Attività ITS Work Package 1 "Physics Performance"

ITS WP1 activities overview

ALICE

Not started 1) Complete studies that were not mature enough for the TDR

Done 2) Input to decision on beam pipe radius

Done 3) Requirements for proton-proton running

Ongoing 4) Performance with final detector specs and more realistic experimental conditions

- New MC simulation (also with MFT): wait for software readiness

Ongoing 5) Assess physics performance of ITS+TRD+TOF

- First studies (Λ_c) started

Discussions started 6) Trigger: do we need a ITS-based trigger for UPC?

- Discussion with UPC group started

Discussions started 7) Further explore the potential of extended acceptance

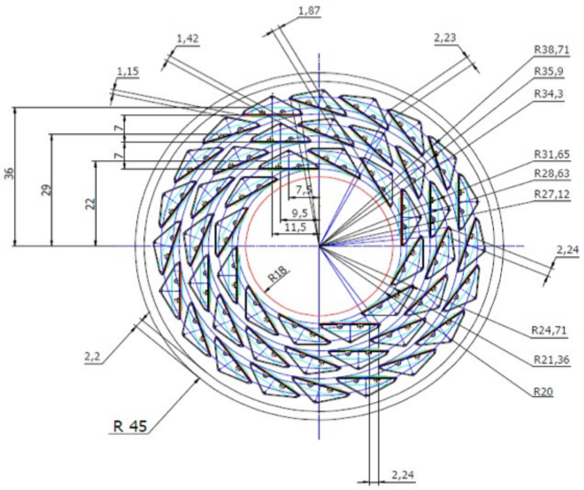
- For correlations, also considering ITS+MFT

Ongoing 8) Fast simulation tools to study reconstruction of rare signals

- Advancing well

Beam pipe and ITS inner barrel

Inner Barrel radii



Inner Barrel for 1.76cm beam pipe

TDR:

- 1.94 cm avg.) bpipe (Baseline)

L0:2.317cm

L1:3.119cm

L2:3.898cm

Reduced:

- 1.76cm (avg.) bpipe

L0:2.136cm

L1:2.863cm

L2:3.59cm

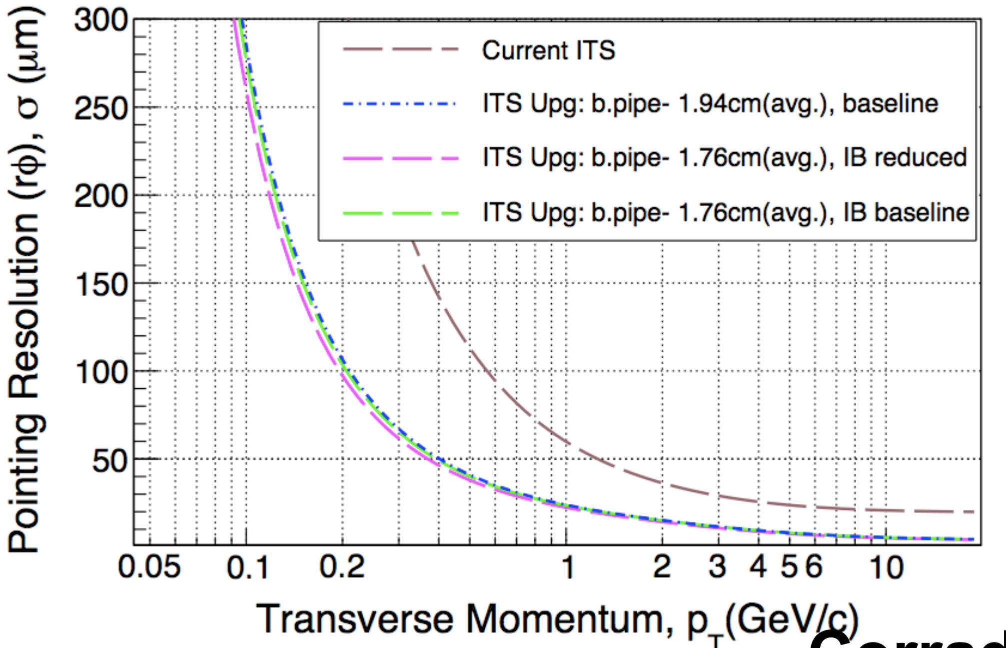
Intermediate:

- 1.86 cm avg.) bpipe (Baseline)

L0:2.317cm

L1:3.119cm

L2:3.898cm



Corrado, Gudda

Beam pipe and IB radii: outcome

Potential gain
Potential loss

- Effects of a smaller beam pipe radius:
  1. Tracking resolution improves at low p_T → significant gain? **NO**
  2. The ITS IB could be placed closer (see below)
  3. OR: The ITS IB could be kept as is → easier installation **YES**
  4. The MFT could be placed closer → increased η acceptance? **NO**
  5. γ conversions closer to the primary vertex → bad for dielectrons? **NO**
- Effects of smaller ITS IB radii:
  1. Tracking resolution further improves at low p_T → significant gain? **NO**
  2. Increase of innermost layers occupancy → higher fake track rate? **YES**

(NO = not substantially; YES = substantially)

→ OK for reducing pipe by 1 mm and leaving IB as is

Approved by MB

Update on pp L_{int} requirements

Measurement	At 5.5 TeV	At 14 TeV	
D^0	6/pb*	Not possible	
Λ_c	0.6/pb*	Not possible	
J/psi from B	3/pb	Not assessed	**Fiorella**
Λ_b	(60 ± 30) /pb	(22 ± 12) /pb	**Cristina**
B+	(80 ± 60) /pb	(40 ± 30) /pb	**Johannes**
Jets	300/pb	80/pb	**Mateusz**

- *: from LOI, to be revised based on TDR performance
- **Should be ok also MFT Physics, to be verified**
- Beauty measurements are OK at 14 TeV (scaling error much smaller than for charm)
- Jets: 300/pb not possible… will have to do with 14 TeV, but need a sample at 5.5 TeV (to be quantified) for validation of 14 TeV scaled ref.

Standard MC Production & Analysis

Concept – What are the limitations on generated statistics?

→ Computing time & storage space!

Most of the computing time is spent here!

ESD/AOD track cuts + PID

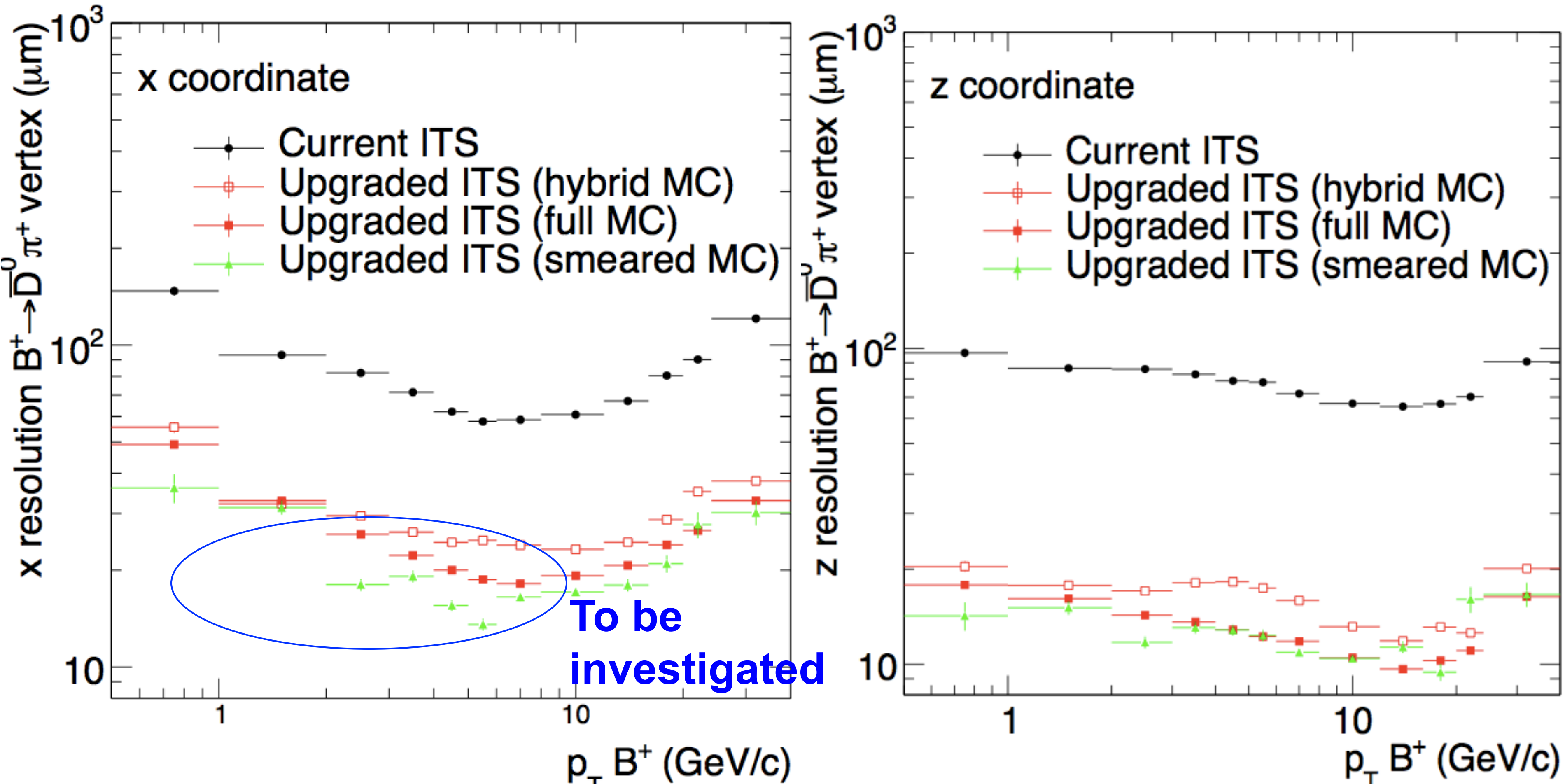
HIJING, ...

Parameterized Fast Track Simulation & Analysis

Concept – Ideally, we end up with "on-the-fly" ESD and AOD generation, comparable to *ITSImprover*

First checks on full chain for B→$D^0\pi$ reconstruction

- Full chain kine→ESD→AOD→AODvertexingHF in place
- First comparison of B+ secondary vertex resolution



EXTRA SLIDES

Breve riassunto attività recente: physics performance per il TDR

Summary of physics reach

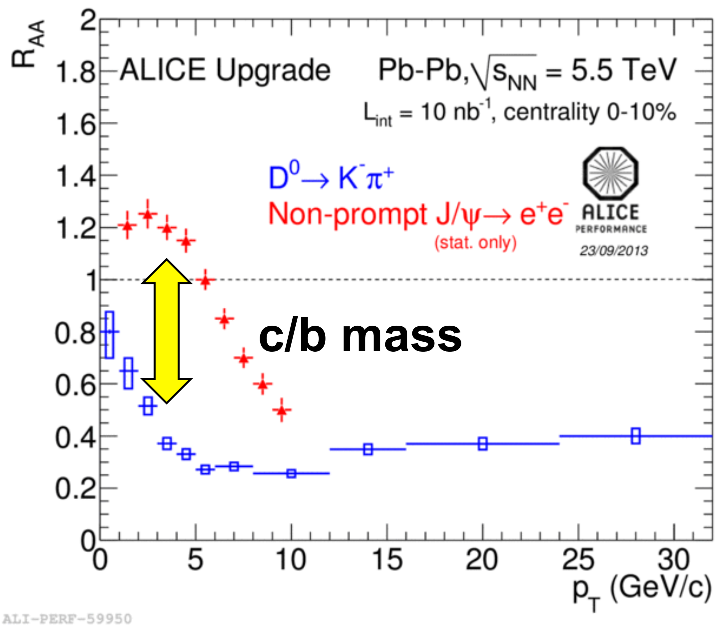
New wrt CDR	Full MC	Observable	Current, 0.1 nb^{-1}: p_T^{min} (GeV/c)	Current, 0.1 nb^{-1}: statistical uncertainty	Upgrade, 10 nb^{-1}: p_T^{min} (GeV/c)	Upgrade, 10 nb^{-1}: statistical uncertainty
		Heavy Flavour				
	→	D meson R_{AA}	1	10 %	0	0.3 %
→		D_s meson R_{AA}	4	15 %	< 2	3 %
	→	D meson from B R_{AA}	3	30 %	2	1 %
→		J/ψ from B R_{AA}	1.5	15 % (p_T-int.)	1	5 %
→	→	B^+ yield	not accessible		3	10 %
	→	Λ_c R_{AA}	not accessible		2	15 %
	→	Λ_c/D^0 ratio	not accessible		2	15 %
→	→	Λ_b yield	not accessible		7	20 %
	→	D meson v_2 ($v_2 = 0.2$)	1	10 %	0	0.2 %
→		D_s meson v_2 ($v_2 = 0.2$)	not accessible		< 2	8 %
	→	D from B v_2 ($v_2 = 0.05$)	not accessible		2	8 %
→		J/ψ from B v_2 ($v_2 = 0.05$)	not accessible		1	60 %
→	→	Λ_c v_2 ($v_2 = 0.15$)	not accessible		3	20 %
		Dielectrons				
		Temperature (intermediate mass)	not accessible			10 %
		Elliptic flow ($v_2 = 0.1$) [14]	not accessible			10 %
		Low-mass spectral function [14]	not accessible		0.3	20 %
		Hypernuclei				
→	→	$^3_\Lambda$H yield	2	18 %	2	1.7 %

Heavy Flavour R_{AA} and flow

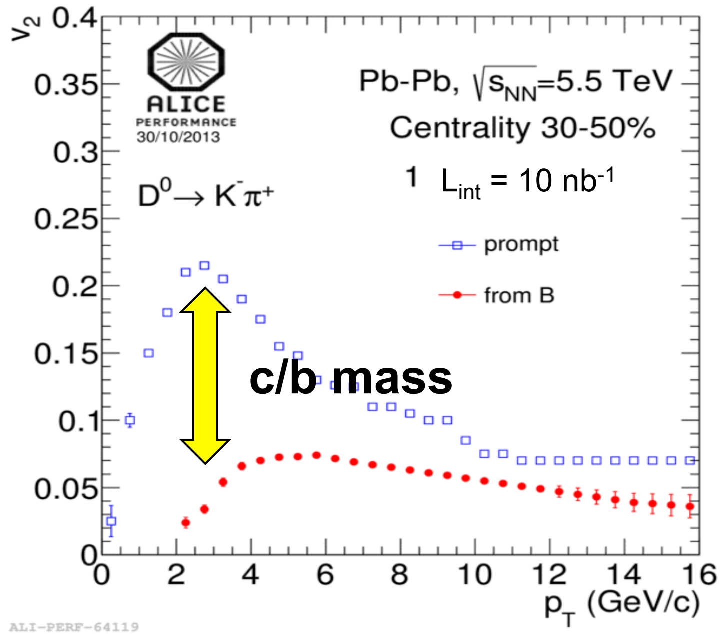
- Pin down mass dependence of energy loss
- Investigate transport of heavy quarks in the QGP
  - Sensitive to medium viscosity and equation of state

→ R_{AA} and v_2 of D and B in a wide p_T range

Prompt D^0 and Non-prompt J/ψ R_{AA}



Prompt and non-prompt D^0 v_2

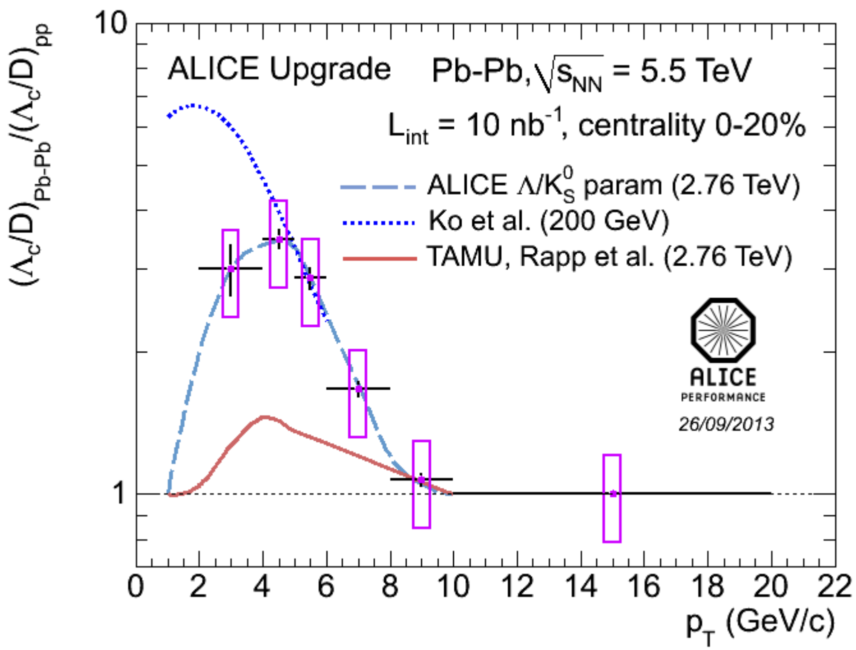


Input values from BAMPS model:
C. Greiner et al. arXiv:1205.4945

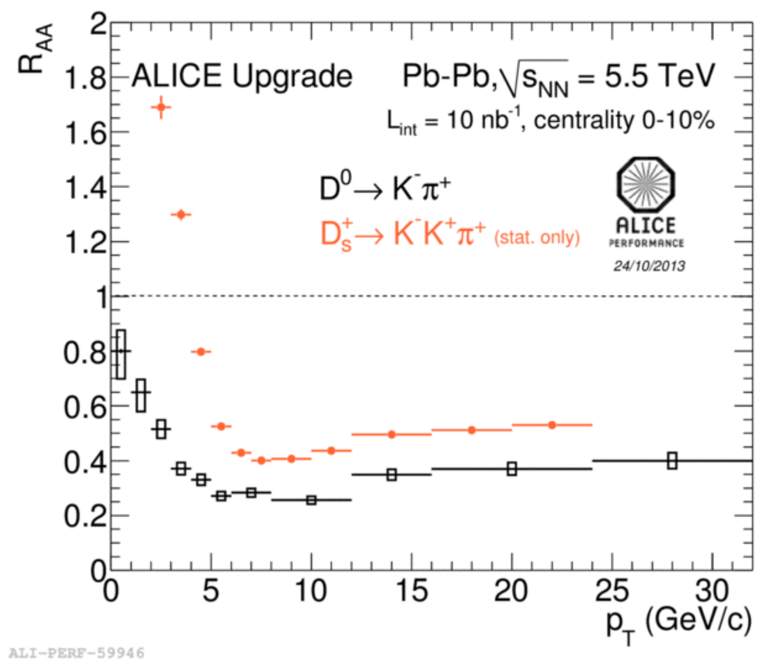
Heavy Flavour "hadrochemistry"

- Investigate thermalization and hadronization mechanism (recombination?)
- $\Lambda_c \rightarrow pK\pi$ and $D_s \rightarrow KK\pi$ ($c\tau$=60 and 150 μm)

Λ_c/D enhancement
(full detector sim.)

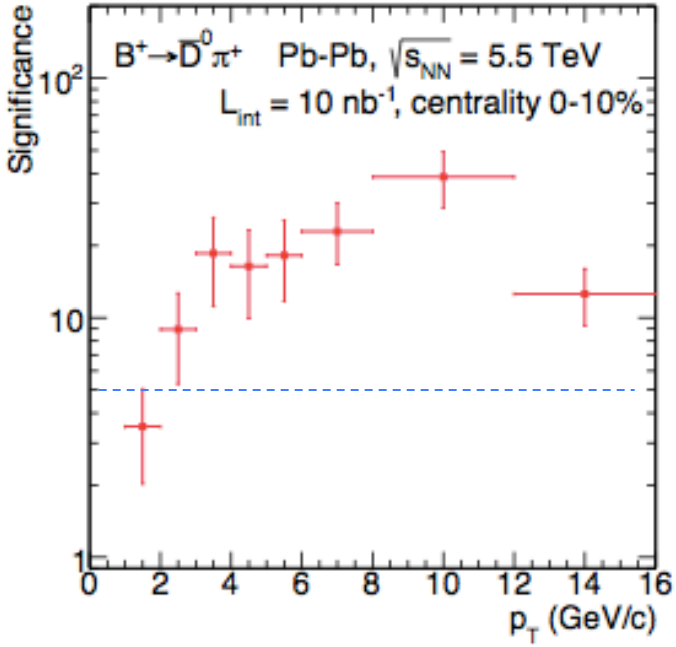


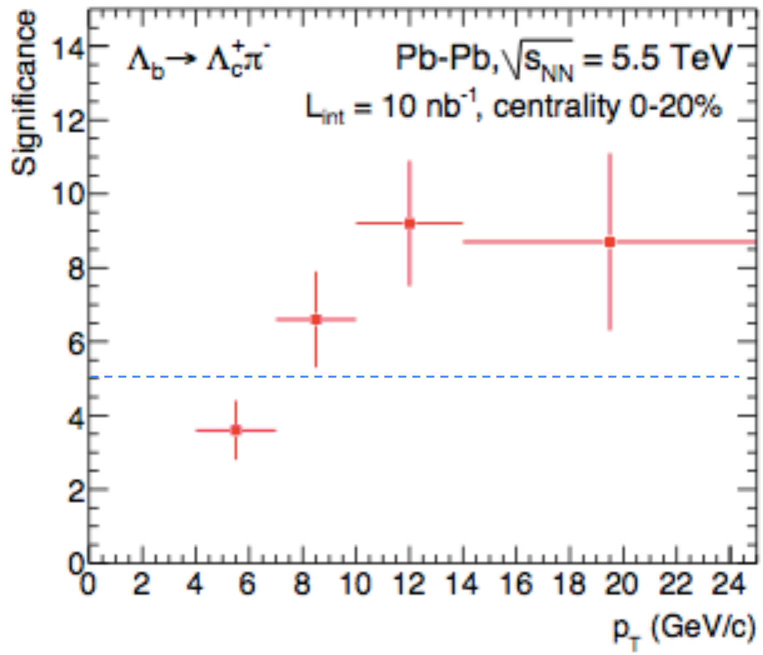
D^0 and D_s R_{AA}

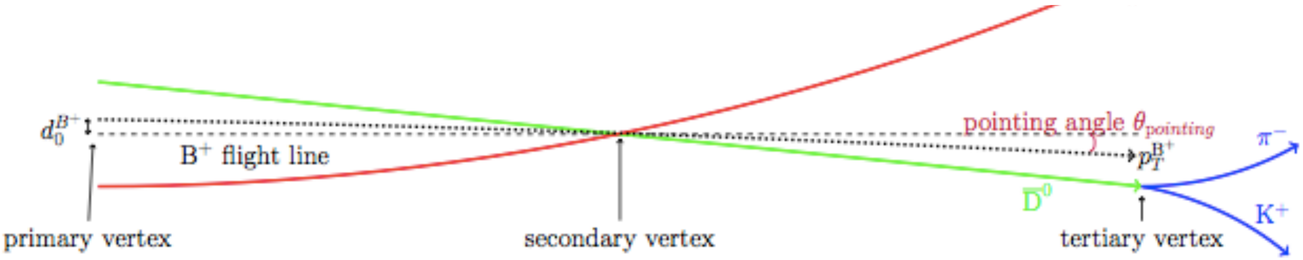


Exclusive beauty reconstruction

- Tracking precision and large L_{int} gives access to fully reco beauty decays
- Two benchmark channels considered: $B^- \rightarrow D^0(\rightarrow K\pi)\pi^-$ and $\Lambda_b \rightarrow \Lambda_c(\rightarrow pK\pi)\pi^+$, both with BR~$10^{-4}$ and similar topology







Study on effect of ITS PID

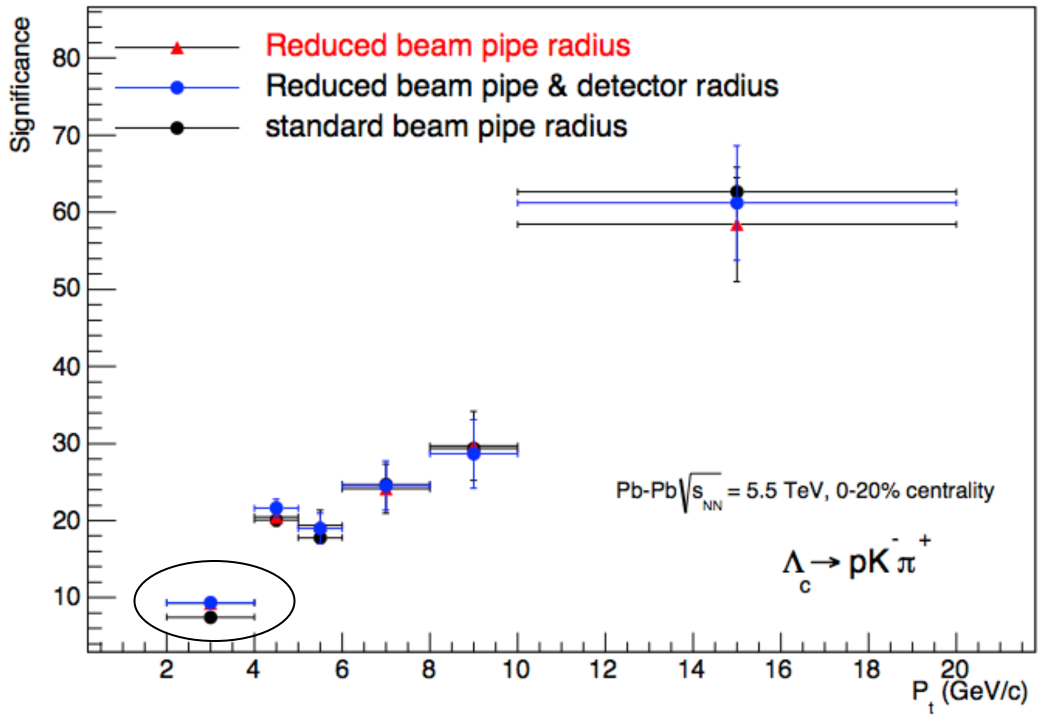
- Q: need PID in the new ITS for the Upgrade programme?
- We have studied the benefit of ITS PID for the two items that are potentially more sensitive
  - $\Lambda_c \rightarrow pK\pi$: where PID is important because $c\tau$ is only 59 μm
  - Low-mass dielectrons: eID for low-p_T conversion rejection
- In both cases, the effect of PID in the ITS is marginal:
  - $\Lambda_c \rightarrow pK\pi$: only few % effect on significance in 2-3 GeV/c
    - Because it is more effective to decay tracks with p_T>800 MeV/c
  - Low-mass ee: statistical error on high-mass inverse slope T is 8% w/ PID and 11% w/o PID

→ *Decision to build ITS without PID capability*

Λ_c and pipe / IB radii

ALICE
Rossella

- Studied using Hybrid method on MC with new ITS (LHC13d19)



- Significance improves by 20% in bin 2-4 GeV/c (from 8 to 9.5)
  - Not a substantial change

Radii and occupancy

ALICE

Ruben

- Occupancy in innermost layers has two components
  - Hadronic: scales with $1/r^2$ → +20% from 23 to 21 mm
  - QED electrons: scales faster than $1/r^2$ (very soft p_T spectrum) → +50-70% from 23 to 21 mm
- Layer-0 occupancies in central collisions estimated for Pb-Pb 50 kHz (30 μs read-out cycle for pixels)

	1 central + 0 m.b.	**1 central + 1 m.b.**	**1 central + 2 m.b.**	**1 central + 3 m.b.**
21 mm	48 hits/cm^2	58 hits/cm^2	68 hits/cm^2	78 hits/cm^2
23 mm	64 hits/cm^2	75 hits/cm^2	87 hits/cm^2	98 hits/cm^2
21 / 23	**+33%**	**+30%**	**+28%**	**+26%**