Minutes of Meeting, 2017-04-21
Working group on novel accelerator techniques (NAT)
Minutes by Erik Adli

In general, the minutes will cover some key points from the discussion, and not all the details of the slides (available on indico).

Topic: Physics considerations for multi-TeV collisions

Speaker: Philipp Roloff (CERN)

Philipp started with an overview of Higgs physics studies at CLIC, and some of the advantages of an e-e+ collider versus a hadron collider; for example: direct studies of single Higgs events, model independent coupling measurements, less likely to be "fooled" by unknown processes (and more).

Multi-TeV electron acceleration only

Plasma accelerators are less developed for positron acceleration than electron acceleration. Philipp discussed physics possibilities assuming only electrons (not positrons) can be accelerated by NATs to multi-TeV. Focus was on Higgs physics :

1) Asymmetric collisions.
Assume a 380 GeV RF-based CLIC. Keep the same e+ RF-linac. Build an 11 TeV e- linac with NATs. The Ecom will be 3 TeV. There are then two significant disadvantages with respect to symmetric collisions: 1) interesting physics will be too strongly boosted in the forward direction for current detector concepts to be useable. 2) The beam power will increase linearly with the e- beam energy, while Ecom will only increase by square root. The machine efficiency is dropping accordingly. *In conclusion: strongly asymmetric multi-TeV collisions seems to be of little interest* [for the main physics program].

2) e-e- collisions.
Main Higgs production channels are not accessible with e-e- (ZH, WW), only ZZ. Also luminosity of an e-e- collider compared to a similar e+e- collider would be lower due to focussing and defection of the beams. *e−e− is therefore not very promising for Higgs physics.*

3) gamma-gamma colliders
Has already been studied before for lower energy colliders (CLICHE, SAPPHIRE). While an e-e+ at the corresponding Ecom would be better for Higgs studies, in general, it would be interesting to re-study the physics capability of a Multi-TeV gamma-gamma. *This topic will be revisited in a future WG meeting.* Philipp would need a photon spectrum for the Ecom to be studied.

10-30 TeV e- e+ colliders

s-channel process cross sections (Higgsstrahlung) drop with the square toot of Ecom, while t-process cross sections (WW, ZZ-fusion) increase with log. Ecom.

At 30 TeV, assuming the same luminosity as 3 TeV CLIC, larger single and double Higgs event samples would be produced with respect to a 3 TeV machine. Triple-Higgs studies may be accessible. Reach for new physics increase with Ecom, but depending on the search luminosity requirements also increase (for example pair production of super symmetric particles). The luminosity for a 10-30 TeV machine should not be smaller than $10^{34}/cm^2/s$ (3 TeV CLIC); would profit from being higher (how high depends on physics). *A multi-TeV e- e+ machine with a luminosity several orders lower than CLIC 3 TeV CLIC would not be great interest.*

Polarization

This topic was discussed after the meeting, not during, and included in these minutes for completeness. In general note that both beams do not have to be polarized; e.g. 80% polarization for e- gives is in most cases similar performance as 40% polarization e- and 40% polarization e+.

CLIC 3 TeV has 80% e- polarization and no e+ polarization. A 10 TeV collider would be very interesting also with no polarization in either beam. Some cross sections are enhanced with polarization. The energy reach for new physics may in some cases increase with polarized beams.

Time structure

Detector concepts could be adapted to a different time structure than the short pulse of CLIC (240 ns pulses at 50 Hz), for example a "continuous" bunch crossing rate, like the LHC (one bunch at 25 ns). ILC is "in between", with ms pulses at 5 Hz. *A different time structure could than CLIC and ILC should therefore not be a show-stopper for developing new collider concepts.*

Parameter set for future physics studies

Default luminosity option: same as CLIC 3 TeV. Two options to be studied: a factor 5 higher, and lower.

A1) e- e+. 10 TeV. 1 x $10^{34}/cm^2/s$. No polarization.
A2) e- e+. 10 TeV. 5 x $10^{34}/cm^2/s$. No polarization.
A3) e- e+. 10 TeV. 2 x $10^{33}/cm^2/s$. No polarization.

Integrated luminosities to be studied: 150 fb^-1, 750 fb^-1 (default) and 4 ab^-1.

B) gamma-gamma. Photon spectrum will be calculated based on e- e+ beams as for case A1. Polarization?

Next meeting (12/5, 2017)

Argonne National Lab will present their activates and dielectric structures. We will discuss how dielectric structures may help improve CLIC, and possible areas of collaborations between Argonne and CLIC.