

The CMS ECAL Barrel HV power supply

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The CMS electro-magnetic calorimeter comprises 75848 scintillating lead tungstate crystals. 61200 crystals are contained in the ECAL Barrel section and these are readout by avalanche photodiodes (APD) with internal gain. The APD gain strongly depends on the bias voltage that, for a gain $G=50$, is around 400 V. In order to match the requirements for gain stability, the power supply voltage must be stable to within 0.01%.

In this talk we describe our experience with the installed Barrel HV power supply system which has been used for data taking at the LHC since 2008.

Summary

The CMS electro-magnetic calorimeter (ECAL) is used to detect and measure the energy of photons and electrons produced by collisions at the LHC.

The barrel part is composed of 61200 lead tungstate (PbWO_4) crystals whose scintillation light is detected using Avalanche Photodiodes

(APD) produced by Hamamatsu Photonics. Since two APDs are used for each crystal, a total of 122400 APDs are present in the ECAL. A dedicated high voltage (HV) power supply system is used to bias them.

The HV system and its characteristics directly influence the constant term of the ECAL resolution and then the performance of the entire ECAL in searching for new physics, where precise electrons and photons energy measurement is required (e.g. the most promising decay channel studied at LHC for detecting a "light" Higgs boson is $H \rightarrow \gamma\gamma$).

APDs in CMS require to be operated at a gain $M=50$ and so to be biased in proximity of the breakdown region (350-450 Volts); since the APD gain has a quite high dependence on the bias voltage (about 3.1%/V at gain 50), a very stable power supply is mandatory.

To successfully comply with the design goal of ECAL resolution constant term of 0.5% , the contribution due to the HV stability should not exceed 0.2%.

Such request implies that the high voltage stability has to be of the order of 60–65 mV. This requirement is applied to the combination of electrical system characteristics: noise, ripple, voltage regulation and absolute precision, for short and long term periods and lead to a tolerance of $\pm 20\text{mV}$ on each contribution.

The CMS ECAL HV power supply system, developed starting from 1999 by INFN Roma in collaboration with CAEN Company and used for data taking at LHC since 2008, is composed of 18 SY1527 crates and 144 A1520E boards, each hosting 9 HV channels. Each channel is used to bias 100 APDs and it is possible to set its output voltage in the 0V-500V range, while the maximum output current is in the 0-15mA range. Remote monitoring and control of all individual channel parameters (status, output voltage, current, etc.) is possible through Ethernet connection. This talk describes the HV power supply system characteristics and its performance after 4 years of operations at CMS showing the data related to long term stability , noise and reliability.

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