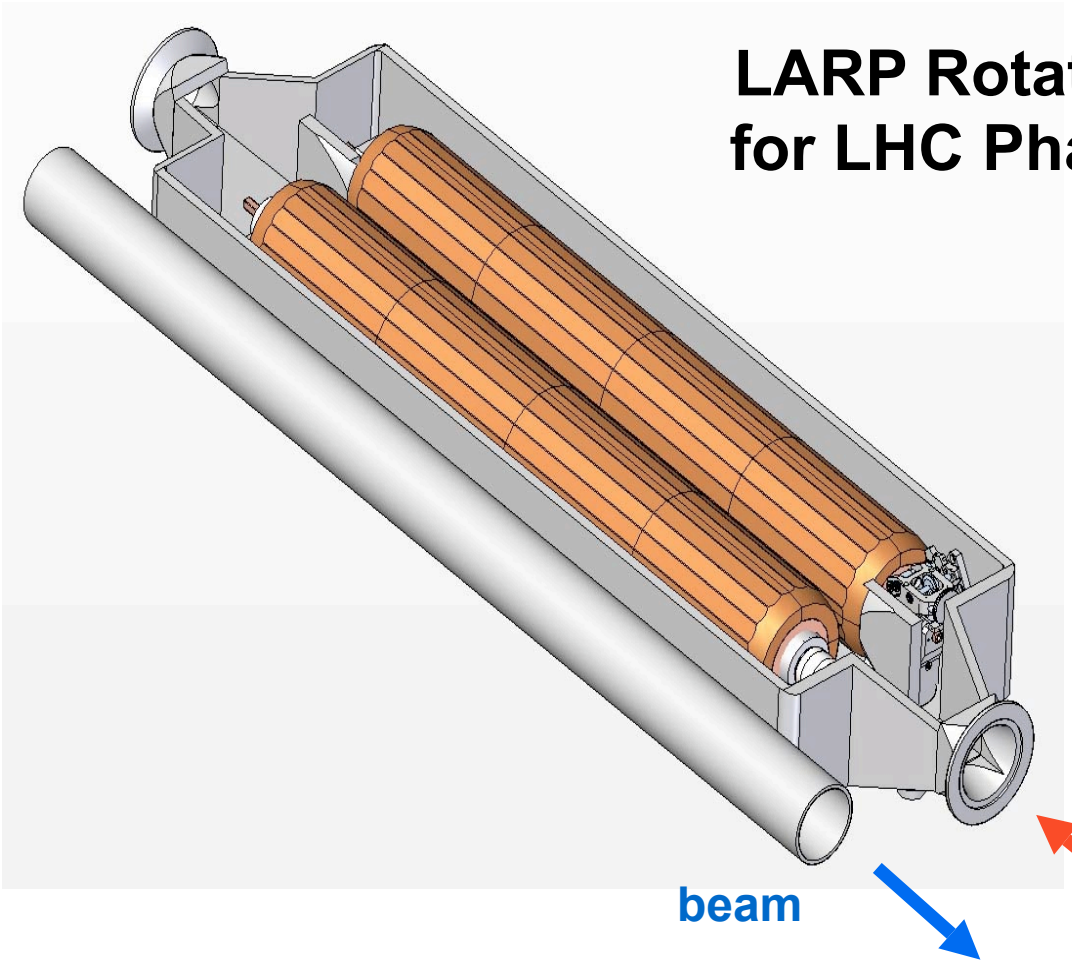
US LHC Accelerator Research Program

BNL - FNAL- LBNL - SLAC

LARP Rotatable Collimators for LHC Phase II Collimation

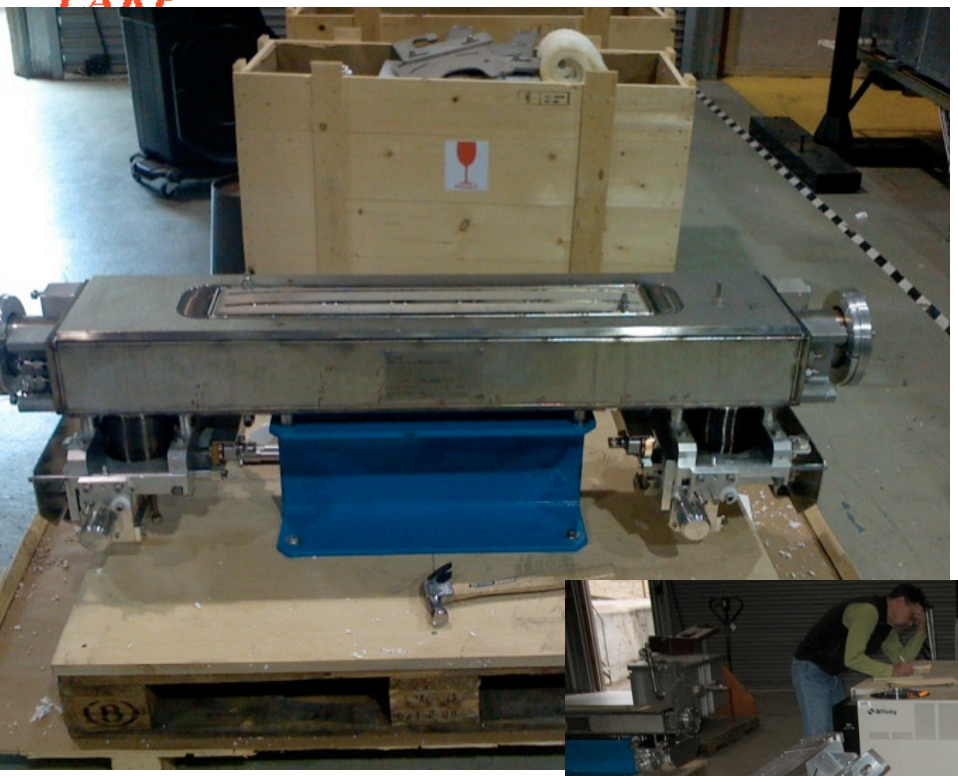


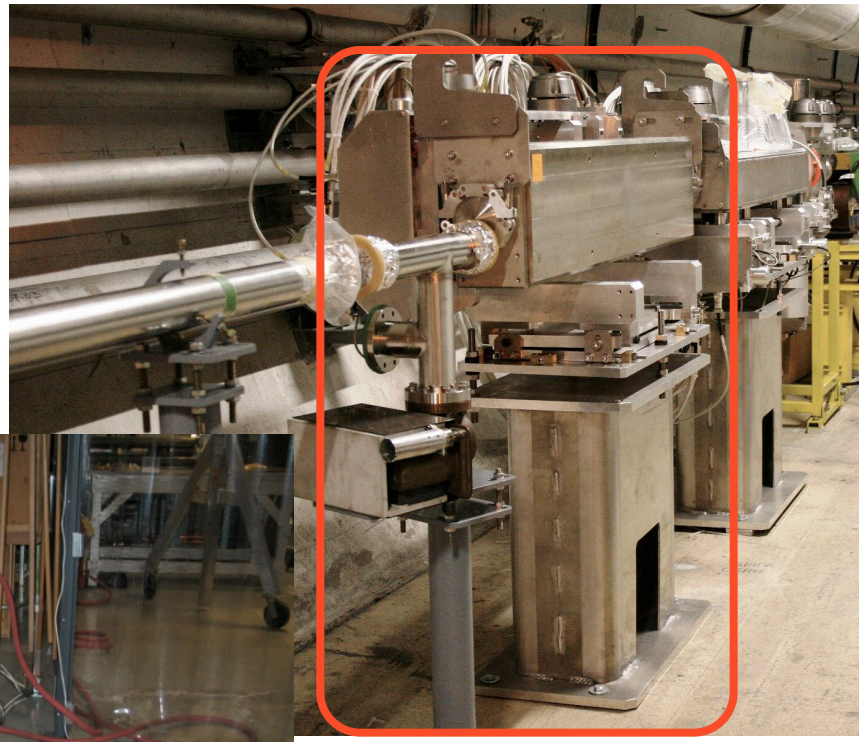
12 November 2007
SLAC R&D Status Meeting

- Gene Anzalone, Eric Doyle, Lew Keller, Steve Lundgren, Tom Markiewicz & Jeff Smith

CERN Phase I collimator finally arrived!

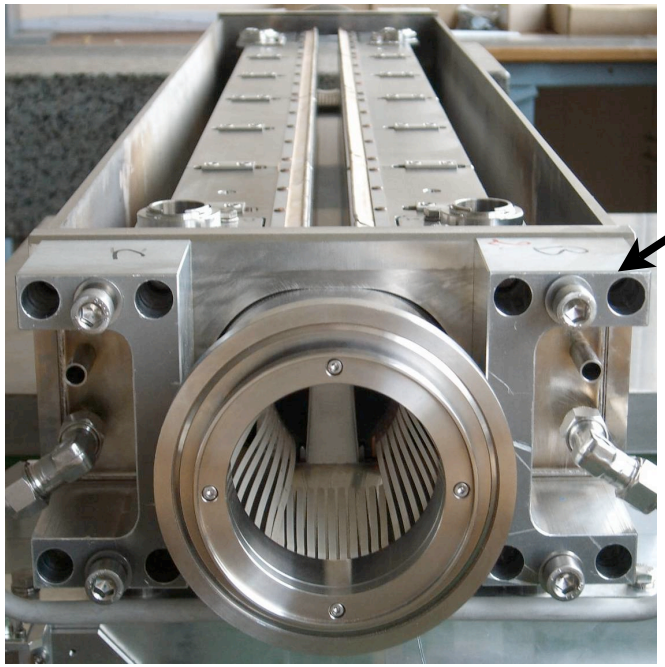
3 crates
Including support hardware



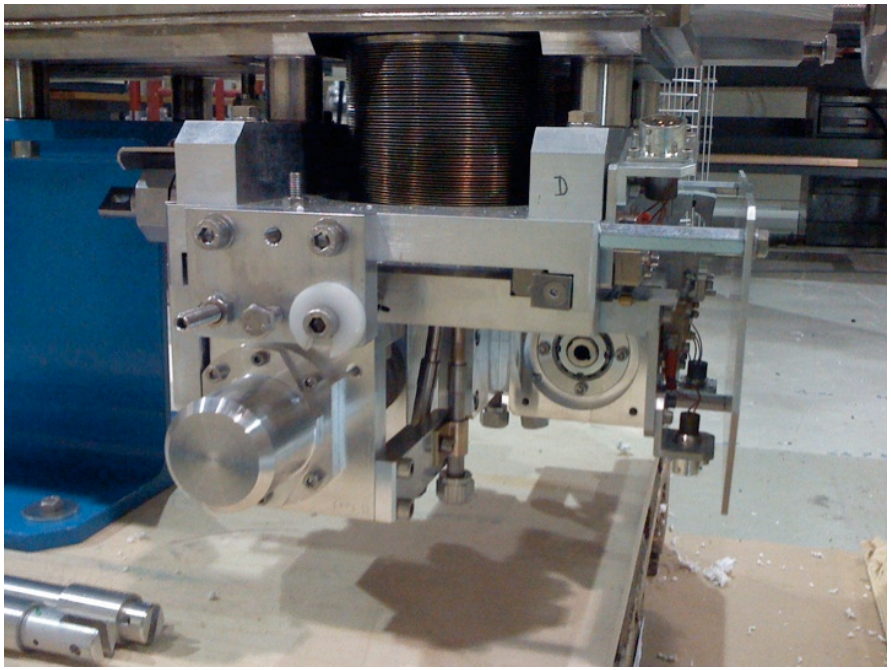


CERN Phase I collimator plans

- Will attempt to use as much of the phase I design for phase II (sans carbon jaws).
- First confirm we can operate the jaw mechanism as-is before any modifications.
- Cut off lid and install weights to see if mechanism can move our heavier jaws.
  - Already purchased higher torque stepper motors to accommodate heavier jaws, but will the mechanism support the greater forces?
  - Make modifications as necessary.

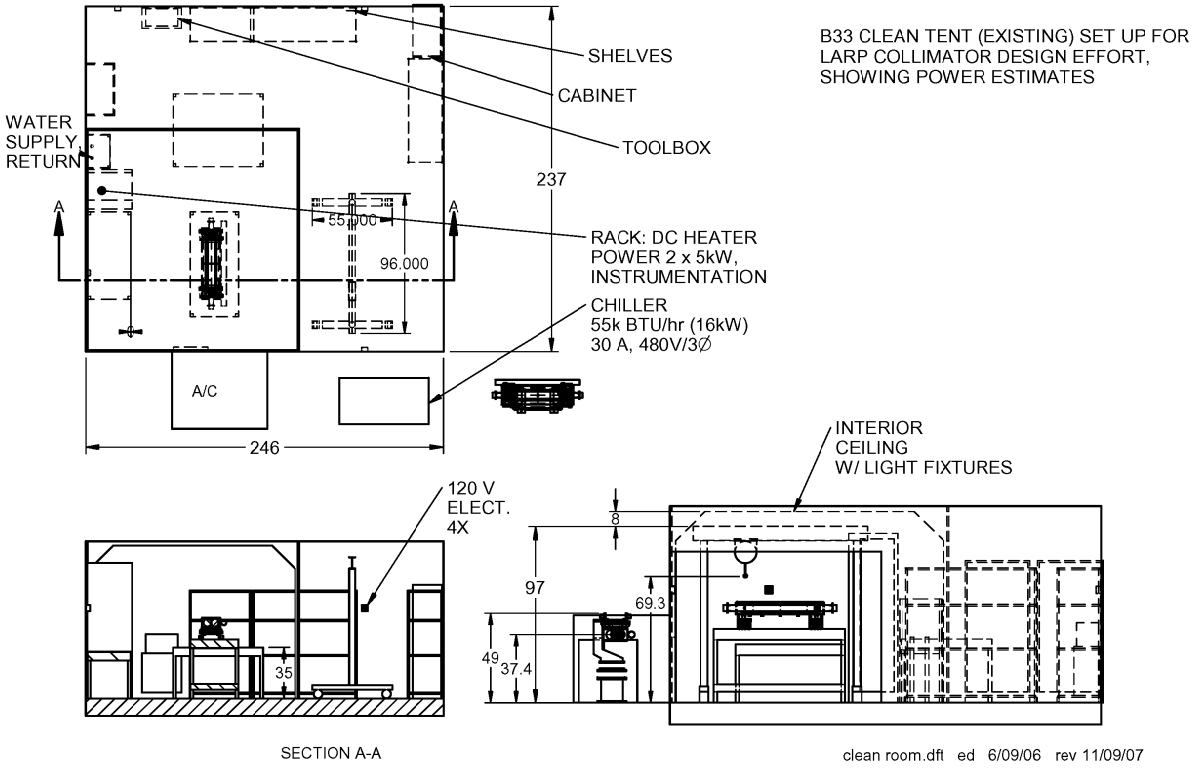


(Stock photo, we haven't cut it open yet)

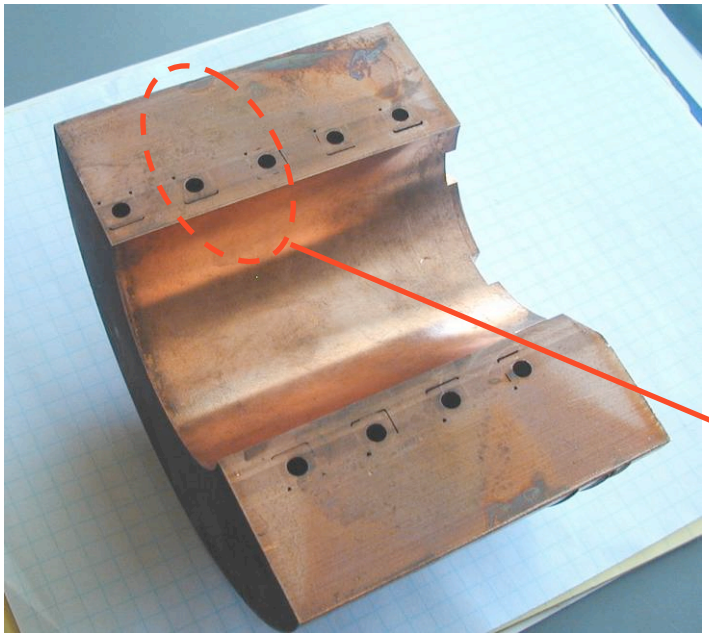


PLans with phase I

- Currently adapting mounting for placement in our clean room in B033
- Will have three experiments in clean room concurrently.



Braze Test #3: Sectioning & Examination
Cu grain boundary cracking during brazing



Specimen 140mm OD x 60mm ID x 200mm L (¼ section shown)

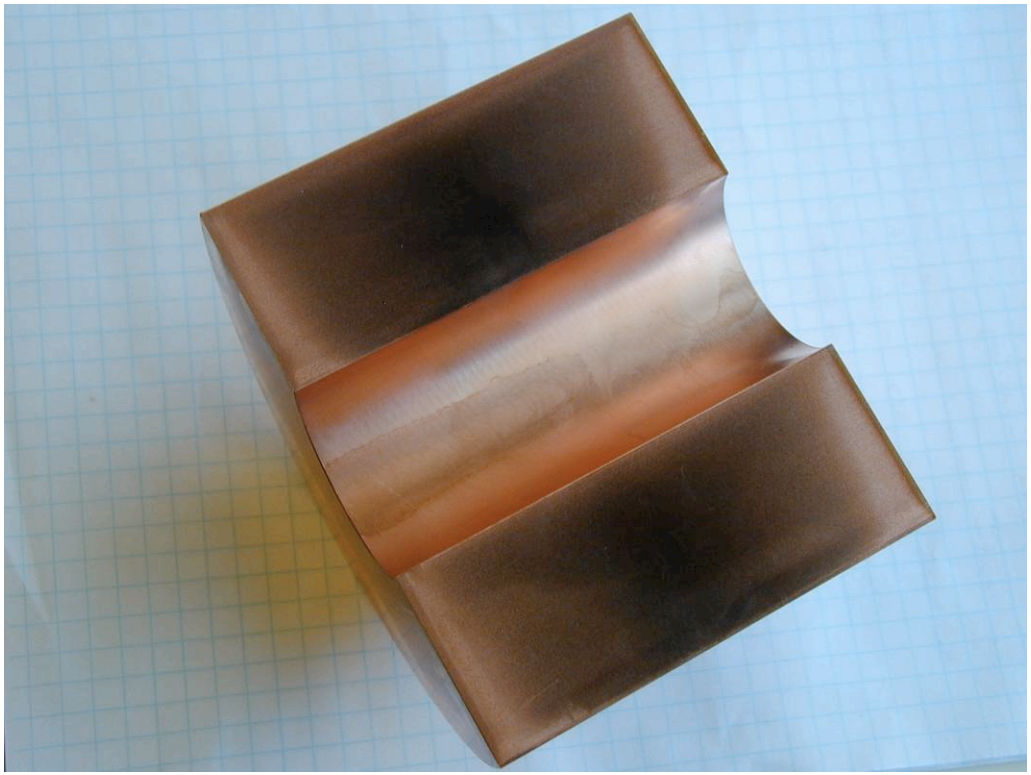
- **one braze cycle in the 900 C range**
- **grain boundary cracks located in interior regions**
- **believed due to excessive heating rate**
- **Glidcop to be tested UPDATE: has been tests...**

Concerns

- **Effect on performance**
- **What happens in accident case?**

Glidcop Al-15 Heat sample

While 1st jaw used to test thermal mechanical issues is Copper, first full 2 jaw prototype will use Glidcop



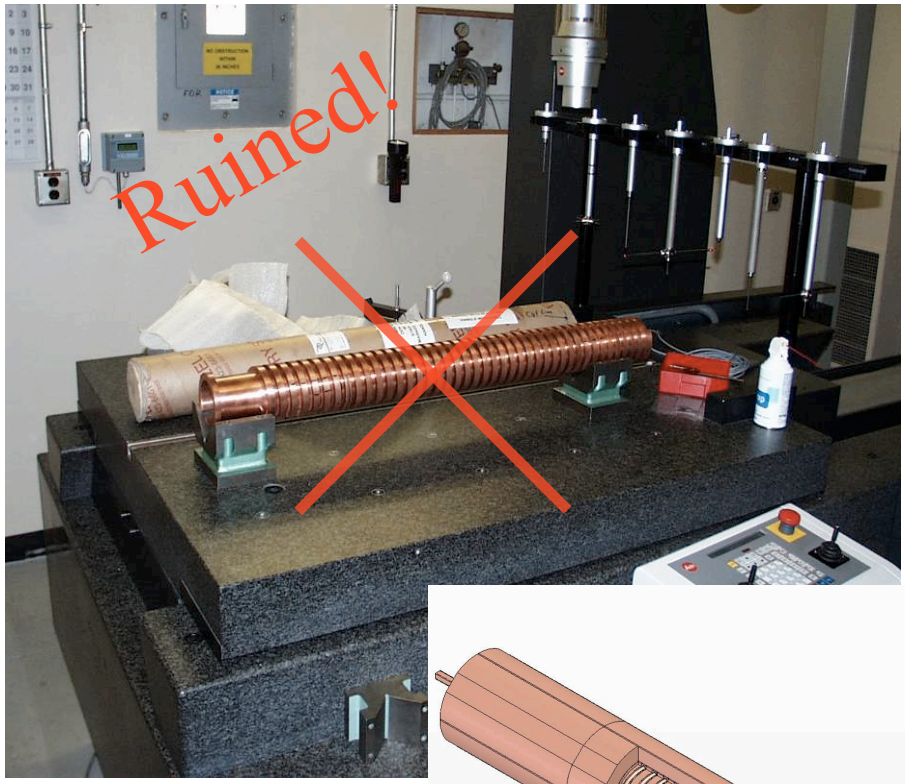
2 Heats (at Jaw brazing temperature)

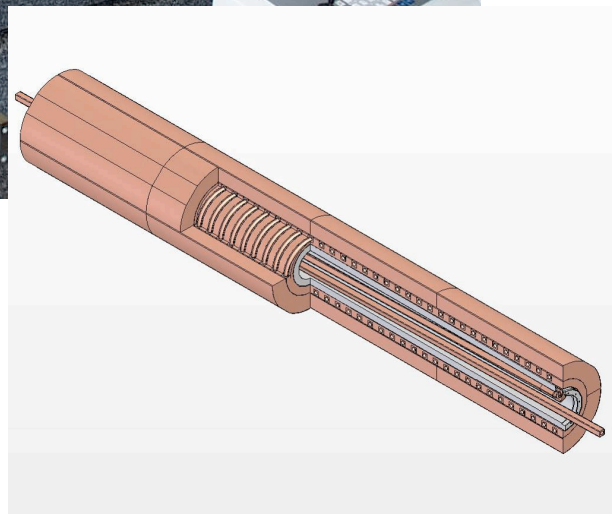
No grain boundary cracking is apparent

Metallographic samples are being prepared for microscopic inspection

Full length Jaw manufacturing

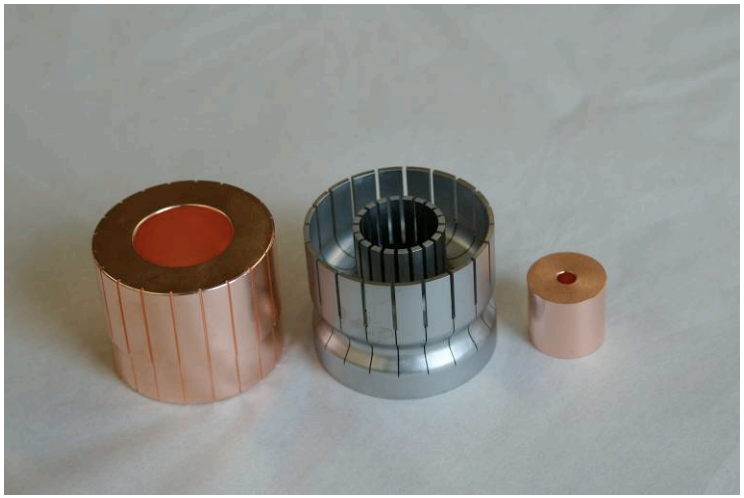
- During drilling of central bore to accommodate molybdenum shaft, outside shop ruined our mandrel!
- New mandrel being manufactured
  - Gun drilling complete
  - But shoulder and groove still to be completed
  - Given an 8 week estimate for delivery, however this is top priority so may deliver earlier.

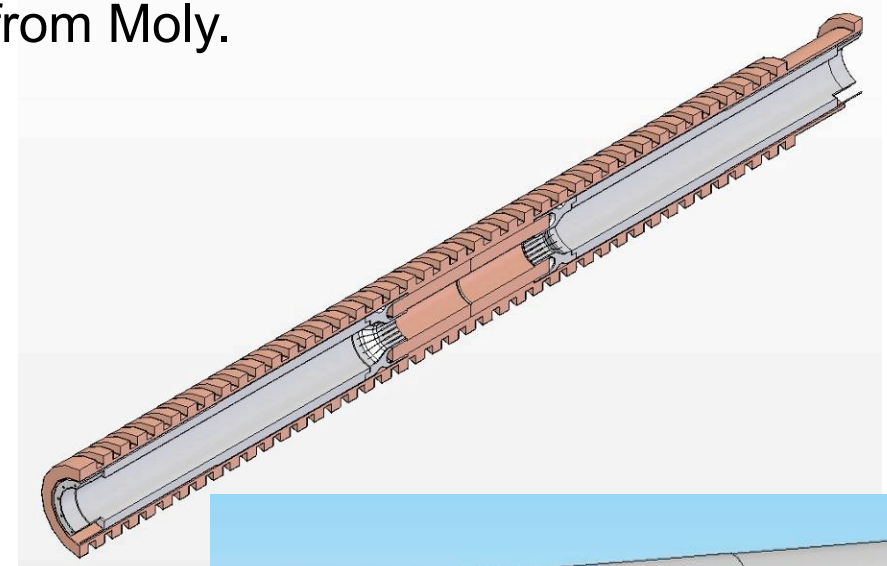


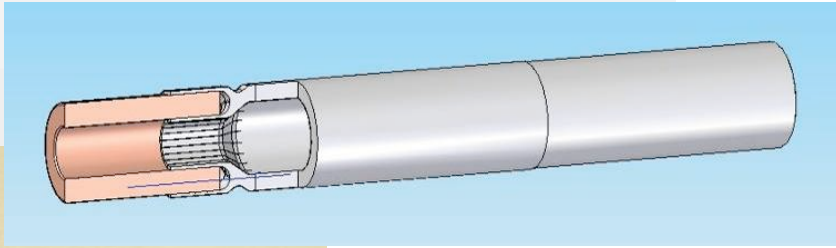


Cu-Mo joint: Segmented Moly for expansion

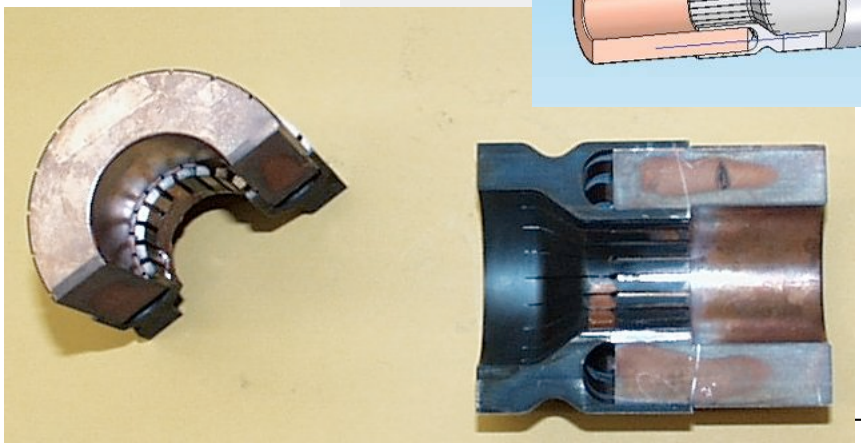
- Use a segmented flexible molybdenum end to prevent fractures and prevent Co from pulling away from Moly.







Has passed metallurgical tests and will be used for full length jaw

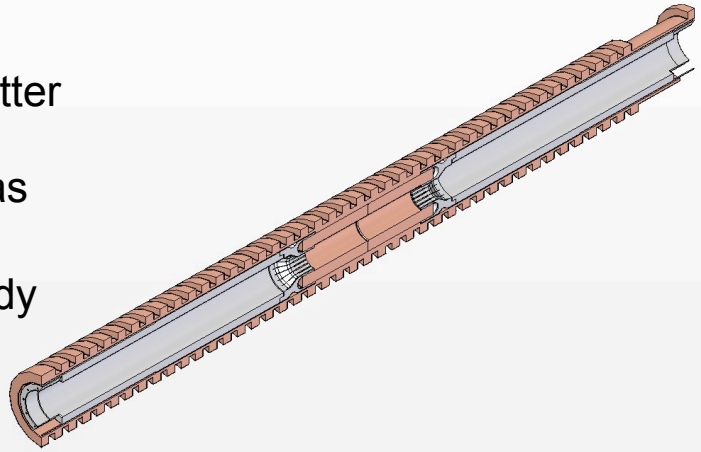


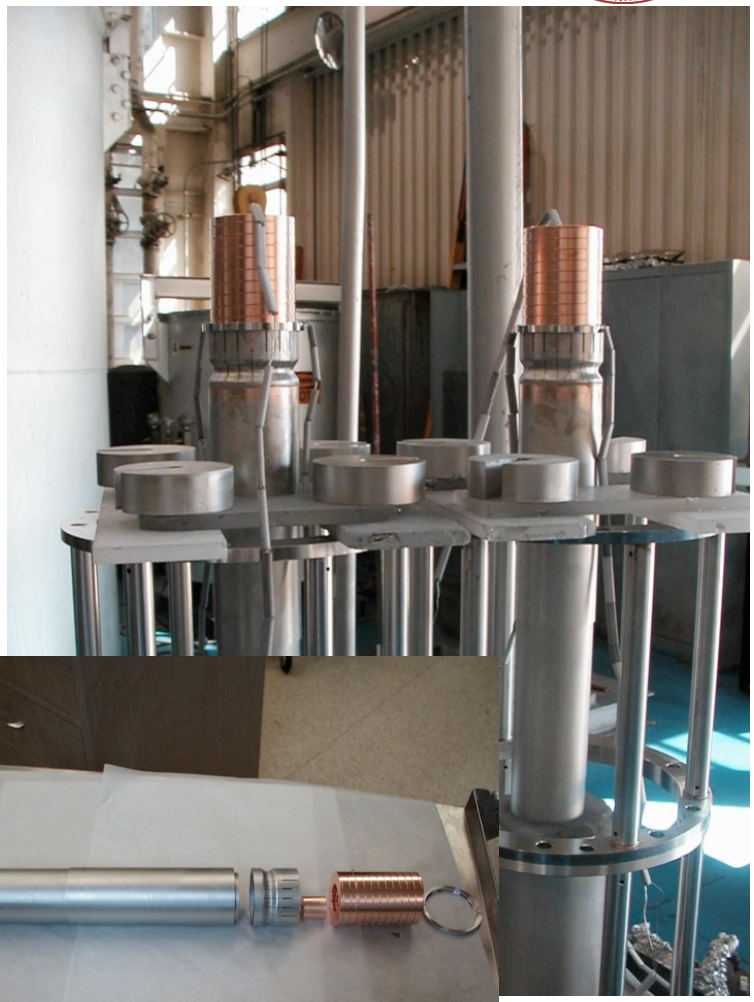
Segmented shaft slice and dice results

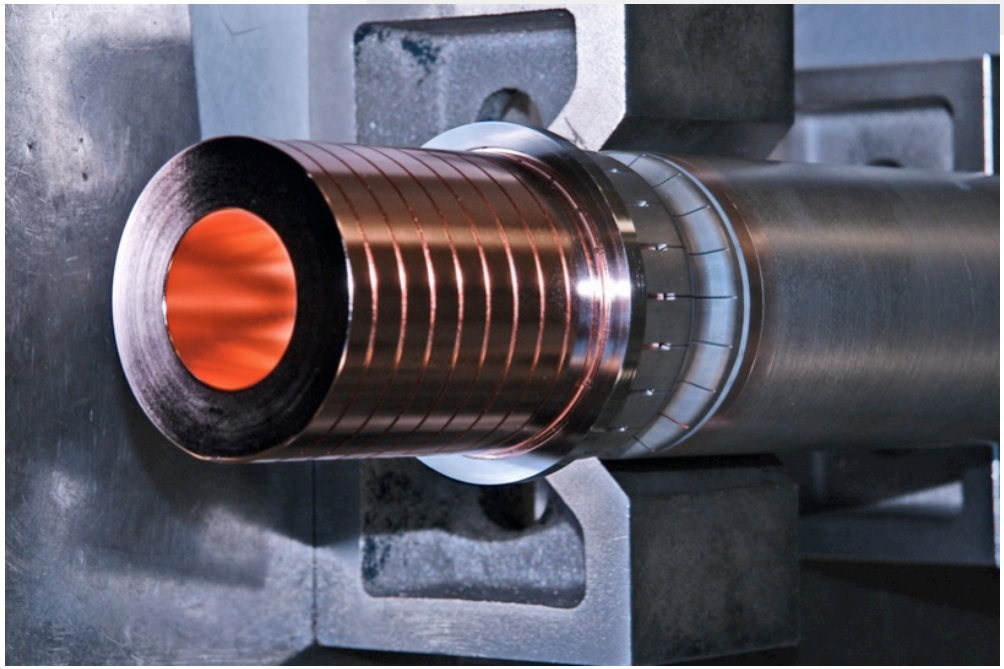
- Looks good!

Full length Jaw Manufacturing

- Moly shaft in better shape and proceeding as planned.
- Brazed and ready for mandrel.

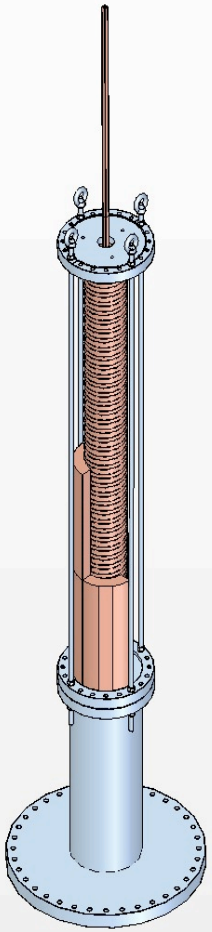


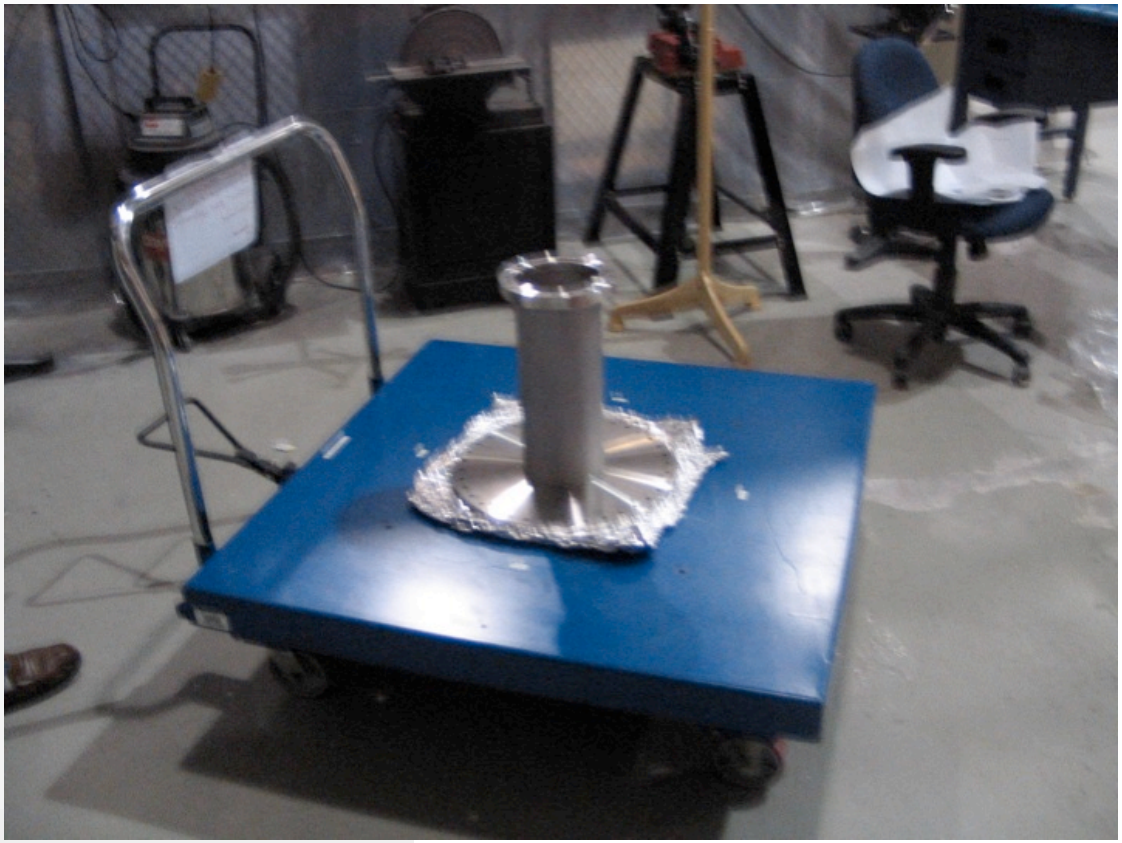




Fixture for stacking 16 24cm-long quarter round jaws on full 960mm cooling coil wrapped mandrel

(mostly catalog parts: ordered)





RF and Image Current Shielding

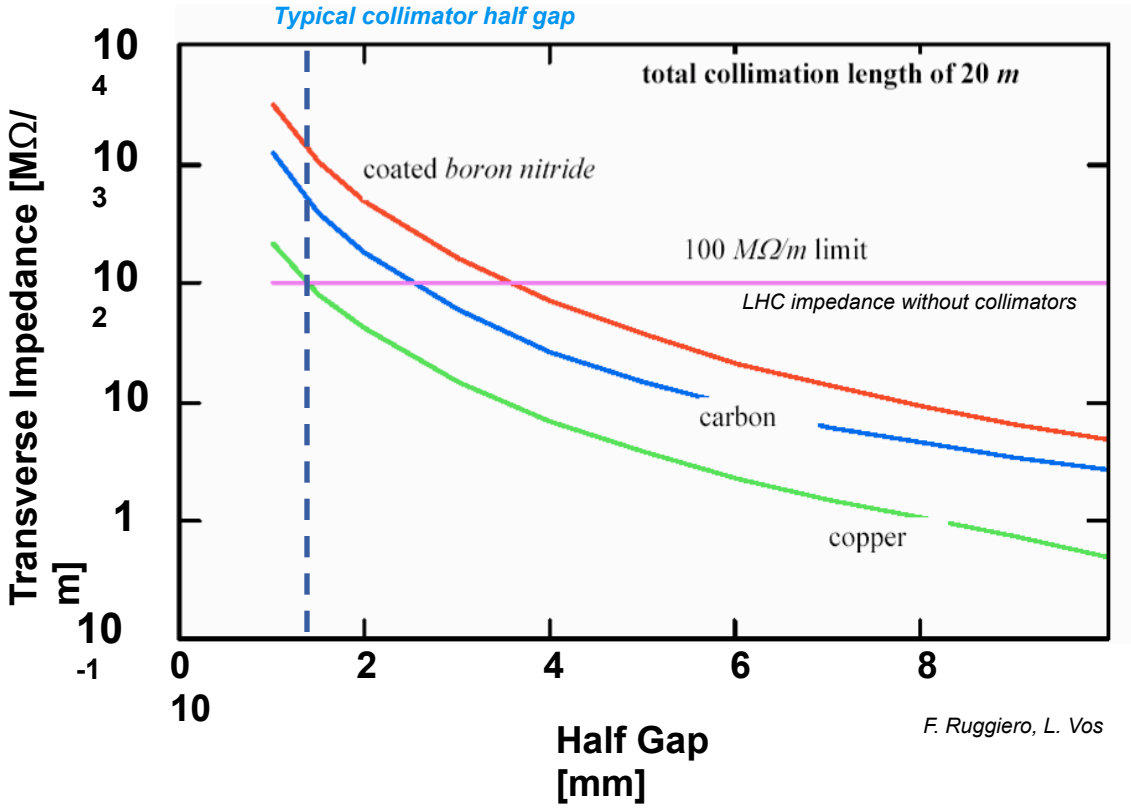
ONLY PART OF DESIGN THAT REMAINS TO BE FINALIZED

•Copper Jaws lower resitive impedance considerably over Carbon Jaws (phase I design) nevertheless, LHC impedance still dominated by collimators

•In Progress:

- Discussions with CERN and PeP-II experts
- MAFIA simulations
  - Geometric versus resistive contributions
  - trapped modes?
- Maybe try HFSS?

– Transverse impedance probably most critical

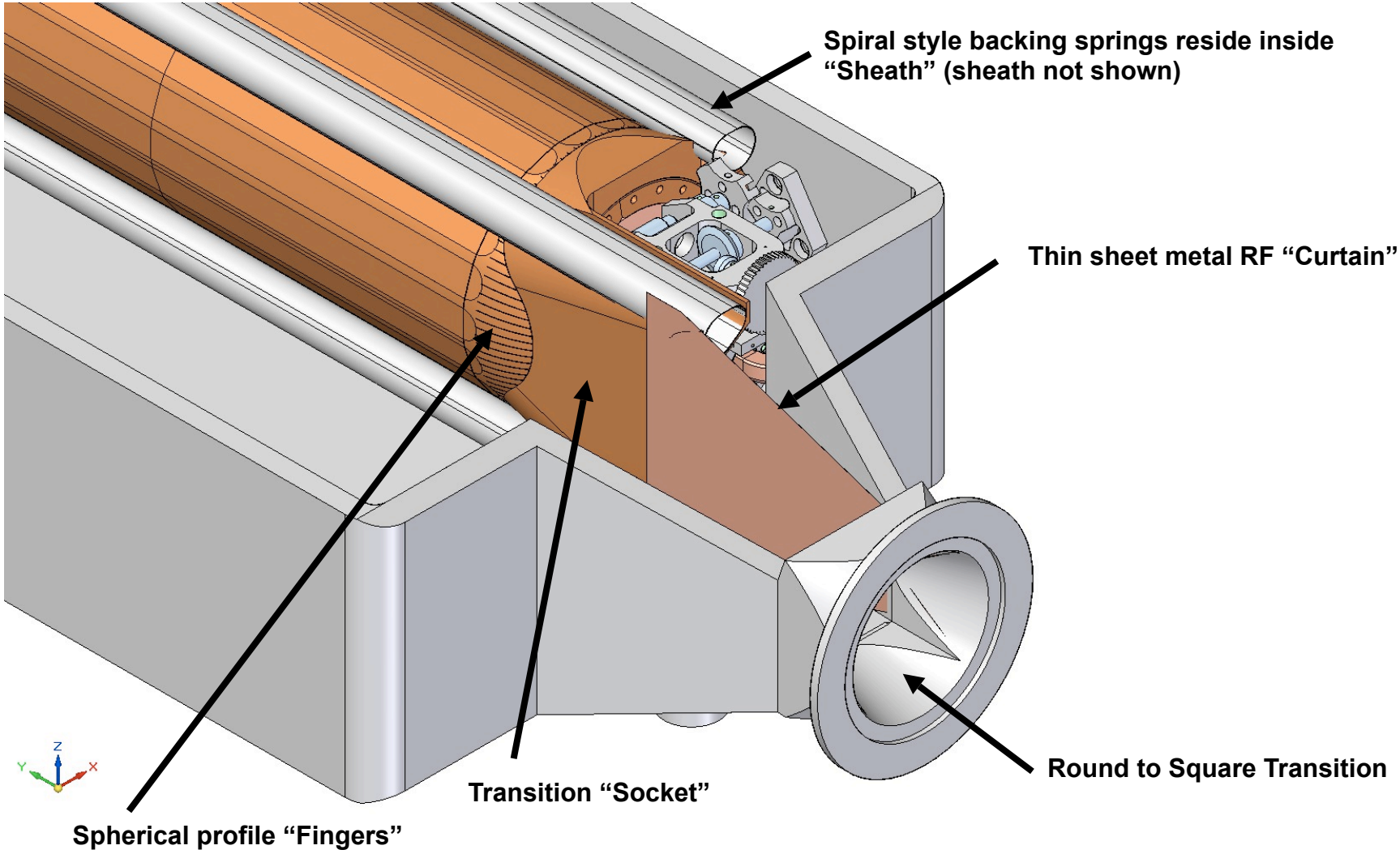


F. Ruggiero, L. Vos

To be done:

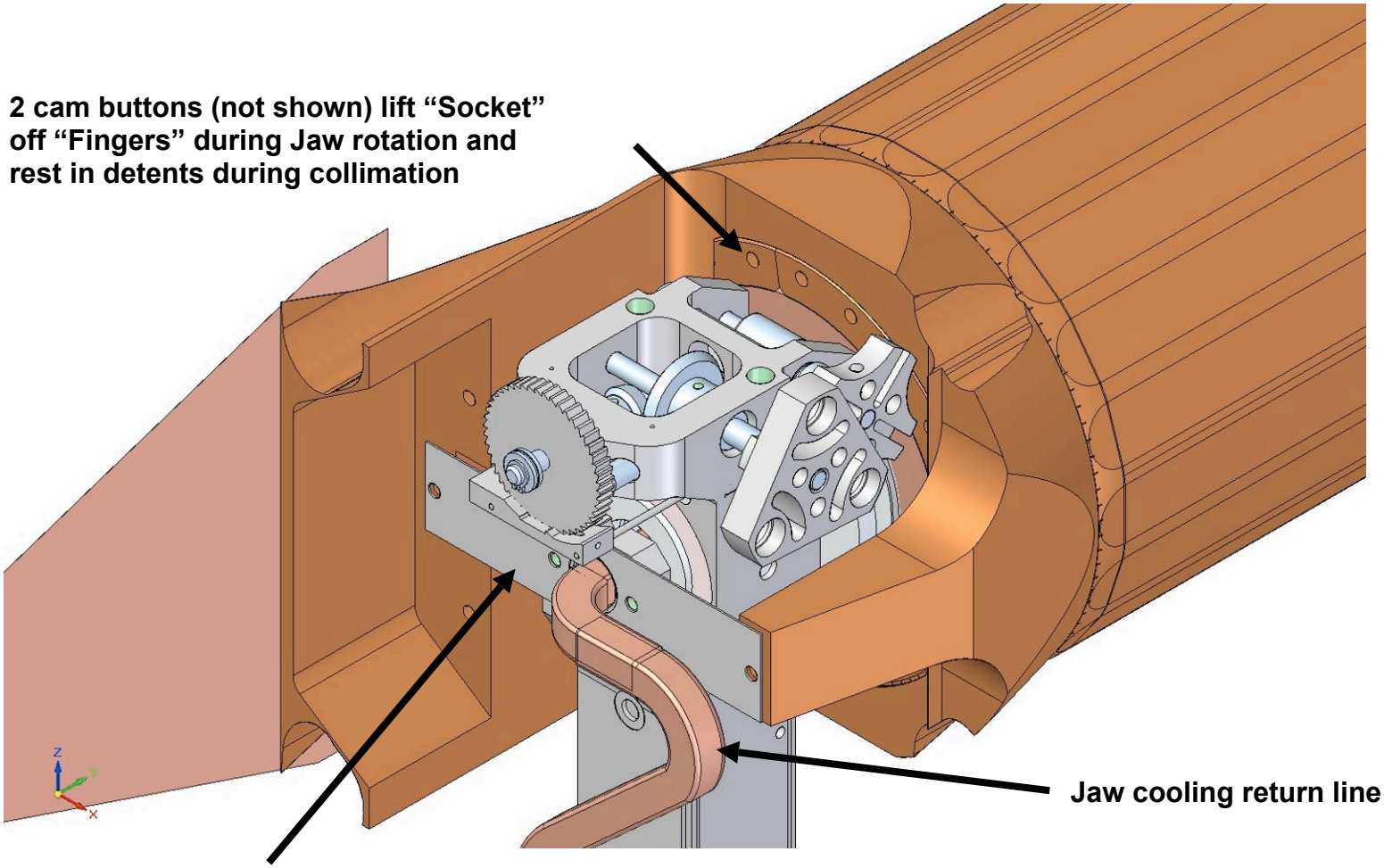
- Bench top impedance measurements with stretched wire and network analyzer
- Contact resistance measurements

Up Beam end beam side view

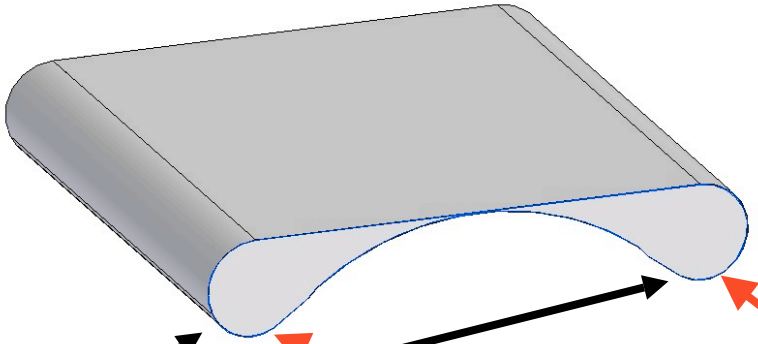


Up Beam end detail view away from beam side

- 2 cam buttons (not shown) lift “Socket” off “Fingers” during Jaw rotation and rest in detents during collimation

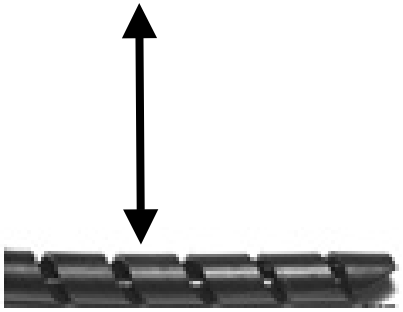


“Sheath” concept for transverse RF seal

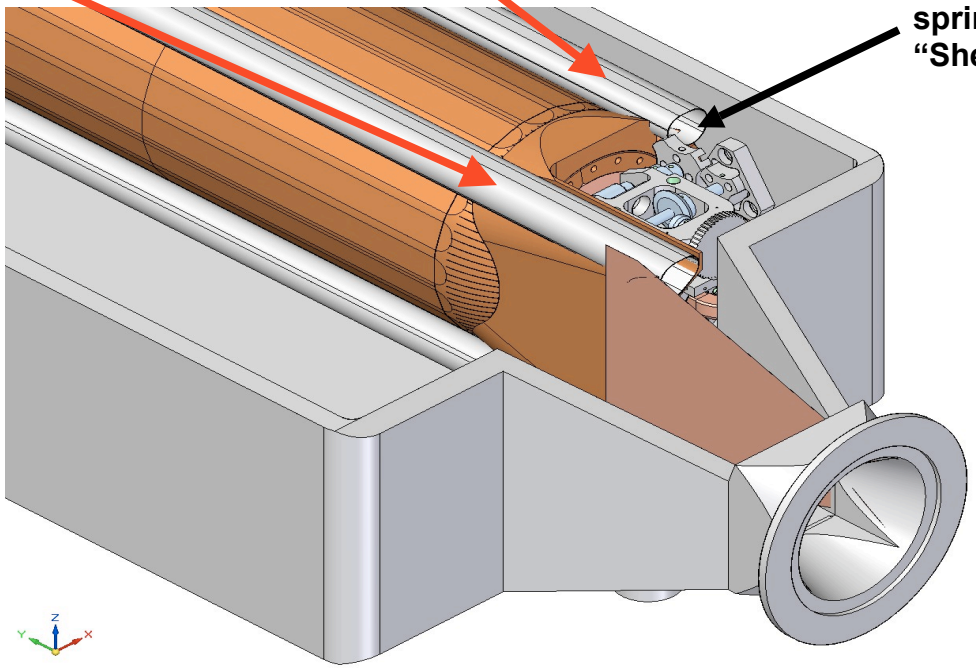


Sheath may require slits at 3mm intervals along loop sides to prevent wrinkling

Paired spiral type RF Springs fit inside loop for balanced loading



Spiral style backing springs reside inside “Sheath”

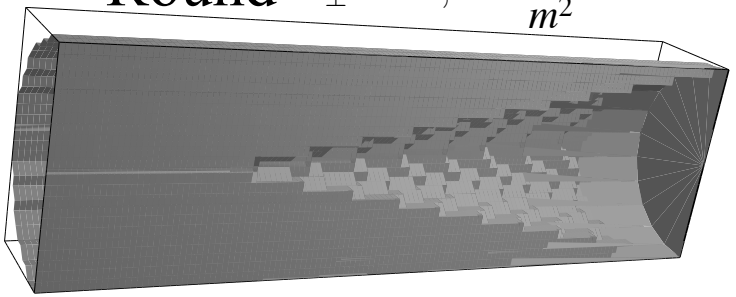


MAFIA Simulations

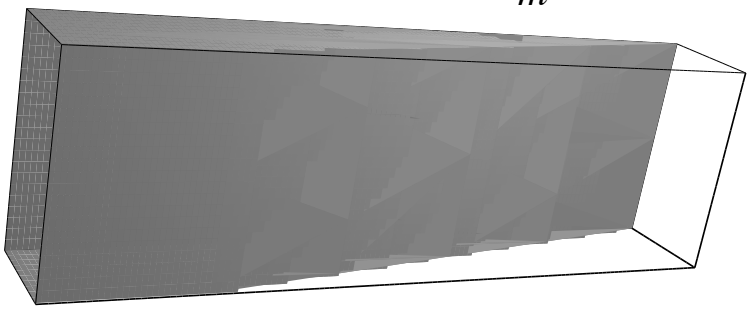
Have begun basic comparative studies between different collimator geometries and our current design

- ★Studies so far suggest rotatable jaws with conic ends result in larger transverse geometric wakefield than round or flat jaws.
  - ★Transverse kickfactor shown at right
  - ★studies ongoing...MAFIA doesn't do smooth tapers too well...
- ★Calculations show resistive wall impedance ~10 times larger than geometric for round collimator.
  - ★But is this true for our geometry?

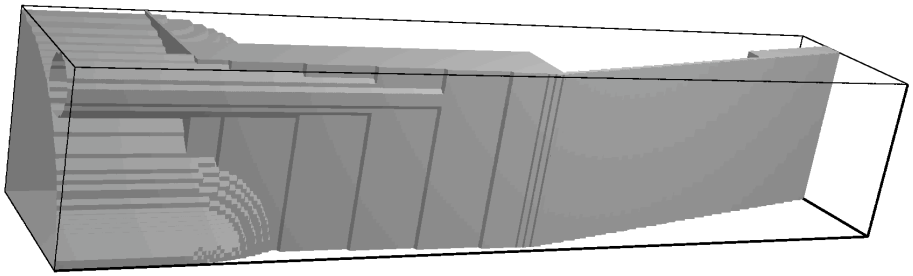
Round $k_\perp \approx 33{,}000 \frac{1}{m^2}$



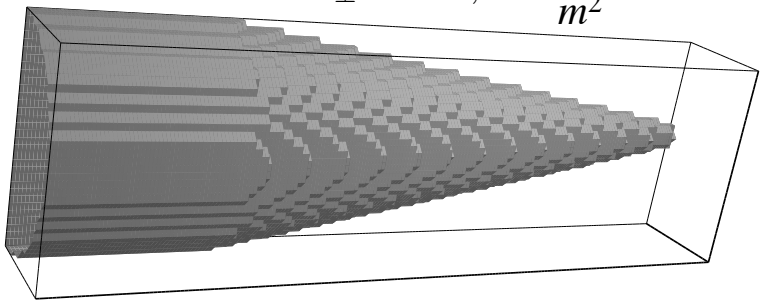
Flat $k_\perp \approx 50{,}000 \frac{1}{m^2}$



Current realistic design $k_\perp \approx \text{TBD}$

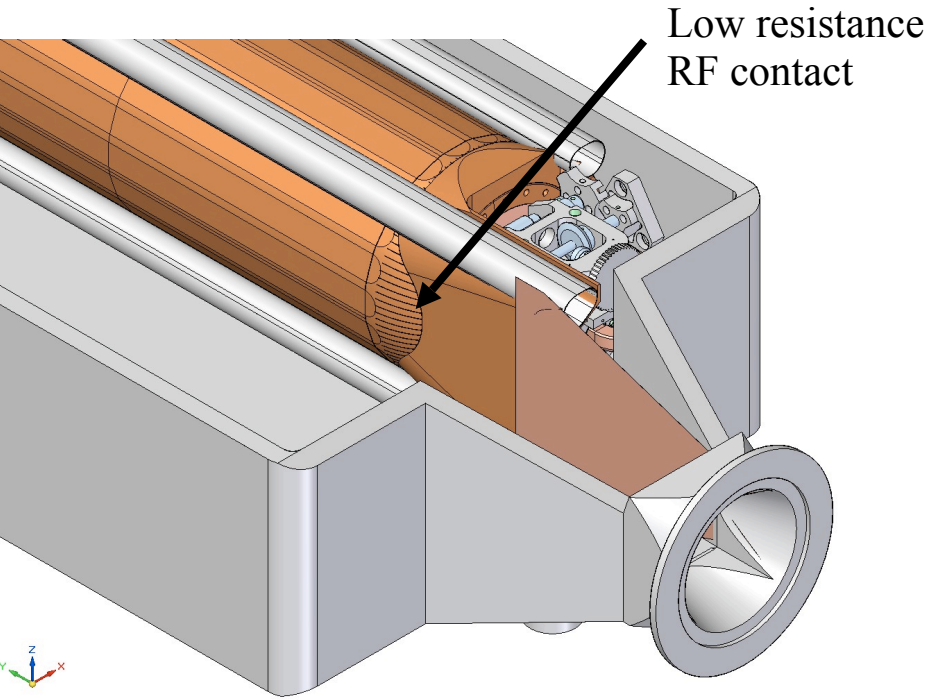


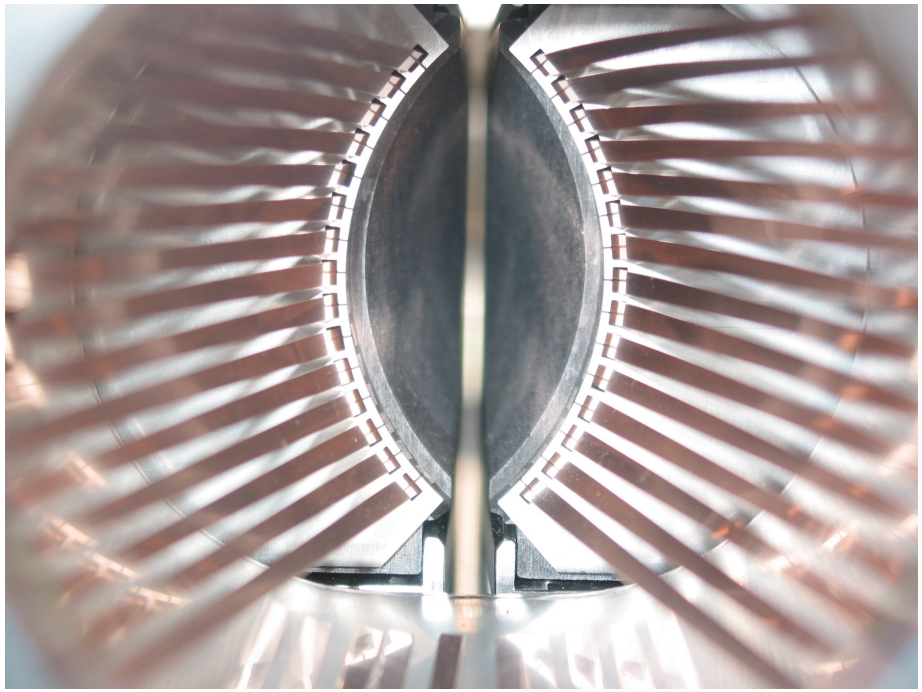
Conic $k_\perp \approx 100{,}000 \frac{1}{m^2}$



RF Contacts

- Must have low impedance for RF contacts, especially Jaw/transition piece interface
  - This interface must have ~<0.02 mOhm total low frequency resistance
  - What kind of electric contacts should be used here?
    - Silver plated? Rhodium? Is copper good enough? Cold welding copper?
- Will perform RF contact resistance measurements with HP ##### microOhm multimeter.





RF contacts in Phase 1 collimators