3.1 Operation at LHC

The LHCf-2 detectors were installed 140m away from LHC IP1 (ATLAS). Each detector has two calorimeter towers composed of 44±1 cm of tungsten plates, 16 sampling layers of plastic scintillators, and four X-Y pairs of position sensitive detectors (SciFi in Arm1 and silicon strip detector in Arm2). The responses of the detectors for high energy particles were tested in the fixed target experiments using electron beams below 220 GeV, proton beams below 350 GeV and muon beams below 150 GeV [3]. The performance for electromagnetic showers is well understood using the Monte Carlo simulations.

The LHCf-2 detectors will be upgraded with GSO scintillators for the coming s = 14 TeV run (for more radiation hardness). GdSiO₃ (GSO) scintillator has very excellent radiation resistance, fast decay time and a large light yield. The radiation hardness of GSO and its optical characteristics have been measured with Carbon ion beams at the Heavy Ion Medical Accelerator in Chiba (HIMAC). After exposure of 7x10⁸ Gy, the light yield of GSO scintillator did not decrease, but rather an increase up to about 25% was observed [6]. The first GSO-LHCf detector will be constructed in this summer and tested its performance by using CERN SPS beams.

The LHCf experiment[1,2] is one of the LHC forward region experiment dedicated to the cosmic-ray physics. The LHCf target is to provide the energy and transverse momentum spectra of particles emitted to the forward region of the LHC interaction point (IP1).

The LHCf detector: Two independent detectors called Arm1 and Arm2 were installed 140m away from LHC IP1 (ATLAS). Each detectors have two calorimeter towers composed of 44±1 cm of tungsten plates, 16 sampling layers of plastic scintillators, and four X-Y pairs of position sensitive detectors (SciFi in Arm1 and silicon strip detector in Arm2). The responses of the detectors for high energy particles were tested in the fixed target experiments using electron beams below 220 GeV, proton beams below 350 GeV and muon beams below 150 GeV[3]. The performance for electromagnetic showers is well understood using the Monte Carlo simulations.

Summary

- The LHCf experiment is dedicated to the cosmic-ray physics and successfully finished the first phase of data taking at 2010.
- As first physics result, the energy spectra of gamma of η > 10.94 and 8.81 < η < 8.99 at 7 TeV have been investigated and compared with several hadronic interaction models. None of the model agrees perfectly with data. Other analysis such as n° spectra, gamma spectra at 0.9 TeV, hadron spectra, PT distribution, wider n coverage, etc are also ongoing.
- LHCf is also assumed to take data at 14 TeV collisions. Detectors will be upgraded with GSO scintillators for the coming 14 TeV run after 2014.
- Additional possibility to take data at p-A and A-A collisions is also in study to infer the nuclear effect or directly simulate CR-air interaction.
- Using both existing data and future experiments, LHCf will provide crucial data to constrain hadronic interaction models and improve the interpretation of UHECR observations.

Motivation of LHCf experiment

For the recent observations of high energy cosmic ray by the AUGER observatory and the TA experiment, the uncertainty in hadron interaction models becomes more important to understand its spectra. To constrain the uncertainty in the hadron interaction models in terms of the cosmic-ray physics, to observe the very forward particles in high energy accelerator are essential.

Gamma spectra @ s = 7 TeV

The LHCf experiment has successfully measured the energy spectra of gamma emitted in the very forward region of the LHC in 2010. We compared the results of s = 7 TeV collision at the LHC with the several hadronic interaction models used in cosmic-ray observations. No model is able to describe completely the experimental data.

Data used in this analysis was obtained on 15 May 2010 during proton–proton collisions at s = 7 TeV with zero degree beam crossing angle (LHC Fill 1104). The total luminosity of the three crossing bunches in this fill, L = (6.3±6.5) x 10³⁵ cm⁻² s⁻¹. The ranges used for the small calorimeters and the large calorimeters are [η > 10.94, Δp = 360.0°] and [8.99 > η > 8.81, Δp = 20.0°], respectively. Only single hit event were selected in this analysis. The result was summarized to physics paper[4].

References