

# Americas Summary

CM Ginsburg  
ILC/S0 Meeting  
27 Apr. 2010

# Production Cavities in progress

- TB9ACC013 (dressed)
  - In ICB; no smoking gun seen in Questar cavity inspection. HPR +HTS re-test (displaces TB9AES010).
- TB9AES009 (dressed)
  - In HTS; cooldown 4/26 for the first time after coupler alignment problem fixed; test complete ~5/10
- ACCEL8 (dressed)
  - Preparation for HTS: at MP9; expect ready for HTS by 5/10
- TB9AES008 (dressed)
  - Preparation for HTS: HPR at ANL last week
- TB9AES010 (dressed)
  - At MP9. Will be next after TB9ACC013 (re-prep) for HTS preparation
- TB9ACC016
  - At MP9 in process of dressing. Ti ring was welded
- TB9AES007 (@JLab)
  - 41 MV/m vertical test at JLab 3/16. To be packed up 4/26, sent out 4/27, arrive guestimate ~5/10 for dressing measurements, HPR+VTS prep, VTS, dressing
- TB9RI018 (@JLab)
  - 1<sup>st</sup> vertical test took place before final EP (goal: qualify furnace; however additional items were in furnace); 21 MV/m with field emission limitation
  - 2<sup>nd</sup> test (1<sup>st</sup> pass) after light EP+120C bake, 33 MV/m low-Q0 limitation
    - Problems with final EP blamed as possibility for low Q0
    - NW8 permeability too high (>1.1) and blamed as possibility for low Q0
- (continued...)

# Production Cavities (cont.)

- TB9RI024\*
  - Had light-EP at ANL, 120C bake and IB1 VTS test
  - At 2K, maximum gradient 28.8 MV/m with Q0=6.5E9, limitation quench/FE. Mode measurements plus very crude second sound measurement implicate cell#2 or cell#1.
  - To be field flatness measured and optically inspected, then light-EP and re-test
- TB9RI026
  - Was 800C furnace treated at JLab after FNAL/ANL bulk-EP
  - At FNAL/ANL: optically inspected, tuned, light-EP, VTS prepped, 120C baked
  - IB1 VTS test yesterday: initially reached 29 MV/m with several FE burn-off events; did not recover well from one FE event; final gradient limit 20 MV/m; R(res)~11nOhm
- TB9RI019(@JLab)
  - At JLab bulk-EP, ethanol rinse, HPR, 800C HT (only item in furnace), NO final-EP
  - To be installed in vertical test dewar 4/26 for cool down and 1<sup>st</sup> vertical test at JLab
- TB9RI029\*
  - At ANL for light EP+VTS prep [first try w/ lower-T (~25-30C) and lower-V (14.5V) light-EP]
- TB9RI021\* shipped 4/23 (UPS) back to FNAL after JLab for 800C HT (arrive 4/27?)
- TB9RI020 optical inspection complete; to ANL for bulk-EP (prefer TB9RI026 results 1<sup>st</sup>...)
- TB9RI022\*, TB9RI027 done with incoming inspection; to optical inspection one-by-one
- Incoming inspection started on TB9RI028
- To be inspected: TB9RI025\*, TB9RI023\*
- TB9NR001, TB9NR002 incoming inspection complete, to be optically inspected
  - Expect some discussion with vendor about incoming QC results this week
- New cavities
  - The first AES cavities expected in ~month. Remainder (4) NR due ~June

27 Apr 2010

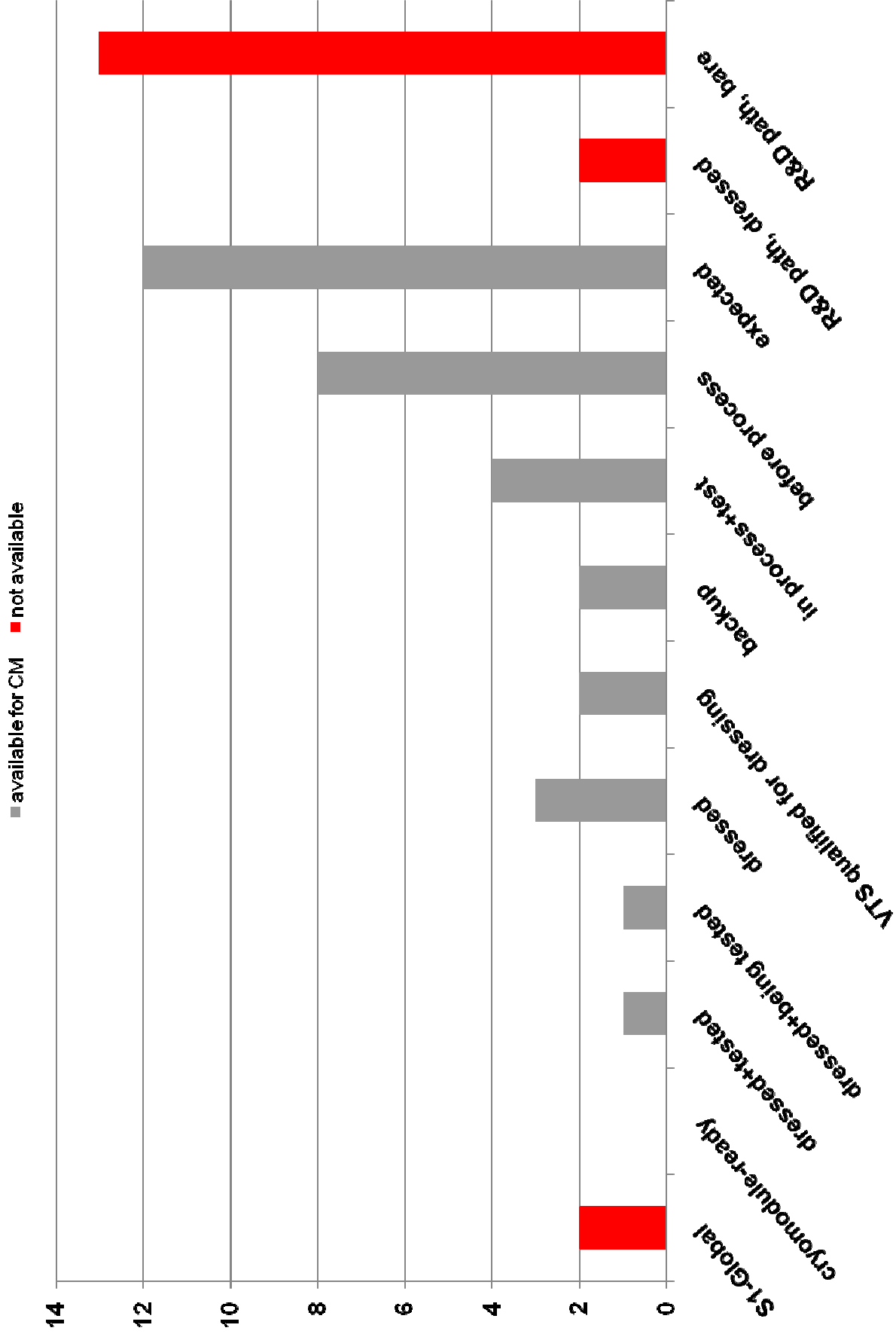
CM Ginsburg S0 Mtg

\*=bulk-EP'd at RI

# R&D Cavities in progress

- AES003 (spot polished at KEK)
  - light EP and VTS prep completed at ANL; to be tested at IB1 VTS soon
- ACCEL6 and ACCEL7
  - Held in reserve as CM2 backup cavities until they can be replaced by better cavities
- TB9ACC014 (after dented cell was tuned to lower field)
  - Vertical test 15.Feb.: 29 MV/m at 2K; some FE observed. Q0 @max grad=1.4E10
    - max gradient is preliminary
  - retest with second sound and different thermometry configuration ~4/29
- TB9ACC017
  - Limited in VTS to 12.3 MV/m, limiting pit found in HAZ cell#4
  - Pit replica study in progress
- AES001 (dressed)
  - Pit replica study performed by KEK personnel at FNAL last week
- TB9ACC010, ACCEL9, TB9AES005, TB9ACC015 (@ Cornell)
  - are in various stages of tumbling and VEP. Being used for VEP commissioning and performance improvement.
- TS7MSU001 & TS7MSU002 (visual inspection and tuning only, then return)
  - FNAL work completed
  - At MSU for process/test

# Americas 9-cell Cavities

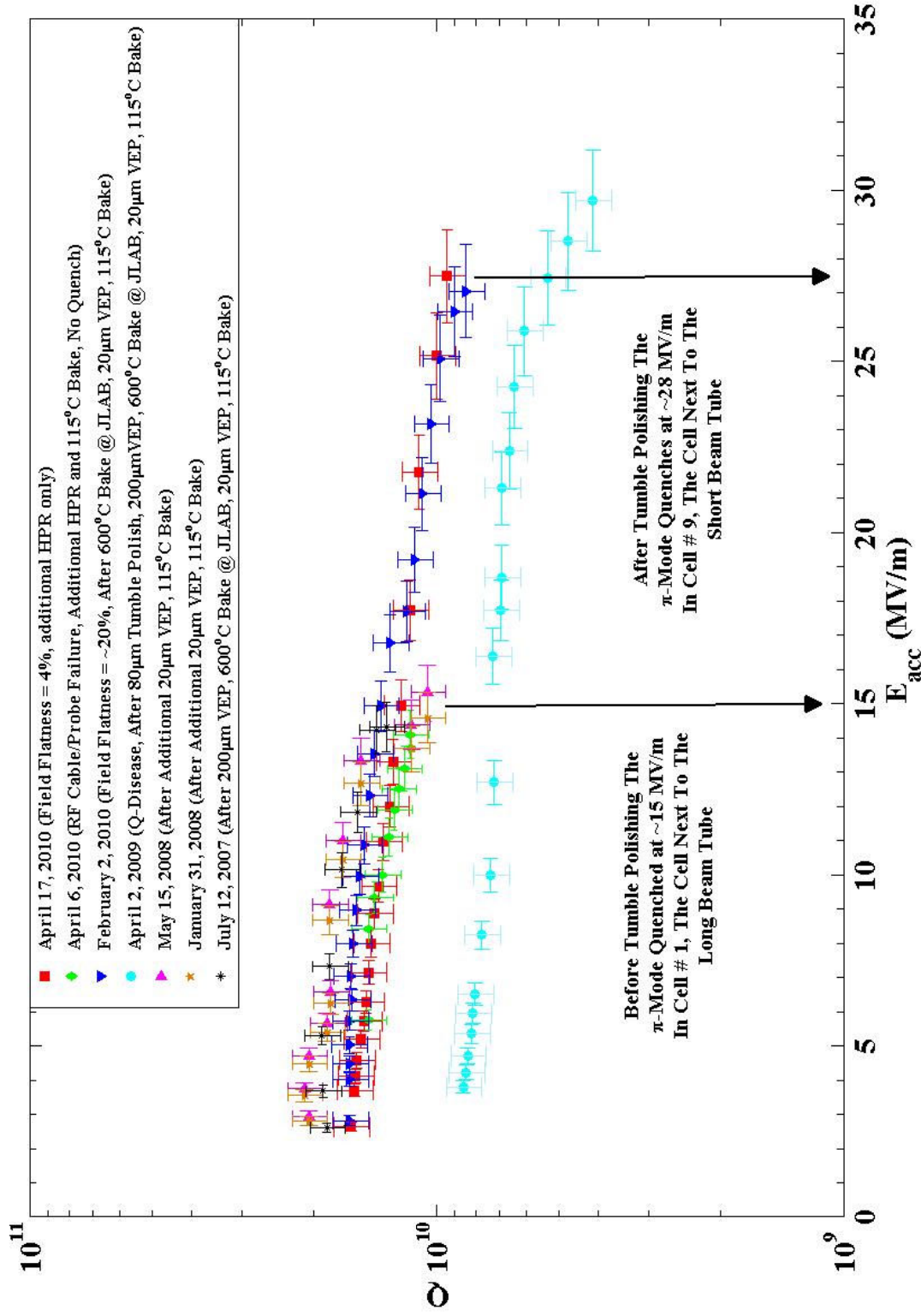




- My focus still is on the training of a new technician in the Cornell cavity processing facility. He is learning how to VEP.
- The multi-cell T-Map insert is ready for its first T-Mapping test (Dave Meidlinger & Eric Chojnacki).
- We have micro-polished 1 and bulk polished 1.5 single-cell cavities at 20-25 C in the past month. The micro-polished cavity will be tested this Wednesday. The first of the bulk polished cavities was hydrogen degassed last Friday and will be tested in  $\sim 3$  weeks.
- LR9-1 was tested again after field flatness tuning. The same result was achieved. Details on next slide.
- I started tumble polishing of AES5. The extra weight has already broken the system. We should be back up and running in  $\sim 3$  weeks.



# LR9-1 Test Results



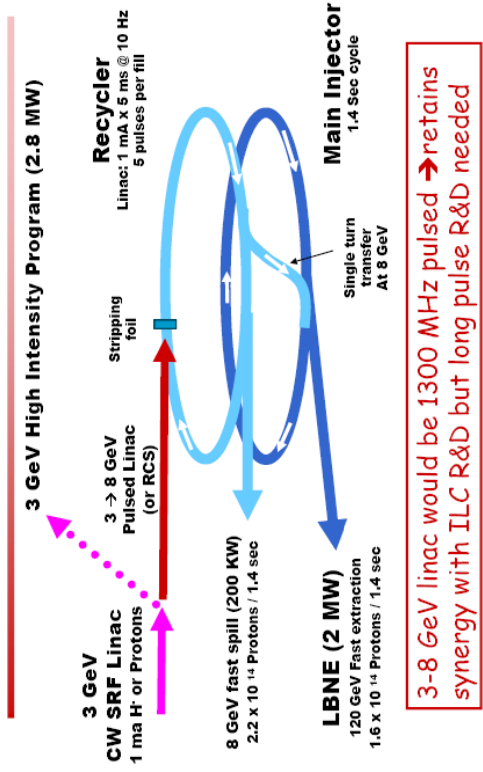
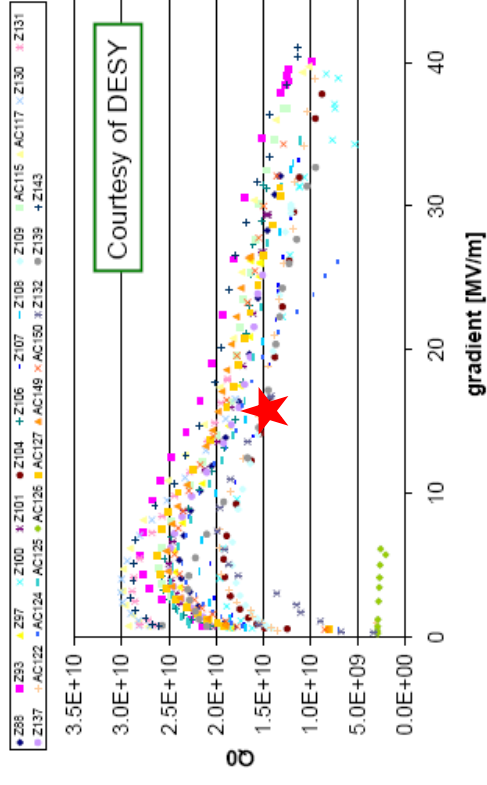
# Needs for $\beta=1$ cavities: Project X

Project X

ICD-2 Layout



DESY data (last test) - status March 2009



TTC/Fermilab, Sept 2010 - R.D. Kepphart

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- 2-3 GeV contains ~65 Tesla-like cavities:  $\sim 17$  MV/m,  $Q_0 = 1.5E10 @ 2K$
- Future 3-8 GeV = either a pulsed linac (Tesla-like cavities) or a rapid cycling synchrotron
- Linac: 200 Tesla-like cavities in 25 cryomodules operating at 25 MV/m

Kepphart



# Cavity gradient highlights

Integration of improved cavity fabrication, improved EP and post-EP cleaning and other clean cavity assembly is pushing gradient yield up to >35 MV/m by the 1<sup>st</sup> or 2<sup>nd</sup> pass tests



## ILC activity @ JLAB

by R.L. Geng et al., SRF2007 and 2009

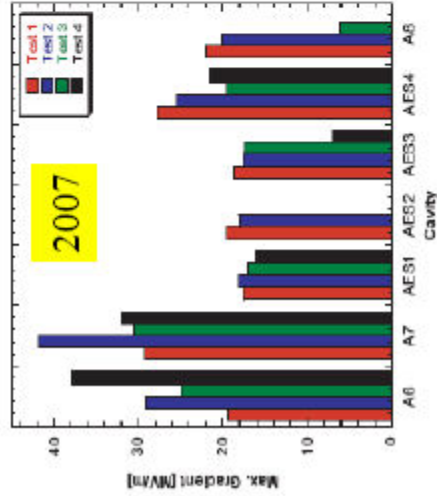


Figure 2: Maximum gradient is achieved by 9-cell cavities.

22.Apr.2010

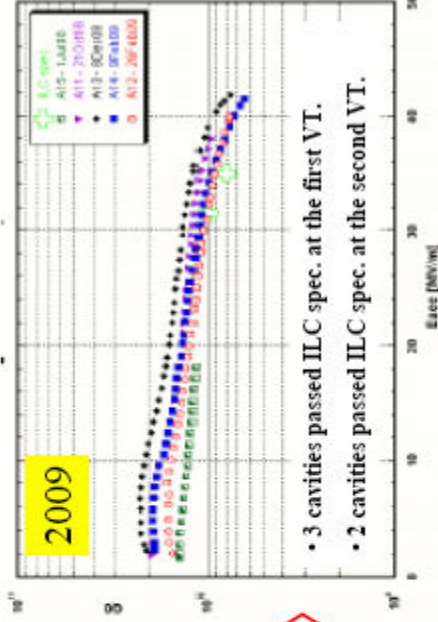
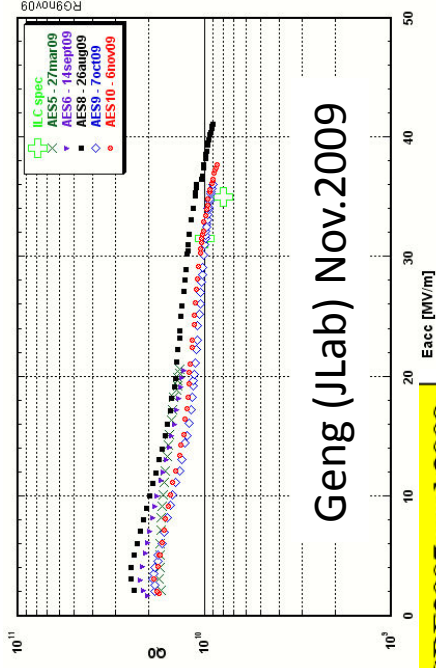


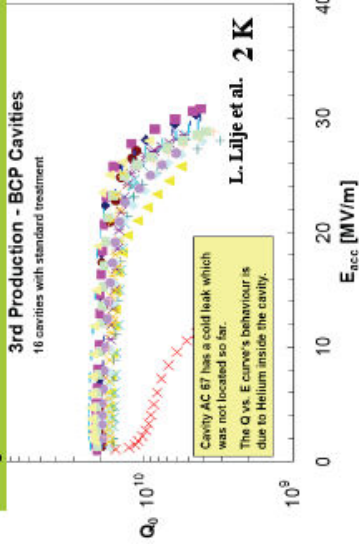
Figure 3: Performance of 5 new cavities manufactured by ACCEL and EP processed and tested since July 2008 at JLab. Error bars are not shown for clarity.

Ginsburg/Lu TTC2010

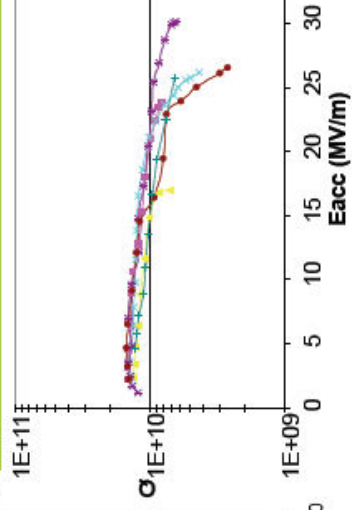
# Quantification of Q0

- Exceptionally high Q0 values of 5E10 – 1E11 have been achieved in a few cavities in vertical tests
- In larger samples
  - Significant variation in medium field Q0 values
  - Poor repeatability of high-Q0 results
  - No systematic understanding
  - Low (~120C) and high temperature (800C-1400C) heat treatments impact residual resistance and medium field Q-slope, but no coherent picture
- Cavity Q0 at operating gradient has high impact on cost
  - Q0 of 2E10 at 1.8K is currently realistic

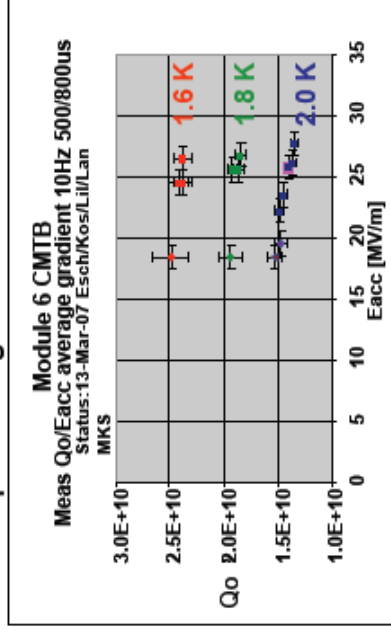
## Q0 versus Eacc: TTF 9-cell cavities



## Q0 versus Eacc: Cornell 9-cell cavities



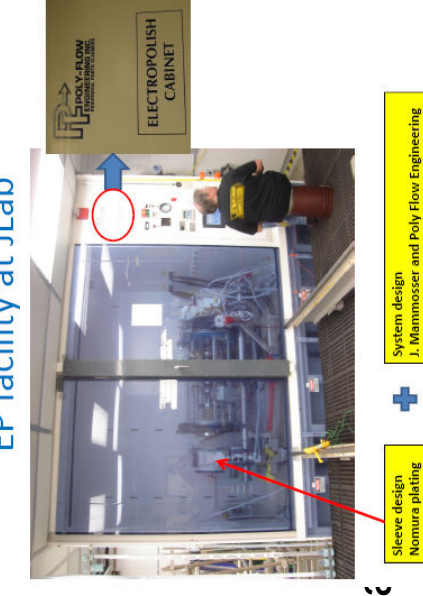
## • Best performing TTF/FLASH module:



(Courtesy of R.Lange et al. DESY MKS)

# Standard Cavity Processing

EP facility at JLab



- Extremely useful to have in-person visits of experts to other laboratories to compare notes
- Variations found, some effect still unclear:
  - Facility
    - EP acid tank capacity and acid volume
    - EP acid flow rate
    - EP and water rinsing atmosphere (nitrogen vs. air)
    - EP acid temperature
    - EP voltage and current
  - Operation
    - Rotation after EP
    - Flow rate of water rinse
    - Rinse flow route
    - Rinse time
    - #fill/dumps
- No substitute for in-person on-site interaction; additional visits anticipated
- When results are reproducible, anticipate updating TTC technical board recommendation for cavity processing



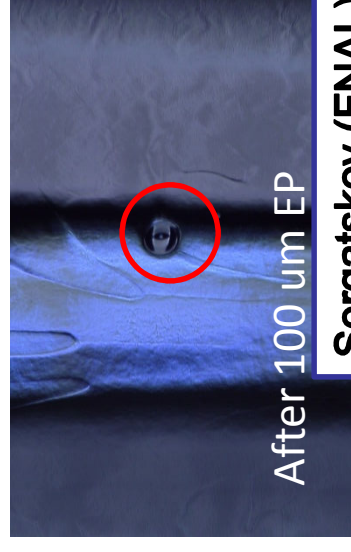
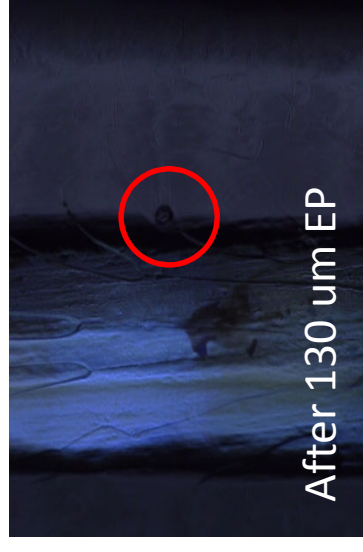
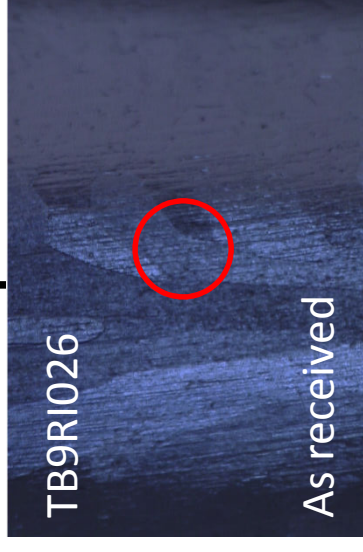
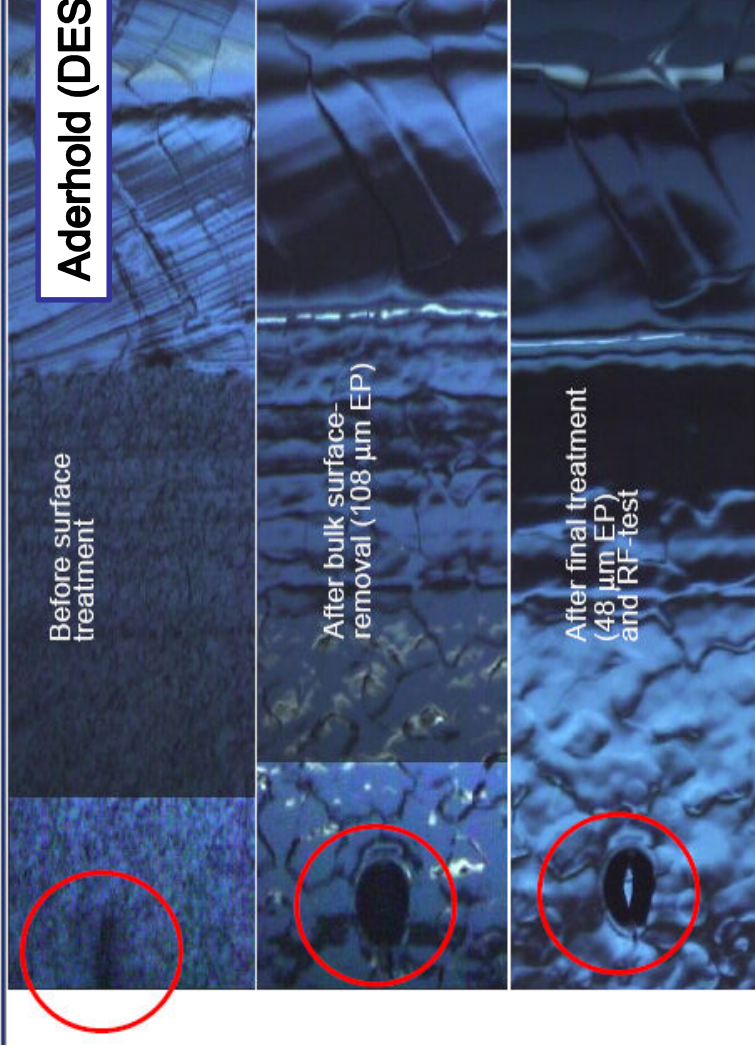
## Cavity surface processing reproducibility

- Monitor/control of parameters at JLab [Reece]
  - Stability improving at JLab over time
  - Cavity performance too
- 
- Monitor/control of parameters at KEK [Sawabe]
  - EP electrolyte
  - EP temperature, current, cooling
  - Detergent
  - Waste water



# Cavity Understanding: optical inspection

## Evolution of defect in Z142

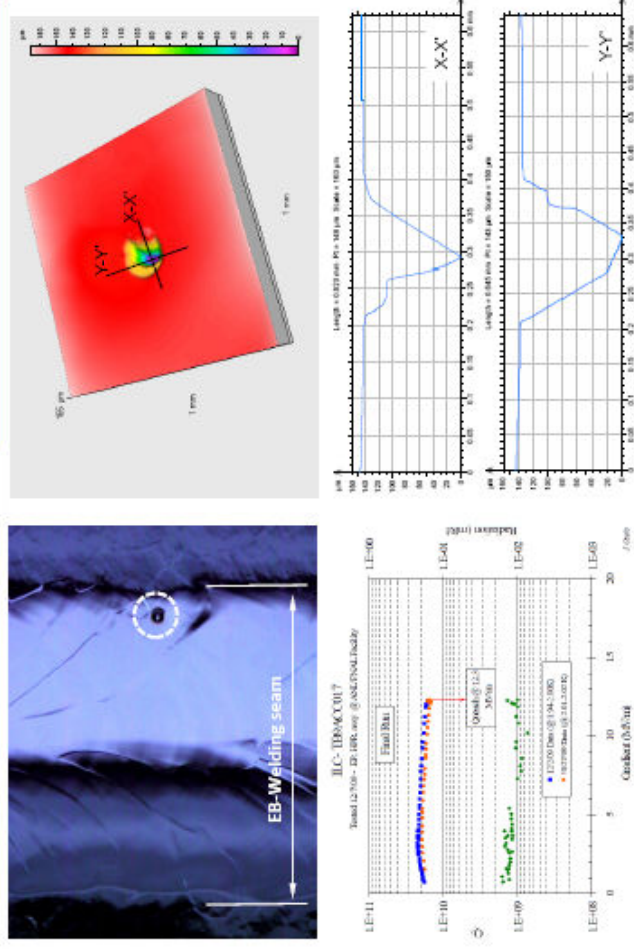


Sergatskov (FNAL)

# Cavity understanding: replicas+3D geometry measurement

- FNAL [Ge]
- Combined with thermometry and profilometry

1.3GHz 9-cell cavity TB9ACC017



— TB9ACC017 quenched at 12.3MV/m,  
Pit was found at Cell #4 equator 180 deg region (quench location),  
the pit is 150  $\mu\text{m}$  deep and 200  $\mu\text{m}$  wide on the top.



## Cavity understanding: replicas+3D geometry measurement

- Collaborative effort!
- KEK replica of dressed cavity AES001 at FNAL 4/21



## Improving the Cavities (1)

- FNAL Tumbling [Cooper]
- Good results on 1-cell, limited statistics



## • Cornell Tumbling [Hoffstaetter]

- Repair of LR9-1 (AES 9-cell re-entrant) from 15 to 28 MV/m





## Improving the Cavities (2)

- **Laser remelting [Ge]**
  - Good result on single-cell (TE1ACC003, 36->39 MV/m, was already a pretty good cavity), to be expanded to 9-cell



The Pit before re-melting



After re-melting

Images was taken from Kyoto Optical Inspection machine

- **Grinding [Hayano] (shown earlier)**
  - Several examples of improvement shown

Non  $\beta < 1$  observation number 1:

Most important new result:

G. Ciovati's demonstration that a cavity can be degassed and then successfully tested without the need for material removal after the furnace treatment. This suggests the following simplified cavity treatment sequence:

1. 80  $\mu\text{m}$  CBP
2. 80  $\mu\text{m}$  EP
3. 800C degas (G<sup>2</sup> cycle / JLab)
4. "No touch" field flatness tune (R. Geng / JLab)
5. HPR
6. 120C
7. RF test