

Physics with Muons at the FPF

Simulation and Measurements

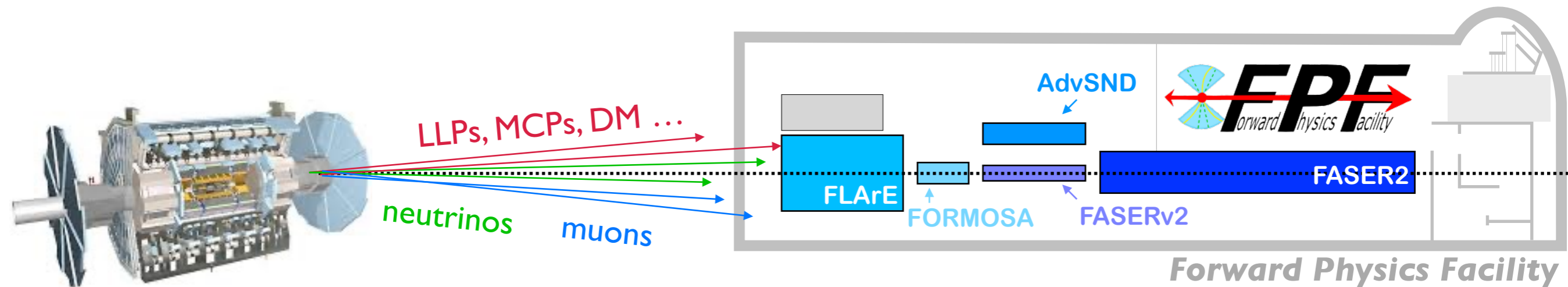
FPF Theory Days
September 18th 2023

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Muons at the FPF: Idea

LHC produces **intense**, strongly **collimated** beams of **highly-energetic** light particles in the **forward** direction towards the **FPF**.

An extensive physics case for the FPF has been established using the beams of **neutrinos** and potential **new particles**.



There is also a large flux of high-energy **muons** going through the FPF:
 $\approx 0.1\text{Hz/cm}^2$ or 10^{11}ab/m^2

Can we do something with them?

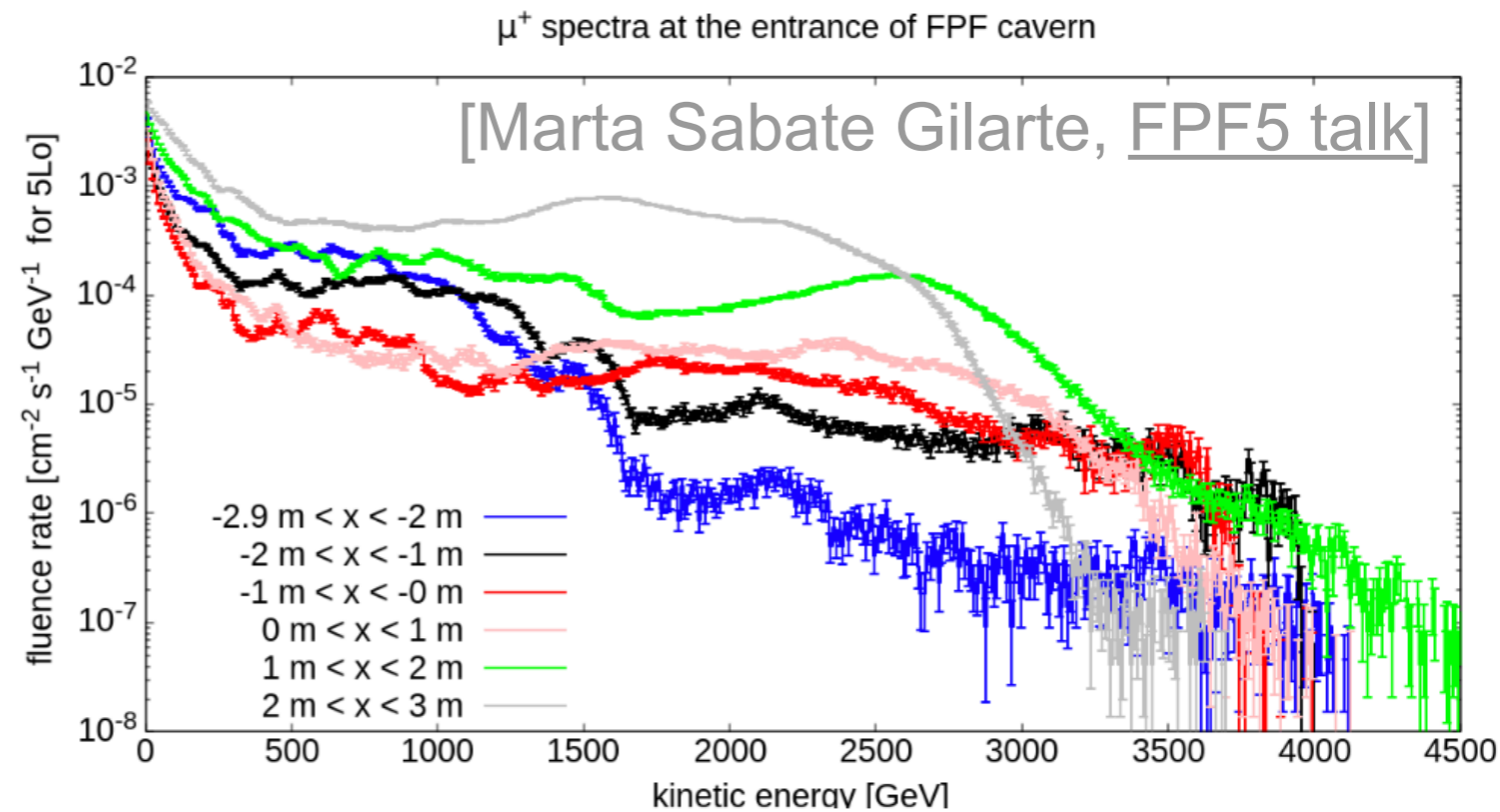
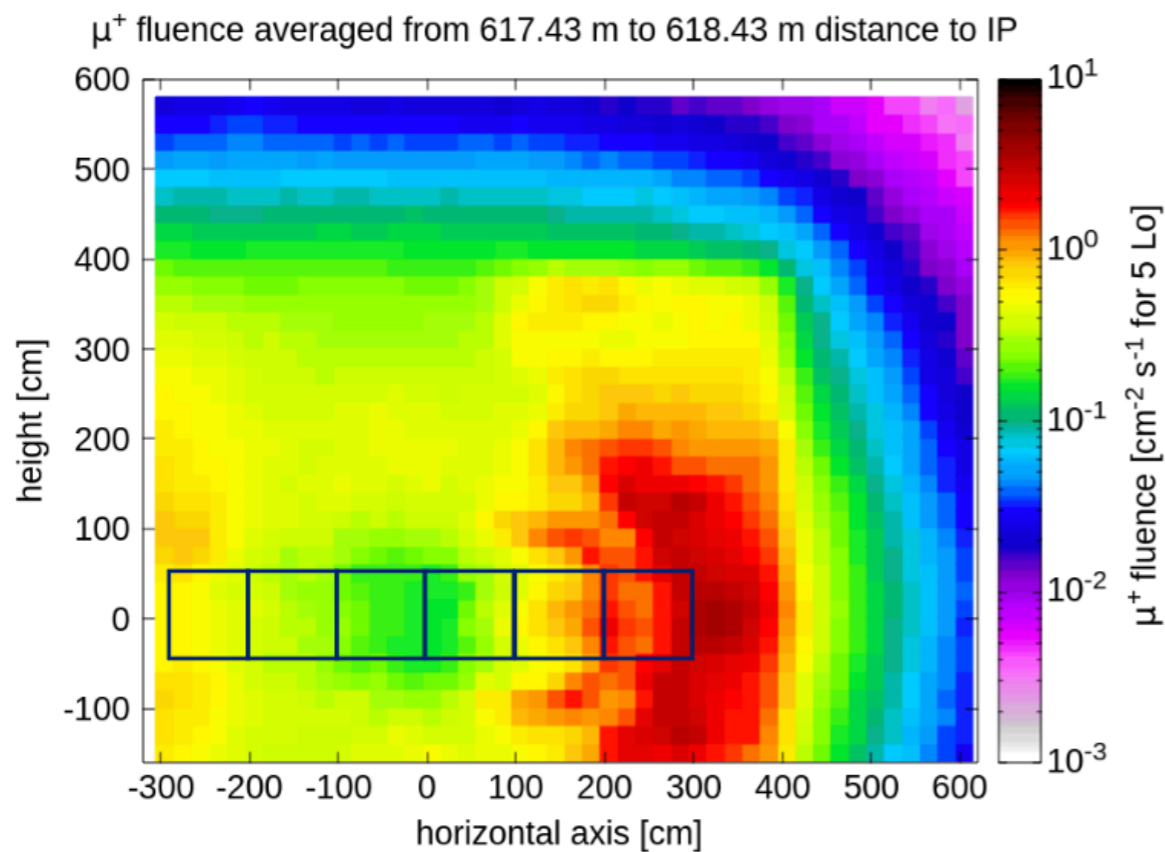
Muon Simulation

muons originate from various sources: hadron decay, secondary interactions
full simulation of particle transport through LHC needed

FLUKA simulation (by CERN EN-STI team)

fluences of μ^+ and μ^-

MC sample available: <https://cernbox.cern.ch/s/FpLFGYSIMZTpIKV>

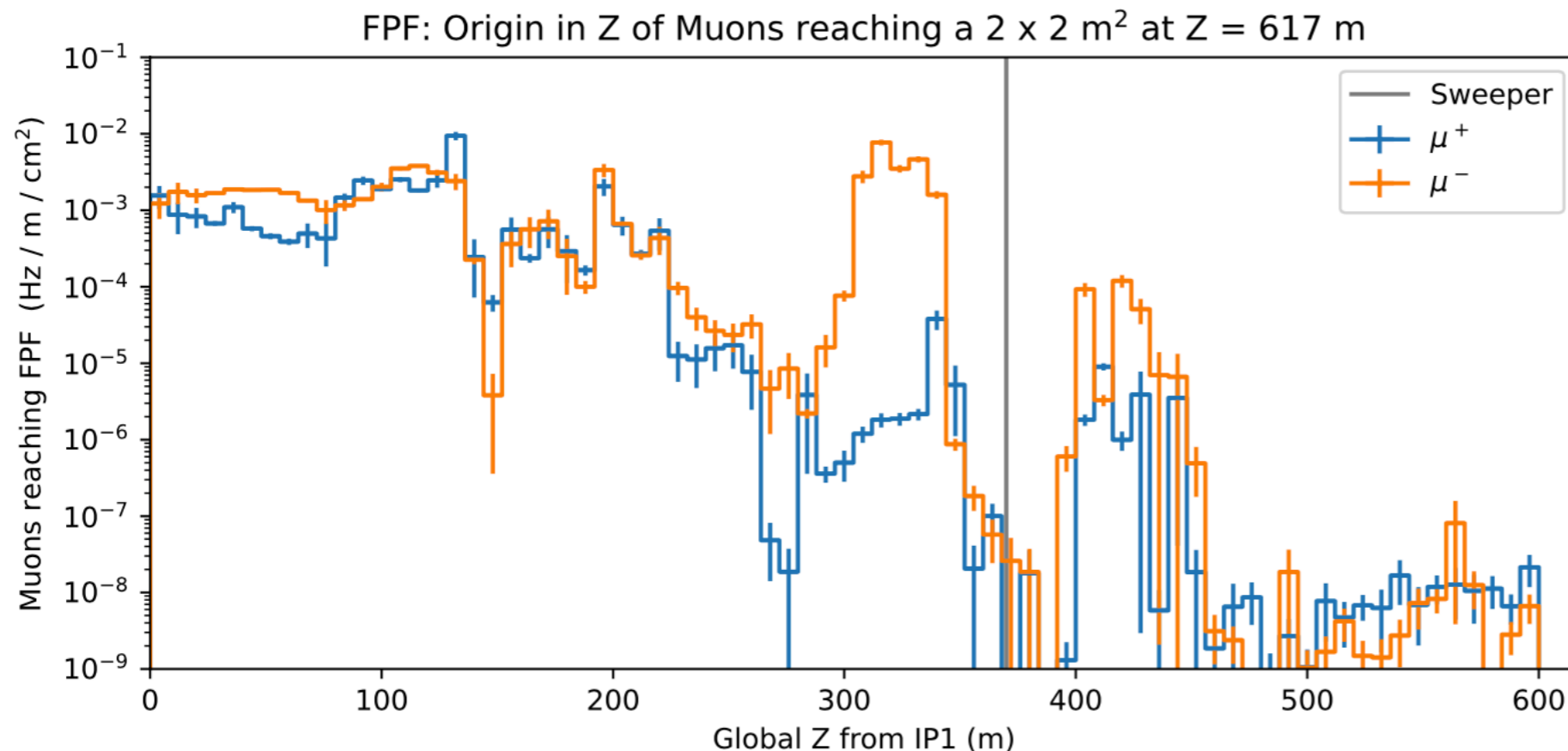


Muon Simulation

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BDSIM simulation (by Laurie Nevay)

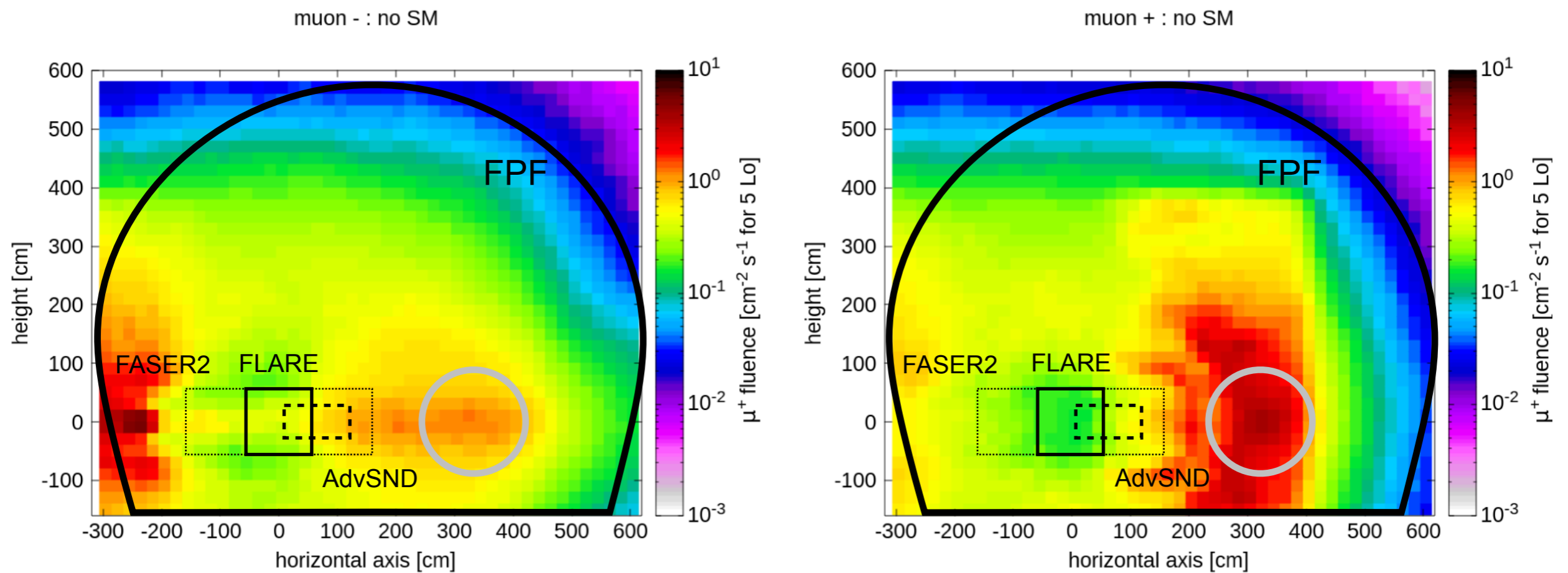
full trajectory and event history of muons
MC sample available



[Animation of Muon Flux Origin](#)

Detector Coverage

Current FPF detectors placed in muon flux minimum
(to reduce possible backgrounds)

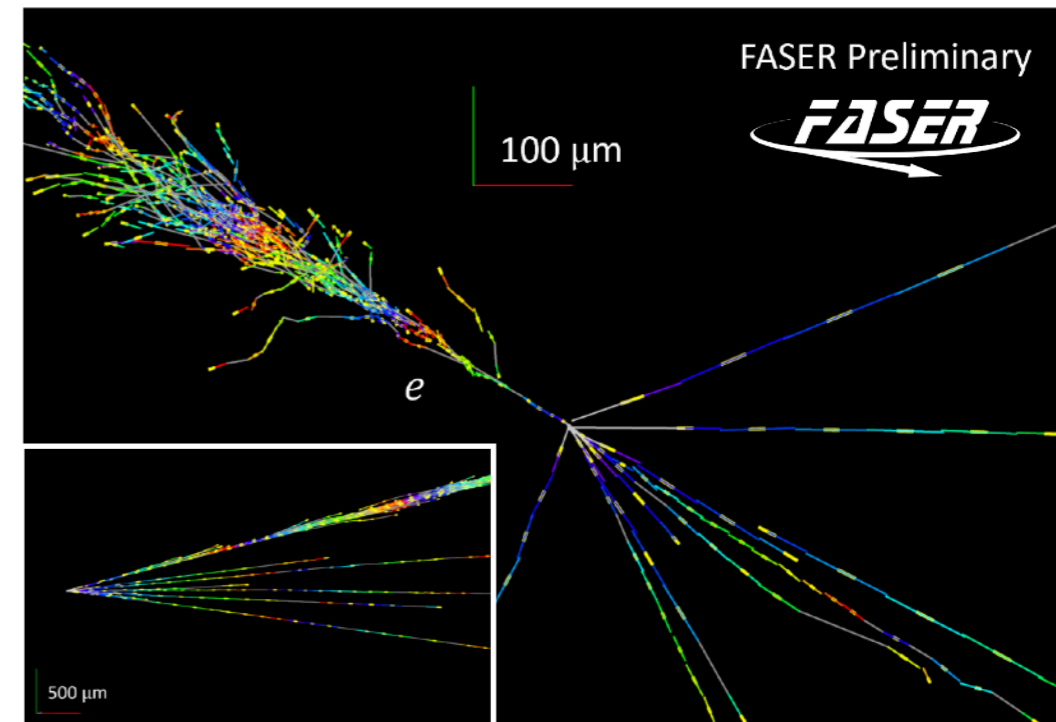


Room for dedicated experiment at muon flux maximum?

Possible Measurements

emulsion detector:

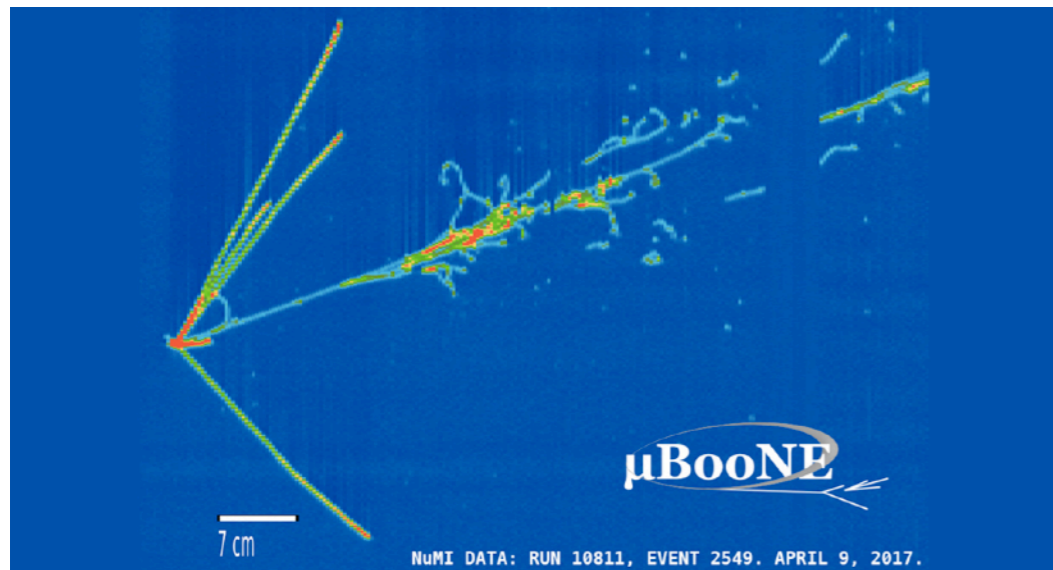
μm resolution picture of interaction
lepton ID, charm ID
no neutral hadrons, no charge ID
poor energy resolution



Symbolic picture

liquid argon detector:

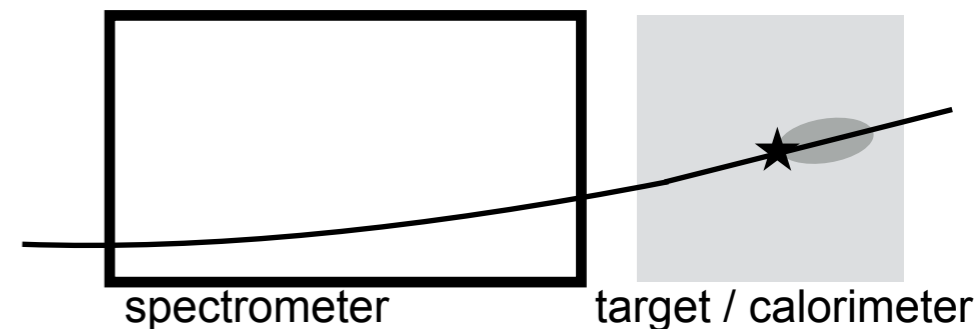
mm resolution picture of interaction
some PID, energy resolution
no charge ID



Symbolic picture

electronic detector:

no picture of interaction
muon momentum and charge
great energy resolution

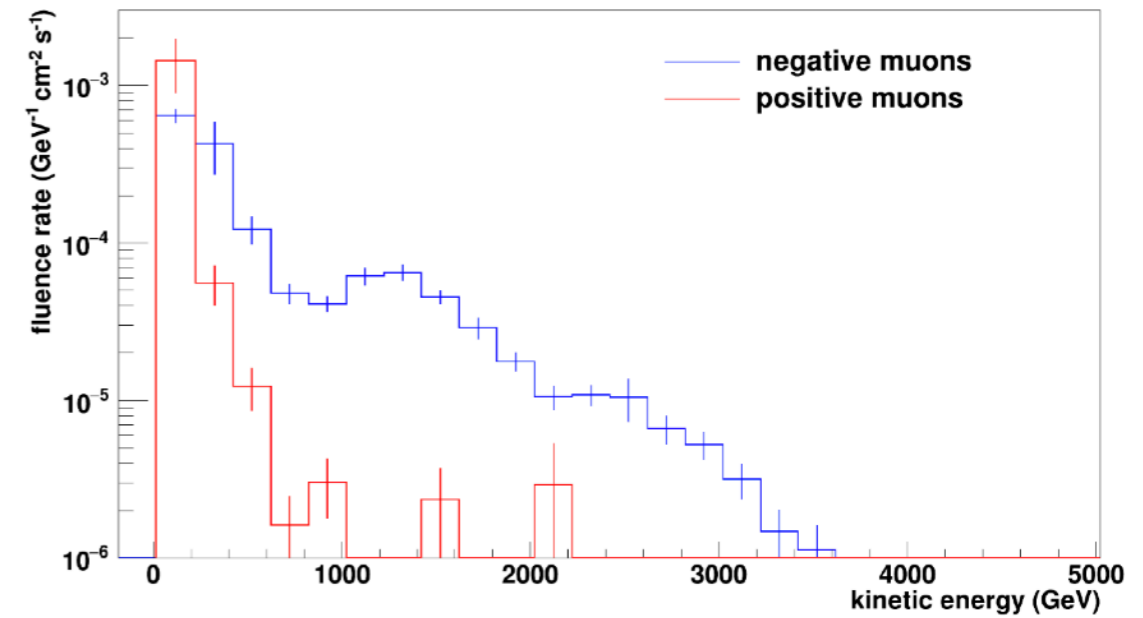


Combination of these experiments? New setup?

Current FASER Measurements

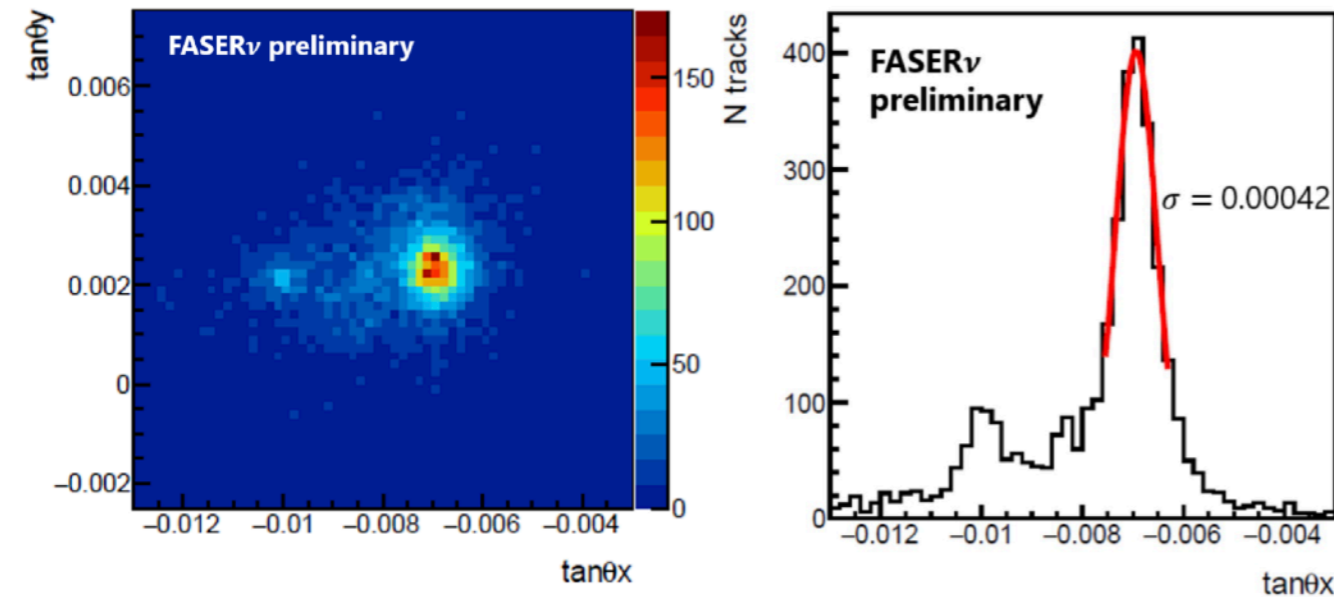
FASER spectrometer:
muon charge and energy spectrum

Fluence rate ($\text{GeV}^{-1} \text{cm}^{-2} \text{s}^{-1}$) for muons: 10 GeV threshold



[FLUKA Simulation, [1812.09139](#)]

[Jamie Boyd, [FPF5 talk](#)]



FASER ν : precision angular distribution around LOS

flux modules: spatial and angular distribution away from beam axis

