Minutes of Meeting, 2017-02-17
Working group on novel accelerator techniques
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: Introduction,

Speaker Erik Adli

The mandate was presented (mandate available on the indico page). The mandate for the working group is very broad. As starting points all types of technologies can be considered. The goals include investigating if an existing first stage of a linear collider can extended in energy using novel accelerator technology (NAT), but also to understand how a linear collider optimized from start for NAT could perform. Eventually, the study should also give input to the design of a future linear collider to avoid incompatibilities, and encourage reuse of eventual existing hardware.

Steinar emphasizes: we are the LC study at CERN; anything that is LC we can and have to consider relevant without losing sight of the primary goal of presenting a project plan for CLIC by ~2019 and support common developments with ILC.

Topic: Requirements for future linear colliders

Speaker Daniel Schulte

The main optimizations performed for RF-based linear colliders were presented and discussed.

Direction the study can take was discussed, although concrete tasks and studies will not be defined until after the next meeting. These directions include :
* Understand better how to optimize a given technology, including the assets and limitations, in order to arrive at a credible design for a multi-TeV machine (entirely) based on NAT. It was suggested to start by a 3 TeV since the working group has extensive experience for this energy. Further on, the promise of going towards very high energy (OM higher) should be studied as well. To arrive at a credible conceptual design, models and tools must be developed, a significant effort, but necessary. Issues and risks must be identified and addressed.
* Looking outside the main linac: study the benefit of NAT at injectors and beam delivery system
* Afterburner, in the sense add NAT stages to an existing linear collider : question arose whether this is really interesting, as it this study not allow a clear path towards OM higher collision energies.

Daniel suggest that a design process considers the following partition :

- fundamental design for an ideal machine, limited by physics
- beam stability (ideal machine), mostly limited by physics
- machine imperfection, can in principle be improved by technology development

Daniel did a survey of and commented on existing concepts/considerations based on PWFA, LWFA and DLA. A few of the general comments related to on these concepts :

- CLIC rf to beam efficiency is limited by transverse beam stability. In order to have a credible number for efficiency for NAT, transverse beam stability must be understood and considered as well. As example, the CLIC design methodology, taking into account single-bunch wakes and multi-bunch wakes was outlined. Took also time for the CLIC-project to take transverse effects into the optimization.
    - Remark Walter: all NAT presented are co-linear; the non co-linear CLIC schemes means that there are less requirements on the drive beam quality
    - Remark: would be interesting to see the optimization for the much-mentioned PWFA-LC plasma cell
- assuming much better generation and preservation of emittance that linear colliders should be backed up by a receipt on how this can be achieved, which could then eventually benefit RF linear colliders
- emittance do not necessarily scale down to very small numbers with number of particles (DLA), certainly not for positrons
- challenging to find a nanometer-emittance positron source without having a damping ring
- eventually, it is the cost (per luminosity, energy) that is the ultimate criterion
- As for RF linear colliders, one must push the relevant parameters of the luminosity formula (in particular, reducing vertical beam size, eps_y, beta_y, will always lead to improvement)

Drive beams :
A linac based on NAT will most likely require a new drive beam design. Drive beam schemes for a PWFA-linac were only quickly mentioned. This topic will discussed in more details in a later meeting. Still interesting to look at how a CLIC DB complex could be re-used.
Proton drivers : stored energy issue in LHC: ramping rate an issue for proton ring (when you ramp down in LHC, you keep most of the energy). Are proton drivers interesting? Patric: should perhaps rule out, due to efficiency, and the fact that we lose advantages of the ring.

Drive beam jitter:
DB needs to be stable to within few nm in PWFA-LC, if not bunches would miss each other at collisions. Effect analogue to quadrupole effect in conventional main linac. Angular tolerance: jitter below 0.5 radian [more worrisome]. NB: DB jitter and WB jitter are not equivalent.

Luminosity considerations :

all concepts see the same beam-strahlung challenges when going to large collision energy. From luminosity formula, luminosity increases when sz is shorted (because sx smaller as well), but beam strahlung parameter Ypsilon will increase as 1/sz - cannot be too large (pair-production, background).

Vertical size do not affect beam strahlung, so always good to decrease vertical beta function and emittance.

Wall-plug to drive beam efficiency: possible to beat CLIC? (about 60%). Perhaps SC linac can give similar efficiency (re-use idea: ILC cavities).

Tentative work steps, where CLIC-expertise can contribute, were suggested (see slides for details) :

- derive credible main linac parameters for PWFA-LC (would need study team to understand PWFA transverse instabilities better)
- develop realistic drive beam concepts for PWFA
- review dielectric structures
- technological developments for main linac: improved stability and timing
- study how to push emittance further down
- study improved focusing at collision
- look at new overall concepts, with physics

For the latter, dialog and input with CERN physics groups will be useful. For example, what is the interest for :

- gamma-gamma colliders (avoid positron challenges)
- low-luminosity, very high-energy colliders
- asymmetric colliders (very high-energy e- (NAT accelerated) colliding against lower energy positrons (accelerated with RF)
- low-luminosity, electron-proton colliders

Next meeting (24/3)

Patric Muggli will give an overview of the novel accelerator techniques, including the experimental status of the different technologies. This information will be helpful in order to decide on topics and directions for the working group.