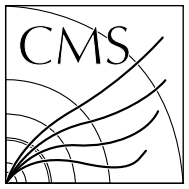
Available on CMS information server

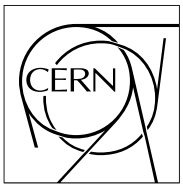
CMS DP -2013/032



The Compact Muon Solenoid Experiment

CMS Performance Note

Mailing address: CMS CERN, CH-1211 GENEVA 23, Switzerland



29 October 2013 (v2, 30 October 2013)

BCM1F Performance in 2012

CMS Collaboration

Abstract

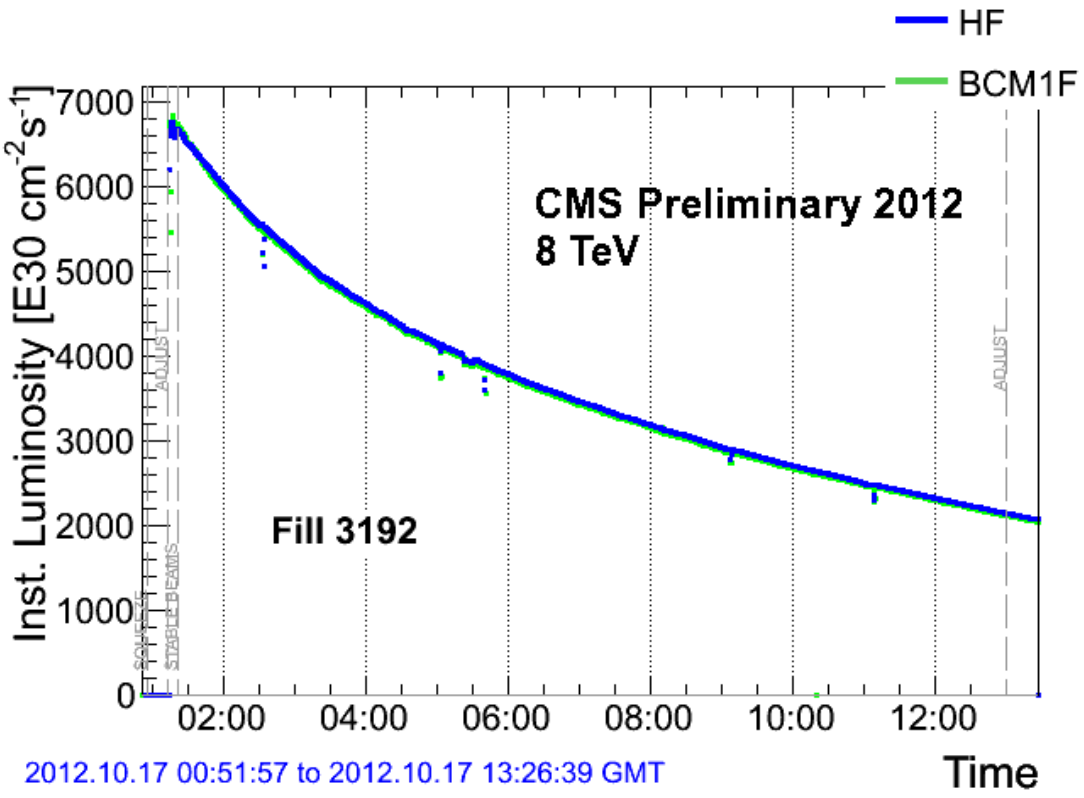
The Fast Beam Condition Monitor BCM1F consists of 8 single-crystal CVD 5 mm x 5 mm diamonds positioned 1.8 m on either side of the interaction point at a radius of 4.5 cm from the beam pipe. The signal is read out, shaped by a frontend ASIC, and converted to an optical signal which is then transmitted to the backend electronics in USC55. The data travels parallel paths: a discriminator path registers the time of signal pulses and transfers this information to the readout electronics, while an ADC captures full orbits for monitoring studies but is prevented from acting as data readout by a high deadtime. BCM1F provides information on the condition of the beam and ensures that the inner detector occupancy is sufficiently low for data-taking. In addition to providing beam information, BCM1F also detects collisions and as such can be used as a luminometer. Effort was made to commission BCM1F as an online luminometer in 2012. In 2012 the Real-time Histogramming Unit (RHU) for BCM1F readout was introduced. The board provides 8 channels of deadtimeless full-orbit histograms with a configurable accumulation interval, with bins in 6.25-ns intevals, or four bins per bunch bucket. Also during Run I, the effects of radiation damage to various parts of the BCM1F system became apparent. The diamond sensors themselves were subject to a high amount of radiation, which cause charge traps to form within the material, reducing the efficiency of hit detection in BCM1F. In addition, the optical driver was integrated into the sensor module and therefore subjected to the same amount of radiation. Deterioration was observed in various ways, including the decreasing range of signal heights transmitted.

BCM1F Performance in 2012

CMS Collaboration

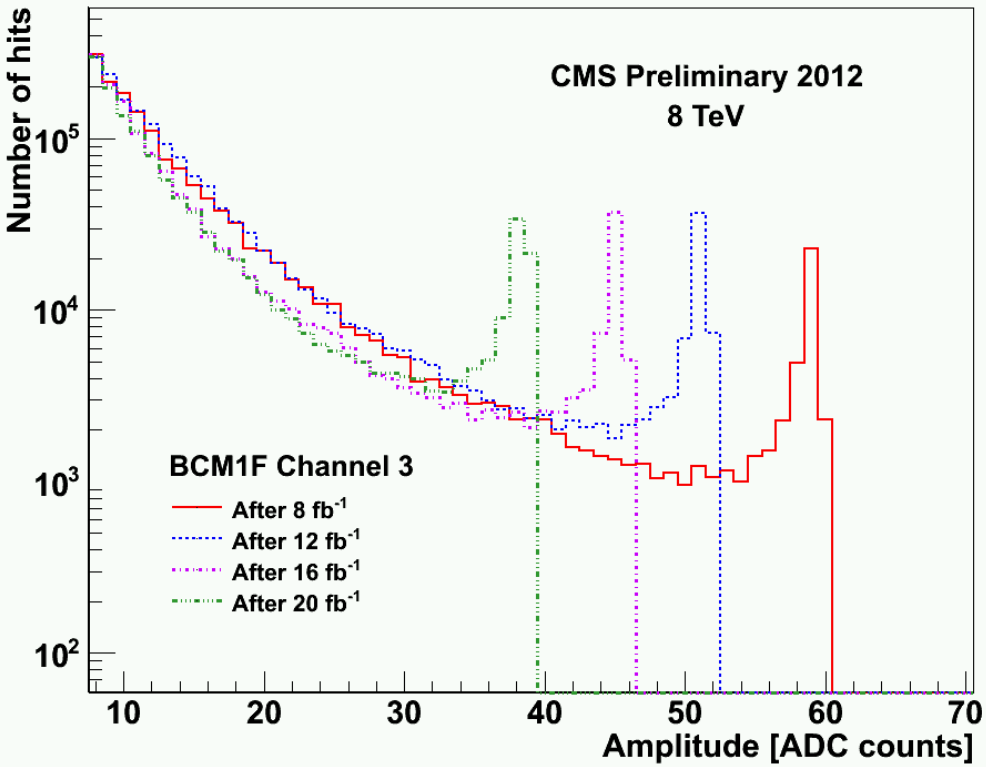
Contact: Jessica Leonard

Online Luminosity Measurement



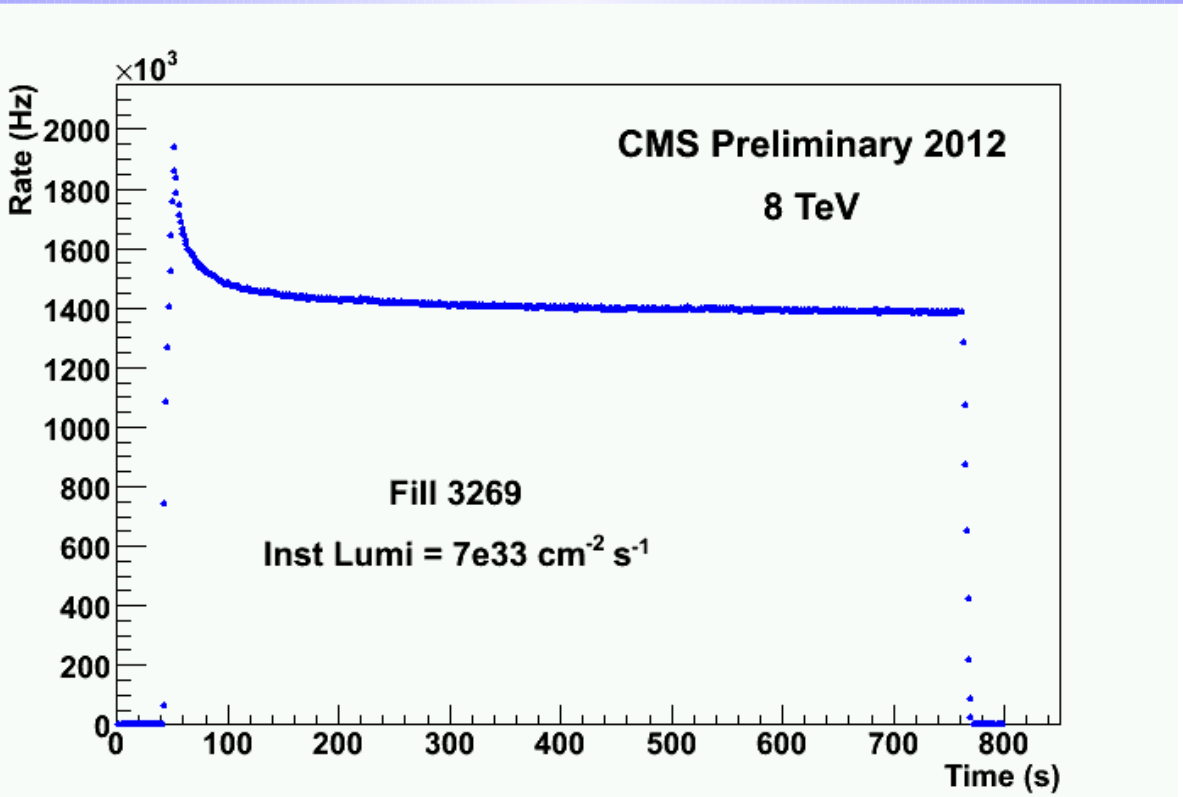
"Instantaneous luminosity measured by the fast beam condition monitor BCM1F and the forward hadronic calorimeter HF, plotted as a function of time during a single fill. The BCM1F value was normalized to HF at a previous point in time. This plot shows how well BCM1F tracks HF within that normalization, showing BCM1F's suitability to complement HF as an online luminometer."

Frontend Radiation Damage



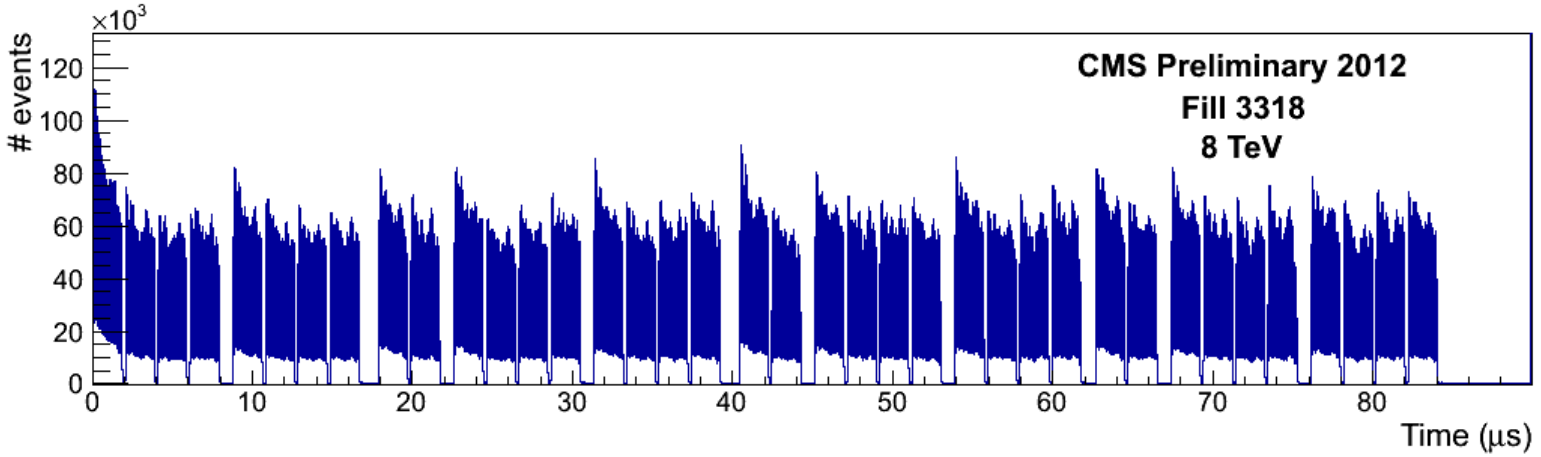
"A single BCM1F channel's amplitude spectrum (in ADC counts) plotted for several values of integrated luminosity. The endpoints indicate the saturation amplitude of the front-end 1310 nm laser driver and take into account the baseline subtraction algorithm. The saturation amplitude decreases with integrated luminosity, showing successive radiation damage of the laser driver. BCM1F receives approximately 2.9e12 cm^{-2} hadron fluence per fb^{-1}."

Rate Decrease with Polarization



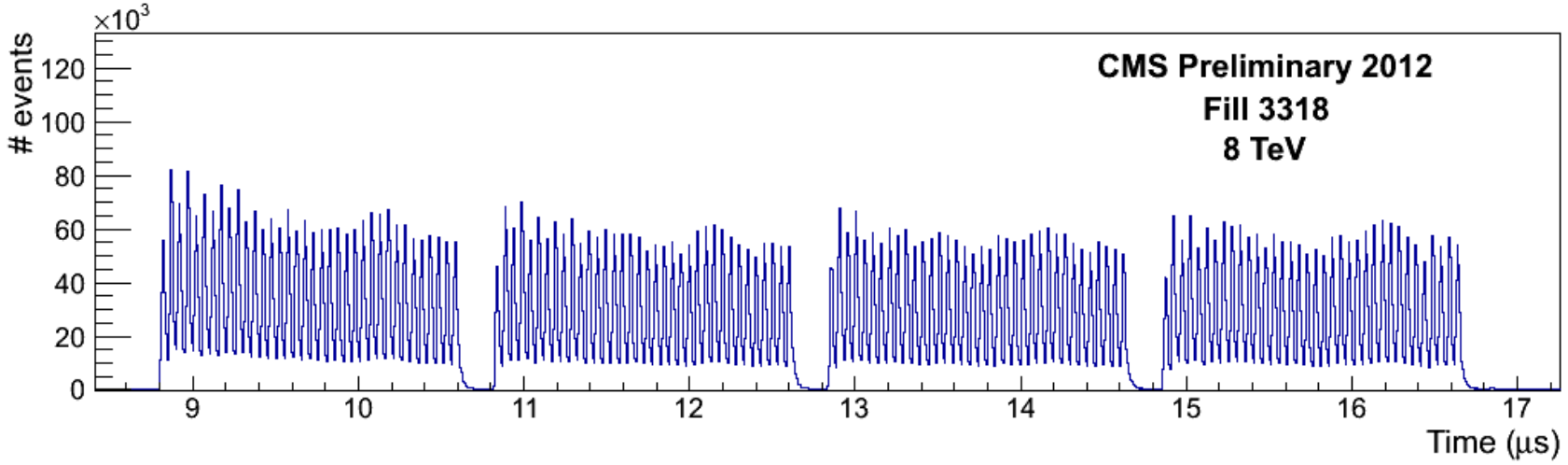
"Hit rate for a single BCM1F channel after turning on the high voltage across the diamond sensor. The high voltage begins at a value of 0 V and is ramped to its final value of 250 V within several seconds. The rate peaks before settling into a significantly lower stable value. This shows the buildup of polarization in the diamond sensor. Polarization occurs when charge traps formed by radiation damage are filled in such a way as to compensate for the applied electric field, lowering the hit detection efficiency. BCM1F receives approximately 2.9e12 cm^{-2} hadron fluence per fb^{-1}. At the time of the measurement, CMS had received 18 fb^{-1} of integrated luminosity."

RHU Full-Orbit Histogram



"Cumulative full-orbit histogram from the Real-time Histogramming Unit (RHU) used by the fast beam condition monitor BCM1F. Hits from a single BCM1F sensor are histogrammed in 14256 bins per orbit (4 bins per bunch crossing) for a proton-proton fill. The spacing between bunches is 50 ns. The structure of the bunch trains is clearly visible within the orbit."

RHU Full-Orbit Histogram Zoom-in



"Zoom-in of cumulative full-orbit histogram from the Real-time Histogramming Unit (RHU) used by the fast beam condition monitor BCM1F. Hits from a single BCM1F sensor are histogrammed in 14256 bins per orbit (4 bins per bunch crossing) for a proton-proton fill. The spacing between bunches is 50 ns. The structure of the bunches is clearly visible within the bunch trains."