

FCC Studies 2027–2029

From the LHC to FCC-ee: preparing Finnish participation in the next collider era

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The 2027–2029 window is the time to establish a Finnish FCC presence

- The 2026 European Strategy recommends FCC-ee as the preferred next flagship collider at CERN (as does the Finnish input).
- A CERN Council construction decision is expected around 2028.
- FCC Week 2026 in Helsinki gave Finland momentum; the project converts it into a standing national structure.
- HL-LHC remains the medium-term priority, so FCC activity begins through focused, low-overhead extensions of existing strengths.

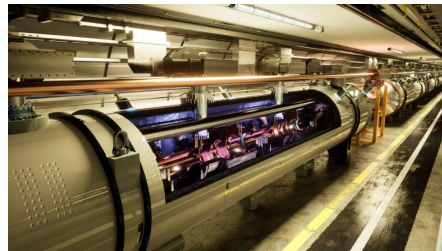


Image: CERN, artistic representation of FCC-ee (2026).

Project logic: existing HIP strengths
→ finished FCC outputs → external
funding and formal roles.

Finland connects a strong national community to the global FCC effort



Finnish Particle Physics Days: Henning Kirschenmann



FCC Week 2026: Jeeti Kalombo / CERN

Nearly 70 participants at Particle Physics Days 2025; 656 at FCC Week 2026

Four focused entry points reuse strengths that HIP already has

1. From CMS jets through LEP data to FCC-ee

CMS jet calibration and tagging expertise, LEP open data, FCC-ee α_s , Higgs and top observables.

2. Photon-induced processes

CMS/PPS $\gamma\gamma$ and τ experience, plus PYTHIA validation against LEP data.

3. Detector entry points

Silicon, MAPS, timing/LGAD, electronics and particle-flow performance assessed with common criteria.

4. Software and training

A reproducible analysis workflow and a Finnish/Nordic-Baltic workshop or hackathon.

- HIP targets **0.1% jet-energy precision** in CMS and studies jet, V+jet and top observables.
- The started LEP/FCC-ee α_s analysis provides a concrete seed: Le and Voutilainen with d'Enterria.
- A 2027 MSc pilot will reproduce a LEP event-shape or jet-rate result with modern, reproducible tools.
- Jet tagging expertise and energy-scale control transfer to $H \rightarrow b\bar{b}, c\bar{c}, gg$ and top-threshold studies.

Finished output

By early 2028

A thesis-scale result with an FCC component and a documented workflow.

Thread leads: Kirschenmann, Laurila

Contributing: Le, Voutilainen, d'Enterria

Photon modelling offers a distinctive, decision-robust niche

- CMS Forward Physics measures exclusive $\gamma\gamma \rightarrow \ell^+\ell^-$ and prepares $\gamma\gamma \rightarrow \tau^+\tau^-$.
- Related FCC-ee processes and τ final states are signals and precision-limiting backgrounds.
- PYTHIA expertise enables validation against LEP data and improved photon-virtuality modelling.
- Two-photon modelling is under-resourced and retains value if the FCC schedule changes.

Finished output

By mid-2028

A validation result, technical note or thesis component.

Thread leads: Österberg, Helenius

Contributing: Lehti; interface with L. Harland-Lang

A technology route in 2028; the concept decision comes later

Technology routes – choose one in 2028

- Silicon tracking and vertexing via DRD3
- MAPS and digital calorimetry via ALICE/FoCal
- Precision timing and LGAD technologies
- Detector readout, trigger and control electronics
- Particle-flow reconstruction and detector optimisation

Co-leads: Brücken; Luukka / Österberg / Räsänen (tbc)

Contributing teams: instrumentation and analysis

Common assessment criteria

- Scientific leverage and HIP fit
- Person-power and cost
- HL-LHC complementarity
- International maturity

Detector concepts – not decided here

ALLEGRO, IDEA and CLD are monitored through Pekkanen, Pirttikoski and Mieskolainen (ALLEGRO), and the IFNC. Commitment follows the Council decision.

Technology-route decision: mid-2028

Recommend one preferred technology route, timed to feed the FCC pre-TDR process. No institutional commitment to a detector concept (ALLEGRO / IDEA / CLD) within the project period.

Training turns a small initial effort into reusable capacity

- 1 **Start with an authentic analysis:** the LEP open-data pilot connected to FCC-ee observables.
- 2 **Preserve the workflow:** minimal FCC software, open data, computing and analysis-preservation guidance.
- 3 **Broaden the network:** a Finnish and Nordic-Baltic workshop or hackathon (if resources allow).
- 4 **Reuse the platform:** future externally funded MSc, PhD and postdoctoral projects start from tested material.

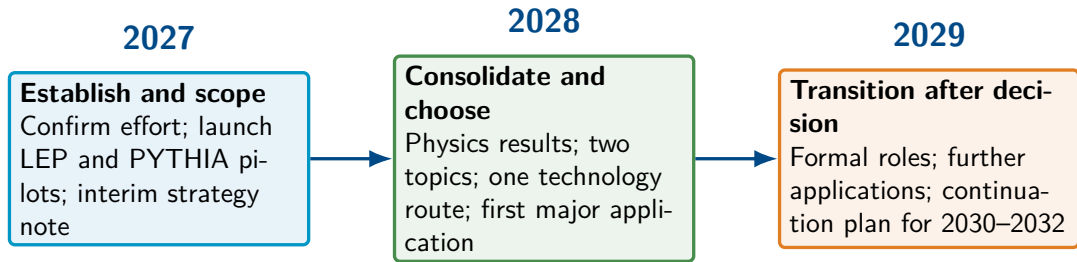


Image: FCC Collaboration, FCC Week 2026 Helsinki.

Thread leads: Laurila,
Kirschenmann

Open science: Lassila-Perini

The work plan establishes scope before major investment



Decision points

- End 2027: pilots demonstrate credible participation
- Mid-2028: narrow the portfolio; publish the strategy report by year-end
- After the Council decision: map formal commitments

Indicative minimum operational invest.

EUR 10–20k/year, partial student support and about 0.5–1.5 FTE across project and thread leads, mostly through explicit reallocation.

Evidence first → narrower scope → formal commitments

Named leads connect each thread to existing HIP strengths

Project lead: Henning Kirschenmann

From CMS jets through LEP data to FCC-ee

Thread leads: H. Kirschenmann, S. Laurila

Contributing: V. D. Le, M. Voutilainen, d'Enterria, ...

Photon-induced processes

Thread leads: K. Österberg, I. Helenius

Contributing: S. Lehti; interface with L. Harland-Lang, ...

Detector entry points

Co-leads: E. Brücken; P. Luukka / K. Österberg / S. Räsänen (tbc)

Contributing: T. Hildén, F. Garcia, A. Karadzhinova-Ferrer, M. Mieskolainen, J. Pekkanen, A. Pirttikoski, ...

Software and training

Thread leads: S. Laurila, H. Kirschenmann

Open science: K. Lassila-Perini

Execution safeguards

- Explicit effort agreements
- bounded outputs
- two physics topics and one technology route before scale-up

Proposed roles; participation fractions remain to be agreed.

The main risks are explicit and manageable

Risk	Why it matters	Mitigation built into the plan
Limited person-power	Existing programmes retain primary commitments	Confirm effort explicitly; use bounded pilots and finished outputs
Delayed or negative FCC decision	Timing and formal roles may change	Prioritise LEP analysis, generator validation, technology scoping and training with standalone value
Over-broad scientific scope	Visibility is diluted across too many topics	Narrow in 2028 to two physics topics and one technology route
Funding gaps	Major positions and detector R&D exceed the operational budget	Work towards at least two external applications or pre-proposals

The project gives HIP options at the 2028 decision point

- A **national anchor** during the decisive FCC period
- Finished physics outputs and one evidence-based technology-route recommendation
- A reusable training platform and Nordic-Baltic network
- A route for HIP-associated researchers abroad and future funding applications

Guidance requested from the SAB

- 1 When should Finland commit to a detector concept?
- 2 How should Nordic/Baltic activity be coordinated?
- 3 What minimum resourcing makes the plan executable?

Backup: finished outputs and funding traction

When	Visible output	Primary lead
H1 2027	Participation confirmed; LEP pilot and PYTHIA task list launched; detector EoI engagement	Kirschenmann / thread leads
Jun–Dec 2027	Internal scoping note; first α_s result or status note; interim Finnish FCC strategy note	Kirschenmann, Le, Voutilainen, d'Enterria,
Mid–late 2028	Detector-entry recommendation; $\gamma\gamma$ validation note; open Finnish FCC strategy report	Thread leads / Kirschenmann
2028–2029	At least two funding applications or pre-proposals; Nordic-Baltic exchange	All / Laurila
2029	Formal-role mapping and continuation plan for 2030–2032	Kirschenmann

Backup: operational investment and funding routes

Indicative minimum operational invest.

- EUR 10–20k per year for FCC/PED/CERN travel, workshops, visitors, dissemination and contingency
- Partial MSc/PhD project support
- About 0.5–1.5 FTE across project and thread leads, mostly through explicit reallocation among HIP projects

Funding pathways opened

- Research Council of Finland and FIRI
- MSCA, ERC and COST
- DRD common projects and FCC PED roles
- Private Finnish foundations
- Network and coordination funding

Backup: proposed personnel and interfaces

Area	Proposed contributors and interfaces
Leadership / QCD	H. Kirschenmann; M. Voutilainen; S. Laurila; V. D. Le; collaboration with D. d'Enterria
Photon physics / generators	K. Österberg; I. Helenius; S. Lehti; contact with L. Harland-Lang
Detector systems	E. Brücken; P. Luukka; T. Hildén; F. Garcia; A. Karadzhinova-Ferrer; S. Räsänen; CMS Upgrade, ALICE and DRD3 interfaces
Calorimetry / reconstruction	M. Mieskolainen; J. Pekkanen; A. Pirttikoski; contact with J. Pata
Open science / training	K. Lassila-Perini; MSc students to be recruited
All personnel retain their primary duties; FCC participation begins at small, explicitly agreed fractions of time.	

Backup: funding routes follow the outputs

Activity	Project output	Natural route
LEP/FCC-ee α_s	Result or MSc note; reproducible workflow	RCF, MSCA, FCC software/training networks
PYTHIA $\gamma\gamma$ validation	Technical note or validation result	RCF, ERC, EU networks
Detector-entry assessment	Ranked R&D recommendation	RCF/FIRI, DRD common projects
Detector performance	Reconstruction/performance contribution	MSCA, COST, FCC PED roles
Nordic-Baltic coordination	Workshop or visitor exchange	Network/coordination funding