A. Poblaguev

Event selection at the Hjet

- *Recoil Mass Cut*
- *Missing Mass Cut*
- *How to measure kinetic energy of punch through protons (can we separate stopped and punch through protons)*
- *Some preliminary results for extended proton energy cut: 1 < Ekin < 11 MeV*

Recoil Mass

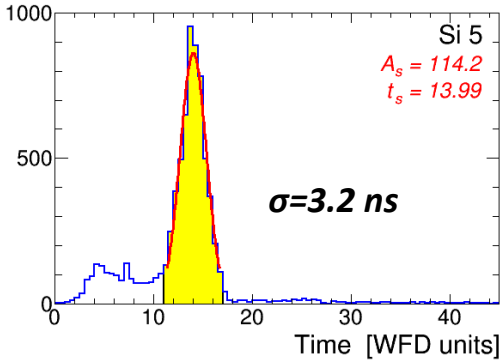
$$T = \frac{M_p v^2}{2} \quad \Rightarrow \quad M_R = \frac{2T(t-t_0)^2}{L^2} = M_p + M_p \frac{(2+\delta t/t_f)\delta t}{t_f}$$

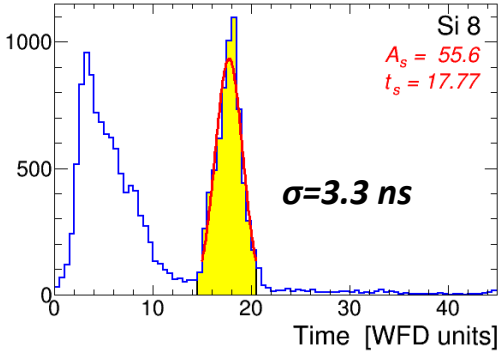
$$\delta t = t - t_p = t - t_f - t_0; \qquad t_f = \frac{L}{c}\sqrt{\frac{M_p}{2T}}$$

$$\delta M_R = \sqrt{2M_p T}\,\frac{\delta t}{L/c}$$

Variation of *δt* are defined by bunch length
It is independent on recoil proton energy.

Recoil mass cut is similar to the *time* cut
But is energy dependent, and, thus, less efficient.
We should use *time* cut instead





Missing Mass

$$M_M^2 = (p_b + p_j - p_R)^2 = M_p^2 - 2(E + M_p)T + 2\sqrt{E^2 - M_p^2}\sqrt{(2M_p + T)T}\sin\theta$$

For elastic *pp* scattering:

$$M_M^2 = M_p^2 \;\Rightarrow\; \sin\theta = \sqrt{\frac{E + M_p}{E - M_p}}\sqrt{\frac{T}{2M_p}}$$

We do not measure angle *ϑ* but we may constrain it from the detector geometry

$$\sin\theta \to \frac{z_s}{L} = \sqrt{\frac{E + M_p}{E - M_p}}\sqrt{\frac{T_s}{2M_p}}$$

$$M_M^2 = M_p^2 - 2(E + M_p)\sqrt{T}\left(\sqrt{T} - \sqrt{T_s}\right)$$

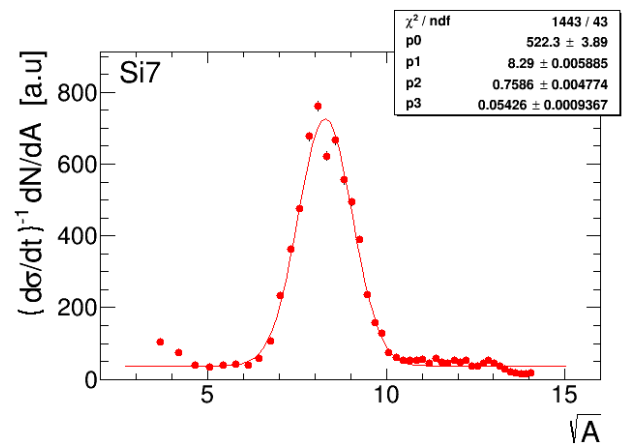
$$\delta M_R^2 = -2(E + M_p)\sqrt{T}\delta\sqrt{T}$$

Variations of *δ√T* are defined by thickness of jet and width of Si strip

$$\sigma_z^2 = \sigma_{\text{jet}}^2 + \Delta^2/12 = 2.7^2 + 3.7^2/12 = (2.9\ \text{mm})^2$$

It is independent on recoil proton energy.

Missing mass cut is similar to the *√T* cut
But is energy dependent, and, thus, less efficient.
We should use *√T* cut instead



Time/Amplitude distribution for elastic protons

$$\left(\frac{d\sigma}{dE}\right)^{-1}_{\text{elastic}} \quad dN(T,t) = \mathcal{N}\ e^{-(\sqrt{T}-\sqrt{T_s})^2/2\sigma_T^2}\ e^{-(t-t_p)^2/2\sigma_t^2}\ d\sqrt{T}dt$$

$$t_p = t_0 + \sqrt{\frac{M_p}{2T}}\frac{L}{c} \qquad \sigma_t = \sigma_{\text{bunch}}$$

$$\sqrt{T_s} = \sqrt{2M_p}\sqrt{\frac{E-M_p}{E+M_p}}\frac{z_s}{L} \qquad \sigma_T = \sqrt{2M_p}\sqrt{\frac{E-M_p}{E+M_p}}\frac{\sqrt{\sigma_{\text{jet}}^2+\Delta^2/12}}{L}$$

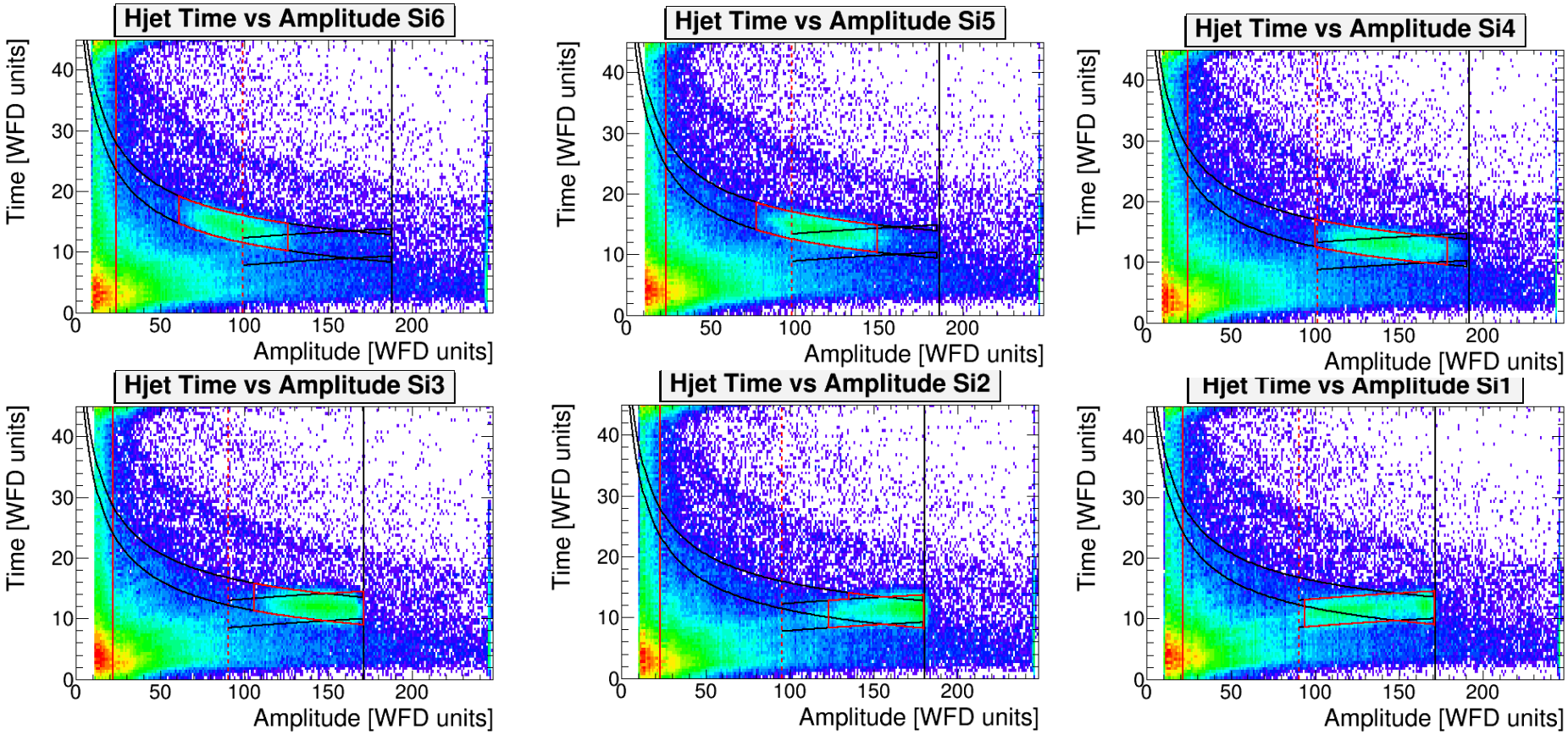
$$\sigma_{\text{jet}} \approx 2.7\ \text{mm} \qquad \Delta = 3.7\ \text{mm}$$

It is a simple double Gaussian distribution
$\mathcal{N}, \sigma_T, \sigma_t$ ***are the same for all strips***

- This feature may be employed for a precision energy calibration
  http://public.bnl.gov/docs/cad/Documents/A%20precise%20in%20situ%20calibration%20of%20the%20RHIC%20H-Jet%20polarimeter.pdf
- Magnetic field corrections should be applied. These corrections may be measured in the calibration process.
- For punch through protons kinetic energy differs from measured (deposited) one.

Stopped and Punch through protons

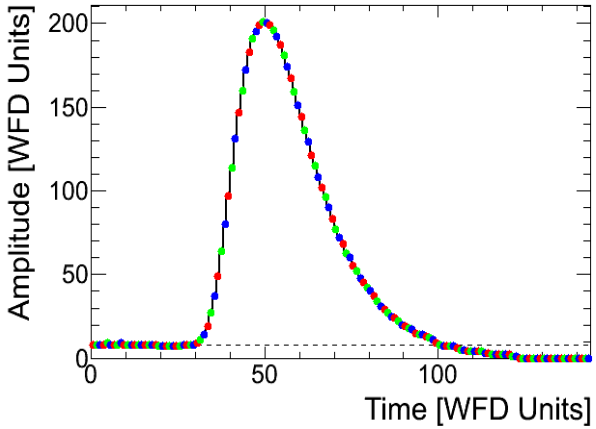
- **Recoil protons with energy up to *11 MeV* are detected**
- **Only part of kinetic energy is deposited in Si for "punch through" protons *T>7.5 MeV***

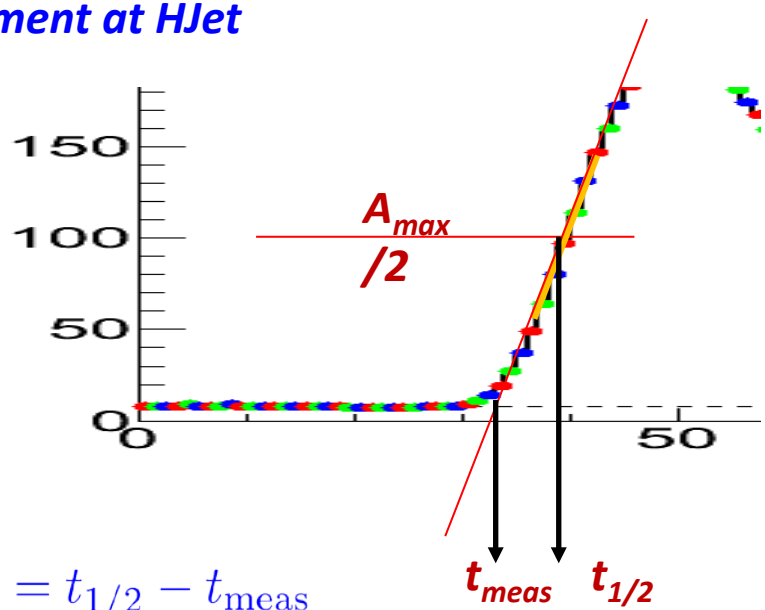


For deposited energies above *4-5 MeV* stopped and punched through protons can not be separated using time/amplitude distributions only.

Does waveform shape depend on proton energy?

Time measurement at HJet



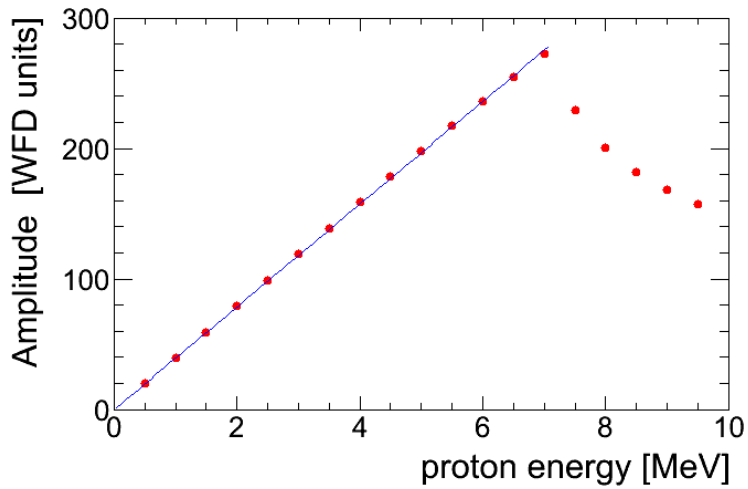


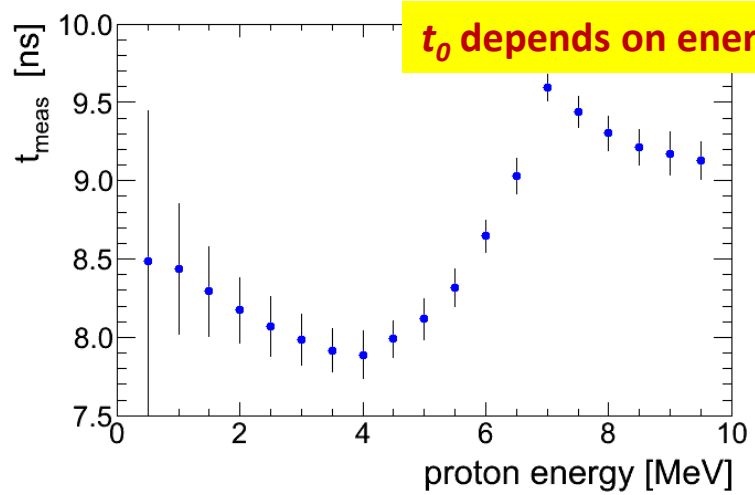
$$\Delta t = \frac{A_{max}/2}{dA/dt} = t_{1/2} - t_{\mathrm{meas}}$$

The Δt , which is calculated by product, is a simple criteria to monitor the signal shape.

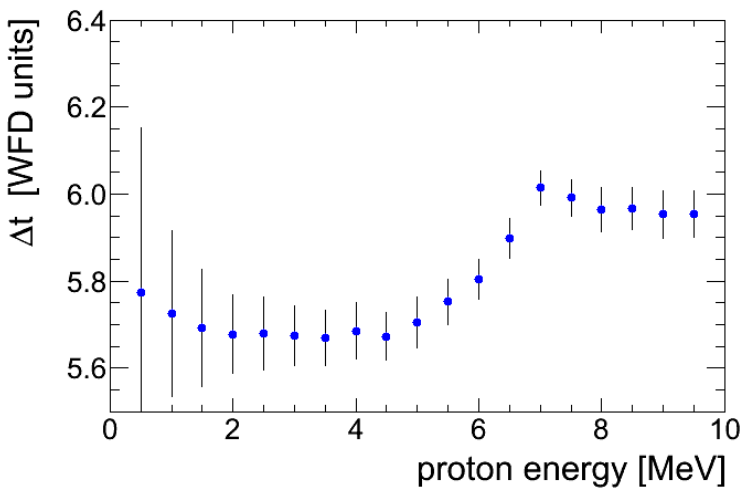
Waveform Simulation (for old detectors)

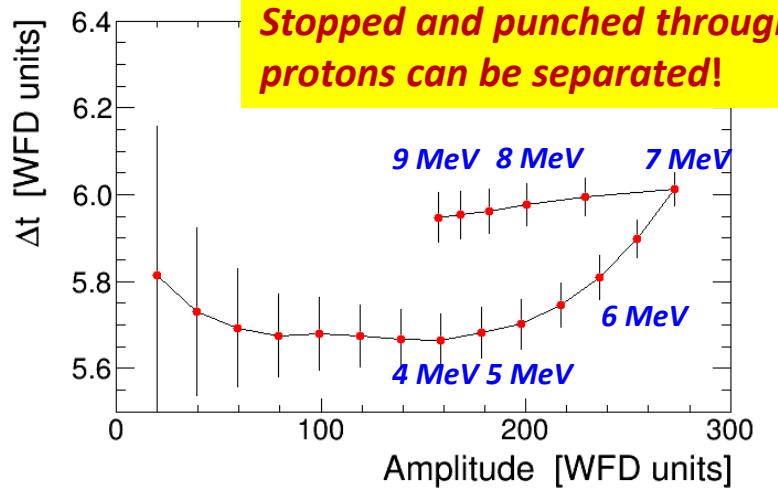
http://public.bnl.gov/docs/cad/Documents/Waveform%20dependence%20on%20signal%20amplitude%20in%20the%20RHIC%20H-Jet%20polarimeter.pdf





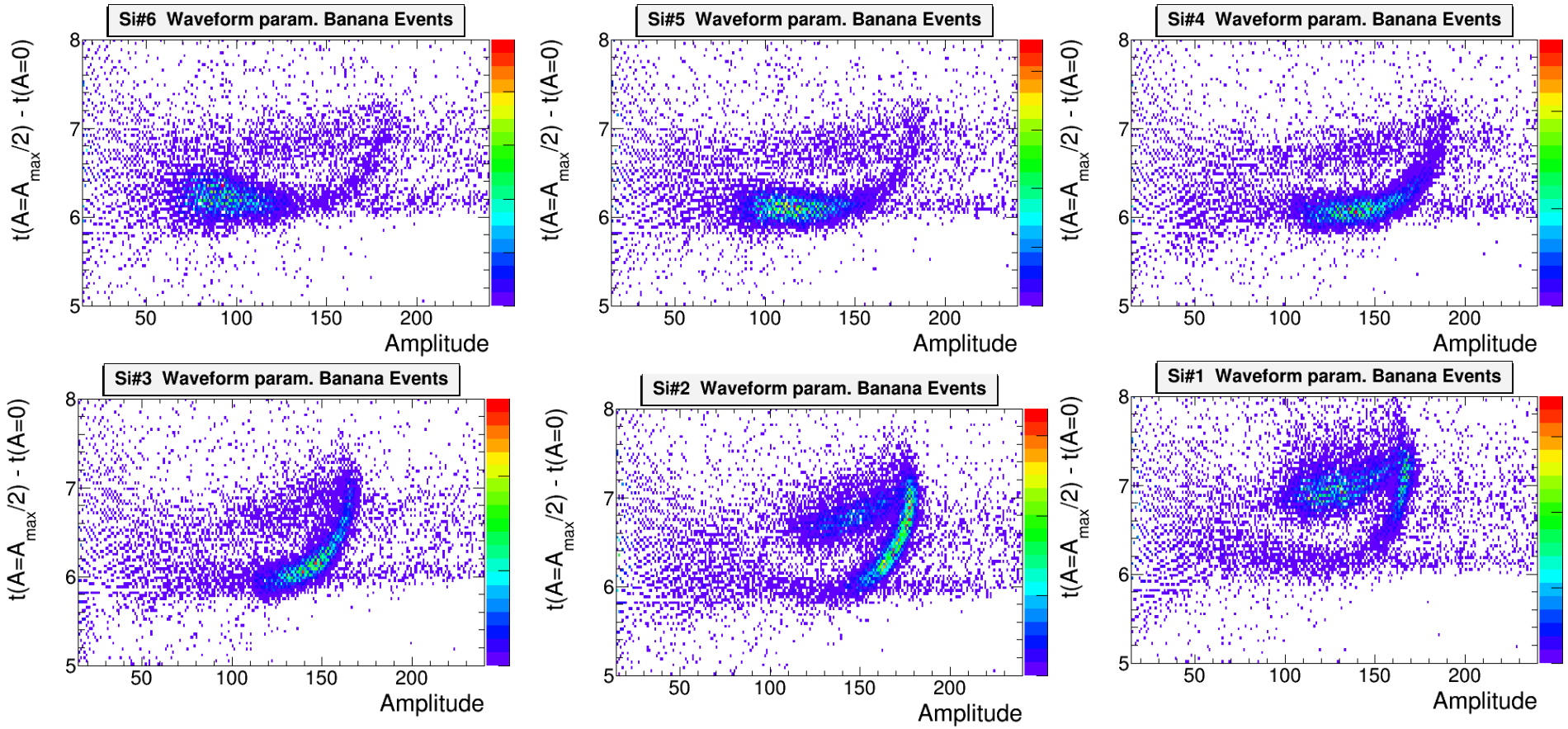
***t_0* depends on energy !**





Stopped and punched through protons can be separated!

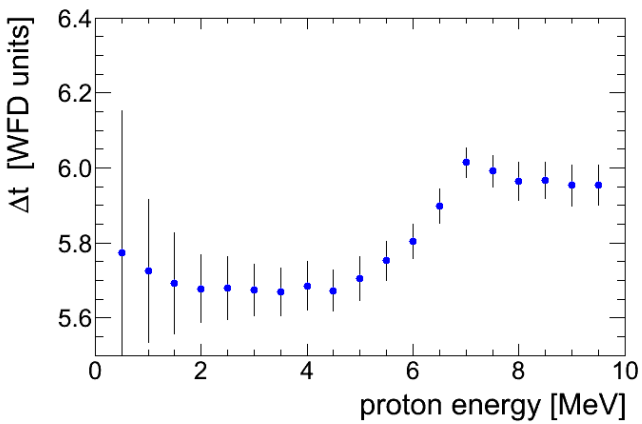
New Detectors. Fill 18684



- **Waveform shape may be used to separate stopped and punch through protons**
- **Measured amplitude *A* and waveform shape *Δt* allows one to reconstruct pion kinetic energy**
- **Not implemented yet**

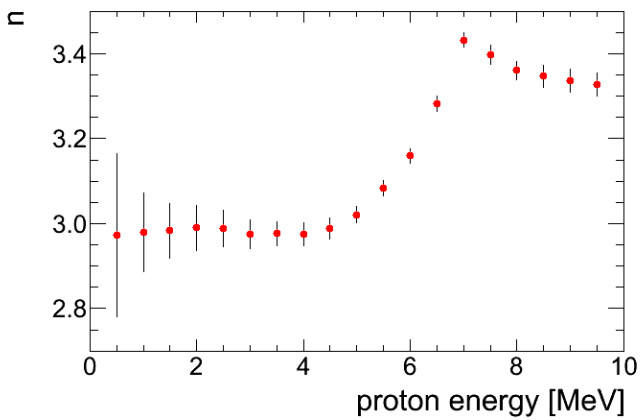
What has to be done to implement the method

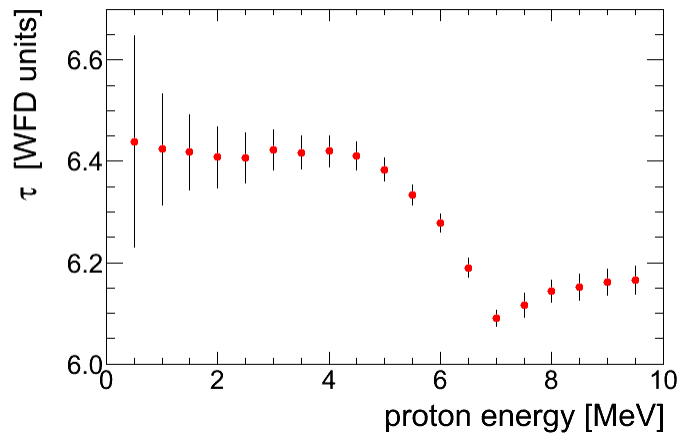
- **Parametrization of the dependence *Δt* on *A***
- **Calibration**



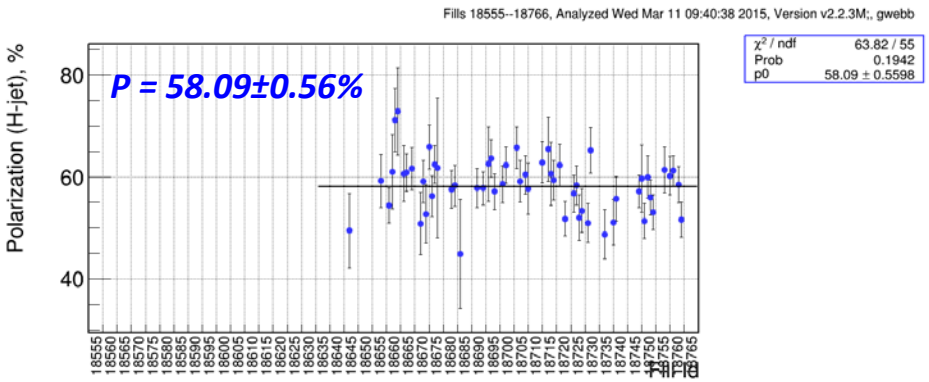
Δt **is only one possible parametrization of the waveform shape. Perhaps, the fit parameters *n* and *τ* may provide better solution**

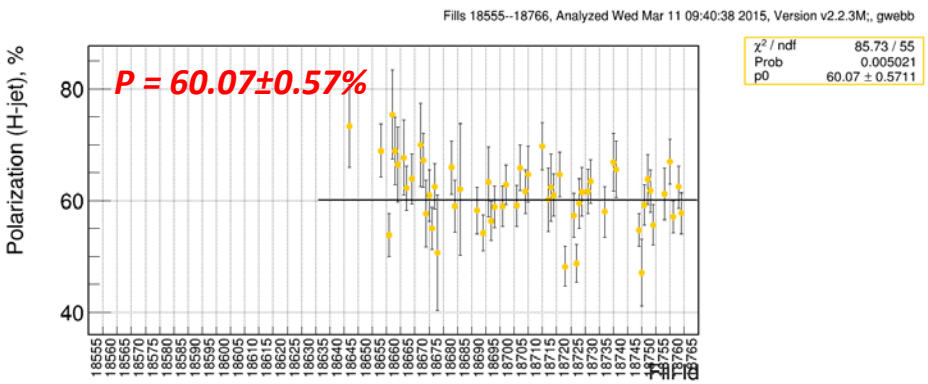
$$A(t) \sim (t - t_0)^n \, exp\left(-\frac{t - t_0}{\tau}\right)$$

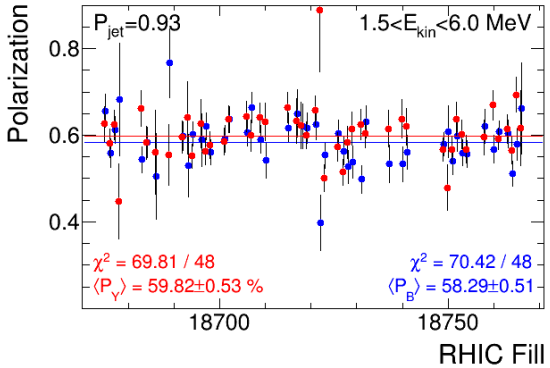


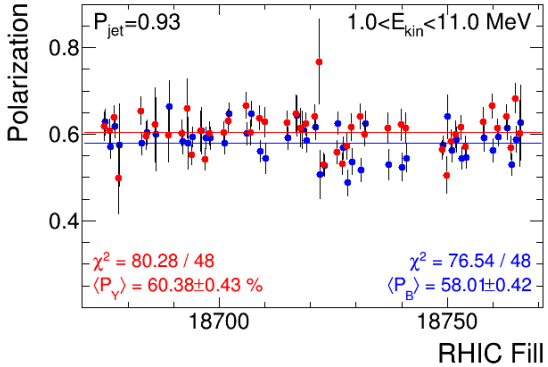


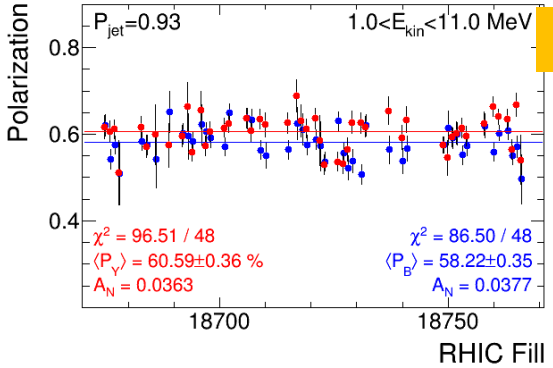
Extended Energy cuts ($1<E_{kin}<11$ MeV). First results.











Fixed A_N

Extended energy range does not change the average value of polarization, but gives an improvement in statistical accuracy.