Summary of SRF WG, LCWS14

H. Hayano, A. Yamamoto

SRF (15 talks)

Cavity	**XFEL Vertical Test Results and extrapolation to ILC, N. Walker(DESY)**
	SRF R&D on Q0 and gradient at DESY, A. Navitski(DESY)
	Update on High Efficiency High Gradient SRF Cavities, R. Geng(Jlab)
	Status of Cornell SRF R&D, F. Furuta(Cornell)
	Fabrication of TESLA(Euro-XFEL)-shape cavity at KEK, T. Saeki(KEK)
	CEA Expertise with Vertical Electroploishing(VEP), F. Eozenou(Saclay)
	VEP status at Marui Galvanizing Co. Ltd/KEK, T. Saeki(KEK)
Cryomodule	**LCLS-II Cryomodule Design, T. Peterson(FNAL)**
	CM-2 Status, E. Harms(FNAL)
	IHEP ILC Test Cryomodule Status, J. Zhai(IHEP)
	STF Cryomodule Status, H. Nakai(KEK)
HL-RF	**US-ILC Waveguide Industrialization Study, C. Adolphsen(SLAC)**
	LCLS-II RF Design, C. Adolphsen(SLAC)
Infrastructure	**Infrastruc. Updates for LCLS-II Cryomodule Construction, E. Daly(Jlab)**
	New SRF Facility at KEK, H. Hayano(KEK)

Slide pick-ups for the most concerned

CAVITY & TEST NUMBERS

Up to 31 August 2014

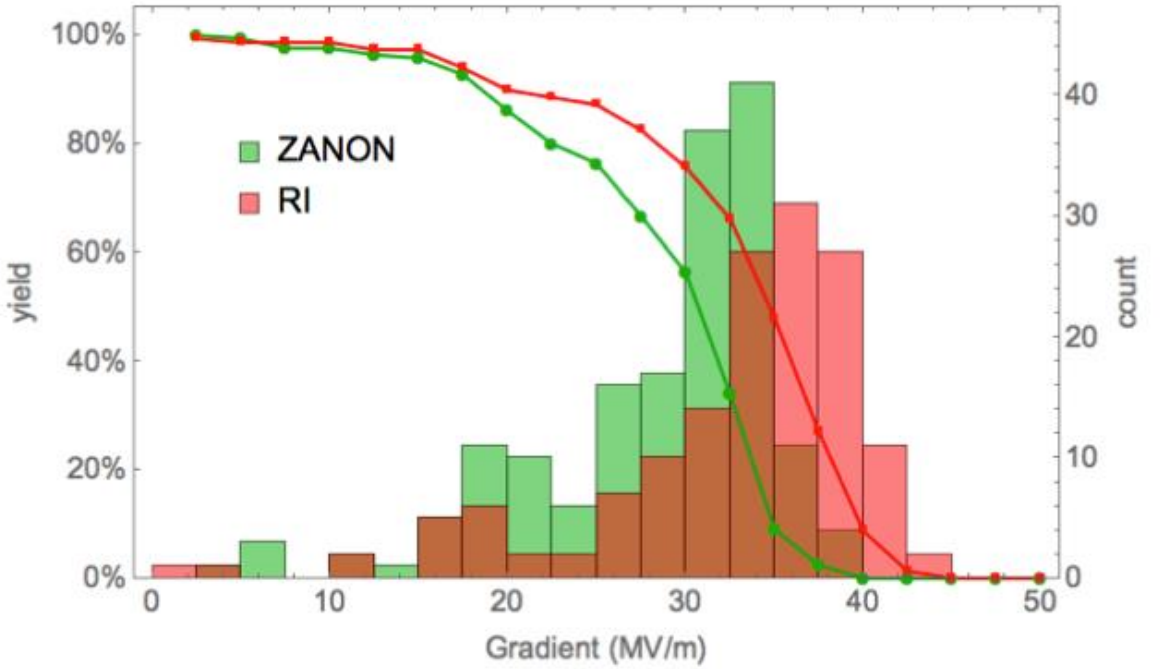
	ZANON	RI	TOTAL
Number of cavities	224	183	407
Number of vertical tests	337	255	592
Tests/cavity	1.50	1.39	1.45

XFEL cavities

XFEL Vertical Test Results and extrapolation to ILC, N. Walker(DESY)

YIELD

- **MAX FIELD**
- as received
- Excluding bad tests (leaks, RF problems etc.)



Cavities	313	(77%)
Tests	313	(52%)

	Tests	Average	RMS	Yield@20	Yield@26	Yield@28
ZANON	165	28.5	7.	86%	73%	65%
RI	148	32.8	7.6	90%	86%	82%
All	313	30.5	7.6	88%	79%	73%

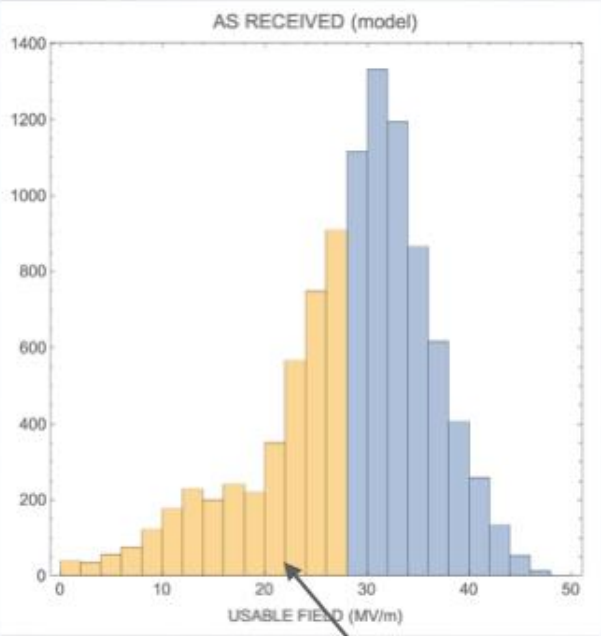
XFEL cavities

XFEL Vertical Test Results and extrapolation to ILC, N. Walker(DESY)

A MODEL FOR ILC

RI USABLE FIELD distribution used t generated 1st pass VT results

XFEL HPR results used to generate model for (HPR) retreatment



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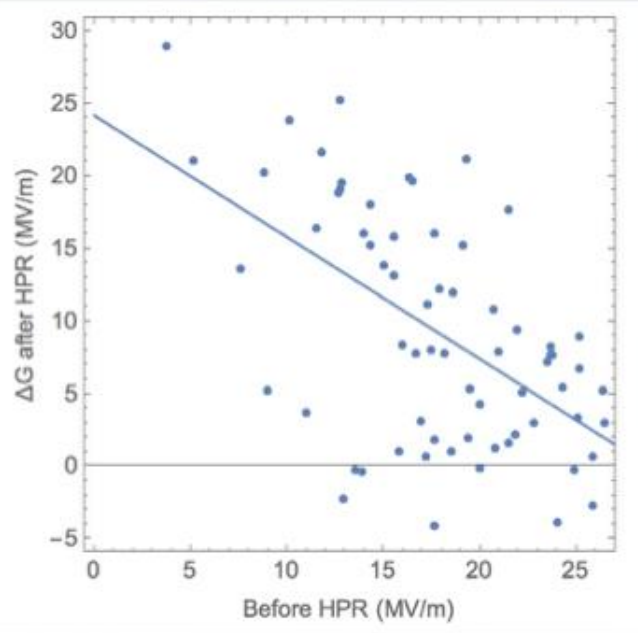
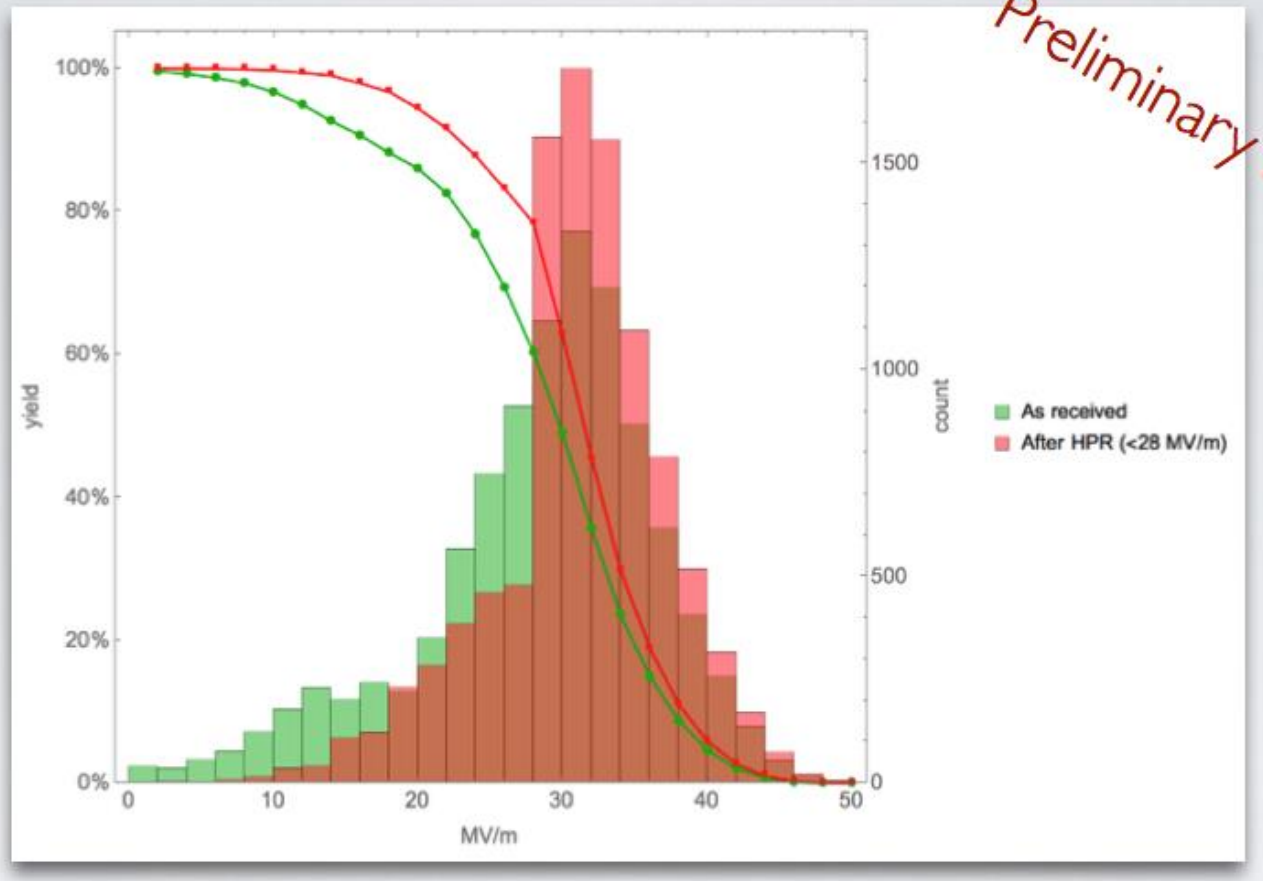


Retreatment model applied to cavities with $G<28$ MV/m

XFEL cavities

XFEL Vertical Test Results and extrapolation to ILC, N. Walker(DESY)

ILC MODEL - RESULT



	Tests	Average	rms	Yield@28	Yield@31.5	Yield@35
As received	10000	28.4	8.3	61%	40%	19%
Second Pass	10000	30.9	6.4	77%	49%	24%

XFEL cavities

XFEL Vertical Test Results and extrapolation to ILC, N. Walker(DESY)

European ILC-HiGrade programme

24 cavities are added to the ***EXFEL*** order as a part of the ILC-HiGrade program:

- Initially, serve as **quality control (QC)** sample for the ***EXFEL***
  - extracted regularly, ~**one cavity/month: first half of cavities arrived!**
  - after the **normal acceptance test** will be **taken out** of the production flow --> **R&D**

- Delivered with **full treatment** but **no helium tank**
  -> **maximize** the data output from the test

- Further handling within **ILC-HiGrade** **as feasibility study** for **ILC goal**:
  - "Second sound" and T-mapping from the 2nd cold RF test
  - optical inspection (OBACHT) and replica

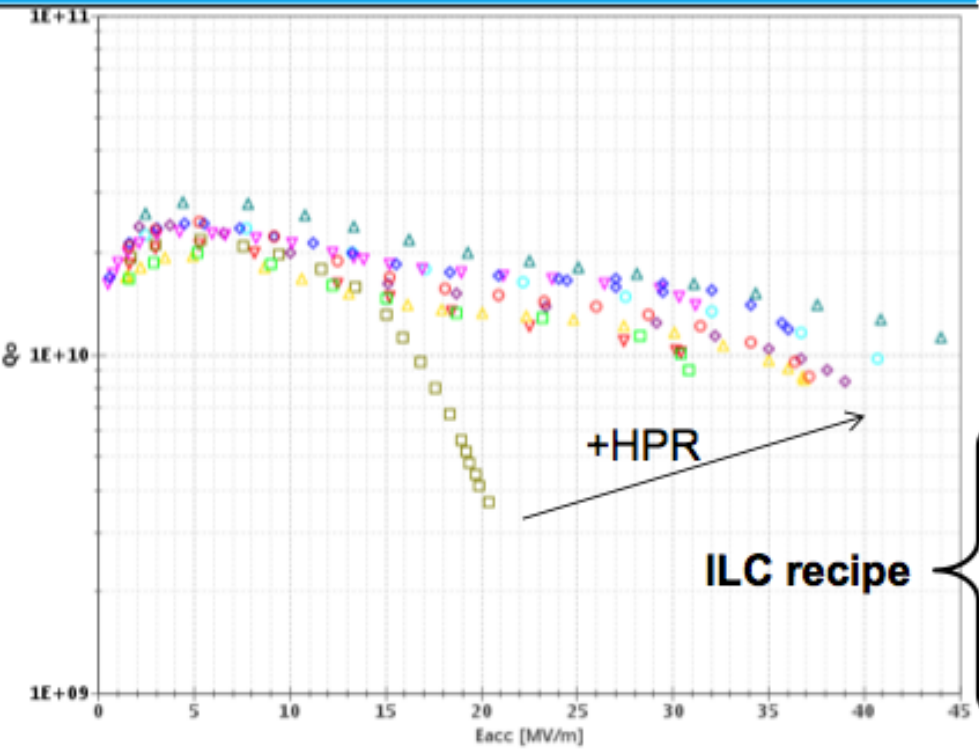
  Further treatment options:
  - Centrifugal Barrel Polishing (CBP)
  - Local Grinding repair
  - additional EP polishing

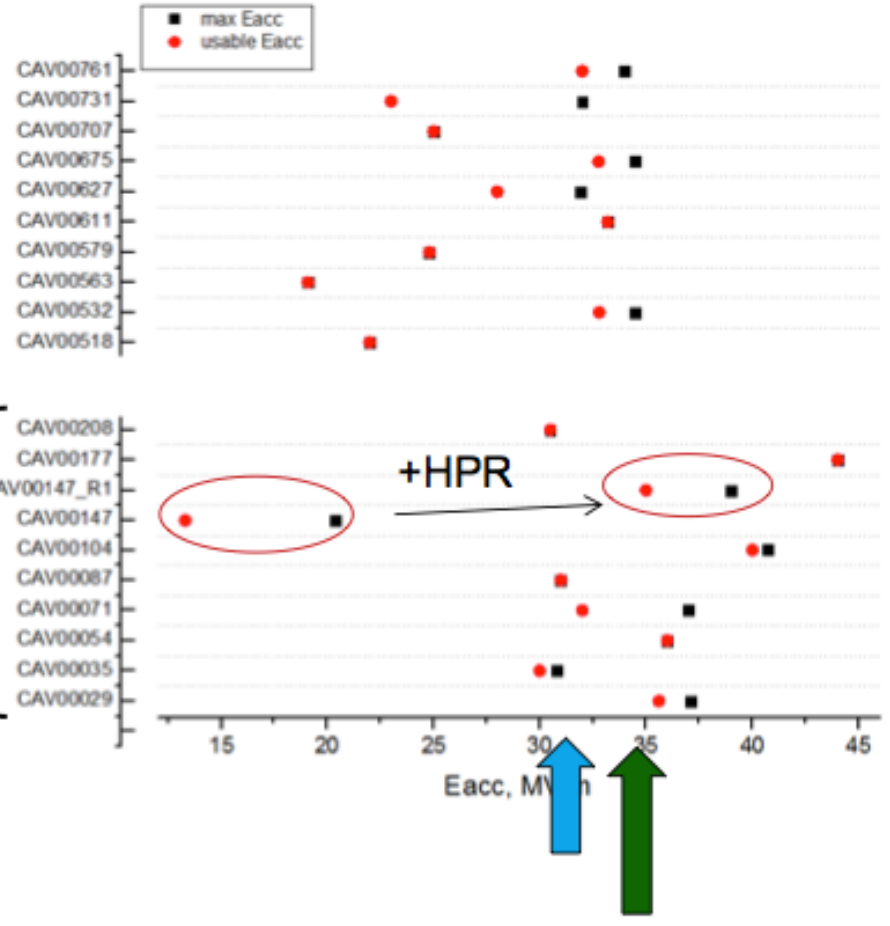
- Eventually aim **3 world record modules** from the **24 ILC-HiGrade cavities**

ILC-Higrade cavities

20 out of 24 already delivered

Cold rf results of ILC-HiGrade cavities





- CAV00029 Test:1.2 AMTF 09/09/13 2[K] bd
- CAV00035 Test:1.2 AMTF 09/09/13 2[K] bd_fe
- CAV00054 Test:1.2 Hall 3 24/09/13 2[K] bd
- CAV00071 Test:1.2 Hall 3 24/10/13 2[K] none
- CAV00087 Test:1.2 Hall 3 18/11/13 2[K] bd
- CAV00104 Test:1.2 AMTF 04/12/13 2[K] pwr_fe
- CAV00147 Test:1.2 AMTF 03/04/14 2[K] bd_fe
- CAV00147 Test:2.1 AMTF 28/05/14 2[K] pwr
- CAV00177 Test:1.1 AMTF 10/06/14 2[K] pwr
- CAV00208 Test:1.1 AMTF 01/09/14 2[K] bd

- "ILC recipe" provides cavities with maximum usable gradient of **~31.9±8.2** MV/m and **34.9±4.7 MV/m after retreatment**
- some achieve >40 MV/m

ILC-Higrade cavities

- Main limitation is FE

Introduction

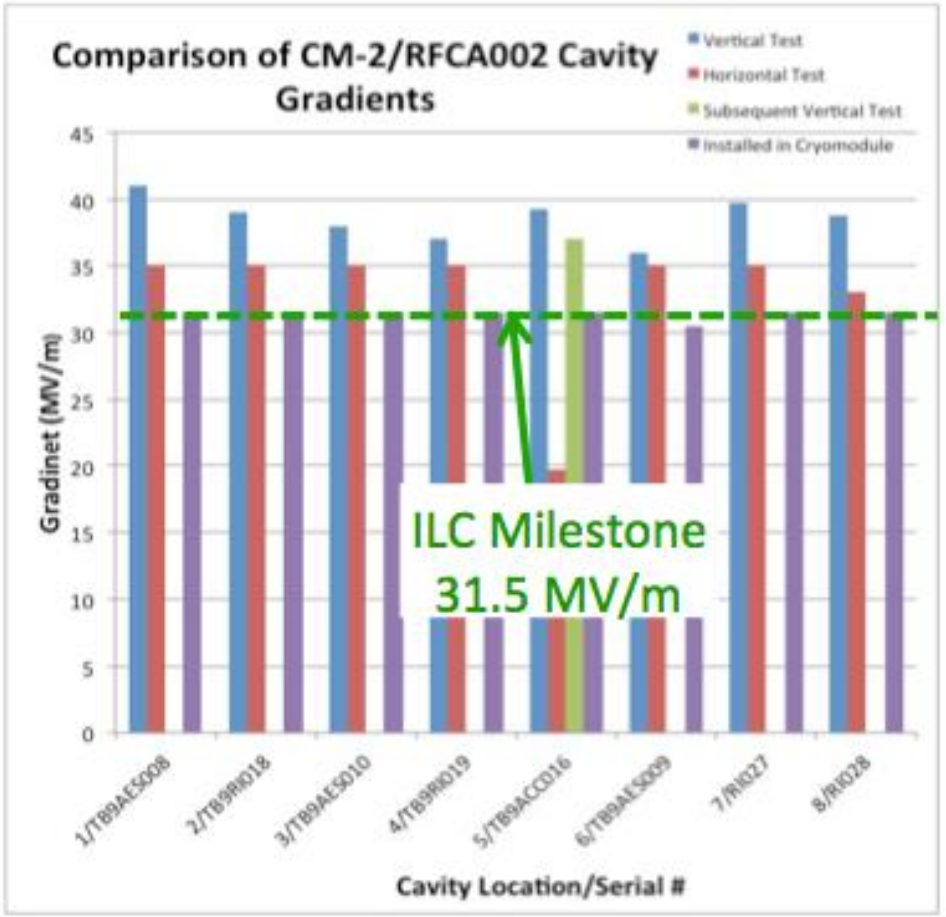
- CM-2 is
  - Type 3+ ILC type Cryomodule
  - 8 cavities (1.3 GHz) built by industry
  - Vertical and Horizontal tests at JLab & Fermilab (good to 35 MV/m)
  - Cryomodule assembled at Fermilab
  - first ILC type cryomodule which may(?) reach average gradient specification of 31.5 MV/m
  - Designed for pulsed operation
- Main accelerating device for ASTA
- Expect beam tests in FY2015


CM-2 installed in ASTA cave

ILC Cryomodule

Single cavity results

- Operating conditions
  - 2 Kelvin (23 Torr)
  - Pulsed operation
  - 1.6 ms pulse
    - 590 μs fill + 969 μs flattop
  - 5 Hz repetition rate
  - Q_L set to 3.5 E6, variable coupling
  - LFDC active
- Results
  - 7/8 cavities achieve 31.5 MV/m (administrative limit)
  - Cavity #6 quenches at 30.5 MV/m



ILC Cryomodule

Fabrication of two TESLA(Euro-XFEL)-shape cavities by MHI

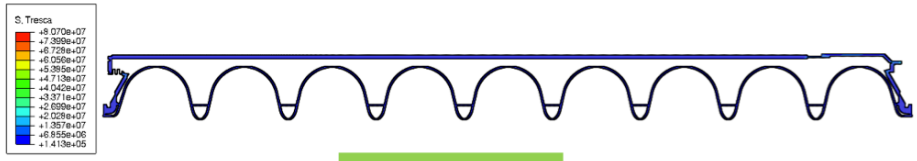
Fabrication of two TESLA(Euro-XFEL)-shape cavities by Toshiba

Simulation analysis by Toshiba

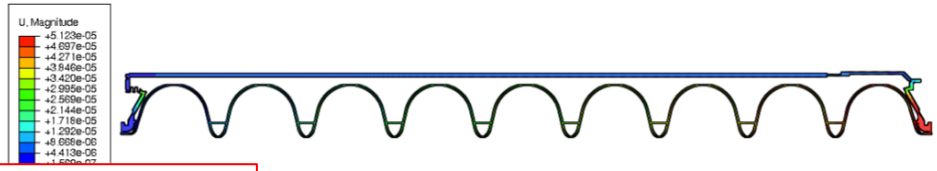
Case-A: T=20 ^{0}C, Pressure=0.2 MPa

Preliminary

Unit in MPa



Stress distribution



Displacement x 5

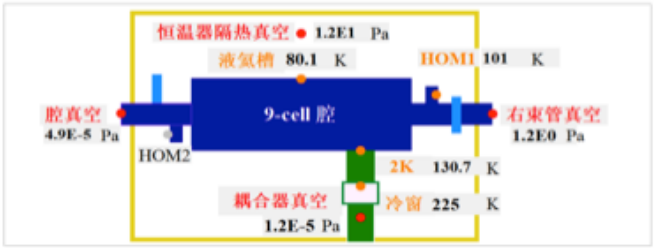
ILC Cavity

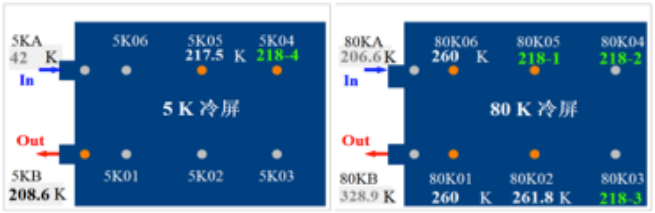
Fabrication of TESLA(Euro-XFEL)-shape cavity at KEK, T. Saeki(KEK)

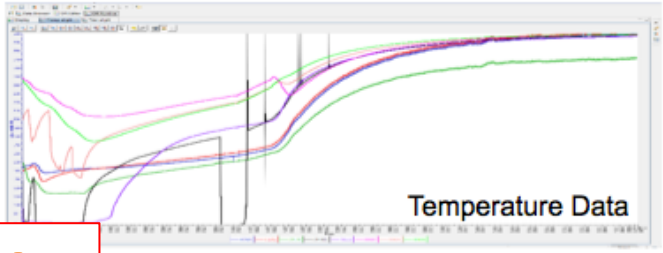
STF CM-1 + 2a (1)

ILC Cryomodule

Vacuum and Temperature Reach







- Cavity and coupler cold window cooled to 80 K (< 40 K/h), cavity vacuum 4E-5 Pa (small ion pump), coupler vacuum 5E-6 Pa.
- Some thermometers did not work
- Due to leak of the cryogenic line connection, outgassing and small pumping rate, isolation vacuum was only 1~10 Pa after cooling down. Thus, 5 K and 80 K shield reached 140 K at lowest.
- We will solve the isolation vacuum leak problem and do 80 K cool down test again in November.
- 2 K high power horizontal test next year (cryo-plant OK, klystron deliver early next year)

ILC Test Cryomodule

Construction status of new building

Construction compeletion will be end of Jan. 2015

ILC Infra-structure

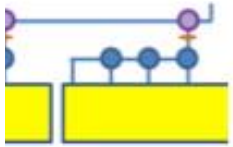
New SRF Facility at KEK, H. Hayano(KEK)

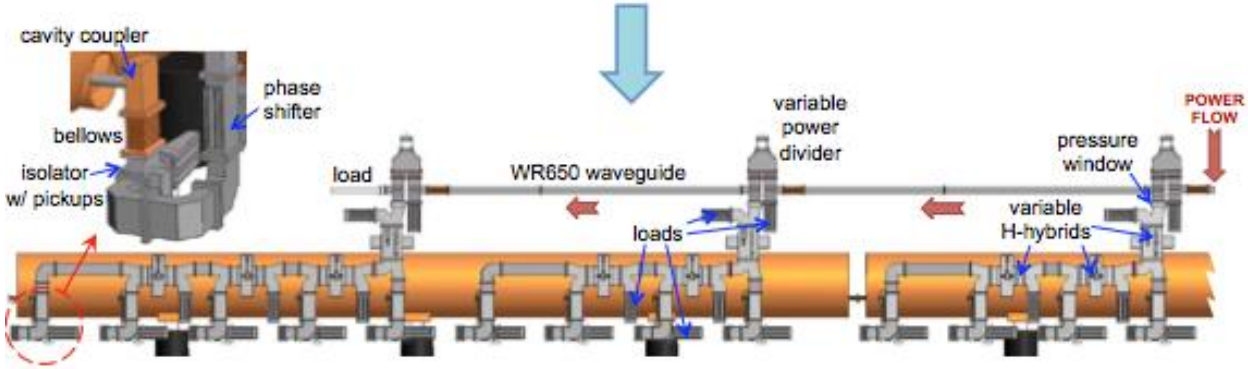
Post-TDR MEGA Cost Study Scope

- Twelve production schemes considered:
  - deliver full, only standard waveguide, only circulators and loads, and only electromechanical devices
  - at 3 varied production levels (25%, 50% and 100%)
  - over a period of 6 years with up to 2 additional years for the following to be completed:
    a. Casting and extrusion tooling and process development / qualification
    b. Facility build-out
    c. Equipment and workstation installation and pre-production verification / release
    d. Production tooling and process development and qualification
- The results of this study include plant layouts, time planning for equipment and labor, work flow diagrams, and costs for the industrial components of plan estimated at 2013 prices and rates

-Cavity LPDS Unit

e via VPD's without affecting phases.





Each cavity feed line has a **phase shifter**, isolator w/ bi-directional coupler, and flex guide

ILC WG cost study

US-ILC Waveguide Industrialization Study, C. Adolphsen(SLAC)

Slide pick-ups from world-wide R&D

High efficiency, High gradient study at JLAB

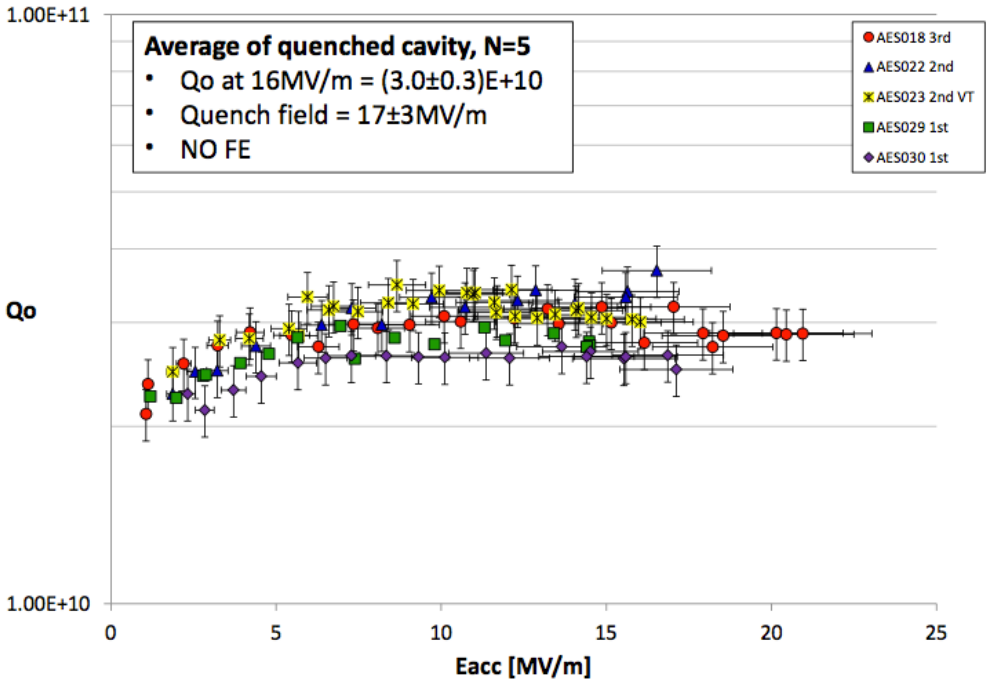
LSF Prototype Cavities

- Two single-cell LSF shape cavities built and tested
- Large-grain Nb
- Both reached 37-38 MV/m without field emission
  - BCP so far
  - EP next to raise gradient

High Q study, ERL cryomodule at Cornell

Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)

N-doped 9-cell VT results at 2K



F. Furuta, Cornell SRF R&D status, LCWS14 Belgrade

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MLC assembly

F. Furuta, Cornell SRF R&D status, LCWS14 Belgrade

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Vertical EP study at Saclay, KEK

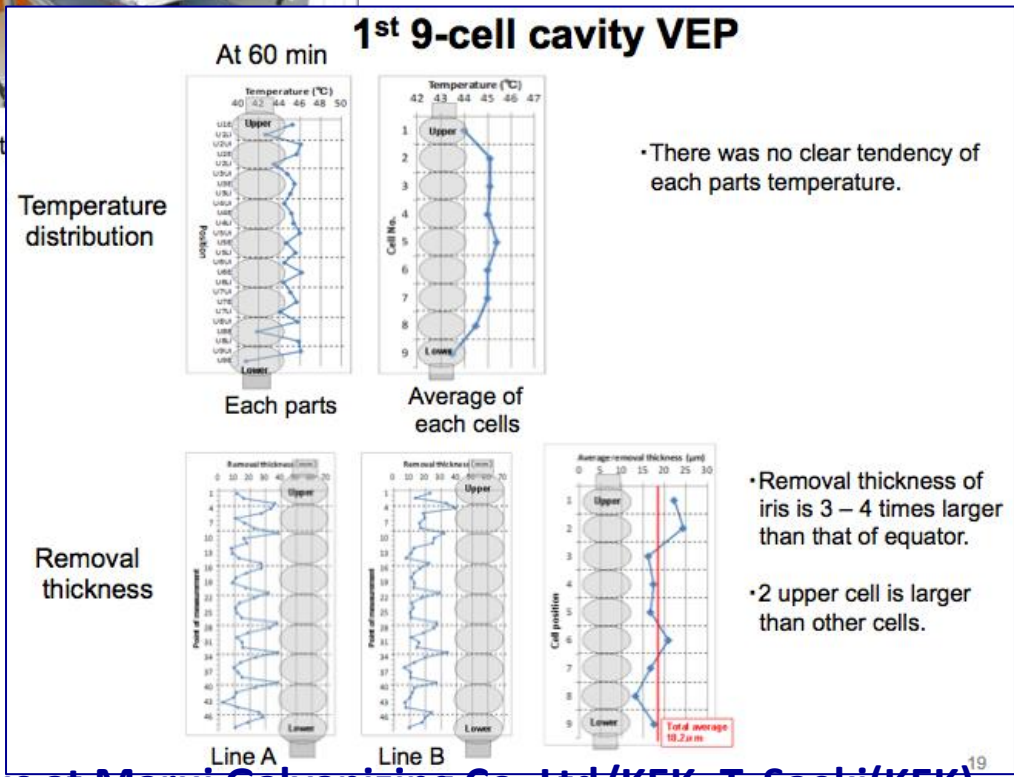
DEDICATED HANDLING TOOLS

Handling tools for 704 MHz and 1300 MHz resonators

Horizont

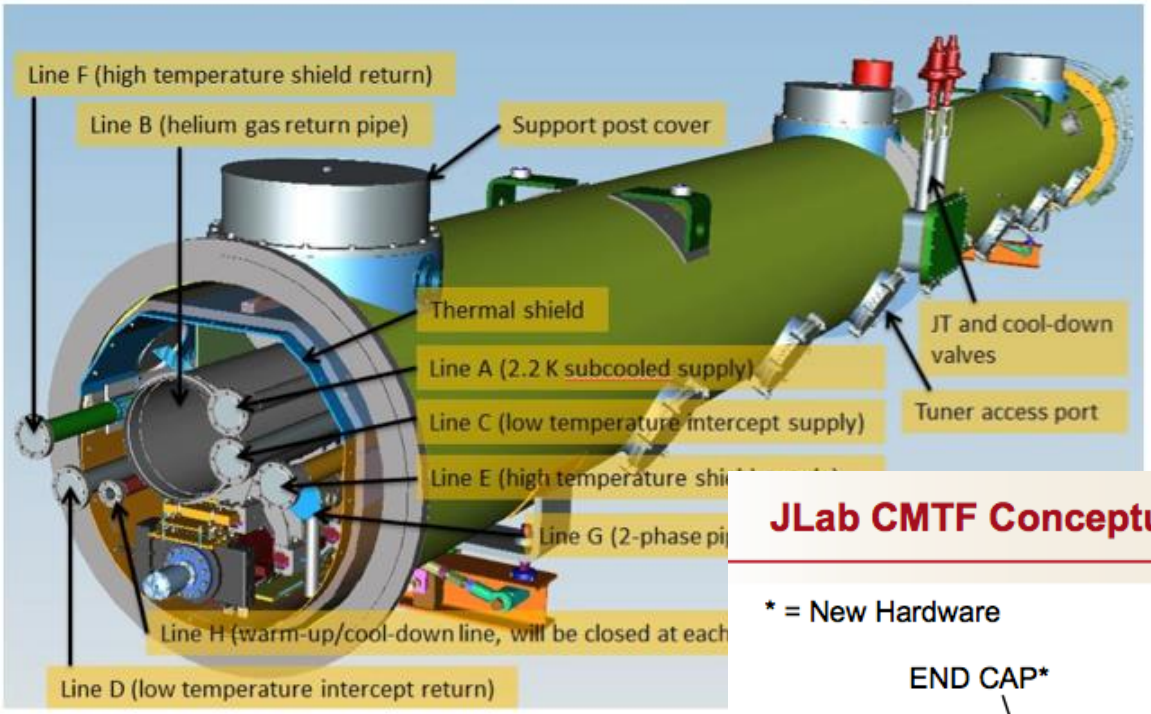
CEA Expertise with Vertical Electroploishing(VEP), F. Eozenou(Saclay)

1st 9-cell cavity VEP



VEP status at Marui Galvanizing Co. Ltd/KEK, T. Saeki(KEK)

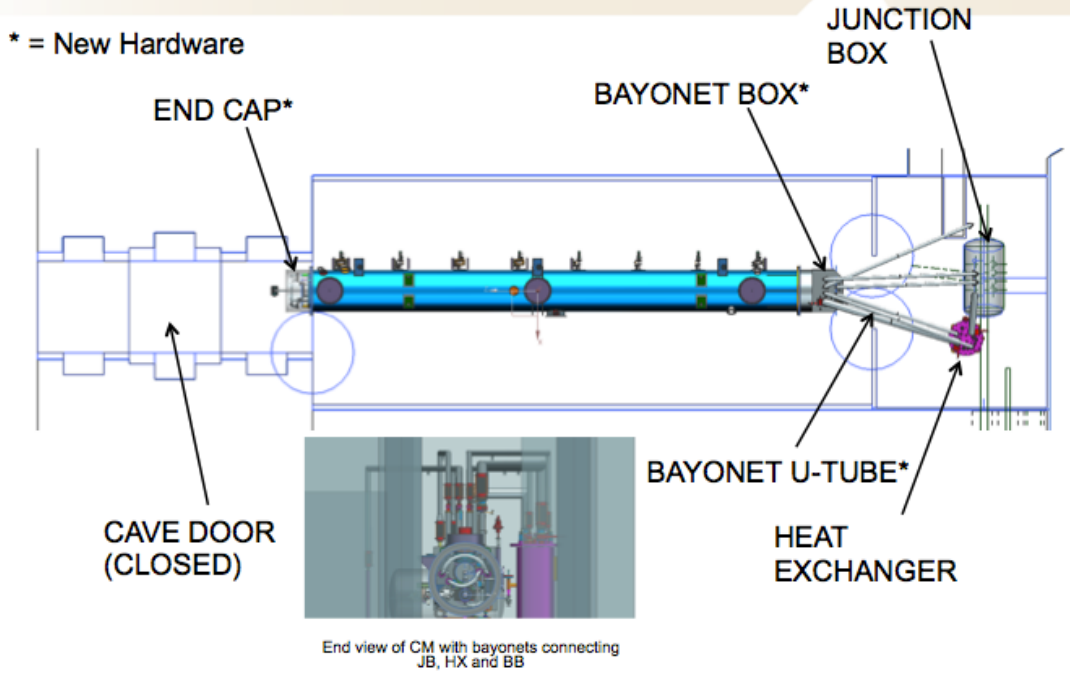
LCLS-II Cryomodule, facilities at FNAL, Jlab



Peterson - LCLS-II Cryomodule Design - 7 Oct 2014

LCLS-II Cryomodule Design,
T. Peterson(FNAL)

JLab CMTF Conceptual Layout



End view of CM with bayonets connecting JB, HX and BB

Weekly SRF Meeting, September 24th, 2014

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Infrastruc. Updates for LCLS-II Cryomodule Construction, E. Daly(Jlab)

LCLS-II power source, coupler consideration

SigmaPhi 10 kW CW Solid State Amplifier

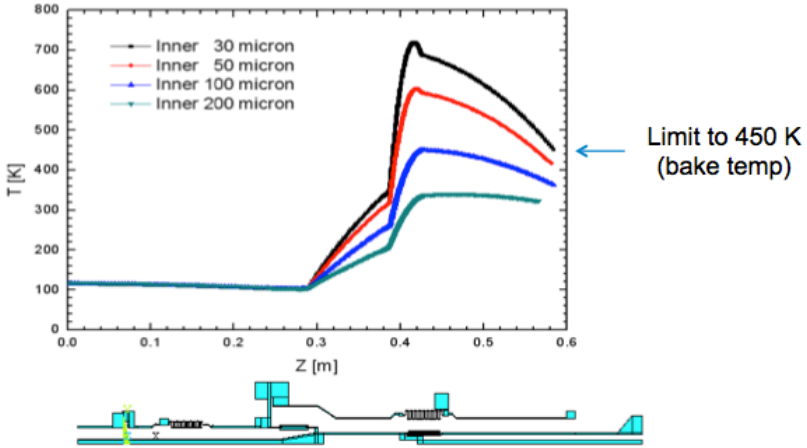
Consists of eight 1.25 kW water-cooled modules - each module has eight 160 W, isolated transistor units that are summed in a coaxial combiner – the output of the each module drives a common WR650 waveguide

Newer units with higher power transistors produce 16 kW in one rack

Ten 10 kW units at ELBE/HZDR and a 5 kW unit at Cornell

Coupler Heating

Inner conductor temperature for 15 kW TW operation for various thicknesses of the warm section inner conductor copper plating



Green-ILC (8 talks)

Joint session with HF2014(Beijing)	**Energy consumption and savings potential of CLIC, P. Lebrun(CERN)**
	A Green CEPC using the power of nuclear waste, Z. Liu(IHEP)
	Greening for Bosons, T. Parker(ESS)
	HEP future: to be green or not to be, D. Perret-Gallix(IN2P3)
	Current status of Green-ILC Activities in Japan, T. Saeki(KEK)
In LCWS	**R&D of the CPD klystron at KEK, K. Watanabe(KEK)**
	Application of Permanent magnet focusing to MBK, Y. Iwashita(Kyoto)
	Energy management example in a building complex, T. Saeki(KEK)

Sorry, no time to summarize Green ILC, within 15min,

Global organization for Green ILC

ILC Energy Center

ILC High-Energy Research Center

- Fundamental Research
- HEP Applications

Industry

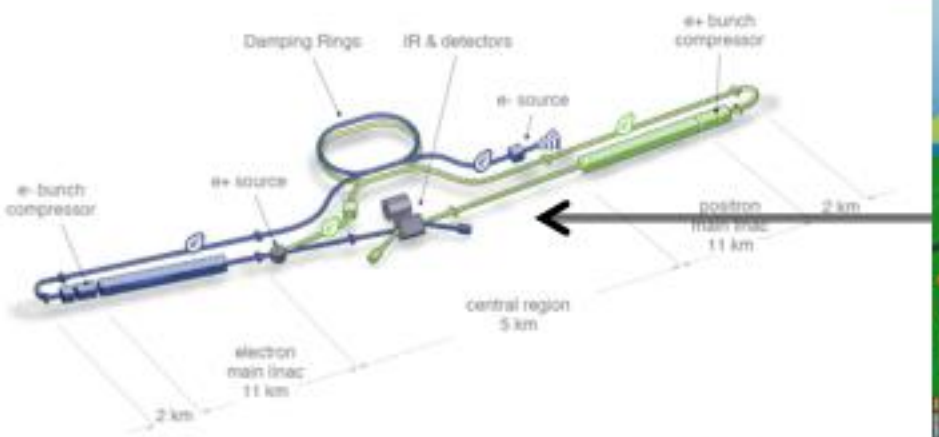
ILC Sustainable Energy Research Center

- Basic Research
- Application R&D
- Pilot Power plant for ILC

High-Energy community

Electrons, photons, neutrons factories
HPC/GRID Computing
Energy storage tech.

Energy community



Denis Perret-Gallix@in2p3.fr CNRS/ IN2P3LAPP - KEK

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