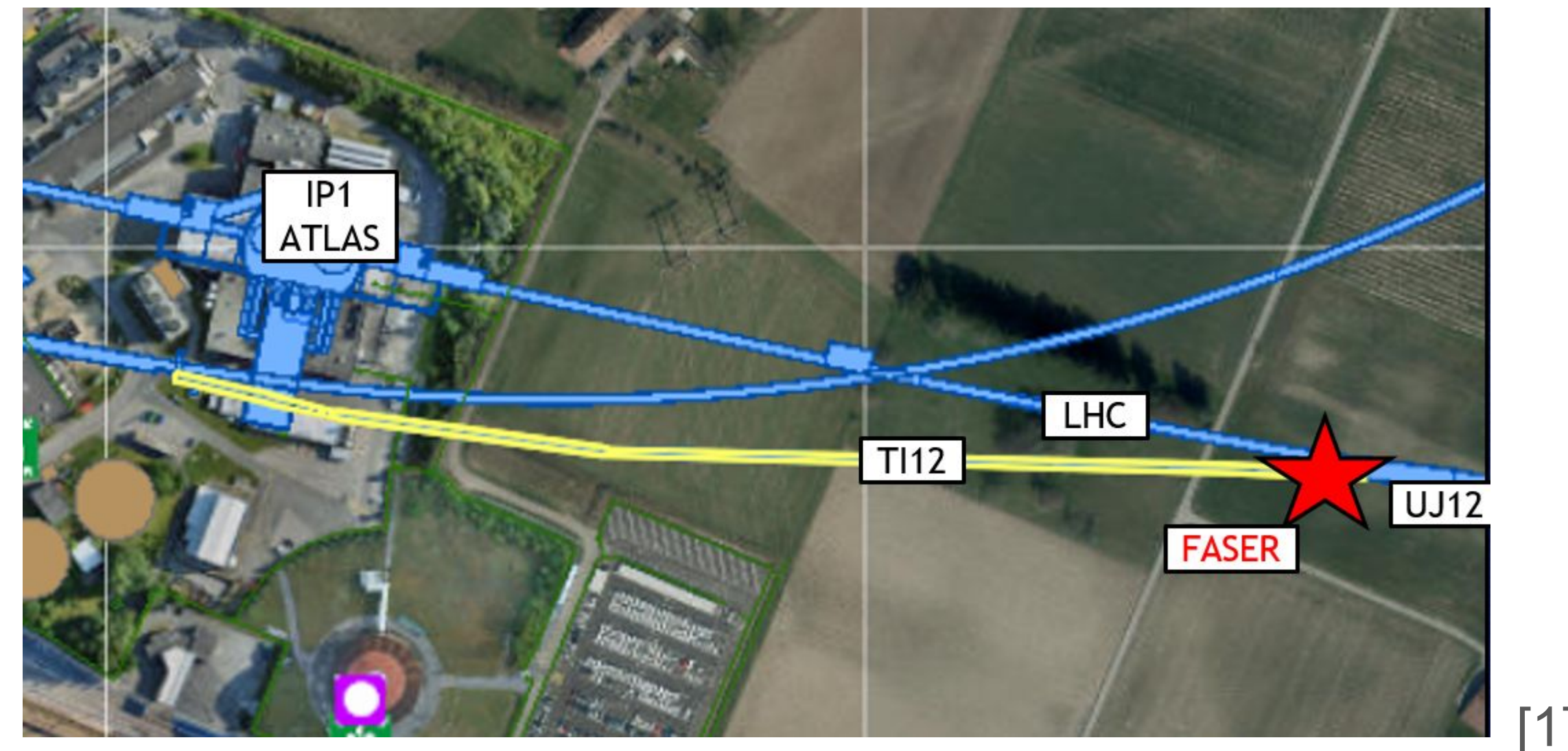


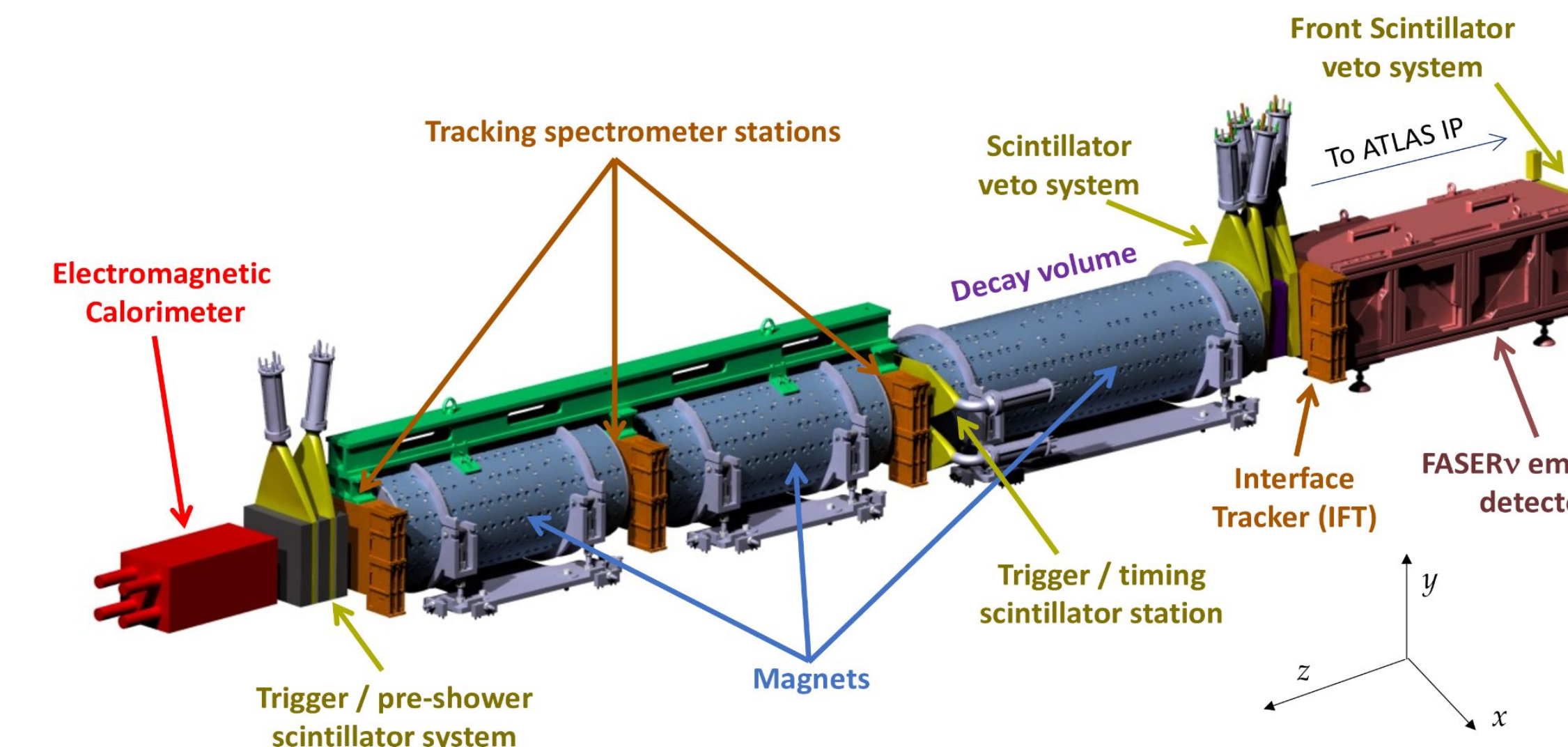
Introduction

FASER is an experiment at CERN located 500m downstream of ATLAS on the collision line of sight axis. With 100m of rock shielding FASER it is able to study weakly interacting very forward boosted particles such as neutrinos with very little background.



[1]

Detector

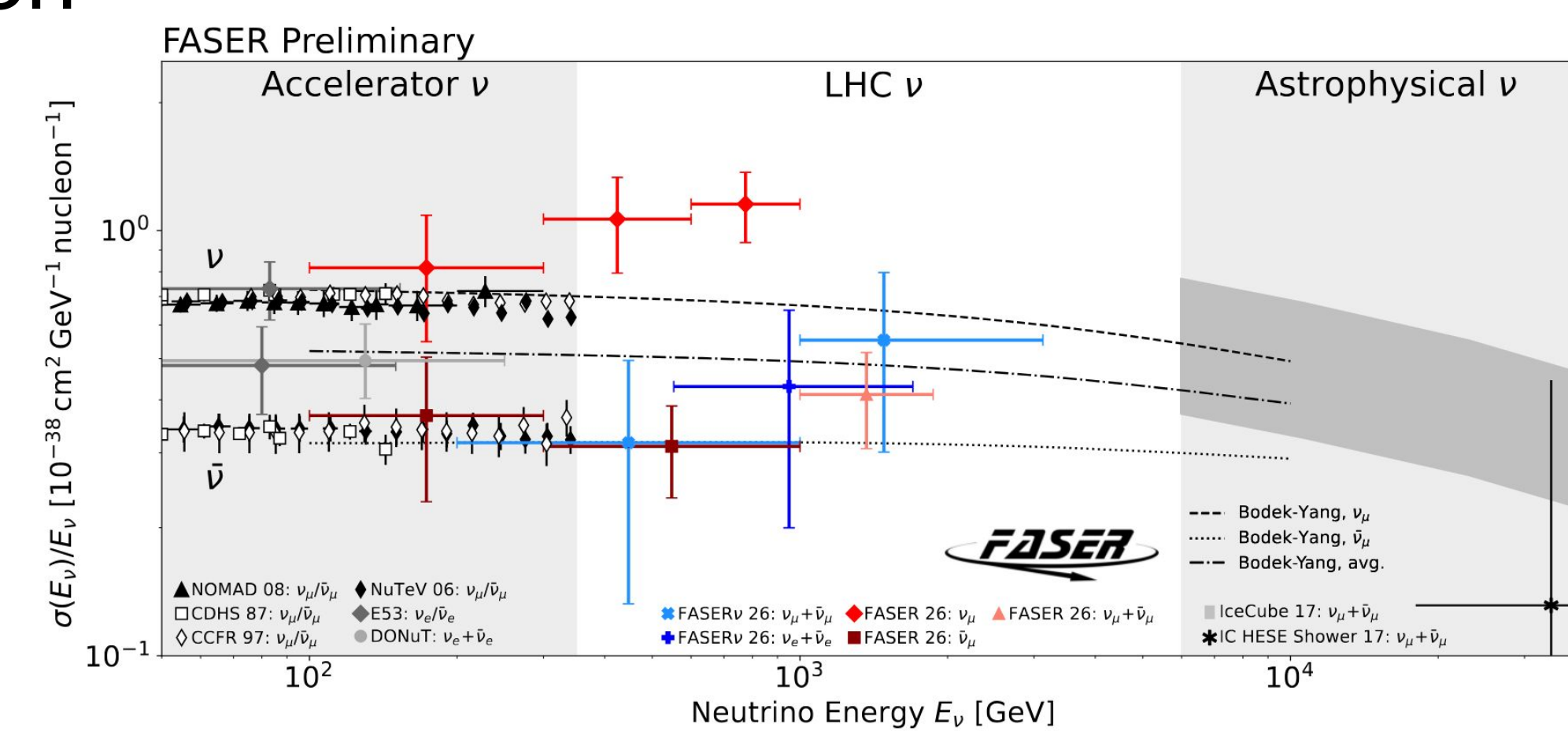


- The FASER Detector has three key parts for neutrino physics
 - Emulsion box: Acts as 1.1 ton tungsten target for the muon neutrinos
 - Tracking spectrometer: Measures muon momentum
 - Calorimeter: Target for electron neutrinos and measures electron energy

[1]

Motivation

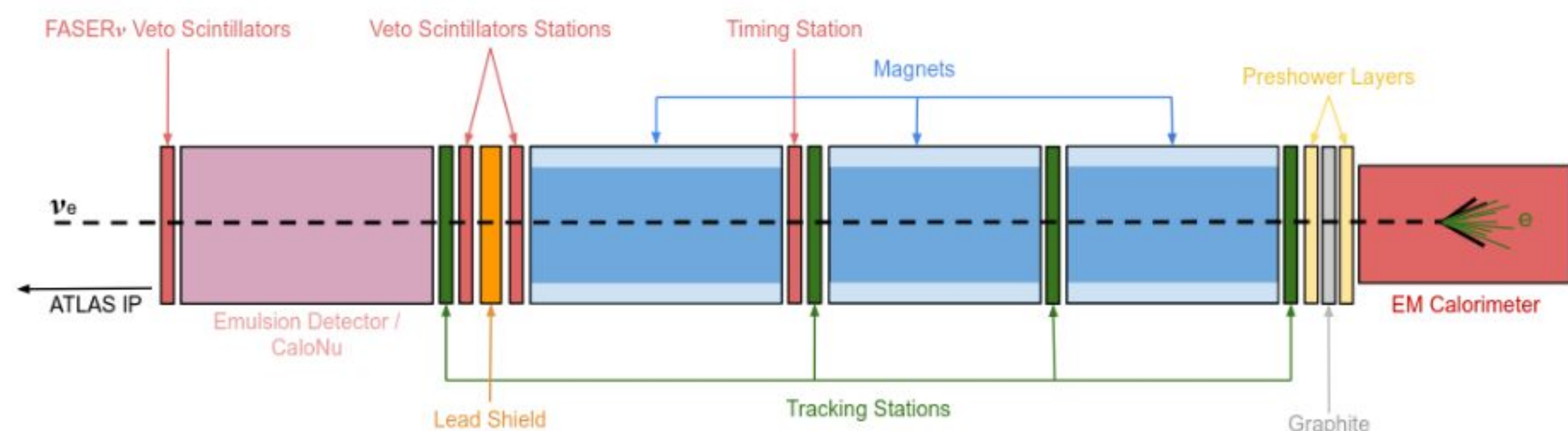
- FASER was the first experiment to detector collider neutrinos
 - Is one of two experiments that have detected collider neutrinos
- Collider neutrinos are at an unique energy scale
 - Accelerator neutrinos goes up to approximately 360 GeV
 - Astro neutrinos goes as low as approximately 6 TeV
 - The gap is filled in by collider neutrinos



Backgrounds

- Dominant backgrounds comes from **other neutrino interactions**
 - Neutrino interactions are
 - Neutral Current (NC)/Charged Current (CC)
 - Electron, Muon, or Tau
 - In the fiducial volume or out of the fiducial volume
- Other minor/negligible backgrounds includes
 - Muons that evade the veto scintillators
 - Neutral hadrons produced in the rock in front of FASER
 - Non-collision backgrounds such as cosmic

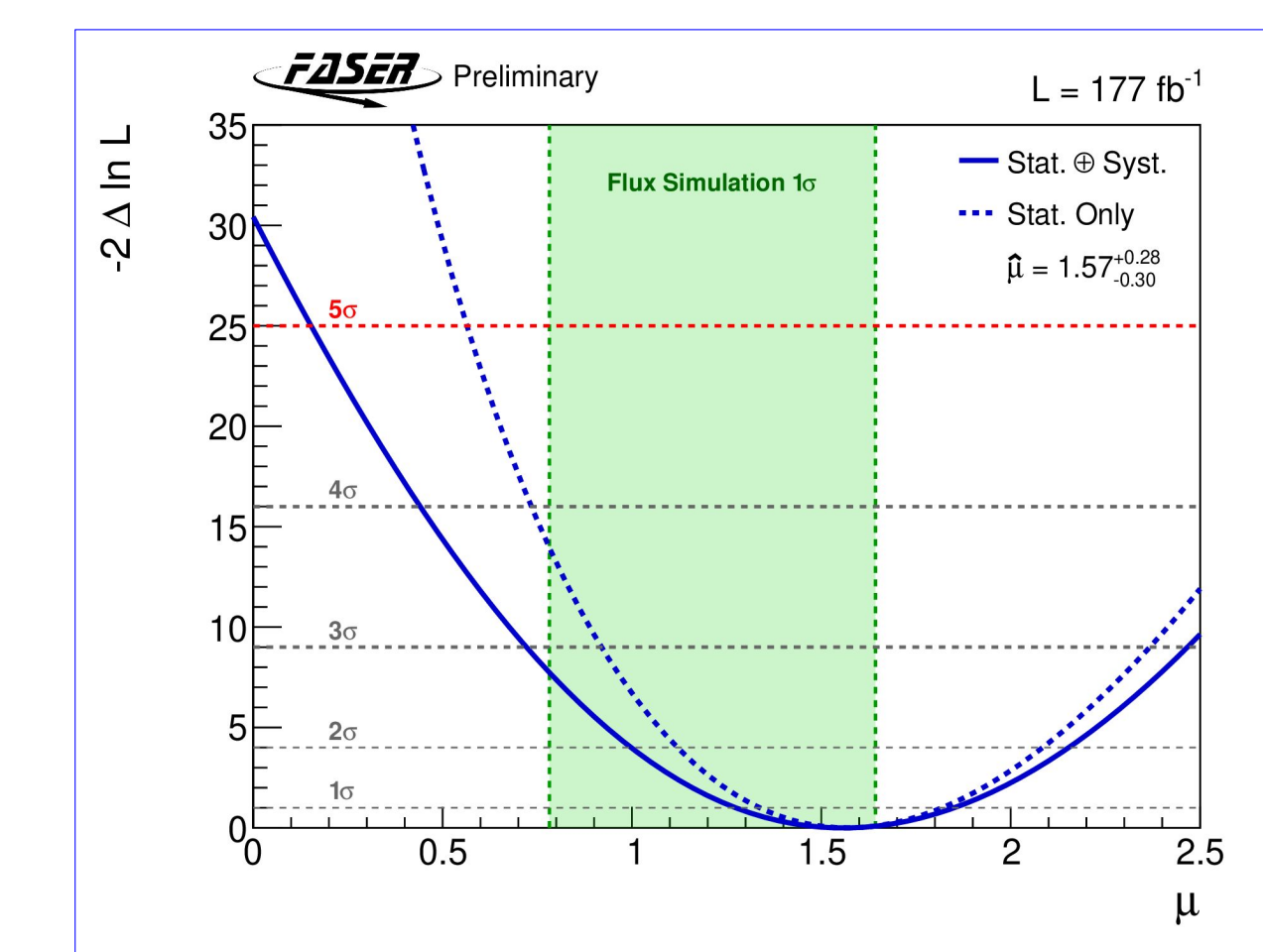
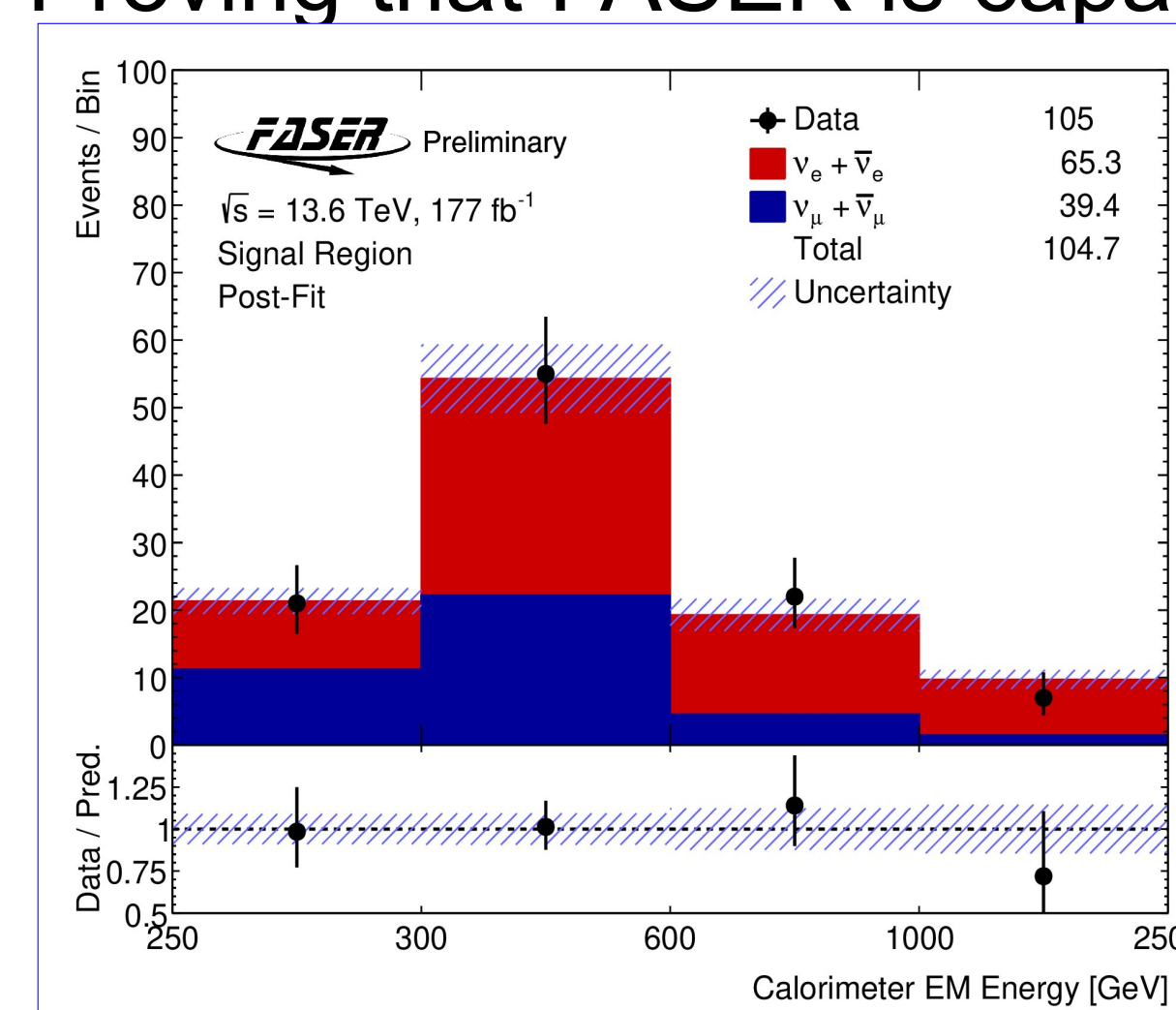
Measuring Electron Neutrinos



- Signal: Electron Neutrino CC+NC interactions in the EM Calorimeter
- Expects no signal upstream of the Preshower
- The interactions causes a shower in the Calorimeter resulting in a large energy deposit
- Dominant background is Muon Neutrino interactions in the Calorimeter

Electron Neutrino Results

- FASER was able to achieve a 5σ observation of electron neutrino with 177 fb^{-1}
 - Proving that FASER is capable of an electronic measurement of electron neutrinos

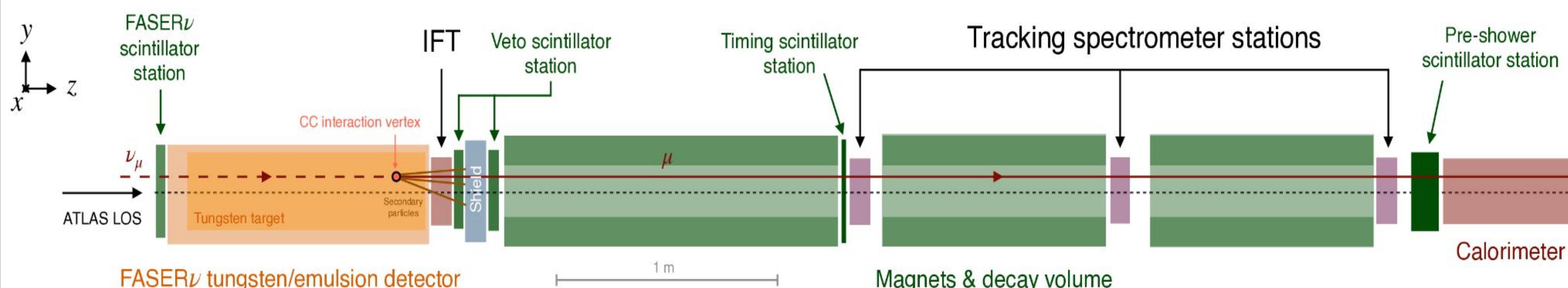


[2]

Future Work for Electron Neutrinos

- Measuring Cross Section
- Two new orthogonal signal regions
 - Interactions in the Preshower
 - Interaction in the last tracking magnet
- For 2025 data and beyond
 - New Preshower pixel detector with additional tungsten absorbers.
 - Future work will leverage additional resolution and statistics

Measuring Muon Neutrinos

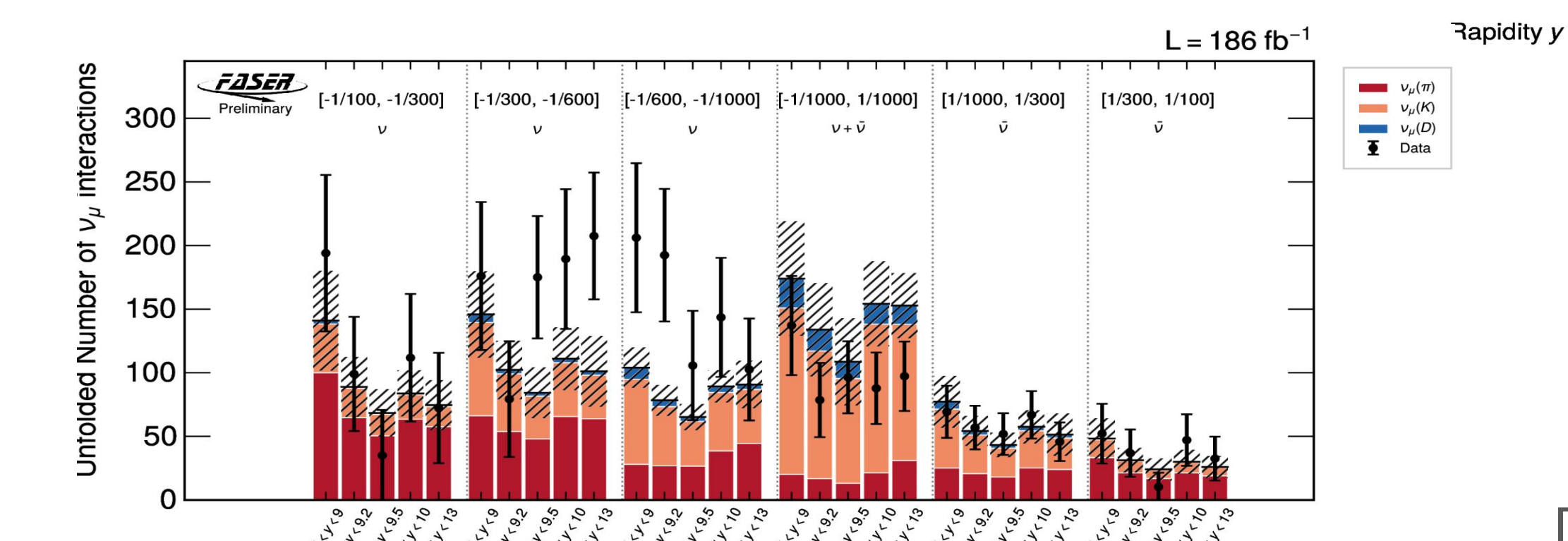
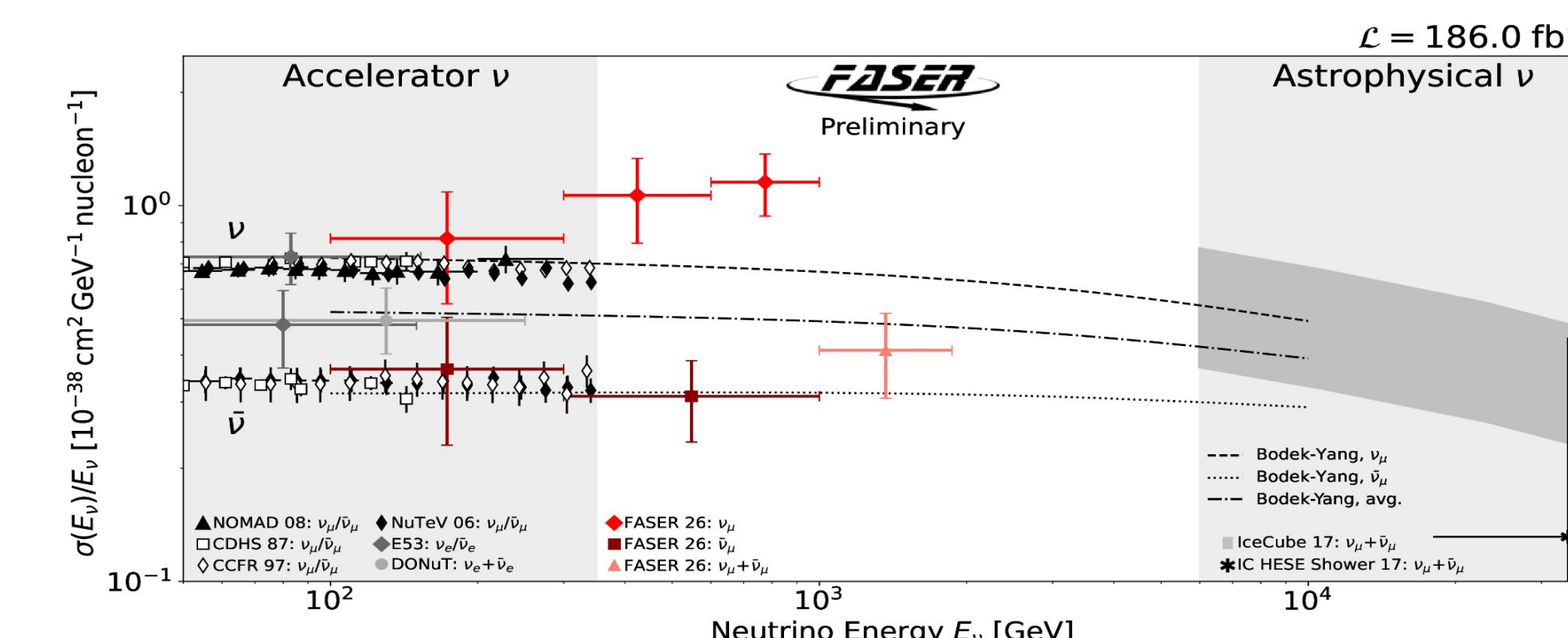


- Signal: Muon Neutrino CC interactions in the emulsion box
- Resulting Muon easily escapes the tungsten and forms a fiducial track in the tracking spectrometer
- Dominant background is Muon Neutrino CC interactions outside of the fiducial background

Muon Neutrino Results

- FASER was able to make a measurement of Muon Neutrino Cross Sections both as a function of energy and Rapidity with 186 fb^{-1} of data

	q_{μ}/p_{μ} bin	$[-100, -300]$	$[-300, -600]$	$[-600, -1000]$	$[-1000, 1000]$	$[1000, 300]$	$[300, 100]$	Total
Simulation								
Signal	ν_{μ} CC (fid.)	78.0 ± 18	138.0 ± 27	109.0 ± 17	180.0 ± 40	108.0 ± 24	44.0 ± 13	662.0 ± 85.1
Background	ν_{μ} CC (non-fid.)	7.8 ± 1.3	7.6 ± 1.6	4.3 ± 1.0	4.5 ± 1.4	6.0 ± 1.3	6.6 ± 1.7	36.2 ± 6.5
	ν_{μ} CC	1.7 ± 0.8	0.6 ± 0.4	0.16 ± 0.10	0.19 ± 0.18	1.4 ± 0.6	2.2 ± 1.4	6.2 ± 3.2
	ν_{μ} CC	0.17 ± 0.19	0.10 ± 0.20	0.04 ± 0.09	0.09 ± 0.08	0.12 ± 0.22	0.19 ± 0.13	0.7 ± 0.7
	ν NC	3.6 ± 0.8	1.3 ± 0.4	0.47 ± 0.20	0.26 ± 0.22	1.9 ± 0.6	3.6 ± 0.8	11.1 ± 2.4
Total		91.6 ± 20.2	147.5 ± 29.2	114.3 ± 18.5	189.3 ± 43.1	117.5 ± 26.0	56.5 ± 14.8	716.7 ± 85.5
Data								
Total		113 ± 10.6	216 ± 14.7	167 ± 12.9	146 ± 12.1	118 ± 10.9	61 ± 7.8	821 ± 28.7



[3]

References

- [1] FASER Collaboration, "The FASER detector," JINST 19 (2024) no. 05, P05066, arXiv:2207.11427 [physics.ins-det].
- [2] FASER Collaboration, "Measurement of High-Energy Electron Neutrino Interactions the FASER Calorimeter at the LHC." <https://cds.cern.ch/record/295644>
- [3] FASER Collaboration, "Measurement of Muon Neutrinos as a Function of Energy and Rapidity with FASER." <https://cds.cern.ch/record/2956617>