Tracking for long-lived particles at STCF

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STCF tracking system 1

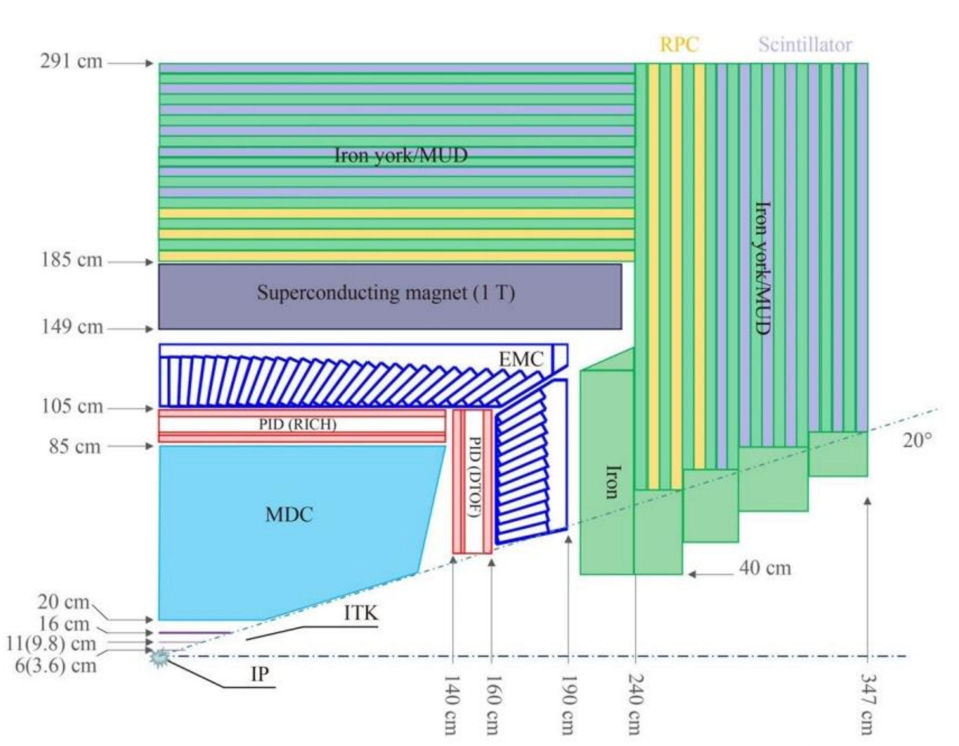

Fig1.Schematic layout of the STCF detector. The number in brackets indicate the radii of the MAPS based ITK[1]

- STCF[1] will provide an unique platform for in-depth studies of hadron structure and non-perturbative strong interaction, as well as probing physics beyond the Standard Model at the τ-Charm sector succeeding the present Being Electron-Positron Collider II (BEPCII).
- STCF tracking system has a three-layer inner tracker with radii of 60 mm, 110 mm, and 160 mm and a drift chamber.
- Long-lived particles, e.g. the lambda baryon, may decay within or outside the inner tracker hence leaving very limited number of hits at the inner tracker of STCF.

ACTS seeding efficiency for long-lived particles 2

ACTS: A Common Tracking Software[2]

- Developed based on C++17 (—>20)
- Does not depend on the specific detector and magnetic field
- Strict thread safety
- Less dependence (Eigen)
- Highly configurable
- Adapt to modern computing frameworks

- Performance of ACTS seeding and Combinatorial Kalman Filter algorithms for long-lived particles in $J/\psi \to \Lambda(\to p\pi^-)\bar{\Lambda}(\to \bar{p}\pi^+)$ events at STCF has been studied
- ACTS seeding efficiency approaches 100% when the vertex displacement of particles is below 60 mm
- ACTS seeding efficiency drops to 0% if displacement exceeds 60 mm.

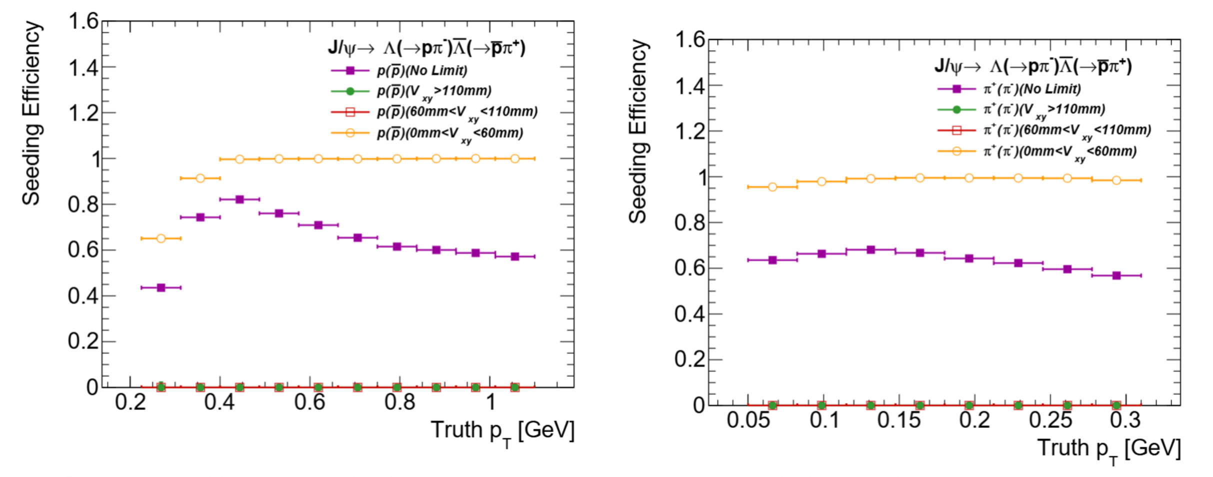

Fig2.The seeding efficiency for p and π with 20k generated in $J/\psi \to \Lambda(\to p\pi^-)\bar{\Lambda}(\to \bar{p}\pi^+)$ events as a function of p_T and $cos(\theta)$

Tracking strategy for long-lived particles 3

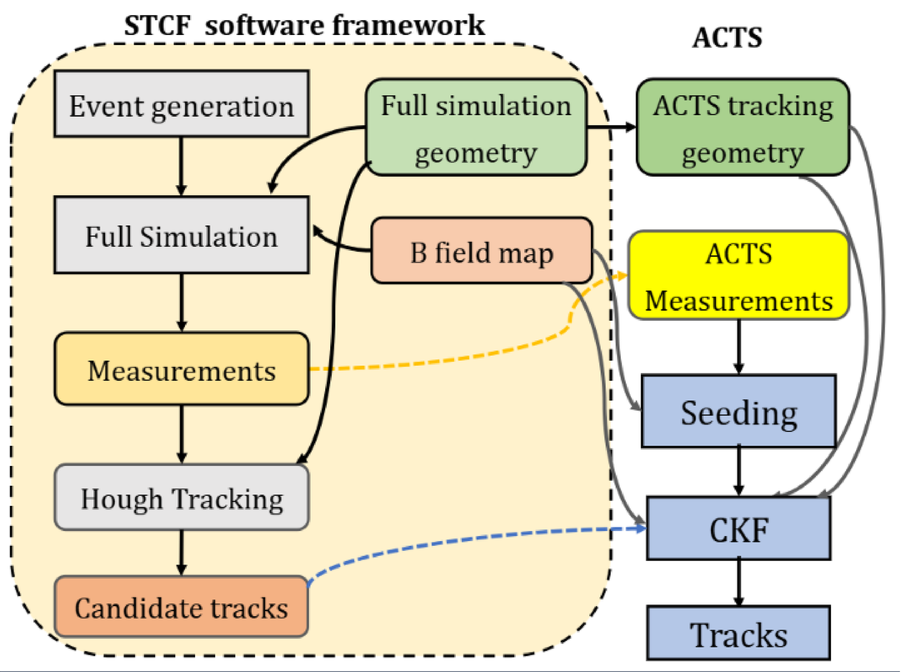

Fig3.Workflow of studying tracking performance using candidate tracks and measurements from SCTF in ACTS

- Improving the tracking performance of ACTS for long-lived particles at STCF by combining Hough Transform and Combinatorial Kalman Filter (CKF).
- One ROOT-based reader extracts simulated hits from full simulation data and converting them into ACTS measurements.
- One ROOT-based reader extracts initial track parameters from Hough Transform and converting them into ACTS track parameters.

Hough Transform and CKF 4

- Hough Transformation[3] serves as a global tracking algorithm in OSCAR, operating on the principle of transforming each point in geometrical space into a line in parameter space, represented by the Hough curve.
- CKF algorithm relies on an initial track seed, which provides an estimate of the measurements associated with the sensitive surfaces of the tracking geometry.

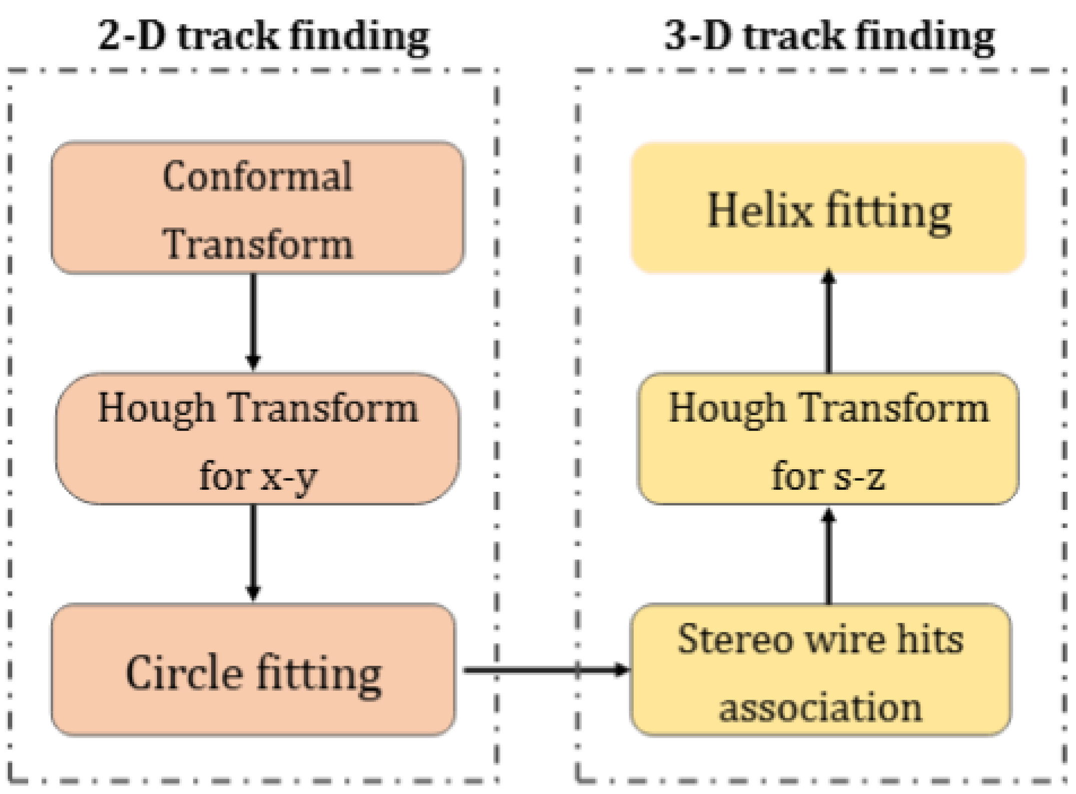

Fig4.The workflow of track finding using Hough Transform in OCSCAR

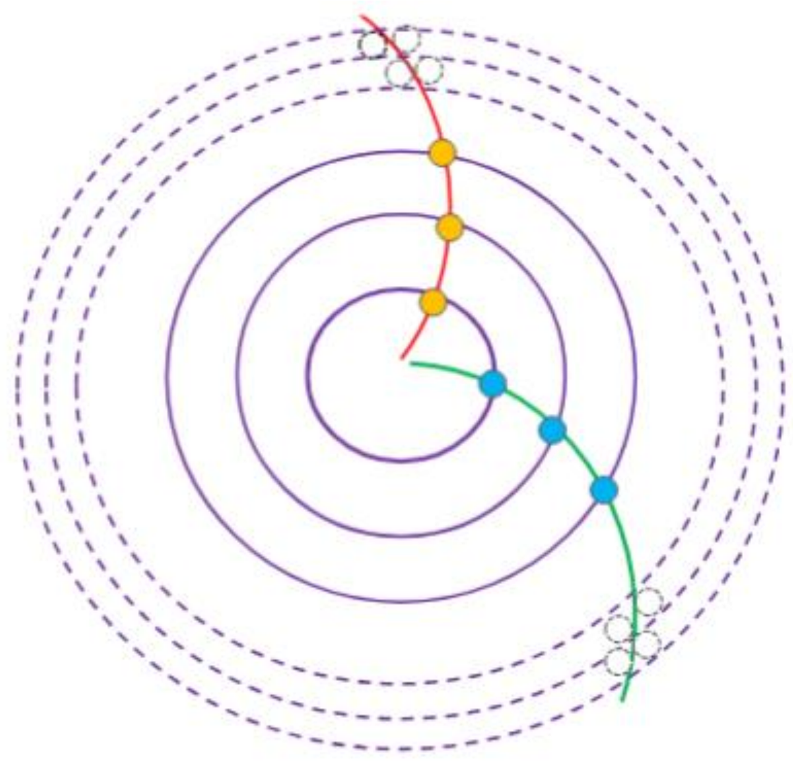

Fig5.Illustration of track finding using CKF with ITK and MDC of STCF

Distributions of $J/\psi \to \Lambda(\to p\pi^-)\bar{\Lambda}(\to \bar{p}\pi^+)$ 5

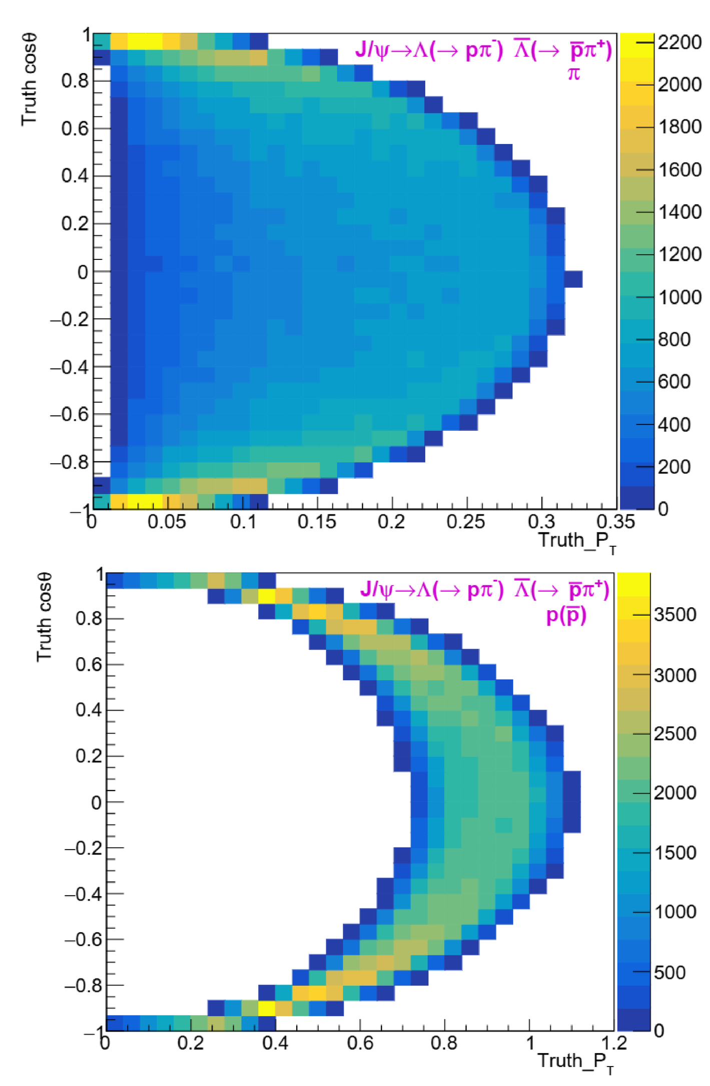

Fig6.The distributions of pt versus cos for p and π

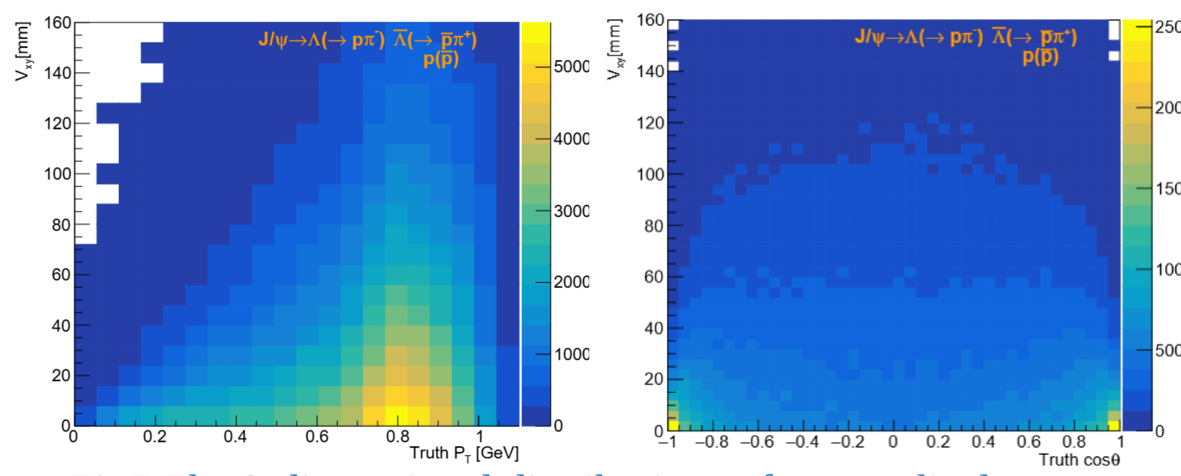

Fig7.The 2-dimensional distributions of vertex displacement versus p_T and $cos(\theta)$ for p

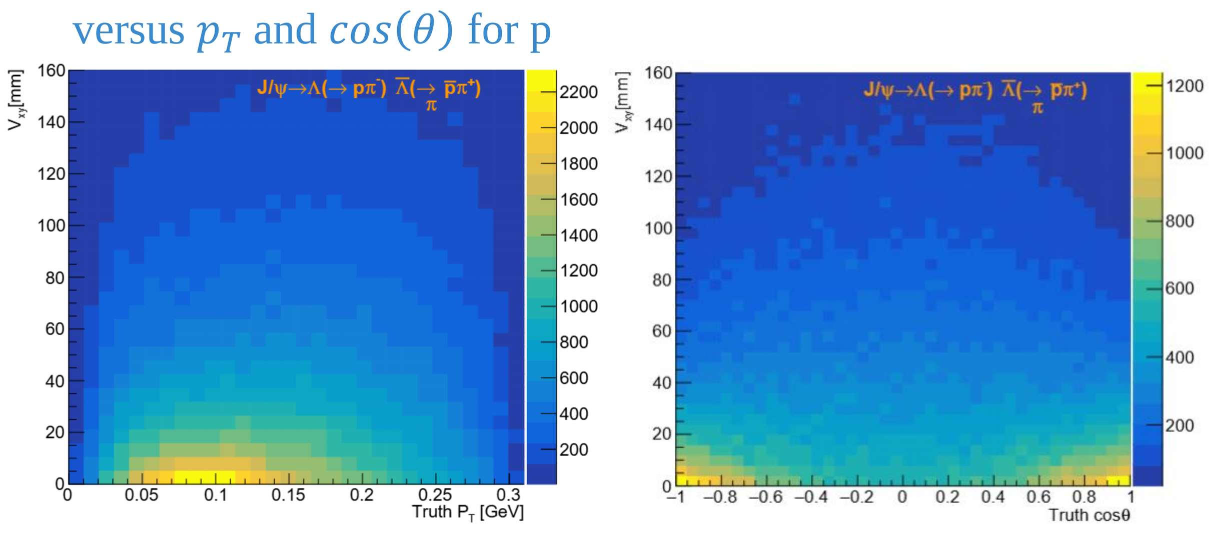

Fig8.The 2-dimensional distributions of vertex displacement versus p_T and $cos(\theta)$ for π

Tracking performance 6

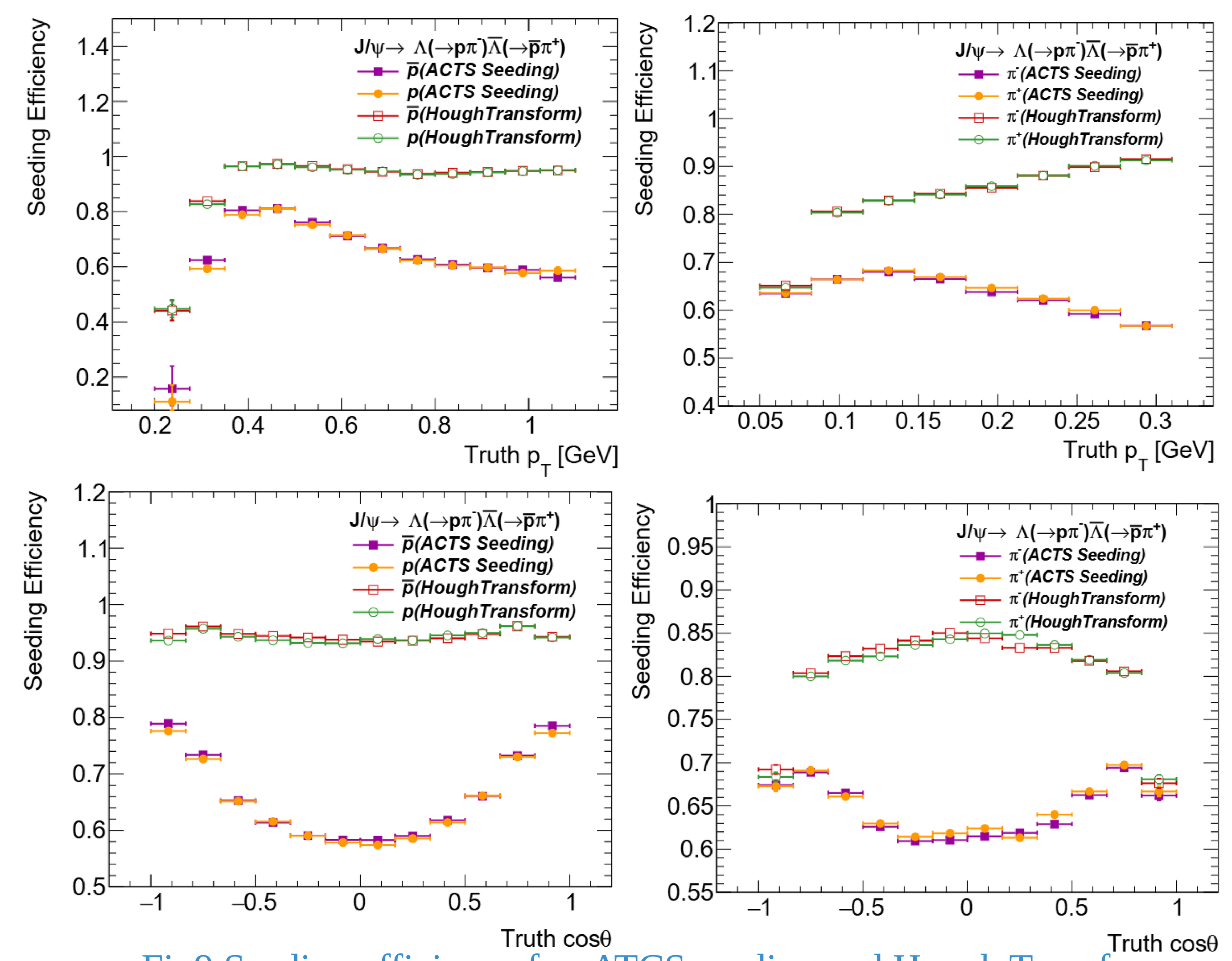

Fig9.Seeding efficiency for ATCS seeding and Hough Transform

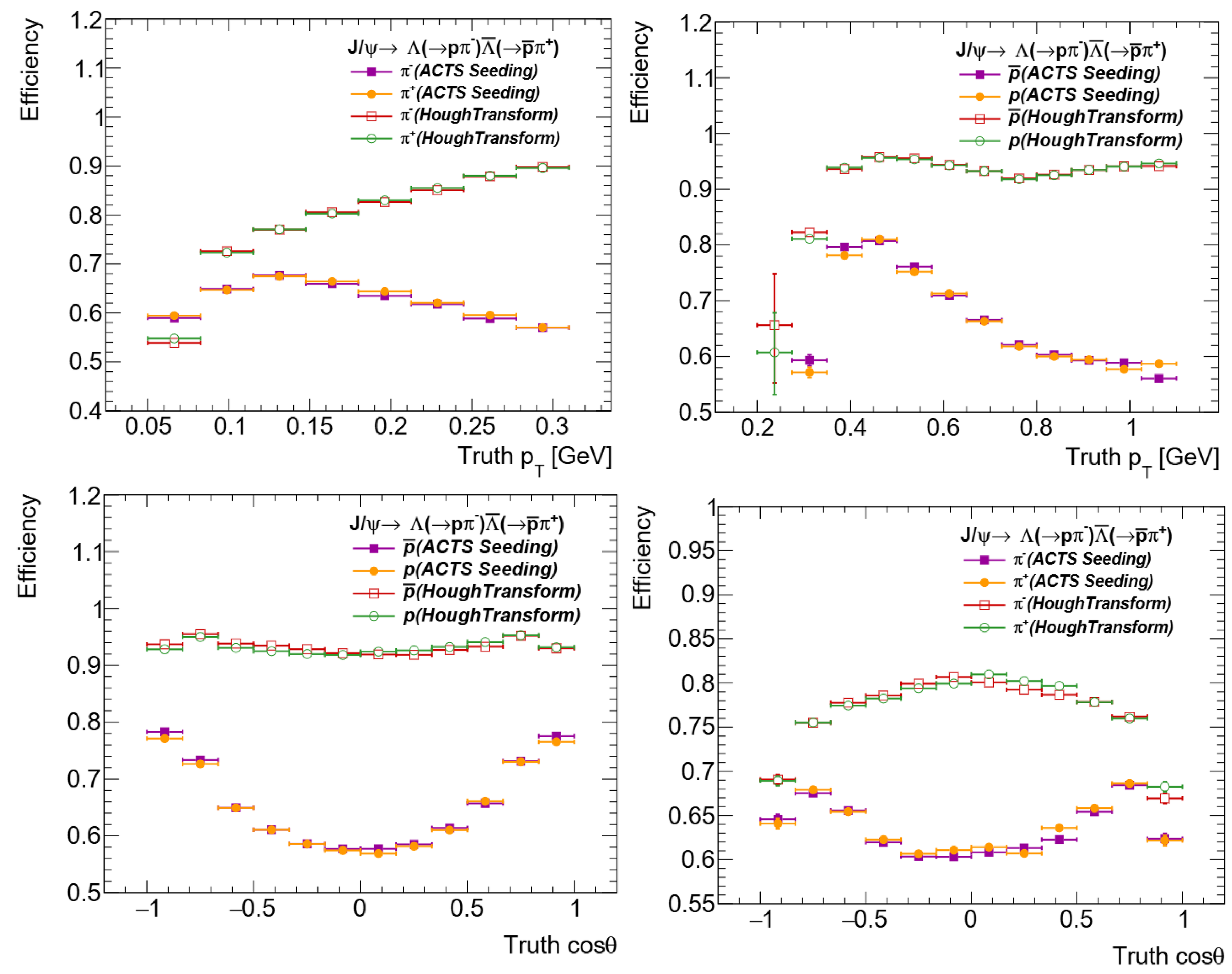

Fig10. Efficiency for ATCS seeding+CKF and Hough Transform+CKF

- Compared to ACTS seeding, the seeding efficiency of Hough Transform has been greatly improved.
- Hough Transform has better tracking efficiency compared to ACTS seeding, especially for with momentum in the range of [0.6, 1.1] GeV and for π with momentum in the range of [0.2, 0.3] GeV.

[1] STCF Conceptual Design Report
[2] Github: https://github.com/acts-project/act
[3] Hang Zhou:https://indico.cern.ch/event/1338689/contributions/6010610/