Hunting for millicharged particles at the LHC

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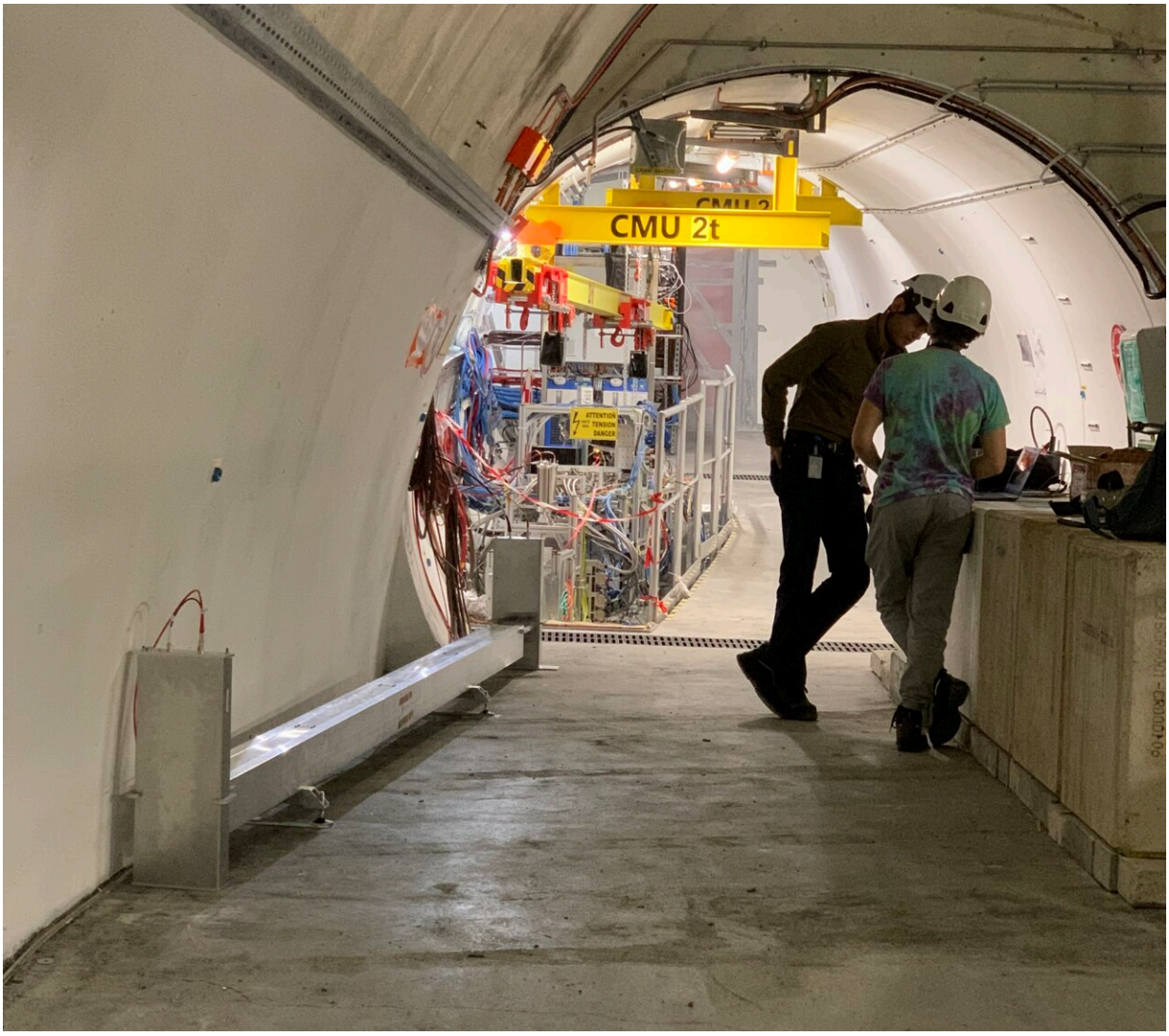

The FORMOSA demonstrator (foreground) during installation in the underground cavern of the FASER experiment (background). Credit: CERN

The LHC family of experiments continues to grow. Alongside the four main experiments, a new generation of smaller experiments is contributing to the search for particles predicted by theories beyond the Standard Model, our current theory of particle physics.

Recently, the FORMOSA demonstrator, which hunts for millicharged particles, has been installed in the cavern containing the FASER detector, 480 meters downstream from the ATLAS interaction point. It will now collect its first data.

Some theories predict the existence of millicharged elementary particles that would have a charge much smaller than the electron charge. If they exist, they would give clues to a theory beyond the Standard Model and could be considered as candidates for dark matter.

The FORMOSA demonstrator aims to prove the feasibility of the full experiment, which is intended to be installed in a proposed underground hall located about 620 meters away from the ATLAS interaction point.

This experimental area—the Forward Physics Facility—is under study within the Physics Beyond Colliders initiative and is expected to host several experiments that will search for long-lived particles predicted by theories beyond the Standard Model.

These particles would be produced by collisions at the center of the ATLAS detector and would interact feebly with Standard Model particles. If approved, the experiments, among them the the proposed FASERν 2 and FLArE experiments, could start taking data when the High-Luminosity LHC is switched on in 2029.

The FORMOSA demonstrator comprises scintillators. When interacting

with a charged particle, the scintillators emit photons that are subsequently converted into an electrical signal. While cosmic muons or those from ATLAS collisions may also strike the scintillators, millicharged particles typically deposit much less energy into each layer, distinguishing them from muons that traverse the detector.

"Initial studies with so-called no-beam data and source tests look already promising. This marks an important step towards achieving the goal to run the demonstrator this year and a great demonstration of the collaborative spirit of the projects within the Forward Physics Facility," says project leader Matthew Citron from University of California, Davis.

Millicharged particles have become a particular focus of research in recent years. The MilliQan detector, located 33 meters away from the CMS interaction point, as well as MoEDAL-MAPP close to LHCb, started data taking during LHC Run 3.

In 2020, a study carried out with a smaller demonstrator, MilliQan had ruled out the existence of millicharged particles for a range of masses and charges. Thanks to a higher volume of detection and its location in the far forward region of the LHC collisions, the FORMOSA experiment hopes to extend this search.

Provided by CERN

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