The Earth's upper atmosphere is constantly hit by a storm of particles called cosmic rays. These particles collide with the nuclei in the upper atmosphere producing many secondary particles, which in turn collide with other nuclei in the atmosphere. This cascade continues, producing a shower of particles that reach the ground. The size of this particle shower depends on the energy of the cosmic ray.

A huge number of cosmic rays hit the Earth's atmosphere every second, but occasionally one arrives with so much energy that it produces an enormous shower of billions of secondary particles. These ultra-high-energy cosmic rays are very rare, arriving at a rate of just one per square kilometre per century, and their source is still a mystery. Since they are so rare, it is very difficult to study them.

Just as in a cosmic ray shower, secondary particles are created during the head-on collisions in the LHC. LHCf is positioned to detect these secondary particles. The data collected will help to confirm the theoretical models that describe what happens to ultra-high-energy cosmic rays when they enter the atmosphere.
Forward
During a collision many different particles are flung out in all directions, but the highest energy particles are scattered forwards - in almost the same direction as the beams inside the LHC.

Straight ahead
Unlike the four big LHC experiments, LHCf sits in a straight line from the collision point, and so can detect ‘forward moving’ particles. These are very similar to the particles created when an ultra-high-energy cosmic ray hits the Earth’s atmosphere. The results will help in the search for the origins of these mysterious cosmic rays.

Double detectors
LHCf is made up of two independent detectors located in the LHC tunnel, 140 metres either side of the huge ATLAS experimental cavern.

Each detector is placed along the beam pipe, at the point where the pipe splits into two. Here they will look at neutral particles, which are unaffected by the very strong magnetic fields that guide the positively charged proton beams around the LHC.

Before reaching the LHCf detectors, the LHC protons are directed into two separate beam pipes, while the neutral particles carry straight on into the detectors.

LHCf is designed to operate at relatively low luminosity. Once the LHC beams become too intense the experiment will be removed.

Small…but effective
Each detector is just 30 cm long and weighs only 70 kg. However the technology used is very similar to that which you might find in the other huge LHC experiments.

30 people from 6 different countries work on the LHCf experiment, with major contributions from Japan and Italy.