



CEBAF, the great leap of faith

How CEBAF switched to SRF and set a new benchmark for the technology

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Perspectives on Superconducting RF
Jefferson Lab May 19th 2014

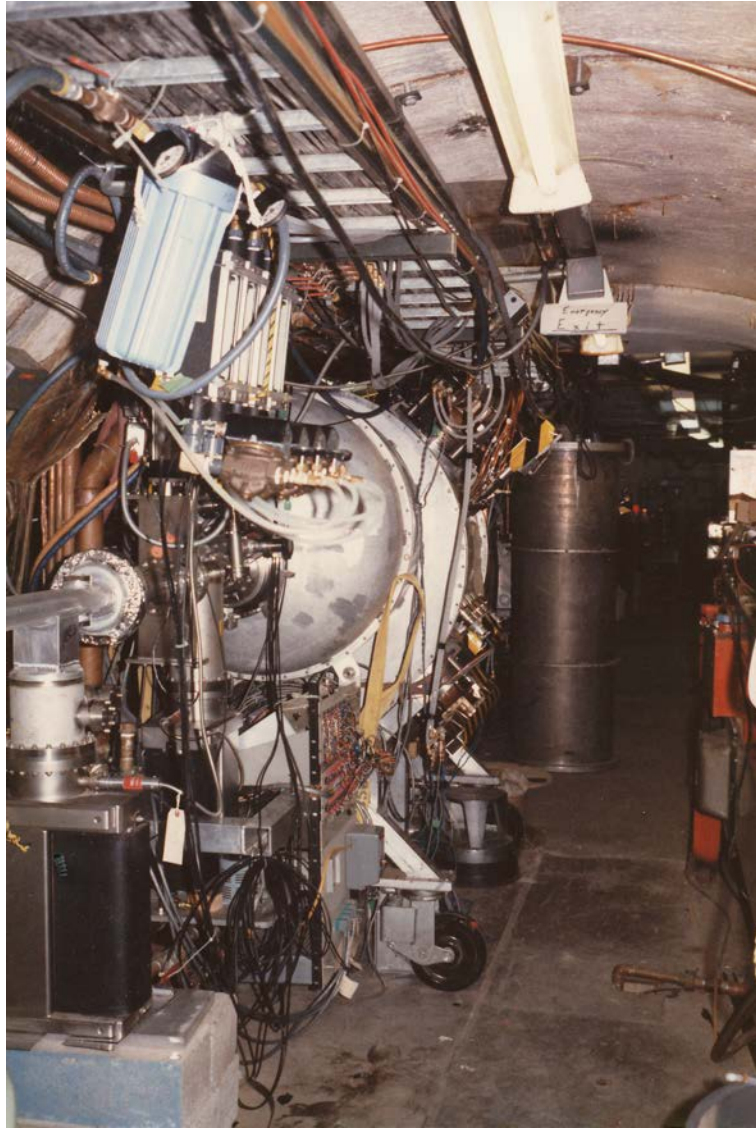
Path to CEBAF

- Robert Hofstadter – HEPL Stanford, nuclear structure research, 1950's
- Alan Schwettman et al. – HEPL SRF, 1970's
 - Working through SRF practicalities in SCA – multipacting and HOM damping
- James McCarthy – UVA
 - Dreaming of Physics in Virginia with a continuous stream of 4 GeV electrons
- Franz Gross – W&M
- SURA - 1980
- Bromley – NSAC Panel on Electron Accelerator Facilities
 - 1983 “shoot-out”
 - SURA wins!
- What's in a name?
 - National Electron Accelerator Laboratory – NEAL
 - Nuclear Science Accelerator Laboratory – NEAL
 - Continuous Electron Accelerator Facility - CEBAF

CEBAF changing shape

- CEBAF winning machine design **1983**: *pulse stretcher ring*
- Successful 5-cell elliptical SRF cavity beam test in Cornell's CESR – **1984** **HOM damping and gradient demonstrated** (6.5 MV/m) (but no application future at Cornell) (Elliptical shape was **Kneisel** design)
- Hermann Grunder – CEBAF Director, **1985**
- Gutsy push to change technologies to SRF, adopting the tested Cornell cavity design (and staff) Aug. 1985 – Feb. 1986
- Hermetic cavity pair concept developed at Cornell - Kneisel
- SRF-based CDR review **Feb 1986**
- Congressional approval Oct. 1986 for **FY87** construction start!! (those were the days...)
- Green site challenges

Beam Test with 5-cell Cavities in CESR - 1984



- **6.5 MV/m E_{acc} demonstrated** with beam
- 22.7 mA stored beam
- 283 W HOM power damped with waveguide couplers in external water-cooled loads
- Instability thresholds were carefully identified

The drama was quite spellbinding, no doubt.

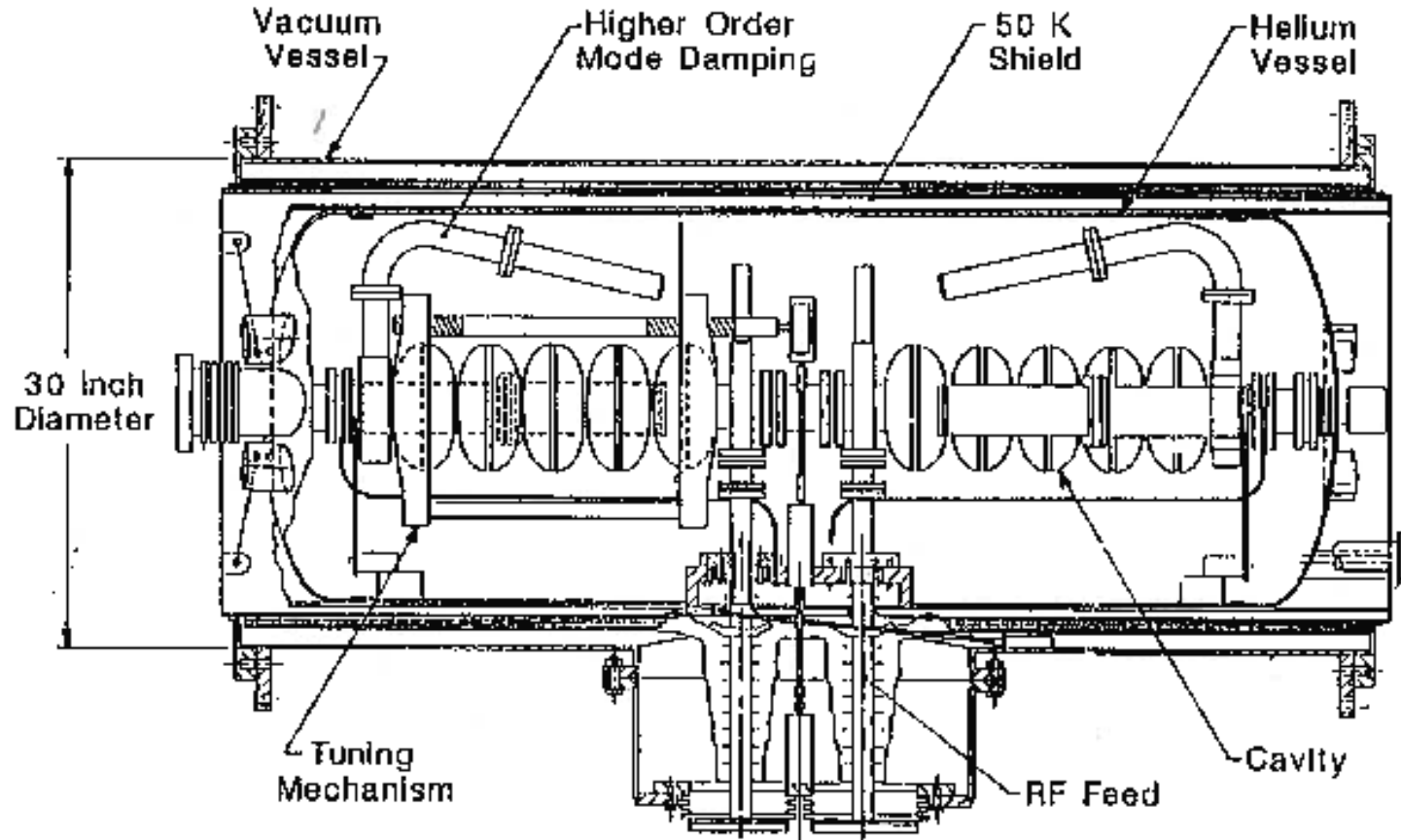


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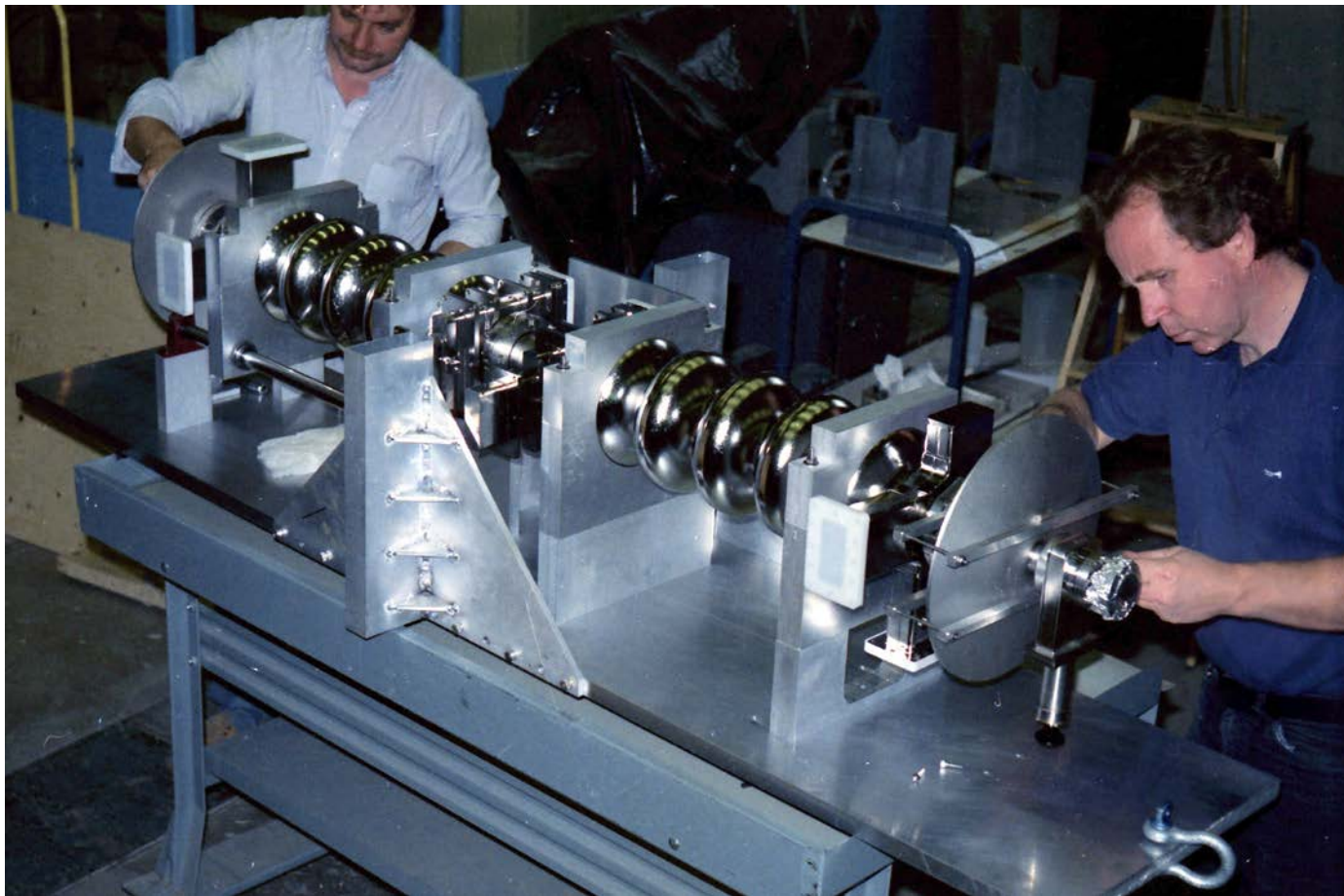
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- **“Green”** site challenges - many

CRYOSTAT AND CAVITY PAIR

CEBAF

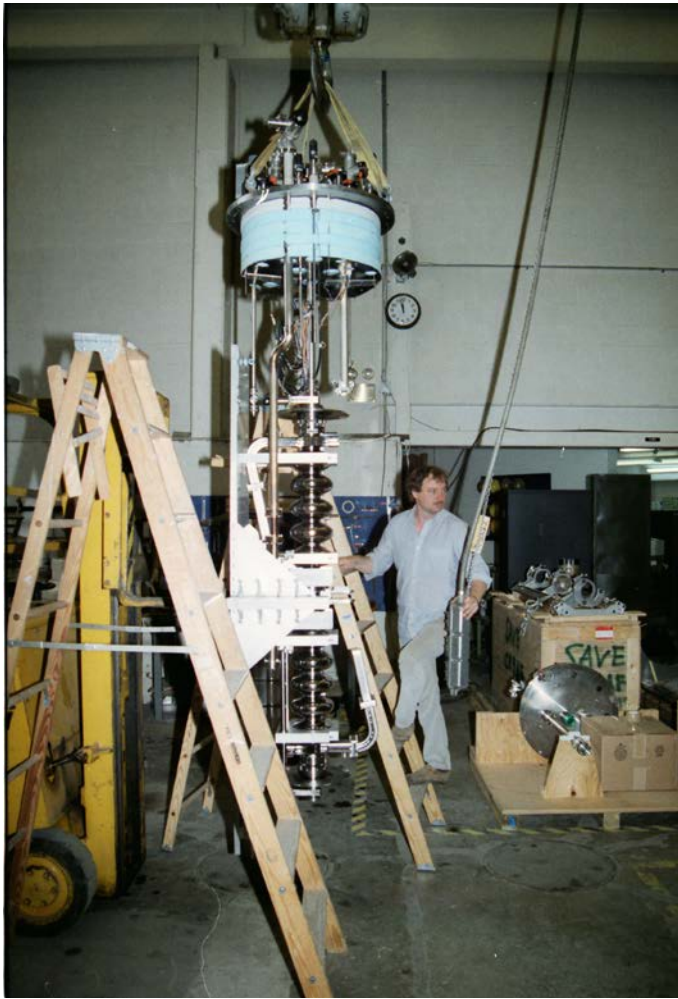


Key building block for both performance confidence and Project schedule



First prototype cavity pair assembly at Cornell - 1987

Improvisation was Required



First
cavity
pair

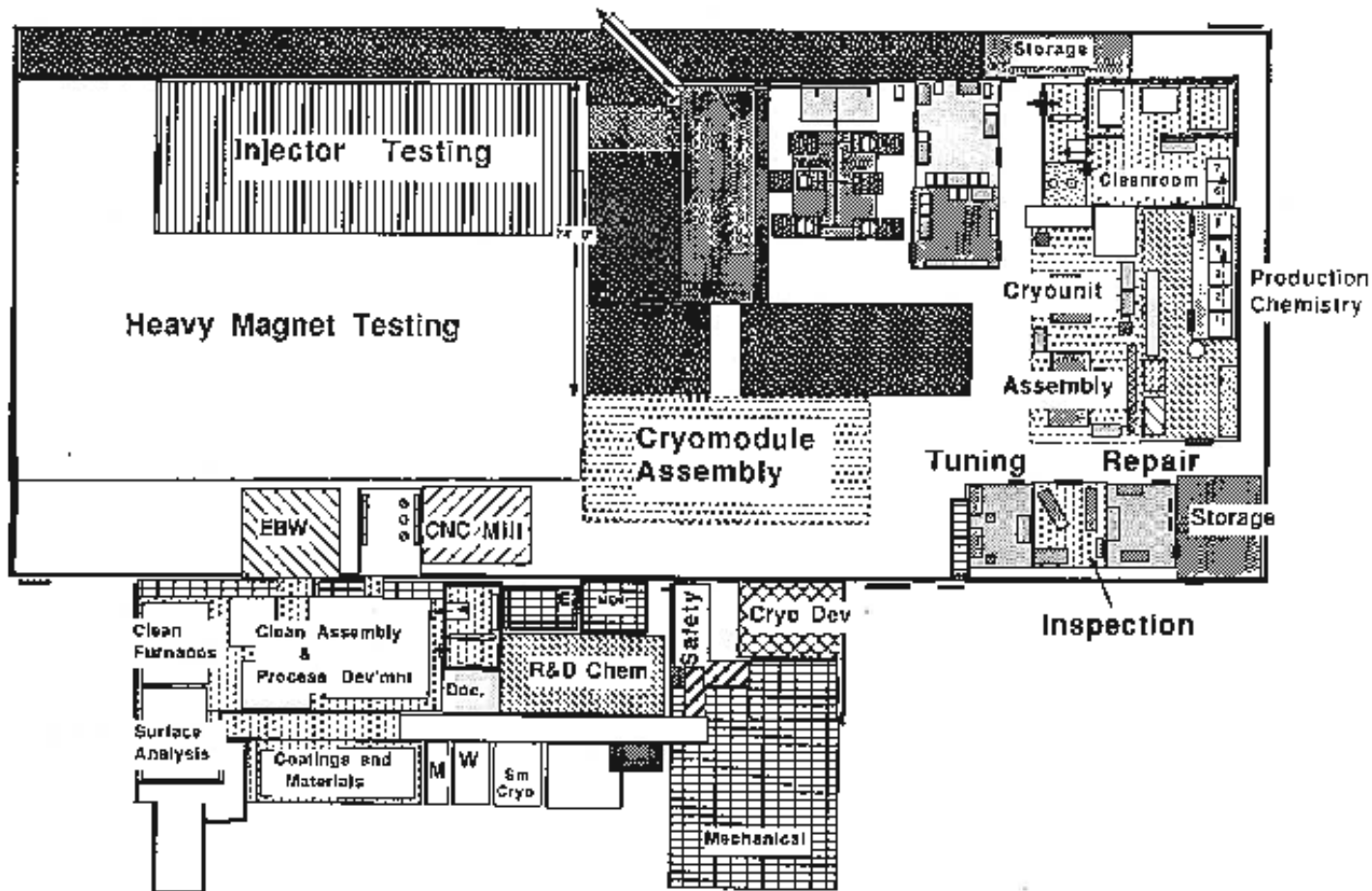


But, yes safety standards have subsequently evolved .

National Advisory Board – June 1987

Hermann Grunder employed the High- T_c showmanship of Helmut Piel at his home to help build comfort with superconductivity





Test Lab space planning 1987 (using MacDraft on a 1 MB Mac Plus)

NAB:G/4-5/87:cor/SRF:#11

Conclusion of 2-year CEBAF-Cornell collaboration

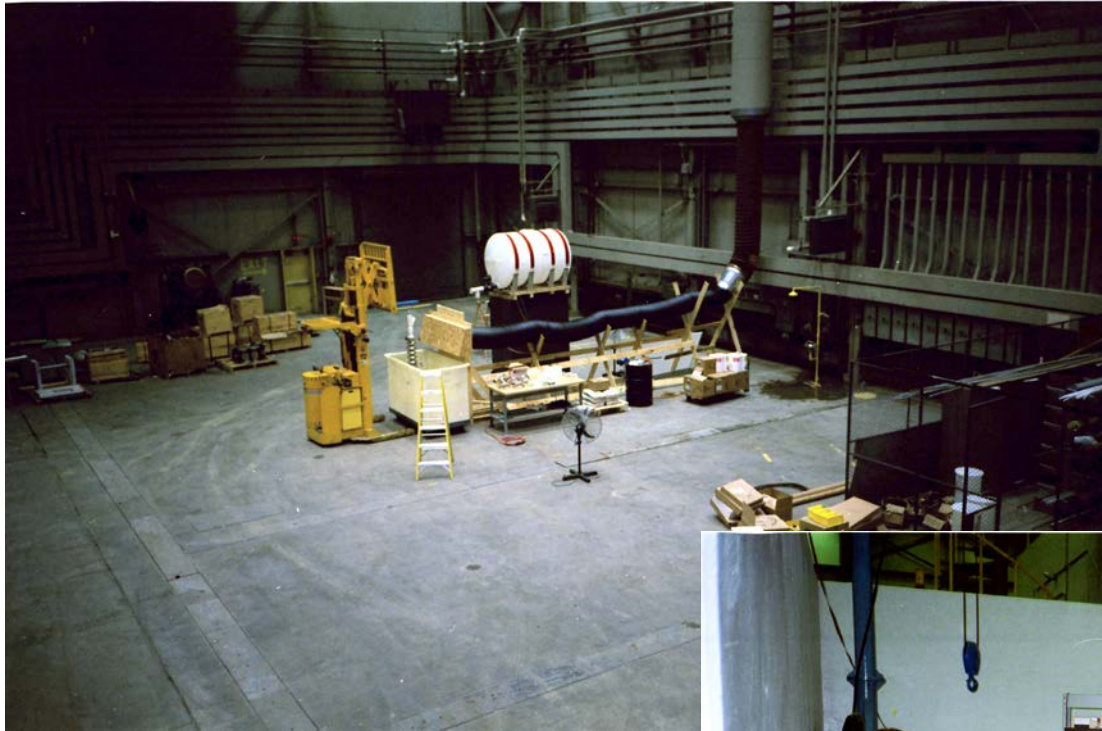
- Grunder was learning that Sundelin actually meant what he said
- The “young” guys were ready to move to VA



Clear Mission



1987-1988



First cavity chemistry station

First SRF cavity testing station



1987-1988



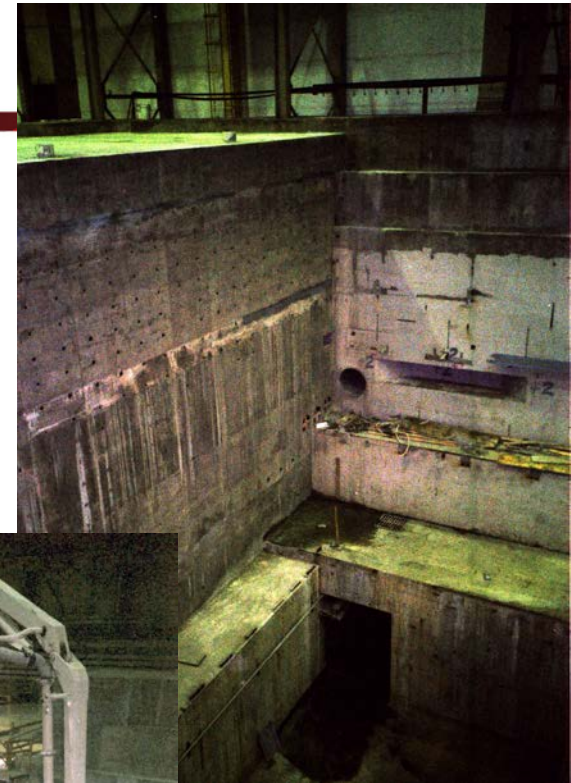
Can we build a cleanroom around this?

Test Lab 1988

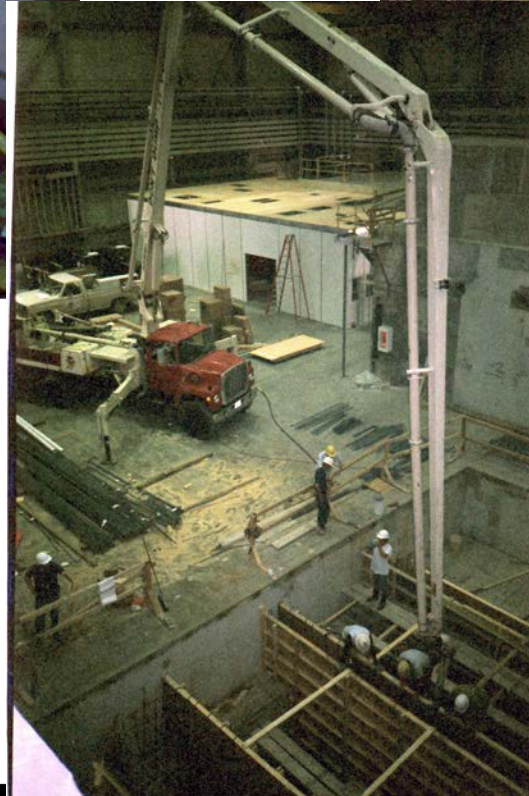
- 1st cavity assembly tent
- Injector test area
- Cryogenic transfer line fabrication
- Plus machine shop and storage!



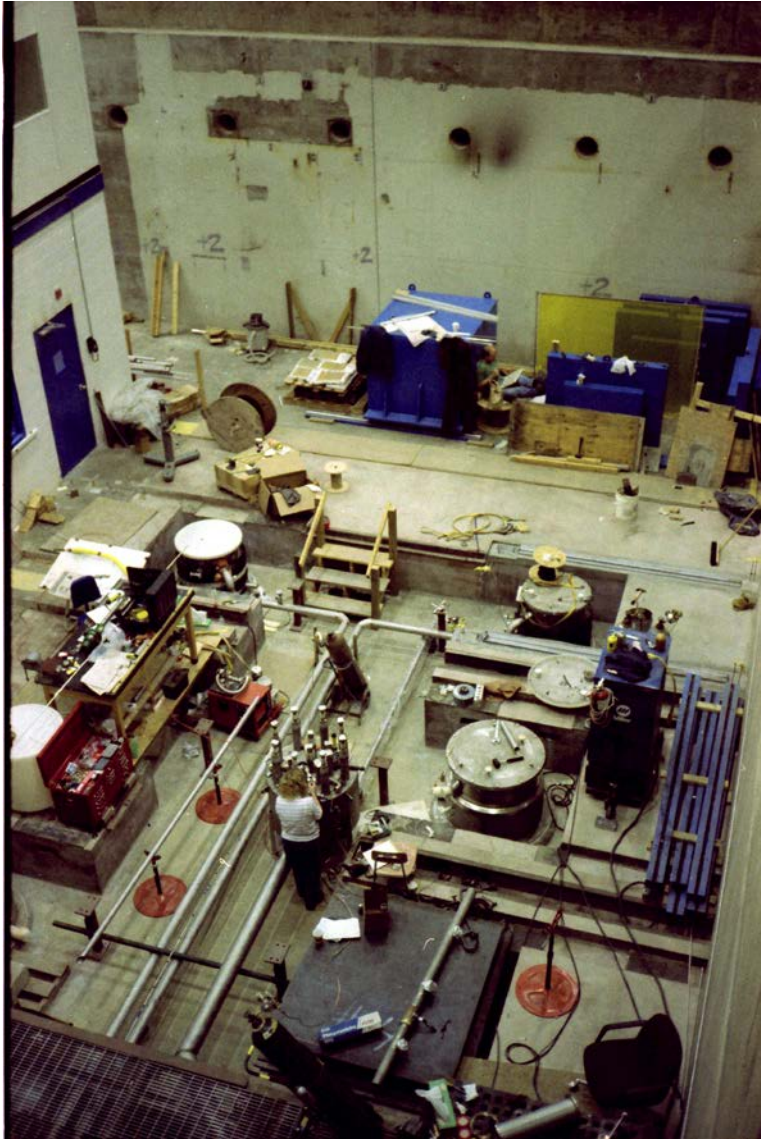
1987-1988



“Let’s test cavities and cryomodules here”

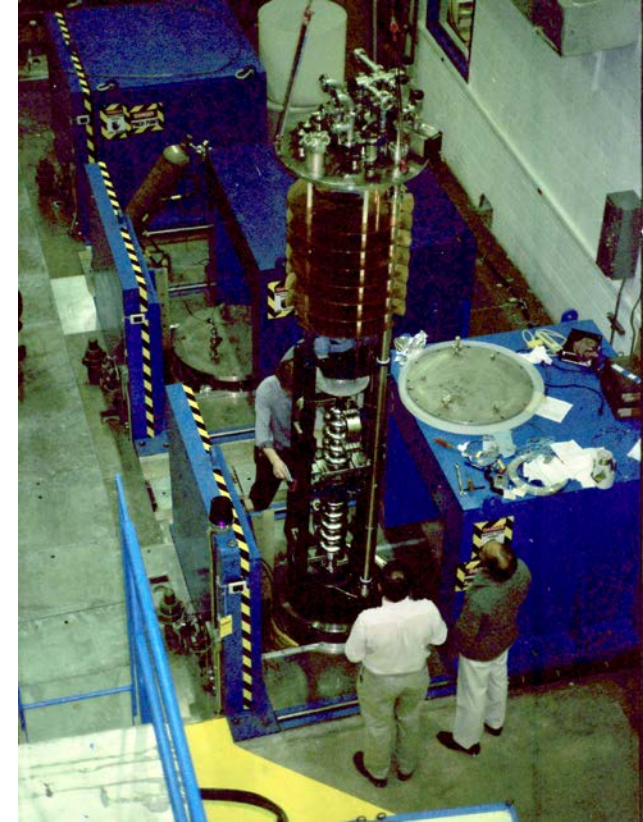


1989-1990



Construction of Vertical Test Area

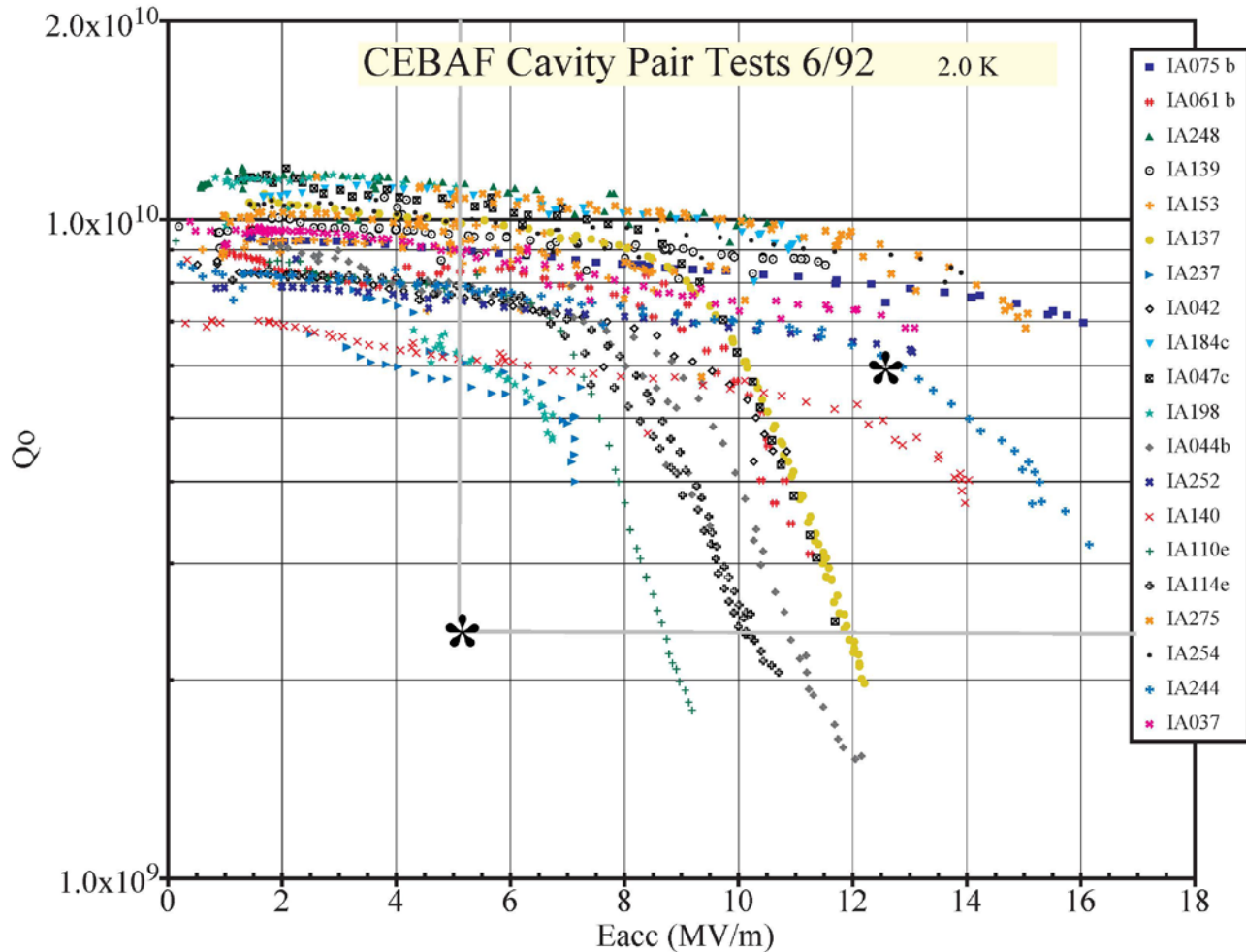
1991 – Ready to start testing Cavity Pairs for CEBAF



The first of 170?

CEBAF Cavities

One month's worth of production cavity testing for CEBAF in 1992.



Dramatic Success

- “Between **May 1990 and September 1993**, over **275 rf tests** were made on cavity pairs at 2.0 K. From these tests 15 pairs were rejected and subsequently reworked.”
- “The CEBAF cavity pairs were produced as a quality product due to a concerted effort of many people spread over a period of ten years. **The principal architects were P. Kneisel and R. Sundelin.** The cavity manufacturer, Siemens, delivered cavities on schedule and well within specifications. Dedicated processing and assembly staff refined the technique appropriately for production operations, and the auxiliary cavity pair components were developed, fabricated and integrated into the pair package by additional diverse CEBAF staff members. The results reported here, are thus the fruit of the labor and creativity of many people.”
 - » “Production Vertical Cavity Pair Testing at CEBAF”, C. Reece, P. Kushnick, J. Mammoser, and T. Powers, SRF93

Cryomodule Assembly, Installation, and Commissioning

1991 – 1993

- **32 8-cavity cryomodules were assembled , installed, and commissioned in CEBAF**
- **Production rate was two cryomodules per month**

Nobody had done that before

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CEBAF Operational

- July 1994 first **beam on target**
- May 25, 1995 full **4 GeV** design energy
Beam on Target
- Already looking toward 6 GeV and ahead “to the 10 GeV range.”
 - » “CEBAF Commissioning and Future Plans,” H. Grunder PAC95

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**A timely opportunity fully exploited for science,
with thanks to Peter Kneisel for very critical contributions
creating the opportunity for success.**