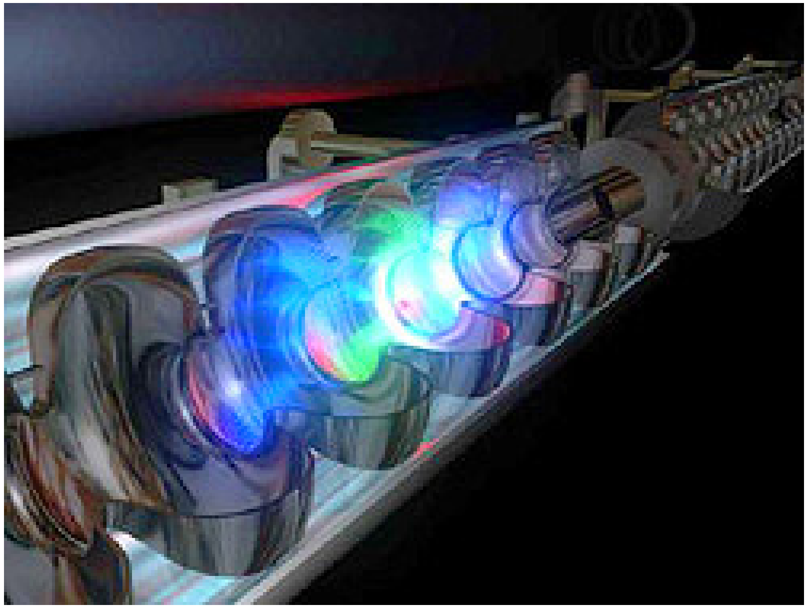
Summary of ILC-GDE



Barry Barish

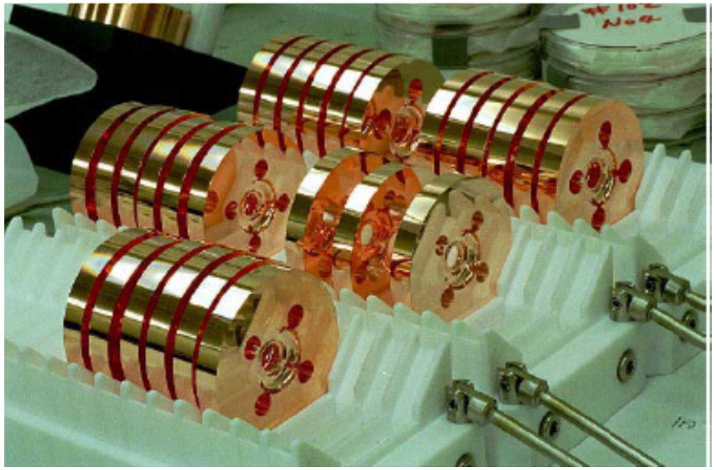
IPAC-13

Shanghai, China

13-May-13

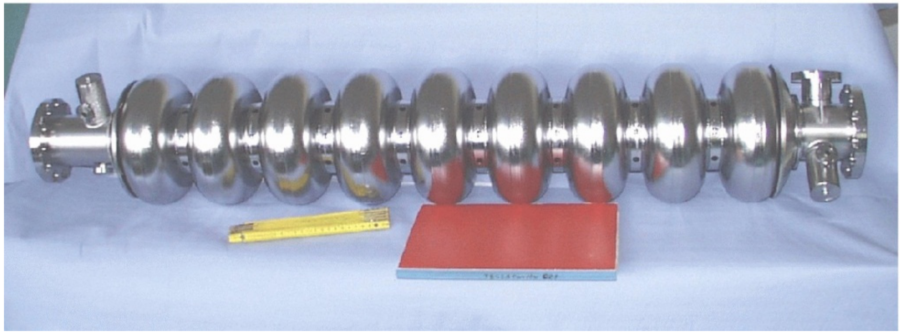
HEP Lab-driven R&D programs

- Room temperature copper structures (KEK and SLAC)



OR

- Superconducting RF cavities (DESY)



A Global Initiative for an ILC

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

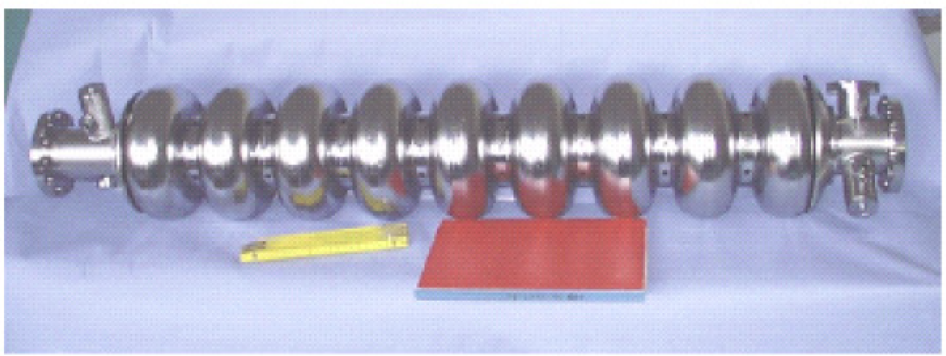
- Chose ILC accelerator technology (SCRF)
- Determined ILC physics design parameters
- Formed Global Design Effort and Mandate (TDR)

ITRP in Korea

International Technology Recommendation Panel Meeting
August 11 ~ 13, 2004. Republic of Korea

Particle Accelerator Conference
Knoxville, Tennessee, USA • May 16-20, 2005

Personal Perspectives on the ITRP Recommendation and on the Next Steps Toward the International Linear Collider



Barry Barish
PAC Annual Meeting
Knoxville, Tennessee
16-May-05

Why a TeV Scale?

- Two parallel developments over the past few years (the science & the technology)
  - The precision information e^+e^- and ν data at present energies have pointed to a low mass Higgs; Understanding electroweak symmetry breaking, whether supersymmetry or an alternative, will require precision measurements.
  - There are strong arguments for the complementarity between a ~0.5-1.0 TeV ILC and the LHC science.

ILCSC/ICFA Parameters Studies

physics driven input

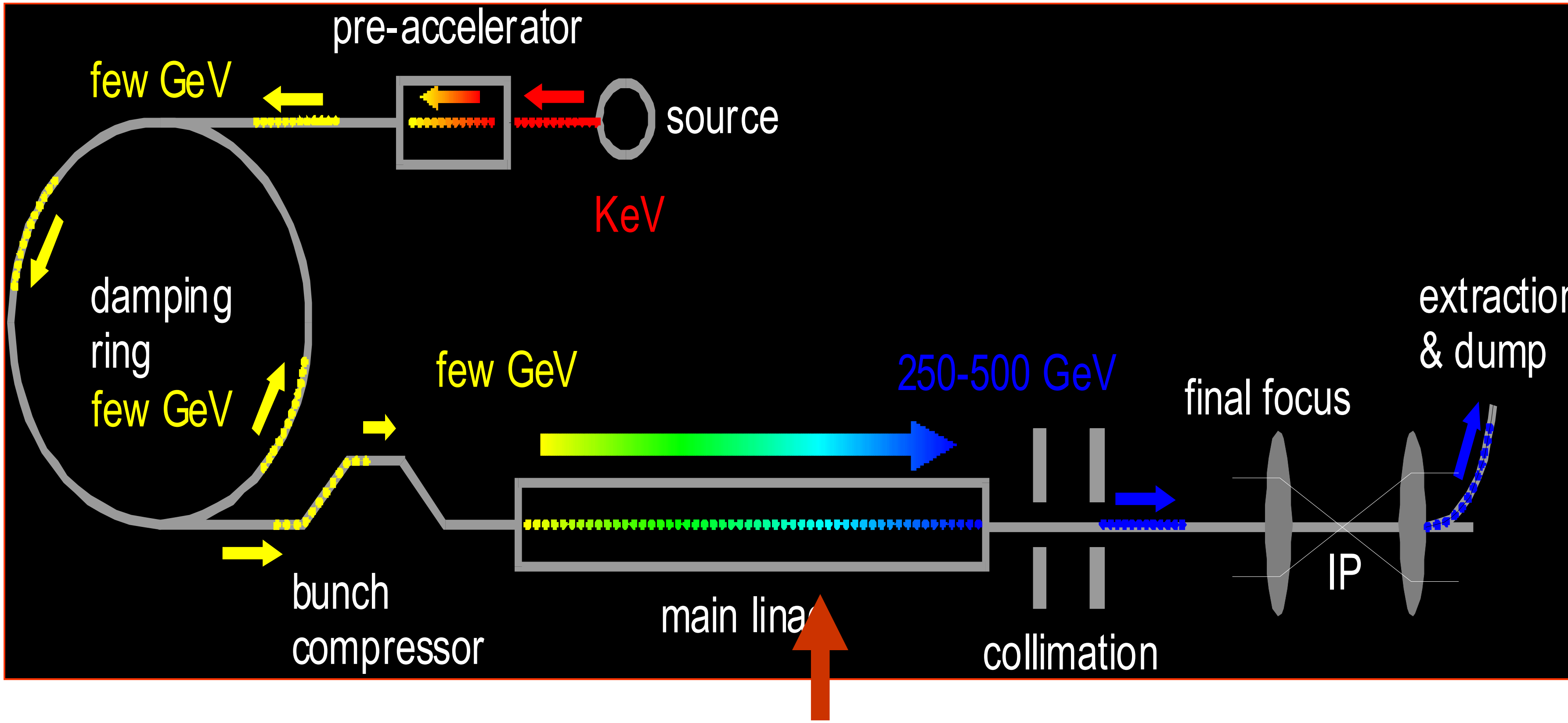
Key Parameters

- **Luminosity → $\int L\,dt = 500\ \mathrm{fb}^{-1}$ 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**

GDE -- Design a Linear Collider



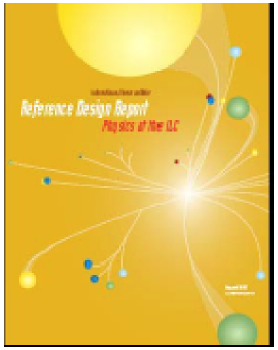
Superconducting RF Main Linac

Reference Design - 2008

RDR Reports

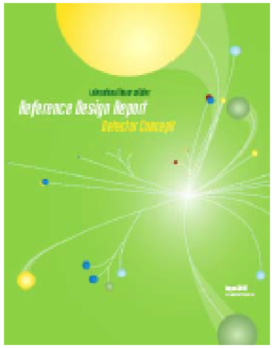
- Reference Design Report (4 volumes)

Executive Summary



Physics at the ILC

Accelerator



Detectors

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

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)**

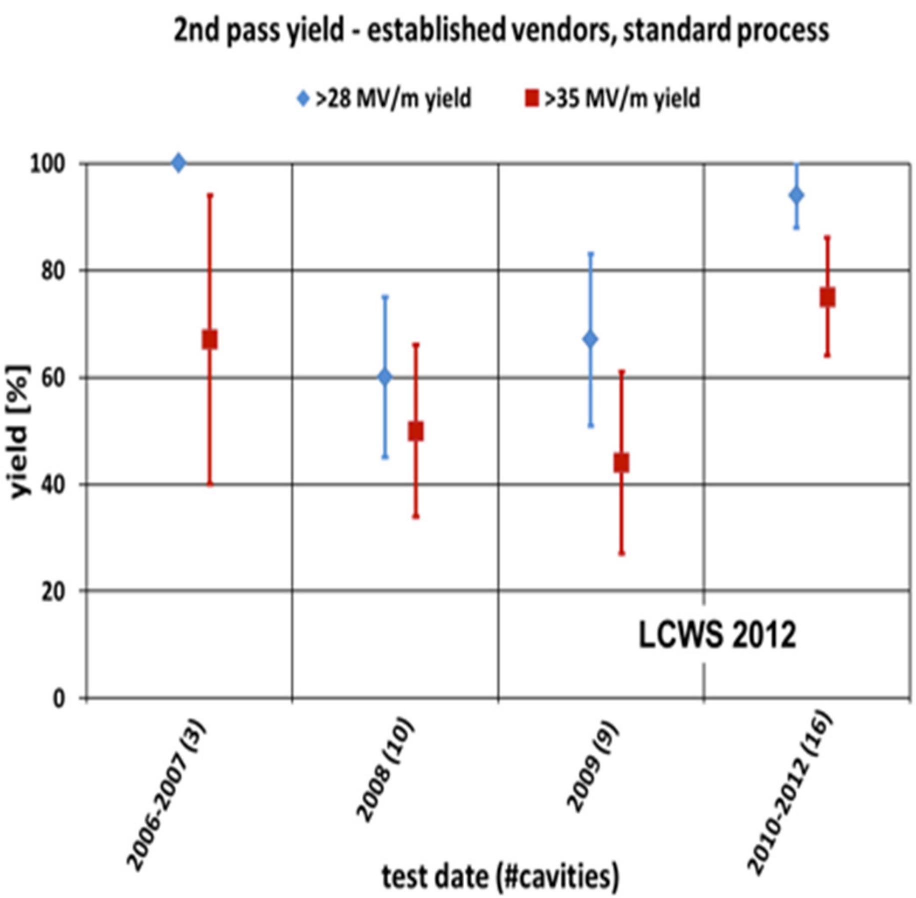
Globally Coordinated SCRF R&D

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



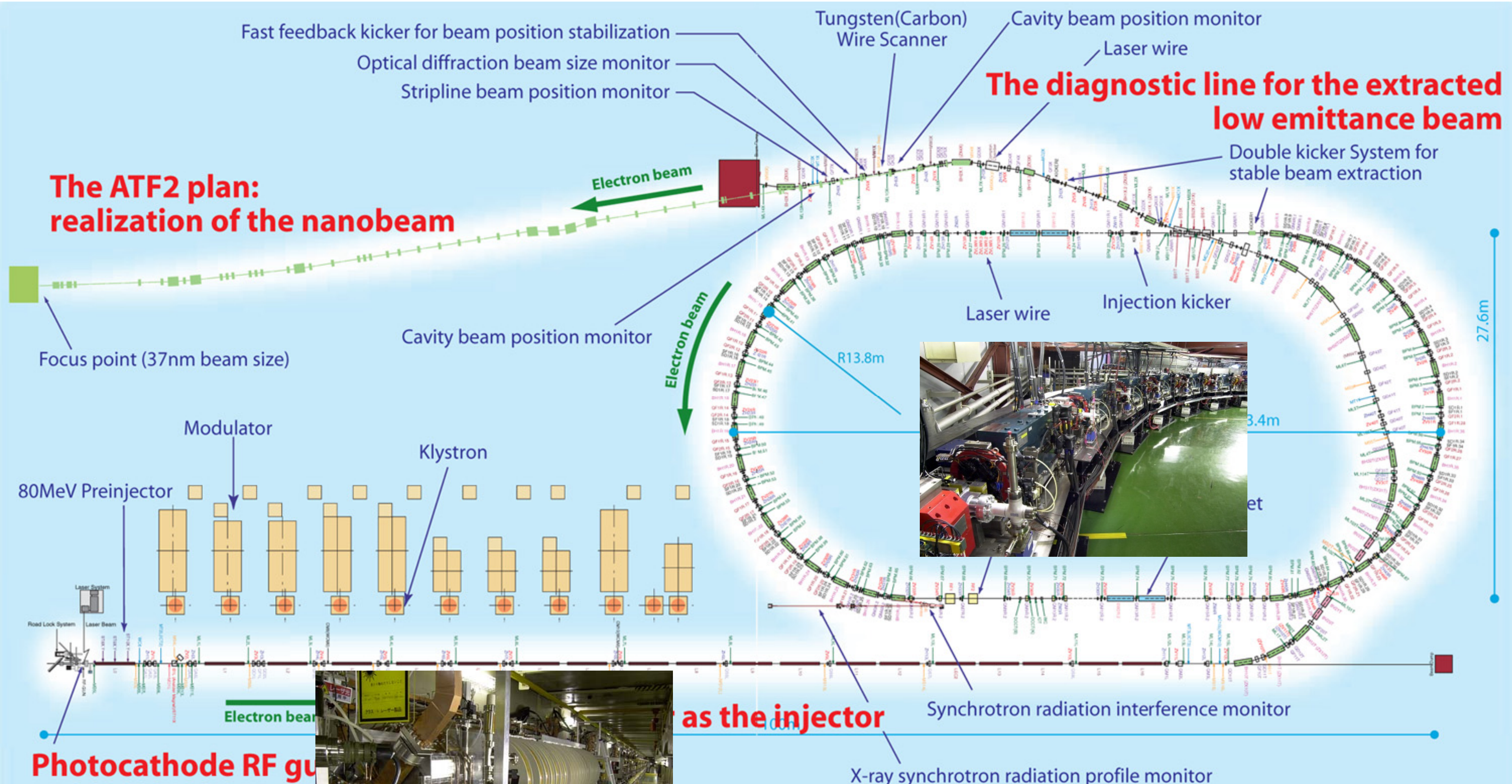
Production yield:
94 % at > 28 MV/m,

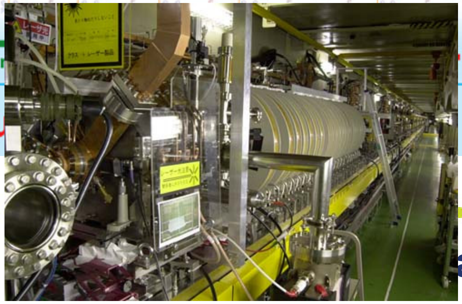
Average gradient:
37.1 MV/m

Global Plan for SCRF R&D

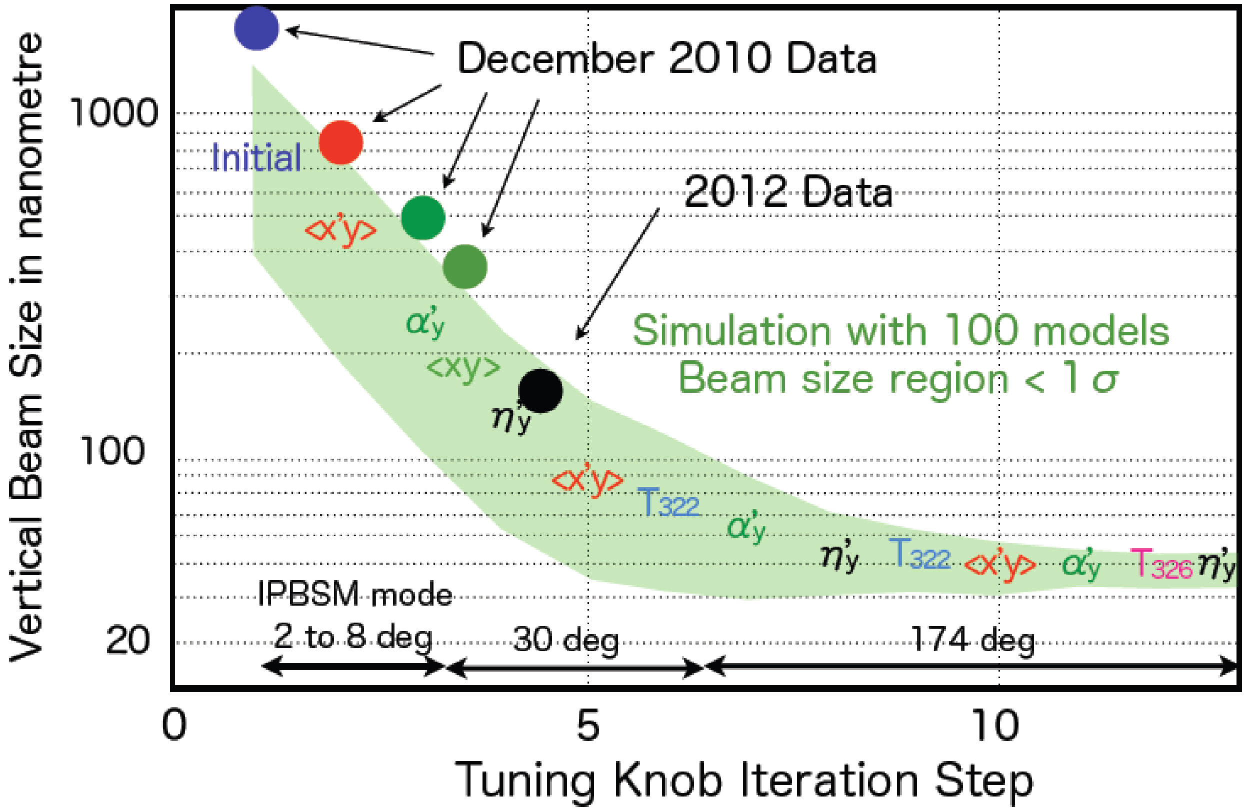
Year	07	2008	2009	2010	2011	2012
Phase	TDP-1			TDP-2		
Cavity Gradient in v. test to reach 35 MV/m	→ Yield 50%			→ Yield 90%		
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for string assembly and test (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration		FLASH (DESY) , NML/ASTA (FNAL) QB, STF2 (KEK)				
Preparation for Industrialization			Production Technology R&D			
Communication with industry:	1st Visit Vendors (2009), Organize Workshop (2010) 2nd visit and communication, Organize 2nd workshop (2011) 3rd communication and study contracted with selected vendors (2011-2012)					

Accelerator Test Facility (ATF)



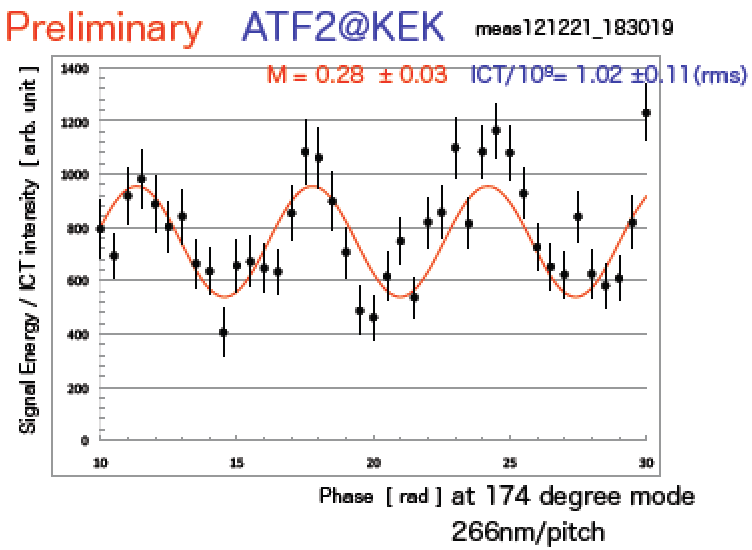


ATF-2 earthquake recovery



- **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



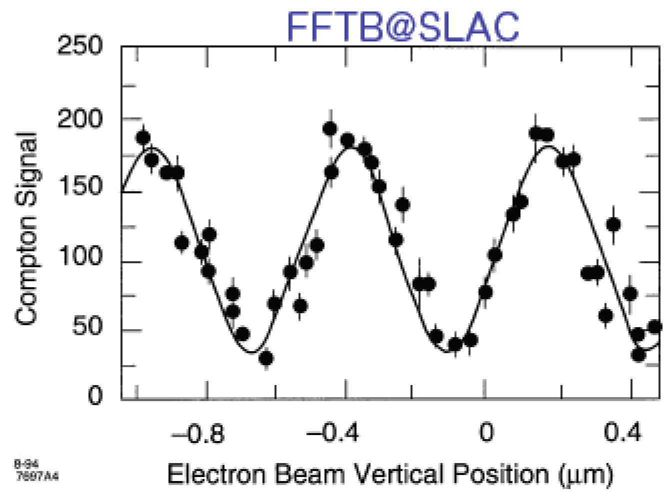
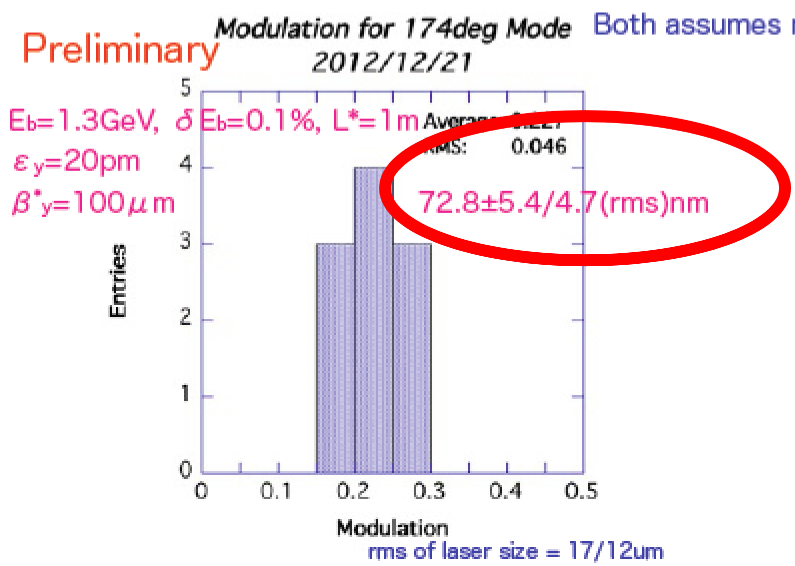


Figure 5.6: Laser-Compton beam size measurement performed in May of 1994. The measured size is 77±7 nanometers.

Both assumes no modulation reduction



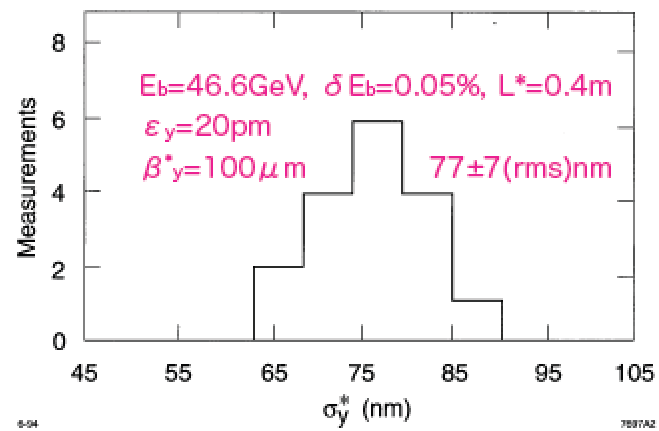
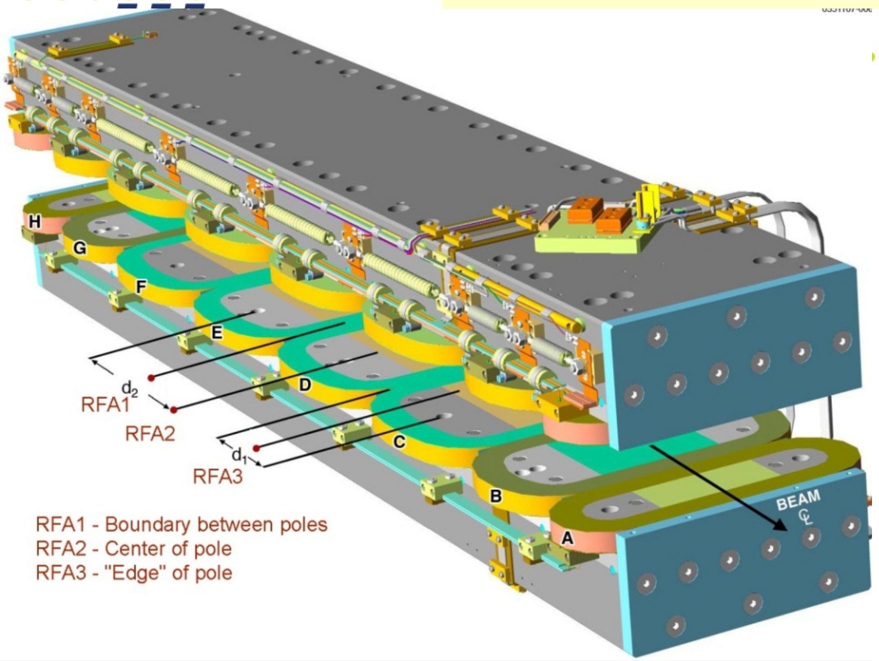
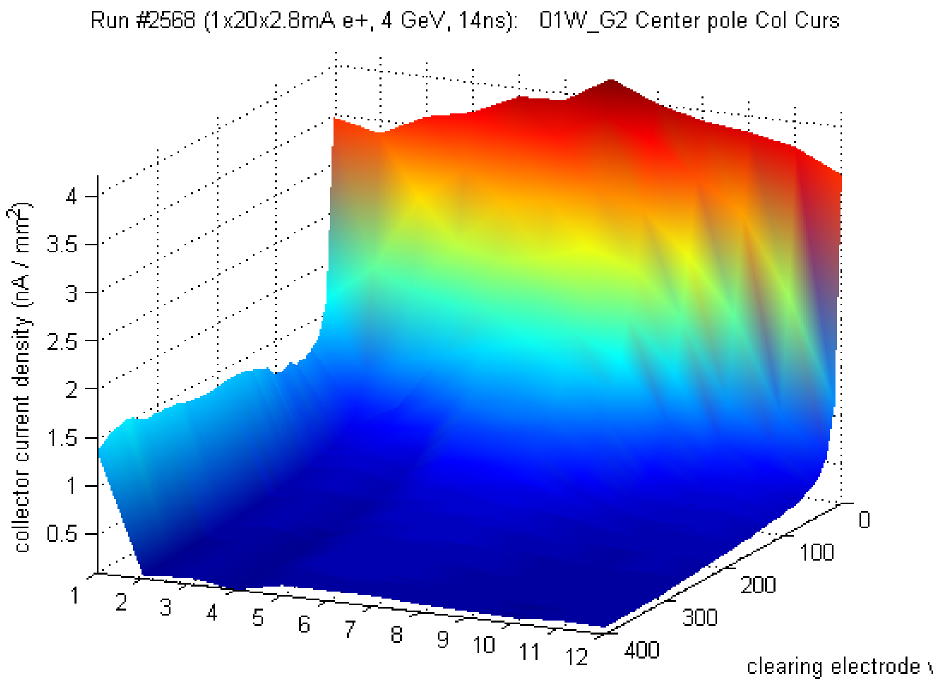


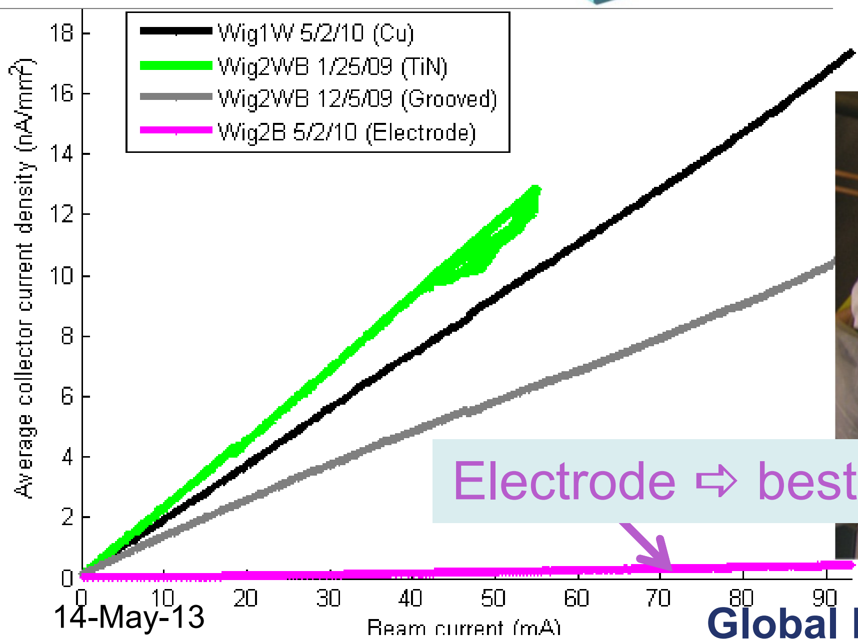
Figure 5.7: Histogram of measurements made during the last 3 hours of the May, 1994 FFTB run. Average size measured was 77 nm, with an RMS of 7 nm.

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

CesrTA - Wiggler Observations







Electrode ⇨ best performance

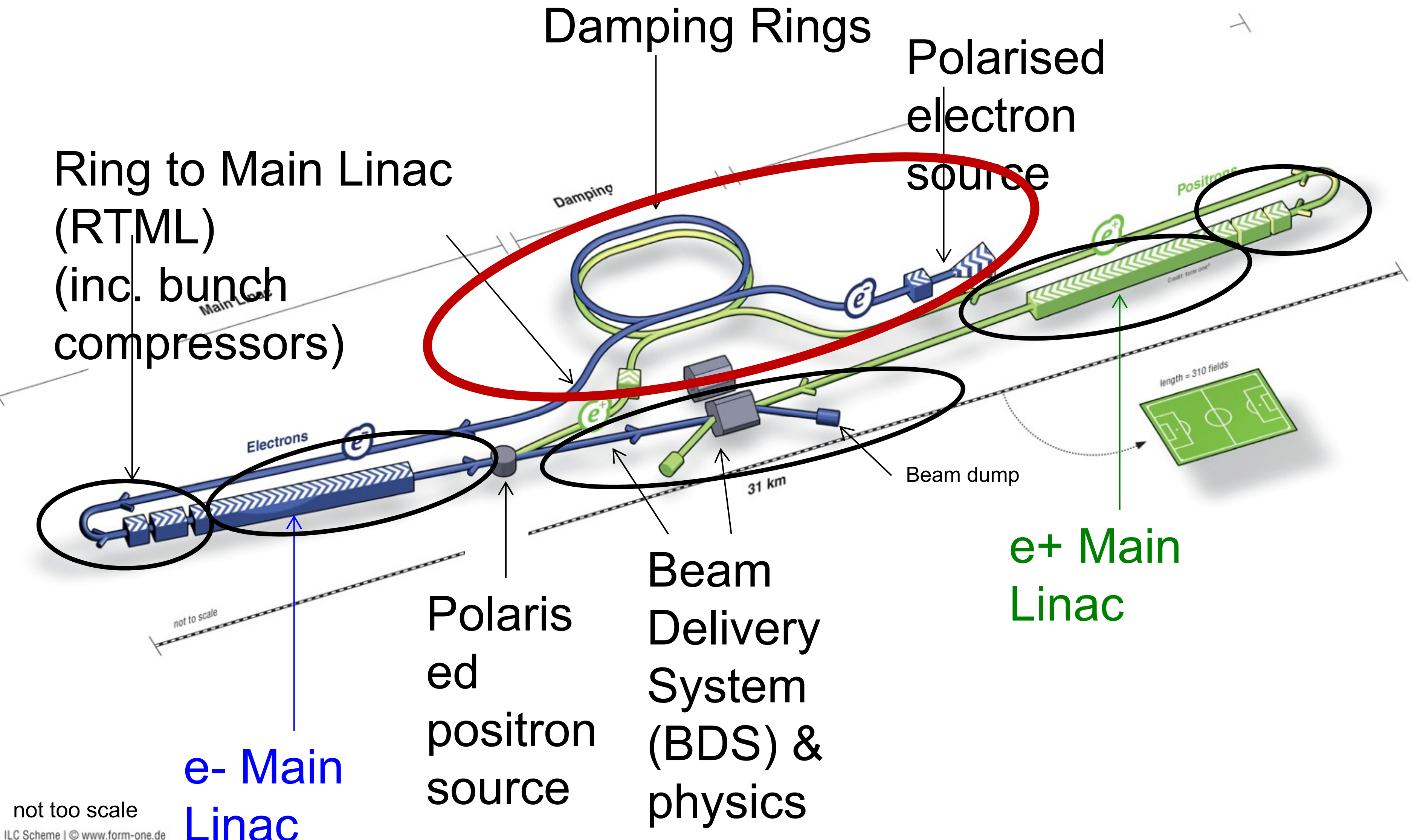
Baseline Mitigation Plan

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**

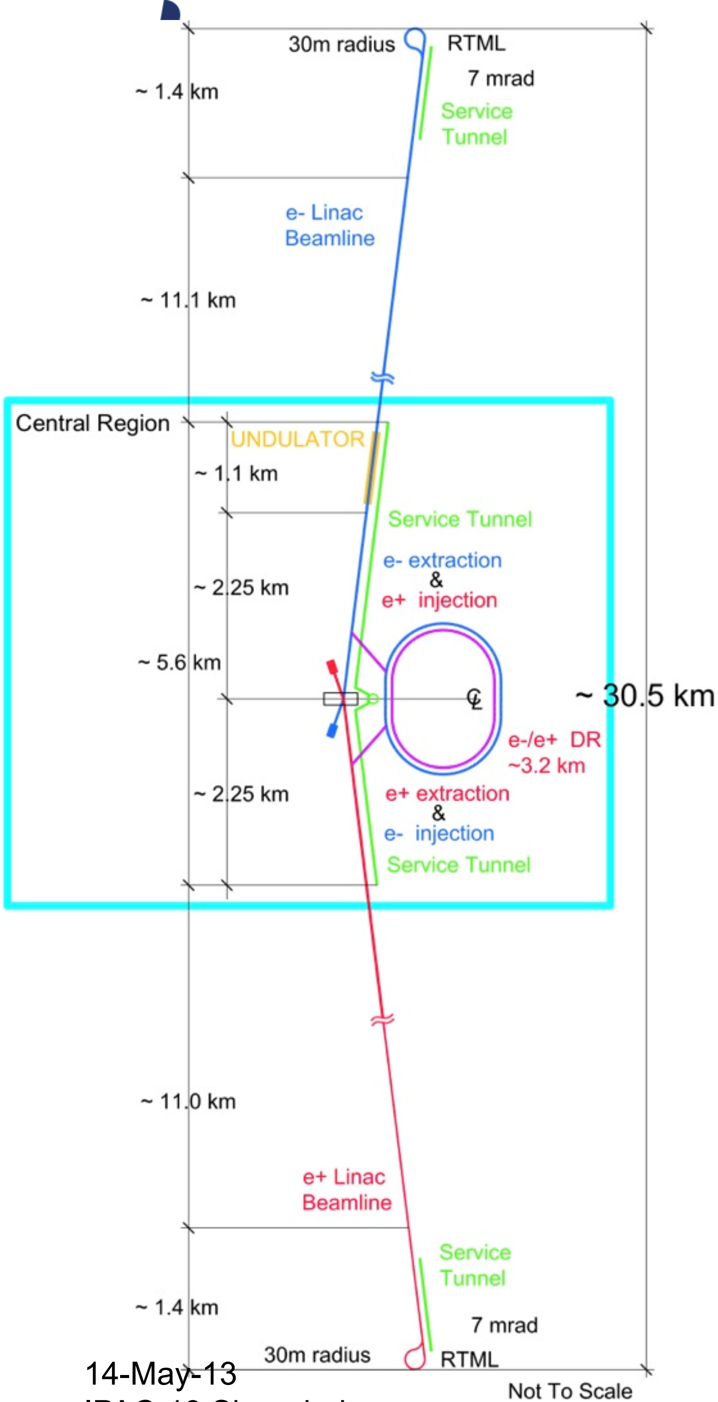
*Drift and Quadrupole chambers in arc and wiggler regions will incorporate antechambers

- 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 in a Nutshell

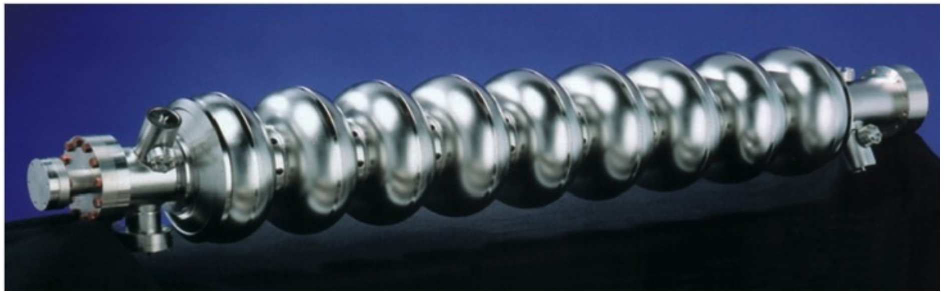


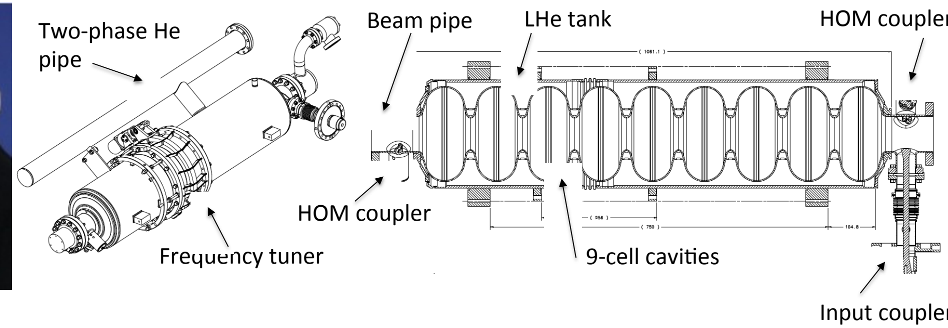
Layout

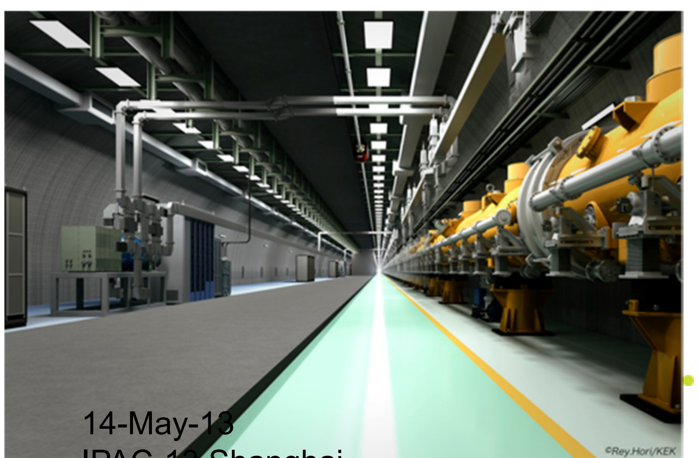


Total site length (500 GeV CM)	**30.5 km**
SCRF Main Linacs	**22.2 km**
RTML (bunch compressors)	**2.8 km**
Positron source	**1.1 km**
BDS / IR	**4.5 km**
Damping Rings (circumference)	**3.2 km**

SCRF Linac Technology







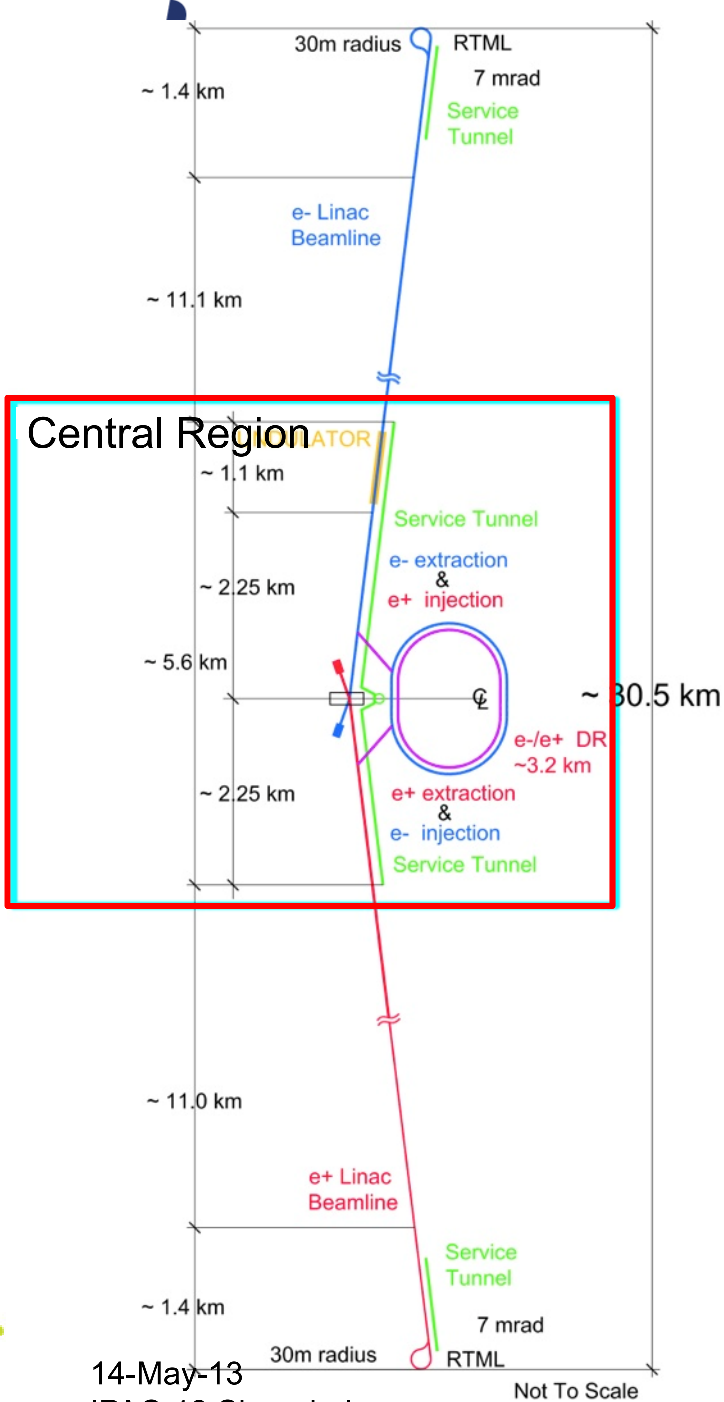
1.3 GHz Nb 9-cellCavities	16,024
Cryomodules	1,855
SC quadrupole pkg	673
10 MW MB Klystrons & modulators	426 / 461 *

* site dependent

Main Linac Parameters

Average accelerating gradient	31.5 (±20%)	MV/m
Cavity Q_0	10^{10}	
(Cavity qualification gradient	35 (±20%)	MV/m)
Beam current	5.8	mA
Number of bunches per pulse	1312	
Charge per bunch	3.2	nC
Bunch spacing	554	ns
Beam pulse length	730	μs
RF pulse length (incl. fill time)	1.65	ms
Pulse repetition rate	5	Hz
Beam power per cavity (peak)	190*	kW

* at 31.5 MV/m

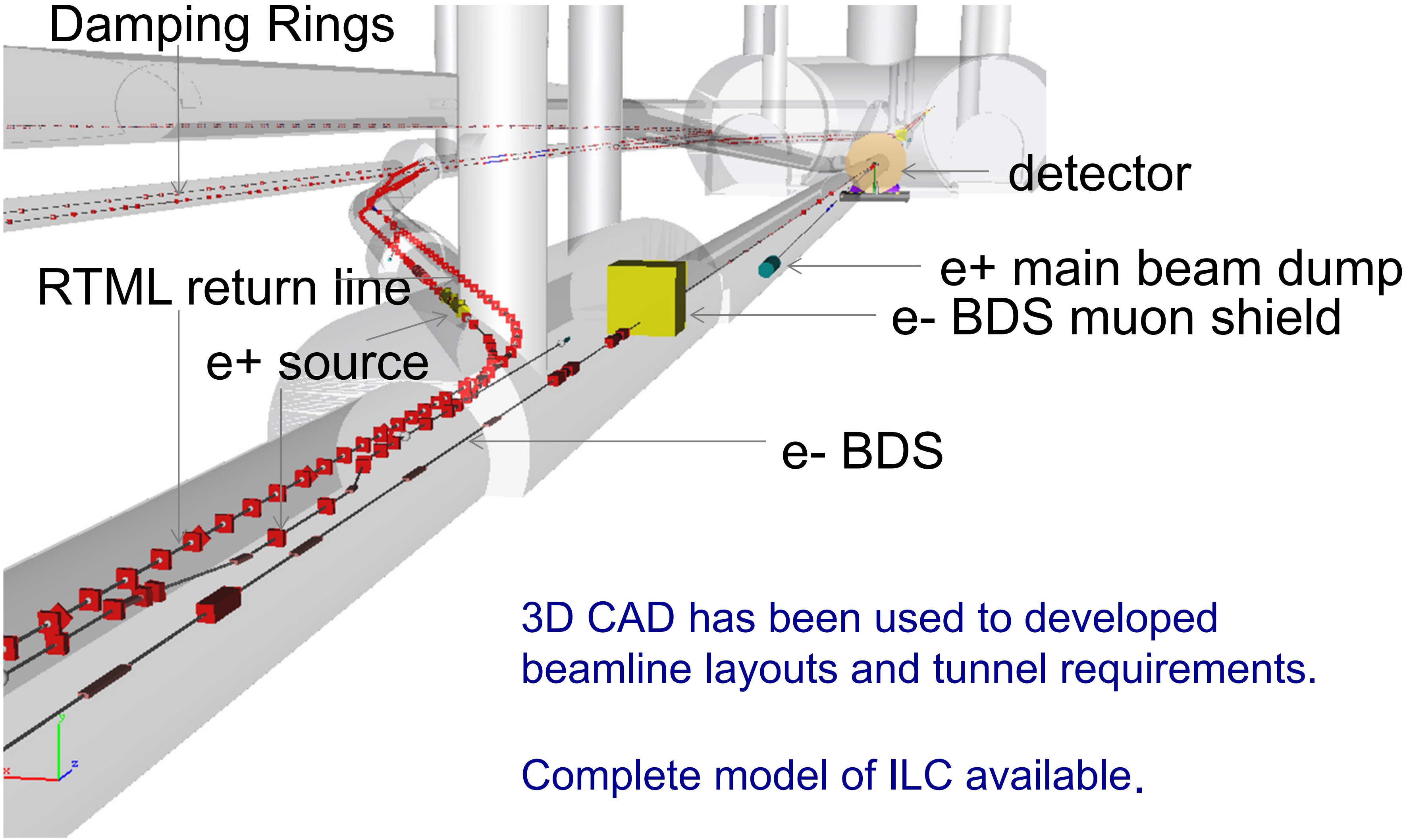


Central Region

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

  (electron source through IR (detector hall): common tunnel)
- Complex and crowded area

Central Region Integration

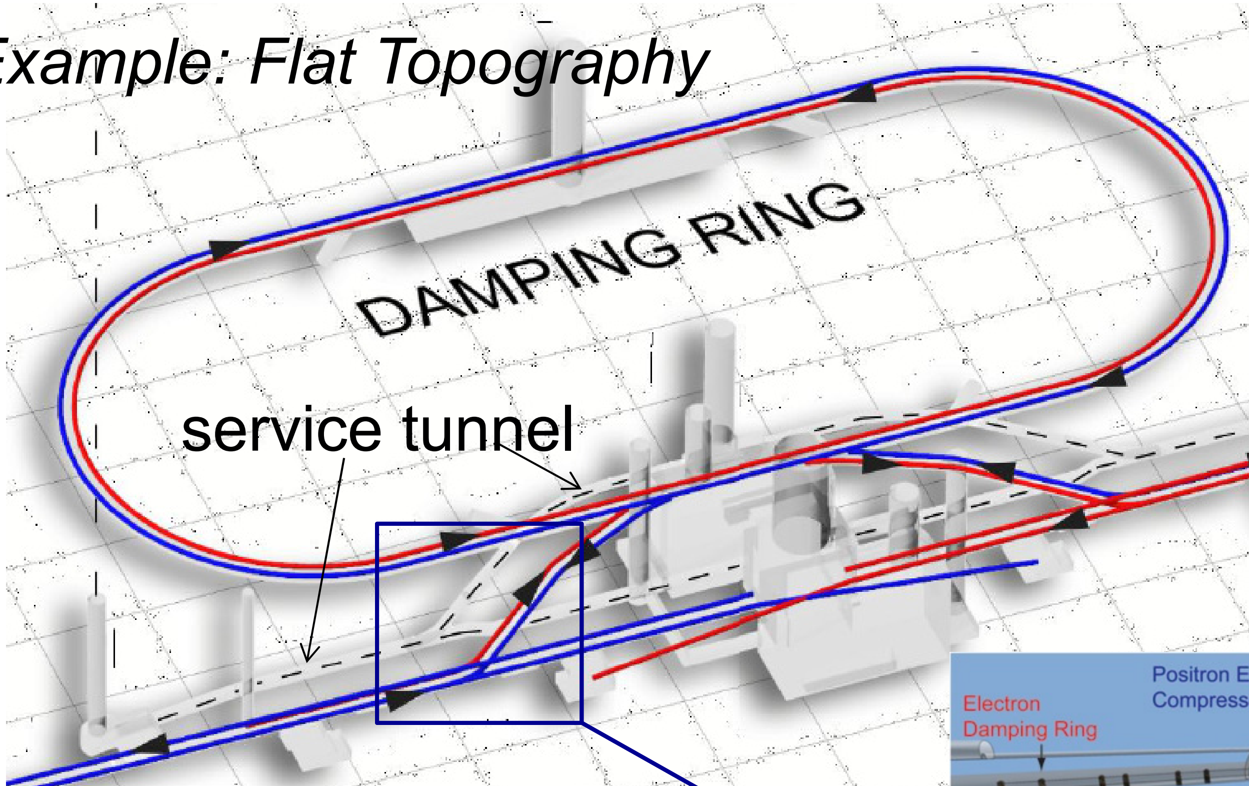


3D CAD has been used to developed beamline layouts and tunnel requirements.

Complete model of ILC available.

Central Region

Example: Flat Topography

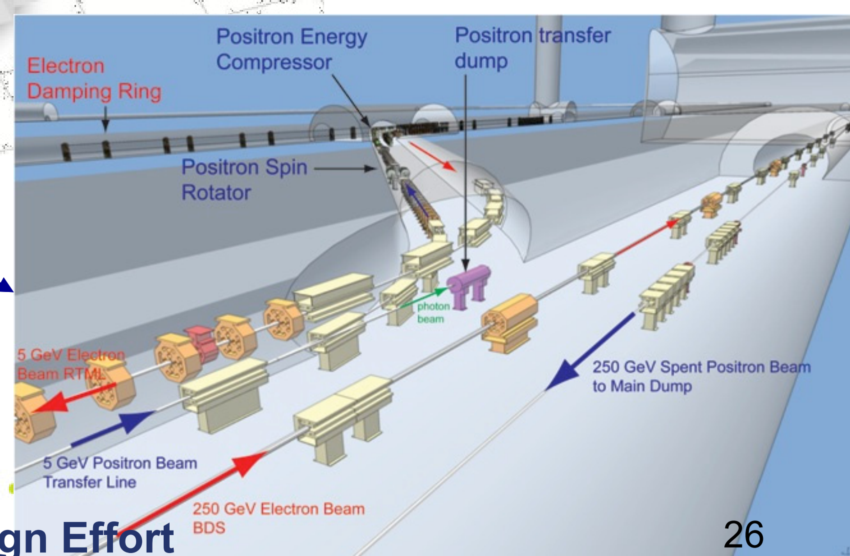


The central region **beam tunnel** remains a **complex region**.

Complete, detailed and **integrated lattices** are now available
→ component counts
→ cost estimate

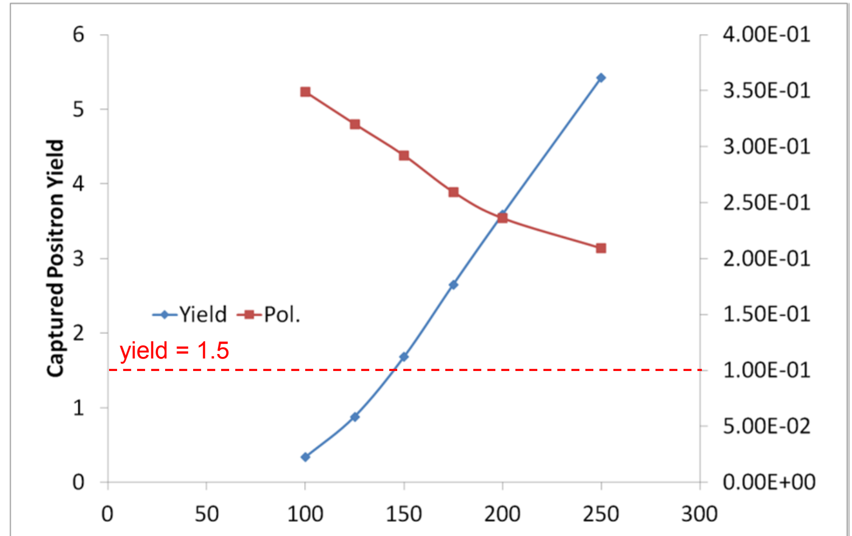
Generic design used for **geometry** and generating **component counts** and **CFS requirements**.

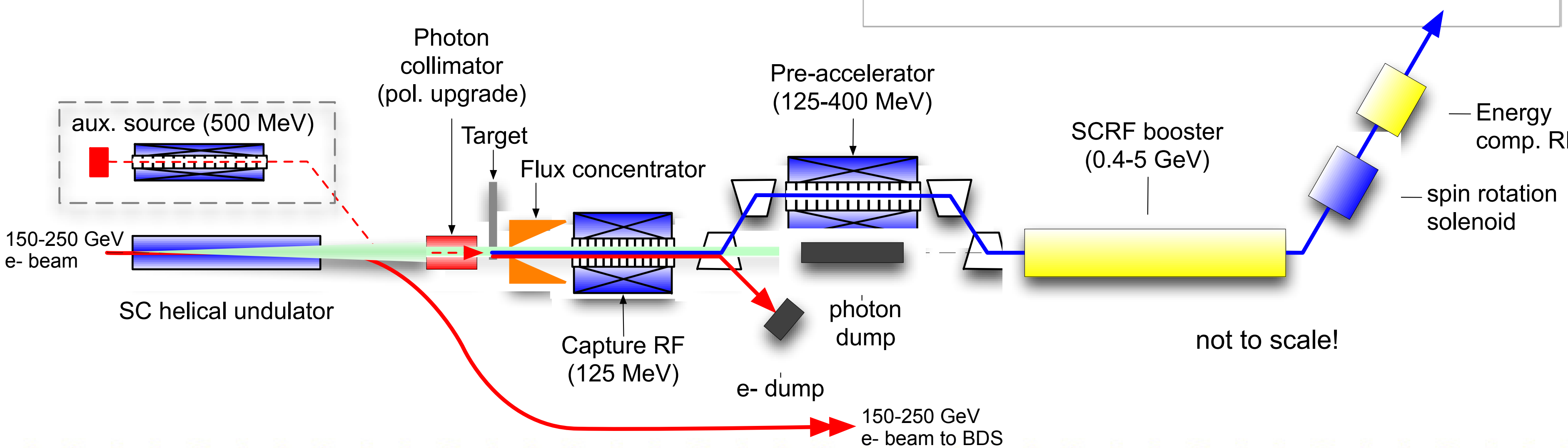
*CFS (particularly **CE**) solutions are **site-dependent**!*



Positron Source (central region)

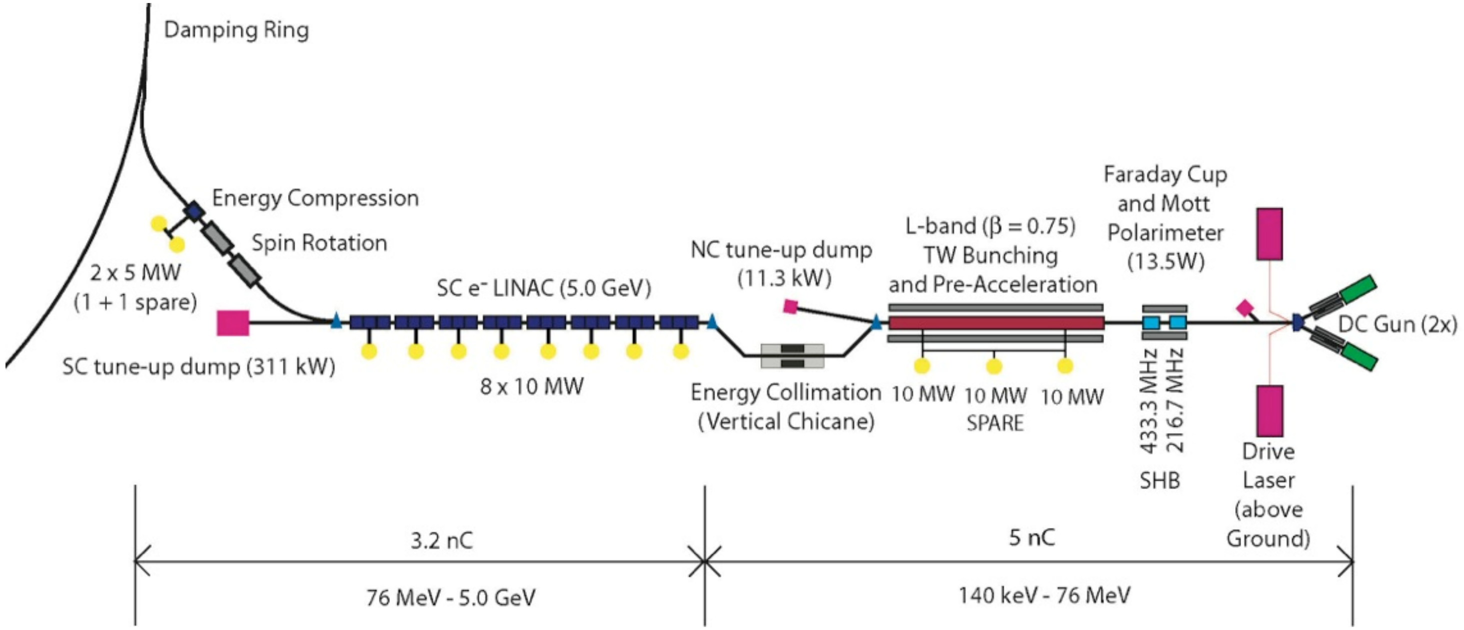
- located at exit of electron Main Linac
- 147m SC helical undulator
- driven by primary electron beam (150-250 GeV)
- produces ~30 MeV photons
- converted in thin target into e+e- pairs



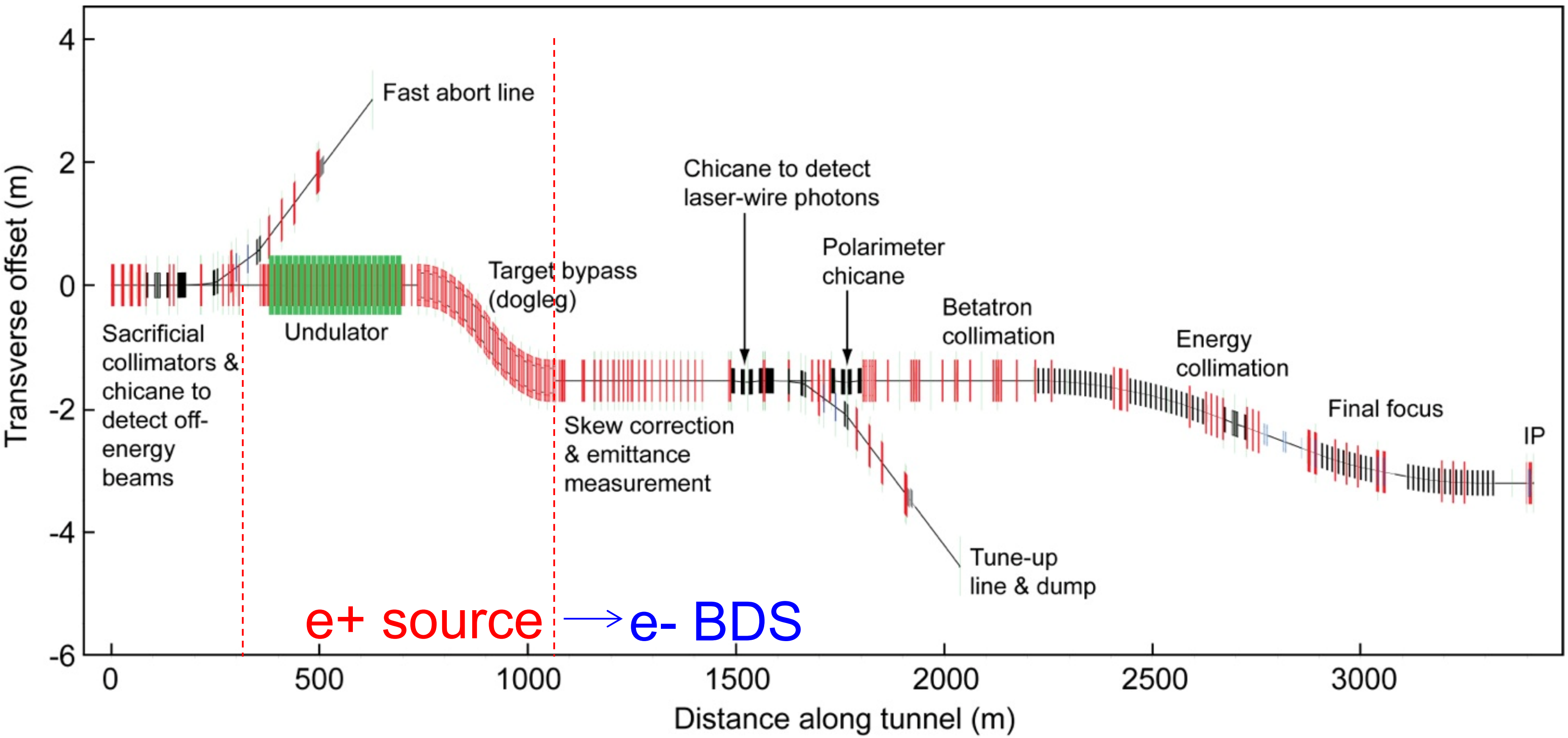


Polarised Electron Source

- Laser-driven photo cathode (GaAs)
- DC gun
- Integrated into common tunnel with positron BDS



Beam Delivery System and MDI



electron Beam Delivery System

Policy Speech by PM Abe
(Japanese version of 'State of the Union')
Feb 28, 2013

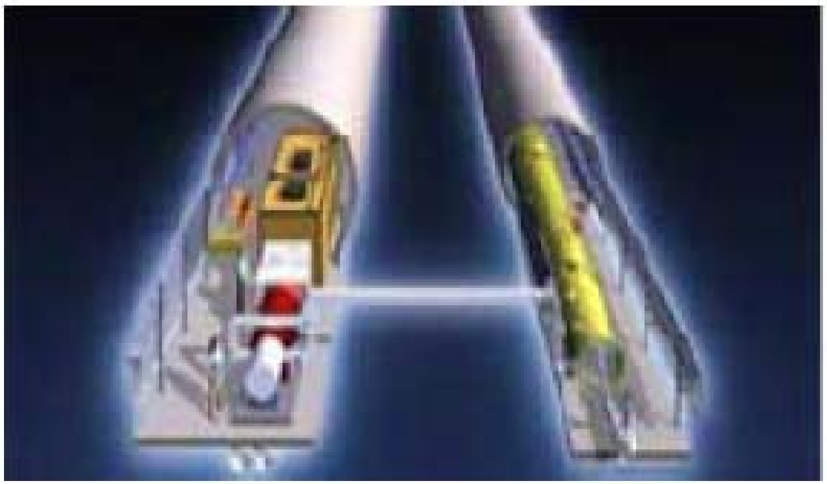
- 'Japan is driving global innovation in cutting-edge areas, including among others the world's first production test of marine methane hydrate, a globally unparalleled rocket launch success rate, and our attempts to develop the most advanced accelerator technology in the world.'

PM Abe at the 83rd session of Diet

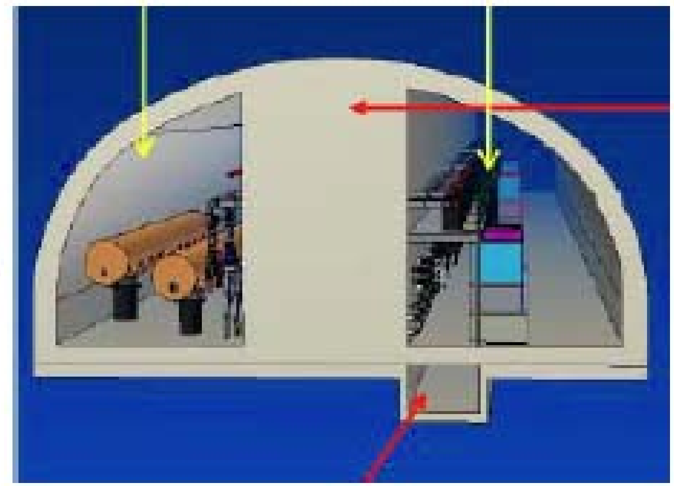
Tunnels in the Japanese Mountains

New Tunnel Shape

RDR two tunnel design (2007)



TDR mountain sites



Japanese initiative for hosting the ILC

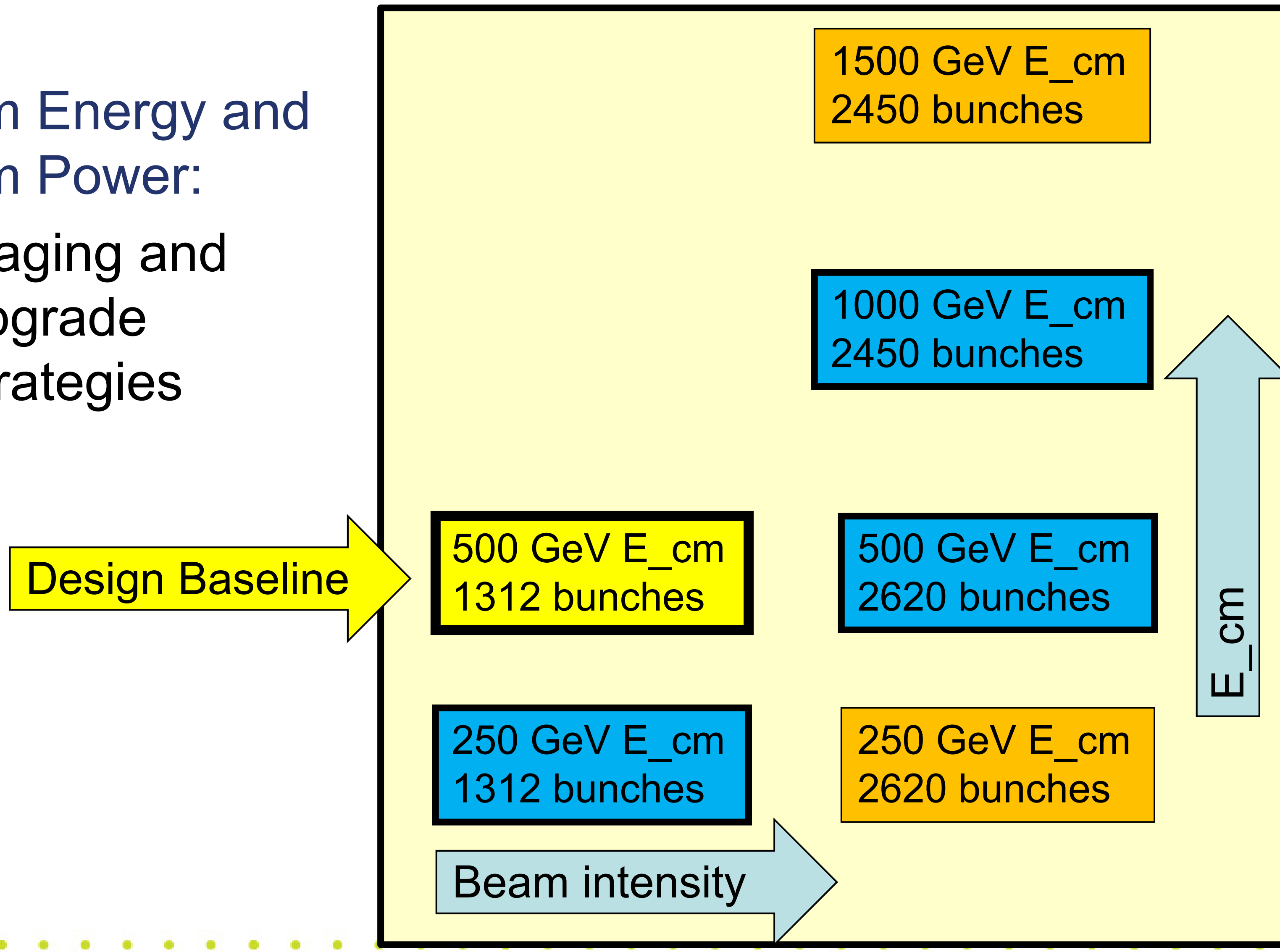
- Higgs Factory / Staged approach
- Developed through International Collaboration
- Linear Collider Collaboration (Lyn Evans – Director)

10 Diet Members visit ATF-2 (KEK)

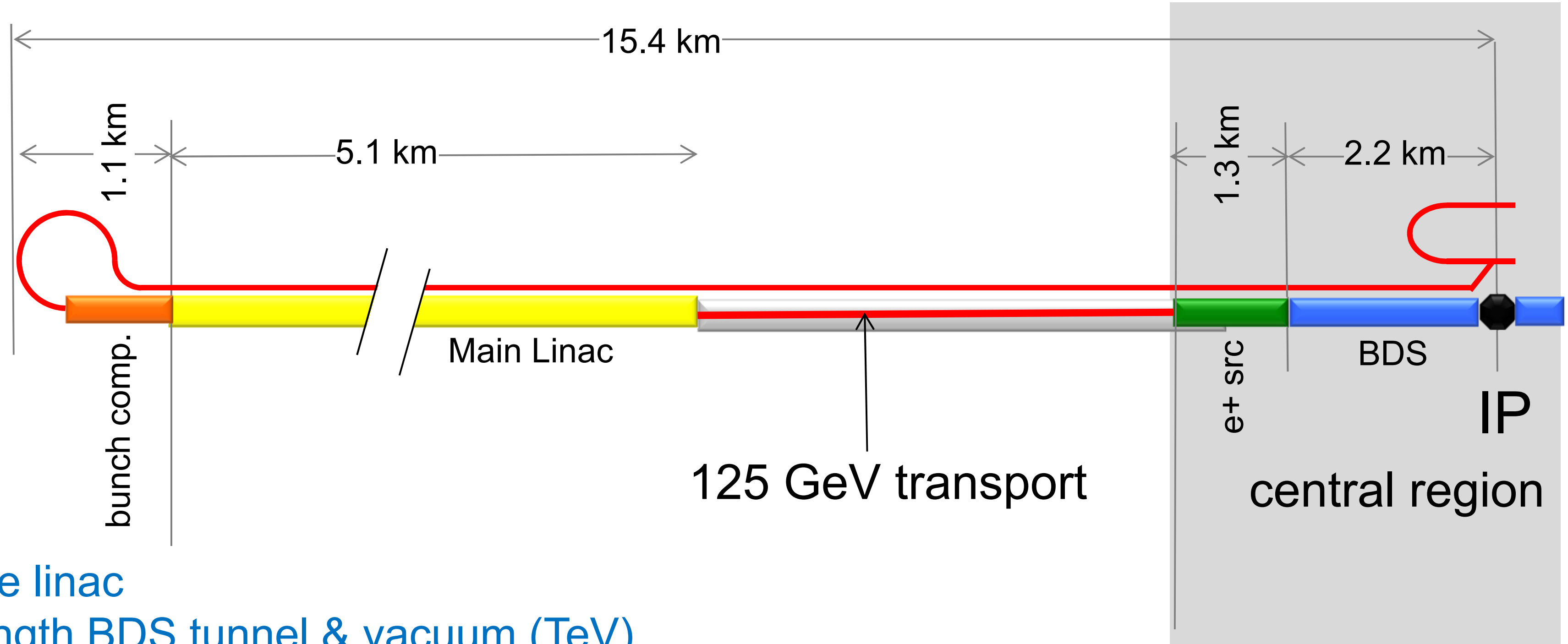
Staging and Upgrades:

Beam Energy and Beam Power:

- Staging and Upgrade Strategies



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

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.