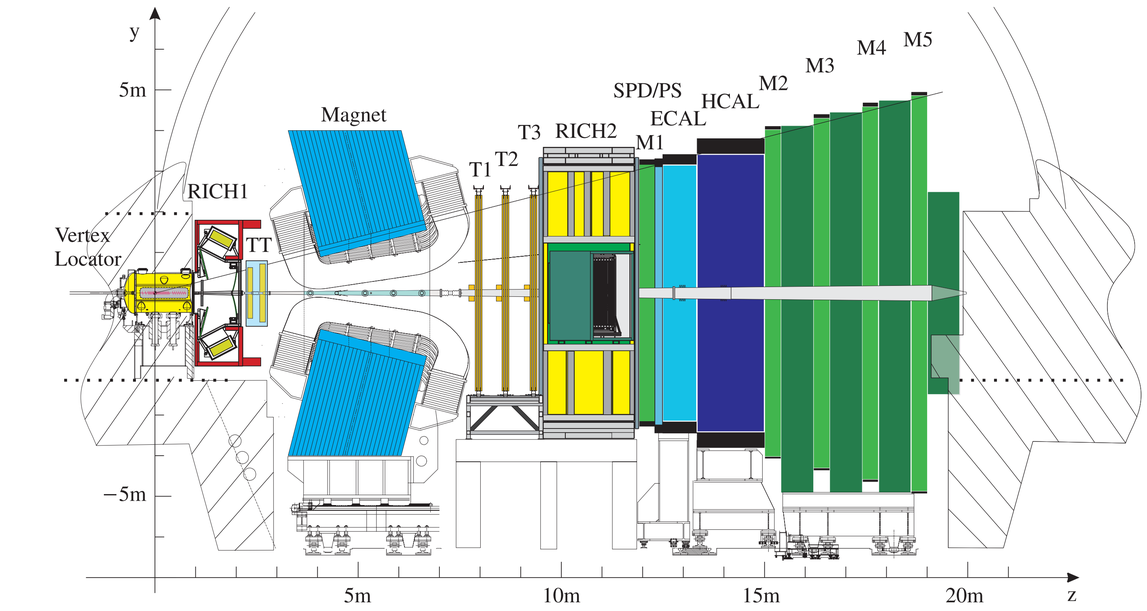
Open charm production in fixed-target pNe collisions with LHCb

Gabriel Ricart

Département de Physique Nucléaire, CEA/Irfu



The LHCb detector

The LHCb detector is one of the 4 main experiments of the LHC. Located 100m underground, the single arm forward spectrometer is specialised in the study of the heaviest constituents of hadronic matter: the beauty and charm quarks.

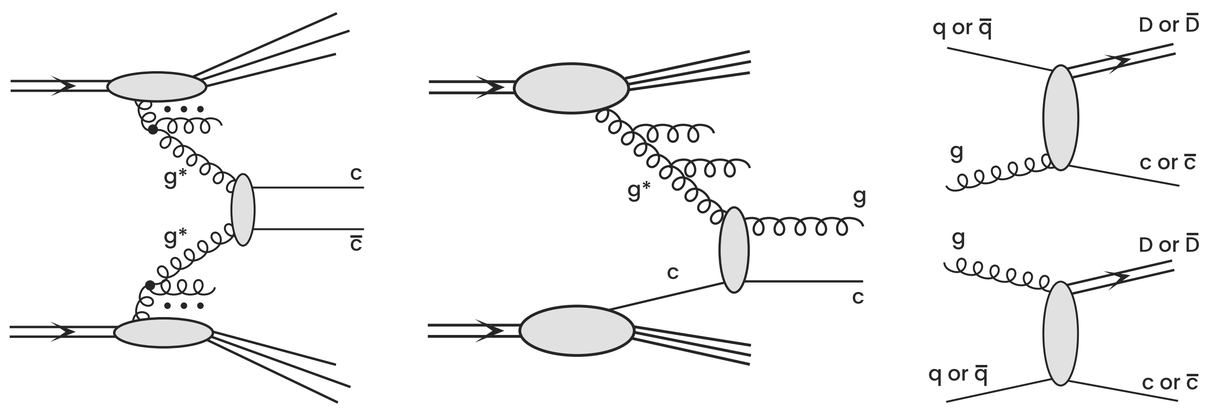
In addition to the usual collider mode, LHCb can run in a fixed-target configuration by injecting noble gas into the beam crossing region, thanks to the SMOG (System for Measuring Overlap with Gas) system.

The charming origin of matter

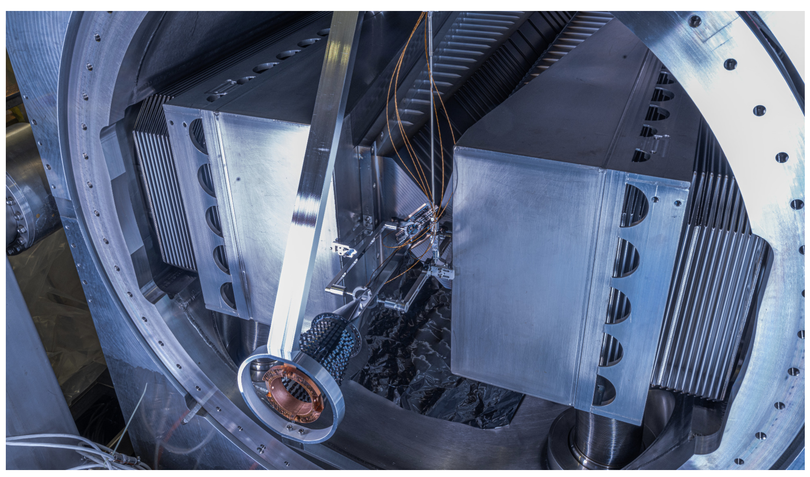
Quarks and gluons combine themselves into hadrons during a process called hadronization. Once bound, quarks are confined inside the hadrons, and are not able to escape.

This phenomenon is thought to have taken place a few microseconds after the Bing-Bang, leading to the creation of protons and neutrons, which will then form the first nuclei.

Hadrons containing one charm quark, the so-called open charm hadrons, are used as probes of the hadronization process, opening a new path towards the understanding of the origin of matter.



Diagrams of three charm production mechanisms. Standard QCD off-shell gluon fusion (left), intrinsic charm (center) and recombination (right).



The SMOG2 gas storage cell. Installed in 2020, it allowed LHCb to simultaneously record beam-beam and beam-gas collisions for the first time in 2022.

Probing hadronization with LHCb

The production mechanisms of D mesons in the backward kinematic region are poorly understood. The unique capabilities of the LHCb detector in its fixed-target configuration using the SMOG system allow to directly constrain production models via cross-section and asymmetry measurements in the negative center-of-mass rapidity region.

In addition to the standard QCD mechanism of gluon fusion, two other charm production contributions are taken into account: intrinsic charm, related to the knock-out of a charm quark from the nucleon, and recombination with light quarks.