TILC09, 04212009

Parallel session summary ML/SCRF

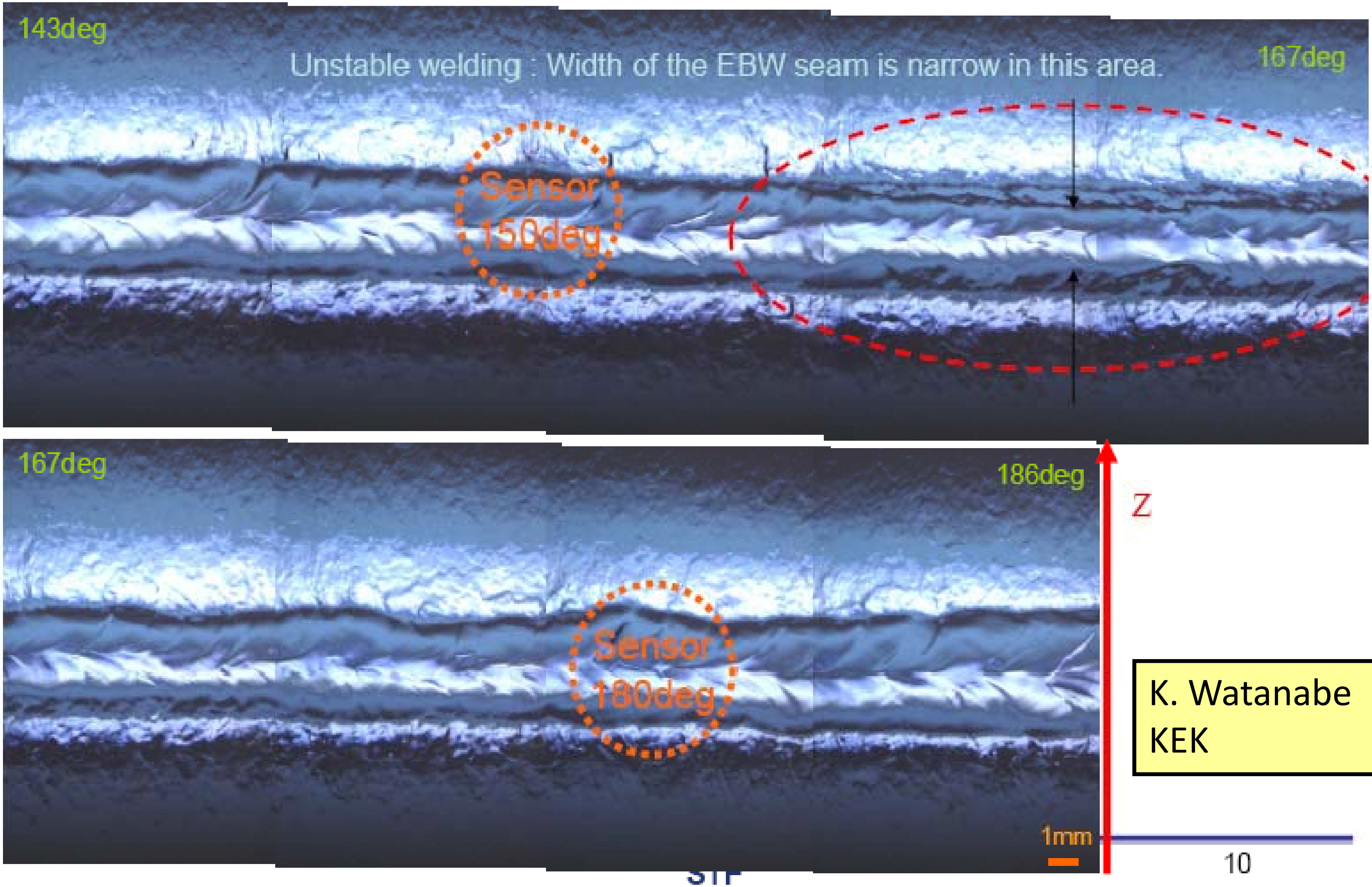
L. Lilje, H. Hayano, N. Ohuchi, S. Fukuda, C. Adolphsen
(with help of Chris Nantista)

Overview S0 Session

- Vendor qualification using temperature mapping and high-resolution optical inspection
  - Example on optical inspection from Asia
  - Example of single cells in new preparation facility from the US
- Very good series with good results on initial test
  - At JLab
- Sample tests of rinsing methods
  - Choices of either ethanol or ultrasonic degrease are validated
- Industrialization in Europe for XFEL
  - Preparation for call for tender
  - Streamlining procedures
  - Improving quality control
  - International process:
    - CEA, INFN, DESY
    - ILC participation via M. Champion and H. Hayano

MHI-05 2nd V.T. : #5 cell equator, 29.2MV/m @ 7/9

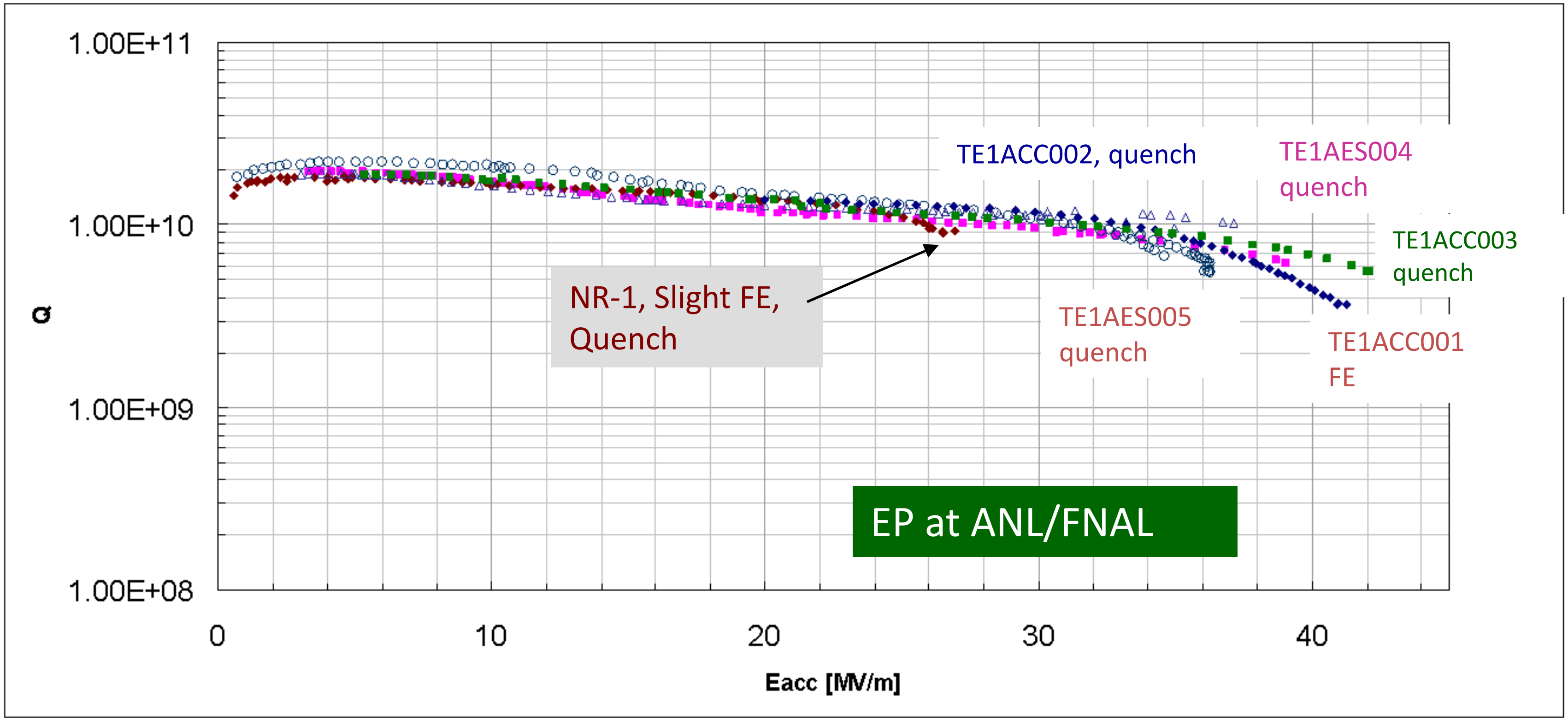
Heating area #5 cell equator : 120° ~ 180° : Sensor 120° ⊿T=1 K, 150° ⊿T=10 K, 180° ⊿T=5 K



K. Watanabe
KEK

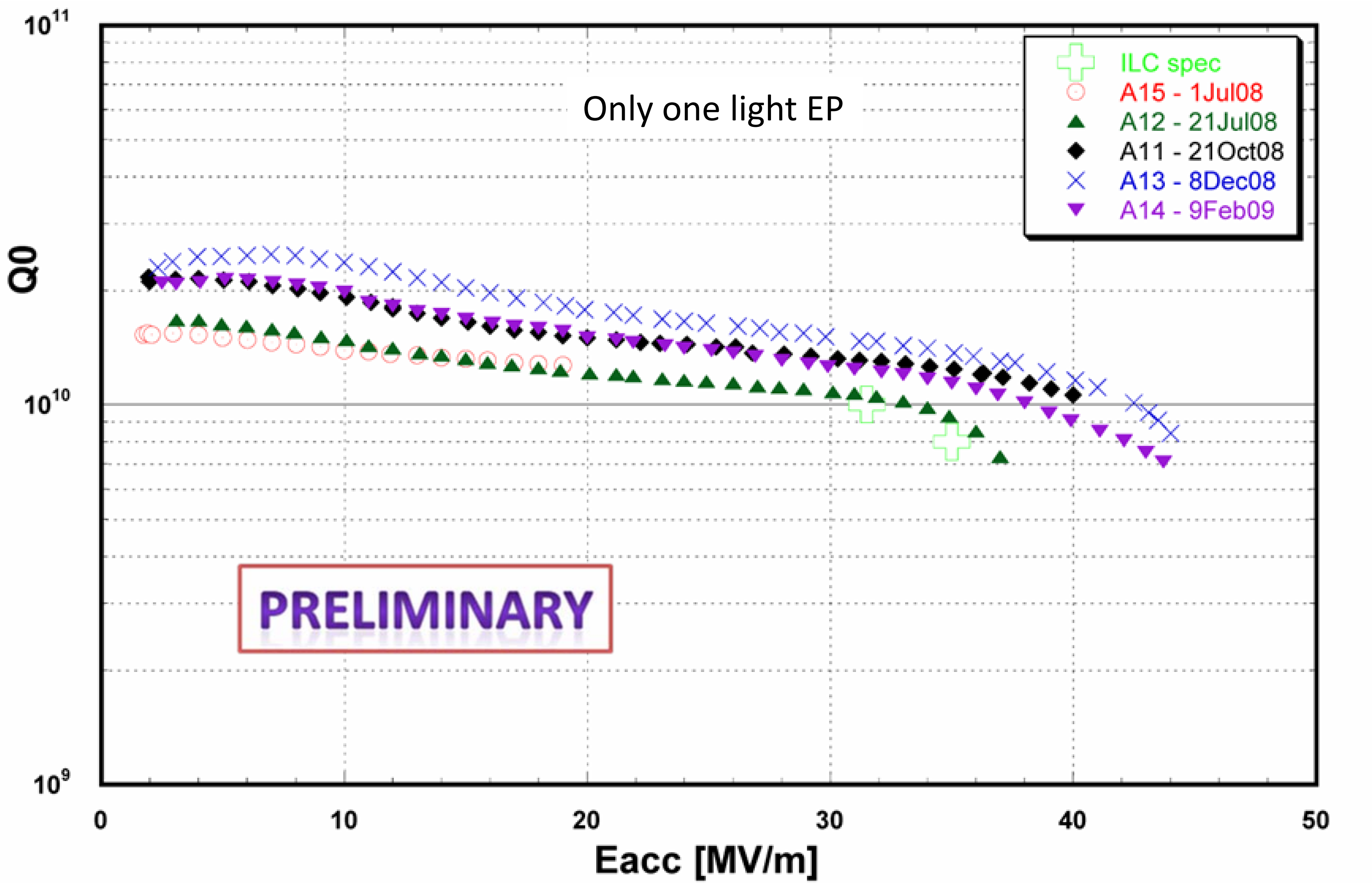
EP single cell cavity performance

FNAL,ANL



	BCP	EP	Ethanol	Eacc [MV/m]	Notes
NR-1	150	93		26.5	Oxidation by acid residual
TE1AES004	107	65		39.2	Equator large pit present
TE1AES005	104	100	Yes	36.3	Oxidation by HPR water
TE1ACC002		112	Yes on second	37.1	
TE1ACC001		99		41.3	FE appeared after 120°C baking
TE1ACC003		119		42.1	Pit present
TE1ACC004					

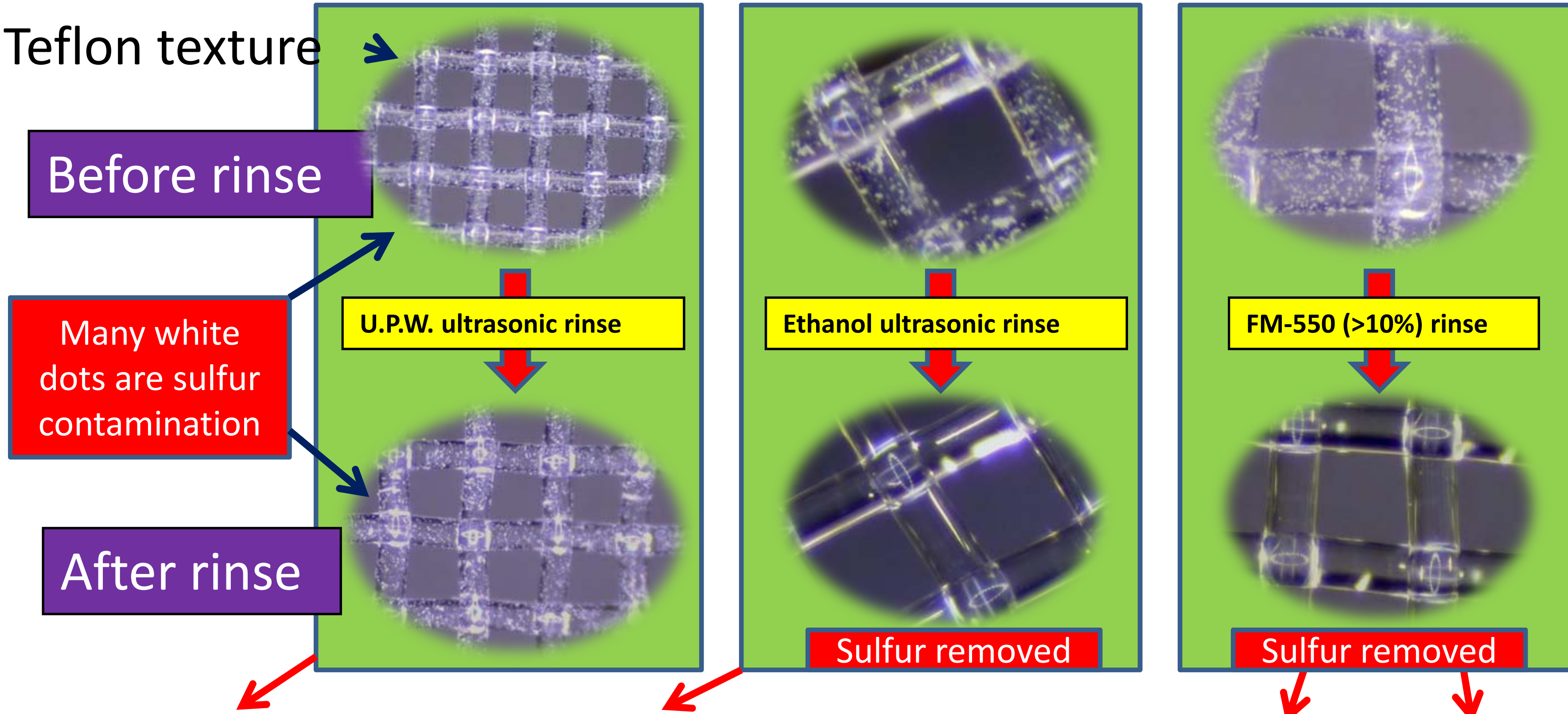
One vendor cavity in past 6 months EP processed and RF tested at JLab



T. Saeki

KEK

Rinse Effect to Remove Sulfur precipitation/contamination

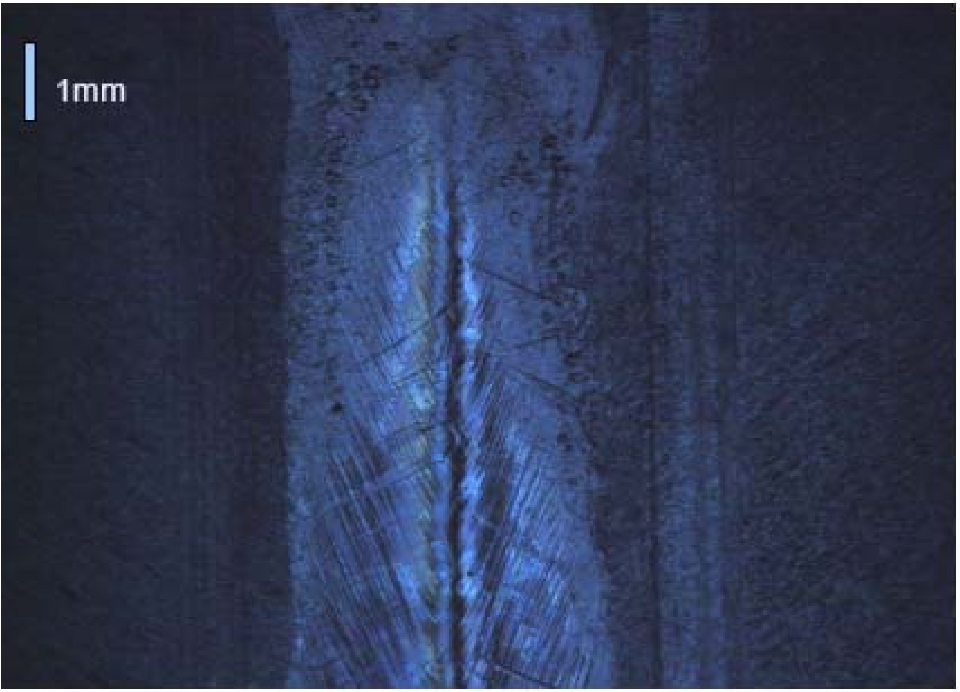


	U.P.W. ultrasonic rinse	Ethanol rinse (vibration)	Ethanol ultrasonic rinse	Detergent FM-550 2 %	Detergent FM-550 5 %	Detergent FM-550 10 %	Detergent FM-550 20 %
Cleaning Result	×	△	○	△	△	○	○

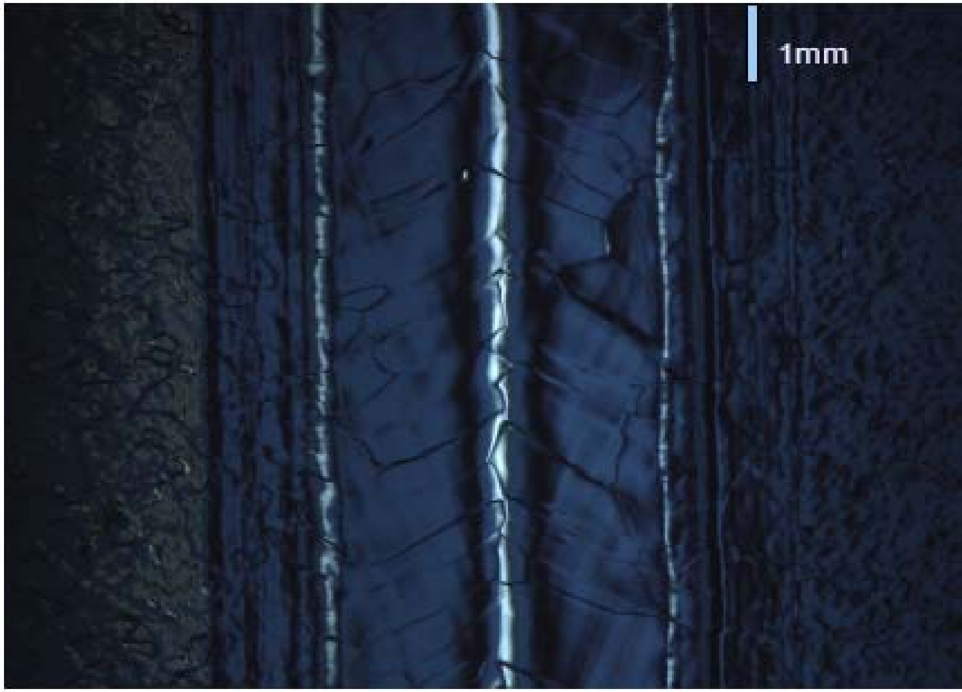
Evolution of defects:

Systematic inspection through full preparation process

Equator #7 at 44 deg.



Before treatment



After 108 μm main EP

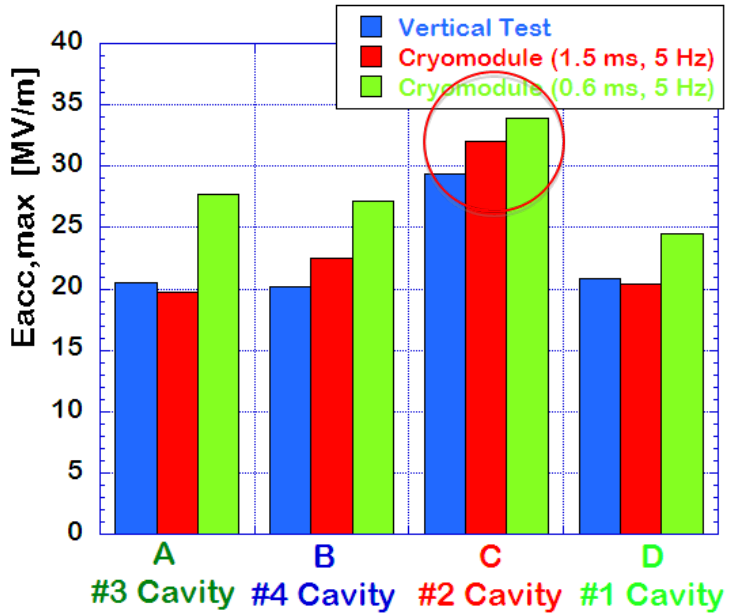
- Pits at weld interface removed by main EP

S. Aderhold
DESY

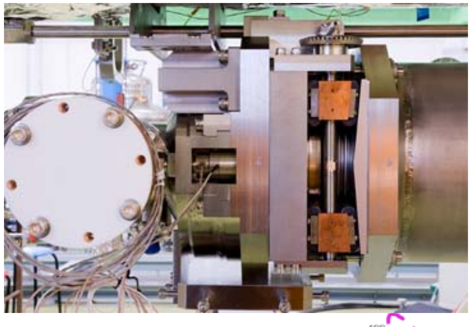
Cavity integration Session

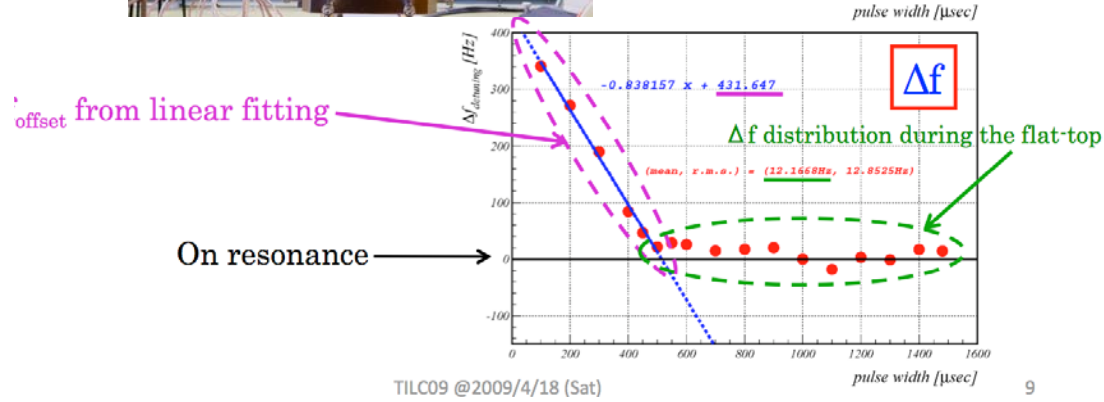
- KEK-STF cryomodule tests, etc
  - 4 cavities module test (STF1.0), with one cavity of 32MV/m operation.
  - magnetic shield evaluation
  - TTF-V coupler test
- Slide-Jack tuner : Lorentz detuning meas. and compensation
  - LD meas. by pulse-cut method,
  - optimization of LD compensation at 31MV/m
  - response meas. in room temp.
- Blade tuner : qualification tests
  - LD compensation, mechanical backlash, piezo response are qualified.
  - fabrication for FNAL-CM2, S1G, ILC-Higrade
- Plug-compatibility
  - boundary of input coupler

STF module test

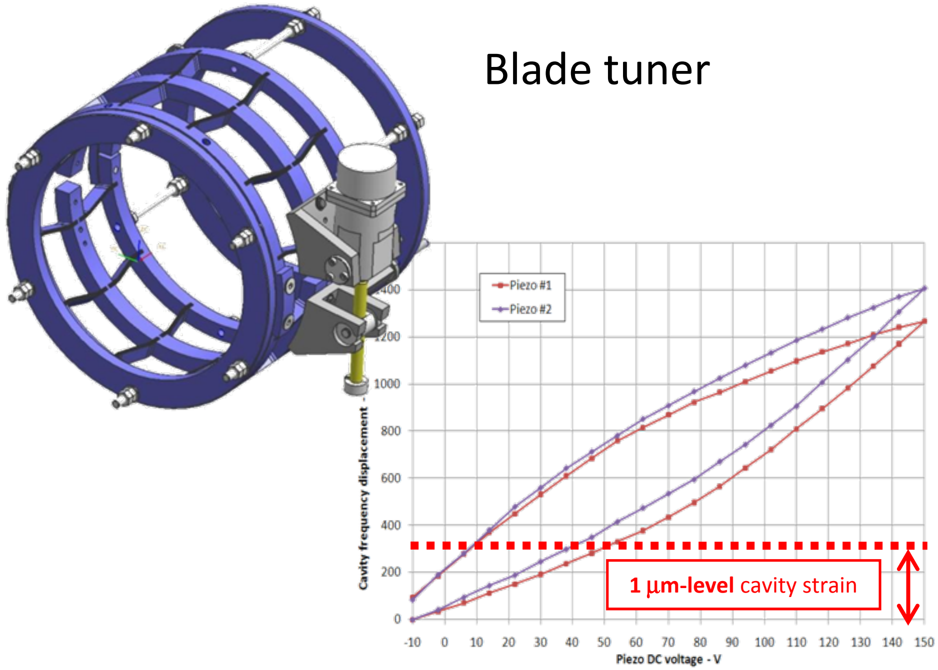


Slide-jack tuner

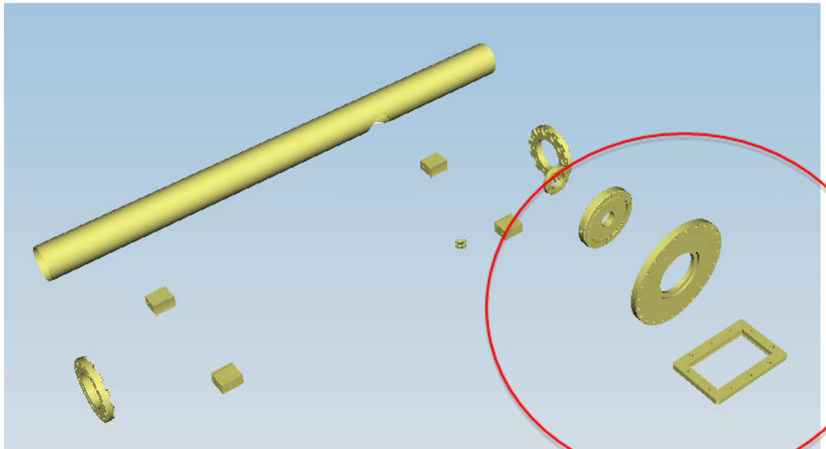




Blade tuner



Input coupler boundary



For non-BCD input port diameter:
think it as cavity package :cavity + input coupler,
keep boundary as a cavity package

Cryomodule parallel session(April 20 9:00-12:30)

- **Main target (Construction of S1-G cryomodules)**
  - Discussion of S1-G cryomodule (Module-C) after DESIGN WORK
    - Confirmation of the general schedule of S1-G cryomodule
      - FNAL cavities will be supplied with being jacketed and helium supply pipe after vertical tests in the end of this fall.
      - The installation of cryomodules into the STF tunnel is scheduled at the end of May, and the cold test will start at June 2009.
    - Starting to make the list of the Module-C components and the responsible institute.
    - Strategy to understand the thermal performance of S1-G cryomodules and to define the heat load of ILC cryomodule by the cold test.
      - Analysis of thermal characteristics of S1-G cryomodules by INFN.
      - Measurements of heat loads and thermal behaviors of the modules
        - » Defining the number of thermal sensors and locations, WPMs and the other sensors.
    - Preparation of assembly of FNAL/DESY cavities and KEK cavities.
      - Comparing the assembly procedures in the clean room, and alignment tools.

Cryomodule Design Optimization

Plug-compatible and Cost reduction

Thermal design (based on TTF-type III)

- Thermal performance of the components
  - Thermal intercepts
  - RF cables
  - Input couplers (Tesla type, KEK type)
  - Quadrupole package and BPM
- Evaluation of heat loads at 31.5 MV/m
- Temperature profile in the module
  - Module design with or without 5K shield
  - Cooling scheme in the cryomodule

Mechanical design

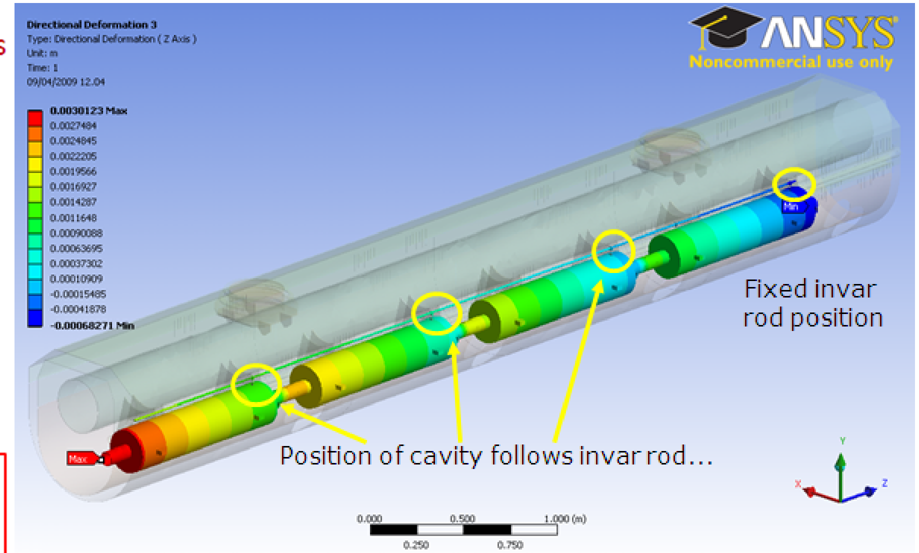
- Assembly process and tooling
- Alignment method

Tests and measurements

- Cold test of cryomodule with or without 5K shield at KEK-STF
- CM1 at FNAL-NML
  S1-Global at KEK-STF
- Dynamic heat load measurements at FLASH

Design of ILC proto-type
Type IV or V at FNAL
STF2 module at KEK

Longitudinal behavior

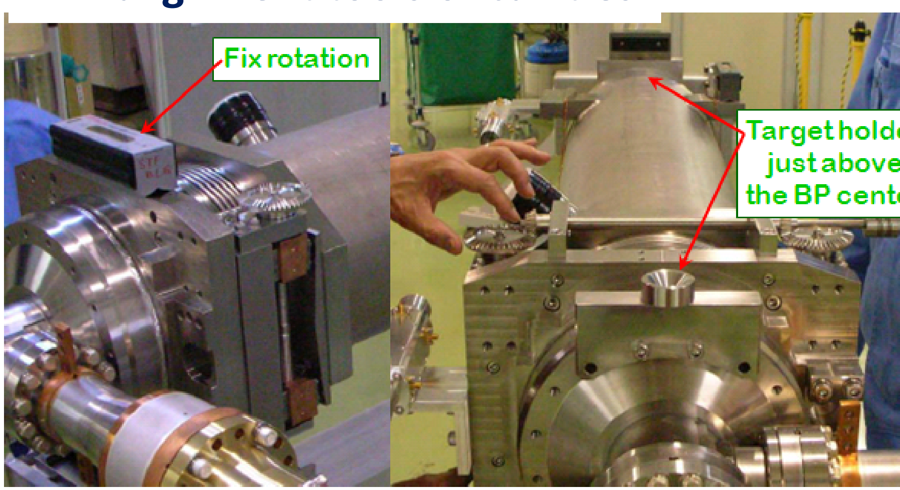


S1_

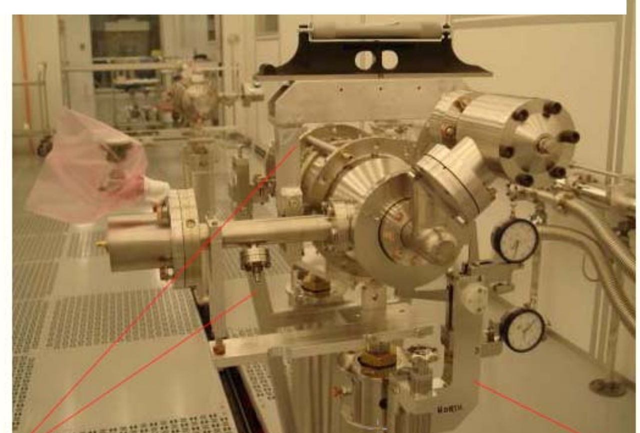
Thermal analysis of S1-G cryomodule (Module-C) by the INFN group.

Assembly study for FNAL/DESY/KEK cavities

KEK alignment tools of cavities



FNAL alignment tools of cavities



Rotational Alignment fixture

X-Y Alignment fixture

HLRF Session

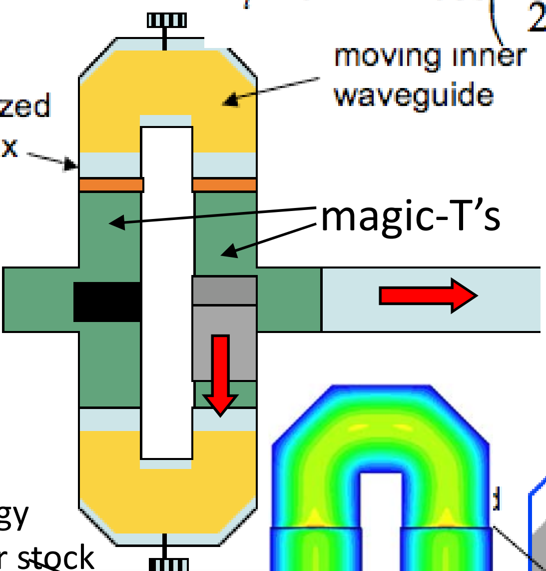
- New phase shifter design, hybrid design
  - SLAC design.
  - KEK design.
- circulator elimination test
  - successful operation by vector sum control, need to study hybrid isolation.
- cavity grouping by gradient for fixed coupling coupler
  - proper grouping leads no tunable coupler.
- Klystron cluster concept
  - new design of coaxial tap off.
  - cost analysis
  - LLRF comments
- Distributed RF concept
  - cost study of 1 klystron for 2 cavities is on a way.
- Single tunnel study of these concept at KEK
  - DRFS likely in Asia site.

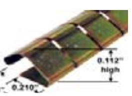
Phase Shifter for Remote Controllable VTO Alternate

Christopher Nantista
SLAC

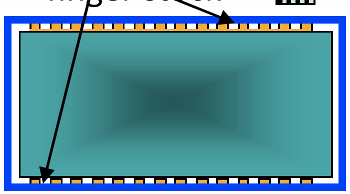
$$E_e = -ie^{i\left(\frac{\phi_1+\phi_2}{2}\right)}\sin\left(\frac{\Delta\phi}{2}\right)$$

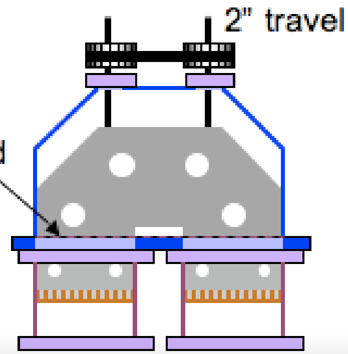
$$E_t = e^{i\left(\frac{\phi_1+\phi_2}{2}\right)}\cos\left(\frac{\Delta\phi}{2}\right)$$





springy finger stock



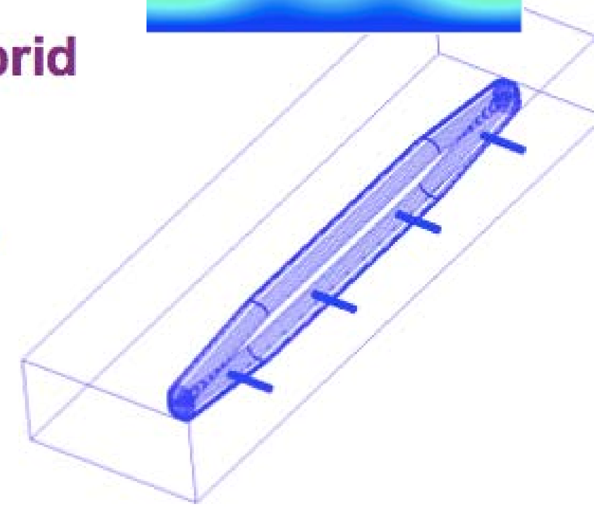


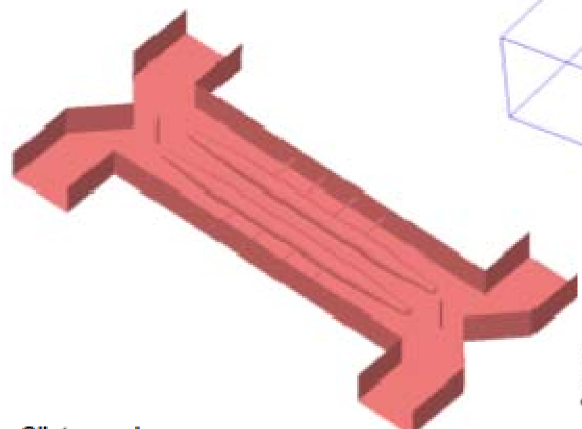
- takes advantage of required U-bends;
- match ideally unaffected by position;

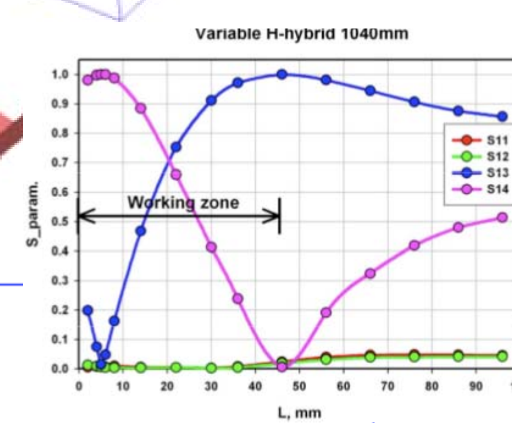
- makes maximal use of commercially available parts and
- is remote-controllable.

New phase-shifter and Variable Hybrid

S.Kazakov







Conclusion

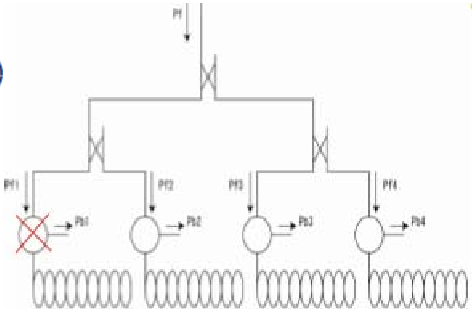
New tape of all metal phase shifter was designed, built and tested.
Phase shift range – 130°, air breakdown limit ~ 5.5 MW
Phase shifter was tested till 2.9 MW without breakdowns.

New design of more powerful phase shifter is made.
Air breakdown limit ~ 12MW

Design of full range variable H-hybrid is made.
Air breakdown limit ~ 12MW

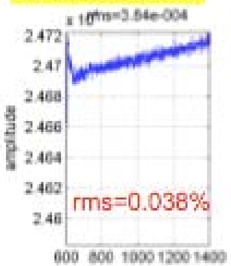
Elimination of circulators at STF-1

Shin Michizono (KEK)

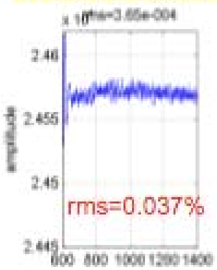


- System configuration at STF-1
- LLRF stabilities without circulators
- Forward and reflection rf fields
- Low power measurements
- Comparison between low-power and high-power

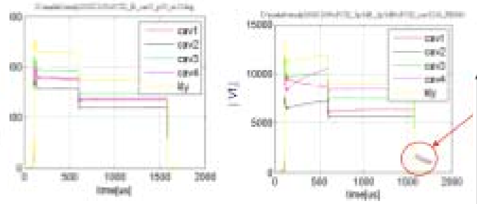
With Circulators



Without Circulators



Vith circulators *Without circulators*



		(0 mm, 10 mm, 0 mm)			(−5 mm, 10 mm, 0 mm)	
		low-level	w/circulators	w/o cir.#1	low-level	w/o cir.#1
Port 1	S11	−44	−45	−29	−22	−20
Port 1-2	S21	−29	−43	−30	−27	−26
Port 1-3	S31	−34	−42	−31	−34	−31
Port 1-4	S41	−35	−49	−34	−33	−34
Port 1-5	S51	−6			−6	

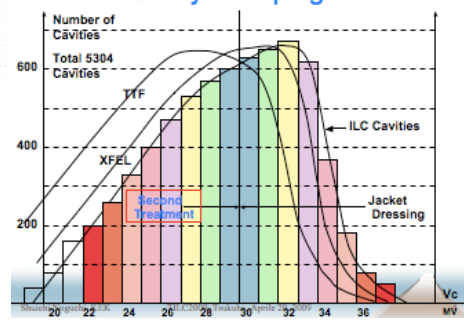
When the isolation is worse, high-power and low-power results agree well.

- ***Stabilities of the Acc fields are almost same.***
  Vector sum amplitude: 0.038-0.037%rms.
  Vector sum phase:0.02-0.018deg.rms
- ***Due to reflection wave,***
  Detune and Q_L can not be determined accurately.
- ***High power and low power results agree well in case of poor isolation.***
  High power effects (temperature, high-rf fields) induce the difference in isolatiion(?)

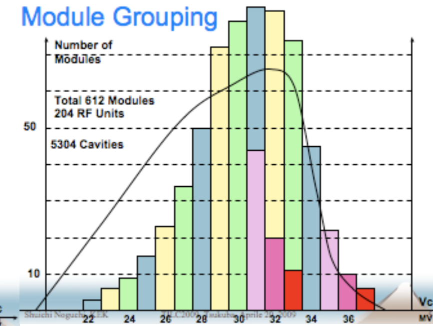
Coupler Tune-ability & Power Distribution System

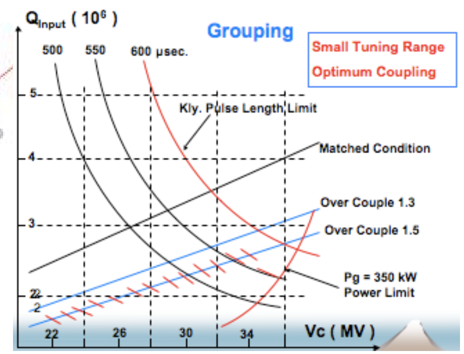
Shuichi Noguchi

Cavity Grouping



Module Grouping





Cost Comparison

ML costs 4000 MILC, Assembly & Tuning Cost are not evaluated.

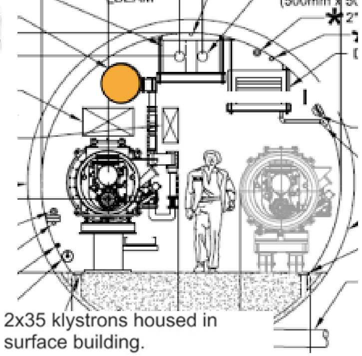
Tuning	Energy Reduction	Extra Cost	Devise Cost	Total Cost-Up
No Tuning	> 10 %	> 400	0	> 400
Full Tuning	0	0	60 + 60	120
Coupling 2.5 – 6.7 x 10^6	1.8 %	72	60	132
Power 227 – 347 kW	1.5 % 1.6 % (5mA)	60	60	120

Summary

- Cavity Grouping Scheme is Proposed.
  Power Effective, Small Tuning Range & Less DLD Effect.
- If we use this scheme, and assume the following number, the coupling tune-ability may be not cost effective.
  Coupling Error : 15 % RMS
  Gradient Distribution : 1.5MV RMS
- Input Coupler must have a capacity of 400 kW.
- Precise Evaluation of cost performance is necessary.

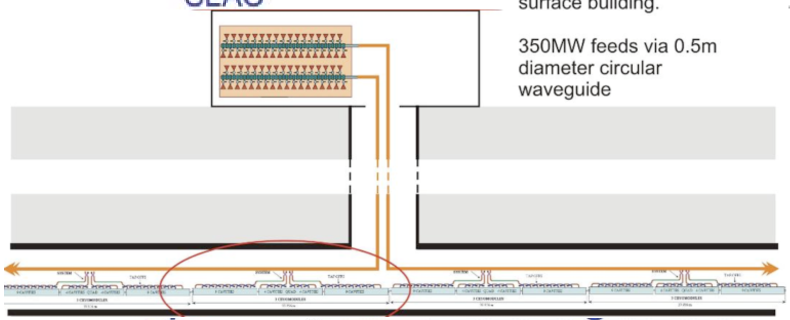
Klystron Cluster Concept for ILC High-Power RF Power Distribution

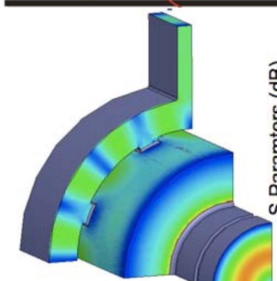
Christopher Nantista
Chris Adolphsen
SLAC

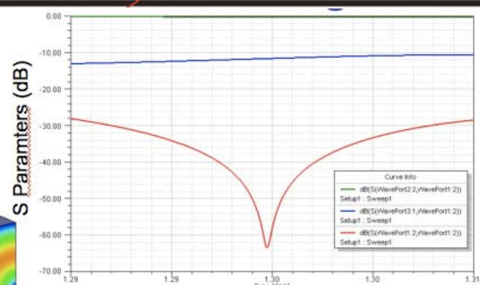


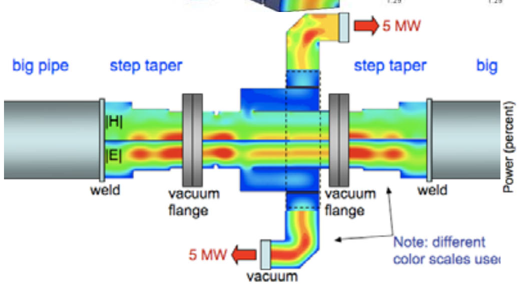
2x35 klystrons housed in surface building.

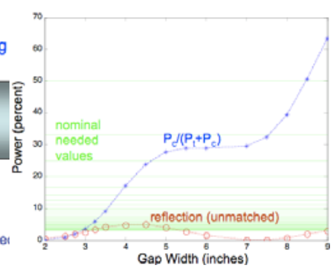
350MW feeds via 0.5m diameter circular waveguide









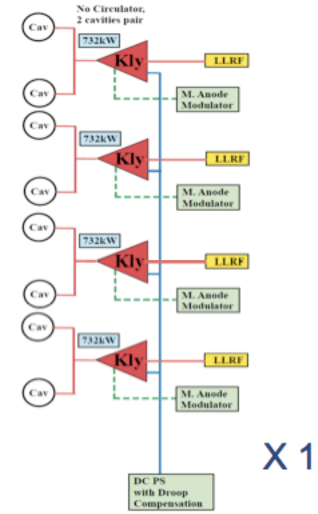


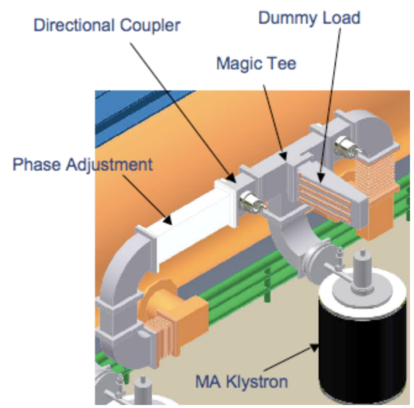
Surface klystron clusters can save ~300 M$ (~200 M$ from eliminating service tunnel and ~100 M$ from simpler power and cooling systems).

The proposed CTO tap in/off design is likely to be robust breakdown-wise. Have a plan to demonstrate its performance, although with only 1/5 of the worst case ILC stored energy after shutoff.

Distributed RF-source Scheme (DRFS) First Design

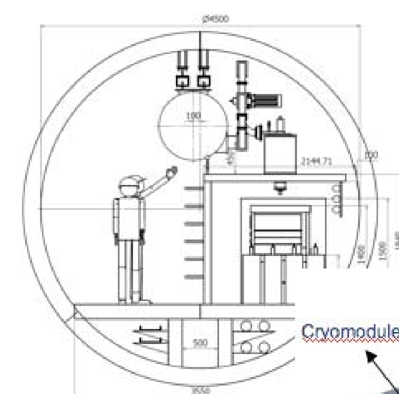
Shigeki Fukuda (KEK)



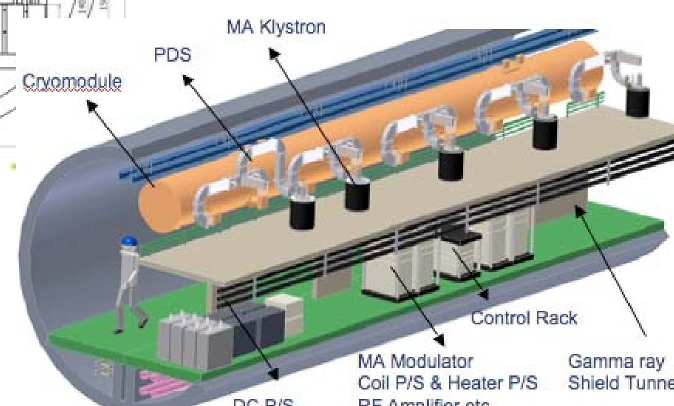


Design Parameters

- Frequency 1300MHz
- Output Power 750kW
- RF pulse width 1.565ms
- Beam pulse width 1.7ms
- Average RF power 6kW
- Peak beam voltage 62kV
- Peak beam current 21A
- Beam Perveance 1.36mP(@62kV)
- Gun Perveance 1.735mP (@Ea-k=53kV)
- DC Gun Voltage(A-B) >64kV
- Tetrode MA-type
- Electromagnetic Focusing
- Water cooling
- Total length 1.1m
- Weight 70kg



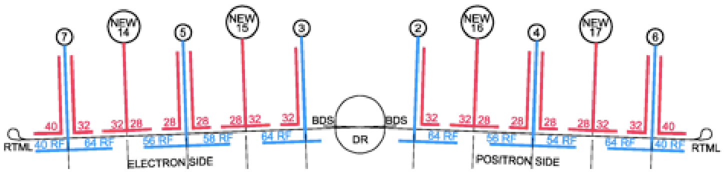
Cross Section



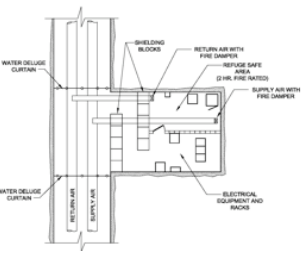
Americas KlyCluster Cost Analysis Overview

(Vic Kuchler for)
Tom Lackowski

- Four shafts added for RF Waveguides.



Area of Refuge



Functional Requirements used in the RDR have been maintained.

Life Safety further study.

Changes in the costs are a reflection of the KLY Cluster scheme only; potential savings from other value engineering ideas have not be incorporated.

- **corresponds to -4.9% savings wrt ILC RDR est**

GDE ACCELERATOR ADVISORY PANEL REVIEW

CONVENTIONAL FACILITIES AND SITING GROUP

Single-tunnel scheme studies at KEK (RF Cluster and Distributed RF System)

Atsushi Enomoto

Contents of this talk

- Two kinds of single-tunnel schemes applicable for the Asian sample site (deep tunnel).
- Pros and cons of these schemes from CFS point of view.
- Understanding of degree of cost impacts for the single tunnel scheme.
- Plans of further studies.

RDR

Point ID	Elevation (A) Surface	Elevation (B) Beam Tunnel	Overburden above Beam Tunnel = (A)-(B)	Elevation (C) Entrance	Drop from Entrance to Beam Tunnel = (C)-(B)	Length from Entrance to Beam Tunnel
7	400	80	320	204	124	1,540
5	368	80	288	226	146	1,608
3	488	80	408	238	158	1,706
2	180	80	100	156	76	1,198
4	164	80	84	117	37	652
6	178	80	98	165	85	934
Average	296	80	216	184	104	1,273

Impacts on Main Linac civil engineering

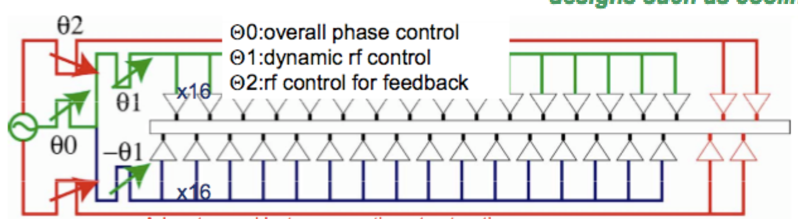
Main Linac CF	RDR	RF Cluster	Distributed RF
Tunnel	ϕ4.5m, 22.3 km X2 (double)	ϕ4.5m, 22.3 km X 1 (single)	ϕ4.5m, 22.3 km X 1 (single)
Penetration Safety path Refuge area	(ϕ0.43m, ϕ0.3m X2) X10m X560 1.2m X2.2m X20m X48 None	None None ?	None None None
Access shaft/tunnel (Size and quantity)	X6 7m X6.5m X~1,270m X6	X10 7m X6.5m X~1,270m X6 3.5m X3.5m X~1,270m X4	X 7m X6.5m X~1,270m X6
Shaft-base cavern	X6 16m X18m X100m	X6 ~ half	X6 16m X18m X100m
Surface building	X6 4,300m2 X6	X10 ~7,000m2 X10	X6 4,300m2 X6

Summary of this talk

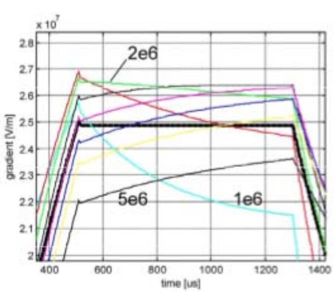
- As a study of minimum machine, two kinds of single-tunnel schemes was investigated in order to apply them for the Asian sample site (deep tunnel).
- Though both of two are considered to be applicable, from a civil-engineering point of view, "Distributed RF Scheme" seems more suitable for the Asian site.
- Further studies should cover overall CF designs such as cooling and safety issues.

LLRF Comments on the RF cluster and Distributed RF schemes

Shin Michizono (KEK)



Advantage: klystron operation at saturation
only 3 phase control
Disadvantage: each two-units should be operated at same power



	Baseline	Single tunnel	Klystron cluster	Distributed rf
No. of tunnels	2	1	1	1
LLRF unit	Service tunnel	Beam tunnel	Beam tunnel	Beam tunnel
Cavity/ rf unit	26	26	780	2
No. of vector sum	26	26	780	2
QI and power distribution control	Necessary	Necessary	Difficult	No need
No. of llrf cable /rf	~80	~80	~80*30 or fast optical cables	6
Loop delay	~1 us	~1 us	~10 us	~0.3 us

	Klystron cluster	DRFS
FB performance	Not good	Better
Ql and power distribution control	Difficult	No need
Each cavity field flatness	Worse	Best or better
Exception handling	Quite complicated	Easy
LLRF cost	Similar to baseline	13% expensive than baseline

end of slide