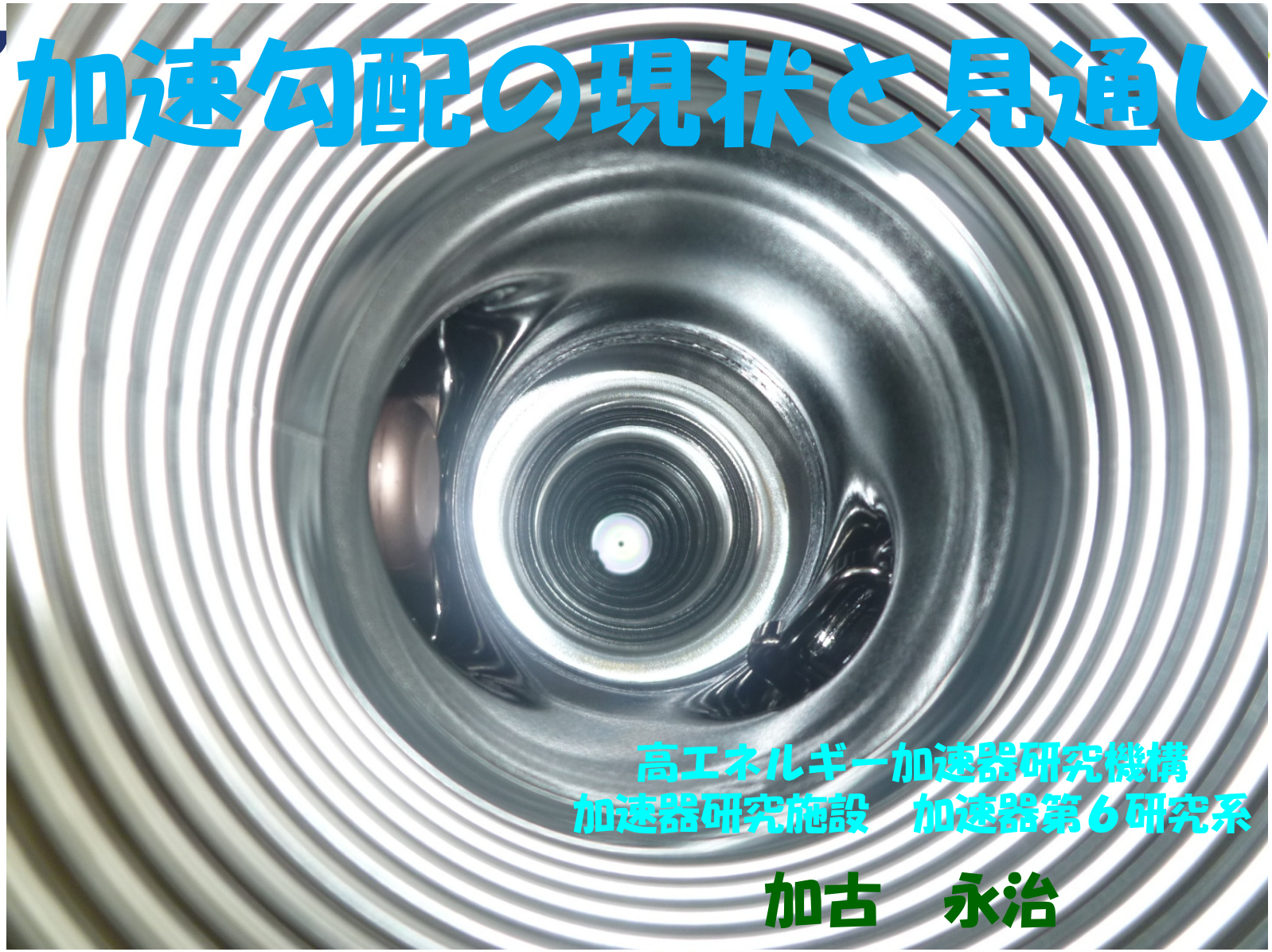
加速勾配の現状と見通し

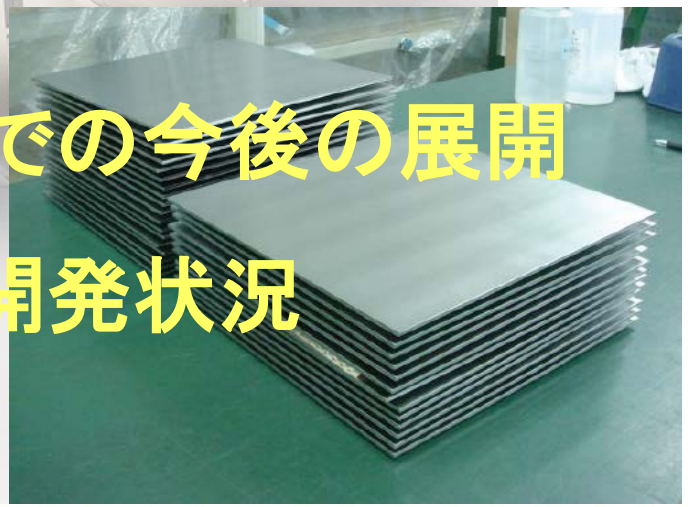


高エネルギー加速器研究機構
加速器研究施設　加速器第６研究系

加古　永治

発　表　内　容

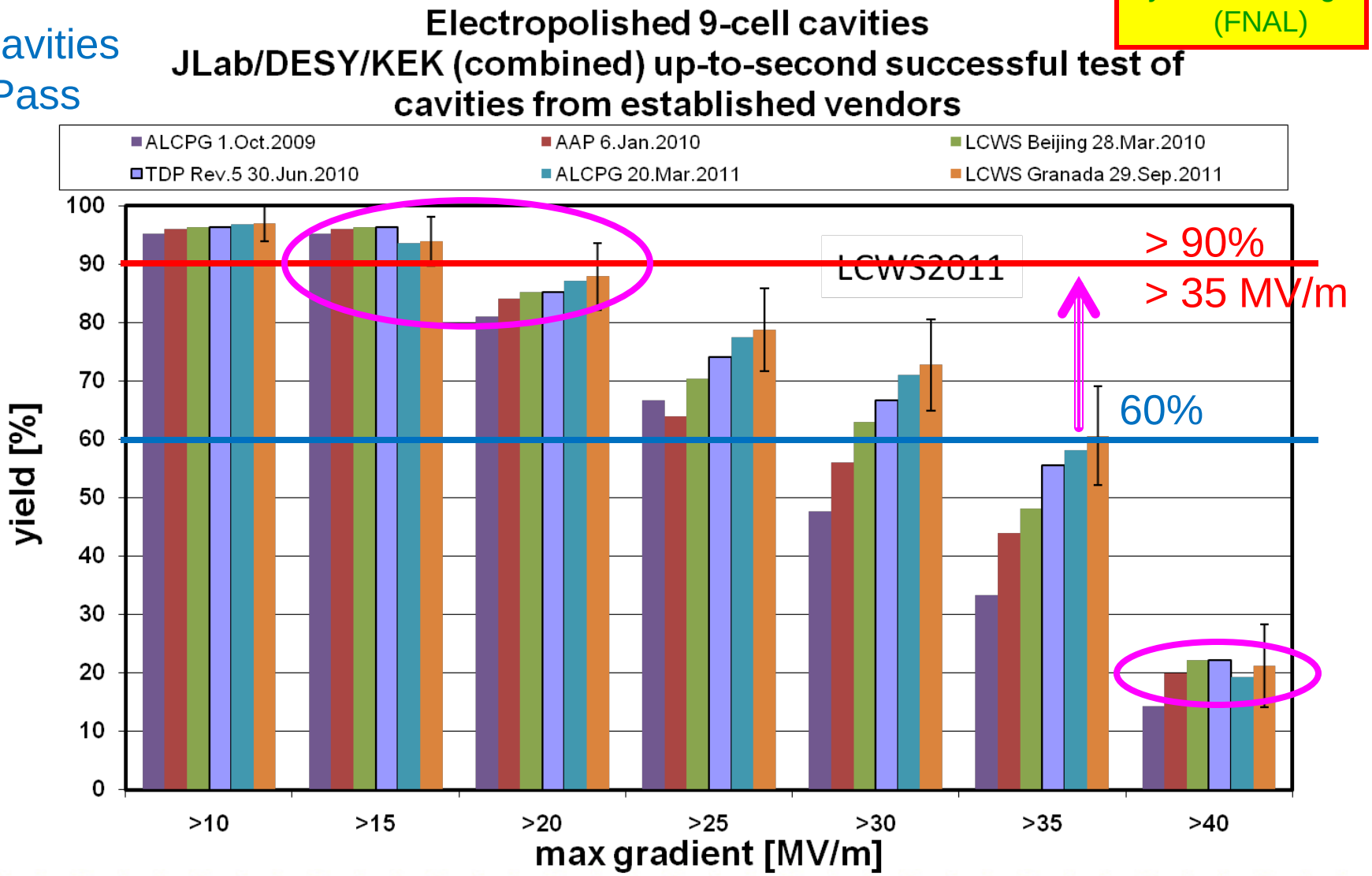
- 海外での高加速電界性能の現状
- 国内での高加速電界性能の現状
- 超伝導高周波試験施設での今後の展開
- 国内企業などでの空洞開発状況
- 今後の展望とまとめ



高加速電界性能の現状のまとめ

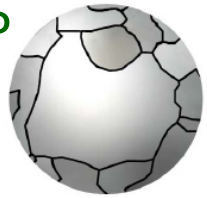
by C. Ginsburg (FNAL)

38 cavities
2nd Pass



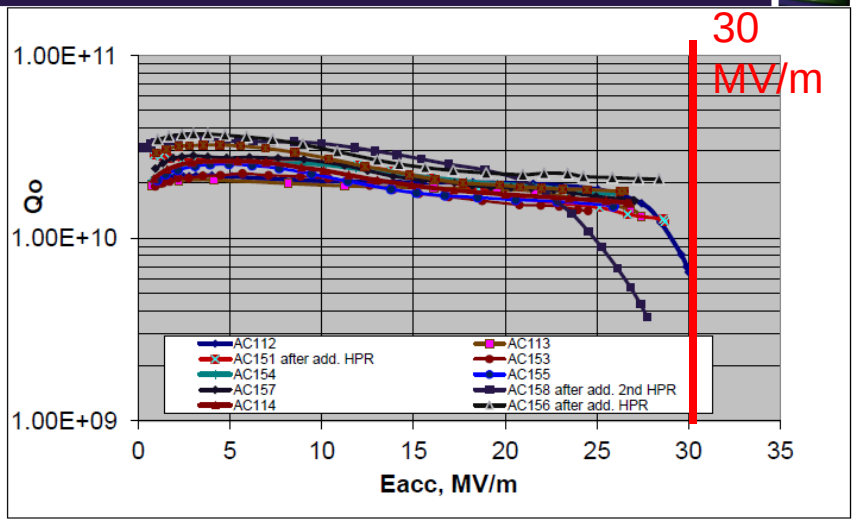
高加速電界性能の現状@DESY

11 Large Grain Cavities:
Eacc,max < 30 MV/m, after CP



European XFEL

$Q_0(E_{acc})$ of the LG cavities AC112- AC114, AC151-AC158 at 2K after BCP.

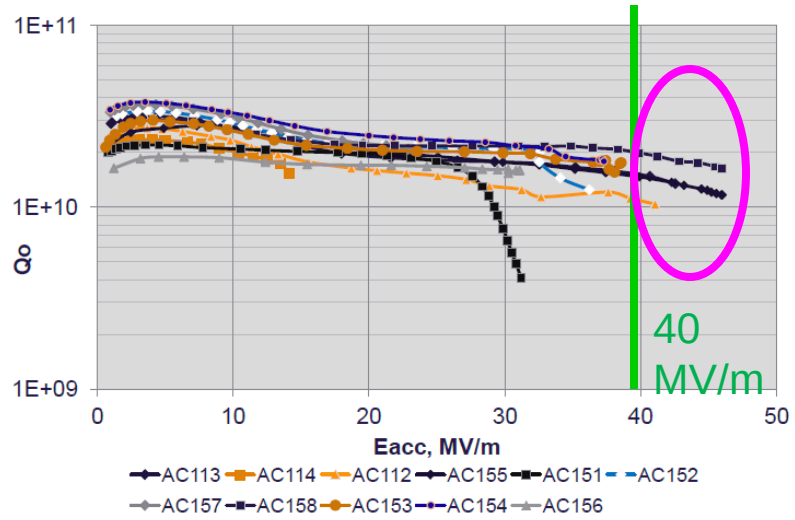


m rough BCP, annealing at 800° C for 2h, final BCP of 20 µm and C for 48h. AC112 is not baked; AC113and AC114 are baked after additional 20µm BCP; AC158 after 2nd HPR has FE

cember 5-8, 2011, Beijing, China

European XFEL

$Q_0(E_{acc})$ performance of the LG cavities AC112- AC114, AC151-AC158 at 2K after 50-120 µm EP, 800° C , baking.



AC151, AC152 and AC 157 are in retreatment at DESY (add. EP)

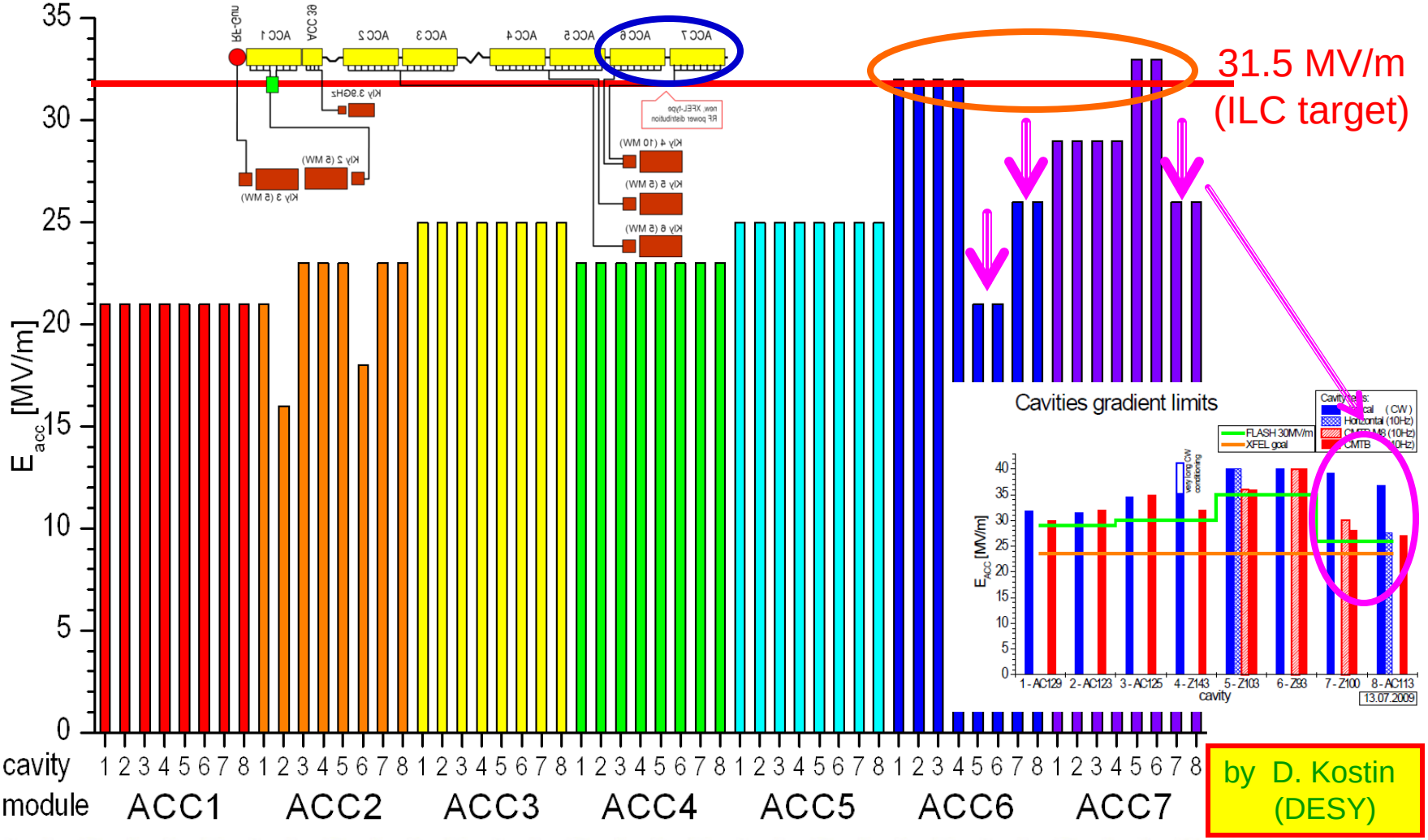
W. Singer, TTC Meeting, December 5-8, 2011, Beijing, China

by W. Singer (DESY)

3 Large Grain Cavities:
Eacc,max > 40 MV/m, after EP

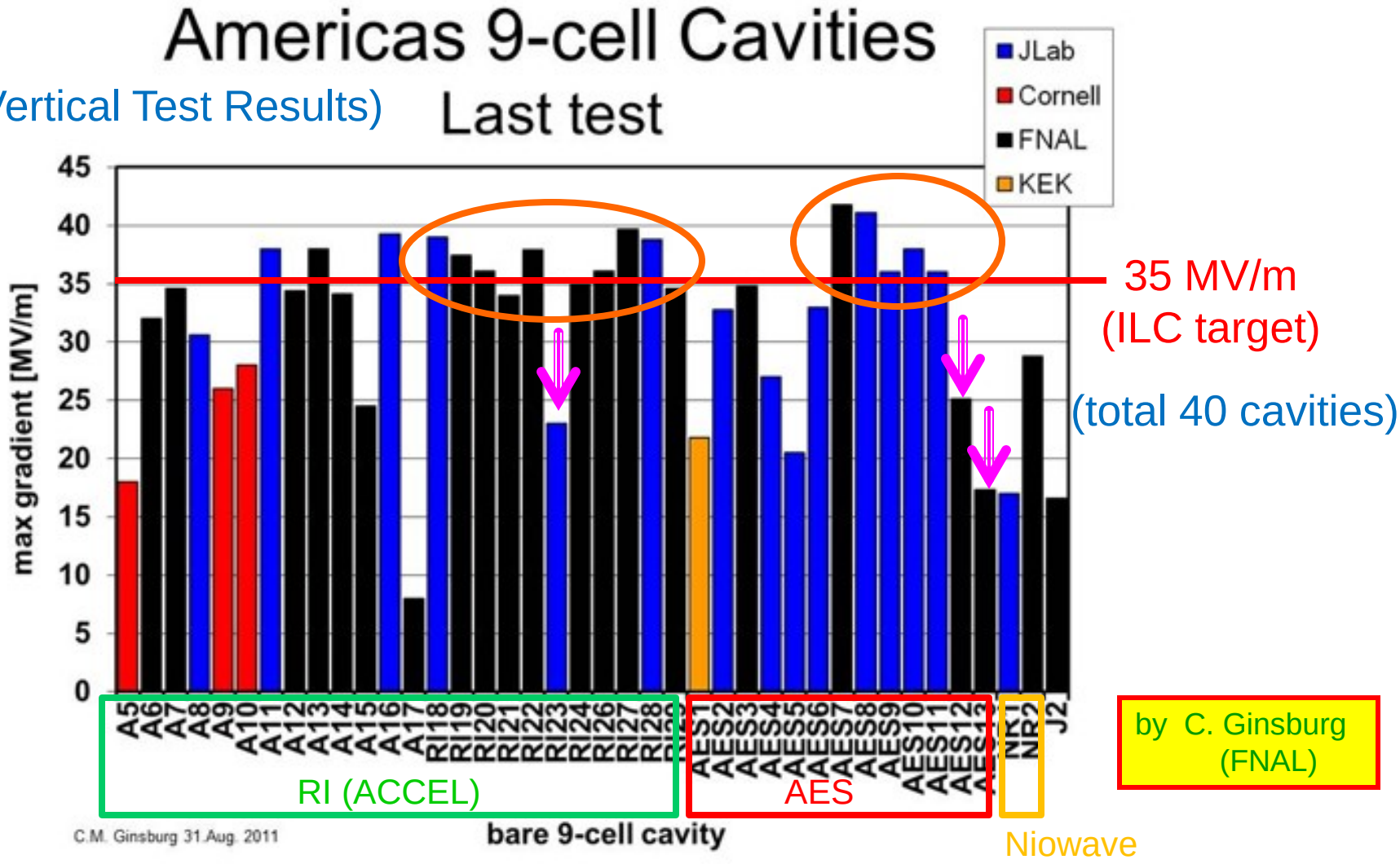
高加速電界性能の現状@DESY

Operational Gradient in FLASH Module ; total 56 cavities

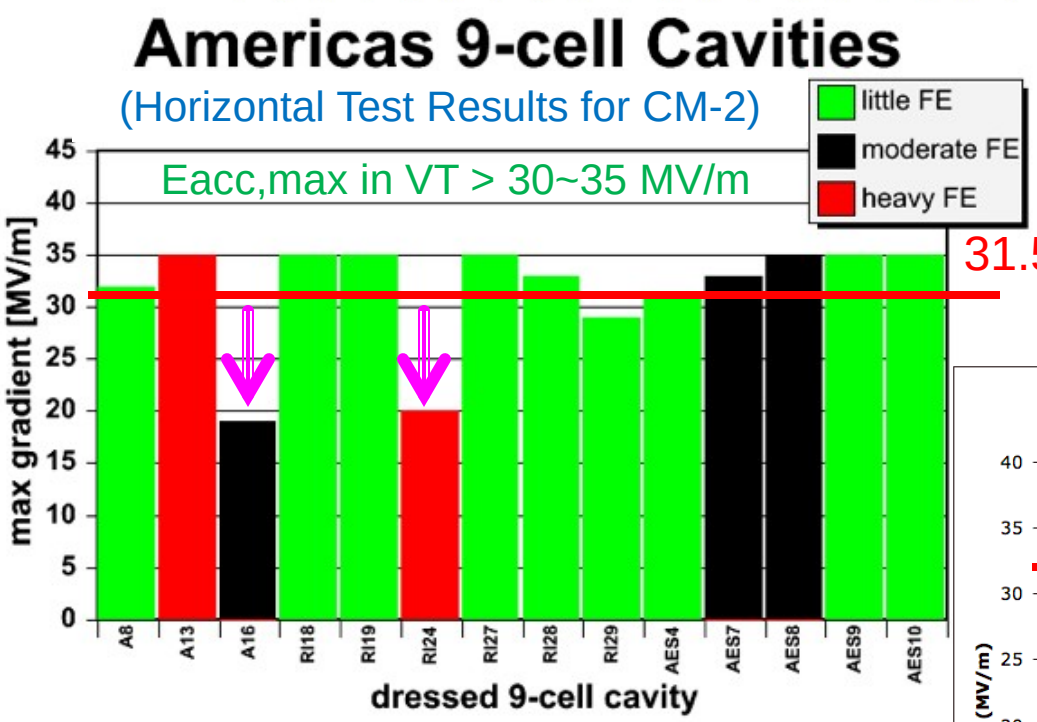


by D. Kostin (DESY)

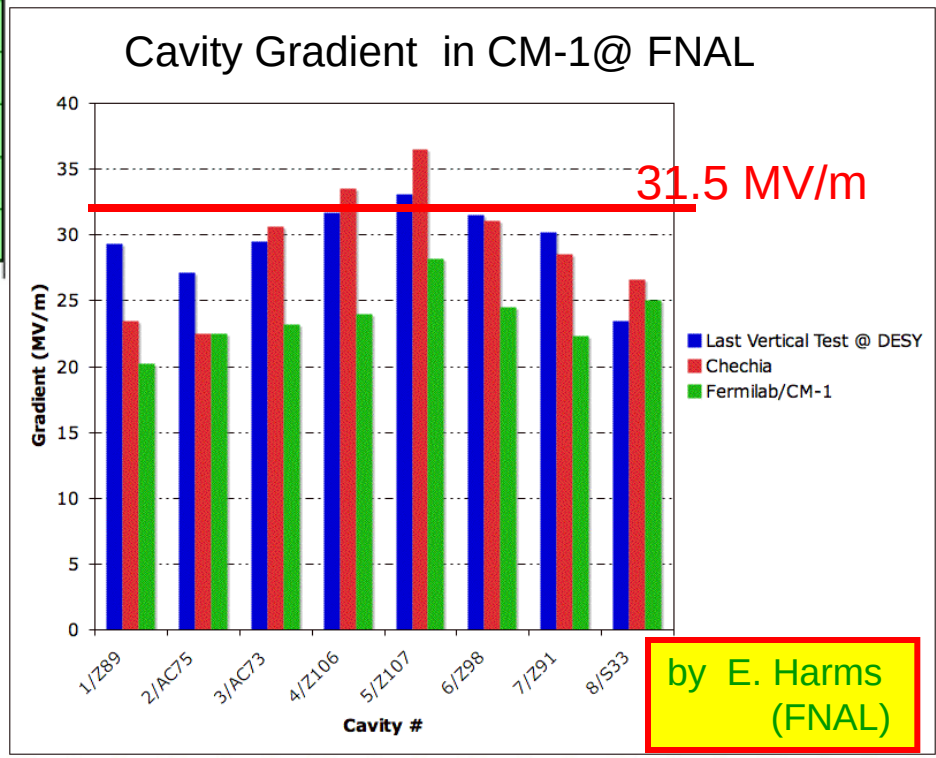
高加速電界性能の現状@FNAL



高加速電界性能の現状@FNAL



by A. Hocker (FNAL)

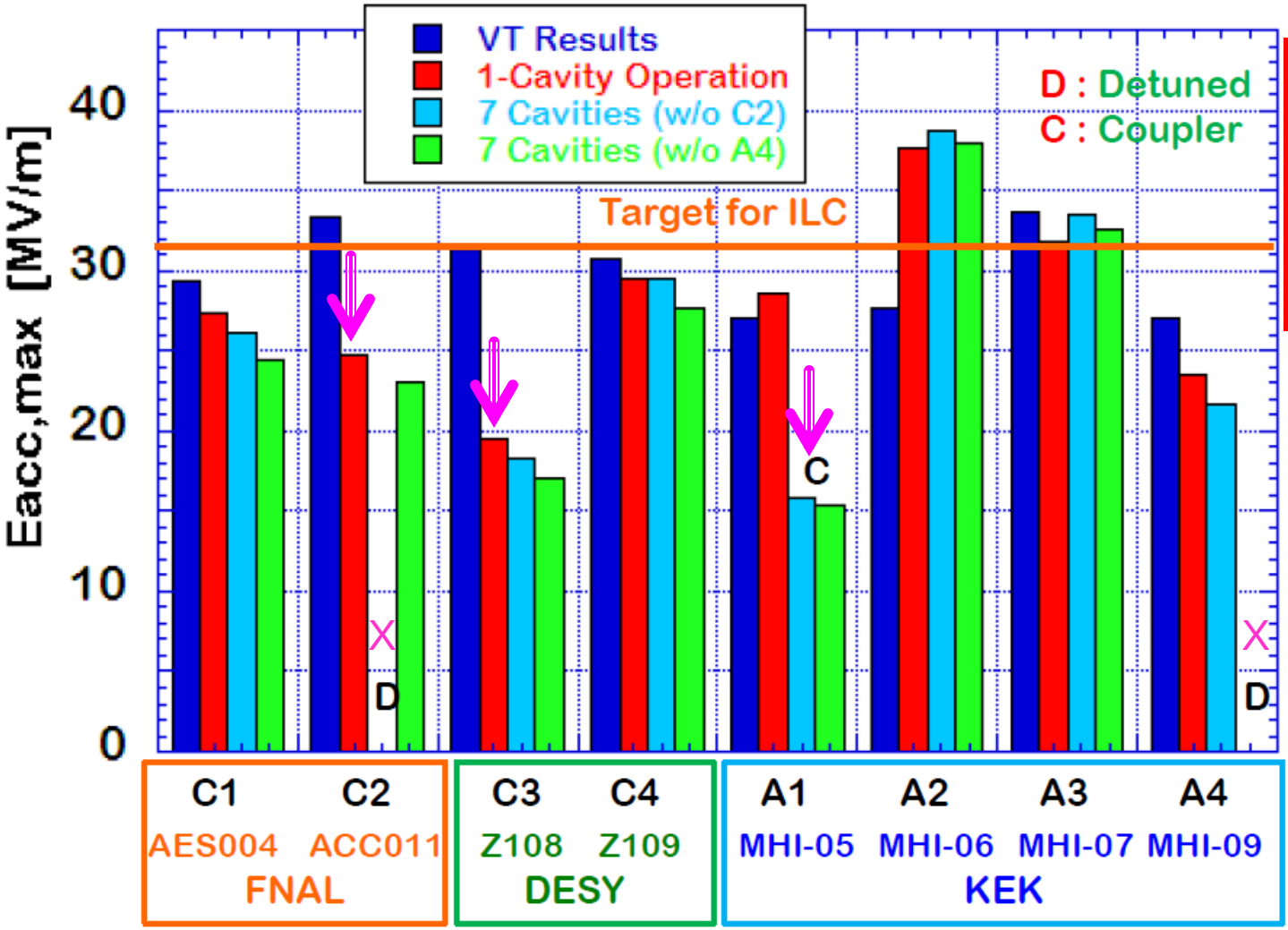


by E. Harms (FNAL)

Eacc,max in VT = ave. 30 MV/m @ DESY
Eacc,max in HT = ave. 29 MV/m @ DESY
(3 % down)
Eacc,max in CMT = ave. 24 MV/m @ FNAL
(20% down)

Operational Gradient of 8 cavities < 22 MV/m ??

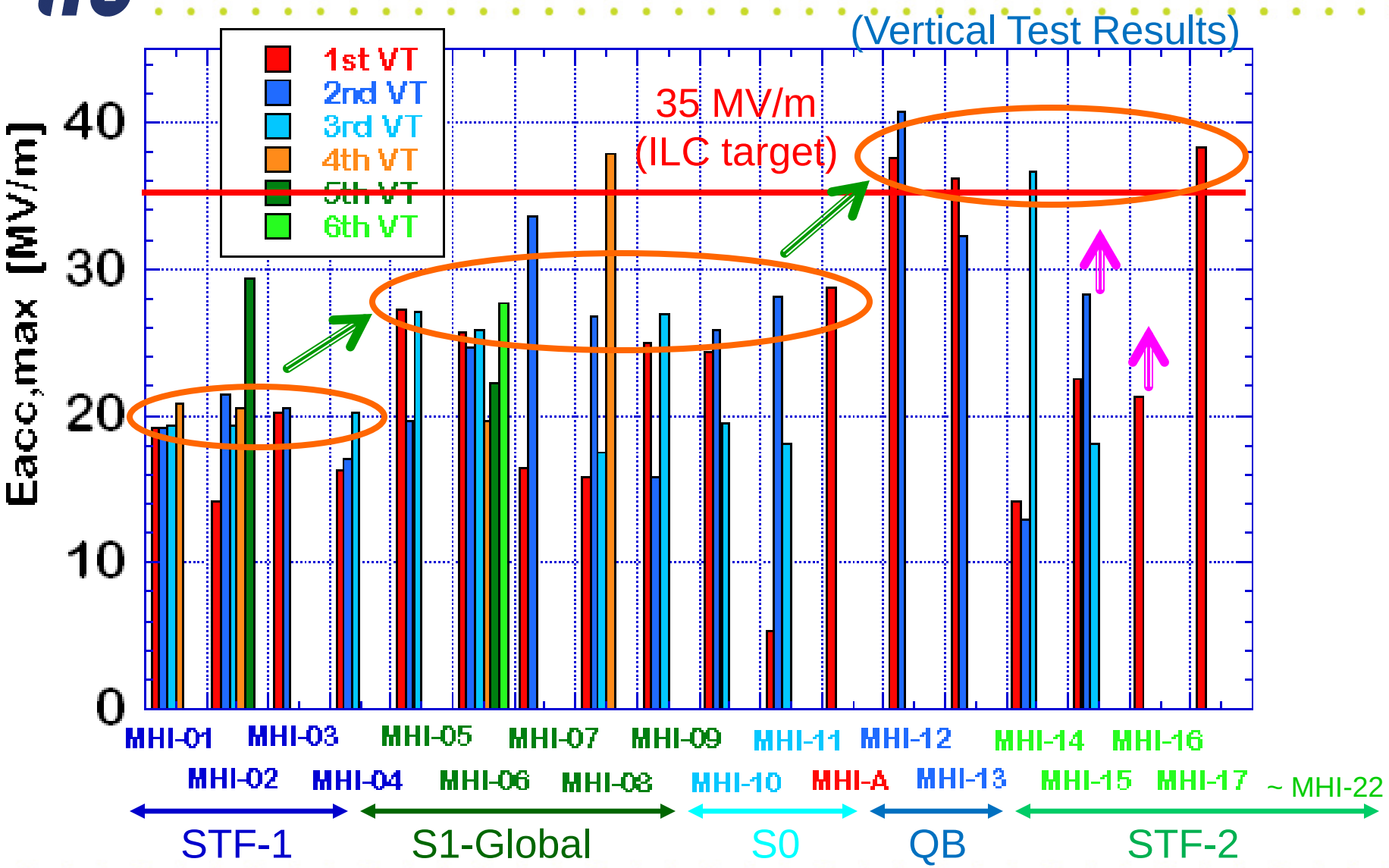
高加速電界性能の現状@ S1-G/KEK



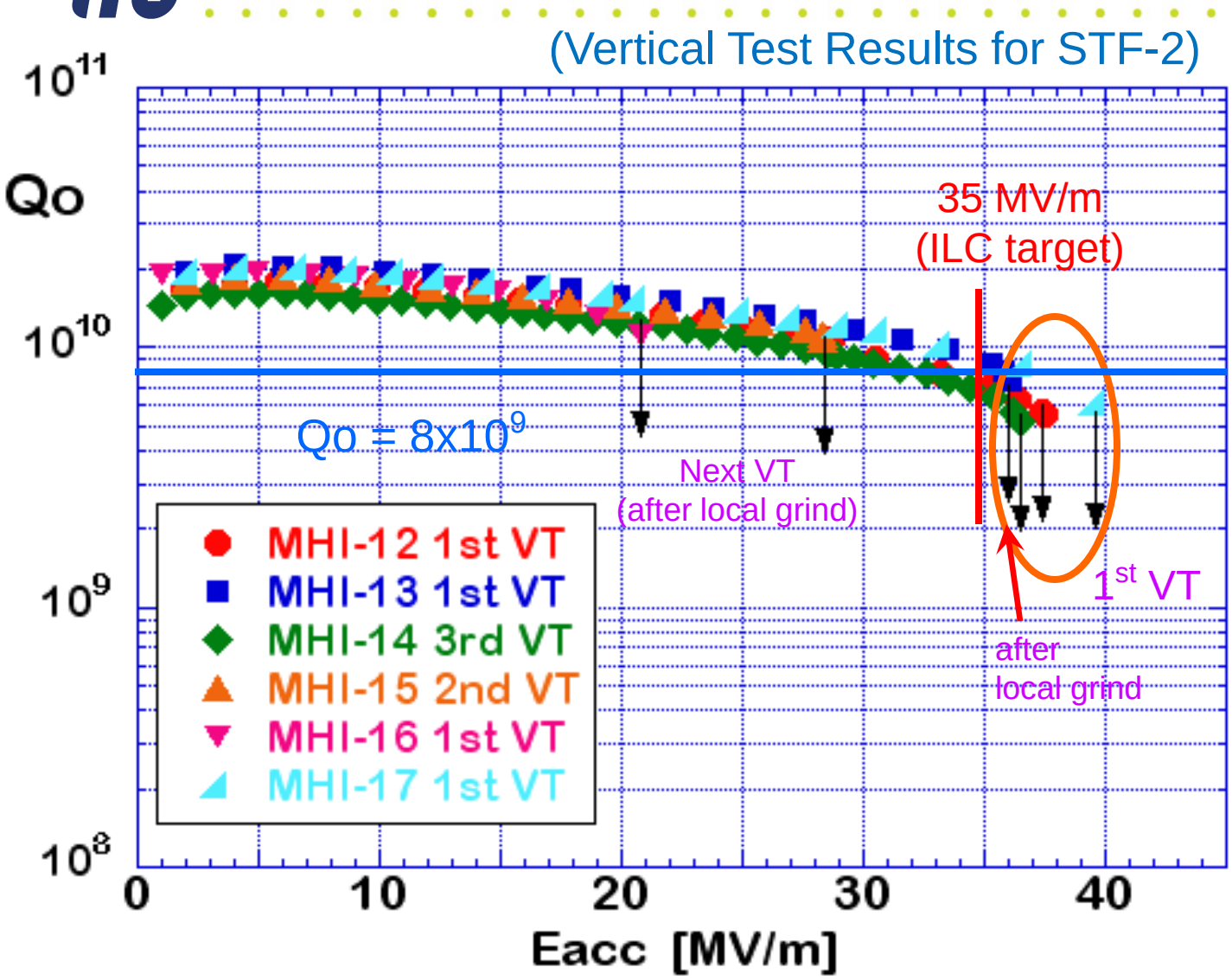
ave. Eacc,max
VT : 30.0 MV/m
1 cav : 27.8 MV/m
7 cav : 26.2 MV/m
7 cav : 25.4 MV/m

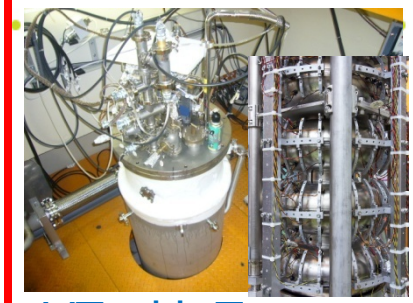
Reduction
by 13% from VT

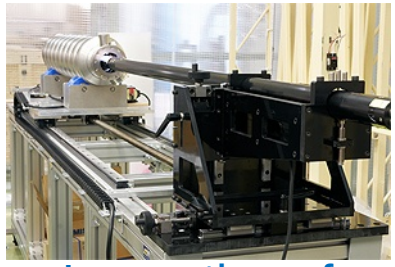
高加速電界性能の現状@KEK

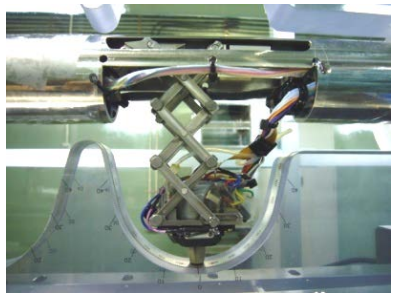


高加速電界性能の現状@KEK

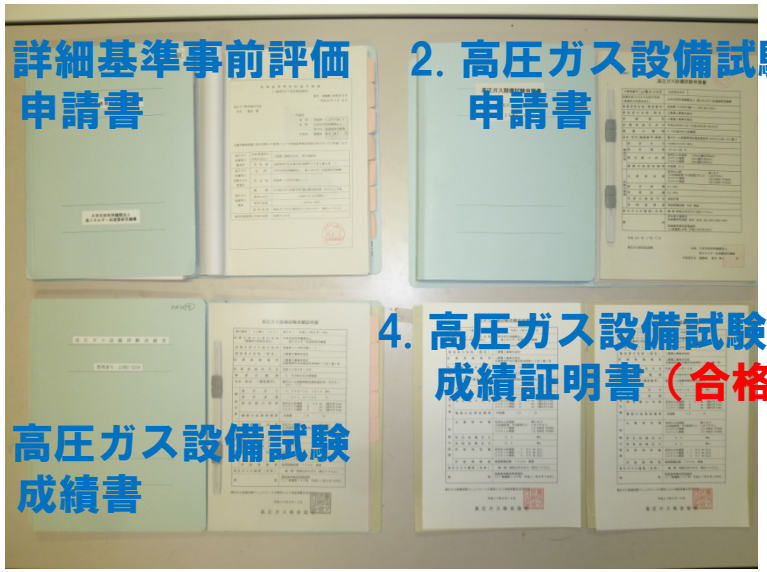


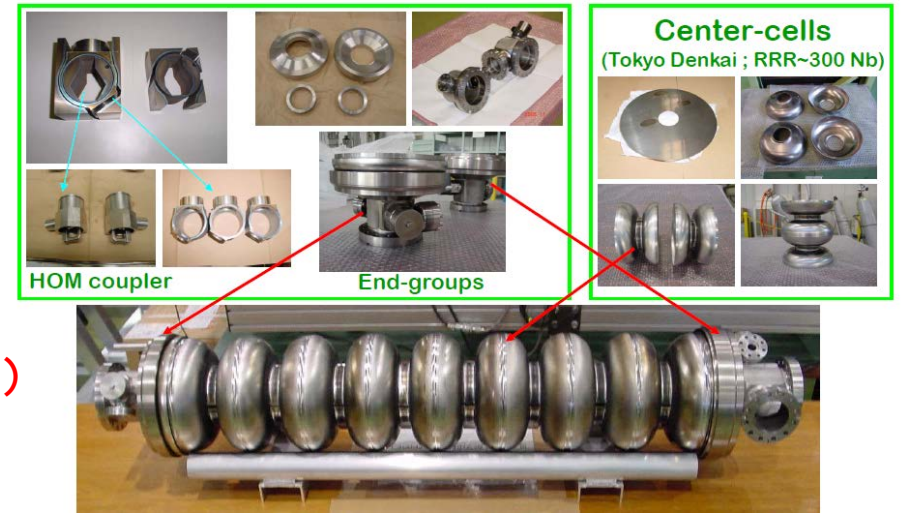

VT with T-map


Inspection of inner surface


Local Grinding

一般高圧ガス設備対応超伝導空洞



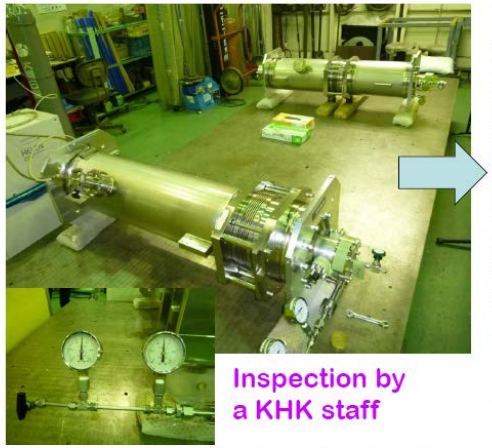


Nb Cavity
at 1.5 times of design pressure
(test with water : 0.3 MPa)

Inspection by
a KHK staff

Vertical test of 9-cell cavity

Cavity unit with Jacket
at 1.25 times of design pressure
(test with He gas : 0.25 MPa)

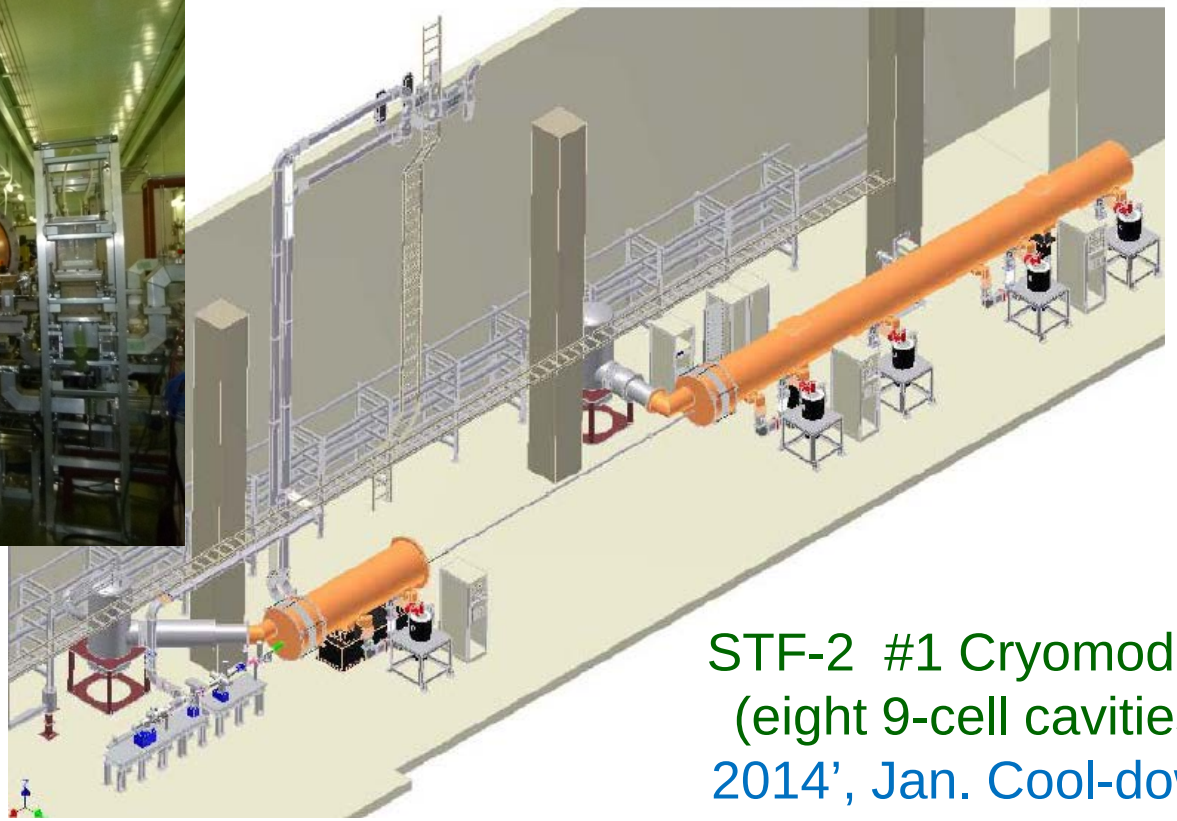


Inspection by
a KHK staff

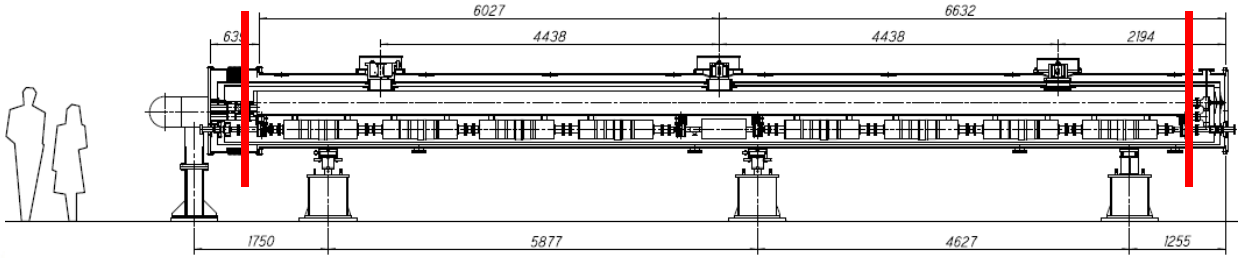
Cavity string assembly

STF-2 計画@KEK

Capture Cryomodule
(two 9-cell cavities)
2012', Feb. Cool-down

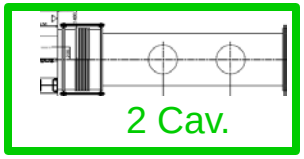


STF-2 #1 Cryomodule
(eight 9-cell cavities)
2014', Jan. Cool-down



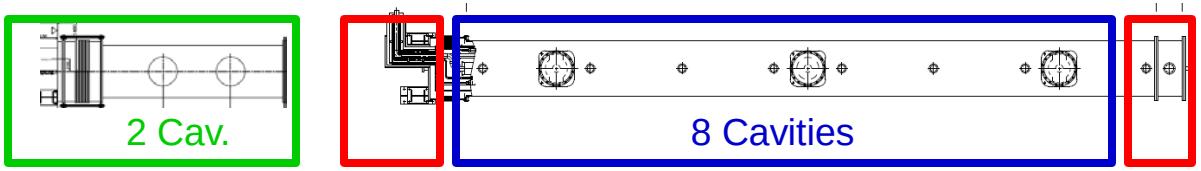
STF-2 計画@KEK

1. Capture Cryomodule (2)



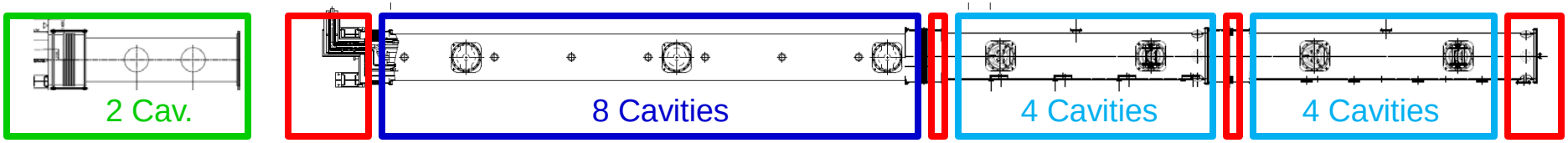
2012', Feb. Cool-down
(for Quantum-Beam Experiments)

2. Capture Cryomodule (2) + STF-2 #1 Cryomodule (8)



2014', Jan. Cool-down
(#1; for long cryomodule performance)

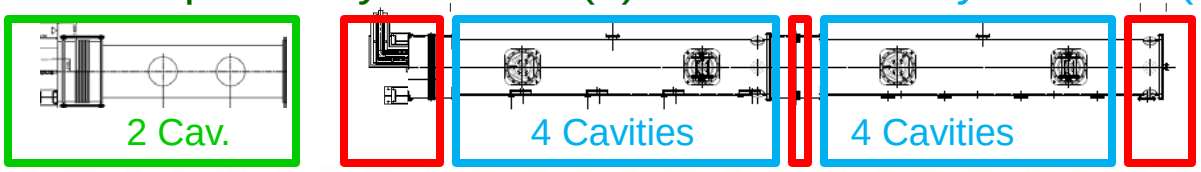
3-a. Capture Cryomodule (2) + STF-2 #1 Cryomodule (8)
+ STF-2 #2 Cryomodule (4) + #3 Cryomodule (4)



Under Discussion !!

(2015', Jan. Cool-down)

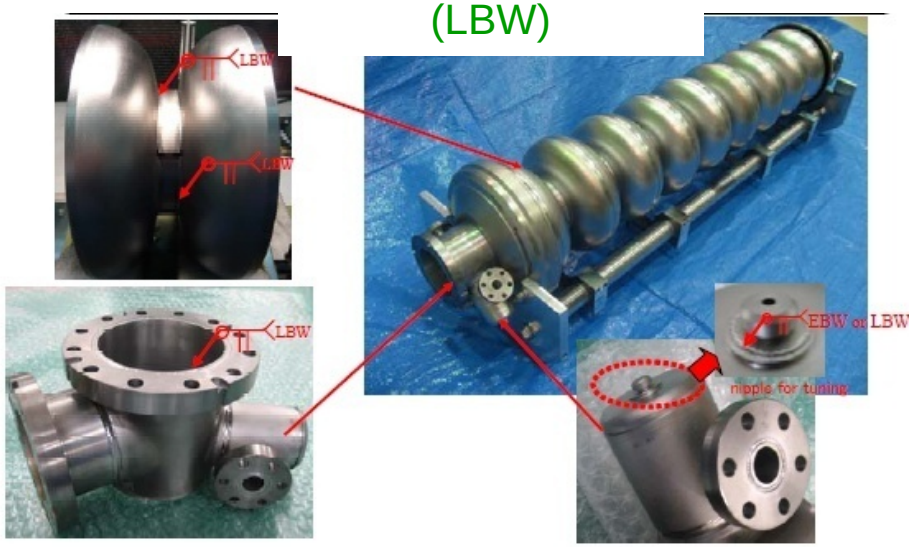
3-b. Capture Cryomodule (2) + STF-2 #2 Cryomodule (4) + #3 Cryomodule (4)



(#2 ; for cost reduction)
(#3 ; for R & D)

超伝導空洞の開発@三菱重工業

MHI-A 9-cell cavity
(LBW)

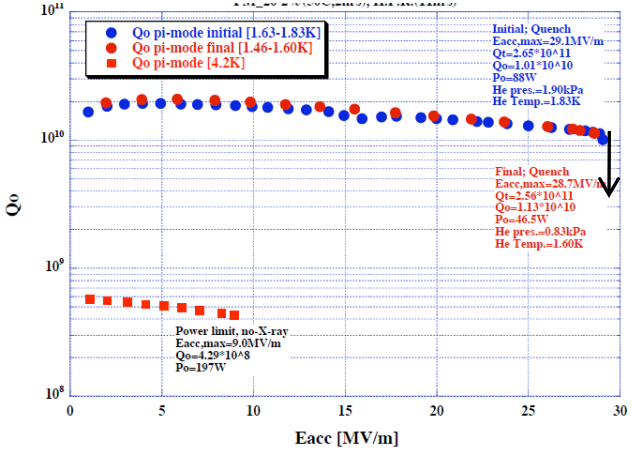


MHI-B 2-cell cavity
(seamless dumbbell)

MITSUBISHI HEAVY INDUSTRIES, LTD.
Our Technologies, Your Tomorrow

by K. Sennyu (MHI)

500 MHz cavity
(KEKB-Type)



Quench at
28.7 MV/m

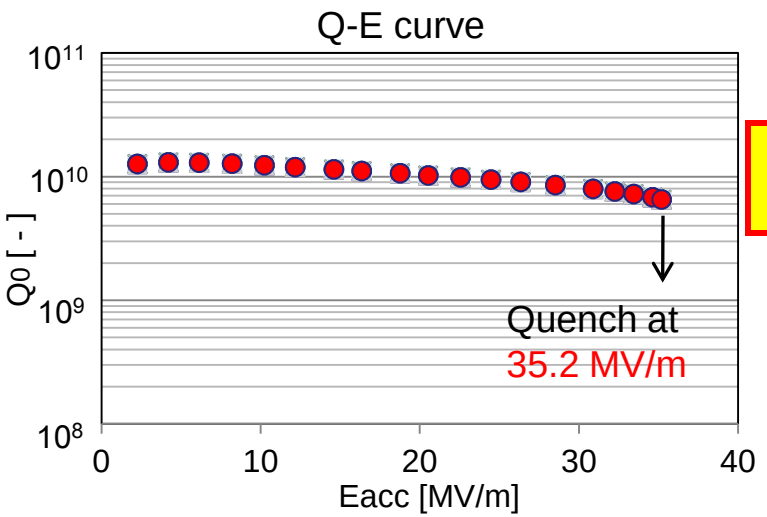
by new EBW
- MHI-B
  1 set
- 500 MHz cavity
  3 sets

Under adjustment of EBW parameters for ILC/STF cavity.

超伝導空洞の開発@日立製作所

HITACHI
Inspire the Next

Completed HIT-01 cavity
(no HOM couplers)



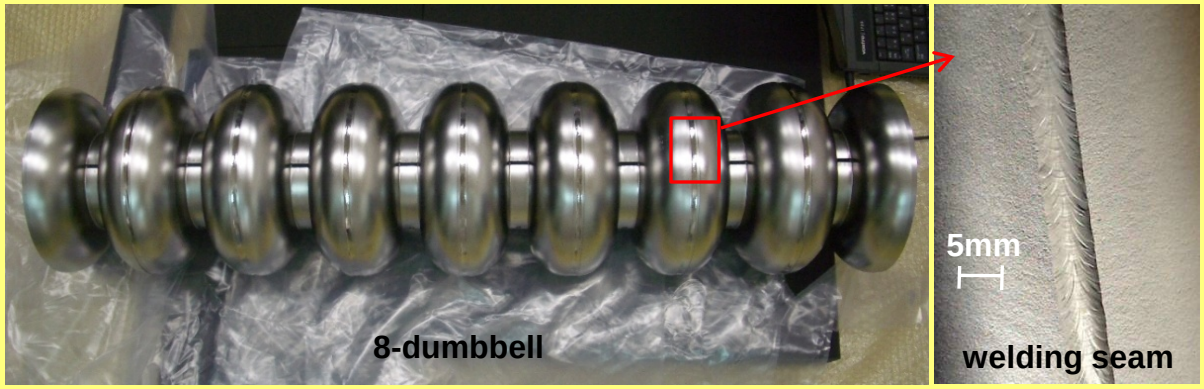
HITACHI
Inspire the Next

by T. Watanuki
(Hitachi)

Current status of HIT-02 cavity with HOM couplers

(1st VT in Apr. 2012')

Completed center cells



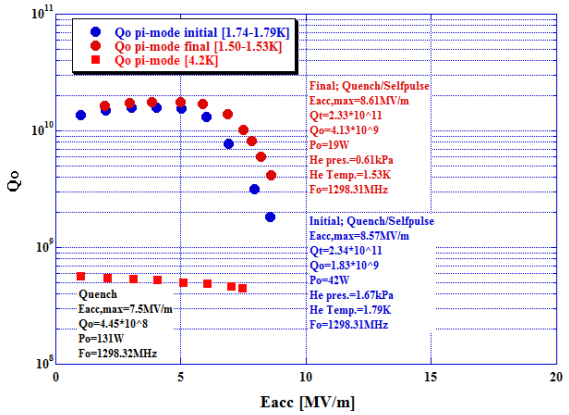
HOM coupler

超伝導空洞の開発@東芝

First 9-cell cavity fabrication (TOS-01 cavity)

(no HOM couplers)

Process optimization



Vertical test results (First 9-cell cavity)

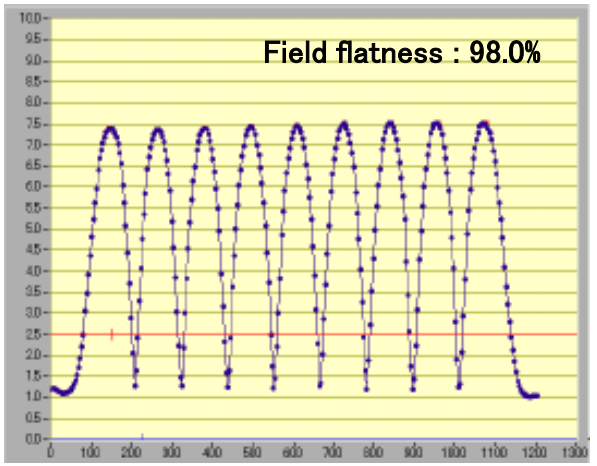
Second 9-cell cavity fabrication (TOS-02 cavity)

TOSHIBA Leading Innovation

by T. Ohta (Toshiba)

(no HOM couplers)

Electro polish (100μm removal)



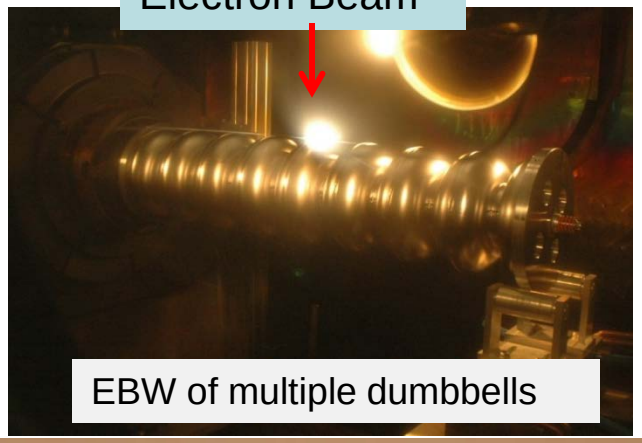
Field distribution after Pre-tuning

Now, in preparation of vertical test. (1st VT in Jan. 2012')

超伝導空洞の開発@高エネ研

EB Welding of center-cells at job-shop

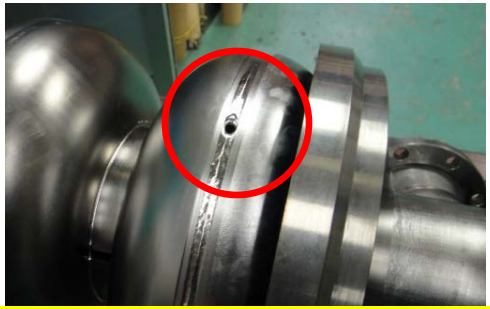
Electron Beam



EBW of multiple dumbbells

by T. Saeki (KEK)

KEK

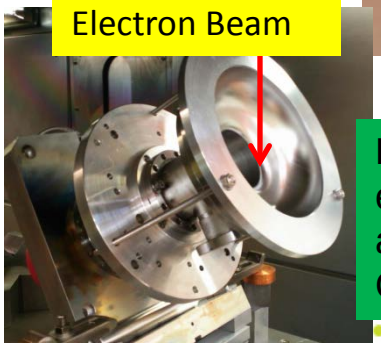


EBW failure (a hole at end-cell)

Dumb-bell (Nb)

Training for repairing a hole.

Electron Beam



EBW of end-group at CFF/KEK

EBW assembly of center-cells at Job-shop.
EBW assembly of end-groups at CFF/KEK.

Fabrication of KEK-00 cavity

(1st VT in Mar. 2012')

End-group

今後の展望とまとめ

◆　高加速電界の達成率は着実に向上しているが、現実的な到達値としては >80% @ Eacc>30MV/m が妥当と思われる。ある確率で製作される20MV/m以下で制限される空洞への対応が必要。

◆　クライオモジュールでの運転加速電界の低下の原因理解については、今後数十台規模のクライオモジュールの建設＆試験、長期間が必要。現存する8空洞内蔵クライオモジュールは、DESY(8), FNAL(2), KEK(0) 。

◆　クライオモジュールでのビーム加速試験のためには、超伝導空洞の高圧ガス対応が必須であり、空洞開発には段階的な長期戦略が必要。

Acknowledgements

Special thanks go to

H. Umezawa (Tokyo-Denkai),
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T. Senba, M. Watanabe and T. Watanuki (Hitachi),
H. Hayano, S. Noguchi, T. Saeki, M. Satoh,
T. Shishido, K. Watanabe, Y. Yamamoto (KEK)