GDE Summary

Marc Ross
Nick Walker
Akira Yamamoto

Content

- Accelerator Design & Integration
- SCRF status
- Workshop highlights
- GDE-CERN collaboration
- Towards the ILC Technical Design Report

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AD&I Re-Baseline Rationale

- Cost constraint in TDR
  - **Updated cost estimate in 2012 ≤6.7 BILCU**
  - **Need margin against possible increased component costs**
- Process forces critical review of RDR design
  - **Errors and design issues identified**
  - **Iteration and refinement of design**
  - **More critical attention on difficult issues**
- Balance for risk mitigating R&D
  - **Majority of global resources focused in R&D**
  - **Important to prepare / re-focus project-orientated activities for TDP-2**
- Need for design options and flexibility
  - **Unknown site location**

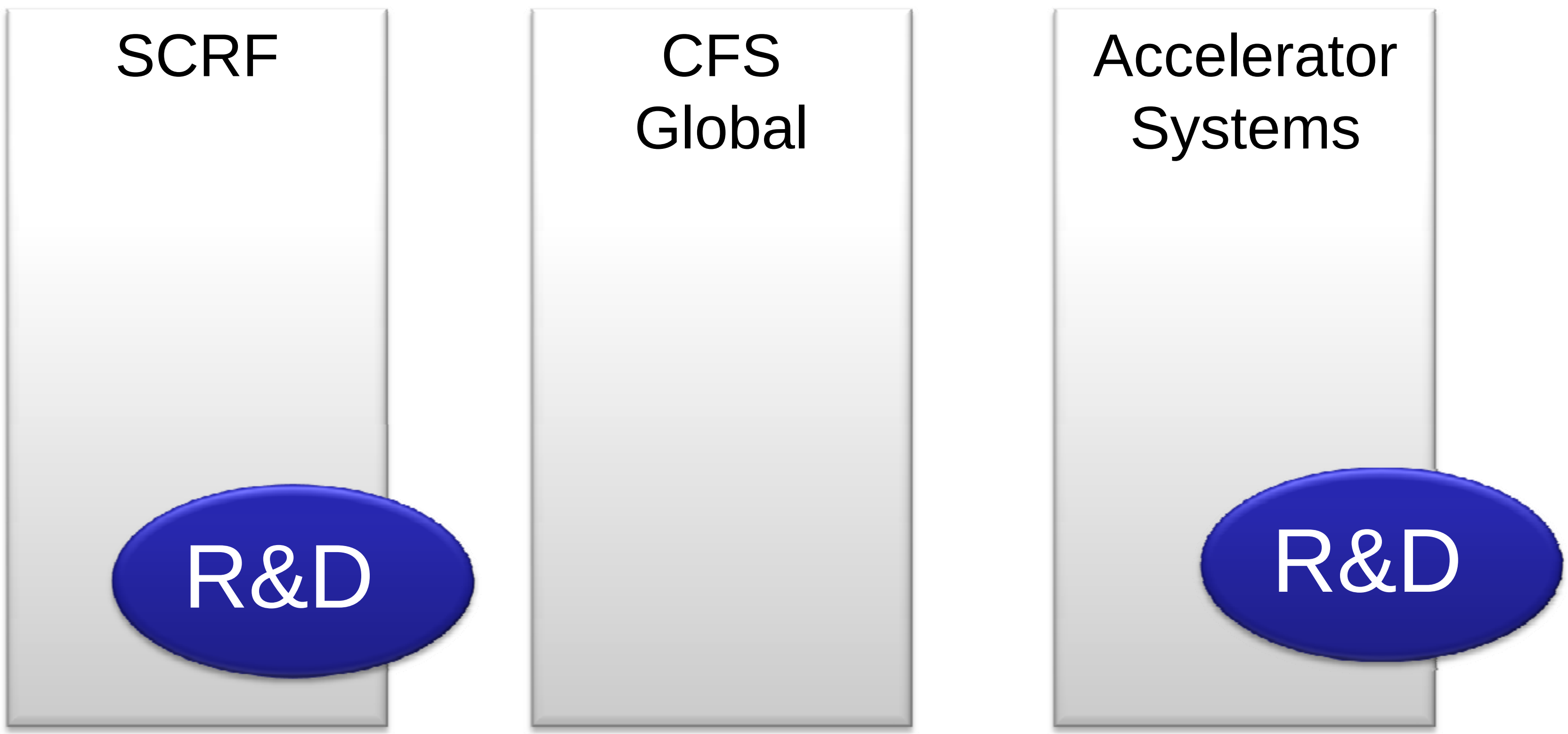
PM believe this will lead to a more

- Robust
- Mature
- Defendable

Design.

Basically a better design.

Integrating the AD&I Team



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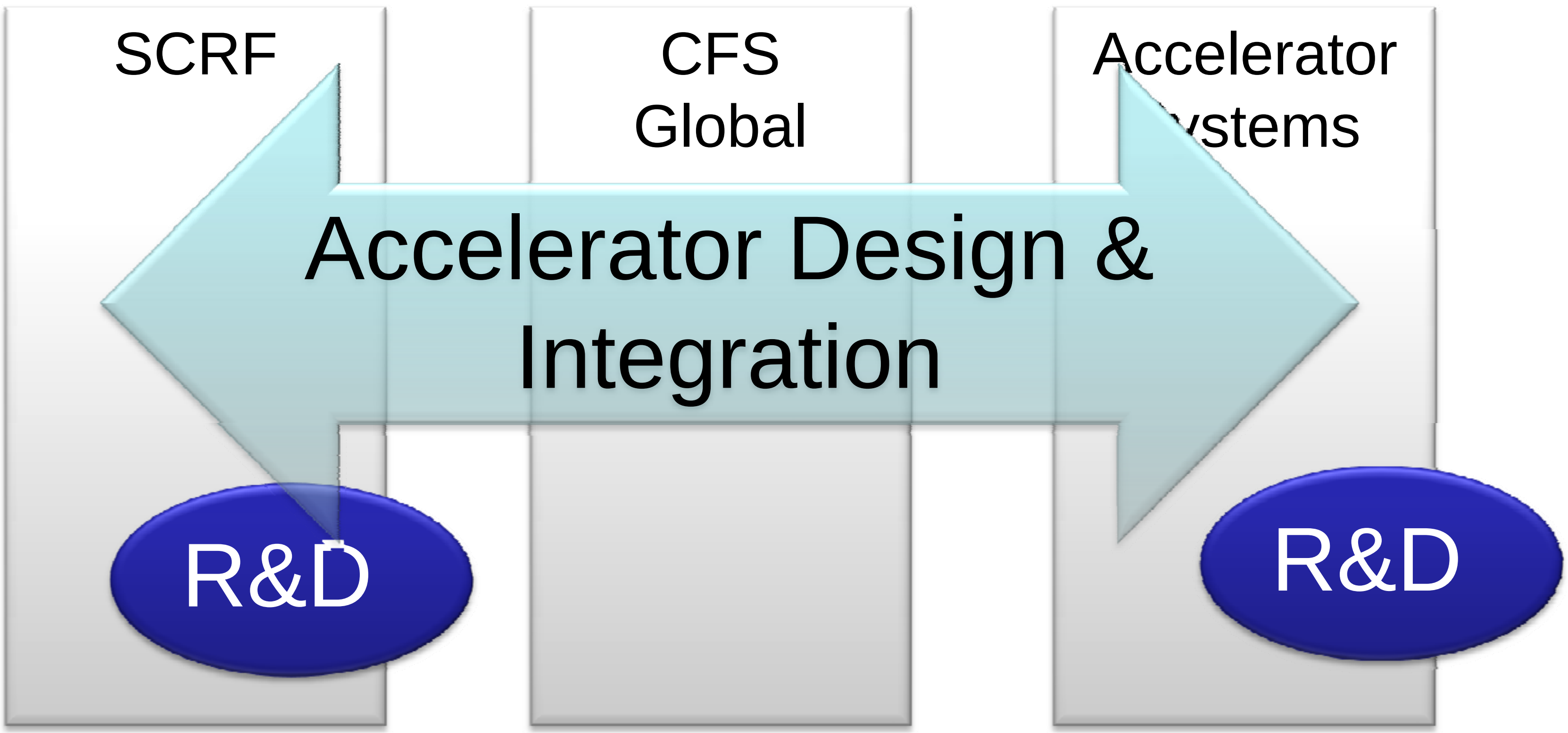


AD&I

The end of TDP-1 in sight

ALCPG ’09

New baseline Proposal discussions (SB2009)

End 2009

Formal Proposal Document for new Baseline

(AD&I team)

LCWS Beijing

Formal acceptance of new Baseline for TDP-2

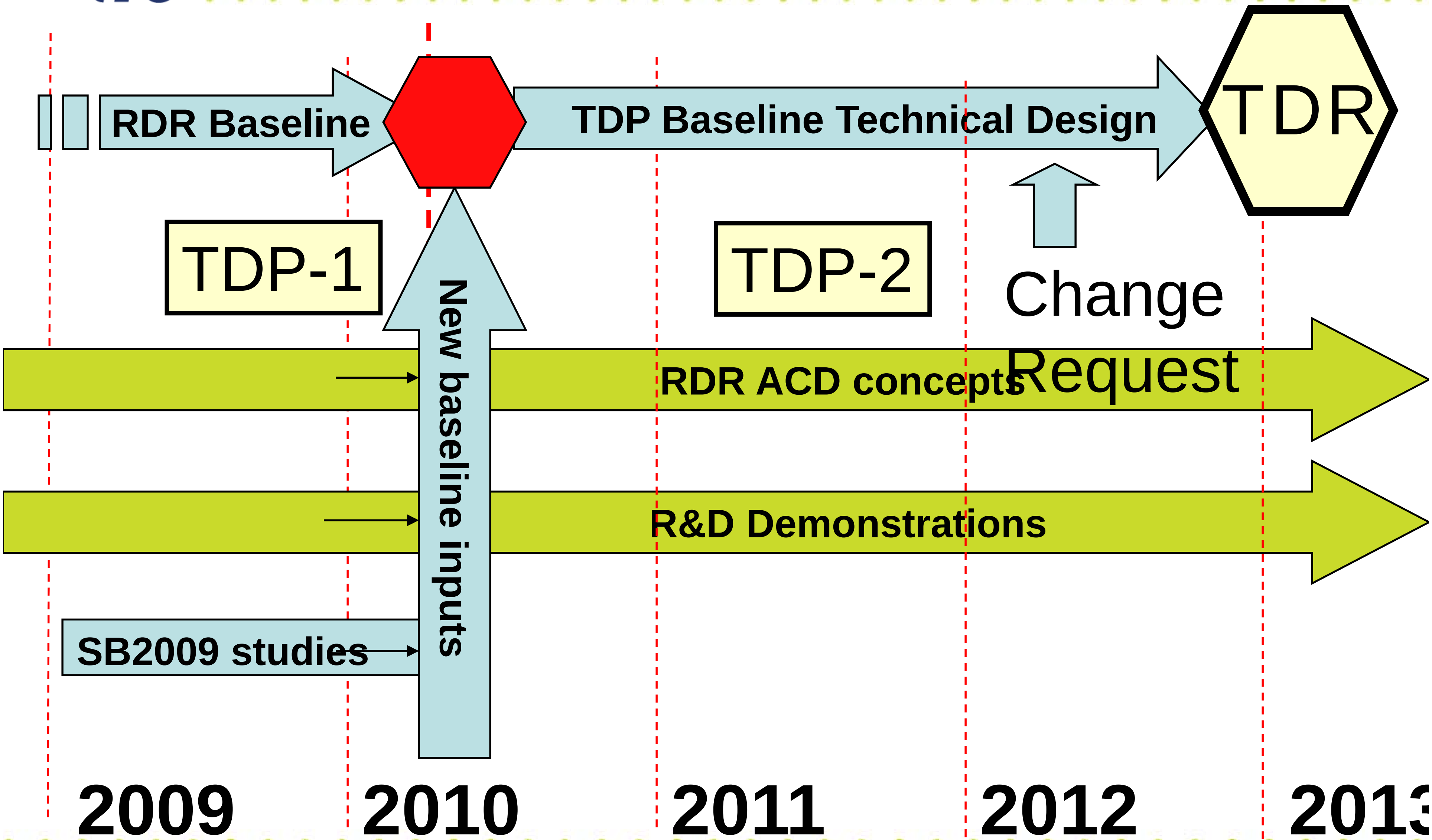
TDP2

Technical Design Report (2012)

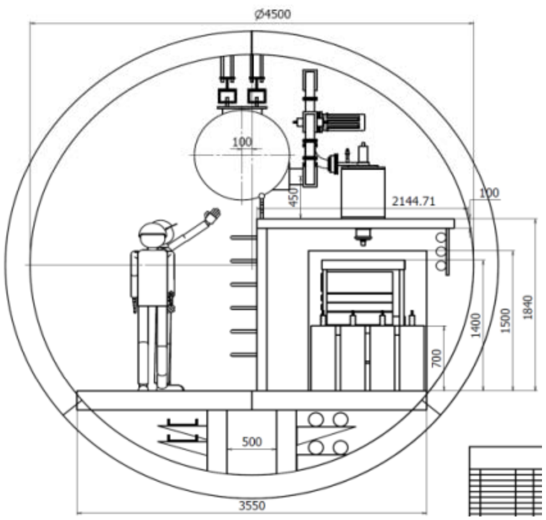
The Purpose of the Baseline

- A consistent and feasible design & layout that will be used as a platform for Design and Cost work in TDP-2
  - **2 stated TDR deliverables**
- Not necessarily the machine that will be finally constructed!
  - **R&D continues in parallel**
  - **Unknown time scale to approval/construction**
  - **A ‘snapshot’ of the State-of-the-Art in 2012**
- Design variants an important aspect
  - **More than one configuration will likely be supported**
  - **Specifically → proposed Main Linac (single tunnel & HLRF)**
- Finite global design resources means we must limit our (study) options

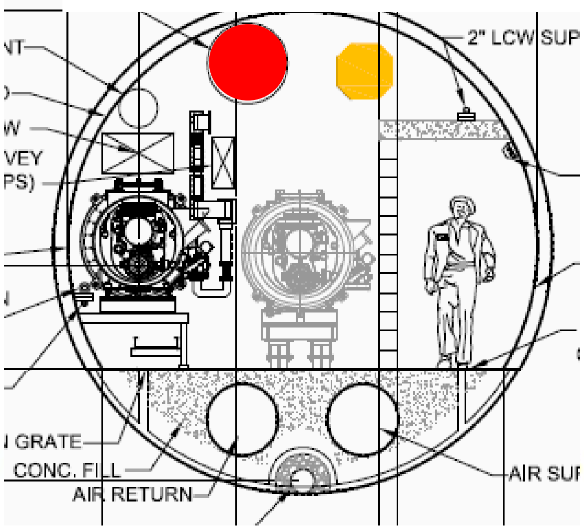
Technical Design Phase and Beyond



Single Tunnel ML: Availability



RF Waveguide

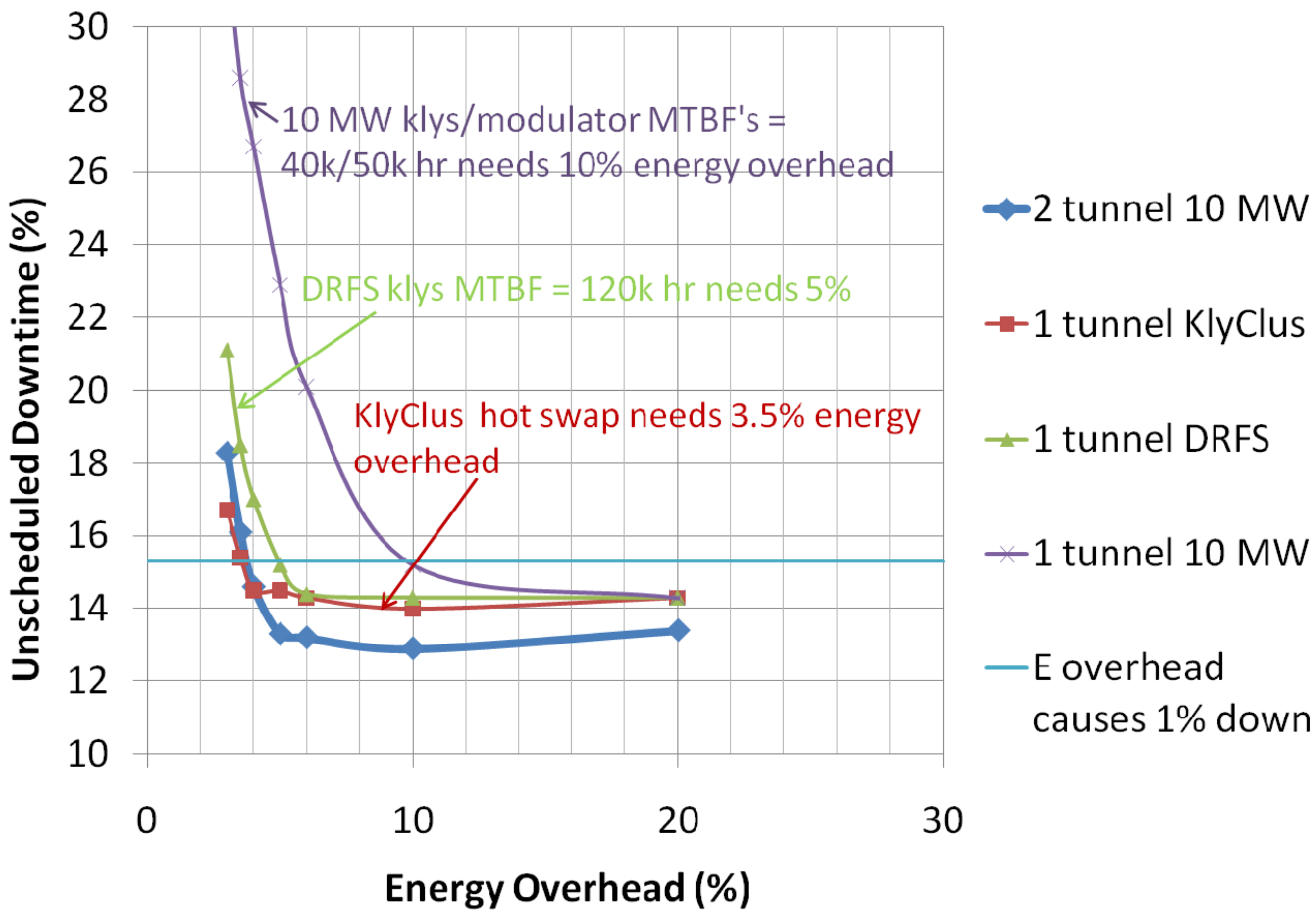


- Availability Studies
  - **Technical solution for single tunnel has been found**
  - **HA requirements have been specified**
  - **Both HLRF schemes can be made to work from an availability standpoint**
    - 3-4% RF overhead required
  - **Achieving HA for the ILC remains a recognized challenge**

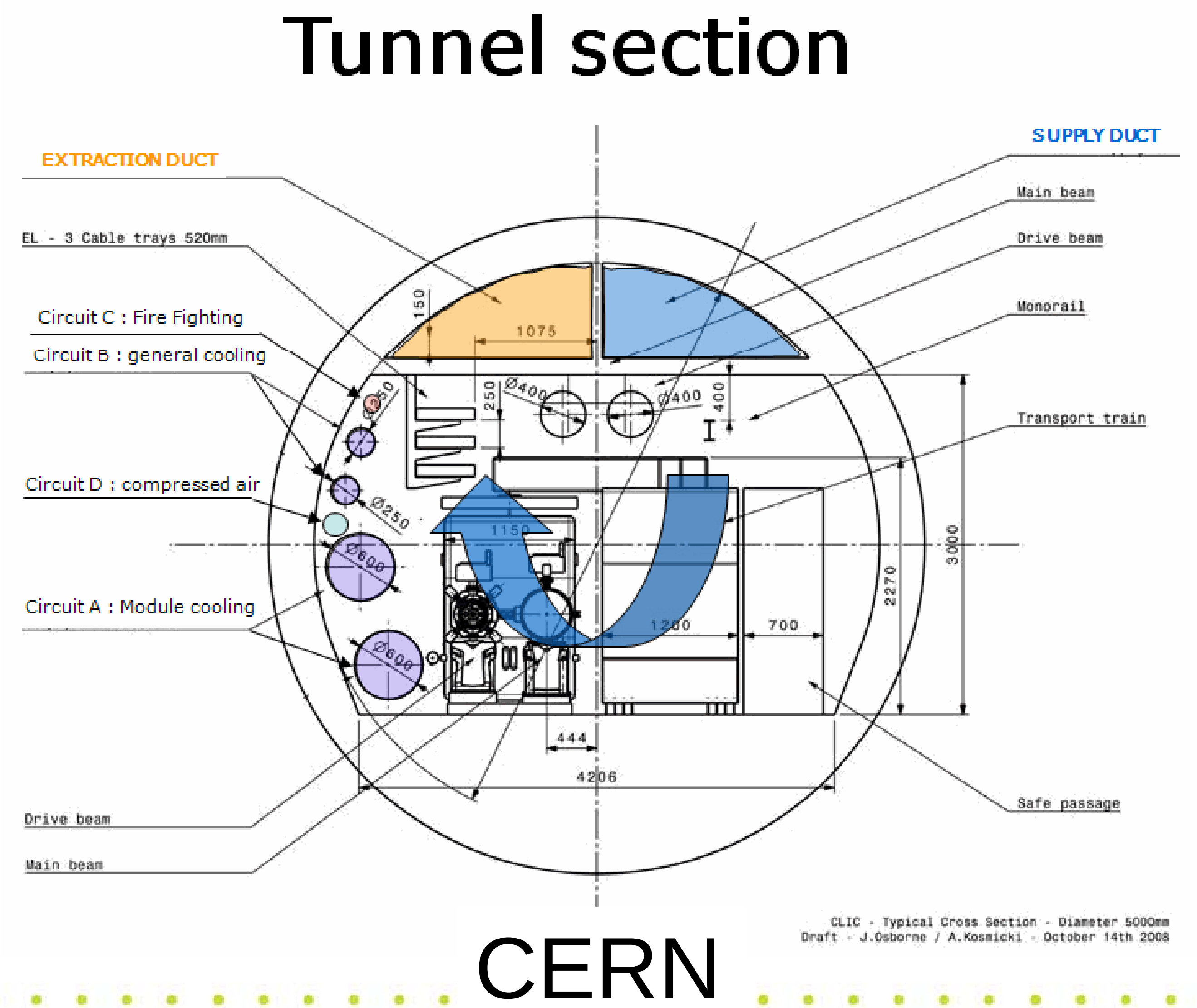
Availability Task Force Co-Conspirators:

- Group 1 (Availsim)
  - **Tom Himel (lead)**
  - **Eckhard Elsen**
  - **Nick Walker**
  - **Ewan Paterson**
- Group 2 (Analysis)
  - **John Carwardine (lead)**
  - **Marc Ross (chair of full group)**
  - **Ewan Paterson**
- Group 3 (Spreadsheet availability calculation)
  - **Tetsuo Shidara (lead)**
  - **Nobuhiro Terunuma**
- Contributions from Chris Adolphsen, Nobu Toge, Akira Yamamoto

Single Tunnel ML: Availability



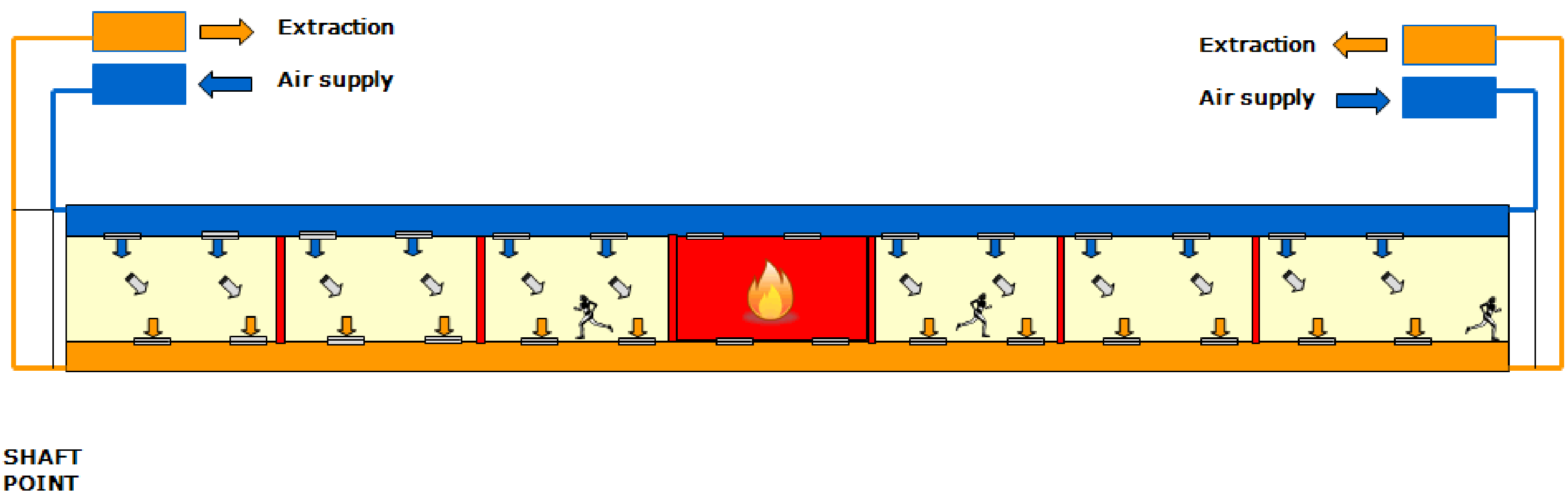
Single Tunnel ML: Safety



- Different regional approaches being studied
- Importance of flexible design to understand potential impact of regional safety codes

European Design: Tunnel Compartmentalization

Safety considerations



- Control of the pressure from both ends of a sector.
- Control of the pressure (overpressure or underpressure in each area).
- Fire detection per sector compatible to fire fighting via water mist.

Physics Scope Impact

- Lower beam power option $\rightarrow$ more demanding beam-beam parameters
  - **Increase beamstrahlung / increased vertical disruption**
  - **Full spec. L requires exotic techniques (travelling focus)**

- E+ source at 250 GeV point
  - **Impact in lower Ecm running**
    - Light Higgs scenario

Questions (Physics & Detector)

- Ecm <300 GeV Running
  - **What luminosity can we expect?**
  - **What is the scope for recovering 1/γ luminosity dependence?**
  - **Understanding physics scope impact?**

- Lower Power Option
  - **Impact of higher beamstrahlung**
  - **Pair spectrum (backgrounds)**
  - **Luminosity spectrum**

Questions (Physics & Detector)

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- Lower Power Option
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GDE will attempt to provide input on these questions to P&D groups as soon as possible

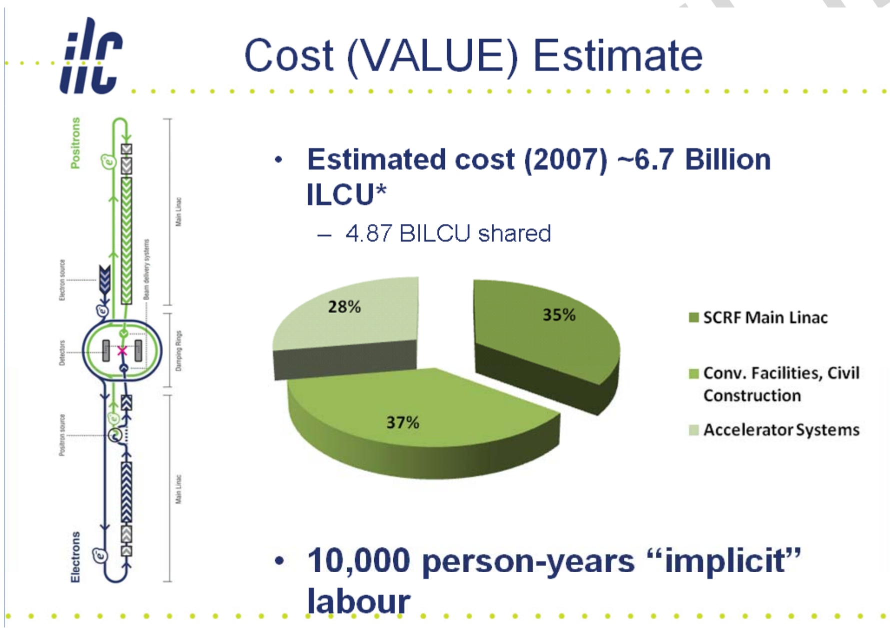
Cost Estimates for SB2009 Studies

- SB = Strawman Baseline – For the TDR, the GDE is considering possible changes in the ILC RDR Baseline to improve performance or to reduce cost
- Such possible scenarios or proposals were outlined for further study at DESY in May 2009
- Adoption of each of these cost reduction proposals must be weighed against increasing the risk of meeting performance goals by GDE Management
- Estimates for each of these scenarios are needed in order to identify and concentrate our limited resources on those with highest cost reduction impact
- Area Systems Leaders & Conventional Facilities team performed another cost estimating pass for these possible scenarios

Cost Increments
(Rough Estimates from 10.2008)

- Main Linac (total) ~ 300 MILCU
- Low-Power option ~ 400 MILCU
- Central injector Integration ~ 100 MILCU
- Single-stage compressor ~ 100 MILCU

VERY PRELIMINARY!
confirmed



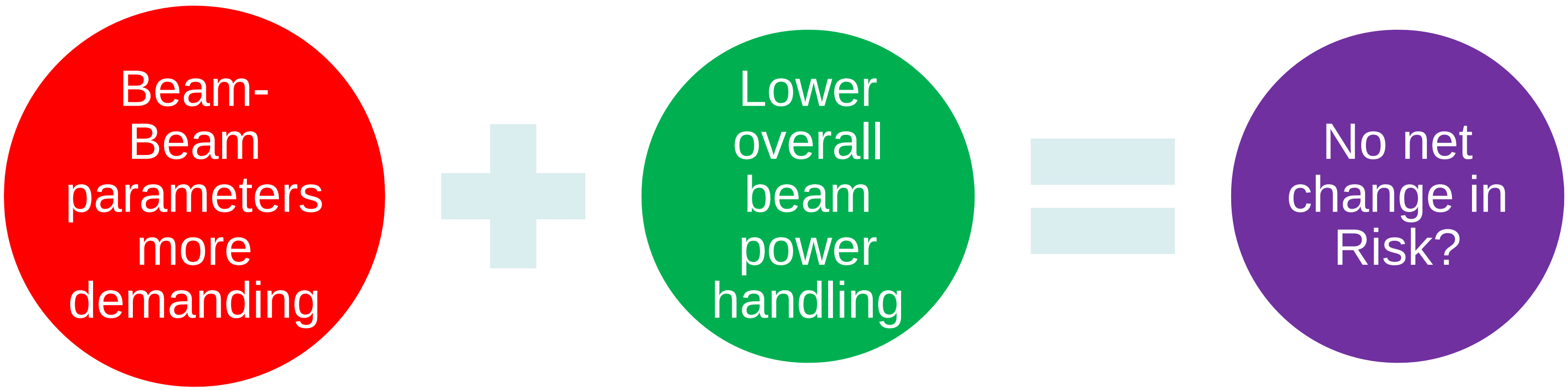
– VERY preliminary: better estimates will be made (end 2009)
  - But still based/scaled from RDR value estimate

– Elements *not* independent! Careful of potential double counting!

– **Cost vs Performance vs Risk**: important information for making informed decisions in 2010

Understanding Risk: The Big Picture

Example: low power option

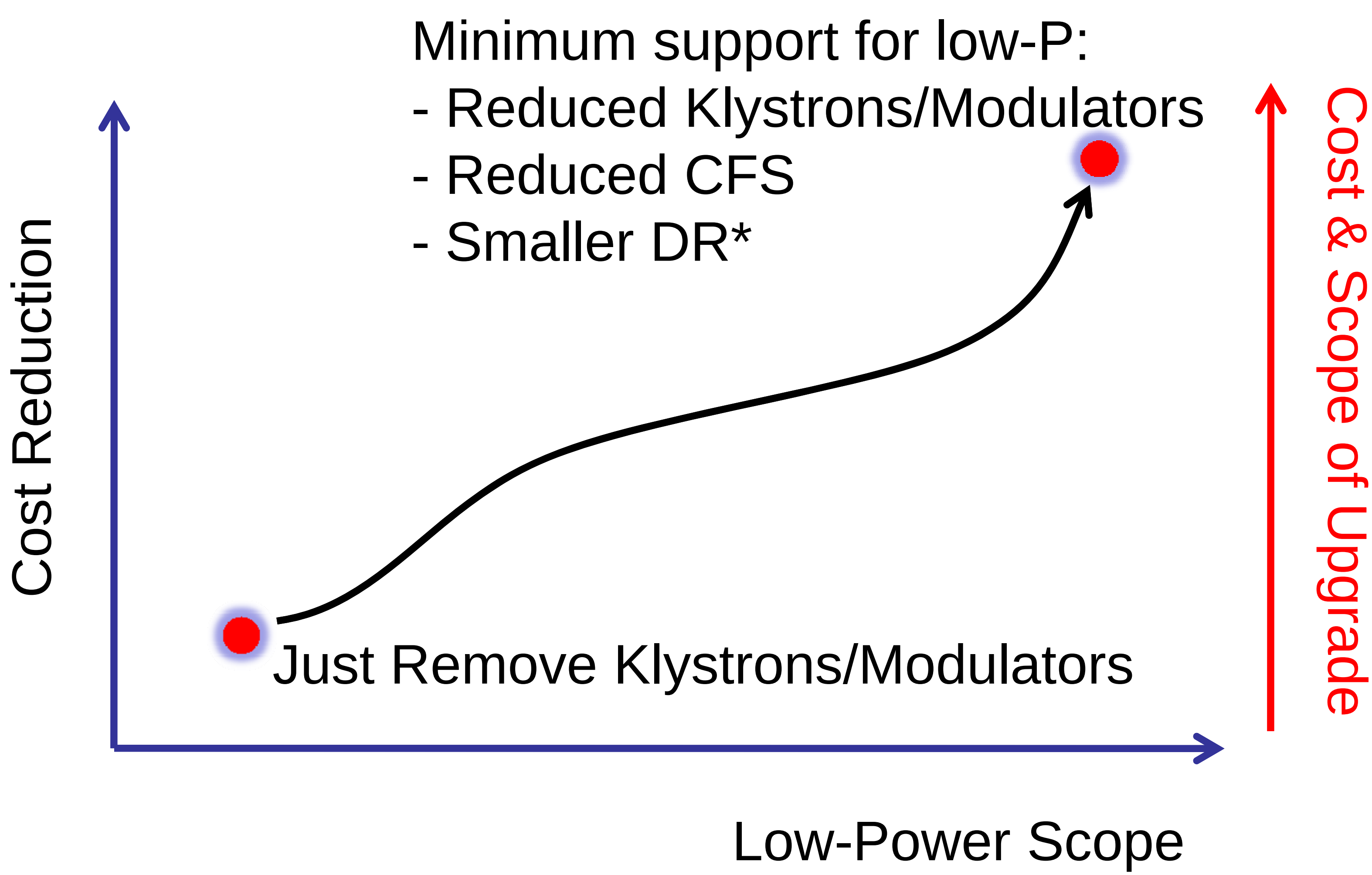


- Many aspects of SB2009 reduce risk to project as a whole
  - Reduced CFS scope (27km tunnel) $\rightarrow$ reduced risk to construction schedule and cost overruns
  - Lower beam power handling
- Must be balanced against increase ‘risk’ to performance
  - Beam-beam parameters
  - Low energy running scenarios
  - Availability / commissioning etc.

Upgrade Considerations: Luminosity

- Reduced power option opens up scope for possible Luminosity Upgrade
- i.e. putting back 30-50% missing klystrons and associated infrastructure
- Potentially up to ×2 increase in L
  - After initial running experience is gained
- Impacts many systems.
- Various scenarios can be considered
  - Impacts on upfront cost saving

Low-P: Upgrade Options



Feedback / Input on SB2009

Input and feedback required.
Process has been defined.
The Research Director is organizing
feedback from Phys & Det. community.

ALCPG '09

New baseline Proposal discussions (SB2009)

End 2009

Formal Proposal Document for new Baseline

(AD&I team)

LCWS Beijing

Formal acceptance of new Baseline for TDP-2

TDP2

Technical Design Report (2012)

AD&I SB2009 focus meeting 2-3.12 DESY

e+ Source at 250 GeV

- cost reduction, dogleg instead of chicane; shares emergency extraction (MPS) and emittance diagnostics with BDS, also one less (emergency) dump. Operations impact - MPS

- need to decelerate beam (RDR). Conceptually feasible but not easy with full beam loading. Energy spread and stability of decelerated beam. Beam energy plus klystron forward power (for beam loading compensation) all dumped into RF loads in tunnel. Wasn't studied for RDR.

- Rdr solution requires front end of linac to run flat out at 31.5MV/m no "risk" margin for operations.

- long e+ low-e transport line not needed in ML tunnel (more power supplies and space needed in single tunnel)

Consider E+ Source Layout

Move the source system to the end of the E- linac…..>

The Target/Capture section would now be close to the MPS collimators at the beginning of the BDS.

While on access into the IR all systems operate and the main e- drive beam would go to the tune up dump, a shared dump.

We save ½ , 600m, of the positron insert! But we also shorten the low energy e+ transport by several kilometers and open up several possible scenarios for starting the machine at lower energies and simple upgrades to “full” energy.

All systems except the linac are now within +/- 2.5 km of the IR.

An Integrated Central Campus

Paterson, Dubna, 06.2008

Positron Source Lengths - RDR

TABLE 2.3-2	
Positron Source beamline lengths.	
Area Length (meters)	
Undulator chicane insert	1257
Undulator center to target	500
Undulator insert length	200
Target Hall length	150
400 MeV long transport line	5032
Total RF acceleration length	350
Damping Ring injection line	431

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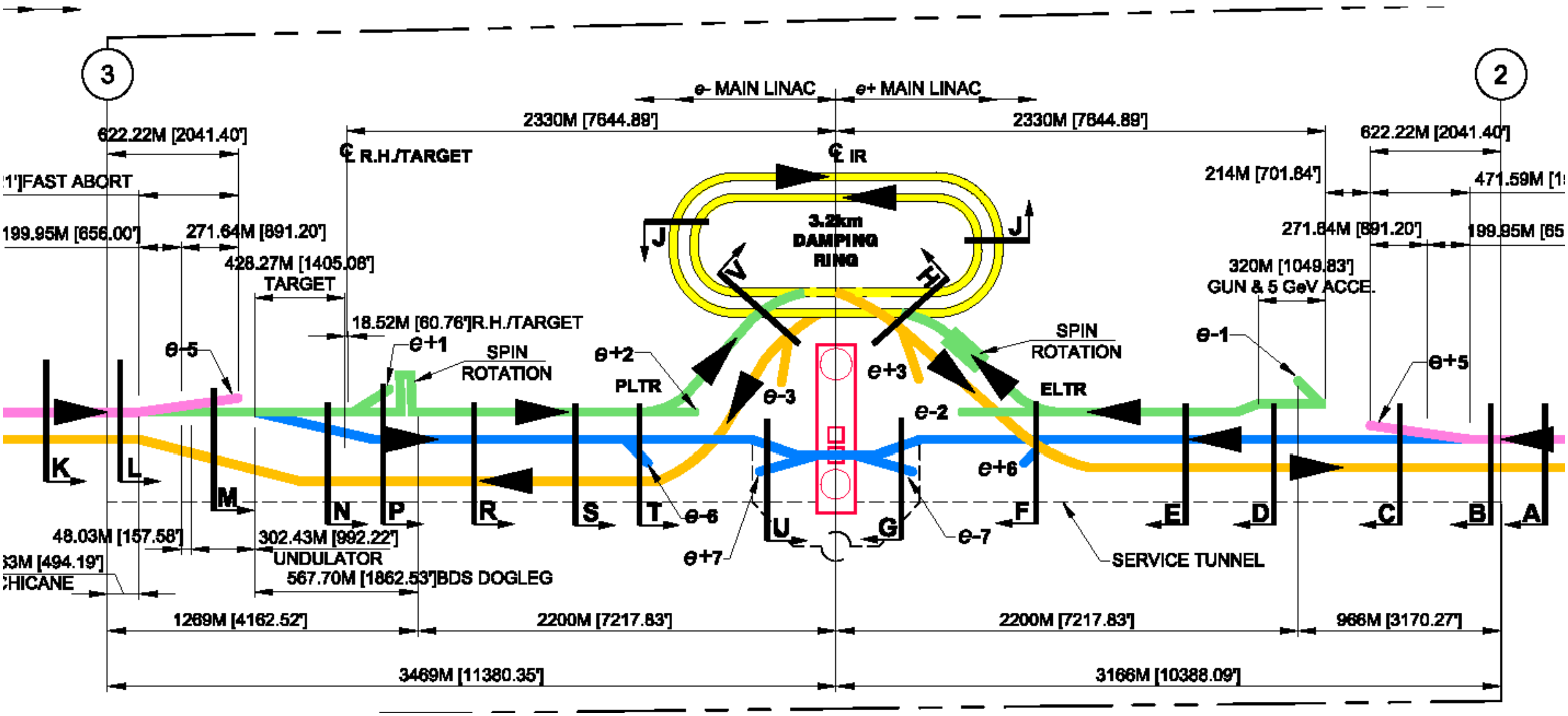
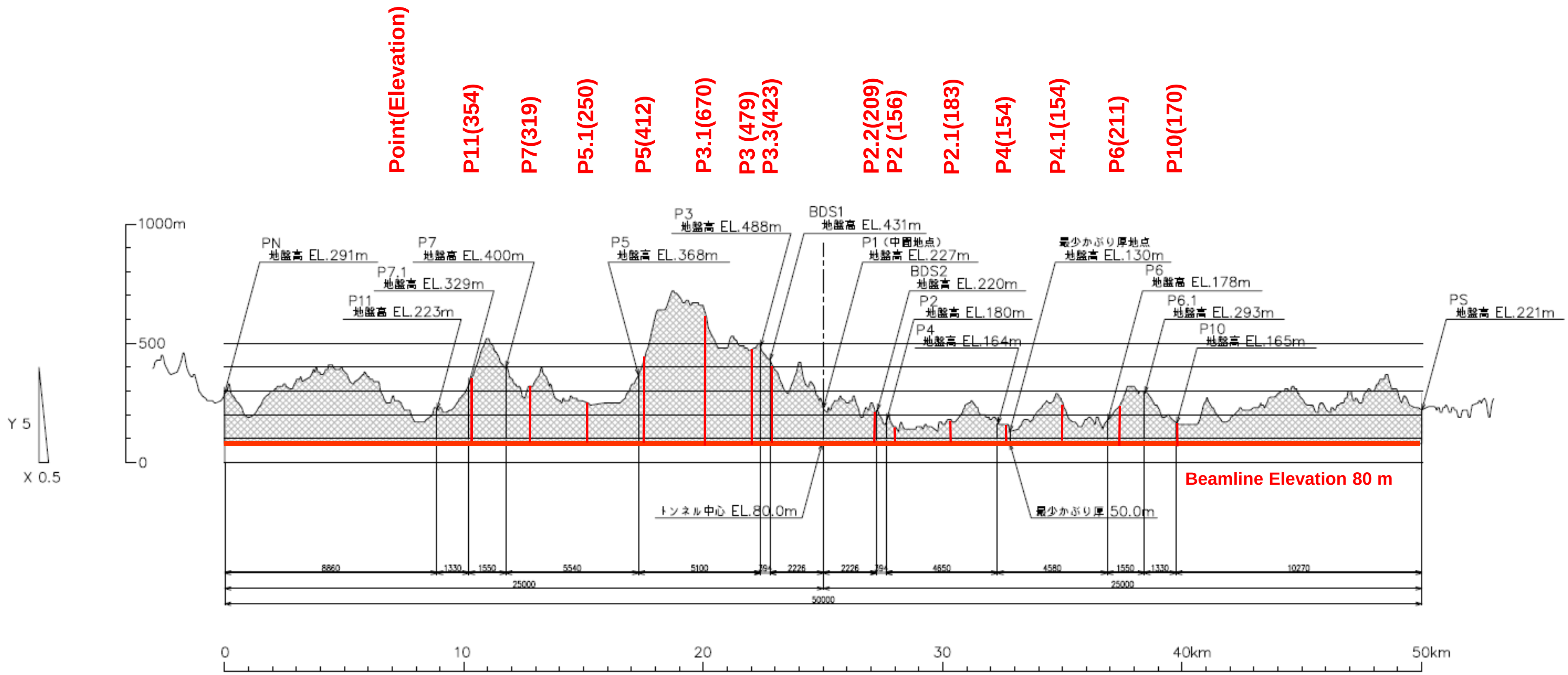
Central Region Integration - CFS

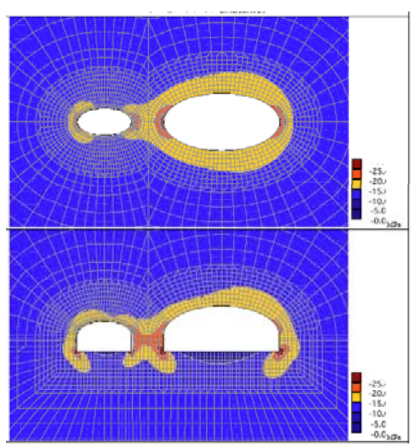


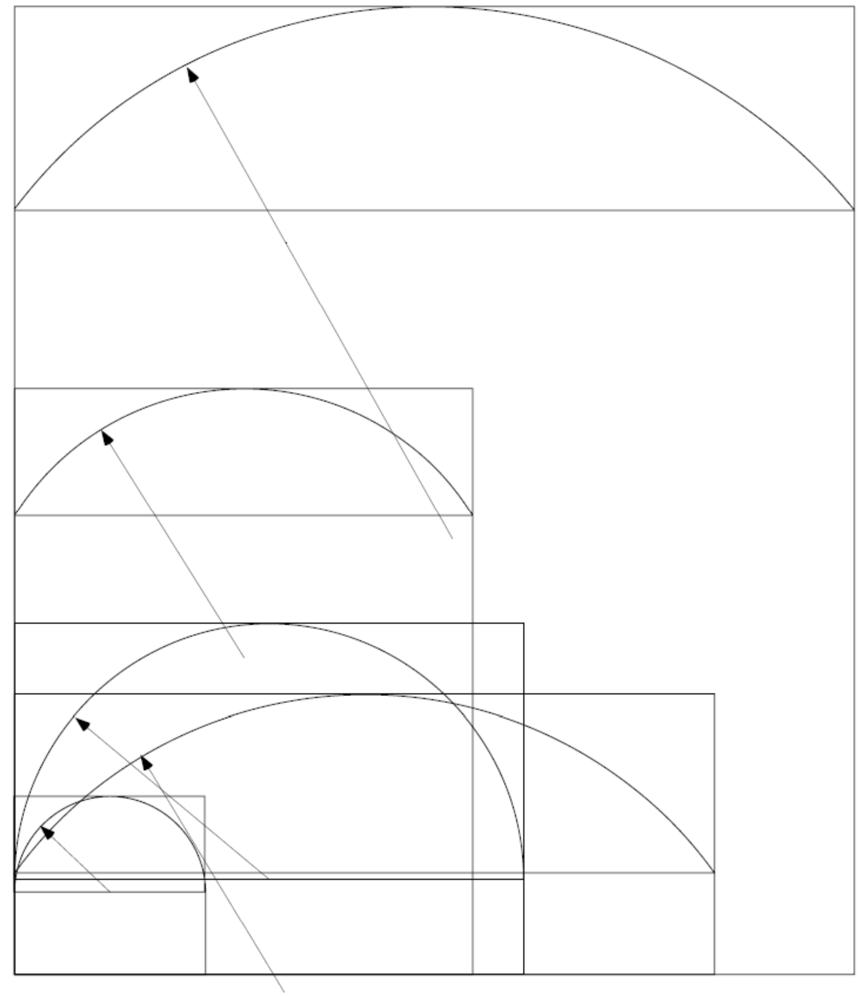
Access Points (SB2009)



Tunnel Cross Section in Asian Sample Site

Positron generator hall in “1.2km area” of the e- Beamline.





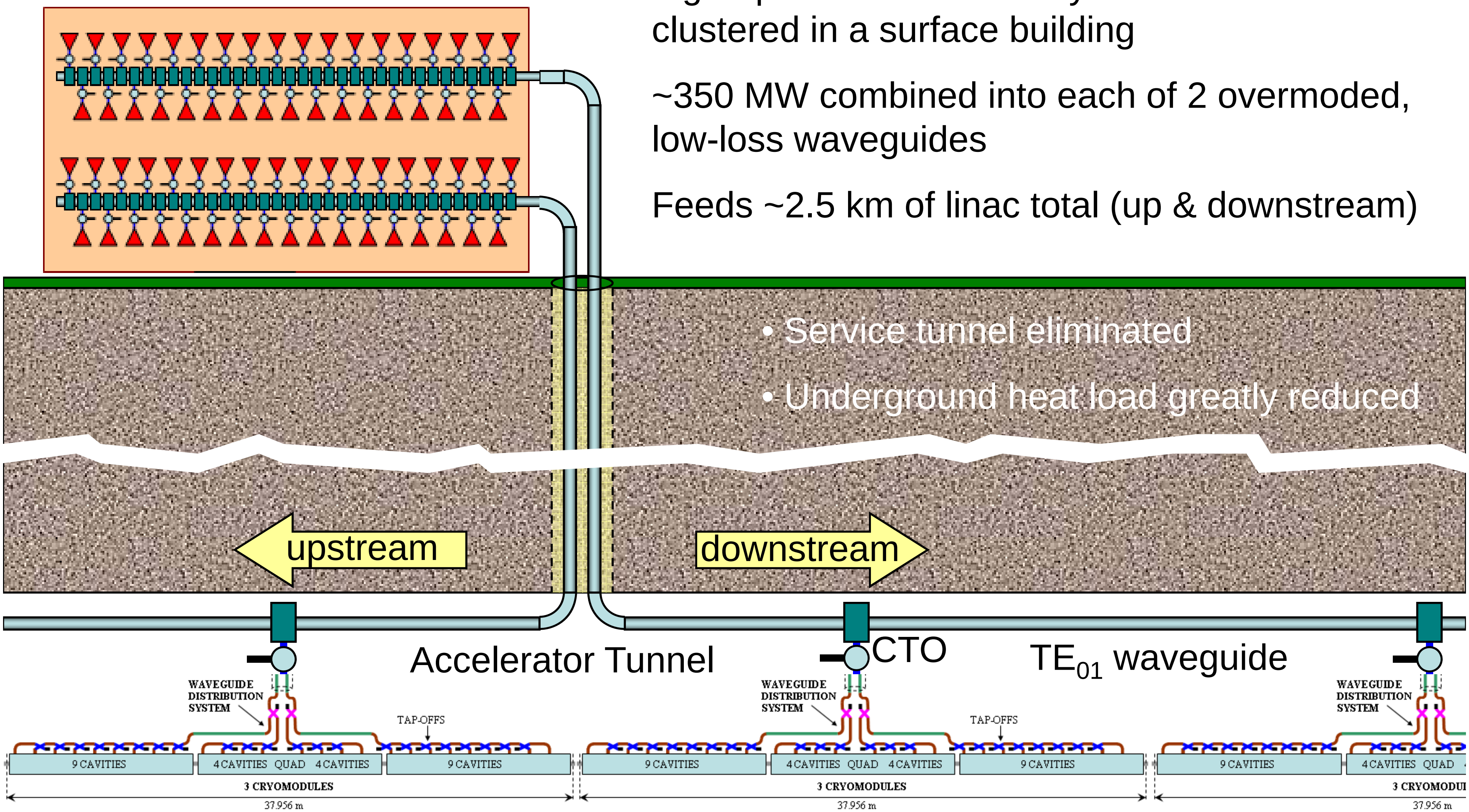
2 HLRF Schemes: 1) Klystron Cluster Layout

Surface rf power cluster building

2 groups of ~35 10 MW klystrons & modulators clustered in a surface building

~350 MW combined into each of 2 overmoded, low-loss waveguides

Feeds ~2.5 km of linac total (up & downstream)



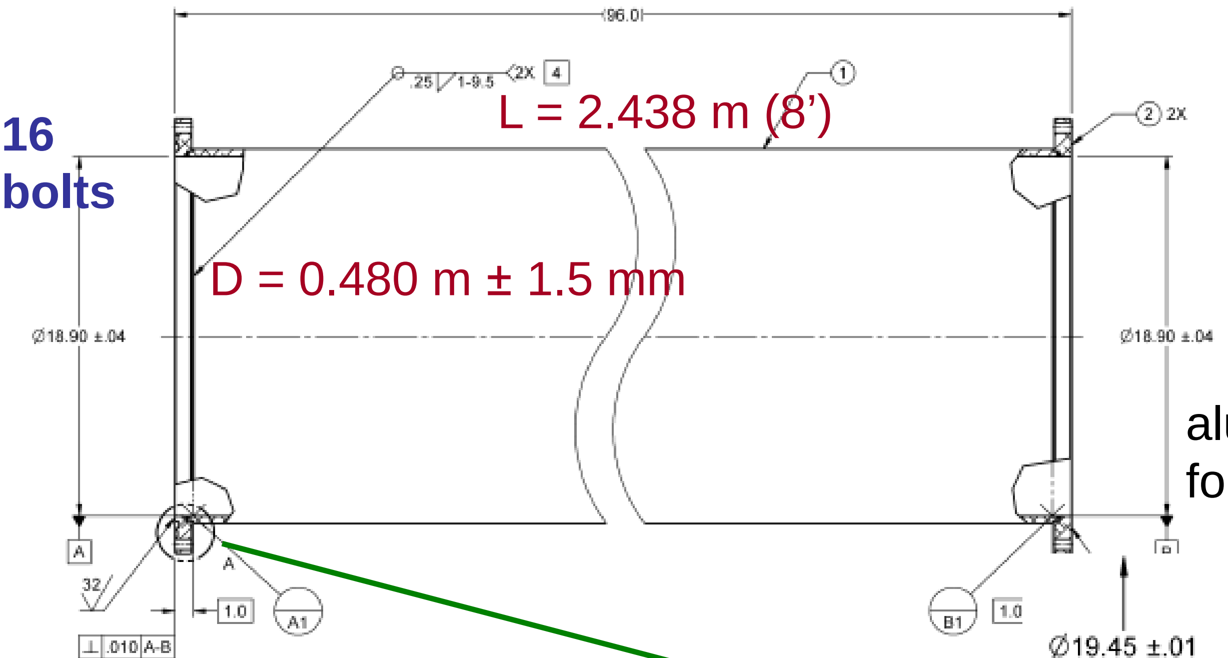
Chris Nantista

Main Waveguide ('Big Pipe')

16 bolts

L = 2.438 m (8')

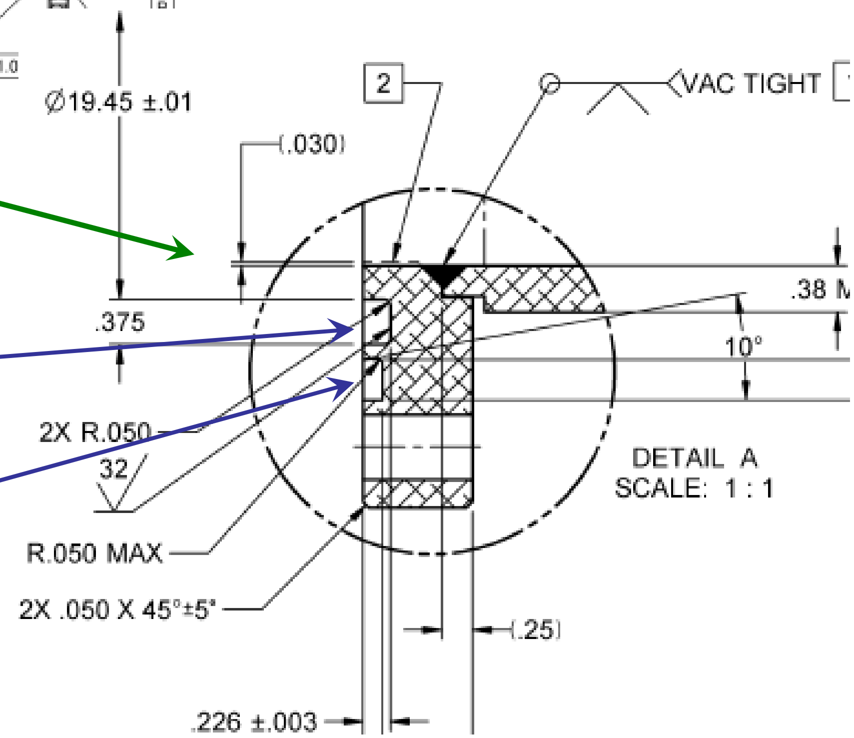
D = 0.480 m ± 1.5 mm



We've placed an order for 4, 9.75 m sections

due in January 2010

aluminum,
formed & welded



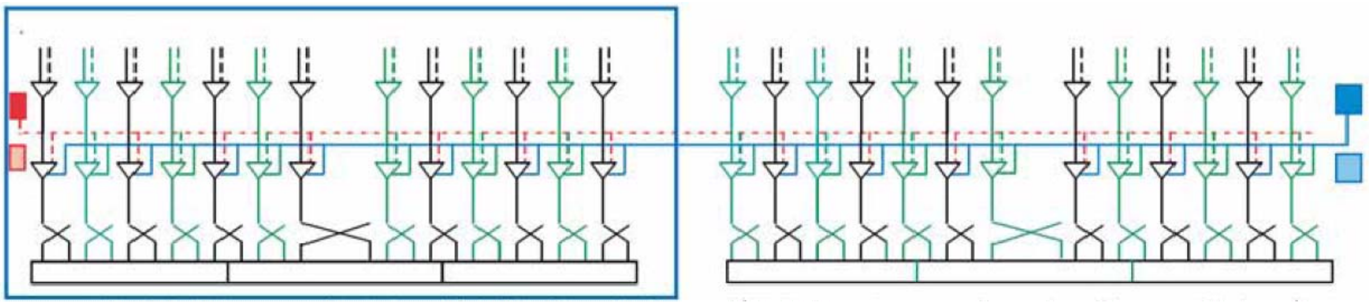
one-side double grooved flanges:

vacuum seal – Viton® fluoroelastomer O-ring

rf back-up seal – Bal Seal® canted coil contact spring

2) Distributed RF Scheme (DRFS)

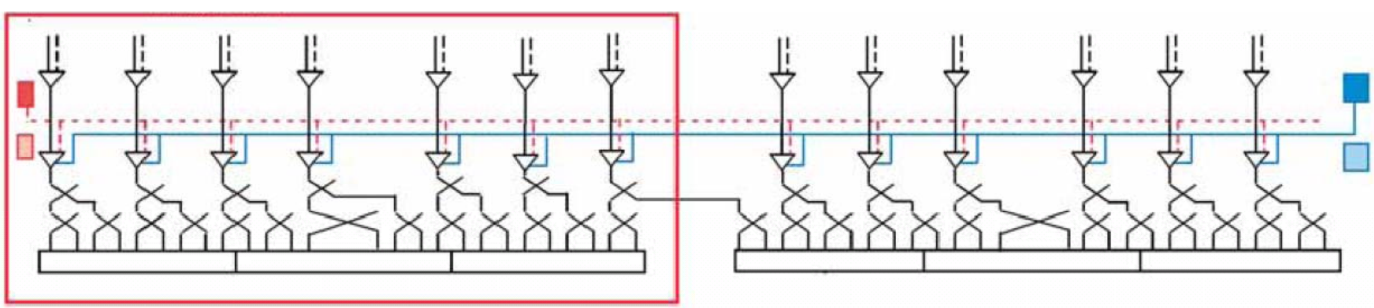
Standard Scheme: One DC PS/MA modulator drives 26 klystrons (6 cryomodules)



High availability with backup DC PS and MA modulator

Maximum efficient usage of SC cavity

Low Power Option



Low Power Option

Aiming for the easy upgradeability to standard scheme

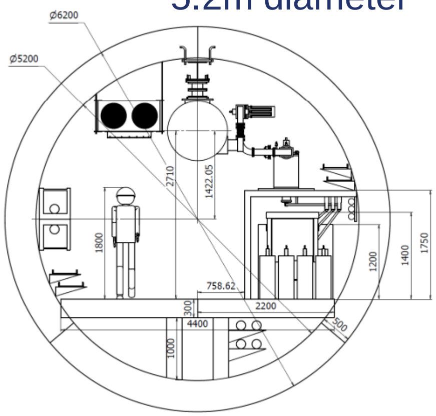
Low cost

Partial sacrifice of DRFS operability

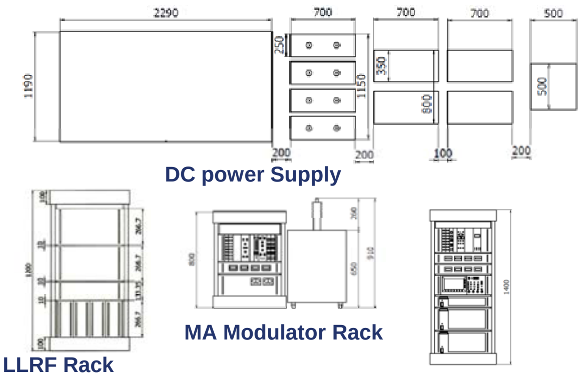
Shigeki Fukuda

DRFS Full Power Layout

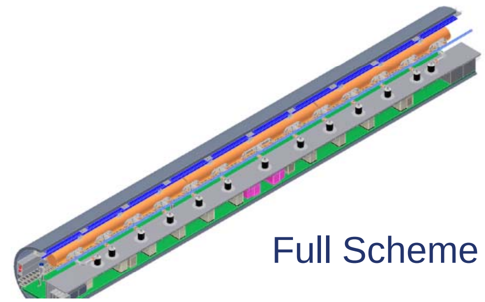
5.2m diameter



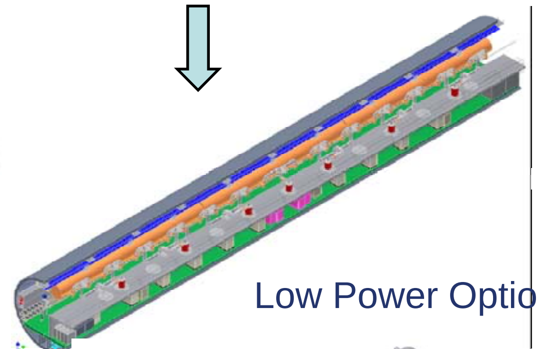
Components Size



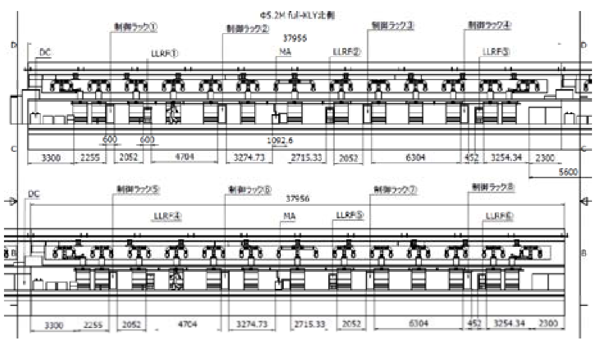
Full Scheme to Half Option

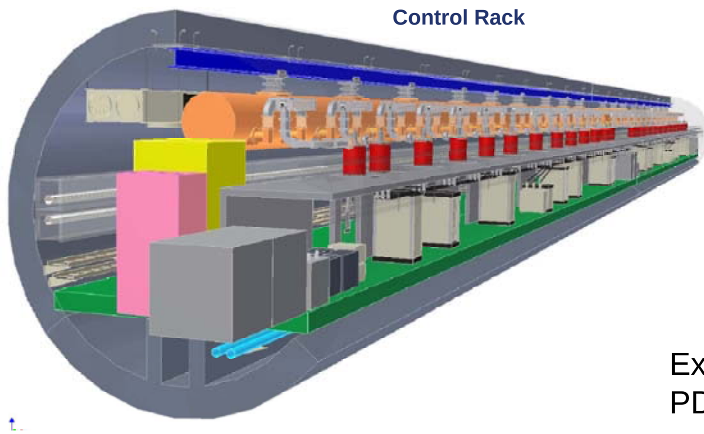


Full Scheme



Low Power Option

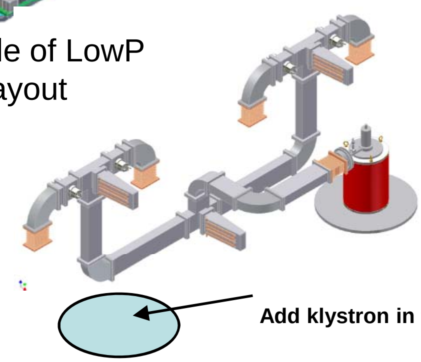




2 RDR-RF units Layout

3D View of DRFS

Example of LowP PDS Layout



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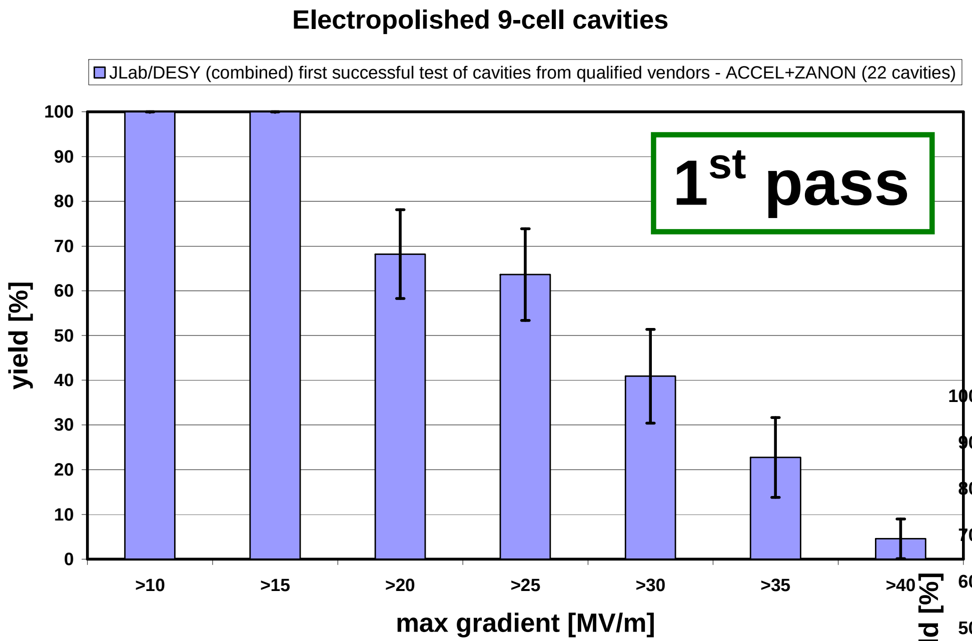
Global Plan for SCRF R&D

Year	07	2008	2009	2010	2011	2012
Phase	TDP-1			TDP-2		
Cavity Gradient in v. test to reach 35 MV/m	>> Yield 50%			>> Yield 90%		
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for plug-compatible string (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY)			NML (FNAL) STF2 (KEK) FLASH (DESY)	
Preparation for Industrialization			Mass Production Technology R&D			

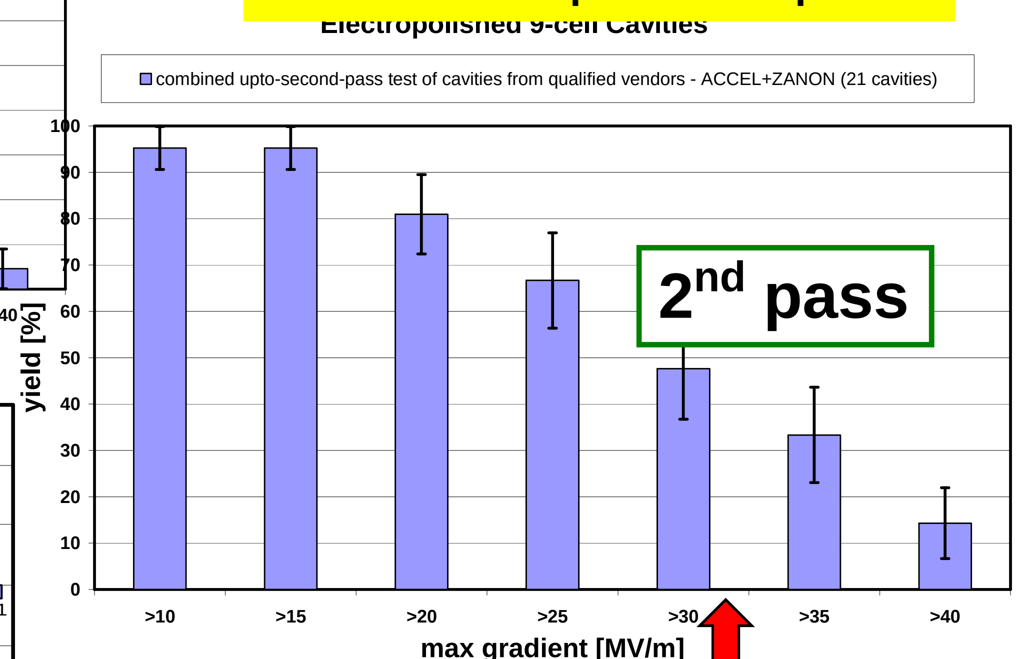
Global Gradient R&D Highlights

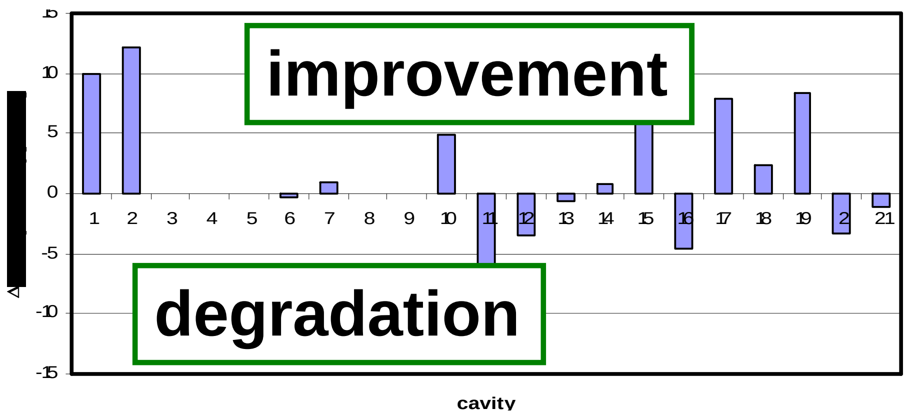
- Americas
  - **1st US industry built 9-cell cavity passed ILC spec and reached 41 MV/m.**
  - **ANL/FNAL joint facility validated by EP proc. & testing of 1-cell cavity > 40 MV/m.**
  - **Improved understanding of quench limit by T-mapping and inspection.**
- Asia
  - **MHI#9 reached 27 MV/m during first RF test.**
  - **Improved understanding by T-mapping and optical inspection of 9-cell cavities.**
  - **Successful multi-wire slicing of ingot niobium.**
- Europe
  - **Improved understanding by optical inspection and T-mapping of 9-cell cavities.**
  - **Microscopic understanding of defect by cutting 9-cell cavities.**
  - **XFEL cavity call for tenders.**
- GDE SCRF Cavity Technical Area
  - **Yield evaluation method proposed (1st-pass and 2nd-pass production).**
  - **Formed global cavity database team toward global gradient yield curve.**

New Production Yield after 1st and 2nd Pass (RF) Test



Yield at 35 MV/m:
22 % at 1st pass
33 % at up to 2nd pass

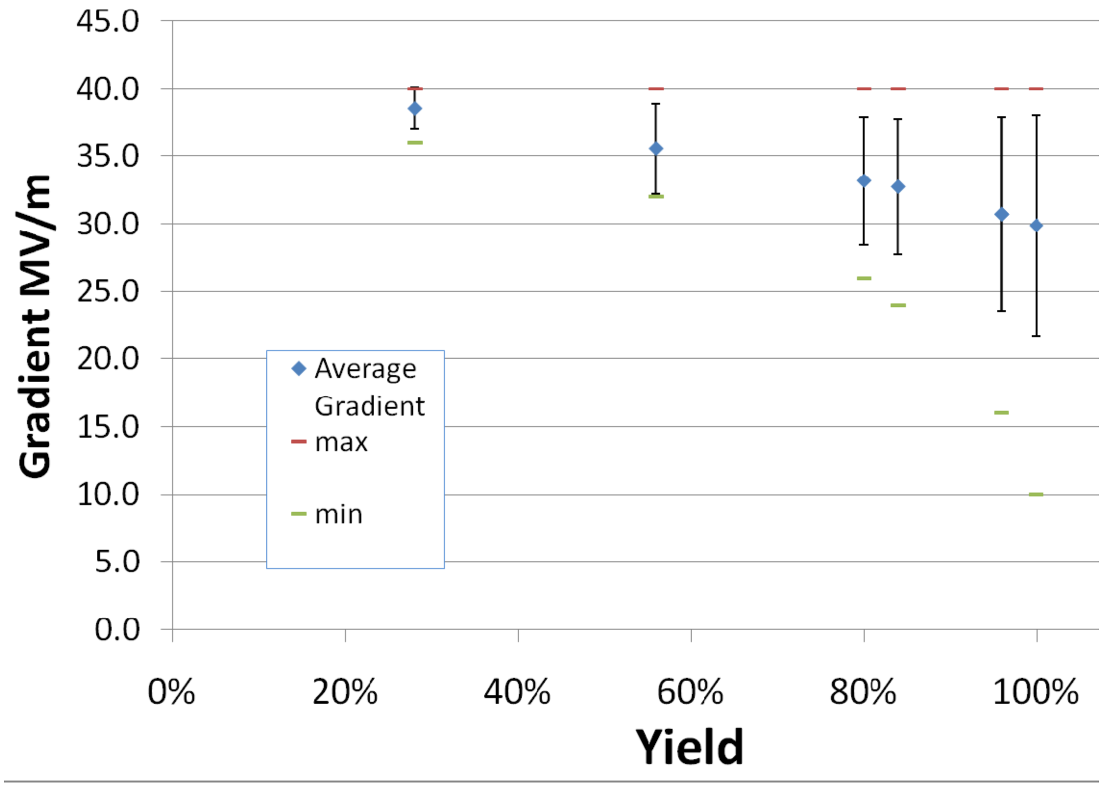




ILC Operation at <31.5 MV
ld reaching ~ 40 %

Reported by C. Ginsburg and GDB team

Alternate Yield Definition: Study



- Allowing for gradient spread
- Additional RF power needed to compensate
- 20% spread seems reasonable

Cavity Gradient Study - Summary

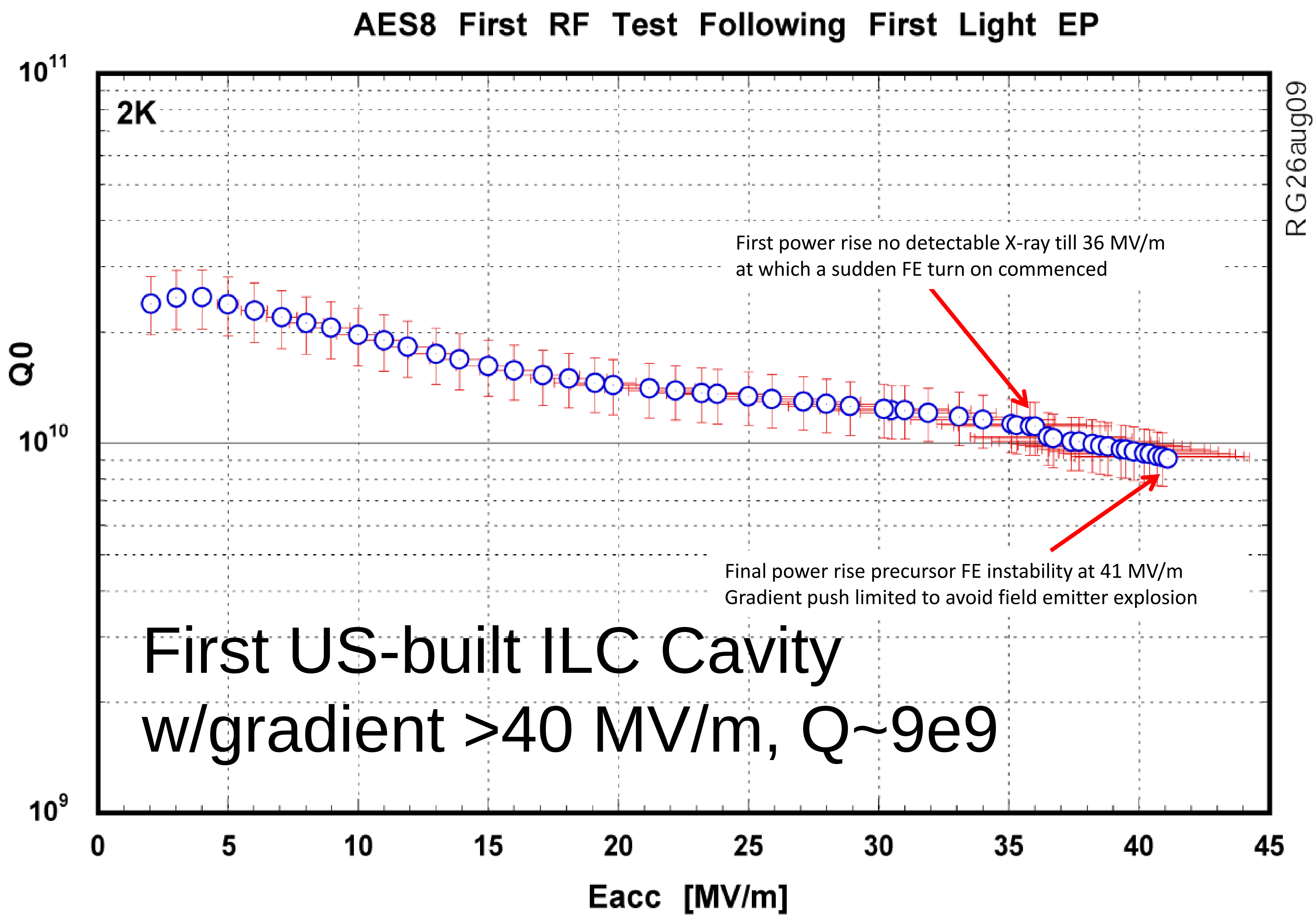
- Yield at 35 MV/m (w/ established vendors: **RI, Zanon**)
  - **22 % at 1st pass (statistics 22)**
  - **33 % at 2nd pass (statistics 21, as of 2009-07))**
    - Average Gradient reaching 30 MV/m
  - DESY Prod-4 data to be added, (10 more statistics)
- New statistics coming (w/ potential vendors)
  - **AES: to be counted from #5** (to be confirmed)
  - **MHI: to be counted from #5** (to be confirmed)
- Selecting statistics needed for 'Production Yield'
  - **to evaluate readiness of industrialization and cost**

Note: *Numbers of Cavities for 'gradient research': need to be separately counted.*

Progress and Prospect of Cavity Gradient Yield Statistics

	PAC-09 Last/Best 2009-05	FALC 1st Pass 2009-07	ALCPG 2nd Pass 2009-10	To be added (2009-11)	Coming Prod. Y. (2010-06)	Research cavities
DESY	9 (AC) 16 (ZA)	8 (AC) 7 (ZA)	14 (AC/ZA)	10 (Prod-4)	5	8 (large G.)
JLAB FNAL/ANL/Cornell	8 (AC) 4 (AE) 1 (KE-LL5) 1 (JL-2)	7 (AC)	7 (AC)	~ 5 (AE)	12 (AC) 6 (AE)	6 (NW) (including large-G)
KEK/IHEP				5 (MH)	2 (MH)	~5 (LL) 1 (IHEP)
Sum	39	22	21	20	25	**~ 20**
G-Sum				41	66	

Statistics for Production Yield in Progress to reach > 60, within TDP-1.
We may need to have separate statistics for 'production' and for 'research'


AES8 First RF Test Following First Light EP
2K
Q0
10^{11}
10^{10}
10^{9}
0
5
10
15
20
25
30
35
40
45
Eacc [MV/m]
RG26aug09
First power rise no detectable X-ray till 36 MV/m
at which a sudden FE turn on commenced
Final power rise precursor FE instability at 41 MV/m
Gradient push limited to avoid field emitter explosion
First US-built ILC Cavity
w/gradient >40 MV/m, Q~9e9

S1 Goal: Reached at DESY with PXFEL1
reported by H. Weise, at SRF-09

NewsLine

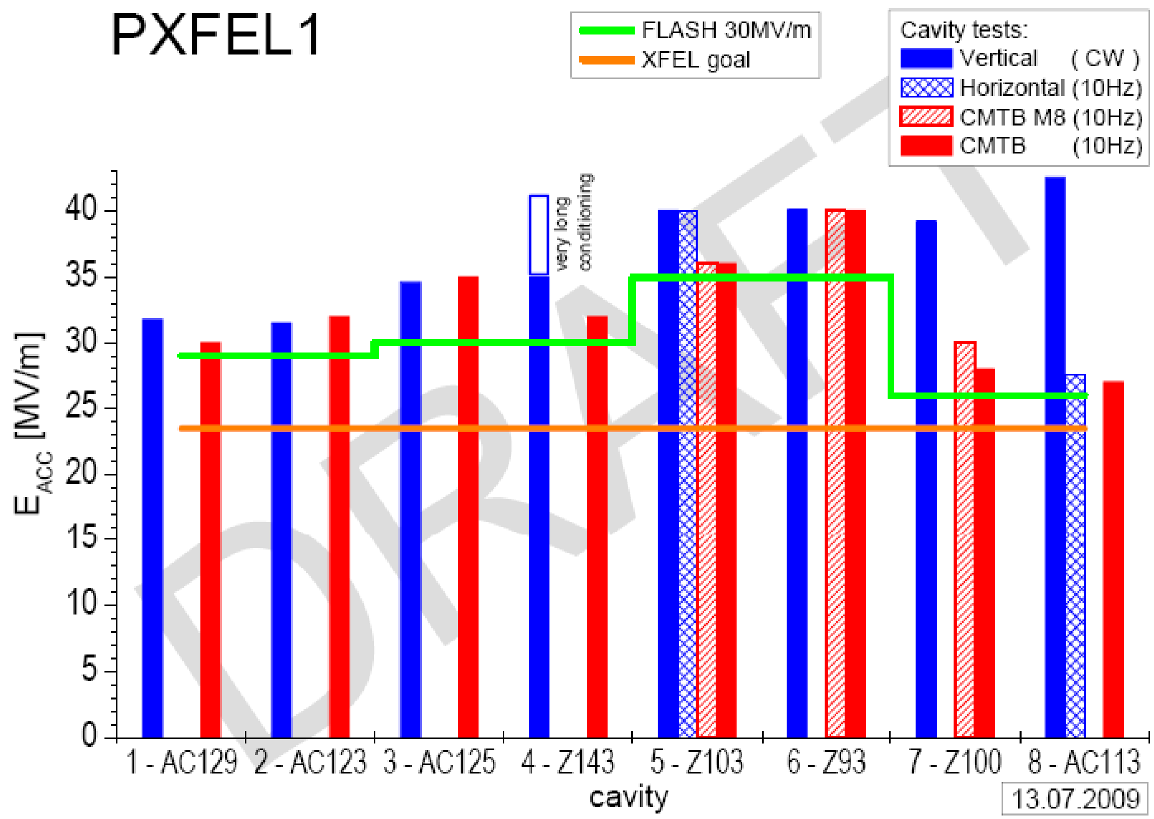
Around the World

Cryomodule surpasses ILC gradient test

European-XFEL cryomodule using SCRF technology sets new record

The cryomodule that set the world gradient record in the testbench at DESY

A cryomodule prototype for the European XFEL has set the world gradient record for cryomodules built with superconducting radiofrequency technology, reaching an average accelerating gradient of more than 32 megavolts per metre (MV/m) in recent



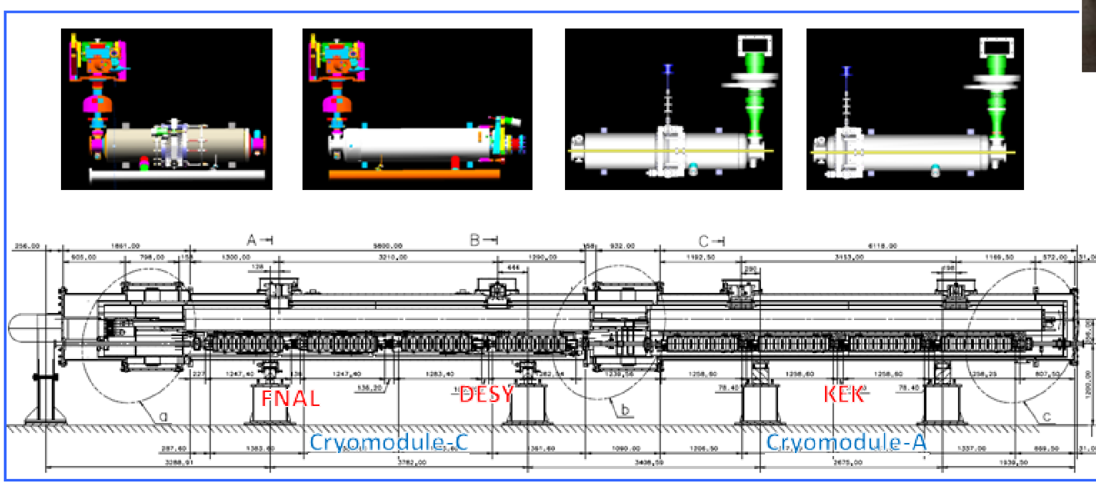
First XFEL prototype module **exceeds 31.5 MV/m average**
Module will see beam in FLASH accelerator in 2010 (average of 30MV/m)

Note: DESY prepared cavities and assembled with the cryomodule cold mass contributed by IHEP - Beijing for XFEL prototype

S1-Global in Progress

INFN/ZANON completing Cryomodule

- Global effort for cryomodule test for ILC operational goal
  - **INFN: Cryomodule**
  - **DESY: 2 cavities**
  - **FNAL/JLab: 2 cavities**
  - **KEK: 2 cavities, Cryomodule**



INFN/KEK Crew visit Z
for diagnostics installat
in July 2009

S1 Global at this Meeting

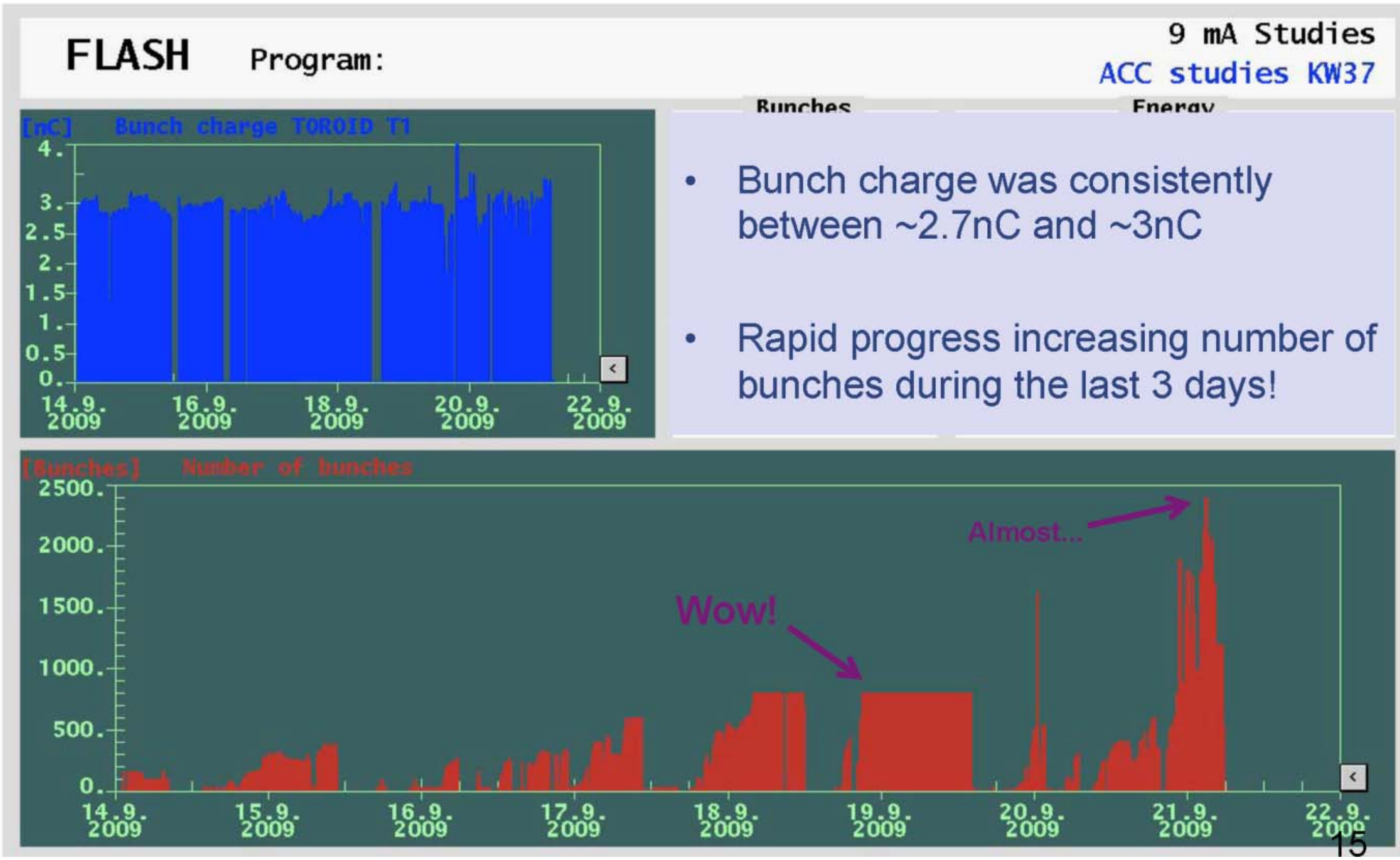
1. 5 of 8 cavities identified (2/2 DESY, 3/4 KEK, 0/2 FNAL)…remainder in process
2. 99% Deliverable Parts Agreed Upon
3. Delivery Dates of Parts Mapped Out / Confirmed
4. Test Plans Presented
5. Instrumentation Plans in Progress
6. Review of RF Systems at KEK for S1G
7. Discussions on:
    1. Tooling requirements and review of potential pieces available worldwide
    2. Coordinating use of FNAL shipping frames for all DESY/FNAL cavities
    3. Assembly procedures
    4. Further meetings for further information transfer in next months
    5. Proposals for participation by laboratories presented

S2: 9mA Experiment - DESY

History of bunch charge and number of bunches during Week #2

Charge (nC)

Number of bunches



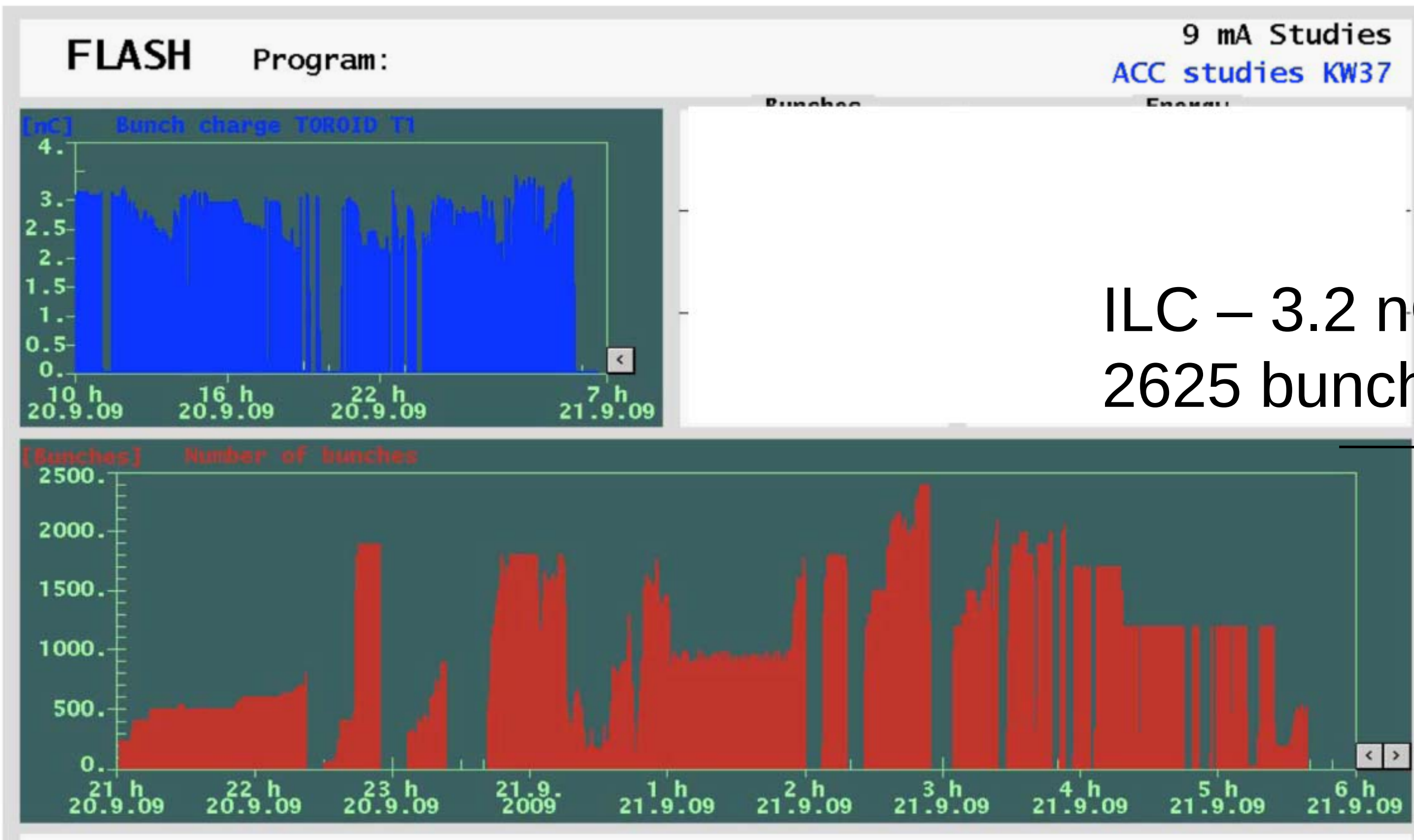
One week Operation 14-22.09.2009

S2: 9mA Experiment

- ***26 KW beam operation*** **at FLASH (6.7 MW equivalent at 250 GeV) for short periods**

Last shift… almost 2400 bunches

Number of bunches



ILC – 3.2 nC, 2625 bunches

One shift Operation 2100:0600 20-21.09.2009

XFEL Project Governance:

- **Full speed ahead for the European XFEL GmbH!**

- It is “an important step for basic research,” as Prof. Frieder Meyer-Krahmer, State Secretary at the German Federal Ministry of Education and Research (BMBF), put it: the international state convention on the construction and operation of the European XFEL was initialled on 23 September 2009 in Berlin. *“Nothing could stop the foundation of our research institution any more now,” rejoices Prof. Massimo Altarelli,* designated chairperson of the management board of the European XFEL GmbH.

XFEL Project Linac Update

- XFEL Linac ~835 cavity contract call for tender has been distributed
- Expect contracts to be negotiated and signed by early 2010 – delivery starting ~one year later
- XFEL production ‘stream’ contract will include ~ 30 ‘high gradient’ cavities funded through EC
  - **These will processed and subjected to tests beyond nominal production process**
- Costs and production strategy to be discussed between project teams

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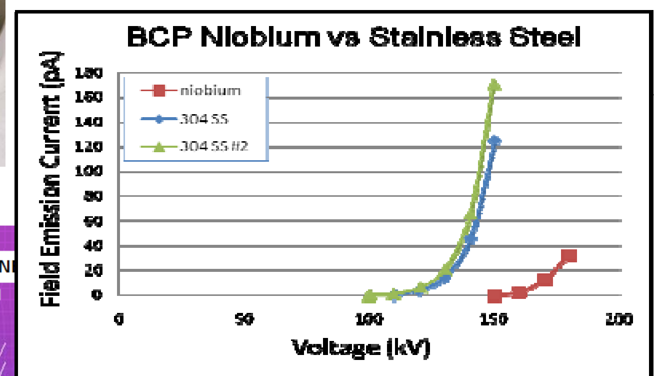
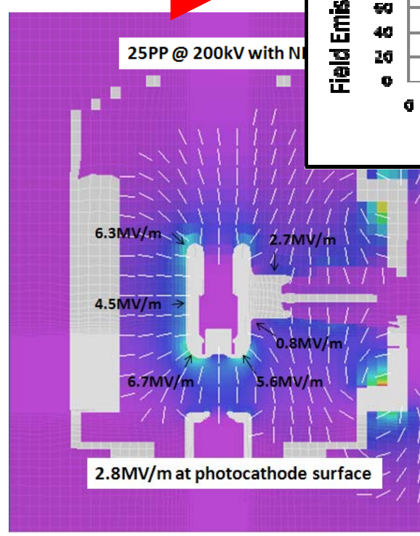
Gun Development at Jlab

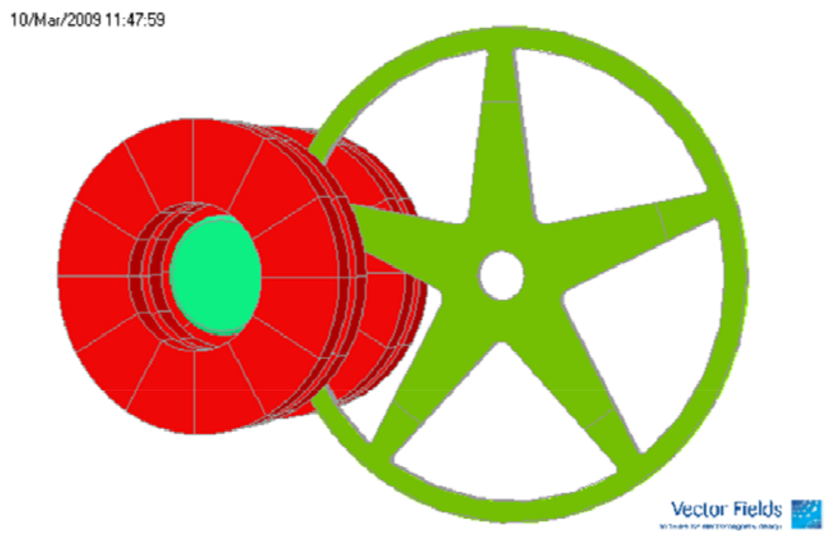
- Inverted Gun installed at CEBAF
- Development of single crystal Nb electrodes (suppression) of field emission)
- Work on HV design to reach 200 kV (and beyond)

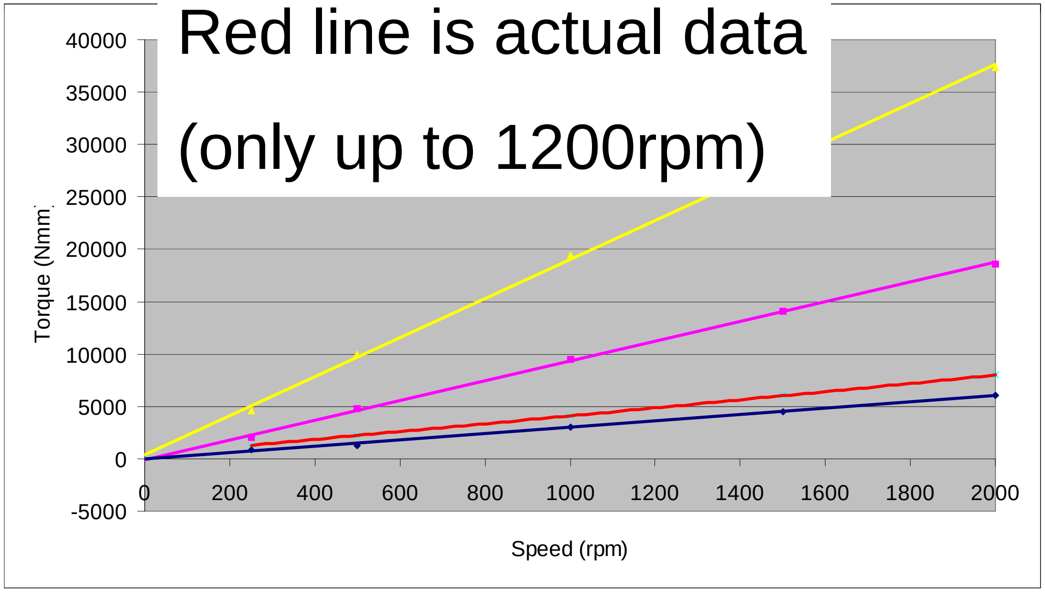




Positron target

- Baseline target eddy current experiment data analysis has started
- Results agree best with simple model which doesn't include spokes – puzzling but good news as lowest torques (lowest energy dumped in target)!





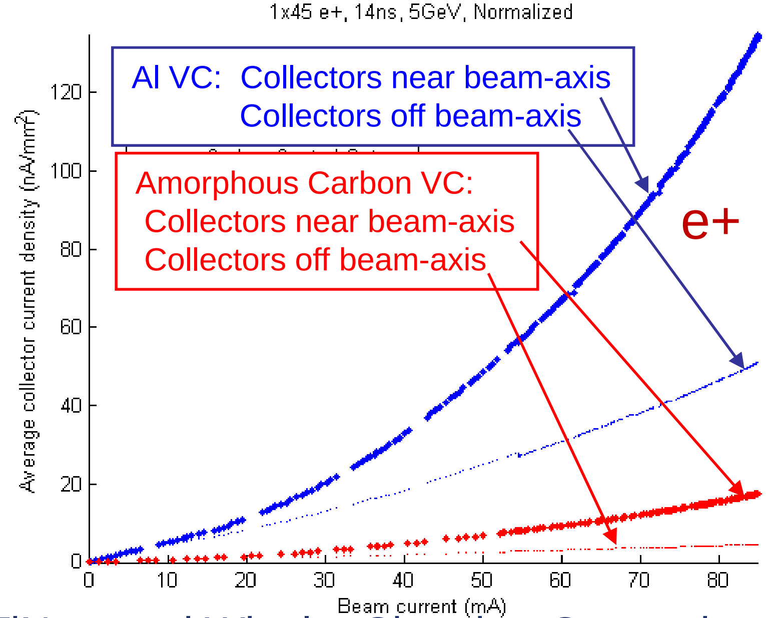
KEK Beam Tests

- Hybrid target (300 Hz source)
  - **Installed on KEKB linac**
  - **Pilot run OK, full expt Jan – Mar 2010**
- Liquid lead target (300 Hz source)
  - **On ATF Linac – parameters not testing enough but good experience will be gained**
  - **Install Dec/Jan, expt schedule not set yet**
- BN Window test (for liquid lead target)
  - **On KEKB ring beam dump**
  - **Will use BN-solid Pb-BN sandwich**
  - **First tests Oct 09**
  - **Beam parameters well matched**

E cloud Mitigation Studies

- Comparisons of EC mitigations:
  - **Environments: Drift, Dipole, Wiggler**
  - **Chamber Surfaces: Al, Cu, TiN coating, amorphous carbon coating, grooves, electrodes**

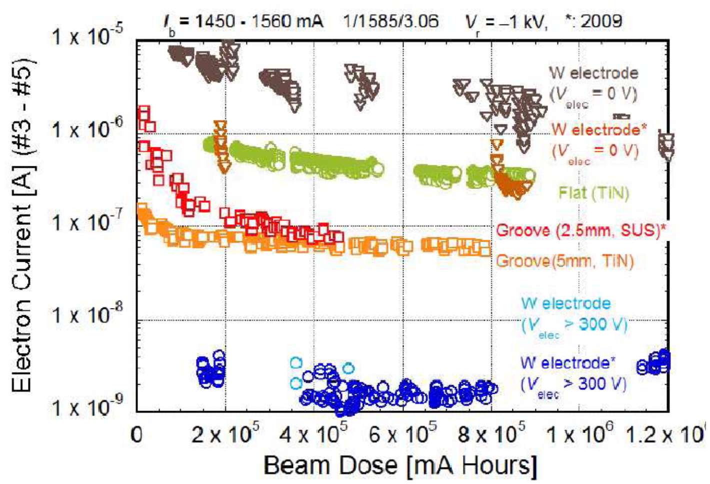
Measurements at CesrTA



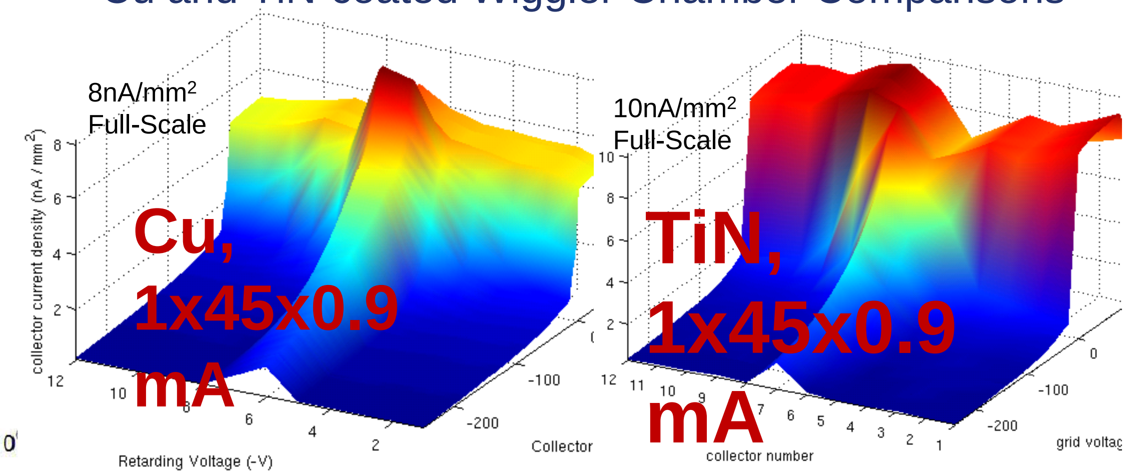
KEK

Groove and Clearing electrode

- Compared to the case of TiN-coated flat surface
  - Clearing electrode (> +300 V): 1/100~1/500
    - ~1/50 of groove structure



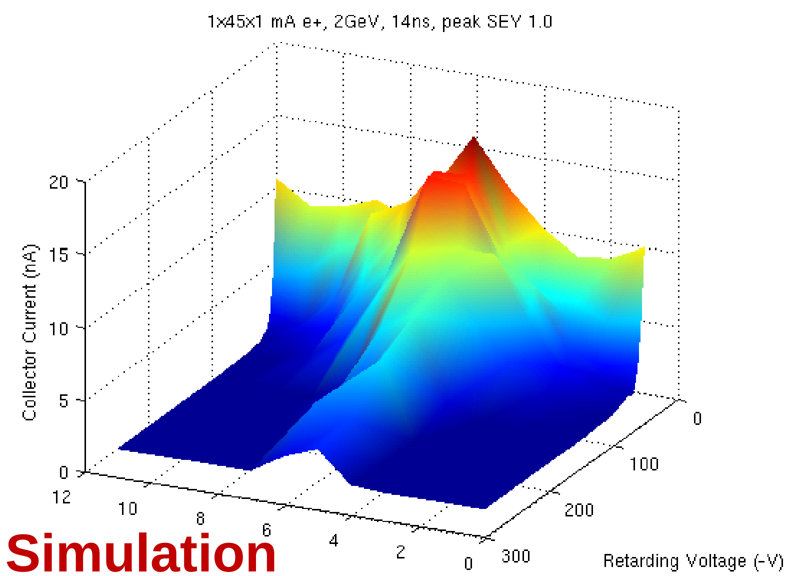
Cu and TiN-coated Wiggler Chamber Comparisons

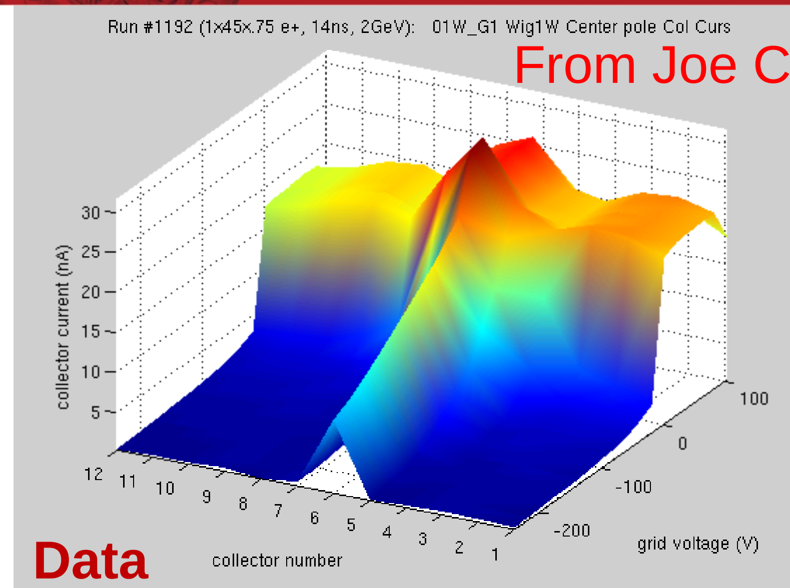


Cornell University
Laboratory for Elementary-Particle Physics

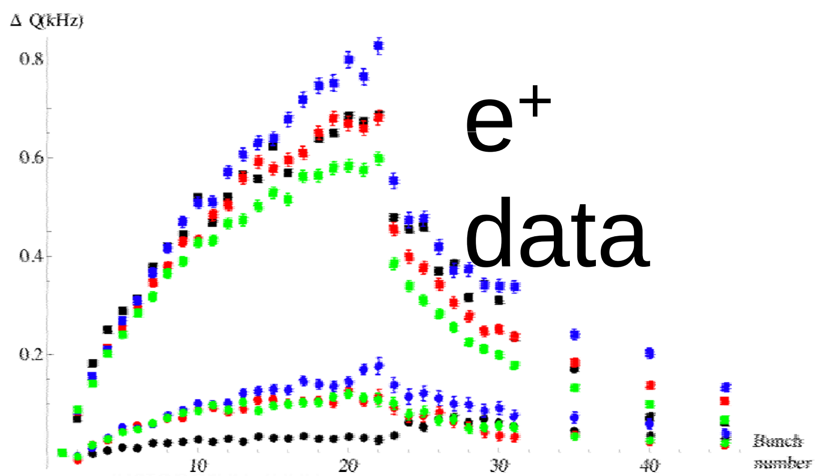
Wiggler: ECLOUD RFA Model

From Joe Calvey





Coherent tune shift vs. bunch number



Working Group Charges

- To evaluate electron cloud mitigation techniques, simulations and code benchmarking for the Damping Ring. In particular, evaluate the differences between mitigations as grooves clearing electrodes, coating (TiN, TiZrV NEG and amorphous Carbon) regarding their feasibility, effectiveness, impact on the vacuum system, on the beam impedance and on costs, for different regions of the DR as drifts, arc magnets and wigglers.
- To recommend a baseline solution for the electron cloud mitigations in the 6.4km (RDR) and 3.2km (SB2009) DR.
- Evaluate the ‘upgrade’ potential from the SB2009 proposed 1312 bunches back to the current RDR nominal value of 2623 (doubling the current) immediately identified bottlenecks.
- Evaluate the current limits due to e-cloud for the 3.2 km DR.

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CERN-GDE Collaboration

- Beyond CLIC-ILC synergy →
- Have prepared a request to CERN for collaborative activity on:
  - **Cryomodule mass-production**
  - **Cryogenics**
  - **Tunnel Safety (partly included in CLIC Collaboration CFS working group)**

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Planning for TDP-2

- Must now begin
- AD&I effort will focus on
  - **Consolidating new accepted baseline**
  - **Further detailed design work**
  - **Cost estimation (update)**
  - **Construction schedule**
  - **Documentation (ILC-EDMS)**
- Project Implementation Plan
  - **SRF mass-production and in-kind models**
    - Industrialisation
  - **Governance etc.**
- Risk Mitigating R&D
  - **Continues**

- Major update to R&D Plan expected in mid-2010
  - **Reflect detail plans for the above**