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The Compact Muon Solenoid Experiment

CMS Performance Note

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BCM1F Performance Plots for EPS 2015

CMS Collaboration

Abstract

The Fast Beam Condition Monitor BCM1F consists of 24 single-crystal CVD 5 mm x 5 mm diamonds positioned 1.8 m on either side of the interaction point at a radius of 6.5 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 dedicated fast readout electronics, while an ADC system 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.

BCM1F Performance Plots for EPS 2015

BRIL DPG

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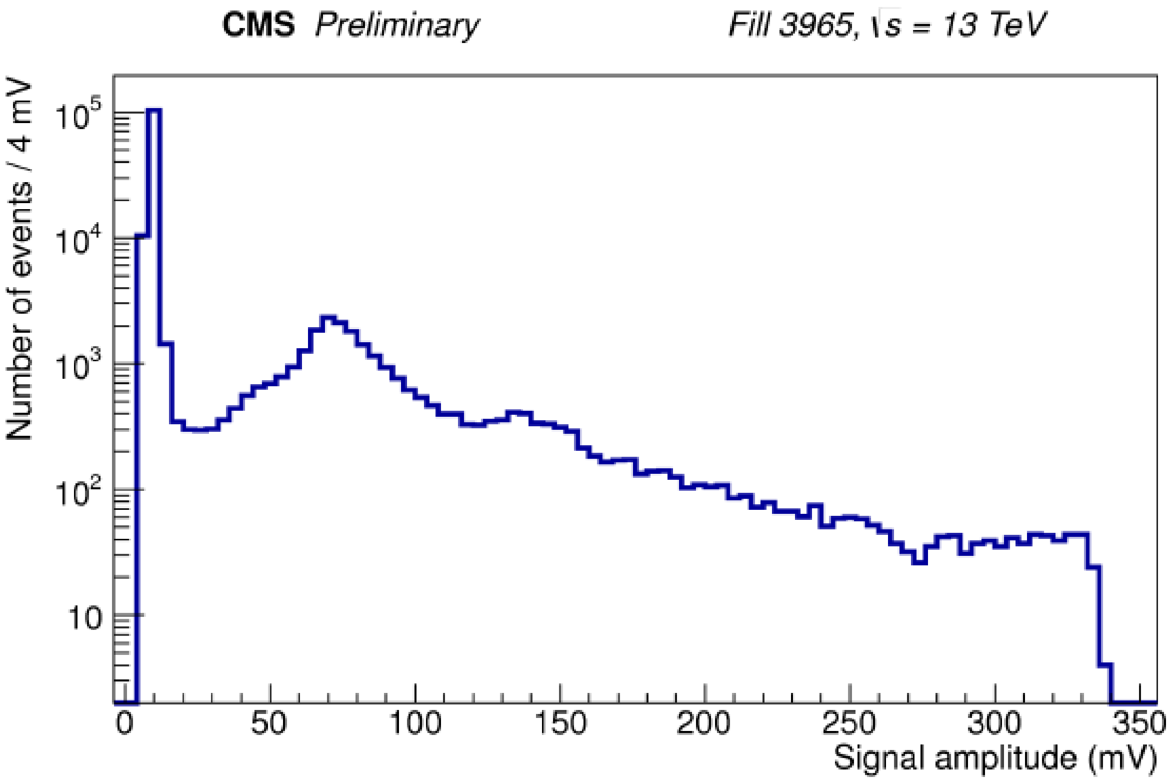
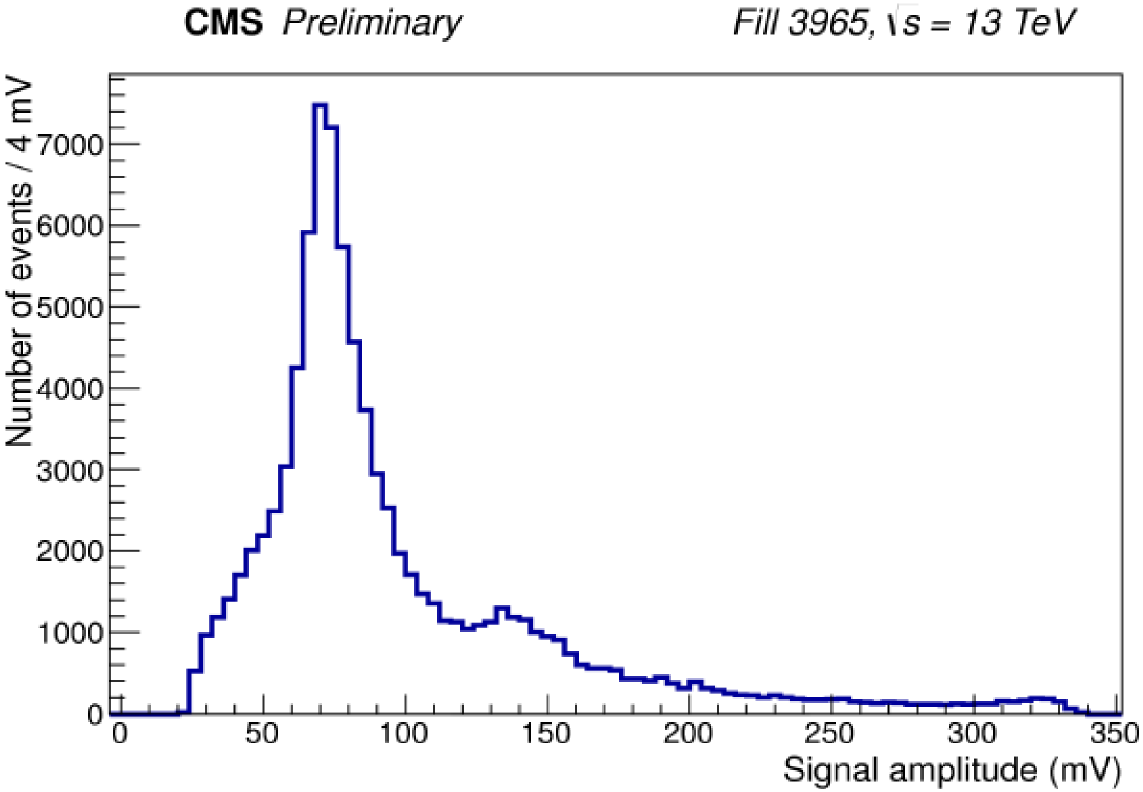


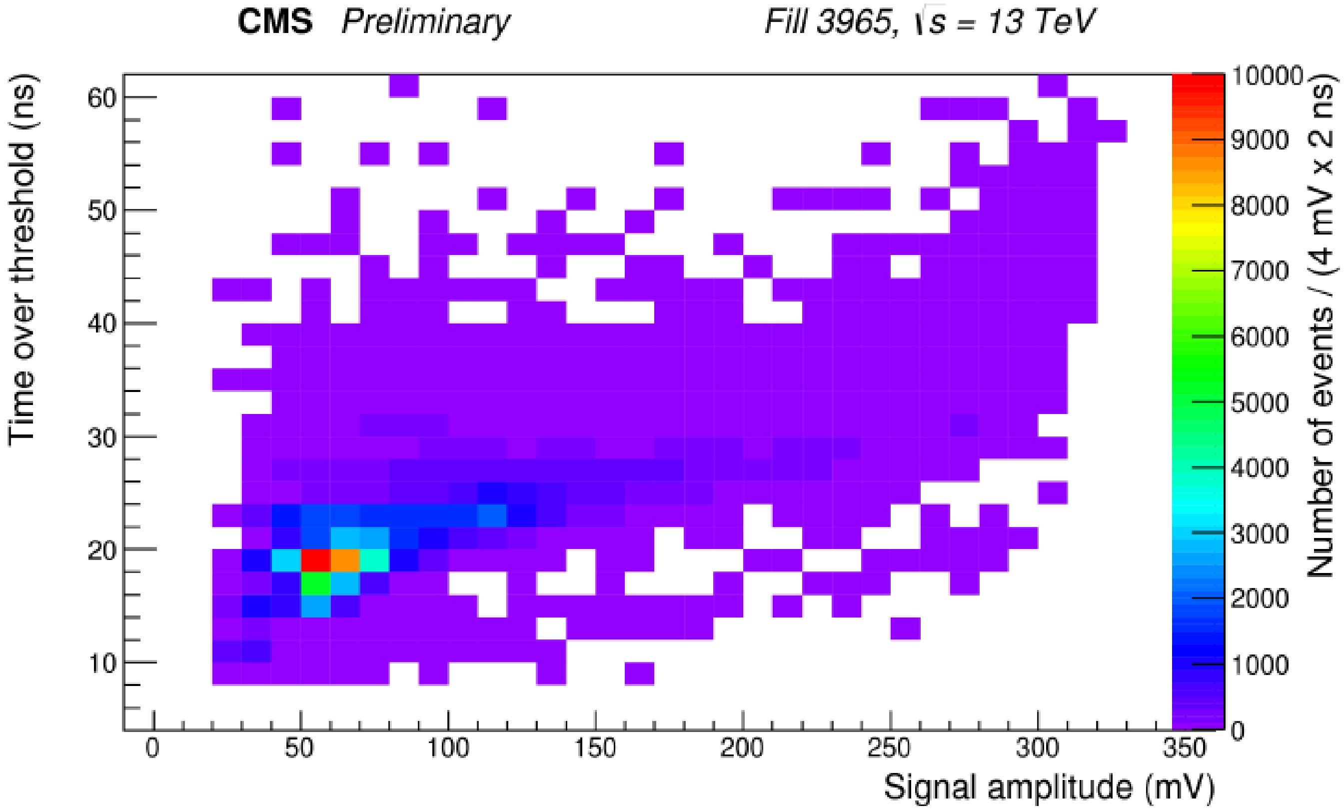
An example of the BCM1F amplitude spectrum. Signal and pedestal.

The VME ADC data was collected with colliding beams in the LHC. The signal amplitude spectrum was built using a simple peak finding algorithm. The MIP amplitude distribution is expected to be peaked around 70 mV. The pedestal and the MIP peak are clearly separated. The sharp dropoff at 330 mV is due to saturation of the frontend electronics at this amplitude.



An example of the BCM1F amplitude spectrum. Signal amplitude cut A > 20 mV.

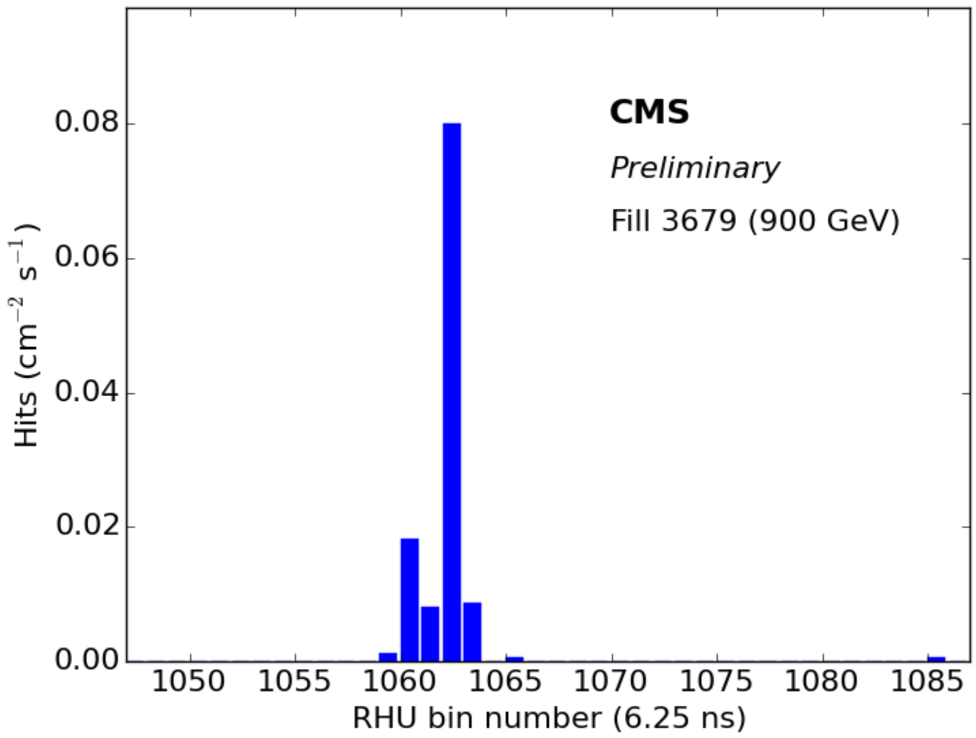
The VME ADC data was collected with colliding beams in the LHC. The signal amplitude spectrum was built using a simple peak finding algorithm. The peak around 70 mV corresponds to 1 MIP and that around 140 mV to 2 MIPs.



Time over threshold vs. signal amplitude:

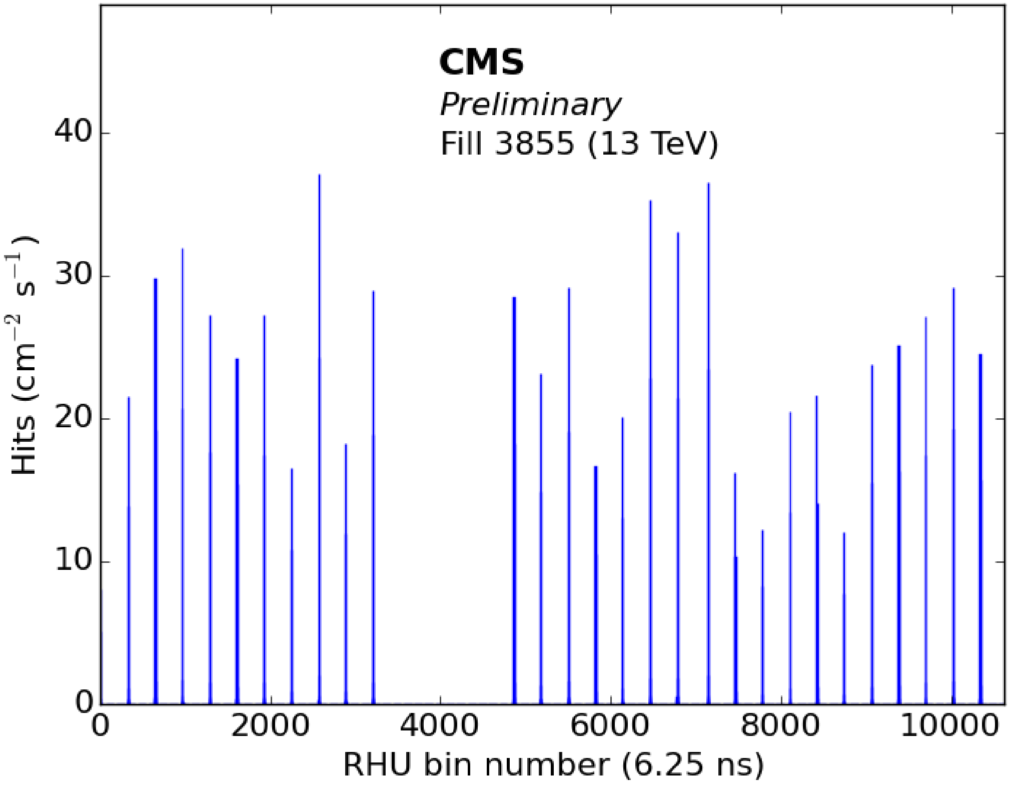
The VME ADC data was collected with colliding beams in the LHC. The time over threshold of each signal is plotted against the signal amplitude. The frontend electronics were designed to have a time over threshold of 25 ns for a typical MIP signal; this is the time between colliding bunches in the LHC. For this channel, 78% of all signals show this behavior.

Incoming/Outgoing Beam Separation



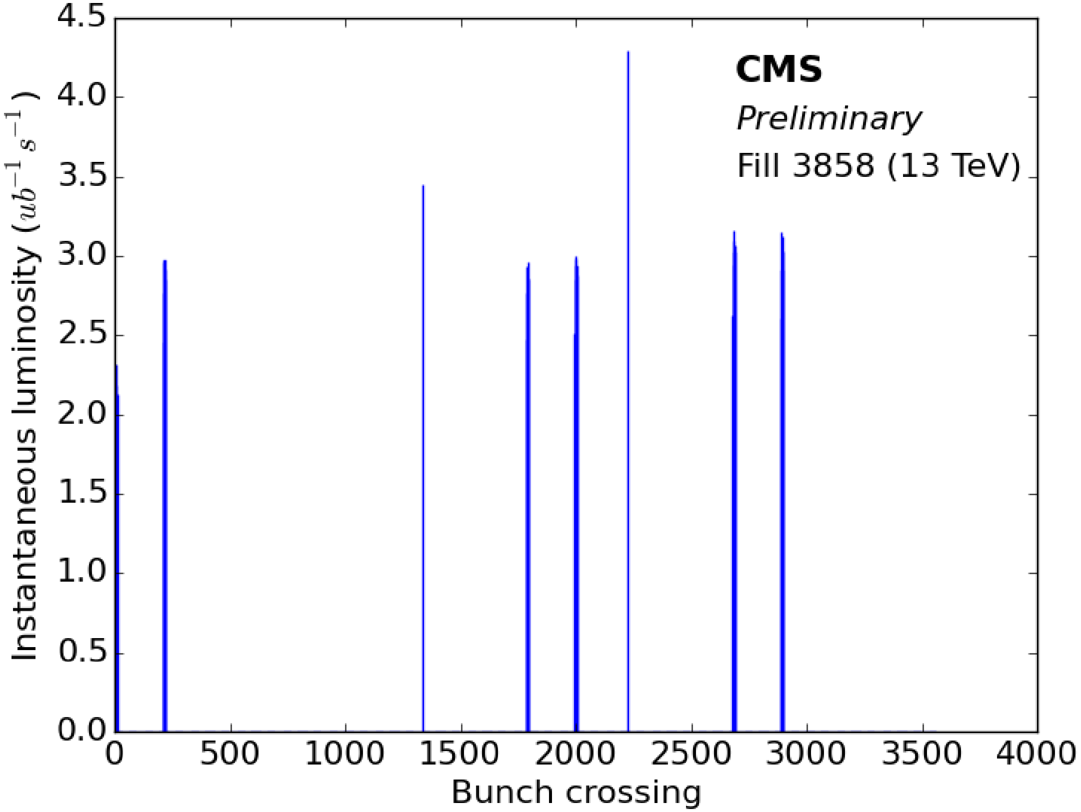
The Realtime Histogramming Unit (RHU) reads deadtimeless, full-orbit histograms from the Fast Beam Condition Monitor BCM1F. Each bin is 6.25 ns; there are 4 bins per bunch crossing. Each histogram is integrated over a period of 4096 orbits. The data here was taken over ~2.5 minutes. This plot shows the ability to distinguish between incoming and outgoing beam in a single bunch crossing. The first peak shows incoming beam background, while the second peak shows outgoing beam background plus collision products. These peaks are used to provide beam background and luminosity measurements separately.

Bunch Structure



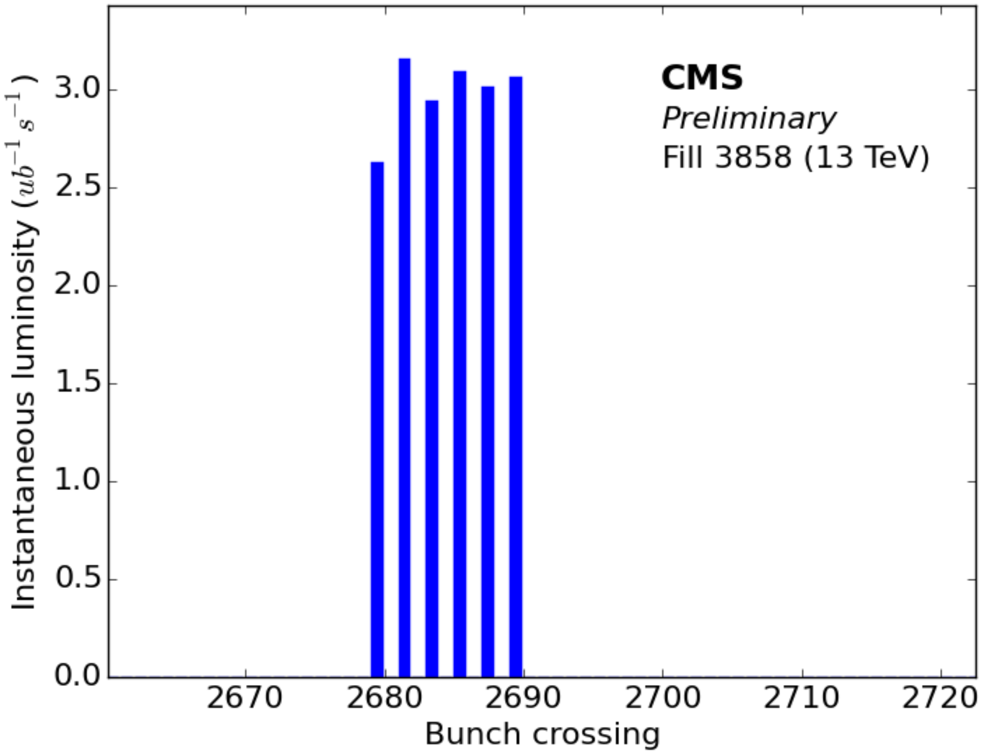
The Realtime Histogramming Unit (RHU) reads deadtimeless, full-orbit histograms from the Fast Beam Condition Monitor BCM1F. Each bin is 6.25 ns; there are 4 bins per bunch crossing. Each histogram is integrated over a period of 4096 orbits. The data here was taken over ~2.5 minutes. This plot shows the structure of bunches over part of the orbit as visible in the RHU.

Bunch-by-bunch Luminosity



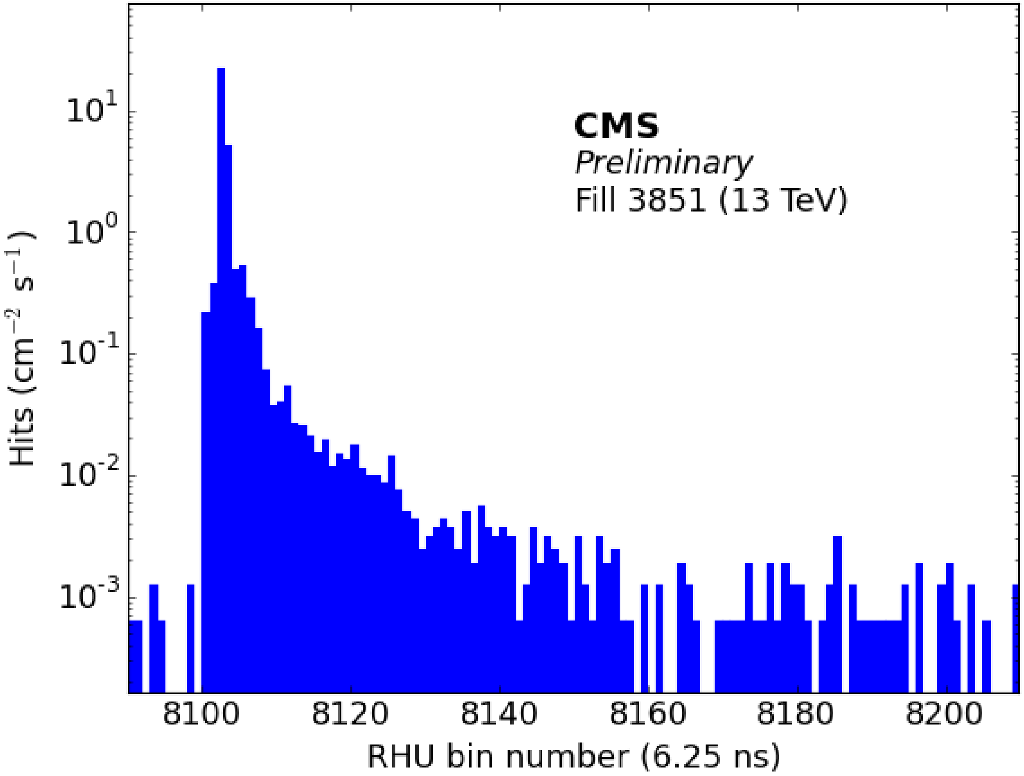
The Fast Beam Condition Monitor BCM1F reads out full-orbit histograms with which per-bunch luminosity can be calculated. This plot shows the luminosity per bunch for a given fill structure. The data here was taken over ~2.5 minutes. Luminosity is calculated using zero-counting, taking the number of empty orbits for each bunch crossing and averaging over all channels. The luminosity measurement was calibrated using periodic beam optimization scans.

Bunch-by-bunch Luminosity



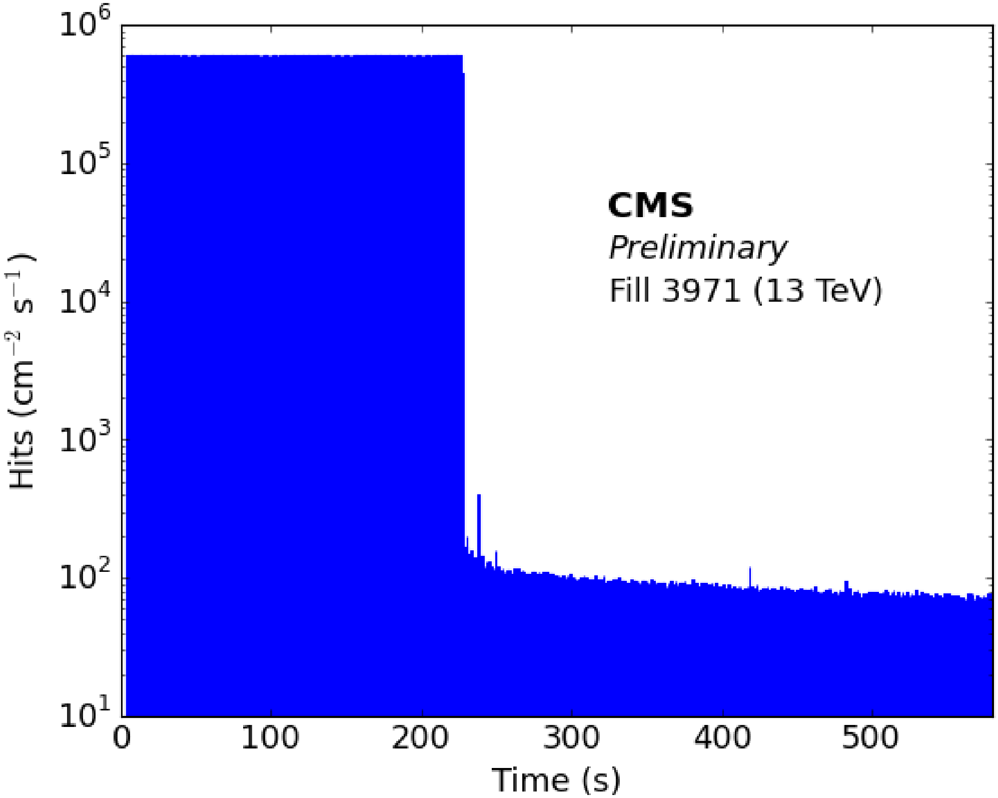
The Fast Beam Condition Monitor BCM1F reads out full-orbit histograms with which per-bunch luminosity can be calculated. This plot shows the luminosity per bunch for a bunch train with 50-ns spacing. The data here was taken over ~2.5 minutes. Luminosity is calculated using zero-counting, taking the number of empty orbits for each bunch crossing and averaging over all channels. The luminosity measurement was calibrated using periodic beam optimization scans.

Albedo Tail



The Realtime Histogramming Unit (RHU) reads deadtimeless, full-orbit histograms from the Fast Beam Condition Monitor BCM1F. Each bin is 6.25 ns; there are 4 bins per bunch crossing. Each histogram is integrated over a period of 4096 orbits. The data here was taken over ~2.5 minutes. This plot shows the albedo tail occurring after a single colliding bunch. Knowledge of the albedo tail is necessary to correct for albedo contributions to the signal measured during successive collisions.

Post-Fill Activation



The count rate per cm^2 averaged over all channels as measured by the Fast Beam Condition Monitor BCM1F before and after a stable beams fill was dumped. Time is measured in seconds from the beginning of the plot; the beam dump occurred at 225 s. The plot shows that after a fill, the measured activation is relatively high and decreases gradually towards a plateau level. A few rate spikes due to sensor noise are visible; these are filtered out of luminosity and background measurements via an automatic masking algorithm.