Detectors for high count rate measurements with a compensation for MPPC gain dependence on temperature

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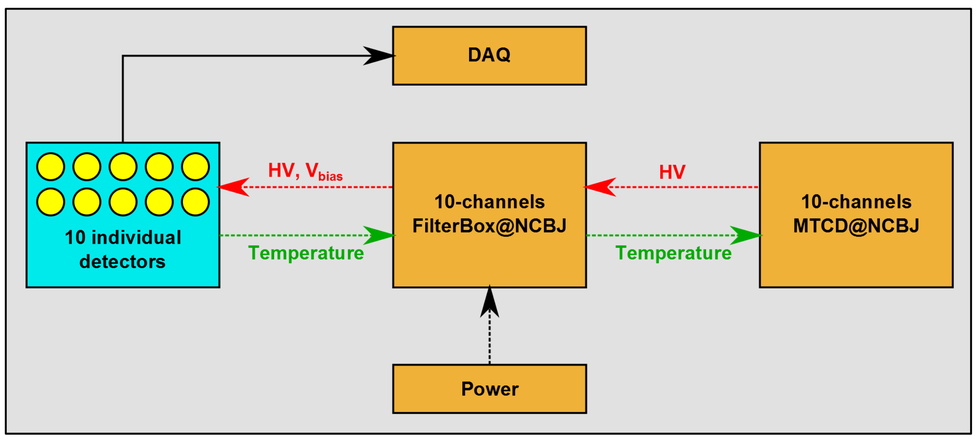
Multi Pixel Photon Counter (MPPC) is one of devices called silicon photomultiplier (SiPM). It is characterized by a fast response time, high gain coefficient, high photon detection efficiency resulting in good energy resolution, low voltage operation, resistance to mechanical shocks, compactness and immunity to a magnetic field. A MPPC gain is temperature dependent, so it is necessary to use a device which allows to maintain a constant value of a MPPC gain.
We report on two devices designed at the National Centre for Nuclear Research (NCBJ): FilterBox@NCBJ and MTCD@NCBJ to be used at the Joint European Torus (JET) during high count rate measurements.

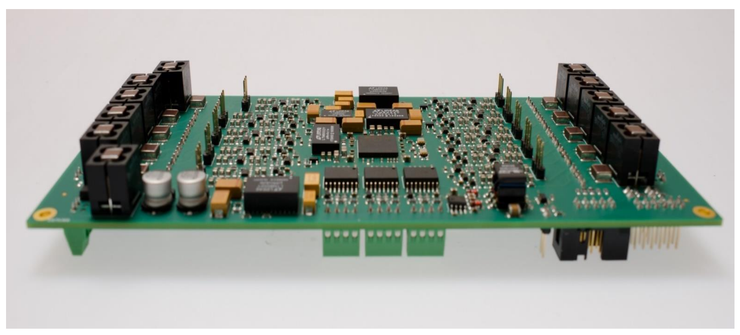
MEASUREMENT DETAILS

- **20 mm×15 mm cylindrical $CeBr_3$ scintillator**
- **MPPC type S13361-3050NE-04 from Hamamatsu**
- **active system based on a transimpedance amplifier (TIA) to obtain a signal characterized by a high output amplitude with low time-constant**
- **^{137}Cs source emitting 661.7 keV gamma line with an activity of 400 MBq**
- **CAEN Desktop Digitizer DT5730**



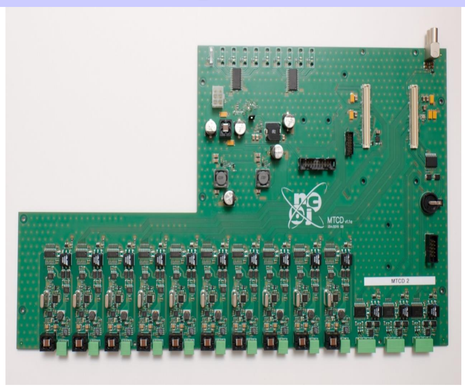
- **setting of MPPC bias voltage**
- **integrated temperature sensor**
- **integrated power supply**
- **advanced power supply closed loop control**

FilterBox@NCBJ



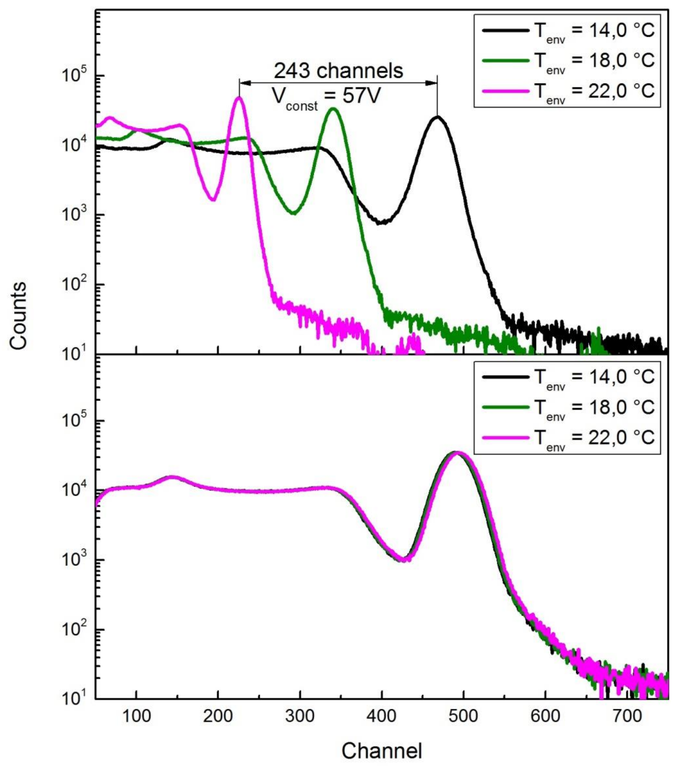
1. to serve for all individual detectors,
2. to filter a bias voltage for MPPC in a detector,
3. to power active elements, e.g., TIA and a temperature sensor, mounted on PCB. For each detector, a separated DC linear voltage regulator is used to minimize noise and crosstalk between detectors,
4. to provide communication with the MTCD@NCBJ using three independent communication channels based on a RS485 standard actual detector temperature values are read from FILTERBOX@NCBJ via RS485.

MPPC Temperature Compensation Device MTCD@NCBJ

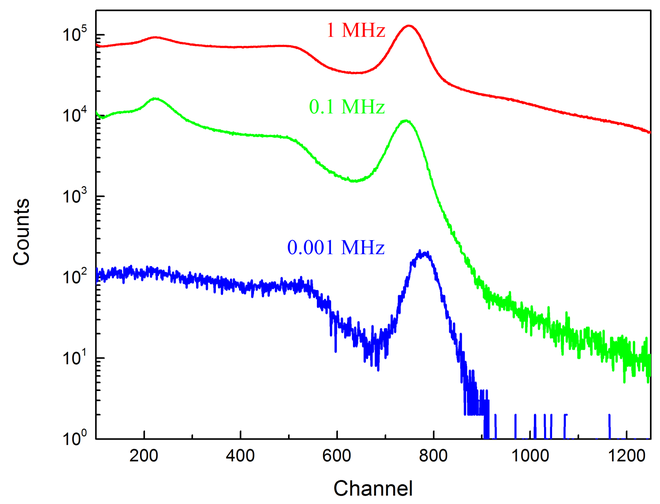


The MPPC Temperature Compensation Device (MTCD@NCBJ) is using a measured dependence of a breakdown voltage on temperature to maintain a constant value of the MPPC gain. The MPPC Temperature Compensation Device (MTCD@NCBJ) with integrated power supplies comprises two main parts: one is connected with 10 adjustable MPPC bias voltage channels for each individual capsule, the other one is used to determine an optimal value of a bias voltage which guarantees a constant gain.

MEASUREMENT RESULTS



Peak position as a function of MPPC temperature.
***Upper:* without MTCD@NCBJ.**
***Lower:* with MTCD@NCBJ.**



Rate (Mcps)	Peak position (PP) (ch)	delta = |PP-PP_{av}| /PP_{av} (%)	FWHM (%)
1	749	2.5	8.48
0.1	743	3.3	8.46
0.001	778	1.2	7.65

Peak position as a function of count rate.

REFERENCES

- *High performance detectors for upgraded gamma ray diagnostics for JET DT campaigns*, I. Zychor et al., *Physica Scripta* ***91*** *(2016) 064003.*
- *Development of MPPC-based detectors for high count rate DT campaigns at JET,* G.Boltruczyk et al., *Fusion Engineering and Design (2017).*

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