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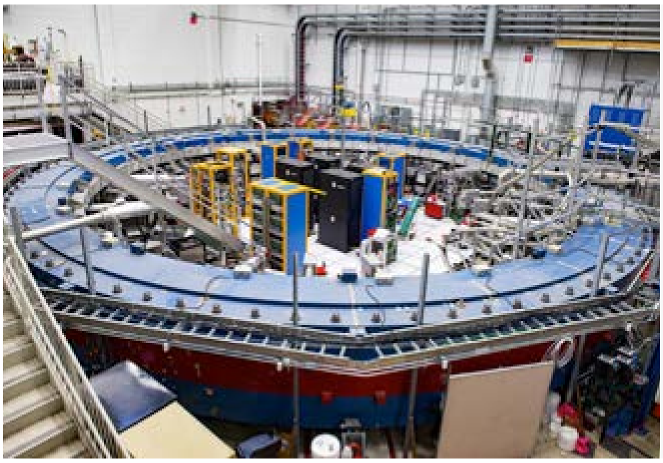

MUON G-2, AWAITING THE FIRT RESULTS

After three years of activity, the Muon g-2 international collaboration, Fermilab's experiment dedicated to the precision measurement of the anomalous magnetic moment of the muon, is preparing to release its first results, which could pave the way for a new physics. The analysis of the data collected so far could in fact shed light on a new class of subatomic constituents associated with the fluctuations of the so-called false vacuum, the quantum field that pervades space apparently devoid of matter. Coordinating the activities foreseen during the phase preceding publication is Graziano Venanzoni, an INFN researcher from the Pisa division, recently elected by the Muon g-2 collaboration as the new spokesperson of the experiment, an appointment that also comes in recognition of the fundamental role played by INFN in the project.

One of the properties of charged particles with their own rotation (spin) is that they possess a magnetic moment which, to use an analogy, can be compared to the magnetic field of the needle of a compass. In the family of leptons, to which muons, electrons and tauons belong, the magnetic moment is nevertheless characterised by a peculiarity attributable to these particles only, which exhibit a magnetic moment value different from the one predicted by the standard model (equal to 2). The deviation from the theoretical predictions is calculated by subtracting that foreseen by the theory from the measured value, indicated with the letter g (hence the name of the Muon g-2 experiment). The existence of the anomaly was first identified in 1947 in the electron, thanks to an experiment conducted by Polykarp Kusch and Henry Foley, a discovery that won the two physicists the Nobel Prize in 1955. The most recent confirmation, on the other hand, dates back to the early 2000s, and is due to the E821 experiment of the Brookhaven National Laboratory in Upton, which focused on the study of muons.

In order to explain the magnetic moment anomaly, the existence of interactions between muons and

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virtual particles generated by the constant fluctuations of quantum vacuum energy has been proposed. To verify this hypothesis, however, it is necessary to measure the discrepancy of g compared to its theoretical value with absolute precision. This is what is being done with Muon g-2 at Fermilab, which aims to provide definitive proof of the muon's magnetic moment anomaly, a result that could reveal valuable information for future research into the unknown particles populating the false vacuum.
The result of an international collaboration, in which INFN is participating with one of the most numerous research groups involved, including the Naples, Pisa, Roma 2 and Trieste divisions, the associated group of Udine and the Frascati National Laboratories, Muon g-2 uses Fermilab's accelerators to generate muon beams with speeds close to the speed of light. Once stored inside a circular magnet, the muons reach the experiment's detectors. In order to increase the performance of Muon g-2, which aims to improve the accuracy of the measurements made in Brookhaven by a factor of 4, the experiment uses 24 extremely sensitive calorimeters, whose control is entrusted to a laser calibration system developed by INFN in collaboration with the CNR’s National Institute of Optics. Moreover, to avoid any errors in the data analysis that could compromise the results of Muon g-2, and in particular those related to subjective conditioning, the collaboration has adopted the so-called blind analysis, which involves the inclusion of an artificial and unknown constant during data acquisition, a constant that is revealed only at the end of the calculation procedures. Finally, INFN’s involvement also concerns the data analysis activity of the experiment, to which, together with five other research groups, it makes a 20% contribution. In addition to the interest in what they may reveal, the first results of Muon g-2, which refer to its first data acquisition cycle (run 1) carried out in 2018, will be used to improve the accuracy of the next results, which will be taken from the two subsequent data acquisition cycles in 2019 and 2020.