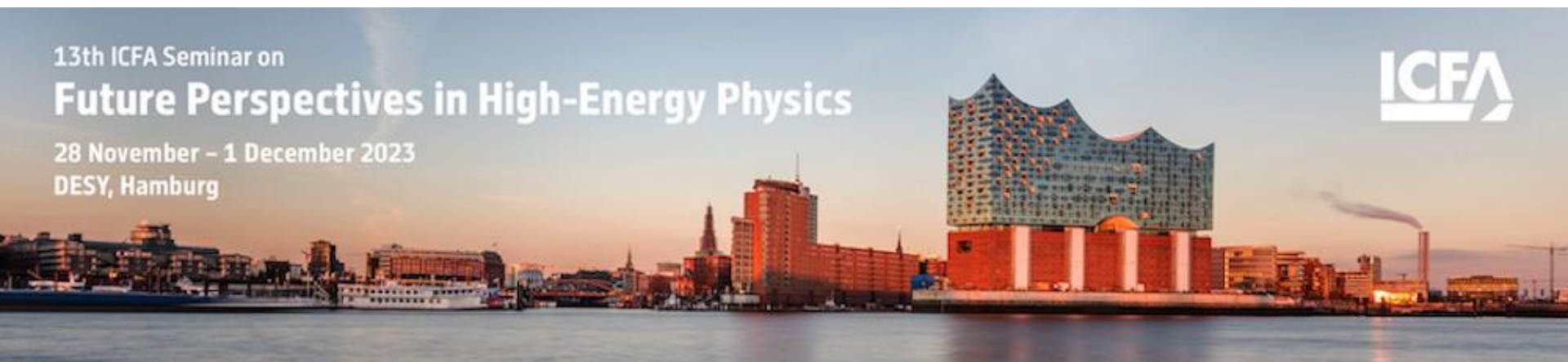


ICFA Seminar: a short review

Ties Behnke, DESY

13th ICFA Seminar on
Future Perspectives in High-Energy Physics

28 November – 1 December 2023
DESY, Hamburg



Seminar organized every 3-5 years, at different places around the world, by ICFA
Attendance by invitation, 2023 218 participants, including many lab directors and
representatives of funding agencies.



Schedule

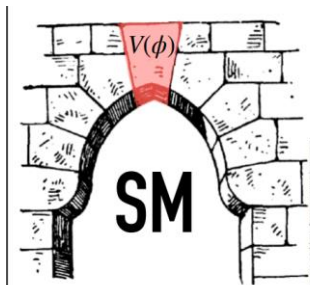
10:00	Electroweak physics at the LHC (including top mass and top properties)	Qiang Li	09:15 - 09:40
	Characterizing the Higgs boson - present and future	Sarah Helm	09:40 - 10:05
	Searches for BSM Higgs bosons and di-Higgs production	Roger Wolt	10:05 - 10:30
	Higgs theory perspective	Daniel de Florian	10:30 - 10:55
11:00	Coffee break		11:00 - 11:30
12:00	The Theory Landscape of Dark Matter	Yonit Hochberg	11:30 - 11:55
	Status of WIMP Searches: from deep underground and the sky	Jianglai Liu	11:55 - 12:20
	Searches for axions and other low-mass dark matter candidates	Axel Lindner	12:20 - 12:45

Broad survey of the field

- Current status
- Future initiatives
- Main directions of the fields

Talks and
round table discussion

Where are we going?



the Higgs
potential



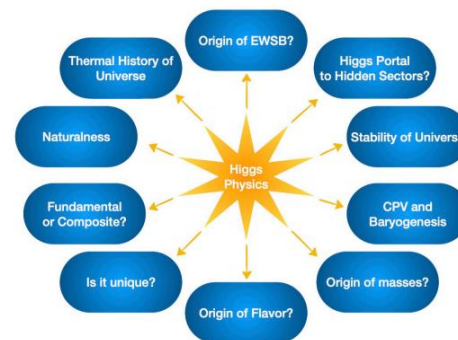
Dear Santa Claus,

*We have been good
these past decades.
Please could you
now bring us*

- *a dark matter candidate*
- *an explanation for the fermion masses*
- *an explanation of matter-antimatter asymmetry*
- *an axion, to solve the strong CP problem*
- *a solution to fine tuning the EW scale*
- *a solution to fine tuning the cosmological constant*

Thank you, Particle Physicists

ps: please, no anthropics



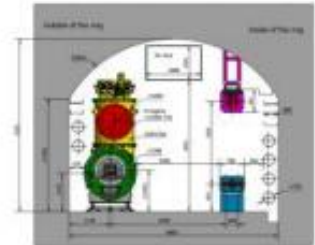
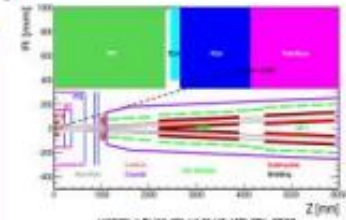
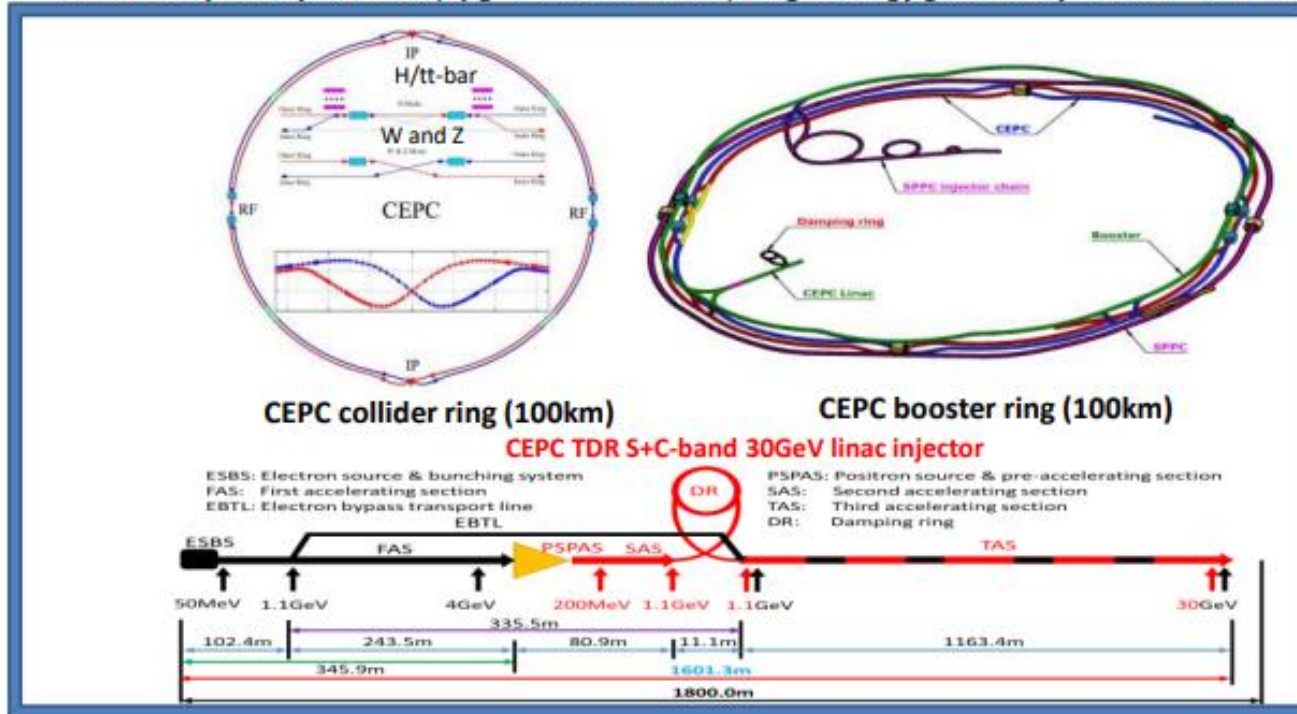
At any future collider:
“The guaranteed discovery: The Higgs Potential
(Observation of HHH interaction)”

CEPC Status: reported by J. Gao



CEPC Higgs Factory and SppC Layout in TDR

CEPC as a Higgs Factory: **H, W, Z**, upgradable to **ttbar**, followed by a SppC (a Hadron collider) $\sim 125\text{TeV}$
 30MW SR power per beam (upgradable to 50MW), high energy gamma ray 100Kev \sim 100MeV



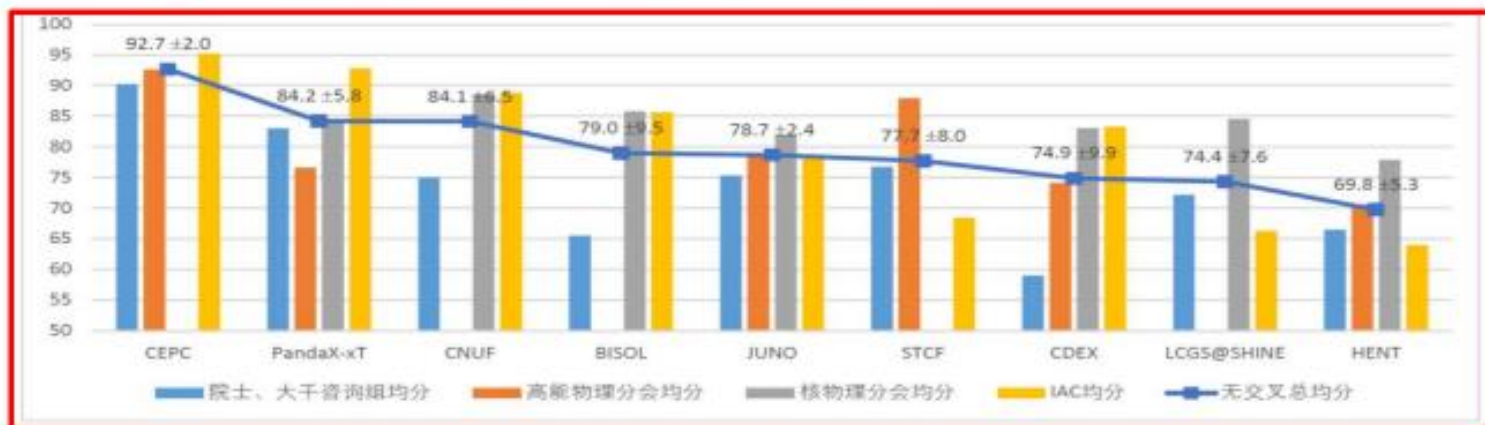
CEPC Civil Engineering





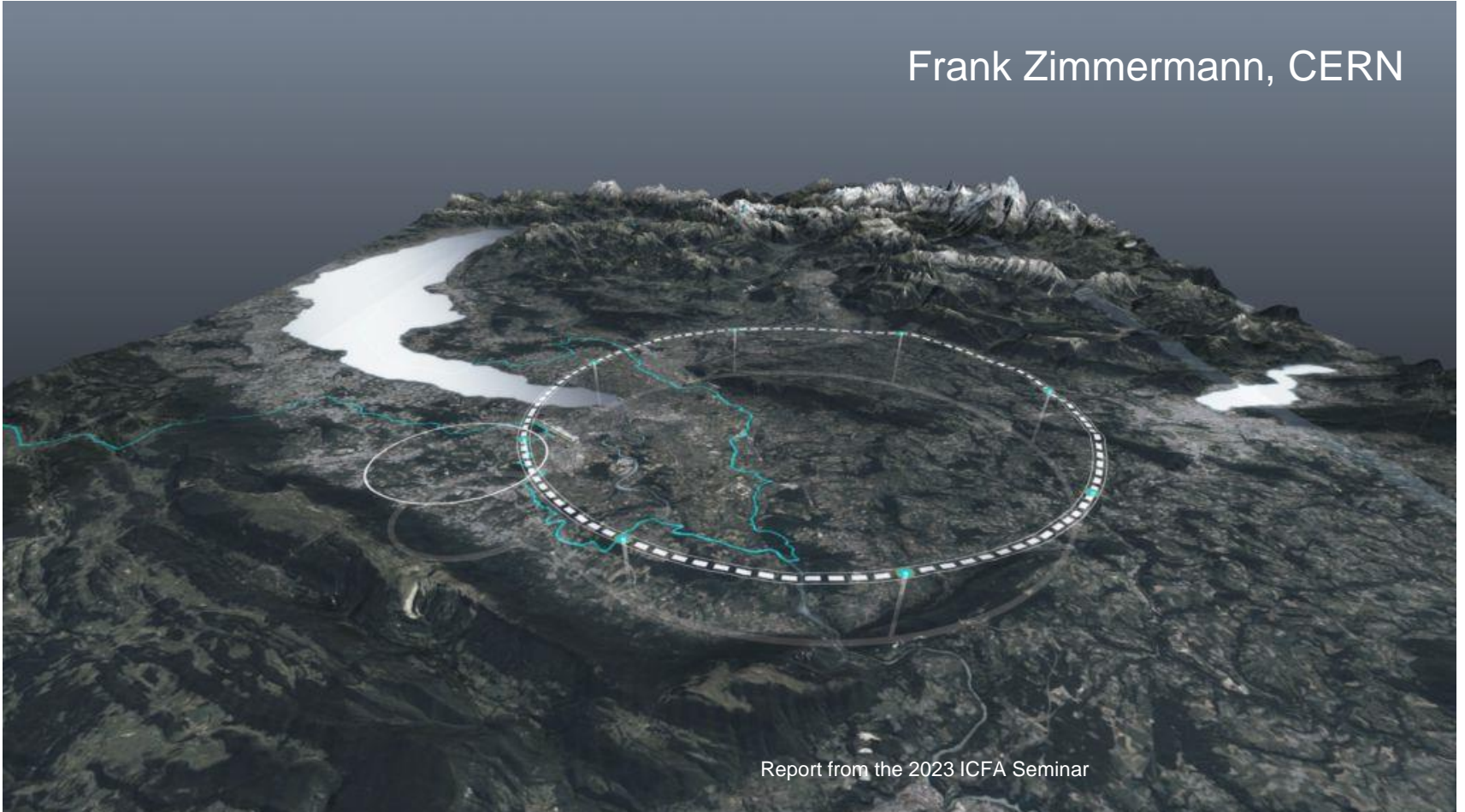
CEPC Project Development towards Construction

- **TDR has been completed** (review + revision) to be **formally released at the end of Dec. 2023**
- **CAS is planning for the 15th 5-years plan for large science projects**, and a steering committee has been established, **chaired by the president of CAS**
- **High energy physics and nuclear physics**, as one of the 8 groups, has been working on this for a year:
 - Setting up rules and the standard (based on scientific and technological merits, strategic value and feasibility, R&D status, team and capabilities, etc.), established domestic and international advisory committees
 - Collected 15 proposals and selected 9, based on the above-mentioned standard
 - Evaluations and ranking by committees after oral presentations by each project
- **CEPC is ranked No. 1, with the smallest uncertainties, by every committee**
- **A final report has been submitted to CAS for consideration**



CERN Future Circular Collider Study

Frank Zimmermann, CERN



Report from the 2023 ICFA Seminar

FCC timeline: technically driven

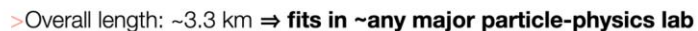
Frank Zimmermann, CERN

2025-2026	Permits and authorization for complementary site investigations
	Tendering for environmental impact and <u>authorisation</u> processes contract, tendering for subsurface investigations
2027-28	Complementary subsurface investigations
	Tendering for CE consultants, environmental impact studies, public concertation
2028	Project approval
	Award of CE consultant contracts
2029-30	Tender design
	Preparing calls for tenders for CE construction,
	Project <u>authorisations</u> in France and Switzerland obtained, preparations of infrastructures for construction
2031 mid 2032	Construction design, Tendering for construction
mid 2032	Award of CE construction contracts
	Preparation of site completed (road access, electricity, water...)
2033	Ground breaking

ILC in Japan



- ## CLIC at CERN



- >Length dominated by e⁻ beam-delivery system

Steinar: An adaptable e⁺e⁻ LC facility for the world

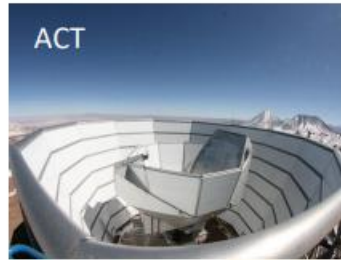


A LC facility can be extended in length for higher energies, using the same or improved versions of the same technology, e.g. as suggested for ILC, CLIC, C3 and HALHF.

- 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
- Starting point for fast implementation: ILC has the most mature linac technology for large scale implementation, that is also well established in all regions and in industry - it is based on a 20-21km long and ~9-10m wide tunnel
- 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

Non-collider physics: example CMB physics

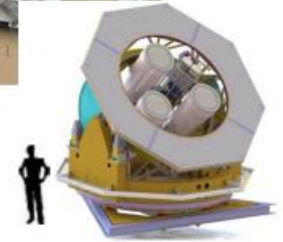
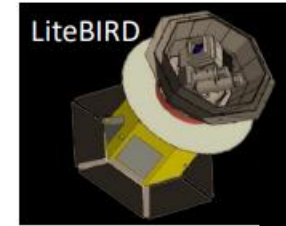
PAST



PRESENT

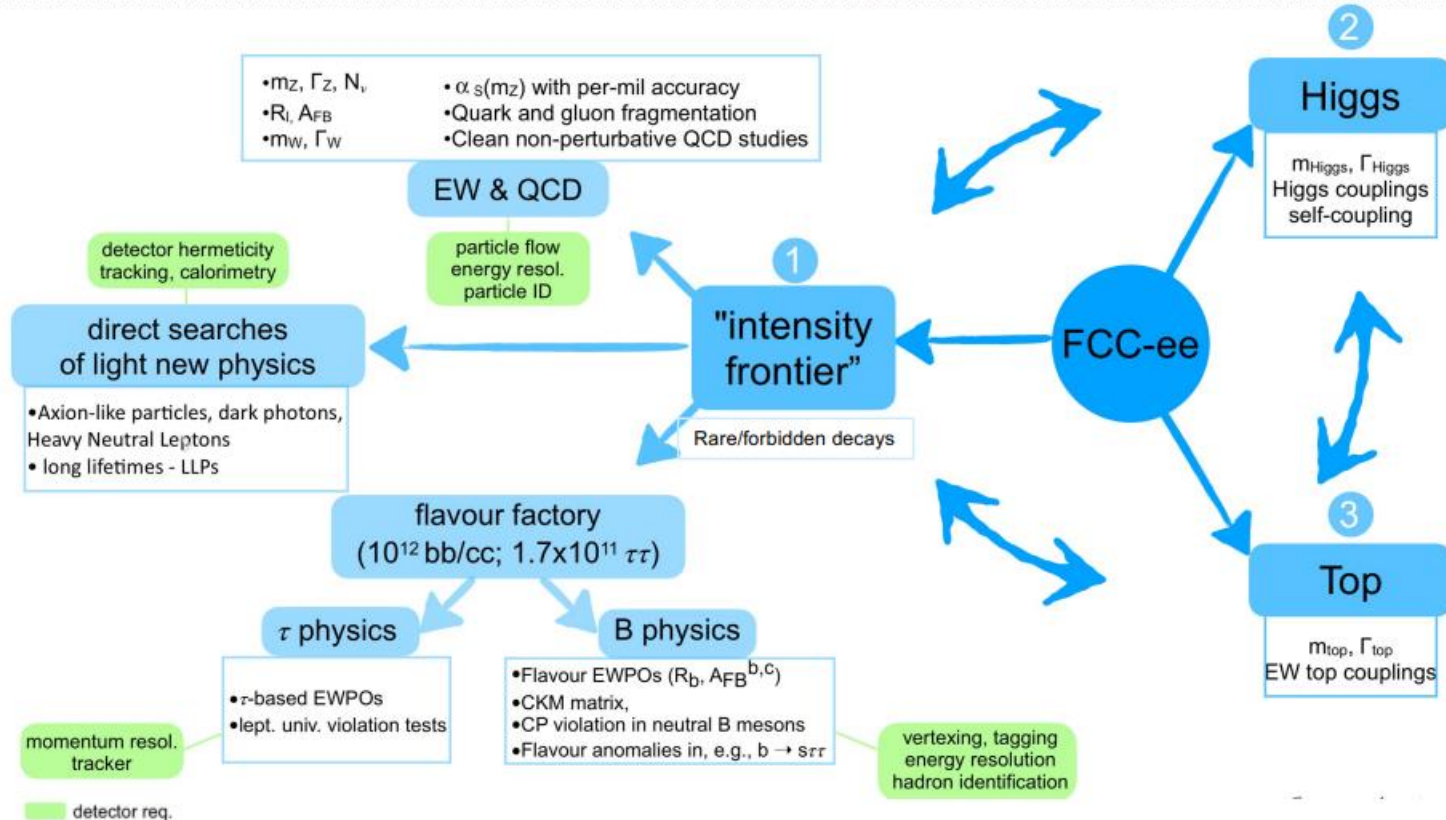


FUTURE



The Landscape of discovery

illustration is for FCC — but message is comparable for other colliders



desirable features of the next major HEP project(s)?

an important target to be reached \sim guaranteed discovery

exploration into the unknown by a significant factor in energy

major progress on a broad array of particle physics topics

likelihood of success, robustness (e.g. multiple experiments)

cost-effective construction & operation,
low carbon footprint, novel technologies

Strategy discussion

Round table discussion:

- Fabiola Gianotti (CERN)
- Shoji Asai (KEK)
- Jifang Wang (IHEP)
- Lia Merminga (FNAL)
- Moderators Ursula Bassler, Nigel Smith



CERN clearly put its priority on FCC (ee and hh): need to satisfy the CERN community

KEK continues to push for ILC@Japan

China pushes CEPC, is actively lobbying for international participation (but there is no junctim on international participation)

US is relatively open on collider discussions, no very clear position (but P5 recommendation will come our Dec 8)

Conclusion

A strategy for the next decade(s) in particle physics is taking shape

Currently a lot of emphasis is put on circular colliders, but other options are not off the table

A decision on where to go

- Within science will happen within the next few years (P5, ESP, ...)
- It is not clear if/when/how politics will follow
- Neighboring fields (cosmology, astroparticle, gravitational waves, etc) have ambitious plans as well

Outlook

NO ILD group meeting in January

ILD in-person/ hybrid meeting at CERN **Jan 15-17**

ILD group meeting on **February 6, 14:00** hours Paris time