“Performance Plot Goals for the TDR”

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EIC local meeting
November 28, 2023

(Pre-)TDR

The EIC Project includes both the facility and the (project) detector,

The Project currently aims for CD-2 (baseline) approval in Spring 2025, and so far also for CD-3 (start of construction)

CD-(2)3 requires a (pre-)TDR,

The formal (pre-)TDR will thus presumably be a rather vast document driven by the EIC Project; (my) assumption is that the experiment component will be written to purpose on an aggressive timeline,

ePIC as a collaboration will likely want to pair this with one or more publications; (my) assumption is one more oriented towards the instrument and another more towards the nuclear science the instrument will enable,

My assumption is that the upcoming Collaboration meeting at ANL will serve as the kick-off meeting for these publications,

It seems, to me, natural to consider a subsystem (pre-)TDR as template for some of the work ahead.

(Pre-)TDR

ALICE-TDR-017

CERN-LHCC-2013-024
02 December 2013

Technical Design Report for the Upgrade of the ALICE Inner Tracking System

The ALICE Collaboration

J. Phys. G: Nucl. Part. Phys. **41** (2014) 087002 The ALICE Collaboration

(Pre-)TDR

Detector performance and Physics performance are in addition to — not instead of — a vast amount of other work ahead…

Physics topics — my (personal) take:

- Needs three-ish topics — guidance from:
  - NAS report — emphasis on a) discovery potential from gluon self-interaction and b) imaging
  - Community white paper — (spin) structure, tomography, nuclear structure and saturation, hadronization
  - (Yellow Report, DPAP proposals)

Natural then to consider core observables — at least:

- inclusive structure functions; F_2, F_L, F_2^{charm}, g_1,
- Di-hadron (-jet) correlations, inclusive and semi-inclusive (incoherent) diffractive cross-sections,
- Exclusive photon and vector-meson production off nucleons and nuclei (coherent diffraction),
- Semi-inclusive (spin-)structure functions as a function of transverse momentum (k_T and $k_\perp$),
- …

(Pre-)TDR

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Detector performance — ITS2 outline (chapter-7)

- Experimental conditions, requirements, detector specifications
- Simulation tools and models, reconstruction tools
- Track and vertex reconstruction performance
- What-if scenarios, including failure / redundancy questions

Figure set from the ITS2 TDR — Chapter 7

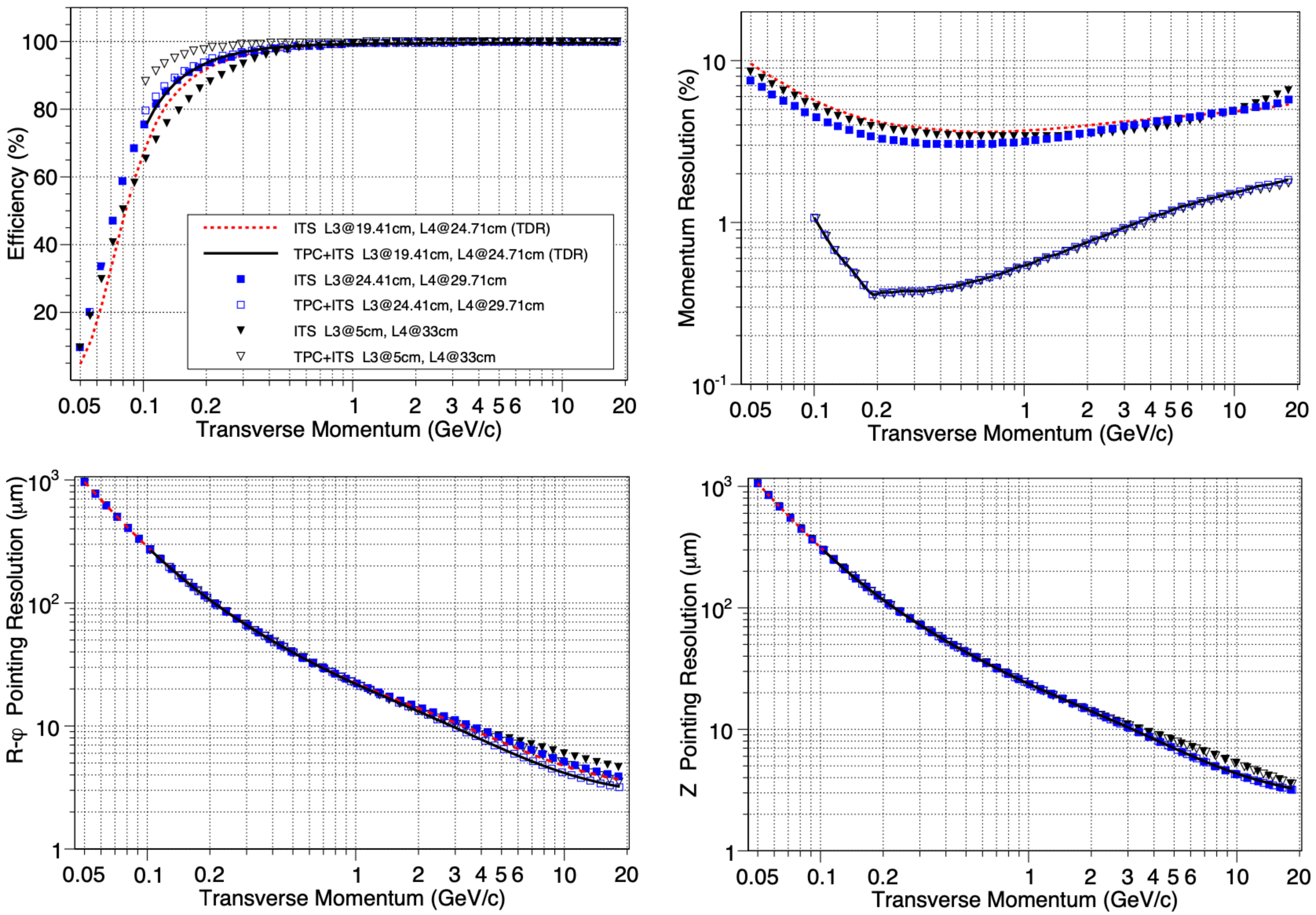

Figure 7.1: Performance of the ITS stand-alone and TPC+ITS combined reconstruction for different radial positions of the ITS layers.

Figure set from the ITS2 TDR — Chapter 7

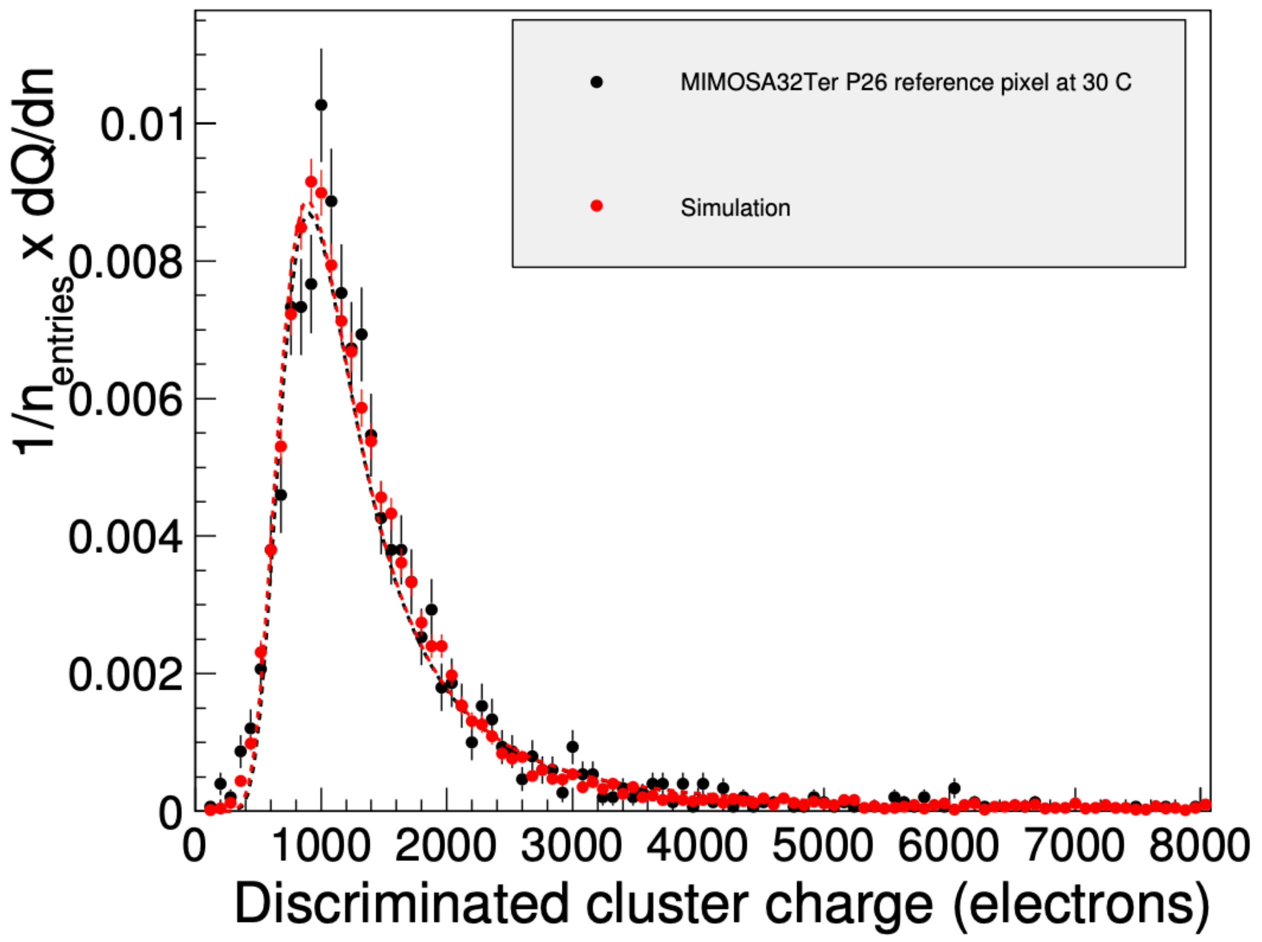

Figure 7.2: Comparison of cluster charge from tuned simulation and test beam measurement for MIMOSA-32Ter P26 reference pixel at 30 °C.

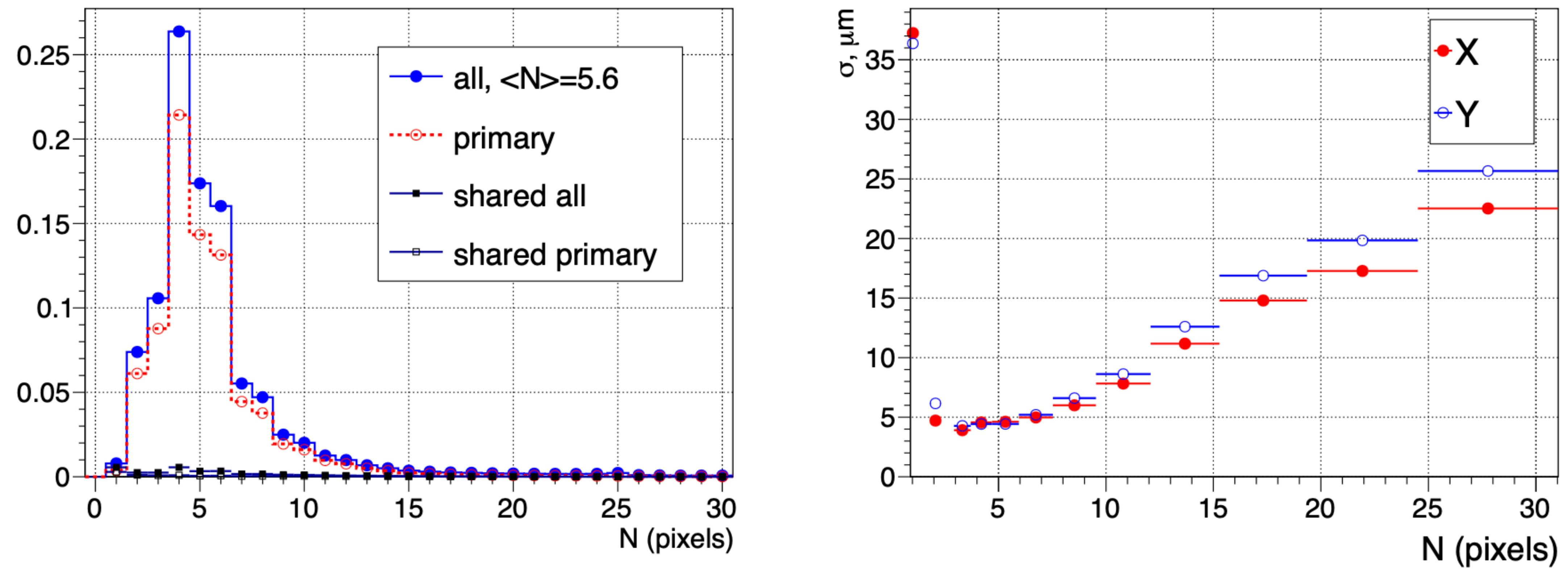

Figure 7.3: Cluster size distributions for all the charged particles and for primary charged particles (empty red circles). The term *shared* denotes hits that contribute to more than one cluster (left). Resolution on x (red full circles) and z (blue empty circles) directions as a function of the cluster size (right).

Figure set from the ITS2 TDR — Chapter 7

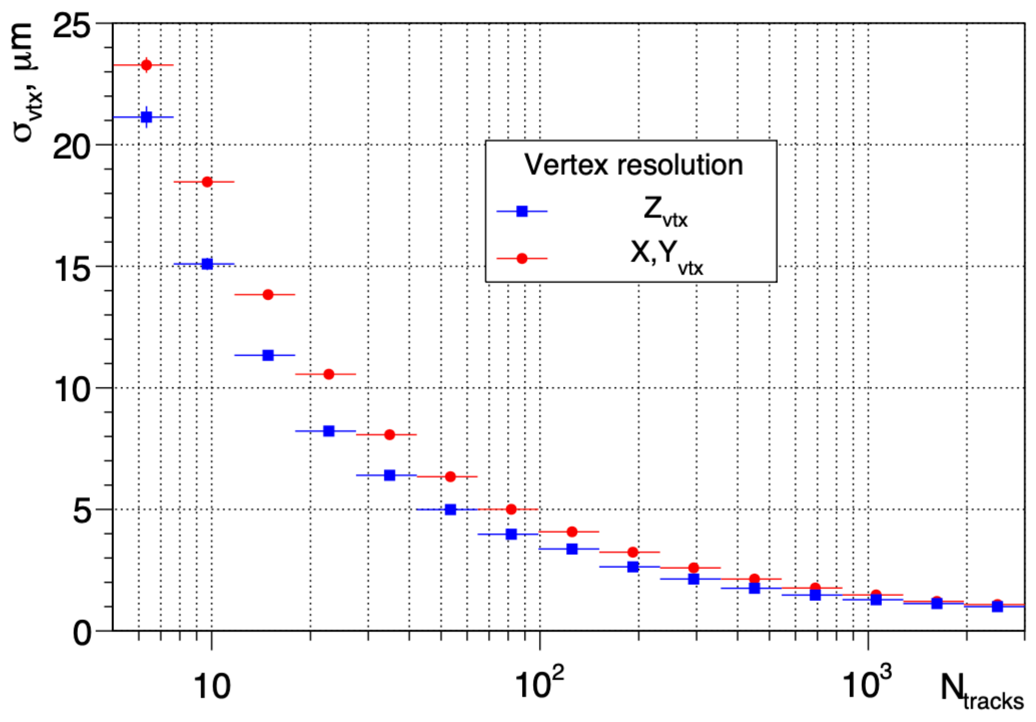

Figure 7.4: Resolution on the primary vertex reconstruction as a function of the number of tracks used to determine the primary collision coordinates.

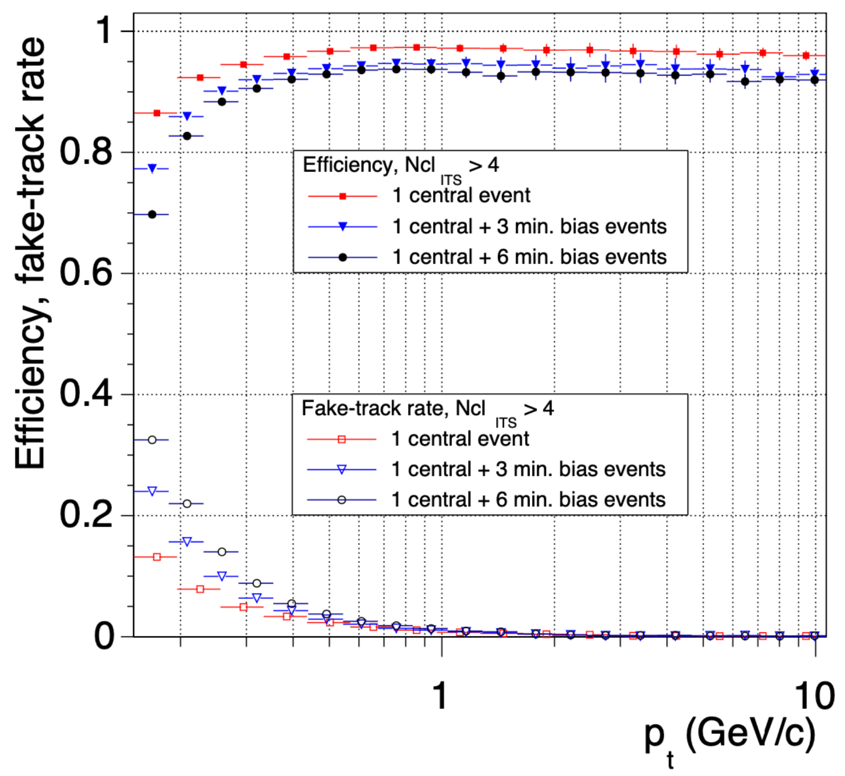

Figure 7.5: Track-matching efficiency between the TPC and upgraded ITS for different levels of event pileup.

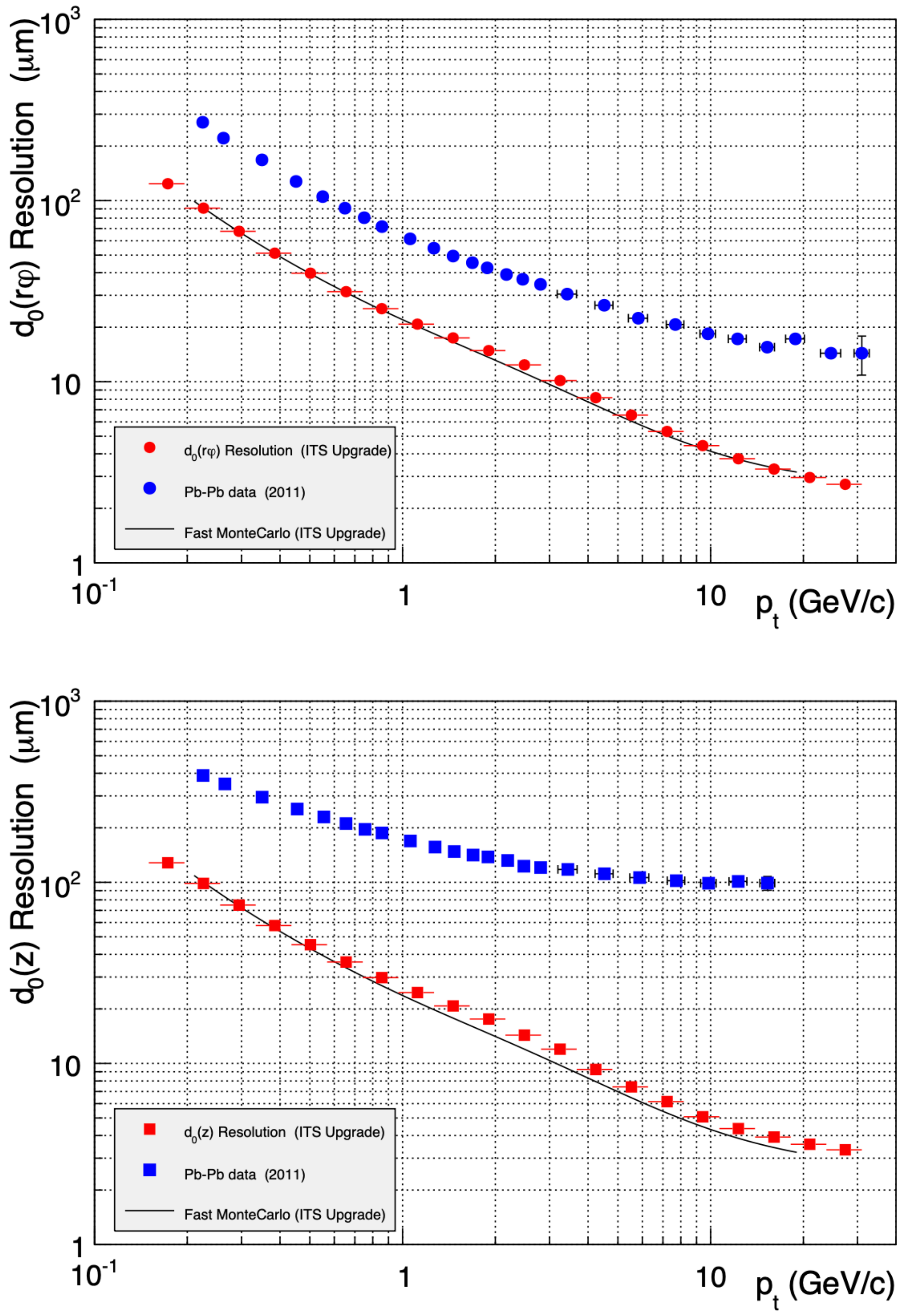

Figure 7.6: Impact-parameter resolution for primary charged pions as a function of the transverse momentum for the current ITS and the upgraded ITS in the transverse plane (upper panel) and in the longitudinal direction (lower panel).

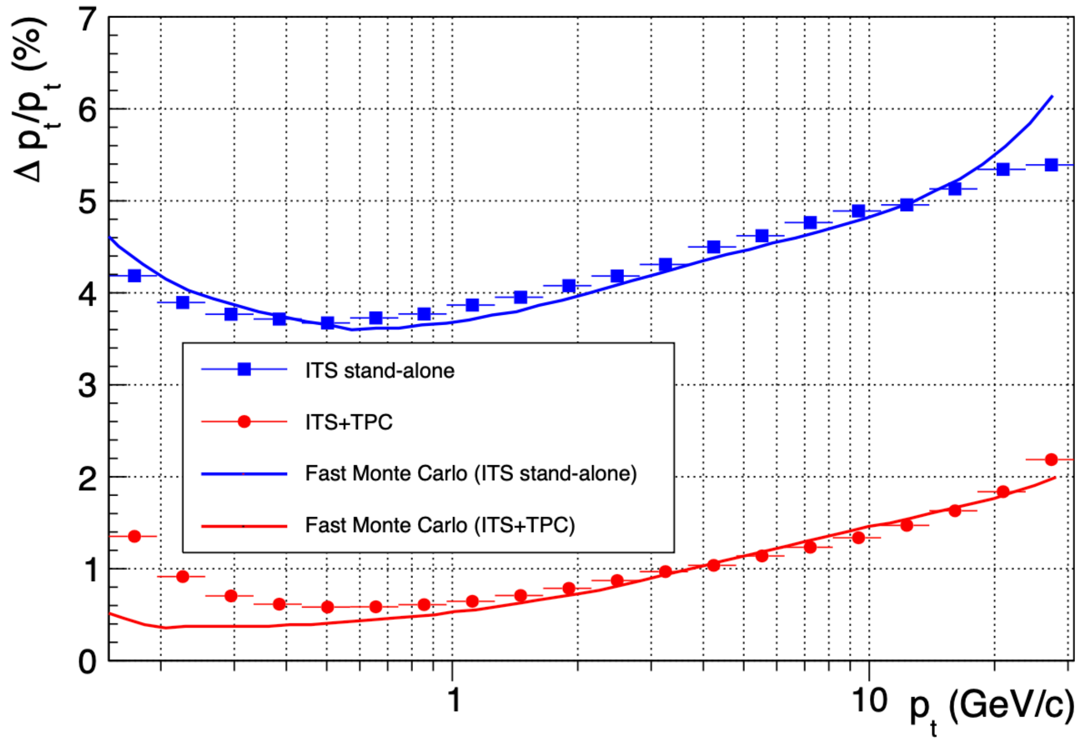

Figure 7.7: Transverse momentum resolution as a function of p_T for primary charged pions for the upgraded ITS. The results for the ITS stand-alone and ITS-TPC combined tracking mode are shown.

Figure set from the ITS2 TDR — Chapter 7

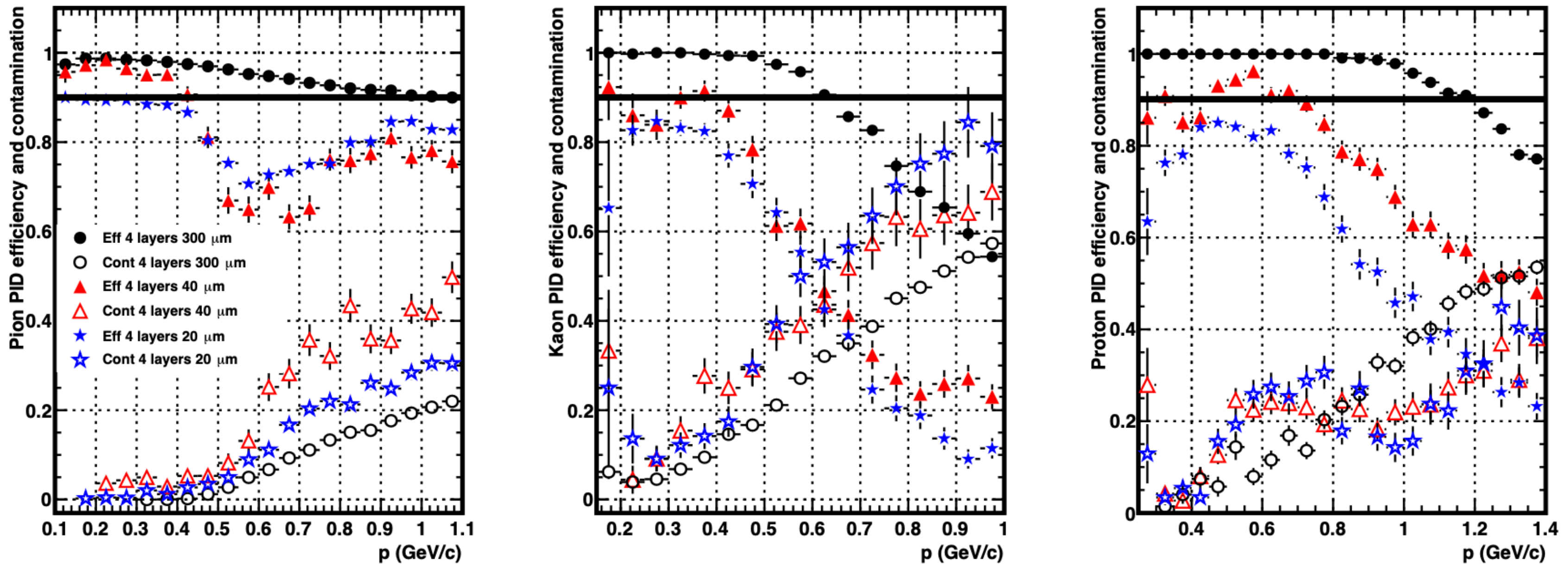

Figure 7.8: PID efficiency (closed symbols) and contamination (open symbols) as a function of the particle momentum assuming the relative abundances of π^+, K^+ and p as obtained from preliminary Pb–Pb data at $\sqrt{s_{NN}} = 2.76$ GeV for different configurations: four layers 300 µm thick (black circles), four Outer Layers 40 µm thick of pixel detectors (red triangles) and four layers 20 µm thick silicon detectors (blue stars). Pions, kaons, and protons are shown in the left, middle and right panels respectively. In all plots, a line corresponding to a PID efficiency of 90 % is drawn as a reference.

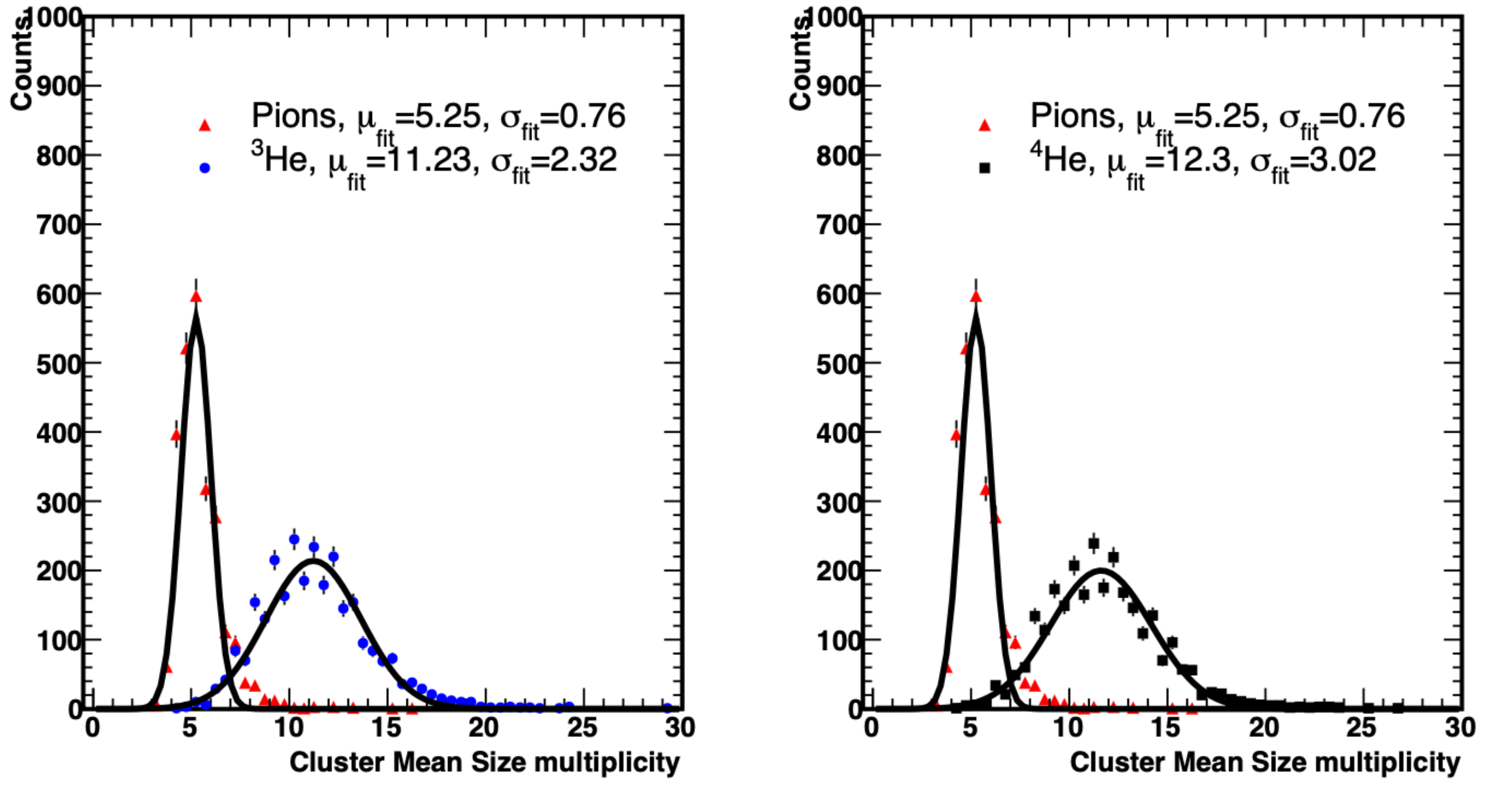

Figure 7.9: Multiplicity distribution of the mean value of the cluster size for pions (red triangles) and ^{3}He (blue dots) in the 6.1 GeV/c to 6.2 GeV/c momentum range (left). Multiplicity distribution of the mean value of the cluster size for pions (red triangles) and ^{4}He (black squares) in the 6.1 GeV/c to 6.2 GeV/c momentum range (right). In both figures, a Gaussian fit is superimposed to the distributions and the μ and σ values of the fits are reported in the legend.

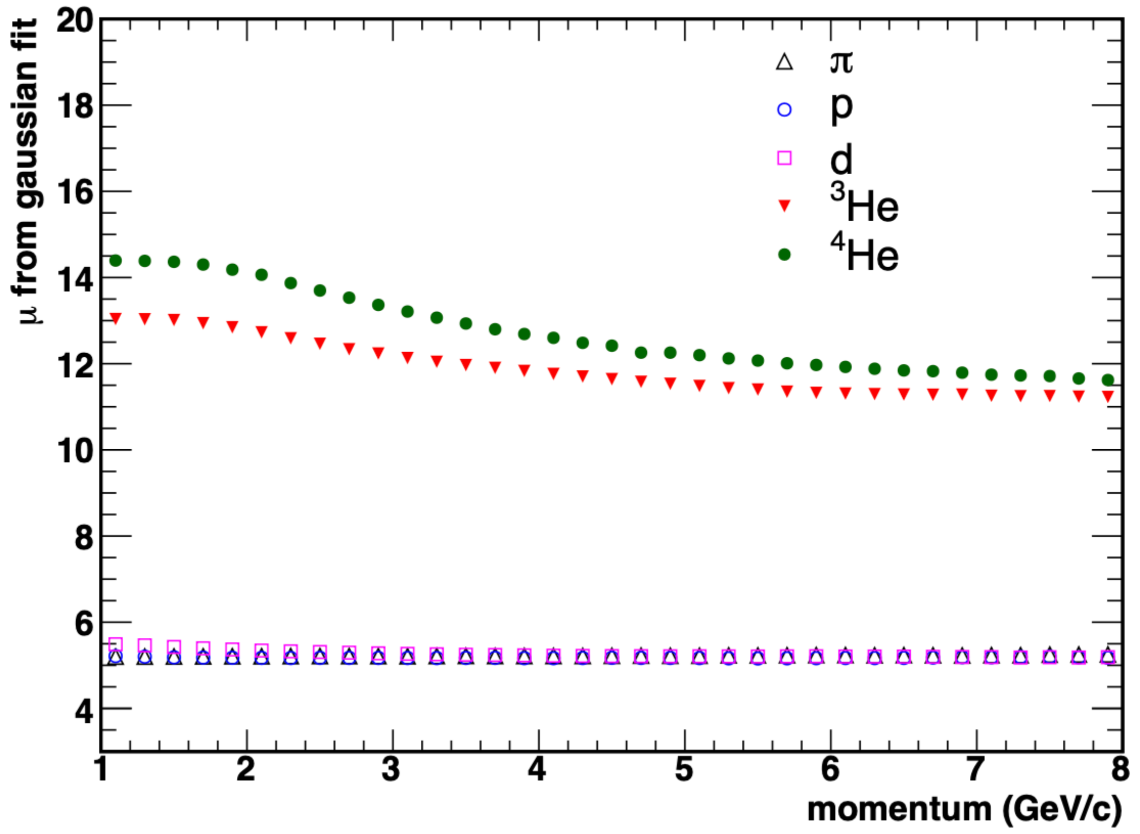

Figure 7.10: Mean values extracted from the Gaussian fit to the cluster size multiplicity distribution as a function of the momentum for the different simulated particle species (pions – black triangles, protons – blue circles, deuterons – magenta squares, ^{3}He – red triangles, and ^{4}He – green dots).

Figure set from the ITS2 TDR — Chapter 7

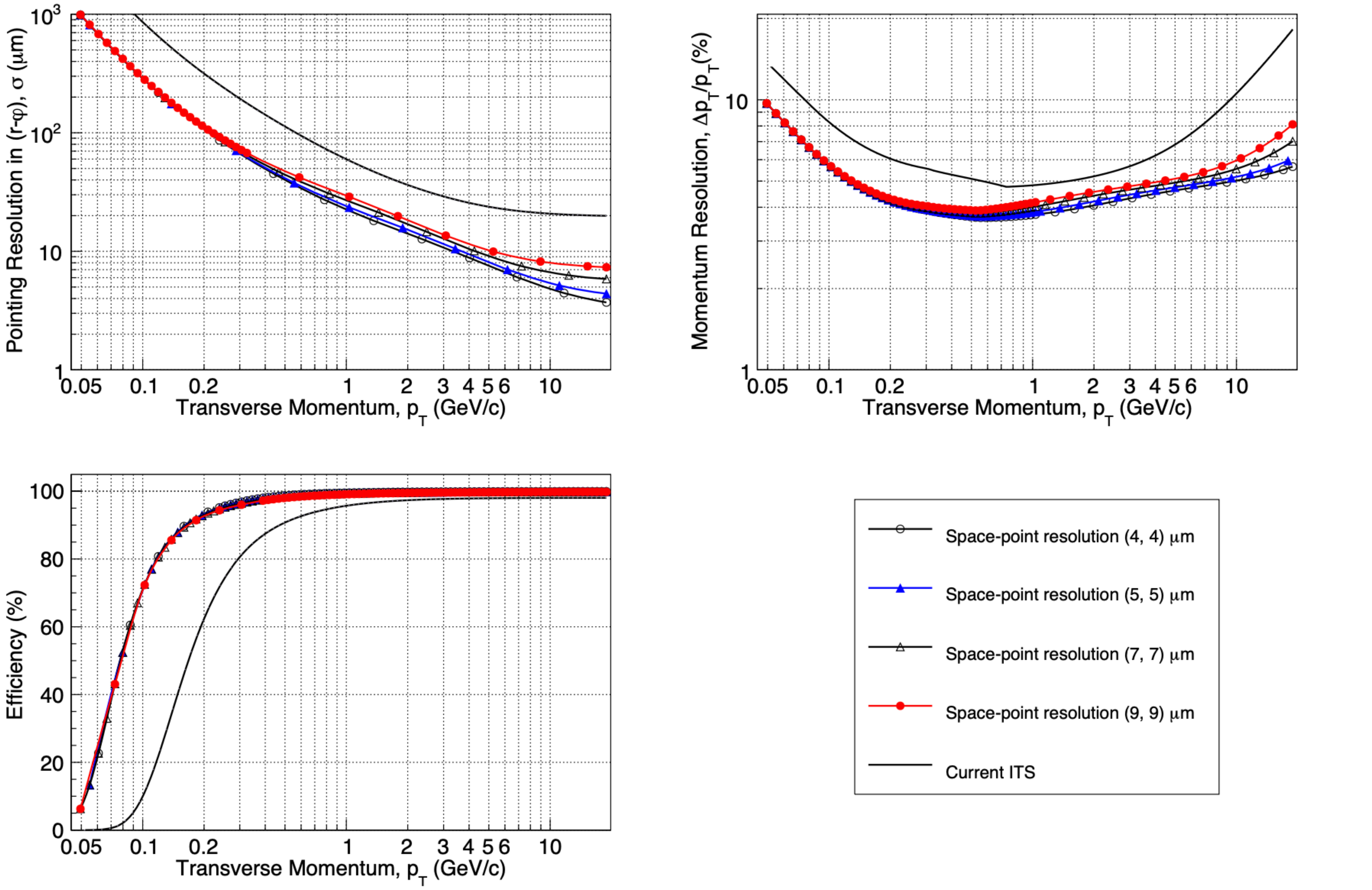

Figure 7.11: Pointing resolution, momentum resolution, and tracking efficiency obtained with the stand-alone upgraded ITS reconstruction assuming different space-point resolutions. For comparison, the performance of the current ITS is shown as well.

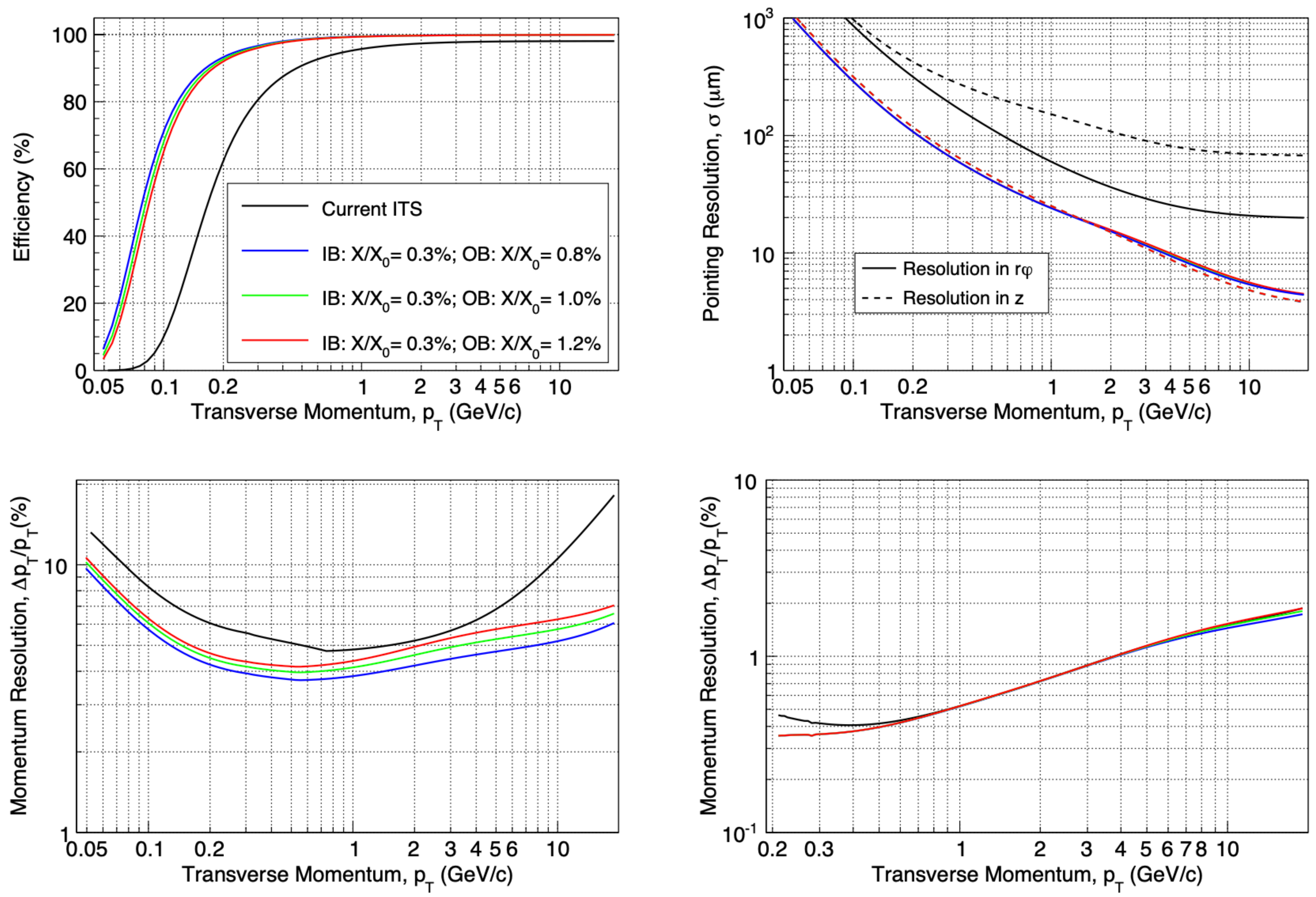

Figure 7.12: Top panels: Stand-alone tracking efficiency (left) and pointing resolution (right) for charged pions as a function of the transverse momentum for the current ITS and different material-budget options for the upgraded detector. Bottom panels: transverse momentum resolution for charged pions as a function of p_T for the current ITS and different material-budget options for the upgraded detector (the results for the ITS stand-alone and ITS+TPC combined tracking are shown on the left and on the right, respectively).

Figure set from the ITS2 TDR — Chapter 7

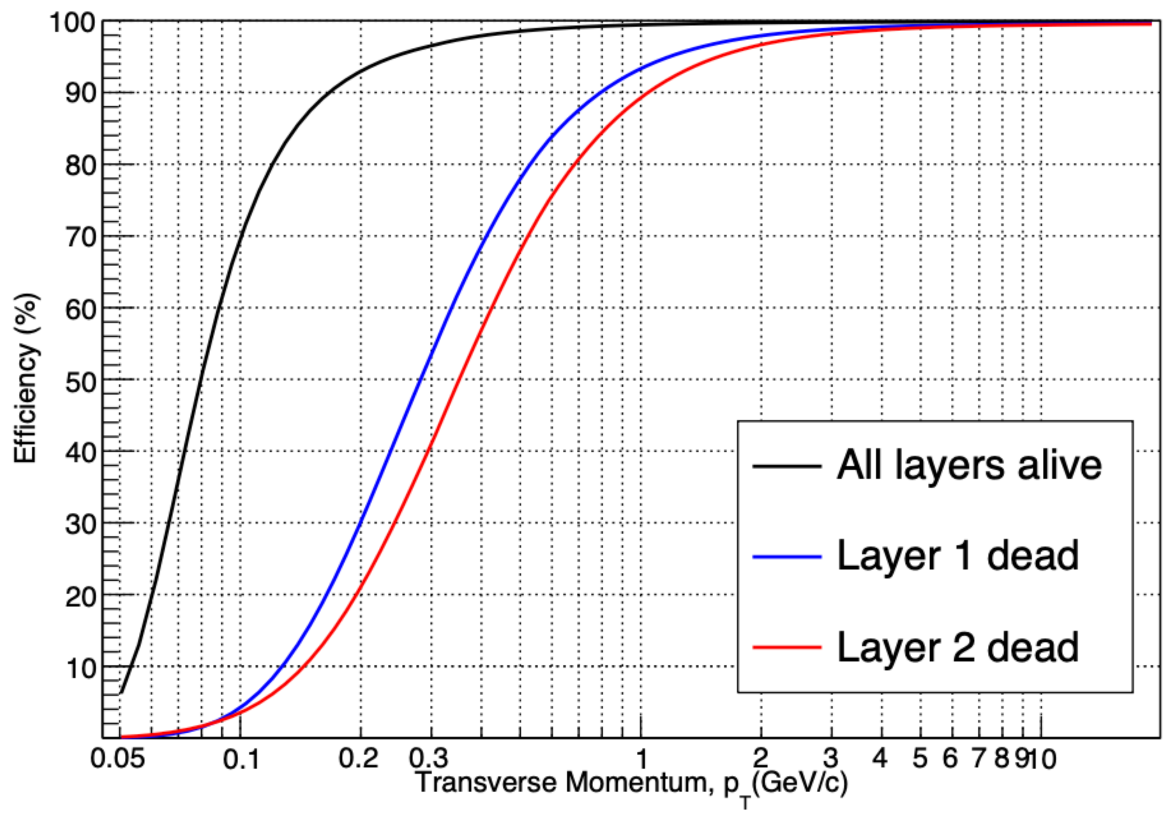

Figure 7.14: Tracking efficiency for the upgraded ITS. The two worst scenarios for the tracking efficiency where layer 3 (red) or layer 2 (blue) is dead is compared to the case of all layers working properly.

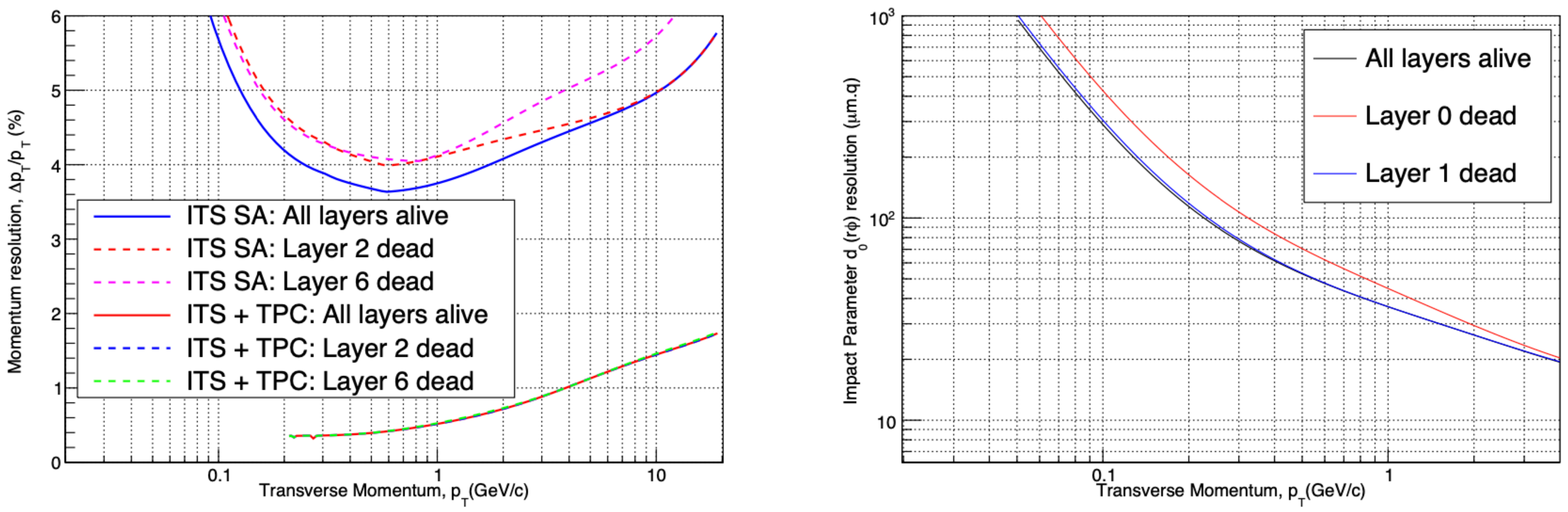

Figure 7.15: Momentum (left) and impact parameter (right) resolution for the upgraded ITS. The worst scenarios for the momentum (left) and impact parameter (right) resolution are compared to the case of all layers properly working. The momentum resolution for combined ITS and TPC tracking stays practically unchanged.

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My (personal) annotation(s):

- Consider track-pair resolutions (invariant mass), possibly resolutions within jets,
- ADC or cluster-size based PID figures not immediately applicable — tracking into PID subsystems certainly is,
- Consider effects of mis-alignments.