# SUPERCONDUCTING LINAC AND ASSOCIATED DEVELOPMENTS AT IUAC, DELHI

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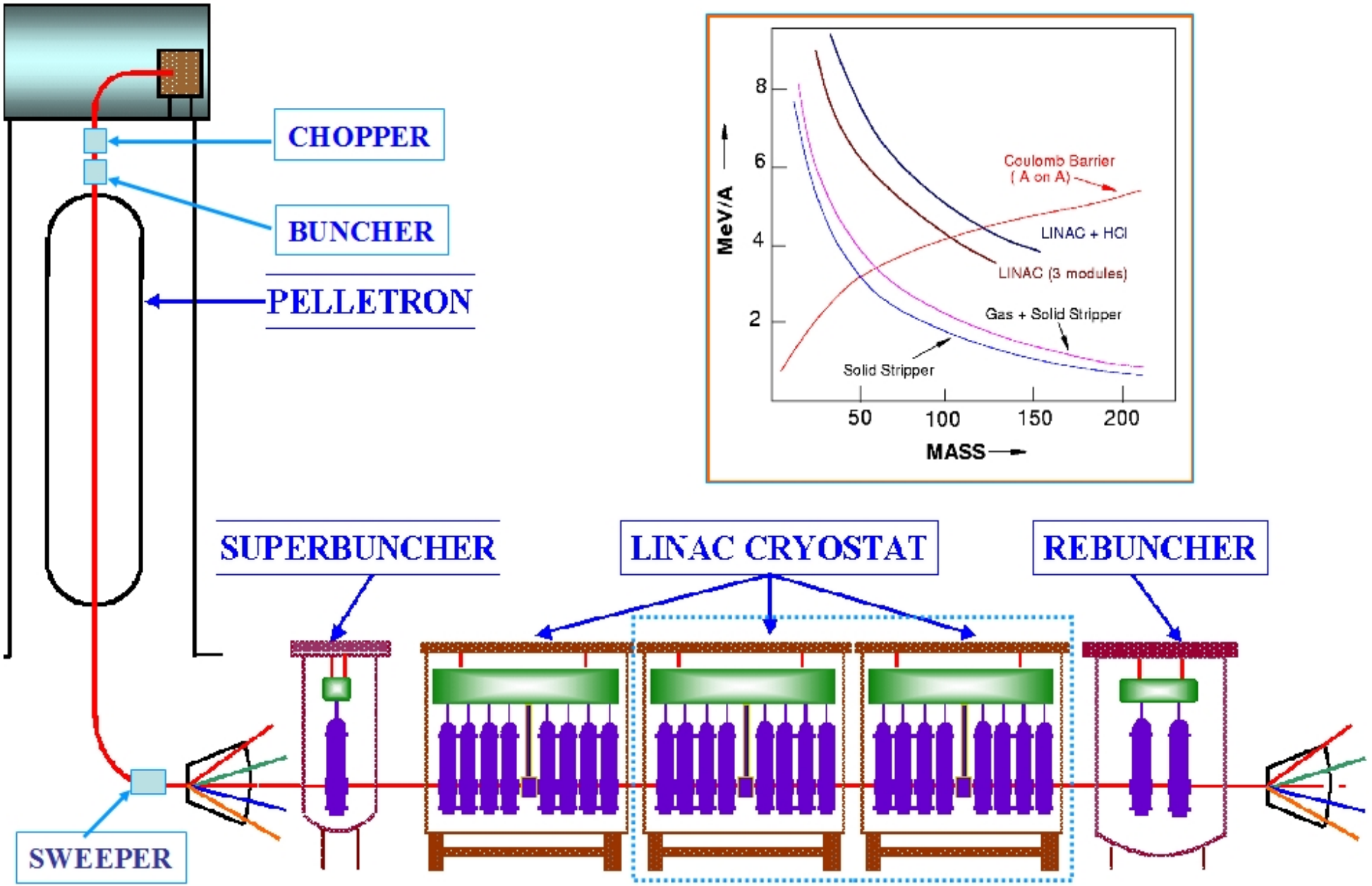
**New Delhi, India**

# Layout of Pelletron and Superconducting Linac Booster




15 MV

3 x 8 Nb QWRs, 97 MHz, β = 0.08

**Superconducting Linac booster for Pelletron**

- **Nb QWR developed in collaboration with ANL, USA**
- **Subsequent in-house technology development**

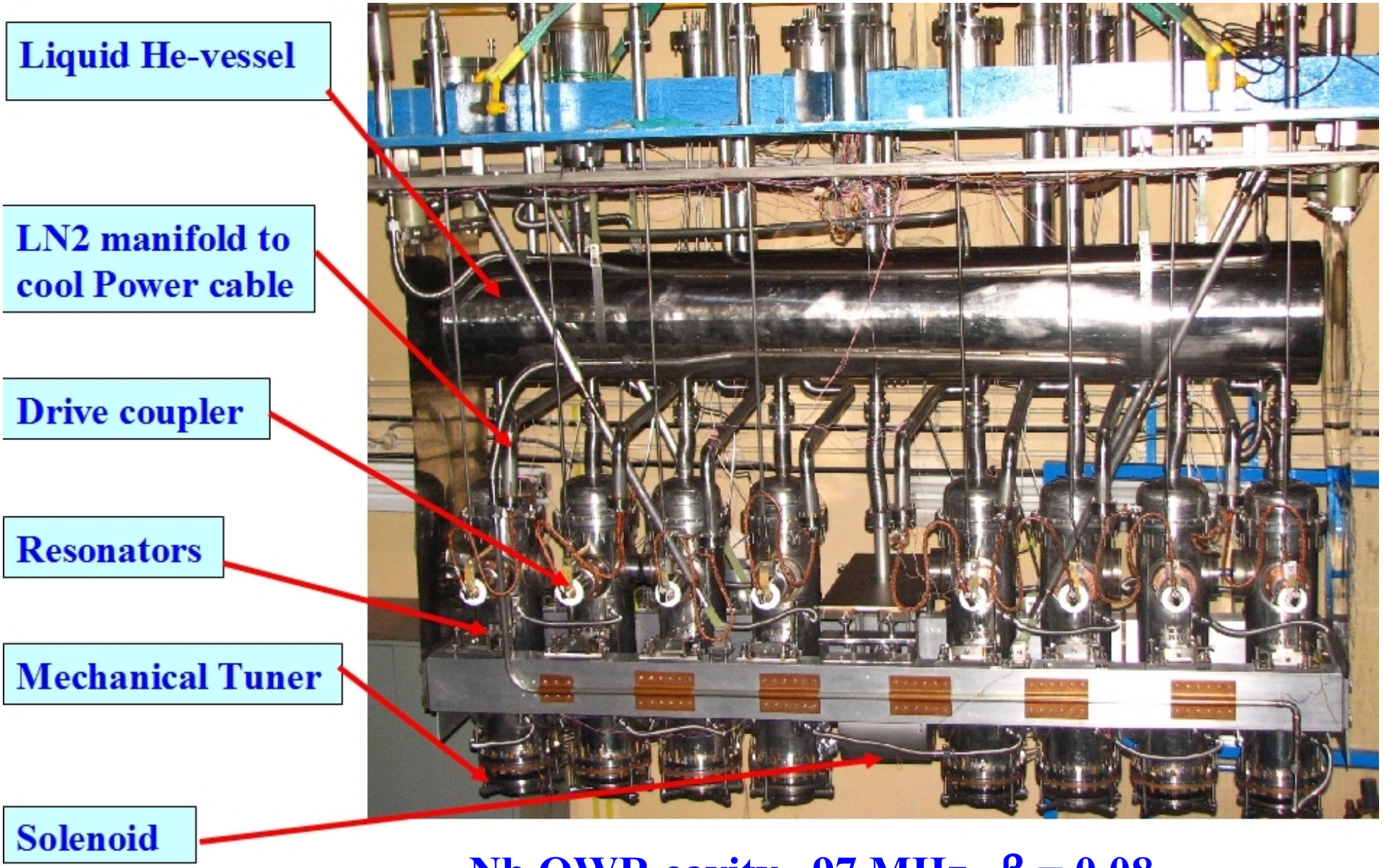
**High Current Injector**

- **Novel Electron Cyclotron Resonance ion source.**
- **Room temperature RFQ, DTL, Low beta SRF cavity**

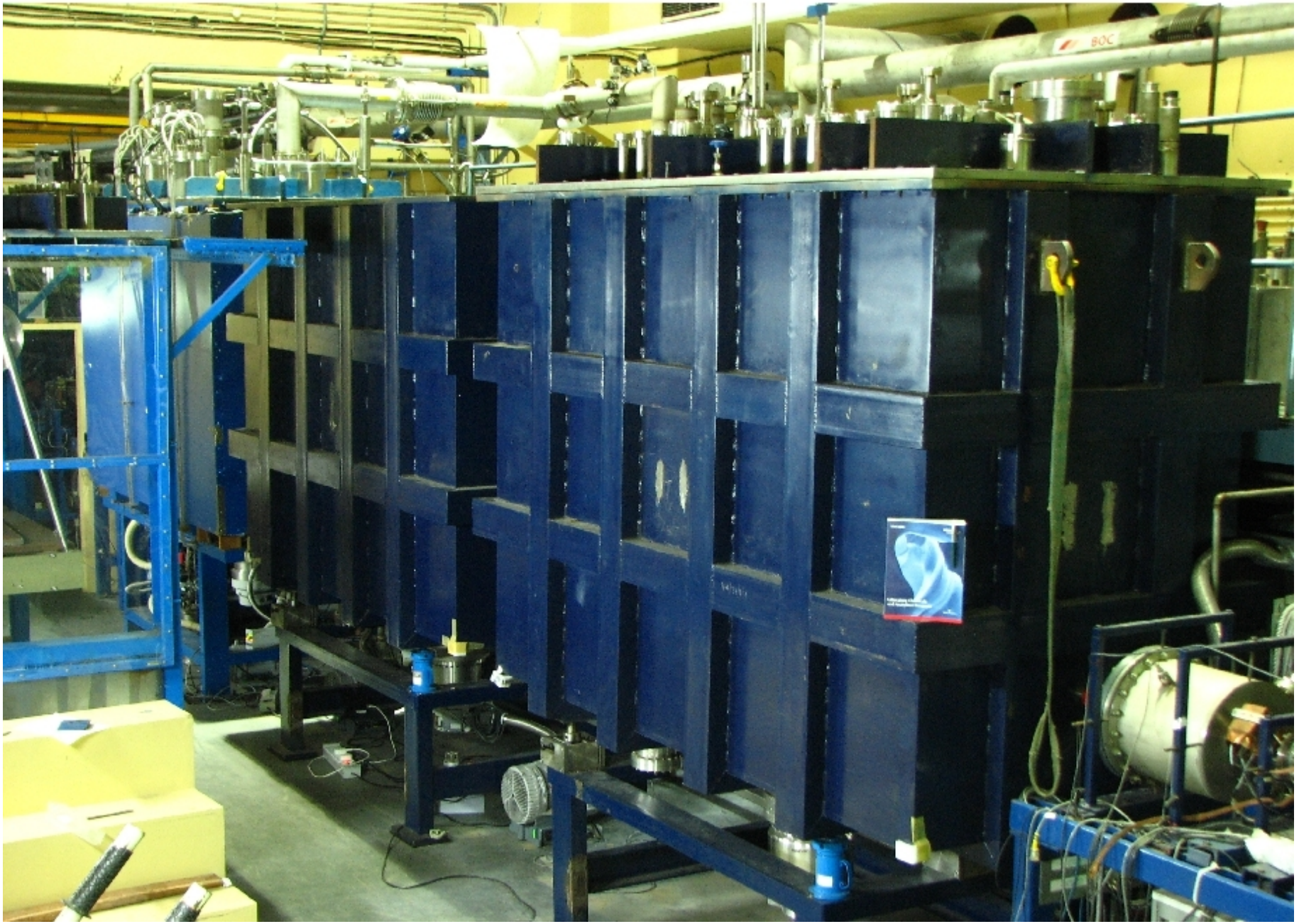
**Other Resonator Development**

- **Single Spoke Resonator**
- **1.3 GHz TESLA type cavity**

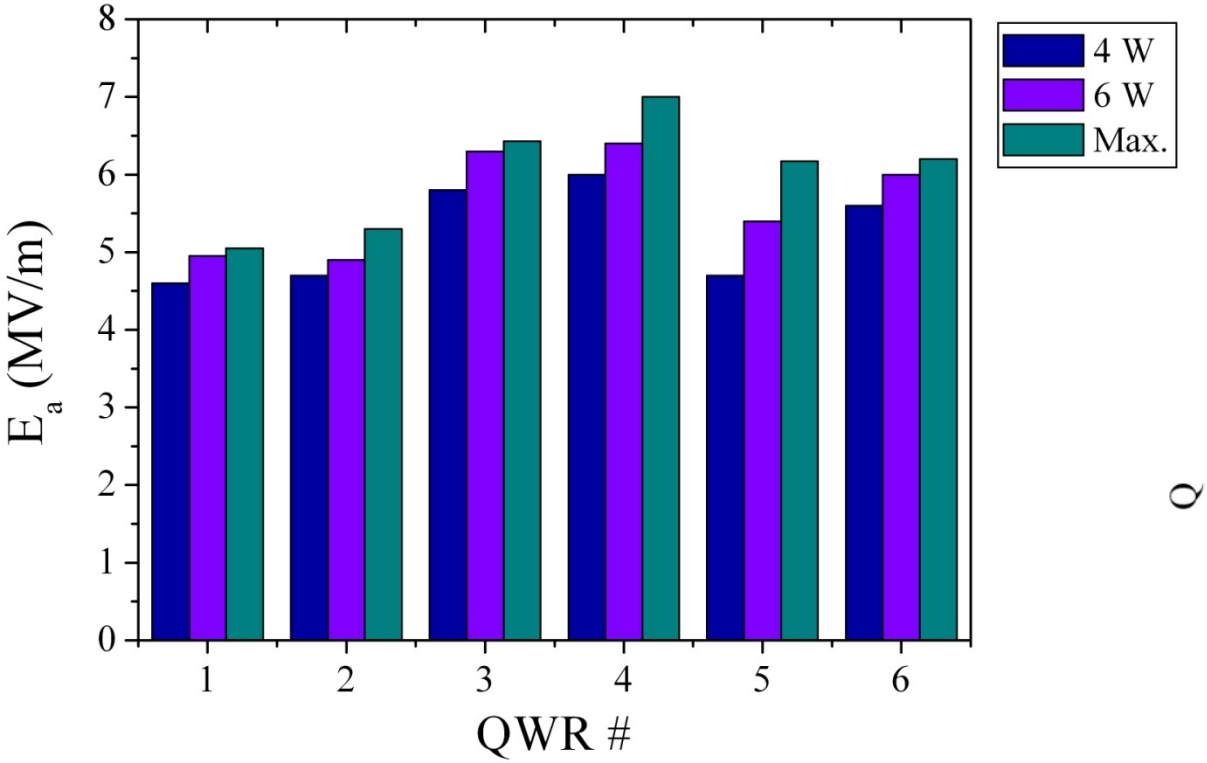
# Inside of a Linac Module



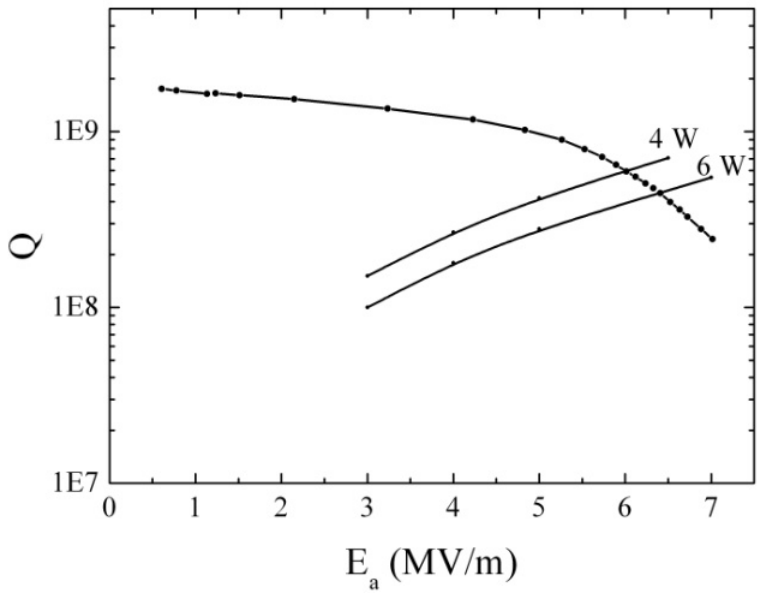

**Nb QWR cavity, 97 MHz, β = 0.08**



**All three Linac Cryostats in Beam Line**




Accelerating gradient E at 4.2 K achieved in different QWRs




Resonator Q as a function of the accelerating gradient E at 4.2 K

# Problems encountered:

**To lock resonators at fields @ 6 watts, due to presence of microphonics, power > 300 watts was required.**

**@ 300 watts, cable melting, heating up of the drive coupler causing increased cryogenic loss.**

**Solution: Frictional damping using SS balls.**
**Cooling of drive coupler**

# Recent Improvements:

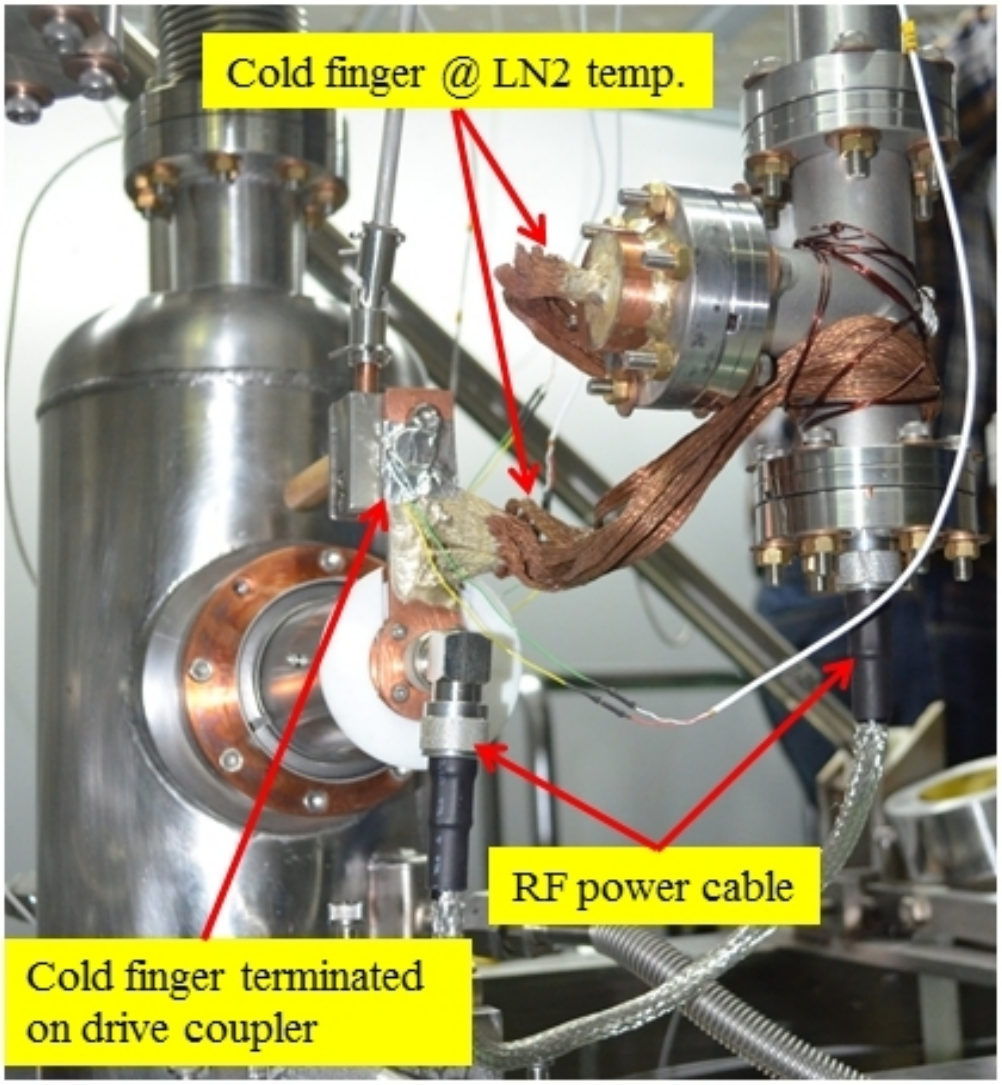
**More efficient vibration damping using SS balls of mixed diameters.**

**An alternate tuning mechanism using piezo actuators has been tried out successfully.**

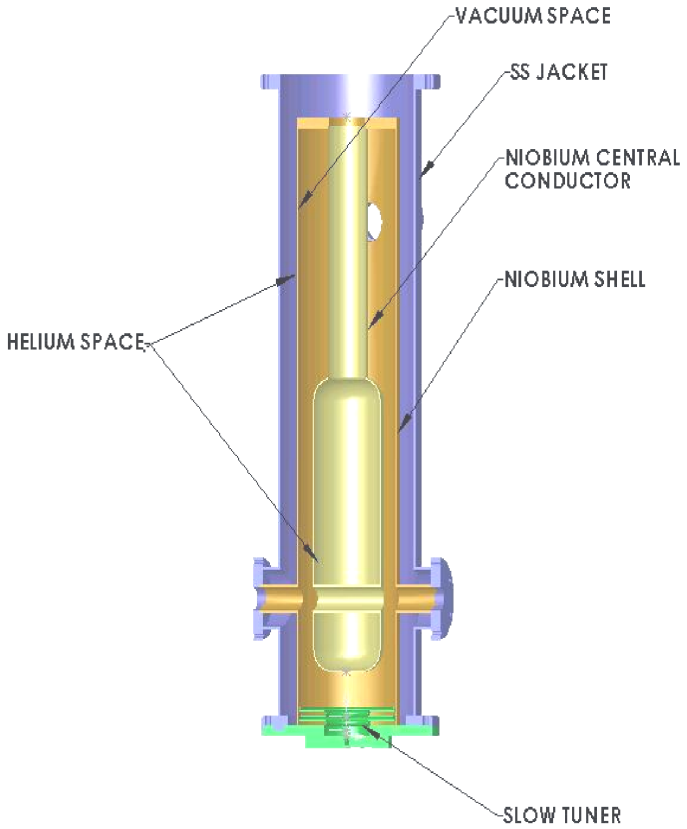
**An additional cooling mechanism for power coupler has been successfully tested.**

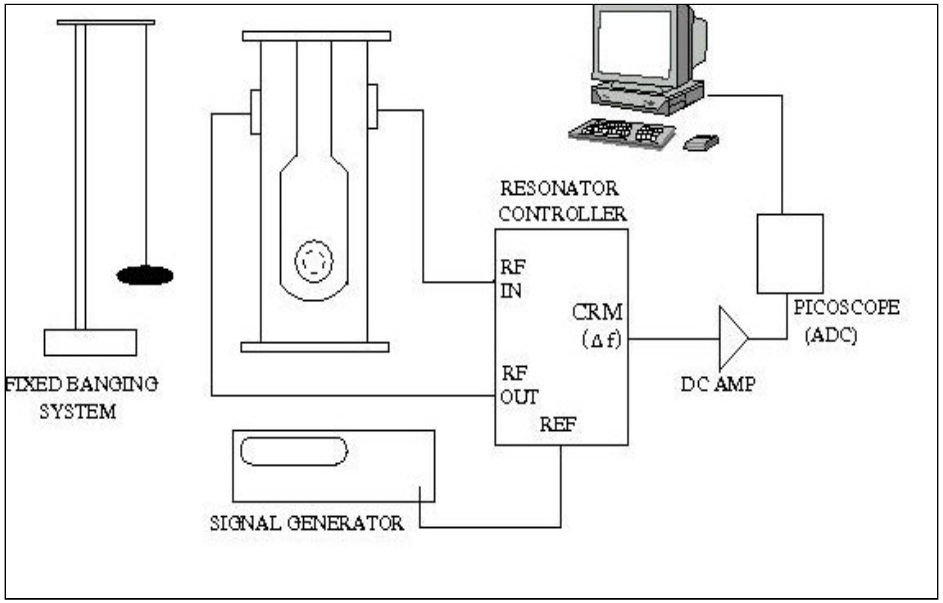
**A commercial high temperature cable (HP226, 275 C) (100% shielded) tested successfully with higher power.**

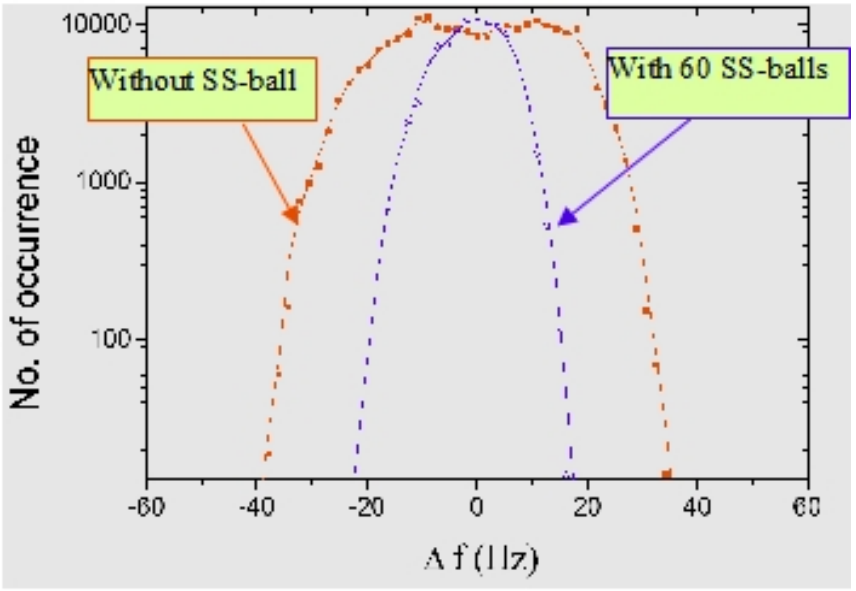
# Additional Cooling of drive coupler

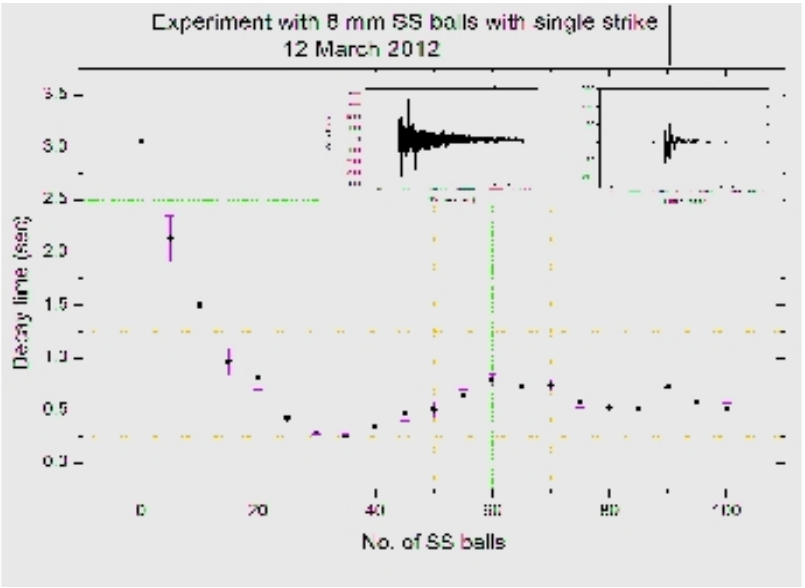


# Vibrational Damping



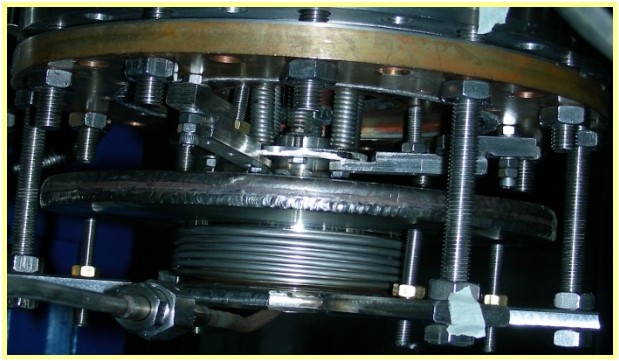



# Piezo Tuner

Frequency fluctuation happens in two time scale –
Fast – due to presence of microphonics,
Slow – due to Helium pressure fluctuation etc.




Piezo-Crystal specifications:
Model – P-844.60,
Voltage: -20 to 100 V,
Open loop travel: 90 µm,

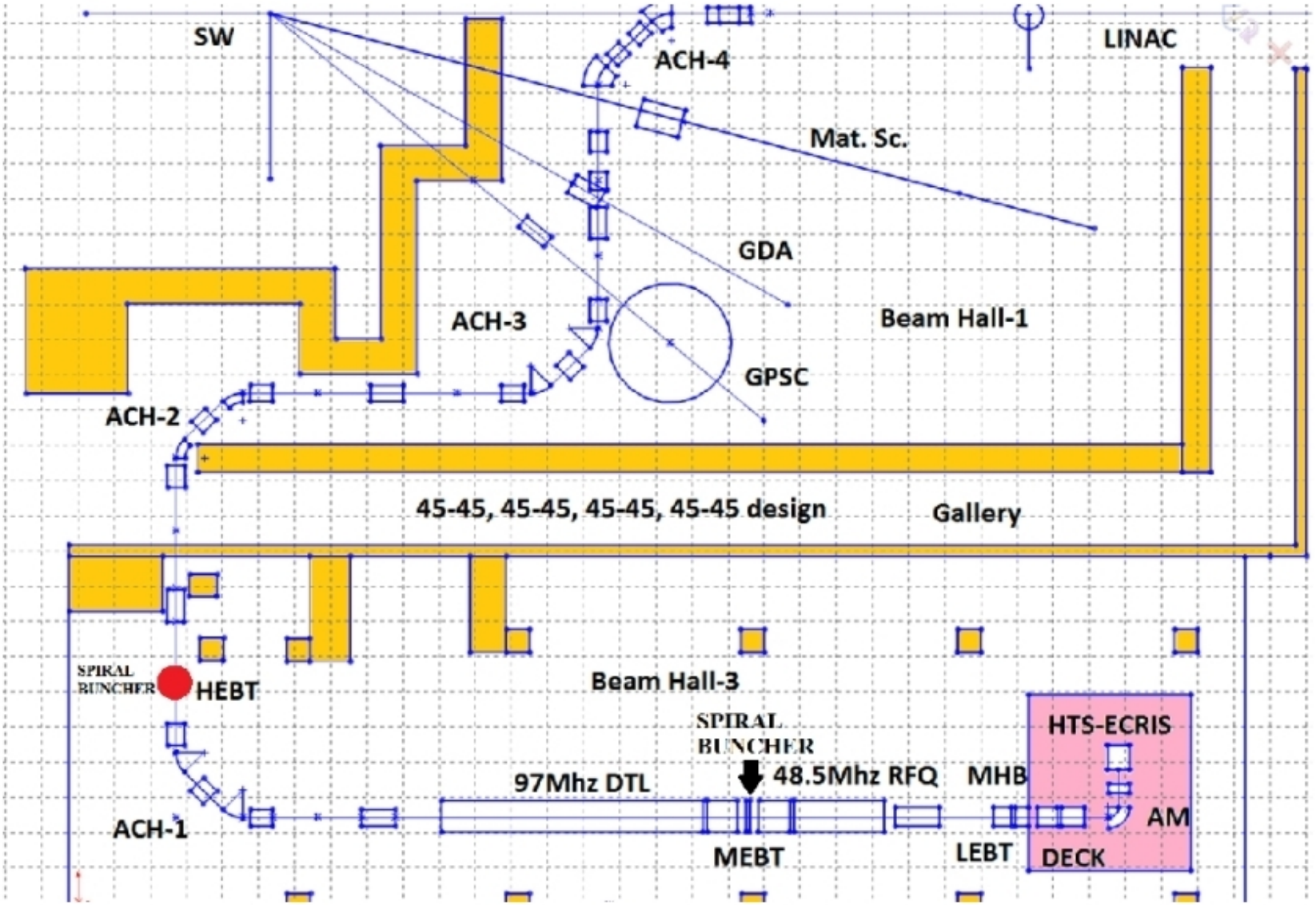
| Gas controlled tuner (Present) | | | Piezo-crystal tuner (new) | | |
|---|---|---|---|---|---|
| Response Time | Frequency Variation | Amplifier Power | Response Time | Frequency Variation | Amplifier Power |
| Seconds | 97,000,000 ± 50 Hz | 100 + 80 watts | ~ 50 msec | 97,000,000 ± 2.5 Hz | 100 + 4 watts |

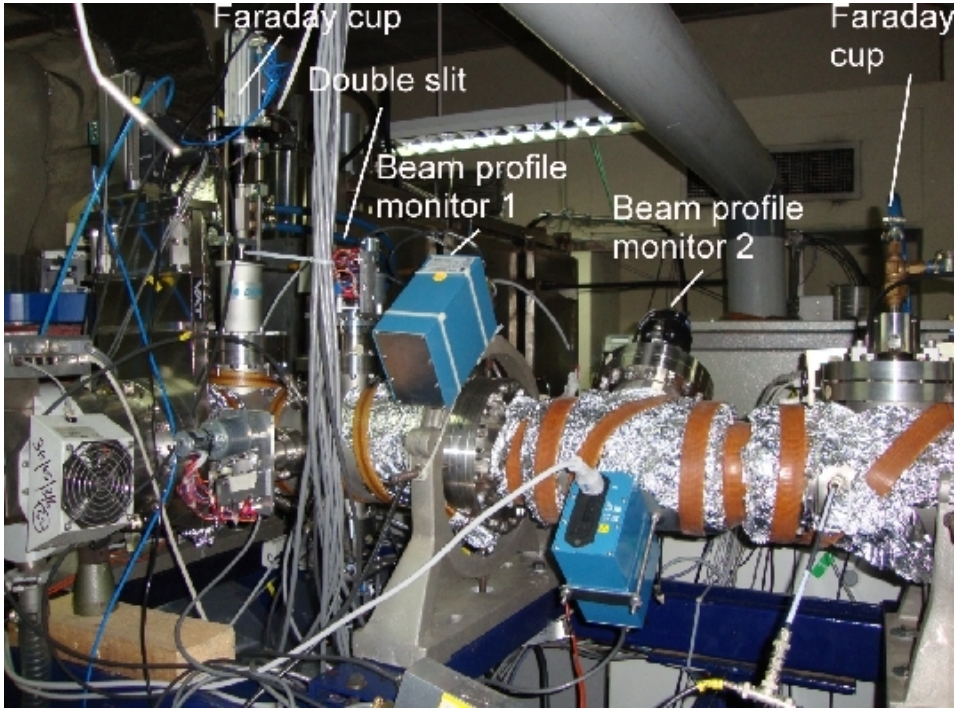
Tuning range by mechanical movement:
~ 150 kHz at RT
~ 100 kHz at 4.2K

Tuning range by Piezo control:
~ 2.5 kHz at RT
~ 900 Hz at 4.2K

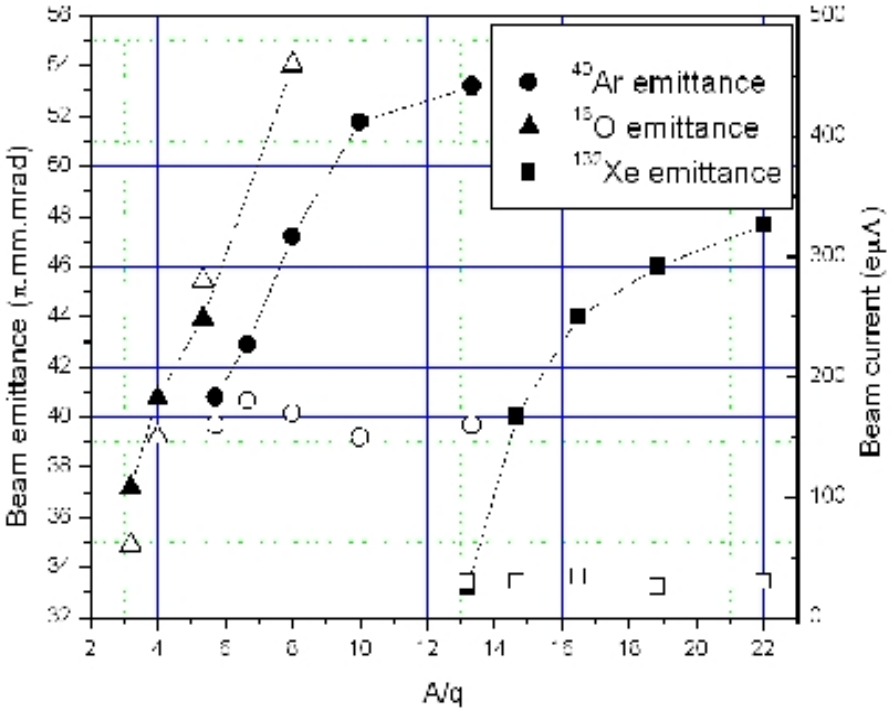
**POSTER TUPB033**
**B.K. SAHU et al**

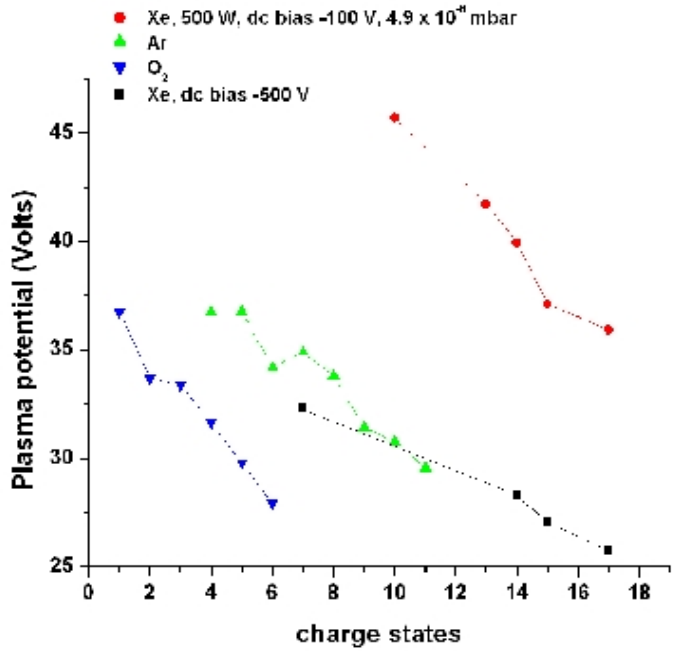
# ECR based High Current Injector for LINAC



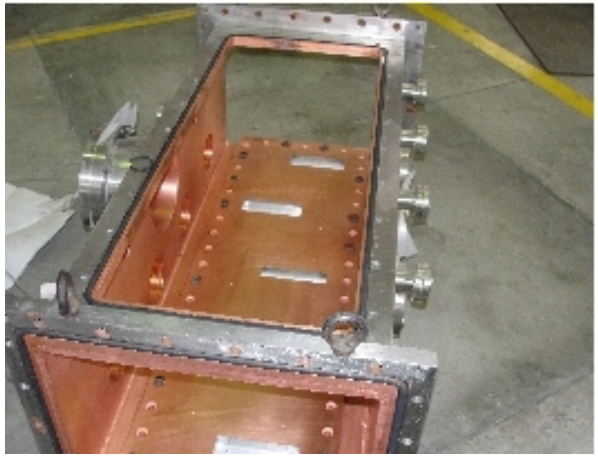


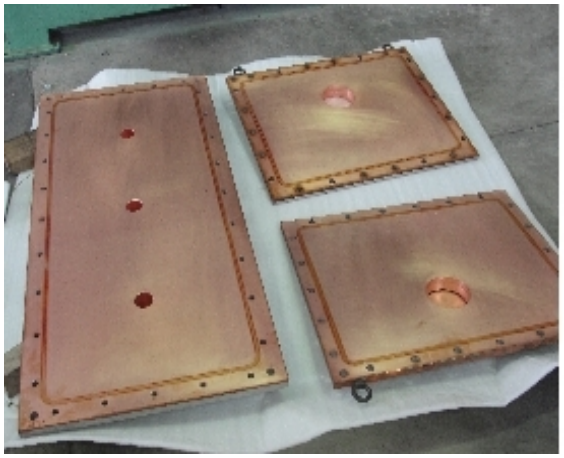

# PKDELIS ECR source and emittance measurement

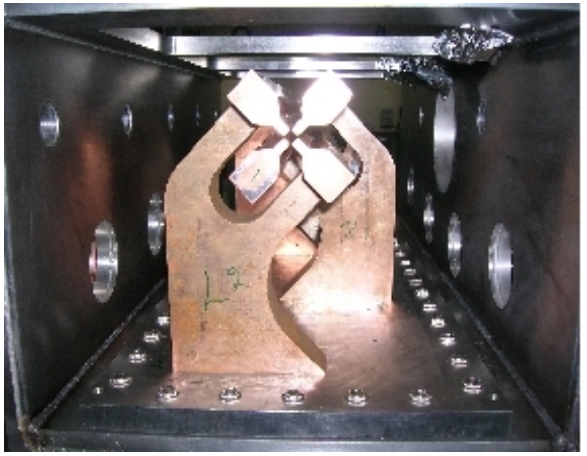


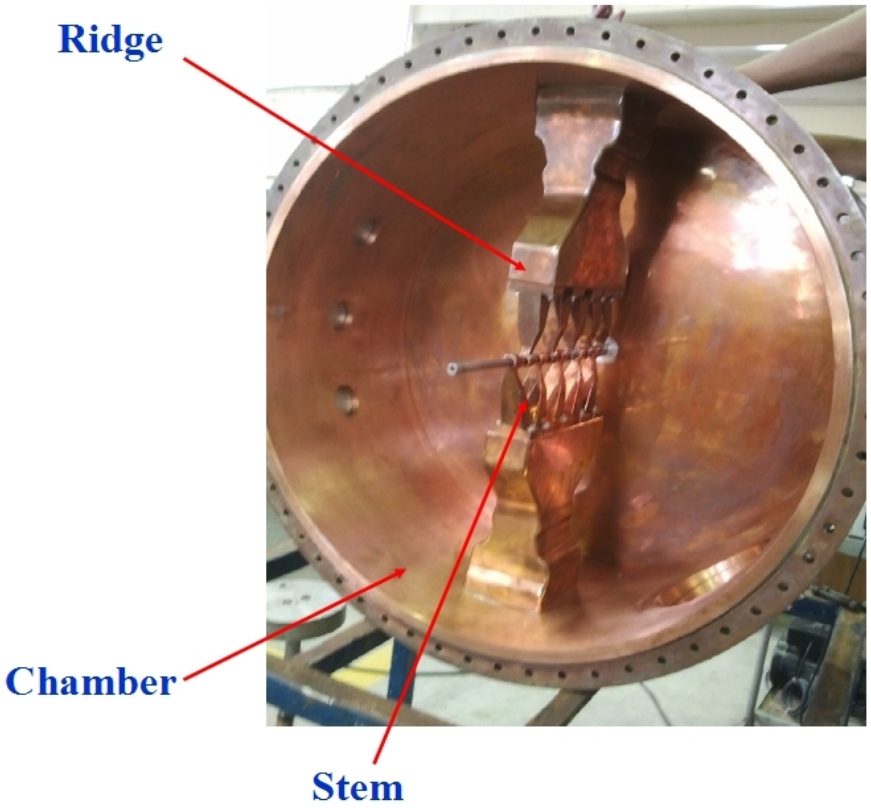

# Plasma potential measurement



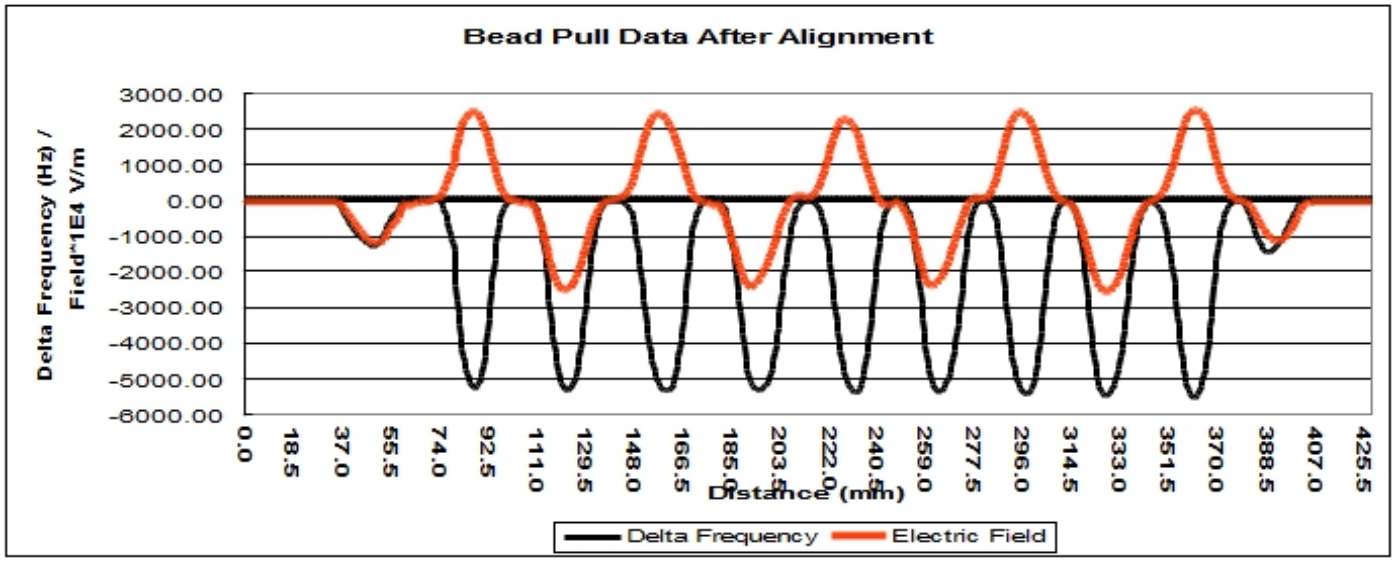




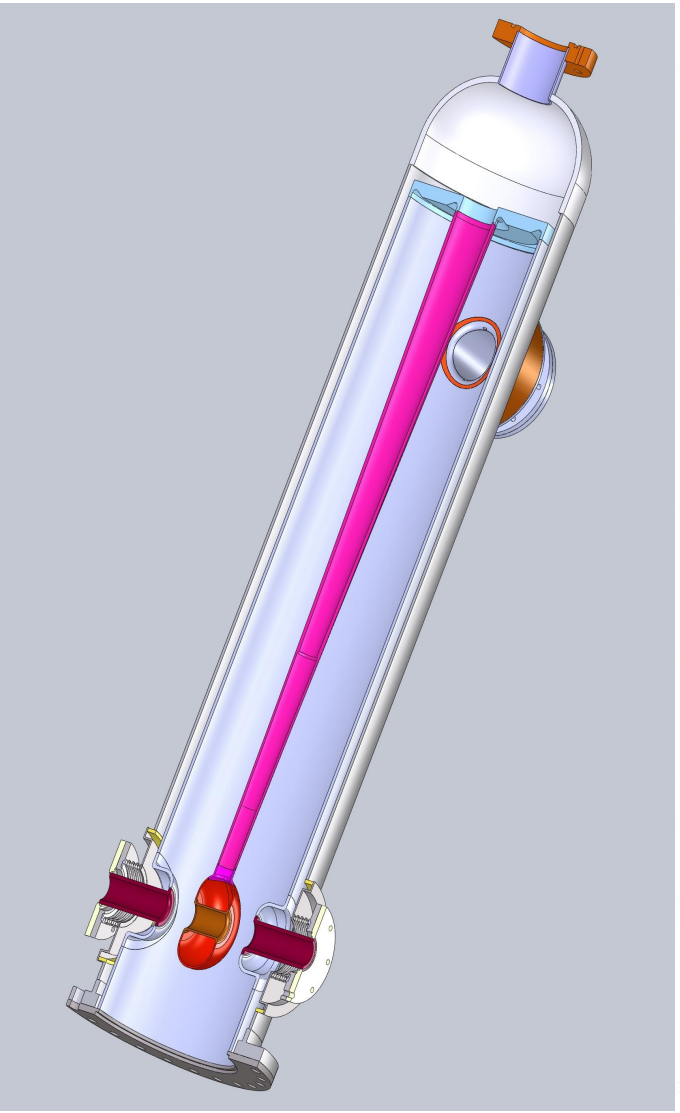
## RFQ Prototype with Cu plated ss tank, Cu vanes tested upto 26 kW




1. Input 180 keV/u
2. Final energy 1.8 MeV/u
3. 6 tanks, 97 MHz
4. IH Structure
5. Integrated bunching action



# Low beta QWR Cavity $\beta = 0.05$, $f = 97$ MHz



(a)

(b)

# STATUS of HCI

| | |
|---|---|
| HTS ECR Ion Source, DC, (PKDELIS) | **Ready** |
| ECR + HV Deck, DC, 8 keV/amu | **Design Completed / Fabrication** |
| MHB, 12.125+24.25+48.5, 1kV Peak | **Fabrication** |
| RFQ, 48.5, 180 keV/amu | **Prototype Tested/ Fabrication** |
| DTL, 97, 1.8 MeV/amu | **Prototype Tested/ Fabrication** |
| Low Beta Cavity, 97, 0.05 | **Cu Prototype Over/ Nb Fabrication** |

# SRF Infrastructure at IUAC



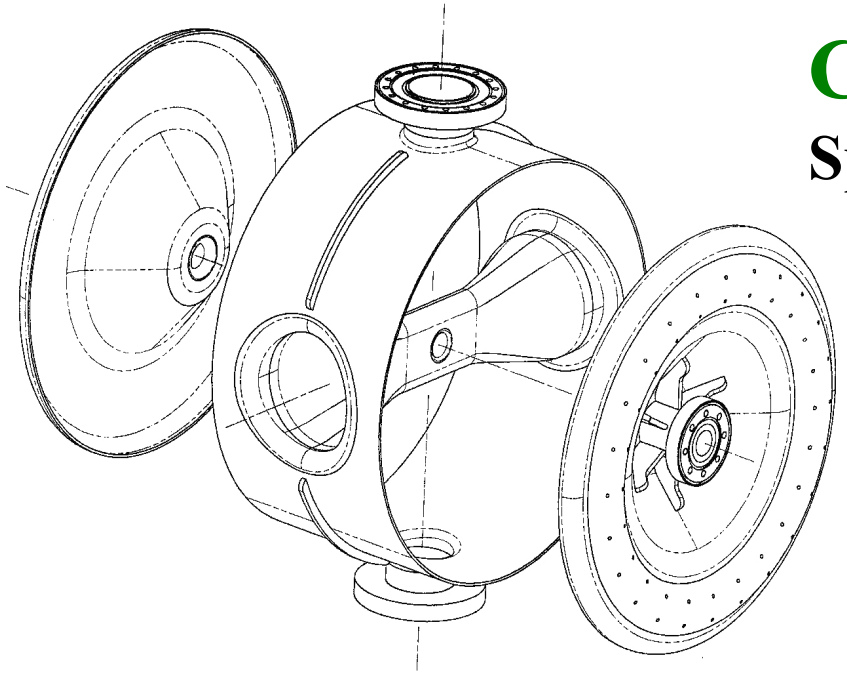
All mechanical works, e.g. forming machining etc. are performed by a commercial vendor, with whom we closely work.




**Liquid He Plant with dewar. Cap – 750W, Tested for 950W**

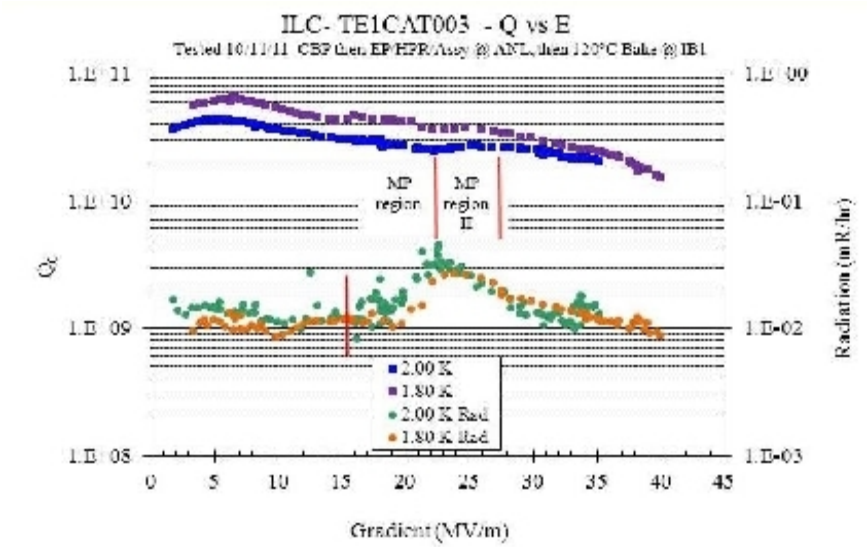
# Collaborations

## Spoke Cavity for Fermilab Project X




**β =0.22, 325 MHz**

## 1.3 GHz TESLA type Cavity with RRCAT & Fermilab




# SUMMARY

**Superconducting Linac Booster operation made smoother and performance improved.**

**Alternate high current injector project prototypes tested.**

**New SRF cavities being developed in collaboration.**

**Thank You for your attention!**