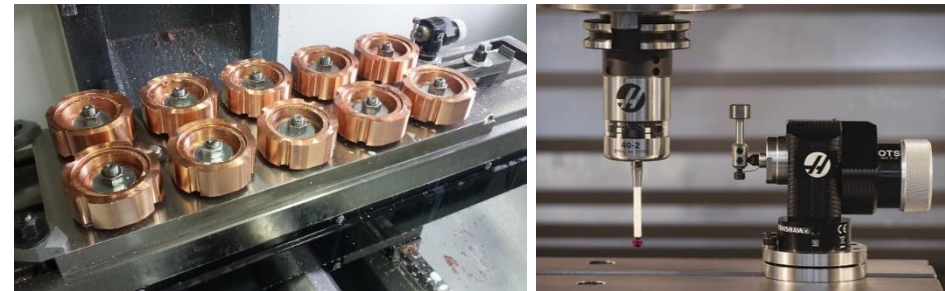
Our Capabilities

HAAS ST-10 CNC Turning Center



- Max Cutting Diameter/ Length - 356/406 mm
- Spindle Max Speed - 6000 r/m;
- Positioning - $\pm 5 \mu$
- Repeatability - $\pm 2.5 \mu$

HAAS TM-1P CNC Vertical Milling Machine



- Working area - 762x305x406mm;
- Spindle Max speed - 6000 r/m;
- Positioning - $\pm 10 \mu$
- Repeatability - $\pm 5 \mu$

Thank you for Attention

Engineering Team

