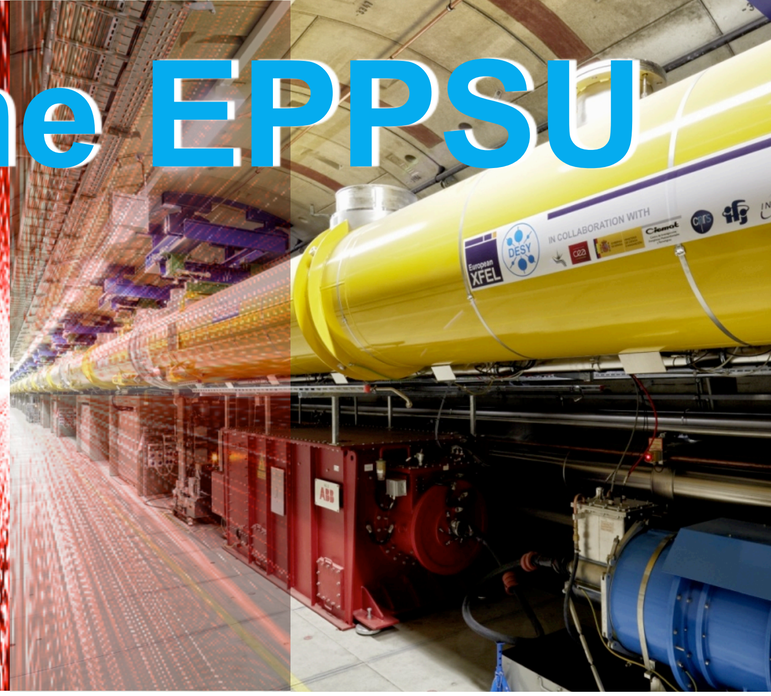
DESY Preparations for the EPPSU

Initiatives towards the EPPSU lead by DESY scientists



Jenny List

98th meeting of the DESY Physics Research Committee
DESY Hamburg
Nov 5 2024

European Strategy Update

DESY.

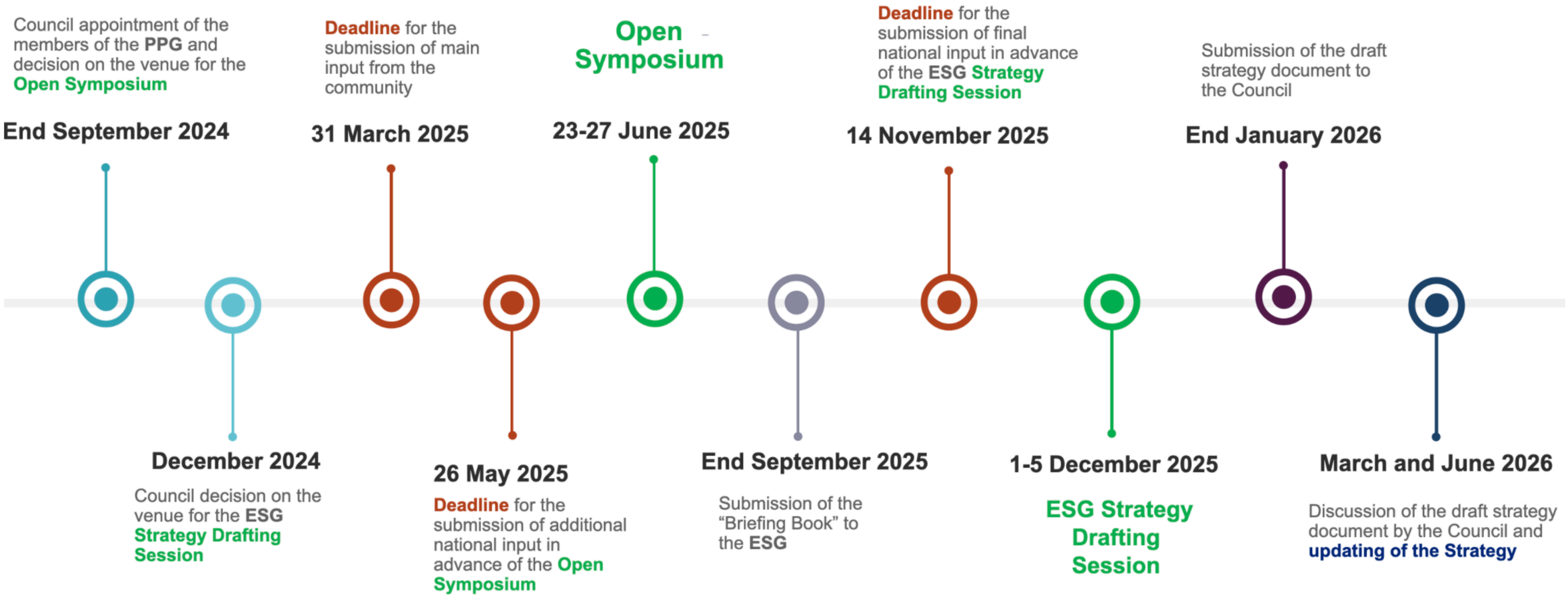
Overview

The menue for today

- **The process of updating the European Strategy for Particle Physics**
- **EPPSU contributions with DESY participation**
  - **German national contribution & ECRs**
  - numerous individual scientific inputs => not covered here
  - **selected submissions with (leading) contributions from DESY**
  - **submissions for experiments at DESY**
  - **new strategic initiatives (co-)initiated by DESY scientists**
- **Conclusions**

The EPPSU Process

c.f. https://europeanstrategyupdate.web.cern.ch/



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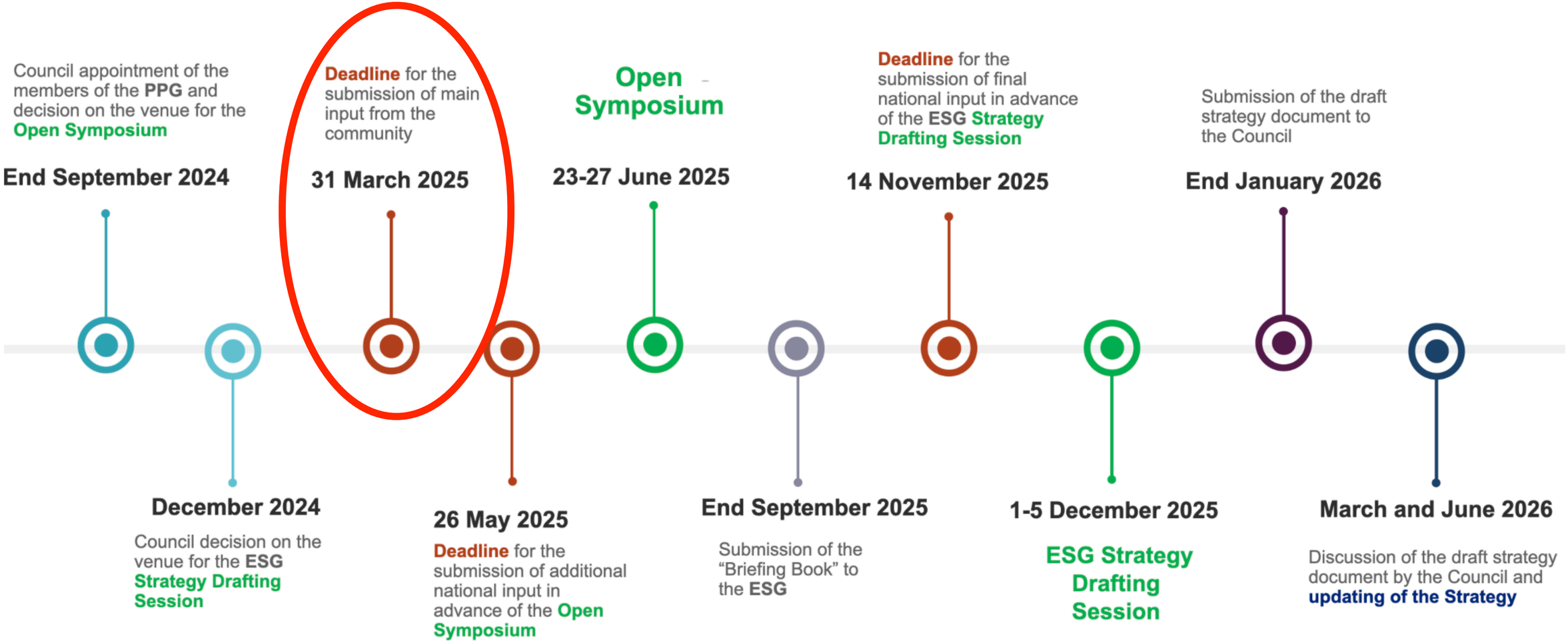

The remit of the European Strategy Group

as approved by CERN Council in June 2024

The remit of the European Strategy Group (ESG), established in June 2024, is to develop an update of the European Strategy for Particle Physics and submit it for approval by the Council. The aim of the Strategy update should be to develop a visionary and concrete plan that greatly advances human knowledge in fundamental physics through the realisation of the next flagship project at CERN. This plan should attract and value international collaboration and should allow Europe to continue to play a leading role in the field.

The ESG should take into consideration:

- ❑ the input of the particle physics community;
- ❑ the status of implementation of the 2020 Strategy update;
- ❑ the accomplishments over recent years, including the results from the LHC and other experiments and facilities worldwide, the progress in the construction of the High-Luminosity LHC, the outcome of the Future Circular Collider Feasibility Study, and recent technological developments in accelerator, detector and computing; the international landscape of the field.

The Strategy update should include the preferred option for the next collider at CERN and prioritised alternative options to be pursued if the chosen preferred plan turns out not to be feasible or competitive. The Strategy update should also indicate areas of priority for exploration complementary to colliders and for other experiments to be considered at CERN and at other laboratories in Europe, as well as for participation in projects outside Europe.

The ESG should review and update the Strategy and add other items identified as relevant to the field, including accelerator, detector and computing R&D, the theory frontier, actions to minimise the environmental impact and to improve the sustainability of accelerator-based particle physics, the strategy and initiatives to attract, train and retain the young generations, public engagement and outreach.

The ESG should submit the proposed Strategy update to the Council by the end of January 2026.

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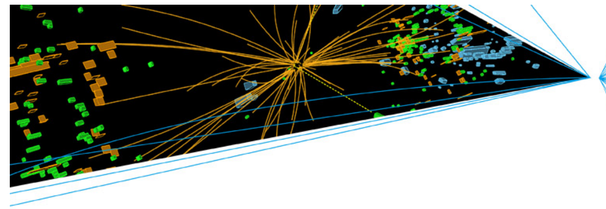
The German national process toward the EPPSU

Organized by the Committee for Elemetary Particle Physics - KET

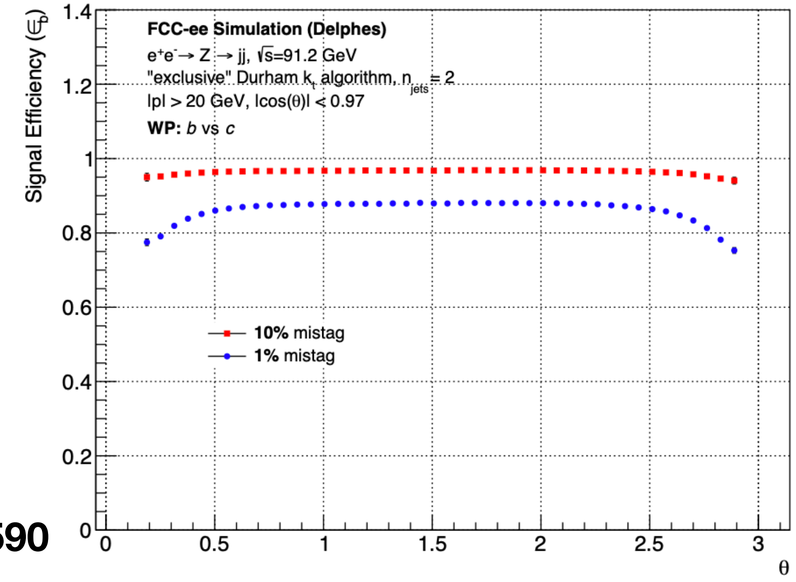


- three strategy workshops
  - **“non-collider” Nov 22-24, Bad Honnef,** https://indico.desy.de/event/45358/
    - DESY speakers: A. Ringwald, F. Kling, R. Jacobs, M. Kowalski, I. Schulthess, K. Peters
  - **“collider” Nov 27-29, DESY,** https://indico.desy.de/event/45276/
    - DESY speakers: G. Weiglein, S. Moch, C. Schwanenberger, M. Wing, B. List + JL co-chair of PC
    - **incl. 1/2 day Early Career Scientists part, organised by yHEP**
      => yHEP and DESY ECB contribute actively to ECFA ECR panel
  - **“concluding” Jan 19-22, Bad Honnef**
- KET identified core teams to write conclusions from discussions at each workshop
- new KET (starts Nov 21) will then finalize and sign-off on German EPPSU input
- time between March 31 and Open Symposium deemed too short to update national input
  => if update will be needed, aim for Nov 2025 deadline

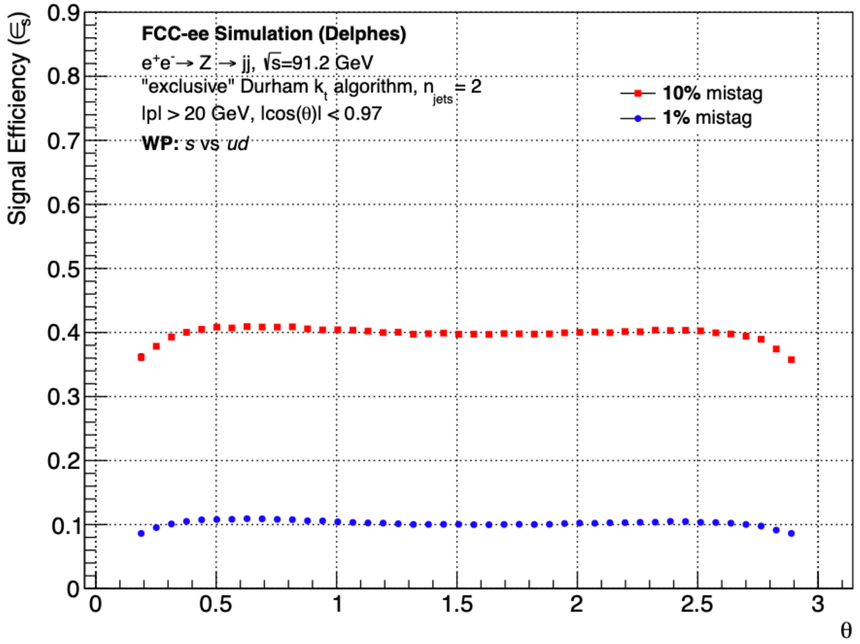
Selected submissions with (leading) contributions from DESY

FCC Feasibility Study

- mainly run by CERN (of course)
- **DESY leadership roles C.Grojean & F.Sefkow**
- further DESY contributions to
  - MDI: M division with FTX, FCCIS project
  - ILD@FCC-ee
  - H->ss in fast simulation of IDEA
  - long-lived particle searches and other low mass exotica
  - di-Higgs production FCC-hh
  - key4HEP software stack
  - new particles with low mass splitting
- **for EPPSU: final report of Feasibility Study**



arxiv:2406.08590



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Only a selection!

ECFA Higgs/Top/EW Study

- DESY co-coordinators: JL (WG1 Physics Potential), D. Zerwas (WG2 Physics Analysis Methods), F. Sefkow (WG3 Detectors)
- last WS held Oct 10-12 in Paris, ~200 participants
- **for EPPSU: final report**
  - **~100 inputs on new physics studies received (WG1)**
  - first draft to rECFA & IAC by mid-December
  - approval by rECFA in early March, public *before* 31st

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ILD Detector Concept

- developed for ILC, recently explored applicability for FCC-ee
- spokesperson T.Behnke; 3 more DESY scientists in Executive Team
- **EPPSU input: position ILD as detector concept for *any* Higgs factory**
- with its established full simulation & reconstruction and proto-collaboration structures serves as platform for Higgs factory detector ideas and physics case
  => core software support from FTX group crucial

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Other colliders with smaller DESY contributions

- Muon Collider:
  - F. Meloni, P. Pani
  - **DESY will host IMCC2025 May 12-16**
- LHeC: C. Schwanenberger
- **prepare EPPSU inputs**

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ILC in Japan

- JL chair of IDT-WG3
- **important DESY contributions to ongoing cost update and sustainability (full LCA of accelerator)**
- **IDT will prepare EPPSU input**

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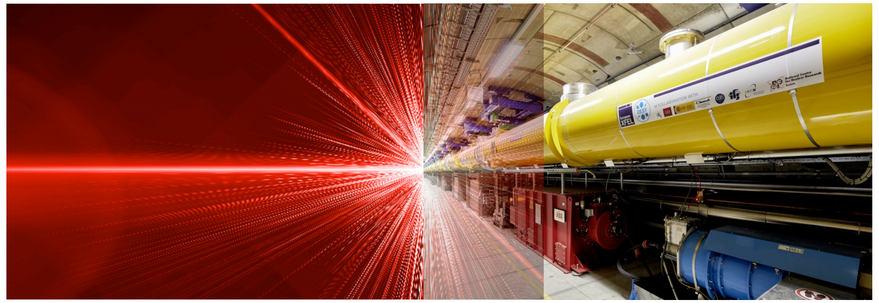
Experiments at DESY: LUXE & SF-QED

Recently very good news on LUXE



- QED in the presence of strong electromagnetic fields is terra incognita
- Strong-field QED workshop at DESY Dec 2-3 https://indico.desy.de/e/sfqed24
- LUXE: precision exploration of Schwinger limit with EU.XFEL (16.5 GeV) and 10…400TW laser
  - received CD1 a year ago
  - received EU INFRA-TECH grant to finance the extraction beam line (ELBEX)
    => general facility for experiments with 16.5 GeV electron beam
    => to start in January 2025
  - 10TW laser donated from U Jena => setup in HERA Hall West for development
  - new spokesperson: M. Wing
- LUPE: first explorations far beyond Schwinger limit with 1 or 6 GeV LPA beam (KALDERA) and laser boosted by plasma mirror
  - submitted ERC Synergy Grant proposal with PIs from CEA Saclay, DESY FH & M, U Rochester/MPI HD
  - detector systems synergistic with LUXE
- **EPPSU input on LUXE in preparation**
- **Under discussion: a broader SF-QED input ?**

Experiments at DESY: Axion Platform @ Hamburg

DESY and the Excellence Cluster “Quantum Universe”

ALPS-II

- Model-independent approach: identify a dark matter candidate, measure coupling strength to photons

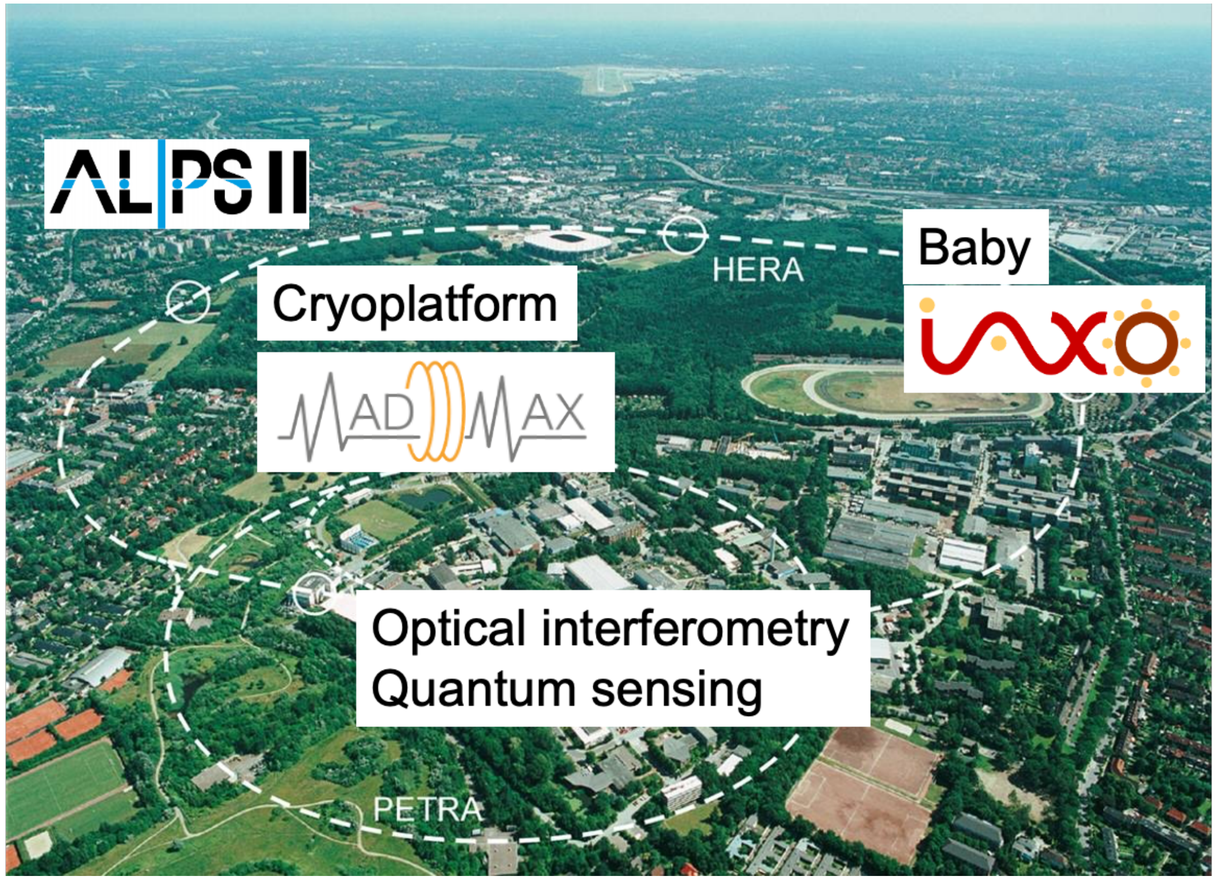
Baby IAXO

- Determine solar axion flux, coupling strength to electrons and nuclei
- Enlarge discovery parameter space
- IAXO Collaboration: EPPSU input on (full) IAXO, **with strong DESY participation**

MADMAX

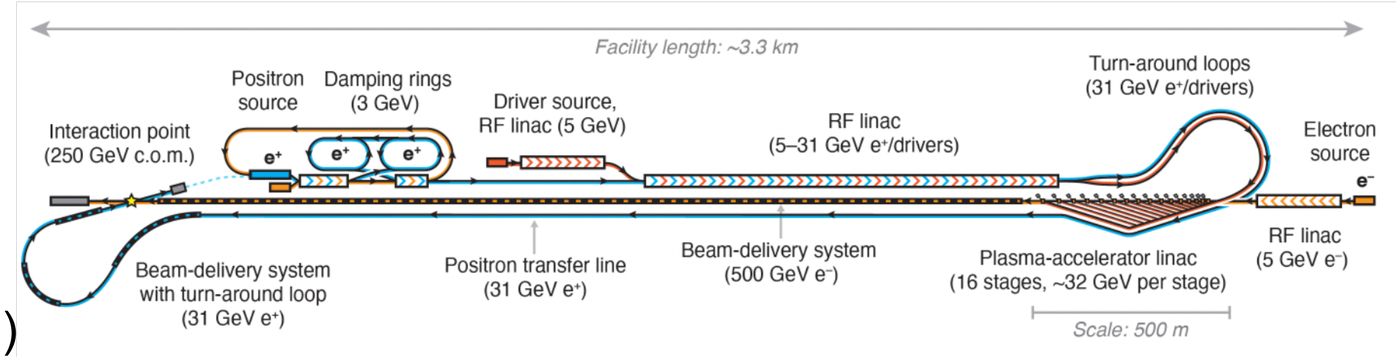
- Confirm axions as dark matter constituents
- Enlarge discovery parameter space

=> under discussion:
EPPSU input Axion Platform @ Hamburg

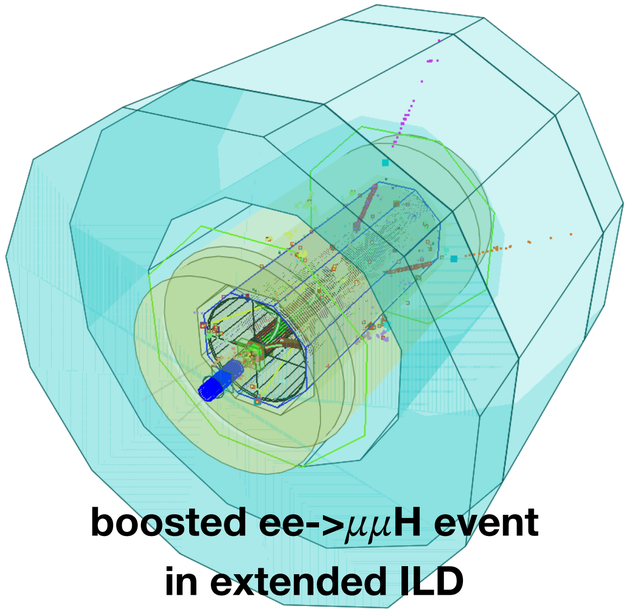


Strategic Initiatives co-lead by DESY: HALHF

Guiding Beam-Driven Plasma Wakefield Acceleration towards Collider Needs



- Hybrid Asymmetric Linear Higgs Factory (New J.Phys. 25 (2023) 9, 093037)
- ~ 3km !
- Workshops in Oslo (Apr ‘24) and Erice (Oct '24)
  - identify system challenges
  - optimise accelerator design & cost
  - consolidate new baseline
- Physics & Detector:
  - working towards an adapted, asymmetric version of ILD
  - many interesting design tasks (tracking & vertexing, luminosity measurement, EWPO, …)
  - so far no fundamental show-stoppers to achieve ILC-like performance
- **EPPSU input in preparation**
- HALHF WS at DESY Feb 27/28 to finalize EPPSU



boosted ee->$\mu\mu$H event in extended ILD

Strategic Initiatives co-lead by DESY: Dark Matter Technology Network

Proposal for an input to the EPPSU process

Complementarity to large colliders: Dark Matter experiments at CERN and other labs in Europe

- Next-generation experiments often beyond capabilities of single lab
- Many common interests: beams (eg CERN, Bonn, DESY), magnets (eg CERN, DESY), RF cavities, cryo (eg DESY), detectors, underground infrastructure (eg LNGS, LSM), software, data management, …
  => to be fostered & coordinated
- Technologies developed for collider-based experiments complement APPEC activities

=> calls for combined action to further dark matter research in Europe!

Proposal: Form a "Dark Matter Technology Network" of European institutions that

- engage in dark matter searches using accelerators or other significant infrastructures,
- command significant expertise, infrastructures and facilities,
- are willing to share knowledge and infrastructure and
- contribute to the network with dedicated person power and resources at a level to be defined by all partners.

Drivers: J. Schieck (HEPHY), T.Schörner (DESY), D.Zerwas (DMLab)

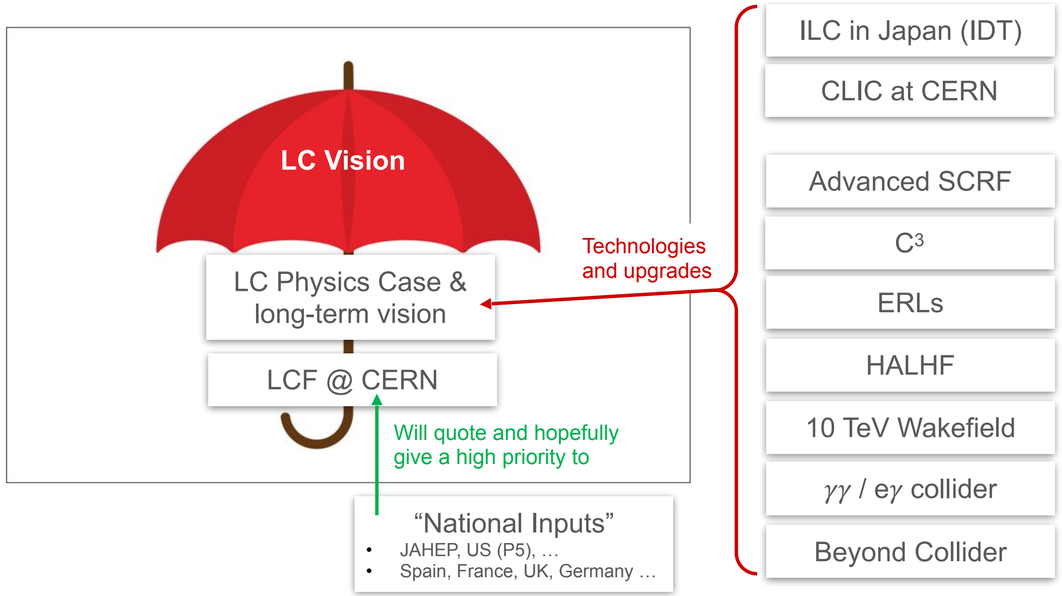
- interested partners so far: HEPHY, U Bonn, DESY, IJCLab, DMLab
- organize discussion during November to decide on EPPSU input

Strategic Initiatives co-lead by DESY: Global Linear Collider Vision

An umbrella for all Linear Collider proposals

- think-tank initiated in spring 2024 by S.Stapnes & JL
- presented and discussed at LCWS 2024
- **decided to present for the EPPSU:**
  a) a **Global LCVision**
  - physics case and the priorities on top-level parameters
  - upgrade strategies — also across technologies

  b) turn this into a proposal for a **Linear Collider Facility @ CERN**



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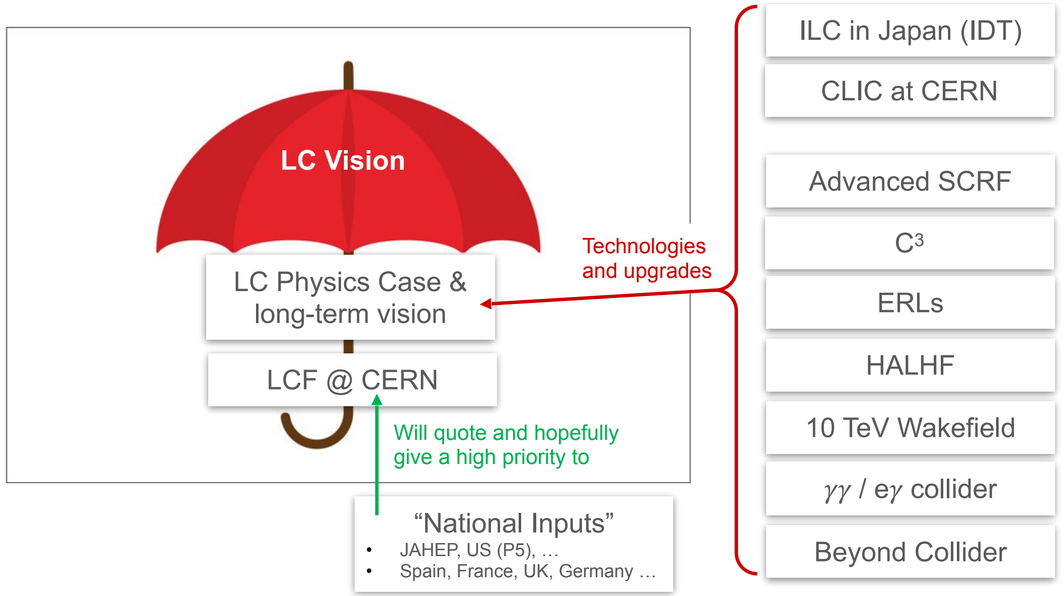

- Coordination group & 8 expert teams work on baseline & upgrade scenarios:
  - baseline: Linear Facility, with 2 Beam Delivery Systems (2 IRs), beyond-collider facilities, length
    a) ~20 km (e.g. 250 GeV SCRF)
    b) ~30 km (e.g. 550 GeV SCRF — CEPC complementarity from day-one)
  - upgrades: put advanced technologies into same tunnel
- A (very small) team at CERN & DESY working on siting, drawings, sustainability …
- ILC costing being updated (review in Dec, public in Jan), combine with CLIC CFS costing for LCF@CERN

Conclusions

DESY in the EPPSU

- DESY is engaged in preparations for the EPPSU at various levels
  - from “contributing” to “spearheading”,
  - from ECFA study to German national input,
  - from local experiments to candidates for the next flagship project at CERN
  - plus a dedicated submission on the plans of DESY

=> DESY has a strong role in shaping the future of particle physics — and considers it important that the strategy process is a real process with open discussions

=> everybody at DESY is invited to engage

- eg at the 2nd FH Future Collider Day (Nov 11, https://indico.desy.de/event/46801/)
- or at the KET strategy workshops

Thank you
- any questions?