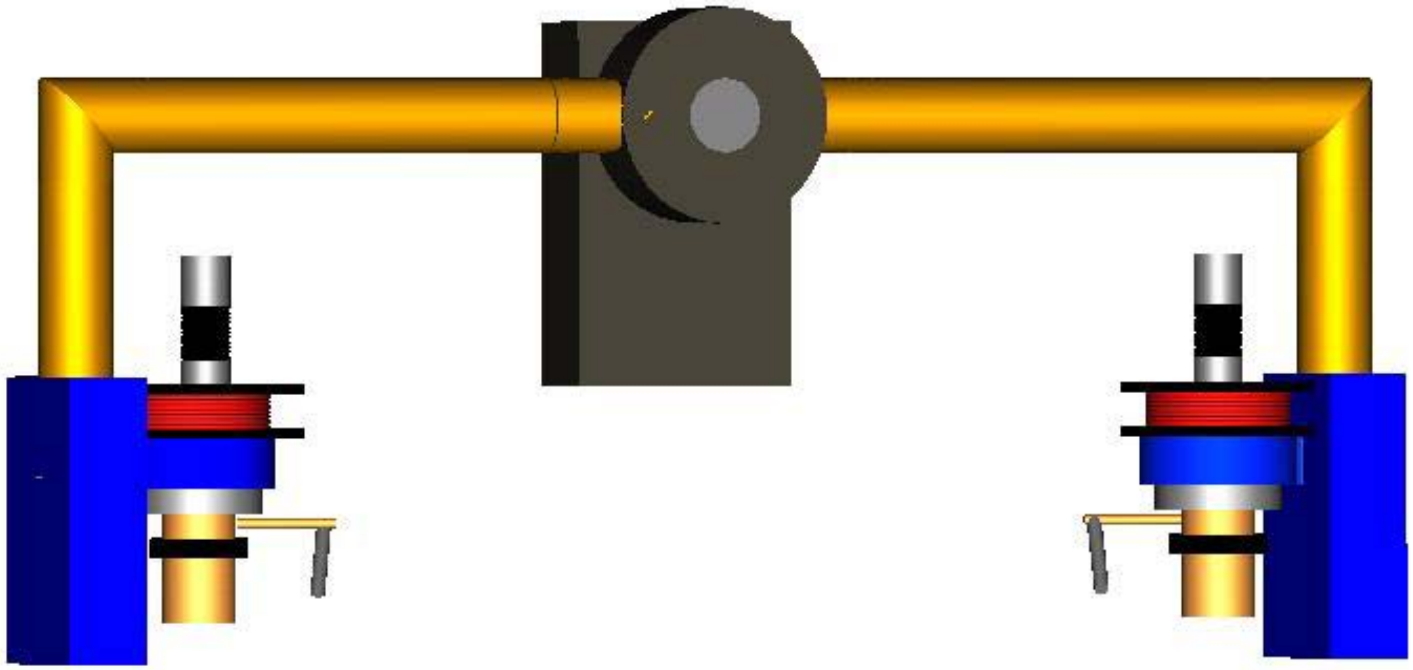
CoStub and CaCo: combining IOTs power

Bea Bravo

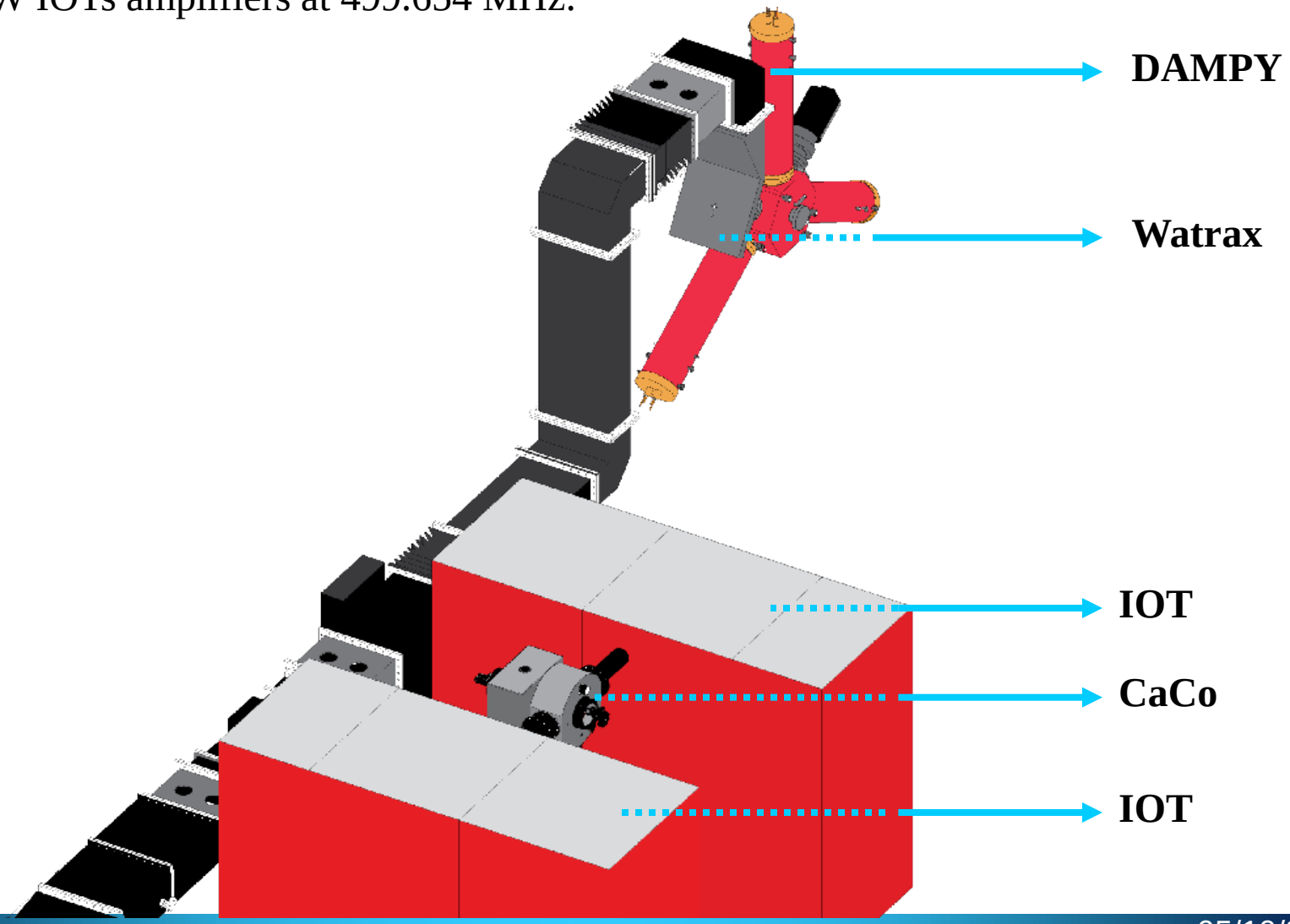


Overview

- Introduction
- CaCo: high power operation
- CoStub: mechanical design and first tests
- Conclusions

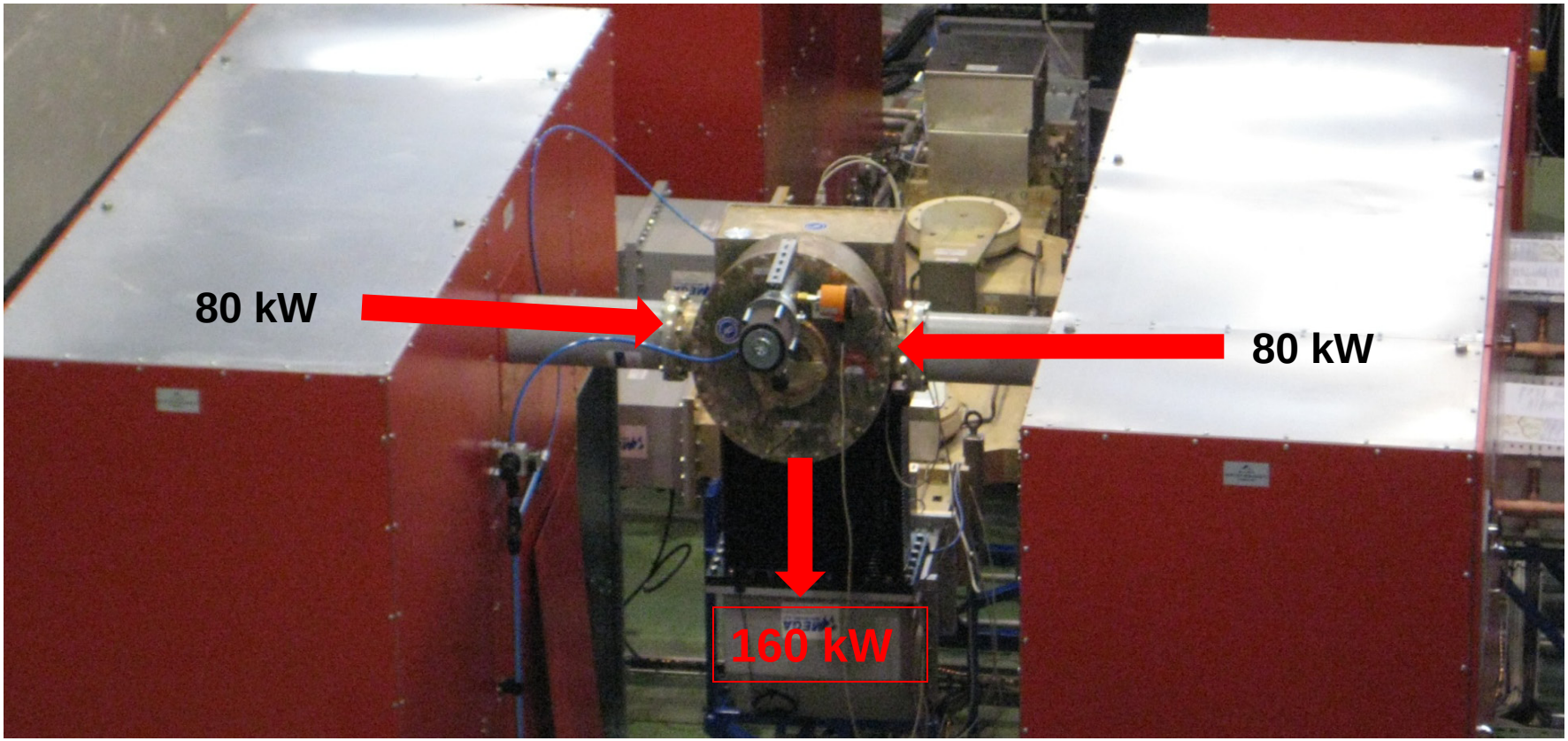
Introduction

- The ALBA storage ring uses six room temperature cavities; each one is fed by two 80kW IOTs amplifiers at 499.654 MHz.



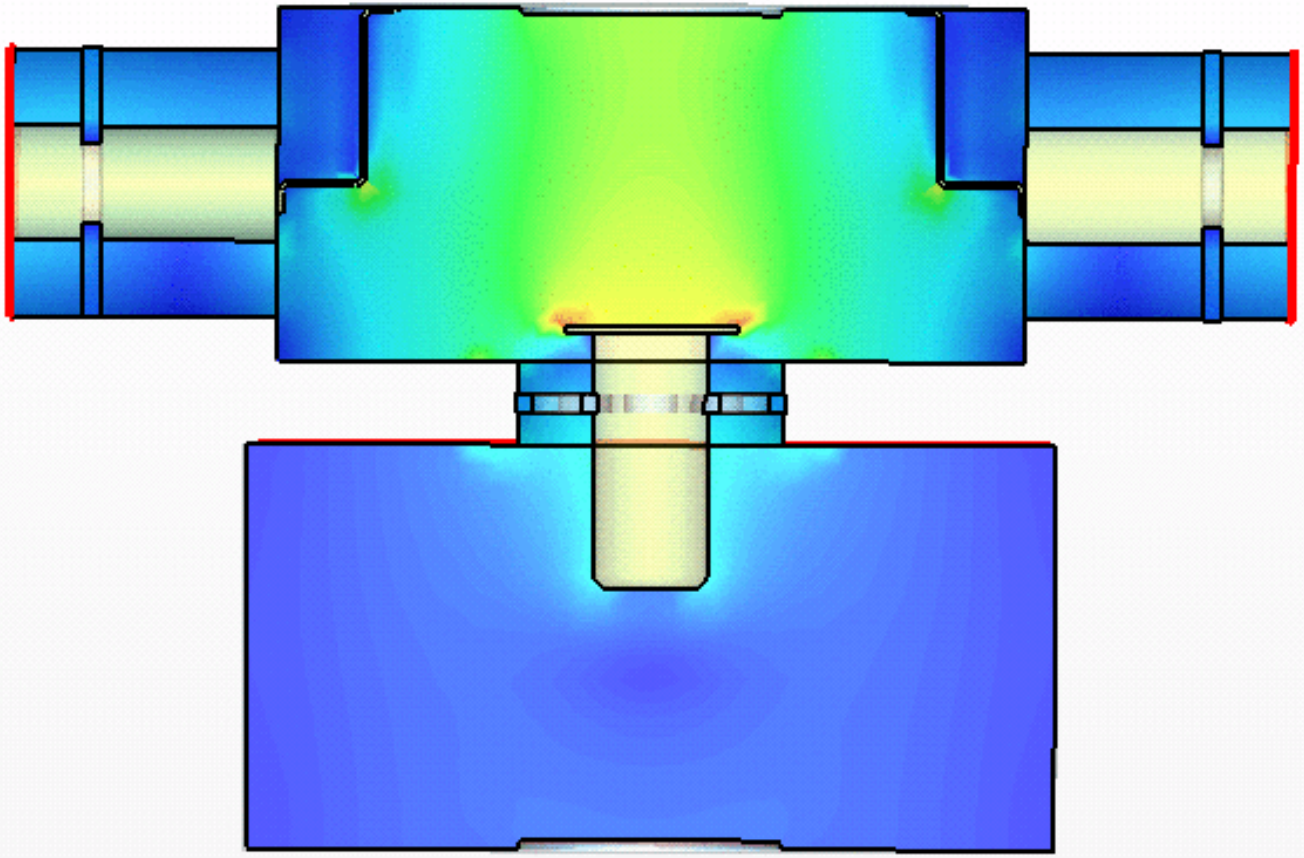
CaCo: Symmetrical mode

- CaCo is a three port device and is realized using a coupled pillbox cavity.



CaCo: Symmetrical mode

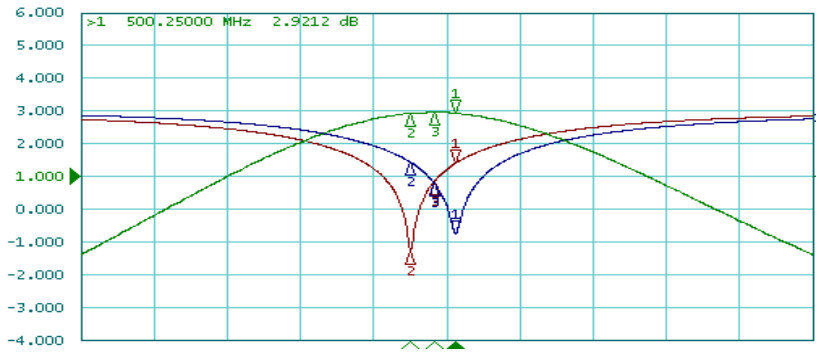
- In this mode the two active IOTs feed CaCo symmetrically
- The two incidents waves from the IOTs are combined in CaCo and the resulting wave leaves by the rectangular waveguide.



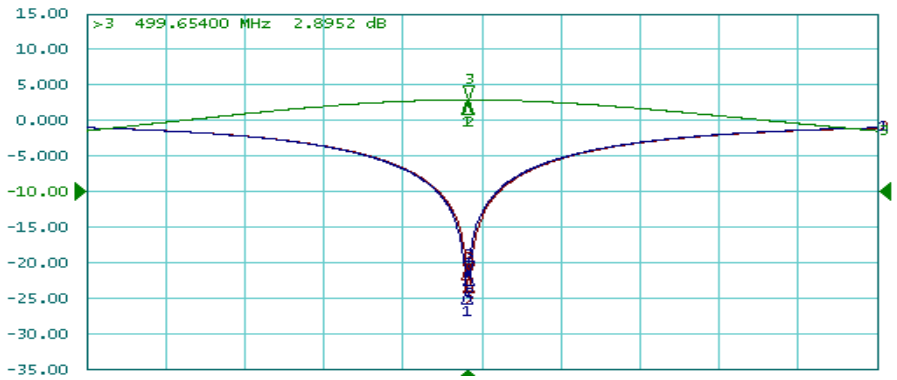
CaCo: Symmetrical mode

- Optimum performance of the CaCo is depending on the right phase and amplitude of the two incident ways.
- Phase difference of 10º, which increase the reflections at the IOT ports from -44 dB up to -20 dB.

Phase difference 10º



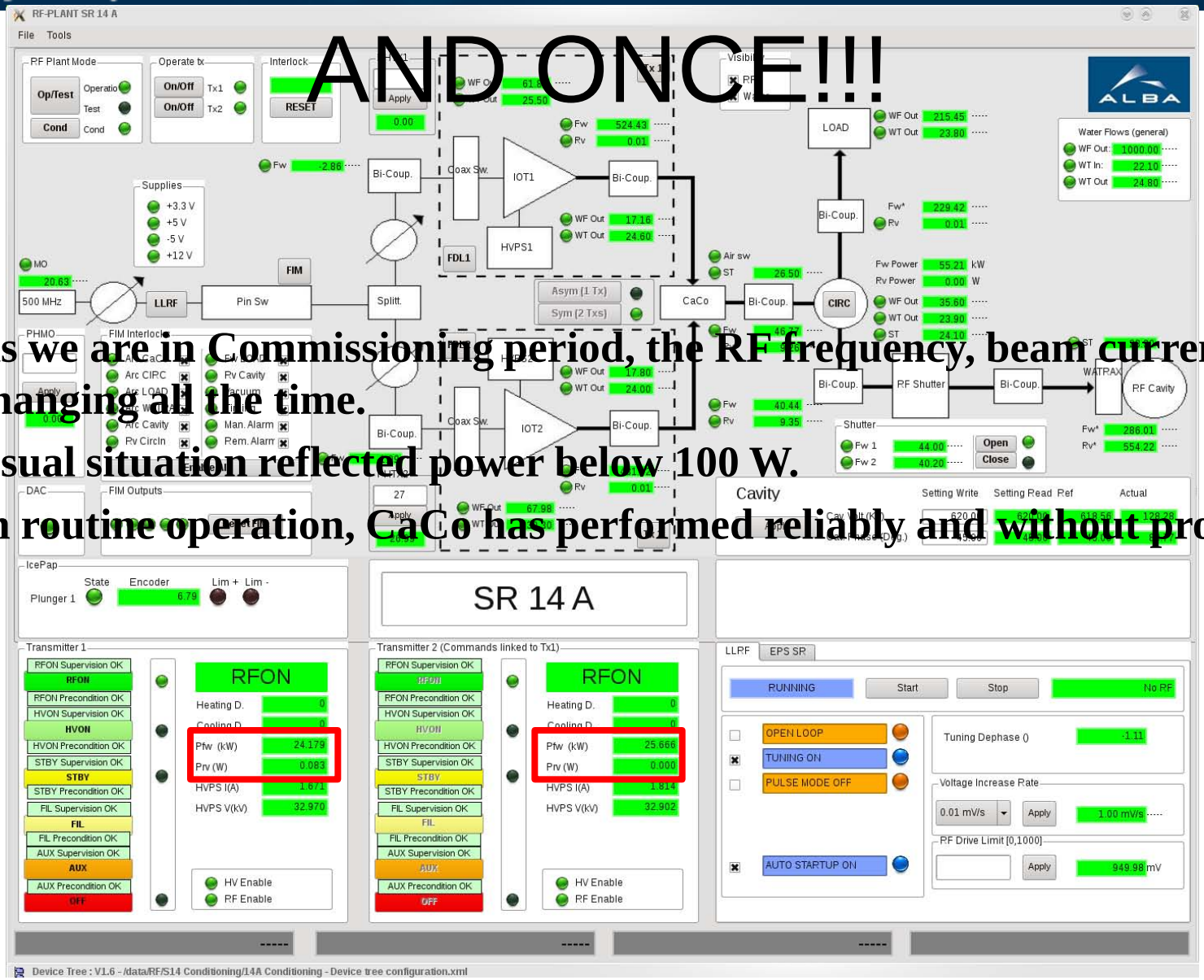
After optimization



- In real operation the incident power of each IOT will include losses and phase delays due to the different IOTs behaviour but also due to connectors, cables and transitions.
  - Via DLLRF we can control the IOT gain, and the phase difference between the inputs.
  - And we can tuning CaCo using the plunger (thermal effect at high power)

CaCo: Symmetrical mode

AND ONCE!!!



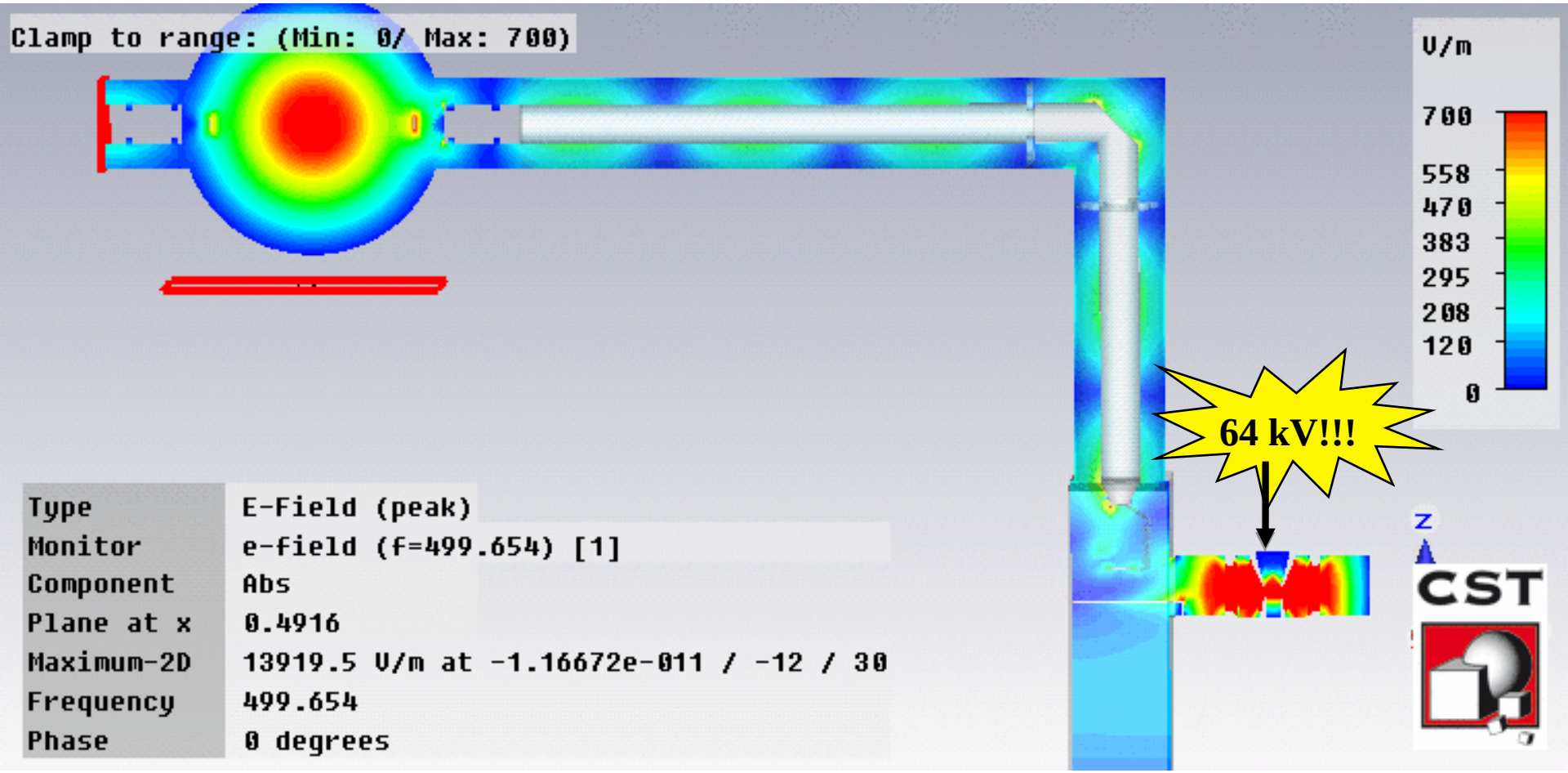
- **As we are in Commissioning period, the RF frequency, beam current is changing all the time.**
- **Usual situation reflected power below 100 W.**
- **In routine operation, CaCo has performed reliably and without problems.**

CaCo: asymmetric mode

- **Asymmetric mode: high power test**
  - Asymmetric mode: Caco is fed by the left arm.
  - First full power test of this mode was dramatic.

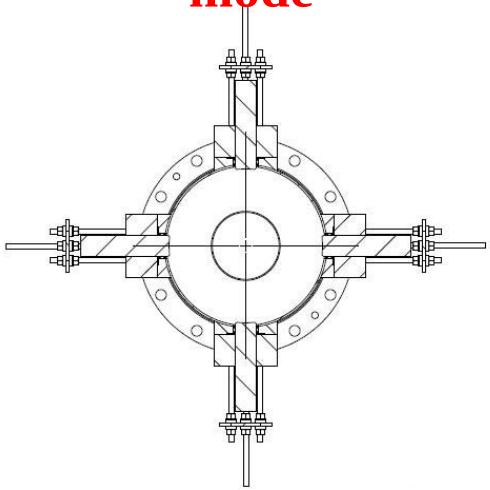
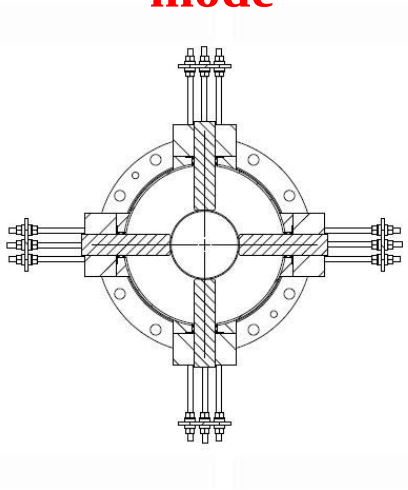
CaCo: asymetrical mode

- Simulation of IOT and Caco
  - **NO COOLING ACTIVATED!!!**



Proposal of a solution: CoStub

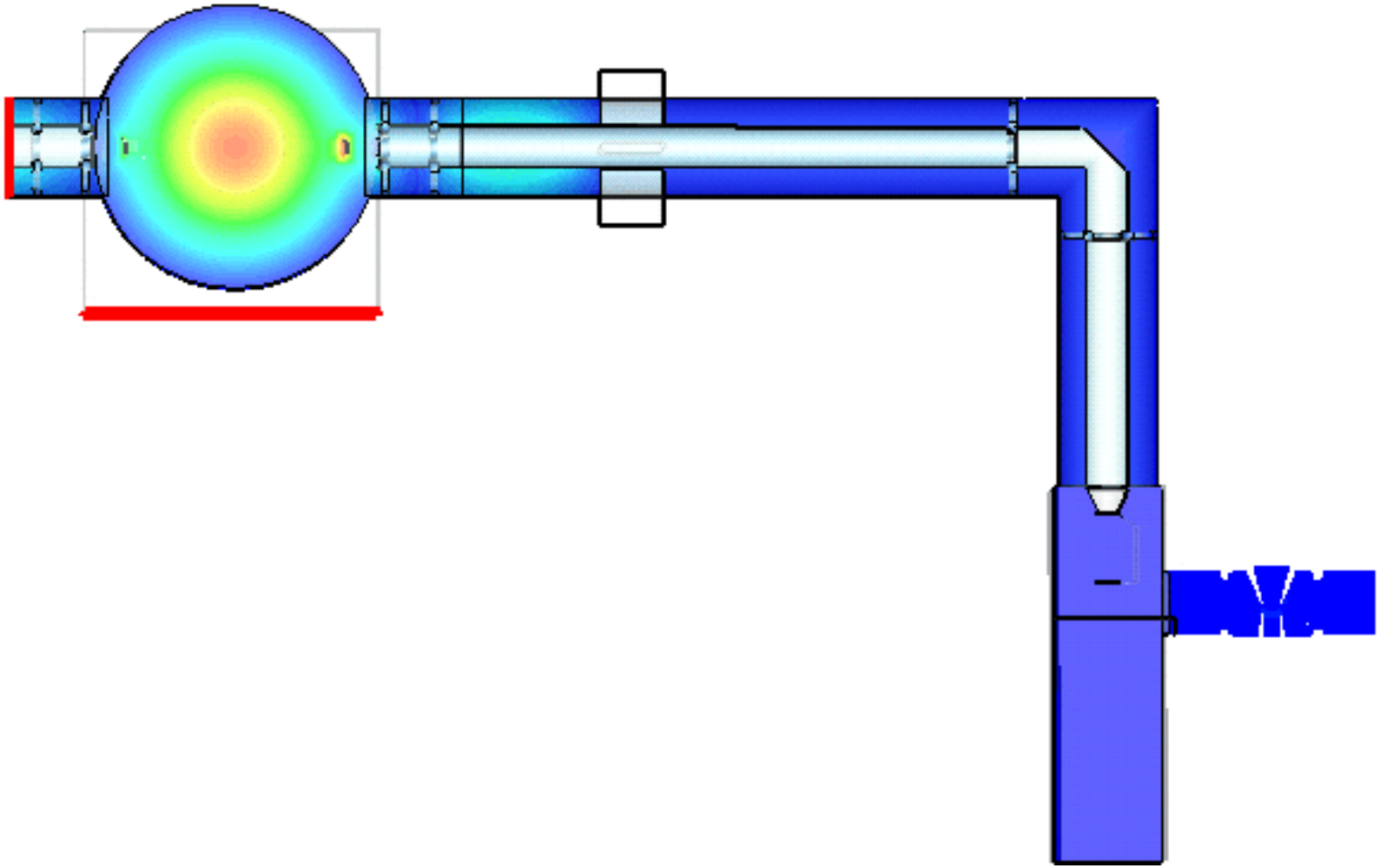
- **CoStub** is a device formed out of a coaxial waveguide and four stubs.

Symmetric mode	Asymmetric mode
	
Stubs out do not perturb the symmetric mode	Stubs IN behave as a shortcircuit

Number stubs	4
Distance between the stubs	90 degrees
Position respects Caco	236 mm away
Length	100 mm
Width	20 mm
|S21|	-53 dB
Power loss	10 W
Efield max around the stubs (scaled for 80000 RMS)	14000 V/m

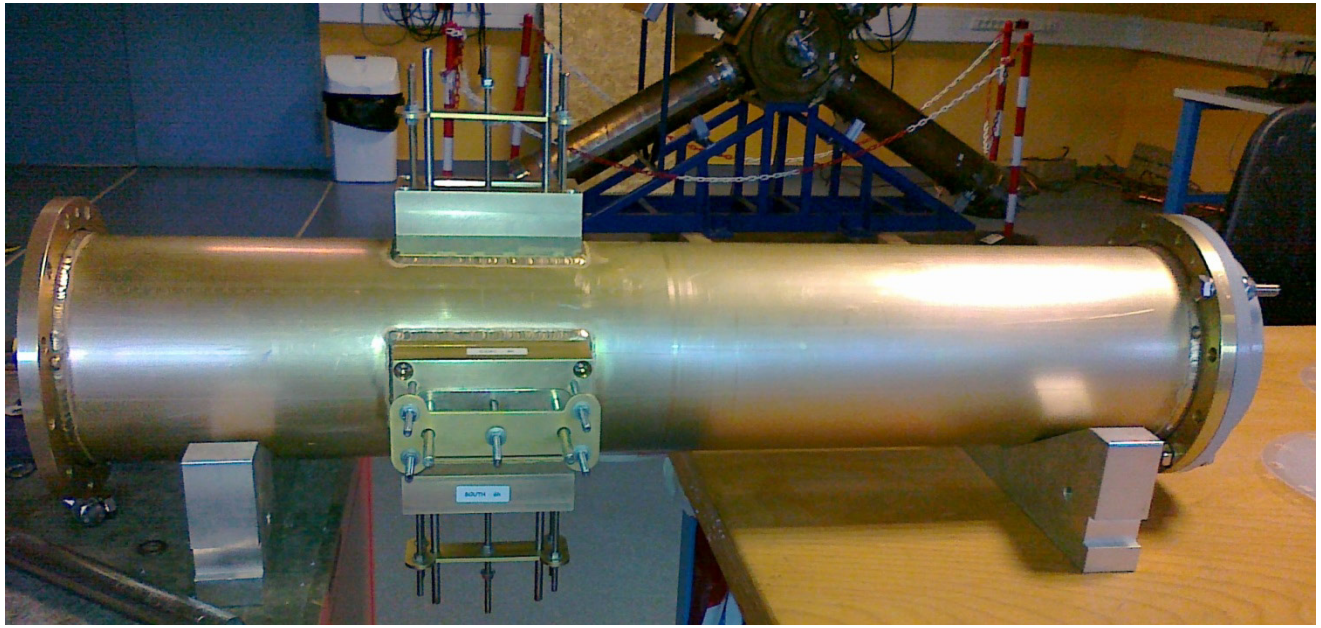
Proposal of a solution: CoStub

- Final design



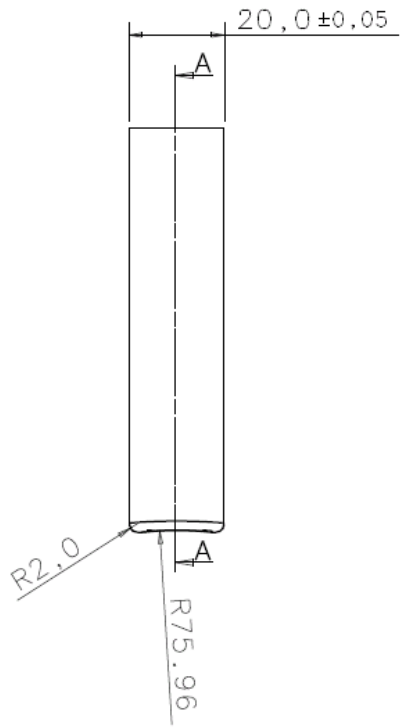
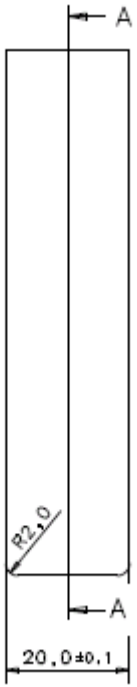
Proposal of a solution: CoStub

CoStub



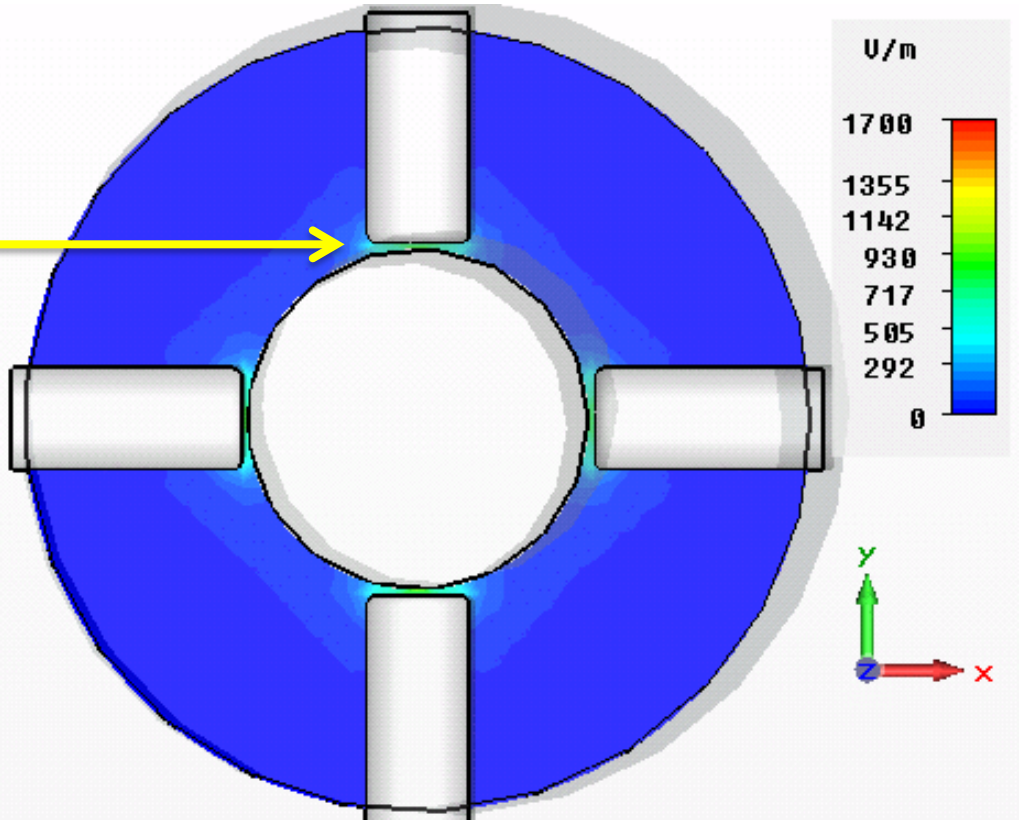
CoStub: Mechanical design

- First design the bottom part of the stubs were concave.
- Factory sugestion: flat Stubs (cheaper and easier mechanization).

First design	Current design
	

CoStub: Mechanical design

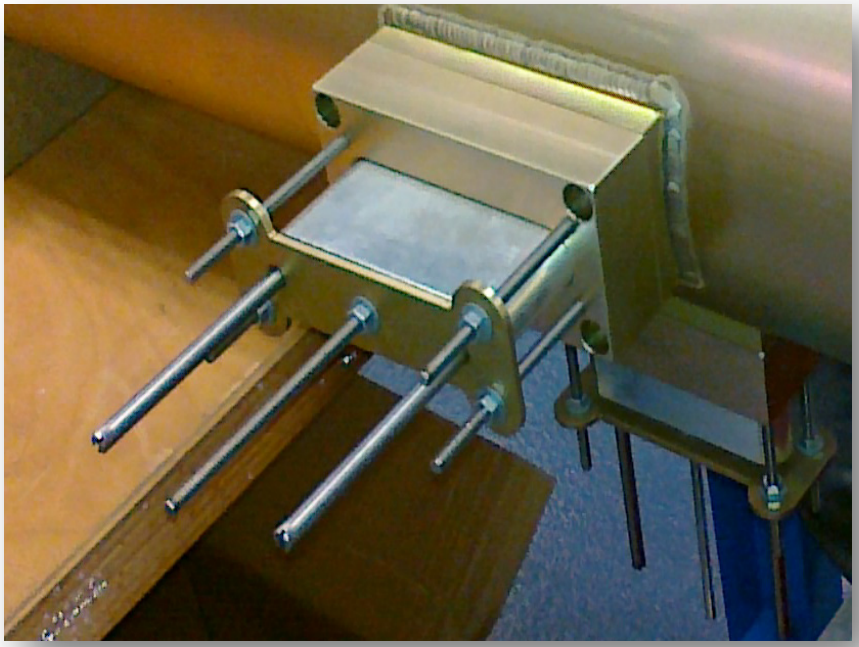
If there is a small gap between the stub and the inner conductor of the coaxial, CoStub will malfunction.

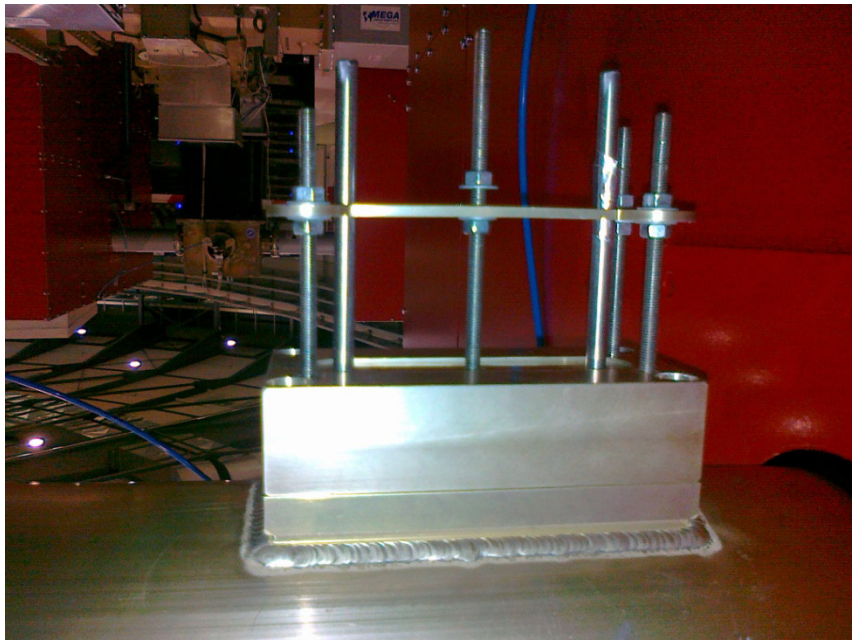


CoStub: Mechanical design

- The screws avoid movements of the stubs and ensure a good contact between stubs and inner conductor.

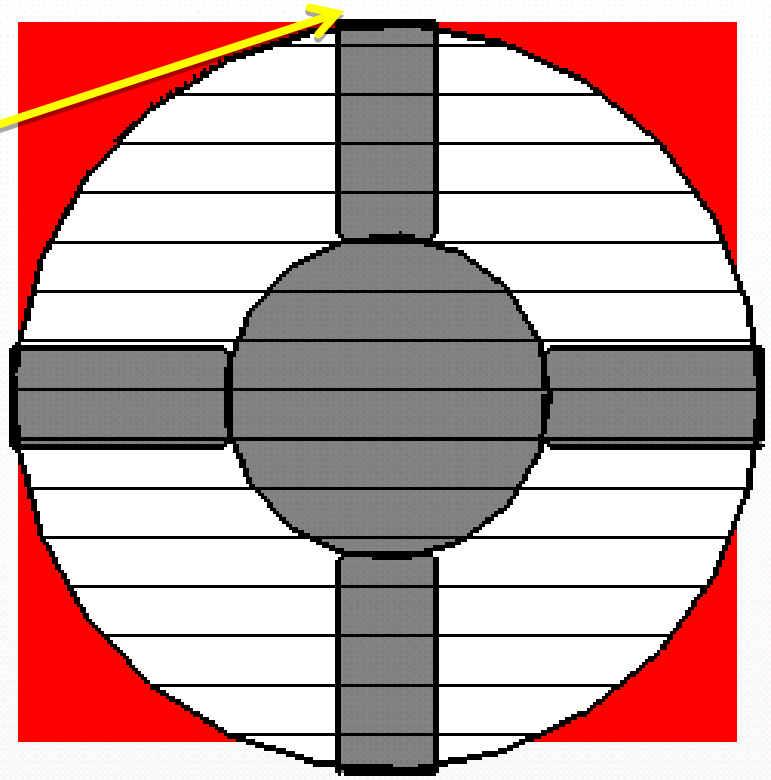
- No engine will be used.





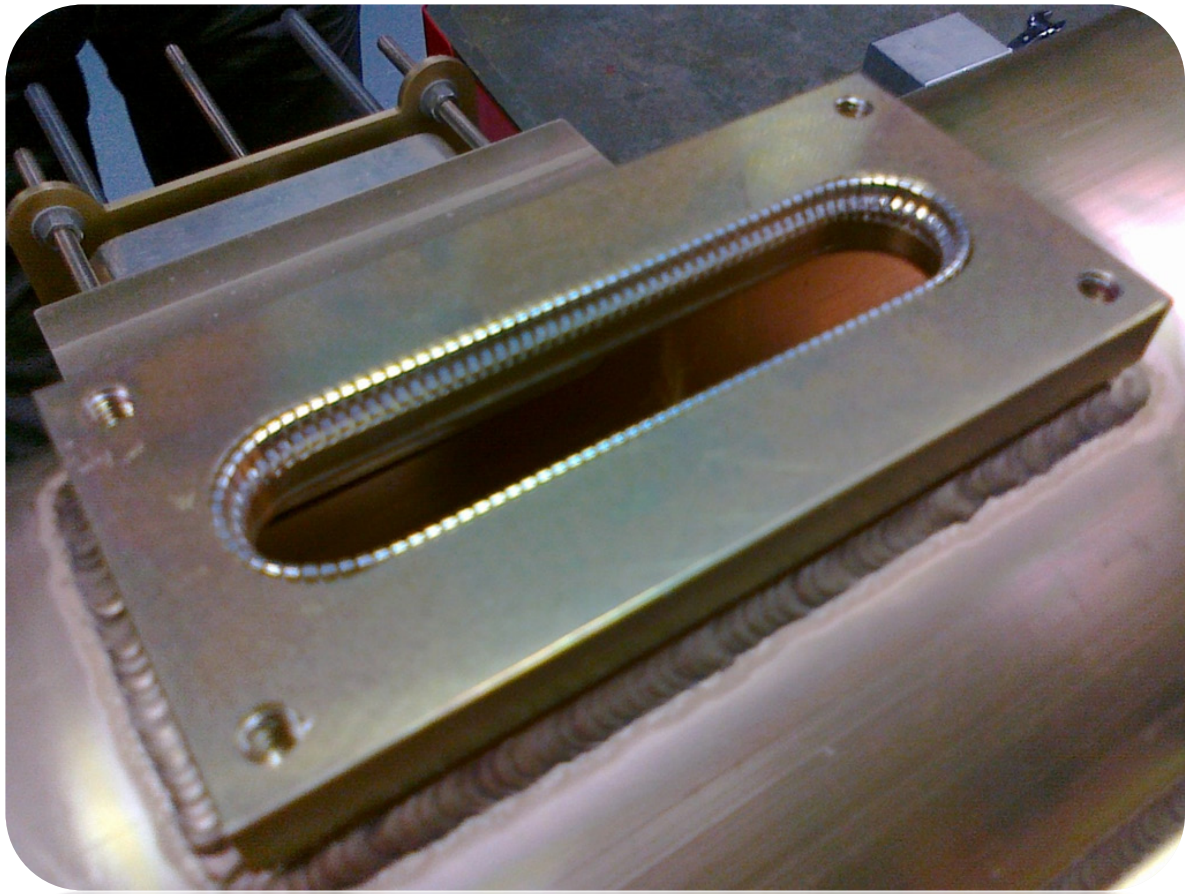
CoStub: Mechanical design

It is necessary some space between the stubs and the coaxial waveguide.

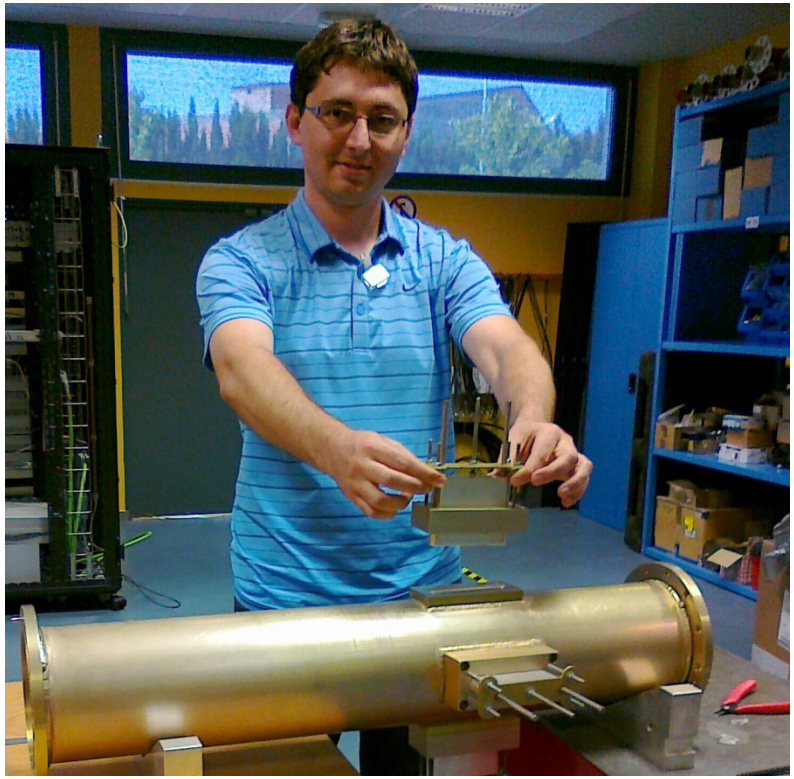


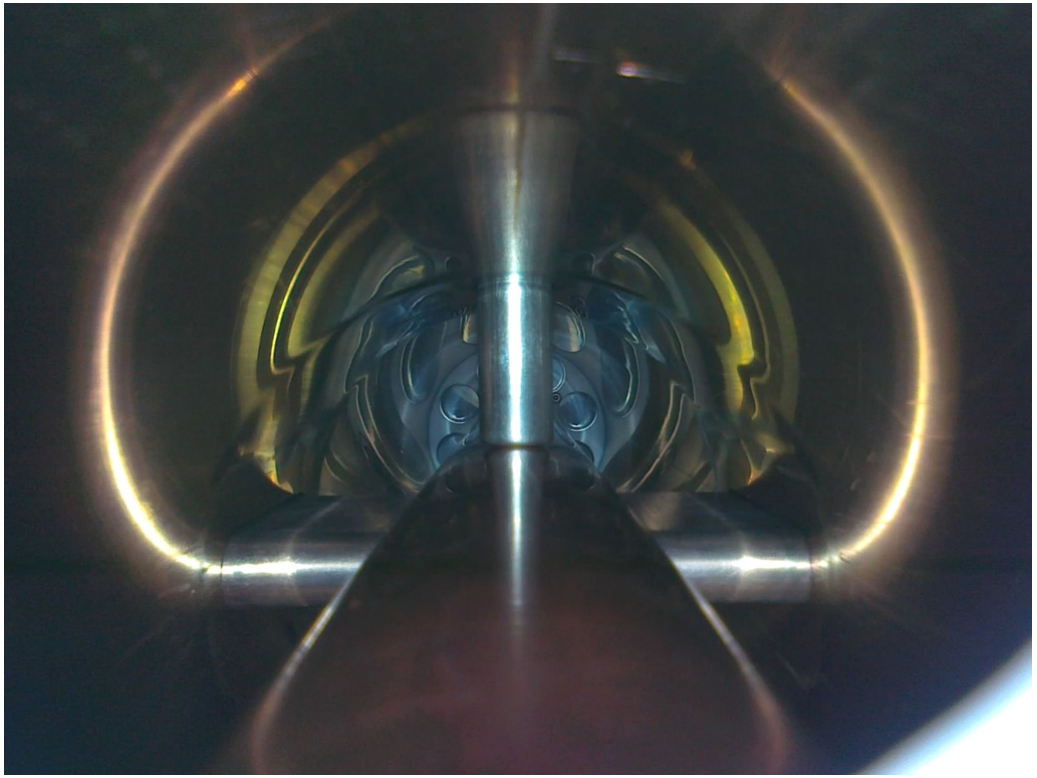
CoStub: Mechanical design

- Rf fingers allow good RF contact.

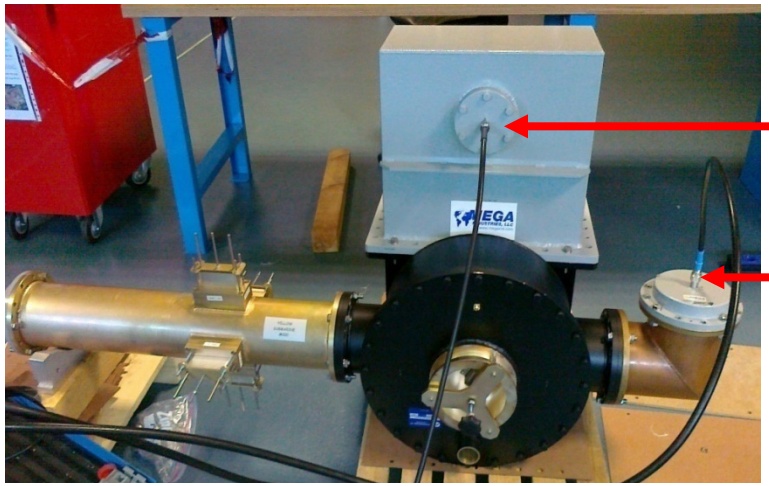


CoStub: Mechanical design

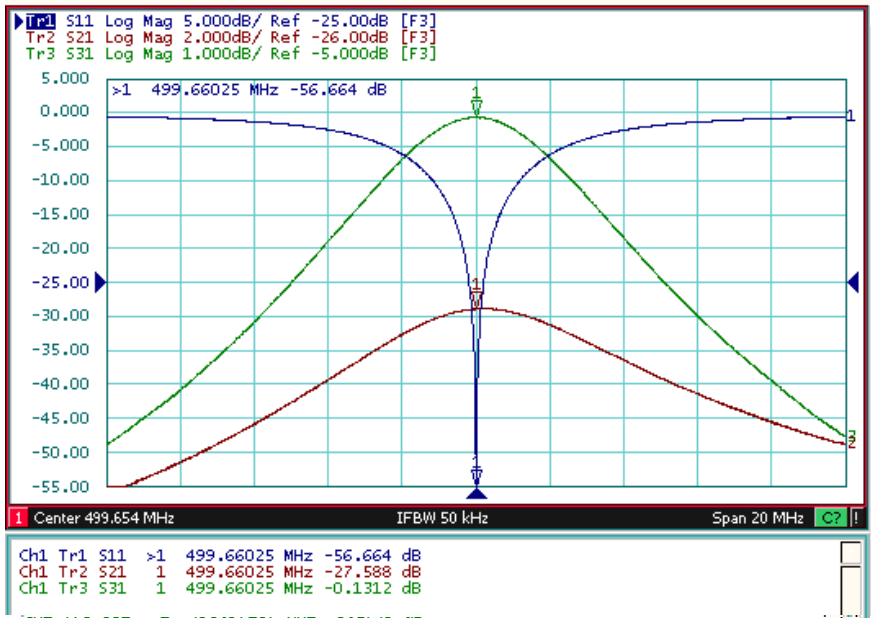




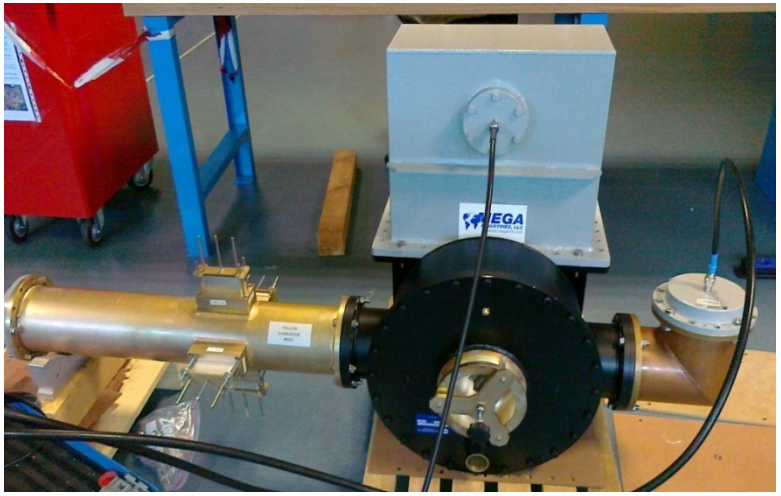
Asymmetrical mode: low power test



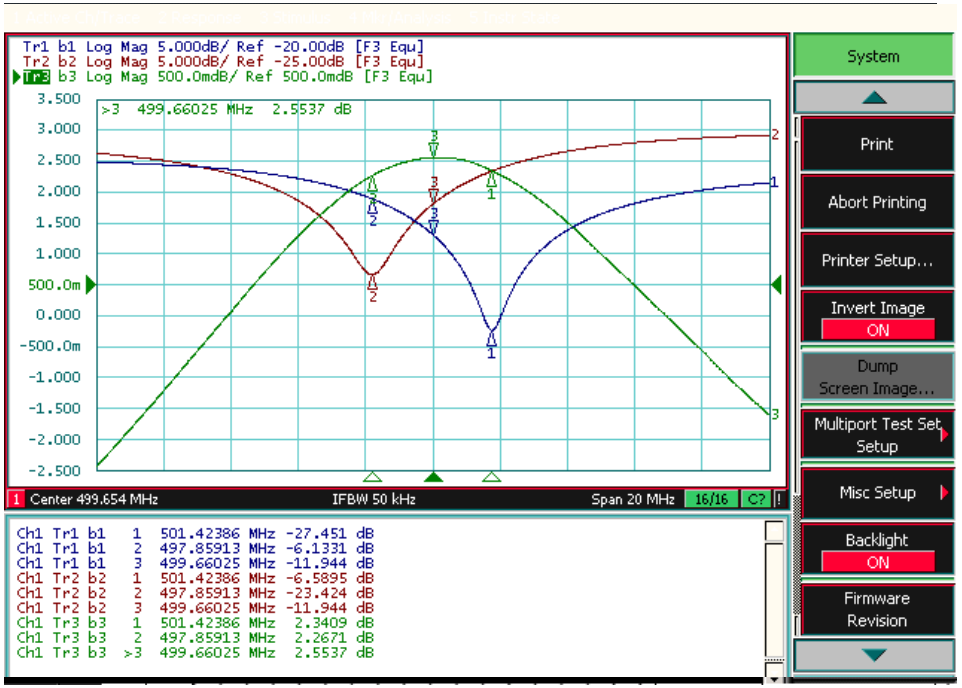
Measurements:



Symmetrical mode: low power test



Measurement:
reflected power at
the input port **-42 dB**



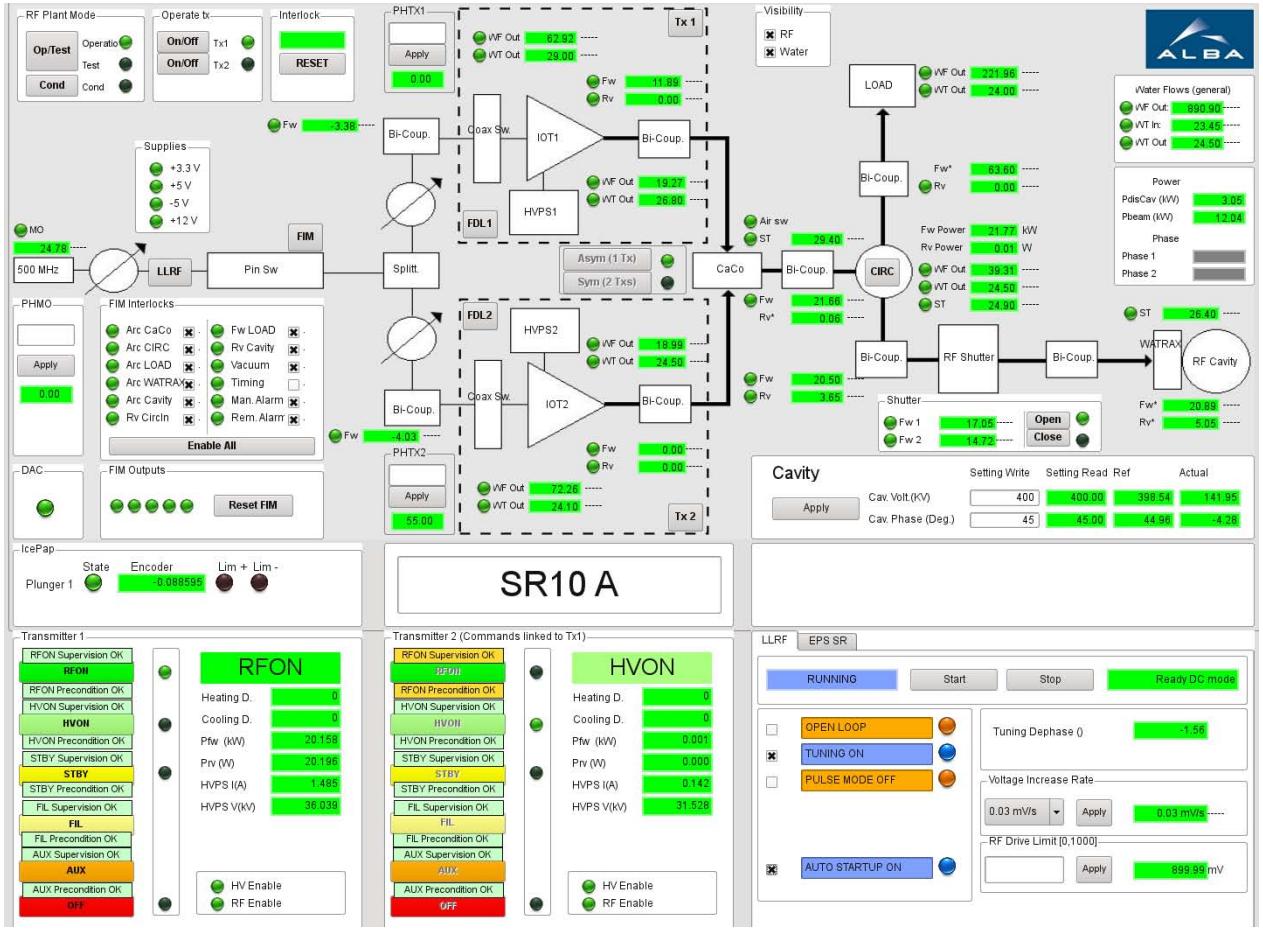
CoStub: High power test

FIRST TEST: CoStub is assembled to a power meter. We increased the power till **80kW.**

Power after Costub AT 80 kW	0.365 W
Initial/ final temperture of the stubs at 80 kW	24ºC/26ºC
Arcs	Not detected
RF Leaks	Not observed
Power Reflected to the active IOT at 80 kW	85 W

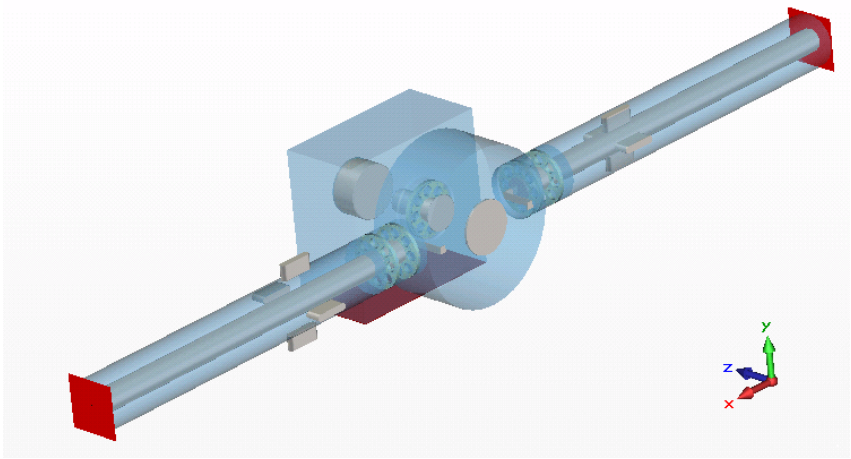
CoStub: High power test

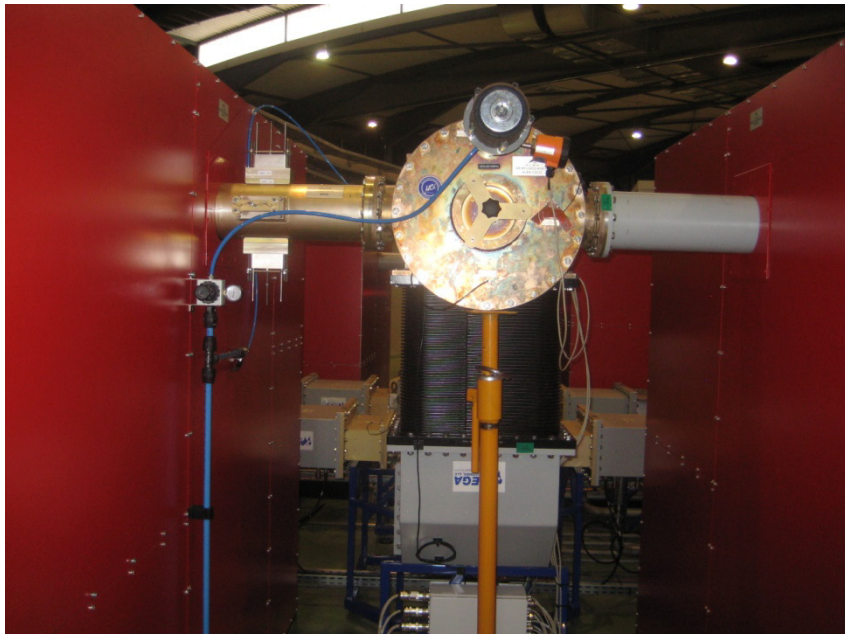
- **SECOND TEST (last Friday!!!)**: CoStub is assembled on an IOT.
  - Passive IOT is at HVON.
  - Shutter open. At the same time we were conditioning the cavity.



CoStub: High power test

- No sparking, overheating neither RF leaks were observed.
- The results were in very good agreement with the simulations.





Conclusions

- The two possible operation modes of CaCo at high power have been tested.
  - The symmetrical mode works properly and without presenting any problem.
  - The asymmetrical mode a standing wave is created between the passive IOT and Caco, provoking a large voltage in the gap of the passive IOT.
    - A new device, CoStub (coaxial stub), to short circuit the coaxial waveguide of the passive arm and protects the passive has been designed, built and tested successfully.

Acknowledgement

- **Michel langlois** for helping us to understand why the ceramic of the passive IOT broke.
- **Eric Montesinos** for his kind suggestions.
- **Francis** for taking time for consultation and discussions despite the eventful months around the commissioning.
- **Filip Mares** for his support in the mechanical design of the CoStub, the new pick up loop, alignment device for the pick up loops.
- All the people that has been involved in those projects: Vacuum group, the people of the workshop, …

Thank you very much for your attention