Status of the ILC

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EUDET Annual Meeting

19. October 2006

Disclaimer

- I am not a GDE member!
- So all I will present in this talk does not reflect any official position about the ILC and might well be wrong or outdated!

ILC Timeline

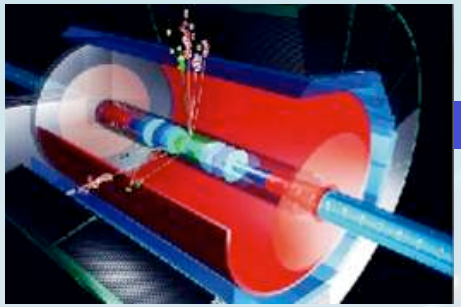
2005 2006 2007 2008 2009 2010

Global Design Effort → **Project**

Baseline configuration

Reference Design

Technical Design



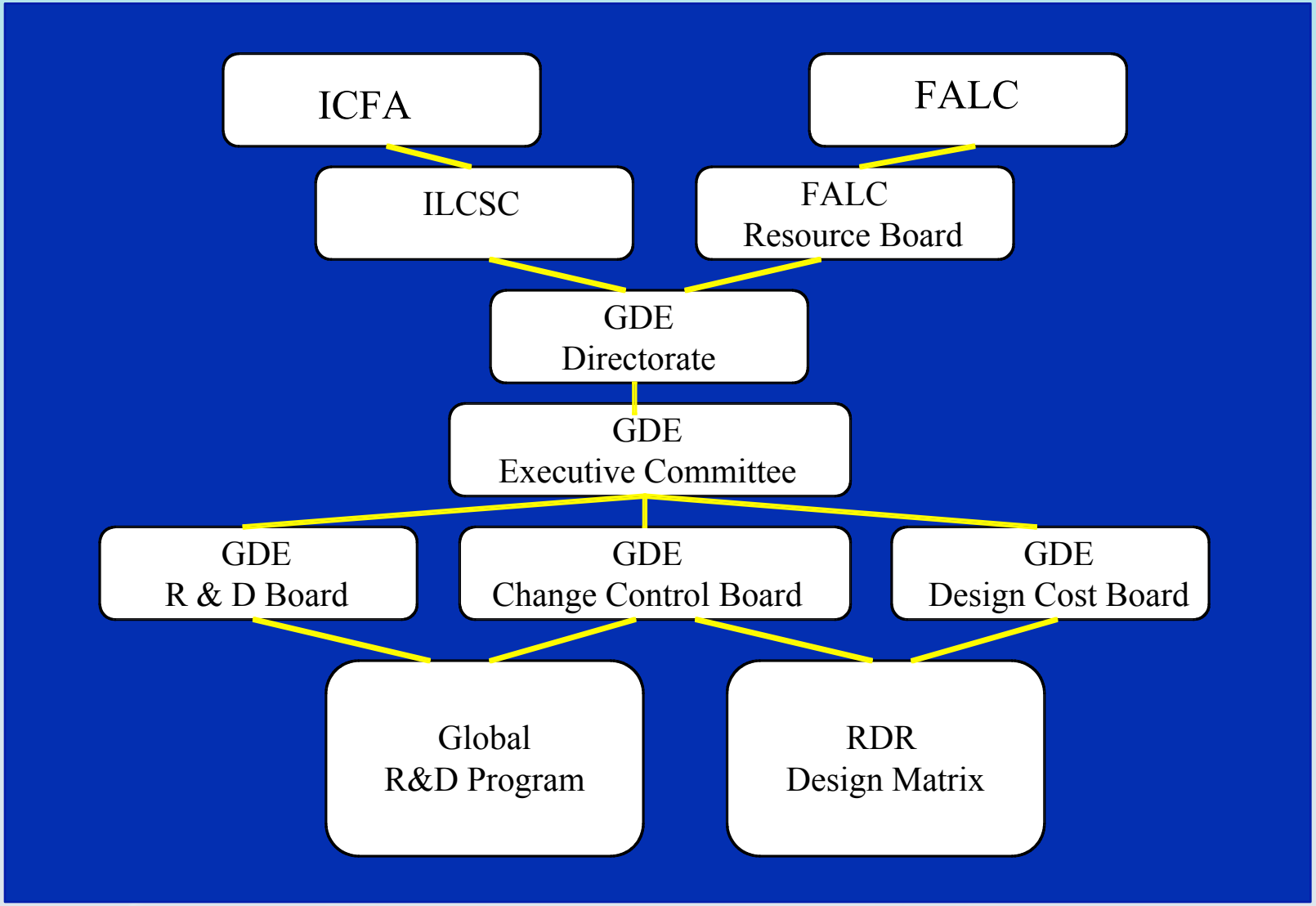
ILC R&D Program

Expression of Interest to Host

International Mgmt

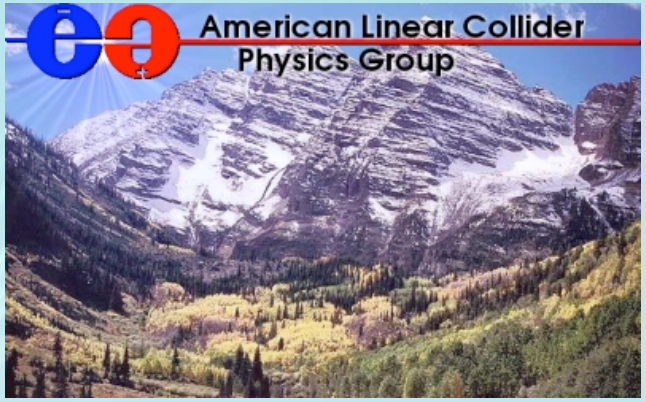
B. Barish

The Structure of the ILC



The ILC Baseline

- The ILC baseline has been developed from the discussions at Snowmass 2005.
- The baseline was documented in the ‚Baseline Configuration Document' BCD and finalised at the GDE meeting in Frascati in November 2005.
- BCD also contains ‚alternatives': design choices which offer attractive benefits (better physics, less cost) and may become baseline but still need more R&D.



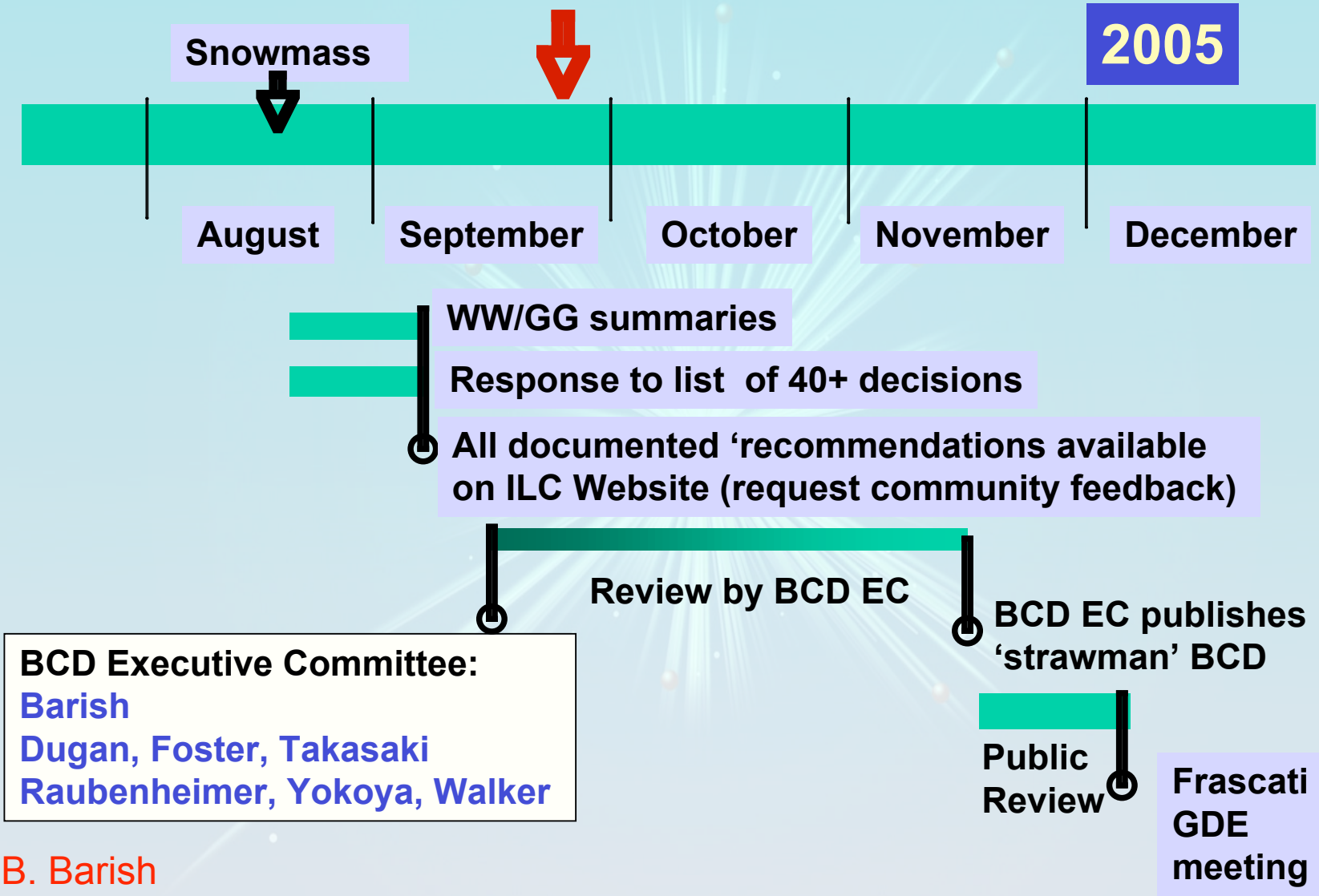
The International Linear Collider

Global Design Effort

Baseline Configuration Document

http://www.linearcollider.org/wiki/doku.php?id=bcd:bcd_home

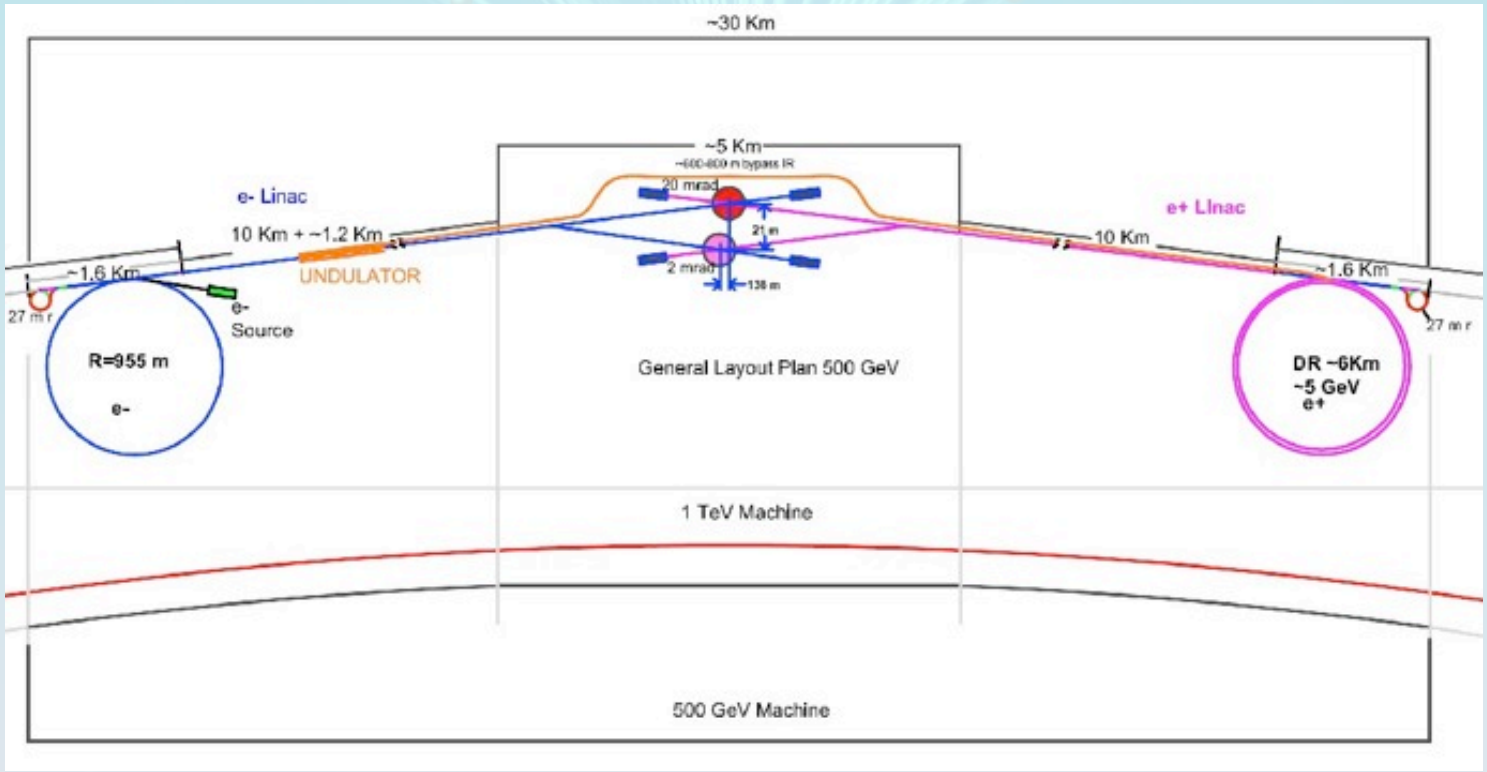
From Snowmass to the BCD



B. Barish

ILC Baseline Design

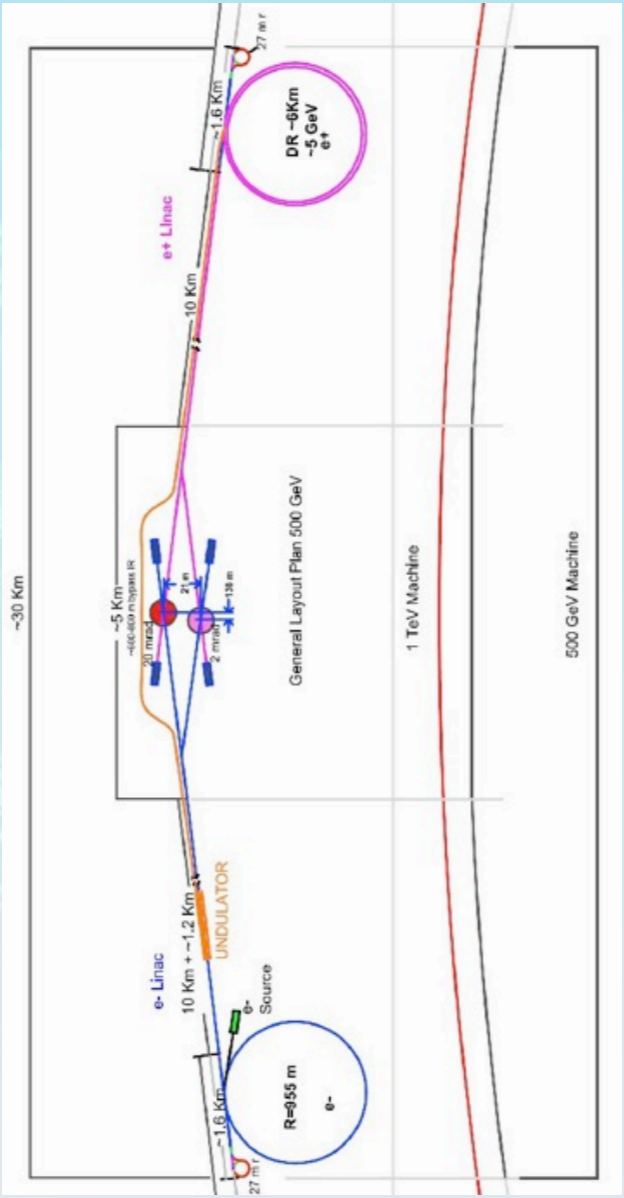
- The baseline design was mainly driven by physical and technical requirements.
- Cost consciousness was always important but gets it even more now that realistic cost estimates are collected in the GDE.



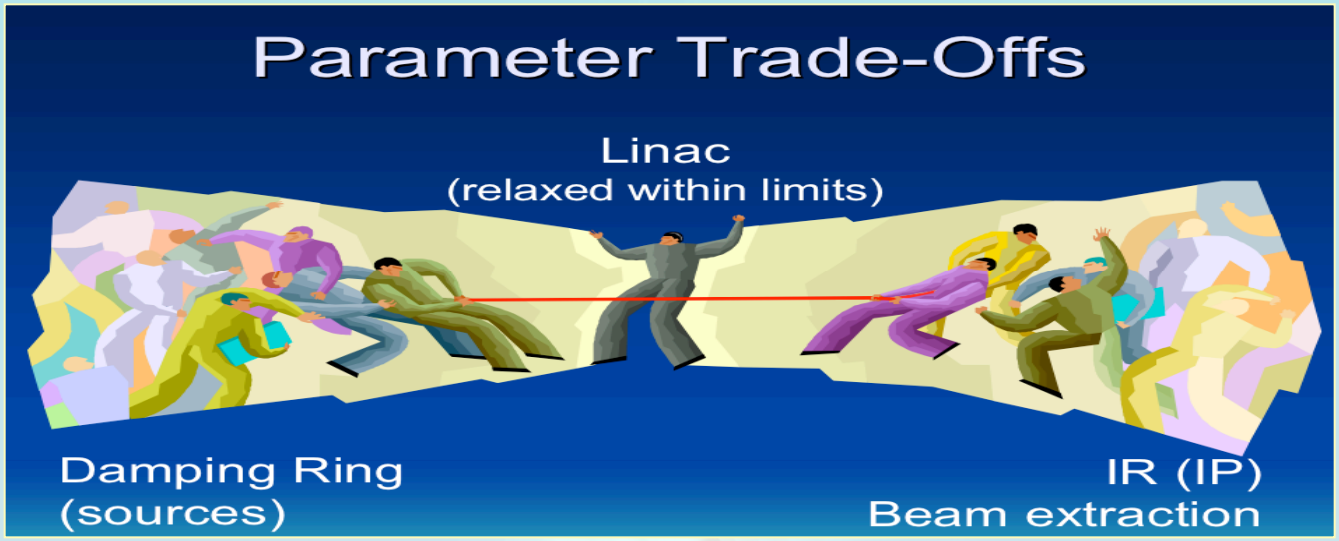
ILC 500 GeV Frascati Baseline

- Two Linacs of ~10km length following the curvature of the earth
- Operating gradient of 31.5 MV/m
- Laser straight beam delivery system with two interaction regions, 2 and 20 mrad crossing angles
- Three damping rings of ~6.7 km circumference (one for electrons, two for positrons)
- Undulator based positron source (allows for polarised positrons from the beginning)
- Upgrade path to 1TeV: extend the tunnels by 2 x 9.3 km, add cavities with 36 MV/m gradient
- Design Luminosity: $2x10^{34}cm^{-2}s^{-1}$

- The ILC Baseline has been put under configuration control
- Changes to the baseline need to undergo a decision process initiated and controlled by the GDE Change Control Board (Chair: N. Toge)



The ILC Parameter Space



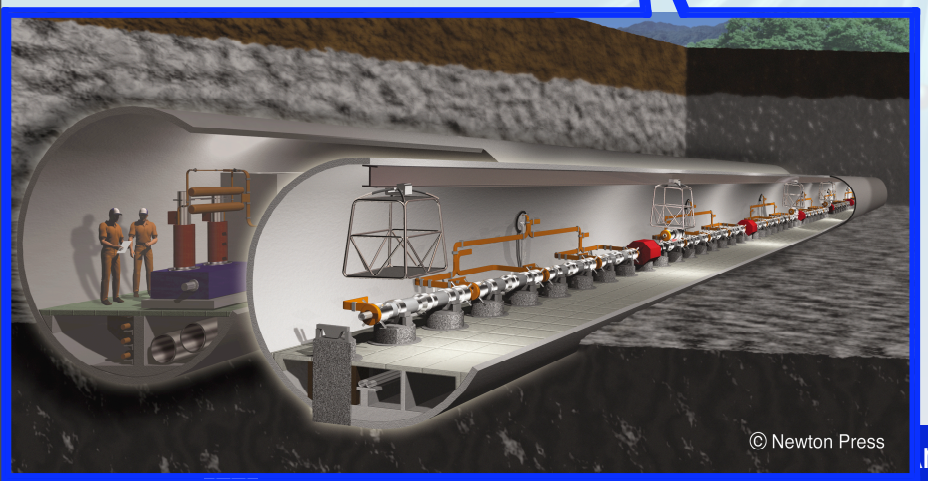
		min		nominal		max	
Bunch charge	N	1	-	2	-	2	$\times 10^{10}$
Number of bunches	n_b	1330	-	2820	-	**5640**	
Linac bunch interval	t_b	**154**	-	308	-	461	ns
Bunch length	σ_z	**150**	-	300	-	500	μm
Vert.emit.	$\gamma\epsilon_y^*$	**0.03**	-	0.04	-	0.08	mm-mrad
IP beta (500GeV)	β_x^*	**10**	-	21	-	21	mm
	β_y^*	**0.2**	-	0.4	-	0.4	mm
IP beta (1TeV)	β_x^*	**10**	-	30	-	30	mm
	β_y^*	**0.2**	-	0.3	-	0.6	mm

ILC Facility

Main Research Center

Particle Detector

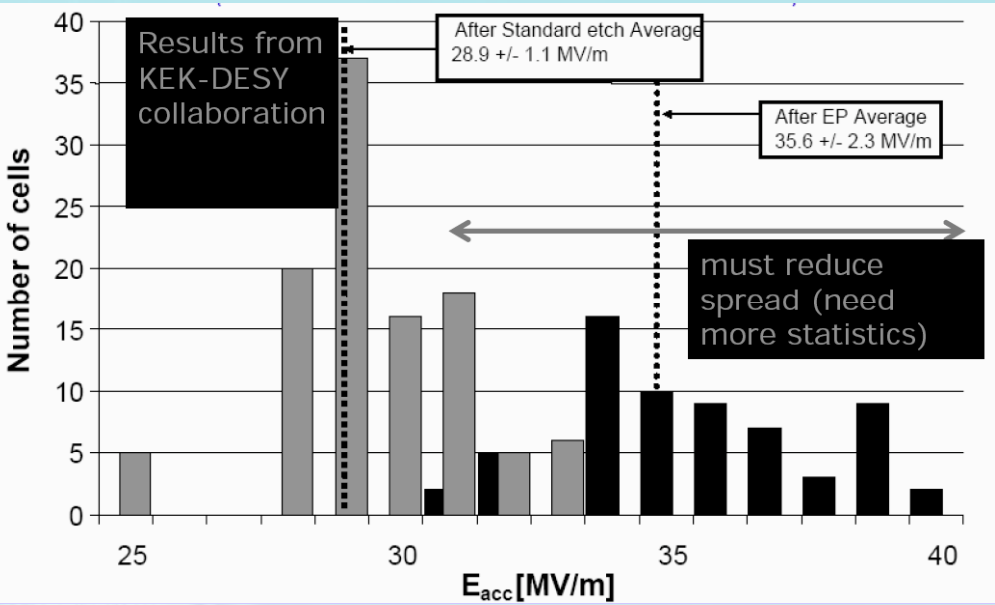
~30 km long tunnel

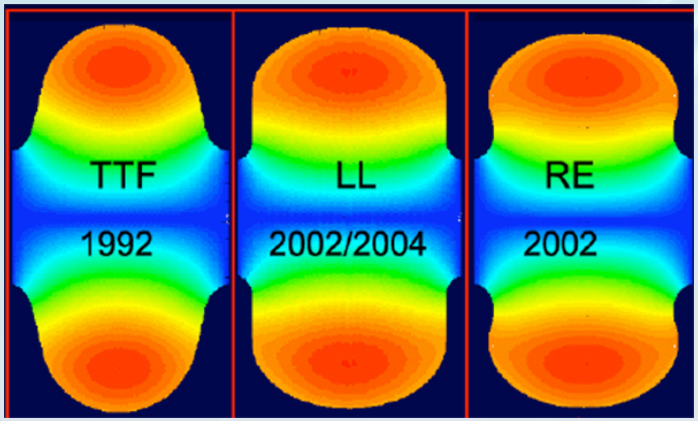


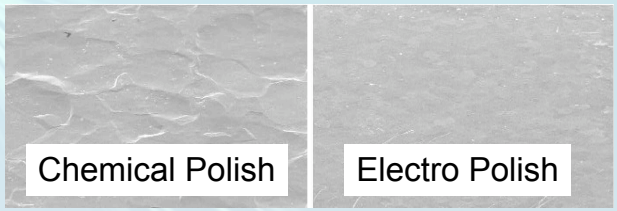
Two tunnels

- accelerator units
- other for services - RF power

R&D on Superconducting Cavities



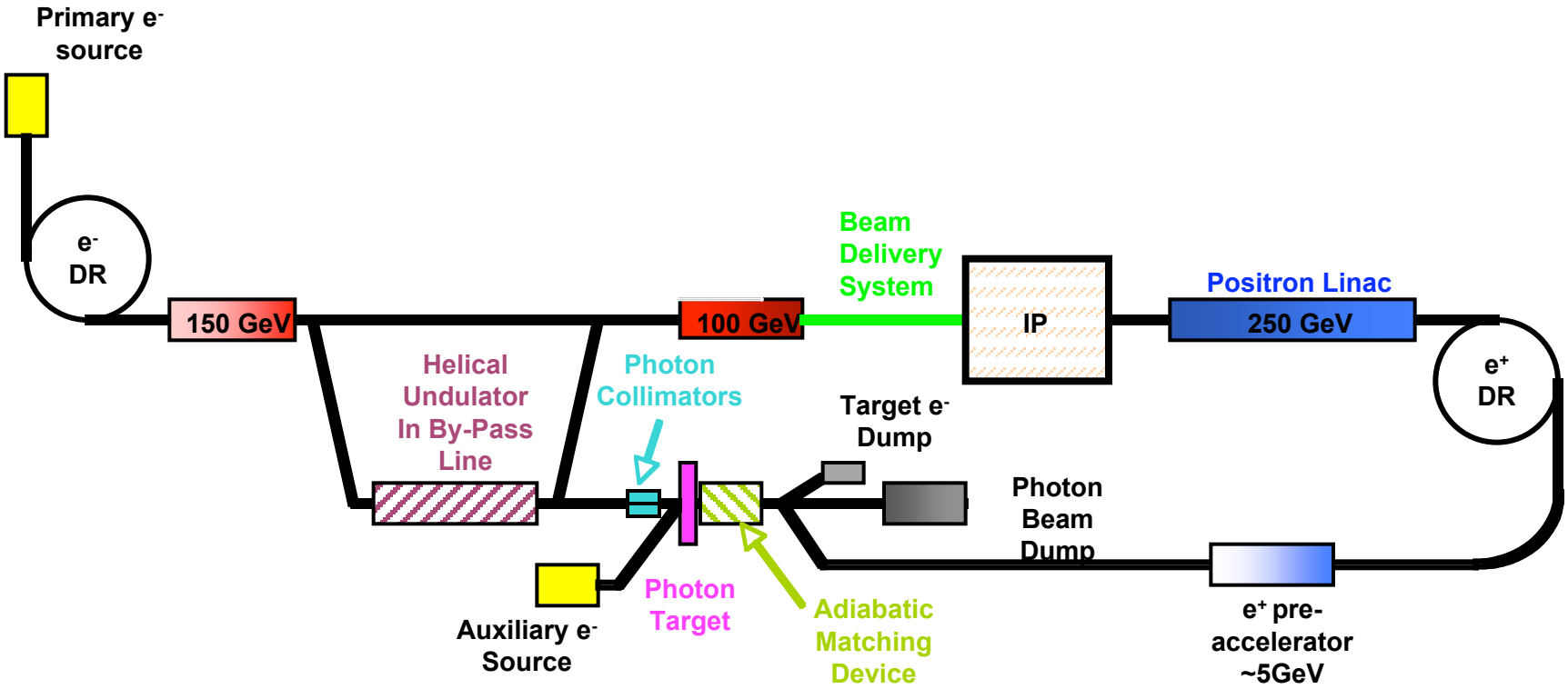




	Cavity type	Qualified gradient	Operational gradient	Length	Energy
initial	TESLA	35 MV/m	31.5 MV/m	10.6	250
upgrade	LL	40 MV/m	36 MV/m	+9.3	500

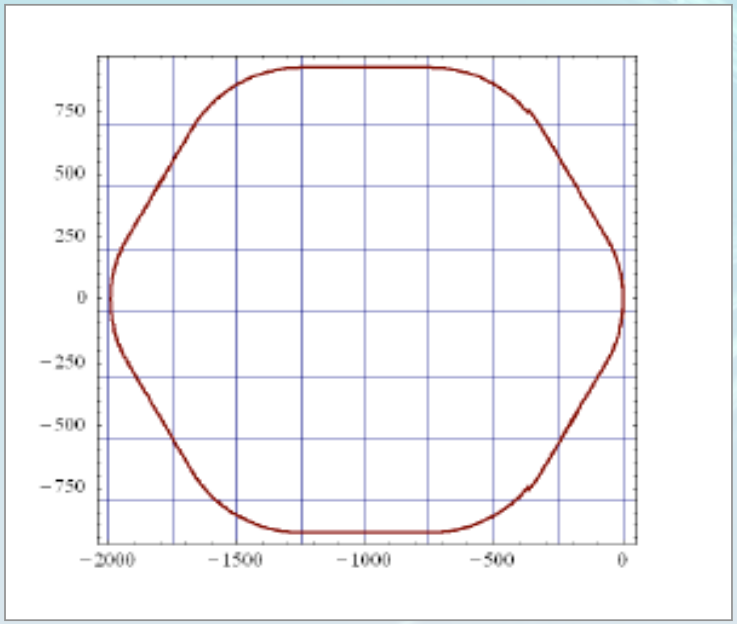
Positron Source

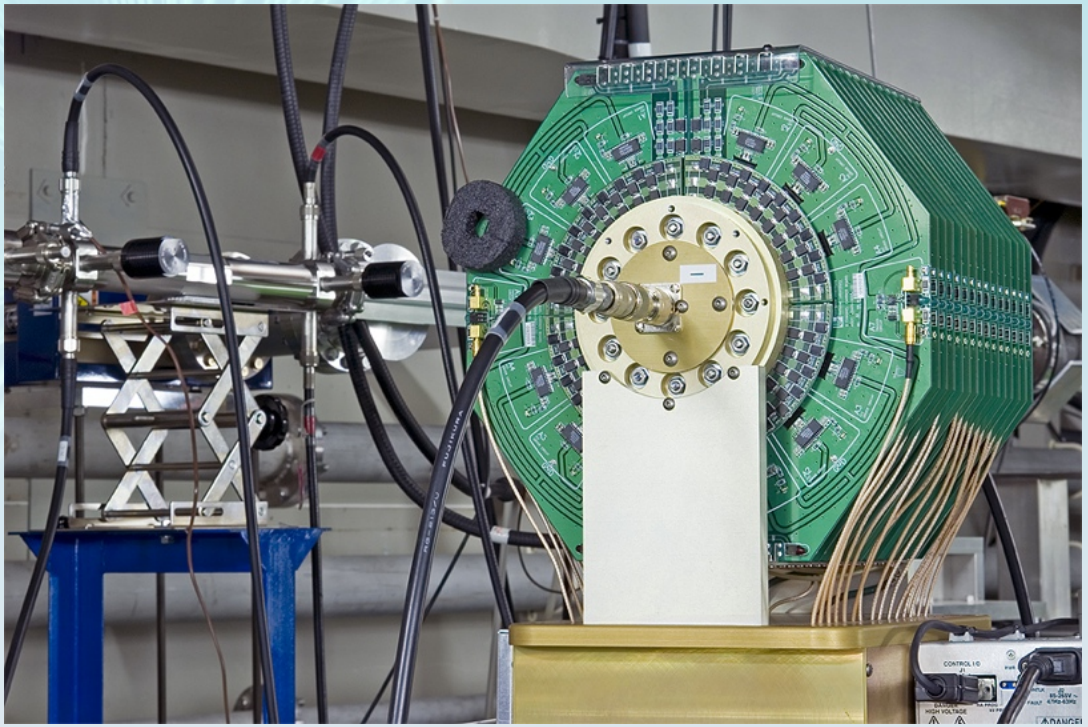
- Helical Undulator Positron Source with Polarised Beams



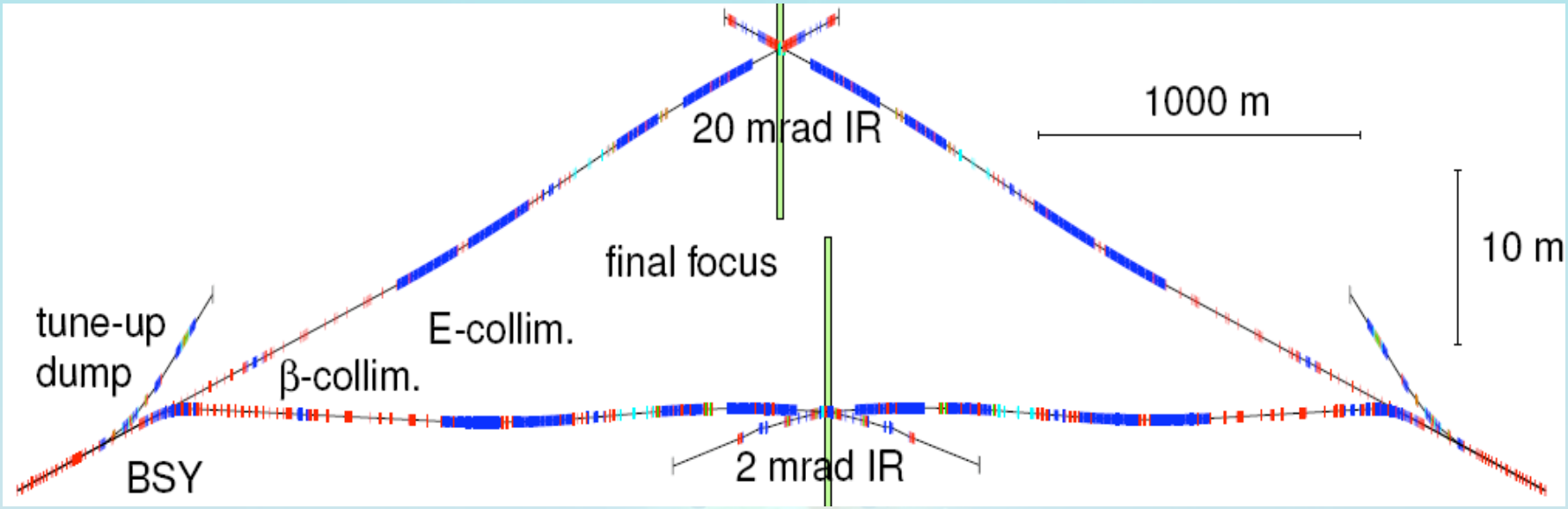
Damping Rings

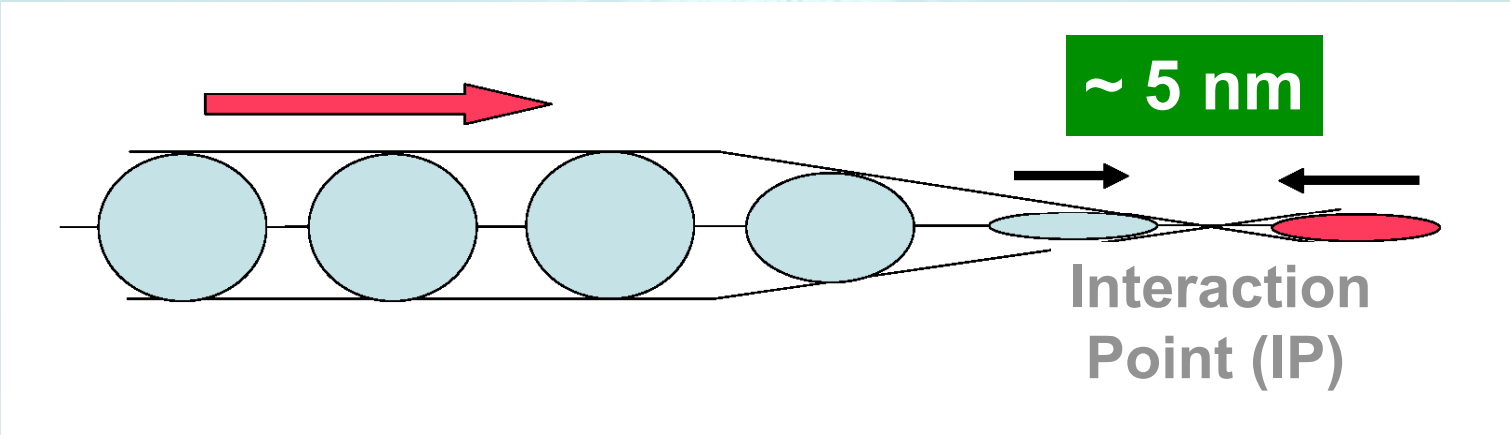
- Challenge: store 295 km long bunch train in a 6 km ring
- Requires very fast kickers
- Lots of challenging accelerator physics



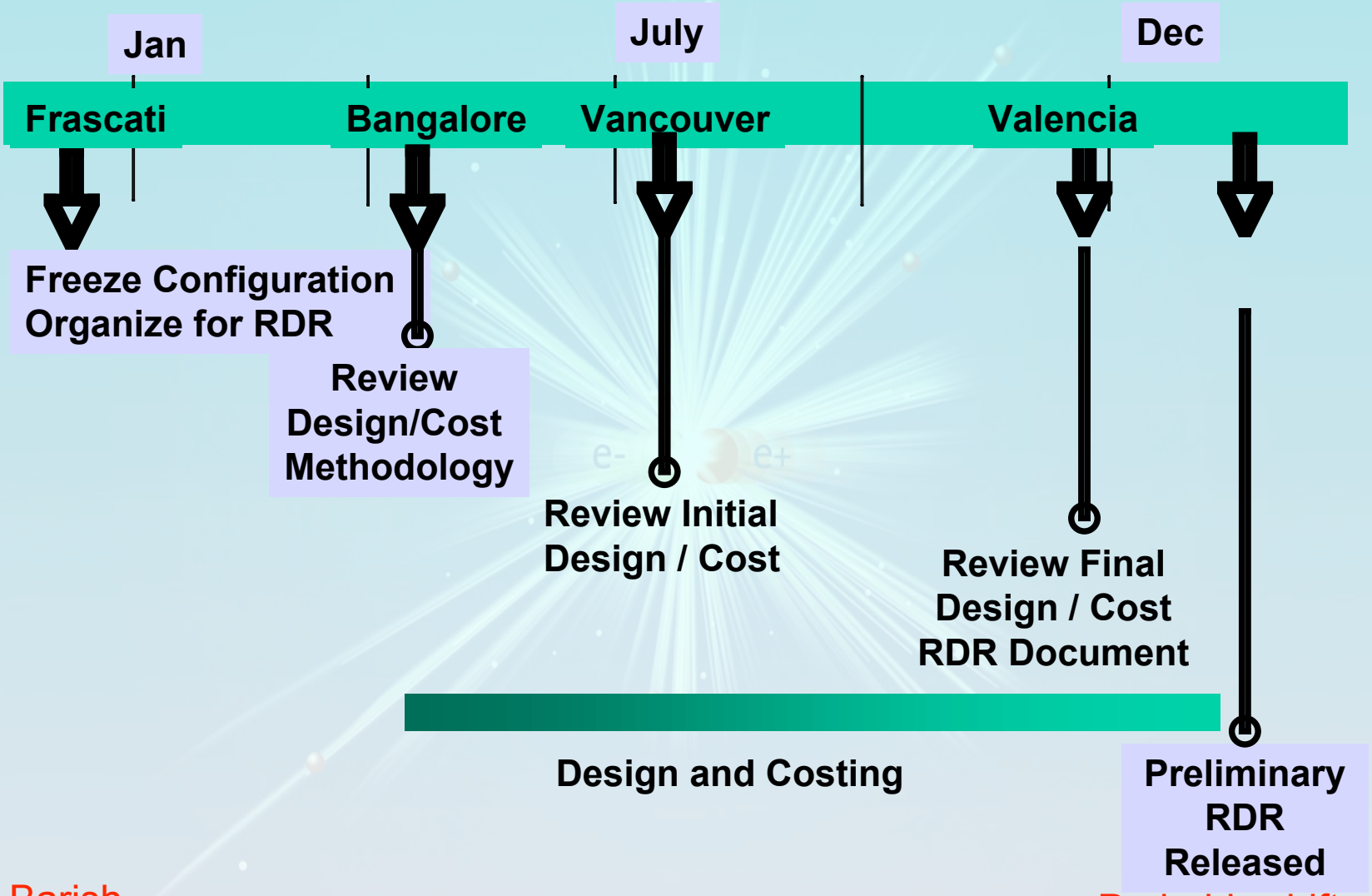


Beam Delivery System





The Way to the RDR



B. Barish

Probably shifted to 02/2007 (ACFA WS)

The Reference Design Report

- High level description of accelerator, sites and cost
  - Executive Summary
  - Accelerator Design
  - Technical and Global Systems
  - Conventional Facilities
  - Sites
  - Costs
  - TDR R&D Plan
- Editor: Nan Phinney
- Co-editors: Nick Walker, Nobu Toge
- Total pages: ~250
- Accompanied by the Detector Concept Report DCR
- Draft ready at the Valencia meeting (Nov 06)
- Publication most probably at Beijing meeting (Feb 07)

The Detector Concept Report

- Physics
- Detector Concepts
  - We can do ILC physics
  - We have different and complementary solutions
  - We have a clear vision on how to reach the goals (R&D)
  - We have some understanding of the detector costs
- Integrated presentation of the Concepts
- Case for two Detectors/IRs

- Physics editors: K. Moenig, A. Djouadi, M. Yamaguchi, Y. Okada, M. Oreglia, J. Lykken
- Detector editors: T. Behnke, C. Damerell, J. Jaros, A. Miyamoto
- Cost analysis of concepts: M. Breidenbach, H. Maki, H. Videau
  - →interaction with GDE Cost Board

The Glossy ILC Report

- Translate the RDR and DCR into an exciting and enticing story for governments, funding agencies and policy-makers
- Lead with science!
- First Step: Appoint a board with chair, ILC communicators and representation from all regions and detector/machine communities
- Solicit feedback from our “customers” and produce a glossy report (25-35 pages?)
- Publish report in early 2007, coordinated with the preparation and release of the RDR and DCR

ILC Costing

- RDR should contain a price tag with ~20% accuracy
- Follow ITER „Value“ and CERN „CORE“ model for international projects
  - Provides basic agreed costs → common „value“ plus in-house labour
- RDR will provide information for translation into any country‘s cost estimating metric, e.g. how to handle contingencies, in-house labour, etc.
- Assumes 7 years construction time
- Based on a call for world-wide tender →lowest reasonable price for required quality
- Site-specific costs are considered accordingly
- Final way of presentation of multiple costs is still under discussion

Costs Roll-ups

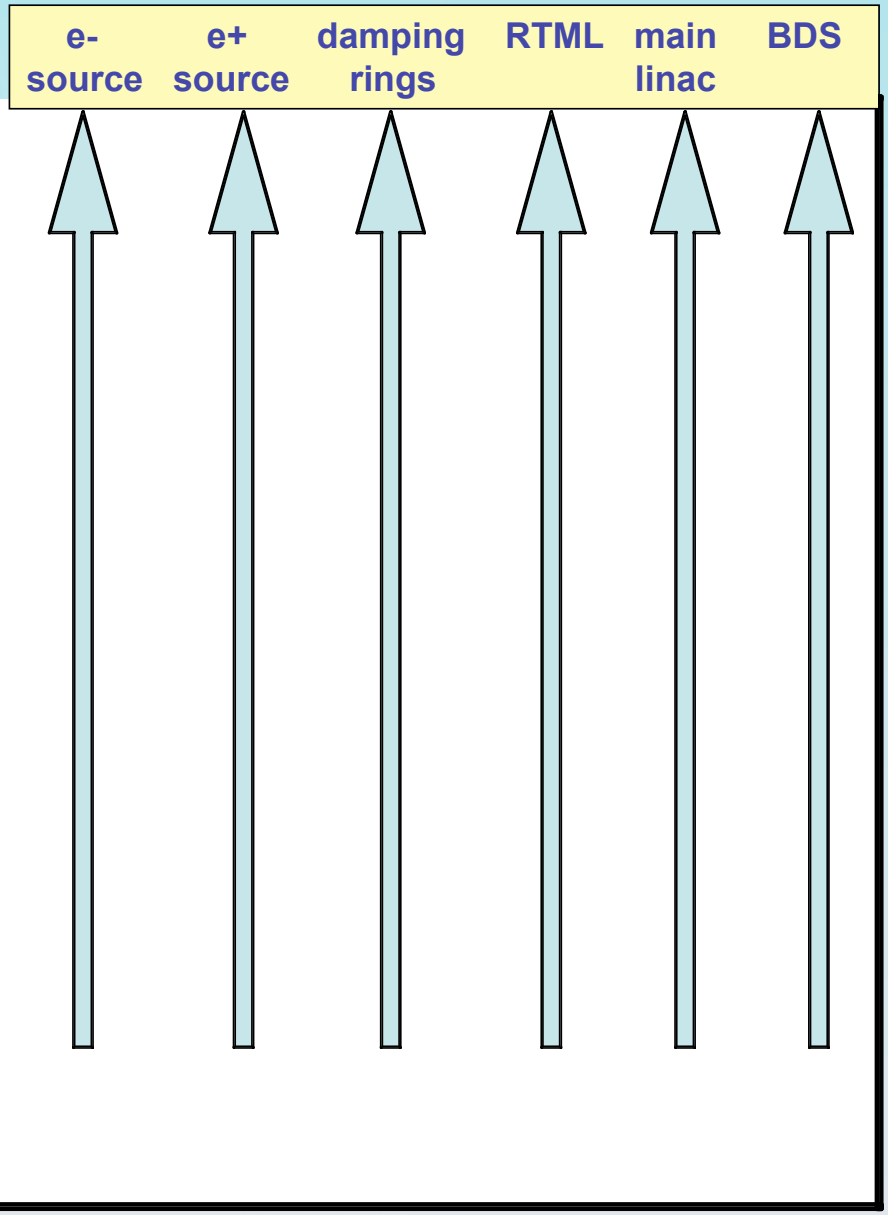
Area Systems

Technical Systems

- Vacuum systems
- Magnet systems
- Cryomodule
- Cavity Package
- RF Power
- Instrumentation
- Dumps and Collimators
- Accelerator Physics

Global Systems

- Commissioning, Operations & Reliability
- Control System
- Cryogenics
- CF&S
- Installation



The ILC Baseline after Vancouver

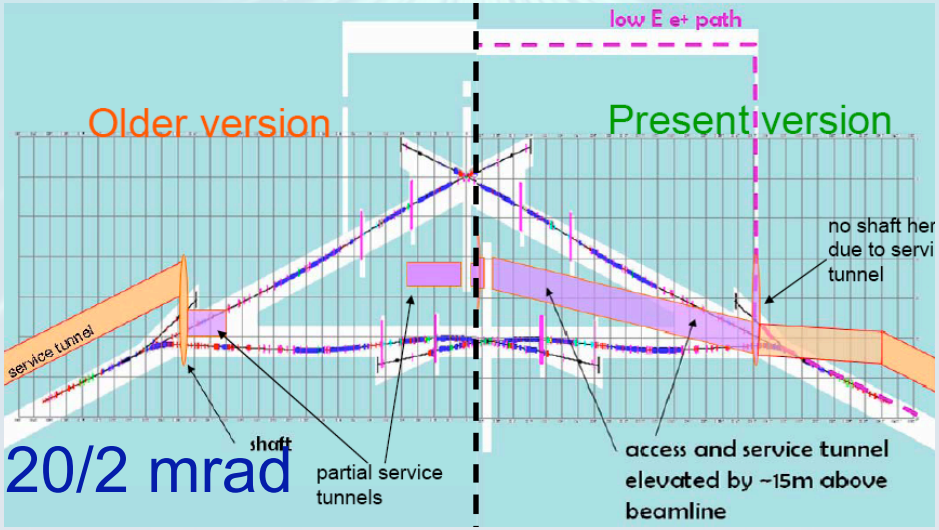
- The Vancouver Workshop (July 2006) was the first important milestone for the GDE on its way to the Reference Design Report RDR
- First numbers for realistic costing of the subsystems have been assembled in Vancouver
- Cost discussion is very confidential
  → Cost Disclosure Rules!
  Just four people have the complete overview: GDE director and three cost engineers

- From the reactions of the GDE it is save to assume that the first assembled cost numbers were rather high
- Cost cutting measures have been discussed in Vancouver and are just started to being realised

- First change requests to the CCB are coming in!

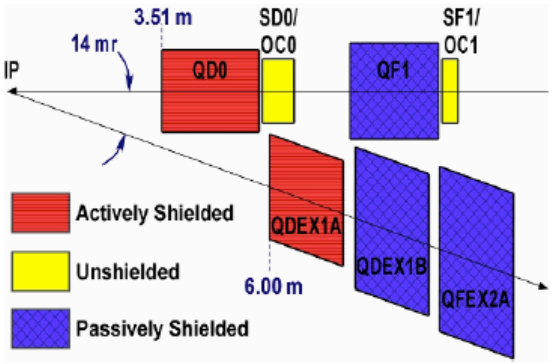
BDS Change Request: Crossing Angle

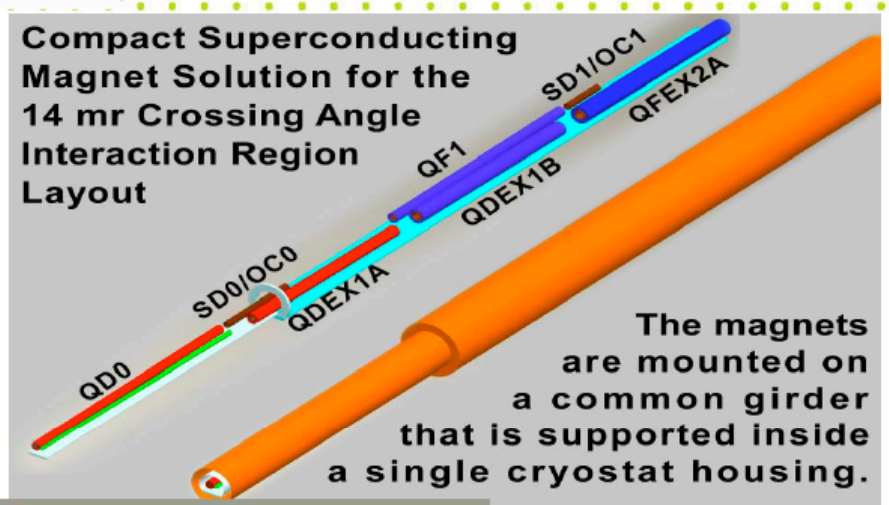
- Beam Delivery System change request
  - Submitted on July 29th to the CCB
  - Approved by GDE EC on September 21st.
- Changing the baseline from 2/20 mrad crossing angles to a symmetric configuration of 14/14 mrad
- Both detectors will be placed at the same longitudinal position (z=0) in one detector hall
- Reason: substantial cost savings

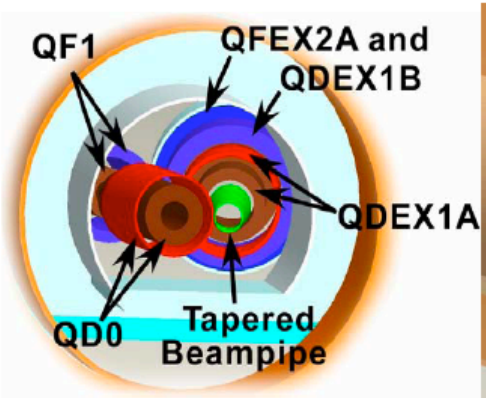


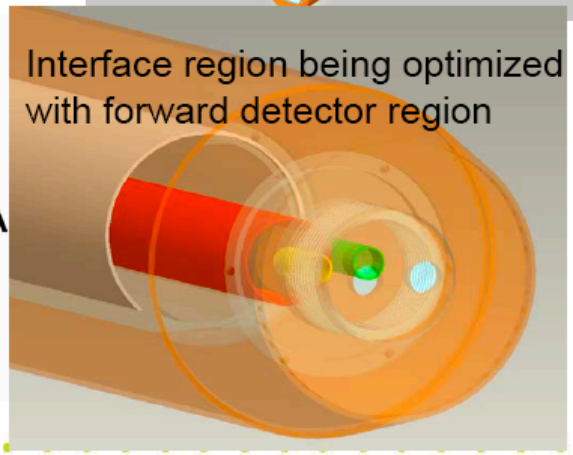
20/14 mrad IR

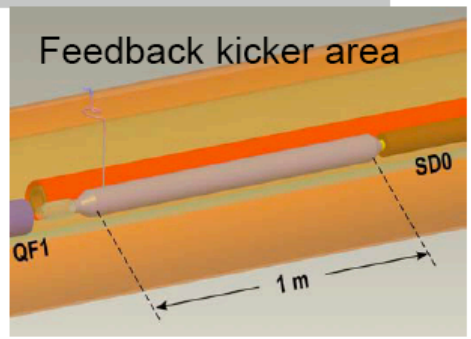
BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division











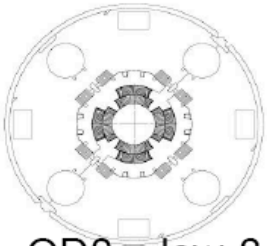
July 22, 2006 VLCW06

Global Design Effort

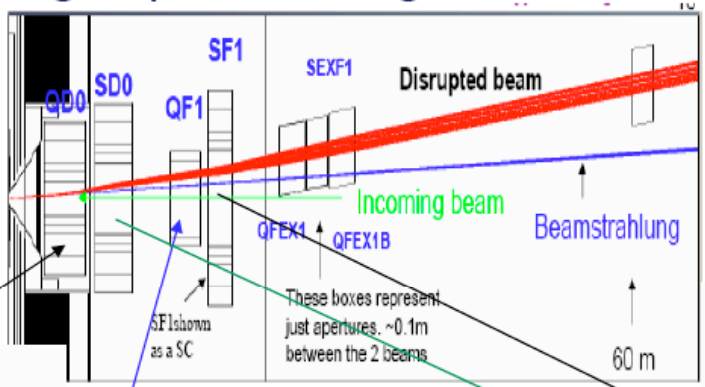
BDS R & D 8

2 mrad IR

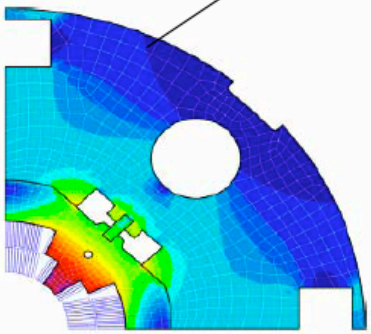
- To extract the disrupted spent beam+ beamstrahlung requires large aperture magnets



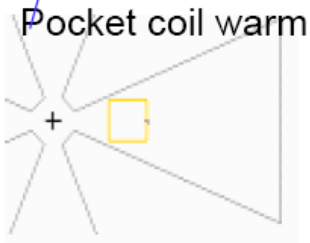
QD0 ~ low-β
LHC quad



Large aperture,
R= 88 mm (SD0),
112 mm(SF1)
sextupole design

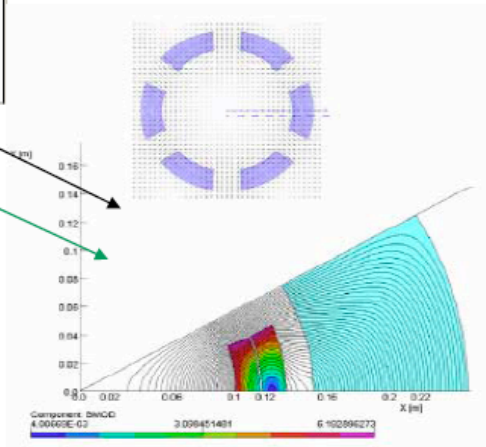


Kashikhin, FNAL



Pocket coil warm QF1

Spencer, SLAC



Kashikhin, FNAL

BDS Change Control Request: Detector Assembly

- The BDS group has submitted a second CCR regarding the assembly procedures of the detector
  - So far underground assembly was assumed
  - Now suggestion to go to a surface assembly model
- Idea: Prepare a large enough surface hall in which the detector parts can be assembled and commissioned as far as possible
- Lower the detector segments later when the underground facilities are available

➡ CMS like assembly model

- Advantages:
  - smaller underground hall needed → cost reduction
  - timing problems: GDE CFS people claim that underground hall will be ready so late that the goal of starting physics runs 8 years after approval cannot be met

Detector Assembly Timelines

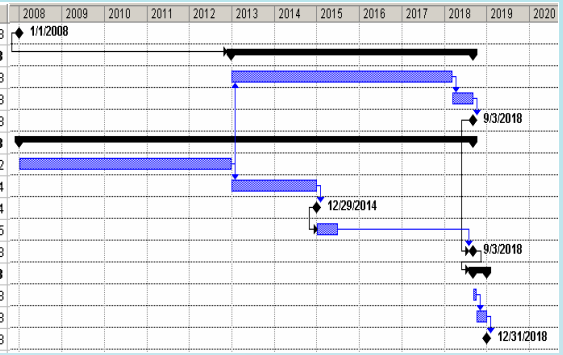
- Underground hall ready
  4y11m after approval
  (CERN experience)

- Surface hall ready
  2y4m after approval

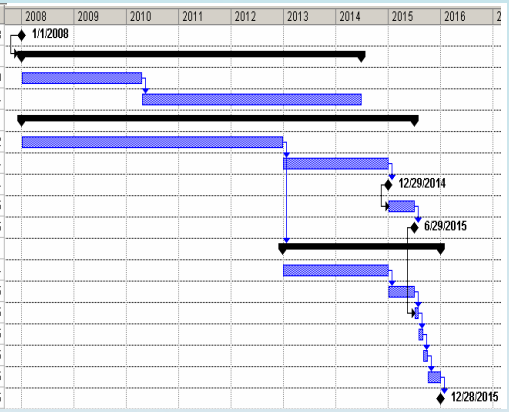
- Detector assembly
  245w (surface)
  270w (underground)

- Underground assembly
  would miss goal ‚physics 8 years after approval' by ~3 years

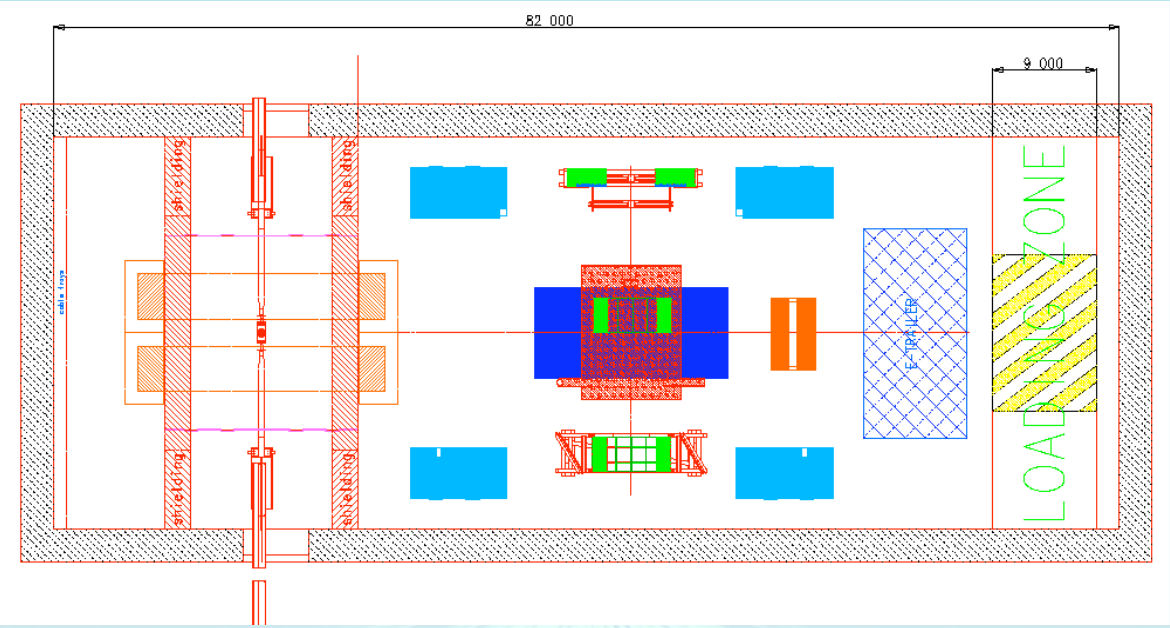
Task Name	Duration	Start	Finish
Project approved	0 days	1/1/2008	1/1/2008
Construct detector	**297 wks**	**12/25/2012**	**9/3/2018**
detector assembly	271 wks	12/25/2012	3/5/2018
detector underground commiss.	26 wks	3/6/2018	9/3/2018
Detector ready for IP	0 days	9/3/2018	9/3/2018
Construct beamlines	**557 wks**	**1/1/2008**	**9/3/2018**
prepare underground tunnels	260 wks	1/1/2008	12/24/2012
beamline hardware installation	105 wks	12/25/2012	12/29/2014
Start of beam commissioning	0 days	12/29/2014	12/29/2014
BDS beamline pre-commiss.	26 wks	12/30/2014	6/29/2015
IP ready for detector	0 days	9/3/2018	9/3/2018
Final assembly & commissioning	**17 wks**	**9/4/2018**	**12/31/2018**
Detector moved to IP	4 wks	9/4/2018	10/1/2018
Final beam commissioning	13 wks	10/2/2018	12/31/2018
Ready for physics run	0 days	12/31/2018	12/31/2018



Task Name	Duration	Start	Finish
Project approved	0 days	1/1/2008	1/1/2008
Construct detector	**338 wks**	**1/1/2008**	**6/23/2014**
prepare surface building for detector	120 wks	1/1/2008	4/19/2010
detector assembly	218 wks	4/20/2010	6/23/2014
Construct beamlines	**391 wks**	**1/1/2008**	**6/29/2015**
prepare underground tunnels	260 wks	1/1/2008	12/24/2012
beamline hardware installation	105 wks	12/25/2012	12/29/2014
Start of beam commissioning	0 days	12/29/2014	12/29/2014
BDS beamline pre-commissioning	26 wks	12/30/2014	6/29/2015
BDS ready for detector	0 days	6/29/2015	6/29/2015
Final assembly & commissioning	**157 wks**	**12/25/2012**	**12/28/2015**
Detector underground assembly	105 wks	12/25/2012	12/29/2014
Detector pre-commissioning	26 wks	12/30/2014	6/29/2015
Detector roll-in	4 wks	6/30/2015	7/27/2015
Support tube, beam-pipe, VTX install	5 wks	7/28/2015	8/31/2015
Detector check-out	4 wks	9/1/2015	9/28/2015
Final beam commissioning	13 wks	9/29/2015	12/28/2015
Ready for physics run	0 days	12/28/2015	12/28/2015

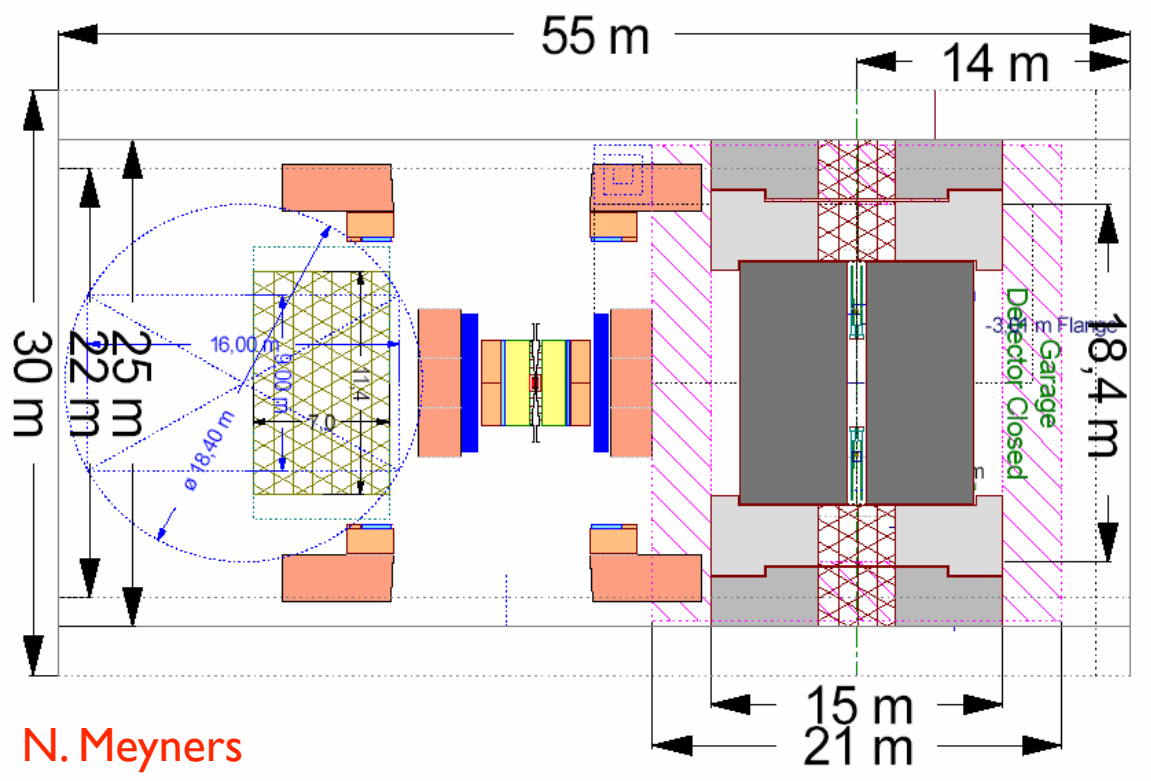


TESLA Detector Hall



- Hall size: 82m x 30m
- Beam position: 16/66m away from left/right wall
- Beam height: 8m above floor
- Crane hook: 19m above floor
- Access shaft: 9m x 16m
- Cranes: 2 x 80t

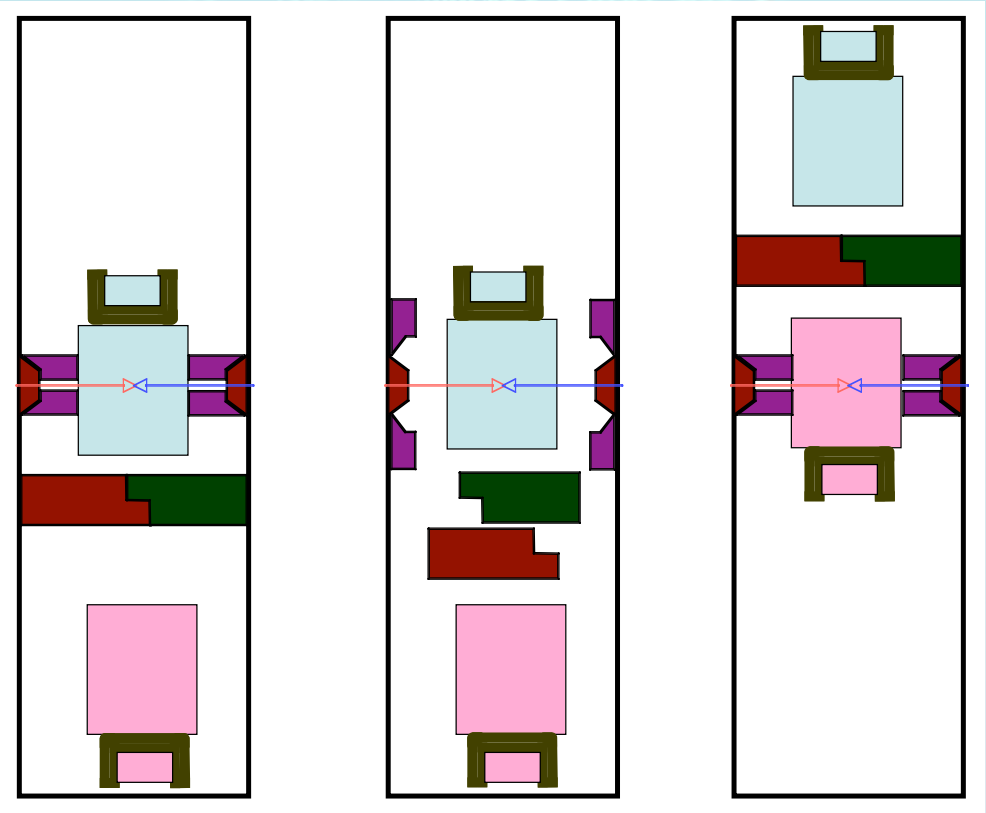
LDC Detector Hall Study



- Detector concept groups are studying the detector hall and detector integration issues
- Learn from CERN experience →engineering forum last week at CERN

One Step Beyond: Push/Pull

- Do we really need two beamlines?
- Finite switch-over time between beamlines makes it attractive to consider a two detector push/pull operation mode
  - Substantial cost saving potential!



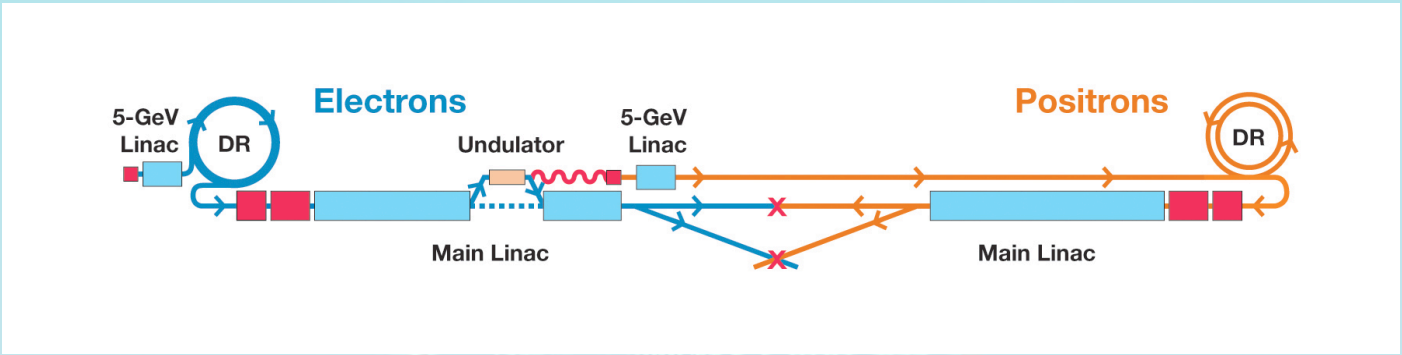
The Push/Pull Study Group

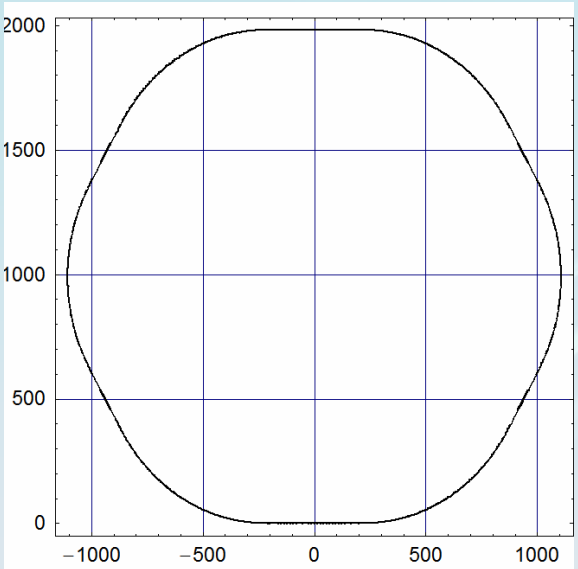
- The GDE and the Worldwide Study have initiated a Study Group which should explore the technical feasibility of a configuration with one interaction region and two detectors
- Questions to be answered
  - Historical and organisational questions
  - Accelerator design questions
  - Detector design questions
  - Engineering integration questions
- 19 members
  - Chair: Andrei Seryi (SLAC)
  - Detector Concepts
  - Accelerator Experts
  - WWS Co-chairs
- First status report will be given at the Valencia meeting

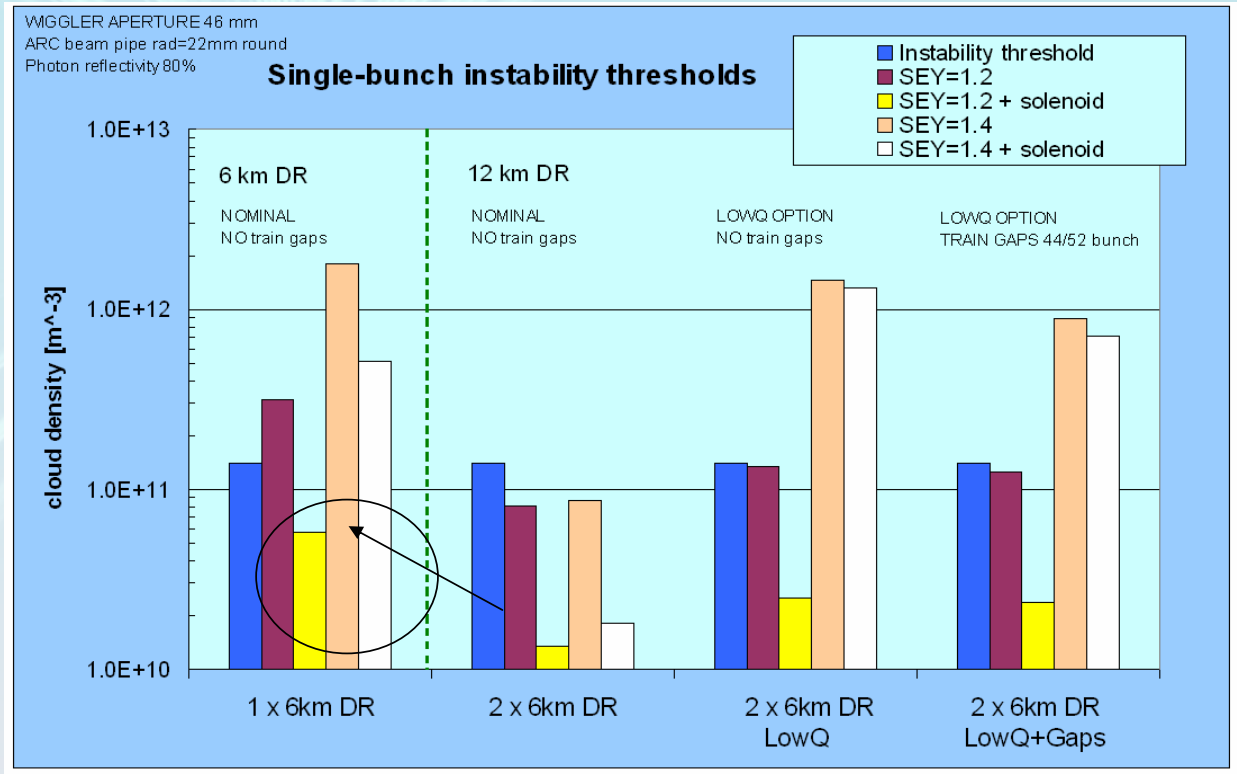
Damping Rings Change Request: One Positron Ring

- DR change request submitted on August 4th
  - Approved on September 21st.
- Old design: one 6.7 km DR for electrons, two stacked 6.7 km rings for positrons
  - Reason: mitigate electron cloud effects
  - Synchrotron radiation produces free electrons in the beam pipe via photo effect
  - Negatively charged electron cloud is attracted by positively charged positron beam and disturbs beam quality
- New design: just one 6.7 km DR for positrons, upgrade to second ring in the same tunnel should remain possible
- Hope to mitigate electron cloud effects with better vacuum, low SEY materials, etc.
- Risk: might affect luminosity!

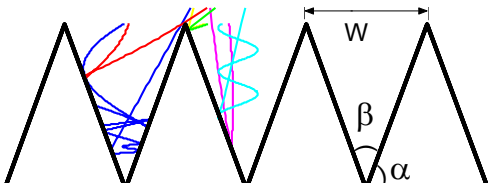
Electron Clouds in Damping Rings

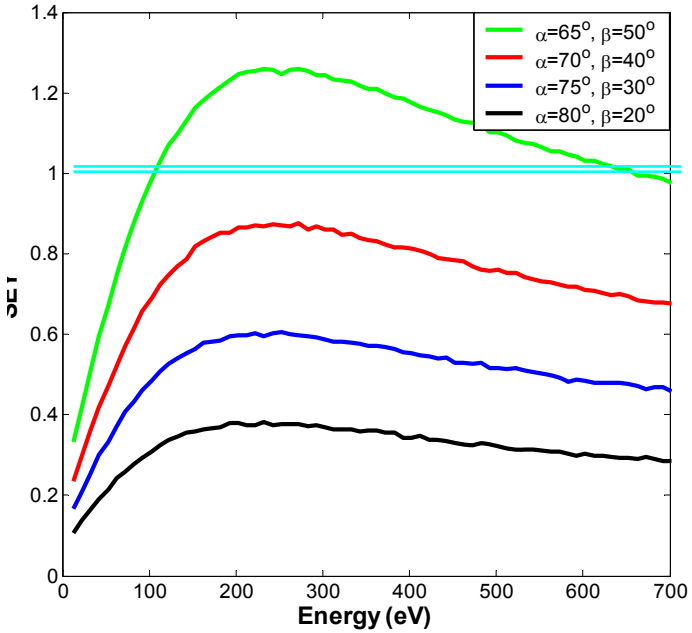




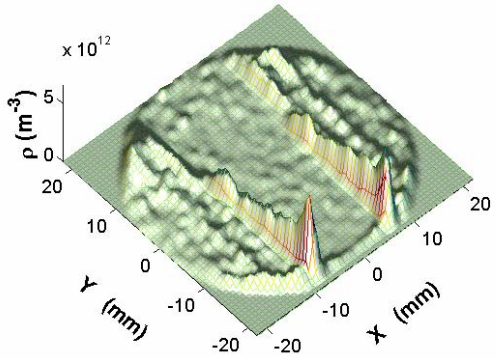


Electron Cloud Effect Mitigation

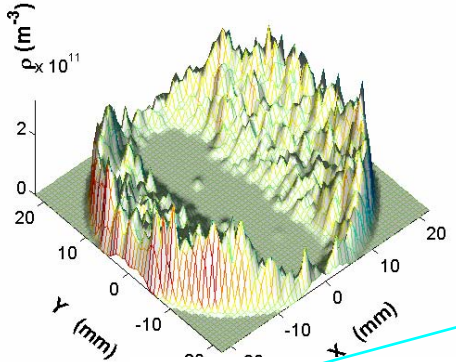


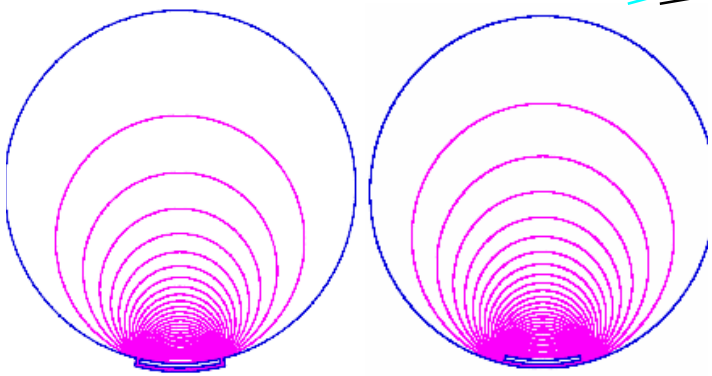


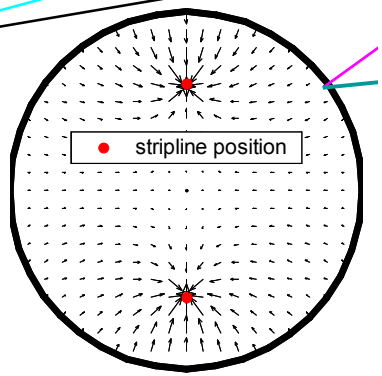
Strip-line type



Wire type







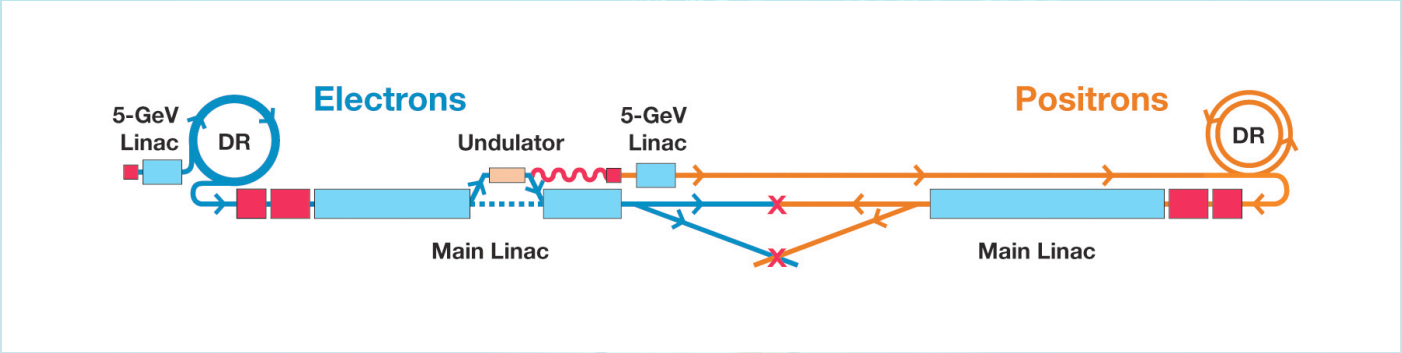
Strip-line type

Wire type

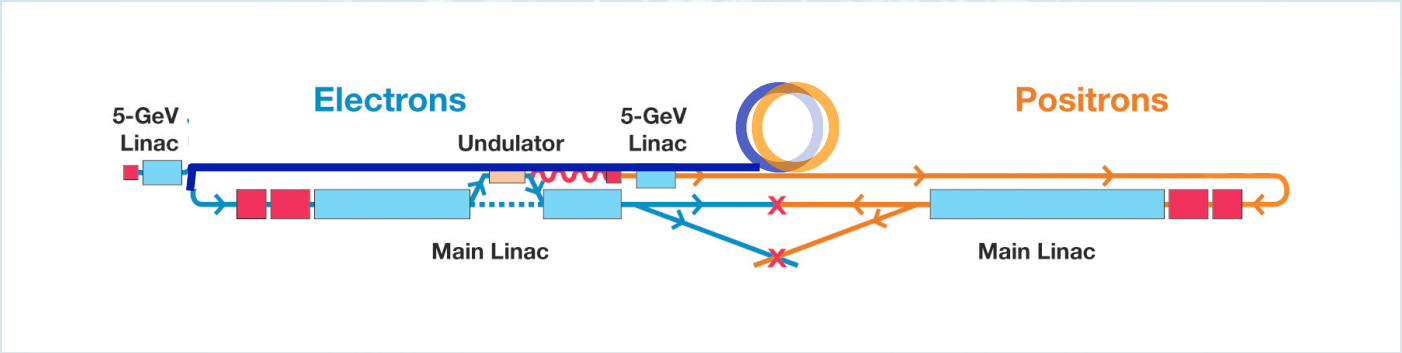
- Reduce Secondary Electron Yield using e.g.:
  - grooved surfaces
  - clearing electrodes

DR Change Request: Rings Location

- Move both damping rings into one tunnel at the centre of the machine where the central lab is supposed to be



- Reduce construction cost on tunnel, but need more transfer line →total cost reduction



Summary

- The ILC design is approaching the real axis
- The GDE is confronted with a huge task in developing a machine design which
  - reaches the ILC physics goals
  - is mature and stable enough to guarantee high availability
  - is affordable

- The Baseline of the machine is evolving right now
- The Reference Design Report is the next important milestone supposed to be published early next year