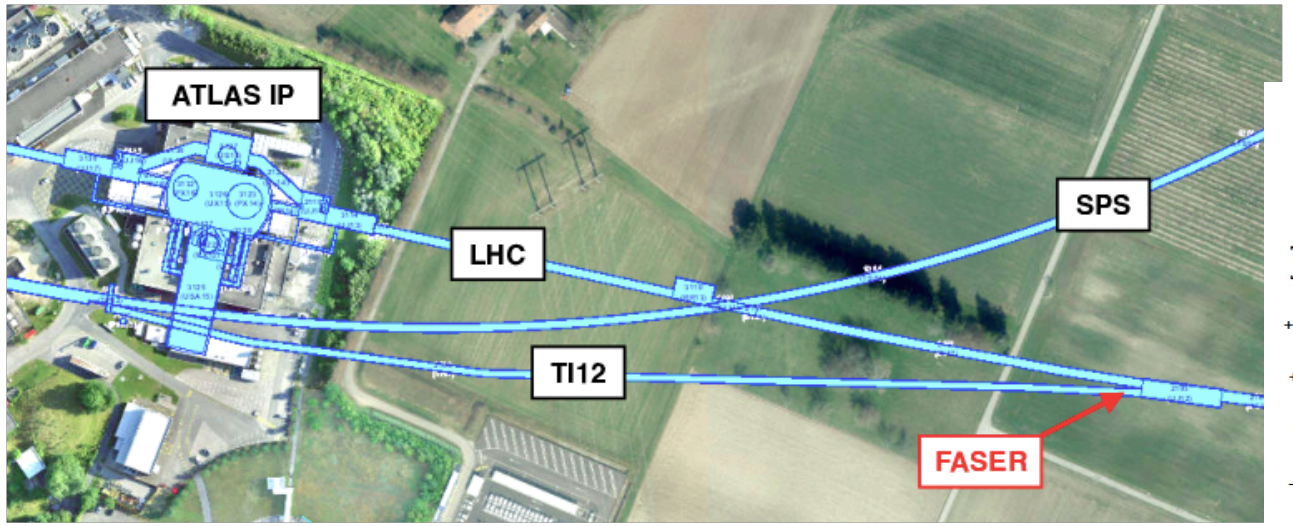
Monica D’Onofrio, Carl Gwilliam,
PhD student: Charlotte (Lottie) Cavanagh

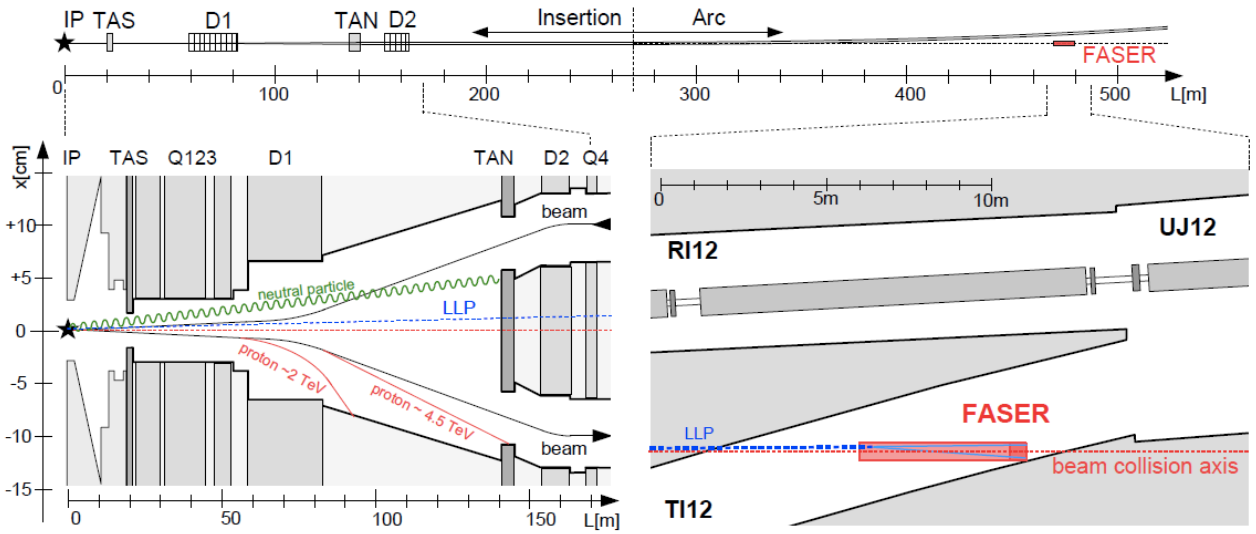
The FASER experiment

ForwArd Search ExpeRiment at the LHC – approved in 2019

- Located along the beam collision axis line of sight (LOS), in the side tunnel TI12, 480 m downstream from the ATLAS interaction point
  - Where the main LHC tunnel starts to curve away from the LOS



Schematic of how light, long-lived particles (LLPs) produced at the ATLAS IP will travel through various components of the LHC infrastructure on their way to FASER.



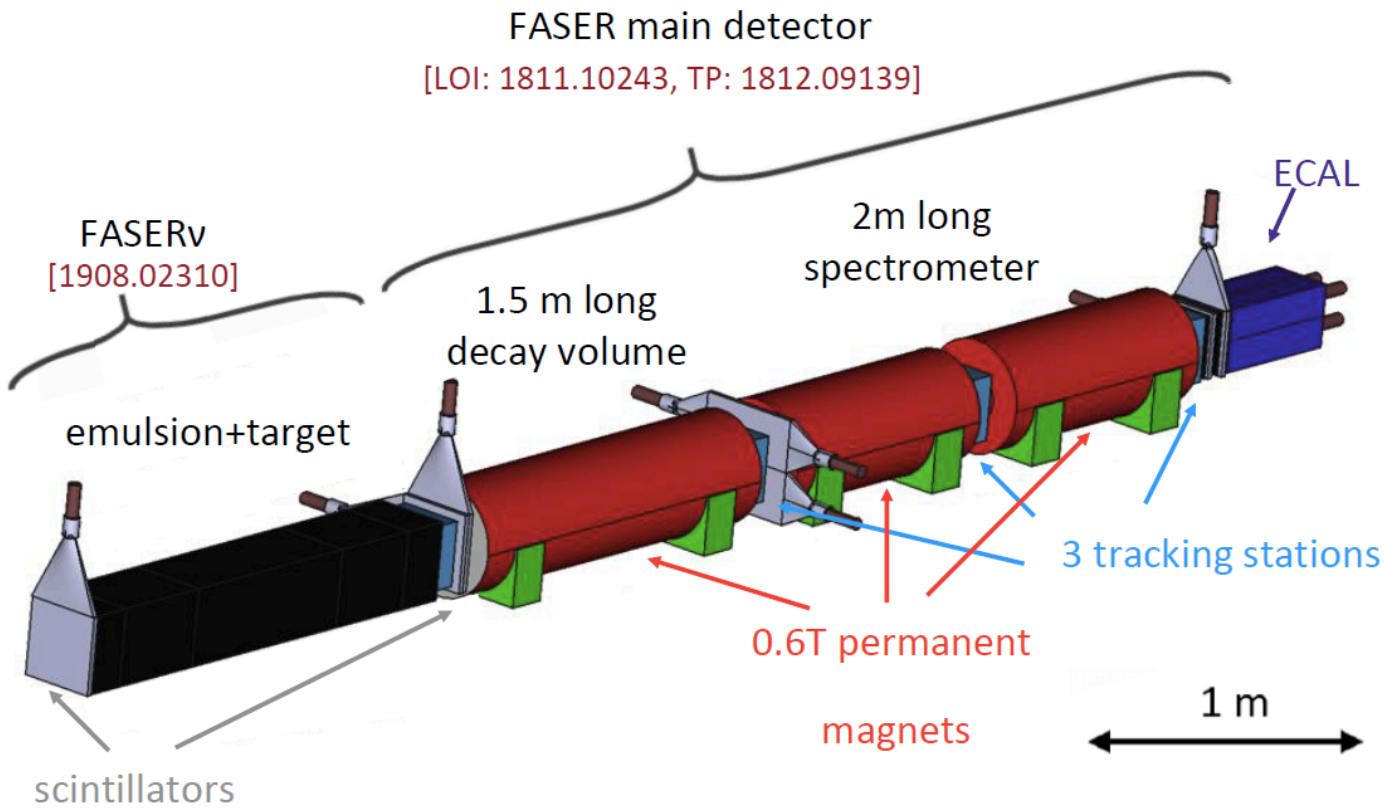
The FASER experiment

ForwArd Search ExpeRiment at the LHC – approved in 2019

- Small detector made of two scintillator stations, followed by a 1.5m long dipole magnet with three tracking stations – each of SCT modules; the final component is the EM calorimeter (made of LHCb calo modules)
- An additional sub-detector (FASERν) has been approved to be in front of FASER to realise a specific neutrino programme

Liverpool joined in 2020 – only UK institute in the collaboration, which aims to be small ☺

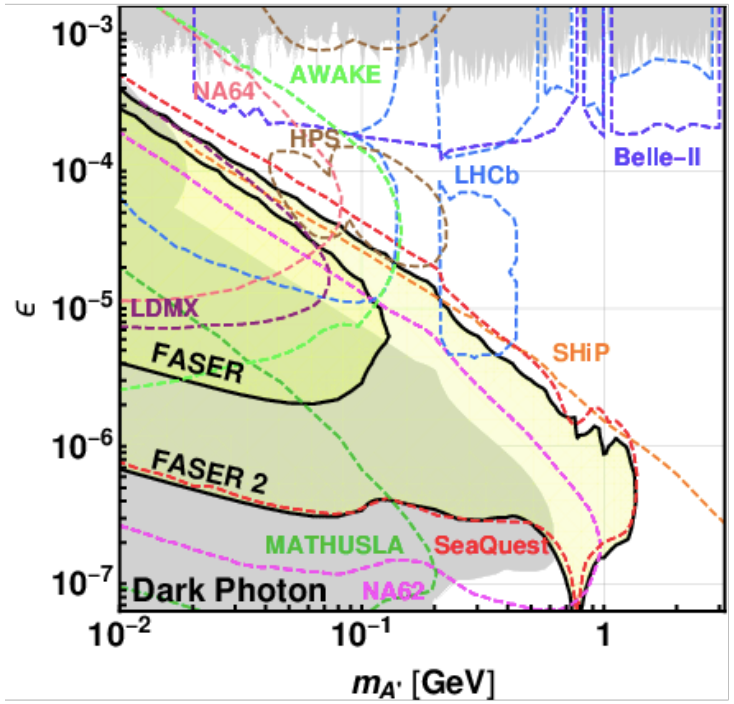
In contact with FASER members who recently moved to UK to present an SoI in 2022.

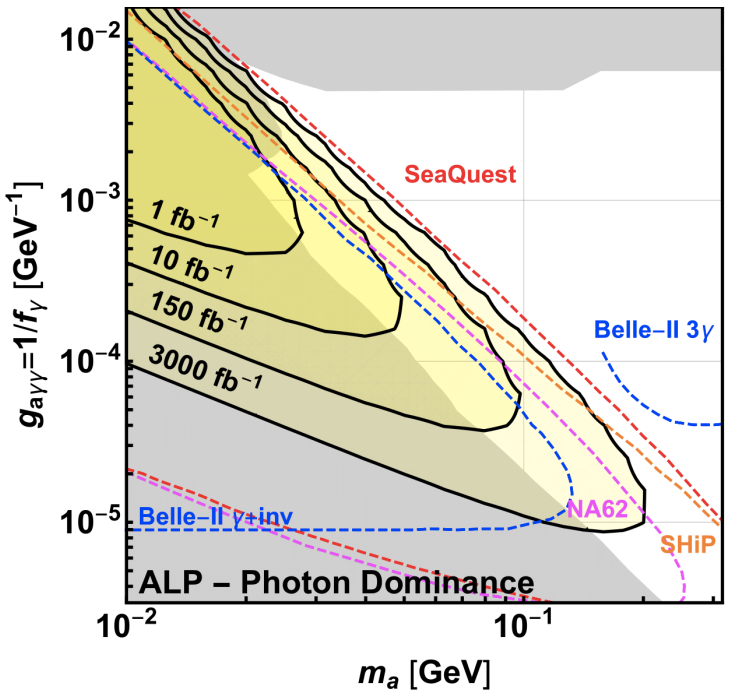


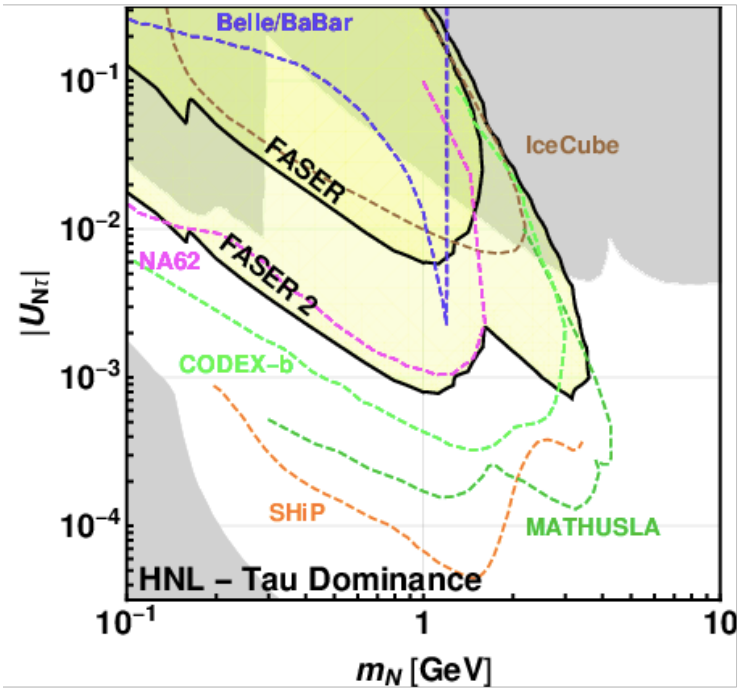
Physics motivations

FASER has been designed to search for new, light and weakly-interacting particles and study the interactions of high-energy neutrinos

- BSM programme targeting **dark photons, ALPs** and **heavy neutrinos**:
  - $pp \rightarrow$ LLP + X, LLP travels ~480 m, LLP $\rightarrow$ charged tracks + X.
- Complementing ATLAS and other non-collider experiments and targeting unique regions of the parameter space

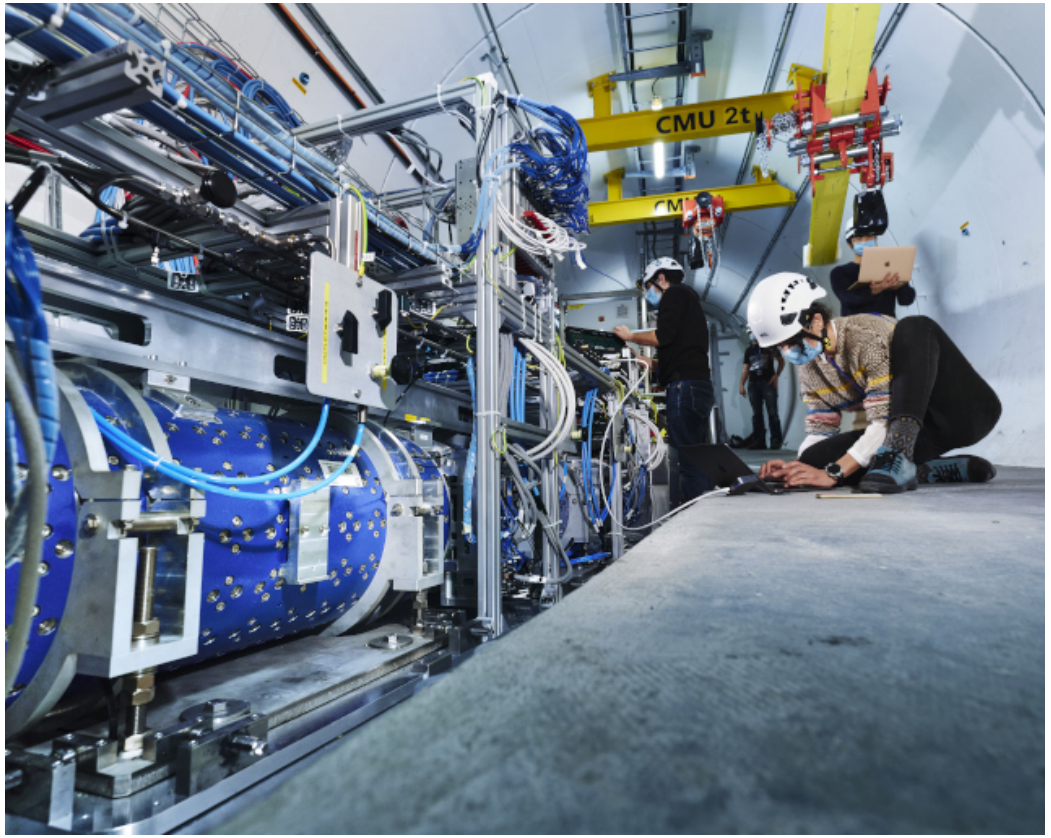


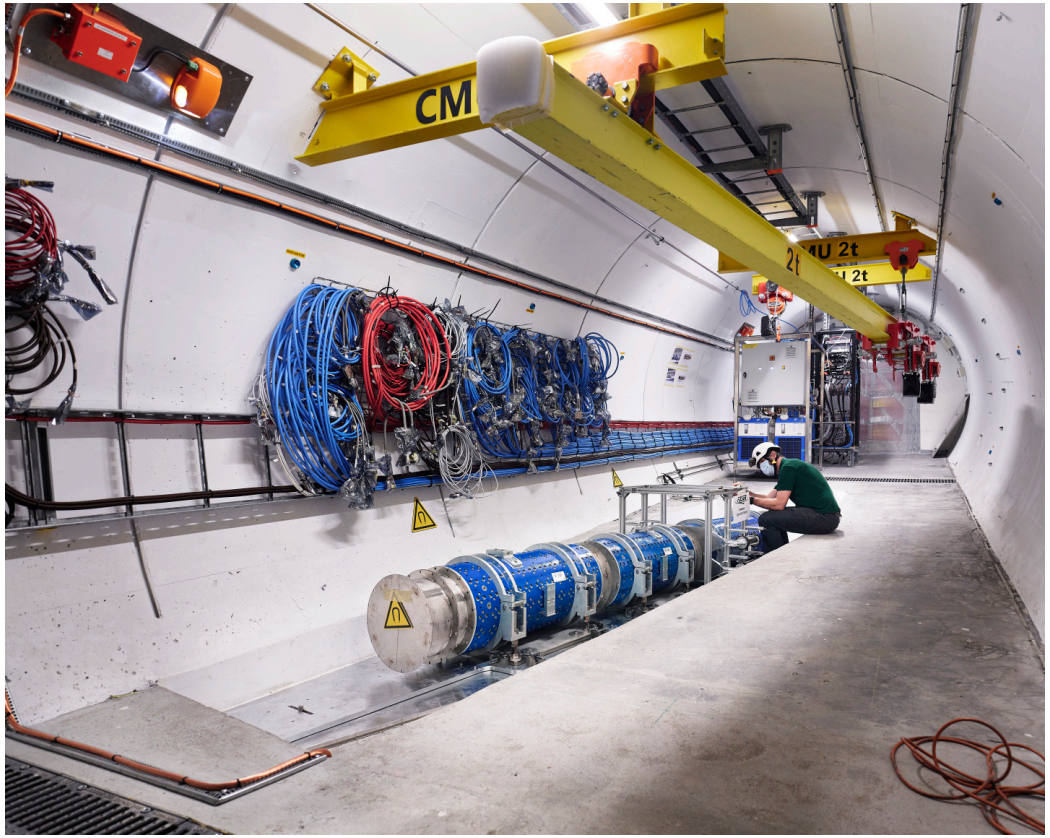




Now installed at CERN !

- During 2020, the Liverpool team helped with remote shifts serving the purpose of pre-commission the detector, in particular the tracker
- Successful installation of the experiment ended in March – now continuing with testing and planning also test beam for the calorimeter modules to be done in summer

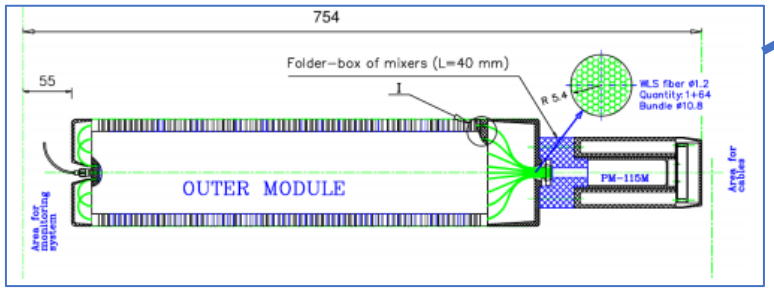




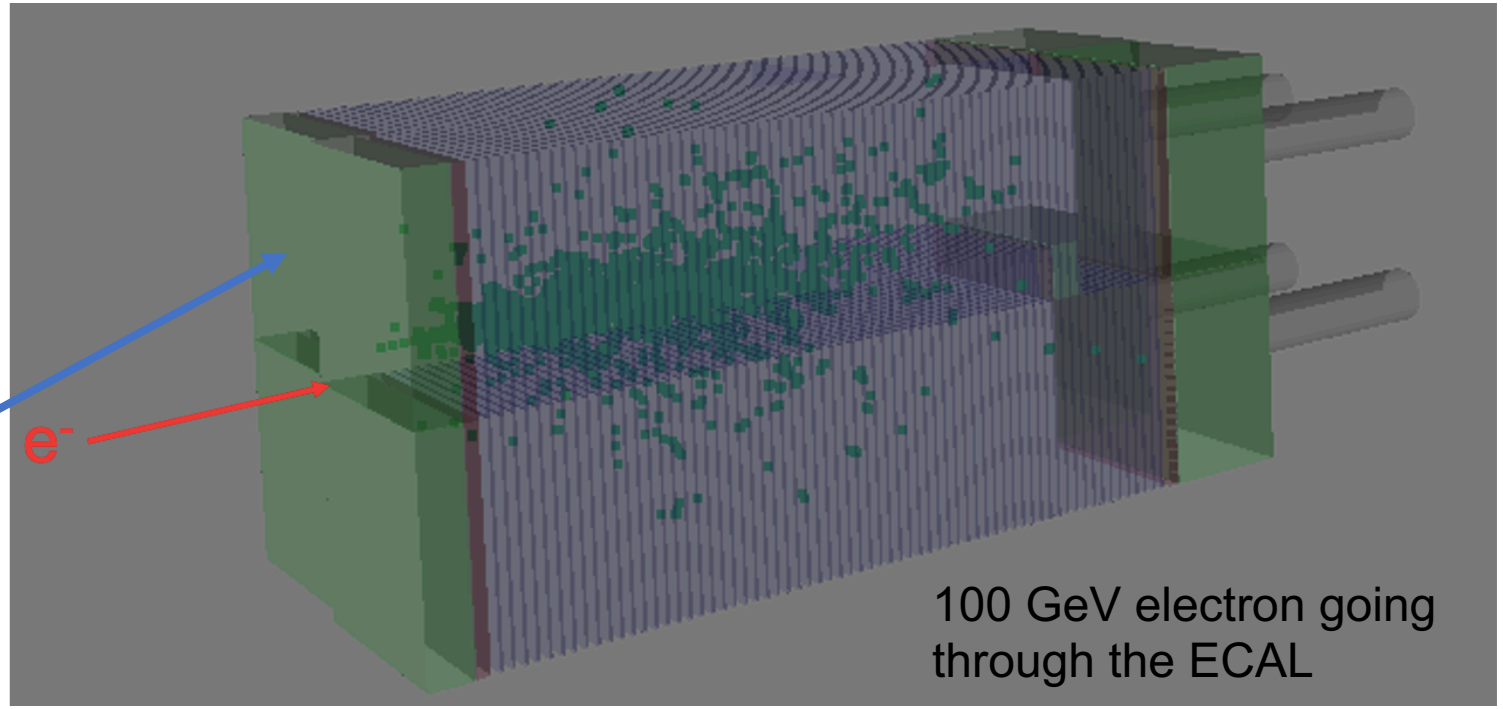
Calorimeter simulation studies

- Our first task is to provide the collaboration with a reliable simulation of the calorimeter (ECAL), built using 4 LHCb calorimeter modules
- A lot of work has been done by Lottie (PhD) on this, using Geant4 and software inherited from ATLAS

After several tests and studies, this is now part of the official FASER simulation!



4 modules structure for ECAL



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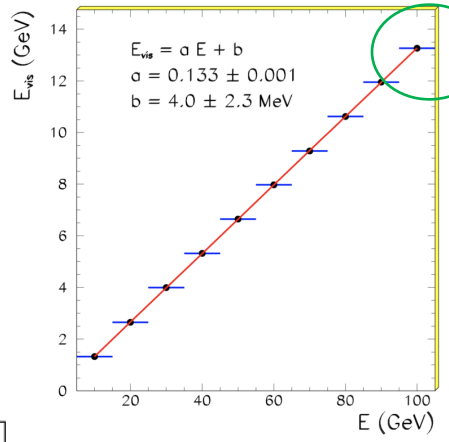
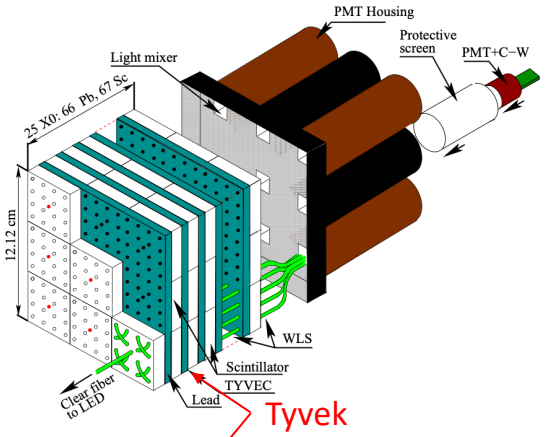
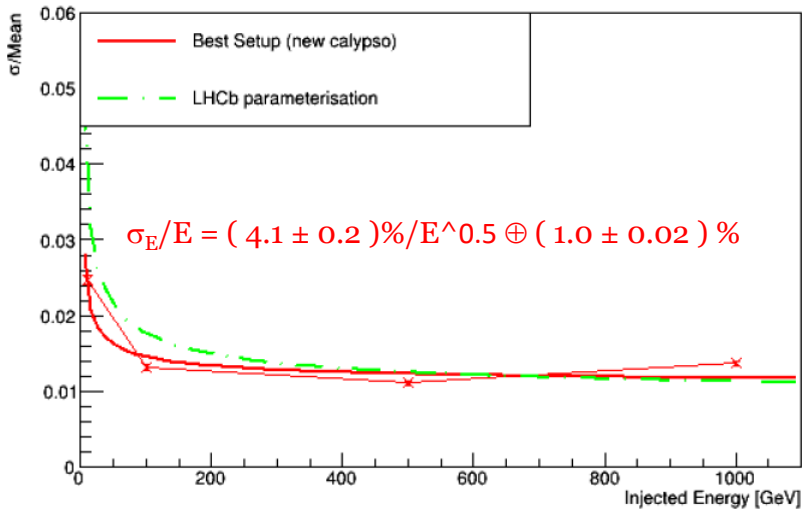


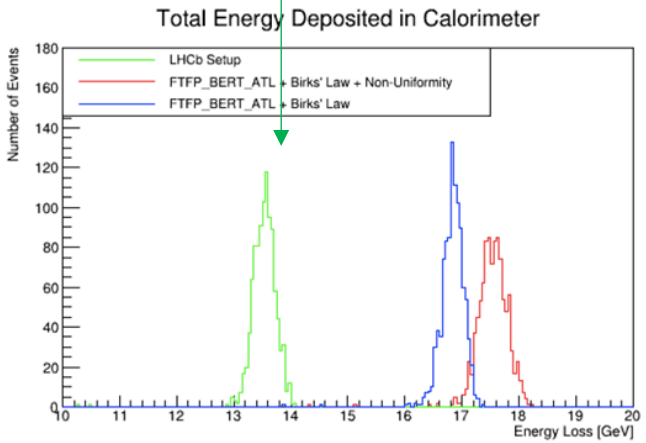
https://cds.cern.ch/record/1445300

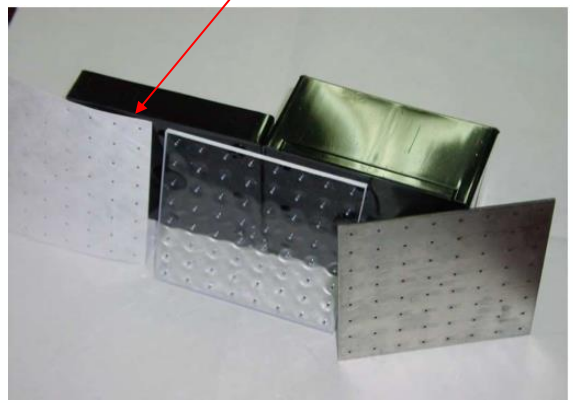
Previous LHCb results

Improved emulation of geometry and material wrt to LHCb needed because of the nature of the experiment









Next steps and outlook

- We are now starting to study data reconstruction from the ECAL using cosmic data collected during recent tests
- In parallel, we are also looking at simulation of potential signals, aiming to:
  - reproduce and possibly improve sensitivity studies e.g. for dark photons with the current, more refined, detector software
  - Evaluate the need for fast simulation depending on data volume
- Data-taking will start in 2022, and we will be ready to analyse data from day 1
- On the longer term, we are interested to potential detector development in case FASER 2 is approved:
    - would require a much larger tracker – can exploit new technologies
    - would also require a better calorimeter – LAr applications