Main features of PETS tank

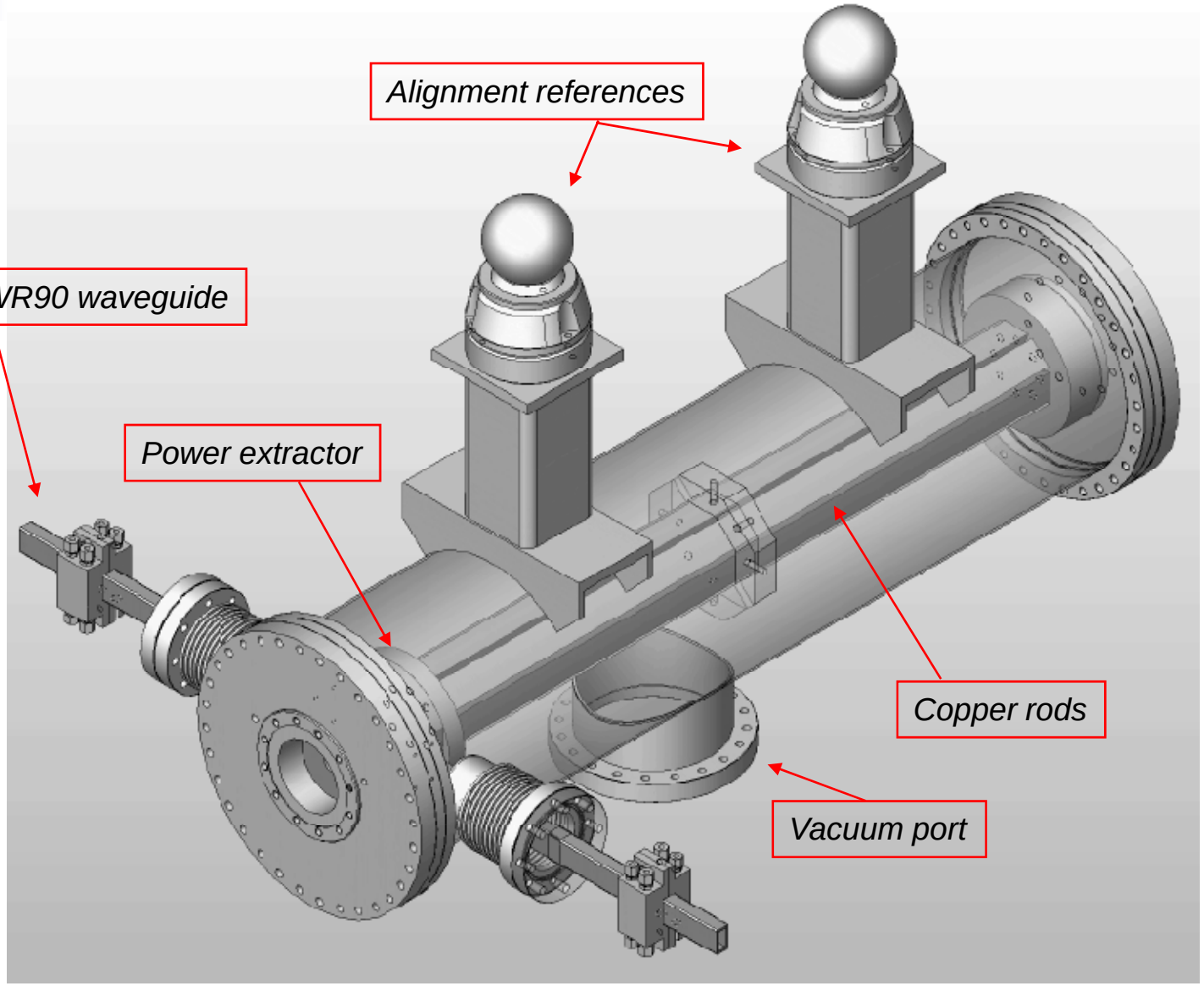
(I will review the present status of the PETS tank design for CTF3. Hopefully, PETS tank will be similar in CLIC)

MINISTERIO DE EDUCACIÓN Y CIENCIA
Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

J. Calero, D. Carrillo, J.L. Gutiérrez, E. Rodríguez, F. Toral

CERN, 17/10/2007

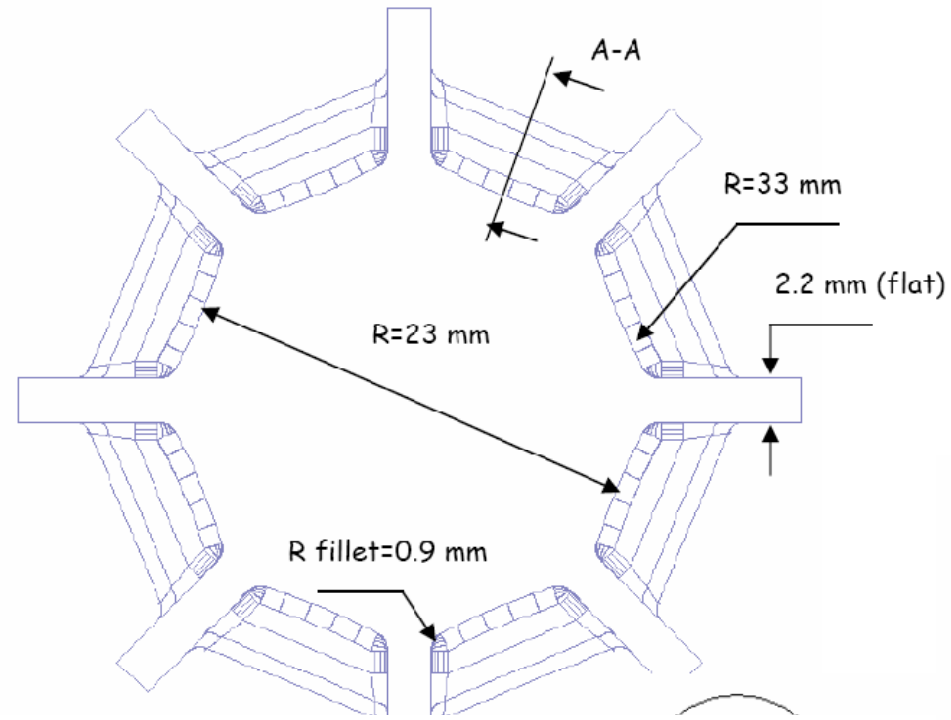
General layout



Outline

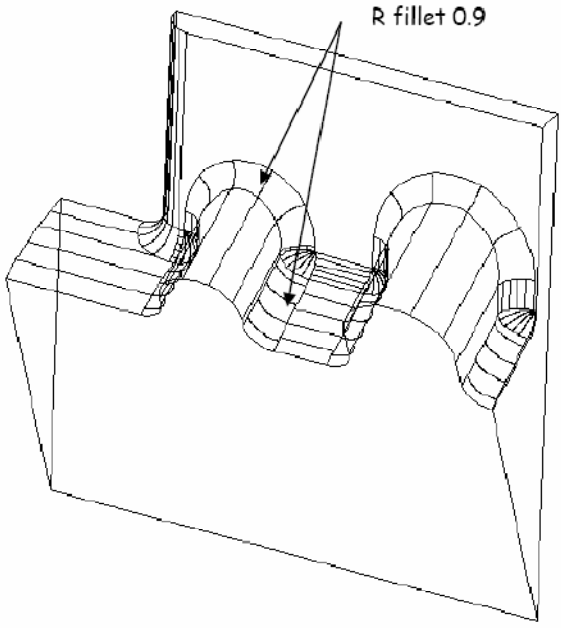
- ✓ Copper rods
- ✓ Power extractor
- ✓ Waveguides
- ✓ Assembly
- ✓ Thermal calculations
- ✓ Cooling system
- ✓ Near future plans and conclusions

Copper rods (I)

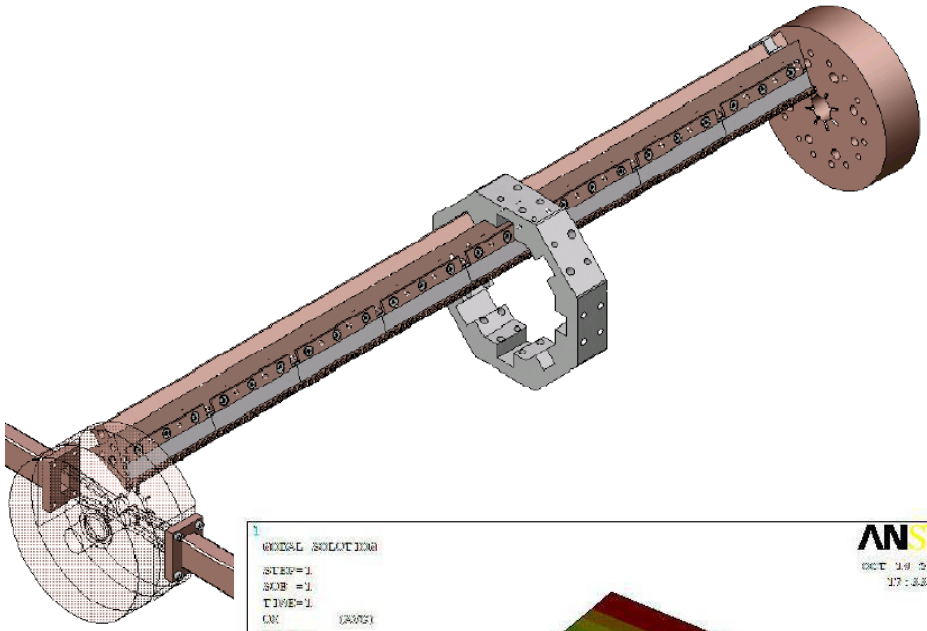


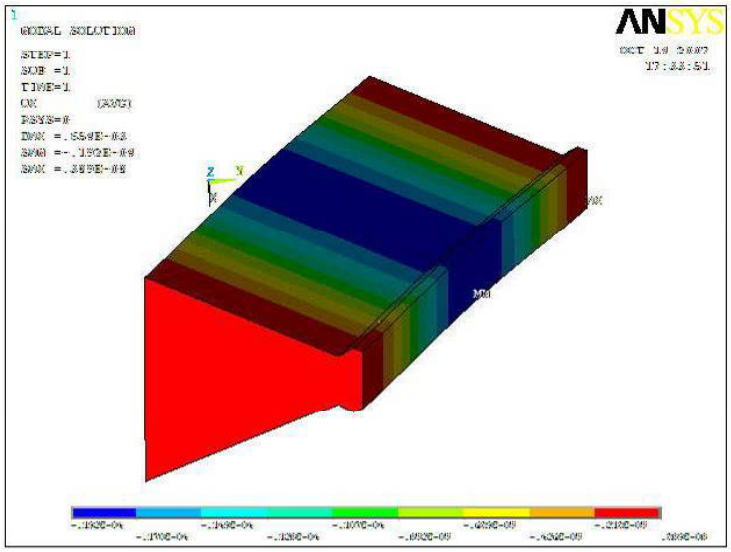
Courtesy I. Syratchev, CERN

- Geometry has been changed (June'07). Now teeth are rounded.
- Advantages: lower peak field, shorter transition to circular aperture (matching cell).



Copper rods (II)

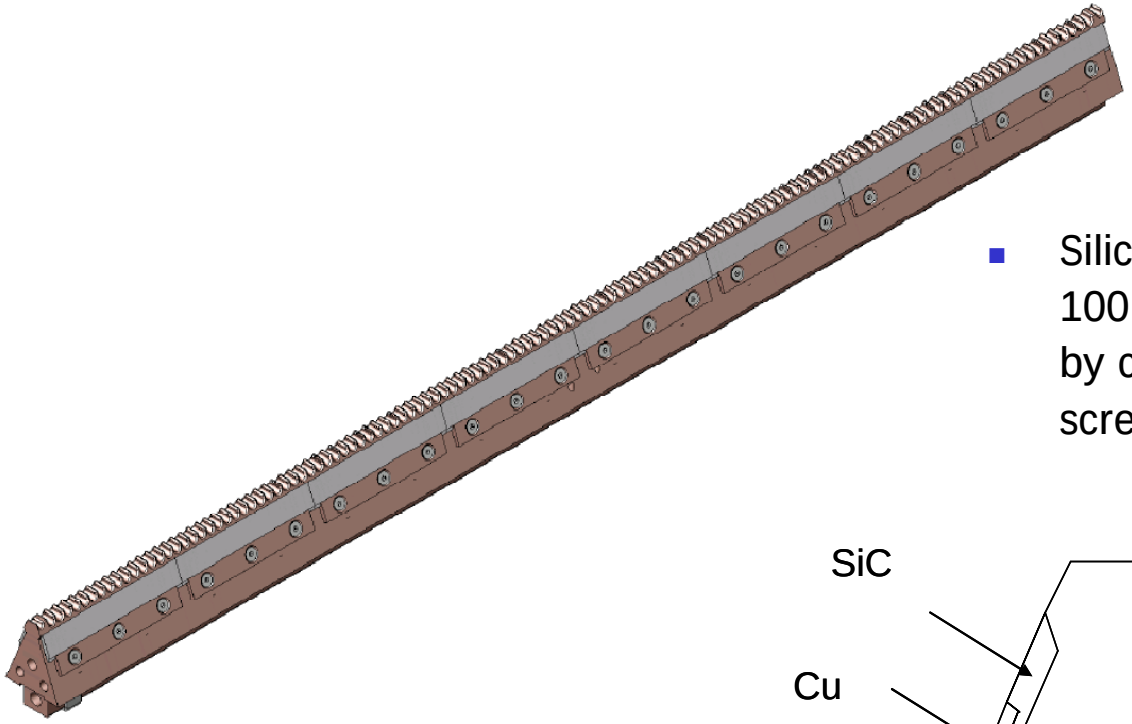




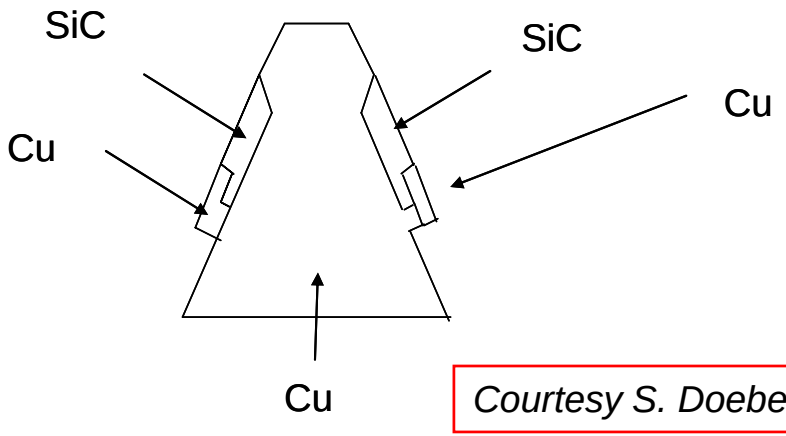
- End rings: two pins on each rod for alignment and one screw for clamping.
- Enhanced thermal contact: all the rods have the same length and contact pressure is made by bolts.
- Intermediate stainless steel ring: the assembly is stiffer and sag is negligible. Two pins and two screws on each rod.

Height (mm)	Sag (micron)
35	29.3
40	23.4
45	19.2

Copper rods (III)

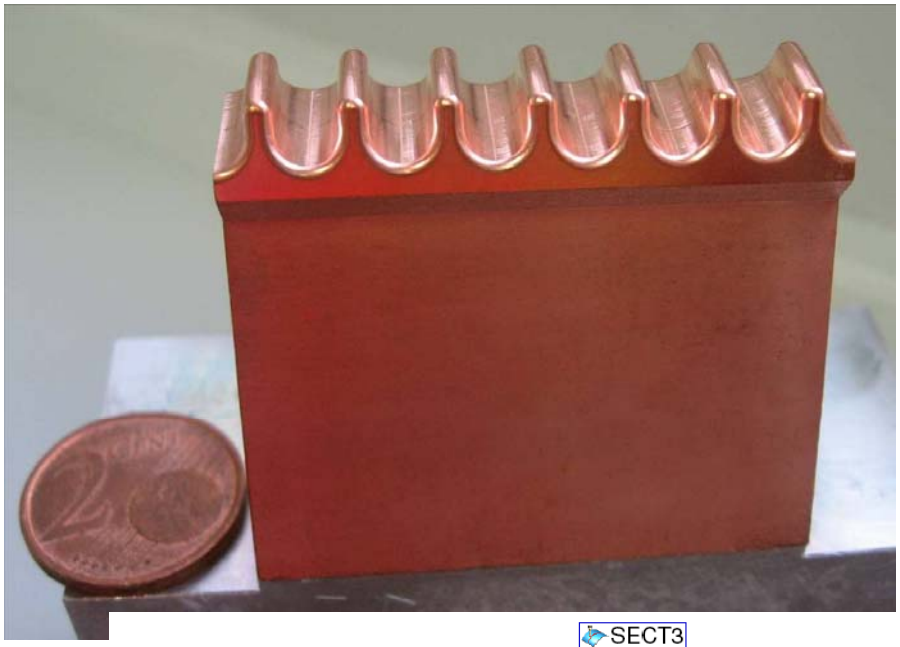


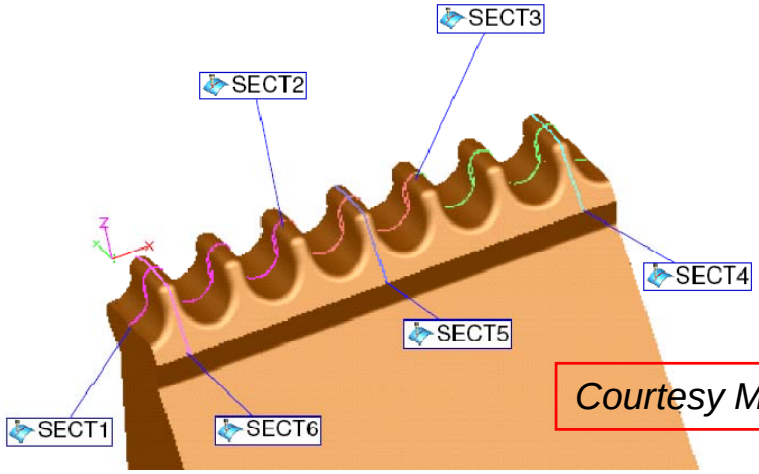
- Silicon carbide absorbers are split in 100 mm long plates. They are hold by copper plates and embedded screws.



Courtesy S. Doebert, CERN

Copper rods (IV)

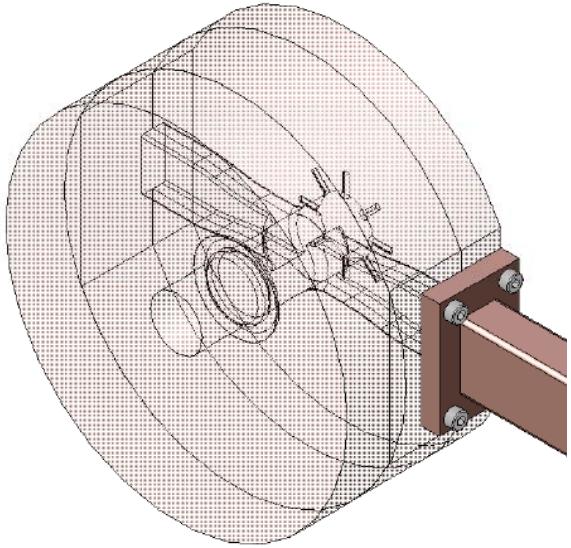


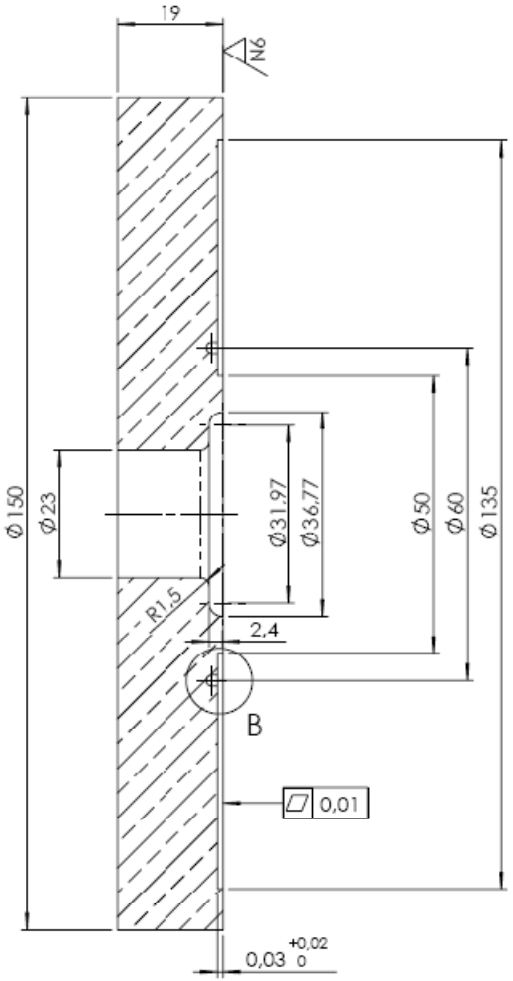


- A short probe has been fully milled using sulphur-free coolants.
- Measured roughness is 0.4 micron, in the order of the requested one, 0.3 micron (~skin depth 12 GHz).
- Requested geometrical tolerance is ±20 micron. Some difficulties arose to measure the piece due to the lack of flat reference faces, but it is within tolerances, generally speaking.
- Next step is 800 mm long rod. OF copper has just arrived.

Courtesy M. Taborelli, CERN

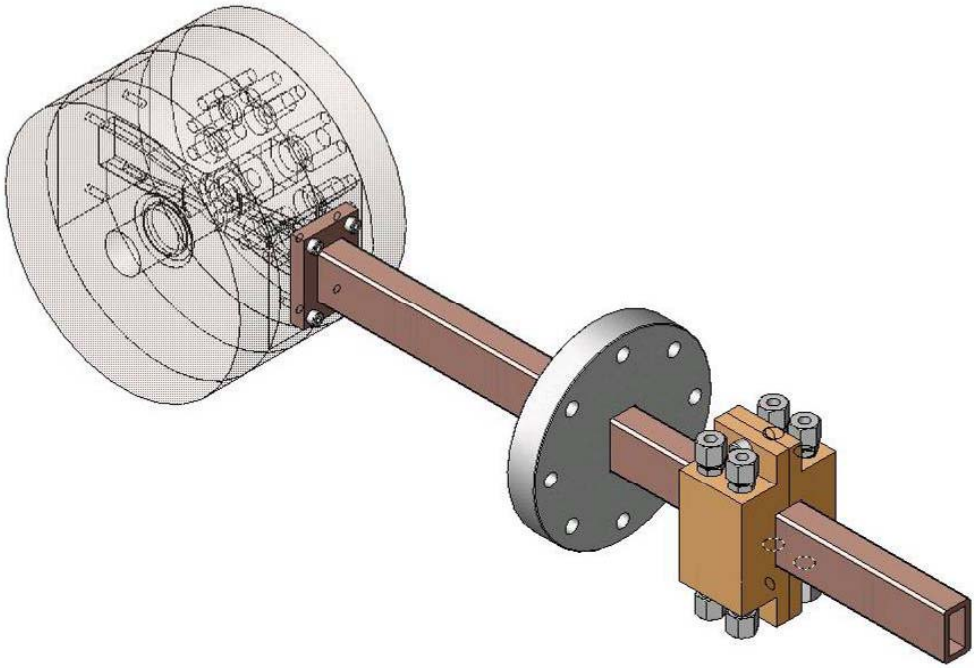
Power extractor





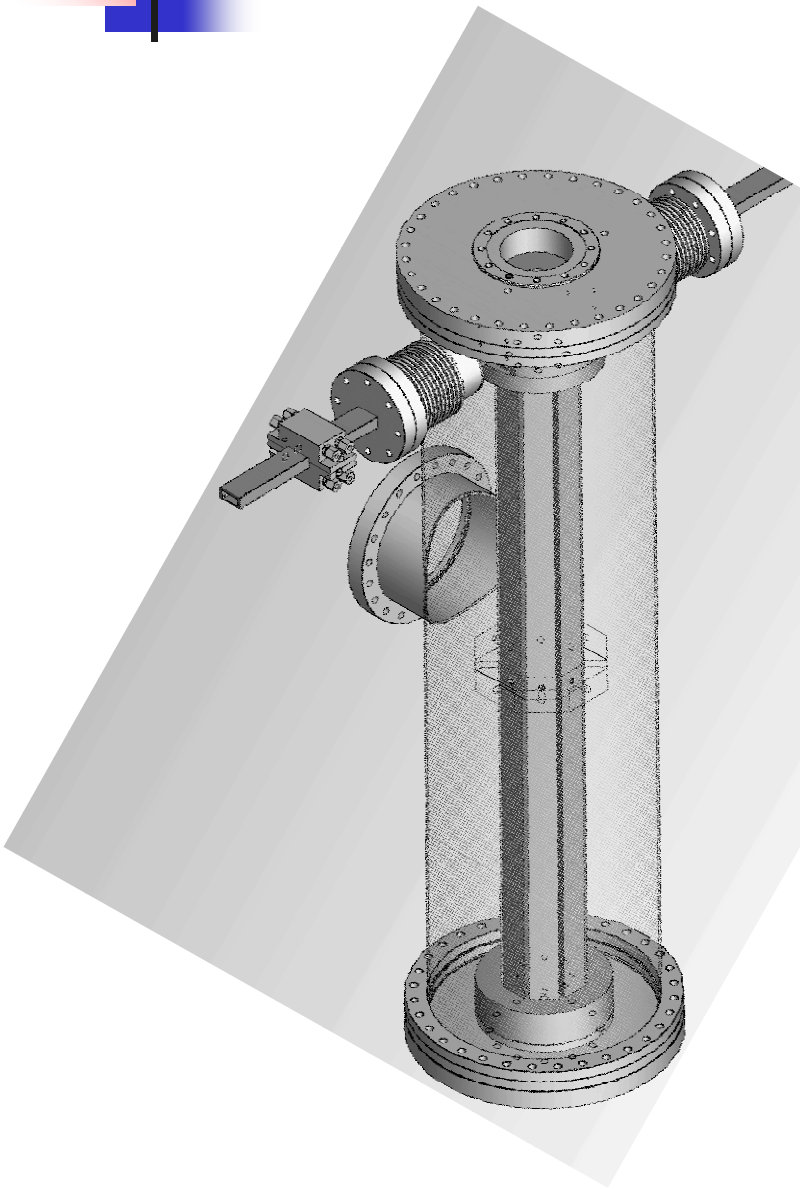
- Machined in three parts with pins for reference.
- Brazed to avoid virtual leaks and to enhance electric contact. It is important to avoid migration of brazing alloy into waveguide.
- We have placed the order for OF copper plates for first tests in a vacuum oven.

Waveguides



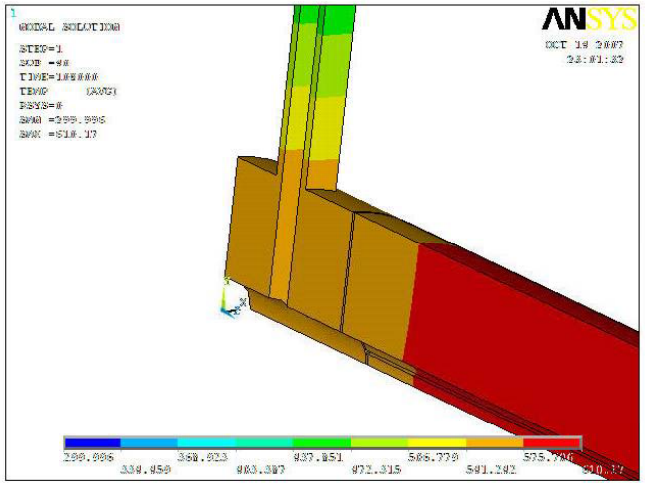
- Thick wall WR90 waveguides: 3.17mm.
- RF flange on the power extractor not defined yet. Large contact surface will decrease thermal resistance. It should be fixed once the copper set is inside the tank!
- A stainless steel vacuum flange should be brazed to the waveguide to close the tank (similar to SLAC design). Bellows will allow for misalignment.
- An additional copper flange will provide additional cooling if necessary.

Assembly



- Vertical assembly of the copper rods, the stiffening ring and the two copper ends.
- That block is placed on top of the tank endplate, and surrounded by the tank wall.
- Waveguides will be fixed afterwards, and finally, the tank will be closed.
- The PETS axis reference is transferred outside by means of two pins drilled on the endplates.
- Cooling system interface is still not included.
- RF screens are not included at this moment.

Thermal calculations (I)



- Steady state FEM: only conduction and natural convection. Thermal contact resistances are modelled with typical values from literature.
- Heating due to RF losses (imported from HFSS and averaged) and beam losses:

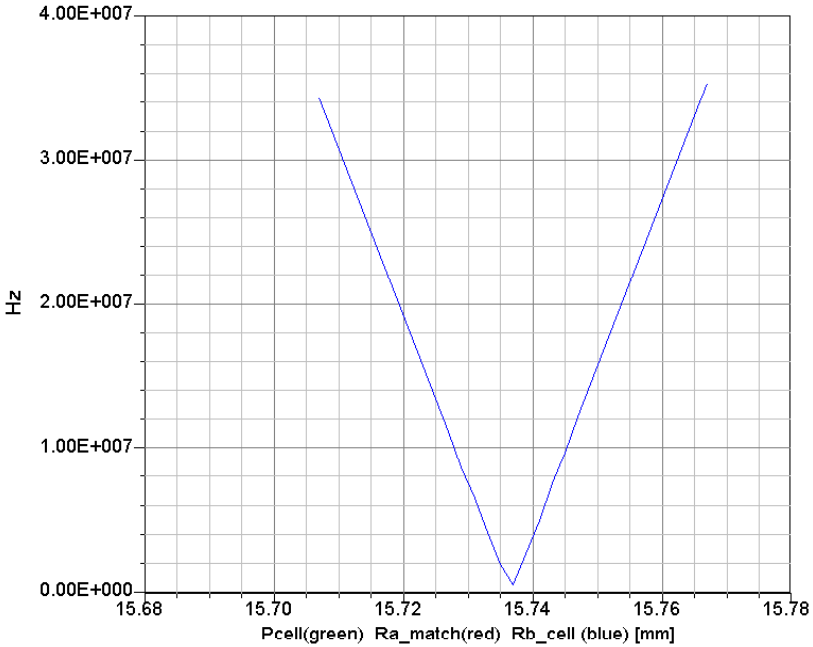
$$P_{beam\_losses} = 0.1 \times 150MeV \times 30A \times 140ns \times 5 = 315W$$

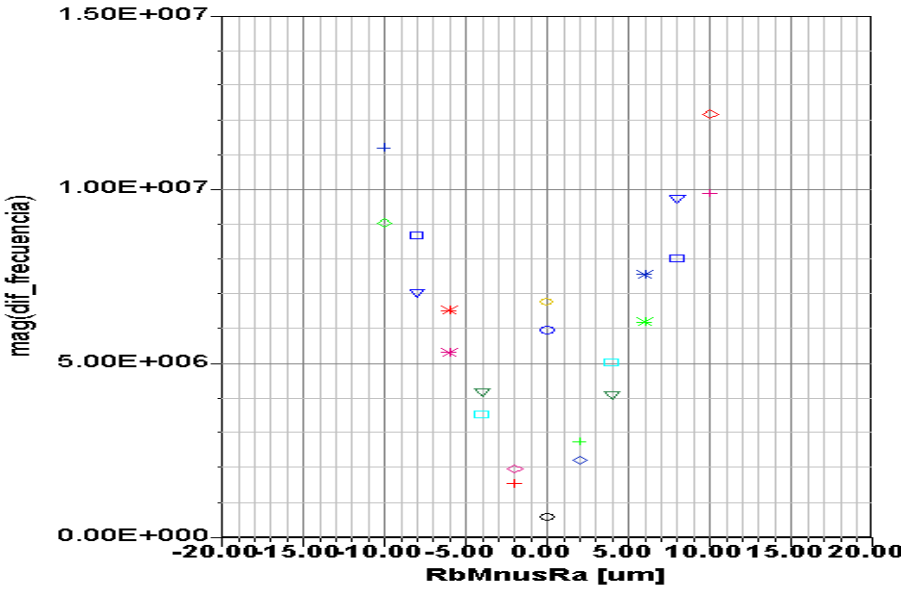
- In steady state:

Beam losses (%)	Peak temperature (K)
1	338
2	368
5	459
10	610

Thermal calculations (III)

- A temperature increase of 30ºC means a unitary elongation of $5*10^{-4}$, that is, about 8 micron for the PETS radius.
- RF sensitivity analysis shows a variation of few MHz.

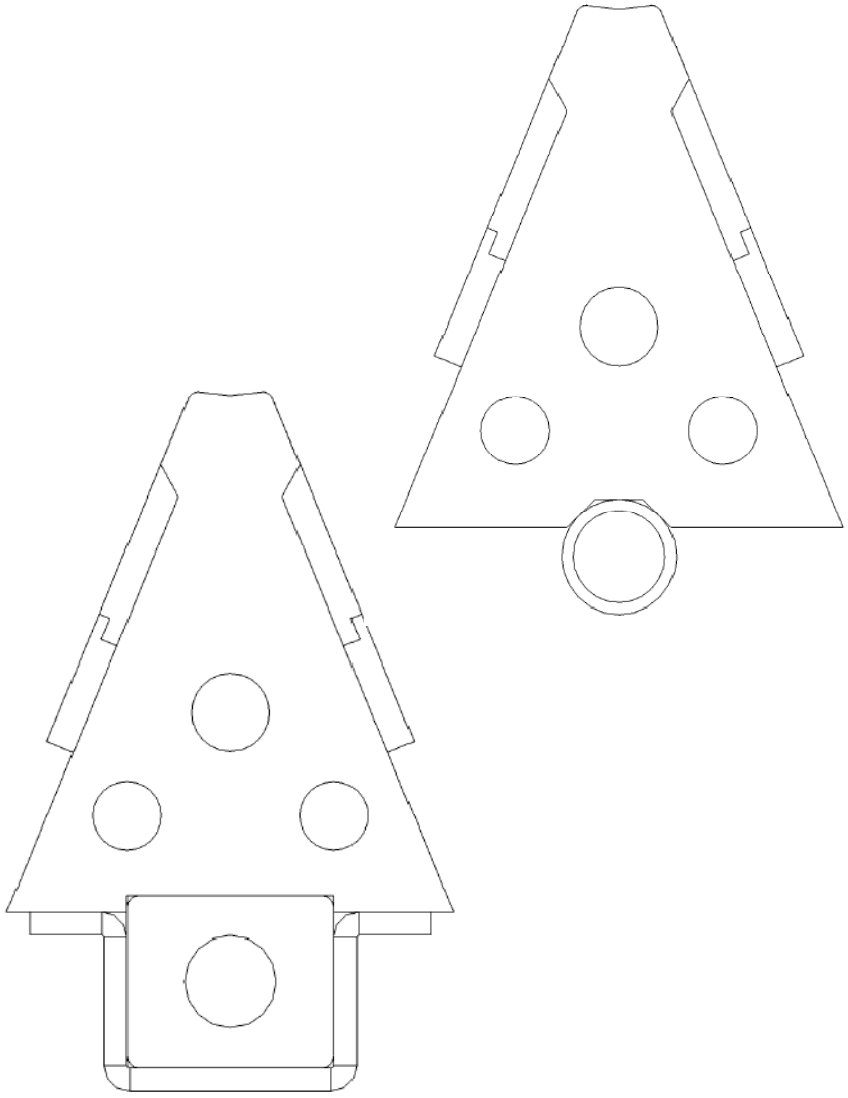




Courtesy of David Carrillo

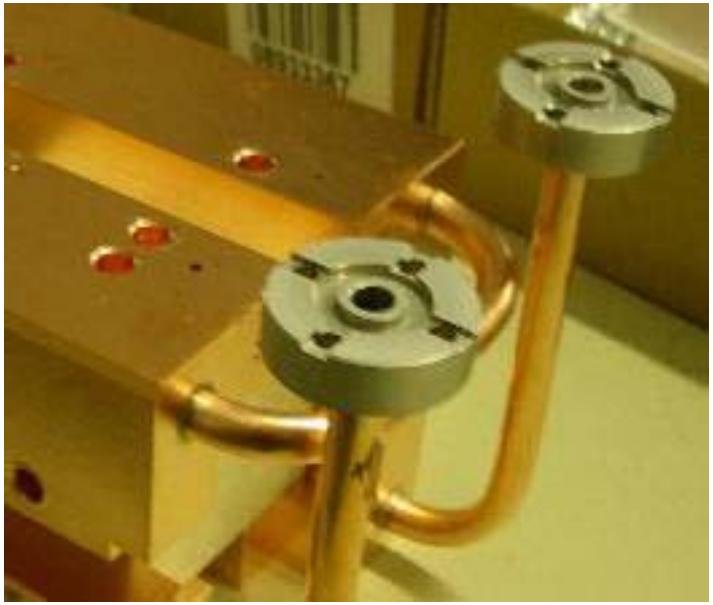
Cooling system (I)

- Two choices: square or round pipe.
- Square pipe: flatness?, bending?, contact pressure?
- Round pipe: contact surface?, larger hole for the same external dimensions.
- Contact resistance: just clamping? Cold soldering is not allowed.
- Thermo-hydraulic analysis is not finished



Cooling system (II)

- Two choices: high-vacuum tight connectors or brazing custom connectors.
- CERN has no good experience with commercial connectors.
- We cannot put directly the pipes into the oven because they are two long. Solutions are under study (shorter pipes, curing bent pipes...)



Courtesy A. Rodriguez, CERN

Near future plans

- Brazing tests have maximum priority to finish the power extractor design.
- An order for the machining of the 800 mm rod will be placed in the next days.
- A decision has to be made on the cooling system.
- We continue with the vacuum tank design. CERN has to confirm the instrumentation and vacuum ports/flanges to be included.
- We are also working on the test program definition, in collaboration with CERN. Some components are already designed and commercial components are being ordered. More information in the talk by David Carrillo.

Conclusions

- Conceptual design of PETS tank is on-going.
- There are a lot of difficult issues to solve:
  - high precision copper machining,
  - complex assembly,
  - cooling system under high-vacuum conditions,
  - brazing...
- Test program is being defined.
- Time schedule is very tight, but more manpower is now available. Tasks will run in parallel.
- Hopefully, all this experience will be directly transferred to PETS tank in CLIC.