

Expected Tracking performance of the ATLAS ITk detector for HL-LHC

Warren Guerin

On behalf of the ATLAS Collaboration

Laboratoire des 2 Infinis – Toulouse (L2IT – IN2P3), Université de Toulouse

warren.rodolphe.guerin@cern.ch

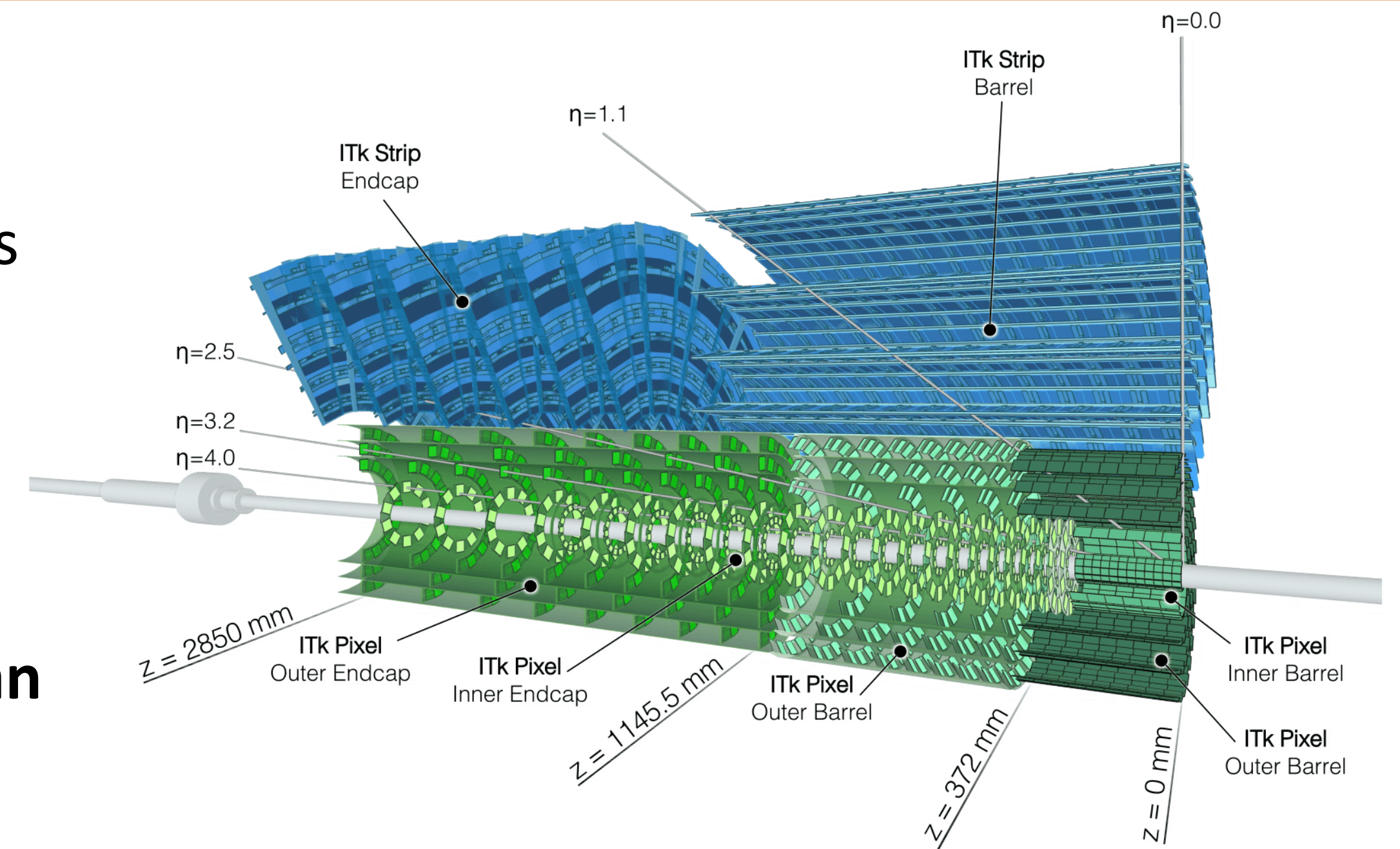


ATLAS Inner Tracker Geometry

ATLAS Inner Tracker:

- Build for the **High-Luminosity LHC** phase scheduled to begin in 2030
- Fully silicon based detector made of 3D **pixel** and double-sided **strip** modules covering a pseudo-rapidity range of $|\eta| < 4.0$.
- Designed to work in a dense environment $\rightarrow \langle \mu \rangle \sim 200$
 $\langle \mu \rangle$: Average number of pp interactions

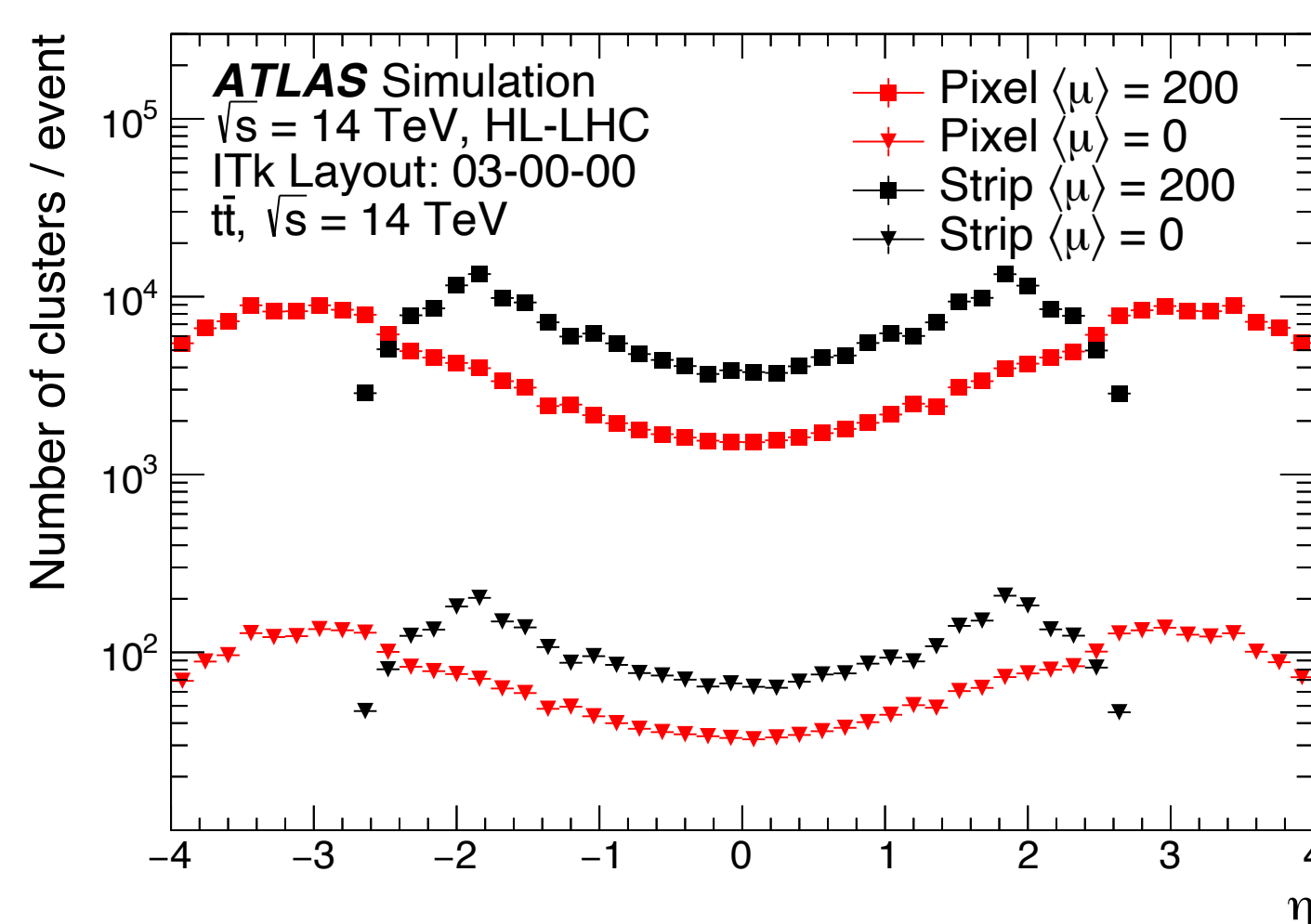
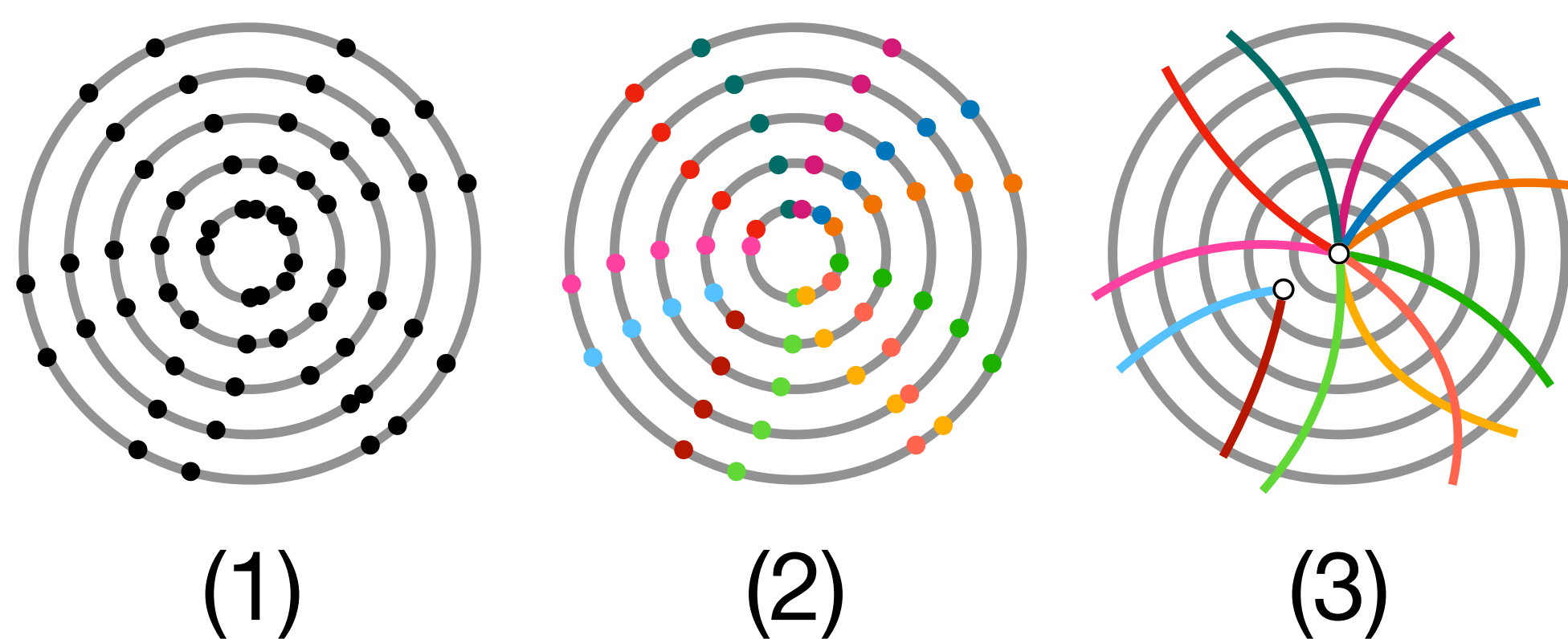
Aim to reconstruct tracks left by charged particles with $p_T > 1$ GeV leaving an average of 9 hits across the detector.



Track Reconstruction & Selection

Track Reconstruction

- Space point formation (1)
- Track finding (2)
- Parameter estimations (3)



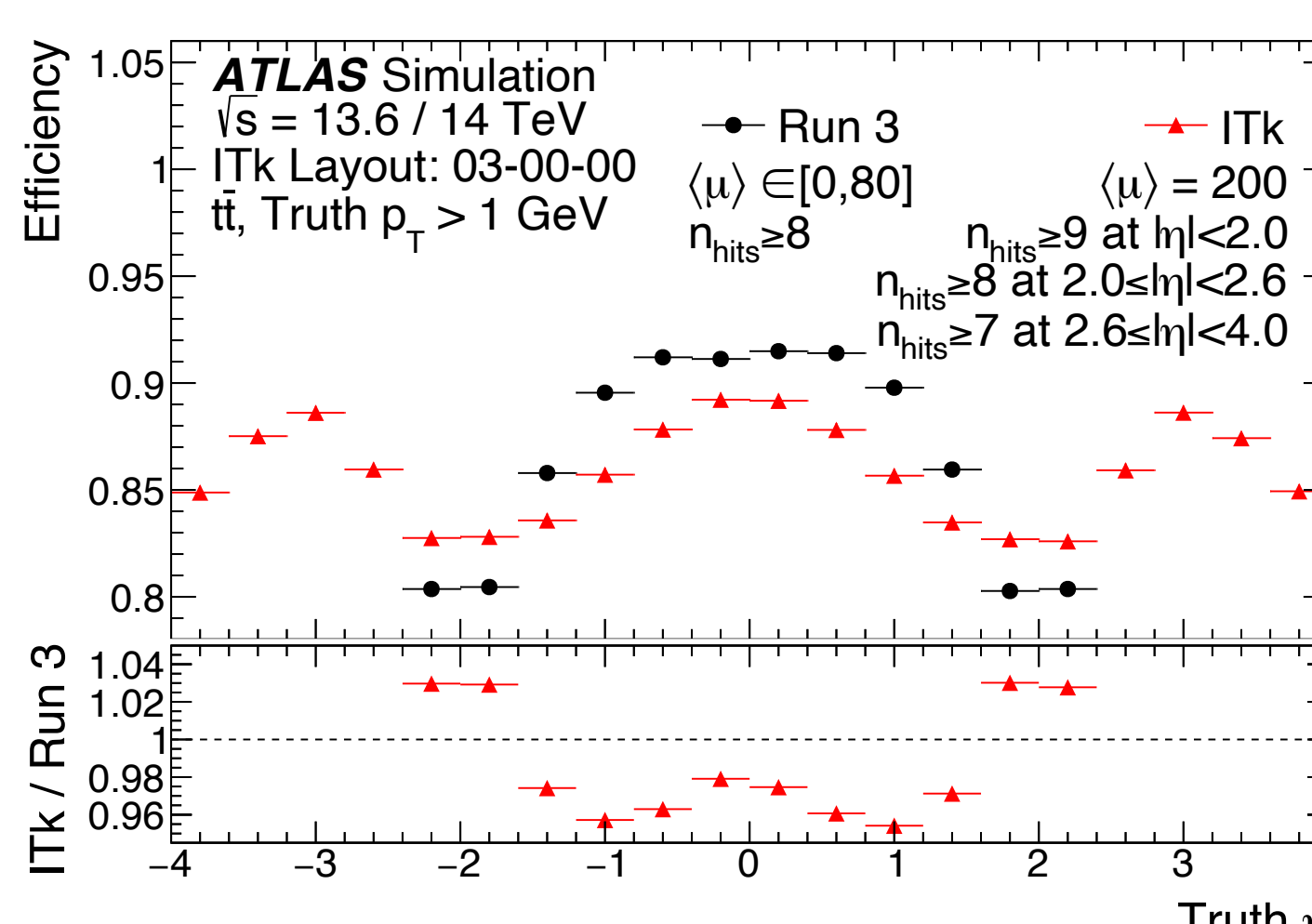
- Challenging dense environment at the HL-LHC.

Track selection

- η -dependent requirements :

Requirements	Pseudorapidity interval		
	$ \eta \leq 2.0$	$2.0 < \eta \leq 2.6$	$2.6 < \eta \leq 4.0$
Pixel + strip hits	≥ 9	≥ 8	≥ 7
Pixel hits	≥ 1	≥ 1	≥ 1
Holes	≤ 2	≤ 2	≤ 2
p_T [MeV]	> 900	> 400	> 400
$ d_0 $ [mm]	< 2.0	< 2.0	< 10.0
$ z_0 $ [cm]	< 20.0	< 20.0	< 20.0

Tracking efficiency

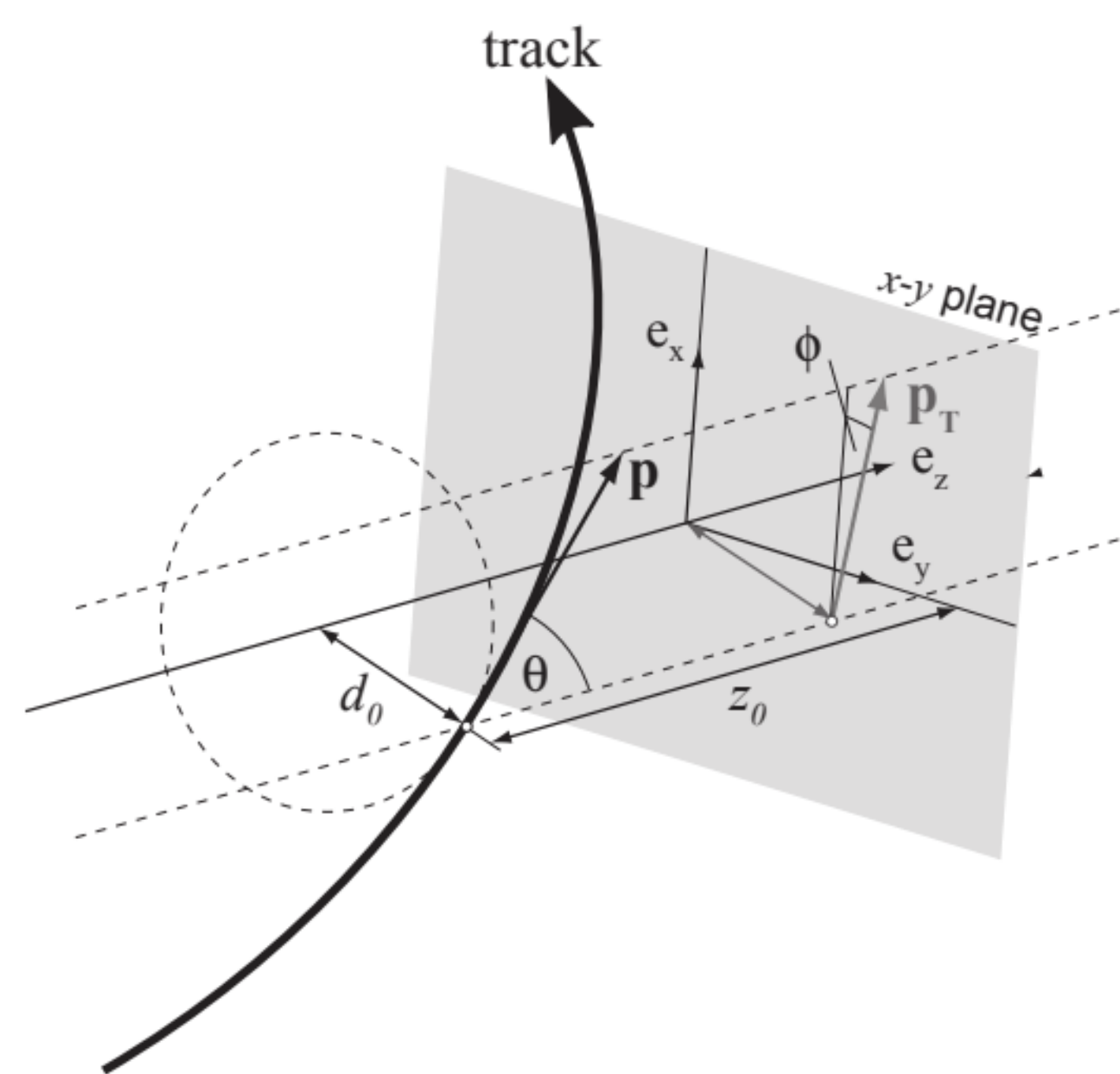


Competitive efficiency with Run 3 Inner Detector with harsher conditions

Track parameter resolution

Track definition

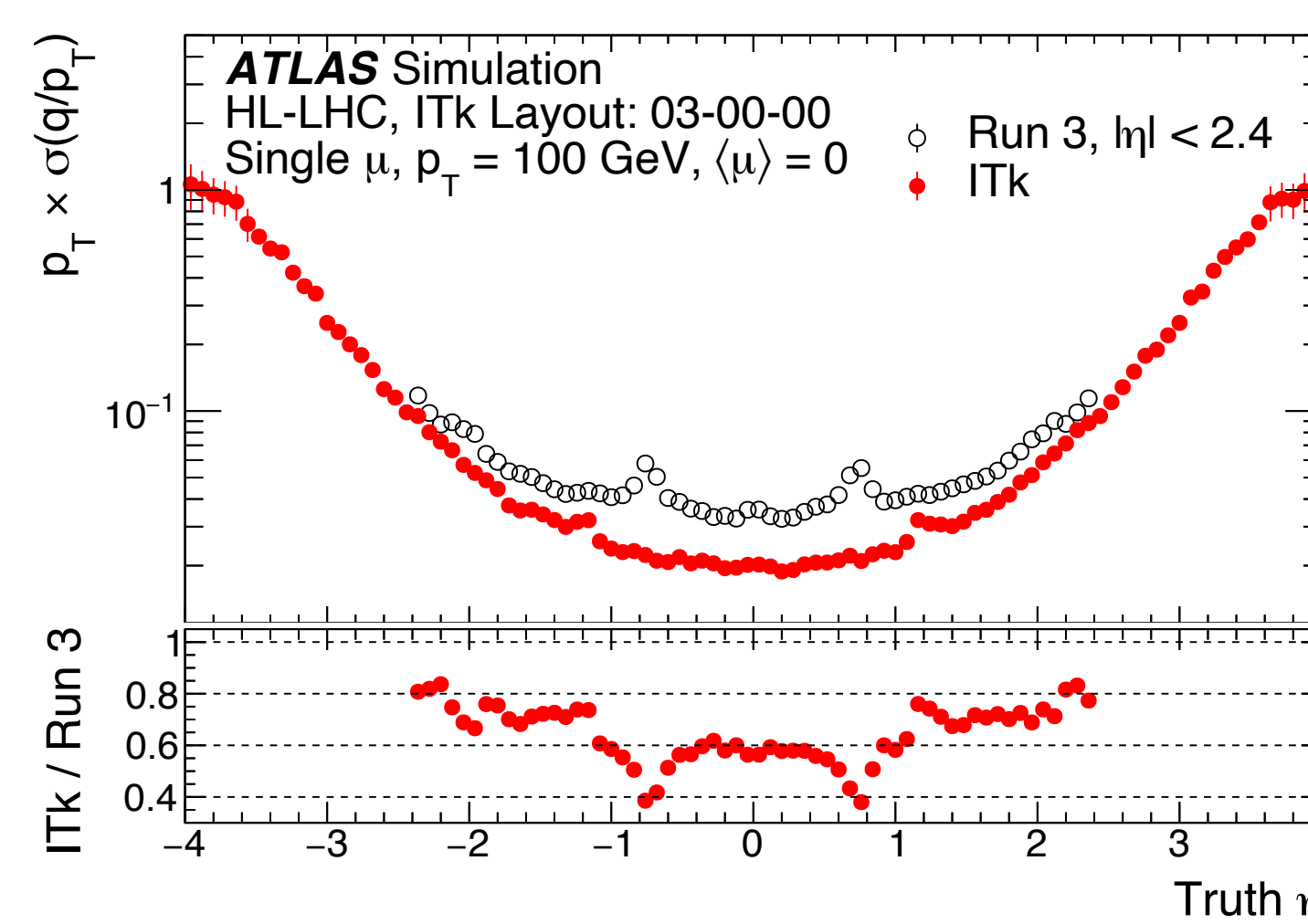
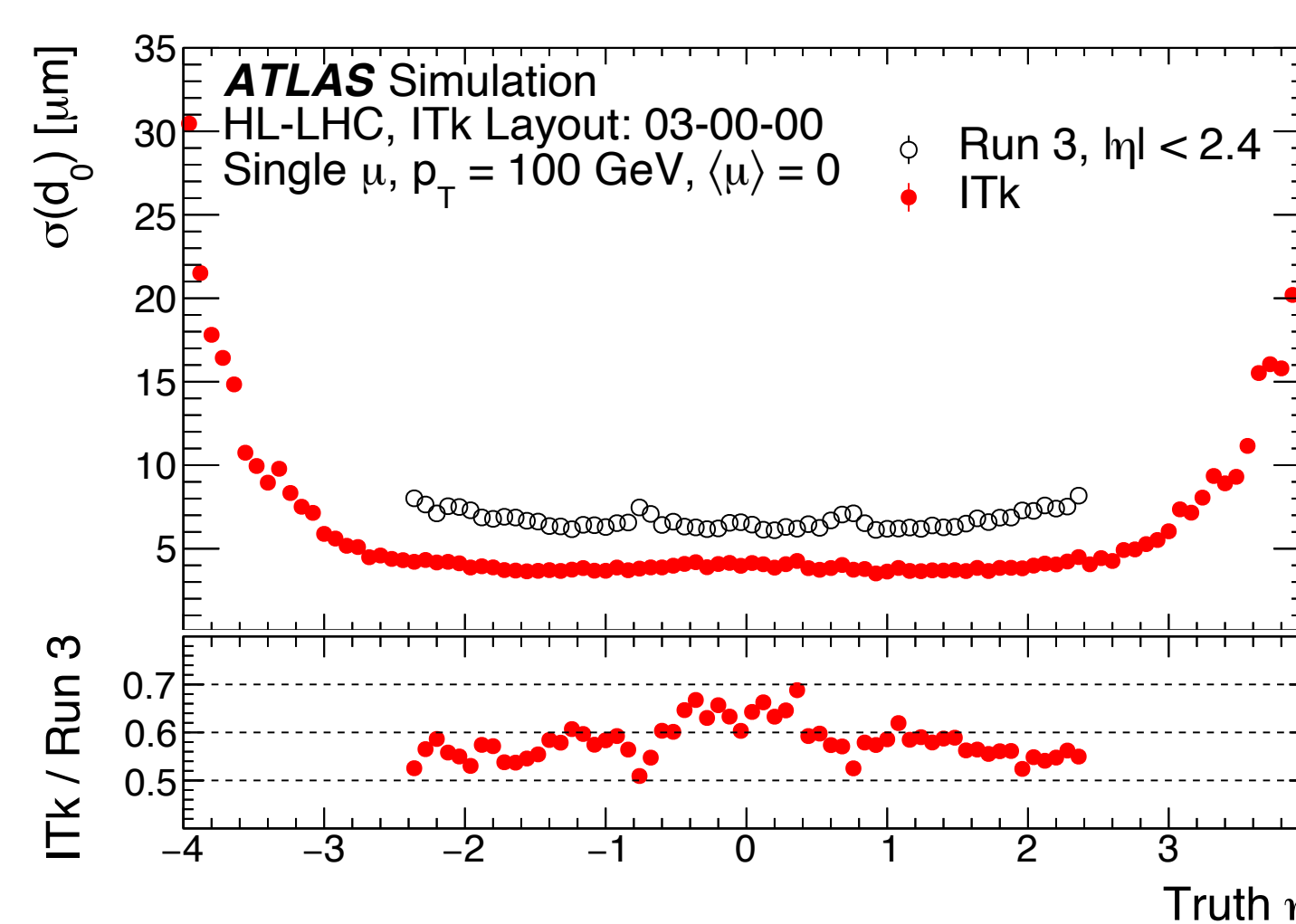
- 5 parameters to define tracks



Global track parameters e.g. wrt. perigee

$$\left(d_0, z_0, \phi, \theta, \frac{q}{p} \right)$$

Resolution

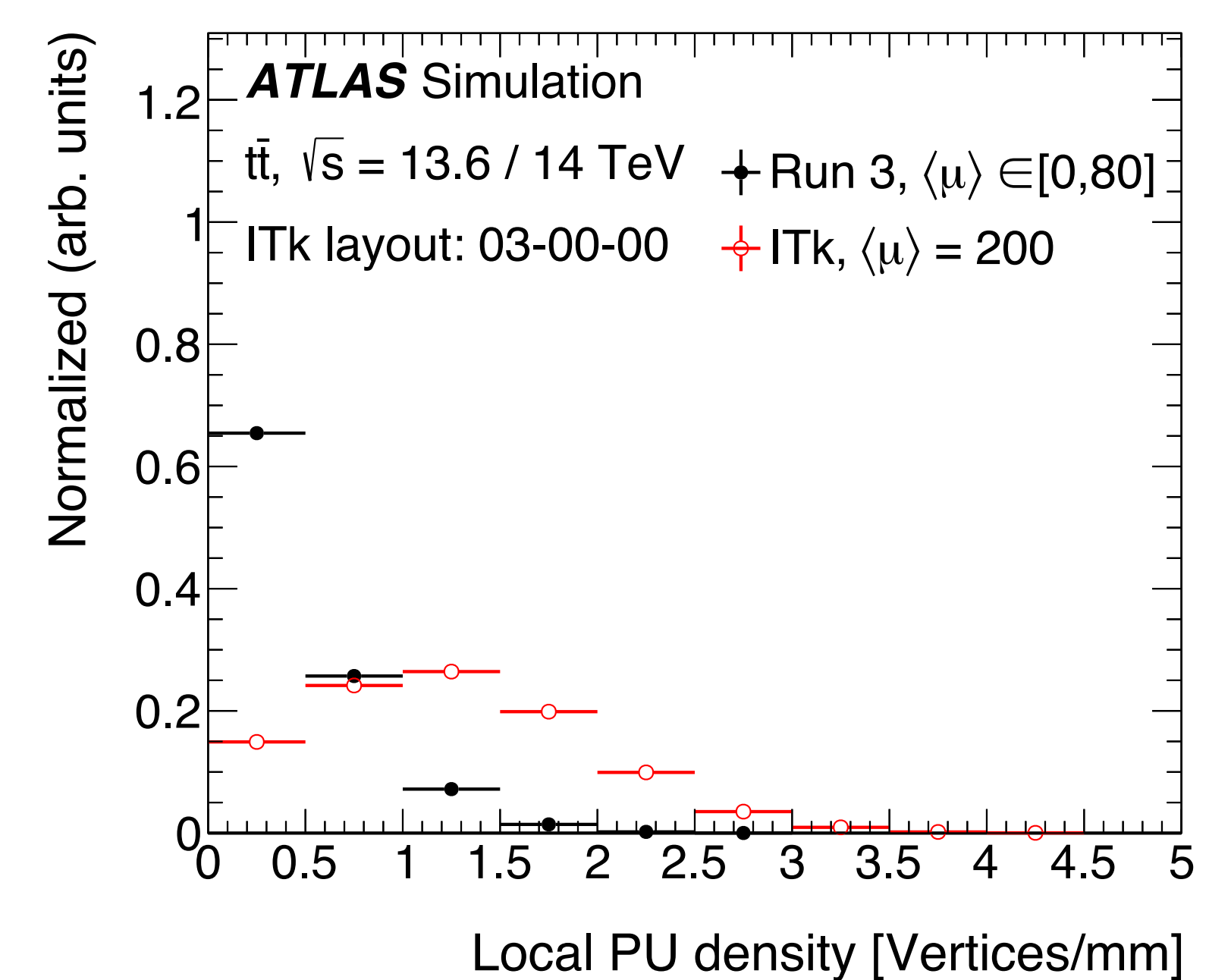


Better parameter resolutions for ITk thanks to novel detector technologies

Vertex Reconstruction & Selection

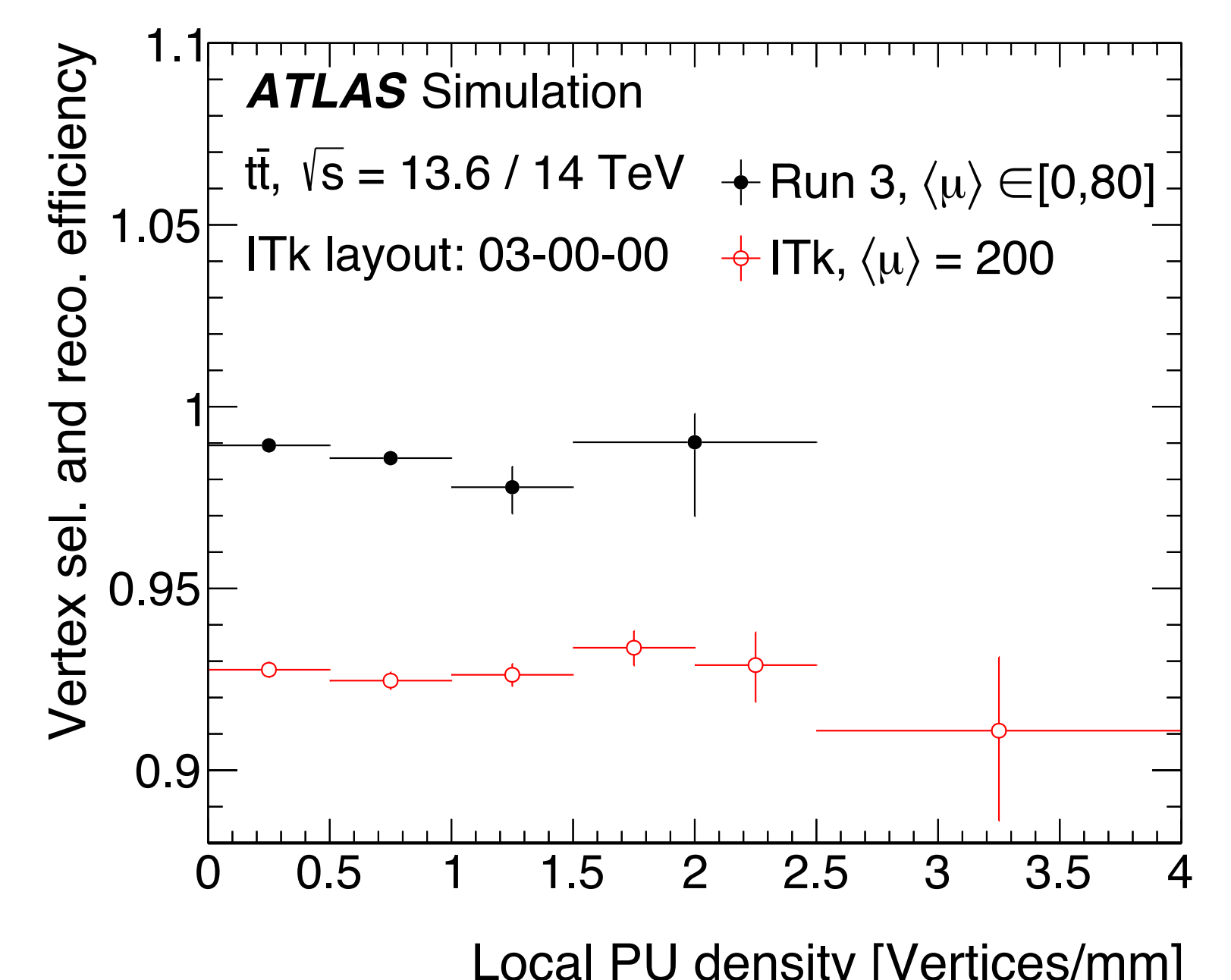
Vertex reconstruction goals

- Define the primary vertex (PV) from the hard-scatter (HS) process
- Reject pile-up vertices from the PV.
- Local PU density : Number of vertices around the true HS vertex in a 4 mm window.



Vertex Reco. & Sel. efficiency

- Fraction of events where a vertex is reconstructed within 0.1 mm of the true HS position along the beam axis.
- Second track selection to ensure reliable impact parameter resolution



Stable efficiency even under high number of pp interactions