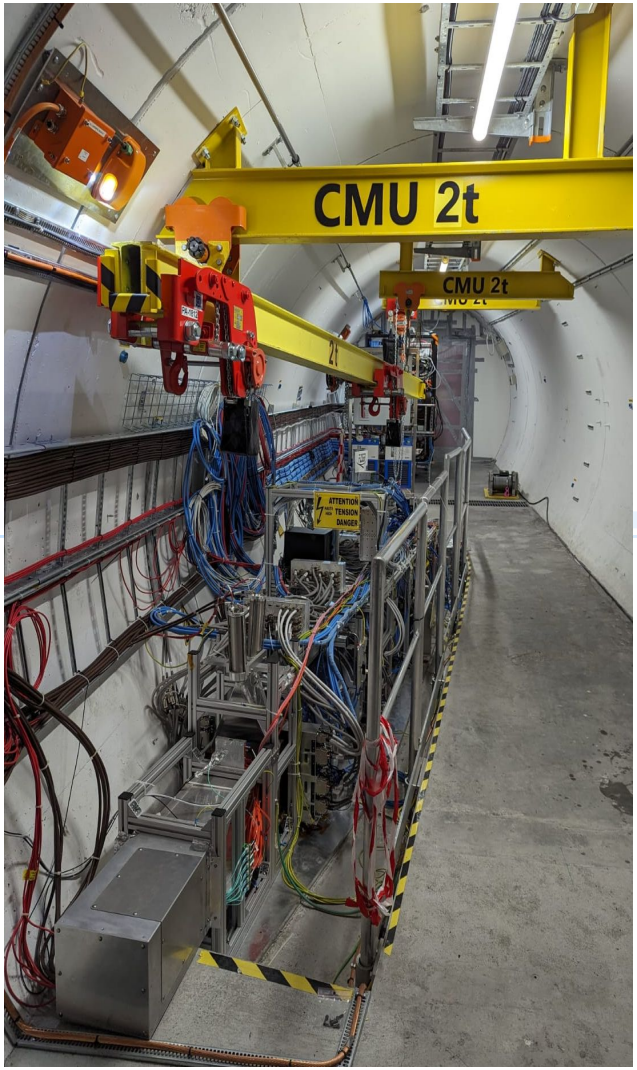
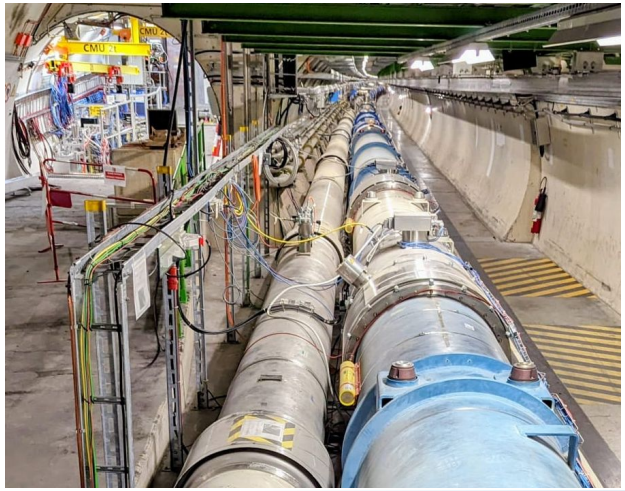
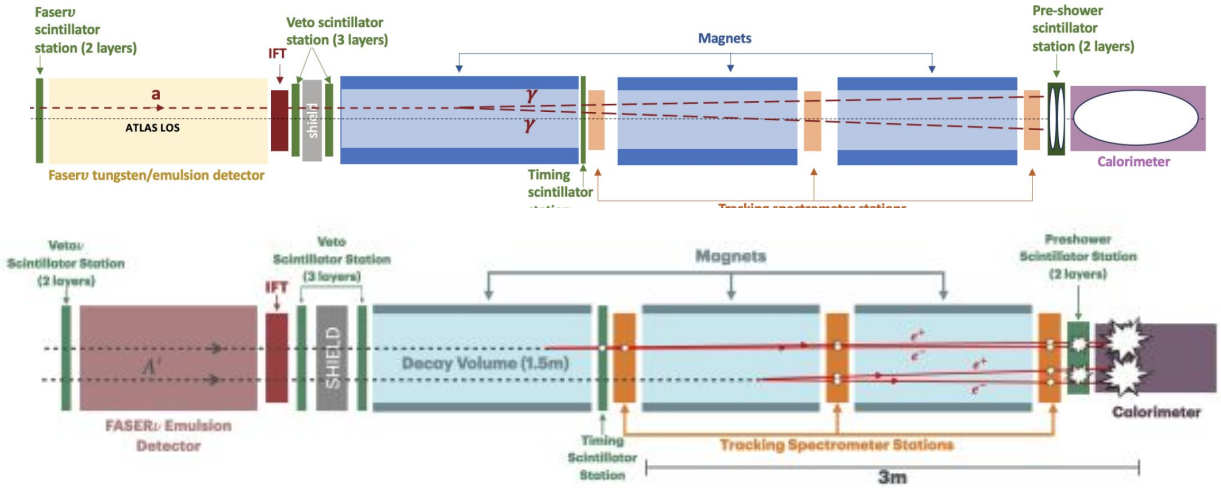




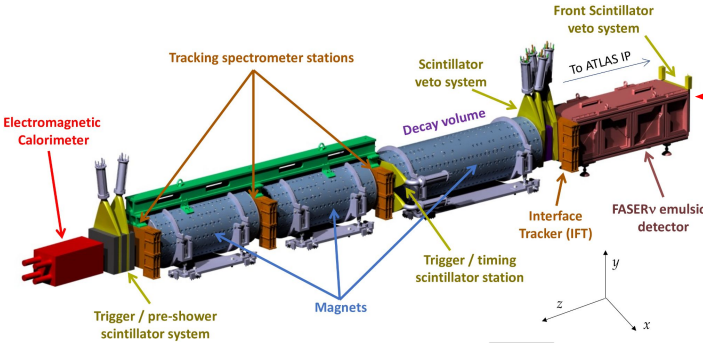
FASER

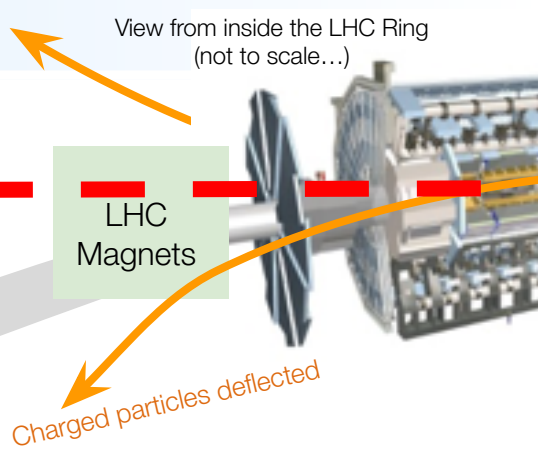
J. Anders
(on behalf of the Liverpool team)

HEP Annual Meeting



The FASER Experiment





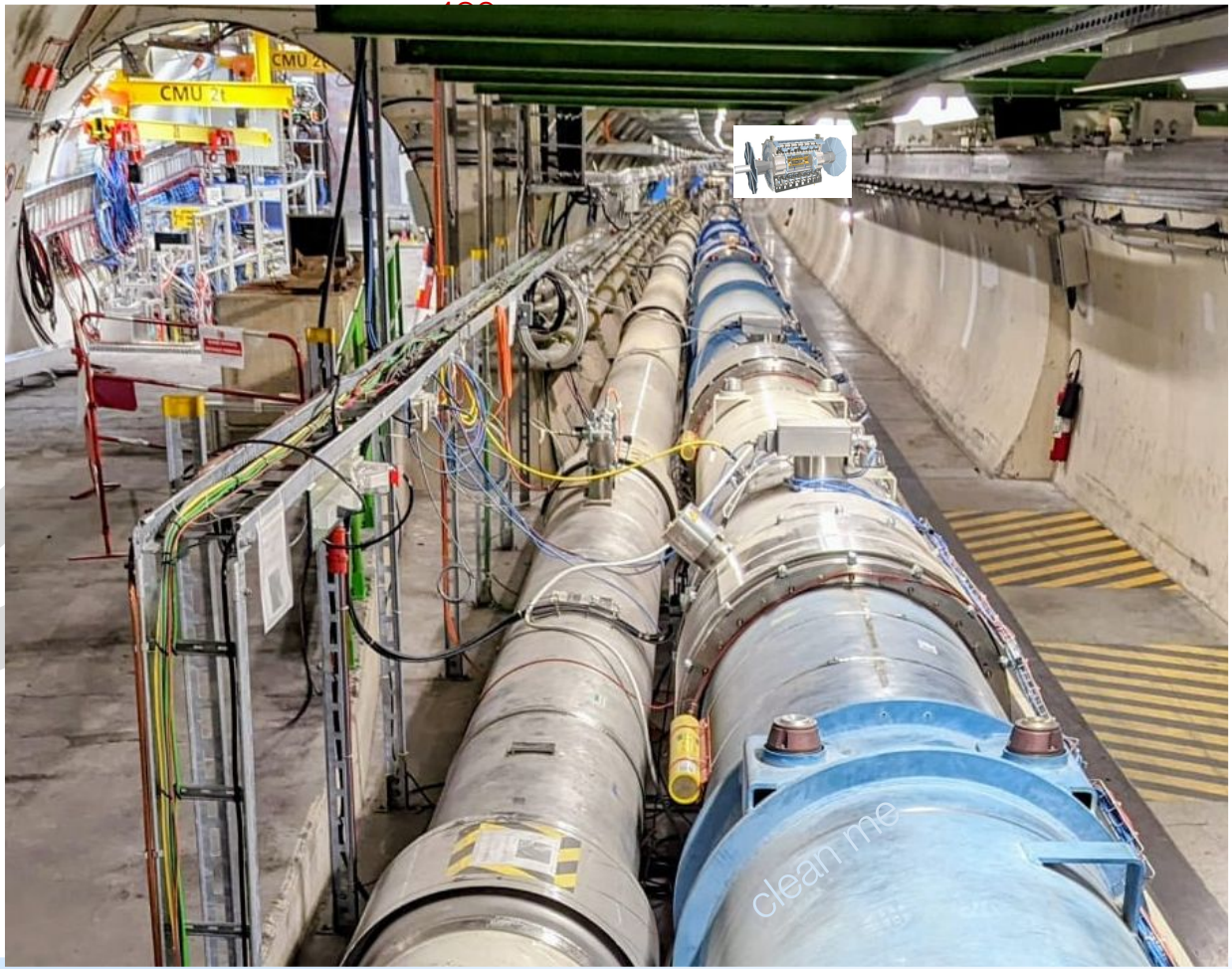
TI12

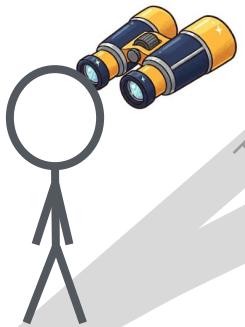
LHC Tunnel

- In operation since the start of Run 3 FASER is designed to investigate long-lived neutral particles:
  - Search for long-lived BSM particles (LLPs)
  - Measure TeV-scale neutrinos

- Take advantage of the pp collisions within ATLAS, and the LHC design
  - Benefit from the collimated flux of forward hadrons, increased light production
  - Shielded from charged particles (LHC magnets) and neutral hadrons (100m rock)

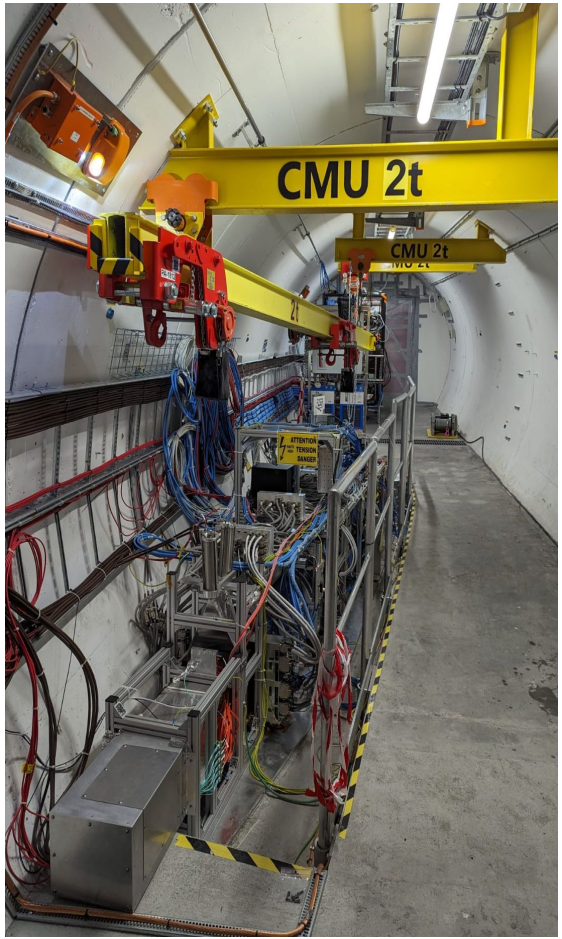
The FASER Experiment

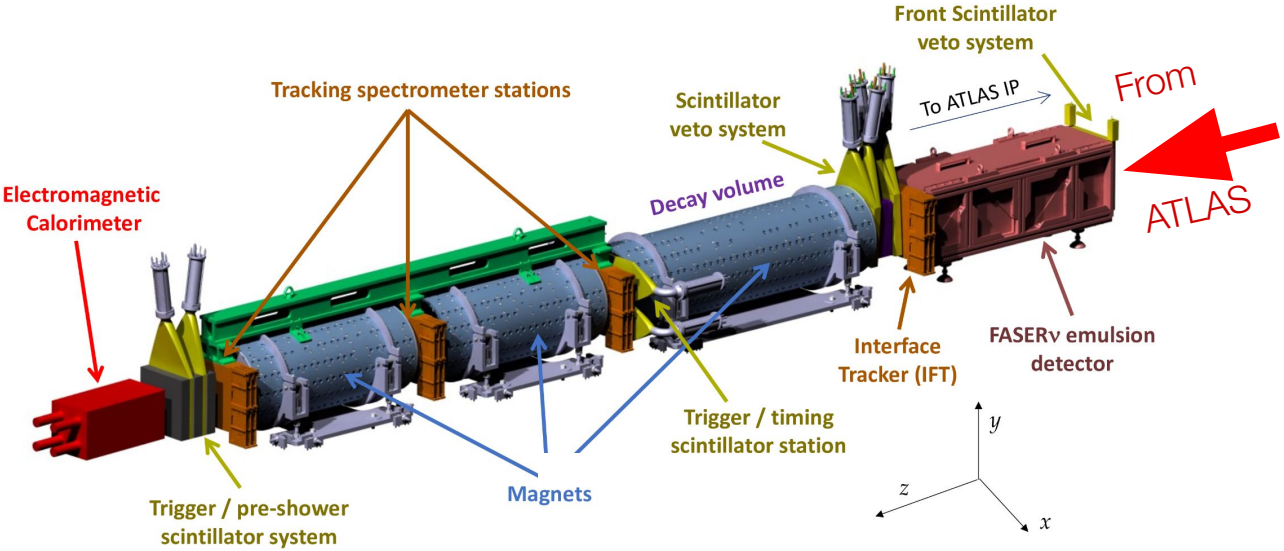




TI12

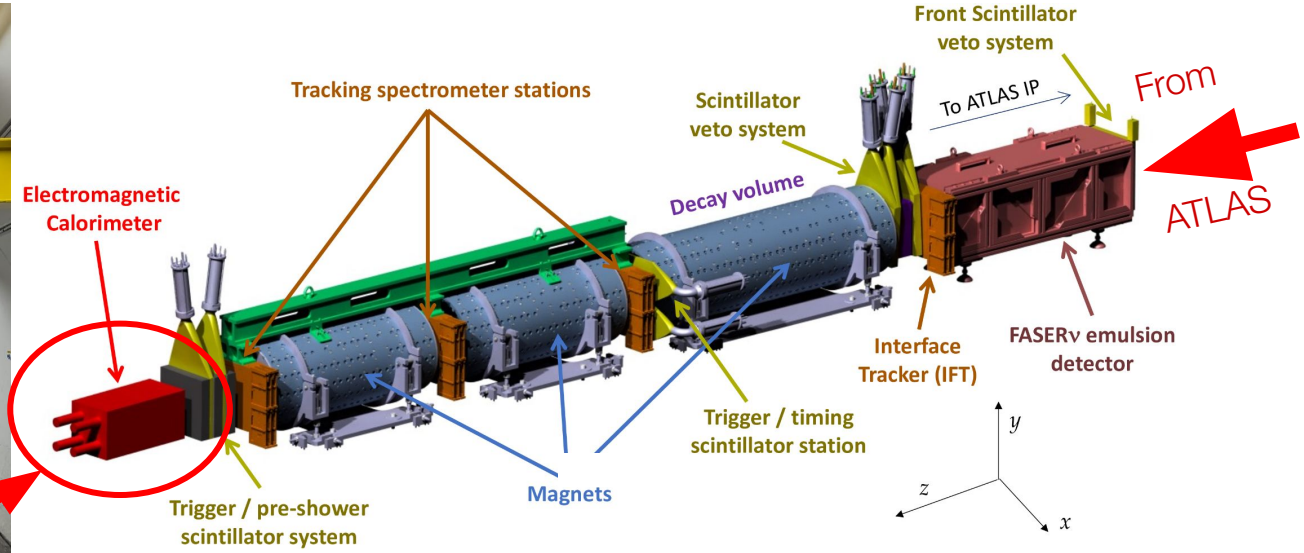
The FASER Detector





- Small detector: 7m long and 20cm wide
  - Silicon Trackers (repurposed ATLAS SCT modules)
  - Calorimetry (from LHCb)
  - Since 2025: Upgraded Calorimeter Preshower and Muon ID
- FASERν detector
  - Tungsten emulsion detector
  - Dedicated to neutrino measurements

The FASER Detector



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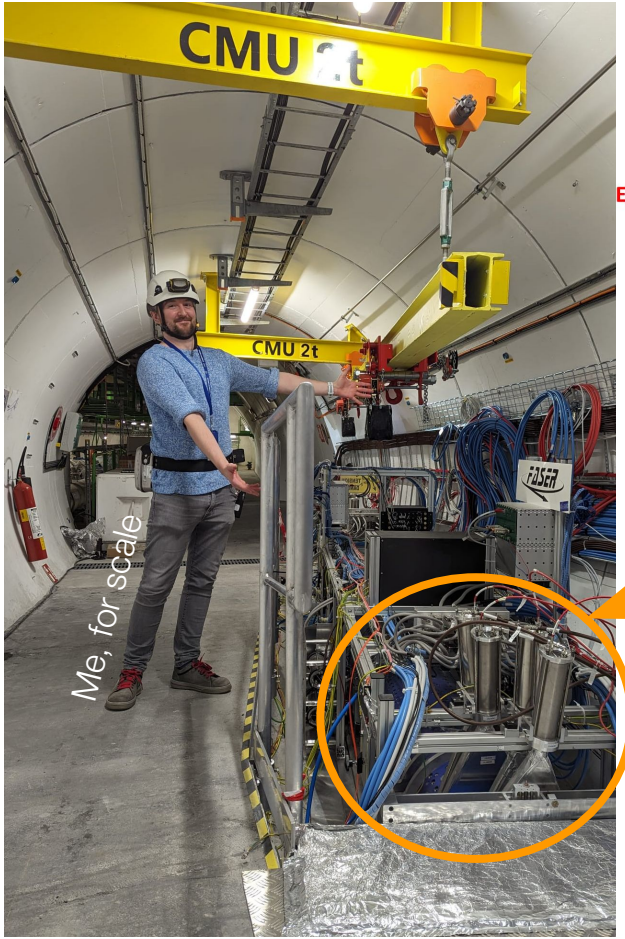
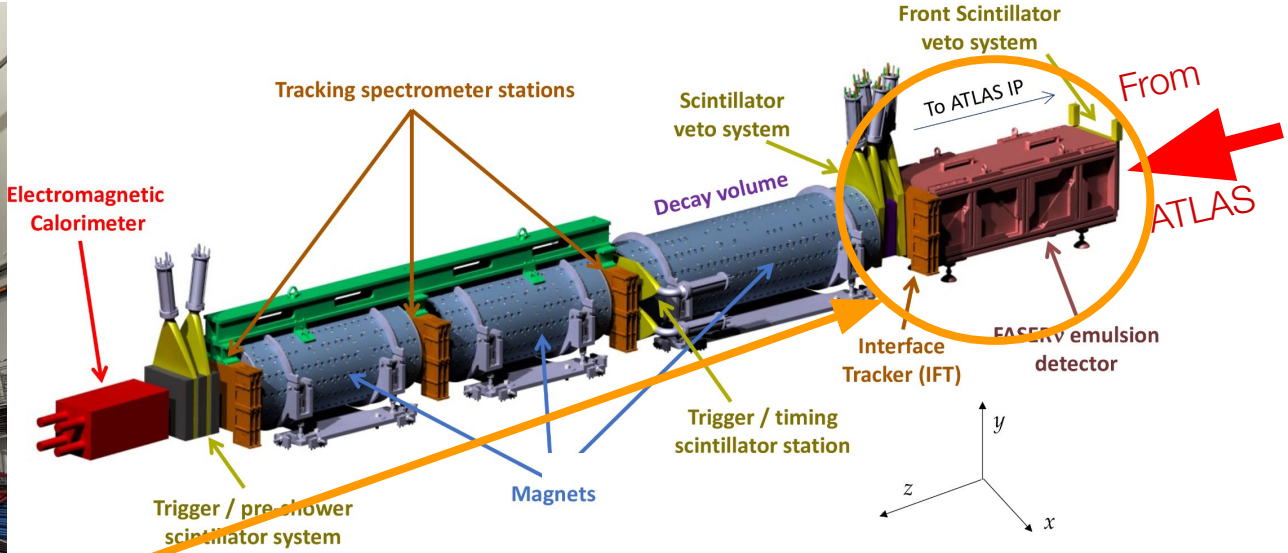
The FASER Detector





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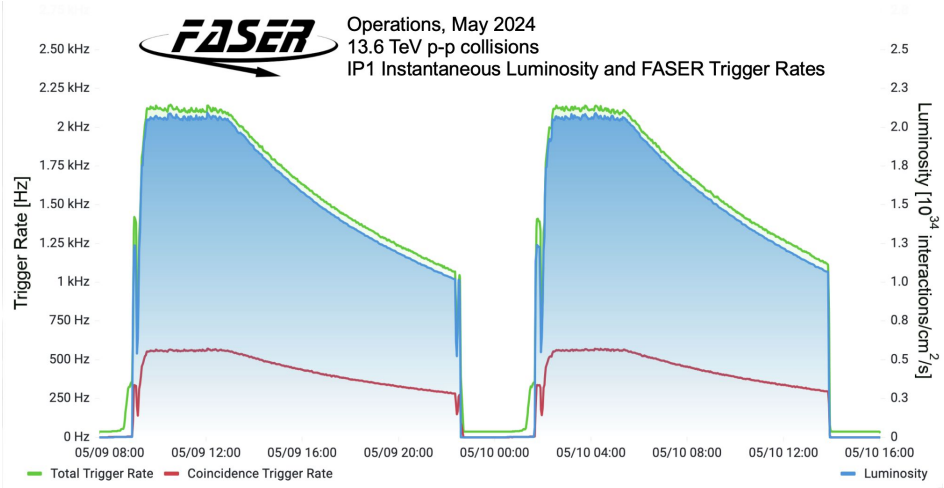
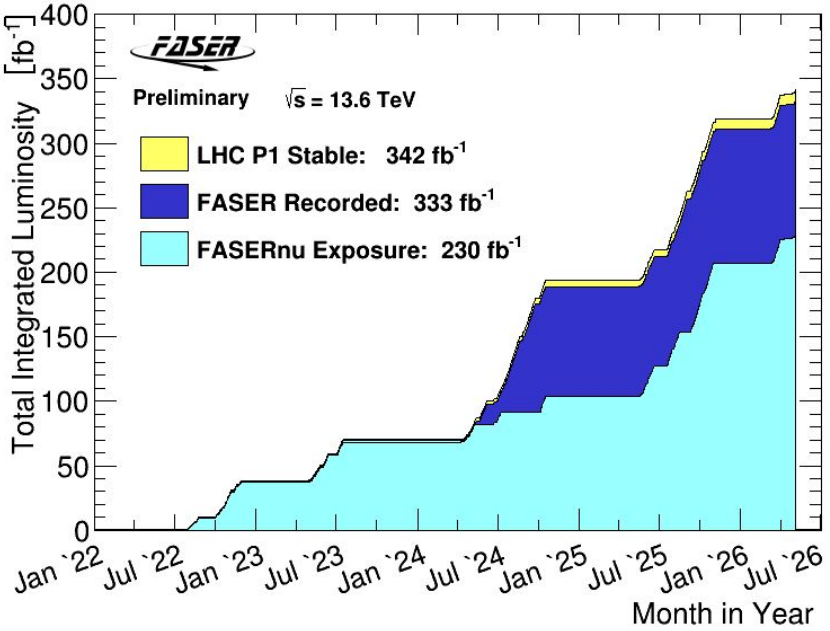
FASER Operations





- Successful data-taking throughout Run 3
  - 97% data-taking efficiency
- 333fb^{-1} (as of last week) recorded
  - 230fb^{-1} with the emulsion detector
- Smooth operations throughout Run 3
  - With thanks to Pawan and Sinead who performed monitoring & run manager shifts

FASER Collaboration

- Strong impact from Liverpool, in physics and international coordination roles:
  - Monica: Collaboration Board Chair
  - Carl: (ex-)Physics Coordinator
- Strong within the UK
  - FASER-UK: 4 institutes + RAL
  - Monica UK PI

Collaboration Meeting!

FASER Collaboration Meeting #7

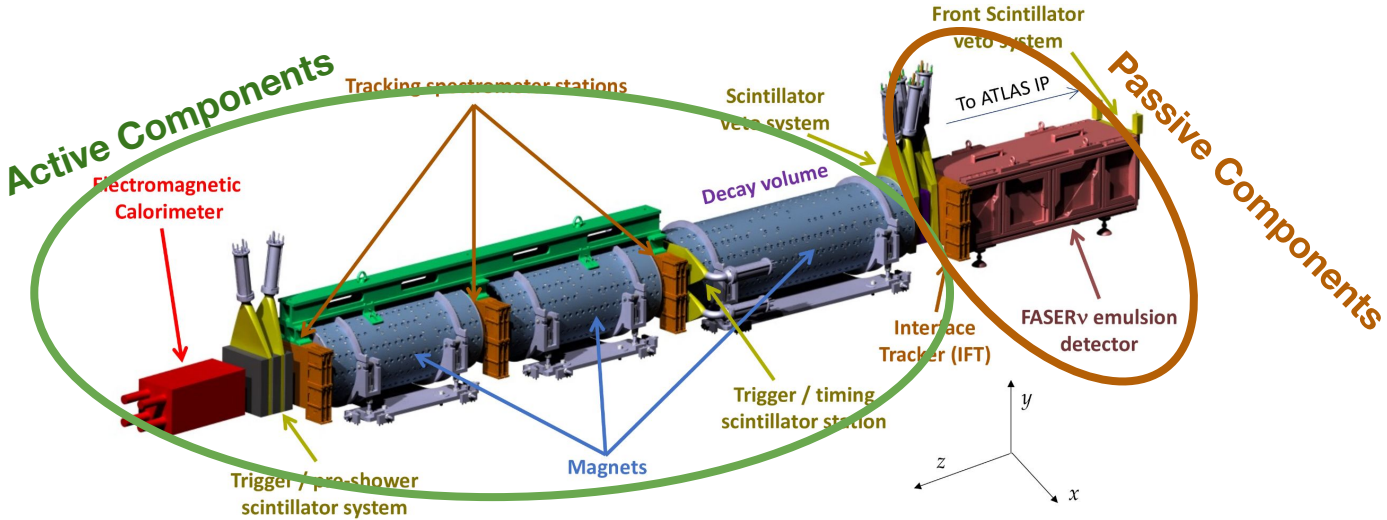
1 Sept 2025, 10:00 → 3 Sept 2025, 16:40 Europe/Zurich

Barkla Lecture Theatre (Chadwick Building)

Carl Gwilliam (University of Liverpool (GB)), Jamie Boyd (CERN), Jonathan Lee Feng (University of California Irvine (US)), Monica D'Onofrio (University of Liverpool (GB))

- Hosted a very successful collaboration meeting
  - 53 Attendees
  - Over 3 Days
  - Productive discussions leading to the most recent set of published results
  - (An aside: I'm never organising a dinner for physicists again…)

FASER Physics

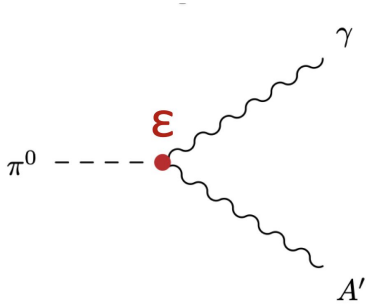


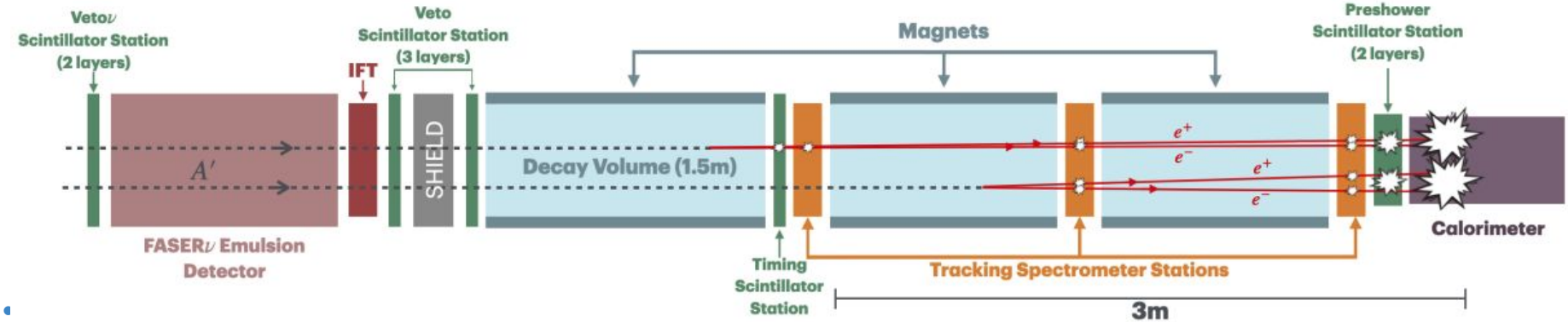
- Five results prepared for Moriond this year!
  - Electronic/Active detector data, collected with the trigger - 177fb^{-1} (2022-2024)
    - BSM - Dark Photon Analysis → Liverpool involvement
    - Neutrinos - First Electron Neutrino measurements → Liverpool Involvement
    - Neutrinos - Double-differential muon neutrino measurements
  - Emulsion/Passive detector information (slower as this requires replacing the emulsion layers and performing scans) - 9.5fb^{-1}
    - Neutrinos - TeV Electron and Muon neutrino measurements
    - SM - Muon-neutrino induced Charm production

Dark Photon Search

CONF-Note, Physics Briefing

- Dark Photon Search using events with tracks
  - Investigating dark photons (A') decaying to e^+e^-
  - No upstream interactions, at least one (partial) track and energy deposits in the calorimeter
    - Significant work on tracking to identify close-by and partial tracks



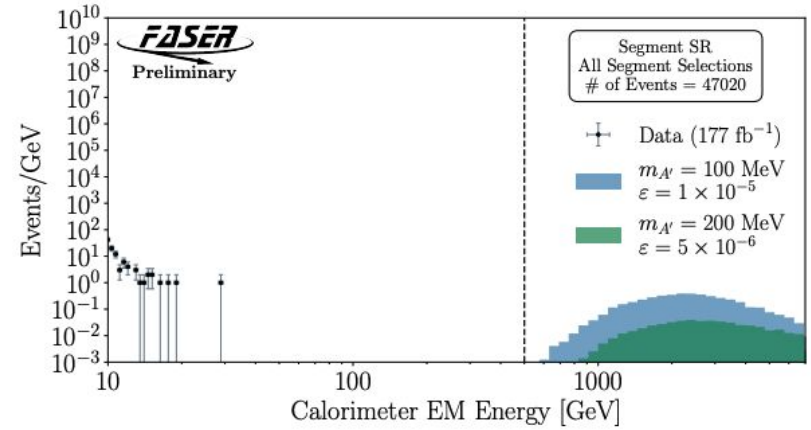


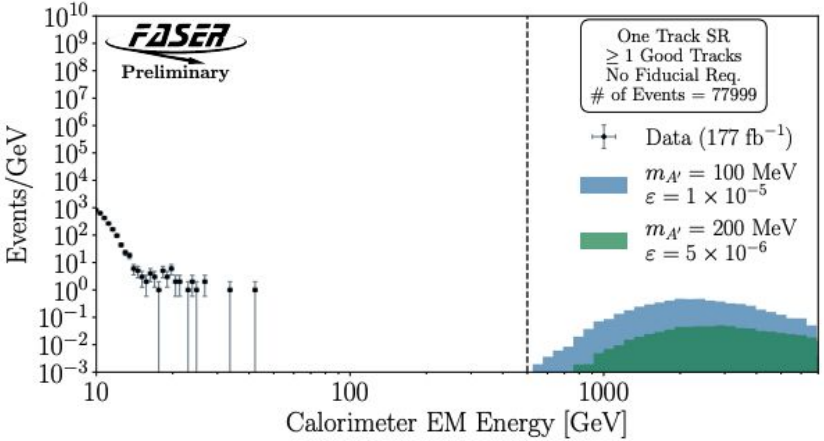
- Beam-induced backgrounds, Neutral hadrons, Geometric muons
- Neutrinos!

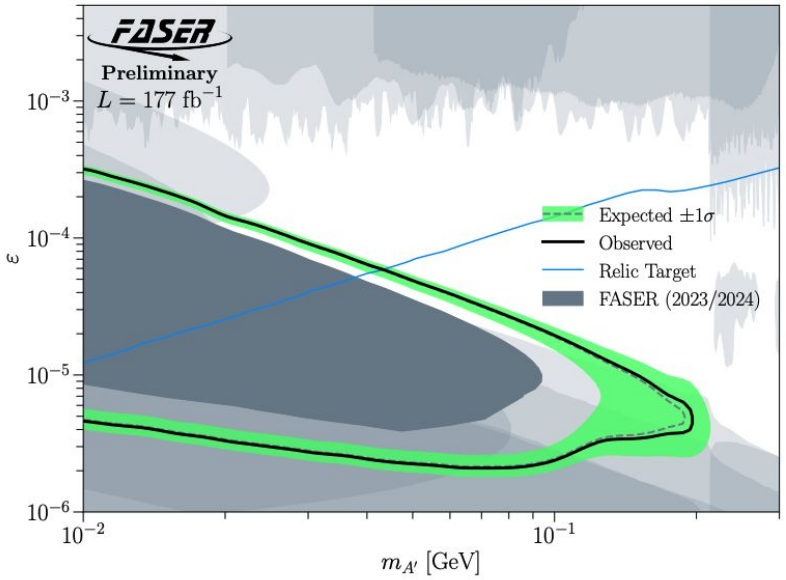
Pawan, John, Carl

More details in Pawan's talk

Dark Photon Search





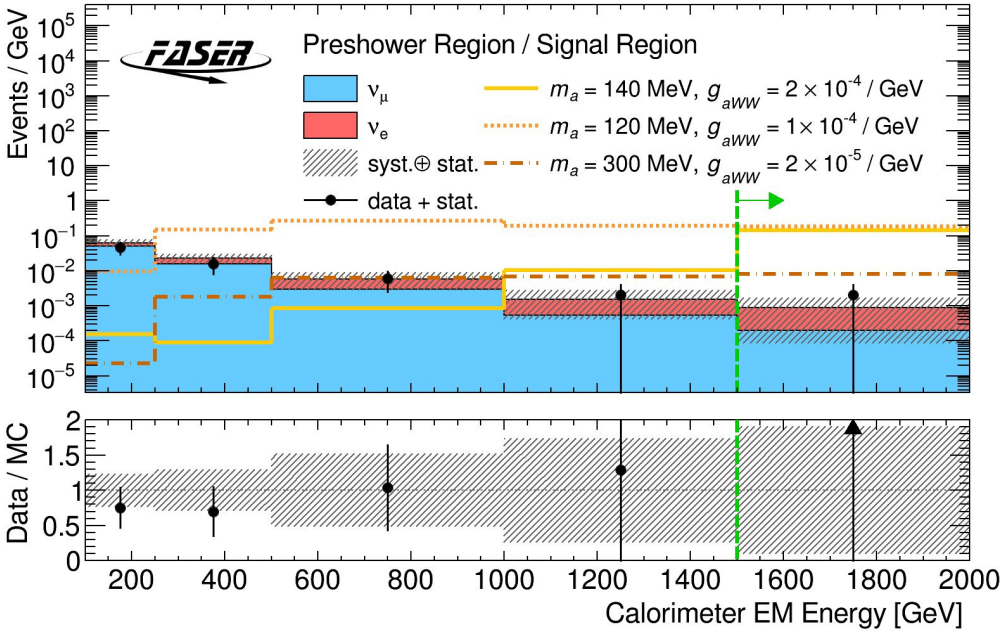


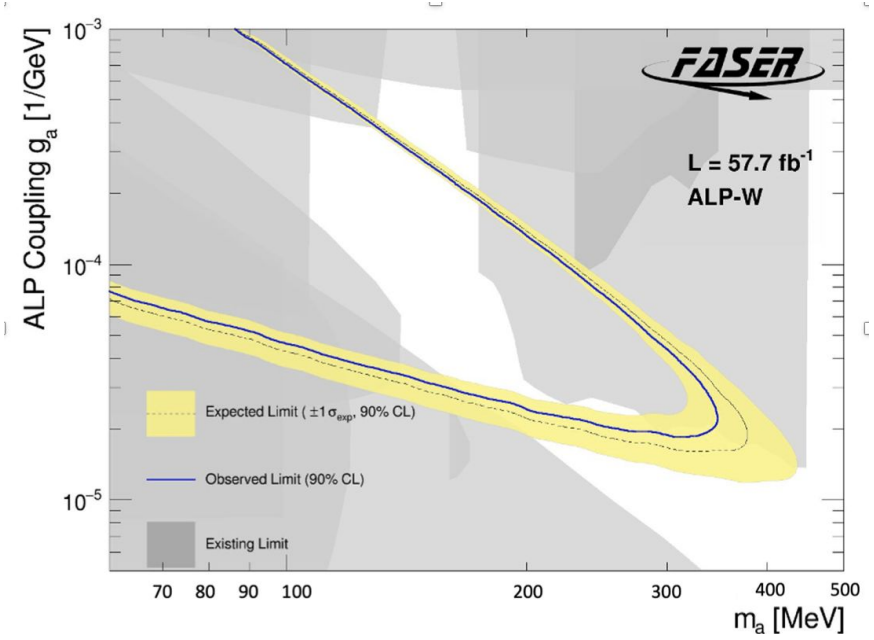
- Stringent Signal region selections to reduce backgrounds to ~0 level
  - No signal in any of the scintillators
  - Total calorimeter energy exceeding 500 GeV
  - Two SRs
    - At least one 1 partial track (segment)
    - At least one (full) track

Upcoming Results - ALPs Search

Sinead, Pawan, John, Carl, Monica

- Ongoing follow-up on the recent ALPs search (published last year: JHEP-01-2025-199)
  - Main background: Neutrinos!



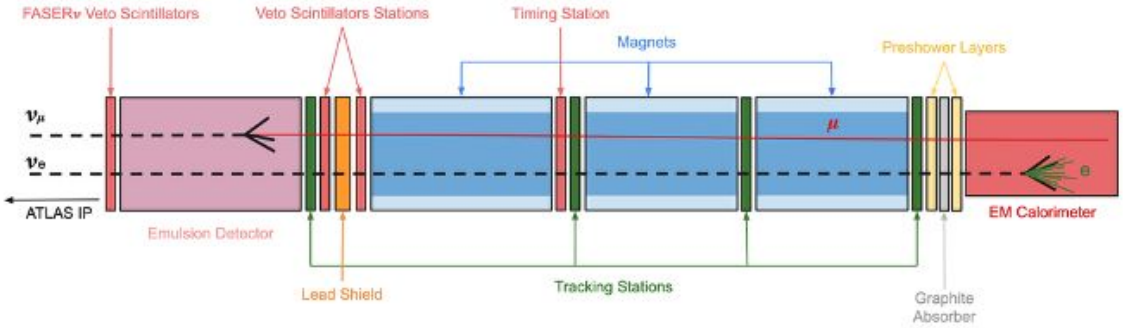


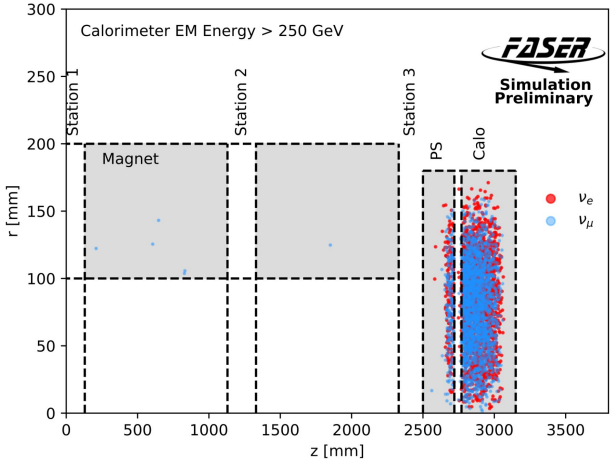
To be Updated Soon!

Electron Neutrino Analysis

CONF-Note, Physics Briefing

- Dedicated electron neutrinos analysis
  - Motivated by the amount of electron neutrinos found in the ALPs SRs





- Select events with only large calorimeter energy
  - Suggesting a neutrino interaction within the calorimeter

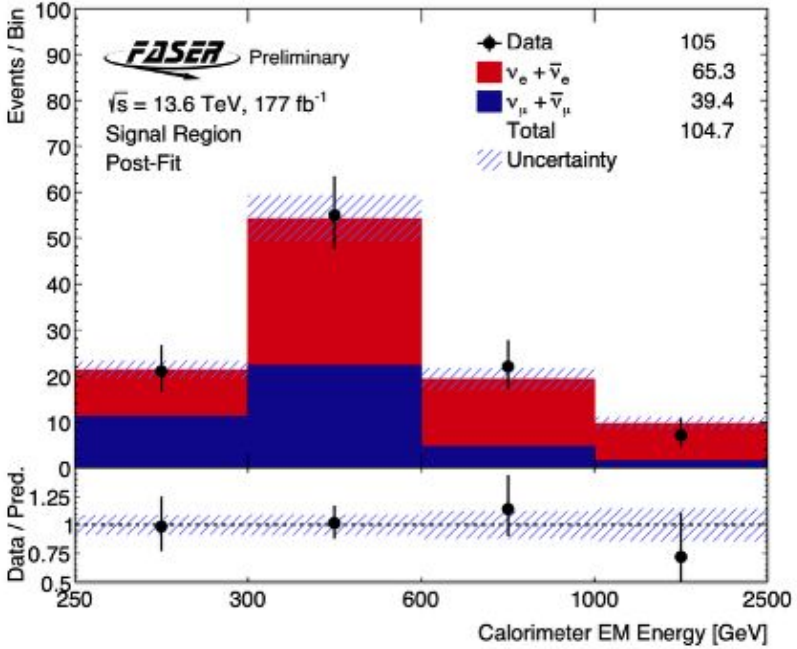
Sinead, John, Carl, Monica

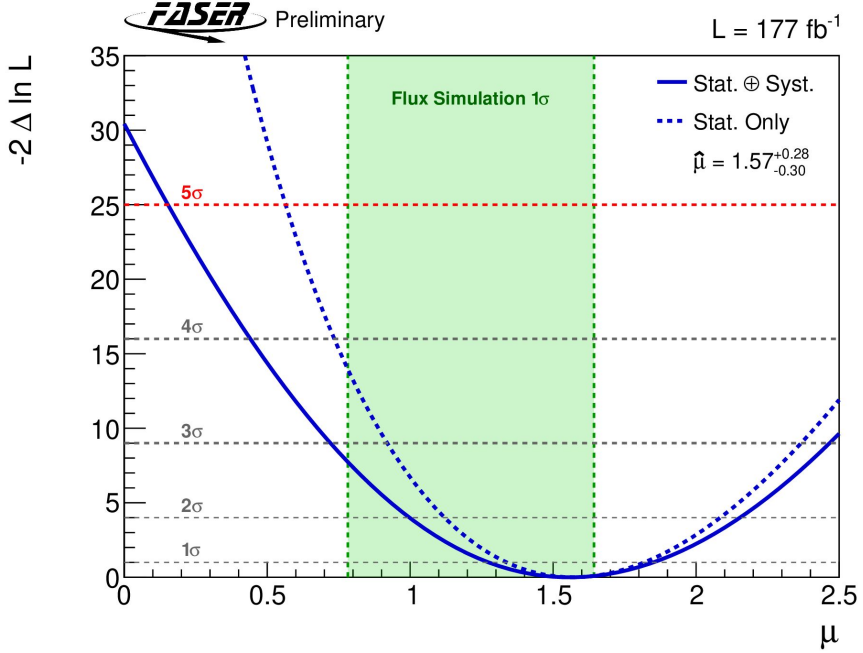
More details in Sinead's talk

Electron Neutrino Analysis

CONF-Note, Physics Briefing

- Other backgrounds from Hadrons, and Geometric muons
  - Liverpool effort estimating both using data-driven methods to reduce to a negligible level (and setting up the statistical framework)

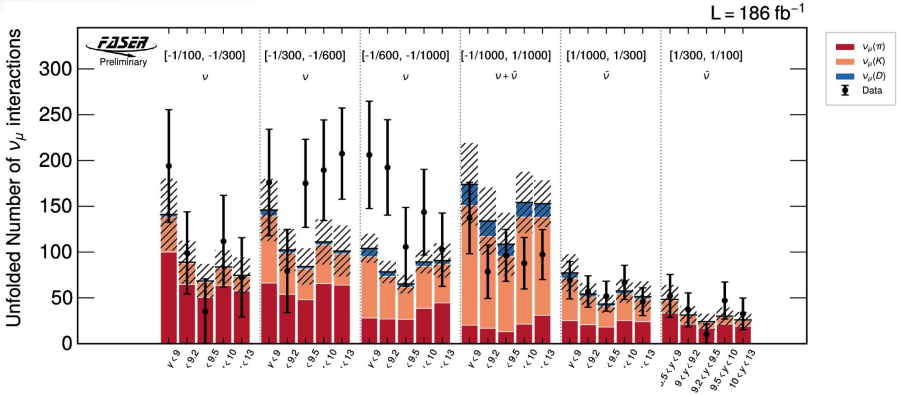


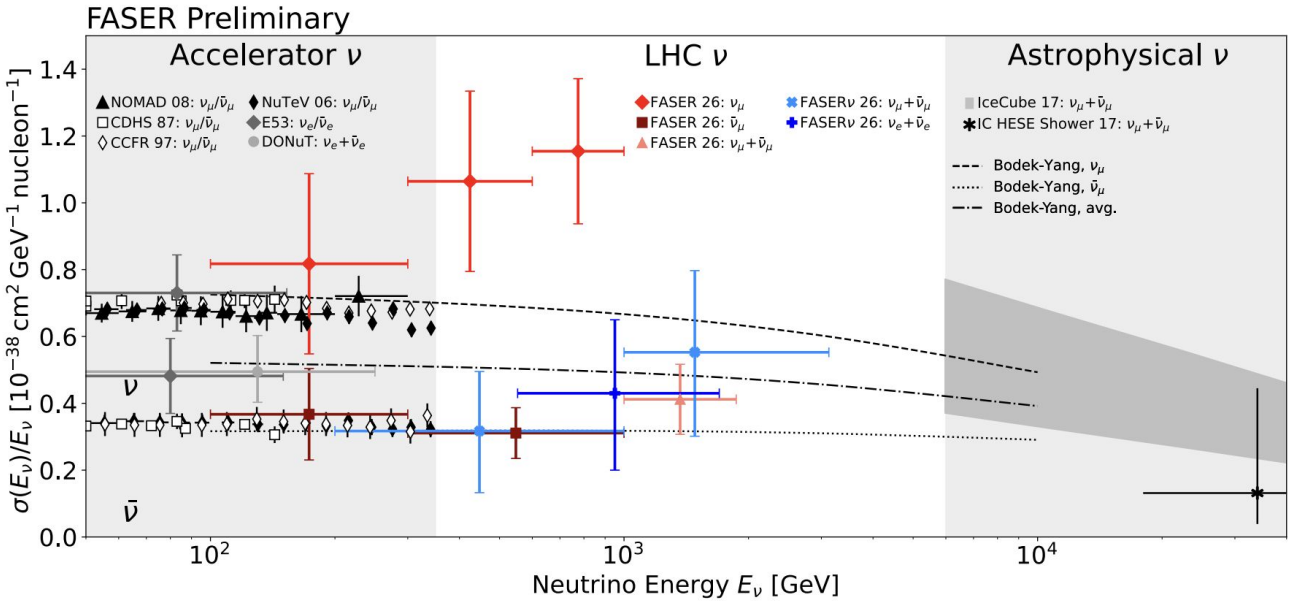


- ~5 sigma observation
  - Complementary to FASERν results

Other FASER Neutrino Results

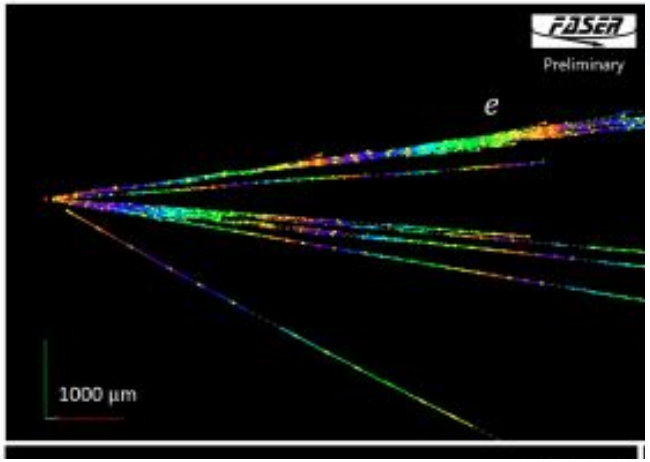
- Building on the previous muon neutrino result, now performing double-differential muon- neutrino measurements

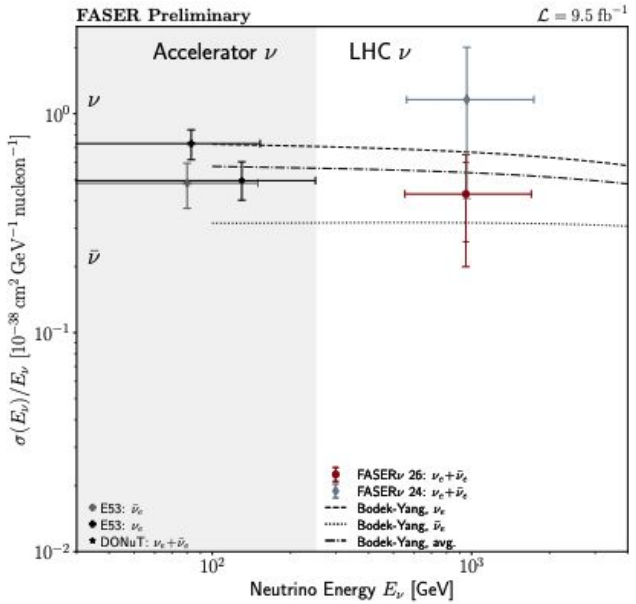


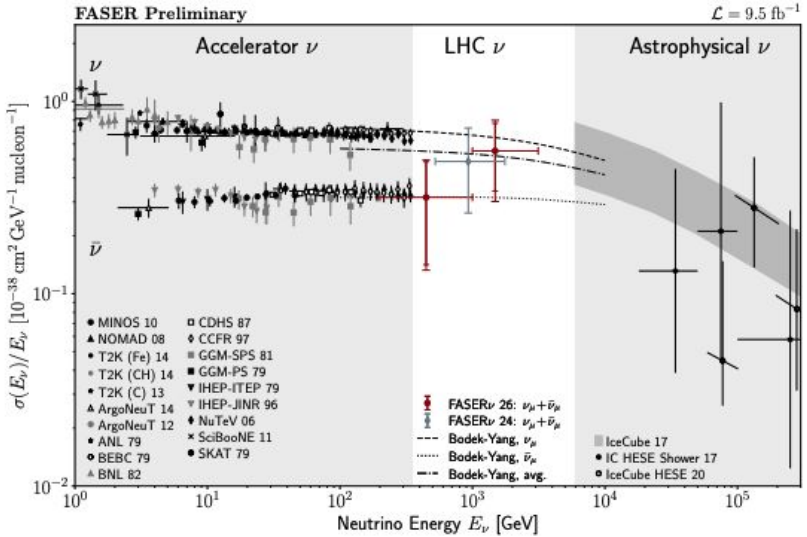


FASER (Emulsion) Results

- Differential cross-section results measured with 9.5fb^{-1} of FASERν data (CONF Note)
  - Slower rate of data collection as film must be scanned, digitised and processed

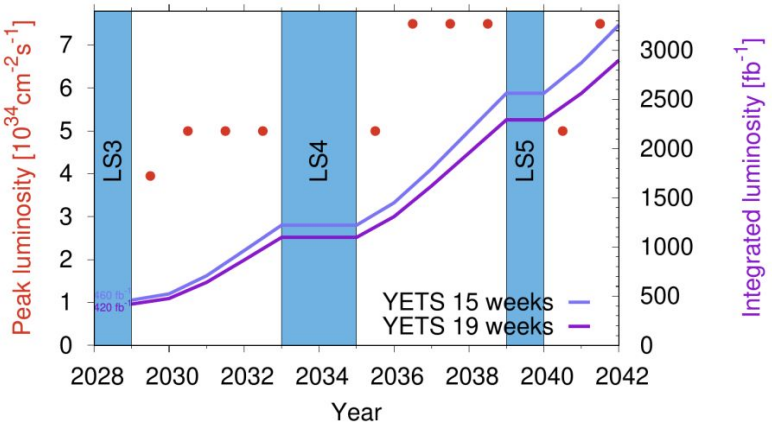


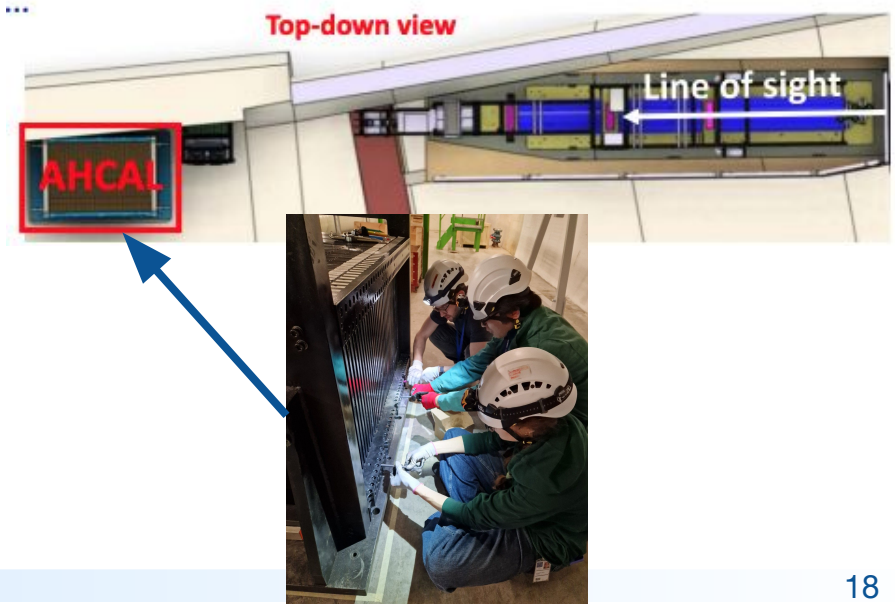




FASER at the HL-LHC

- FASER has been approved to operate during Run 4!
  - Projected 2025+Run 4 luminosity ~770fb-1
- Considerable ongoing work deciding upon detector configuration for Run 4
  - Monica and Carl on the Run 4 task force reviewing different proposals
  - Liverpool contributing to studies working towards the configuration of the decay volume
- Significant effort developing and testing detector technologies for Run 4 operations
  - Including the AHCAL hadronic calorimeter that Annabelle (slides) is working on
  - In addition to further emulsion and electronic neutrino technologies (some prototypes of which have been tested in the tunnel)

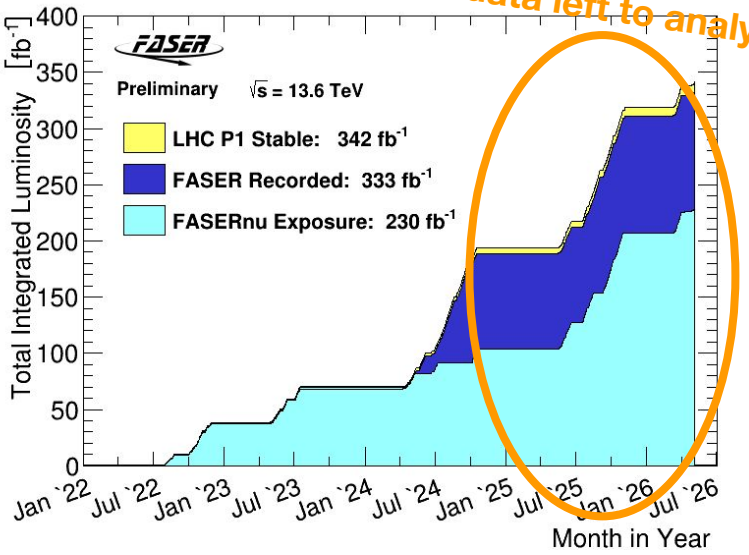




Summary and Outlook

- Considerable physics analyses performed by FASER already with only ~2 years of data
  - Covering BSM searches and neutrino measurements
- Lots to look forward to in the coming years
  - Physics results with the 2025 and 2026 data
    - Including the upgraded preshower from 2025+
- Ongoing efforts planning for Run 4 operations, deciding upon the detector configuration and developing detector technologies

~50% of the data left to analyse



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