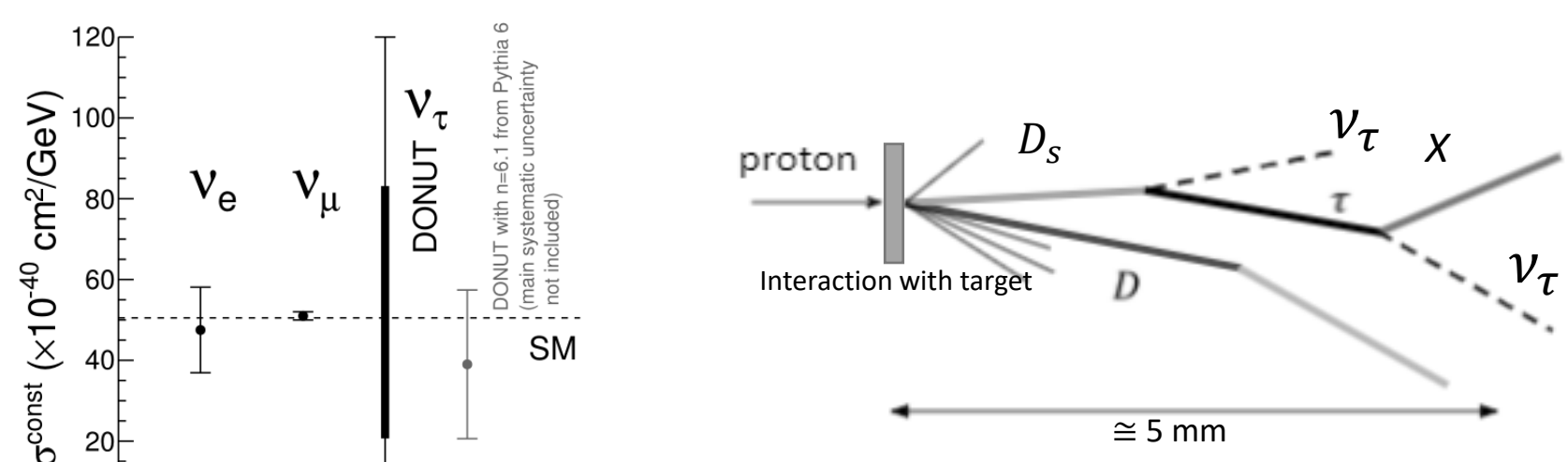


Abstract

The NA65/DsTau experiment at CERN-SPS has been proposed to measure an inclusive differential cross-section of a Ds production with a consecutive decay to tau lepton in p-A interactions. The peculiar Ds cascade decay topology ("Ds->tau->X: double kink") in a few millimeters range is detected by the nuclear emulsion tracker thanks to its excellent spatial resolution. A large amount of charmed particles decay events will be detected as well, providing a possibility for interesting by-product studies, in particular a search for intrinsic charm in a proton. A pilot data sample was collected in 2018. Main data sample was collected in 2021-2023. In this poster, We will outline the DsTau experiment and present charmed particles decay analysis using the pilot data sample. We also report the status of the data taking for the main data sample.

Experiment

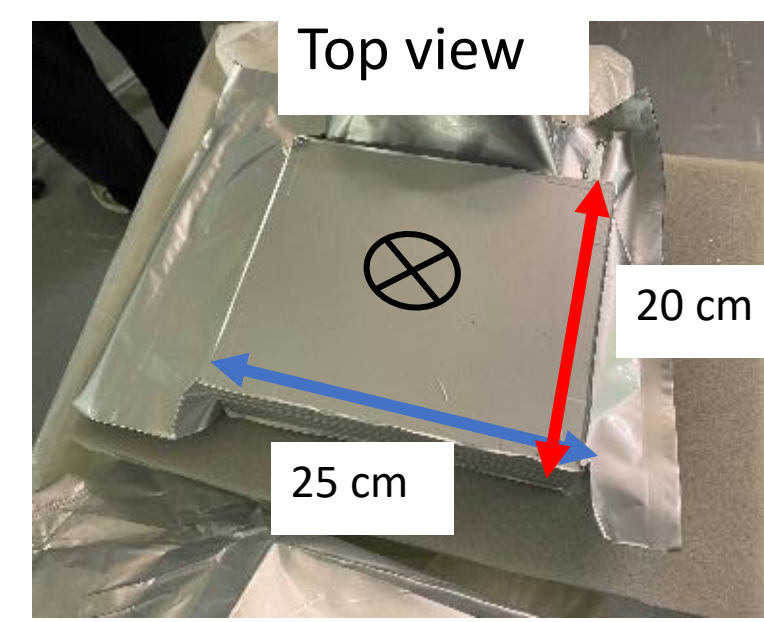
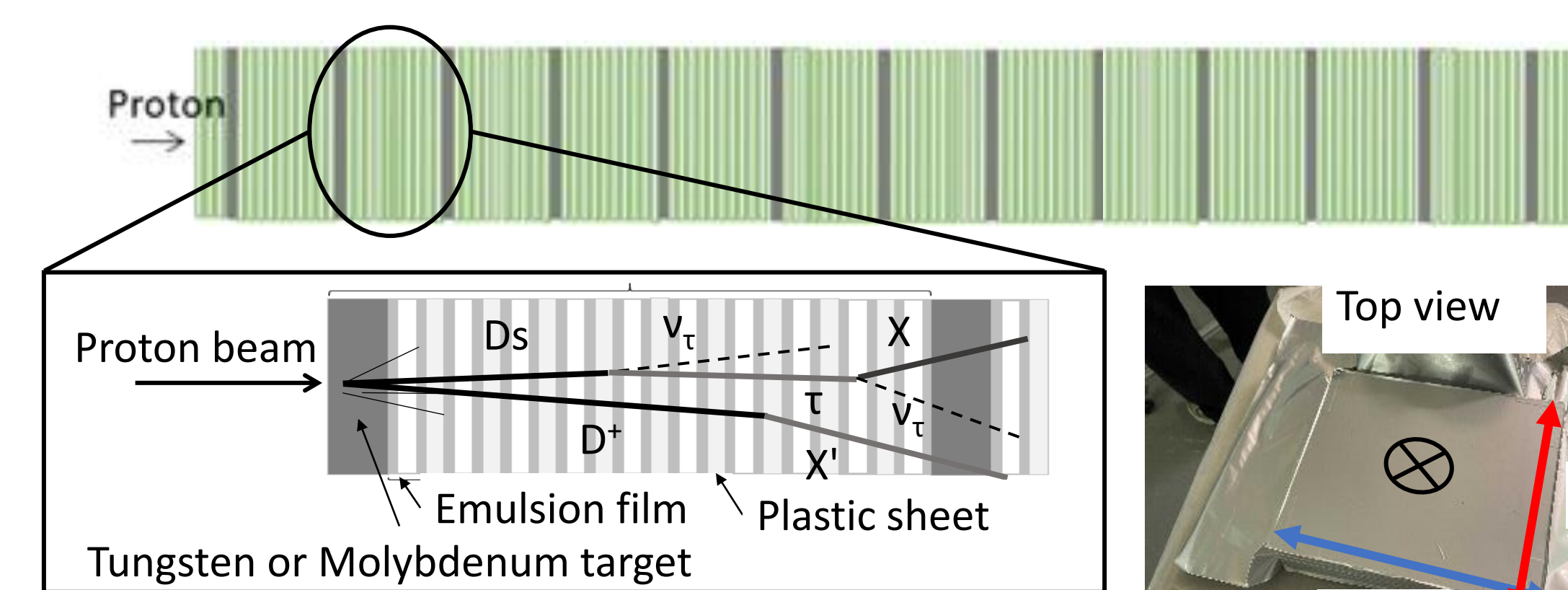
Motivation and goal



- Studying ν_τ production with $D_s \rightarrow \tau \rightarrow X$ consecutive decays [1]
- Reducing the systematic uncertainty 50% \rightarrow 10%

- Studying forward charm production
 - ex) **intrinsic charm** = valence quark like c in the proton
 - ν_τ flux may change by a factor of 10 [2]
 - Carry significant part of proton's momentum
- \Rightarrow Study high momentum charmed particle decay events
- Collected 2×10^8 proton interactions
- $\Rightarrow \sim 10^5$ charmed particle decay events, **1000** $D_s \rightarrow \tau \rightarrow X$ events

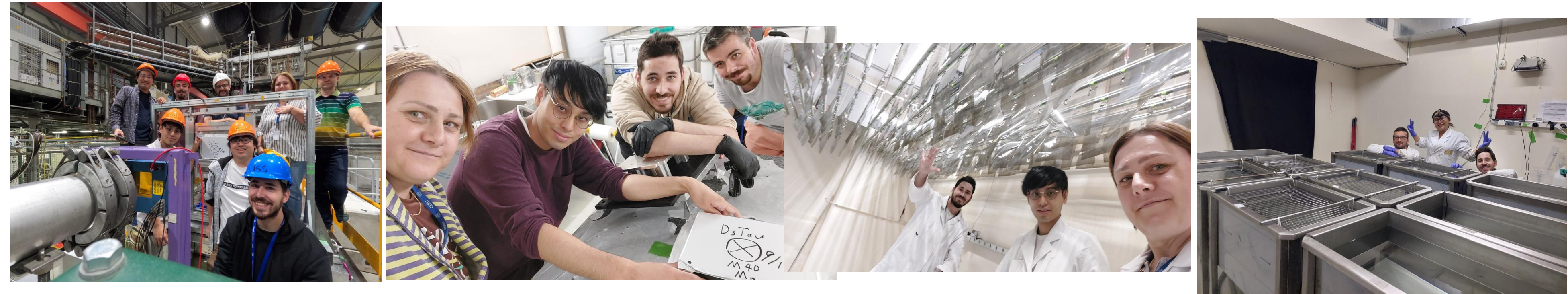
Experimental setup



- 400 GeV/c proton beam at CERN SPS
- The kink angle between $D_s \rightarrow \tau \sim$ a few mrad \Rightarrow detect with emulsion film
- 130 emulsion films for one module

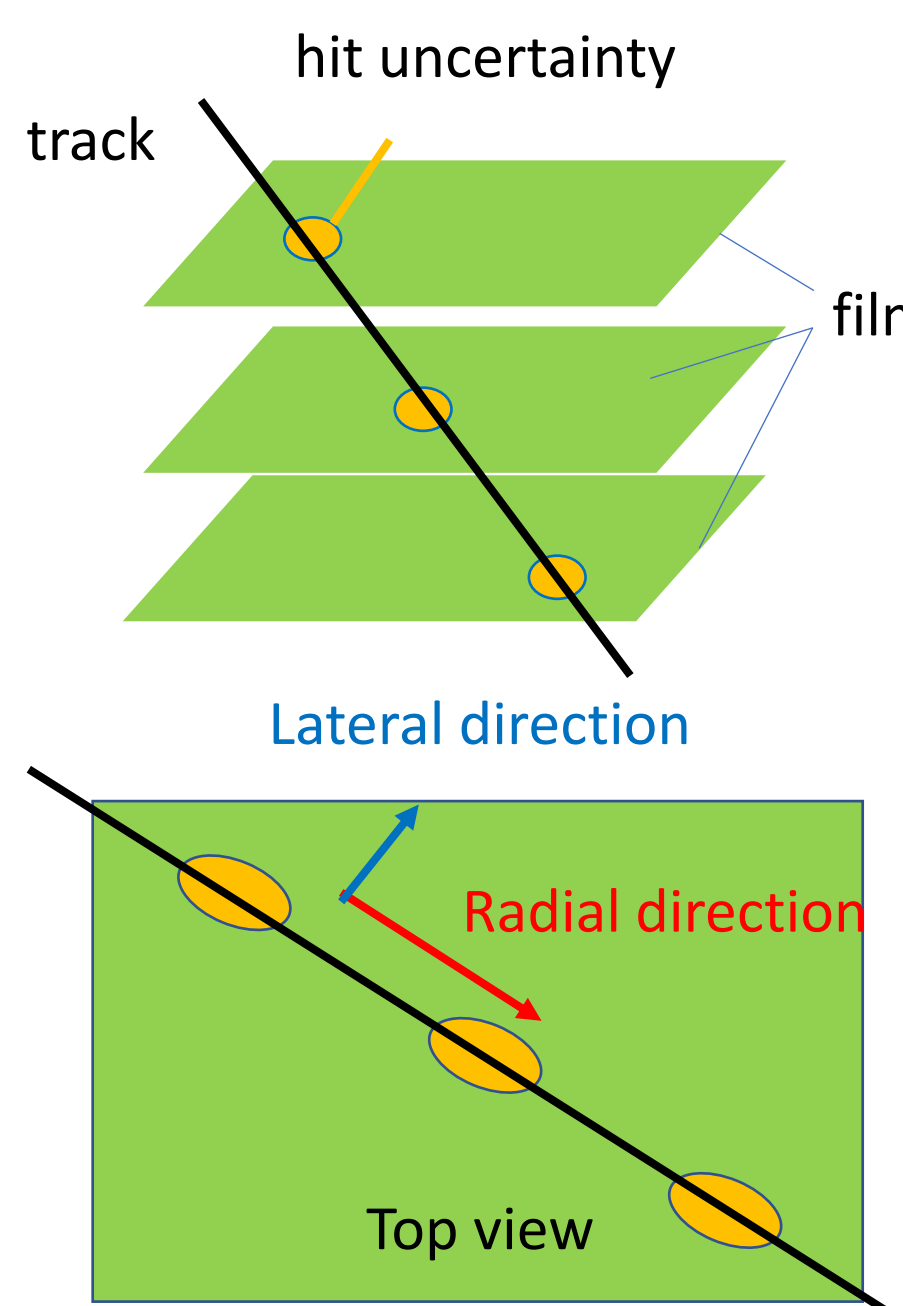
	Number of modules	Films(m ²)
2018 pilot run	1/4×30=7.5	49
2021 physics run	17	110
2022 physics run	17	110
2023 physics run	40	260

2023 physics run

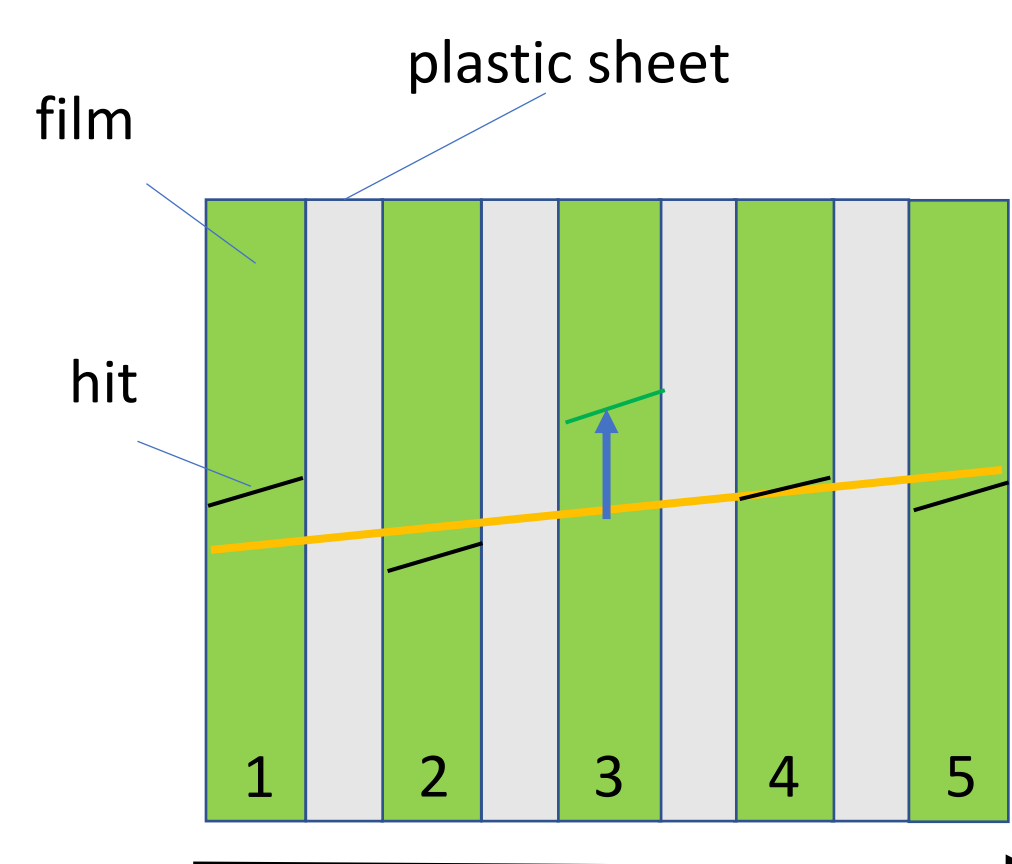


Detector performance evaluation

- The charmed particle decay events are identified with a kinematic cut based on Monte Carlo (MC) simulations implemented with the detector performance
- \Rightarrow We evaluated the position and angle accuracy of the films with 2018 pilot run data



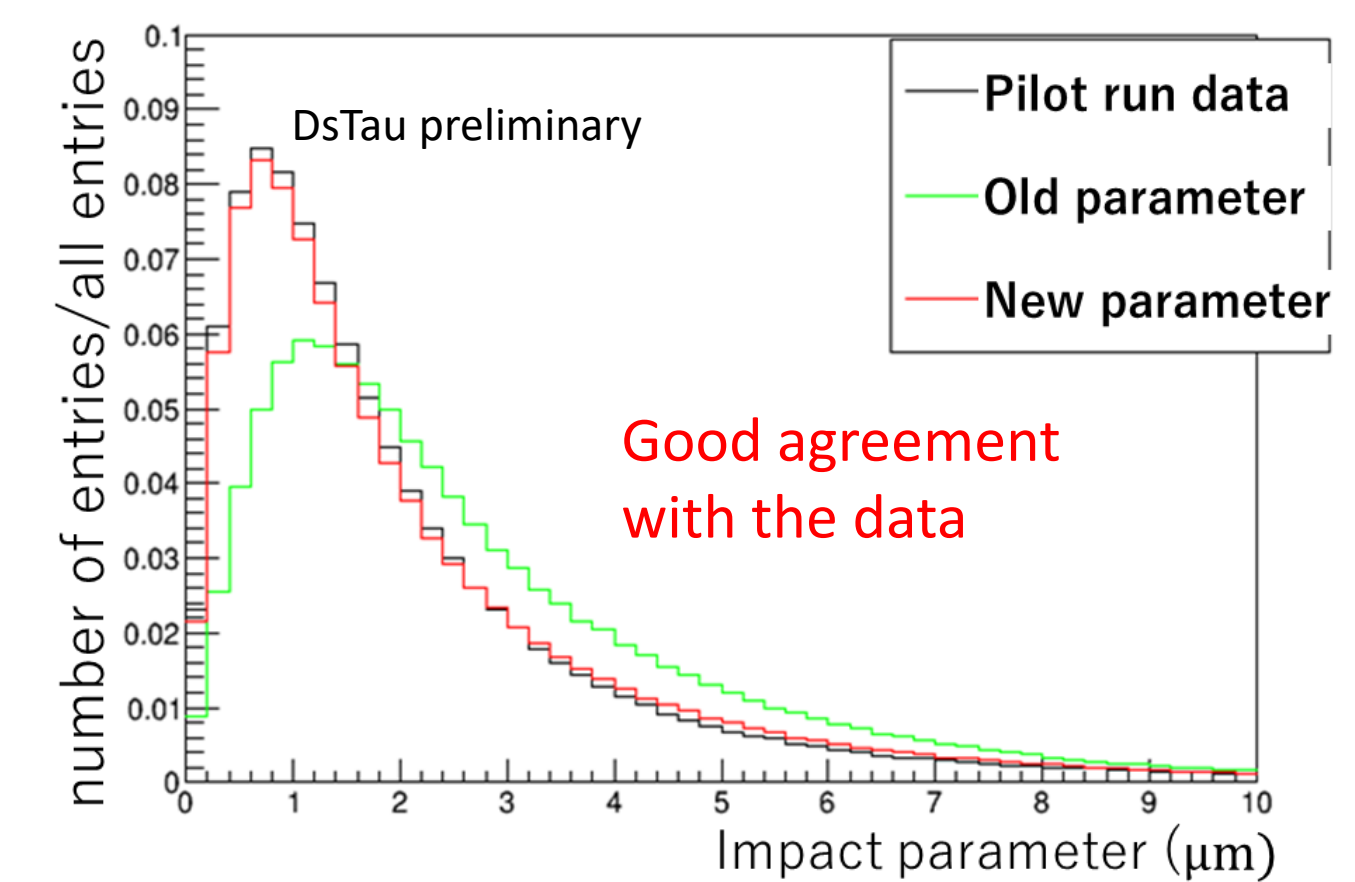
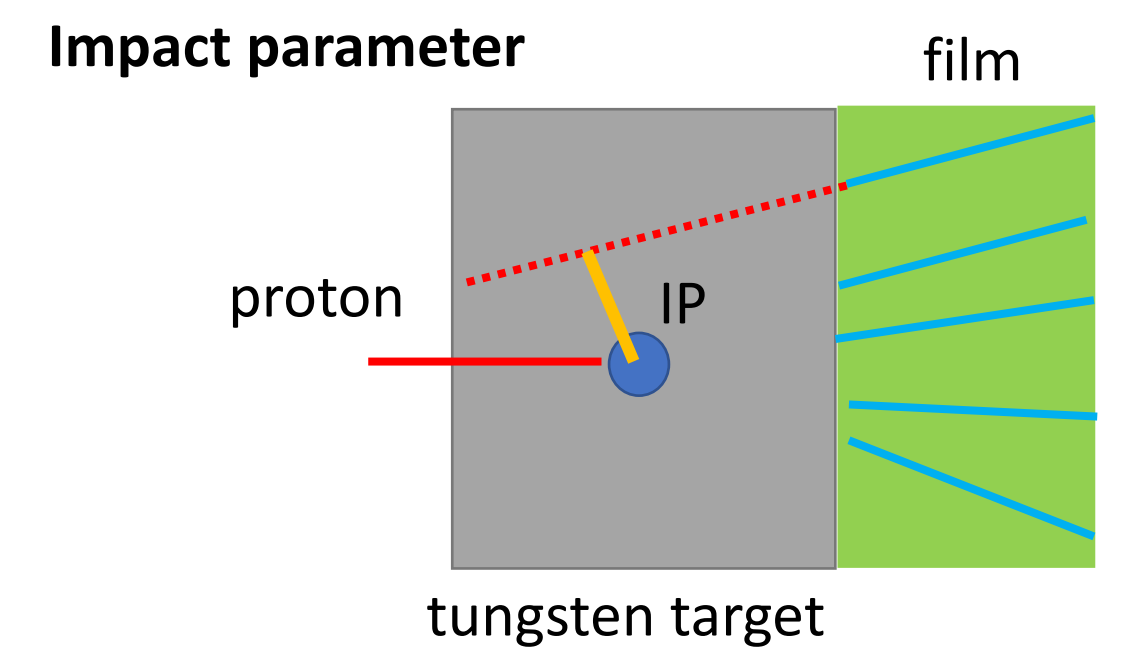
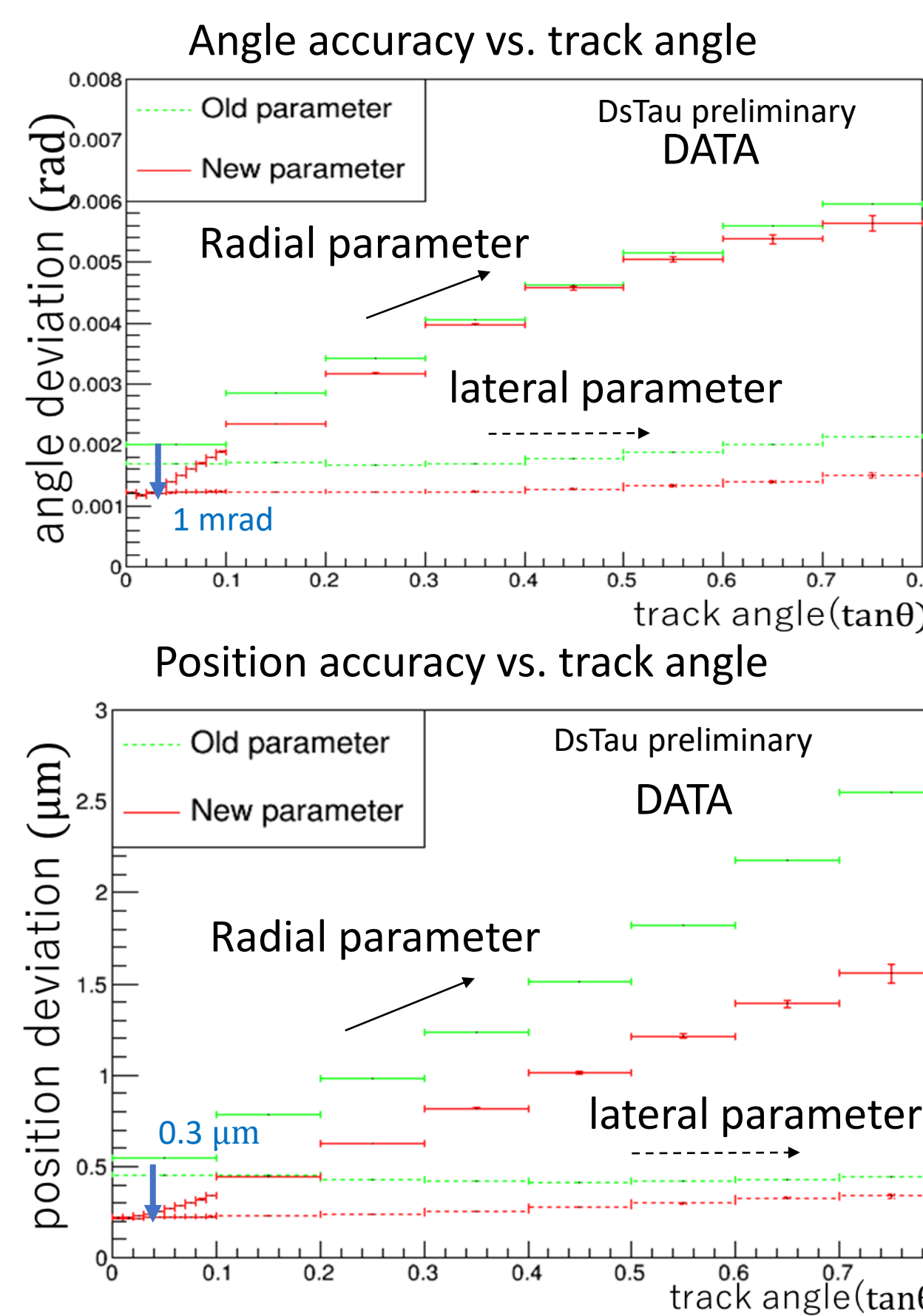
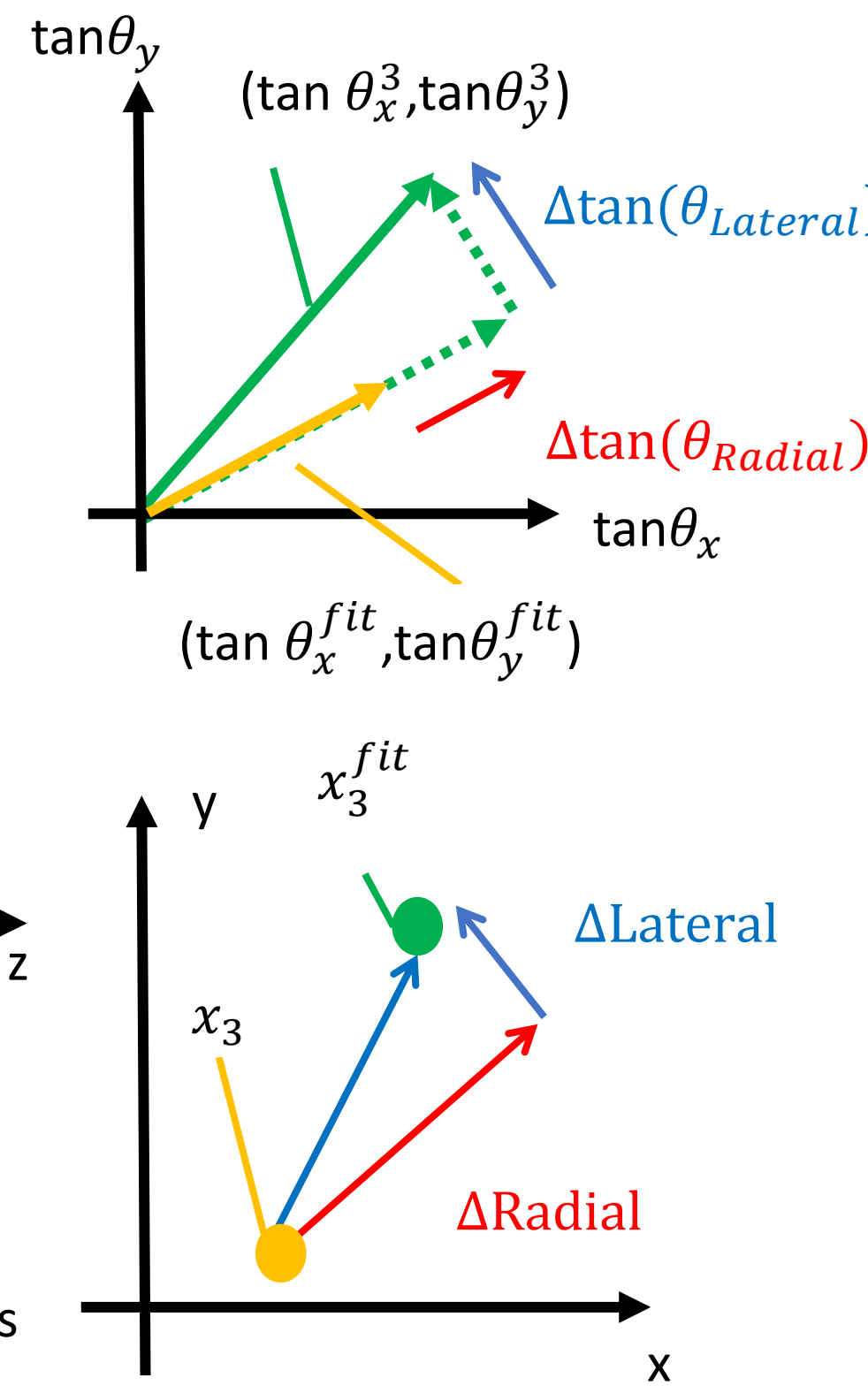
The accuracy was resolved into the **same direction(radial)** and **perpendicular direction(lateral)** to the incoming track



Fit 5 consecutive hits position with linear function

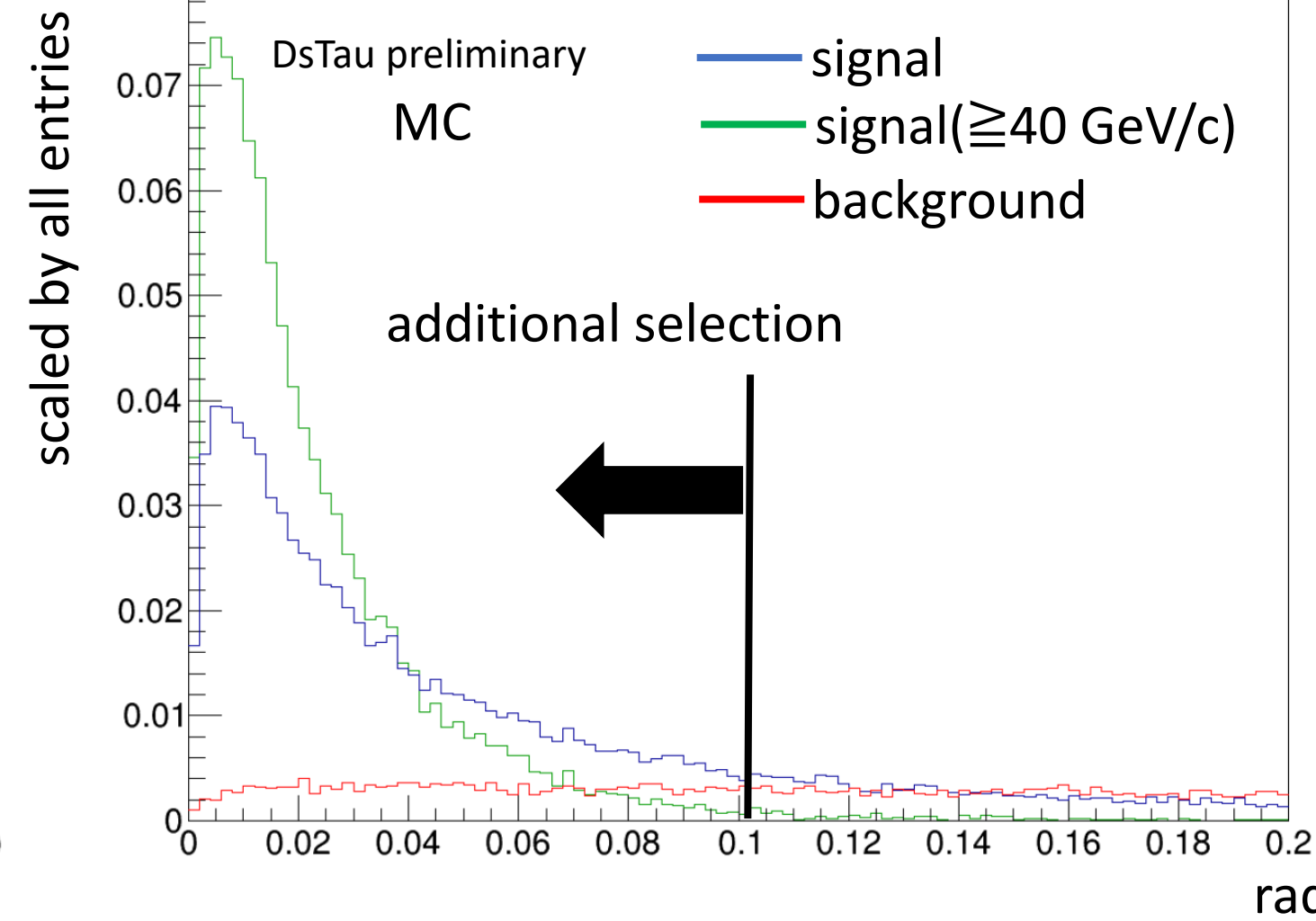
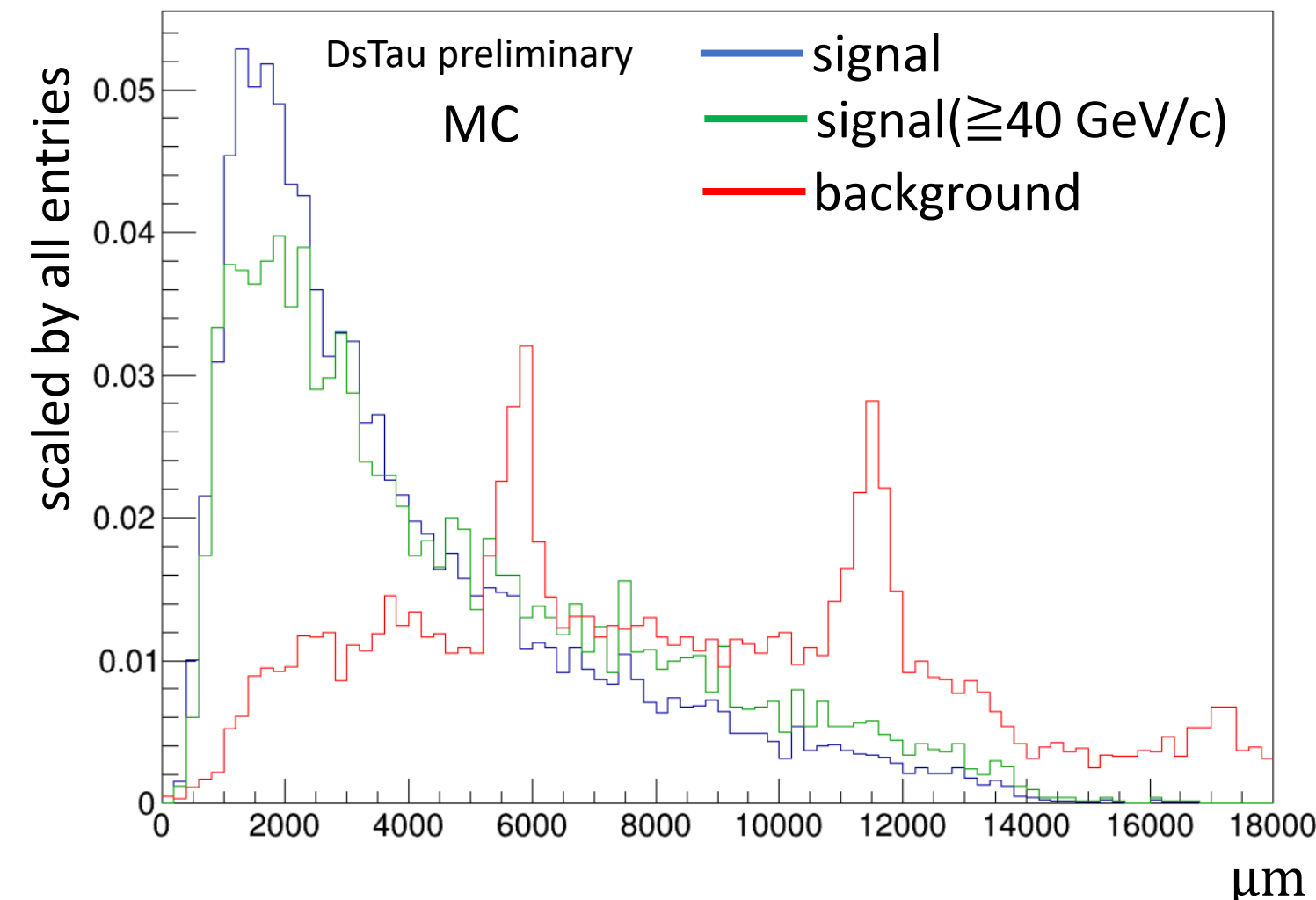
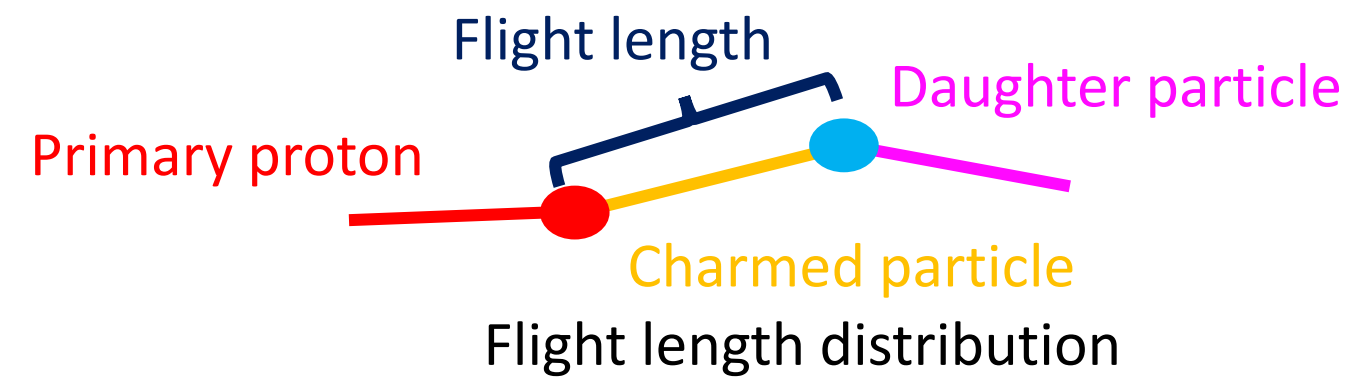
Selection:

- number of hits ≥ 20
- Require no tungsten plates between the 5 hits



High momentum charmed particle decay study

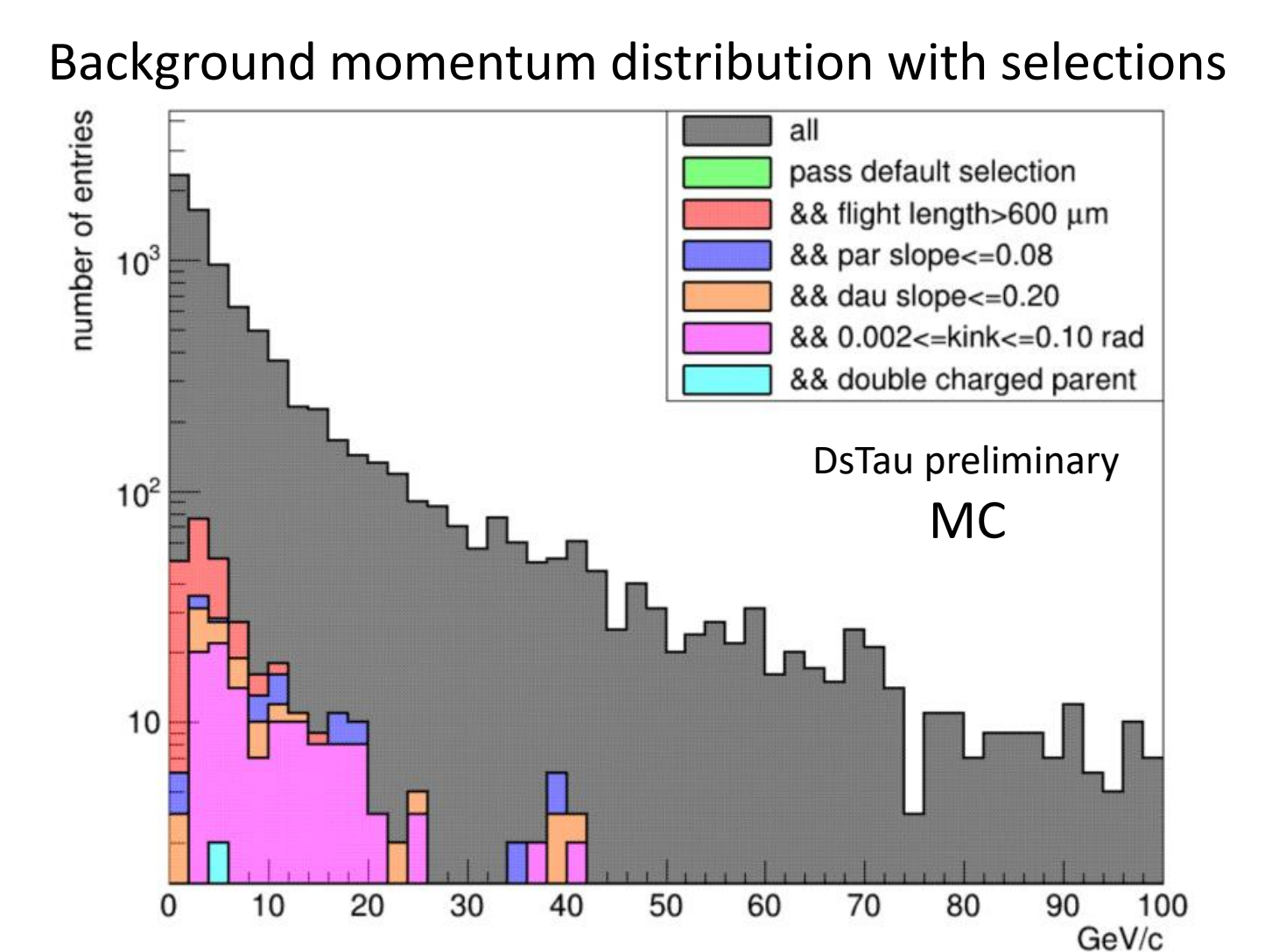
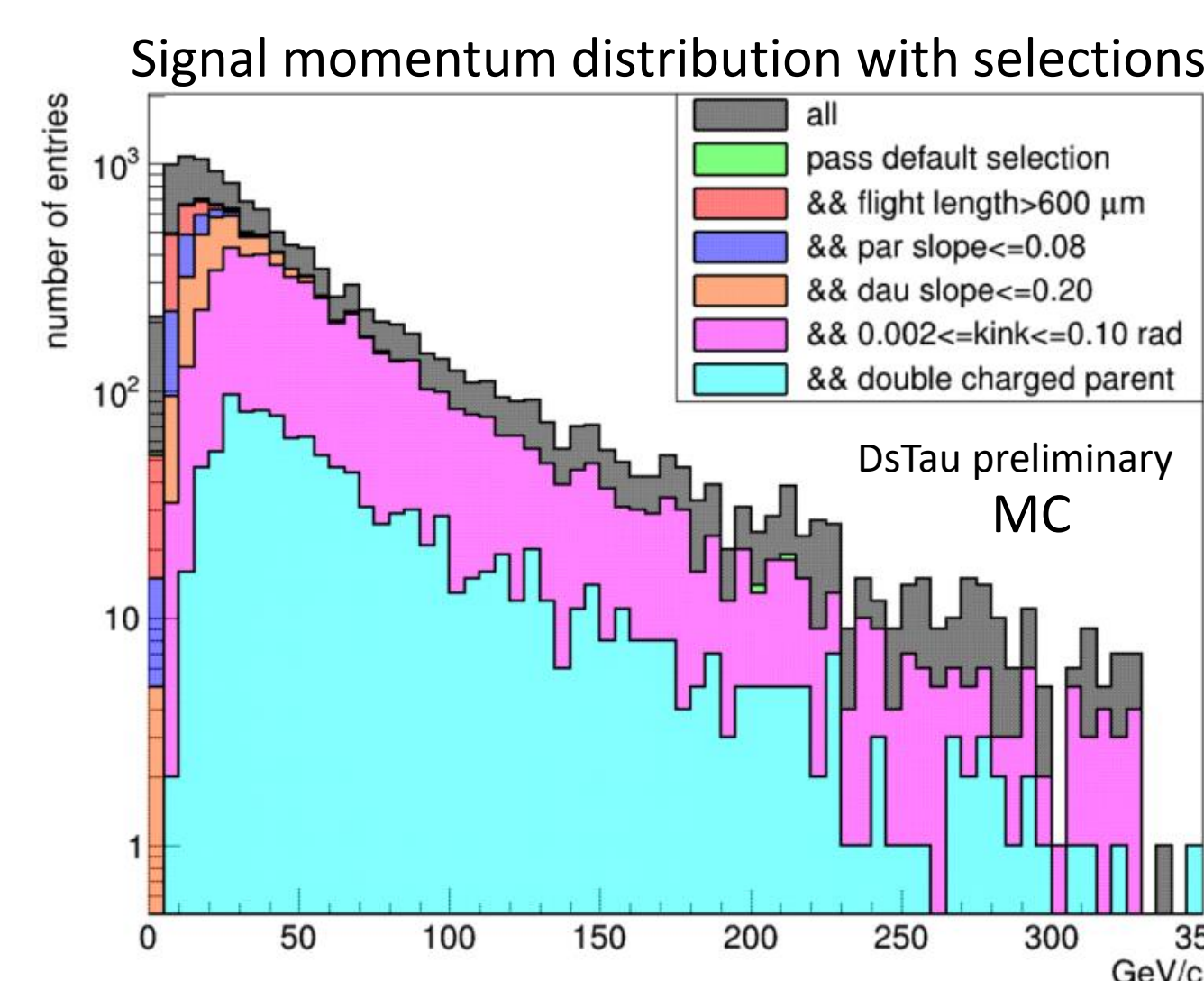
- The main background: hadronic interaction events
- Compare characteristic variables between signal and background
 - signal: charged charmed particle decay event simulated with pythia8+Geant4
 - background: secondary interaction simulated with EPOS+Geant4



Default charged charmed particle decay event selection	
The parent passes through at least two emulsion film	
The flight length of the parent ≤ 10 mm	
The decay vertex is not in tungsten	
The $\tan\theta$ of parent ≤ 0.3	
The $\tan\theta$ of daughter ≤ 0.5	
$0.002 \text{ rad} \leq \text{kink angle} \leq 0.5 \text{ rad}$	
$5 \text{ um} \leq \text{IP between primary vertex and daughter} \leq 700 \text{ um}$	

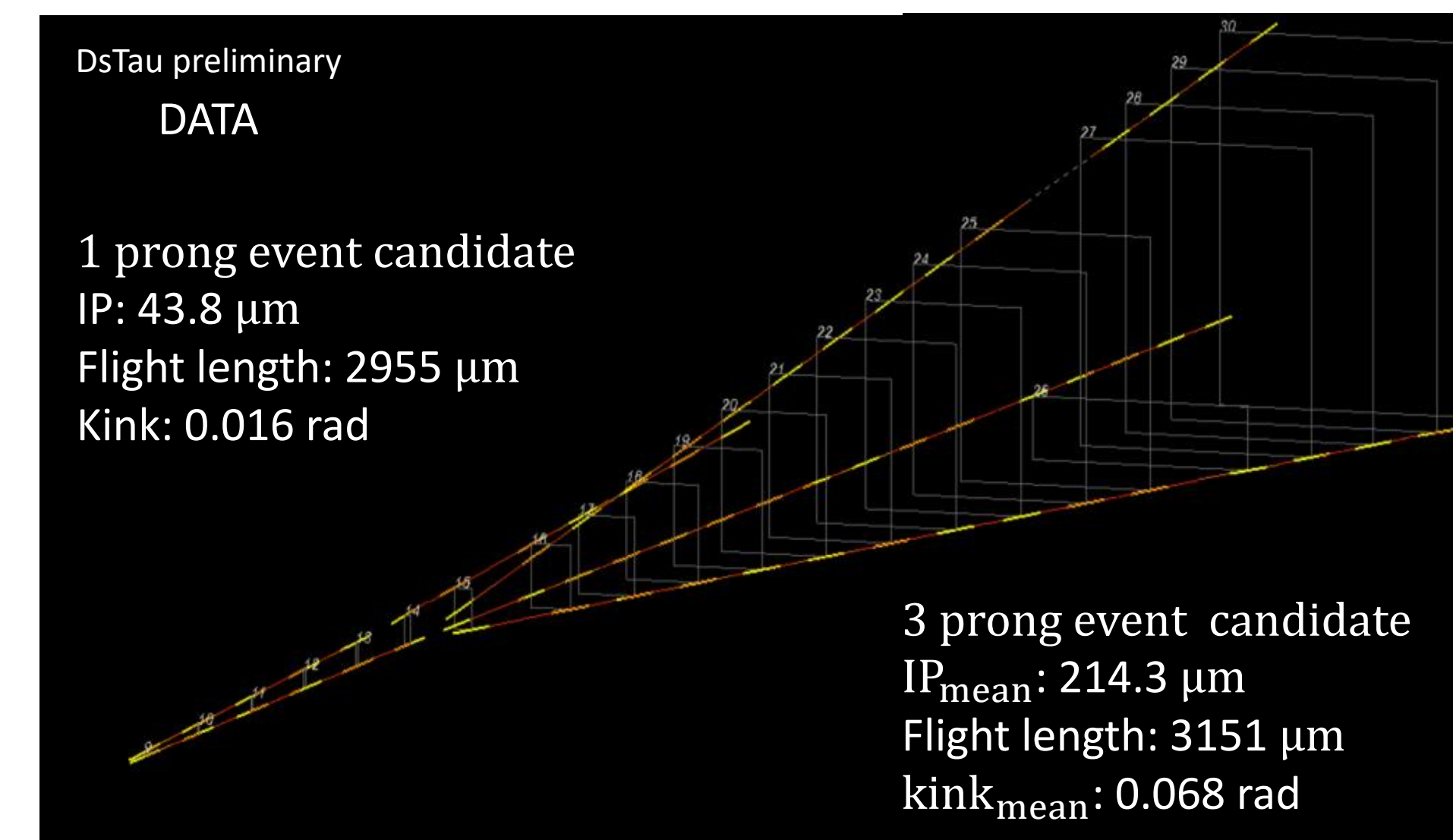
Additional selection for high momentum decay	
The flight length of the parent ≥ 0.6 mm	
The $\tan\theta$ of parent ≤ 0.08	
The $\tan\theta$ of daughter ≤ 0.2	
Kink angle ≤ 0.1 rad	

Event selection and evaluation



- The efficiency: 10% (signal), 0.03% (background)
- 67% of the signal pass selection ≥ 40 GeV/c**

Apply the selection to pilot run data



- Apply the selection to the pilot run data
- Found some event candidates
- Still a lot of background
 - ex) low momentum scattering
- multi-variable analysis & neutral decay study are in progress

Summary

- The NA65/DsTau experiment is ν_τ production study through measuring D_s production cross section
- The detector performance was evaluated with 2018 pilot run data and the new Monte Carlo simulation reproduce the data well.
- We made the selection for high momentum charmed particle decay events
- Signal efficiency is 10% and background efficiency is 0.03%. 67% of the signal pass the selection ≥ 40 GeV/c**
- We will perform multi-variable analysis with a selection cut based on this new parameter of the detector performance.

References

[1] The DsTau collaboration. DsTau: study of tau neutrino production with 400 GeV protons from the CERN-SPS. J. High Energ. Phys. (2020), 33.
 [2] Weidong Bai, Mary Hall Reno, Prompt neutrinos and intrinsic charm at SHiP, J. High Energ.Phys. (2019) 77.