A new run of the CLOUD experiment examines the direct effect of cosmic rays on clouds

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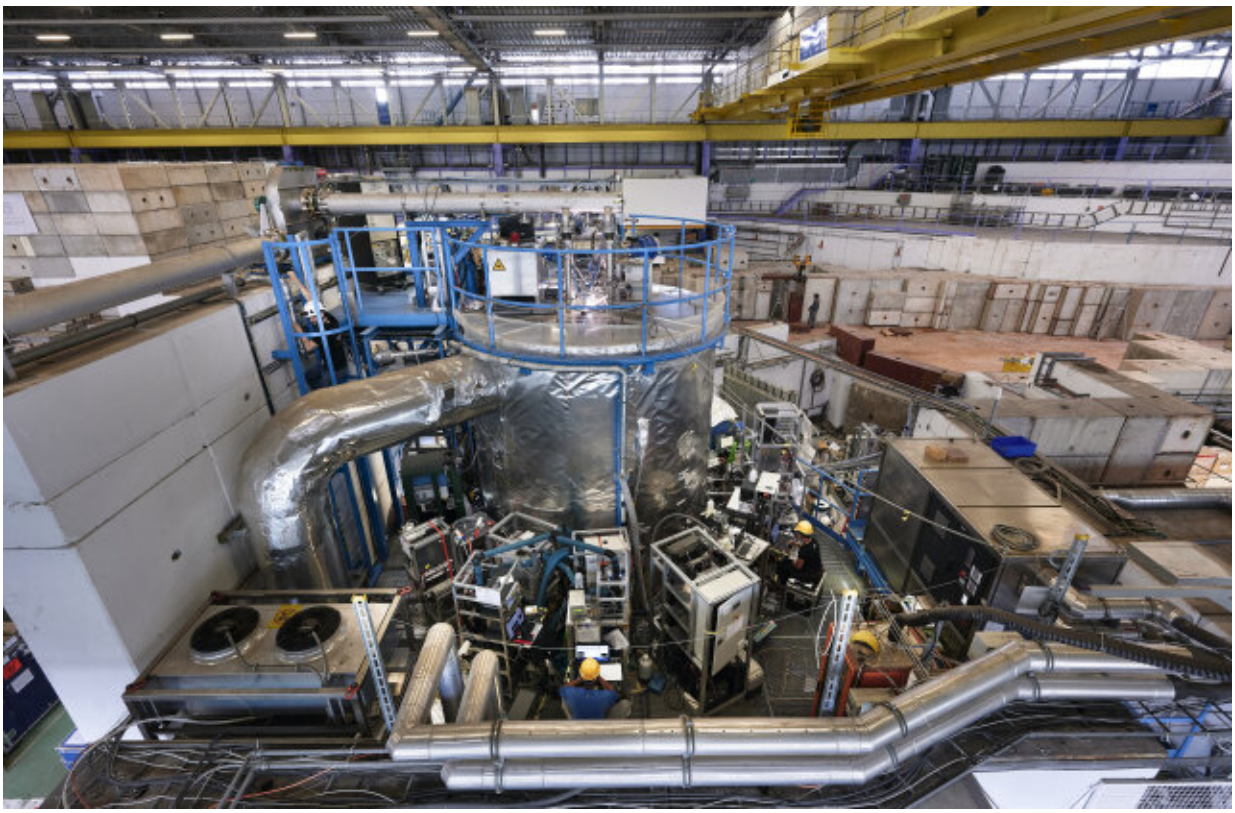

The CLOUD experiment in the CERN East Hall at the start of the CLOUDy run, on 23 September 2019. The chamber is enclosed inside a thermal housing that precisely controls the temperature between -65 °C and +40 °C. Instruments surrounding the chamber continuously sample and analyse its contents. Credit: CERN

CERN's colossal complex of accelerators is in the midst of a two-year shutdown for upgrade work. But that doesn't mean all experiments at the Laboratory have ceased to operate. The CLOUD experiment, for example, has just started a data run that will last until the end of November.

The CLOUD experiment studies how ions produced by high-energy particles called cosmic rays affect aerosol particles, clouds and the climate. It uses a special cloud chamber and a beam of particles from the Proton Synchrotron to provide an artificial source of cosmic rays. For this run, however, the cosmic rays are instead natural high-energy particles from cosmic objects such as exploding stars.

"Cosmic rays, whether natural or artificial, leave a trail of ions in the chamber," explains CLOUD spokesperson Jasper Kirkby, "but the Proton Synchrotron provides cosmic rays that can be adjusted over the full range of ionisation rates occurring in the troposphere, which comprises the lowest ten kilometres of the atmosphere. That said, we can also make progress with the steady flux of natural cosmic rays that make it into our chamber, and this is what we're doing now."

In its 10 years of operation, CLOUD has made several important discoveries on the vapours that form aerosol particles in the atmosphere and can seed clouds. Although most aerosol particle formation requires sulphuric acid, CLOUD has shown that aerosols can form purely from biogenic vapours emitted by trees, and that their formation rate is enhanced by cosmic rays by up to a factor 100.

Most of CLOUD's data runs are aerosol runs, in which aerosols form and grow inside the chamber under simulated conditions of sunlight and cosmic-ray ionisation. The run that has just started is of the "CLOUDy" type, which studies the ice- and liquid-cloud-seeding properties of various aerosol species grown in the chamber, and direct effects of

cosmic-ray ionisation on clouds.

The present run uses the most comprehensive array of instruments ever assembled for CLOUDy experiments, including several instruments dedicated to measuring the ice- and liquid-cloud-seeding properties of aerosols over the full range of tropospheric temperatures. In addition, the CERN CLOUD team has built a novel generator of electrically charged cloud seeds to investigate the effects of charged aerosols on cloud formation and dynamics.

"Direct effects of cosmic-ray ionisation on the formation of fair-weather clouds are highly speculative and almost completely unexplored experimentally," says Kirkby. "So this run could be the most boring we've ever done—or the most exciting! We won't know until we try, but by the end of the CLOUD experiment, we want to be able to answer definitively whether cosmic rays affect clouds and the climate, and not leave any stone unturned."

Provided by CERN

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