The Standard Model is one of the fundamental theories of modern physics, which describes elementary particles and their interactions. For over 50 years, it has been extensively tested in a wide range of experiments, resulting in major breakthroughs like the discovery of charm and top quarks, gluons, W and Z bosons or, more recently, the Higgs boson – all of which were first predicted. Despite this success, it is still riddled with many problems – most notably, it fails to explain important phenomena such as gravity or why everything is made out of matter rather than antimatter. With all the issues present, we know for a fact, that it is definitely not the final theory of particle physics. For this reason, scientists all over the world are constantly comparing its predictions with data collected using particle colliders, in a joint effort to understand exactly where and how it breaks. At the same time, new theories are being developed and tested in the very same way.

The measurement proposed in this project involves a production of a Z boson and two b-quarks. Due to the nature of strong interactions, quarks can never be observed alone and immediately form a cascade, where new quark-antiquark pairs are created spontaneously from the vacuum and bind with the single quark. Such cascade results in a stream of light hadrons (composite particles made of quarks) flying in a narrow cone – a particle jet. Physics involving jets from heavy quarks (like the b-quark) offers a very unique opportunity to test the Standard Model and search for New Physics at the same time. In particular, a number of ways to include such quarks in theoretical calculations exist. Even though the differences are rather technical, they're very important for physicists. The results of this measurement can be used to check the validity of each approach.

They will also be compared with predictions of the Standard Model, as any significant discrepancy would be a strong argument for the influence of New Physics. Because of the underlying mechanisms, the studied decay is especially sensitive to hypothetical heavier versions of involved particles, often denoted as *Z'* and *b'*. The former appears in many new theories and may soon play a leading role in the search for a Standard Model successor. The latter is a part of an open question of exactly how many quark generations exist (we only know for sure it's at most 9). Its discovery could provide indirect evidence for the existence of heavy neutrinos and help to explain the asymmetry between matter and antimatter. Interestingly, even a lack of discovery is important as it may be used to exclude some New Physics scenarios.

The process is also an important background for the studies of a Higgs boson, because they are often done when it is produced together with a Z boson and decays into a pair of b-quarks. As a result, the final state contains the same particles and both look very similar in the detector response. It is thus crucial to precisely know all the differences in order to be able to separate events from both decays.

Since the sensitivity to New Physics depends directly on the precision of measurement and number of preserved signal events, the jets formed by b-quarks have to be reconstructed and identified as efficiently as possible. For this reason, a novel approach will be developed to exploit the characteristics of the LHCb detector. It reverses the usual procedure of reconstructing a jet and looking for hadrons containing b-quarks (b-hadrons) in assigned particles to identify it as a b-jet. Instead, the points where such hadrons decayed are found first (they can be recognised by long lifetime) and are used to determine the direction in which the jet should be reconstructed. Because the procedure starts with b-hadrons, the resulting jets are automatically identified as originating from b-quarks and a very high sample purity can be achieved.

As the LHCb detector covers a very unique kinematic region, the measurement is very important, because it provides results complementary to other experiments. Consequently, it will also be the very first measurement of proposed process in this region.