

Update on ESS Bilbao MEBT Diagnostics Contribution

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On behalf of the ESS Bilbao teams

3rd BI Forum, Trieste 26-27 April 2017



Outlines

- FC Status
- WS Status
- EMU Status
- ACCT/FCT Status
- BPM Status
- ✓ BPM Striplines Design
- ✓ BPM Stripline prototype fabrication
- ✓ BPM Stripline measurements

Contributors

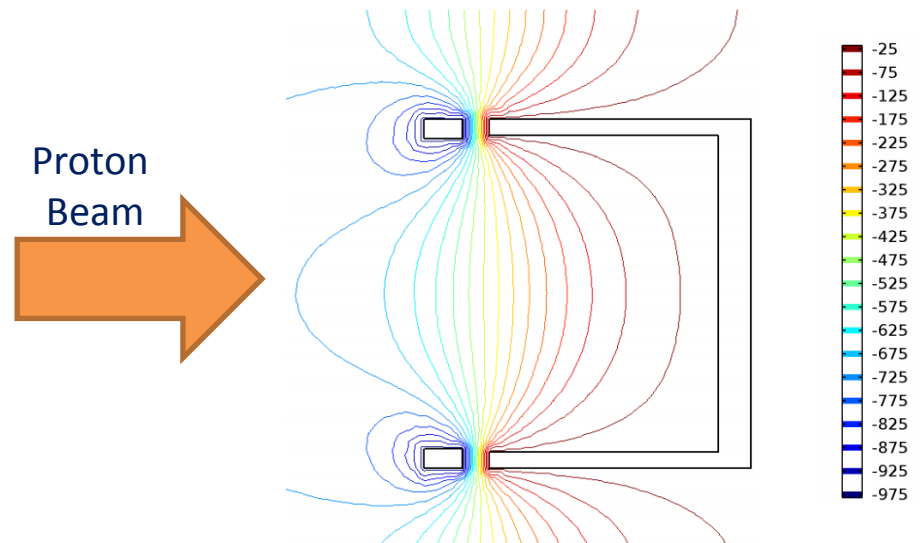
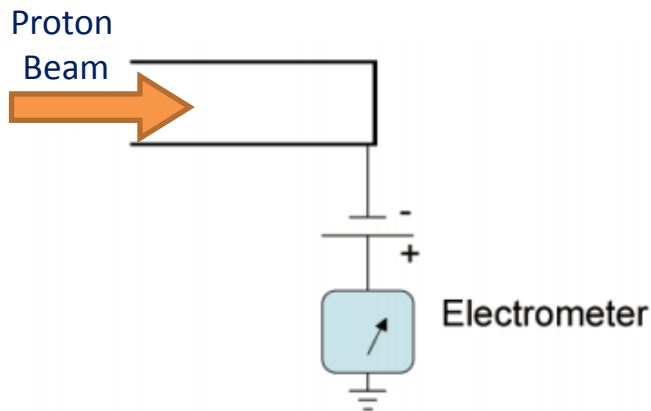
- A. R. Parámo, T. Mora, D. de Cos, R. Miracoli, A. Vizcaino, I. Mazkianan, Z. Izaola, C. de la Cruz, I. Ortega, A. Milla, A. Serrano, V. Tobajas, A. Ortega, I. Rueda, A. Zugazaga, D. Fernandez, J.L. Muñoz, S. Varnasseri, I. Bustinduy

Faraday Cup Status

FC: Introduction

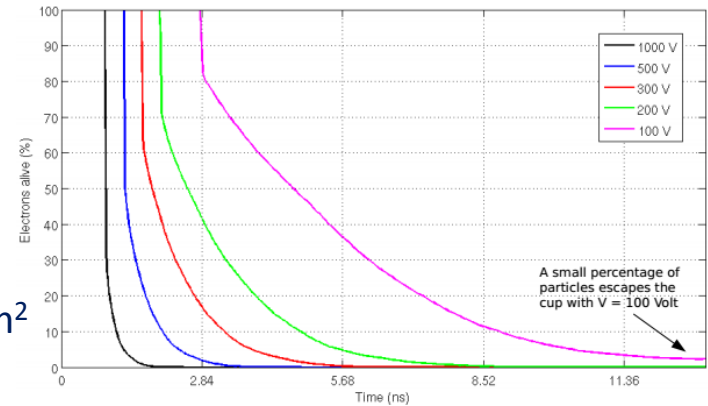
- The MEBT Faraday Cup measures the total beam current.
- Faraday Cup is used in Fast and Slow tuning modes.

Parameter	Value	Parameter	Value
Proton Energy	3.63 MeV	Beam Size	σ_x 2.488 mm
Intensity	62.5 mA		σ_y 2.624 mm
Mode I: Fast Tuning	5 μ s - 14 Hz - 16 W		
Mode II: Slow Tuning	50 μ s - 1 Hz - 11 W		



FC: Conceptual Design

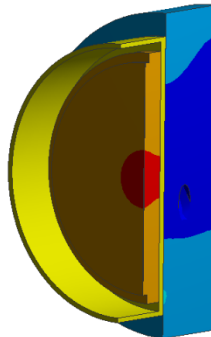
- Conceptual Design (already presented in BIF I/II)
 - Secondary Electrons Suppression
 - 100 % secondary electron suppression in ns
 - Repeller voltage -1000 V
 - Thermomechanical Analysis
 - Graphite can withstand irradiation up to $\sim 6 \mu\text{C}/\text{cm}^2$



Case	I'' ($\mu\text{C}/\text{cm}^2$)	ΔT (K)	σ_{Int} (MPa)	$\sigma_{Int}/\sigma_{Lim}$
FC: 30° (Transient)	4.0	659	45	54%
FC: 30° (Transient+Steady)	4.0	620	44	53%

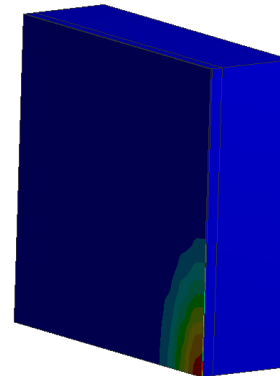
D: Steady-State Thermal
 Temperature
 Type: Temperature
 Unit: K
 Time: 1

385.13 Max
 375.43
 367.73
 359.03
 350.33
 341.63
 332.93
 324.23
 315.54
 306.84 Min



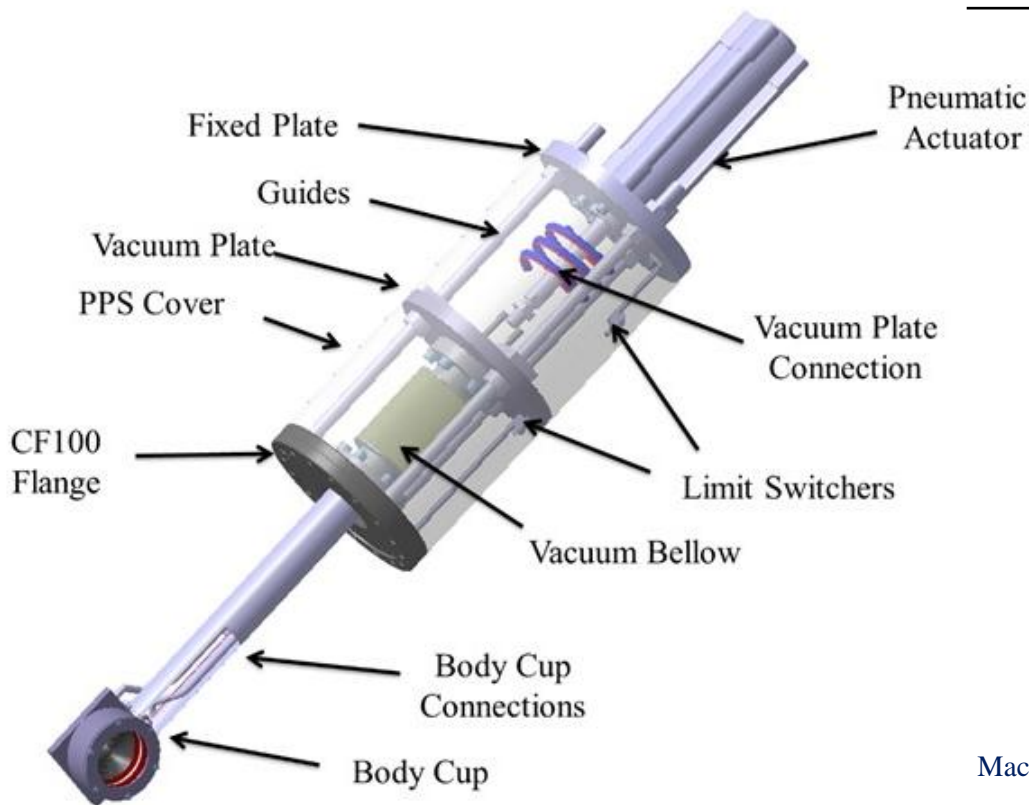
C: Transient Thermal
 Temperature_50μs
 Type: Temperature
 Unit: °C
 Time: 5.e-005

732 Max
 661
 590
 520
 449
 378
 307
 237
 166
 95.1 Min



FC: Specifications

- Technical Specifications: MEBT-BI-FC90-03



Parameter	Description
Beam Irradiation	3.63 MeV - 62.5 mA
Peak Beam Power	230 kW
Average Beam Power	16 W
Temperature	Body Cup 5-200 °C Actuator System 5-50 °C
Vacuum Conditions	10 ⁻⁷ to 10 ⁻¹⁰ mbar
Refrigeration	25 °C, 5 bar, 2 l/min
Body Cup Materials	Graphite Collector Stainless Steel Body Copper Repeller Alumina/Macor Insulators
Repeller Voltage	1000 V
Collector Signal Connection	BNC or SMA
Repeller Power Supply Connection	MHV
Pneumatic Actuator	5-10 bars
Automatic Actuator Retraction	Spring > 250 N
Machine Protection System Limit Switchers	Integrated in the frame
Local Control Limit Switchers	Integrated in actuator

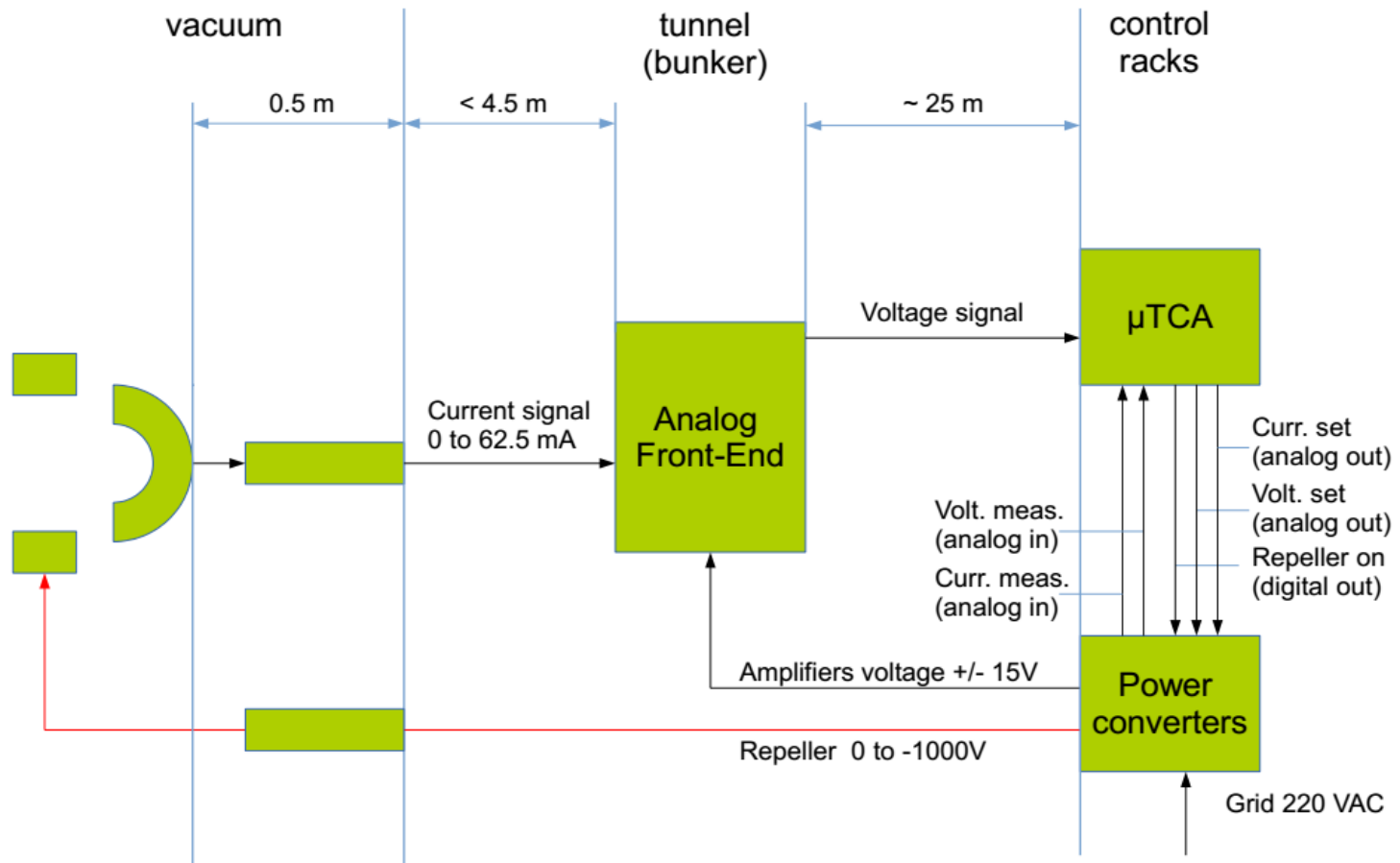
FC: Status

- The FC is on its tendering phase, for beginning of manufacturing in the next months.

Concept	Deliverables	Responsible	Deadline
Contract Signature	Conceptual Design: ESS-Bilbao will supply the CAD conceptual design to the contractor.	ESS-Bilbao & Contractor	T0
Detailed Design	Detailed Design Documentation: Blue-prints, description of the components and materials specifications	Contractor	T1=T0+2 months
Detailed Design Approval		ESS-Bilbao	T2 = T1 + 2 weeks
Product Delivery	Faraday Cup Product	Contractor	T3= T2 + 3 months
	Product Documentation: Blue-prints, description of the components and materials specifications		
	User's Guide / Safety Instructions: description of the operation of the product and safety measures		
Product Acceptance		ESS-Bilbao	T4 = T3 + 1 month

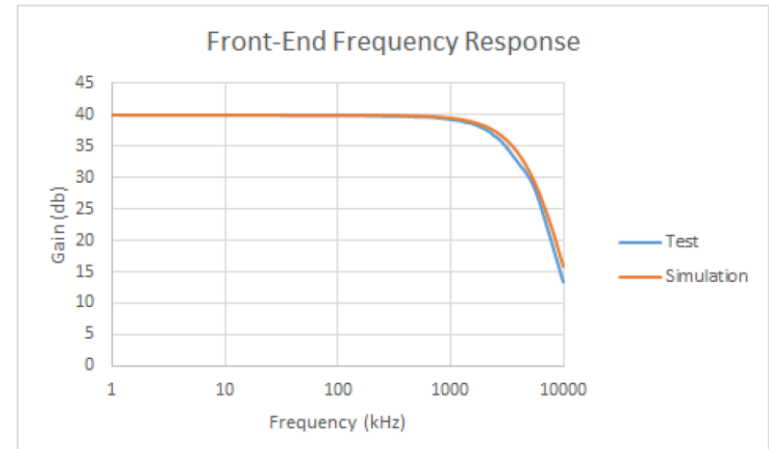
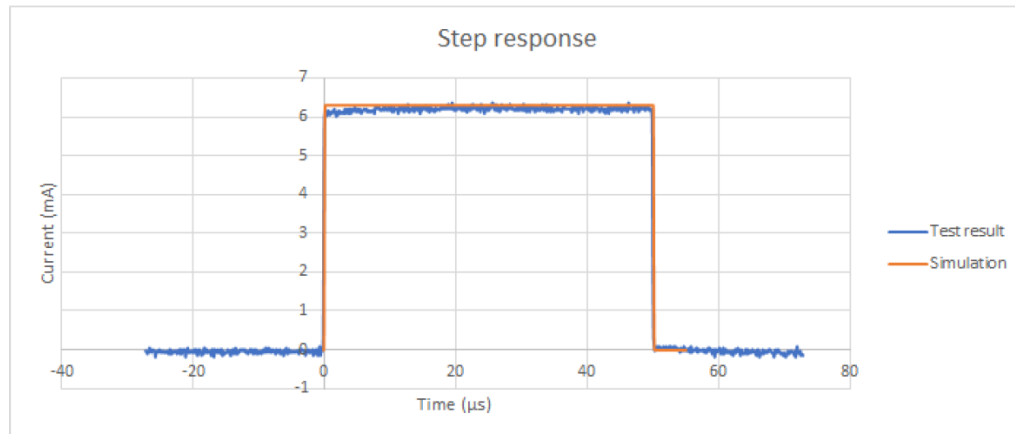
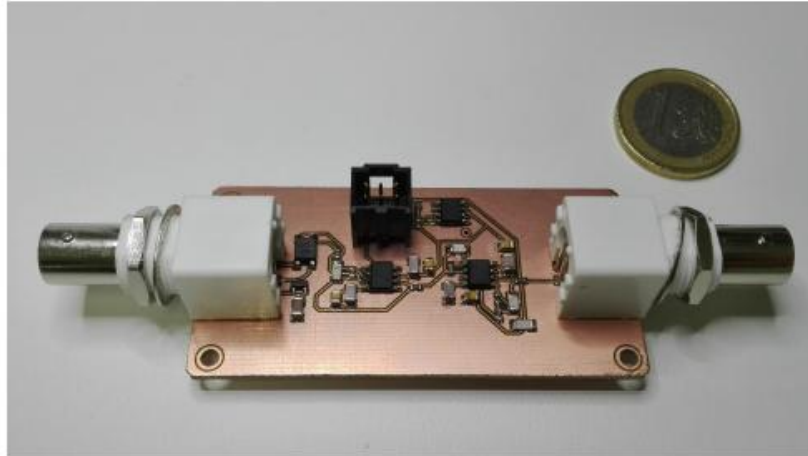
FC: Electronics

- Analogue Front-End Prototype Manufacturing and Tests



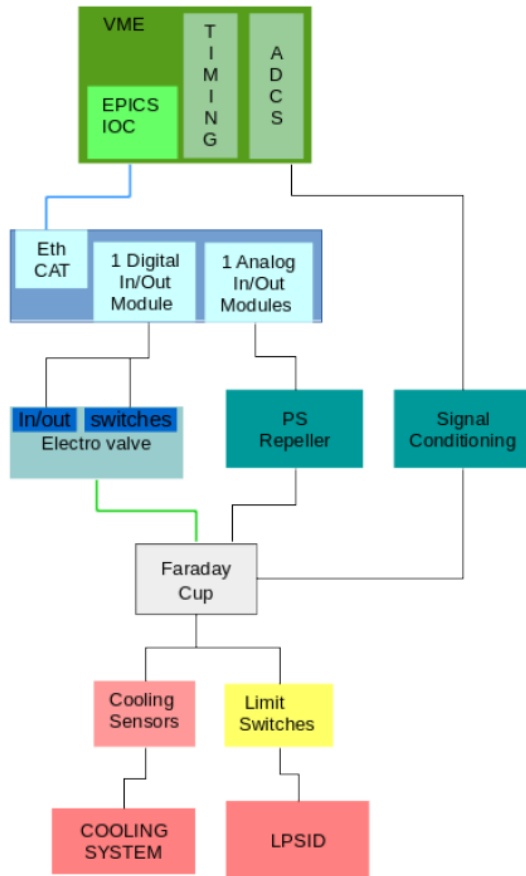
FC: Electronics

- Analogue Front-End Prototype Manufacturing and Tests
 - Step and Frequency Response Tests



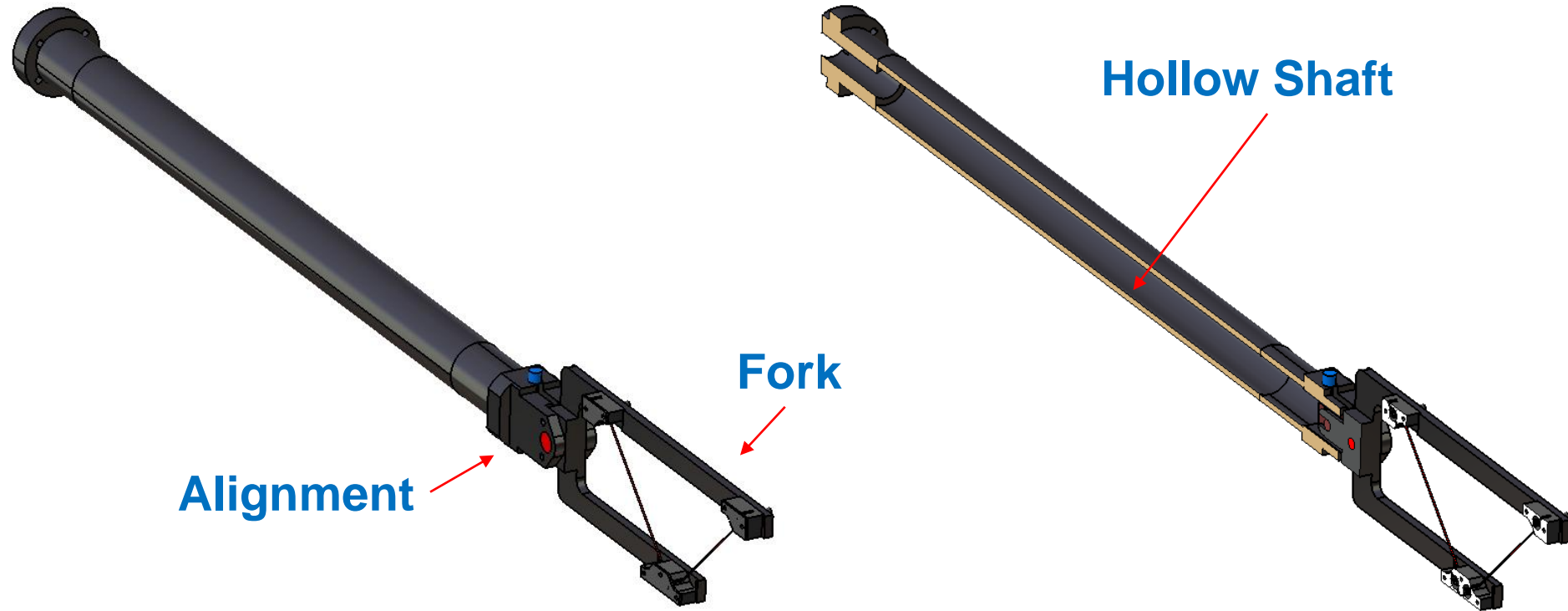
FC: Control

- IOC and OPI development
- Analogue Front-End integration



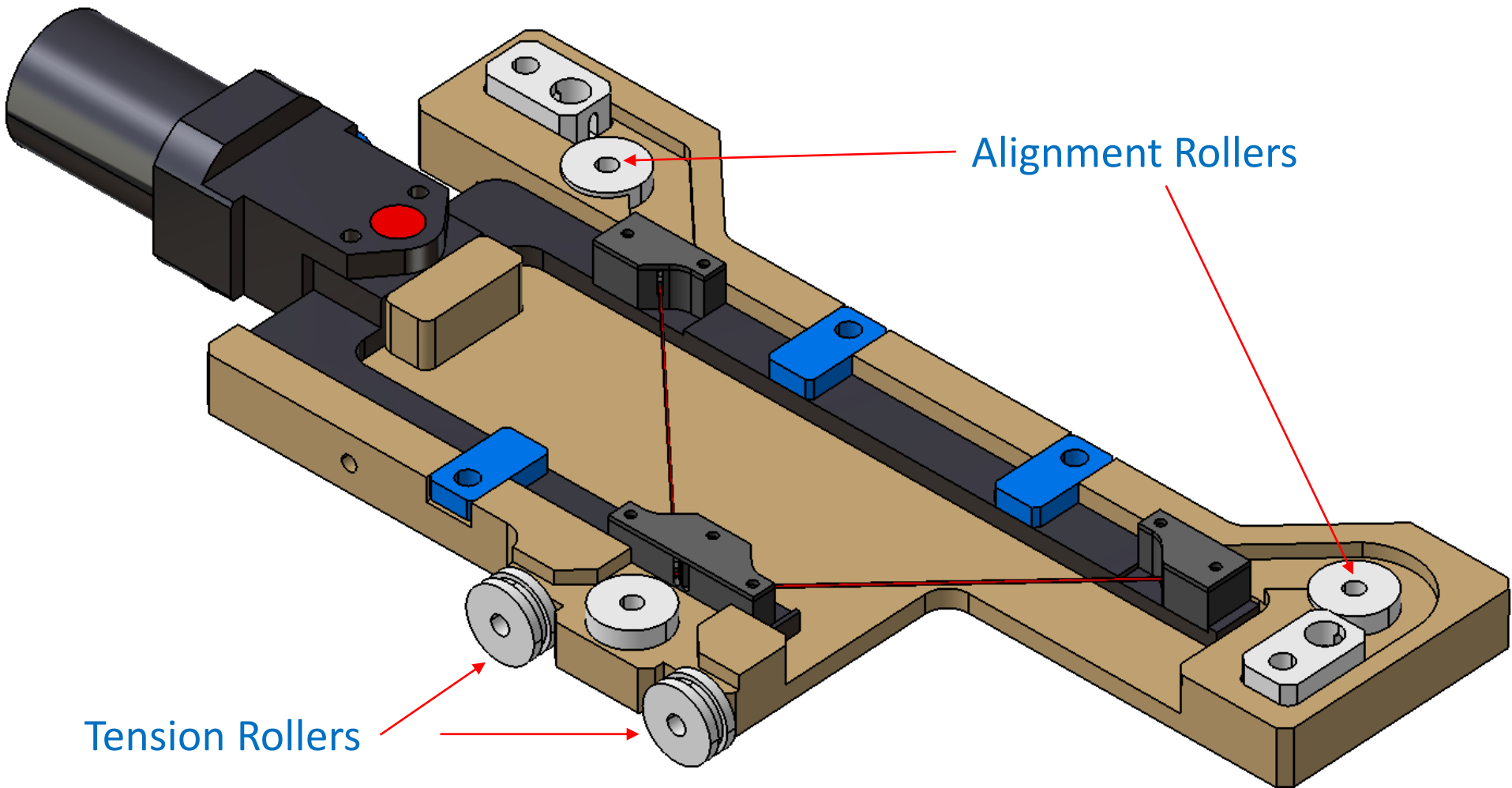
Wire Scanner Status

Wire Scanner Status

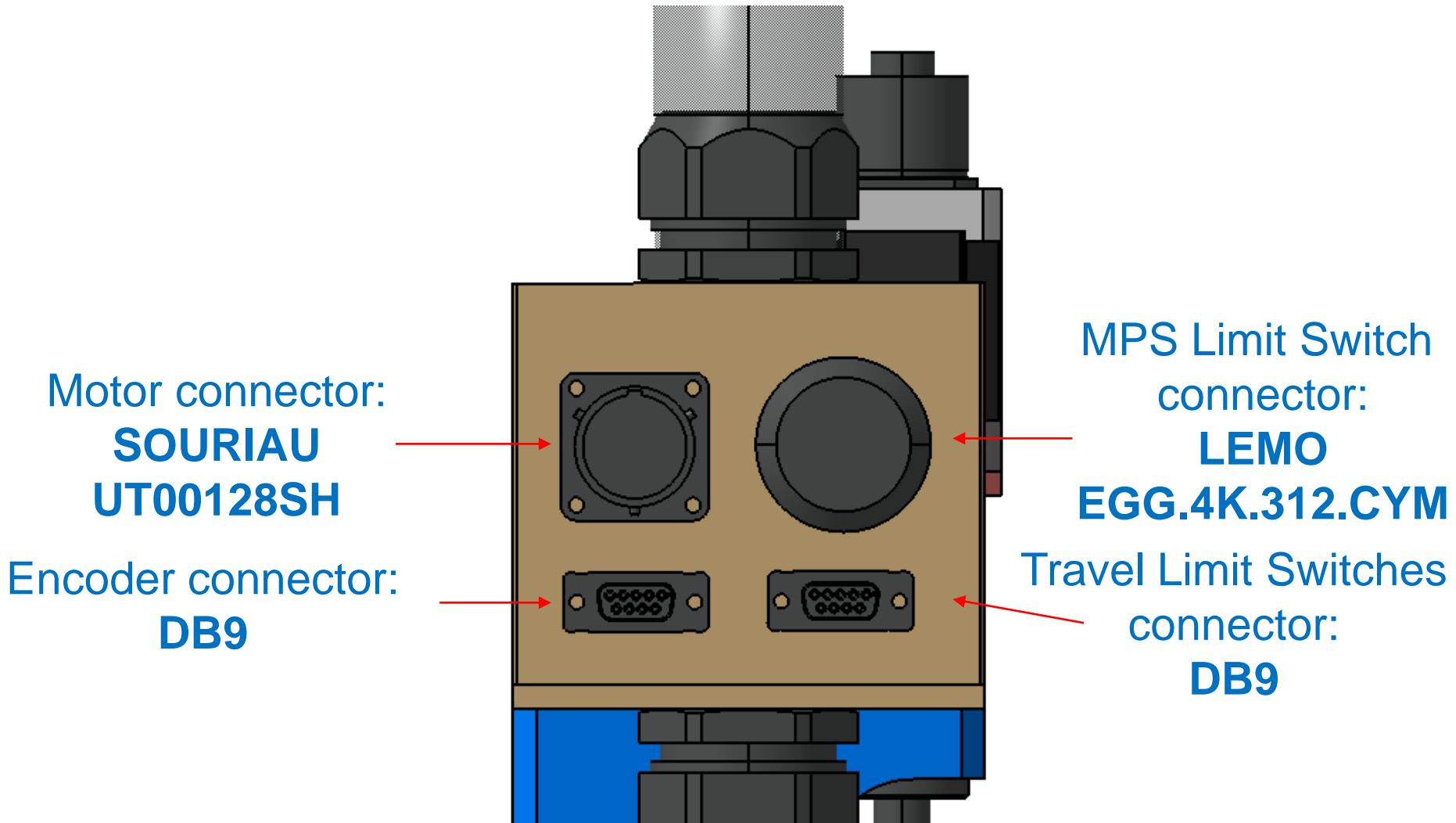


- An Alignment system has been added to correct possible missalignments during the assembly
- The Shaft is hollow in order to insert the signal cables through this.

Wires Alignment Toolkit



Patch Panel



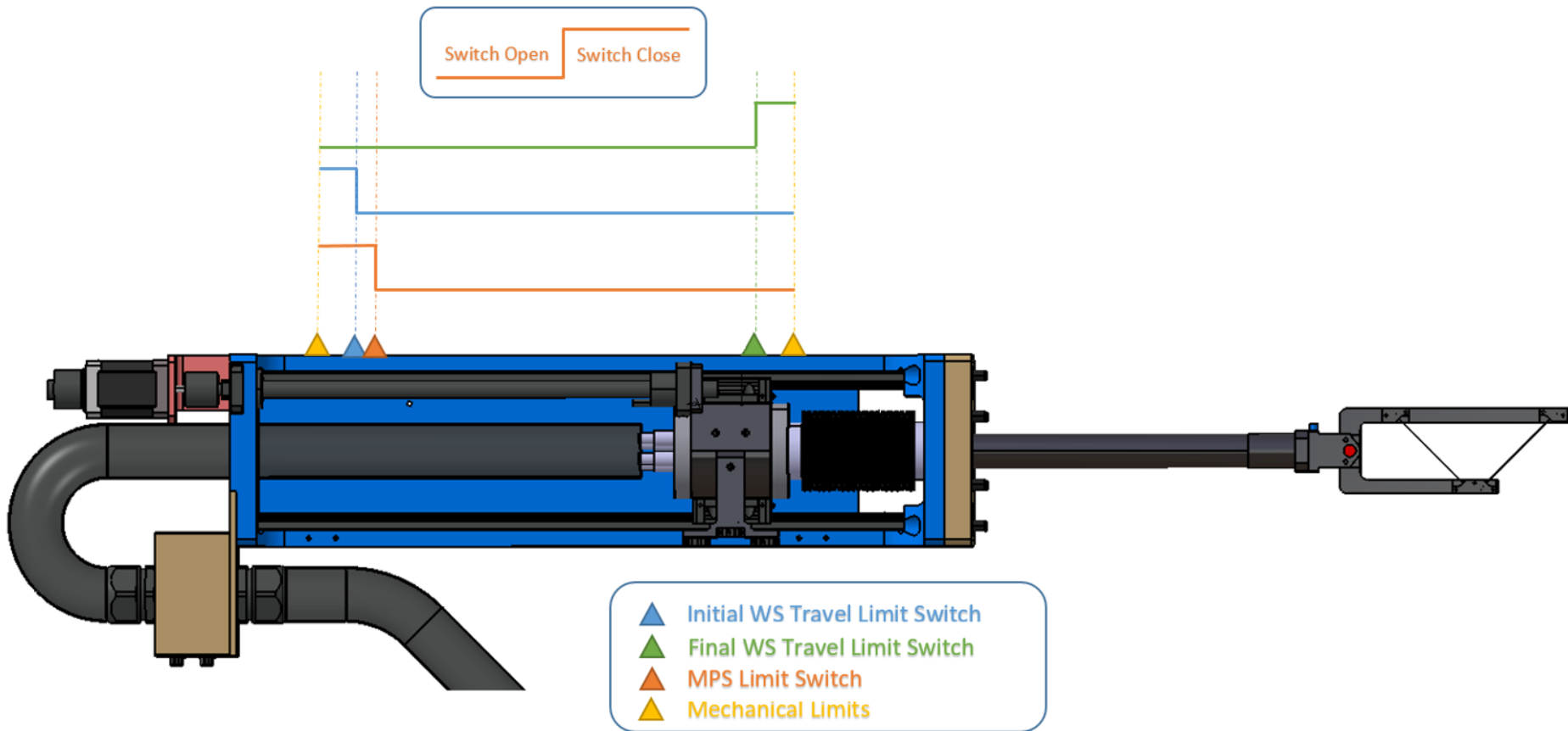
Motor connector:
**SOURIAU
UT00128SH**

Encoder connector:
DB9

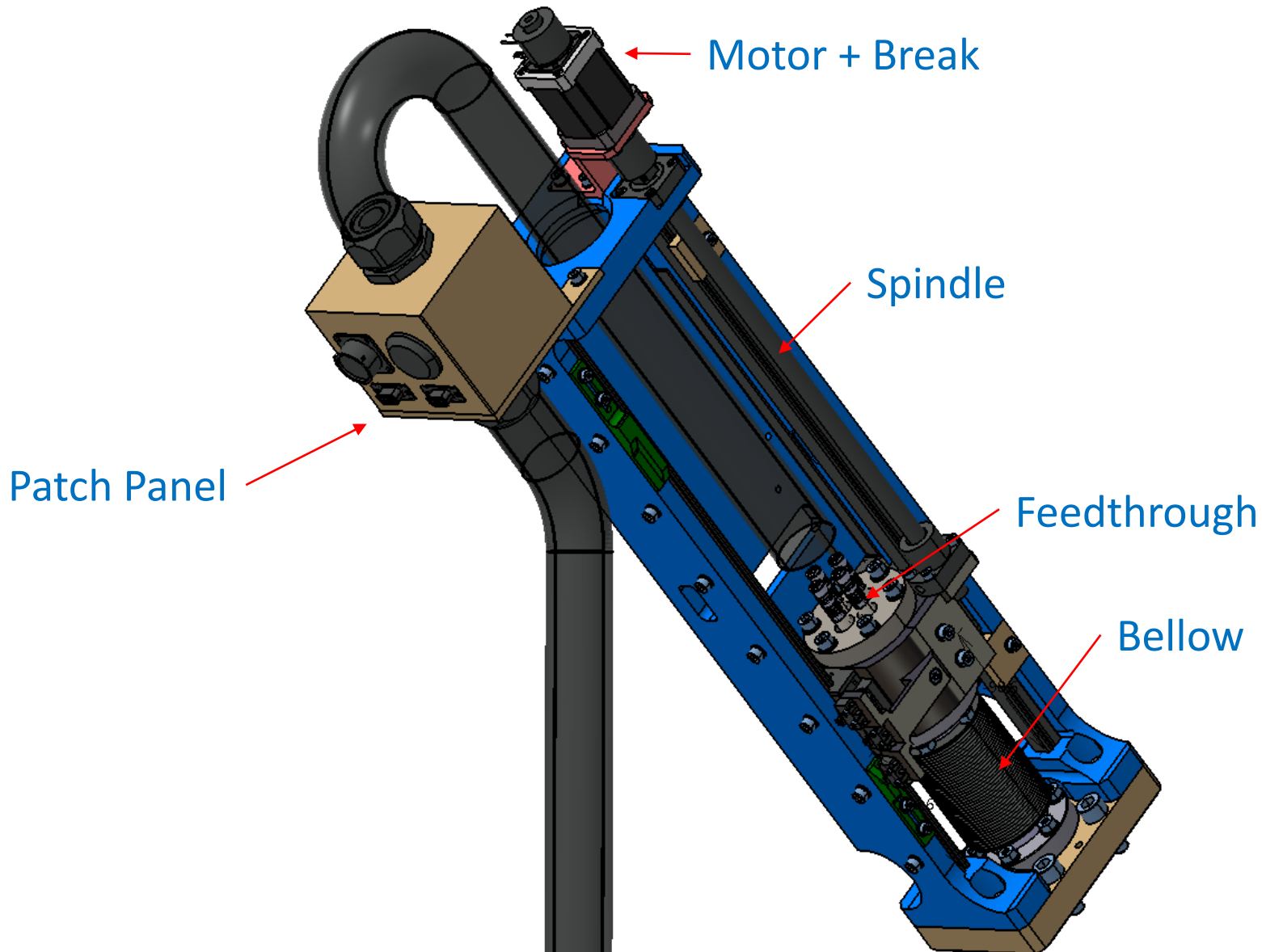
MPS Limit Switch
connector:
**LEMO
EGG.4K.312.CYM**

Travel Limit Switches
connector:
DB9

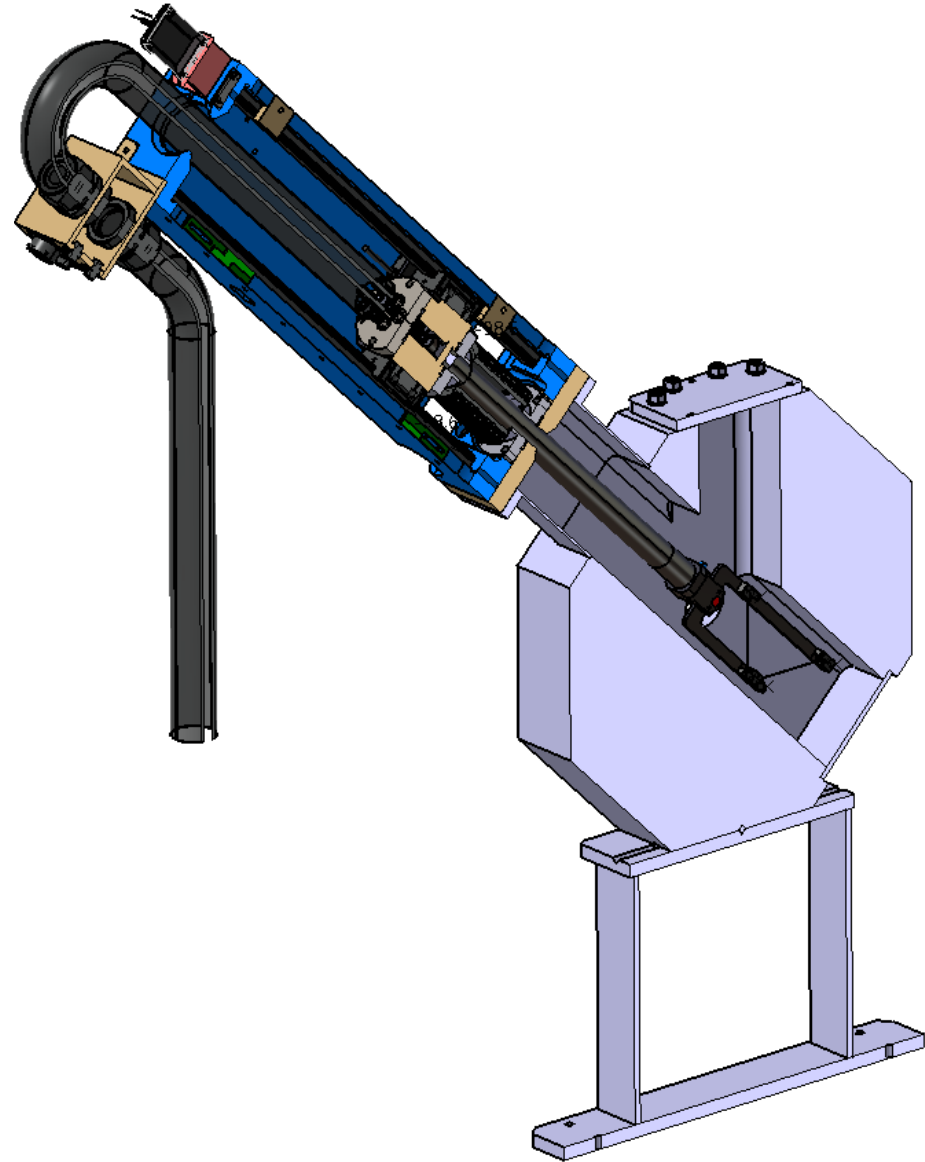
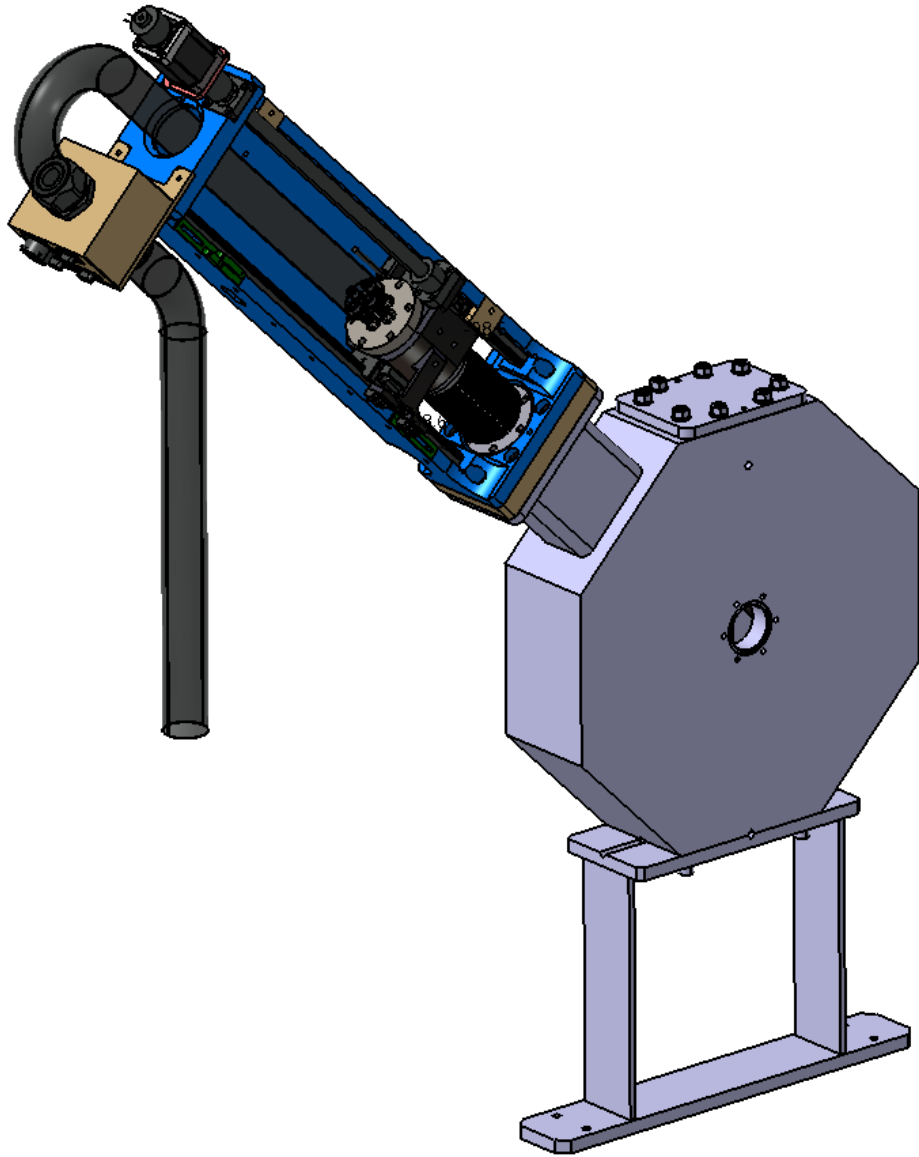
Limit Switches position and functionality



Wire Scanner Actuator

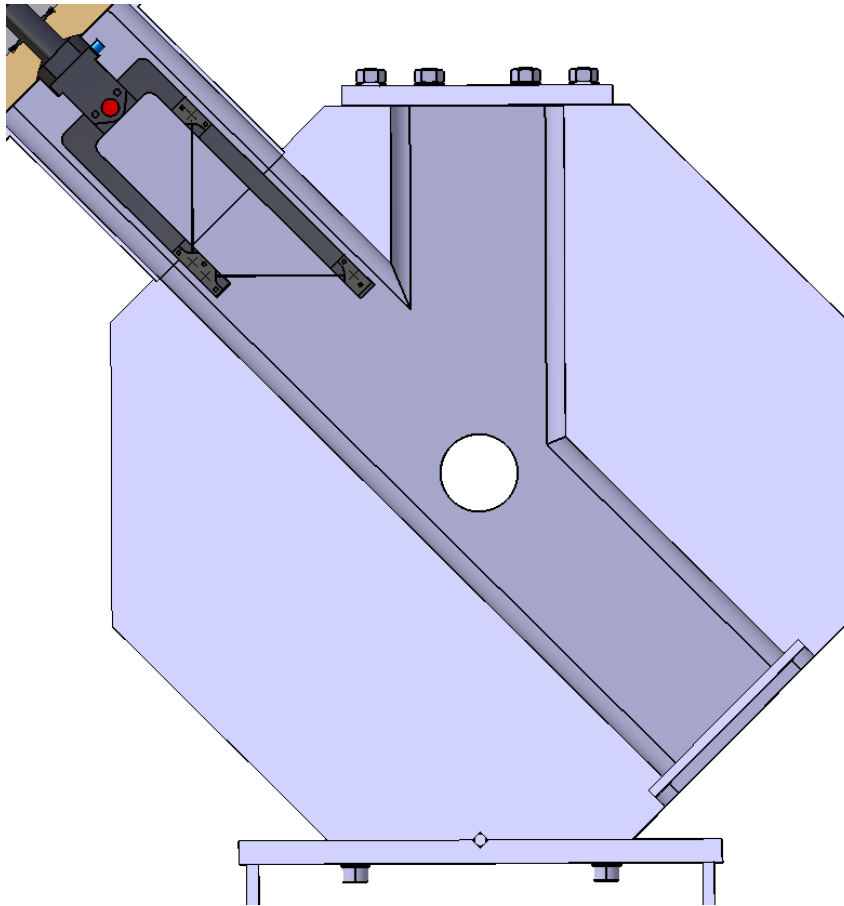


Wire Scanner Vessel

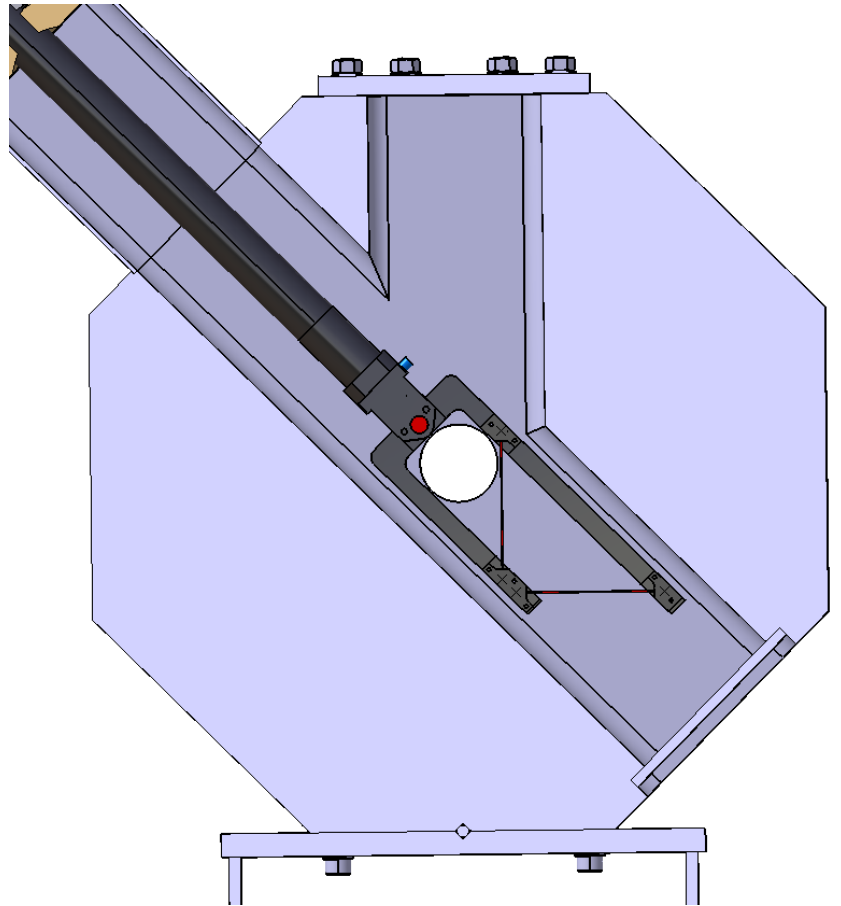


Wire Scanner Travel

WS Parking position
(0 mm)

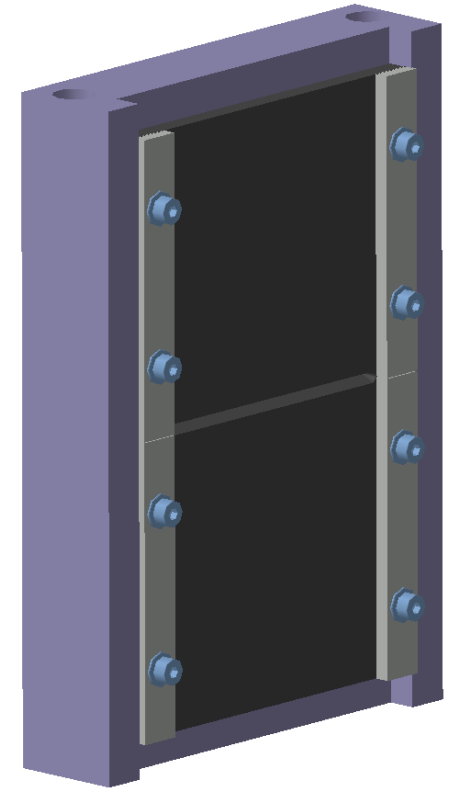
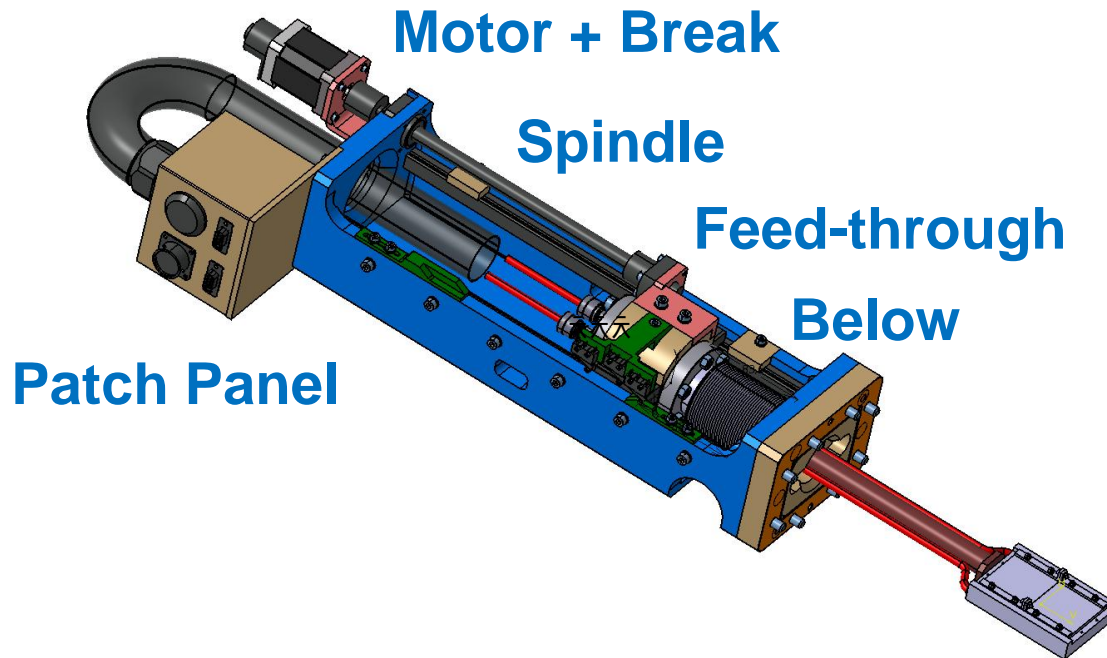


WS Final position
(240 mm)



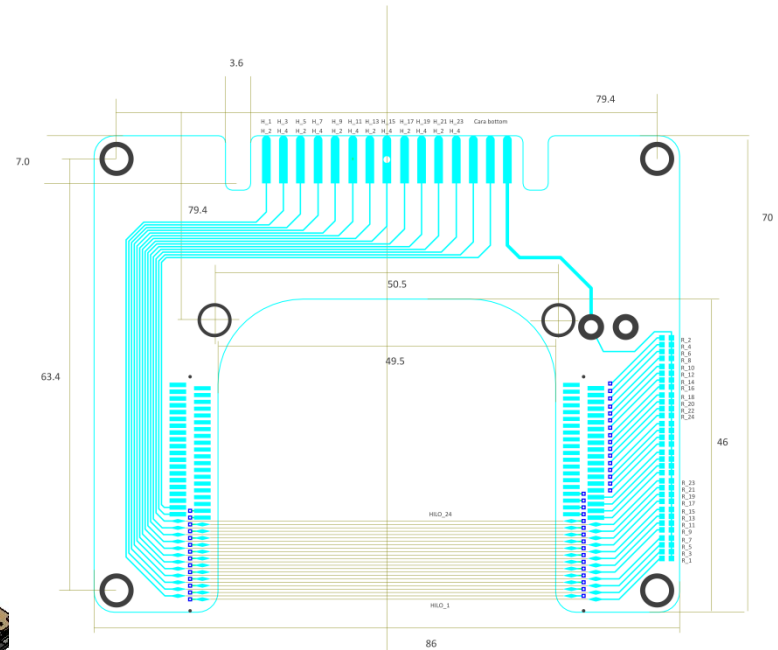
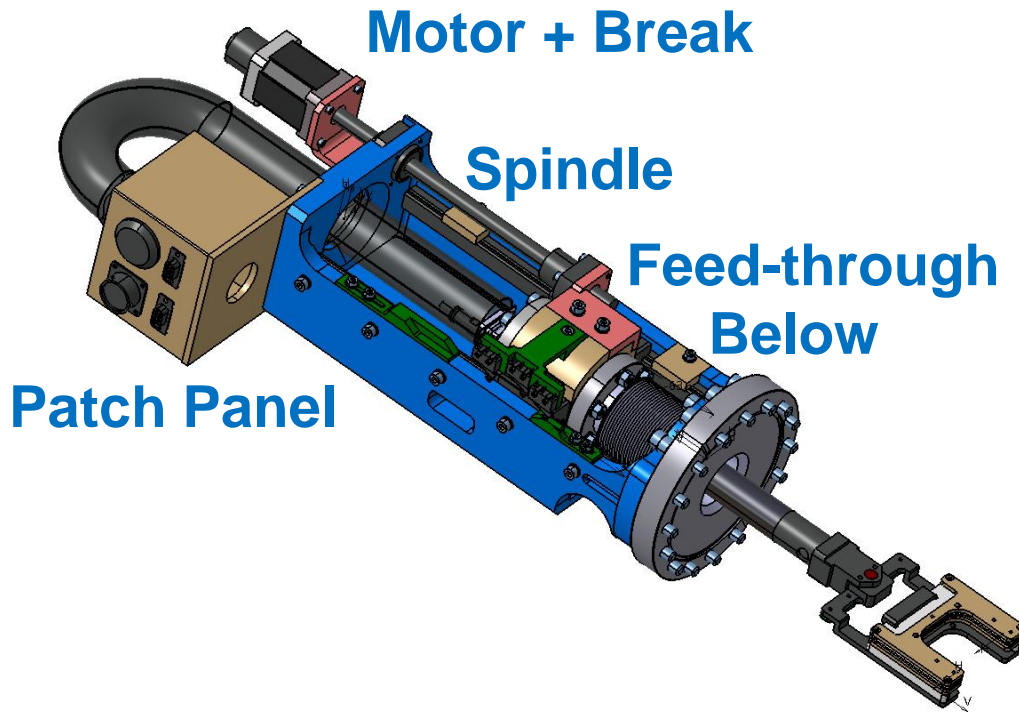
Emittance Meter Unit Status

EMU Status



- Slit actuator mechanical design finished (similar to WS)
- Slit conceptual design underway (Graphite plates in an Steel substrate)
 - 100 μm aperture
 - Two independent plates with a 50 μm rabbet
- Cooling pipes up to the Steel substrate

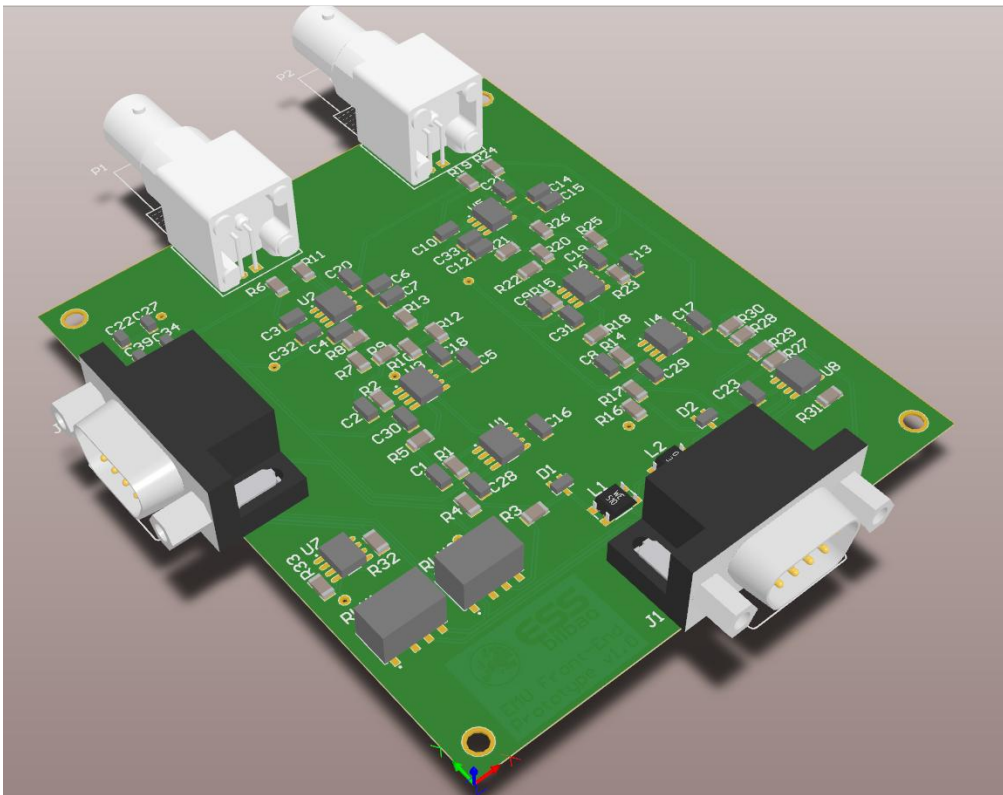
EMU Status: Electronics



- Slit actuator mechanical design finished (similar to WS)
- Grid final PCB design done
- Grid first prototype (with 4 wires) passed ESS vacuum test
- Final prototype (with 24 wires) in production (delivery expected in two weeks)

EMU Status: Electronics

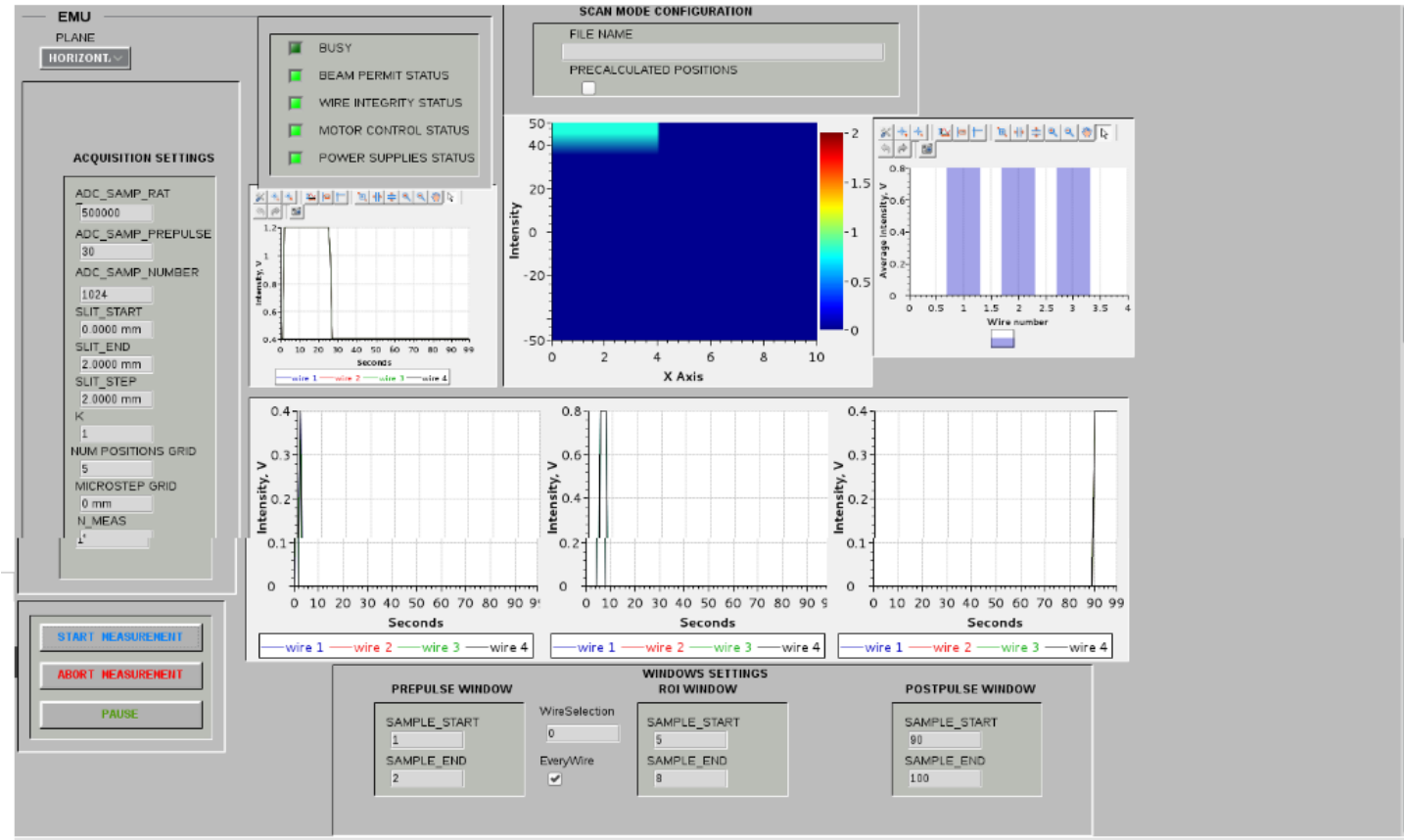
Prototype with 2 channels



Features:

- Covert collected current into a readable voltage signal
- Amplifying & Filtering
- Prototype in production
- (we should receive it soon)
- Test with 2 channels, final version 24 channels
- Prototype includes switches to change from Vertical to Horizontal wires
- Includes broken wires checking system

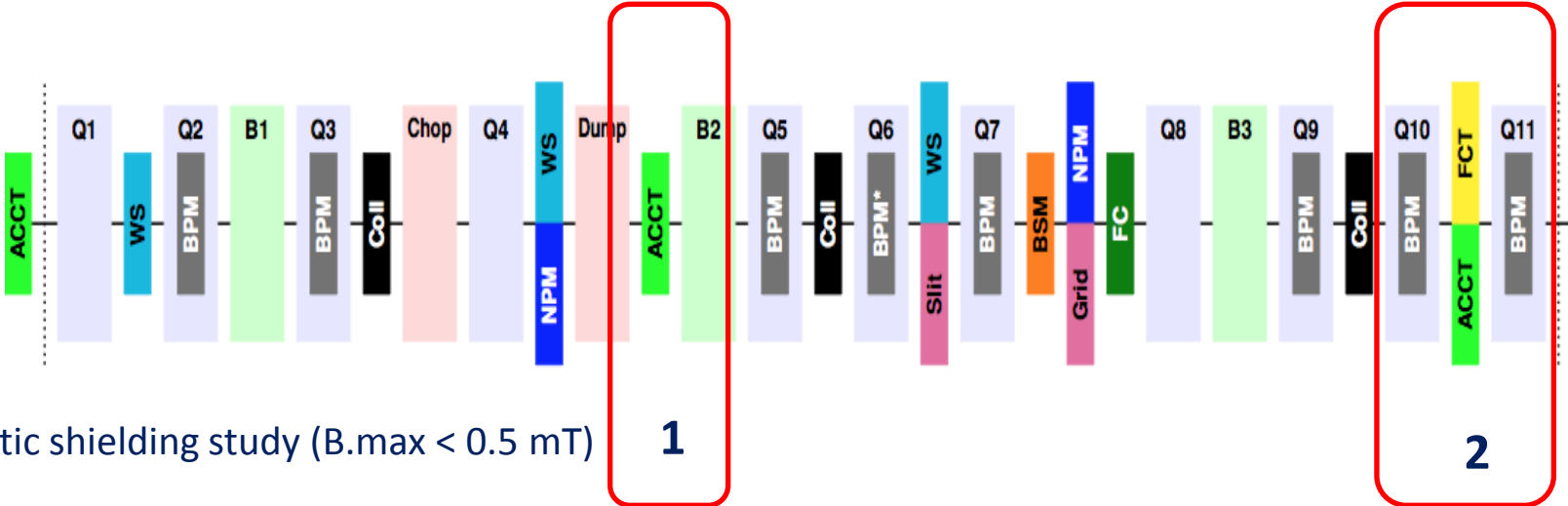
EMU Status: GUI



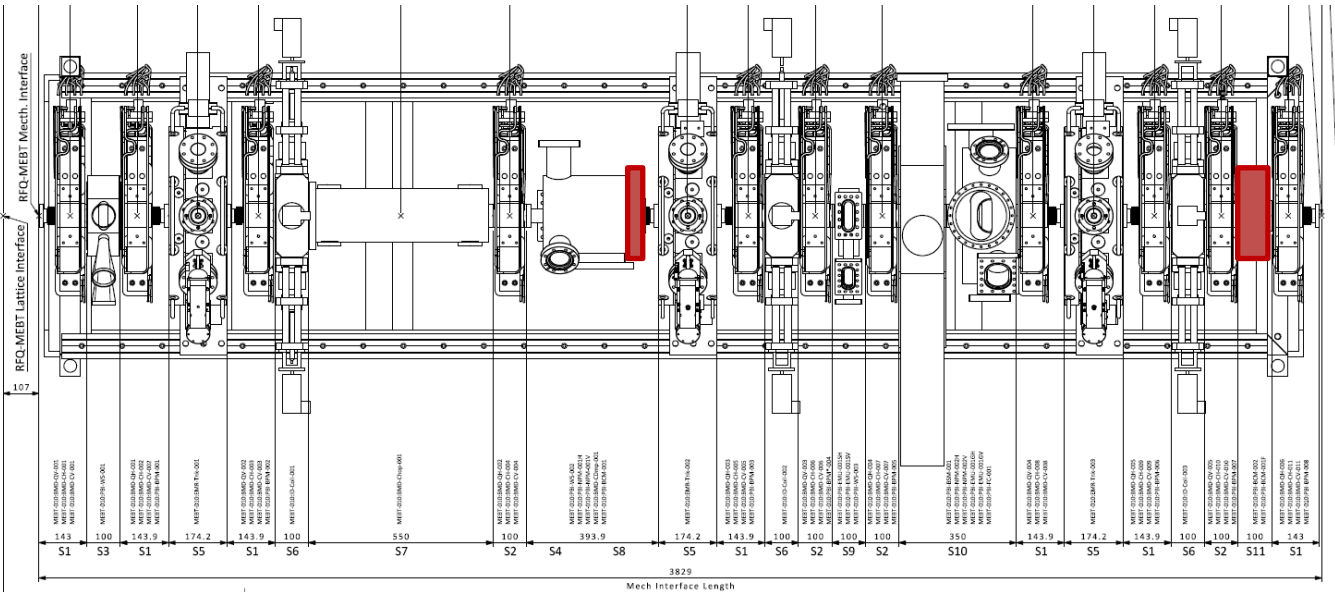
- Main functionality (movement, signal acquisition) implemented
- Uses SSCAN module
- Tests underway

ACCT/FCT Status

ACCT/FCT Status

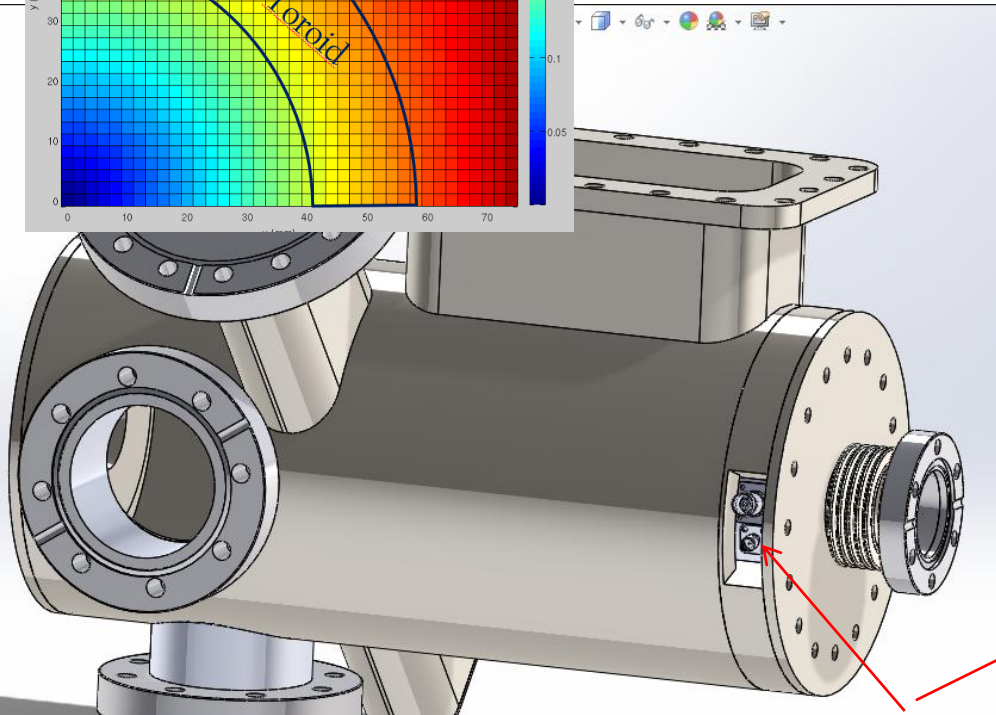
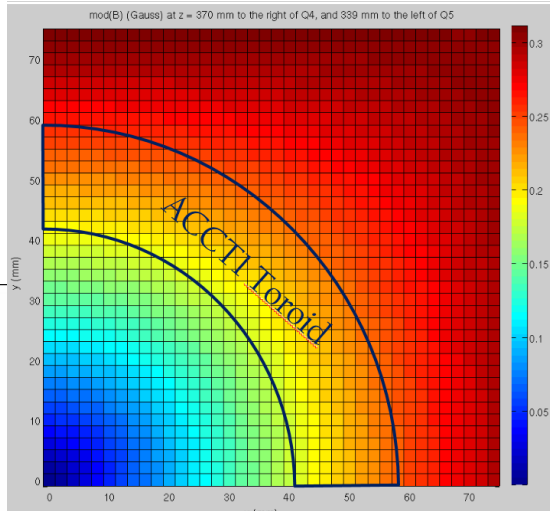


Magnetic shielding study (B.max < 0.5 mT)

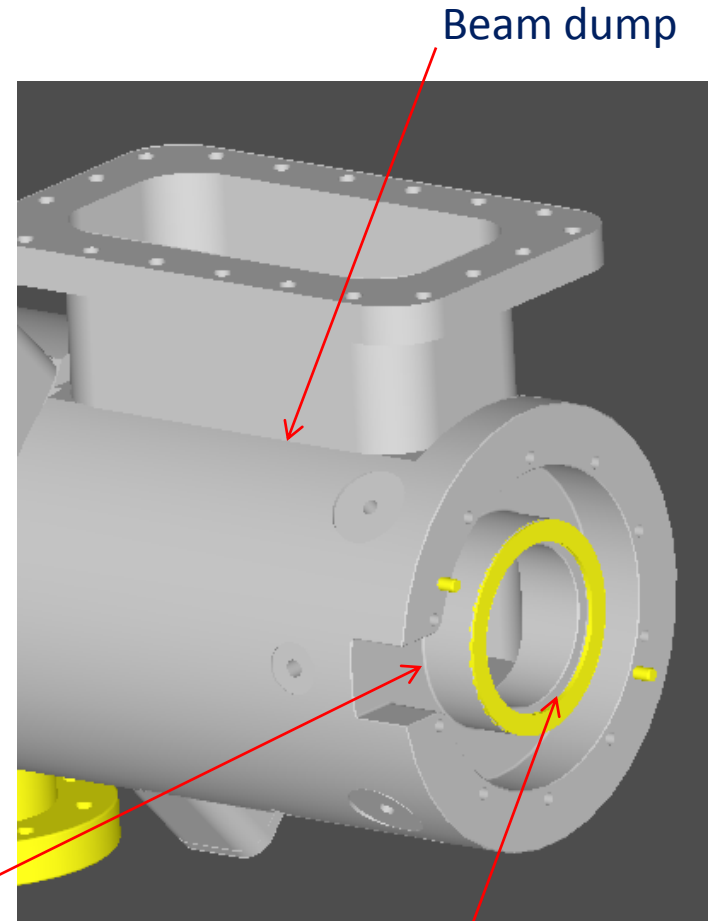


ACCT1

Analysis show no requirement for magnetic shielding.



In-Air ACCT1
 $\phi 82$

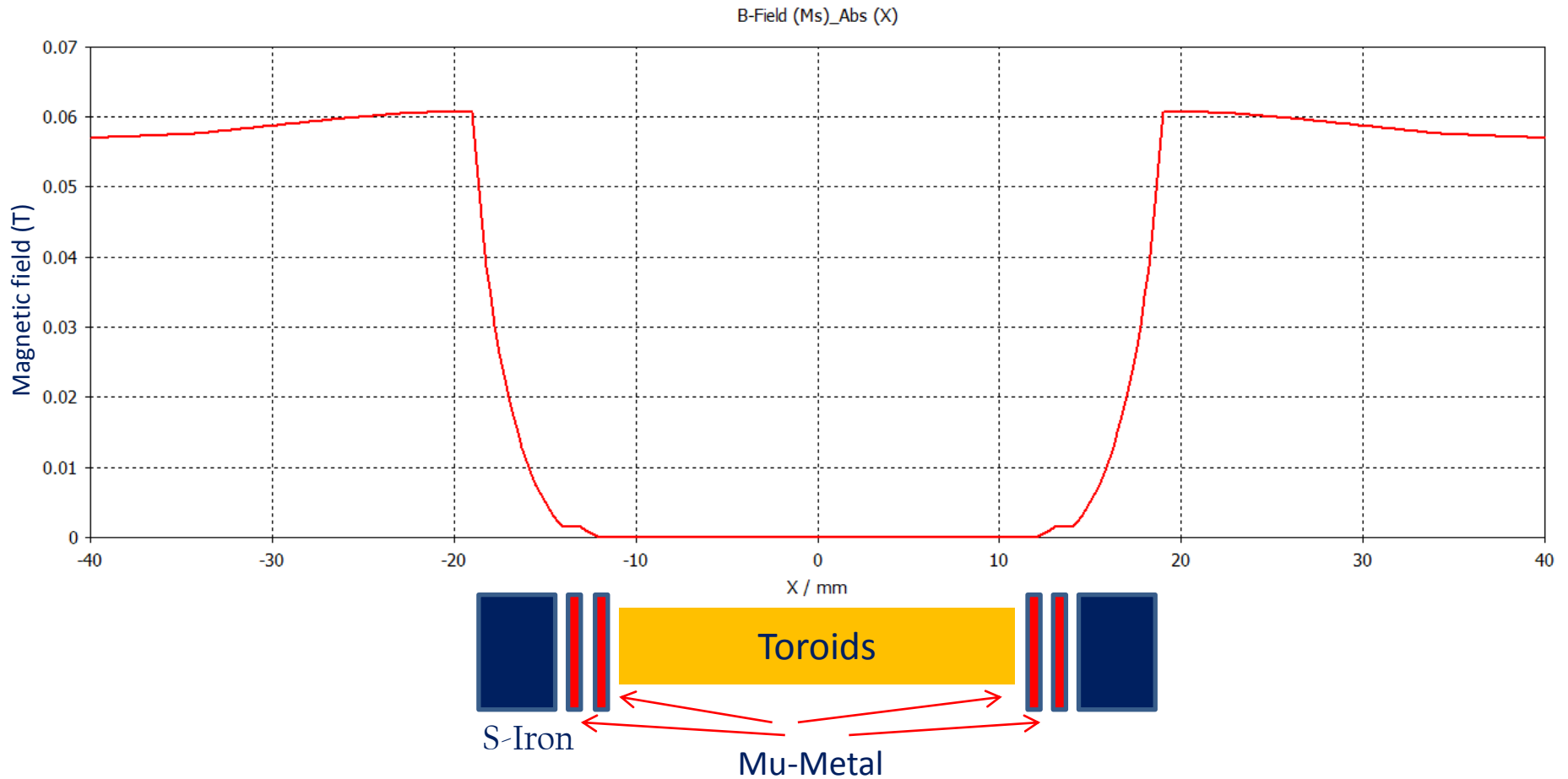


EPDM Gasket

ACCT2/FCT (Combined)

External magnetic field is high, and without proper shielding the toroids go to saturation.

External magnetic field in the Toroids location



Two options for Combined BCT

In the second location (ACCT2/FCT), the external magnetic field level is high and requires magnetic shielding. In this location the external magnetic fields from adjacent quadrupoles reach to 35 mT.

- In-Air
 - No guarantee for the possible resonances and effects on FCT bandwidth (neither us, nor Bergoz).
- In-Flange
 - Slightly more expensive, but the characteristics are identified.

SMA, BNO connectors

MEBT Combined BCM's (In-Air option)

Coils

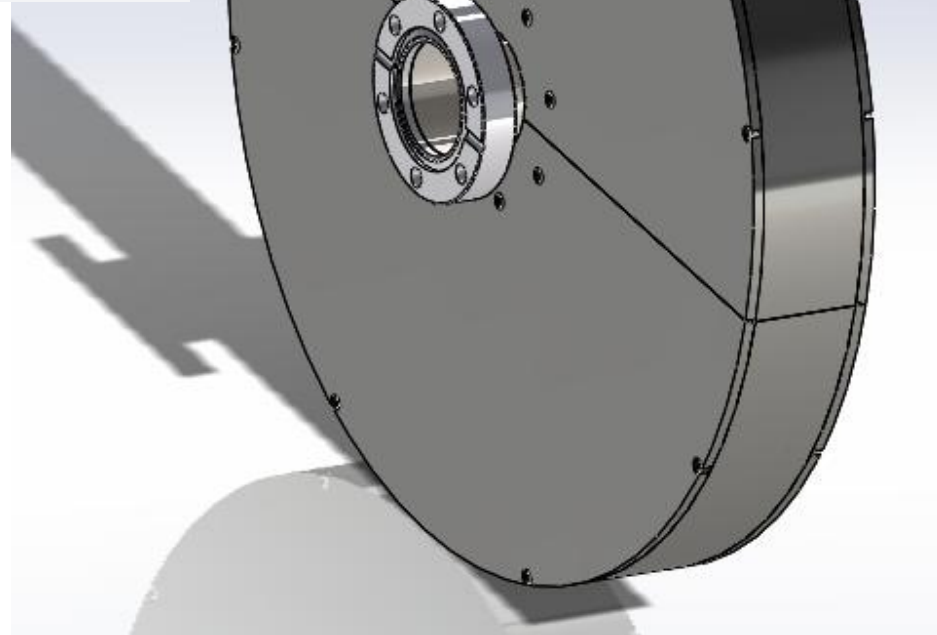
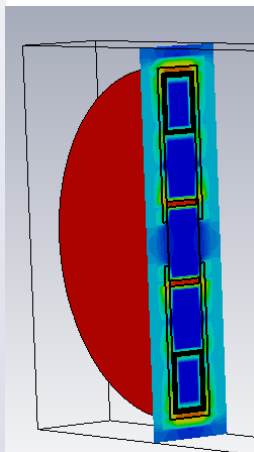
MuMetal1
MuMetal2

Soft Iron

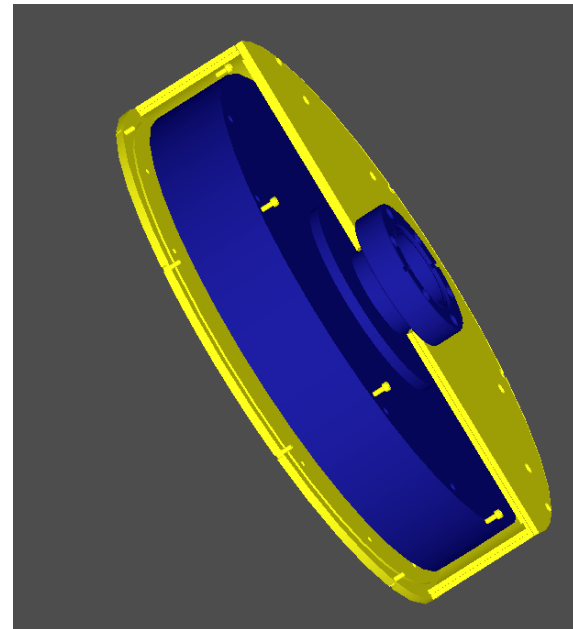
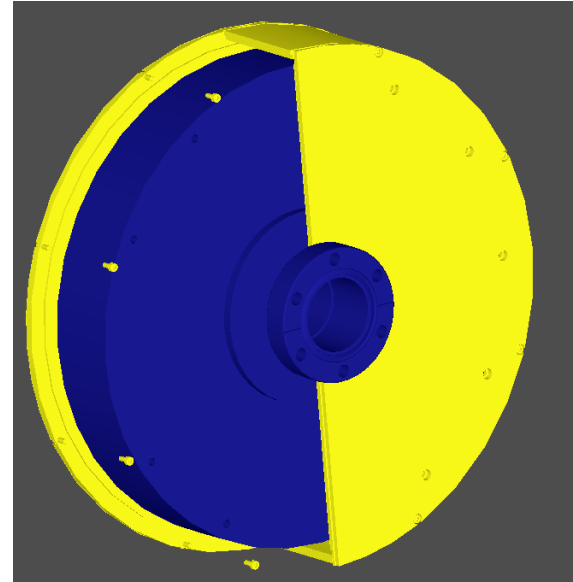
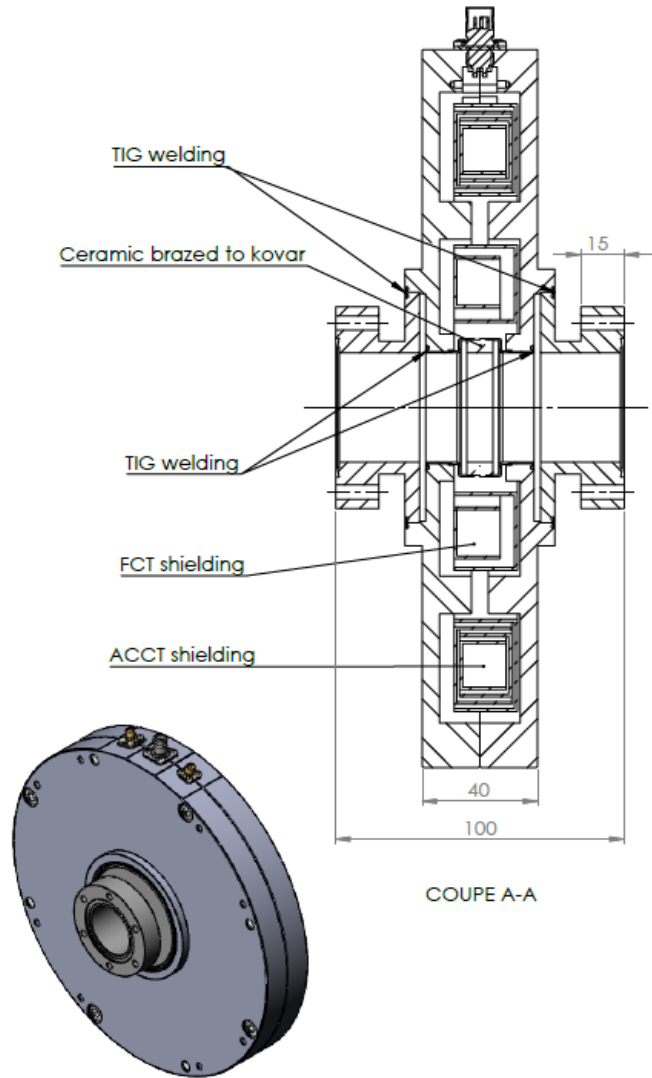
SS

Al2O3

RF fingers



✓ Solution: In-Flange Option



BCT Status

Within next month we will start the ordering/tender process of ACCTs/FCT and thick soft iron shield.

- Detailed drawings (Joint Bilbao with Bergoz): May 2017
- Launch the fabrication. June 2017
- FAT: Oct. 2017
- Delivery to Bilbao: Nov. 2017
- Tests in Bilbao: Dec 2017

BPM Status

MEBT BPM Stripline Status

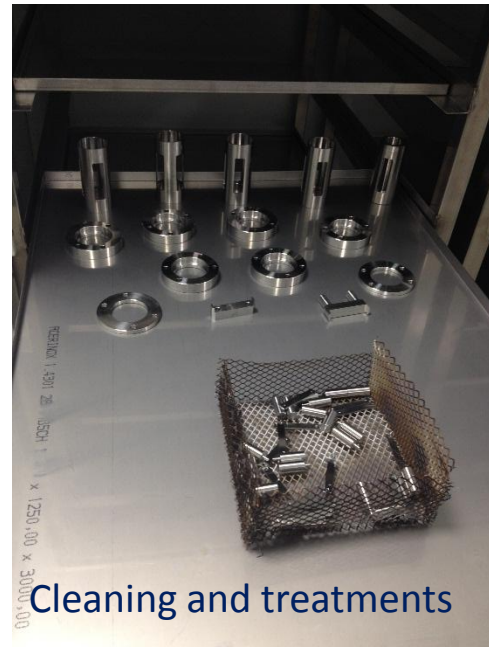
- ✓ 3D Electromagnetic and mechanical Design: Finished February 2016
- ✓ Fabrication process started: April 2016
- ✓ Finished first prototype: April 2017
- ✓ Partial measurements of prototype finished: April 2017



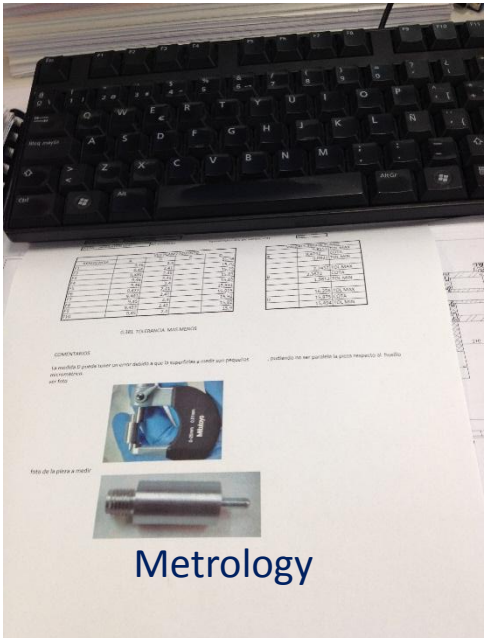
Vacuum tests



Magnetic permeability tests



Cleaning and treatments



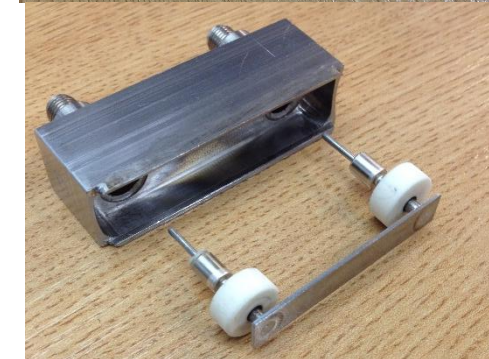
Metrology



Fabrication pieces

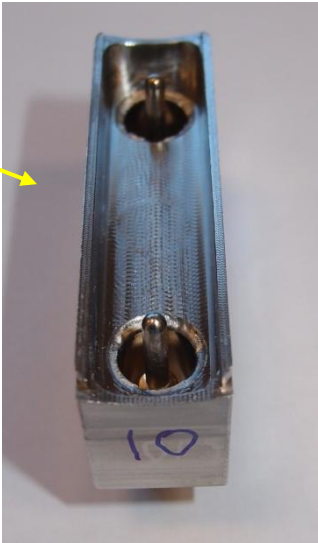
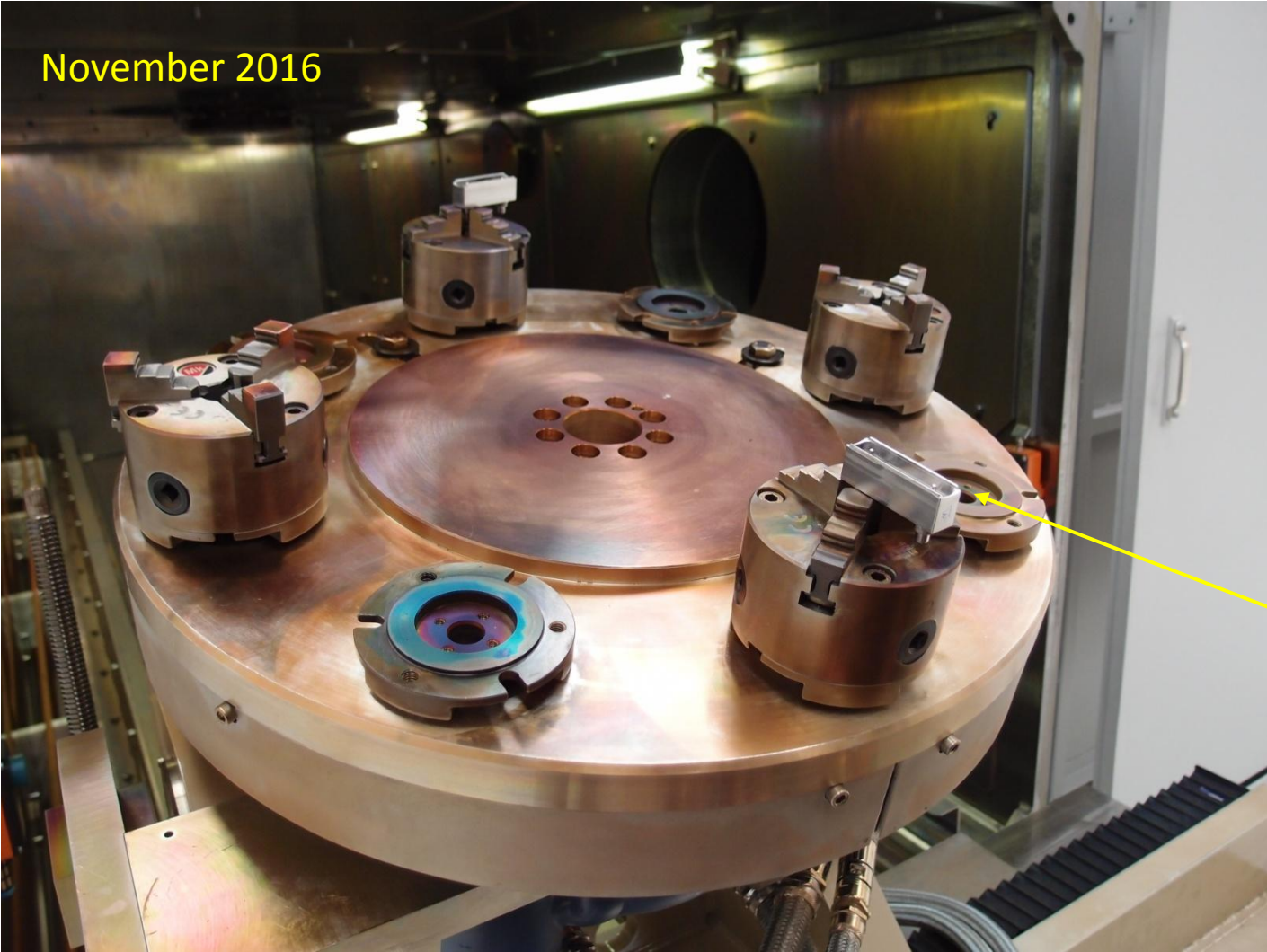


Failures!!

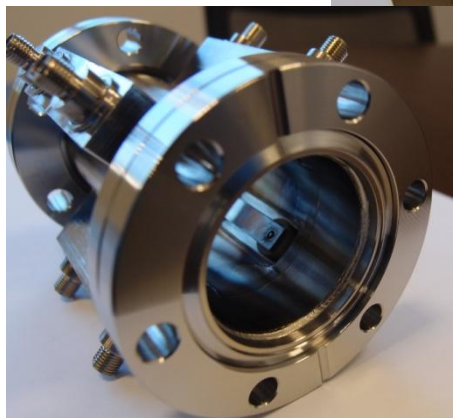


Fabrication process: e-beam welding

November 2016



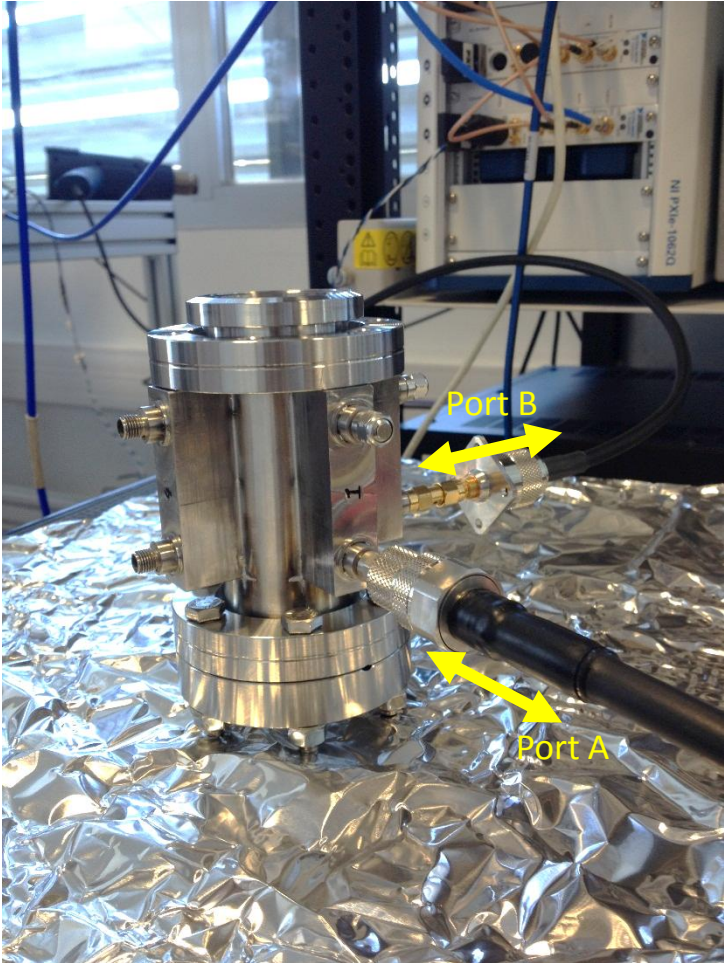
MEBT BPM prototype, April 2017



BPM Stripline measurements

- Signal transmission and matching
- Coupling between electrodes
- Resonances (to 4 GHz)

Measurement setup for high frequency checks

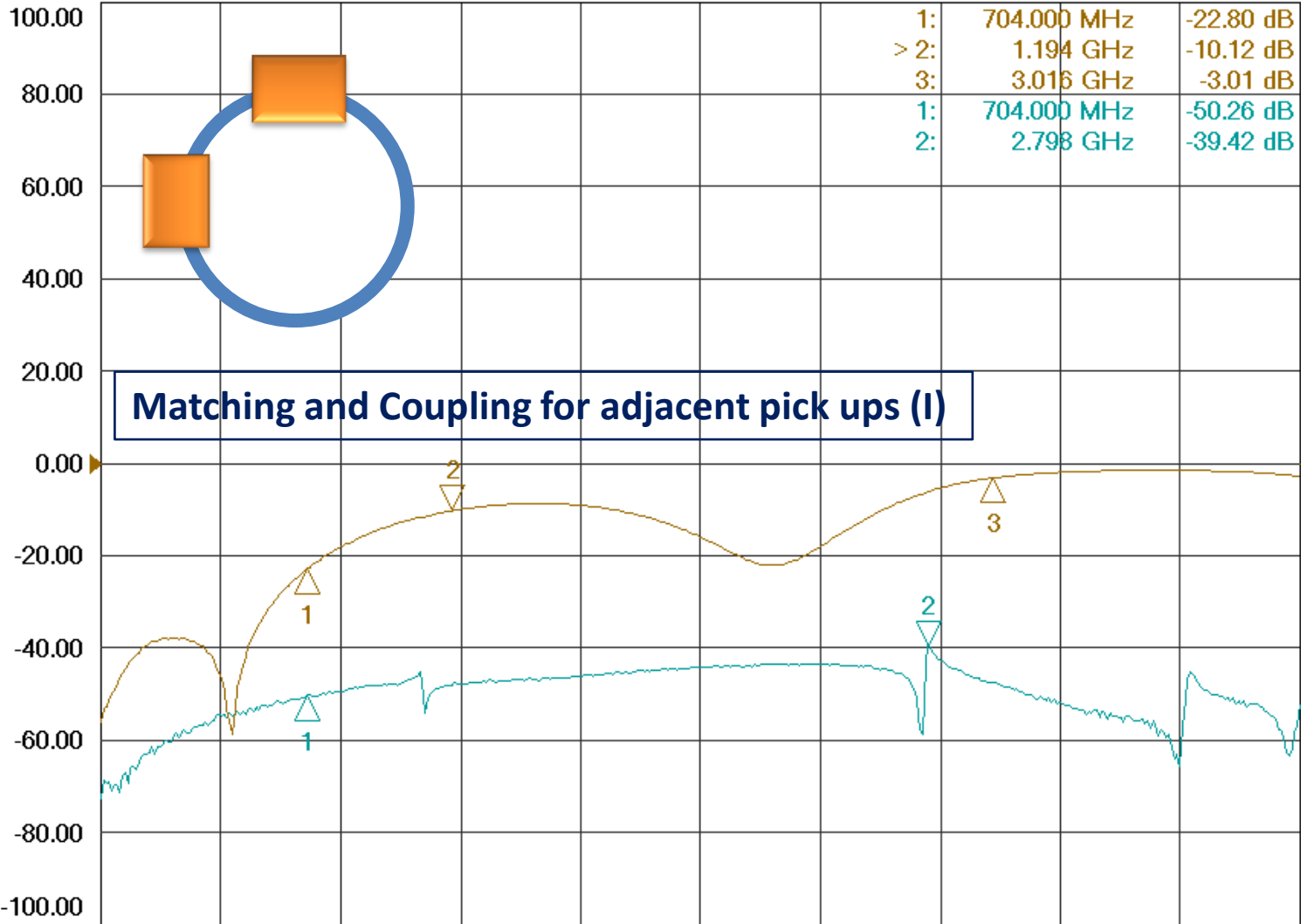


Scale Per Division 20.000 dB

Scale

Tr 1 S11 LogM 20.00dB/ 0.00dB

Tr 2 S21 LogM 20.00dB/ 0.00dB



Matching and Coupling for adjacent pick ups (I)

Autoscale

Autoscale

All

* Scale

Reference

Level

Reference

Position

Electrical

Delay

Phase

Offset

More

Favorites

1 >Ch1: Start 10.0000 MHz

Stop 4.05000 GHz

Scale Per Division 20.000 dB

Scale

Autoscale

Autoscale

All

* Scale

Reference

Level

Reference

Position

Electrical

Delay

Phase

Offset

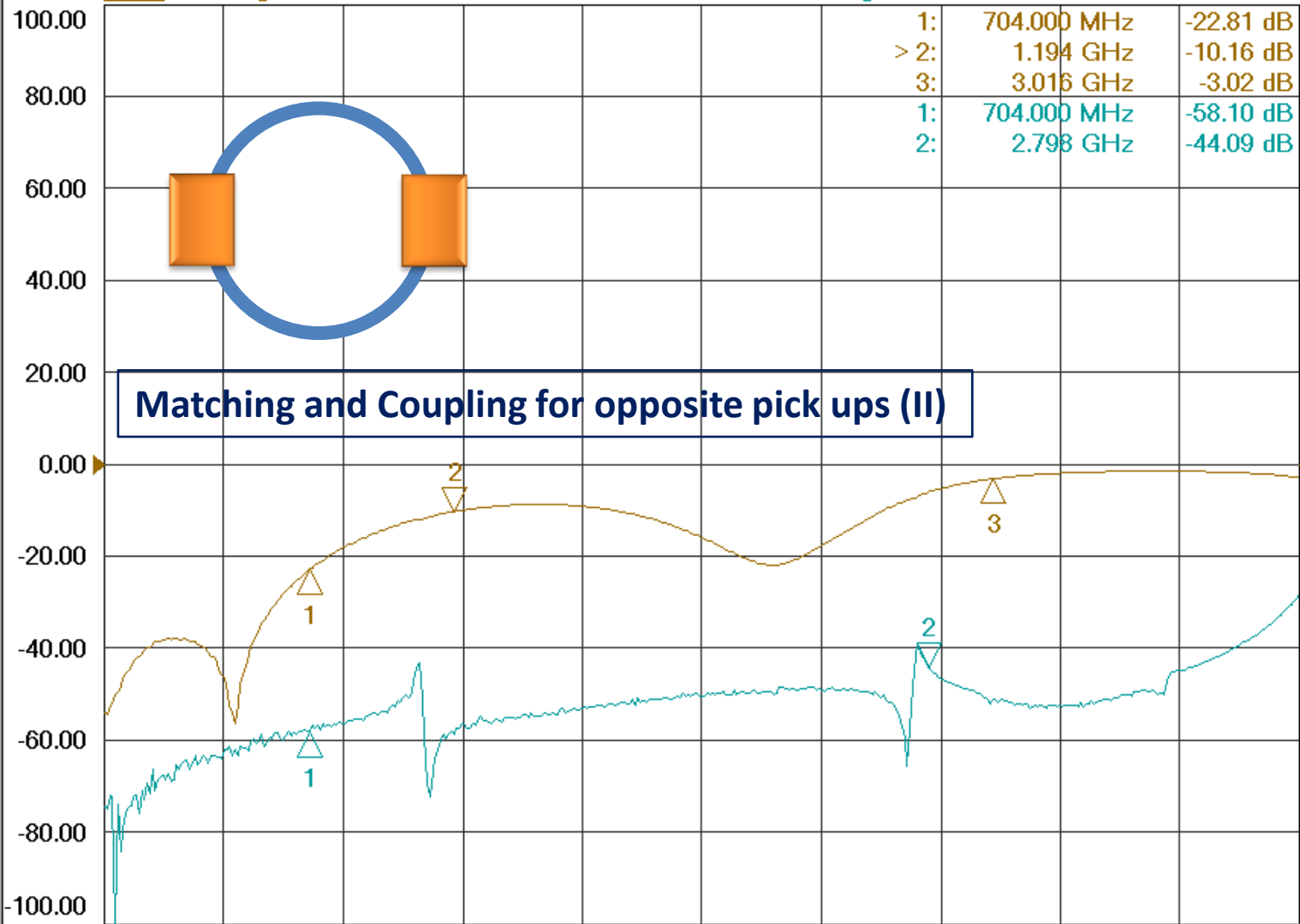
More

Favorites

LCL

Tr 1 S11 LogM 20.00dB/ 0.00dB

Tr 2 S21 LogM 20.00dB/ 0.00dB



Matching and Coupling for opposite pick ups (II)

1 >Ch1: Start 10.0000 MHz

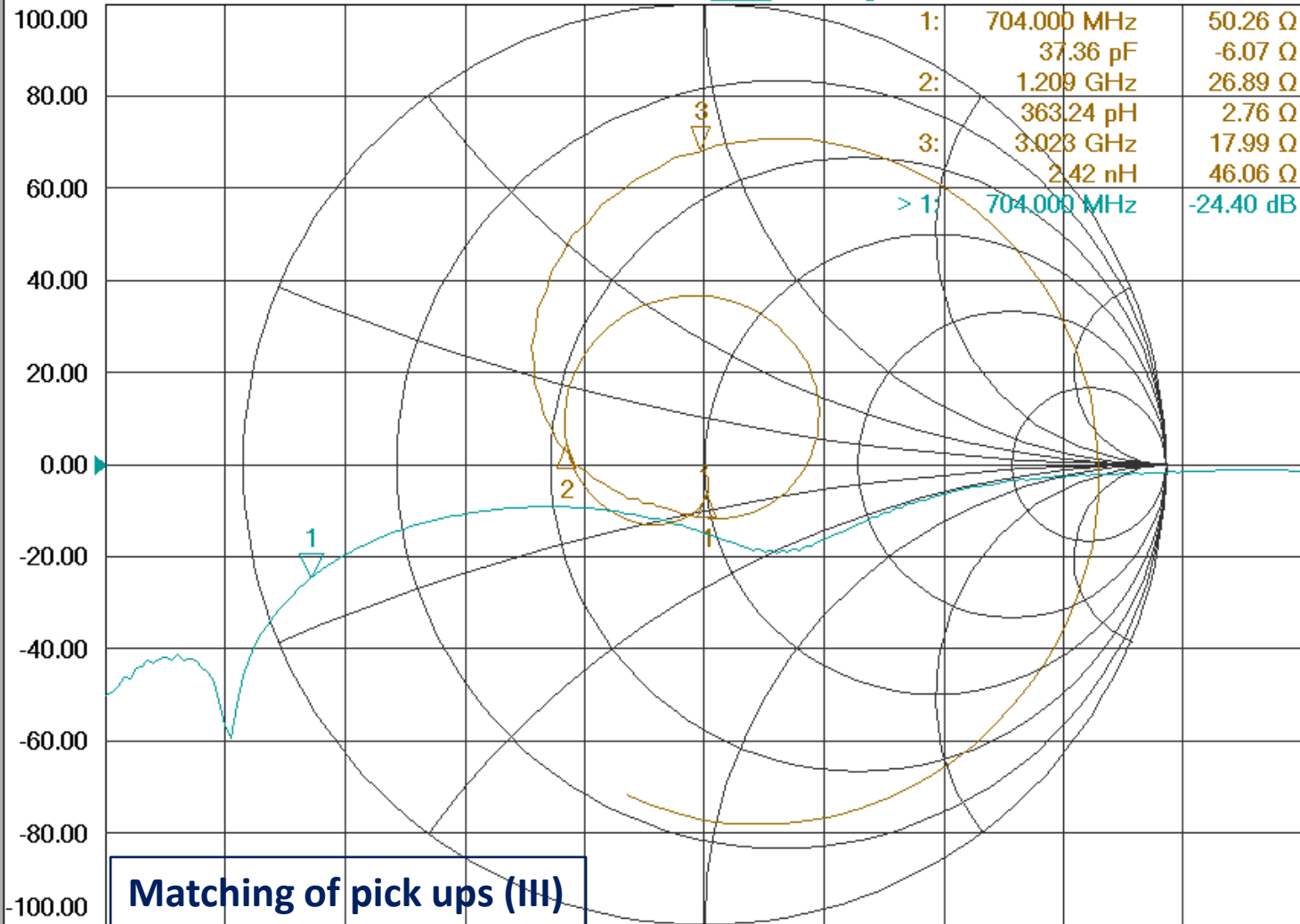
Stop 4.05000 GHz

Marker 1 704.00000000 MHz

Marker

Tr 1 S11 Smith 1.000U/ 1.00U

Tr 4 S22 LogM 20.00dB/ 0.00dB



* Marker 1

Marker 2

Marker 3

Reference

More Markers ▶

Turn Off Markers ▶

Properties ▶

Marker Functions ▶

Favorites

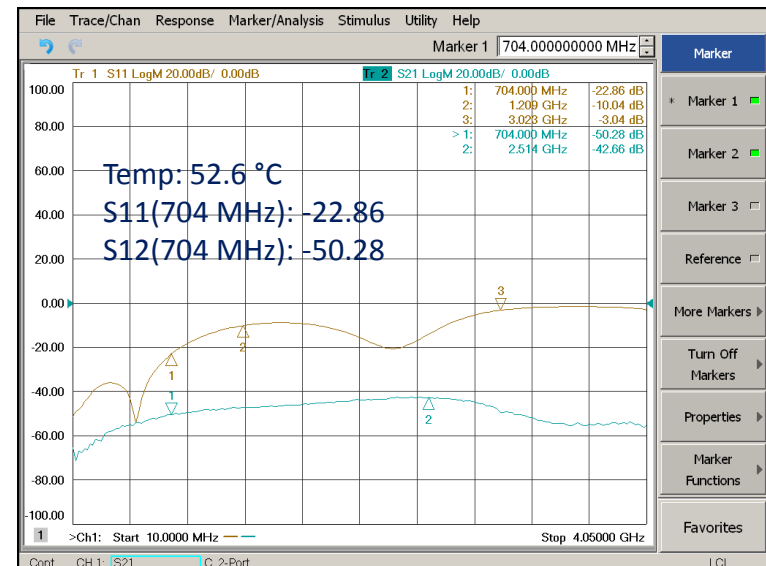
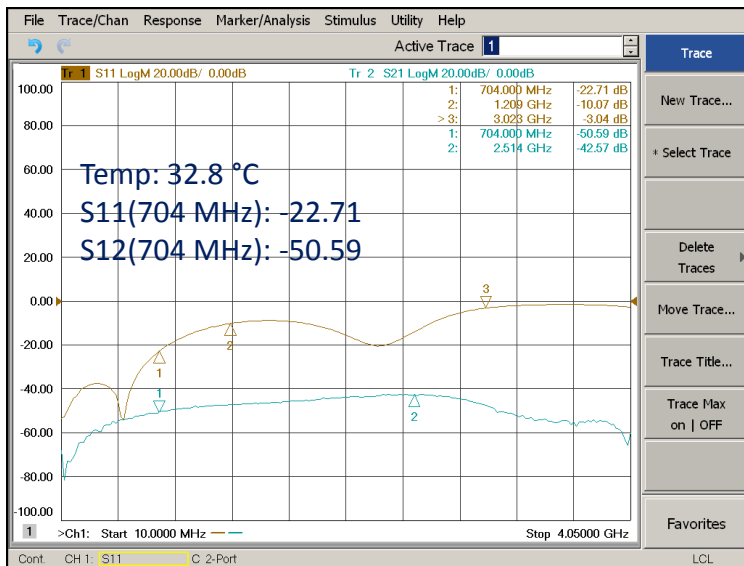
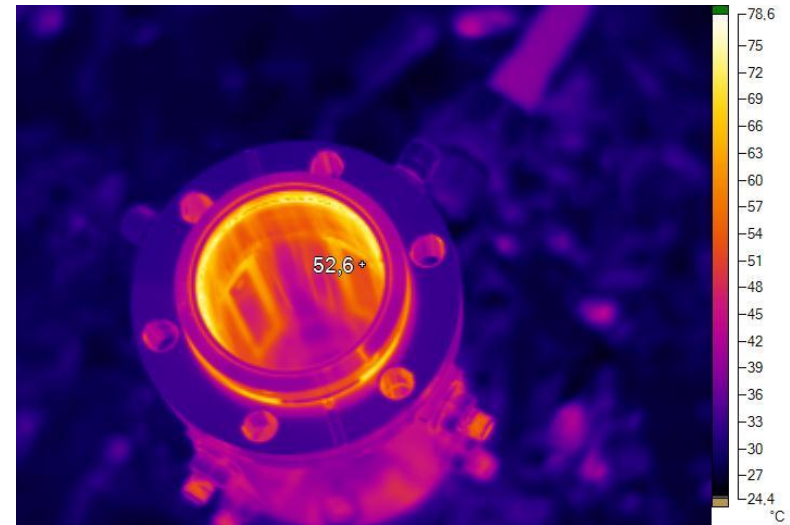
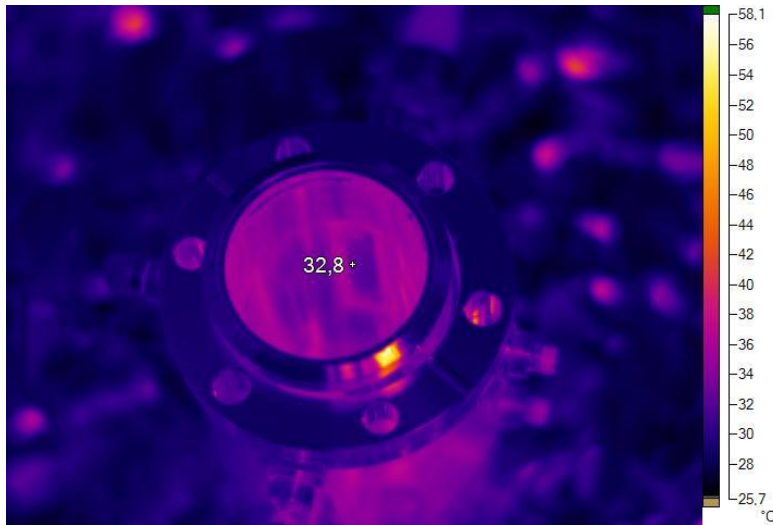
Matching of pick ups (III)

1 >Ch1: Start 10.0000 MHz — — Stop 4.05000 GHz

Cont. CH 1: S22 C 2-Port

LCL

Thermal effects on BPM HF characteristics



BPM Status

- Prototype finished and primary tests are Ok.
- In the final touches during mechanical valorations, one electrode has been damaged.
- The components fabrication for the 8 BPMs will be started soon (May 2017).
- The components should be delivered before August 2017.
- The welding and fabrication of 8 BPM sets. (expected to be finished December 2017).
- Tests and measurements. (February 2017)

Technical Inquiries:

FC: Angel Rodriguez

WS: Alvaro Vizcaino

EMU: Zunbeltz Izaola

BPM/BCM: Seadat Varnasseri