

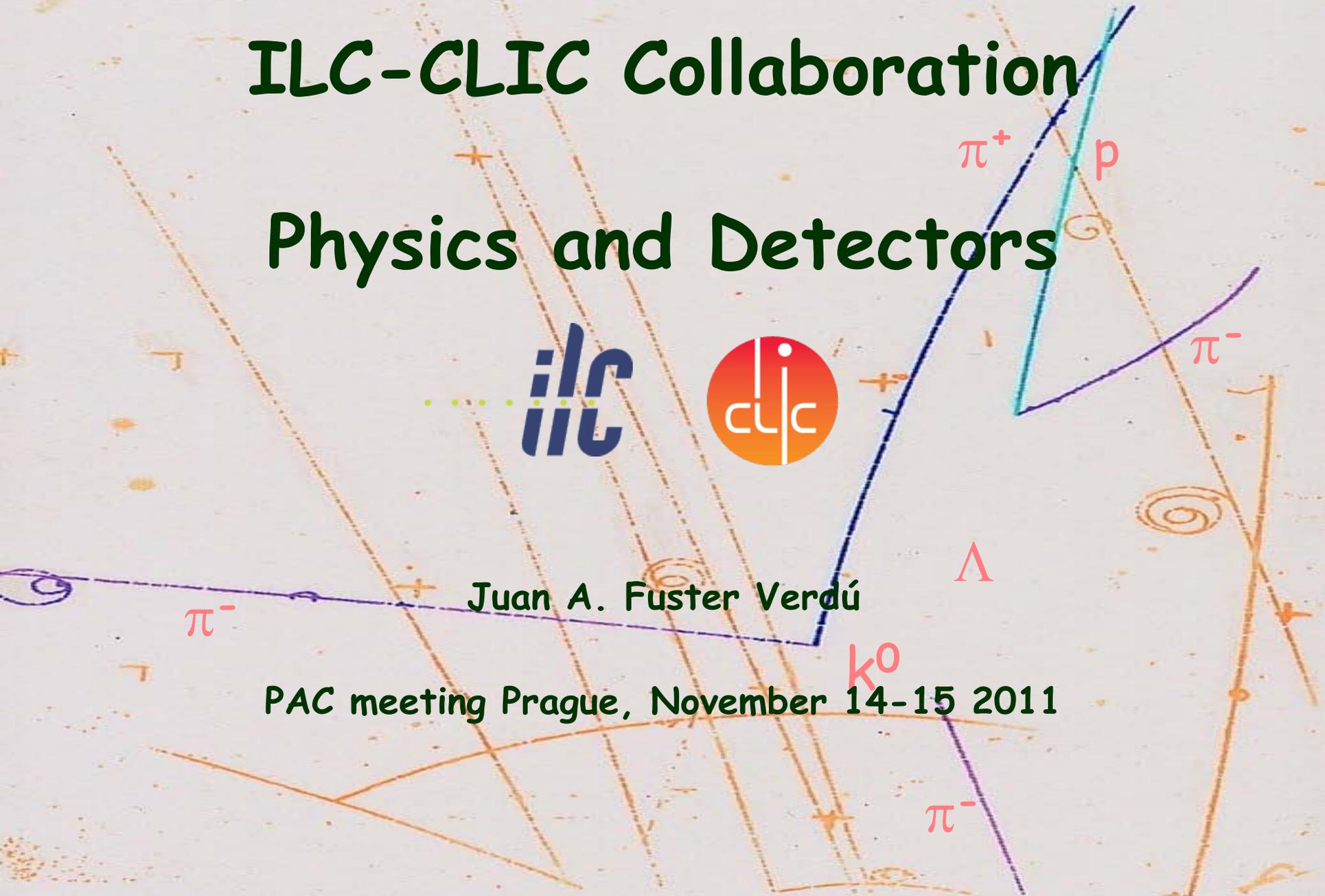
ILC-CLIC Collaboration

Physics and Detectors



Juan A. Fuster Verdú

PAC meeting Prague, November 14-15 2011



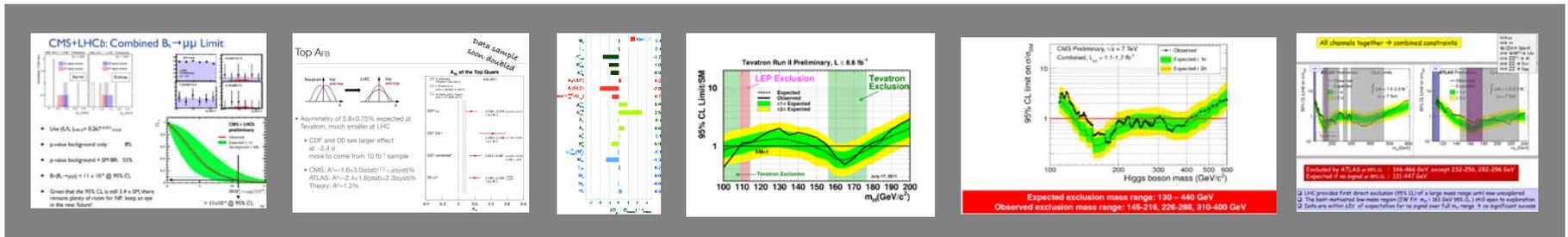
Physics situation

LHC is presently:

Exploring the physics at $10^{-17}\text{cm} \Leftrightarrow \text{TeV}^{-1}$, ie, the weak scale (High Energy Frontier, ATLAS + CMS)

Testing Flavour Physics (High Intensity Frontier, LHCb + ATLAS + CMS)

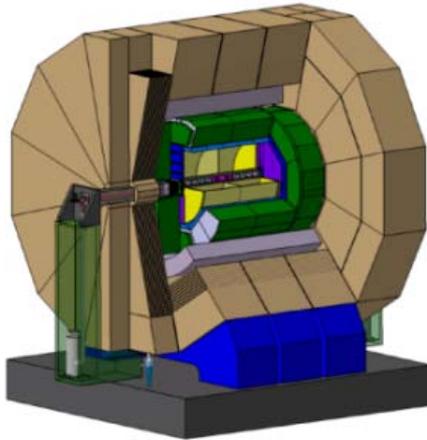
Testing Hadronic Physics (ALICE + CMS + ATLAS)



Exciting results await to come, among them, by the **end of 2012** it will be possible to either find the Standard Model Higgs or to exclude it (Tevatron+LHC)

Detector Concepts

Two validated detector concepts for the ILC

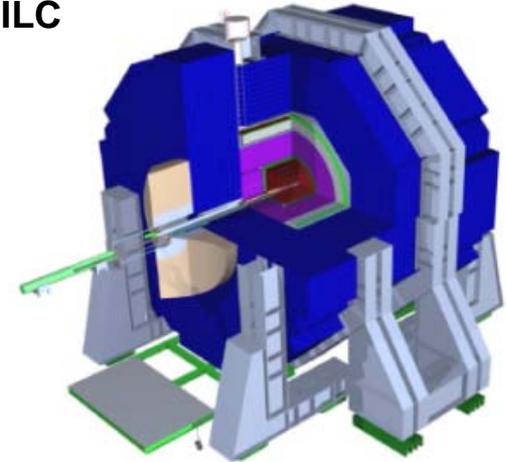


ILD

SiD

With ILC-CLIC cooperation

CLIC_SiD and CLIC_ILD concepts



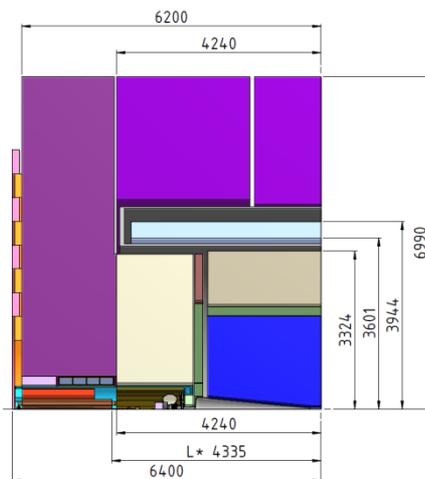
- Need to cover the physics potential of the full energy range, including 0,5-1,0 Tev (higher energies, shorter bunch spacing, harsher backgrounds)

- Not full new concepts but modifications to ILC and SiD:

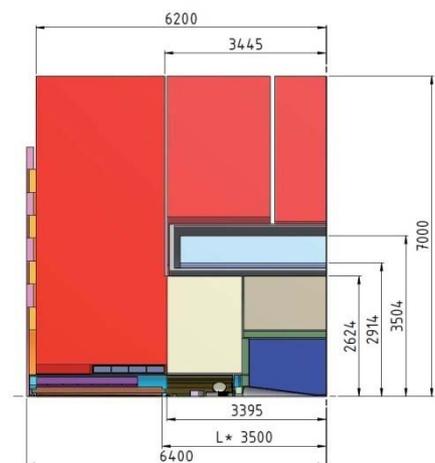
- Vtx. 2,5-3,0 cm,
- HCAL 7,5 λ ,
- B=4-5 T
- Redesign FWD region

- Tracking and ECAL unchanged

CLIC_ILD [4T]



CLIC_SiD [5T]

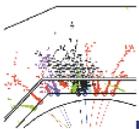


ILC – CLIC Cooperation

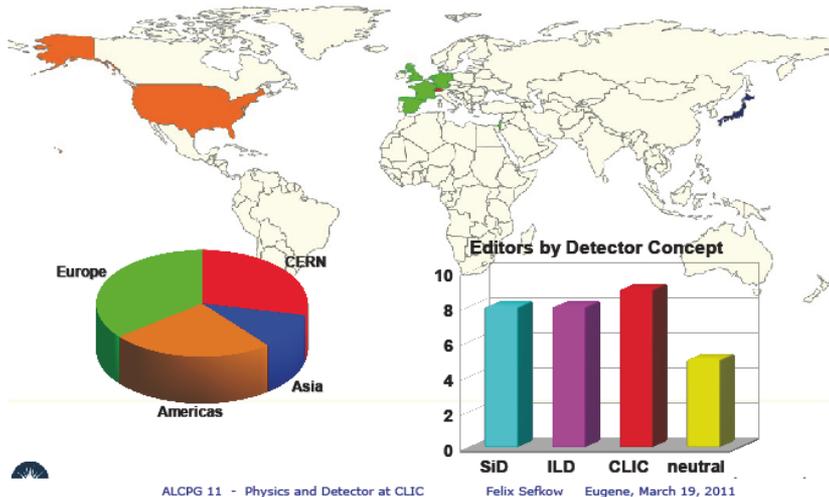
A working group to cooperate and discuss synergies between ILC and CLIC in Physics and Detectors.

M. Demarteau, J. Fuster, L. Linssen, F. Sefkow, M. Stanitzki, M. Thomson, S. Yamada (chair)

(<http://indico.cern.ch/categoryDisplay.py?categId=3018>)



CLIC CDR Phys & Det editors



Both Communities have committed to cooperate elaborating:

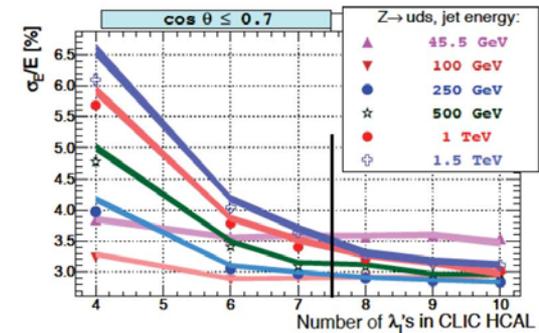
- the CLIC CDR (2011)
- the ILC DBD (2012)

List of Cooperative tasks (agreed Oct. 2010) - presented at Taipei PAC -

Core Software development

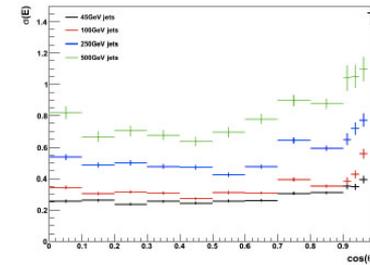
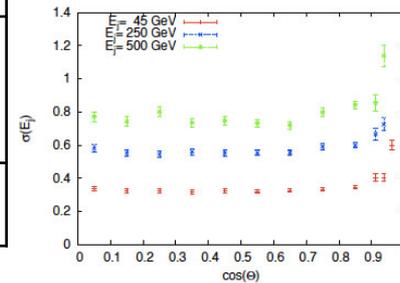
Core software Mokka/Marlin	Improvements to the geometry descriptions in Mokka/Marlin (involving mostly members of CERN, DESY, LLR)
Pandora_PFA_new	New Pandora architecture allows use of Pandora in ILD and SiD (SLAC, N. Graf). Participation in the re-write of Pandora, in particular the photon clustering algorithm (Cambridge univ, with help from CERN). The SiD version (interface) is called SLiCPandora.
Pandora_PFA_new	Assesment of performance of Pandora PFA new in jet reconstruction (Barklow), PFO lepton-id
GRID production tools	Setting up of automatic GRID production tools and file database for Mokka/Marlin and for SLiC/LCSim (using the LHCb DIRAC framework)
TPC pattern recognition and track reconstruction	Development of improved TPC pattern recognition and track reconstruction with the aim of providing parametrisations which can be used in the ILD TPC tracking
Hadronisation in Geant4	Study and improvements to the hadronisation models in Geant4

Pandora based optimization



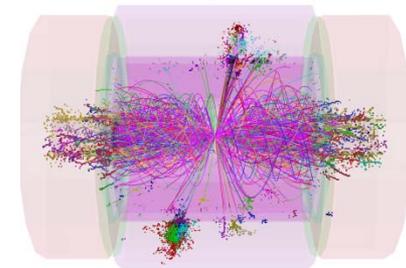
CLIC SID

CLIC ILD (J.M.)



Work on overlay of background and physics

Overlay of incoherent pairs and $gg \Rightarrow$ hadron events	Work on overlay of background and physics events, gaining experience that is also of use for ILC
Forward region background studies	Detailed forward region simulations with study of backscattered particles in Mokka/Marlin
Muon background from machine	Study of (horizontal) muon background from the machine and its rejection in the tracking/calor codes



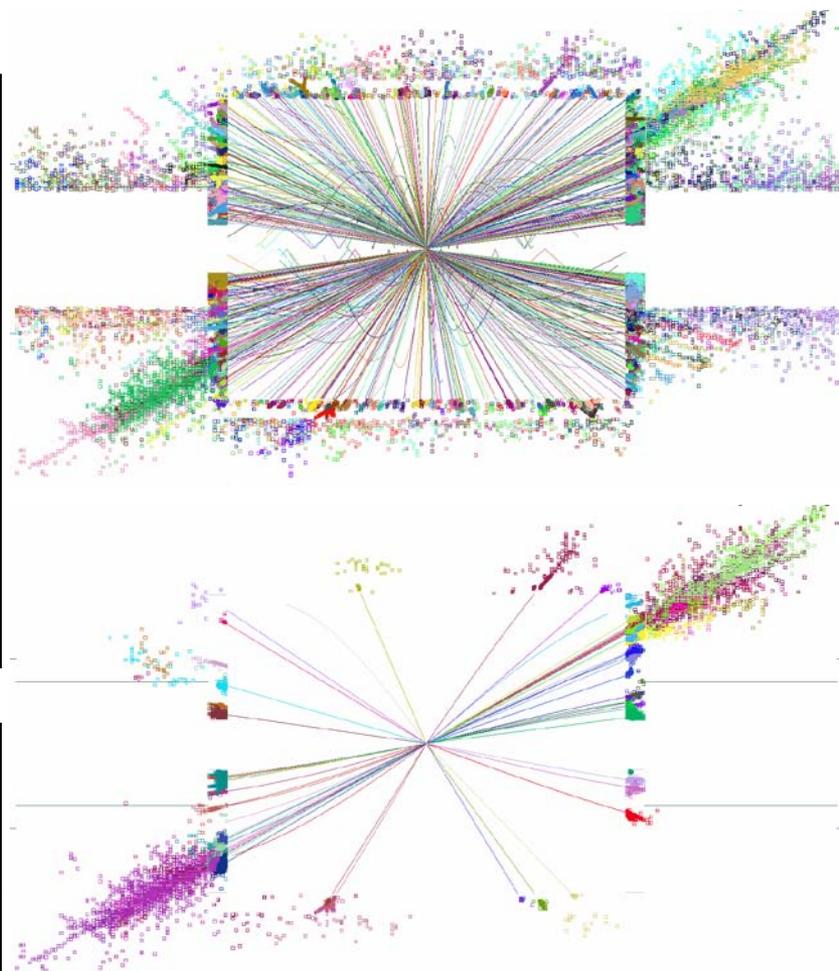
List of Cooperative tasks (agreed Oct. 2010) - presented at Taipei PAC -

Assessment of high energies, with clear interest for future 1 TeV ILC work

SiD tracking at high energies	Assesment of SiD tracking at high energies and with background overlay
Muon id and muon optimisation	Study of muon-id, dramatic energy loss by muons, hadron shower leakage
Tau finder	Development of a tau finder and tau reconstruction (currently in Marlin, but can extend to SiD software)
SiD and ILD detector adaptations for higher energies	For the CLIC study, the ILD and SiD concepts are adapted to higher energies (and of course also to CLIC background conditions). These adaptations will provide useful input to define 1 TeV detector strategies for the ILC.
Optimisation of physics observables	For the CLIC study we work on the optimisation of physics observables at 3 TeV. The corresponding adaptations to the various codes will serve the ILC as well.

Engineering studies

Vibration studies, forward region quadrupole suspension	Vibration studies at LHC locations, study of QD0 suspension including FEA and design, corresponding opening scenarios (this is partly CLIC-specific, due to the severe CLIC requirements)
Push-pull studies and requirements for experimental area	Push-pull studies and requirements for experimental area and its services
Solenoid magnet studies	Solenoid magnet (4T and 5T) caluculations and design parameters
Solenoid services	Studies of solenoid services and quench protection compatible with push-pull



Z->uds @ 1TeV + 60BX gg->hadrons before and after timing cuts on PFOs

List of Cooperative tasks (agreed Oct. 2010) - presented at Taipei PAC -

Electronics developments

TPC pad readout	Development of TPC pad readout electronics, based on S-Altro (microelectronics) design
TPC pixel readout	Design of pixel chip for TPC readout (Timepix2 chip)
Microelectronics support	Microelectronics support, training, foundry services, design reviewing for LC community

HCAL R&D

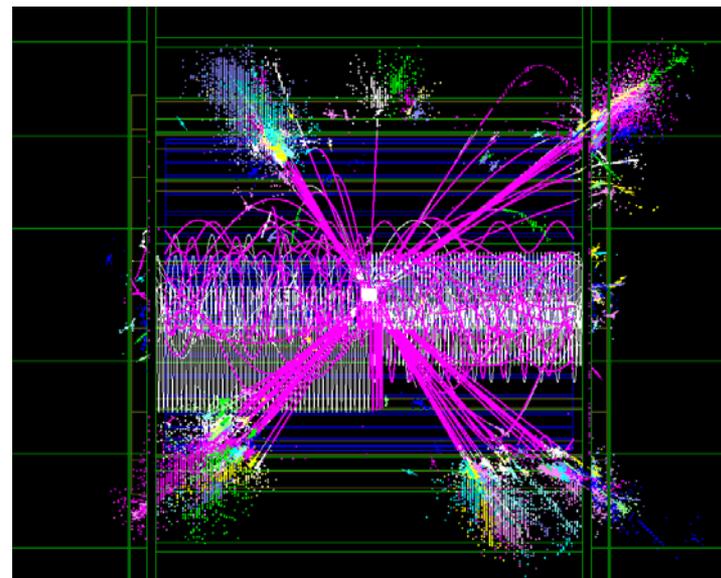
Tungsten-based HCAL studies within CALICE	Preparation of beam tests of a large HCAL prototype, based on Tungsten absorbers and various CALICE active media
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FCAL

Beamcal and lumical simulation models	Setting up and maintenance of Mokka/Marlin/Geant4 simulation model of Beamcal and Lumical; software support for ILC FCAL members
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Benchmarks

$e+e \rightarrow h\nu_e \nu_e$ $e+e \rightarrow H^+H^-$ $e+e \rightarrow H^0A^0$ $e+e \rightarrow q_R q_R$ $e+e \rightarrow \ell^+ \ell^-$, $\ell = e, \mu$ $e+e \rightarrow \chi^+ \chi^-; \chi^0 \chi^0$ $e+e \rightarrow t\bar{t}(0,5 \text{ TeV})$	Cambridge (chair), CERN, MPI Munich, LAPP, UCSC, Prague, Barcelona, SLAC, RAL, DESY
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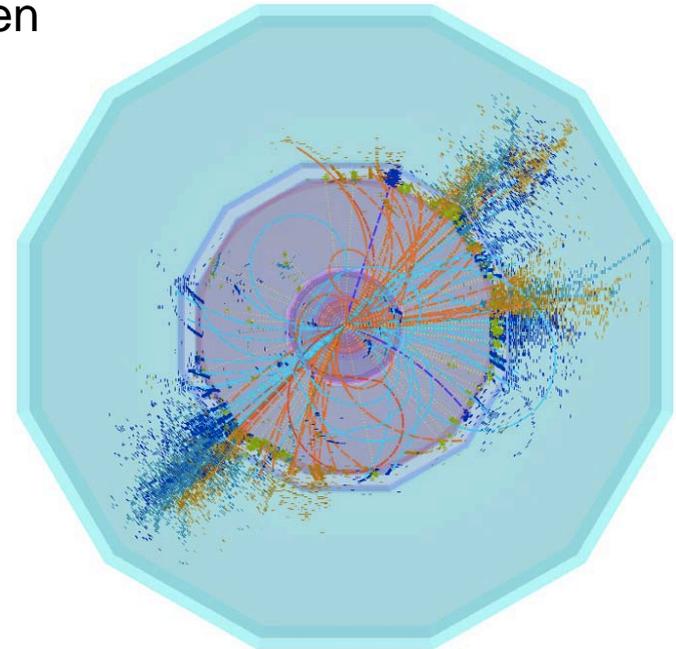
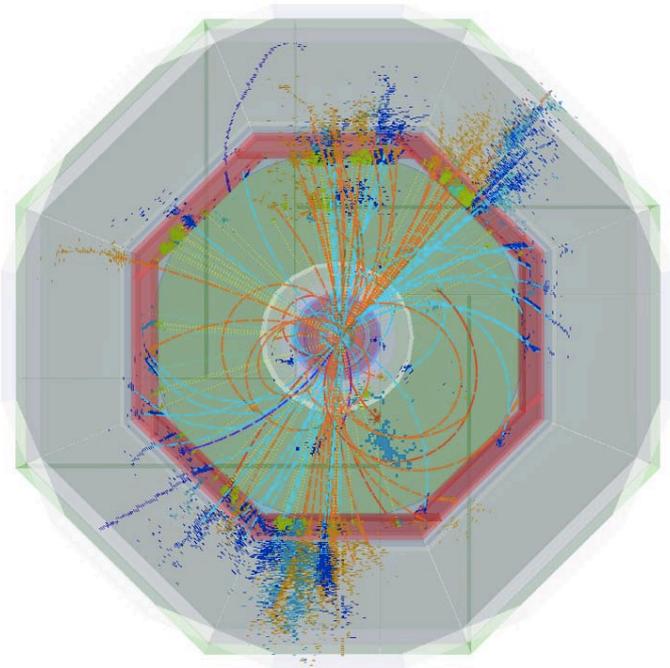


HA→bbbb (CLiC_ILD)

CLIC

physics and detector study

Lucie Linssen



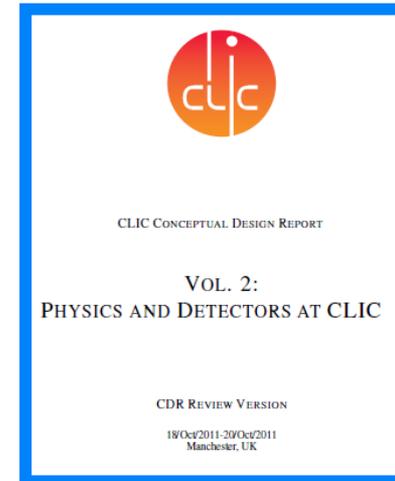
Status CLIC physics&detector CDR



There was a pre-release of CDR on September 8th 2011

<https://edms.cern.ch/document/1160419>

The physics & detector CDR was reviewed on October 18-20 2011



Name
Stefan Soldner-Rembold (chair)
Philip Bambade
Giovanni Batignani
Brigitte Bloch
Daniel Elvira
Philippe Farthouat
Paul Grannis
Marian Ivanov
Richard Nickerson
Arnulf Quadt
Rob Roser
Nobu Toge
Yifang Wang
Pipa Wells
Hitoshi Yamamoto

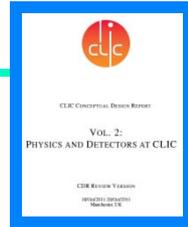
← Review committee members

<http://indico.cern.ch/conferenceDisplay.py?confId=146521>

Overall the CDR document was very well received

Received a list of questions/comments:

- Most could be answered at the review
- Some suggestions for further clarification, new plots
- Some suggestions for study at the next project phase



CDR Volume 2

Main editors:

Chapter editors:

- Chapter 1:** CLIC physics potential-----
- Chapter 2:** CLIC experimental conditions----
and detector performance requirements
- Chapter 3:** CLIC detector concepts-----
- Chapter 4:** CLIC vertex detectors-----
- Chapter 5:** Tracking systems-----

- Chapter 6:** Calorimetry-----
- Chapter 7:** Solenoids and magnet systems--
- Chapter 8:** Muon systems at CLIC-----
- Chapter 9:** Very forward calorimeters-----
- Chapter 10:** Readout electronics and-----
data acquisition
- Chapter 11:** Detector integration-----
- Chapter 12:** Physics performance-----

- Chapter 13:** Future plans and R&D proposals
- Chapter 14:** Detector costs-----

Editors of CDR Volume 2

Lucie Linssen , Akiya Miyamoto, Marcel Stanitzki, Harry Weerts

Gian Giudice, James Wells

Mark Thomson

Jim Brau, Dieter Schlatter, Frank Simon, Graham Wilson

Bill Cooper, Dominik Dannheim, Steve Worm

Marcel Demarteau, Carlos Lacasta, Takeshi Matsuda, Tim

Nelson, Jan Timmermans

Felix Sefkow, Tohru Takeshita, Andy White

Andrea Gaddi, Yasuhiro Makida

Burkhard Schmidt

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Jean-Jacques Blaising, Jan Strube, Frederic Teubert

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Markus Nordberg

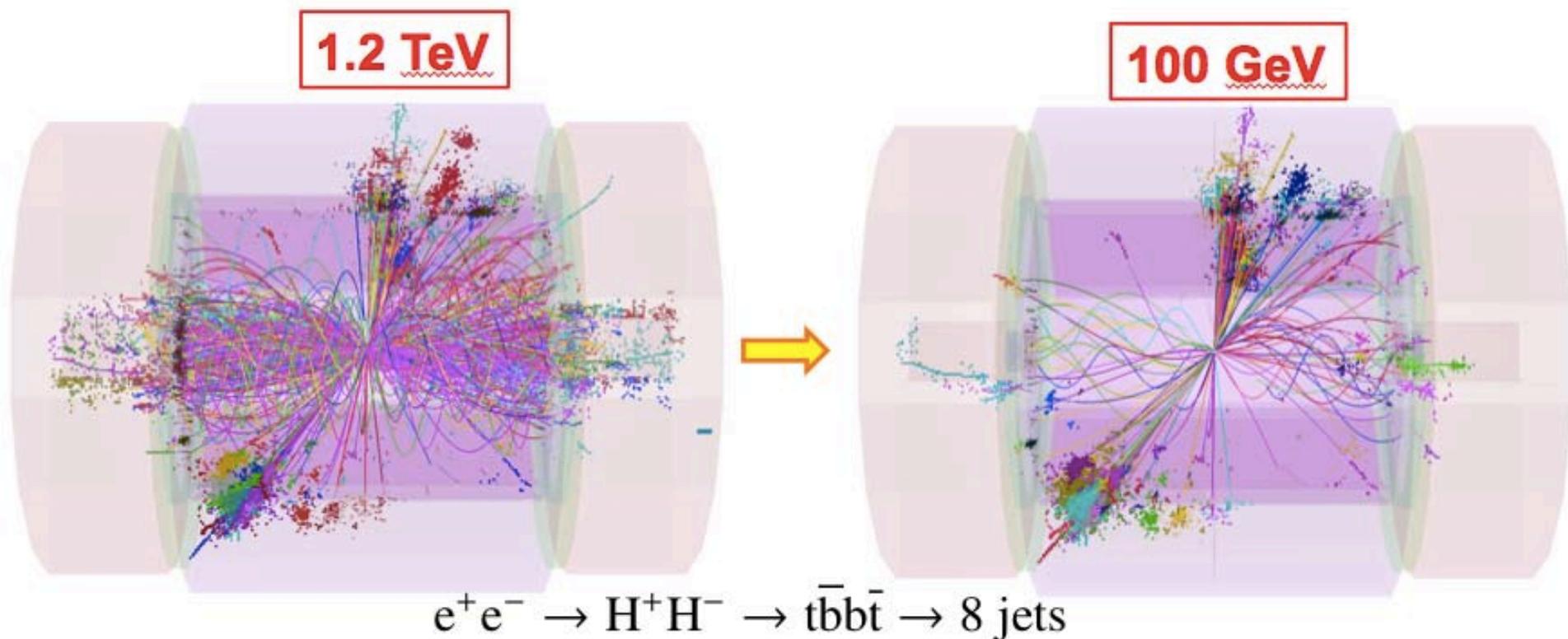
Main message from the CDR



Physics at a multi-TeV CLIC machine can be measured with high precision, despite challenging background conditions

Background suppression successfully applied by:

- Precise selective timing cuts on fully reconstructed particles (PFO's)
- Well-adapted jet reconstruction (taken from hadron colliders)

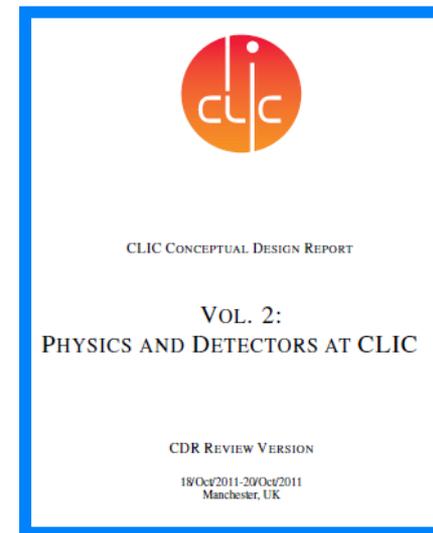


CDR status and short-term plans



The CDR contents will be **finalised before the end of 2011**.

In the meantime comments from the committee are being included, and some work is being added on systematic studies, measurement of beam energy spectrum and polarisation.



The CLIC physics&detector CDR will be presented to the **CERN Scientific Policy Committee**, December 12+13th, 2011

Publication of the CDR in the form of a **CERN yellow report**

There is a common CDR signatories list for the accelerator+detector.
Set up as a support for high-energy linear collider and support for continuation of R&D:

<https://indico.cern.ch/conferenceDisplay.py?confId=136364>

Currently 430 signatories (on Nov. 10th)

Further work for Volume 3 in 2012



There will be some continuation of CLIC CDR work in 2012

Summary document for accelerator, physics and detectors (Volume 3)

Volume 3 will comprise:

- summary of Vol. 1&2 on accelerator and physics/detector
- staged energy approach for CLIC
- cost estimate
- future plans: 2012-2016 and beyond

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And also: preparation for the **update of the European Strategy for Particle Physics**
Including a **common LC physics document**



At the Granada LCWS11 workshop agreements were made between CLIC physics&detector team and the SiD and ILD concepts.

The CLIC team will contribute to the DBD preparations in various areas:

- Production of simulation data for the physics benchmark studies
- Adaptation and assessment of software tools (PFA, tracking, background overlay)
- Physics benchmark studies (e.g. ttH)
- Continued collaboration on engineering, push-pull and magnet studies
- Participation in editing tasks

In addition, there is extensive ongoing collaboration on hardware R&D:

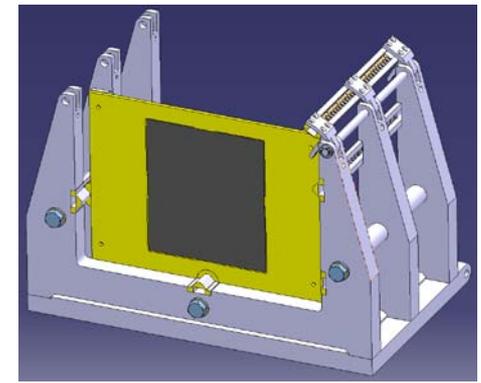
- CALICE => HCAL beam tests with tungsten absorber and scintillator + RPC
- LC-TPC => electronics development for pixel readout and pad readout
- FCAL => simulation studies and mechanics for multi-layer beam test



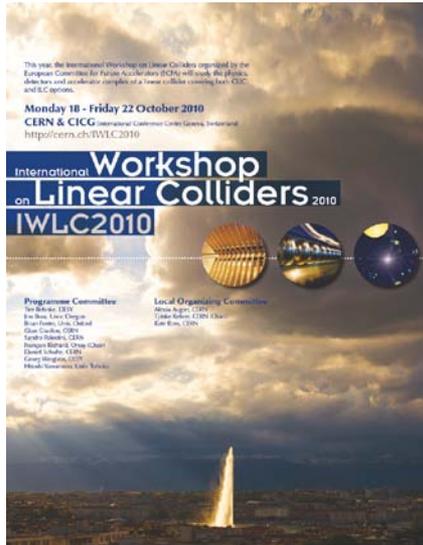
Lucie Linssen



Slides for PAC meeting November 2011



Joint Organization of Linear Collider Workshops



Two workshops have already been jointly organized by ILC and CLIC:

- IWLC-2010, Geneva
- LCWS11, Granada

The annual International Workshop on the Linear Collider (LCWS) will be fully common between ILC and CLIC, both for the accelerators and for the physics/detectors

LCWS11 Conference Organization:

Joint Organizing Committee (JOC) composed by 12 people representing:

- 4 Detector R&D, ILC+CLIC, 3 RG-WWS+CLIC
- 4 Theoreticians
- 4 Accelerator, ILC+CLIC

Program Committee (PC) composed by 30 people:

- JOC (12)
- WWS (15)
- Local Chair and Co-chair (2)
- Additional members to help with regional balance (1)



Some LCWS11 numbers

- ✓ 365 Participants registered
- ✓ 20 grants awarded covering accommodation and fee
- ✓ 31 countries
- ✓ 489 contributions
- ✓ 130 sessions (53 different topics for sessions starting from 8 R&Ds, 9 AWGs, 12 Sp., 3 ILC+CLIC Det.)
- ✓ Maximum of 14 parallel sessions in coincidence
- ✓ Students (PhD and last year) helped in the organization. Total 14. CERN DG certificated their contribution
- ✓ Public talk by Francois Richard (~400 attendees)
- ✓ Alexia Augier from CERN helped to organize the event. Very important and useful contribution.

LCWS11Program : Plenary Talks and Topics, ILC+CLIC

✓ Usual ILC+CLIC detector and accelerator reports:

- **Accelerator:** B. Barish, S. Stapness, Y. Yokoya, J.P. Delhay
- **Detector R&D:** S.Yamada, M. Thomson, A. White, M. Vos, L. Linssen

✓ Regional strategies for future with Linear/Lepton Colliders

- A. Suzuki, D. MacFarlane, T. Nakada

✓ LHC results and future prospects

- R. Heuer

✓ Physics Implications of LHC results (theory)

- G. Weiglein, M. Peskin

✓ ICFA+ILCSC perspectives for Linear Colliders and highlights on future organization post-2012

- A. Suzuki, J. Bagger

LCWS11 Program: Special Sessions, ILC+CLIC

Special Sessions	AIDA	M1	Iván Vila
	R&D Linear Collider spin-offs	M2	W. Lohman
	Implications of the 2011 experimental results for physics at future lepton colliders	M3	Michael Peskin, Gudrid Moortgat-Pick
	WWS-OC	M4	Jim Brau, Hitoshi Yamamoto, Juan Fuster
	PEB	M5	Sakue Yamada
	GDE-EC	M6	Barry Barish
	IDAG	M7	Michel Davier
	Preparation for European Strategy for Particle Physics	M8	Steinar Stapness, Brian Foster
	μ -Collider	M9	R.Lipton
	ILC Tev upgrade and CLIC staging considerations	M10	J. Brau, N. Walker, D. Schulte
	Cost Management	M11	G.F. Dugan
	Program Committee	M12	F. Cornet

5. CLIC representation in WWS-OC

The WWS was formed to represent the community of users for all linear colliders, including CLIC. The committee discussed how to increase connections with CLIC colleagues within the WWS-OC. It is important that CLIC physicists are represented in the WWS-OC. CLIC management strives to expand beyond Europe, which is increasing interest in all regions. There are WWS-OC members with varying connections, but the WWS-OC recognizes that more representation of CLIC contributors is desirable, particular in proportion to the interests in CLIC in each region. The membership of the WWS-OC is selected from each region based on each region's process. Each of the 3 co-chairs are nominated by their respective regions, and confirmed by the full WWS-OC. It was agreed that the membership of the WWS-OC would be surveyed to determine if some members were ready to step down, and if so, preference in the selection of the next replacement member in each region should favor colleagues contributing to CLIC. The possibility of increasing the number of members from each region was discussed. The WWS co-chairs will investigate the best solution and propose to the WWS-OC.

6. Action items

- discuss with the GDE and CLIC management the organizational structure for LCWS12, and get it set up early,
- review the membership of the WWS-OC for possible rotation off the committee.

2012 LC Workshops

- **Linear Collider Forum, Feb 7-9, DESY Hamburg,**

The Meeting will be particularly dedicated to new Linear Collider physics studies and analyses (**ILC and CLIC**) and with regard also to LHC results. The contributions will be published at EPJ. Next year the **European Strategy for Particle Physics** will be updated and submitted to CERN Council for approval in December 2012. The results of the LC-Forum therefore will have direct impact for the European Strategy. The new LC physics contributions will also be an important input for the **ILC DBD** physics chapter, organized by Michael Peskin.

The registration is open from November 15th, 2011 on:

<http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=5380>

- **ACFA – LCWS (KILCW12), April 23-26, Korea, Gyeongju/Daegue**

LOC is preparing the web site, which will be published soon.

2012 LC Workshops

- **LCWS12, University of Texas at Arlington 22-26 October 2012**

2012 will be a milestone year for high energy physics and the linear collider community. The ILC accelerator Technical Design Report will be completed at the end of 2012 along with Detector Baseline Design (DBD) reports. The CLIC project will have achieved significant progress, including completion of the Conceptual Design Report. The LHC experiments anticipate significant advances in searches for the Higgs boson and supersymmetric particles as they finish the successful 7 TeV run.

- **IEEE NSS,/MIC Anaheim 29-30 October, “Special Linear Collider Event”**

Two days mini-workshop dedicated for Linear Collider.

ILC – CLIC Cooperation Summary

- End of 2012 is a time when:
 - ✓ LHC results at 7 TeV will be available with $\sim 15 \text{ fb}^{-1}$ per experiment. Increase energy.
 - ✓ Tevatron data will also be well understood/final.
 - ✓ Among other issues, the existence or absence of SM Higgs should be known.
- ILC and CLIC activities show an excellent progress and are working hard towards reaching the maximum amount of useful information for 2012 discussions
- A common coordination ILC-CLIC working group exists and cooperation is developing very positively:
 - ✓ CDR (CLIC) document ready by the end of 2011, and
 - ✓ DBD (ILC) documents which will be ready by the end of 2012
- Common cooperative tasks are identified and a good motivation from groups is shown. It has worked for CDR and is planned for DBD.
- Most present LC workshops are being jointly organized by both communities, ILC and CLIC. In future this cooperation will surely be enhanced.