GDE Meeting in Frascati

D. Schulte

Charge

- Finalisation of the BCD
- Organisation of the future ILC work
- Open GDE meeting (everybody is welcome)
- I will focus on some points
  - E.g. review of work progress since Snowmass largely ignored

Arriving at the BCD

- 1st ILC Workshop at KEK (11.2004)
  - working groups (WG) formed to begin identifying contentious design issues
- 2nd ILC Workshop Snowmass (8.2005)
  - modified WG continue identifying baseline design and alternatives
  - newly formed ‘Global Groups’ begin to discuss and catalogue global design issues
  - 2nd Snowmass week: concentrate on the list of ‘Top 40’ critical design questions (Himel List)

Arriving at the BCD (cont) 2005

August | September | October | November | December

WW/GG summaries + broader input

Response to Himel list (40 questions)

all documented ‘recommendations’ publicly available on www (request community feedback)

review by BCD EC

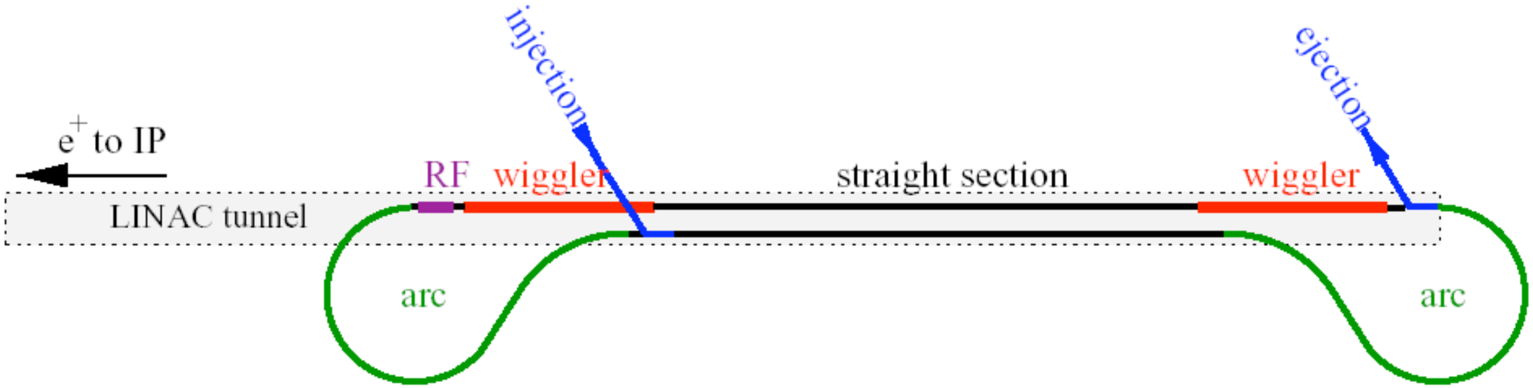
BCD EC publishes ‘strawman’ BCD

public review

Frascati GDE meeting

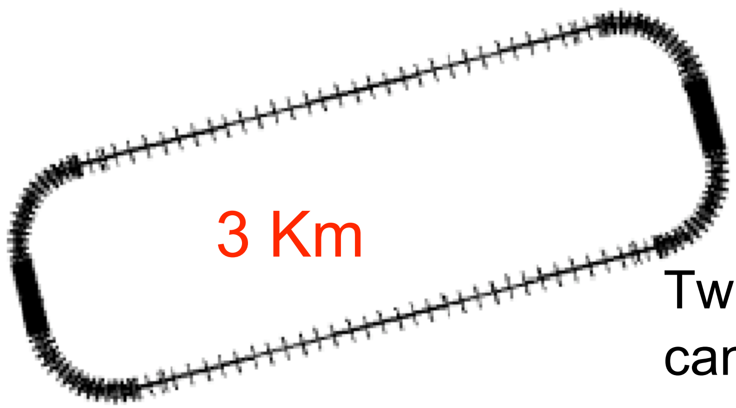
BCD Executive Committee (EC):
Barish
Dugan, Foster, Takasaki (regional directors)
Raubenheimer, Yokoya, Walker (acc. design leads)

Circumference options
from TESLA dogbone 17 Km to 6 & 3 Km

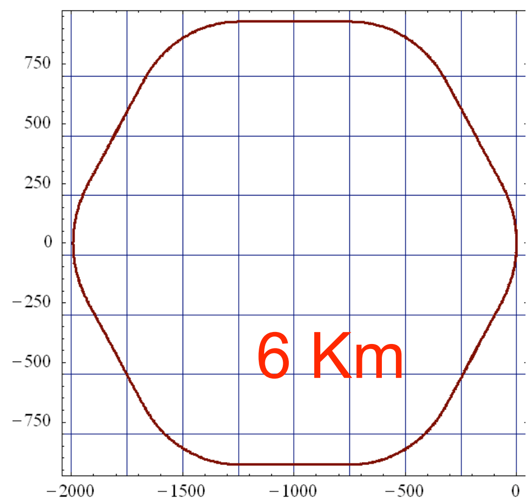


3 or 6 km rings can be built in independent tunnels

“dogbone” straight sections share linac tunnel



Two or more rings can be stacked in a single tunnel



Issues for the circumference choice

- Kickers
  - –Injection/extraction kickers are more difficult in a shorter ring.
  - –R&D programs are proceeding fast, it is expected a demonstration for a 6 km circumference.
- Electron cloud effect
  - –Shorter rings have a closer bunch spacing, which greatly enhances the build-up of
  - –electron cloud. Electron cloud density is dominant in the wiggler and in the dipole. Electron cloud instability could limit the stored current or increase the vertical beam size in the positron ring. R&D programs on mitigation tecniques are in progress at different storage rings.
- Acceptance
  - –Given the high average injected beam power injection efficiency has to be ~100% for the nominal positron distribution. The dogbone damping rings have a small acceptance, while the nearly circular 6 km ring has the largest acceptance.
- Ion effects
  - –Fast ion instability could limit the current in the electron ring. Fill pattern and vacuum pressure are more significant than the circumference for the severity of the effect. Gaps in the fill and very low vacuum levels will be necessary to mitigate ion effects.

Issues for the circumference choice

- Space charge
  - The incoherent space-charge tune shift is proportional to the ring circumference. The coupling bumps used to reduce this effect in the dogbone ring could be some risk for the vertical emittance.
- Tunnel layout
  - Sharing the linac tunnel reduces the time available for commissioning and reduces the availability.
  - Stray fields in the linac tunnel could adversely affect the vertical emittance
  - of the extracted beam.
- Cost
  - Smaller rings have lower cost. Dogbone shape allows tunnel cost saving.

Recommendation for the circumference (baseline configuration)

- **Positrons:** two rings of ~ 6 km circumference in a single tunnel.
- Two rings are needed to reduce e-cloud effects unless significant progress can be made with mitigation techniques.
- Preferred to 17 km due to:
  - Space-charge effects
  - Acceptance
  - Tunnel layout (commissioning time, stray fields)
- **Electrons:** one 6 km ring.
- Preferred to 3 km due to:
  - Larger gaps between minitrains for clearing ions.
  - Injection and extraction kickers ‘low risk’
- Estimated cost for 3x6 km rings is lower than 2x17 km.

Taks Forces on Critical Choices

- Undulator source position
  - Tom Himel (SLAC)(lead), Kaoru Yokoya (KEK), Nick Walker (DESY)
- Energy upgrade scenario
  - Nobu Toge (KEK) (lead), Tor Raubenheimer (SLAC), Lutz Lilje (DESY)
- Number of IR's; choice of crossing angles
  - Tom Markiewicz (SLAC) (lead), Wilhelm Bialowons (SLAC), Hitoshi Yamamoto (KEK)
- Number of linac tunnels
  - Jean-Pierre Delahaye (CERN) (lead), Nan Phinney (SLAC), Hitoshi Hayano (KEK)
- Laser-straight/kinked/curved linac
  - Daniel Schulte(CERN) (lead), Warren Funk (Jlab), Tetsuo Shidara (KEK)

Keep-alive Source Intensity

- Requirement from availability studies is that it be strong enough that diagnostics (primarily BPMs) work as well with the keep-alive source as they do with full intensity beams.
- Must be no gain, offset, or resolution changes that prevent machine development and beam based alignment results from being as useful as those done with full beam intensity.
- We asked a few diagnostics people what intensity this would take and they thought they could do it with 1% of design intensity but admitted they were uncertain as systematic errors are the problem and there is no design yet.
- We recommend a minimum intensity requirement of 10% of nominal intensity to reduce the chance of such systematic errors making the keep-alive source nearly useless and because there are inexpensive ideas on how to make a 10% source.
- This source would have all bunches filled to 10% of nominal intensity. Note that higher intensity is better even at the expense of populating a smaller fraction of the bunches.

Location of Undulator – Mid or End

- Positron yield for beam energies between 100 and 150 GeV and at the Z: favors MID.
- Positron yield at high energies: favors END
- Cost: favors neither
- Energy jitter for beam energies less than 150 GeV: favors END
- Need for e+ tuning when energy is changed: favors MID
- Flexibility of linac operation: favors END
- BDS upgrade flexibility: favors MID
- Difficulty of Main Linac Energy Upgrade : favors MID or Neither

Energy Upgrade Options that were considered

	Option 1	2	3	4
Φ1 Tunnel	~41km	~41km	~22km	~41km
Φ1 Linac Installation	~22km Upstream Half	~24.4km Upstream Half	~22km Whole	~22km Sparcified
Φ1 Nominal Gradient w. full current	31.5MV/m	28MV/m	31.5MV/m	31.5MV/m
Φ1 Energy Reach	500GeV	500GeV (~560GeV w. reduced current)	500GeV	500GeV

Recommendations as submitted to GDE EC

- Recommend Option 1
  - Option 1 offers good operability during Phase-1, adequate provision for beam diagnostic capabilities and ability to accommodate upgraded SRF hardware components relatively seamlessly.
  - Option 1, being conceptually the simplest among the schemes considered here, helps GDE develop the solid understanding of the practical fundamentals of the engineering designs and the cost analyses the most *rapidly*.
  - Much of the understanding on the engineering and the cost, to be gained from the exercise with Option 1, can be readily applied to examine the technical and cost implications of other Options soon thereafter, if deemed adequate.

Remarks to GDE EC (1)

- Concerning Option 3:
  - Option 3 offers the lowest cost for Phase-1 yet it requires the highest cost for the whole Phases 1&2, because of the staged civil construction and relocation of the injector systems.
  - Phase-2 upgrade for Option 3 is likely to take the longest time period, because of, again, the staged civil construction and the fact that the installation of RF source components cannot start till the extension tunnels are complete.
  - The relative merit of Option 3 will have to be looked at in the context of the project acceptance from the political or long-term financial standpoint. Such analysis can be done after the complete Option 1 study is done.

(NT comment: Implications on the prospects for physics programs also need to be looked at, but our TG report did not specifically touch on it).

Remarks to GDE EC (2)

- Concerning Option 4:
  - Option 4 offers the operability and upgradeability similar to those of Option 1, plus substantially more diagnostic sections during Phase-1.
  - At this point, however, the task group does not see convincing technical justification for this option.

Remarks to GDE EC (3)

- Concerning the Energy and Acc Gradient:
  - Assumed accelerating gradient of 31.5MV/m for Phase-1 and 36MV/m for Phase-2 are a major challenge.
  - Vigorous, coherent and organized international collaboration programs are mandatory to establish especially the quality control measures which reduce the performance scatter currently observed.
  - A detailed list of R&D topics has been established in the WG5 Snowmass reports, as well as in BCD.

Number of IR's/Crossing Angle

Working Group 4 Recommendations:

- BCD: Two BDS (2 mrad & 20mrad), Two IR halls, separated in z, Two detectors
- ACD1: Two BDS (2 mrad & 20mrad), One IR hall, z=0, Two detectors
- ACD2: One BDS (X-angle unspecified), One IR hall, z=0, Two detectors, push-pull capability

Minimal Configuration

- One BDS, One IR Hall, One detector designed so as to permit construction of a second BDS, IR Hall and detector at a later date.

Recommendation on IRs

If civil cost proportional to volume of excavation neglect any gain from having one large IR rather than 2 smaller Ir's

Cost(BCD)=Cost(ACD1)

Cost of 2nd IR Hall only ~ 30M€, 58M$, $78 \cdot 10^8$¥

Cost Increment(ACD2)-Cost(Minimal)<< Cost(Detector)

WG4 not ready for recommend a configuration for down-select

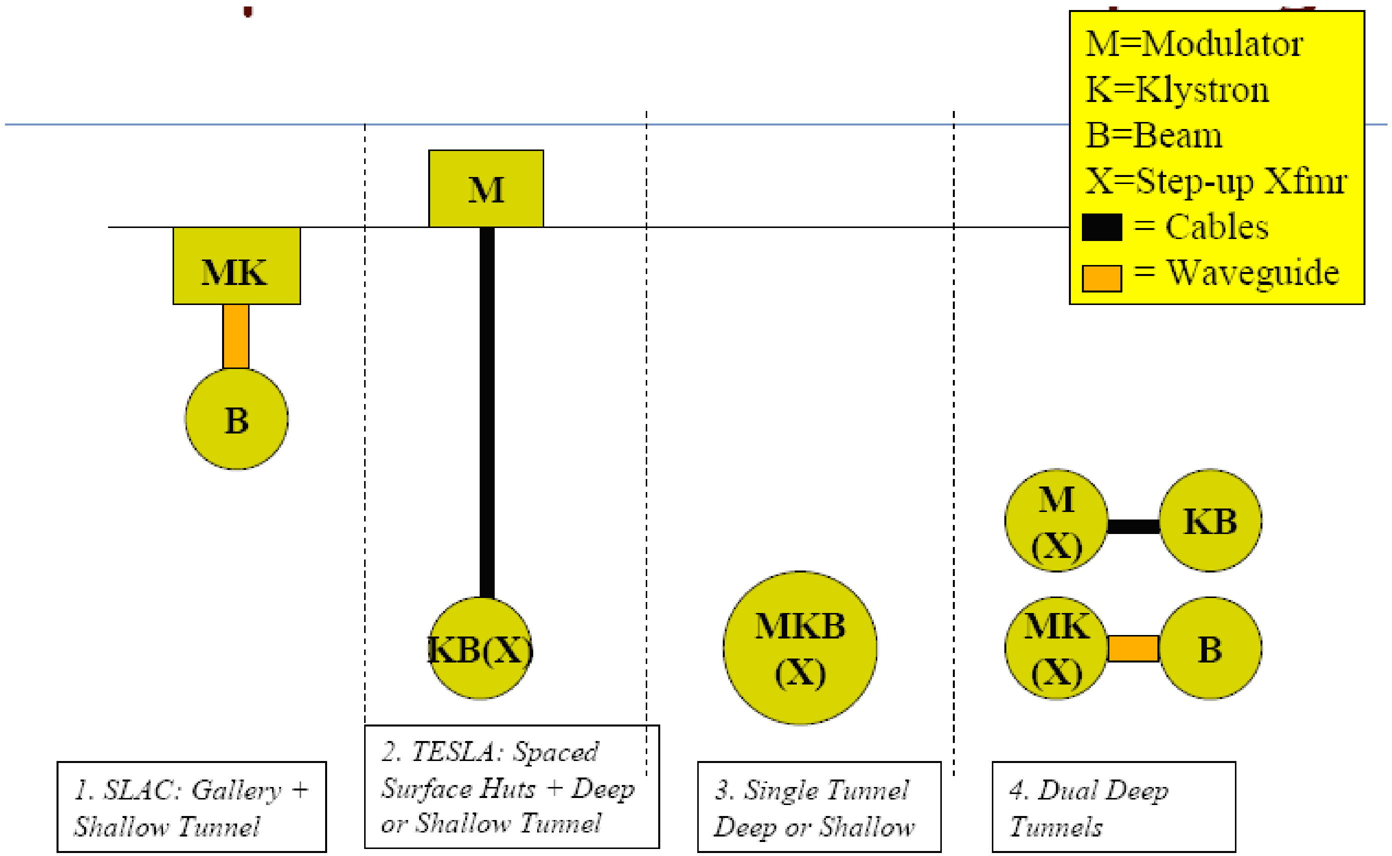
Cost numbers not internationally agreed upon

Sub costs related to IR (Halls vs. dumps vs. Beamline CF vs. beamline Hardware) vary greatly

Stay with Baseline 2-20mrad Configuration

while WG4 & CDE Board do their work

Number of Tunnels

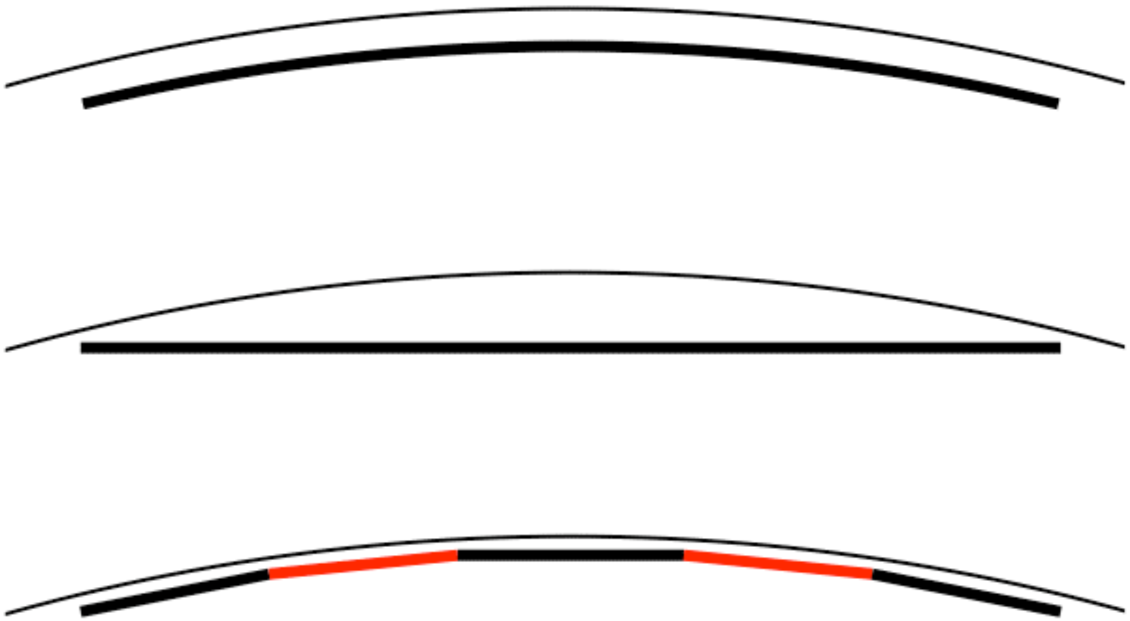


Recommendation on Number of Linac Tunnels

We concur with the recommendation of Global Group 1 at Snowmass and recommend the two tunnel option with the justifications below

- The additional cost is marginal when considering the necessary overhead and equipment improvements to comply with reliability and safety issues,
- A better availability with higher risk of success on the necessary MTBF improvements of the critical components
- Simpler installation and likely shorter schedule
- Easier maintenance and consolidation of equipments
- Smaller exposure of equipments to radiation and corresponding damage
- Easy access to key electronics for fine tuning during commissioning
- Easier energy upgrade

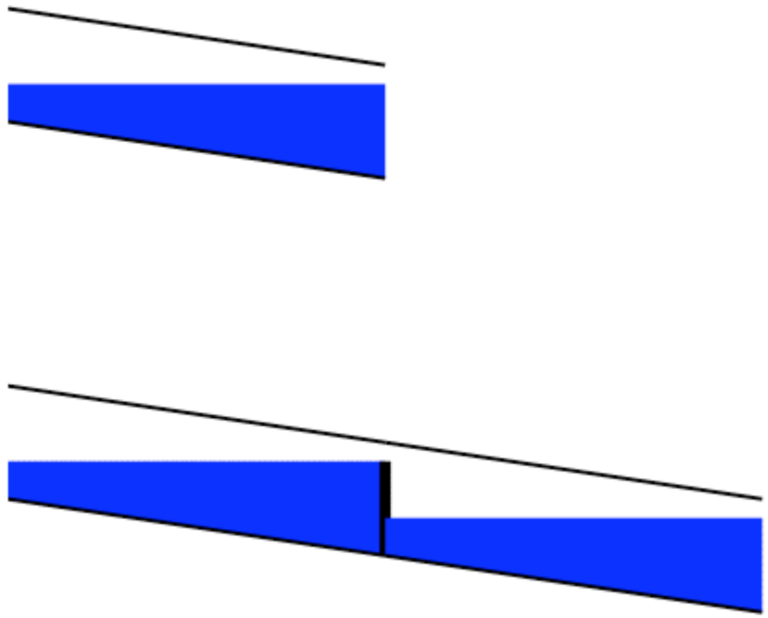
Tunnel Construction



- Curved allows cut and cover
  - But excluded at most sites
- Curved/piece-wise straight allow experimental hall in cut and cover
  - Shorter access shafts
- Very site dependent / cannot decide without site

Kryogenics

Problem in two-phase pipe can be mitigated
But slows helium distribution down
May require more instrumentati
Piece-wise straight tunnel
leaves some tilt so need to
understand maximum tolerance
A bit of tilt due to WG4



Beam Dynamics

For curved tunnel:

Synchrotron radiation < 50 mW at 500GeV

Emittance growth for perfect alignment is negligible

Power supply stability of 0.01% sufficient

Emittance growth using beam-based alignment seems same as for laser straight

BPM scale error seems OK at 1%

Beam energy knowledge seems OK

But more detailed studies required

In piece-wise straight tunnel problems are more localised

More studies required for all solutions

Linac Curvature Conclusion

- Based on a review of the available material, we conclude that there is no evidence that any of the three options is not viable. The choice can therefor mainly be based on cost considerations. The actual optimum choice is site dependent but in most cases it is expected that the tunnel that follows the earth curvature is cheapest.
- R&D required
  - Detailed study of impact on beam dynamics are critical
    - High priority to find potential problems as soon as possible
  - Small tilt angles at the end of the main linacs

Barish 'Mini-MAC' high-points

- Richter
  - importance of energy flexibility and incremental energy upgrade
    - physics-driven in light of early LHC results
  - The case for 2 detectors – 2 IRs
- Oide
  - luminosity parameters – designing a 5×10^{34}machine
  - Design of RF system to 'true average gradient performance'
  - Questions concerning e+ source
  - DR discussions (favours dogbone?)

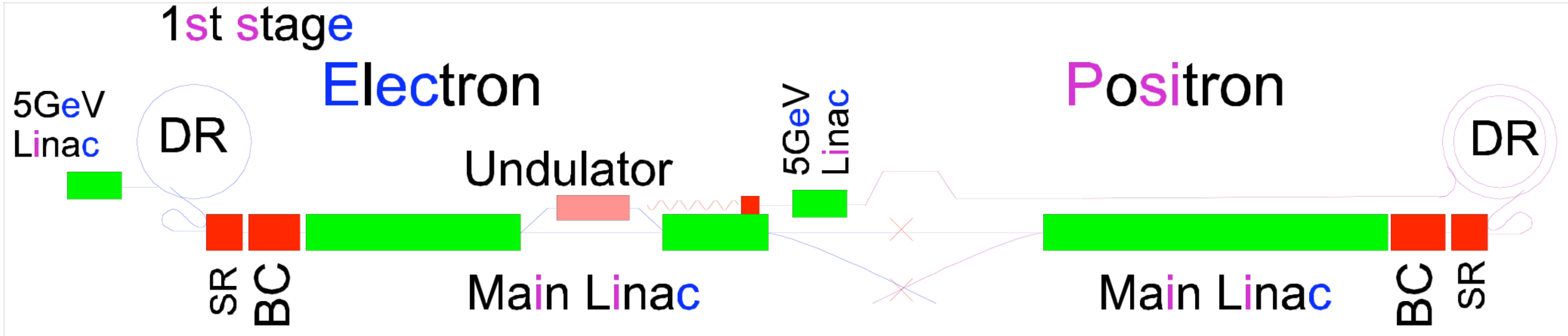
BCD EC will respond to all comments and questions

BCD EC contrary decisions

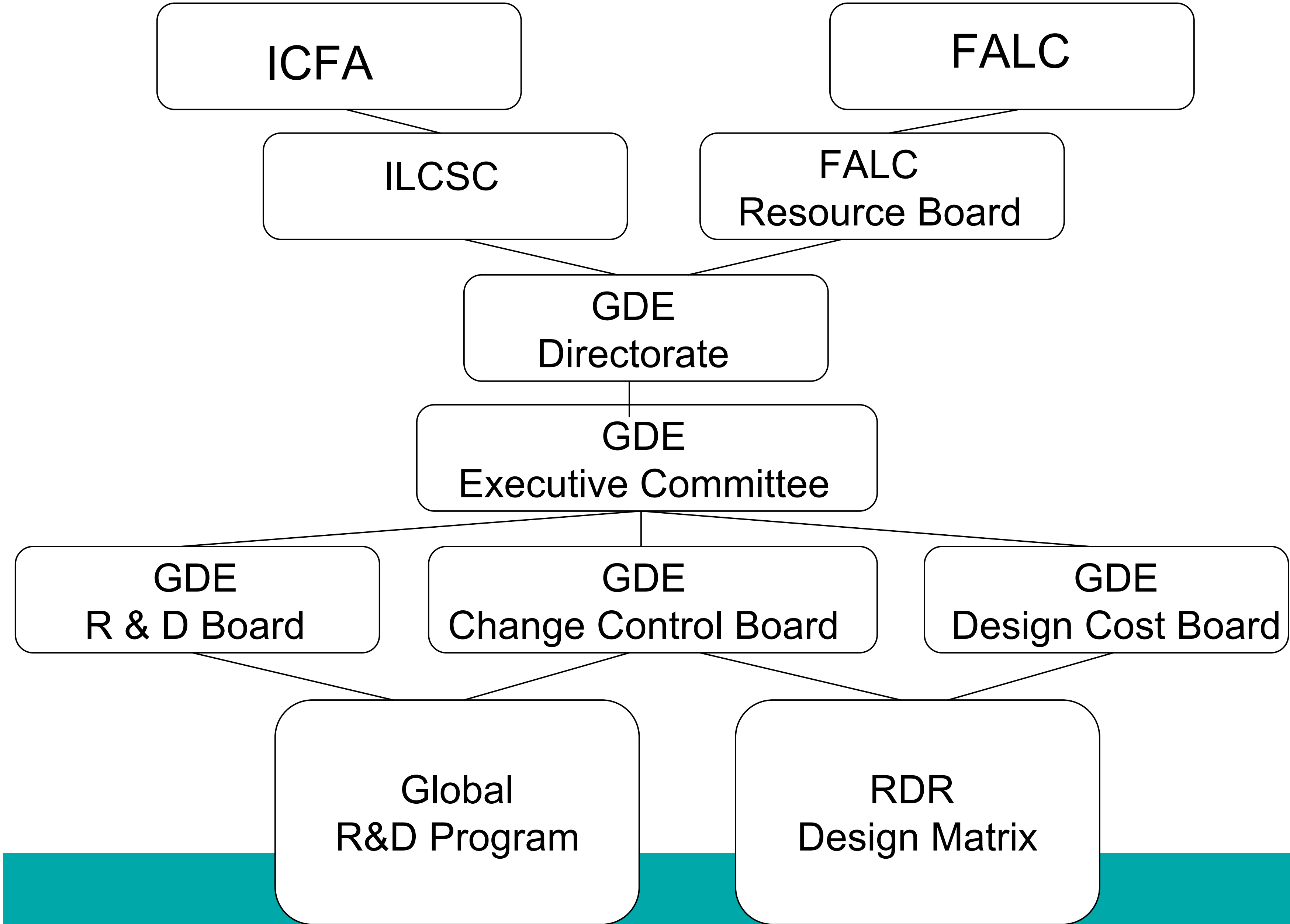
- Energy upgrade – short tunnel adopted
  - option 3 in white paper
- Main linac quadrupole spacing
  - 32 quads per quadrupole (24 recommended by WG1)
- RTML (bunch compressor)
  - cost minimal system (two-stage compressor)
  - evaluate (cost) single-stage system with two-stage system as upgrade

rationale: cost

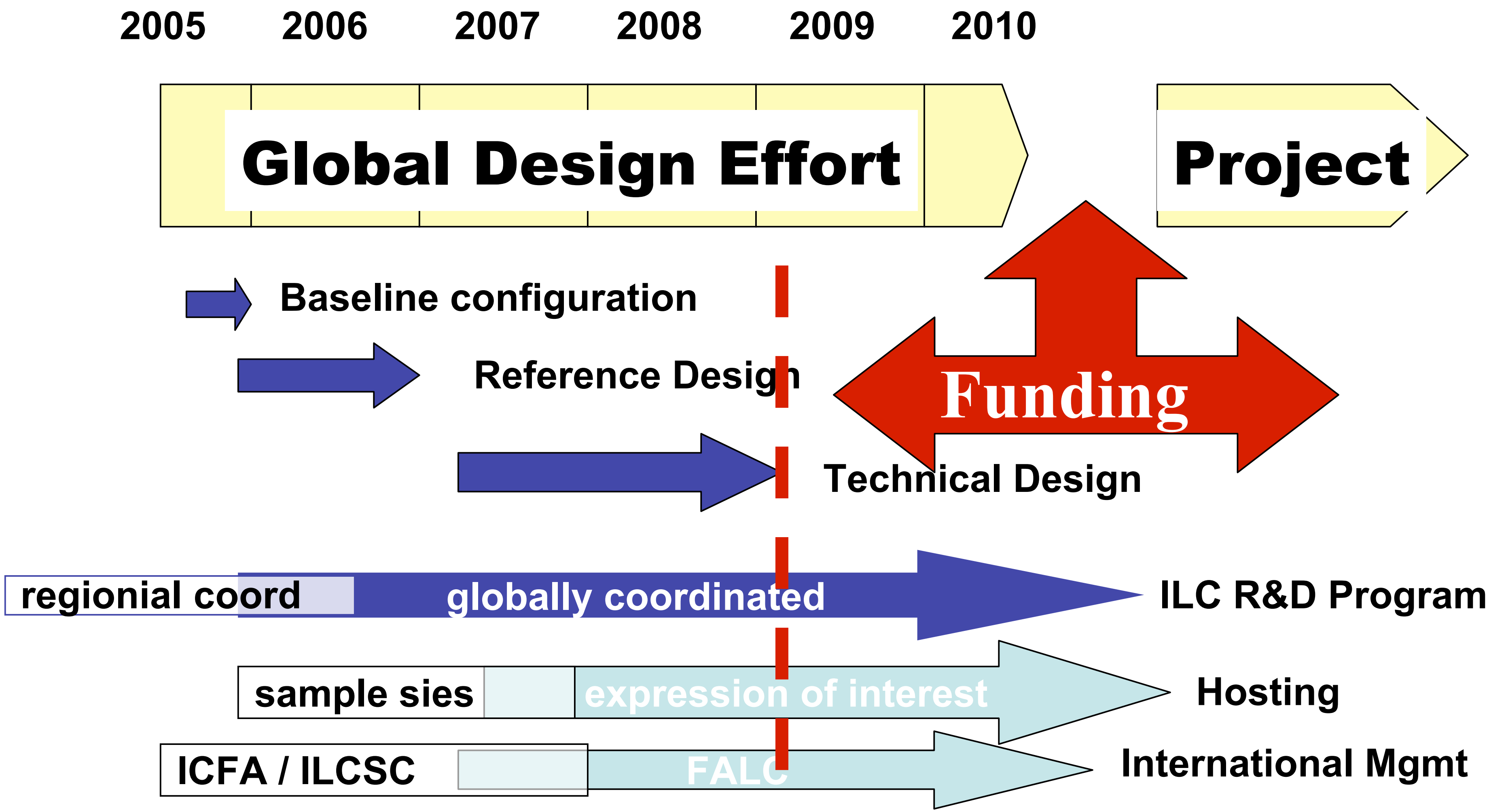
The Baseline Machine (500GeV)



GDE RDR / R&D Organization



The GDE Plan and Schedule



GDE Organizational Evolution for RDR

- Selected additions to the GDE following the BCD completion having needed skills in design, engineering, costing, etc
- Change Control Board
  - The baseline will be put under configuration control and a Board with a single chair will be created with needed expertise.
- Design / Cost Board
  - A GDE Board with single chair will be established to coordinate the reference design effort, including coordinating the overall model for implementing the baseline ILC, coordinating the design tasks, costing, etc.
- R&D Board
  - A GDE Board will be created to evaluate, prioritize and coordinate the R&D program in support of the baseline and alternatives with a single chair
    - Brau - Americas
    - Richard - Europe
    - Yamamoto - Asia
  - Accelerator Experts (44 GDE members)

Change Control Board (CCB)

Nobu Toge (chair)

- The Change Control Board is responsible for maintaining the baseline configuration as defined in the Baseline Configuration Document. The first action of the CCB will be to finalize the BCD and put it under configuration control. In addition to maintaining the baseline, the CCB will assess R&D projects defined in the BCD that potentially can lead to improvements over the baseline in cost or performance. The CCB will define what needs to be demonstrated in these R&D projects, in order to be considered for a CCB action to replace the baseline.

- The CCB will work with the GDE EC to formalize levels for taking change control actions. Major changes in the baseline defined as changing costs by more than $100M or make significant changes in performance, schedule or risk will be recommended to the Director and GDE EC for final approval. For all other changes, the CCB will be the final authority.

Change Control Board (CCB)

Nobu Toge) (chair)

Markiewicz	US
Mishra	US
Funk	US
Kubo	Asia
Kuriki	Asia
Pagani	EU
Blair	EU
Schulte	EU

Design Cost Board (DCB)

Peter Garbincius (chair)

- The Design / Cost Board will be responsible for assessing and providing guidance for the overall RDR design effort program. The DCB initial goals will be to propose the overall structure and content for the RDR document to be developed by the end of 2006. It also will provide early guidance required to enable the design / cost effort to get fully underway by the time of the Bangalore GDE meeting.
- The DCB will set goals and milestones for producing the RDR, conduct design reviews and provide guidance and assessments of the RDR effort. The DCB will report to the Director and EC regularly as the design / cost effort progresses, reporting on early evaluations of costs, problems and changes needed in the BCD, etc.

Design Cost Board (DCB)

Peter Garbincius (chair)

Phinney	US
Paterson	US
Kephart	US
Enomoto	Asia
Shidara	Asia
Terunuma	Asia
Bialowons	EU
Delahaye	EU
Napoly	EU

Global R&D Board (RDB)

Bill Willis (chair)

- The Global R&D Board will be responsible for assessing and providing guidance for the overall R&D program. The RDB will suggest priorities for the research facilities and R&D supporting the baseline, the R&D on alternatives to the baseline and selective R&D that could further the field in the longer term. The mission will also include global assessments and recommended priorities for the detector R&D program and evaluate the balance between accelerator and detector R&D.
- The RDB will develop a proposal driven program, structured in the sense of defined goals, and milestones, and resources evaluated on a common basis to allow comparison across different regions and national funding systems. It will conduct reviews and identify gaps in coverage of topics, resource or technical issues, duplications, and other concerns..

Global R&D Board (RDB)

Bill Willis (chair)

Padamsee	US
Himel	US
Wolski	US
Hayano	Asia
Higo	Asia
Elsen	EU
Lilje	EU
Garvey	EU
Damerell	EU

Area Systems

e- source	e+ source	Damping Rings	RTML	Main Linac	BDS
	Kuriki	Gao	E.S. Kim	Hayano	Yamamoto (MDI Ch)
???		Guiducci	PT	Lilje	Angal-Kalinin
				Adolphsen	
Brachmann	Sheppard	Wolski		Solyak	Seryi

Technical Systems			
Vacuum systems	Suetsugu	Michelato	Noonan
Magnet systems	Sugahara	BINP ??	Thompkins
Cryomodule	Ohuchi	Pagani	Carter
Cavity Package	Saito	Proch	Padamsee
RF Power	Fukuda	Saclay ??	Larsen
Instrumentation	Urakawa	Burrows	Ross
Dumps and Collimators	KEK	??	??
Accelerator Physics	Kubo	Schulte	??
Global Systems			
Commissioning, Operations & Reliability	Terunuma	Elsen	Himel
Control System	Michizono	Simrock	Carwardine
Cryogenics	Hosoyama	Tavian	Peterson
CF&S	Enomoto	Baldy	Kuchler
Installation	Shidara	Bialwons	??