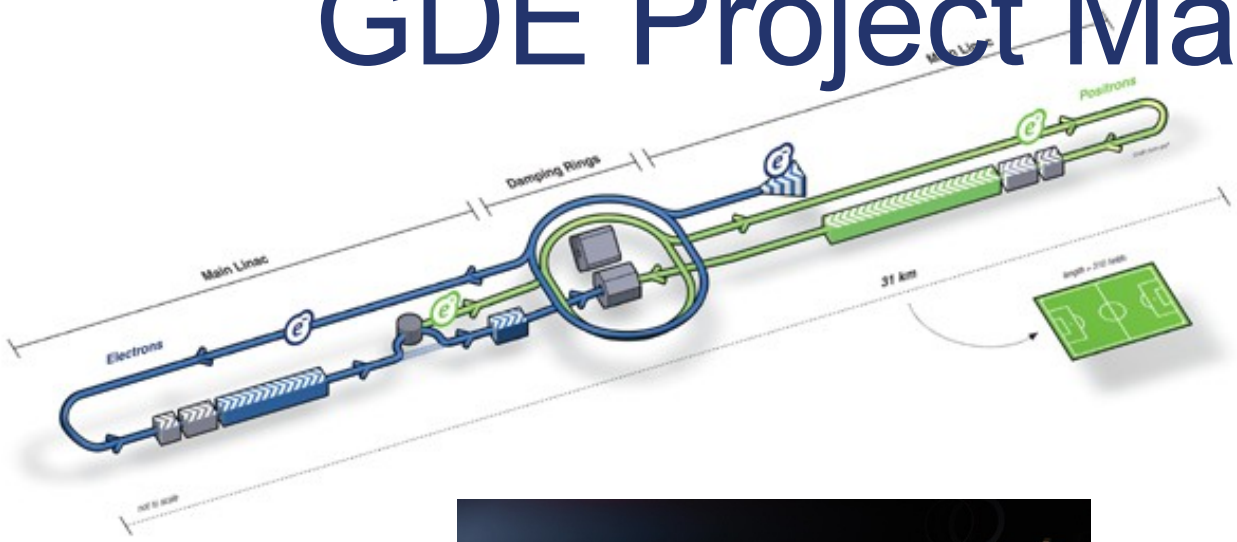
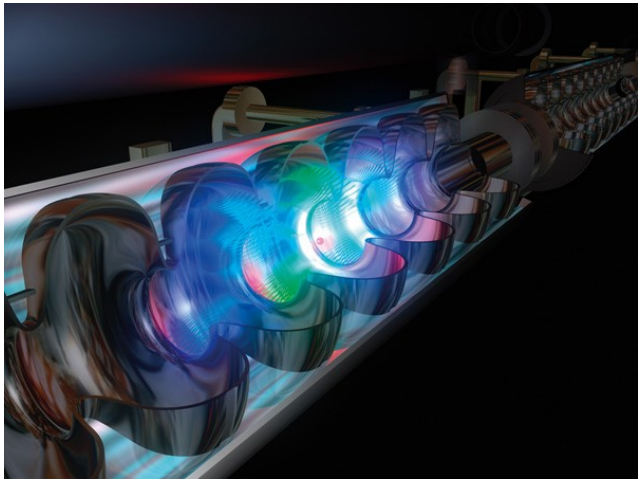
GDE Project Management Summary





Nick Walker
Marc Ross
Akira Yamamoto

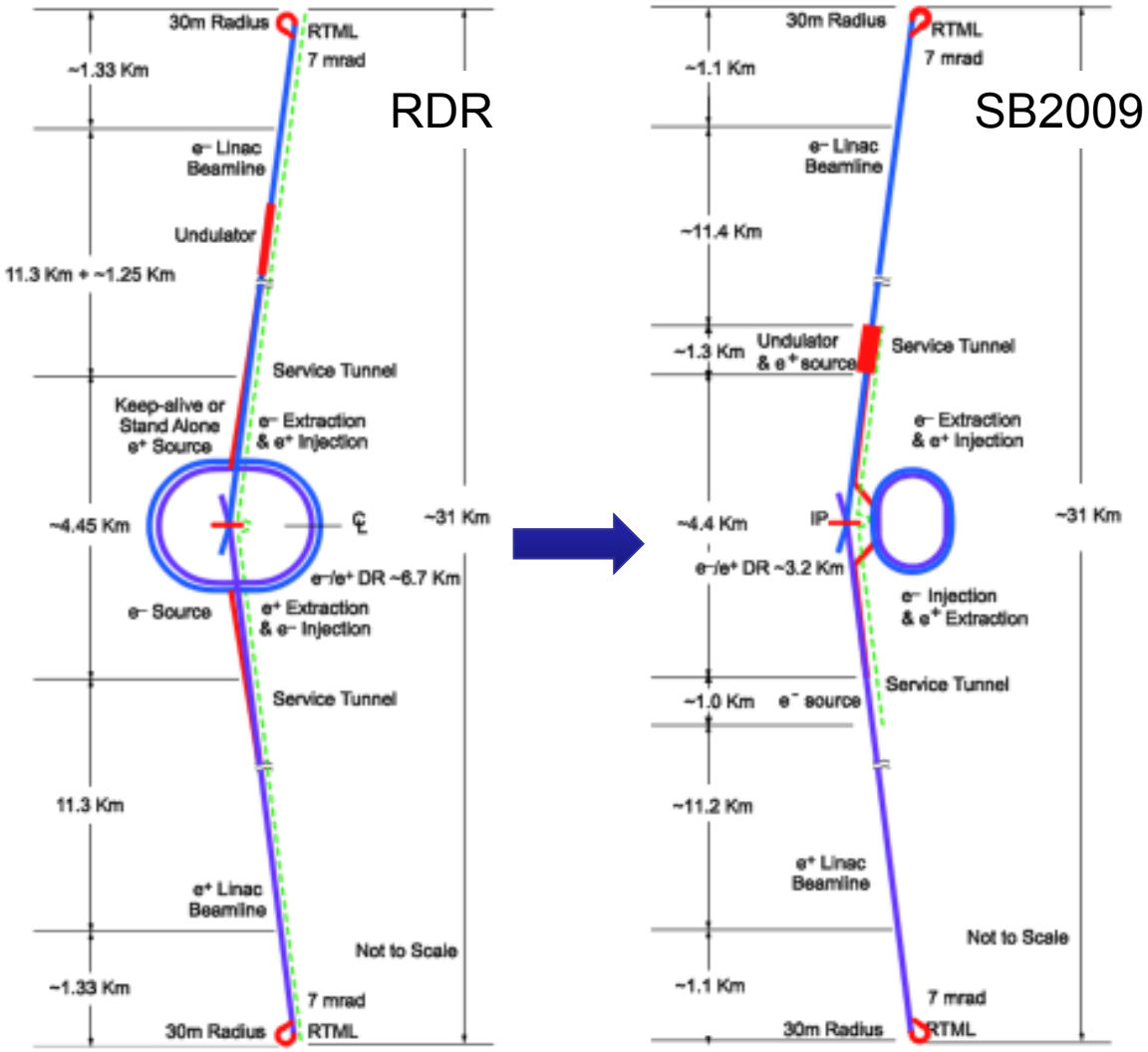
23.03.2011
ALCPG'11 Eugene Oregon

What's in store

- New Baseline for the TDR
- Remaining AD&I work for the TDR
- Towards 1000 GeV
- CLIC
- SCRF mass production and cost
- CFS civil engineering
- Beam Test Facilities
- Summary

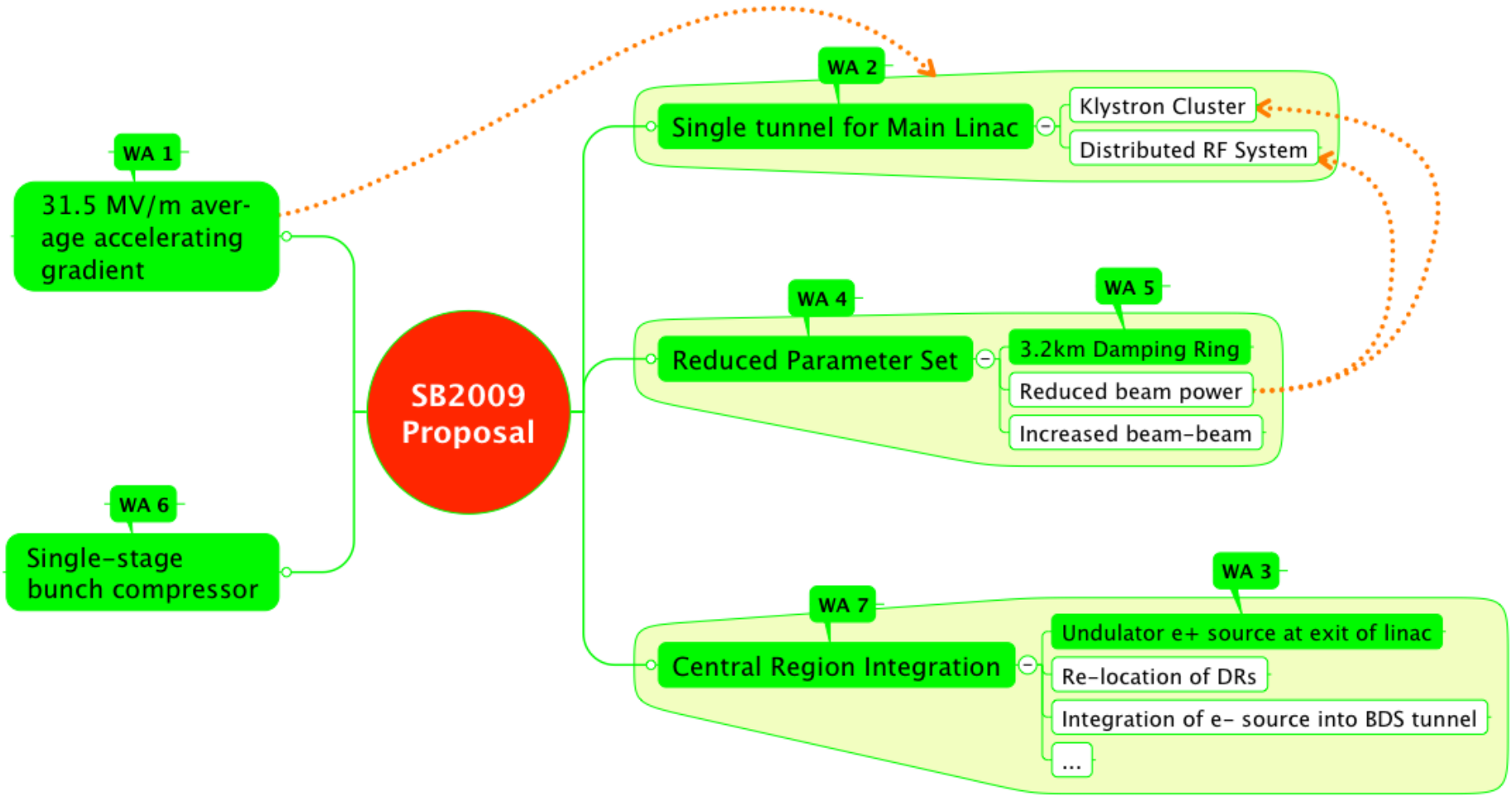
New BASELINE for the TDR

Accelerator Design & Integration

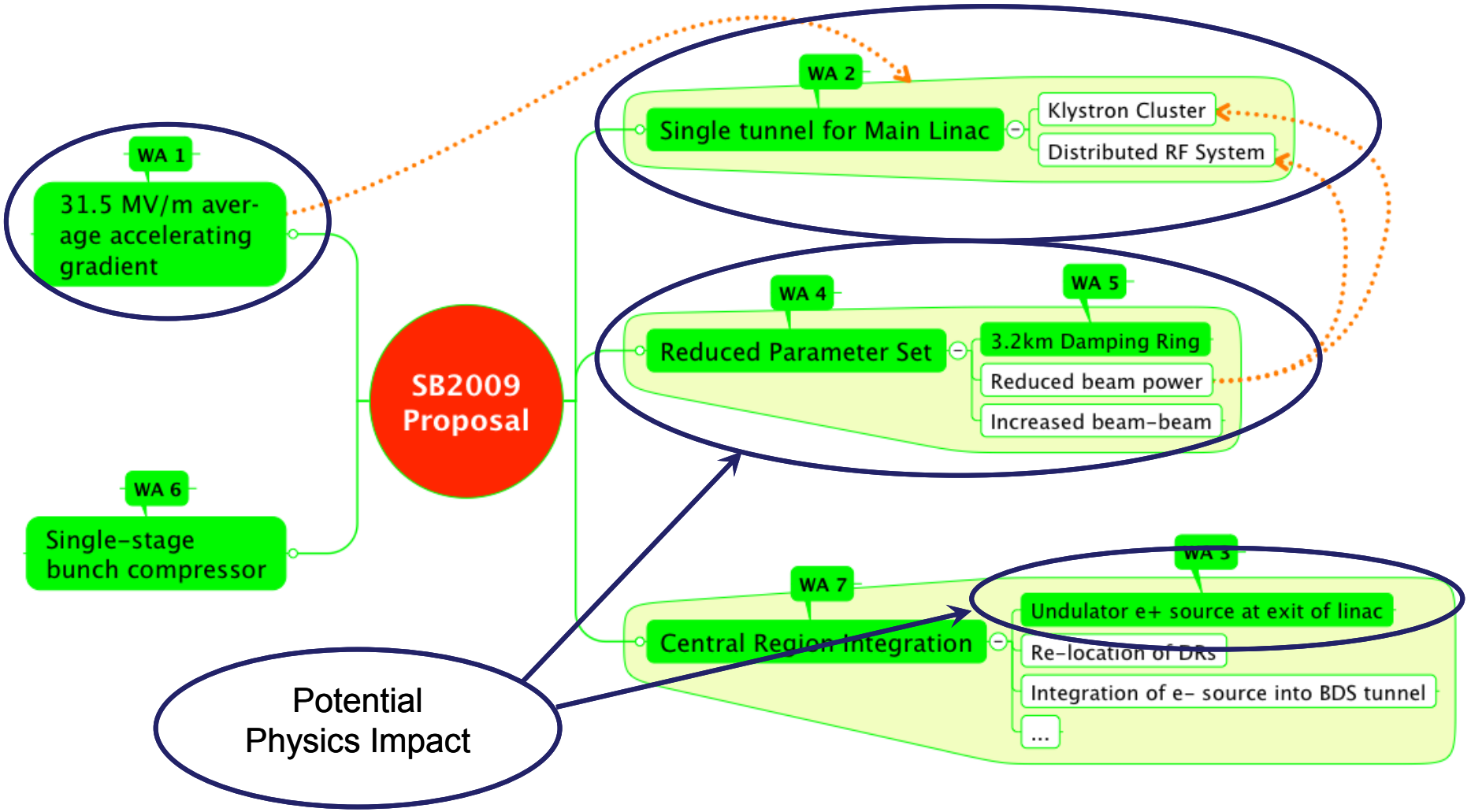


- **2009 Design Studies**
  - on-going
- **Cost Constraint**
  - 'Global' Value Engineering
- **Towards an agreed-upon baseline for the TDR**
  - Top-Level Change Control Process (**TLCC**)
  - Communication with stakeholders (e.g. Physics & Detector groups)

SB2009 Proposal



TLCC Themes


WA 1
31.5 MV/m aver-age accelerating gradient
WA 2
Single tunnel for Main Linac
Klystron Cluster
Distributed RF System
SB2009 Proposal
WA 4
Reduced Parameter Set
WA 5
3.2km Damping Ring
Reduced beam power
Increased beam-beam
WA 6
Single-stage bunch compressor
WA 7
Central Region Integration
WA 3
Undulator e+ source at exit of linac
Re-location of DRs
Integration of e- source into BDS tunnel
...
Potential Physics Impact

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

Proposals submitted to director

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

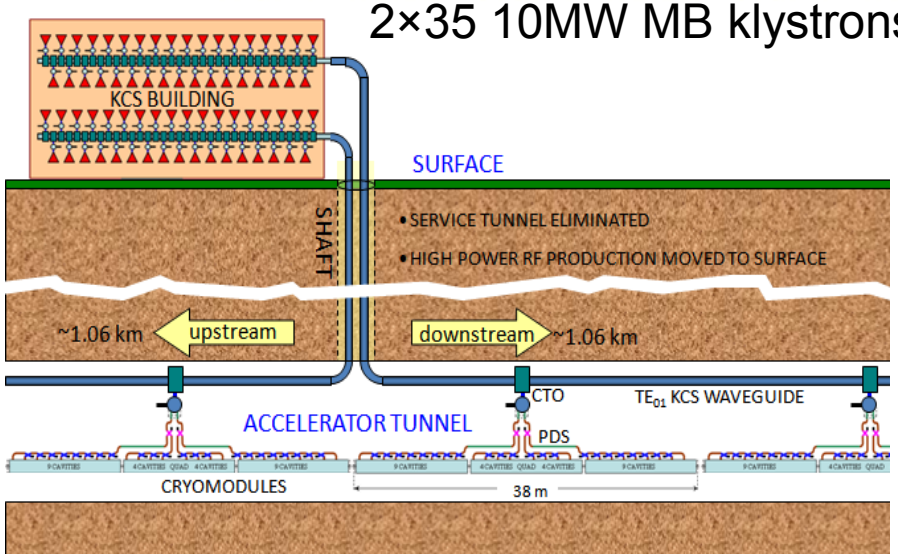
- Change evaluation panel
- Chaired by Director

APPROVED!

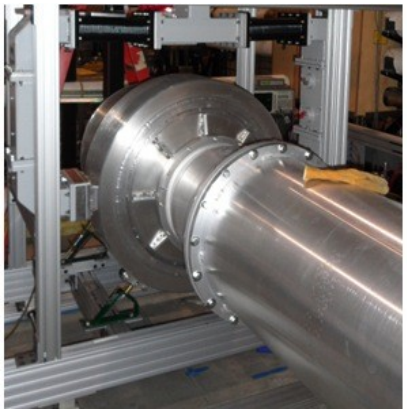
keywords: open, transparent

High-Level RF Solutions

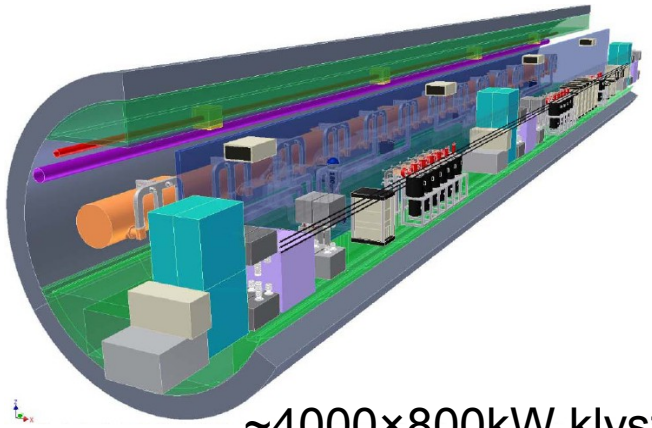
2×35 10MW MB klystrons



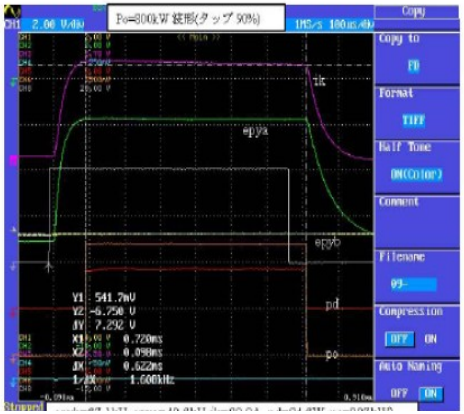
Klystron Cluster Scheme, KCS (SLAC)



Distributed RF Sources, DRFS (KEK)

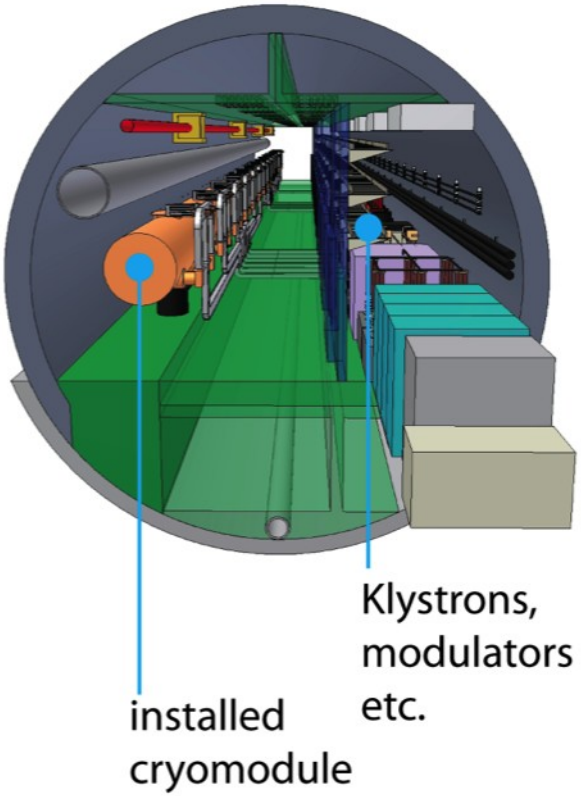


~4000×800kW klystrons

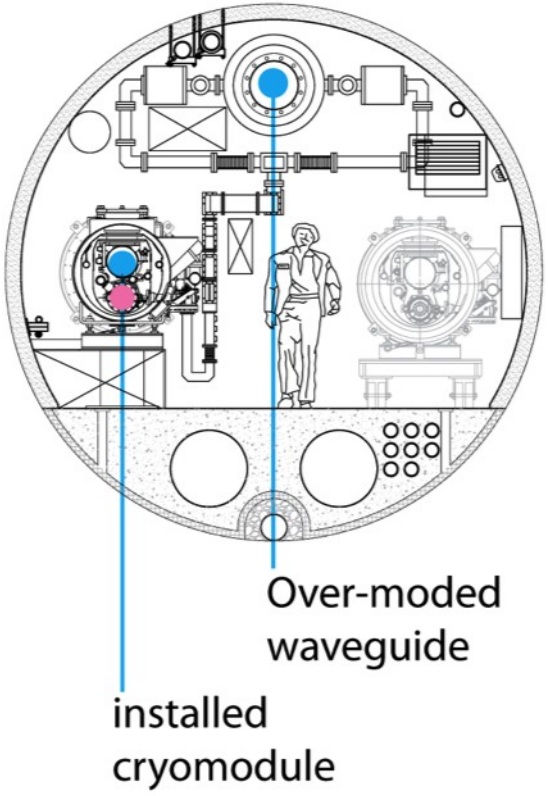


Main Linac Tunnel Solutions

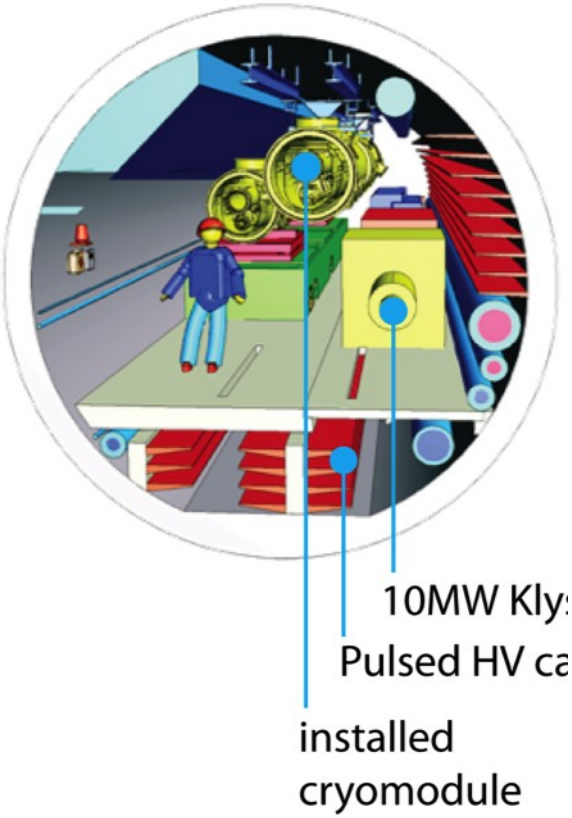
(A) DRFS



(B) KCS



(C) RDR HLRF Tech.



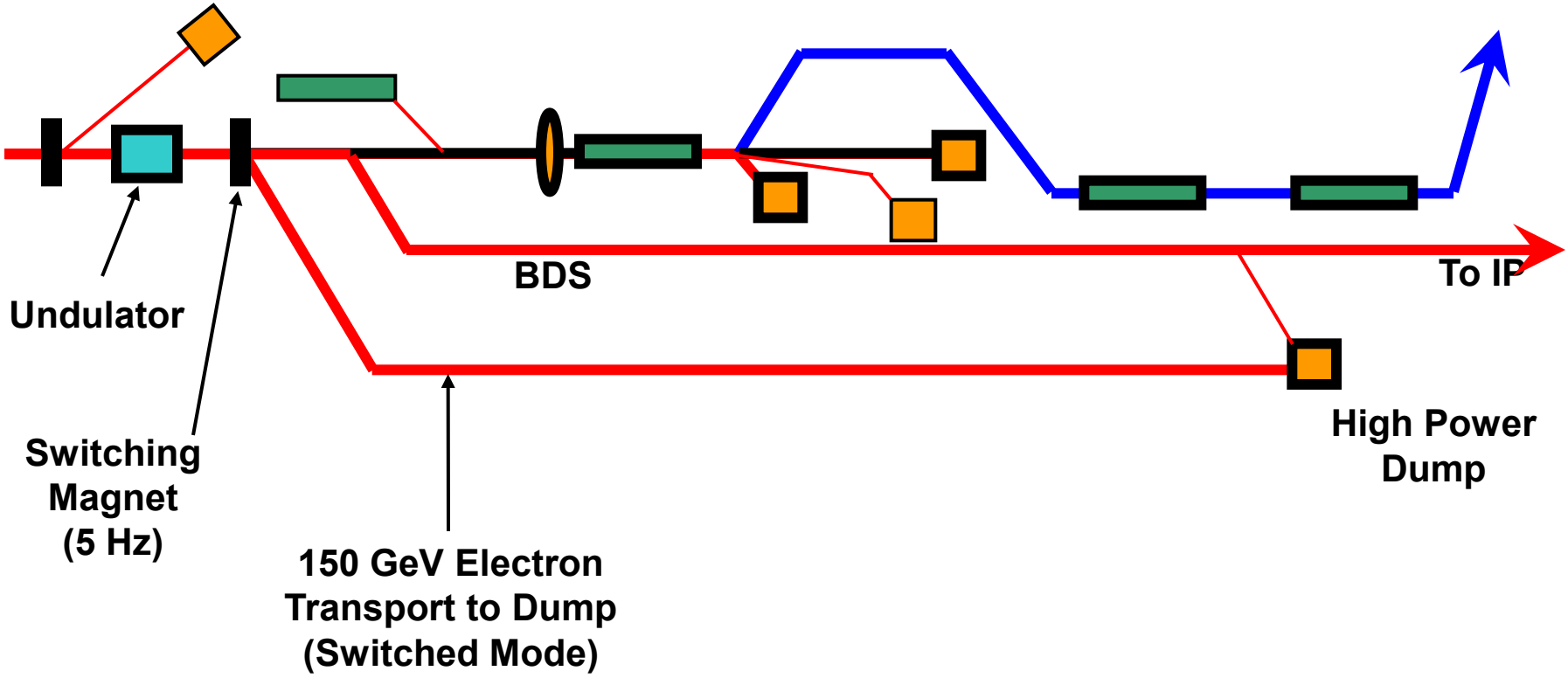
Reduced Power Option

								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

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

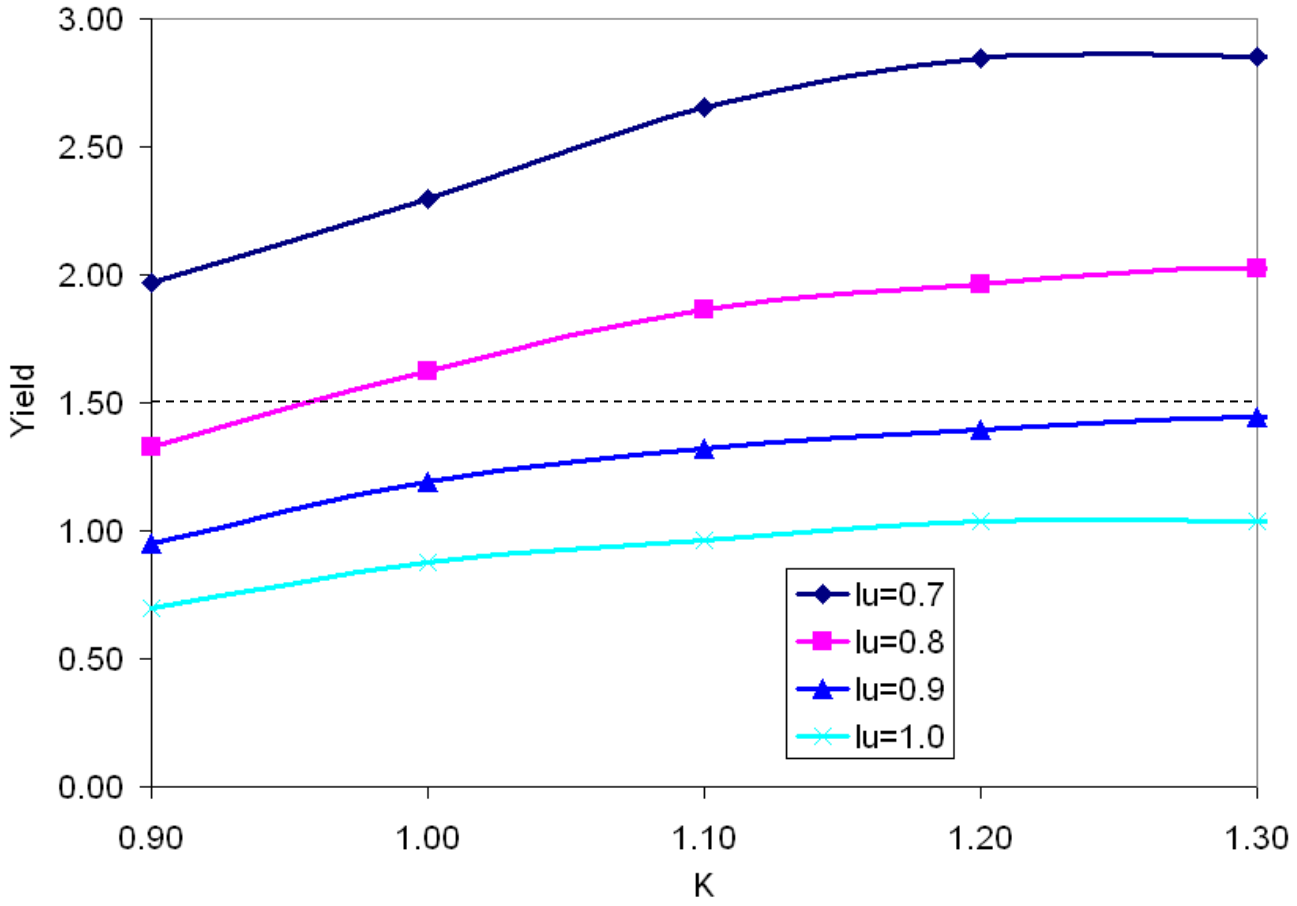
Important: recovery (upgrade) scenario now supported
- e.g. support for 3 DRs in single tunnel

e^+ Production: Switched Mode



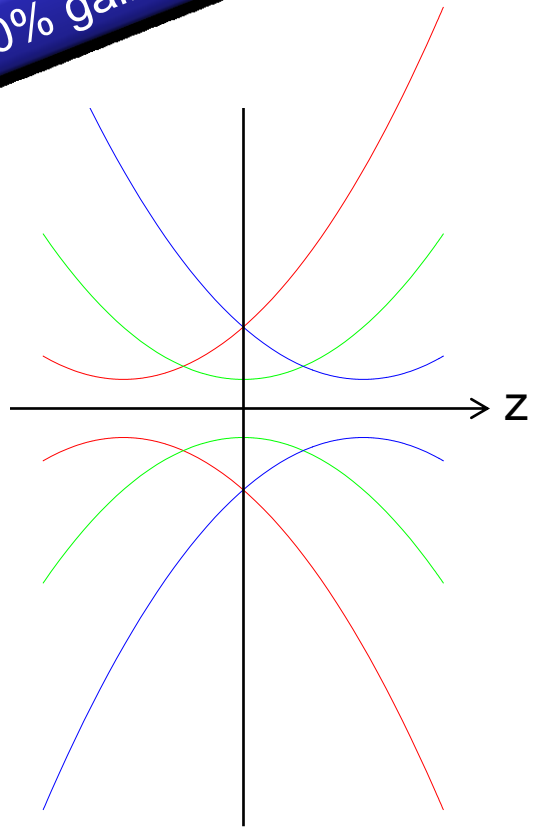
Nb3Sn Undulator R&D

High K, short period undulator with 100 GeV drive beam



What is required for Travelling Focus?

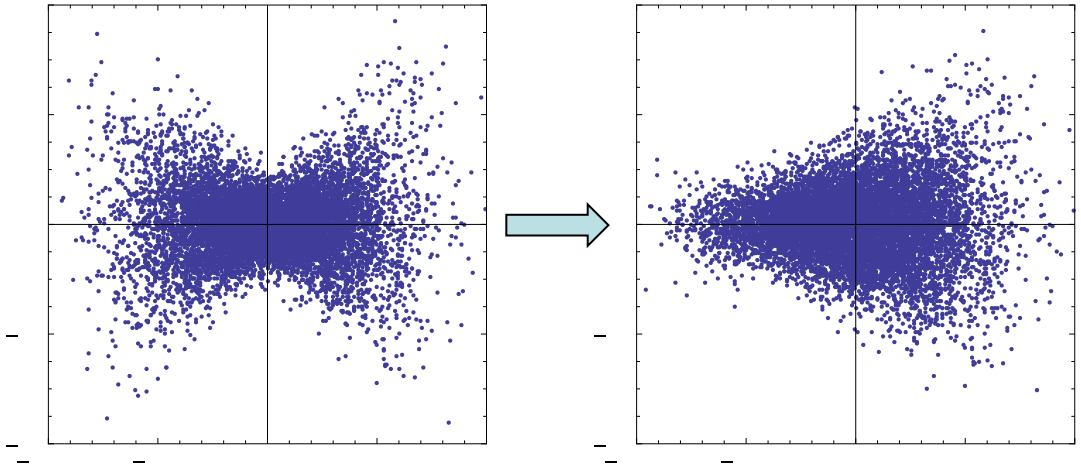
30% gain in L



Shift the waist (focal point) of each *z*-slice by -*z*/2

Apply an additional (coherent) shift of $-\sqrt{3}\sigma_z/2$

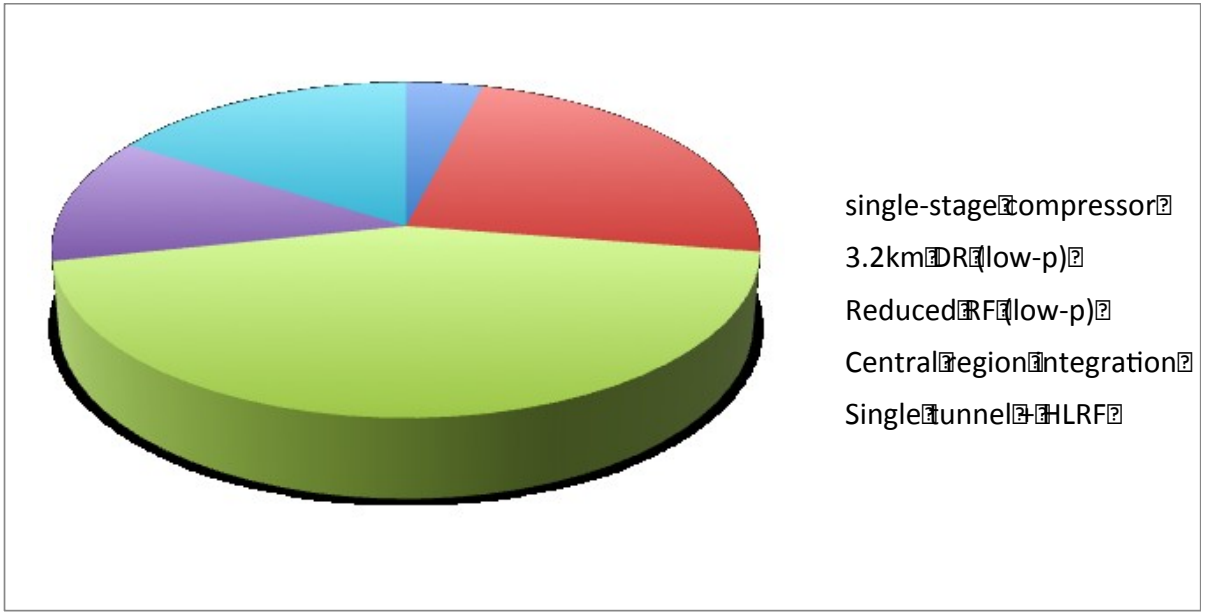
Note: Guinea Pig applies to both planes



Considered high risk. Requires further study (on going)

TLCC – Bottom Line

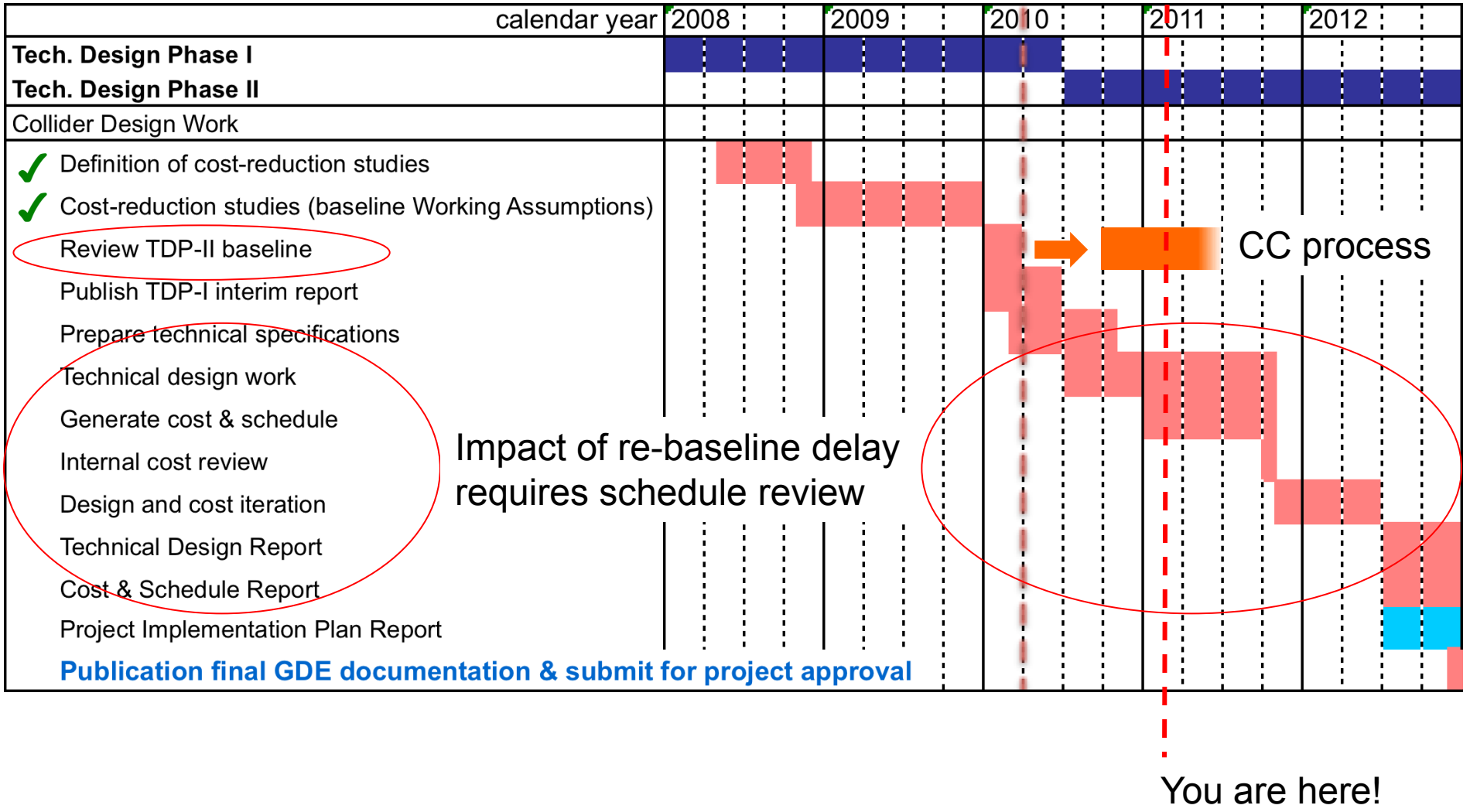
- **Cost containment: 600-800 MILCU**



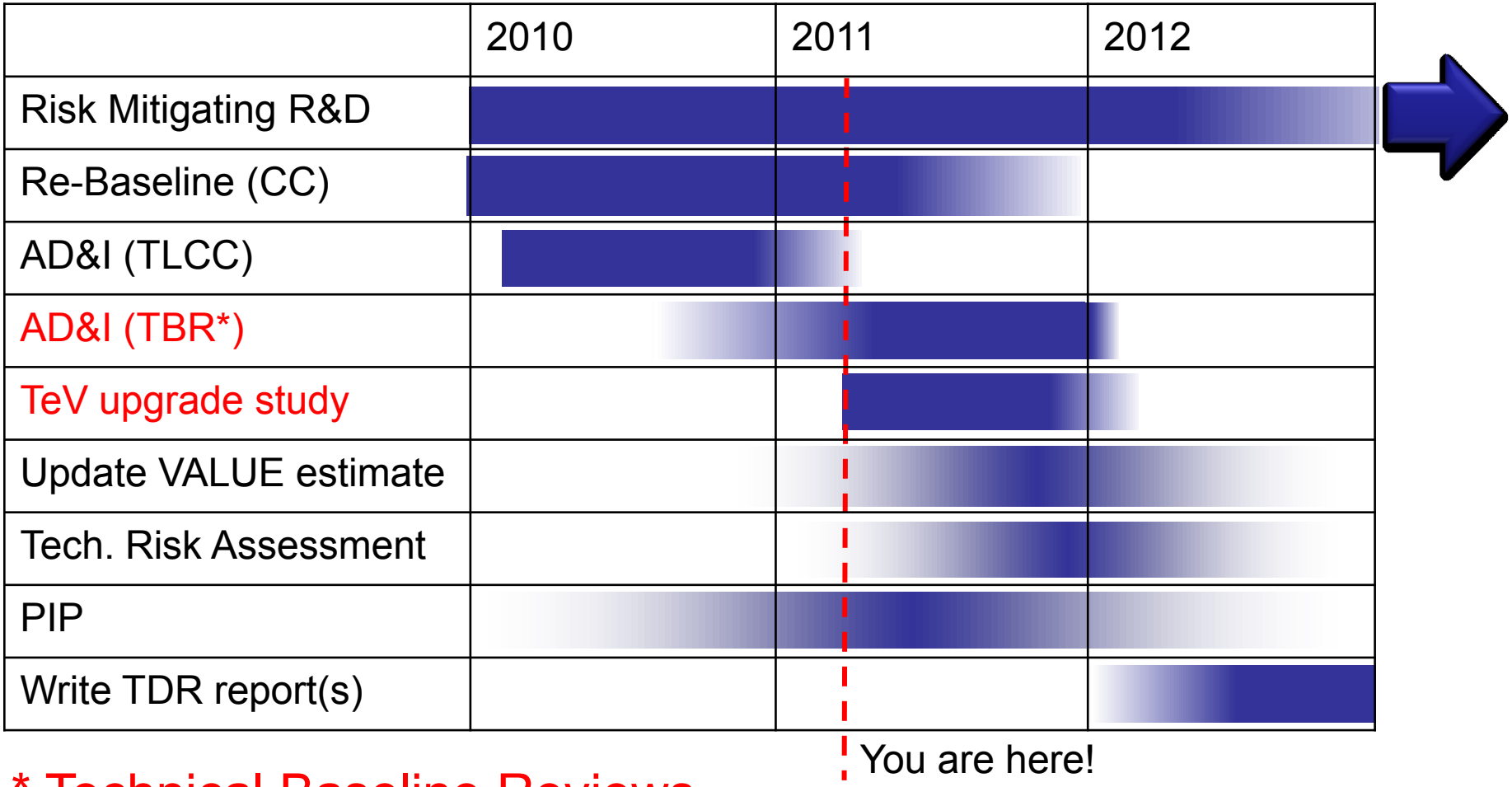
- **Performance in principle maintained**
- **Higher risk (top 30% lumi)**

AD&I: Next Steps towards the TDR

Collider Design Work (ADI)



Planning for the TDP 2



* Technical Baseline Reviews

TDP Key Focus (beyond R&D)

SCRF Cost	CFS design & cost	Baseline Design
• mass production models • global distribution	• Design update • Value engineering	• Final design decisions • Documentation • Cost estimate

Highest Priority (new estimate)

High Priority (updated estimate)

RDR update Documentation (scaled estimate)

CFS requirements critical input

Technical Baseline Reviews

- **The next "thing" after TLCC**

- **Similar format to TLCC BAW but reduced scope**
  - next-level of design decisions
  - PM (not Director) driven

- **two-day focus workshops**
  - face-to-face for key (mandatory) participants, but
  - open meetings to all who wish to attend
  - Webex available
  - Written detailed summaries to be provided

Open and transparent process

TDR Technical Baseline Reviews

- **Dates and venues:**

Baseline Technical Reviews		
Area / Group	When	Where
DR	7-8 July, 2011	INFN
RTML	TBD (Oct 2011?)	Fermilab
BDS	27-28 Oct 2011	DESY
Sources	12-13 Dec 2011	ANL
SCRF / Main linac integration	Winter 2011 / 2012	KEK
CFS	Winter 2011 / 2012	Fermilab / Cern

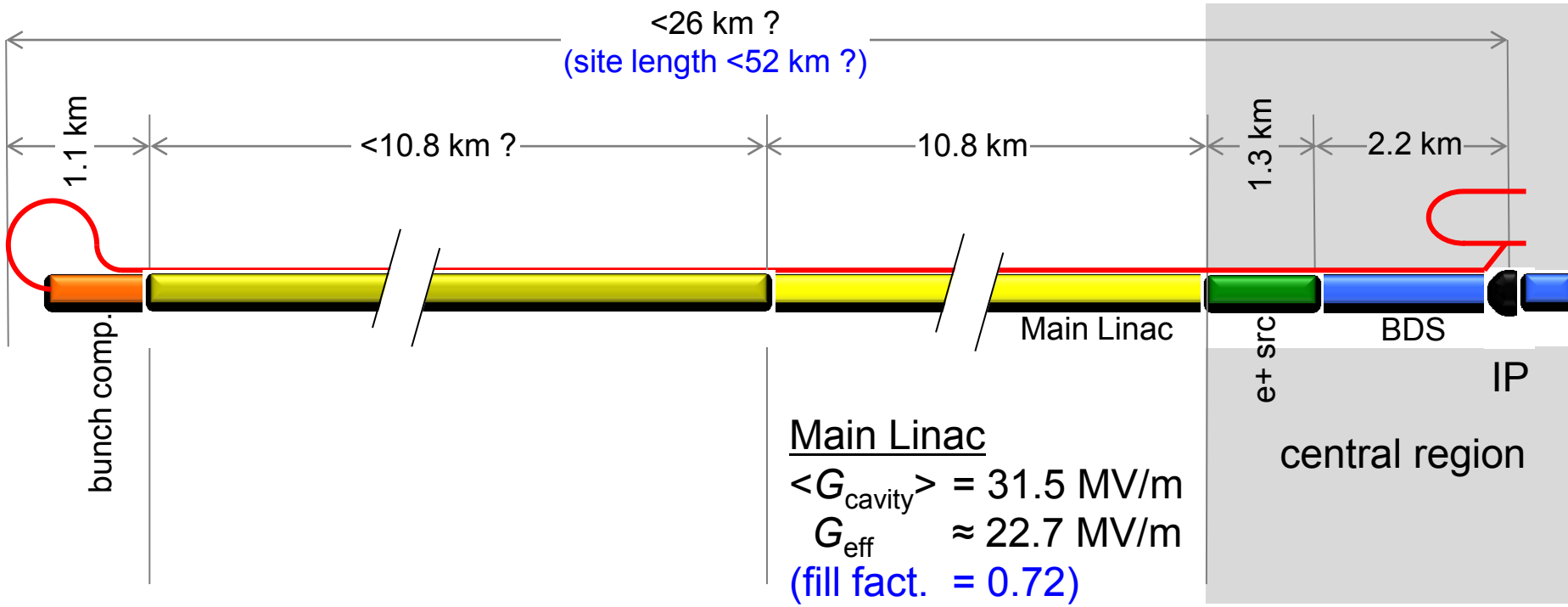
- **Physics and Detector to be represented**

Towards 1000 GeV

ILCSC Parameters subcommittee report:

"an initial center-of-mass (cms) energy up to 500 GeV with the ability to upgrade to 1 TeV"

From 500 to 1000 GeV



Main Linac

$\langle G_{cavity} \rangle$ = 31.5 MV/m

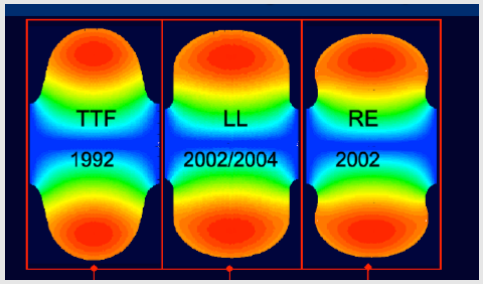
G_{eff} ≈ 22.7 MV/m

(fill fact. = 0.72)

Snowmass 2005 baseline recommendation for TeV upgrade:

G_{cavity} = 36 MV/m ⇒ 9.6 km

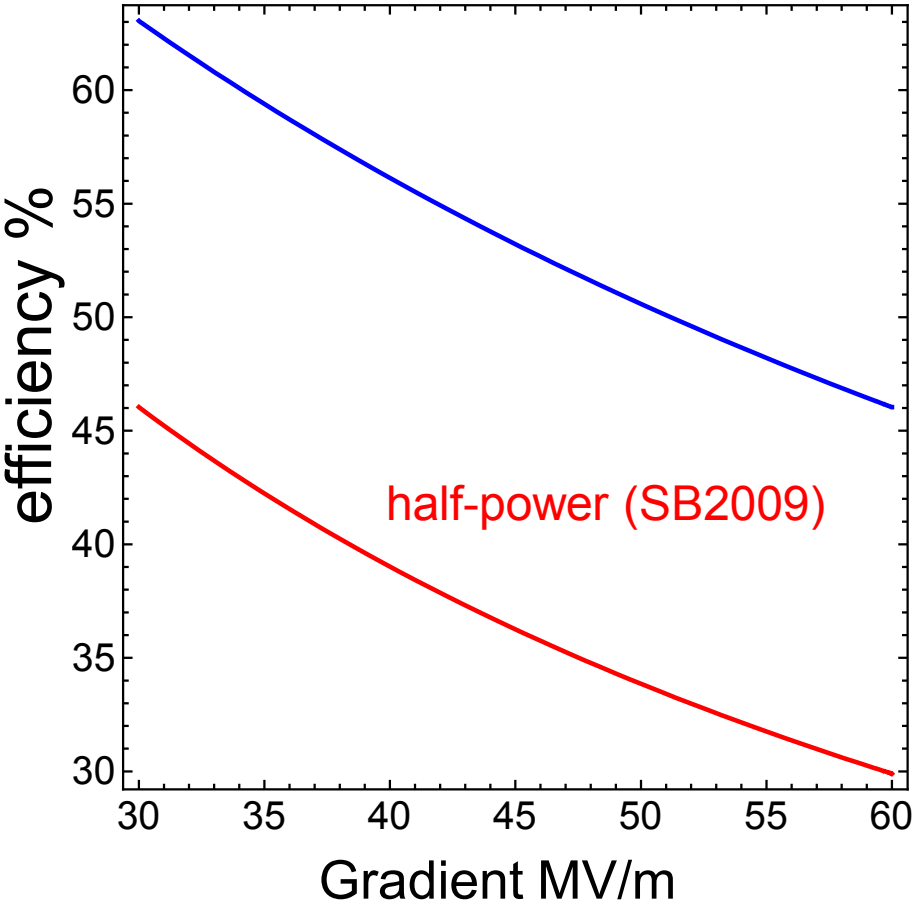
(VT ≥ 40 MV/m)

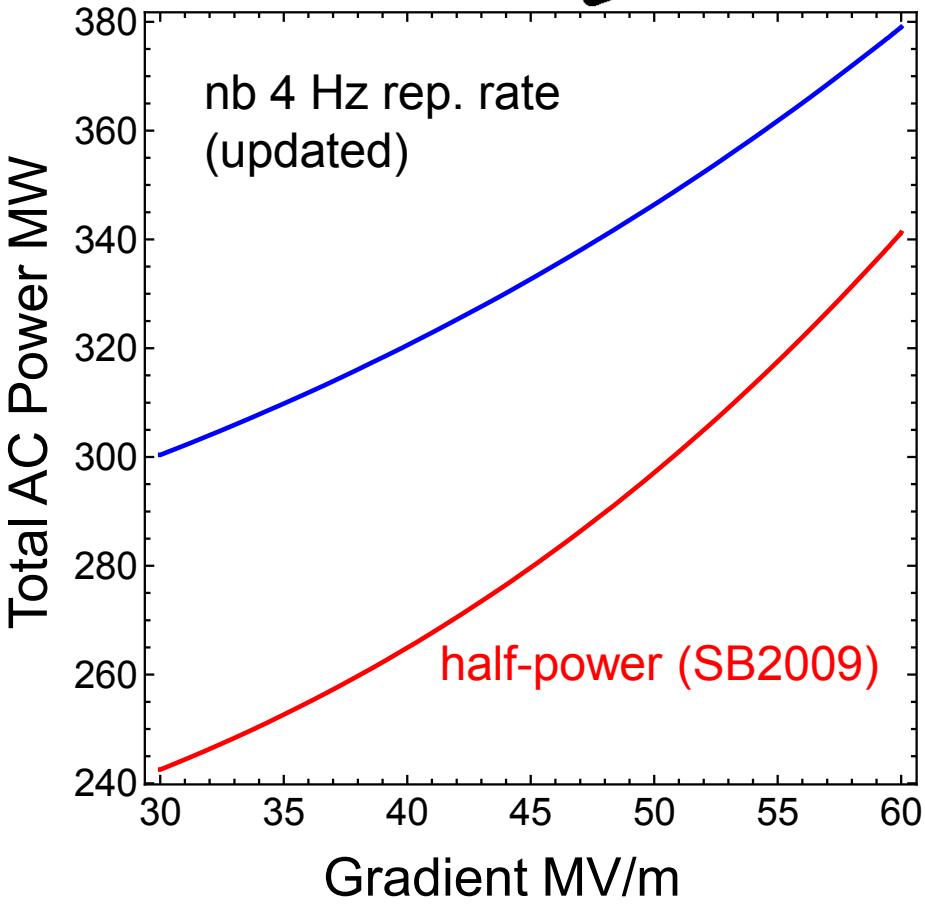


Based on use of low-loss or re-entrant cavity shapes

Efficiency and Power

Updated





Simples scaling – needs more detailed analysis

1 TeV Tentative Parameters

Collision rate	f_{rep}	4	Hz
Number of bunches	n_b	2625	
Bunch population	N_-	2	$\times 10^{10}$
Bunch seperation	Δt_b	356	ns
Pulse current	I_{beam}	9.0	mA
RMS bunch length	σ_z	0.3	mm
RMS energy spread (e-, e+)	$\Delta p/p$	0.105, 0.038	
Polarisation (e^-, e^+)	P_-	80, 22	%
Emittance (linac exit)	$\gamma\varepsilon_{x,y}$	10, 0.035	μm
IP beta function	$\beta_{x,y}$*	30, 0.3	mm
IP RMS beam size	$\sigma_{x,y}$*	554, 3.3	nm
Vertical disruption parameter	D_y	19.2	
Luminosity	$\boldsymbol{L}$	**2.70**	$\times 10^{34}$ cm^{-2}s^{-1}
Fraction of luminosity in top 1%	$L_{0.01}/L$	63.5	%
Average energy loss	δE_{BS}	4.9	%
Number of pairs per bunch crossing	N_{pairs}	169	
Total pair energy per bunch crossing	E_{pairs}	1084	TeV

Current "official" parameter set in EDMS*.

Should still be considered tentative, pending review and further study.

Understanding (and updating) these parameters is our job for the next ~6 months.

negotiation!

* EDMS Doc ID: D*925325
http://ilc-edmsdirect.desy.de/ilc-edmsdirect/file.jsp?edmsid=*925325&fileClass=ExcelShtX

CLIC Status

CLIC Study since IWLC10:

Goal: Extend LC to multi-TeV

- **CLIC technology feasibility up to 3 TeV →**
  - ***underway*** **in CTF3 2011 / 2012**
  - **(3 TeV ~ consistent with LHC)**
- **energy will *certainly be limited* by practical considerations →**

power consumption:

- ***recent re-estimate*****:** **568 MW@ 3 TeV**
  241 MW@500 GeV

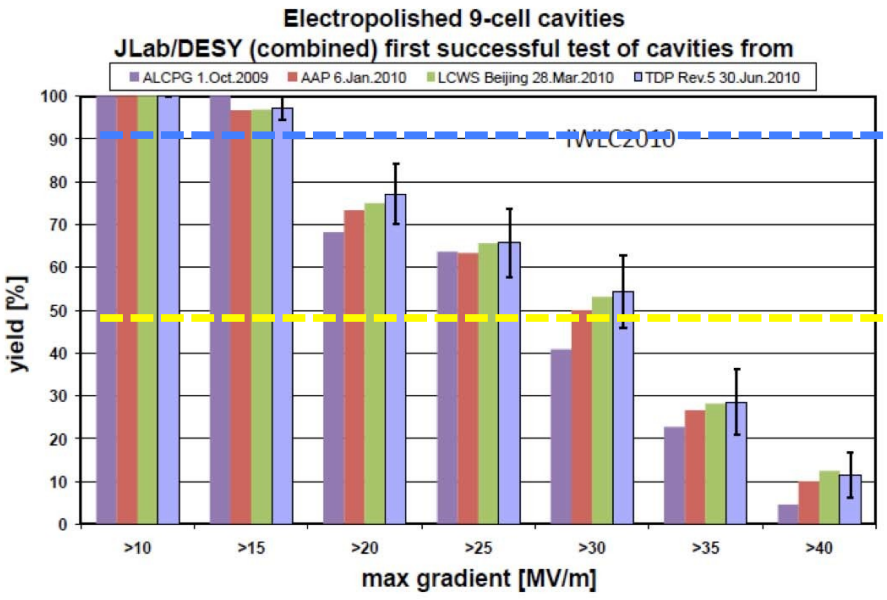
(or cost)

For LCWS11 – Granada

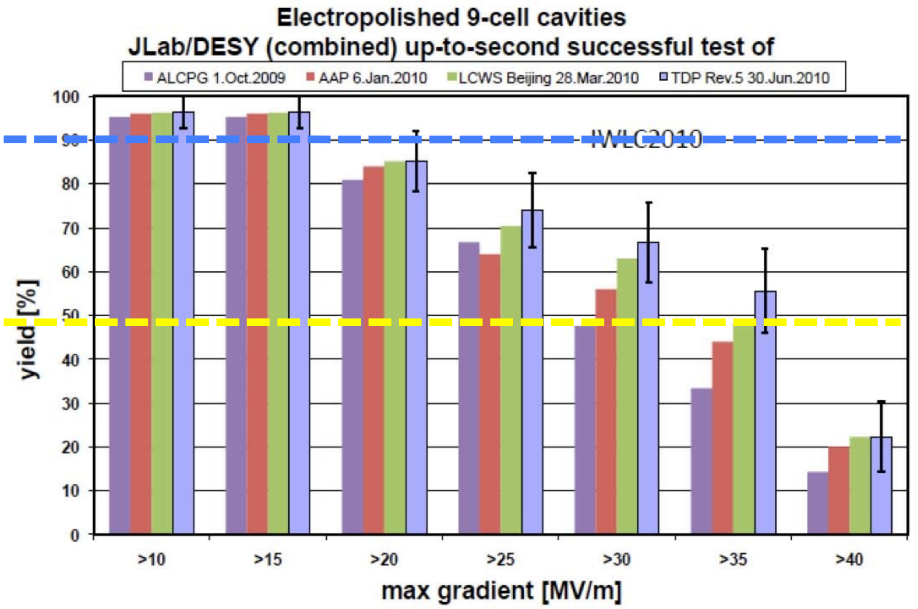
- **26-30 September 2011**
- **Joint CLIC / GDE Workshop**
  - Prepare for European Strategy for PP mid 2012
  - CLIC will indicate by Spring 2012 the CLIC cost in an energy band including 500 GeV up to an energy (1 to 2 TeV?)
  - ***Strong overlap with GDE (500 GeV to 1 TeV)***
- **Workshop to be planned 'jointly'**
- **From GDE:**
  - Goals and agenda to help prepare for ESPP

SCRF R&D
Mass production models and cost

Production Yield - Progress



1st pass



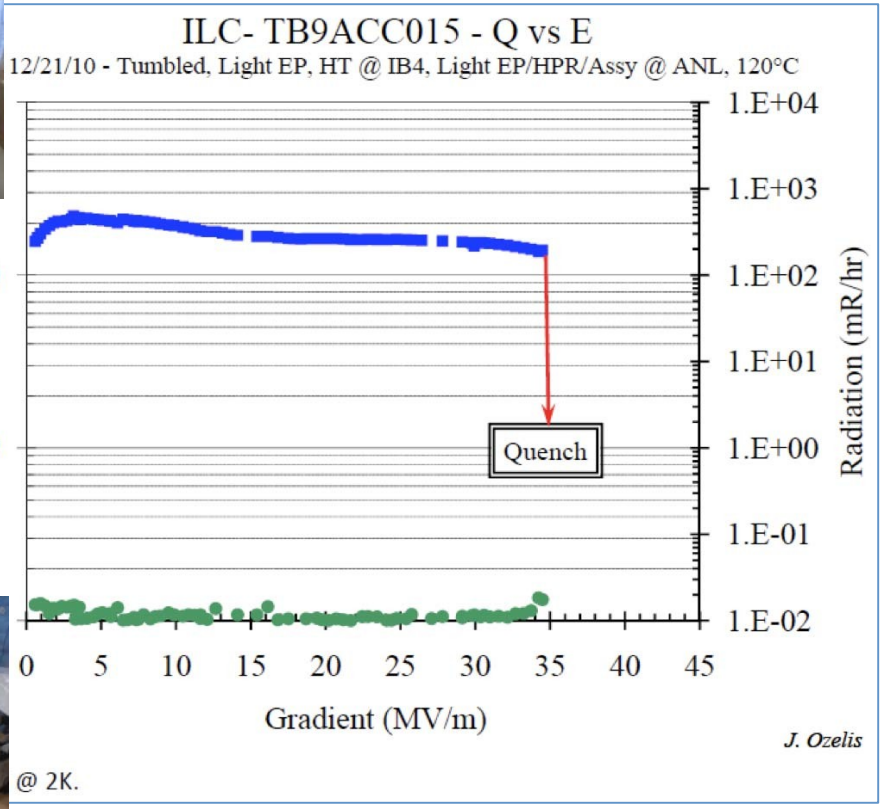
2st pass

Only contains: 2 vendors + 2 infrastructure (DESY, JLAB)

Next update:
Additional Japan vendor + 2 infrastructure (KEK, FNAL/ANL)

B. Kephart / C. Cooper / J. Ozelis/

TB9ACC015: Tumbled at FNAL
Reached E = 34.5 MV/m, Q = 1.4E10



Process	At
Tumbling, 6 steps, 150 μm	FNAL
Light EP	FNAL/ ANL
HT, 800C, 3h	FNAL
Light EP, 5μm HPR Ass'y	FNAL/ ANL
Baking 120C, 64h	FNAL

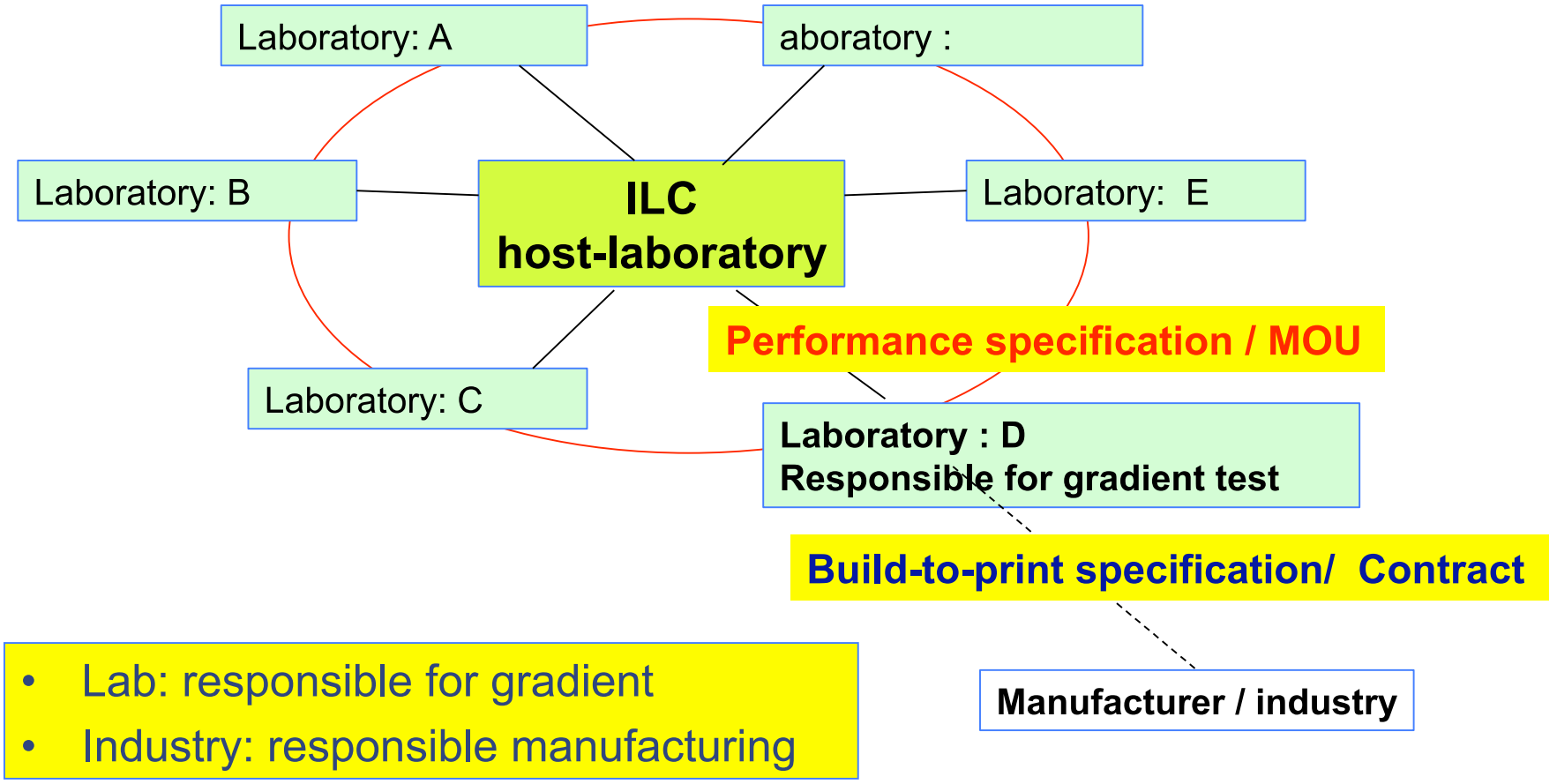
R&D towards possible cost reduction

Progress in the 3rd batch production at MHI (No. 12 ~ 22) processed at KEK

Test Date	Name of cavity	Process Cycle	E-max [MV/m]	Q0 at E-max	Q0 at 35 MV/m	Project
2010/11/11	**MHI-12**	1st	**37.5**	5.4E9	7E9	Q. B. / Injector
2010/12/18		2nd	**40.7**	6.18E9	1E10	
2010/11/25	**MHI-13**	1st	**36.2**	7.5E9	9E9	Q. B. / Injector
2010/12/22		2nd	32.2	8.75E9	---	
Plan in 2011	MHI-14	1st, 2nd,				STF2, CM1
	MHI-15	1st, 2nd,				STF2, CM1
	. . .	. . .				
	MHI-22	1st, 2nd,				STF2, CM1

An Industrialization Model and Responsibility

A. Yamamoto



- Lab: responsible for gradient
- Industry: responsible manufacturing

Plan for Visiting Vendor

No.	Date	Company	Meeting Place	Technical sbject	Notes
1	2/8	Hitachi	Hitachi / Tokyo	Cavity & Cryomodule	
2	2/8	Toshiba	Toshiba / Tokyo	Cavity & Cryomodule	
3	2/9	MHI	MHI / Kobe	Cavity & Cryomodule	
4	2/9	Tokyo Denkai	TD / Tokyo	Nb Material / Sheet	
5	2/18	NingXia, OTIC	OTIC / NingXia	Nb Material / Sheet	
6	3/3	Zanon	INFN / Milano	Cavity & Cryomodule	
7	3/4	RI	RI, Koeln	Cavity & Cryomodule	
	TBD	Heraeus/Plansee	EU	Material	
8	3/14	AES	AES,	Cavitu & Cryomodule	
9	3/15	Niowave	Niowave	Cavity & Cryomodule	
10	/16	PAVAC	PAVAC	Cavity & Cryomodule	
	3/17	Wah-Chang	In Oregon	Nb Material / Sheet	

postponed!

GDE members: PMs, and RDs / Cost-experts / Experts from Lab (shared regionally)

Cost Estimation - SRF

- **Substantial SRF progress since TESLA cavity / Nb sheet cost studies (2000-2002)**
  - Gradient performance
  - Global expertise
  - XFEL contract
- **Issued five-point 'Request for Information' to 12+ vendors**
  - 2 March 2011 (basis XFEL specification)
  - http://www.linearcollider.org/GDE/Project-Managers/2011-Visit-to-SCRF-cavity-cryomodule-manufacturers
- **Expect direct responses May '11**

GDE – SRF Industry partnership

- **in lieu of (or together with) contracted in-depth studies: five-point request**
  1. Cost estimates, with breakdown, for 6 cases
     (one absolute (with breakdown); other 6 relative)
  2. Factory siting recommendation
  3. Project / industry shared responsibilities
  4. Deliverables
  5. Consortium (multi-industry / lab) recommendation

- **to be discussed and received in time for PAC review (Taipei, 19-20.05)**

- **Satellite meeting – SRF 2011 Chicago (24.07)**

Schedule: Cost Estimation SRF

- **PAC summary** **05/11.2011**
- **SRF 2011** **07.2011**
- **Preliminary analysis** **12.2011**
- **TDR Tech Baseline review** **early 2012**

- **Issues:**
  - Extrapolation to realistic production models
  - Balancing multiple production models
  - Providing a link to the RDR cost

PAC Report (11.2010)

- **ILCSC Project Advisory Committee**
  - L. Evans, Chair

"chemistry is under control" "if material and welds are good … cavities are good"

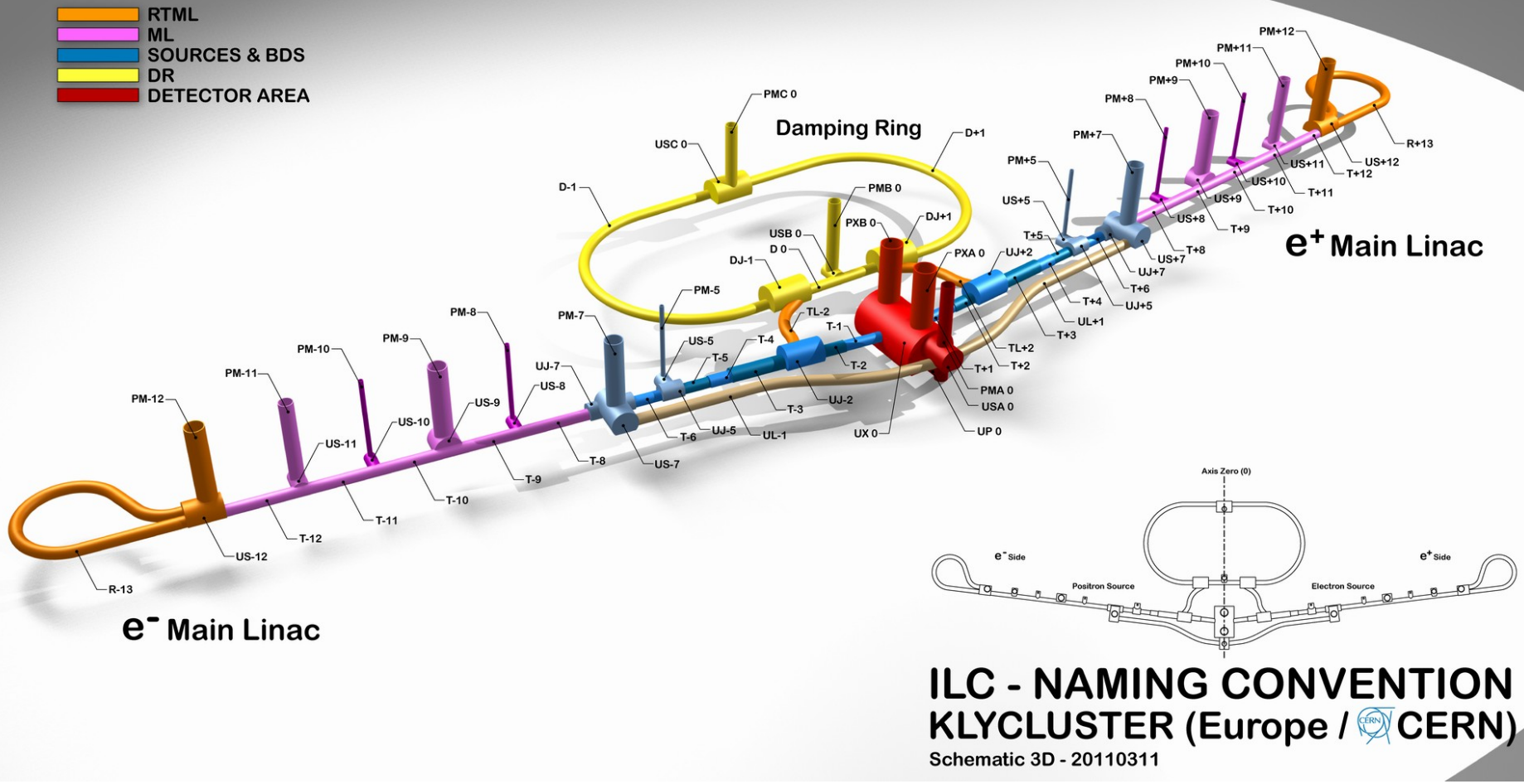
"big strides" :- Automate the process to get 100% yield

"policy for industrialization will govern the R&D"

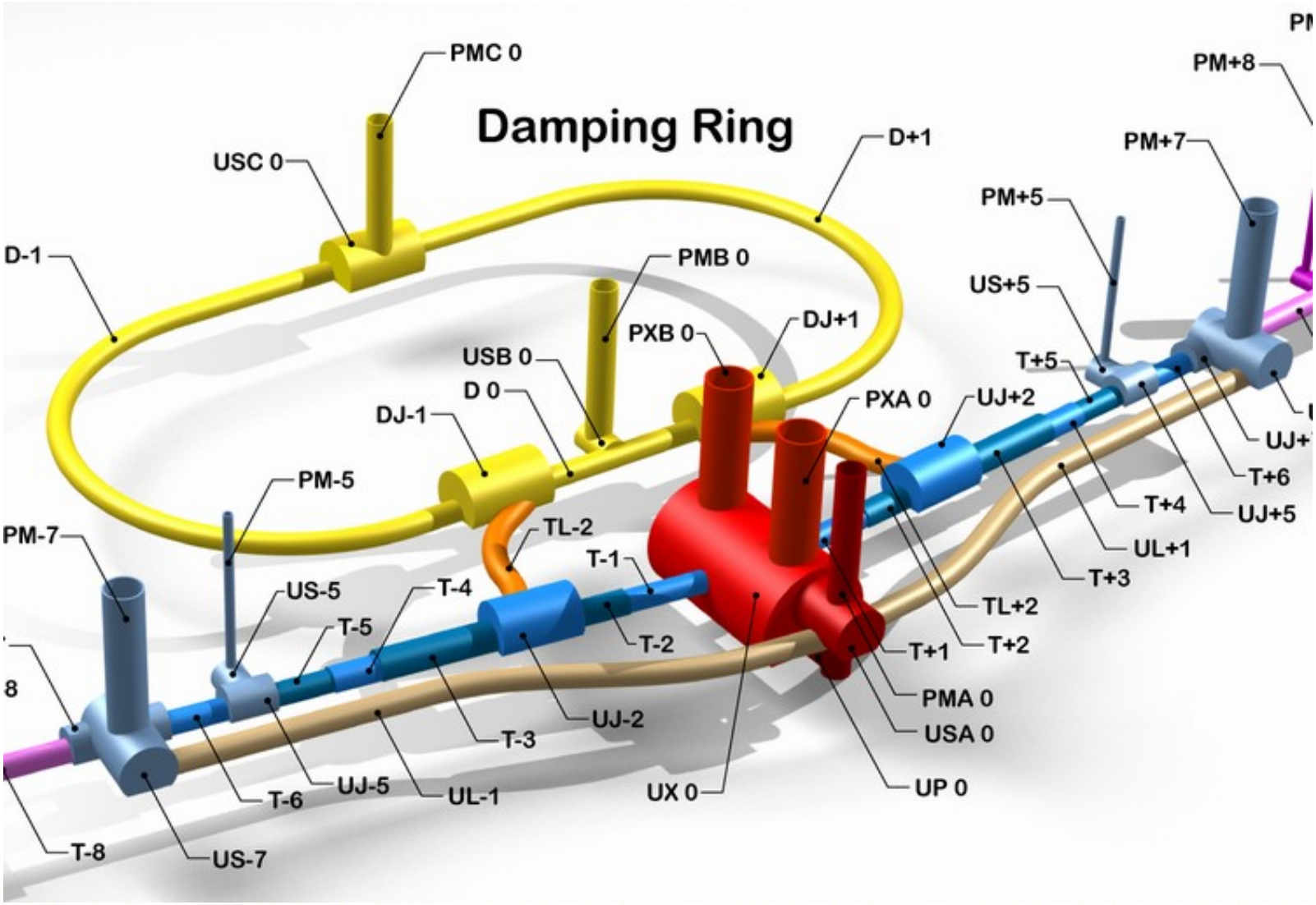
"not so positive for cryomodule…"
field emission remains a problem

CFS – the other cost driver

Ready to build…?



Central Region

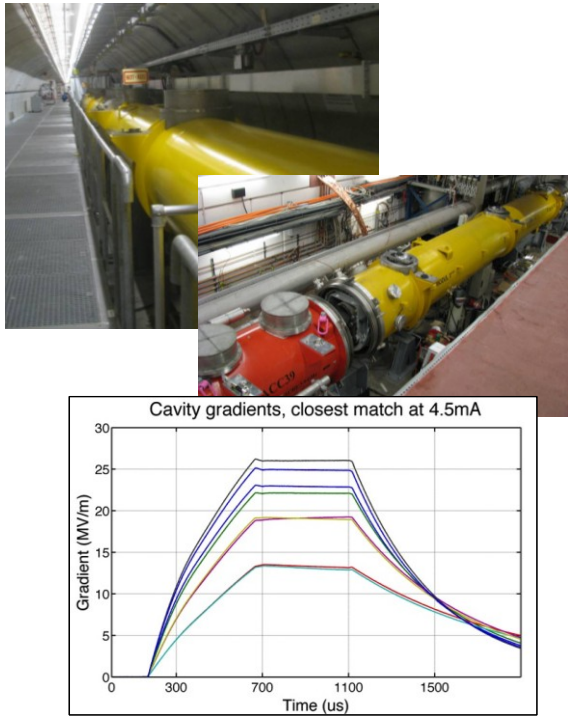


Beam Test Facilities

Beam Test Facilities

- **TTF/FLASH (SCRF linac beam tests)**
- **CesrTA (Electron Cloud and low-emittance)**
- **ATF/ATF2 (Damping ring and FFS)**

• ATF/ATF-2 (KEK)

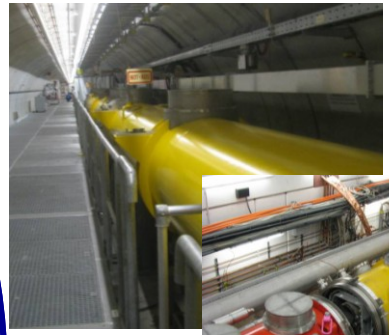


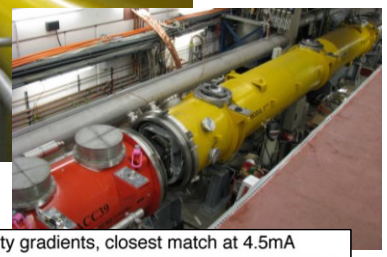
TTF/FLASH (DESY)

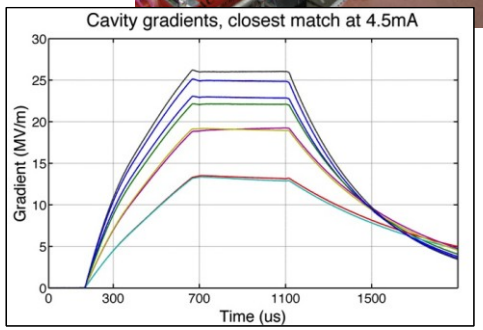
• CesrTA (Cornell)

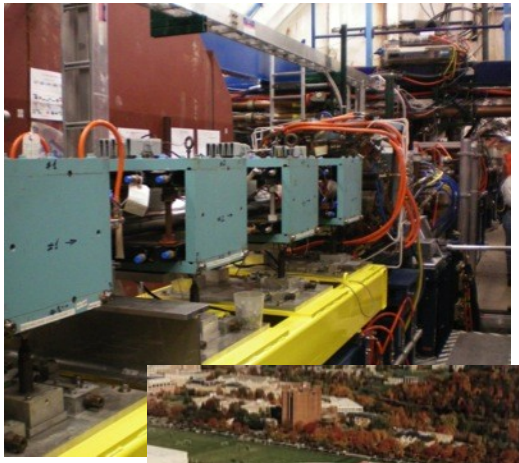
Beam Test Facilities

- **TTF/FLASH (SCRF linac beam tests)**
- **CesrTA (Electron Cloud and low-emittance)**
- **ATF/ATF2 (Damping ring and FFS)**







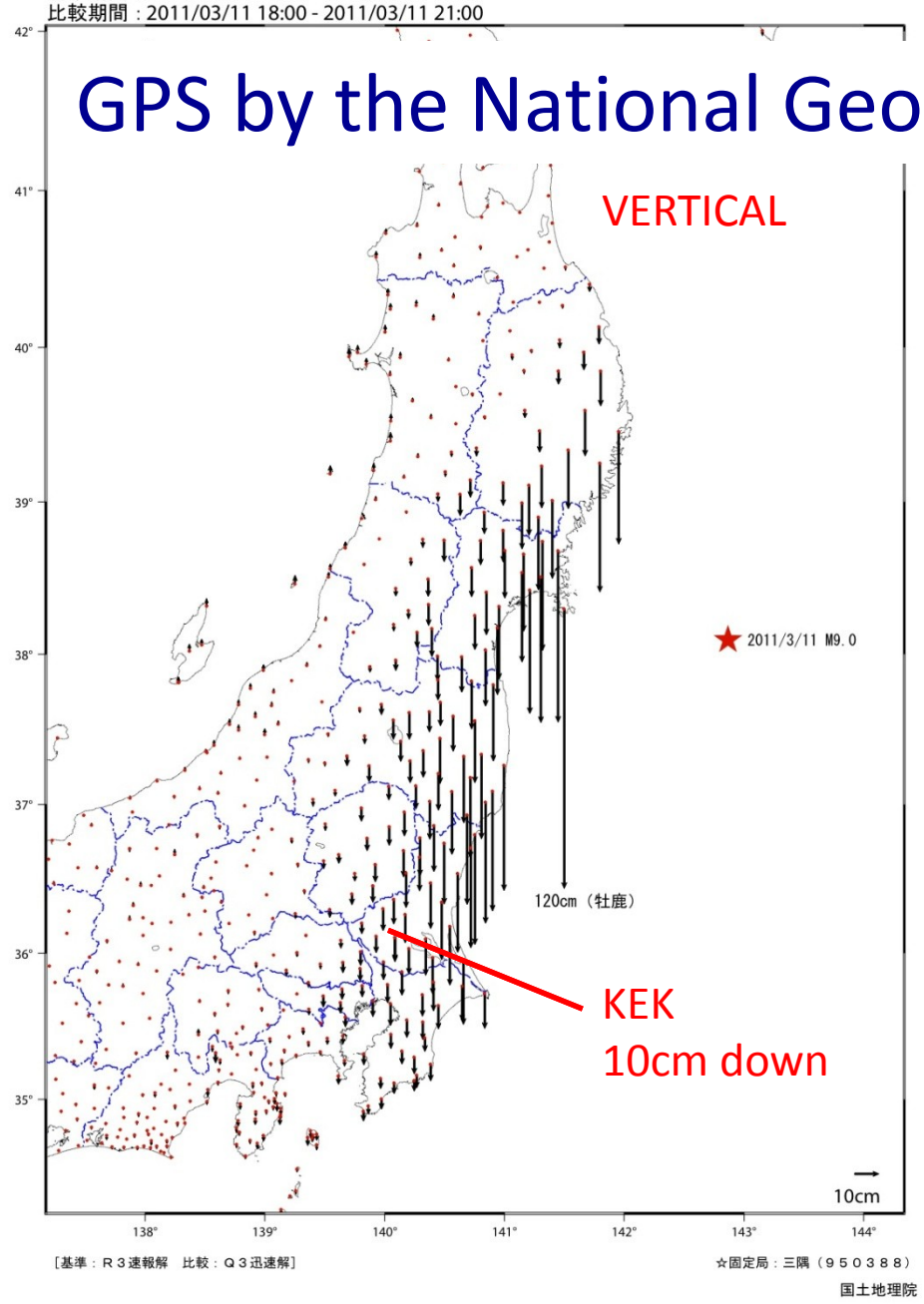


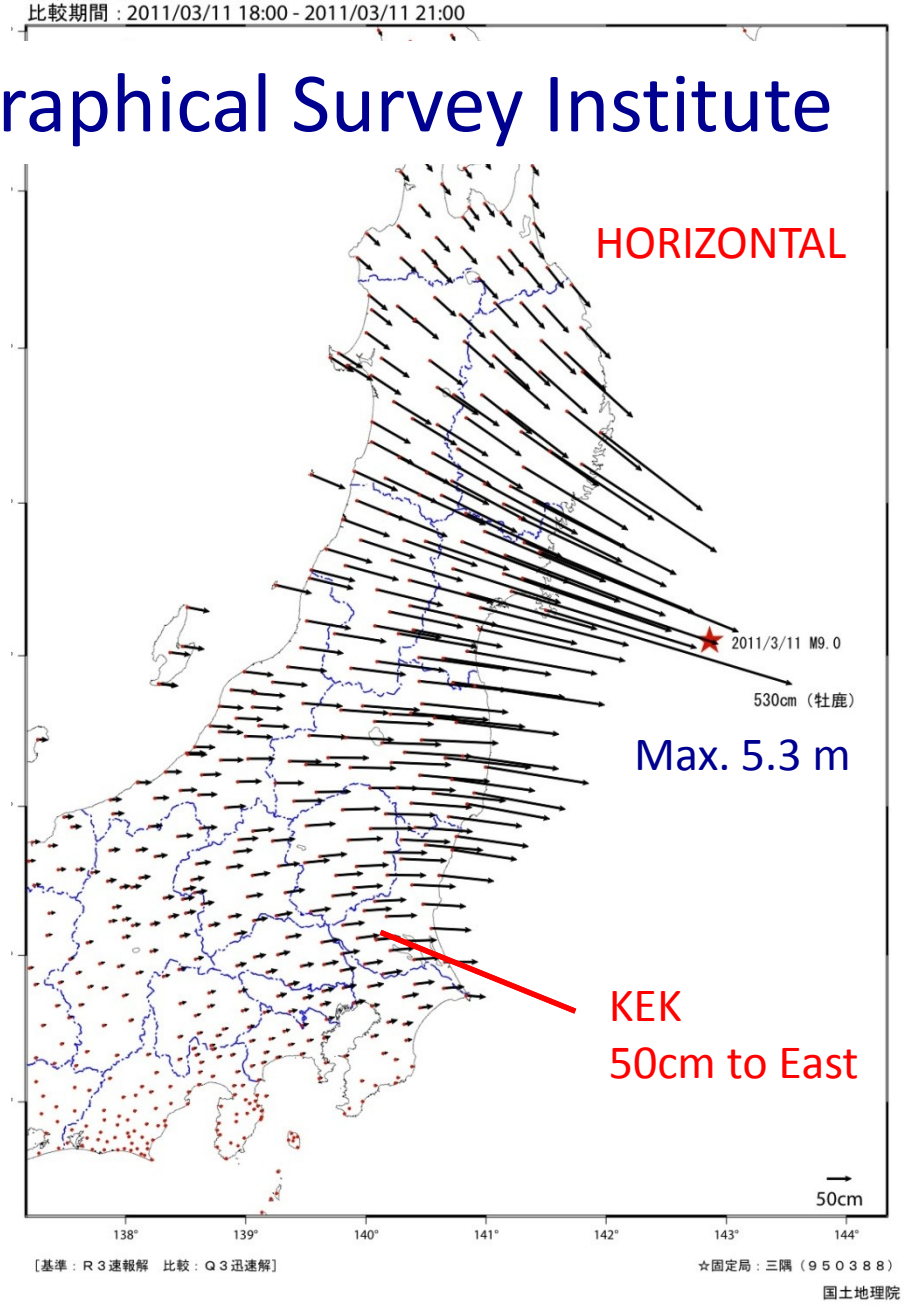
- ATF/ATF-2 (KEK)

TTF/FLASH (DESY)

- CesrTA (Cornell)

GPS by the National Geographical Survey Institute

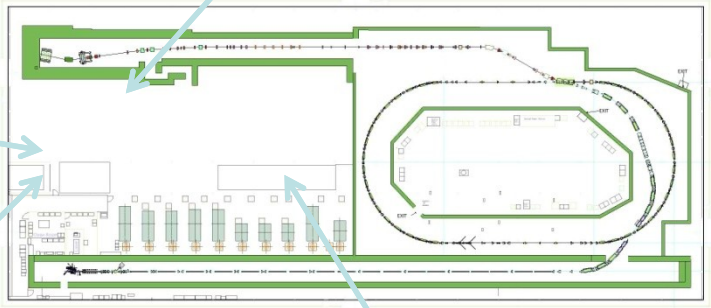




Facility Damages

Main power cables for the ATF building

Not well fixed blocks.



ATF/ATF2 Outlook

- **FORTUNATEY – damage appears mostly superficial**
  - infrastructure remains intact
- **However, damage assessment continues. Still much to repair!**
- **ATF2 would have run for another 2 months until summer shutdown**
  - restart in October 2011
- **Most optimistic: Fall of 2011 (??)**

In Summary

In Summary (1/2)

- **GDE working towards successful completion of its mandate**
- **TD Phase 2 now underway**
- **2011**
  - final outstanding baseline decisions
  - SCRF & CFS Cost estimation
  - TeV upgrade study
- **2012**
  - Design and cost consolidation
  - Write the TDR

In Summary (2/2)

- **Identification of R&D beyond 2012**
  - SCRF test infrastructure
  - Ultra-high gradient R&D
  - Beam Test Facilities
  - …

- **LHC – outstanding progress! Guaranteed to have many answers in 2013**

We must – and will be – prepared ☺

- **See you at LCWS'11 – Granada – Sept 2011**