ITS upgrade WG1 update

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Outline

- $D^0 \rightarrow K\pi$ update (A. Rossi, S. Moretto)
- $B \rightarrow J/\psi \rightarrow ee$ update (C. Di Giglio)
- $\Lambda_c \rightarrow pK\pi$ update (C. Terrevoli, M. Mager)
- $B \rightarrow e$ plans (M. Kweon)

$D^0 \rightarrow K\pi$ update

D^0 in PbPb down to p_t=0

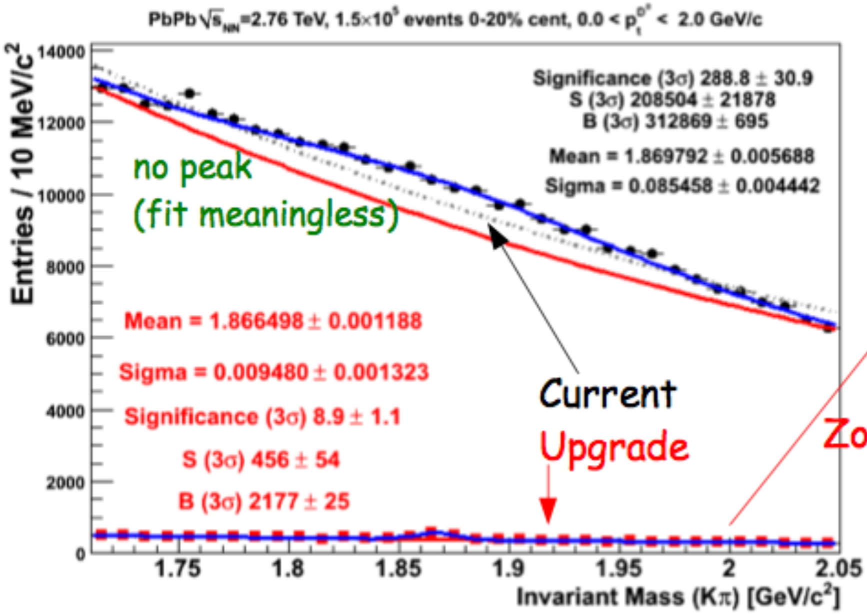
<u>"New" AOD production</u>:

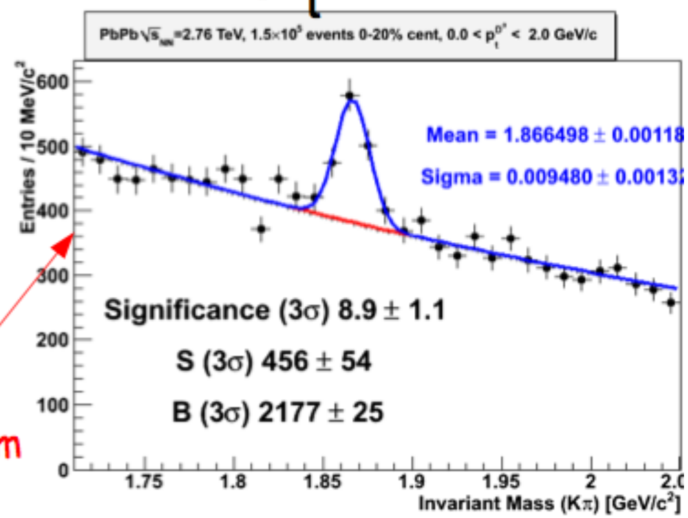
- AOD058
  - Hijing + N Pythia events with PWG3 signals (N varying from 20 in the central to 5 in the peripherals) -> CHARM ENRICHED SAMPLE (but Hijing events always there)
- Cut p_t^{D0}>2 GeV/c removed

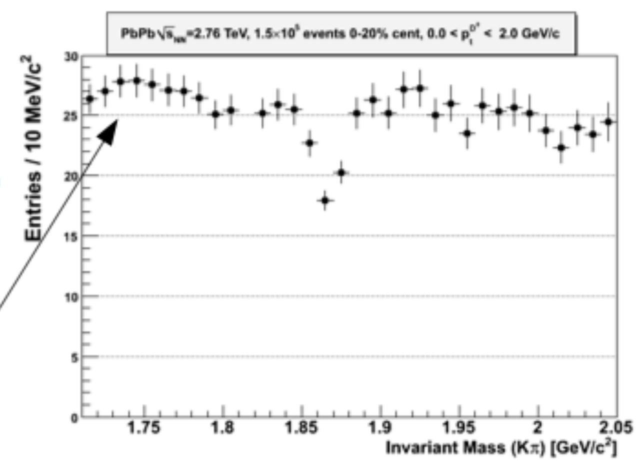
<u>ITS upgrade scenario</u>: "all new", x/X_0=0.3% per layer

$D^0 \rightarrow K\pi$ update (0-2 GeV/c)

D^0 in PbPb down to p_t=0





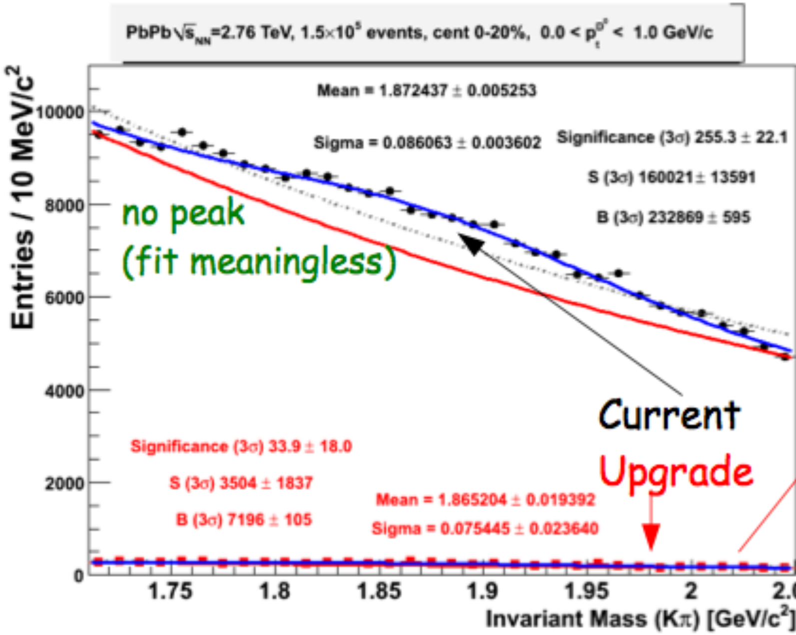


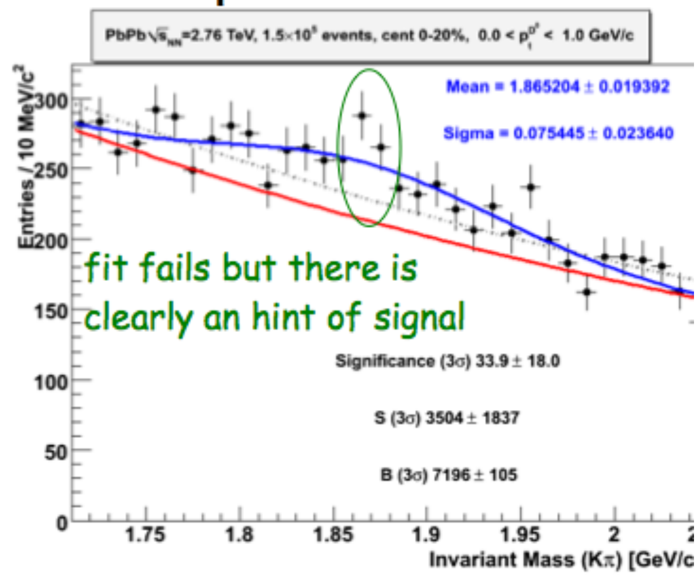
Centrality 0-20%, p_t<2 GeV/c

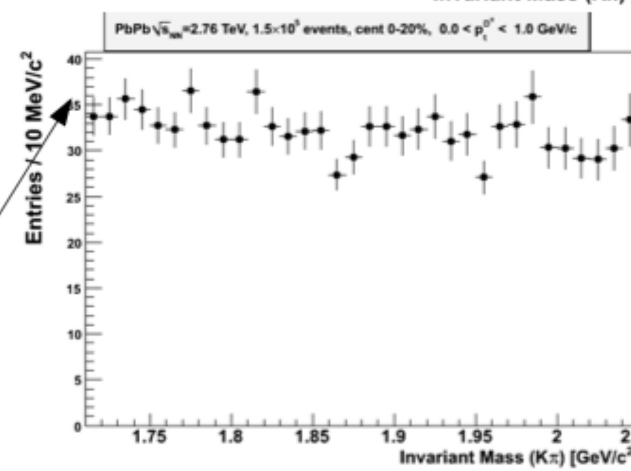
- Cut not optimized, for both cases (never tried to go below 2 in PbPb for computational reasons): decided almost blindly (let's say on the basis of personal experience...)
- **Factor ~25 improvement in background rejection**
- With these cuts the difference is between being able or not to do the measurement

$D^0 \rightarrow K\pi$ update (0-1 GeV/c)

D^0 in PbPb down to p_t=0







Centrality 0-20%, $0<p_t<1$ GeV/c

- Cut not optimized, for both cases (never tried to go below 2 in PbPb for computational reasons): decided almost blindly (let's say on the basis of personal experience...)
- **Factor ~34 improvement in background rejection**
- With these cuts the difference is between being able or not to do the measurement

$D^0 \to K\pi$ update

Towards quantitative estimates

- Need to estimate significance and back rejection improvement expected in data (what has been done is not from a MB MC sample)
- S,B = signal, background per event
  - for a given set of cut
- ε = D^0 efficiency, from charm enriched sample -> from Correction Framework & Hybrid approach (ongoing, feasible)
- $S_{corrected}$ = S/ε per event
- in many cases extrapolation, assumptions are needed
  - e.g. R_{AA} below 2 GeV/c

not trivial it's 1

$$B_{ITSupg} = B^{MB\ MC}_{ITSupg} \times \frac{B^{data2010}_{ITScur}}{B^{MB\ MC}_{ITScur}} \qquad S_{ITSupg} = \epsilon_{ITSupg} \times S^{data2010}_{corrected}$$

$$\mathrm{Signif}_{ITSupg}(N_{ev}) = \frac{S_{ITSupg} \times \sqrt{N_{ev}}}{\sqrt{S_{ITSupg} + B_{ITSupg}}} = \frac{\epsilon_{ITSupg} \times S^{data2010}_{corrected} \times \sqrt{N_{ev}}}{\sqrt{B^{MB\ MC}_{ITSupg} \times \frac{B^{data2010}_{ITScur}}{B^{MB\ MC}_{ITScur}} + \epsilon_{ITSupg} \times S^{data2010}_{corrected}}}$$

$D^0 \rightarrow K\pi$

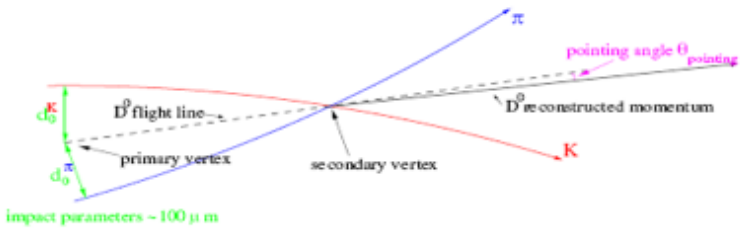


Figure 1: Schematic view of the D^0 decay in the $D^0 \rightarrow K^-\pi^+$ channel.

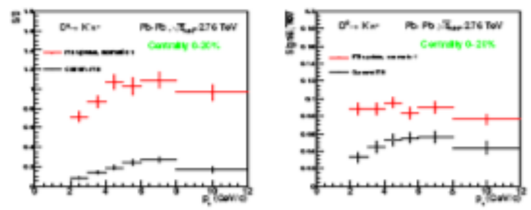


Figure 2:

0.1 A benchmark channel: D0-¿Kpi reconstruction

As described in Section ?? and reference therein, ALICE measured the D meson RAA in PbPb collisions at $\sqrt{s_{\rm NN}}$ = 2.76 TeV via the recontruction of the D0-¿Kpi (BR=3.89%, $c\tau \approx 123$ μm), D*-¿Kpipi (via D*-¿D0pi, strong decay, BR=67.7%). D+-¿Kpipi (BR=9.4%, $c\tau \approx 312$ μm) decay channels (see [?] for the decay properties quoted). All analyses are based on the reconstruction and selection of secondary vertex topologies with a (order of) hundred of microns separation from the primary vertex. Displaced tracks are selected and good alignment between the D meson momentum and the flight-line connecting the primary and decay vertex is required (i.e. small pointing angle, see the sketch of the D0 decay in Fig. 1). The amount of D0 and D+ decaying in the selected channels is comparable because the larger D+-¿Kpipi BR is balanced by the more copious D0 production (a factor about 2.3 []). However, despite the smaller lifetime, the two prong decay topology makes the signal extraction easier in the D0-¿Kpi case than in the D+-¿Kpipi case. The main reason is related to the higher combinatorial background, which rises proportionally to $N_{\rm tr}^{n_{\rm pr}}$ with $N_{\rm tr}$ the event multiplicity and $n_{\rm pr}$ the number of prongs. As shown in Fig. 1 and explained in [], due to the relativistic boost, the pion and kaon tracks have an intrinsic impact parameter in the transverse plane typically of the order of the D0 $c\tau$ for sufficiently high D0 transverse momentum, thus can be identified as displaced tracks if the track resolution in the vicinity of the vertex is of the order of tens of microns. The average pt of the decay tracks is lower for D+ than for D0, hence, especially at low pt, D+ tracks are more affected by multiple scattering effects. Therefore, the D0-¿Kpi decay channel was reconstructed in PbPb collisions in a wider pt range, $2 < pt < 12$ $/c$, and yielded the most precise RAA measurement, with a statistical error of the order of 25% in the centrality range $0 - 20\%$. The better signal extraction and the possibility to have a realistic reference of the performance on real data, provide a more detailed understanding of the analysis and allows for a more realistic study of the benefits that would come from an upgrade of the ITS. Therefore, the D0 case can be considered as a benchmark for all the D meson analyses. In central (0-20%) PbPb collisions the raw yields were extracted with a statistical significance of the order of 8-10, depending on the pt, and the statistical error (that can be estimated also as the inverse of the statistical significance) was at the level of 10-15%. The main cut variables used are the product of decay track impact parameters, the cosine of the pointing angle and the decay length. The two latter variables were calculated also in the transverse plane only to improve the separation between signal

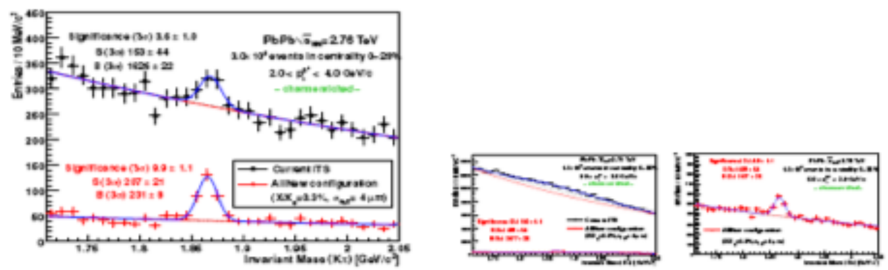


Figure 3:

Figure 4:

and background, profiting of the better resolution in the rphi plane with respect to the z coordinate (see Figure ??). For the background, composed mainly by pair of primary tracks, the distribution of the product of decay track impact parameters is symmetric and peaks at 0, the width being determined by the detector impact parameter resolution. For signal, the distribution is asymmetric: positive values are induced by detector resolution. The cosine of the pointing angle is ideally 1 for signal candidates while has a flat distribution for background. The decay length distribution of reconstructed D0 meson is the convolution of the true decay length distribution and a resolution term, which characterizes the background distribution. The narrower the background distribution is, the better the signal and background shapes can be distinguished. An improved detector resolution would provide a better separation between signal and background, thus the possibility to reject more background and, eventually, release the cuts in order to keep more signal, increasing the selection efficiency. Generally, this also allows to reduce the systematic uncertainties arising from a not fully precise description of the detector properties (including alignment) and performances (e.g. vertex and track

Next Steps:

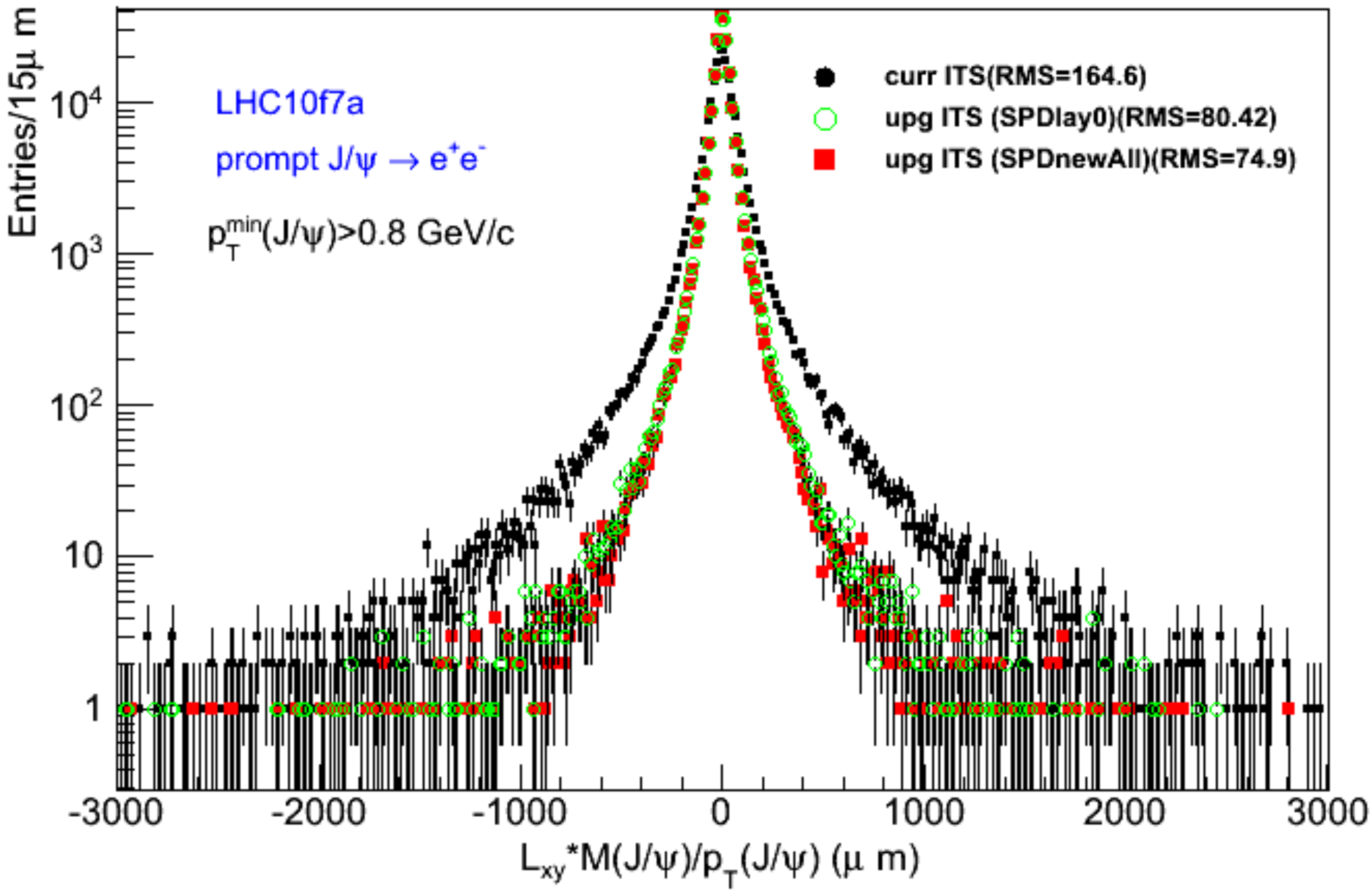
- LHC11a3 : too low statistic → study the LHC11a10b_bis collection

-in this new collection: evaluate scaled significance

-try to optimize cuts in the different pt bin

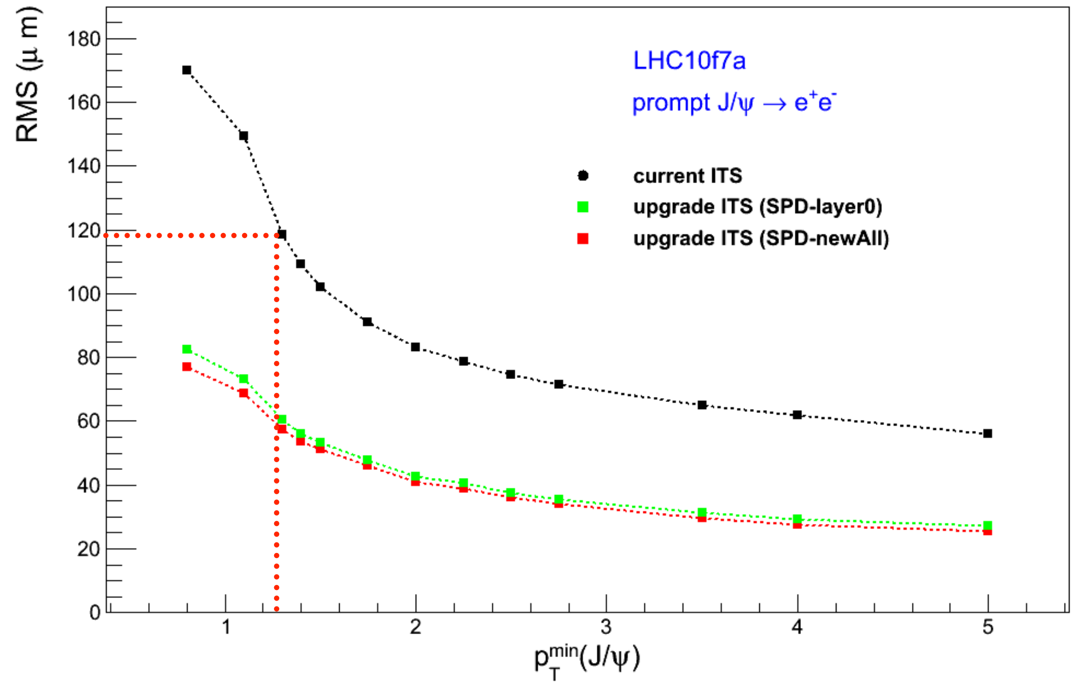
B→J/psi: results with hybrid method

- **Resolution function:**

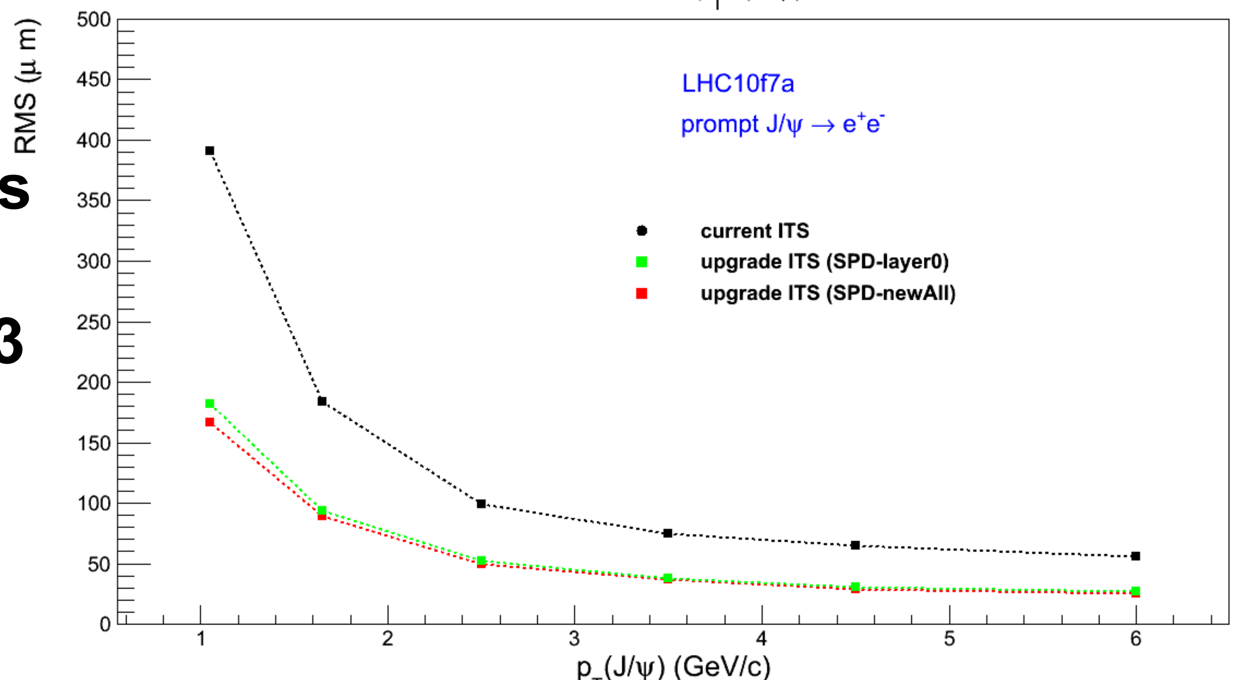


- **SPDlay0→SPDnewAll ~ 7% improvement**

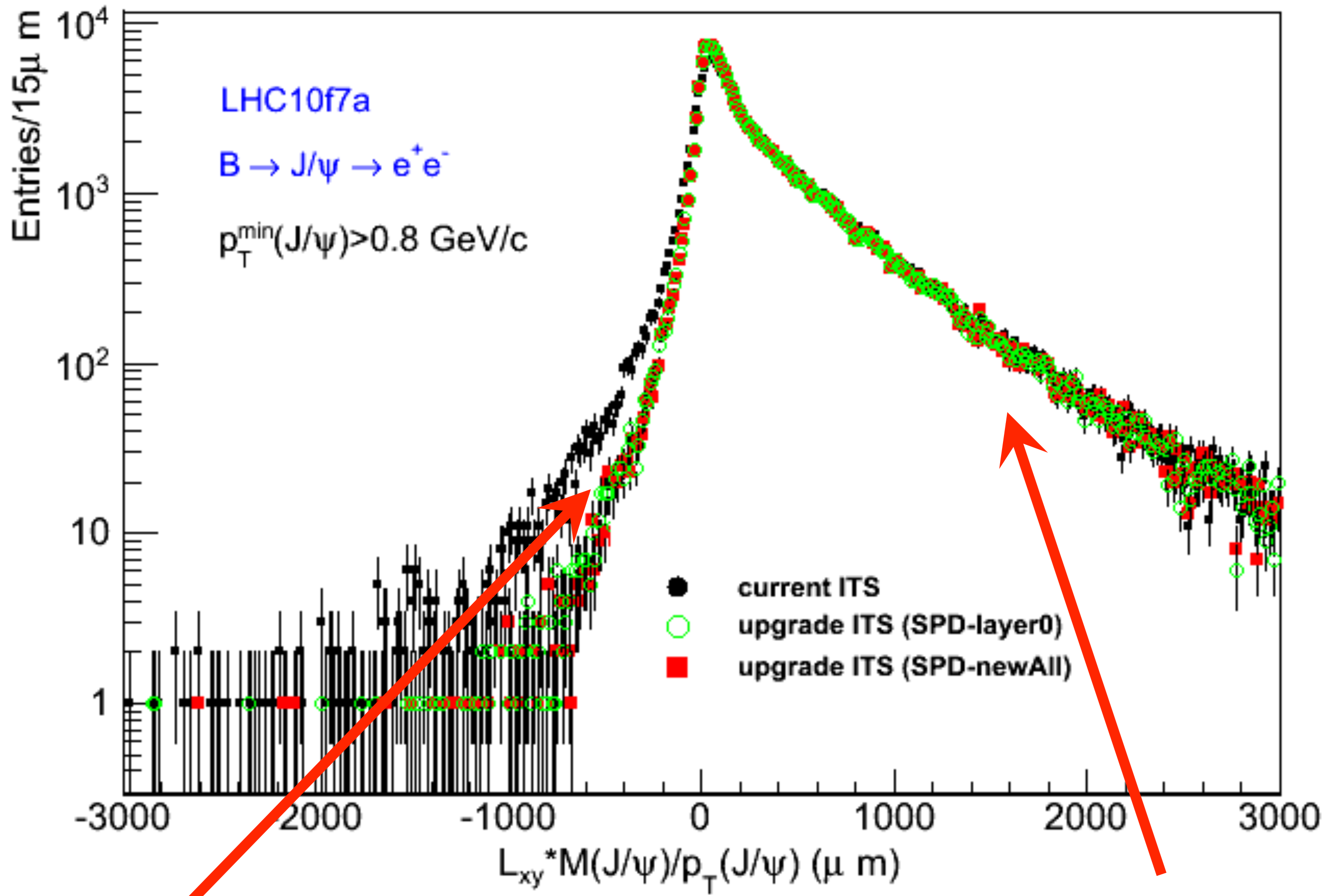
- **Resolution function RMS vs p_T^{min}(J/psi)**



- **Resolution function RMS vs p_T(J/psi) = [0.8-1.3,1.3-2,2-3 ,3-4,4-5,5-7] GeV/c**



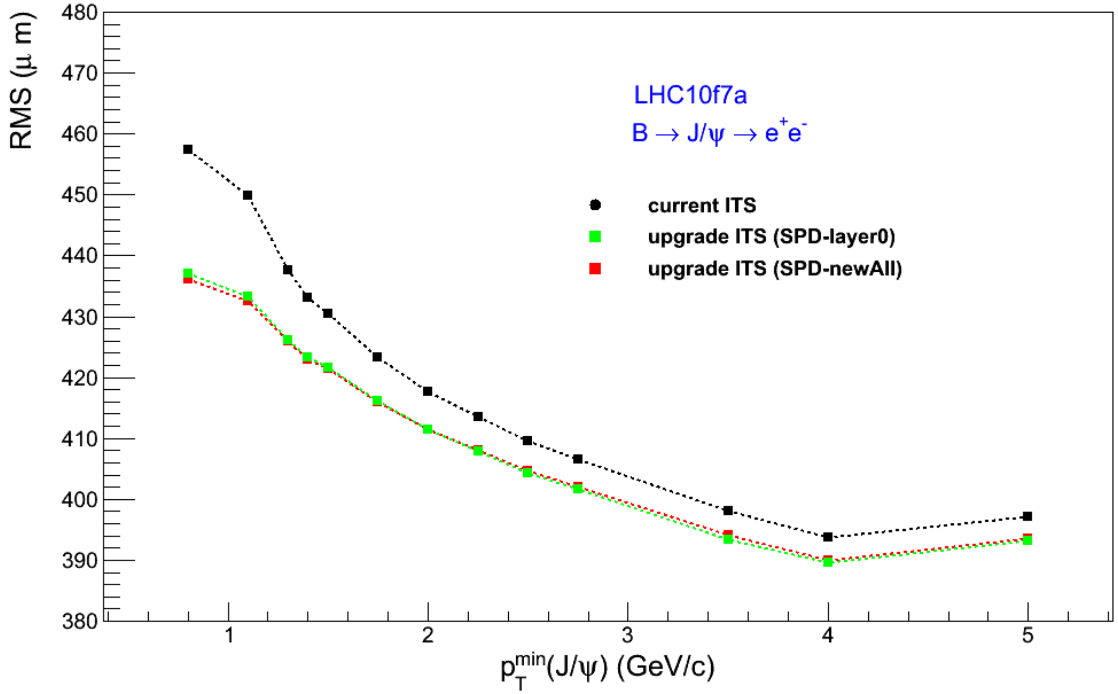
• **MC J/psi from B:**



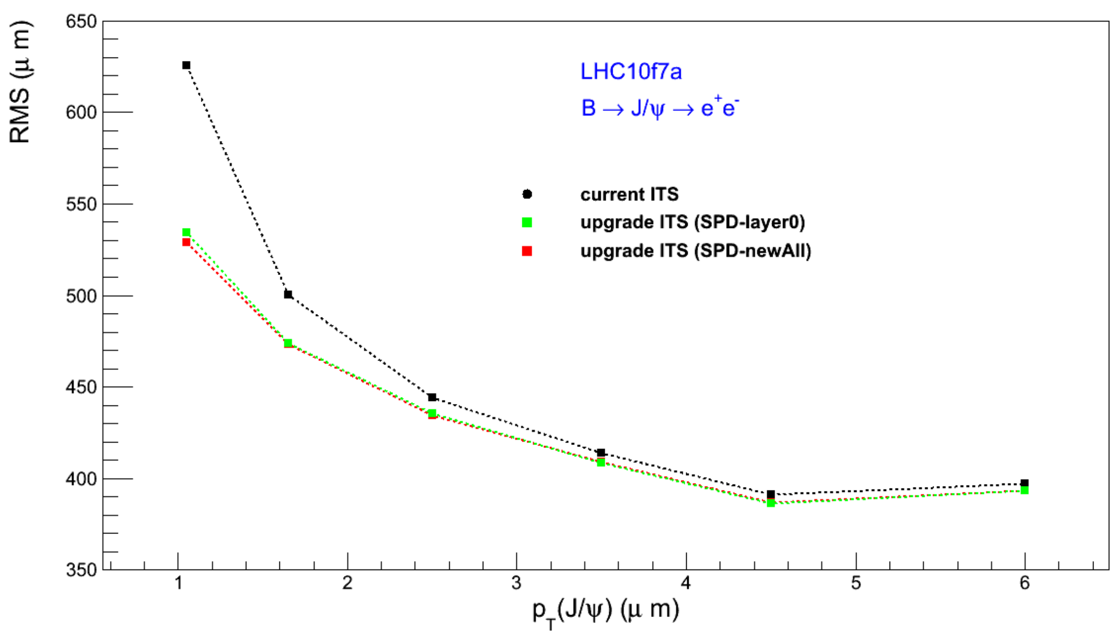
Effect of resolution improvement

Region where fB extraction is performed

• J/psi from B RMS vs p_T^{min}(J/psi)

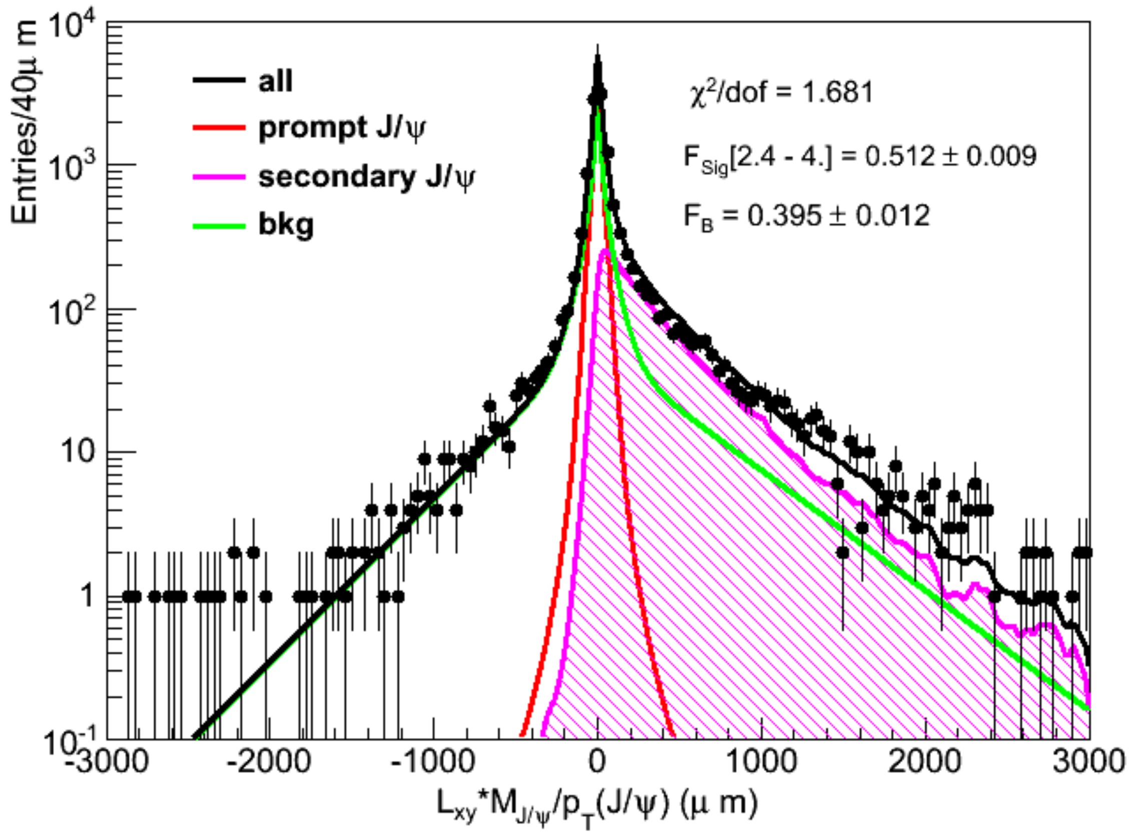


• J/psi from RMS vs p_T(J/psi) = [0.8-1.3,1.3-2,2-3 ,3-4,4-5,5-7] GeV/c



Current status: likelihood fit (MC validation)

- **ITS upgrade (NewAll conf.)**



- Ad hoc mixture of prompt J/ψ, (B→)J/ψ and bkg events used for MC validation ((X,M) pairs randomly extracted from distribution functions)
- Expected relative abundances in this/next year data taking depend on the trigger we choose

B→J/ψ analysis requirements:

- Increase statistical significance → we need a proper trigger for electrons
- Keep J/ψ transverse momentum reach reasonably low, i.e ~ 1.3-1.5 GeV/c ($p_T(B) \to 0$)

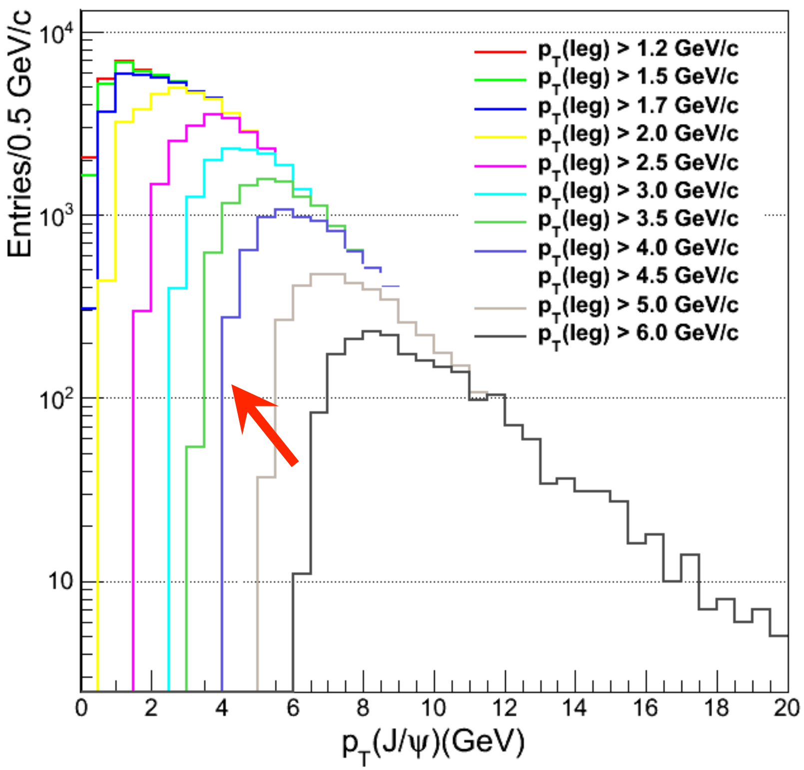
Trigger scheme: 2 possible scenarios

- Actual: use of EMCAL (+TRD) in pp and PbPb collisions → trigger on single/double electrons
- Future: use of a topological trigger with ITS
- Both of them need quantitative study and optimization…but few qualitative considerations may be done

1st scenario: EMCAL(+TRD)

ALICE

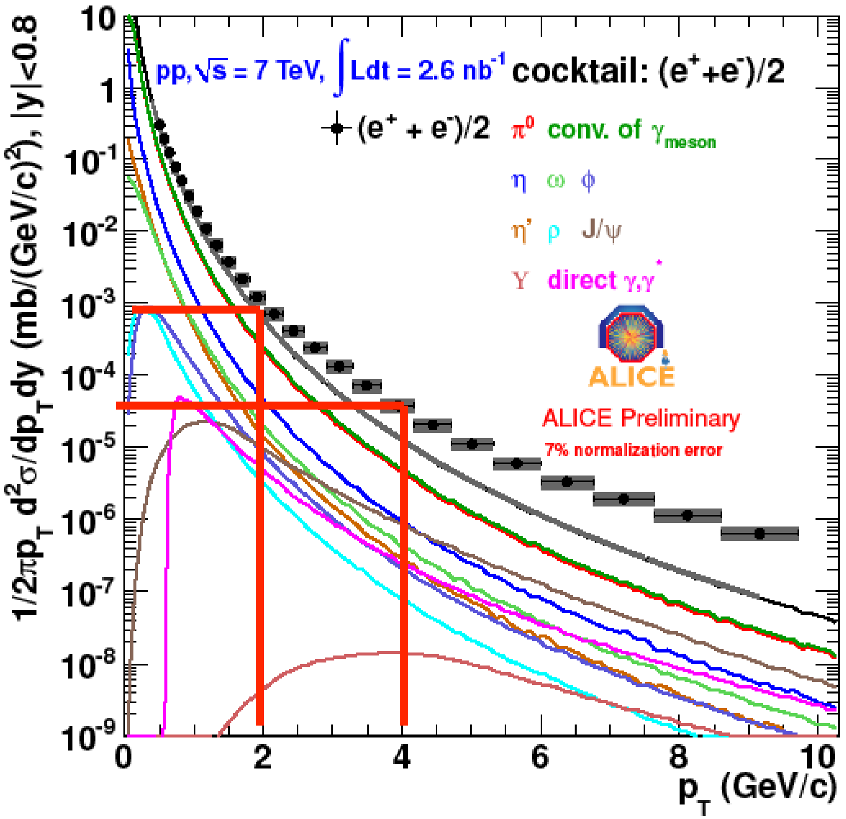
- Current status: rare triggers runs since 2 June (→ see F.Antinori, PF 15/06/2011):
  - 100 kHz interaction rate
  - ~ 30 Hz EMCAL L0 (momentum threshold = 4.8 GeV on single track)
  - \+ mix of other rare triggers (single muon, dimuon unlike-sign, dimuon like-sign)

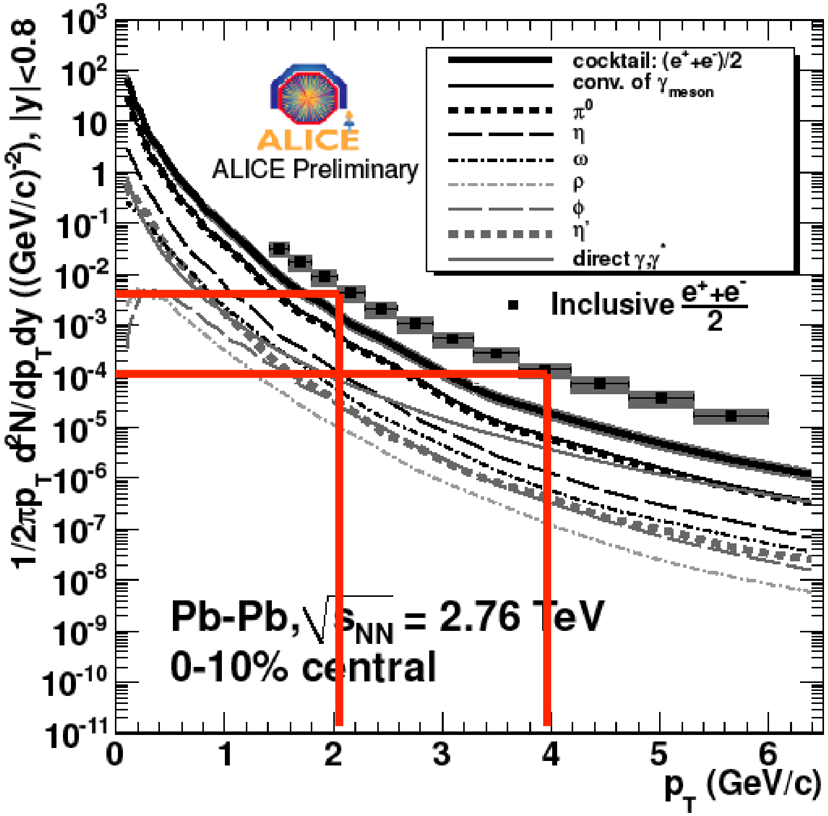


- **Low $p_T(J/\psi)$ reach requirement → need to go below 4 GeV on single electron momentum threshold with EMCAL**
  - **Need to define optimal cut on single track**

1st scenario: EMCAL(+TRD)

- Can we go down below 4 GeV on single electron? → main limitation is EMCAL L0 trigger rate





- **We need the development of di-electrons pair dedicated trigger with EMCAL + TRD (ex. EMCAL L0 + TRD L1) → EMCAL/TRD expertise is required**

2nd scenario: topological trigger with ITS

ALICE

- Possible scheme for $B \rightarrow J/\psi(\rightarrow ee)$ analysis:
  - L2 trigger
  - build J/ψ candidate in ITS applying invariant mass constraints
  - look at corresponding tracks in TRD which:
    - Are compatible with two electrons
    - Point back to a secondary vertex far away from the interaction vertex
  - Cut on the impact parameter/pseudoproper-decay-length ($c\tau(B) \sim 500\mu m$)

- Advantage is the rejection of the component from prompt J/ψ
  - Needs a rethinking of the analysis

$\Lambda_c \rightarrow pK\pi$
Optimization of the analysis cuts

- sample analyzed for the optimization:
  - LHC10f7a pp (charm enriched)
- only current production cuts applied to the sample
  - list of production cuts at slide number 8
- choice of the "best cut"
  - comparison between the amount of signal and background rejected with the current analysis cuts and the new cuts
  - choice done looking at the maximization of the significance and minimization of signal loss

B→e plans

- Method used for the study with D meson can be adopted: Recalculate track parameter according to estimation. Will be done in ESD level.

$$MCtruth + \frac{\mathrm{Re}\,sidual(upgrade)\ at\ given\ p_t}{\mathrm{Re}\,sidual(current)\ at\ given\ p_t} \times (difference\ from\ MCtruth\ of\ the\ given\ trackparameter)$$

already existing

ex. transverse impact parameter

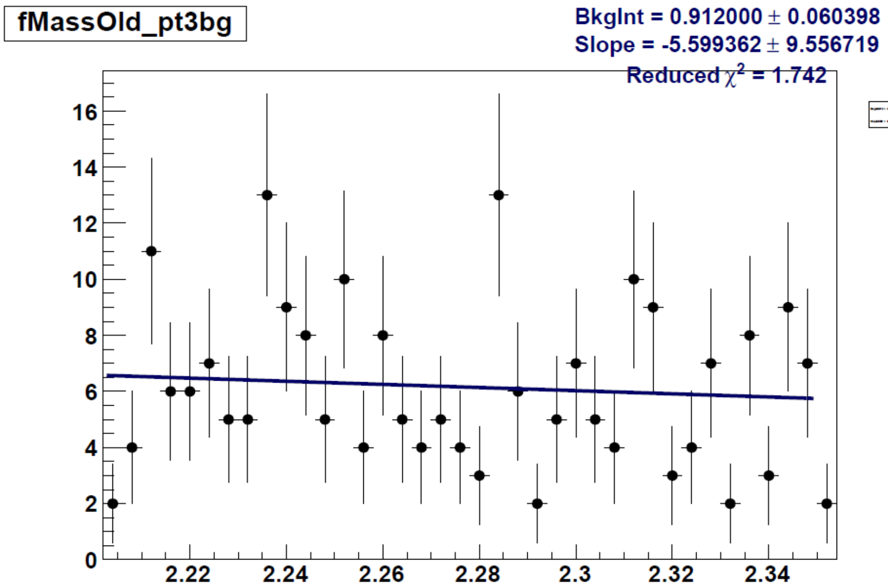
- Material budget: Rescale conversion electron based on material budget changes

- Check systematics
- Normalized d_0 for electrons from b,c and background(compare current and upgrade)
- S/B vs pt with 3 sigma cut (compare current and upgrade)

Production and Analysis cuts

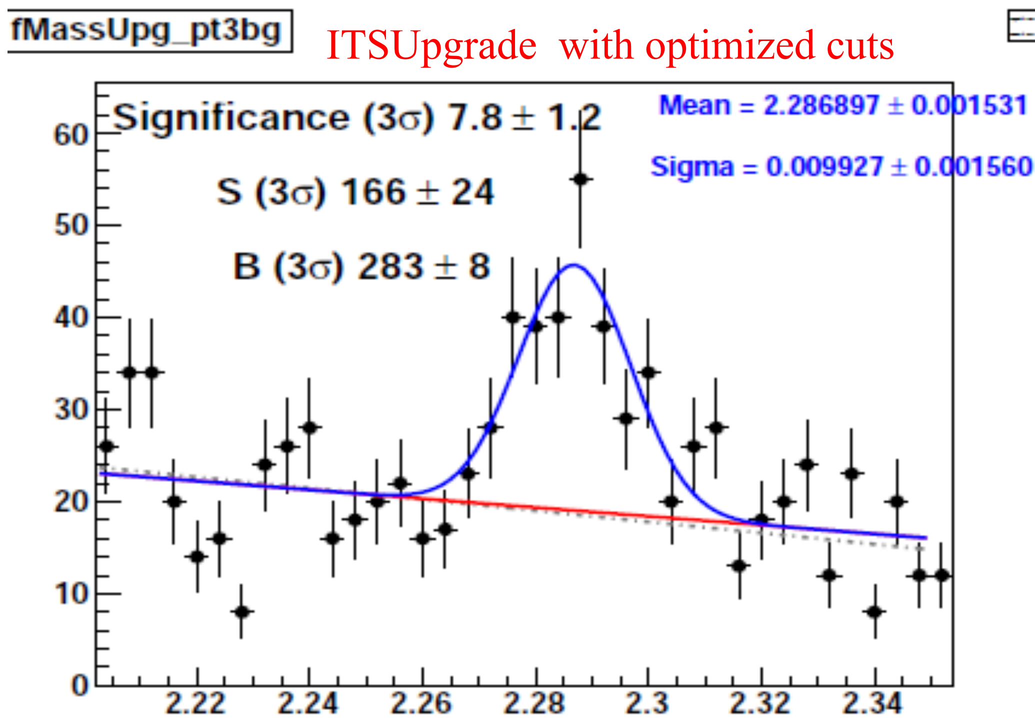
Λc cuts	Prouction	Analysis (ptbin0,1,2,3)	My Cuts
p_T (K)	> 0.4	> 0.6	>0.6
p_T (π)	> 0.5	>0.6, 0.8, 1, 1.2	>0.5
d0(K)	>0	>0	<0.4
d0(π)	>0	>0	<0.4
dist12ToPri m	>0.01	>0.01	>0.015
SigmaVertex	< 0.06	<0.03	<0.04
decayLength	>0.005	>0.005, 0.015, 0.018, 0.018	>0.008
p_T max	>0.7	>0.6, 0.8, 1, 1.2	>0.7
CosPointAng	>0	>0	>0.7
Sumd0^2	>0	>0	>0.3
Dca	<0.05	<0.04, 0.04, 0.03, 0.03	>0.008

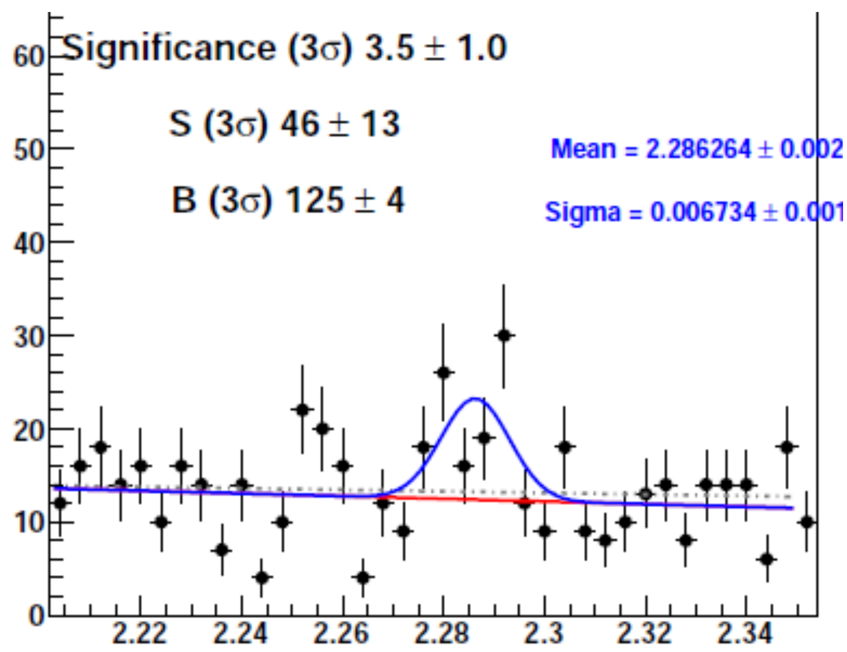
LHC10f6a: pp Minimum Bias 7TeV ~ 70 10^6 events
ITS All New



←Current ITS with current cuts: no peak found

ITSUpgrade with optimized cuts



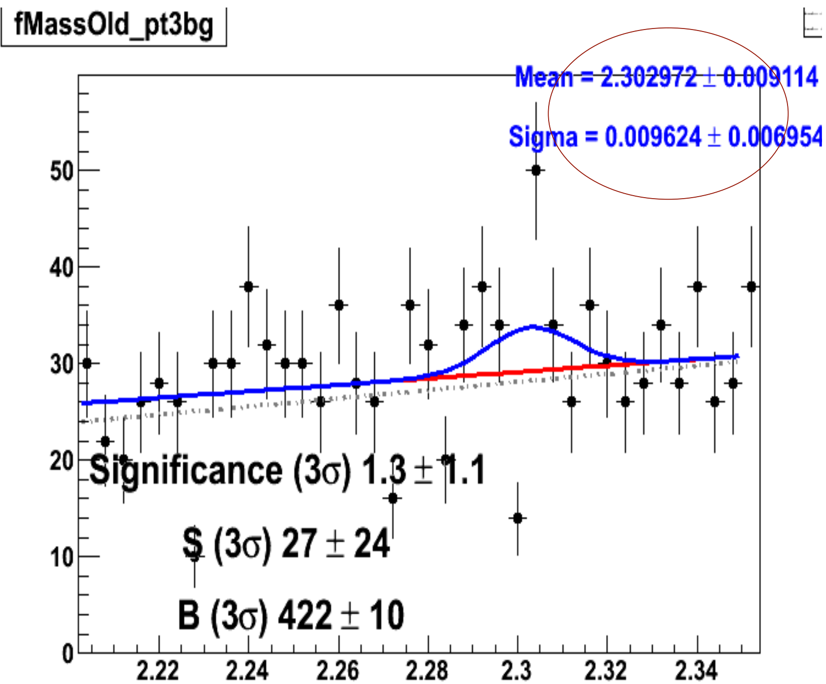


← Current ITS with optimized cuts

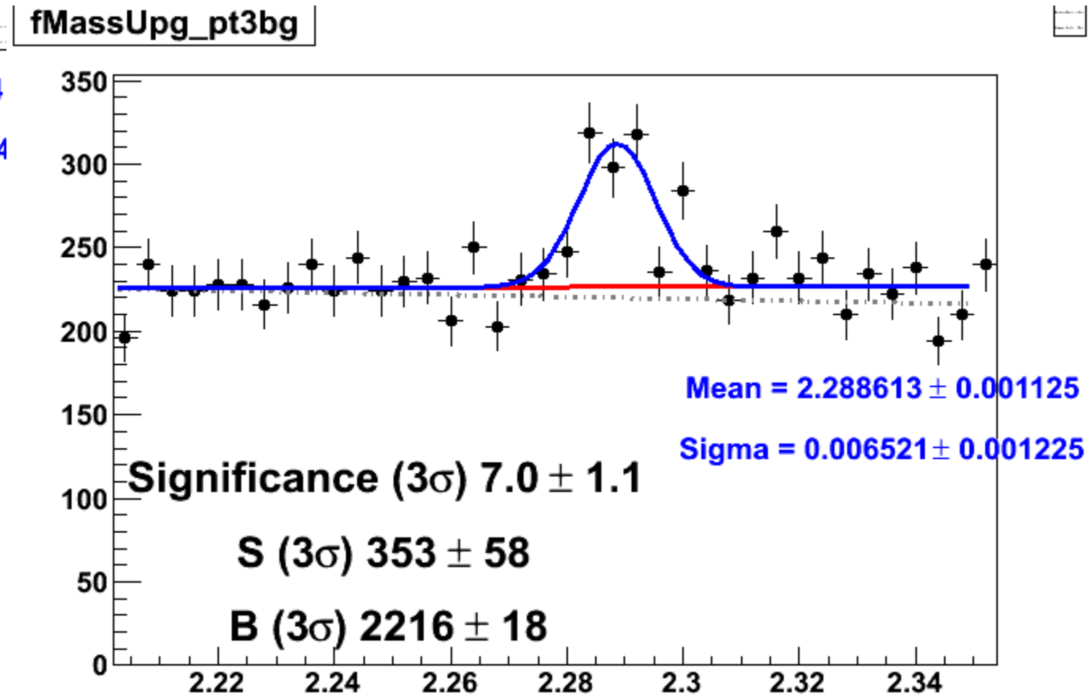
LHC11a3: Pb-Pb 2.76 TeV ~ 127.000 events

Charm and Beauty enriched, with PWG3 barrel signals ,0-20% centrality

ITS All New



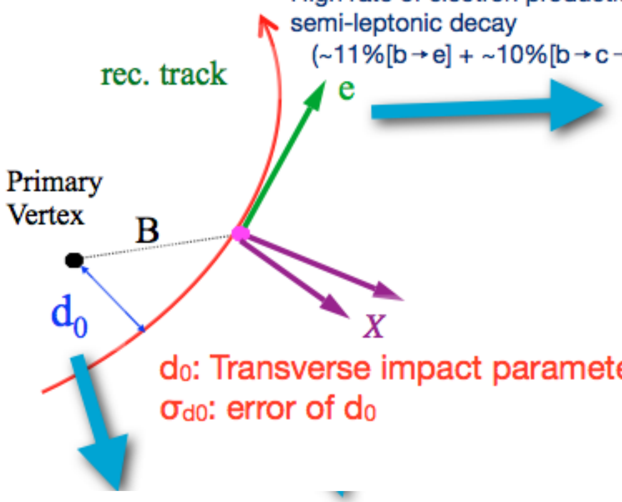
Current ITS: not a true peak



ITSupgrade and optimized cuts

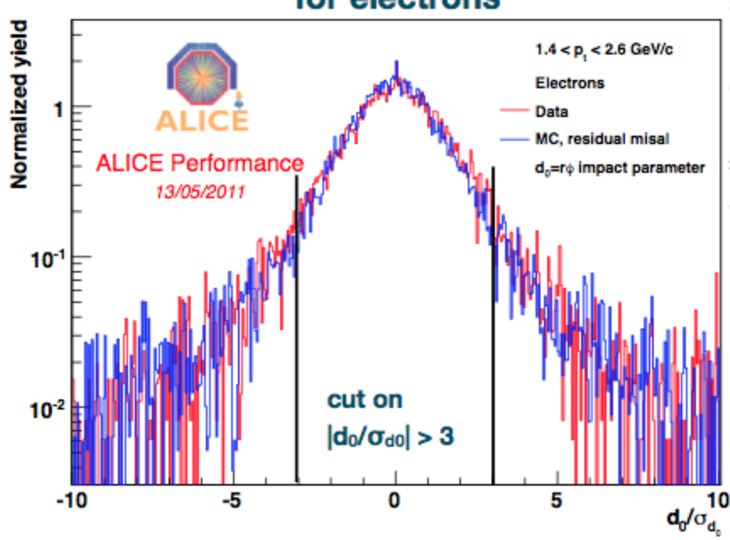
B→e plans

High rate of electron production via semi-leptonic decay
(~11%[b→e] + ~10%[b→c→e])

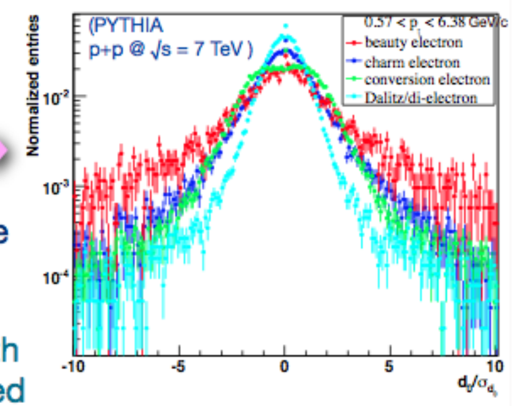


d_0: Transverse impact parameter
σ_{d0}: error of d_0

Impact parameter performance for electrons



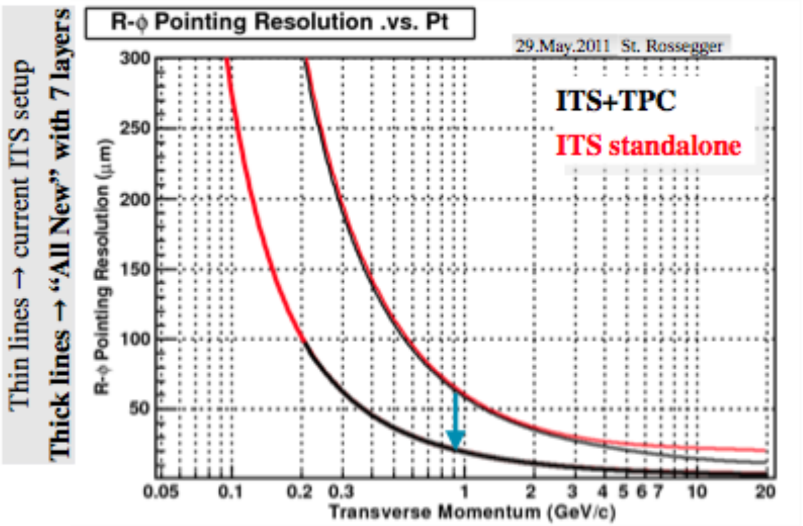
Beauty meson has cτ ≈ 500 μm and a hard momentum spectrum, which leads larger impact parameter of decay electrons than those of backgrounds
⇒ obtain a high purity sample with the following strategy:



1. Electron identification with TPC, TOF and TRD combined
2. Impact parameter cut to reject misidentified $\pi^{\pm}$, $e^{\pm}$ from Dalitz decays, γ conversions and charm meson decays
3. Estimate remaining $e^{\pm}$ from charm decays via measured D meson cross section and $e^{\pm}$ from Dalitz decays and γ conversions via measured π^0 meson cross section

B→e plans

How the measurement of beauty could be improved by ITS upgrade



- Monolithic–like pixels(example) provide ~ factor 3 improvement for the transverse impact parameter resolution

  ↓

  Reduce the current systematics by the impact parameter cut. we can also apply tighter impact parameter cut (ex. 3σ → 2σ) to increase beauty decay electron efficiency with better control of systematics

- Monolithic–like pixels(example) provide ~ factor 3 reduced material budget (in this analysis, we require hit on the first pixel so that we can directly compare single layer's material budget)

  ↓

  Reduce electron backgrounds coming from the photon conversion → increase purity(signal/background)

$$\frac{Conv.}{Dalitz} = \frac{BR^{\gamma\gamma} \times 2 \times \left(1 - e^{-7/9 \times X/X_0}\right) \times 2}{BR^{Dalitz} \times 2}$$