Consideration on the Field Gradient and Yield toward Re-baselining in TDP2

Akira Yamamoto

To be presented at ALCPG/ILC-GDE,
Oct. 1, 2009

Design Considerations for the ILC

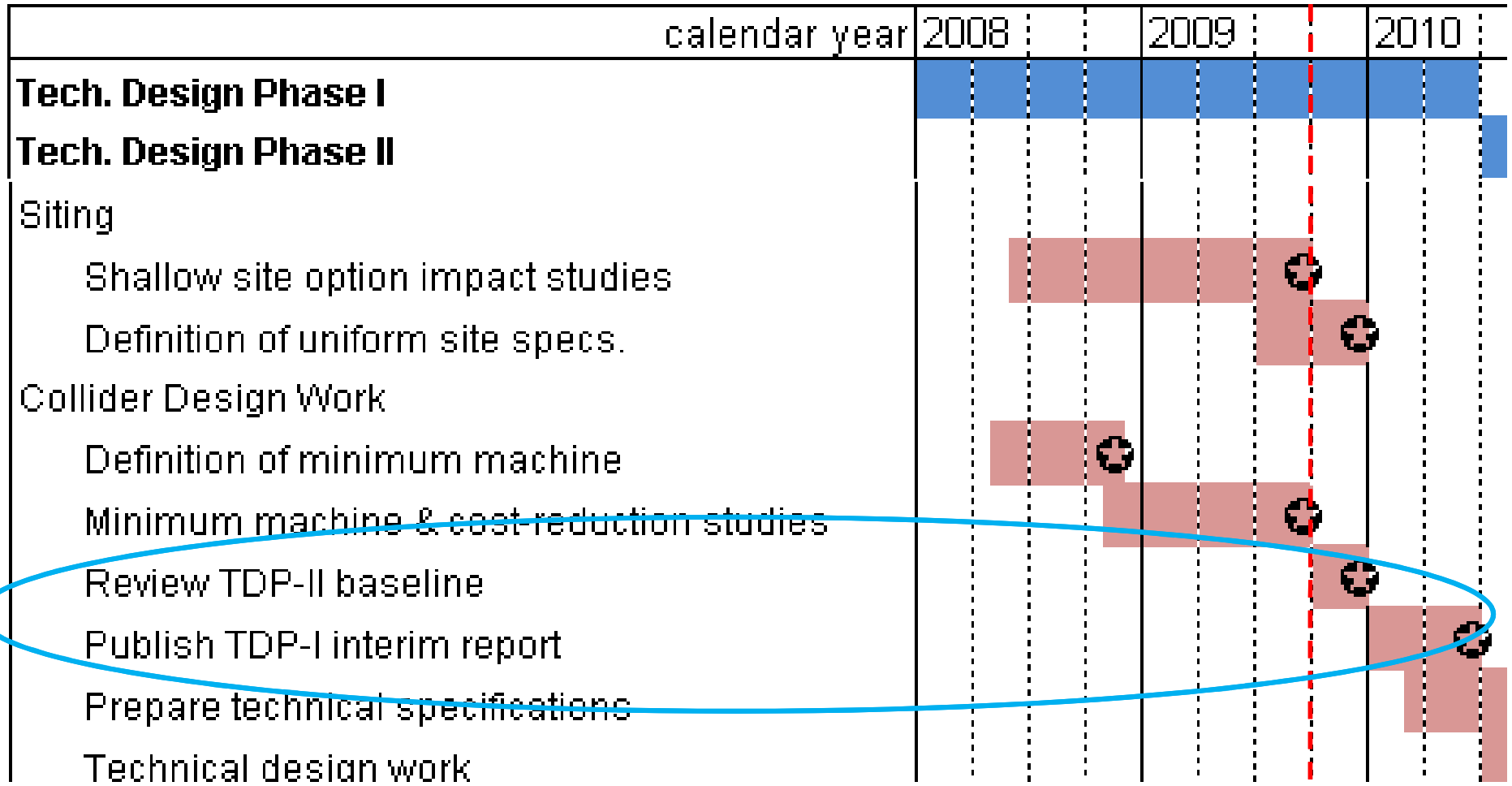
Towards a new baseline for TDP2: an open discussion with the Detector & Physics Community

Presented by

Nick Walker for the GDE Project Management

at GDE Plenary, Albuquerque, Sept. 29

TDP R&D Plan


calendar year
2008
2009
2010
Tech. Design Phase I
Tech. Design Phase II
Siting
Shallow site option impact studies
Definition of uniform site specs.
Collider Design Work
Definition of minimum machine
Minimum machine & cost-reduction studies
Review TDP-II baseline
Publish TDP-I interim report
Prepare technical specifications
Technical design work

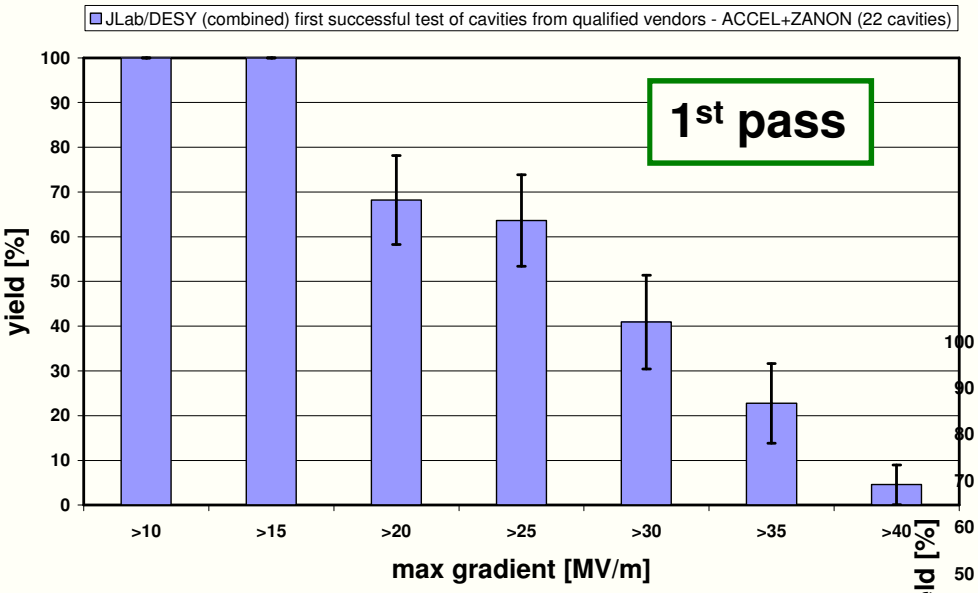
Global Plan for SCRF R&D

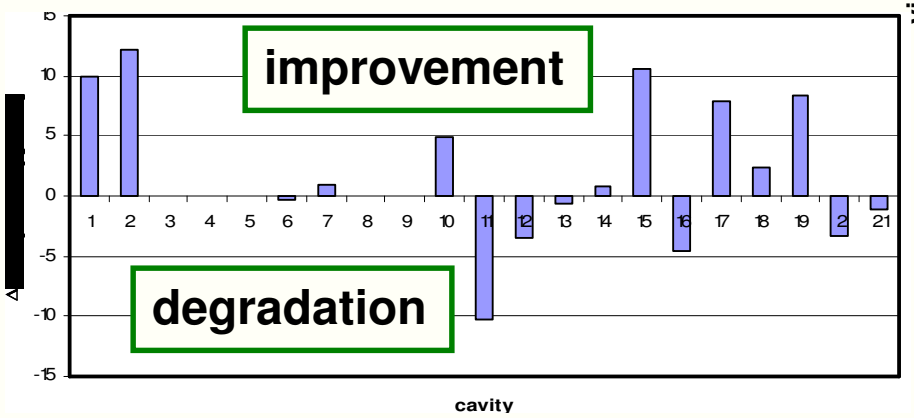
Year	07	2008	2009	2010	2011	2012
Phase	TDP-1				TDP-2	
Cavity Gradient in v. test to reach 35 MV/m	>> Yield 50%				>> Yield 90%	
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for plug-compatible string (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY)			NML (FNAL) / STF2 (KEK)	
Preparation for Industrialization			Mass Production Technology R&D			

Comparison of 1st and 2nd Pass Yields

Fermilab

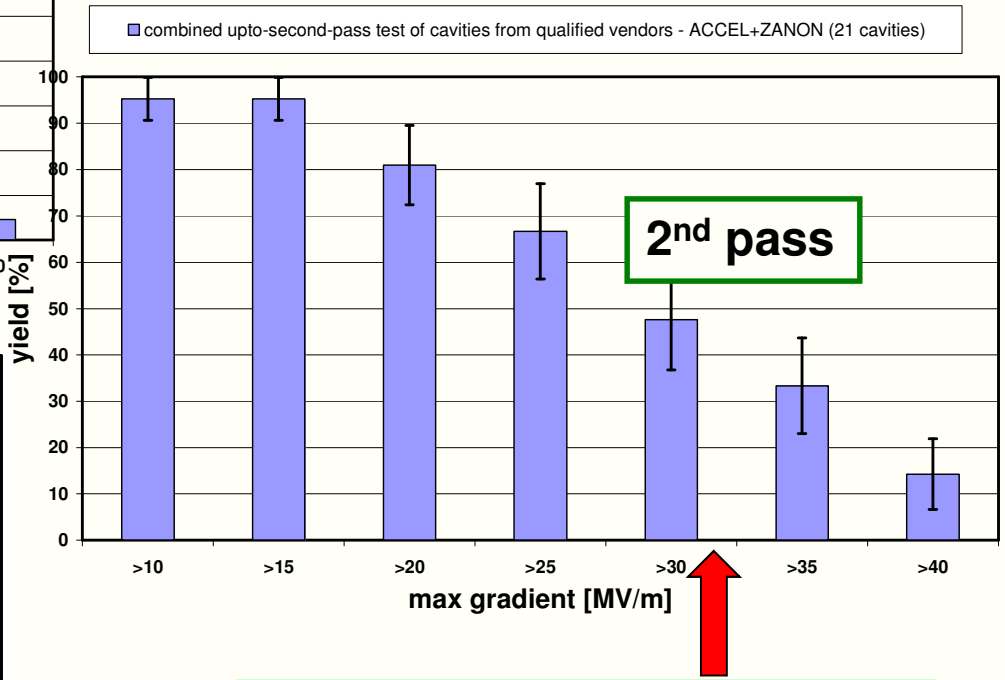
Electropolished 9-cell cavities





Yield at 35 MV/m:
22 % at 1st pass
33 % at up to 2nd pass

Electropolished 9-cell Cavities



ILC Operation at <31.5 MV/m>
Yield reaching ~ 40 %

Cavity Gradient Study - Summary

- Yield at 35 MV/m (by leading/qualified vendors)
  - 22 % at 1st pass (statistics 22)
  - 33 % at 2nd pass (statistics 21, as of 09-07))
  - DESY prod-#4 to be added, (stat. to be ~ 30)
- New yield statistics (w/ potential vendors)
  - AES: to be counted from #5 (to be confirmed)
  - MHI: to be counted from #5 (to be confirmed)
- Limited 'Prod. Y.' statistics to be understood
  - 'Production Yield': to evaluate readiness of industrialization/production-stage, and cost
  - 'Cavities for HG research': necessary to be separately counted.

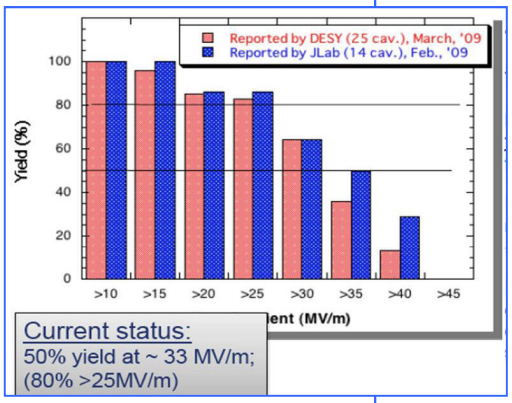
Progress and Prospect of Cavity Gradient Yield Statistics

	PAC-09 Last/Best 2009-05	FALC 1st Pass 2009-07	ALCPG 2nd Pass 2009-10	To be added (2009-11)	Coming Prod. Y. (2010-06)	Further, Research cavities
DESY	9 (AC) 16 (ZA)	8 (AC) 7 (ZA)	14 (AC/ZA)	10 (Prod-4)	5	8 (large G.)
JLAB FNAL/ANL/Cornell	8 (AC) 4 (AE) 1 (KE-LL5) 1 (JL-2)	7 (AC)	7 (AC)	~ 5 (AE)	12 (AC) 6(AES) 6(NW) -x	X + a (including large-G)
KEK/IHEP				5 (MH)	2 (MH)	1 (LL) ++ a 1 (IHEP)
Sum	39	22	21	20	31 - x	10 + x + a
G-Sum				~ 41	72 - x	

We may need to have separate statistics for 'production' and for 'research'

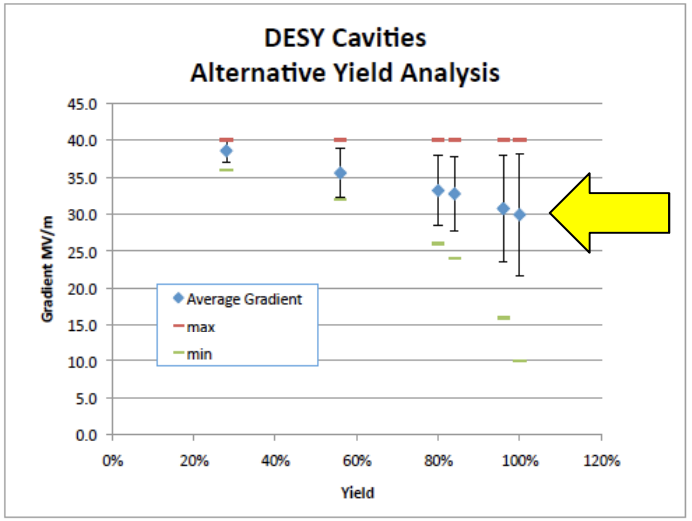
A New Approach
Average Gradient Yield

Suggested by Nick Walker



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

cutoff	5	10	15	20	25	30	35	40
	10							
	16	16	16					
	16	16	16					
	18	18	18					
	24	24	24	24				
	26	26	26	26	26			
	26	26	26	26	26			
	26	26	26	26	26			
	28	28	28	28	28			
	30	30	30	30	30			
	30	30	30	30	30			
	32	32	32	32	32	32		
	32	32	32	32	32	32		
	32	32	32	32	32	32		
	32	32	32	32	32	32		
	32	32	32	32	32	32		
	34	34	34	34	34	34		
	34	34	34	34	34	34		
	36	36	36	36	36	36	36	
	38	38	38	38	38	38	38	
	38	38	38	38	38	38	38	
	38	38	38	38	38	38	38	
	40	40	40	40	40	40	40	
	40	40	40	40	40	40	40	
	40	40	40	40	40	40	40	
yield	100%	96%	96%	84%	80%	56%	28%	0%
mean	29.9	30.8	30.8	32.8	33.2	35.6	38.6	
min	10	16	16	24	26	32	36	
max	40	40	40	40	40	40	40	
std	8.2	7.2	7.2	5.0	4.7	3.3	1.5	



Yield is estimated assuming a specific lower cut-off in cavity performance, below which cavities are assumed 'rejected'.

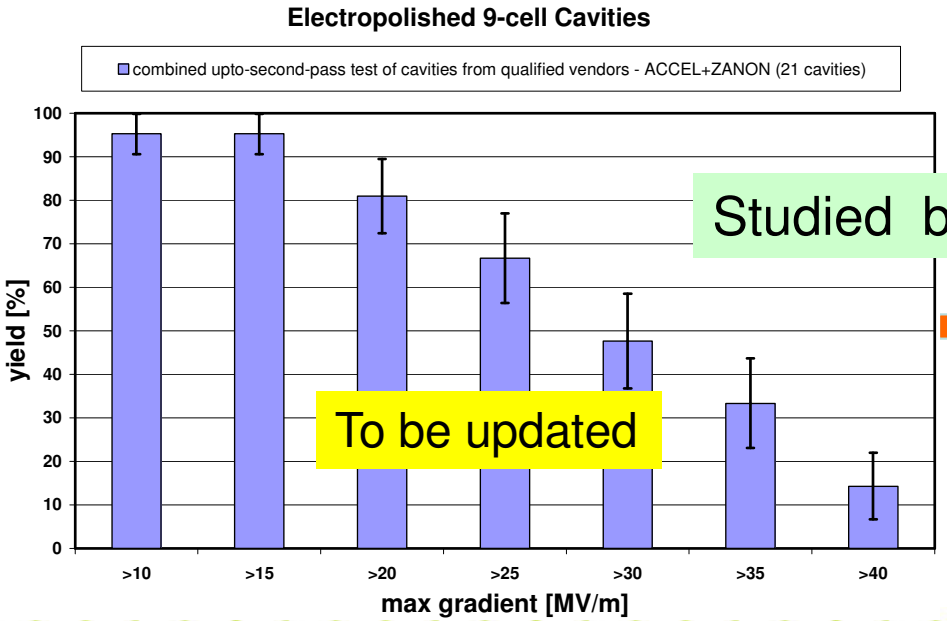
Error bar is +/- one RMS value (standard deviation of the polulation) of the remaining (accepted) cavities (gradient above cut-off).

Additional bars (min, max) inidcated the minimum and maximum gradients in the remaining (accepted) cavities.

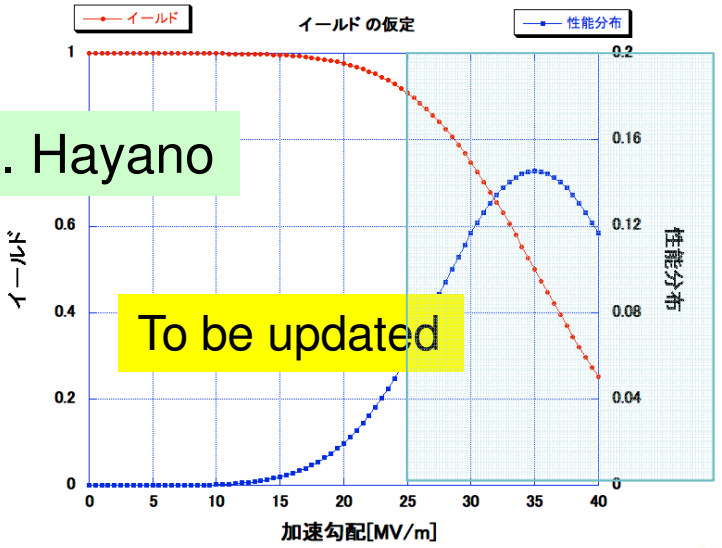
Data based on the plot presented in PAC, Vancouver,
>> Average gradient reached ~ 30 MV/m

Field Gradient Distribution to be accepted in ILC Operation

- A model (to be discussed)
  - Operational field gradient: 31.5 MV/m +/- 20 %
  - Maximum field gradient (in VT): 35 MV/m +/- 20 %
  - 'Production yield' may be re-considered, with the distribution taken into account.



Studied by H. Hayano

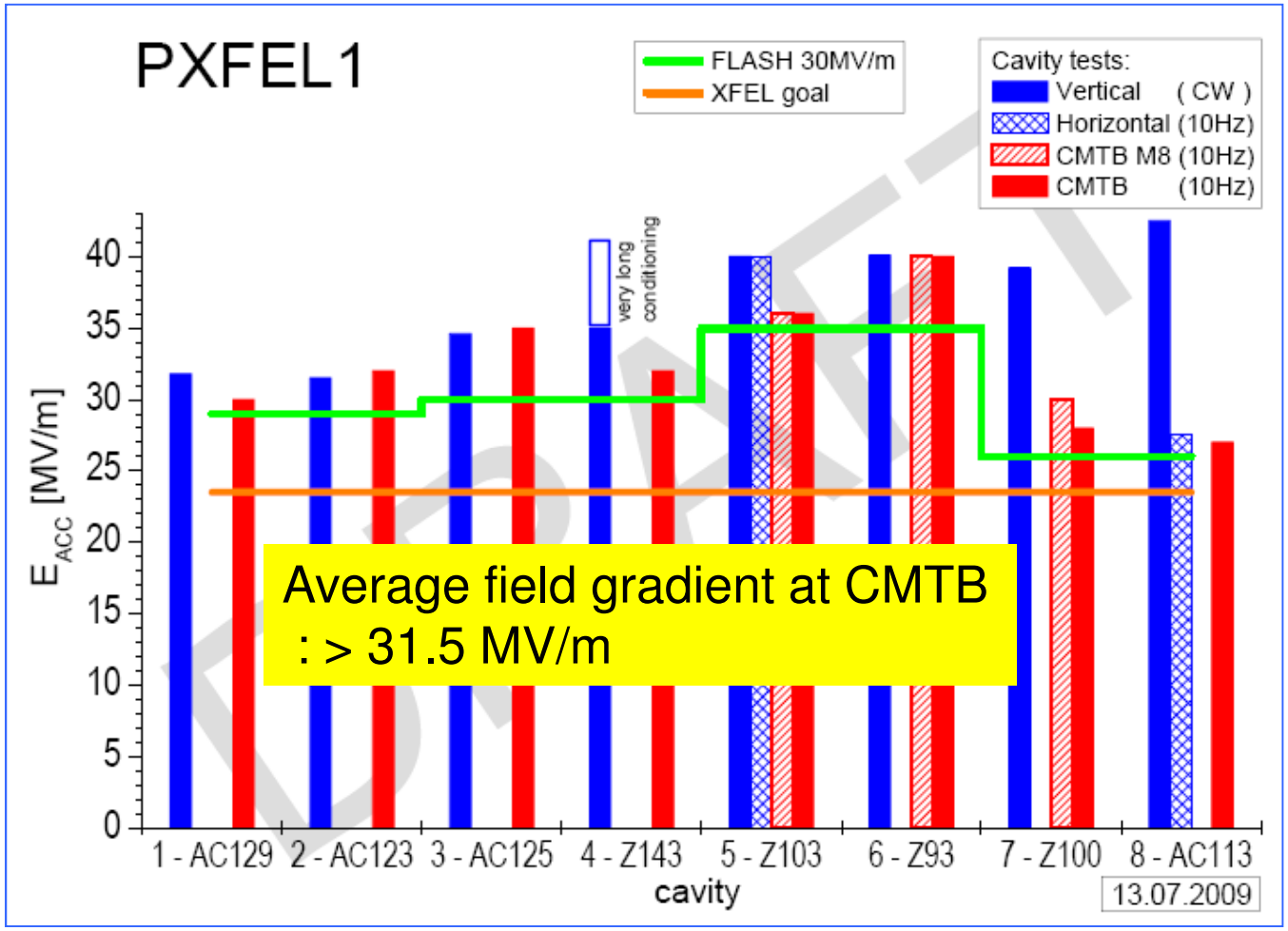


A Proposal for Re-baseline Cavity Gradient and Yield, in TDP-2

- Operational field of <31.5 MV/m> (@ Q0 = 1E10)
  - Keep it, as the 'averaged field gradient' in the ILC operational condition with cryomodule string, and
  - Accept the gradient distribution of (~ 20 % (b/w 25 – 38 MV/m) in operation (note: exact number to be further well discussed)
    - See the recent progress at DESY PXFEL cryomodule test result
- Maximum gradient of 35 MV/m (@ Q0 = 8E9) in vert. test
  - keep our R&D goal of the yield of 90 % at 35 MV/m, as a target, and
  - Recognize that the yield may be acceptable to be ~ 50 % with the +/- 20 % distribution (i. e., b/w 28 and 42 MV/m) of the gradient.
- Production Yield
  - the yield of 90 % at the 28 MV/m, and 50 % at 35 MV/m may meet the the ILC operational field gradient with a margin of 10 % , by taking the above model with the distribution of +/- 20 %.

S1 Goal: Reached at DESY PXFEL1

reported by H. Weise, at SRF-09



Note: DESY prepared cavities and assembled with the cryomodule cold mass contributed by IHEP for XFEL prototype

Accelerating Gradient toward Re-Baselining in TDP-2

- Parameter with largest cost-leverage
  - Major focus of global R&D effort ('S0')
- On-going database effort to evaluate 'yield'
  - Cost implications
- For TDP-2 baseline, unlikely to change current Working Assumption (31.5 MV/m)
- Change of gradient at later stage only affects length of linacs
  - At 10% level easily scalable
  - No other subsystems affected
- New approach to 'yield' being evaluated, supporting larger spread in cavity performance
  - Average still (currently) 31.5 MV/m
  - Up to 20% spread is probably acceptable

Progress of Yield Statistics

	PAC-09 Last/Best 09-05	FALC 1st Pass 09-07-07	ALCPG 2nd Pass 09-10-01	To be added (09-10)	Coming Prod. Y. (10-06)	Coming Research cavities
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KEK/IHEP				4 (MH)	3 (MH)	1 (LL)
Sum	39	22	21		32 - x	9 + x + y
G-Sum				40	72 - x	81 + y

We may need to have separate statistics for 'production' and for 'research'
The number of resarch purpose cavities still to be