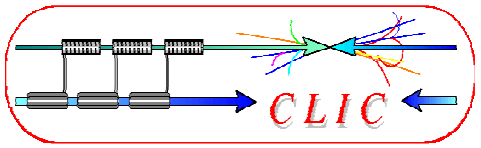
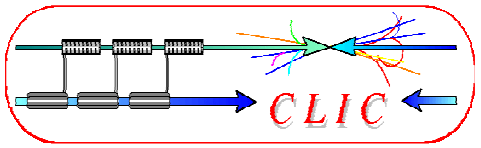


optimisation for higher energies/CLIC

Outline:

- Software and optimisation needs/plans
- PFA
- TPC simulation for CLIC
- LCFI flavour tagging
- Overlay processor
- Muon background

ILD performance optimisation session
André Sailer
29/1/2010



CLIC optimisation plans

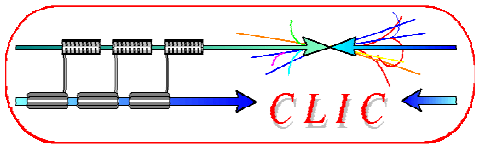
As the CLIC detector study is still in an early stage, there are still lots of optimisation studies to be done.

At the moment, we are trying to build up the tools for these studies (with your help!).

Therefore, this talk is more about **“tools for optimisation”** than about the optimisation subjects themselves.

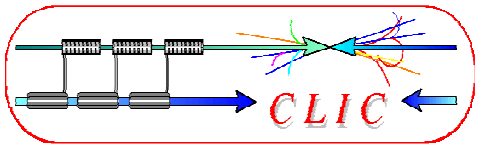
Most of our upcoming optimisation studies will be related to:

- Separation of physics from beam-induced background
- Effects of the higher energy like:
  - Boosted jets
  - Physics goes more forward
  - Flavour tagging (e.g. with long decay length)
  - Lepton id (e.g. Tau id)



Full Detector Simulation

- Using Mokka for CLIC_ILD and SLiC for CLIC_SiD Simulation tools, both based on Geant4
  - Will not do anything twice, some with one, some with the other
- CLIC_ILD model implemented for a few months
- Thanks to Paulo, Angela et al., coming soon to the central Mokka database
  - Larger vertex detector, larger vacuum tube, tungsten HCal, 20 mrad crossing angle, different LumiCal and BeamCal sizes, 4 Tesla field, No (Anti)DID



PFA/Jets/Leptons

We are eagerly waiting for the new PFA to become available. This will allow us to optimise PFA for typical high-energy situations:

- boosted jets, with high particle densities
- merging of jets, or confusion due to particle/jet mixing

SiD PFA in NewPandora framework worked on by Norman Graf will enable us to study PFA at SiD (Old SiD PFA was prohibitively slow at 3 TeV, complicated to adapt Pandora to SiD)

Optimisation of jet reconstruction in the presence of background.

The Durham algorithm has some problems with our hadron background

→We will look at different jet algorithms

Improved Lepton ID

Need a better (understanding of) PFOID

A TPC at a Linear Collider

Martin Killenberg

TPC spatial resolution in z: 0.5 mm
TPC 2-track resolution in z: 6 mm

	Bunch Spacing		Bunch Train Length		
	time	drift length	BX	time	drift length
ILC	369 ns	18 mm	2625	≈1 ms	50 m
CLIC	0.5 ns	25 µm	312	156 ns	7.8 mm

ILC:

- Large complex picture with data from 100 BX simultaneously in TPC
- Bunch crossings can be distinguished

CLIC:

- Whole bunch train within limit of z 2-track resolution
- High track multiplicity
- Narrow jets (3 TeV)

TPC Software

Reconstruction Scheme:

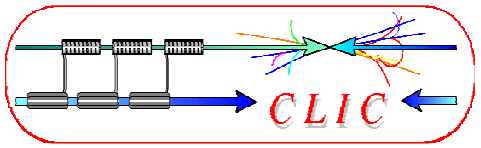
1. Local pattern recognition in the TPC
   - Find track candidates
   - Suppress (micro)curlers
   - Identify particles not coming from vertex
2. Matching with silicon tracker and calorimeter
   $\Rightarrow$ assign to correct bunch crossing
3. Track fit

Requirements:

- Realistic event overlaying
- Detailed, realistic full simulation and digitisation
- Local TPC pattern recognition
  - Without vertex constraint
  - Best possible 2-track separation in rϕ
- Improved local and global track fitting (Atlas tracking code?)

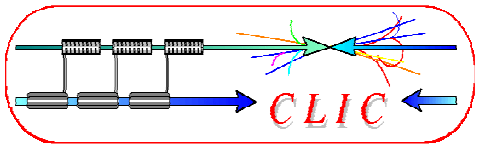
Flavour tagging

- Oxford team (Andrei Nomerotski and Tomas Lastovicka) are currently working on the optimisation of LCFI flavour tagging at high energy. Will be most useful to prepare for ILC studies at 1 TeV.



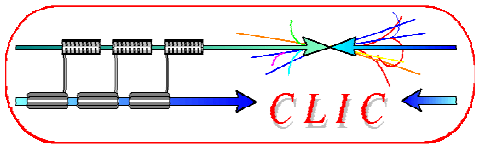
Overlay processor

- We use the overlay processor for ~3 $\gamma\ \gamma$ →hadron background events/BX
  - Add background from pairs later
- This is done before the digitisation stage, by overlaying physics with the background of N bunch crossings
- We run the full simulation, then analysis independently for each N (e.g. 0, 20, 40, 60)
- Extend Overlay processor to introduce different time-stamping capabilities for different sub detectors (e.g. 5 ns in tracker, 20 ns in Calos)
  - Already implemented in Marlin-Overlay for the different layers of the VXD



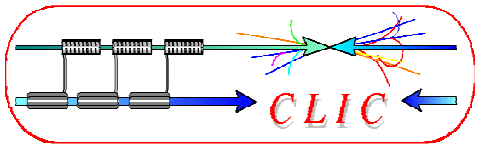
Muon background from the machine

- Muon background from the accelerator will traverse the detector horizontally (at CLIC up to 10^5muons/BT, mean energy 200 GeV).
- Current track finder requires tracks to pass through the vertex. This constraint does not allow to study the impact of the Muon background on the detector performance.
- Similar issue applies probably to calorimeter reconstruction.

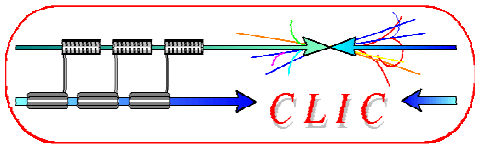


Grid Production

- Once we have (most of) the tools we are going to simulate, reconstruct, analyze our benchmark processes
- Use a dedicated grid production tool, Dirac, developed/used by LHCb (LCD/LHCb/Desy working together)



Spare slides

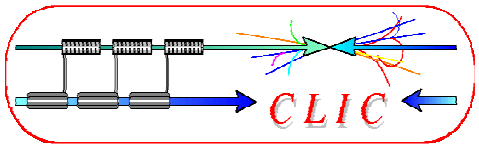


Core software development

Ongoing developments with involvement of LCD@CERN team:

- Use of LHC ROOT functionalities in ILC software (focused on ILD, collab. with DESY)
- Possible transfer of ATLAS tracking code into Mokka/Marlin (in collab. ATLAS, DESY, CERN) *see talk of Steve Aplin 27/1*
- Improved geometry toolkit in Mokka/Marlin (CERN+DESY+✪) *see talk of Astrid Münnich 27/1*
- Contribution to TPC reconstruction code (Martin Killenberg)
- Improvements of hadronisation process descriptions in Geant4 (collaboration between CERN/Geant4 and CALICE)
- Re-structuring of Pandora PFA (led by M. Thomson, Cambridge). The new Pandora can also be used with SiD (SLiC) processed events. ✪ *see talk of John Marshall 27/1*
- Grid processing and file catalog: we get support from LHCb to adopt their DIRAC system. Pilot project is starting now with LHCb/DESY/CERN. “ILC VO” is already activated for grid processing at CERN. *see talk of Jan Engels 27/1*

✪ also in AIDA



what LCD@CERN can bring to ILD

It is obvious that many years of ILC study bring a lot to the CLIC study and to the new LCD project at CERN.

In a nutshell, what does LCD@CERN bring to ILD?

- Use of ILD software tools at higher energy, participation in the necessary improvements → very useful for the upcoming 1 TeV ILC studies
- Participation in software framework development (including use of LHC tools) and: Grid tools, TPC pattern recognition in Marlin, contribution to Pandora-PFA, Geant4 hadronisation process
- Studies with overlaid background and optimisation of physics observables
- Study of the ILD detector concept at higher energies and reflect on possible improvements → might be in the interest of ILD
- Dense tungsten HCAL studies/tests
- Solenoid R&D, of mutual interest
- Timepix-2 and S-Altro developments for TPC readout
- ……