Alternative digital filter for LumiCal (TB2016)

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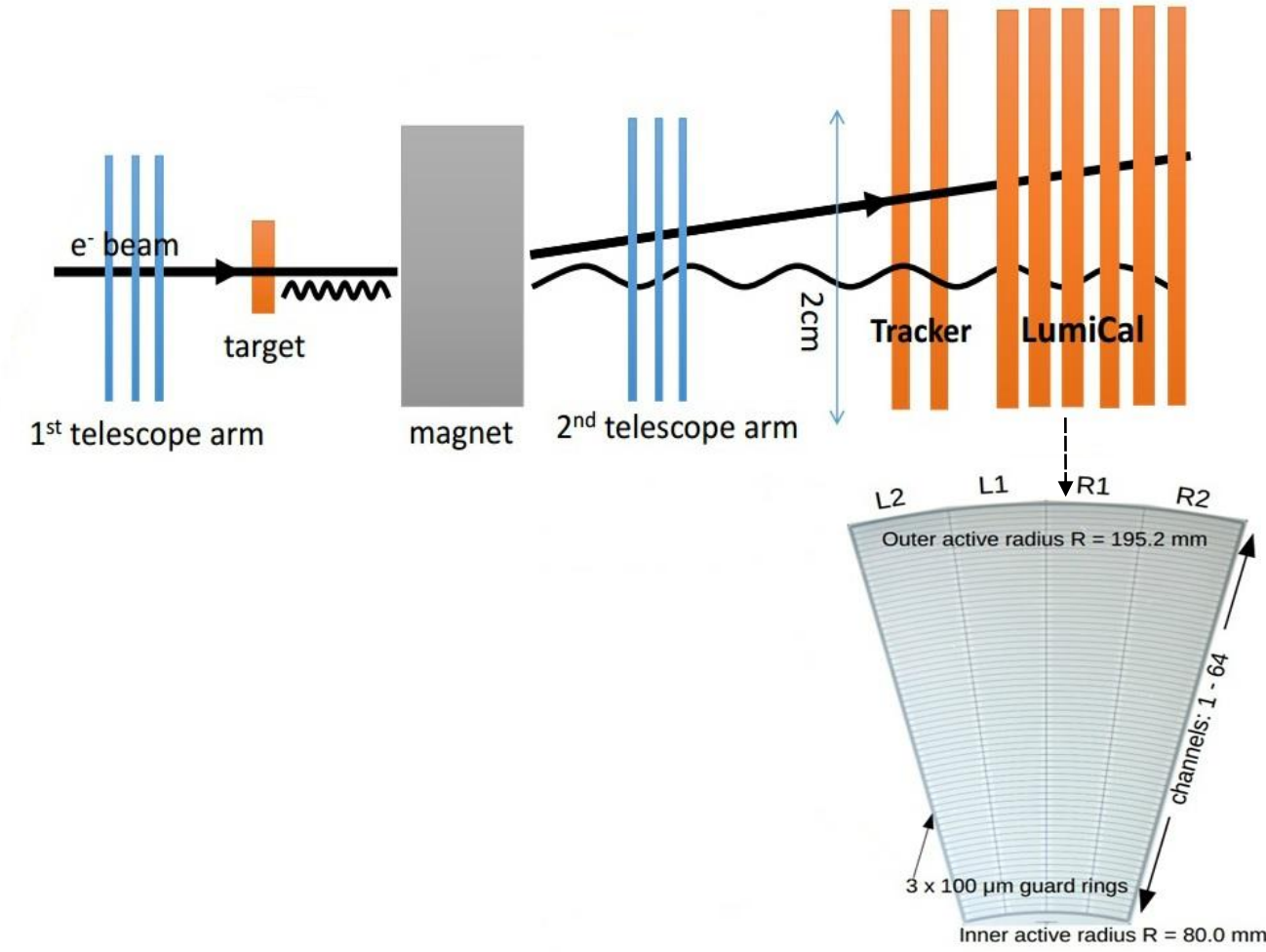
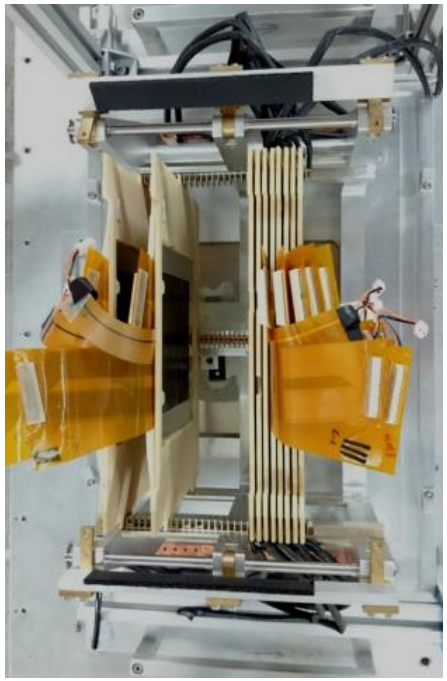
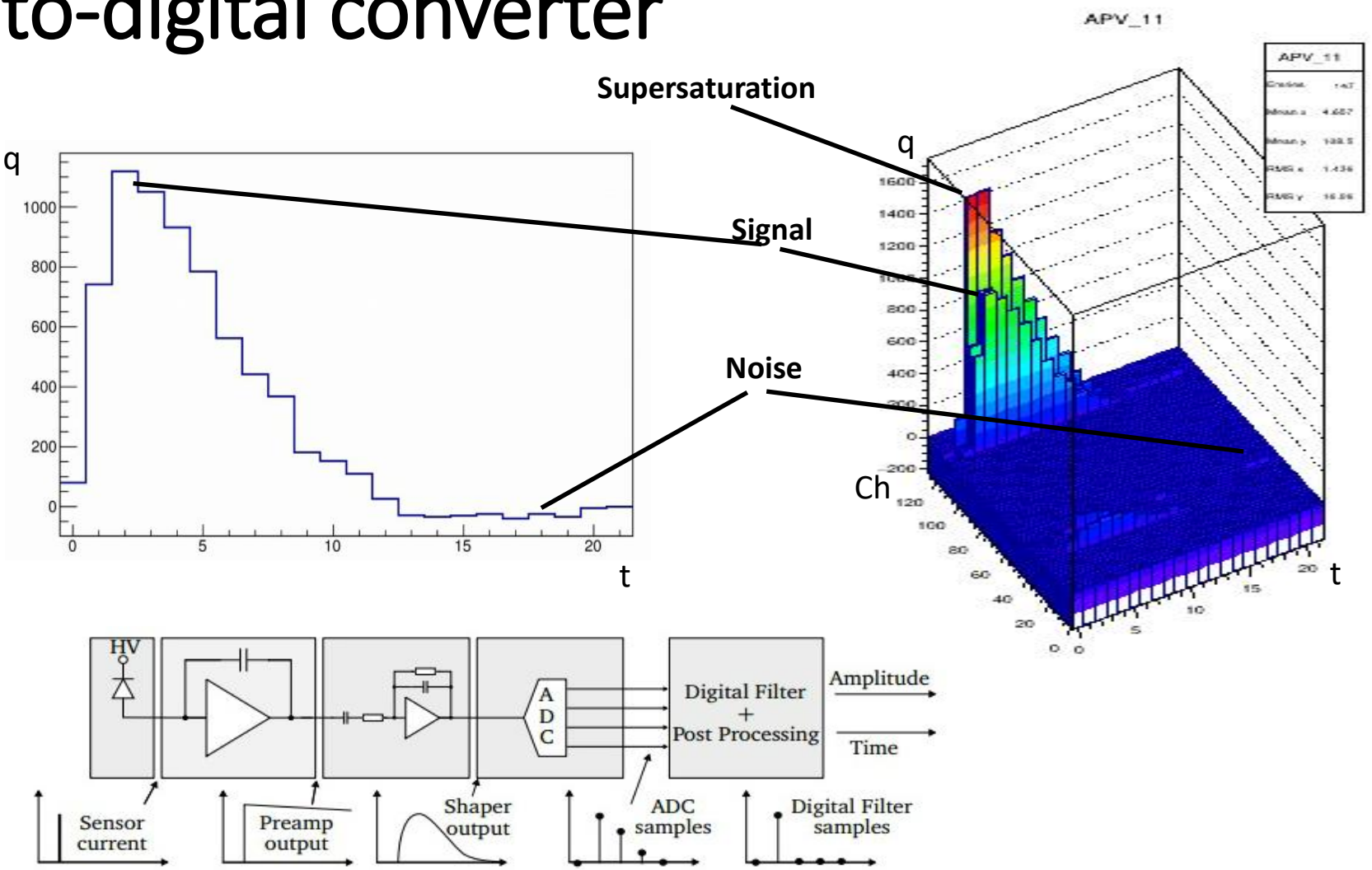
Scheme TestBeam 2016





Time scanning of the signal in analog-to-digital converter

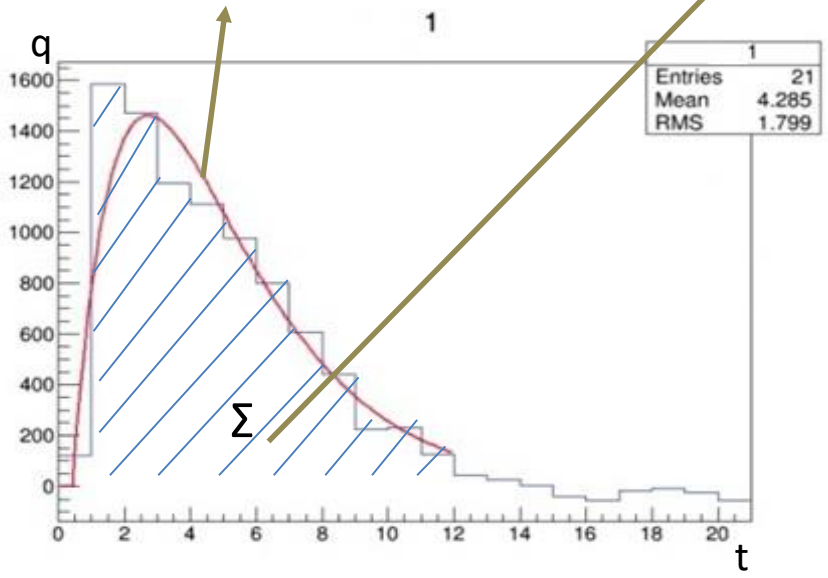


Digital signal filter

Standard scheme for digital filter – fitting time scan in a channel and definition maximum of the function (A_{fit}).

$$F(x) = \frac{A(x - t_0)}{\tau} * \exp\left(1 - {}^{(x - t_0)}/_{\tau}\right)$$

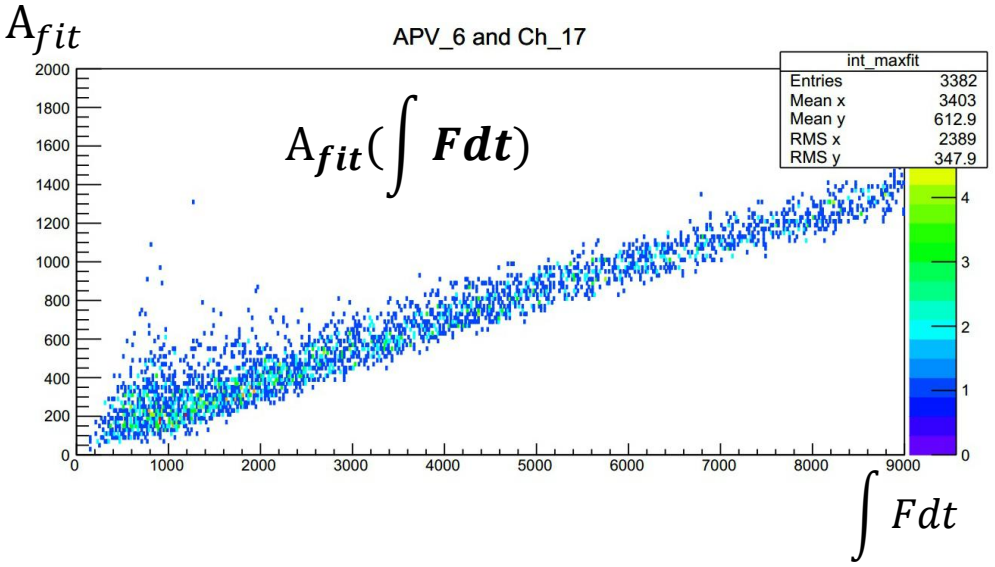
Alternative scheme: Parameterize a maximum value (A_{par}) with a sum signal value at the time(Σ) in each channel.

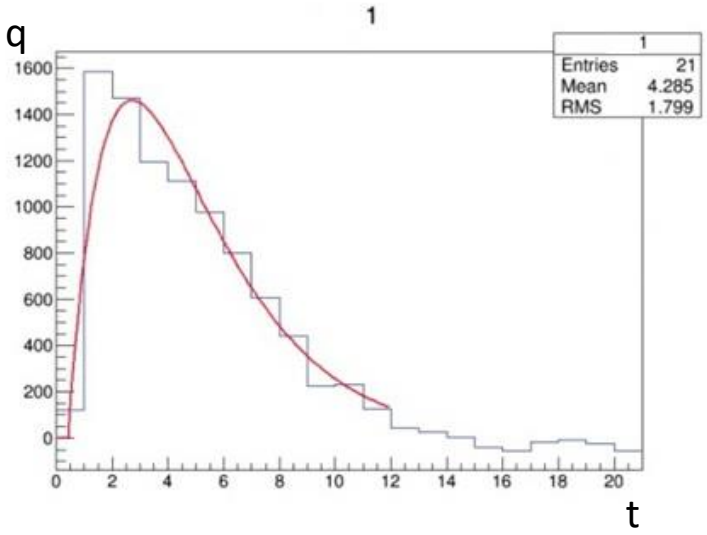


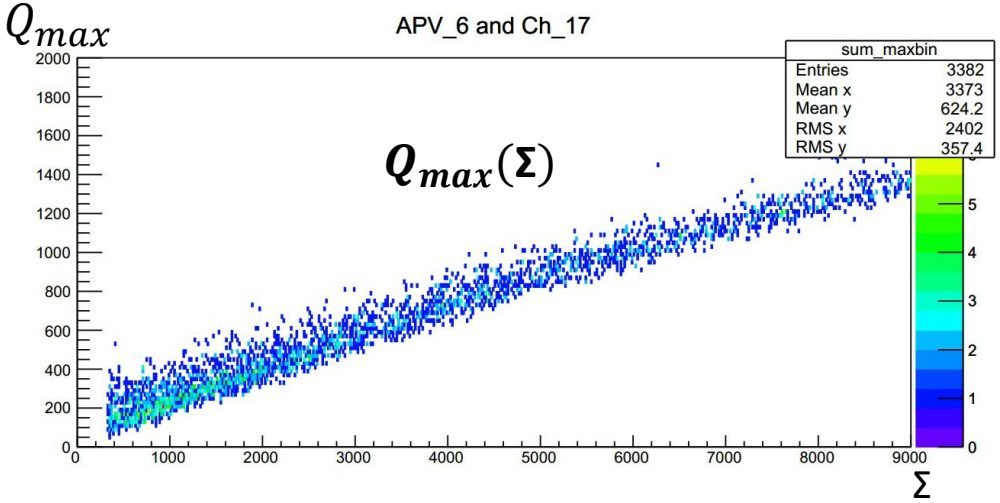
Motivation:
- stability
- less resource consuming
- can be hardware-based

Check digital filter schemes

- Each point on the histograms on the right corresponds to the signal with h. 1
- Integral and sum was taken at the full time interval
- No cuts were used

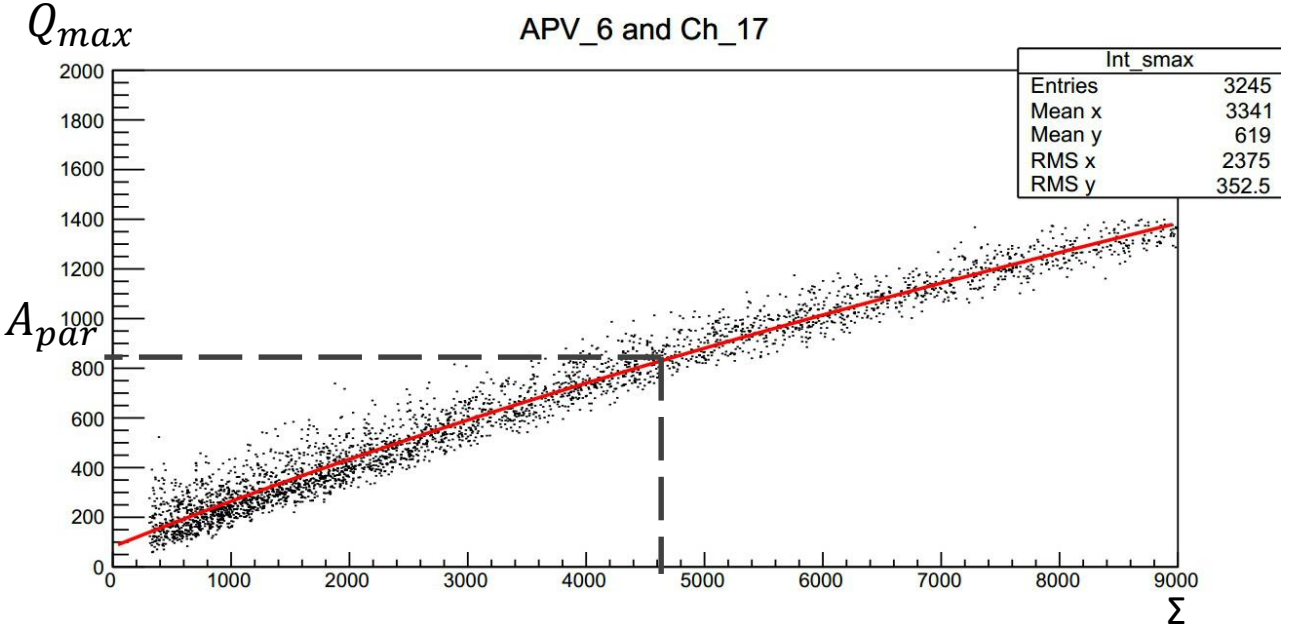






Parametrization $Q_{max}(\Sigma)$

A scheme with parameterization must be individually defined for each channel



$$S(x) = p1 + p2\sqrt{x + p3}$$

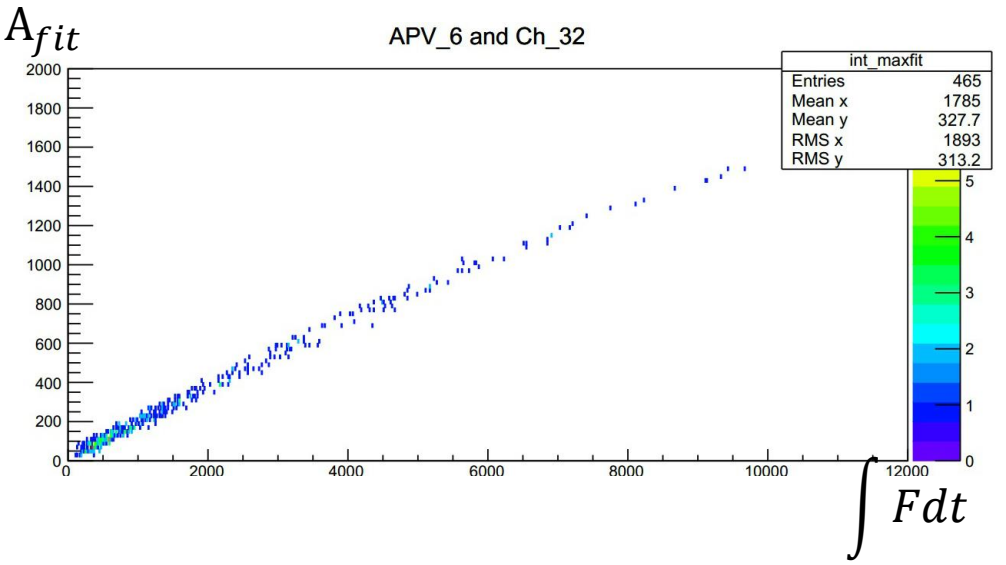
chi2=25738.8 NDF=1898 chi2/NDF=13.561

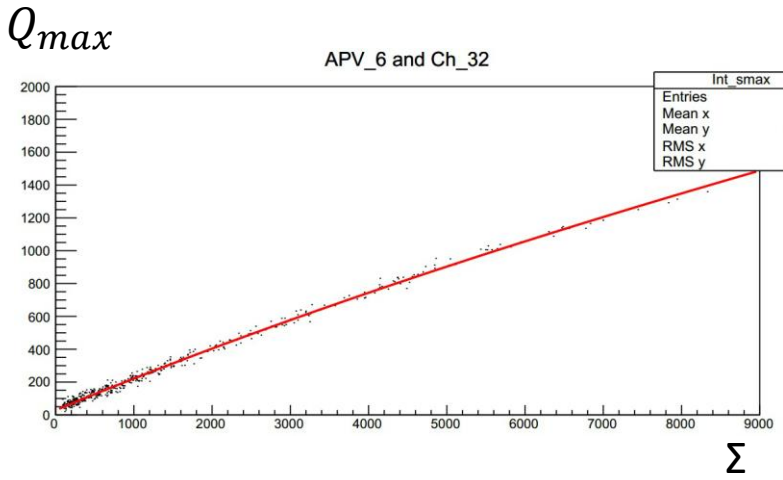
p1=-1580.38 p2=25.7465 p3=4162.02

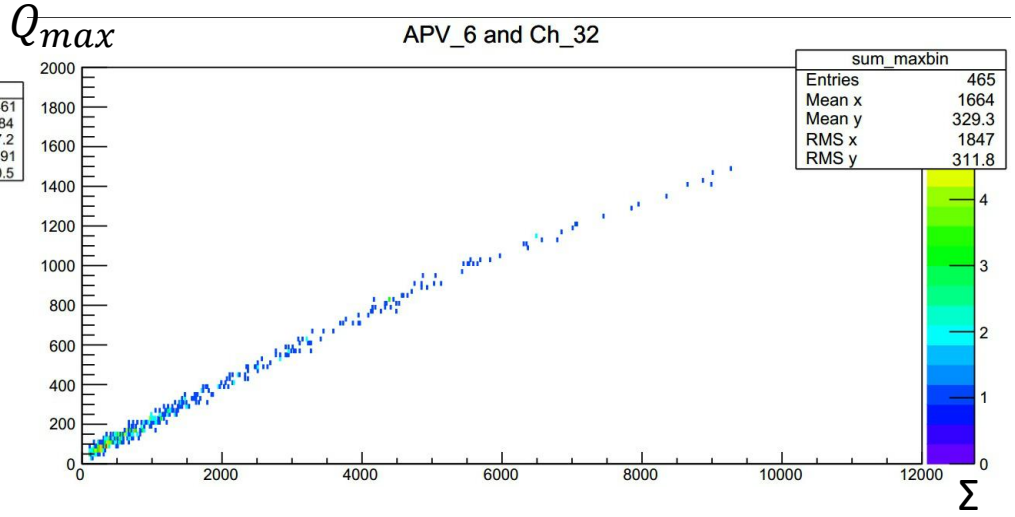
Other run

chi2=487.41 NDF=307
chi2/NDF=1.58766

p1=-3243.67 p2=36.0212 p3=8252.89

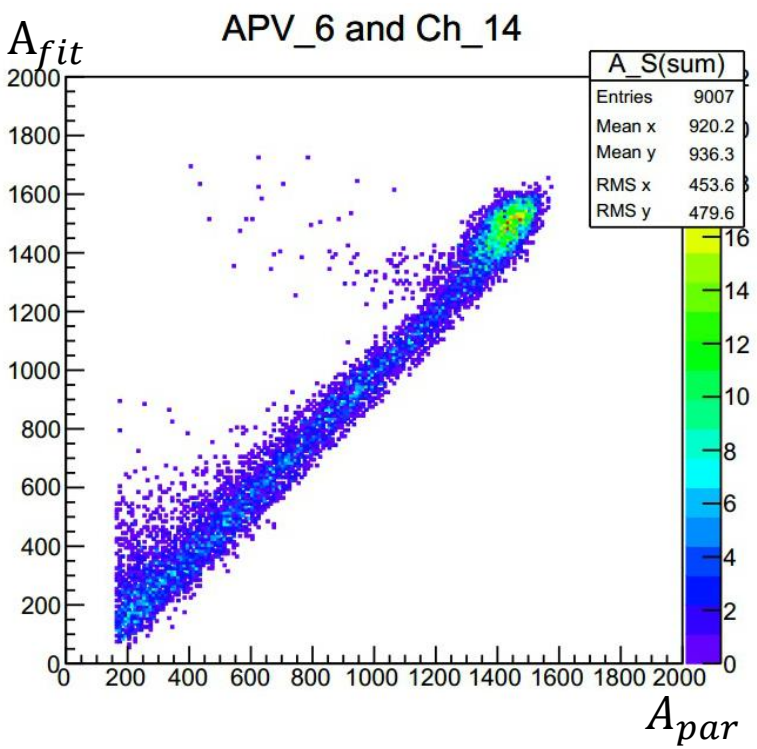




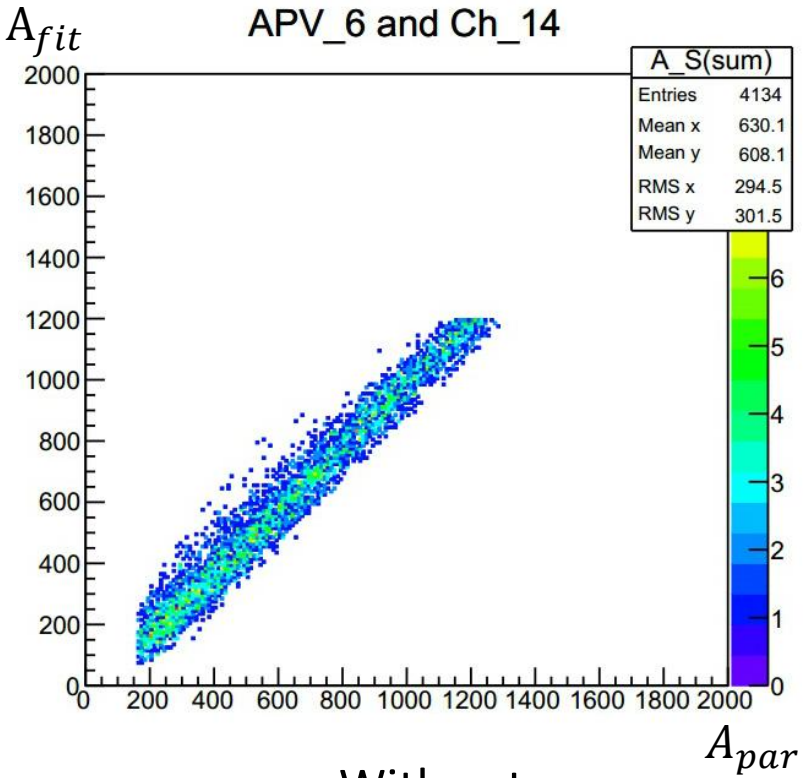


Correlations

The filtering scheme with parametrization has no systematic deviation from the fitting scheme

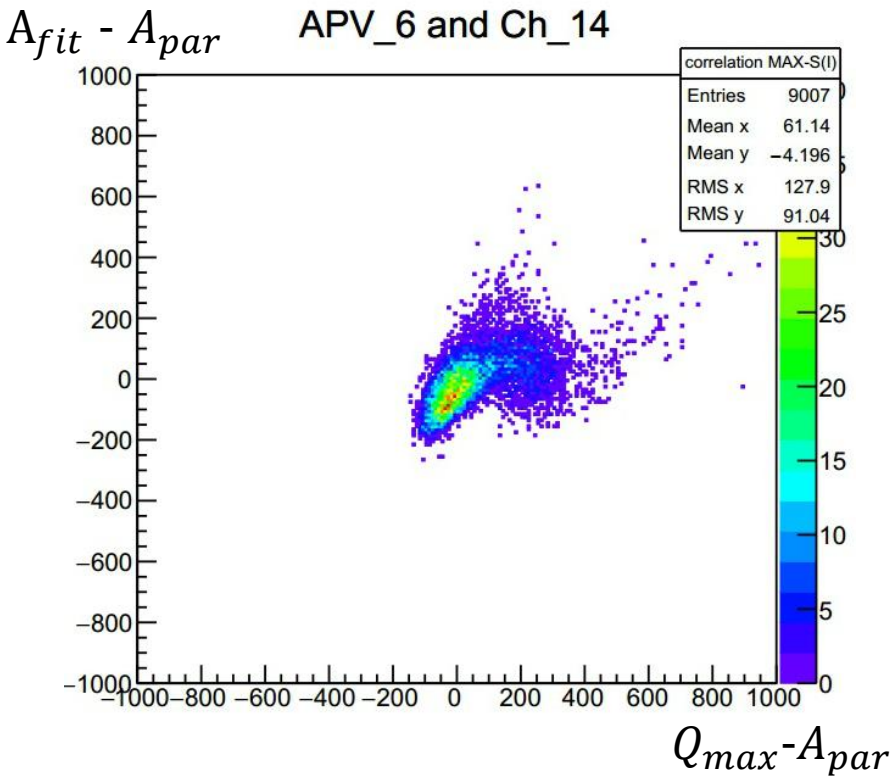


Correlation A_{fit} and parametrization A_{par}

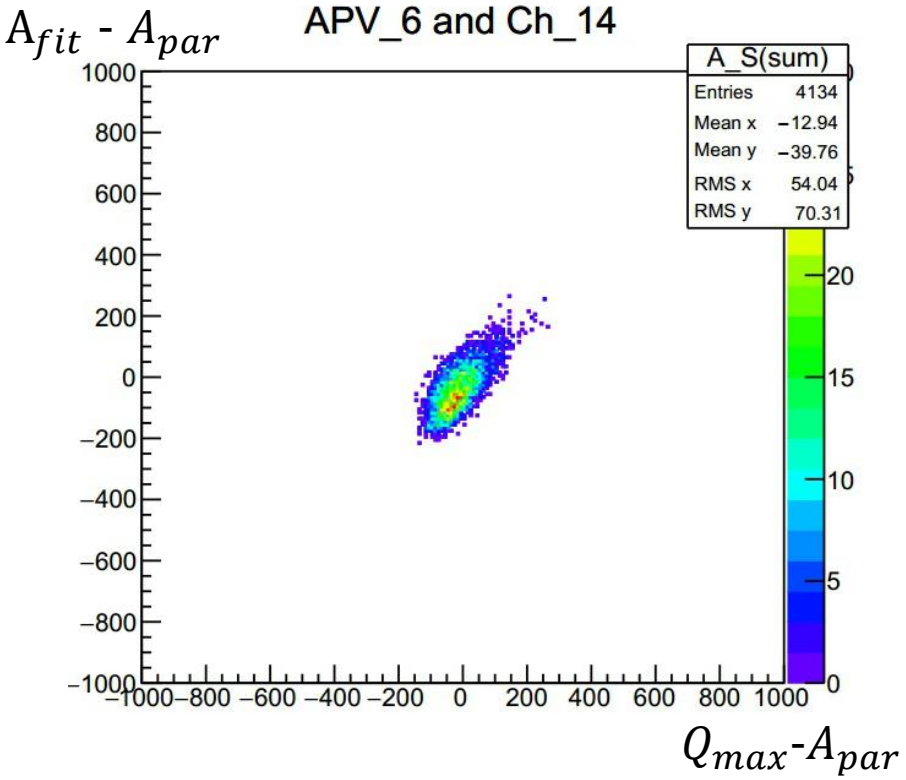


With cut

Correlations



Correlation A_{fit} - A_{par} and Q_{max}-A_{par}



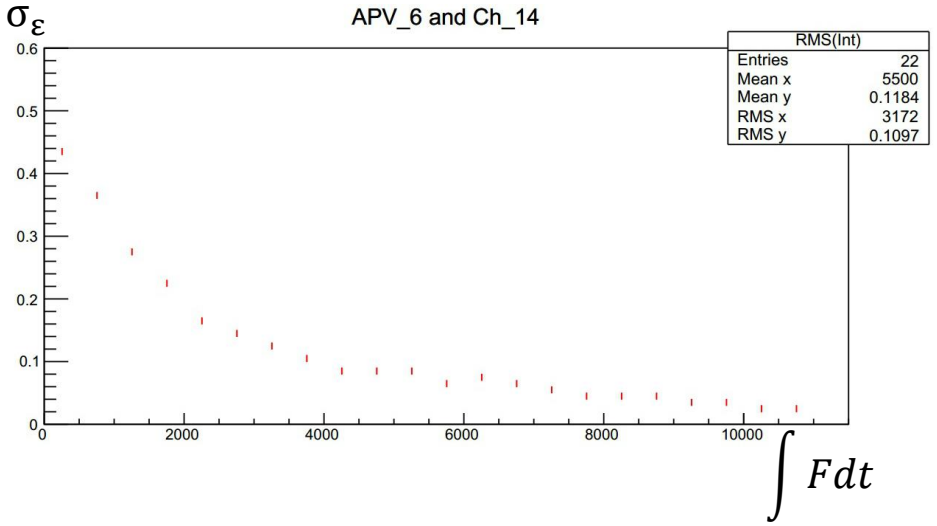
With cut

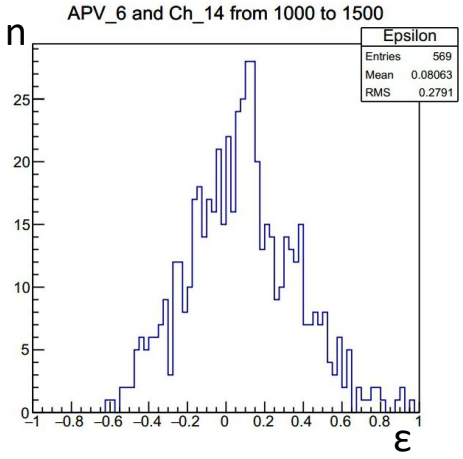
Relative fluctuations between digital filter schemes

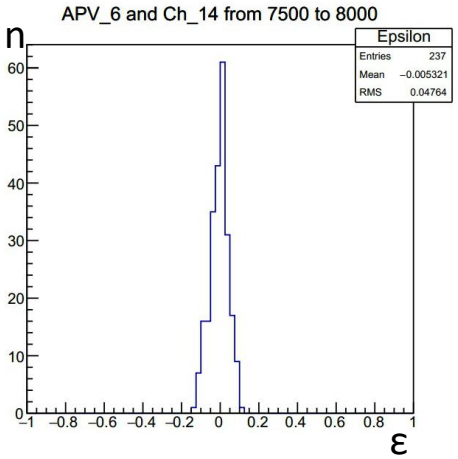
$$\varepsilon = \frac{A_{par} - A_{fit}}{A_{fit}}$$

$$\sigma_\varepsilon = RMS(\varepsilon)$$

- Fluctuations in fitting scheme depend heavily on the amount of charge
- Fluctuations have statistical nature and don`t have systematic deviations





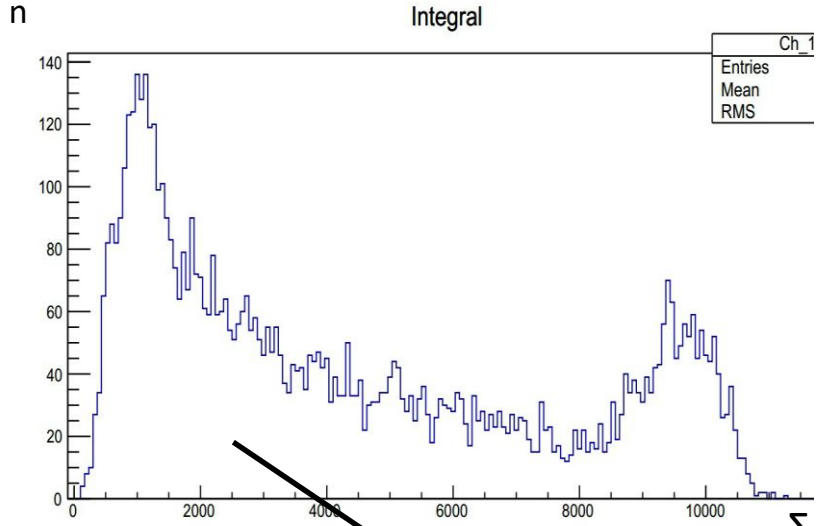


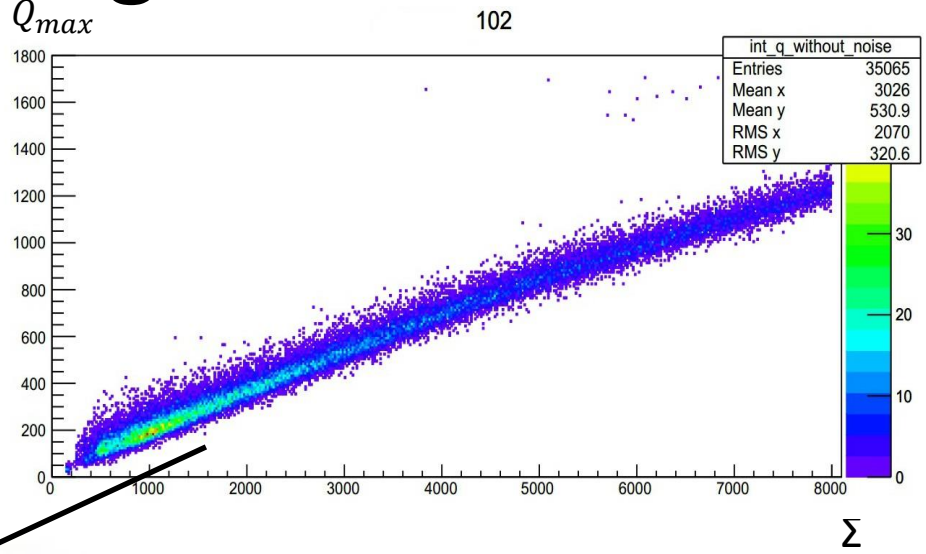
Summary

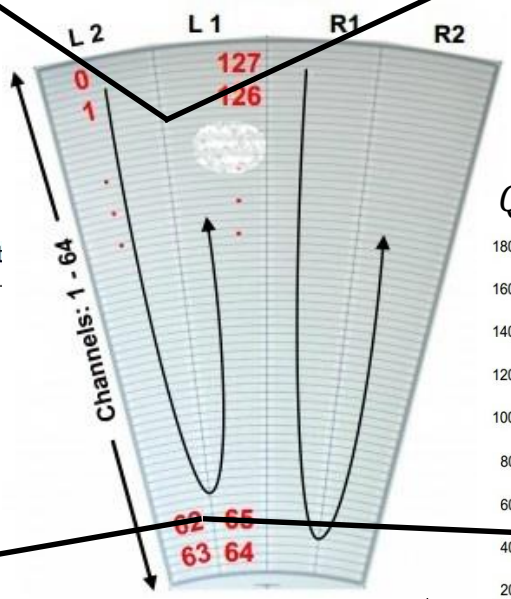
- ✓ **Developed the alternative scheme of digital signal filter**
- ✓ **Compared standard and alternative schemes**
- ✓ **Developed the scheme of digital filter approximately 150 times faster than the standard**

Thank you for your attention!

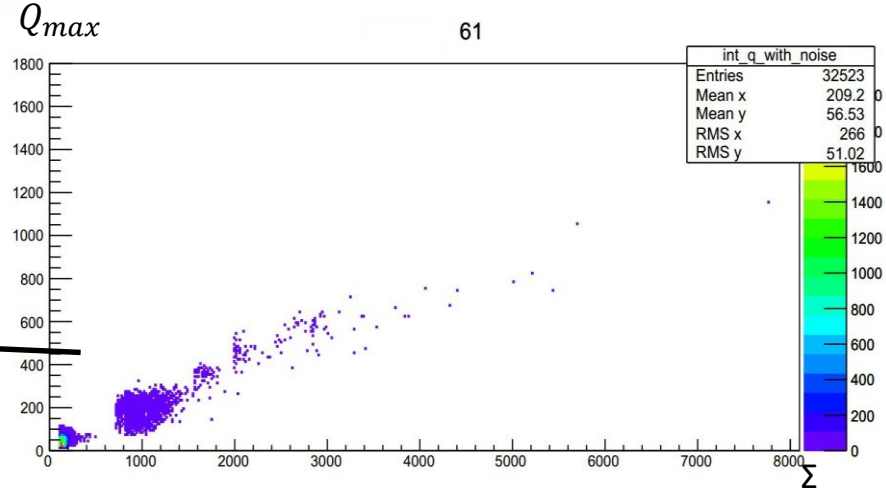
Σ and signal







636 run, E=5GeV, w/o charge divider



Correlations

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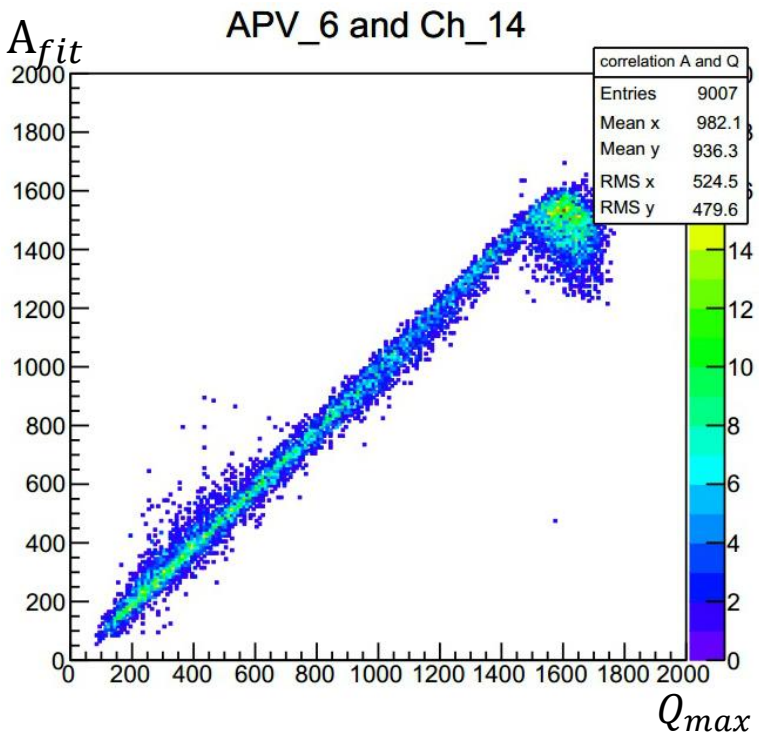
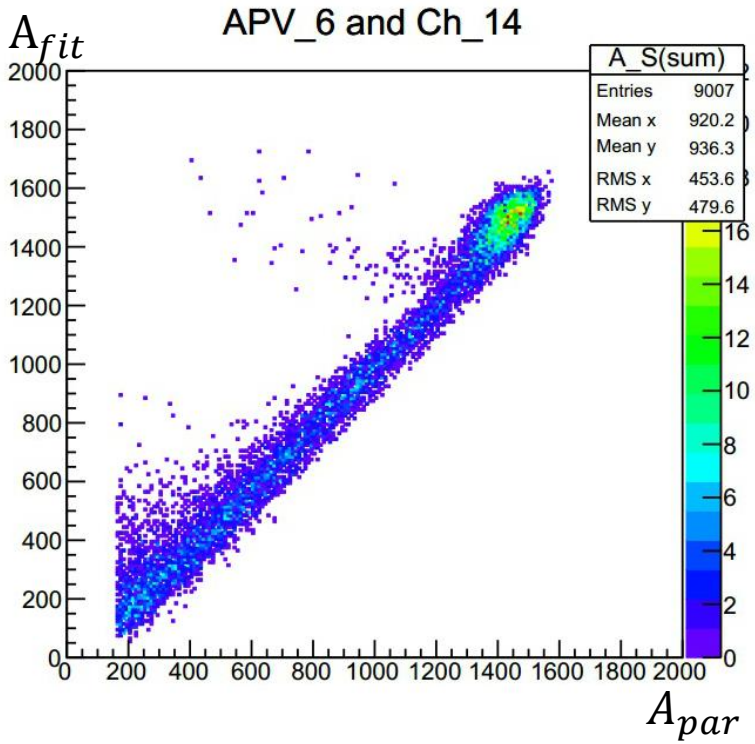


Correlation A_{fit} and Q_{max}



Correlation A_{fit} and parametrization A_{par}

Correlation and fit of noise