

Measuring the cross section of v_e at TeV energies using the FASER electronic detector

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FASER (ForwArd Search ExpeRiment)

- Sits in a previously disused service tunnel in the LHC
 - On the line of sight (LOS) 480m downstream from the ATLAS interaction point
- Searches for light feebly-interacting long-lived particles (LLPs) in far-forward region
 - E.g. Dark Photons (<u>A' Paper</u>)
 - Axion-like Particles (ALPs) (<u>ALPs Paper</u>)
- Conducts neutrino studies using both :
 - Electronic detector (FASER)
 - Dedicated emulsion detector (FASERNu)





ATLAS IP

(480M)

LHC BEAMPIPE

FASER

- Small detector on the line of sight of the ATLAS IP
 - 7m in length
 - 20cm aperture
- Comprised of:
 - Tracking Spectrometer
 - 1.5m long decay volume w/ 0.55 T Magnetic Field
 - Electromagnetic Calorimeter
 - Scintillators
 - MuonID
 NEW
 - Dedicated emulsion detector (FASERv)
- Mostly built from existing parts with some exceptions





ALPs Search → ALPtrino Analysis

- Search for Axion Like Particles (ALPs) conducted by FASER last year ALPs analysis observed a significant selection of neutrinos in the control region
 - CR region is now our region of interest
- New analysis utilises predefined neutrino regions outlined in the ALPs analysis
 - Makes use of a similar approach and framework
 - Require:
 - No signal in either veto scintillator
 - No signal in timing
 - Preshower and calorimeter cuts defined for neutrinos
 - Aims will be to **measure the cross section of the electron neutrino** using the electronic components of the FASER detector
 - i.e. An electronic electron neutrino analysis
 - Dubbed the ALPtrino analysis





ALPtrino (Electronic Electron Neutrino Analysis)

- Aim : Measure electron neutrino flux at TeV energies
 - MC predicts significance in excess of 5 σ
 - Use entire dataset currently available
 - 190 fb⁻¹(2022-2024 Data)
- Split analysis into orthogonal regions as defined in ALPs analysis
 - E.g. Calorimeter and Preshower regions
 - Cuts applied to define this region isolate where the neutrino interacted in the detector
 - First looks at migration matrices show these regions provide good reconstruction of neutrino energy
- Electron neutrinos are targeted in this analysis:
 - Similar hypothesis to electronic muon neutrino analysis conducted last summer (<u>CONF Note</u>)
 - Will utilise this result to provide an accurate estimate of backgrounds from muon neutrinos



Calorimeter EM Energy [GeV]

ALPtrino Backgrounds

- FASER in low background environment:
 - Still need to account for background from:
 - Muon decay to neutral hadrons
 - Large-angle muons-
 - Non-collision backgrounds
 - Scintillator inefficiencies

Large Angle Muons

- Not all muons that enter FASER necessarily pass through all vetos
 - Could have some that enter at a large angle
 - Would contribute to the background
- In this analysis :
 - Utilise a data-driven (ABCD) method to estimate the background due to large angle muons in our signal region
- Potentially larger contribution from this background in 2024 data
 - There was a change of LHC optics that resulted in FASER experiencing a high muon rate last year



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Next Steps

- ALPtrino analysis is progressing and we plan to present results in Autumn
 - Plan for this to be followed by a paper at the end of the year

Operations

- FASER continues to perform well
- Will continue taking on run manager shifts while on LTA and in Liverpool
- End of LTA this autumn
 - 6 month industrial data science placement in final years