# R&D in New Cavity Shapes

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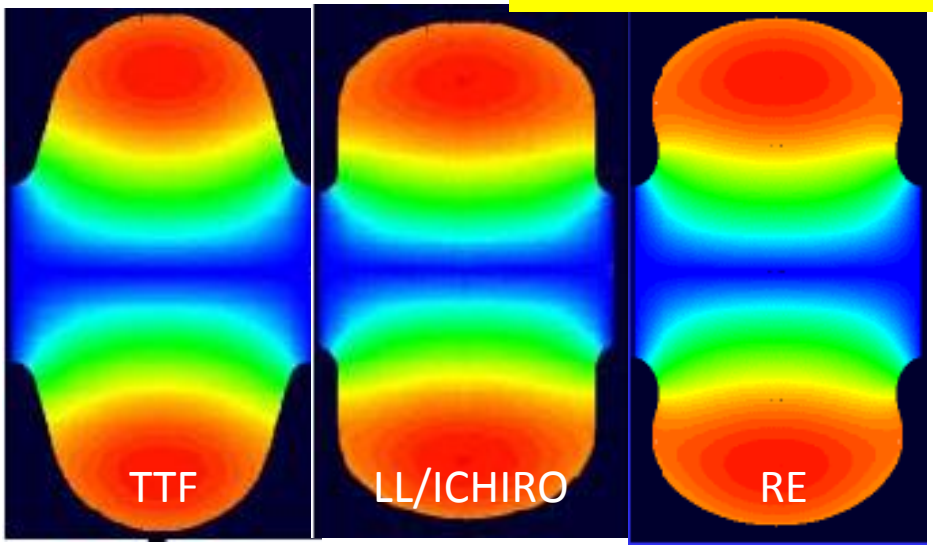
# Introduction

# New cavity shapes for high gradient

## New Cavity Shape with low Hp/Eacc

from J.Sekutowicz lecture Note

$$E_{acc} = \frac{H_{CR}^{RF}}{H_{pk} / E_{acc}}$$




**TTF: TESLA shape**
**Reentrant (RE): Cornell Univ.**
**Low Loss(LL): JLAB/DESY**
**LL/ICHIRO: KEK**

| shape | TTF | LL/ICHIRO | RE |
|---|---|---|---|
| Iris Diameter [mm] | 70 | 60 | 60 |
| Ep/Eacc | 1.98 | 2.36 | 2.28 |
| Hp/Eacc [Oe/MV/m] | 41.5 | 36.1 | 35.4 |
| G*R/Q [$\Omega^2$] | 30840 | 37970 | 41208 |
| Eacc[MV/m] | 42.0 | 48.5 | 49.4 |

# ILC Baseline/Alternative cavity shapes

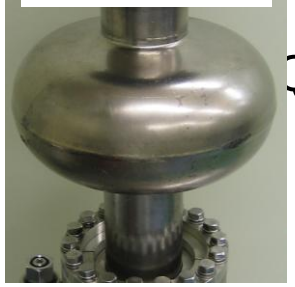
| ILC main linac cavity | | BCD: Baseline | ACD: Alternative |
|---|---|---|---|
| Cavity Shape | | TESLA | Low loss Reentrant |
| Acceptance Performance | Eacc[MV/m] | 35 | 40 |
| | Qo | 0.80E10 | 0.80E10 |
| Operation Performance | Eacc [MV/m] | 31.5 | 36 |
| | Qo | 1.0E10 | 1.0E10 |

# VT results of new shapes

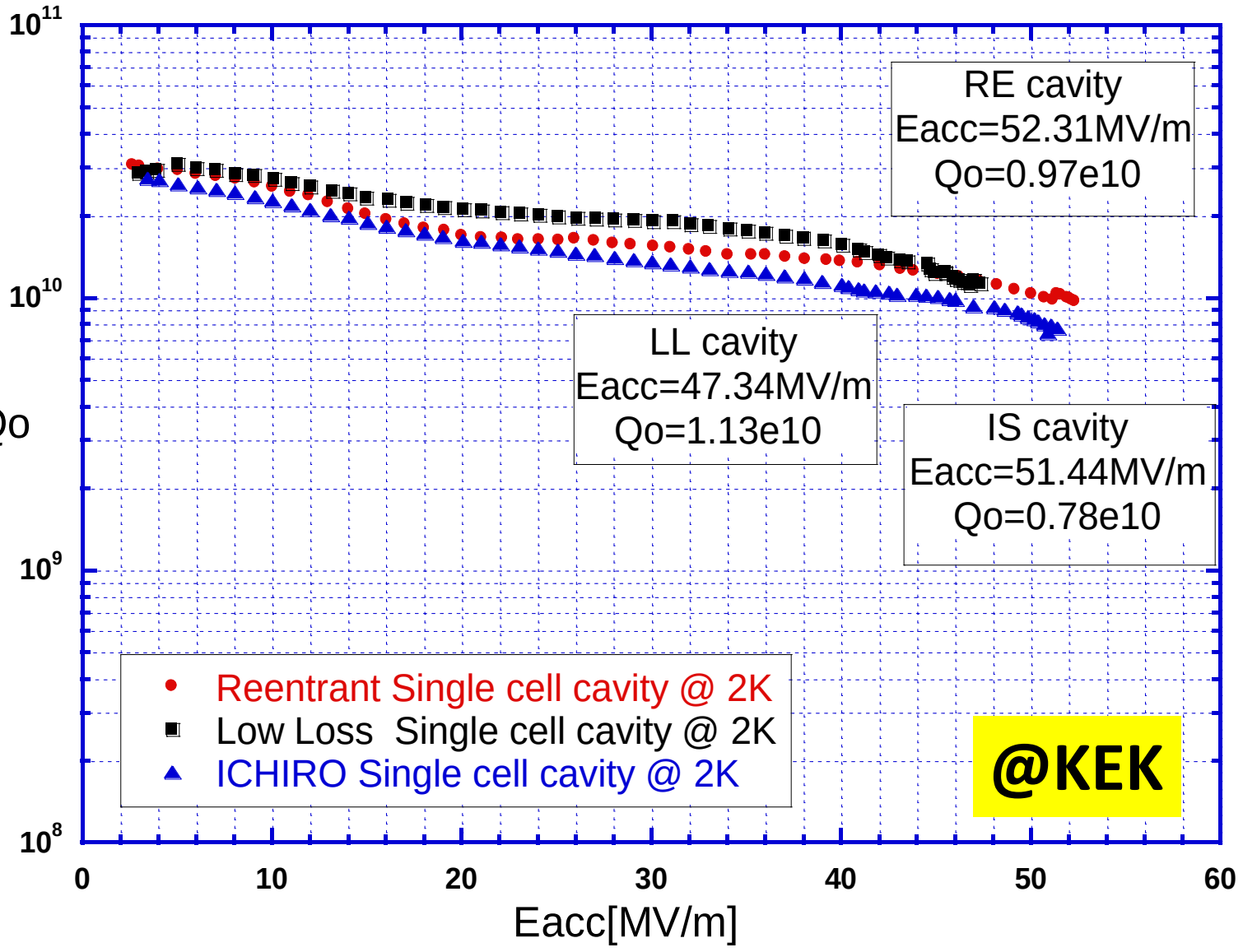
# Proof of high gradient w/ single cells (1)

Reentrant

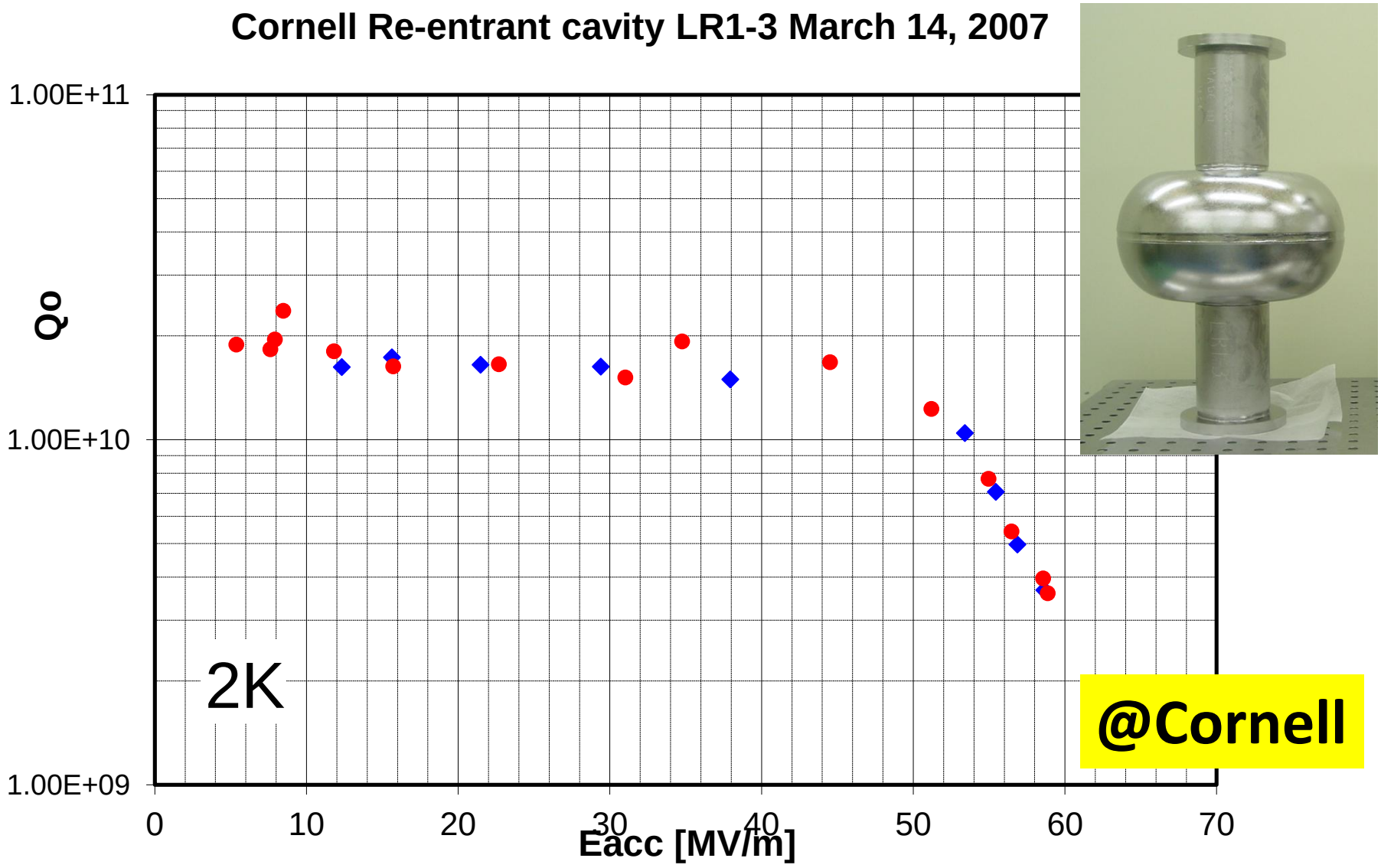
Low Loss



Ichiro Single

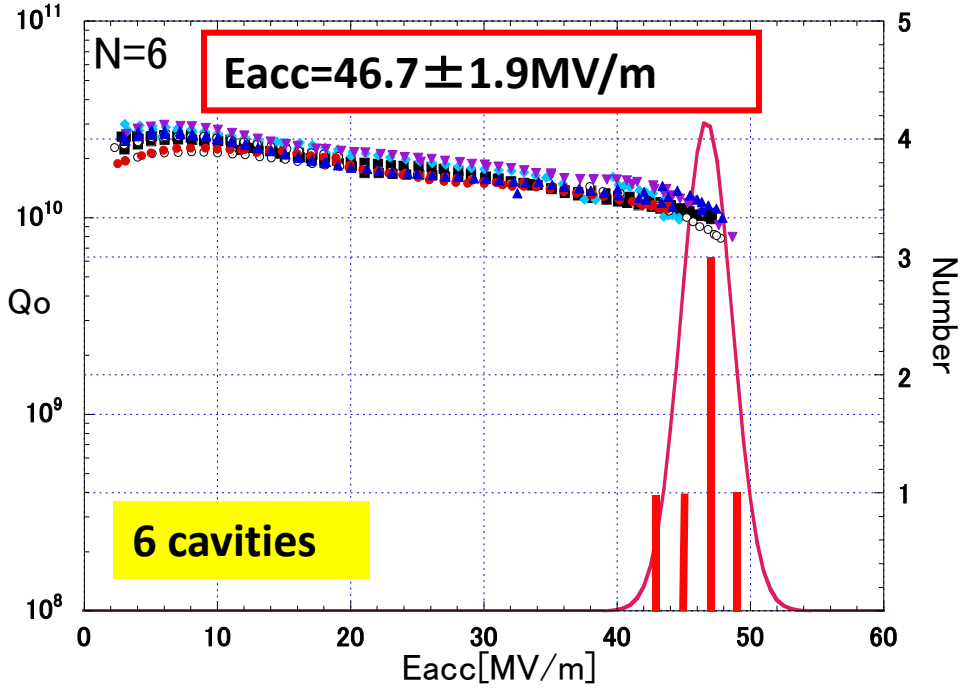


# Proof of high gradient w/ single cells (2)

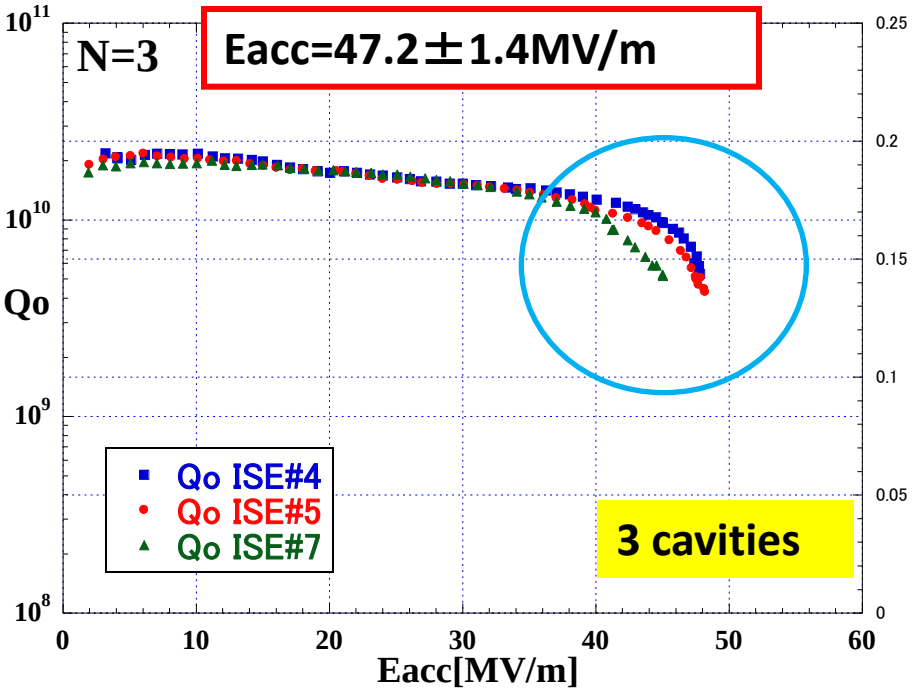


# Statistics for ICHIRO singles

## Center cell single




## Full end group single

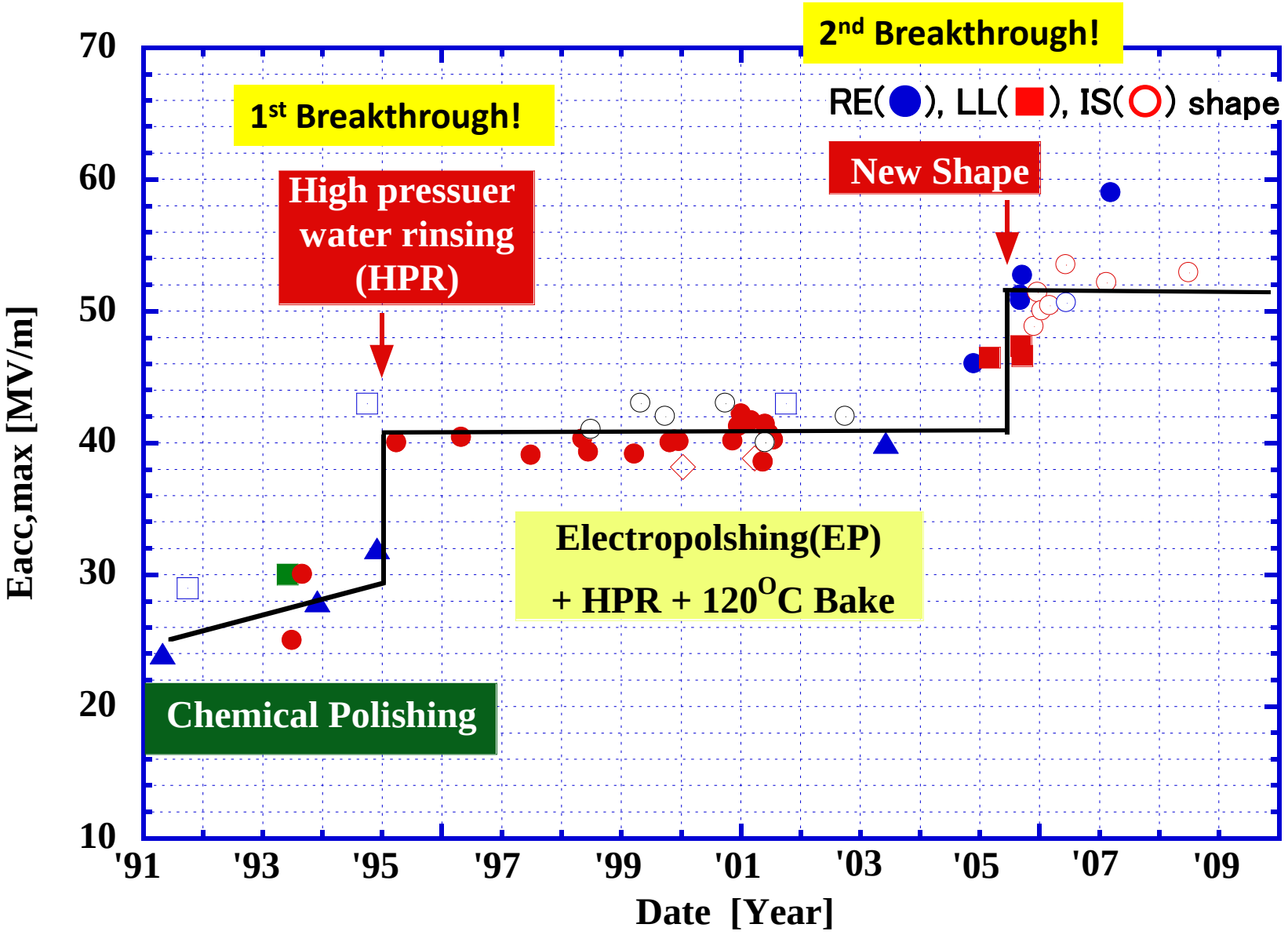



Current best recipe for ICHIRO

CBP+CP+AN+EP(80μm)+EP(20μm)+flash EP(3μm)
+Ethanol rinsing+Wiping+HPR+Bake

Q-slope issue remains.
- ▸R&D for post EP cleaning
- ▸new design, DDC.

# Eacc vs. Year, single cell



# Status of new shape singles

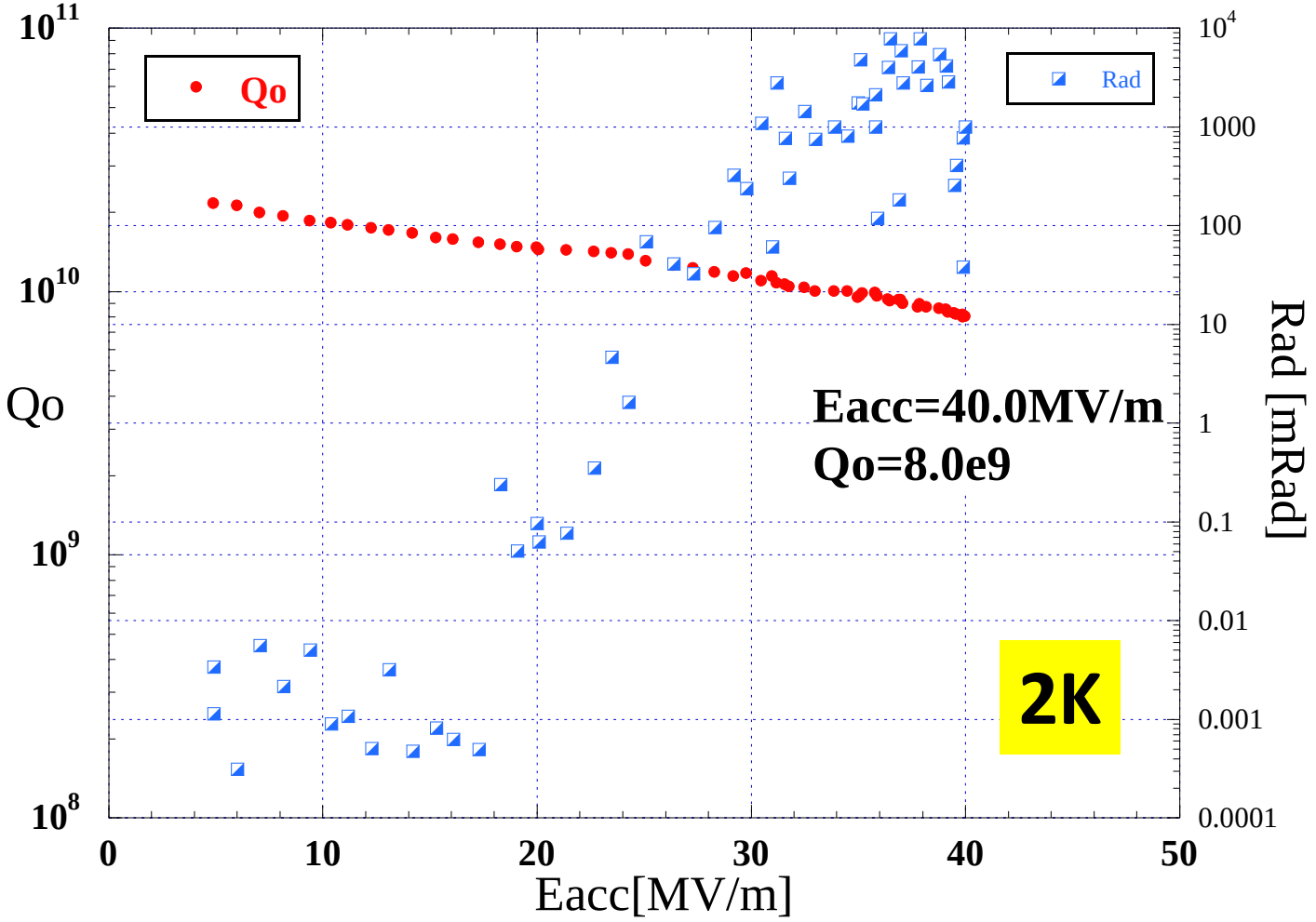
KEK had successfully demonstrated >50MV/m with new shape cavities of Low loss, ICHIRO, and Reentrant.
Cornell had achieved 59MV/m with Reentrant.

These singles were processed by CBP and horizontal EP.

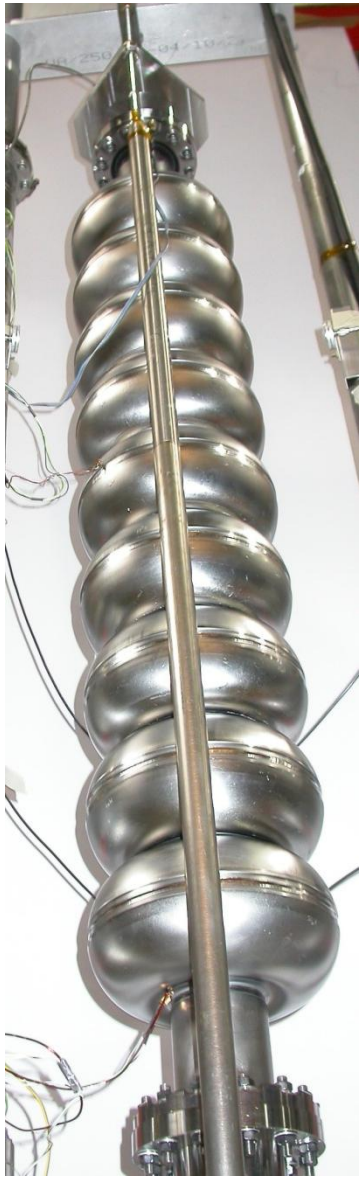
Reentrant cavities were also done by high temp anneal at Cornell before CBP.

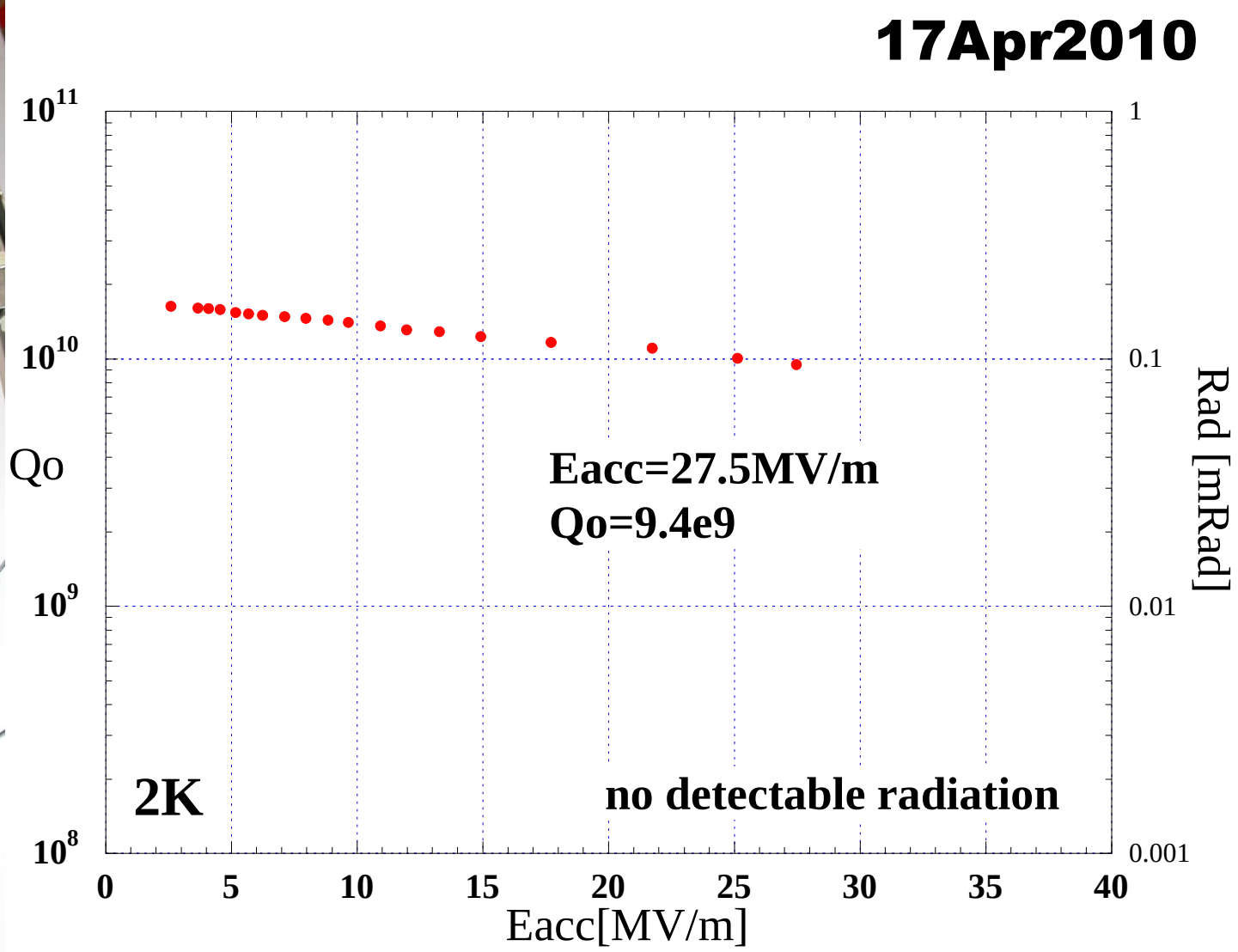
# ICHIRO 9-cell #7 (w/ HOM) at KEK/Jlab

14Dec2010



# Re-entrant 9-cell (no HOM) at Cornell



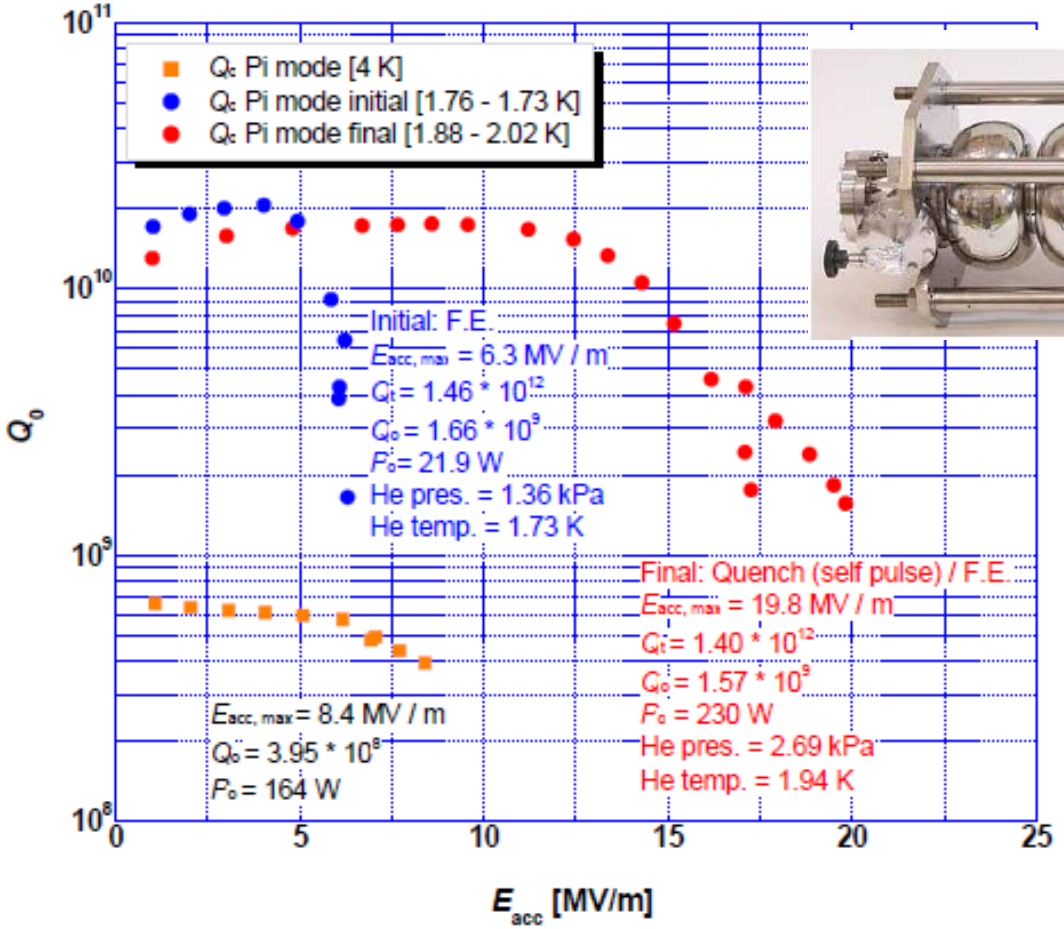


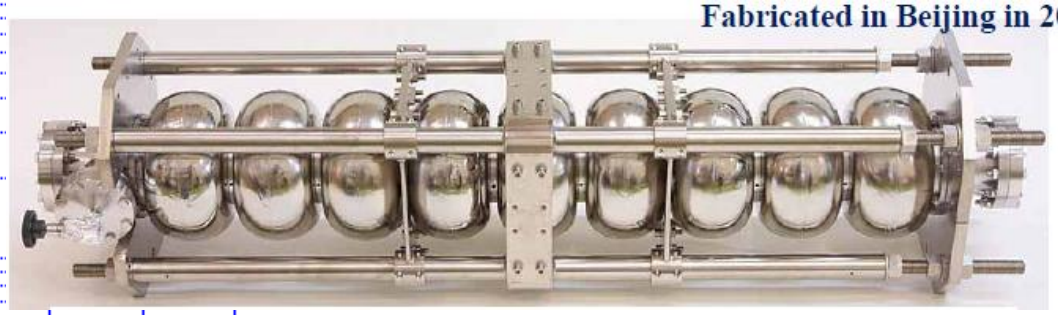
# IHEP-01 LG Low loss 9-cell at IHEP/KEK

**IHEP-01 Large Grain Low Loss 9-cell Cavity (without HOM couplers)**

**1st Vertical Test, July 1, 2010**

CBP (190 μm), BCP (110 μm), Annealing (750°C, 3 h), Pretuning (94 %), Ultrasonic (Micro-90 2%, 50°C, 3 h), BCP (20 μm), Ultrasonic (UPW), Low Pressure Rinsing @ IHEP Ultrasonic (Liquinox 2%, 43°C, 3 h), HPR (8.5 h), Baking (105°C, 48 h), VT @ KEK



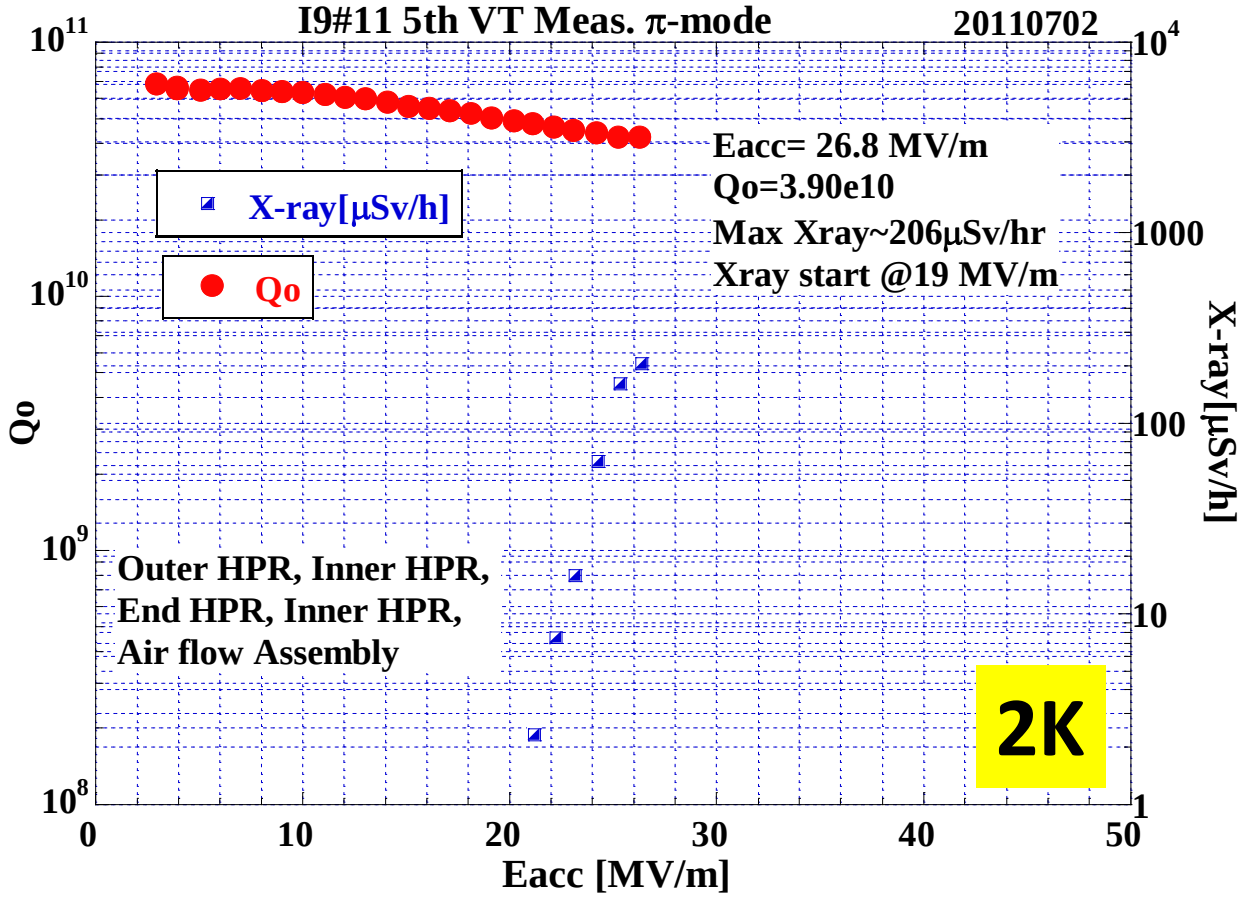



Fabricated in Beijing in 2009

**1Jul2010**

# LG ICHIRO 9-cell #11(w/ HOM) at KEK

**2Jul2011**



# Status of new shape 9-cells

ICHIRO#7 achieved 40MV/m with Qo of 8e9 in collaboration with Jlab and KEK so far.

Reentrant 9-cell achieved 27~30MV/m with vertical EP.

Demonstration of 50MV/m is current top priority for new shape 9-cells.

Large grain LL and ICHIRO cavities are processed and tested. These cavities are processed by BCP, not EP.
So far 20~27MV/m are achieved.

# What are the issues of new shapes?

At the moment, available number of new shape multi cell cavities are very small.
ICHIRO = 3(FG)+2(LG), RE=1(FG),Low loss=1(LG)

So fabrication error like a defect in EBW seam might be big issue. But we have a tool to fix them, like CBP, local grinding, laser re-melting, etc..
It is expectable to improve performance more by them.

Other limitations like FE, Q-slope, quench, etc.. are same with baseline cavities. So feedbacks from them are also important.

# What are the issues of new shapes?

New shape cavities has also another challenges with challenge of 50MV/m.

>ICHIRO #7 + MO seal.

>Reentrant + vertical EP.

>LG Low loss/ICHIRO + BCP.

For 50MV/m with new shapes,
it is better to separate additional challenges and use most reliable ways.

# Future plan

ICHIRO activities at Jlab will continue.
ICHIRO#7 and another LG ICHIRO 9-cell are planed to be processed and tested at Jlab in future.

Cornell has a plan to try horizontal EP on Reentrant 9-cell.
Cornell also has 3-cell Reentrant cavity. This cavity will be also processed and tested as a step of multi cell.

# R&D plan of Cornell SRF group after 2012

1) New shapes for high voltage cavities.
   *we are involved in reentrant shapes, ICHIRO.

2) OST quench detection and other SRF test techniques.
   *we have been involved in several techniques, e.g. T-maps.

3) Field emission detection.
   *we have started a simulation effort for field emission, dark current, and radiation background.

4) New SRF materials.
   *we are already producing Nb3Sn.

5) Nb/Cu Cavities.
   *already investigating spun cavities from explosion bonded copper on niobium.

6) New production techneques: spinning and/or hydroforming.
   *we are involved in spinning already.

7) Cut-cavity analysis of single cells.
   *we have done much of this, e.g. in Alexander Romanenko's PhD.

# Summary

New shapes have successfully demonstrated high gradient of 50MV/m with single cells.

Demonstration of 50MV/m with multi-cell is top priority for new shapes. So far ICHIRO 9-cell achieved ACD requirement of 40MV/m with Qo of 8.0e9 at VT.

After demonstration of 50MV/m wit multi cell, high yield is also necessary. Feedbacks from baseline cavities are important.

We already have pieces for 50MV/m and high yield. New shapes, reliable vendors, procedures and facilities. 50MV/m with 9-cell will be in hand soon.