

SRF Regional Report (Americas)

H. Padamsee

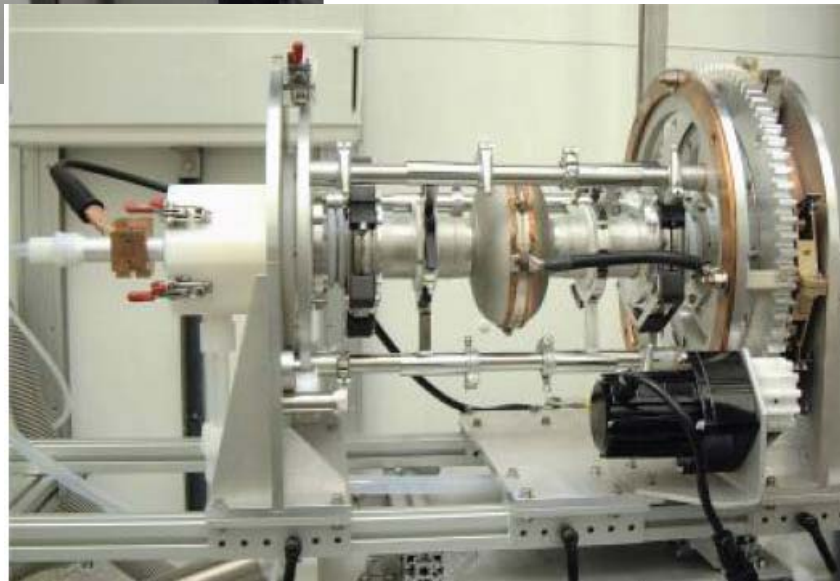
- Many thanks to
 - Mark Champion, Tug Arkan, Elvin Harms, Camille Ginsburg, N. Solyak, Genfa Wu, Joe Ozelis, A. Mukherjee, M. Kelly, Rongli Geng, Peter Kneisel, C. Reece, T. Tajima, R.Laxdal

Outline

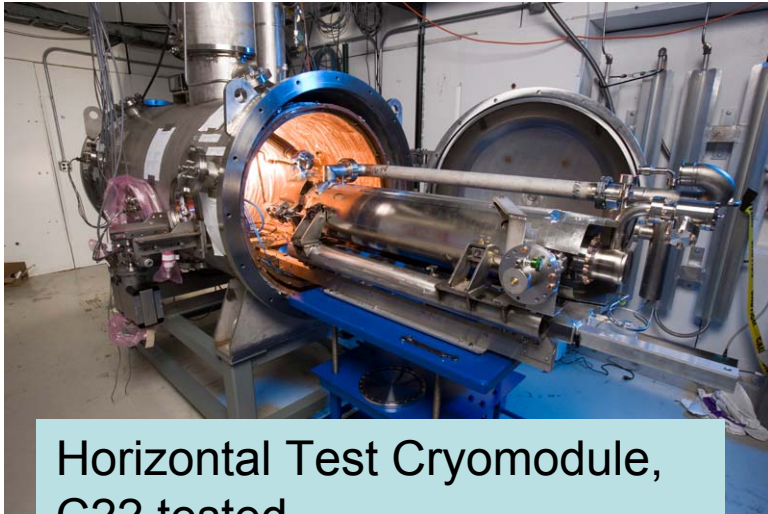
- Status of infrastructure installations (FNAL, ANL)
- SRF R&D for ILC - S0/S1 (Jlab, Cornell)
 - + New vendor qualification
- Large Grain 9-cell first results (Jlab)
- 3rd Harmonic Status (FNAL)
- ERL Injector work at Cornell
- Newcomer TRIUMF
- CEBAF Upgrade and SNS covered in separate talks

Argonne EP Commissioned with One-Cell

Cornell HPR System
Designed and Under
Construction (FNAL)



Fermilab CM Assembly



Horizontal Test Cryomodule,
C22 tested



String Assembly with DESY Cavities



Cryomodule Assembly with DESY Assistance



First CM Ready for Test Facility

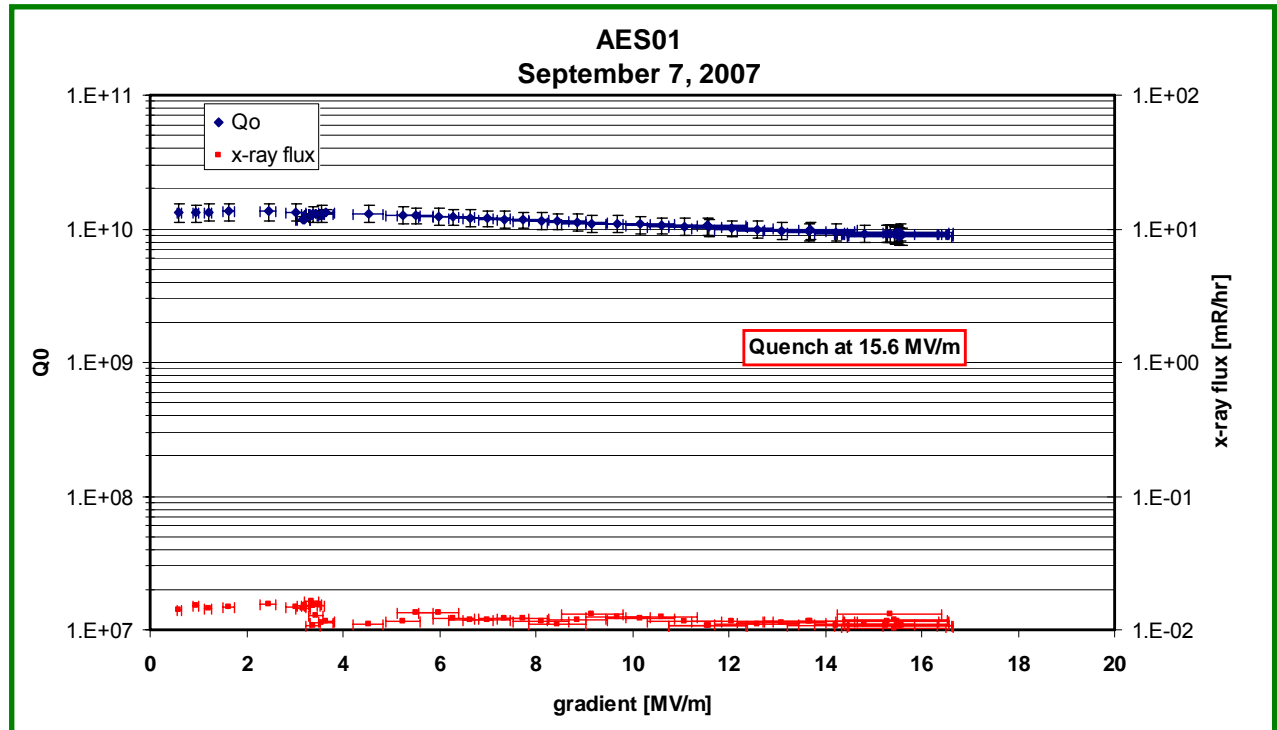
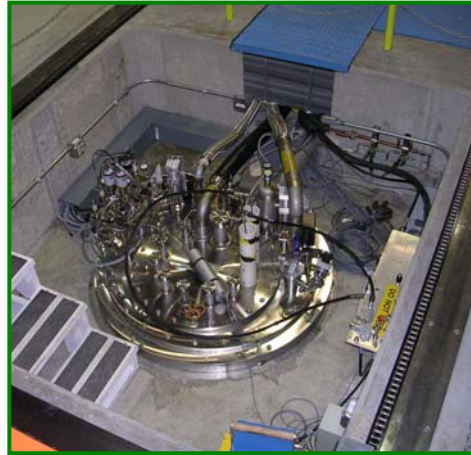
Comments on CM Assembly

- String assembly 10 days
- Cold mass assembly 14 days
- Cold mass transported to CM assembly building
- CAF-MP9 to CAF-ICB
- CM assembly complete
- CM assembly infrastructure now fully operational
- Second cold mass assembly fixture installed at CAF-ICB.



Fermilab: Vertical Test Set Up Complete

1st 9-cell Cavity Test Result

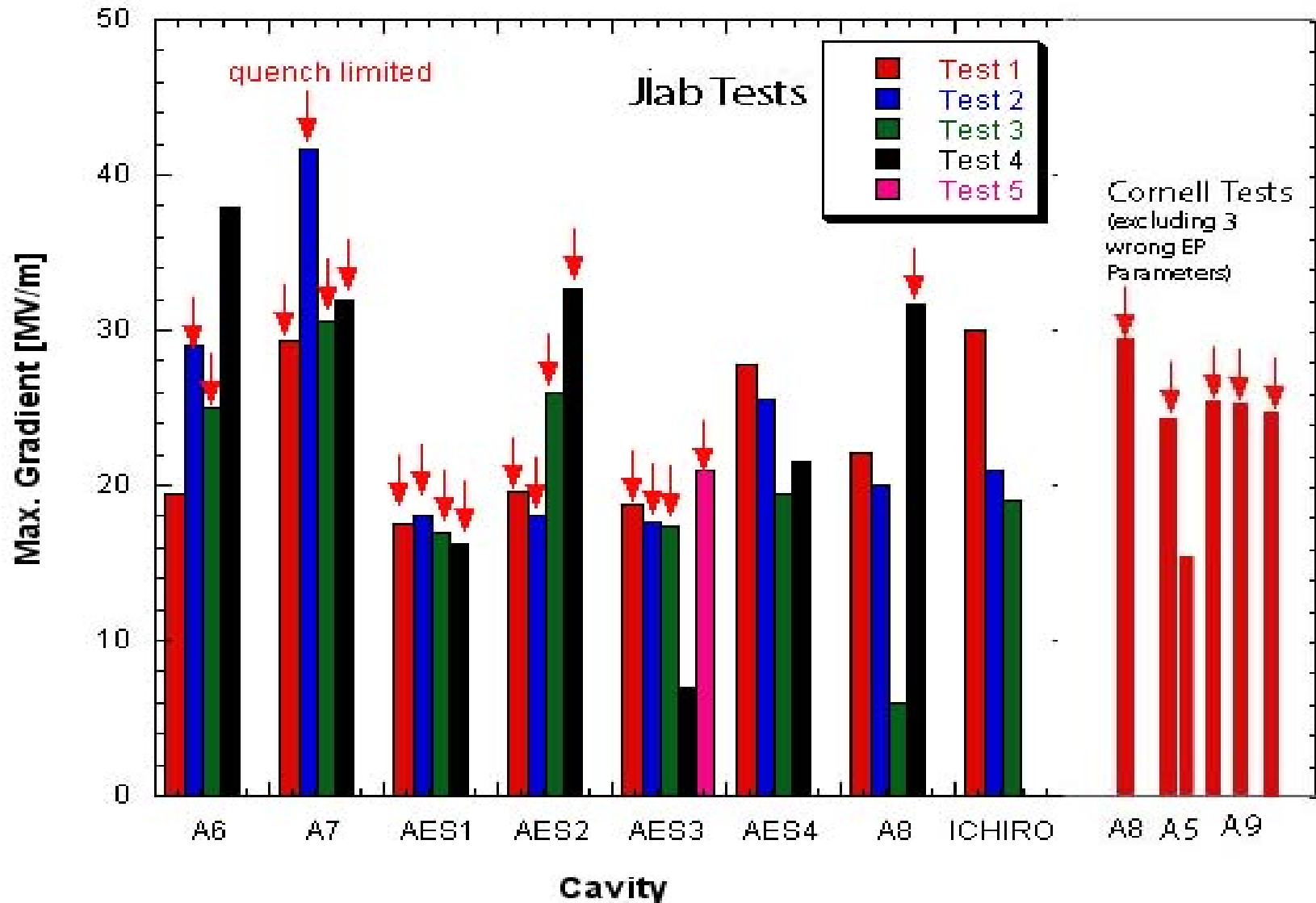


9-cell EP and Vertical Tests

- Jlab
 - Achieved 30 cycles of EP/VT per year.
 - Post-EP ultrasonic cleaning with “soap” always used.
 - A6 and A7 processed 4 cycles for ILC S0/S1.
 - A8 started on S0 tight loop
 - KEK ICHIRO 5 cavity testing started
 - New vendor cavities evaluation AES 1 – 4
- Cornell
 - One cycle per month
 - Post-EP ultrasonic cleaning with “soap” always used.
 - A8 and A9 qualified for quench ≥ 25 MV/m
 - A8 sent to Jlab for tight S0 tight loop
 - A9 started micro-EP (5 microns) to study effect on quench
 - 9-cell re-entrant cavity work started
 - New vendor AES (new beam welder) 1-cell cavity rapid qualification

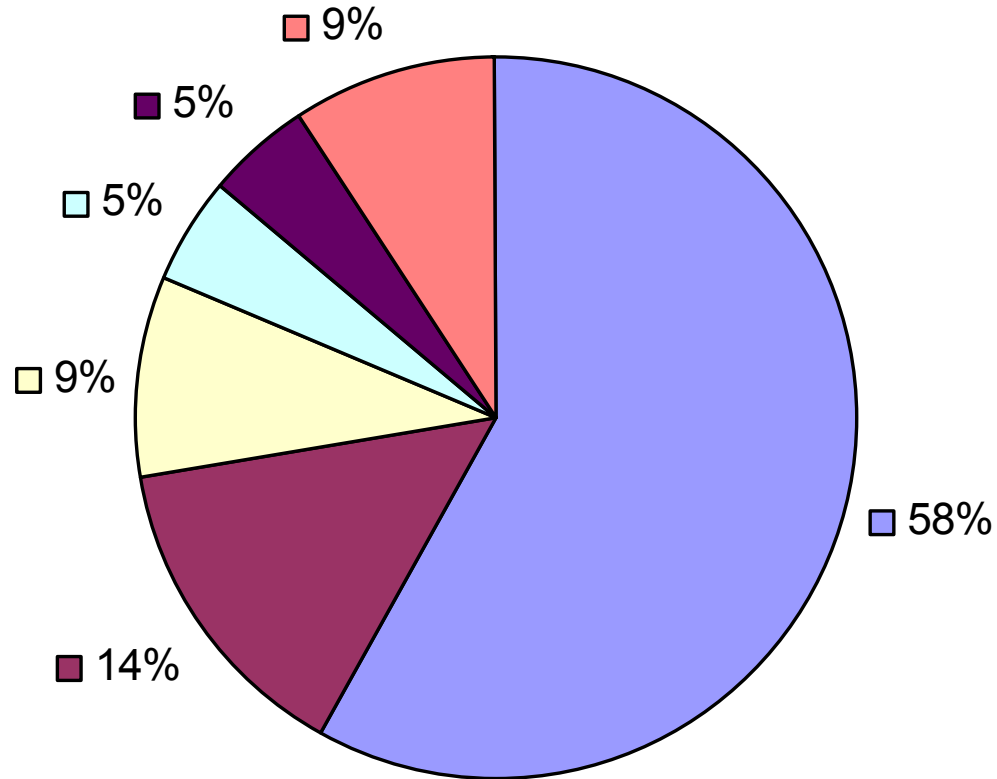
9-cell Test Results

Mostly Jlab and Some Cornell



Jlab

Total 43 vertical tests



■ quench ■ field emission ■ cable breakdown ■ available power ■ Q-slope ■ other

Best 9-cell cavity gradient results

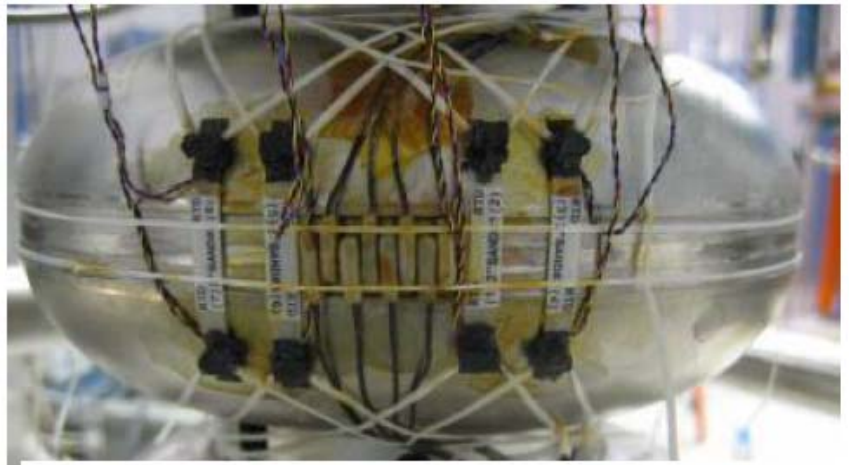
- 4 cavities (A6, A7, A8, AES2) best gradients of 31-42 MV/m. Quench limit sensitive to re-processing.
- 2 cavities (AES4, ICHIRO5) reached gradient of 28-30 MV/m. Field emission limit.
- 2 cavities (AES1, AES3) reached gradient of 19-21 MV/m. Quench limit **insensitive** to re-processing
- Pass-band & Thermometry to locate defect.
- AES 3 defect is in cell 6
 - Near, but outside equator weld
- AES 1 sent to FNAL to qualify VTS, quench located
 - Quench in cell #3
 - Near, but outside equator weld
 - AES 1 sent to KEK for optical microscopy (shown in WG2)

Jlab Study: Quench Behavior With Material Removal (More in WG1)

- 3 Cavities: Quench limit gradient improves with more material removal (e.g. 20 μ m)
 - A6 test 3 to 4: 25 MV/m => at least 38 MV/m.
 - A7 test 1 to 2: 29 MV/m => 42 MV/m.
 - AES2 test 2 to 3 to 4: 18 MV/m => 26 MV/m => 33 MV/m.
- 2 Cavities: Quench limit gradient deteriorates with 20 micron material removal.
 - A6 test 2 to 3: 29 MV/m => 25 MV/m.
 - A7 test 2 to 3: 42 MV/m => 30 MV/m.

Thermometry Efforts to Localize Quench

- Fermilab/Jlab
- Add few Cernox thermometers around equator
- Fermilab: One cell covered with thermometers under development
- Jlab, complete one-cell coverage

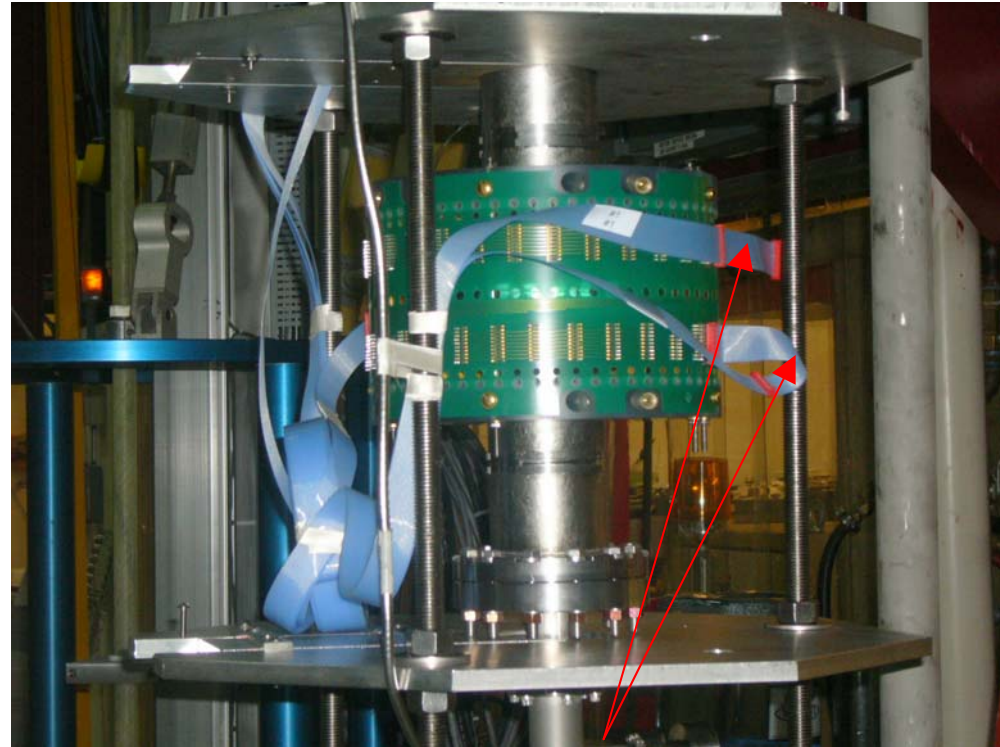
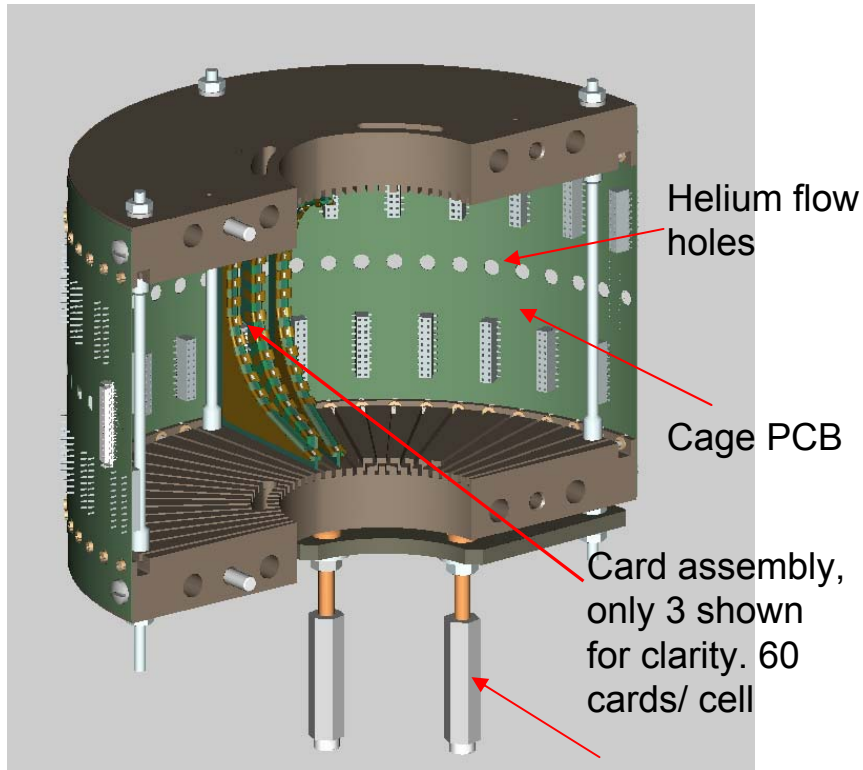


Fermilab: Cavity Thermometry

✿ 1-cell prototype was made and the fixture was cold tested (shock) successfully

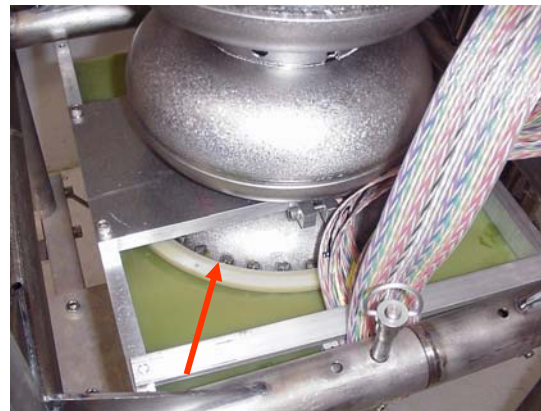
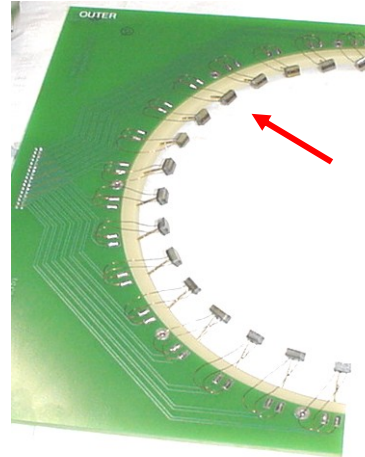
Model of half cage assembly

1-cell prototype

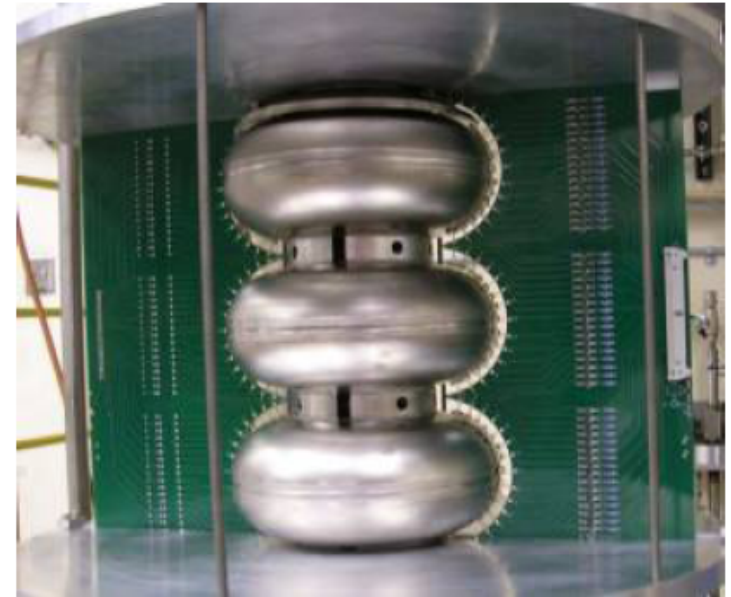
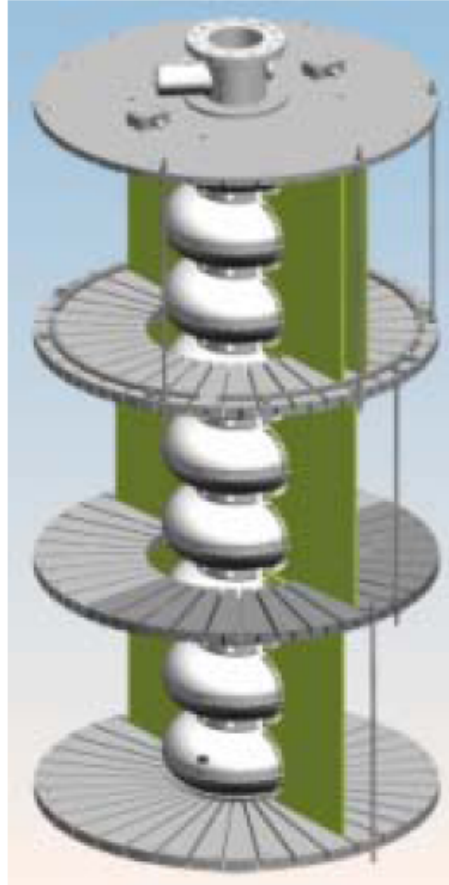
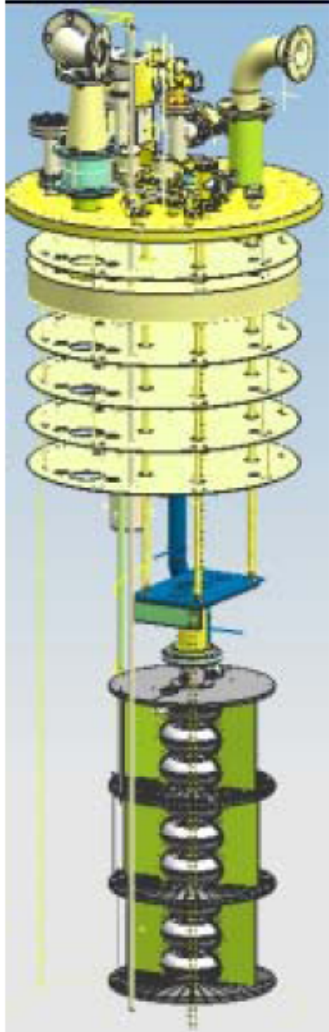


Jlab One Cell Thermometry Assembly

9-cell cavity assembly



LANL 9-cell T-map System



- each PCB covers 3 cells
- 108 boards cover the cavity every 10 degrees
- expected scanning time is ~2 seconds.

New Vendor Development Continued

AES New Beam Welder : Rapid Qualification

5 Single Cells, 110 mm BCP, HPR 2 hrs

- Cornell/FNAL collaboration
- BCP and Tests carried out at Cornell
- 4 of 5 cavities reached 25 MV/m without quench
 - limited by high field Q-slope
- 1 of 5 cavities reached 17 MV/m limited by field emission
- AES new beam welder is qualified

Single Cells, Large Grain

Reproducibility Tests: Summary

- Ningxia

$$119 \text{ mT} \leq H_q \leq 155 \text{ mT}$$
$$\langle 141 \text{ mT} \rangle$$

$$E_{\text{acc}} = 35 \text{ MV/m,}$$

- Heraeus

$$125 \text{ mT} \leq H_q \leq 166 \text{ mT}$$
$$\langle 147 \text{ mT} \rangle$$

$$H_q = 147 \text{ mT}$$

Tesla-shape

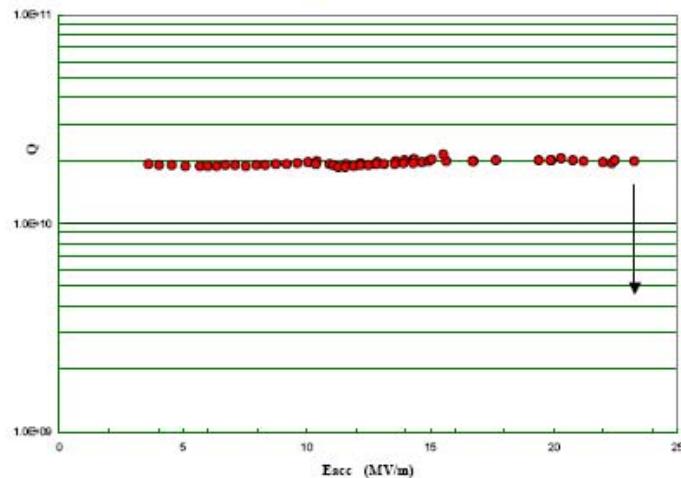
- In – situ baking at 120C for 12 hrs eliminates the Q-drop

9-cell Cavity performance(Jlab)

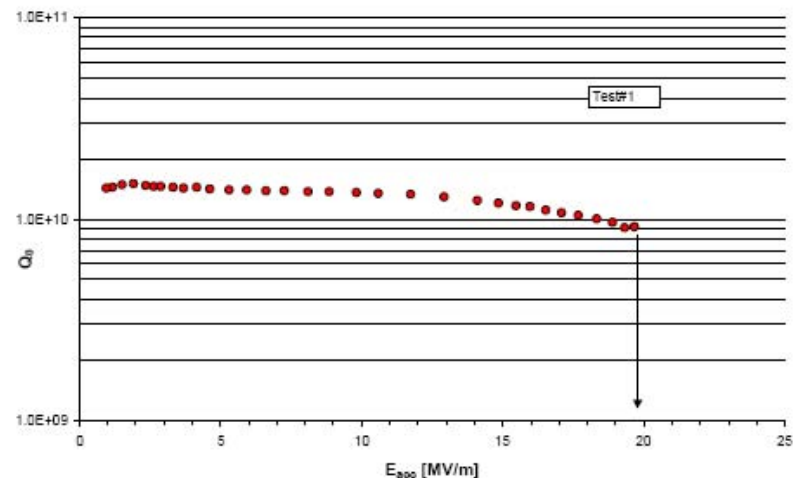
Large Grain

- Two 9-cell cavities (LG#1, LG#2) were fabricated at Jlab from large grain CBMM niobium (ingot "D"); several holes during EBW in both cavities
- Standard processing: pre-tuning, 100 micron bcp, hydrogen degassing at 600C for 10 hrs, final tuning, final bcp
- LG #1 received only ~ 40 micron, LG#2 ~ 57 micron bcp in final bcp
- LG#1: quench at $E_{acc} = 23$ MV/m,
- LG#2: quench at $E_{acc} = 20$ MV/m

Large Grain LG#1



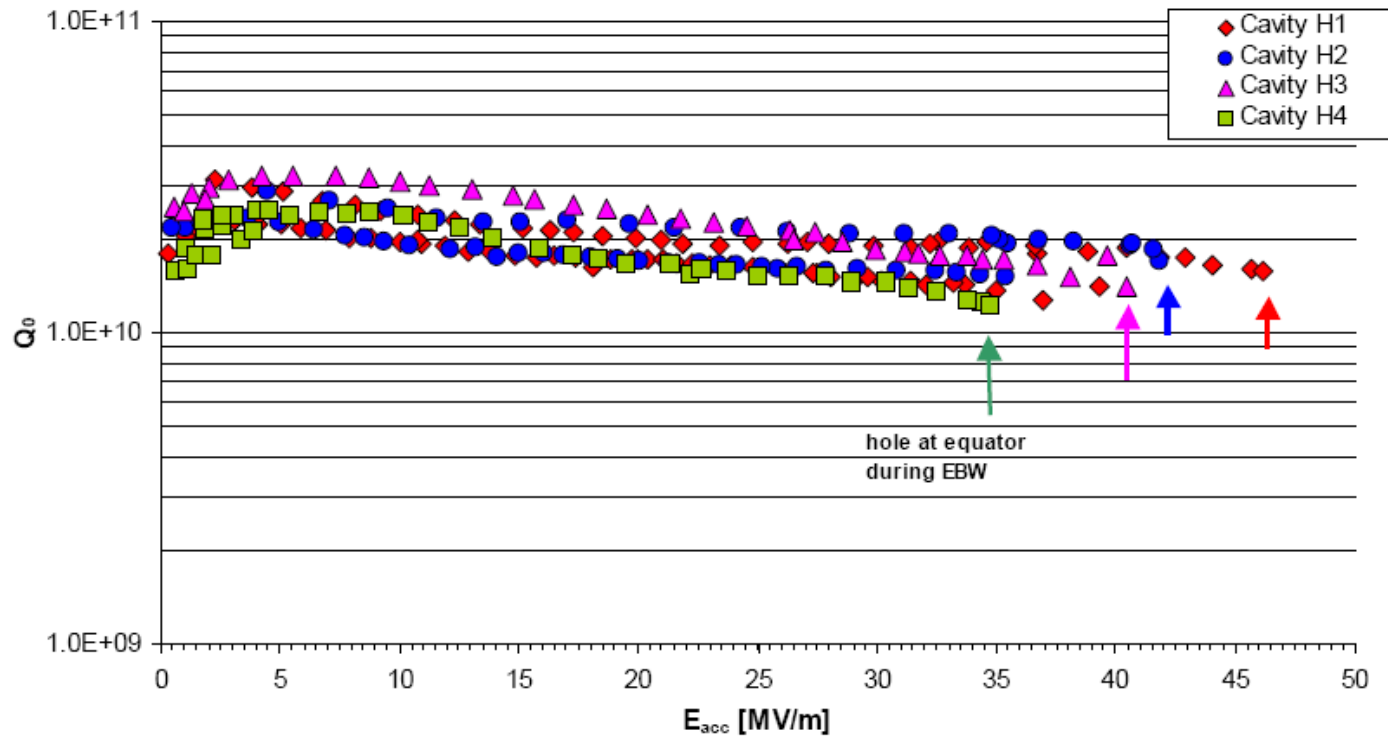
Large Grain ILC 9-cell Cavity #2



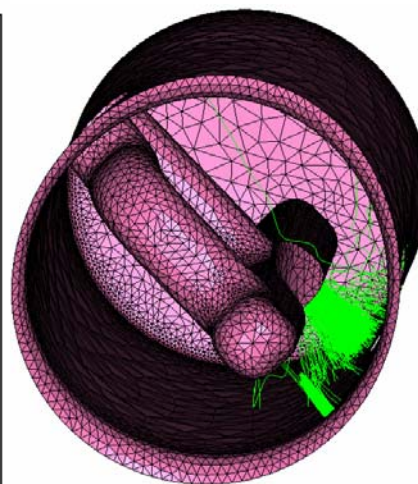
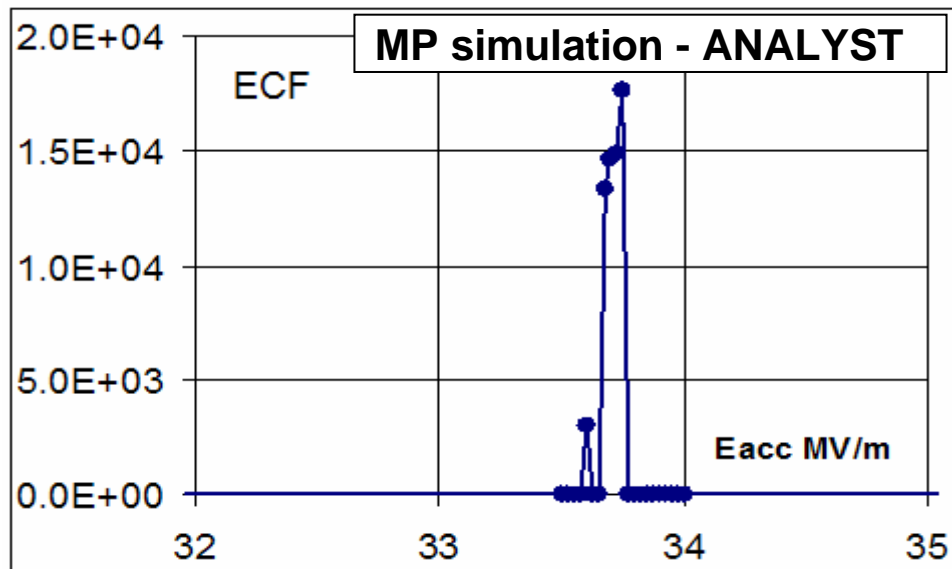
Reproducibility Tests(3)

Heraeus Nb, LL shape

LL Single cell cavities, Heraeus Nb, inner cell geometry



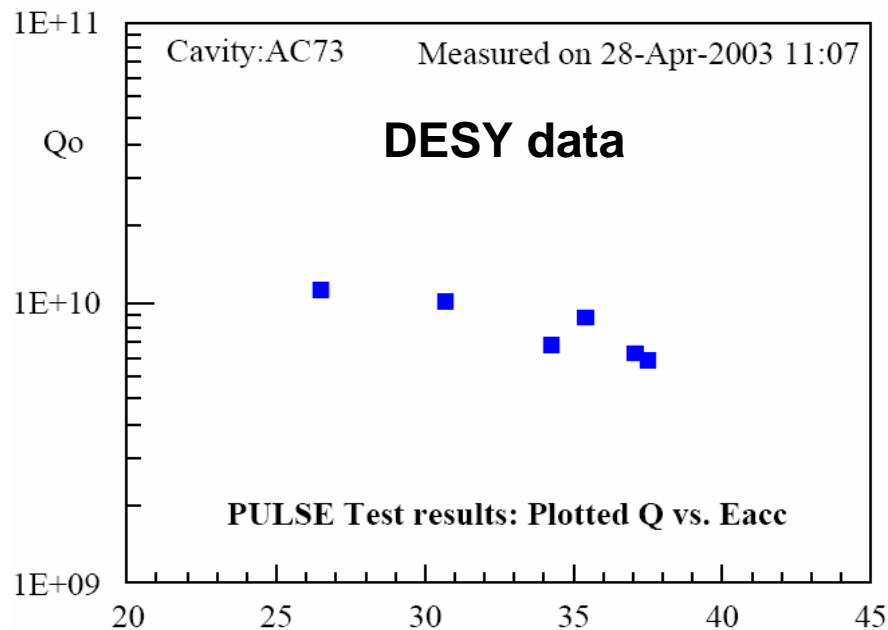
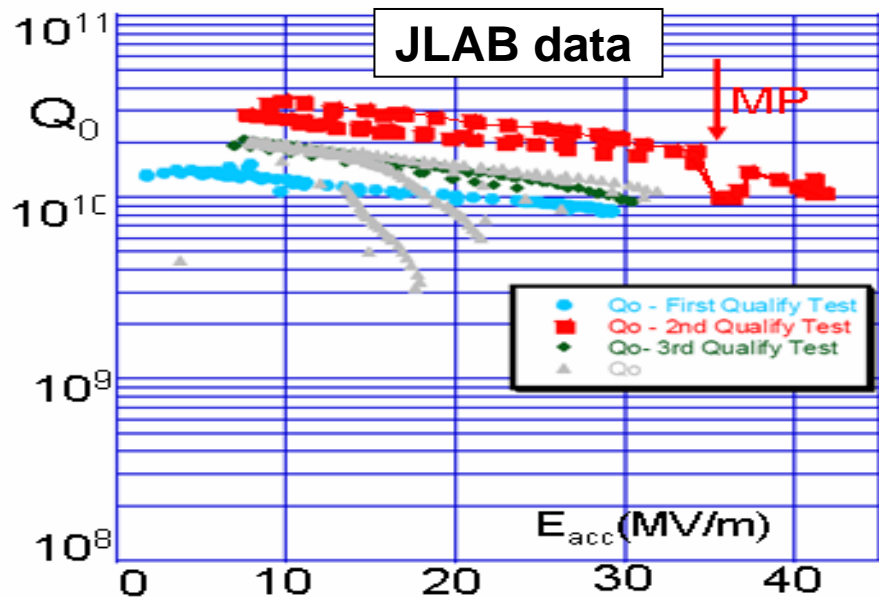
Caution: MP in ILC HOM coupler: leg-wall gap



Trajectories at $E_{acc} = 33.8$ MV/m

Good correlation between 1D, 3D & measurements.

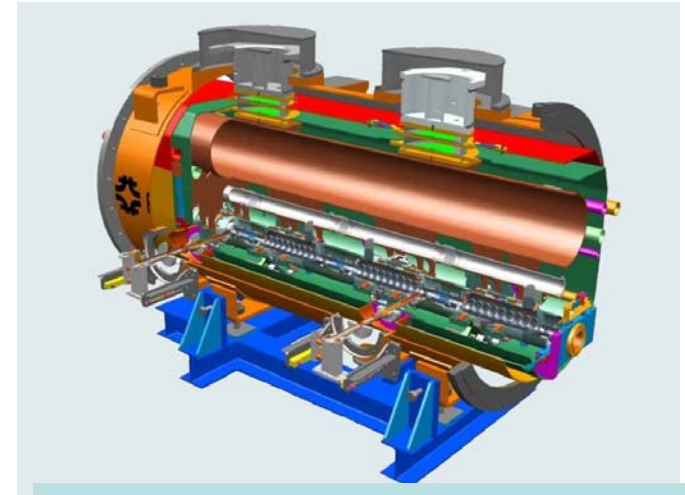
A7 - VERTICAL TEST DATA



Third Harmonic Effort FNAL

- **Status**

- **8 cavities have been fabricated**
 - 5 have had at least one vertical test
 - Cavity #7 being prepped for first test
- **2 cavities welded into Helium vessels**
 - One prototype fitted into Horizontal Test Stand, cooled to 1.8K and low power tested (10 kW)
 - Cavity #5 ready for Horizontal Test within 2 weeks
 - Remaining vessels due in few weeks
 - Two cavities ready to be welded into vessels
- **One pair of couplers trimmed to proper length have been conditioned**
 - 2nd pair to be readied after Cavity #5 Horizontal Test
- **All test areas commissioned and operational**
- **Shipping/Transport studies and preparations in progress and reviewed**



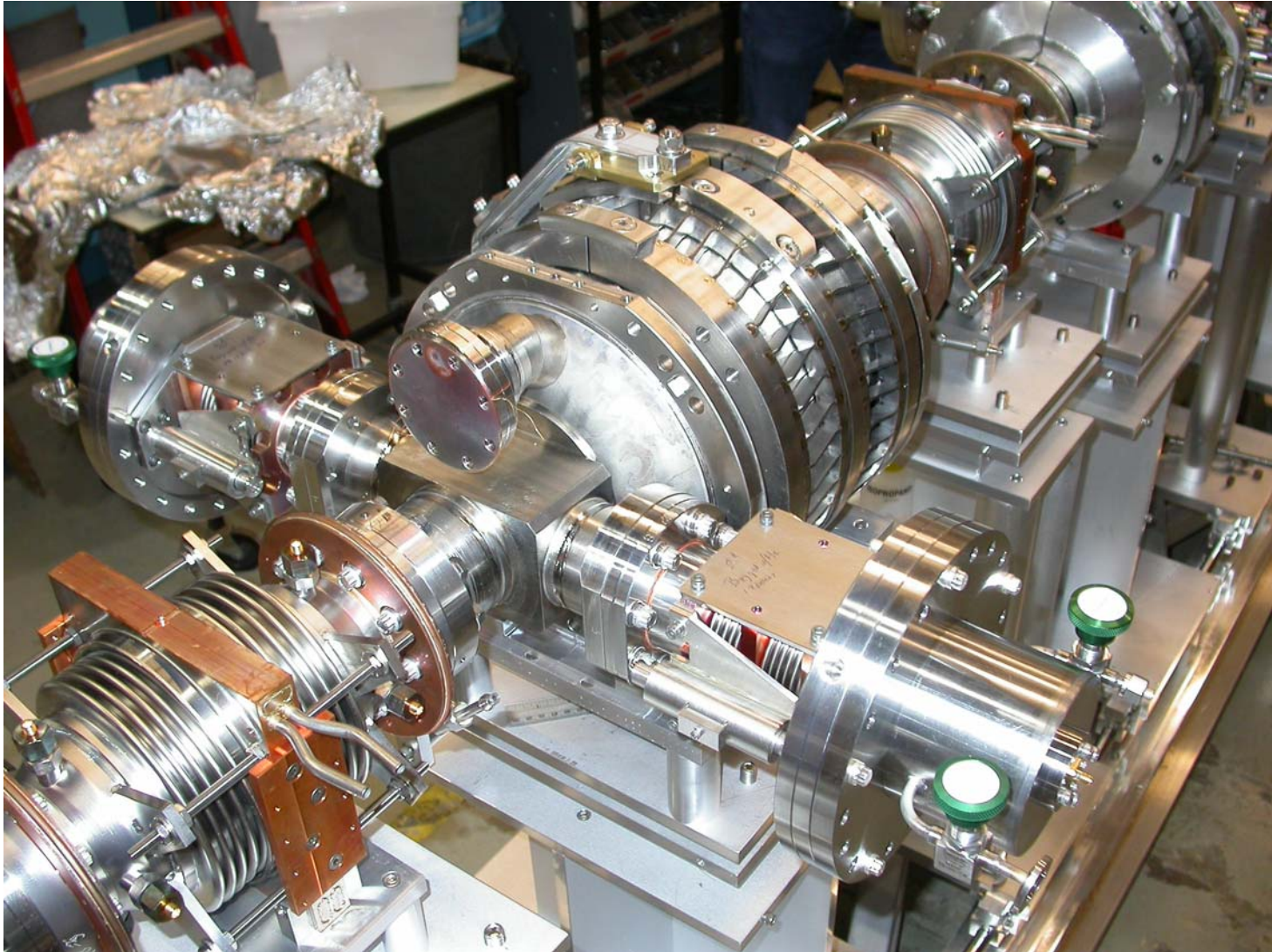
- **Future**

- **Building up a queue of cavities to be welded into helium vessels**
- **Cavity string assembly could begin in late March**
- **Plan to ship module late spring/early summer**



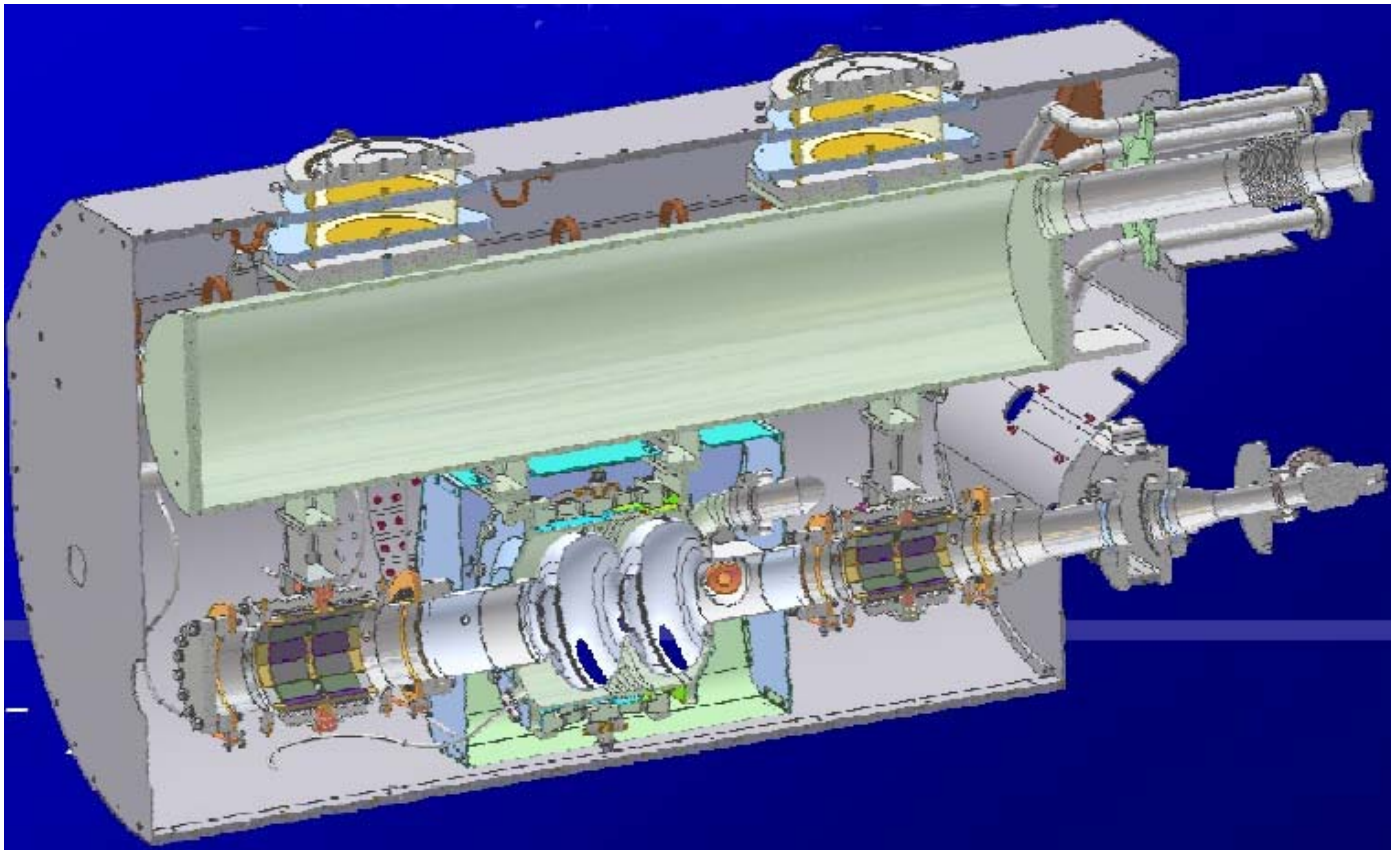
Cavity #1 dressed
for HTS commissioning
October 2007

Cornell ERL Injector, 2-cell Cavity Assembly: He Vessel, Blade Tuner, Two Input Couplers, Ferrite HOM Absorbers

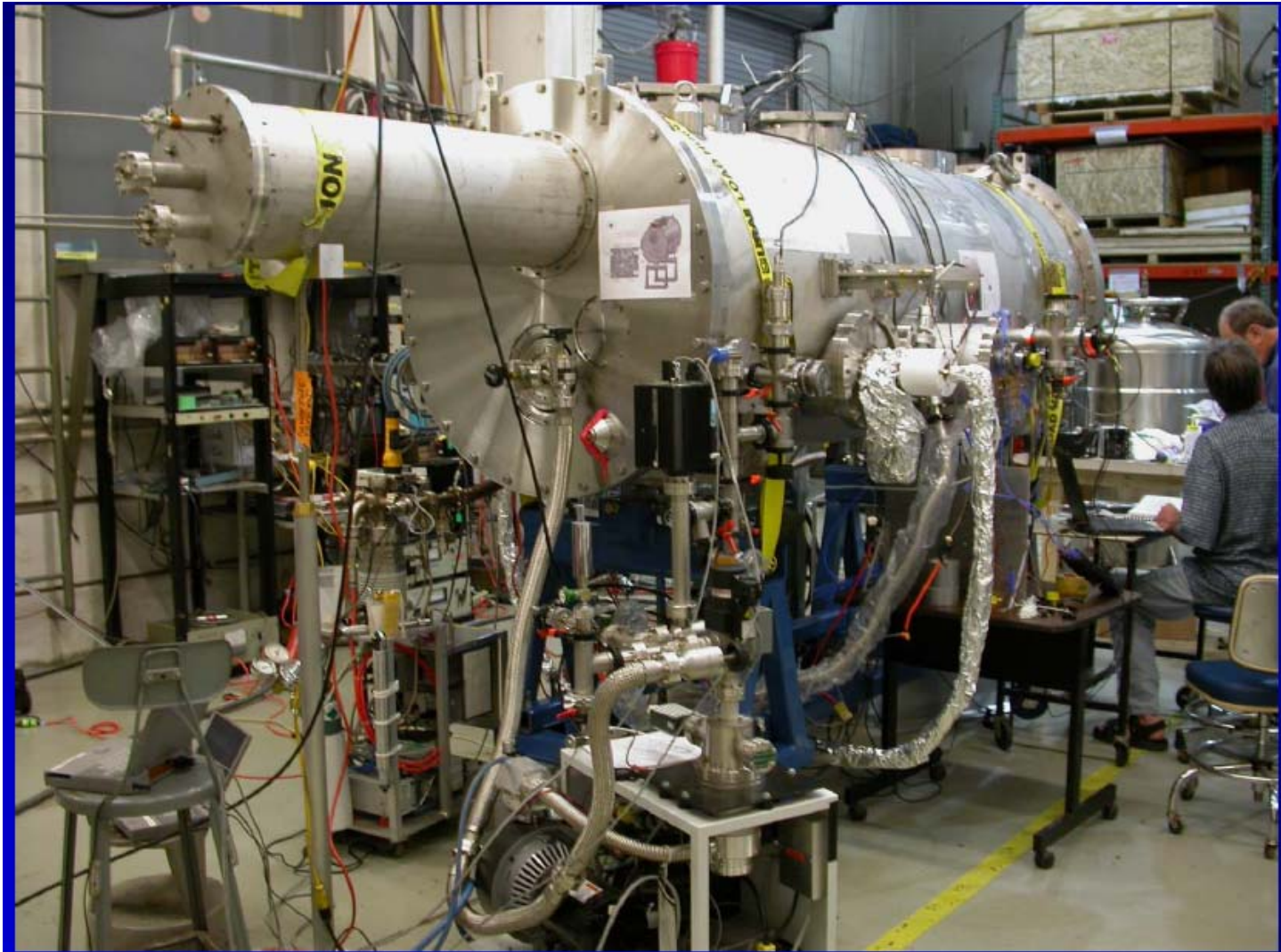


Horizontal Test Cryostat for One Cavity

- Design specs:
 - cw operation, 5 MV/m at 100 mA, and 15 MV/m at 33 mA
- $Q = 10^{10}$ at 2 K

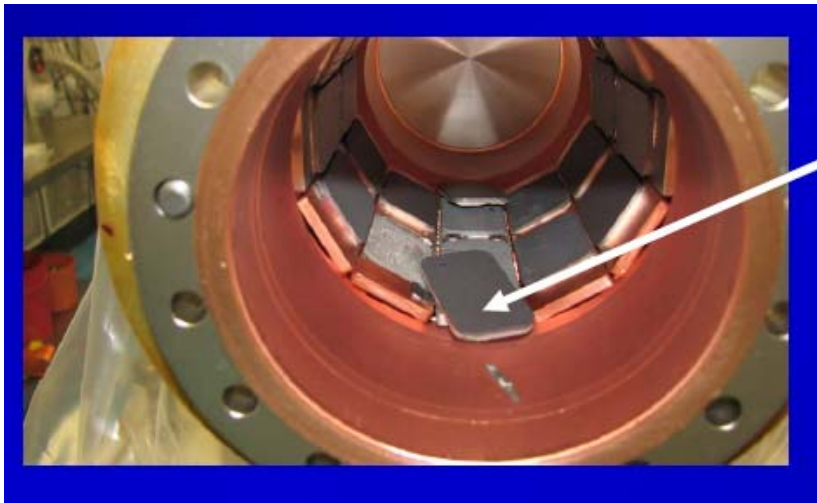


Finished Test Cryomodule



Results

- CM design, and assembly procedures OK,
- 1.8 K cw operation possible
- CW operation: $E_{\max} = 9.5 \text{ MV/m}$,
 - limited by power dissipation at $Q = 1.5 \cdot 10^9$.
- Pulsed: $E_{\max} = 13 \text{ MV/m}$
- After disassembly found
- Two ferrite tiles detached and dropped on beam pipe during cool down from large HOM
- Mismatch stress between large ferrite tile and Cu-W backing plate
- Small particles fell into cavity.
 - After disassembly, only HPR rinse restored cavity $Q_0 > 10^{10}$, as desired.
- Need to find better match for ferrite, copper-tungsten bond.
- OR better stress-relief (smaller tiles)

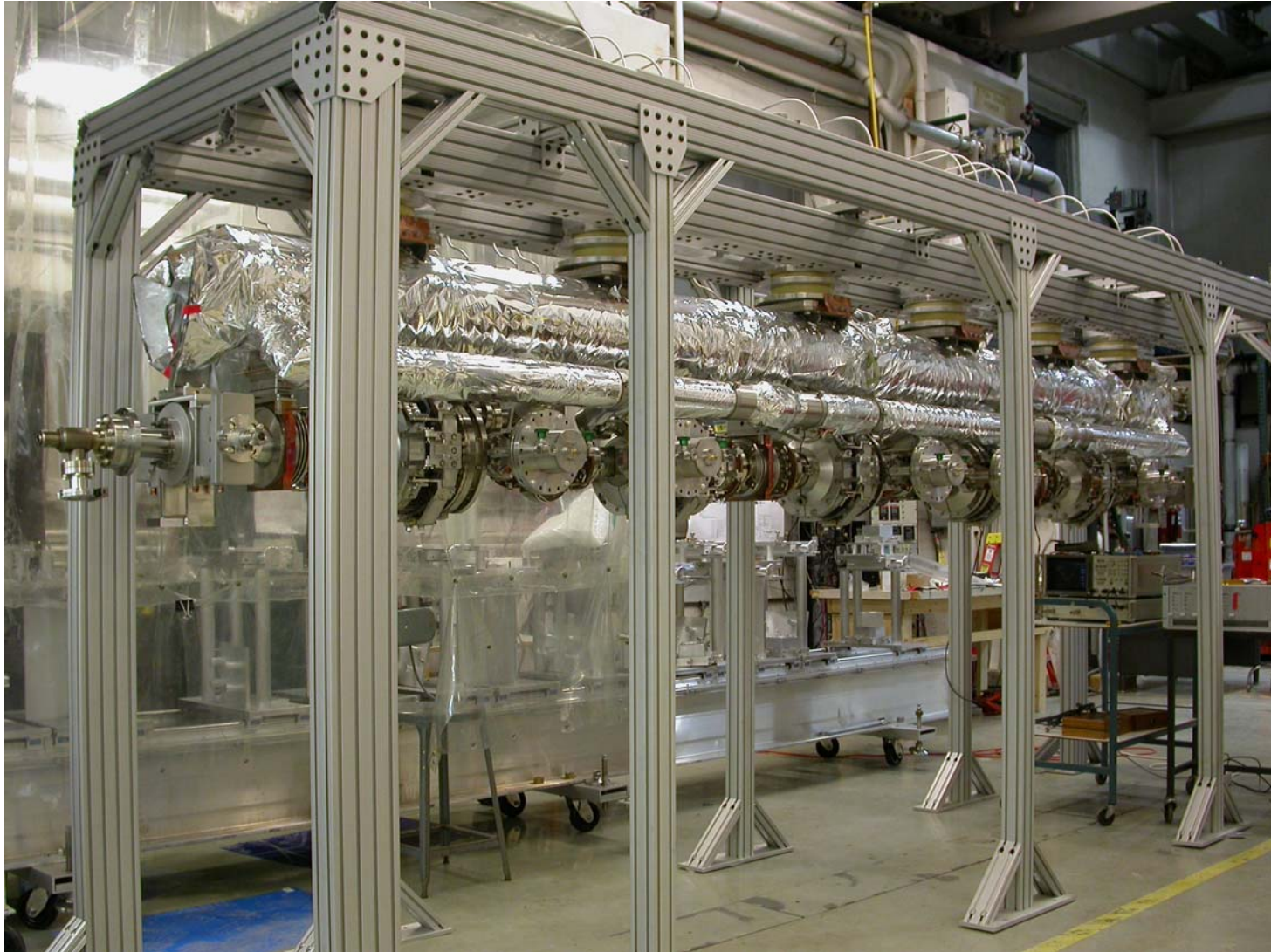


5-Cavity String Assembled

- Replace mismatched tiles with better matched tiles in large HOM load.



String on Helium Gas Return Pipe Test Anticipated April 2008

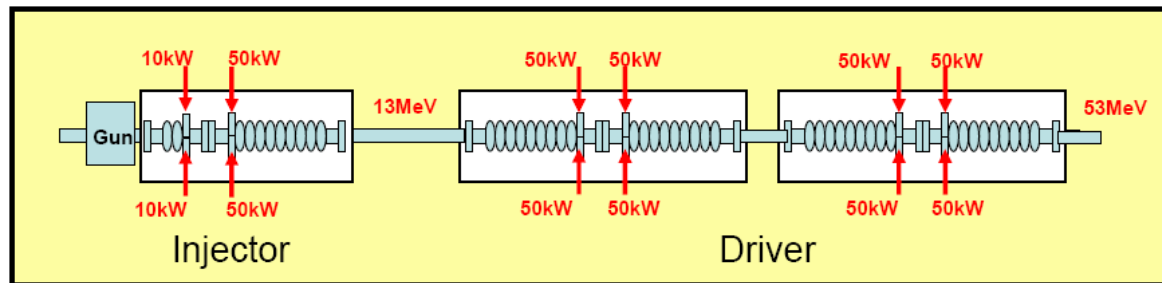
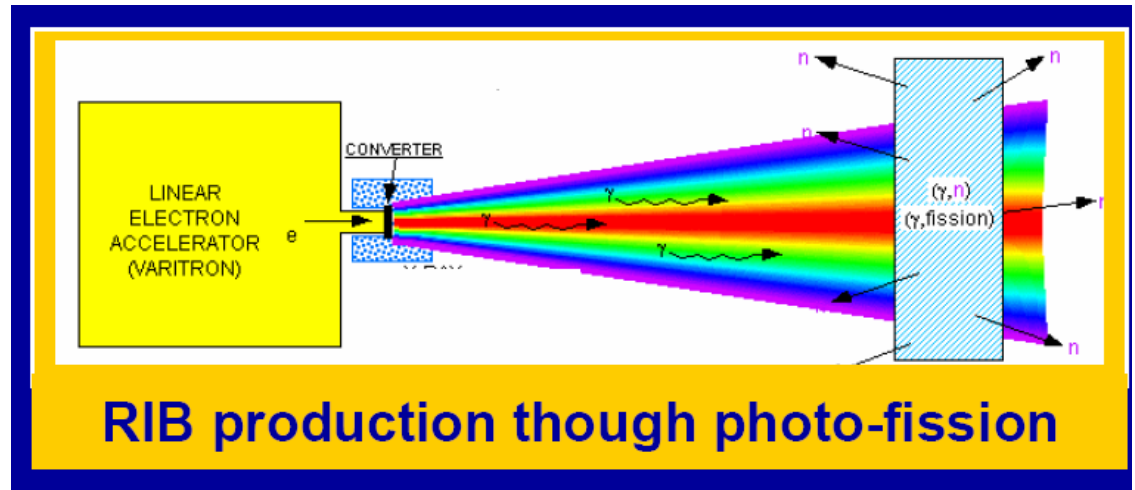




TRIUMF and Electrons

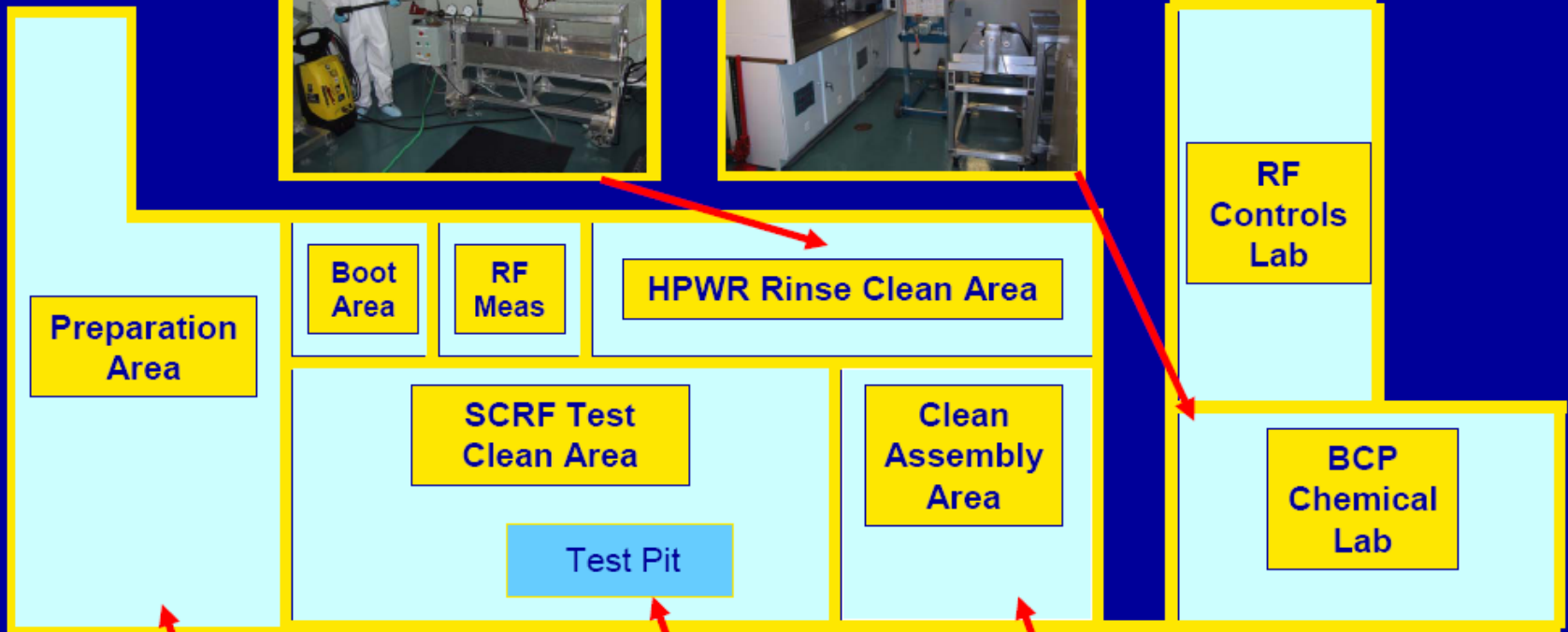


- Pursuing funding for a 50MeV e-linac as a Rare Isotope Beam (RIB) driver
- Qualify PAVAC as North American vendor for ILC cavities
- TRIUMF is prototyping two bulk niobium quarter wave cavities with PAVAC





SRF@TRIUMF : Infrastructure





PAVAC:

Local Fabricator



- Who is PAVAC?
 - A Canadian Company located in Richmond B.C.
- Specializing in
 - Electron Beam Welding
 - Pulsed Electron Beam Drilling and Surface-Micro Machining
 - Pulsed Electron Beam Coating (PEB-PVD)
- Presently fabricating two $\beta=0.11$ prototype cavities for testing by year end

PAVAC



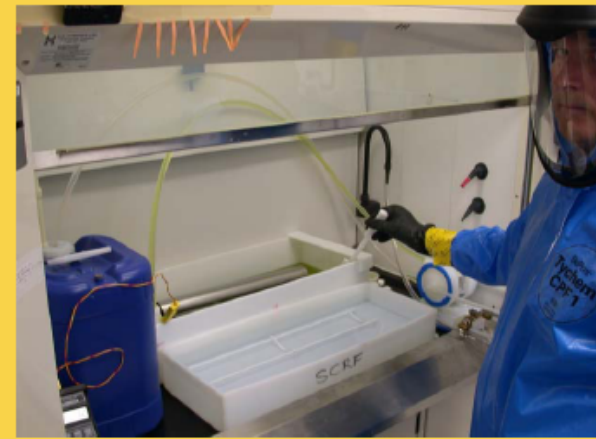
Forming and Machining



EB Welding



Pre-weld Etching - TRIUMF



Conclusions

- Major progress in
 - Infrastructure installation
 - One TTF cryomodule completed
 - More than 50 9-cell cavity prep/tests completed
- AES vendor prospects improving
- New projects based on TESLA technology coming on line.
- Basic R&D activities at Jlab on Field emission, Sulphur particles and Cornell, some to be reported during WGs.