Brian Foster

Oxford

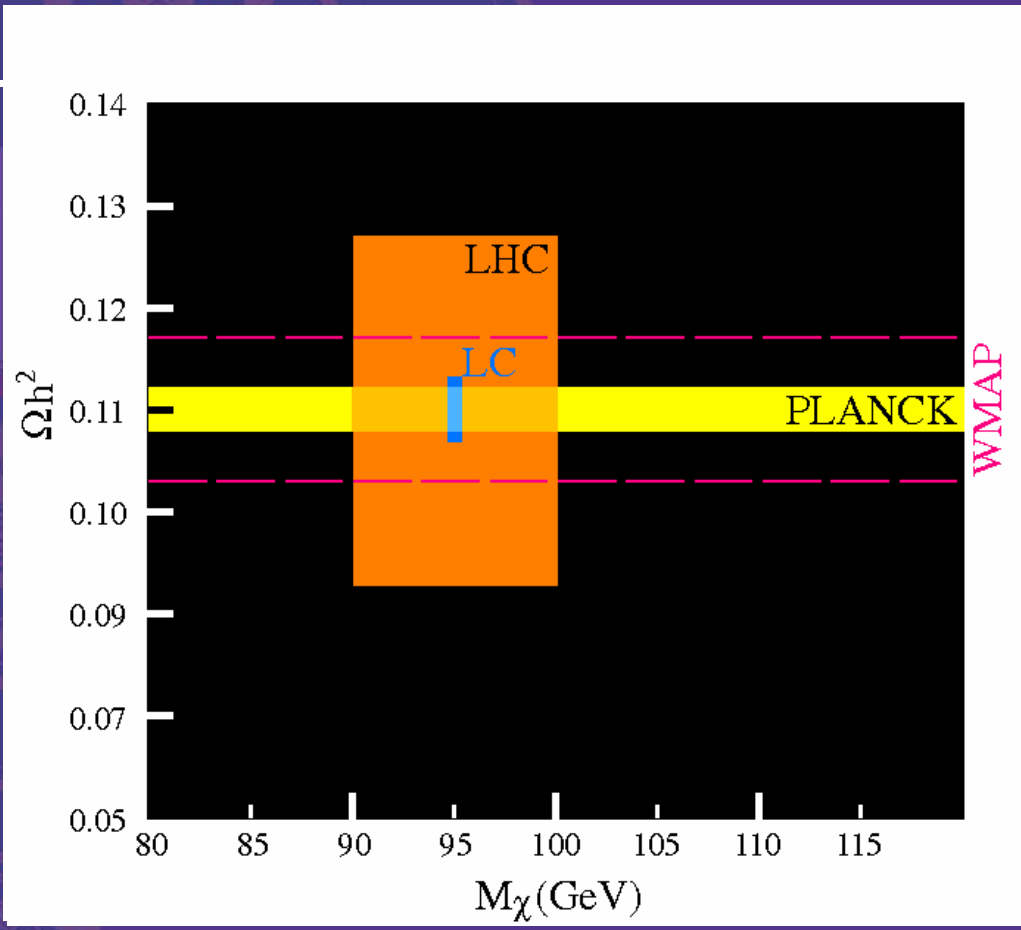
The International Linear Collider

TOP 2006
Coimbra
14/01/06

- Why/what is ILC?
- The Global Design Effort
- Current status of the crucial design elements & BCD status
- Experiments
- Next steps & summary

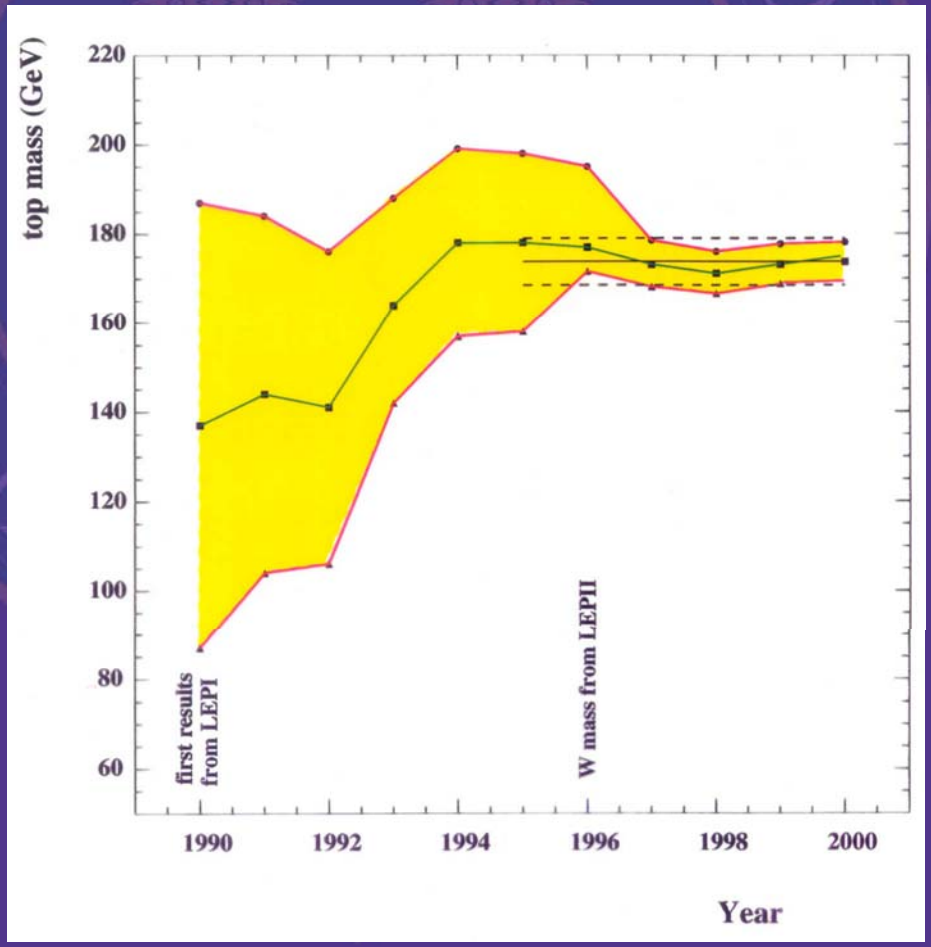
Why/what is ILC?

- **Why do we want to build a high-energy e^+e^- collider?**
- **Physics case rests on three legs:**
  known phenomena that ILC will definitely study- top quark;
- **the Higgs: for which there is very strong indirect evidence and if LHC doesn't find it then ILC will be essential to understand why;**
- **new particles for which there is very strong theoretical prejudice**



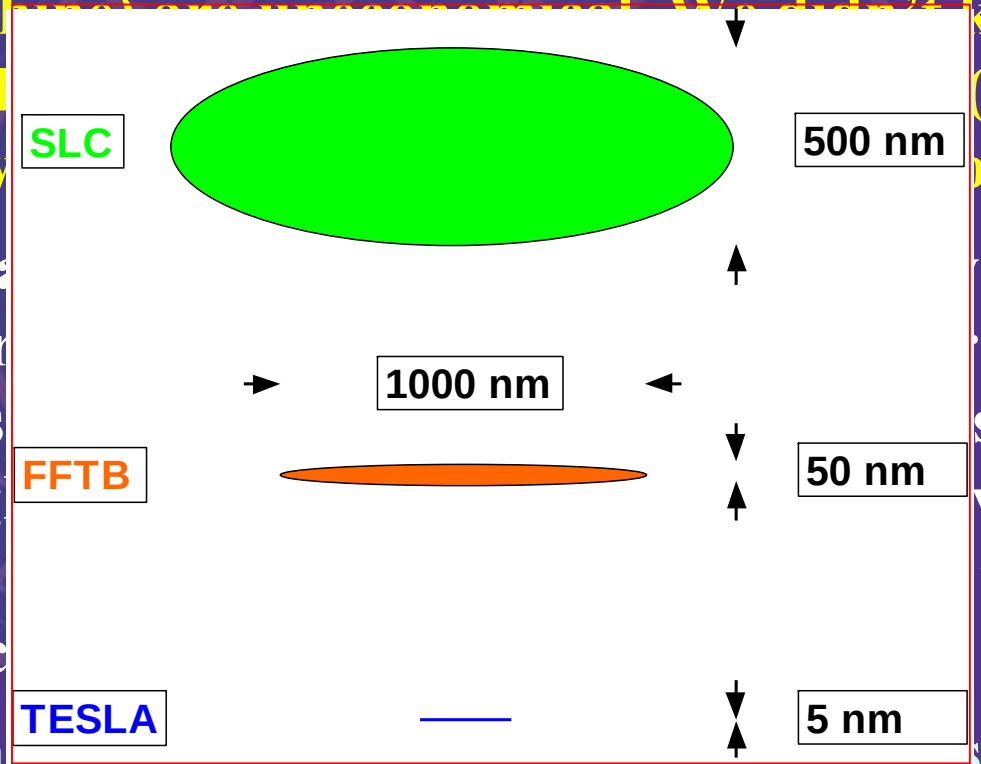
Why/what is ILC?

- **Furthermore the high precision of e^+e^- means that it is sensitive to phenomena far above its CM energy because of quantum corrections – as LEP proved.**



Why/what is ILC?

- Because radiated synchrotron-radiation power goes like m^{-5}, circular e^+e^- colliders bigger than LEP (the previous CERN mac… …know how to build compl… …(p-antip) and LEP) w… …– the ILC.
- The ILC is a… …nchrotron radiation pr… …orbit. The challenges s… …s, the beams pass throug… …ving many chances for … …they pass through eac…
- The only wa… …sh the beams to a tiny volume so that one pass gives all the particles the same chance to interact that many passes gives less dense bunches.



ILC Parameters

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

- **The machine must be upgradeable to 1 TeV**

GDE

- The Mission of the GDE
  - Produce a design for the ILC that includes a detailed design concept, performance assessments, reliable international costing, an industrialization plan , siting analysis, as well as detector concepts and scope.
  - Coordinate worldwide prioritized proposal driven R & D efforts (to demonstrate and improve the performance, reduce the costs, attain the required reliability, etc.)
  - B. Barish is Director, assisted by 3 regional directors: BF (Europe); F. Takasaki (Asia); G. Dugan (Americas)

Snowmass

2005 International Linear Collider Physics and Detector Workshop
and Second ILC Accelerator Workshop
Snowmass, Colorado, August 14-27, 2005

GDE – Staffing

Chris Adolphsen, SLAC
Jean-Luc Baldy, CERN
Philip Bambade, LAL, Orsay
Barry Barish, Caltech
Wilhelm Bialowons, DESY
Grahame Blair, Royal Holloway
Jim Brau, University of Orego
Karsten Buesser, DESY
Elizabeth Clements, Fermilab
Michael Danilov, ITEP
Jean-Pierre Delahaye, CERN,
Gerald Dugan, Cornell University
Atsushi Enomoto, KEK
Brian Foster, Oxford University
Warren Funk, JLAB
Jie Gao, IHEP
Terry Garvey, LAL-IN2P3
Hitoshi Hayano, KEK
Tom Himel, SLAC
Bob Kephart, Fermilab
Eun San Kim, Pohang Acc Lab
Hyoung Suk Kim, Kyungpook Nat'l Univ
Shane Koscielniak, TRIUMF
Vic Kuchler, Fermilab
Lutz Lilje, DESY

Americas	1
Europe	2
Asia	1

New Members

Peter Garbincius (FNAL)
Marc Ross (SLAC)
Bill Willis (Columbia)
Andre Seryi (SLAC)
John Sheppard (SLAC)
Ewan Patterson (SLAC)
Maseo Kuriki (KEK)
Kiyoshi Kubo (KEK)
Nobuhiro Terunuma (KEK)
Norihito Ohuchi (KEK)
Susanna Guiducci (INFN)
Deepa Angal-Kalinin (CCLRC)

Totals

Americas	23
Europe	23
Asia	16

Baseline Concept

Design Outline

- Accelerating gradient
- Positron generation scheme
- Shape & size of DR
- Number of bunch compressor stages
- Number of main tunnels
- Earth's curvature
- Number of IPs and crossing angle
- Configuration layout of linac, DR,

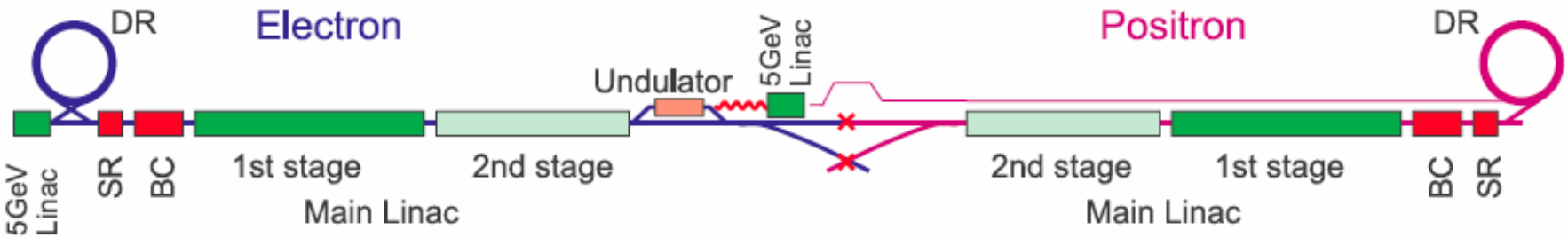
etc. .....

BCD will contain

- Description and reason of selection of **BC** (Baseline Configuration)
- together with description of **AC** (Alternative Configuration) which is
  - still premature but may be completed in the near future
  - expected to give better performance and/or cost reduction

BCD overview

- Currently the ILC BCD looks like this:



- Process overseen by ILC Executive -
  B. Barish, G. Dugan, BF, F. Takasaki,
  T. Raubenheimer, N. Walker, K.Yokoya.

Official BCD

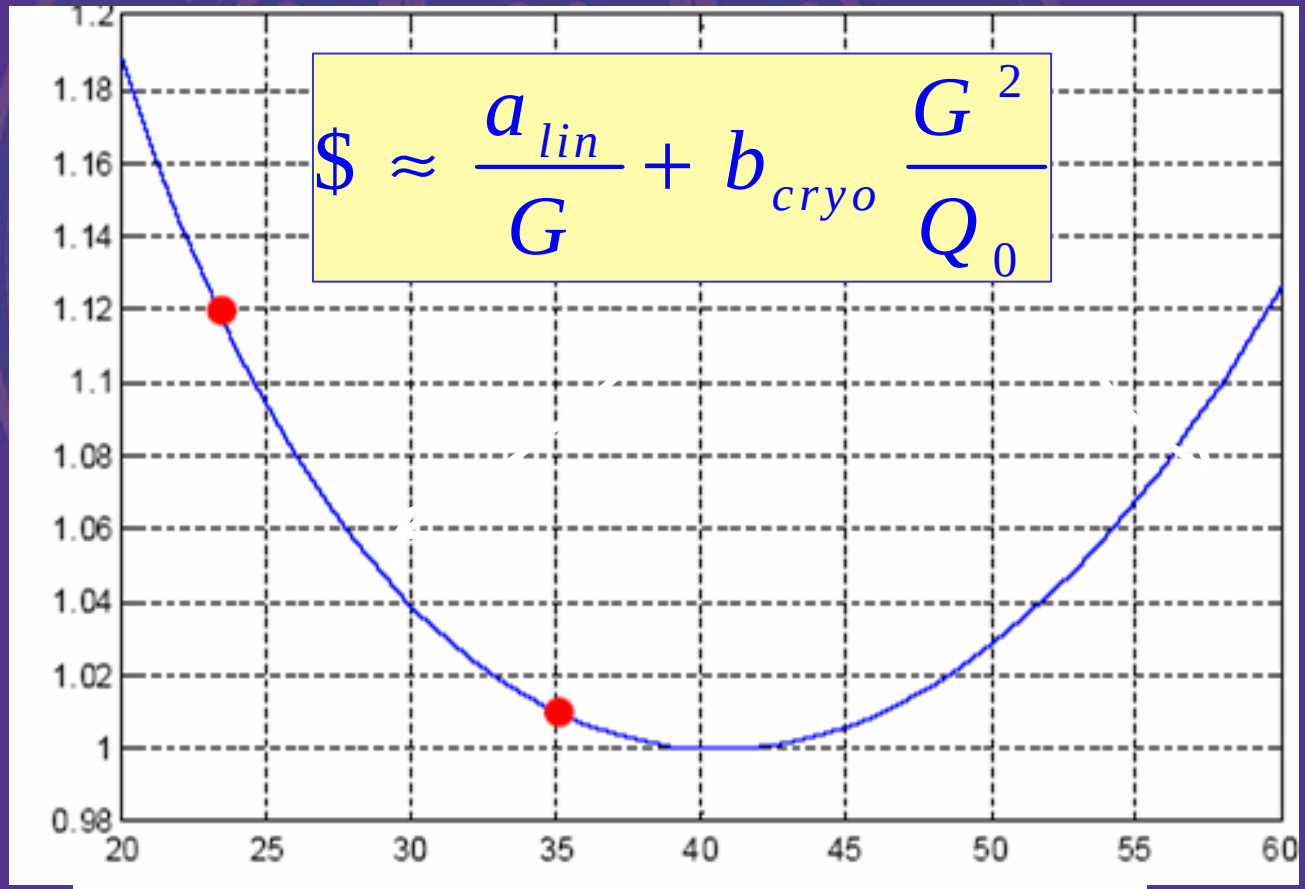
- **The BCD has now been released and can be found at:**
  http://www.linearcollider.org/wiki/doku.php?id=bcd:bcd_home.
- Parameters for $2*10^{34}$:

		min	nom	max	
Bunch charge	N	1	2	2	x10^10
Number of bunches	n_b	1330	2820	**5640**	
Linac bunch interval	$_b$	**154**	308	461	ns
Bunch length	$_z$ **150**	300	500		m
Vertical emittance	$_y$	**0.03**	0.04	0.08	m.mrad
IP beta (500GeV)	$_x$	**10**	21	21	m
	$_y$	**0.2**	0.4	0.4	m
IP beta (1TeV)	$_x$	**10**	30	30	m
	$_y$	**0.2**	0.3	0.6	m

- **What are most important parameters to be tuned?**

BCD & AC cavities

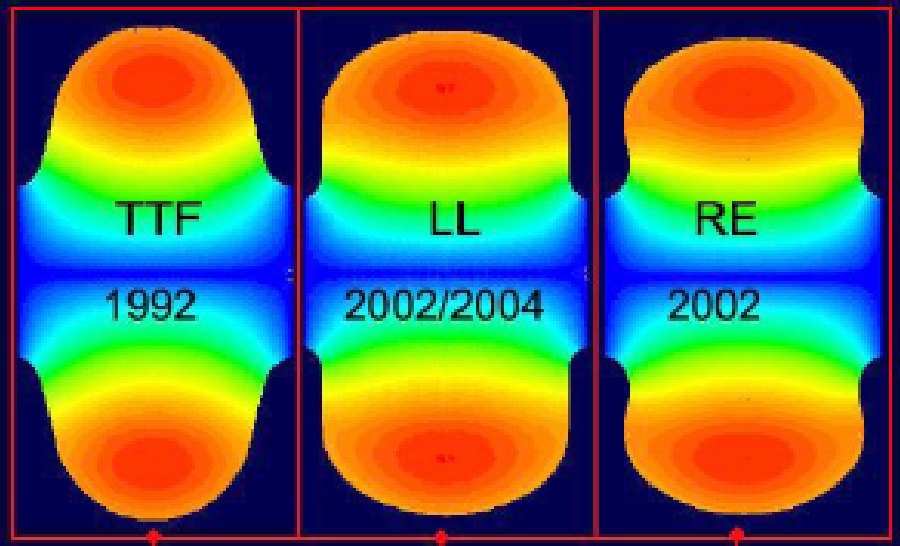
- What knobs do we have to turn?



C. -

BCD & AC cavities

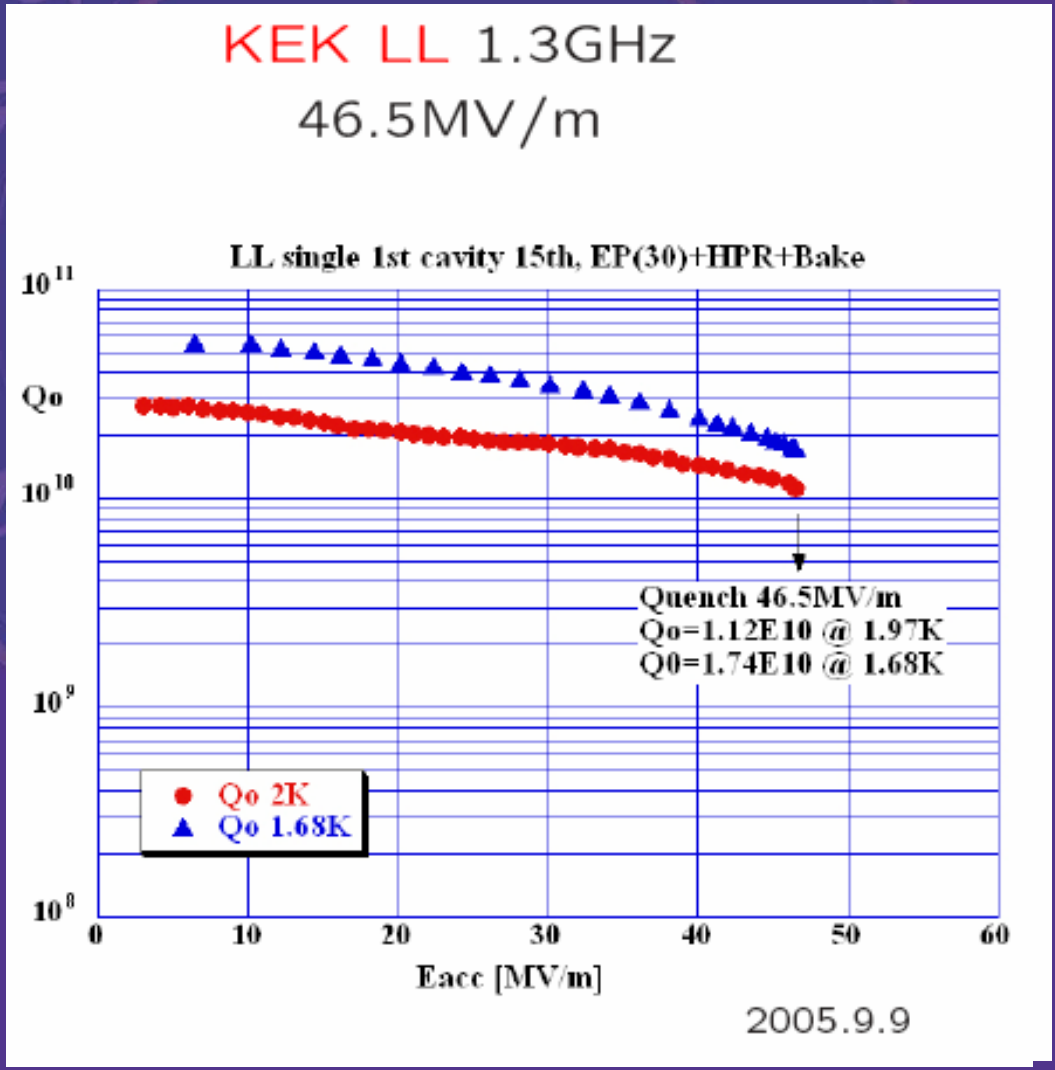
Example: 1.3 GHz inner cells for TESLA and ILC



r_{inb}	[mm]	35	30	33	
k_{cc}	[%]	1.9	1.52	1.8	field flatness
E_{peak}/E_{acc}	-	1.98	2.36	2.21	max gradient (E limit)
B_{peak}/E_{acc}	[mT/(MV/m)]	4.15	3.61	3.76	max gradient (B limit)
R/Q	[Ω]	113.8	133.7	126.8	stored energy
G	[Ω]	271	284	277	dissipation
R/Q*G	[Ω*Ω]	30840	37970	35123	dissipation (Cryo limit)

BCD & AC cavities

- Single cell status



BCD & AC cavities

- **BCD**

	500GeV stage		2nd stage (1TeV extension)	
	Baseline	Alternative	Baseline	ultimate dream
Acc.Grad.	**31.5(35)**	**36(40)**	**36(40)**	
Q_0 (10^{10})	1.0(0.8)	1.0(0.8)	1.0(0.8)	
Cavi.shape	TESLA-type	LL/RE super-structure	LL/RE super-structure	single-crystal Nb super-structure

'31.5(35)' means

- Adopt only the cavities over 35MV/m in vertical test (average over $\gtrsim$37MV/m needed, taking into account the production yield)
- Prepare RF and cryo-system for 35MV/m
- but operate at 31.5MV/m
- Tunnel length to be computed using 31.5MV/m

- According to the baseline, the main linac length ~41km for 1TeV
- Adding other components, the tunnel would be nearly 50km long

Klystron Fabrication

- **Several suppliers for BCD:**
  - MBKs almost satisfy the specification : 10MW, 1.5ms, 65%
  - Cost saving persued : sheet beam, inductive output tube, etc

Thales

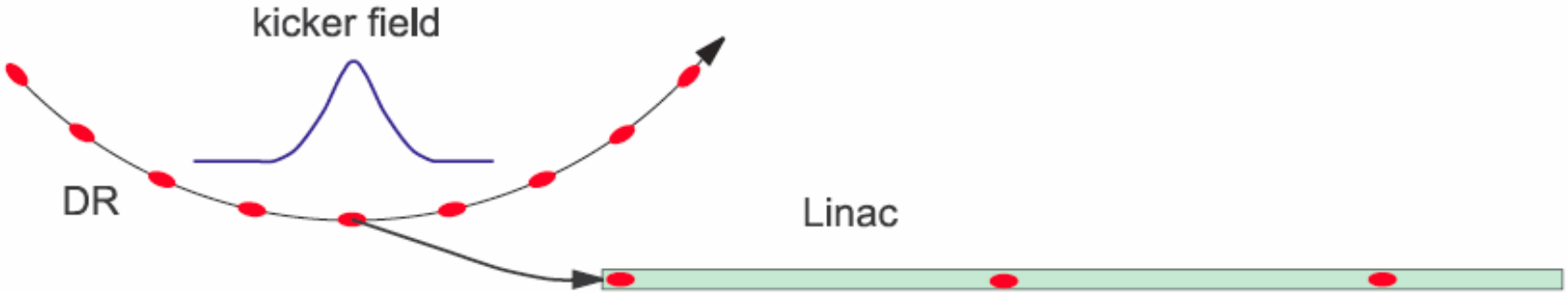
CPI

Toshiba

Damping rings

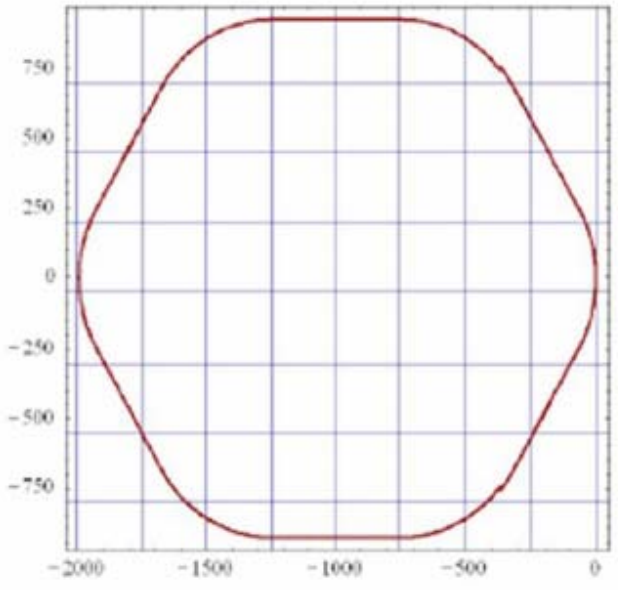
Area in which technology has really advanced

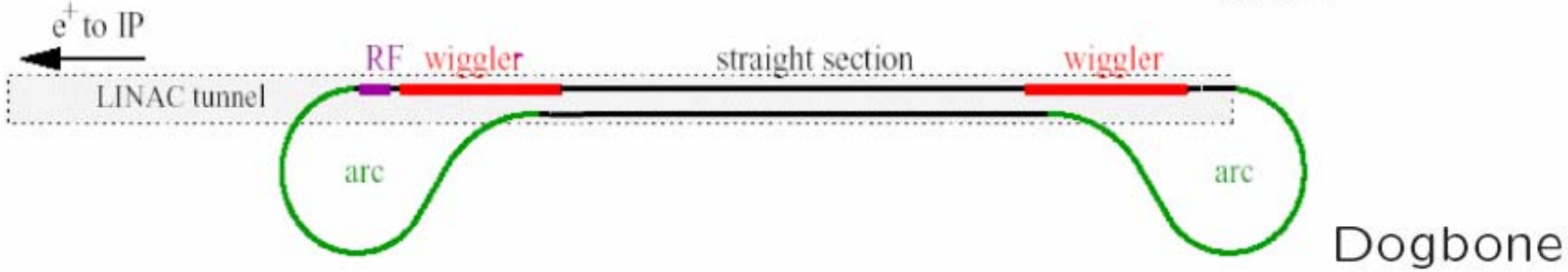
- Number of bunches 3000 (6000 desirable)
- 300ns interval in linac $\Rightarrow$ total length $\sim$1ms $\rightarrow$ 300km
- Store compactly in DR
  (circumference 20km $\rightarrow$ bunch interval $\sim$20ns, 6km $\rightarrow$ $\sim$6ns)
- Bunch by bunch extraction at 300ns interval (injection, too)



Damping rings

- **Three candidates emerged from Snowmass:**



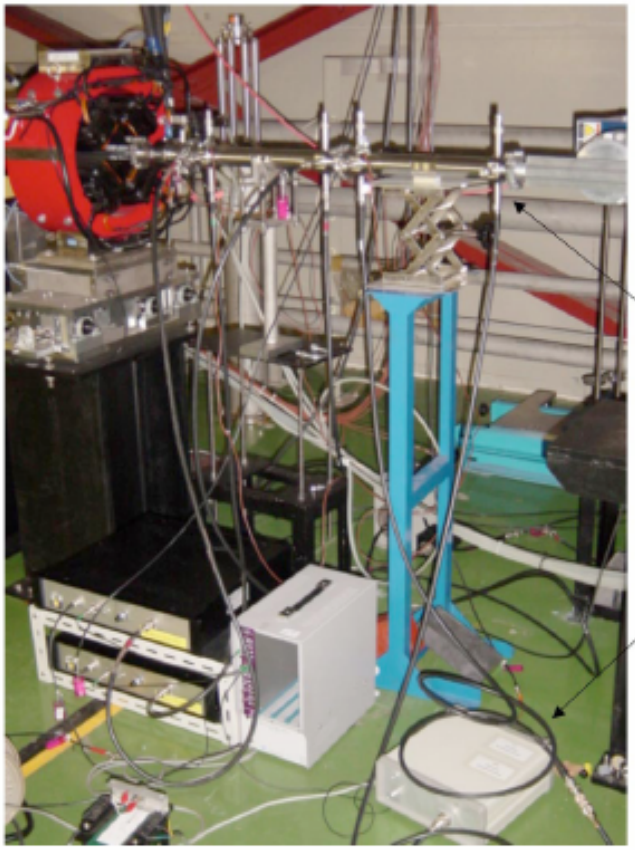


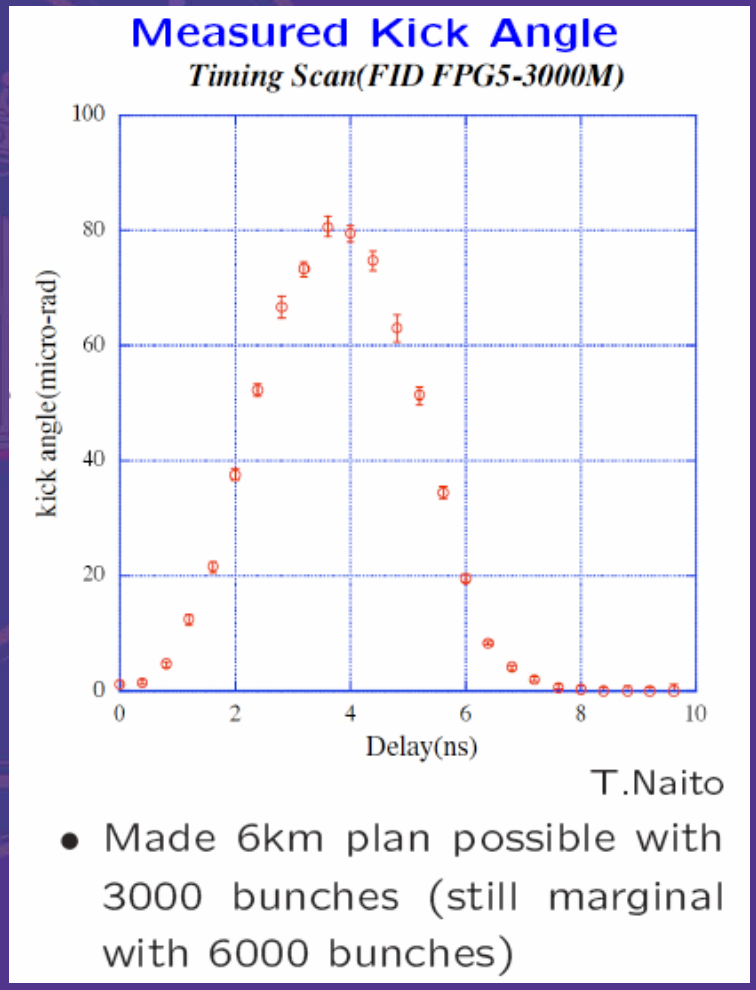
- Dogbone (circumference 17km) share the tunnel with main linac

Damping rings

- **Pulser development at KEK ATF**

rise(fall) 3.6nsec,
kick angle 80μrad、stability <0.75%

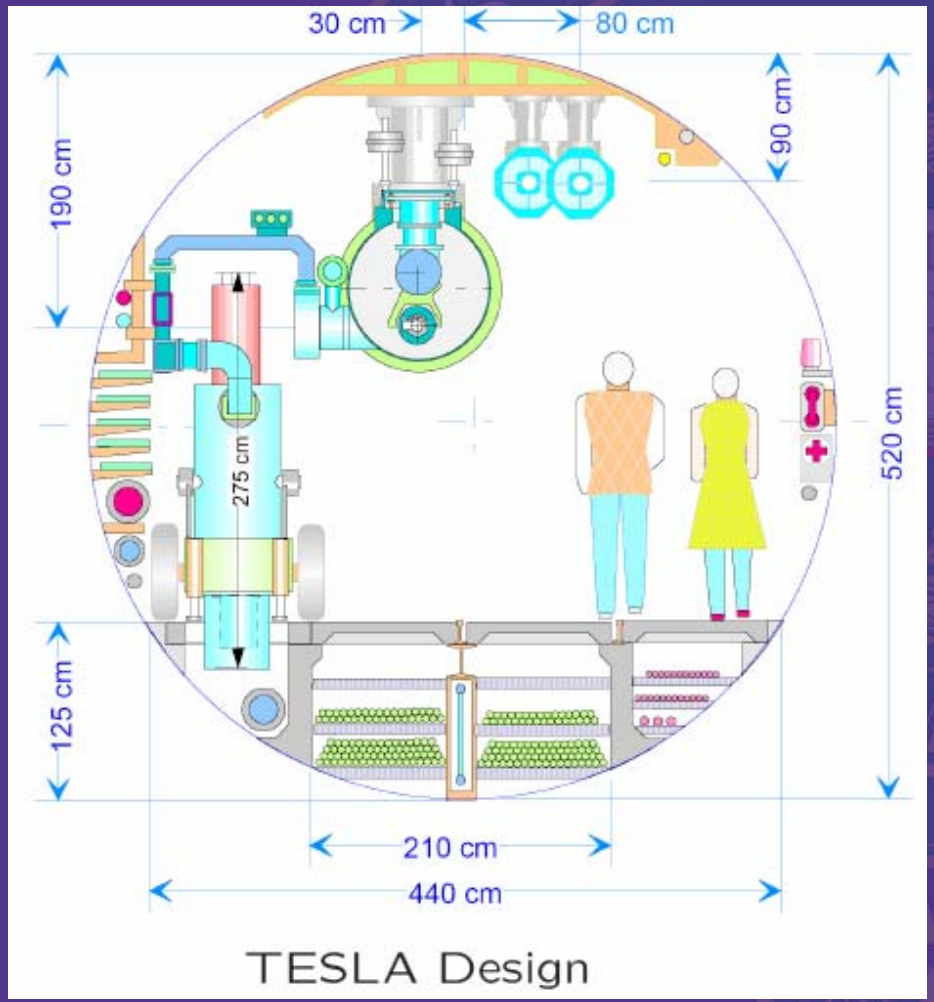




- **BCD has 2*6km e^+, 6 km e^-; dogbone backup.**

How many tunnels?

- **TESLA had 1 - warm design had 2:**



TESLA Design

- RF system (klystron, modulator?)
- Linac cryomodule
- 2 Damping Ring lines (dogbone case)
- Other beam transfer lines
  - ⋆ DR → Linac
  - ⋆ Positron → DR

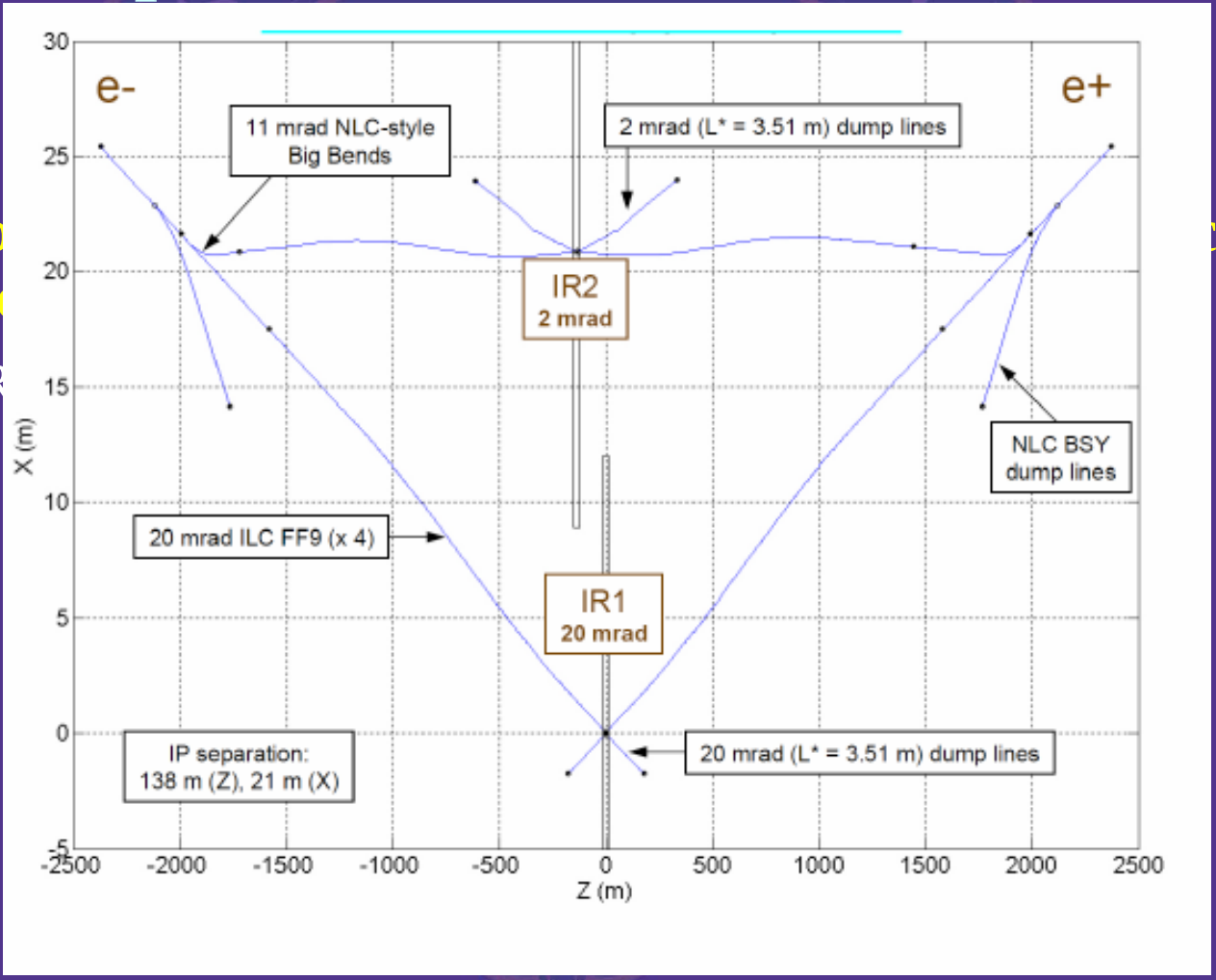
  (depending on layout & e^+ generation)

- 1 tunnel saves ~300MEuro (TESLA estimation)
- But subject to many operation problems

- **BCD - 2 tunnels following earth's curvature**

How many IRs?

- **If no $ problem, answer clear - 2IPs, 2 det.**
  - Ro… …./det.
    pe…
    (iIR…
    - …
    - …
    - …
    - …
    - …
    - …



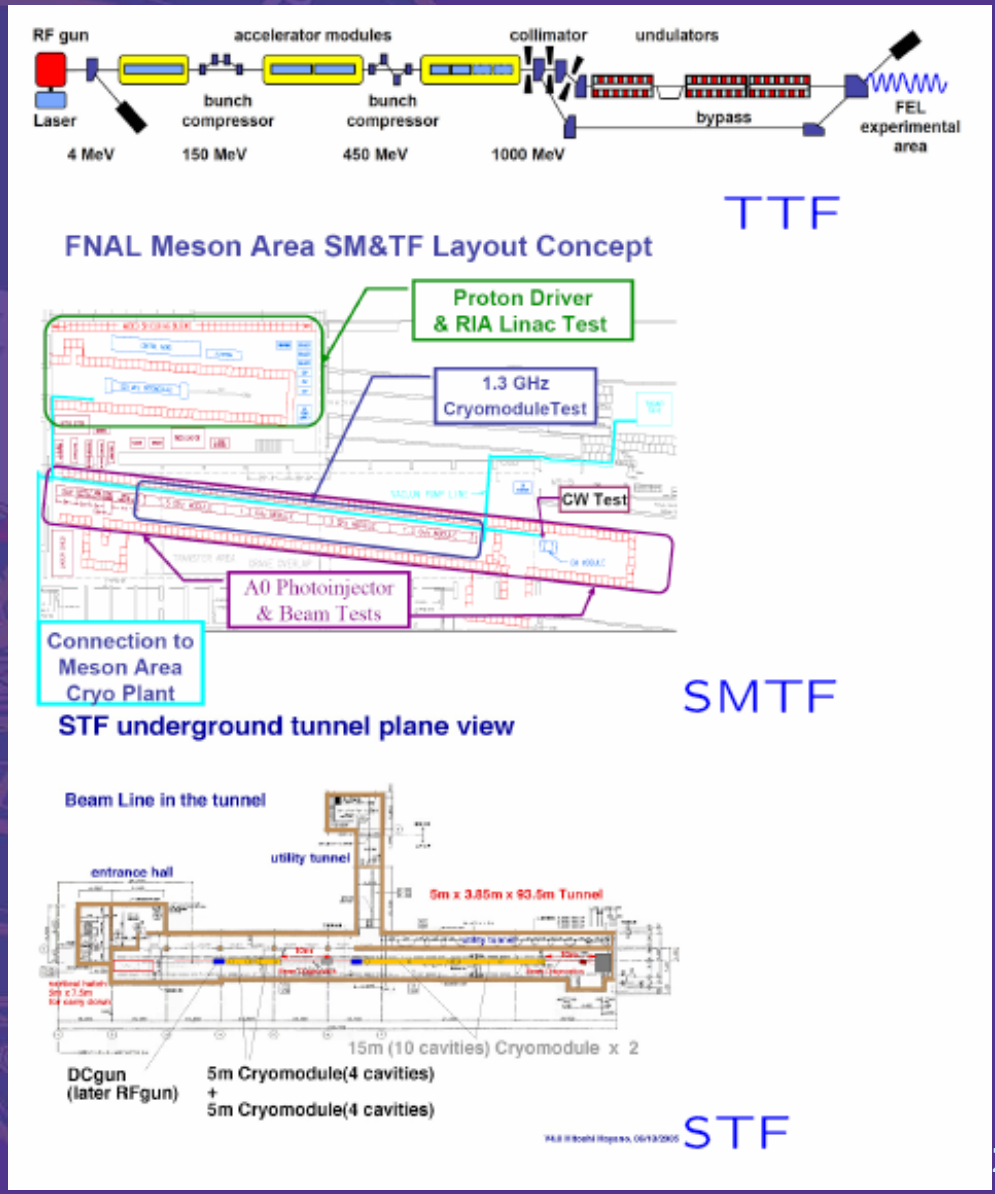
- **BCD - 2 IPs shifted.**

Tunnel length

- **Options:**
  Build full 1 TeV-length tunnel and only populate the first half;
  Build full 1 TeV-length tunnel and use the full length with gaps;
  Build only 500 GeV-length tunnel and extend to 1 TeV length as subsequent upgrade.
- **The BCD is the short tunnel. The long tunnel half full should be an option we will present to governments with the suggestion that it would be very sensible to build the whole tunnel.**

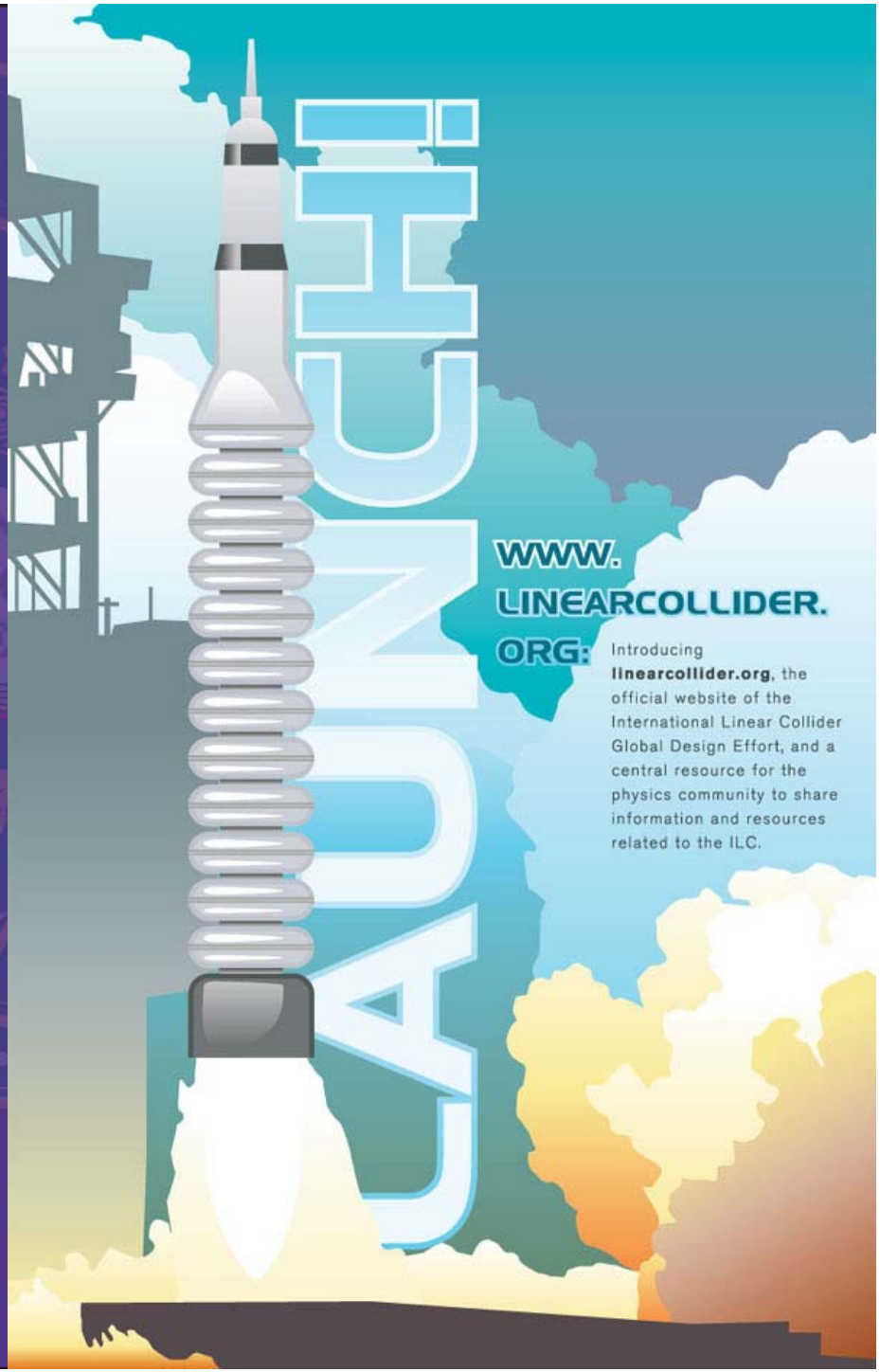
Test facilities

- TTF exists at DESY, SMTF (FNAL), STF (KEK):
- Stimulate SC industry in the regions - collaborate on SC technology



ILC Communications

- Launch of New ILC Website @ Snowmass
  www.linearcollider.org
- "One Stop Shopping"
  - electronic data management system (EDMS), news, calendar of events, education and communication



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- Around the World
- Calendar
- Glossary

Latest News

9 August 2005
ILC GDE Press Release
World's Particle Physicists to Address Scientific Revolution at Snowmass, Colorado Workshop, August 14-27
Read release...

6 July 2005
***National Geographic*:**
Scientists Ponder Universe's Missing Antimatter
Read story...

ILC News Archive from Interactions.org

Latest Documents

Discovering the Quantum Universe:
The Role of Particle Colliders
Report for EPP2010

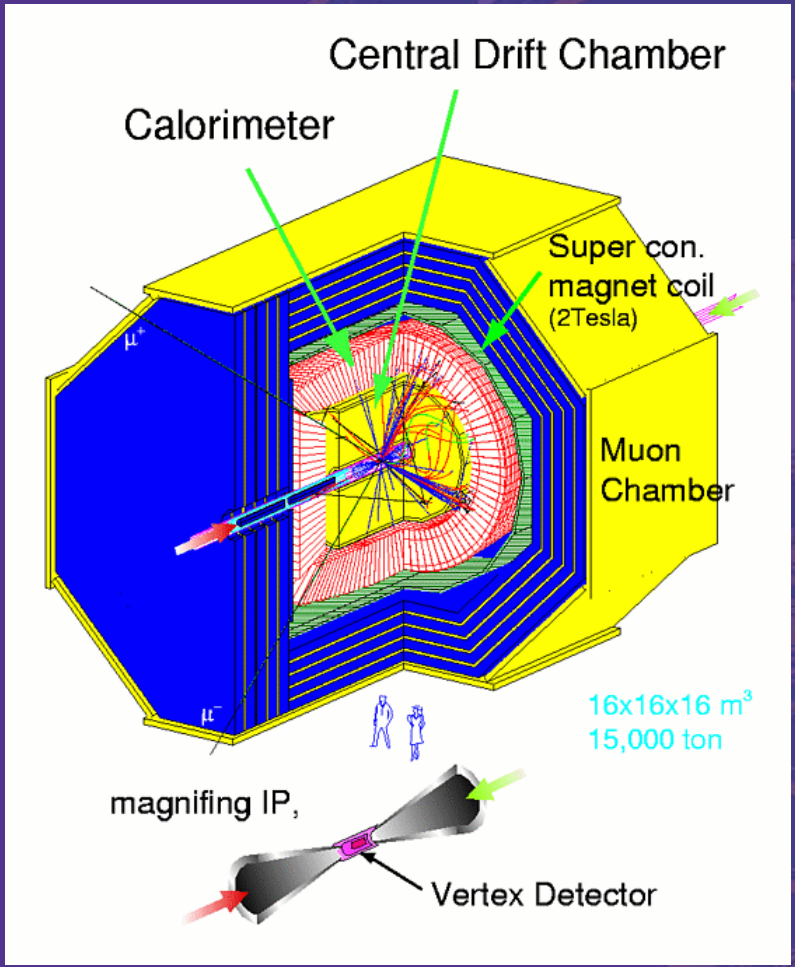
Features

2005 Snowmass Workshops
Information and schedules
Highlights posted twice per day

symmetry - August 2005
The ILC issue

Talk: The ILC Global Design Effort
Barry Barish
EPP2010, 2 August 2005

Detector Concepts and Challenges

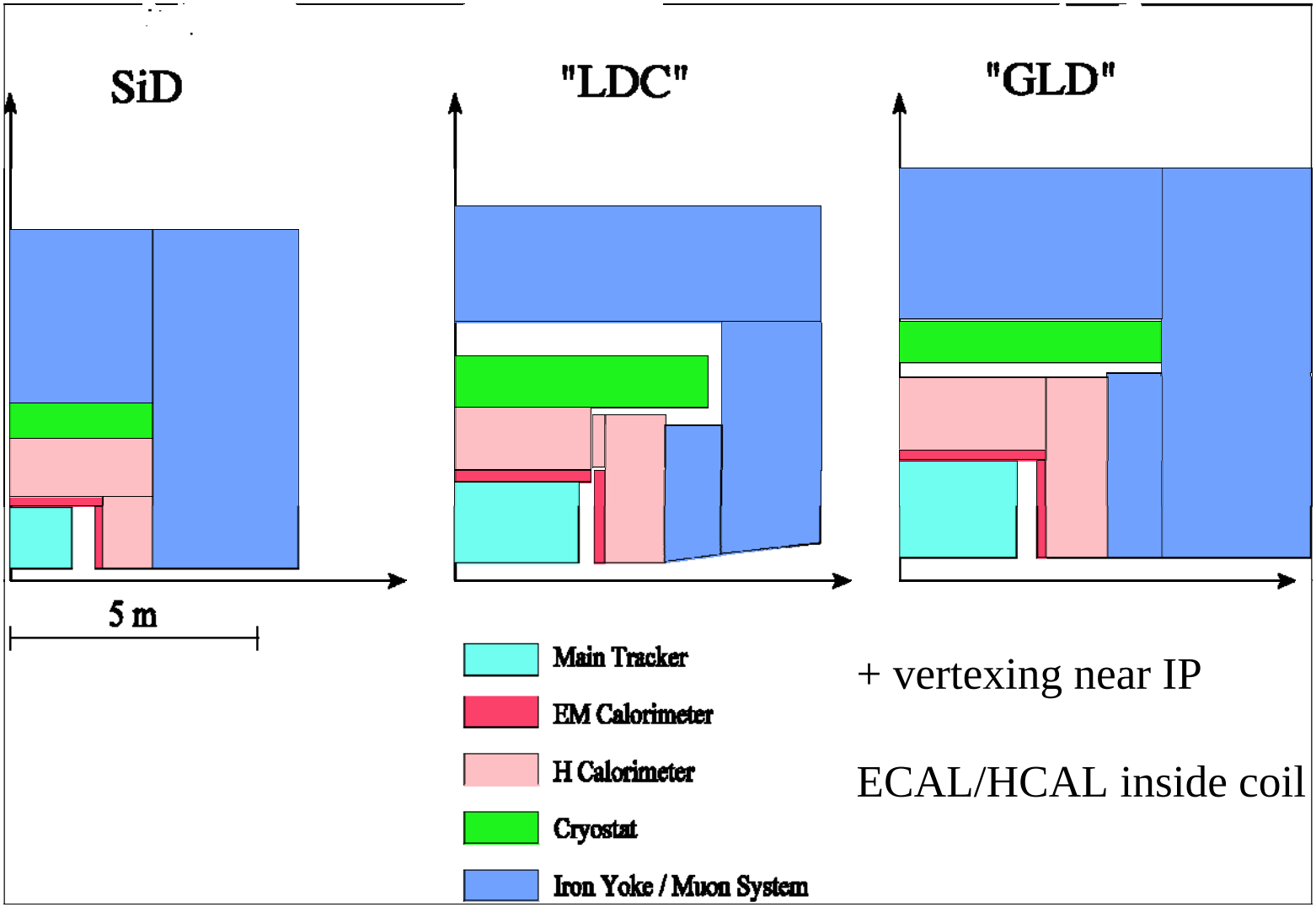


- Three concepts under study
- Typically requires factors of two or so improvements in granularity, resolution, etc. from present generation
- Focused R&D program required to develop the detectors -- end of 2005
- Detector Concepts will be used to determine machine detector interface, simulate performance of reference design vs physics goals next year.

Snowmass - detectors

- SiD (American origin)
  - Silicon tracker, 5T field
  - SiW ECAL
  - 4 ‘coordinators’ (2 Americans, 1 Asian, 1 European)
- LDC (European origin)
  - TPC, 4T field
  - SiW ECAL (“medium” radius)
  - 6 ‘contact persons’: (2 Americans, 2 Asians, 2 Europeans)
- GLD (Asian origin)
  - TPC (+Silicon IT), 3T field
  - W/Scintillator ECAL (“large” radius)
  - 6 ‘contact persons’: (2 Americans, 2 Asians, 2 Europeans)

Snowmass - detectors



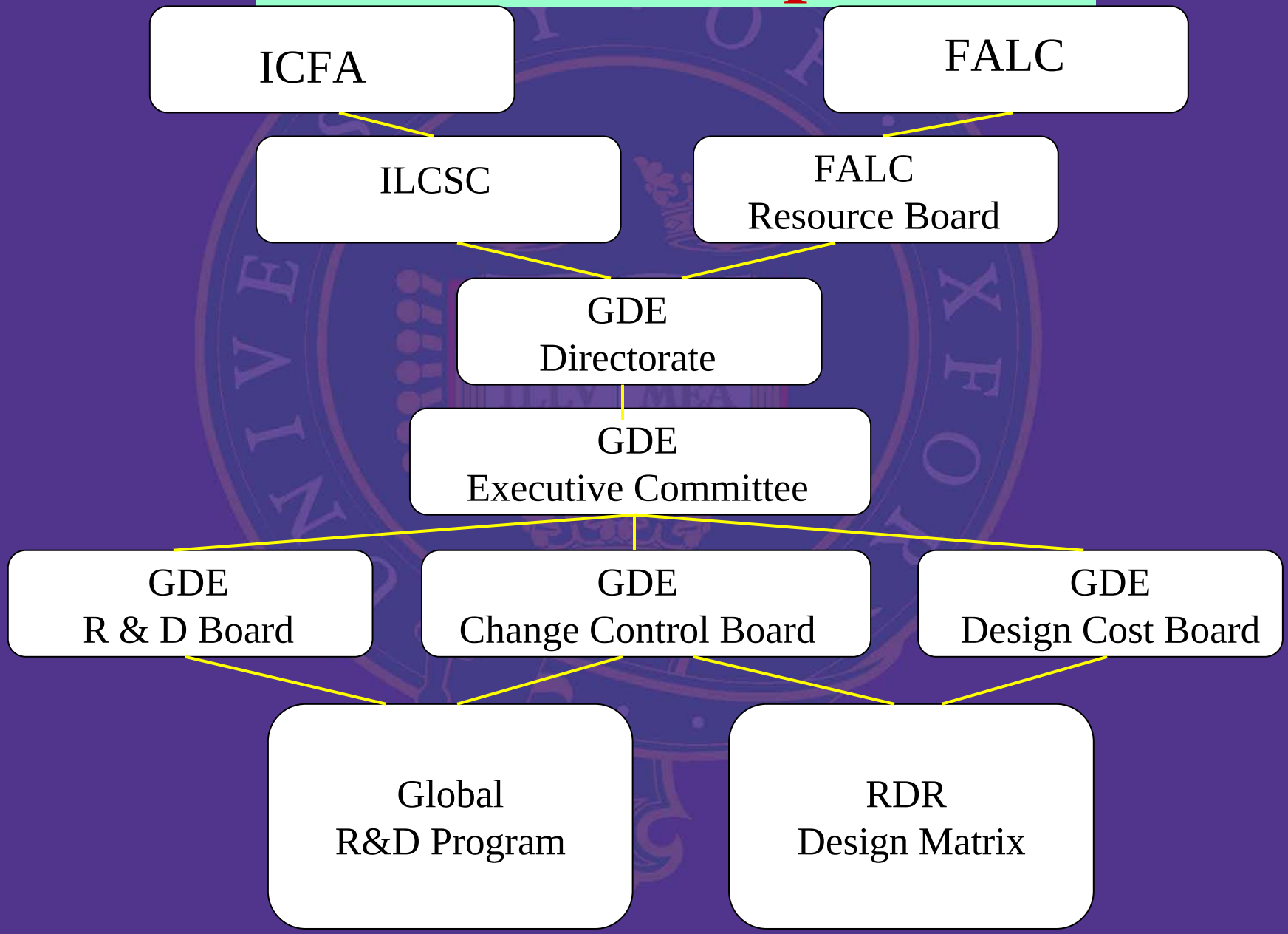
Next steps for GDE

- RDR will take forward the BCD, refine the design and in particular gather industrialisation data in order to form the basis for reliable cost estimate with the RDR.
- Need to put new structures & people in place for next step to RDR.
- Aim is to have all the new structures operating well and giving a status report by the next GDE meeting in March in Bangalore.

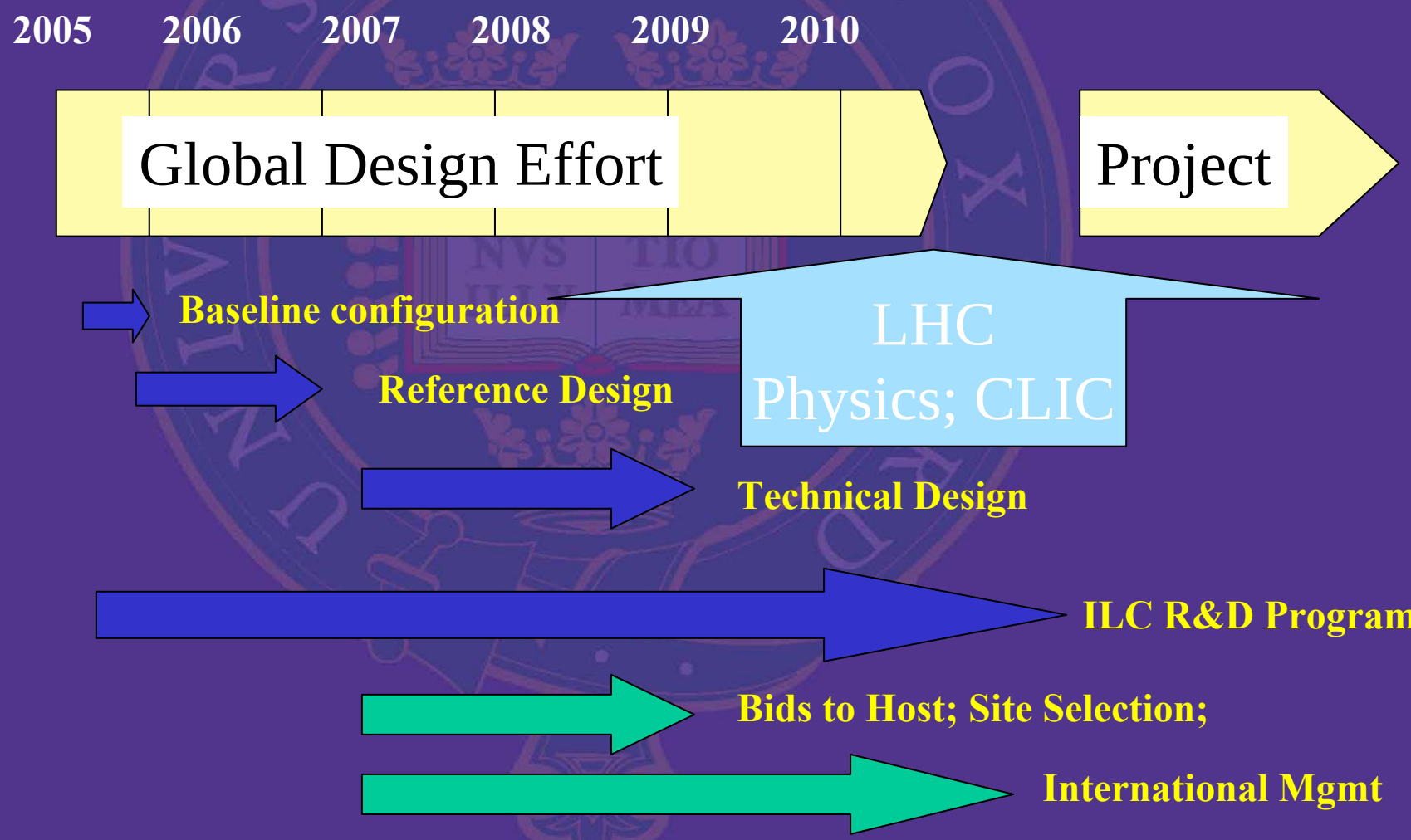
Next steps

- There will be 3 new boards: Change Control Board; Global R&D Board; Design & Cost Board.
- The RDR will be produced using a matrix structure of “area systems” and “technical systems” to account for the structure of the project.

Next steps


ICFA
FALC
ILCSC
FALC
Resource Board
GDE
Directorate
GDE
Executive Committee
GDE
R & D Board
GDE
Change Control Board
GDE
Design Cost Board
Global
R&D Program
RDR
Design Matrix

GDE Plan & Schedule



Summary

- The GDE is functioning well and growing.
- The Baseline Design for the ILC is complete. Lots of real work is going on as well as the necessary organisation.
- Frascati meeting finalised the BCD and kick-started us into the next, RDR, phase. Three more meetings planned this year - Bangalore, Vancouver and Valencia - the RDR is planned to be ~ finished by Valencia in 11/06. Then onwards & upwards to TDR.
- The ILC is gathering momentum!!!