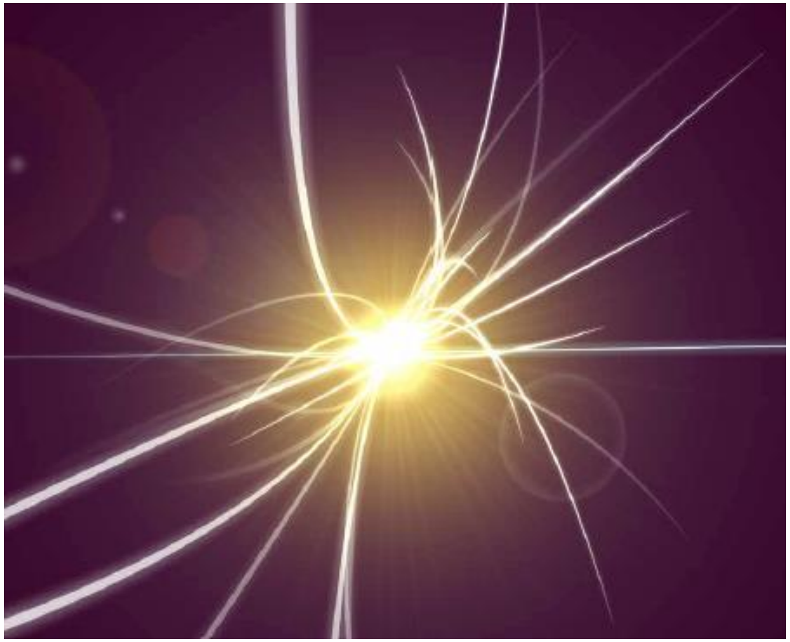
GDE

The path to a TDR



Barry Barish

ECFA LC2013

DESY Hamburg, Germany

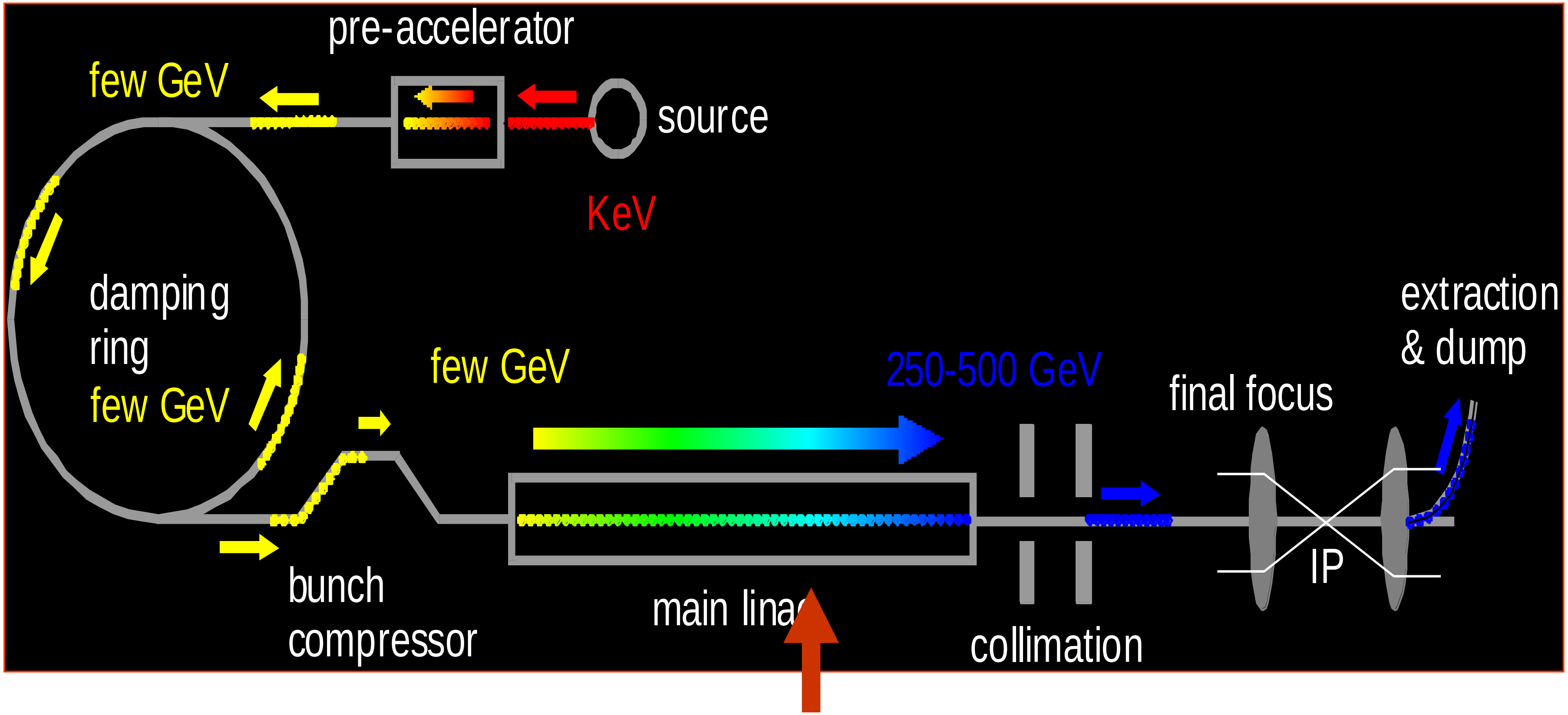
27-May-13

A Global Initiative for an ILC

International Committee for Future Accelerators (ICFA) representing major particle physics laboratories worldwide.

- Chose ILC accelerator technology (SCRF)
- Determined ILC physics design parameters
- Formed Global Design Effort and Mandate (TDR)

GDE -- Design a Linear Collider



Superconducting RF
Main Linac

ILCSC/ICFA Parameters Studies

physics driven input

Key Parameters

- **Luminosity → $\int L dt$ = 500 fb^{-1} in 4 years**
- **E_{cm} adjustable from 200 – 500 GeV**
- **Ability to scan between 200 and 500 GeV**
- **Energy stability and precision below 0.1%**
- **Electron polarization of at least 80%**

Options

- **The machine must be upgradeable to 1 TeV**
- **Positron polarization desirable as an upgrade**

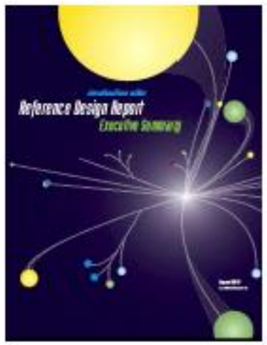
RDR Design Parameters

Max. Center-of-mass energy	500	GeV
Peak Luminosity	~$2x10^{34}$	$1/cm^2s$
Beam Current	9.0	mA
Repetition rate	5	Hz
Average accelerating gradient	31.5	MV/m
Beam pulse length	0.95	ms
Total Site Length	31	km
Total AC Power Consumption	~230	MW

Reference Design - 2008

RDR Reports

- Reference Design Report (4 volumes)



Executive Summary

Physics at the ILC

Accelerator

Detectors

11-Feb-08
ILCSC

Global Design Effort

5

Major R&D Goals for Technical Design

SCRF

- **High Gradient R&D - globally coordinated program to demonstrate gradient by 2010 with 50%yield; improve yield to 90% by TDR (end 2012)**
- **Manufacturing: plug compatible design; industrialization, etc.**
- **Systems tests: FLASH; plus NML (FNAL), STF2 (KEK) post-TDR**

Test Facilities

- **ATF2 - Fast Kicker tests and Final Focus design/performance EARTHQUAKE RECOVERY**
- **CesrTA - Electron Cloud tests to establish damping ring parameters/design and electron cloud mitigation strategy**
- **FLASH – Study performance using ILC-like beam and cryomodule (systems test)**

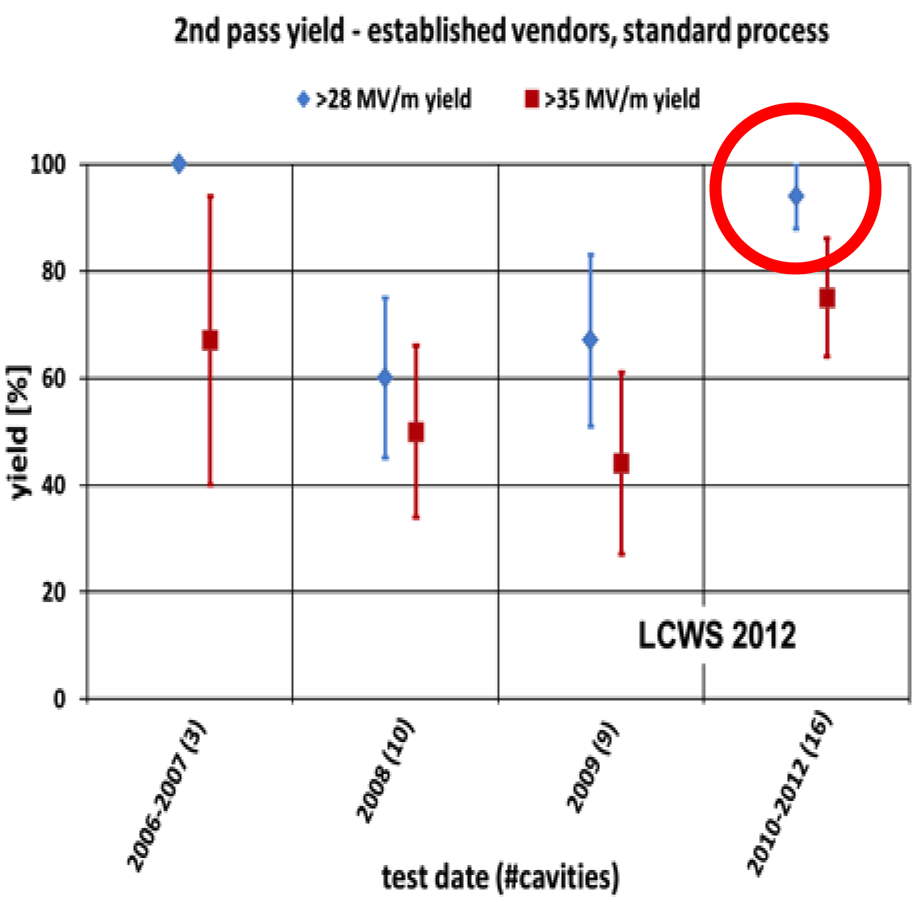
Globally Coordinated SCRF R&D

Figure 1.2-1: A TESLA nine-cell 1.3 GHz superconducting niobium cavity.

- Achieve high gradient (35MV/m); develop multiple vendors; make cost effective, etc

- Focus is on high gradient; production yields; cryogenic losses; radiation; system performance

Progress in Cavity Gradient Yield



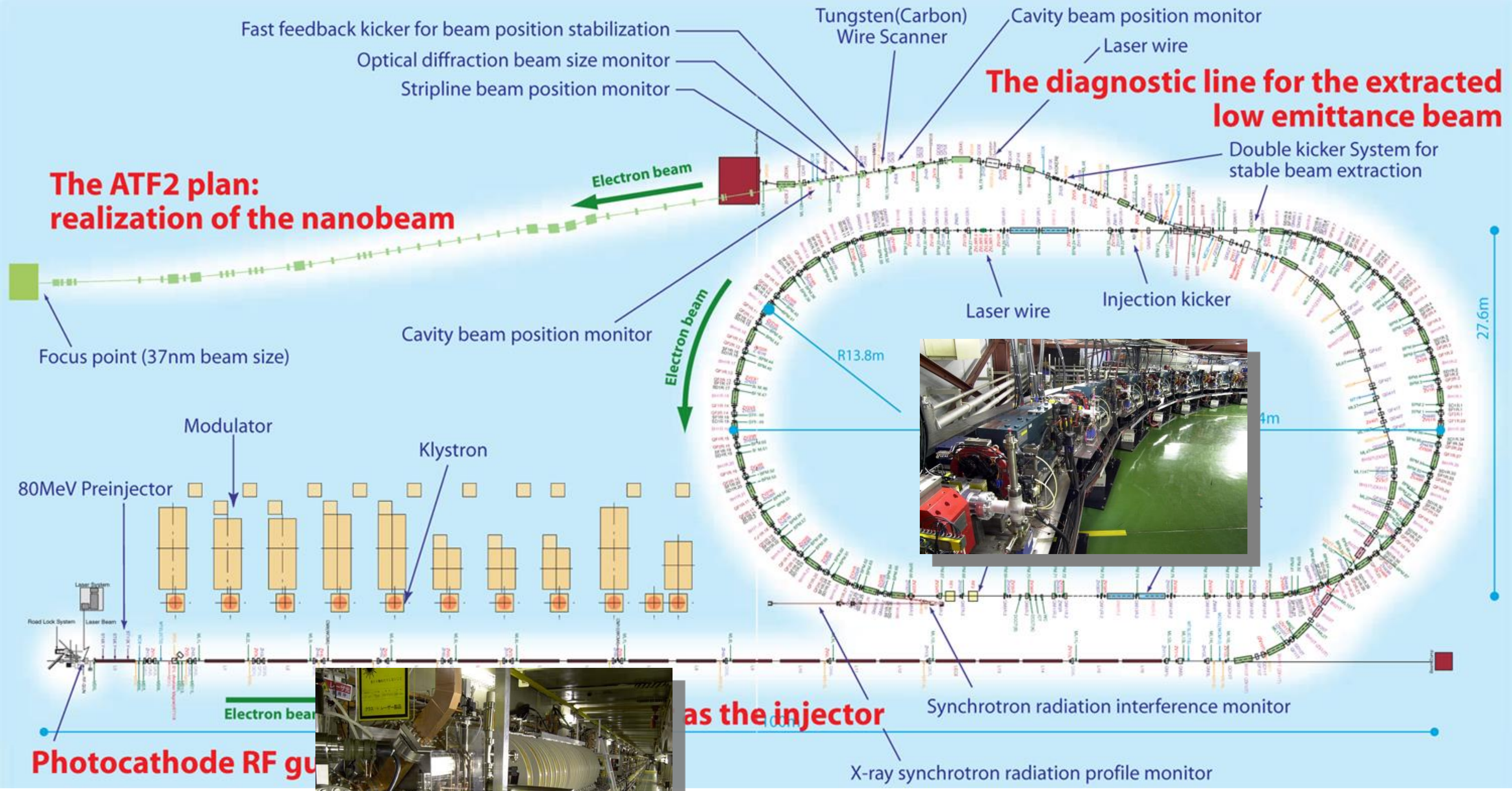
Production yield:
94 % at > 28 MV/m,

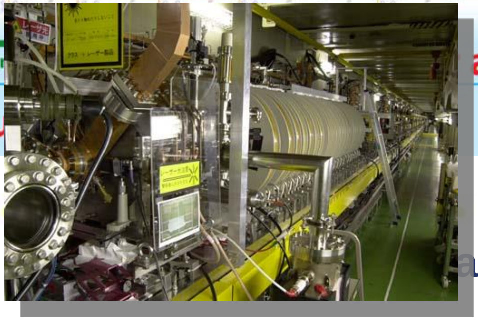
Average gradient:
37.1 MV/m

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 string assembly and test** (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		**FLASH (DESY) , NML/ASTA (FNAL) QB, STF2 (KEK)**				
Preparation for Industrialization			**Production Technology R&D**			
Communication with industry:	1^{st} Visit Vendors (2009), Organize Workshop (2010) 2^{nd} visit and communication, Organize 2^{nd} workshop (2011) 3^{rd} communication and study contracted with selected vendors (2011-2012)					

Accelerator Test Facility (ATF)



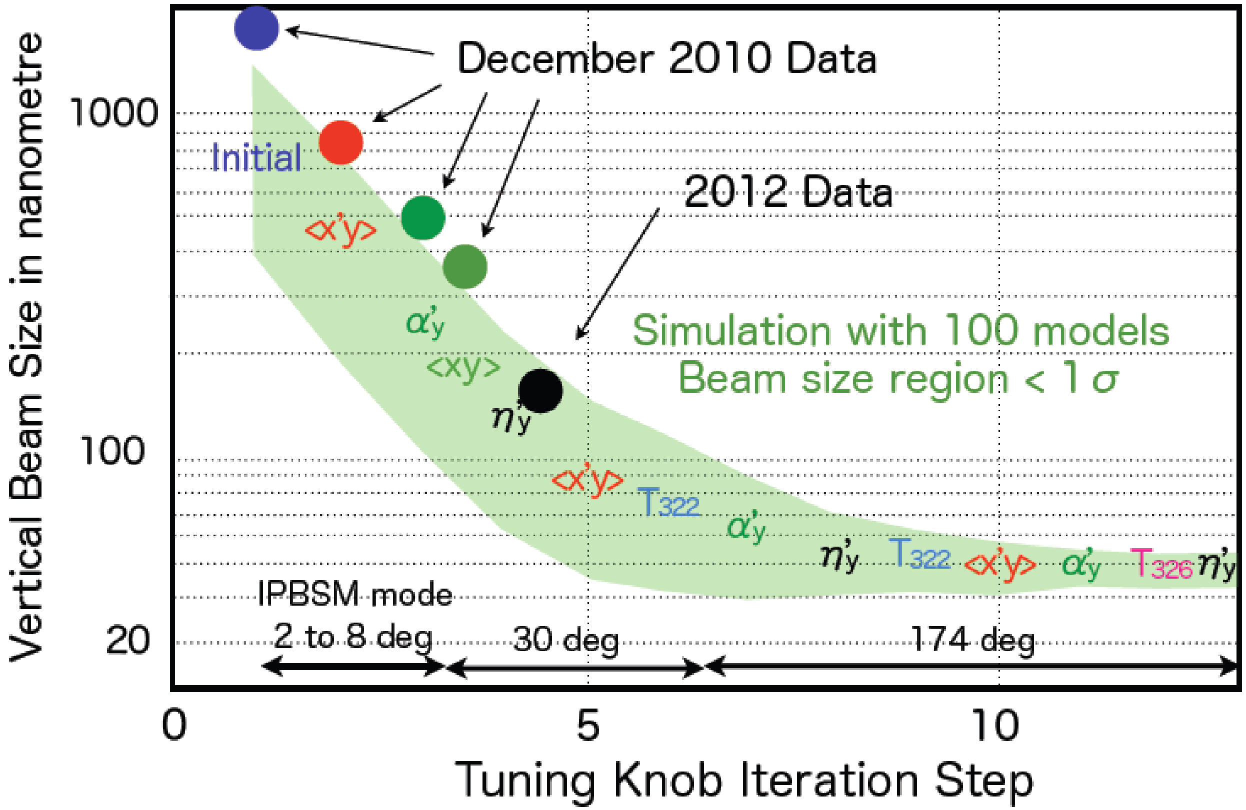


PAC Review -- Response to #2

"The lack of progress towards the 37 nm ATF2 IP goal is a concern. Several issues have already been resolved, and the currently scheduled modifications should lead to significant progress towards the goal."

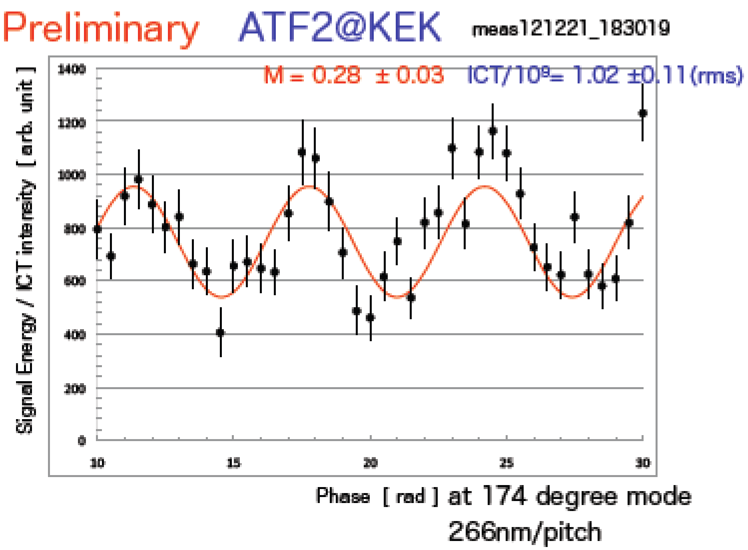
- This was slowed by the earthquake in Japan. Progress immediately following the technical review (see figure)
- We are instituting a technical review in May aimed at assessing technical status and proposing future goals and program needed for ILC.

ATF-2 earthquake recovery



- **Vertical beam size (2012) = 167.9 plus-minus nm**
- **1 sigma Monte Carlo**
- **Post-TDR continue to ILC goal of 37 nm + fast kicker**
- **Stabilization studies**

ATF-2 achieves 72.8 nm



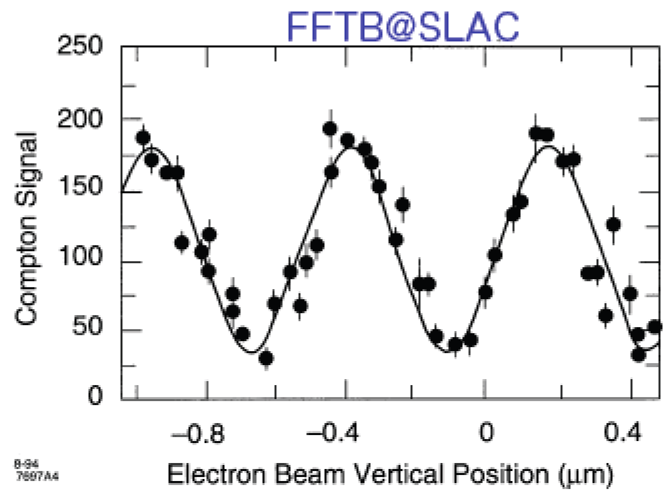
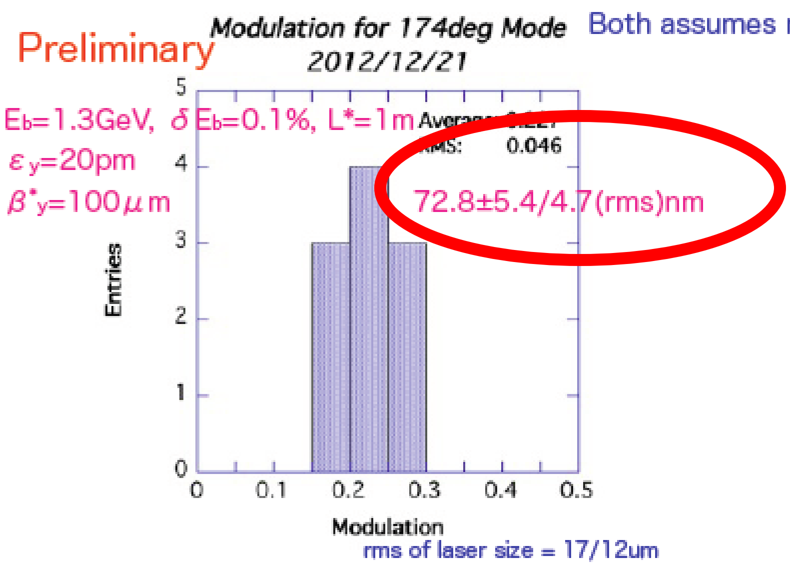


Figure 5.6: Laser-Compton beam size measurement performed in May of 1994. The measured size is 77±7 nanometers.

Both assumes no modulation reduction



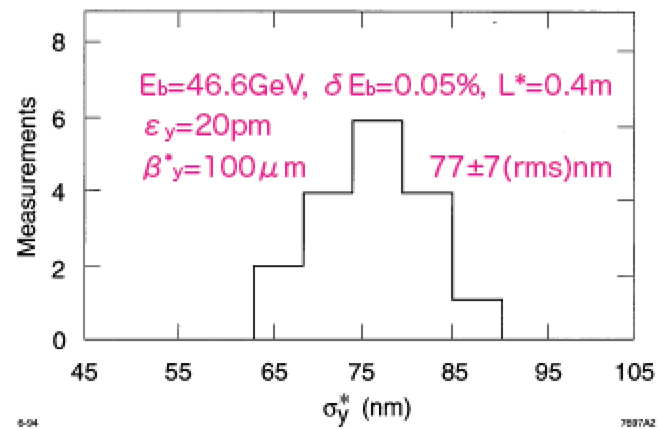
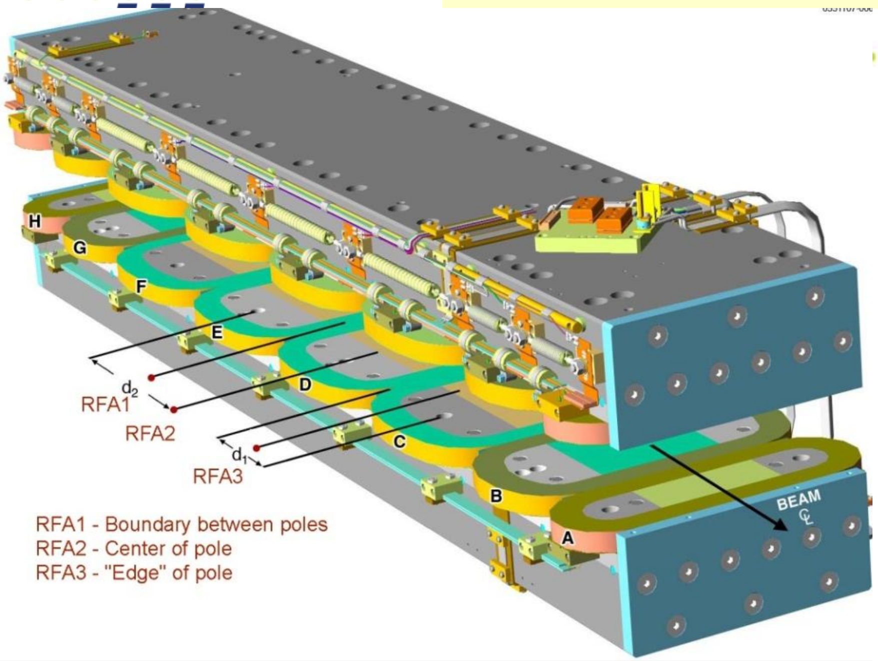
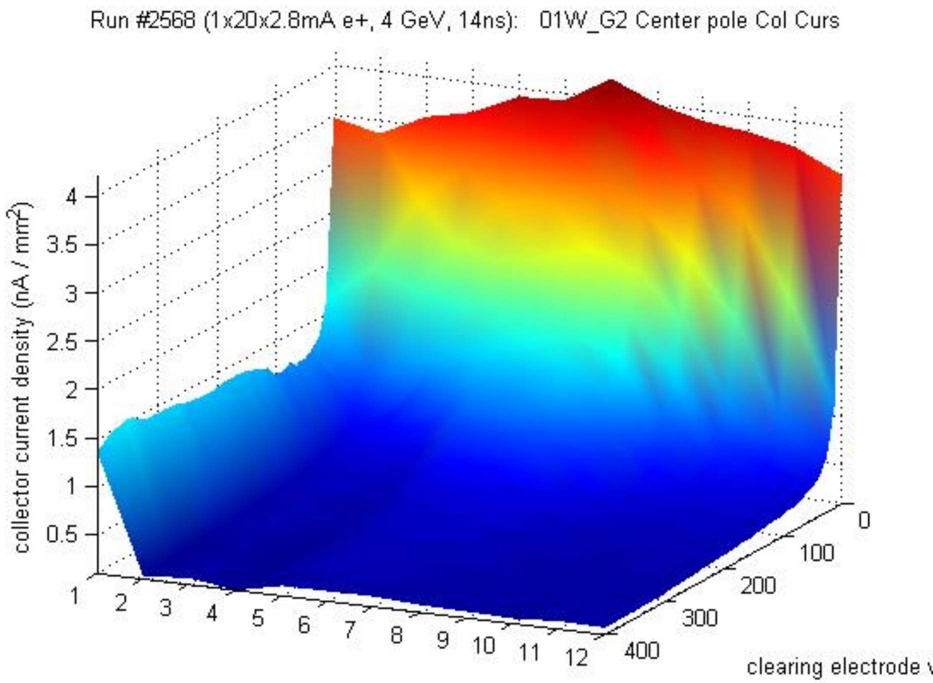


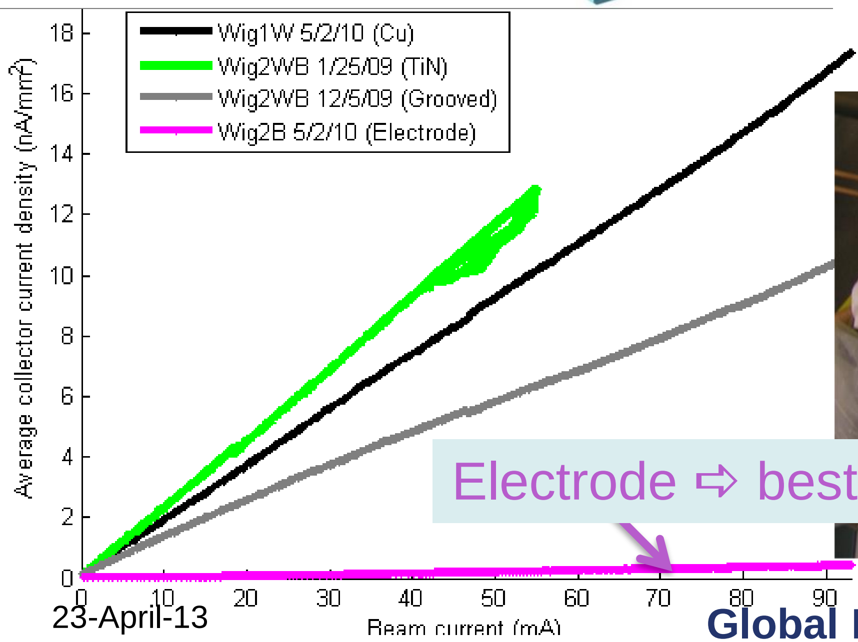
Figure 5.7: Histogram of measurements made during the last 3 hours of the May, 1994 FFTB run. Average size measured was 77 nm, with an RMS of 7 nm.

rms of laser size = 50um -> M reduction of 10%

CesrTA - Wiggler Observations







Electrode ⇨ best performance

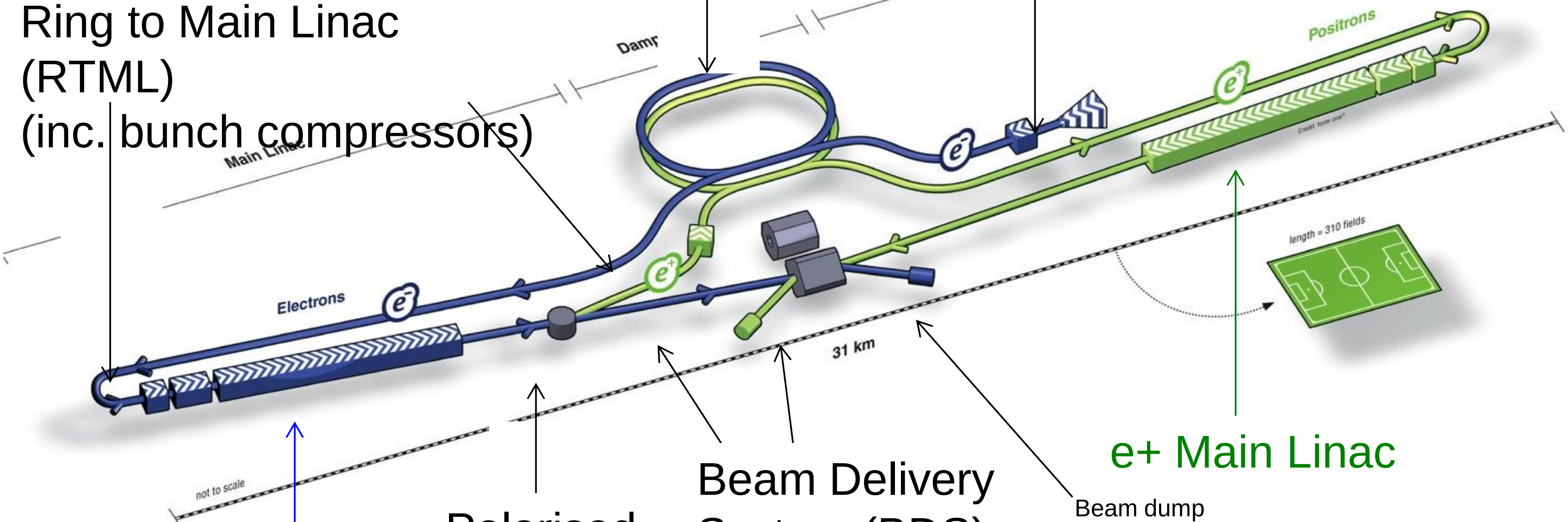
Baseline Mitigation Plan

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

ILC TDR Layout



Damping Rings

Polarised electron source

Ring to Main Linac (RTML) (inc. bunch compressors)

e- Main Linac

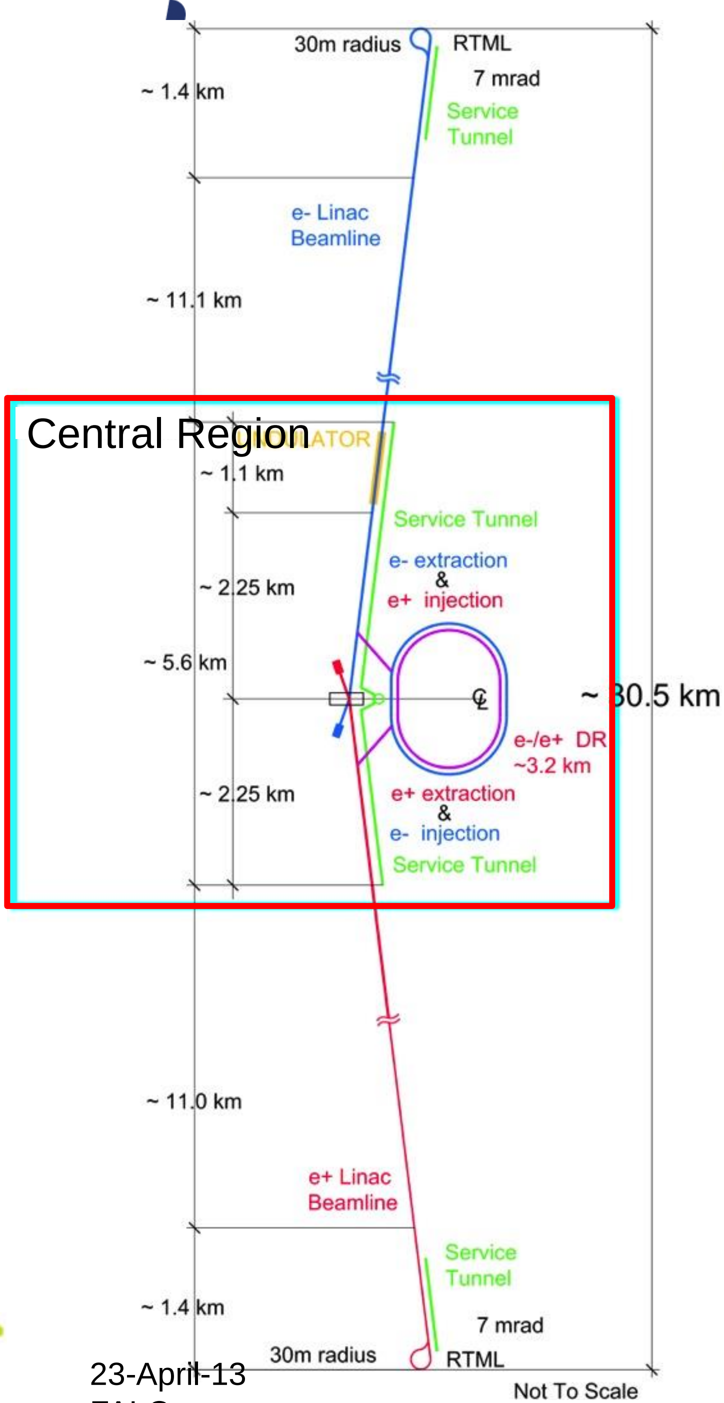
Polarised positron source

Beam Delivery System (BDS) & physics detectors

Beam dump

e+ Main Linac

not too scale

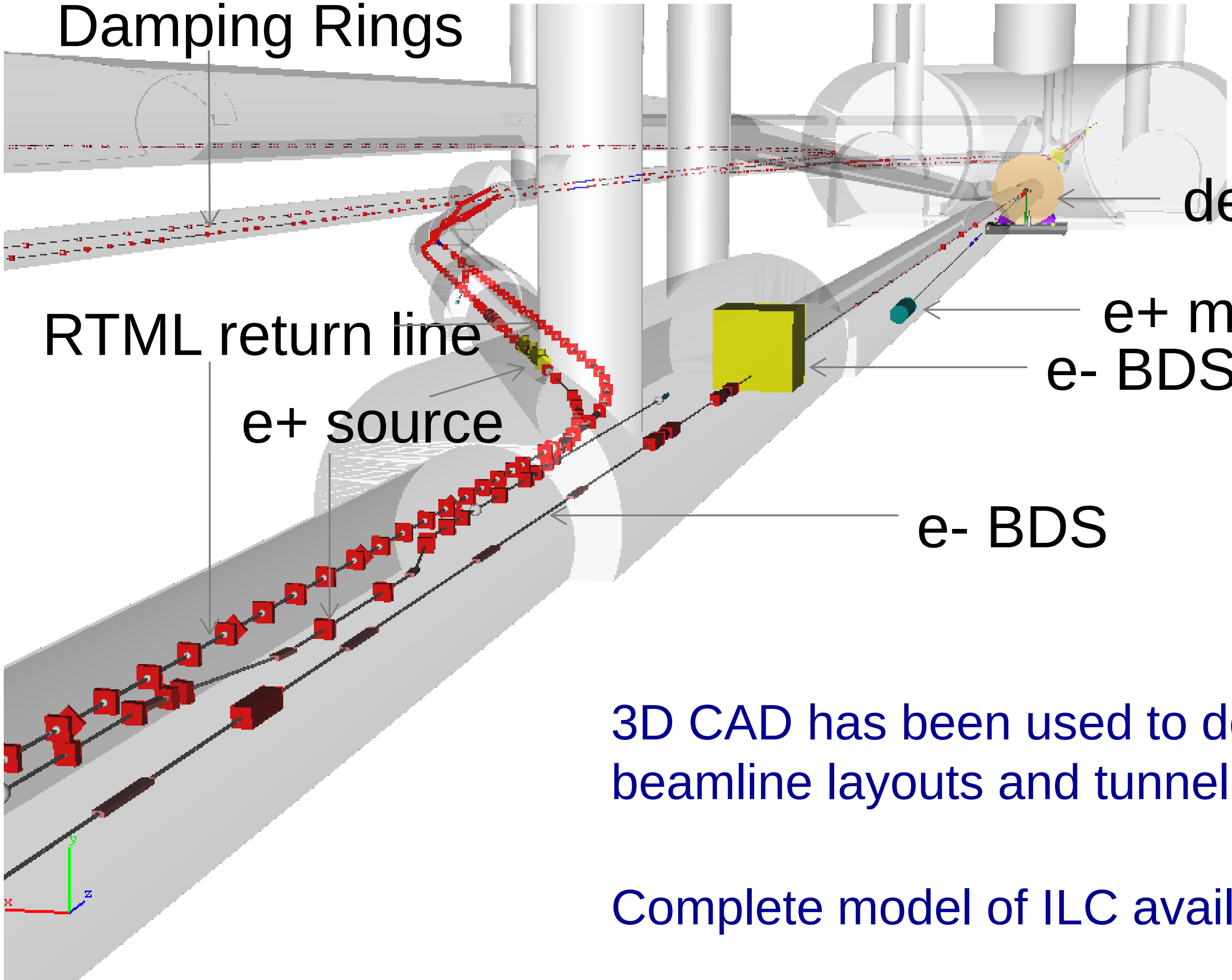


Central Region

- 5.6 km region around IR
- Systems:
  - electron source
  - positron source
  - beam delivery system
  - RTML (return line)
  - IR (detector hall)
  - damping rings

  } common tunnel
- Complex and crowded area

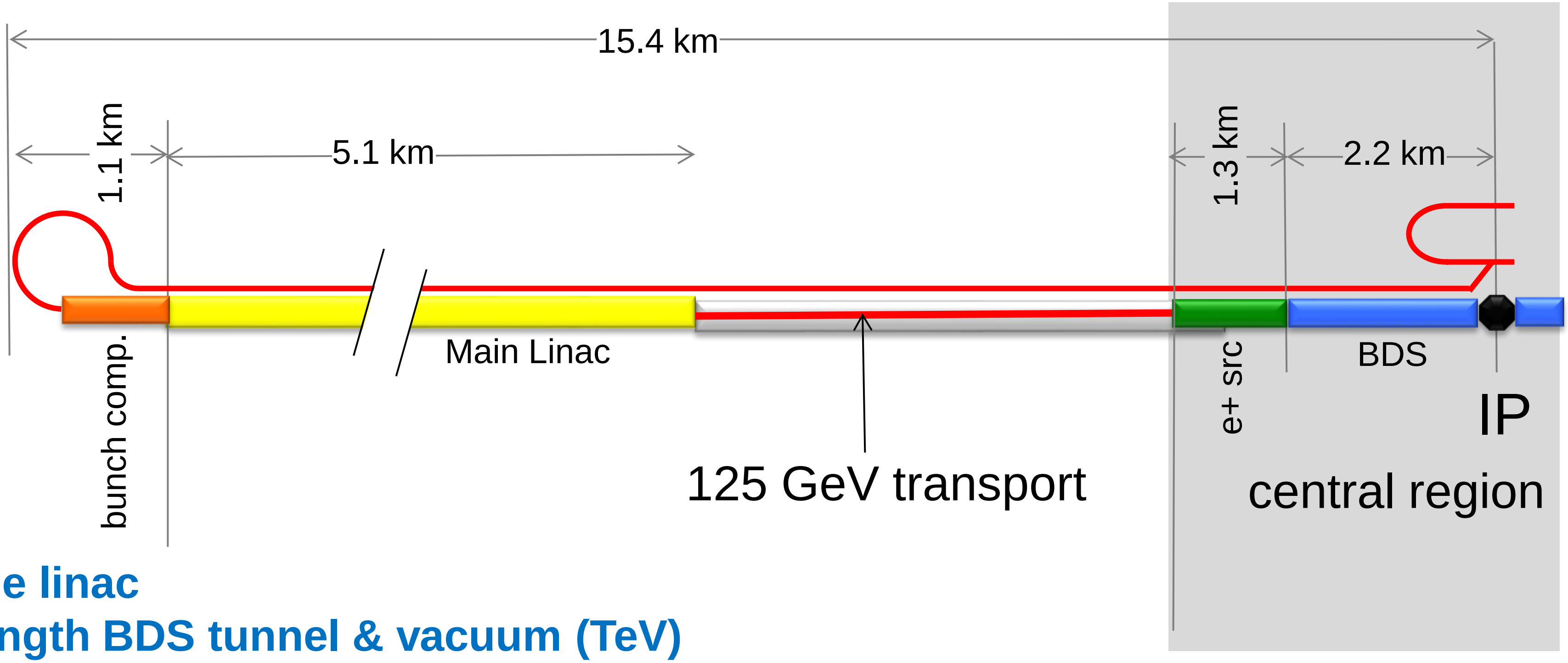
Central Region Integration



3D CAD has been used to developed beamline layouts and tunnel requirements.

Complete model of ILC available.

250 GeV – Staged ILC



Half the linac
Full-length BDS tunnel & vacuum (TeV)
½ BDS magnets (instrumentation, CF etc)
1 RTML LTL
5km 125 GeV transport line

Extended tunnel/CFS already 500 GeV stage

ILC TDR Value estimate

- The Value estimate for the cost of the ILC design as presented in the Technical Design Report, averaged over the three regional sites, is **7,780 MILCU (Jan 2012 US$) (TDR)**
- This may be compared with the escalated RDR estimate of **7,266 MILCU (RDR)**.
- The overall cost growth between the TDR and the RDR, not attributable to inflation, is thus 514 MILCU, i.e, **an increase of approximately ~ 7%.**

- The explicit Labor estimate for the ILC design as presented in the Technical Design Report, averaged over the three regional sites, is **22,613 thousand person-hours (TDR)**.
- This may be compared with the RDR estimate: **24,427 thousand person-hours (RDR)**

Draft Cost Review Report

- *In responding to the charge, the review team has assessed the overall quality of the design and the cost estimate and determined that it is sufficient to begin the preparatory activities for construction and to steer the future R&D program. The team has also come to the conclusion that the quality of the TDR and its associated cost document as well as the supporting documentation is sufficient to begin negotiations among contributing parties and government agencies to determine how to execute the project. As compared to other projects of similar scale (ITER, LHC, ATLAS, CMS, ALMA, XFEL, FAIR, ESS) the quality of the documentation presented by the GDE team is equal to or above those that were used to launch into a similar process. The TDR is a robust estimate for its intended purpose - and - as expected for an estimate at this stage, there is a substantial list of recommendations that should be addressed at an*

Final Remarks and Conclusions

- The TDR will complete the GDE mandate for the ILC .
- **Official release scheduled for 12 June 2013**.
- The major milestones of the R&D program have been achieved; and a detailed technical design for the ILC has been produced, including a new value costing
- The ILC is ready for the next steps: Selecting a site and host country; forming a collaborative international project; and entering into a final engineering design.