# Summary for the general public

Recent decades have seen rapid advances in particle physics, largely due to particle colliders that accelerate particles to ever higher energies. The largest accelerator today is the Large Hadron Collider (LHC), located at the European Organization for Nuclear Research CERN near Geneva. The facility allows for collisions of proton beams at ultra-relativistic center-of-mass energies in the order of 13-14 TeV. Particles produced in such collisions are recorded by dedicated detectors located close to the beam collision points. The largest detector at the LHC is ATLAS (A Toroidal LHC ApparatuS), which allows measurements at nearly full solid angle.

Since 2010, the LHC has made it possible to accelerate not only beams of protons, but also heavy ions - lead and xenon. In particular, collisions of lead ions are a promising subject of research due to the fact that lead is the heaviest stable element. During ultra-relativistic lead-lead collisions, quarks and gluons go into an asymptotic state of freedom and behave as unbound particles. This kind of matter is commonly referred to as quark-gluon plasma. It is likely that in the millionths of a second after the Big Bang, the universe was in this state of matter. It is believed that the quark-gluon plasma can also be formed during supernova explosions or inside neutron stars.

The best theory to date describing particle physics is the Standard Model. The heaviest component of matter in this model is the top quark. This particle is characterised by two types of charge - electric, responsible for the electromagnetic interaction, and colored, associated with the strong interaction. In addition, it is the only quark that decays before the process of merging quarks and gluons into hadrons, called hadronisation. This provides a unique opportunity to study so-called "naked quarks". The decay of the top quark includes the formation of the lighter beauty quark and the $W$ boson, which decays into leptons (electrons, muons and taus), among other things. Because of its large mass and color charge, the top quark is a promising candidate for studying the properties of the quark-gluon plasma.

Due to the relatively low value of the cross-section, top-quark pair production has not yet been observed in lead-lead collisions to date. The proposed research will involve measuring top-quark pair production in a channel with one electron and one muon. Experimental data from lead-lead collisions collected in 2015 and 2018 by the ATLAS experiment will be used for this purpose. The project will develop novel methods for data analysis. A dedicated simulation will also be generated to compare real data with theoretical predictions. The available data statistics will enable a pioneering analysis that has the potential to provide the first evidence for top-quark pair production in lead-lead collisions in the ATLAS experiment. The obtained result will be compared with existing measurements in lead-lead collisions by the CMS experiment and proton-proton collisions by the ATLAS experiment, and with the latest theoretical models. With this project, the heaviest elementary particle, the top quark, will join the set of other hard probes that are used to study the properties of the quark-gluon plasma.