

<https://indico.in2p3.fr/event/32629>

## 3rd ECFA workshop on $e^+e^-$ Higgs, Electroweak and Top Factories

**Paris, 9-11 October 2024**

in person workshop

206 participants

last of the series of workshops on the physics, experiment and detectors for future  $e^+e^-$  factories before ESPPU process; crucial opportunity for the community working on the future  $e^+e^-$  factories to gather and discuss the latest results and developments on these activities in view of the **submission of an ECFA report as input to the next strategy update**

# timetable

<https://indico.in2p3.fr/event/32629/timetable/#20241011.detailed>

<b>Welcome from IN2P3 and IRFU</b> <i>Dr Christelle Roy</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:10 - 09:25		<b>Linear Colliders: recent updates and goals/plans for contribution to ESPPU</b> <i>Steinar Staphes</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:30 - 09:55		<b>Generators and Theory developments needed for HET physics</b> <i>Carlo Carloni Calame</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:00 - 09:25	
<b>ESPPU process and timeline; goals of the workshop</b> <i>Paris Sphicas</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:30 - 09:40		<b>US planning for a Higgs Factory</b> <i>Ritchie Patterson</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:00 - 10:15		<b>Towards detectors for HET factories / tracking and vertexing systems</b> <i>Fabrizio Palla</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:30 - 09:50	
<b>The need for a Higgs, Electroweak, and Top factory</b> <i>Margarete Mühlleitner</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:45 - 10:10		<b>CEPC: status of the proposal, and plans</b> <i>Joao Guimaraes da Costa</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:15 - 10:30		<b>Towards detectors for HET factories / calorimeter and PID systems</b> <i>Nicolas Morange</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 09:55 - 10:15	
<b>Software for future colliders</b> <i>Juraj Smiesko</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:15 - 10:30		<b>Banquet information</b> <i>coffee break: Workshop Photo</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:30 - 11:00		<b>Towards detectors for HET factories / electronics, mechanics, integration</b> <i>Thomas Bergauer</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:20 - 10:40	
<b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:30 - 11:00		<b>Exploring the nature of Higgs boson</b> <i>Jan Hajer</i> <b>Status of the Sherpa 3.0</b> <i>Daniel Reich...</i> <b>Heavy Neutral Leptons Search</b> <i>Sofia Giappi...</i>		<b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 11:15	
<b>Overview on low mass searches</b> <i>Tania Robens</i> <b>Measurement of hadronic cross sections</b> <i>Alexis Maloizel</i> <b>Search for additional Higgs bosons</b> <i>Anne-Marie...</i> <b>Search for invisible decays</b> <i>Aman Desai</i> <b>Evidence for BSM physics</b> <i>Francois Ric...</i> <b>Prospects for light exotic particles</b> <i>Prof. Aleksa...</i> <b>The H2M project: Porting the functions to C++</b> <i>Dominik Dannheim</i>		<b>Design performance and simulation</b> <b>Search for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Determination of the Higgs self-coupling</b> <i>Jurong Tian</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 11:15 - 11:30	
<b>Search for heavy particles</b> <i>Jurong Tian</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Design performance and simulation</b> <b>Search for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Top mass and electroweak couplings</b> <i>Matteo DeFranco</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 11:35 - 11:50	
<b>EW precision: Z fermion final states (Bjorken+M23 and beyond)</b> <i>Daniel Jeanty</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 17:25 - 17:40		<b>WG2: Technical Benchmark</b> <i>Alan Price</i> <b>Beam-Induced Backgrounds</b> <i>Lindsay Gray</i> <b>Luminosity Spectrometry</b> <i>Jürgen Reuter...</i> <b>Bunch Structure Spectrometry</b> <i>Dimitris Ntoun...</i>		<b>talks by winning posters</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 11:55 - 12:20	
<b>OKM matrix elements from WW decays</b> <i>Ulrich Eidel...</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 17:45 - 18:00		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>WG1 (physics potential): HTE subgroup report/plans</b> <i>Karsten Köneke et al.</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 14:00 - 14:10	
<b>Heavy quark fragmentation and hadronisation</b> <i>Lukasz Gouskos</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:05 - 18:20		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>WG1 (physics potential): PREC subgroup report/plans (on zoom)</b> <i>Ayres Freitas</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 14:15 - 14:25	
<b>Measurements of BH to tau-lepton properties at FCC-ee</b> <i>Marta Preite</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:30 - 18:52		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>WG1 (physics potential): GLOB subgroup report/plans</b> <i>Marcel Vos</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 14:30 - 14:40	
<b>CPV measurement in HZZ (VBF) at 1 TeV ILC</b> <i>Nanka Bozovic-Jelisavcic</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:52 - 18:54		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>WG1 (physics potential): FLAV subgroup report/plans</b> <i>Stephane Monteil</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 14:45 - 14:55	
<b>ALLEGRO simulated performance</b> <i>Topik Li</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:34 - 18:36		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>WG1 (physics potential): SRCH subgroup report/plans</b> <i>Roberto Franceschini</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 15:00 - 15:10	
<b>K4DePerformance: A Framework for Tracking Performance Studies in Full Simulation Environments</b> <i>Gaëlle Sedovskii</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:38 - 18:40		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Next steps and timelines for ECFA Report; approval process</b> <i>Aidan Robson et al.</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 15:15 - 15:30	
<b>SCMICAL evolution: Time integration and algorithmic improvements for the APRIL Particle Flow</b> <i>Tanguy PASQUIER</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:40 - 18:42		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Discussion: what is missing; how to engage in ESPPU process</b> <i>Paris Sphicas</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 15:35 - 15:50	
<b>Calorimetry simulations for the ALLEGRO FCC-ee detector</b> <i>Filomena Sopkova et al.</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:42 - 18:44		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Closeout</b> <i>Gregorio Bernardi</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 15:55 - 16:00	
<b>QCD &amp; Lund Jet Plane Studies at FCC-ee</b> <i>Lutz Panzer et al.</i> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 18:44 - 18:46		<b>Searches for heavy particles</b> <i>Juraj Smiesko</i> <b>EFT interactions of Dark Matter</b> <i>Gaio Marmo</i> <b>Hints for New Higgs Bosons</b> <i>Suroo Banik</i> <b>SUSY Parameter determination</b> <i>Gustaf Moor...</i> <b>Dark Matter searches in the LHC</b> <i>JAYITA LAHIRI</i> <b>The ABC compact BSM</b> <i>Serena Pezz...</i> <b>coffee break</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:35 - 10:45 <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55 <b>Searches for LLPs</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 10:45 - 10:55		<b>Further topics on working groups</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 19:05 - 19:15 <b>Summary and next steps towards ECR White Paper input to EPPSU (talk)</b> <i>Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon</i> 19:15 - 19:30	

# ESPP (I): launch of next (current) update

□ In March 2024 CERN Council launched the new ESPP process:

□ Timeline:



# ESPP (II): Secretariat, EDG, PPG and working groups

- **"Secretariat":**
  - Secretary (chair): K. Jakobs
  - CERN SPC chair: H. Montgomery
  - ECFA chair: PS
  - LDG chair: D. Newbold
    - M. Seidel from 1/1/2025
- **European Strategy Group (ESG):**
  - Secretariat (secretary chairs ESG);
  - One rep per CERN member state;
  - One rep per lab in LDG;
  - CERN DG, CERN DG-elect;
  - Invitees: PPG, President of Council, 1 rep from each Associate Member State and Observer State, 1 rep from EC; chairs of ApPEC, NuPECC, ESFRI
- **Physics Preparatory Group (PPG):**
  - Secretariat (secretary chairs ESG);
  - 4 people nominated by SPC
  - 4 people nominated by ECFA
  - 2 people nominated by Americas
  - 2 people nominated by Asia
  - 1 person nominated by CERN
- **Nine Working Groups (WGs):**
  - Last time's Computing and Instrumentation split (8 WGs of 2020 ESPP→ 9 WGs):
    - **Computing WG and**
    - **Instrumentation WG**
- **Increase engagement by HEP community:**
  - Each WG: only one co-convener from PPG
  - Second co-convener from SPC/ECFA lists
  - So: Ex-officio members (ECFA, SPC and LDG Chairs) and representatives from the Americas and Asia are not co-convener.
- **Role of representatives from Asia and the Americas, and ex-officio members and Chair: maintain coherence of overall effort.**
- **Engage the generation most concerned: Each WG must appoint a scientific secretary who is an Early Career Researcher:**
  - A scientist without an indefinite position and within 10 years from PhD.
  - To be selected by conveners, using nominees collected by ECFA and their own knowledge of the people in the thematic area.

# ESPP (III): Working Groups and Conveners

## Charge to WG conveners:

- Selection of Early Career Scientists
- Definition of sub-topics and appointment of additional WG members
- Definition of Benchmark processes
- Organisation of WG meetings
- Writing the Physics Briefing Book (will be supported by Roger Forty, who has agreed to be Scientific Secretary of the Strategy update)

## Instrumentation WG:

- The “portal” to all that we want the next ESPP to contain
- Co-convended by Thomas Bergauer and Ulrich Husemann
- Things to consider: areas of concentration; suggestions for key participants (to Thomas & Ulrich)
- Closer to EDP: it would be very useful to have active involvement by EDP members in the Instrumentation group

Working group	Co-conveners	Co-conveners
	PPG member	
Electroweak physics	Monica Dunford (DE, exp)	Jorge de Blas (ES, <u>theory</u> )
Strong interaction	Cristinel Diaconu (FR, exp)	Andrea Dainese (IT, exp, HI)
Flavour physics	Gino Isidori (CH, theory)	Marie-Hélène <u>Schune</u> (FR, <u>exp</u> )
BSM physics	Fabio Maltoni (BE/IT, theory)	Rebecca Gonzales-Suarez (SE, exp)
Neutrino physics and cosmic messengers	Pilar Hernandez (ES, theory)	Sara Bolognesi (FR, exp)
Dark matter and dark sector	Jocelyn Monroe (UK, exp)	Matthew McCollough (CERN, theory)
Accelerator science and technology	Gianluigi Arduini (CERN, acc)	Phil Burrows (UK, exp, acc)
Detector instrumentation	Thomas Bergauer (AT, exp)	Ulrich Husemann (DE, exp)
Computing	Tommaso Boccali (IT, exp, comp)	Borut Kersevan (SL, exp, comp)

10 European countries and CERN represented  
12 men, 6 women; 13 experiment, 5 theory

# project overviews & status reports

09:00

**FCC: recent updates and goals/plans for contribution to ESPPU**Frank Zimmermann *Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon*

09:00 - 09:25

**Linear Colliders: recent updates and goals/plans for contribution to ESPPU**Steinar Stapnes *Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon*

09:30 - 09:55

10:00

**US planning for a Higgs Factory**Ritchie Patterson *Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon*

10:00 - 10:15

**CEPC: status of the proposal, and plans**Joao Guimaraes da Costa *Amphi Farabeuf, Campus des Cordeliers, Paris, Metro Odeon*

10:15 - 10:30

# An adaptable e<sup>+</sup>e<sup>-</sup> LC facility at CERN



A LC facility can be **extended in length** for higher energies, using the same or improved versions of the same technology, e.g. as suggested for ILC, CLIC, C3 and HALHF.

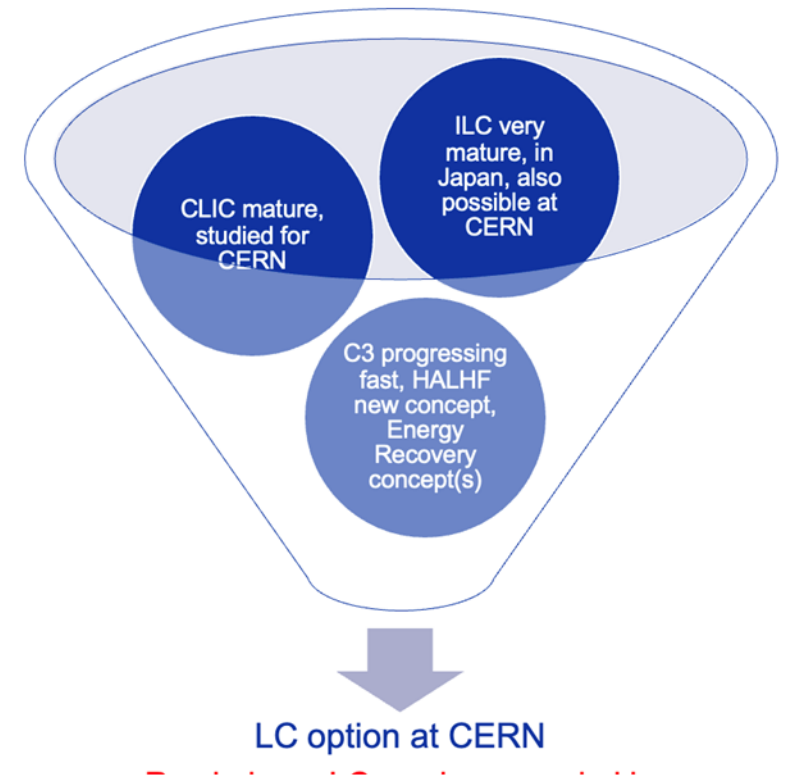
- It is also possible and realistic to **change to more performant (usually higher gradient) technologies** in an upgrade, e.g. from ILC to CLIC or C3, maybe even plasma and energy recovery based solutions
- The **physics at higher energies** – Higgs sector and extended models with increased reach and precision, top in detail well above threshold, searches and hopefully new physics – will open for a very exciting long term e<sup>+</sup>e<sup>-</sup> programme
- Such a programme can **run in parallel with future hadron and/or muon colliders** that can be developed, optimised and implemented as their key technologies mature

# ESPP inputs – I

Higgs factory focussed studies	Project input (the traditional way)
ILC	ILC in Japan
CLIC	CLIC at CERN
C3	Project study, focus on next phase
HALHF	Project concept, pre-CDR
Energy recovery	Project concepts and plans

Consider a LC facility as outlined on previous page

**The challenge for the EPSS update:**



General goals for LCs:

- Lower cost to get to Higgs and top than a circular machine.
- Power similar to LHC, or lower
- Footprint similar to LHC, CE cost risks therefore manageable
- Does not determine footprint of future energy frontier machines (hadrons and muon), and it has its own upgrade opportunities.



# US Higgs factory effort

## US Planning for a Higgs Factory

Ritchie Patterson, Cornell University

for the US Higgs Factory Steering Committees

10 October 2024

# US - CERN Statement of Intent

### The US and CERN intend to:

- Enhance collaboration on future planning activities for large-scale, resource-intensive facilities ...;
- **Continue to collaborate in the feasibility study of the Future Circular Collider Higgs Factory (FCC-ee...;**
- Discuss potential collaboration on pilot projects on incorporating new analytics techniques and tools such as artificial intelligence (AI) into particle physics research at scale.



OSTP, April 26, 2024

**Should the CERN Member States determine the FCC-ee is likely to be CERN’s next world-leading research facility following the high-luminosity Large Hadron Collider, the US intends to collaborate on its construction and physics exploitation, subject to appropriate domestic approvals.”....**

**The full statement:** <https://www.state.gov/joint-statement-of-intent-between-the-united-states-of-america-and-the-european-organization-for-nuclear-research-concerning-future-planning-for-large-research-infrastructure-facilities-advanced-scie/>

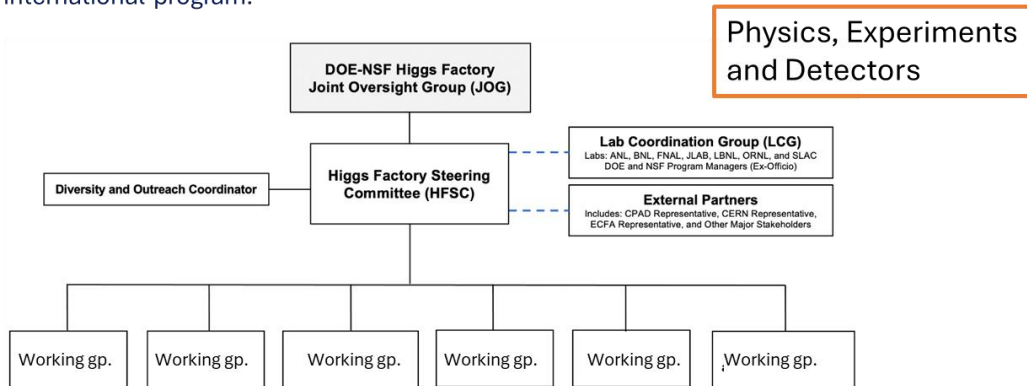
10 Oct 24

US Higgs Factory | 3rd ECFA Workshop

# Two coordination Consortia

## ❖ A national Higgs Factory Coordination Consortium (HFCC)

- ❖ Provide strategic direction and leadership for the U.S. community to engage, shape and thereby advance the development of physics, experiment and detector program for a potential future Higgs factory and to ensure cooperation with our partners in the international program.

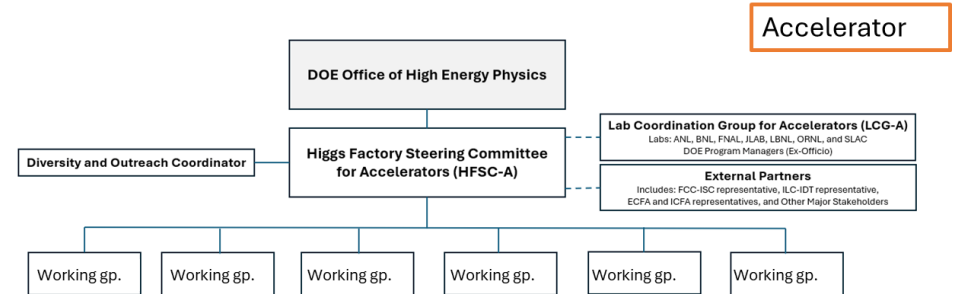


10 Oct 24

US Higgs Factory | 3rd ECFA Workshop

## ❖ A national Higgs Factory Coordination Consortium for Accelerators (HFCC-A)

- ❖ Provide strategic direction and leadership for the U.S. community to engage, shape and thereby advance the development of the accelerator program for a potential future Higgs factory and to ensure cooperation with our partners in the international program.



10 Oct 24

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## R&D support - PED




- ❖ DOE authorized \$0.5M in support of FY24 R&D.
- ❖ The HF Steering Committee allocated funds to the following **FY24** activities needing short-term support in areas including:
  - MAPS
  - TCAD simulations
  - Straw tubes
  - Gaseous tracker
  - Eco-friendly gases
  - LAr demonstrator modules
  - Low power TDC
  - Software development
- ❖ Moving forward, we will use a bottom-up process to allocate funding, similar to those of US ATLAS and US CMS.

PED workshop on 19-20 Dec at SLAC

# CEPC - IHEP

## IHEP Experience on Accelerator Construction



 <p><b>BEPC</b></p> <p>Construction years: 1984-1988 Budget: 0.24 Billion CNY <i>On time, on budget</i></p>	 <p><b>BEPCII &amp; BESIII</b></p> <p>Construction years: 2004-2008 Budget: 0.64 Billion CNY <i>On time, on budget</i></p>	 <p><b>ADS</b></p> <p>Construction years: 2011-2016 Budget: 0.40 Billion CNY <i>On time, on budget</i></p>
 <p><b>CSNS</b></p> <p>Construction years: 2011-2018 Budget: 1.87 Billion CNY <i>On time, on budget</i></p>	 <p><b>HEPS</b></p> <p>Construction years: 2019-2025 Budget: 4.8 Billion CNY <i>Completed in 2024, on schedule, on budget</i></p>	<p>IHEP has constructed large-scale accelerator facilities since 1980's, including <b>circular collider, proton superconducting linac, spallation neutron source, and a synchrotron radiation source</b>. All these high-budget accelerators have been built on schedule and on budget.</p>

# CEPC - IHEP

## CEPC in Synergy with Other Accelerator Projects in China

**Total cost of accelerator projects under construction: 39B RMB**  
 (more than CEPC cost of 36.4B RMB)

Project name	Machine type	Location	Cost (B RMB)	Completion time
<b>CEPC</b>	Higgs factory Up to ttbar energy	Led by IHEP, China	<b>36.4 (where 19B for accelerator)</b>	Around 2035 (starting time around 2027)
<b>BEPCII-U</b>	e+e- collider 2.8 GeV/beam	IHEP (Beijing)	<b>0.15</b>	2025
<b>HEPS</b>	4 <sup>th</sup> generation light source of 6 GeV	IHEP (Huairou)	<b>5</b>	2025
<b>SAPS</b>	4th generation light source of 3.5 GeV	IHEP (Dongguan)	<b>3</b>	2031 (in R&D, to be approved)
<b>HALF</b>	4th generation light source of 2.2 GeV	USTC (Hefei)	<b>2.8</b>	2028
<b>SHINE</b>	Hard XFEL of 8 GeV	Shanghai-Tech Univ., SARI and SIOM of CAS (Shanghai)	<b>10</b>	2027
<b>S3XFEL</b>	S3XFEL of 2.5 GeV	Shenzhen IASF	<b>11.4</b>	2031
<b>DALS</b>	FEL of 1 GeV	Dalian DICP	-	(in R&D, to be approved, )
<b>HIAF</b>	High Intensity heavy ion Accelerator Facility	IMP, Huizhou	<b>2.8</b>	2025
<b>CIADS</b>	Nuclear waste transmutation	IMP, Huizhou	<b>4</b>	2027
<b>CSNS-II</b>	Spallation Neutron source proton injector of 300 MeV	IHEP, Dongguan	<b>2.9</b>	2029

28

# CEPC plan

## CEPC Plan: 15th Five Year Plan



### Preparation for China's 15th Five-Year-Plan (2026-2030)

- Preparation is beginning....
- Procedure not clear yet
- The overall funding not known yet
- Coordination among IHEP, CAS, local and national governments expected
- CEPC aims at a start date in 2027-8, in the middle of the 15<sup>th</sup> Five-Year-Plan

In the near future, the CEPC team will:

- complete the detector TDR<sub>rd</sub>
- proceed well into the EDR work
- make ready the necessary documents for the proposal

# CEPC promise

## Final remarks

**CEPC continues to evolve towards possible approval in the near future**

**CEPC EDR Phase: 2024 - 2027**

**Reference Detector TDR: by June 2025**

Documentation to be completed for government's approval within 15<sup>th</sup> Five-Year-Plan of China

**Aim to start construction in 2027-2028 → Physics collisions in 2030's**

**CEPC is committed to strive to maximize international collaboration**

Help from international scientists and labs will be essential to maximize the CEPC physics outcome (at least 2 international experiments are expected)

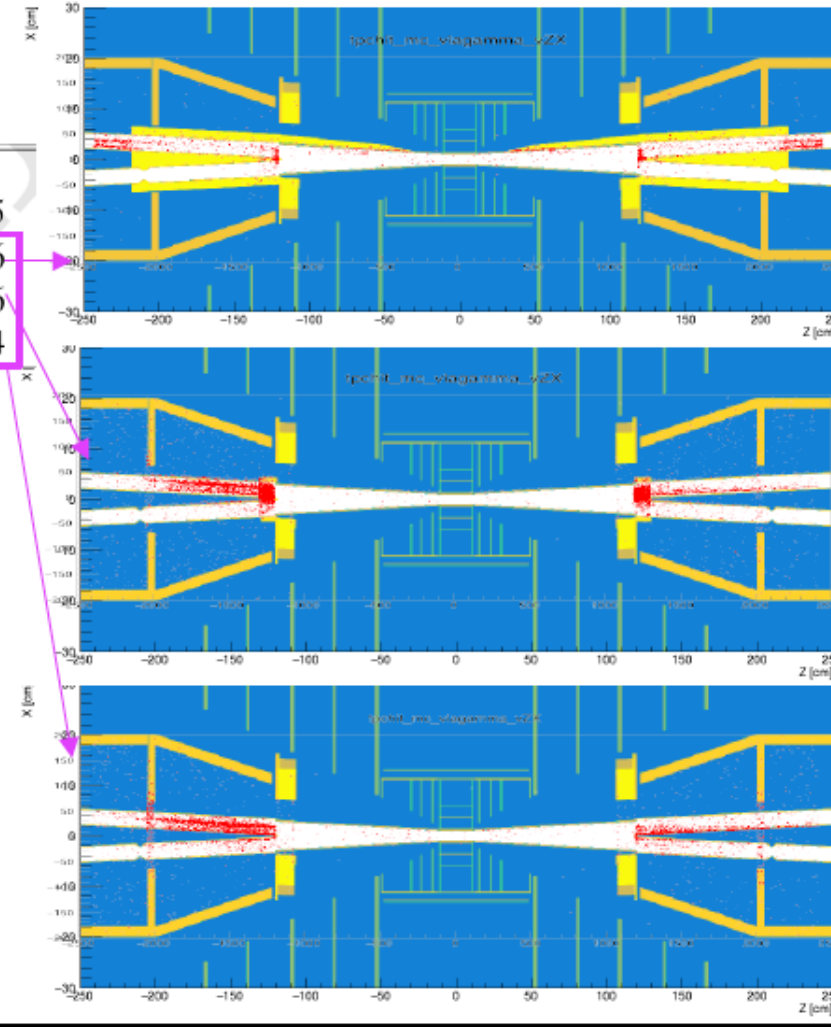
Important to continue exploring the R&D synergies between CEPC, FCC-ee and other international HEP projects

**If successful, CEPC will offer the HEP community an early Higgs factory**

33

new FCCee models			
ILD_FCCee_v01	2.0 (uniform)	FCC-ee	$351 \pm 115$
ILD_FCCee_v01	2.0 (map)	FCC-ee	$261 \pm 86$
ILD_FCCee_v01	2.0 (map), no mask	FCC-ee	$707 \pm 116$
ILD_FCCee_v01	2.0 (map), no mask HOM	FCC-ee	$536 \pm 114$

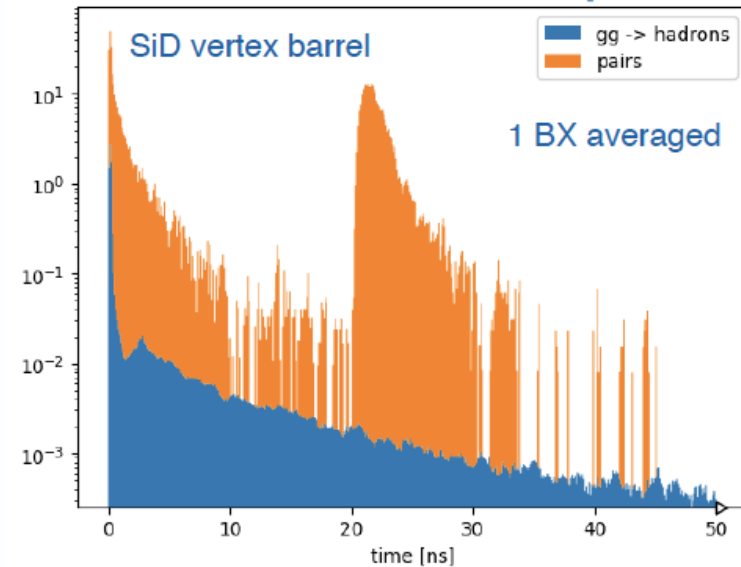
- many TPC hits induced by beamstrahlung interactions with shielding
- if we remove the shielding, they just interact elsewhere: actually *increases* TPC backgrounds
- can we consider applying an additional  $B_x$  field to steer pairs into outgoing beampipe ? (a la "anti-DID")
- a stronger detector solenoid and/or larger exit beampipe may also help



Daniel Jeans – TPC beamstrahlung (IPC) backgrounds



## Time Structure of Pairs and Hadron Photoproduction (II)

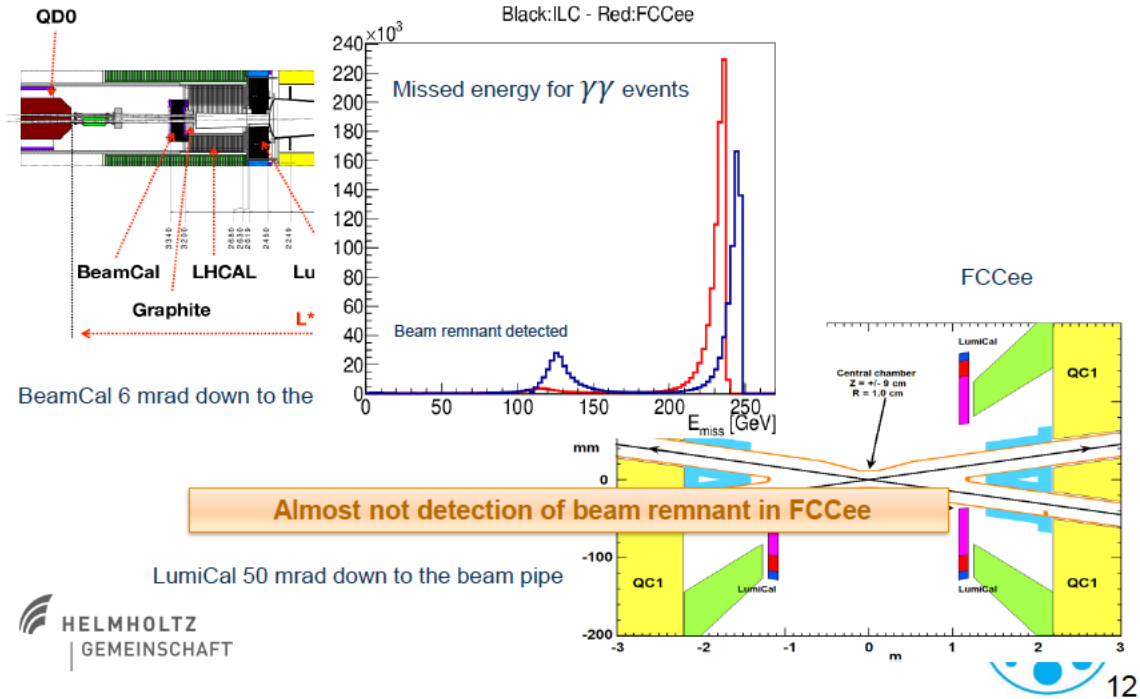


- Hadron photoproduction has  $\sim 0.1-1\%$  effect compared to pairs when in-time with that background
  - $\sim 50\%$  effect out of time with the two major components, from long tail
  - Very different patterns concerning out of time pileup!
- We'll see in a moment this corresponds to  $\sim 5e-6$  occupancy effects at C3
  - The answer is different in the calorimeters (but no time to discuss today)



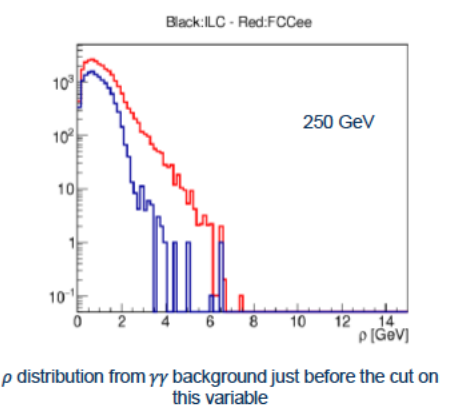
Lindsay Gray - comparing IPC vs  $\gamma\gamma \rightarrow hadrons$  backgrounds @C<sup>3</sup>

### Evaluating impact of FCCee-like MDI in $\tilde{\tau}$ sensitivity (ctd.)



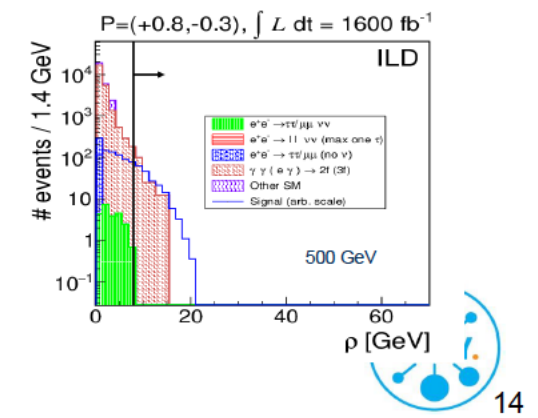
### Evaluating impact of FCCee-like MDI in $\tilde{\tau}$ sensitivity (ctd.)

Effect of hermeticity on  $\rho$  cut



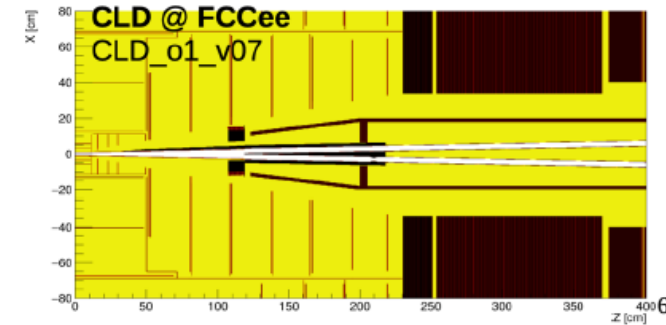
Designed to cut against back-to-back  $\tau^+\tau^-$ 's

$\rho$  cut should be increased by about 75% to keep the same level of background, but this would remove about 82% of the signal

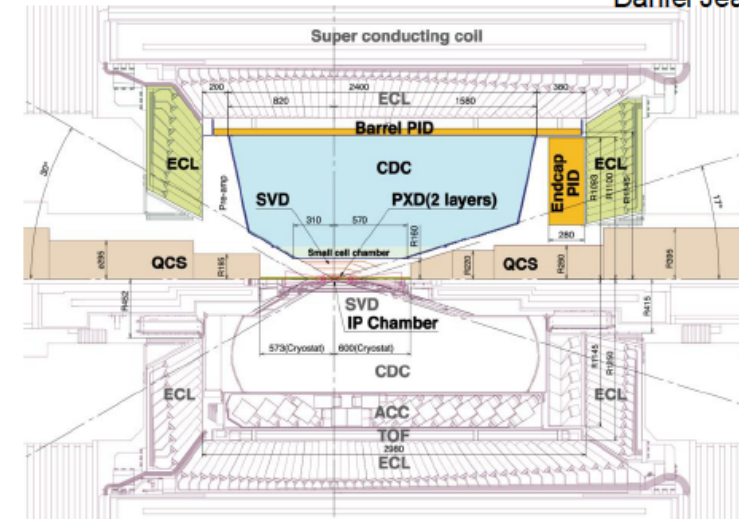


# Integration

- Machine-Detector Interface is significantly different @ ILC and FCC-ee
  - Very similar to Belle-II, where QCS (final focusing magnet) is 60cm away from IP
- Installation and fast access for maintenance of vertex detector need to be considered



Daniel Jeans





## Machine Interface

### Beam pipe radius at IP constrained by beamstrahlung

- FCC-ee/ CepC 1 cm
- ILC 1.3 cm
- CLIC 2.96 cm

### Angular acceptance

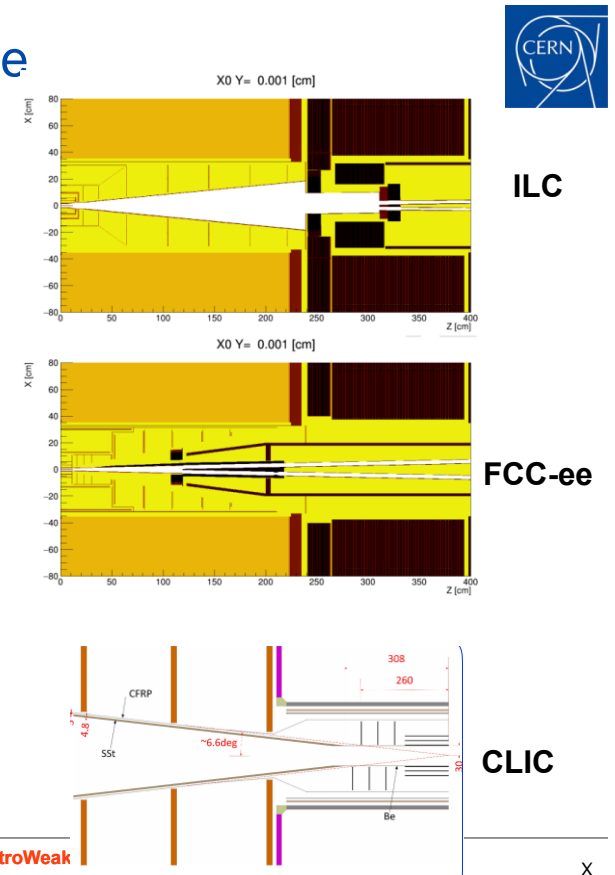
- FCC-ee/ CepC ~110 mrad (Luminometer)
- ILC/ CLIS ~105 mrad (conical beam pipe)

### Magnetic field

- FCC-ee/ CepC 2 T, 3 T (CepC for other energies)
- ILC 3.5-5 T
- CLIC 4 T

### L\* (IP distance from first quadrupole)

- FCC-ee/ CepC 2.2 m (inside the detector)
- ILC 4.1 m
- CLIC 6 m





# (SELECTED) HIGHLIGHTS FROM 3RD ECFA MEETING ON HIGGS, ELECTROWEAK AND TOP FACTORIES

Fabrizio Palla

INFN Pisa and CERN

MDI meeting – CERN

14 October 2024