Summary report of the fundamental power couplers meeting at SLAC

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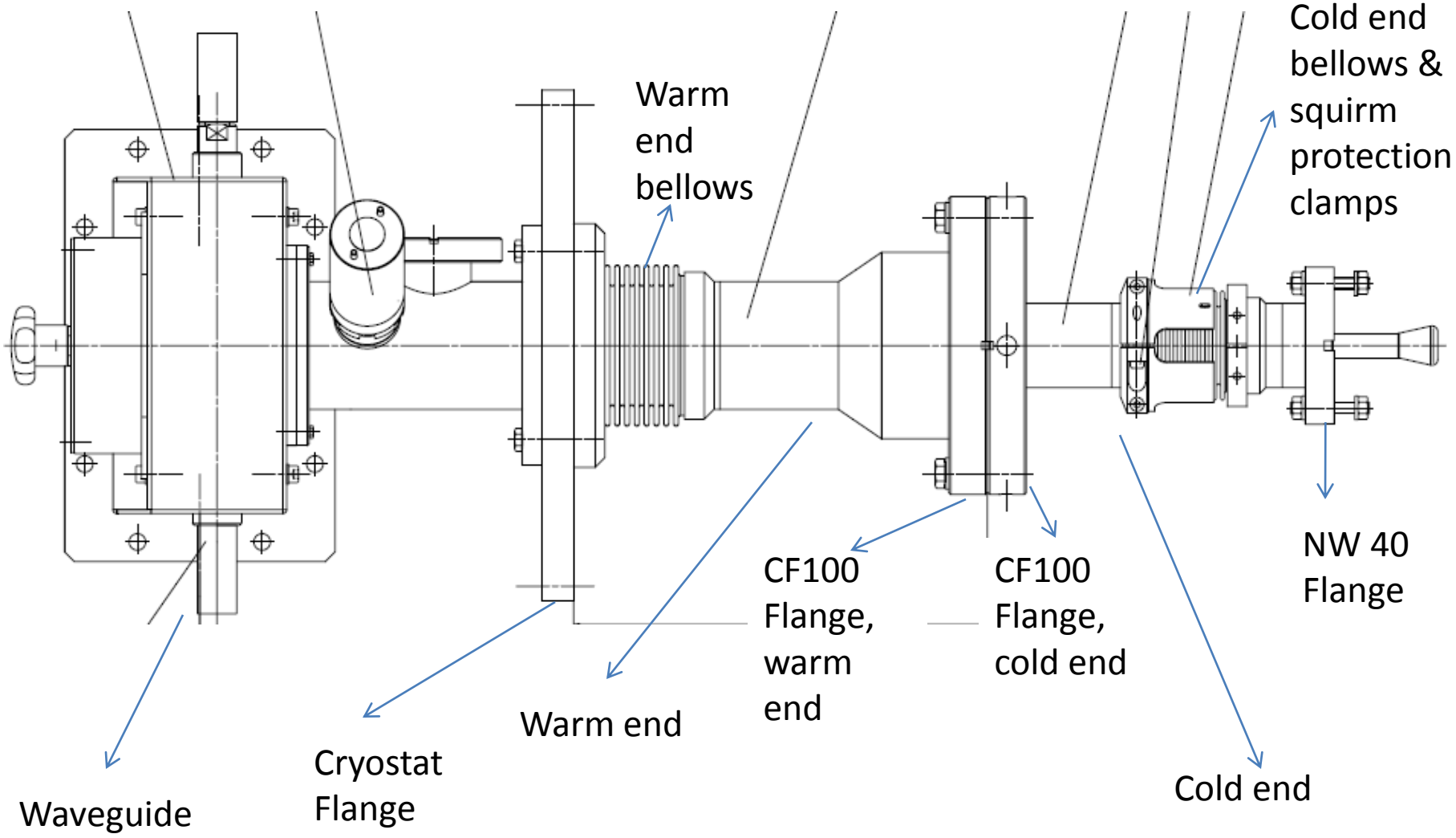
Outline

- Introduction
- 1.3 GHz Fundamental Power Coupler (FPC) problems encountered at FNAL
- Tour of SLAC FPC cleaning, assembly & high power conditioning infrastructure
- Minutes of the FPC problems meeting

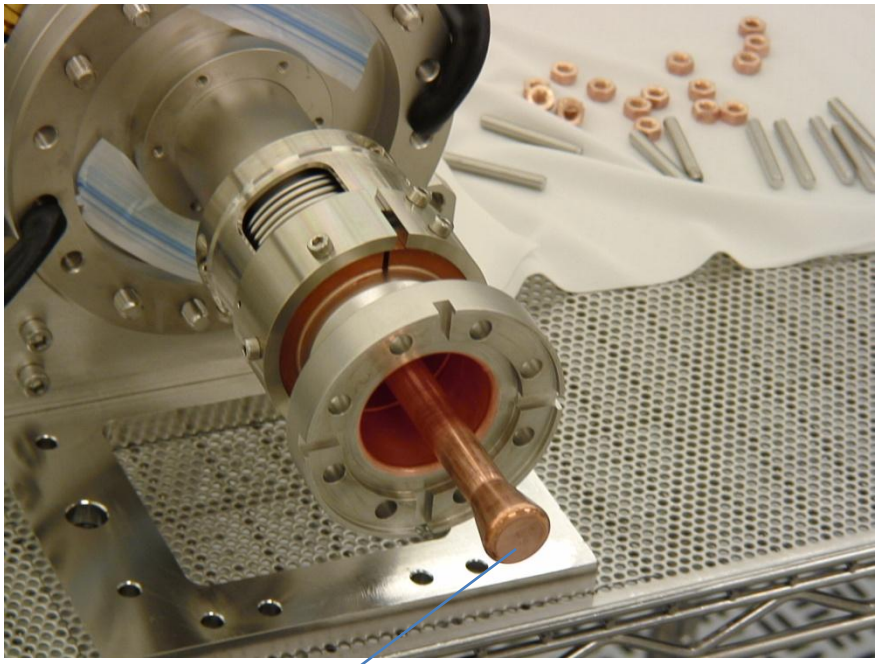
Introduction

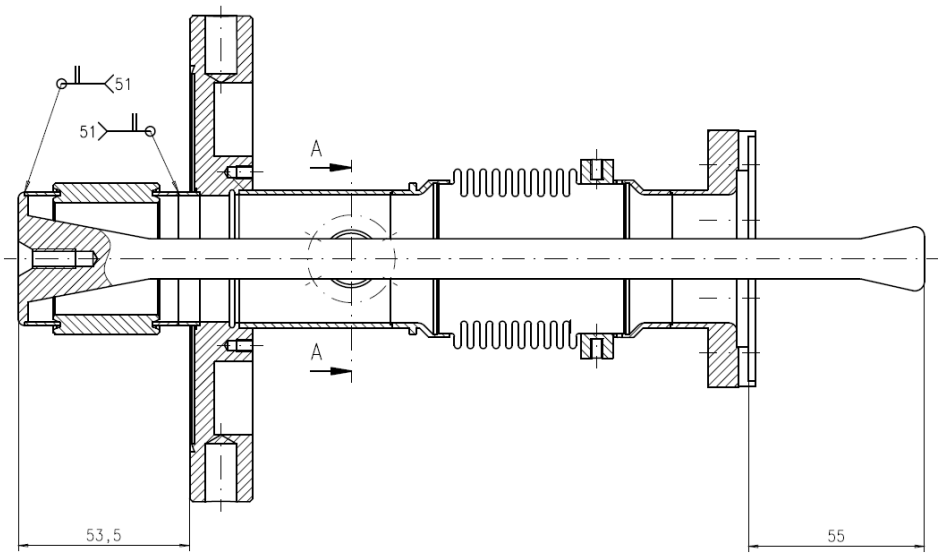
- 1.3GHz Couplers are fabricated by an industrial vendor, CPI at Boston:
  - DESY drawings are used, no FNAL drawings
  - CPI is a mostly proven vendor, they fabricated most of the TTF couplers for DESY.
  - CPI had couple of bad years where the quality of the couplers went significantly down; we were told by the DESY colleagues that CPI has recovered and back on track to be a reliable vendor.
- 12 couplers were initially purchased from CPI by FNAL. These couplers were purchased as an addition to an existing DESY order of couplers.
  - These couplers were fabricated during the bad quality era.
- Couplers went directly to SLAC for QA, cleaning, sub-assembly, high power conditioning, packaging and shipping to FNAL for use on 1.3GHz cavities
- FNAL receive the couplers as pairs at CAF:
  - Cold ends directly enter the CAF Class 10 cleanroom for assembly to a dressed cavity in preparation for horizontal test
  - Warm ends are stored in a dessicator under nitrogen purge
  - Waveguides and associated parts/hardware are stored in a cabinet

1.3GHz FPC


Warm end bellows
Cold end bellows & squirm protection clamps
CF100 Flange, warm end
CF100 Flange, cold end
NW 40 Flange
Waveguide
Cryostat Flange
Warm end
Cold end

Cold End Antenna Eccentricity



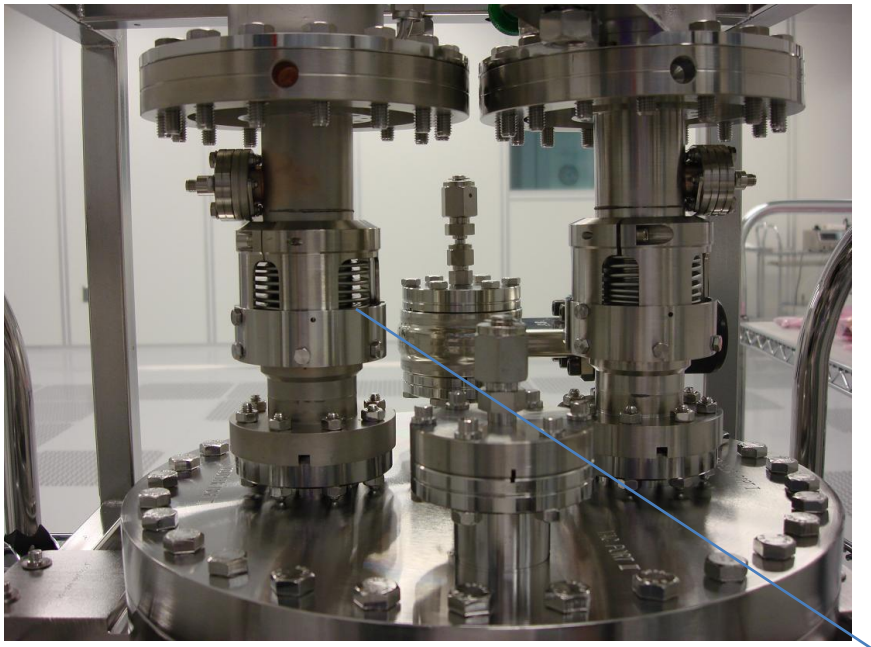


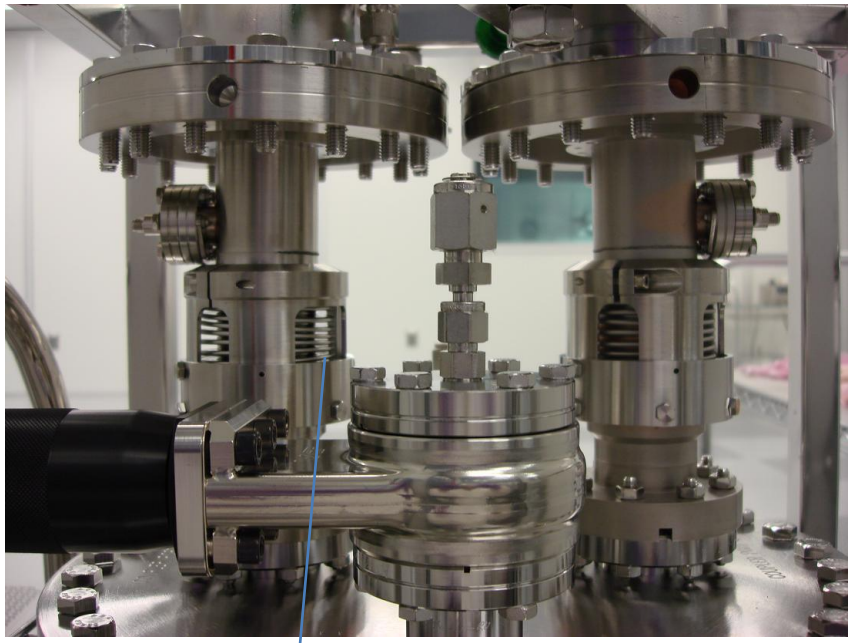
Cold end Antenna is not concentric to the NW40 flange during cold end assembly to the cavity in the CAF cleanroom

- Brazing of the antenna to the CF100 cold end flange is not done properly and/or
- Cold end bellows are twisted; NW40 flange and CF100 flange is not parallel

Cold End Bellows

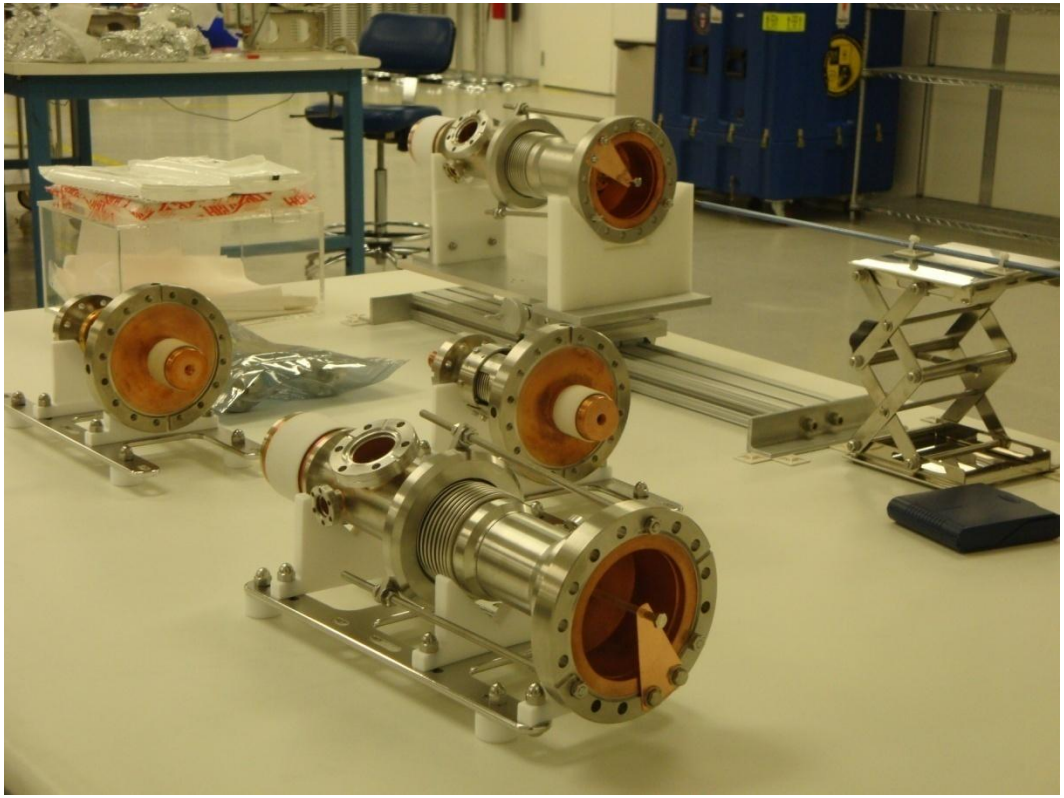
Cold End Couplers are received as pairs assembled on the conditioning stand, shipped under vacuum.





Twisted bellows, convolutions not parallel

Tour of SLAC FPC Infrastructure



Incoming QA: Class 100,000 cleanroom
Visual Inspection of the clocking of the flanges
Boroscope Inspection of the internals of the cold and warm ends
No mechanical measurements are done at SLAC
CPI does not provided any mechanical measurement data

Tour of SLAC FPC Infrastructure

Storage of the Coupler Components in a nitrogen purged dessicator after incoming QA (not in a cleanroom)

Tour of SLAC FPC Infrastructure

Couplers are moved into a Class 100 cleanroom where they are ultrasonically cleaned with a detergent

Tour of SLAC FPC Infrastructure

Couplers are moved to another Class 100 cleanroom adjacent to the ultrasonic cleaner room for rinsing, drying and assembly.

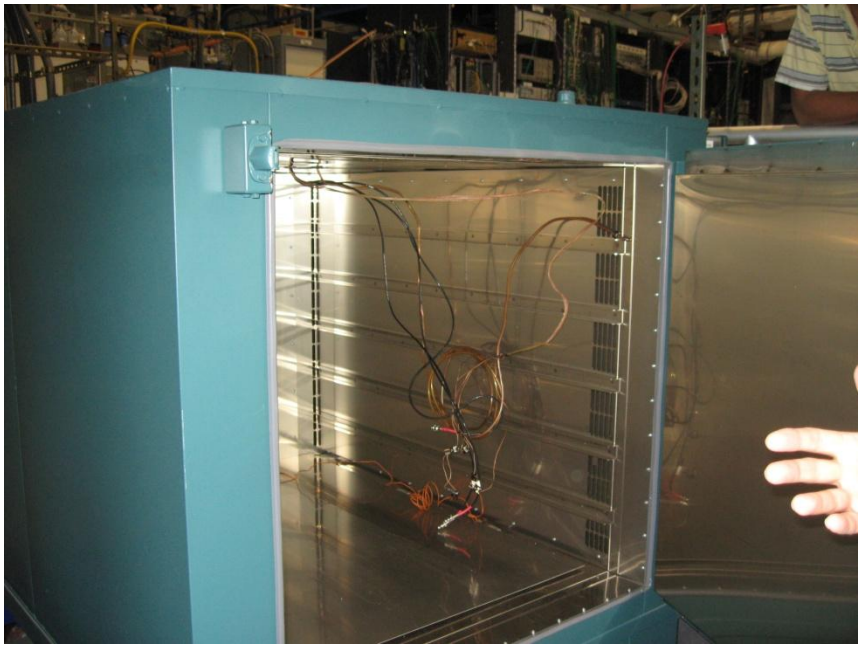
Cold end and Warm end sub-assemblies

Cold End to Warm end assembly on the high power conditioning stand

Tour of SLAC FPC Infrastructure

Assembled Coupler on the conditioning stand is leak checked in the Class 100 cleanroom

Tour of SLAC FPC Infrastructure



-Coupler on the conditioning stand is put into a box and the box is backfilled with nitrogen. Then the box is placed inside an oven for baking at 150 degree C.
-During baking, there is actively pumped vacuum inside the coupler.

Softwall cleanroom where the waveguide assembly is done to the coupler for high power conditioning

Issues Discussed

- Incoming QA, need for mechanical measurements of some critical dimensions
- Twist of the cold end bellows, need to support the CF100 cold end flange during assembly of the coupler onto the conditioning stand
- RF issues (Andrei will cover)

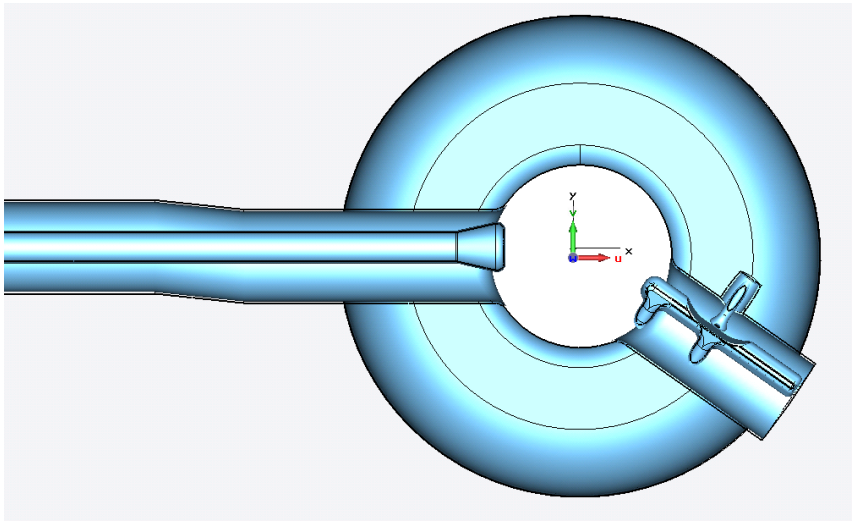
Schedule

- From the initial order of 12 couplers:
  - So far, we have received 8 (4 pair) couplers from SLAC
  - The 5th pair was being assembled in class 100 during our visit. We agreed to pull out from cleanroom for mechanical QC of the components
  - The 6th pair had an accident during 150C bake. The vacuum was lost inside the couplers, blanket nitrogen was not enough to eliminate the oxidation of the copper coating inside the couplers. SLAC will try to salvage the 2 cold ends from this pair.
- There is an open order of 10 couplers at CPI:
  - Delivery to SLAC: 2 by the end of June, 4 by the end of the July, 4 by the end of August
- 22 couplers are ordered as a part of the ARRA funds

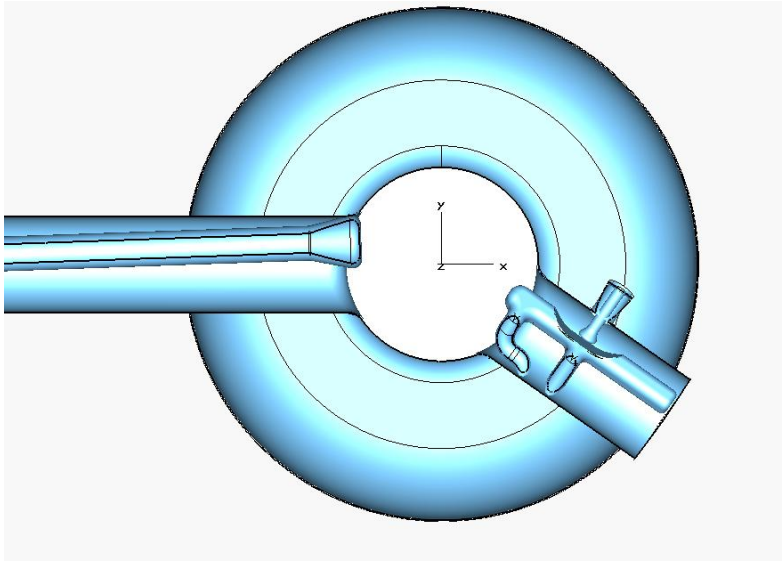
Summary

- SLAC will conduct a more detailed incoming QA including the mechanical measurements of some critical features.
- Cold end twisted bellows issue was understood and mostly eliminated by SLAC technicians. (A more permanent tooling rather than a counterforce wrench needs to be developed for repeatable results)
- A visit to CPI is planned by the end of May 2010

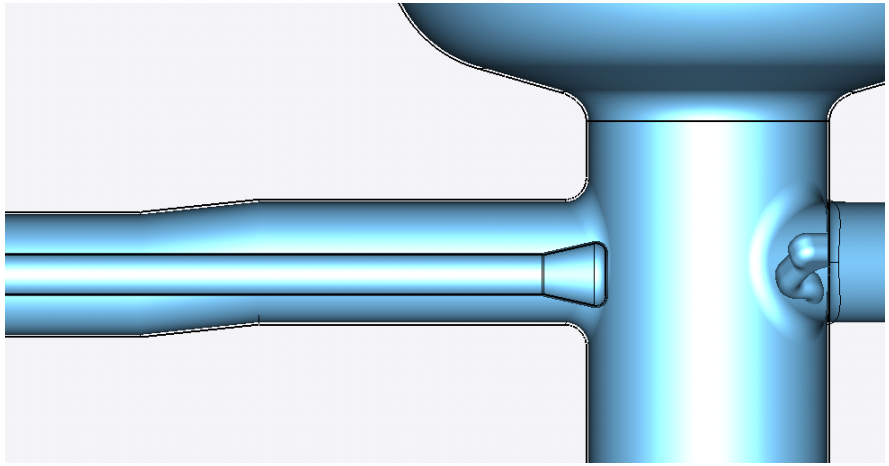
Vertical antenna shift



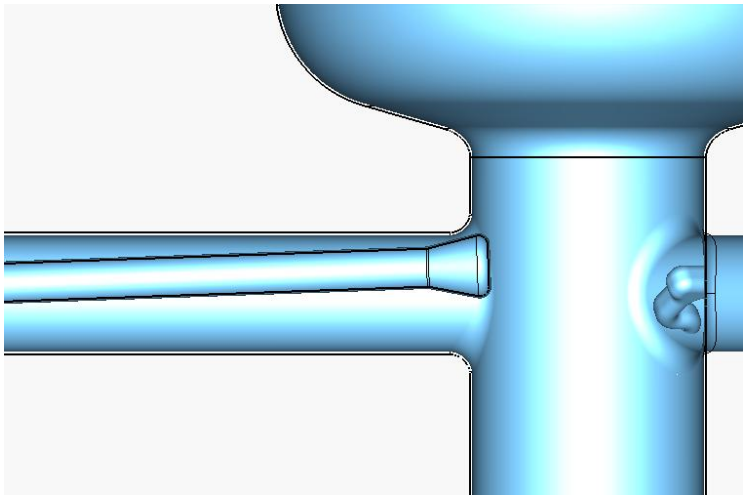
Vertical antenna tilt



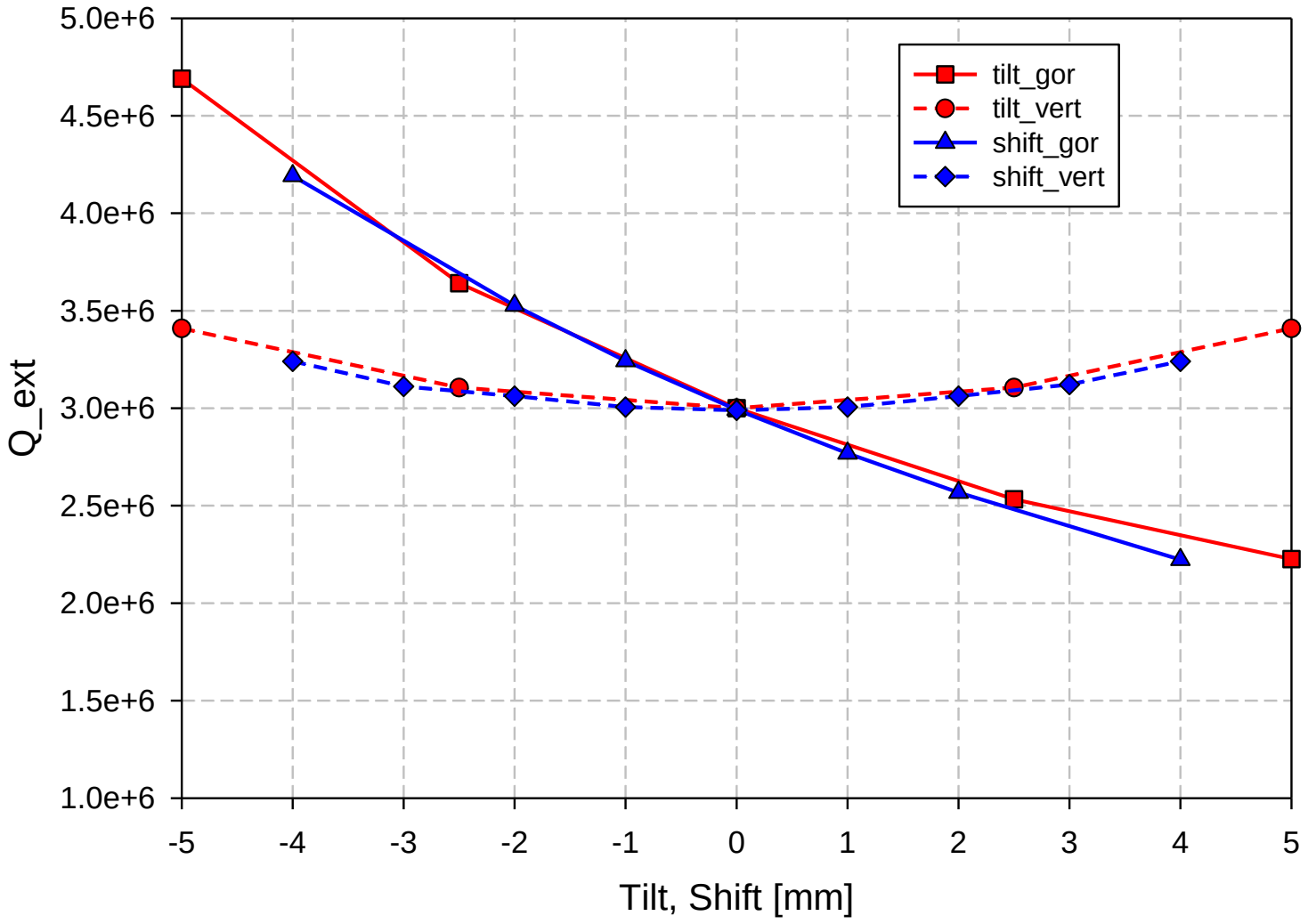
Horizontal antenna shift



Horizontal antenna tilt

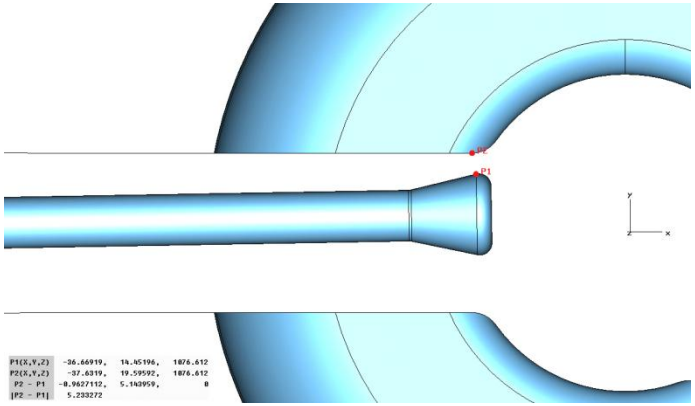


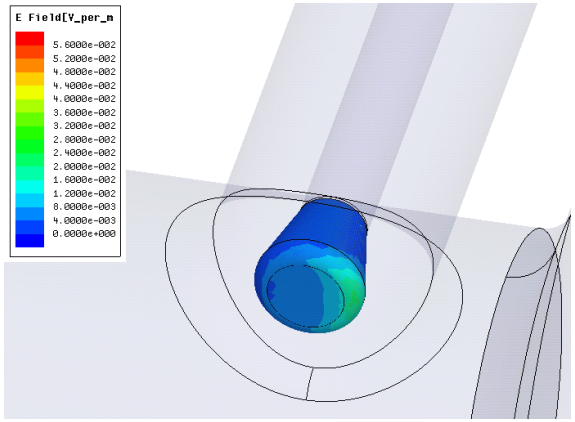
ILC-structure Q-external versus antenna displacements

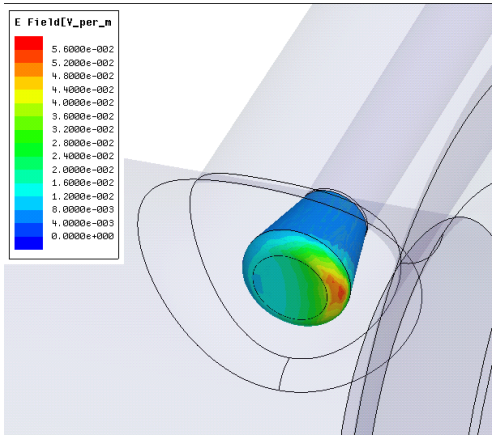


E-field

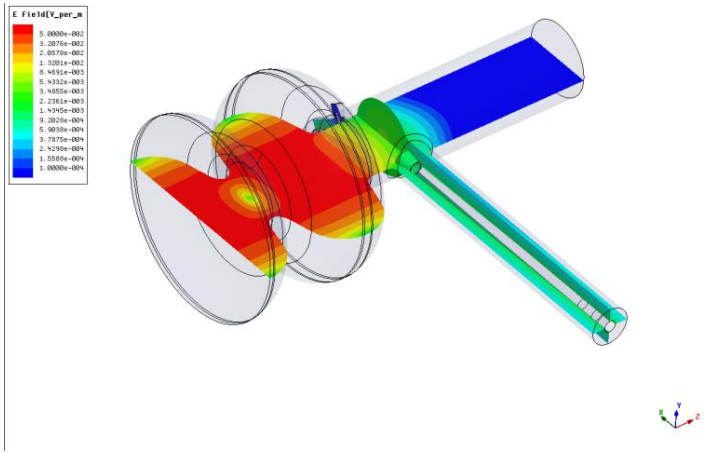
1 degree antenna tilt

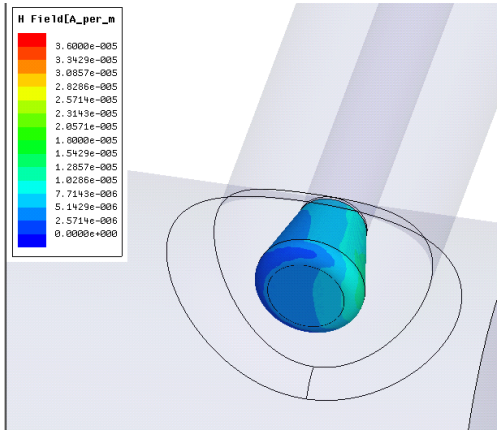


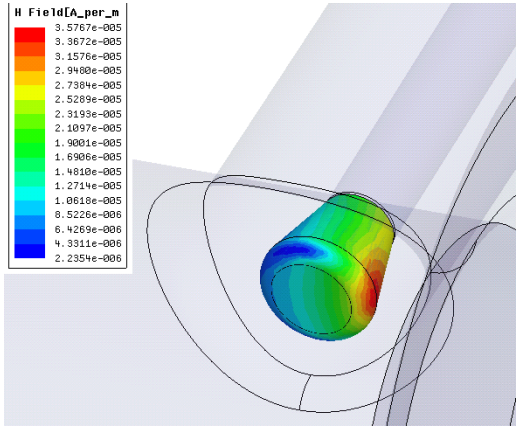




H-field







Conclusion

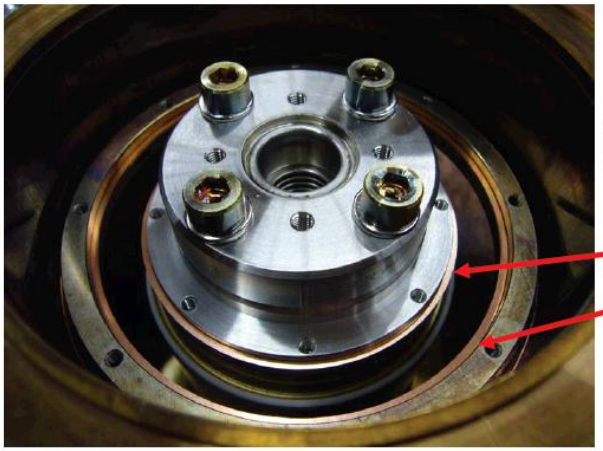
1. Both antenna tilt and shift demonstrates the same behavior .

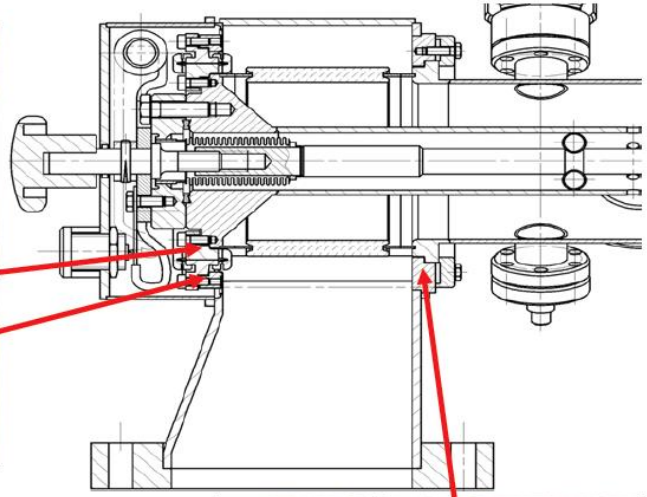
2. The most sensitive manufacturing parameter is a horizontal antenna tilt. Both vertical and horizontal antenna tilts regarding to the 70K flange should be within ± 1 deg (~ ± 5mm antenna tip shift)*.

3. The mutual cavity and coupler cold part flanges displacements allow up to ± 5 mm* non-concentricity (could be limited by other factors like a higher electric field).

* - assuming that 50% of the Q-ext change is a maximum allowed at the nominal antenna position.

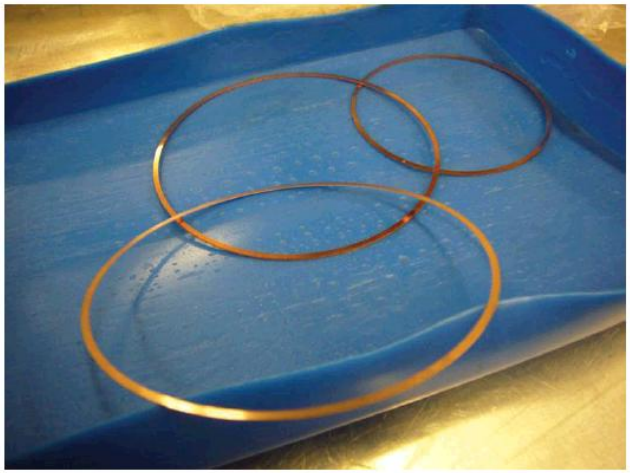
Solutions, RF seal between flanges





two seal solutions:

- thin spring like Cu Be seal, tested – OK
- soft copper seal, test just started



Window ceramic discoloration