

INTERPLAY WITH EXPERIMENTAL PHYSICS AND TECHNOLOGY PROGRAMS.

DFG Rundgespräch: Theory Hub for FCC-ee Physics
JGU Mainz, July 2/3, 2026

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HELMHOLTZ



Image Source: FCC Study

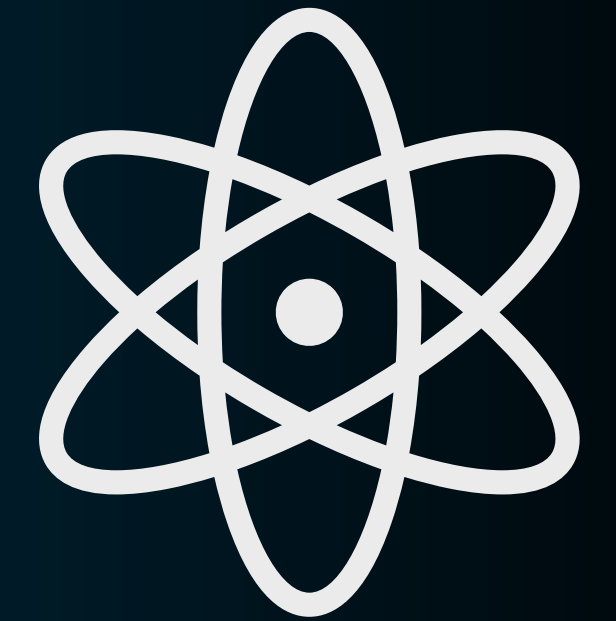
FCC-ee Goals

Scientific, Technological, and German Political Perspectives.

Scientific goal: leadership in **fully exploiting FCC-ee data** for physics (Higgs, QCD, electroweak, flavor, BSM)
→ cannot be done by experimentalists alone, **close collaboration** with theory community **indispensable**

Technological goal: push the envelope of **technology** in accelerators, detectors and computing (including AI, electronics, quantum technologies)
→ Germany providing **unique expertise**

Political goal: strengthen European **technological sovereignty** and **generate revenue** for German industry



Unique Technology Expertise for FCC-ee

German Technology Focus: Accelerators.

Key **accelerator** expertise, e.g.:

- **Superconducting radio frequency (SRF) cavities** developed for European XFEL and other X-ray lasers
- **Beam instrumentation**, digital twins

Ongoing effort: German institutes part of **coordinated R&D programs** across Europe (e.g. ECFA accelerator R&D roadmap)

Future: **adaption** of technologies to FCC-ee needs, **industrialization**

Unique Technology Expertise for FCC-ee

German Technology Focus: Particle Detectors, Electronics, Computing

Key particle detector expertise & leadership:

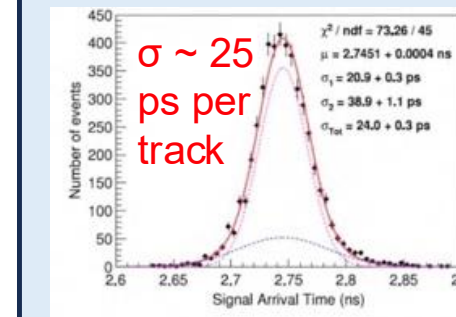
- **Tracking:** silicon and gaseous vertexing/tracking
- **Calorimetry:** highly granular imaging calorimeters
- **Detector concepts:** full system integration including electronics, software & simulation, AI, online and computing → theory input indispensable

Ongoing effort: **strategic R&D** on detector technologies in ECFA DRD collaborations

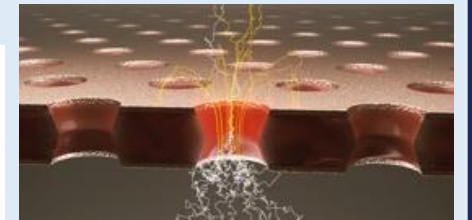
Future: formation of (proto-)collaborations for FCC-ee experiments

DRD1: Gaseous Detectors

Large · Fast · eco-friendly
gases · MPGD, e.g. GEMs

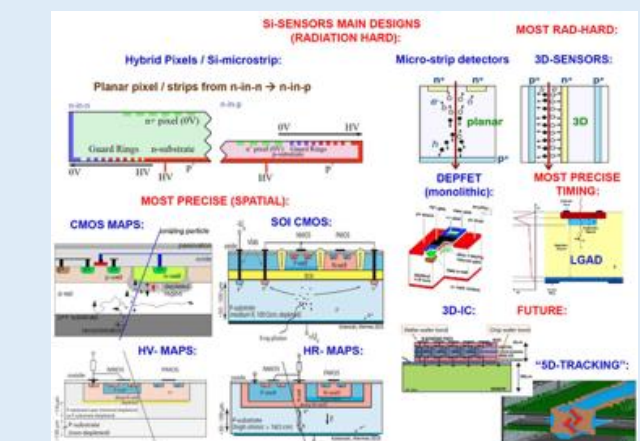


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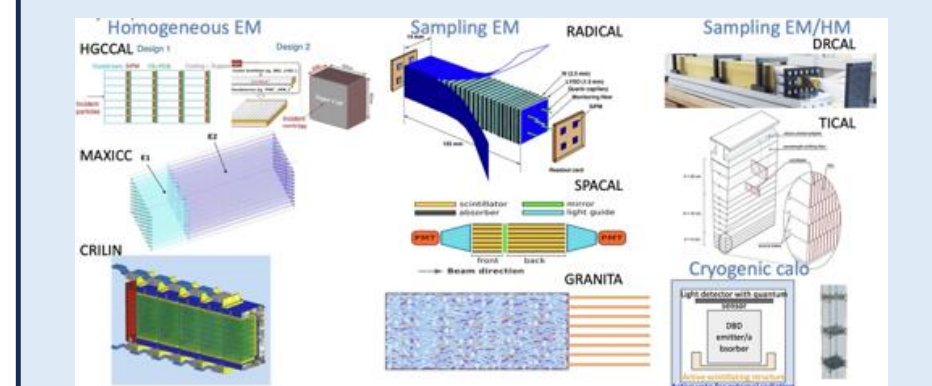
DRD3: Semiconductor Det.

Monolithic CMOS · LGADs ·
radiation hardness · interconns.



DRD6: Calorimetry

Energy resolution · High
granularity · dual readout ·
particle flow · sandwich · optical



Tech Sovereignty and Industry Revenue

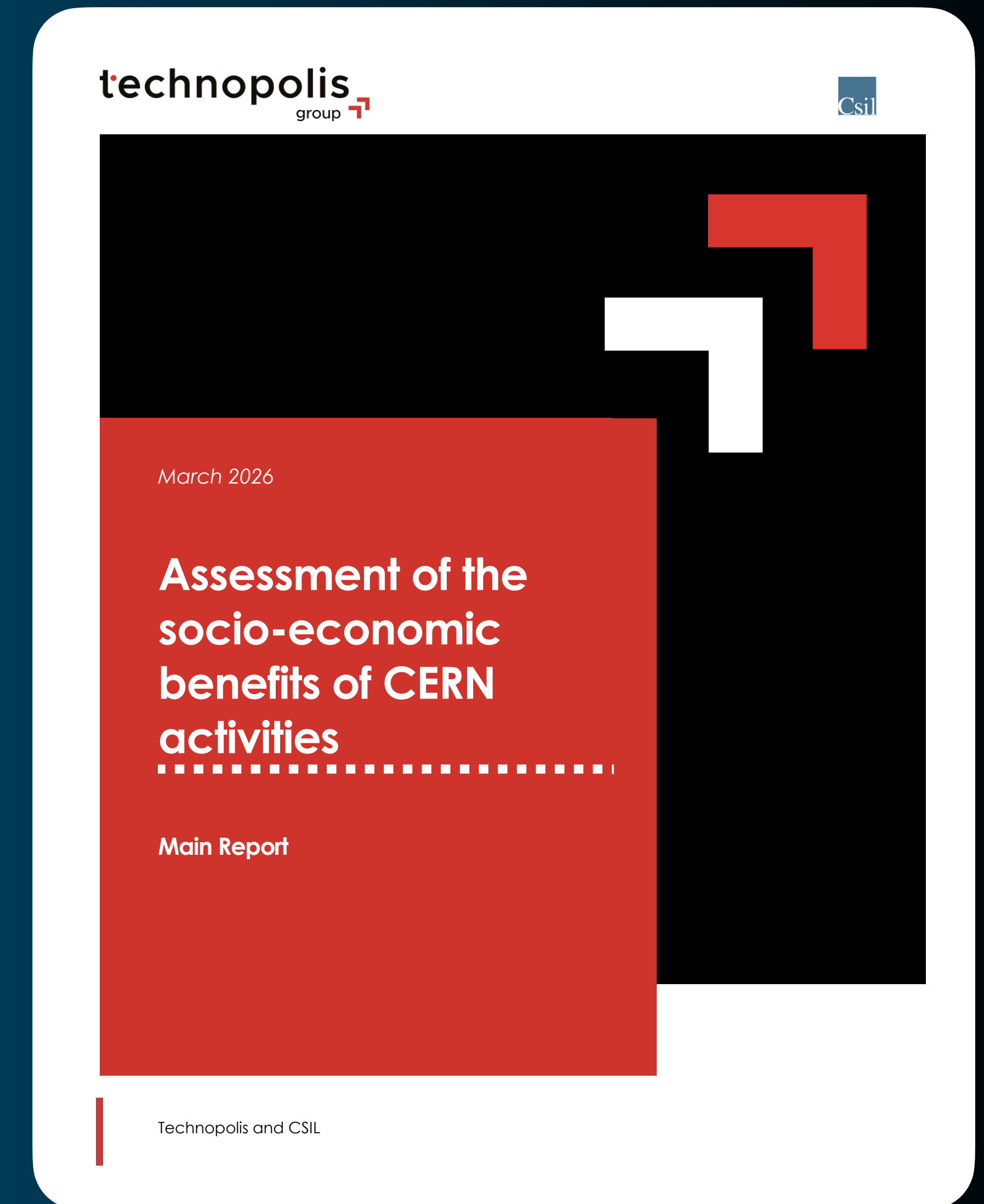
Socio-economic Benefits of Basic Research.

Large-scale projects like FCC-ee contribute to **European technological sovereignty**:

- Systematically identify potential for **bidirectional technology transfer**
- Train highly skilled **deep-tech experts**

Large-scale research projects generate **industry revenue**:

- Industrialize mass production of components (e.g. SRF cavities: successfully industrialized for European XFEL)
- Contribute to civil construction (e.g. CO₂ reduced concrete), ...



<https://zenodo.org/records/19910290>

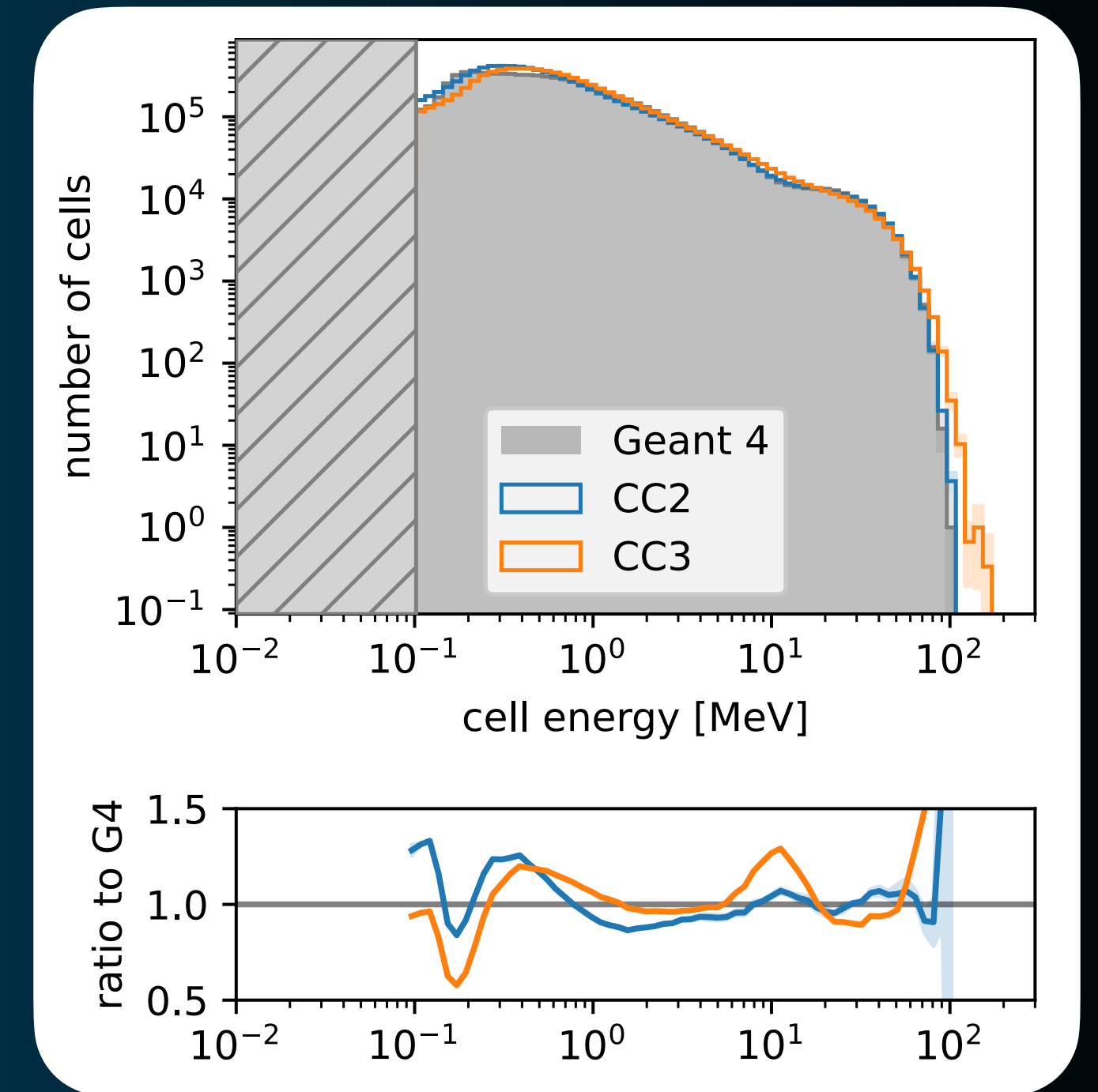
FCC-ee Activities at DESY Today

Future Flagship as a Strategic Goal of Helmholtz Matter.

Broad FCC-ee engagement in DESY's particle physics division

- Vertex detectors and highly granular calorimeters
- Studies on physics (Higgs, Flavor, BSM), background, machine-detector interface
- Software stack and detector simulation
- Phenomenological studies and MC generators
- Coordinating roles in physics and detectors

Accelerator division: superconducting RF cavities



From Helmholtz Matter Strategic Evaluation Report 2026:
"Continue strengthening preparation for the next European flagship collider programme and associated detector and computing technologies."

DESY's Particle Physics Vision

German National Laboratory for Particle Physics.

Key contributions to **international flagship projects**:

- **ATLAS & CMS** including upgrades, Belle II
- **Future flagship** collider at CERN

Complementary **on-site program** at DESY: axions, gravitational waves, strong-field QED

Support of **German community**

Upcoming: **German FCC-ee Workshop** at DESY, December 2–4, 2026



Conclusion

Towards an FCC-ee Theory Hub.

Successful implementation of large-scale scientific projects like the FCC-ee requires **interplay of complementary efforts**:

- Theory – experiment – technology
- Academia – industry – politics

FCC-ee Theory Hub: very welcome in German FCC-ee community, **fully complementary** to experimental physics and technology efforts

Thank You.

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