- CDR chapter 3 -

Current status

14th of November, 2011

Contents

3.2 Performance of present ITS detector

→ ***Collection of performance plots used as a reference for the Upgrade-Performance***

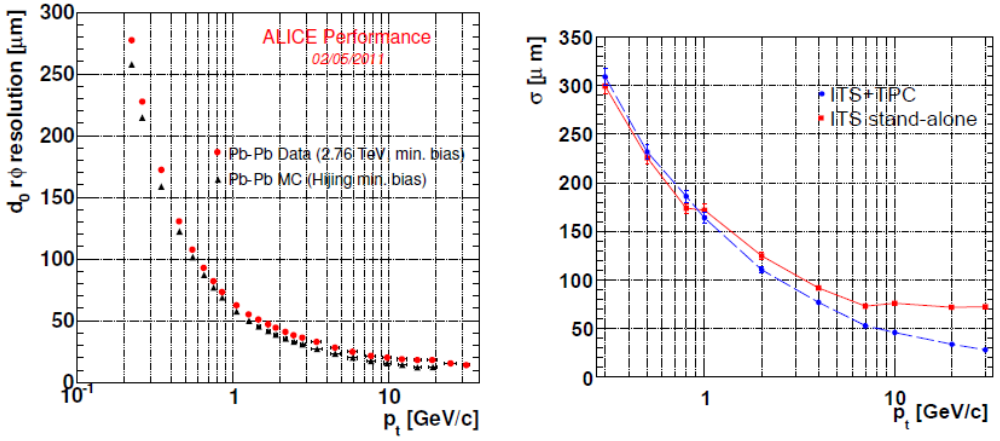
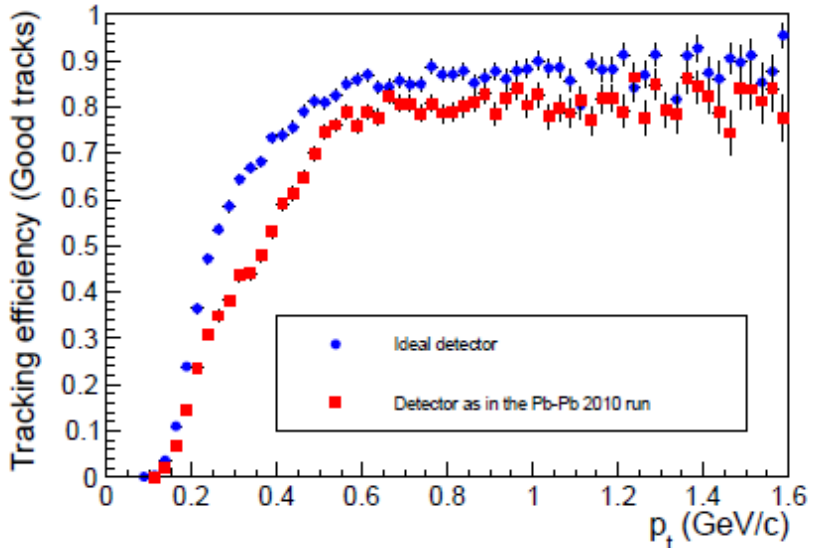


Figure 3.1: Impact parameter resolution of present ITS versus p_t, for the $r\phi$ (left, Pb–Pb data and MC) and z (right, pp MC simulation [1]) components. Reconstructed tracks have been selected requiring successful refit in ITS and 6 ITS clusters per track.



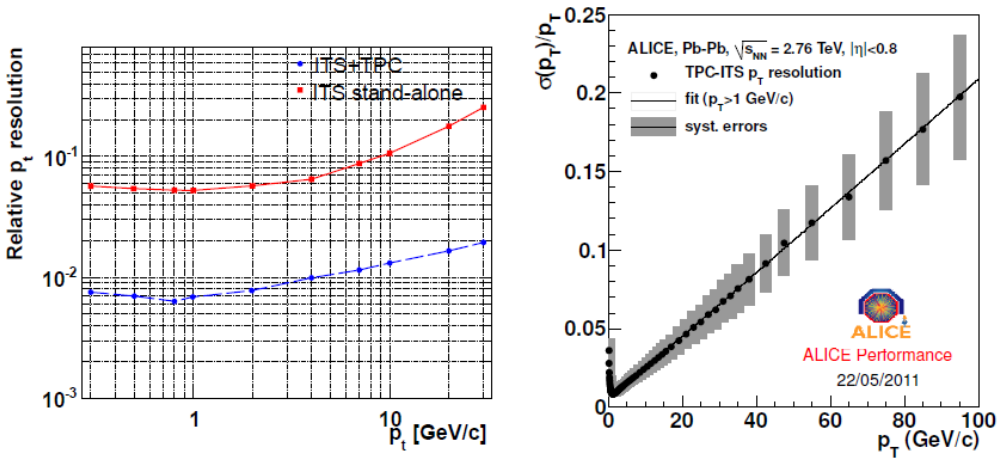
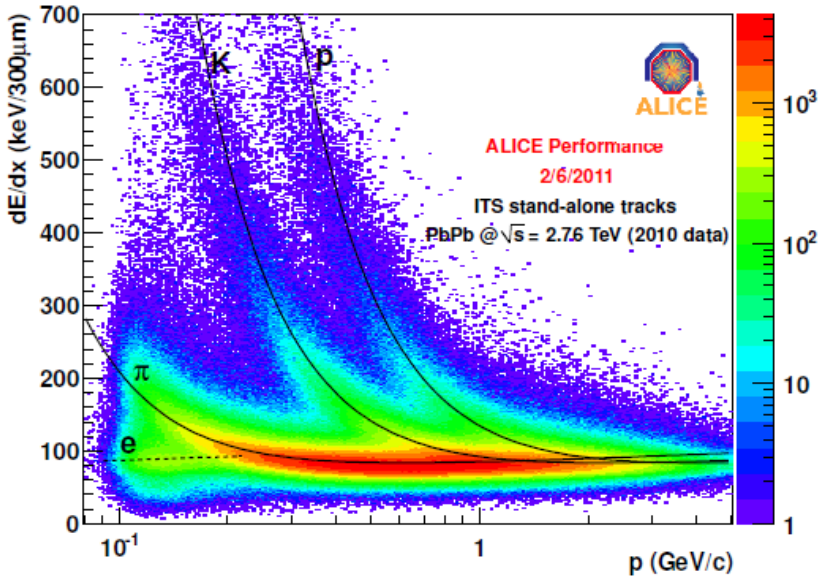


Figure 3.2: Left panel: ITS stand-alone relative p_t resolution in Monte Carlo pp simulation compared to ITS-TPC combined resolution in the p_t range $[0.3, 30]$ GeV/c [1]. Right panel: relative p_t resolution as a function of p_t for ITS-TPC combined tracks in an extended p_t range in Pb–Pb collisions.

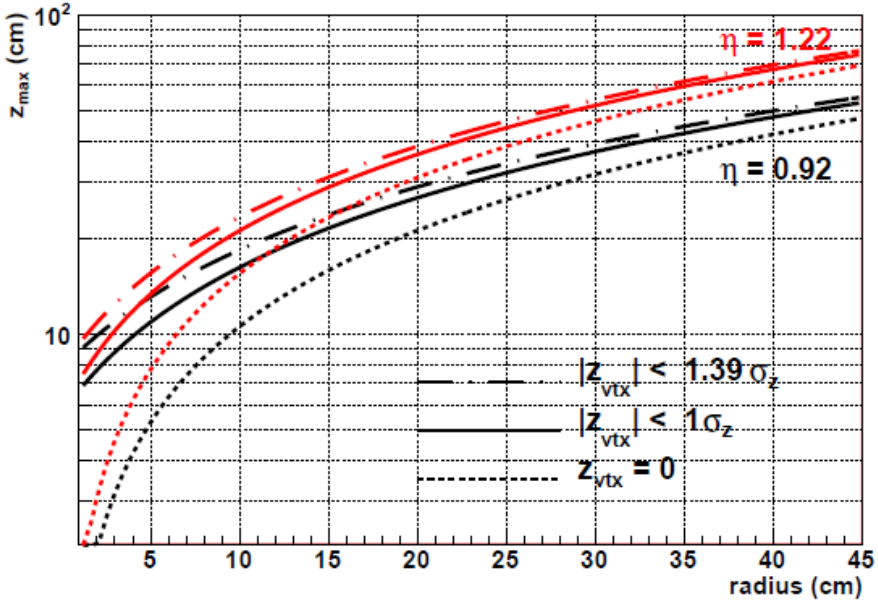


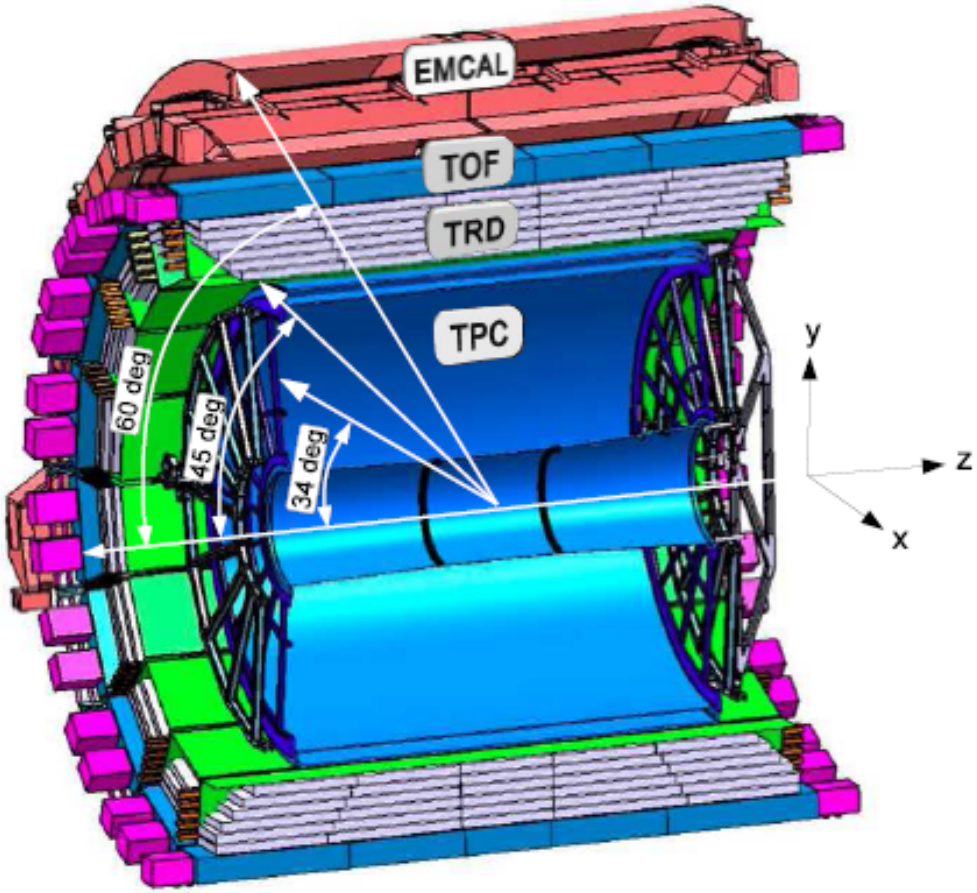
3.3 Simulation conditions

→ ***Particle load (hit densities), detector acceptance and basic considerations on material budget, detector segmentation a.s.o.***

Table 3.3: Expected hit densities in central Pb–Pb collisions (incl. secondaries produced in the material simulated assuming the current ITS setup) and QED electrons for different integration times. Interaction rates of 8 (and 50) kHz and a 0.5 T magnetic field have been assumed.

Radius (cm)	Primary and secondary particles (cm^{-2})	QED electrons for τ=100 ns (cm^{-2})		QED electrons for τ=1 μs (cm^{-2})		QED electrons for τ=50 μs (cm^{-2})	
		8 kHz	50 kHz	8 kHz	50 kHz	8 kHz	50 kHz
2.2	74.05	0.022	0.137	0.220	1.374	10.99	68.71
2.8	45.71	0.014	0.085	0.136	0.848	6.79	42.42
3.6	27.65	0.008	0.051	0.082	0.513	4.11	25.66
20.0	0.90	0.000	0.002	0.003	0.017	0.13	0.83
22.0	0.74	0.000	0.001	0.002	0.014	0.11	0.69
41.0	0.21	0.000	0.000	0.001	0.004	0.03	0.20
43.0	0.19	0.000	0.000	0.001	0.004	0.03	0.18





3.4 Simulation tools

→ *Descriptions, validation and comparison of the three different simulation tools, more details can be found in the Appendix ...*

Fast Estimation Tool (FET)
Fast Monte-Carlo Tool (FMCT)
Full Monte-Carlo Sim (FullMC)

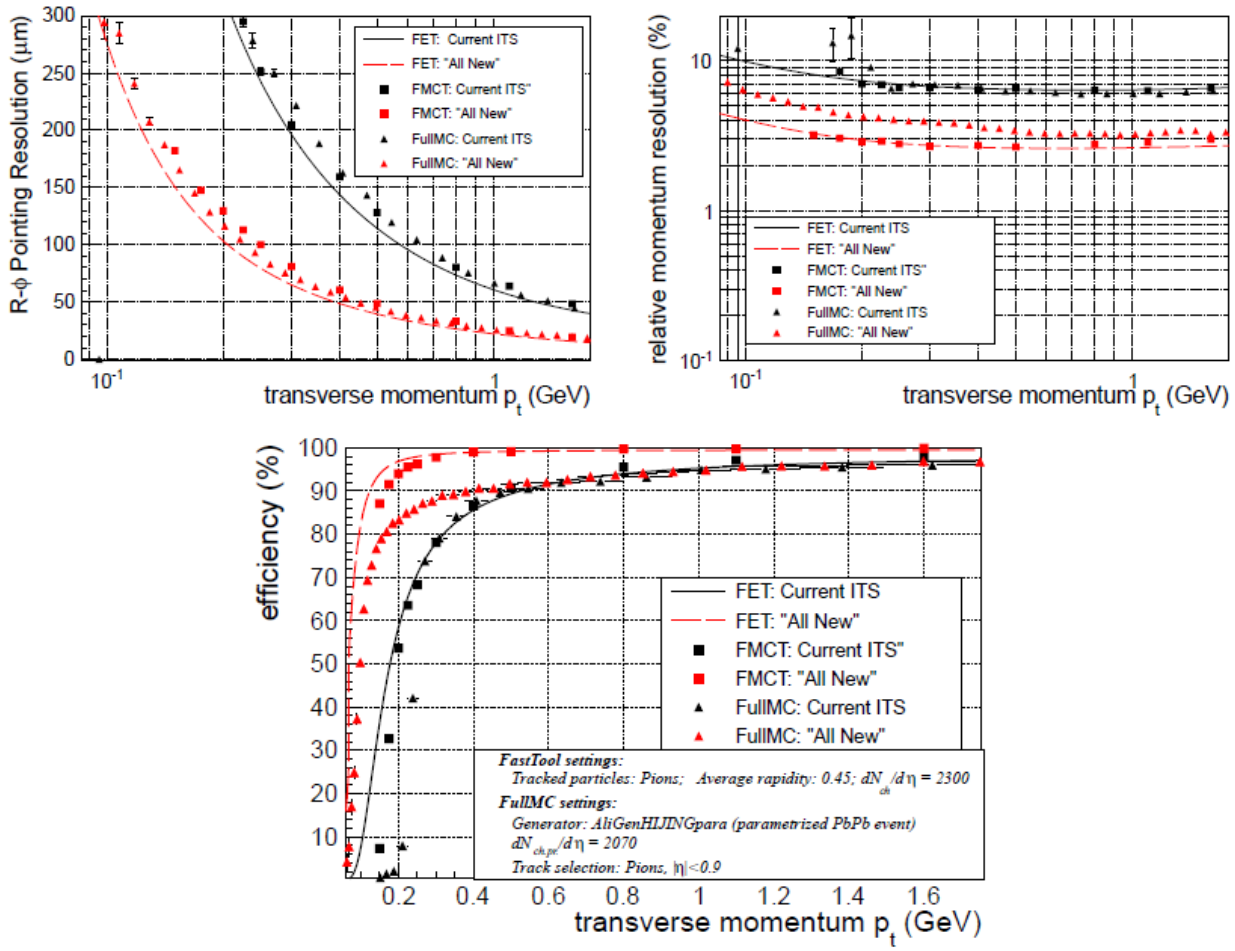


Figure 3.12: Comparison of the three simulation methods for the current ITS and the "All-New" upgrade scenario.

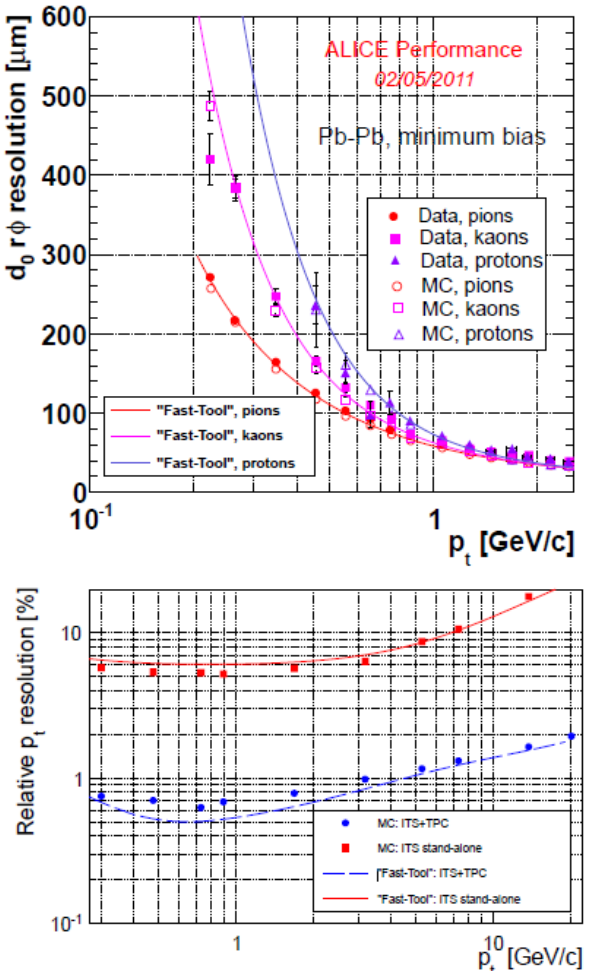


Figure 3.10: Validation

3.5 Impact parameter resolution

→ *… dependance on radial distance, material budget and intrinsic detector resolution*

Material budget: in figure 3.14 the pointing resolution as a function of the transverse momentum is shown in the case of layer L0 placed at 2.2 cm and three values of its relative radiation length X/X_0, assuming the spatial resolution of the current pixel detector. The results for the current ITS without L0 are also reported for comparison.

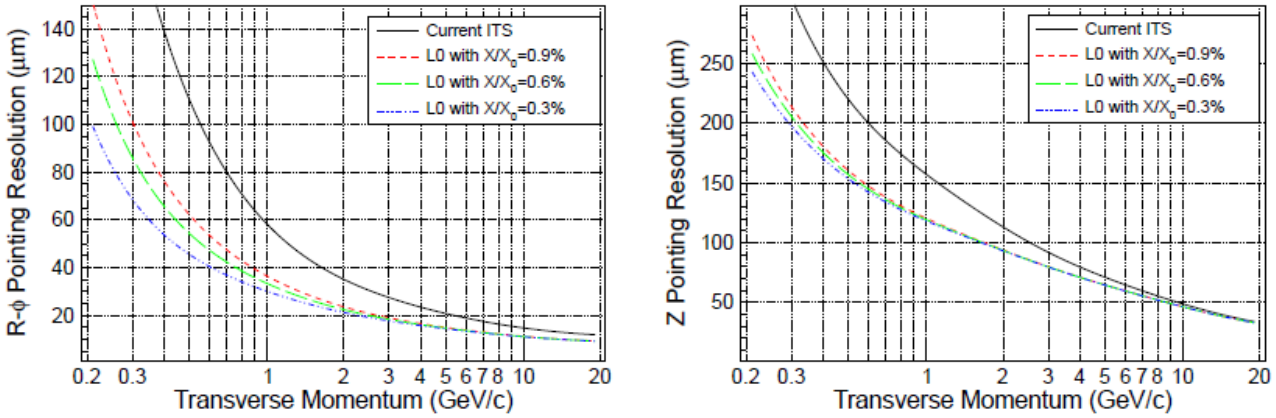


Figure 3.14: $r\phi$ (left) and z (right) pointing resolution of charged pions at the primary vertex versus transverse momentum p_t for different material budget of the layer L0 in ITS-TPC combined tracking mode.

3.6 Upgrade scenarios

→ ***Description and performance comparison of the two upgrade scenarios ...***

Table 3.4: Characteristics of the Upgrade Scenario 1 - "New-SPDs"

Layer / Type	r [cm]	$\pm z$ [cm]	Intrinsic resolution [μm] $r\phi$	z	Material budget X/X_0 [%]
Beam pipe	2.0	-	-		0.22
1 / new pixel	2.2	11.2	4	4	0.30
2 / new pixel	4.7	15.1	4	4	0.30
3 / new pixel	9.0	21.7	4	4	0.30
Th. shield	11.5	-	-		0.65
4 / drift	15.0	22.2	35	25	1.13
5 / drift	23.9	29.7	35	25	1.26
Th. shield	31.0	-	-		0.65
6 / strip	38.0	43.1	20	830	0.83
7 / strip	43.0	48.9	20	830	0.83

Table 3.5: Characteristics of the Upgrade Scenario 2 - "All-New"

Layer / Type	r [cm]	$\pm z$ [cm]	Intrinsic resolution [μm] $r\phi$	z	Material budget X/X_0 [%]
Beam pipe	2.0	-	-		0.22
1 / new pixel	2.2	11.2	4	4	0.30
2 / new pixel	2.8	12.1	4	4	0.30
3 / new pixel	3.6	13.4	4	4	0.30
4 / new pixel / strip	20.0	39.0	4	4	0.30
5 / new pixel / strip	22.0	41.8	4	4	0.30
6 / new pixel / strip	41.0	71.2	4	4	0.30
7 / new pixel / strip	43.0	74.3	4	4	0.30

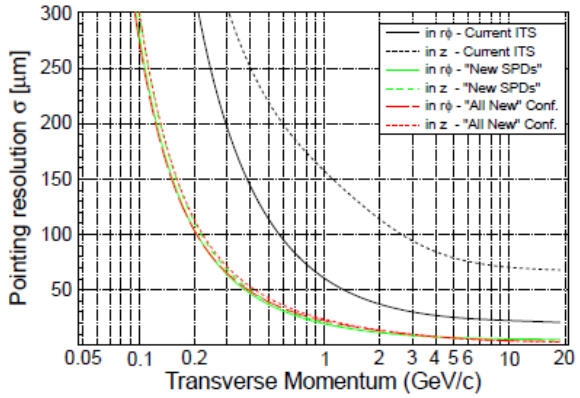


Figure 3.16: Pointing resolution to the vertex

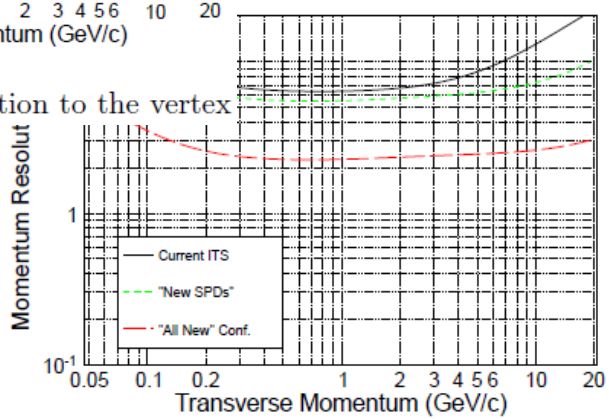


Figure 3.18: Transverse momentum resolution

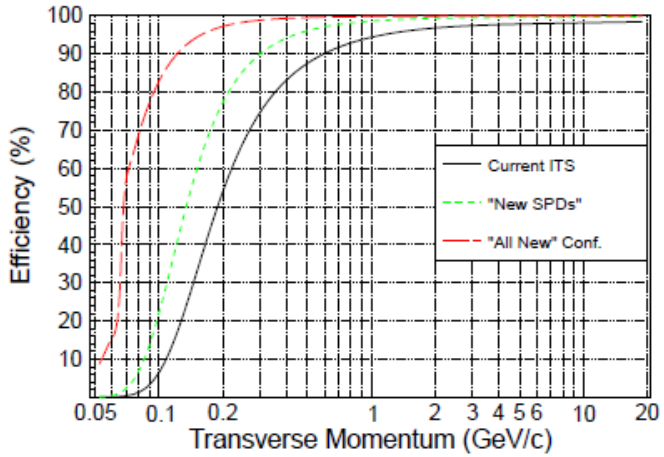


Figure 3.19: Tracking efficiency of charged pions

3.7 Particle Identification

→ ***Simulations for PID performance for different configurations ...***

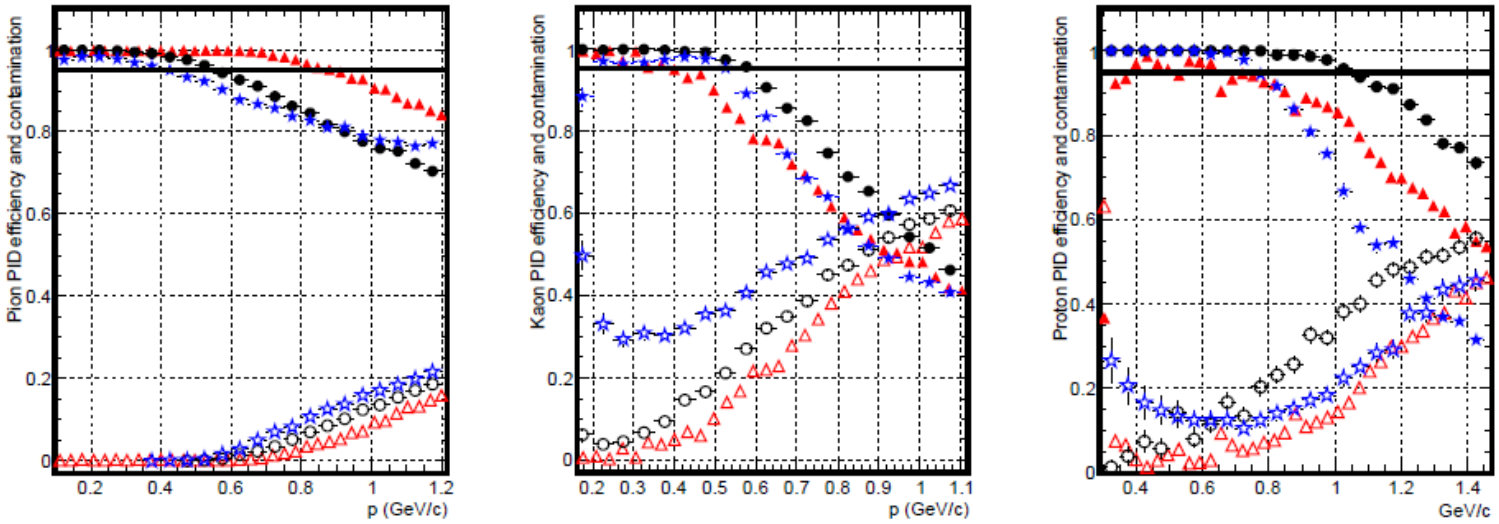


Figure 3.28: Efficiency (closed symbols) and contamination (open symbols) as a function of the particle momentum assuming the relative abundances of π^+, K^+ and p as obtained from preliminary PbPb data at $\sqrt{s_{NN}}$ = 2.76 GeV for different configurations: 4 layers 300 μm thick (black circles), 7 layers 100 μm thick (red triangles) and 7 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 95 % is drawn as a reference.

with different π^+, K^+ and p relative abundances. The results indicate that a very good PID performance is achievable with 7 layers 100 μm thick each detector as with 4 layers 300 μm thick. With a 7 layers 20 μm thick detector configuration, the particle separation is still possible, although in a reduced momentum range.

3.9 Radiation environment

→ ***Defines radiation robustness of the pixel detectors (incl. Safety factors). To be updated to the HL-LHC conditions ...***

Detailed studies have been done in the past for the expected dose in the ALICE detector according to the running scenario [16, 17]. In figure 3.29, the expected doses and hadron fluences as a function of the radial distance from the beams are shown for a 10 years standard running scenario. The dose values have been recently re-evaluated, as reported in [17]. The hadron flux values, which are given in 1 MeV neutron equivalent, are taken from [16] and have been renormalized by a factor 0.94. The latter is the ratio between the dose values quoted in [17] and in [16].

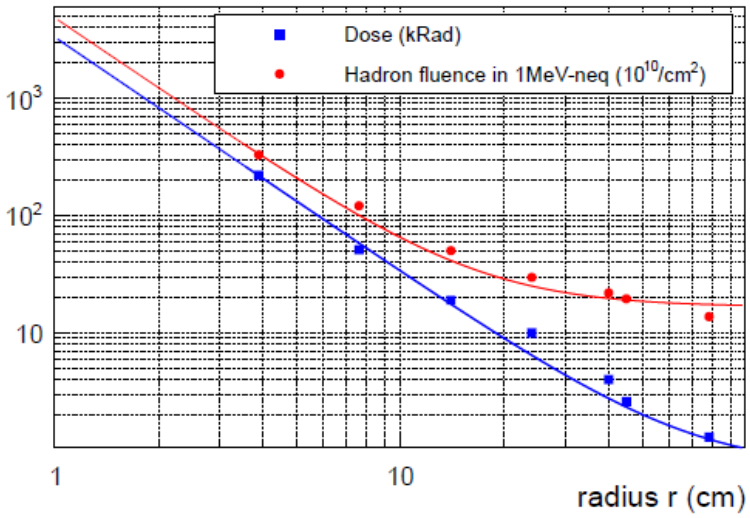


Figure 3.29: Dose and hadron fluences (in 1 MeV neutron equivalent) for a 10-year standard running scenario of the LHC as a function of the radial distance of the layers.

3.10 Further studies

→ *e.g. Redundancy (more layers) and more detailed study regarding "geometry of innermost layers"*

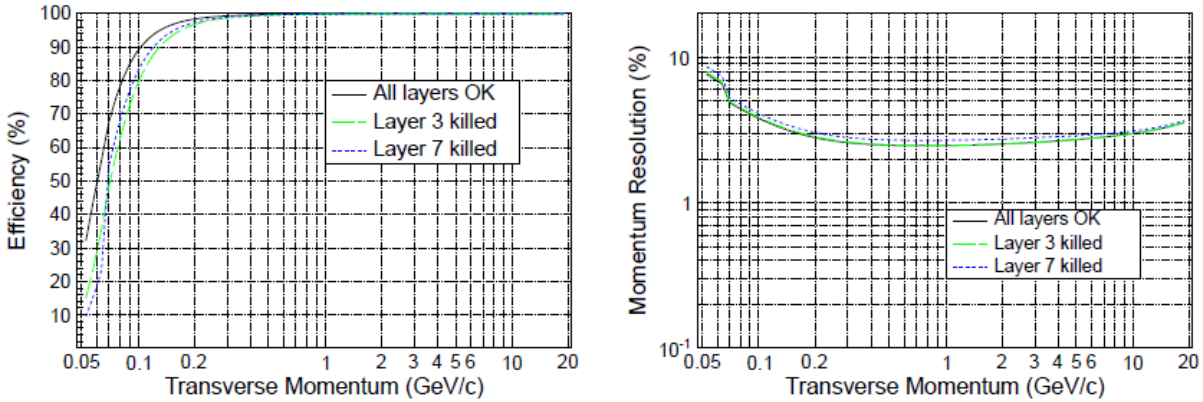


Figure 3.31: Tracking efficiency (left) and momentum resolution (right) for the new configuration with two extra layers, see the text for details. The radial distances of the layers are $\{2.2, 2.8, 3.6, 4.2, 20.0, 22.0, 33.0, 43.0, 43.6\}$ cm. The event of having the layer 3 at 3.6 cm (cyan) or the layer 7 at 33.0 cm (green) dead is compared to the case of all layer properly working.

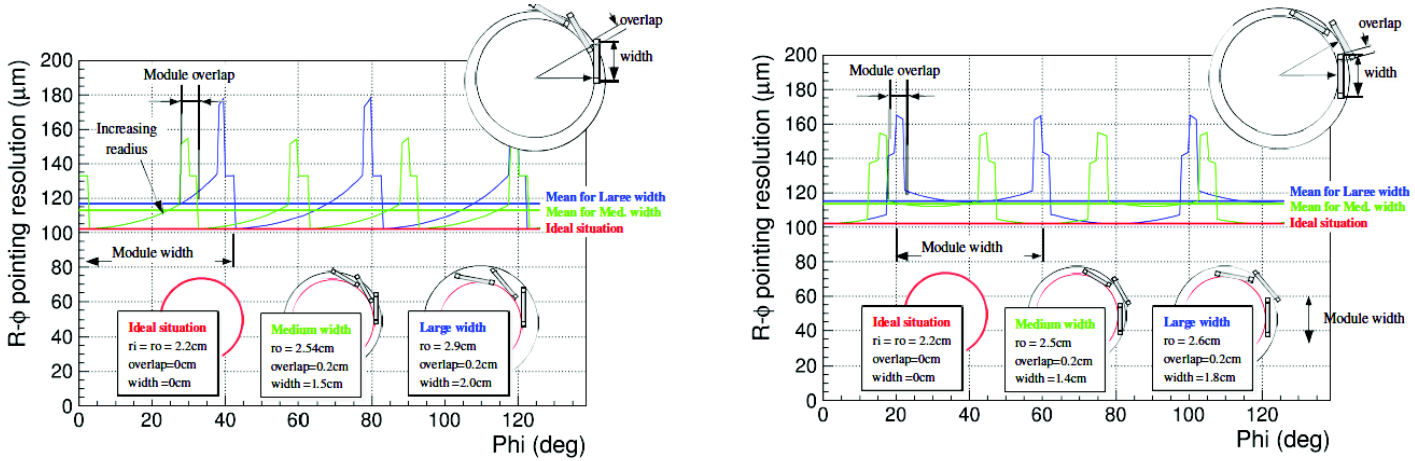


Figure 3.32: Pointing resolution to the vertex versus ϕ for charged pions with transverse momentum p_t of 0.2 GeV. Two different layer geometries are considered: a "turbo-like" geometry (left panel) and a "two-radii" geometry (right panel). In all cases the minimum radius of the

This is of course not the end because this chapter will evolve further towards Version 2.0 ....

(see slides by Giuseppe)