SiD' and CLIC CDR preparations

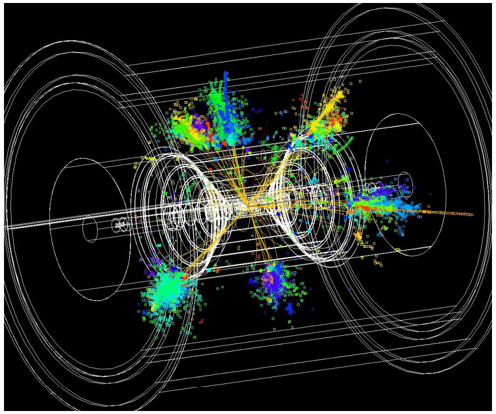
Outline:

- Introduction
- Description of SiD' detector
- R&D in software/hardware for SiD'
- Preparations for the CLIC CDR
- Conclusions

Introduction

In several aspects the CLIC detector will be more challenging than ILC case, due to

- the higher energies involved
- the higher beam-induced background
- the time structure of CLIC

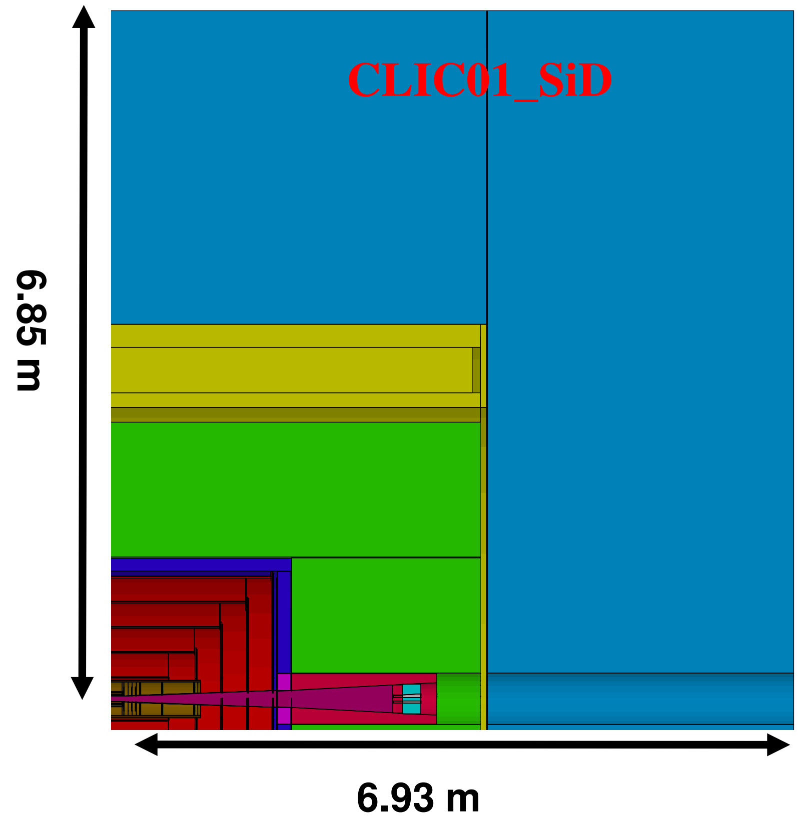


Most of the R&D currently carried out for the ILC is most relevant for CLIC. No need to duplicate work.

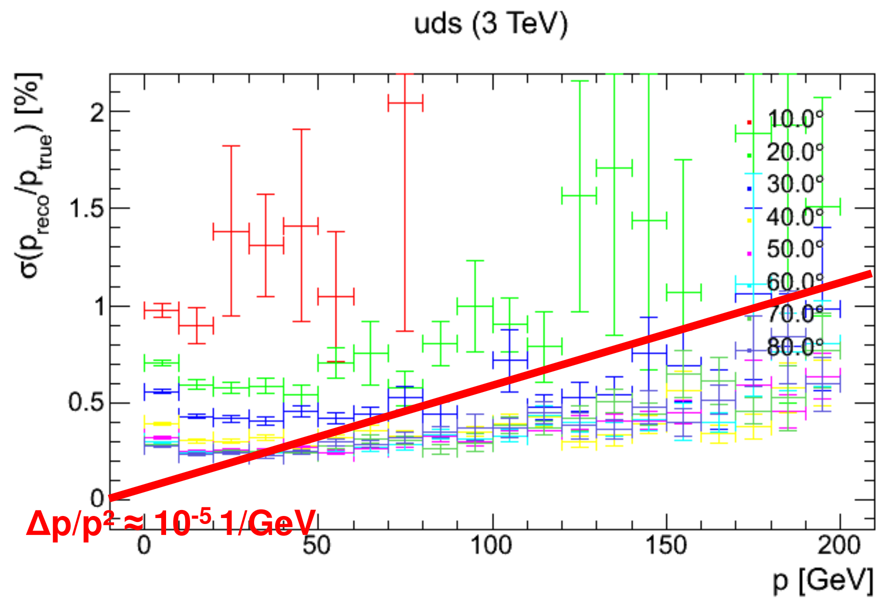
➔CERN LCD project has joined the validated ILC concept and technology collaborations CALICE, EUDET, FCAL, LCTPC

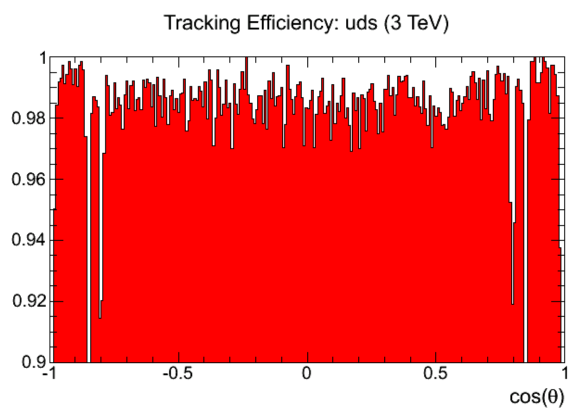
Besides **extensive simulation studies** and **software development** for the CLIC detector studies, **CLIC-specific hardware and engineering development** is required in a number of areas.

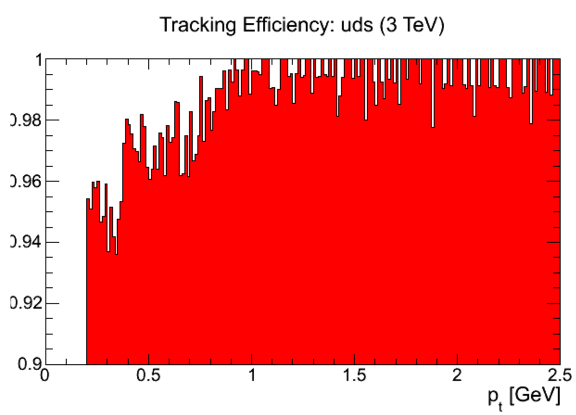
- Modified SiD02 to CLIC requirements
  - increased inner coil radius to allow for more HCal thickness
  - Changed HCal barrel material to tungsten
  - Increased number of HCal layers to 70
  - Changed vertex detector to avoid pair background: r_inner = 30 mm
- CompactXML is very convenient

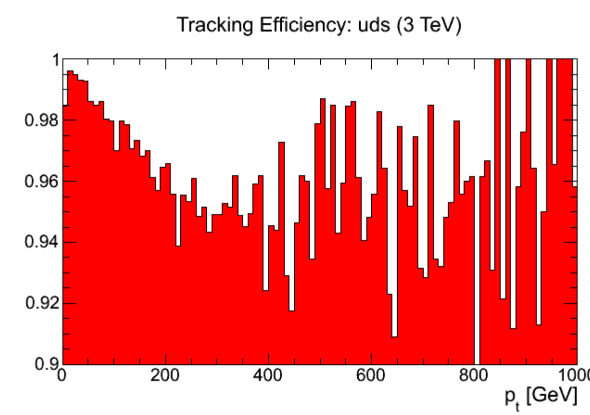


- Tracking algorithms work out of the box with SiD standard strategies
- Tracking performance goal reached
- Low tracking efficiency for high p_t needs to be investigated
- Next steps
  - Optimize strategies
  - Add with beam-background – time stamping?



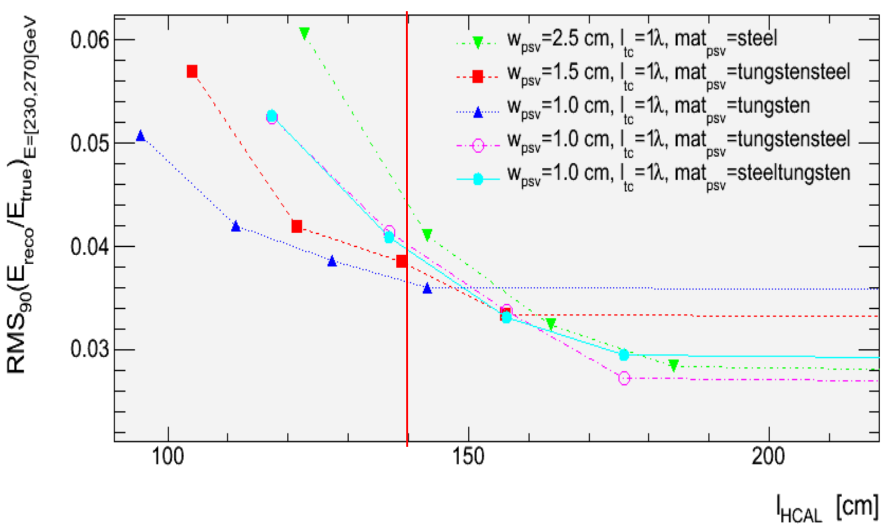


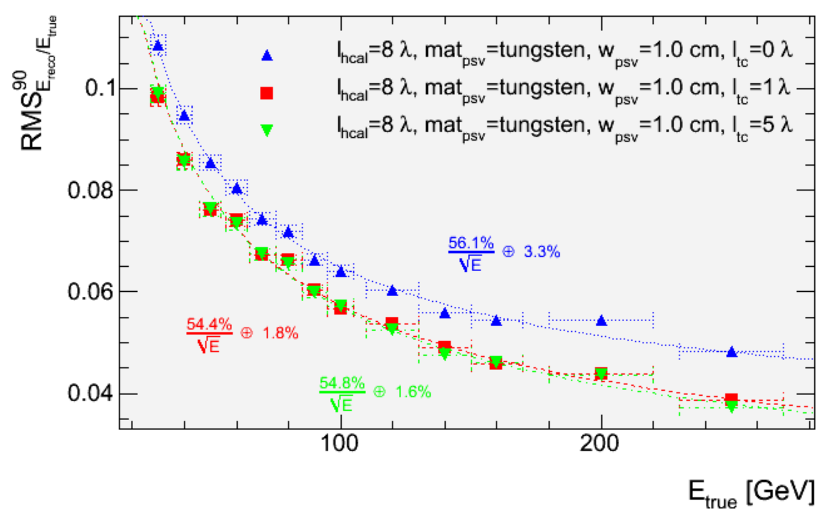




Tungsten HCal Studies

- Simulation of various materials and various sampling ratios
- Optimization for available space (inner coill radius)
  - ~7.5 ● Hcal of ~10 mm W + 5 mm Scint (~70 layers)
- Impact of tail catcher
- Next steps
  - Need to investigate impact on PFA performance
  - Simulation studies for a W HCal prototype





Peter Speckmayer & Christian Grefe

Hardware/engineering R&D

Hardware/engineering R&D needed beyond present ILC developments:

- Time stamping
  - Most challenging in inner tracker/vertex region; trade-off between pixel size, amount of material and timing resolution (~10ns)
  - Needed for most other sub-detectors (e.g. calo at ~20 ns level)
- Power pulsing and DAQ developments
  - In view of the CLIC time structure
- Hadron calorimetry
  - Dense HCAL absorbers to limit radial size (PFA calo based on tungsten)
- Solenoid coil
  - Reinforced conductor (building on CMS/ATLAS experience)
  - Large high-field solenoid concept
- Overall engineering design and integration studies
  - For heavier calorimeter, larger overall CLIC detector size etc.
  - In view of sub-nm precision required for FF quadrupoles

In addition: Core software development

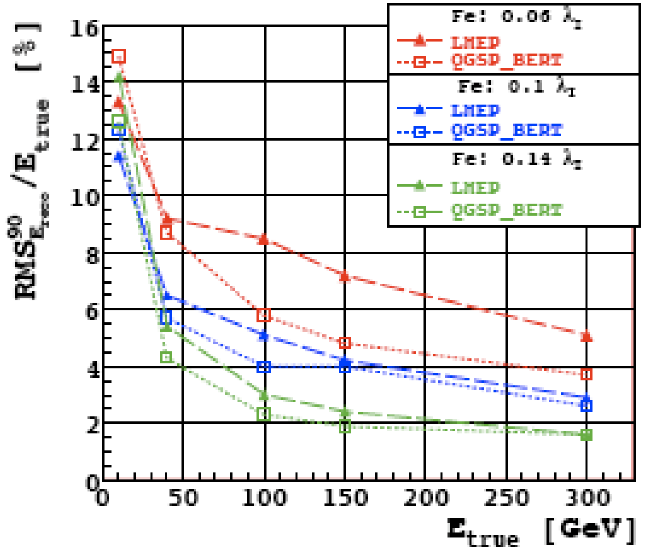
Tungsten HCAL prototype (1)

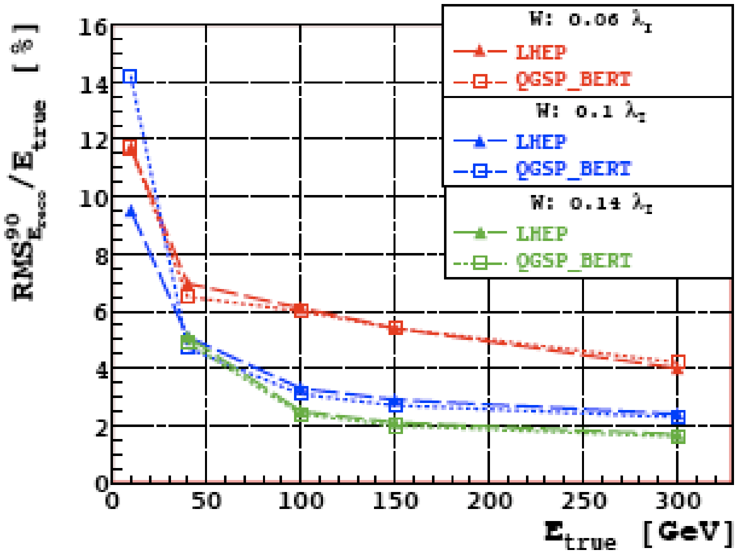
Motivation:

- To limit longitudinal leakage CLIC HCAL needs ~7Λ_i
- A deeper HCAL pushes the coil/yoke to larger radius (would give a significant cost and risk increase and for the coil/yoke)
- A tungsten HCAL is more compact than Fe-based HCAL, while resolutions are similar (increased cost of tungsten barrel HCAL compensates gain in coil cost)

See talks of Jan Blaha, Christian Grefe at this conference

➔Prototype tungsten HCAL: check simulation in test beam





Fe and W based HCAL resolutions

Angela Lucaci-Timoce DESY)

Tungsten HCAL prototype (2)

Main elements (all still under discussion):

- 40 or more layers of Tungsten absorber ~10×800×800 mm^3
- Phase 1: use current CALICE HCAL scintillator planes
- Phase 2:
  - a) New integrated AHCAL scintillator planes
  - b) New DHCAL micromegas planes

Time scale:

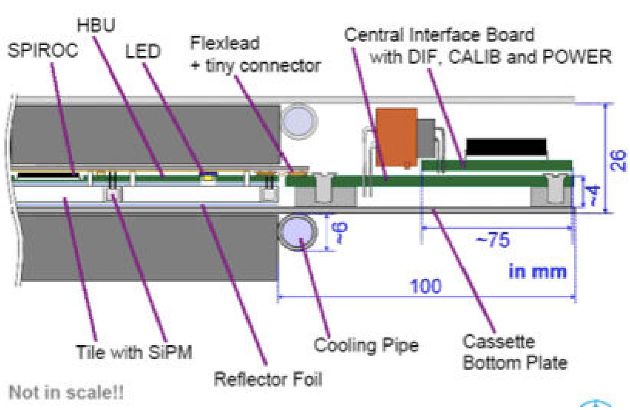
- First beam tests at CERN in 2011

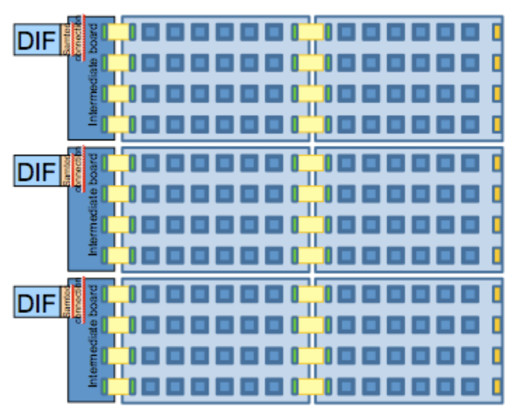
Discussions with interested institutes have just started

http://indico.cern.ch/conferenceDisplay.py?confId=68025

Integrated scintillator plane

DESY





Layout 1 m^2 micromegas

LAPP-Annecy

Solenoid R&D

- CLIC/ILC put high demands on solenoid (beyond CMS experience)
- Possible R&D subjects
  - Reinforced conductor (new Al alloys, nano-structured aluminium, cable-in-conduit)
  - Overall solenoid design and ways to reduce yoke mass
  - Optical-fibre based temperature/strain measurements in winding pack

Magnet experts from several institutes have show interest (CEA-Saclay, CERN, Cornell, ETHZ, Genova-INFN, FNAL, KEK, Protvino, SLAC)

Two upcoming meetings are foreseen:

- At CERN on October 13th (in the margin of CLIC'09)
- Hefei China, in the margin of MT21 (October 18-23)

Contact persons: Herman.TenKate@cern.ch, Andrea.gaddi@cern.ch

Time-stamping in tracking

Our next hardware R&D priority:

Identify **vertex (tracking) R&D project** suitable for **time-stamping** development

Time-stamping resolution of ~10 ns required

Forum discussion foreseen at the upcoming CLIC'09 workshop:
http://indico.cern.ch/conferenceDisplay.py?confId=45580

Core software development

Following a common LC software workshop in May 2009

http://indico.cern.ch/conferenceDisplay.py?confId=58717

CERN plans to contribute to a number of common LC software developments:

- Use of ROOT with LCIO
- Improved I/O (using ROOT I/O)
- PFA development (with Mark Thomson)
- Generic geometry toolkit
  - Description of complex shapes
  - Interfaces to full simulation, fast simulation, reconstruction, visualisation tools; with high-level interface
  - …. etc
- Data access and data storage database
- Grid access

Will organise meeting around November ~10th to discuss requirements

CLIC physics benchmark processes

1. $e^+e^- \to WW\nu\nu$, $ZZ\nu\nu$, $W/Z \to qq$, at 3 TeV (also 1 TeV partially, 2 data sets)
   - W/Z separation
   - particle energy flow
   - forward region performance
2. $e^+e^- \to Z'$ resonance scan, $Z' \to \mu^+\mu^-$, at 3 TeV
   - beamstrahlung
   - tracking resolution at high energy
3. $e^+e^- \to HH\nu\nu$, $H \to bb$ for $m_H = 120$ GeV and $H \to WW$ for $m_H = 180$ GeV, at 3 TeV (2 data sets)
   - $H/Z/W$ separation
   - forward region performance
   - b-tagging
   - missing E_T
4. $e^+e^- \to t\bar{t}$, [illegible] at 3 TeV (2 data sets)
   - cross section, asymmetry A_{FB}, asymmetry A_{LR}
   - b-tagging at highest energy
   - jet charge
   - multi-jet jet algorithms
   - boosted jets
5. [illegible] at high [illegible] and [illegible] mass (such as SUSY K' point and K' point), at 3 TeV (2 data sets)
   - forward region performance
   - beamstrahlung
   - τ-tagging
   - precision end point measurements

[1] For the CLIC 500 GeV case [illegible]

lcd.web.cern.ch/LCD/.../CLICDetectorBenchmarkProcesses.pdf

CLIC CDR

The CLIC CDR is due for end (~December) 2010.

There will be 4 volumes:

1. Executive summary document
2. CLIC accelerator and site facilities
3. Physics and Detectors
4. Costing (may move to Vol1)

The CDR document for physics/detectors will be some 100-150 pages.

CLIC CDR will be based on required changes for CLIC to the validated ILC detector concepts.

This is a conceptual design report, feasibility will not be demonstrated for all issues.

CLIC CDR layout (1)

Chapter 1-4

1. Introduction
2. CLIC physics potential
   - 2.1. Higgs physics (light Higgs and accompanying new physics)
   - 2.2. Supersymmetry
   - 2.3. Extra dimensions and other possible CLIC physics
3. Strategy for design choices
   - 3.1. Benchmark processes for detector performance assessment
   - 3.2. Luminosity and background conditions for a CLIC detector at 0.5 TeV and 3 TeV
   - 3.3. Beyond the ILC detector concepts
4. Detector performance requirements
   - 4.1. General optimisation (incl. detector aspect ratio, magnetic field vs. radius, flavour tagging)
   - 4.2. Calorimetry requirements (incl. e.g. general PFA considerations)
   - 4.3. Vertexing requirements
   - 4.4. Tracking requirements
     - 4.4.1. Central tracking
     - 4.4.2. Forward tracking
   - 4.5. Very forward calorimeter requirements

CLIC CDR layout (2)

Chapter 5-11

1. Tracking system
   1.1. Vertex detector
   1.2. Tracking detector
      1.2.1. Central tracker
      1.2.2. Forward tracker
2. Calorimeter system
   2.1. Electromagnetic calorimeter
   2.2. Hadron calorimeter
3. Superconducting Solenoid
4. Muon system
5. Very forward calorimeters
   5.1. Luminosity calorimeter
   5.2. Beam calorimeter
6. Readout electronics and data acquisition
7. Detector integration
   7.1. Mechanical concept, assembly and opening
   7.2. Push-pull operation and alignment

CLIC CDR layout (3)

Chapter 12-17

1. Physics performance for benchmark processes
    1.1. Benchmark studies of an XXX-like detector concept
    1.2. Benchmark studies of an YYY-like detector concept
    1.3. …
2. R&D prospects
3. Costs
4. Conclusion
5. Acknowledgment
6. Bibliography

I) Annex: SW packages used

CLIC physics/detector CDR

Comments:

The work for the CDR will be based on the “official” agreements between ILC and CLIC.

The CDR will mostly be based on **simulation studies for the CLIC** case and **existing ILC hardware experience**. As CLIC-specific hardware R&D will only start in 2010, its result will come too late for the CDR.

Depending on their importance and the amount of work done, some chapters may be thicker than others.

Some studies will be done with the SiD concept, others with the ILD concept, so the document will have a mix of both. Depending on the actual work done, this may not turn out to be fully balanced.

CDR organisation

We are looking for **editors, taking responsibility for the individual chapters** (typically 2 persons per chapter).

Editors from CERN are available, but ideally would like to have also many editors from outside CERN (members of the concept and technology collaboartions).

Appointment of editors will be done on an individual basis, following their involvement and interest.

The editors set up a work plan for the subject of their chapter, and help to identify participants (with our help).

Timeline:

•Appointment of editors ~November 2009 (after CLIC'09 workshop)

•Detailed work plan for the chapters: ~March 2009

What is needed from SiD?

Continued collaboration and support for the SiD software.

Possibility to run the software with substantial γγ background (and incoherent pairs for the inner vertex regions).

Solution to simulate the SiD_ish detector at 3 TeV including particle flow.

Improvement in flavour tagging (ongoing LCFI flavour tagging studies in Oxford)

Optimisation of the tracking

Lepton identification, including tau's

With many thanks to all SiD colleagues, who have given us lots of software support and expert advice !