ENGINEERING DESIGN AND FABRICATION OF PETS

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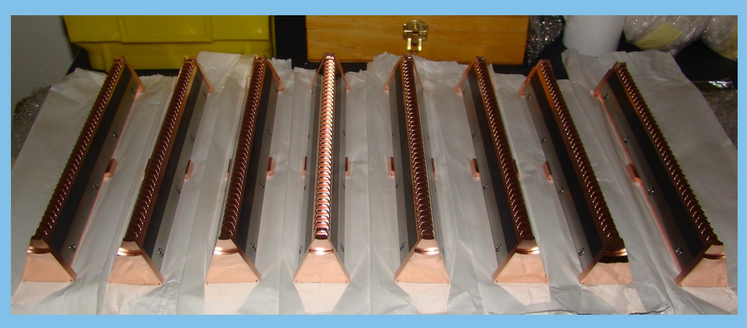
Abstract

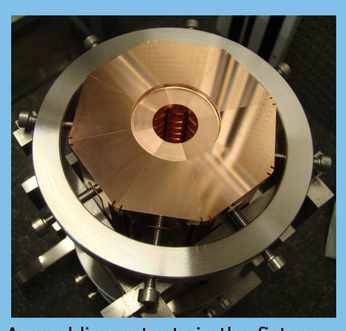
The CLIC Power Extraction and Transfer Structure (PETS) is a passive microwave device in which bunches of the drive beam interact with the impedance of the periodically loaded waveguide and generate RF power for the main linac accelerating structure. The CLIC PETS is one of the key components in the CLIC two-beam acceleration scheme. Each PETS is comprised of eight octants separated by the damping slots. Each slot is equipped with HOM damping loads. This arrangement follows the need to provide strong damping of the transverse modes. The PETS unit is an assembly of two PETS arranged in series with all technical systems: vacuum system, RF waveguides, cooling system and supporting system. Along with the PETS itself an important part of unit is the compact coupler with On-Off mechanism. General requirement for the vacuum is to provide system pressure equal to 10^{-9} mbar. Tolerance requirements are the following: shape accuracy of critical surfaces to be equal to 0.015 mm, and roughness is 0.1 μm. The demands on the high power production (~ 150 MW) and the needs to transport the 100 A drive beam for about 1 km without losses [1], makes the PETS design rather unique and the operation very challenging.

11.4 GHz PETS Test assembly

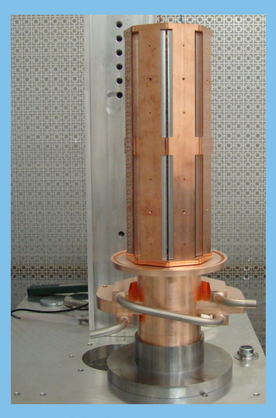
In May 2010, the 11.4 GHz damped PETS has been assembled and shipped to SLAC for high-power test. The test has shown good results. The positive experience of this work has been taken into account when designing of the CLIC PETS. Below there are some photos showing the main phases of the assembly process:



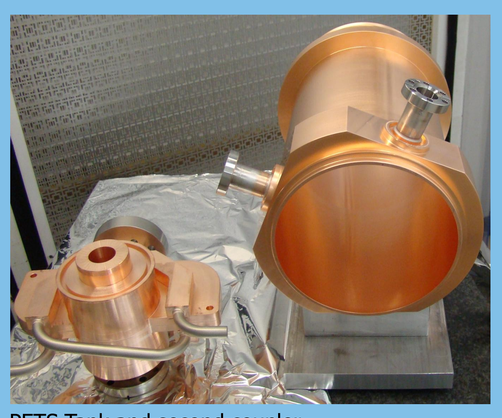
PETS octants with attached damping material.



Assembling octants in the fixture.



Assembled PETS mounted on the coupler.



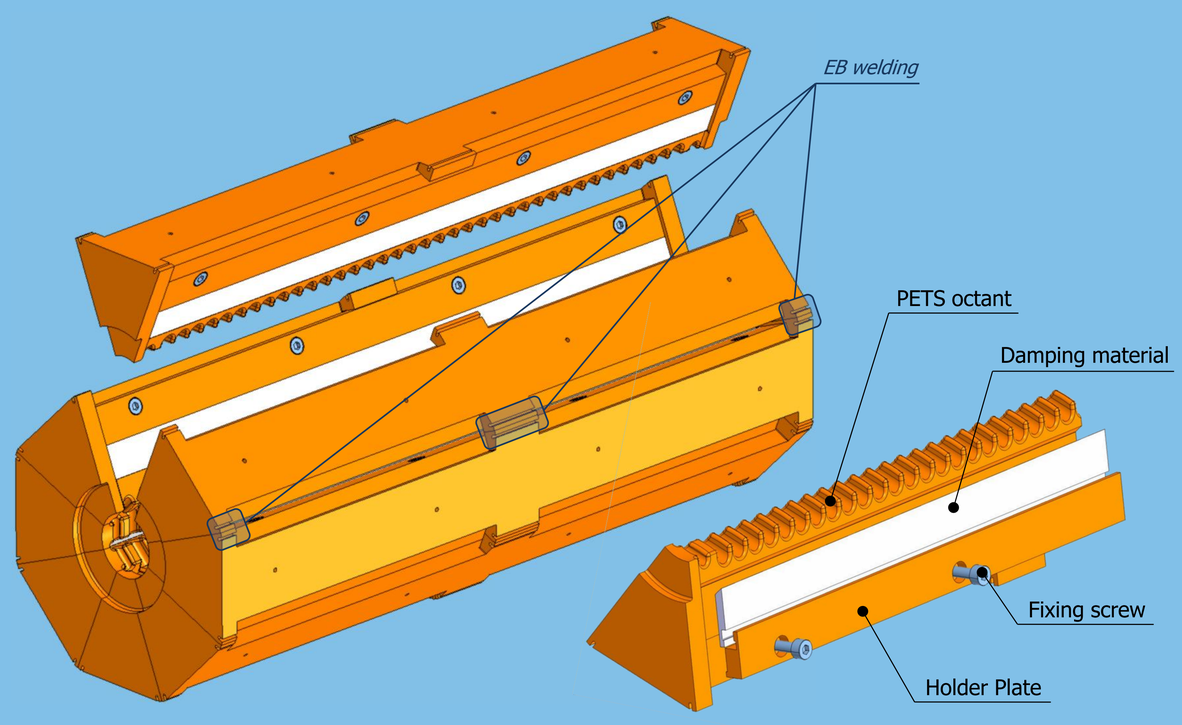
PETS Tank and second coupler.

Complete assembly.

PETS bar

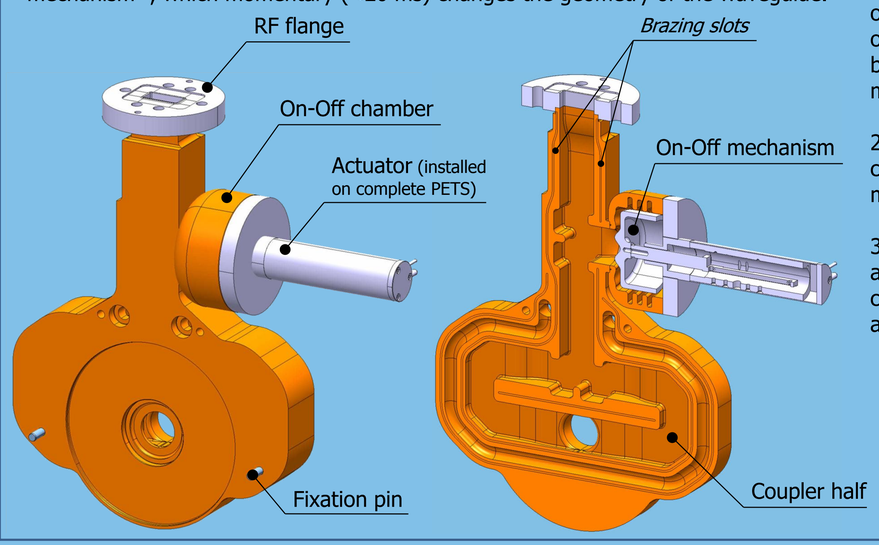
The PETS, hereinafter referred to as PETS bar (to distinguish it from the complete PETS unit) is composed of eight identical parts, octants. The copper octant has a wedge-shaped cross-section profile, while the narrow side of octant has the corrugated RF geometry. Each octant is damped with SiC shim attached to the lateral surfaces. The fixation of damping materials is performed by use of copper holder plates and vented screws.

The octants are welded with EB welding in three places by each edge.



Compact coupler with On-Off mechanism

The compact coupler is an essential part of the PETS unit. It combines three functions: transferring RF power to the main linac ac. structure, connecting two PETS bars and cutting the produced power by means of integrated actuator, "On-Off mechanism" , which momentary (<20 ms) changes the geometry of the waveguide.

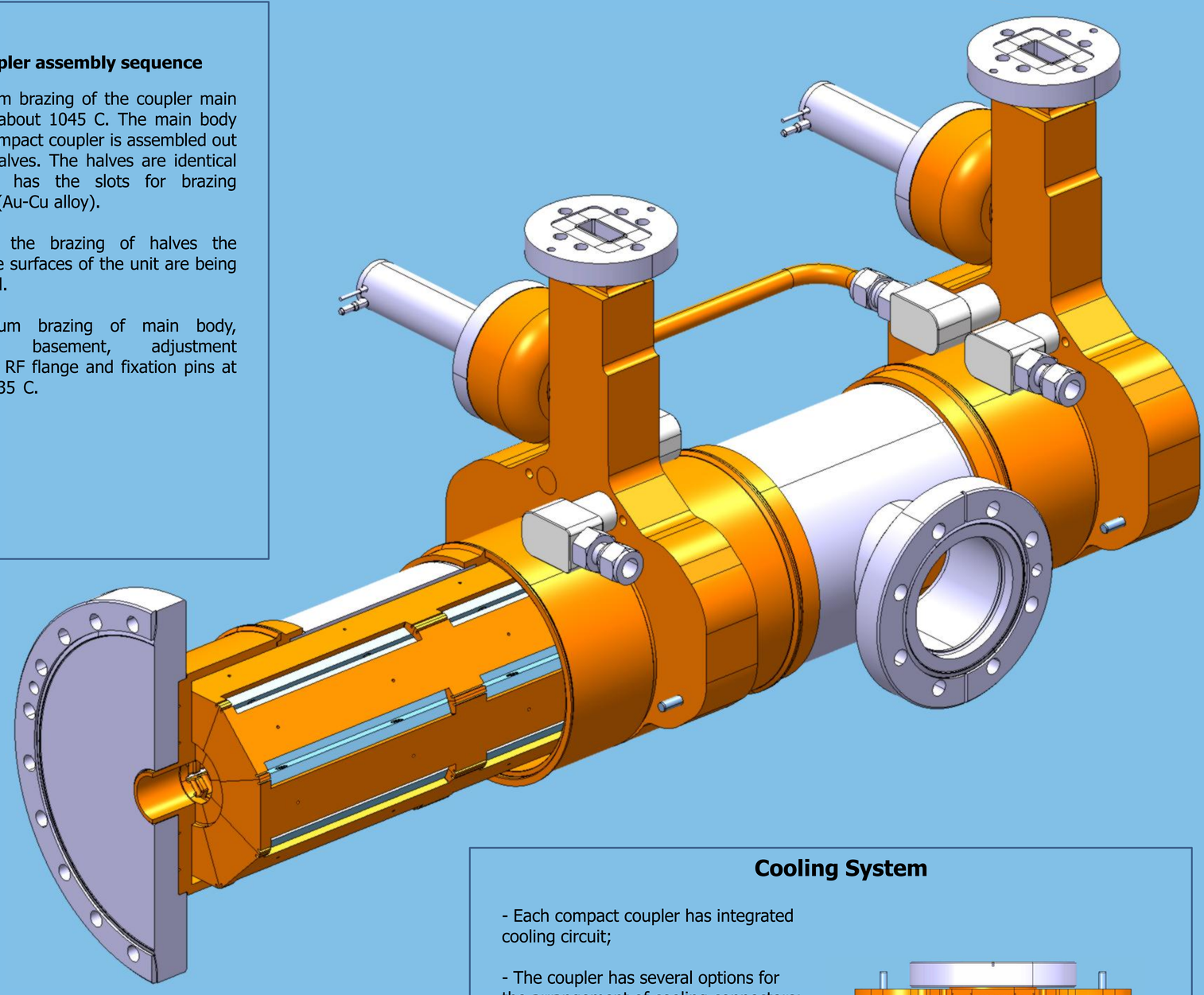


Coupler assembly sequence

1. Vacuum brazing of the coupler main body at about 1045 C. The main body of the compact coupler is assembled out of two halves. The halves are identical but one has the slots for brazing material (Au-Cu alloy).

2. After the brazing of halves the conjugate surfaces of the unit are being machined.

3. Vacuum brazing of main body, actuator basement, adjustment chamber, RF flange and fixation pins at about 1035 C.

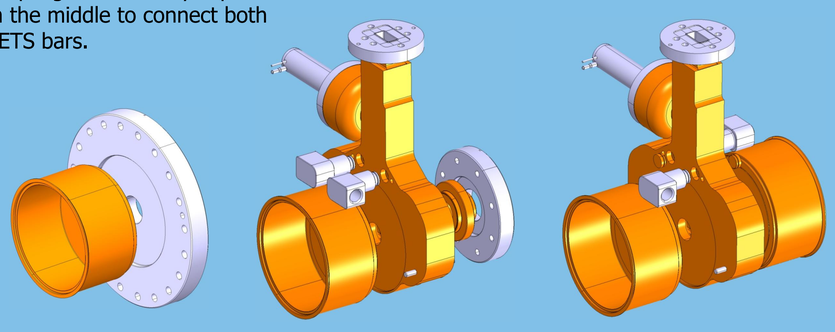


PETS assembly sequence

1. PETS bar, octants assembly (see the description above).

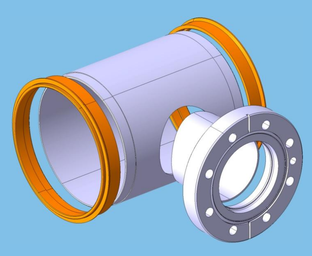
2. Compact coupler (see the description above).

3. Compact coupler–adapters subassemblies.
The complete coupler assembly is brazed with copper adapters and cooling fittings at about 1020 C. There are tree types of coupling subassemblies, two of it are placed at the ends of PETS and have the flanges to connect the PETS with next units. The third coupling subassembly is placed in the middle to connect both PETS bars.



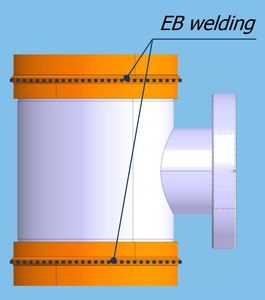
Closure subassemblies.

Middle subassembly.



4. PETS mini-tank (see picture on the left).
The stainless steel case of mini-tank is composed of housing tube, vacuum interconnection tube and vacuum flange, welded together by the use of TIG welding. Copper flanges are brazed in vacuum at about 1045 C.

5. General assembly.
PETS bars are being placed inside mini-tanks and capped with coupler-adapters assemblies. The joint is welded by the use of EB welding (see picture on the right).



6. Miscellaneous.
The rest is a screwing-on of standard cooling connectors and the cooling pipe connecting two couplers. Herein the installation of the actuators.

Conclusions

Resuming the progress it is worth mentioning that there are three programs running in parallel. PETS designed by CIEMAT for the CLEX experiment and two variants of the CLIC PETS – nominal for CLIC and mock-up for Lab test. The last two are now at the latest engineering phase and the mocked up PETS is already completed in drawings and ready for the fabrication. The test running of current and future CLIC PETS, shall bring significant results to the whole CLIC program.

ACKNOWLEDGMENT

The development described in this paper is the result of the international collaboration. The authors wish to thank all of the members of the collaboration for their valuable contribution.

REFERENCES

[1] I. Syratchev et al. "High RF Power Production for CLIC", Proceedings of PAC 2007, Albuquerque, New Mexico, USA.

Cooling System

- Each compact coupler has integrated cooling circuit;

- The coupler has several options for the arrangement of cooling connectors;

- Couplers are connected through the single cooling system;

- Standard water connectors.