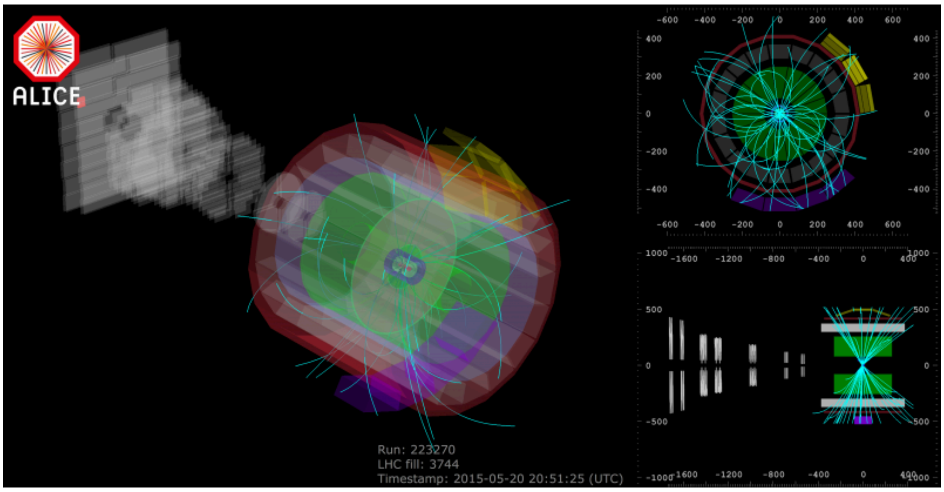
Large Hadron Collider

The Large Hadron Collider (LHC) is one of the biggest currently operating scientific projects in the World. The LHC is mostly known because of the discovery of the famous Higgs boson by the ATLAS and CMS experiments, the missing link in the Standard Model of Particle Physics. This discovery lead to the Nobel Prize in physics in 2013 awarded to Belgian physicist François Englert and British physicist Peter Higgs, for their prediction of the mechanism that contributes to the understanding of the origin of mass, connected to the prediction of the existence of the Higgs particle.

ALICE

Beside the mentioned two big detectors, ATLAS and CMS, other experiments are analyzing the data from the LHC. The third one, in the respect of the mass and size, is ALICE - A Large Ion Collider Experiment. The group from the Faculty of Physics from Warsaw University of Technology is involved in the scientific collaboration of ALICE. It is the only experiment especially designed and optimized to study heavy-ion collisions and the properties of the hot and dense Quark Gluon Plasma: strongly interacting system that existed fraction of a second after the Big Bang, the beginning of the Universe. Apart from the heavy-ion interactions, ALICE studies also elementary proton-proton collisions employing unique particle identification capabilities of the experiment.



Goal of the project

The main goal of this project is to study fundamental mechanisms governing production of particles in the high-energy collision employing angular correlations - correlations in the relative pseudorapidity ($\Delta\eta$) and azimuthal angle ($\Delta\varphi$), between the produced particles as well as full jet reconstruction. The study of particle production, particularly through the analysis of jets and minijets, plays a pivotal role in advancing our understanding of high-energy physics. Jets—collimated streams of particles originating from the fragmentation of quarks and gluons—and their smaller-scale counterparts, minijets, provide direct insight into the fundamental processes governed by Quantum Chromodynamics (QCD), the fundamental theory governing strong interactions. These phenomena are essential for testing the predictions of the Standard Model, probing the behavior of strongly interacting matter, and exploring extreme conditions such as those found in heavy-ion collisions, where the Quark-Gluon Plasma (QGP) is formed. Furthermore, jets and minijets serve as sensitive tools for uncovering new physics, as deviations in their production or characteristics may signal beyond-Standard Model phenomena, including dark matter interactions or exotic particle states. Studies of jets and minijets bridge theoretical predictions and experimental observations, offering a deeper understanding of particle dynamics, the structure of matter, and the forces that govern the universe.

Significance of the project

The project will allow us to broaden our knowledge of particle physics within the highest achievable energies. Precise understanding of the fundamental mechanisms underlying the collisions of protons and charm quarks is crucial for the correct interpretation of the current international studies as well as will allow to improve the Monte Carlo models and therefore theoretical predictions.