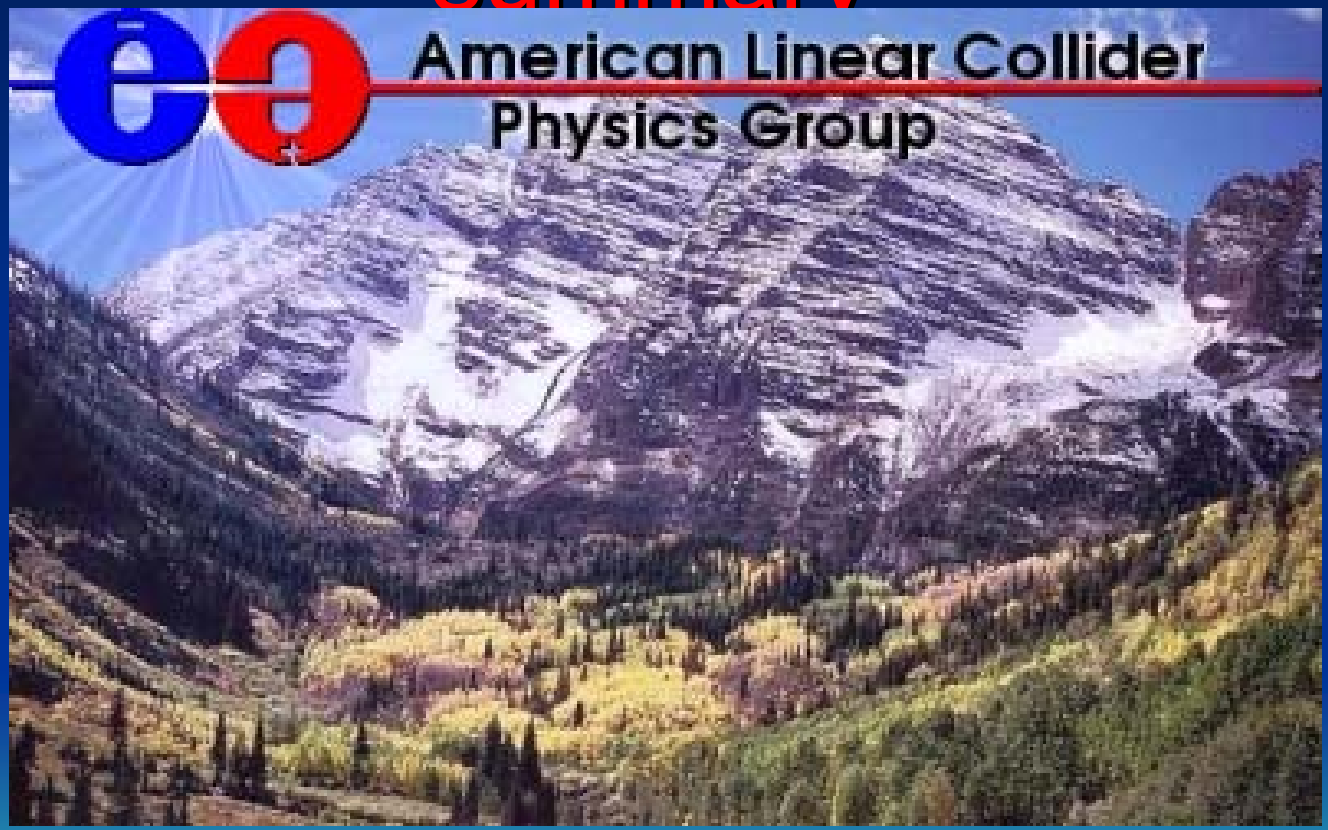
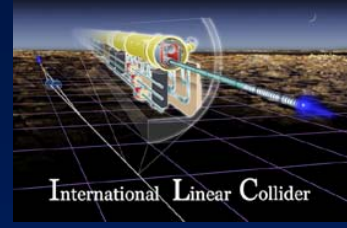
ILC-Snowmass workshops summary



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



General

- One year after the decision on SC technology
- 2nd ILC workshop but first after nomination B.Barish
- 2 weeks with ILC Acc & Physics workshops in parallel
- 650 participants (400 physicists, 250 Accelerator exp.)
- First week: Working group analysis of systems with identification of critical issues
- Second Week: Analysis and possibly recommendations of preferred and alternative options for critical issues
- Forum:
  - Industry
  - Challenges for realizing the ILC (DOE representatives)
  - How does the ILC case depend on LHC?
- Set-up and organisation of GDE central team

First GDE meeting on 16/08 (open)

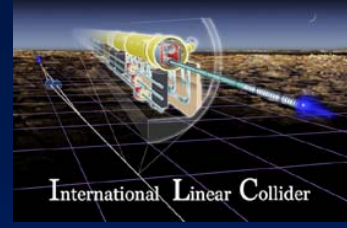
GDE Meeting 16 August 2005

Click on images for larger versions

After huffing and puffing their way up the steep hill to the Top of the Village condos, more than 50 people gathered in the Gatehouse on Tuesday afternoon for the first GDE meeting. “I think that our meeting was scheduled all the way at the top of this hill to prove that if you’re in the GDE, you can climb a mountain,” said GDE Director Barry Barish.

Who, what, why, when, where and how were the primary questions at the meeting. Among many other topics, Barish outlined who is part of the GDE, what the GDE needs to accomplish and how the GDE will be organized. “It’s a tremendous milestone for us that we are all sitting in this room and that such a talented worldwide group could be put together,” he said. “The main activity for me the last few months was putting together a great group. Now we just need to figure out what to do.”

One of the first issues that Barish plans to address is how the GDE will actually do work together. Videoconferencing is one way to hold global meetings, but different time zones and connectivity issues sometimes make these meetings cumbersome. Choosing an Electronic Document Management System is another crucial task for the GDE. In order to find the best EDMS by the end of 2005, Barish will form a sub-committee of approximately six people. “Getting the right EDMS and other communicating tools is crucial,” he said. “People should suggest who should be on the sub-committee. Give me your input and tell me what we need to do.” The GDE will meet next on Saturday morning to plan the second week of the workshop.



Transition to the GDE

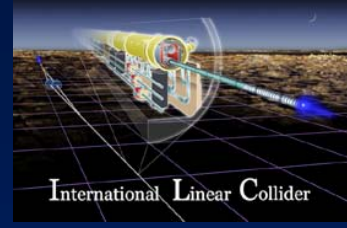
- The Mission of the GDE
  - Produce a design for the ILC that includes a detailed design concept, performance assessments, reliable international costing, an industrialization plan , siting analysis, as well as detector concepts and scope.
  - Coordinate worldwide prioritized proposal driven R & D efforts (to demonstrate and improve the performance, reduce the costs, attain the required reliability, etc.)

--- The composition:

- Three regional directors have identified GDE members (with agreement from BB)
- 49 (current) members representing approximately 20 FTE
- GDE group consists of:
  - core accelerator physics experts
  - 3 CFS experts (1 per region)
  - 3 costing engineers (1 per region)
  - 3 communicators (1 per region)
  - representatives from WWS

The GDE Composition: 40 members = 20 FTE

who: http://www.linearcollider.org/cms/?pid=1000066



Chris Adolphsen, SLAC*
Jean-Luc Baldy, CERN*
Philip Bambade, LAL, Orsay
Barry Barish, Caltech (the boss)
Wilhelm Bialowons, DESY*
Grahame Blair, Royal Holloway*
Jim Brau, University of Oregon
Karsten Buesser, DESY
Elizabeth Clements, Fermilab
Michael Danilov, ITEP
Jean-Pierre Delahaye, CERN (EU dep. dir.)
Gerald Dugan, Cornell University (US dir.)
Atsushi Enomoto, KEK*
Brian Foster, Oxford University (EU dir.)
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*

Tom Markiewicz, SLAC
David Miller, Univ College of London
Shekhar Mishra, Fermilab
Youhei Morita, KEK
Olivier Napoly, CEA-Saclay
Hasan Padamsee, Cornell University
Carlo Pagani, DESY
Nan Phinney, SLAC
Dieter Proch, DESY*
Pantaleo Raimondi, INFN
Tor Raubenheimer, SLAC*
Francois Richard, LAL-IN2P3
Perrine Royole-Degieux, GDE/LAL
Kenji Saito, KEK*
Daniel Schulte, CERN*
Tetsuo Shidara, KEK
Sasha Skrinsky, Budker Institute
Fumihiko Takasaki, KEK
Laurent Jean Tavian, CERN
Nobu Toge, KEK
Nick Walker, DESY (EU dep. dir.)*
Andy Wolski, LBL*
Hitoshi Yamamoto, Tohoku Univ
Kaoru Yokoya, KEK*

* workshop WG/GG conven

File Edit View Go Bookmarks Tools Window Help

New Tab | ILC Home

ILC International Linear Collider

for Collaborators | for The Press | for Communicators | for Students and Educators | search: [ ] go

- What is the ILC?
- Global Design Effort
- Talks
- Reports and Statements
- ILC in the News
- Images
- Contacts
- 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

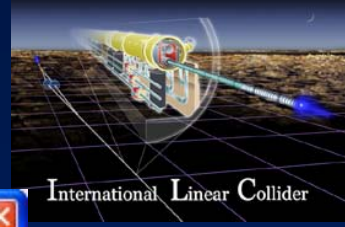
Features

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

ILC Newsline



ILC NewsLine - Netscape

File Edit View Go Bookmarks Tools Window Help

http://www.linearcollider.org/newsline/

New Tab | ILC NewsLine

ILC NewsLine

Archive | ILC Home | Subscribe | Submit Suggestions — August 15, 2005

Calendar

Upcoming meetings, conferences, workshops

ALCPG Workshop
Snowmass, USA, August 14-27, 2005

2nd ILC Workshop
Snowmass, USA, August 14-27, 2005

Nanobeams 2005
Kyoto, Japan, October 17-21, 2005

ECFA ILC Workshop
Vienna, Austria, November 14-17, 2005

2006 LCWS 2006
Bangalore, India, March 9-15, 2006

Full Calendar

Image of the Week

Feature Story

Thraciam Propontida Trucemue Comata Silua

TESLA Tunnel
Image Courtesy DESY Hamburg

Et hoc negat minacis Hadriatici negare litus insulasue Cycladas Rhodumque nobilem horridamque Thraciam Propontida trucemue Ponticum sinum, ubi iste post phaselus antea fuit comata silua.

Phaselvs ille, quem uidetis, hospites,

Director's Corner

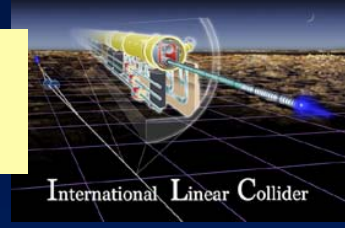
Barry Barish

Phaselvs ille, quem uidetis, hospites, ait fuisse nauium celerrimus, neque ullius natantis impetum trabis nequisse praeterire, siue palmulis opus foret uolare siue linteo. Et hoc negat minacis Hadriatici negare litus insulasue Cycladas Rhodumque nobilem horridamque Thraciam Propontida trucemue Ponticum sinum, ubi iste post phaselus antea fuit comata silua; nam Cytorio in iugo loquente saepe sibilum edidit coma. PHASELVS ille, quem uidetis, hospites, ait fuisse nauium celerrimus, neque ullius natantis impetum trabis nequisse praeterire, siue palmulis opus foret uolare siue linteo.

Et hoc negat minacis Hadriatici

Subscribe at http://www.linearcollider.org

The GDE Plan and Schedule



2005 2006 2007 2008 2009 2010

Global Design Effort

Project

Baseline configuration

Reference Design

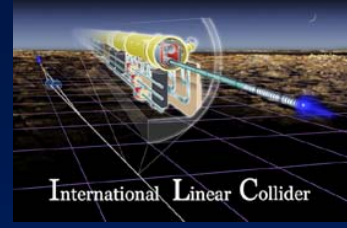
LHC Physics

Technical Design

ILC R&D Program

Bids to Host; Site Selection;

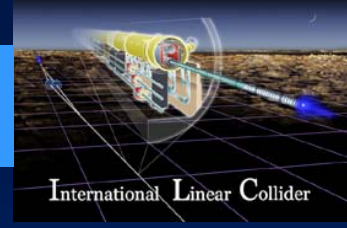
International Mgmt

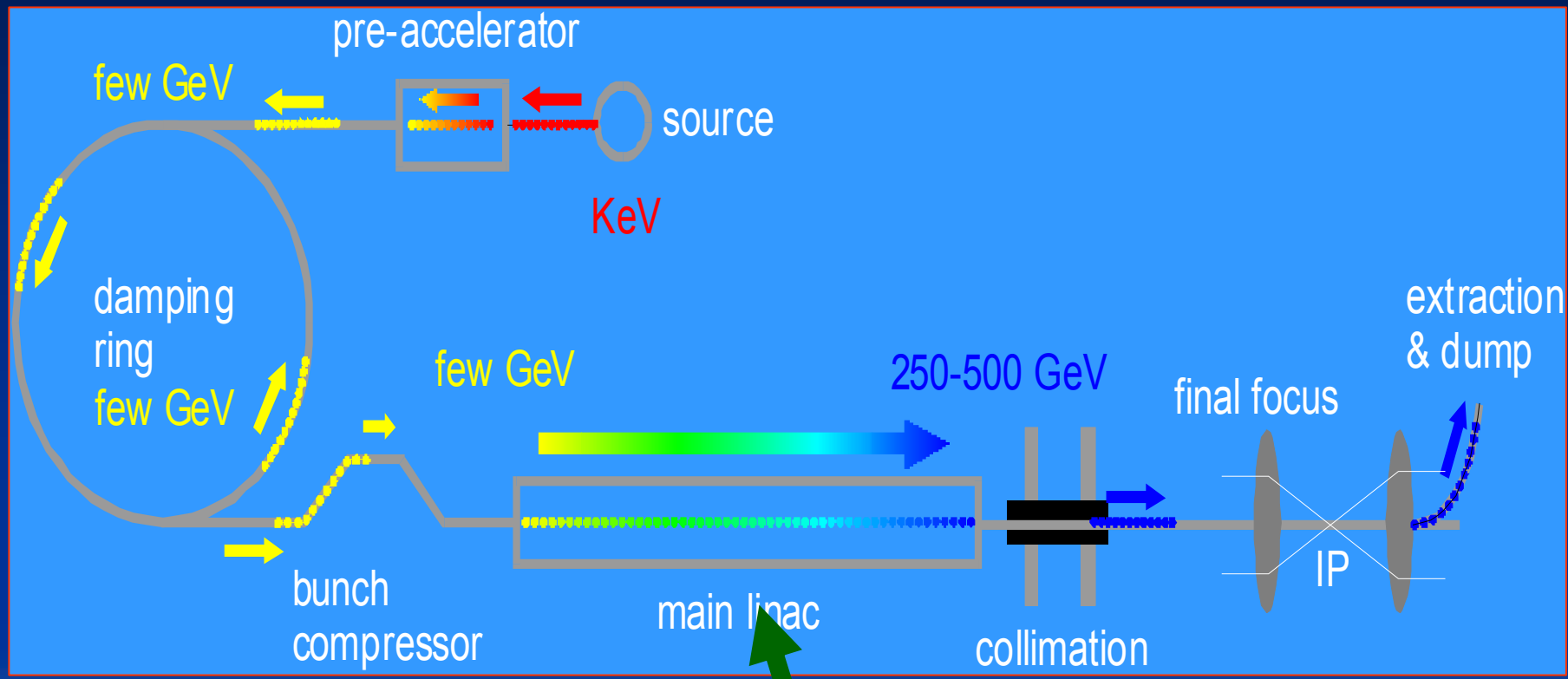


Baseline / Alternative: some definitions

- Primary GDE Goal:
  - Reference Design Report including costs end 2006 related to sample sites
- Intermediate goal (follows from primary)
  - Definition of a Baseline Configuration by the end of 2005; this
    - will be designed to during 2006
    - will be the basis used for the cost estimate
    - will **evolve** into the machine we will build

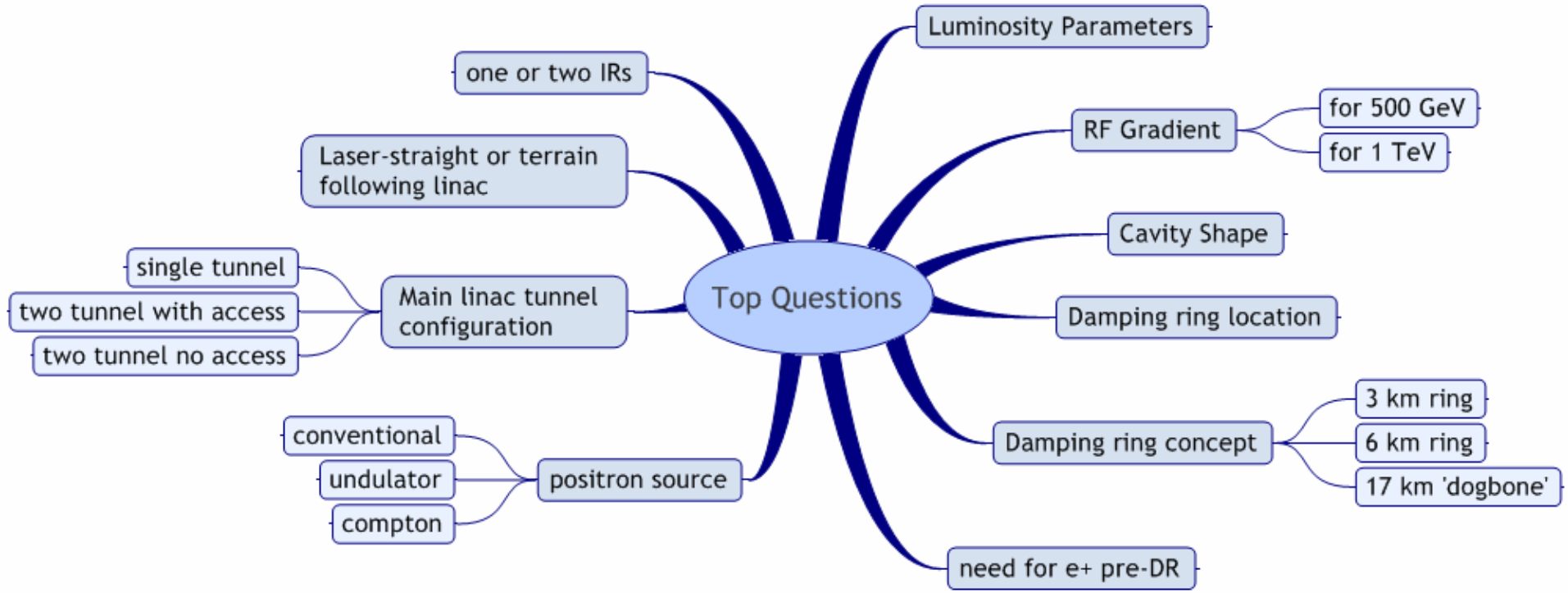
Starting Point for the GDE



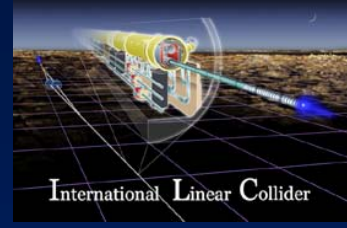


Superconducting RF Main Linac

The Hard Questions

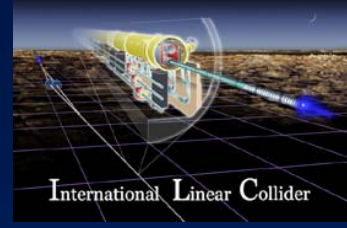


41 critical decisions

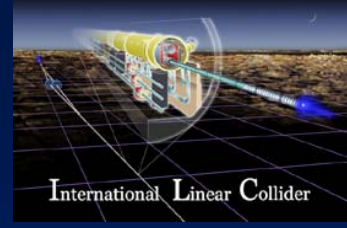


ID	Decisions
2	beam and luminosity parameters. All groups involved
	* main linac starting gradient, upgrade gradient, and upgrade path
	Emittance growth favors higher gradients
	Is upgrade cost of new scheme really less?
	Upgrading from 28 to 31.5 requires rewiring RF distribution and changing refrigeration.
	Adiabatic upgrade only reasonable if needed to warm cryo string for repair anyway.
3	Tevatron energy upgrade was done this way (by replacing the worst magnets).
4	straight or follow earth's curvature?
	* 1 or 2 IRs, if two, run interleaved?
	Want more info on desire to have no bends in last 5 km of linac tunnel.
	What info is needed on gamma gamma?
	Having smaller difference between crossing angles of the two IRs may cause problems with not having
5	enough transverse distance between the tow IRs.
6	1, 1.5, or 2 tunnel
	* DR size and shape
	Said prefer shortest ring that works. Should be cheapest.
	What are longitudinal parameters of bunch for 7 GeV dogbone? Answer: not known yet.
7	If need to do 6000 bunches. Would have to do two 6 km rings.
	e+ source type conv/undulator/Compton
	Type of keep alive source is undecided.
	To do giga Z there is an extra souce at 100 GeV point used to make e+. The first 100 GeV and a
	bypass line are used to make the luminosity bunch.
8	Agreed to include the pros and cons from WG3 in the write-up. They were used in the decision making.
	is there an e+ pre damping ring
9	No
10	DR location: 1st half tunnel, 2nd half, ceiling, under cryomodules, separate tunnel
11	cavity shape/iris size
	How much is a 1% change in average luminosity worth?
12	Between 2 and 100 M$
	Maximum AC power the site can use
13	No talk given
	Minimize capital cost + N years of operations. N=?
14	No talk given
15	crossing angle
	* amount of electronics in tunnel
	Robotic repair may be useful in areas where the tunnel is too radioactive
16	The accelerator and electronics must be designed for robotic maintenance
17	bunch/train structure
	* Number of bunch compressor stages
18	What is cost differential between 1 and 2 stage? Don't have costs, but do have length differences
19	tunnel depth
20	* # cavities per cryomodule
	* gamma-gamma upgrade path
	Is 20 mrad plan OK for gamma gamma? No. Needs closer to 25 mR
	Intermediate angle (about 12 mR) is definitely not good for gamma gamma.
	Maybe a stubbed off tunnel would allow an upgrade to g-g
21	Whatever option is picked, must understand the upgrade path
	* Linac modulator voltage
22	This is really the same as question 24.
23	Linac power sources

Goals of the 2nd Workshop



- Continue process of making a Recommendation on a Baseline Configuration
- Identify longer-term Alternative Configurations
- Identify necessary R&D
  - For baseline
  - For alternatives
- Priorities for detector R&D

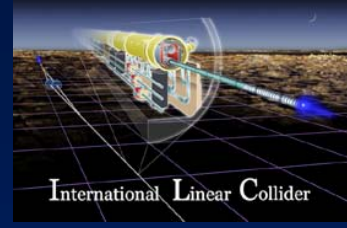


Baseline / Alternative: some definitions

Baseline: a forward looking configuration which we are reasonably confident can achieve the required performance *and* can be used to give a reasonably accurate cost estimate by mid-end 2006 (→ RDR)

Alternate: A technology or concept which may provide a significant cost reduction, increase in performance (or both), but which will not be mature enough to be considered baseline by mid-end 2006

Note:
Alternatives will be part of the RDR
Alternatives are equally important

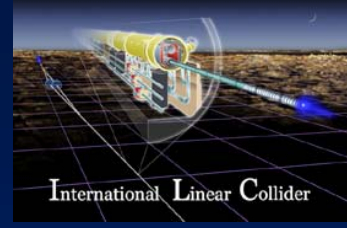


BCD review process

- BCD Executive Committee (EC) will monitor BCD progress
  - Review WG/GG summary write-ups (recommendations)
  - Review each question on the Himel list
- BCD EC will identify needed additional input
  - additional (missing) expertise (members) of the GDE
- Strawman BCD available mid-November (web)
- Presentation of strawman BCD at Frascati GDE meeting (Dec. 7-10)
- Final agreed BCD to be documented
- Final BCD becomes property of 'Change Control Board' end 2005 / beginning 2006

… and then the real hard work starts ☺

Towards a final BCD



we are here

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

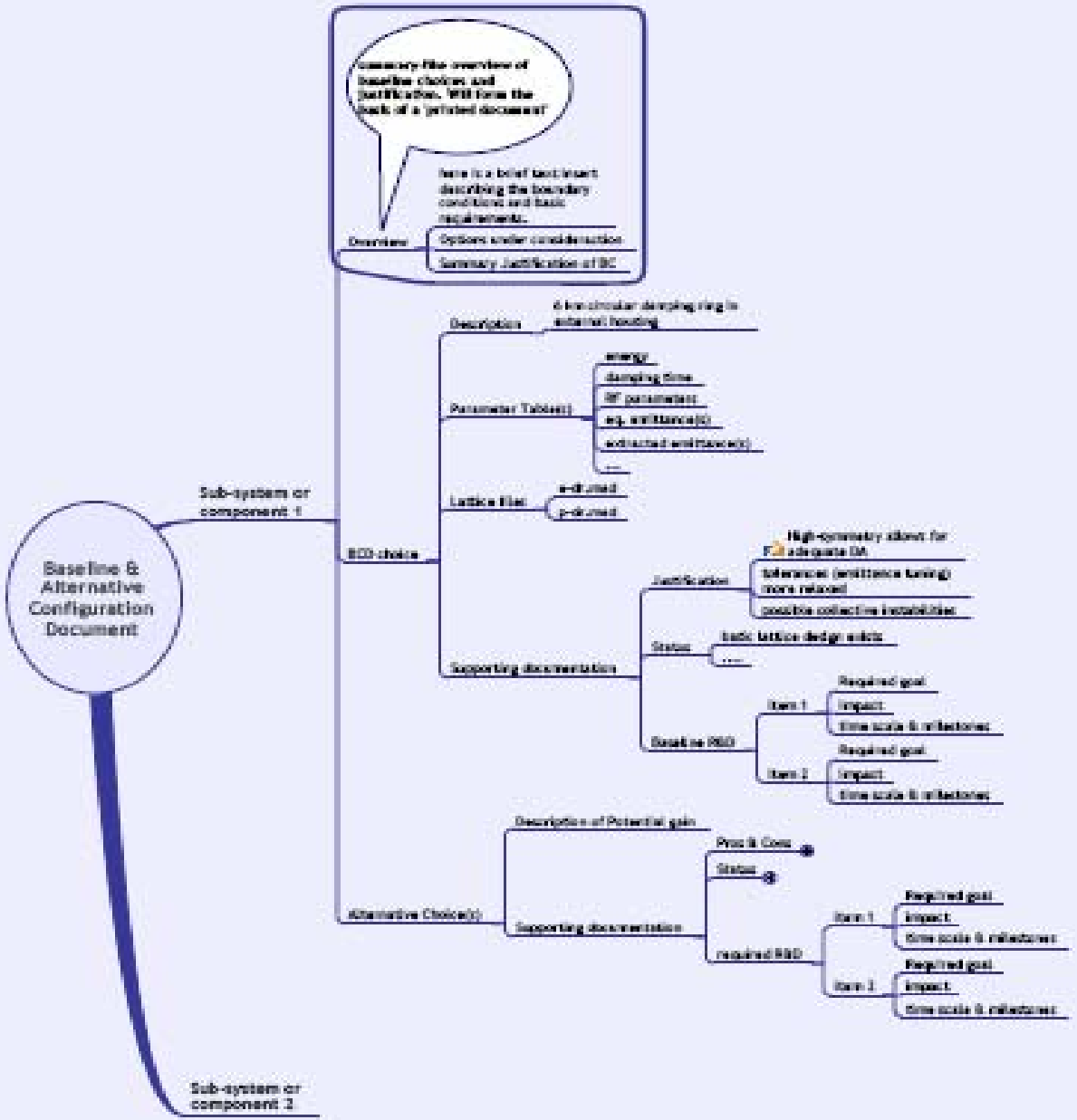
BCD Executive Committee (EC):

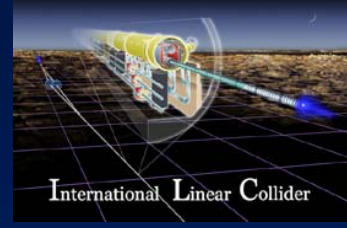
Barish

Dugan, Foster, Takasaki (regional directors)

Raubenheimer, Yokoya, Walker (gang of three)

BCD&RDR

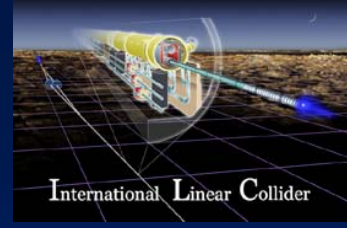

Baseline & Alternative Configuration Document
Sub-system or component 1
Sub-system or component 2
Overview
Options under consideration
Summary Justification of BC
BCD choice
Description
Parameter Table(s)
energy
damping time
RF parameters
eq. emittance(s)
extracted emittance(s)
Lattice file
e-driven
p-driven
Supporting documentation
Justification
Status
basic lattice design exists
Baseline R&D
Item 1
Required goal
Impact
Time scale & milestones
Item 2
Alternative Choice(s)
Description of Potential gain
Supporting documentation
Pros & Cons
Status
required R&D



Multi-TeV option?

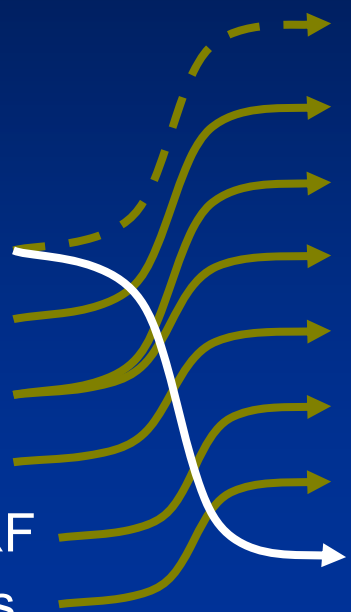
- CLIC study committed to inform the ILC community about the key issues to be respected in order to allow the use of the ILC site for a possible future upgrade into the Multi-TeV range based on CLIC technology
- H.Braun and D.Schulte kindly agree to coordinate the study and edit an ILC/CLIC note on the subject

The Year After 'Unification'



Birth of the GDE and Preparation for Snowmass

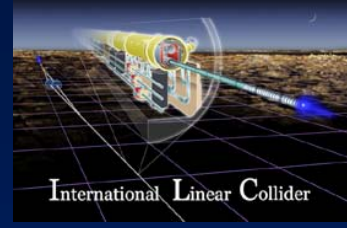
- WG1 Parms & layout
- WG2 Linac
- WG3 Injectors
- WG4 Beam Delivery
- WG5 High Grad. SCRF
- WG6 Communications

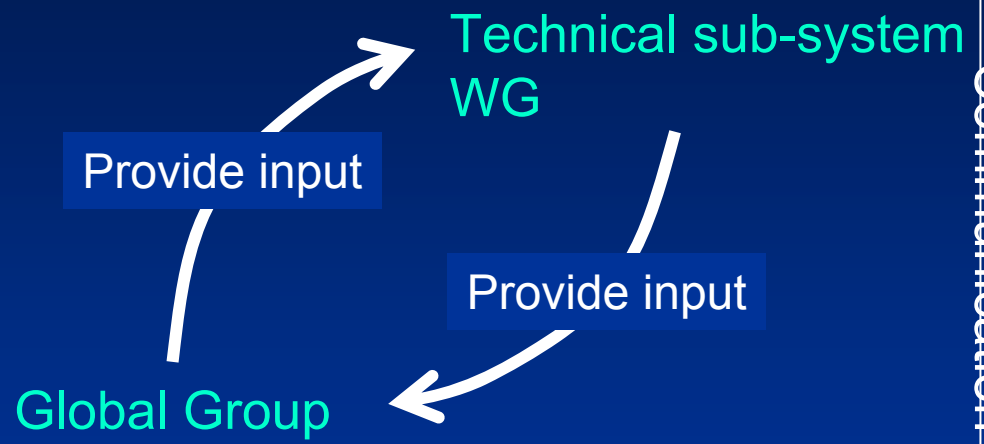


- WG1 LET beam dynamics
- WG2 Main Linac
- WG3a Sources
- WG3b Damping Rings
- WG4 Beam Delivery
- WG5 SCRF Cavity Package
- WG6 Communications
- GG1 Parameters & Layout
- GG2 Instrumentation
- GG3 Operations & Reliability
- GG4 Cost Engineering
- GG5 Conventional Facilities
- GG6 Physics Options

Introduction of **G**lobal **G**roups
transition workshop → project

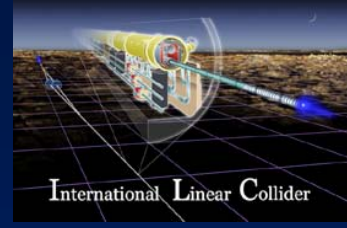
2nd ILC Workshop (Snowmass)





- GG1 Parameters (D.Schulte)
- GG2 Instrumentation (H.Braun)
- GG3 Operations & Reliability
- GG4 Cost & Engineering (J.P.D.)
- GG5 Conventional Facilities (J.L.Baldy)
- GG6 Physics Options (A.de Roeck)

- WG1 LET bdyn.(D.Schulte)
- WG2 Main Linac (L.Tavian)
- WG3a Sources (JPD)
- WG3b DR (JPD)
- WG4 BDS (H.Braun
- WG5 Cavity (V.Parma, J.Tuckmantel)
- Communication (J.Gillies)



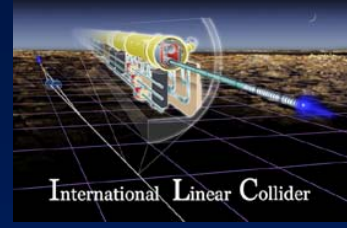
WG3a Sources Summary

Jim Clarke

on behalf of

John Sheppard, Masao Kuriki, Philippe Piot

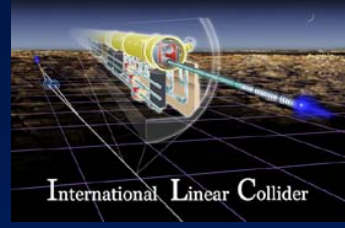
and all the contributors to WG3a

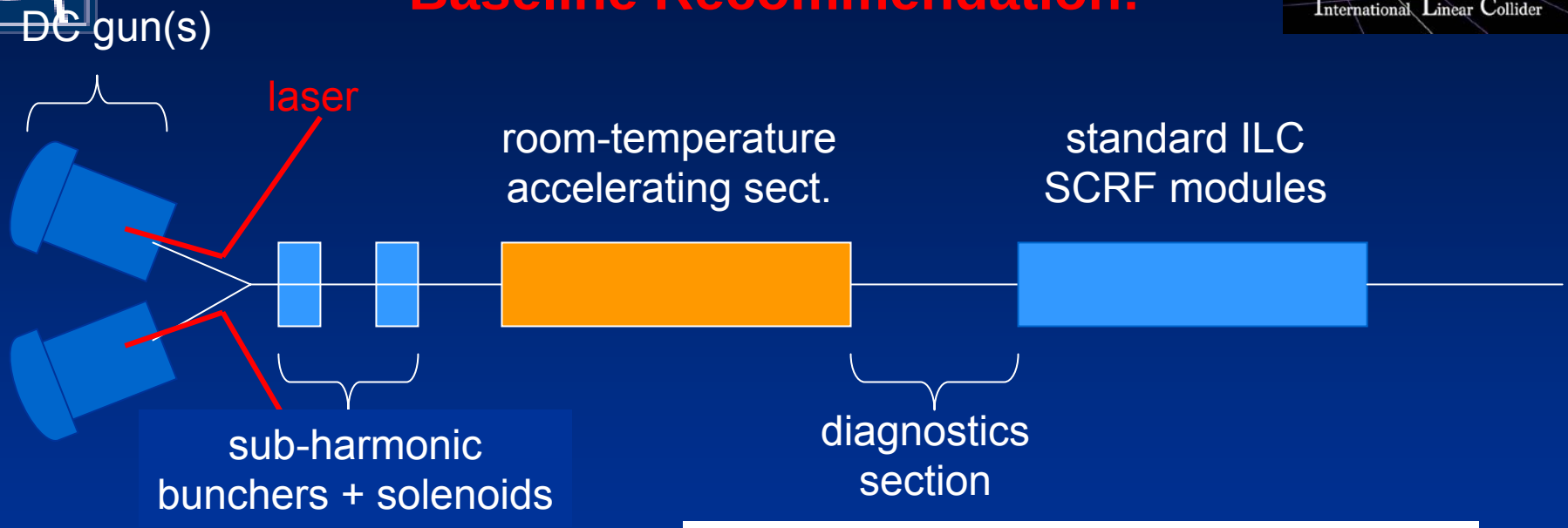


Goals for WG3a

- Review ILC electron and positron source requirements.
- Review proposed source designs.
- Make recommendation for the baseline reference design.
- Develop list of R&D tasks.
- Discuss design options.
- Propose a timeline for the development of the ILC sources which includes criteria and milestones for technology selection.
- Make a list of current activities; make a list of institutional interest in future development activities.

ILC polarized electron source, Baseline Recommendation!





Laser requirements:

pulse energy: ~ 2 μJ
pulse length: ~ 2 ns
pulses/train: 2820
Intensity jitter: < 5 % (rms)
pulse spacing: 337 ns
rep. rate: 5 Hz
wavelength: 750-850 nm

DC gun:

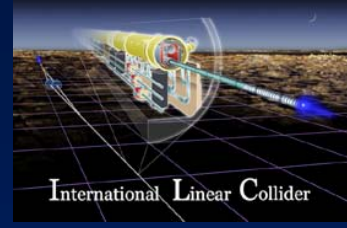
120 keV HV

photocathodes:

GaAs/GaAsP

Room temperature linac:

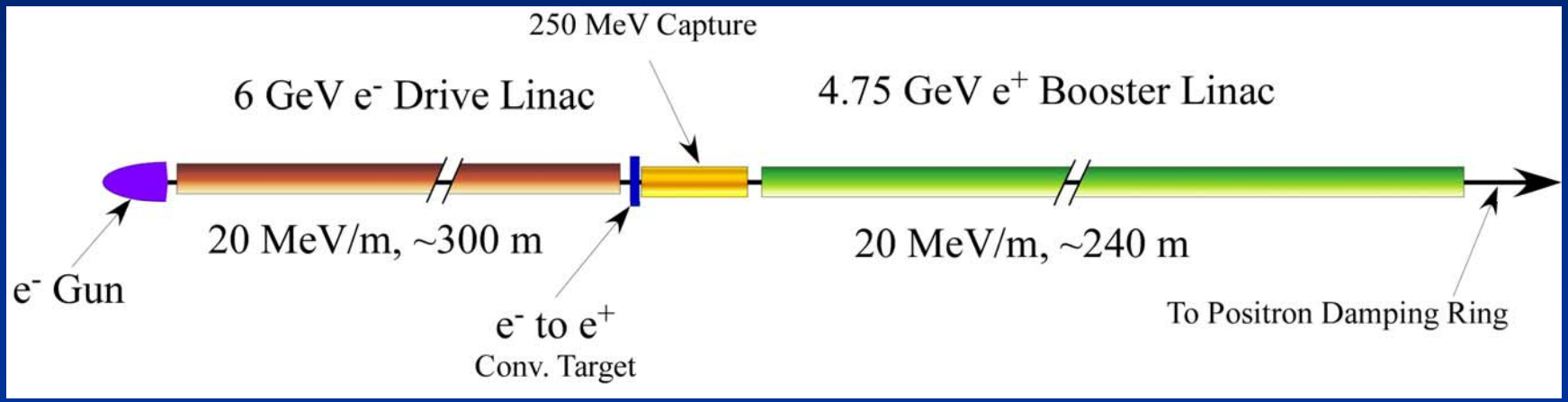
Allows external focusing by solenoids
Same as e+ capture linac



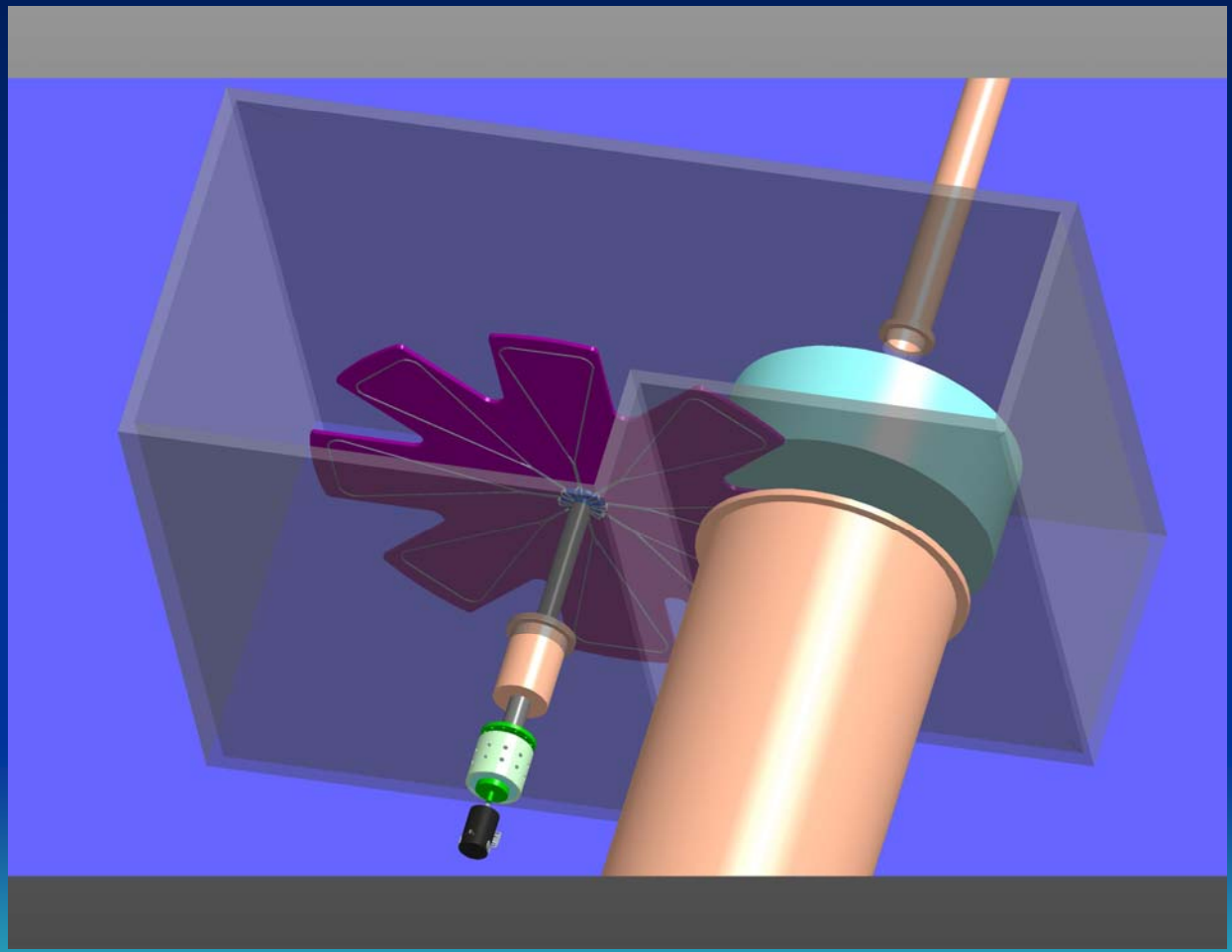
Positron Source

- 4 sessions dedicated to positrons
- 13 presentations
- 3 alternative schemes were considered in detail
- Lively discussion on pros and cons of each scheme !!

“Conventional” Scheme



Conventional Target



Target material
WRe

56kW absorbed

Target rotates at
360m/s

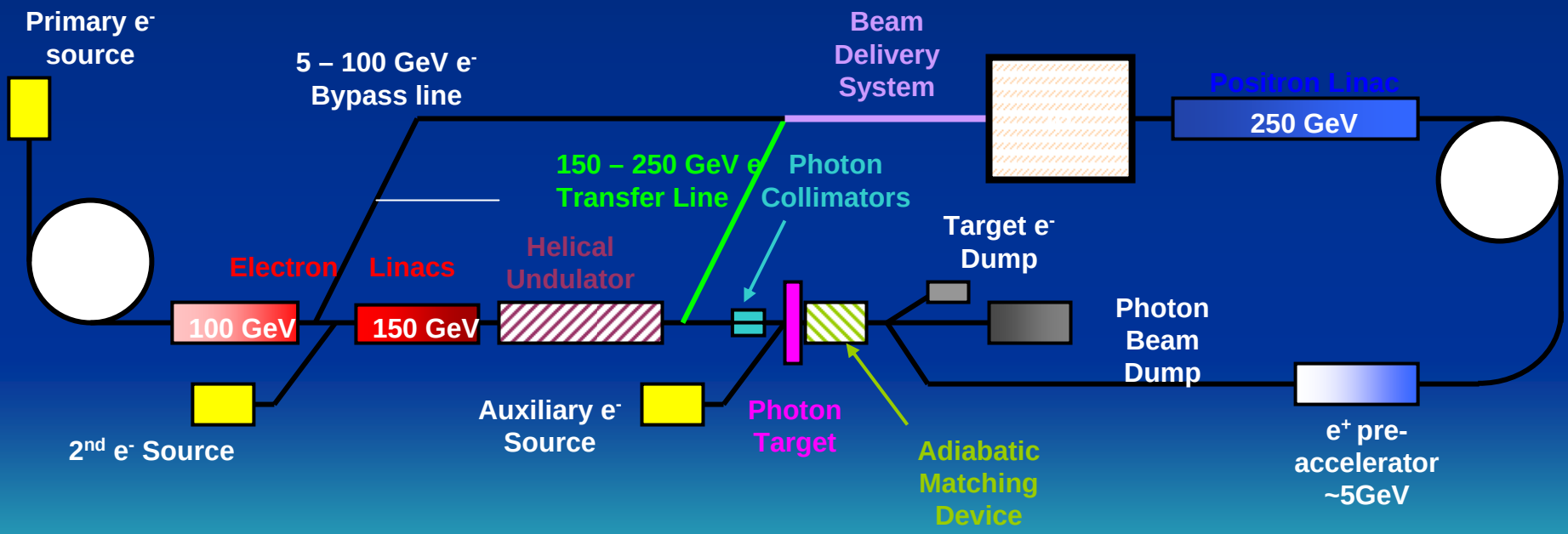
Operates at fatigue stress of material

W Stein, LLNL

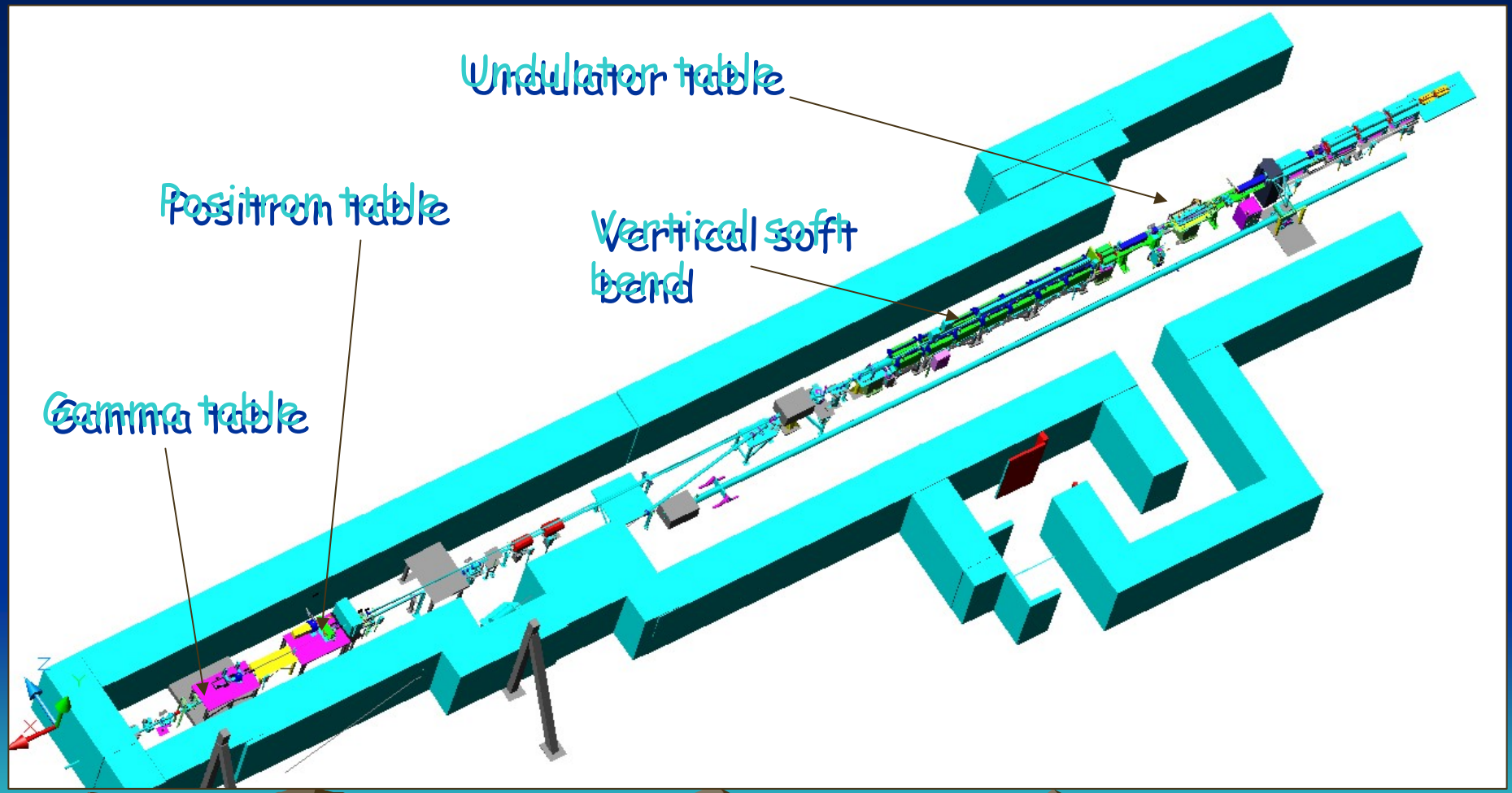
Undulator Based Source

Many options for undulator placement etc

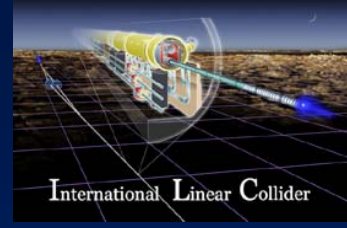
Schematic Layout – Undulator @ 250GeV & Transfer Paths



E-166 at SLAC


Undulator table
Positron table
Vertical soft bend
Gamma table

E-166 Results

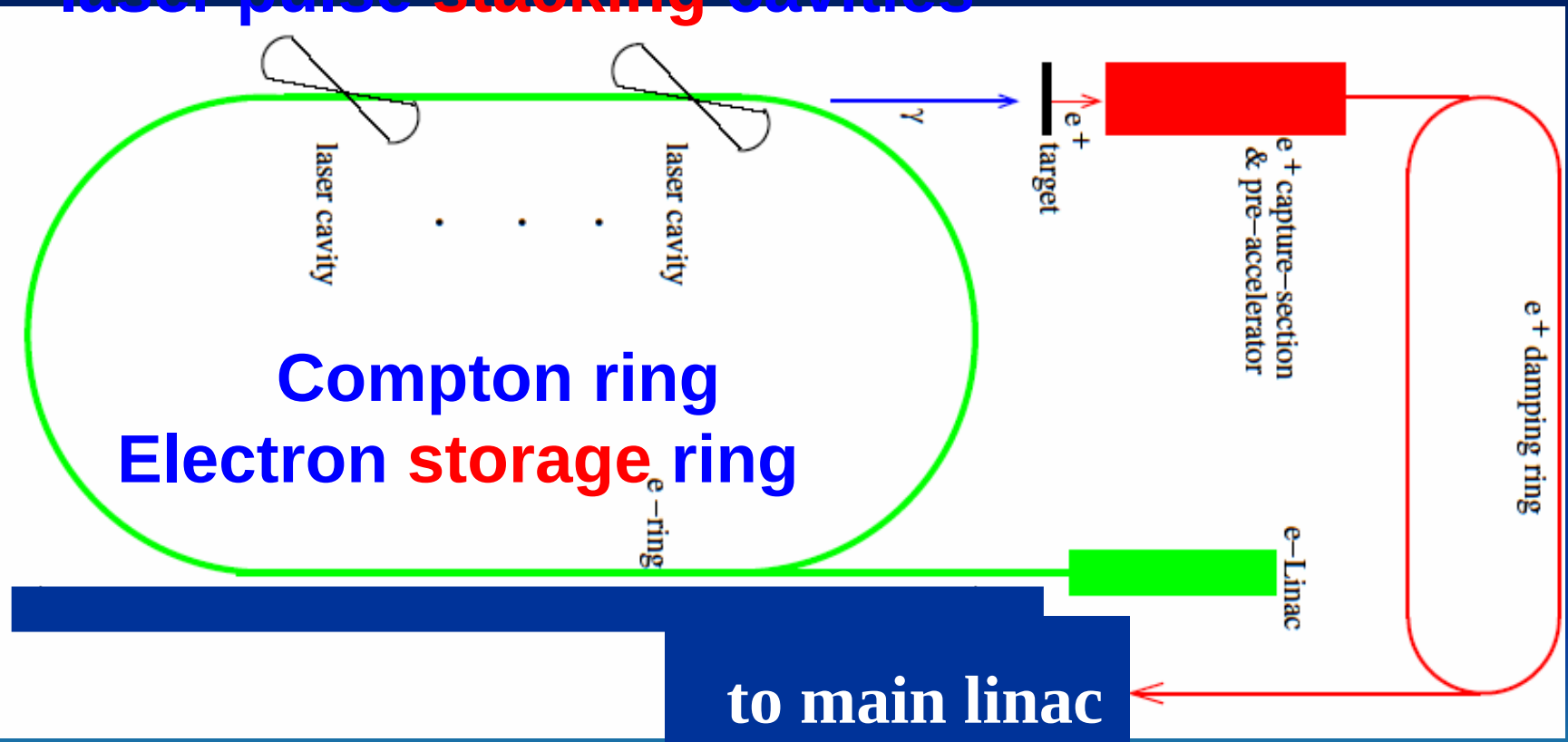


- Number of photons agrees with expected
- Gamma polarisation agrees with theory 82-99.3 %±10-20%
- Number of positrons agrees with expected

- Positron Polarisation = 95 %±30%
- Simulated 84%

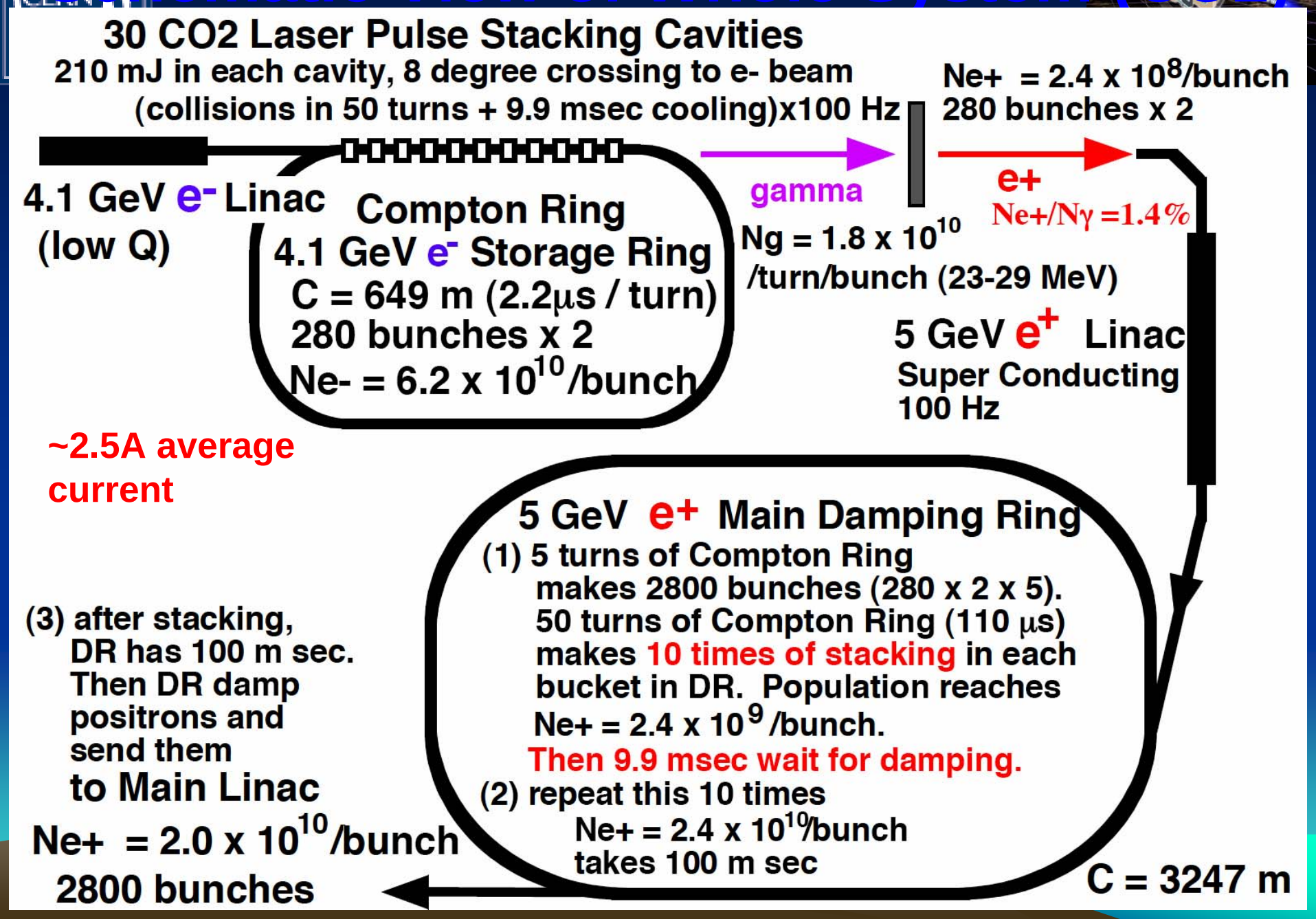
Compton Scheme

laser pulse stacking cavities

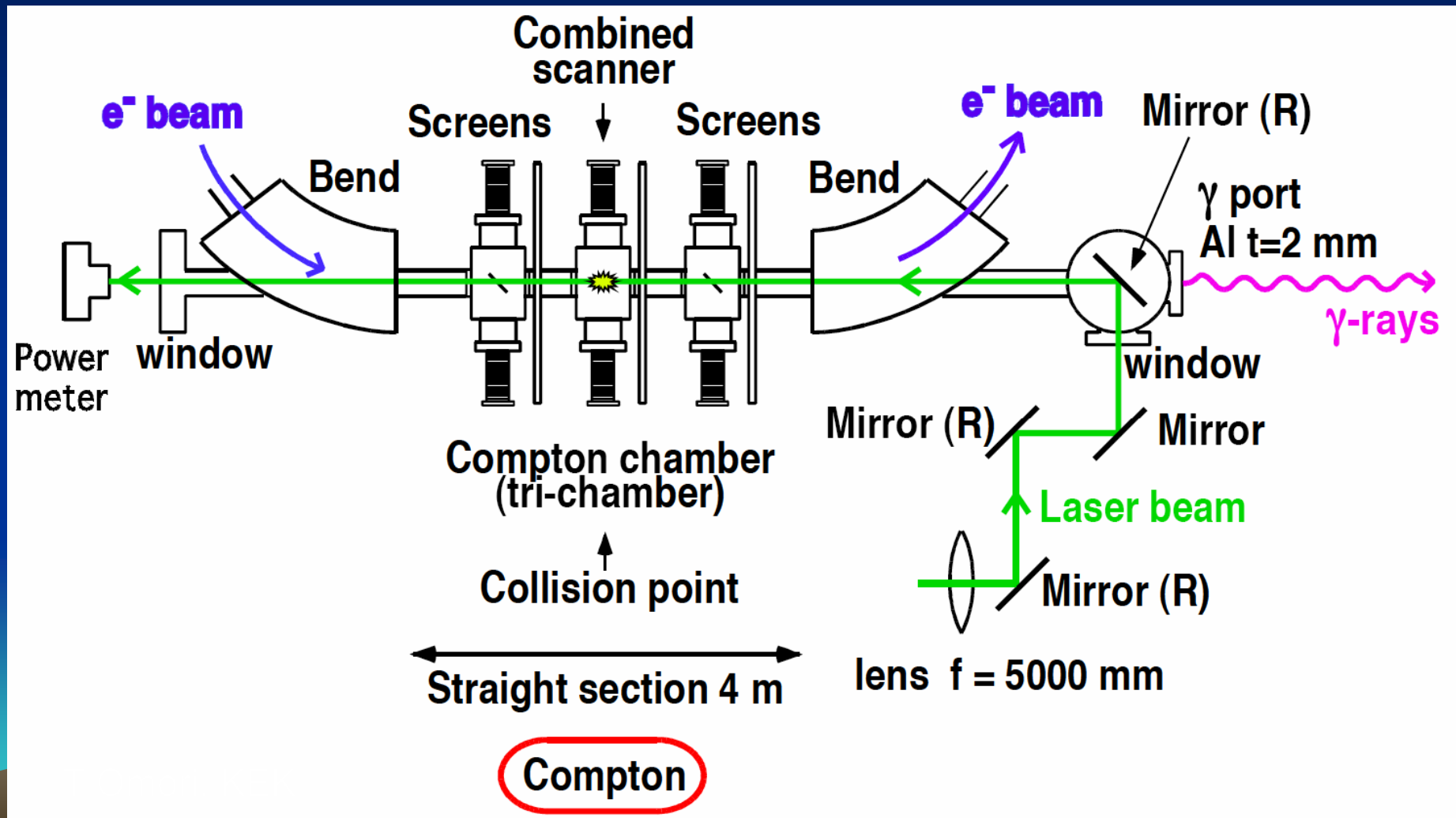


positron stacking in main DR

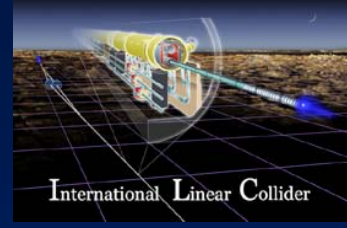
Schematic View of Whole System (CO2)



Proof of Principle at KEK



Positron Source



- Undulator source
  - Uses main electron beam (150-250 GeV)
  - Coupled operation ☹
  - Efficient source ☺
  - Relatively low neutron activation ☺
  - Polarisation ☺

WG3a recommendation for baseline

Will need 'keep alive source' due reliability issues

- Laser Compton source
  - Independent polarised source ☺
  - Relatively complex source
  - Multi-laser cavity system required
  - Damping ring stacking required
  - Large acceptance ring (for stacking) ☹
  - Needs R&D

WG3a recommended alternative.

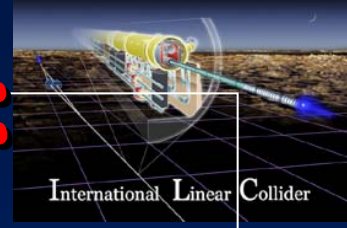
Strong R&D programme needed

- Conventional Source
  - Single target solution exists
  - Close to (at?) limits ☹
  - Independent source ☺

Currently on-hold as a backup solution

Pre-damping ring **not** required ☺

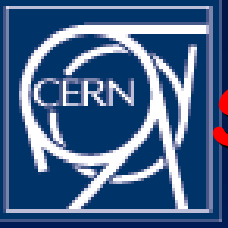
Working Group 3b: Damping Rings *Summary*



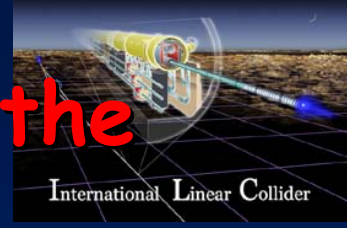
Jie GAO (IHEP), Susanna GUIDUCCI (INFN), Andy WOLSKI (LBNL)

2nd ILC Workshop, Snowmass
Plenary Summary Session

August 19, 2005



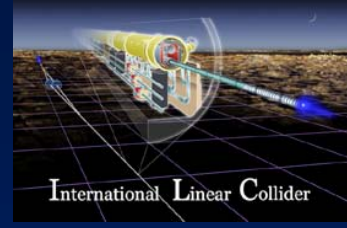
Seven "reference" lattices span the configuration space



Lattice Name	Energy [GeV]	Circumference [m]	Cell Type
PPA	5.0	2824	PI
OTW	5.0	3223	TME
OCS	5.0	6114	TME
BRU	3.7	6333	FODO
MCH	5.0	15935	FODO
DAS	5.0	17014	PI
TESLA	5.0	17000	TME

- Note: cell type is important because of the potential impact on sensitivity to magnet misalignments, sensitivity to collective instabilities etc.

Damping Rings



- Damping Rings
  - Emittance Goals
    - 1 pm !
  - Dynamic Aperture
    - lattice design
    - wiggler
  - Instabilities (collective effects)
    - electron cloud
    - fast ion
    - …
  - Kicker Technology
  - Circumference
  - $ COST
  - Commissioning

☺

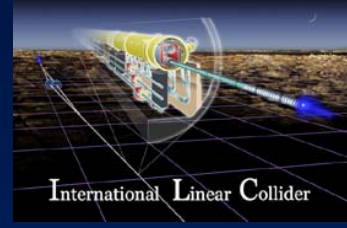
☹

higher I_{av}

smaller circumference
(faster kicker)

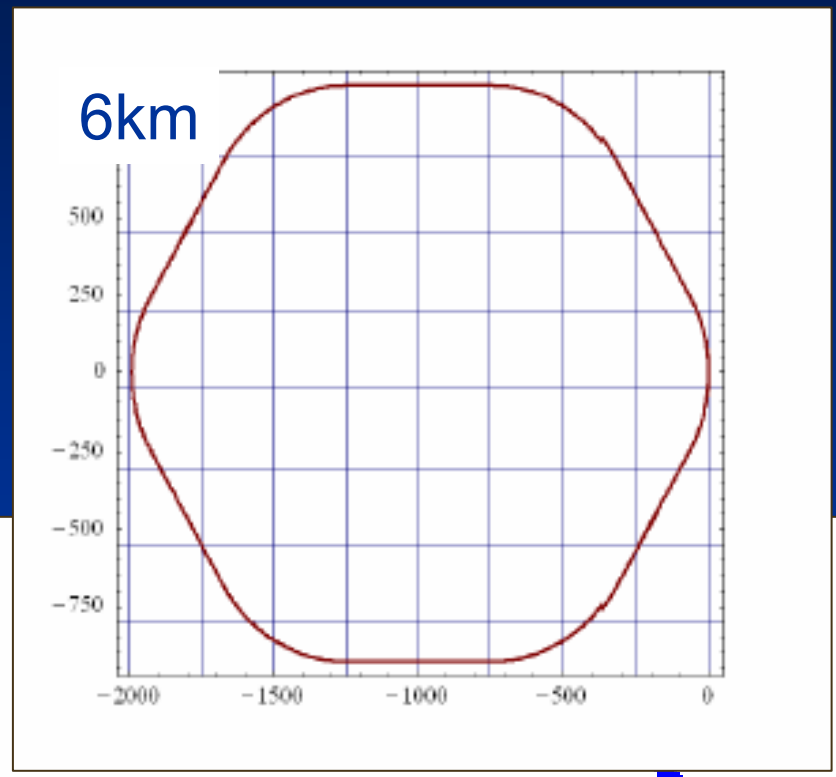
bunch train compression
300km → <20km

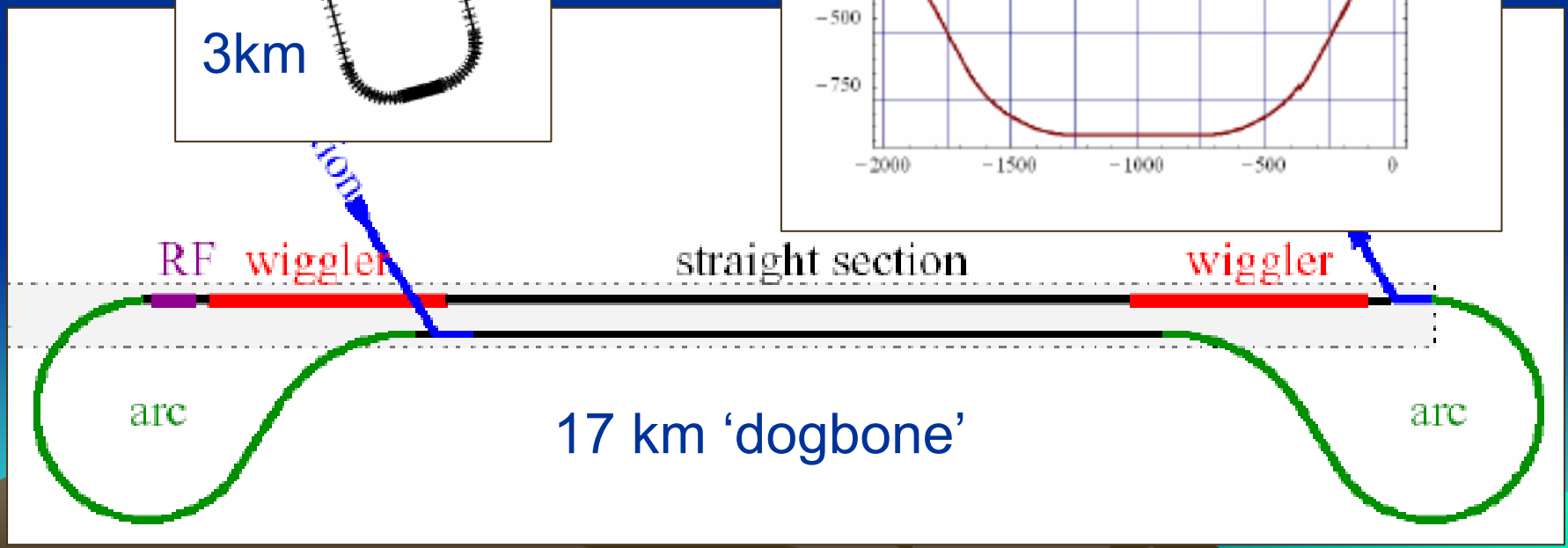
Task forces have been charged to study the key issues



- The task forces (and co-ordinators) are:
  1. Acceptance (Y. Cai, Y. Ohnishi)
  2. Emittance (J. Jones, K. Kubo)
  3. Classical Instabilities (A. Wolski)
  4. Space-Charge (K. Oide, M. Venturini)
  5. Kickers and Instrumentation (T. Naito, M. Ross)\
  6. Electron Cloud (K. Ohmi, M. Pivi, F. Zimmermann)
  7. Ion Effects (E.-S. Kim, D. Schulte, F. Zimmermann)
  8. Cost Estimates (S. Guiducci, J. Urakawa, A. Wolski)
  9. Polarization (D. Barber)
- The various configuration options are being studied, using the seven "reference" lattices as a basis, and applying a consistent set of analysis techniques and tools.
- The goals of the task forces are to produce information that can be used to inform the configuration selection.
- Work is in progress. There are roughly 30 active participants altogether, and 36 talks have been given. All three regions are strongly represented.

Damping Rings: Three variants





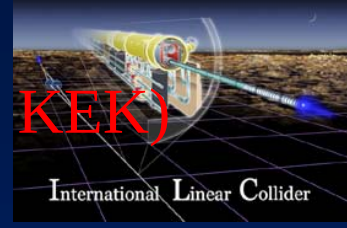
Kickers and Instrumentation: Progress and Plans

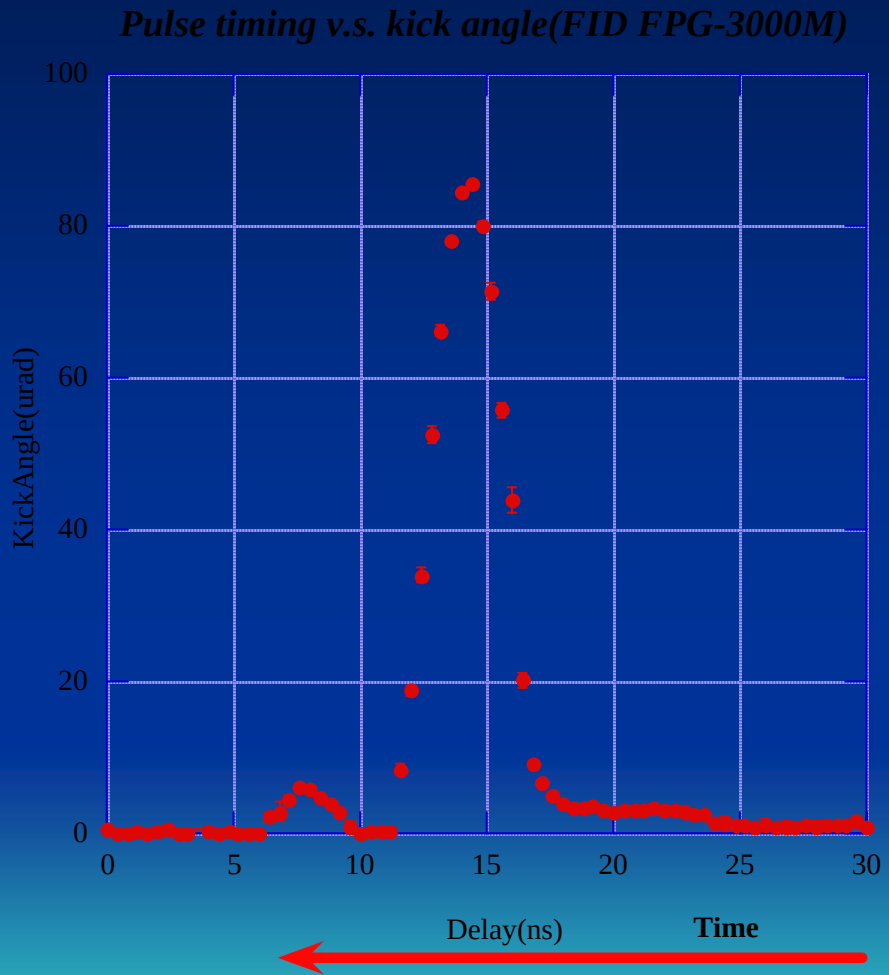
- **TF5: Kickers and Instrumentation (Chair: T. Naito and M. Ross)**

- T. Naito, ATF kicker studies
- R. Larsen/M.Ross, Inductive adder pulsers
- H. Weise, DESY FET pulsers
- G. Gollin, FNAL Fourier series kicker studies
- P. Raimondi/S.Tantawi, RF kickers
- J. Urakawa, Instrumentation R&D at KEK-ATF
-

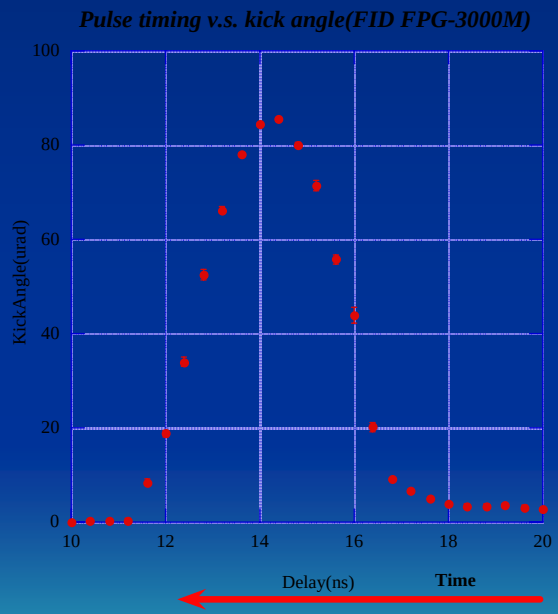
Measurement result of FPG5-3000M

(Naito's talk, KEK)





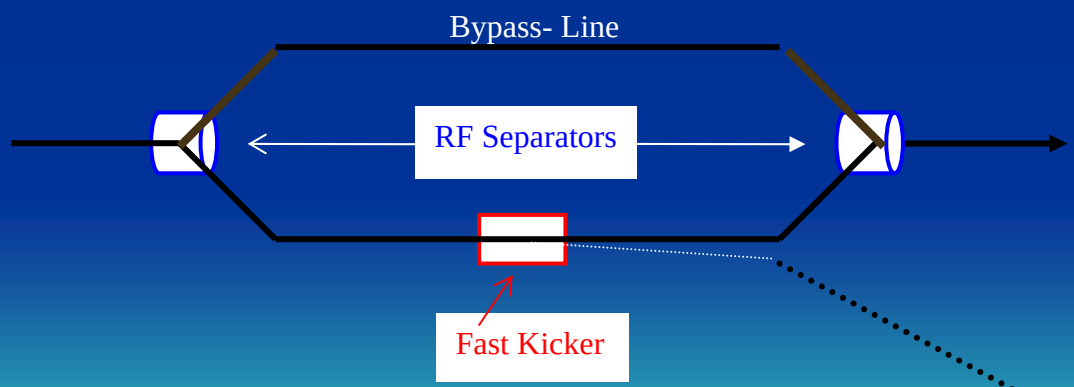
Rise time~3.2ns
Kick angle ~85μrad
(calc. 94.7μrad)

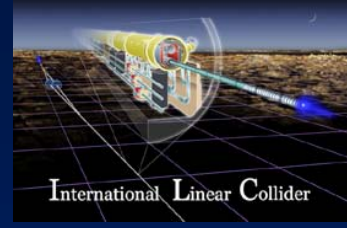


Expanded horizontal scale

Bypass Injection/Extraction
Andrew Hutton

- The minimum circumference of the ILC Damping Rings is limited by the rise and fall times of the injection and extraction kickers. This proposal uses an RF separator system to separate every third pulse and send it into the injection/extraction line. The other bunches are sent through a bypass line of equal total length. The bunches are then recombined into a uniform train in the rest of the damping ring.
- The circumference can then be chosen as short as is permitted by other parameters. When (and if) faster kickers are developed, the bypass can be deleted and all the other parameters of the damping rings remain unchanged. RF SeparatorsFast KickerBypass Line





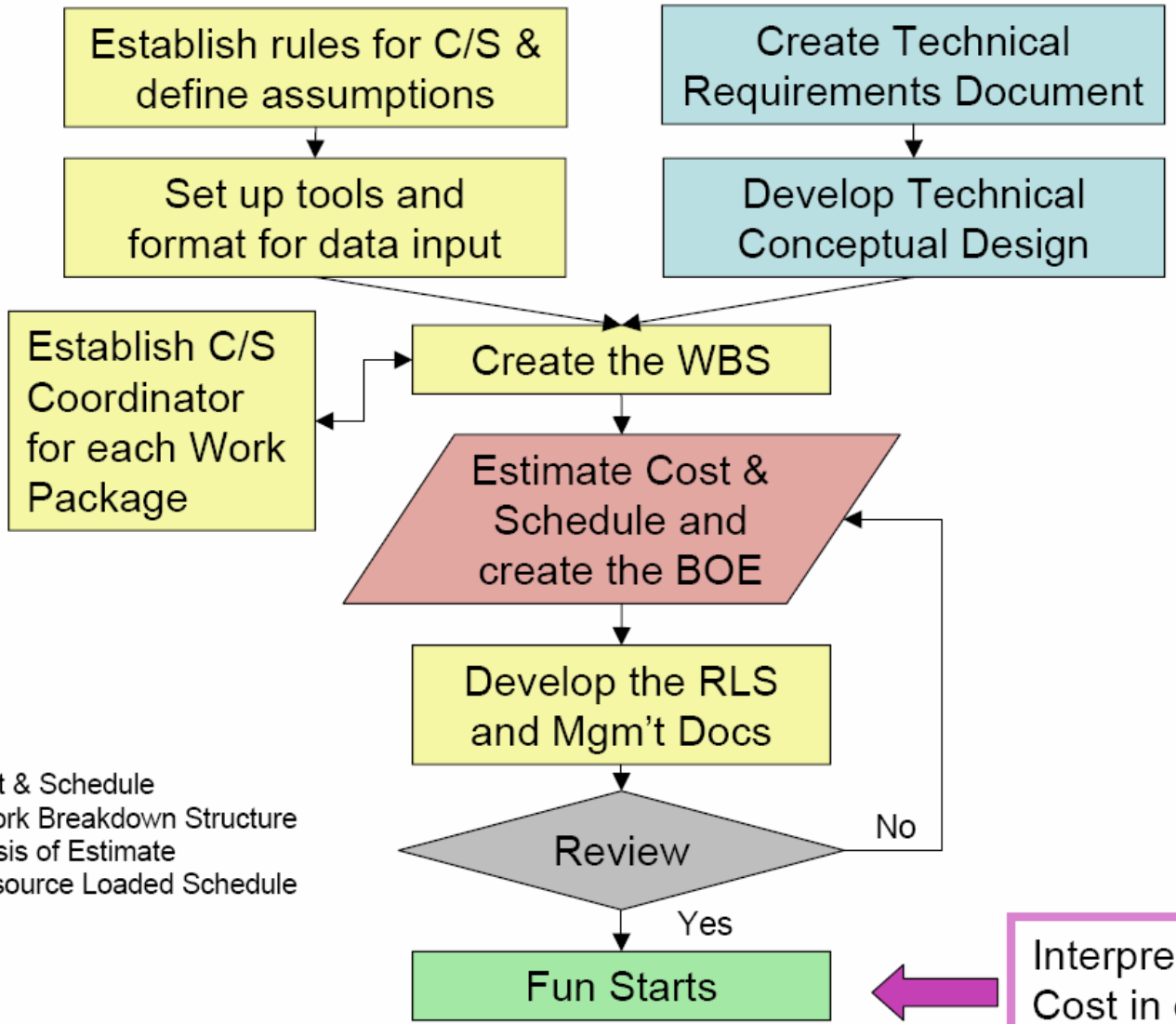
Damping Rings: Recommendation

- Not Yet!
- Systematic analysis of all rings being made
  - Dynamic aperture
  - Emittance performance (tolerances)
  - Electron cloud
  - Fast ion instability
  - …
- Positive R&D on fast kickers will allow smaller circumference than TESLA dogbone
- Recommendation to be made this Autumn (Meeting at CERN or Vancouver)

Charge to GG5: Cost & Engineering

- Develop engineering and costing standards
- Develop cost model for BCD selection
- Develop a process to arrive at cost & schedule estimate for the RDR

General Methodology



C/S = Cost & Schedule
WBS = Work Breakdown Structure
BOE = Basis of Estimate
RLS = Resource Loaded Schedule

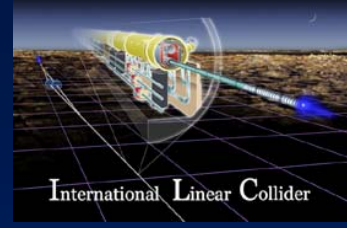
Establishing ILC Standards

- Fortunately we have examples to follow
  - CERN system for LHC (Impressive! talk by Jean Pierre Delahaye)
  - Other international projects (e.g. ITER)

- Specific near-term Recommendations
  - Examine the CERN LHC system and its applicability to ILC

  - EDMS (Electronic Data Management System)
    - Appoint a group to collect requirements for an ILC data management system
    - Survey available systems
    - Make a recommendation to GDE very soon (already the GDE plan)

  - Engineering Drawings
    - Collect requirements for ILC Standard CAD systems
    - Use 3-D CAD modeling for all drawings including Civil!
    - Establish Drawing standards (units, dimensioning, and language)
    - Survey existing CAD software, including interoperability across regions
    - Recommend a standard ILC system to GDE



ILC management tools

- Creation of a Committee to:
  - review the needs and analyse the various available tools
  - advice B.Barish and GDE on the best tools to be adopted for ILC
  - J.Ferguson kindly agreed to act as the CERN representative (appointed by B.Barish)
  - Decision before the end of the year in order for the tools to be available from the BCD to the RDR (documentation, Configuration Change Management, etc…)

CERN Director-General Shares Advice about International Projects and Costing

Click on image for larger view

On Monday morning CERN Director-General Robert Aymar addressed Global Group 5 – Cost and Engineering to share his experiences with ITER, an international project that many ILC scientists are using as a model. Aymar described the twenty-year cost estimate and planning process for ITER. Global Group 5 members had the opportunity to ask Aymar questions that ranged from "Will the ILC need an international treaty?" to "Will the ILC take twenty years to plan like ITER?" Aymar warned about such complications as exchange rates over a period of ten years. He explained that the Japan to U.S. exchange rate varied by more than 50% over ten years. "The estimates start side by side and end up with very different costs because you are not working with the world market," said Aymar. He also advised scientists to keep in mind that the government's timescale is very different from the scientific timescale. "International cooperation is a good way to slow down everything," he said. "As soon as you get through to the diplomats to get an international agreement, you have to follow their timescale, not the technical timescale." Aymar's final words of advice to Global Group 5 were to define a goal. "Our goal for ITER was to provide each party with an understanding of an equitable contribution," he said. "Presenting the cost estimate for the ILC is totally different. You have to put in very strong terms what the goal is for the costing estimate."

Unified Cost in ITER

Globally unified components cost (in virtual money)

Regional cost data

ITER Entity

Regional cost data

Responsible Laboratory

Engineering cost data

Industry

Responsible Laboratory

Engineering cost data

Industry