

New Digitizers For Position Sensitive ^3He Proportional Counters

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Abstract: ^3He gas-filled detectors are a classical choice for the detection of thermal and cold neutrons. The incident neutrons are captured by the ^3He producing a tritium and an hydrogen which are sharing the 765 keV of energy generated in the reaction. The classical geometry of a charge-division neutron detector consists of a cylindrical volume housing a resistive anode. Electrical signals are extracted at both ends of the tube and the information about the interaction point along the tube can be derived by the ratio of the collected charged at both ends. The classical analog approach for the charge readout consists of a shaping amplifier coupled with a peak sensing ADC. We report on the development of a new digital front-end electronics based on 64 channels, 65 Msample/s and 12 bit digitizers. Excellent results have been obtained in terms of position resolution and signal to noise ratio when adopting a continuous digital filtering and Gaussian shaping.

Charge-Division Principle

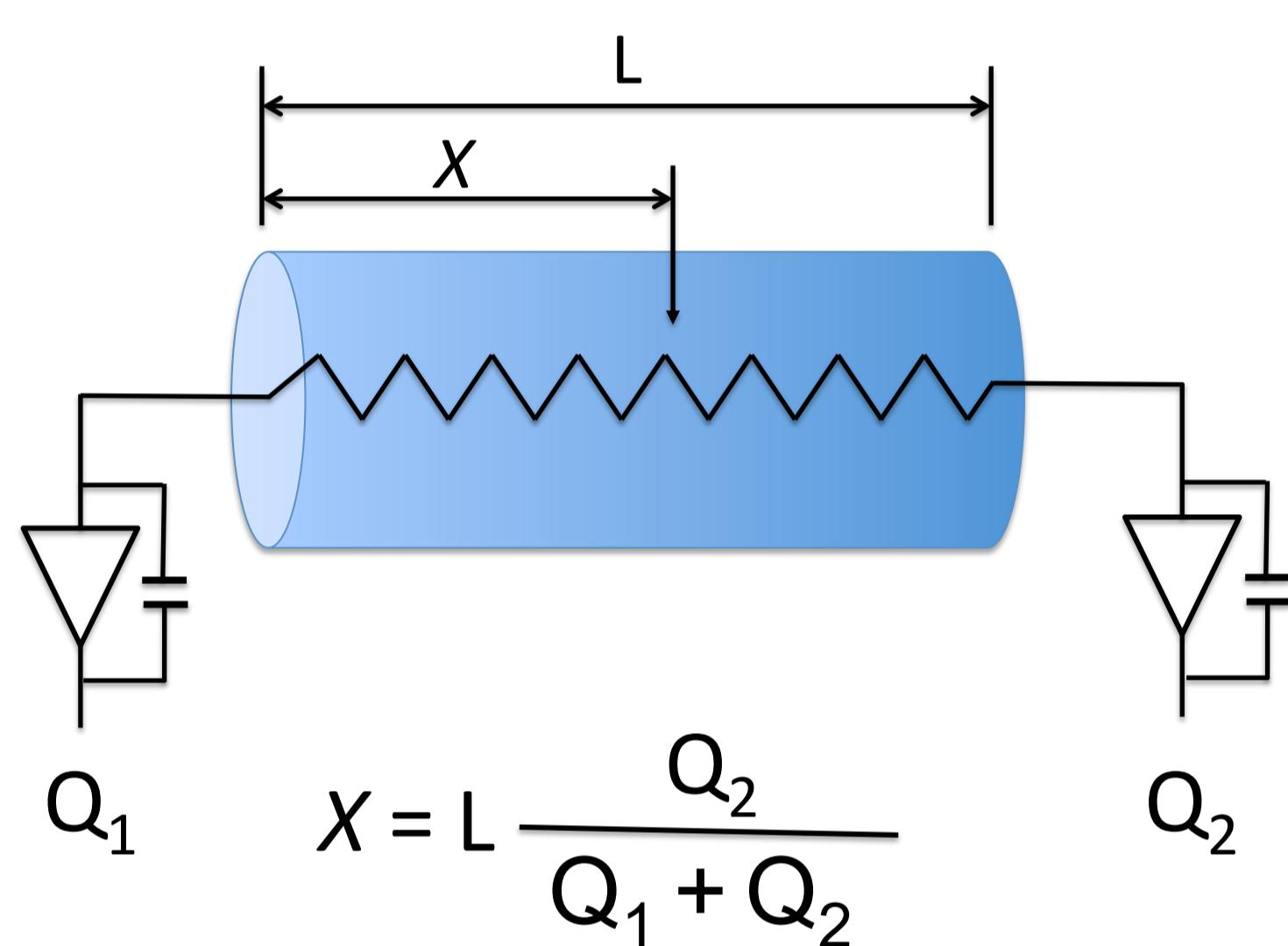


Fig. 1: Examples of differential pulse-shapes from ^3He tube which depends on the interaction location and on the charge propagation direction.



Digital Front-End Electronics

CAEN V1740

- 12 bit ADC
- 62.5 MHz sampling rate
- 64 channels
- Custom firmware for charge-division



Digital Signal Processing

- 4th order Gaussian filter
- Pole-Zero compensation
- Baseline correction
- Trigger on coupled channels

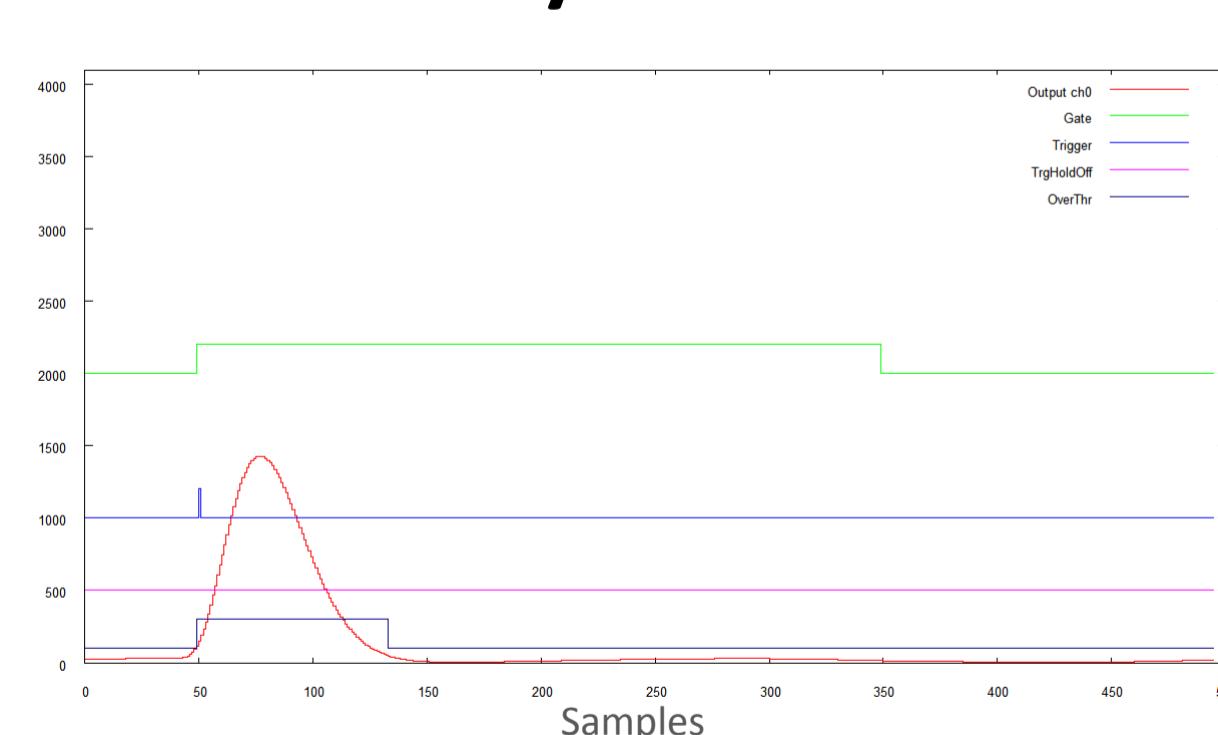


Fig. 2: The result of the digital filtering. Also visible the trigger signal and the different gates

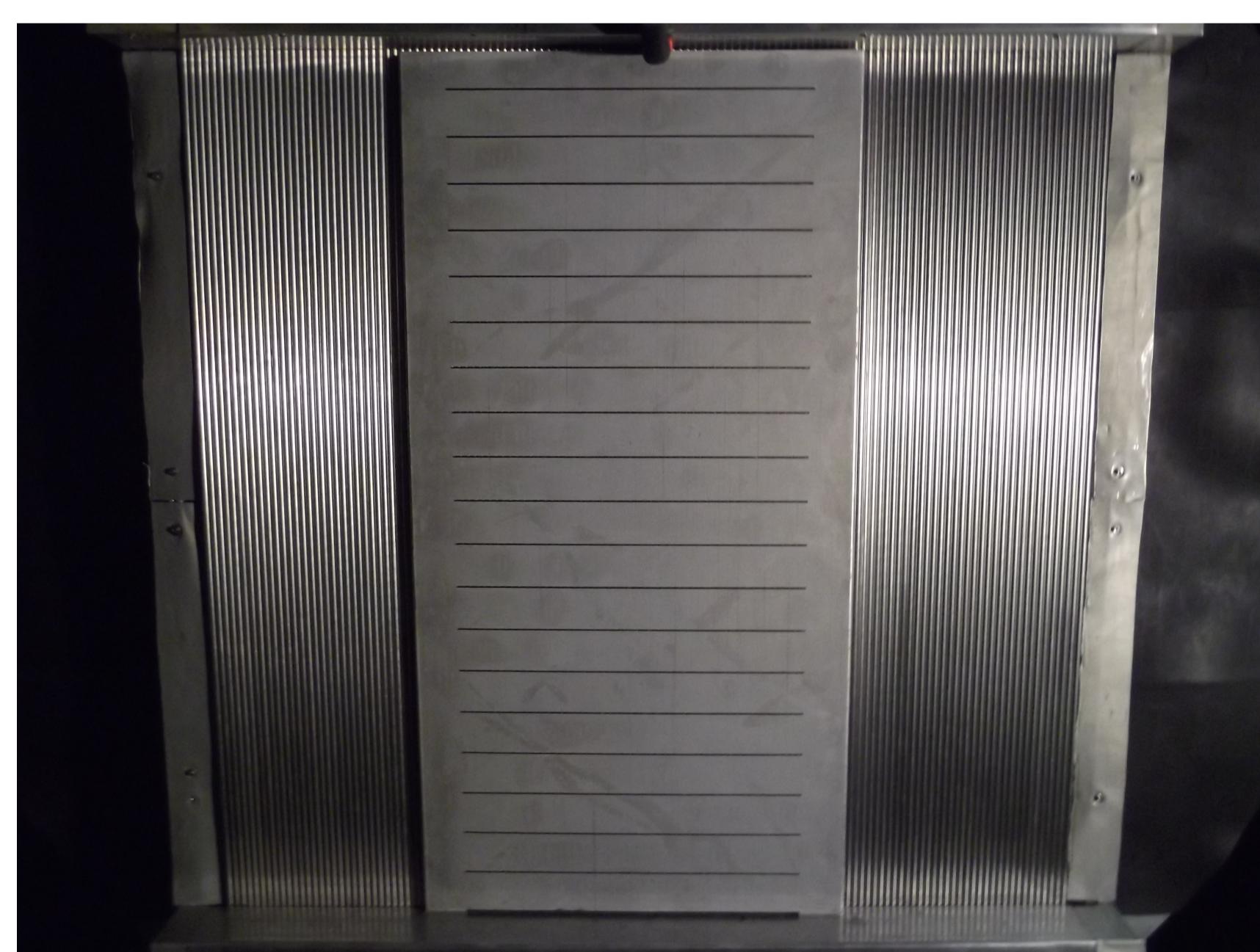


Fig. 3: The detector of D22 small angle scattering diffractometer with the Boral mask used for the measurements

For the final firmware validation we have acquired data using a large ^3He detector counting 128 tubes each of 1 m height and 8 mm diameter, containing 12 bar of ^3He . This detector, installed at the D22 beam-line of Institut Laue-Langevin, provides a detection efficiency of about 70% at a wavelength of 6 Å.

Conclusions

Using as base hardware a commercial digitiser board from CAEN we have implemented in the existing FPGA of the board a new charge-division firmware especially designed for position sensitive ^3He proportional counters. A 4th order digital Gaussian filter for the pulse shaping, as well as pole-zero and baseline correction have been included in the firmware. Obtained results both on laboratory test and on real detector show excellent performances of the digital electronics that will be soon ready for commissioning on various instruments at the Institut Laue-Langevin.

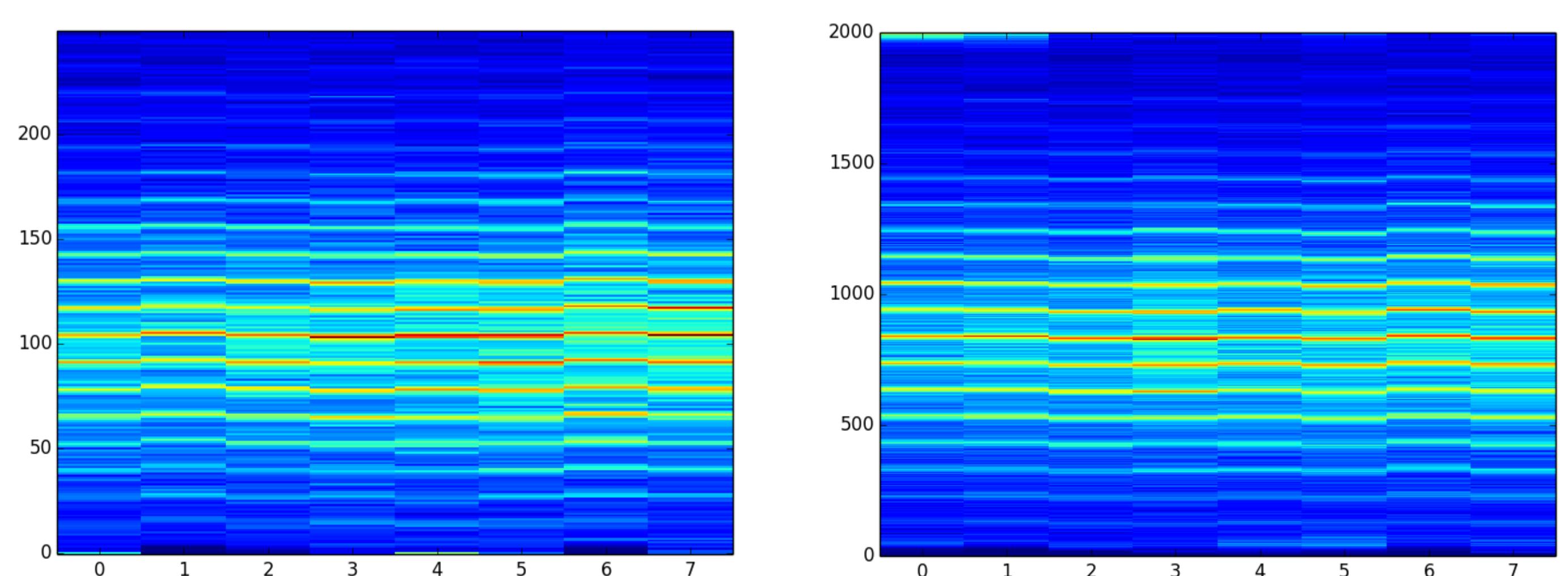


Fig. 4: Results obtained with our standard analog electronics (DPM8)

Fig. 5: Results obtained with the digital electronics and the new firmware.