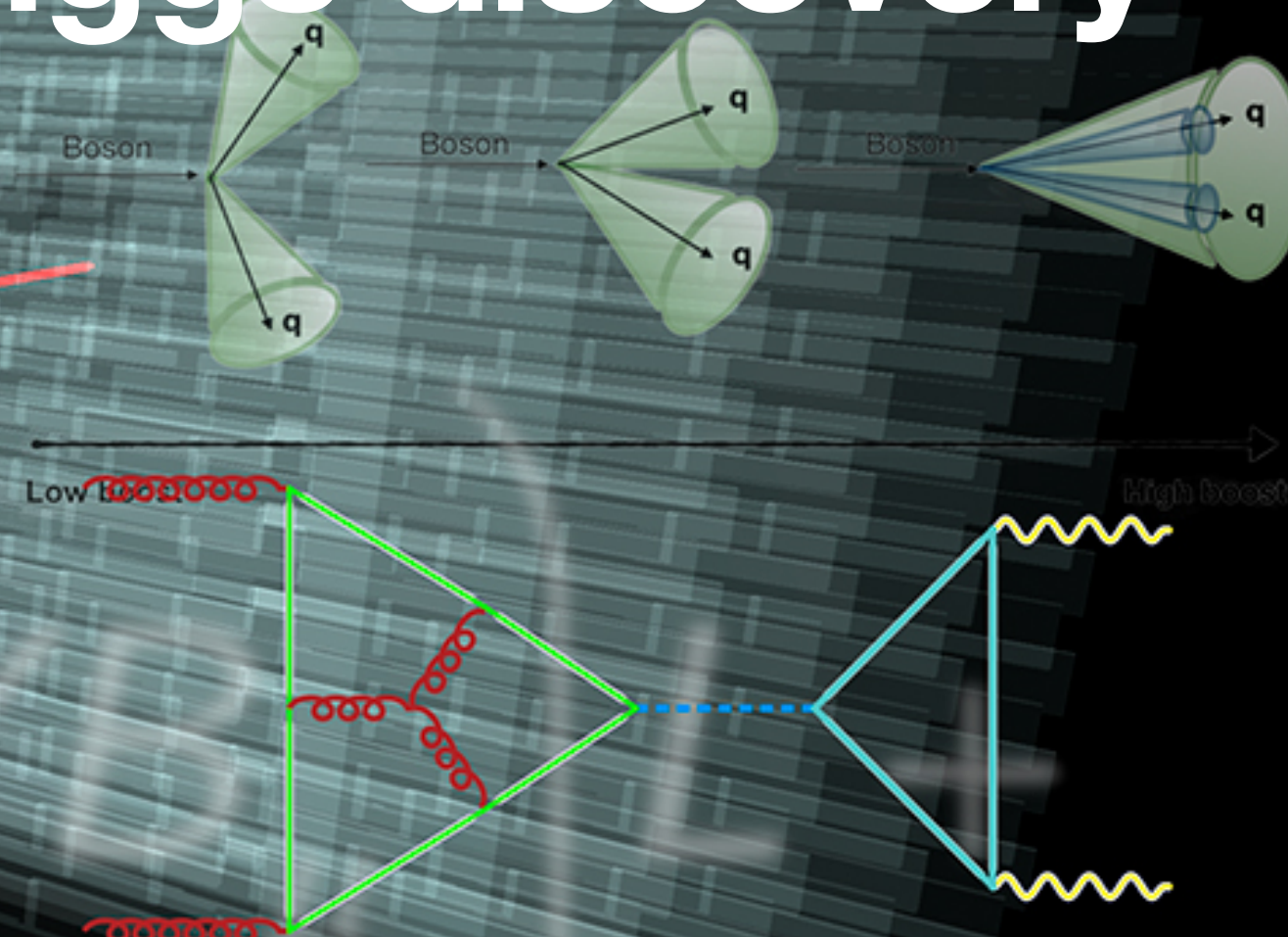


$$\mathcal{L}_{SM} = \frac{1}{2} \left| \left(i\partial_\mu - \frac{1}{2} g\tau \cdot W_\mu - \frac{1}{2} g' Y B_\mu \right) \phi \right|^2 - V(\phi) + g'' (\bar{q} \gamma^\mu T_a q) ($$

SFB TRR 257: P3H

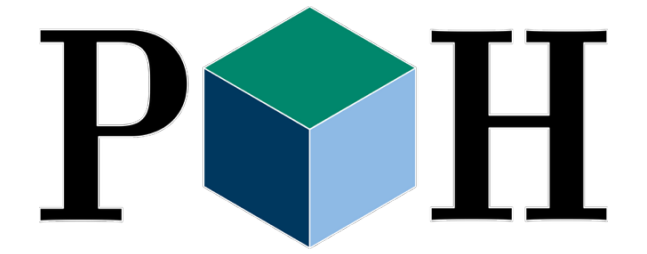
Particle Physics Phenomenology after the Higgs discovery

FCC Theory Hub Rundgespräch



Mainz, 02.07.2026

Basic facts and figures of P3H

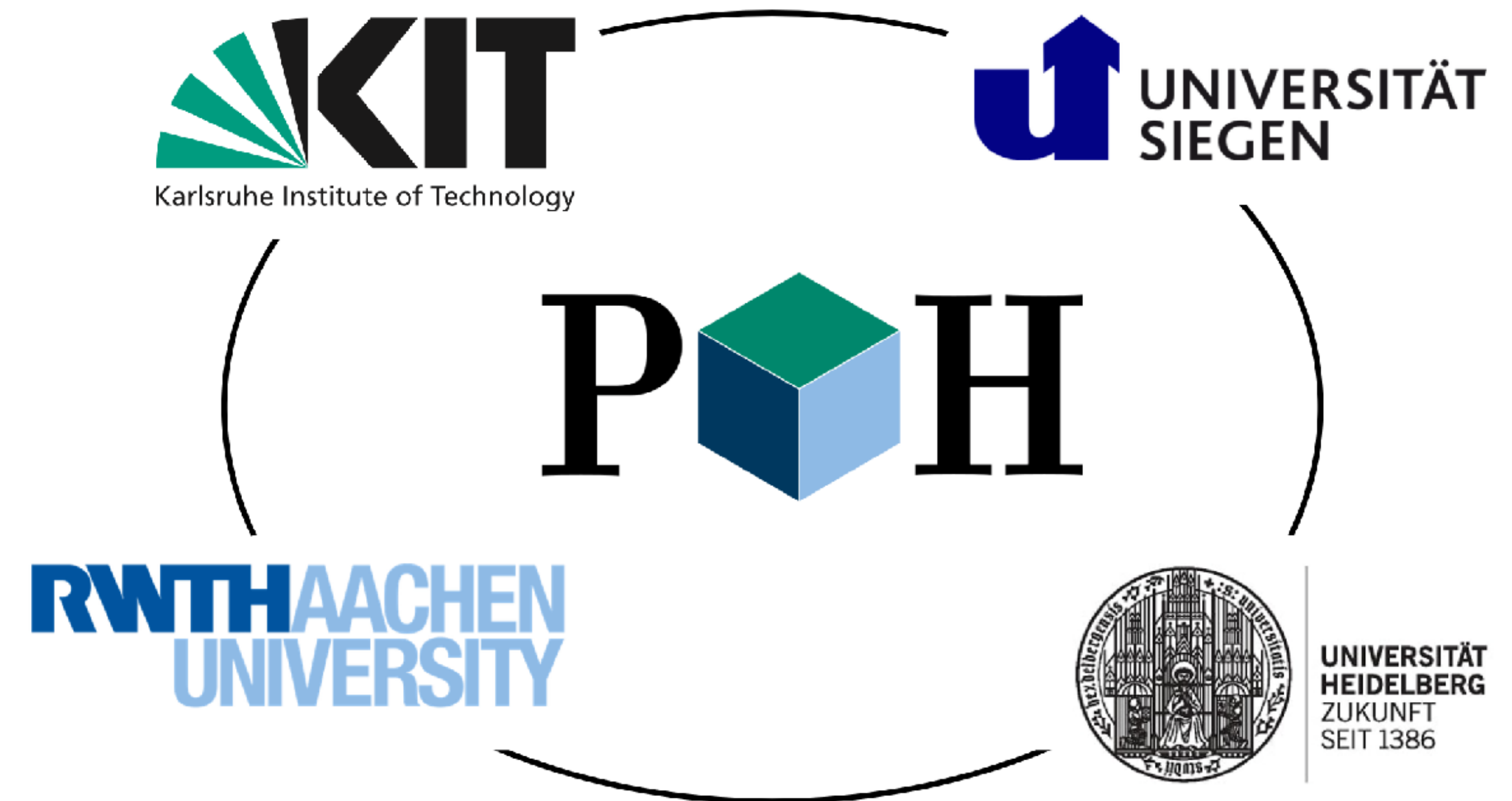


3 sites: RWTH Aachen, KIT, Siegen University

<https://p3h.particle.kit.edu/>

1 associate member: Heidelberg University

- 1st funding period 01/2019-12/2022
spokesperson Kirill Melnikov
- 2nd funding period 01/2023-12/2026
spokesperson GH
- currently applying for 3rd funding period
21 project leaders, 23 projects



Research rationale

- P3H was created in response to the paradigm shift towards *indirect searches* for New Physics
- requires **high precision** of theory predictions and tools
- **multi-faceted approaches** needed:
 - combination of collider- and flavour physics
 - EFT descriptions, concrete models, and matching
 - model-agnostic anomaly searches
 - inclusion of information beyond colliders (e.g. dark matter searches, gravitational waves, ...)

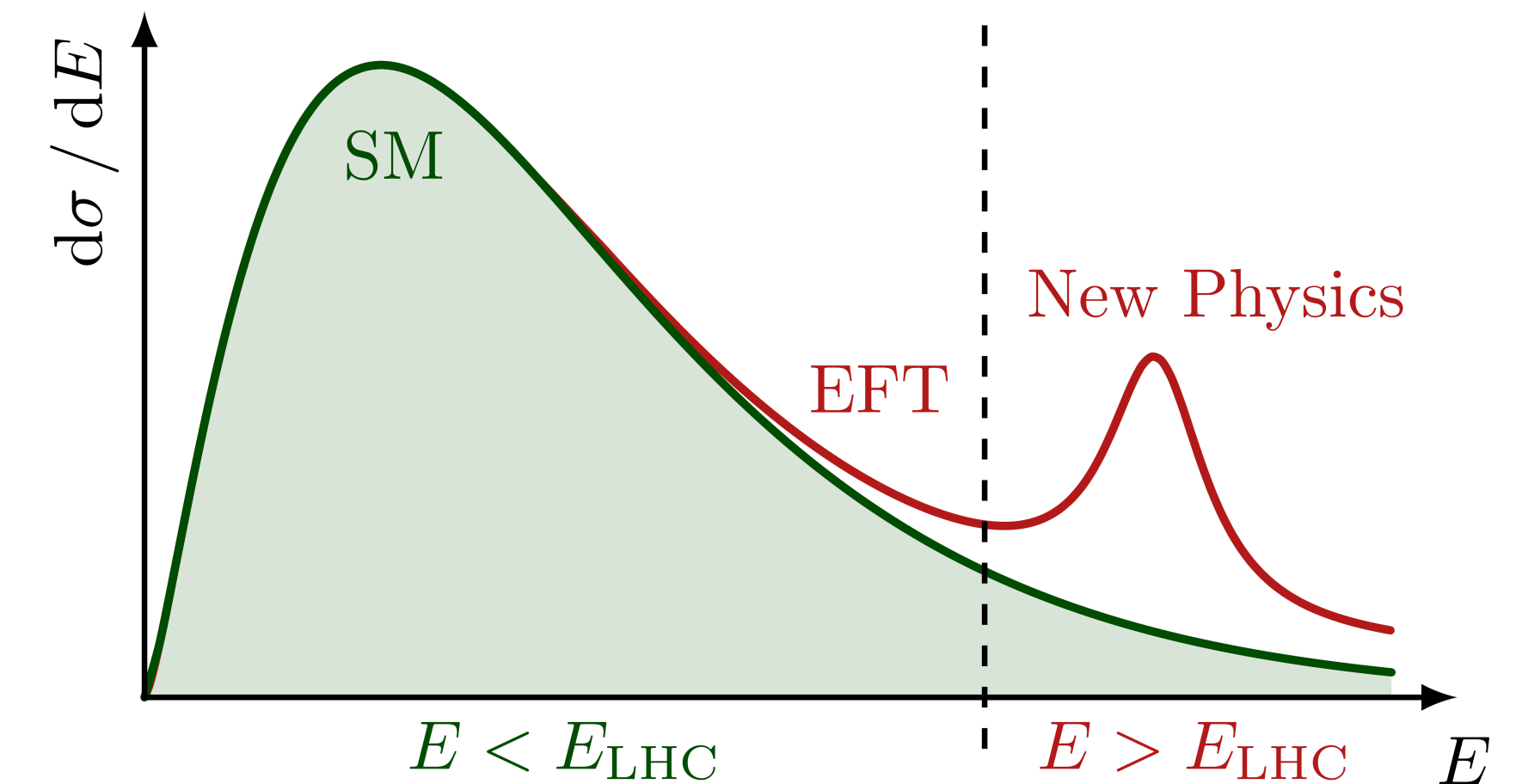
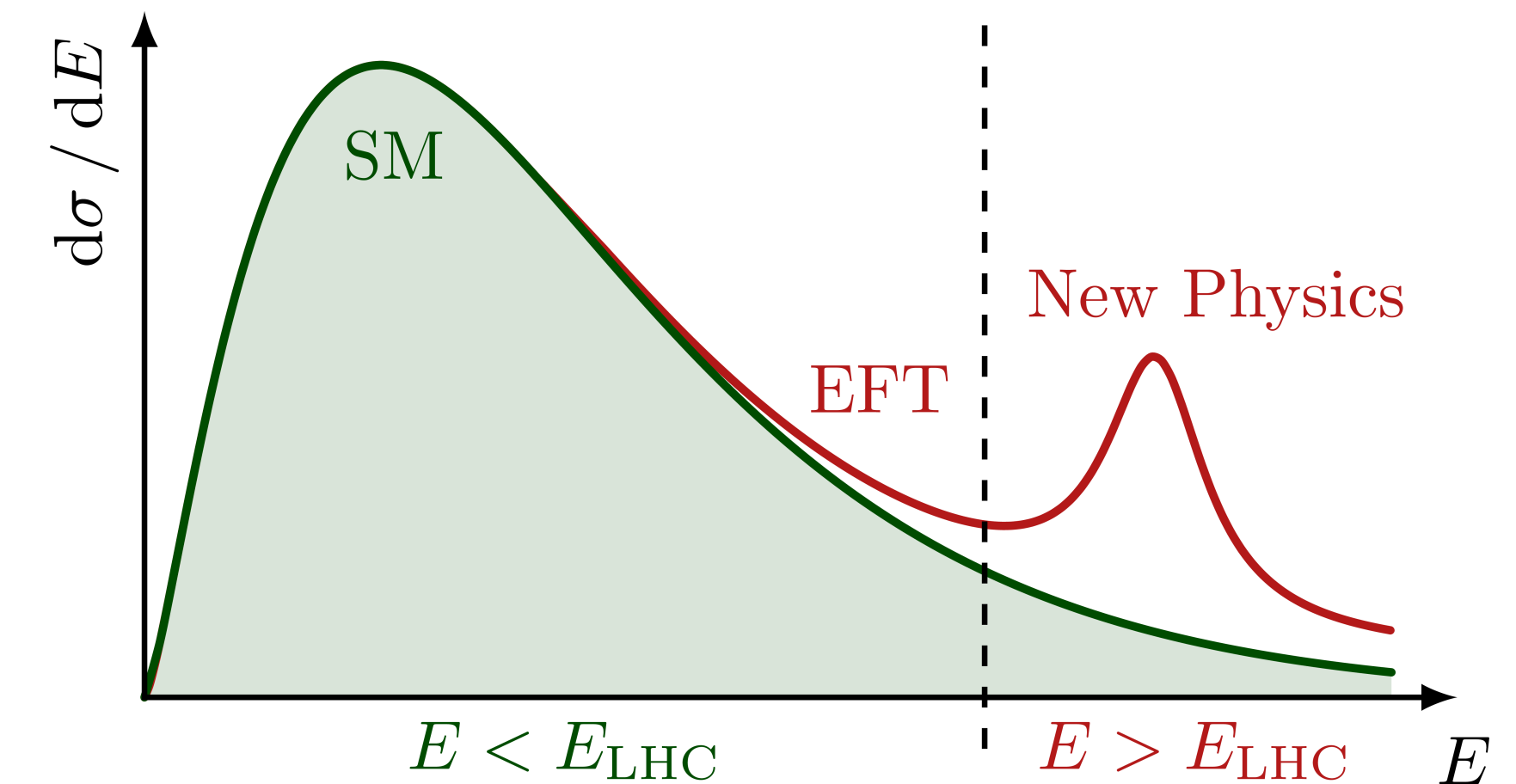


image credit: tikz.net

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such a breadth is not feasible for a single university

Main research areas

Matrix structure of research fields A, B, C and 3 approaches:

	1. Precision calculations	2. Effective Field Theories	3. Models of New Physics
A: Higgs physics	H and HH production channels to highest precision	HEFT, SMEFT, RGE running, global fits	Extended Higgs sectors, early universe
B: top, vector bosons, QCD, dark matter	Precision top quark physics, V+jets, power corrections	SCET; SMEFT in the top quark sector	Dark sectors, anomaly searches (ML)
C: Flavour physics	inclusive B -decays, $B - \bar{B}$ mixing	exclusive b-decays, charm physics	New physics related to flavour observables

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EFTs also enter here

precision enters almost everywhere

⇒ topics overlap and get increasingly tighter connected

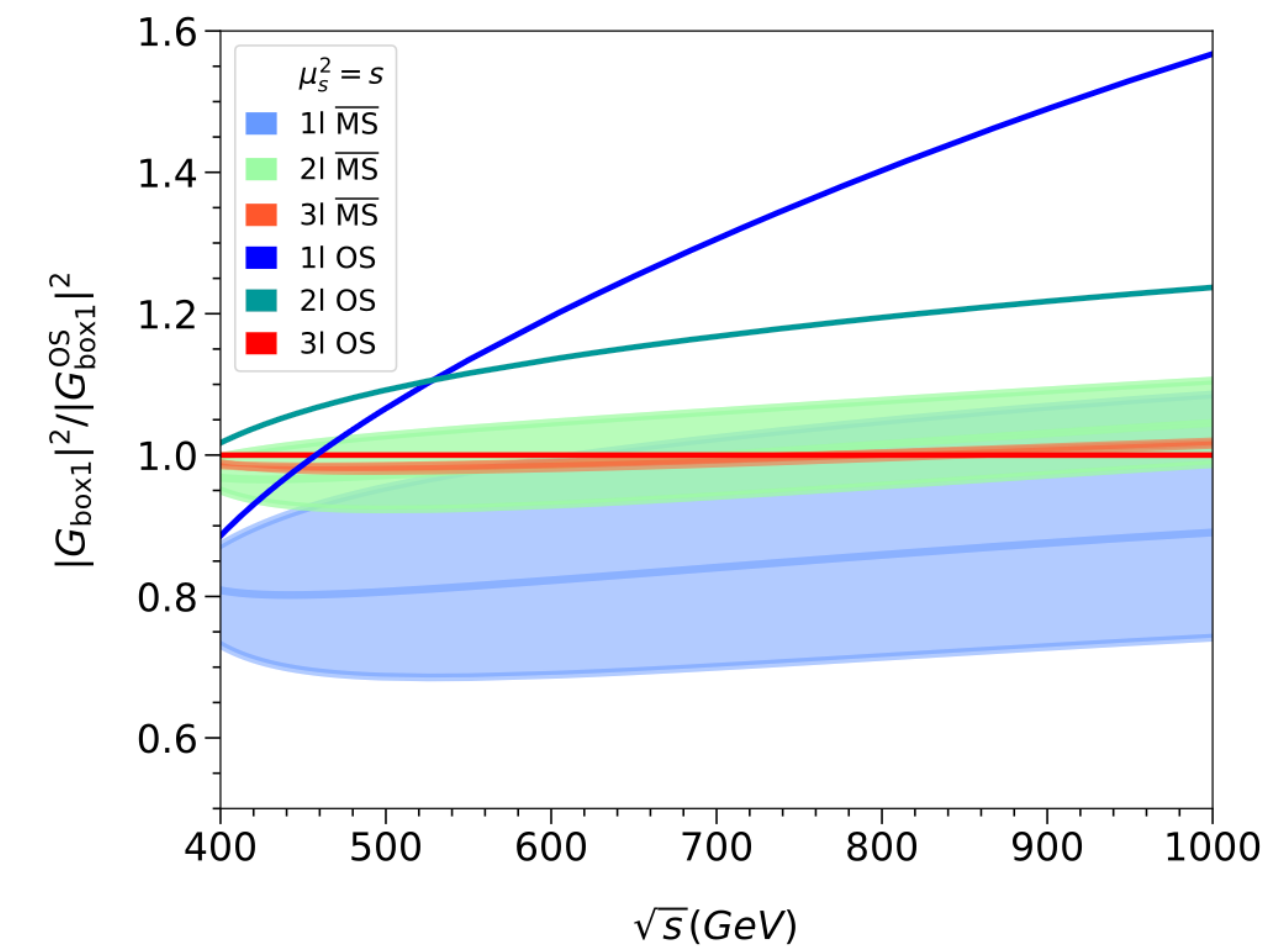
Some research highlights

Research area A:

- dominant uncertainty ($\sim 20\%$) in Higgs boson pair production due to top mass scheme dependence:

much reduced at 3-loop level (large-N limit)

Davies, Schönwald, Steinhauser [2503.17449](#)



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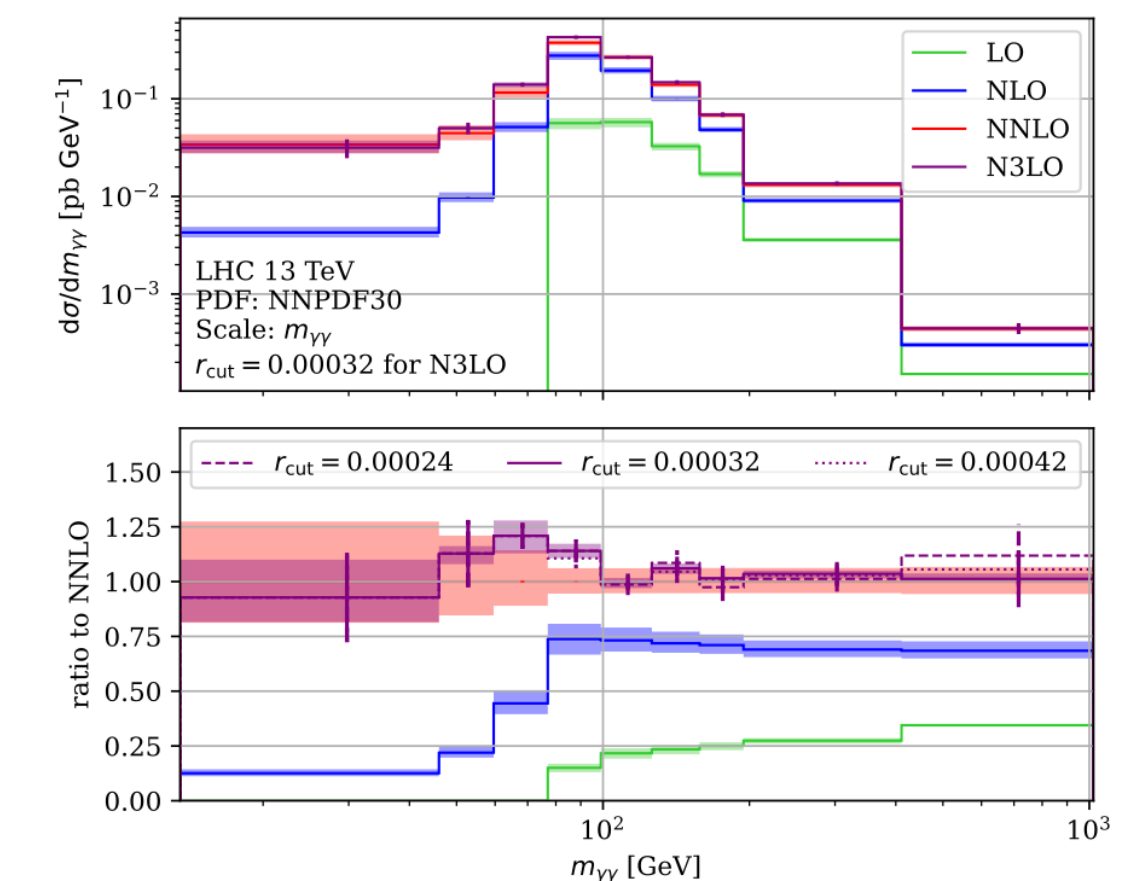
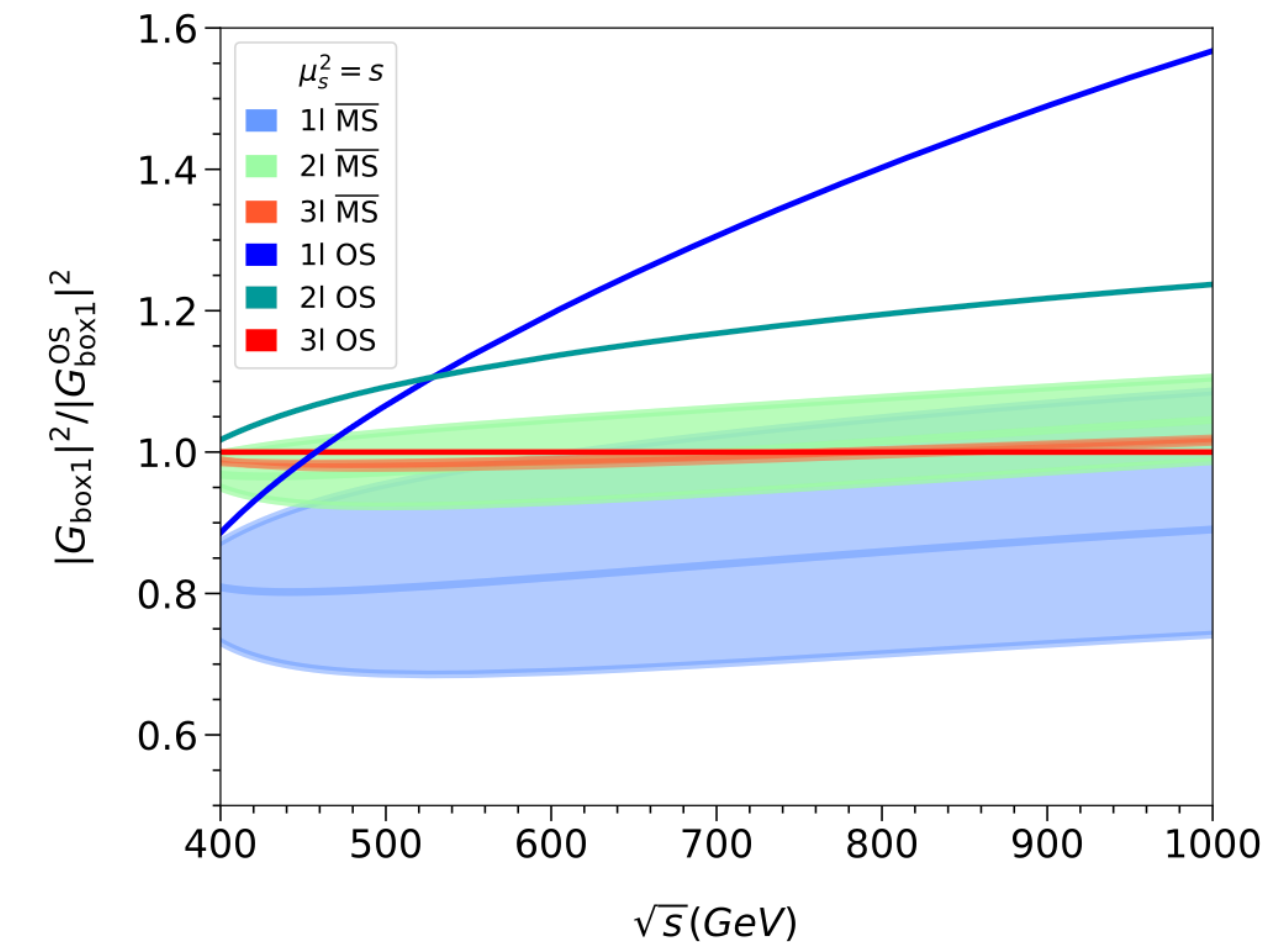
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Research area B:

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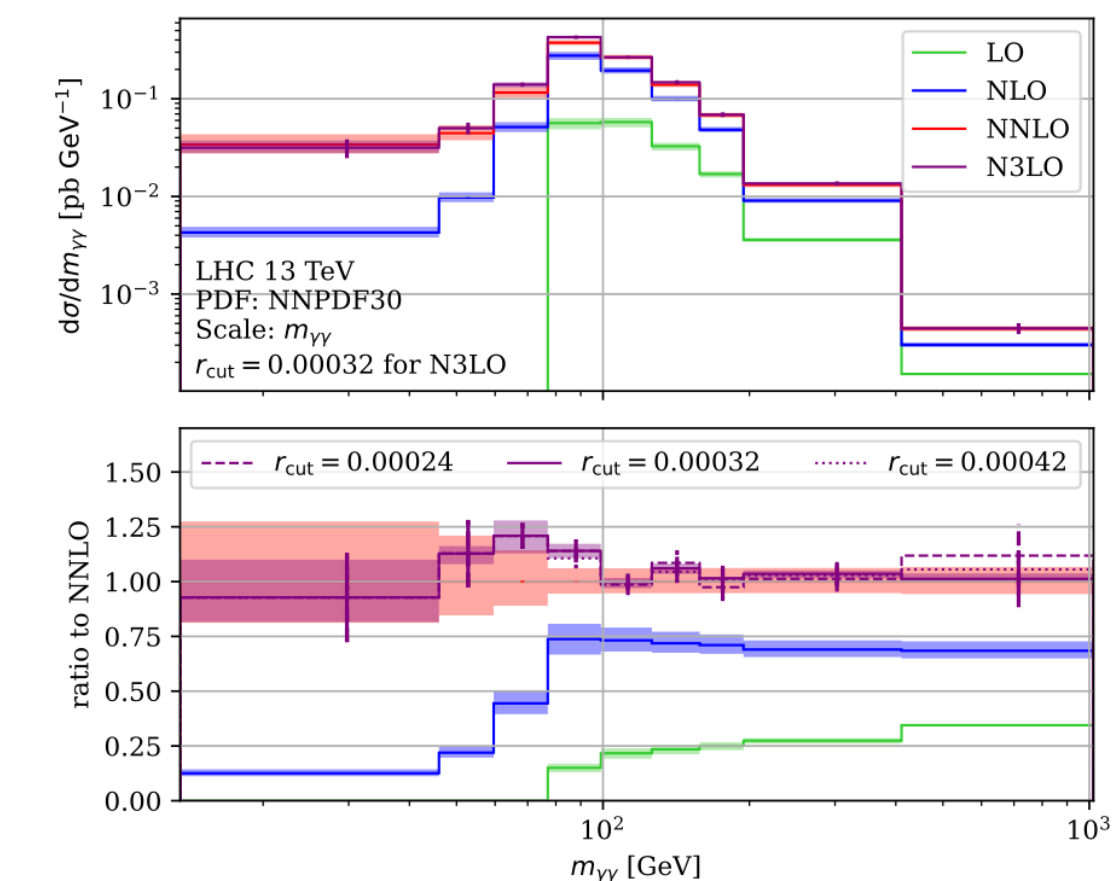
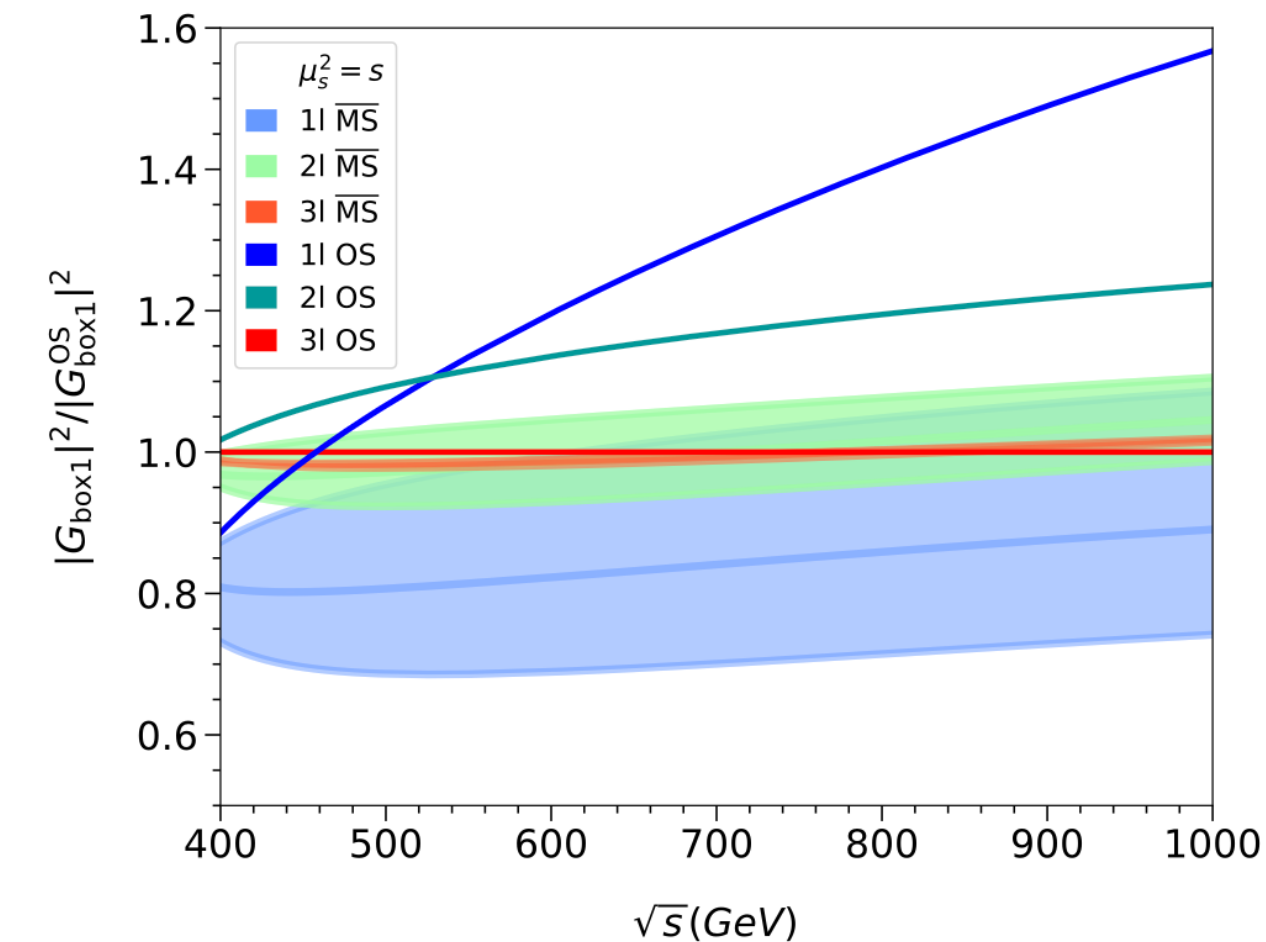
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Czakon, Eschment, Generet, Poncelet [2604.12613](#)

Research area C:

- demonstrated that the **gradient flow** method provides an excellent framework to combine **lattice** simulations with **perturbative** calculations

Black, Harlander, Kohnen, Witzel et al. [2603.28517](#)



Structural benefits

- Additional support from the University sides

scientific exchange and networking

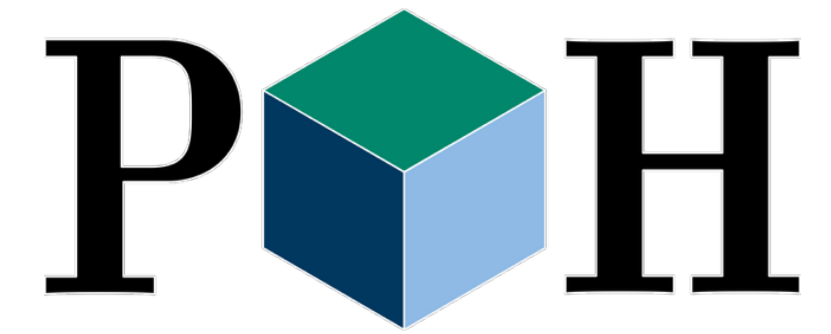
- P3H Annual Meeting
- Topical Workshops and conferences
- Visitor Programme

education of the next generation

- P3H Young Scientists Meeting
- P3H Summer School
- strong connection to local Graduate Schools (e.g. RTG 2497, KSETA, EXC 3107 School)
- Soft-skill training, EDI training

knowledge transfer

- Outreach



International Summer School
in Bingen 2024



Alumni Colloquium



Strange & Charming

P3H podcasts

HP2 Conference 2026

Relation to FCC(-ee) physics

- P3H focuses primarily on physics at the (HL-)LHC and Belle2
- Two projects contain dedicated FCC-ee calculations as sub-projects
- The methods and precision tools developed within P3H will be very beneficial for Future Colliders
- P3H would lay an ideal basis for a Priority Programme in FCC e+e-physics.

Outlook

Quote from the European Strategy (Update 2026) Document:



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→ **P3H and other current programmes**

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→ **P3H and other current programmes**

The electron–positron Future Circular Collider (FCC-ee) is recommended as the preferred option for the next flagship collider at CERN.

→ **Theory Hub for FCC-ee**