



ILD discussion

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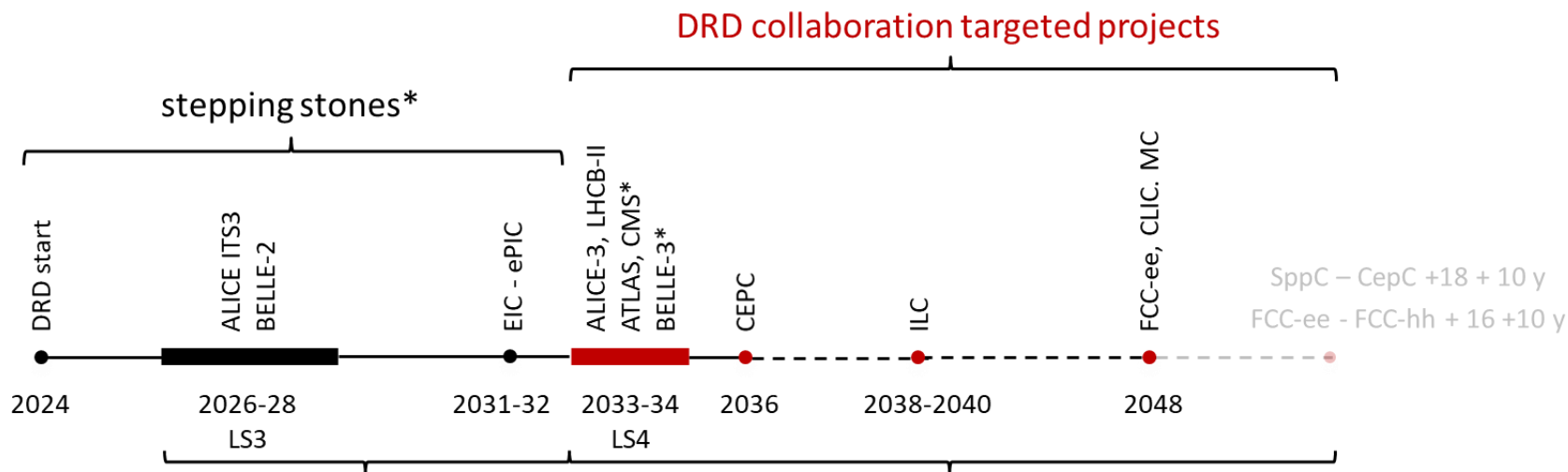
ILD meeting CERN

Discussion Session



- How do we position ILD?
- How do we develop ILD further
- How do we ensure that ILD remains at the forefront of concept developments
- Short report by the IA chair (Daniel)

Time lines of projects

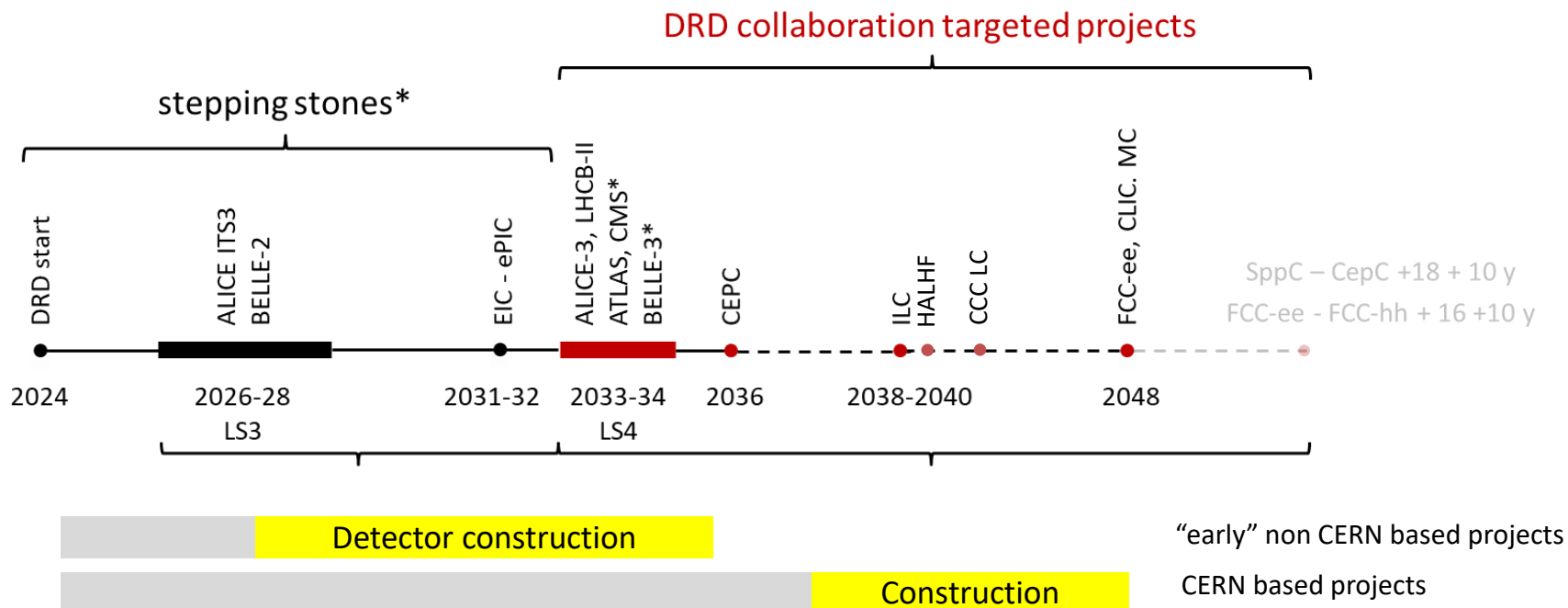


experiment entering engineering phase
SoA 1st implementation in experiments

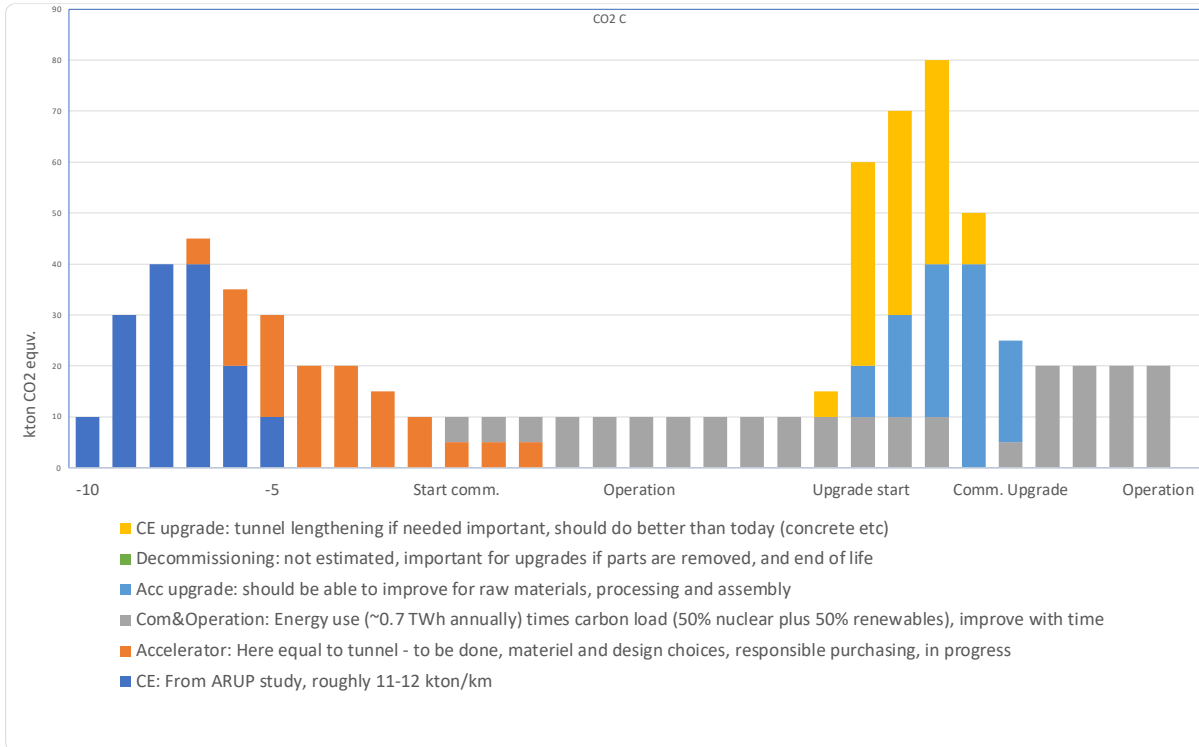
not yet approved, technical planning constraints:

- ALICE-3, LHCB-II, FCC-ee - CLIC : HL-LHC planning
- CEPC, ILC : approval decision
- MC : accelerator muon cooling R&D
- SppC, FCC-hh : accelerator magnet R&D

Time lines of projects



Non Science Drivers



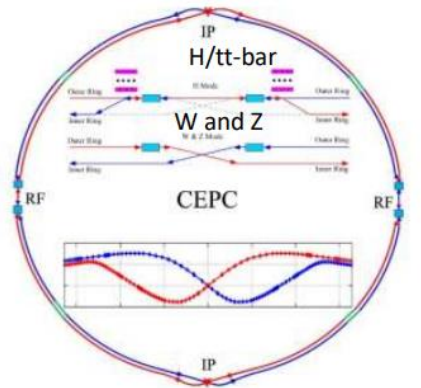
- Environmental impact of our projects
- Politically this is rapidly gaining importance
- This will need to be part of discussions of any project we consider in the future

From talk by Steinar Stapnes, Monday plenary

The global situation



- CERN pursues FCC as highest priority (but not exclusively)
- Europe has agreed on Higgs factory, prepares the decision at the next strategy through the ECFA study (and others)
- US has opted-in to the Higgs factory off-shore, has narrowed to options to FCC-ee or ILC
- Japan continues to push for ILC, though there is no clear roadmap
- China pushes strongly for CEPC as an alternative to FCC



CEPC collider ring (100km)

CEPC

International review of design and costing recently finished
Costing scheme developed (collider Chinese (90% local government, 10% national government), detector 50% international)
International participation invited, but not required
Goal: include in next 5-year plan, construction could start in 2028

ILD: a range of opinions



ILD has been conceived about 10 years ago. It is now time to re-visit many of the choices and “modernize” ILD. There is no need to fundamentally change ILD.

Do we have the resources for a re-invention of ILD?

We need to develop a way to interact closely with the DRD's

Known R&D collaborations are the much larger DRD

Particle flow still the right paradigm for a detector at a Z or Higgs factory?

How can we serve a wide range of conditions

How do we organize ourselves?

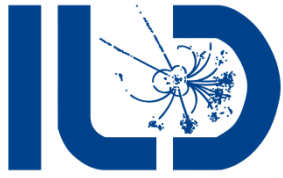
Prime and has been set by history. Converge and one collider concept

The conditions in particular the inner part of the detector are different for different colliders

How should ILD continue?



- Interaction with other Higgs factory detector concepts
 - Participation
 - Contribution
 - Integration
- Question: does our strategy document from one year ago needs an update?



Remarks by the IA chair



ILD subdetectors: Vertex

- Inner detector region: Vertex Detector
 - Can the same geometry serve Z running and Higgs running?
 - How do we improve our forward region in the VTX
 - How bad is the MDI situation at FCC-ee
 - How can we further reduce the material:
 - Integration study
 - Cooling
 - Cooling
 - Support structures in particular for the forward integration
 - Technologically:
 - Is the ALICE bent sensor our new baseline? How does an endcap in this technology look like?
 - Timing:
 - Where do we implement timing
 - Which level of timing do we go for
 - Cooling

ILD subdetectors: tracking



- TPC technologies:
 - Great progress on pixel TPC: should we make this the new baseline for ILD?
 - Choice of gas:
 - Physical properties
 - Environmental properties
- TPC at Tera-Z:
 - Backgrounds look frightening
 - Distortions look frightening
 - Need a risk vs opportunities analysis
- Innovative TPC concepts:
 - Integrate Silicon into the TPC?
 - Are there ideas for optimal endcaps?
 - What is the ultimate material lower limit?
 - How can we fully leverage the PID potential
- Stability in particular for Z running

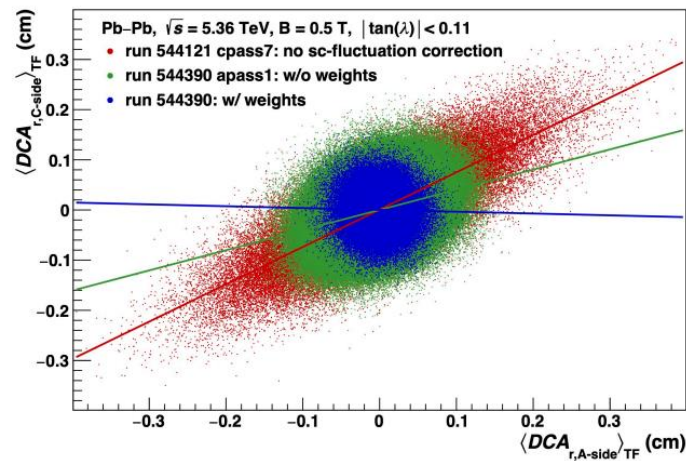
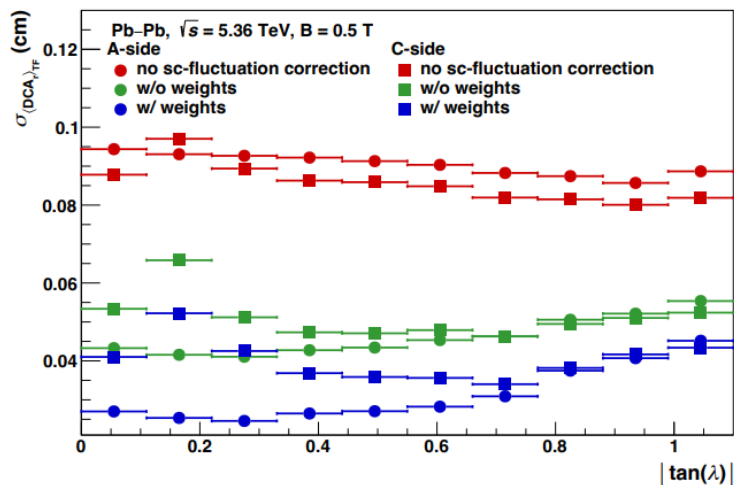
Make sure we remain realistic in assumptions in particular on material!

ILD calorimeter

- Particle Flow calorimeter (CALICE type calorimeter) remains our core priority
 - Evolution, not revolution
 - Profit a lot from the experiences which are being gained in the CMS upgrade
- We need to invest into reconstruction system
 - PANDORA is not properly supported
 - There is little in way of new algorithm development
- We have not looked at the Muon System for a long time

Calibration Concept

- In general we have not made progress in this area over the past few years
- Calibration at FCC-ee for $E > 91$ GeV will be similar to ILC
- Calibration at FCC-ee (91 GeV) will be a real challenge
 - Need to understand the limits
 - The combination of high backgrounds with extreme stability requirements is highly non-trivial



Triggering

- ILD currently is untriggered
 - Stream data from the detector
 - Need large bandwidth
 - Need large computing power to process the stream
- Is a minimum triggering scheme thinkable
 - Problem with biases
 - But potentially more “environmentally friendly”?
- Does out scheme scale to the Z-running
 - At ILC: probably yes
 - At FCC-ee: I am not so sure



Analyses in ILD



- ILD has been very visible globally (see talk by Filip this morning)
 - Snowmass study
 - ECFA study
- The ECFA focus topics define a solid basis for studies: <https://arxiv.org/abs/2401.07564>
- The extend of realization is mostly resource driven, less strategy driven
- Understanding the Z: should we make a stronger case with polarization and Giga Z?

The importance of such studies as ways to develop new methods should not be underestimated

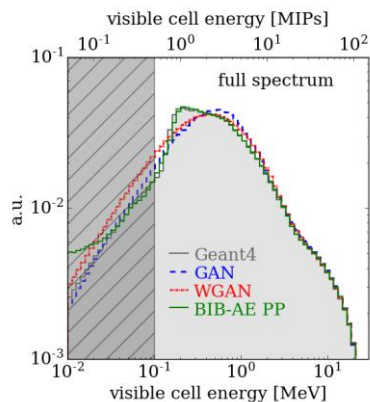
ILD and Software



ILD has done a lot on the software and reconstruction side:

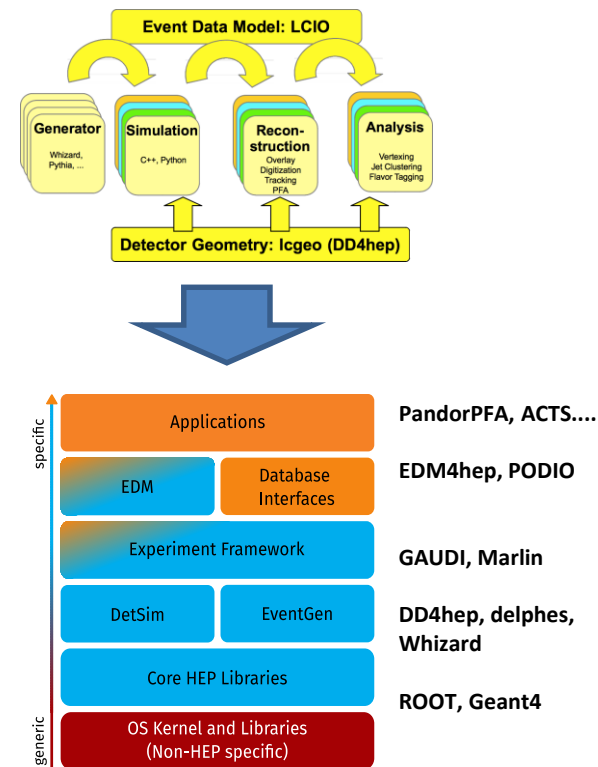
- We are a central player in pushing community wide software solutions in particular with **iLCSoft** (LCIO, DD4hep, etc) developed over 15 years
- We are deeply engaged already with communities (linear, circular, FCC-hh) to modernize our software stack: **key4hep** (DD4hep, EDM4hep,...)

There is enormous progress out there in the community on computing, computing models, computing implementations, analysis methods and tools:



- parallelisation, multi-threading
- GPU based computing
- Machine Learning and AI
- Quantum computing

F. Gaede, E.Eren et al.:
Use of GAN's to simulate
photon showers in the ILD
Calorimeter (2005.05334)



ILD and Software



- ILD has always been strong on software – though always with a small team
- ILD always has followed a larger vision with the software, not just a “it needs to work” approach
- We should work hard to ensure that we can continue to do so
 - Integration into other efforts to “sell” these activities to funding agencies
 - Strengthen the person-power basis
- Discussion:
 - What data samples should be produced
 - Which models should be used
 - What fits with our scarce resources

Fast vs Full

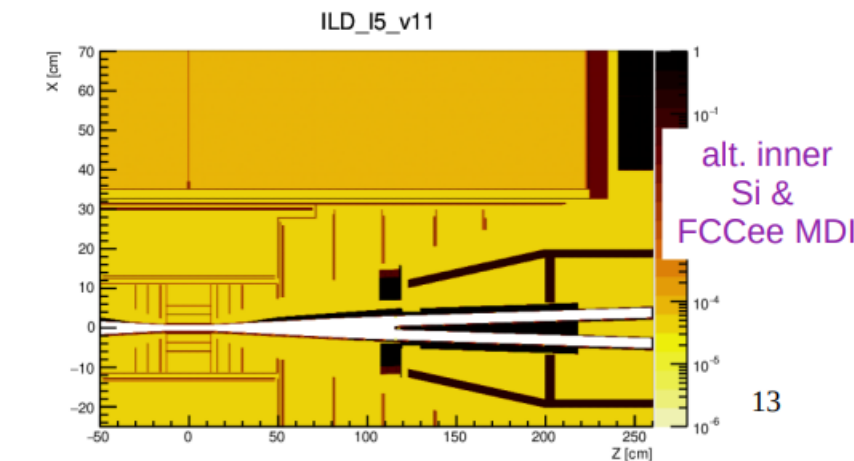


- Our full simulation remains the “work” horse
 - We need to converge on a FCC-ee layout
 - We need to ensure that the simulation stays in step with potential detector upgrade
- Fast simulation
 - For ILD@AC (any collider) we should define SGV as the tool to use for fast simulation
- Generator
 - Lets not forget generators: with Mikael we have a dedicated expert, but we need a backup and strengthening of the effort also in the long term perspective

Machine Detector Interface



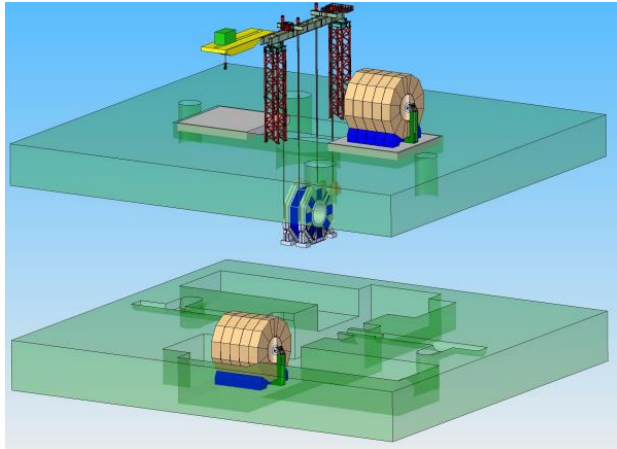
- The MDI for FCC-ee / CEPC is very different
- We need to iterate on a proper design of this region



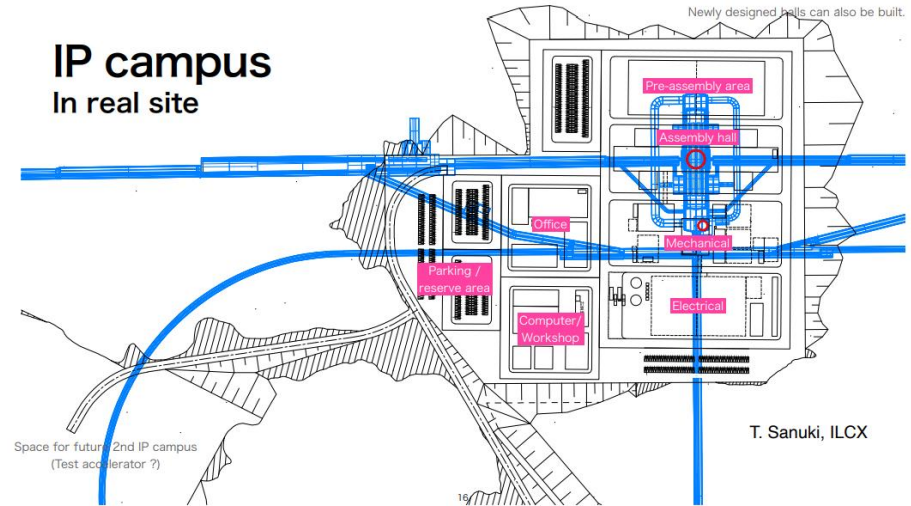
- RE-appearance of the “mask”
- Very different mechanical situation
- Impact on background
- Impact on layout of forward detectors

ILD Integration

- For ILC, a detailed integration concept exists
- Design of the interaction between ILD and experimental hall is well advanced
- This will be different at other colliders: potential impact on the design of the detector



From Karsten Buesser
Report from the
MDI workshop Sept. 23











The ILD concept

General remarks

- Very good and productive meeting
 - About 40 people here on-site
 - Up to 30 people connected remotely at different times.
- As usual too little time for in-depth discussions
 - A lot of interest in developments of subdetector technologies
 - A lot of interest in questions of integration and system development
- A 2 day meeting is not enough to really make progress
 - We need discussions in the subdetector groups/ among experts to make progress
 - We need to follow this discussion up regularly in ILD