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# Fermilab PIP Booster Accelerator RF Cavity Refurbishment

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ARW 2015

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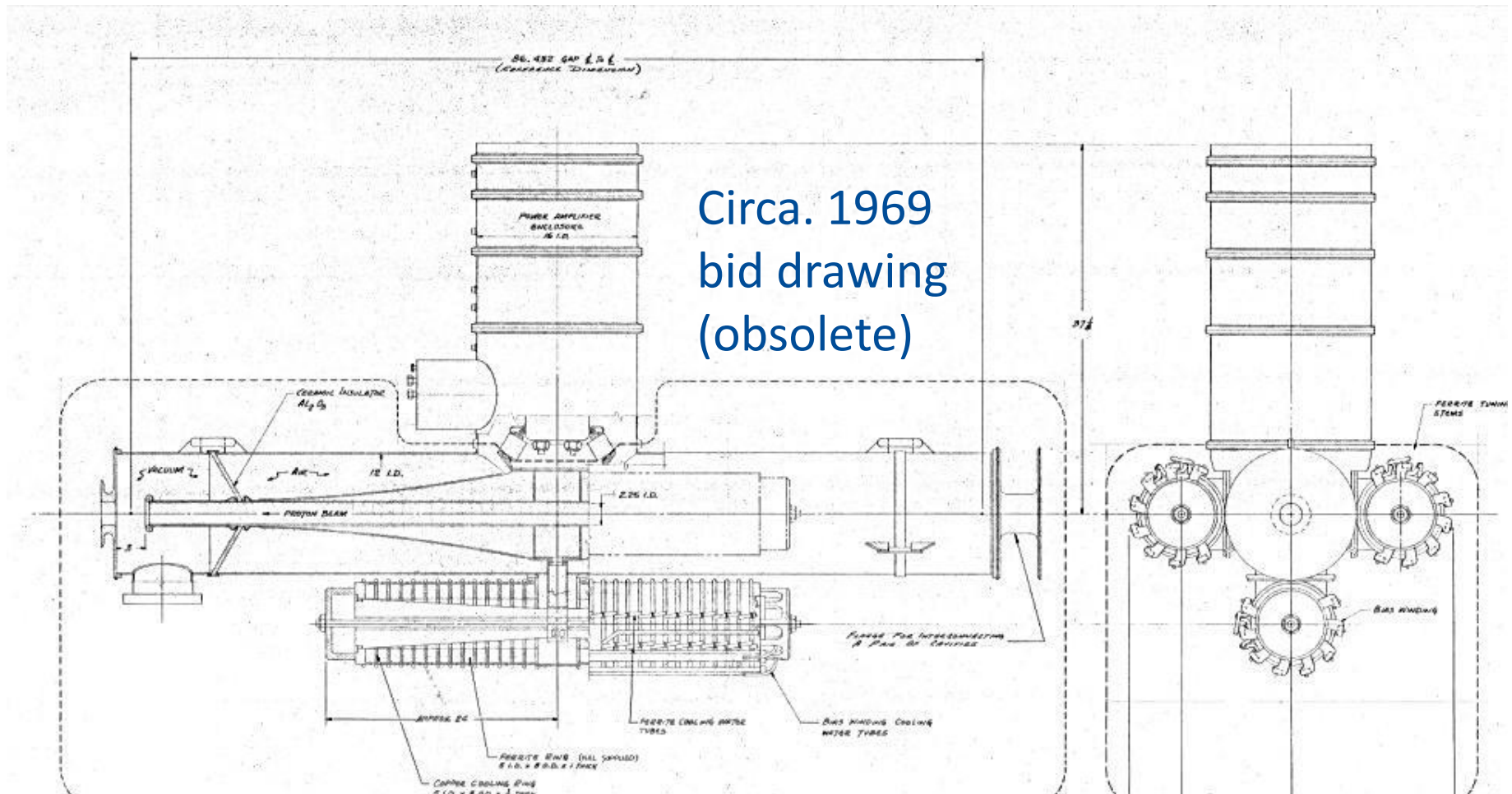
# Topics

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- Proton Improvement Plan (PIP)
- Booster Radio Frequency (RF) Cavities
- Cavity Refurbishment
- Tuner Refurbishment
- Planning for failure
- Testing and Summary



# Booster RF Cavity



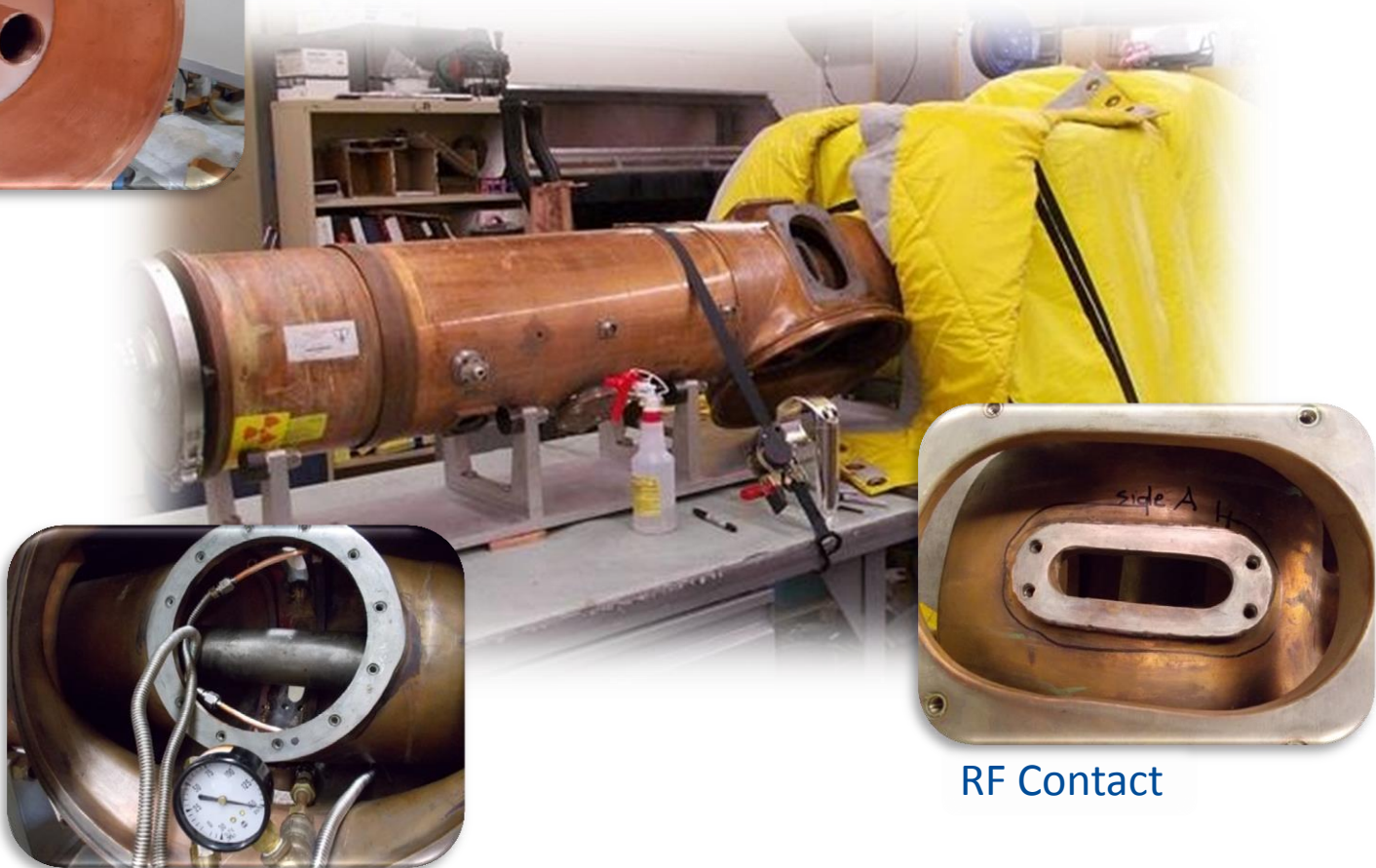
Critical advantage: Access to retired personnel with development knowledge

# Cavity Refurbishment- Scope

Cavities are radioactive and fragile!



Vacuum



Misc.

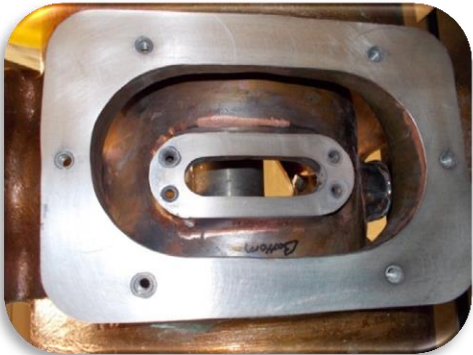


RF Contact

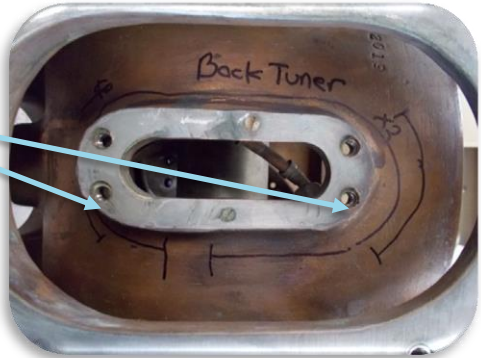
# Cavity Refurbishment- RF Contact



Milling improved quality, reduced time and distance (dose). ~ 7 days → 2 days



Insufficient contact = heat and RF leakage



# Cavity Refurbishment- Vacuum Repair and Upgrade



Leaking “pie-tin” quick disconnect flange

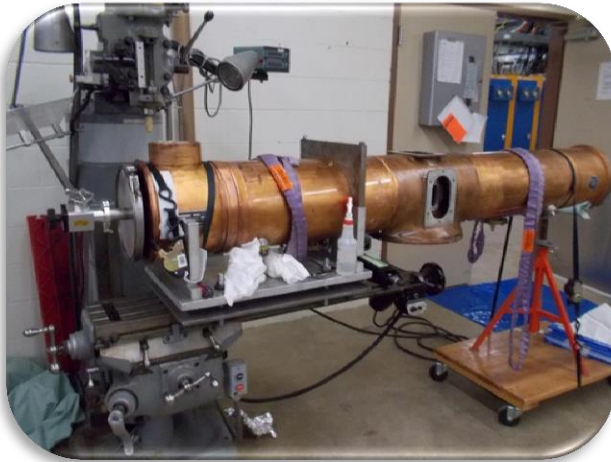
Removal with Wach’s tool



Replace with solid flange



# Cavity Refurbishment



Improvised repair tooling



Alignment fiducials installed



Water cooling repair/upgrade

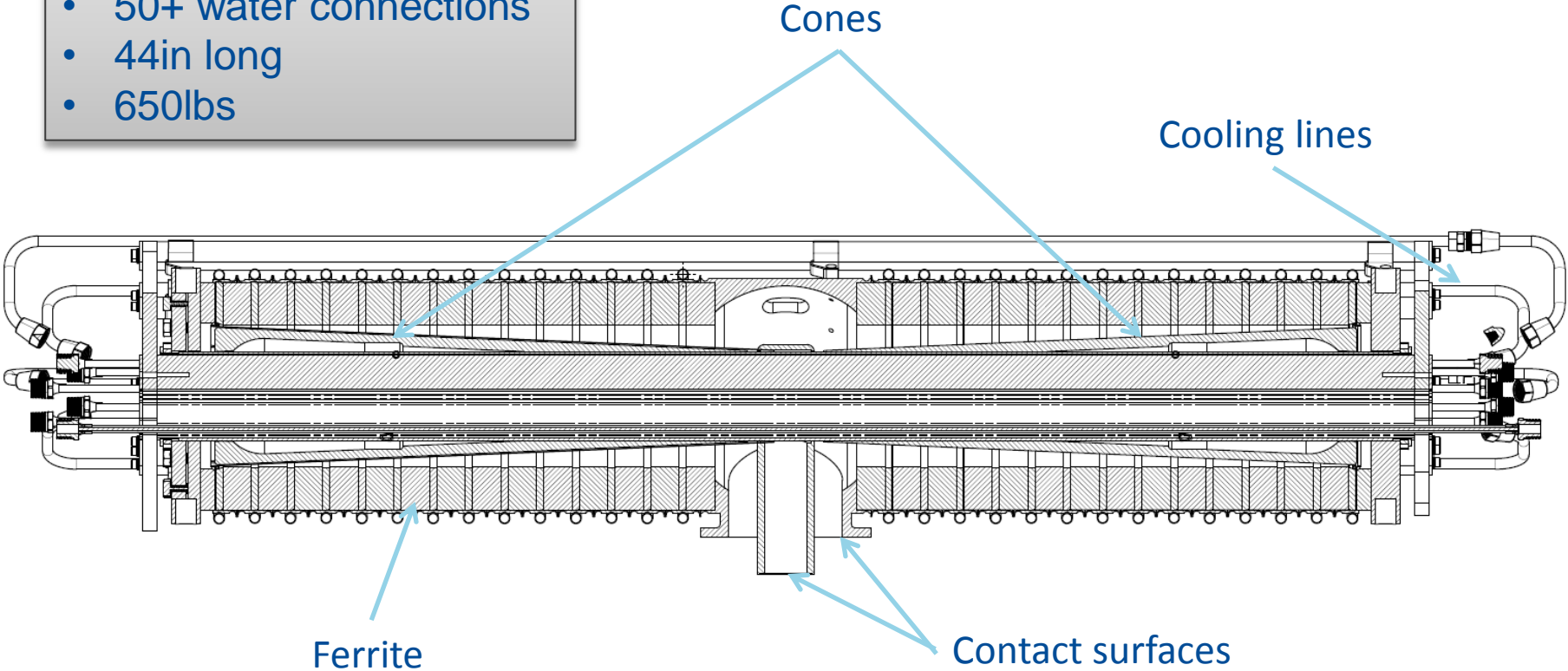


Internal sparking and damage

# Tuner Refurbishment

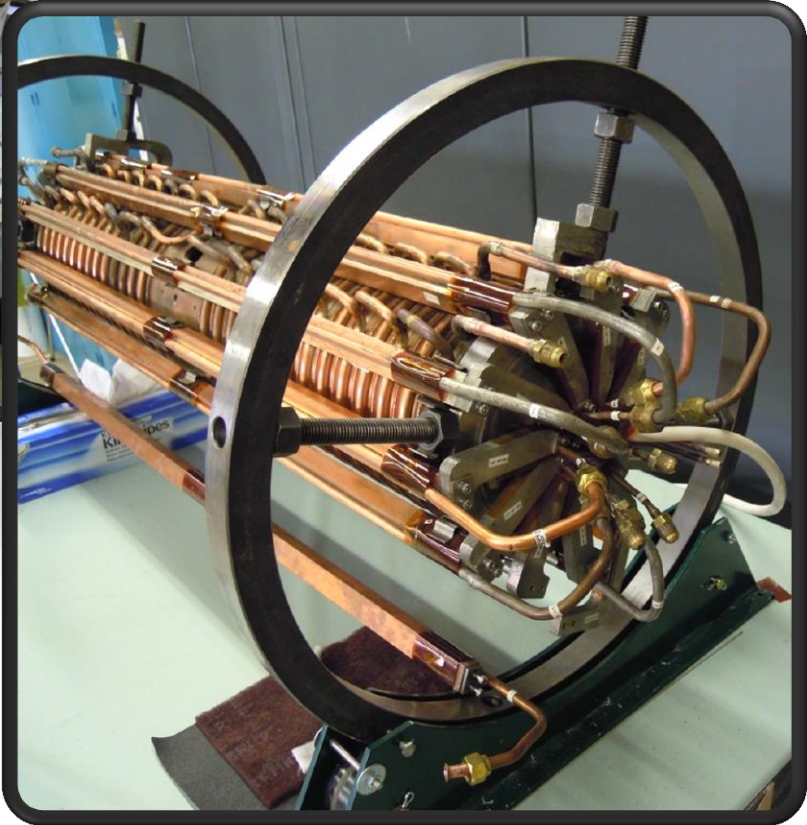
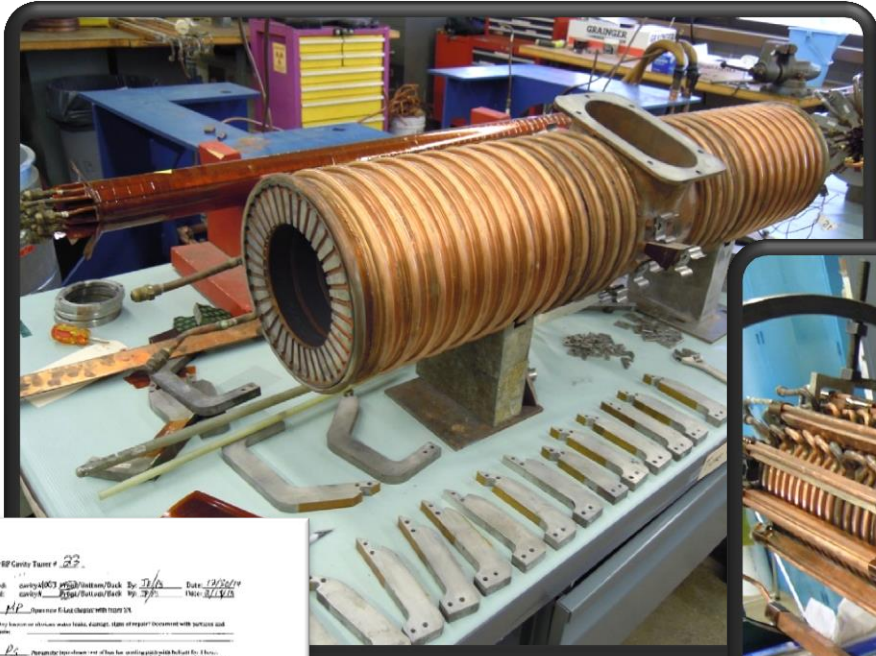
Each tuner:

- 500+ pieces
- 150ft+ tubing
- 50+ water connections
- 44in long
- 650lbs





# Tuner Refurbishment



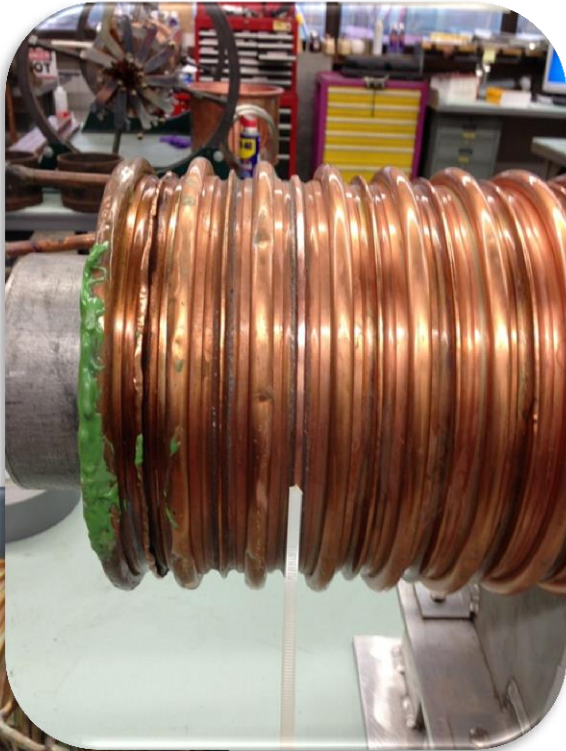
**Revised PIP Cavity Tuner # 22**

Part no. 40013 PIP/Revised/Rev. 7/13 Date: 12/20/15  
 Issue no. 4 PIP/Revised/Rev. 7/13 New: 12/20/15

- HP** Measure RFLC tuner with respect to
  1. Measure RFLC tuner with respect to
- PS** Parallel the top-down view of the tuner with the ballast for 1 hour
  1. Measure RFLC tuner with respect to
  2. Measure RFLC tuner with respect to
  3. Measure RFLC tuner with respect to
- PS** Measure RFLC tuner with respect to
  1. Measure RFLC tuner with respect to
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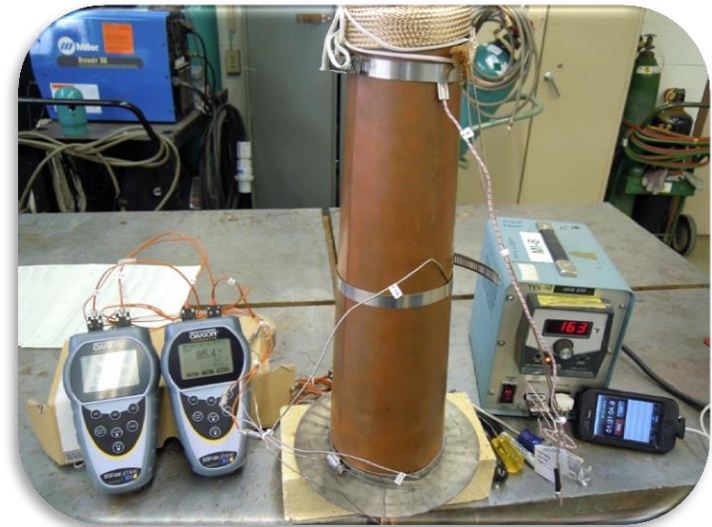
Revision Date: 12/20/15

# Tuner Refurbishment- Risk



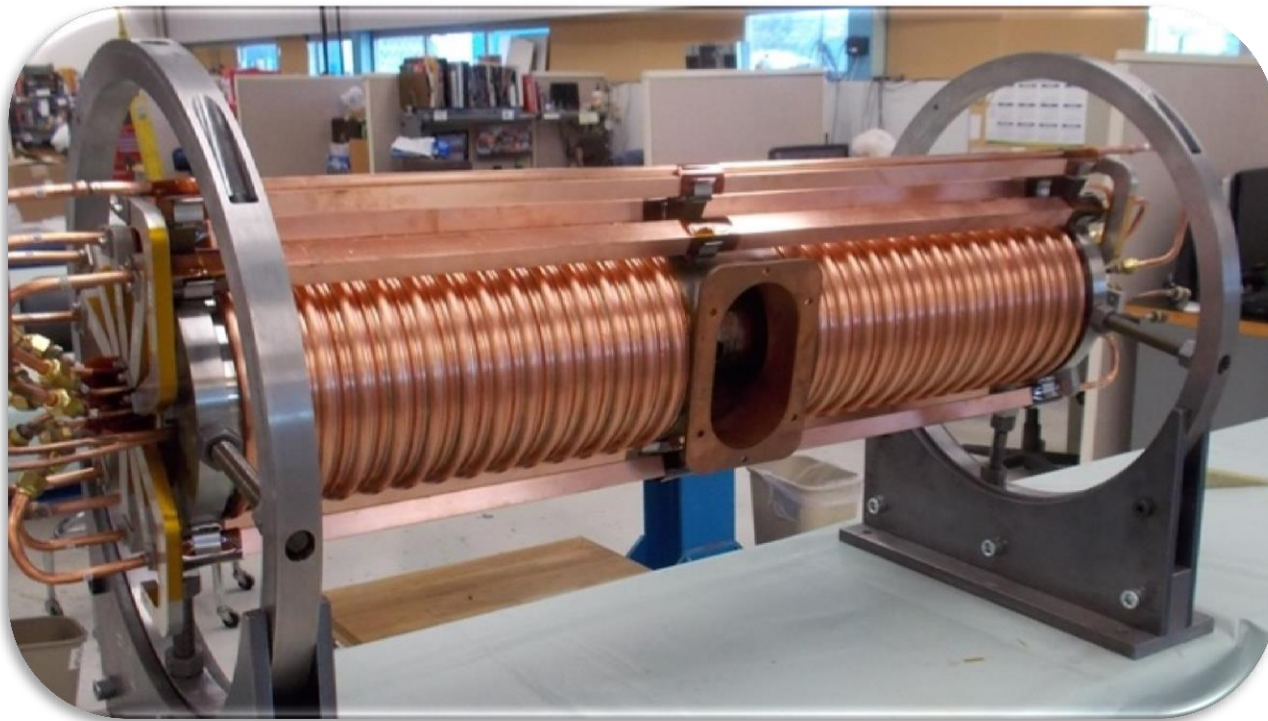
# Tuner Refurbishment- Procurement and challenges

- Difficult procurement
  - Stock items not stock (tube sizes)
  - Common processes no longer common
  - Unusual materials
- Original drawings not updated
  - Undocumented revisions
  - All hand drawings, no CAD
- Little data available for optimizing design changes or benchmarking



# Tuner Refurbishment- Planning for failure

- Have begun building new tuner assemblies
- Potentially replace all refurbished tuners with new



# Cavity Testing and Summary

- Each assembly tested for two weeks prior to install
- Thermal sensors near critical surfaces for real time data
- Beginning production of two spare cavities

- 17 of 20 cavities installed
- 50 tuners refurbished
- 3 tuners built new

