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The Upgraded CMS Preshower High Voltage System

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In March 2012 the high voltage system of the silicon-sensor-based CMS Preshower detector underwent a significant upgrade. In addition to a doubling of the number of power supplies, a new active distribution board was developed and installed. This new board provides much improved flexibility in the powering, necessary to cope with the expected evolution of the 4288 silicon sensors with radiation damage. It also provides an active measurement of the ˜2200 HV "lines"that go to the detector, enabling fast identification/diagnosis of any anomalous currents and providing detailed knowledge of the sensor current evolution with time.

Summary

From 2009-2011 the 4288 silicon strip sensors that comprise the CMS Preshower detector were biased by 192 commercial multi-channel power supply channels through 16 custom 9U distribution boards (4 types, with 7 different types of plug-in mezzanine). The distribution boards fanned-out the voltage to around 2200 high voltage "lines", most of which powered two sensors in parallel and some that powered singlets. The sensors originate from 6 manufacturers and have a large spread in voltage required for full depletion (Vfd) –from 50V up to 300V. The sensors have thus been grouped on the detector such that a single HV channel powers sensors with similar Vfd. The Vfd is expected to change with accumulated radiation fluence –increasing up to 500V before decreasing again. As the fluence is strongly dependent on pseudorapidity, the optimum grouping will change with time, but the HV system was not flexible enough to cope with these changes. In addition, in 2010 & 2011, 2% of the sensors started to exhibit anomalously high leakage currents, requiring them to be disconnected via jumpers in the distribution boards. Identification of the sensors responsible for the high currents was difficult due to the high currents only being visible at the level of the HV channel –which powers up to 30 sensors.

In 2011 the Preshower group decided to purchase an additional 192 HV channels and re-design the distribution boards to provide additional flexibility and the possibility of in-situ current measurements of individual HV lines. The new design is a single board type that can be configured for any present or future powering scheme. This is achieved through the use of a large array of connector pins and the placement of jumpers between appropriate pins, depending on the configuration required. The boards also include voltage divider networks for measuring the current of each HV line via plug-in "ELMB"cards (used extensively in ATLAS and CMS). The ELMBs are read-out by a PVSS application, providing regular on-line measurements of the current of each HV line. This allows the evolution of the sensor currents to be followed in real time and any problematic sensors identified quickly.

The manufacture of the distribution boards was not simple. In particular, the large pin arrays were extremely difficult to solder reliably, and warping of the 9U PCBs was severe. A press-fit solution was chosen and was found to be 100% reliable.

The new HV system –additional power supplies and new distribution boards –was installed in March 2012. The system provides a better optimization of the voltage distribution and the on-line current measurements are not only useful for spotting problems but also for following the evolution of the silicon sensors with radiation, useful for long-term performance estimations as well as estimations of the actual radiation levels in CMS. The new system has also allowed the "unplugged"sensors to be re-connected on individual HV channels, thus restoring the 2% of the detector lost in 2010/2011.

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