



CLICdp news

CLICdp Collaboration Meeting
1 October 2020

Aidan Robson

Start to see CERN response:

ECFA

European Committee for Future Accelerators



ECFA Newsletter 5 (August 2020)

Initial views on the European Strategy implementation

by Fabiola Gianotti (CERN Director-General)

The 2020 update of the European Strategy for Particle Physics (ESPP) provides a realistic and prudent approach to setting ambitious and visionary scientific objectives. It lays the foundations for a bright future for particle physics in Europe, within the global context of the field.

Implementation of the ESPP has started at CERN, and a few examples are listed below. The full exploitation of the LHC, including the high-luminosity upgrades, remains CERN's highest priority. Accelerator R&D studies are being reinforced, in particular in the domain of superconducting high-field magnets. The feasibility study for the FCC (Future Circular Collider), which should be completed by the next Strategy update, will focus on the tunnel (high-risk zones, environmental aspects, etc.) and on the main technologies for the e^+e^- and pp colliders. To maintain CLIC as an option for a future collider, as recommended by the ESPP, resources will be allocated to continue work on key accelerator technologies. An effort on muon colliders is starting with the goal of addressing the main challenges (neutrino background, muon source and cooling, accelerator and collider rings, etc.) and of developing the design of a demonstrator by the next ESPP update. Physics Beyond Colliders activities will be strengthened. Work at the Neutrino Platform continues, in support of the European community involved in long-baseline projects in the US and Japan. A Quantum Technology Initiative has been launched at CERN, in collaboration with similar efforts in CERN's Member States and beyond, to develop innovative computing technologies for future projects.

<https://cds.cern.ch/record/2729018>

The ESPP is the result of two years of intense and successful efforts by our community to prepare and discuss high-quality scientific and other input. Similarly, its implementation will require the work, dedication and enthusiasm of the full community.

The CLIC Accelerator is developing a plan for 2021–25 to maintain CLIC as an option for a Higgs/top machine

- ◆ Concentrating on key technologies
 - high gradient (X-boxes programme)
 - nanobeam (focus on beam-delivery)
 - drive-beam (high-efficiency klystrons)
- ◆ Operating CLEAR
- ◆ Emphasising collaborations and making sure that CLIC technologies are exploited externally (medical/industrial)

→ more from Steinar tomorrow

Could be desirable for CERN to act centrally to facilitate 'Higgs Factory' R&D in a general way (also muon collider?)

- building on synergies among projects, retaining critical mass

In a similar direction, ECFA proposes a "Physics, Experiments & Detectors @ Higgs Factories" (PED@HF) series – see Jorgen's talk

→ discussion in the Institute Board



Snowmass21



Lols submitted:

- on the accelerator:

https://www.snowmass21.org/docs/files/summaries/AF/SNOWMASS21-AF4_AF3-EF0_EF0-177.pdf

- the physics potential:

https://www.snowmass21.org/docs/files/summaries/EF/SNOWMASS21-EF0_EF0_CLICphysics-170.pdf

- and the detector:

https://www.snowmass21.org/docs/files/summaries/IF/SNOWMASS21-IF3_IF6_Mathieu_Benoit-188.pdf



31/8/2020

The Compact Linear Collider (CLIC) Snowmass 2021 LoI: Physics Potential

Contact person: A. Robson^{1)*}

, R. Franceschini^{†‡}, L. Linssen[§], P. Roloff[§], U. Schnoor[§], A. Wulzer^{§¶}, A.F. Zarnecki^{||}

On behalf of the CLIC and CLICdp Collaborations

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Abstract

By providing e^+e^- collisions over the broad energy range 380 GeV to 3 TeV, the Compact Linear Collider (CLIC) provides excellent sensitivity to Beyond Standard Model physics, through direct searches and via a broad set of precision measurements of Standard Model processes, particularly in the Higgs and top-quark sectors. We strongly encourage the full consideration of multi-TeV lepton collisions as part of the Snowmass 2021 process.

Energy Frontier Topical Groups:

- (EF01) EW Physics: Higgs Boson properties and couplings
- (EF02) EW Physics: Higgs Boson as a portal to new physics
- (EF03) EW Physics: Heavy flavor and top quark physics
- (EF04) EW Physics: EW Precision Physics and constraining new physics
- (EF05) QCD and strong interactions: Precision QCD
- (EF06) QCD and strong interactions: Hadronic structure and forward QCD
- (EF07) QCD and strong interactions: Heavy Ions
- (EF08) BSM: Model-specific explorations
- (EF09) BSM: More general explorations
- (EF10) BSM: Dark Matter at colliders

Detector optimisation and detector technology R&D for the CLIC detector and for the CLD detector of FCC-ee



Snowmass21 Letter of Interest

Mathieu Benoit^{1a}, Dominik Dannheim^b, Philipp Roloff^b, Andre Sailer^b
^a Brookhaven National Laboratory, USA, ^b CERN, Geneva, Switzerland

on behalf of the CLICdp collaboration and of the CLD detector study

Introduction:

The recent update of the European Strategy for Particle Physics allocates its highest priority to a future electron-positron Higgs factory. This conclusion is motivated by a number of physics arguments, such as precision Higgs physics, top-quark physics, electroweak observables and a broad scope for other precision measurements. Four high-energy electron-positron colliders have been proposed for construction. Linear colliders offer the advantage of reaching very high energies, up to 1 TeV for the ILC and up to 3 TeV for CLIC, while circular colliders, FCC-ee and CEPC, offer unprecedented luminosities at the 91 GeV Z-peak. Both linear and circular colliders can operate at energies close to the highest Higgs and top-antitop production cross sections. The ILC and CEPC are proposed for construction in Asia (Japan, China), while CLIC [1] and FCC-ee [2] are proposed for construction in Europe (CERN). In light of the European Strategy, CERN is continuing to invest in the key CLIC accelerator technologies while in parallel carrying out a feasibility study for FCC.

The CLICdp collaboration² has developed the CLICdet [3] detector concept and is actively engaged in the corresponding detector technology development. The CLICdet development has strongly benefited from an integrated effort on detector optimisation studies, full simulation software development and relevant hardware R&D. In recent years, members of the CLICdp collaboration and the FCC collaboration have adapted the CLIC detector concept for operation at FCC-ee. The resulting CLD [4] concept was scaled from the CLICdet concept, taking FCC-ee experimental conditions and design constraints into account. The CLD detector was optimised in view of the FCC-ee Higgs and top physics energy stages (250 GeV – 365 GeV) and its performance was validated.

The Compact Linear Collider (CLIC) Snowmass 2021 LoI

A. Robson (University of Glasgow), P.N. Burrows (University of Oxford),
D. Schulte and S. Stapnes (CERN)^{*}

Introduction

The Compact Linear Collider (CLIC) is a multi-TeV high-luminosity linear e^+e^- collider under development by the CLIC accelerator collaboration [1]. The CLIC accelerator has been optimised for three energy stages at centre-of-mass energies 380 GeV, 1.5 TeV and 3 TeV [2].

Detailed studies of the physics potential and detector for CLIC, and R&D on detector technologies, are carried out by the CLIC detector and physics (CLICdp) collaboration [1]. CLIC provides excellent sensitivity to Beyond Standard Model physics, through direct searches and via a broad set of precision measurements of Standard Model processes, particularly in the Higgs and top-quark sectors.

The CLIC accelerator, detector studies and physics potential are documented in detail at: <http://clic.cern/european-strategy>.

CLIC layout

A schematic overview of the accelerator configuration for the first energy stage is shown in Figure 1. To reach multi-TeV collision energies in an acceptable site length and at affordable cost, the main linacs use normal conducting X-band accelerating structures; these achieve a high accelerating gradient of 100 MV/m. For the first energy stage, a lower gradient of 72 MV/m is the optimum to achieve the luminosity goal, which requires a larger beam current than at higher energies.

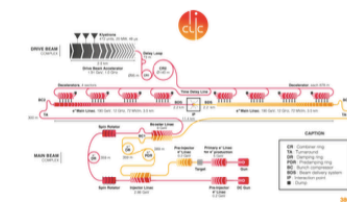


Figure 1. Schematic layout of the CLIC complex at 380 GeV.

intensity pulses that are distributed alongside the main linac, where they release the stored energy in power extraction and transfer structures (PETS) in the form of short RF power pulses, transferred via waveguides into the accelerating structures. This concept strongly reduces the cost and power consumption compared with powering the structures directly by klystrons.

The upgrade to higher energies is done by lengthening the main linacs. While the upgrade to 1.5 TeV can be done by increasing the energy and pulse length of the primary drive-beam, a second drive-beam complex must be added for the upgrade to 3 TeV.

An alternative design for the 380 GeV stage has been studied, in which the main linac accelerating structures are directly powered by klystrons. The further stages will also in this case be drive-beam based.

Parameter overview

The parameters for the three energy stages of CLIC are given in Table 1. The baseline plan for operating CLIC results in an integrated luminosity per year equivalent to operating at full luminosity for 1.2×10^7 s [3]. Foreseeing 8, 7 and 8 years of running at 380, 1500 and 3000 GeV respectively, and a luminosity ramp up for the first years at each stage, integrated luminosities of 1.0, 2.5 and 5.0 ab^{-1} are reached for the three stages.

CLIC provides $\pm 80\%$ longitudinal electron polarisation and proposes a sharing between the two polarisation states at each energy stage for optimal physics reach [4].

Luminosity margins and performance

In order to achieve high luminosity, CLIC requires very small beam sizes at the collision point, as listed in Table 1. Recent studies have explored the margins and possibilities for increasing the luminosity, operation at the Z-pole and gamma-gamma collisions [5].

The vertical emittance and consequently the luminosity are to a large extent determined by imperfections in the accelerator complex. Significant margin has been added to the known effects to enhance the robustness of the design; without imperfections a factor three higher luminosity would be reached at 380 GeV [6]. At this energy also the repetition rate of the facility, and consequently luminosity,

Priority: keeping high-energy lepton collisions on the agenda:

CLIC in the Snowmass Process

Studies of high-energy lepton collisions should be a feature of the Snowmass physics considerations. As particular areas of focus beyond Higgs physics we would like to emphasise:

- the importance of top-quark physics in e^+e^- collisions
- the importance of several energy stages in e^+e^- collisions
- direct searches, in particular for elusive signatures
- further and novel ways of constraining new physics from precision measurements
- the importance of beam polarisation
- BSM scenarios of particular interest in multi-TeV lepton collisions

Colleagues from the US and elsewhere are invited to participate in CLIC physics studies, for example using the CLIC Delphes card [19] and Whizard 2 settings [20], or alternatively the full DD4hep/GEANT simulation and iLCSoft/Key4hep reconstruction. In particular, if new Snowmass benchmarks are defined, we should be glad for CLIC sensitivities to them to be studied.

CLIC physics is being well represented in WGs

- participation encouraged, though timing and frequency difficult
- thanks to those attending; if others are following groups please let me know

Energy
Frontier:

EF01: EW Physics: Higgs Boson properties and couplings

EF02: EW Physics: Higgs Boson as a portal to new physics

(BSM Higgs such as the 2HDM, SUSY Higgs (e.g. $A \rightarrow Z h$, same as LFV and Charged Higgs etc.),

Extra scalars, Exotic Higgs Decays, mono-Higgs searches)

-> [Philipp presented a talk]

EF03: EW Physics: Heavy flavor and top quark physics

-> Frank/Marcel/Filip/Kacper

EF04: EW Precision Physics and constraining new physics

-> Wolfgang [and Philipp presented a talk]

EF08 - BSM: Model specific explorations

(Models including SUSY, Extra Dimensions, and Leptoquarks)

-> [Aidan]

EF09 - BSM: More general explorations

(New Fermions, e.g., Top partners, Excited Quarks/Leptons, Sterile Neutrinos;
New Bosons, e.g., W' , Z' , diboson-resonances; Dark/Hidden sectors, e.g., ALP,
dark photons; Long-live particle signatures; BSM interplay with EFT)

-> [Aidan]

EF10: BSM: Dark Matter at colliders

-> Filip (also ILC contact); also Roberto



Snowmass21



Instrumentation Frontier

– focus is on Detector technologies; no structure for “Overall design & optimisation of experiment concepts”.

Most relevant topical groups:

IF03: Solid State Detectors and Tracking

IF06: Calorimetry

Next is the Community Planning Meeting,
next week (5–8 October):

<https://indico.fnal.gov/event/44870>

– emphasis is on cross-group and cross-frontier overlaps:
discussions rather than overview presentations.



CLICdp activities – papers



Papers published since 1 October 2019 → across the range of our activities!

Design and characterisation of the CLICTD pixelated monolithic sensor chip

<https://ieeexplore.ieee.org/document/9178777>

CLICdp-Pub-2020-003

The impact of synchrotron radiation at the Compact Linear Collider

<https://doi.org/10.1016/j.nima.2020.164522>

CLICdp-Draft-2020-009

Combining TCAD and Monte Carlo Methods to Simulate CMOS Pixel Sensors with a Small Collection Electrode using the Allpix2 Framework

<http://dx.doi.org/10.1016/j.nima.2020.163784>

CLICdp-Pub-2019-008

CP-violating Higgs-gauge boson couplings in $H \nu \nu^-$ production at three energy stages of CLIC

[Eur. Phys. J. C 80 \(2020\) 229](#)

CLICdp-Pub-2019-004

Conformal tracking for all-silicon tracker at future electron-positron colliders

<http://dx.doi.org/10.1016/j.nima.2019.163304>

CLICdp-Pub-2019-003

ARRAY: An Open Source, Modular and Probe-Card based System with Integrated Switching Matrix for Characterisation of Large Area Silicon Pad Sensors

<http://dx.doi.org/10.1016/j.nima.2019.06.007>

CLICdp-Pub-2019-002



CLICdp activities – analysis



Physics potential for boosted topologies in top-quark pair production at a multi-TeV Compact Linear Collider

CLICdp-Note-2020-004 <https://arxiv.org/abs/2008.05526>

All-hadronic HHZ production at 3 TeV CLIC

CLICdp-Note-2020-003 <https://arxiv.org/abs/2008.05198>

All-hadronic HZ production at high energy at 3 TeV CLIC

CLICdp-Note-2019-005 <https://arxiv.org/abs/1911.02523>

Double Higgs paper in journal review

→ some updates from full-simulation HHZ (above) and referee comments

Ultimate sensitivity $g_{HHH}/g_{HHH}(\text{SM})$: [-8%, +11%]

Work continuing on other analyses including:

LFV Higgs decays, Hidden Valley at the first stage, WW production, Higgs mass from direction of b-jets, IDM scalar searches, $H \rightarrow t\bar{t} + \text{missing energy}$ in 2HDM+a model, Higgs to ZZ^* at 3TeV and 350GeV, Higgs to gamma gamma at 3TeV

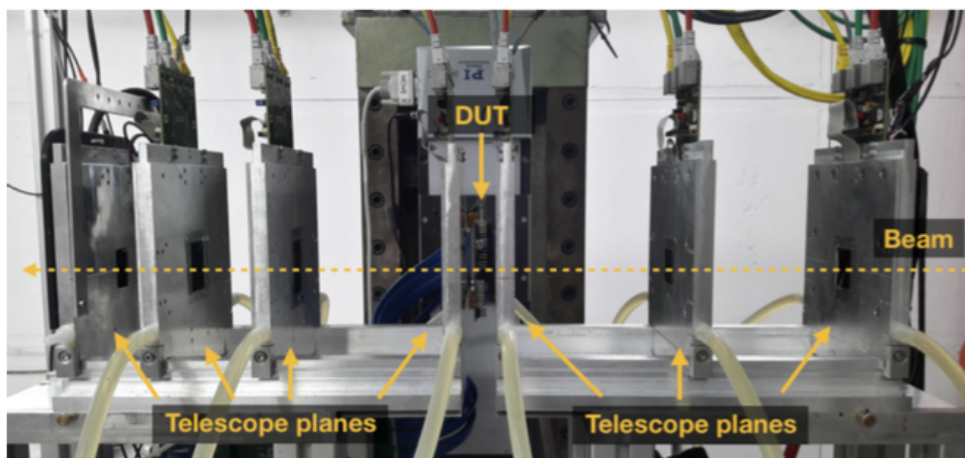
Top threshold scan optimisation

DM searches using mono-photon signatures

DM searches using disappearing tracks

} Talks on these tomorrow morning

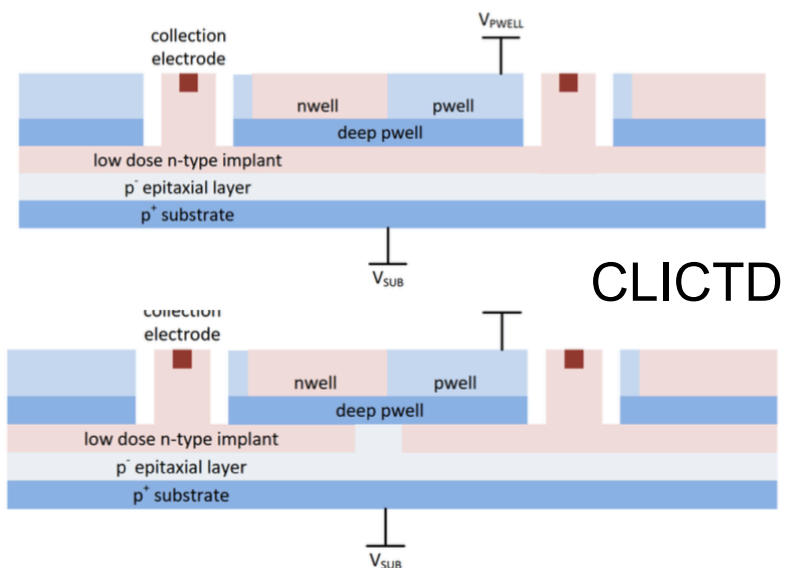
Group from CERN went to DESY testbeam in July/August



- first tests with anisotropic conductive film (ACF) assembly

- ATLASpix
HVMAPS - $40 \times 130 \mu\text{m}^2$ pixel size

- CLICTD
fully integrated small collection electrode HR-CMOS chip
 $30 \times 37.5 \mu\text{m}^2$ pixel size, $30 \times 300 \mu\text{m}^2$ readout channel size
investigating process variants



-> talks on all of these later,
plus CLICpix2, ELAD, sensor
simulation and optimisation

FLASH therapy

<https://home.cern/news/news/knowledge-sharing/cern-and-lausanne-university-hospital-collaborate-pioneering-new-cancer>

<https://physicsworld.com/a/cern-accelerator-technology-to-underpin-flash-radiotherapy-facility/>

CERN and Lausanne University Hospital collaborate on a pioneering new cancer radiotherapy facility

CERN and the Lausanne University Hospital (CHUV) are collaborating to develop the conceptual design of an innovative radiotherapy facility, used for cancer treatment

15 SEPTEMBER, 2020



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RADIO THERAPY | RESEARCH UPDATE

CERN accelerator technology to underpin FLASH radiotherapy facility

17 Sep 2020 Tami Freeman



eSPS proposal

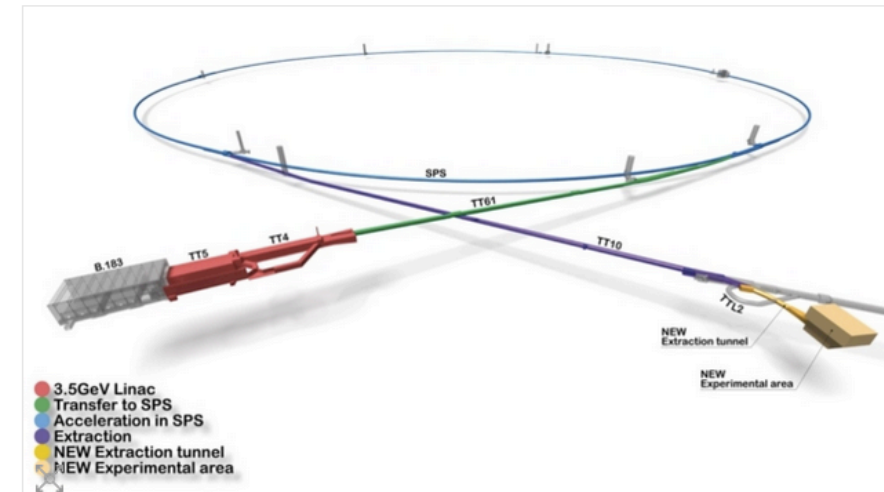
<https://cerncourier.com/a/electron-makeover-proposed-for-the-sps/>

Physics ▼ Technology ▼ Community ▼ In focus Magazine

ACCELERATORS | NEWS

Electron makeover proposed for the SPS

29 September 2020



The proposed "eSPS" would be fed by a new linear accelerator (left) and could serve plasma wafekfield R&D and experiments in the dark sector. Credit: CERN

CERN's Super Proton Synchrotron (SPS) could be upgraded so that not only protons have the possibility to be accelerated, but also electrons. A 173-page [conceptual design report](#) posted on arXiv on 15 September describes the installation of a high energy

Many thanks indeed to Naomi van der Kolk and Erica Brondolin, stepping down from the Speakers Committee



Since 2015 (!)



Since 2019

Thanks to Emilia Leogrande for agreeing to continue.
Lucie and Aidan will take the roles for now.



Other WGs and committees



WG Physics Analysis

Philipp Roloff (CERN)

Filip Zarnecki (University of Warsaw)

WG Physics Potential

Andrea Wulzer (CERN)

Jorge de Blas (University of Durham)

James Wells (Michigan)

WG Vertex and Tracking Detector Technology

Dominik Dannheim (CERN)

Mathieu Benoit (Brookhaven National Laboratory)

Publications Committee

Nigel Watson (University of Birmingham)

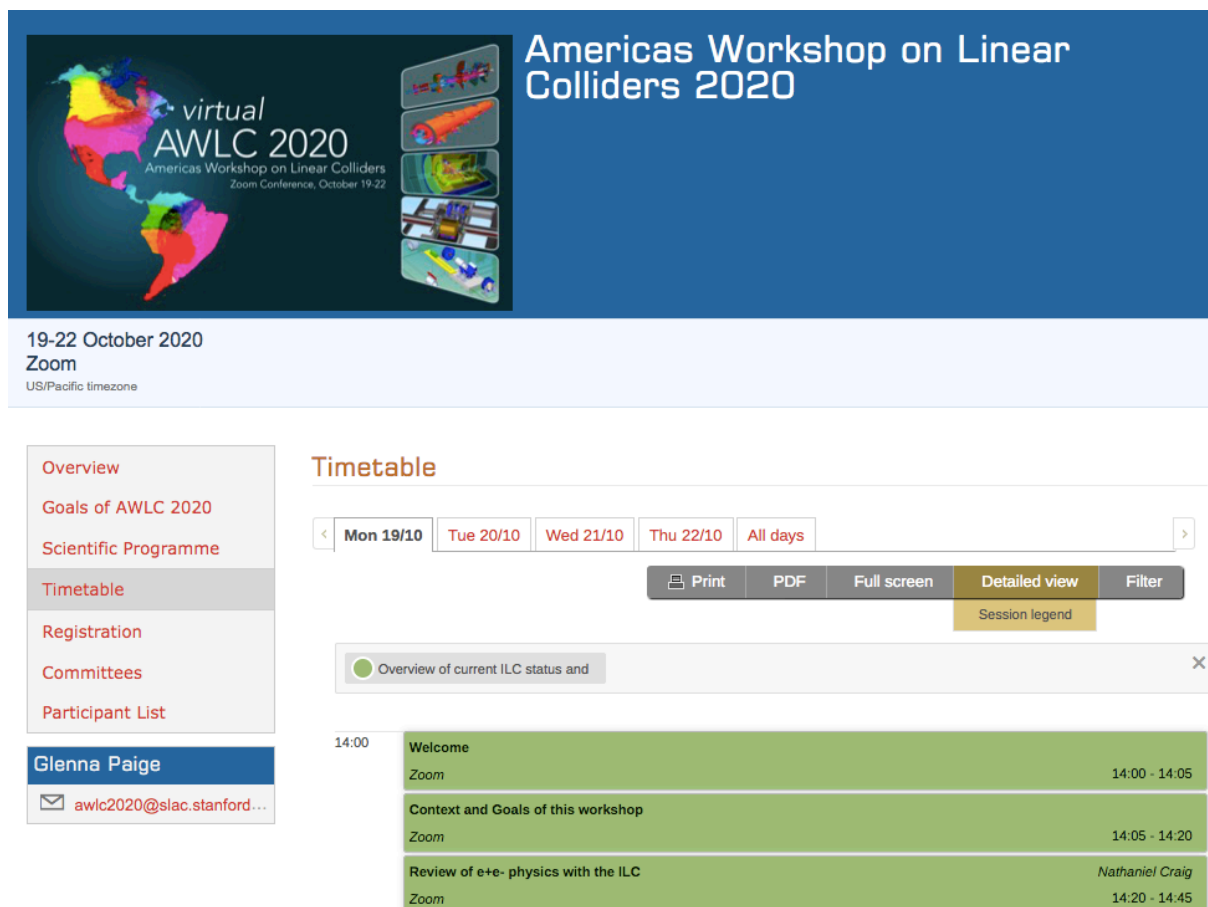
Aharon Levy (University of Tel Aviv)

Ulrike Schnoor (CERN)

Simon Spannagel (DESY)

Americas Workshop on Linear Colliders takes place 19-22 October
<https://agenda.linearcollider.org/event/8622/>

Focus is on encouraging US interest in ILC and session timing is unfortunate for Europe (23h start) – but participation encouraged



Americas Workshop on Linear Colliders 2020

virtual AWLC 2020
Americas Workshop on Linear Colliders
Zoom Conference, October 19-22

19-22 October 2020
Zoom
US/Pacific timezone

Overview

- Goals of AWLC 2020
- Scientific Programme
- Timetable**
- Registration
- Committees
- Participant List

Glenna Paige
 ✉ awlc2020@slac.stanford...

Timetable

< Mon 19/10 Tue 20/10 Wed 21/10 Thu 22/10 All days >

Print PDF Full screen Detailed view Filter

Session legend

Overview of current ILC status and

14:00

Welcome	Zoom	14:00 - 14:05
Context and Goals of this workshop	Zoom	14:05 - 14:20
Review of e+e- physics with the ILC	Nathaniel Craig	14:20 - 14:45



Collaboration meeting



Thursday

14:00	Welcome	Aidan Robson 14:00 - 14:02
	News from ECFA	Jorgen D'Hondt 14:02 - 14:20
	CLICdp news	Aidan Robson 14:20 - 14:40
	CLICpix2 planar-sensor studies	Morag Jean Williams 14:40 - 15:00
15:00	Update on ACF interconnect studies	Mateus Vicente Barreto Pinto 15:00 - 15:20
	ELAD simulation update and plans for production	Anastasiia Velyka 15:20 - 15:40
	ATLASpix test-beam analysis status and plans for MightyPix testing	Jens Kroeger 15:40 - 16:00
16:00	Coffee break	16:00 - 16:15
	CLICTD test-beam results	Katharina Dort 16:15 - 16:35
	Simulation-based CMOS sensor optimisation	Magdalena Munker 16:35 - 16:55
17:00	New developments for the Allpix-Squared simulation tool	Simon Spannagel 16:55 - 17:15
	Highlights from 10 years of CLICdp pixel-detector R&D	Mathieu Benoit 17:15 - 17:35

Friday

09:00	CLIC accelerator plans	Steinar Stapnes 09:00 - 09:20
	Report from the publications committee	Nigel Watson 09:20 - 09:30
	Whizard news and updates	Wolfgang Heinz Kilian et al. 09:30 - 09:50
	key4hep update	Valentin Volk 09:50 - 10:15
10:00	CLIC physics potential for DM searches at 3 TeV using mono-photons and polarised beams	Jean-Jacques Blaising 10:15 - 10:40
	Coffee break	10:40 - 11:00
11:00	New approach to DM searches with mono-photons	Pawel Sopicki 11:00 - 11:20
	Top threshold scan optimisation	Kacper Nowak 11:20 - 11:40
	DM searches using disappearing tracks	Ulrike Schnoor 11:40 - 11:55
12:00		
13:00	CLICdp Institute Board	

THANK YOU to everyone who has prepared updates !!!