Which linear collider and where

What can technology achieve, views from an independent thinker

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Today status: Two competing projects, for a near future LC, NLC and TESLA both reasonably close to be "freezed".

That is: if one will be approved and funded now, it can be build as currently designed and function with perfomances very close to specs:

- Time (10-15 years)
- Cost (5-10 B$)
- Energy (0.5-1.0TeV cm)
- Luminosity (more than 10^{34} cm^2/s)

One project for a later in the future LC: CLIC, aimed at higher energies (>3TeV) and luminosities (>10^{35}), that requires further R&D before reaching a "mature" design.

NLC and TESLA largely based on concepts already developed for SLC:

- Polarized source (polarized e+ are new)
- Damping Rings
- Linear Accelerator
- Collimation system
- Final Focus
- Dump line

All these subsystems are better versions of what has been built for SLC.They are largely based on the know-how from SLC and all the test facilities operating around the world.

Their requirements are much more demanding of what achieved in SLC. For example:

Sources: higher polarization (>90%)
higher charge and power (*50)

Damping Rings: smaller emittances (ε_x/10, ε_y/100)

Accelerator: higher energy (*10)
smaller emittance growth (/100)

Final Focus: more focusing ($\sigma_x\sigma_y$/5000)

Dump Line: more power (*500)

We believe that these very demanding requirements can be met, and that there are no critical elements that can seriously jeopardize the goals. However some new unknown factors might always be around the corner and there is no absolute certainty that they will not show up after the machine has been build.

Acceleration

The technology choice to accelerate the beam it is no longer a key factor for the LC:

Both cold and warm technology produce already gradients compatible with Ecm>500GeV. R&D for higher gradients continues all the time (and must never stop…), but already the cost of the LC is weakly affected by this parameter (<20%).

Acceleration II

Warm-Cold: Small impact on overall Cost (<10%)

SC-RF has less wakefields

X-Band has intrinsically more wakes but the system has been designed to reduce their effects to negligible levels

This problem has been overstimated because the SLC experience: it took several years to reach negligible emittance growth in the LINAC, but it had not been build for a linear collider !

Upgradability

Lep:

Initially operating with normal-conducting RF:
Ecm=100GeV

Second fase operating with super-conducting RF:

Ecm=200Gev

Tunnel already designed to host LHC

Very wide Physics reach and long life of the complex.

Upgradability

LC:

Initially operating with "state of the art" RF (Ecm>0.5TeV)

After few years of operation, adiabatic increase of the energy upgrading the RF system and adding more accelerating structures (Ecm>1.0TeV CM).

Further energy increase could be foreseen by lenghtening the tunnel and/or replacing the accelerating structures with higher gradient ones (Ecm> 2.0 TeV)

CLIC:

Several subsytems have requirements at least one order of magnitude more demanding than NLC-TESLA. I personally think that it will never work if an "intermediate" step (LC) is not fully exploited first, like probably this LC could have never worked without SLC.

CLIC needs extensive R&D on the acceleration system AND on all the other subsystems.

LC Upgradability II

Replace the RF system with CLIC technology or any other high gradient solution that will be avalaible at the time (>2020) (Ecm>5.0TeV)

The LC should have built in the capability to extend its energy reach as far as possible.

On of the biggest features of the LC is that it is LINEAR and has no hard limits to its maximum energy. Almost everything else can be reused when its energy is increased:

Upgradability II

Tunnel

Injection System

Beam Delivery System

Detector

Conventional facilities

KNOW-HOW

TIME

Conclusions

We could plan to build an experimental facility that can operate succesfully and make new physics for at least the next 20-30 years.

According to the present designs, the NLC solution is more suitable for a pratically indefinite energy increase, whereas TESLA needs some redrawing.

When the LC is build, the most logical site for CLIC (or an equivalent project) in terms of COST, TIME and DELIVERED LUMINOSITY is in the LC place.