PWG5 (Heavy Flavour) summary

Alexander Zinchenko

Outline

1. Scope of activities
2. Inner Tracking System (ITS) performance evaluation
3. Related Work Packages:
    1. Vertex finding in low-multiplicity events
    2. Energy loss simulation and reconstruction in TPC (*dE/dx* PID)

Scope of activities

1. Open charm studies: exclusive decays → Inner Tracking System (ITS) performance evaluation (synergy with ITS project) → dedicated track reconstruction methods (“Vector Finder”)
2. Semi-leptonic decays and charmonia → lepton (electron) tagging (synergy with dilepton studies) → energy loss simulation and reconstruction in TPC for *dE/dx* PID

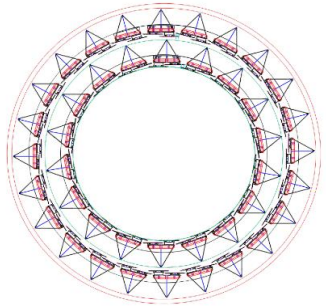
MPD Inner Tracking System based on MAPS

The two-stages construction scenario. Stage-1 (by 2022/2023)

MPD - ITS

The Outer Barrel.

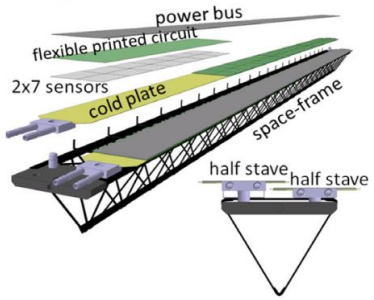
ALICE-ITS2 technology (42 Staves)

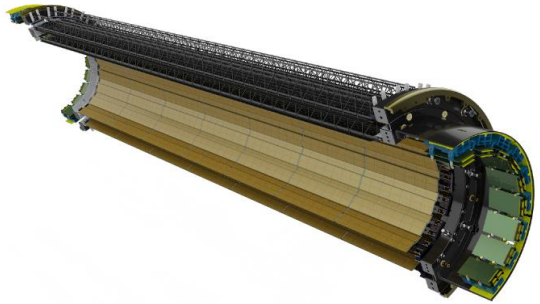


Layer 4: 18 Staves (36 Panels)
Layer 5: 24 Staves (48 Panels)

Sensor

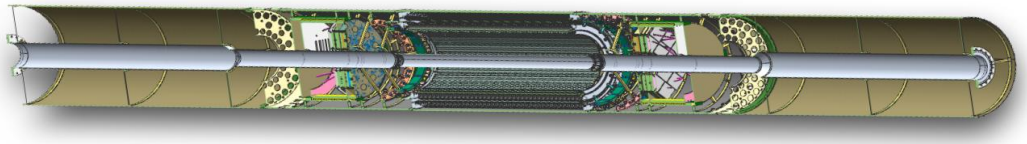
100 um-thick MAPS



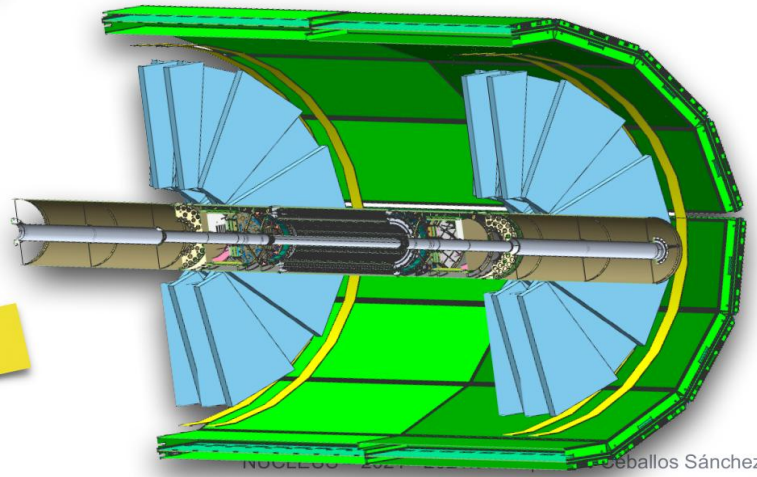


The Integration Mechanics.

(Beam pipe, TPC, FFD)



MPD Stage-I !!!



C. Ceballos Nucleus 2021

MPD Inner Tracking System based on MAPS

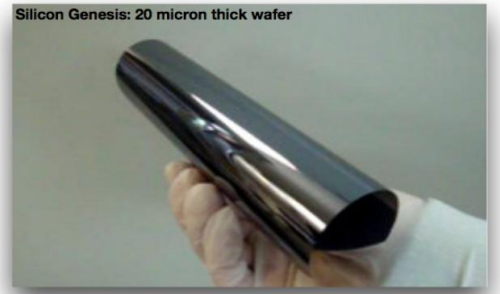
The two-stages construction scenario. Stage-2 (by 2025/2026)

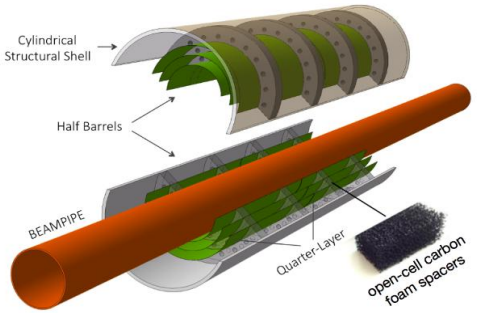
MPD - ITS

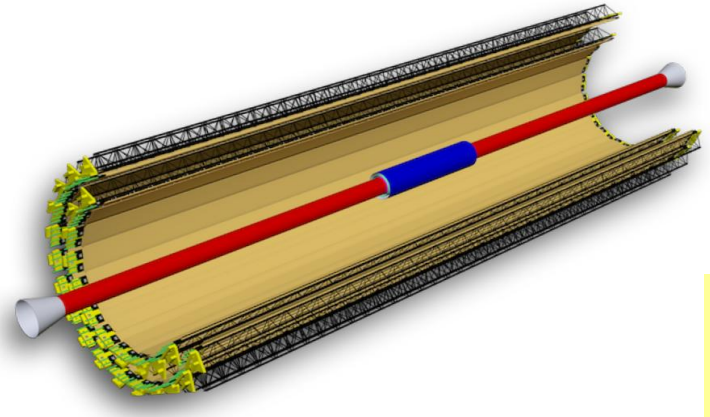
The Inner Barrel.

Goal: Use double-size ALICE-ITS3-like sensors on a beam pipe of 40 mm in diameter

ALICE-ITS3 (Under R&D): 20 um-thick (!!!) by 280 mm-long bent MAPS







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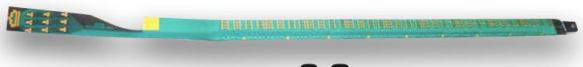
Nucleus 2021

BackUp plan: Built an ALICE-ITS2-like IB

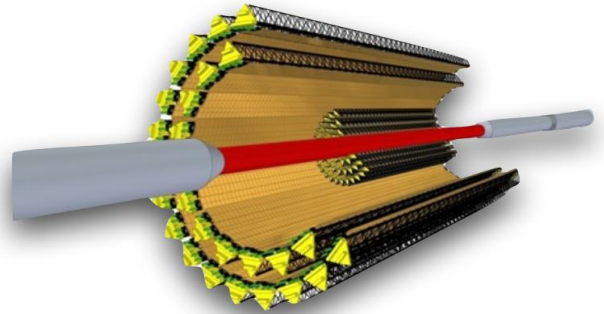
Sensor

50 um-thick MAPS

IBHIC



9 Sensors



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MPD Inner Tracking System based on MAPS

D^+_s reconstruction in central Au+Au at NICA energy

Particle	Mass [MeV/c^2]	Mean path $c\tau$ [mm]	Decay channel	BR	Multiplicity
D^+	1869.6	0.312	$\pi^+ + \pi^+ + K^-$	9.13%	10^{-2}
D^+_s	1968.5	0.150	$\pi^+ + K^+ + K^-$	5.50%	10^{-2}

Reconstruction of D^+_s is more complicated task compared to D^+ for three reasons:
1) due to the decay length is 2 times shorter,
2) due to the BR is 2 times less,
3) due to the decay channel, since the reconstruction efficiency of K tracks is lower than that of π tracks.

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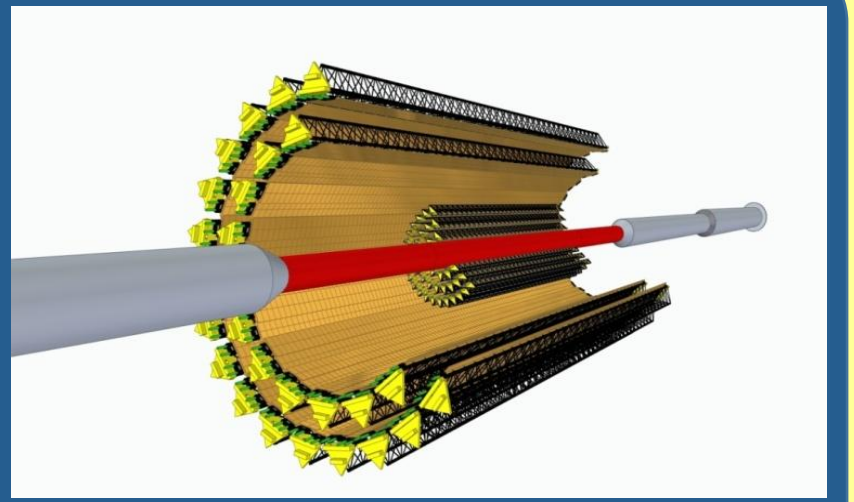
N. Maltsev @ Nucleus 2021

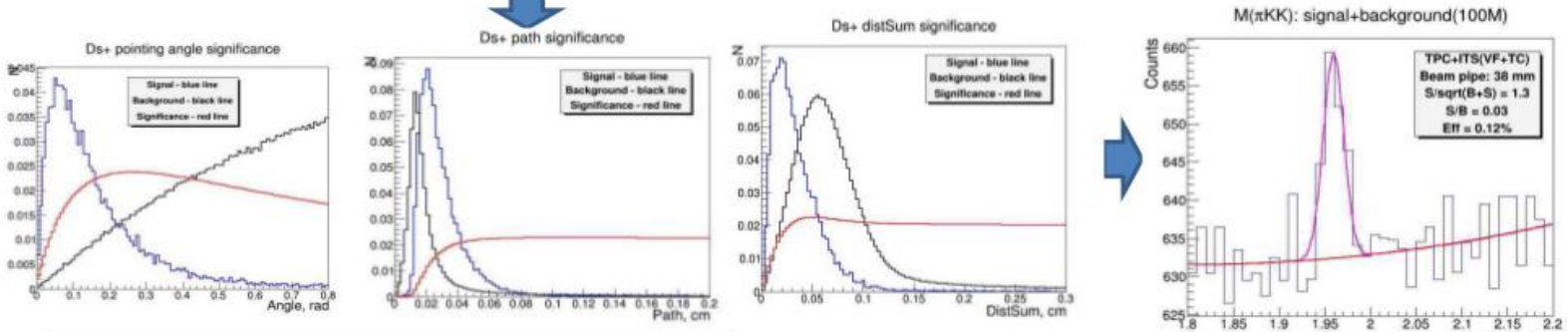


MPD Inner Tracking System based on MAPS

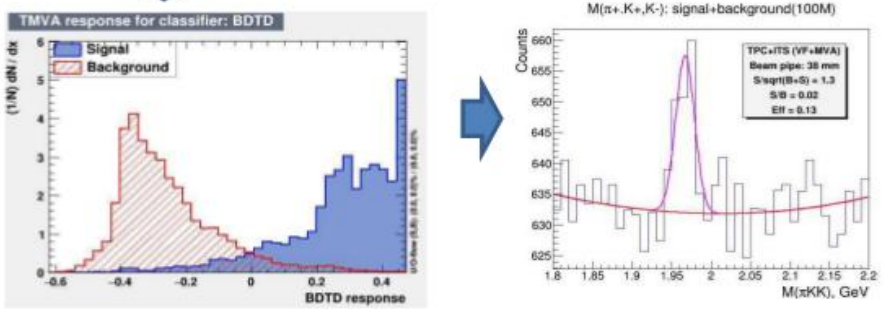
D^+_s reconstruction using VF

TC: *dca*(π, K) > 0.018 cm, *angle*(D^+_s) < 0.22 rad & *dist*(πK) < 0.04 cm & *path*(D^+_s) < 0.05 cm

$D^+_s \rightarrow K^- + K^+ + \pi^+$



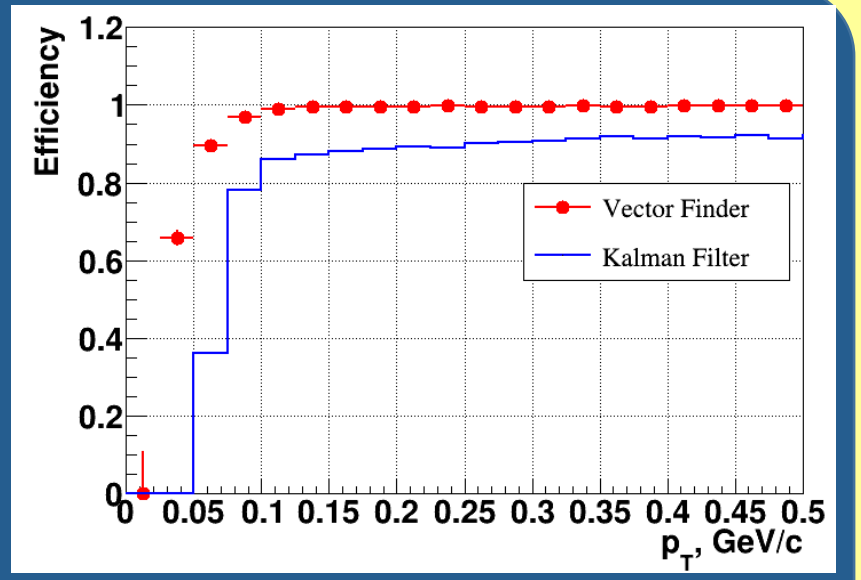
MVA: *dca*(π, K) > 0.02 cm, BDT_response>0.25

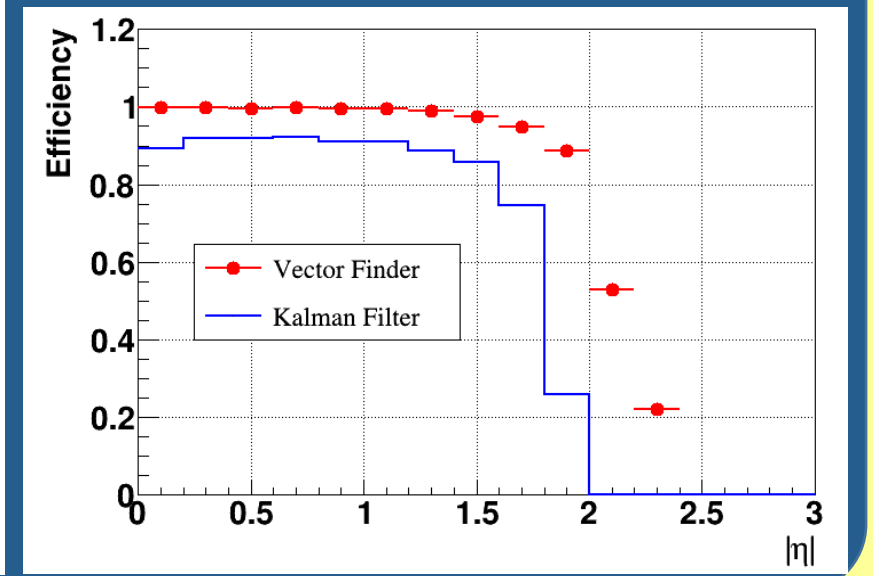


Particle	D^+_s	
Method	TC	MVA
Efficiency, %	0.12	0.13
Significance	1.3	1.3
S/B(2σ) ratio	0.03	0.02

VF mechanism opens up the feasibility of reconstruction D^+_s with an efficiency of 0.12 % by both TC and MVA methods at the same level of significance (1.3) with project ITS

N. Maltsev @ Nucleus 2021 (Equivalent statistics ~100M Au+Au)



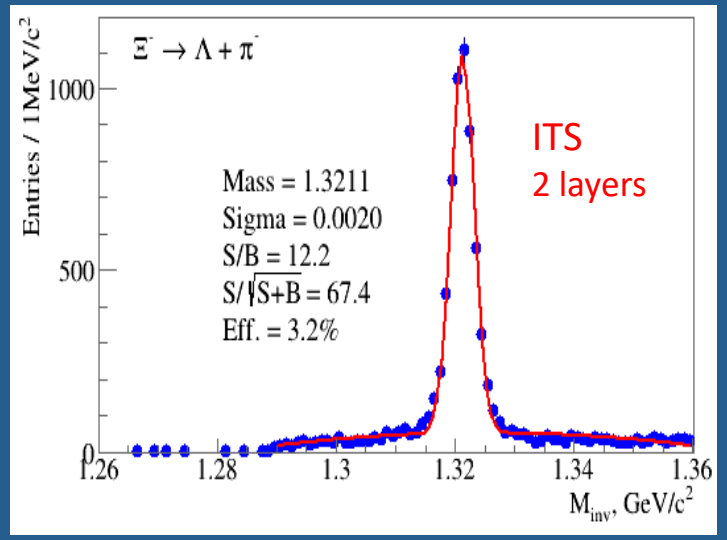


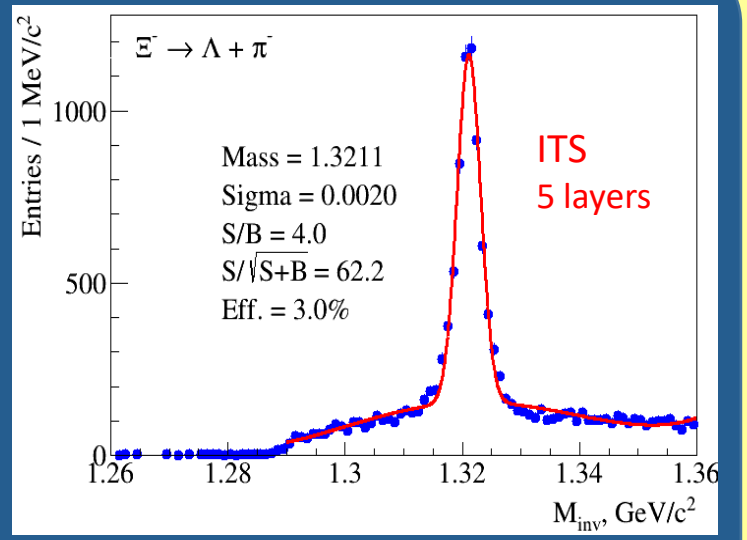
ITS Stage 1 (2-layer) – performance for hyperons

D. Suvarieva @ Nucleus 2021
V. Vasendina

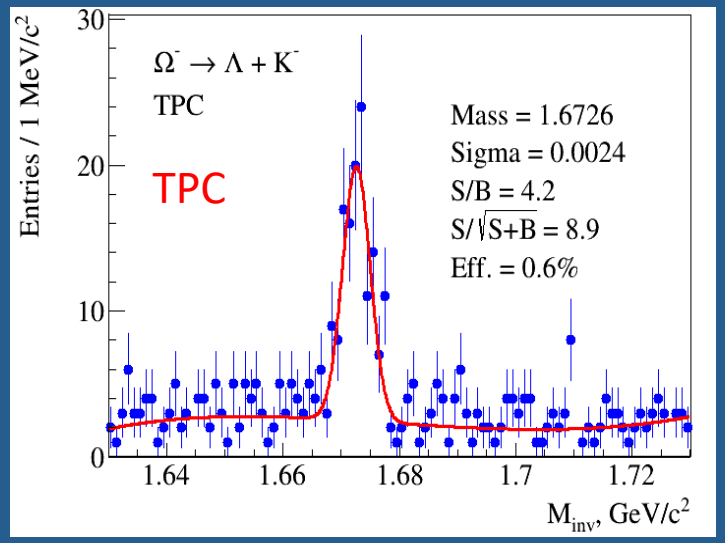
Ξ^- hyperon

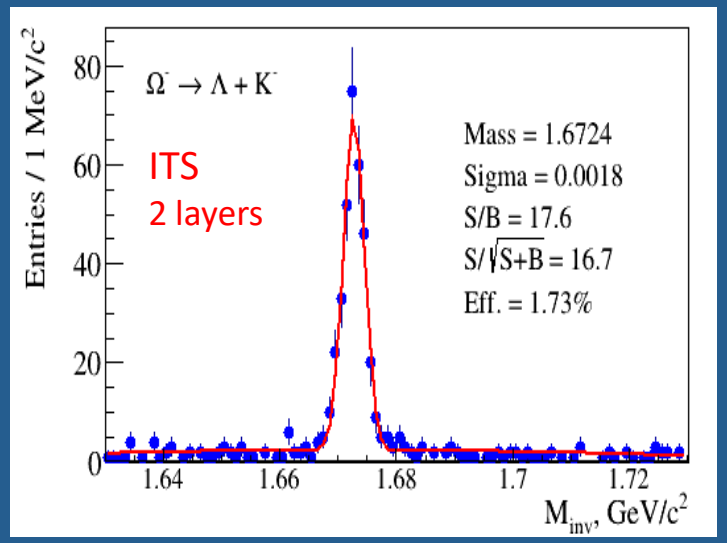
UrQMD central (0-3 fm) Au+Au at 9 GeV
250k events, Ideal PID

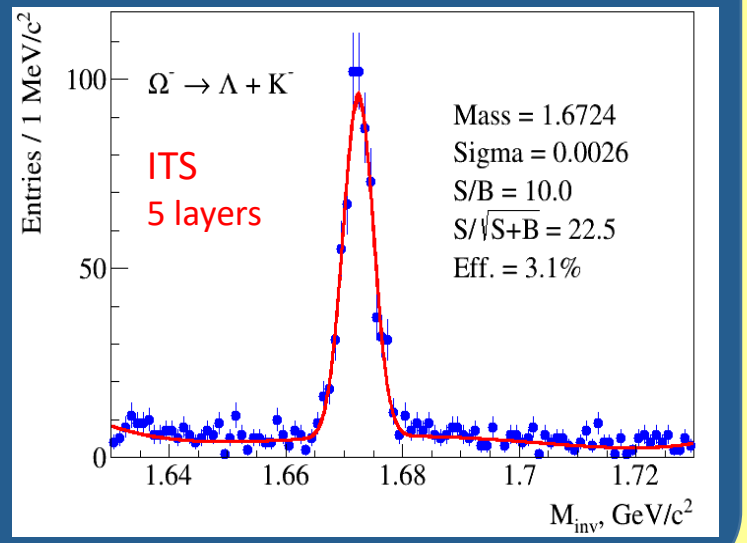




Ω^- hyperon

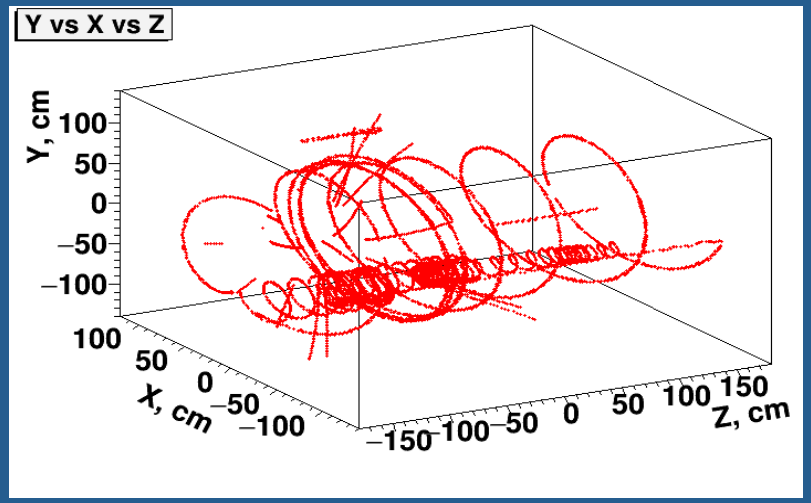


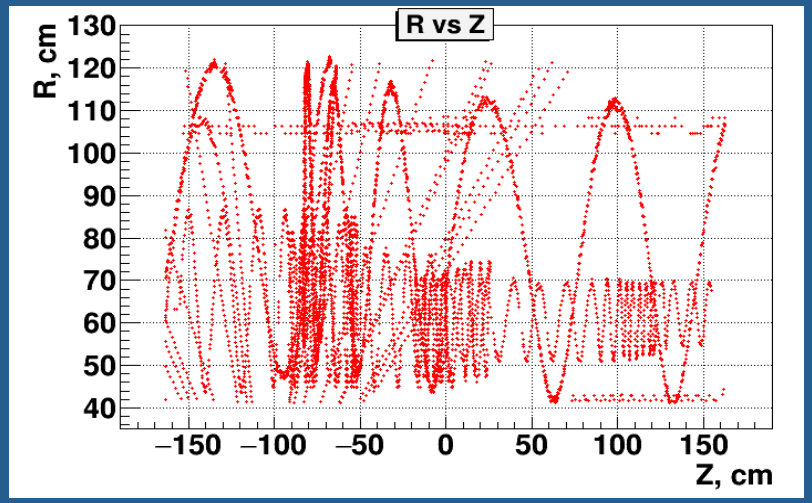




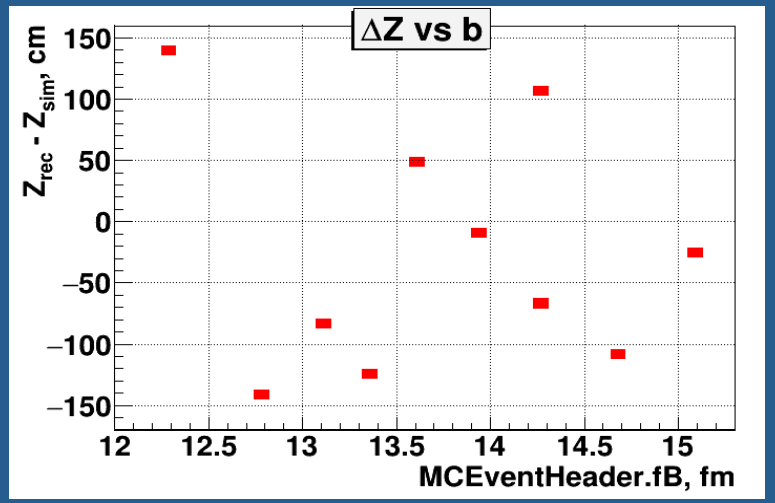
Vertex reconstruction in low-multiplicity events

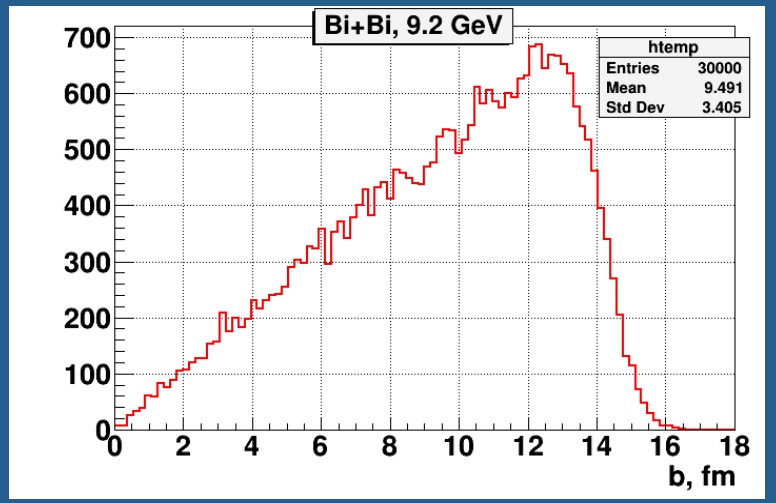
BOX: 10 π^+, 10 π^-; flat Z: -149 – +149 cm

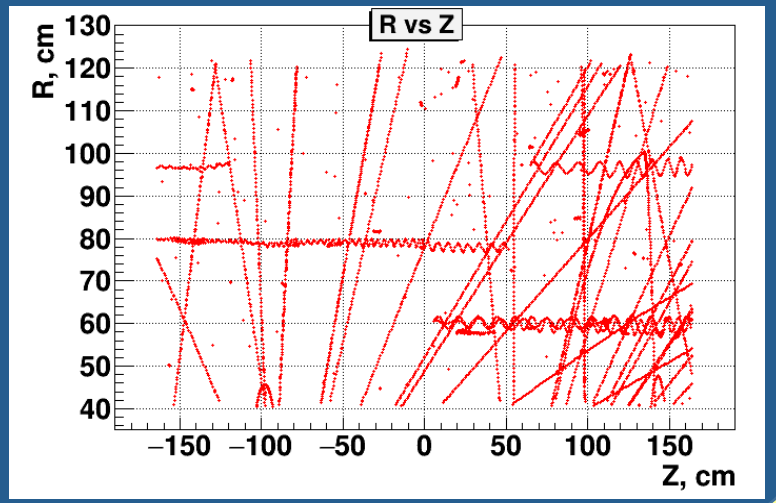




Bi + Bi @ 9.2 GeV







Leptonic decays – energy loss simulation in TPC

History:

GEANT3 does not properly describe energy losses in TPC gas
GEANT4 “has even more problems with this” (statement from some PANDA presentation)

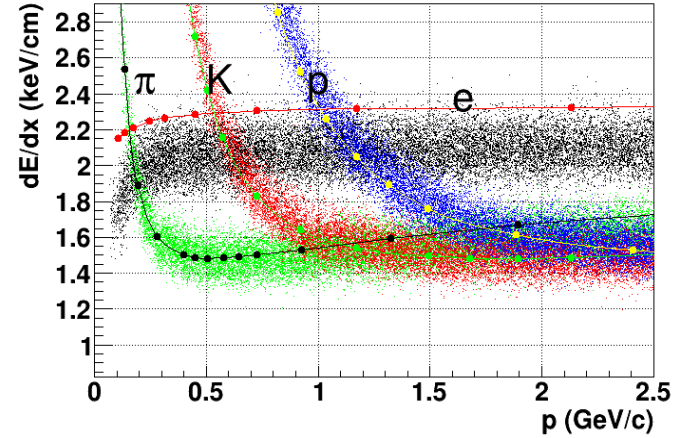
Method:

Implement energy loss simulation in TPC based on parameterization of results obtained from the microsimulation package GARFIELD++ (HEED) - now simulation agrees with measurements in STAR and ALICE TPC

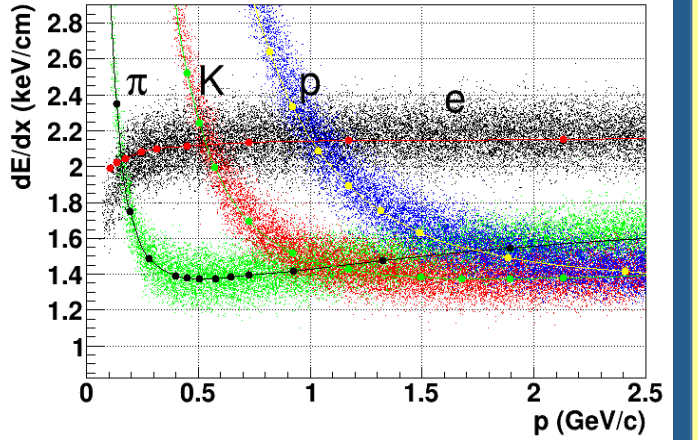
I. Rufanov - LHEP JINR

dE/dx in TPC

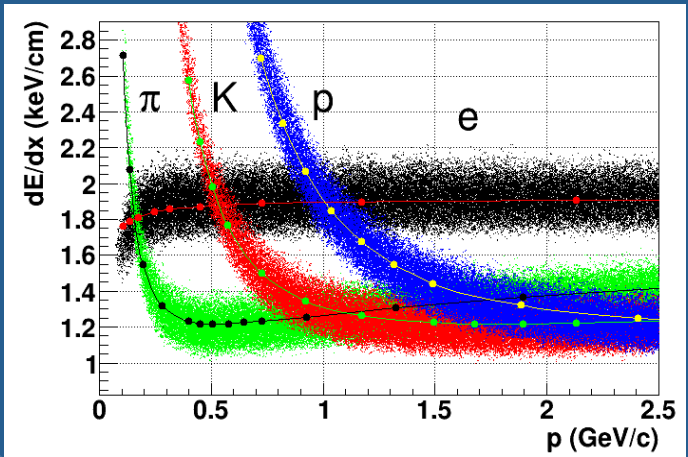
GEANT3



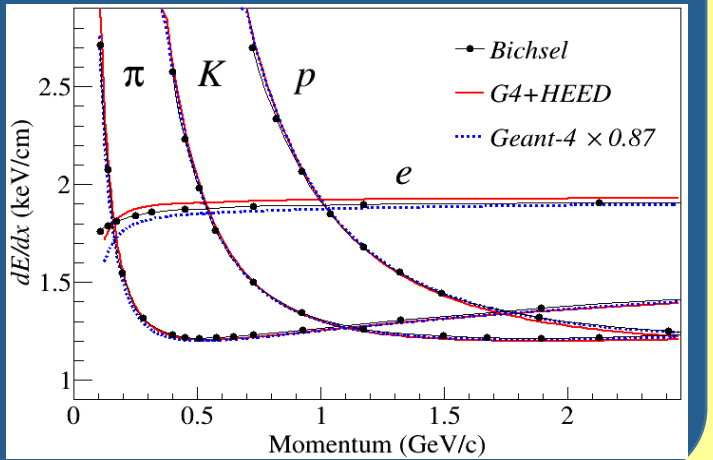
GEANT4



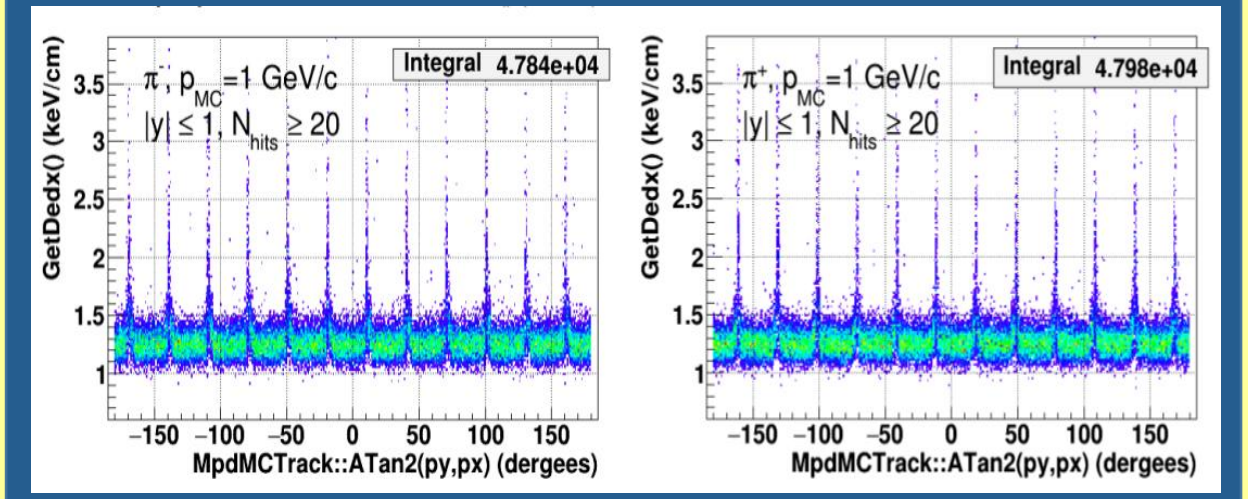
GEANT3(4) + HEED

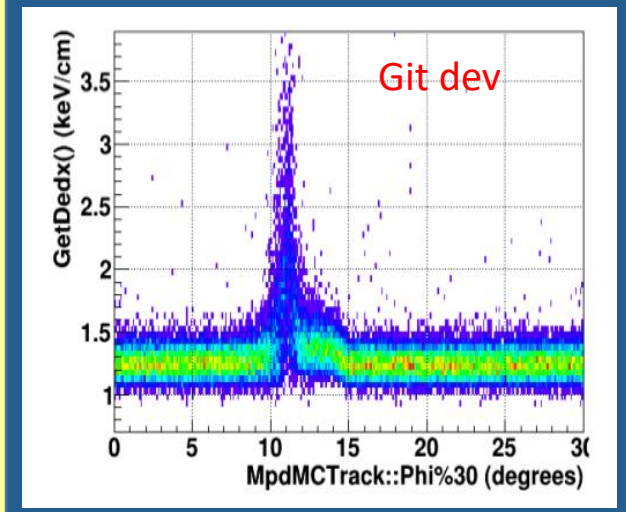


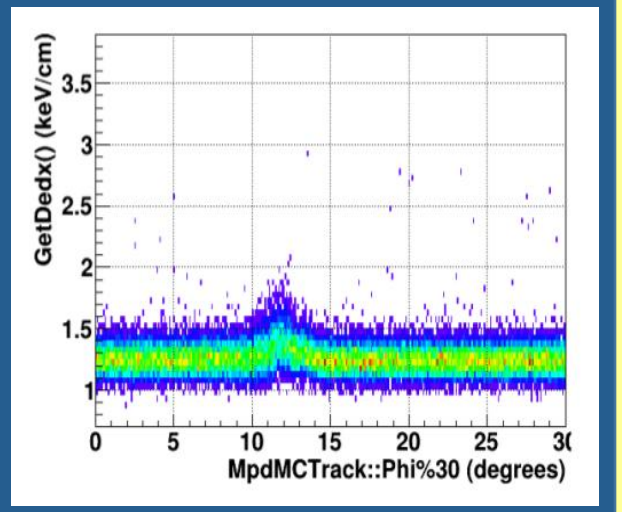
Hans Bichsel



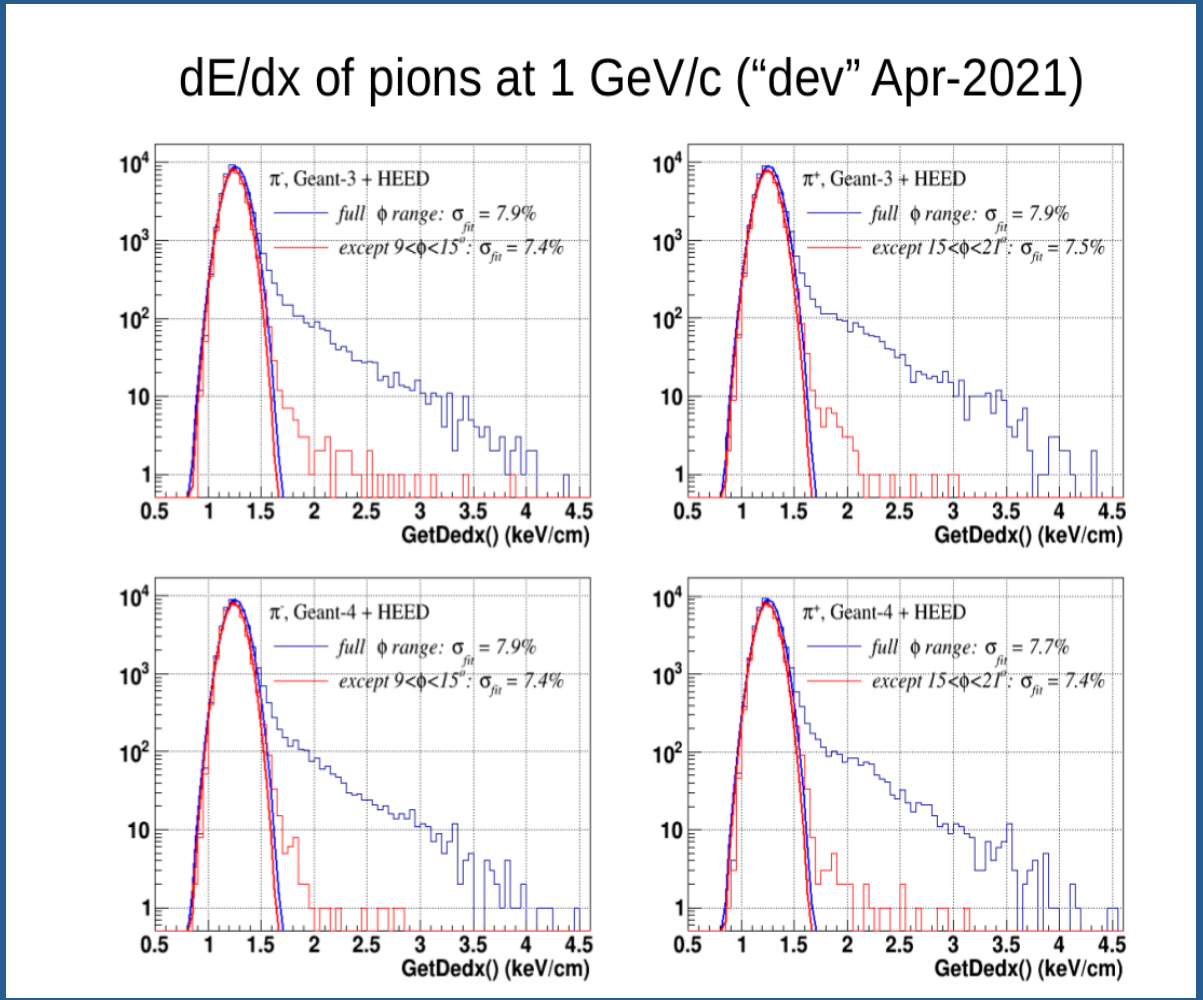
Leptonic decays – energy loss simulation in TPC







dE/dx in TPC



Summary / Outlook

- MPD ITS – related activity: dedicated track reconstruction package achieved a level allowing people to use it for detector optimization studies; ALICE ITS-3 – like geometry will be evaluated

- Leptonic decays – related activity: energy loss reconstruction requires work on cluster finder package (synergy with femtoscopy – separation of close tracks)