Performance of the present ITS: tracking

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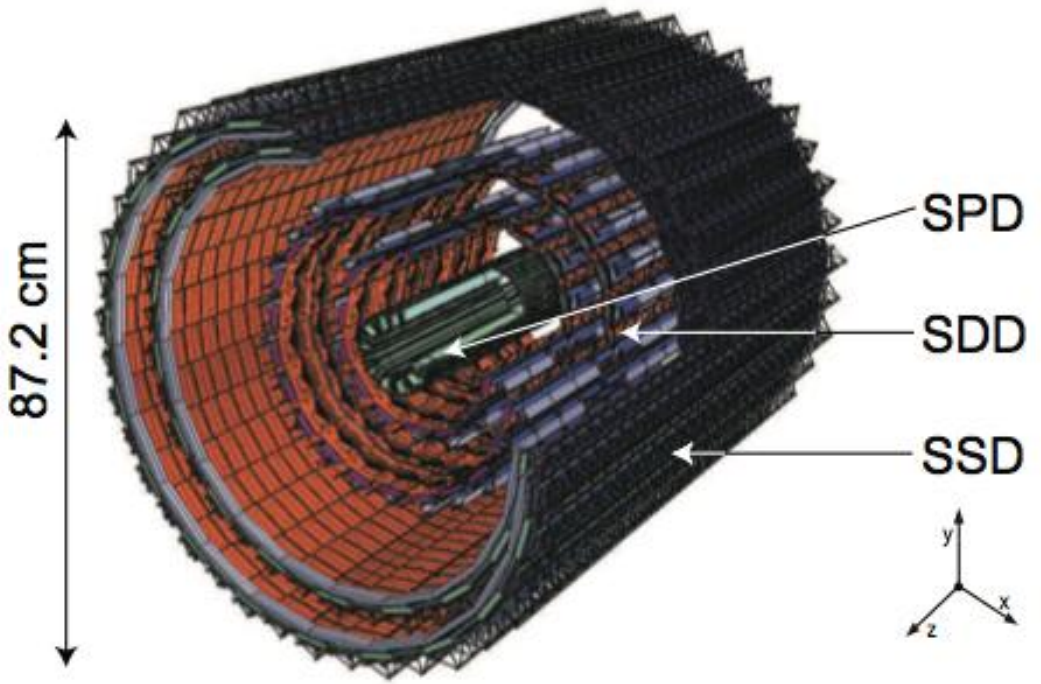
showing work of many many people, of course …

Outline

- ITS alignment
- Tracking approaches
- Tracking efficiency
- Tracking spatial resolution & open issues

ITS alignment challenge



Silicon Pixel Detector (SPD):
- ~10M channels
- 240 sensitive vol. (60 ladders)

Silicon Drift Detector (SDD):
- ~133k channels
- 260 sensitive vol. (36 ladders)

Silicon Strip Detector (SSD):
- ~2.6M channels
- 1698 sensitive vol. (72 ladders)

ITS total:
2198 alignable sensitive volumes
→ 13188 d.o.f.

ITS alignment strategy

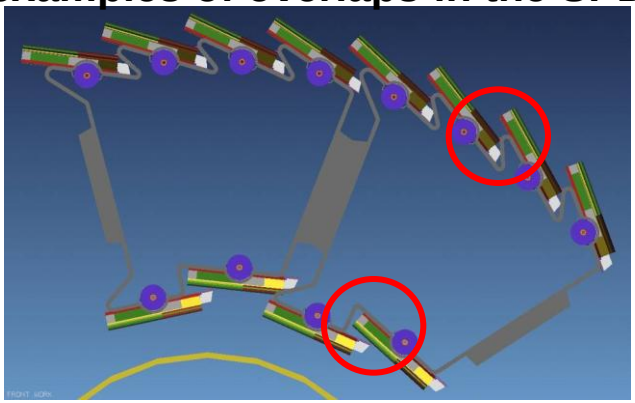
- Use survey measurements for SDD and SSD
  - modules on ladders
  - ladders on cone
  - validated with cosmics (ALICE-INT-2009-045, -047)
- Track based alignment with Millepede: global track-to-point residuals minimization
- *First alignment with cosmics (JINST 5 (2010) P03003):*
  - SPD alignment with cosmics 2008 (B=0), with Millepede
    - few modules on the sides “corrected” later with 900 GeV pp data
  - second method (local residuals minimization) for cross-check, with cosmics
  - SSD internal alignment from survey only (cosmics-validated)
  - SPD-to-SSD alignment with Millepede
  - SDD: not aligned
  - ITS-to-TPC alignment with cosmics + pp 2009

ITS alignment current status

- Track sample for alignment:
  - 115 M tracks B-on (LHC10b, i.e. April)
  - 40 M tracks B=0 (LHC10c)
  - cosmics 2009-2010 B-on also used
- Current alignment
  - use Millepede (ITS alignment + SDD calibration)
  - SPD: fully realigned
  - SDD: vdrift calibrated for part of the modules; survey for modules; ladders aligned
  - SSD: still only survey
    - ladder alignment under test
  - ITS-to-TPC: same as before
- Ongoing: z alignment with SDD, correction for Lorentz angle (→ redo alignment after this step)

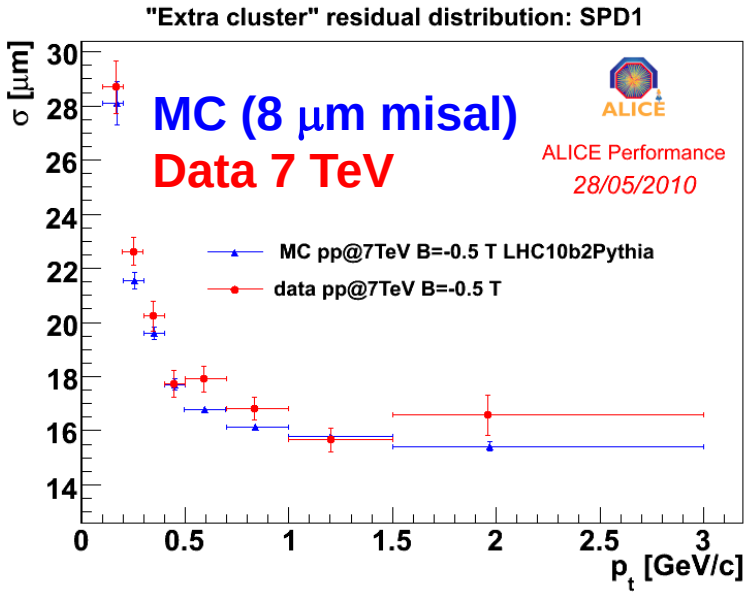
Alignment quality: SPD double hits in overlaps

examples of overlaps in the SPD

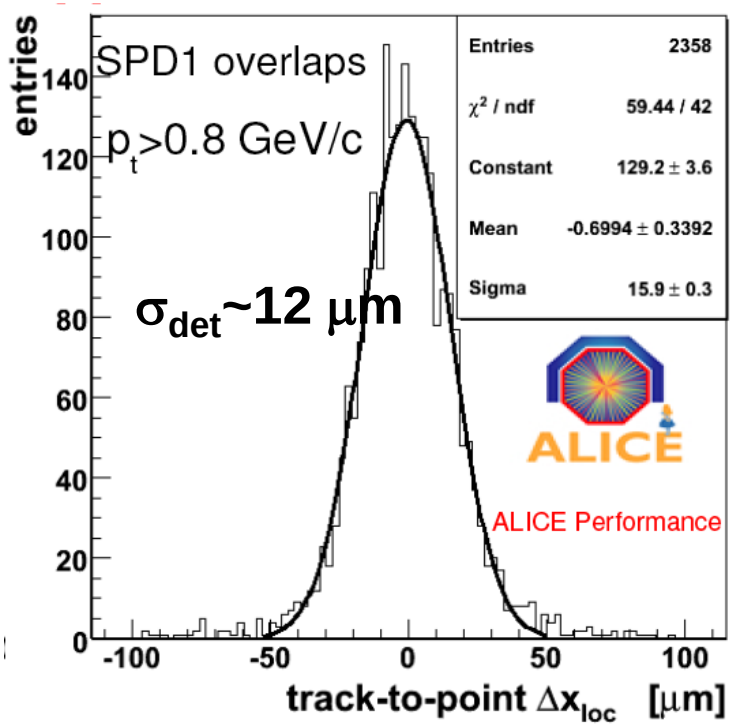


→ Residual between the two hits is sensitive to alignment quality & intrinsic resolution

$$\sigma_{residual} \sim \sigma_{det} \sqrt{2}$$



pp 7 TeV B=0.5T



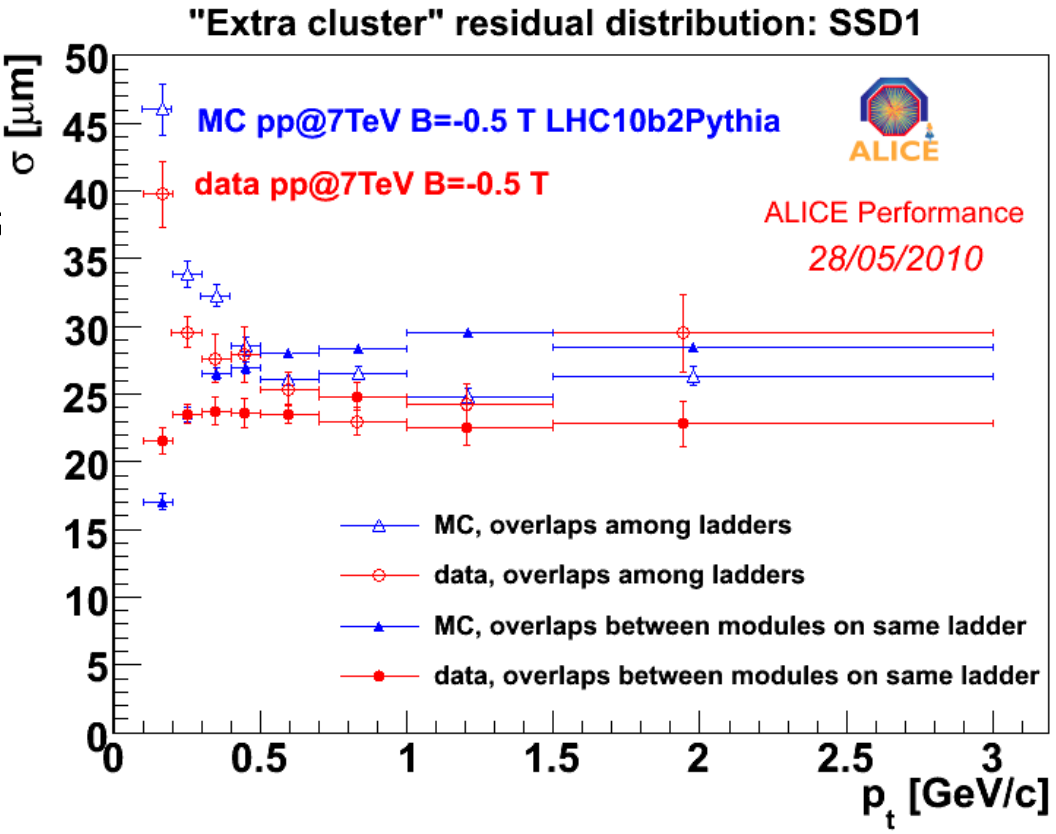
~8 μm misalignment

Alignment quality: SSD double hits in overlaps

→ Residual between the two hits is sensitive to alignment quality & intrinsic resolution

$$\sigma_{residual} \sim \sigma_{det} \sqrt{2}$$

SSD survey re-validation with pp collisions (full barrel)



MC, residual misal.
Data pp 7 TeV

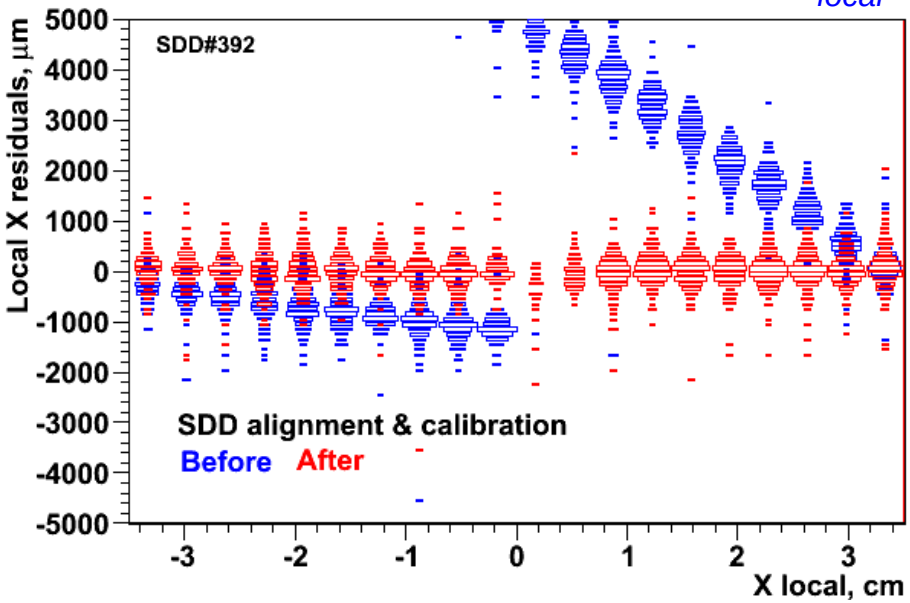
closed: same ladder
empty: different ladders

$\sigma_{det} \sim 20\ \mu m$

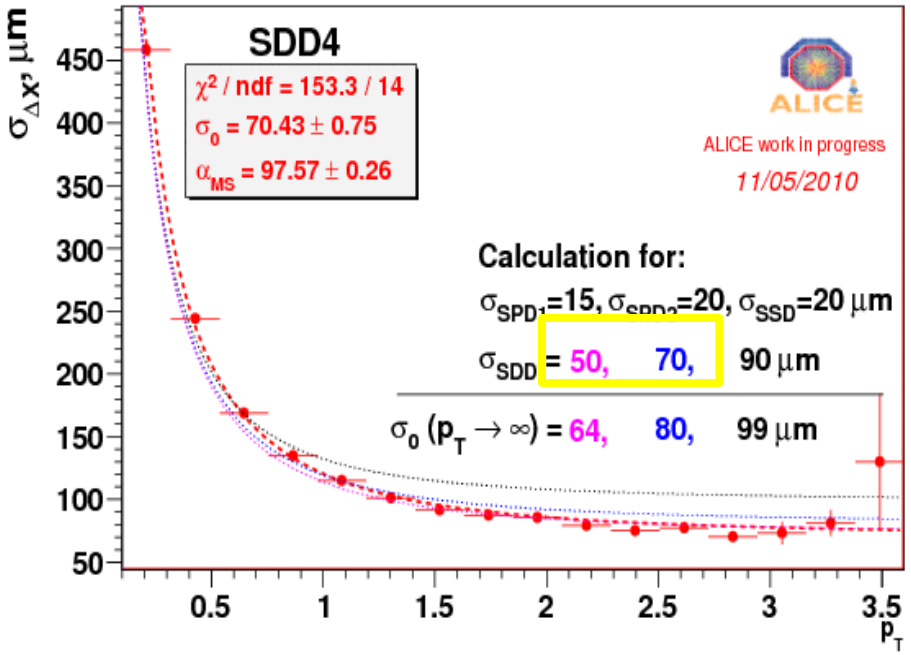
SDD calib & align with MP2

- Special feature for SDD in Millepede2: calibration parameters (t_0 and v_{drift} correction) added on top of geometrical misalignments as free parameters in the fit to track-to-point residuals
  - t_0 initial values estimated from the minimum drift time (or residuals in the two drift regions)
  - v_{drift} correction needed for:
    - Modules with malfunction injectors (≈ 30%)
    - Systematic effects in the estimation of the drift speed with injector

unbiased residuals at SDD vs x_{local}



σ of unbiased residuals at SDD:



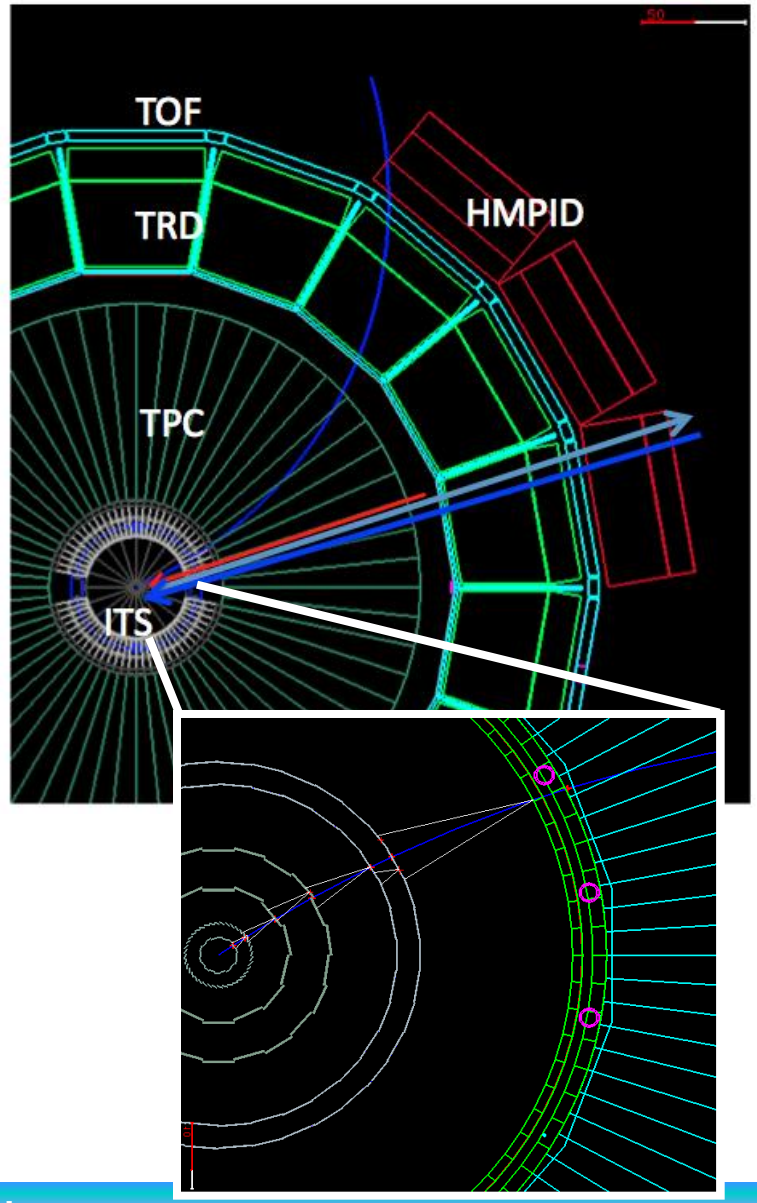
Alignment status summary

	SPD1	SPD2	SDD1	SDD2	SSD1	SSD2
intrinsic resolution [μm] rϕ z	10 120	10 120	35 25	35 25	20 830	20 830
estimated residual misalignment* rϕ z	<10 negl	<10 negl	60** 50	60** 50	<15 ~100	<15 ~100
systematic error in tracking*** rϕ z	10 100	30 100	500 100	500 100	20 500	20 500

* excluding “weak modes” (global distortions)
** well-behaved modules (calibration, vdrift uniformity)
*** optimized for high-tracking eff. and good track precision

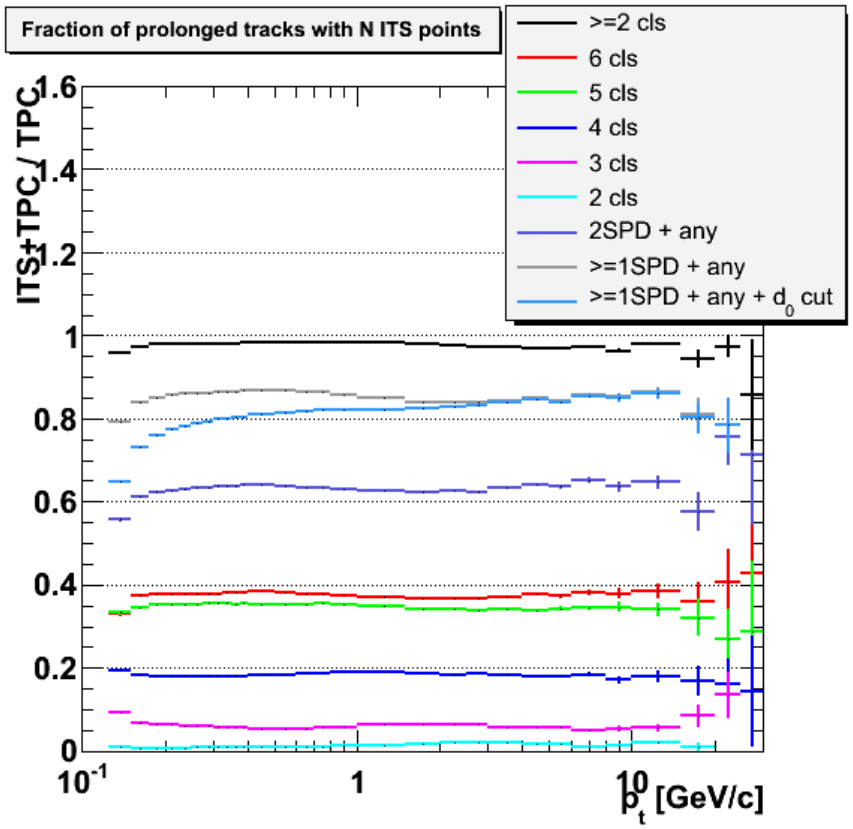
ITS tracking approaches

- *Barrel global tracking*
  - Kalman filter
  - **TPC→ITS**
  - **ITS→TRD**
    - out to PID detectors
  - **refit → ITS**
- Then, *ITS standalone tracking* with left-over points
  - recover track missed by TPC (dead areas)
  - low p_t reach
  - outward or inward

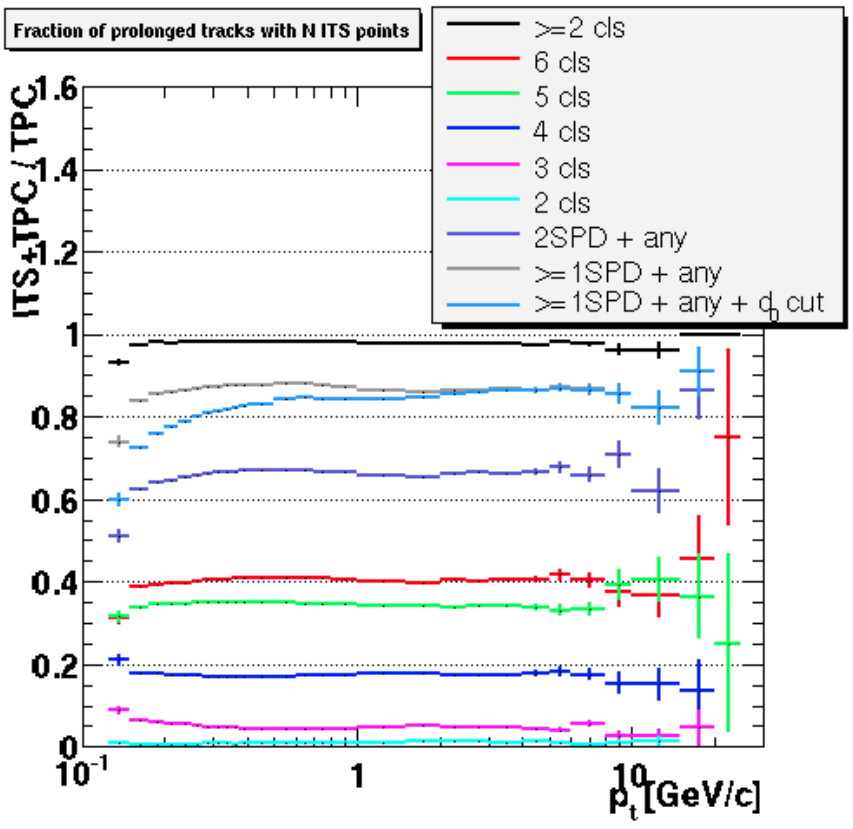


Tracking efficiency: TPC-ITS prolongation

Data: 117220-117222 pass2



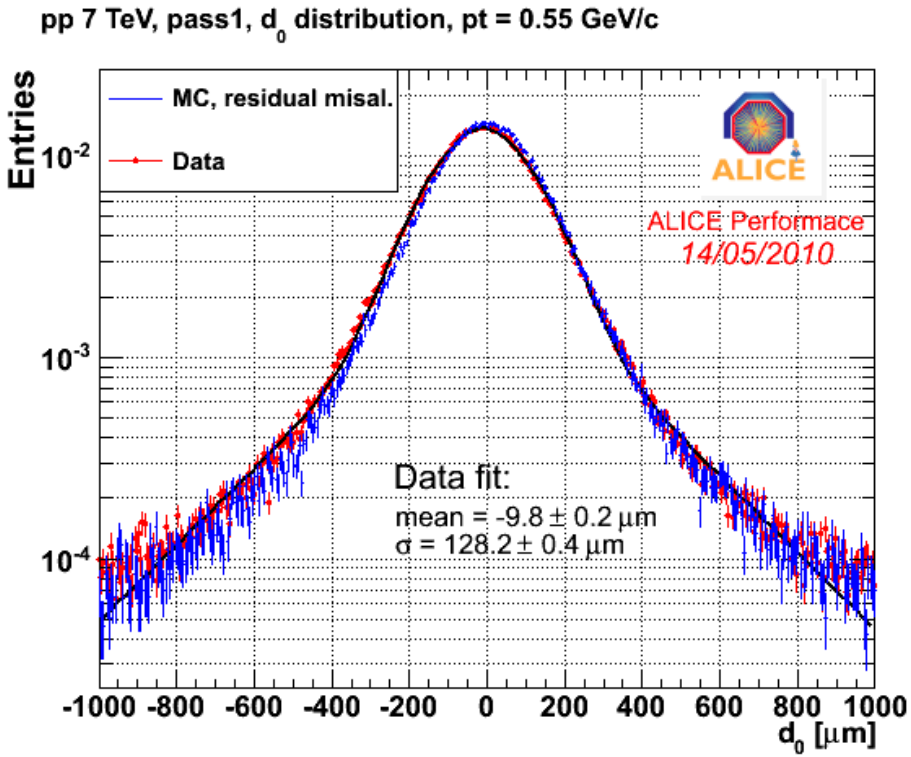
MC: 117112 LHC10d2



Track selection (denominator definition):
nclsTPC>70, TPC χ^2/cl<4, TPC ell. dca (2.4cm x 3.2cm), $|\eta|<0.8$

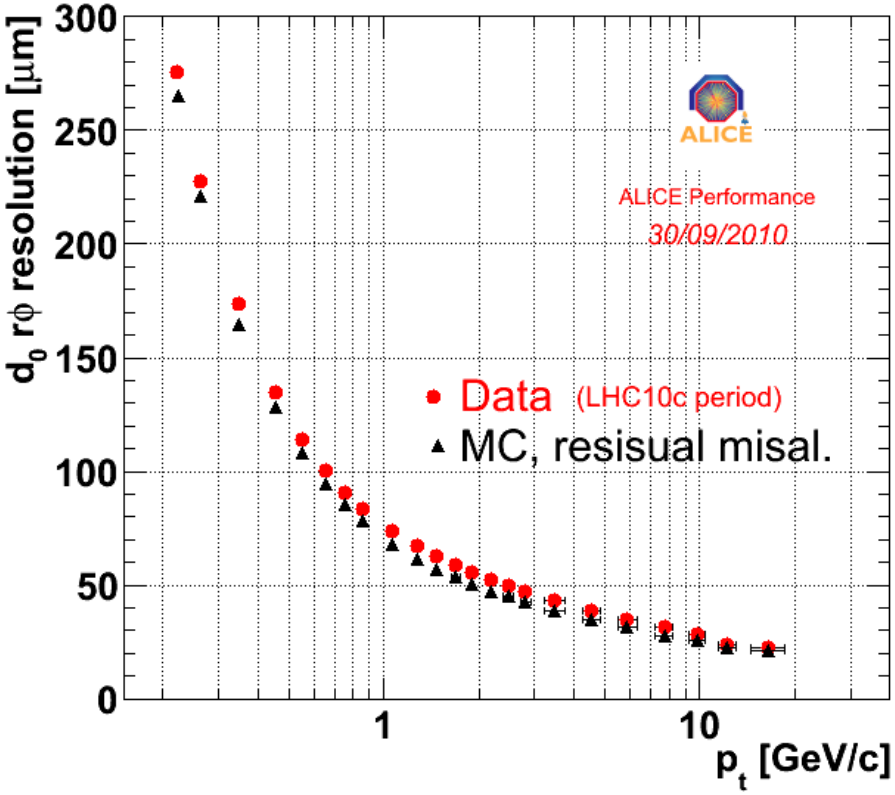
Impact parameter resolution

- Track selection: standard TPC cuts + kITSrefit + 2 SPD
- Method:
  - d_0 distribution wrt primary vertex from tracks (without the current track)
  - Gaussian+Exp tails fit
  - Sigma, dominated by primaries, estimates track + vertex resolution



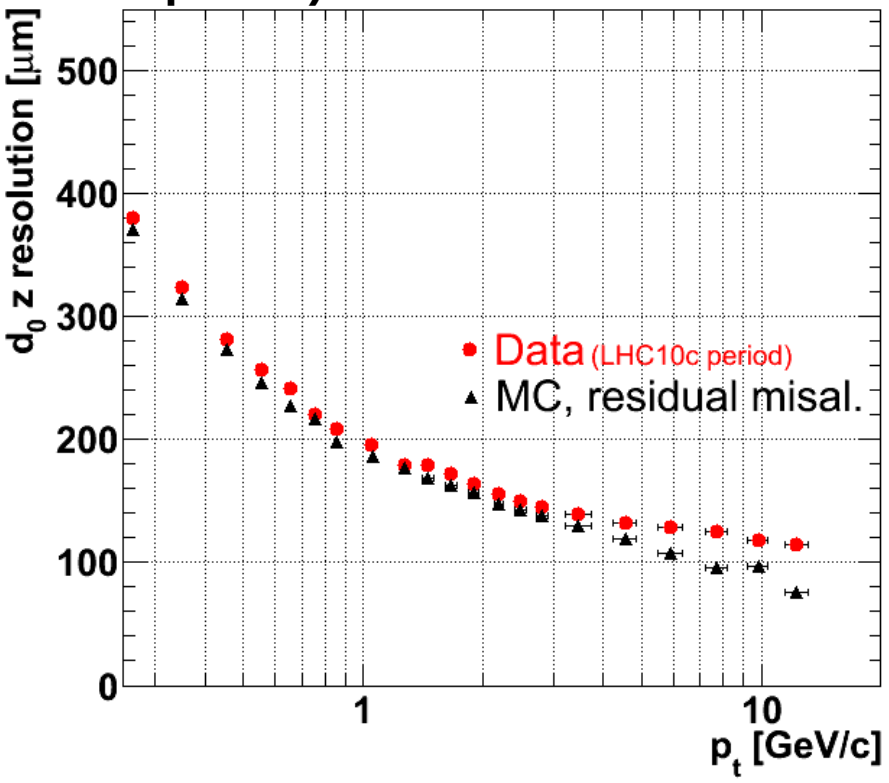
d_0 resolution $r\phi$ and z

rϕ



includes vertex resolution (35→ 10 μm)

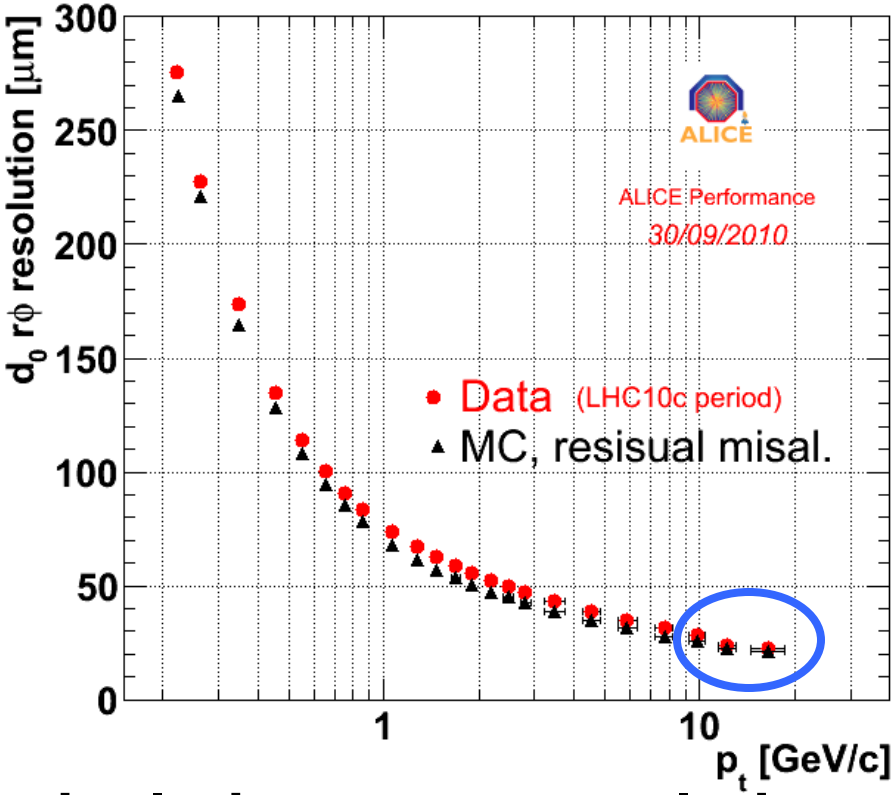
Z (limited by large errors on SDD points)



includes vertex resolution (<100 μm)

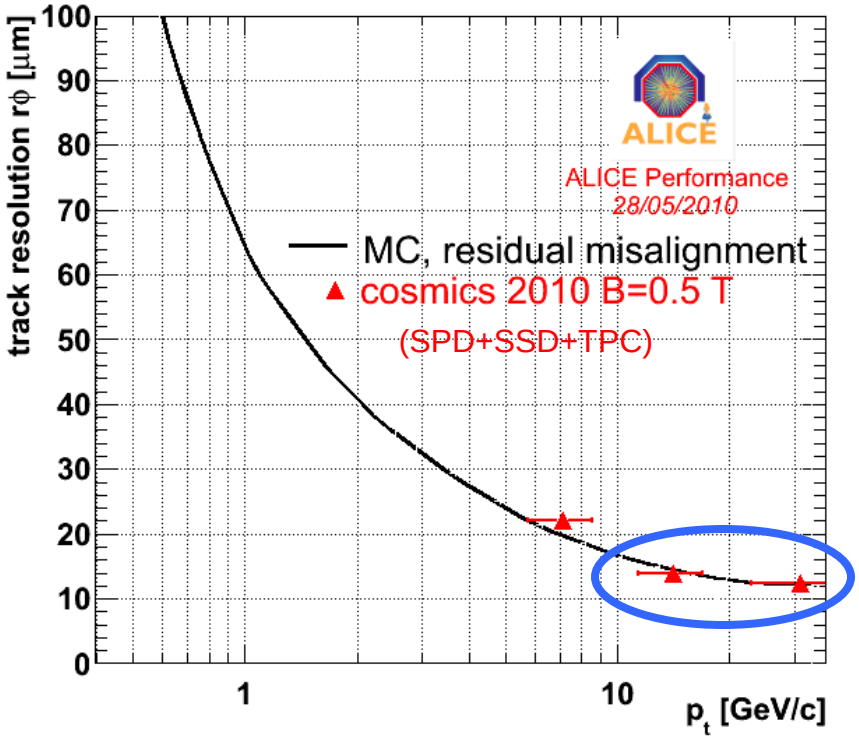
d_0 resolution rϕ from pp and cosmics

pp 7 TeV:



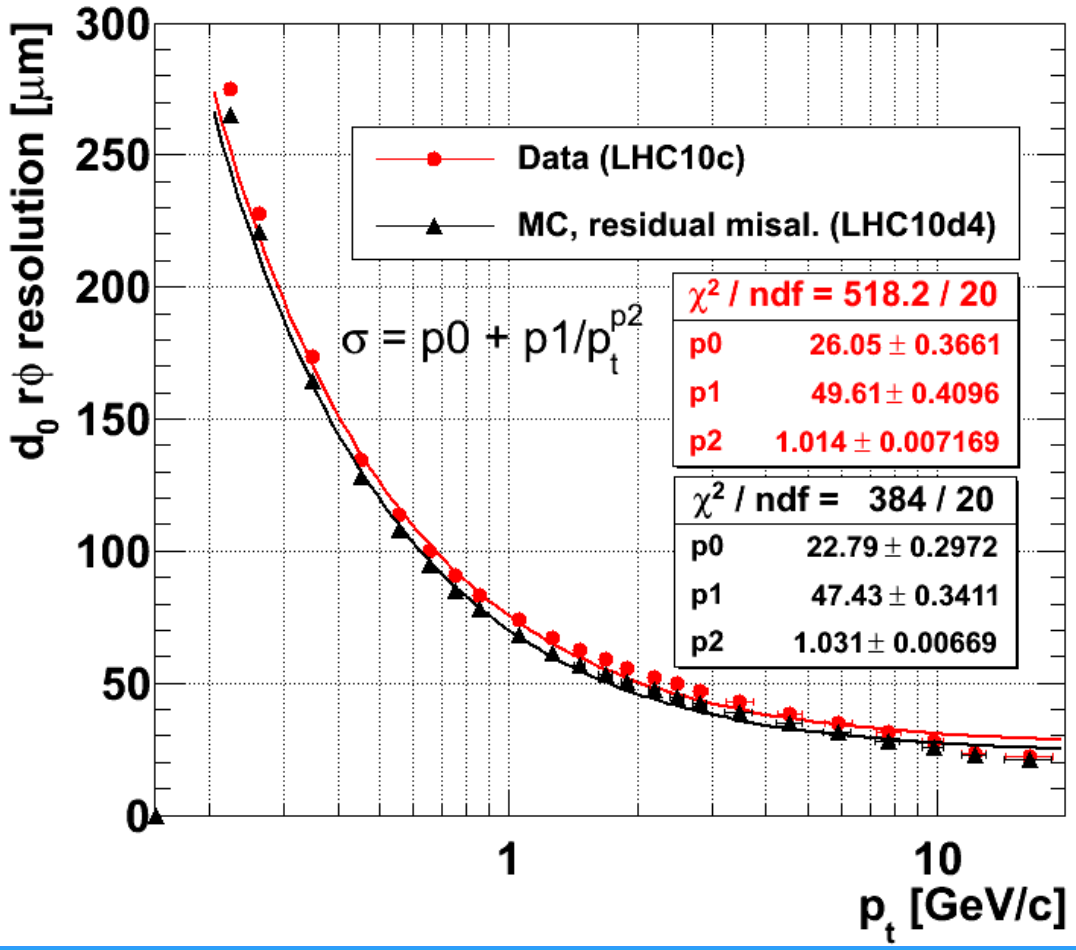
includes vertex resolution

Cosmics 2010 (0.5T): top-bottom track matching



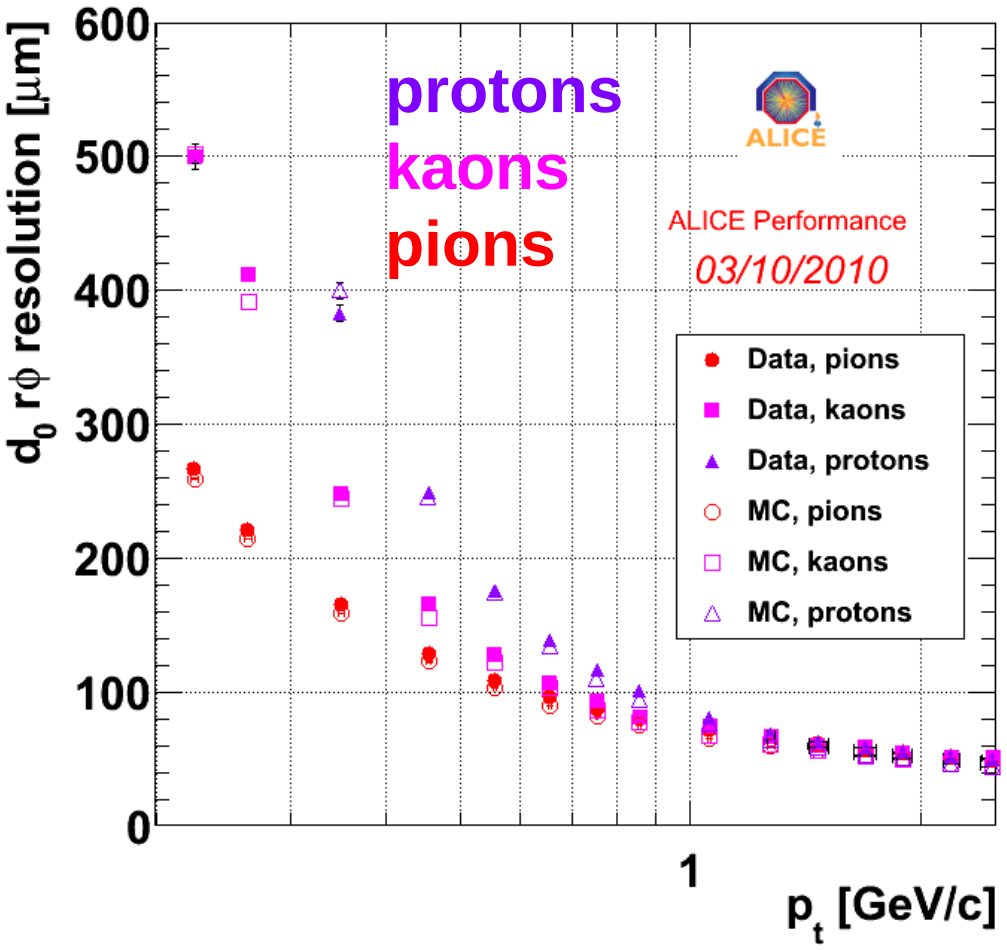
d_0 resolution $r\phi$ fit

- Empiric fit with $a+b/p_t^c$, only for primary track selection code
  - other parameterizations under study



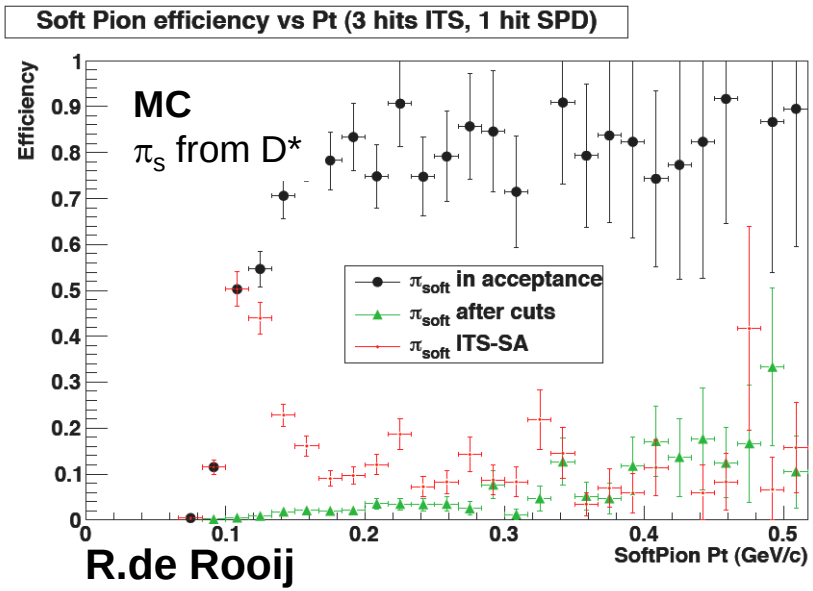
Particle species dependence

- With combined PID (ITS, TPC, TOF)
  - multiple scattering (~ 1/pβ)
  - nuclear interactions
- Good agreement data-MC
  → material OK

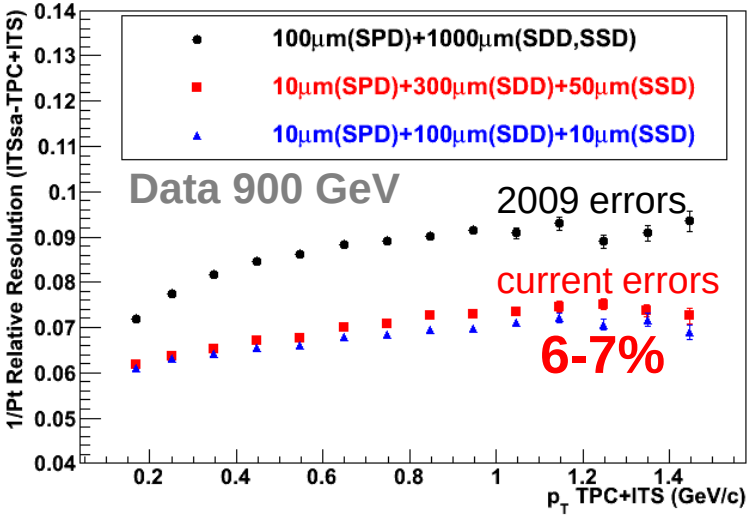


ITS standalone tracker

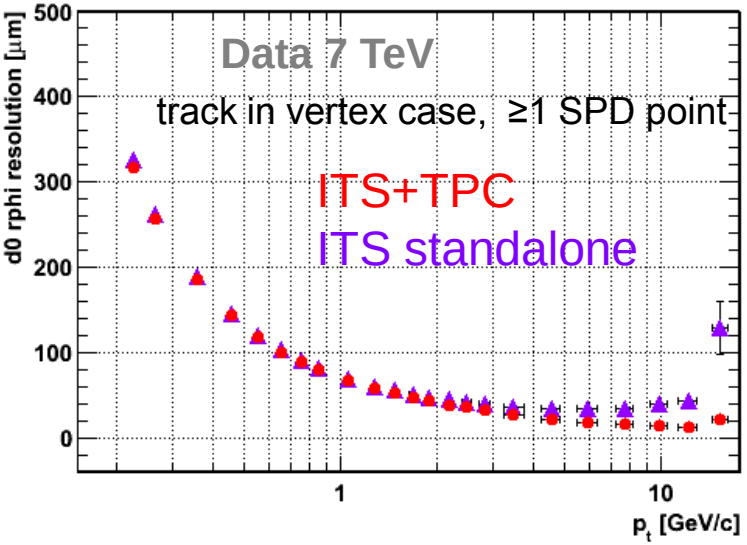
- Extends p_t acceptance down to ~100 MeV/c (→ spectra, D*⁺⁺)



- Moderate p_t resolution

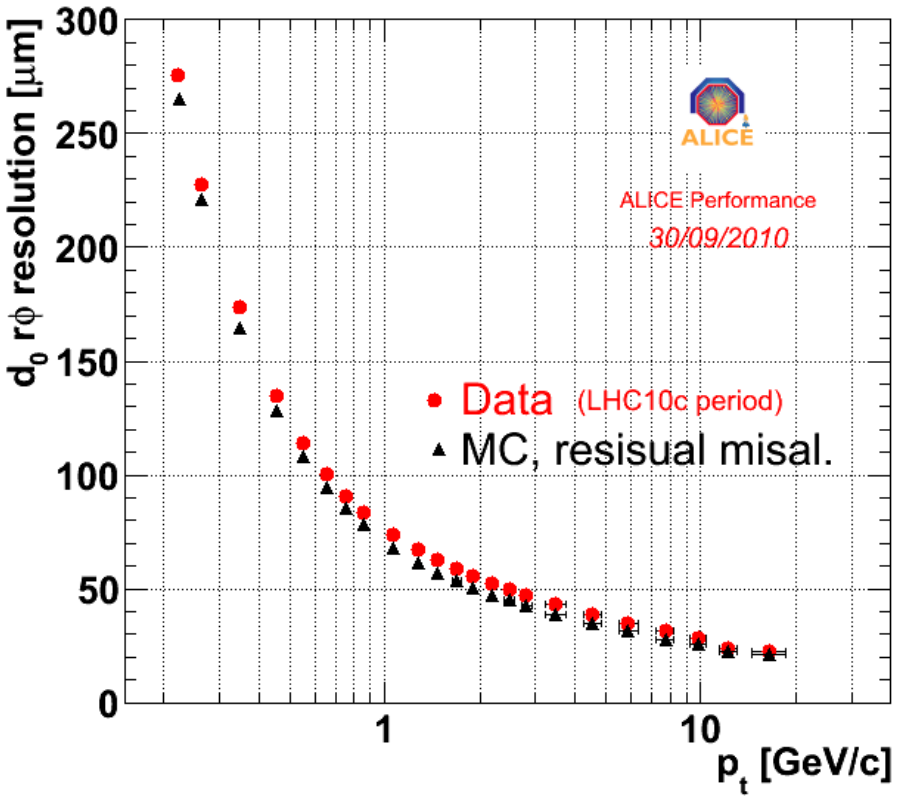


- But almost same position resolution as ITS+TPC

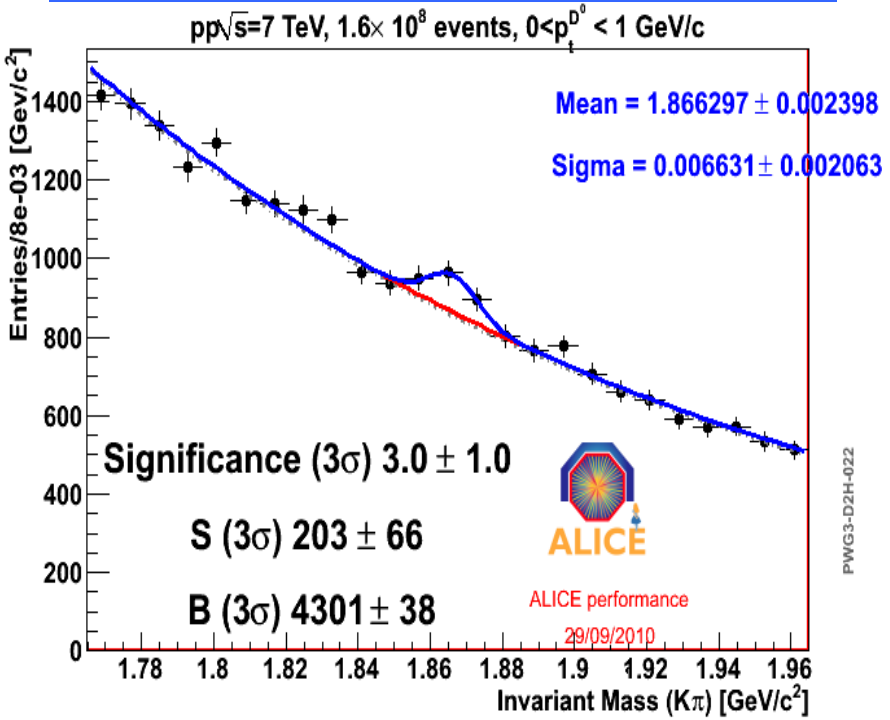


Summary

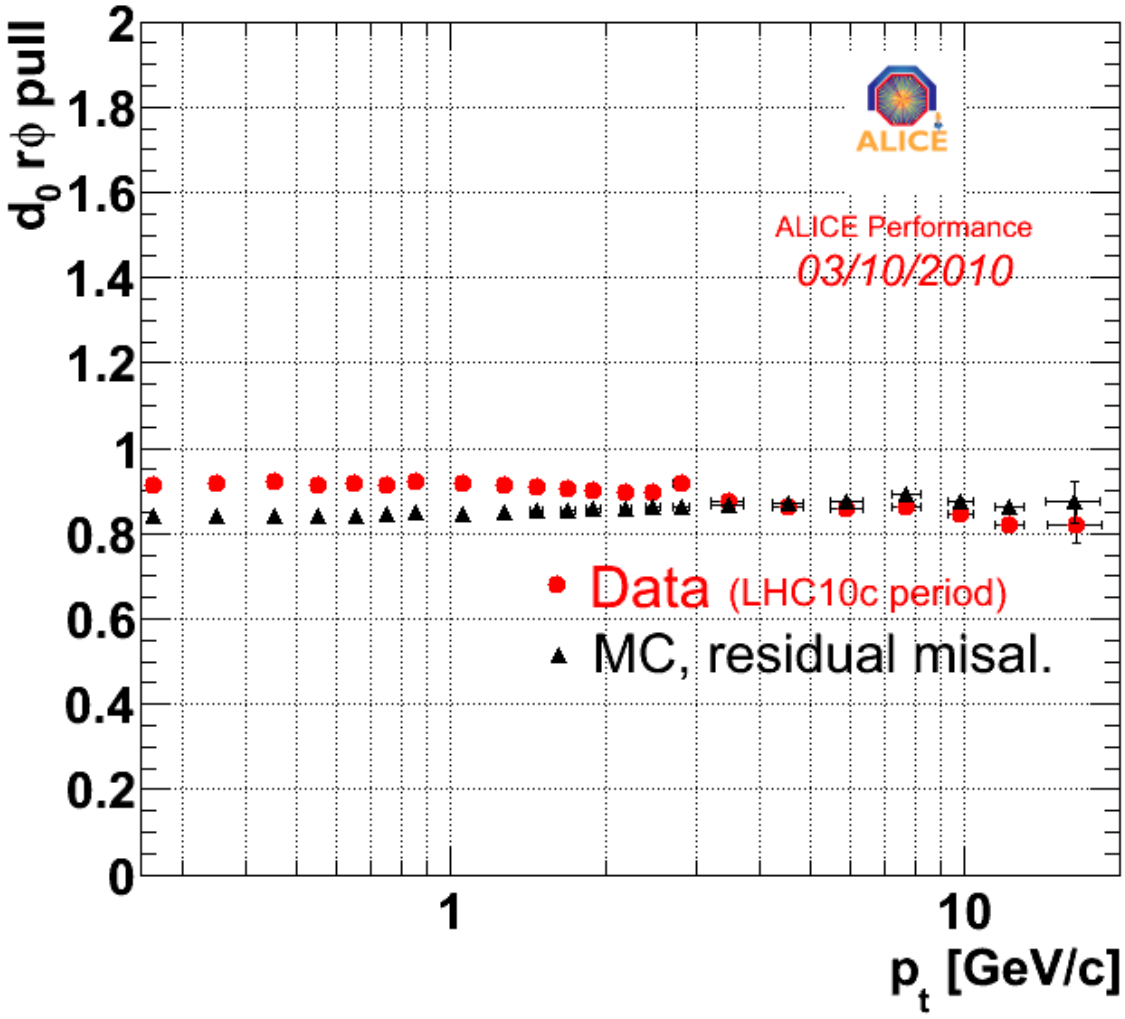
- ITS overall tracking performance within ~5-10% to target
- Not yet for z resolution (in progress)
- Now addressing the small systematic deviations from MC



$D^0 \rightarrow K\pi$ below 1 GeV/c ?



EXTRA SLIDES


d_0 rϕ pull
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
10
p_t [GeV/c]
ALICE
ALICE Performance
03/10/2010
Data (LHC10c period)
MC, residual misal.