

Anti-Deuteron Identification for Absorption Cross-Section measurement in ALICE



ALICE REU

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Research Experiences
for Undergraduates
National Science Foundation



THE UNIVERSITY OF
CHICAGO₁



About Me

At home:

Home Institution:

University of Chicago, Chicago, IL, USA

Degree:

Physics Bachelors (minor in medieval studies)

Future Plans:

After CERN, I hope to continue in physics, going on to a PhD

At CERN:

Research Group:

ALICE HMPID group, working on anti-deuteron identification

Favorite Experience:

Getting to work at the place I've dreamed of coming to for years

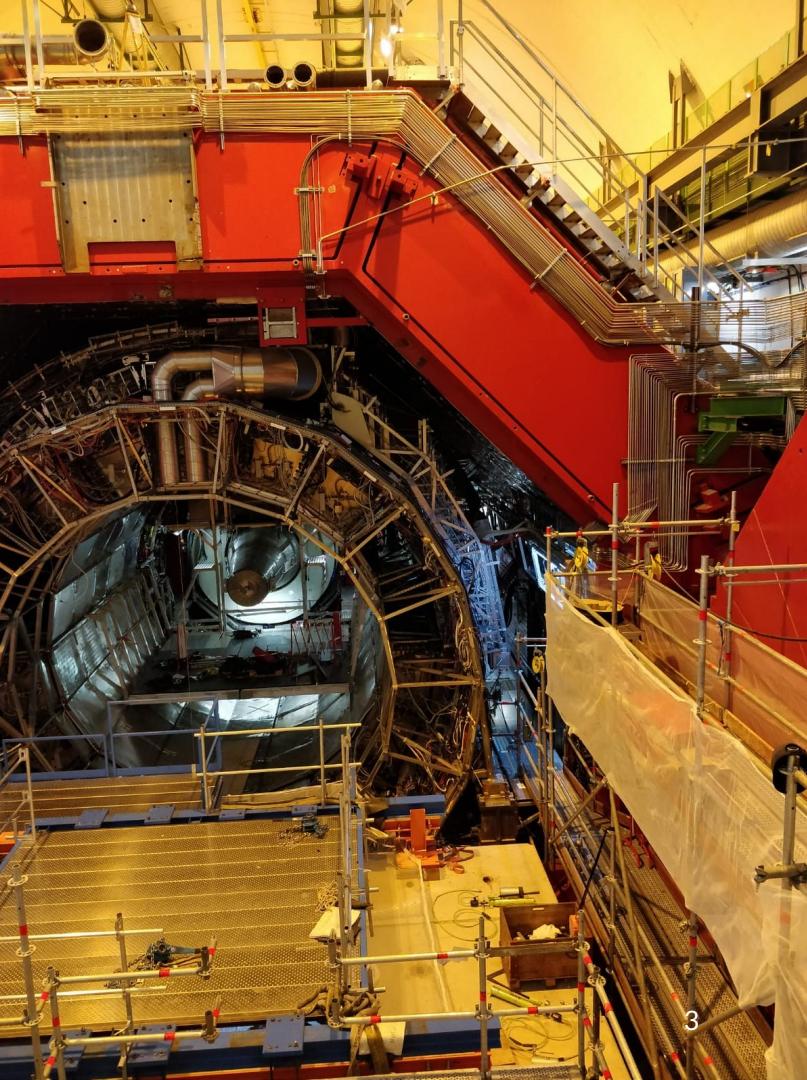
ALICE Overview

A Large Ion Collider Experiment - Explores the nature of quark-gluon plasma

- Mimics conditions of early universe
- Confinement
- Chiral symmetry restoration

Heavy ion collisions in the LHC - partons produced and measured through 18 detector systems

- Optimized for high momentum resolution
- Particle identification



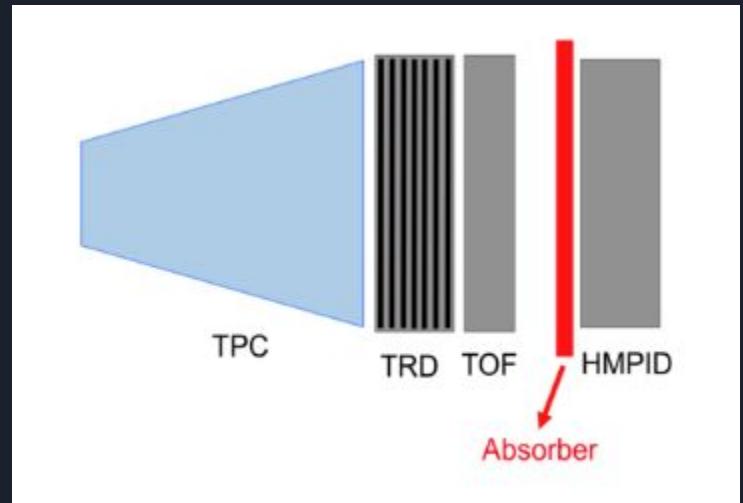
Experimental Setup

Run III upgrade:

- Use HMPID to calculate Anti-Deuteron absorption cross section.
- Use the cross-section to limit uncertainties on light nucleus production

Possible absorbers include aluminum, graphite, and silicone

The absorption cross-section has never been measured in this momentum range, and there is no theory which predicts it.



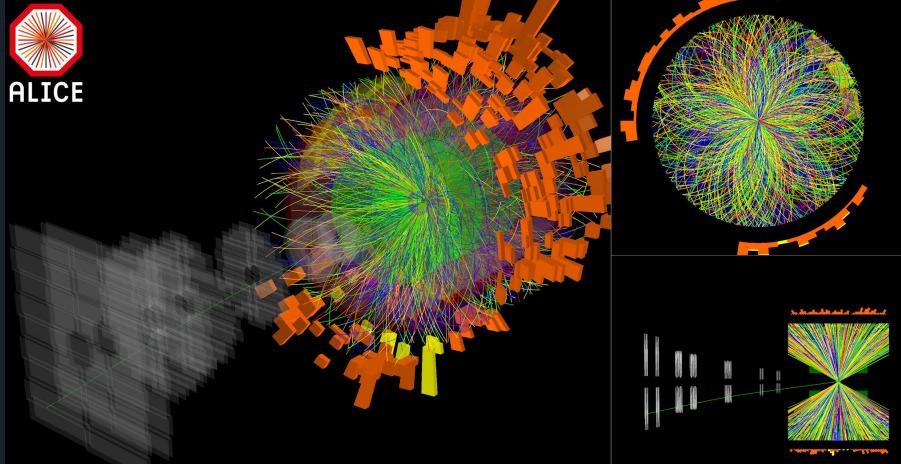
[1]https://indico.cern.ch/event/770604/contributions/3201842/attachments/1746010/2826694/Physics_for_the_HMPID_in_Run3_v3.7.pdf

Step 1: Particle Identification

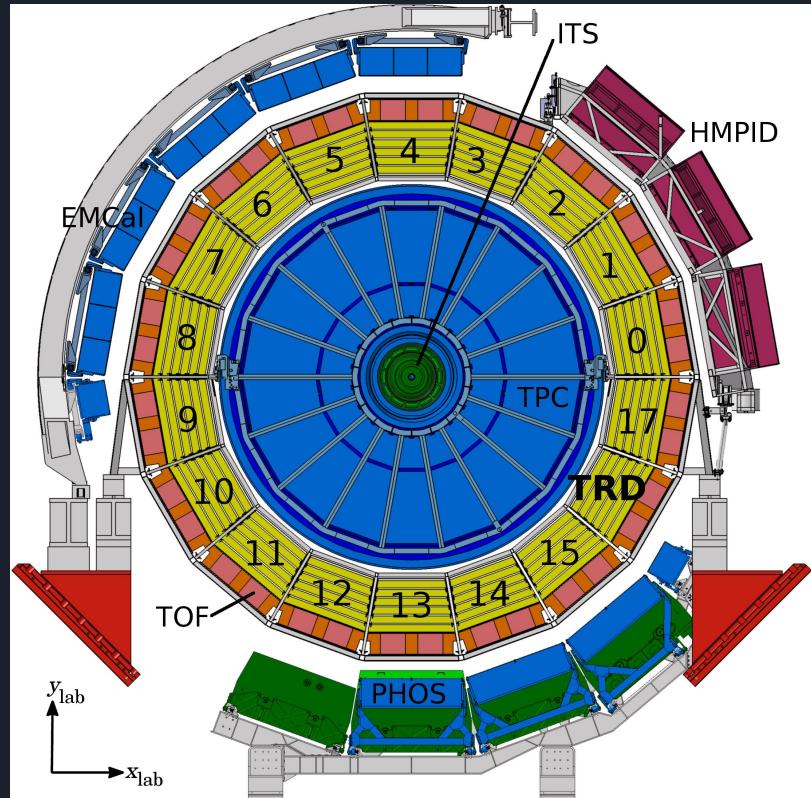
Taking advantage of ALICE's geometry, we use inner detectors to identify Anti-Deuterons

Question:

In what ways can the TPC, TOF, and TRD contribute to particle identification?



[2]<http://cds.cern.ch/record/2649643>

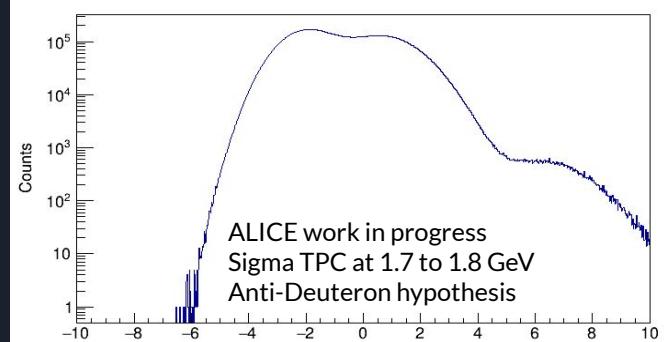
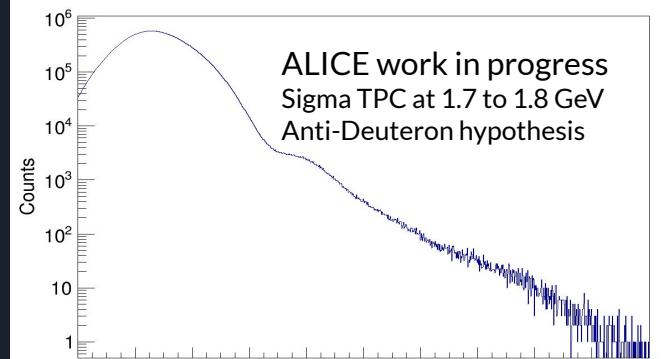
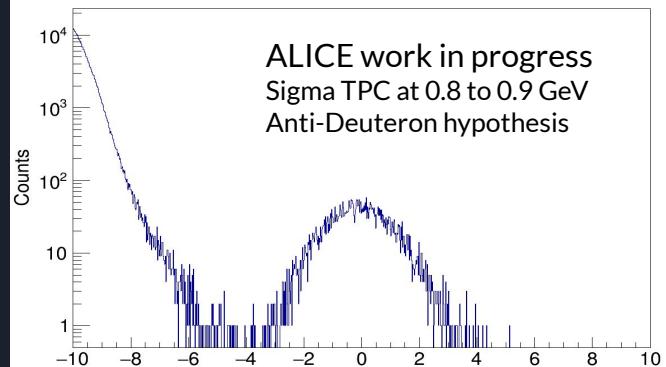
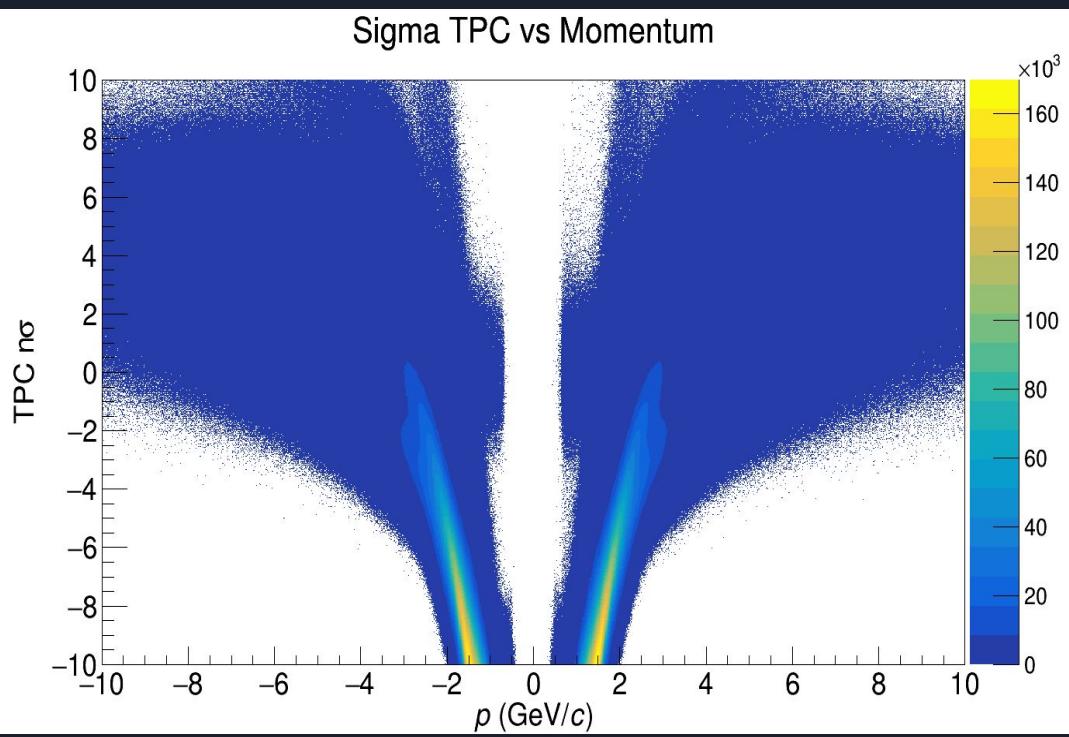


[3]<https://cds.cern.ch/record/2281131/plots>

Anti-Deuteron ID: TPC

Right: Sigma TPC at various momenta

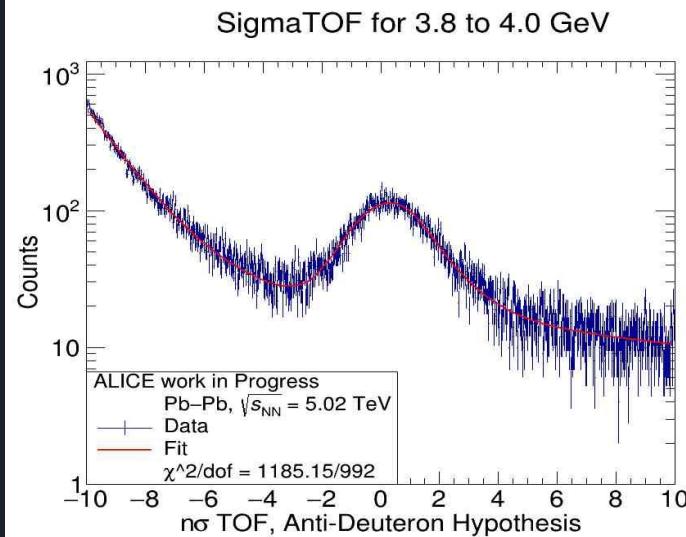
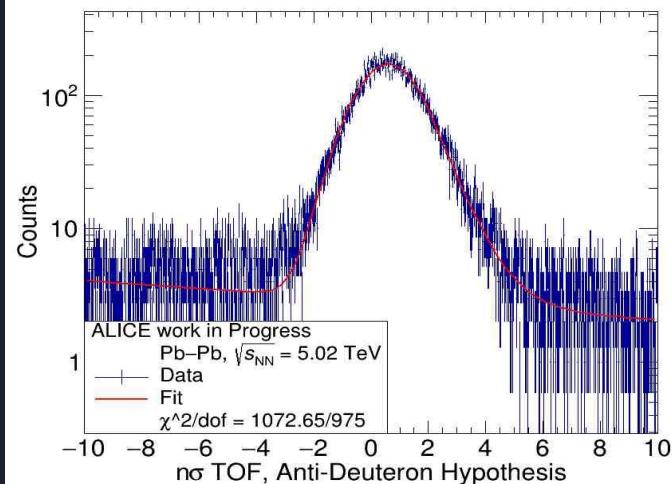
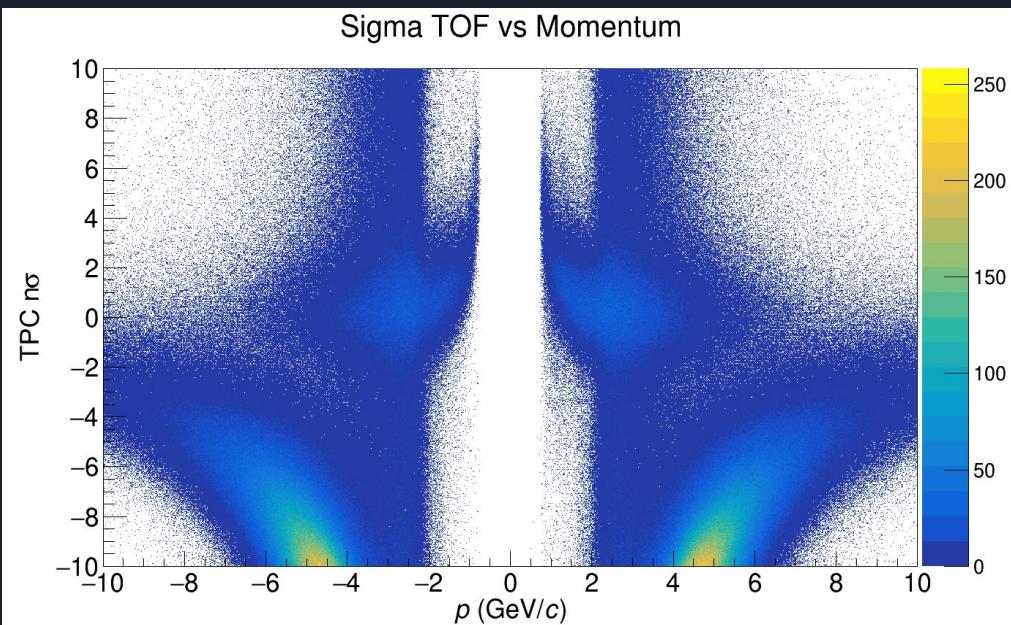
Below: Occurrences of Sigma TPC vs momentum



Anti-Deuteron ID: TOF

Left: Sigma TOF, fit to a gaussian with exponential tail and exponential background

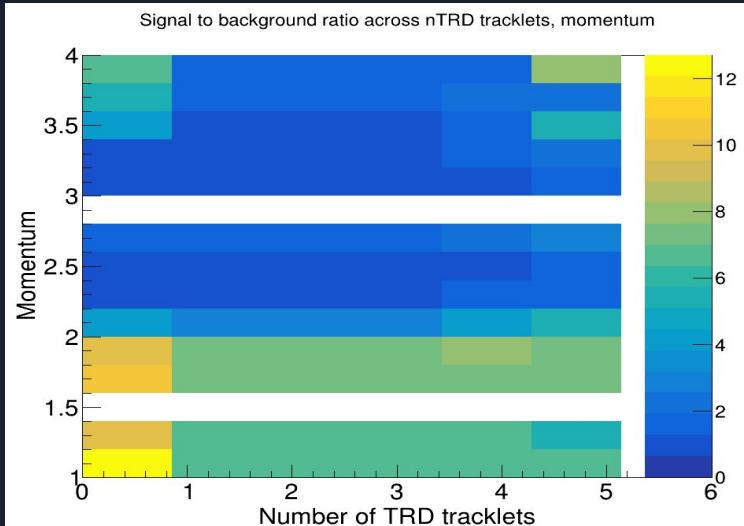
Below: Sigma TOF vs momentum for tracks which fall within 3 sigma of the (Anti-)Deuteron hypothesis in the TPC



Anti-Deuteron ID: TRD

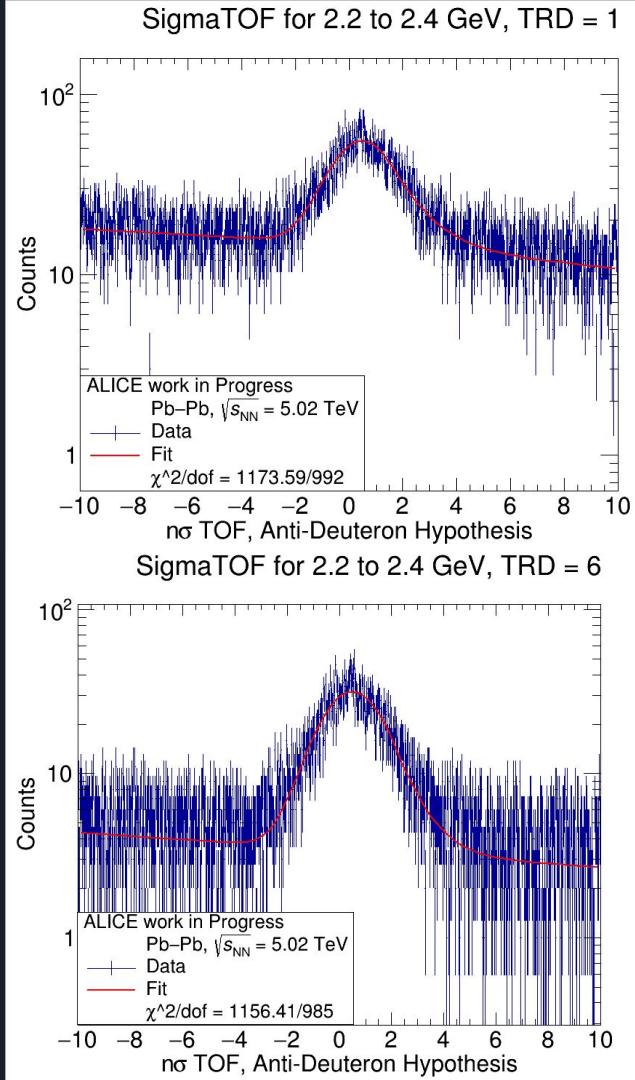
tracklets

Question: Can we use information from the number of TRD tracklets to improve our identification?



Method: Fit the data from TOF response as before, but now filtered for a minimum number of TRD tracklets.

Result: Unfortunately, this doesn't help



Step 2: Simulating the Absorption Cross-Section

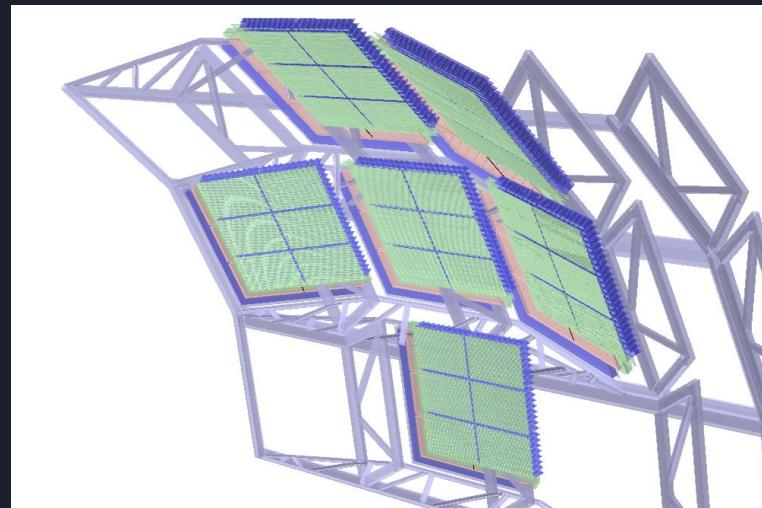
The High Momentum Particle Identification (HMPID) System

General:

- Ring Imaging Cherenkov Detector
- Identifies high-momentum charged particles
- 6 clusters

In the simulation, we place a different absorber in front of each cluster

We'll use the multi-wire proportional chamber (MWPC), part of the HMPID system, to match hits to particle tracks identified by the inner detectors.



[4]<http://alice-offline.web.cern.ch/Activities/Geometry/index.html>

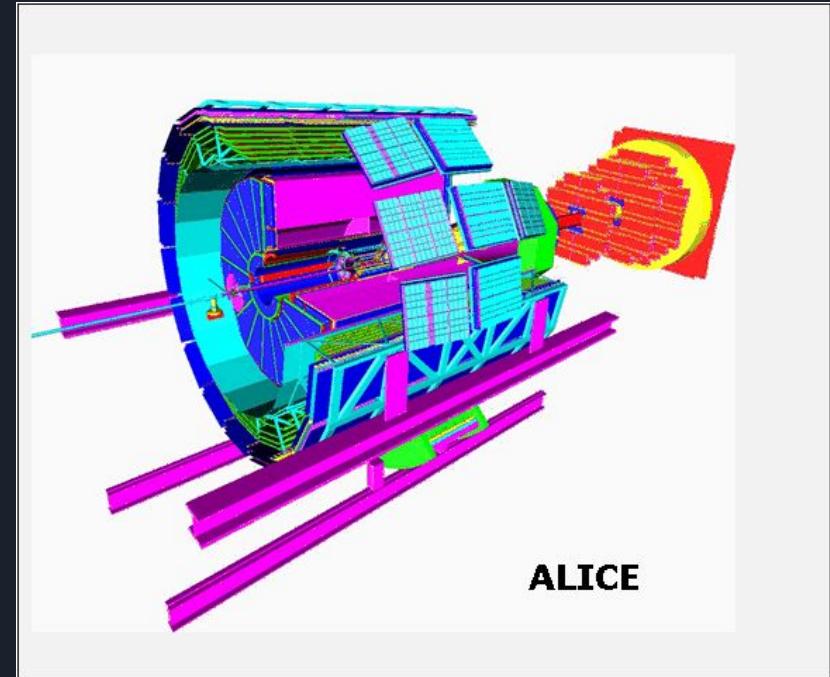
Simulation Details

Using HIJING and GEANT3 to simulate the collisions and propagation through ALICE

- Particle identification efficiency in simulation
- Track matching efficiency
- Measure total inelastic cross section for both deuterons and anti-deuterons

The key question:

Can we identify (anti-)deuterons well enough to calculate an absorption cross-section at low energy, without a theory on which to base the measurement?



[5]<https://root.cern.ch/root/html534/guides/users-guide/Geometry.html>

Questions?

