



# ILC 9-cell Cavity Results from JLab

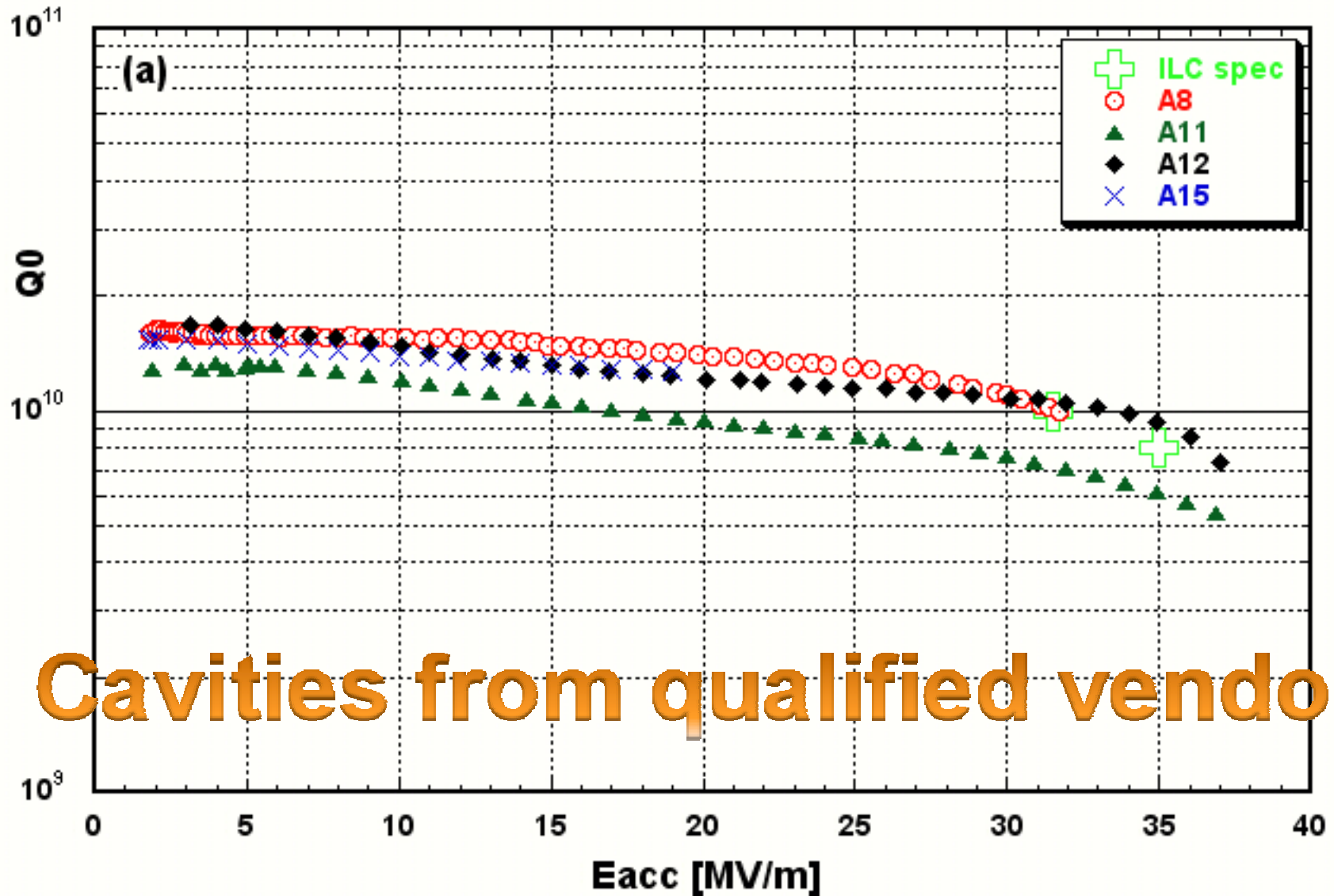
in collaboration with FNAL and KEK

Bob Rimmer

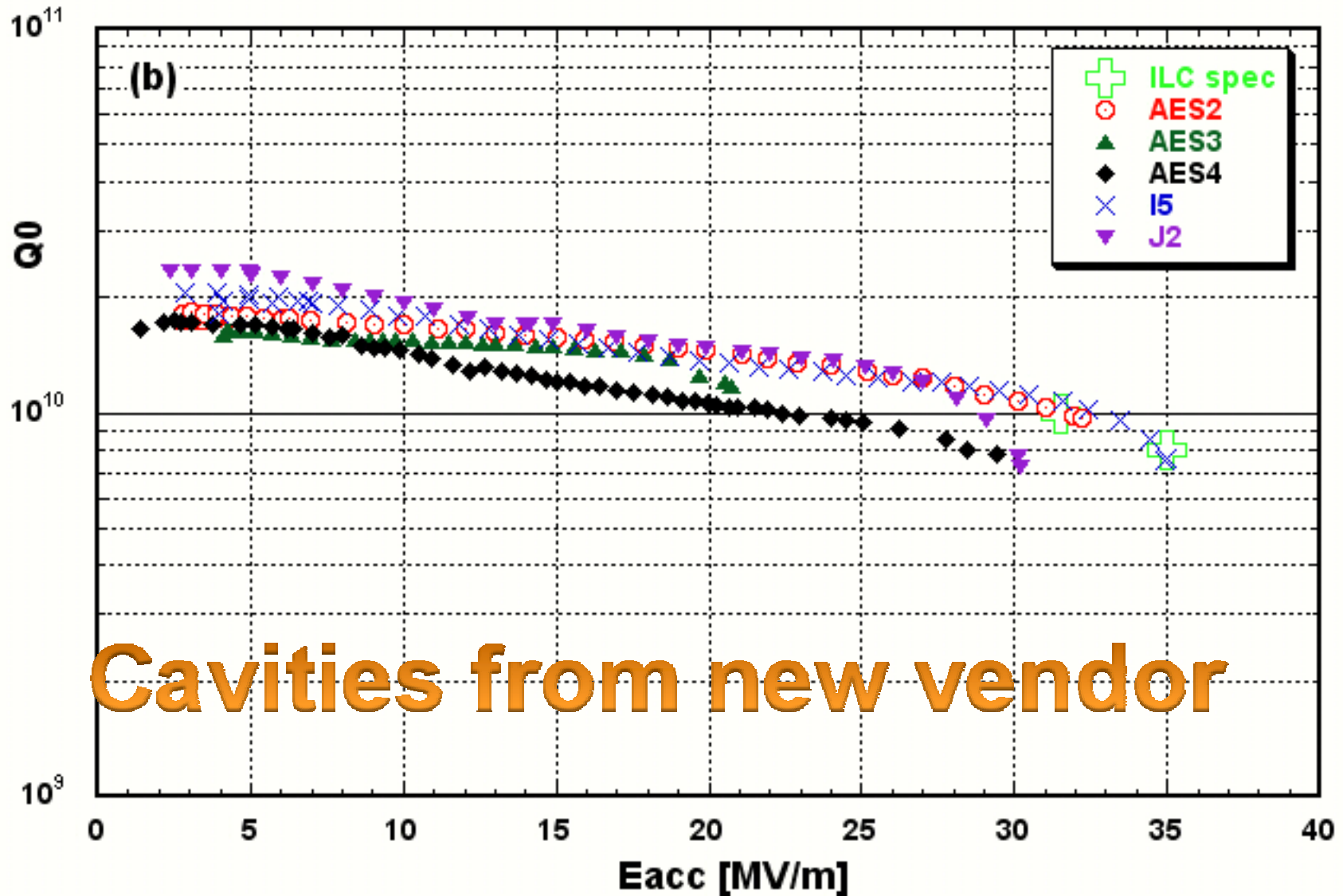
For the Jefferson Lab team  
TTC meeting, October 20-23, 2008



# New 9-cell Results Since SRF2007



# New 9-cell Results since SRF2007 (cont.)



# 2 Year Overview of 9-cell Activities at JLab

- 12 cavities EP processed, RF tested.
- 114 hour active EP time.
- 30 EP & 30 VT cycles done in FY07
- 17 EP & 27 VT cycles done in FY08 (more VT in 08 for understanding FE and quench).

## Results published at SRF2007 & LINAC08:

1. R.L. Geng et al., “Latest Results of ILC High-Gradient R&D 9-cell Cavities at JLAB ”, SRF2007, Beijing, China, October 2007, WEP28.
2. R.L. Geng et al., “High-Gradient SRF R&D for ILC at Jefferson Lab”, LINAC08, Victoria, Canada, September 2008, THP042.

2008 as compared to prior year  
 Progress made toward  
 reaching 35 MV/m after 1<sup>st</sup> light EP  
 (data sampling of cavities by qualified vendor)

	Jan 07	Mar 07	Nov 07	Jul 08	Jul 08	Aug 08	
Cavity	A7	A6	A8	A12	A15	A11	Yield
Eacc $\geq$ 31.5 MV/m?	Y	Y	Y	Y	N	Y	5/6 (83%)
S0 cycles needed	2	4	3	1	-	1	
Eacc $\geq$ 35 MV/m?	Y	Y	N	Y	N	Y	4/6 (67%)
S0 cycles needed	2	4	-	1	-	1	

Relevant improvements made toward optimal processing with JLab facilities

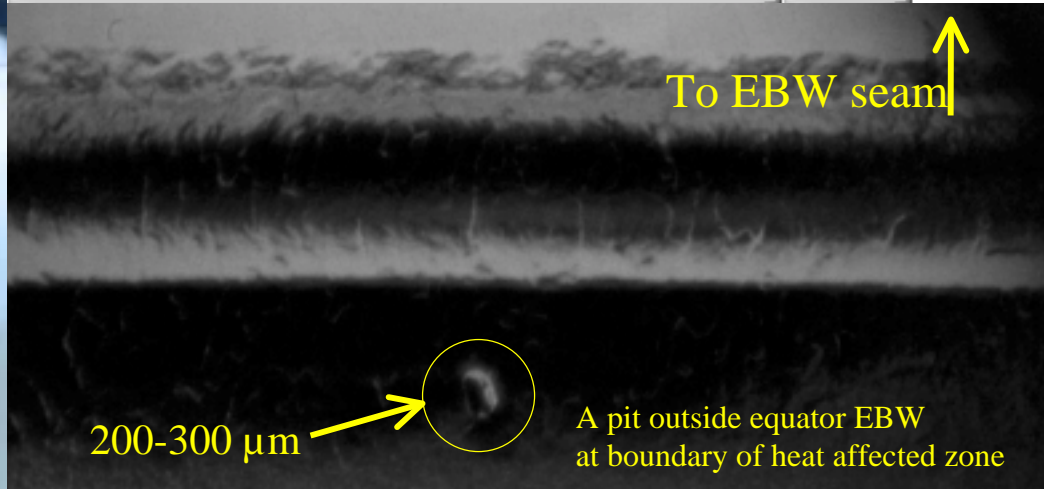
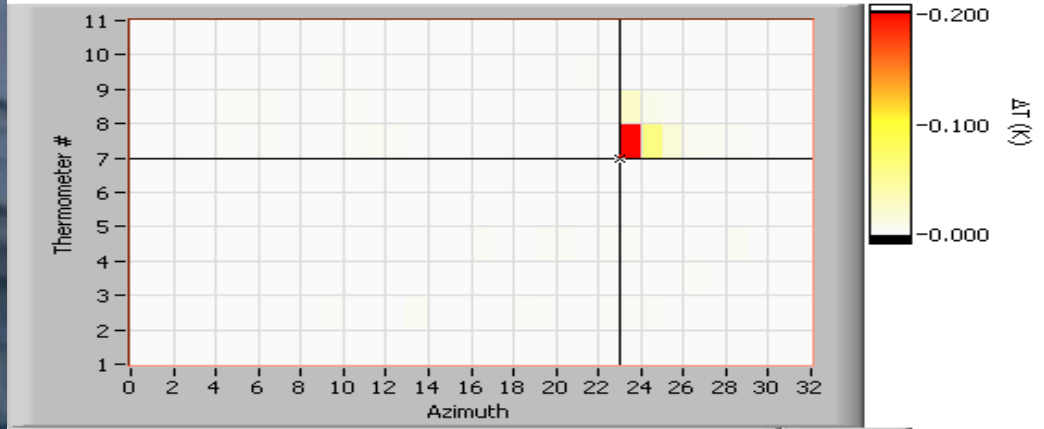
- Initial acid mixing volume ration 1:10 (HF(49%):H2SO4(98%))
- Nominal voltage 14-15 V
- Continuous current oscillation
- Minimum purging N2 gas
- HPR after bulk EP and before 600 C furnace heat treatment
- ...

# Understand Gradient Limitation when Quench is Hit in Real 9-cell Cavities

1. Pass-band measurements determine quenching cells.
  - So far, only two candidate cells need attention in actual quench limited 9-cell cavities
2. Second test with T-mapping near equator of 2 cells.
3. Visual inspection with long-distance microscope 9-cell cavity inspection apparatus.



# A15 gradient limit at 19 MV/m: T-mapping found a hot spot correlated to quench Long distance microscope identified a defect near hot spot



# More on cavity inspection

- Observe & document features on as-built surface (already started with A13, J1 and J2).
- Track notable features along with cavity processing steps.
- Find quench location with T-mapping and re-inspect.
- Goal is to establish correlation between relevant defect and quench.
- Initial data point out the importance of heat affected zone of EBW (equator, iris and stiffening ring).
- More inspection results in later talk.



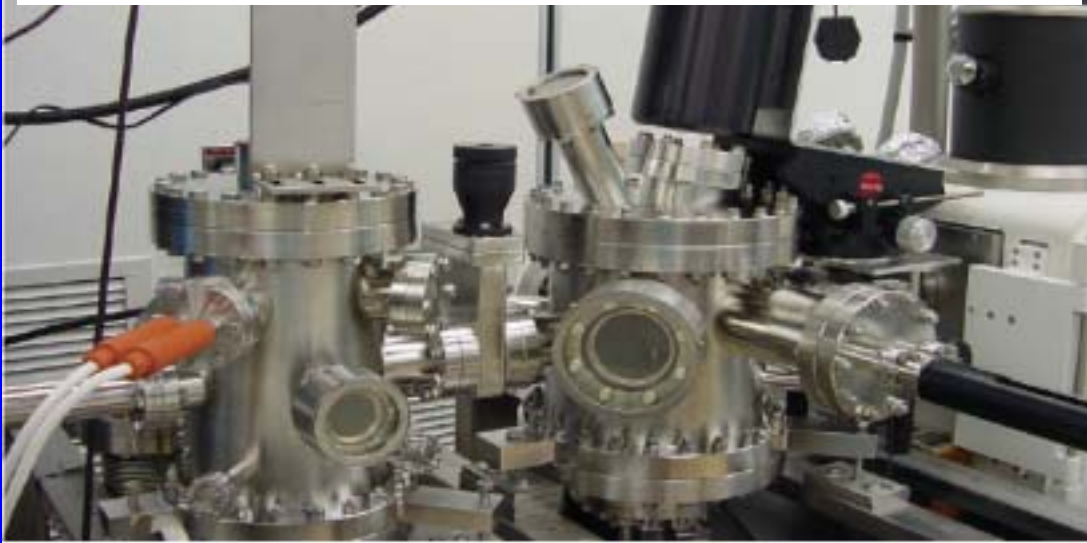
# Field Emission

- FE remains an issue.
  - Some cavity testing FE limited.
  - Many cavity testing have finite FE loading.
  - FE risk due to re-contamination (such as He tank dressing) remains a threat.
- Understanding and improvement needed.

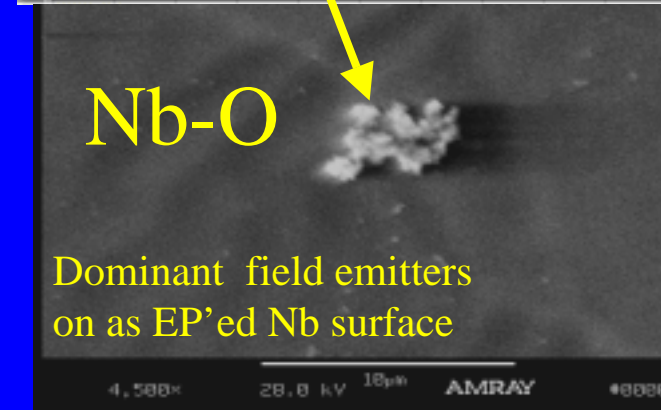
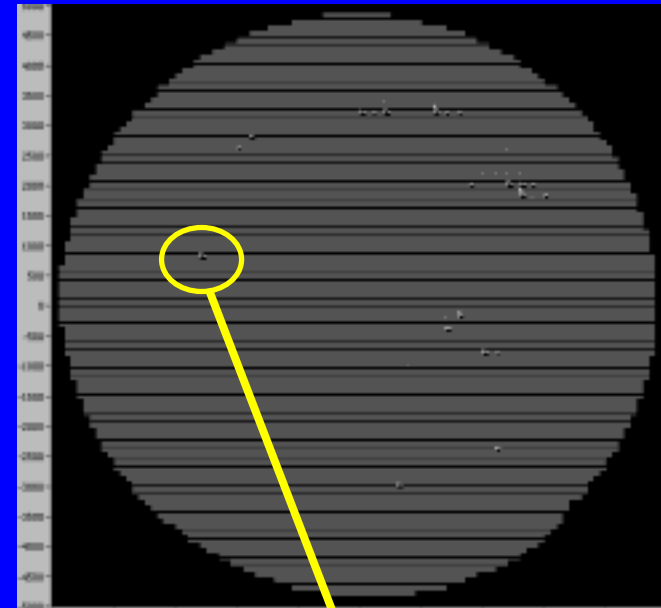
# Understanding FE Behavior w/ Samples

Surface studies of Nb samples EP'ed together w/ 9-cell cavities

## JLab Scanning Field Emission SEM



- Scan Nb surface with biased tip – DC field upto 140 MV/m
- Field emission sites and I-V curve registered
- Sample transferred to SEM chamber under vacuum
- Nature of field emitter determined



# Understanding FE Behavior w/ Samples

Bacteria growth after extended  
Contact with DI water



KEK Sponge cleaning  
Collaboration with JLab  
US-Japan Cooperation Fund

Before

250× 20.0 kV 100 μm AMRAY #0000

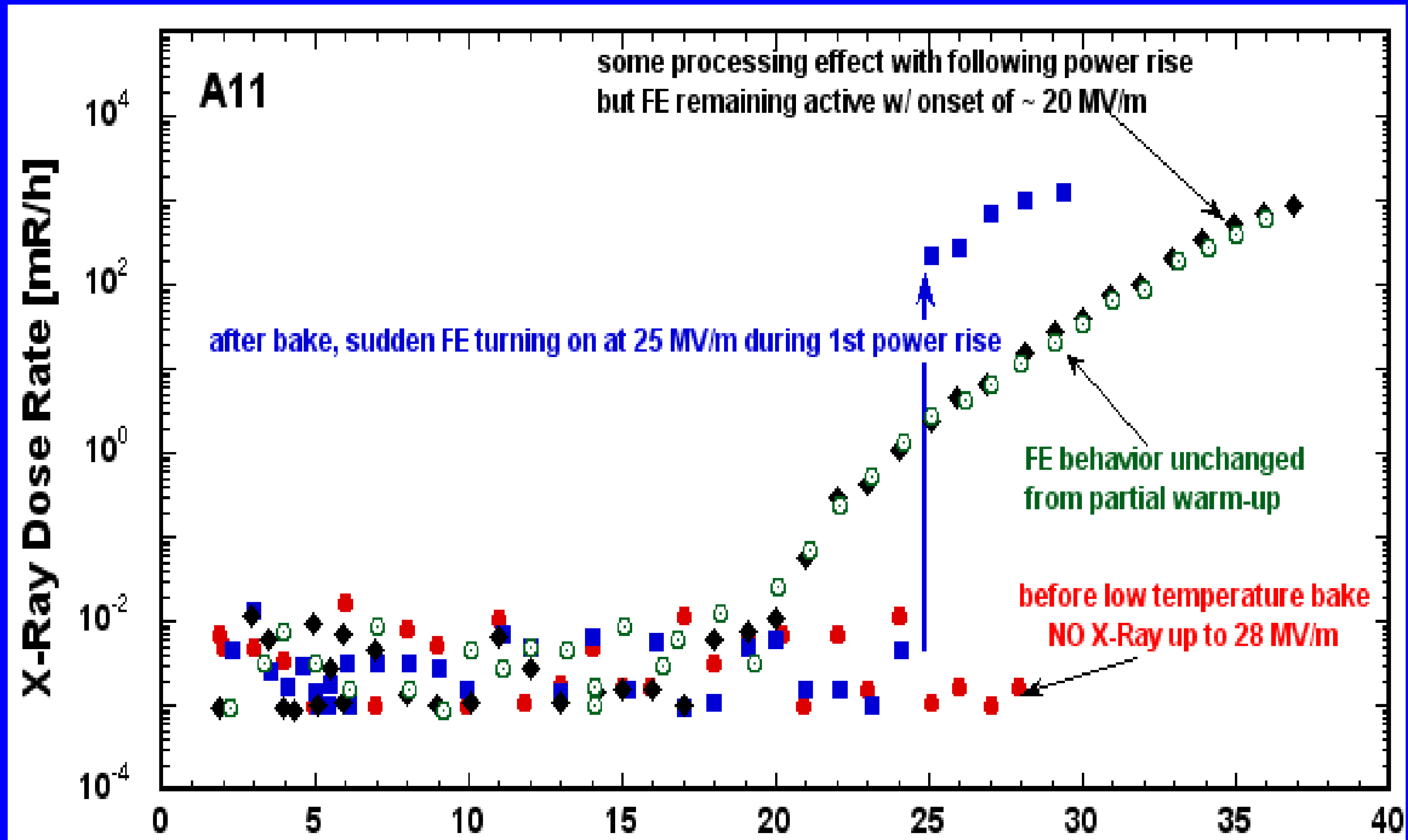
After

250× 20.0 kV 100 μm AMRAY #0000

20-23, 20

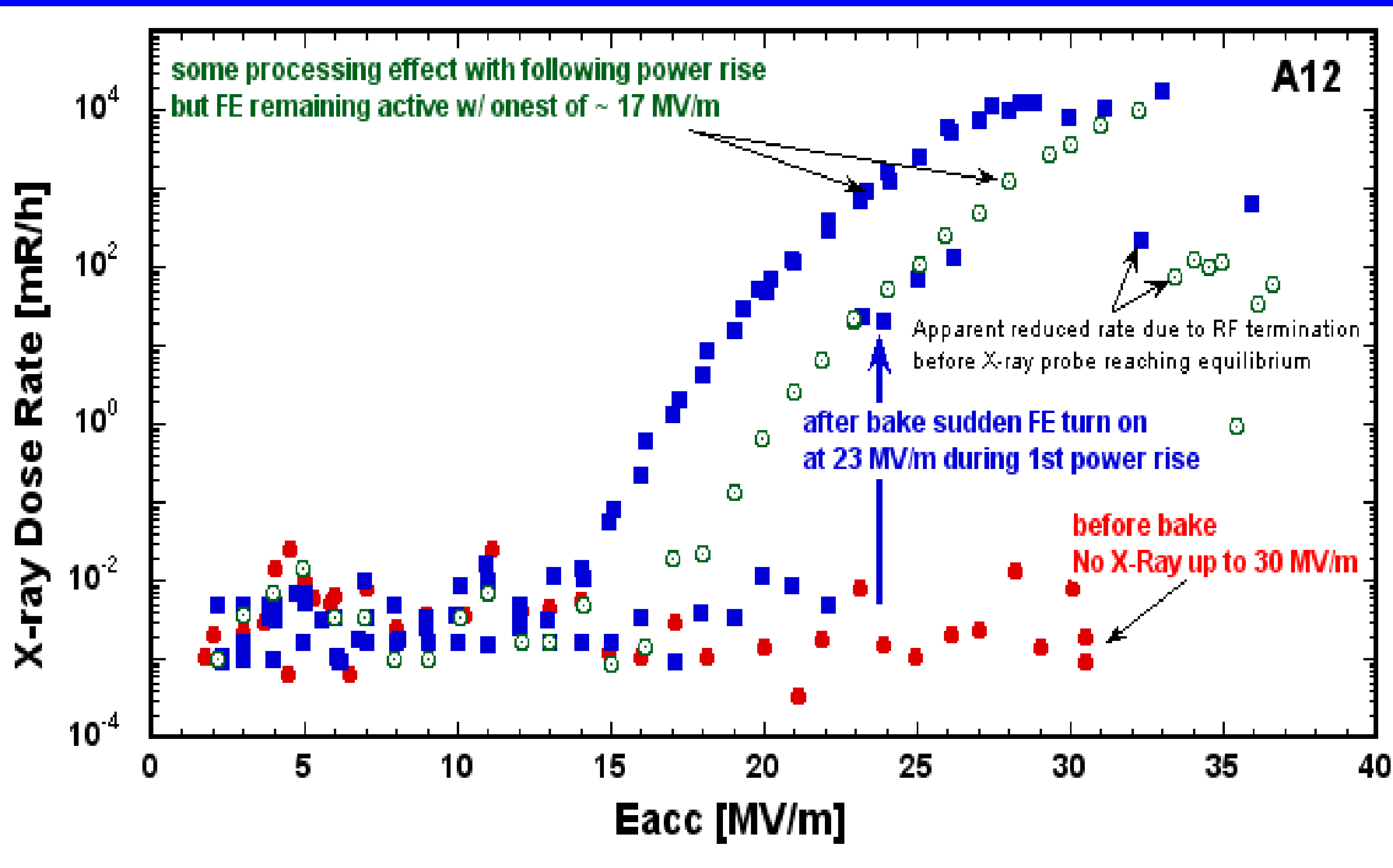
# Understanding FE Behaviors w/ Real Cavities

## Observation of Baking Induced Field Emission in EP'ed Cavity

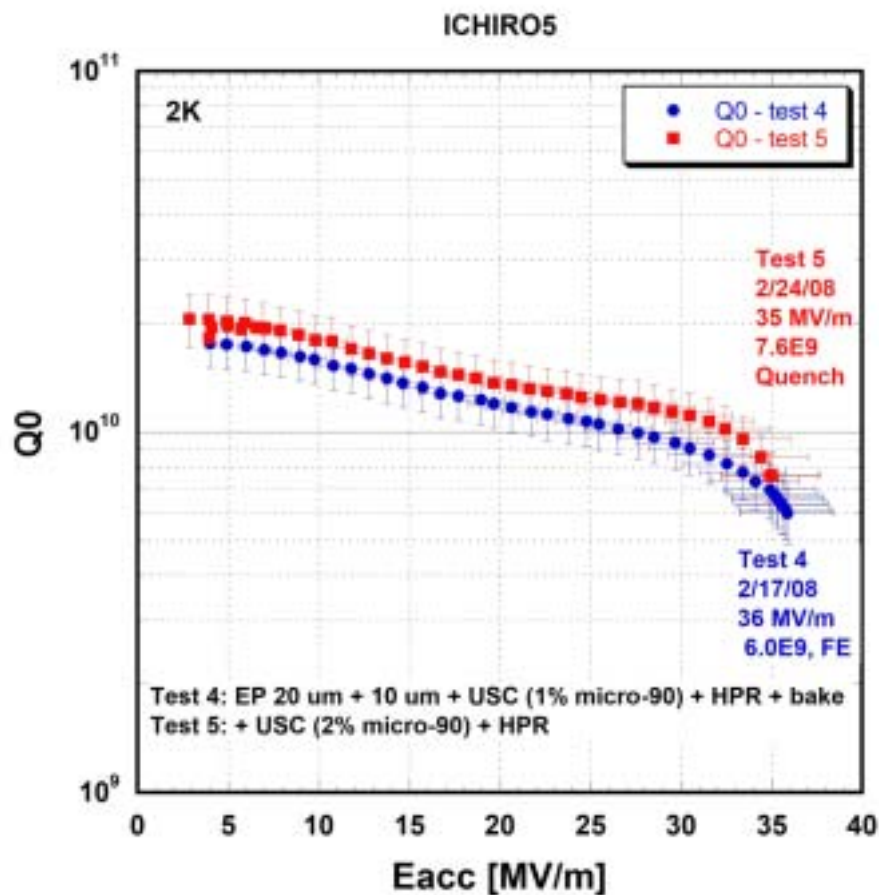


# Understanding FE Behaviors w/ Real Cavities

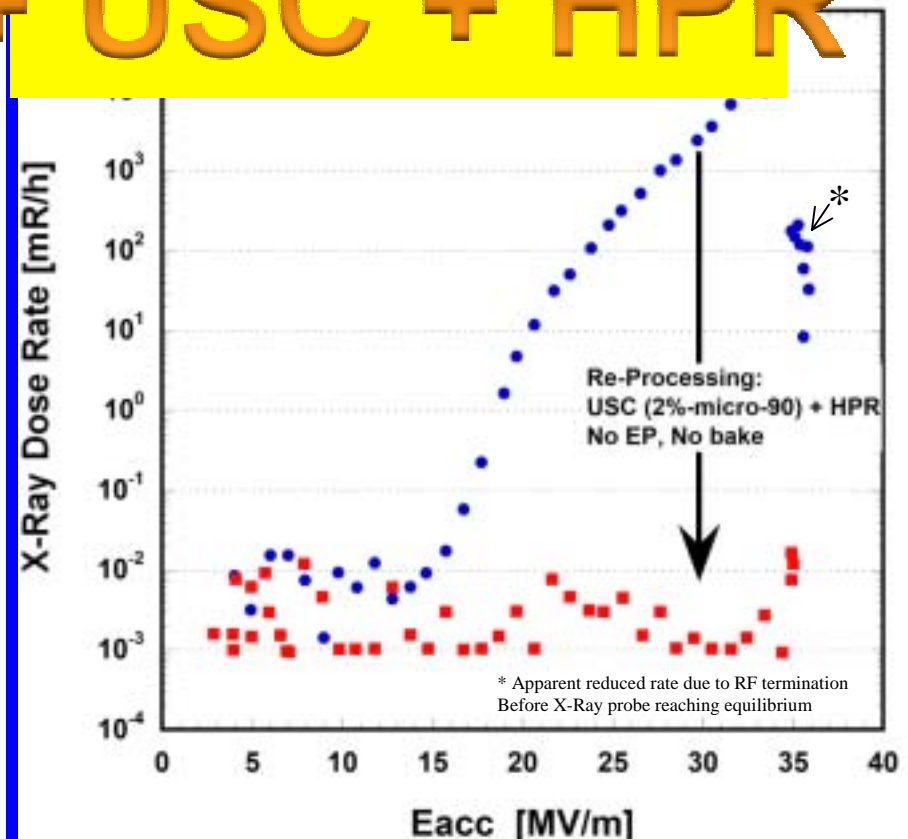
Observation of Baking Induced Field Emission in EP'ed Cavity (cont.)



# First Example of Reducing/Eliminating Field Emission by Re-cleaning

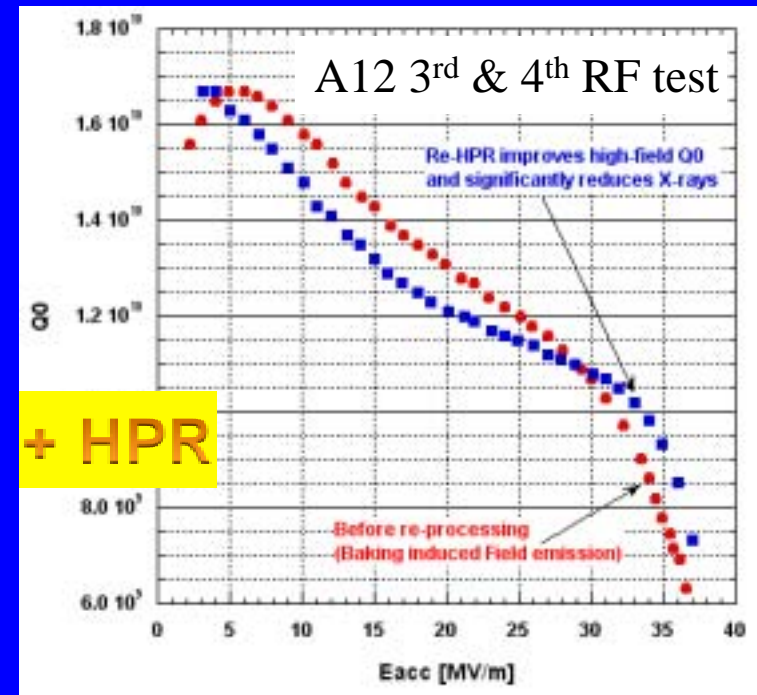
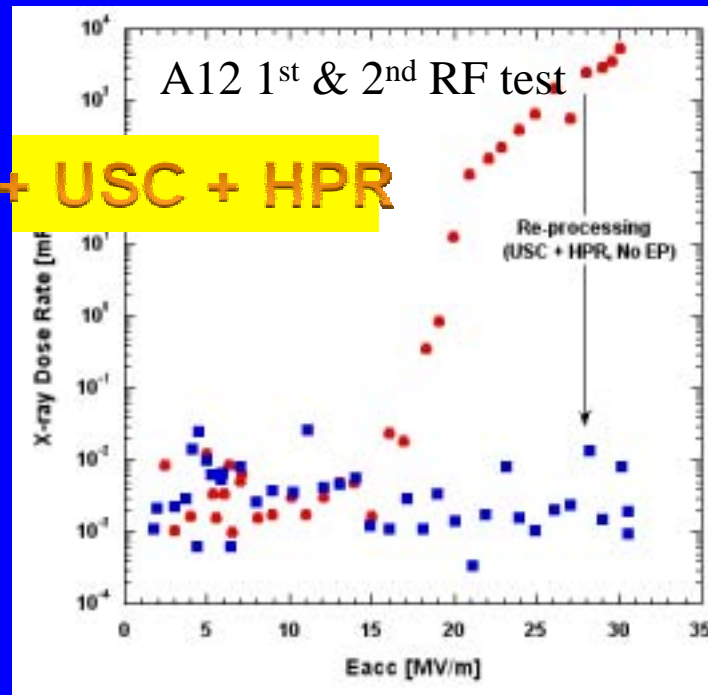


+ USC + HPR



More details of multiple processing and testing results can be found in JLab report at ILC SCRF meeting, April 21-25, 2008, FNAL

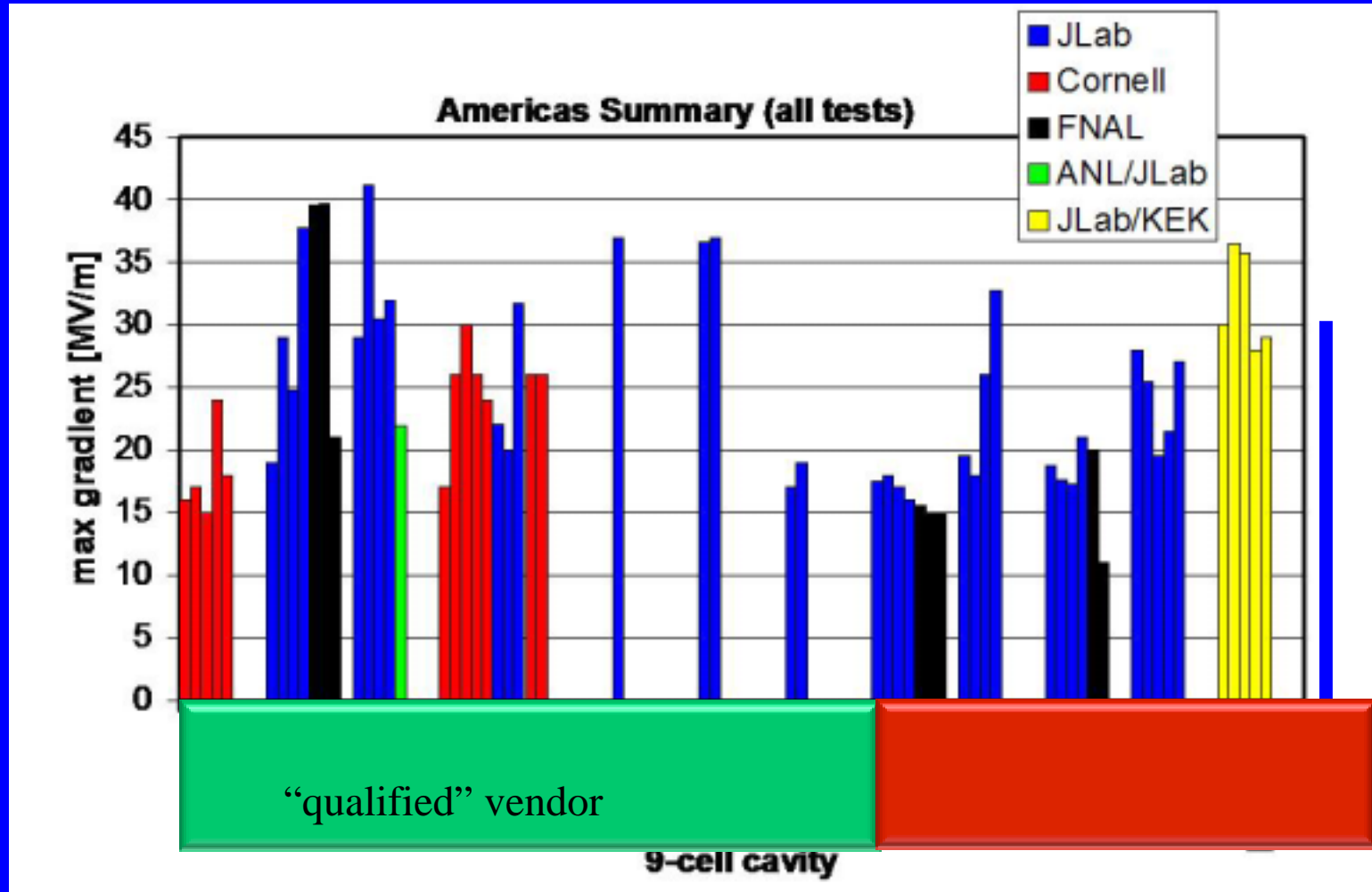
# More Examples of Reducing/Eliminating Field Emission by Re-cleaning



Another example is A6: last S0 test at JLab 37 MV/m, limited by field emission. After shelf storage over a year, A6 re-cleaning (USC + HPR) and shipped under vacuum, RF test at FNAL saw an improved Q(Eacc) over the last test at JLab.

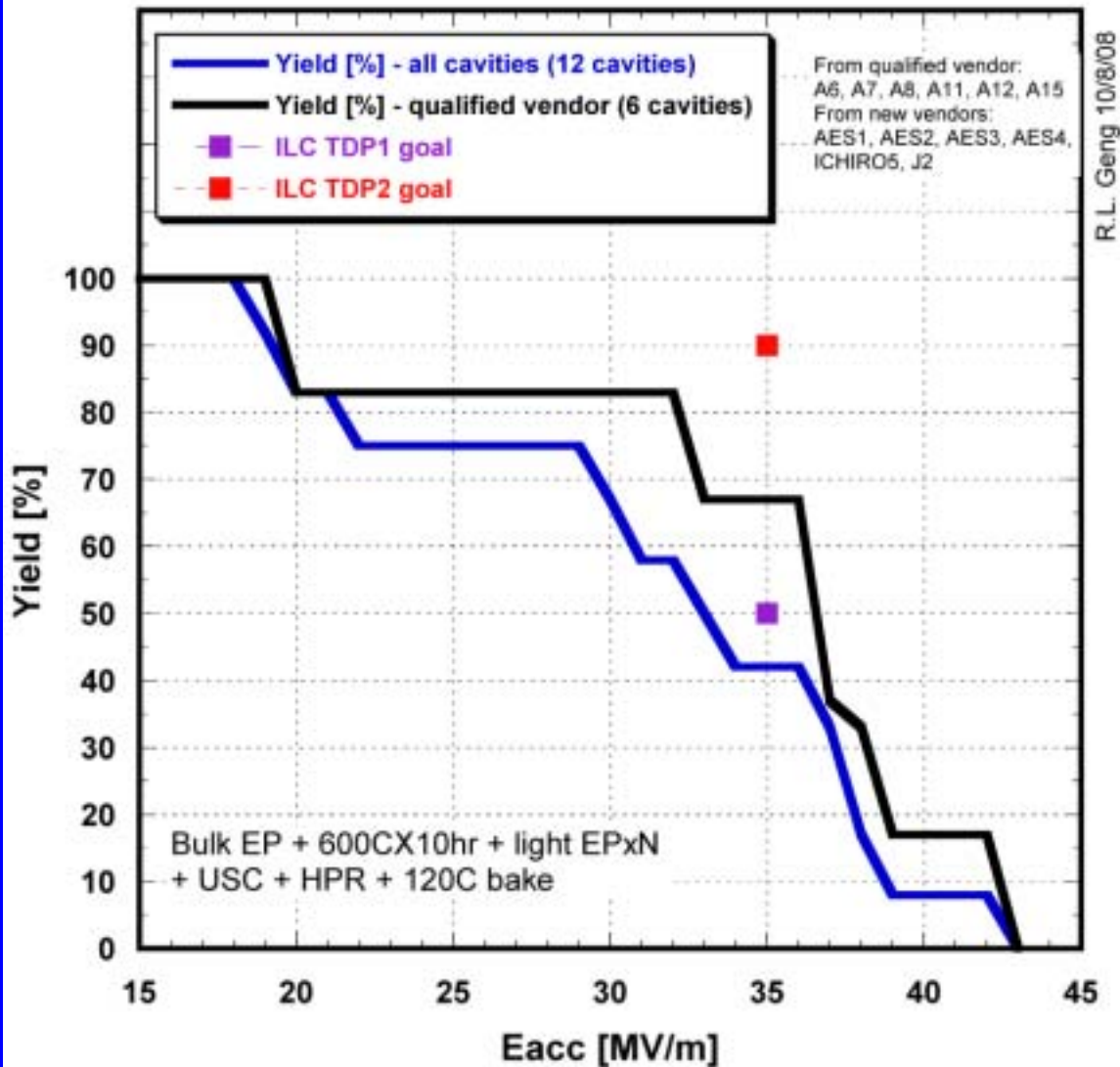


# JLab Electropolished & Tested 12 of 14 (85%) US & US/Japan 9-cell Cavities

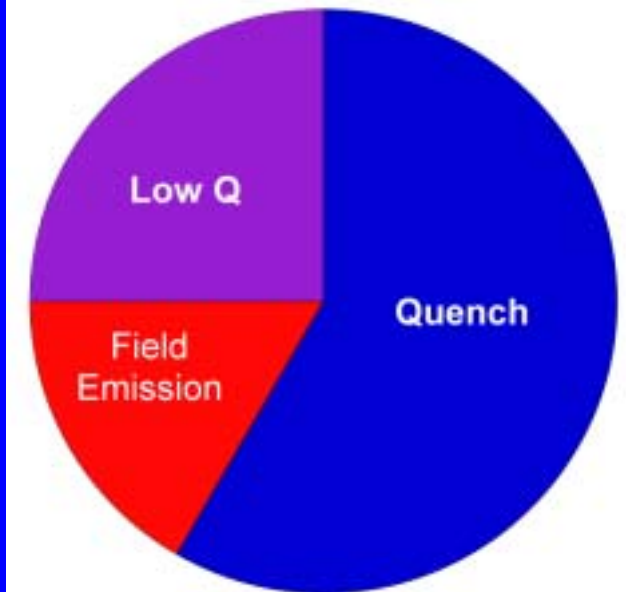


Graph credit: Camille Ginsburg, FNAL

## Best Gradient Yield 9-cell Data from JLab as of October 2008



## Best Gradient Limit 9-cell (12 total) data from JLab as of October 2008



## First Cycle and Second Cycle Yield as of October 2008 Sampled from JLab Data

