SCRF Monthly WebEx Meeting

May 20, 2009

Agenda

1. Reports from PMs
2. Reports from Group Leaders
3. Discussion to prepare for the DESY AD&I Meeting

   How we may fix (optimize) re-baseline gradient?
4. Plan for further meetings

Reports from PMs

- SCRF Organization Update: (A.Yamamoto)
  - **SCRF Cavity (Preparation/Process) Group Leader transferred from L. Lilje (DESY) to R. Geng (Jlab)**

- Review by AAP: (M. Ross)
- (Review by ILC-PAC: (M. Ross)) >> briefly

- Plan for DESY AD&I Meeting, May 28, 29 (N. Walker)
  - **to be focused later in this meeting,**
- Plan for ILC-CLIC collab. meeting, June 11, 12 (M. Ross)
- Plan for TTC meeting
  - **a presentation from GDE to report the status and to acknowledge the TTC effort, (A. Yamamoto)**

Technical Areas and Groups

- Engineering and Scientific Management
- 25 (16 below PM)
  - **7 Asia**
  - **7 EU**
  - **11 Americas**

Akira Yamamoto
Project Manager
SCRF Tech.

- Tetsuo Shidara (KEK)
- Jim Kerby (FNAL)
- L.Lilje >> R. Geng — Cavity Processing
- Hitoshi Hayano (KEK) — Cavity Production & Integration
- Norihito Ohuchi (KEK) Leader, Harry Carter (FNAL) Co-Leader — Cryomodule
- Shigeki Fukuda (KEK) — HLRF
- Tom Peterson (FNAL) — Cryogenics
- Chris Adolphsen (SLAC) — Main Linac Integration

Marc Ross
Project Manager (chair)
CFS & Global

- Wilhelm Bialowons (DESY)
- John Carwardine (ANL)
- John Osborne (CERN) — Civil Engineering
- Vic Kuchler (FNAL) — Conventional Facilities

Nick Walker
Project Manager
Accelerator Systems

- Frank Lehner (DESY)
- Junji Urakawa (KEK)
- Axel Brachmann (SLAC) — Electron Source
- Jim Clarke (STFC) — Positron Source
- Susanna Guiducci (infn) — Damping Ring
- Nikolay Solyak (FNAL) — RTML
- Andre Seryi (SLAC) — BDS
- Kiyoshi Kubo (KEK) — Simulation

Review Report from AAP

SCRF

- Considerable progress in cavity gradient

The AAP recommends a strong interaction between laboratory experts and new vendors during all stages of cavity fabrication.
The AAP recommends that for the yield study further evaluation be made of the quality of cavities (Q-values) along with gradient. Electron loading and x-ray intensities at 35 MV/m should be closely monitored.

- New cryomodule assembly facilities at KEK and FNAL

The AAP recommends that a strong effort be made to complete this test on schedule.

Review Report from AAP (2)

SCRF cont'd

- S1-Global effort
  - Effort to integrate various cavity varieties in one cryomodule
- New cryomodule assembly facilities at KEK and FNAL
- Expand industrial base

The AAP suggests adapting the scientific goals for S1-global effort at KEK to better match the expectations.

The AAP encourages support for the ongoing cryomodule efforts at DESY, in the context of the XFEL activities, and at FNAL.

The AAP recommends an evaluation of the Quantum beam Project at KEK on the timeline for achieving the S2 goal.

The AAP recognizes that the entire R&D program will not conclude by 2012, and still need results of these test facilities. The XFEL and Project-X will be also important, especially in evaluation of the manufacturing cost of a large linac.

Similar efforts to expand the industrial base for other components such as couplers, tuners and the cryomodule should also be explored.

Review Report from AAP (3)

Plug Compatibility

- Definition of interfaces
  - eases international collaboration and fosters technological progress
- ILC design should be uniform
  - operation
  - maintenance

The AAP fully supports the plug-compatibility concept for the SCRF R&D and suggests introducing an element of competition by maintaining a score list of advantages and disadvantages of individual design variants for cavity, coupler and tuner.

The AAP encourages the Project Management to develop criteria for evaluating and eventually selecting optimal design variants.

The AAP believes that the final machine design, namely the design that will be sent to industry for manufacture, requires a single design for the RF components.

Review Report from AAP (4)

RF Components

- RF Distributions
  - KlyCluster
  - Distributed RF (x13 klystrons)

The AAP recognizes the merits of the proposals and suggests continuing the value engineering of these options. The value engineering must include a risk assessment, i.e. availability studies and maintenance ability in addition to the cost comparison.

Review Report from AAP (5)

Report on the
AAP Review at TILC'09

April 17-21, 2009, Tsukuba, Japan

Overview

more details in the document released for PAC review May 9-10, 2009

DESY AD&I Meeting

- Participation: 23 (not including DESY)
  - **Additional 5 from DESY**
    - Walker, Bialowons, Elsen, Lehner, Hagge, (Warmbein)
  - **Possible DESY “Guests”:**
    - Weise, Lilje, Reschke, Singer, Flöttmann, Hott,…?

- TAG leaders not present: (but hopefully WebEx participation)
  - **Geng (Cavity)**
  - **Ohuchi (cryomodule)**
  - **Petersen (cryogenics)**
  - **Seryi (BDS – Deepa Angal-Kalinin deputising)**
  - **Clarke (e+ source – Ian Bailey deputising)**
  - **Kubo (Simulation)**

- MDI representatives
  - **Karsten Büßer**
  - **Phil Burrows**

- Pre-meeting (Wednesday 27th)
  - **CAD-3D,**
  - **CFS etc.**

DESY AD&I Meeting

- Memo send to pmedr@fnal.gov 14.05.09
  - **Preparatory information**
  - **PM's "Baseline Proposal" (see next slide)**
    - Strawman Baseline 2009 (SB2009)
  - **Questions (per TAG) that need to be raised/answer**

- Strategy
  - **Achieve sign-off/decision on as many issues as possible**
  - **Catalogue and prioritise issues which require further work to 'make decision'**
  - **Focus on Technical Issues and Decisions**
    - Report the implications

- Issues beyond 'technical design decisions'
  - **Resources available for design work – will set scope!**
  - **Communication and transparency**
  - **Final consensus building process (see later)**

PM “SB2009” Proposal

- A Main Linac length consistent with an optimal choice of average accelerating gradient
  - **currently 31.5 MV/m, to be re-evaluated**
- Single-tunnel solution for the Main Linacs and RTML, with two possible variants for the HLRF
  - **Klystron cluster scheme**
  - **DRFS scheme**
- Undulator-based e+ source located at the end of the electron Main Linac (250 GeV)
- Reduced parameter set (with respect to the RDR) with n_b = 1312 and a 2ms RF pulse.
- ~3.2 km circumference damping rings at 5 GeV, 6 mm bunch length.
- Single-stage bunch compressor with a compression factor of 20.
- Integration of the e+ and e- sources into a common “central region beam tunnel”, together with the BDS.

DESY AD&I Meeting

- Expected controversial issues:
  - **Single tunnel (availability)**
  - **Positron source (KEK issues)**
  - **Low-P option (luminosity)**

- Timeline and deliverables
  - **DESY meeting**
    - table of SB2009 decisions and comparison to RDR
    - List of action items to resolve by ALCPG
    - Formation of small specific “Task Forces” as needed
      - e.g. operations and availability
  - **ALCPG**
    - Final review of SB2009 (by this PM team)
    - Resolve remaining (top-level) questions
    - Outline of draft proposal document with writing assignments
  - **December 2009**
    - Final draft of SB2009 proposal document – submitted to EC and AAP for review
  - **January 2010**
    - AAP review – update final document
    - Formal submission to community for comment (deadline)
    - July 2010 – publication of new TDP2 baseline

DESY AD&I Meeting: TO DO

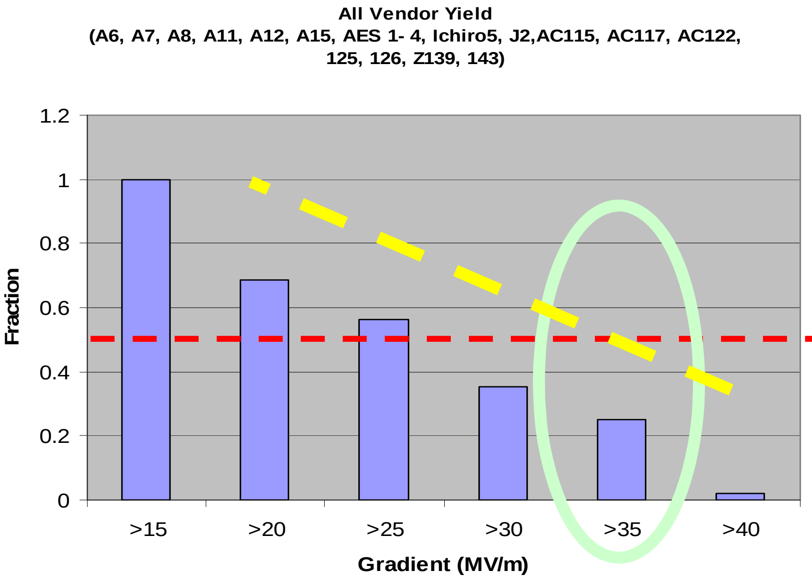
- Review current schedule and modify as appropriate
  - **Use 14.05 prep. Memo as guidance (plus input from Ewan)**
- Opening PM presentation critical to set tone of meeting
  - **Outline of SB2009**
  - **Pros and cons (as seen by PM)**
  - **Integration issues etc.**
- Prepare one more general email with more details
  - **After updating the programme**
  - **Try to contact each ‘convener’ to make sure he/she understands what is required.**
- Will produce written summary of meeting
  - **Will ask Frank L. to take notes – one other for cross-check?**

Global Plan for SCRF R&D

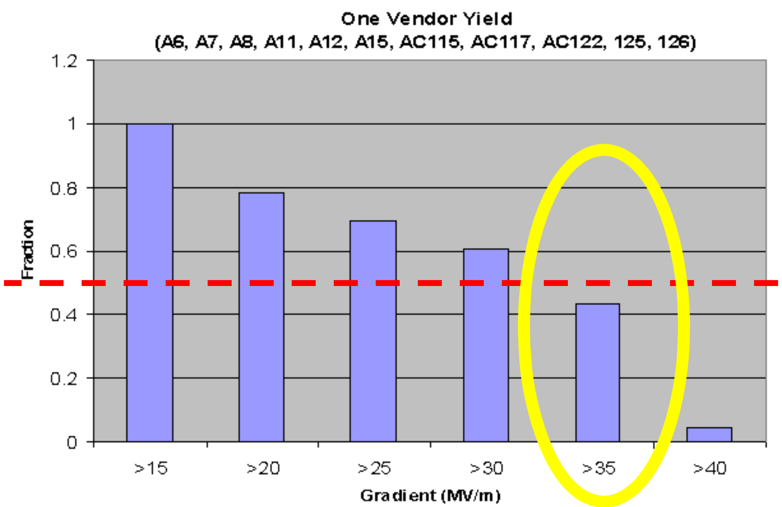
Calender Year	2007	2008	2009	2010	2011	2012
Technical Design Phase	TDP-1			TDP-2		
Cavity Gradient R&D to reach 35 MV/m		Process Yield > 50%		Production Yield >90%		
Cavity-string test: with 1 cryomodule		Global collab. For <31.5 MV/m>				
System Test with beam 1 RF-unit (3-modulce)		FLASH (DESY)			STF2 (KEK) NML (FNAL)	

Global Yield of Cavities Recently Tested at Jlab and DESY

48 Tests, 19 cavities	23 tests, 11 cavities
ACCEL, AES, Zanon, Ichiro, Jlab	One Vendor



50%



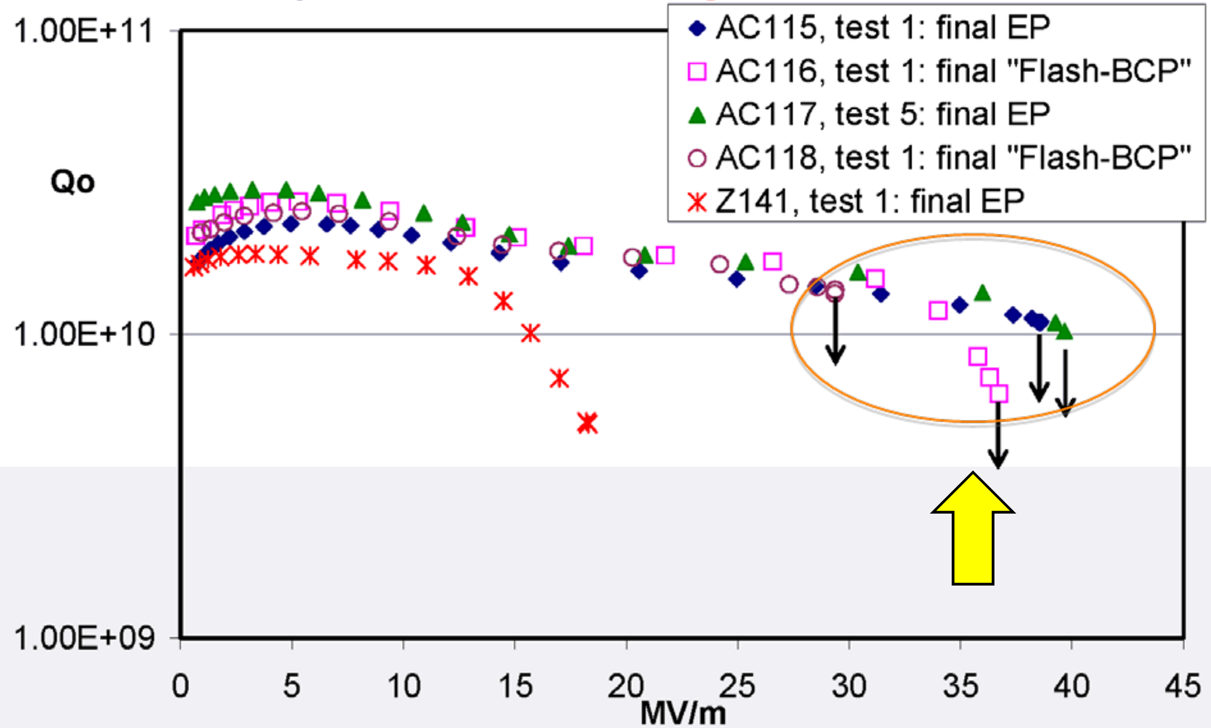
Yield 45 % at 35 MV/m being achieved by cavities with a qualified vendor !!

A Summary from TTC-08 (IUAC), ILC-08 (Chicago) by H. Padamsee

Industrial (EP) Effort in Europe

6th cavity production – rf results

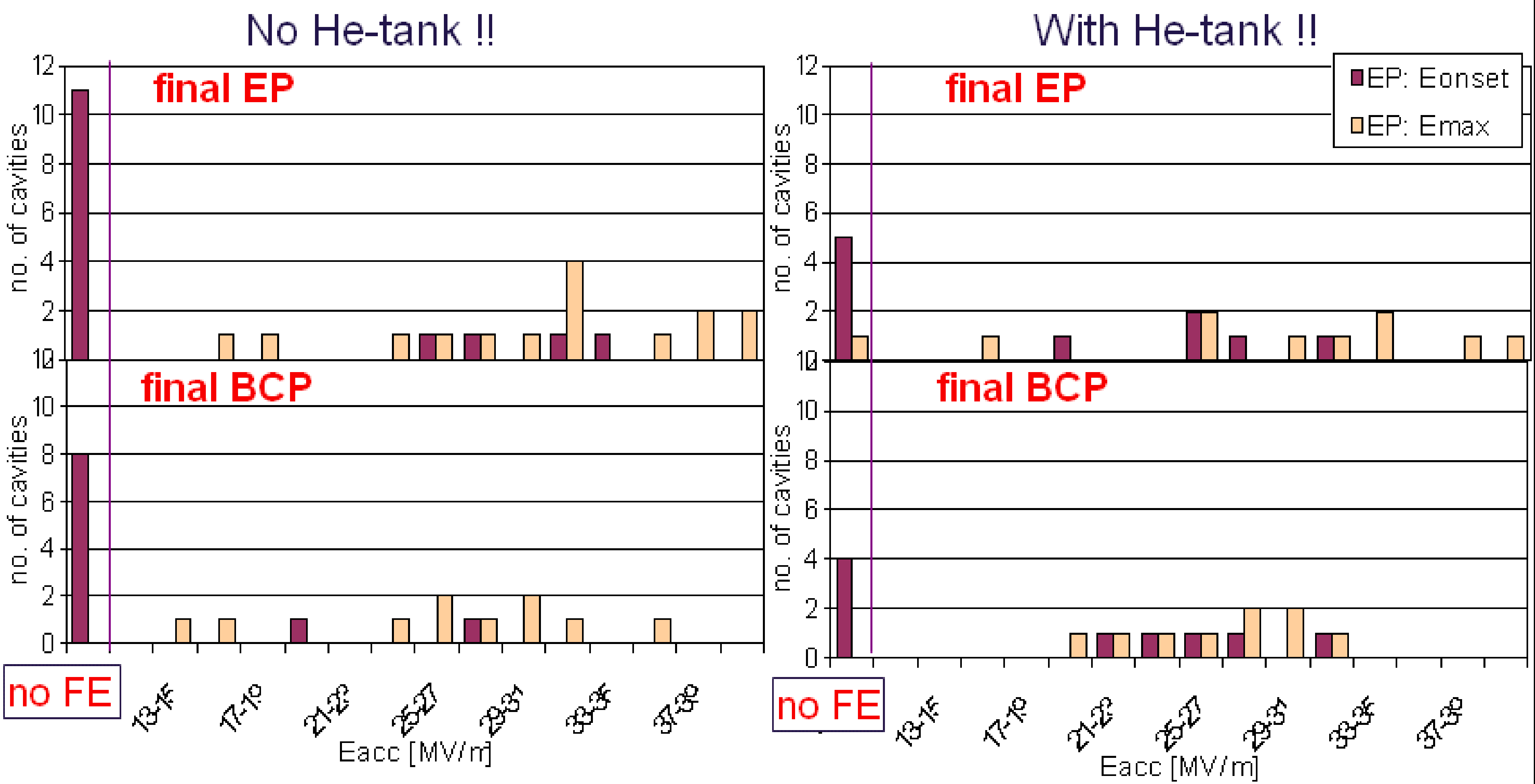
- excellent + promising first results including first Plansee nine-cell (AC115)
- Z141 as first cavity with surfaces damages after fabrication under investigation



Detlef Reschke, DESY
MAC DESY, May 08, 2008

- The average gradient, **36 MV/m, achieved** with AC115-118

Final preparation: Analysis of final test



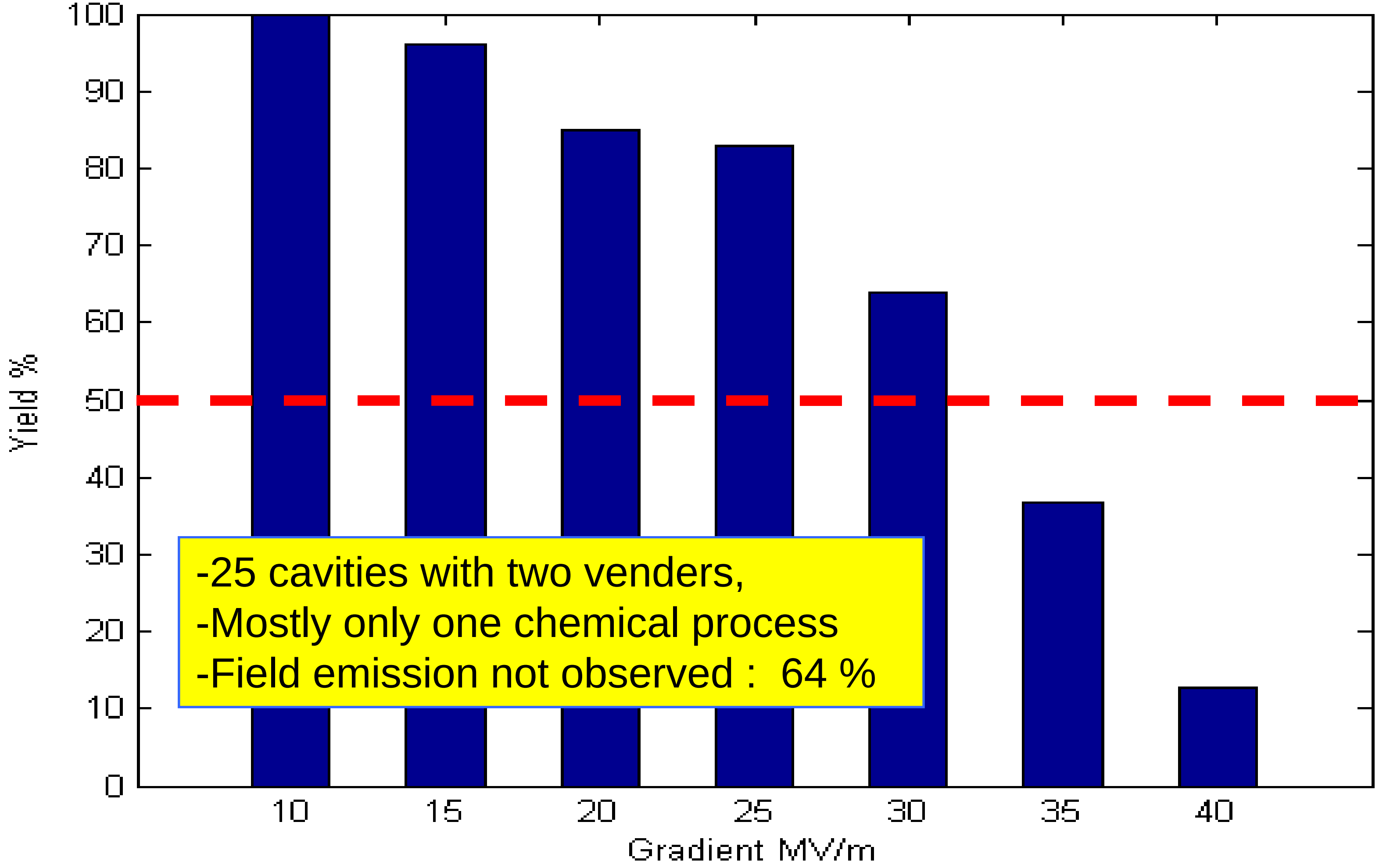
=> as expected: some improvement with respect to field emission

=> "final EP" gives higher E_{max} than "final BCP"

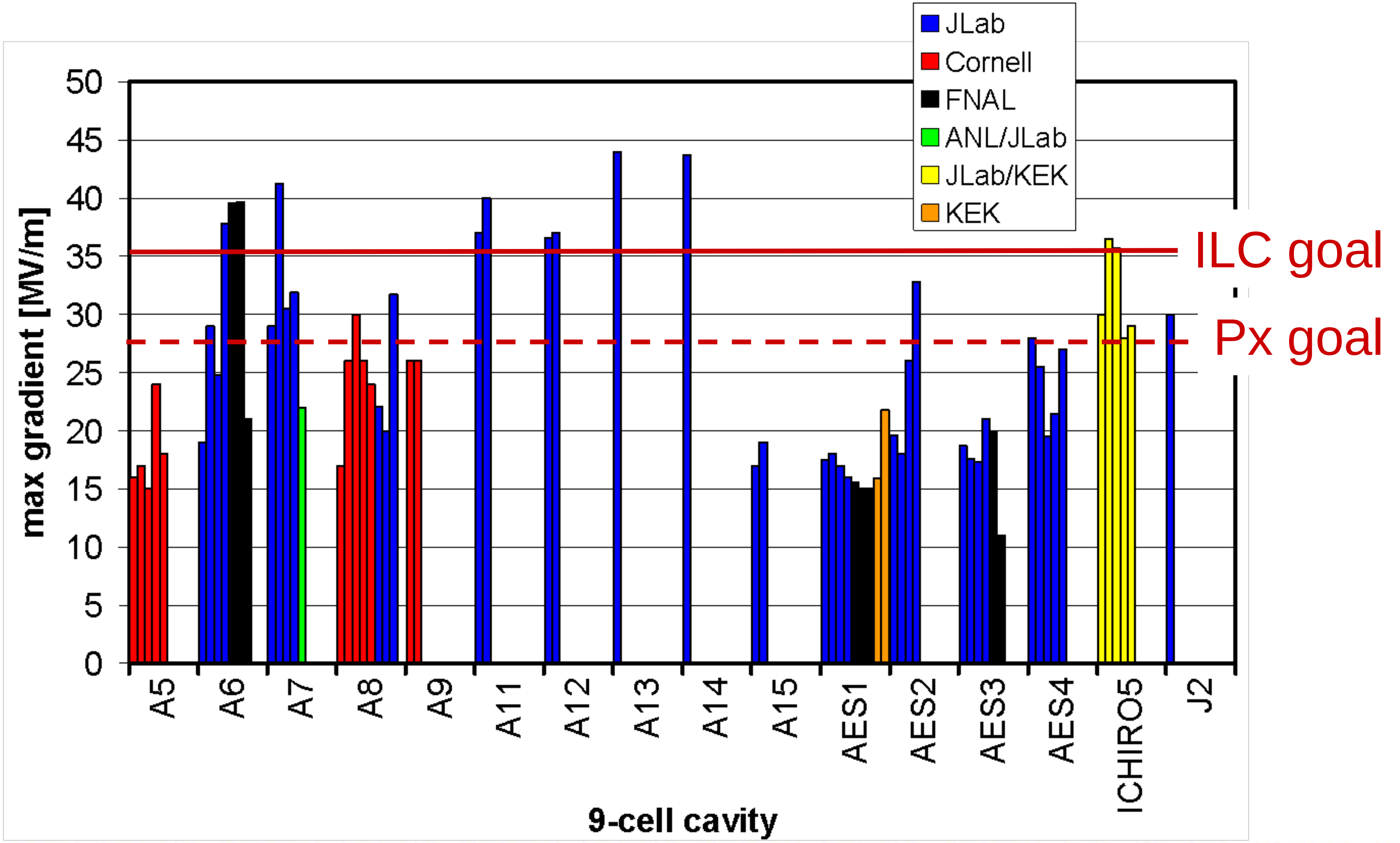
D. Reschke, to be published SRF 2009

Recent Progress in Yield at DESY

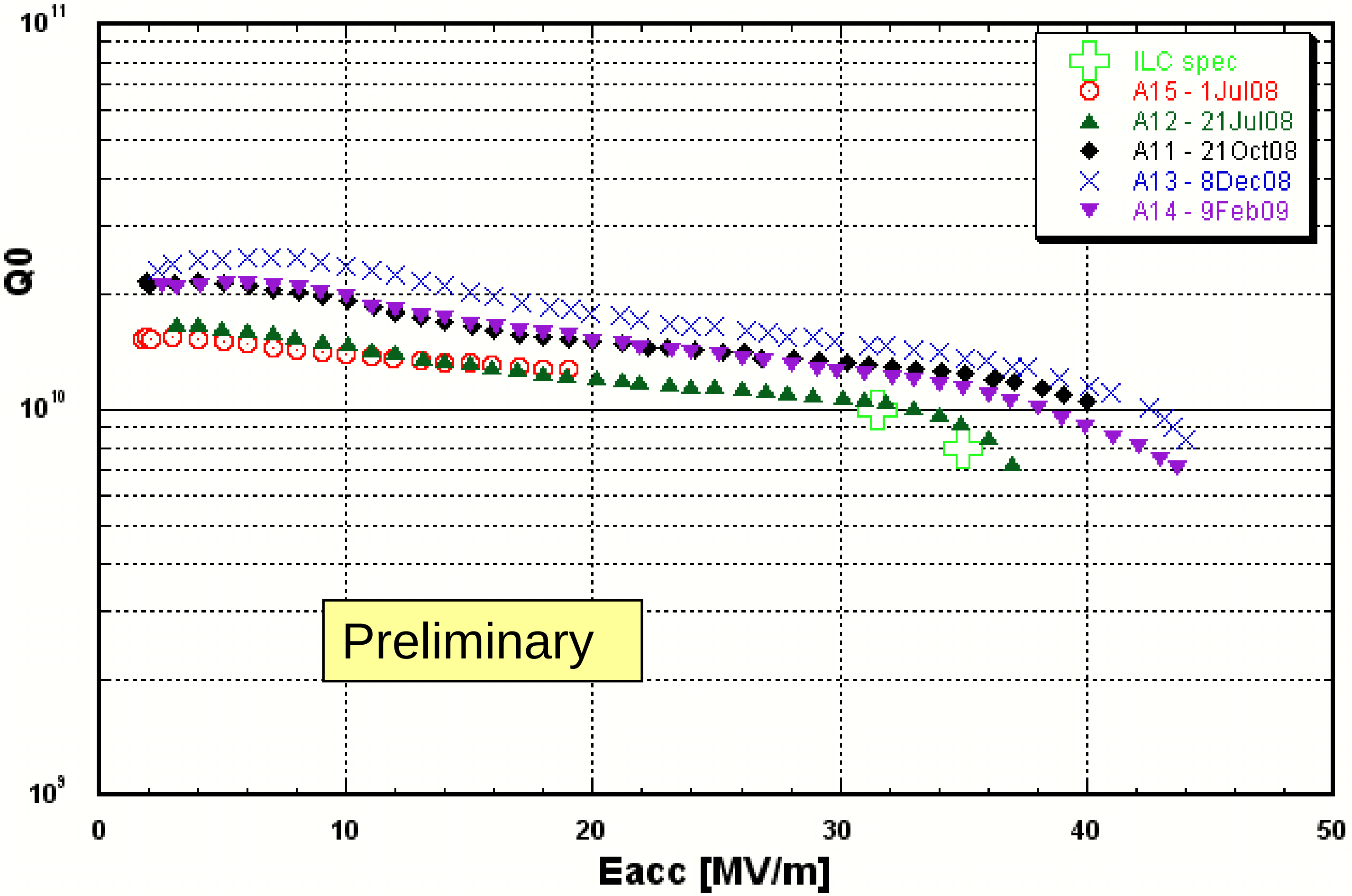
Data provided by D. Reschke, and reassembled by M. Ross



Summary of 9-cell Vertical Tests in U.S. as of Feb., 2009

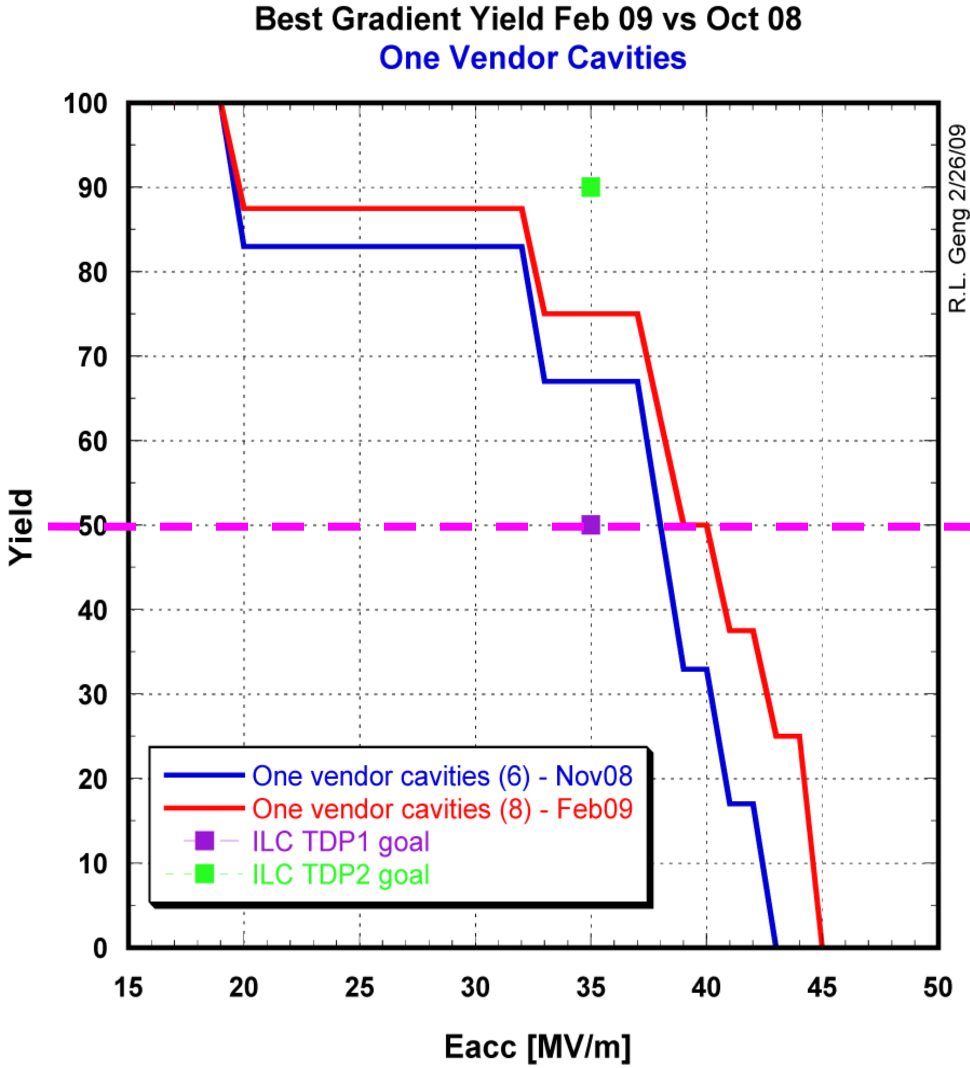


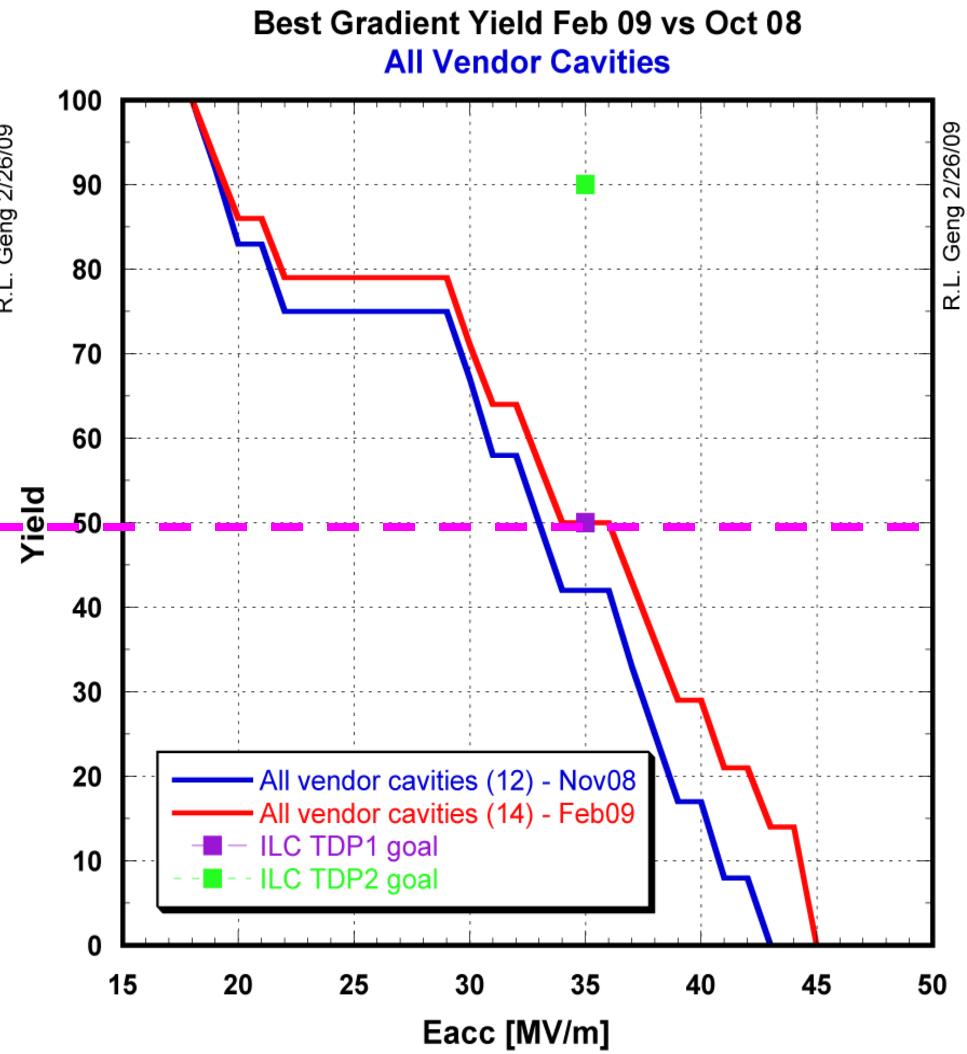
America R&D: Recent 9 cell series



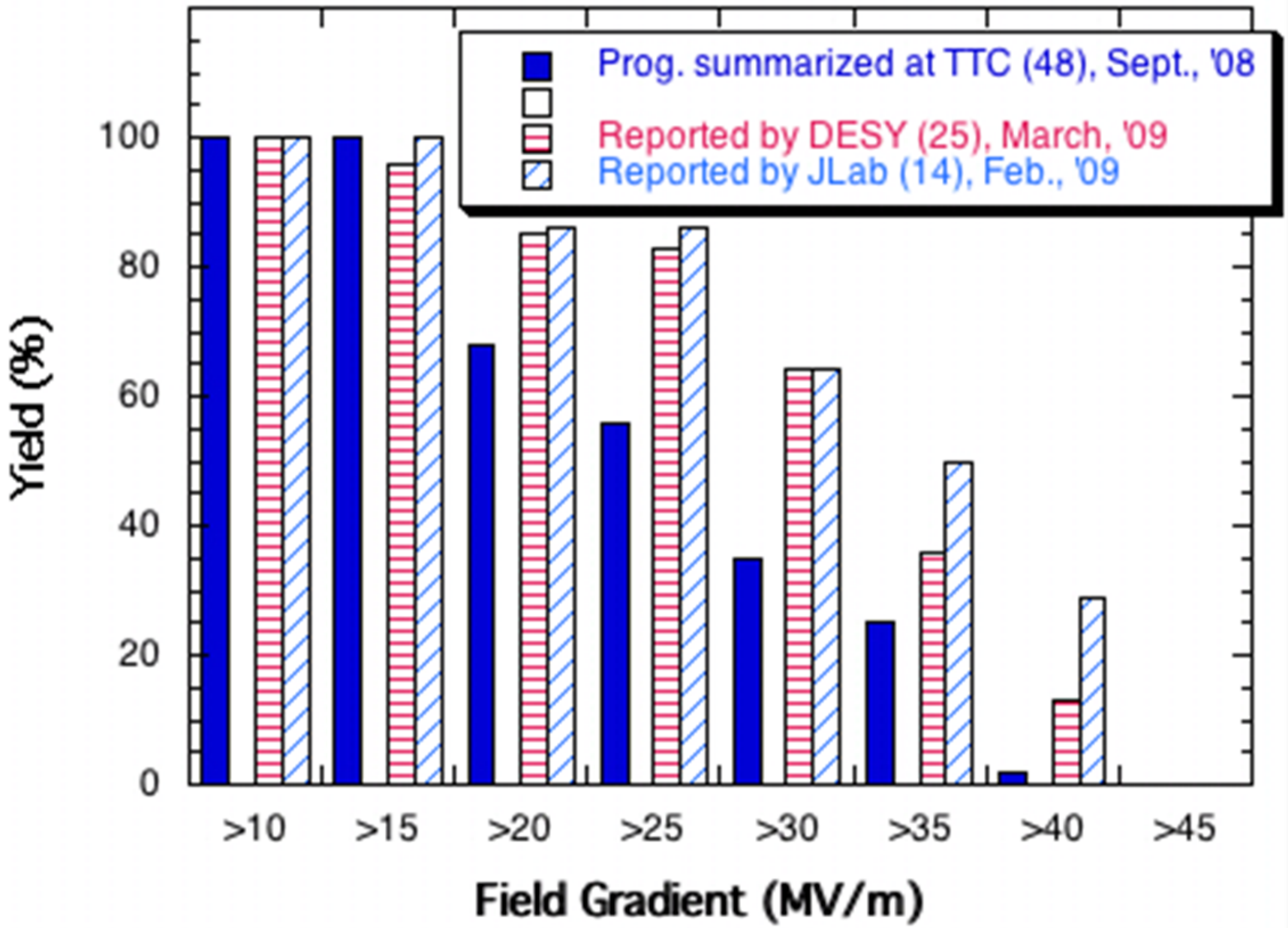
- Five 9-cell cavities: built by ACCEL, and processed/tested at Jlab.
- All processed with one bulk EP followed by one light EP and by ultrasonic pure-water cleaning with detergent (2%).

Recent Gradient Yield Progress at JLab





Progress summarized at TTC and recently reported by DESY/Jlab ('09)



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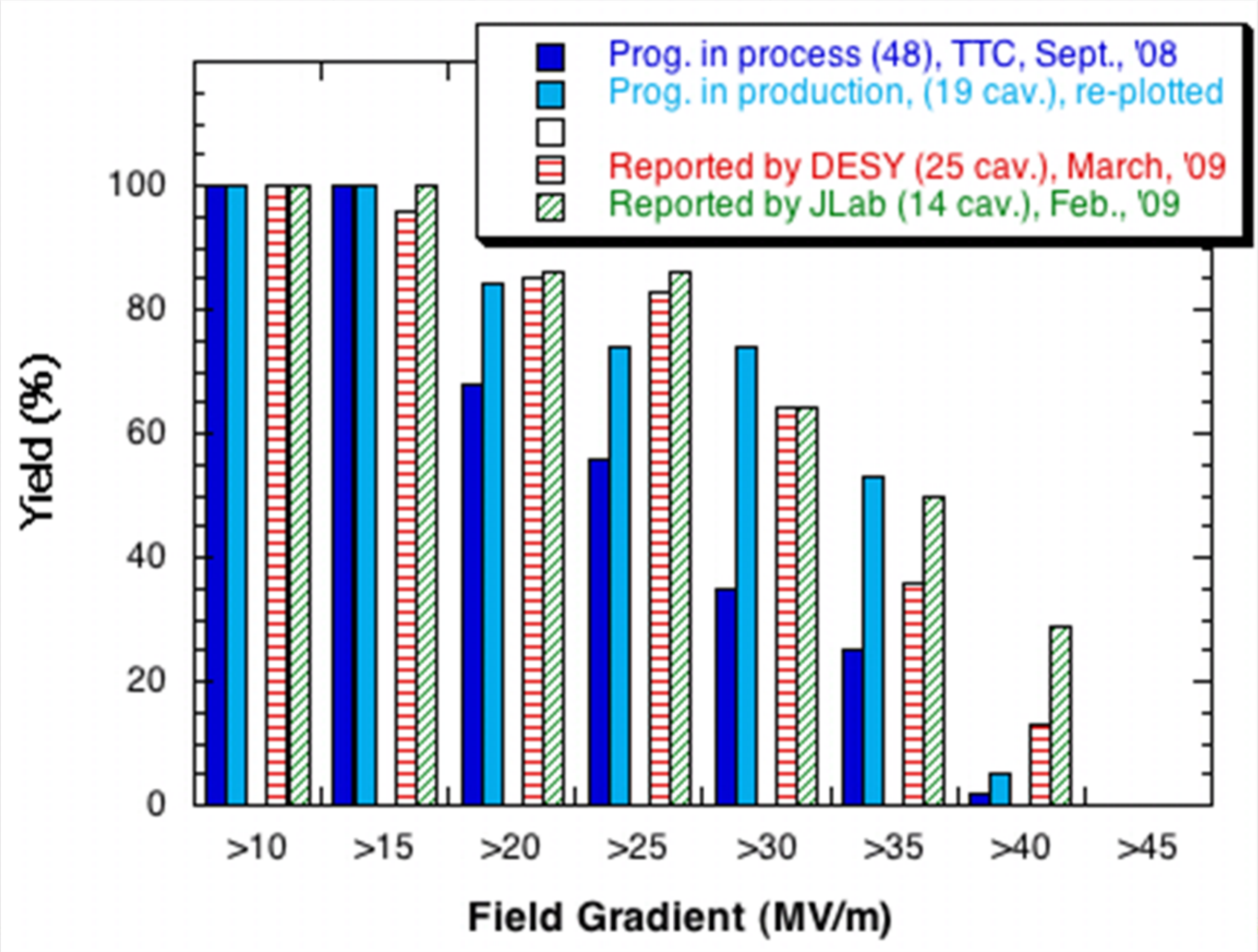
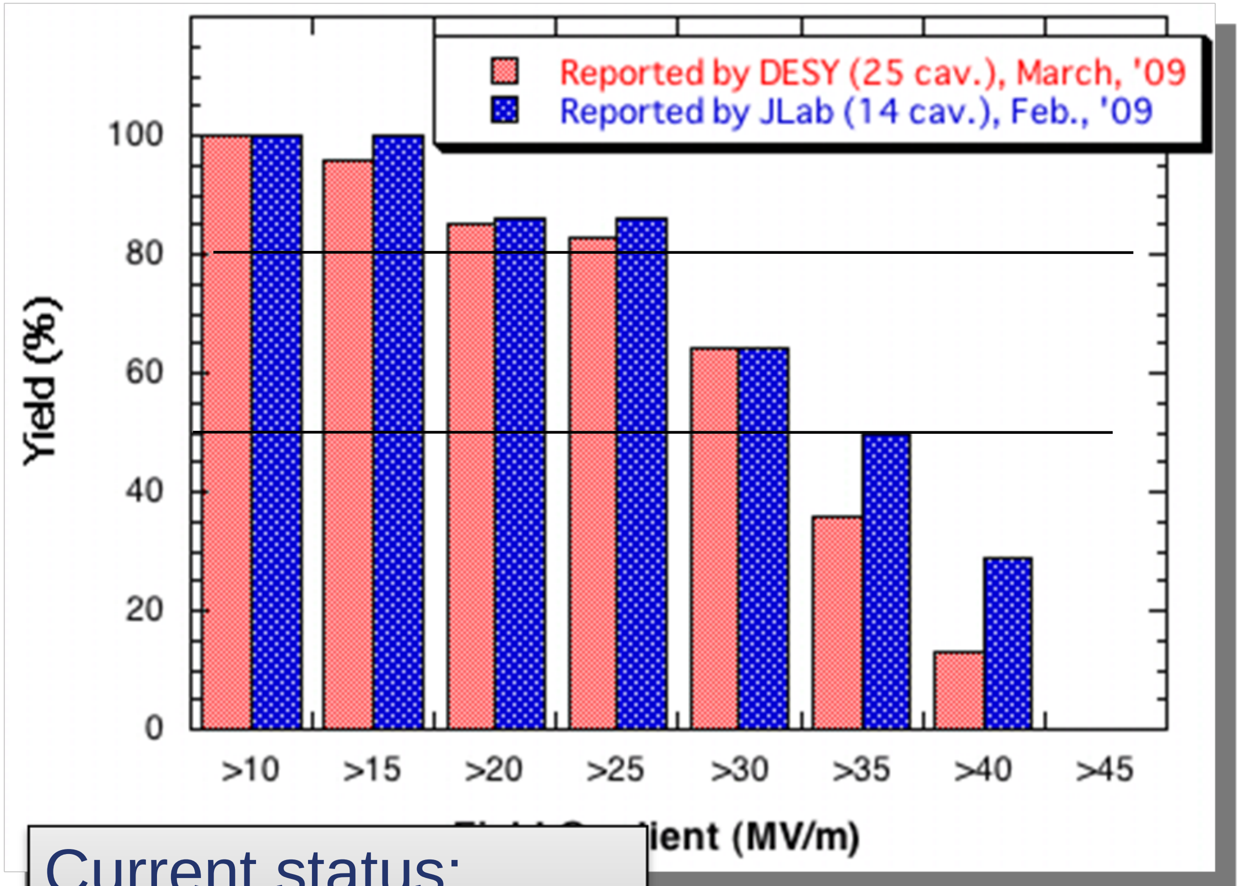


Progress Towards High-Gradient Yield



<u>Current status:</u>
50% yield at ~ 33 MV/m;
(80% >25MV/m)

Recent DESY/JLab "production" series.

Total 39 cavities (08/09)

Mostly result of **<u>first cold-test</u>** (few cases second-test)

Field Emission greatly reduced (rinses)
→ identified RDR barrier

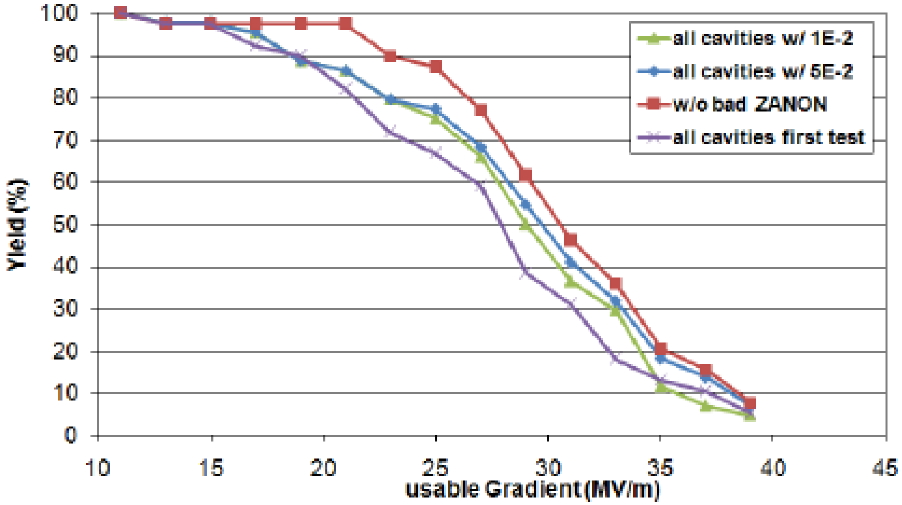
Baseline gradient re-evaluation (TDP1) expected to be based on sample of >60 cavities

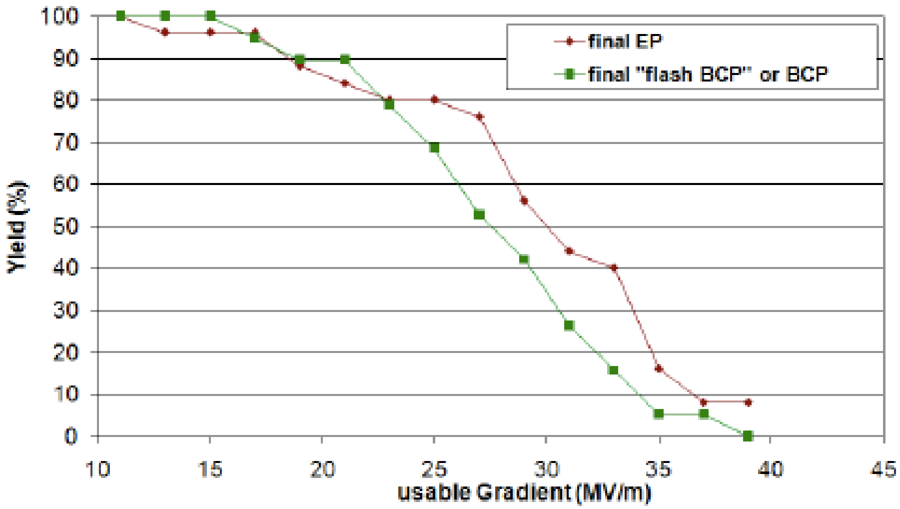
Reported at ILC-PAC by N. Walker

European XFEL

Progress Integrated at DESY

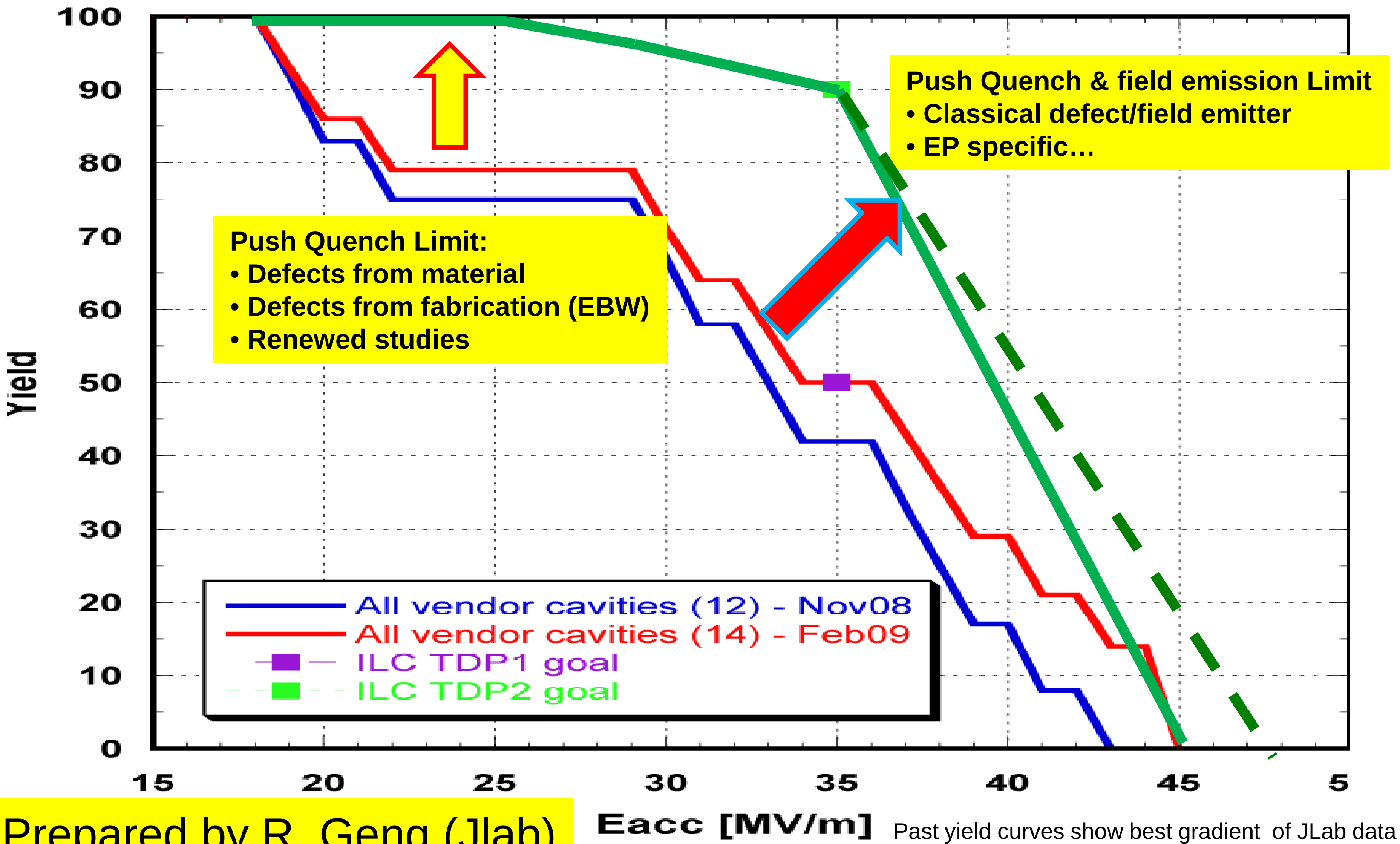
- cavity progress can be evaluated on the basis of **44 measured cavities**
  - 23 cavities w/o He tank
  - **21 cavities with He tank,** i.e. XFEL configuration
  - Approx. **60%** of the cavities with final **electro-polishing** (EP)
  - Approx. **25% with additional High Pressure Rinsing (HPR)** due to field emission (FE)
  - **Difference between first and last test** dominated by FE reduction
  - **Definition of radiation limit at** XFEL gradients not too critical
  - choice of final surface treatment impacts yield at higher gradients
- yield seems to depend on **steps after the final chemical treatment;** further improvement expected for series production





HELMHOLTZ ASSOCIATION

How May We Reach Our Goal?



Prepared by R. Geng (Jlab)

Past yield curves show best gradient of JLab data set

R&D Mile Stone

- From TDP R&D Plan, Release 3, p8

3.1.2 SCRF Technical design and R&D Milestones

The milestones for the TD Phase 1 and 2 SCRF goals outlined in section 3.1.1 (notably the S0, S1 and S2 programs) are given in Table 3.1.

Table 3.1: Milestones for the SCRF R&D Program.

High-gradient cavity performance at 35 MV/m according to the specified chemical process with a process yield of 50% in TDP1, and with a production yield of 90% in TDP2 (S0, see section 3.1.3 for definition of process yield)	2010 2012
Plug-compatible Cryomodule internal and external interface specifications to be defined: - including considerations of tuneability and maintainability - thermal balance and cryogenics operation - beam dynamics (addressing issues such as orientation and alignment)	2009
Cavity-string performance in one cryomodule with the average gradient 31.5 MV based on a global effort (S1 and S1-global)	2010
Cryomodule-string performance achieving the average gradient 31.5 MV/m with full-beam loading and handling (S2)	2012

Definition of Yields

- Definition of “Process” and “Production” Yield given In page 9.

For the purpose of evaluating progress towards producing cavities with a reproducible gradient near our goal, we have separated the concept of yield into two distinct definitions for the TD phases:

- For TD Phase 1, we define ‘process yield’ as the number of accepted cavities divided by the number of chemically processed cavities which fulfil some specified and justifiable criteria, such as those ordered from a qualified vendor or those passing specified mechanical test criteria. This allows us to separate fabrication-related defects, such as the pits or bumps in the vicinity of the electron-beam weld, from chemical surface treatment and cleaning-related problems. Final chemical treatment and rinsing is often done at an institution, rather than in industry, and is tightly coupled to the final assembly and testing procedure.
- For TD Phase 2, definition of ‘production yield’ is the number of accepted cavities divided by the number ordered. Production yield, as defined in the Reference Design, makes allowance for 20% of the cavities to be re-processed.

What we need to make clear?

	Reported by	Base on 3 of tests	Based on # of cavities	Base for yield evaluati on	# of excluded cavities	Process yeild	Producti on yield
TTC summ.	H. Padamsee	48 tests	(19)	48 tests	?	yes	
DESY repot	D. Reschke W. Singer/L. Lilje,	25+?	25	25 cavities	?	Close but not really	Close but not really
JLAB report	R. Geng	14+?	14	19 cavities	?	Close but not really	Close but not really
DESY report	H. Weise	?	?	?	?		

We need more clear definition and rule to plot the yield

For Discussions

- What we have to understand?
  - **Original S0 concept assumed:**
    - Surface can be reset according to the EP process, and
    - Process yield can be improved according to the experience
  - **Finding from experience in these years,**
    - Process repeating may cause degradation of the yield because of other reasons (additional defect according to the additional process/work, errors, etc).
  - **What happened in recent works**
    - Try to complete the process and test in the first cycle, and not to try the second cycle, if the result acceptable.
- How we may re-establish the recipe, evaluation and definition for the yield.
  - **We need again to discuss it, and persons in charge**
    - to monitor and accumulate the data base in a unified evaluation approach.

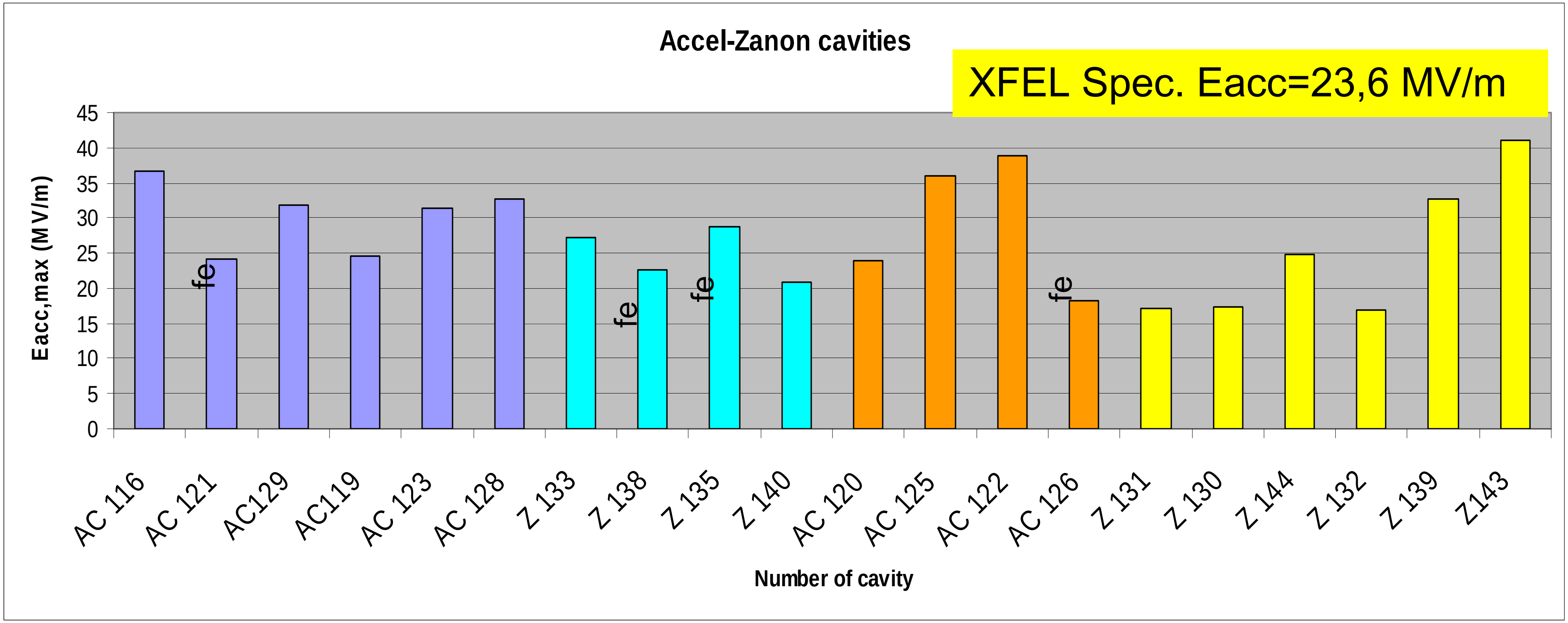
Re-baselining the Field Gradient:
A Possible Scenario

In early 2010 we will review the status:

- Understand the field gradient / process yield
- Estimate whether the 2012 gradient/yield target is achievable based on understanding and extrapolation of available results
  - **Cuts in the data might be required due to, for instance, vendors, process modifications, experience, one-off errors….**
- The 2012 target should be not just yield but on a larger scale economic minimum
- The statistics may not be as large as we originally desired…
  - **our interpretation of the results may have to wait or we may be forced to be more conservative**
- The TDP-2 period may allow for further refinement of component technologies

Backup

Preliminary RF statistic of 6th cavity fabrication at DESY



AC BCP Flash	Z BCP Flash	AC EP	Z EP
E_{acc}=30,2 +/- 4,9	E_{acc}=24,9 +/- 3,8	E_{acc}=29,3+/- 9,7	E_{acc}=24,9+/-4,4

- Max gradient, FE marked, if starts below 20 MV/m
- With He-vessel
- Without HOM pick up

Remark: some Z-Cavities might have suffered from fabrication problems so that the shown result could be independent of the final surface preparation process, i.e. wait for final analysis

Information provided by W. Singer

Guideline: Standard Procedure and Feedback Loop

	Standard Fabrication/Process	(Optional action)	Acceptance Test/Inspection
Fabrication	Nb-sheet purchasing		Chemical component analysis
	Component (Shape) Fabrication		Optical inspect., Eddy current
	Cavity assembly with EBW	(tumbling	Optical inspection
Process	EP-1 (Bulk: ~150um)		
	Ultrasonic degreasing (detergent) or ethanol rinse		
	High-pressure pure-water rinsing		Optical inspection
	Hydrogen degassing at 600 C (?)	750 C	
	Field flatness tuning		
	EP-2 (~20um)		
	Ultrasonic degreasing or ethanol	(Flash/Fresh EP) (~5um))	
	High-pressure pure-water rinsing		
	General assembly		
	Baking at 120 C		
Cold Test (vertical test)	Performance Test with temperature and mode measurement	Temp. mapping	If cavity not meet specification Optical inspection

Numbers of R&D Cavities for ILC partly from the TDP R&D Plan (release 3)

Order	Bef TDP	2008	2009	2010	Sum 2010	~ 2012
Ams (FY)	34	20	40	15	109	TBD
AS (FY)	15	3	13+1*	17+2	48+3	TBD
EU (CY)	68		26 (+808)**		94 (+808)	TBD
Sum	117	23	48 (+808)	34	222 (+808)	

•Japan + China
•** 26 specific for ILC-R&D, 808 for XFEL mass production
- Order in 2010 and later is to be subject to budget available

Tests			2009	2010	2011	2012
Ams (FY)			45	70	TBD	TBD
AS (FY)			12	14	TBD	TBD
EU (CY)			15	10	20	TBD
Sum			72	94	TBD	TBD

Toward Industrialization

- Global status of Industries
  - **Research Instruments and Zanon in Europe**
  - **AES, Niowave, PAVAC in Americas**
  - **MHI in Asia**

Project Scope			
Euro XFEL	~800	2 years	~1 cavity / day
Project X	~400	3 years	~2 cavities/ week
ILC	~15,500	4 years	~20 cavities / day
(÷ 3 regions			~7 cavities / day)

- Industrial Capacity: status and scope
  - **No company currently has required ILC capacity**
  - **Understand what is needed (and cost) by 2012**

Industrialization and cost reduction

- Re-visit previous effort, and update the cost-estimate for production
  - **Review the RDR cost estimate (based on TESLA)**
  - **Include recent R&D experience (industry/lab)**
- Encourage R&D Facilities for industrialization
  - **Develop cost-effective manufacturing, quality control and cost-reduction in cooperation with industry**
- Reflect the R&D progress for cost-reduction
  - **Baseline $\Rightarrow$ Forming, EBW, assembly work…**

A Plan for R&D facilities and Preparation for Industrialization

- Bench-mark R&D facility (pilot plant) to study cost-effective manufacturing,
  - **Forming and preparation machining,**
  - **Pre-surface treatment and preparation,**
  - **EBW process with efficient automation,**
  - **In-line Inspection during fabrication process for quick-feedback,**
- R&D facilities to be sited at Laboratories
  - **Effort to seek for the most cost-efficient manufacturing with keeping information to be open,**
  - **Development to seek for a bench-mark, manufacturing facilities (design and/or itself can be applicable for the real production.**
  - **It is important for industries to participate to the program since Day-1. for planning.**
- We may discuss a possibility
  - An industrial meeting to be held as a satellite meeting at the 1st IPAC, Kyoto, May, 2010.
-

Global Plan for SCRF R&D
A Summary

Calender Year	2007	2008	2009	2010	2011	2012
Technical Design Phase	TDP-1				TDP-2	
Cavity Gradient R&D to reach 35 MV/m		Process Yield > 50%			Production Yield >90%	
Cavity-string test: with 1 cryomodule			Global collab. For <31.5 MV/m>			
System Test with beam 1 RF-unit (3-modulce)		FLASH (DESY)			STF2 (KEK) NML (FNAL)	

R&D/prepare for Indusrialization