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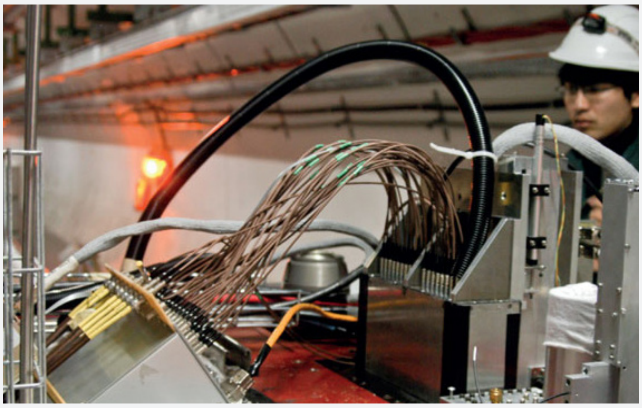

LHCf, the small experiment, is conquering America

LHCf is the smallest of the six experiments at LHC. The LHCf detectors are only 30 cm long and weigh only 70 kg, but the technology is similar to that of the large LHC experiments. LHCf consists of two independent calorimeters, ARM1 and ARM2, normally positioned along the LHC vacuum tube, at the point where it is divided into two. In this area, only neutral particles, not deflected by the strong magnetic fields driving the beam, reach LHCf to be identified. LHCf was created to reproduce in the laboratory the production processes of particles that occur when cosmic rays meet the Earth's atmosphere and help clarify the mysteries concerning their origin and their properties.

In fact, the upper layers of the Earth's atmosphere are constantly affected by a shower of particles called cosmic rays. These particles collide with the atomic nuclei present in the atmosphere and produce many secondary particles that in turn collide with other nuclei, thus generating a cascade of particles whose size depends on the energy of the primary particle.

Analysis of the number of secondary particles produced, and of their energy spectrum, is of fundamental importance for trying to interpret the interaction mechanism of primary cosmic rays with the nuclei of the atmosphere. The properties of primary ultra-high energy cosmic rays are, in fact, obtained through measurements made by detecting the secondary products and using Monte Carlo simulations that describe the interactions of the primary rays with the atmosphere. The models currently used to describe the hadronic interaction of the primary rays with the nuclei of the atmosphere have shown significant mutual discrepancies and also with respect to the data collected by the LHCf experiment. The runs carried out so far by the LHCf experiment with different energies and in lead-proton collisions are of paramount importance for a more realistic description of the process.

Last June, a new milestone was reached by the LHCf experiment which, for the occasion, took on a

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new name, becoming RHICf. Indeed, in September 2016, the two calorimeters, ARM1 and ARM2, which comprise the LHCf detector, were separated for the first time. ARM2 remained at CERN where it was re-installed in the LHC tunnel to take part in the lead-proton collision data acquisition between October and November 2016, while ARM1 flew across the ocean to the Brookhaven National Laboratory to become RHICf. After an intense period of work, at the end of last year ARM1 was installed at 18 metres from the STAR experiment interaction point and during the first months of this year the detector was tested and configured ahead of the dedicated run approved by the BNL PAC. In the third week of June, it then acquired data together with the STAR experiment in proton-proton collisions at 510 GeV of energy in the centre of mass. The configuration of RHICf is very similar to that which the detector occupies when it is installed at LHC, 140 metres from the ATLAS interaction point. At both LHC and RHIC, the experiment is able to detect particles produced far ahead, similar to those produced in cosmic ray cascades. This new run at RHIC fits precisely into this context. The data analysis will provide additional useful information to understand which of the models currently in use best describes the data across the energy range explored so far and will add further important information to better understand the behaviour of ultra-high energy cosmic rays. In particular, by comparing the results of the analysis of the data collected at RHIC (Relativistic Heavy Ion Collider) with those of LHC, it will be possible to carry out an experimental verification of the validity of the scaling law predicted by Feynman in a wide range of energy and in a region traditionally very difficult to explore. ■