CLIC-ILC accelerator collaboration

Ph. Lebrun*
CERN

IWLC 2010 CERN Geneva
22 October 2010

* With the help of E. Elsen, M. Harrison, J. Osborne, Y. Papahilippou, K. Peach, L. Rinolfi, D. Schulte, R. Tomas, K. Yokoya

2008

CLIC / ILC Joint Statements
27 October 2008

Purpose of these statements:

The CLIC and ILC Collaborations agree to work together, within the framework of the CLIC / ILC Collaboration, to outline comparative statements to be used in presenting their respective projects. The Collaboration members agree to limit statements made about each other's projects to specifically agreed upon statements such as those listed below:

- **Project design**

The CLIC and ILC projects both plan to release design documents in the coming years. The CLIC Conceptual Design Report is to be published in 2010. If the CLIC technology is demonstrated to be feasible, a CLIC Technical Design will then be launched for publication in a CLIC TDR by 2015. The ILC TDR will be published in 2012. The design reports are intended to summarize the R&D and project planning at that time and will serve as indicators of project readiness. Both TDRs are intended to be submitted to governments and associated funding agencies in order to seek project approval.

- **Test facilities and system tests**

The CLIC and ILC projects both have test facilities either in operation or under construction for the purpose of demonstrating the performance of key technical components or to allow system engineering and industrialization. For each project, R&D priorities and schedules have been defined and it is anticipated that milestones and progress will be reviewed and reported on by members of the community. The XFEL project, with the same technical basis as the ILC, although at a lower accelerating gradient, and 7% of the energy of one of the ILC linacs, is a large-scale system test and demonstration of the industrialization of the ILC linac technology. The CERN- based CTF3 project is a demonstration of the CLIC two beam technology, although at a lower beam power.

- **Technology maturity and risk**

The collaborations agree that the ILC technology is presently more mature and less risky than that of CLIC. There are plans to demonstrate, by 2010, the feasibility of CLIC technology and to reduce the associated risk in the future. The ILC collaboration will focus on consolidation of the technology for global mass-production. Both collaborations consider it essential to continue to develop both technologies for the foreseeable future.

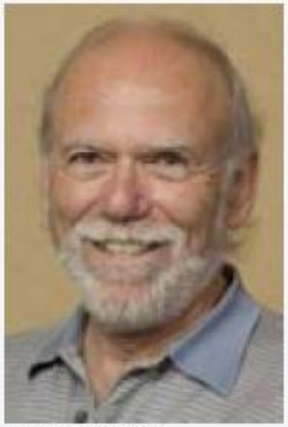
- **Costing**

Project planners from the CLIC and ILC projects are developing common methodologies and tools with the intention of enabling the development of similarly-structured project planning and costing documents for each of the two projects. The two collaborations agree to make no public statements about the comparative cost numbers of the two machines until these project planning and costing documents are complete.

Barry C. Barish
ILC-GDE Director

J-P. Delahaye
CLIC Study Leader

2008



Barry Barish

Jean-Pierre Delahaye, CERN CLIC study leader

Formalising the CLIC-ILC collaboration

Collaboration between our ILC R&D and design work and the parallel effort towards the CLIC concept stands to be of benefit to both groups. This direction also promises to help break down barriers between the two groups, making the worldwide effort towards a linear collider more integrated and unified. Of course, the underlying concepts are fundamentally different and affect much of the rest of the design: for acceleration in the main linac, the ILC uses superconducting RF, whereas CLIC accelerates through a drive beam. Nevertheless, there is a great deal of mutual interest in other areas and we have formed five working groups that are already well underway and two more working groups are being set up. We have now taken the step to formalise the mode of our collaboration, especially regarding guidelines for communication outside the collaboration. This will help enable the joint work to go forward and be used in ways agreeable to both groups.

CLIC-ILC specialized WG

	CLIC	ILC
Physics & Detectors	L.Linssen, D.Schlatter	F.Richard, S.Yamada
Beam Delivery System (BDS) & Machine Detector Interface (MDI)	L.Gatignon D.Schulte, R.Tomas Garcia	B.Parker, A.Seriy
Civil Engineering & Conventional Facilities	C.Hauviller, J.Osborne.	J.Osborne, V.Kuchler
Positron Generation	L.Rinolfi	J.Clarke
Damping Rings	Y.Papaphilipou	M.Palmer
Beam Dynamics	D.Schulte	A.Latina, K.Kubo, N.Walker
Cost & Schedule	P.Lebrun, K.Foraz, G.Riddone	J.Carwardine, P.Garbincius, T.Shidara

STATEMENT OF COMMON INTENT

by the CLIC Collaboration Board and the ILC Steering Committee

2010

Recognising the need for an electron-positron linear collider to explore the physics that will be revealed by the LHC,

Considering the synergies that exist and the opportunities for collaboration that arise between the ILC Global Design Effort and the CLIC collaboration, as well as between the ILC and CLIC physics and detector studies, and

Building upon the CLIC/ILC joint statements,[1]

The two parties **agree** to promote and develop scientific and technical preparations for a linear collider, and to exploit wherever possible synergies between ILC and CLIC, including accelerator, detector and physics topics, so the designs are prepared efficiently in the best interest of high-energy physics.

The ILC Steering Committee and the CLIC Collaboration Board will foster this cooperation by agreeing, reviewing and updating a list of topics of common interest. This includes, but is not limited to, the topics listed in the Addendum to this agreement, which already form the subjects of joint ILC-CLIC Working Groups.

Signed Jonathan Bagger

Date January 11th 2010

(Jonathan Bagger)

on behalf of the ILC Steering Committee

Signed K. J. Peach

Date January 11th 2010

(Ken Peach)

on behalf of the CLIC Collaboration Board

2010

ADDENDUM

The following is a partial list of topics that could be the subject of cooperation between the ILC and CLIC, building upon the ongoing collaborative work.

Accelerator General Issues

Civil Engineering & Conventional Facilities

Cost & Schedule

Beam Delivery System & Machine Detector Interface

Detector General Issues

Positron Generation

Damping Rings

Beam Dynamics

Physics & Detectors

Joint WG on « accelerator general issues »

- Membership:
  - CLIC: Ph. Lebrun (co-chair), K. Peach, D. Schulte
  - ILC: E. Elsen, M. Harrison (co-chair), K. Yokoya
- Mandate
  - The ILCSC and the CLIC Collaboration Board have approved formation of a CLIC/ILC General Issues working group with the following mandate:
    - Promoting the Linear Collider
    - Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently
    - Discussing detailed plans for the ILC and CLIC efforts, in order to identify common issues regarding siting, technical items and project planning.
    - Discussing issues that will be part of each project implementation plan
    - Identifying points of comparison between the two approaches
  - The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board with a goal of producing a joint document.

"Identifying synergies to enable the design concepts of ILC and CLIC to be prepared efficiently"

- Conduct survey of collaborative work done and envisaged by existing specialized CLIC-ILC WGs
  - Beam delivery systems & machine-detector interface
  - Civil engineering and conventional facilities
  - Positron generation
  - Damping rings
  - Beam dynamics
  - Cost & schedule
- From this survey, get a picture of the technical progress, assess usefulness of the collaboration and identify areas of greatest promise for future synergies between CLIC and ILC
- Illustrative examples follow – no attempt to completeness

Joint WG on BDS and MDI

Compared requirements of FFS for CLIC & ILC

The FFS: CLIC Vs ILC

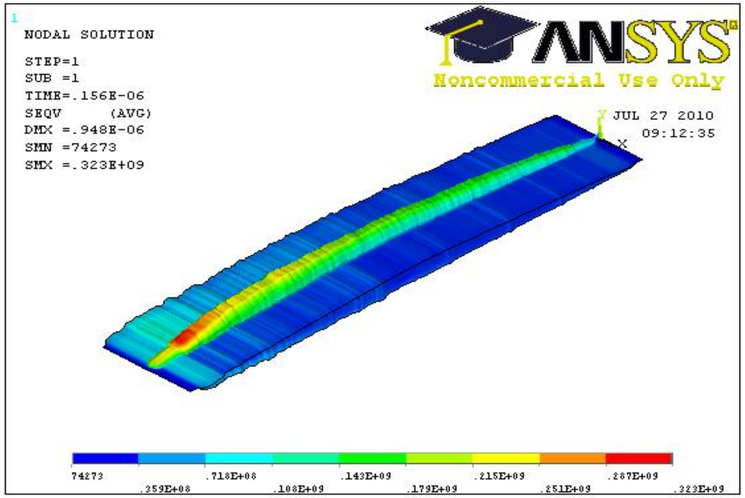
CLIC	ILC
20% lumi loss from SR	Negligible SR
$\sigma_y \approx$ 1 nm	$\sigma_y \approx$ 6 nm
$\beta_y = 70\ \mu$m	$\beta_y = 400\ \mu$m
Chroma. $\approx\ 6.3 \times 10^4$	Chroma. $\approx\ 1.5 \times 10^4$
IP D'_x = 1.4 mrad	IP D'_x = 9 mrad
Energy spread $\approx$ 0.3%	Energy spread $\approx$ 0.1%

CLIC FFS is considerably more challenging in every aspect. ATF2 is the common playground but CLIC requires Ultra-low IP β (see E. Marín's talk).

R. Tomas, CERN

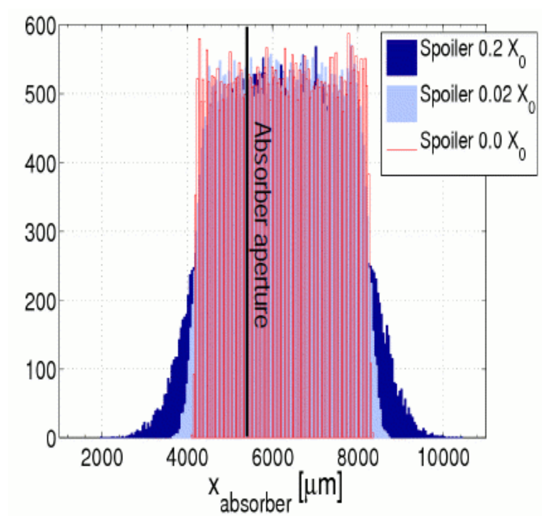
Joint WG on BDS and MDI

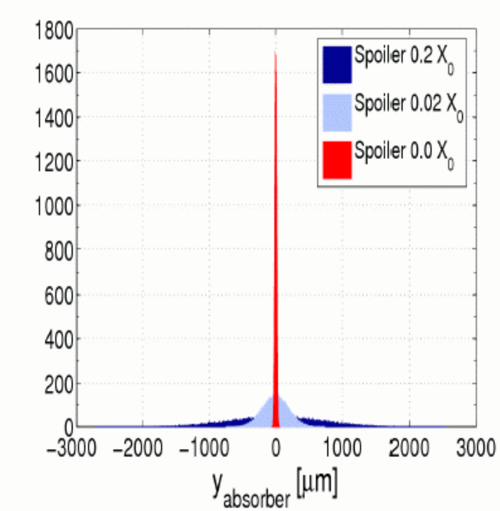
Collimation studies



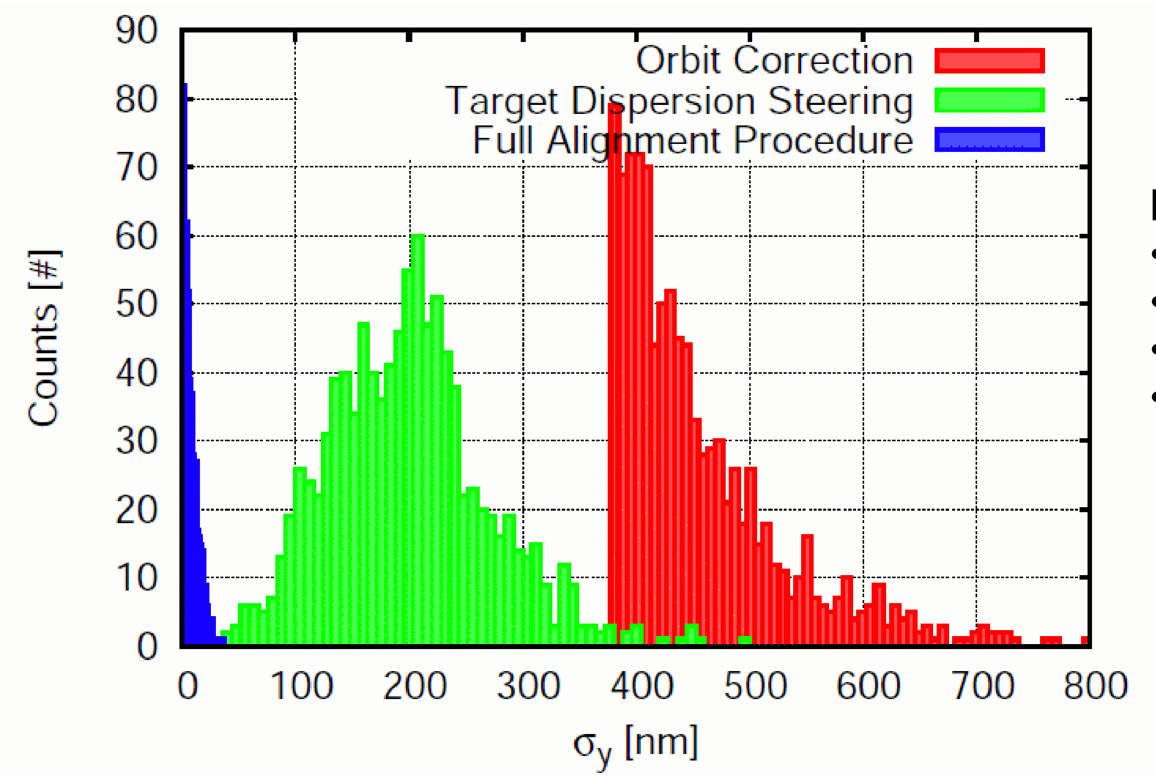
Collimator stress simulation after impact of full train (Luis Fernandez, CI)

Simulated collimation performance (Javier Resta, Oxford)





Joint WG on BDS and MDI
New elaborate FFS tuning techniques

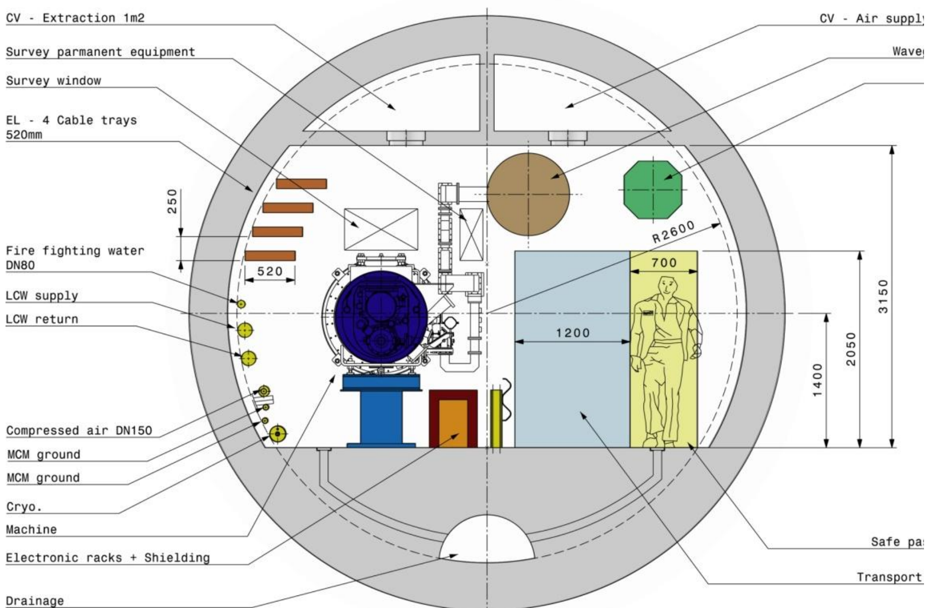


Full alignment =
- orbit correction
- target dispersion steering
- coupling & beta-beating steering
- multipole shunting

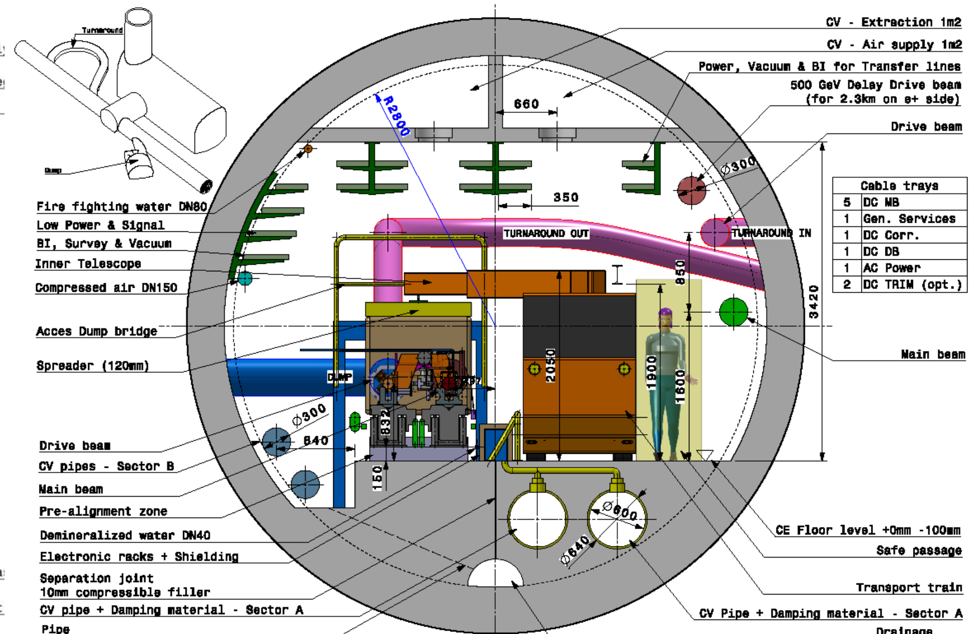
Andrea Latina (Fermilab)

Joint WG on CE & conventional facilities

Tunnel cross sections for ILC and CLIC developed in parallel



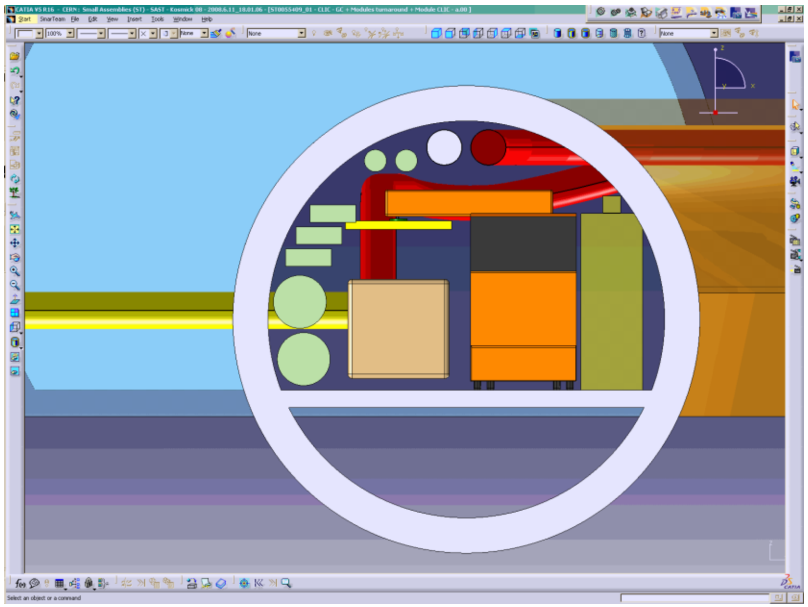
ILC - Typical Cross Section - Diameter 5200mm - Scale 1:25 (
KLY CLUSTER EUROPE - J.Osborne / A.Kosmicki -November 6th 2...



CLIC - Typical Cross Section - Diameter 5600mm - Junction with Turnaround - 1:25
Draft - J.Osborne / A.Kosmicki - August 9th 2010

John Osborne (CERN)

Joint WG on CE & conventional facilities
Transport & installation studies

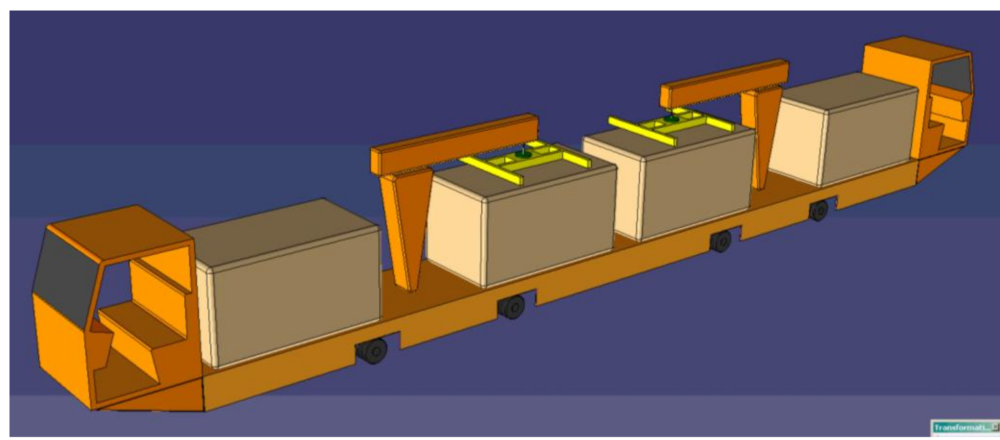


Experience gained from LHC & CLIC transport study currently being applied to ILC e.g. suitability of transport vehicles for sloped access tunnels (Asian site)

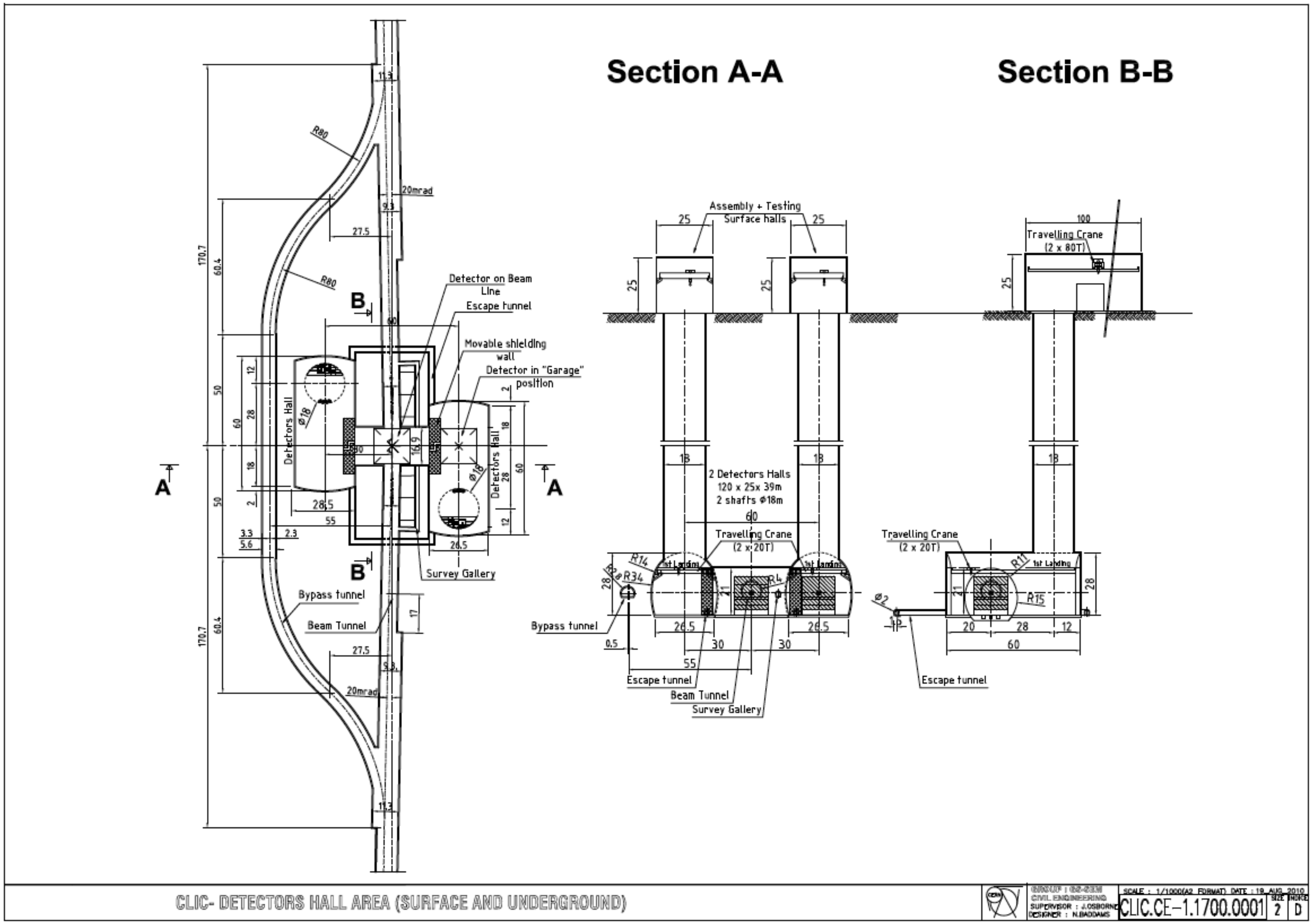
K. Kershaw & I. Ruehl (CERN)

J. Leibfritz (FNAL)

A. Enomoto (KEK)



Joint WG on CE & conventional facilities
Infrastructure design for the experimental areas



Joint WG on positron generation

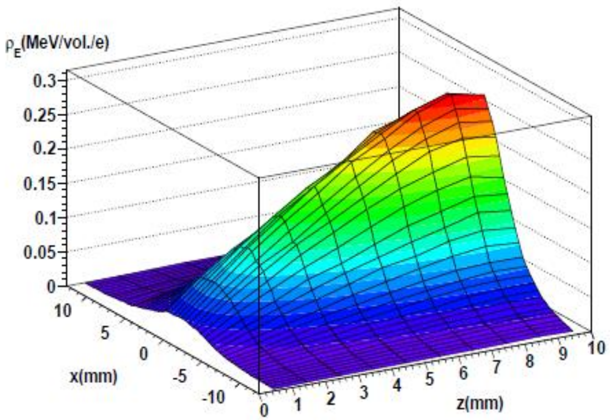
DC gun for polarized electrons for ILC and CLIC

M. Poelker / JLAB

Stainless Steel and Diamond-Paste Polishing
Good to ~ 5MV/m and 100kV

Joint WG on positron generation
GEANT4 & FLUKA simulations for CLIC e+ targets

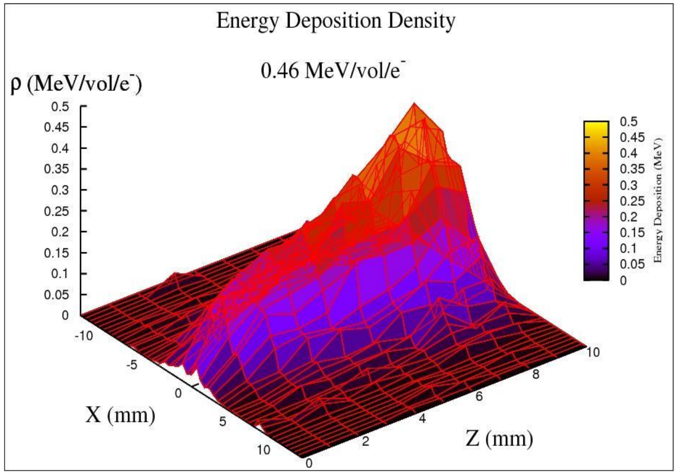
Simulations for a train of 312 bunches providing 2.34×10^{12} e^- per pulse and σ (e^- spot) = 2.5 mm



O. Dadoun / LAL

GEANT4 results:

Mesh volume = 0.25 mm^3
(parallelepiped shape)
PEDD = 0.285 MeV / vol / e^-
PEDD = 1.14 $GeV/cm^3/e^-$
PEDD = 22.14 J/g



E. Eroglu / Uludag University

FLUKA results:

Mesh volume = 0.25 mm^3
(parallelepiped shape)
PEDD = 0.46 MeV / vol / e^-
PEDD = 1.83 $GeV/cm^3/e^-$
PEDD = 35.5 J/g

PEDD = Peak Energy Deposition Density

Joint WG on positron generation

Optical cavity using Compton backscattering for ILC and CLIC polarized e+

Collaboration CELIA, LAL, LMA, KEK, Hiroshima University

Goal: provide a stable resonator with circularly polarized mode and very high stacked power of photons

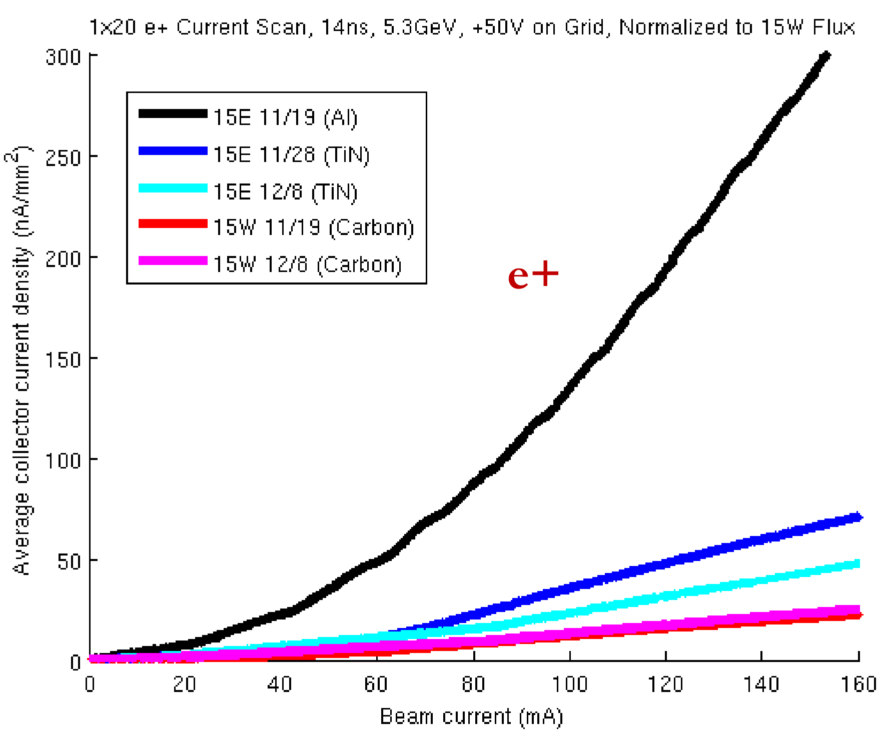
Installed on ATF at KEK in August 2010

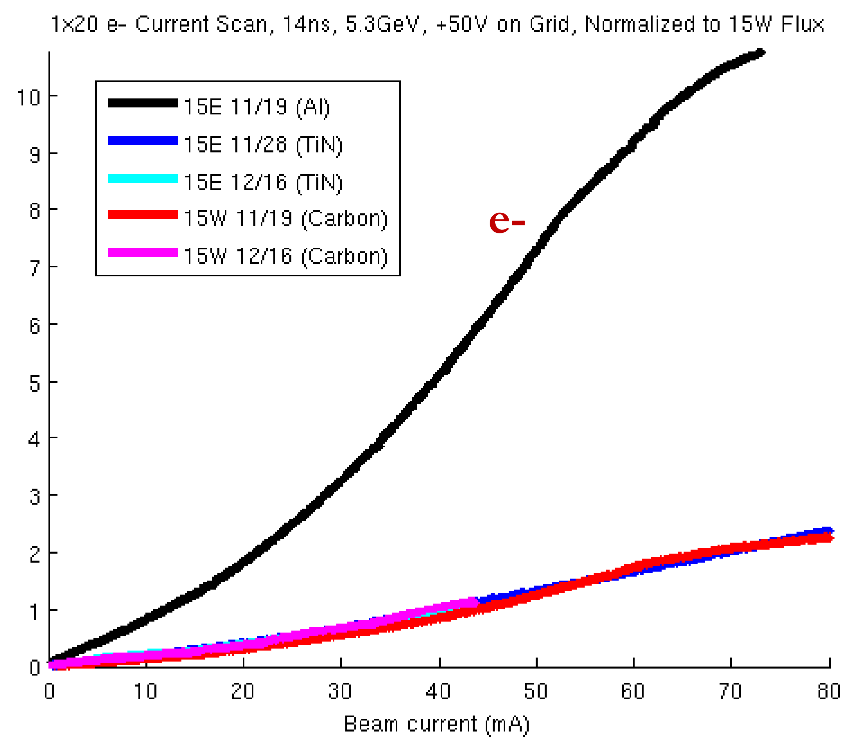
First results presented at IWLC 2010

Joint WG on damping rings
Chamber coating tests in CESR TA

- Conditions: 1x20 e+, 14ns, 5.3 GeV, +50V on grid
- Plots normalized to (15W) photon flux
- Both TiN and especially Carbon coating (CERN) show significantly lower signal than Al surface
- Conditioning can be observed in TiN chamber (recently installed)

M. Palmer, LER2010





Joint WG on damping rings

Low-Emittance Rings collaboration

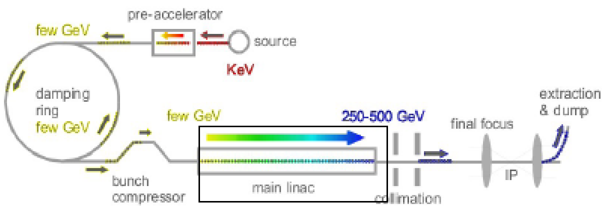
- Initiated by the ILC-CLIC working group on damping rings
- Workshop organized in January 2010 at CERN identifying items of common interest among the low emittance rings community (synchrotron light sources, linear collider damping rings, b-factories)
- Low emittance rings working groups formed
- A EU network proposal is being prepared
- Next workshop to be organized during summer 2011

	Working groups
1	**Low emittance cells design**
2	**Non-linear optimization**
3	**Minimization of vertical emittance**
4	**Integration of collective effects in lattice design**
5	**Insertion device, magnet design and alignment**
6	**Instrumentation for low emittance**
7	**Fast Kicker design**
8	**Feedback systems (slow and fast)**
9	**Beam instabilities**
10	**Impedance and vacuum design**
11	**RF design**

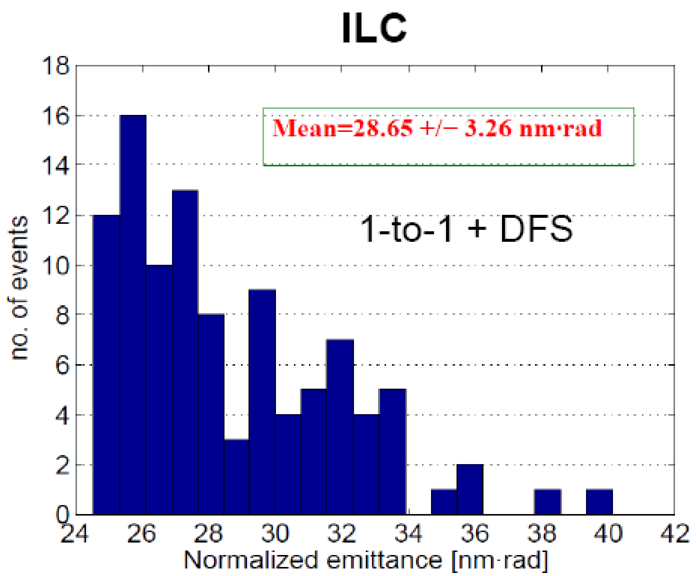
Joint WG on beam dynamics
Compared simulations of emittance at exit of main linac

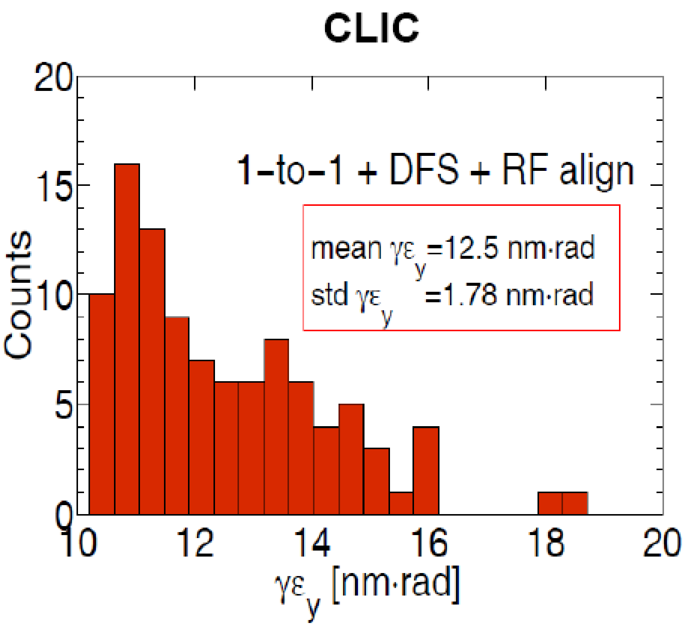
Main Linac

J. Resta-Lopez



Normalised emittance at the exit of the main linac, after applying survey alignment errors and beam-based alignment correction. Results from simulation of 100 machines.





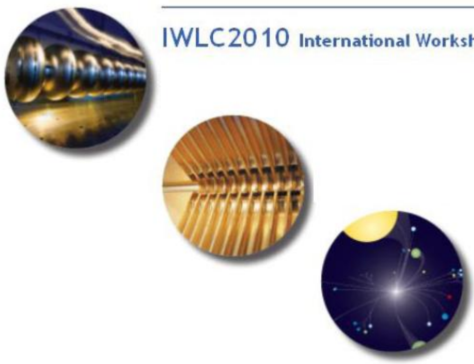
Summary of collaboration through specialized WG

- <u>All WGs operating</u>
  - since (spring to autumn) 2008, with locally some pre-history (EUROTeV)
  - typically monthly meetings (WebEx), face-to-face during ILC or CLIC events
- <u>Membership</u>
  - Truly international, involving many labs/institutes
  - Ranging from 7 to ~ 40 participants
- <u>Main benefits</u>
  - Strengthening of ties between CLIC and ILC study teams
  - Improved collaboration among stakeholders in community beyond CLIC/ILC
  - Peer contribution/expertise on topics of common concern
  - Pooling of expert resources
  - Identification of potential issues
  - Sharing of experience, methods and tools for efficiency and mutual transparency
  - Benchmarking of codes and agreement on standards
  - Access to experimental facilities

Collaboration outside established WG

Example: RF power sources

IWLC2010 International Workshop on Linear Colliders 2010



WHAT IS THE IDEAL POWER SOURCE FOR A LINEAR COLLIDER?

... some thoughts to trigger discussion ...

Erk Jensen
CERN, Geneva, Switzerland

Introduction to L-band Klystrons for the ILC

L-Band Klystron in ILC & Other Project
(For Hints of CLIC RF Source)

Shigeki Fukuda
(KEK)

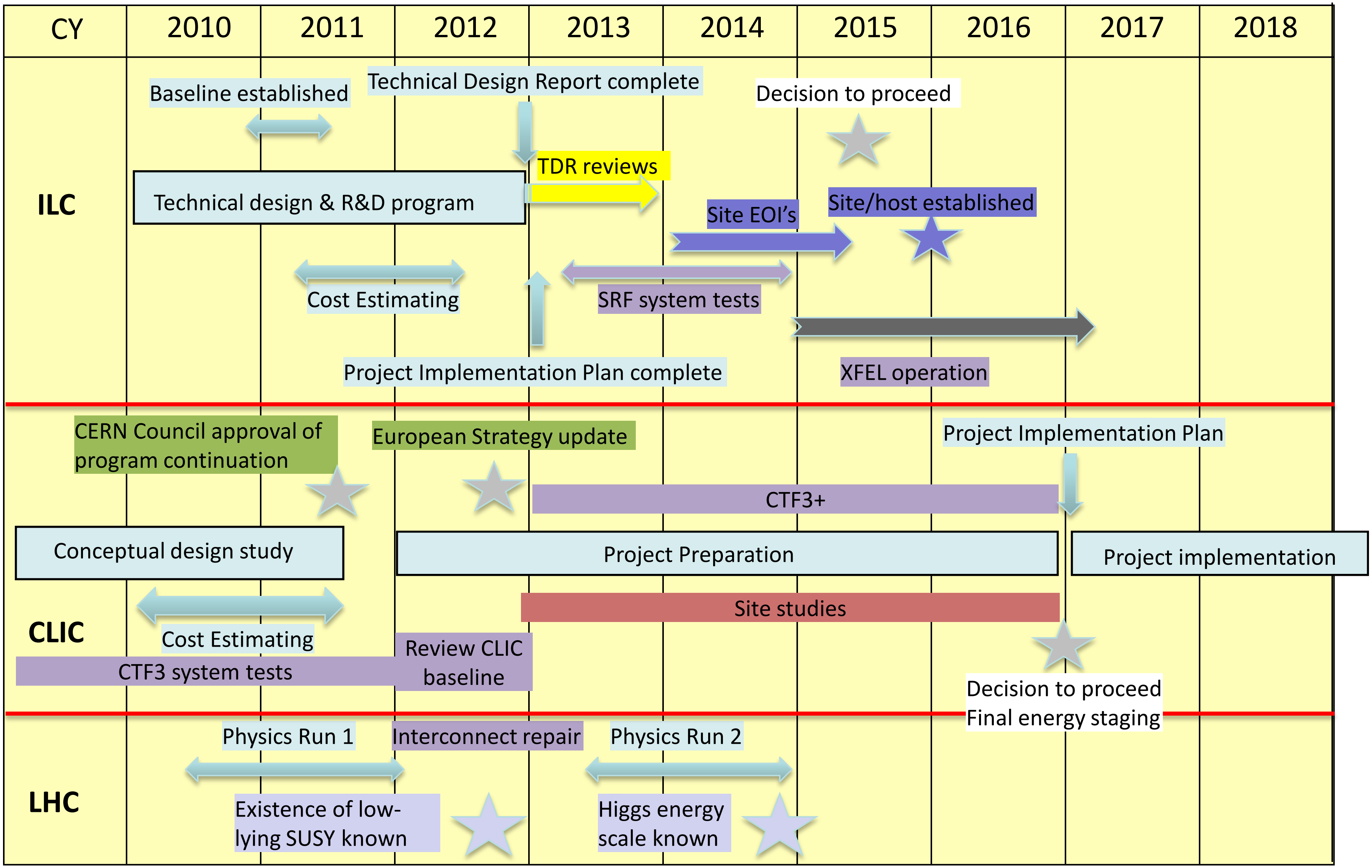
21 October 2010 — **IWLC2010 S.Fukuda-L-band Klystron** — 1

"Discussing plans for the ILC and CLIC efforts in order to identify common issues regarding siting, technical items and project planning"

- Statement on siting of the LC

  The Linear Collider is a completely new accelerator complex, that is, there is as of today no substantial existing accelerator infrastructure that could be re-used to reduce the overall cost of the machine. As a consequence, there is no coupling between the site selection and the technology choice on the basis of any existing legacy infrastructure. If the Linear Collider could be built at or near an existing accelerator laboratory, the existing administrative, technical, office and laboratory infrastructure could be used, thus reducing the overall cost significantly when compared with a "green field" site. However, for an international project of this size, it is assumed that the host provides an infrastructure that is able to deal with the needs of the international community during construction and use of the facility. Consequently there is no compelling reason to constrain the site selection to existing laboratories.
- Recommendations
  - The WG recommends that the CERN management and the ILCSC discuss the methodology of the siting process
  - The CLIC team should determine whether the CLIC design imposes any specific site constraints

CLIC & ILC roadmaps



"Discussing plans for the ILC and CLIC efforts in order to identify common issues regarding siting, technical items and project planning"

- Continued cooperation
  - Observations
    - GDE TDR ⇨ 2012,
    - CLIC Project Preparation ⇨ 2016
  - Recommendation
    - The organization tasked to run the ILC program post 2012 should plan for co-operation with the ongoing CLIC R&D effort
- Systems tests and technical milestones
  - Observations
    - XFEL will provide a major facility demonstration of ILC technology by ~ 2015
    - CLIC technology not yet in a stage to warrant a project proposal
  - Recommendation
    - The linear collider community should satisfy itself that the proposed system tests and technical milestones for both programs are sufficient to justify a full proposal

"Discussing plans for the ILC and CLIC efforts in order to identify common issues regarding siting, technical items and project planning"

Integrated/staged approach to CLIC and ILC

- Scenario studied: staging from ILC 500 GeV to CLIC 3 TeV
  - What could be reused?
  - Technical modifications/adaptations to permit this reuse?
  - Effective savings?
- Interaction region
  - Similar design, high reuse potential
  - Some differences to be settled, e.g. beam crossing angle
  - Savings potential ~ 0.5 GILCU
- Main linac tunnel
  - Two vs. Single tunnel
  - Terrain-following vs laser straight
  - Savings potential ~50 % of total ~ 0.6 GILCU
- Main linac RF
  - Klystrons:
    - adapt frequency and unit power (1.3 GHz, 10 MW), adapt main linac frequency to 11.7 GHz
    - 640 ILC klystrons ~ 30% of CLIC drive beam power
    - Savings potential ~50 % of total ~ 0.1 GILCU
  - Modulators
    - Modular construction would permit reuse for CLIC
    - Savings potential ~ 0.1 GILCU
- Maximum savings significantly less than 1.5 GILCU
- Probably too many compromises – given the evident uncertainties, the WG does not feel this approach should be strongly encouraged

"Discussing plans for the ILC and CLIC efforts in order to identify common issues regarding siting, technical items and project planning"

- Input of ILC TDR to European Strategy Update
  - Observation
    - ILC TDR in preparation during European Strategy Upfate
  - Recommendation
    - The GDE should make any preliminary information from the ILC TDR available on request to the CLIC team
- Elements of cost comparison
  - Observation
    - ILC TDR will contain cost estimates for 500 GeV and 1 TeV
    - CLIC CDR will contain cost estimate for 3 TeV, with scaling to 500 GeV
  - Recommendation
    - A « cost band » (baseline cost + estimated error vs energy) should be developed by the Joint Cost & Schedule WG for each technology in the energy range up to 1 TeV

Conclusion & outlook

- CLIC-ILC accelerator collaboration well established and developing in topics of common interest
  - Essential for sharing experience, methods and tools
  - Efficient through pooling of expert resources and access to experimental facilities
  - Also benefits outside the LC community
  - Should be continued and developed incl. beyond 2012
- Joint WG on accelerator general issues has addressed part of mandate
  - Identify synergies for efficient preparation of CLIC & ILC designs
  - Identify common issues regarding siting, technical items and project planning
  - Recommendations to stakeholders and interim report by end 2010
- Challenging items to be further addressed until 2012
  - Discussing issues that will be part of each project implementation plan
  - Identifying points of comparison between the two approaches
  - Input from ILC TDR, CLIC CDR
  - Coupling to ILC post-GDE phase and CLIC Project Preparation Phase

Responding to R. Heuer's conclusion

In summary

Exciting years ahead of us

We will need

- Preparedness
- Flexibility
- Visionary global policies