Notes/Minutes from WG6 Meeting of 27th September 2010

This brief document contains:

- Notes from the "Software Readiness" meeting of 27/09/2010;
- A proposed timeline for simulation/reconstruction for the CLIC CDR;
- Goals for the next WG6 meeting on software validation (26/10/2010).
- Other outstanding issues.

Talks are available from: http://indico.cern.ch/conferenceDisplay.py?confId=107327

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1. Notes from Meeting

1.1 Luminosity assumptions for CDR Studies (Lucie Linssen)

At a 3 TeV CLIC machine the spectrum has a peak near 3 TeV, accompanied by a long tail towards lower energies. For a total peak luminosity of 5.9×10^{34} $cm^{-2}s^{-1}$ the luminosity in the most energetic 1% part of the spectrum amounts to 2.0×1034 $cm^{-2}s^{-1}$. For most physics analyses the full luminosity spectrum will be used. For estimates of data statistics we assume that an average year of operation of the fully commissioned machine corresponds to 200 days with a 50% effective on-time. Hence, throughout the CDR document the integrated luminosity per year of running at 3 TeV is assumed to be 500 fb^{-1}.

1.2 CLIC_ILD Mokka status (Andre Sailer)

Main changes with respect to ILD:

- Vertex: Added 3 double layer forward vertex disk
- Vertex: used 3 double layer vertex detector as in ILD LoI.
- TPC: cathode gap reduced.
- HCAL: 75 layers of 1cm W in barrel and 60 layers of 2cm iron in endcap.
- Muon acceptance: muon acceptance cut by anti-solenoid, minimum r = 685 mm.
- HCAL acceptance: limited by QD0 to r = 400 mm.

Timing information for calorimeters: it was noted that to retain full timing information for calorimeters requires Mokka/init/lcioDetailedShowerMode true, resulting in very large file sizes. In a follow up to the discussion it is understood that with this option an energy is retained for each Geant 4 step leading to many contributions with the same time. For the overall time structure of the shower this information is not necessary.

Action: run Mokka in default mode (i.e. Mokka/init/lcioDetailedShowerMode false)

Mokka drivers: the possibility of using the new Mokka silicon drivers (e.g. SET, …) was discussed. However these are relatively new and have not been tested.

Action: use old Mokka drivers for Silicon detectors.

Action: Andre to provide a pre-tag version of the CLIC_ILD model in the Mokka database to allow testing outside CERN.

The forward tracking (and vertex detector) layout – needs to be finalized. This should be discussed in a focused WG3. Specifically:

Actions:

- fix date for WG3 meeting to re-discuss layout.
- request plot of occupancy (i.e. hits/mm) as a function of barrel vertex detector radius from 20mm-50mm in 5mm steps (separately for direct and indirect hits).
- re-consider the merits of simulating three double layer VTX vs five single layers; for the CLIC CDR studies it is unlikely that we will be able to take advantage of the background rejection capability of the double layer layout (requires significant new software).
- demonstrate layout is compatible with current reconstruction software.

1.3 CLIC_ILD Mokka Range cuts (Angela Lucaci Timoce)

Default in Mokka is 0.005 mm. Default in Geant 4 is 1mm. CALICE uses 0.05mm. Based on studies of simulation time and the fact that no significant dependence of performance on the range cut was observed it was decided to use 0.05 mm for the production.

Action: Use a 0.05 mm range cut in Mokka.

Timing: with 0.05 mm cut, the average time to simulate a 3 TeV Z→uds event is 24 minutes, i.e. 8 minutes/TeV of visible energy.

1.4 CLIC_SID Status (Christian Grefe)

CLIC_SID is based on the sidloi3 model, which includes planar trackers and polygonal calorimeters as opposed to the simple cylindrical structures used for the SID LoI.

Actions:

- need decision on whether to use RPC based digital HCAL by first week of November (default is to use scintillator HCAL for simulation).
- Need decision on vertex detector/forward tracking layout (as above for Mokka)
- Change material to be consistent with CLIC_ILD
- Optimize yoke layout
- Beamcal position needs to take account of space required for the various forward region elements

Timing (1mm range cut) simulation time for a 2 TeV Z→uds event is 20 minutes, i.e. 10 minutes/TeV of visible energy.

1.5 PandoraPFA (John Marshall)

Lepton ID: Recent work concentrated on Lepton ID with major changes to electron reconstruction and identification. Noted significant tension between good reconstruction of electrons/muons and retaining best jet energy resolution.

Jet Energy Resolution (CLIC_ILD) for Validation tag 3: 2.9 % for 250 GeV jets and 3.0 % for 500 GeV jets.

Split tracks: studies of FullLDCTracking, FullLDCTrackingCLIC and a new version "FullLDCTrackingSPLIT" which incorporates parts of both, show best performance for FullLDCTrackingSPLIT.

Action: need to make decision on which FullLDCTracking version to use. This should be submitted to the IlcSoft repository.

1.6 Pandora for CLIC_ILD (Angela Lucaci Timoce)

Jet energy resolution for very high energy samples: 3.3 % for 1 TeV jets and 3.5 % for 1.5 TeV jets.

Noted degradation in barrel-endcap overlap region and at $\cos\theta=0.75$.

1.7 Pandora for CLIC_SID (Marcel Stanitzki)

Not tested on CLIC_SID yet. Validation_2 version tested with several million events. The ECAL reconstruction and photon ID appear to be OK and the Z peak is reconstructed in the right place. However low momentum neutral hadrons are not being reconstructed correctly. The DHCAL reconstruction remains unexplored. It was noted that PandoraPFA validation version 3 crashes (throws exceptions) – subsequently understood, PandoraPFA now throws if it is passed nans.

It was noted that a change log and more documentation would speed up development.

Actions:

- Introduce change log (done).
- Critical to fix current problems with SID interface to PandoraPFA.

1.8 High Energy Leptons with CLIC_ILD (Jean-Jacques Blaising)

Muons: 90% of muon pair events from smuon pair decays have two muons well reconstructed, 8% one muon + e/pi, and 2% have no muon. Conclude muon reconstruction and momentum resolution has been validated.

Electrons: 78% of electron pair events from selectron pair decays have two identified electrons. There are issues with energy resolution related to FSR and Bremsstrahlung that need study.

Actions:

- understand energy reconstruction, tracking versus calorimeter based.
- one further iteration of PandoraPFA reconstruction to fix remaining electron issues.

1.9 Muon ID in jets (Erik van der Kraaij)

Performance for muons from b-decays in jets: (~90% efficiency/purity)
Still some problems, e.g. lack of angular coverage in barrel/endcap transition region (now understood).

Action: fully integrate new muon finding into PandoraPFA.

1.10 Electrons in jets (Angela Lucaci Timoce)

Studies just beginning; using previous version of reconstruction obtain ~50% efficiency/purity. New version will be more efficient.

Action: repeat studies with new code and iterate with PandoraPFA.

1.11 Photons with CLIC_SID and CLIC_ILD (Peter Speckmayer and Jacopo Nardulli)

Actions: Refine definition of efficiency (common for both detector models)

1.12 Overlay Processor (Christian Grefe/Peter Schade)

Proposed common procedure for event overlay for CLIC_ILD/CLIC_SID. Aim for simple interface. Initially suggested configuration at digitiser level; during discussion (Frank Gaede) proposed that this should all be done in overlay processor with common information being passed to digitisers via existing framework.

The importance of avoiding a separate CLIC software branch was emphasized and agreed.

Action: develop implementations in Marlin and org.lcsim with high priority.

1.13 SID Tracking (Christian Grefe)

Acceptance: goes to zero at 25 degrees, identified after the meeting. Much reduced efficiency in 7-13 degree range – circle fit fails which maybe related to planar geometry? Efficiencies for electrons: ~95 % (away from forward region).

Problems can be fixed on a timescale of 2 weeks (Norman Graf).

Actions:

- Fix tracking problems affecting forward region
- Liaise with ILD/SID on definition of efficiency.
- Recalculate efficiencies for muons/electrons/jets as a function of momentum in angular region with high acceptance.

1.14 ILD tracking (Marco Bataglia)

Good tracking efficiencies down to 7 degrees. However particles with tracks from the IP do not always form PFOs. Particularly evident in forward region, but also some effect in central region.

d0 resolution blows up in two regions of phi

Need to consider how to make modifications to SiliconTracking and FullLDCTracking (fixes to deal with split tracks which were common for high momentum tracks) part of the ILD software release.

Actions:

- Understand tracking biases in phi
- Understand why reconstructed tracks do not always form PFOs
- Define versions of SiliconTracking and FullLDCTracking for use in CDR studies and commit to ILD software repository
- Study two track resolution

1.15 ILD tracking (Steve Aplin)

Noted that FTD background studies not performed previously for ILD LoI and that the issues of combinatorics may be difficult to deal with.

Reproduced d0 biases reported above, these were due to features in the digitiser. Steve has written a new version which will be made available soon. Currently still some strange effects in z0 – under investigation.

Couldn't reproduce sinusoidal (in phi) momentum bias originally seen by Marco.

Actions:

- Release new digitiser code
- Understand reported momentum bias

1.16 SiD tracking (Norman Graf)

Moved from cylindrical to more realistic tracker geometry but no significant changes to track finding/fitting. As a result there are issues with efficiency/speed

Richard Partridge will soon return from vacation – a fix to forward tracking should be relatively simple – timescale two weeks

Actions:

- Follow up with Richard Partridge

1.17 Flavour Tagging (Tomas Lastovicka and Frederik Bogert)

Current work is primarily in understanding variables, in particularly need to understand requirements for tagging long-lived b-jets.

1.18 Computing resources (Przemyslaw Maria Majewski)

Mokka/Marlin processing ratio: approx 10:1. Note that reconstruction times do not include event overlay. Presented results from a significant grid production exercise. Taking into account the improved throughput with range cut reduced to 0.05 mm, production of 10000 events per day (3 TeV visible energy) is possible.

Total CLIC CDR MC production likely to be limited to **< 2 million events**. Exact number depends on reconstruction times with background, breakdown into event categories (time roughly proportional to visible calorimetric energy),

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2 Proposed Timeline for CLIC Simulation Software

Please find below a proposed set of deadlines for the simulation and reconstruction software for the CLIC CDR.

25/10/2010 Finalize geometry for CLIC_ILD and CLIC_SID

- Main issue is the geometry of the vertex detector and forward tracking. This needs to be discussed within WG3 prior to the meeting of the 25th.
- Geometry of tracking should be validated with the reconstruction software to demonstrate that the current reconstruction tools can cope with it.

01/11/2010 Finalize Mokka and SLIC implementations of CLIC_ILD and CLIC_SID

- Models set in stone and tagged.
- All subsequent reconstruction validation studies will use these models.

01/11/2010 Complete implementations of Overlay processor

- Both for Marlin and org.lcsim with background samples available
- Needed for validation and optimization of reconstruction software

01/12/2010 Complete *validation* reconstruction path for CLIC_ILD and CLIC_SID

- i.e. debugged and fully functional reconstruction software, subsequent work focused on final validation and bug fixes rather than new development.

15/12/2010 Finalize reconstruction software and tag releases

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3 Goals for next meetings: 25th/26th October

There will be meetings on the 25th and 26th October to discuss geometry (on the 25th) and a follow up on the readiness of the reconstruction software (on the 26th from 1000-1600). For the latter meeting it is hoped that progress on the majority of the reconstruction related actions will be discussed. Currently the most critical issues are:

- Development of the overlay processors for Marlin and org.lcsim
- Understanding and fixing the tracking issues with org.lcsim
- Understanding and fixing the biases observed in the z0 and momentum distribution for CLIC_ILD
- Validating tracking software (Marlin/org.lcsim) for final tracker layouts
- Implementation and performance of PandoraPFA interface for CLIC_SID
- Better understanding of flavour tagging tools for CLIC CDR benchmarks
- Finalization of lepton ID for CLIC_ILD
- First studies of lepton ID performance with CLIC_SID

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4 Other Outstanding Issues

There a number of other issues which need to be considered:

- Strategy for time-stamping of TPC tracks via linkage with Silicon tracking/calorimeters.
- Particle flow reconstruction strategy in presence of backgrounds. In particular what timing cuts to apply prior to the reconstruction and how to select PFOs from the bunch crossing of interest.
- Definition of the DST format for physics analysis. For CLIC_ILD the default is to use the standard Marlin DST maker. Could consider a common format for CLIC_SID.