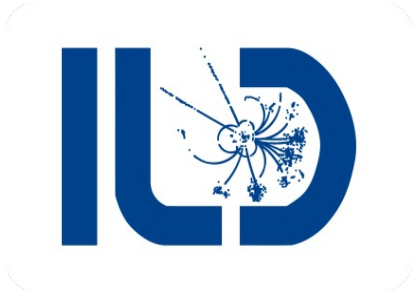


ILD Status and Plans

ILD workshop during LCWS2023@SLAC+online

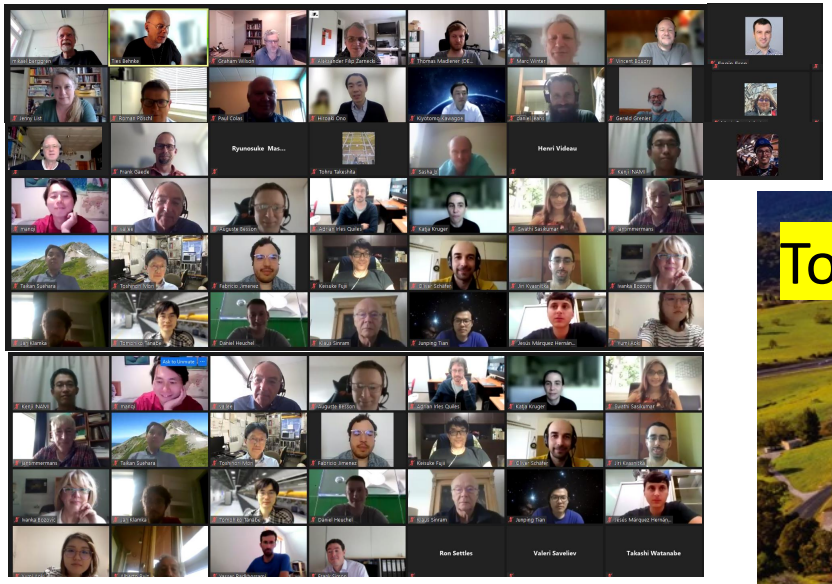
May 17, 2023

K. Kawagoe

Recent ILD workshops

ILD workshop at KEK, 2019

ILD workshop at DESY, 2022



ILD workshop online, 2021

Today: ILD workshop at SLAC+online, 2023

The ILD concept group

- The mission of the ILD concept group is the definition and development of a detector concept for high energy electron positron collisions with particle-flow capabilities with optimal particle identification, for energies between 90 GeV and approx. 1 TeV.
- ILD collects experts from around the world on electron positron physics, precision detectors and detector integration
- Close collaboration with detector R&D groups (CALICE, LCTPC, FCAL, etc)

The ILD concept group was formed in 2007 and has grown to some 59 institutes from around the world. (The membership of 5 Russian institutions has been suspended since 2022.)

Response of ILD to the Ukrainian invasion

Dear ILD member
(Feb 26, 2022)

All of us have followed the dramatic events in the Ukraine over the last few days. We are shocked by the events and the totally unnecessary and unprovoked war. Our thoughts are with all the people who suffer from this war.

In ILD we work together peacefully with people from many different countries. The impact these events will have on science and on our international model of doing science together can only be imagined at this moment.

The ILD ET
Ties Behnke/ Karsten Buesser/ Jean Claude Brient/ Keisuke Fujii/ Mary-Cruz Fouz/ Frank Gaede/ Daniel Jeans/ Kiyotomo Kawagoe/ Jenny List/ Wataro Ootani/ Graham Wilson/ Filip Zarnecki

ILD suspended membership of Russian institutions and halted all collaboration with official Russian places.
ILD maintains contact to Russian scientists through individual agreements, and continues to cooperate at the personal level.

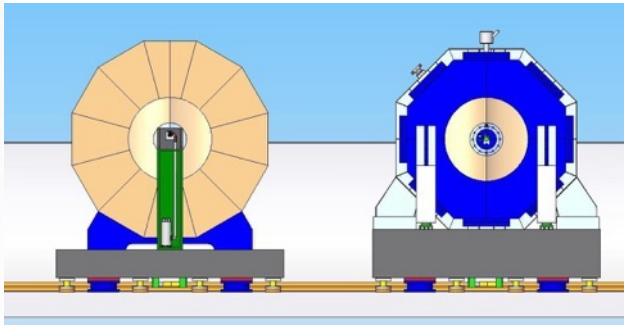
The new Executive Team

- For the next mandate of two years
- Spokesperson: Ties Behnke
  - Deputy spokesperson: Kiyotomo Kawagoe
  - Physics coordinator: Filip Zarnecki (deputy Taikan Suehara)
  - Technical coordinator: Mary-Cruz Fouz (deputy Karsten Buesser)
  - Software coordinator: Frank Gaede (deputy Daniel Jeans)
- 4 elected members
  - Election ongoing, to be finalized next week

The International Large Detector

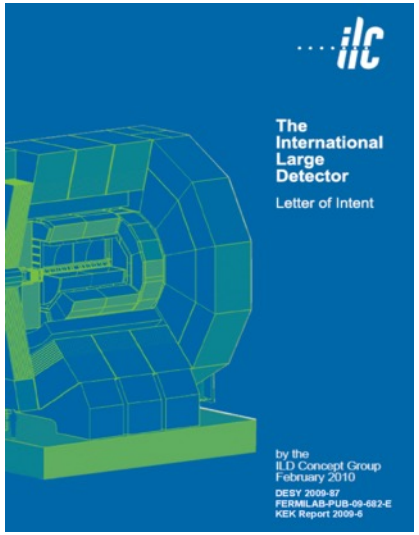
Originally designed as a detector at the ILC

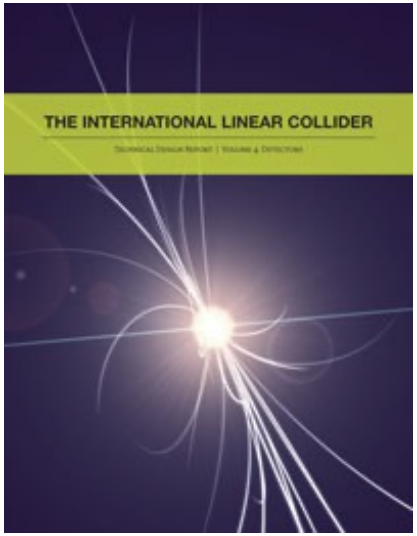
- High granularity calorimeters
- High efficiency tracking
- Excellent vertexing
- Good particle identification
- Hermeticity
- No hardware trigger

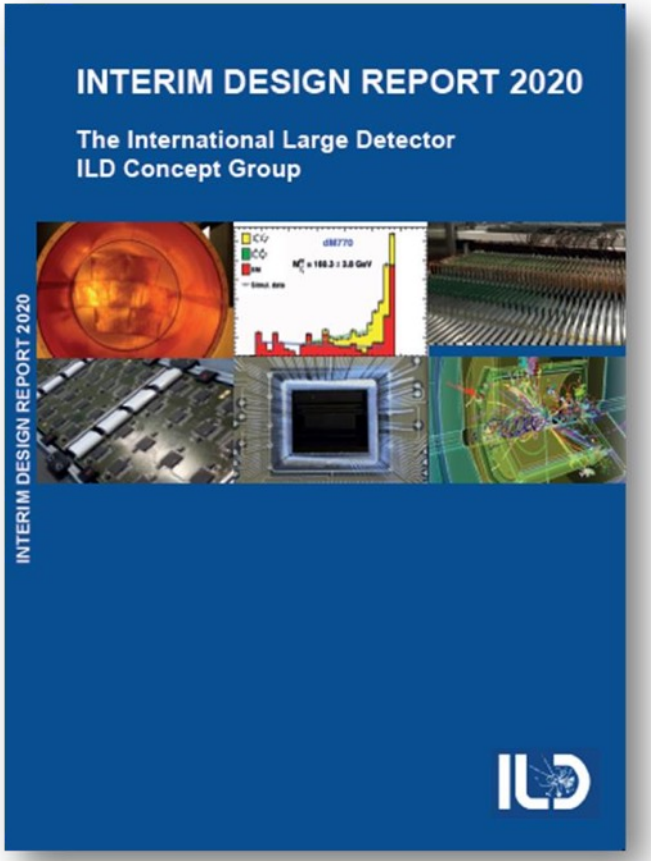


Ready for push-pull concept at a linear collider

Development of the ILD concept







- 2010: Letter of Intent: arXiv:1006.3396
  - Validated by the International Detector Advisory Panel (IDAG) of the ILC, together with SiD
- 2013: Detailed Baseline Design (ILC TDR volume 4): arXiv:1306.6329
- 2020: Interim Design Report: axXiv:2003.01116

- We have defined the overall detector concept
- Detector technologies of subdetectors are still to be chosen

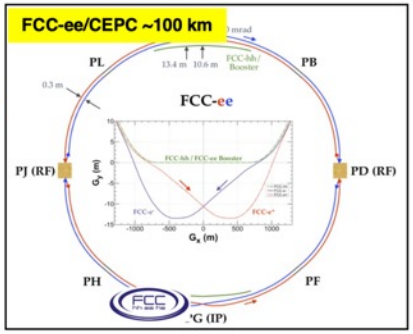
We are open to new ideas / new technologies !!

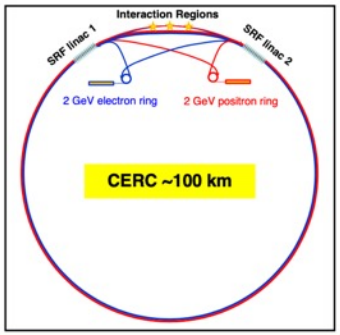
The future electron-positron Higgs Factory

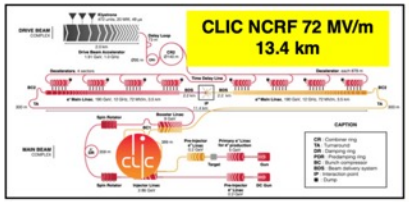
The ILC is technically the most advanced electron-positron Higgs factory. But it is not the only possibility. A variety of linear and circular machines are being studied.

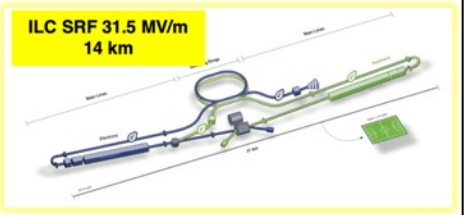
Higgs factory concepts (10)

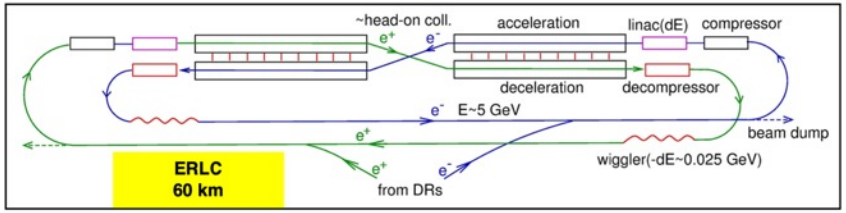
Name	CM energy range
FCC-ee	e+e-, $\sqrt{s}$ = 0.09 – 0.37 TeV
CEPC	e+e-, $\sqrt{s}$ = 0.09 – 0.37 TeV
ILC (Higgs factory)	e+e-, $\sqrt{s}$ = 0.09 – 1 TeV
CLIC (Higgs factory)	e+e-, $\sqrt{s}$ = 0.09 – 1 TeV
CCC (Cool Copper Collider)	e+e-, $\sqrt{s}$ = 0.25 – 0.55 TeV
CERC (Circular ERL collider)	e+e-, $\sqrt{s}$ = 0.09 – 0.60 TeV
ReLiC (Recycling Linear Collider)	e+e-, $\sqrt{s}$ = 0.25 – 1 TeV
ERLC (ERL Linear Collider)	e+e-, $\sqrt{s}$ = 0.25 – 0.50 TeV
XCC (FEL-based $\gamma\gamma$ collider)	ee ($\gamma\gamma$), $\sqrt{s}$ = 0.125 – 0.14 TeV
MC (Higgs factory)	$\mu^+\mu^-$, $\sqrt{s}$ = 0.13 TeV

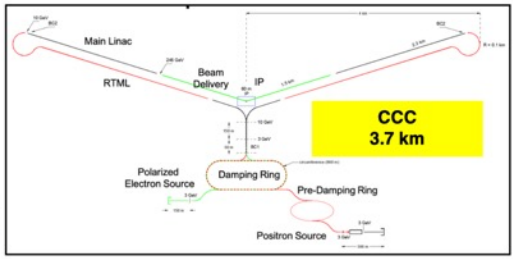


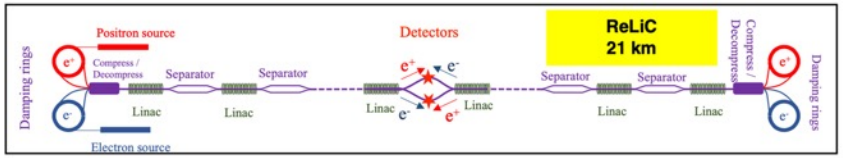












Brookhaven National Laboratory

Taken from Snowmass: Implementation Task Force Report

ILD at a Higgs/ Top/ EW factory

ILD has been developed for the ILC, and has been tuned to the particular beam conditions at the ILC. FCC-ee has very different beam parameters, which will impact the way the experiment is operated. ILD is ready to engage with these studies, and to make the case for an ILD-like detector at FCC-ee in particular. Whether or not this will eventually lead to a proposal to FCC-ee for a concrete detector concept should be decided after a period of study and based on the findings of the study. Such a concrete proposal would imply a more formal collaboration than those ILD has previously had with CLIC and CEPC. Depending on circumstances, it may become of interest to initiate similar collaborations with other collider projects.

Whenever possible ILD will look for and try to utilize cooperation with other groups at the other proposed Higgs factories. Whether or not ILD should also formally join forces with any of the discussed concepts should be decided at a later time, based on the results of the study focussed on the development of the ILD concept as laid out in the appendix to this document.

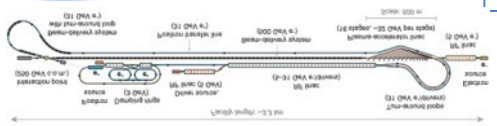
T. Behnke, ILD workshop in Hamburg, 4.10.2022

ILD strategy 2022+

ILD is ready to engage with all Higgs factory studies, and to make the case for an ILD-like detector.
We intend to study the capabilities of ILD at different collider options:

- Impact of pulse structure on ILD (e.g. powering scheme)
- Usage of TPC like detector
- Impact on the forward region
- Impact on no-Trigger scheme
- and others

+ others



https://confluence.desy.de/download/attachments/280866678/ILD_%20Proposal%20for%20an%20ILD%20strategy%202022.pdf?version=1&modificationDate=1666787882265&api=v2

The ILD strategy 2022

ILD strategy 2022

Version 5 27.9.2022 approved by the ILD IA

1. Introduction

The ILD experiment has been conceived as an experiment at the proposed ILC. The detector concept has been developed for a science program which spans collision energies from 90 GeV to approximately 1 TeV [1].

ILD as a concept has been developed with a strong focus on particle flow as the central guiding paradigm for event reconstruction, and has been optimized to operate at the full energy span, at center of mass energies up to 1 TeV. With the strong requirement particle flow puts on the reconstruction of individual particles, the detector has been optimized in this direction. This implies an overall excellent granularity of the detector systems, and it implies a system optimized to extract as much information as possible on individual particles. A special emphasis has been put on ensuring a very hermetic detector, down to very small angles relative to the beam line. A special feature of ILD is the use of a large volume time projection chamber as a key component of the central tracker, which allows not only an excellent reconstruction of tracks, but also contributes to a good particle identification by providing ionization information. ILD at the ILC can operate and has been designed to run without a trigger, allowing optimal sensitivity for in particular unexpected signals. The ILD design has been used as a basis of several detector proposals at other colliders.

In recent years, the international community has embraced the concept of a Higgs factory as the most important future direction of the field. This has been clearly formulated in the 2020 European Particle Physics (European Strategy Group) Strategy Update, which has been taken note of by CERN Council in 2020 [2]. Strategy processes in the Americas [3] and in China are still ongoing at the time of writing this document.

However, no final decision has been reached on a particular collider proposal, but rather a number of approaches are followed in parallel, including several linear and circular collider options, with the proposals being at different levels of maturity. In Europe in particular the CERN proposal for a large ring (FCC) which could host initially an electron positron collider, and then be upgraded later to a proton-proton facility, is receiving significant attention [3]. In China, the HEP community proposes the Circular Electron Positron Collider (CEPC), an electron positron Higgs/Z factory, and its tunnel can host a high-energy super proton-proton collider (SPPC) in the future.

The recent report by the MEXT expert panel on the realization of an ILC in Japan suggested that further international planning is required before a concrete decision to host the facility can be made [4]. ICFA has recently extended the mandate of the ILC International Development

1

An ILD work program

(Appendix of the strategy document)

1. The forward tracking region of ILD has a number of shortcomings. A dedicated optimization for this region, in particular of the acceptance of the vertex detector, should be done. This region will also be heavily affected by different environmental conditions at different collider projects, and might need dedicated solutions for each proposal.

2. Circular colliders will have a smaller inter-bunch timing difference than ILC, and also do not deliver bunch-trains, but rather continuous beams. This significantly changes the possibility to do power-pulsing for the front-end electronics of the ILD sub-detectors. The current design of the ILD sub-detectors depends crucially on their capability to manage the thermal load through power pulsing. Using the ILD sub-detectors at FCC will require a very detailed study of how the systems can perform without power pulsing, and the development of a concept of how the thermal management can work in this new situation, while minimising additional dead material in the system.

3. The close inter-bunch spacing and lack of inter-bunch train quiet periods puts additional challenges on the operation of a TPC in this environment. ILD should explore how an ILD-like TPC would perform in these different conditions, and where the limits are for the TPC. Since the TPC adds significant particle identification power in particular at lower center-of-mass energies, this study should focus on the lower range of energies at a Higgs/ EW/Top factory.

4. A focus of experimentation at circular colliders is a high-luminosity Z program. ILD should investigate how well the detector performs under these conditions, and identify components which might need replacement or modification.

5. Circular colliders will have a very different forward region, in order to control the machine backgrounds, and in order to provide the beam focusing. ILD should develop a concept for a forward region compatible with FCC-ee and study the impact this changed region will have on the detector performance.

6. A central challenge for a detector like ILD, optimized for precision physics, is the delivery of an excellent and stable calibration and alignment environment. These considerations need to be included from early on in the design. The different running conditions and beam conditions might impact the way the detector is to be calibrated and aligned, and need to be studied.

The ILD situation

- Regular online meetings
  - Monthly ILD meetings
  - Bi-weekly Software & Analysis meetings
- Three Working Groups (following talks)
  - Physics Working Group
  - Software Working Groups
  - Technical Working Group
- New ideas on physics & detectors are still emerging
  - Publication of topical papers
  - Presentations at conferences & workshops
    - Regular contributions to ICHEP, EPSHEP, Lepton-photon, and many others
    - 7 contributions to Snowmass 2021
    - 20 contributions to ECFA e^+e^- Higgs/EW/Top factories workshop (October 2022)
    - 17 contributions to LCWS2023 (May 2023)
- Newcomers are welcome !
  - Full membership (institutions)
  - Guest membership (institutions and individuals)
    - Access to ILD information and infrastructure
    - Physics studies with ILD framework
    - Contributions to the development of the ILD detector design and software tools
  - Please contact the spokespersons !!

ILD Collaborative Tools

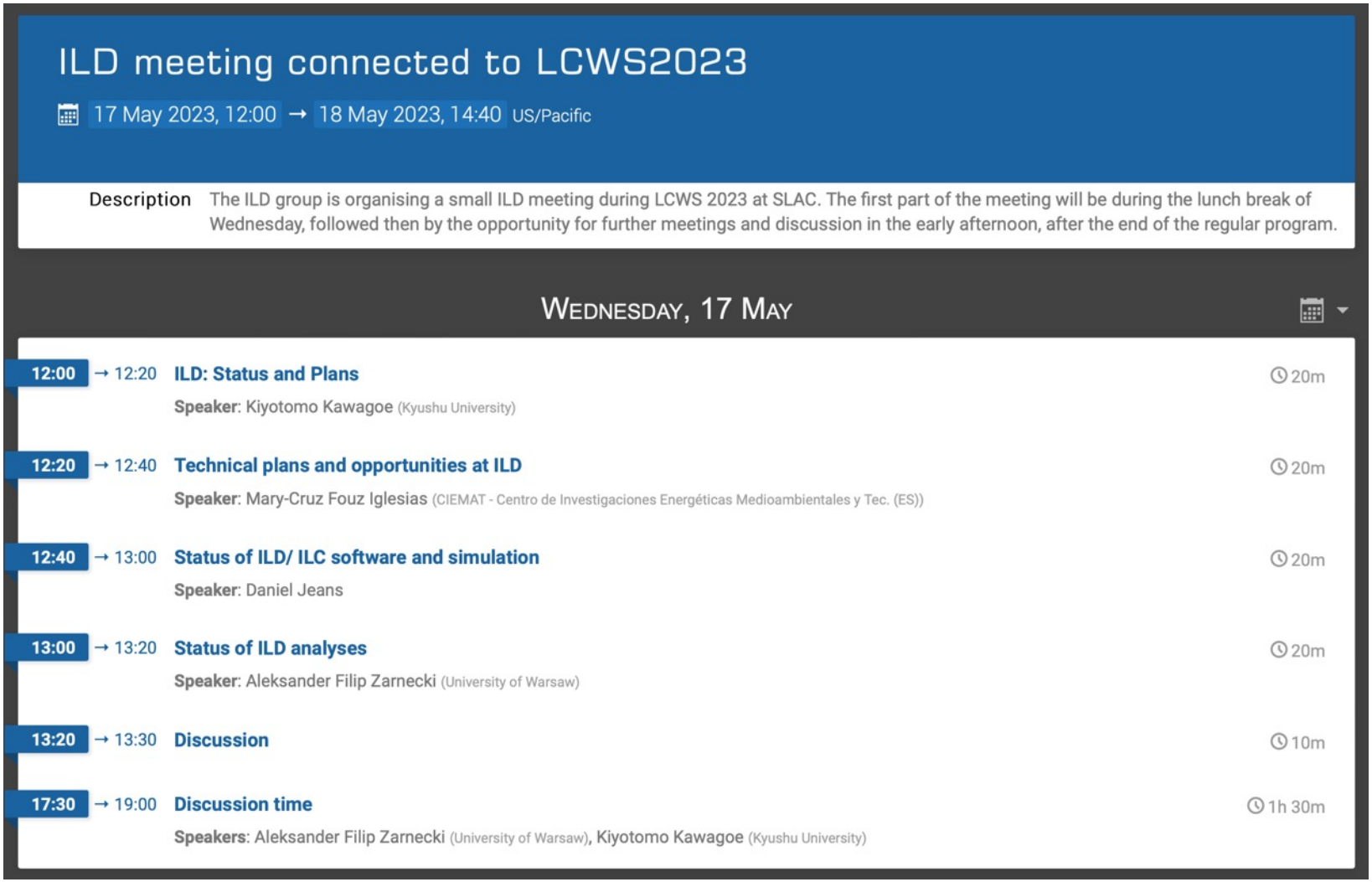
ILD Web page: http://www.ilcild.org

- Transition to new server has happened
- Content is still marginal
- Help is very welcome to fill the WEB page and to continue to improve the logic

ILD confluence page https://confluence.desy.de/display/ILD/ILD

- Overall useful system, intensely used by some groups
- Problem of access for the complete ILD group is still not solved

Today's agenda



ILD meeting connected to LCWS2023

17 May 2023, 12:00 → 18 May 2023, 14:40 US/Pacific

Description The ILD group is organising a small ILD meeting during LCWS 2023 at SLAC. The first part of the meeting will be during the lunch break of Wednesday, followed then by the opportunity for further meetings and discussion in the early afternoon, after the end of the regular program.

Wednesday, 17 May

12:00 → 12:20	**ILD: Status and Plans** **Speaker**: Kiyotomo Kawagoe (Kyushu University)	20m
12:20 → 12:40	**Technical plans and opportunities at ILD** **Speaker**: Mary-Cruz Fouz Iglesias (CIEMAT - Centro de Investigaciones Energéticas Medioambientales y Tec. (ES))	20m
12:40 → 13:00	**Status of ILD/ ILC software and simulation** **Speaker**: Daniel Jeans	20m
13:00 → 13:20	**Status of ILD analyses** **Speaker**: Aleksander Filip Zarnecki (University of Warsaw)	20m
13:20 → 13:30	**Discussion**	10m
17:30 → 19:00	**Discussion time** **Speakers**: Aleksander Filip Zarnecki (University of Warsaw), Kiyotomo Kawagoe (Kyushu University)	1h 30m

Open for non-ILD members