PUBLISHED BY INSTITUTE OF PHYSICS PUBLISHING AND SISSA

RECEIVED: *April 11, 2008*
ACCEPTED: *July 10, 2008*
PUBLISHED: *August 14, 2008*

THE CERN LARGE HADRON COLLIDER: ACCELERATOR AND EXPERIMENTS

The LHCf detector at the CERN Large Hadron Collider

The LHCf Collaboration

ABSTRACT: LHCf is an experiment dedicated to the measurement of neutral particles emitted in the very forward region of LHC collisions. The physics goal is to provide data for calibrating the hadron interaction models that are used in the study of Extremely High-Energy Cosmic-Rays. This is possible since the laboratory equivalent collision energy of LHC is 10^{17} eV. Two LHCf detectors, consisting of imaging calorimeters made of tungsten plates, plastic scintillator and position sensitive sensors, are installed at zero degree collision angle ± 140 m from an interaction point (IP). Although the lateral dimensions of these calorimeters are very compact, ranging from 20 mm$\times$20 mm to 40 mm$\times$40 mm, the energy resolution is expected to be better than 6% and the position resolution better than 0.2 mm for γ-rays with energy from 100 GeV to 7 TeV. This has been confirmed by test beam results at the CERN SPS. These calorimeters can measure particles emitted in the pseudo rapidity range $\eta > 8.4$. Detectors, data acquisition and electronics are optimized to operate during the early phase of the LHC commissioning with luminosity below $10^{30}\,\mathrm{cm^{-2}s^{-1}}$. LHCf is expected to obtain data to compare with the major hadron interaction models within a week or so of operation at luminosity $\sim 10^{29}\,\mathrm{cm^{-2}s^{-1}}$. After $\sim$10 days of operation at luminosity $\sim 10^{29}\,\mathrm{cm^{-2}s^{-1}}$, the light output of the plastic scintillators is expected to degrade by $\sim$10% due to radiation damage. This degradation will be monitored and corrected for using calibration pulses from a laser.

KEYWORDS: Photon detectors for UV, visible and IR photons; Scintillators, scintillation and light emission processes; Solid state detectors; Calorimeters; Gamma detectors; Particle identification methods; Particle tracking detectors; Photon detectors for UV, visible and IR photons; Gamma detectors; Particle detectors; Radiation damage to detector materials; Data acquisition concepts; Detector control systems; Front-end electronics for detector readout; Trigger concepts and systems; Analysis and statistical methods; Pattern recognition, cluster finding, calibration and fitting methods; Simulation methods and programs; Scintillators and scintillating fibers and light guides; Detector alignment and calibration methods; Overall mechanics design.

2008 JINST 3 S08006

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