Studies of tracking performance for a future fixed target programme in ALICE

Md Rihan Haque

Warsaw University of Technology, Poland

collaborators: C. Hadjidakis, D. Kikola, L. Massacrier

Quark Matter 4-10 April, 2022

Motivation for Fixed Target Setup

Motivation:

- ★ Measurement in high x frontier.
- ★ Variable target system *e.g.*, C, W, Au.
- ★ CMS energy $\sqrt{s_{\rm NN}}$ =115 and 72 GeV for $p-A$ and $Pb-A$ systems, respectively.
- ★ Study longitudinal expansion of QGP.
- ★ Factorization of CNM effects & more [1]

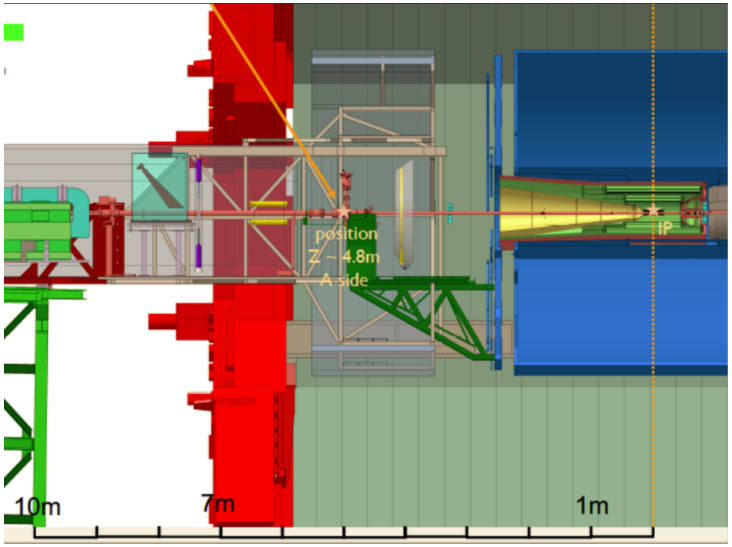
Fixed Target Setup in ALICE:

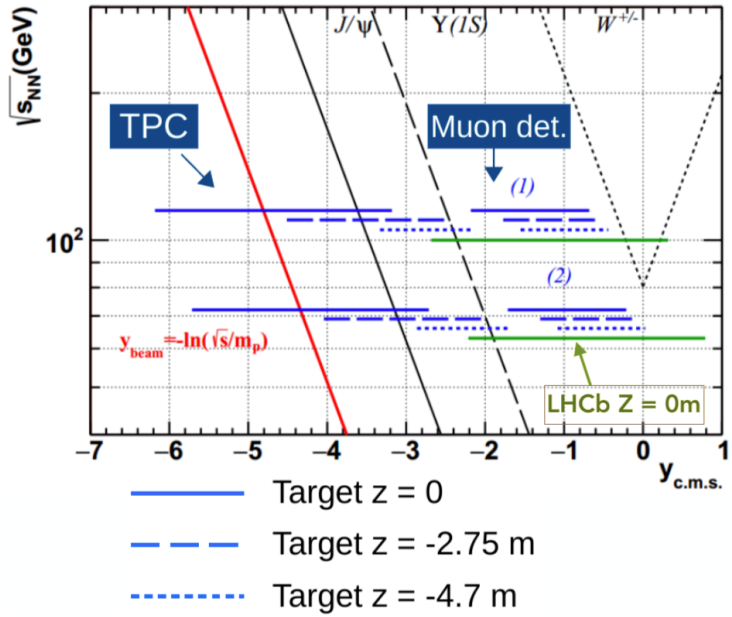
- ☐ proton beam halo can be channeled with bent crystal [2]
- ☐ Optimal target position: 480 cm.
- ☐ Integration with existing system possible with retractable taget setup.

Challenges:

➤ How TPC responses to inclined tracks? (e.g. -2.5 $\leq \eta \leq$ -1.0).

➤ Can we measure Λ, D^0 from FT event ?





[1] C. Hadjidakis *et. al* arXiv:1807.00603v2 [hep-ex]

[2] M. Patecki, HB2021 Beam Dynamics Workshop.

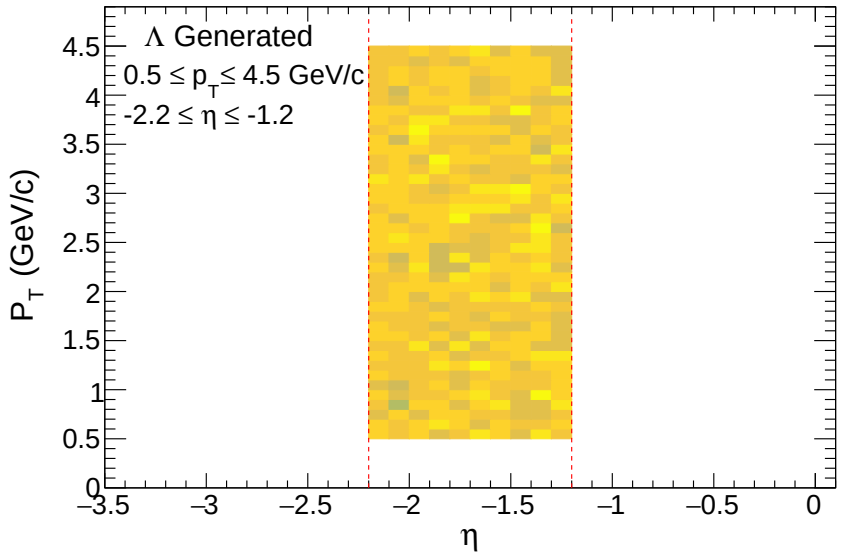
Simulation Configurations

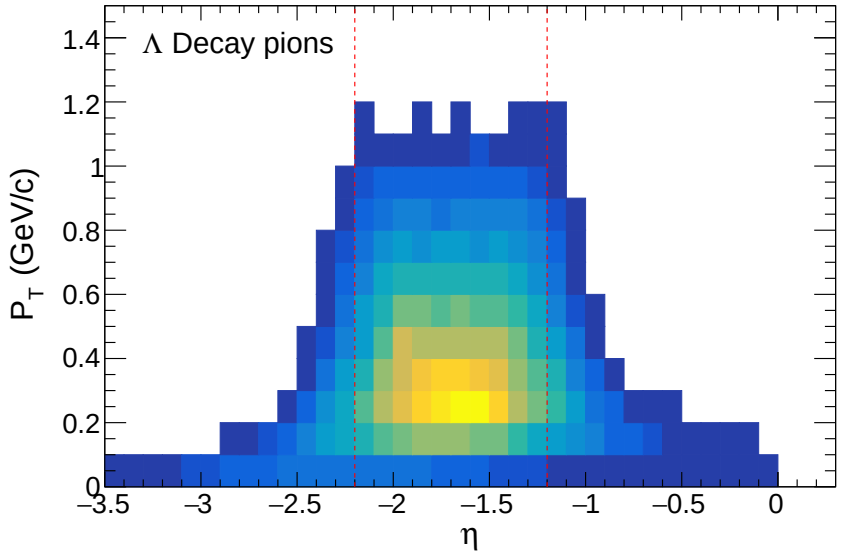
For Charged particles:

- System: proton on Tungsten (W).
- Energy: $\sqrt{s_{\mathrm{NN}}} = 115$ GeV/c.
- Generator: HIJING (w. Run-2 software).
- Reconstruction: with O2 (Run-3 software).
- No. of Events: ∼5000 events.
- Particles: $h^{\pm}$ (-2.2 $\leq \eta \leq$ -1.2).

For Λ particles:

- Fast Decay simulation with detector response for $h^{\pm}$.
- Generated Λ: Flat in p_{T} with -2.2 $\leq \eta \leq$ -1.2 and 0 $\leq \phi \leq 2\pi$.
- Λ Decay: TGenPhaseSpace class (Root).
- No. of Λ: 200K (per set).
- Topological cuts: Decay length, M_{inv}.
- Daughters treated as per charged particle response.
- Vertex resolution is not taken into account.





Simulation Results for Fixed Target (FT) events

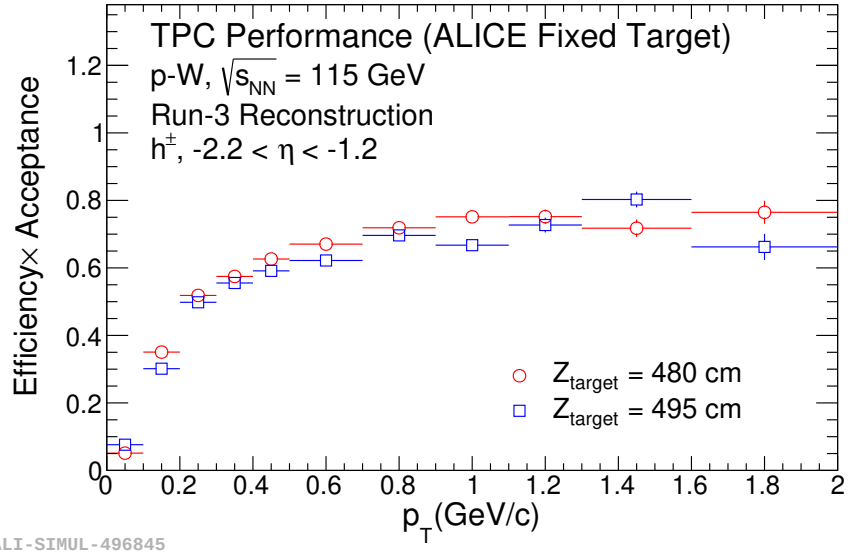
Observations:

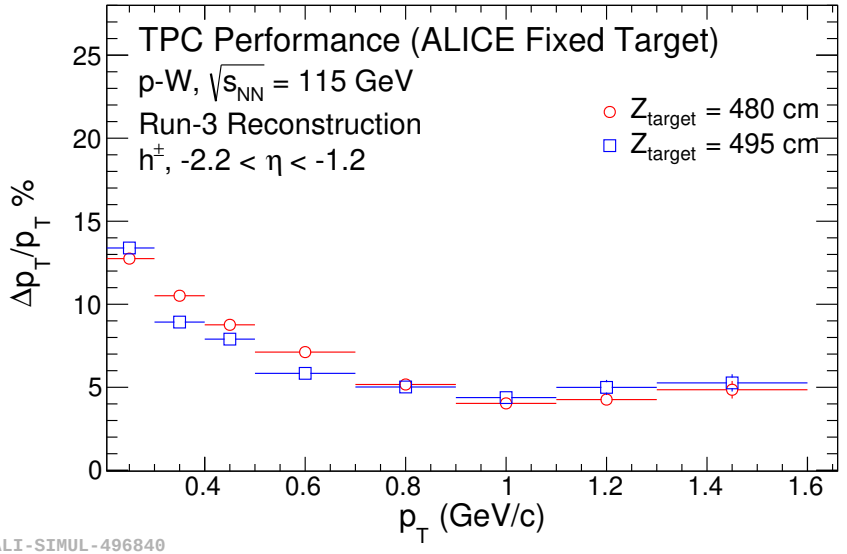
Tracking Efficieny for charged tracks:

- ★ Efficiency X Acceptance shown for Target positions = 480 cm and 495 cm.
- ★ Efficiency is similar for two positions.
- ★ Efficiency is lower than collider tracks. → But sufficient for analysis.

p_{T} Resolution of charged tracks:

- ★ p_{T} resolution estimated with $N_{cls} \geq 70$. → N_{cls} = number of hit points in TPC.
- ★ p_{T} resolution does not depend on target position.
- ★ p_{T} resolution is smaller than collider tracks. → collider tracks has higher N_{cls}.
- ★ Reasonably good p_{T} resolution, → without any dedicated tracker.





Fast Simulation Results for V0 particles in FT event

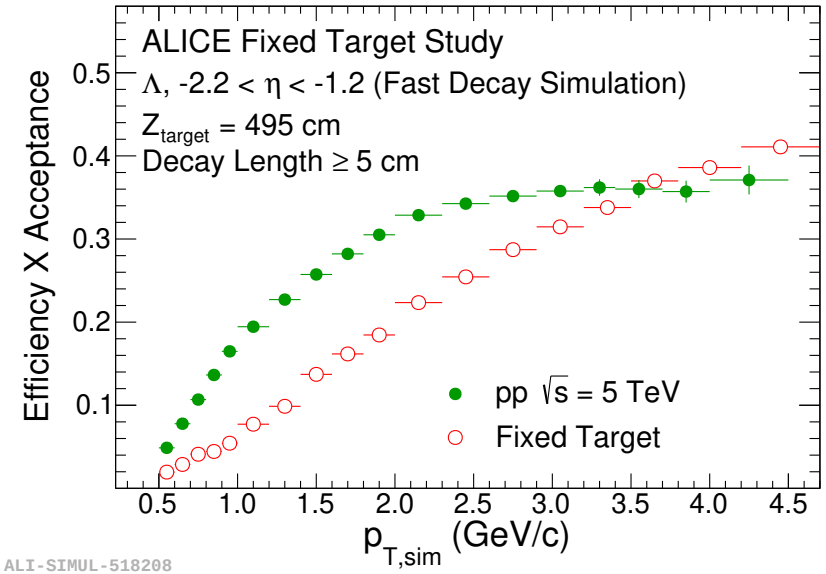
Observations:

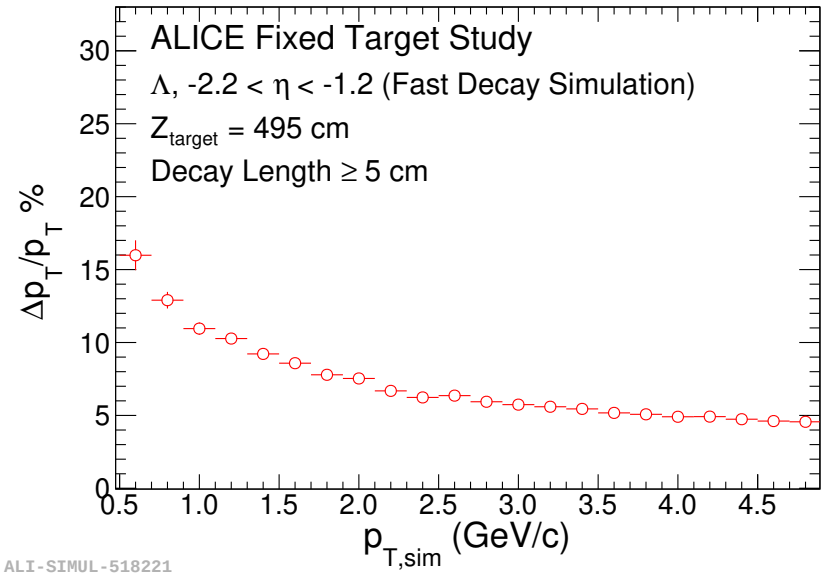
Tracking Efficieny for Λ:

- ★ Efficiency X Acceptance shown for decay length $\geq$ 5 cm.
- ★ Efficiency is lower than Λ from collider events. $\rightarrow$ But sufficient for analysis.

p_{T} Resolution of Λ:

- ★ p_{T} resolution estimated from Λ reconstructed with smeared daughters.
- ★ Pt resolution sufficient for analysis, $\rightarrow$ without any dedicated tracker for FT.
- ★ Caveats: The Λ results should also depend on resolution of the primary vertex, as well as, on the purity of daughter π and p which has not been estimated.





Fast Simulation Results for V0 particles in FT event

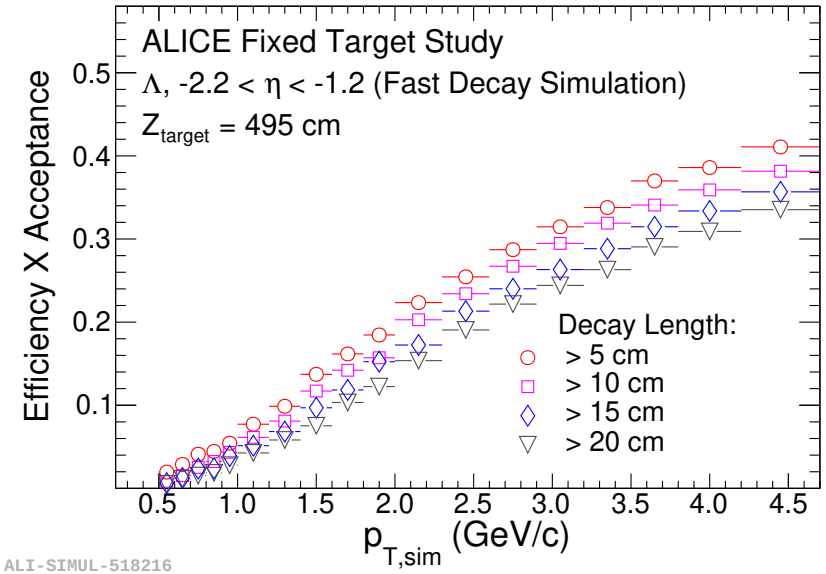
Observations:

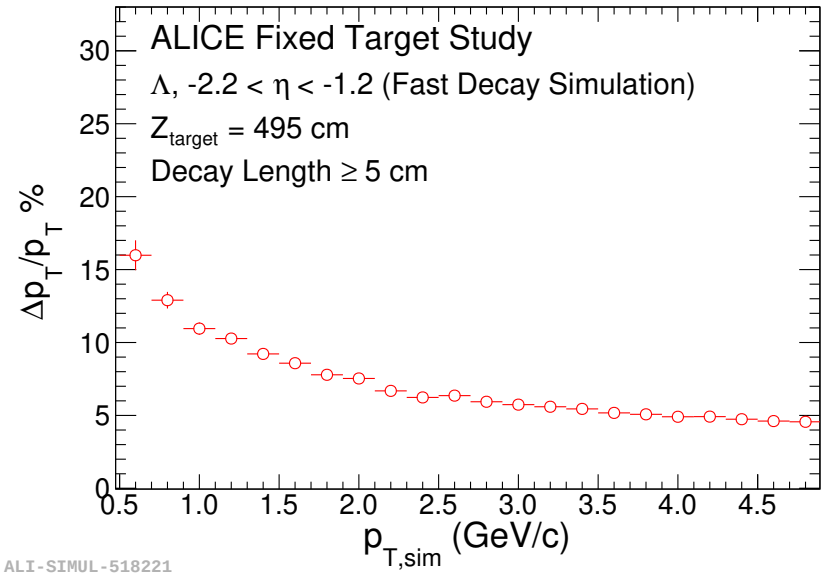
Tracking Efficieny for Λ:

- ★ Efficiency X Acceptance decreases with increasing decay length cut.
- ★ With larger decay length cuts, efficiency decreases. → Still sufficient for analysis.

p_{T} Resolution of Λ:

- ★ p_{T} resolution estimated from Λ reconstructed with smeared daughters.
- ★ Pt resolution sufficient for analysis, → without any dedicated tracker for FT.
- ★ Caveats: The Λ results should also depend on resolution of the primary vertex, as well as, on the purity of daughter π and p which has not been estimated.





Summary and Outlook

Summary:

1. Charged particle tracking efficiency and p_{T} resolution estimated for Fixed Target Setup in ALICE.
2. Efficiency and Resolution for charged particles $\approx$ 70% and 5% for p_{T} $\sim$1 GeV/c.
3. Charged particle response is used as proxy for Fast Simulation study of Λ.
4. Fast Simulation study of shows that the efficiency and p_{T} resolution of Λ are reasonably good (without extra tracking detector).
5. Tracking efficiency and resolution has very weak dependence on Target position, for both Λ and inclusive charged particles.

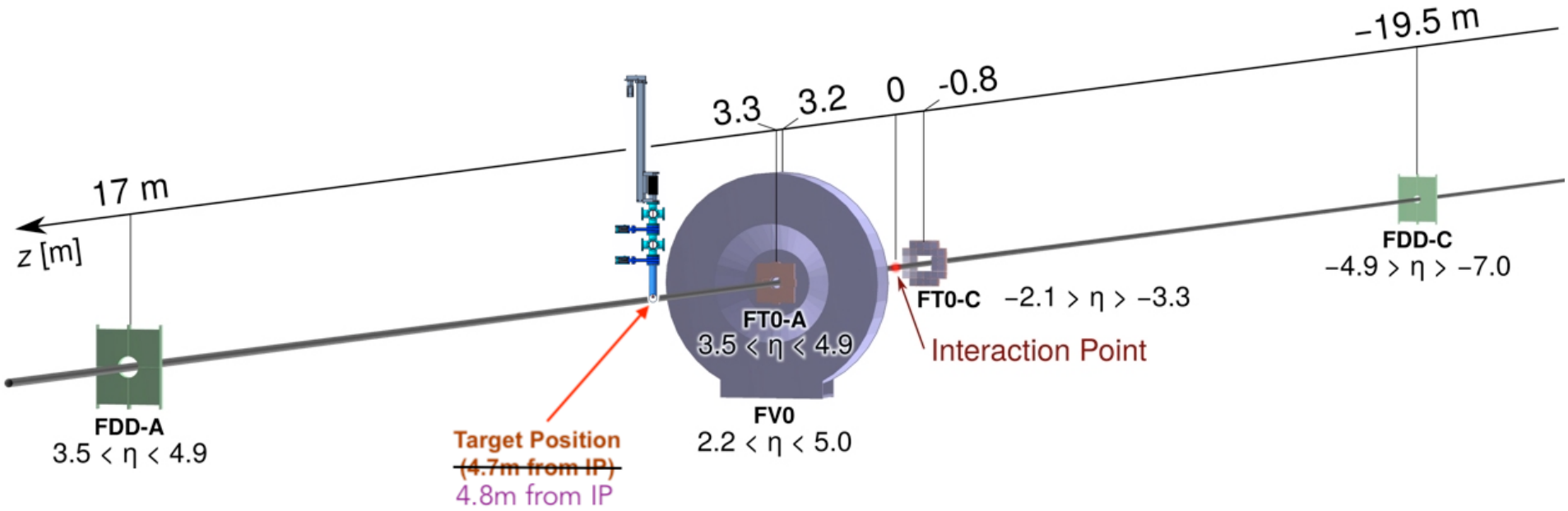
★ Caveats:
– Effects of resolution of the primary vertex, as well as, on the purity of daughter π and p tracks have not been estimated.

Outlook:

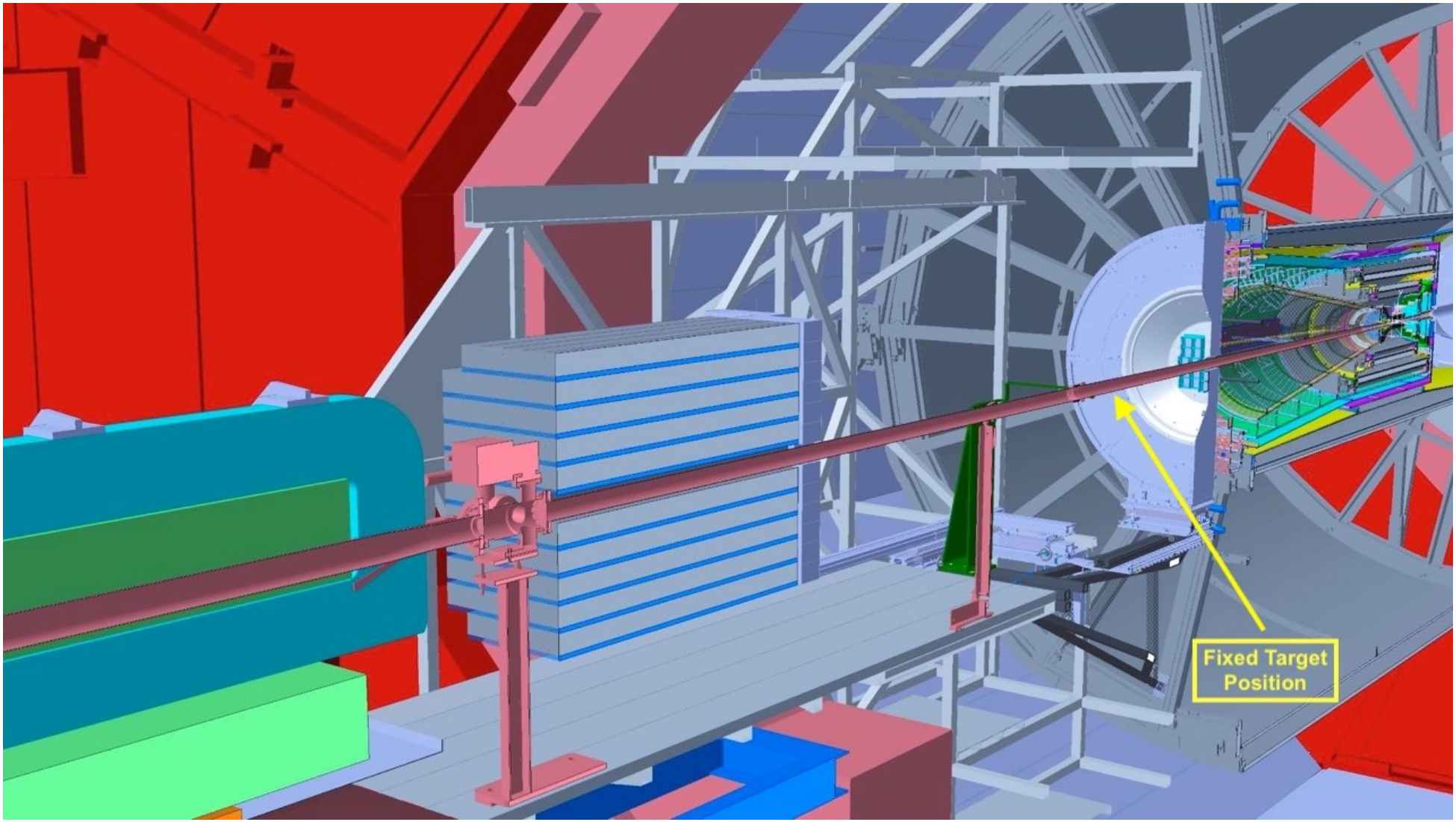
- PID dependence of tracking efficiency and p_{T} resolution.
- Physics performance study using measured efficiency and p_{T} resolution.
- Direct simulation of V0 and (charmed meson) using ALICE Run-3 software.

★ Project is funded by the European Union's Horizon 2020 programme (grant agreement No 824093).

Back up



Target Position sketch-I



Target Position sketch-II