ILC WG5-Asia Report

WG5 convener: K.Saito

- **Demonstrated high gradient with both Reentrant, Low Loss single cell cavities**

ILC WG5 Asia Strategy and RD Issues

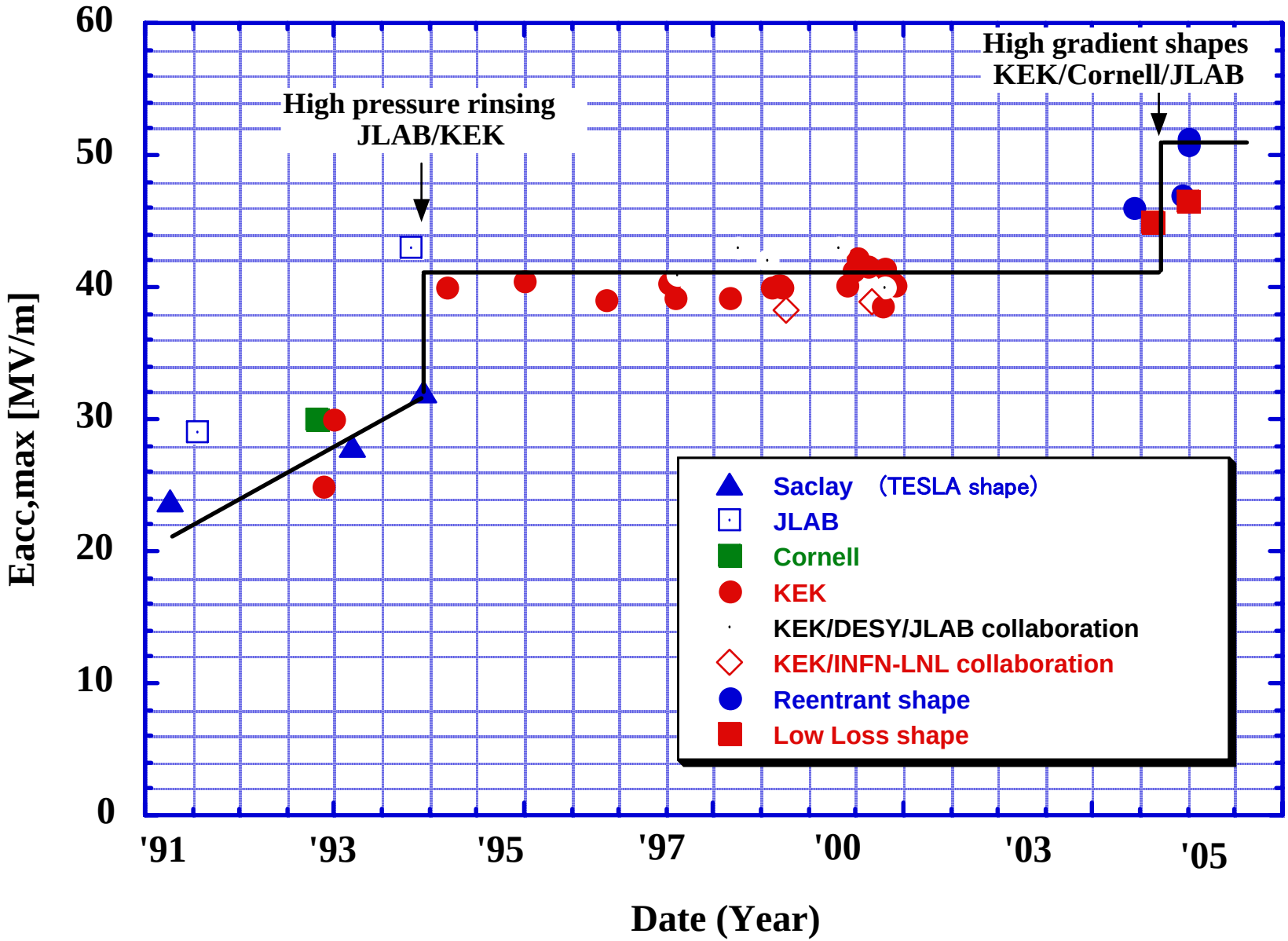
- **Push gradient higher for the future ILC energy reach**
- **Needs enough margin on 35MV/m operation**
- **Cavity operation cost saving by 10% by LL cavity shape**
- **Industrialization : Conventional baseline fabrication and advanced Nb/Cu clad seamless cavity for cost down**

KEK decided to develop the LL shape 9-cell cavity for ILC and demonstrate the high gradient (45MV/m) module operation in STF at least by the TDR/RDR.

Need a wide dynamical range tuner for larger Lorenz detuning
Need a higher power (500kW) input coupler

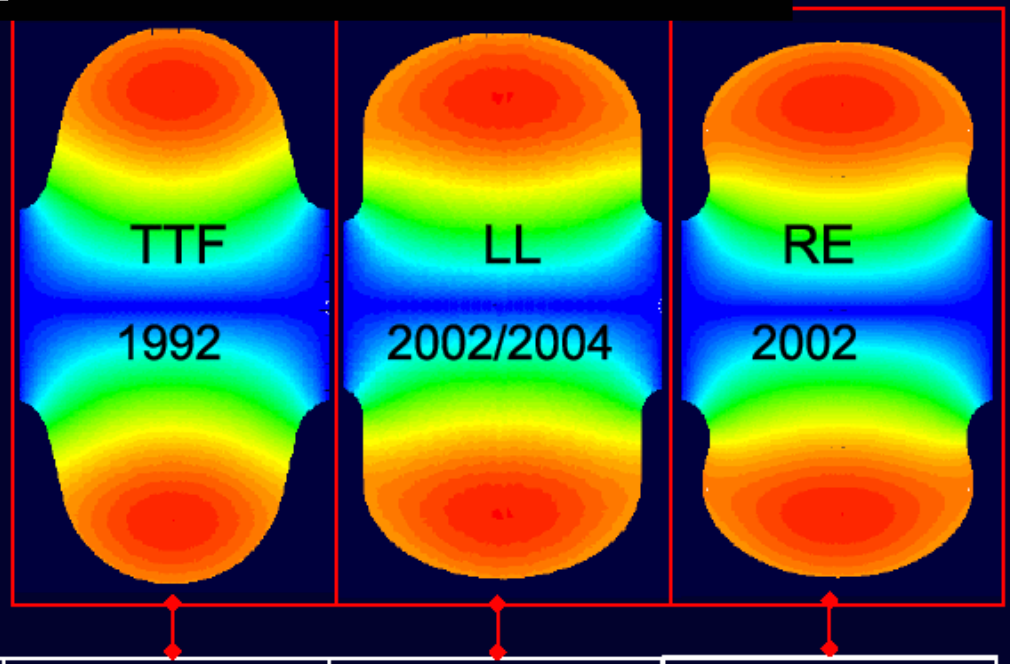
R&D Issues :

1) **45MV/m high gradient cavity**
   → **Demonstrate Eacc > 45MV/m by single cell cavities and 9-cell cavities**
2) **Wide dynamical range tuner system**
3) **500kW high power coupler**
4) **Baseline fabrication, Nb/Cu clad seamless cavity fabrication**


High pressure rinsing
JLAB/KEK
High gradient shapes
KEK/Cornell/JLAB
Saclay (TESLA shape)
JLAB
Cornell
KEK
KEK/DESY/JLAB collaboration
KEK/INFN-LNL collaboration
Reentrant shape
Low Loss shape
Eacc,max [MV/m]
0
10
20
30
40
50
60
'91
'93
'95
'97
'00
'03
'05
Date (Year)

Cavity Design

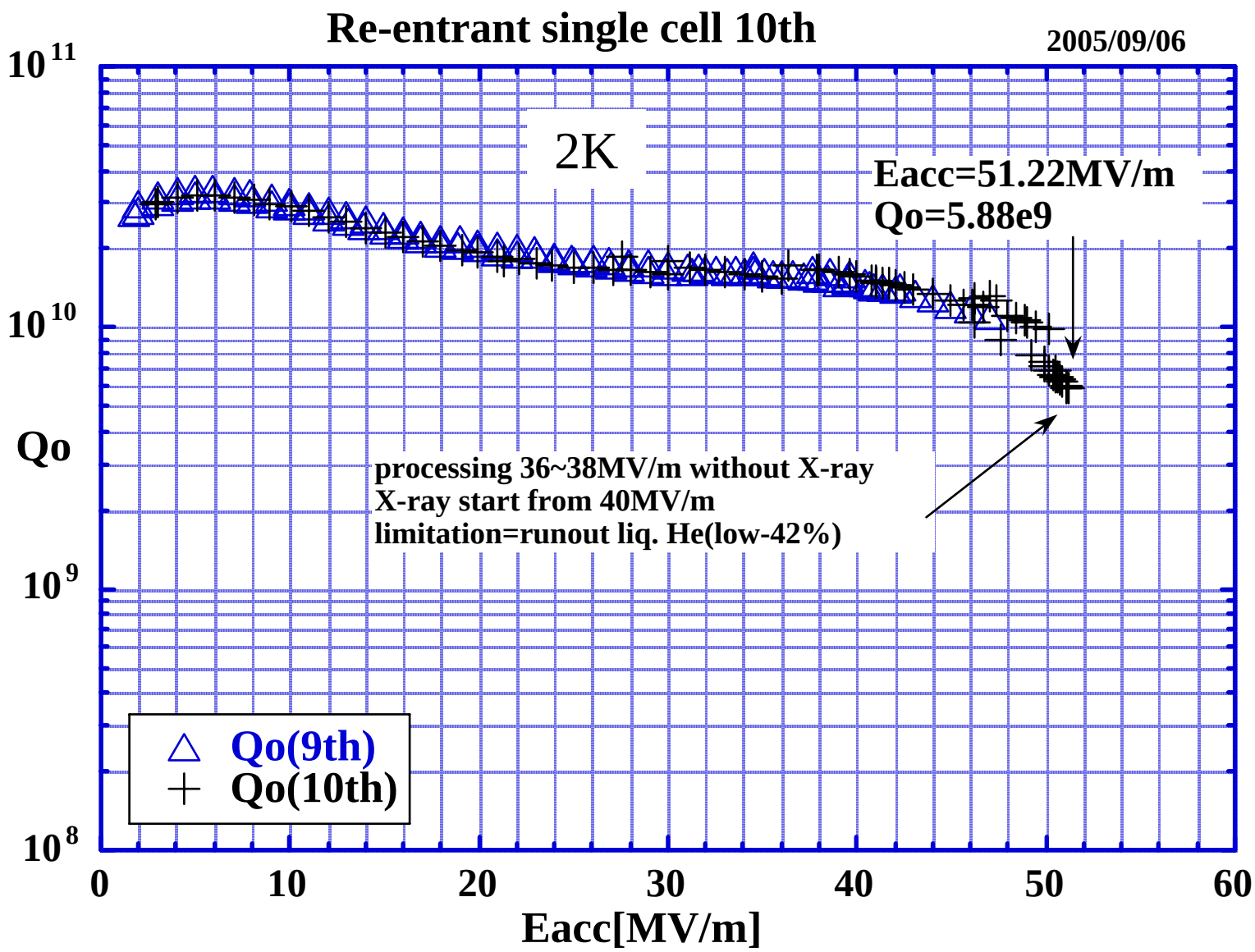
from J.Sekutowicz lectuer Note

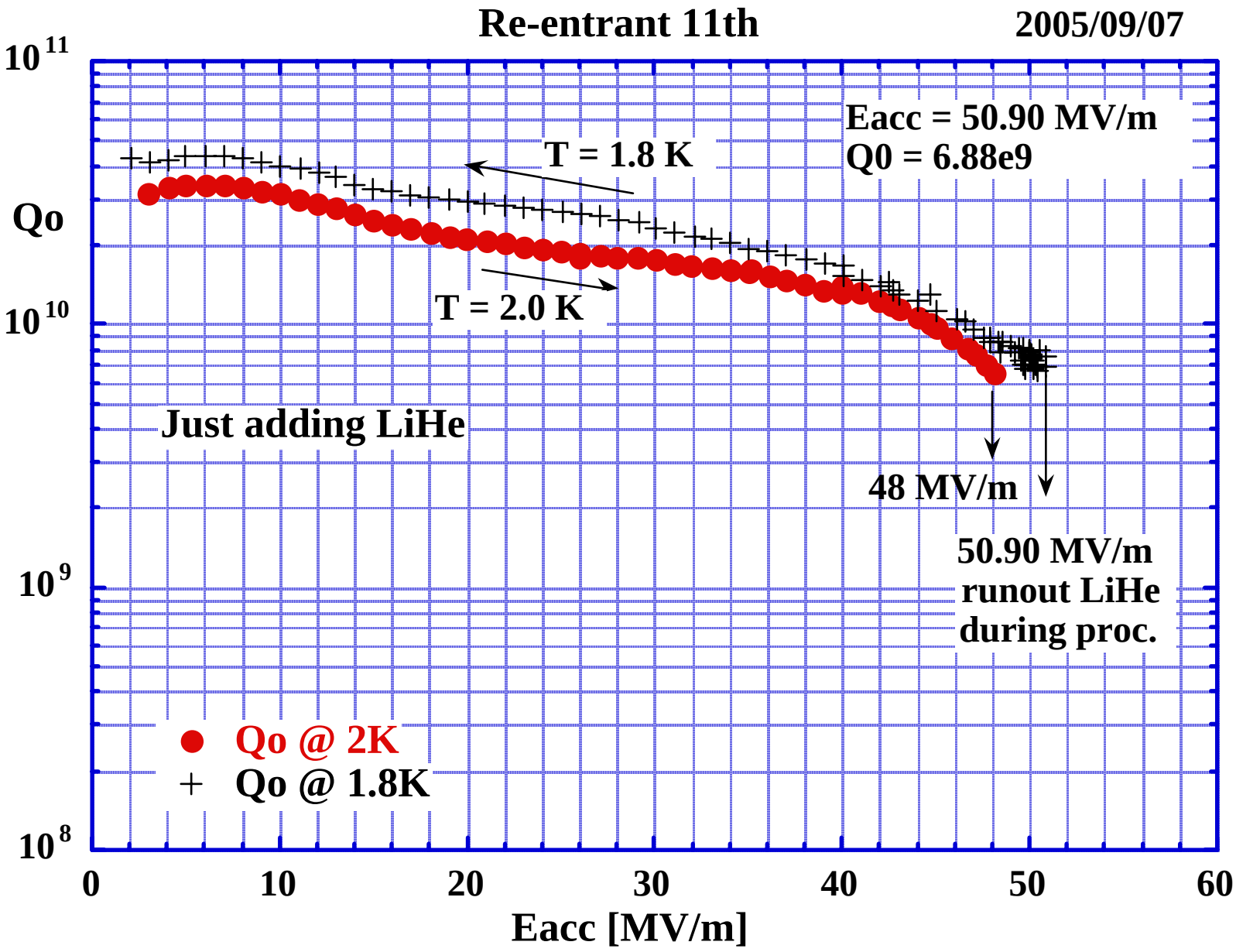


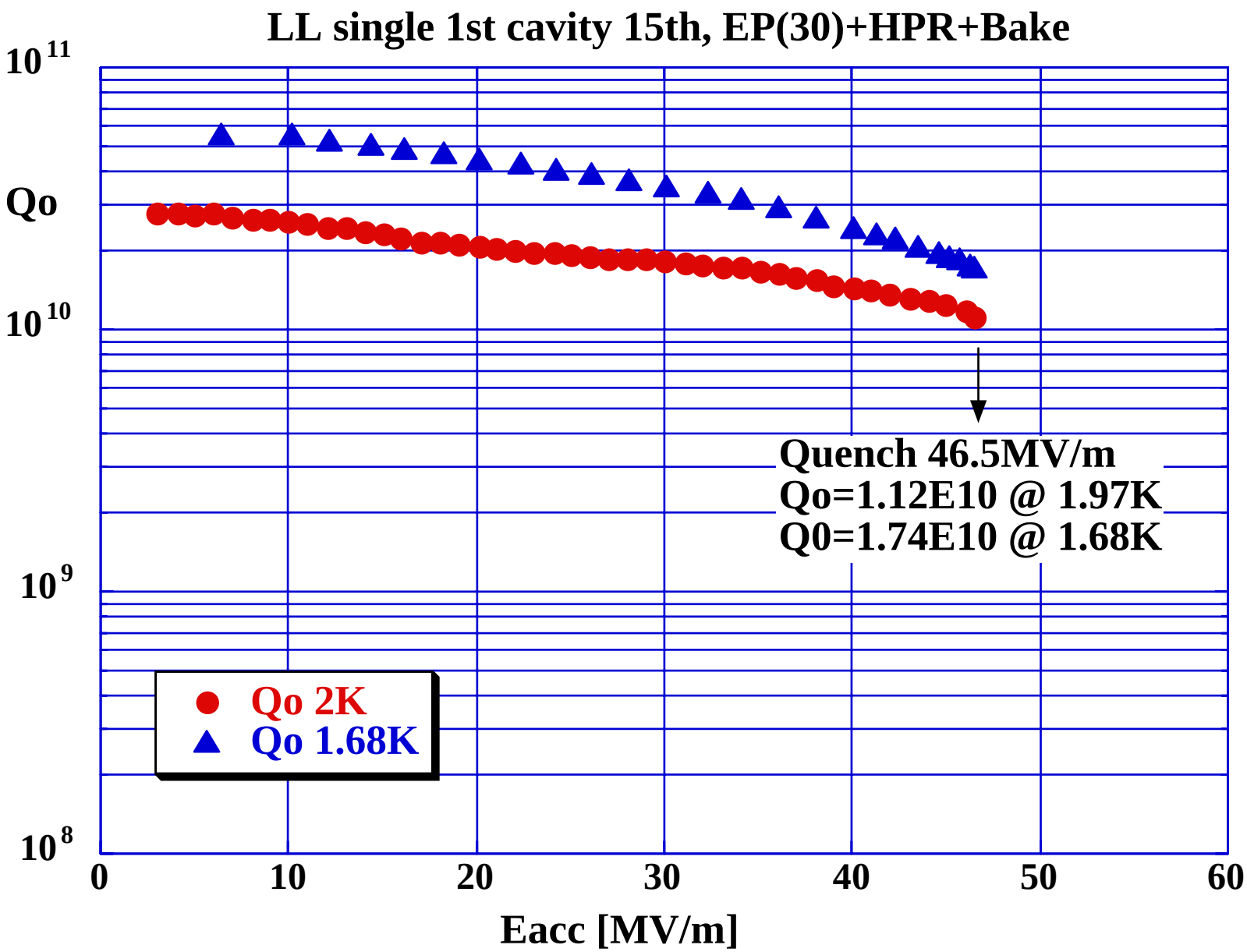
r_{irisb}	[mm]	35	30	33	
k_{cc}	[%]	1.9	1.52	1.8	field flatness
E_{peak}/E_{acc}	-	1.98	2.36	2.21	max gradient (E limit)
B_{peak}/E_{acc}	[mT/(MV/m)]	4.26	3.61	3.76	max gradient (B limit)
R/Q	[Ω]	113.8	133.7	126.8	stored energy
G	[Ω]	271	284	277	dissipation
R/Q*G	[Ω*Ω]	30840	37970	35123	dissipation (Cryo limit)

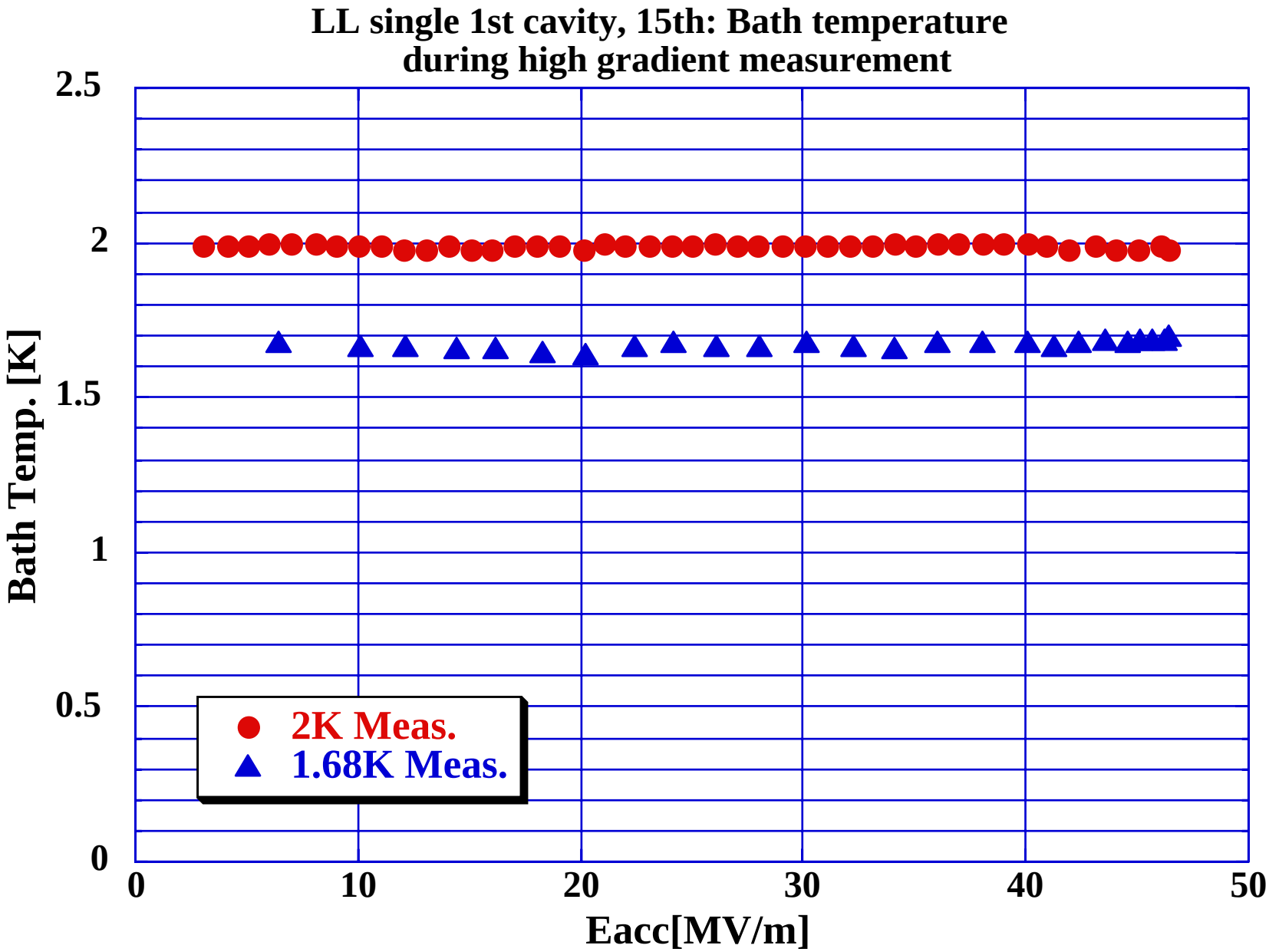
KEK Proposal:

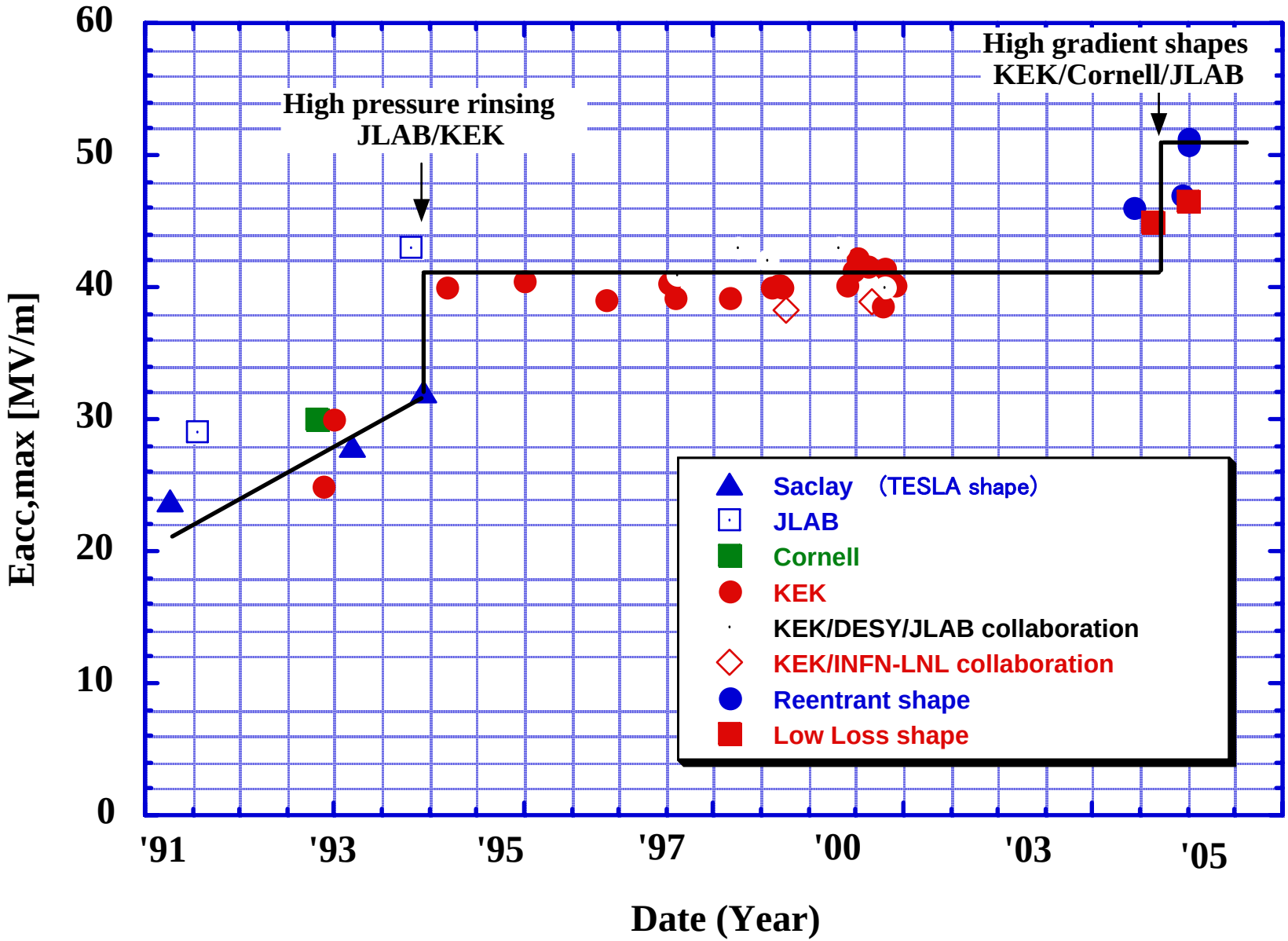
TESLA shape was designed in 1992 optimizing Ep/Eacc against field emission.
Now field emission is not a hard limit by KEK recipe (EP+HPR+Bake process).
Gradient is limited critical magnetic field. Cavity shape has to be optimized on Hp/Eacc and Ep/Eacc for high gradient and high Q.


Re-entrant single cell 10th
2005/09/06
2K
Eacc=51.22MV/m
Qo=5.88e9
processing 36~38MV/m without X-ray
X-ray start from 40MV/m
limitation=runout liq. He(low-42%)
△ Qo(9th)
＋ Qo(10th)
Qo
Eacc[MV/m]
10^11
10^10
10^9
10^8
0
10
20
30
40
50
60


Re-entrant 11th
2005/09/07
Qo
10^{11}
10^{10}
10^{9}
10^{8}
Eacc = 50.90 MV/m
Q0 = 6.88e9
T = 1.8 K
T = 2.0 K
Just adding LiHe
48 MV/m
50.90 MV/m
runout LiHe
during proc.
Qo @ 2K
Qo @ 1.8K
0
10
20
30
40
50
60
Eacc [MV/m]


LL single 1st cavity 15th, EP(30)+HPR+Bake
Qo
10 11
10 10
10 9
10 8
0
10
20
30
40
50
60
Eacc [MV/m]
Quench 46.5MV/m
Qo=1.12E10 @ 1.97K
Q0=1.74E10 @ 1.68K
Qo 2K
Qo 1.68K


LL single 1st cavity, 15th: Bath temperature
during high gradient measurement
Bath Temp. [K]
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
Eacc[MV/m]
2K Meas.
1.68K Meas.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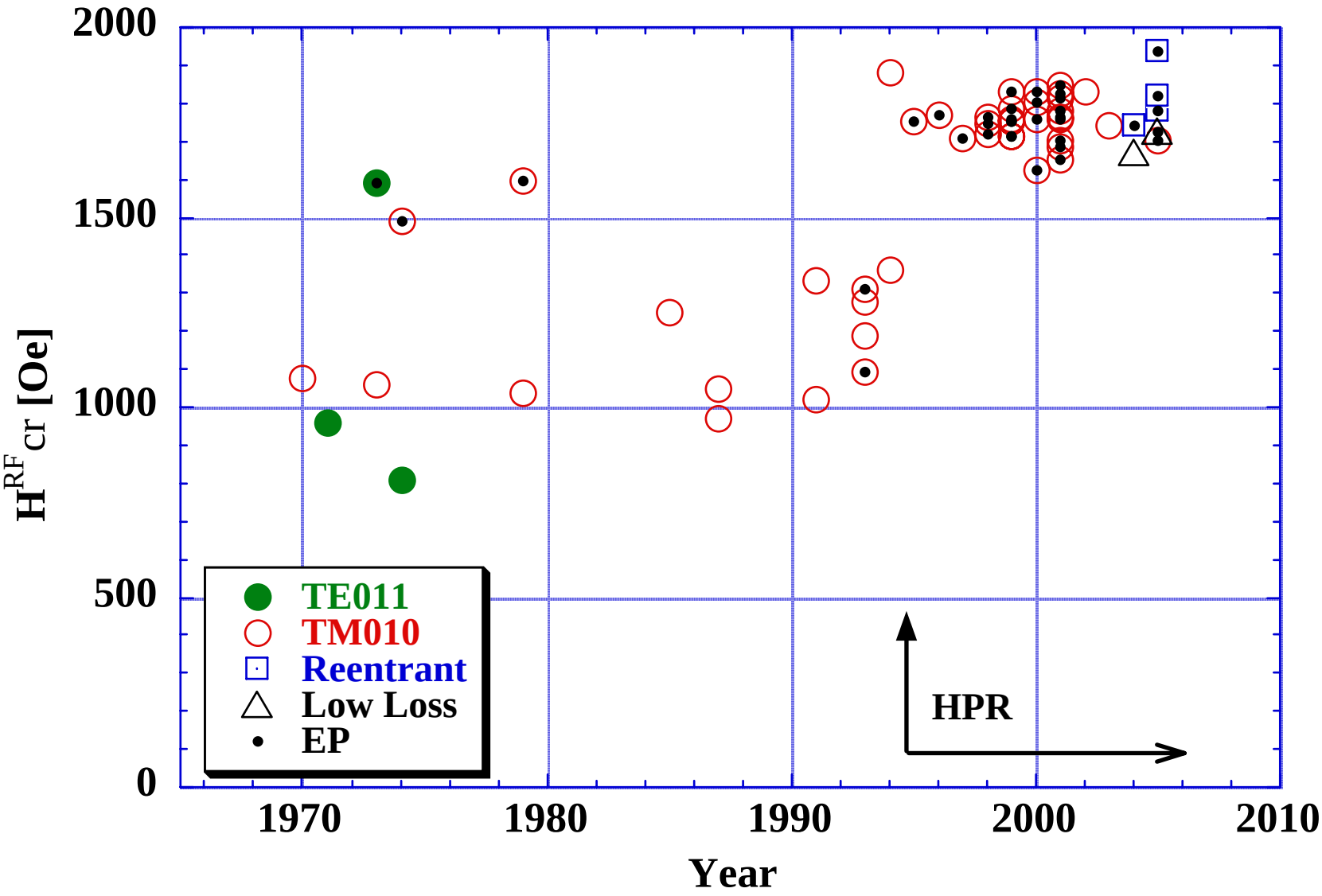
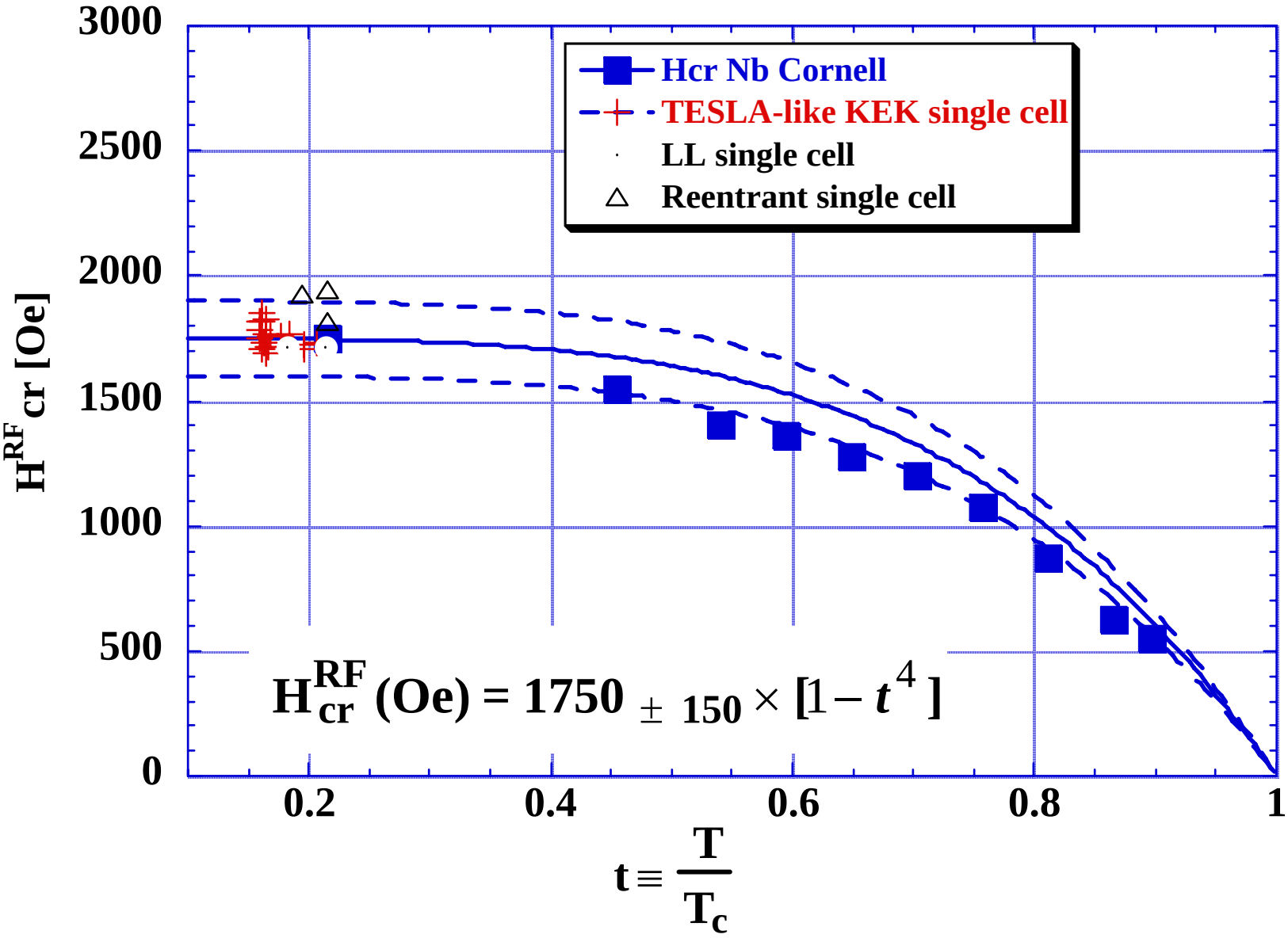
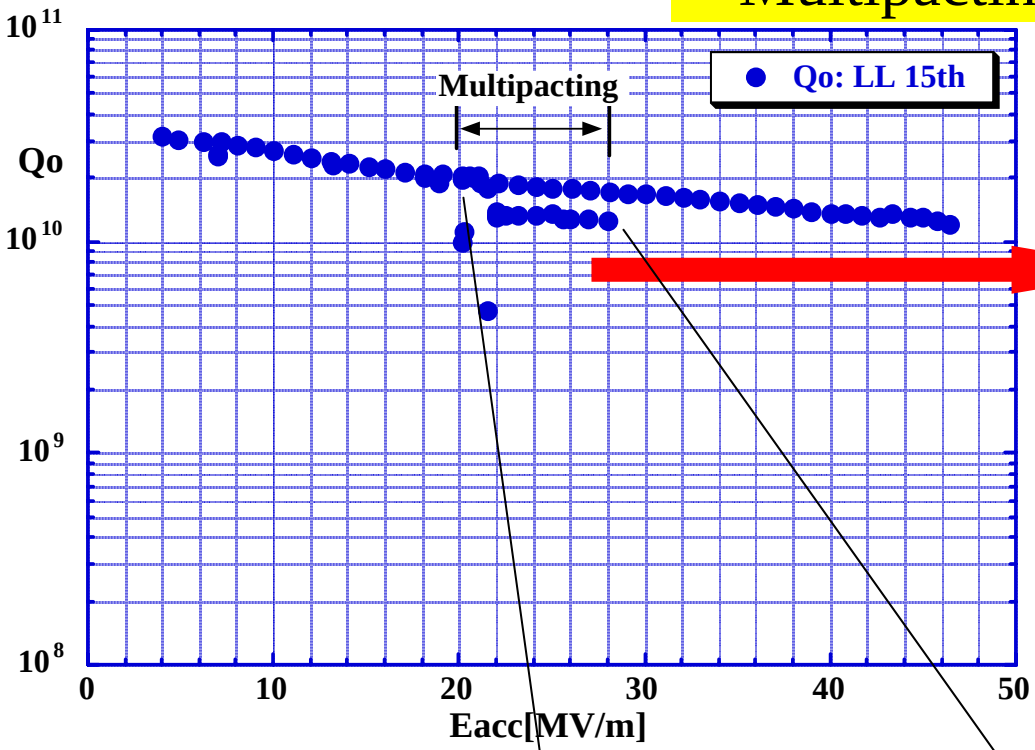
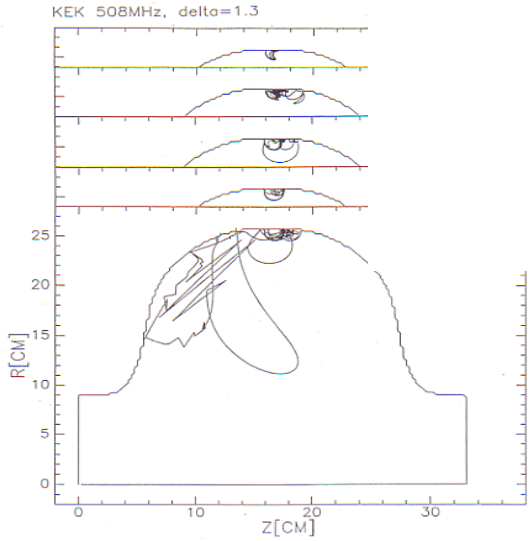

2000
1500
1000
500
0
H^{RF}_{cr} [Oe]
1970
1980
1990
2000
2010
Year
TE011
TM010
Reentrant
Low Loss
EP
HPR


3000
2500
2000
1500
1000
500
0
0.2
0.4
0.6
0.8
1
H^{RF}_{cr} [Oe]
$t \equiv \frac{T}{T_c}$
Hcr Nb Cornell
TESLA-like KEK single cell
LL single cell
Reentrant single cell
$H^{RF}_{cr}(Oe) = 1750 \pm 150 \times [1 - t^4]$

Multipacting

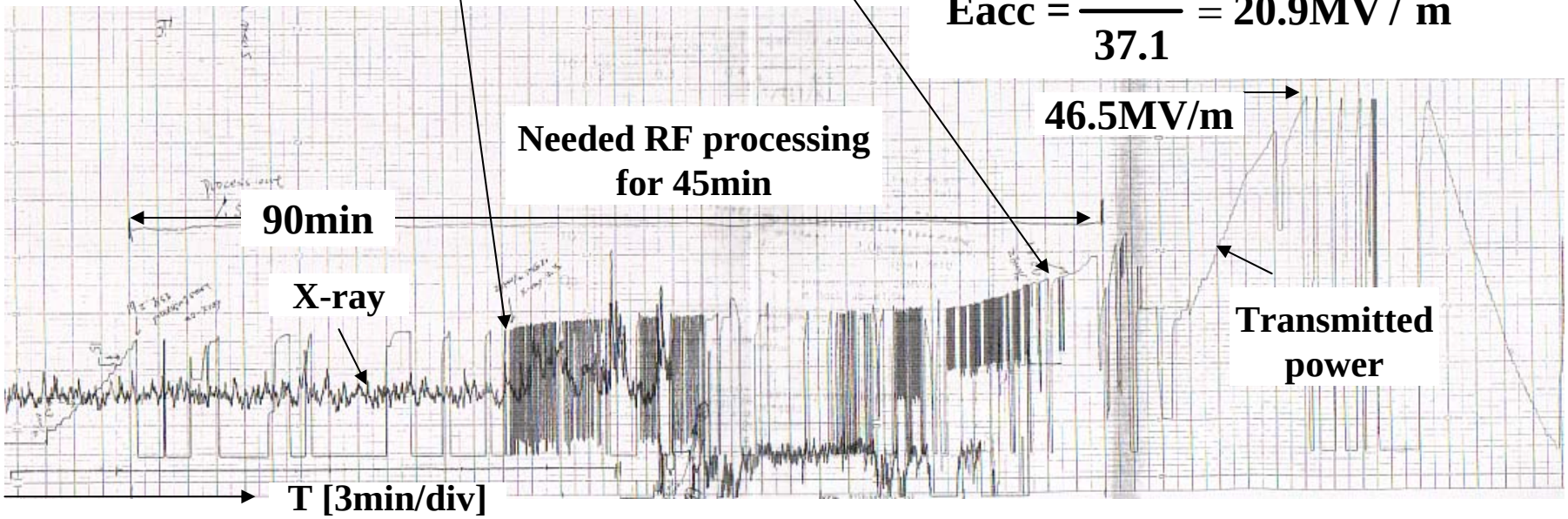




$$\frac{\mathrm{Hp[Oe]}}{\mathrm{f\ [MHz]}} = \frac{0.6}{2n-1}$$ for 2point MP,

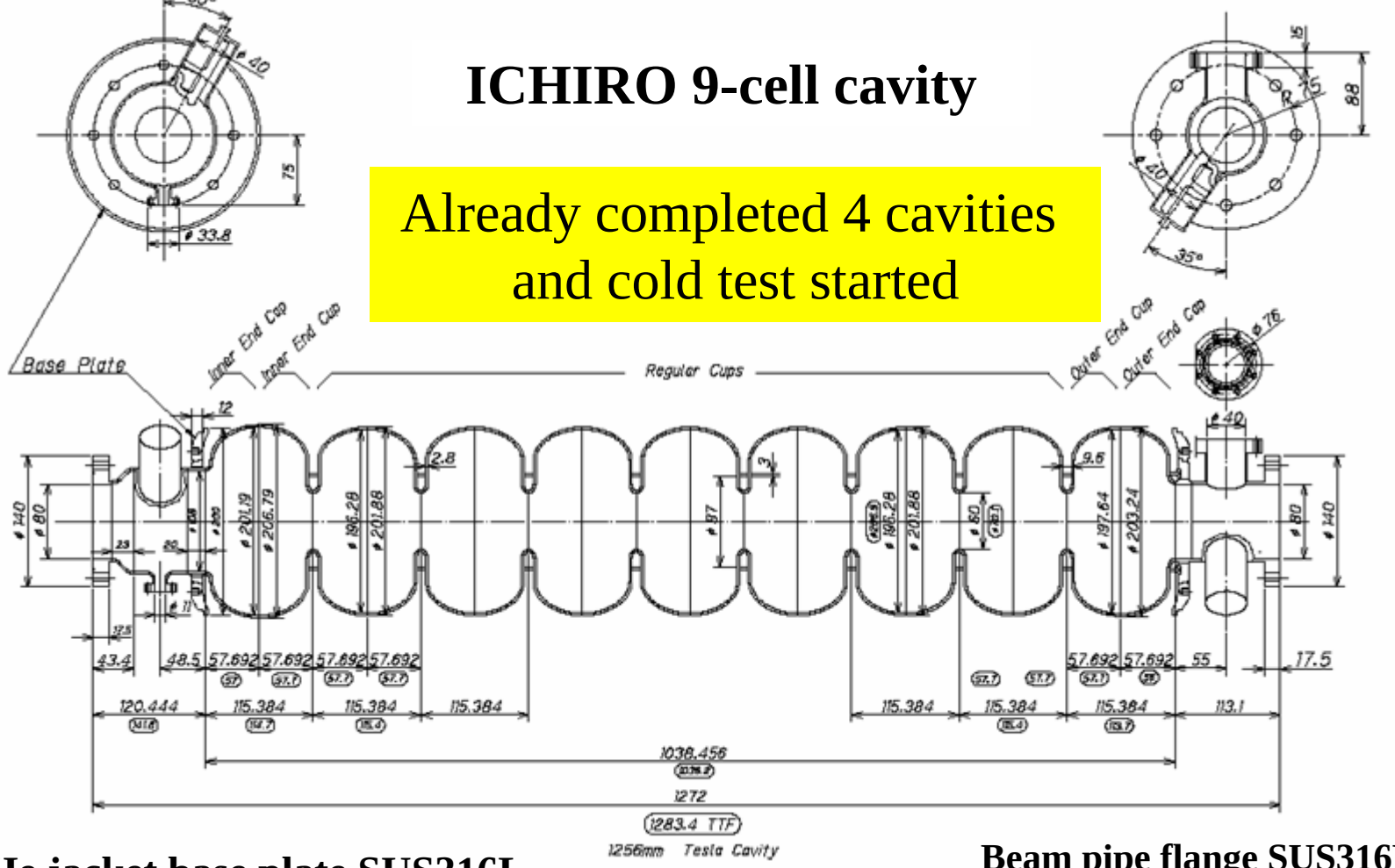
$$\mathrm{Hp} = 1293 \times 0.6 = 775.8\mathrm{Oe}$$

$$\mathrm{Eacc} = \frac{775.8}{37.1} = 20.9\mathrm{MV/m}$$



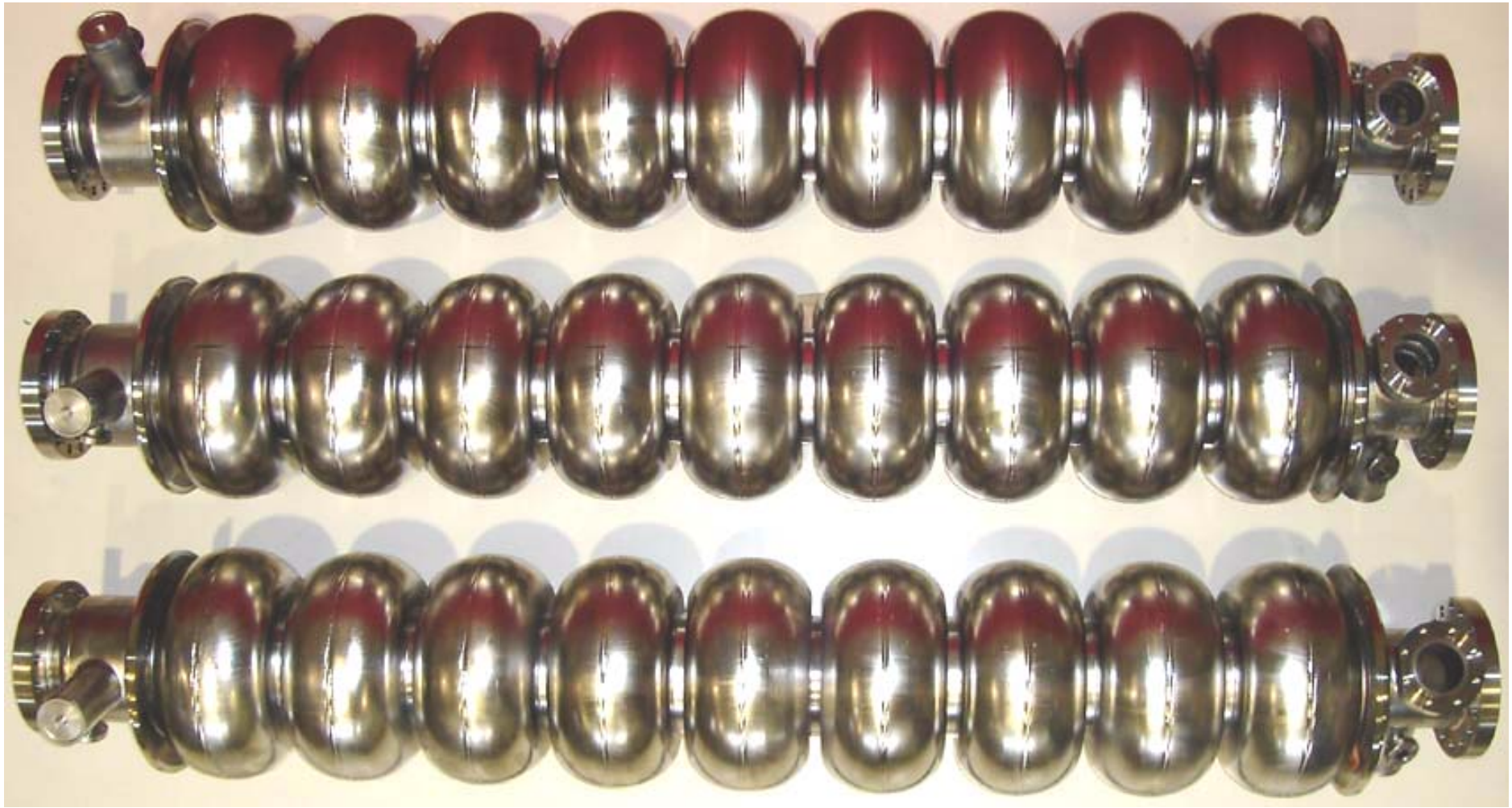
ICHIRO 9-cell cavity

Already completed 4 cavities
and cold test started

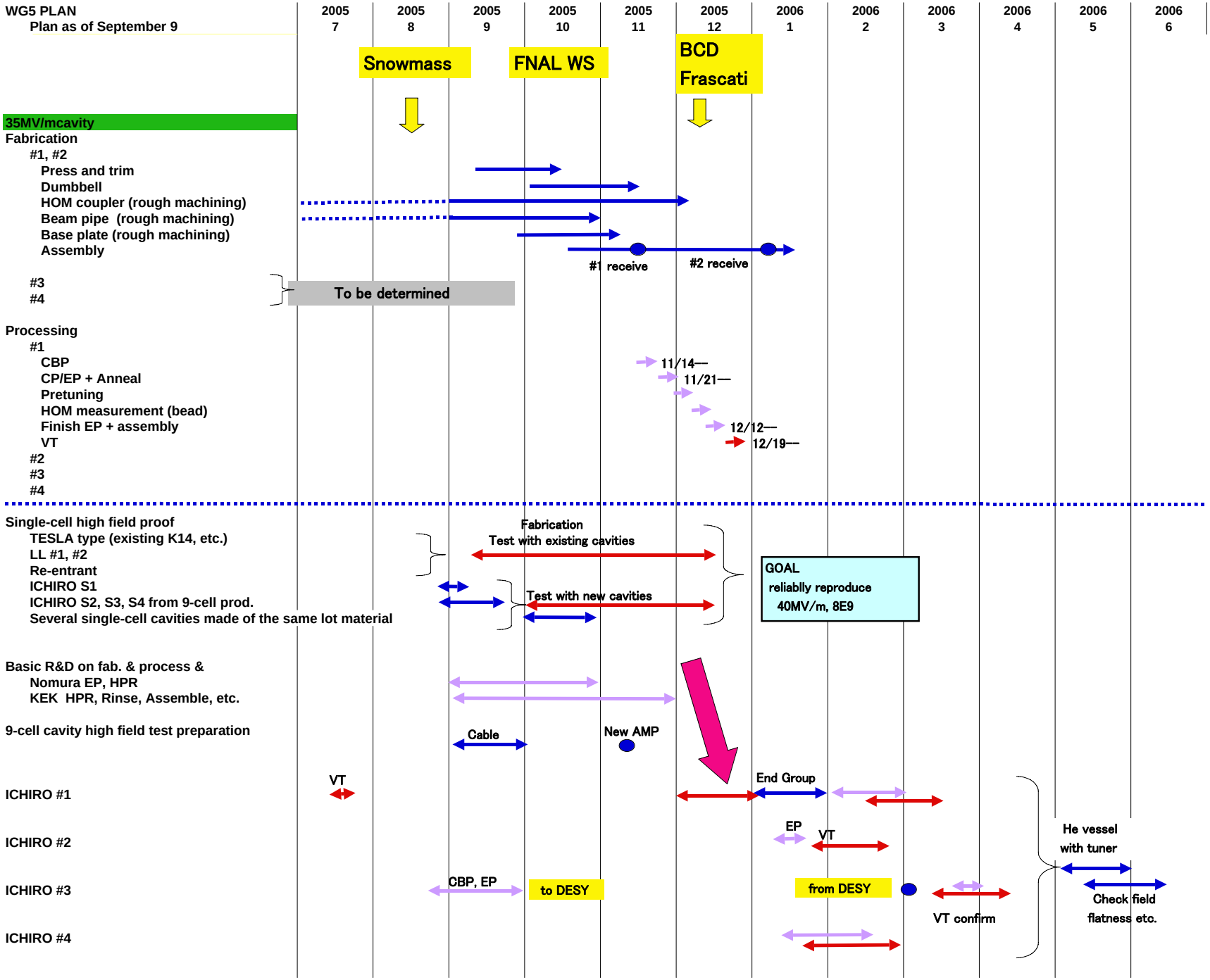


He jacket base plate SUS316L

Beam pipe flange SUS316L



ICHIRO 9-cell cavities @ KEK


WG5 PLAN
Plan as of September 9
2005 7
2005 8
2005 9
2005 10
2005 11
2005 12
2006 1
2006 2
2006 3
2006 4
2006 5
2006 6
Snowmass
FNAL WS
BCD
Frascati
35MV/mcavity
Fabrication
#1, #2
Press and trim
Dumbbell
HOM coupler (rough machining)
Beam pipe (rough machining)
Base plate (rough machining)
Assembly
#1 receive
#2 receive
#3
#4
To be determined
Processing
#1
CBP
CP/EP + Anneal
Pretuning
HOM measurement (bead)
Finish EP + assembly
VT
#2
#3
#4
11/14—
11/21—
12/12—
12/19—
Single-cell high field proof
TESLA type (existing K14, etc.)
LL #1, #2
Re-entrant
ICHIRO S1
ICHIRO S2, S3, S4 from 9-cell prod.
Several single-cell cavities made of the same lot material
Fabrication
Test with existing cavities
Test with new cavities
GOAL
reliablly reproduce
40MV/m, 8E9
Basic R&D on fab. & process &
Nomura EP, HPR
KEK HPR, Rinse, Assemble, etc.
9-cell cavity high field test preparation
Cable
New AMP
ICHIRO #1
VT
End Group
ICHIRO #2
EP
VT
ICHIRO #3
CBP, EP
to DESY
from DESY
VT confirm
ICHIRO #4
He vessel
with tuner
Check field
flatness etc.

Summary

1) ILC WG5-Asia Gruope has verified the high gradient performance for both new shapes: reentrant and low loss.

2) Multipacting is more likely to be a problem for 9-cell cavities.
3) We need establish our preparation recipe from QA point of view.

4) We will concentrate to settle these problems for 3 months and get review with the result.