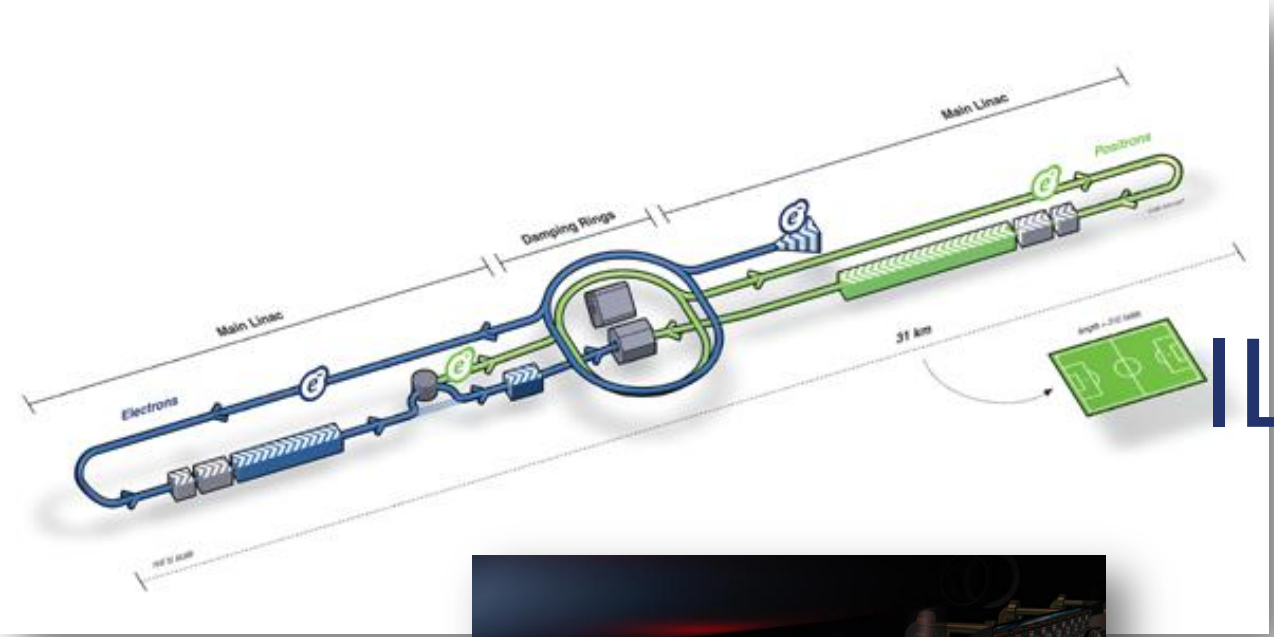
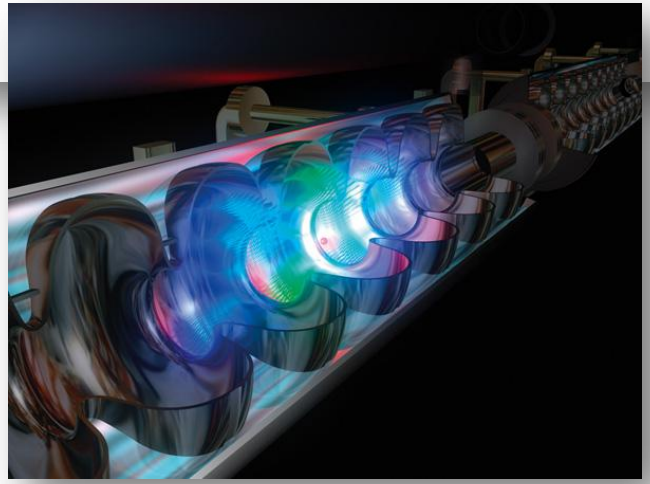


ILC Status



Marc Ross
Nick Walker
Akira Yamamoto

Contents

Global SCRF Global R&D

- High-Gradient
- Cryomodule
- Systems (beam) tests

Accelerator Systems R&D

- CesrTA
- ATF
- …

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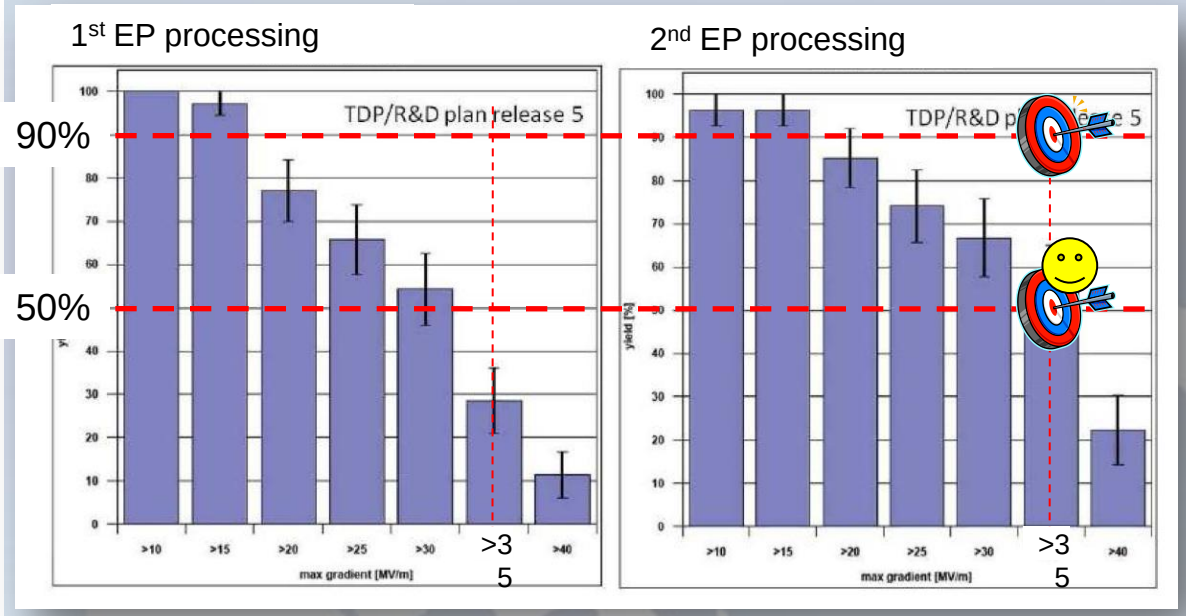
- TLCC process
- BAW-1 conclusions
- Parameters (BAW-2)

Industrialis-ation

- Global Mass Production
- Cost Estimation

SCRF High-Gradient R&D



TDP-2 goal

TDP-1 goal

Production* cavities achieving specified gradient

Production*: cavities having followed baseline ILC production process, as defined by specific cuts specified by the **GDE International Database Team**

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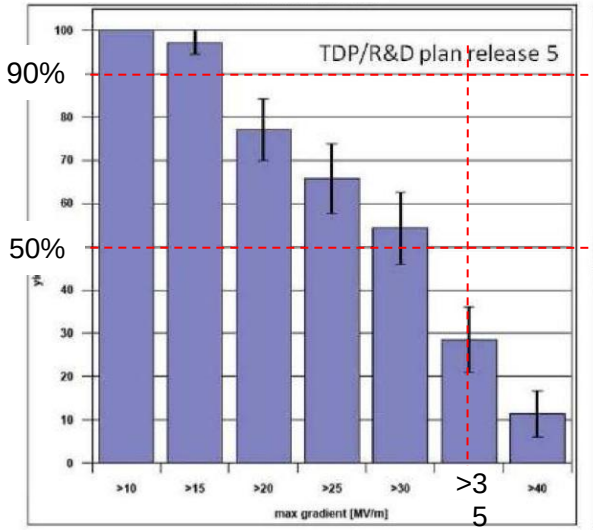
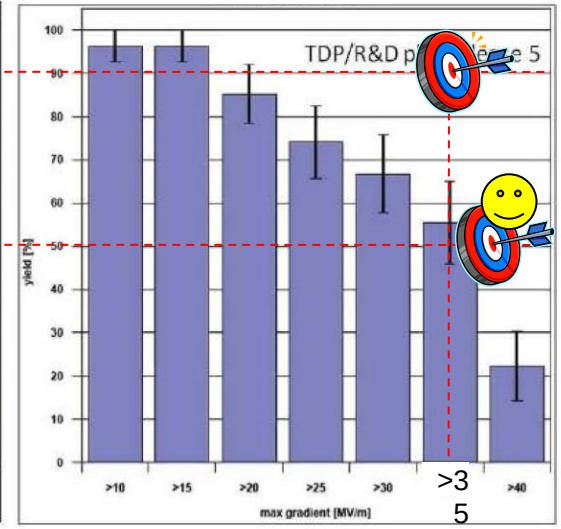
SCRF High-Gradient R&D

1st EP processing



2nd EP processing



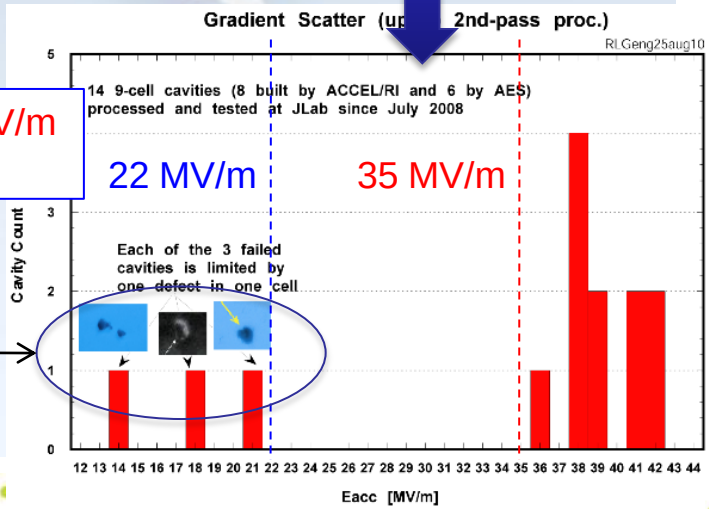
Production* cavities achieving specified gradient

statistics still low ☹

TDP-2 goal

TDP-1 goal

Results from JLab indicate separation of mechanical defects from surface preparation



Average (>35): ~39 MV/m
Yield: 11/14 ~78%

Identified mechanical defects during fabrication

Production*: cavities having followed baseline ILC production process, as defined by specific cuts specified by the **GDE International Database Team**

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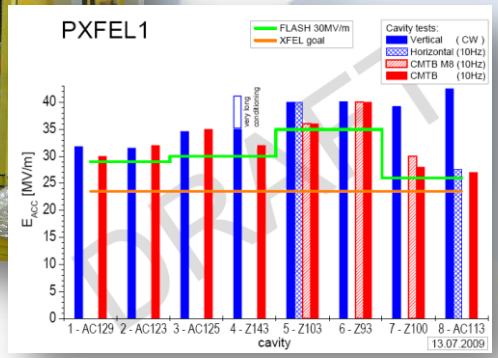
Cryomodule Development & Test

- **KEK: STF – S1-Global**

- **FNAL: Cool-down of CM-1**
  - at new NML facility

- **DESY: XFEL prototype PXFEL-1**
  - <32 MV/m>
  - Operational as ACC7 in FLASH (~30MV/m)



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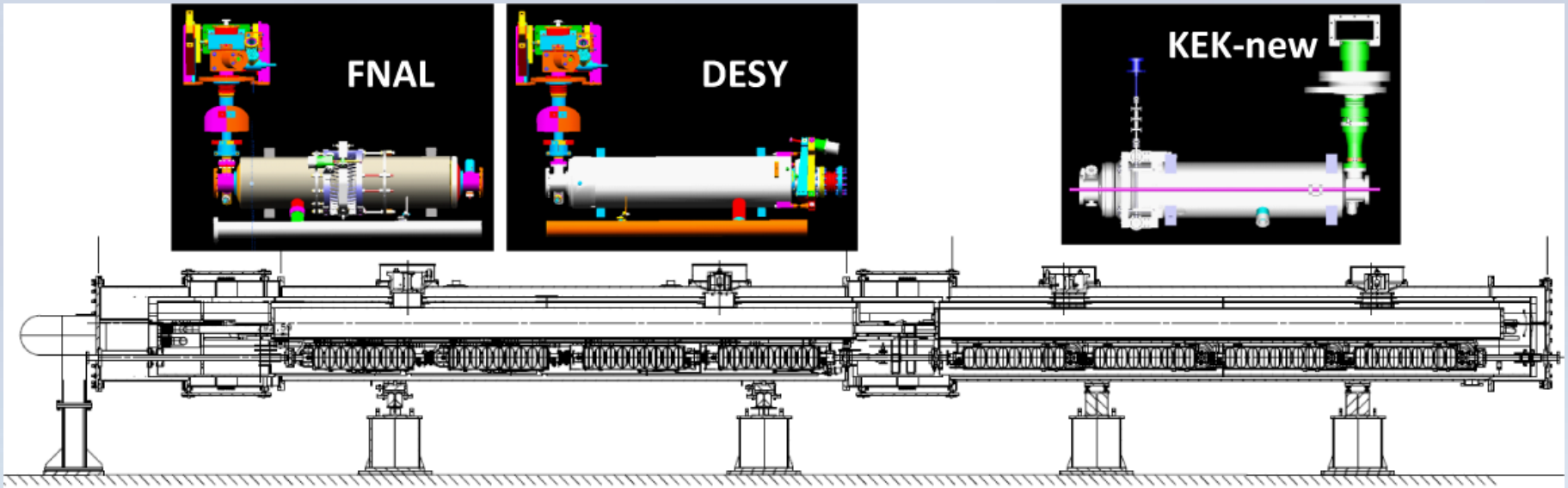
S1-Global @ KEK



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S1-Global @ KEK

- **Hybrid design with components from all three regions**
  - KEK: 4 cavities in 1 cryostat
  - DESY: 2 cavities
  - FNAL: 2 cavities

  INFN / ZANON cryostat
- **Comprehensive test programme**
  - International team
  - Cool-down carefully monitored
    - component alignment
  - Performance test of different component designs
    - 2 types of HP coupler
    - 3 types of cavity tuner
- **Currently on-going**
  - High-power pulse tests: 6 from 8 cavities tested
  - Piezo-tuner experiments (Lorentz Force Deturning)

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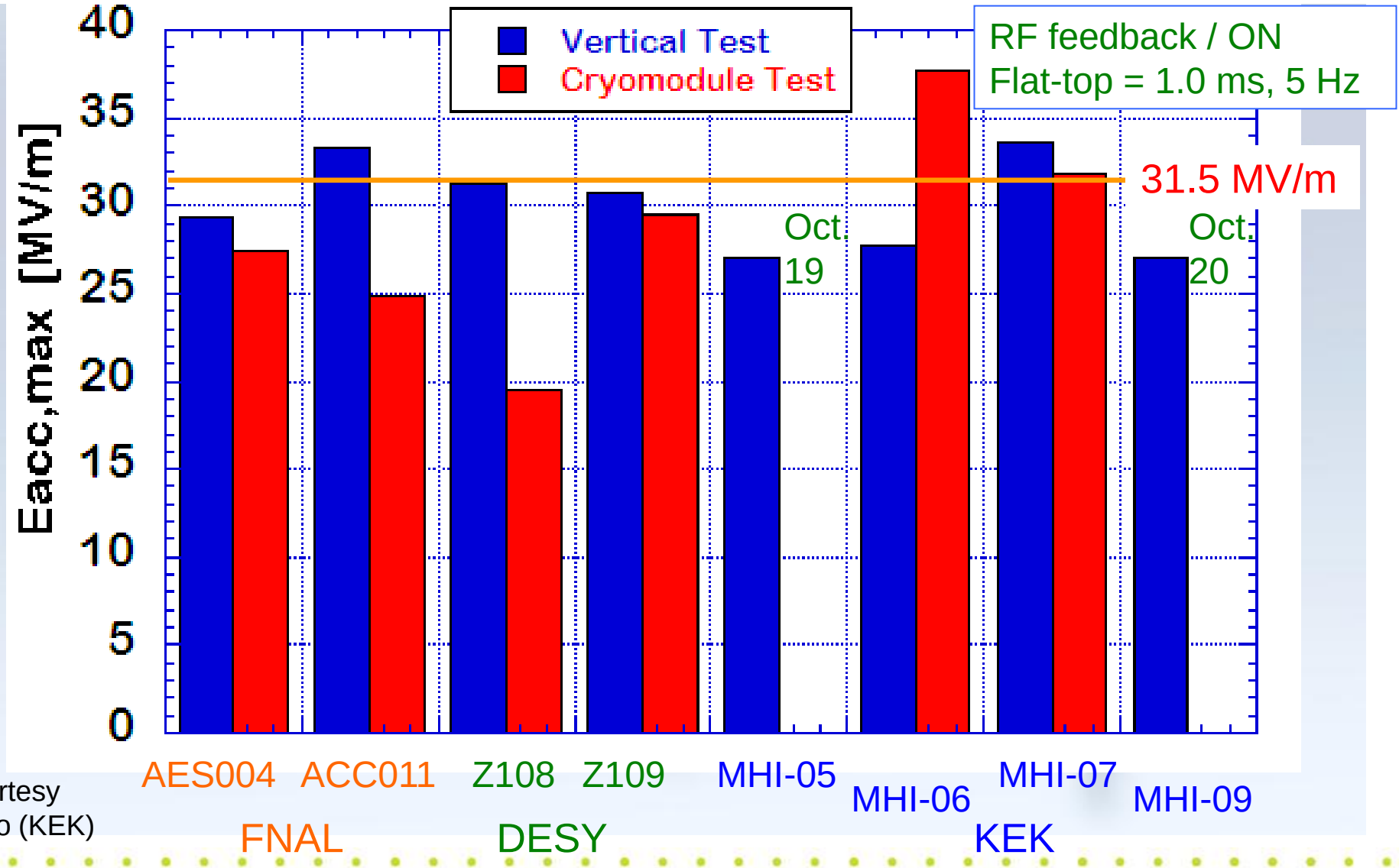
Individual Cavity Performance



Courtesy Kako (KEK)

Integrated Systems Tests

NML (FNAL)

- Under construction
- Up to 6 cryomodules
- Operation: end 2012
  - (3 CM)

FLASH (DESY)

- TDP focus
- 7 CM → 1.2 GeV beam
- photon user facility

STF (KEK)

- "Quantum Beam" experiment 2011
- 1 CM with beam 2013
- (2 CM 2015)

Full systems integration testing

"9mA experiment"
achieved ~1800 bunches at 9mA in 09.2009

$\Delta E/E_{RMS}$ ~0.5% (@ 0.8 GeV)
~0.1% within pulse

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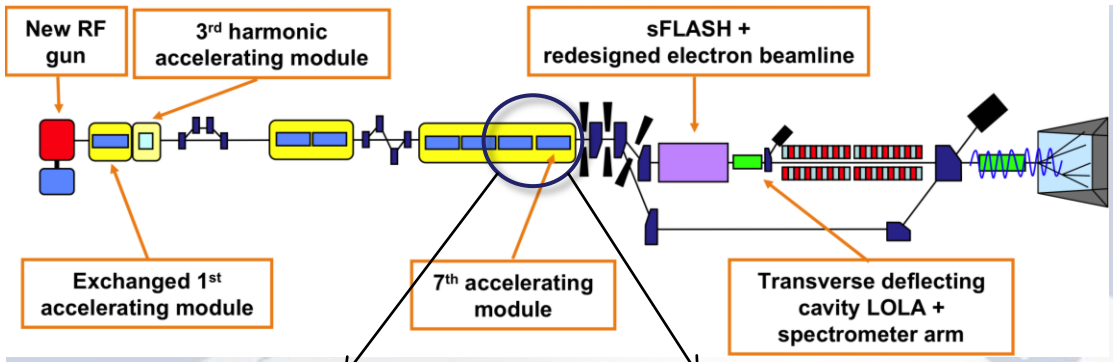
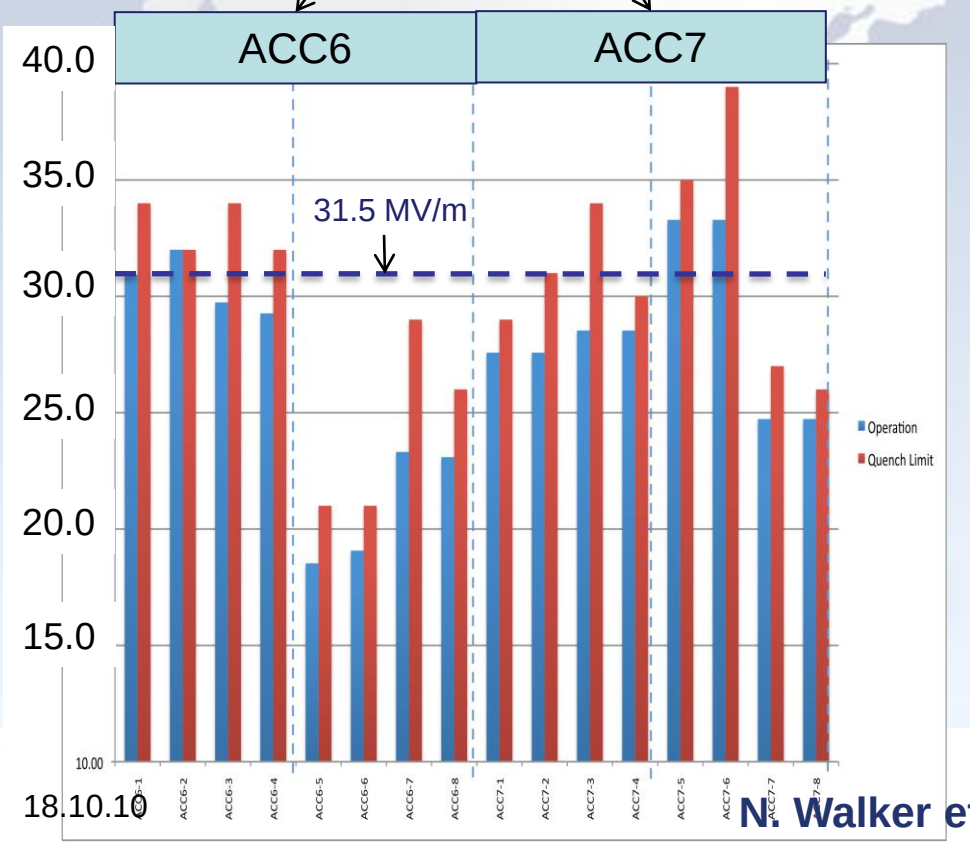
New Configuration for FLASH@DESY





ACC7 cavity quench limits and gradient spread are approaching ILC spec

Opportunity to study:

- **Gradient overhead and RF power overhead near ILC gradients**
- **RF distribution setup schemes with cavity powers close to ILC spec**
- **Lorentz-force detuning + piezo compensation near ILC gradients**
- **Two 9mA runs planned for 2011**
  - **January**
  - **Late Autumn (TBC)**

Significant improvements in operability during 2010 (LLRF)

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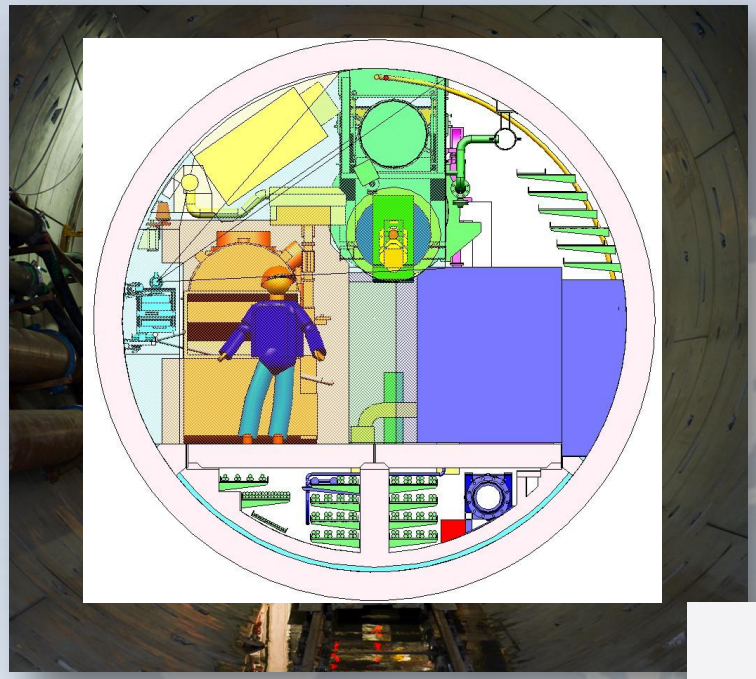
European XFEL

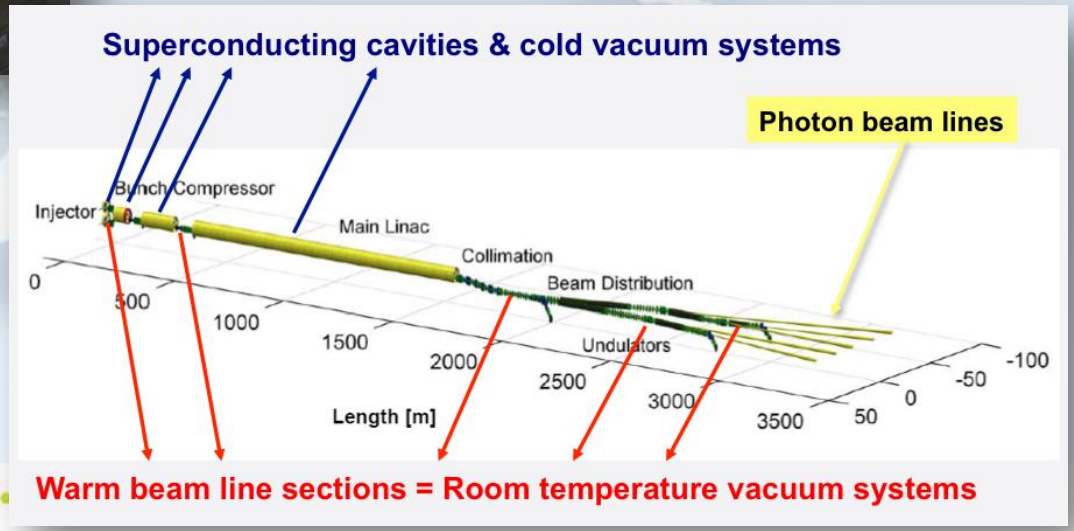


Construction of worlds largest SCRF linac begins (10% ILC prototype)

~800 cavities, ~100 cryomodules

~600 cavities already ordered (2 vendors)

First beam: 2014



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Beam Test Facilities (non SCRF)

- **Two Large Scale Test Facilities for R&D:**
  - Damping Ring (ATF, CesrTA)
  - Beam Delivery System (Final Focus) (ATF2)

strong ILC-CLIC synergy

- ATF/ATF-2 (KEK)

- CesrTA (Cornell)

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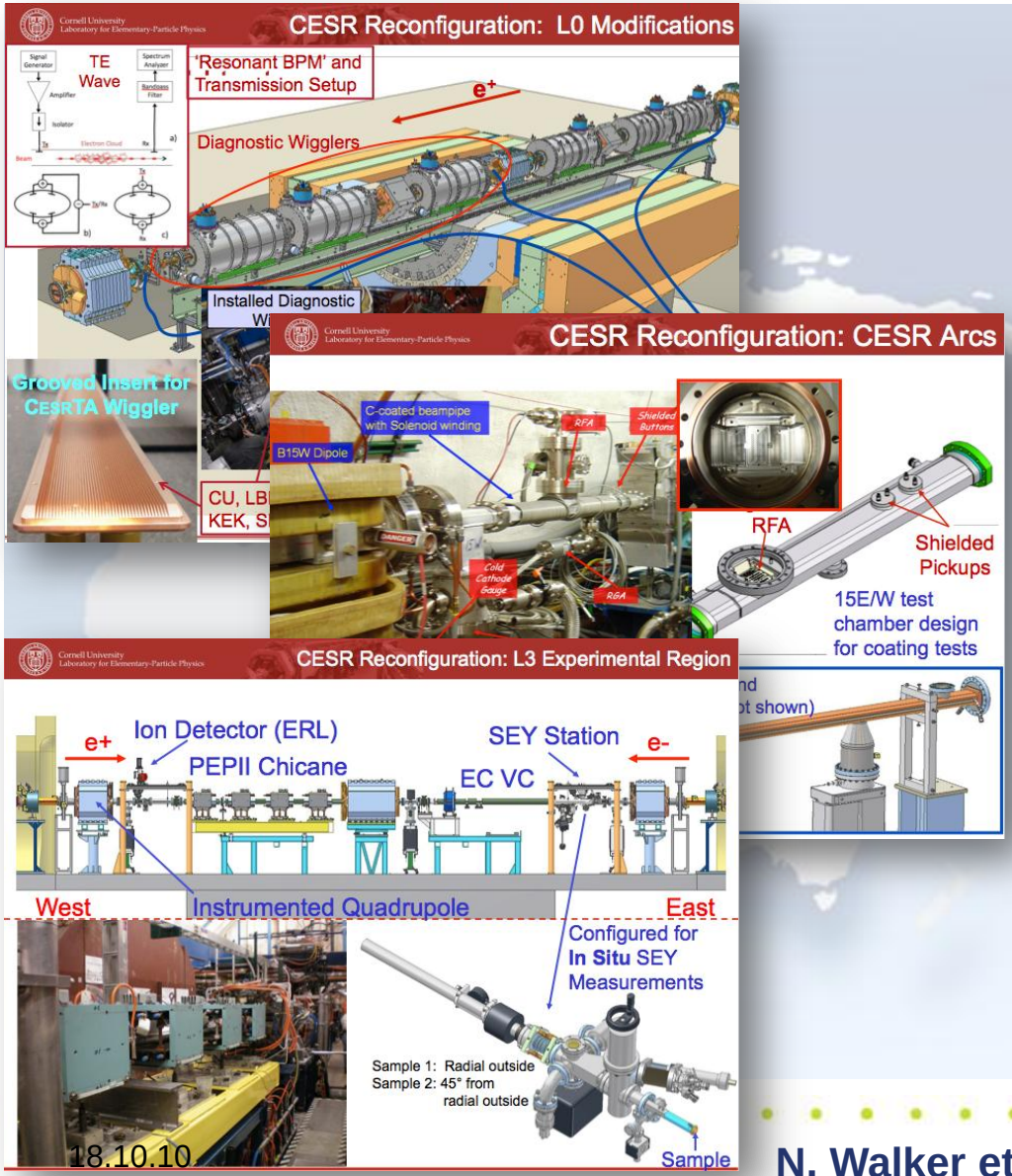
CesrTA Programme (Collaboration)



- **Major Reconfiguration of CESR ring**
- **2 Year Programme**
  - Ending 2010 (i.e. now)
- **Principal goals**
  - Measure EC build-up in wigglers / arcs
  - Evaluate experimentally mitigating techniques
  - Develop (benchmark)models for EC-driven instabilities

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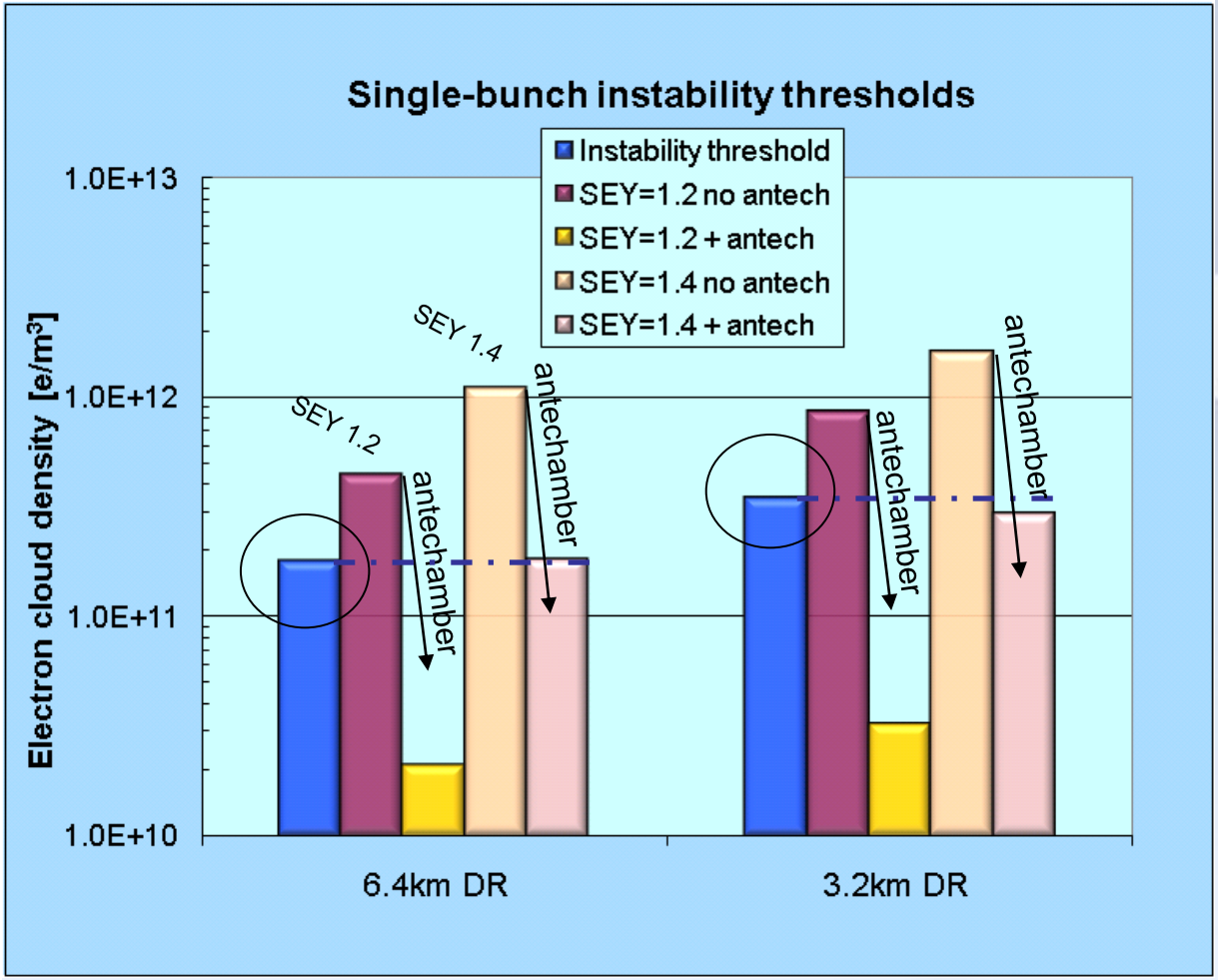
Comparison of 6.4 and 3.2 km DR Options



Summer 2010 Evaluation

- Comparison of Single Bunch EC Instability Thresholds for:
  - 6.4km ring with 2600 bunches
  - 3.2km ring with 1300 bunches
  - ⇨ same average current
- Both ring configurations exhibit similar performance

⇨ 3.2km ring (*low current option*) is an **acceptable** baseline design choice

S. Guiducci, M. Palmer, M. Pivi, J. Urakawa on behalf of the ILC DR Electron Cloud Working Group

EC Working Group Baseline Mitigation Plan

Mitigation Evaluation conducted at satellite meeting of ECLOUD`10 (October 13, 2010, Cornell University)

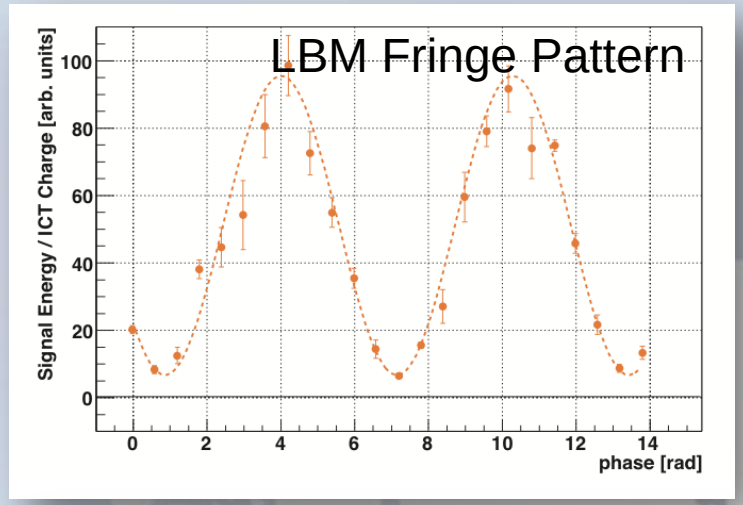
EC Working Group Baseline Mitigation Recommendation				
	Drift*	Dipole	Wiggler	Quadrupole*
Baseline Mitigation I	TiN Coating	Grooves with TiN coating	Clearing Electrodes	TiN Coating
Baseline Mitigation II	Solenoid Windings	Antechamber	Antechamber	
Alternate Mitigation	NEG Coating	TiN Coating	Grooves with TiN Coating	Clearing Electrodes or Grooves

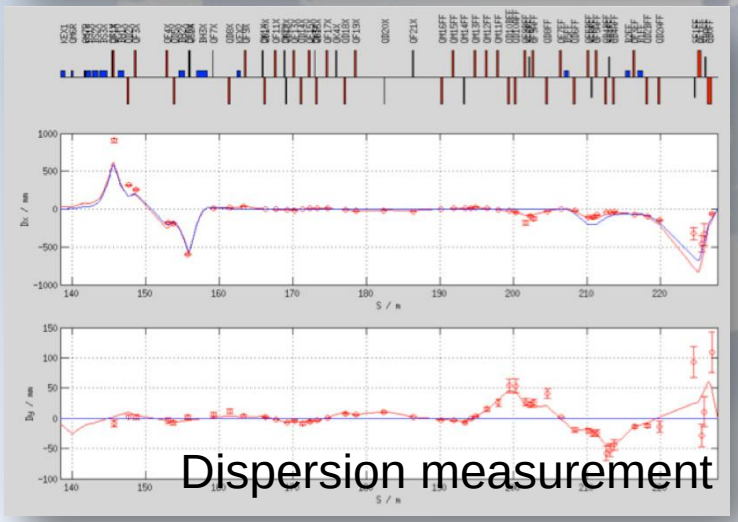
*Drift and Quadrupole chambers in arc and wiggler regions will incorporate antechambers

- Preliminary CESRTA results and simulations suggest the presence of *sub-threshold emittance growth*
  - Further investigation required
  - May require reduction in acceptable cloud density ⇨ reduction in safety margin
- An aggressive mitigation plan is required to obtain optimum performance from the 3.2km positron damping ring and to pursue the high current option

S. Guiducci, M. Palmer, M. Pivi, J. Urakawa on behalf of the ILC DR Electron Cloud Working Group

ATF-2 (KEK)





- **Shintake laser monitor (LBM)**
  - improved S/N
- **Significant progress on optics**
  - beam based alignment
  - tuning algorithms
  - optics modelling
- **2010/11 run just beginning**

σ_y ~ 310 nm

[goal: 38 nm]

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Conventional Facilities & Siting

- **Sites considered (technical solutions)**
  - Europe - CERN, Dubna
  - USA - FNAL
  - Asia - 2 sites in Japan (mountainous regions)

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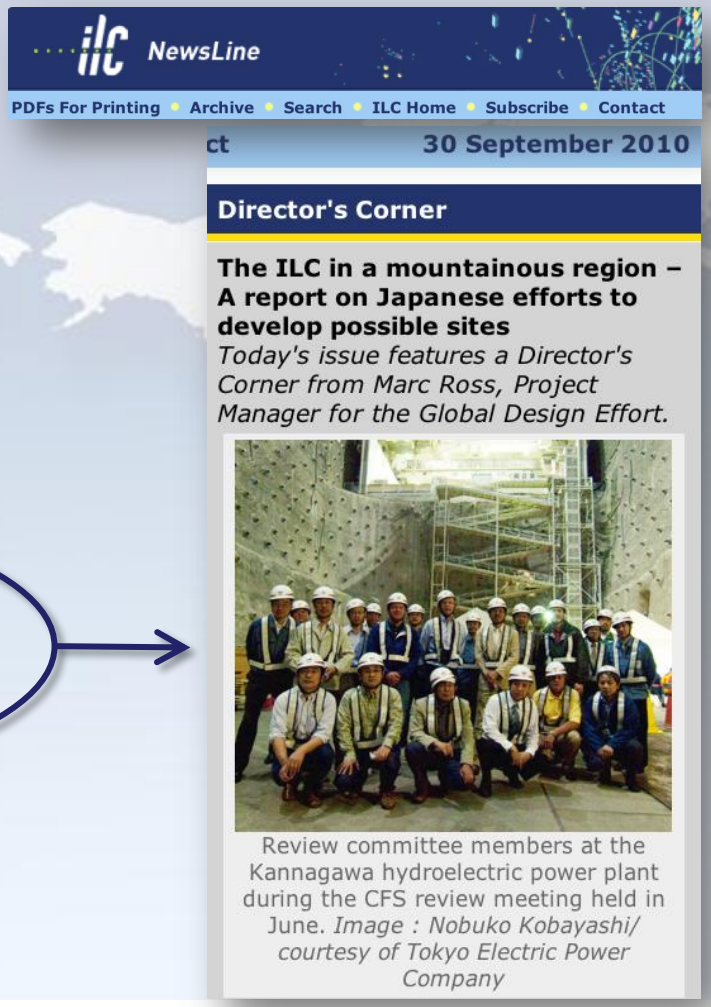

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ct 30 September 2010

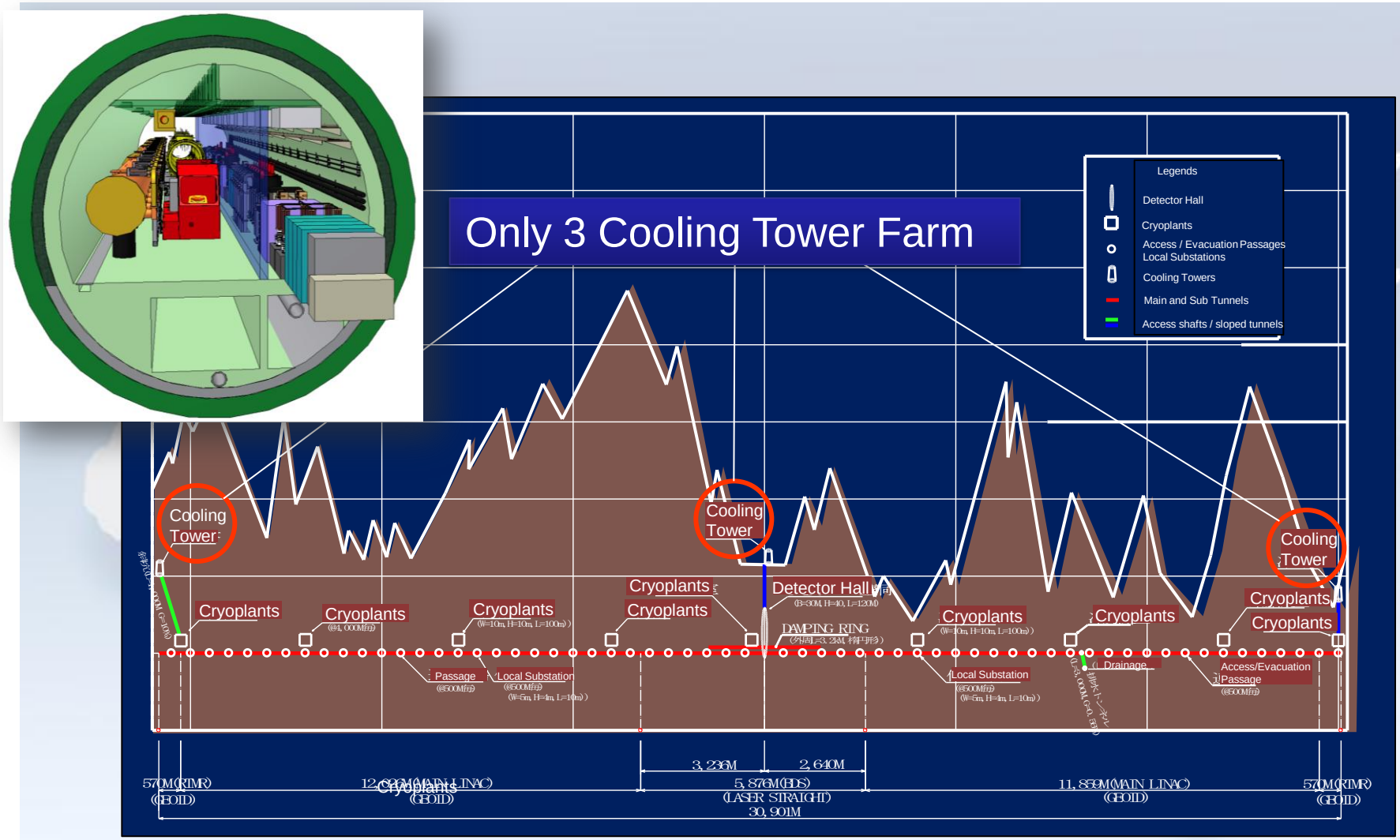
Director's Corner

The ILC in a mountainous region – A report on Japanese efforts to develop possible sites

Today's issue features a Director's Corner from Marc Ross, Project Manager for the Global Design Effort.

Review committee members at the Kannagawa hydroelectric power plant during the CFS review meeting held in June. *Image : Nobuko Kobayashi/ courtesy of Tokyo Electric Power Company*

Conceptual Civil Engineering Study in a Mountainous Region



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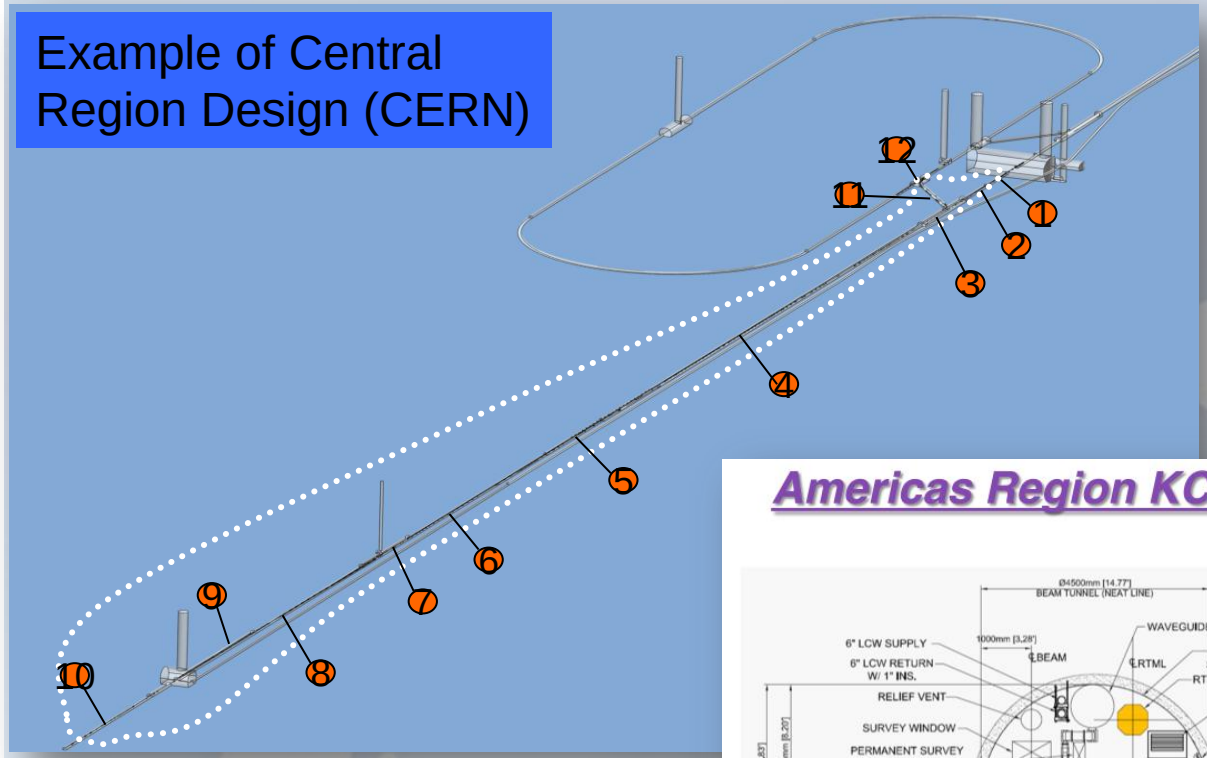
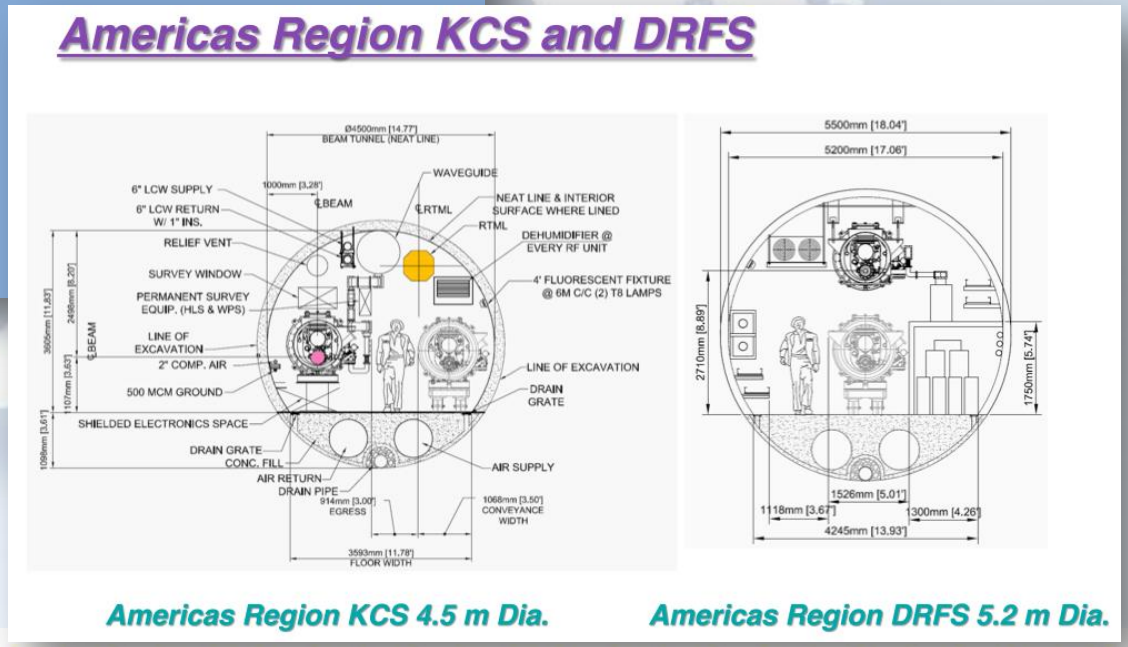
CFS: Other Regions





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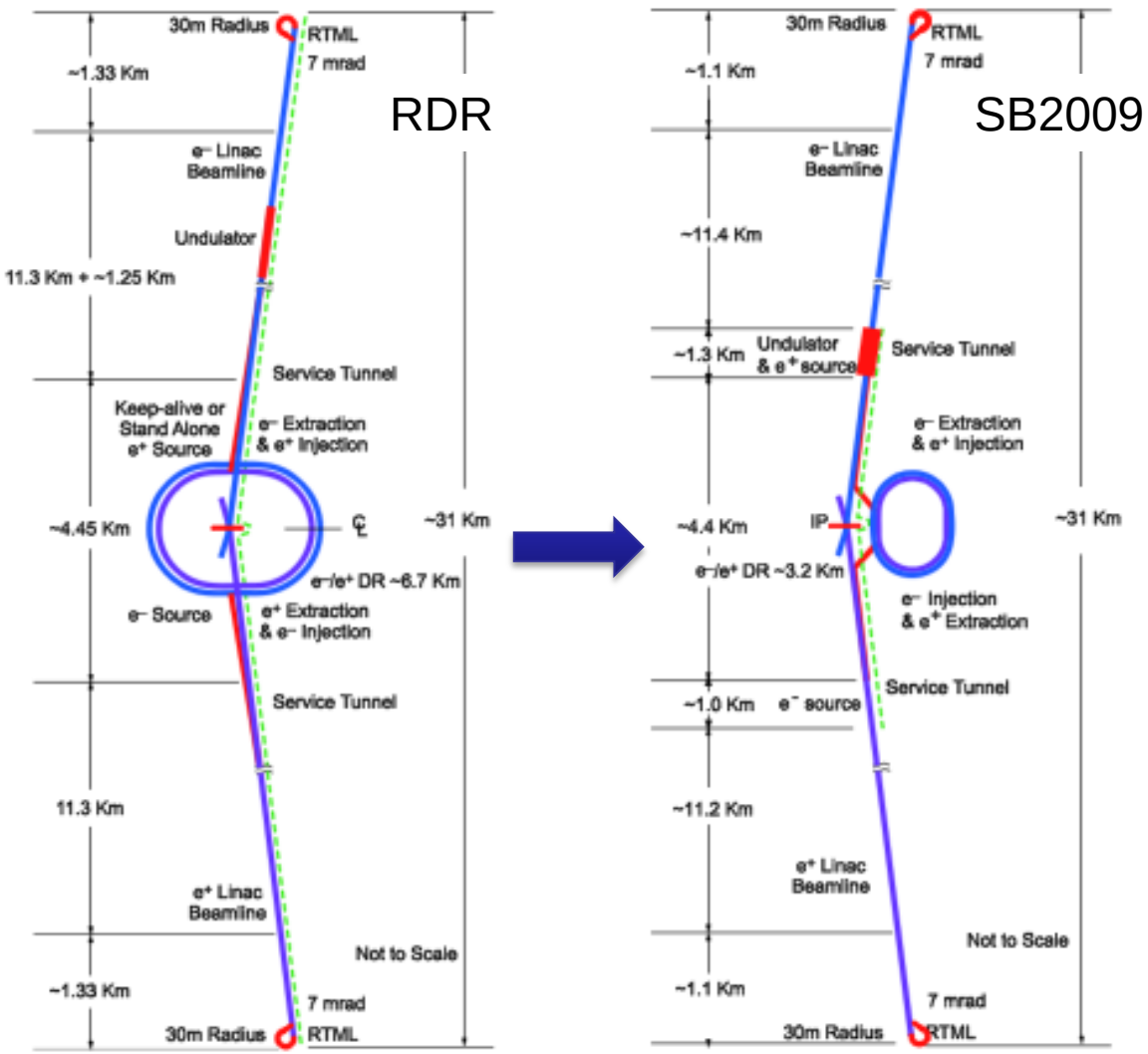
Accelerator Design & Integration



- **2009 Design Studies**
  - on-going
- **Cost Constraint**
  - 'Global' Value Engineering
- **Towards an agreed-upon baseline for the TDR**
  - Top-Level Change Control Process (**TLCC**)
  - Communication with stakeholders (e.g. Physics & Detector groups)

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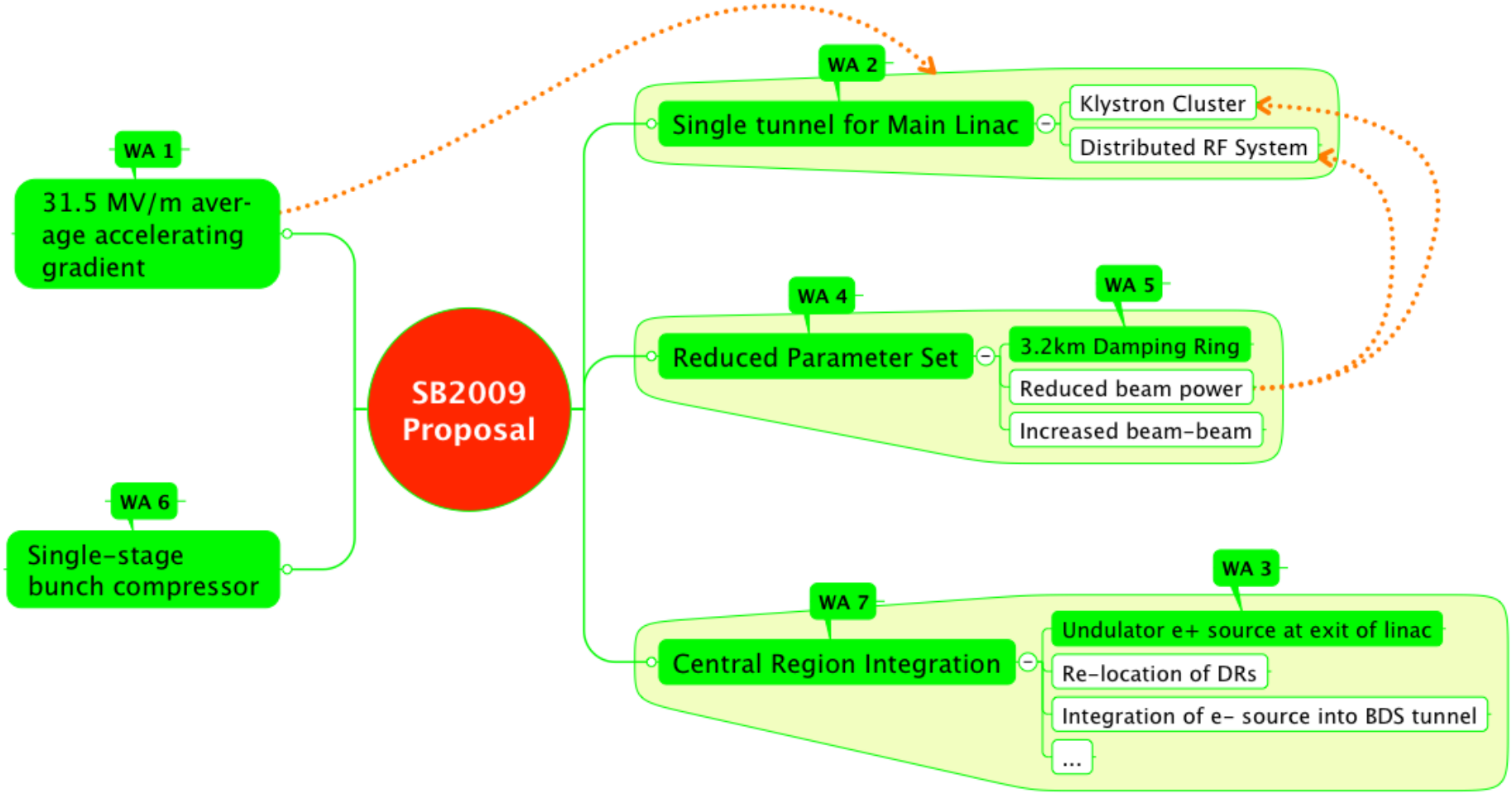
SB2009 Themes



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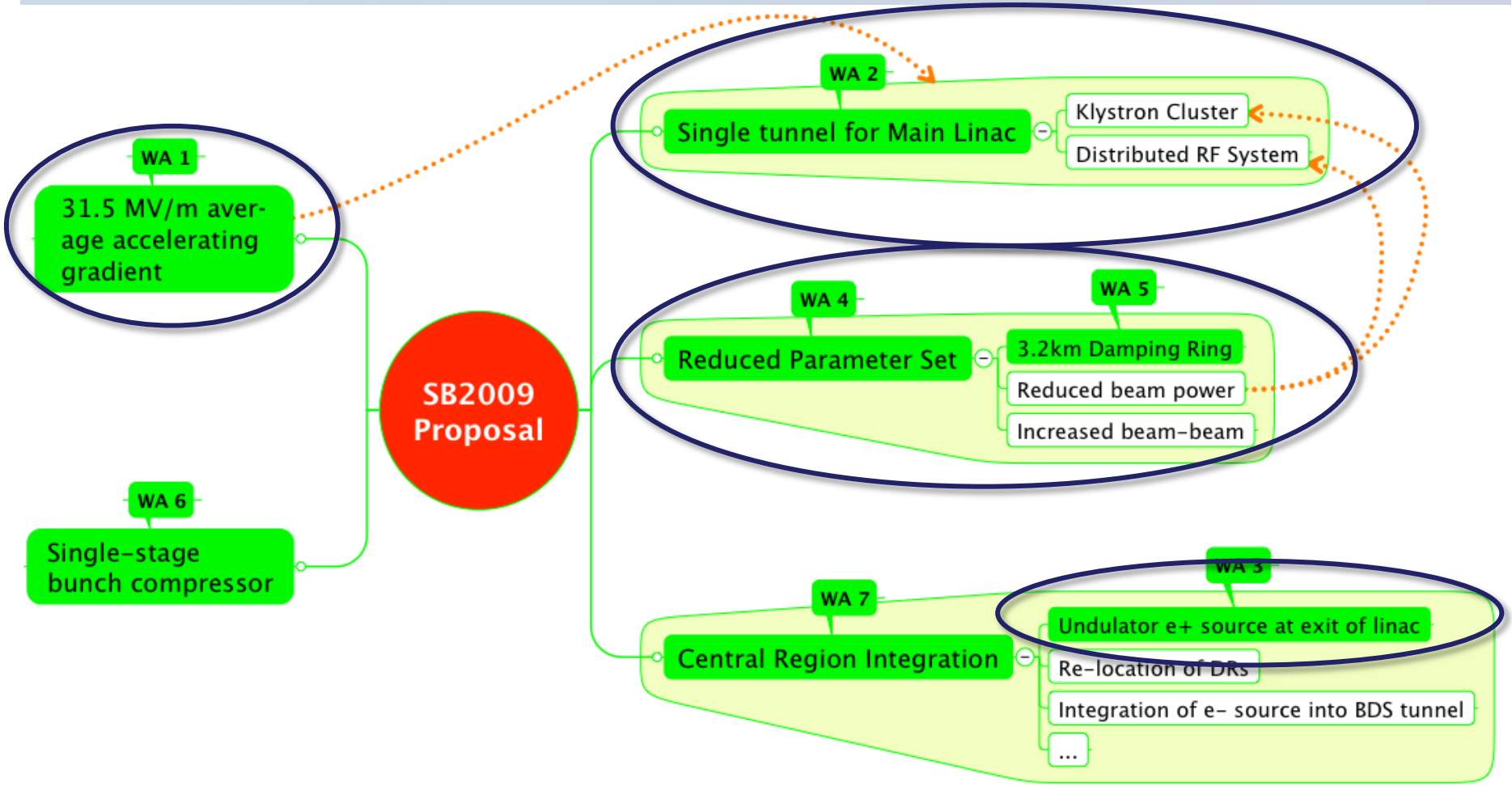
TLCC Themes



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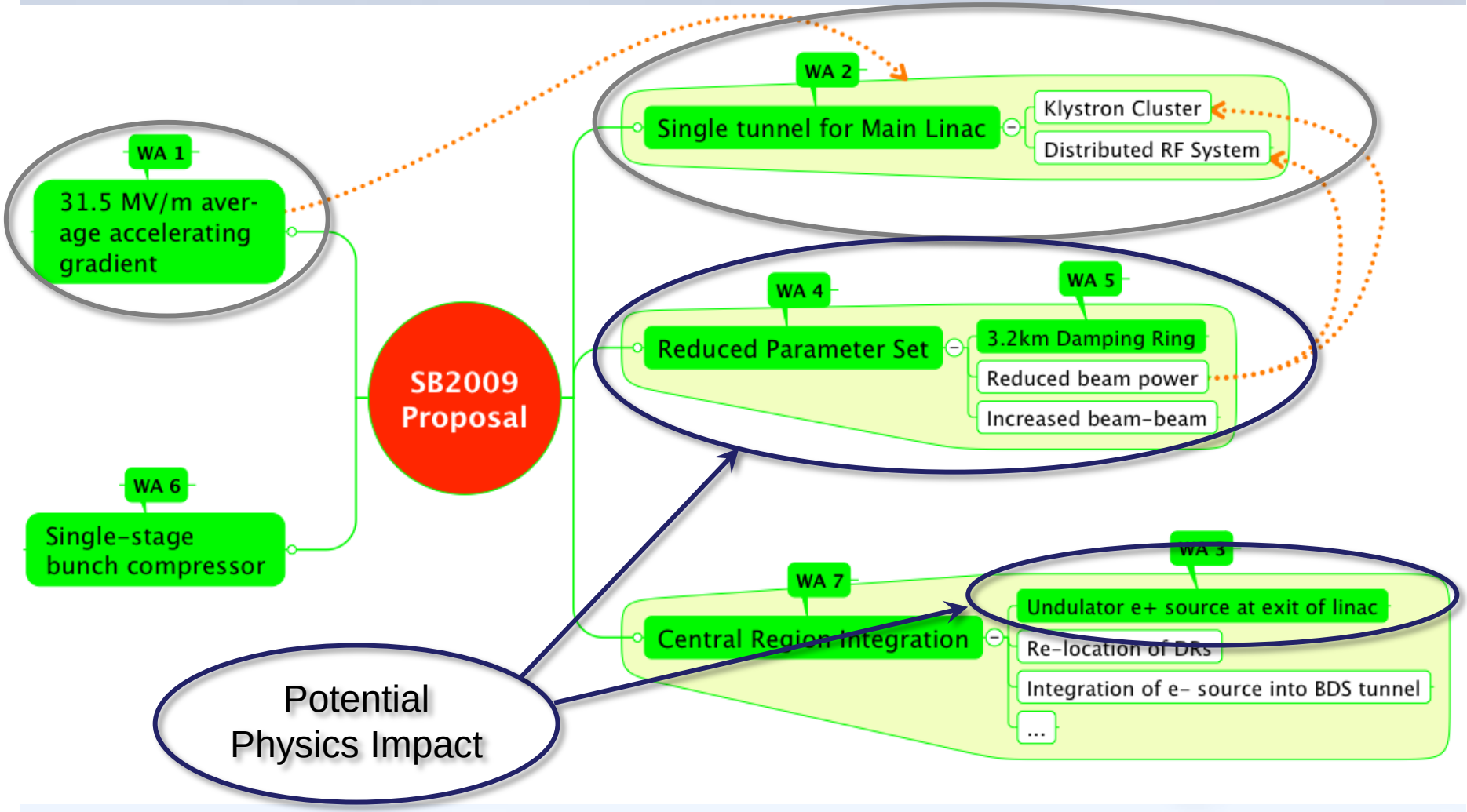
TLCC Themes



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TLCC Process

Issue Identification

- Planning
- Identify further studies
- Canvas input from stakeholders
- …

Baseline Assessment Workshops

- Face to face meetings
- Open to all stakeholders
- Plenary

Formal Director Approval

- Change evaluation panel
- Chaired by Director

keywords: open, transparent

TLCC Process

1. Accelerating Gradient
2. Single-tunnel (HLRF)

1st BAW
KEK 7-10th Sept. 2010

Proposals submitted to director

Issue Identification

- Planning
- Identify further studies
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- …

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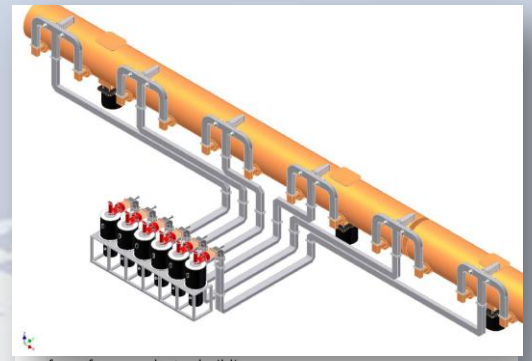
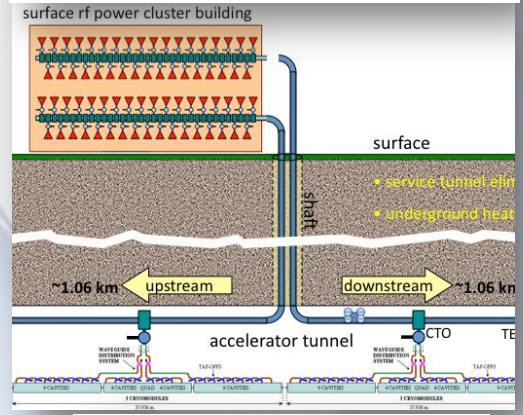
Single Tunnel Options (HLRF)

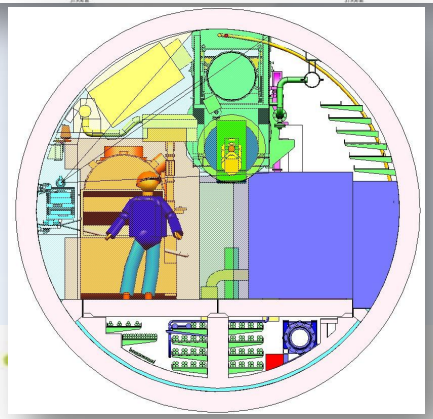
- **Distributed RF Sources (DRFS)**
  - 800 kW MAK
  - Everything in tunnel

- **Klystron Cluster Scheme (KCS)**
  - Surface clusters of klystrons (2×32 MBK)
  - RF power distributed via over-moded waveguide (350 MW)
    - ±1 km

- **RDR HLRF Technology**
  - e.g. XFEL-like solution (pulsed cables)
  - Back-up (risk-mitigation)







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BAW-1: Recommendations

Approx. 58 participants physics & detector reps.

1. Gradient

- Remain at 31.5 MV/m average accelerating gradient
  - → fixed tunnel length
- Additional RF power to accommodate a spread in gradient (±20%)
  - → higher mass-production yield expected ⇒ cost effective
- TDP2 R&D remains ≥35 MV/m low-power vertical test (90% yield)
  - infers <*G*> ~38 MV/m VT (additional margin)

2. Single-Tunnel (Main Linac)

- Go forward with SB2009 proposal
- Both KCS and DRFS R&D have significantly progressed
- Inclusion of RDR HLRF Technology option as **back-up solution**

http://ilcagenda.linearcollider.org/conferenceTimeTable.py?confId=4593

TLCC Process

1. Accelerating Gradient
2. Single-tunnel (HLRF)
3. Low-Power Parameter
4. Positron source location

1st BAW
KEK 7-10th Sept. 2010
2nd BAW
SLAC 18-21st Jan. 2011

Issue Identification

- Planning
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- Canvas input from stakeholders
- …

Baseline Assessment Workshops

- Face to face meetings
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This workshop critical important milestone for TLCC process

keywords: open, transparent

BAW-2 Themes

								upgrade
Centre-of-mass energy	E_{cm}	**GeV**	**200**	**230**	**250**	**350**	**500**	**1000**
Luminosity	L	$\times 10^{34}$ cm^{-2}s^{-2}	**0.5**	**0.5**	**0.7**	**0.8**	**1.5**	**2.8**
Luminosity (Travelling Focus)	L_{TF}	$\times 10^{34}$ cm^{-2}s^{-2}	**0.5**		**0.8**	**1.0**	**2.0**	
Number of bunches	n_b		1312	1312	1312	1312	1312	2625
Collision rate	f_{rep}	Hz	5	5	5	5	5	4
Electron linac rate	f_{linac}	Hz	10	10	10	5	5	4
Positron bunch population	N_+	$\times 10^{10}$	2	2	2	2	2	2

Formally agreed parameter sets across energy range
ILC-EDMS document ID 925325

http://ilc-edmsdirect.desy.de/ilc-edmsdirect/document.jsp?edmsid=*925325

More work and discussion needed (→ this workshop)

BAW-2 Themes

								upgrade
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Primary motivation for low-power:
- Reduced RF power (modulators, klystrons, associated CFS)
- Smaller circumference damping ring (6.4 km → 3.2 km)

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Primary motivation for low-power:
- Reduced RF power (modulators, klystrons, associated CFS)
- Smaller circumference damping ring (6.4 km → 3.2 km)

Low E_{cm} running luminosity improved (over original SB2009)
-10Hz alternative pulse operation mode for e+ production → const. charge
- Modular Final Doublet to adjust IP focusing

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BAW-2 Issues

Travelling Focus

- More detailed simulations required
- Stability issues → impact on feedback and tolerances
- considered higher-risk option
- Inclusion not a cost issue

10Hz Operation (Low E_{cm})

- Positron damping ring 50% duty cycle
- RF solution still required (this workshop)
- Understanding cost impact (1.9% TPC)
- Other emerging options (high-field undulator)

Upgrade / Risk-Mitigation

- Understand scenarios for re-establishing RDR bunch number
- Cost impact (mostly CFS)
- Considered either as possible luminosity upgrade or risk-mitigation (GDE PAC)

Physics impact ⟷ Working with Physics & Detector groups as part of the TLCC process

1TeV Upgrade

								upgrade
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Electron linac rate	f_{linac}	Hz	10	10	10	5	5	4
Positron bunch population	N_+	$\times 10^{10}$	2	2	2	2	2	2

1 TeV Upgrade parameter set now added

- Tentative (subject to change)
- Assumes re-establishment of full RDR bunch number

Complete scope of TeV upgrade will be studied in 2011 (input for TDR)

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Contents

Global SCRF Global R&D

- High-Gradient
- Cryomodule
- Systems (beam) tests

Accelerator Systems R&D

- CesrTA
- ATF
- …

Accelerator Baseline Design

- TLCC process
- BAW-1 conclusions
- Parameters (BAW-2)

Industrialis-ation

- Global Mass Production
- Cost Estimation

TDR: Five Themes to Develop

Industrialisation in-kind contribution models

Site requirements

Project Schedule

Remaining Technical activities

Project Implementation Plan

Remains special case

SCRF Technology
- Regional expertise, global Industrialisation
- Average accelerating gradient
- Cost (cryomodule, mass-production models)

R&D (General)
- Sources
- DR (e-cloud)
- BDS / MDI

AD&I (CFS)
- Consolidation of baseline(s)
- Design choices (parameters, layout etc.)
- Design work (documentation)

Cost & Schedule
- ICET (schedule tool)
- Traceable, defendable
- Justification

TDR Risk
- R&D (and engineering) beyond 2012
- Impact (design, cost, schedule)
- Mitigation (fall-back solutions)

>2012

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>2012

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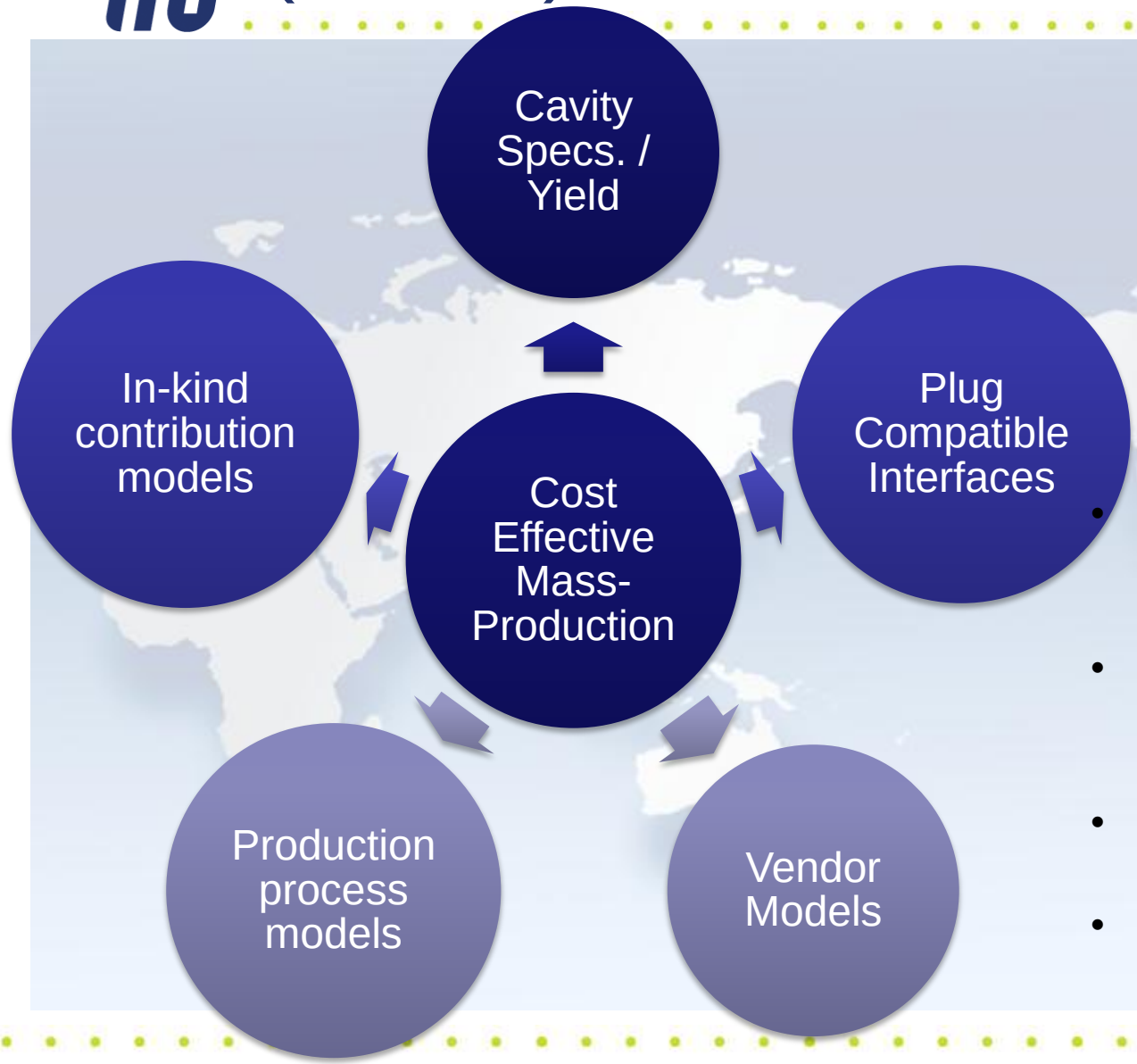
(Global) Mass Production (SCRF)



important focus of this workshop

- Critically important TDP2 activity
- Learn from XFEL experience
  - 5% ILC
- Learn from LHC experience
- Develop realistic models on which to base cost estimate
  - With industry

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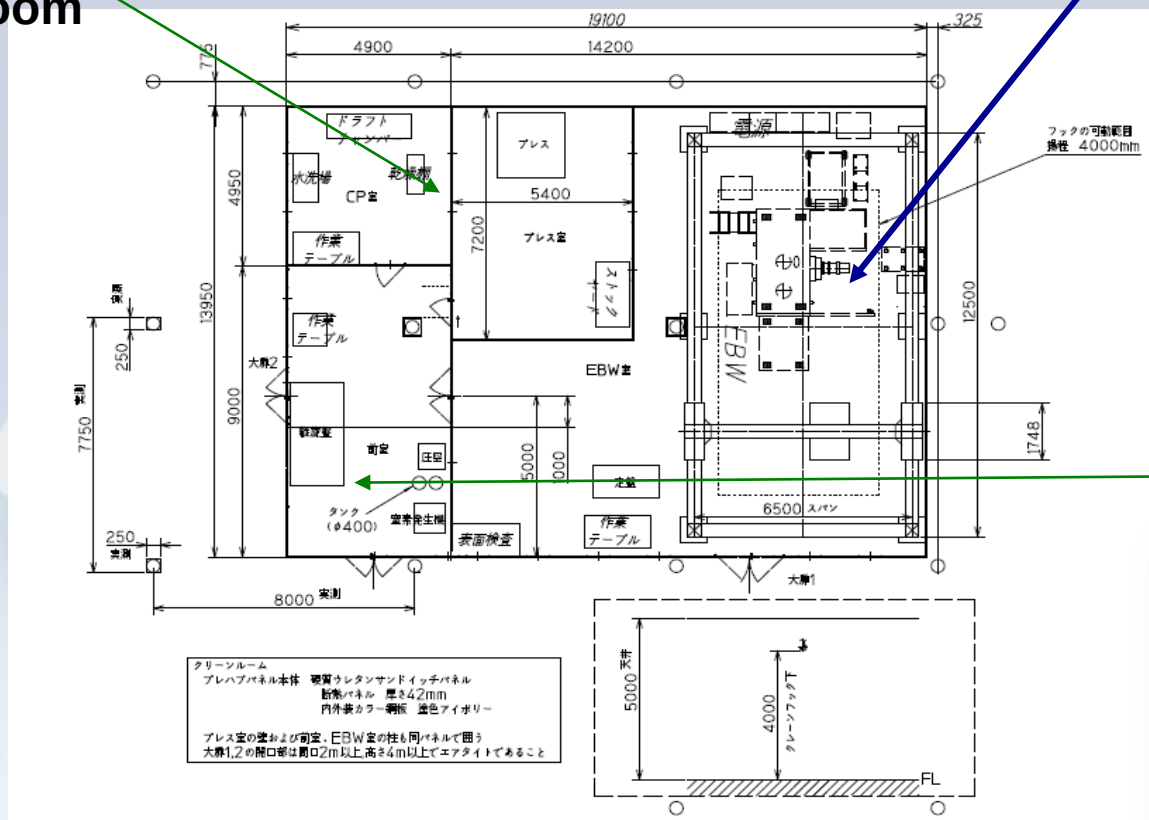
KEK Industrial R&D Pilot Plant

Chemical Polish room

19m x 14m ISO class-5 clean room

Electron Beam Welder



Press machine

Triming machine

work together with industry to develop cost-effective cavity production techniques

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Highlights in Summary

- **Progress on all R&D fronts (~100 M$/Year globally)**
  - Regional SCRF infrastructure now coming up to speed
  - Successful completion of CesrTA (phase 1)
- **Realistic site developments (siting)**
  - Further detailed development of mountainous site (Japan)
- **AD&I: TLCC process underway**
  - development of cost-constrained baseline for the TDR cost estimate
  - 1st BAW complete, proposals sent to Director
  - 2nd BAW being planned
- **TDP-2 focus now on consolidating cost estimate**
  - Global Mass-production of ~1700 cryomodules

On-Track for TDR in late 2012 ☺