Global R&D Effort for the ILC Superconducting RF Technology in the Technical Design Phase

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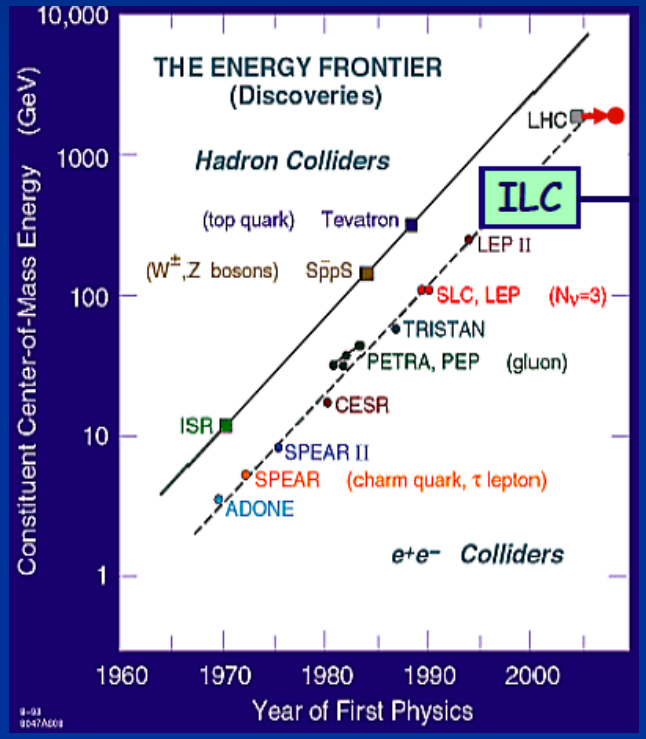
for the ILC Global Design Effort - SCRF

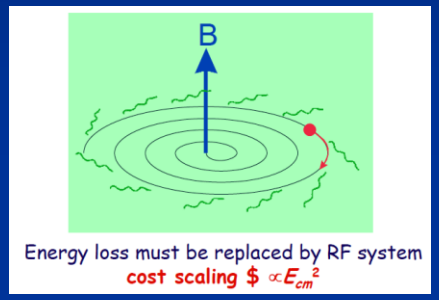
To be presented at Jlab, Sept., 12, 2008

Outline

- **Introduction**
- **R&D Status**
  - Fundamental research with **single-cell** cavities
  - Progress in **9-cell** cavities
- **Plan for Technical Design Phase**
  - High **Gradient**,
  - **Plug-compatible** Engineering
- **Global Plan and Effort**
- **Summary**

Particle Accelerators
beyond limit of circular accelerators





Electron machine

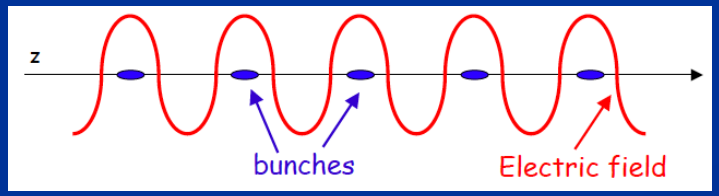
Ring accelerator

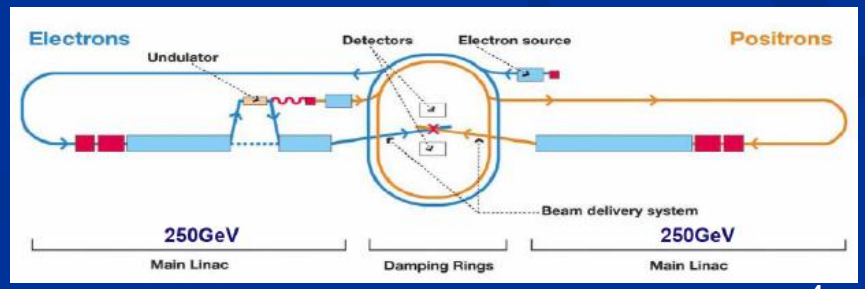
-->> Linear Acceler

Reference Design Report, published, 2007

- **SC linacs: 2x11 km**
  - **for 2x250 GeV**
- **Injector centralized**
  - Circular damping rings
- **IR with 14 mrad crossing angle**

Parameter	Value
C.M. Energy	500 GeV
Peak luminosity	$2x10^{34}$ $cm^{-2}s^{-1}$
Beam Rep. rate	5 Hz
Pulse time duration	1 ms
Average beam current	9 mA (in pulse)
Average field gradient	**31.5 MV/m**
# 9-cell cavity	14,560
# cryomodule	1,680
# RF units	560





Toward Technical Design Report

ILC Research and Development Plan for the Technical Design Phase

Release 2

June 2008

ILC Global Design Effort

Director: Barry Barish

Prepared by the Technical Design Phase Project Management

Project Managers: Marc Ross, Nick Walker, Akira Yamamoto

Reference Design, 2007 >> Technical Design Phase, 2008-2012

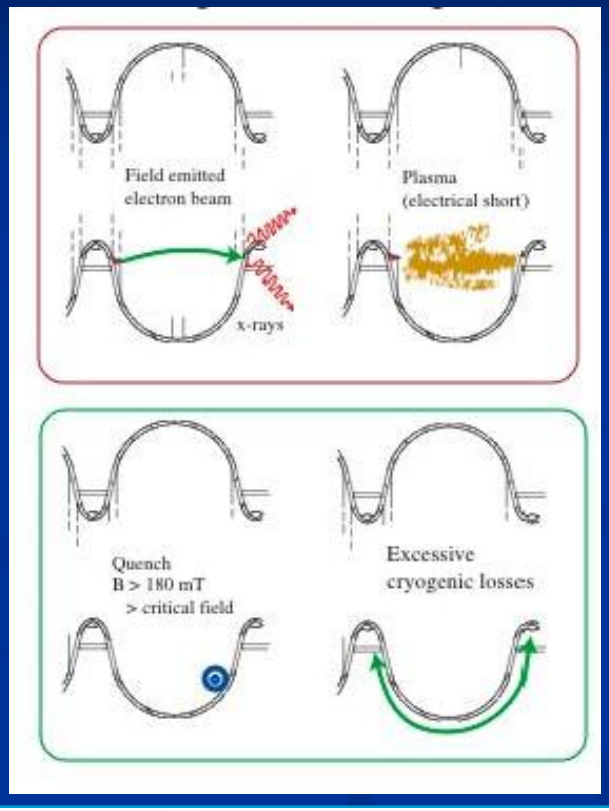
We are now at the stage of progressing from the RD to TD

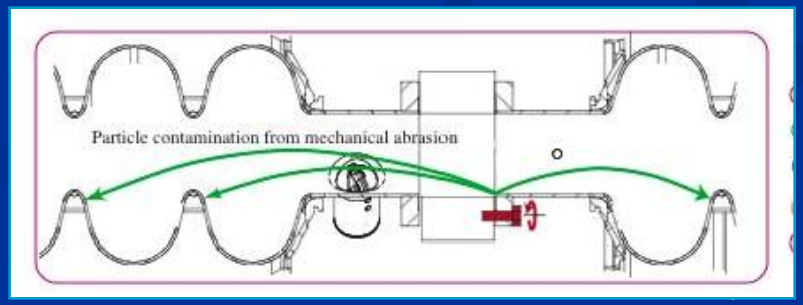
TDP Goals of ILC-SCRF R&D

- **Field Gradient**
  - **35 MV/m** for cavity performance **(S0)**
  - **31.5 MV/m** (10 % lower) for operational gradient
    - to build two x 11 km SCRF main linacs
- **Cavity & Cryomodule Integration with**
  - **"Plug-compatible" concept to:**
    - Encourage "improvement" and creative work in R&D phase
    - Motivate practical 'Project Implementation' to share intellectual work in global effort
- **Accelerator System Engineering andTests**
  - **Cavity-string in one cryomodule (S1, S1-global)**
  - **Cryomodule-string with Beam Acceleration (S2)**
    - With one RF-unit containing 3 crymodule

Why Field Gradient Limited in SC Cavity ? Current major reasons

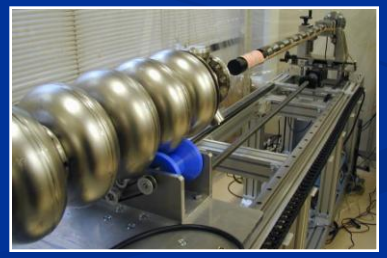
- **Field Emission**
  - due to high **electric field**
    - around "Iris"
- **Quench**
  - caused by surface heating from dark current, or
  - **magnetic field** penetration.
    - around "Equator"
- **Contamination**
  - during assembly

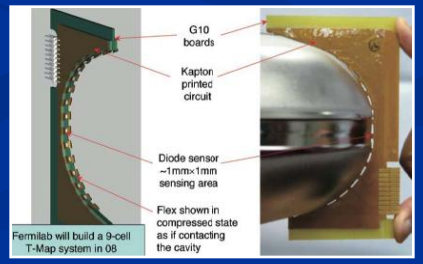




R&D Efforts Required

- **Fabrication:**
  - Forming and welding (EBW)
- **Surface Process:**
  - Chemical etching
    - Electro-polishing
  - Cleaning
    - Ethanol, Detergent, Micro-EP
    - High pressure water rinsing
- **Inspection/Tests:**
  - Optical Inspection (warm)
  - Thermometry (cold)

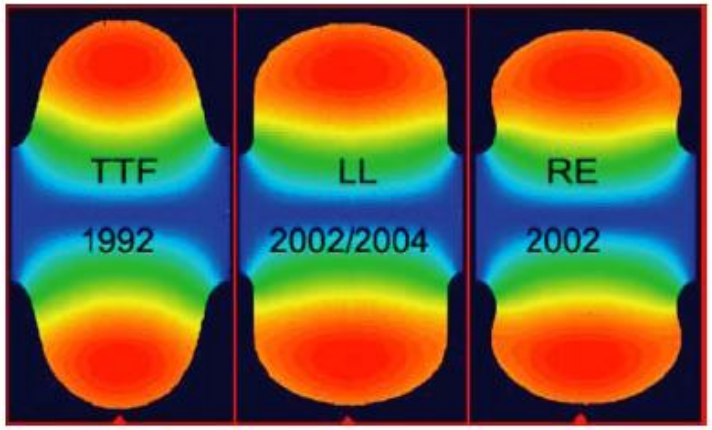




Cavity Shape Design Investigated

TABLE II. CAVITY SHAPES STUDIED FOR THE ILC.

Parameter	TESLA	LL/IS	RE
Iris aperture (mm)	70	60/61	66
E_{peak}/E_{acc}	1.98	2.36/2.02	2.21
B_{peak}/E_{acc} (mT/(MV/m))	4.15	3.61/3.56	3.76
Char. shunt impedance: R/Q (Ω)	114	134/138	127
Geometric factor: G (Ω)	271	284/285	277
$G \times R/Q$ ($\Omega \times \Omega \times 10^5$)	3.08	3.80/3.93	3.51



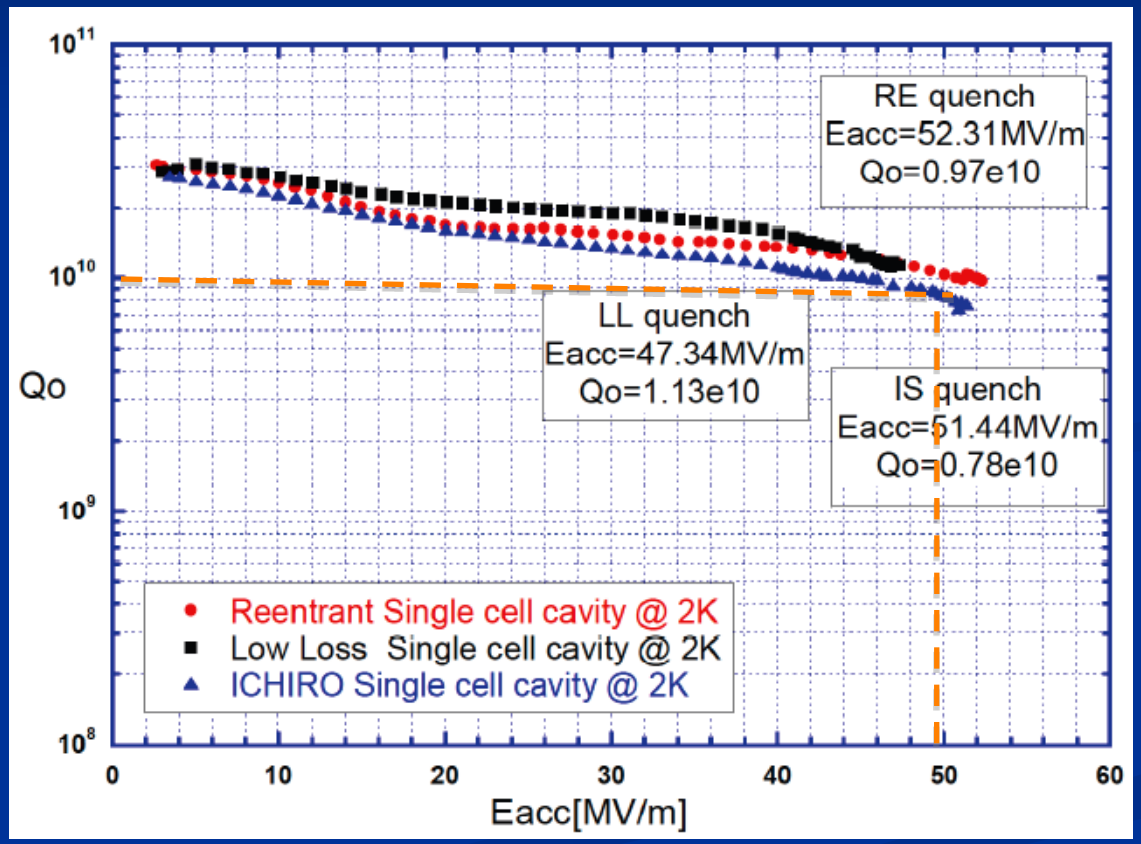
- TESLA
  - **Lower E-peak**
  - Lower risk of field emission
- LL/ IS, RE
  - **Lower B-peak**
  - Potential to reach higher gradient

LL: low-loss, IS: Ichiro-shape, RE: re-entrant

RE and LL R&D with Single Cell

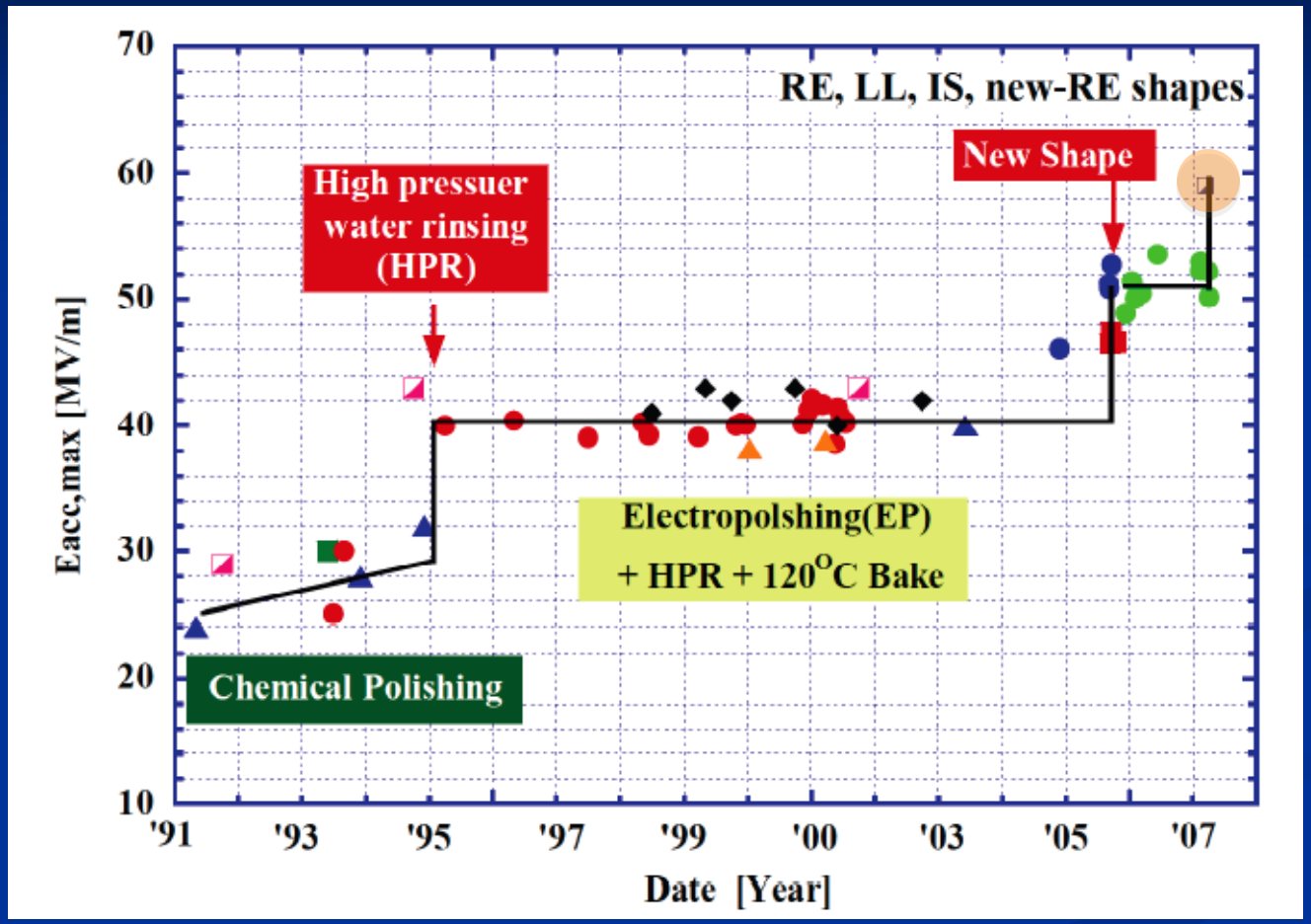
Re-entrant cavity developed at Cornell and processed at KEK

Low-loss/Ichiro cavity developed and processed at KEK



- **> 50 MV/m with single-cell cavities**

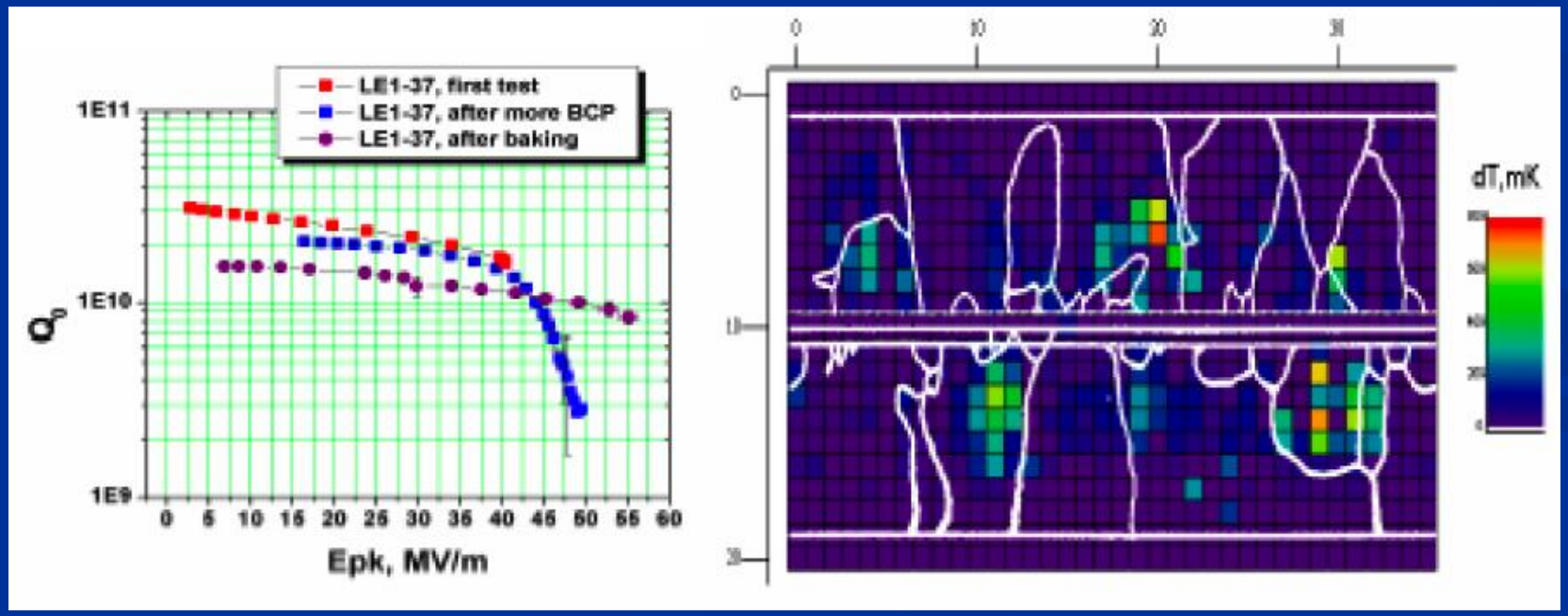
Progress in Single Cell Cavity



- Record of **59 MV/m** achieved with the RE cavity with EP, BCP and pure-water rinsing with collaboration of Cornell and KEK
- (K. Saito, H. Padamsee et al. , SRF-07)

Large-Grain Cavity R&D

- Pioneer work at JLab:
  - Location of grain boundaries and "hot spots"
  - Performance, with CP only, equivalent to EP
    - Various studies in progress in three regions

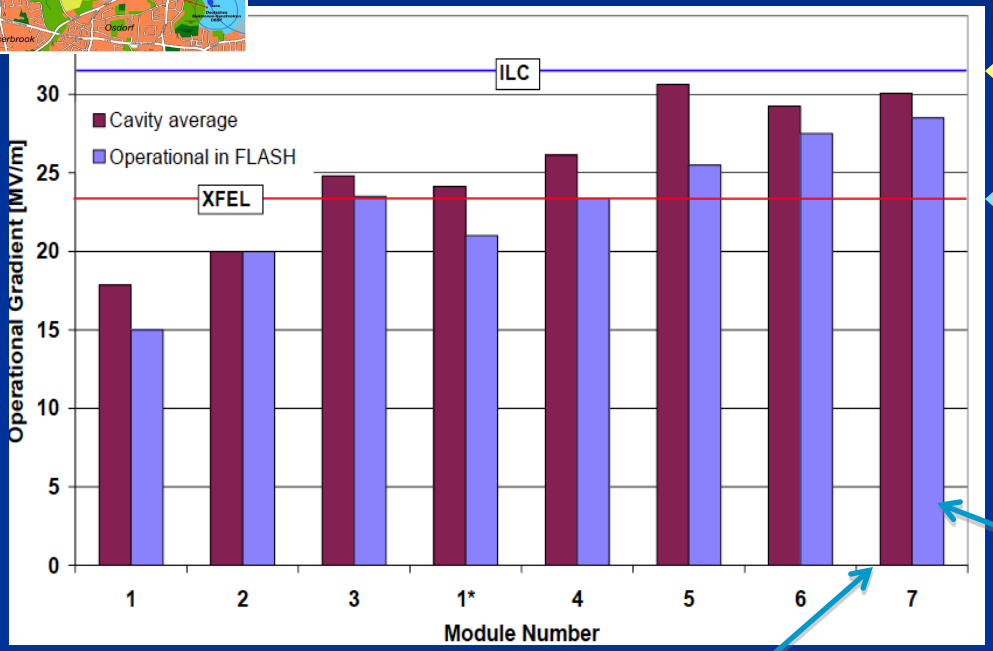


R&D Status of 9-Cell Cavity

- **Europe**
  - "Gradient" improved **(<31.5> MV/m)** with Ethanol rinse (DESY):
  - Large-grain cavity (DESY)
  - Surface process with baking in Ar-gas (Saclay)
  - Industrial (bulk) EP demonstrated **(<36> MV/m)** (DESY)

- **America(s)**
  - Basic research and surface process (Cornell, JLab, Fermilab)
  - Field emission reduced with Ultrasonic Degreasing using Detergent, and "Gradient" improved (JLab)
  - Large-grain cavity **(<36> MV/m)** (JLab)
  - Surface process facility (Fermilab/ ANL)
  - Vertical (cold) test facility with thermometry (Fermilab)
- **Asia**
  - "Gradient" demonstrated, 36MV/ m (LL, KEK-JLab), and 28 MV/ m (TESLA-like in cryomodule, KEK)
  - **Optical inspection** system (KEK)

"Operational Field Gradient"
in progress at TESLA/FLASH toward EuroXFEL



ILC operation :

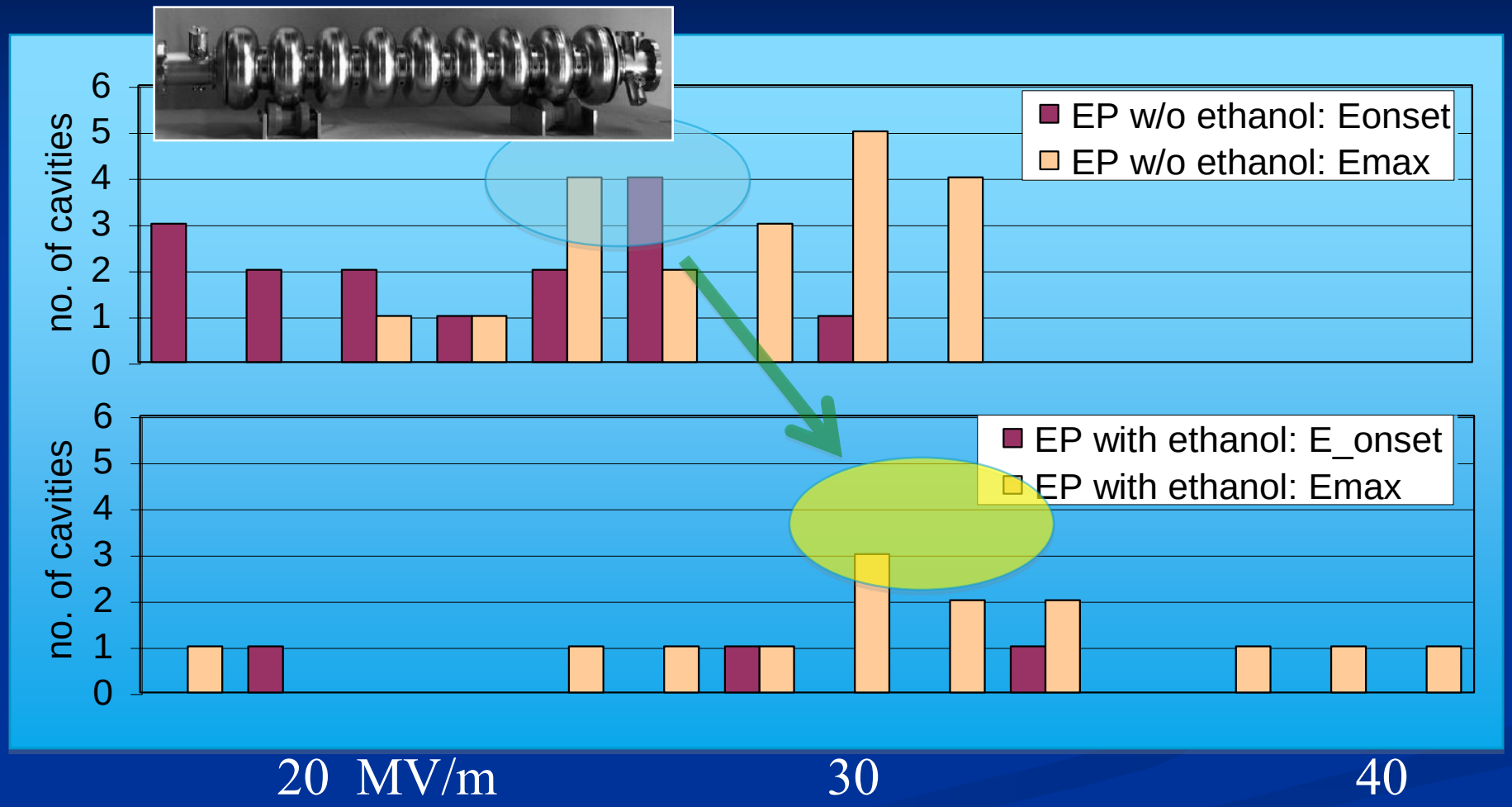
- <31.5> MV/m

R&D Status :

- ~ 30 MV/m to meet XFEL requirement

- **We need 20 % improvement to meet ILC requirement**

DESY: Field Emission Analysis

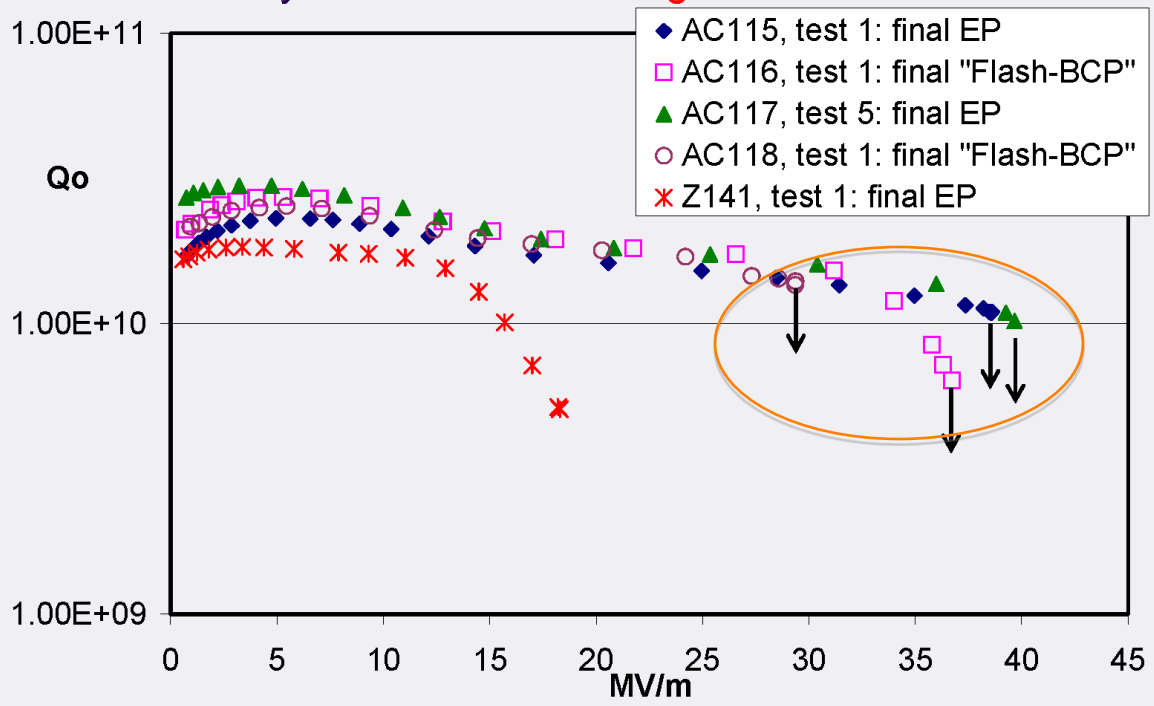


Cavity gradient shifted to High Gradient by 'ethanol rinse', except for "lowest two" (due to different reasons)

Industrial EP at DESY/Plansee

6th cavity production – rf results

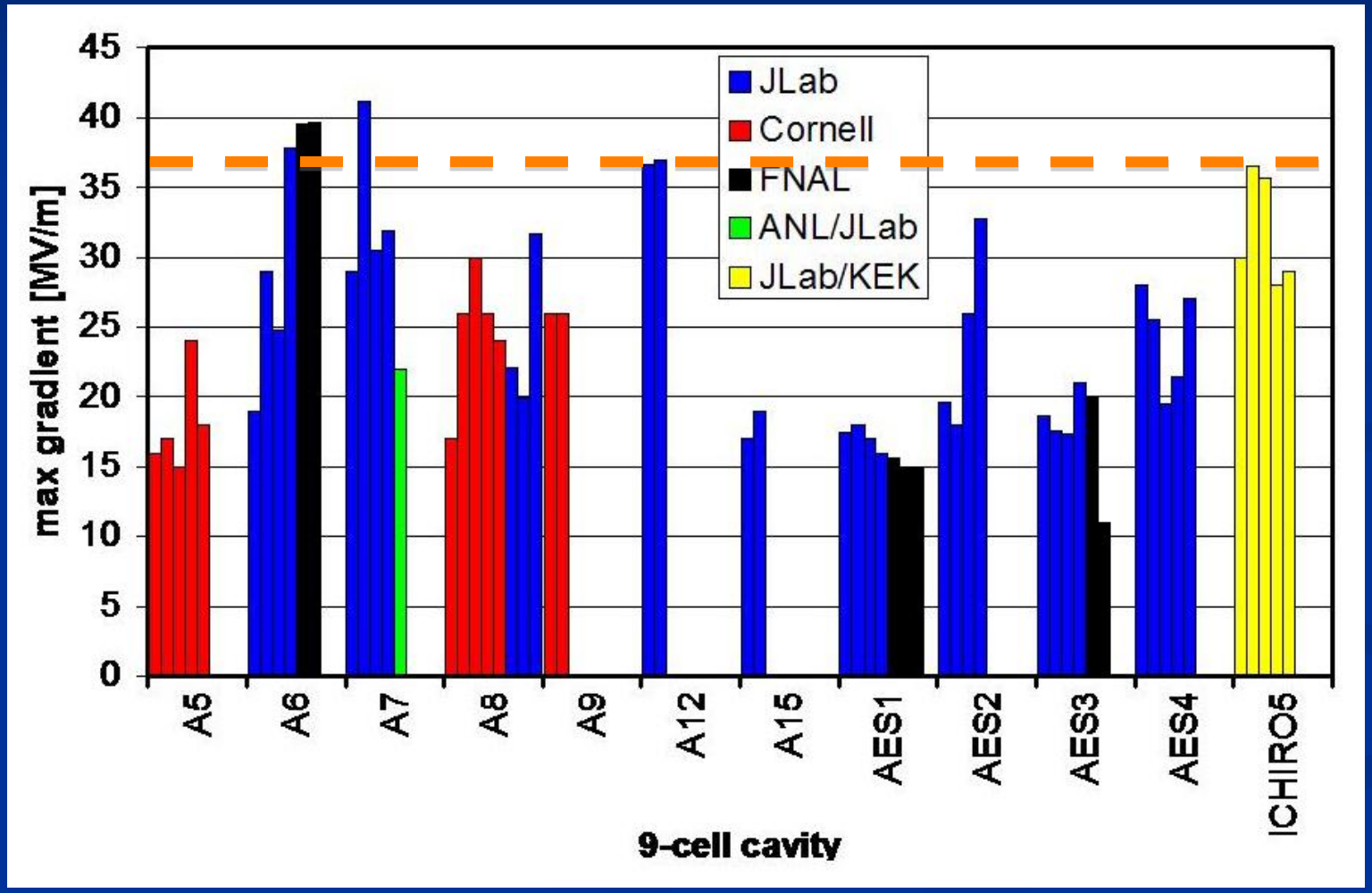
- excellent + promising first results including first Plansee nine-cell (AC115)
- Z141 as first cavity with surfaces damages after fabrication under investigation



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

9-cell Progress in American Laboratories

with Japanese contribution for ICHIRO-5



A (Accell), AES: TESLA shape, ICHITO: LL shape

Progress at J-Lab

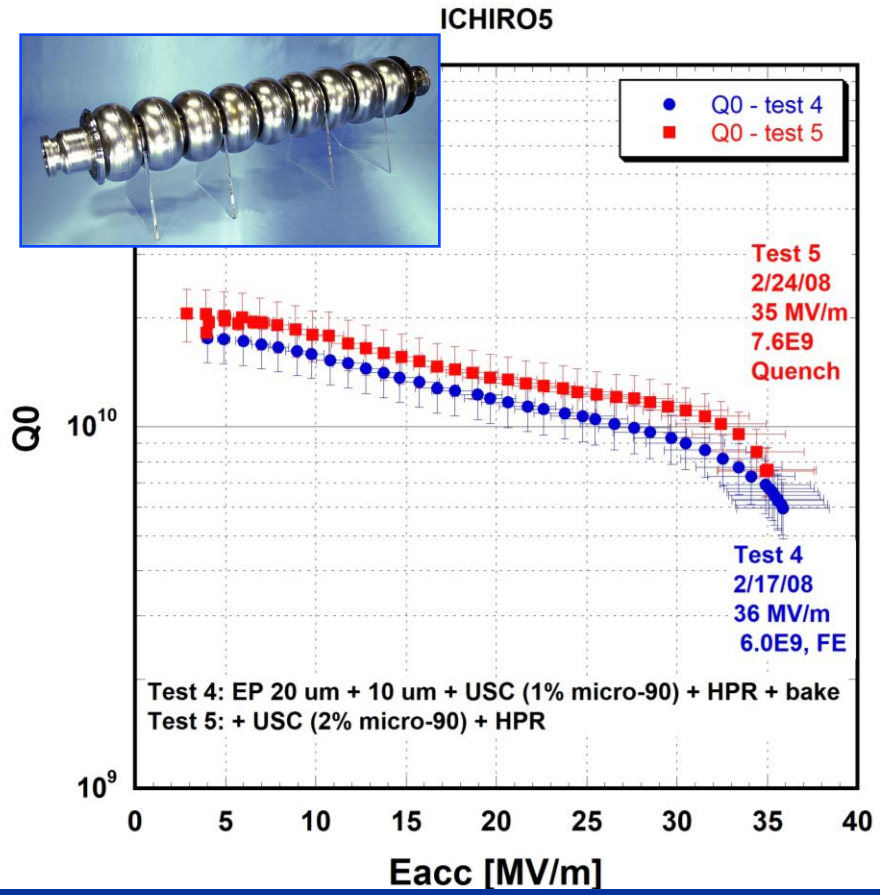
J-Lab (2006-2008)

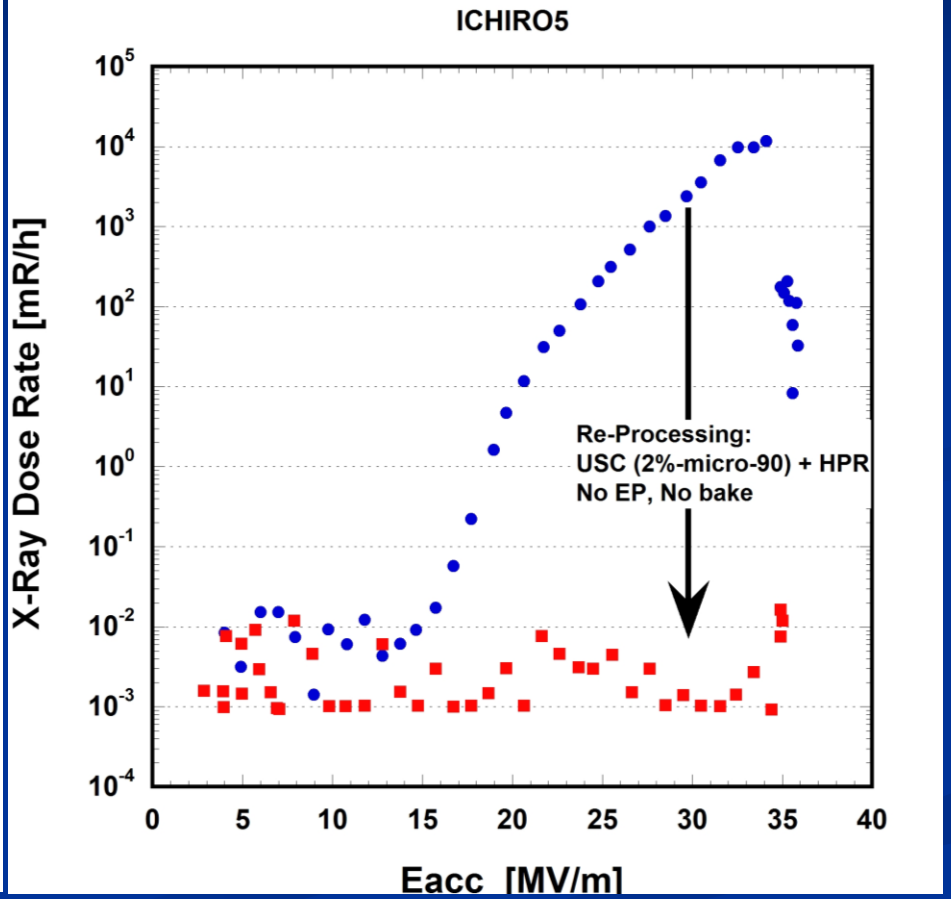
- Nine 9-cell cavities
  - six of them reached >> **30 MV/m**
  - **Ultra-sonic degreasing progressed**

No.	Co-work	Cavity Name	No. Tests	E-max (MV/m)
1	Fnal/Accel	Accel-6	Test-4	38
2	Fnal/Accel	Accel-7	Test-2	42
3	Fnal/AES	AES-2	Tes-t4	32
4	Fnal/Accel	Accel-8	Test-3	31
5	KEK/Kuroki	Ichiro-5	Test-4	36
6	Fnal/Accel	Accel-11	Test-1	30

9-cell LL Cavity, Ultrasonic Degreasing

"ICHIRO-5" Studies at JLab-KEK

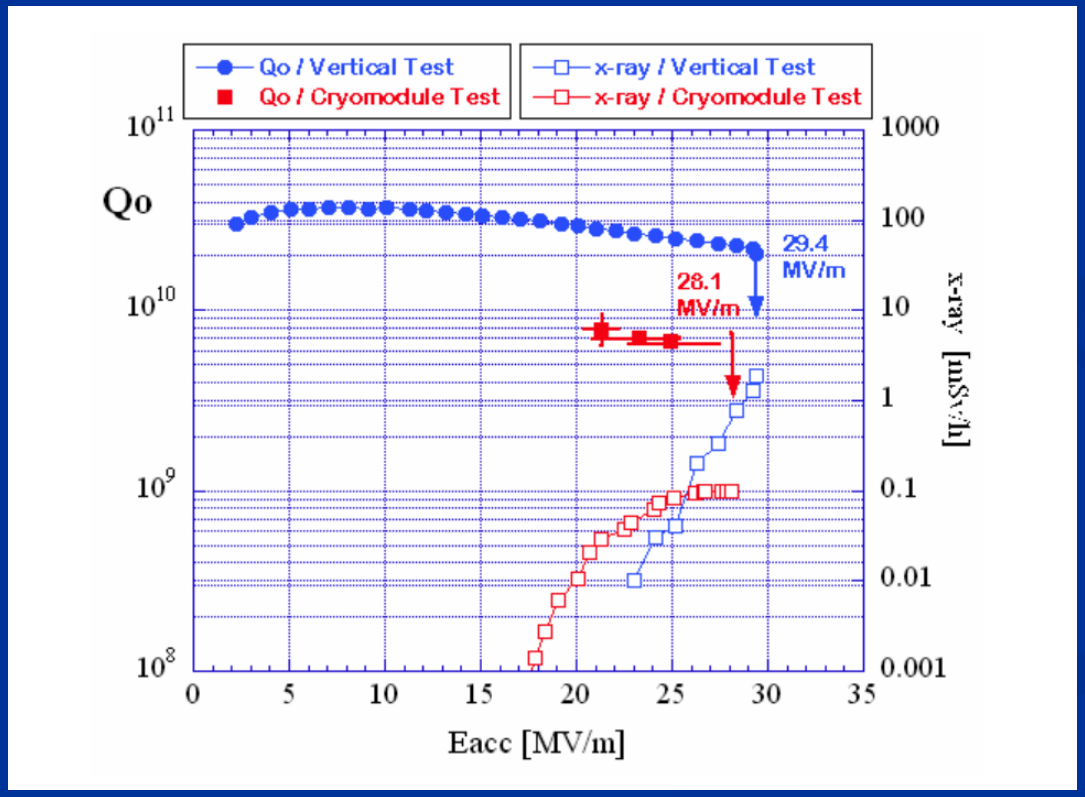


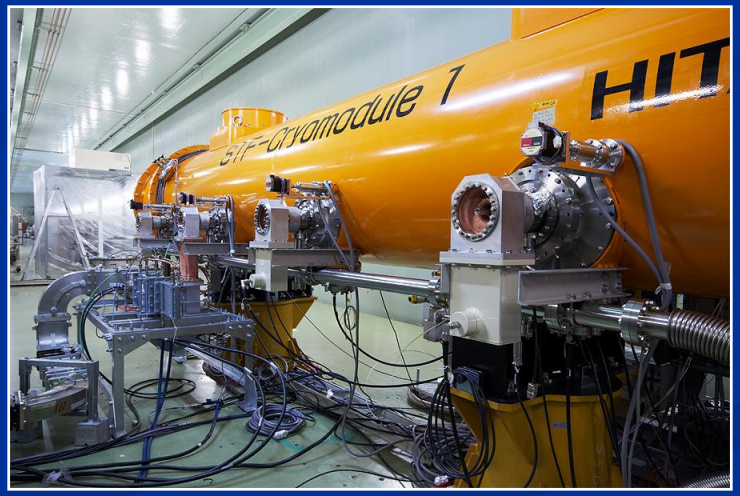


Ultrasonic Cleaning with degreaser very effective to reduce field emission

TESLA-like 9-Cell Cavity at KEK
Cryomodule/Horizontal test Result

June 30 – July 25. 2008: with warm coupler and klystron connection for only BL#2: 28 MV/m achieved





SCRF Activities in Asia

- **Participation in STF at KEK**
  - Cryomodule and coupler design (IHEP)
  - 9-cell cavity fabrication (PAL)
  - LL single cell (IHEP)
  - Cavity design/ processing (PNU/ KNU)
  - Joining STF operation (RRCAT)
- **China**
  - Cavity fabrication (Deep drawing, EBW, CB) (IHEP,PKU.)
  - Large grain cavity (Ningxia, PKU)
- **Korea**
  - Works other than SCRF (RTML design, cavity BPM, DR)
- **India**
  - Nb material investigation
  - Cavity fabrication in cooperation **with FNAL**
  - Cavity process in cooperation **with KEK**

Outline

- **Introduction**
- **R&D Status**
  - Fundamental research (with single cell cavities)
  - Progress in 9-cell cavities
- **Plan for Technical Design Phase**
  - High Gradient,
  - Plug-compatible Engineering
- **Global Plan**
- **Summary**

Plan for Further High Gradient R&D

1: **Research/ find cause** of gradient limit

for quench: **high resolution camera**

for field emission: **further surface analysis**

2: **develop countermeasures**

for quench: **remove beads & pits**,

3: **verify** countermeasures

exchange problem/information

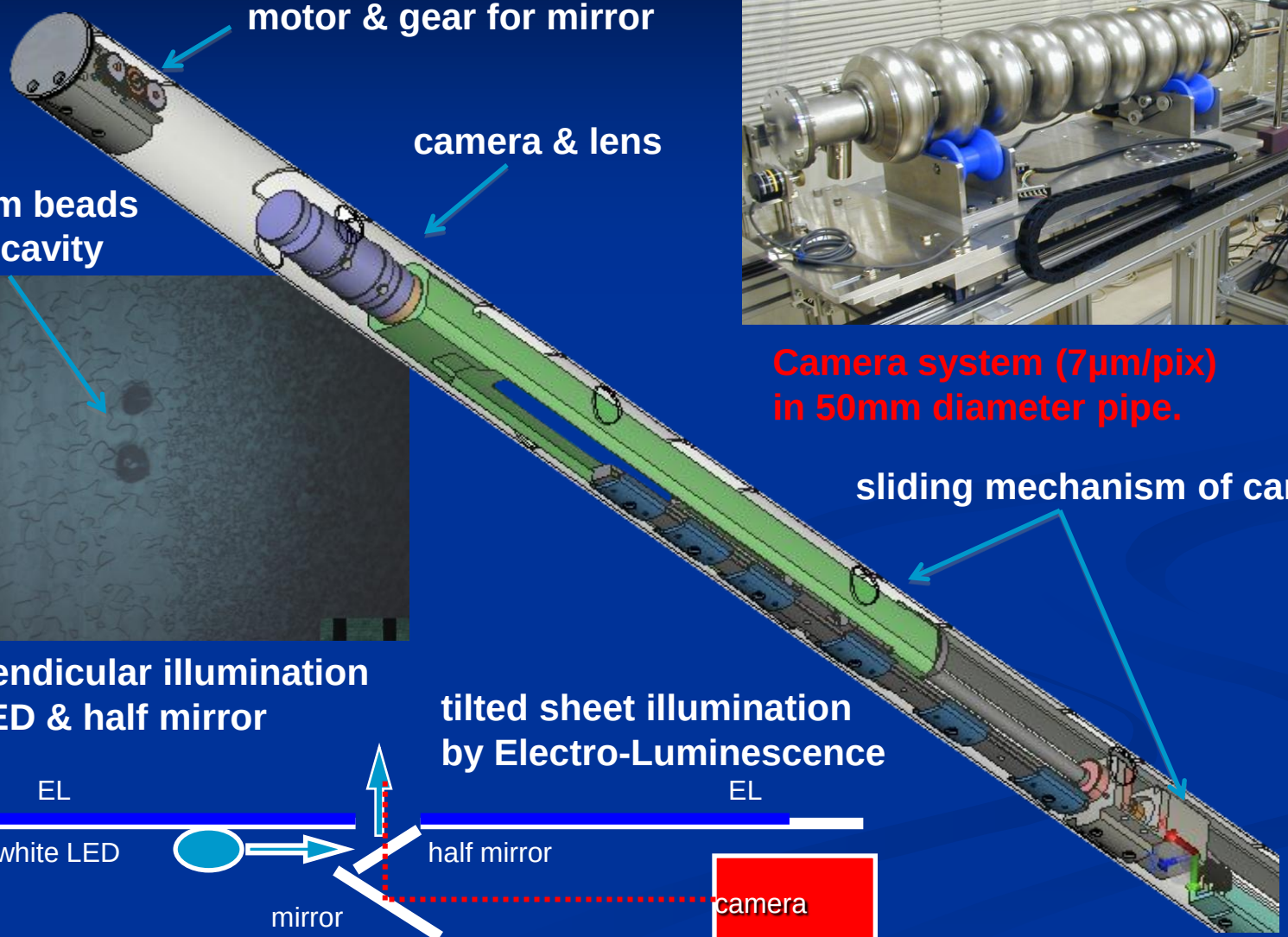
4: **Integrate** the countermeasures

install the countermeasure world-wide and

get **statistics**

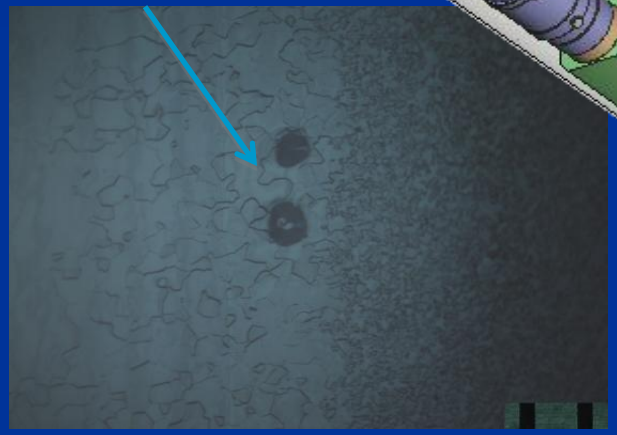
A New High Resolution, Optical Inspection System

For visual inspection of cavity inner surface.



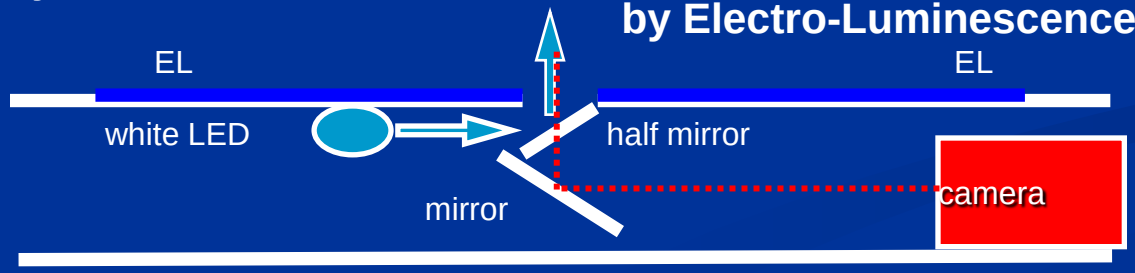
Camera system (7μm/pix)
in 50mm diameter pipe.

~600μm beads
on Nb cavity



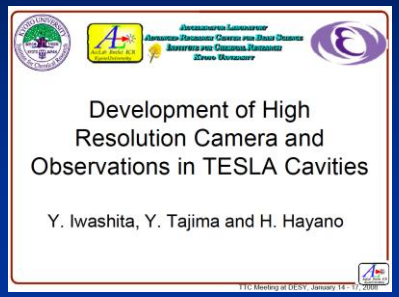
perpendicular illumination
by LED & half mirror

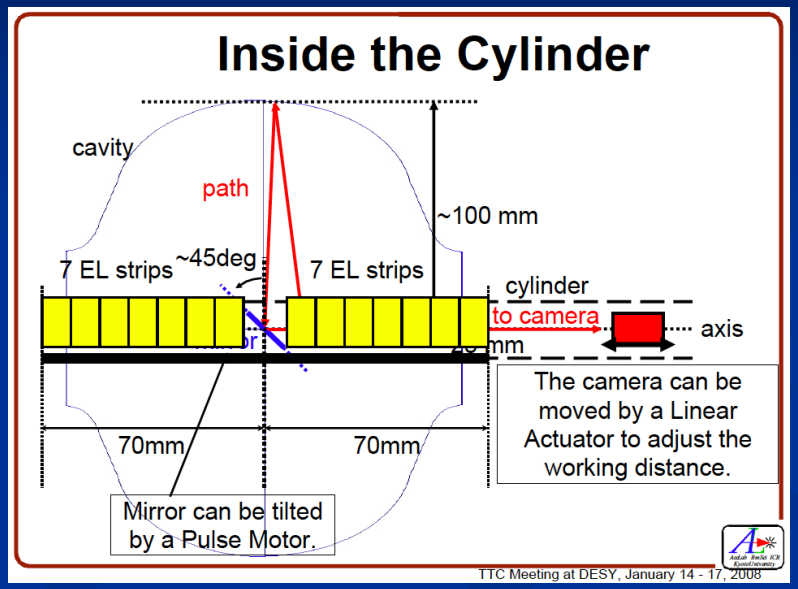
tilted sheet illumination
by Electro-Luminescence

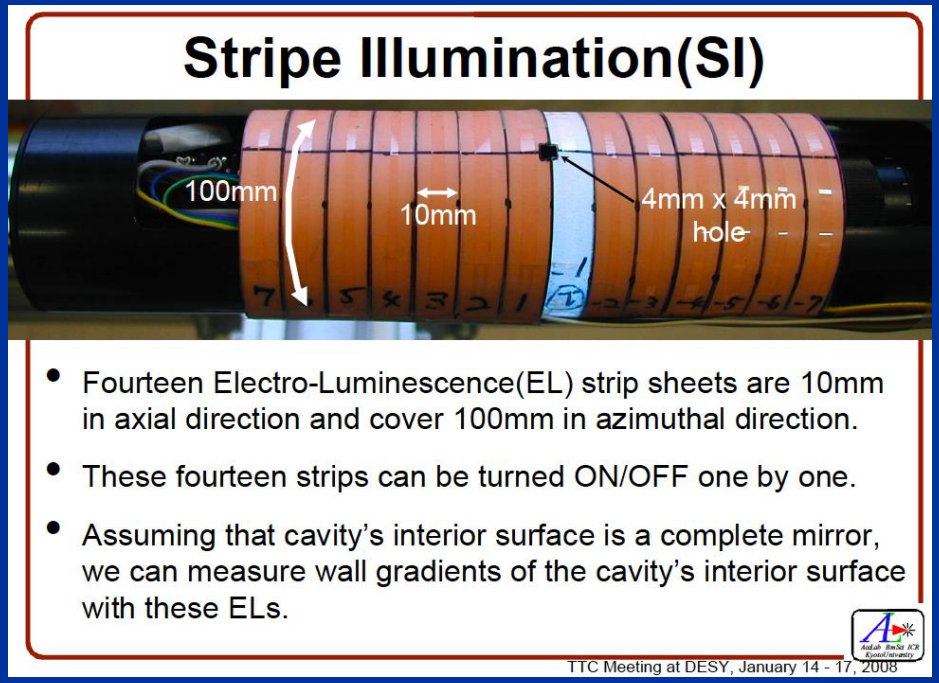


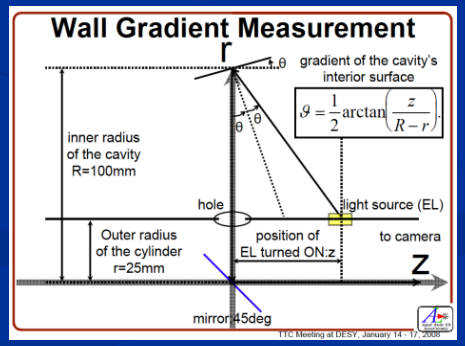
Iwashita (Kyoto) and Hayano (KEK) et al.

Progress in Profile Measurement

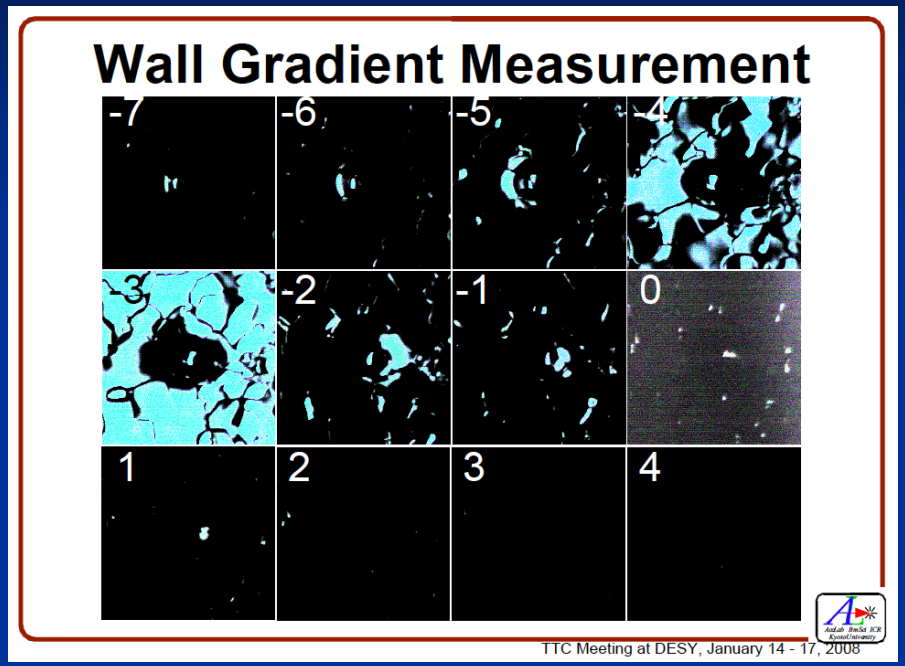


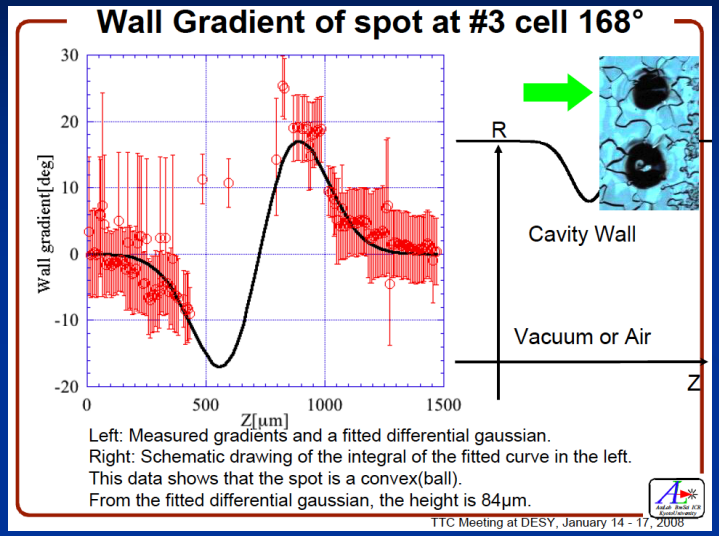


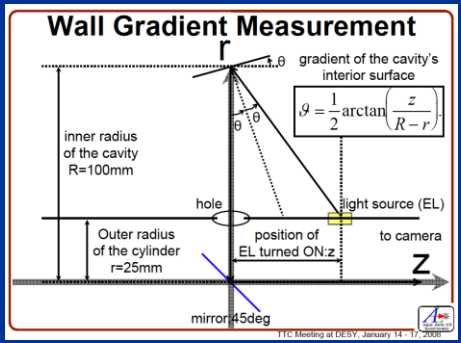


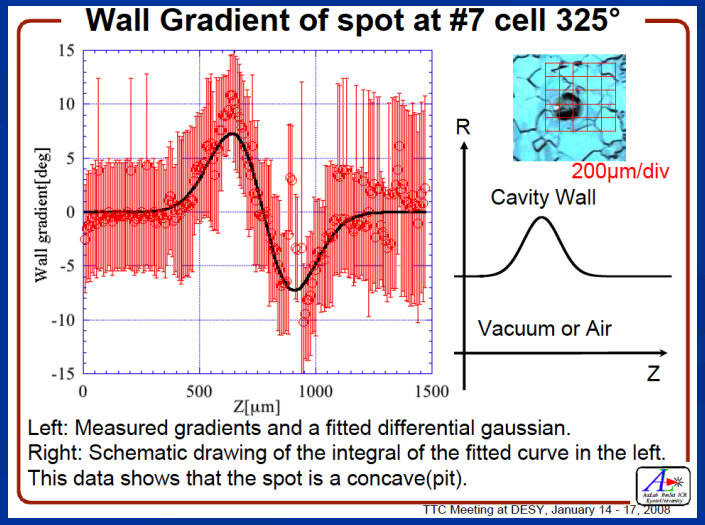


Examples

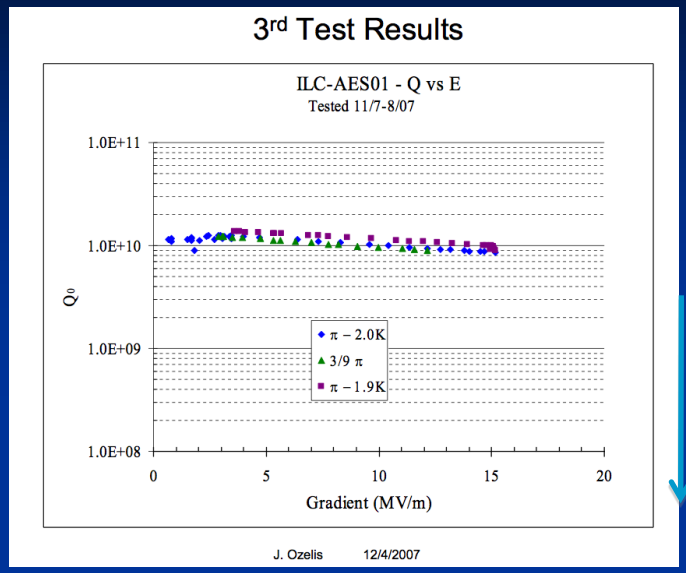

Wall Gradient Measurement
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
TTC Meeting at DESY, January 14 - 17, 2008

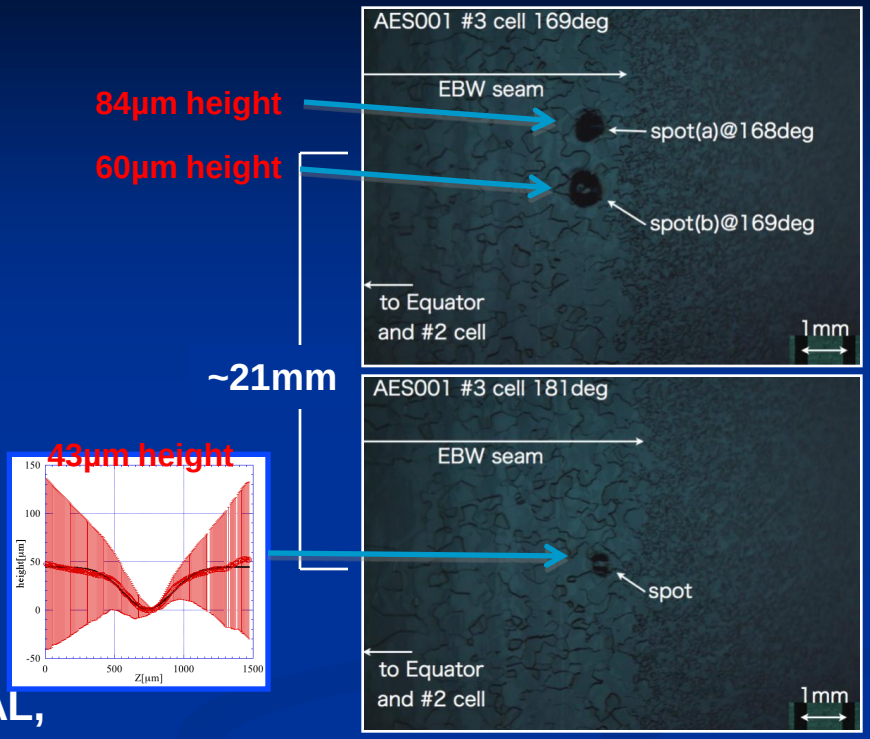

Wall Gradient of spot at #3 cell 168°
Wall gradient[deg]
Z[μm]
R
Cavity Wall
Vacuum or Air
Z
Left: Measured gradients and a fitted differential gaussian.
Right: Schematic drawing of the integral of the fitted curve in the left.
This data shows that the spot is a convex(ball).
From the fitted differential gaussian, the height is 84μm.
TTC Meeting at DESY, January 14 - 17, 2008


Wall Gradient Measurement
r
θ
gradient of the cavity's interior surface
$\vartheta = \frac{1}{2}\arctan\left(\frac{z}{R-r}\right)$
inner radius of the cavity R=100mm
hole
light source (EL)
Outer radius of the cylinder r=25mm
position of EL turned ON:z
to camera
Z
mirror 45deg
TTC Meeting at DESY, January 14 - 17, 2008

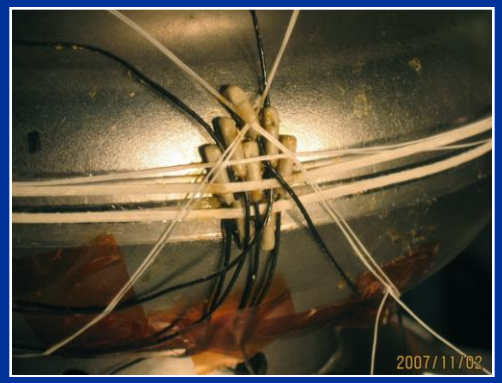

Wall Gradient of spot at #7 cell 325°
Wall gradient[deg]
Z[μm]
R
200μm/div
Cavity Wall
Vacuum or Air
Z
Left: Measured gradients and a fitted differential gaussian.
Right: Schematic drawing of the integral of the fitted curve in the left.
This data shows that the spot is a concave(pit).
TTC Meeting at DESY, January 14 - 17, 2008

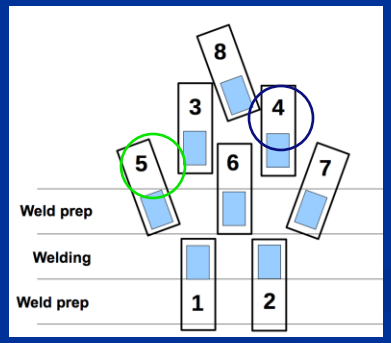
Consistent with Thermal Measurement at FNAL

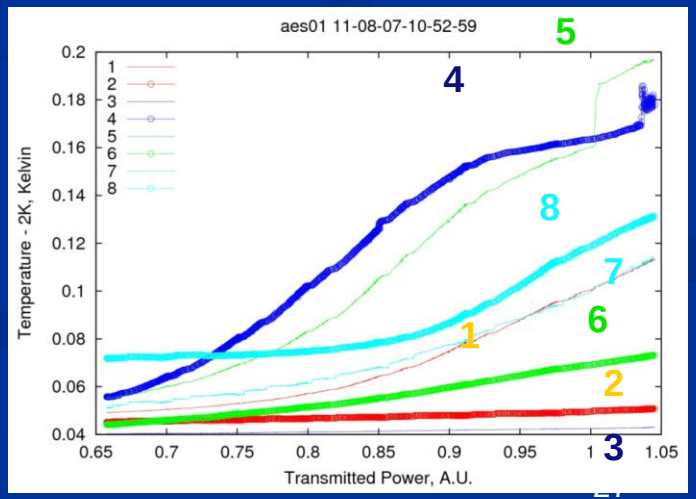




AES01 has hard quench at 15MV/m,
its location was identified by Cernox at FNAL,
(M. Champion et al., This conference)





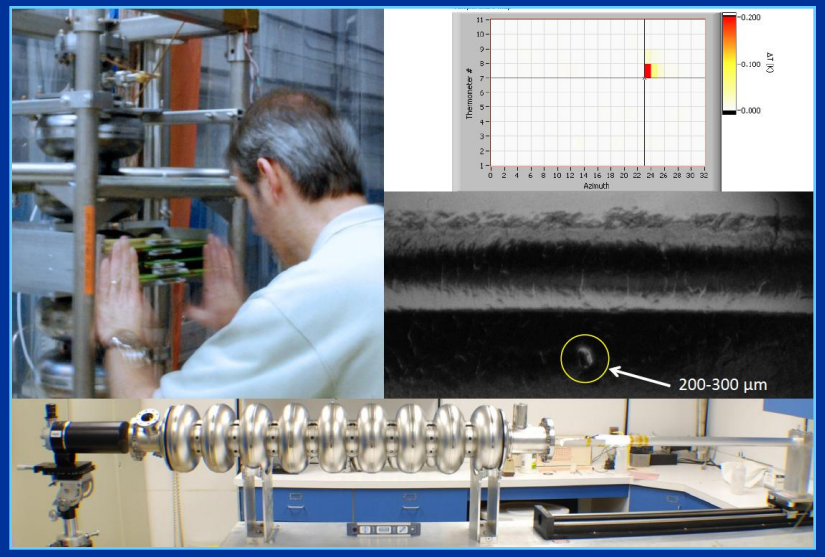


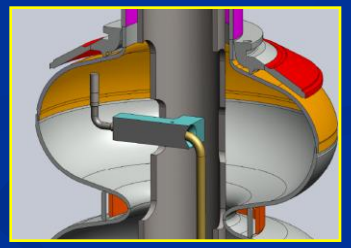
Kyoto-camera found 3 spots in their exact location

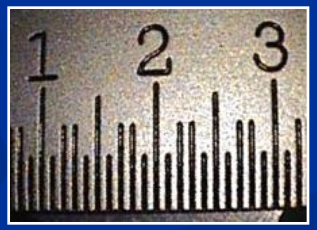
Inspection R&D at JLab and LANL

- Jlab
  - Thermometry and tele-scope

- LANL
  - Thermometry and videoscope







Scale seen by the videoscope

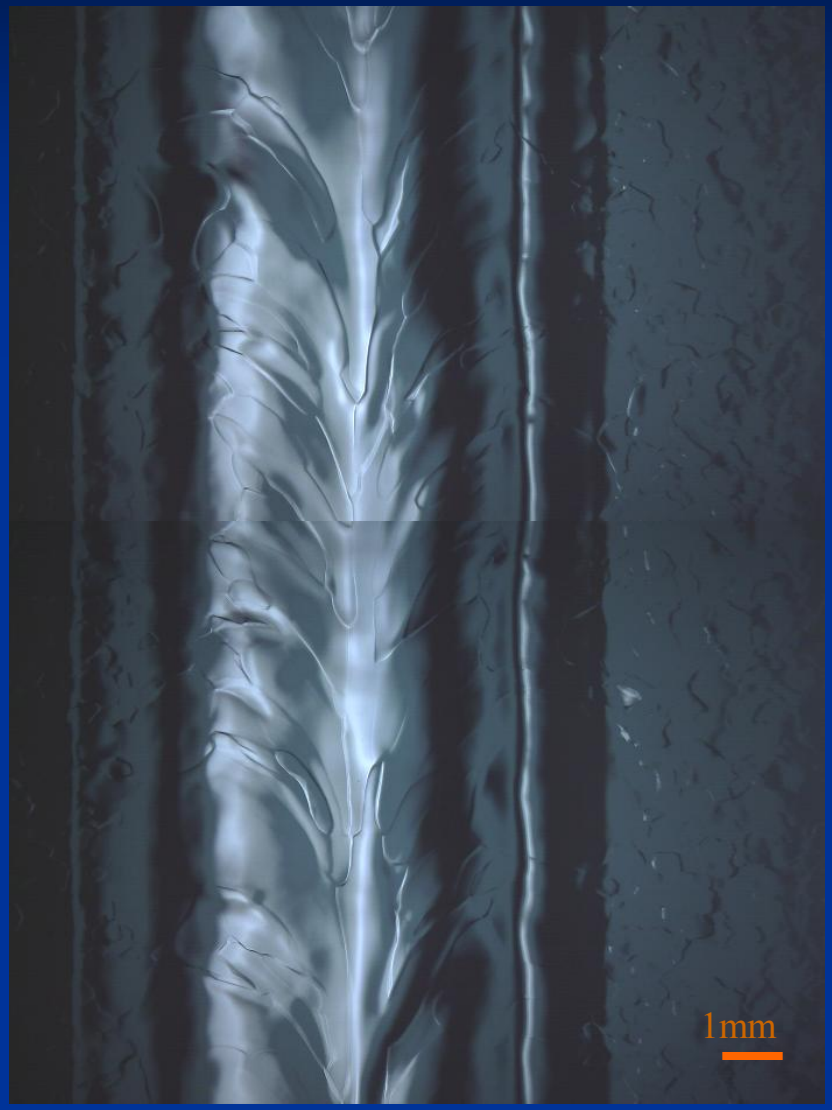
Surface Inspection of DESY AC71

(It has been reached to 40MV/m, however the last measurement was 26MV/m.)

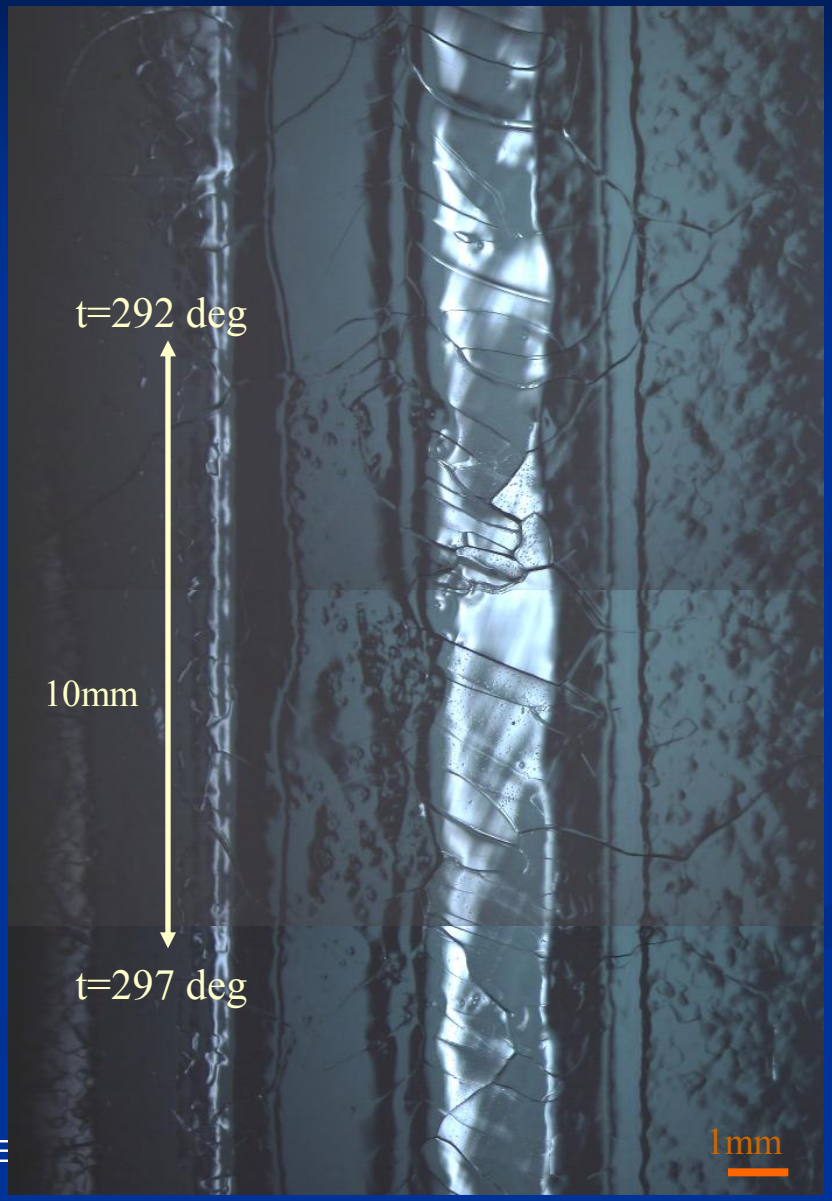
Ken Watanabe 2008/6/20

Equator Comparison(1): AC71 vs. Z110

AC71 #8 equator, t=151 ~ 159 deg, normal

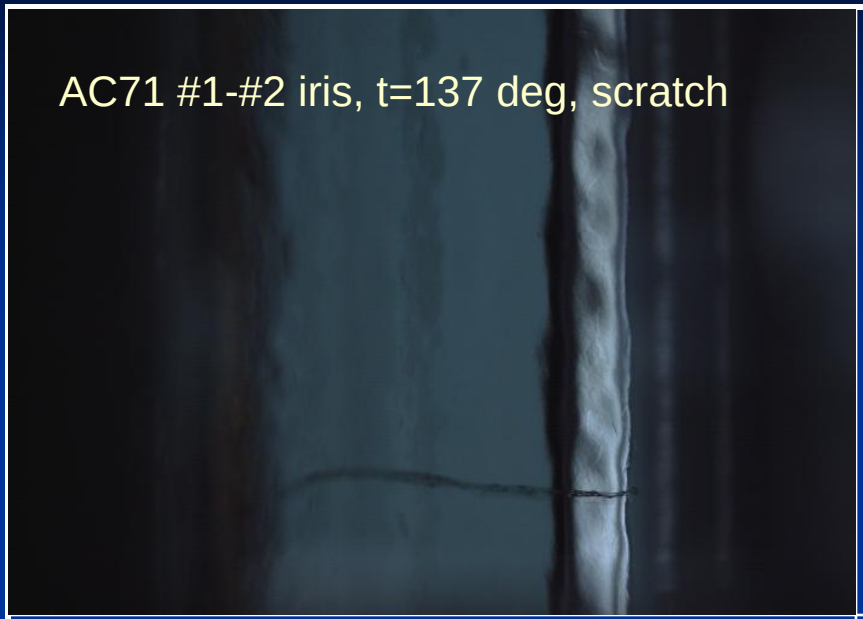


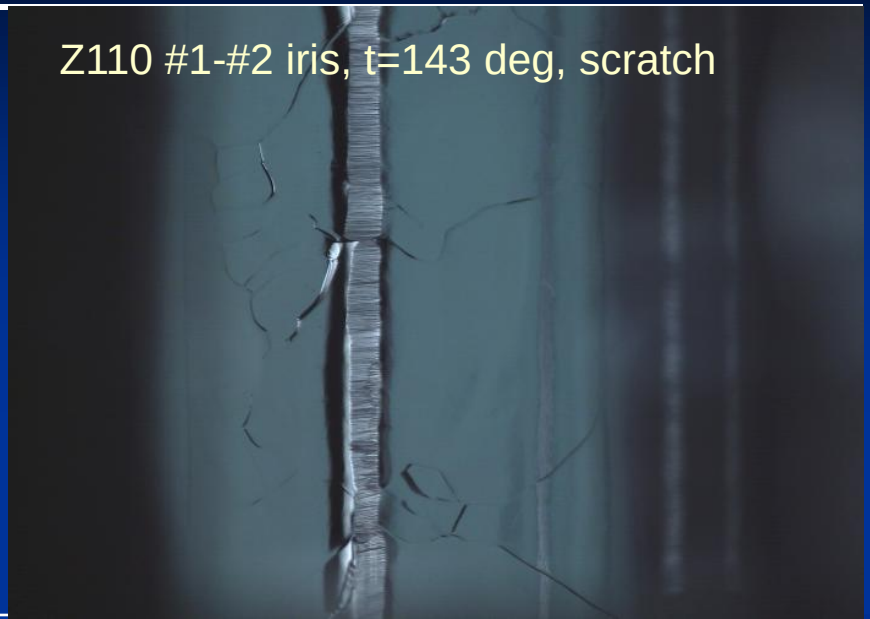
Z110 #8 equator, t=288 ~ 299 deg, heating spot

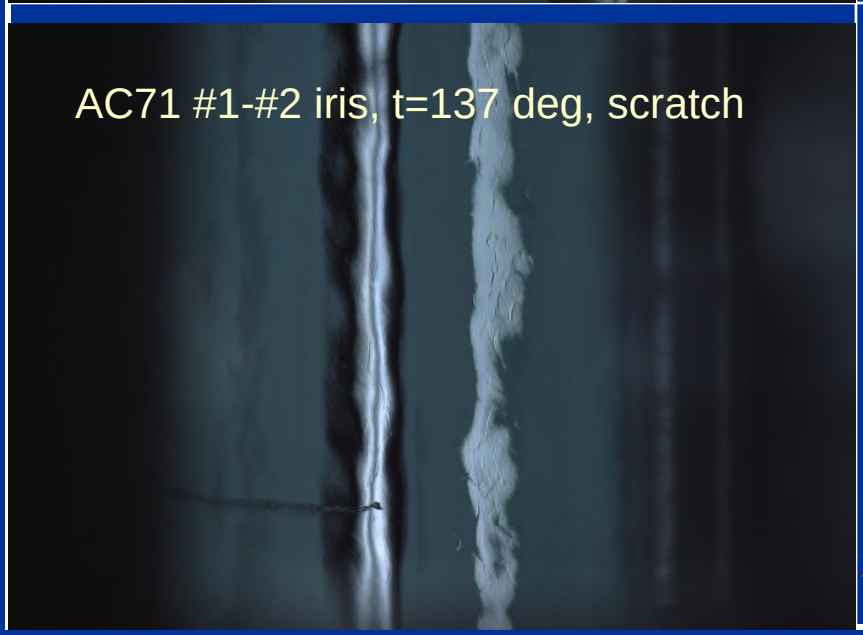


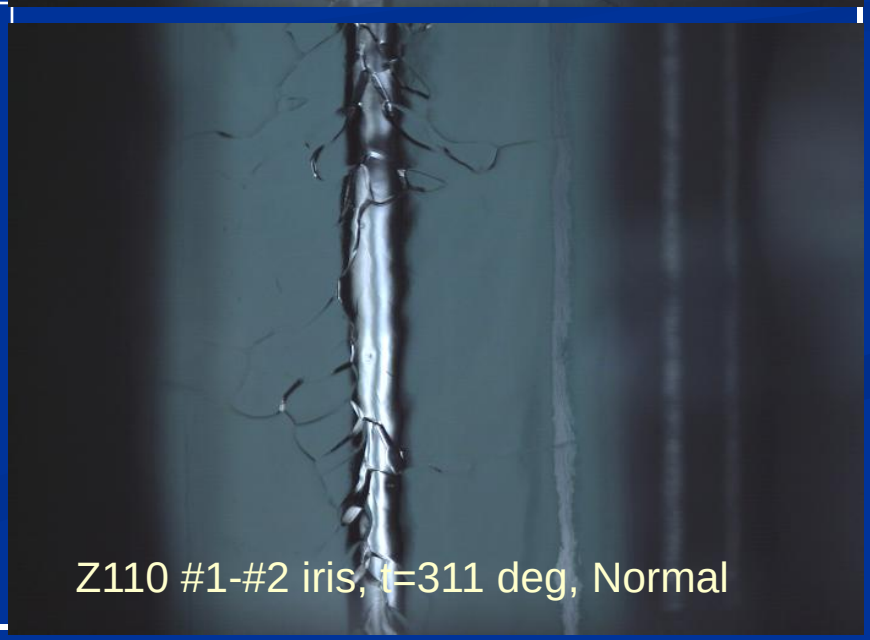
smooth and clean EBW seam in AC

Iris Comparison(1): AC71 vs. Z110

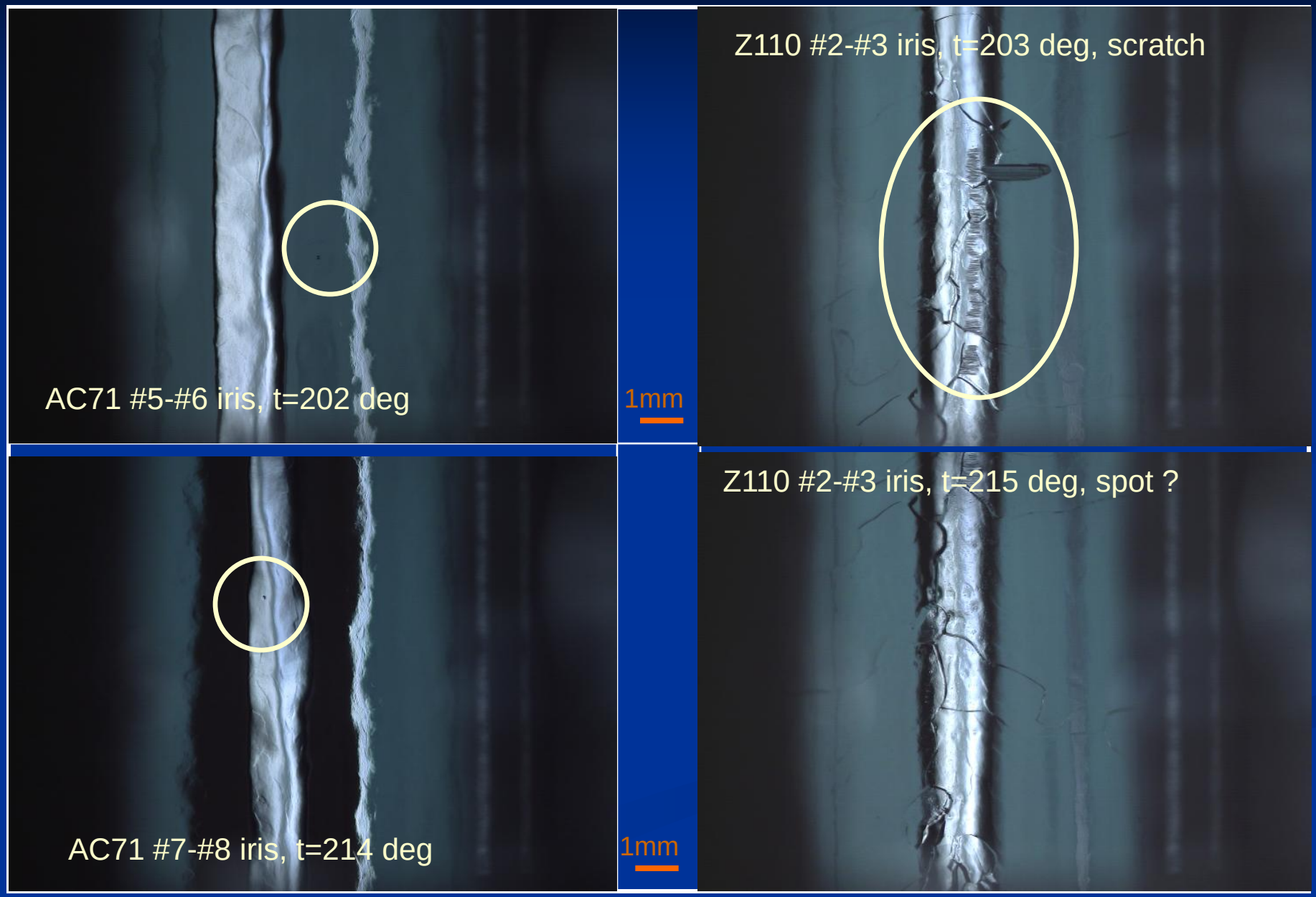


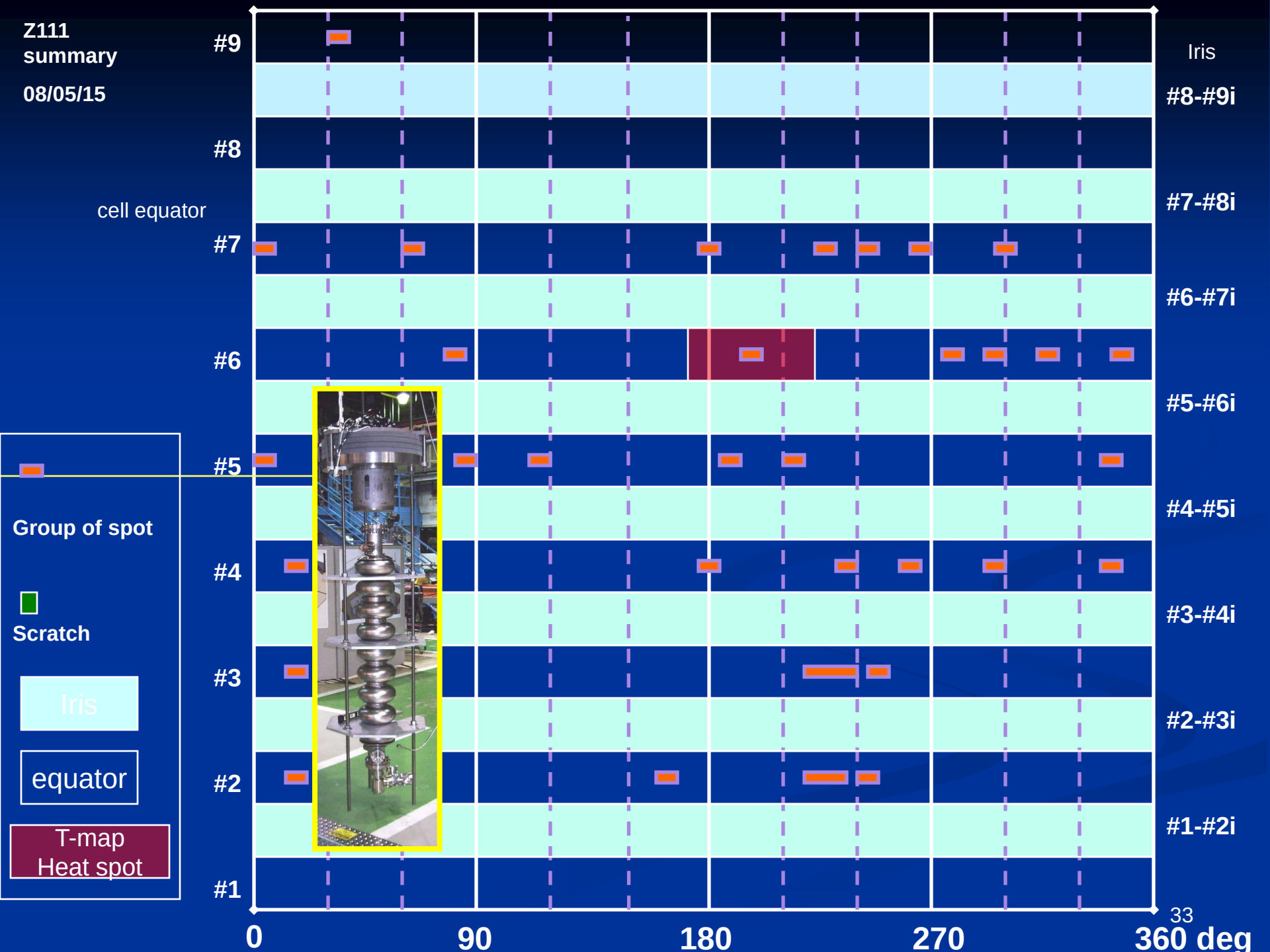






Iris Comparison(2): AC71 vs. Z110




Z111
summary
08/05/15
#9
#8
cell equator
#7
#6
#5
#4
#3
#2
#1
Iris
#8-#9i
#7-#8i
#6-#7i
#5-#6i
#4-#5i
#3-#4i
#2-#3i
#1-#2i
Group of spot
Scratch
Iris
equator
T-map
Heat spot
0
90
180
270
360 deg

Brief Summary

- All equator and Iris of AC71 were inspected by the Kyoto-camera in KEK.
- The maximum gradient attained was 40MV/m, however, it reduced to 26MV/m in the last test. Appearance of strong field emitter was suspected after 40MV/m result.
- EBW of AC71 are fine and smooth than Z110.
- There were several spots with small size and less bumpy.
- The scratch like trace was found on Iris between #1 cell and #2 cell.

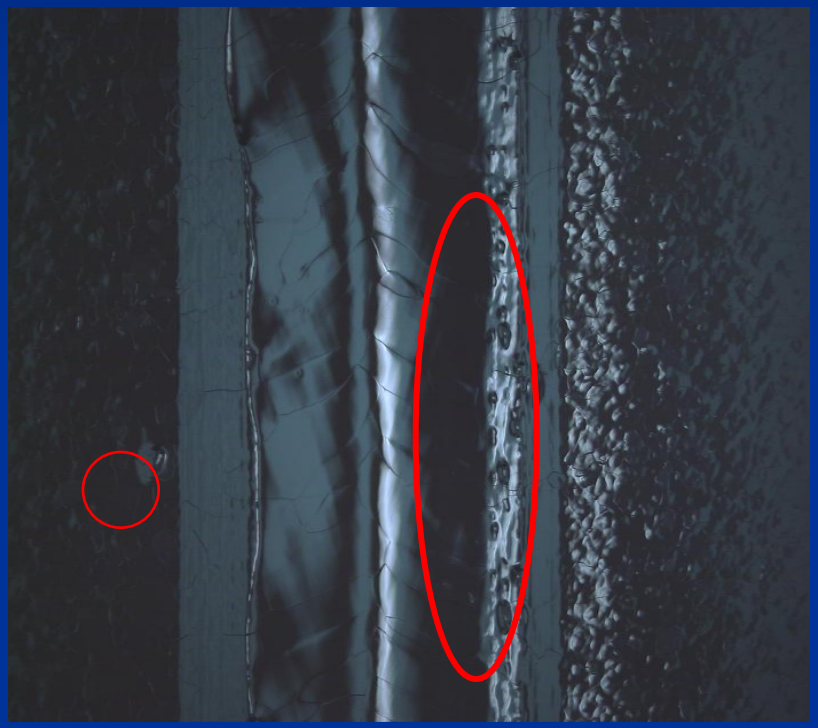
Z111 - Optical inspection

Examples of noticeable problems by comparison:

KEK - DESY

A. Muhs
30.06.2008

Cell 2: Equator at 132 degree

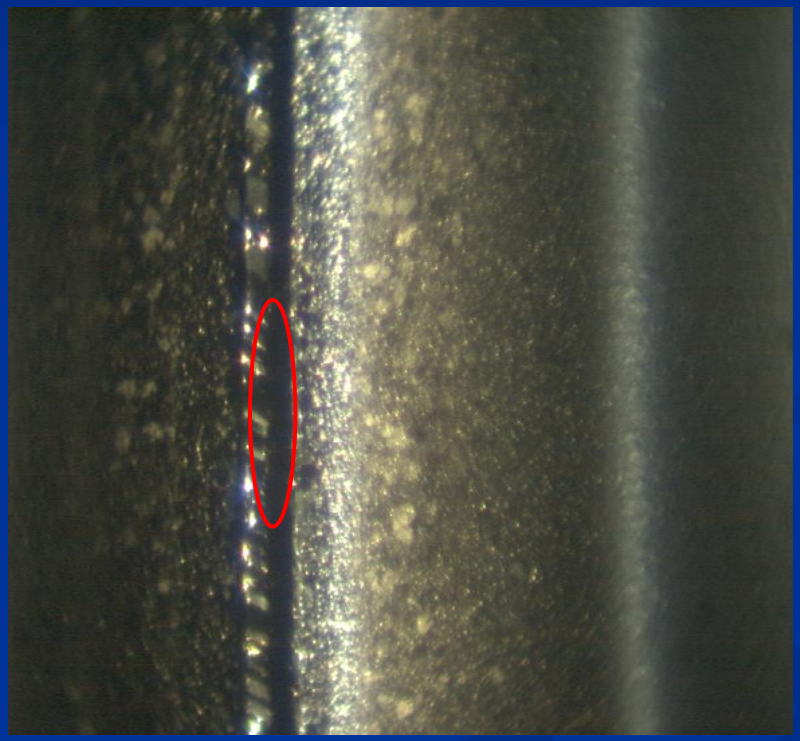


KEK

DESY

Cell 2: Equator at 251 degree

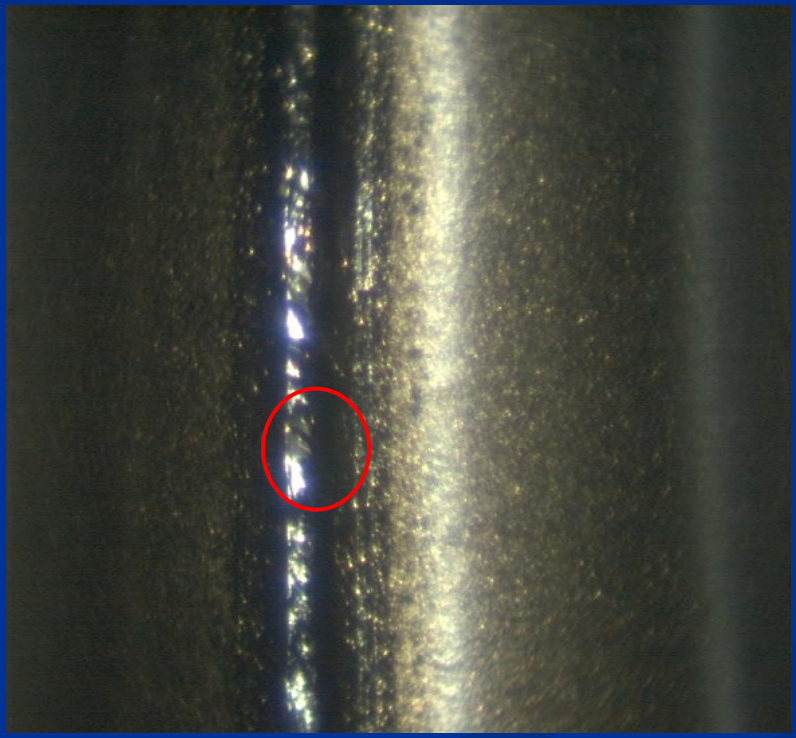
KEK



DESY

Cell 3: Equator at 264 degree

KEK



DESY

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		**Optical inspection**
		(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

w/o optical inspection

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		w optical inspection
		(Tumbling)	(Optical inspection)
Process	EP-1 (Bulk: ~150um)		
	Ultrasonic degreasing (detergent) or ethanol rinse		
	High-pressure pure-water rinsing		w 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
			w optical inspection

Process of STF-Baseline Cavities #5 and #6

2008/6 : Fabricated the STF Baseline cavities #5 and #6 by MHI.

First time of Inspection by using Kyoto camera (After fabrication)

2008/7 : Pre-EP (5 um) and EP-1 (20 um), Total removed about 25 um.

Second time of Inspection by using Kyoto camera (After Pre-EP and EP-1)

2008/8 : EP-1 (100 um), Total removed about 25 um + 100 um

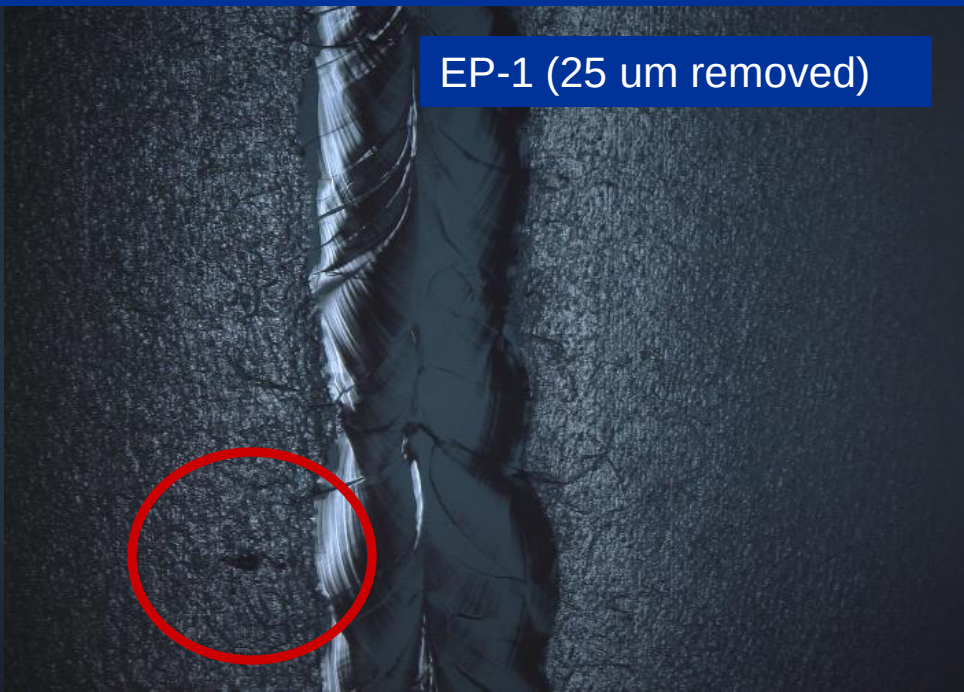
Third time of Inspection by using Kyoto camera (After EP-1)

Measurement and Analysis of the cat eye. (About STF Baseline #6 cavity)

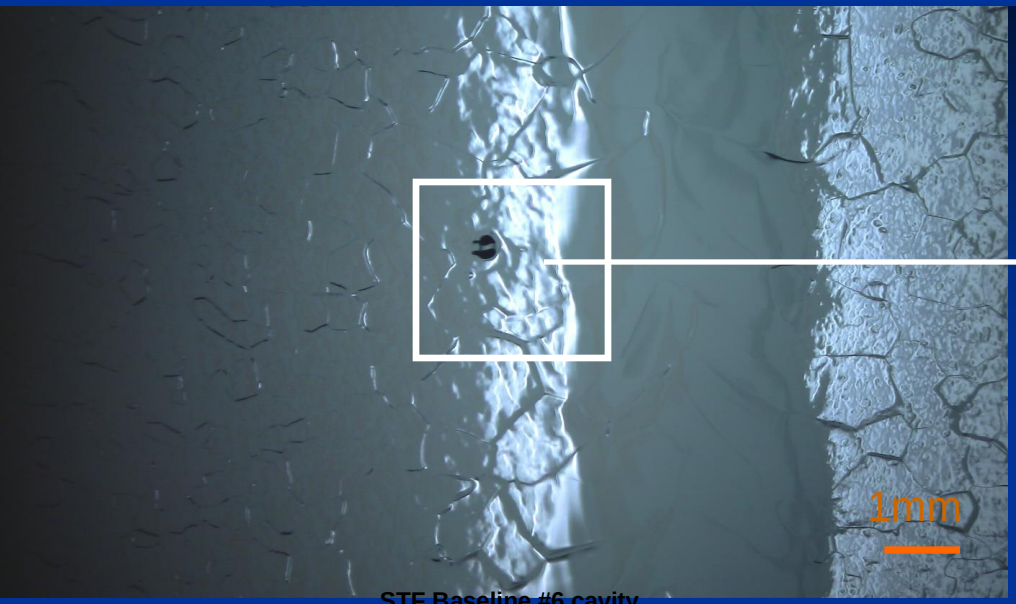
Five cat eyes found at equator,

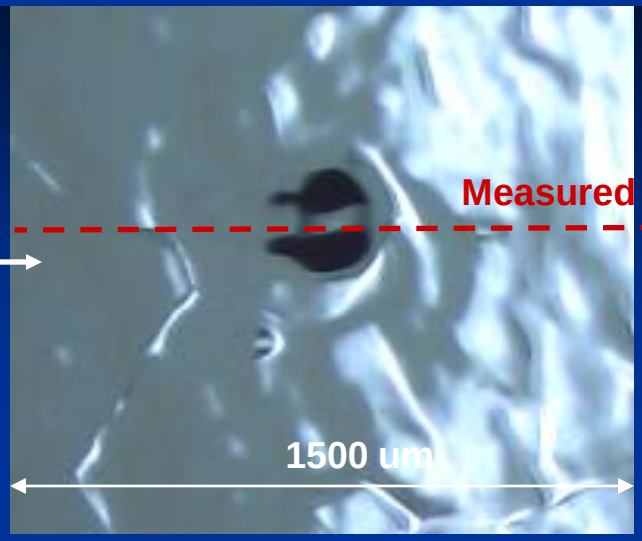
and Three cat eyes found at iris at STF Baseline #6 cavity.

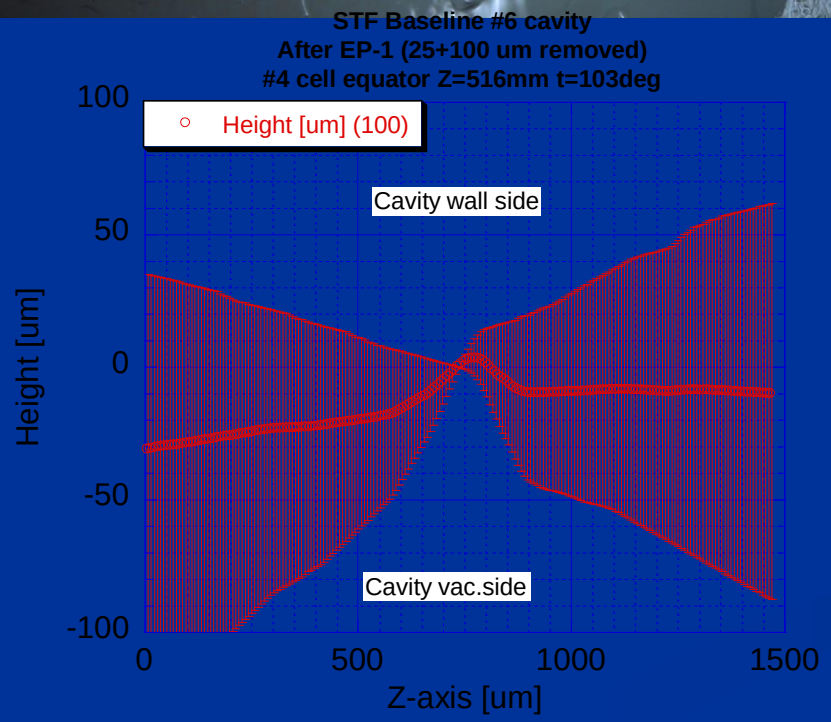
Comparison with each treatment
#4 cell equator, Z=516mm, t=103 deg

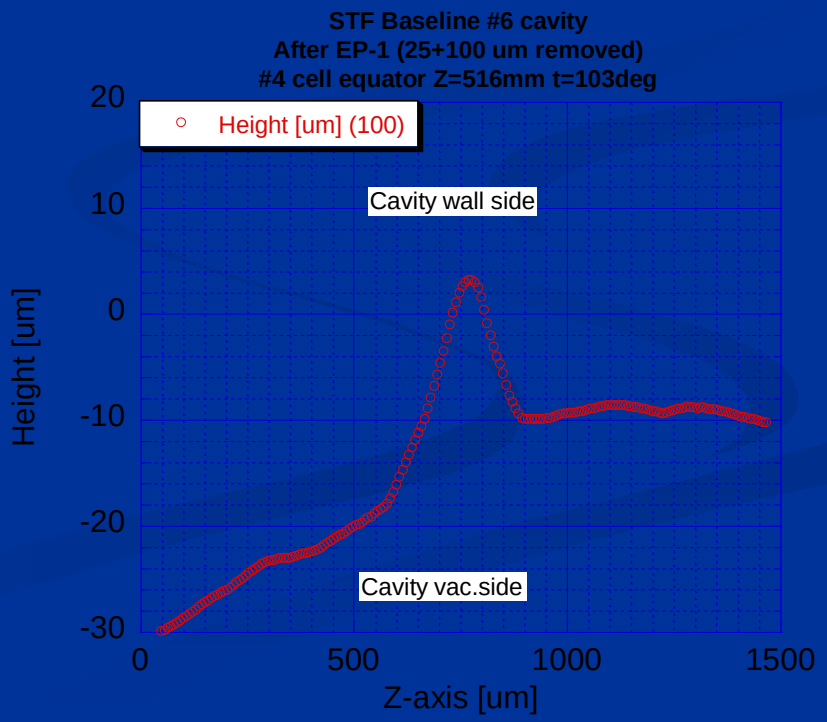


STF Baseline #6 cavity : #4 cell equator, Z=516mm, t=103 deg

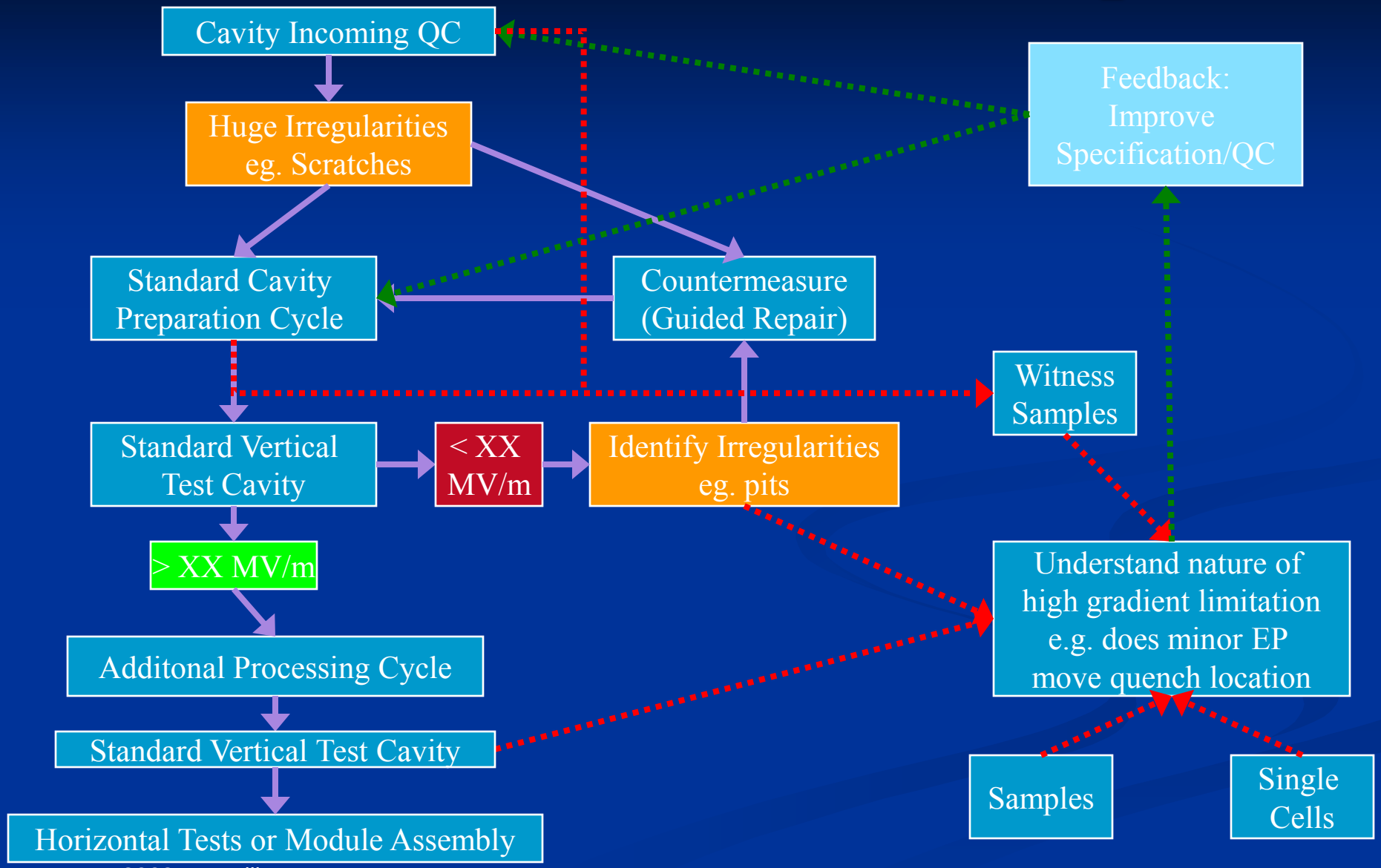








ILC S0 Feedback Loop



To share the best recipe

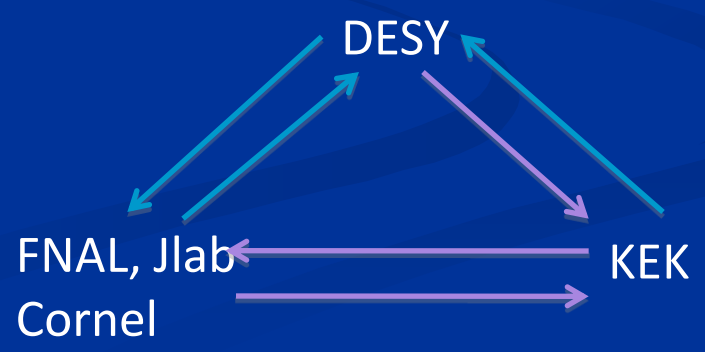
Laboratory credibility for the cavity process/test is important,
to make confident;

- cavity exchange,
- visit and participate process and test,
- open information of the lab recipe,
- share data-base of cavity test,

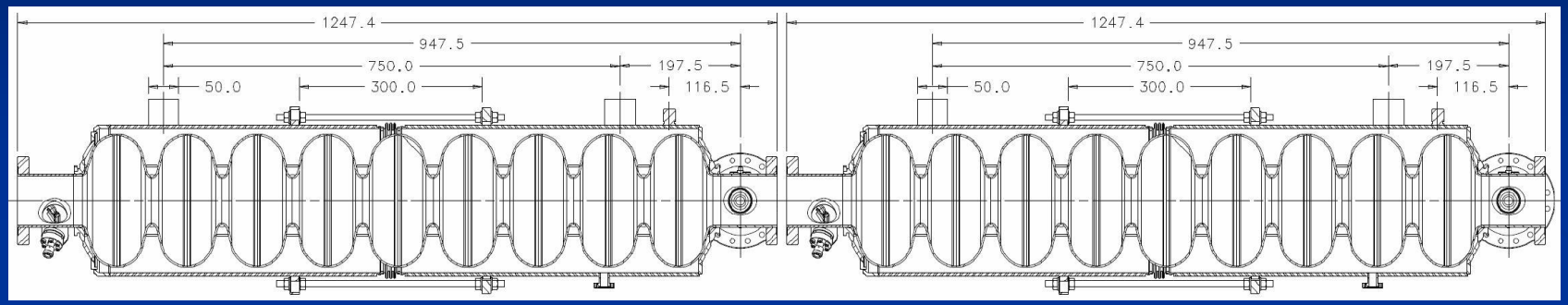
Cavity exchange, so far:

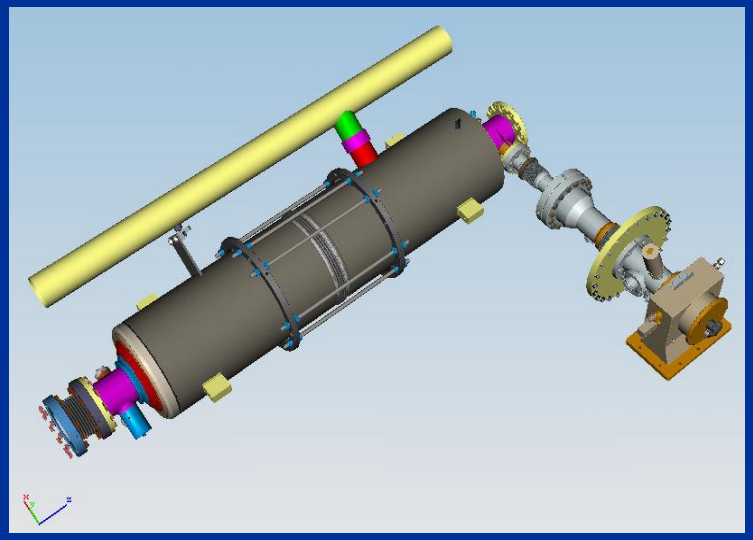
KEK Ichiro#5 (Nomura-process&tested) → Jlab (process&tested) → KEK
FNAL AES01 (process&tested) → KEK (waiting STF facility up)
DESY AC71,74,80 (process&tested) → KEK (waiting STF facility up)

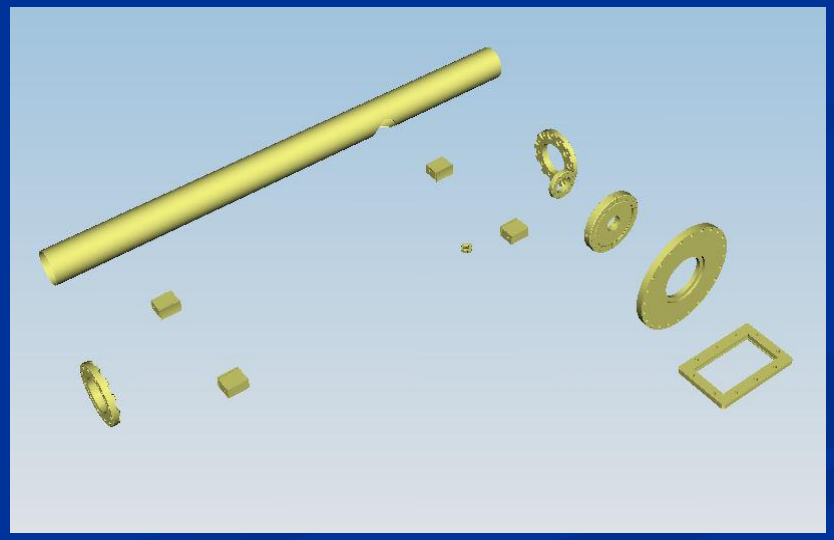
remaining pass : DESY →FNAL
FNAL → DESY
KEK → DESY



Plug-compatibly of Cavities
Important for Global Cooperation

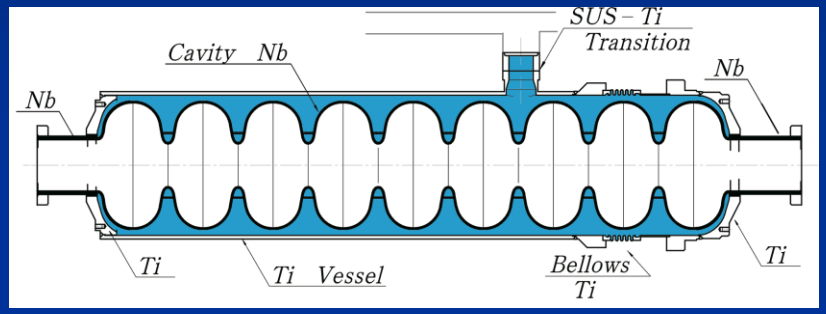


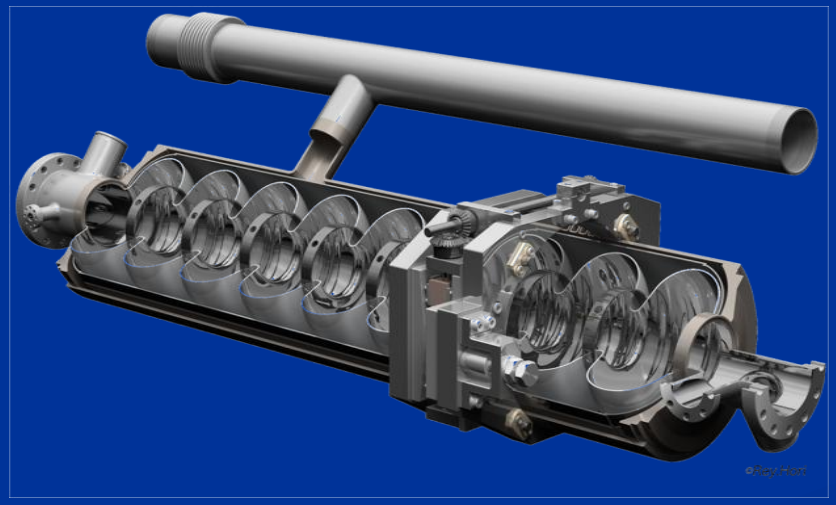




Plug-compatible interface need to be established

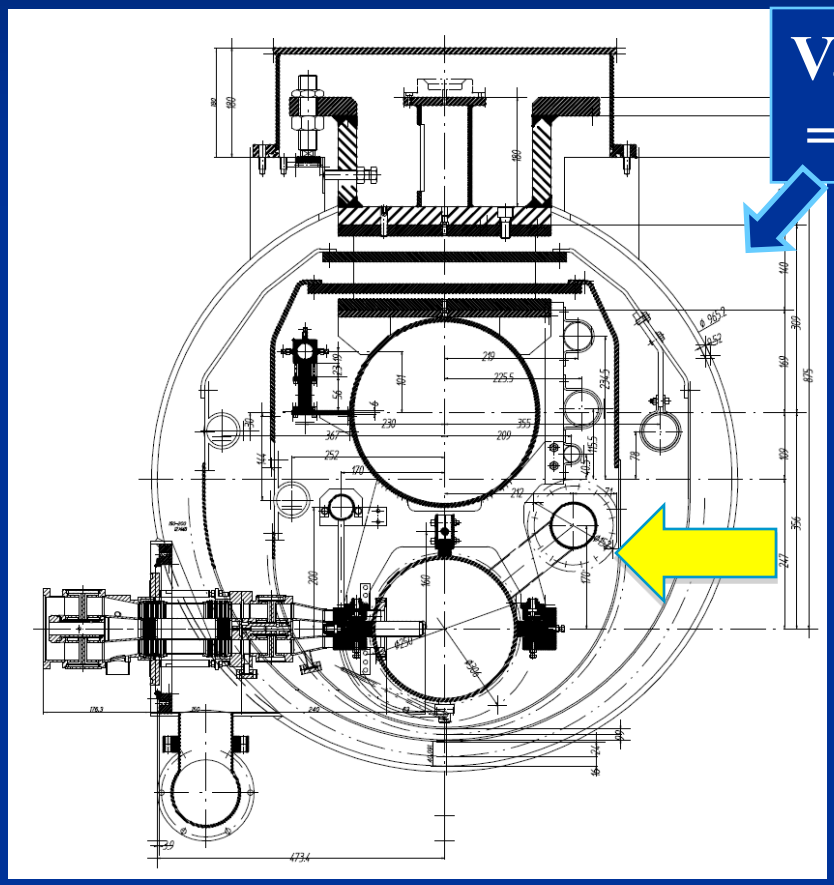
Plug compatible conditions at Cavity package (example)



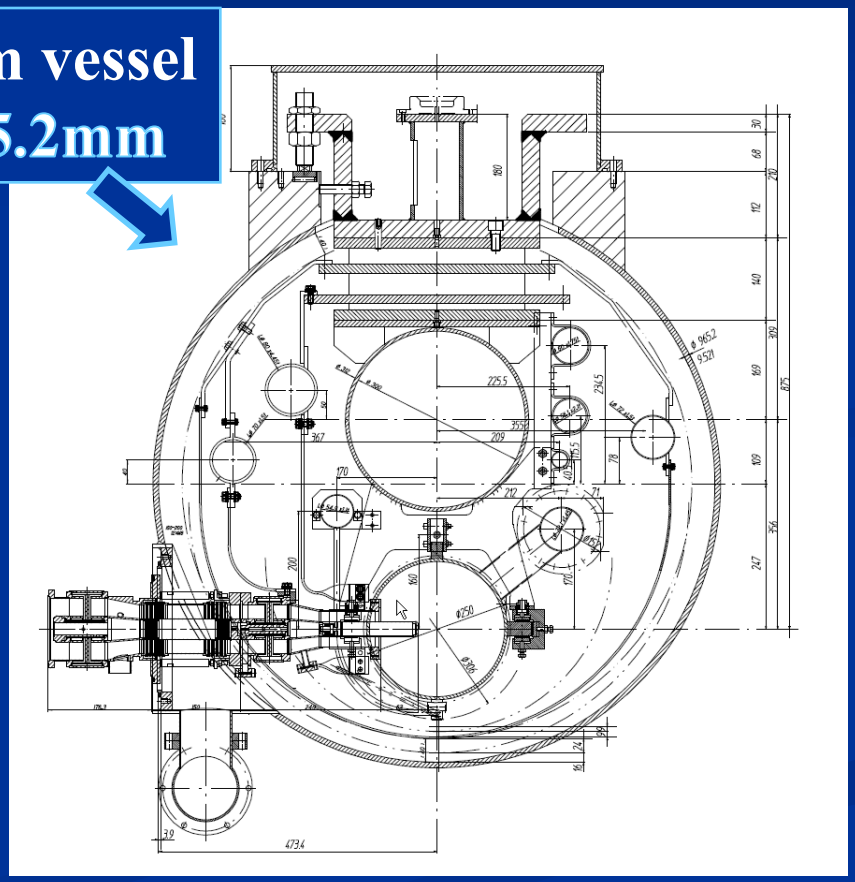


Item	Can be flexible	Plug-compatible
Cavity shape	TeSLA/ LL/ RE	
Length		Required
Beam pipe dia		Reuuired
Flange		Required
Tuner	0	
Coupler flange		Required
He –in-line joint		Required
Input coupler	TBD	TBD

Study of the "plug-compatible" cryomodule cross-section



Vacuum vessel = ϕ 965.2mm



Two shields model based on TTF-III

One shield model to save fabrication cost

Intending "plug-compatibility"

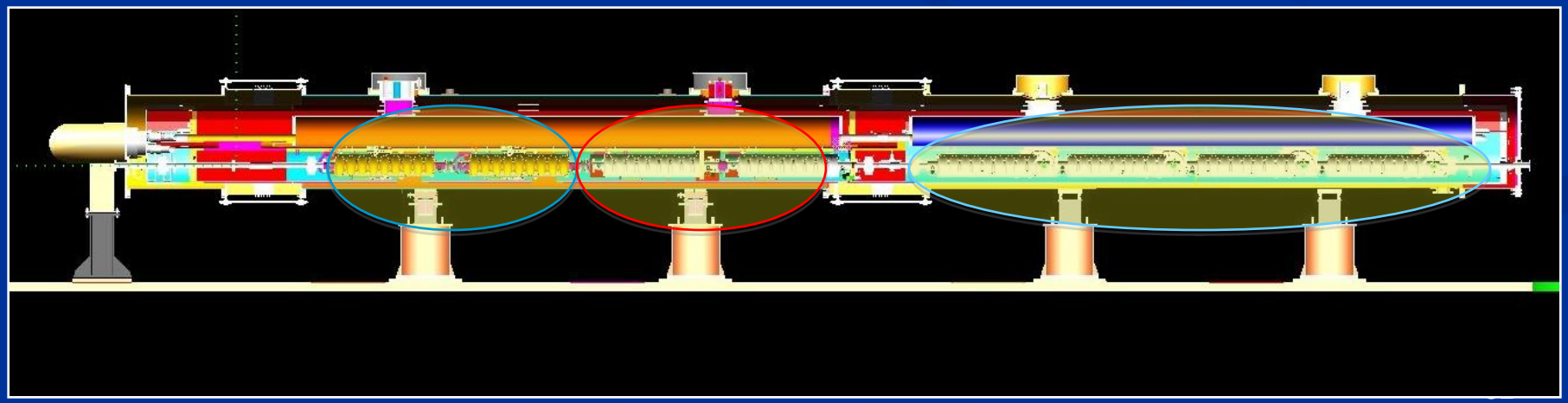
- **Cavity**
  - Status: still in "basic research" to improve field gradient (limit),
  - Establish: unified interface conditions,
  - Keep: "room" to improve field gradient,
- **Cryomodule**
  - Status: ready for "system engineering"
  - Establish: unified interface conditions,
  - Intend: nearly identical engineering design
  - But: need to adapt to each regional industrial constraints (for example: High Pressure Code)

Why "Plug compatible" Integration and Engineering ?

- Encourage R&D effort specially to improve the "gradient"
  - **Cavity Type:** Tesla, Low-loss (Ichiro), Re-entrant
  - **Material:** Fine-grain or large grain
  - **Preparation:** EP, Rinsing,
  - **Tuner type:** various designed w/ various arguments,
  - **Input-coupler:** Fixed, Tunable, However,
- **The "plug –compatible" concept is important,**
  - Beam pipe, cryogenics, and RF connections: **need to be "plug-compatible"**
  - Cavity-Integration in Cryomodule: R&D in global effort

Cavity and Cryomodule Performance Test with Plug Compatibility, in Global Effort

- Cavity integration and the String Test to be organized with:
  - 2 cavities from DESY and Fermilab
  - 4 cavities from KEK
  - Each half-cryomoducle from INFN and KEK

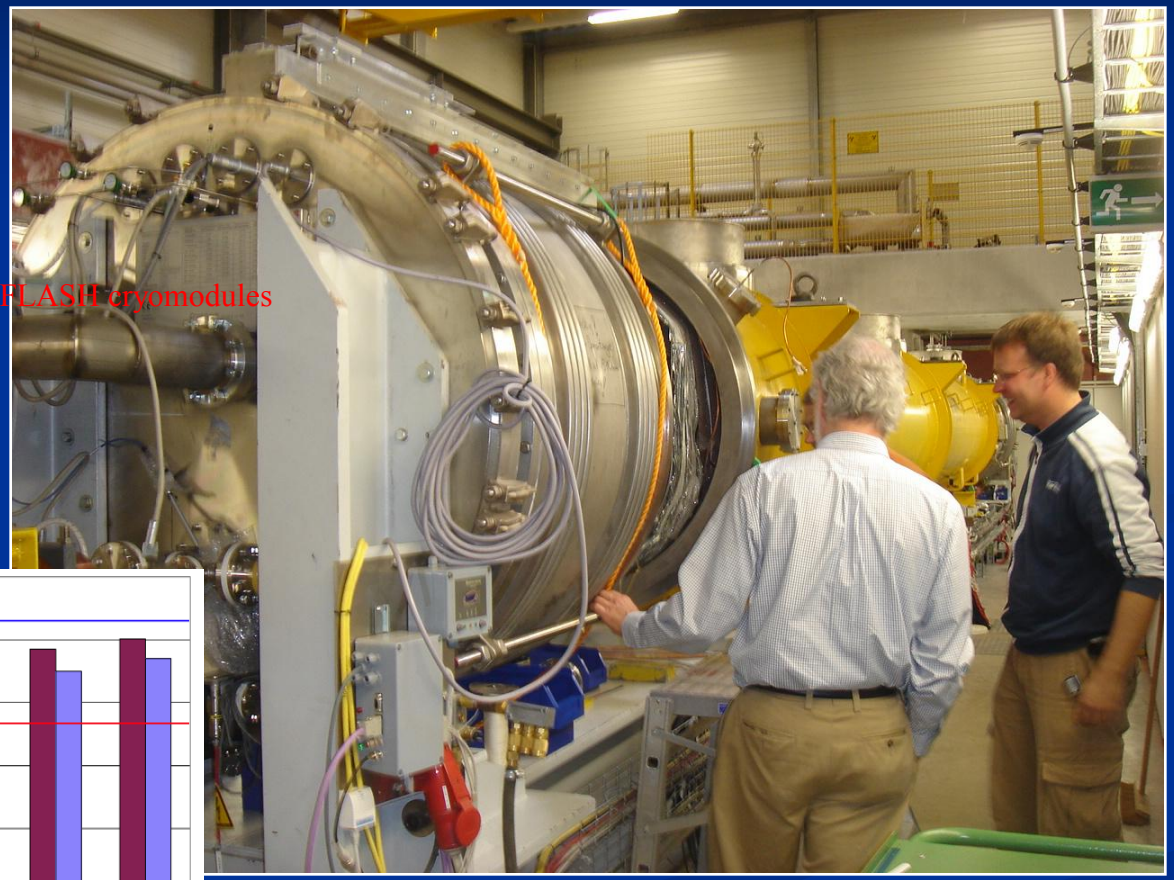


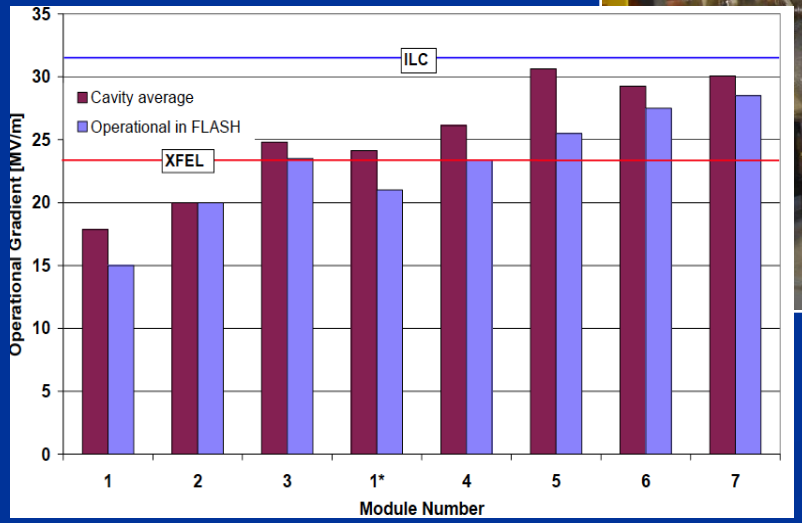
Status of Major Fabrication/Test Facilities

Facility	Host Lab	Operation start
TTF FLASH	DESY	1997~
STF	KEK	2007~2008
ILCTA-ML	FNAL	2008~2009

TESLA/FLASH at DESY

Experiences being gained from TELA/FLASH are critical inputs for ILC:





First nine-cell electro-polishing performed at ANL, May, 2008
Fermilab/ANL Collaboration

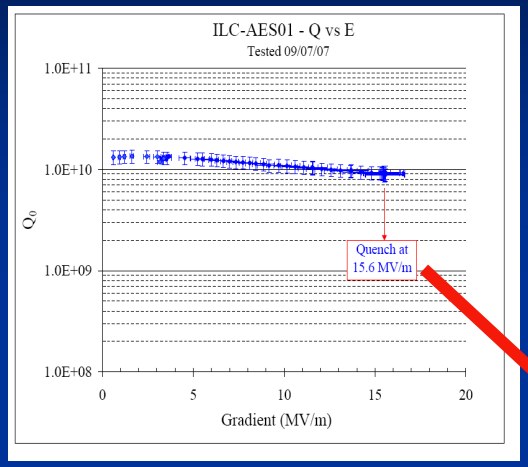
- ACCEL cavity A7 electro-polished at ANL, and
- Further process and tested at Jlab.

Photos courtesy of Mike Kelly

New Vertical Test @FNAL

- Recently commissioned (IB1)
  - Existing 125W@1.8 K Cryogenic plant
  - RF system in collaboration with JLab
  - Evolutionary upgrades:
    - Thermometry for 9-cells
    - Plan for two additional VTS cryostat

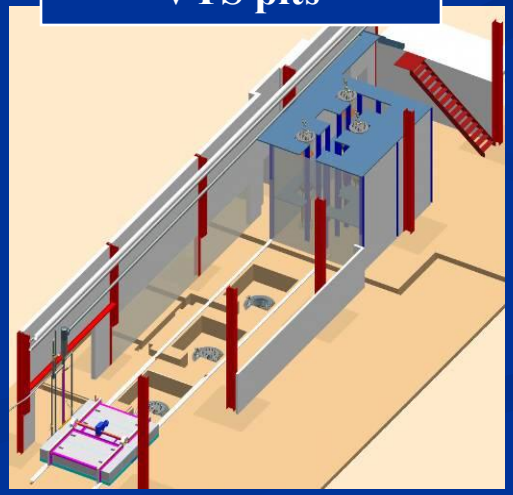
Nine-cell Tesla-style cavity



VTS Cryostat:IB1

New RF & Control Room

Plan for 2 more VTS pits



Cryomodule Assembly Facility at FNAL

- Goal:
  - Assemble R&D Cryomodules
- Infrastructure:
  - Clean Rooms, Assembly Fixtures
  - Clean Vacuum, gas, water & Leak Check
- T. Arkan et al., "Cryomodule assembly and cryomodule assembly facility in Fermilab, this conference, 2LPR06.

ICB clean: Final Assembly fixtures installed

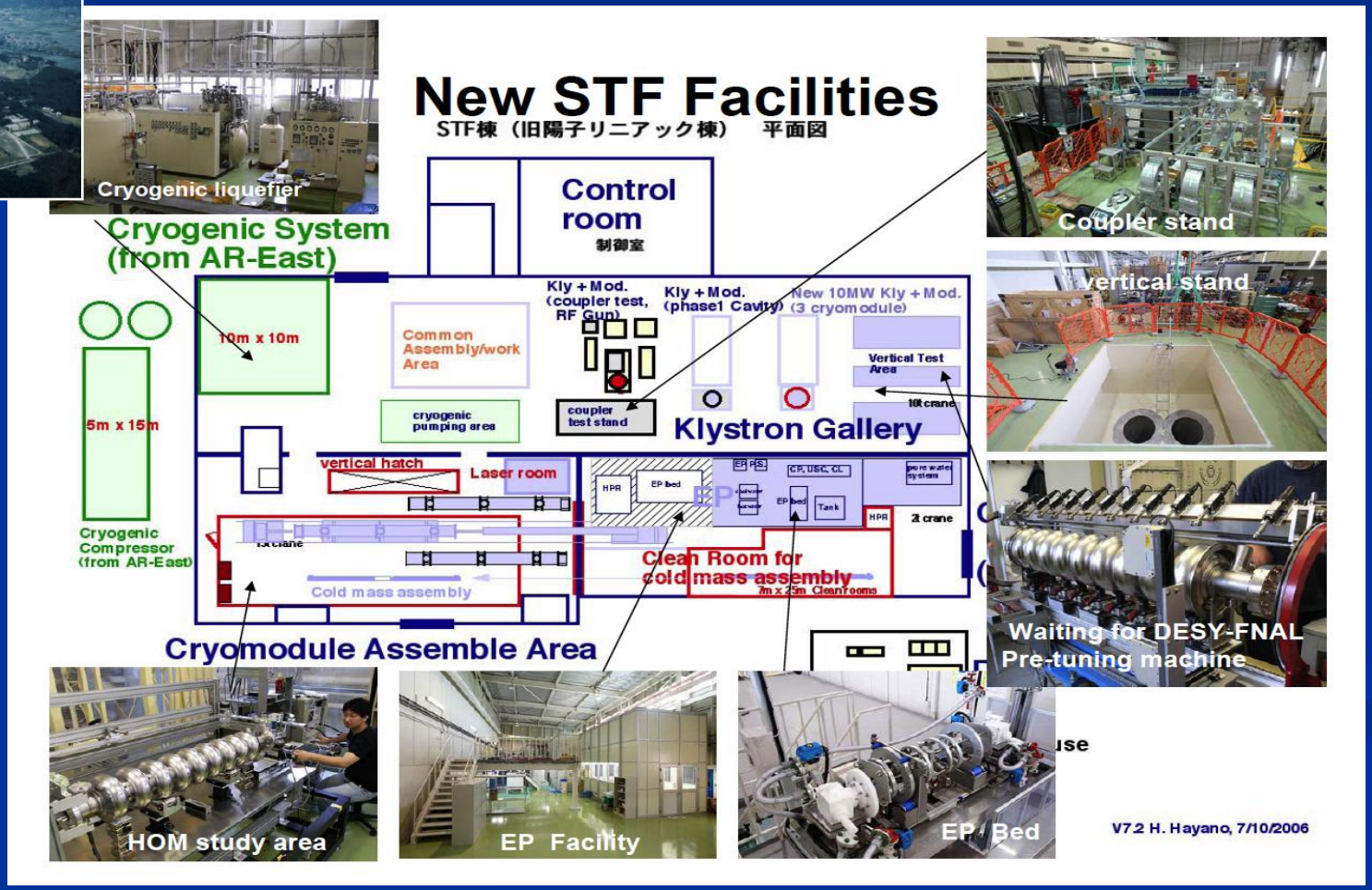
MP9 Clean Room

String Assembly

Cavity string for 1st CM

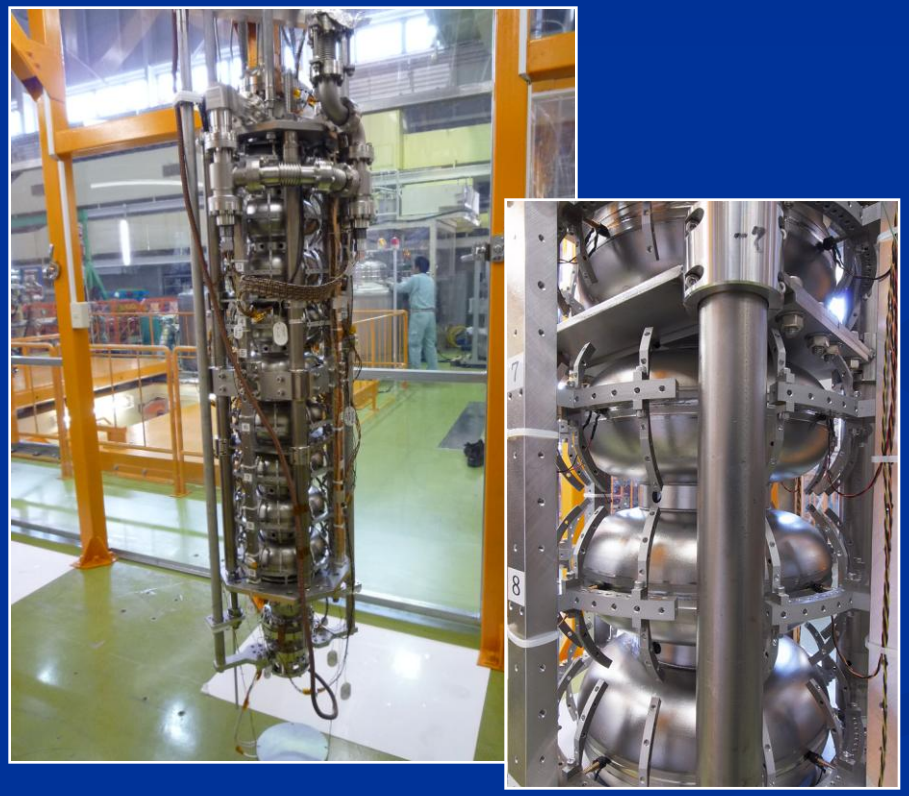
1st U.S. built ILC/PX Cryomodule

KEK: SCRF Test Facility (STF)



STF: Vertical Test Commissioning at KEK

- cool-down test of cryostat was done July 3 – 5, using AES01 cavity.
- EP at STF-EP facility, vertical test again in September.



AES01 cavity with T-map

Installation into vertical cryostat

Beam Acceleration Test (Plan)
with RF unit at DESY, FNAL and KEK

ILC RF unit test, in the existing STF tunnel,

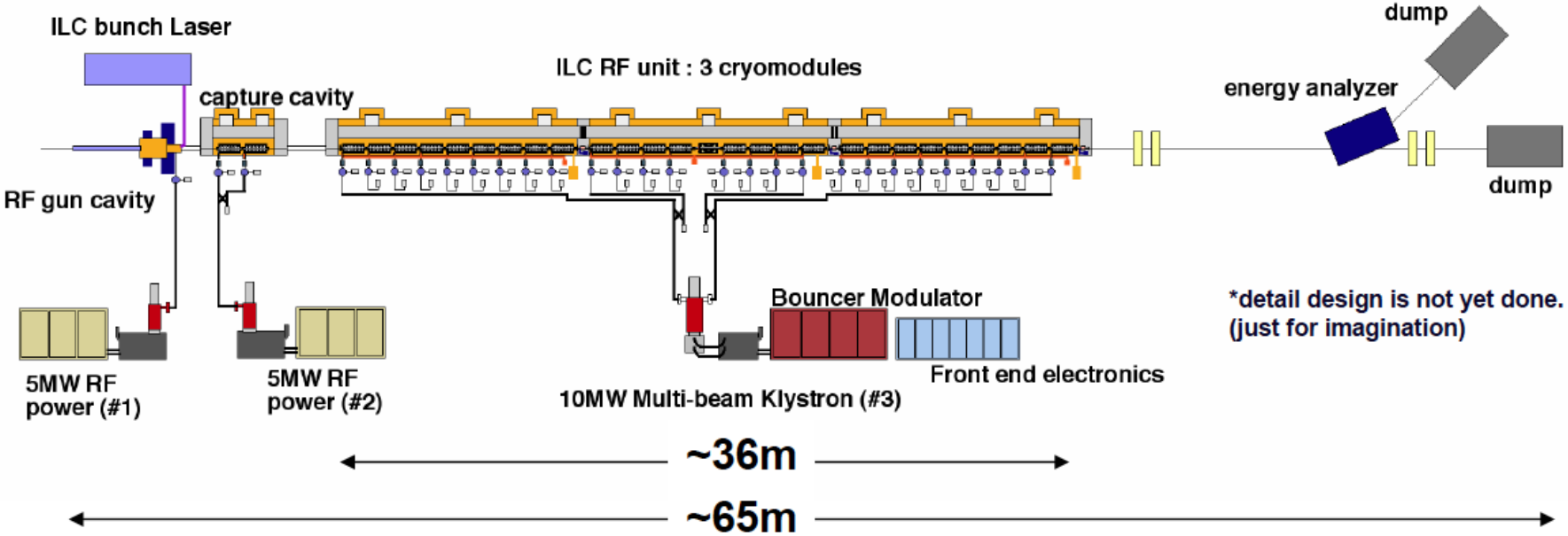
With ILC beam by L-band RF-gun.

design and preparation of vessel code : 2008

fabrication : 2009 - 2010

operation : 2011

STF Phase 2 Plan



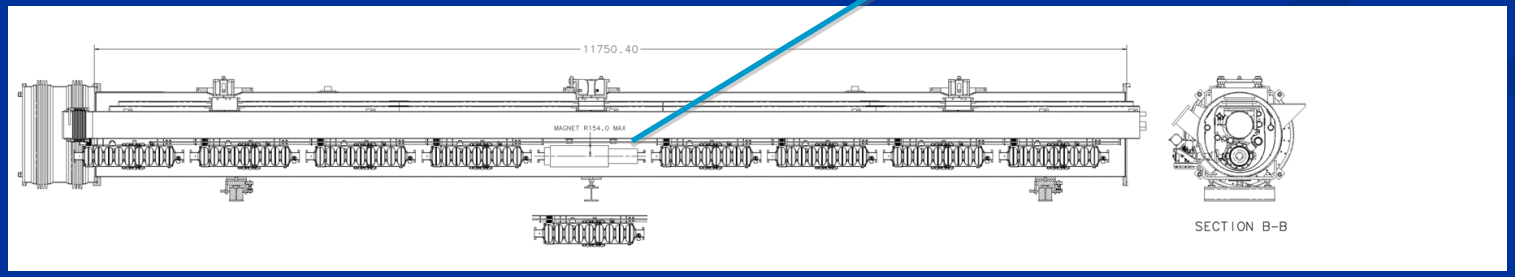
*detail design is not yet done. (just for imagination)

Superconducting Magnets for Beam Focusing and Transport

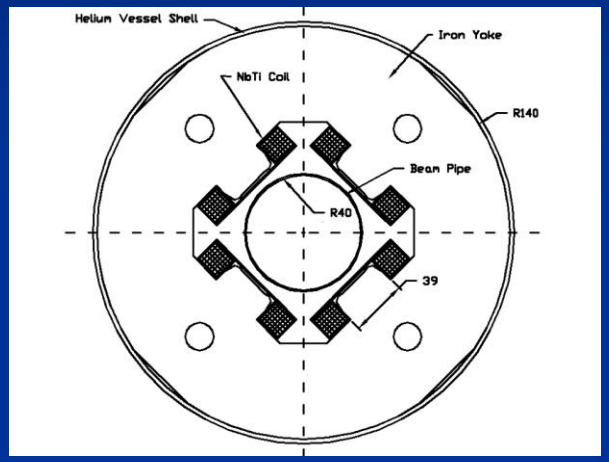
- **Components in Cryomodule**
  - G-integral : 36 T
    Aperture: 78 mm
  - Alignment: < 100 nm

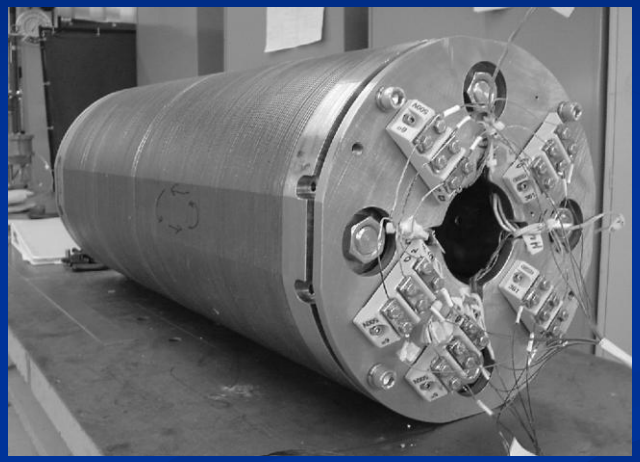
TABLE IV QUADRUPOLE SPECIFICATION.

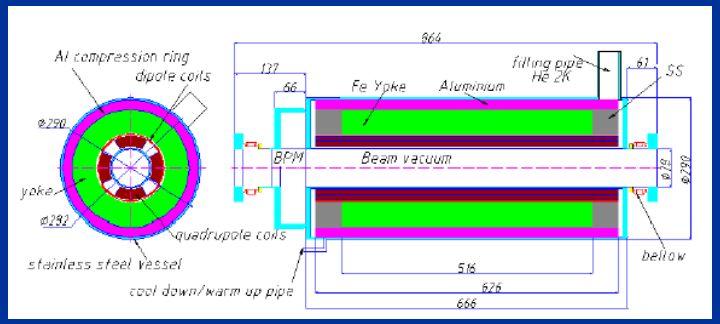
Parameter	Value
Integrated peak gradient	36 T
Aperture	78 mm
Effective length	660 mm
Peak gradient	54 T/m
Field non-linearity at 5 mm radius	0.05 %
Dipole trim coils integrated strength	0.075 T-m
Magnetic center stability	5 μm
Vertical/azimuthal offset in cryomodule	0.3 mm/0.3 mrad
Quantity required	560



Quadrupole R&D Work at Fermilab and SLAC/CIEMAT



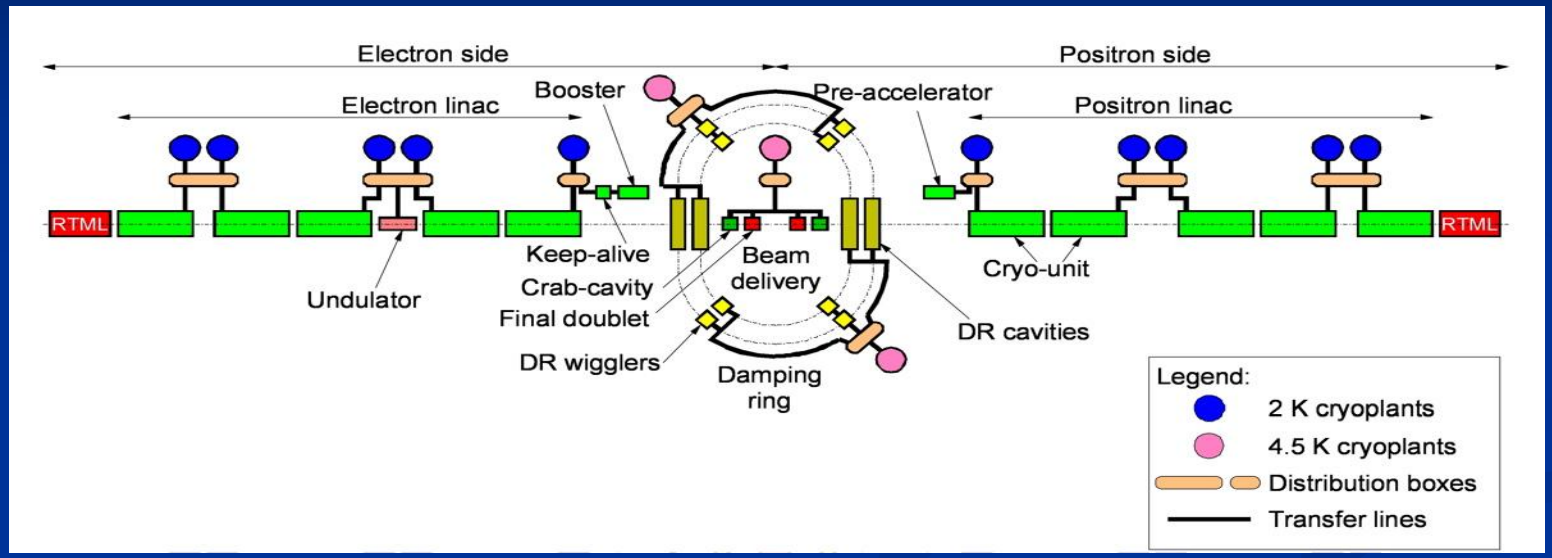




- **Fermilab: V. Kashikhin et al.,**
  - Test results of superconducting quadrupole model for linear colliders
  - **This conference, 4LPA01,**
- **SLAC/CIEMAT: C. Adolphsen et al**

2K Cryogenics Engineering

Scale is equivalent to the LHC cryogenics!!

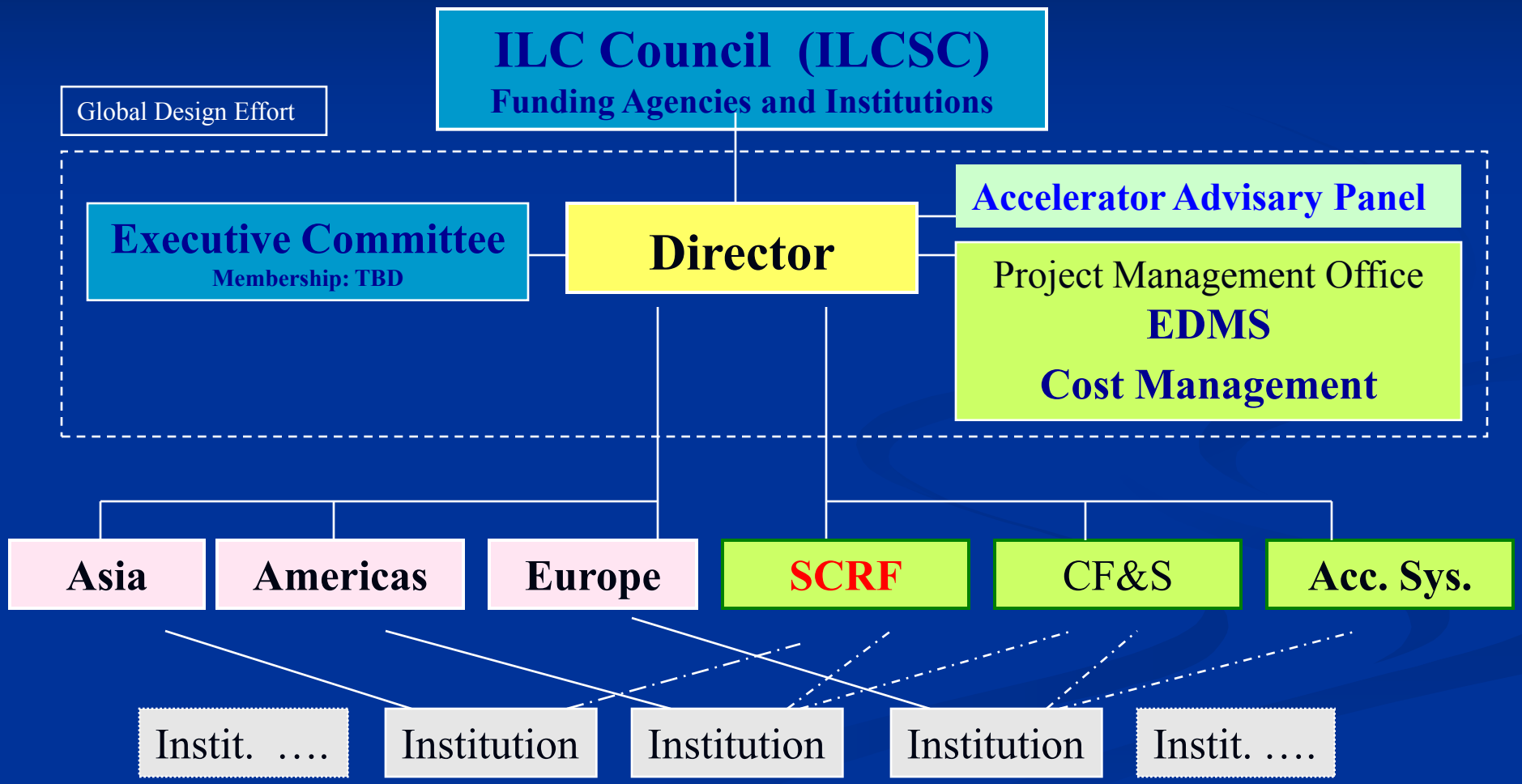


Volumes	Numbers	Liq. He (liter) equivalent	Tevatron eq.	LHC Eq.
One module		346.1		
String	12 modules	4,153	0.1	
Cryo. unit	14-16 strings	62,992	1.0	0.1
ILC ML	2 x 5 cryo. units	630,261	10.5	0.8

Outline

- **Introduction**
- **R&D Status**
  - Fundamental research (with single cell cavities)
  - Progress in 9-cell cavities
- **Plan for Technical Design Phase**
  - Cavity Gradient,
  - Plug-compatible Engineering
- **Global Plan and Effort**
- **Summary**

ILC-GDE Project Management in TDP



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)	

R&D and technical design phase **to be completed in 2012.**

TD Phase 1 Schedule

Published in:
ILC Research and Development Plan for the Technical Design Phase

Release 2, June 2008
(next release 6 months)

Near term effort on these activities

Value engineering

Value engineering

Global Project Plan

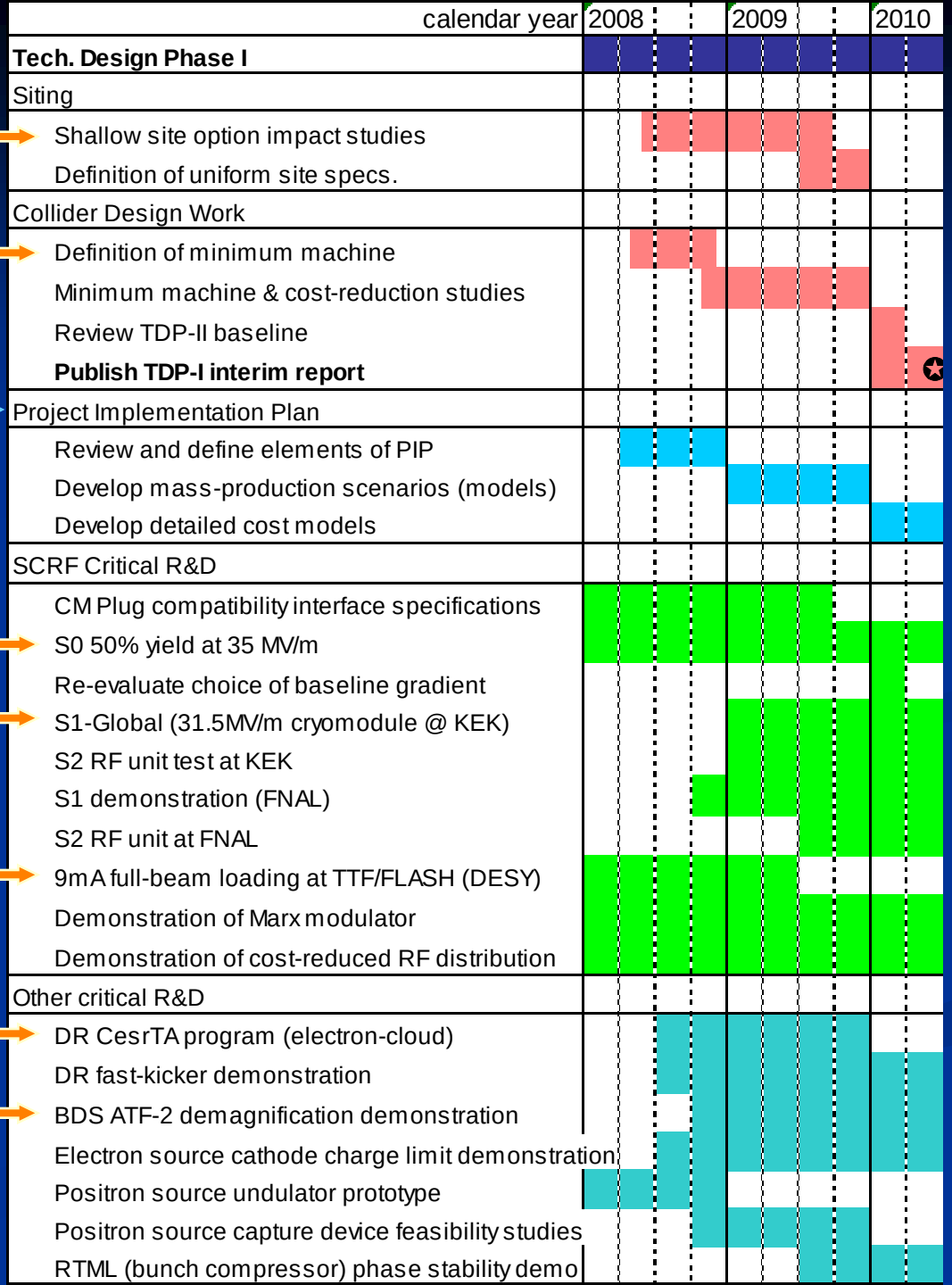
High Gradient

Cryomodule test

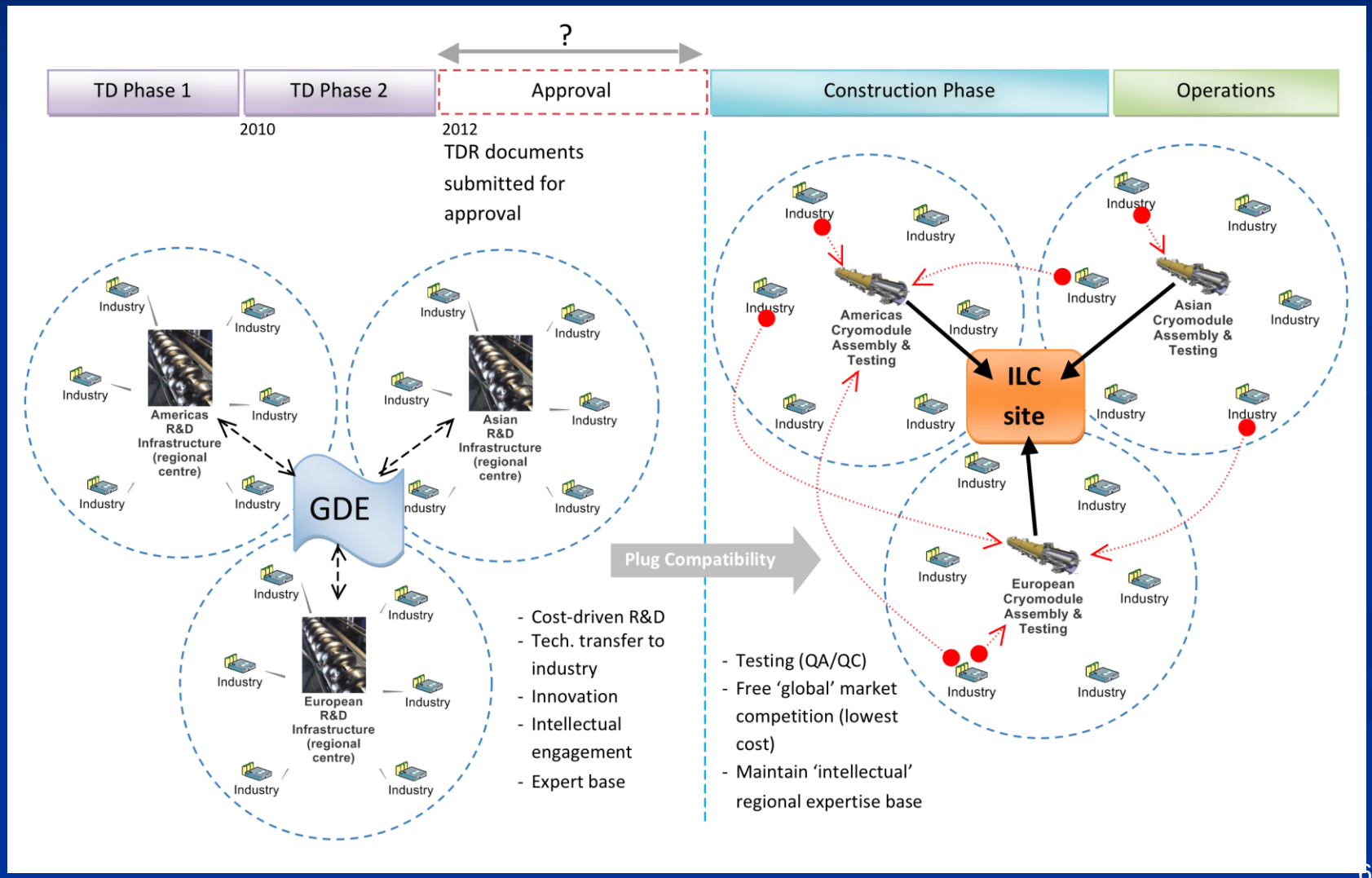
Systems Test

Electron Cloud

Precision beam control



Global Cooperation with Plug-compatible Design and R&Ds



Cooperation with EuroXFEL and Other Projects

European X-ray Free Electron Laser Facility

- EuroXFEL SRF design gradient： 25 MV/m
- ~ 100 SCRF cryomodule, based on the experience at TTF, DESY,
- Leading SCRF industrialization (scale: 1/20 of ILC, in coming 5 years)
- Keep close cooperation with XFEL, on-going project.

Further SCRF Accelerator Project Plans investigated:

- Project X at Fermilab, SC Proton Linac at CERN, and ERL at KEK

Cooperation with the US Laboratories

- Cavity R&D
  - Cavity fabrication: Grain-size, Forming, EBW
  - Surface preparation: Degreasing,
  - Inspection: optical and surface analysis
  - Improvement of Yield: more stability and statistics
  - Plug-compatible cavity design
- Cryomodule
  - Thermal balance : if 5 K shield necessary?
  - Plug-compatible engineering
- Cryogenics
  - Engineering for the best thermal balance

Further Important Collaboration with JLab

- Cavity
  - Material: Large-grain/ single crystal
  - Residual defect: Forming, EBW?
  - Surface process: degreasing, Atomic deposition,
    - Plug-compatible R&D for future application
- Cryogenics
  - Engineering for the best thermal efficiency
- High-pressure system design
  - Consistent engineering and experimental data
  - Nb-SUS joints

A basic Research cooperation expected
- ALD Coated Surface R&D -

SRF Materials: First Acceleration Test of ALD Coated Cavities

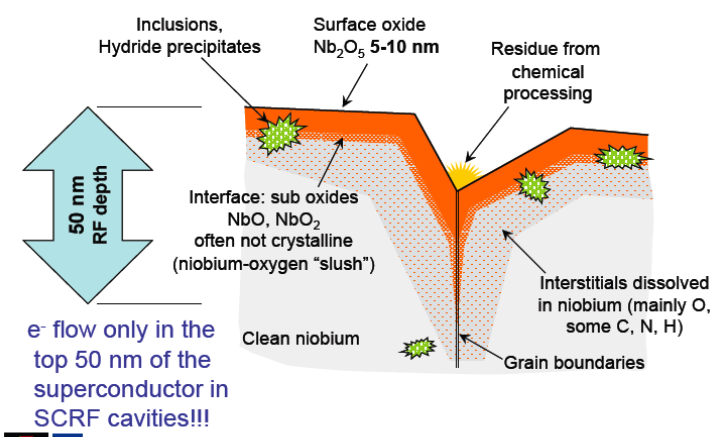
Mike Pellin

Acting Director, Materials Science Division, Argonne
Chemistry Department, Northwestern University

Proslier[1,2], Norem[3], Zasadzinski[2], Kneisel[5], Rimmer[5], Cooley[4], Antoine[4]

1. Materials Science Division, ANL
2. Department of Biological, Chemical and Physical Sciences, IIT
3. High Energy Physics, ANL
4. Technical Division, FNAL
5. J-Lab

Niobium surfaces are complex



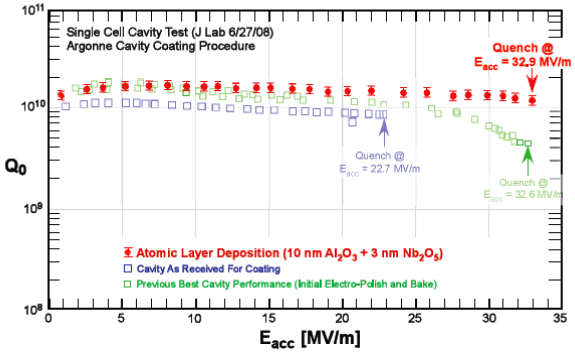
e^- flow only in the top 50 nm of the superconductor in SCRF cavities!!!

Thin Film SCRF Conference; JLab, July 22-25, 2008

Cavity Experimental Plan

1. Obtain a Single Cell Cavity from JLab
   a) "good" performance
   b) Tested several times
2. Coat cavity with 10 nm's Al_2O_3, 3 nm Nb_2O_5
   a) Niobia to reproduce original cavity surface
   b) Dust, clean room care
3. Acceleration Test at J Lab
   a) First test of ALD on cavities
   b) Check for "stuck" dust, high pressure rinse difficulties, material incompatibilities, etc.
   c) Goal: No performance loss
4. Bake @ F

J Lab Cavity: After ALD Synthesis (10 nm Al_2O_3 + 3 nm Nb_2O_5)



- Only last point shows detectable field emission.
- 2nd test after 2nd high pressure rinse. (1st test showed field emission consistent with particulate contamination)

Thin Film SCRF Conference; JLab, July 22-25, 2008

Summary

- **Technical Design Phase in progress:**
  - Phase-1: Technical reality to beexamined,
    - 35 MV/ m with yield 50 % for 9-cell cavity and
    - < 31.5 MV/ m> with the cavity-string in a cryomodule
    - Plug-compatible crymodule to be examined with global effort.
  - **Phase-2: Technical credibility** to be verified
    - 35 MV/ m with the yield 90 % for 9-cell cavity field gradient of
    - System engineering and beam acceleration with one RF unit and 3 cryomodules with the field gradient <31.5> MV/ m.
- **We aim for**
  - Global cooperation for the ILC SCRF technology with having plug-compatibility, and with scoping smooth extension to the ILC construction/ production phase.

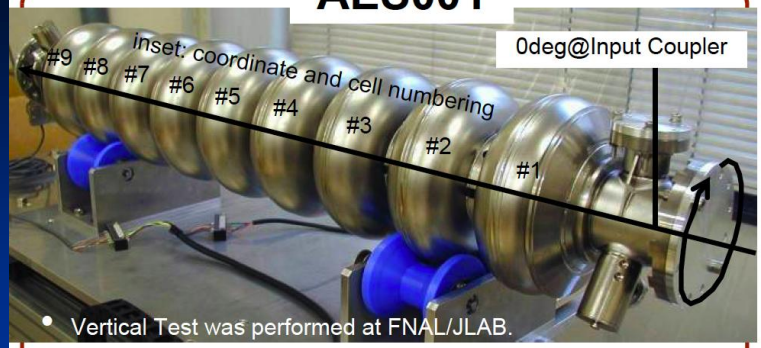
FINAL (080708): Guideline: Standard Procedure and Feedback Loop

	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		(scan for large irregularities)
		(Tumbling)	(Optical Inspection)
Process	EP-1 (Bulk: ~150um)		
	Ultrasonic degreasing (detergent) or ethanol rinse		
	High-pressure pure-water rinsing		(high-resolution)
	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**

w optical inspection

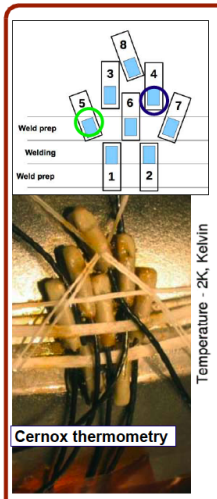
w/ optical inspection

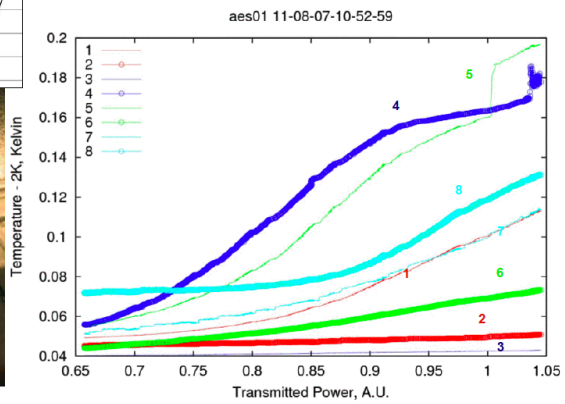
AES001



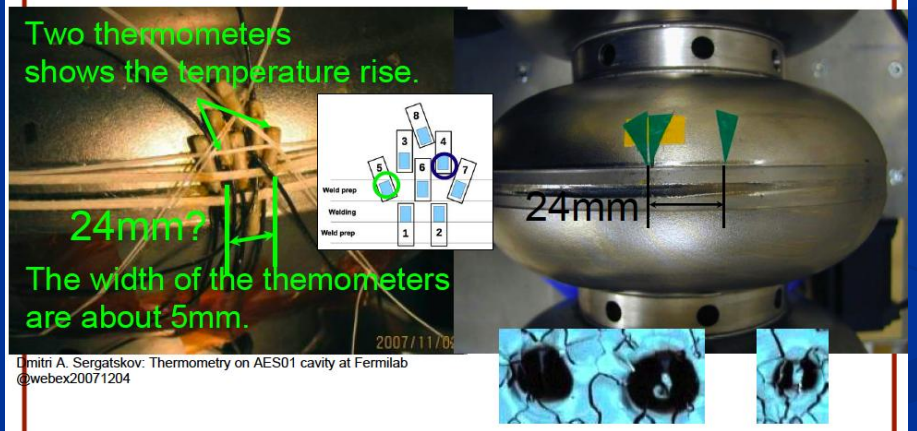
- Vertical Test was performed at FNAL/JLAB.
- Quenched at Eacc~15MV/m without field emission(no Xray).
- Passband mode measurements shows that #3 and #7 cell are suspicious.
- In CERNOX measurements two hot spots were found at the equator region of #3 cell.

AES001 has hard quench at 15MV/m, where its location was identified by Cernox at FNAL.



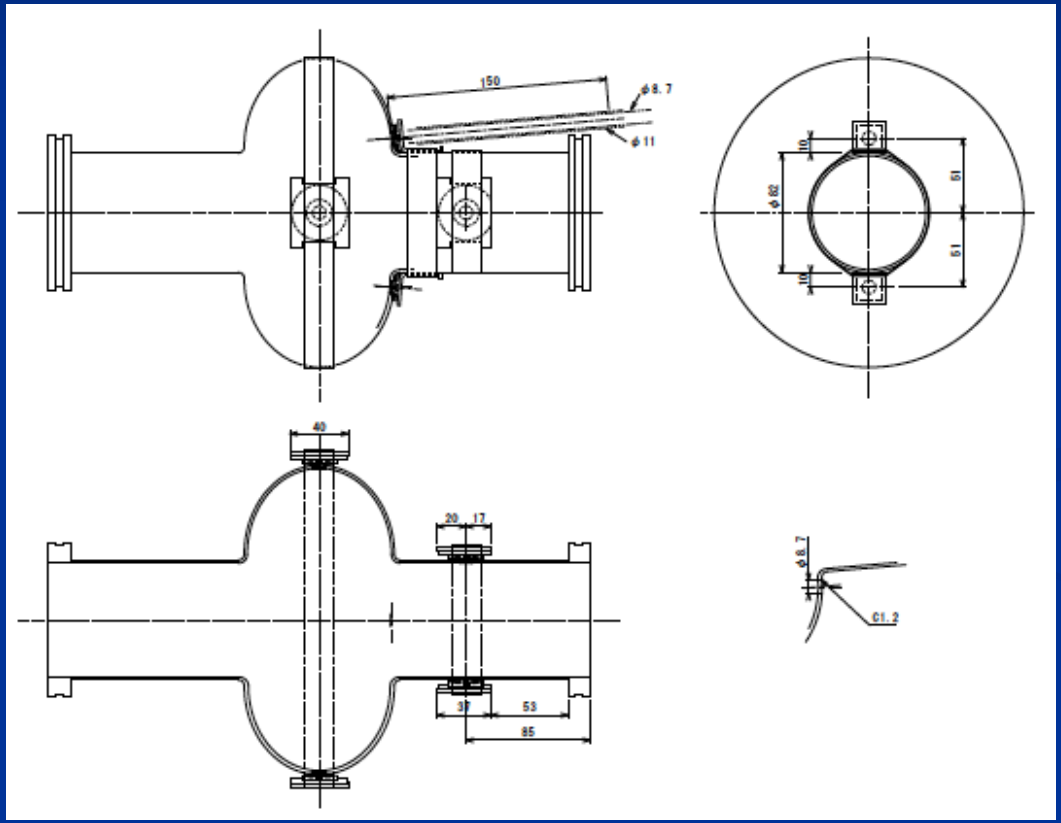


Correlation with Thermometry



Dmitri A. Sergatskov: Thermometry on AES01 cavity at Fermilab @webex20071204

Two hot spots@FNAL/JLAB

Three spots found@Kyoto

Basic Research: Sample Tests JLab-KEK cooperation