Electropolishing Status

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LA-UR-06-6840

Outline

- Progress after the last TTC meeting in Frascati, December 2005.
- Prioritized list for discussions in this TTC meeting

Activities since Frascati meeting (1)

- A web page as a forum to discuss EP was set up in February 2006. My apologies for not having updated this often due to lack of time. Hope it will be like “Wikipedia,” the free encyclopedia that anyone can edit.
- Tele-conferences that include EP activities have started.
  - Every Thursday, calling into FNAL. Mostly America region, but people from Europe sometimes call in, but not from Asia (too late for them). Started in April 2006.
  - Every other Wednesday, Asia-EU-America meeting, calling into FNAL. Started in August 2006.

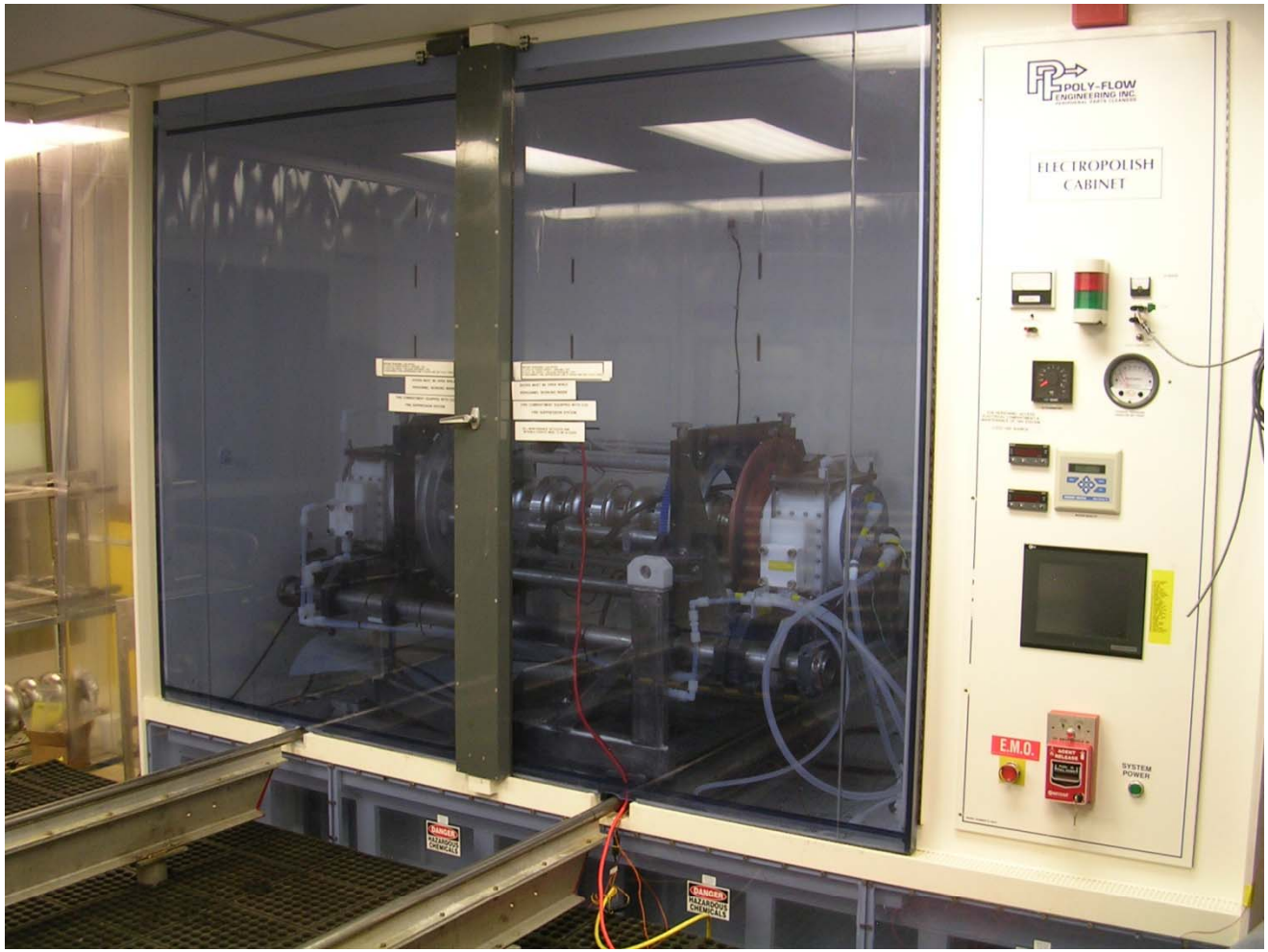
Activities since Frascati meeting (2)

- JLab started 9-cell EP operations
- DESY and KEK have been conducting single-cell R&D programs
- Work on simulating the EP process has started at DESY, FNAL, …
- R&D on EP has started at Virginia Tech. in collaboration with JLab
- ANL has started to design a new EP facility for the ILC in collaboration with FNAL and others

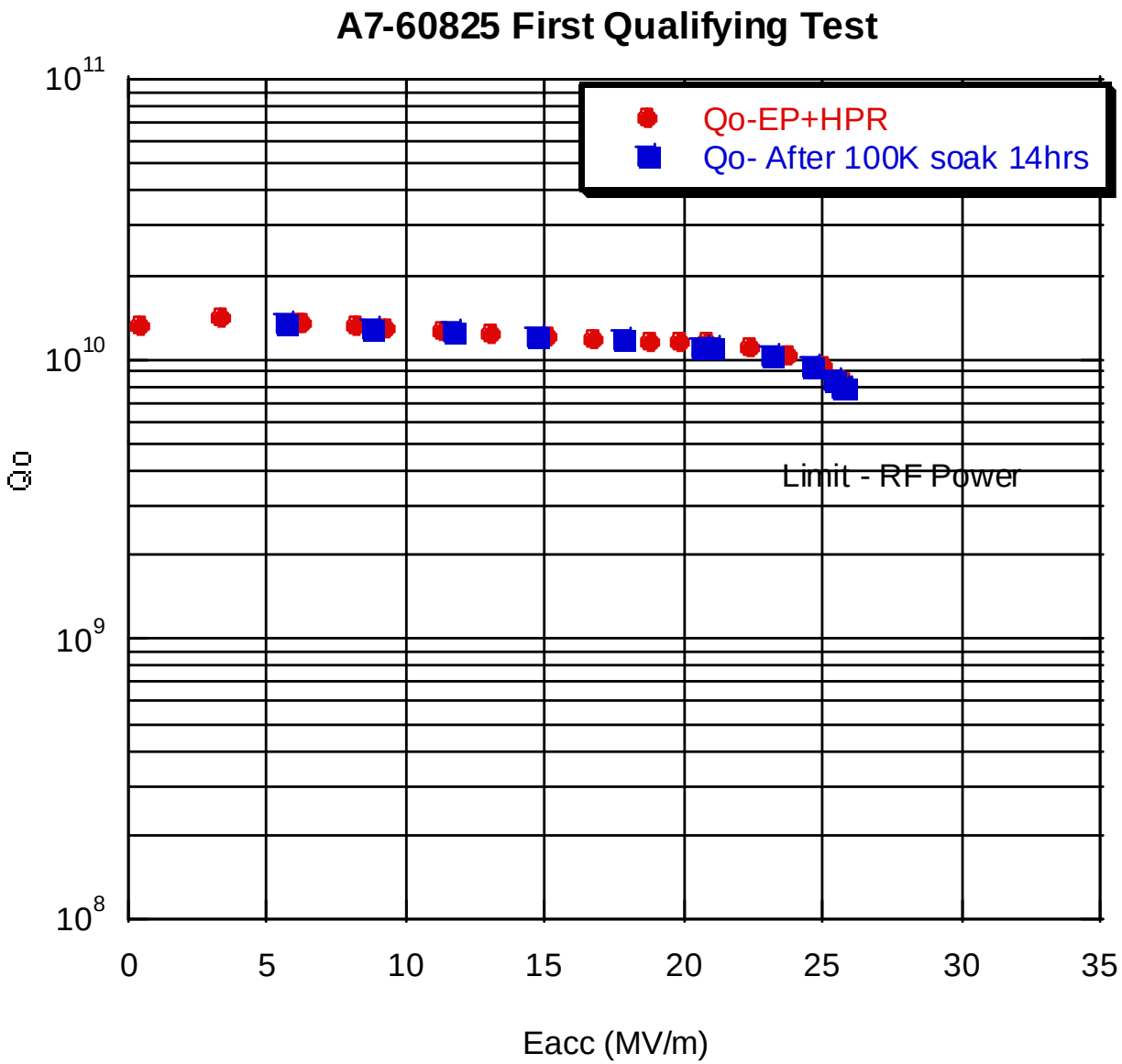
9-cell EP operations at JLab

- JLab performed a light EP on a 9-cell cavity (S35) borrowed from DESY
  - Many improvements in data acquisition were identified and implemented
- A heavy (~170 μm) and light (~15 μm) EP were performed on one FNAL cavity (A-7). 600 °C x 10h H degassing was performed between them.
- The vertical test results have shown no problems on EP. (cell-to-cell variation in removal rate <12%, no hydrogen Q disease!)

JLab EP Cabinet



J. Mammosser, presented in a teleconference on 31 August 2006.



Limited by the RF power available and input coupling!!

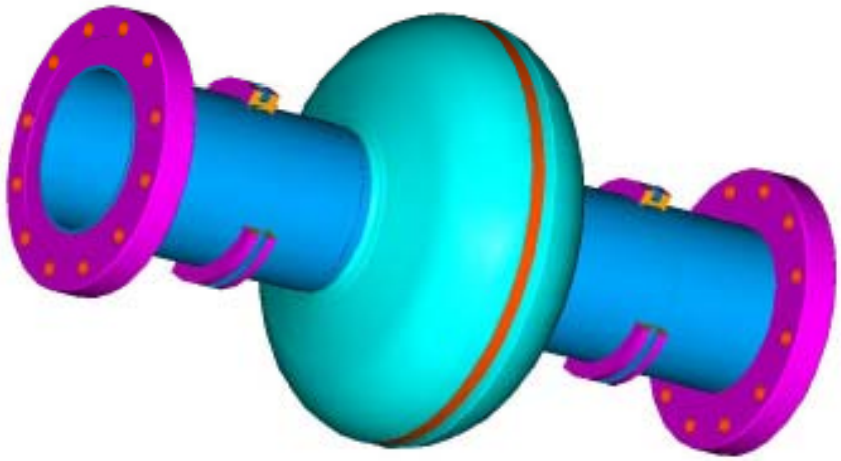
New amplifier should allow us to reach its limiting performance

Need a variable input coupler, evaluating KEK and Jlab designs, will wait for new funding to fabricate

DESY Single cell Status and Results

D. Reschke, presented in a teleconference on 12 April 2006

- DESY standard single-cell cavity:



- 13 cavities at DESY completed:
  - machining, etching, EB welding + mechanical/optical checks inhouse
  - deep drawing of cups and electropolishing (EP) of cavities in industry
- 5 cavities at Accel Co. completed (large grain + mono crystal):
  - final mechanical/optical checks at DESY; EP at Henkel Co.

D. Reschke, presentation on 12 April 2006

Status + Results: Qualification of DESY production

- First step: Qualification of DESY in-house production:
  - 3 single-cells of well-known Nb quality (Heraeus 1999)
  - deepdrawing of cups at Zanon Co.
  - All electropolishing at Henkel Co.
  - Assembly, HPR and tests at hall NO

- all cavities exceed 30 MV/m at high Q-value limited by Quench

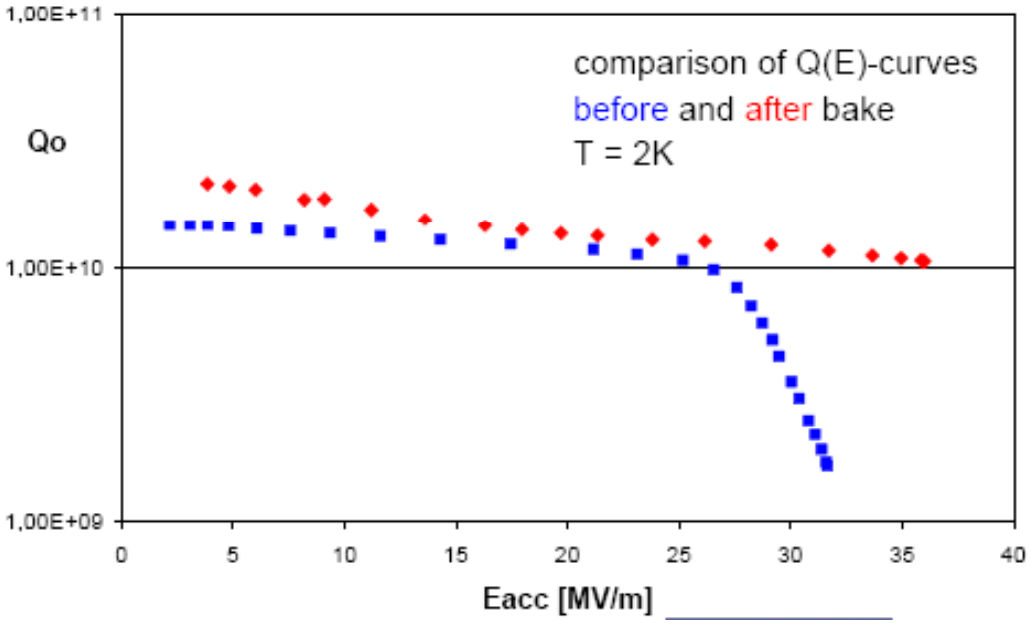
- Example for cavity data presentation

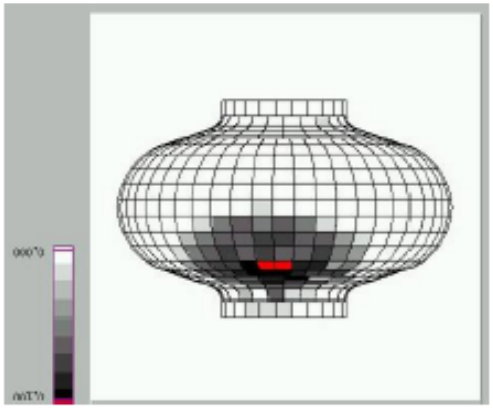
D. Reschke, presentation on 12 April 2006

1DE1: First DESY-Cavity successful

- First Cavity of DESY inhouse fabrication
- 150µm EP@Henkel, 800C, 130µm EP@Henkel, HPR, 127C bake, HPR
  (i) 130µm EP due to grinding; ii) add. HPR after bake necessary due to field emission)

E_{acc} = 36 MV/m @ Q_0 = 1 ·10^{10}; no FE; limited by BD; few MP



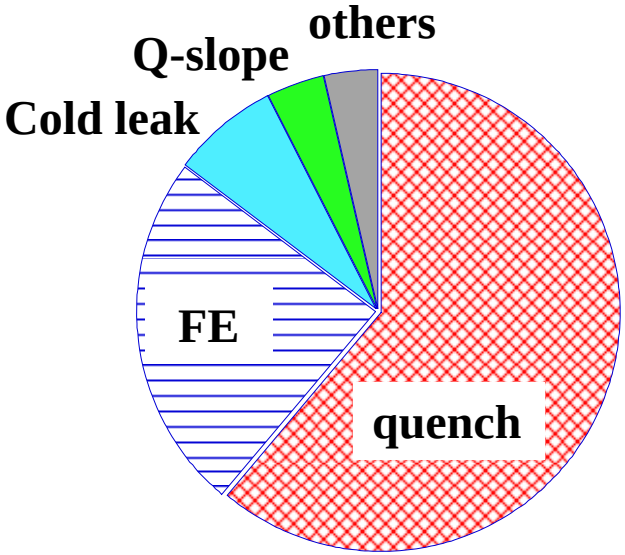


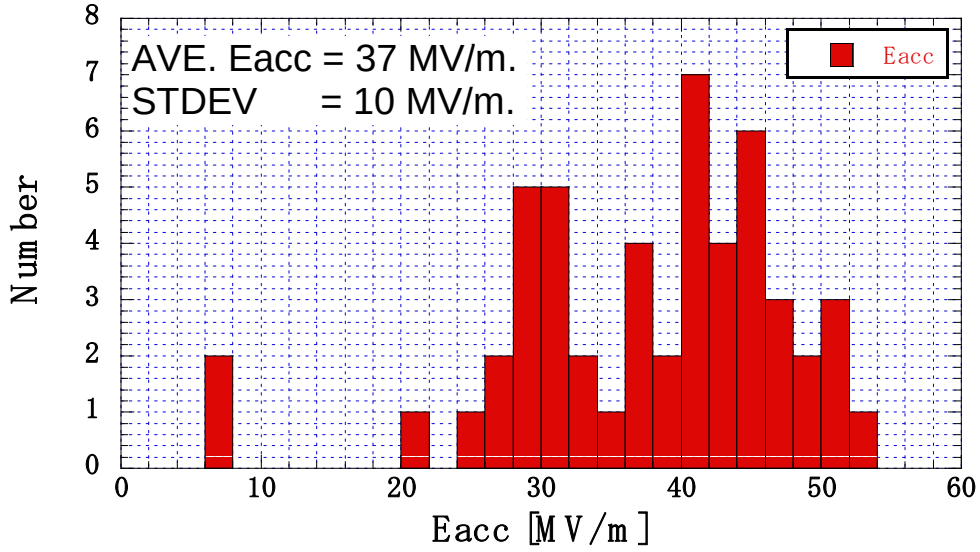
Quench location far off the equator

F. Furuta, presented in a teleconference on 16 August 2006

Ichiro Single (IS) series results

	V.T.	quench	FE	Cold leak	Q-slope	others
IS#2	14	8	5	1		
IS#3	8	4	3		1	
IS#4	11	11				
IS#5	3	1	1			1
IS#6	7	6			1	
IS#7	11	3	5		2	1
total	54	33	14	1	4	2

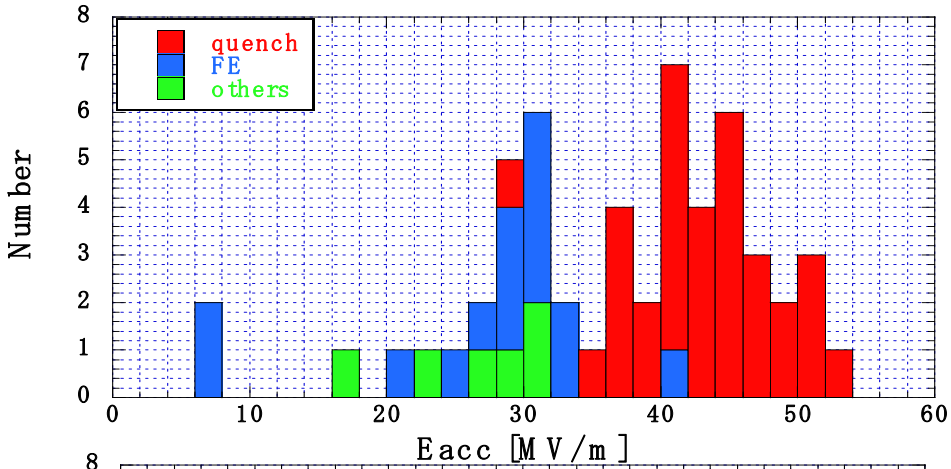




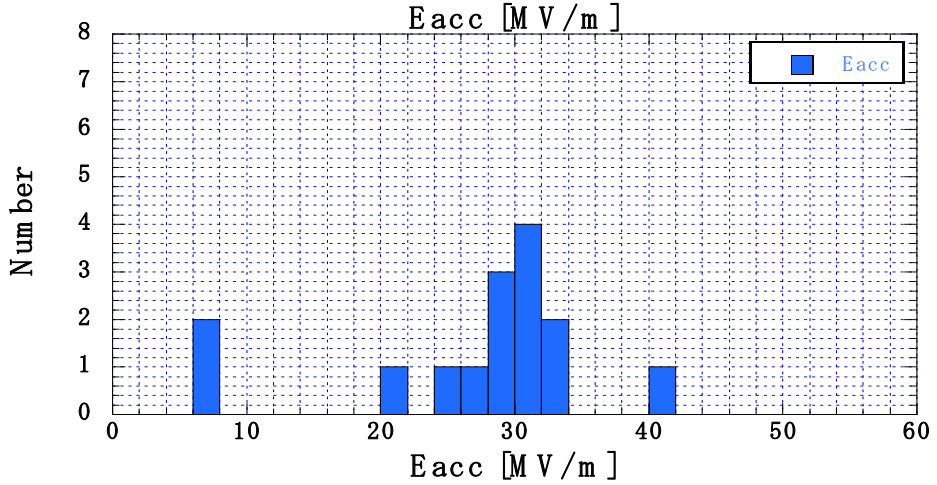
F. Furuta (cont.)

IS series Histogram

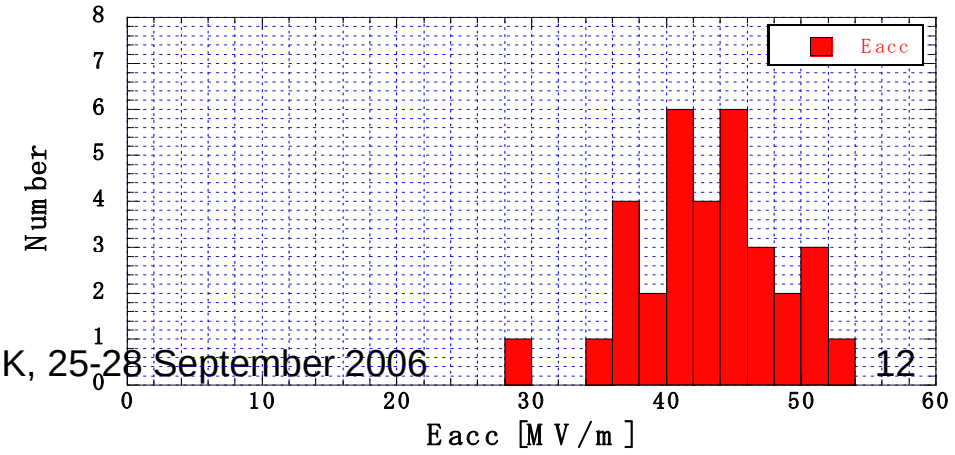
IS cavities results (All)
AVE. Eacc = 37 MV/m.
STDEV = 10 MV/m.



IS cavities results (FE)
AVE. Eacc = 27 MV/m.
STDEV = 9 MV/m.

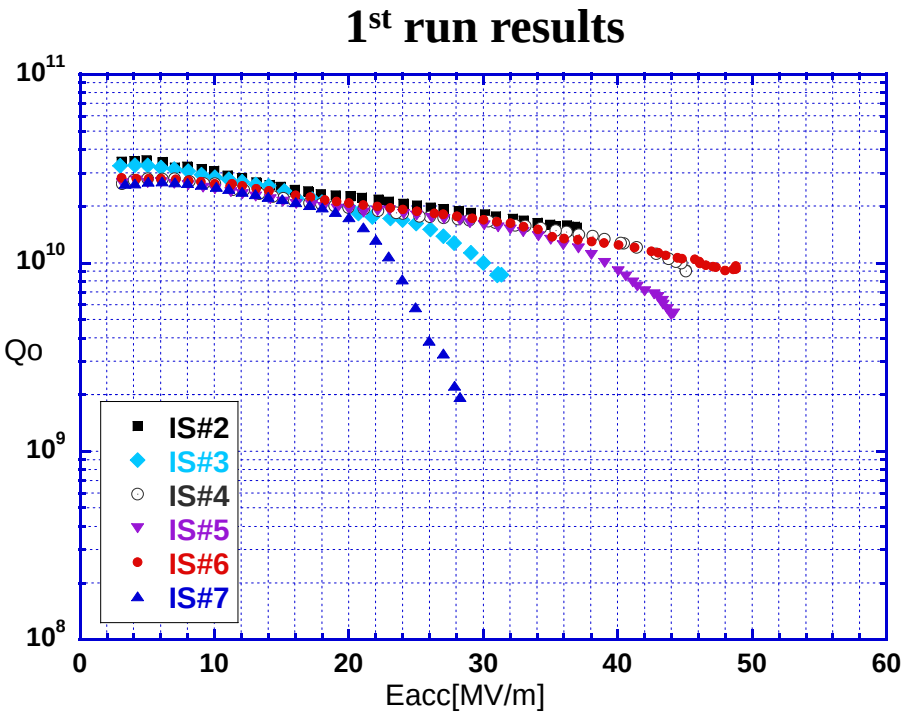


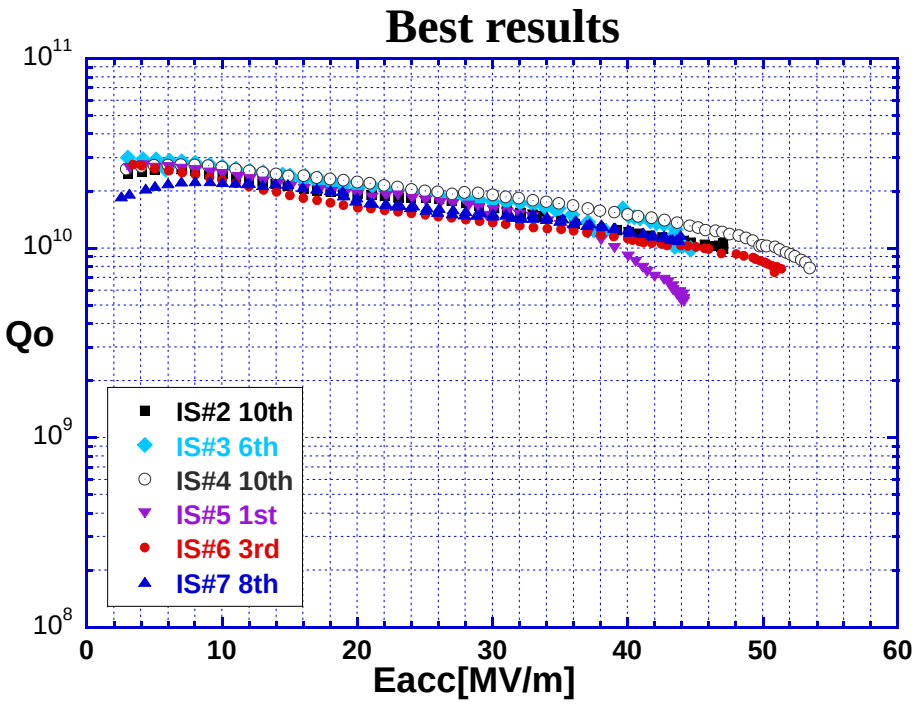
IS cavities results (quench)
AVE. Eacc = 43 MV/m.
STDEV = 5 MV/m.



F. Furuta (cont.)

CBP+EP(80um) + EP(3um, fresh acid, cavity closed) + HPR + Baking(120C*48hrs)





		IS#2	IS#3	IS#4	IS#5	IS#6	IS#7
1st results	Eacc	36.9	31.4	45.1	44.2	48.8	28.3
	Qo	1.53e10	8.66e9	9.07e9	5.38e9	9.56e9	1.94e9
Best results		47.1	44.7	53.5	44.2	51.4	43.9
		1.06e10	0.98e10	7.83e9	5.38e9	7.78e9	1.17e10

Prioritized list for discussions in this TTC meeting

1. Hydrogen Q disease
2. Quality control of EP solution
3. Rinsing of chemical residues such as S
4. Next generation EP facility for large-volume treatment
5. ……

1. Hydrogen Q disease

- This is a serious problem and we need to find a best method to eliminate this ASAP!
- What we found so far
  - It does not occur for single-cell cavities
  - For 9-cell cavities,
    - DESY: 5 out of 29 tests showed the disease [1]
    - KEK: none of 4 tests showed the disease
    - JLab: one test showed no disease

[1] D. Proch, module meeting, 2 March 2006.

2. Quality control of EP solution

- The discussion seems to be converging to this topic after other parameters are controlled in the proper range.
- What we have found so far
  - If the amount of dissolved Nb reaches ~6 g/L, the polished surface starts degrades.
  - If the amount of HF or F^- ions decreases, S is produced. If it increases, the removal rate increases, but it causes corrosion on Al surface.
  - ……..

2. Quality control of EP solution (cont.)

- How can we measure the chemical content and control the mixture?
  - Tomorrow, Claire Antoine will give us a review on available methods and we will have a brainstorming on this.
  - We need to find an online or semi-online monitoring technique that can be implemented relatively easily to the EP system. Hopefully, we can also incorporate a system that can replenish the reduced ions automatically.

3. Rinsing of chemical residues such as S

- Chemical residues such as S can be a source of field emission.
- What we have found so far
  - DESY is using methanol to clean the surface, results??
  - Recently, JLab used a degreasing agent micro-90 with hot DI water in a ultrasonic bath. It seemed OK according to the result. (No FE)
  - H_2O_2 or ozonated water rinsing are other possibilities
- What is the best and most appropriate method will be discussed on Tuesday.

4. Next generation EP equipment for large-volume treatment

- Present DESY, JLab and KEK(Nomura) facilities are similar, although there are slight differences such as H screen, direction of acid injection, etc.
- Their machines are not aimed at large-volume treatment.
- We need to discuss what is required for large-volume treatment and start designing such a facility in collaboration with industry as soon as possible.