T4CM Design and R&D Status at Pisa

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Outline:

- T4CM mechanical drawings.
- R&D in progress:
  - New type of seal for cavity flanges.
  - Transition between SS and Ti.

T4CM Drawings:

- Almost complete set of 2D construction drawings completed.

thanks to Assia Soukhanova (JINR-Dubna) that worked for us last year in Pisa

- List of available drawings:
  - Vessel_cryostat_weldment (26 drawings)
  - Coldmass_sprt_cover (4 drawings)
  - Coldmass_supp_fixed_assy (11 drawings)
  - Coldmass_supp_sld_assy (11 drawings)
  - Cold_mass_assy_T4CM:
    - T4CM_HGR_pipe_assy:
      - Support_Post_assy (15 drawings)
      - HGR_pipe_wldmt (19 drawings)
    - 80K_Heat_shield_assy (9 drawings)
    - 8K_Heat_shield_assy (24 drawings)

T4CM Drawings:

- Small components of “Cold_mass_ assy” and all the internal parts connected to the cavities are missing.

- Very useful exercise to:
  - gain detailed understanding of the whole project;
  - get good understanding of tools for generation of 2D drawings from 3D
    - ready for fast redesign based on future version of the 3D model.
    - ready for integration with DESY-EDMS.

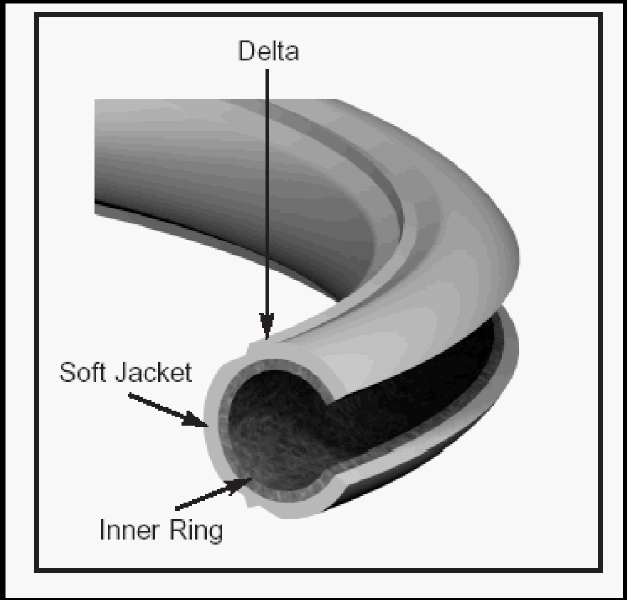
R&D on cavity flange design

- Investigate the possibility to use a new type of seal with low setting load to minimize the flange dimensions.

- We have chosen to use for our tests :
  - Garlock Ultra-Flex seals.

Garlock Ultra-Flex seal

- Designed for semiconductor, high purity, high vacuum applications.
  - He leak rate < 1x10-9 cc/sec
  - 10% load of standard metal seal
  - Good for cryogenic application
  - No out-gassing
  - Flange surfaces stay clean
  - Not magnetic
  - Al coating does not peel off



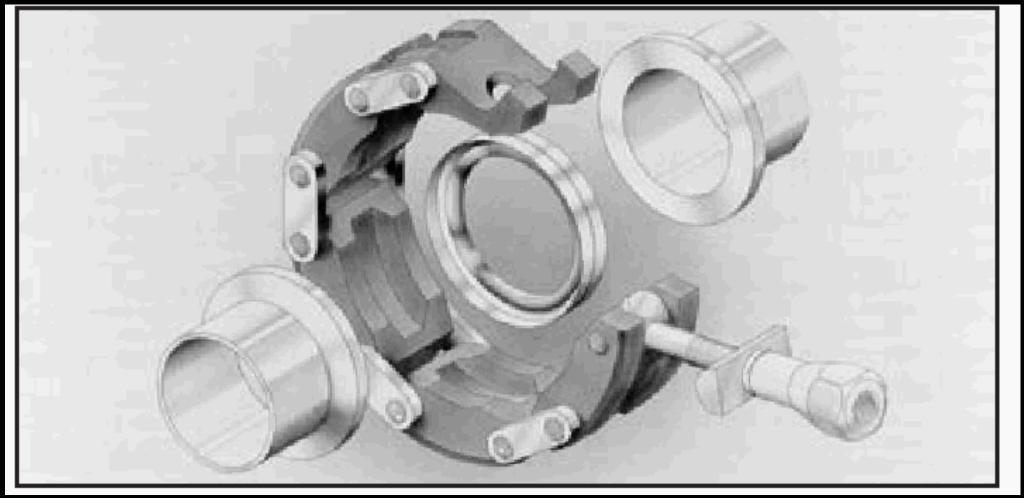
Operating principle:

The Ultra-Flex o-ring relies on the deformation of the material at the Delta under the compression to fill in the micro-surface irregularities. The deformation of the soft material layer is plastic (permanent). Load of the aluminum jacketed seal is 16-30 N/mm.

Garlock Ultra-Flex seal

- The design without the spring inside (unlike the standard Helicoflex gaskets) allows cleaning up to class 10 clean room standards.
- The low setting load allows the use of a quick connection clamp.

(e.g. see picture with conical flanges).



Cavity flange R&D
Status and plan

- O-rings received last week
  - Custom made → about 3 mo delivery time.
- Preliminary tests planned:
  - Repeat the tests made for the diamond shape gaskets in Milan:
    - Compression test at room temperature
      - Measure leak rate vs. compression force
    - Check leak rate at LN_2
      - Use compression force optimized at room temperature
  - Measure particulate release
    - Sensitive particulate probes available in Pisa.
- If successful:
  - Design new flange with low setting force using a lighter connection system.
  - Repeat basic tests with new design.

R&D on SS/Ti transition

- Investigate the Stainless Steel/Ti transition to reduce the cost of Ti components in the T4-Cryomodule design.

- Potential applications:
  - Make SS He tank
  - Make SS II-phase line
    - Connection between two Cryomodules.
- Advantages:
  - The Ti price is about three times the SS.
  - Ratio for bellows is even higher.
  - Simpler in situ welding.
- Concerns:
  - Joint strength, fragility and reliability at room/cryogenic temperature.
  - SS magnetization if used close to the cavity.

SS/Ti transition

- We study three welding techniques :
  - Brazing with an intermediate material.
  - Laser welding.
  - Explosion welding.

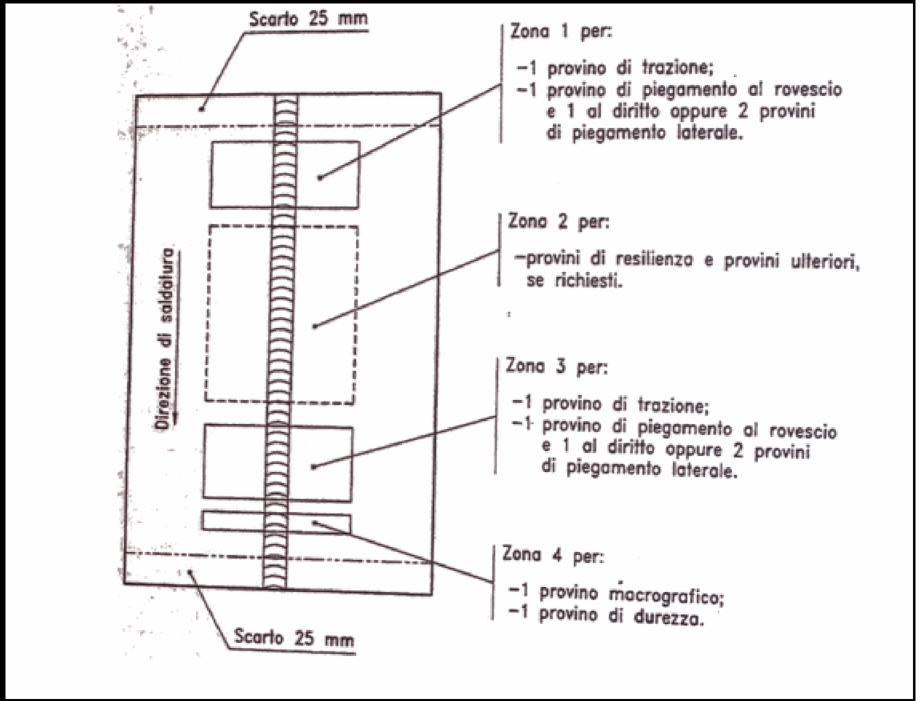
Brazing

- The intermediate material is silver.
- Procedure:
  - A) deposit the silver on the Ti with the standard TIG technique
  - B) braze the SS to the silver with a silver brazing alloy.
- This procedure is commonly used in chemical plants.
- Preliminary tests using SS and TI tubes at company in Padova (CO.ME.C s.r.l.).
  - Joints look solid, but there are external visible defects (sample).

Brazing

❖ Planned systematic tests:

- qualify the process with the UNI procedure for welds using standard flat specimens (butt weld joint on sheets).
  - Traction, bending, hardness, micrography
- test with tubes
  - metallographic analysis of joints
  - leak rate at room and cryogenic temperatures.



Laser welding

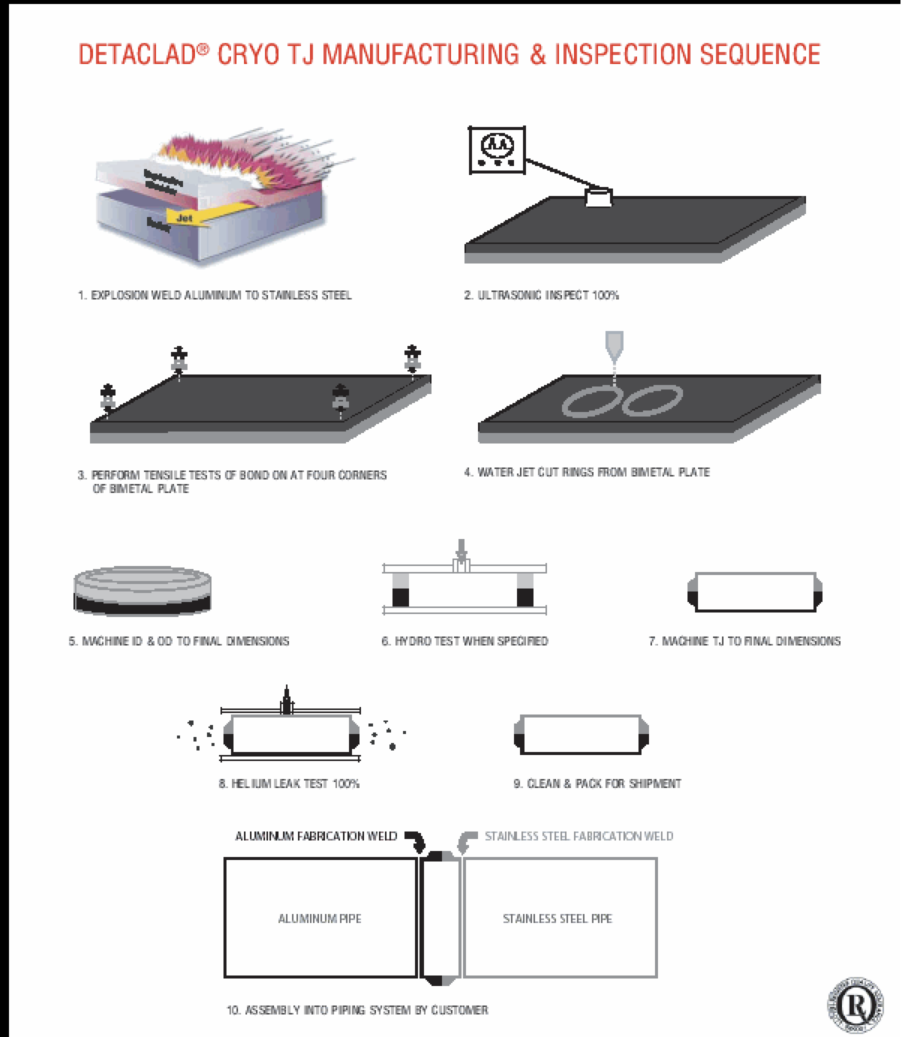
- Use laser technique on a single overlapped joint
  - Ti layer on top of SS layer.
- Use Nd:YAG laser in pulse mode with a high power
  - the idea is to try to reproduce locally the concept of the explosion welding technique.
- Working with TRUMPF producer of laser welding machines
  - Waiting for the production of simple flat sheet samples according the UNI procedure.

Explosion welding

- It's a well established industrial welding process commonly used to welds between different materials.

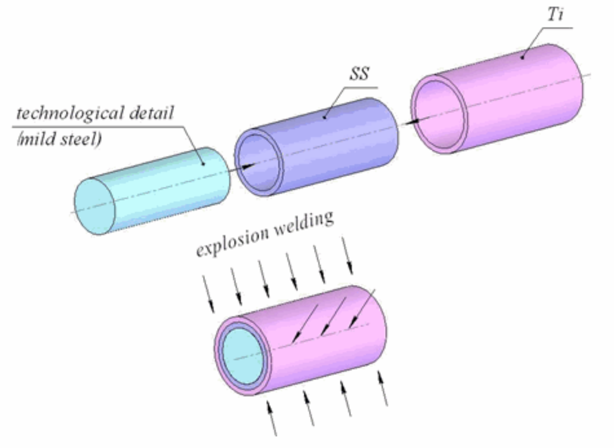
- Major advantage
  - "cold welding" process which is free of the physical, mechanical, and thermal limitations of traditional welding process.

- It's the standard way to obtain the common "Detacouple" Cryogenic Transition Joint between Al and SS (see picture).

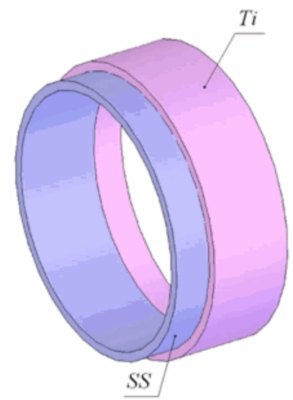


Explosion welding

- A collaboration between JINR (Dubna) – INFN/ Pisa about this item started with the help of proof. Budagov.
  - The colleagues of JINR designed and worked with Russian company to produce the first examples of these Ti-SS joints using explosion welding.
- Metallographic analysis made:
  - macrography
  - microanalysis
  - measurement of microhardness.
- He leak tests at room and nitrogen temperatures made.

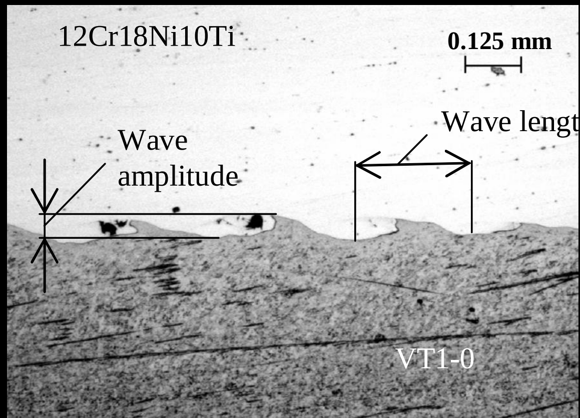


Pic. 1. The applied scheme of explosion welding process



Explosion welding

- Detailed documentation available.



- Producer conclusions:
  - It’s possible to produce reliable Ti/SS tube joints using this technique.
  - He leak rates at room and LN2 temperatures < 1x 10^{-9} atm cc/sec .
  - Metallographic research showed that the quality of the joint is very high.
- The next steps:
  - Make more samples with different type of material.
  - Perform complete set of tests.

Issues for discussion

- Cryomodule design:
  - What needs to happen before 3D model is deemed adequate to restart generating 2D drawings.
  - What is the development strategy until EDMS becomes really usable.
  - Need a schedule update to plan all above.

- R&D:
  - Should discuss where to focus the efforts of the international design group.

Conclusion

- The work about the 2D drawings is almost finished and we are ready to start working using EDMS whenever available.

- Several R&D activities started.