

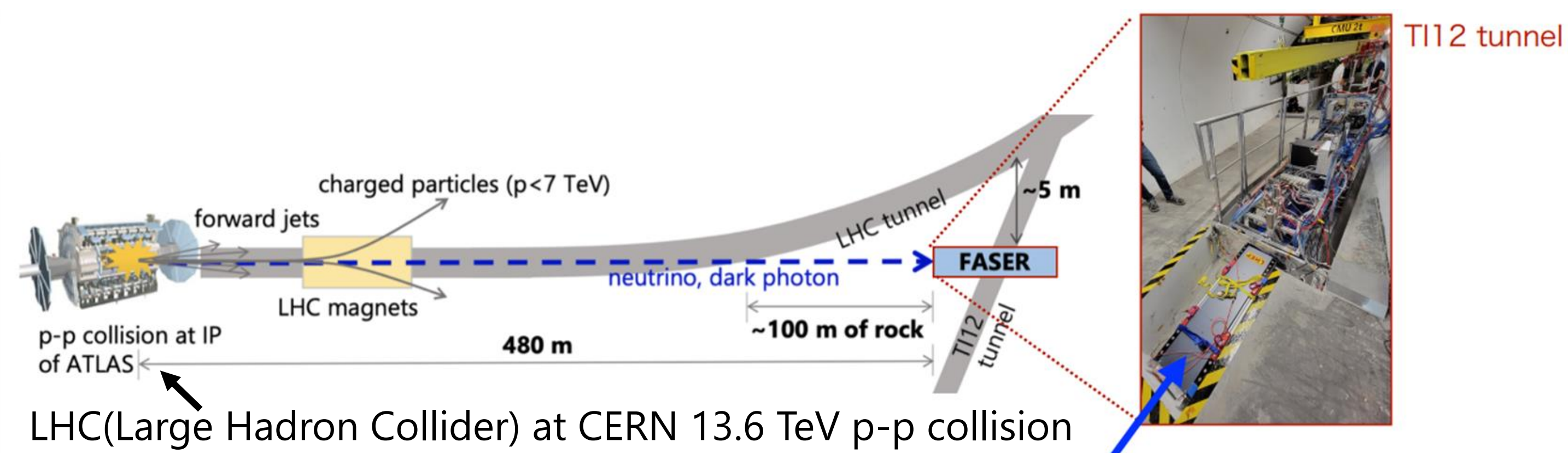
Momentum measurement in the FASERv detector in the LHC-FASER experiment

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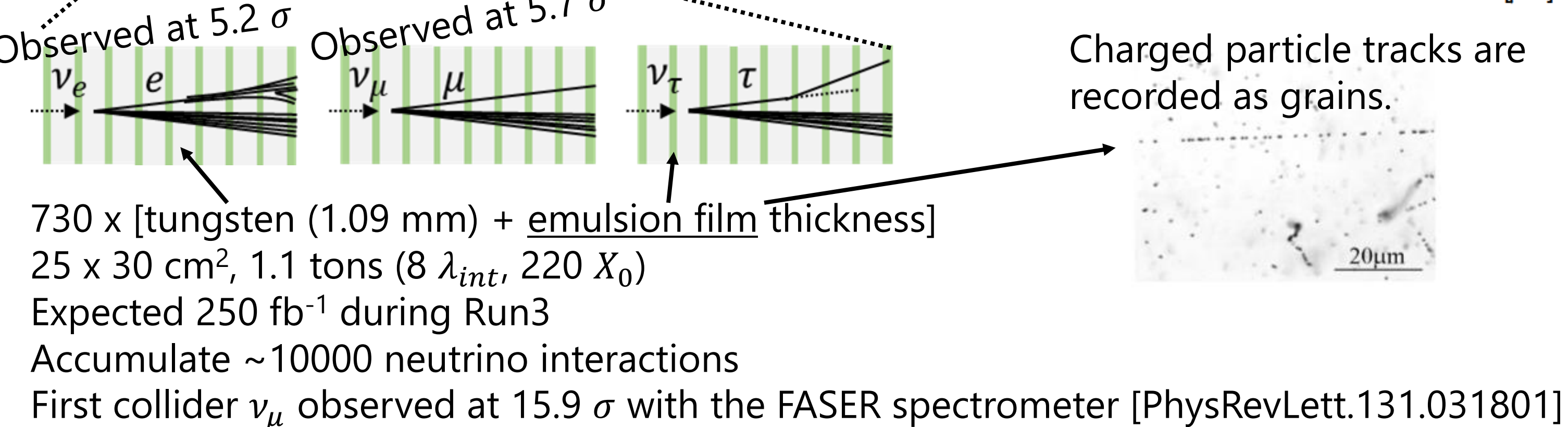
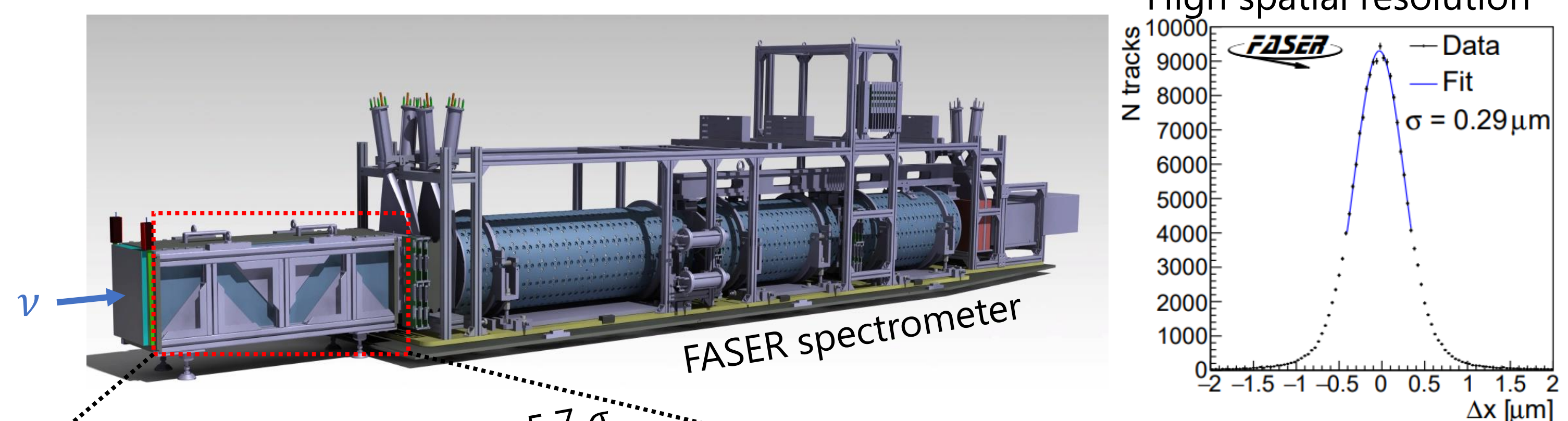


FASER experiment



- Neutrino measurement in the unexplored TeV region and search for long-lived particles
- First ν_e, ν_μ cross-section measurements in the TeV range (see poster ID 270 by J. Atkinson) [arXiv:2403.12520] to appear in PRL

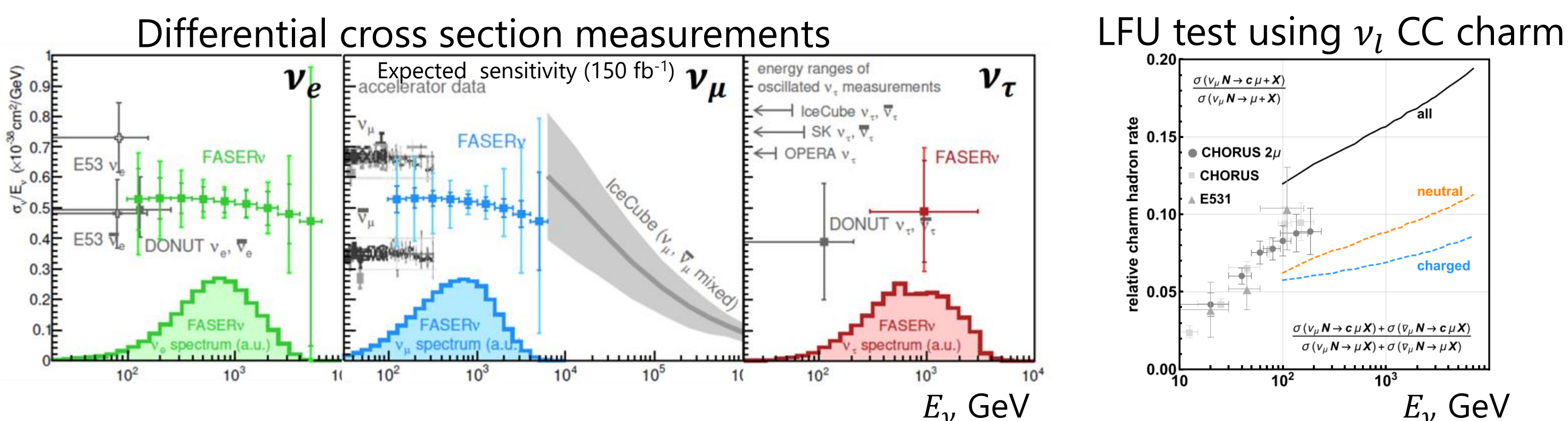
The FASERv detector



Momentum measurement

Purpose

Momentum measurement of charged particles in the TeV range is critical for kinematic analysis in FASERv



Coordinate method to measure momentum

- Calculate position difference s_i

$$s_{plane}^{RMS} = \sqrt{\left(\frac{\sqrt{2}}{3} \cdot \frac{13.6 MeV}{p} \cdot n_{cell} \cdot z_{cell} \sqrt{\frac{n_{cell} \cdot z_{cell}}{X_C}}\right)^2 + (\sqrt{6} \sigma_{pos})^2} \dots (1)$$

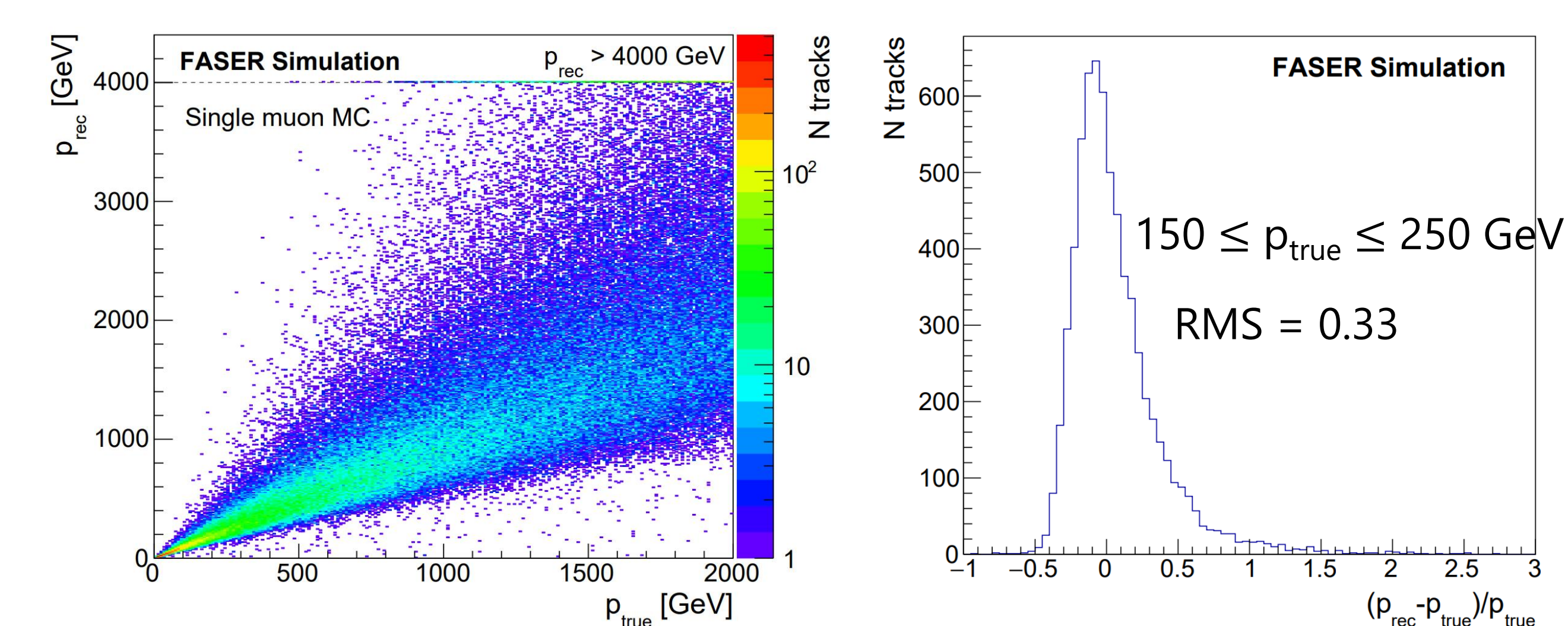
z_{cell} : The thickness of one emulsion film and tungsten plate
 X_C : Compound radiation length (4.57 mm, cf. $X_W=3.5$ mm)
 σ_{pos} : Position resolution

- Shift 1 segment and calculate s_i
- Calculate s^{RMS} and attach error considering independent stats
- Plot s^{RMS} vs. n_{cell}
- Fit the plot with formula (1)

- Increase n_{cell} and repeat ①~③

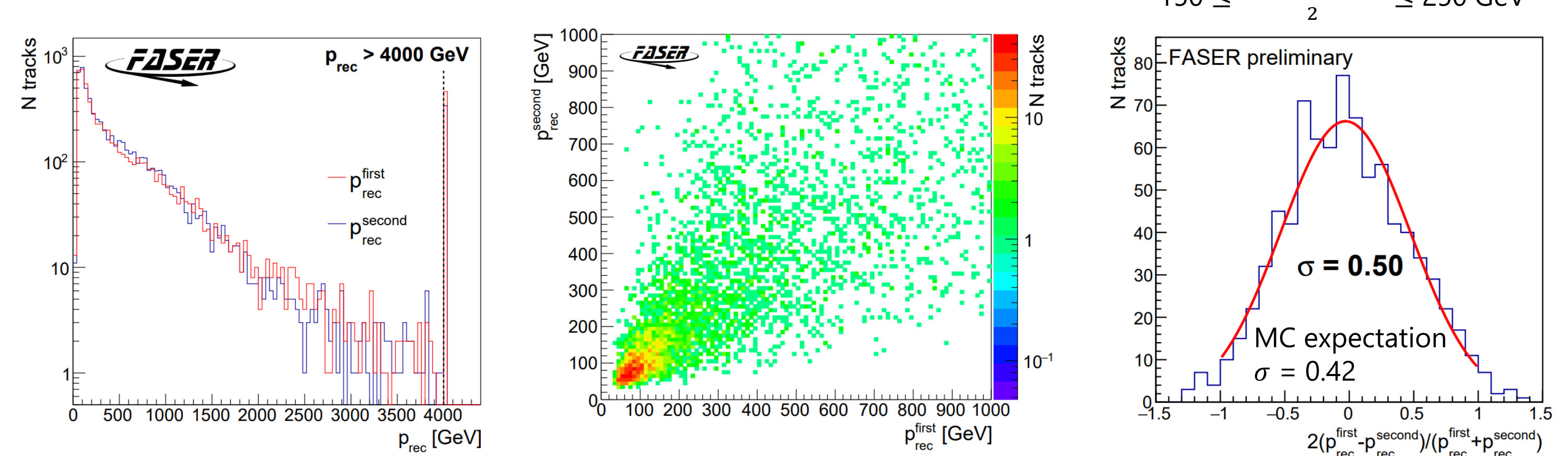
Performance evaluation using MC simulations

- Flat momentum distribution of muons from 1 GeV to 3000 GeV.
- Momentum measurement using 100 tungsten plates and emulsion films.



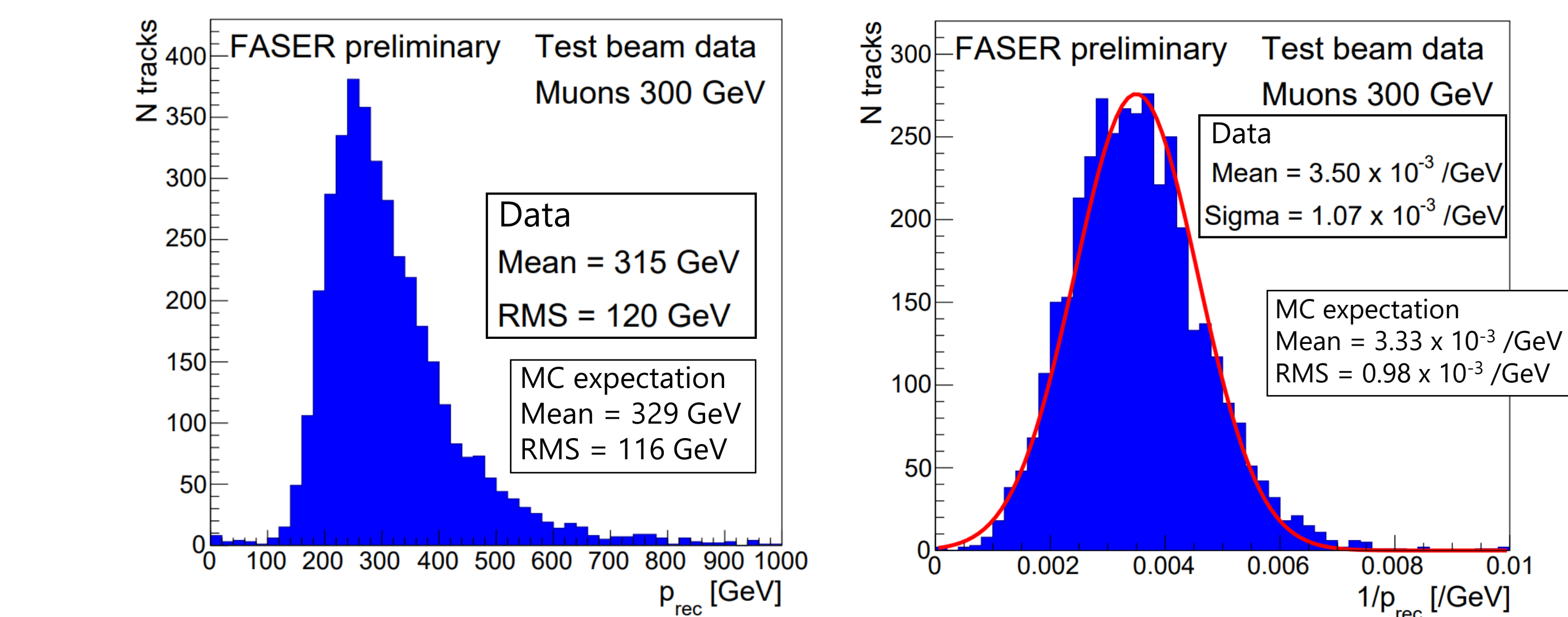
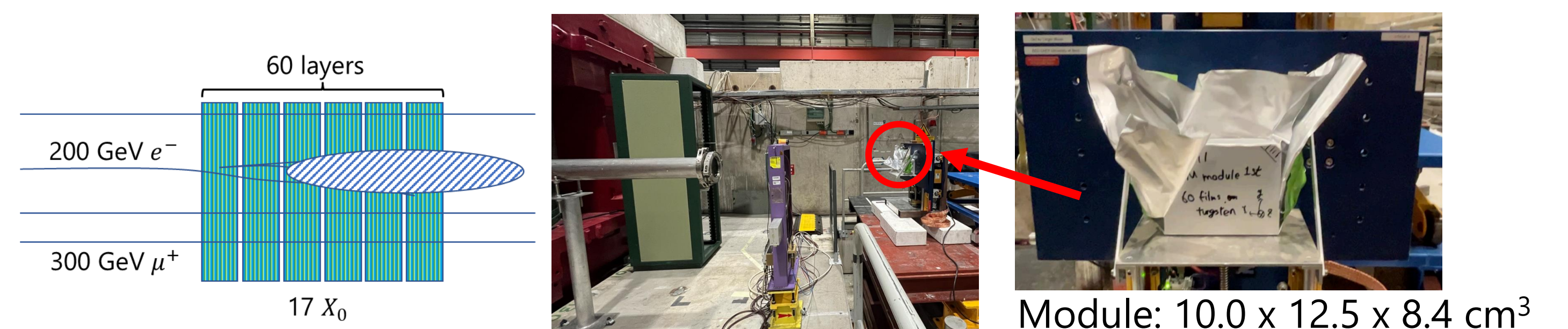
Reproducibility of momentum measurement

- Test reproducibility in data, by splitting long tracks into two and comparing the reconstructed momentum of the two in both data and MC.
- The uncertainty of the measurement around 200 GeV have been checked to apply momentum cut to recent FASERv analysis for removing background events
- Applied high purity selections to reject mis-connections



Test beam experiment

- The test beam experiment had conducted at the H4 beamline at the SPS in August 2023
- Momentum measurement with 60-layer detector, irradiated with 300 GeV muons and 200 GeV electrons
- Compared with the result of single muon MC using $p_{true} = [270, 330]$ GeV

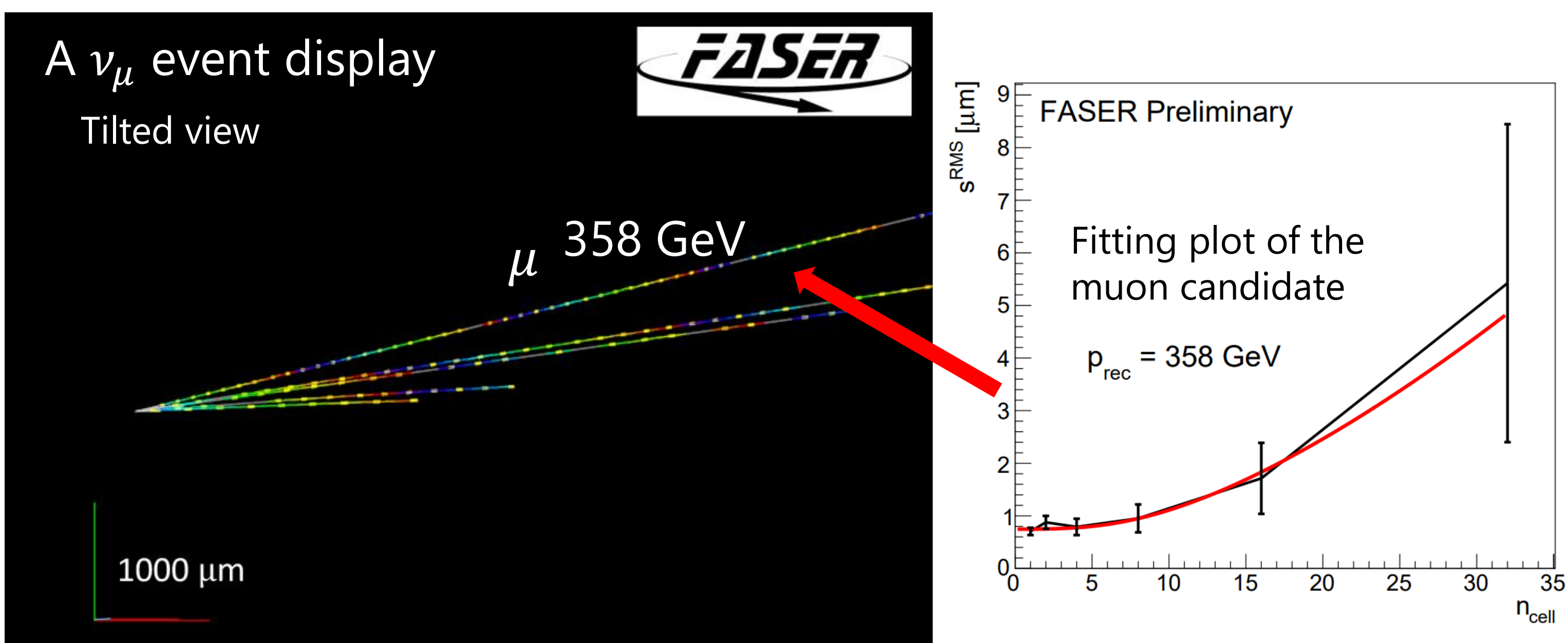
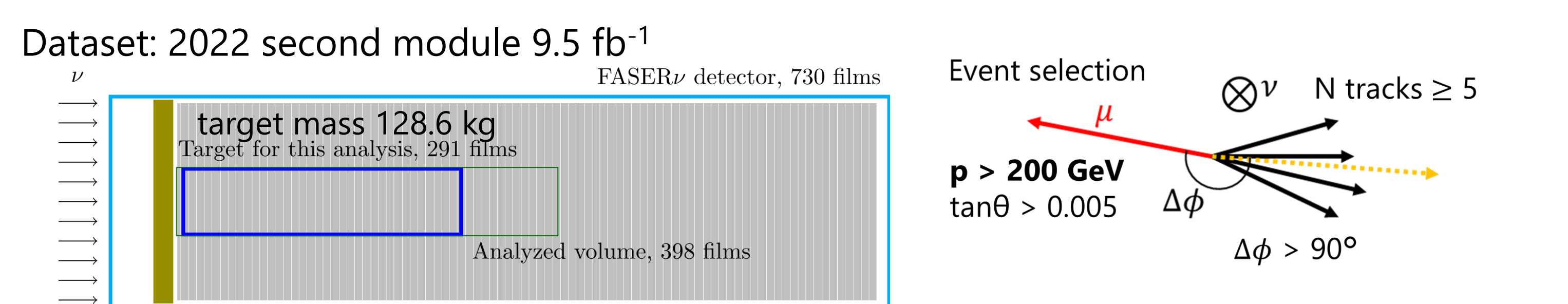


	Center value	Resolution
Test beam data	286 GeV	31%
MC expectation	300 GeV	30%

Test beam 2024 plans

- Muons and hadrons with momenta of 50, 100, 200 and 300 GeV will be irradiated with 100-layer modules at different incident angles
- The hadron sample will also be used to study hadron interactions with tungsten to eliminate charm backgrounds for future studies

ν_μ observation with momentum measurement



Summary of ν_μ events

Expected BG	$0.22^{+0.09}_{-0.07}$
Expected signal	6.5-12.4
Observed	8
Significance	5.7 σ

