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

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

Paris, 9-11 October 2024

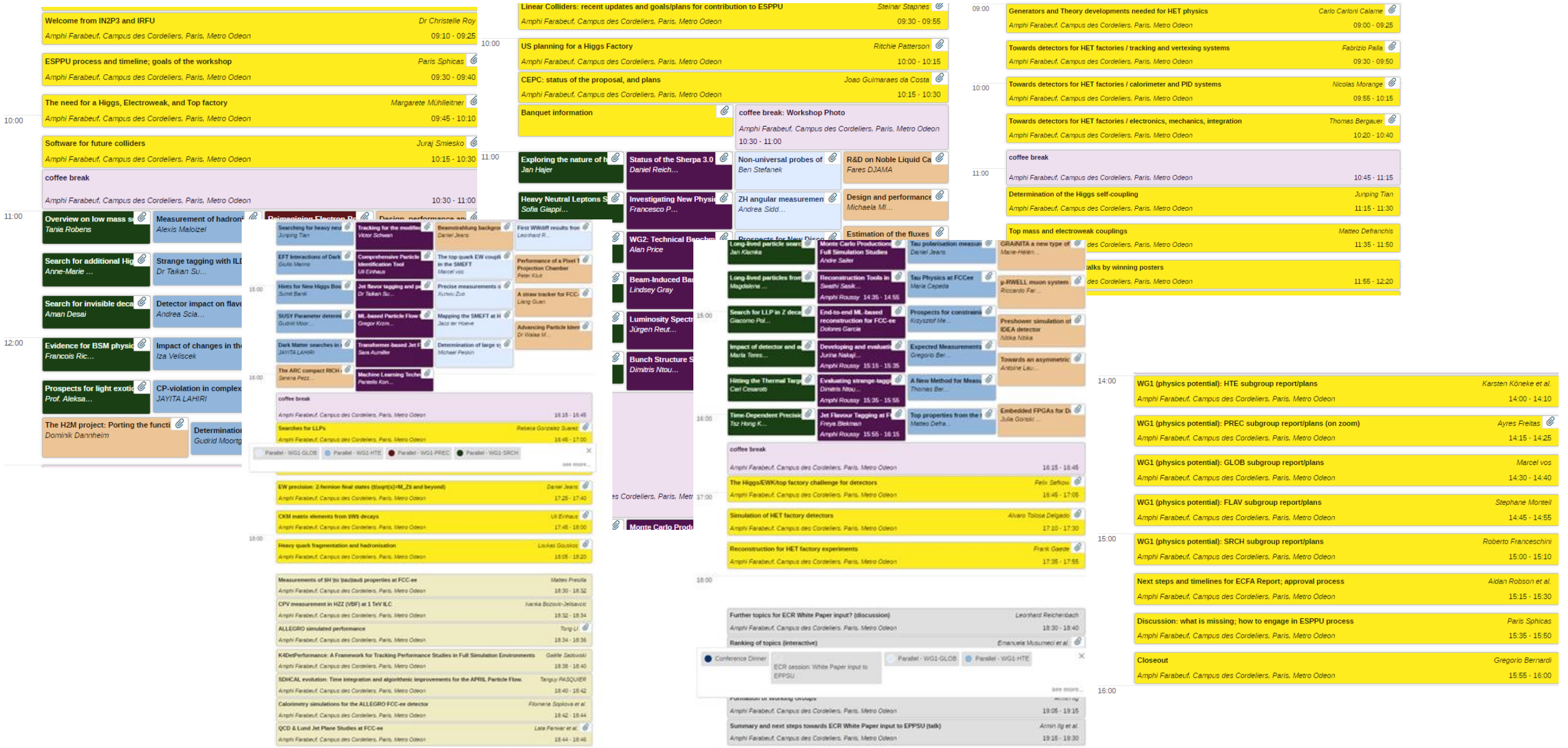
in person workshop

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



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

- **In March 2024 CERN Council launched the new ESPP process:**
  - **Timeline:**

Paris Sphicas

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-conveners.
- **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.

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ESPP (III): Working Groups and Conveners

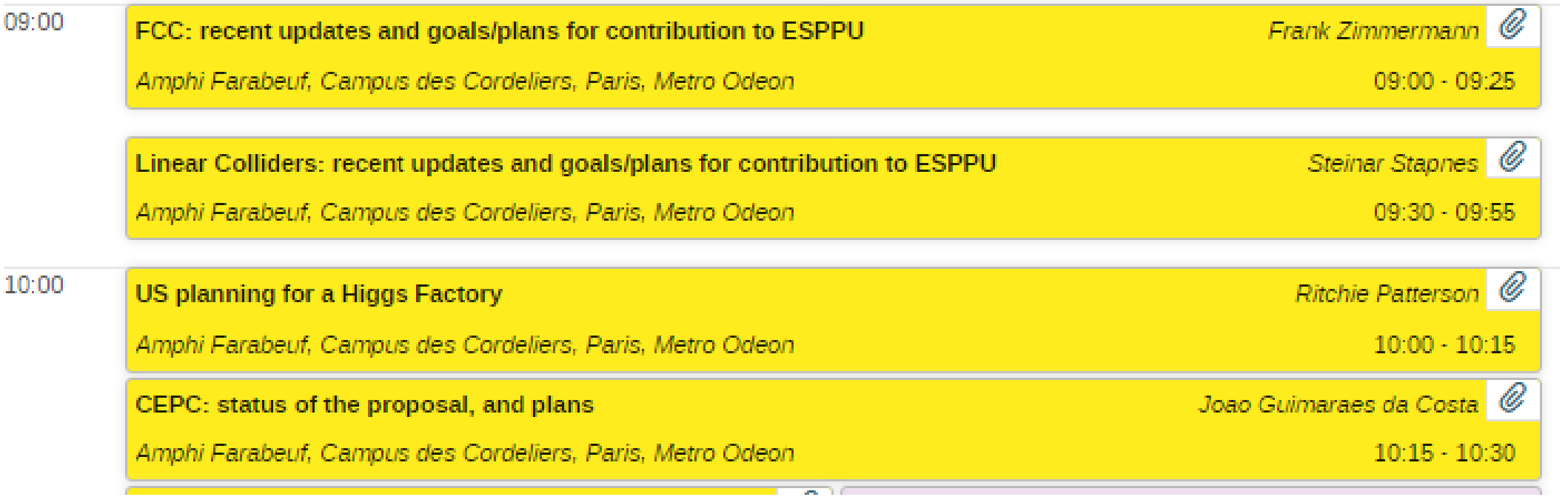
- **Charge to WG conveners:**
  - Selection of Early Career Scientists
  - Definition of sub-topics and appointment of additional WG members
  - Definition of Benchmark processes
  - Organisation of WG meetings
  - Writing the Physics Briefing Book (will be supported by Roger Forty, who has agreed to be Scientific Secretary of the Strategy update)
- **Instrumentation WG:**
  - The "portal" to all that we want the next ESPP to contain
  - Co-convened 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-convener	Co-convener
	PPG member	
Electroweak physics	Monica Dunford (DE, exp)	Jorge de Blas (ES, theory)
Strong interaction	Cristinel Diaconu (FR, exp)	Andrea Dainese (IT, exp, HI)
Flavour physics	Gino Isidori (CH, theory)	Marie-Hélène Schune (FR, exp)
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)

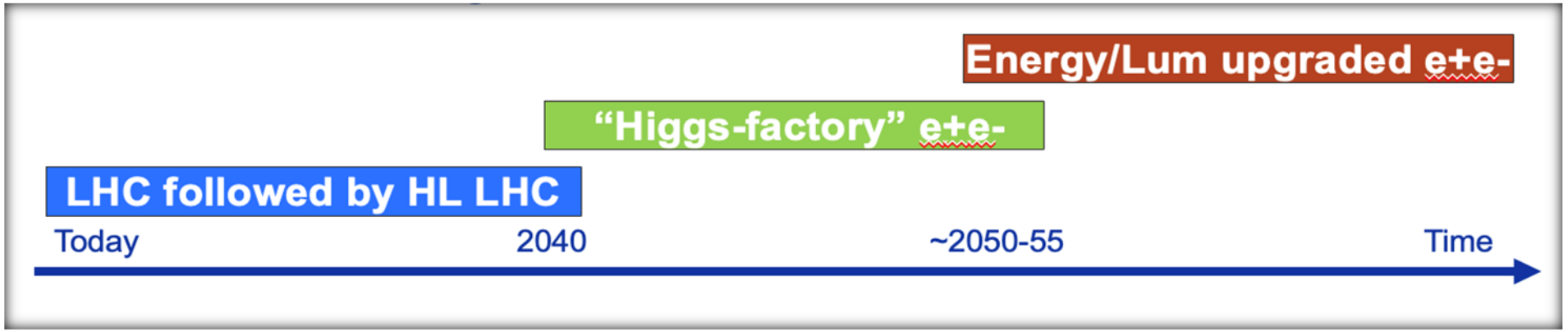
10 European countries and CERN represented
12 men, 6 women; 13 experiment, 5 theory

Paris Sphicas

project overviews & status reports



An adaptable e+e- 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+e- 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

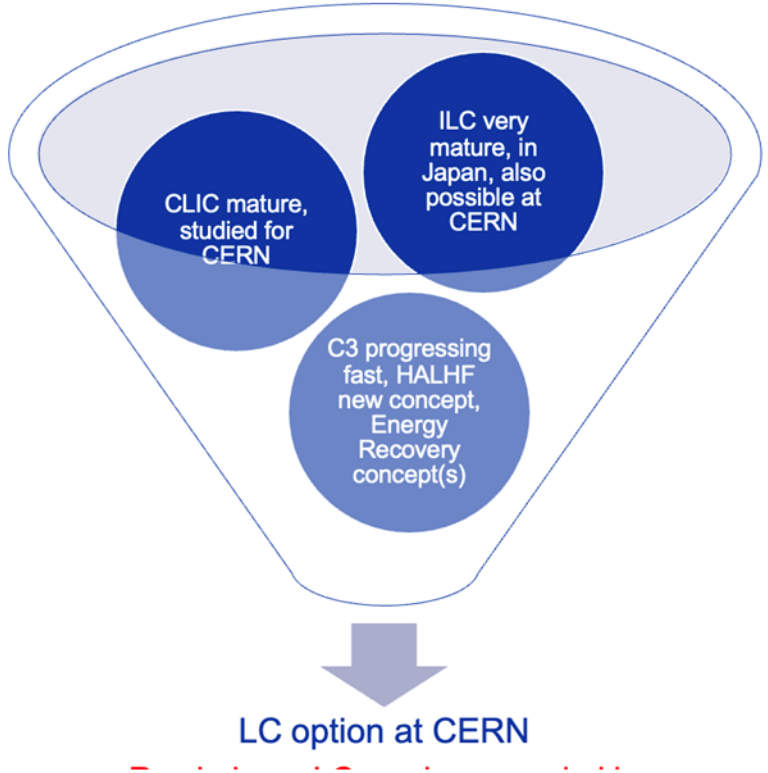
Steinar Stapnes

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.

Steinar Stapnes

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."….

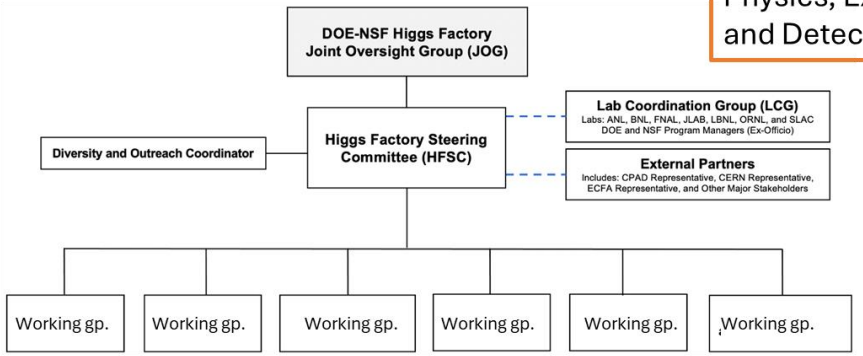
The full statement: https://www.state.gov/joint-statement-of-intent-between-the-united-states-of-america-and-the-european-organization-for-nuclear-research-concerning-future-planning-for-large-research-infrastructure-facilities-advanced-scie/

Ritchie Patterson

Two coordination Consortia

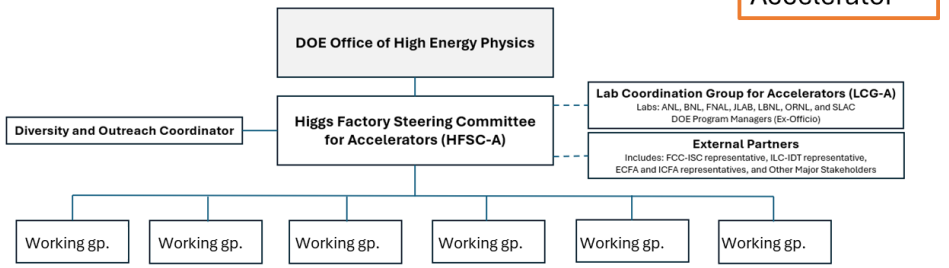
- A national Higgs Factory Coordination Consortium (HFCC)
  - Provide strategic direction and leadership for the U.S. community to engage, shape and thereby advance the development of physics, experiment and detector program for a potential future Higgs factory and to ensure cooperation with our partners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

Physics, Experiments and Detectors



- 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.

Accelerator



Ritchie Patterson

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

Ritchie Patterson

CEPC - IHEP

IHEP Experience on Accelerator Construction

Construction years: 1984-1988
Budget: 0.24 Billion CNY
On time, on budget

Construction years: 2004-2008
Budget: 0.64 Billion CNY
On time, on budget

Construction years: 2011-2016
Budget: 0.40 Billion CNY
On time, on budget

Construction years: 2011-2018
Budget: 1.87 Billion CNY
On time, on budget

Construction years: 2019-2025
Budget: 4.8 Billion CNY
Completed in 2024, on schedule, on budget

IHEP has constructed large-scale accelerator facilities since 1980's, including **circular collider**, **proton superconducting linac**, **spallation neutron source**, and a **synchrotron radiation source**. All these high-budget accelerators have been built on sche

João Guimarães da Costa

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

João Guimarães da Costa

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 15th Five-Year-Plan

In the near future, the CEPC team will:

- complete the detector TDR_rd
- proceed well into the EDR work
- make ready the necessary documents for the proposal

João Guimarães da Costa

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 15th 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

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João Guimarães da Costa

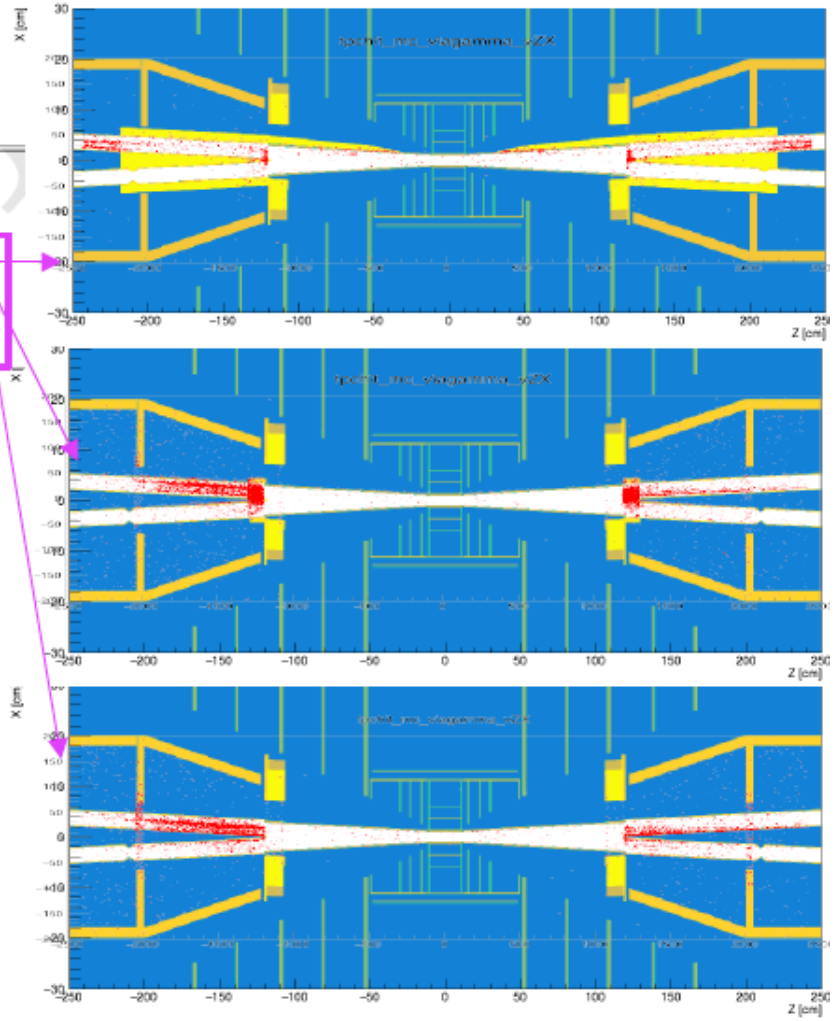
new FCCee models			
ILD_FCCee_v01	2.0 (uniform)	FCC-ee	351 ± 115
ILD_FCCee_v01	2.0 (map)	FCC-ee	261 ± 86
ILD_FCCee_v01	2.0 (map), no mask	FCC-ee	707 ± 116
ILD_FCCee_v01	2.0 (map), no mask HOM	FCC-ee	536 ± 114

- many TPC hits induced by beamstrahlung interactions with shielding

- if we remove the shielding, they just interact elsewhere: actually *increases* TPC backgrounds

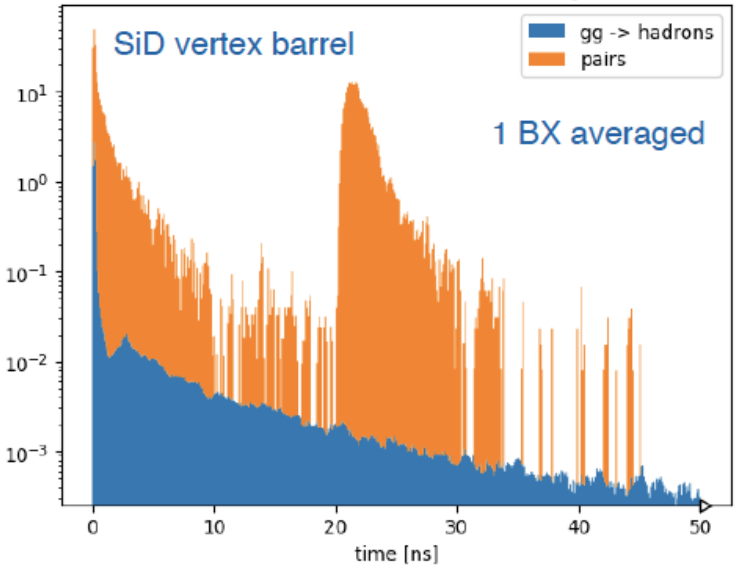
- can we consider applying an additional B_x field to steer pairs into outgoing beampipe ? (*a la* "anti-DID")

- 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)



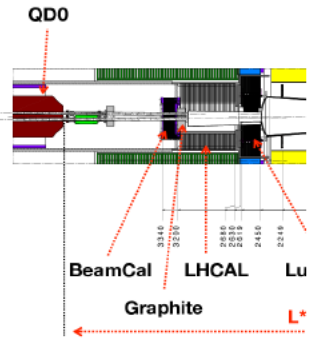
- Hadron photoproduction has ~0.1-1% effect compared to pairs when in-time with that background
  - ~50% effect out of time with the two major components, from long tail
  - Very different patterns concerning out of time pileup!
- We'll see in a moment this corresponds to ~5e-6 occupancy effects at C3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

Fermilab

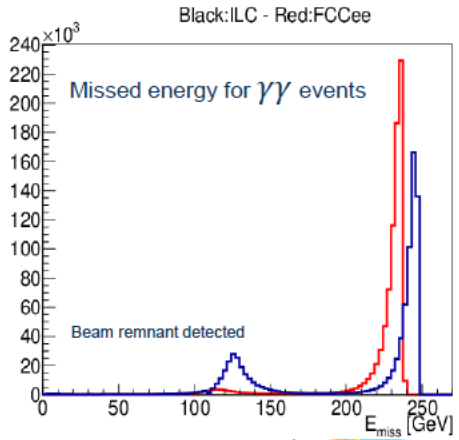
15 10 Oct 2024 L. Gray I C3 Beam Backgrounds

Lindsay Gray - comparing IPC vs $\gamma\gamma \rightarrow hadrons$ backgrounds @C^3

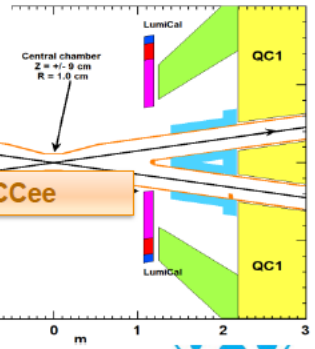
Evaluating impact of FCCee-like MDI in $\tilde{\tau}$ sensitivity (ctd.)



BeamCal 6 mrad down to the



FCCee



Almost not detection of beam remnant in FCCee

LumiCal 50 mrad down to the beam pipe

HELMHOLTZ GEMEINSCHAFT

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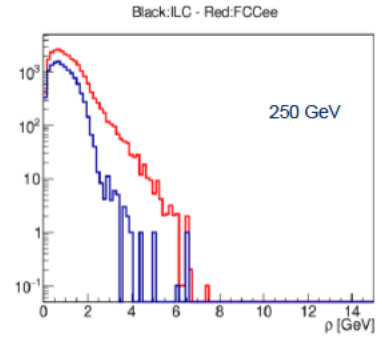
Evaluating impact of FCCee-like MDI in $\tilde{\tau}$ sensitivity (ctd.)

Effect of hermeticity on ρ cut

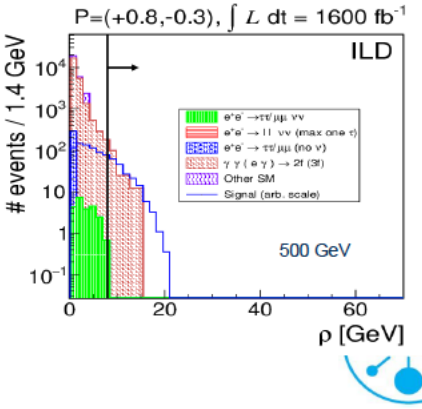


ρ distribution from $\gamma\gamma$ background just before the cut on this variable

HELMHOLTZ GEMEINSCHAFT

Designed to cut against back-to-back τ´s

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



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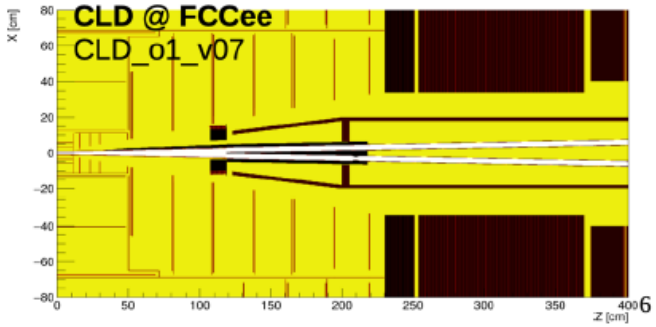
Teresa Núñez – Hermeticity effects on stau sensitivity

ÖAW AUSTRIAN ACADEMY OF SCIENCES

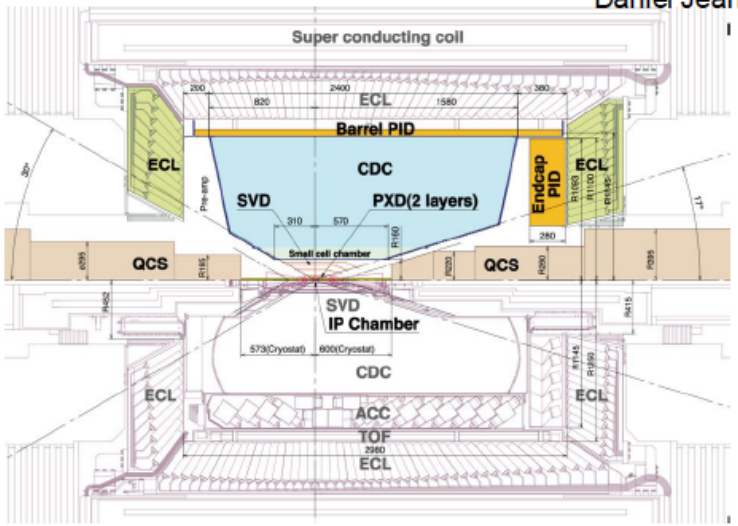
HEPHY INSTITUTE OF HIGH ENERGY PHYSICS

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



Thomas Bergauer – Electronics, mechanics, integration

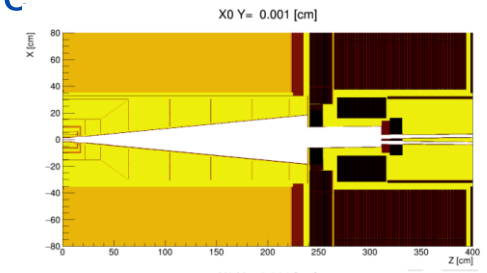
INFN Istituto Nazionale di Fisica Nucleare

INFN PISA Istituto Nazionale di Fisica Nucleare Sezione di Pisa

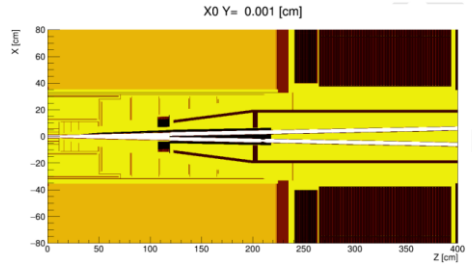
CERN

Machine Interface

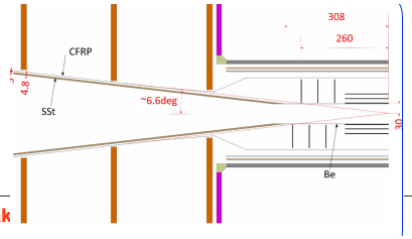
- Beam pipe radius at IP constrained by beamstrahlung
  - FCC-ee/ CepC 1 cm
  - ILC 1.3 cm
  - CLIC 2.96 cm
- Angular acceptance
  - FCC-ee/ CepC ~110 mrad (Luminometer)
  - ILC/ CLIS ~105 mrad (conical beam pipe)
- Magnetic field
  - FCC-ee/ CepC 2 T, 3 T (CepC for other energies)
  - ILC 3.5-5 T
  - 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



ILC



FCC-ee



CLIC

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

Fabrizio Palla

INFN Pisa and CERN

MDI meeting – CERN
14 October 2024