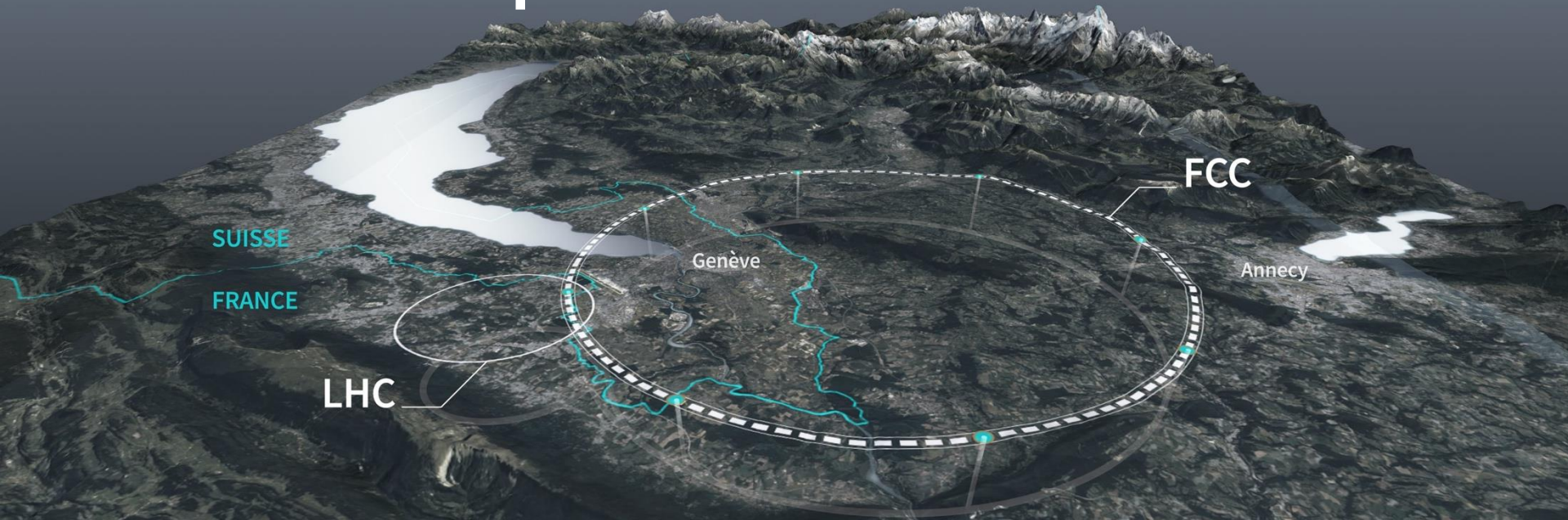
FCC Group – Future Circular Collider



LIP Advisory Board Meeting
23 April 2025
Ricardo Gonçalo – UC / LIP

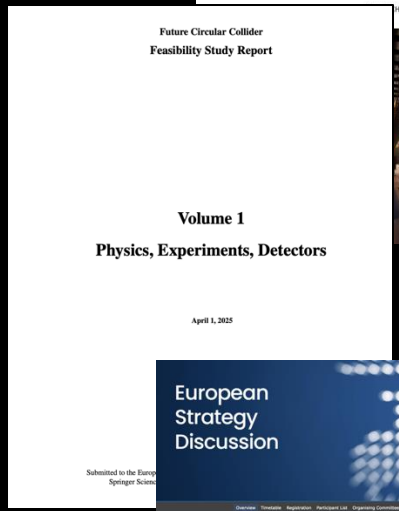
CERN FCC

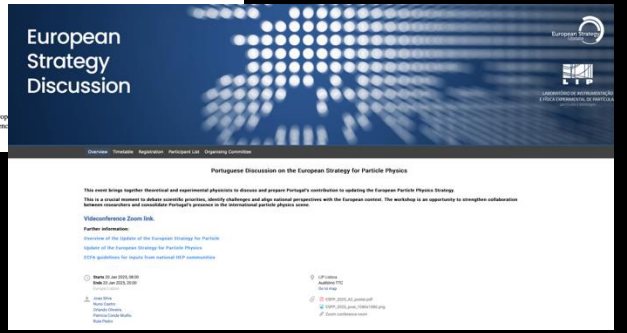
fct Fundação para a Ciência e a Tecnologia

LIP

FCC Group

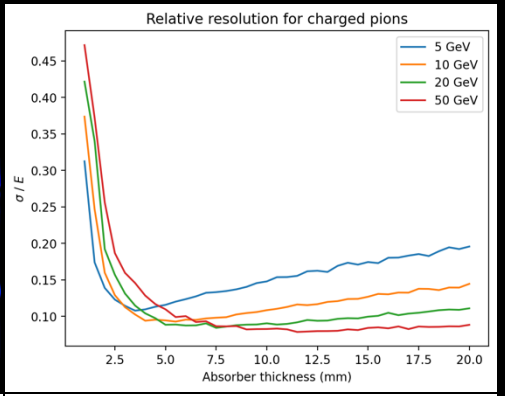
- Group dedicated to future collider studies
  - Main initial focus on FCC-ee
  - Other activity on Muon Collider and Linear Collider, etc
- Participating in ECFA Detector R&D roadmap
  - DRD6: Calorimetry
- FCC Feasibility Study – Final Report
  - Initial objective of the group was achieved
  - LIP contributed to FCC feasibility study
- Portuguese input to update of European Strategy for Particle Physics
  - Well-attended session on 20 January organized by group members organizing

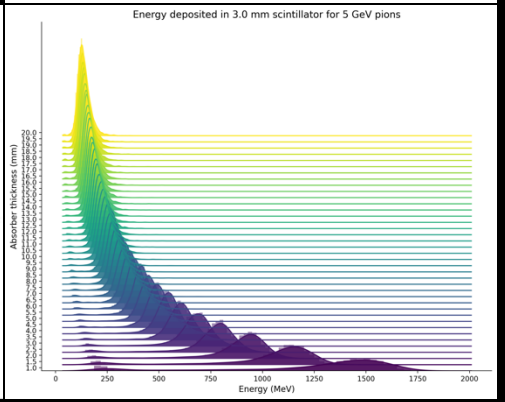




FCC Group – Activity Highlights

- Rad-hard scintillator development
  - Preprint: arXiv:2312.14790
- Allegro detector concept for FCC-ee
  - Simulation of calorimeter design
  - High Granularity HCAL / Iron Yoke:
    - Scintillator + Iron
    - SiPMs directly on Scintillator or
    - TileCal: WS fibres, SiPMs outsider
- Several physics feasibility studies on future accelerator scenarios:
  - FCC, muon collider, ILC, e-p ...



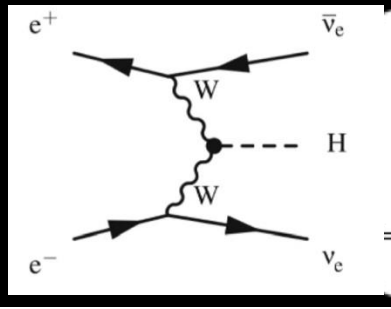


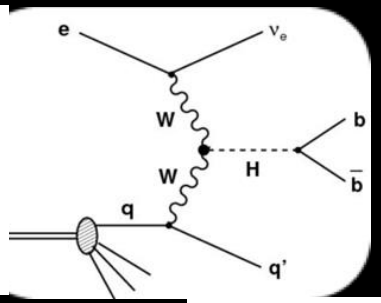
New study: Higgs coupling to W bosons in ee and e-p

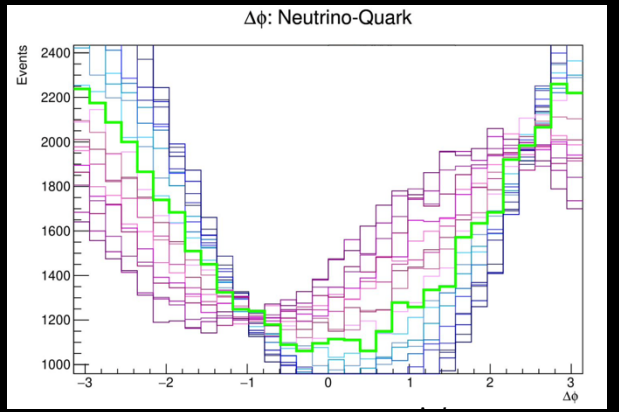
- Beyond SM physics may modify the HWW interaction
  - Possible CP-even: $c_{HW} h^\dagger h W^I_{\mu\nu} W^{I\mu\nu}$
  - CP-odd couplings: $c_{\tilde{HW}} h^\dagger h \tilde{W}^I_{\mu\nu} W^{I\mu\nu}$

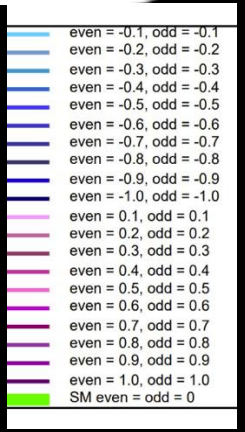
$$\mathcal{L}_{\text{SMEFT}} = \mathcal{L}_{\text{SM}} + \sum_{d>4} \sum_i \frac{c_i O_i^{(d)}}{\Lambda^{(d-4)}}$$

- Visible at high energies:
  - Decay not sensitive
  - Very difficult in e^+e^- collisions
    - VBF involves two neutrinos in final state and cross section only sizeable at large energies
- Comparing sensitivity in e^+e^- and e^-p collisions









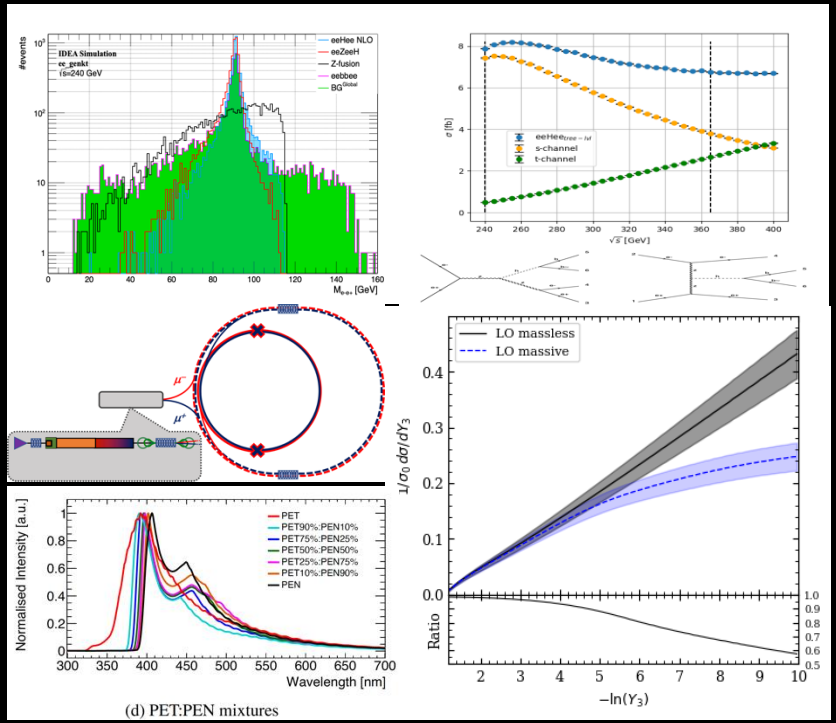
FCC Group – Activity Highlights

Concluded MSc theses:

- W reconstruction for TGC at the ILC (A.Silva, 2024)
- 3-jet cross section for α_s measurement of α_s (J.Reis, 2024)
- $e^+e^- \rightarrow e^+e^-H$ Higgs production (F.Casalinho, 2023)

Articles

- Production and optical characterisation of blended Polyethylene Terephthalate (PET)/Polyethylene Naphthalate (PEN) scintillator samples, NIM-A 1066 (2024) 169627
- Event generators for high-energy physics experiments, SciPost Phys. 16 (2024) 5, 130
- Towards a muon collider, Eur. Phys. J. C 83, 864 (2023)



(d) PET:PEN mixtures

The future…

- So far this group has coalesced research interests on the possibilities of future collider facilities
- The future is uncertain… but exciting!
- Still work to do and bright ideas to be had
- Looking forward to the next steps on the road to future accelerator physics

Strengths, Weaknesses, Opportunities and Threats

- Strengths:
  - Experienced team from different LIP sites and universities – access to students
- Weaknesses:
  - Limited researcher time devoted to FCC – not the only interest of most people in the group
- Opportunities:
  - Contributing to exploit future capabilities of particle physics facilities
  - Good opportunity for student training
  - Technological studies have wide applicability
- Threats:
  - Shortness of dedicated research time

Team: Ricardo Gonçalo, Agostinho Gomes, Filipe Veloso, Grigorios Chachamis, Guilherme Milhano, Inês Ochoa, João Nuno Pires, Liliana Apolinário, Michele Gallinaro, Patricia Conde, Rute Pedro, Luís Gurriana; students: Beatriz Pinheiro Pereira, Rudnei Machado, Ariana Queda, Bruno Rodrigues, Carolina Miranda, Francisco Casalinho, Joana Reis,

Bonus slides

LIP

LET'S INSPIRE PEOPLE

FUTURE CIRCULAR COLLIDER
Innovation Study

Status of Global FCC Collaboration