I L C 2007

Hamburg, May 30 @ DESY

Challenges for the ILC SCRF R&D

Acknowledgments

- Info and slides provided by collaborators from the 3 regions in Global Design Effort and Tesla Technology Collaboration (*many taken from just finished TTC and ILC-MAC meetings, Hasan being my alter ego in this.)*

MAIN MESSAGE

- Good progress is being made
- Progress rate is increasing through recently adapted infrastructures coming on line for ILC SCRF
- Work is underway for a further, very significant, speed up of the rate of progress with additional infrastructure around the world being put into place

High Level Goals

DEMONSTRATE ILC MAIN LINAC TECHNLOGY

- **S0: Demonstrate High Yield of 35 MV/m cavities in vertical test**

- **S1: Assemble and Test several Cryomodules with average gradient > 31.5 MV/m**

- **S2: Demonstrate RF Unit with ILC parameters, design gradient and ILC-like beam at full pulse rate**

SO – Where are we?

- **Proof of principle for 35 – 40 MV exists**
  - *electropolishing seems to be a key step in this*

but

- **Yield is low for 35 MV/m in 9 cells**

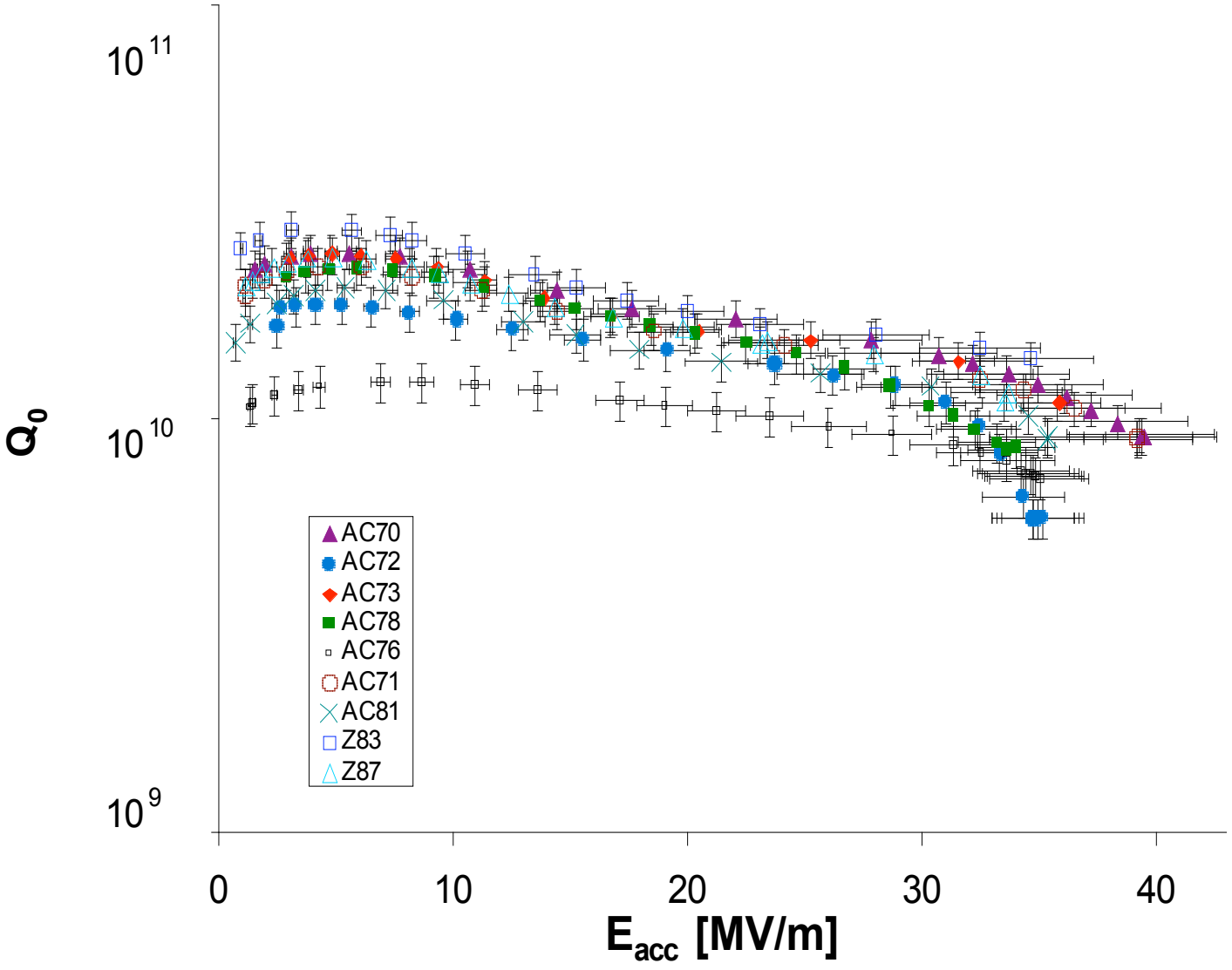
however

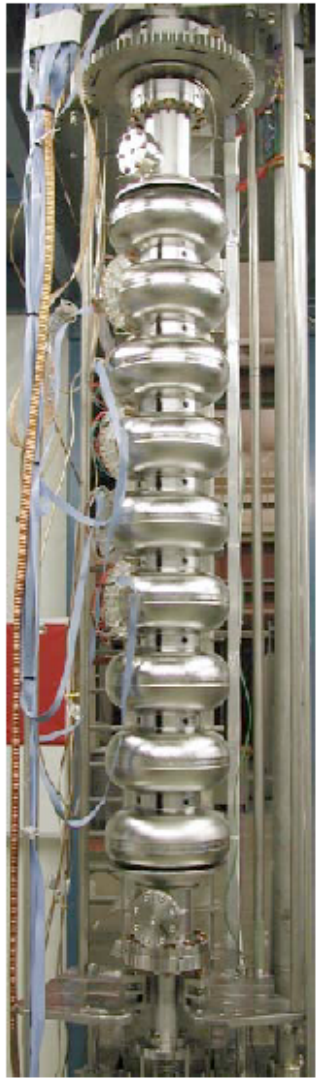
- **Single cell gradients of 40 – 50 MV/m show that baseline procedures are capable of good results**

and

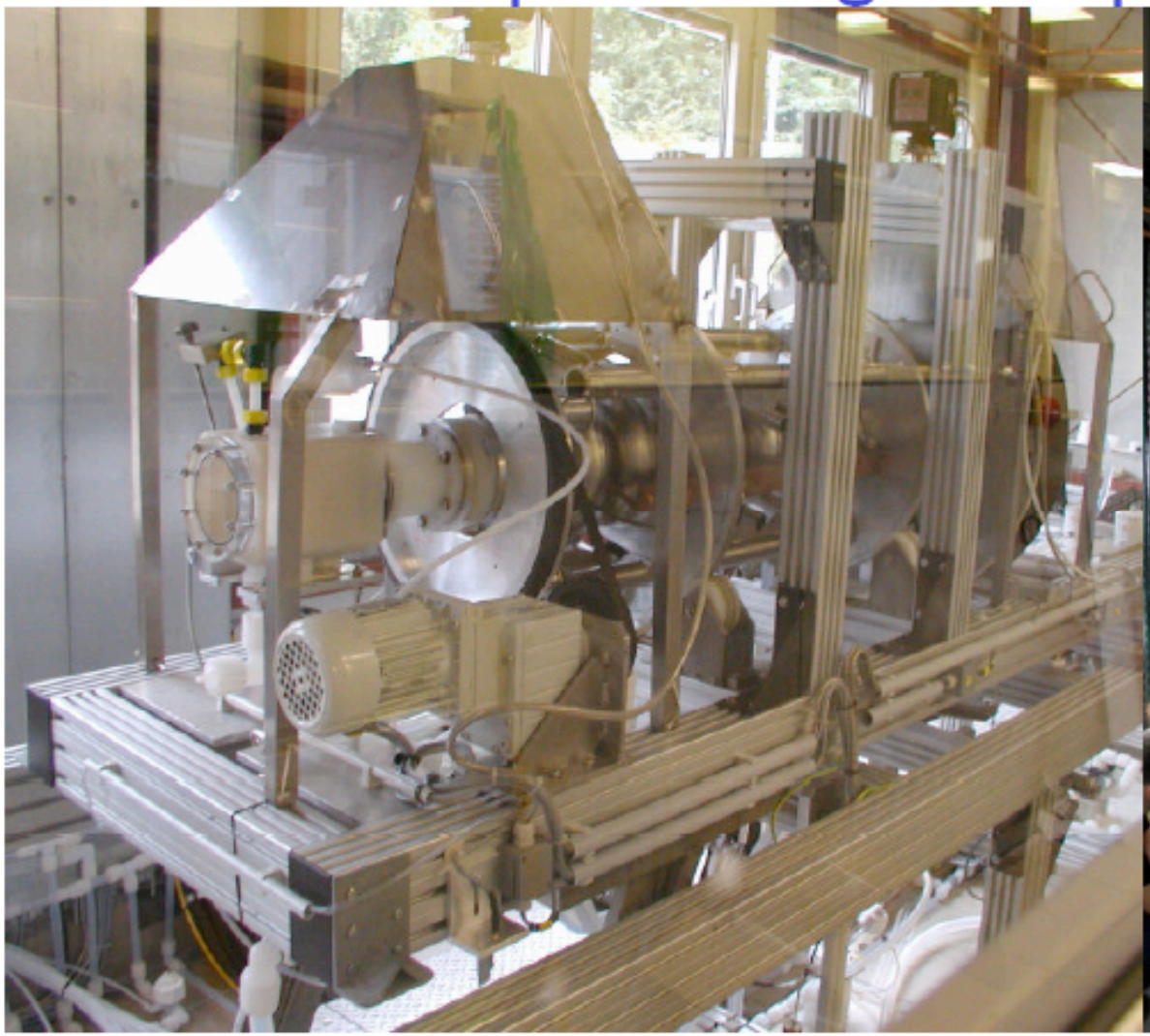
- **Controlled preparation & tests underway at several labs to discover the sources of poor reproducibility.** ***Widely agreed that many coordinated tests will be needed***
- **Basic R&D with single cells also underway to find even better treatments**

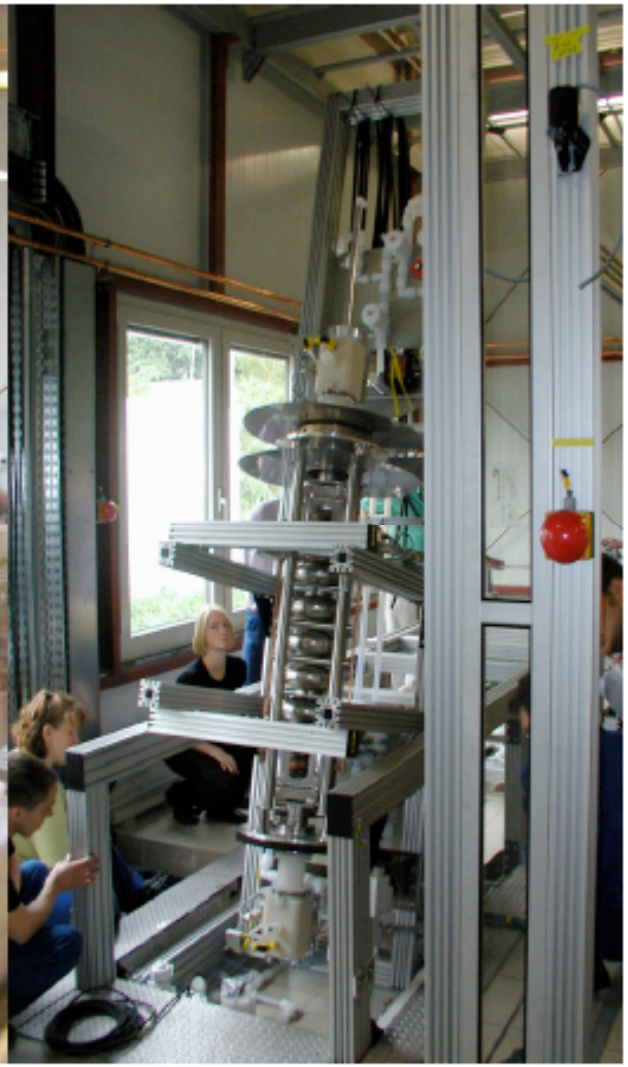
TESLA Nine-Cells: (Proof-of-Principle)
Best tests of 9 best Cavities (Vertical Test Results)



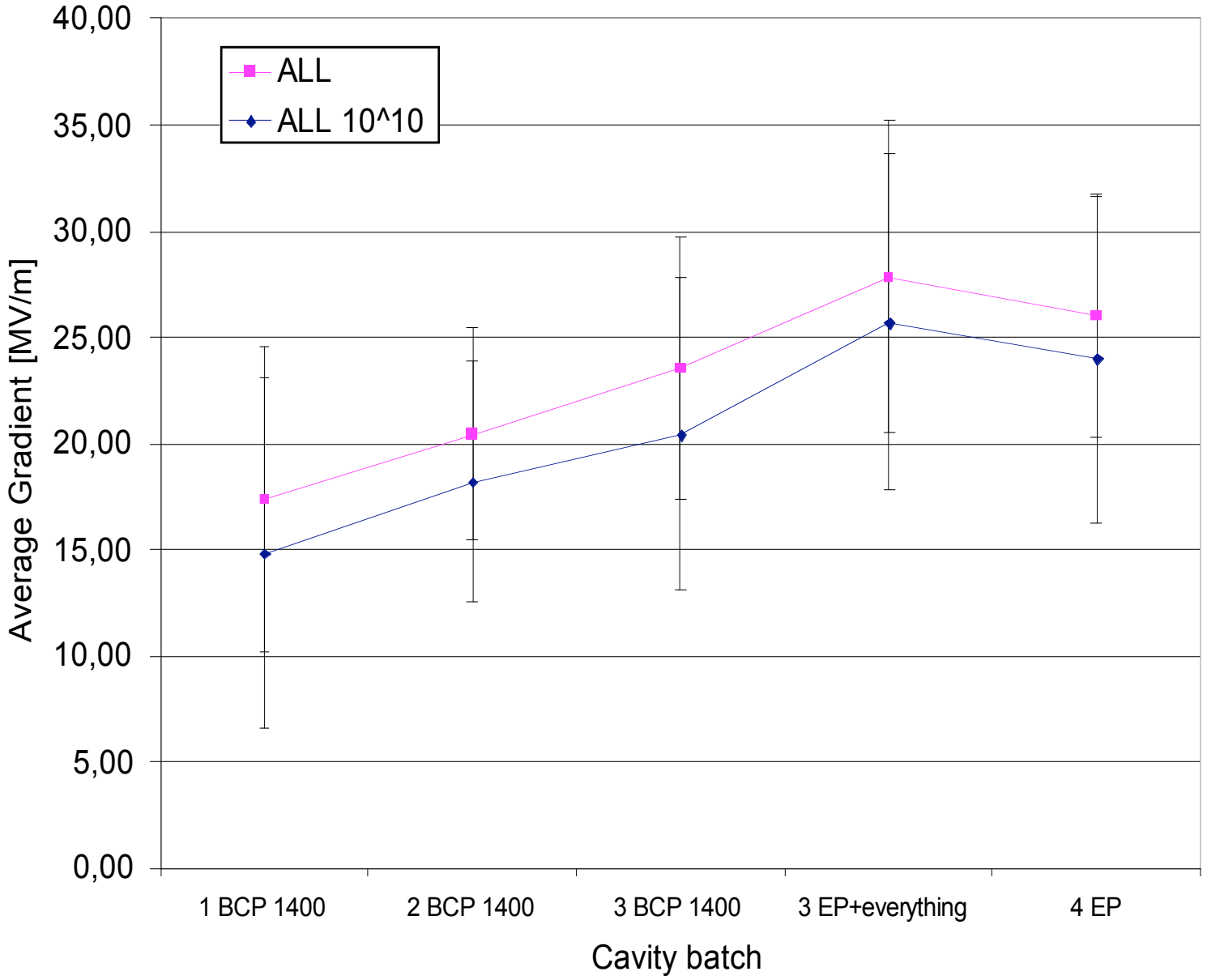


Electropolishing Setup at DESY





Large Spread: All Cavity Tests



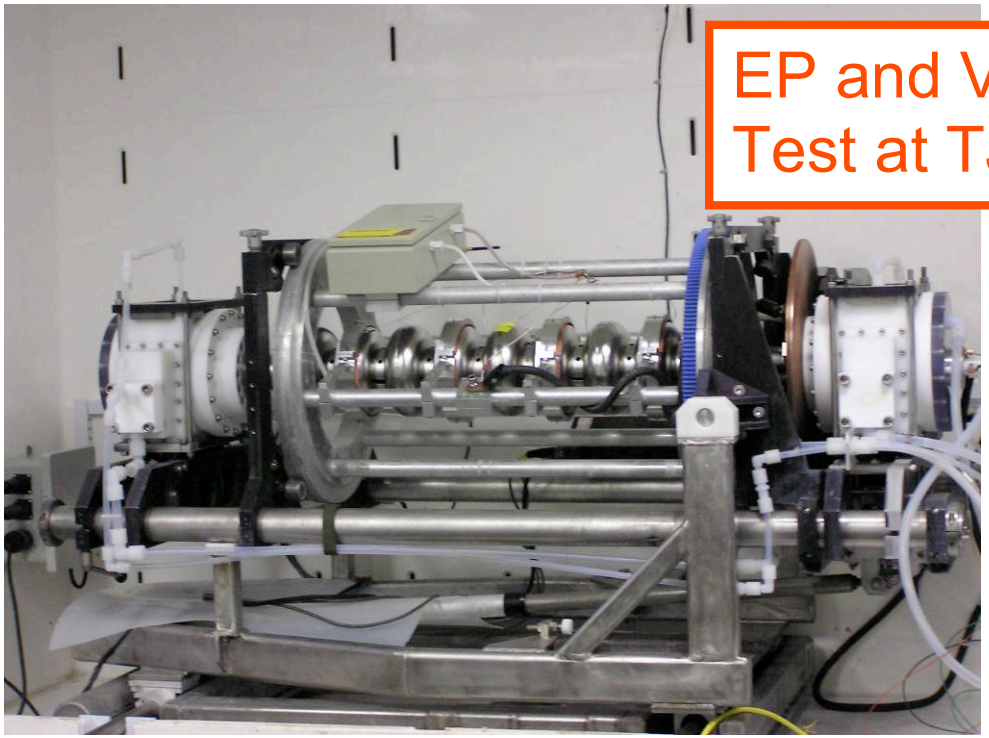
What's Happening Right Now for Increasing Rate ?

- DESY continues 9 cell and single cell treatments and tests. New cavities on order for XFEL

- 9 cell treatments have started at Jlab, Cornell & KEK
  - first results coming in

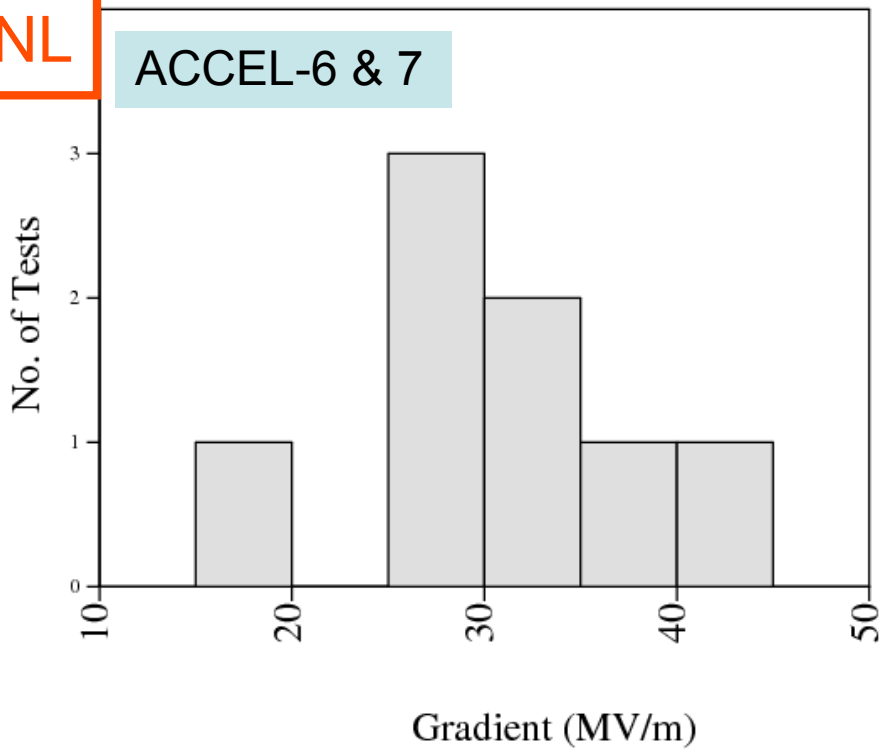
- New cavity treatment and testing capabilities coming on line at KEK, ANL/FNAL soon

•Modified existing infrastructure for EP, HPR, and Vertical Test of 9-cell 1.3 GHz ILC cavities. Better but spreads still big



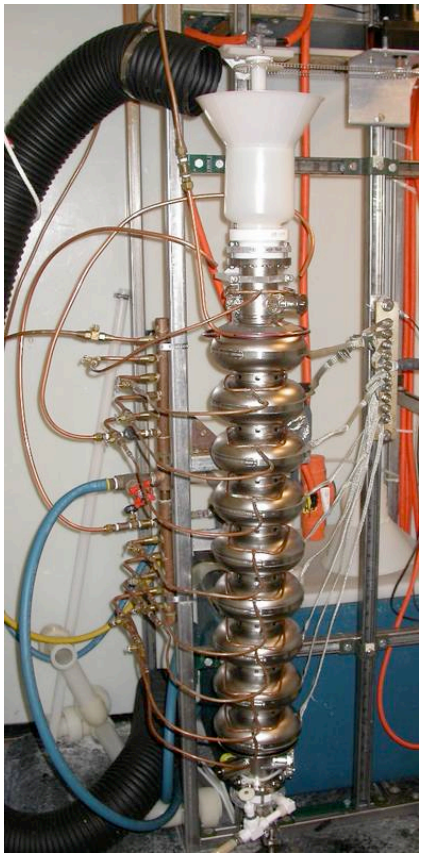
EP and Vert Test at TJNL

ACCEL-6 & 7



EP & Vertical Test: Cornell

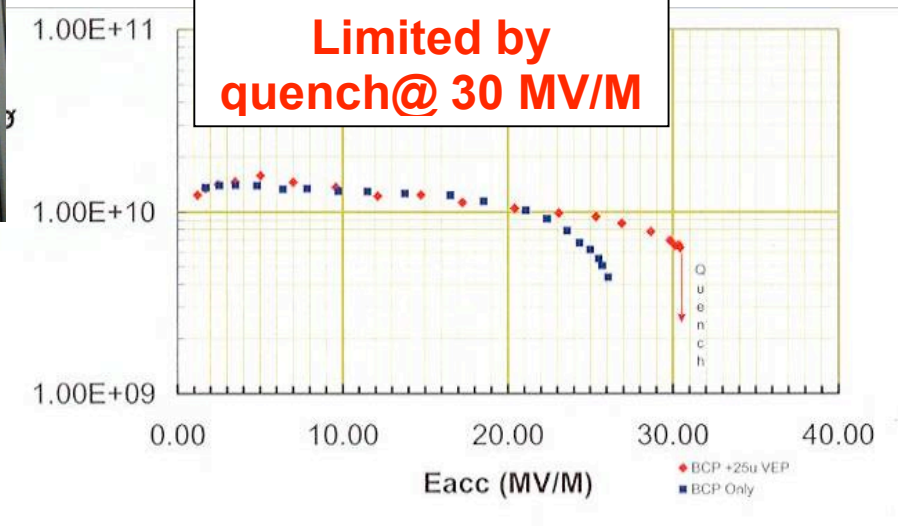
Vertical EP Infrastructure



HPR (High Pressure Rinse)

Vertical test

ACCEL cavity EP Processed & tested at Cornell

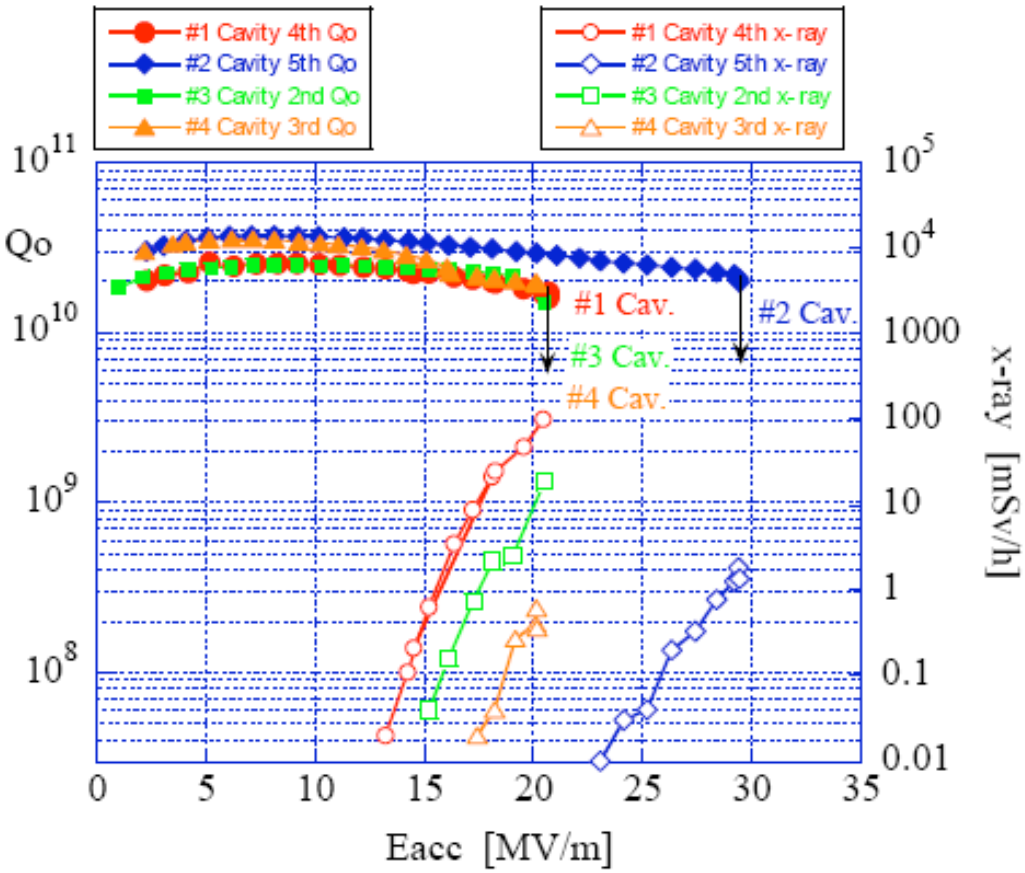


- New vertical EP R&D infrastructure
- Modified HPR, and Vertical Test of 9-cell 1.3 GHz ILC cavities.

KEK

Summary of TESLA style cavities

Gradient Performance



4 TESLA-style cavities (MHI) were processed, and jacketed.
One of them is already installed into cryomodule.
The other 3 are waiting for STF1.0 installation.

New Treatments are on the Way

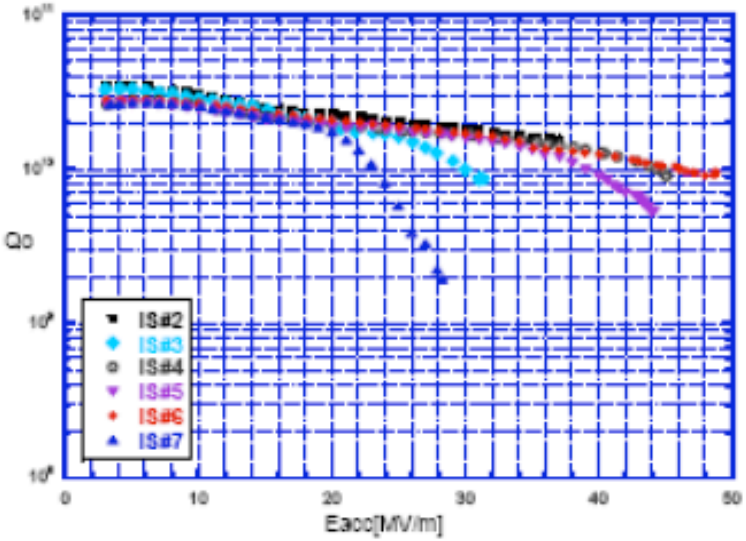
- New single-cell treatment procedure at KEK shows big improvement in spread
  - Add final EP 3 microns with fresh acid in closed cavity

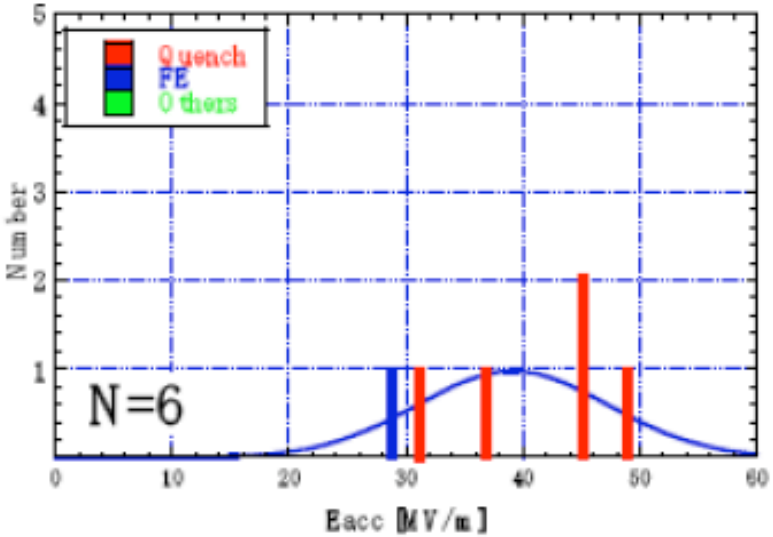
  PLUS

- Jlab ultrasonic degreasing with special detergent and water shows field emission reduction

(A) CBP+CP+Anneal+EP(80μm) +HPR+Baking(120C*48hrs)

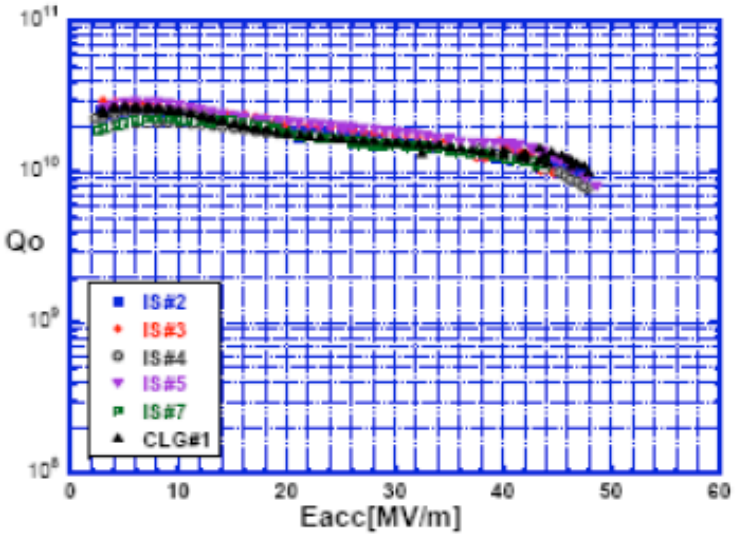
K. Saito et al.

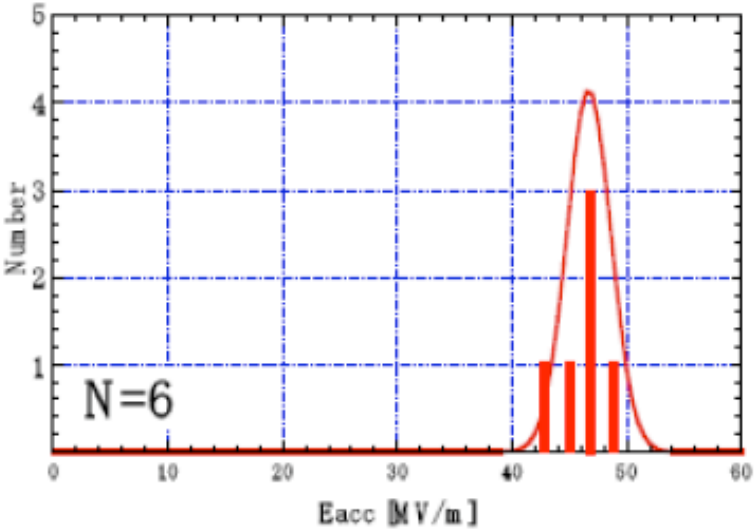




(D) +EP(20μm)+EP(3μm, fresh, closed) +HP* +HPR+Baking (120C*48hrs)

K. Saito et al.





This is absolutely wonderful !

BUT

We need to consolidate our gains by reproducing them in all participant labs

AND

Check it out in 9 cell cavities from qualified vendors

SO THAT

We can uncover the next layer of barriers to reproducibility of high production rate cavities

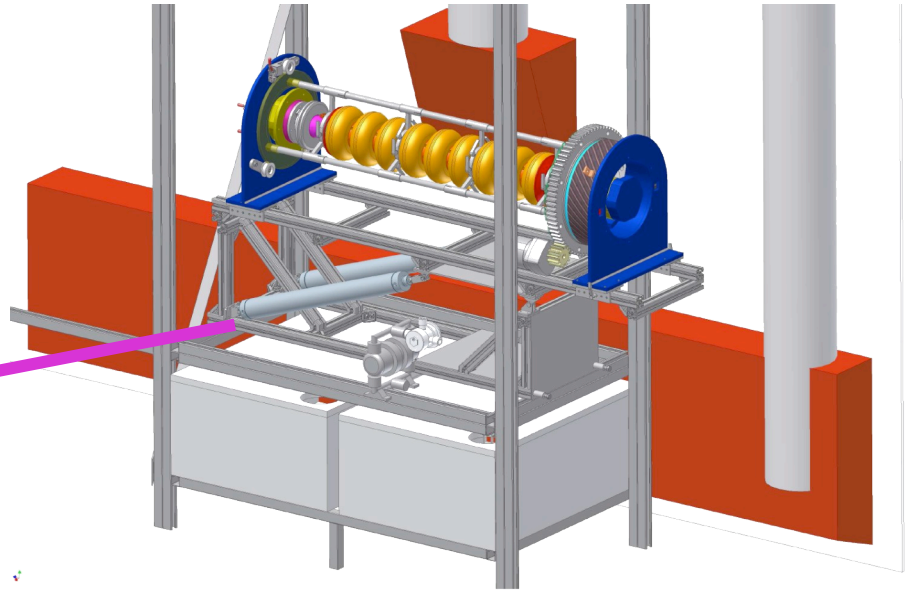
In Aid of This we are
Preparing to Intensify Global SO Activity

- More than 60 new cavities on order by Fermilab, DESY, KEK to be available this year

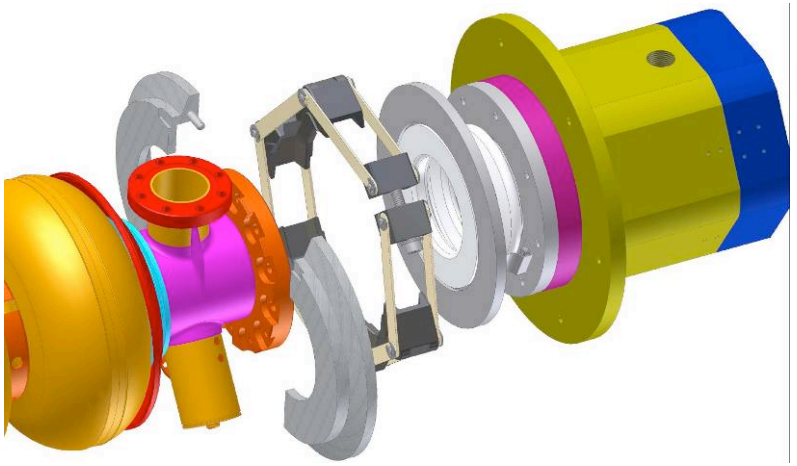
- New Nb and cavity vendors under development
  - Giredmet, Heraeus, Plansee, Ninxia (Nb)
  - AES, Roark, Niowave, Mitsubishi (Cavities)

- New treatment and test facilities under construction
  - Argonne/Fermilab, KEK

New Electropolish facility @ANL



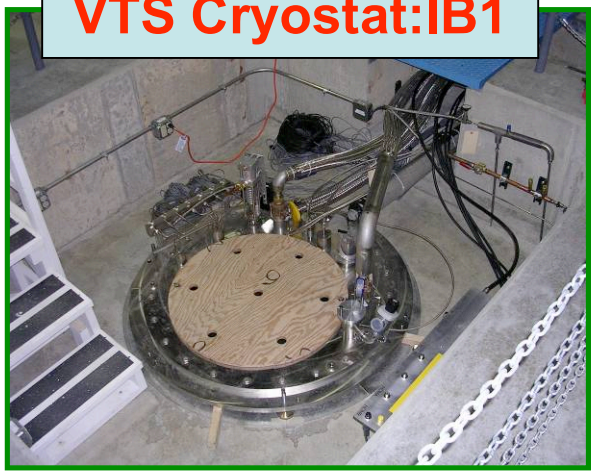
- World knowledge to design new EP system
- Design Review 2/12/07, Under construction
- Plan: Commission late FY07
- Capacity ~ 45 EP cycles per year
- Plan for new HPR system by late 07



New Vertical Test @ FNAL

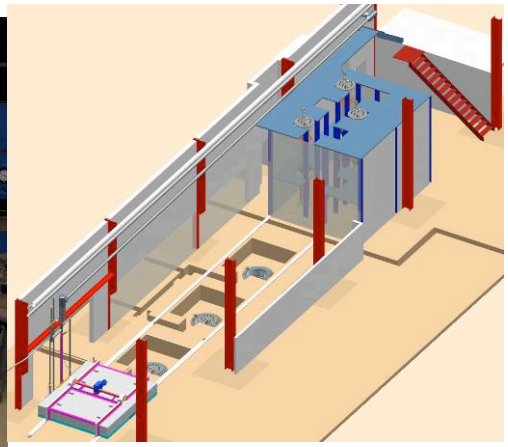
- A new Vertical Test Stand is under Construction at Fermilab
  - Existing 1.8 K Cryogenic plant 125 W at 2 K (250 W intermittent test)
  - RF system based on TJNL system
  - Current test Stand will be capable of testing ~50 Cavities/yr
  - Commission late summer 07,
  - Evolutionary upgrades: Thermometry for 9-cells, 2 cavities at a time, 2 top plates, Cryo upgrades: increased pumping capability & purifiers, up to two additional VTS cryostats

VTS Cryostat:IB1



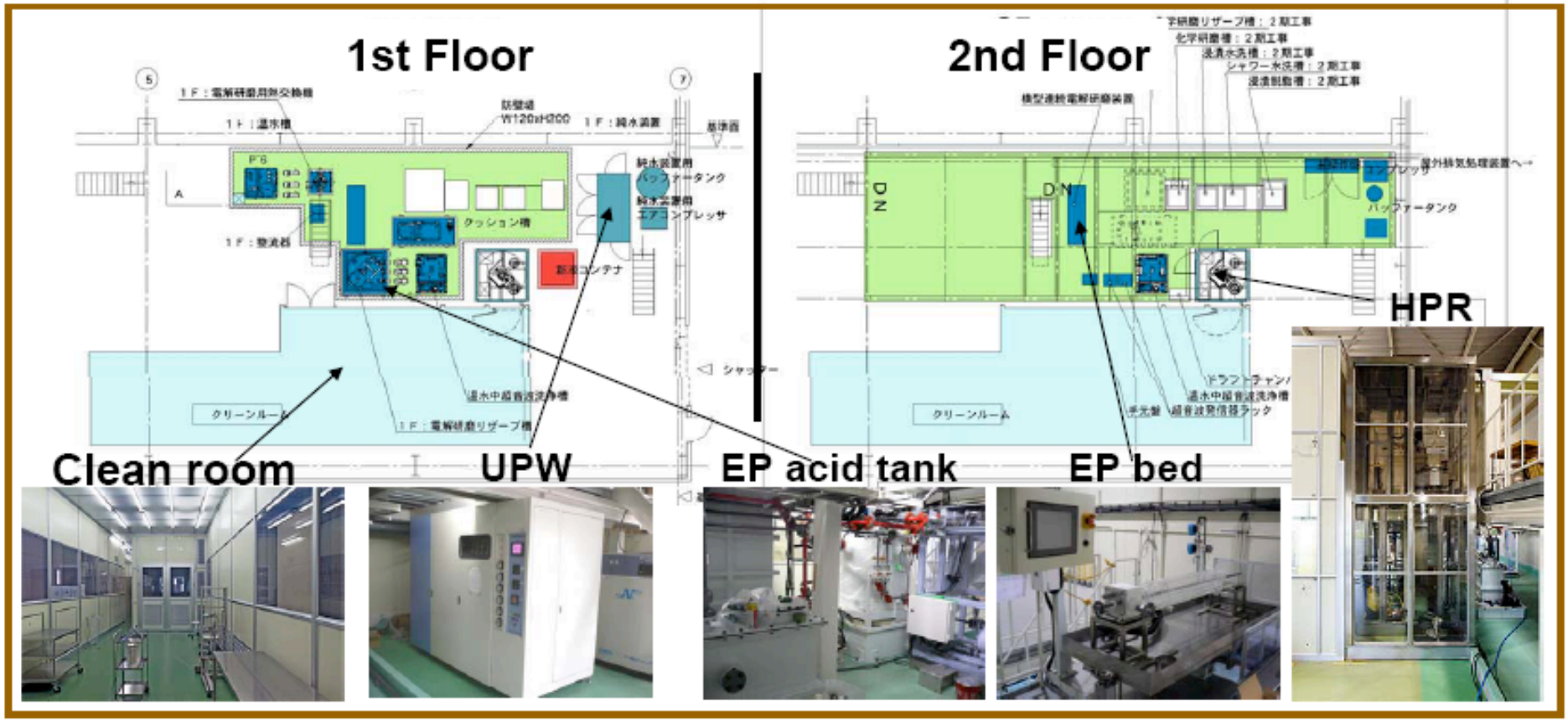
New RF & Control Room

Movable shielding for up to 3 pits



STF Cavity Surface Process Facility

Clean room: in operation for use of short cryomodule assembly.
UPW: in operation.
HPR:under construction. almost completed.
EP : under construction. will be completed in May. 2007.
External acid tank system: will be constructed in summer 2007.
Additional EP system for KEKB-SC&crab cavity: will be done in JFY2008.
CP: will be constructed in JFY2008.



Potential For Cavity Tests by Year

Year	Jlab	Cornell	ANL/FNAL	KEK	DESY	Total
2007	30	10	20	30	50	140
2008	40	10	50	40	50	190
2009	50	10	50	40	50	200

S1

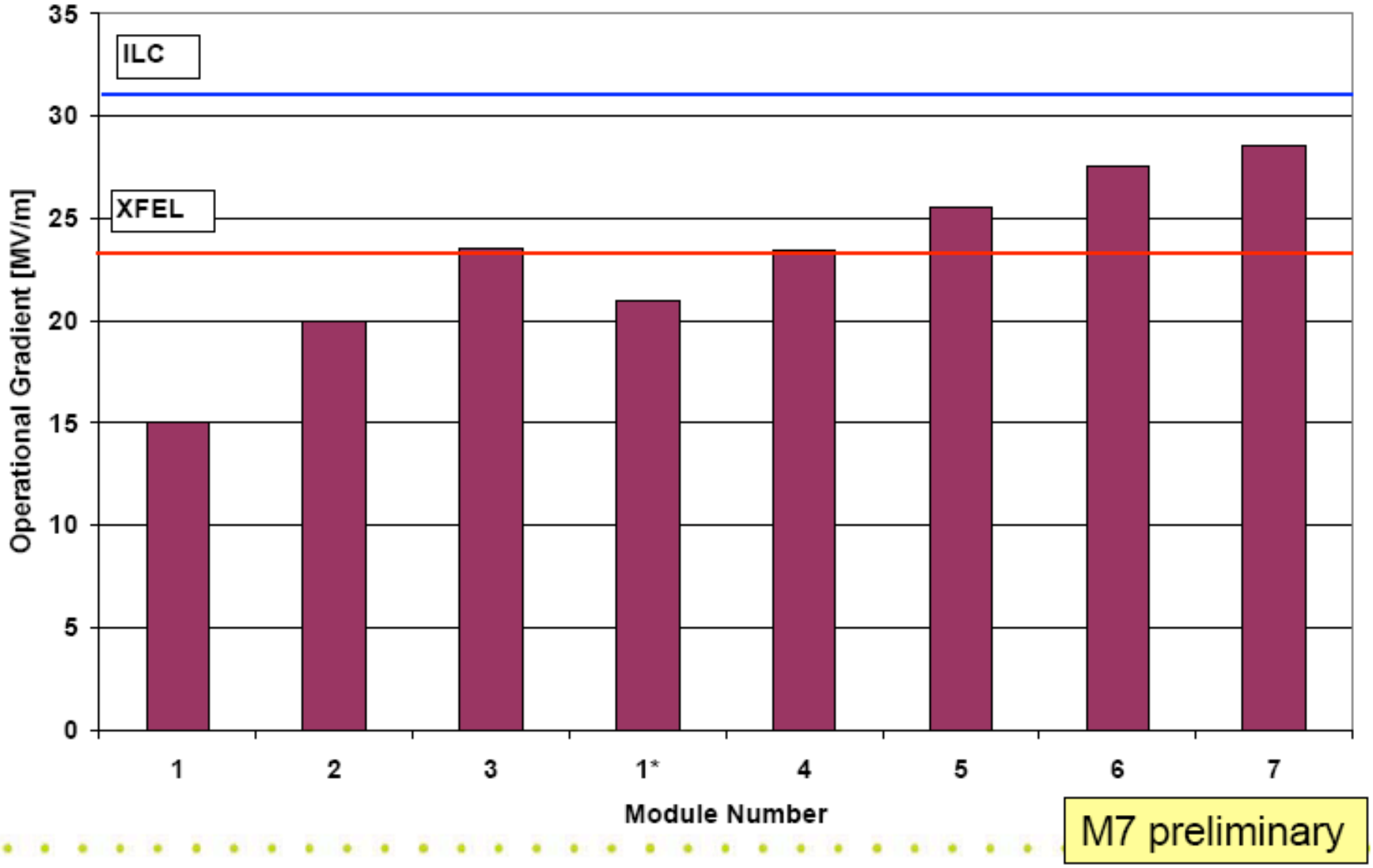
(Assemble and Test Several Cryomodules with average gradients of > 31.5 MV/m)

Significant Progress to Report

- New module test stand commissioned at DESY
  - Module 6 and 7 tested
  - Module gradients increasing steadily towards goal
  - Big improvement in time for coupler processing
- ILC module assembly and test facilities being installed at KEK and Fermilab
- Next generation ILC module design advancing

Module 6 on CMTB

Accelerator Module Operational Gradients



Cryomodule Assembly Facility at FNAL

CAF infrastructure:

- **Clean Rooms (10,100,1000)**
- **String Assembly Fixtures**
- **Ultrasonic Cleaner**
- **Ultra pure DI water**
- **Cavity Handling Cart / Fixture**
- **Cold Mass Assembly Fixture**

STF Building plane view

STF棟（旧陽子リニアック棟）　平面図

Cryogenic System (from AR-East)

Control room
制御室

10m x 10m

5m x 15m

Cryogenic Compressor (from AR-East)

Common Assembly/work Area

cryogenic pumping area

Kly + Mod. (coupler test, RF Gun)

Kly + Mod. (phase1 Cavity)

New 10MW Kly + Mod. (3 cryomodule)

Vertical Test Area

coupler test stand

Klystron Gallery

vertical hatch

Laser room

HPR

EP bed

Tank

Clean Room for cold mass assembly

Cold mass assembly

Cavity Process (EP) & assemble Area (clean rooms)

Cryomodule Assemble Area

S2

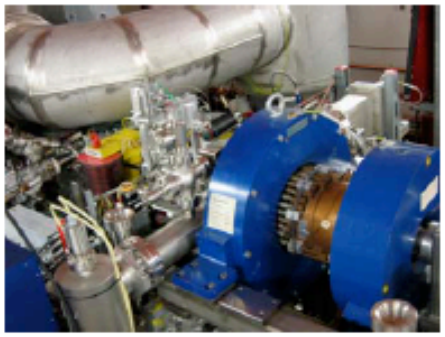
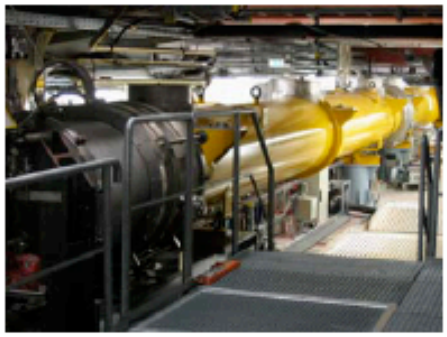
Build and Test one or more complete ILC rf units having ILC gradient, beam parameters and pulse rep rate

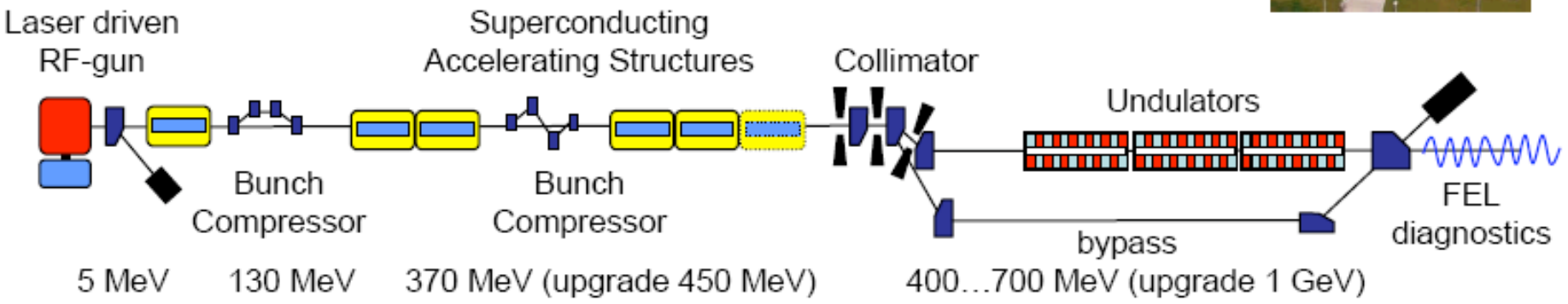
(Continue cryomodule tests in TTF/FLASH with beam. Test as many ideas and components as possible)

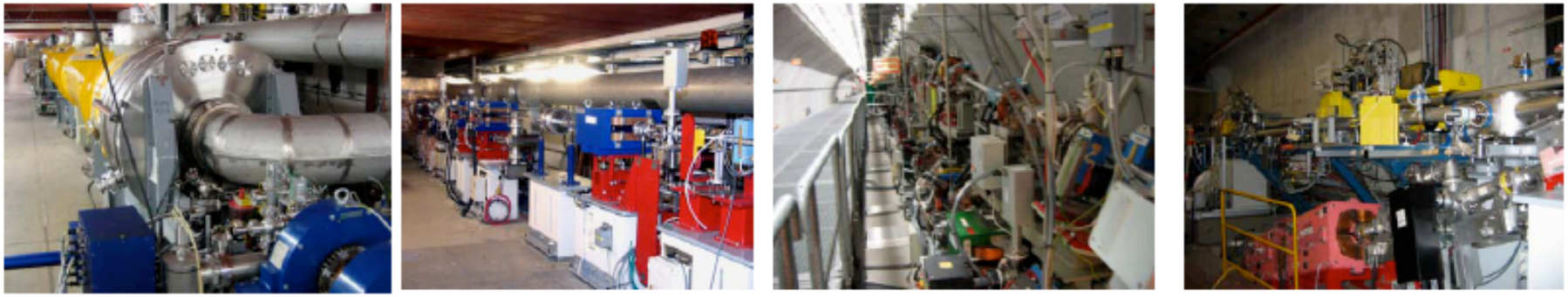
- **We anticipate three facilities capable of carrying out various aspects of this charge**
  - **FLASH linac now in operation**
  - **STF at KEK**
  - **ILCTF at Fermilab**

Lay-out of the FLASH Linac

FLASH
Free-Electron Laser in Hamburg





STF phase 0.5 Cryomodule into Tunnel

carrying down the cryomodule

Downstream module installation

cryomodule sit in the tunnel

- Many important accomplishments have been achieved in TTF/FLASH
  - Long term operation with beam
  - Emittance measurements
  - Emittance transport
  - HOM investigations
  - Highly flexible operation
  - Cryoproperties of modules measured
  - LLRF and synchronization developments
  - Instrumentation development
  - ……much more & more to come
- Still plenty for new S2 facilities in demonstrating full scale ILC rf unit operation with all beam parameters
- Infrastructure is planned and construction begun to address these remaining issues

Alternate Concepts R&D – long range

- Alternate cavity shapes with lower surface magnetic field – hope for higher E_{acc}
  - "Low Loss, "Ichiro", "Re-entrant"
- Alternate material form – hope for lower cost with simpler processing
  - Large grain or even single crystal Niobium
- Alternate fabrication methods to minimize welding
  - Hydroforming, spinning

Progress being made in all three areas

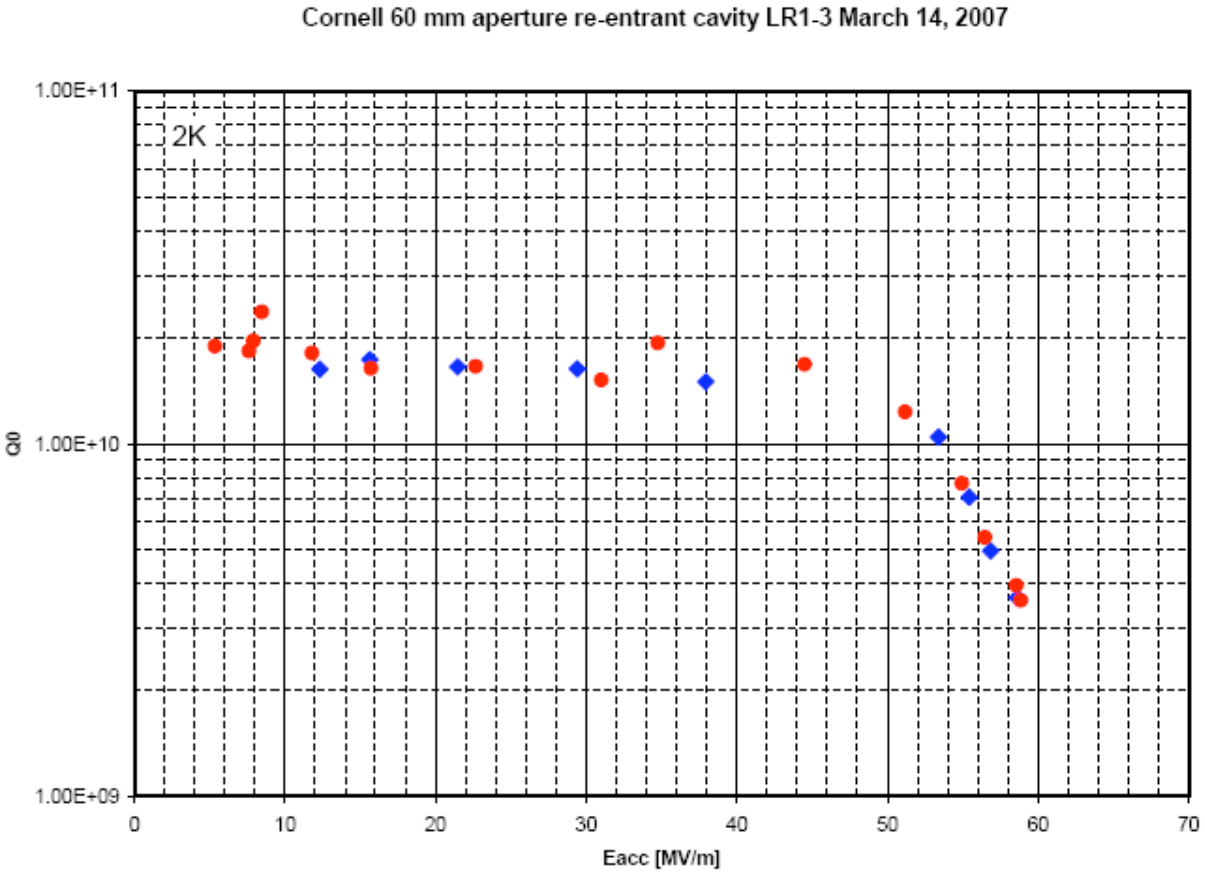
(three examples only - see TTC FNAL reports)

- too early to tell if these will have an impact on ILC but will surely have an impact on SRF applications

60mm-Aperture Re-Entrant Cavity, 58 MV/m!

KEK/Cornell Collaboration

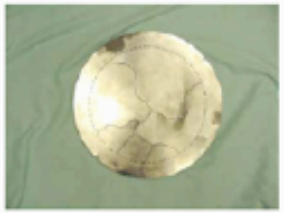
RE-LR1-3



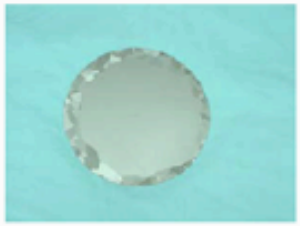
Large Grain Material (JLab)

Large Grain/Single Crystal Niobium[2]

CBMM



Ingot "D",800 ppm Ta



Ingot "A", 800 ppm Ta

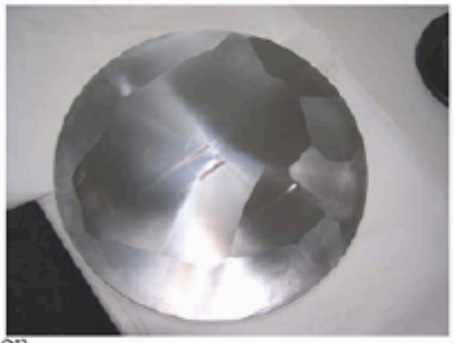
Ingot "B", 800 ppm Ta

Ninxia

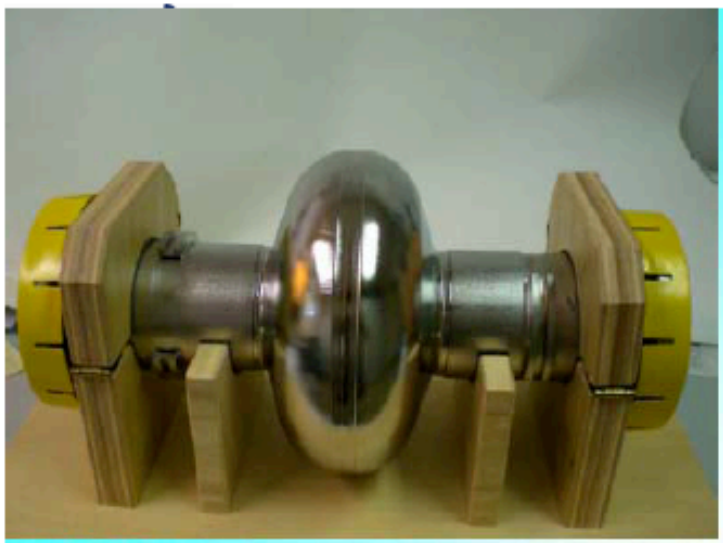
Ingot "C", 1500 ppm Ta

Wah Chang

Heraeus

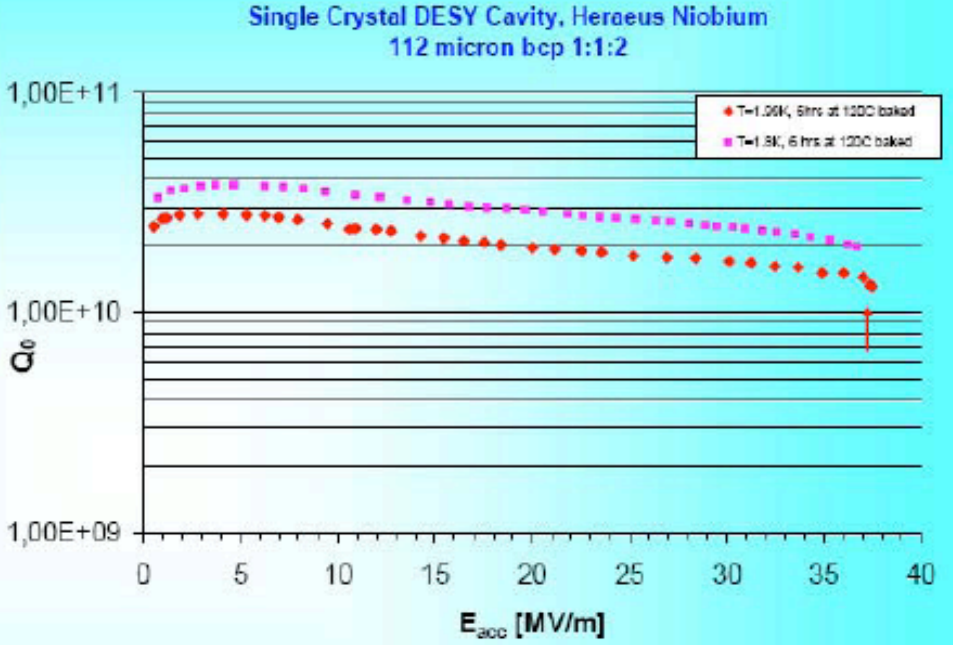


Oct. 30 – Nov. 2, 2006
Single Crystal Workshop
Araxa, Brasil



DESY single crystal cavity 1AC8 build from Heraeus disc by rolling at RWTH, deep drawing and EB welding at ACCEL

XFEL
X-Ray Free-Electron Laser



Q(Eacc) curve after only 112 µm BCP and in situ baking 120°C for 6 hrs.

Preparation and RF tests of P.Kneisel, JLab

Nine-Cell Cavity (Hydroformed)

First Seamless Cavity
(TESLA shape)

three Triple-Cell
hydroformed
at DESY

Final Steps at Zanon : end groups completion – stiffening rings – welding on two iris

Organizational Infrastructure for ILC SRF R&D

- GDE R&D Coordination has been progressing steadily
- It is significantly strengthened by the worldwide linkages of SRF workers as SRF applications expand
  - x-ray and neutron sources, heavy ion accelerators

- This broader perspective is encompassed by the Tesla Technology Collaboration (TTC)
  - 52 member institutions, 12 countries
  - twice yearly meetings deal with all aspects of SRF; contribute knowledge and experience benefiting ILC as well as the other applications

- Don't forget the triennial International SRF Workshops

Summary

- We have made good progress on our way towards meeting our S goals
- Physical infrastructure for accomplishing the R&D needed to meet these goals is in hand or under construction in the three regions
- Qualification of industry to meet demand for the many cavities needed for the R&D program is proceeding at an increasing rate
- The organizational infrastructure needed for coordinating the needed R&D is improving.

- *Review of the great progress made in the last year shows that prospects for success in meeting our S goals are very bright*