Detector Cooperation with CLIC

PAC Pohang meeting
November 3, 2009
Outline

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- ILD/SiD for CLIC ?
- Crucial R&D needed
- Political aspects (WG)
- Potential risks
- Conclusions
Introduction

- Following the initiative taken by Jean-Pierre Delahaye and Barry Barish, the ILC detector community has increasing technical collaborations with CLIC.
- CERN has joined ILD and SiD and the major R&D collaborations and interacts directly with these organizations.
- At CERN the DG has launched a ‘LC project’ beyond the usual technology frontier.
- There are 10-12 FTE at CERN.
- Will be X2 end of 2010.
Questions

- Can ILC validated detectors ILD and SiD be used for CLIC at 3 TeV?
- If not can one define common efforts within the R&D collaborations? (e.g. calorimetry, µvertex RO, new SC for the coil, push-pull issues, engineering...)
- There is of course a caveat given the different roadmaps: CLIC only foresees a TDR in 2016 but needs to provide a CDR in 2010
- ILC, with limited resources (e.g. in the US), needs to complete a detailed baseline study end of 2012 in conjunction with the ILC TDR
- Any initiative should be considered within the ILC roadmap constraints avoiding diversion in our priorities
Similar detectors?

- From studies already reported at PAC (M. Thomson from ILD) PFLOW appears relevant for a multiTeV collider provided that the HCAL is increased to $\sim 8\Lambda_I$
  
  $\rightarrow$ CLIC is studying a **W HCAL**, more compact

- Potential benefit for ILC detectors which could reduce the size of the SC coil but costly solution (100€/kg)

- The CALICE collaboration has taken seriously this possibility

- Recall that the PFLOW simulation assumes $>99\%$ efficiency on tracking achievable in the ILC environment

- Can this figure be maintained at CLIC at 3 TeV with larger, more energetic $\gamma\gamma$ background and challenging duty cycle (BX every 0.5 ns)?
Challenges with tracking

- Recall that while SiD assumes perfect time separation (time stamping) of the data recorded at different BX which seems feasible (but challenging) with ~300 ns BX separation, ILD assumes 50 µs integration for the µvertex.

- For the TPC of ILC γγ events recorded at different BX give well separated vertices which allows topological separation.

- CLIC has a 300 BX with 0.5 ns separation.
Consequences

- First simulations were reported by M. Thomson at CLIC09
- There are indications of significant loss in performances (HA study) in the absence of stamping
- Criticality of the FWD region (e.g. H physics from fusion)
- Need an ‘aggressive’ R&D to perform time stamping on tracking (see 3DIC for vertically integrated Si pixel detectors) and forward calorimetry
- Could be of use for ILD-SiD in particular for what concerns the $\mu$vertex
Two-photon → hadrons background

- Preliminary studies (Battaglia, Blaising, Quevillon) indicate significant two photon background for 3 TeV CLIC operation
- Approx 40 particles per BX ($p_T > 0.15$ GeV, $|\cos \theta| < 0.98$)
  - ~40 GeV visible energy per event
- E.g. Event display for 150 BXs (75 ns) in ILD-like detector

- Results need checking (preliminary)
- With 0.5 ns BX – will inevitably integrate over multiple BXs, how many?
- CLIC at 3 TeV may look rather different to the ILC environment
- In addition, there is also the pair background...
Political aspects I

- CLIC needs help from ILC experts to produce a CDR and calls editors from our community
- CLIC wishes to merge its workshops with ILC (note that there is a large overlap between participants at ALCPG09 Albuquerque and CLIC09 at CERN)
- CLIC wishes to intensify work on R&D through the existing collaborations
- ILCSC has encouraged formation of a CLIC/ILC General Issues working group on detectors
- The format of this WG is under discussion with the CLIC partners
Joint Working Group on General Detector Issues

- November 2, 2009 approved version
- ILCSC has encouraged formation of a CLIC/ILC General Issues working group on detectors by the two parties with the following mandate:
  - Promoting the physics and the detectors of the Linear Collider
  - Identifying synergies between the detectors of ILC and CLIC in performance studies, detector R&D, and software tools
  - Discussing detailed plans for the ILC and CLIC efforts, in order to explore possible collaborations on issues such as critical R&D on sub-detectors, coil studies, push-pull mechanism and MDI aspects
  - Discussing a possible format of collaboration between the ILC validated detector groups and CLIC
- The conclusions of the working group will be reported to the ILCSC and CLIC Collaboration Board.
Political aspects II

- The actual content of these various CLIC-ILC collaborations to be decided directly by the interested parties (mostly CERN and the ILC groups).
- For what concerns the participation of members of SiD and ILD to the CLIC CDR we feel that it should be done in agreement with these collaborations.
- For what concerns the workshops we are already organizing the next European WS (ECFA WS at CERN in Sept 2010) with an OC comprising CLIC+ILC representatives.
- These various initiatives should further improve the good relationships between the two communities.
Potential risks

- ILC is an international organization under ICFA/ILCSC with a well defined roadmap.
- While CLIC-ILC collaboration appears very natural in Europe we need to make sure that it is agreed upon in the two other regions.
- CLIC needs an international R&D oriented towards a multiTeV collider not necessarily overlapping with ILC priorities.
Which Scenario?

The scenario proposed by the CERN DG at LCWS08 in Chicago is that LHC should provide the scientific input for a final choice (through a process which needs to be carefully defined) recalling that ILC is ~ready for construction while CLIC at 3 TeV remote in time.

CLIC500 however appears in direct competition with ILC and the community would like to see clear rules of the game for the assessment of this technology (new ITRP?)

While we fully appreciate the usefulness of the ongoing process to avoid damaging competition the community needs to be well informed on the overall scenario.
Conclusions

- CLIC/CERN can bring tremendous help in improving the ILC detectors
- One should therefore encourage the ongoing collaborations but insuring mutual benefits and avoiding distraction of efforts on the main goal
- The proposed CLIC-ILC WG on detectors should allow better communication
- Common CLIC-ILC workshops will be tried at the next ECFA workshop at CERN
- There are clear specific needs for CLIC which may require marked differences between the detectors and the R&D needs but one can foresee important overlaps
- Political risks cannot be minimized and one needs ICFA/ILCSC/PAC guidance
BACK UP SLIDES
Simulation example of heavy Higgs doublet $H^0A^0$ at $\sim 1.1$ TeV mass (supersymmetry K' point)

$$e^+e^- \rightarrow H^0A^0 \rightarrow bbbb$$

Signal + full standard model background + $\gamma\gamma \rightarrow$ hadron background

CLIC-ILD detector: Mokka+Marlin simulation, reconstruction + kinematic fit.

Zero bunch crossings
$M_A$ mass resol. 3.8 GeV

20 bunch crossings
$M_A$ mass resol. 5.6 GeV

40 bunch crossings
$M_A$ mass resol. 8.2 GeV