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

Julia Book (University of Chicago)

Advisor: Alberto Caliva (GSI Helmholtz Centre for Heavy Ion Research)
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?


Anti-Deuteron ID: TPC

Right: Sigma TPC at various momenta
Below: Occurrences of Sigma TPC vs momentum

ALICE work in progress
Sigma TPC at 0.8 to 0.9 GeV
Anti-Deuteron hypothesis

Sigma TPC vs Momentum

ALICE work in progress
Sigma TPC at 1.7 to 1.8 GeV
Anti-Deuteron hypothesis
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
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.

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?
Questions?