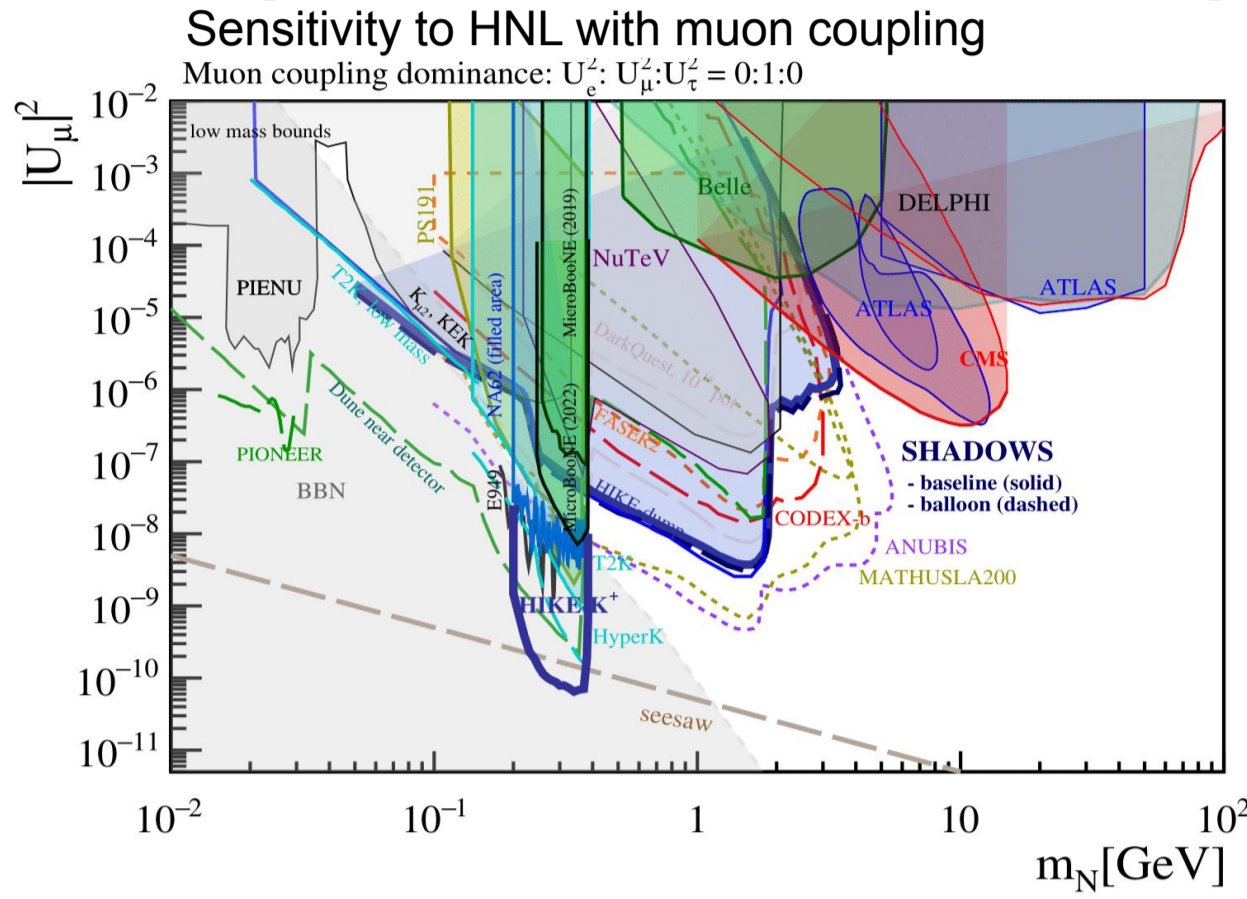


## for the proposed SHADOWS experiment at CERN

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Febly-interacting particles (FIPs) have become a focal point in high-energy physics due to their potential to solve major puzzles, like dark matter and neutrino oscillations [1]. The SHADOWS experiment aims to detect FIPs in the MeV-GeV mass range [2], profiting from the intensity upgrade of the P42 beamline at CERN North Area. Simulation results present the performance of the proposed SHADOWS tracker for FIPs decaying to leptonic states.

### FIP performance of different proposed experiments



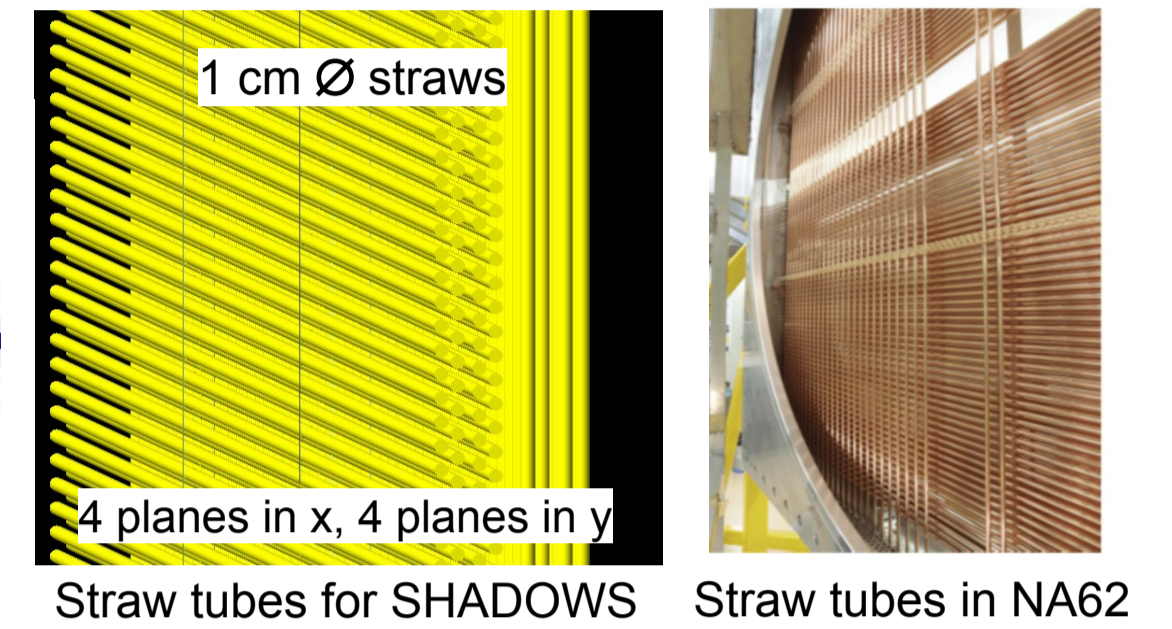
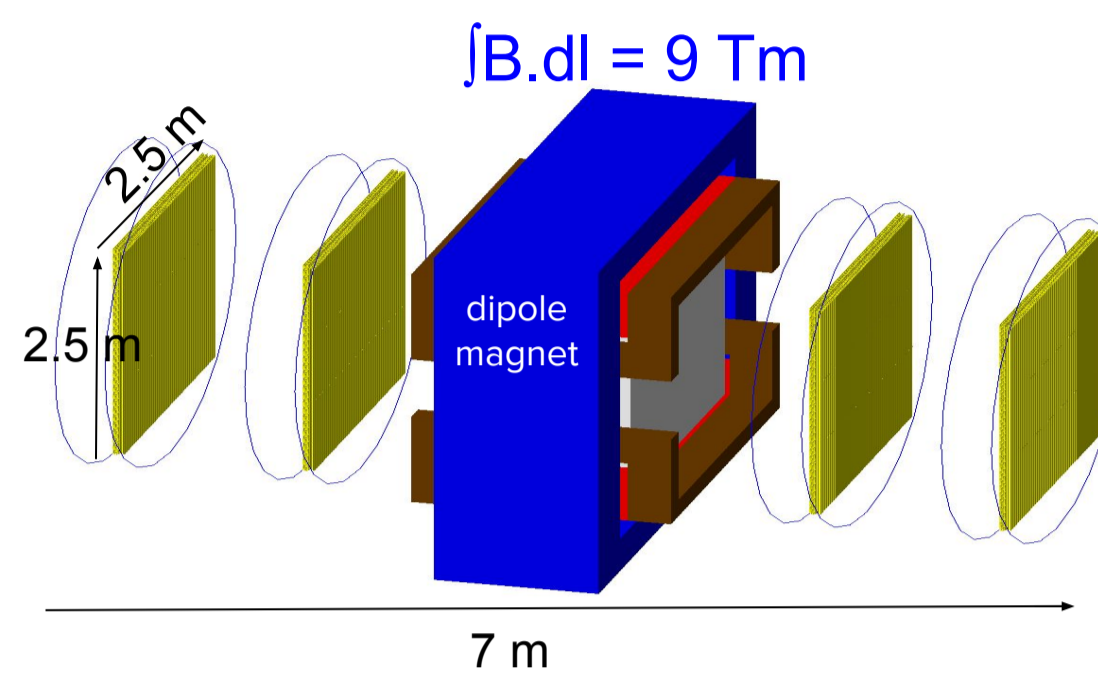
**SHADOWS** (Search for Hidden And Dark Objects With SPS)

Aim: Search for FIPs emerging from charm and beauty decays, in the range of MeV to a few GeV

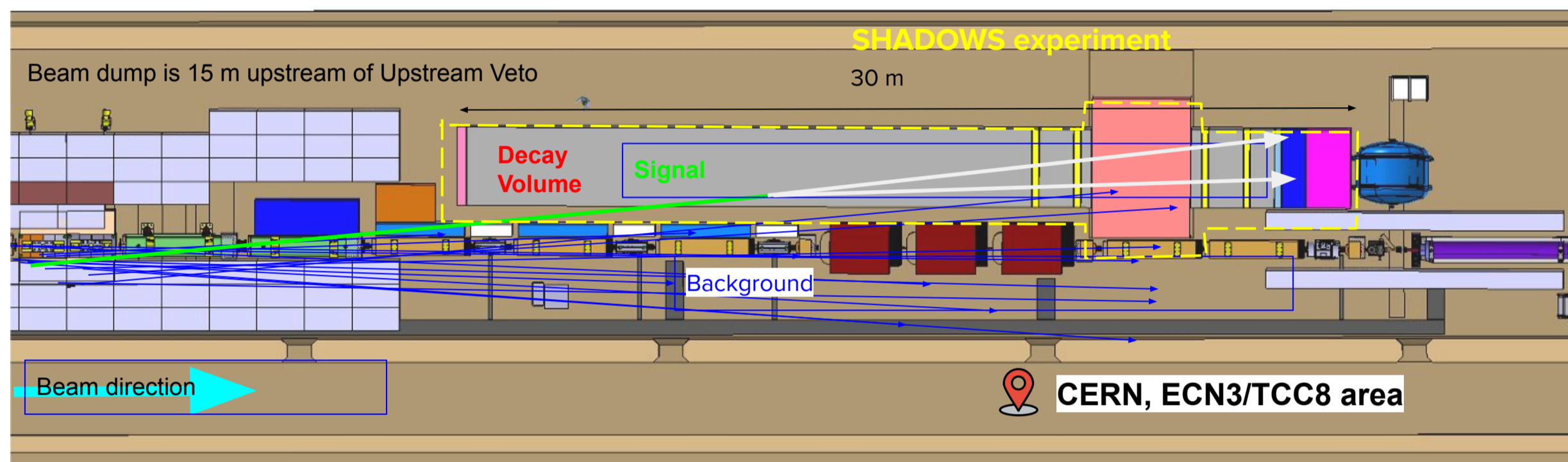
### SHADOWS Spectrometer + Tracking detector

Material budget = 0.1 % radiation length

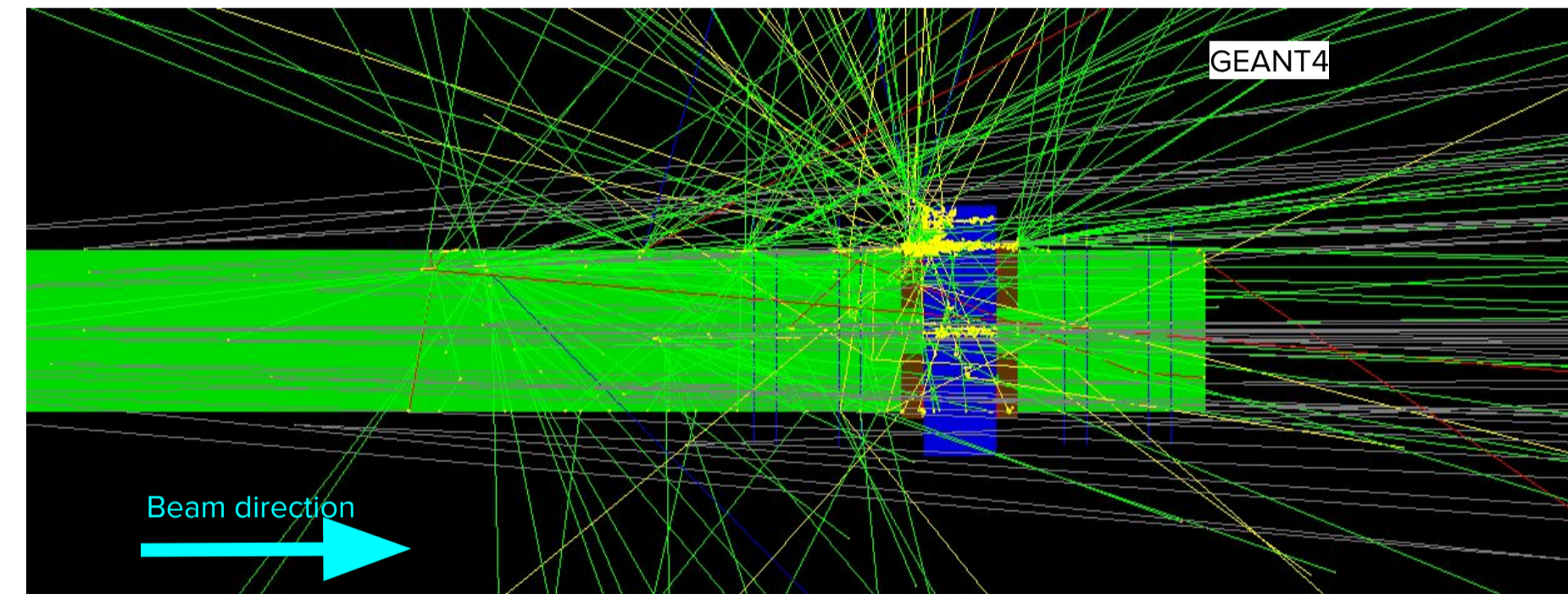
Straw tube tracker chamber



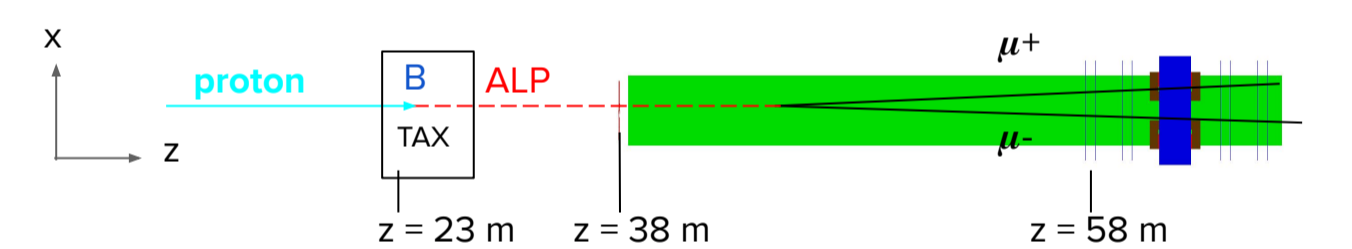
### SHADOWS : Experimental layout



### Signal reconstruction and selection



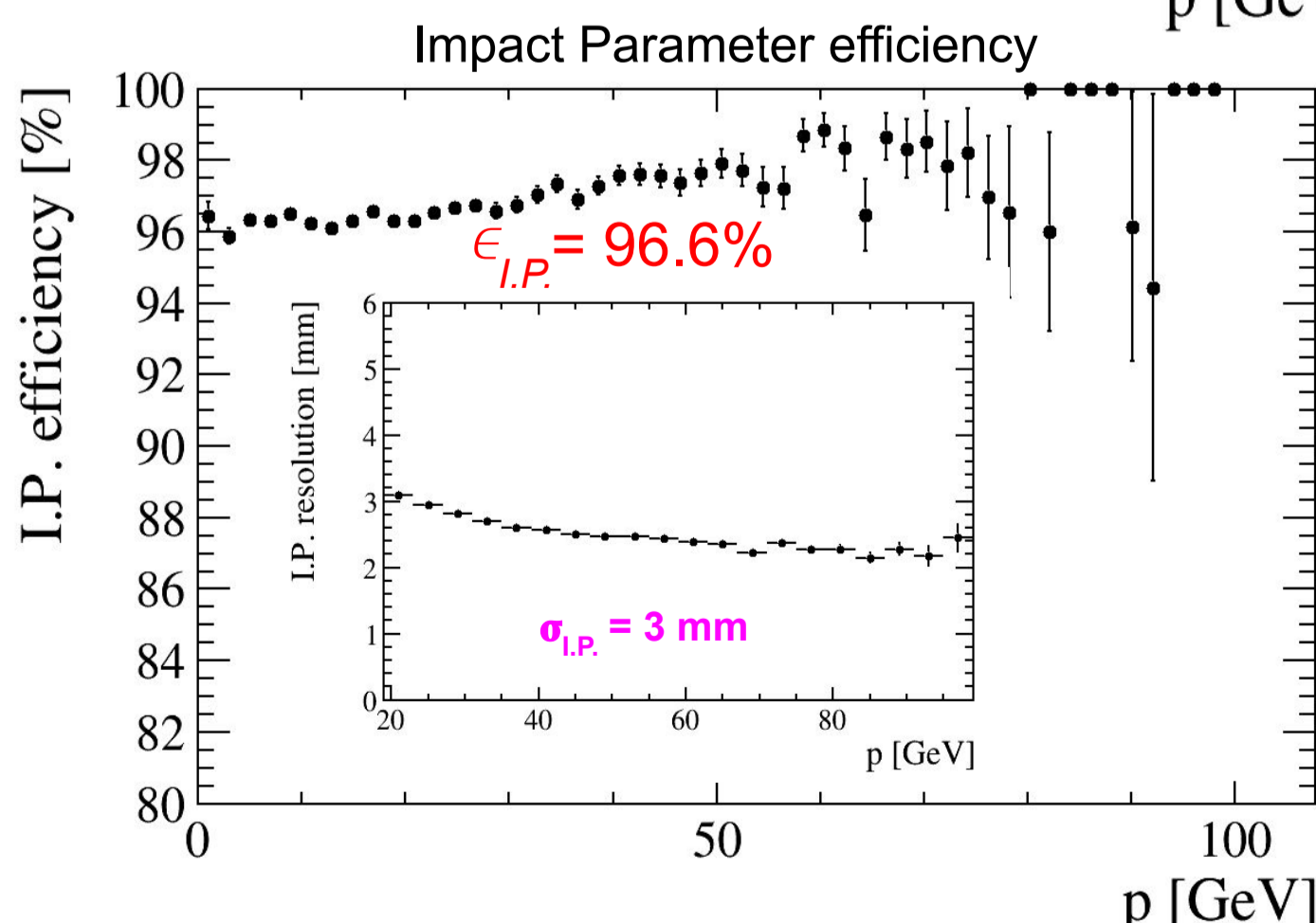
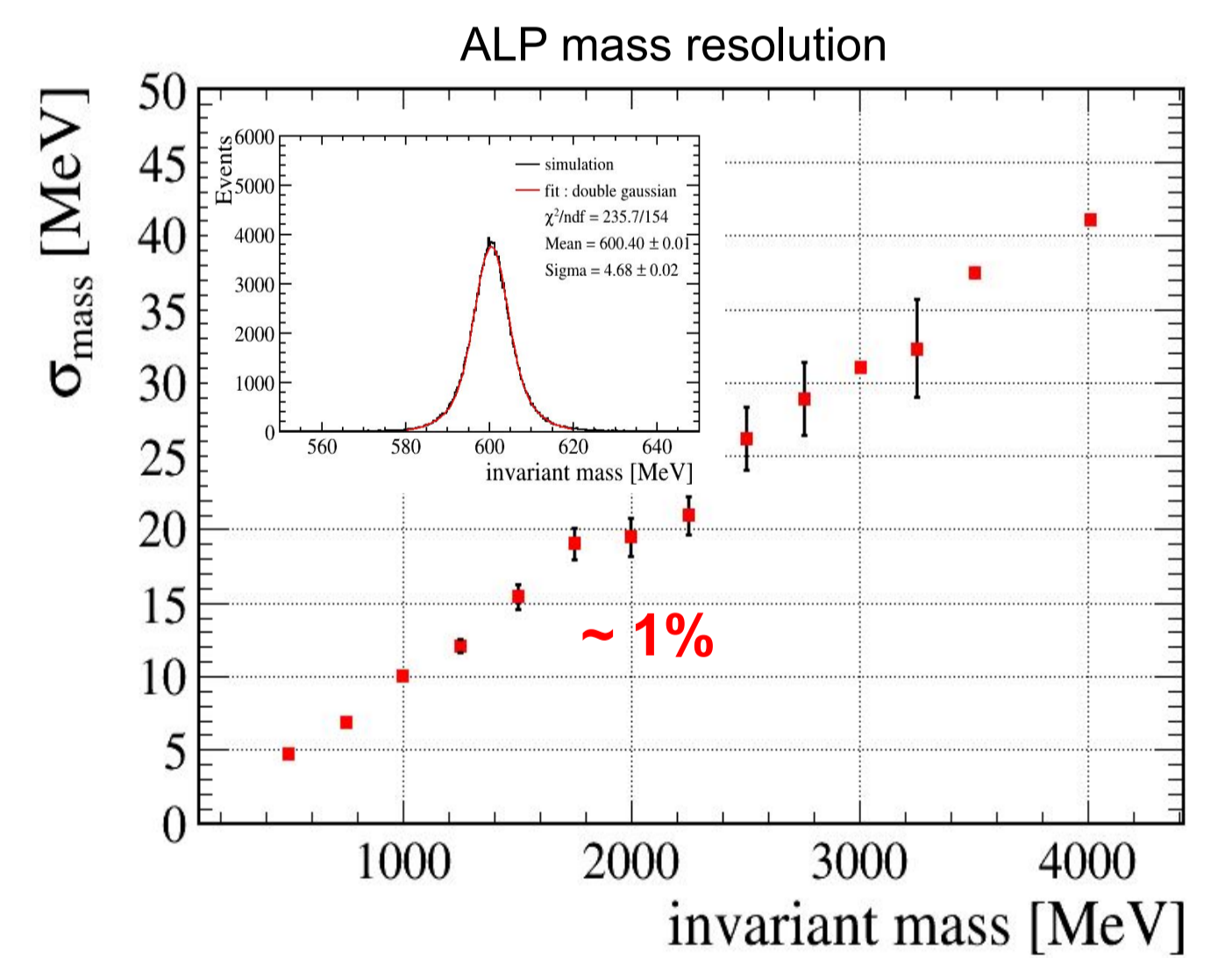
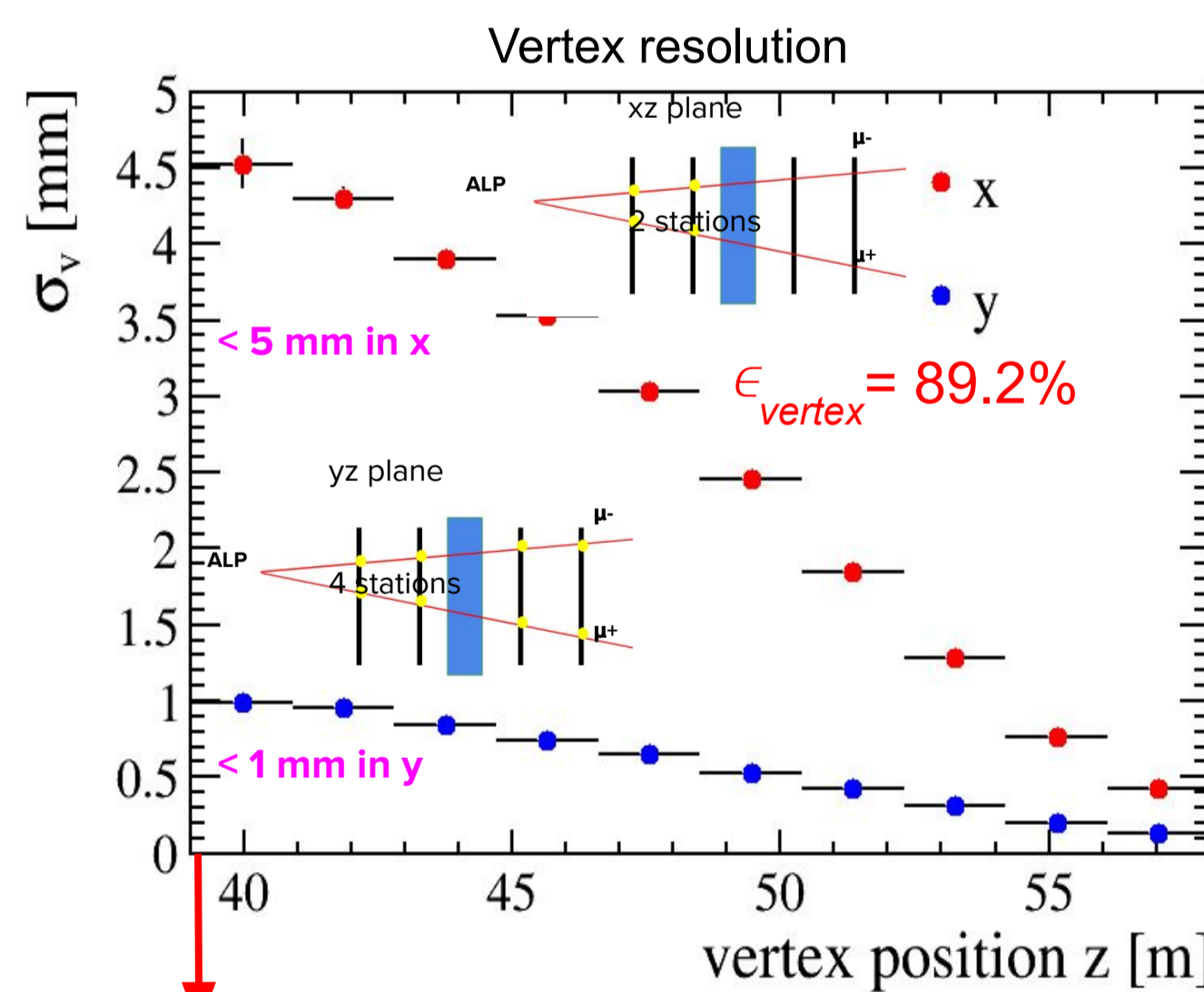
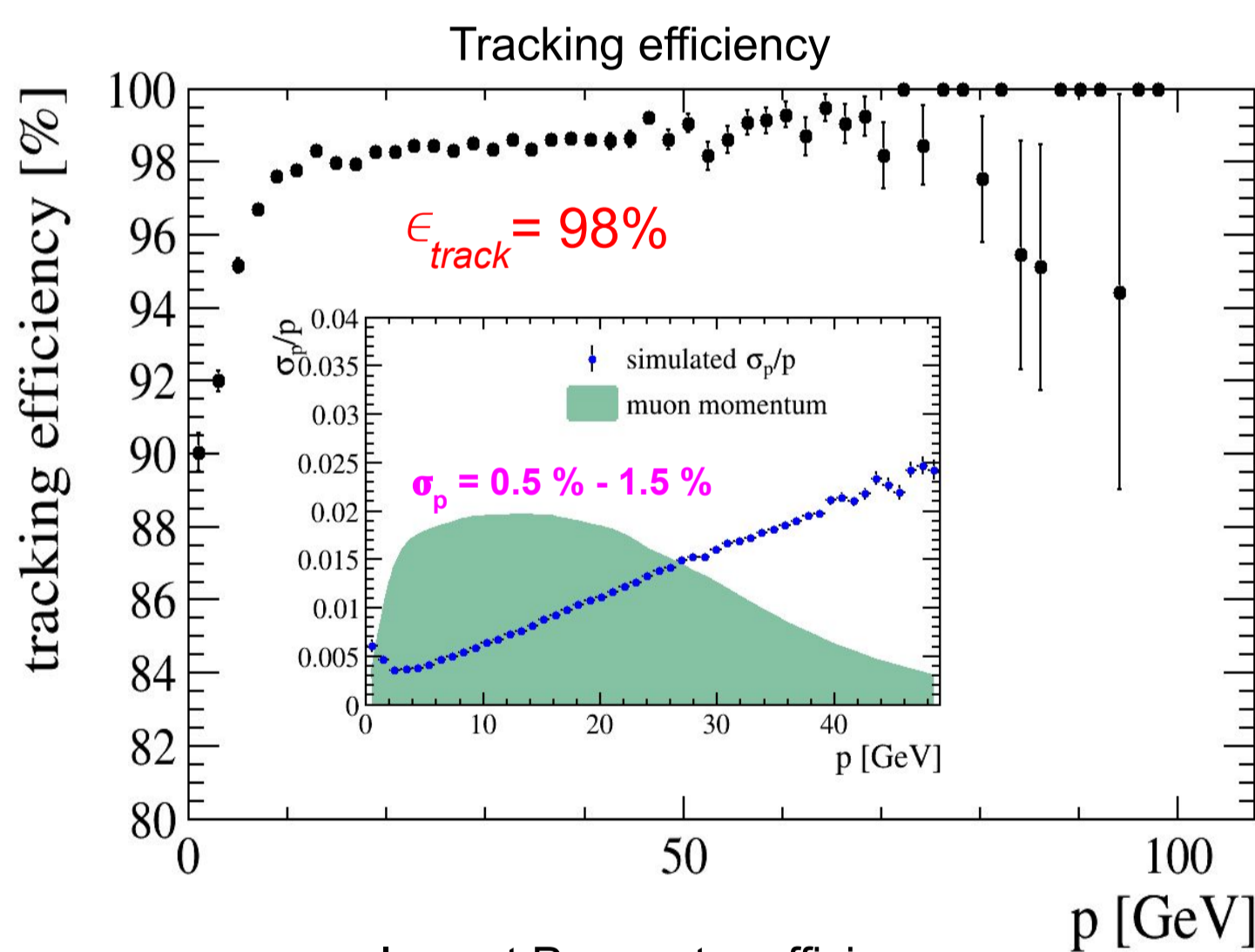
Axion-Like Particle (ALP)



FIP signal used for the simulation : ALP  $\rightarrow$   $\mu^+$   $\mu^-$

“Stay close and stay off-axis” – maximizing acceptance for FIPs from heavy quark decays while minimizing background from the dump.  
Muon background – Efficient background reduction using magnetised iron blocks [2] reduces from  $2 \times 10^9$  muons/spill to 0.0012 muons/spill. Further reduction by reconstruction of FIP decays [3].

### Results : SHADOWS tracker performance



#### ALP Reconstruction Efficiency

$$\epsilon_{ALP} = \epsilon_{track}^2 \cdot \epsilon_{vertex} \cdot \epsilon_{I.P.} = 83\%$$

(for tracks in acceptance)

#### Combinatorial di-muon background (using vertex and I.P. selection cuts)

$6 \times 10^{-10}$ /spill  $\times$   $2.4 \times 10^6$  spills in SHADOWS lifetime (4 years) = **0.001 (0.7)** di-muon events for fully (partially) reconstructed final states

### Summary

- SHADOWS tracker (using straw tubes  $\varnothing$  1cm) can achieve **a few mm vertex resolution** and **1% mass resolution**
- The **(ALP) signal efficiency is 83%** in the acceptance of SHADOWS

### References

- G. Lanfranchi, M. Pospelov, P. Schuster, The Search for Febly Interacting Particles, arXiv:2011.02157 [hep-ph], Ann.Rev.Nucl.Part.Sci. 71 (2021) 279-313.
- SHADOWS collaboration, SHADOWS Technical Proposal, <https://cds.cern.ch/record/2878470/files/SPSC-P-367.pdf>, CERN-SPSC-2023-029 / SPSC-P-367.
- S. Roy on behalf of the SHADOWS collaboration, “The SHADOWS experiment at the CERN SPS”, PoS (EPS-HEP2023) 465 2023 DOI: <https://doi.org/10.22323/1.449.0465>