FCC@Nikhef - March 11, 2026

- Brief introductions from everyone.
- Identify overlaps between FCC and Nikhef research: what aspects of FCC connect to your research interests
- Possible collaborative projects: what kind of project/initiative could you get involved in → collaborative projects
- Initial thoughts on strategically positioning ourselves as Nikhef?
- Decide useful formats for future meetings: updates from projects we work on? discussing papers? … ?
- If time permits: a short update from the FCC physics workshop in January

(Apologies, borrel at the end of the afternoon was not on my radar.)

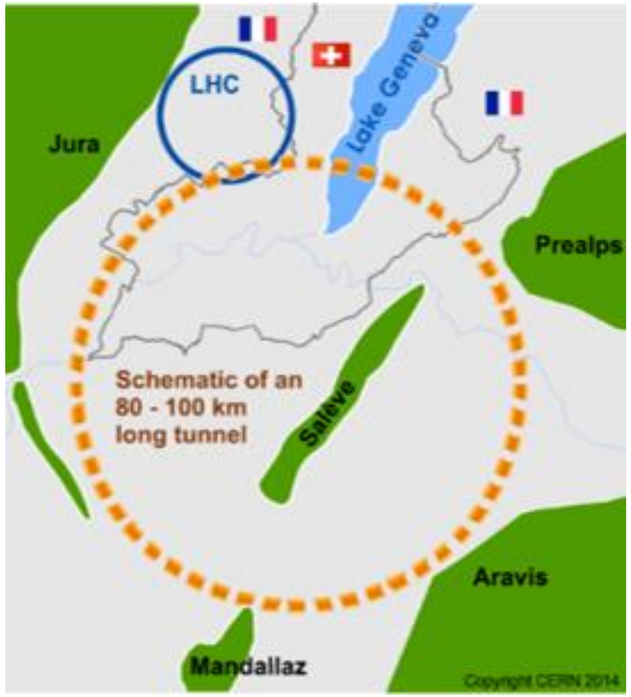
FCC physics workshop 2026

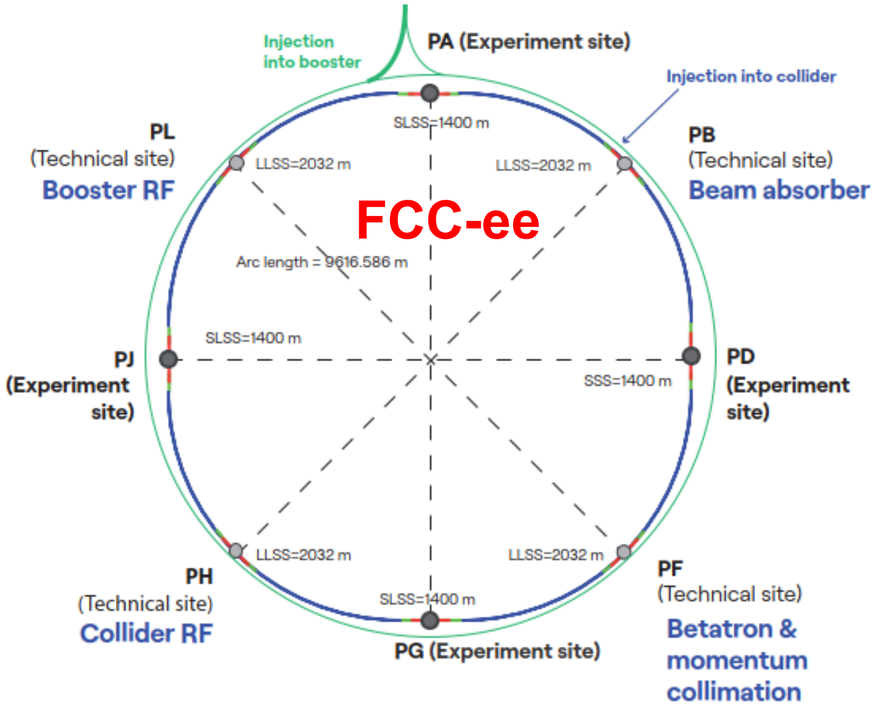
a short summary

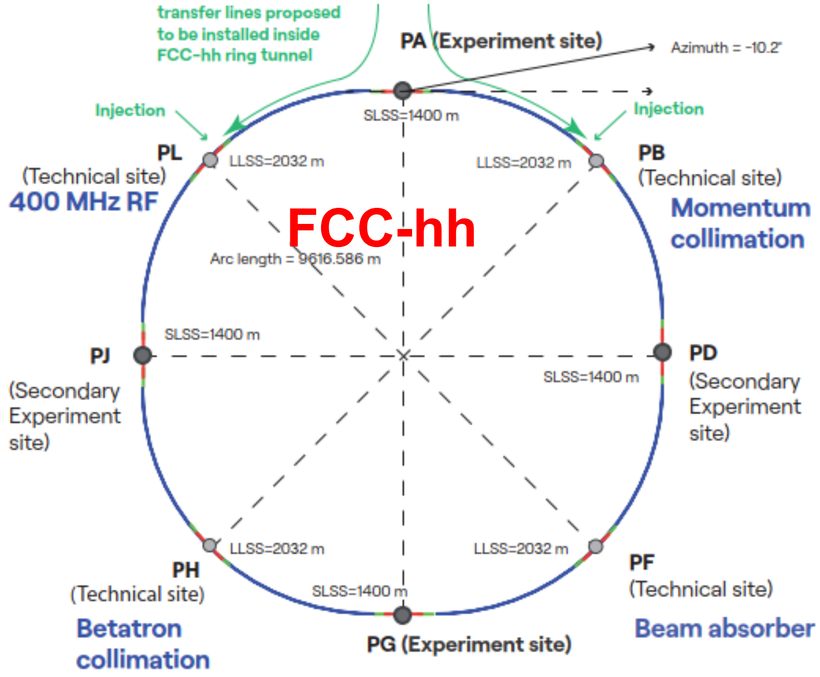
Wouter Waalewijn (UvA/Nikhef)

Future Circular Collider integrated program – scope

- **stage 1: FCC-ee (Z, W, H, $t\bar{t}$) as Higgs factory, electroweak & top factory at highest luminosities**
- **stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, pp & AA collisions; e-h option**
- highly synergetic and complementary programme maximising the physics opportunities
- common civil engineering and technical infrastructures, building on and reusing CERN's existing infrastructure
- FCC integrated project allows the start of a new, major facility at CERN within a few years of the end of HL-LHC



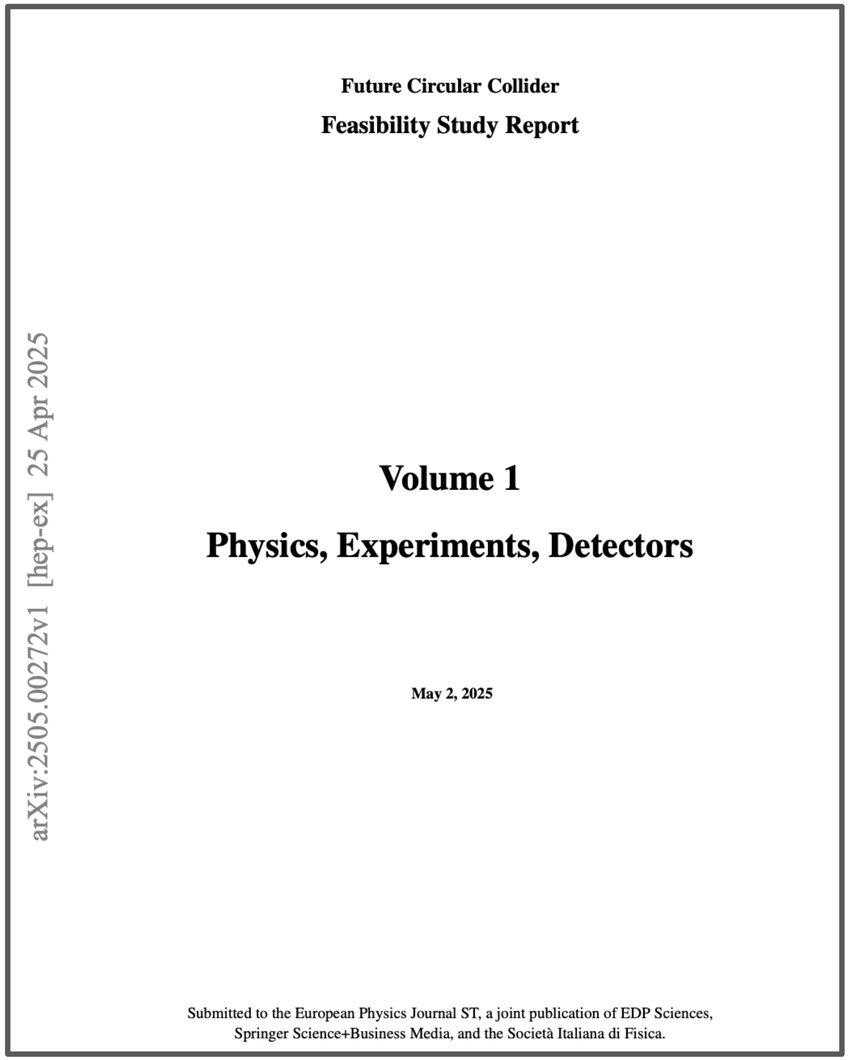




2020 - 2045 | 2048 - 2062 | ~2075 - ~2100

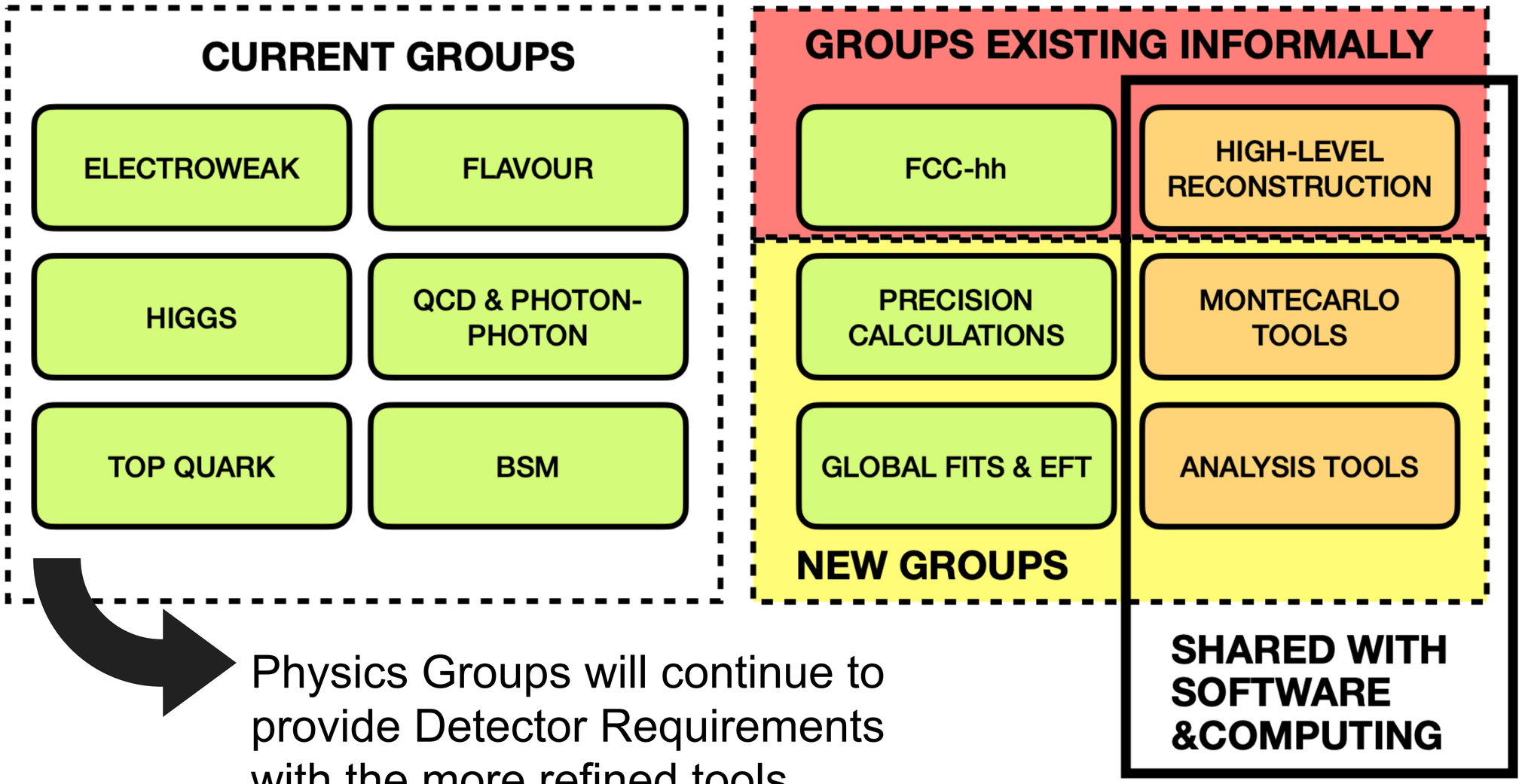
The FCC Feasibility Study

- Conclusion of a long path started in 2020!
- **Physics Programme** articulated physics case of the integrated programme
- **Physics Performance** activities exploited “Case Studies” to extract physics motivated detector requirements
  - developed **tools for simulation** and **reconstruction**, **MC production** in coordination with the Software group
  - developed high level tools for **physics analysis**



Azzi

The new Structure



Physics Groups will continue to provide Detector Requirements with the more refined tools

Azzi

Physics Groups Mandate: a reminder

- ✓ **Phenomenological studies and the definition of benchmark processes.**
  - ✳ selected for their potential to provide meaningful requirements to the other Work Packages (or the other physics groups);
- ✓ **"Case studies" of these benchmark processes,** delivering quantitative requirements, e.g., on detector, operation and theoretical accuracy;
- ✓ **Higher-order calculations, event generators, and global fit frameworks,** with the required precision and technical accuracy

Regular meetings, workshops, training and schools

Internal communication (new ECOI group) via new web interface and more

Azzi

FSR achievements

- **20 dedicated analysis**
- **50+ people from 21 institutes**
- **Complete survey of core Higgs properties**

Coupling	HL-LHC	FCC-ee	FCC-ee + FCC-hh
κ_Z (%)	1.3*	0.10	0.10
κ_W (%)	1.5*	0.29	0.25
κ_b (%)	2.5*	0.38 / 0.49	0.33 / 0.45
κ_g (%)	2*	0.49 / 0.54	0.41 / 0.44
κ_τ (%)	1.6*	0.46	0.40
κ_c (%)	–	0.70 / 0.87	0.68 / 0.85
κ_γ (%)	1.6*	1.1	0.30
$\kappa_{Z\gamma}$ (%)	10*	4.3	0.67
κ_t (%)	3.2*	3.1	0.75
κ_μ (%)	4.4*	3.3	0.42
$\lvert\kappa_s\rvert$ (%)	–	$^{+29}_{-67}$	$^{+29}_{-67}$
Γ_H (%)	–	0.78	0.69
$\mathcal{B}_{inv}$ (<, 95% CL)	1.9×10^{-2} *	5×10^{-4}	2.3×10^{-4}
$\mathcal{B}_{unt}$ (<, 95% CL)	4×10^{-2} *	6.8×10^{-3}	6.7×10^{-3}

FSR volume 1

HZZ channels

ZH(ZZ)	Status@240 GeV	Status@365 GeV
6 lep	done	missing, to be studied
4 lep + 2j	done	missing, to be studied
4 lep + 2v	done	missing, to be studied
2 lep + 4j	done	missing, to be studied
2 lep + 2j + 2v	done	missing, to be studied
2 lep + 4v	N/A, H -> inv analysis	N/A, H -> inv analysis
2j + 4v	N/A, H -> inv analysis	N/A, H -> inv analysis
4j + 2v	byproduct of hadronic analysis, to revisit	byproduct of hadronic analysis, to revisit
6j	done	missing, to be studied
6v	no point	no point

- **VBF HZZ @365 GeV also to be studied**
- **ATM $\ell = e, \mu$, need to include τ modes**

Higgs-EWPO tension

$$Q_{H\Box} = |H|^2 \Box |H|^2 \quad \rightarrow \quad \delta\kappa_V = \frac{v^2}{\Lambda^2} C_{H\Box}$$

$$Q_{HD} = (H^\dagger D_\mu H)^* (H^\dagger D^\mu H) \quad \rightarrow \quad T = -\frac{v^2}{2\alpha\Lambda^2} C_{HD}$$

$$\frac{|C_{HD}|}{|C_{H\Box}|} = \frac{2\alpha|T|_{\text{LEP}}}{|\delta\kappa_V|_{\text{HL-LHC}}} \simeq \frac{0.2\%}{2\%} \simeq \frac{1}{10}$$

Constraints on Wilson coefficients from LEP EWPOs are roughly an order of magnitude stronger than those expected from HL-LHC Higgs measurements

Haisch

Higgs-EWPO tension

$$Q_{H\Box} = |H|^2 \Box |H|^2 \quad \rightarrow \quad \delta\kappa_V = \frac{v^2}{\Lambda^2} C_{H\Box}$$

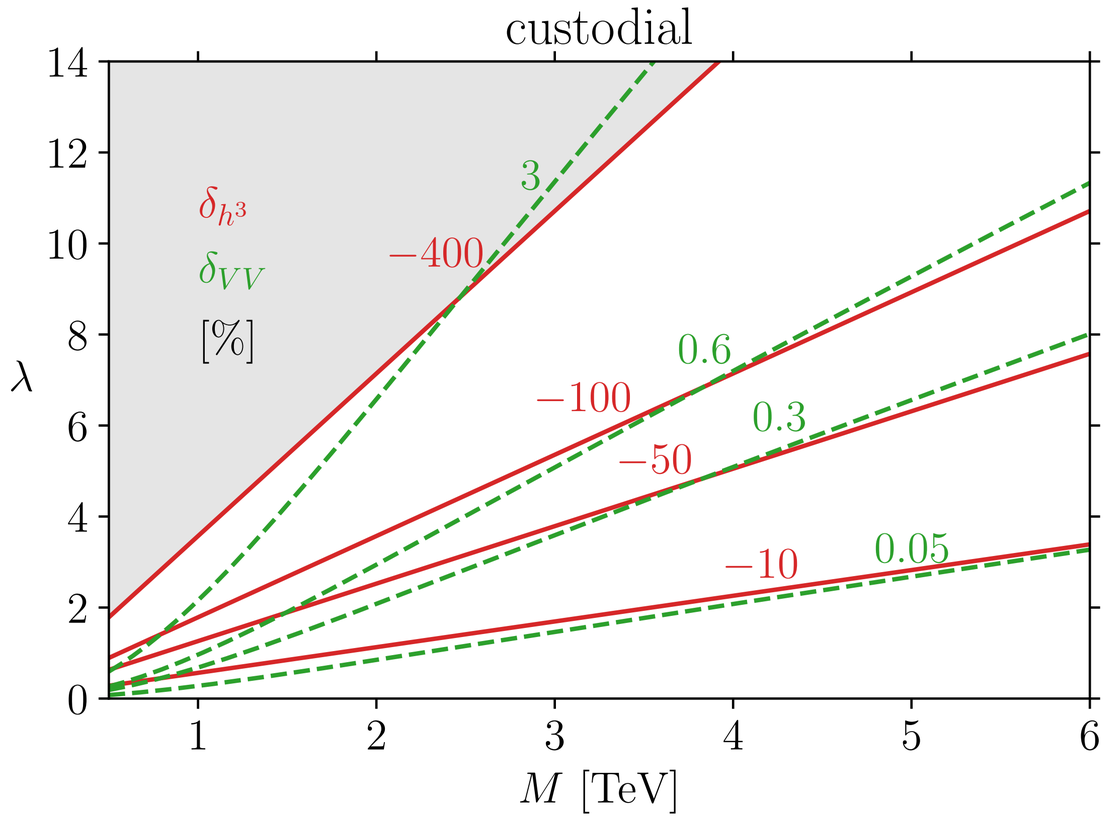
$$Q_{HD} = (H^\dagger D_\mu H)^* (H^\dagger D^\mu H) \quad \rightarrow \quad T = -\frac{v^2}{2\alpha\Lambda^2} C_{HD}$$

$$\frac{|C_{HD}|}{|C_{H\Box}|} = \frac{2\alpha |T|_{\text{FCC-ee}}}{|\delta\kappa_V|_{\text{HL-LHC}}} \simeq \frac{0.02\%}{2\%} \simeq \frac{1}{100}$$

Tera-Z stage of FCC-ee is expected to enhance accuracy of EWPO measurements tenfold, in turn increasing Higgs-EWPO tension by same factor

Haisch

CQ model: $\delta\kappa_3$ vs. $\delta\kappa_V$



Ratio of modifications in Higgs trilinear & Higgs-vector boson couplings can reach a factor of 100 or more with effects up to 400% in h^3 coupling

[Durieux, McCullough & Salvioni, 2209.00666]

Haisch

Where do we want to contribute?

- Theory: precision QCD, parton showers.
- Phenomenological studies: Higgs / EFT interpretations / heavy flavor.
- Detector-level physics studies.
- …

FCC PED highlights from Italy

- IDEA baseline with DR crystal ecal
- Engineered mechanical model of the Machine-Detector-Interface
- Engineered IDEA Vertex detector with improved material budget
- Test beam of first full-hadronic containment DR prototype in October 2025
- Design, operation, test and results from several 2D μRWELL prototypes
- Test beam of different crystals and filters for the crystal calo
- Test beam results on cluster counting for the Drift chamber
- We typically run 6-7 test beams every year
- Studies of HTS solenoid for IDEA reaching 3T
- All sub detectors of IDEA are now in full simulation
  - Global reconstruction is being worked on. Will be ready later in 2026

Activities in 2025

- UK had contributions to PED activities in Higgs, BSM and as part of the FCC-hh study effort, many of which involved masters student projects.
- Strong theory community in the UK- would like to increase collaboration/cross-talk.
- Feasibility study contributions highlighted in the annual FCC-UK meeting hosted at the IPPP, Durham (thanks to our FCC colleagues who came and spoke :))