PDAP

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What is PDAP?

- The Physics & Detectors Advisory Panel (PDAP) reports to the Associate Director (AD) and advises the AD in executing his or her mandate. The chair of the PDAP is appointed by the AD, and the PDAP members are selected by the AD and the chair. The PDAP monitors the physics and detector activities of the ILC and its synergies with CLIC. It makes recommendations such that appropriate progresses are made toward realization of linear collider detectors and collaborations. Typically, the PDAP meetings will be held associated with the international and regional linear collider workshops. Additional meetings may be held when necessary.

  (2015 July H. Yamamoto, LCC AD of Physcs and Detector)

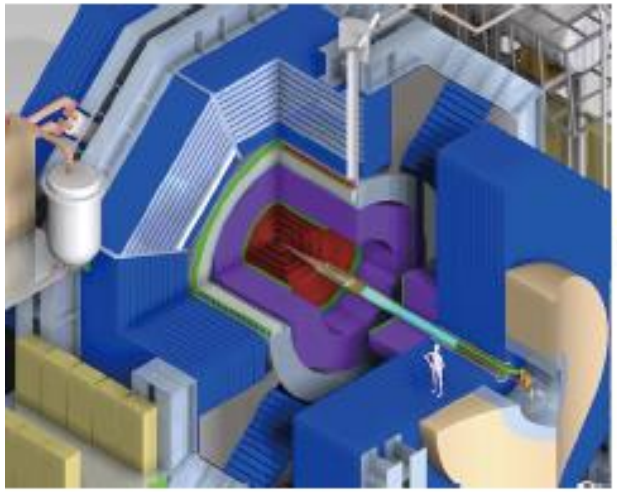
- Paul Grannis (Stony Brook), Sandro Palestini (CERN), JH (KEK)

- The reviews offered an opportunity to take a snapshot of the current status and to look toward future activities when a decision to proceed with linear collider construction is made. Both collaborations agreed that the current '**light reviews**' are appropriate and look forward to more in-depth reviews once the ILC has formal backing.

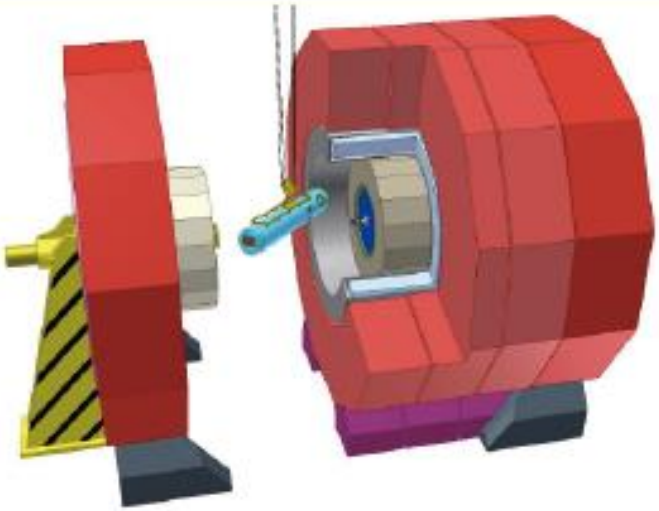
PDAP in LCWS2016 at Morioka

- The PDAP met during the Linear Collider Workshop in Morioka on Dec. 7, 2016.
- Presentations were made by Andy White for SiD, Ties Behnke for ILD and Jan Strube for the R&D liaisons.

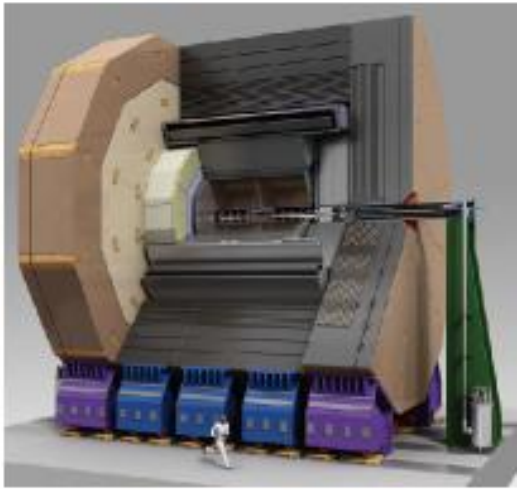
Detector concepts



SiD



CLIC

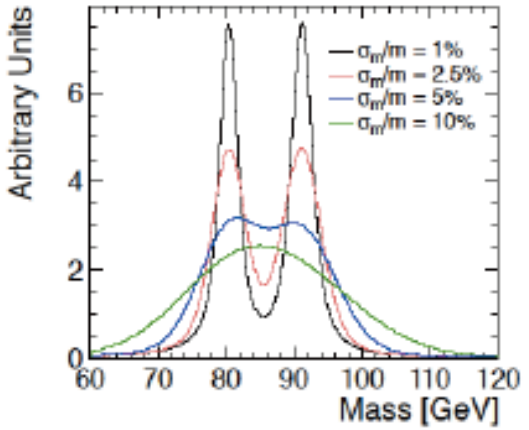


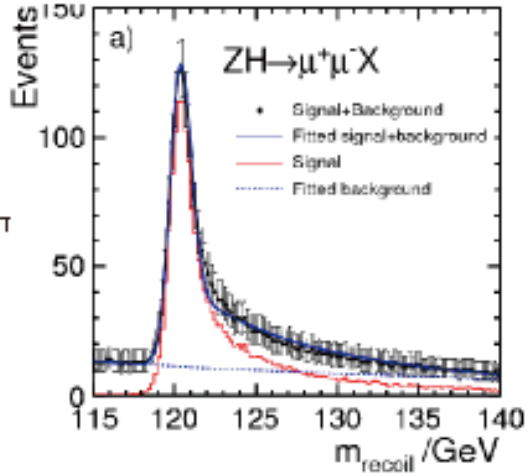
ILD

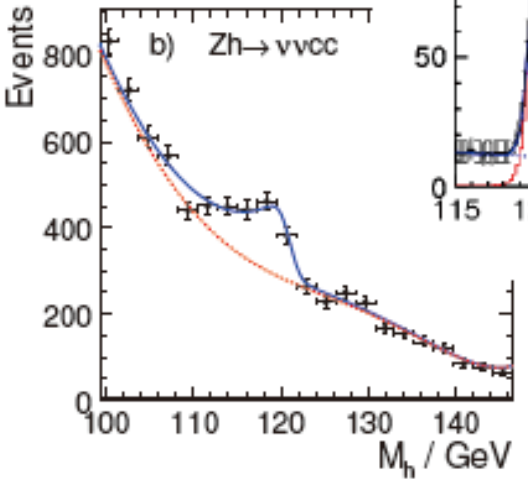
- All present detector concepts driven by particle flow idea
- Similar overall dimensions, 3-5 T solenoidal magnet
- Most sub-detector technologies are considered by all concepts
  - Choices are made for simulation and engineering studies
  - However all remain open for alternatives
  - Strong opinions but no hard constraints (except from machine) from concept on technology
  - Real choices easier when new opportunities open up

Detector requirements for LC physics

- Physics with Higgs and top: need to identify H, t and their heavy daughters, W and Z, by invariant di-jet mass
  - need 3-5% jet energy resolution
  - particle flow **calorimeters**: granularity *and* resolution
- Higgs recoil mass for model-independent ZH cross section, g_Z, decay spectra endpoints
  - need $1/p_T$ resolution $2 \cdot 10^{-5}$
  - **tracker** material 0.1-0.2 X_0
- Charm **vertex** tagging in the presence of overwhelming b background
  - impact parameter resolution $5 \oplus 15/p(\text{GeV})$ μm resolution
- Hermetic angular coverage
  - tag very **forward** electrons

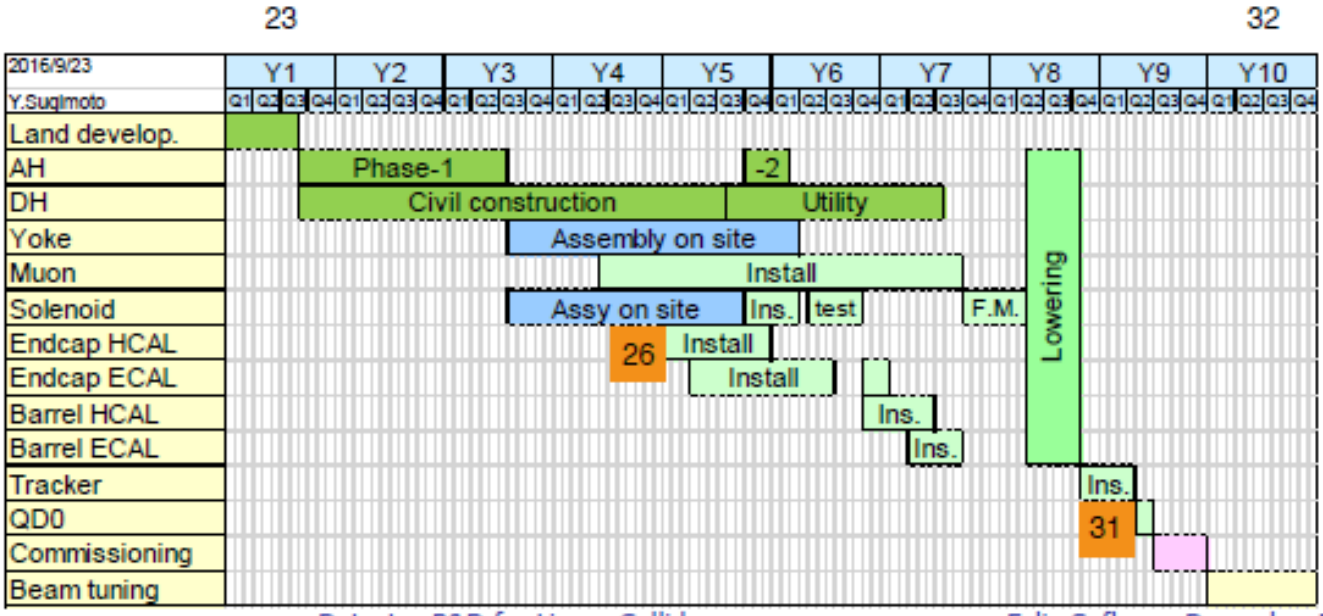






Timelines

- It is challenging to create a coherent R&D effort when time scales are uncertain
- Technologies with different readiness levels are being pursued in parallel
- Diversity will be reduced once timelines etc are known
- Still some general relationships result from detector assembly, see e.g. ILD



Calorimeters need to be ready 5 years before tracker - and probably 7 years before vertex. Construction time beforehand is also longer.

SiD

- Despite minimal funding, the SiD consortium has conducted a number of projects in the past year, and seems to be in a healthy state.

- The PDAP urges the SiD group to prioritize them so as to focus available resources in such a way as to make real progress on at least one of them. This prioritization should take into account the urgency of providing those basic proof-of-principle demonstrations that are needed soon. We agree with the indicated priority for use of US Japan funds for ECAL studies, should they become available.

ILD

- Despite the uncertainties on ILC approval and funding limitations, ILD has made clear progress over the past year. The PDAP applauds ILD for good progress under difficult circumstances. In this year the group has developed a new, more elaborated organization.

- The group continues to carry several options for many subdetectors..... Retaining multiple options does however give added complexity in software, performance and integration studies.

ILD cont.

- We note that embarking on the interface specification documents at this time may be somewhat risky since many technology choices remain to be made and interfaces may depend on these choices, as well as upon changes in the MDI and IR hall designs. Moreover, the interface specification will require scarce engineering resources and thus converging may take a long time.
- ILD noted that manpower for the central silicon strip detectors is not identified. The PDAP has not fully appreciated the rationale for the various silicon strip subdetectors and believes that a review of the definition of their roles and specifications would be useful in this interim period before ILC project decisions.

Common

- Collaboration on other common subsystems such as the forward calorimeters, backgrounds and shielding designs, MDI should continue to be encouraged.

- Concerns were expressed that computing resources for future campaigns of MC simulations of performance could be scarce as the load of LHC, Belle-II and CLIC analyses grow.

R&D

- The document detailing the R&D goals and achievements has not yet been released and the PDAP strongly urges that this occurs very soon.

How is it now?

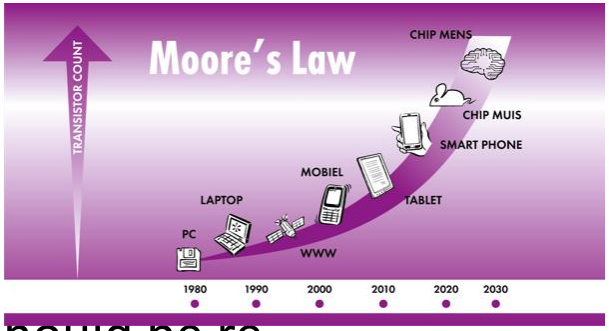
- The plan to have reviews conducted by the ECFA R&D panel, augmented by appropriate experts for a particular review, has been adopted. Such reviews would occur only if requested by the LCC Associate Director for Physics and Detectors. The PDAP believes that this is a good plan for the interim period before a formal ILC project begins.

Final note

- The PDAP review of the detector concepts has been much lighter than the in-depth reviews that are typical for real detector programs. While it may be that this light review process has some value, we suggest that, at this time of transition in the LCC physics and detector leadership, that the need and form of such a review be re-examined.

Appendix: Personal (non official) thoughts

- Frontiers of technologies are advancing day by day. Some of the advanced technologies considered yesterday may be outdated….
  - Moore's low in μ–electronics, SOI, pixel, 3D…
  - Rapid progress in photosensors,
  - Very fast devices,
  - New scintillators,
  - Wider variation of MPGD

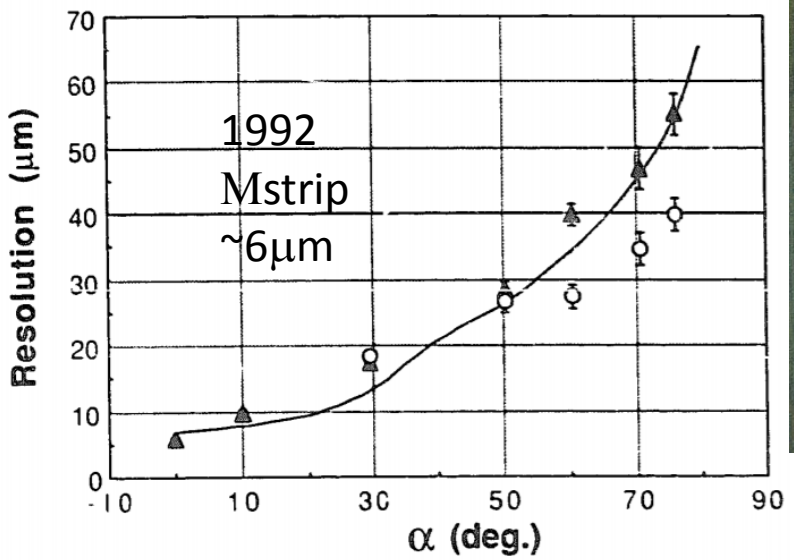


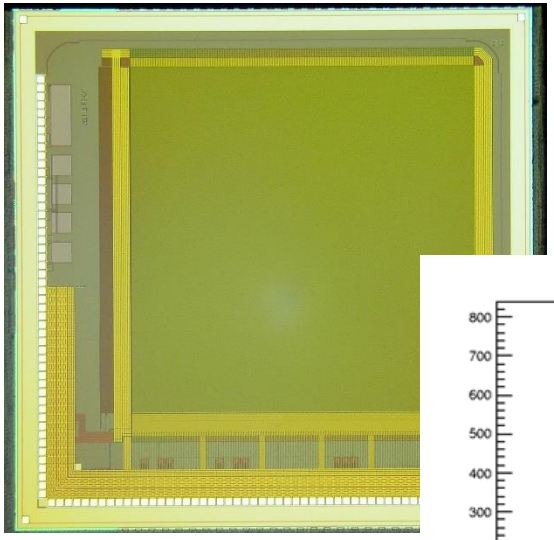
- Concepts and specifications for the LC detector should be re-examined time to time under updated global technology achievements.
- The specifications should not be independent of others.

Slide presented in the PDAP review.

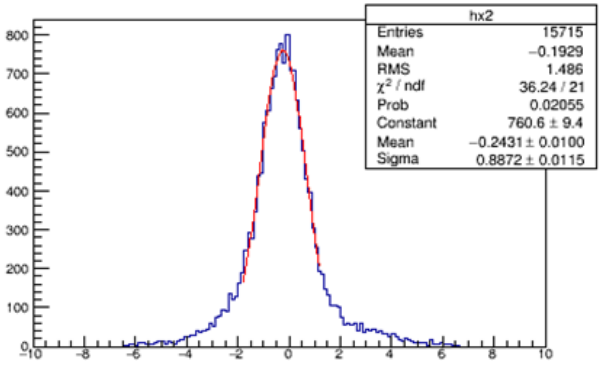
Challenges

- Extreme material budget requirements
  - tracker: ~1% X_0 per layer
  - vertex: 0.1-0.2% X_0 per layer
    - <200 µm of Si, including cables, cooling & supports
- Demanding point resolution
  - 7 µm for tracker, 3 µm for vtx, <25 µm pixel size





2017 SOIpix
0.7 µm

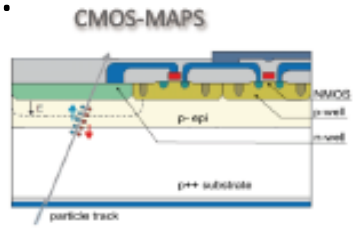


The specifications should not be independent of others.

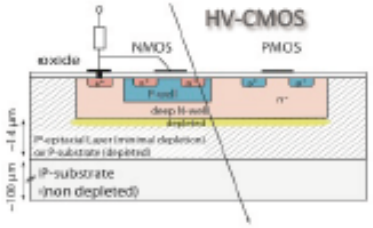
Example: Vertex detector with thinner and higher precision.

Vertex detector general conditions:

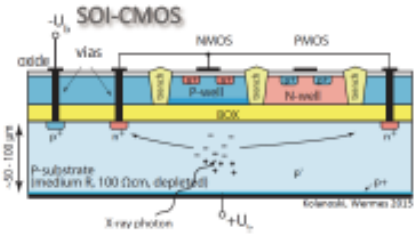
- $\sigma = p\ /(\frac{S}{N})$
- $S \propto thickness$
- $N \propto C \propto p^2/thickness$



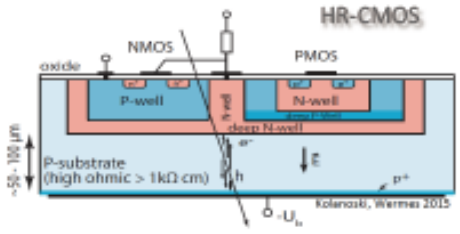
- Charge collection by diffusion



- HV process, 10 – 15 μm depletion region under deep N-well



- Fully depleted or HV process



- Can be fully depleted

- You may have very high precision vertex with slight compromise in thickness.
- Or you may have larger *p* for same σ with higher functions like time stamp capability for BX id.