BELLOWS AND TAPERS FOR THE ALBA STORAGE RING

Application

These RF-bellows are currently operating at the ALBA synchrotron (CELLS – Barcelona – SPAIN).
These bellows has been conceived in order to provide a total axial stroke of 20 mm, also assuring a transversal stroke of ±2 mm between the inlet and the outlet flange with respect to the nominal position.

The RF-bellows are used for guaranteeing the electrical continuity along the profile of the beam pipe for any value of the displacement between the inlet and the outlet flange, within the required axial and radial strokes. At this purpose suitable sliding contacts are used. The sliding contacts are composed of two parts: a sleeve (sliding metallic shield) and a group of spring fingers, aimed at maintaining the contact between the sleeve and the inner pipe. The sleeve is designed in order to minimize discontinuities of the profile (Fig. 2). The assembled system "spring fingers + sleeve" allows to maintain the electrical contact and the cross section of the profile for the whole transversal and axial strokes of the bellows. The additional contribute of CECOM on this task was the study and test of the Copper-Beryllium solution for these RF-sliding-contacts.

The standard bellows were designed in order to connect adjacent vacuum sections with the beam-pipe standard cross-section. In addiction, the following types of RF-bellows were produced:

- Bellows with special cross section different.
- Bellows assemblies with different cross-section between inlet and outlet flange (tapers).
- Assemblies in which a "OFHC copper beam-absorber" is included.

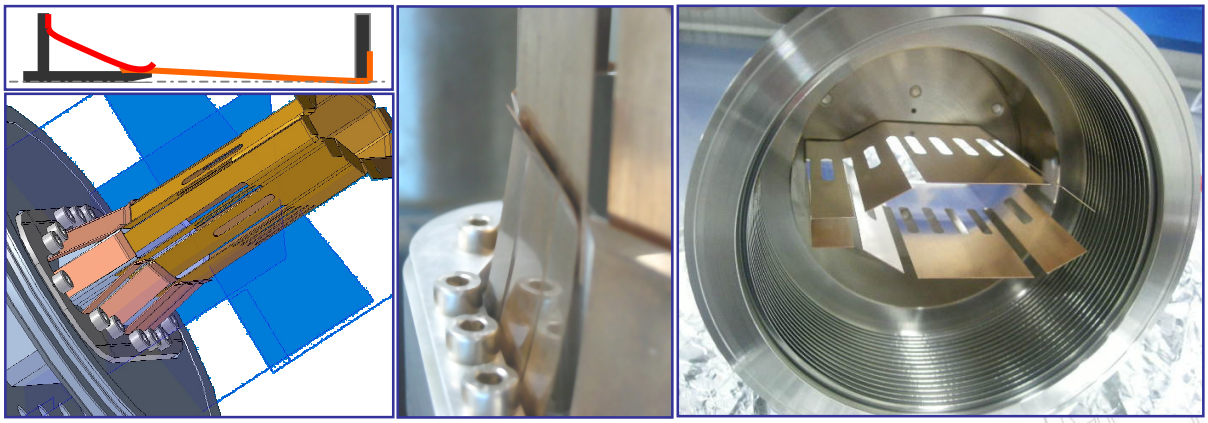


Fig. 1: Drawings and pictures of the "finger / sleeve" RF-coupling

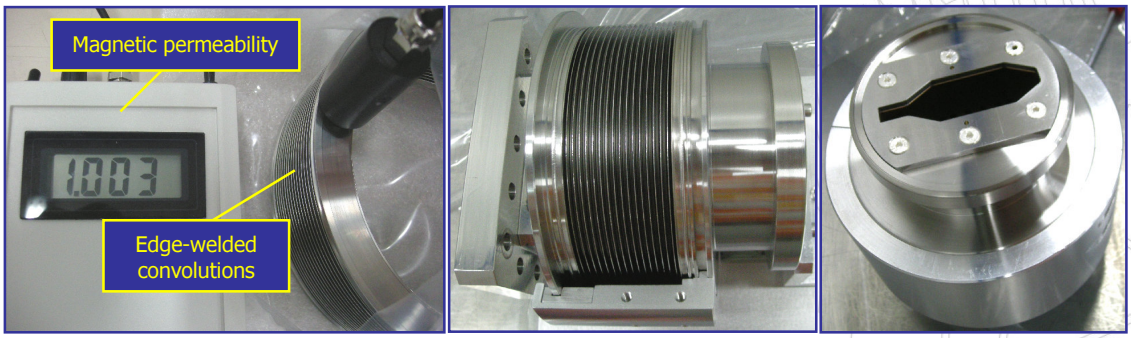


Fig. 2: Edge-welded bellows (check and assembling)

Summary

1 References

This product was produced, tested and delivered by CECOM for "CELLS" (Barcelona – SPAIN). The references of contact persons for this work are available under request.

2 CECOM activities

CECOM carried out the following activities:

- Review of manufacturing drawings:
  - Engineering design
  - Development of tools and equipments needed for the manufacturing)
  - Study and design of the RF-contacts solution with CuBe2 fingers and sleeve
  - Optimization of the design for machining and assembling
  - Optimization of the design for improving vacuum performances
- Purchase of raw materials and commercial components
- Manufacturing of components
- Assembling, welding and brazing
- Cleaning (for UHV application)
- Quality check:
  - Lifetime tests for the prototype
  - Dimensional check of components and assembly
  - UHV tests, including vacuum baking, outgassing rate measurement and RGA

3 Materials

The materials involved with the production of these devices are:

- Stainless steel:
  - AISI 316L ➔ bellows walls and convolutions
  - AISI 316LN ➔ CF flanges
  - CuBe2 (C17500 alloy) ➔ RF-contacts
  - Aluminium ➔ External cover (protection and hardware end-limits)
  - OFHC copper (CuC2) ➔ Beam absorbers

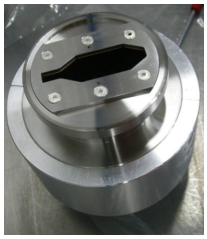
4 Manufacturing

The most relevant aspects related to the manufacturing of these components are:

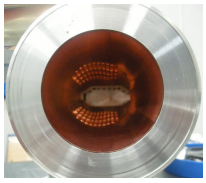
- Bending of the RF-shield
- Machining of the rectangular flat-seal flange (a roughness better than $0.2R_a$ was achieved)
- Preparation for welding and brazing
- Toolings for tests
- Design, development and construction of special tools for the assembling and welding process.

4.1 Standard RF-bellows

These bellows are designed for maintaining the shape of the beam-pipe profile along the movable connections between adjacent vacuum sections.
The locking plate for the RF shield is designed and constructed in order to act as "SPIGOT" coupling, with the goal of guaranteeing the continuity of the profile, which is necessary for preventing RF resonances, that would affect the correct path and shape of the beam. Split rings for the rotateable flanges are used in order to allow the installation of the bolts from the bellows side: this is a further improvement of the compactness of the component. The final tolerance on the relative position between the split rotateable ring and the SPIGOT-plate is 50µm. This SPIGOT coupling is typical of all types of bellows and tapers included in this production.

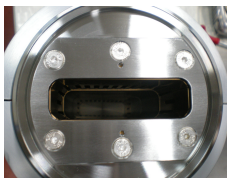


4.2 Special RF-bellows assemblies with beam-absorber

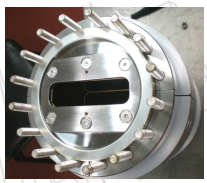


These special bellows include a tapered absorber block within the bellows assembly. The tapered block is made up of OFHC copper, and equipped with slots for allowing the pumping into the inner part, also providing the required electrical continuity (for RF performances).
Thanks to the CAM-programmed wire eroding machining, we had the possibility to obtain the tapered absorber from a unique piece of OFHC copper.
The joint between the tapered block and the adjacent components (flange, pipes and bellow wall) was obtained by means of the vacuum brazing process. The vacuum brazing of the two pumping pipes and of the two edge flanges was carried out simultaneously, during the same vacuum thermal treatment.

4.3 RF-bellows with special inner profile



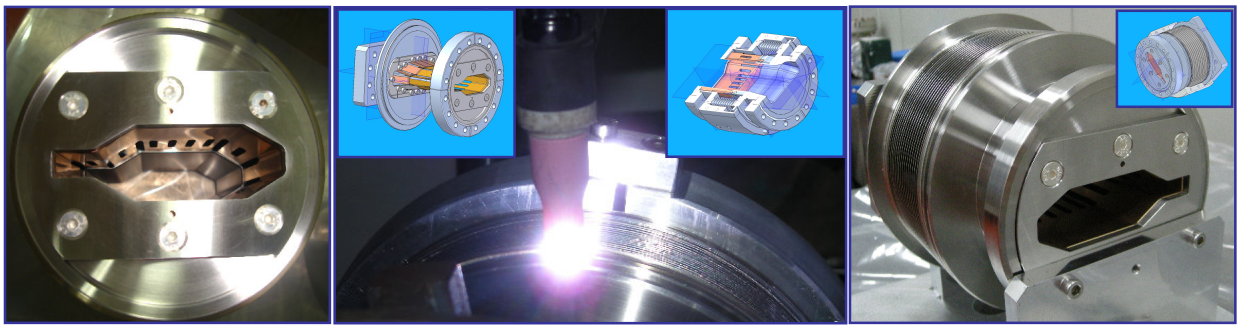
In order to allow the coupling between components of the storage ring characterized by a inner profile different from the standard beam-pipe cross-section, suitable special bellows are used. In particular the BLW3-type bellows are installed close to the sextupole magnets.

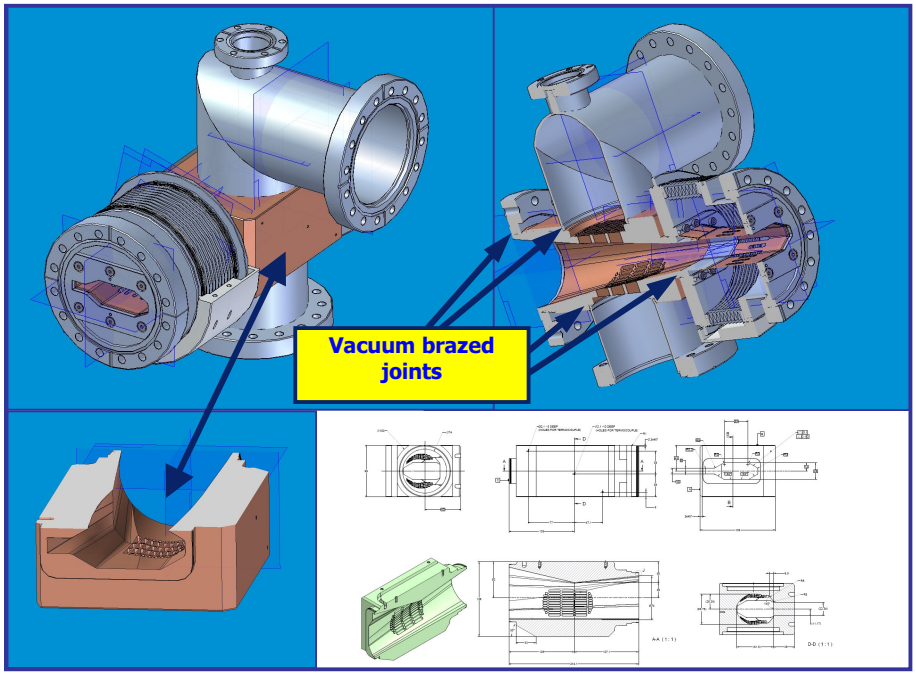


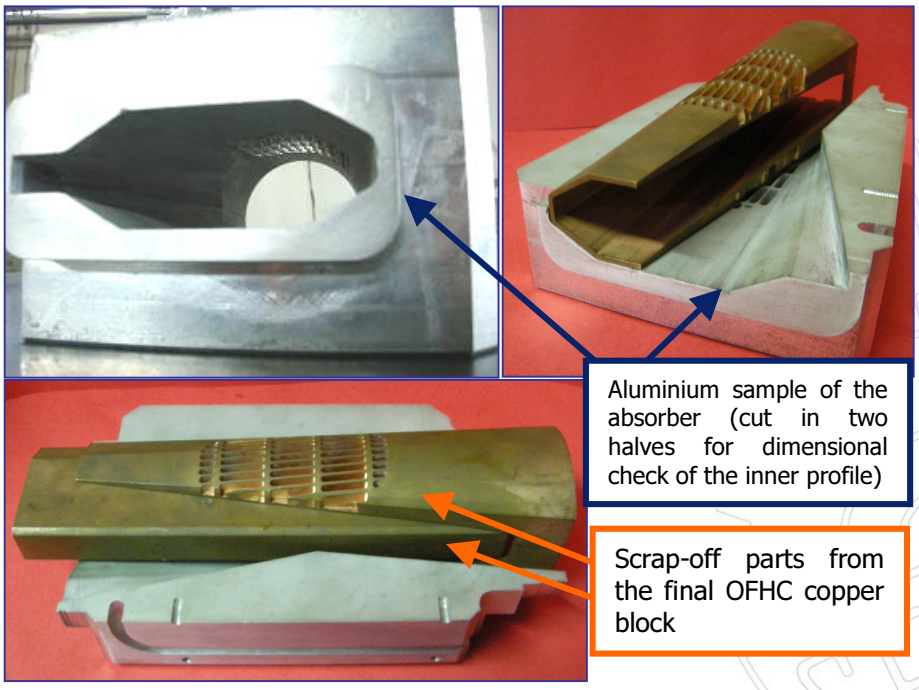
4.4 RF-bellows assemblies with tapered transition

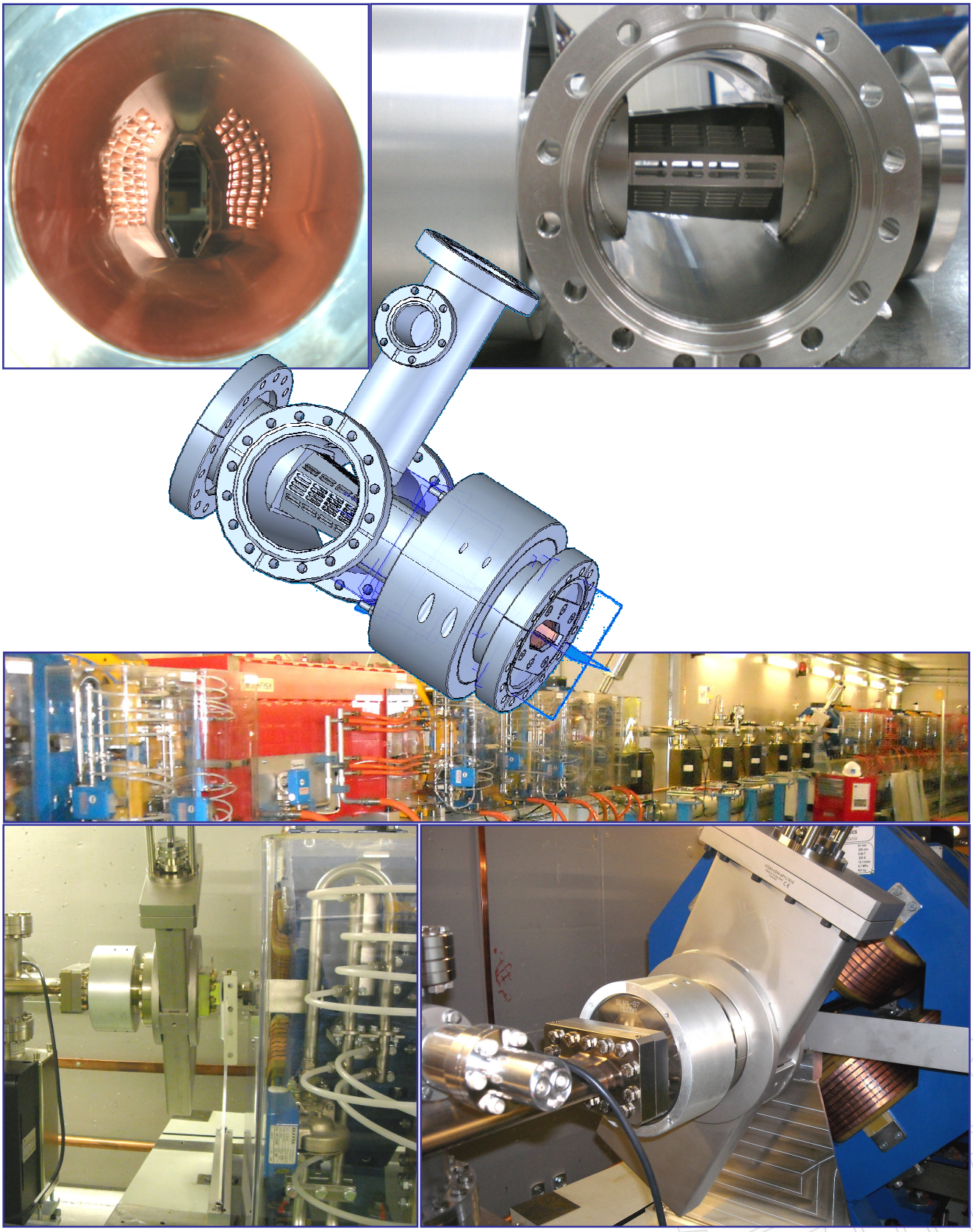
Some special bellows includes a tapered stainless steel chamber, equipped with slots for the pumping if the inner part. The components adjacent to the tapered chamber (pipes, flange and bellows wall) are assembled by means of TIG welding.

5 Pictures and drawings









6 Vacuum performances (UHV)

All the delivered components were successfully vacuum tested in CECOM, according to the following acceptance limits:

- Operating pressure: < $5 \cdot 10^{-10}$ mbar
- Leak tightness: < $1 \cdot 10^{-10}$ mbar·l/s
- Specific outgassing rate: < $1 \cdot 10^{-12}$ mbar·l/(s·cm^2)
- RGA: overall hydrocarbon contamination < 1% of the total pressure

Some reference pictures and results are shown below.