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## **Masters Dissertation: Project Proposal**

**Course Code: PHY5008W**

**The Application of Machine Learning Techniques towards the Optimization of High Energy Physics Event Simulations in the at**

† A Large Ion Collider Experiment

‡ European Organization for Nuclear Research/ Organisation Européenne  
pour la Recherche Nucléaire

͛ Transition Radiation Detector

# **Submitted in Fulfilment of the degree: MSc Data Science**

Contents

[Background 2](#_Toc526365197)

[Motivation 3](#_Toc526365198)

[Research Question 3](#_Toc526365199)

[Aims & Objectives 3](#_Toc526365200)

[Methods 3](#_Toc526365201)

[Bibliography 3](#_Toc526365202)

# Background

1. **A Large Ion Collider Experiment (ALICE)**

A Large Ion Collider Experiment (ALICE) is a large scale collaborative experiment dedicated to studying all collisions involving heavy ions at the Large Hadron Collider (LHC) at CERN (European Organization for Nuclear Research) (1).

In central high energy collisions between heavy ions (i.e. where the centres of colliding nuclei overlap sufficiently), a newly discovered deconfined state of strongly interacting matter, the Quark Gluon Plasma (QGP) can be created in small amounts (1). It is thought that this state of matter was dominant during the first 10-6 s of the Universe’s existence (2). Studying the QGP allows us to explore fundamental research avenues such as Cosmology, the Evolution of our Universe, and one of the fundamental forces in the standard model that is the hardest to probe: the strong nuclear force (2).

ALICE is the first experiment in history capable of producing the QGP in a laboratory setting; and as such, it is equipped to infer a variety of physical variables relating to the QGP, by analysing data from electrons produced during many of the physical processes that occur in the wake of heavy ion collisions, e.g. open heavy-flavour hadron decays, virtual photons, etc (1). Robust electron identification is therefore a crucial part of studying the QGP, and accurately-tuned detector triggers ensure the collection of sufficient amounts of data to guide inferences regarding the statistical distributions of the abovementioned measurables (1).

* + 1. **The ALICE Transition Radiation Detector (TRD)**

The main purpose of the ALICE Transition Radiation Detector (TRD) is the identification of electrons, as well as the operation of event triggers that determine whether data from a specific collision should be kept, based on measurements such as collision centrality, amongst others. As an added benefit, the TRD informs the ALICE central barrel’s calibration, and the data it produces is used extensively during track reconstruction (1).

* + 1. **TRD Physical Properties**

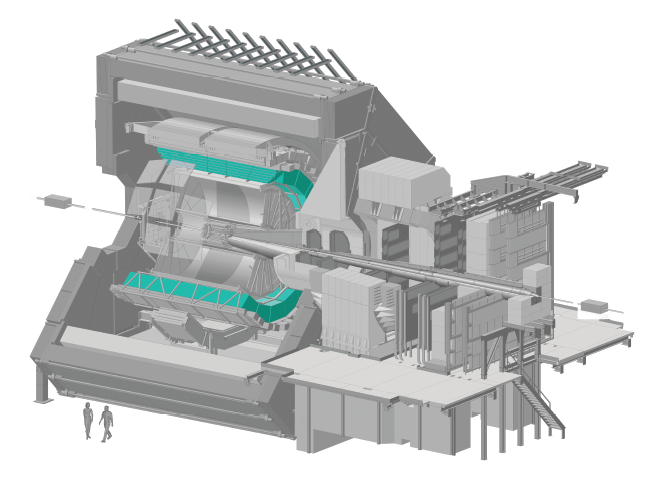


Figure 1: The ALICE TRD, Highlighted in Cyan, within the ALICE main detector

* + 1. **TRD Measurement Mechanism**

As the name suggests, transition radiation occurs when a particle transits across a dielectric boundary, this radiation is often measured in particle detectors to inform track reconstruction. Multiple boundaries are typically required to increase radiation yield, and since highly relativistic particles emit transition radiation that extends into the X-ray domain, the TRD utilizes gases with high proton-number (Z) to absorb this radiation, resulting in a high yield of energy deposition relative to the energy lost via ionization (1).

* + 1. **Current TRD Accuracy**

Currently, at a momentum of around 1 GeV/*c*, a pion rejection factor of 410 is achievable in p-Pb (proton-Lead) collisions, with resolution improving by about 40% when TRD data is included in track reconstruction (1).

# Motivation

# Research Question

# Aims & Objectives

# Methods

# Bibliography

1. *The ALICE Transition Radiation Detector: Construction, operation and performance.* **Collaboration, ALICE.** 2018, Nuclear Inst. and Methods in Physics Research, Vol. 881, pp. 88-127.