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NA62 EXPERIMENT AT CERN TACKLES A VERY RARE PROCESS

A very rare process has been observed with an excellent level of statistical confidence and with unprecedented accuracy by the NA62 experiment at CERN. We are speaking of a particle decay that sees a charged kaon turning into a charged pion with a neutrino and an antineutrino. The new results were presented on July 28 during the International Conference on High Energy Physics 2020 (ICHEP 2020) by the collaboration of researchers working on the experiment, which includes INFN physicists and technologists. The detailed study of this process could allow us to find signs of New Physics, that's the physics that we do not yet know and that could extend our current theories. Indeed, the objective of NA62 is to find in this process something not foreseen by the Standard Model, the theory that today gives us the best description of the world of elementary particles and their interactions.

NA62 is an experiment consisting of several particle detectors using a proton beam extracted from CERN's Super Proton Synchrotron (SPS) accelerator. The protons are made to collide on a beryllium target to generate an intense secondary beam with a significant percentage of kaons, the particles that are the subject of the experiment. Unlike the experiments that have studied this rare decay to date, such as E787 and E949 of the Brookhaven National Laboratory in the United States, NA62 studies kaons "in flight", within a volume, over 60 meters long, in which a vacuum has been created. This approach makes it possible to increase the total number of observable decays. In the data collected in 2018, obtained from more than two billion proton collisions on a beryllium target, NA62 was able to record 17 events that could correspond to this particular decay of the kaon, if added to the three events identified in the data collected between 2016 and 2017, these events provide a great level of statistical confidence (3.5 sigma), making it possible to announce evidence of this very rare decay, which physicists have been searching for over 50 years.

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Analysis of the data proved to be a major challenge: signal events must be extracted from the sea of events that constitute the "background noise", a number one trillion times greater than the number of events to be observed. In these cases, it is important not to be influenced by the data but to define their analysis criteria before the analysis phase itself, based on preliminary studies. This is what was done by applying so-called blind analysis: only after having definitively decided the analysis criteria did the researchers observe the data and find the signal events.

The NA62 collaboration, led by the Italian Cristina Lazzeroni from the University of Birmingham, involves approximately 200 physicists from Europe, the United States, Canada, Mexico and Russia. INFN's commitment stands out with approximately one third of the participants: over 70 physicists and technologists from the Frascati National Laboratories and eight INFN Divisions - Ferrara, Florence, Naples, Perugia, Pisa, Rome1, Rome2 and Turin - are making a decisive contribution to the success of the experiment with important responsibilities, both on the detector (with the development of the highly advanced beam tracking system, the veto system for photon and charged particle backgrounds, and the pioneer detection system) and on the complex data acquisition system of the experiment. ■