Temperature compensation device MTCD@NCBJ for MPPC in plasma diagnostics

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MPPC - Multi-Pixel Photon Counter – is a silicon-based monolithic array of micro-pixel avalanche diodes operating in a Geiger mode.

MPPC is characterized by large internal gain, high photon detection efficiency, high-speed response, excellent time resolution, wide spectral response, immunity to magnetic fields, resistance to mechanical shocks, low power/ voltage operation and compactness.

Due to the fact that properties of MPPC are strongly affected by temperature, it is necessary to stabilize MPPC operation under temperature variations.

MPPC@NCBJ
MPPC Temperature Compensation Device

At the National Centre for Nuclear Research (NCBJ) a MTCD@NCBJ device for real-time temperature monitoring and MPPC gain stabilization was designed and produced for use in gamma ray diagnostics in plasma experiments.

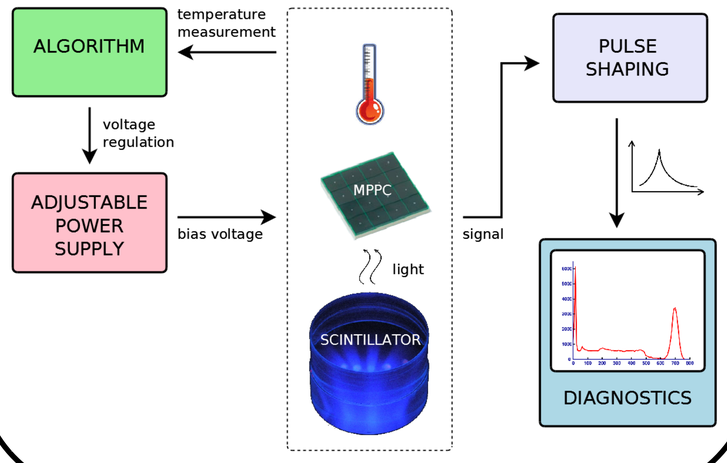
MTCD@NCBJ provides a current limitation and filtering of the MPPC bias voltage.

The device can supply an output voltage up to 80 V.

All functions are controlled from a personal computer.

MPPC detector specifications

S12642-040PA-50 from Hamamatsu
Number of channels: 4×4
Photosensitive area per channel: 3×3 mm
Low voltage operation 65 V
High gain: 10^5-10^6



Joint European Tokamak (JET) requirements during DT experiments

1. **MPPC-based detectors coupled to fast scintillators, e.g., $CeBr_3$ due to expected high count rates during deuterium-tritium (DT) campaigns (in MHz range).**
2. **Limited space for a MPPC–based scintillation detector at JET → dedicated detector setup fitted to "old" detector capsules.**
2. **New electronics using existing cabling: 80 m long cables, four wires in a cable.**
3. **Power supplies and control system put in one box.**

PLASMA 2015
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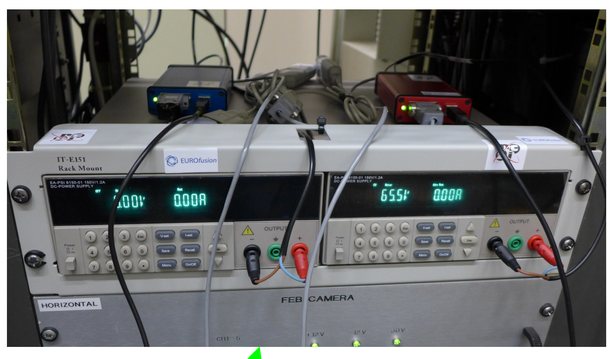
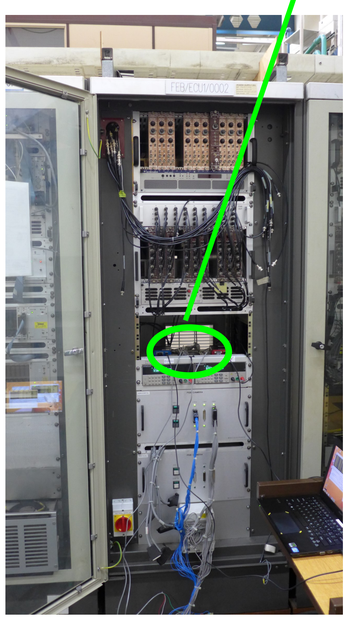
MTCD@NCBJ
FOR GAMMA DIAGNOSTICS AT JET





Two MTCD@NCBJ installed in the Gamma Camera at JET (May 2015)

MTCD@NCBJ, a temperature compensation device, is based on an Atmega128 microcontroller, controlling an EA-PSI6150-01 power supply by an opto-isolated serial interface.

Temperature of the scintillator is measured by a TSIC506F digital thermometer integrated with the detector. The thermometer has an accuracy of ±0.1 K in a temperature range from +5 to +45°C.

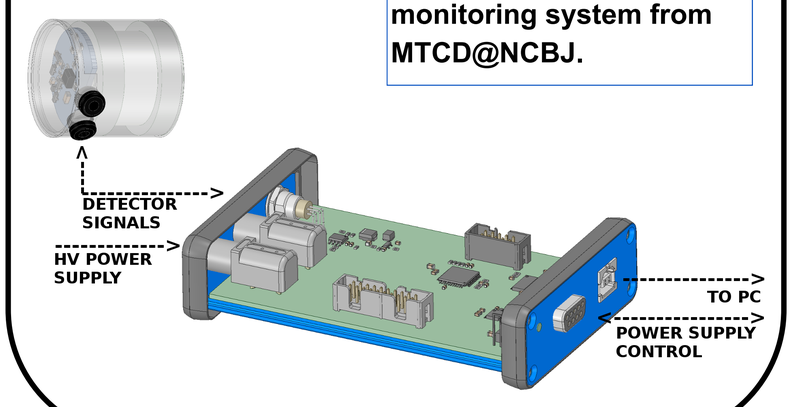
MTCD@NCBJ is using a measured dependence of a bias voltage on temperature to maintain a constant value of the MPPC gain.

DETECTOR SYSTEM
FOR GAMMA DIAGNOSTICS AT JET

Aluminium cylinder detector capsules
Φ 35 × H 35 mm
mounted on a slider to be used with $CeBr_3$ scintillators.

At JET in four conductors of 80 m long electrical cables, 2 conductors were chosen to be used only for MPPC power supply.

Two other conductors were used to send measured temperature values to a control and monitoring system from MTCD@NCBJ.

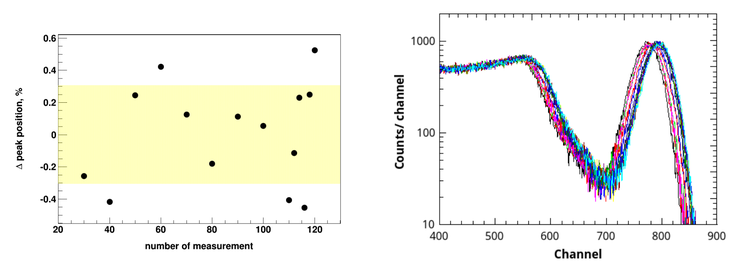


Separate poster presented on scintillator properties "Characterization of scintillators for gamma-ray spectrometry of fusion plasma" by P.Sibczynski et al.

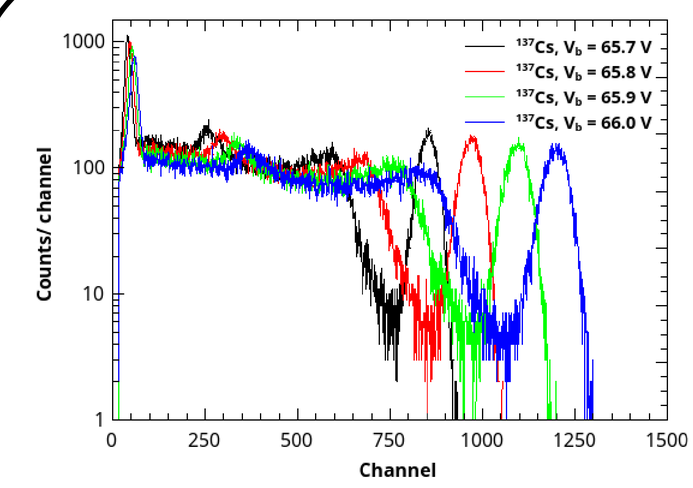
MEASUREMENTS at NCBJ

Measurements were performed with a ^{137}Cs source emitting 661.7 keV gamma line.

A cylinder 20x15 mm $CeBr_3$ scintillator coupled to MPPC was used.



- ***661.7 keV gamma line measured with $CeBr_3$ scintillator***
- ***120 measurement sessions, each lasted 500 s of live time***
- ***17 hours of measurements during day and night with ΔT = 2-3° C***
- **change in Full Energy Peak (FEP) position below 1%**



^{137}Cs spectra measured at constant room temperature at different MPPC bias voltage

ΔU_b =100 mV → ΔFEP ≈ 100 channels
ΔT = 1°C → ΔU_b =70 mV

CONCLUSIONS

- **MTCD@NCBJ optimises a detector operation in varying temperatures.**
- **MTCD@NCBJ is easily extended to a setup for 19 detector system.**
- **19 MPPC power supplies will be integrated in control and monitoring box.**
- **Measured temperature values will be off-line available for further use, including date and time information.**

Acknowledgement

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