High Voltage Power Supplies for the CREAM experiment

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Abstract: The environment conditions of the Long Duration Balloon flight are the worst possible for high voltage electronics which must survive at the altitude of 40 km and a pressure of 5 mbar in the Payload of the CREAM (COSMIC Ray Energy And Mass) balloon. Three different high voltage power supplies (1400V, 2000V and 12000V with a maximum consumption of 20 mA per module) were developed at LPSC for 3 CREAM sub-detectors. The power supplies developed were based on two specific constraints. First, the sensitive cosmic ray detectors need very low noise and stable power. Secondly, the operations near the minimum of the Paschen curve lower the breakdown voltage to 300V/mm compared to 1KV/mm at sea level.

OBJECTIVE

3 dedicated High Voltage Power Supplies were produced. Reliable, robust, light, compact, low consumption –9mA nom each:
- CHERCAM (CHERENKOV CAMERA) -14kV, 2mA x 100 units to power 1800 photomultipliers
- TRD (Transition Radiation Detector) +2kV, 2mA X 8units of 3Dimension module integrated between 1600 Anodes of gaseous straws tubes on 8 layers
- CALORIMETER: -12kV, 6μA x20 units for 40 Hybrid photodiodes (DEP)

THE CREAM experiment

Harsh environment of balloon flight:
- Direct cosmic-ray detection experiment
- Energy range \(10^{12}\) eV to \(10^{15}\) eV
- Flight in 40 km height with radiation from cosmic shower
- High reliability around 5mbar – minimum of Paschen curve
- -10°C During ground Test to +30°C in flight with daily fluctuation around +20°C
- Launched from Antarctic McMurdo Station

FLIGHT RESULTS

Electronics Flight temperature

CHERCAM Voltage good Stability

CONCLUSION

CHERCAM was launched three times from Antarctica with CREAM IV to CREAM VI.

During the next Austral summer 2013-2014, the successor using the TRD high voltage power supplies will be BACCUS instrument (Boron And Carbon Cosmic-rays in the Upper Stratosphere). It directly measures the elemental spectra from lithium to iron nuclei with energies up to \(10^{17}\) eV.

After two HVPS-CAL flights, these -12KV module will be integrated on the CREAM CALORIMETER and will be installed on the International Space Station in 2015.