ILC International Linear Collider

INFN Istituto Nazionale di Fisica Nucleare

Low compression force seal for cavity flanges

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Outline:

- Overview
- Tests made
- Next steps
- First conclusions

- NB. R&D still in progress

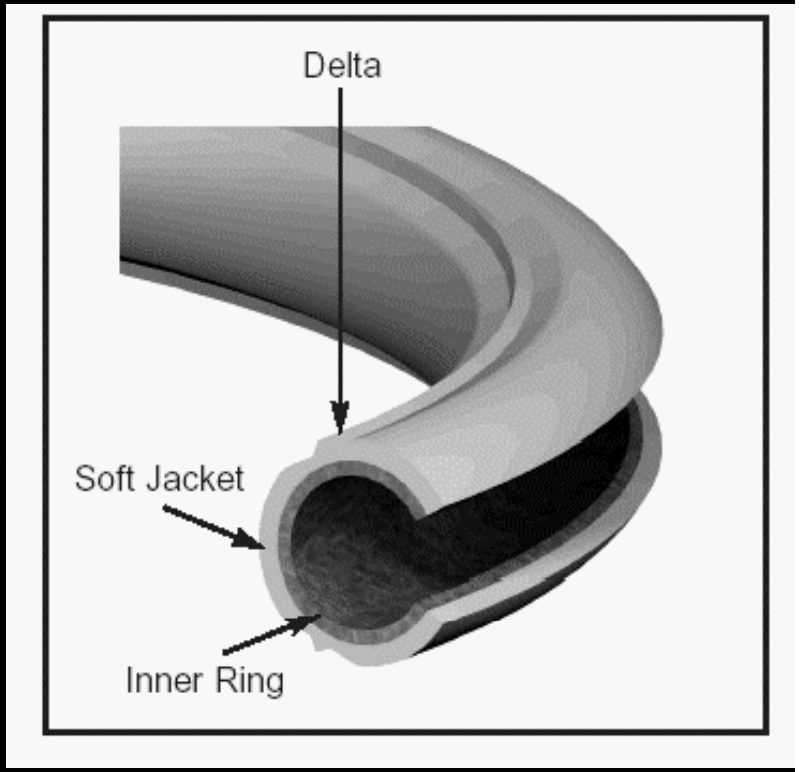
R&D on cavity flange o-rings

- Investigate the possibility to use a seal with low setting load:
  - minimize the flange dimensions
  - reduce distance between cavities
  - simplify the fastening system

- Tests performed on **Garlock Ultra-Flex seals**

Garlock Ultra-flex gasket

- General specs:
  - Inner ring - Inconel (X750)
  - Ext. jacket - Aluminum (A5)
  - Inner/outer diameter: 99.6 x 106.1 mm
  - Cross- section outer diameter: 4.65 mm
  - Compression gap: 0.55 mm
  - Seal working force Y2 = 26 N/mm
  - Total contact force = 8401 N



Summary of tests:

- Materials:
  - 10 Garlock Ultra-Flex gaskets custom made to match ILC design
  - Test flanges similar to those used at LASA-Mi
    - to allow comparison with standard o-ring
- Tests:
  - He-leak tests on Ultra-Flex o-rings at Pisa and Milan-LASA
  - He-leak tests on standard Al diamond shape at Pisa
  - Pollution contamination measurements in Pisa clean rooms.
    - Developed testing technique
    - Made measurements with diamond shape gaskets and Ultra-flex gaskets

He-leak tests in Pisa on Ultra-flex gaskets

- Tests at room temperature and 77 K
- Use stainless steel flanges and NbTi.
- Use several configurations of bolts and torques applied :
  - 12 bolts with 5 or 16 Nm
  - 6 bolts with 20 Nm
- Measurements in liquid nitrogen and after several thermal cycles from 77 to 300 K.

RESULTS:

- With 12 bolts or 6 bolts with the SS flanges or SS/NbTi optimum seal at room temperature (leak rate < 10^{-10} mbar *l /s with a vacuum of the order of 10^{-3} mbar).
- At cryogenic temperature some leaks (3.4 x 10^{-8} , 8.4 x 10^{-6} mbar *l /s).

He-leak tests in Pisa on diamond shaped gasket

- Tests at room temperature and 77K with plastic bag around the flanges.
- Pisa stainless steel flange and the NbTi blind flange (CuNiSil nuts).
- Recommended torque value on screws (24 Nm) (12 bolts used).

RESULTS:

- Optimum seal at room temperature (< 10^{-10} mbar *l /s).
- At cryogenic temperature :
  - He-leak rate = 2 x 10^{-8} mbar *l /s

Pictures of He-leak tests

He-leak tests at LASA on Ultra-flex

- Tests at room temperature and 77 K following the LASA procedure.
- Stainless steel flanges made in Milan
- 12 bolts mounted
- Precise evaluation of applied torque and correlation between leak-rate and flange distance.
- New measurements during thermal transitions.

RESULTS:

- Min. torque to have no He-leaks at room temperature = 2 Nm (against the 24 need for standard gasket)
- Optimum seal at **both** room temperature and 77 K (< 10^{-10} mbar *l /s).
- During the thermal transitions we noticed some peak of $1x10^{-6}$ mbar *l /s leak rate.

Pictures of He-leak tests at Mi-LASA

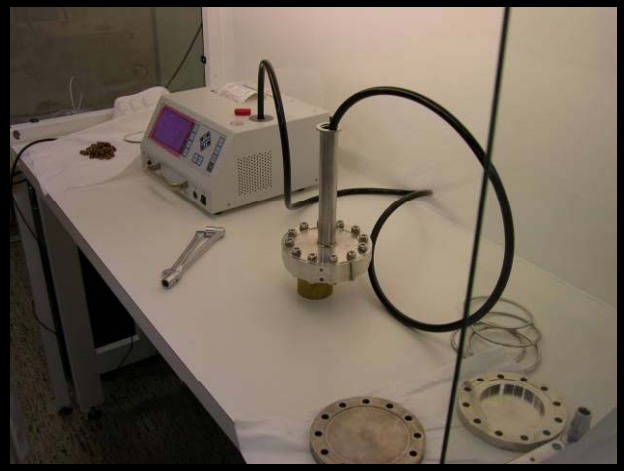
First pollution contamination measurements in Pisa

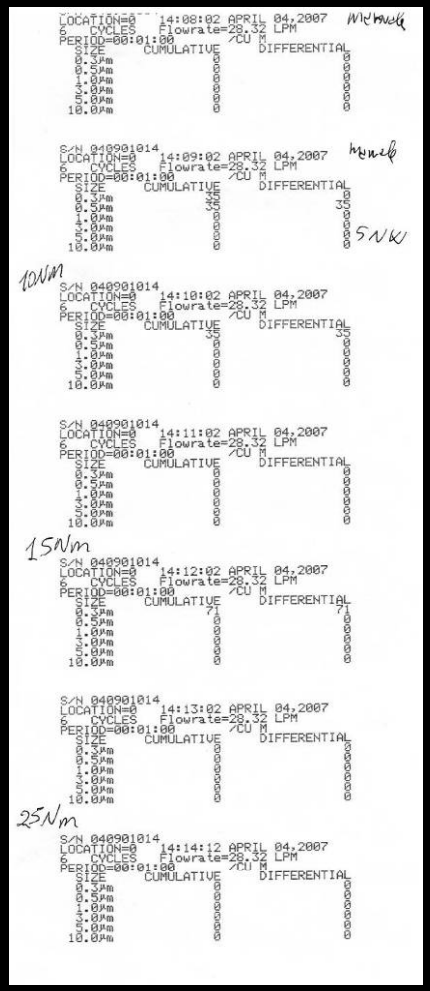
- Made measurements in Pisa class 100 clean rooms
- Set particle counter probe inside the flange pipe and check air pollution inside during flange assembly and tightening of the bolts.

RESULTS:

- No particles detected if o-ring is preloaded before screws insertion
- No particle detected with diamond shape gasket (with SS flanges or SS/NbTi).
- Some particles detected during the squashing of Ultra-flex gasket.

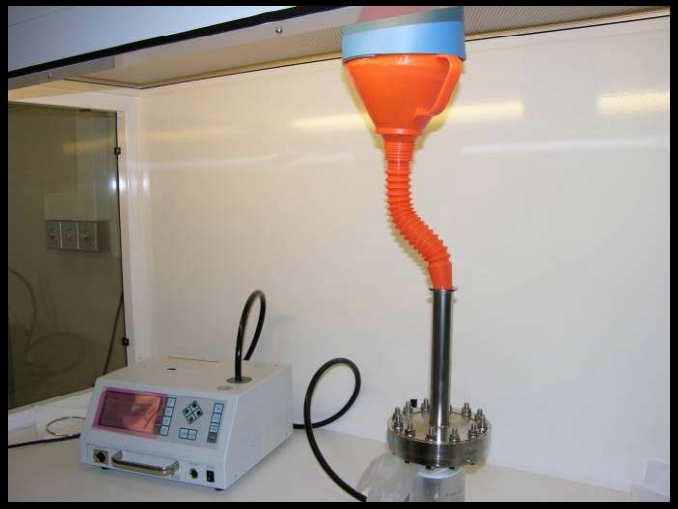
Pictures from first pollution contamination measurements in Pisa clean rooms





Second pollution contamination measurements in Pisa

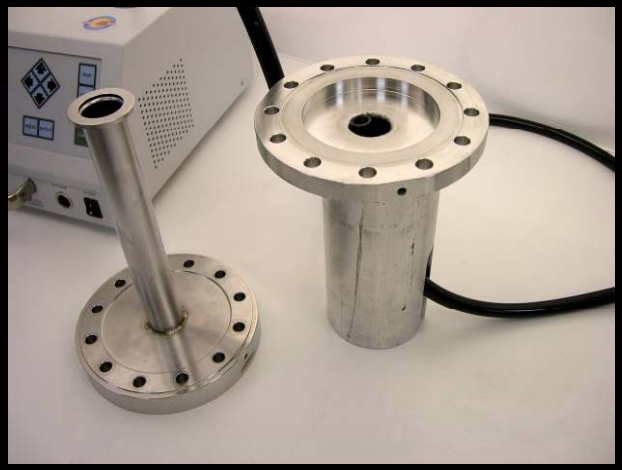
- We opened also the blind flange to have a flow of clean air inside during the flange assembly.
- We put the probe inside the tube of the bottom flange and the top tube in contact with the starting point of laminar flow inside the hood.
- We flow clean air inside the flanges for all the night before the final tightening of the screws.



RESULTS:

- This time no particles detected using both Diamond shaped and Ultra-Flex gaskets.

Pictures from second pollution contamination measurements in Pisa clean rooms

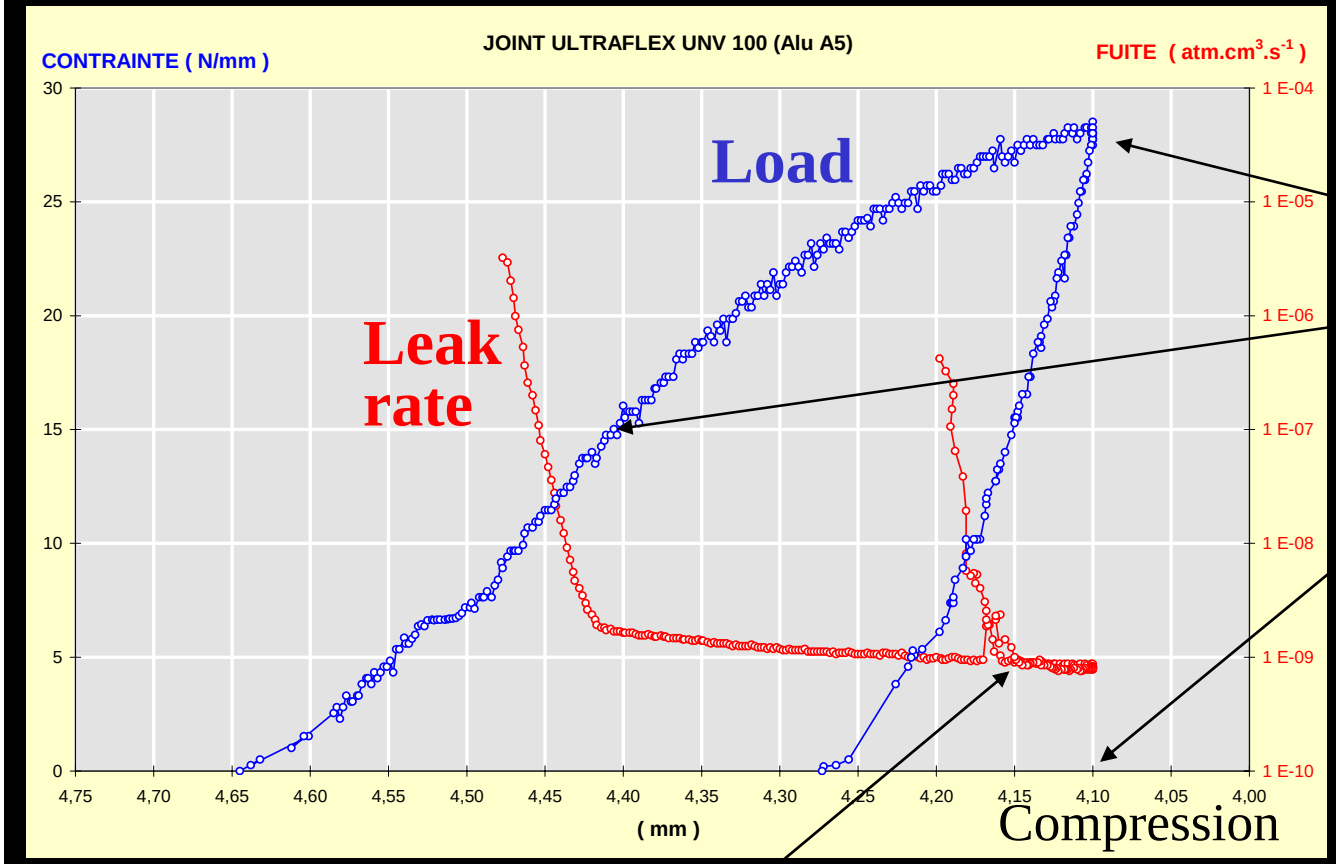


Summary of test results

- Ultra-flex gasket:
  - No leaks at room temperature
  - Some leaks at 77K detected during Pisa tests but no leaks found during Milan tests at same temperature.
  - Low sealing force (2 Nm – 6 Nm).
  - Leaks detected during thermal transitions in Milan tests
  - Some particles detected if the volume air inside the flanges is closed.
  - No particle detected if we flow clean air inside the flanges during the screw assembling.

- Garlock company contacted to have more information

Experimental plot from Garlock:



Optimum linear load:
Y2 = 28.5 N/mm

- Min linear load to obtain request leak-rate:
  Y1 = 15 N/mm

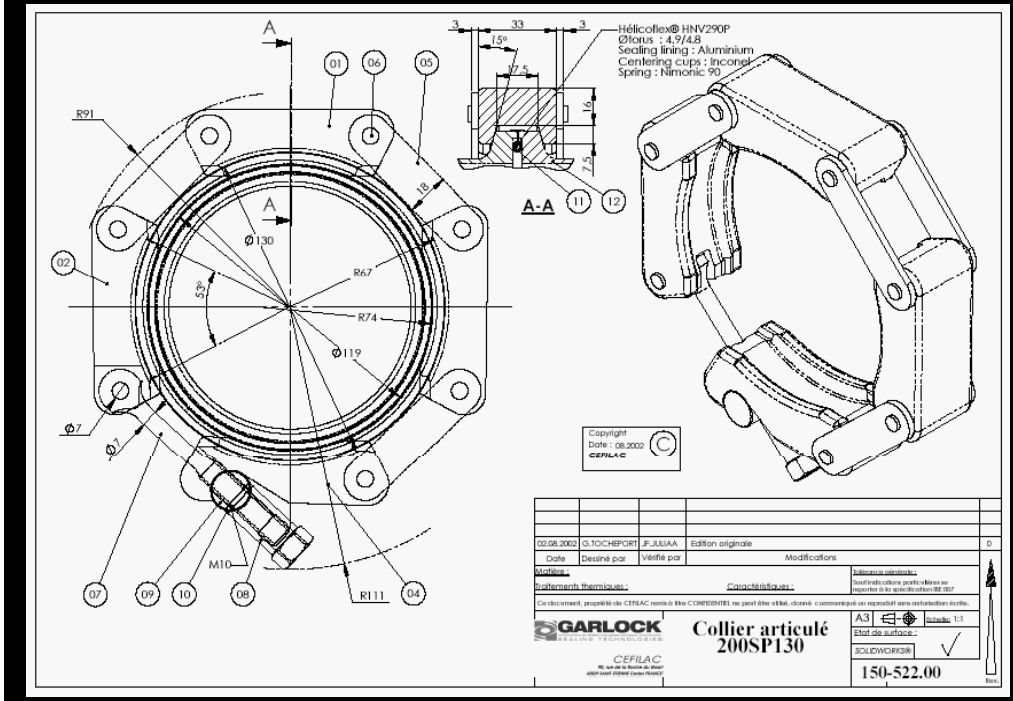
- Optimum compression value:
  E2 = 4.1 mm

Gasket spring-back = 0.05 mm
(similar cross section in helicoflex seal have a value of about 0.2 mm)

Preliminary conclusions:

- Ultra-flex gaskets have shown He leak-rate at room temperature and 77 K adequate for cavity specifications (< 10^{-10} mbar *l /s)
- The gasket setting load is indeed very low
- Some problems noticed during thermal transitions and sometimes at LN_2 temperature
- With proper procedure no particulate detected during the assembly phase and the final tightening of the bolts
- Compression plot shows a very low spring-back (possibly related to the problems observed)
  - Will test new o-rings with larger transverse section and helico-flex (specially made)

Next steps:



- Will receive from Garlock a clamp as drawn
  - Will prepare two matching flanges to repeat all test made
- Will test also larger section gaskets and helico-flex