# Status and Plans of the ILD detector concept

Ties Behnke, December 18, 2020



## ILD: a multi purpose detector for the ILC

- Excellent vertexing very close to the IP
- Hybrid tracking system optimized for excellent resolution at high energies and ultimate efficiency over a broad momentum range
- Particle flow as the key design driver
- Up to HCAL all inside solenoidal coil of 3-4 T













#### Material Budget in ILD



### International Linear Collider





**Polarized beams:**  $P(e^{-}) = 80\%$ ;  $P(e^{+}) = 30\%$  (nominal)

Beam Tunnel (BDS)





 $\rightarrow$  Suggests "power pulsing" (5-10 Hz) of subdetectors with a duty cycle of ~a few %



Typical reduction factor: between 2 and 20

Implementation demonstrated for calorimeter systems and VTX, under study for TPC

#### This has major implications for the readout and DAQ design

- Trigger-less readout of the detector
- Minimizes cooling needs and associated material budget

When this was proposed for ILD, it was an absolut novum. Today LHC-B and ALICE are implementing this in a real detector.

### The current state of the arts in ILD



## The work of ILD over the last years has been documented in the IDR and published this year.

#### **INTERIM DESIGN REPORT 2020**

The International Large Detector ILD Concept Group



https://arxiv.org/abs/2003.01116

#### Subdetector Status

The main component of ILD have been validated and beam-tested

VTX (Belle II)



TPC

Enormous effort went into the the design, the test and the performance validation of the sub-systems.

## SDF

SDHCAL





Si-ECAL









#### Critical areas in ILD





#### Software and Reconstruction

Enormous work by the software group over the past few years to transform the ILD software system

- Transition to DD4HEP and new central simulation framework
- Extension of capabilities towards multi-threading
- Constant modernization
- Move towards more and more common and shared software blocks
  - PODIO
  - DD4HEP
  - Key4HEP
  - ...

- In particular the snowmass effort triggered a large "community" effort
  - New DST definition
  - Interface to new tools like DELPHES
  - Ease the access to data and tools
  - Extensive tutorials for the community

The software work in ILD is central to ILD, and also a high priority part of the FTX work at DESY





Continued strong effort on analysis in the ILD context;

- Nearly all analyses done in full simulation
- Carefull scrutiny of results, process to review papers within ILD is functioning well
- Significant number of publications in the last year to follow up on the IDR



Simlulated H→mumu signal in ILD



arxiv:2009.04340

Dependence of the error on the momentum resolution <sup>12</sup>

#### List of recent papers



	authors	title		
ILD-PHYS-2020- 003	M. Berggren, S. Caiazza, M. Chera, J. List	Kinematic Edge Detection Using Finite Impulse Response Filters	to be submitted to NIM A	
ILD-PHYS-2020- 002	S. Kawada, M. Berggren, J. List	Prospects of measuring the branching fraction of the Higgs boson decaying into muon pairs at the International Linear Collider	accepted by Eur. Phys. J. C	arxiv:2009.04340
IDR	The ILD concept group	International Large Detector: Interim Design Report	DESY 20-034, KEK 2019-57	arxiv:2003.01116
ILD-PHYS-2020- 001	M. Habermehl, M. Berggren, J. List	WIMP Dark Matter at the International Linear Collider	Phys. Rev. D101 (2020) no.7, 075053	arxiv:2001.03011
Input to EPPSU2020	The ILD concept group	The ILD detector at the ILC	DESY 19-215	arxiv:1912.04601
ILD-PHYS-2019- 001	H. Baer, M. Berggren, K. Fujii, J. List, S. Lehtinen, T. Tanabe, J. Yan	The ILC as a natural SUSY discovery machine and precision microscope: from light higgsinos to tests of unification	Phys. Rev. D 101 (2020) 9, 095026	arXiv:1912.06643

### ILD and the IDT: the environment





#### A possible time line





• T+5 years Submission of TDR's

Based on a proposal by IDT1 and Frank Simon

#### Impact on ILD I



Develop a clear plan on needed R&D for ILD

- What promising direction of R&D do we see to further improve ILD
  - Timing
  - Forward
  - ...
- Technology scouting: what new technologies do we see emerging which we can use to
  - Either make ILD better
  - Or make ILD cheaper

ILD is very well positioned:

- Application of our technologies: CMS Calo upgrade, Belle VTX, T2K TPC, ALICE TPC
- We have committed to concrete implementations where needed, we are open where sensible
  - Example calorimeter vs. Silicon tracking
  - We have from very early on included overall integration and coherence in our discussions and work.

#### Impact on ILD II

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

- We are currently driving the field here within the e+e ILC community
- We are reaching out to other communities (linear, circular, FCC-HH)

There is enormous progress out there on computing, computing models, computing implementations, analysis methods and tools.

- Multi-threading
- GPU based computing
- Quantum computing
- Al use in reconstruction and analysis...

We need to position ILD in this rapidly developing area. We can expect to see a heavy influx of new people into this area in the future We will need to understand the role DESY can play in this.

#### Summary

ILD has been functioning well over the last years.

The structures we have defined work well.

We are currently in the process to renew the ILD management

We have achieved a major milestone with the publication of the IDR

We are in the process of defining a future program for ILD

We are striving for a continued strong contribution by DESY and by FTX to ILD.

#### ILD meeting at KEK, 2019





