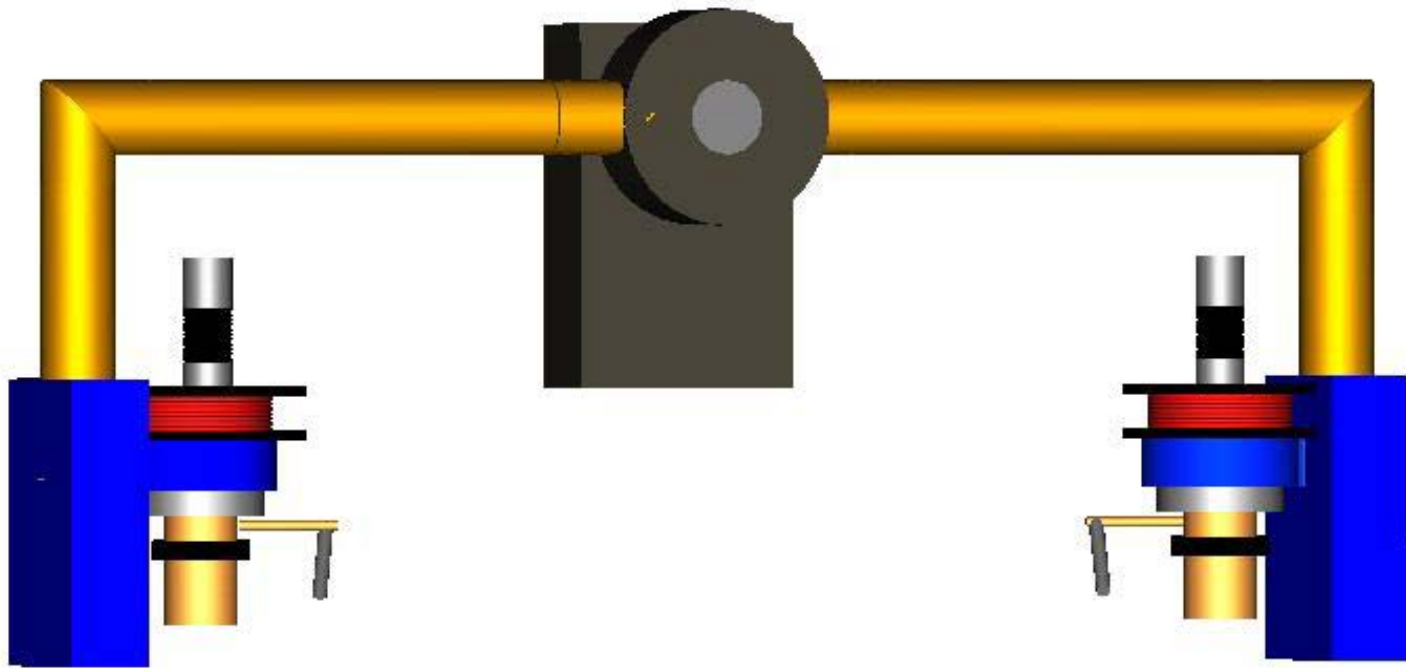


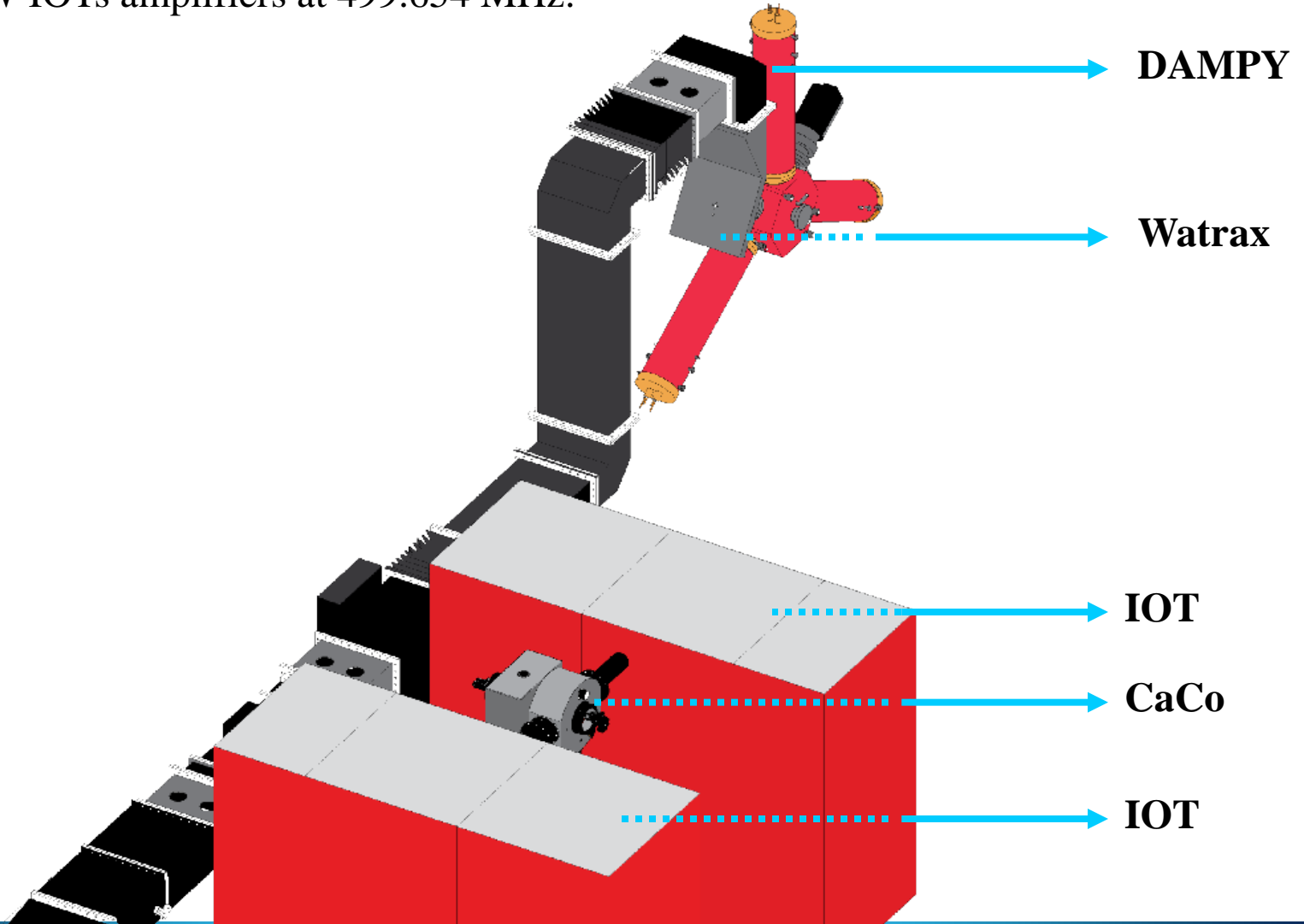
CoStub and CaCo: combining IOTs power Bea Bravo



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

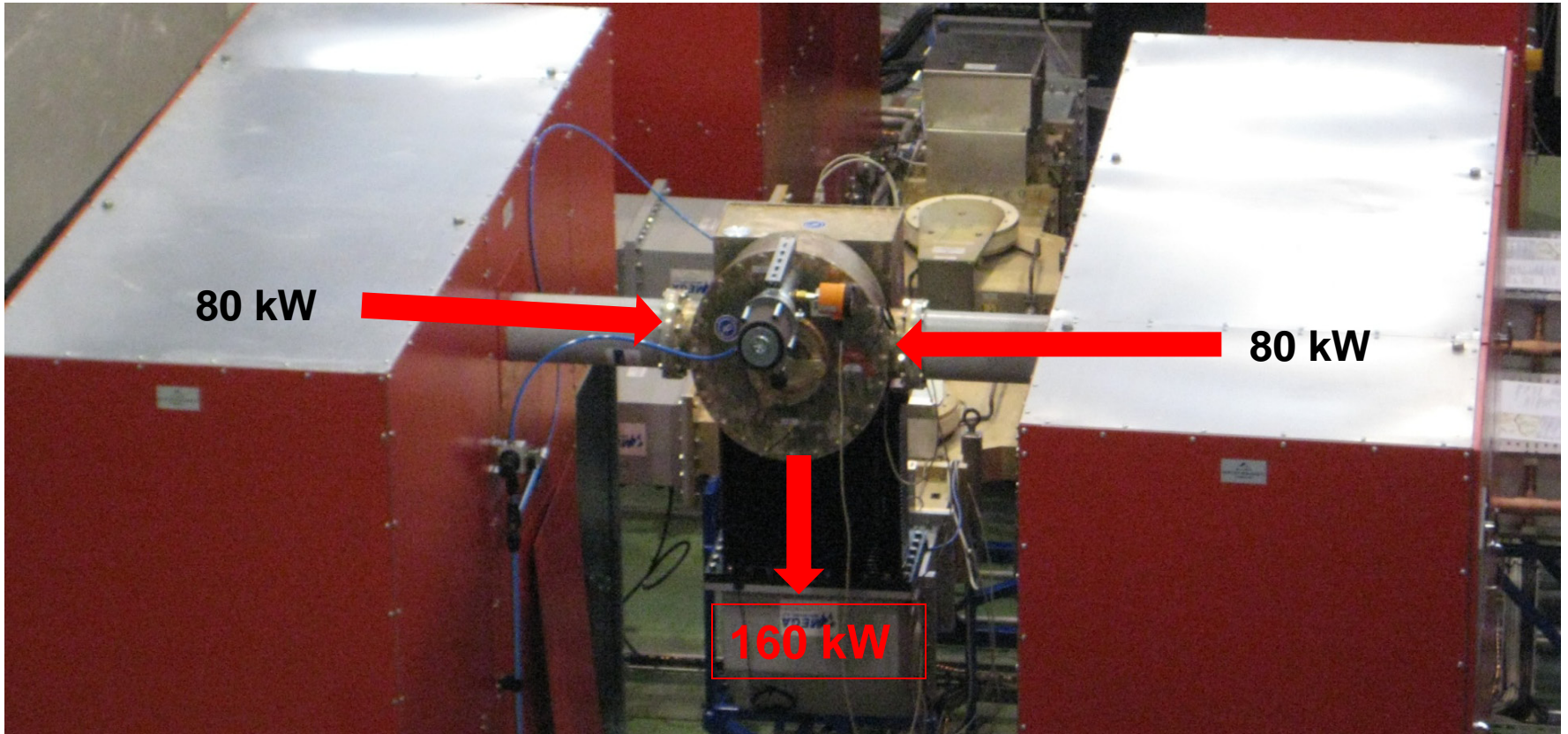
Introduction

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



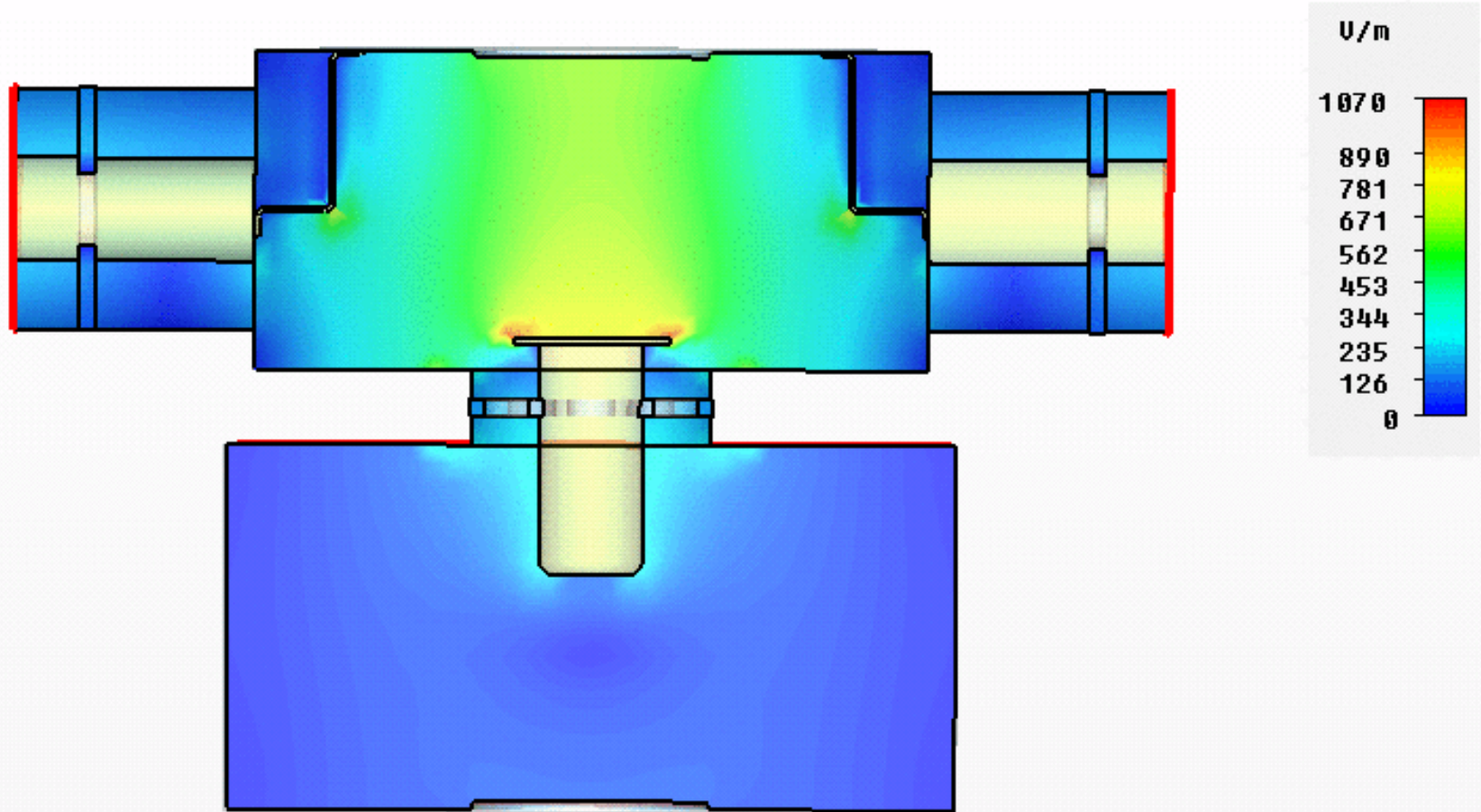
CaCo: Symmetrical mode

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



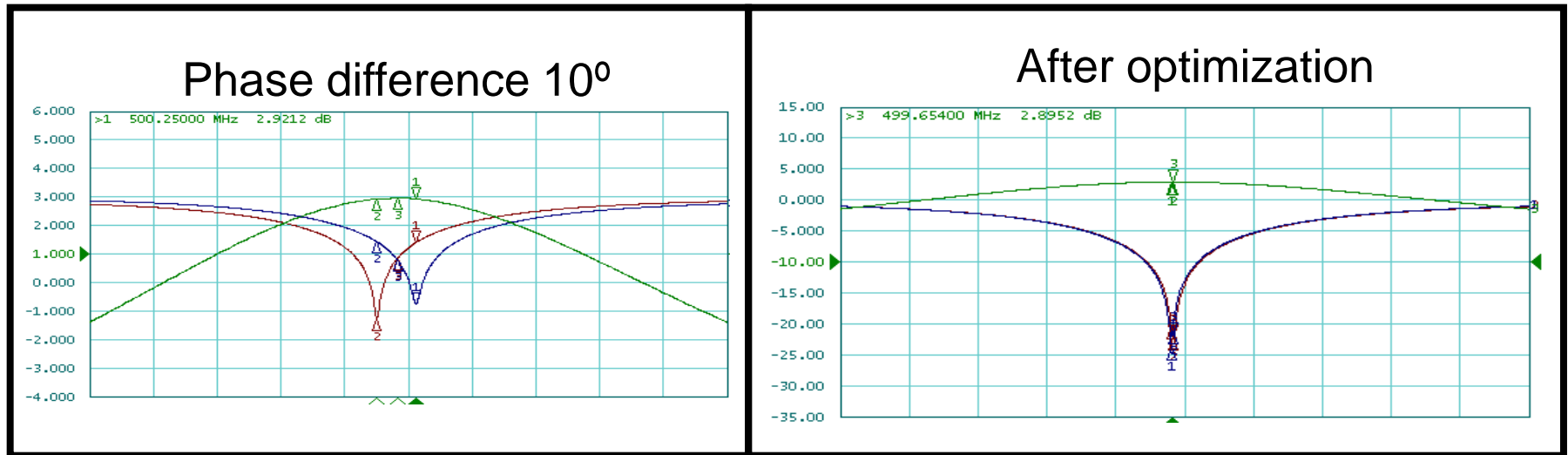
CaCo: Symmetrical mode

- ❑ In this mode the two active IOTs feed CaCo symmetrically
- ❑ The two incident 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 10° , which increase the reflections at the IOT ports from -44 dB up to -20 dB.



- ❑ 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.

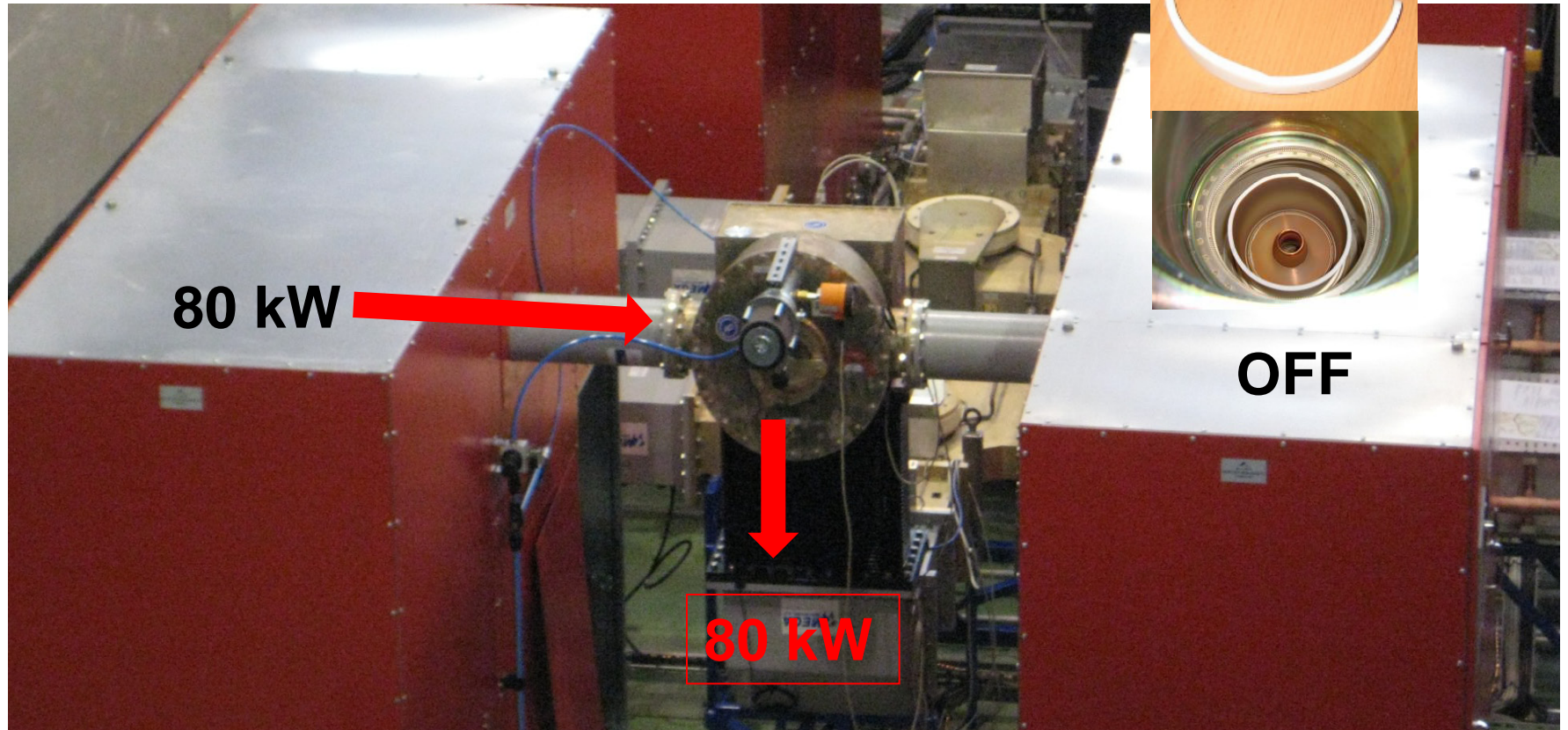
The screenshot displays the control interface for the RF-PLANT SR 14 A. It features a central schematic diagram of the RF system with various components like Bi-Couplers, Coax Sw., IOT1, IOT2, HVPS1, and CaCo. The interface is divided into several panels:

- Operate:** Includes buttons for Op/test, Cond, and Interlock (On/Off Tx1, On/Off Tx2, RESET).
- Supplies:** Shows voltage levels (+3.3 V, +5 V, -5 V, +12 V) and a monitor (MO) at 20.63.
- PHMO:** Lists various interlocks and their status (e.g., Arc CIPC, Pv Cavity, Man. Alarm).
- DAC:** Shows FIM Outputs with a value of 27.
- IcePap:** Displays the state of the Plunger 1 (Encoder: 6.79, Lim +, Lim -).
- SR 14 A:** A central label for the system.
- Transmitter 1 & 2:** Two panels showing RFON status, Heating D., Cooling D., Ptw (kW), Prv (W), HVPS I(A), and HVPS V(kV). In the Transmitter 1 panel, Ptw (24.179) and Prv (0.083) are highlighted with red boxes. In the Transmitter 2 panel, Ptw (25.856) and Prv (0.000) are highlighted with red boxes.
- LLRF:** Shows the system is in a RUNNING state with buttons for Start, Stop, and No RF. It includes control buttons for OPEN LOOP, TUNING ON, PULSE MODE OFF, and AUTO STARTUP ON. Tuning Dephase is at -1.11 and Voltage Increase Rate is 1.00 mV/s.
- Water Flows (general):** A summary box showing WF Out (1000.00), WT In (22.10), and WT Out (24.80).
- Cavity:** Shows settings and actual values for the RF Cavity, including Fw* (288.01) and Rv* (554.22).

CaCo: asymmetric mode

❑ Asymmetric mode: high power test

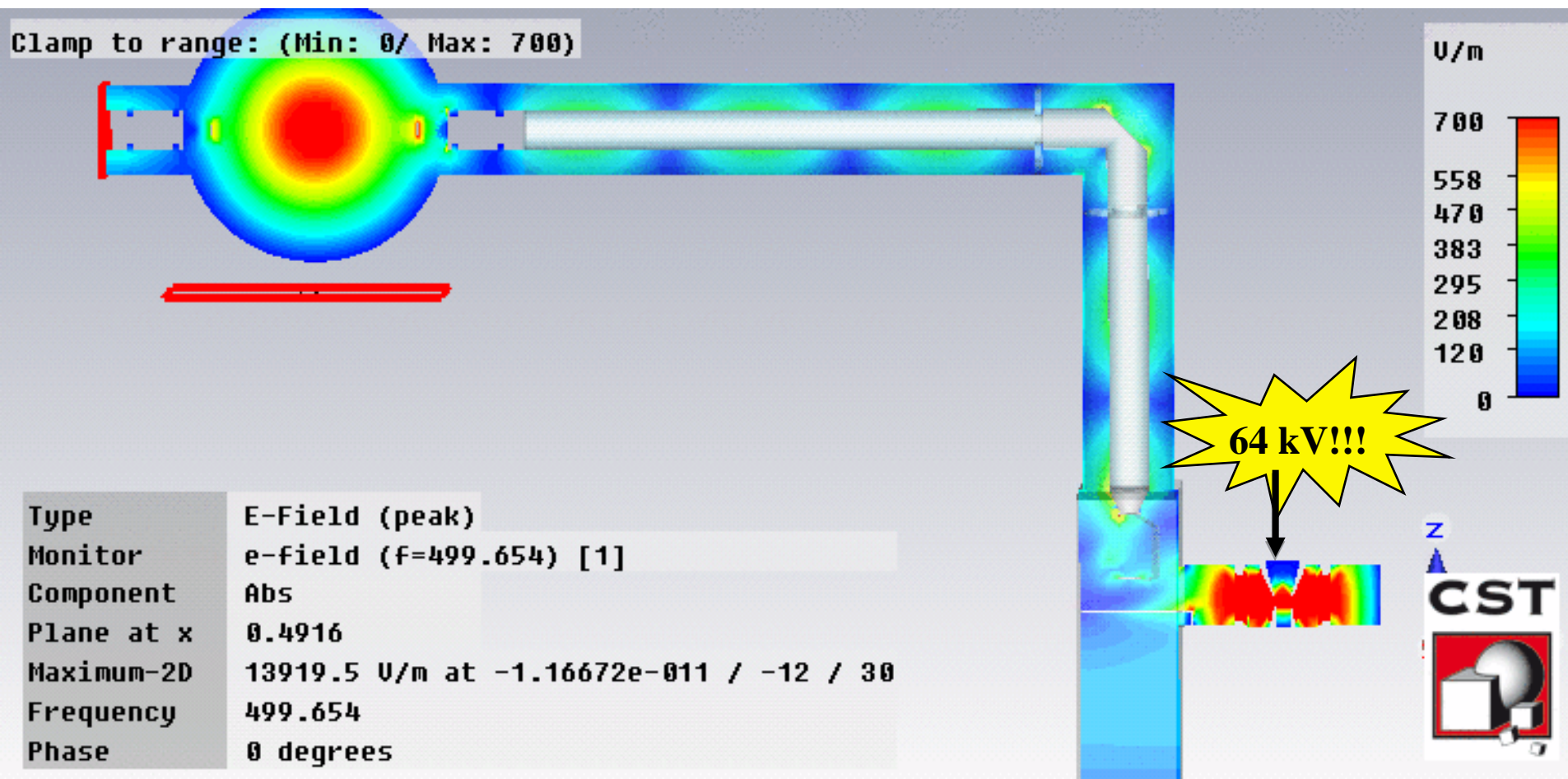
- ❑ Asymmetric mode: Caco is fed by the left arm.
- ❑ First full power test of this mode was dramatic.



CaCo: asymmetrical mode

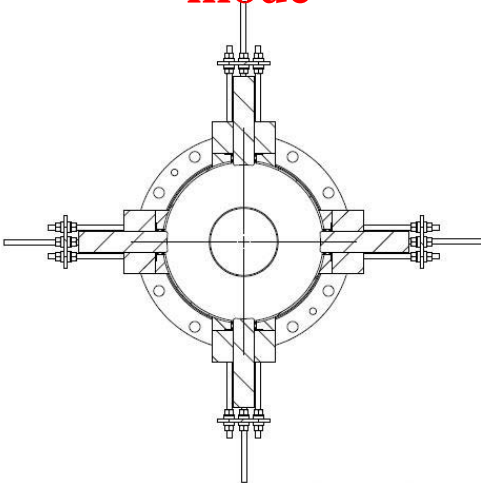
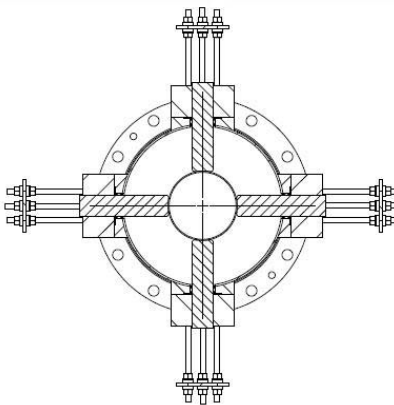
❑ Simulation of IOT and Caco

❑ **NO COOLING ACTIVATED!!!**



Proposal of a solution: CoStub

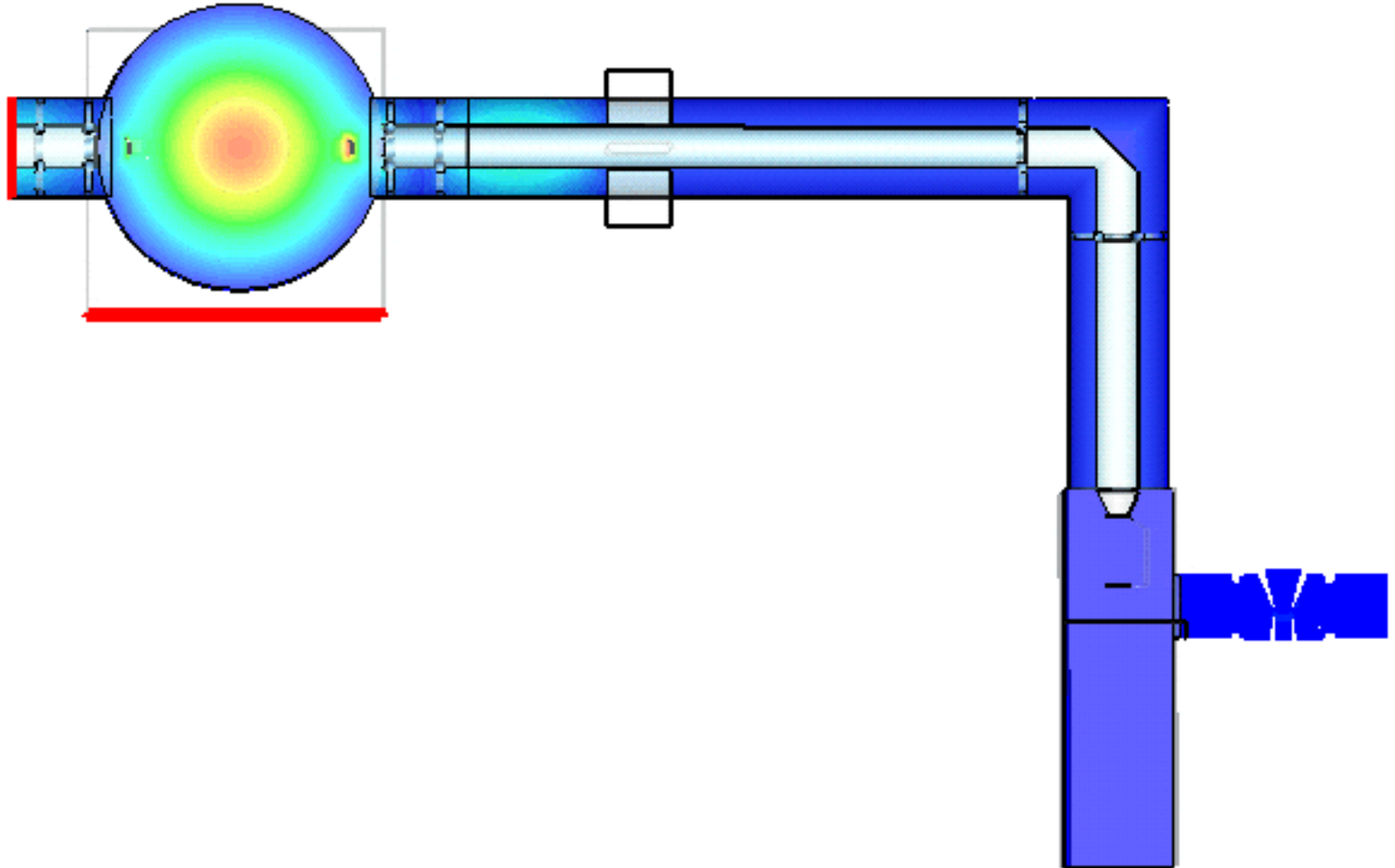
- ❑ **CoStub** is a device formed out of a coaxial waveguide and four stubs.

<p style="text-align: center;">Symmetric mode</p> 	<p style="text-align: center;">Asymmetric mode</p> 
<p>Stubs out do not perturb the symmetric mode</p>	<p>Stubs IN behave as a shortcircuit</p>

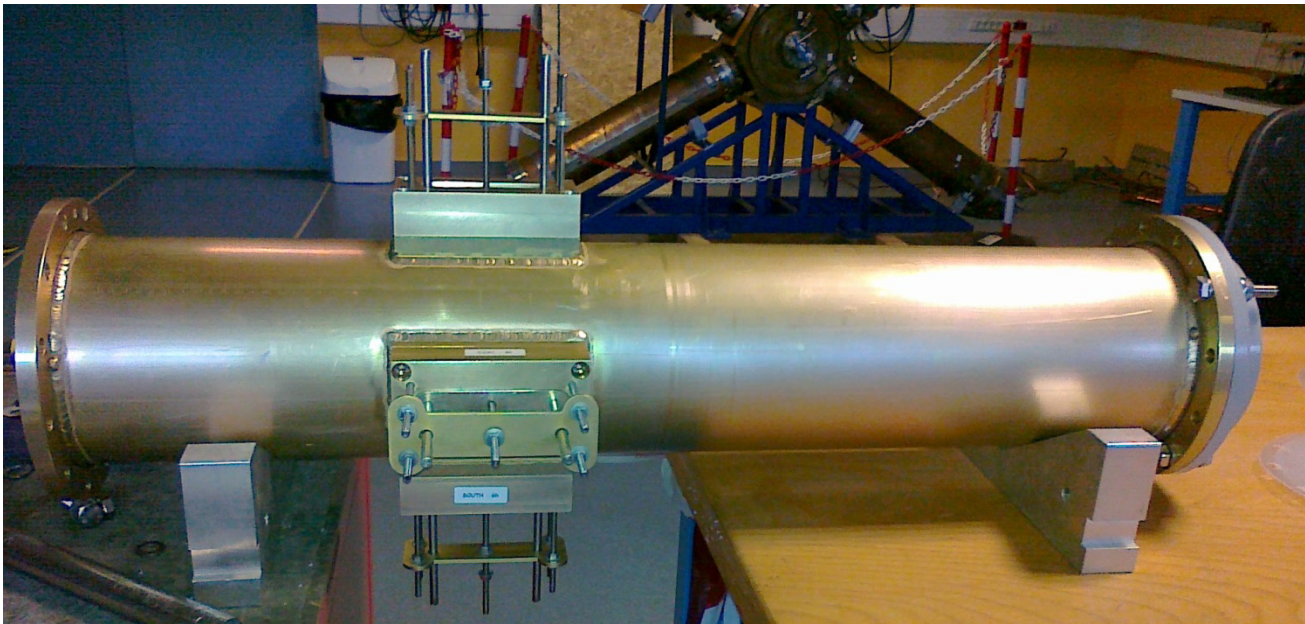
Number stubs	4
Distance between the stubs	90 degrees
Position respects Caco	236 mm away
Length	100 mm
Width	20 mm
S21	-53 dB
Power loss	10 W
Efield max around the stubs (scaled for 80000 RMS)	14000 V/m

Proposal of a solution: CoStub

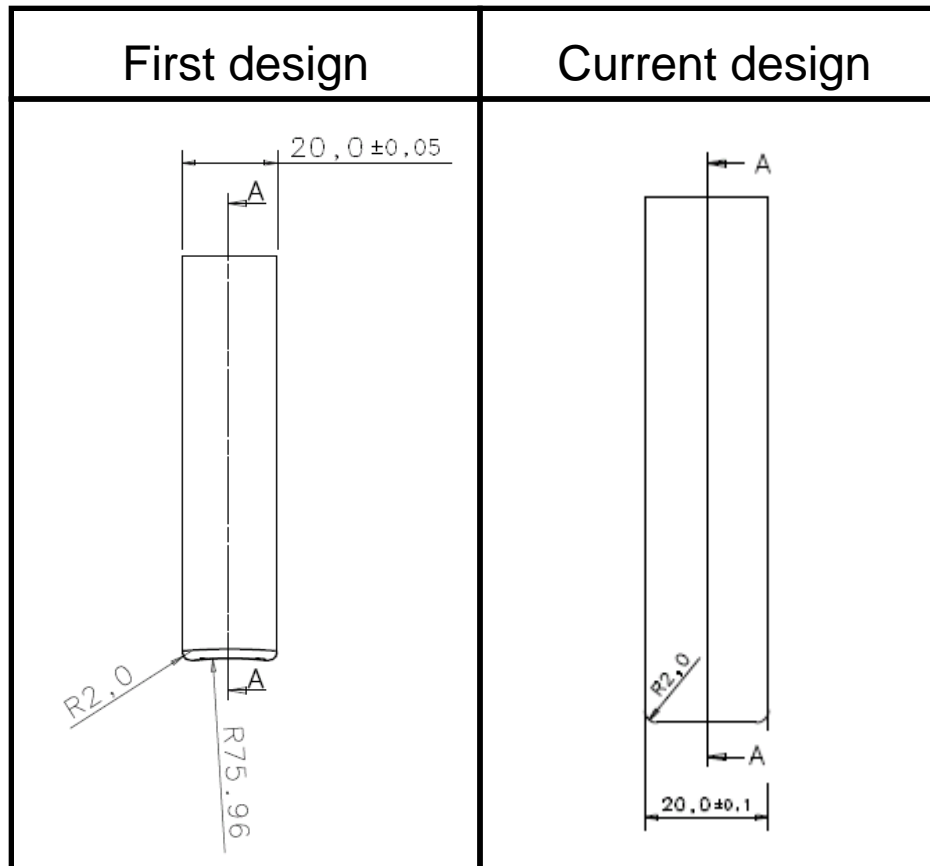
□ Final design



CoStub

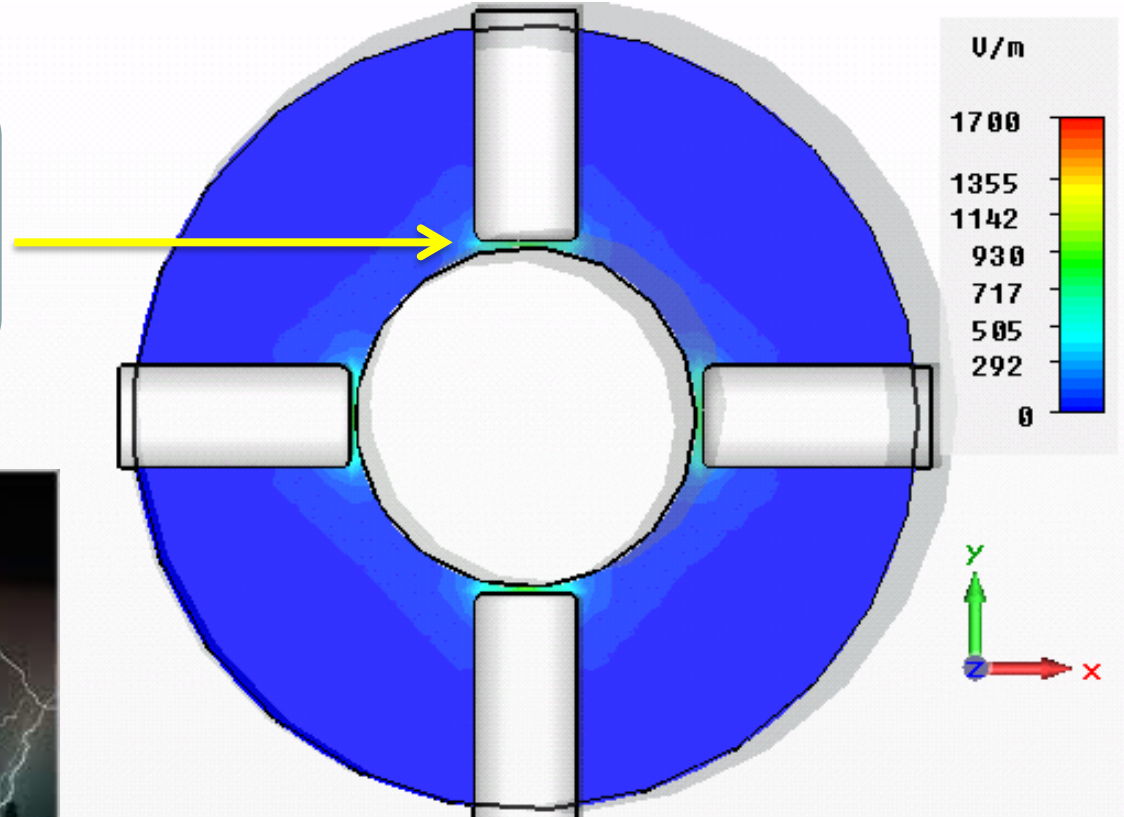


- ❑ First design the bottom part of the stubs were concave.
- ❑ Factory suggestion: flat Stubs (cheaper and easier mechanization).

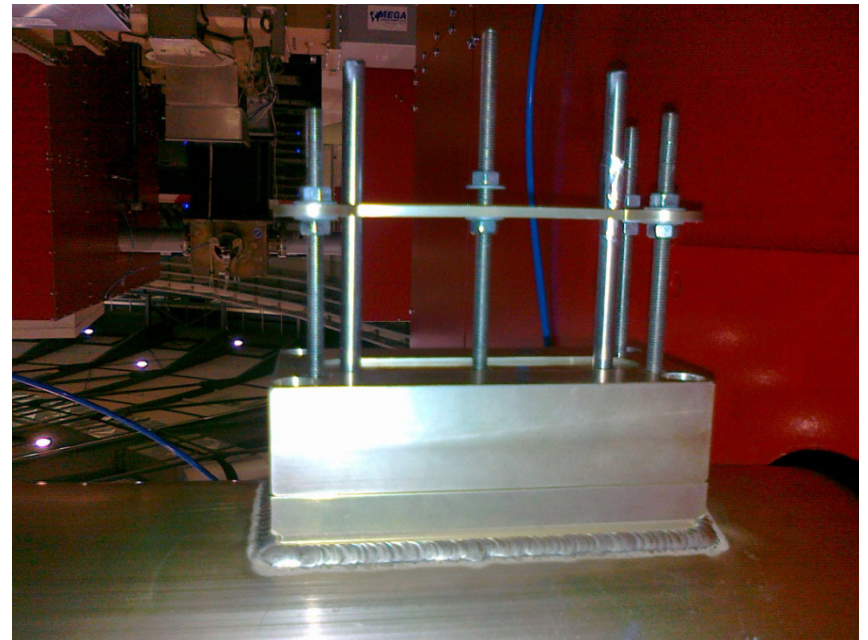


CoStub: Mechanical design

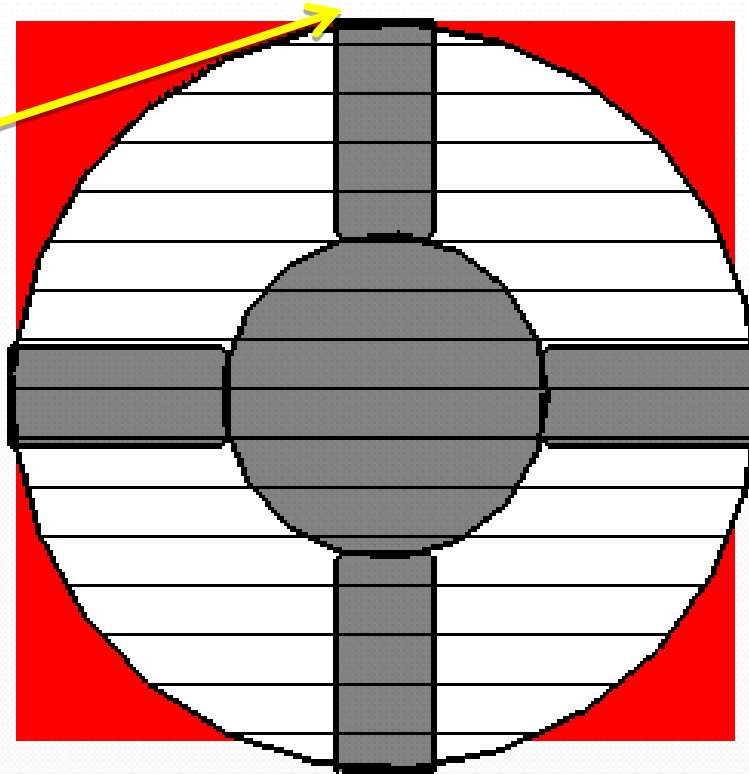
If there is a small gap between the stub and the inner conductor of the coaxial, CoStub will malfunction.



- ❑ The screws avoid movements of the stubs and ensure a good contact between stubs and inner conductor.
- ❑ No engine will be used.

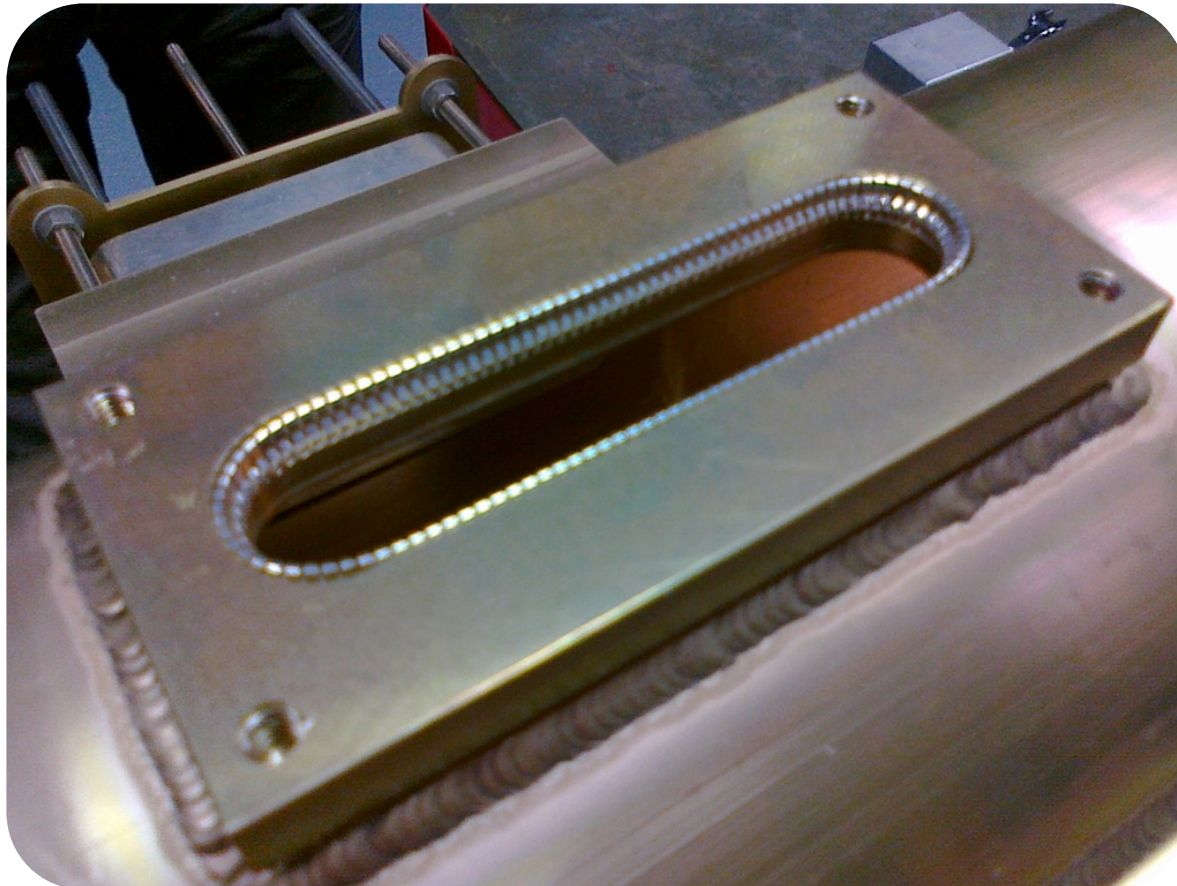


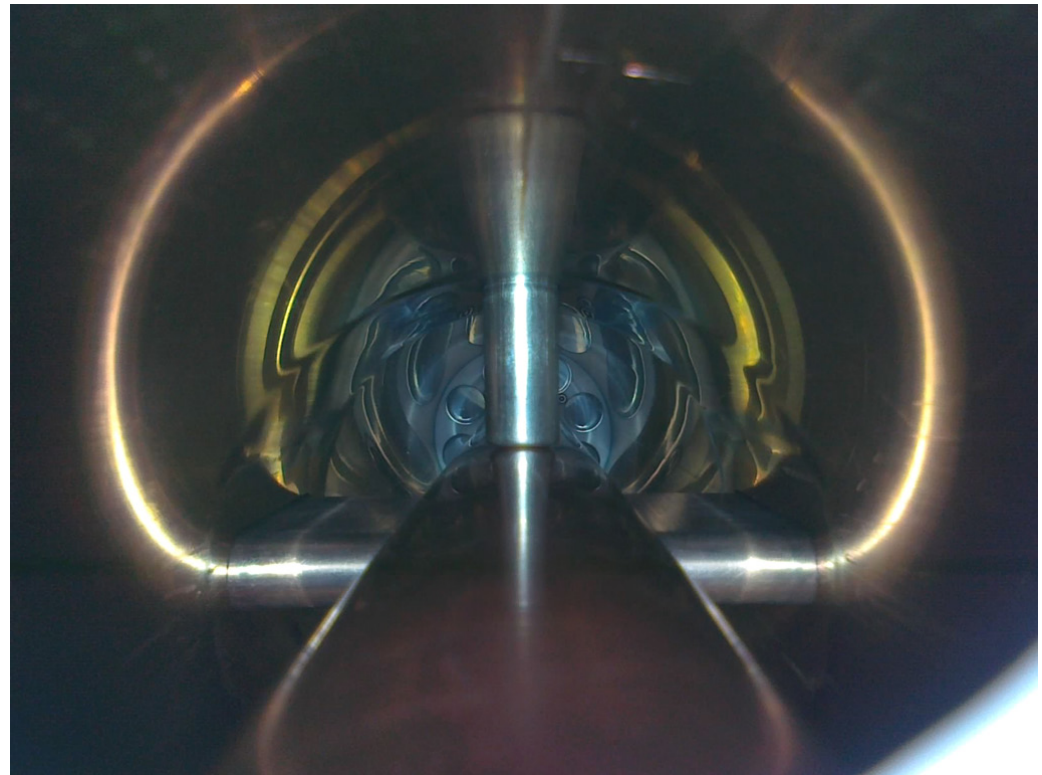
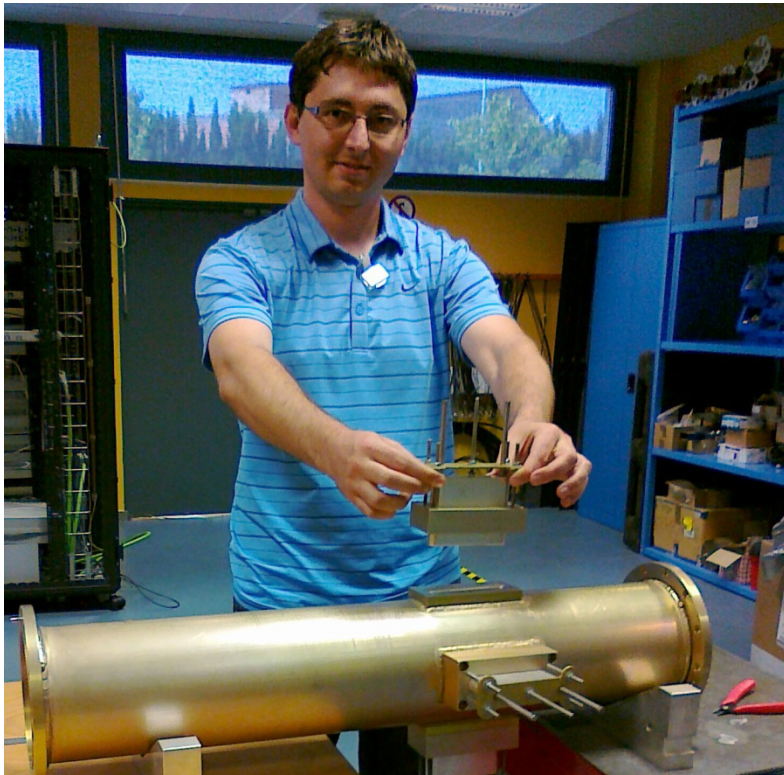
It is necessary some space between the stubs and the coaxial waveguide.



CoStub: Mechanical design

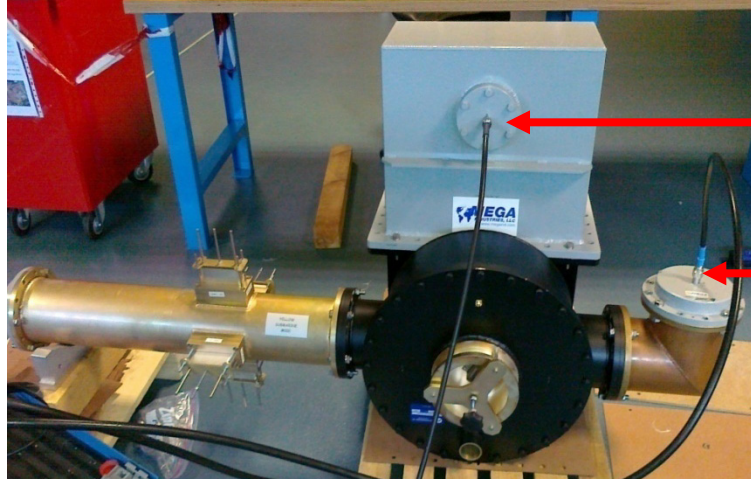
- Rf fingers allow good RF contact.





Asymmetrical mode: low power test

PORT 2



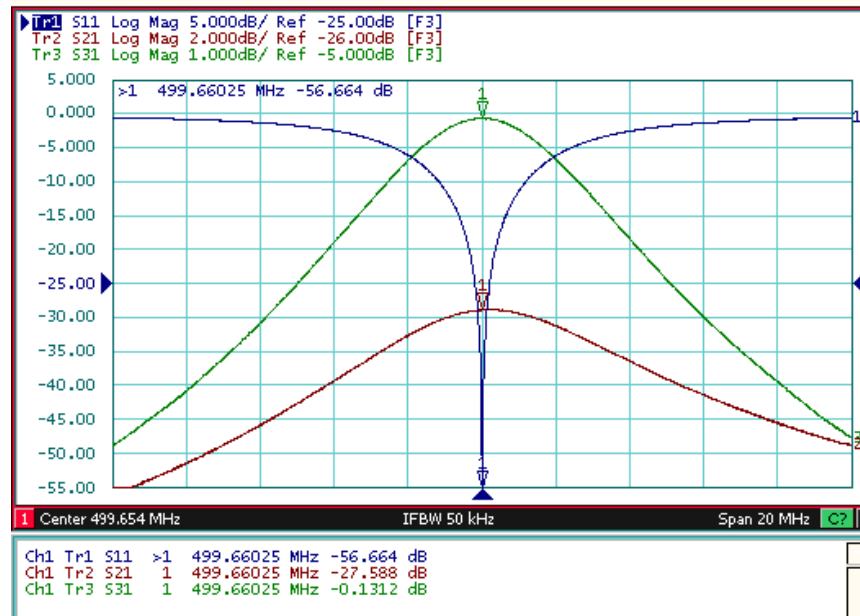
PORT 3

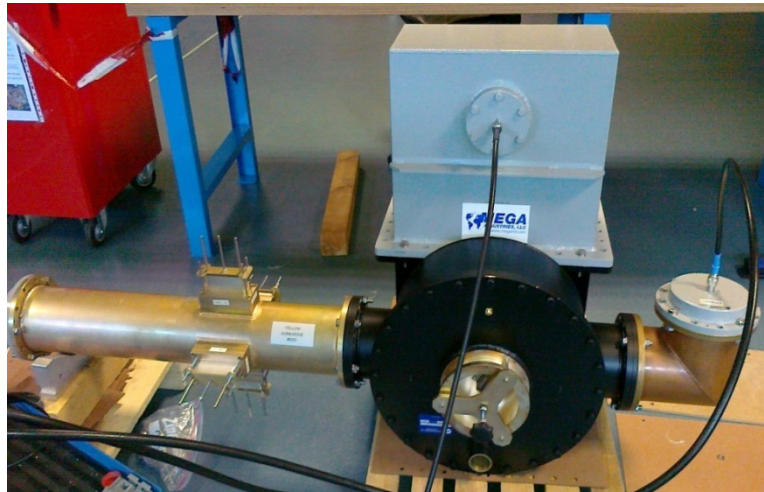
PORT 1

Measurements:

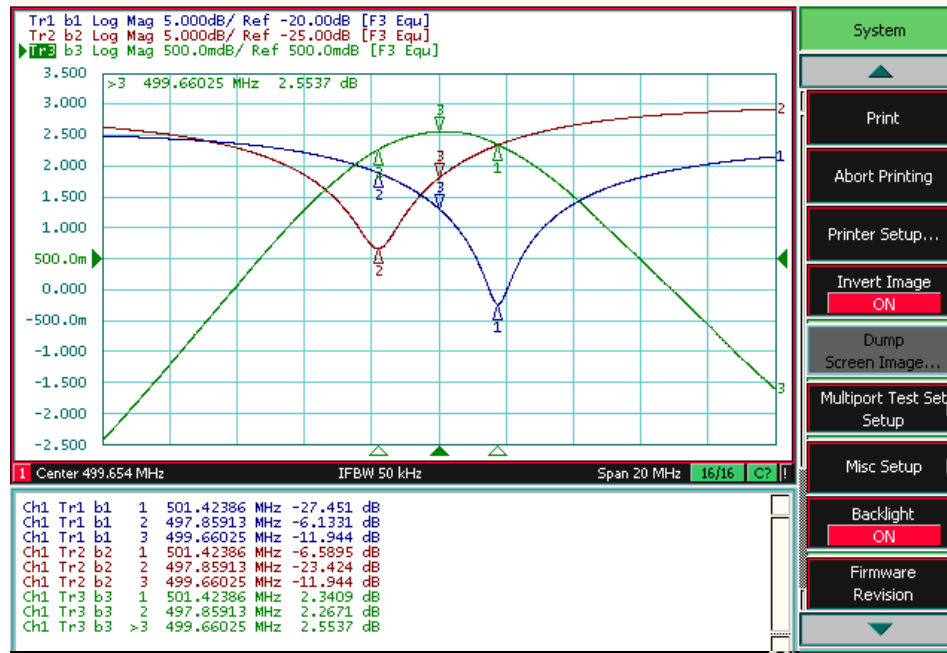
~~INDUSTUBS~~

~~S21 = -27.588 dB~~





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



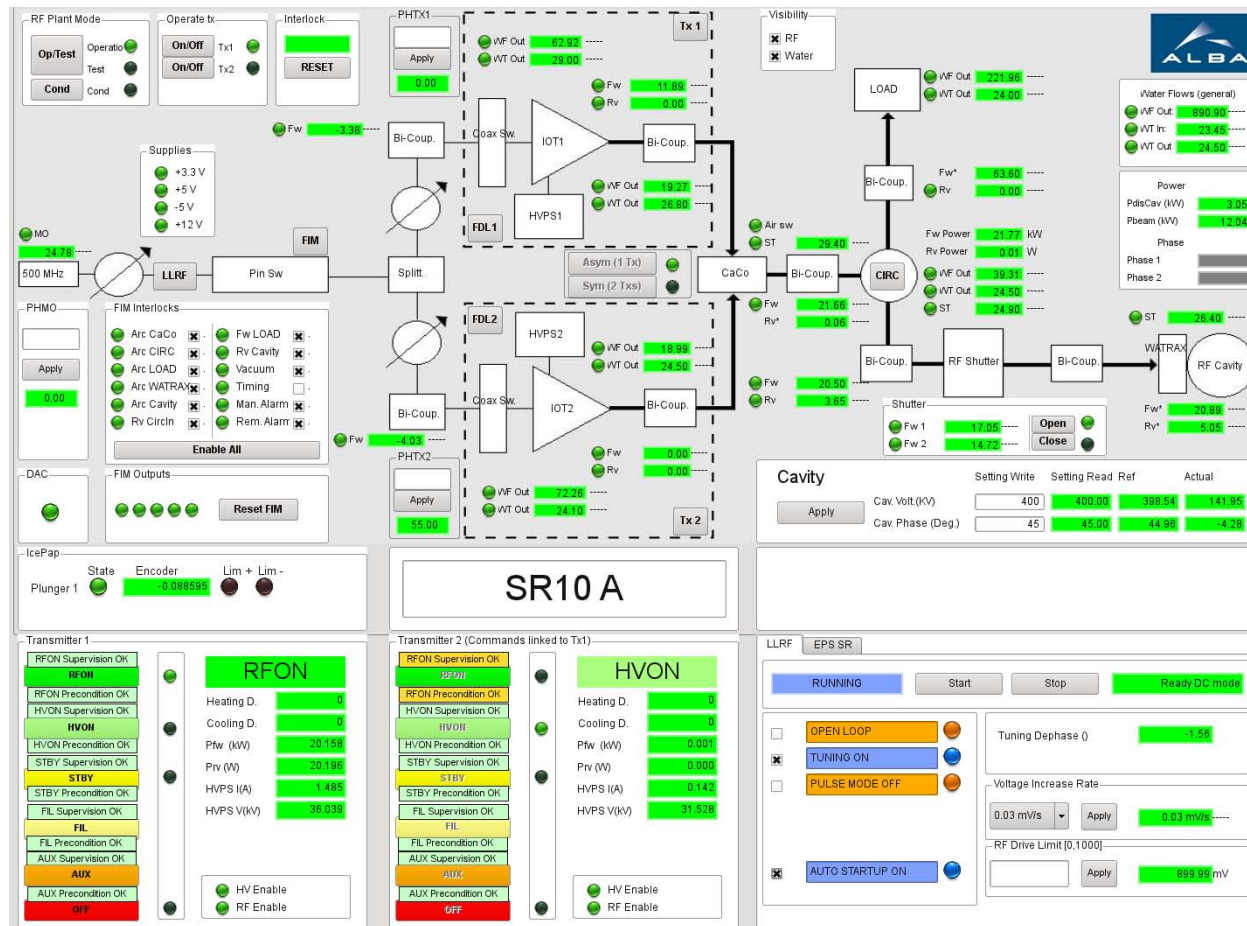
FIRST TEST: CoStub is assembled to a power meter. We increased the power till **80kW**.

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



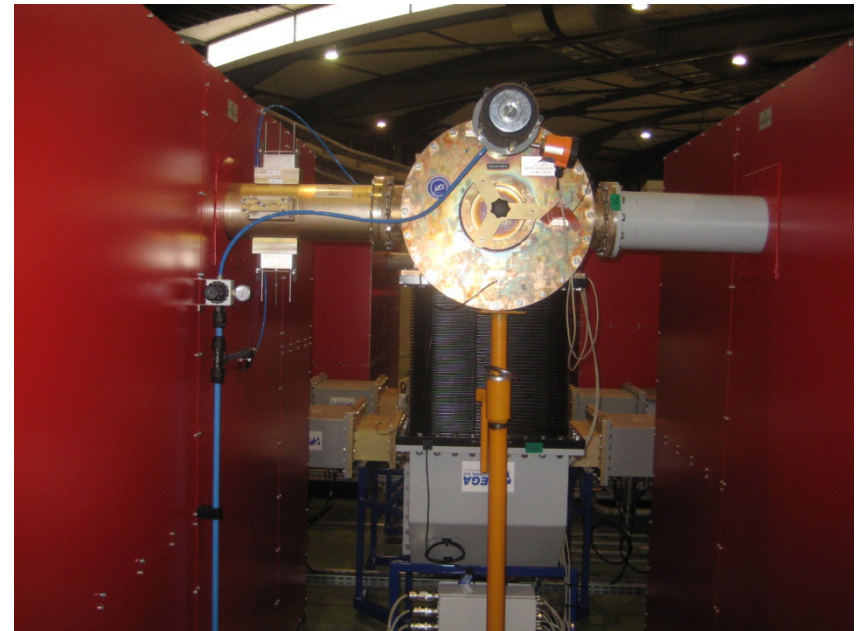
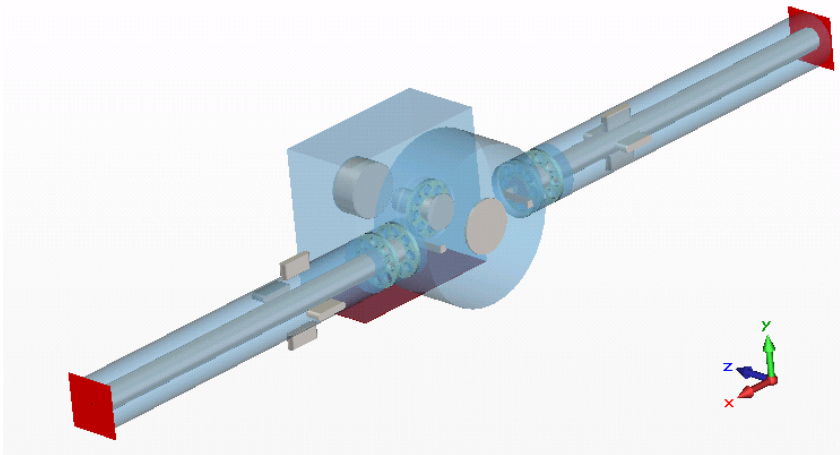
CoStub: High power test

- ❑ **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.

- ❑ **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