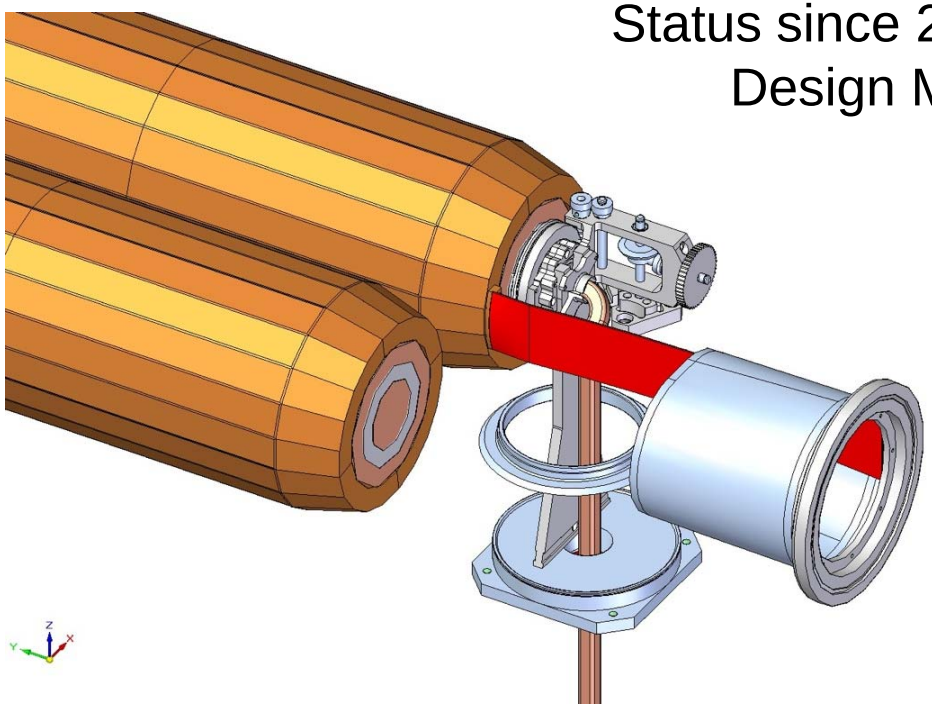
LARP

US LHC Accelerator Research Program

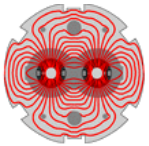
BNL - FNAL- LBNL - SLAC

LARP Rotatable Collimators for LHC Phase II Collimation

Status since 2008 Nov 7 Phase II Design Meeting with CERN



Gene Anzalone (CAD), Eric Doyle (ME-FEA, ret.), Lew Keller (FLUKA, ret.), Steve Lundgren (ME), Tom Markiewicz (Phys), Reggie Rogers (Mech Tech) & Jeff Smith (PD)

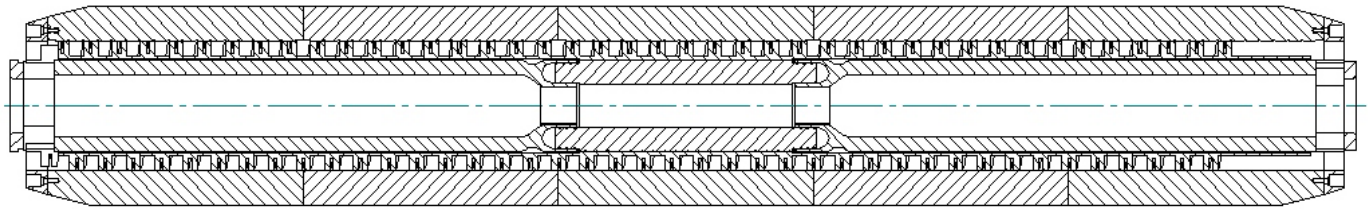


RC1 General Plan

- 3 jaw assemblies, each made of
  - Five ~20cm long ~14cm diameter Glidcop cylinders
    - precision bored to fit over mandrel/coil OD, then brazed
  - One ~1m long OFE Copper mandrel wound with ~16m length square 10mm OFE copper cooling coil with 7mm square bore
    - bored to 2mm clearance with respect to shaft OD
    - precision bored to mate and braze with hub of the shaft assembly
  - One ~ 1.1m long shaft assembly made of two hollow Molybdenum tubes with flexible fingers that will be brazed to a bored Glidcop "Hub"
- Best two jaw assemblies will be used for LHC test collimator
- Third jaw assembly and "RC-0" (Thermal test jaw completed June 2008) used (?) for destructive "robustness" testing in TT60

RC-1 Fabrication Status

- All Glidcop for jaws and shaft hubs ordered and due 12 Dec 2008
  - One length for 1st "center-hub" pre-delivered and center-bored
- 2 Moly half shafts (each with 2 broken fingers) at SLAC
- Remaining 4 moly half shafts promised for 12 Dec 2008
- First brazed shaft assembly being prepped NOW by SLAC with completion (braze half shafts to hub) expected early January 2009
- All 3 1m OFE Copper cylinders coarse "gun-drilled" ready for Mandrel fabrication
- 10mm x 10mm OFE Copper tubing in house
  - French & Japanese vendors contacted for CuNi tubing in 16m lengths
    - Not available
  - Finnish vendor would require large quantity "Mill Run"
    - Plan for this IF RC design chosen for LHC production (sell back unused copper)
    - OFE copper good enough for beam tests
- Complete drawing package for vendor quotation of all intermediate and final precision machining operations expected 5 Dec 2008 with "bid" chosen by end of year

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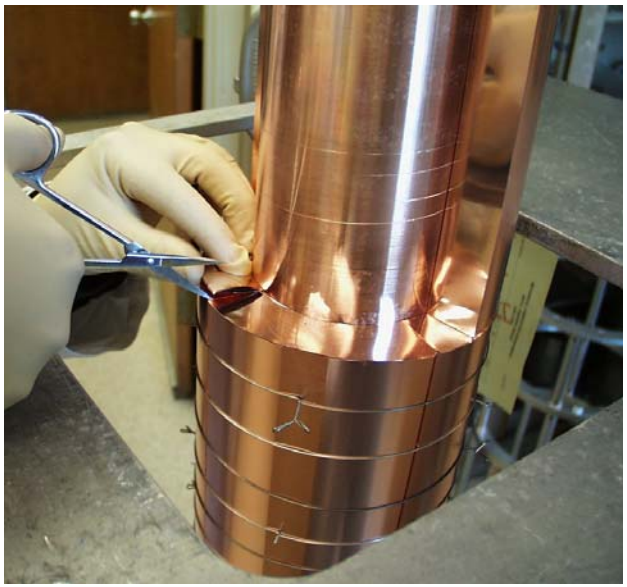
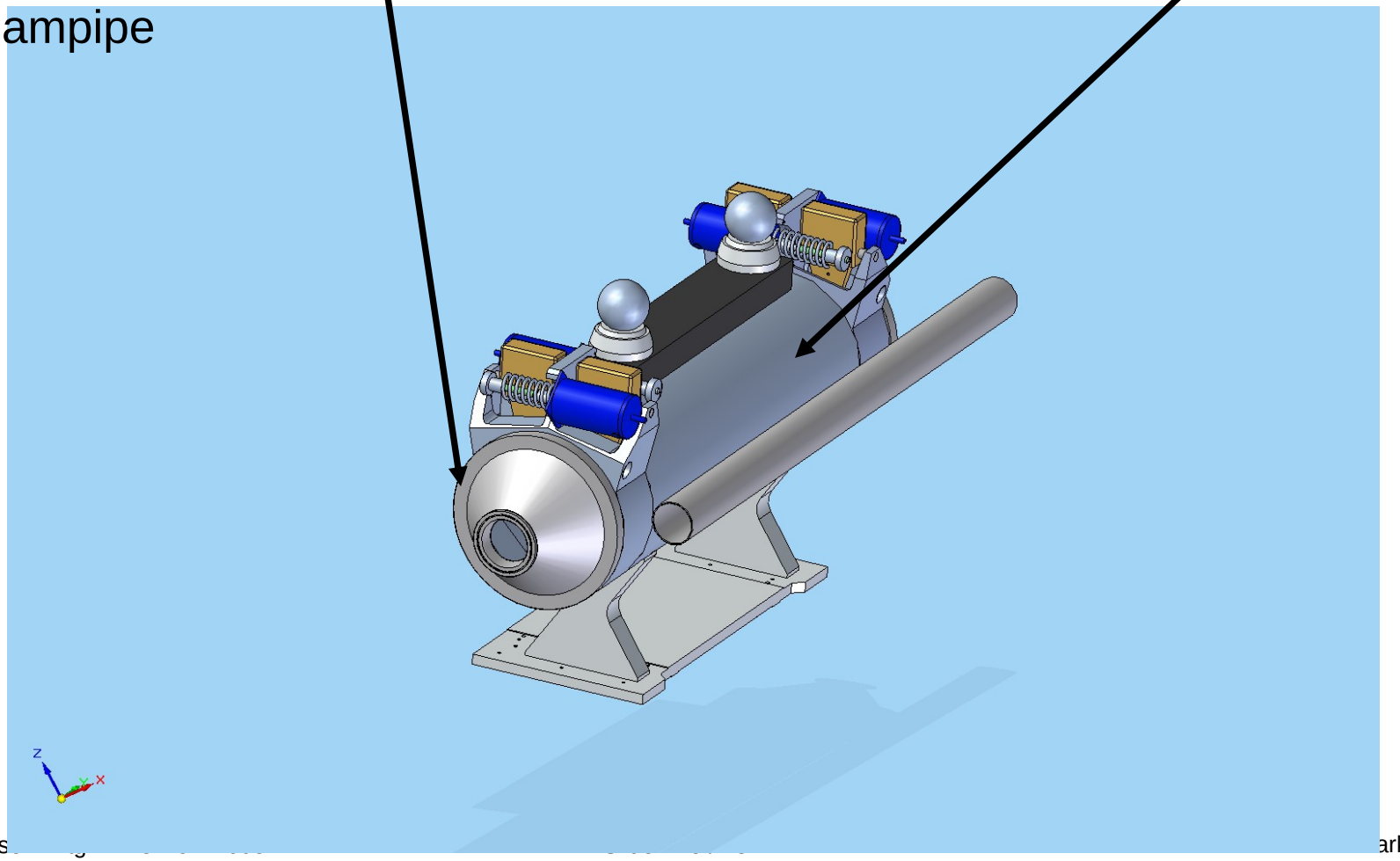
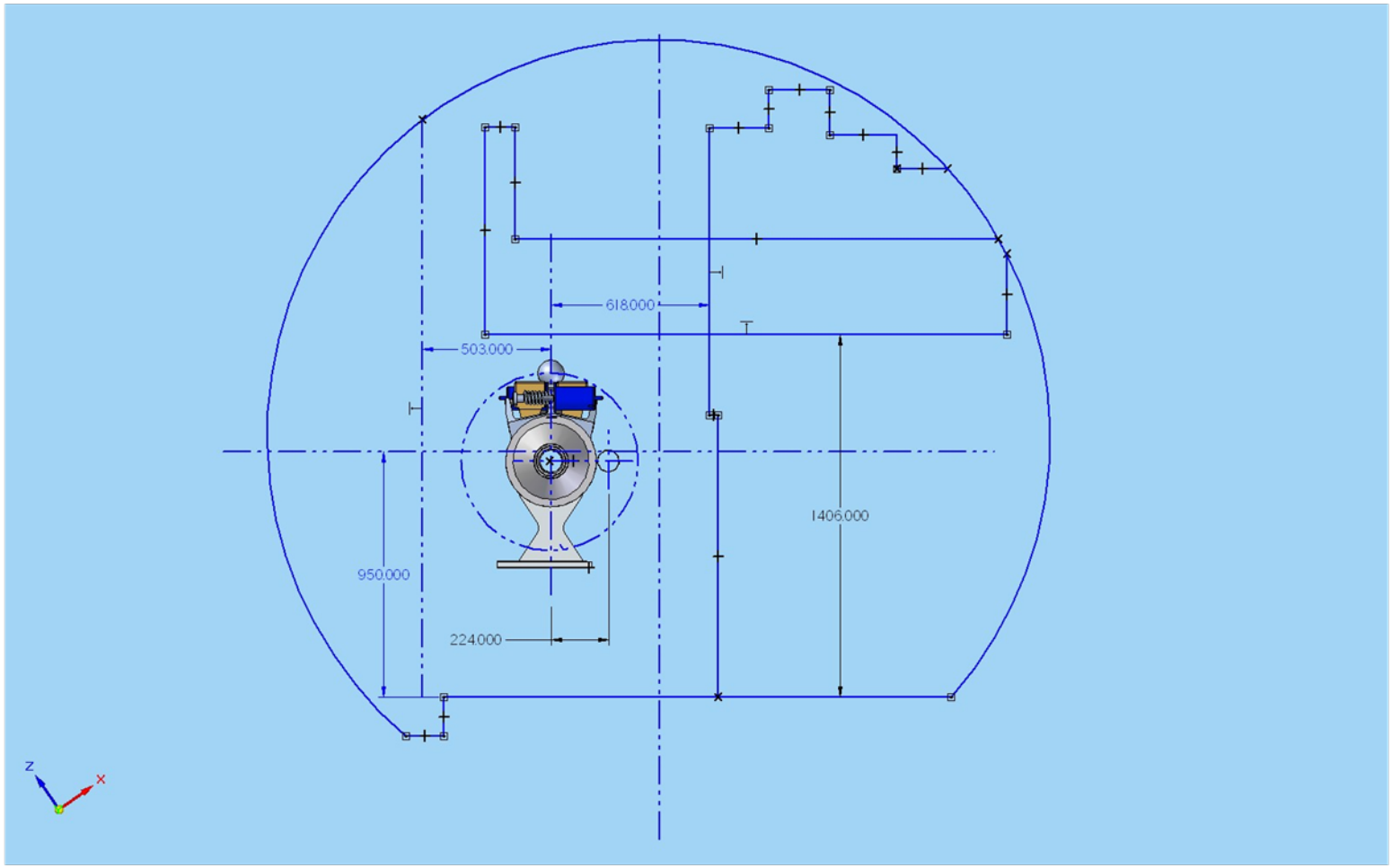


Introduction of New Cylindrical Vacuum Tank Concept

- Modular assemblies weld to 355.6mm O.D. x 6.35mm wall SST Pipe
- CONFLAT flanged adapters seal tank end openings and connect Tank to beampipe



Main Constraints



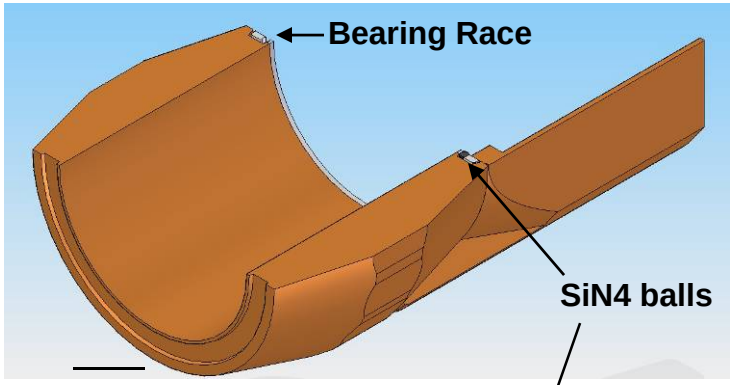
RC-0 Flatness TEST

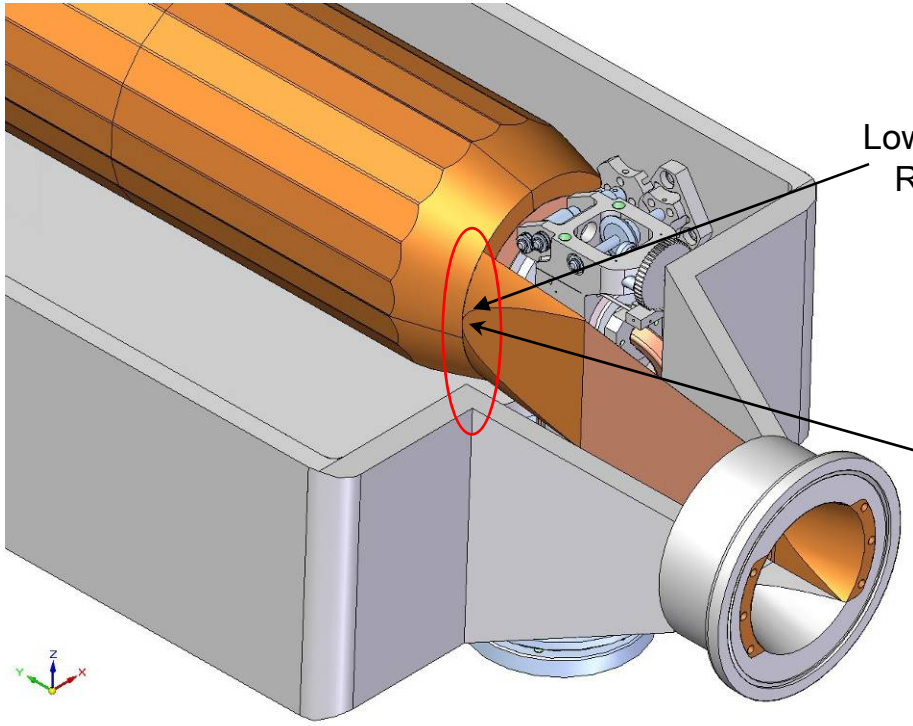
- Measured flatness of 5 of 20 facets after vacuum bakeout
  - Report in preparation: will report fully next time
  - Position measured each 2.5cm in 3 rows per facet
    - 100 measurements/facet
  - All points in central 94cm of 1m length jaw within ±20 um band

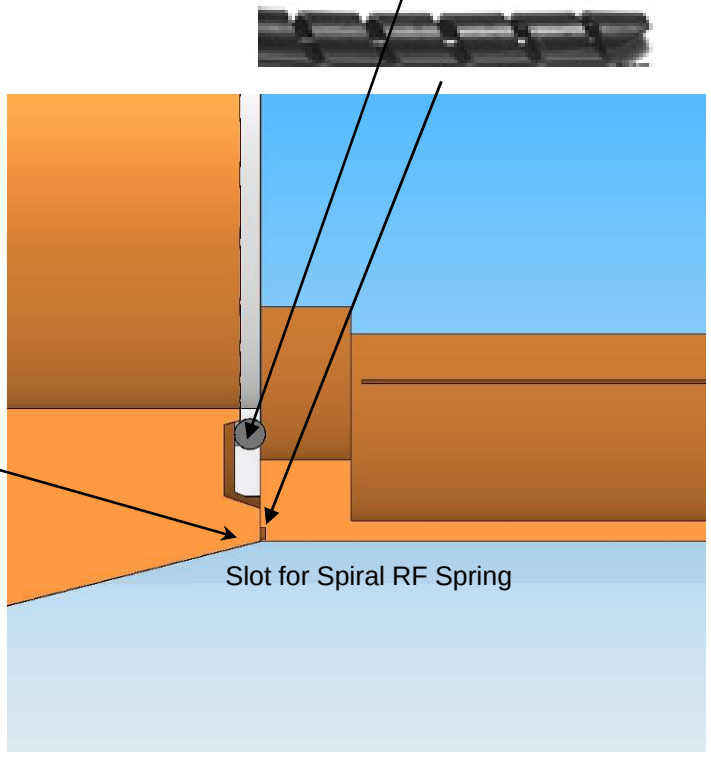
RF Design

Hope to abandon previous design (shown here) that relies on SiN4 balls for rotation and a rhodium coated spring for sub-mOhm contact resistance in favor of one based on conducting ball bearings only

Short RF Test Jaw with End Socket mounted





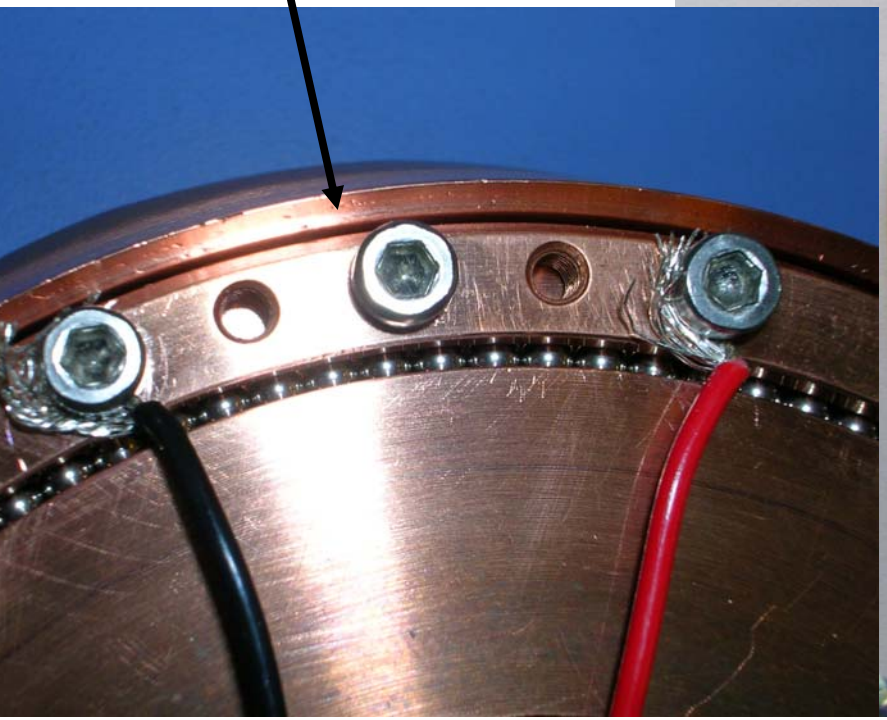


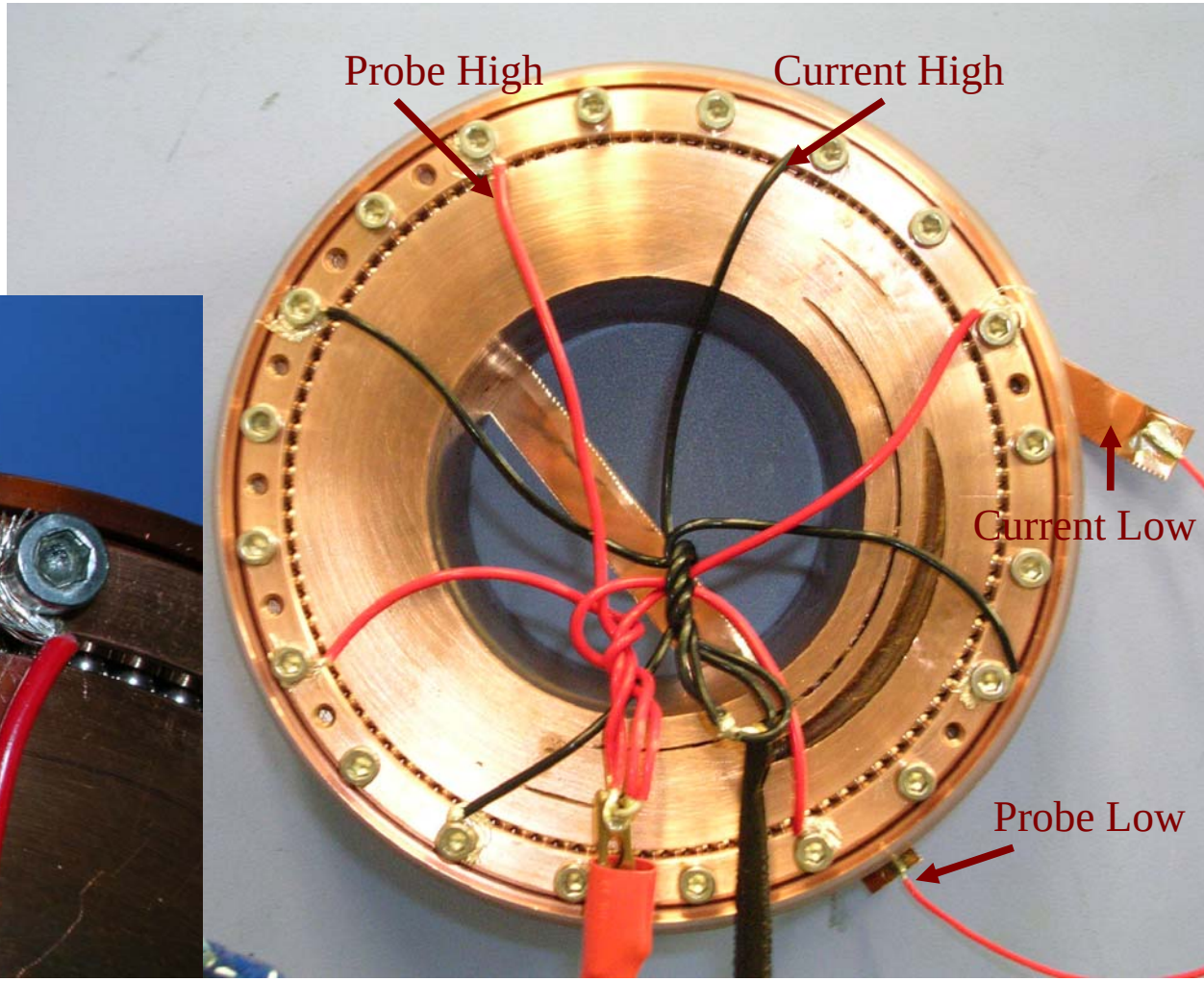
New Contact Resistance Measurements

- The idea is to use conductive ball bearings as the sliding contact between the jaw and the transition foil
- Much more robust (mechanically and electrically) than springs and coils
- Easier to make and assemble
- Balls are not flexible so will not contour to shape (point contact) so potentially less contact area and higher resistance
- Experimental Setup:
  - Use jaw “endcap” already made for RF coil contact tests.
    - Just remove the spring and replace the ceramic balls with metal balls
    - Not really made for this test and the ball groove was not precision machined
      - Should give worst case performance.
  - Three tests:
    - Plain SS, Rhodium and Gold plated balls
    - No plating on the jaw and rail

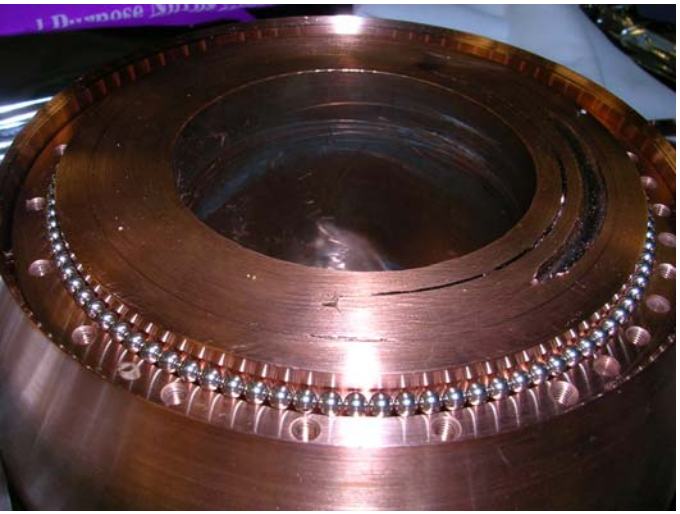
Experimental Setup

Real setup would have balls positioned on other side of ring. But this is fine for this test. Ring touching jaw only through bearings.



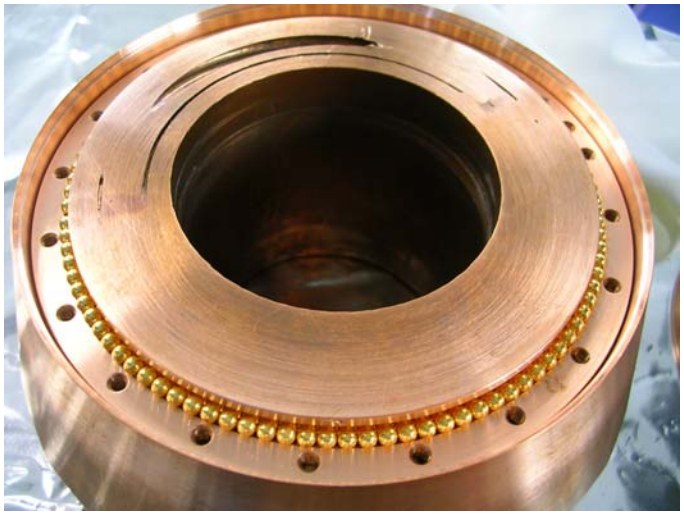


Balls



Bare Stainless Steel

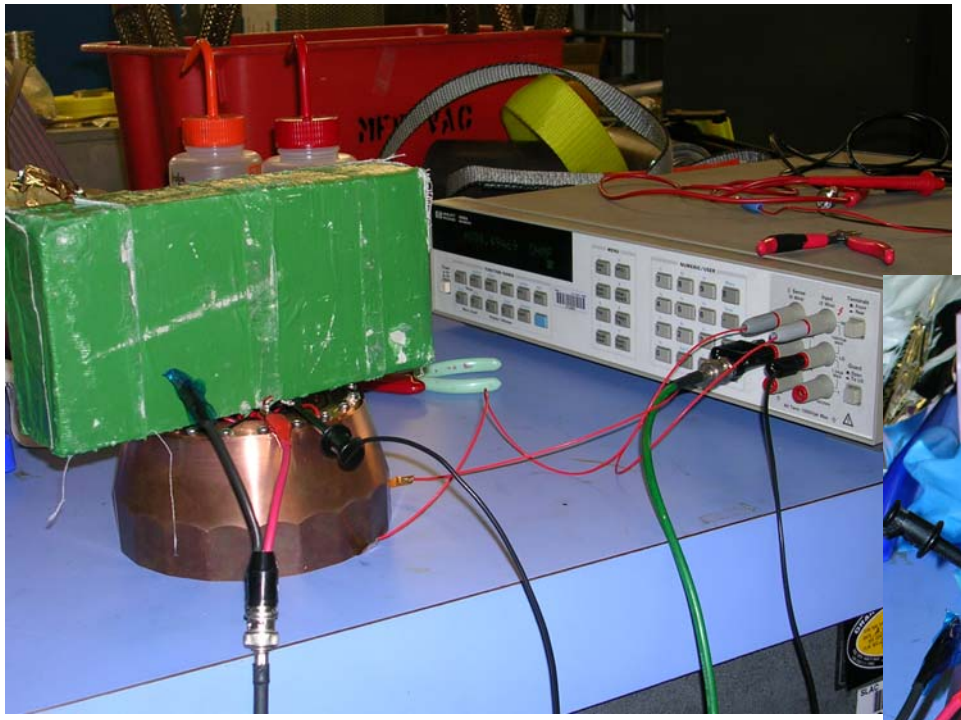
Gold Plated, 4 micron



Rhodium Plated, 2 micron

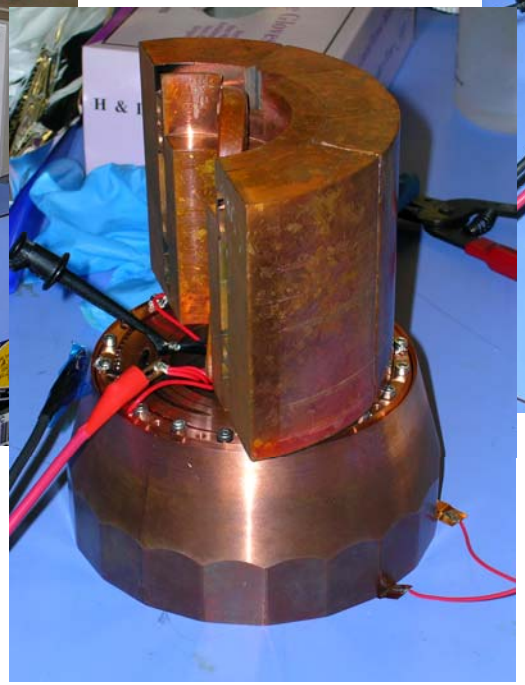
Try Different Loads

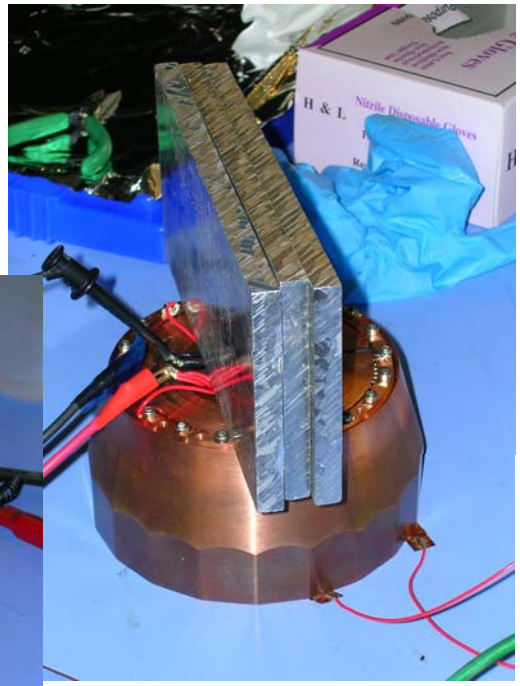
- We want to determine the amount of load needed to bearings to get desired resistance of less than 1 milliohm.



26 pounds (lb)

10 pounds





3 pounds

Sorry for the British Imperial Crown units!

Results

- Target: < 1 mOhm
- Bare SS clearly unacceptable
- Gold plating the best
  - Would require rhodium plating on the jaw tips
- Rhodium probably good enough
  - Allows the jaw tips to be bare copper (Glidcop)
- Bulk resistance of SS balls negligible at 0.005 mOhm
  - All of measured resistance due to contact

Plating	No load	1 lb	3 lb	10 lb	26 lb
Bare	10000 mOhm				500 mOhm
Rhodium	4 mOhm	1.7 mOhm	1.1 mOhm	0.55 mOhm	0.33 mOhm