

29.10.2019



Performance & Simulation of Calo

FOOT Meeting

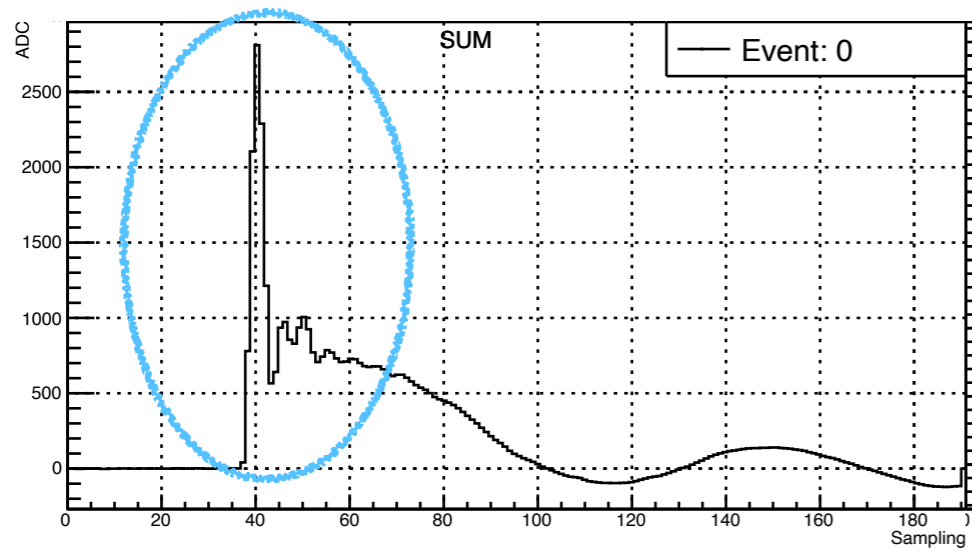
S. Argirò, N. Bartosik, P. Cerello, E. Lopez
Torres, L. Ramello, L. Scavarda

Where were we...

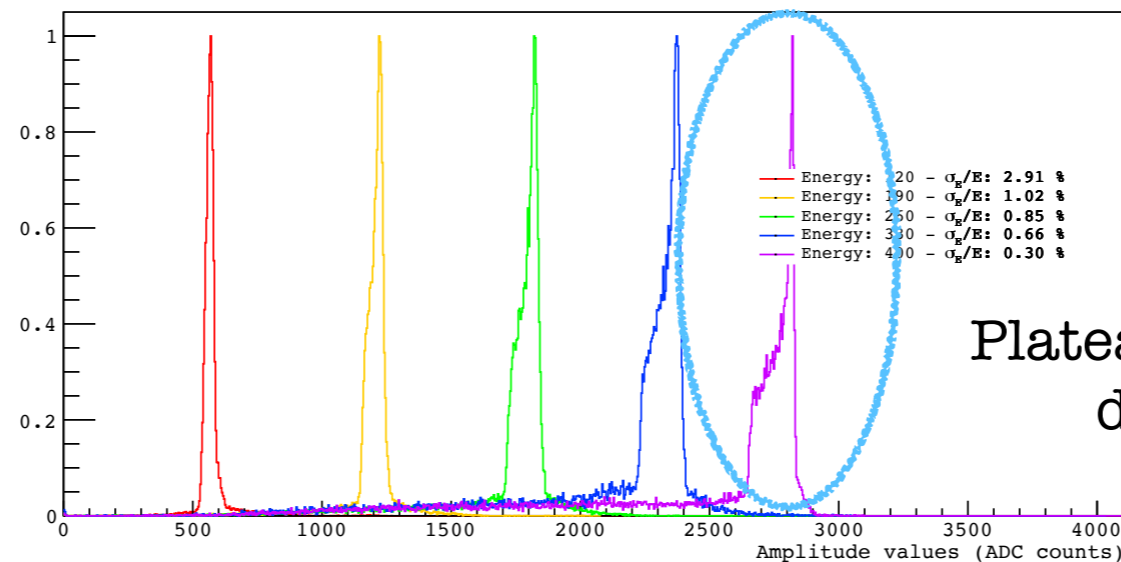
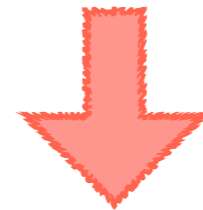


March 2019

Readout board not optimal.
Narrow peak in the first part
of the signals



Low sampling rate of
Digitizer

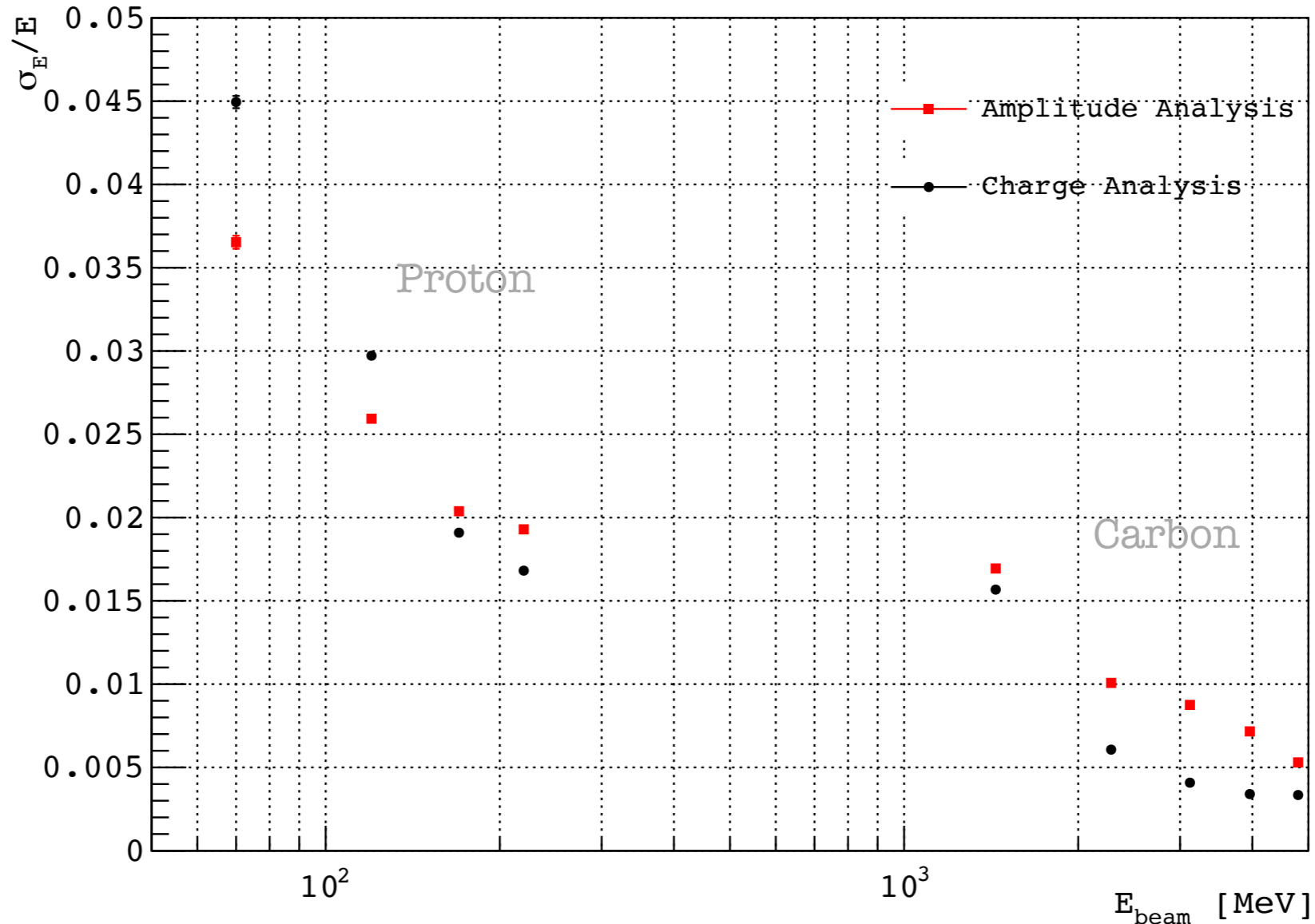


Plateau in amplitude
distribution

Where were we...



March 2019

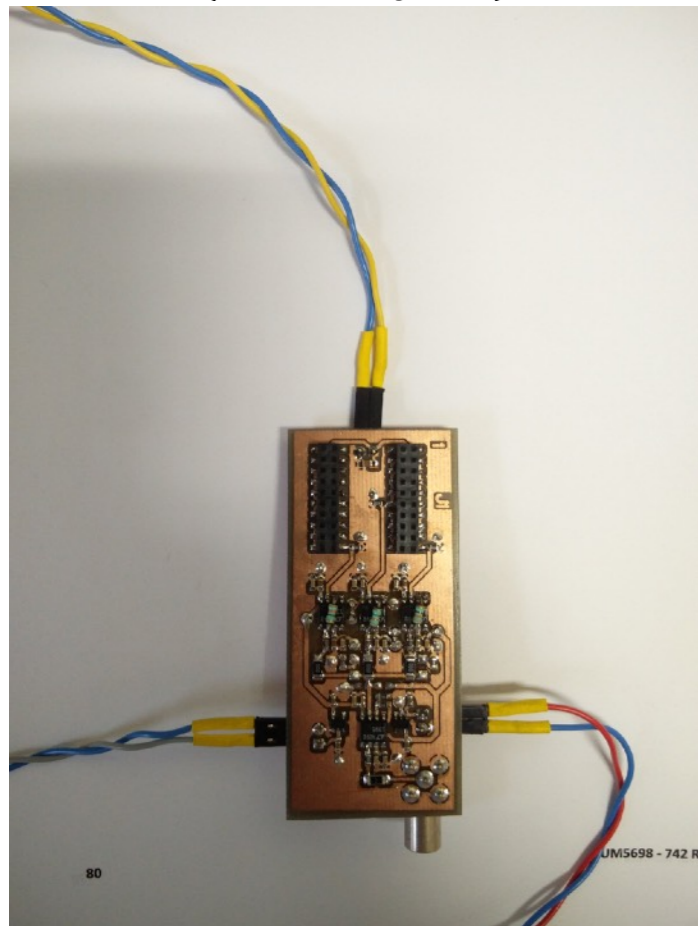


- Charge resolution $< 4.5\%$
- Amplitude resolution $< 3.7\%$
- At higher energy charge analysis allowed to reach better energy resolution

Setup of 01/10/19

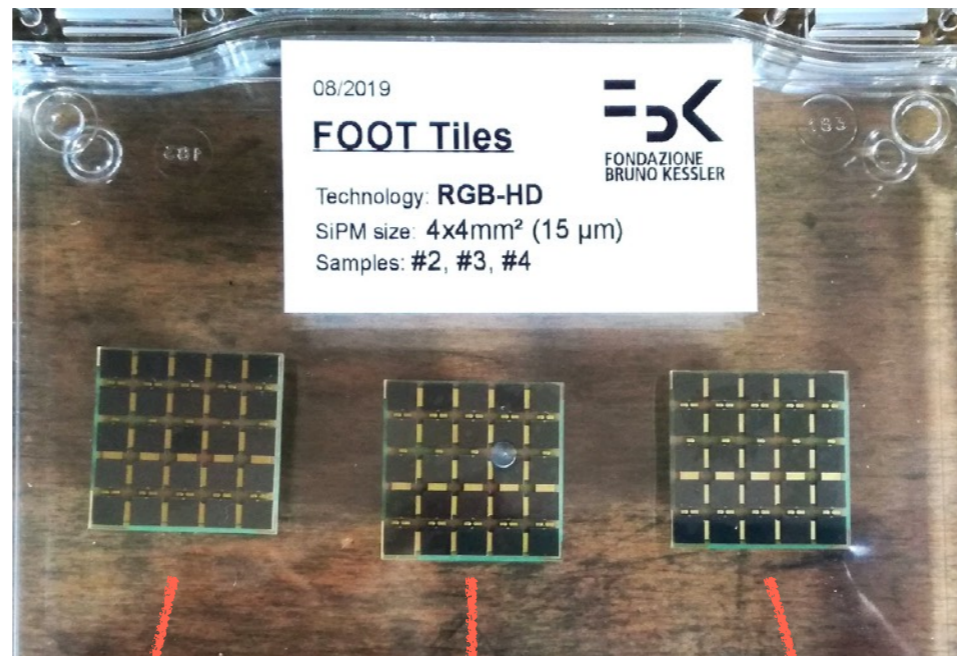


Read out board
(prototype)



read 15 SiPMs

15 μm SiPM arrays,
25 SiPMs in each tile



BGO w/ **white**
painting

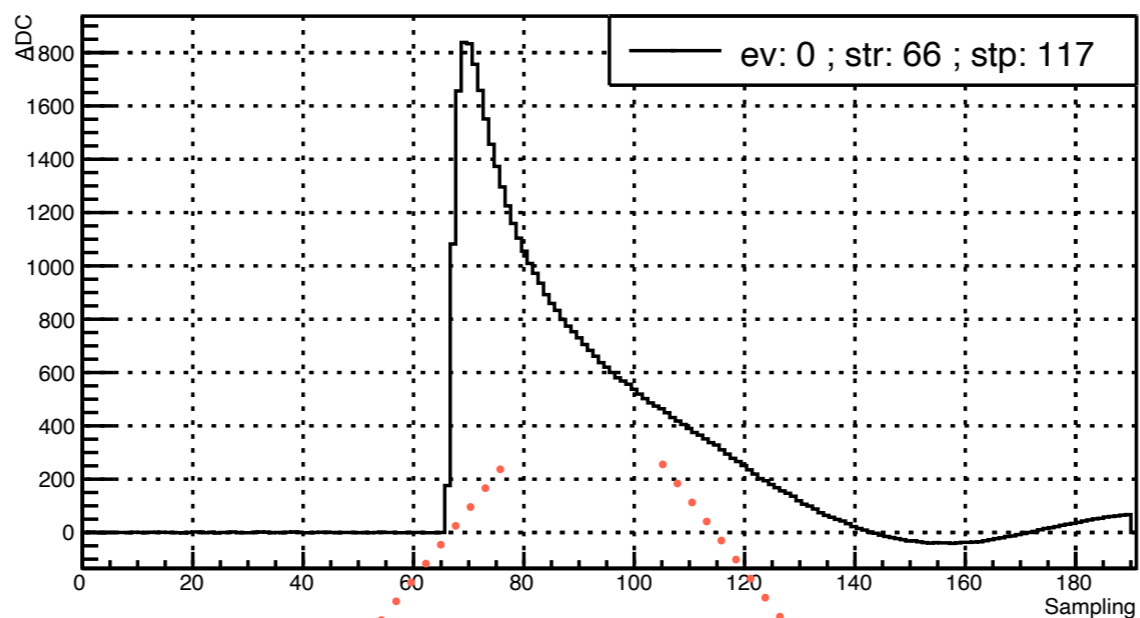
BGO w/ **mylar**

BGO w/ **tyvek**

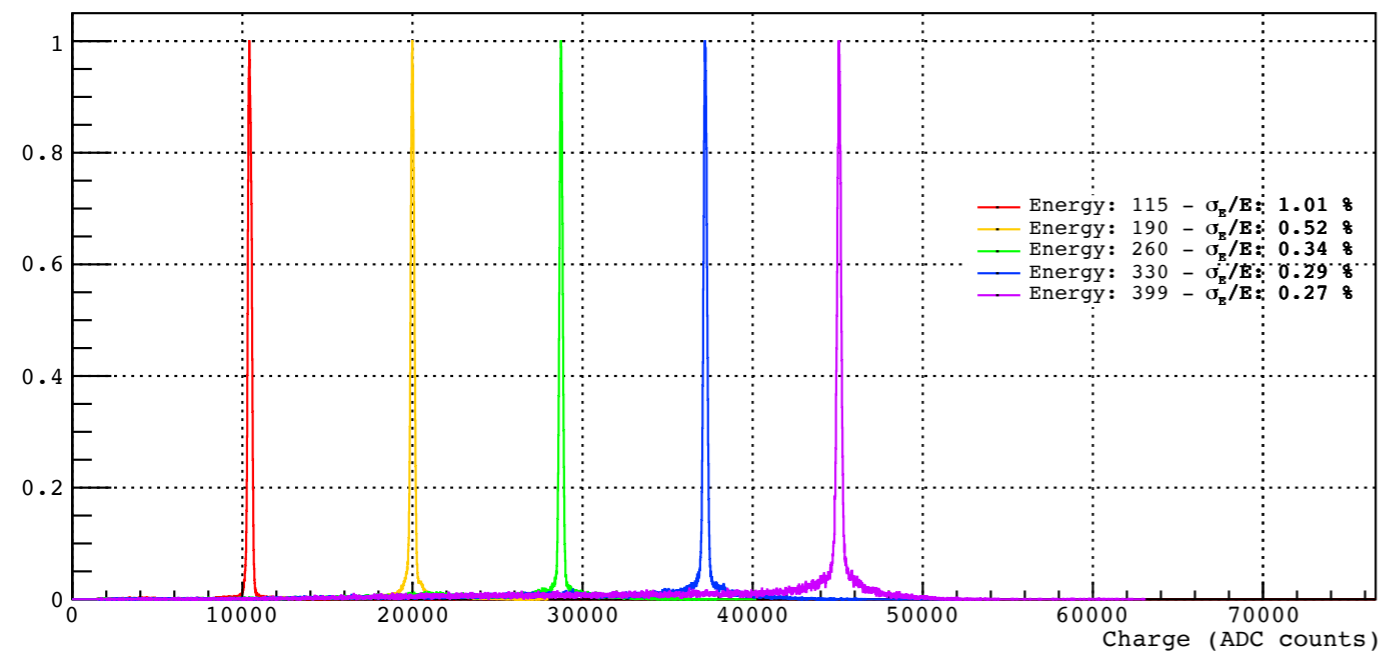
V1740, 2V, 65 Mhz



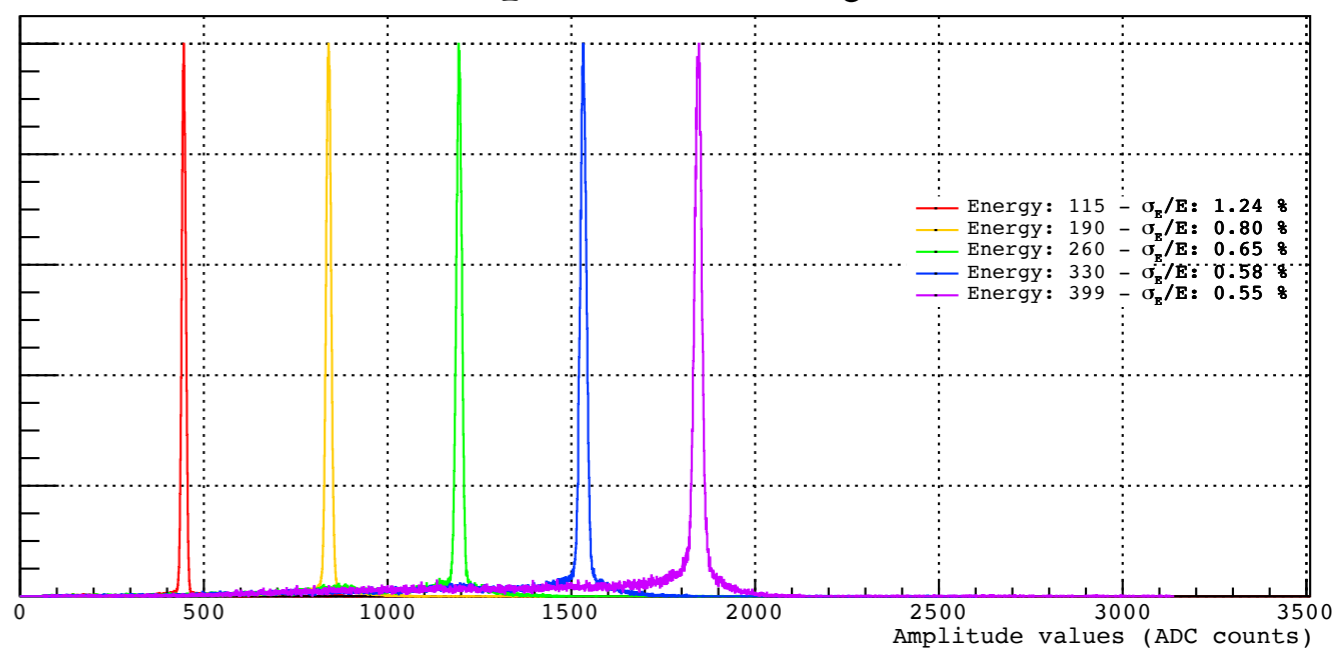
Amplitude & Charge



Charge Analysis



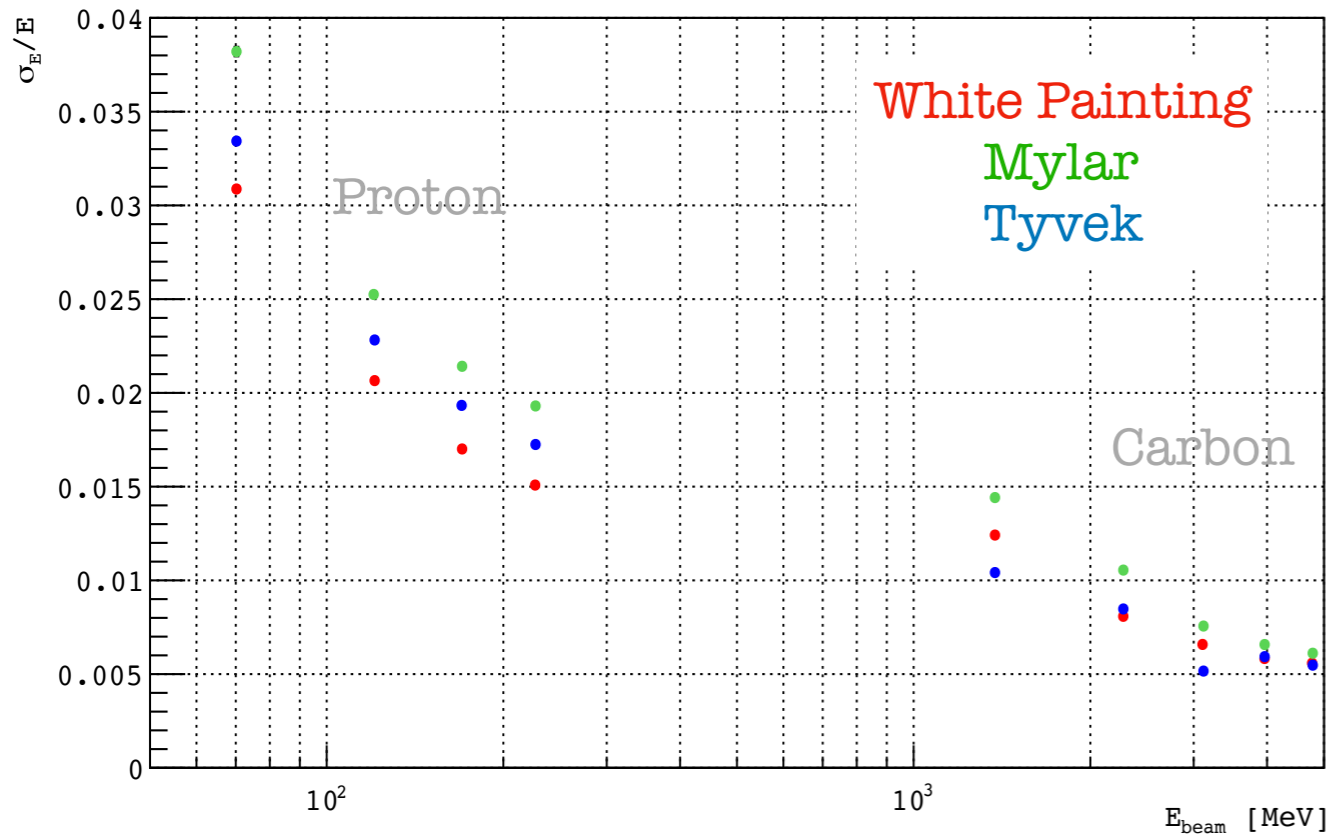
Amplitude Analysis



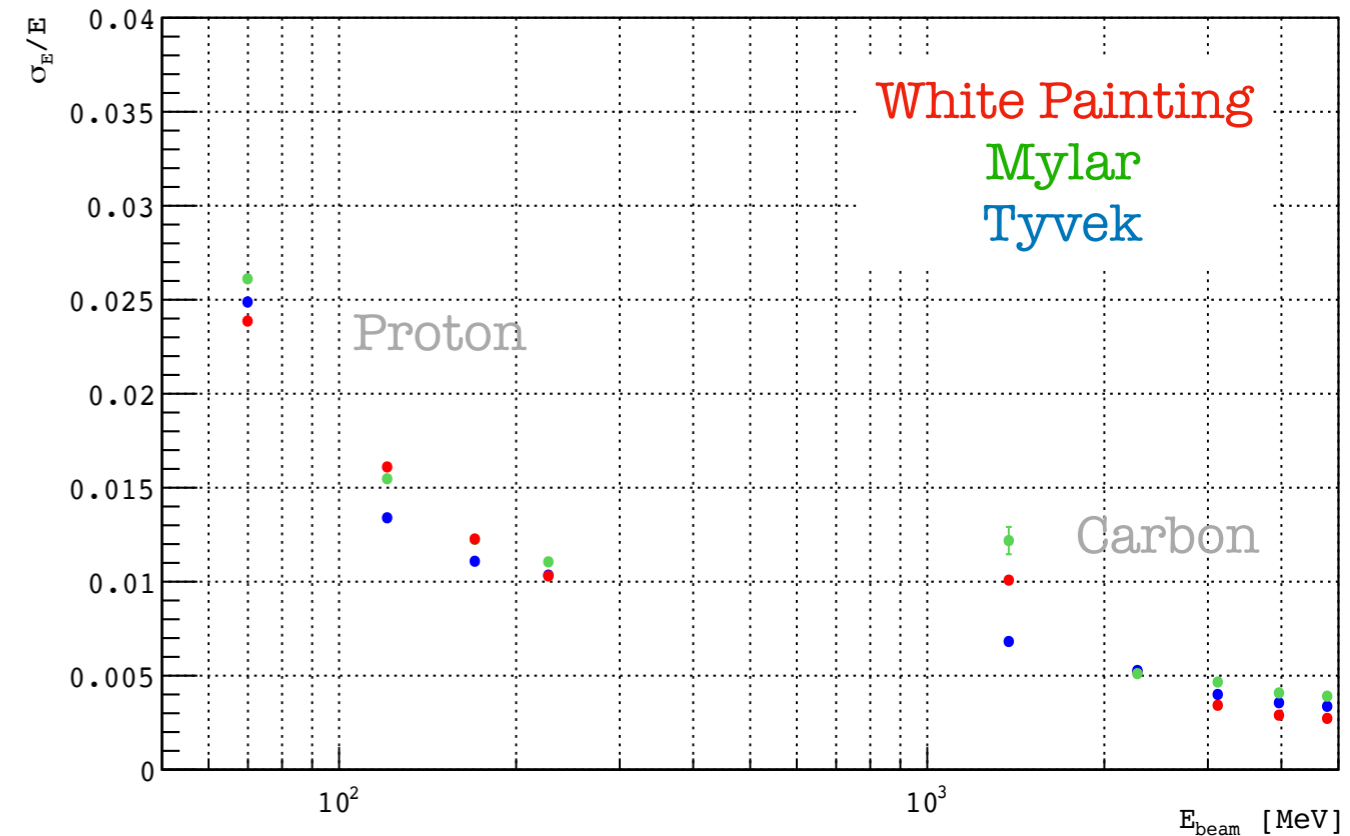
Energy Resolution



Amplitude Analysis

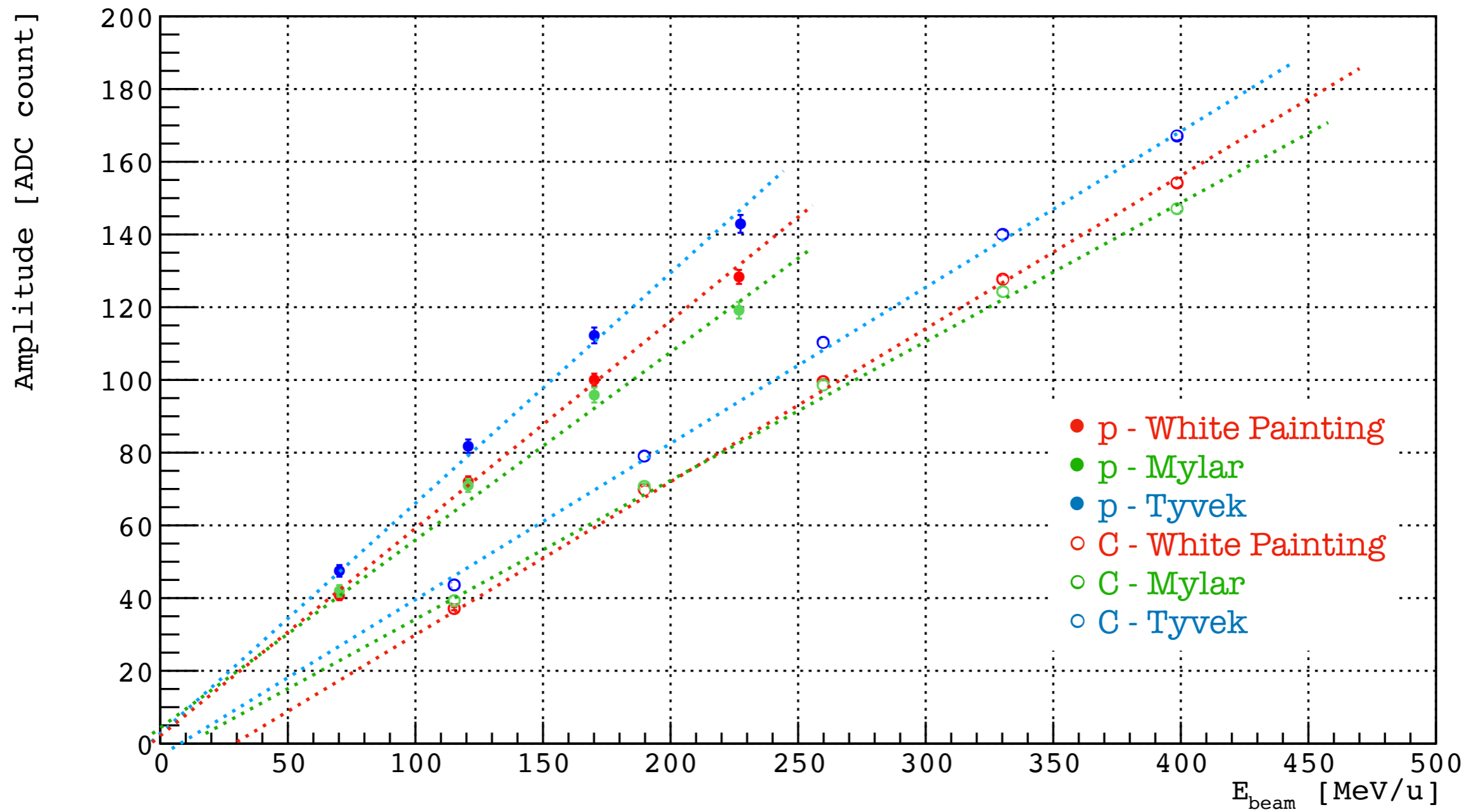


Charge Analysis



- Charge resolution $\leq 2.5\%$ (4.5 %)
- Amplitude resolution $\leq 3.5\%$ (3.7 %)
- 3 wrappings are comparable

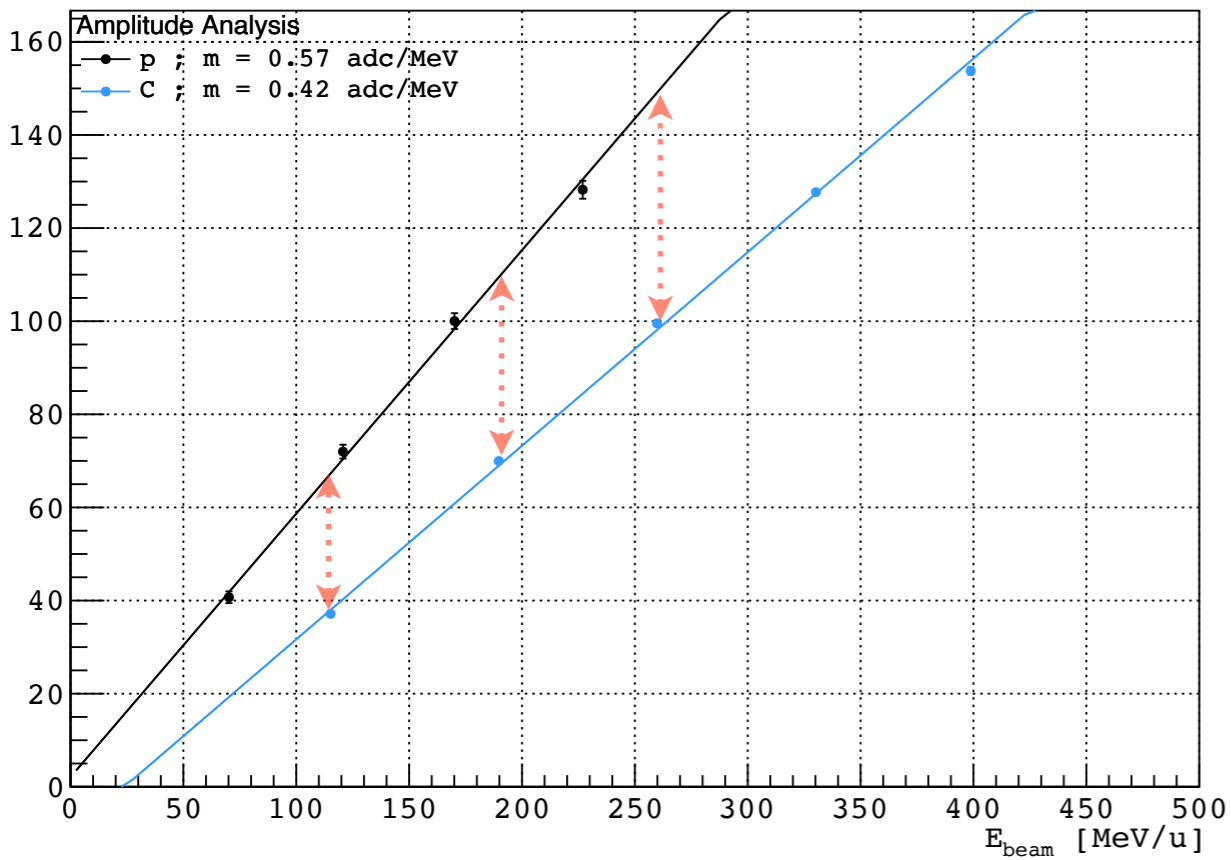
Amplitude Analysis



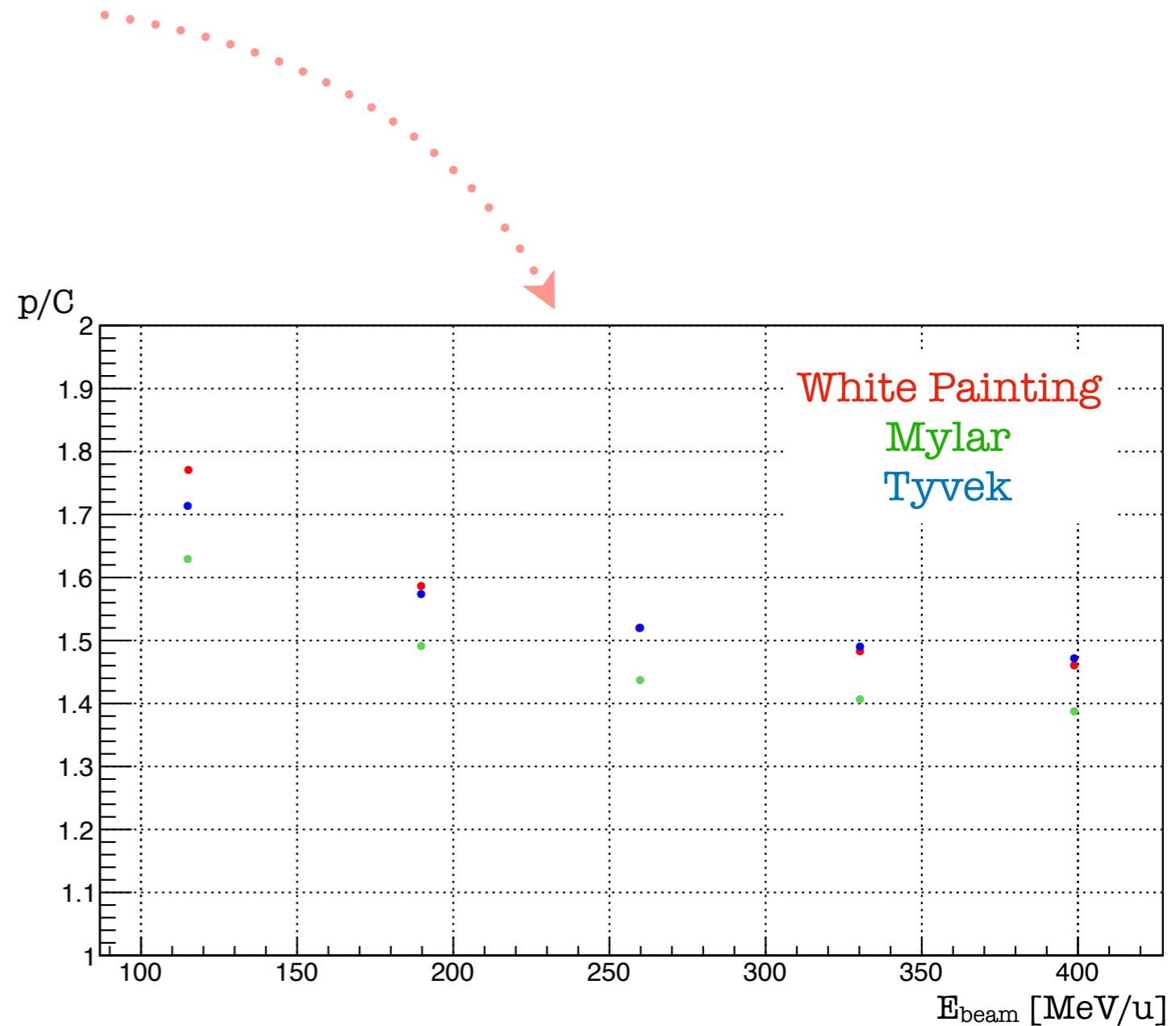
Quenching Effect



_WhitePainting



Ratio between the carbon points and the correspondent values of the proton fit function



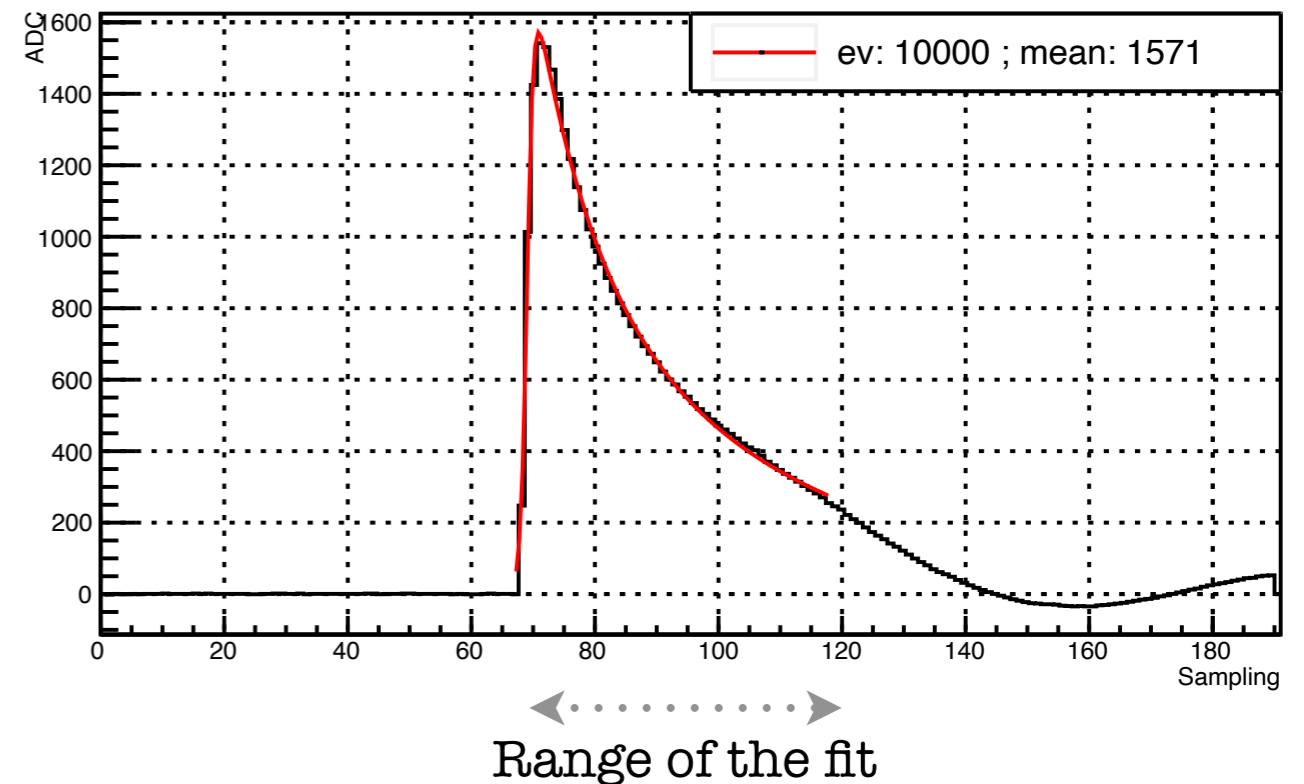
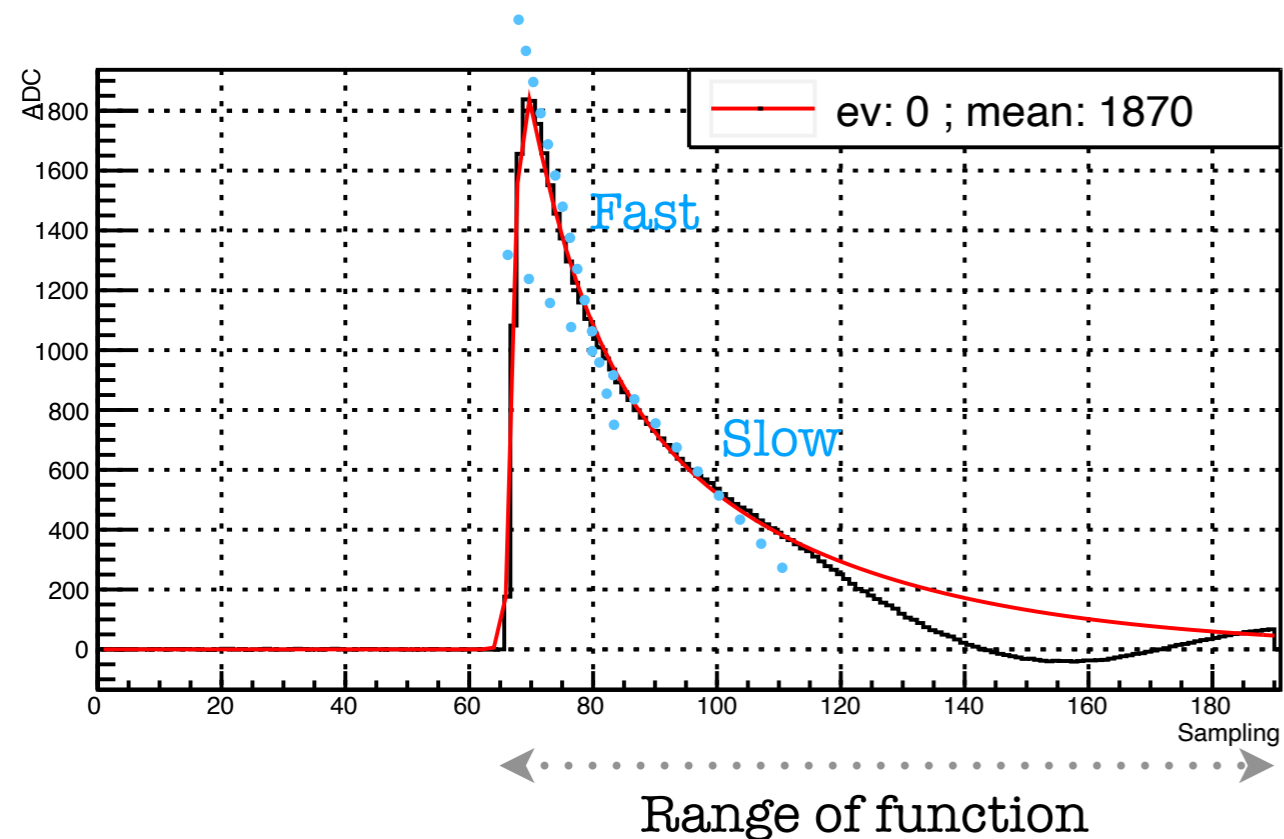
Fit Analysis

$$f(x) = A \cdot (1 - k) \cdot \left(\frac{\exp\left(\frac{t_0 - x}{t_{fs}}\right)}{\exp\left(\frac{t_0 - x}{t_r}\right) + 1} \right) + A \cdot (k) \cdot \left(\frac{\exp\left(\frac{t_0 - x}{t_{fl}}\right)}{\exp\left(\frac{t_0 - x}{t_r}\right) + 1} \right)$$

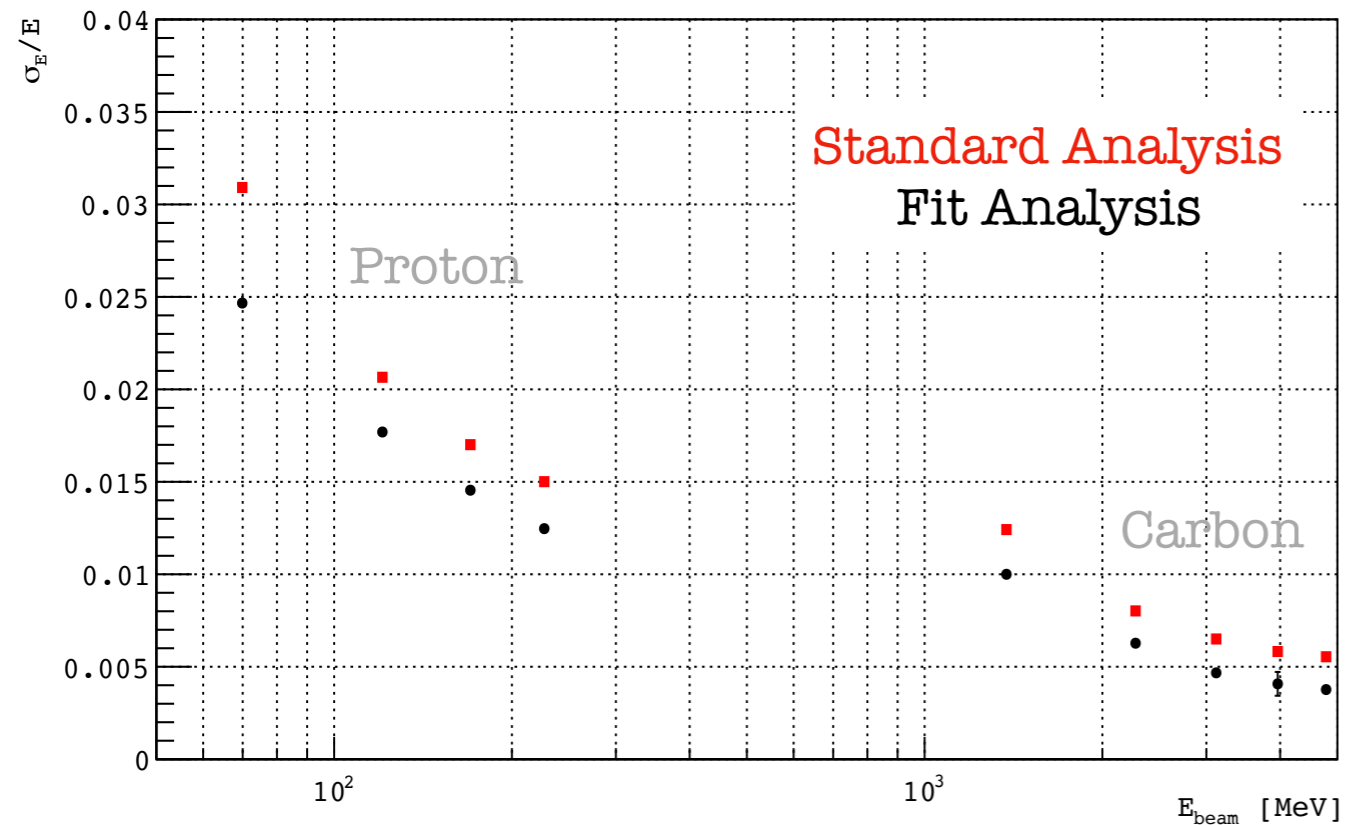
short (fast) component
long (slow) component

- 4 free parameters:
- A: normalization factor
 - t_0 : time of fit start
 - t_r : rising time
 - k: weight of t_{fl}

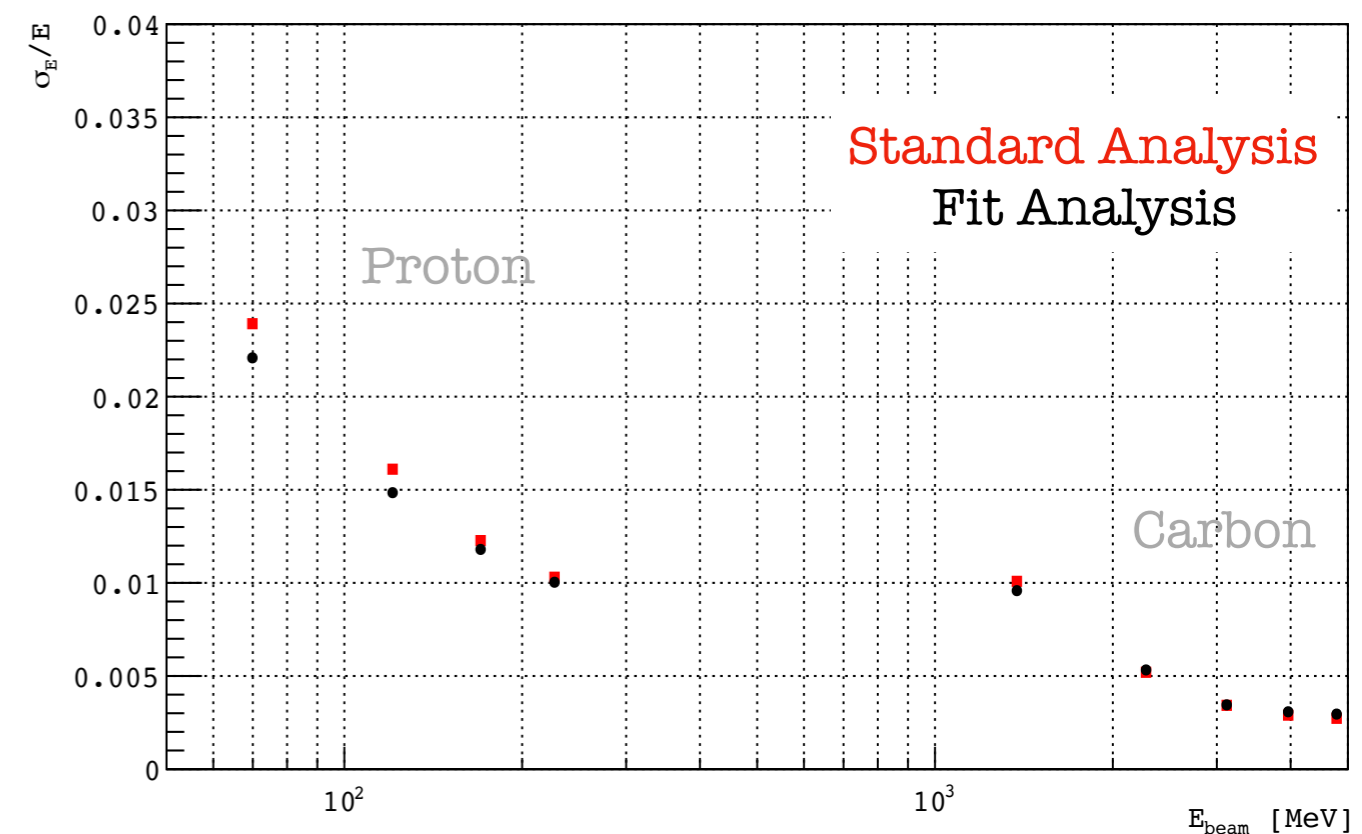
- 2 fixed parameters:
- t_{fs} : 100 ns falling time short
 - t_{fl} : 500ns falling time long



AMPLITUDE ANALYSIS

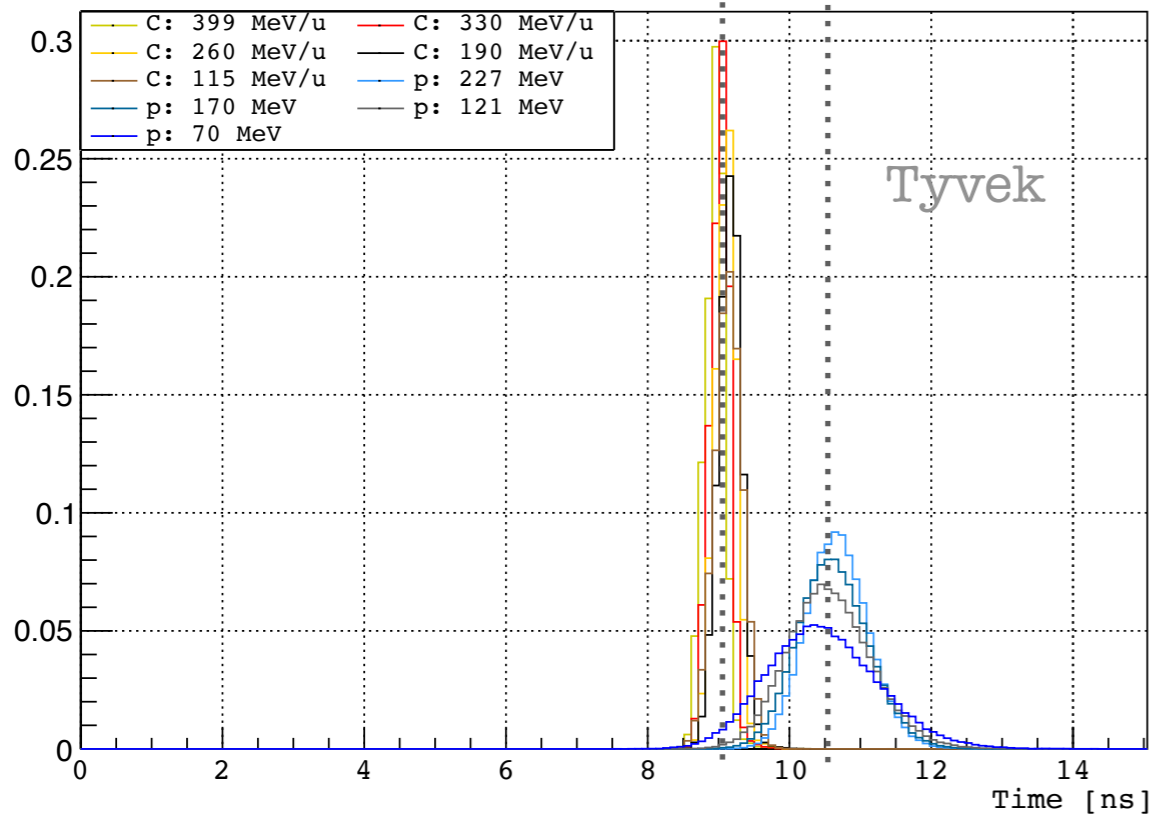
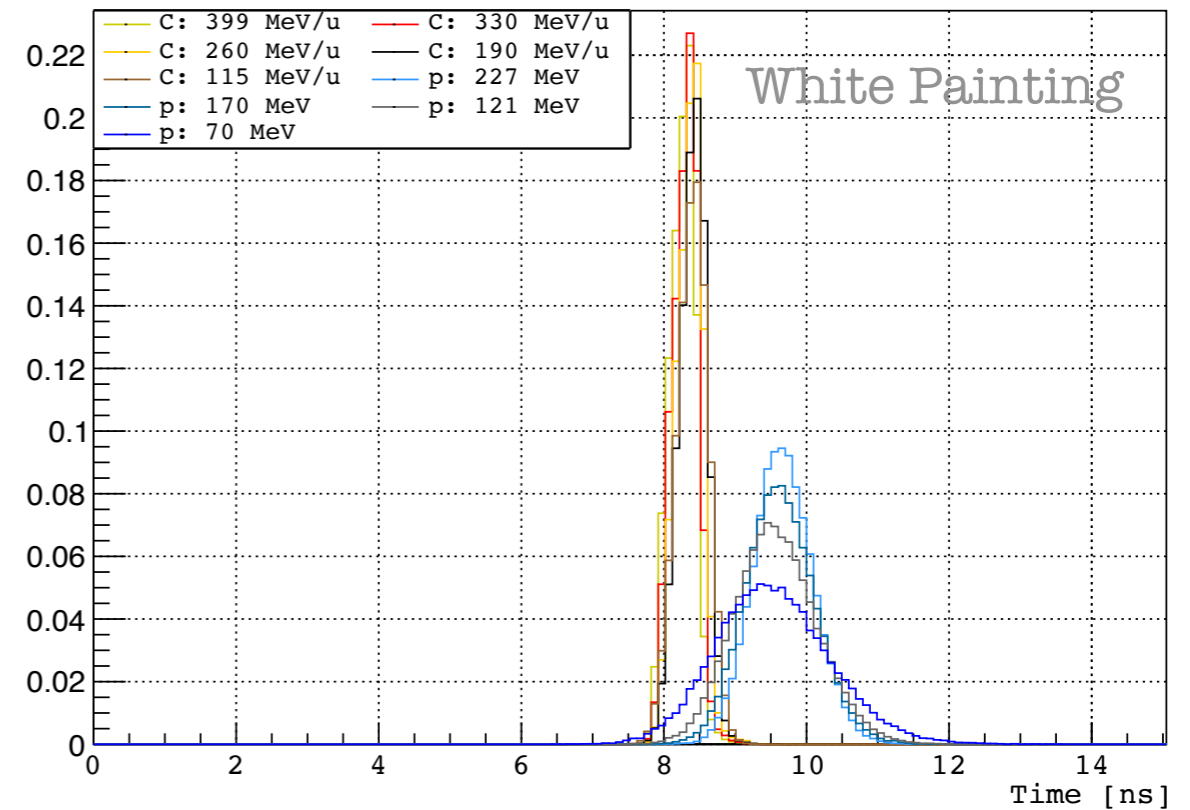
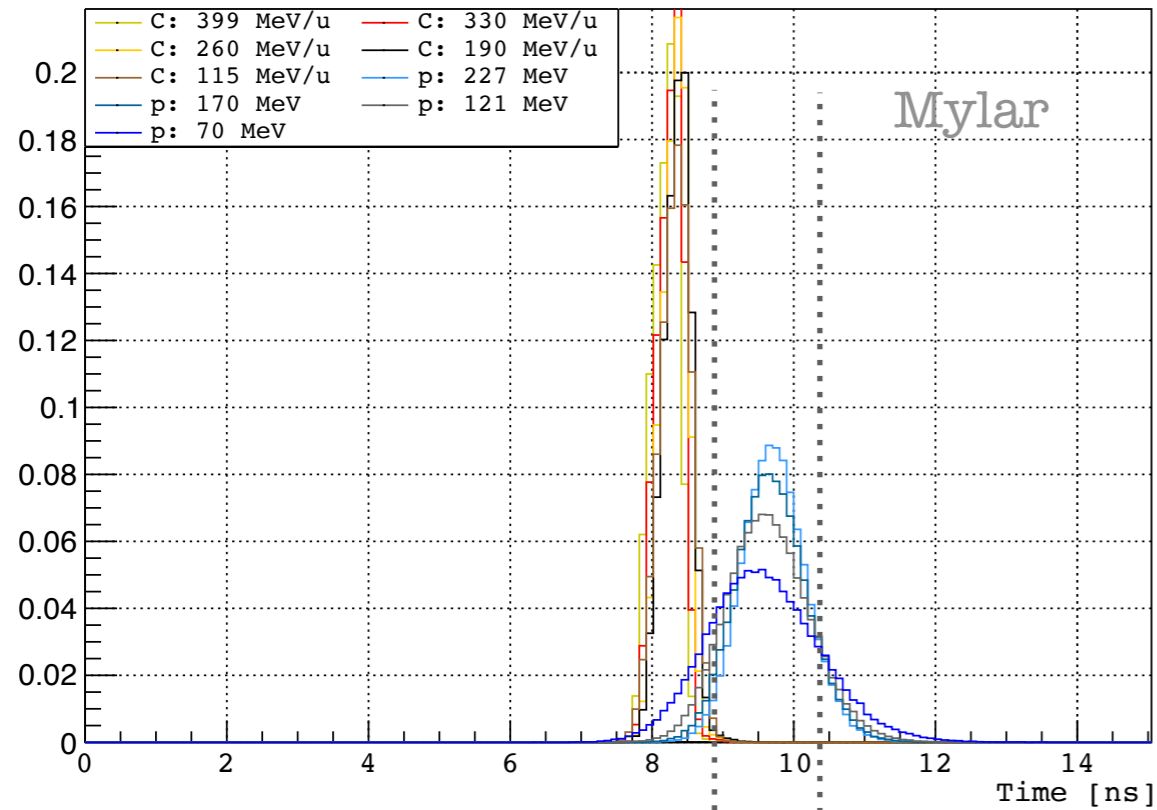


CHARGE ANALYSIS



- Charge resolution $< 2.5 \%$
- Amplitude resolution $< 2.5 \%$
- Improvement of energy resolution with fit analysis
- Amplitude and charge resolution are comparable with fit analysis

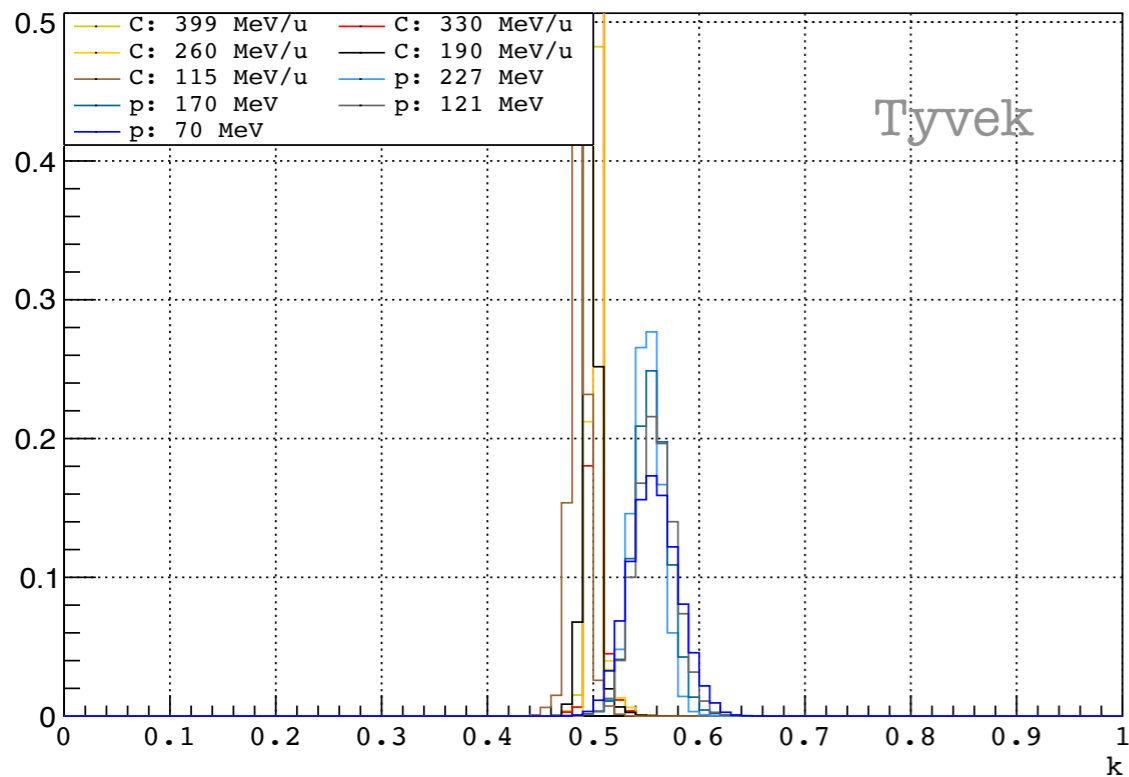
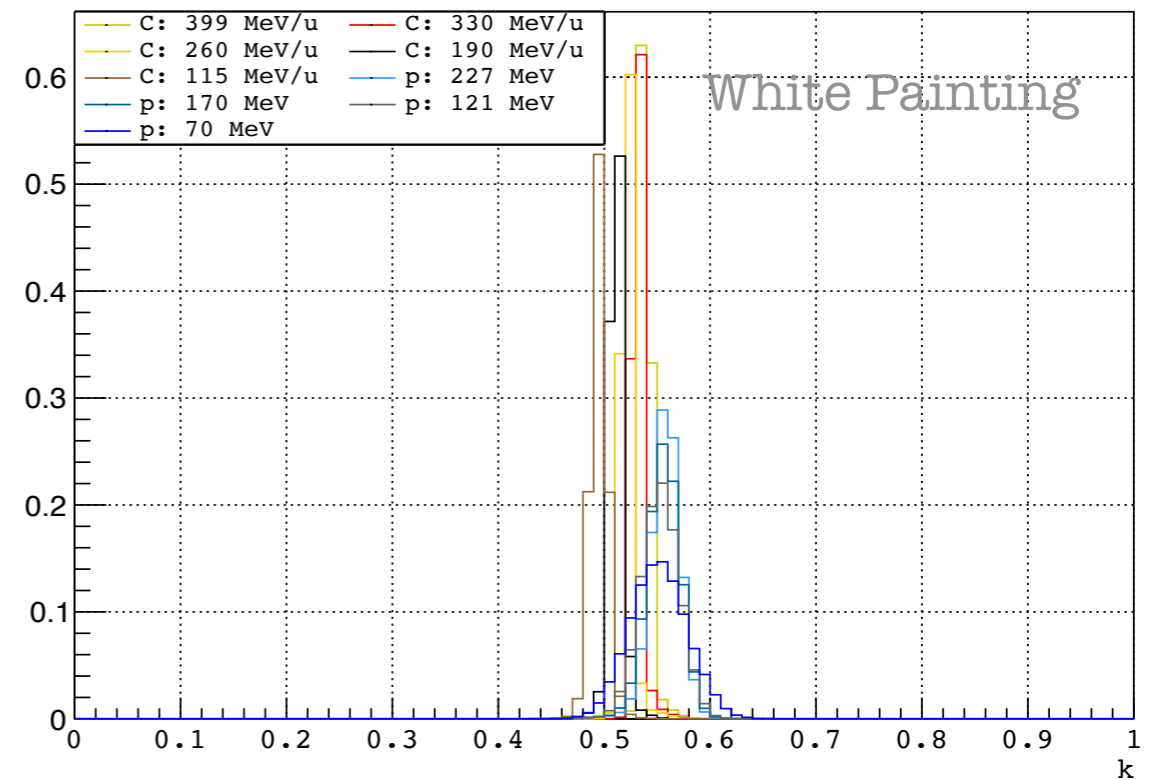
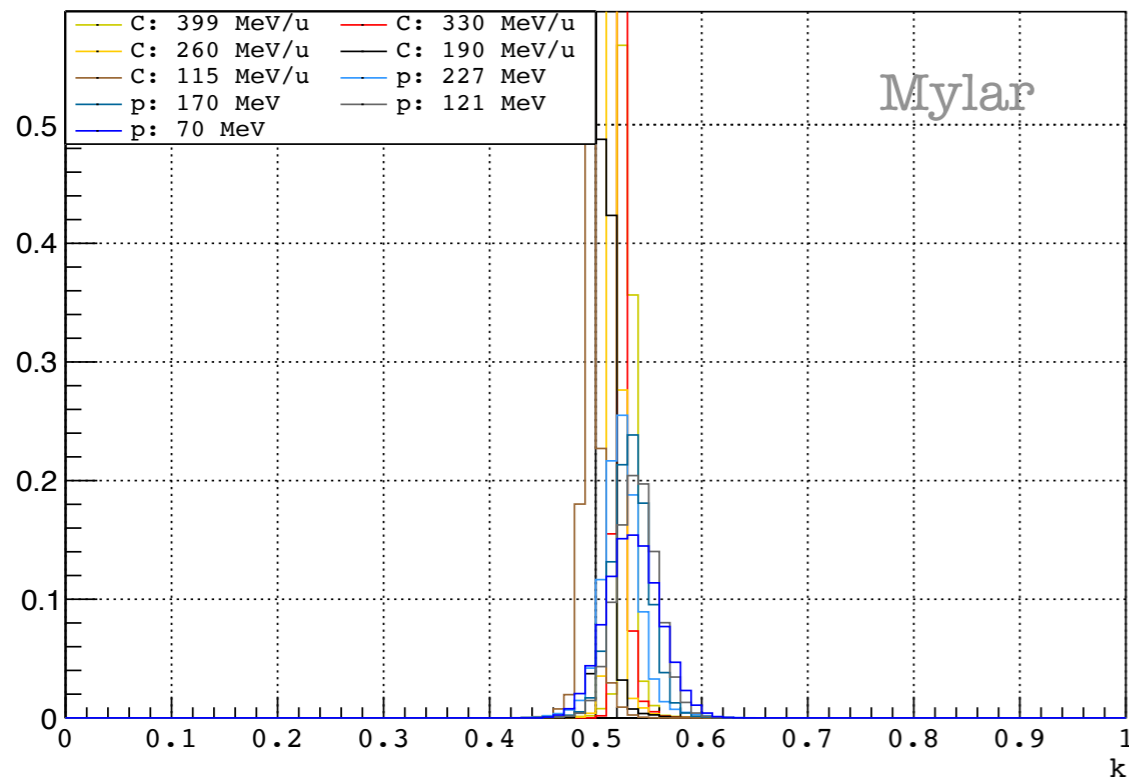
Shape Analysis (1)



Rising Time

- Carbons and protons seem to have two different populations of rising time
- With tyvek the distributions are shifted about 1 ns both for proton and carbon.

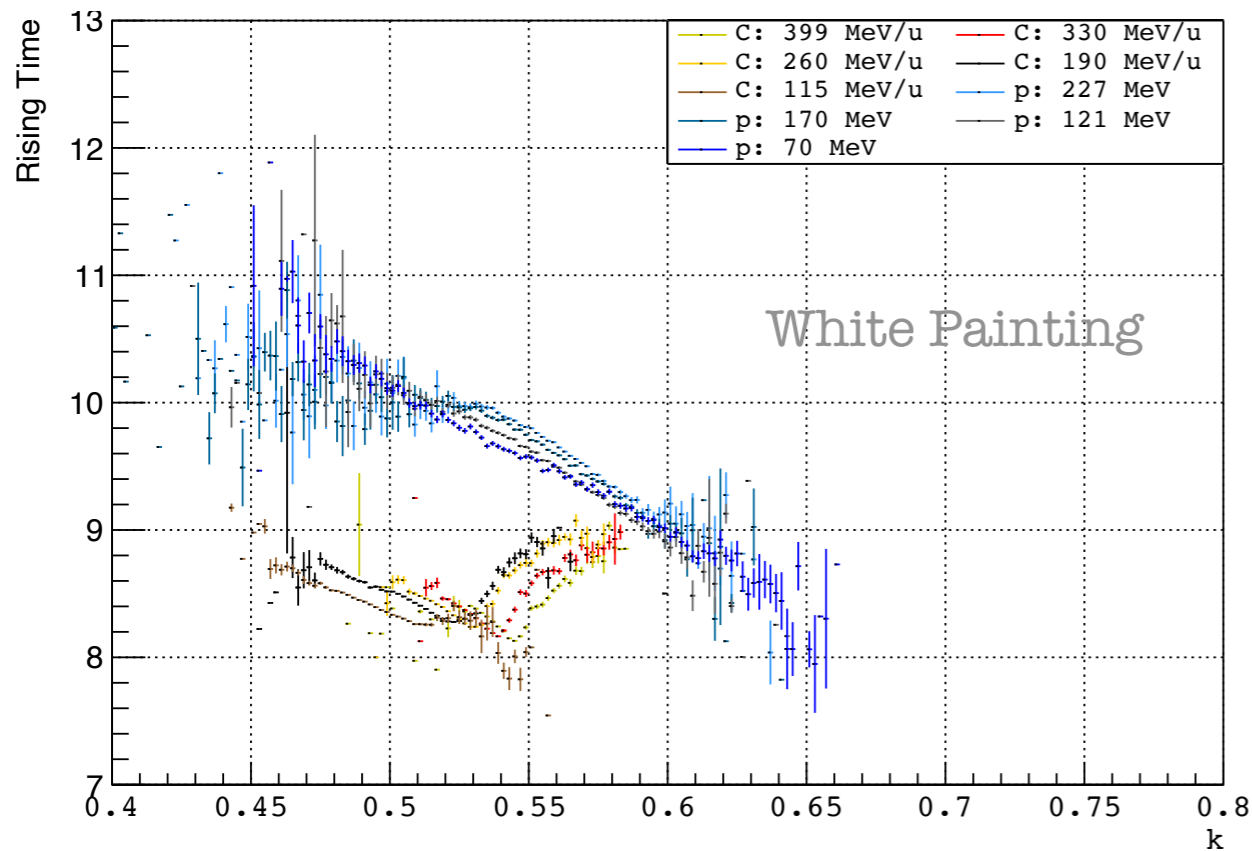
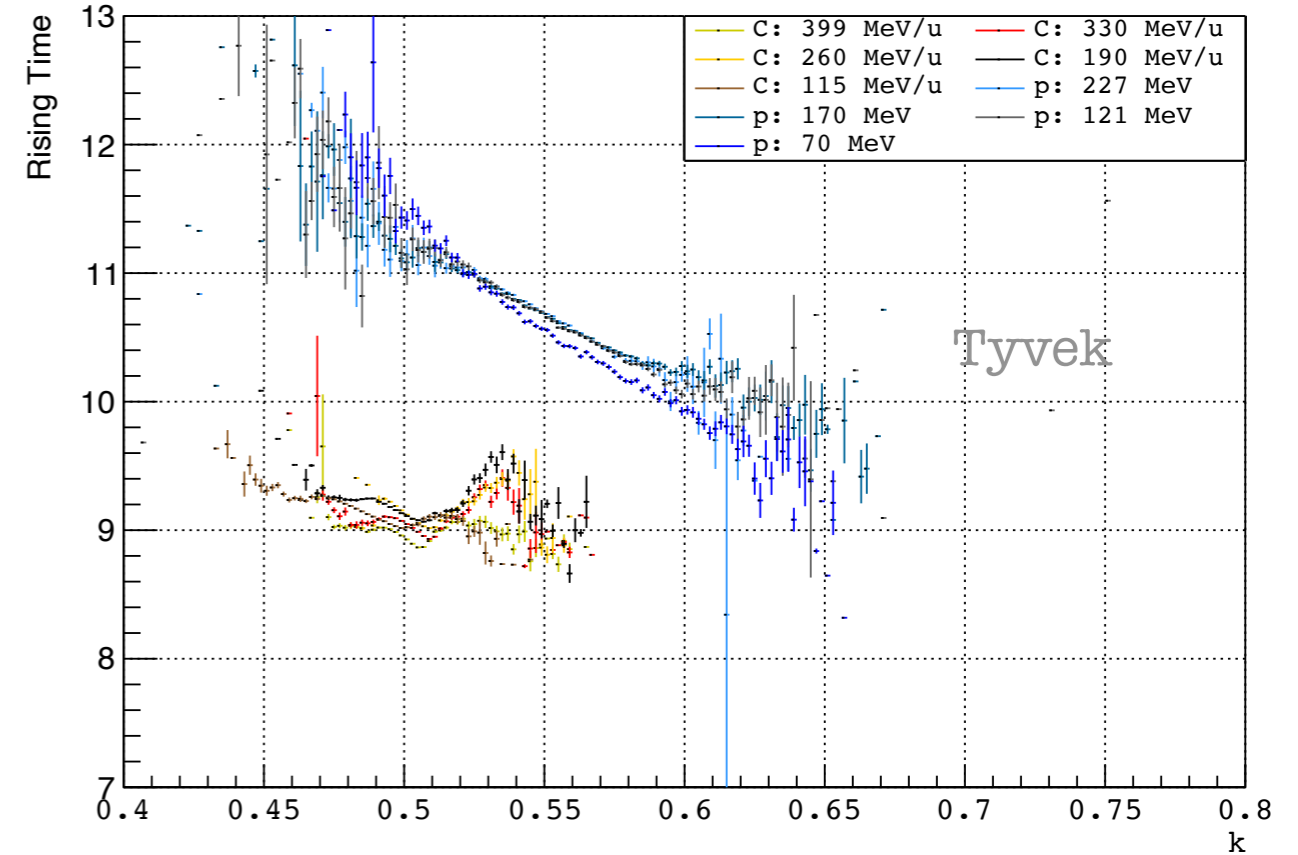
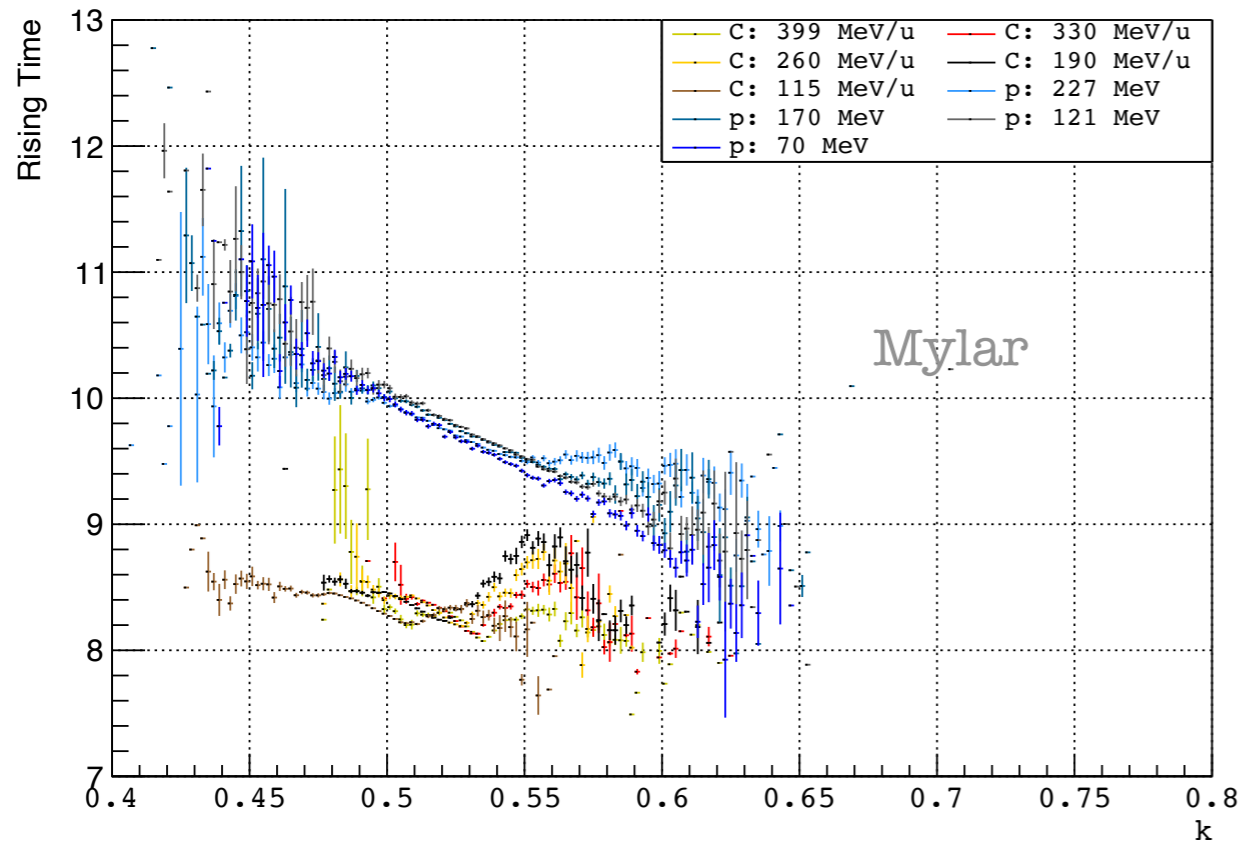
Shape Analysis (2)



Time Factor

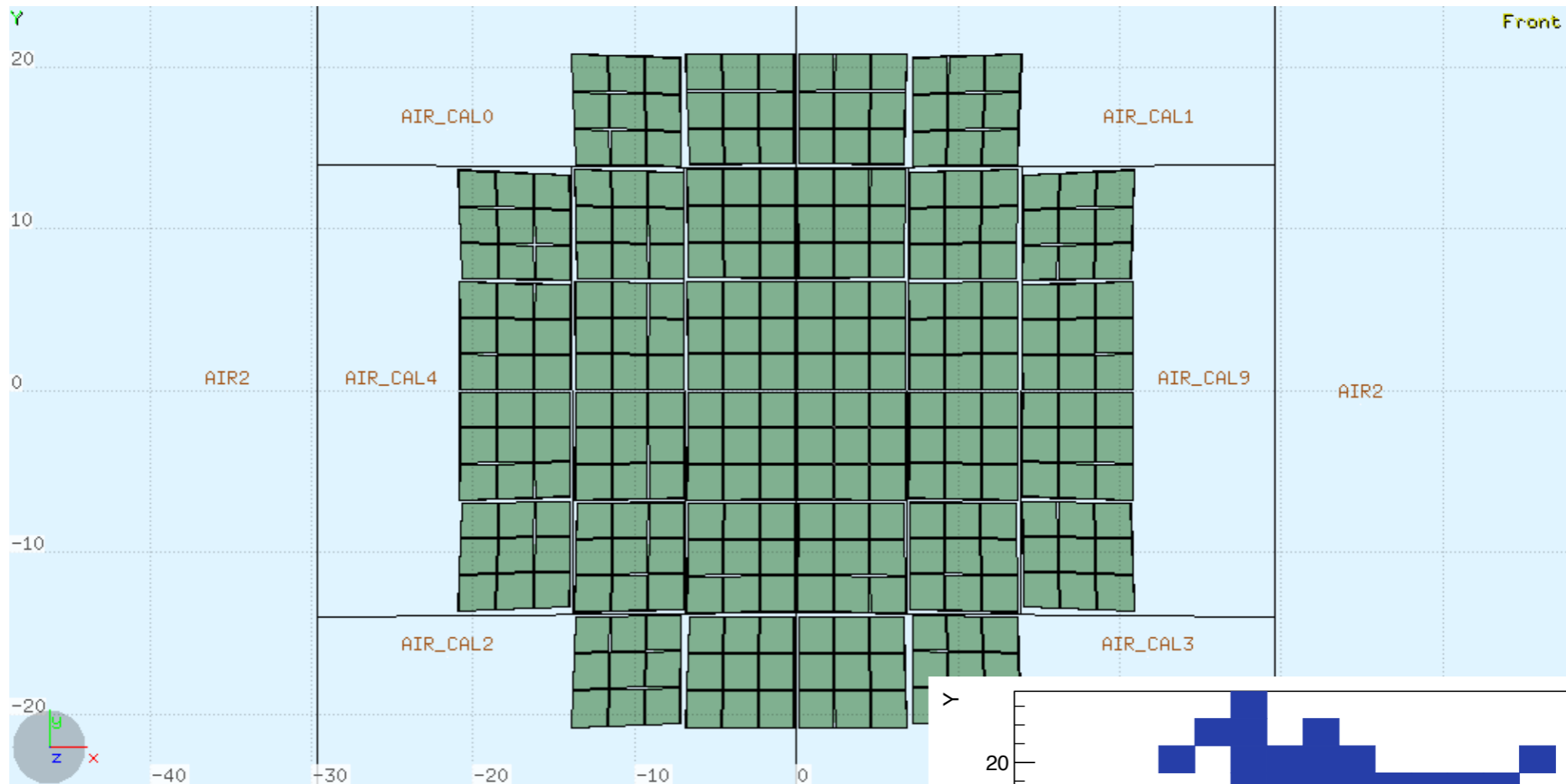
- With tyvek the proton and carbon distribution are better separated

Shape Analysis (3)

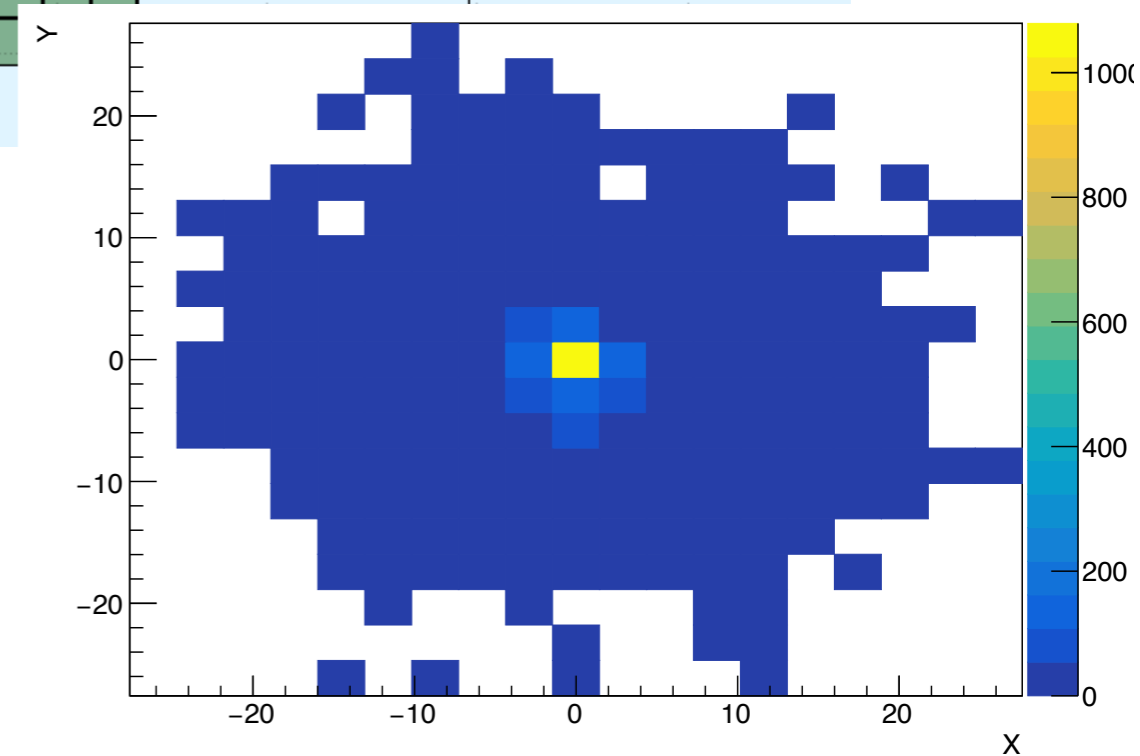


Profile Rising Time vs Time Factor

- With tyvek the profile of proton and carbon are better separated.
- Combining the information of time factor and rising time we should be able to discriminate the particles.



- Full calo geometry with truncated pyramid BGO is ready with FLUKA.
- The FLUKA simulation works
- The digitisation part is ongoing





Conclusions

- Improvement of energy resolution (thanks to new readout board): $< 2.5 \%$
- The performance of the 3 wrappings are comparable
- From shape analysis Tyvek seems to discriminate better protons from carbons
- Full calorimeter with truncated pyramids BGO is ready for FLUKA.

Next Steps

- Test beam foreseen at CNAO 11-13 November:
 - energy scan of one module of calo (9 crystals) rotated with different angles
 - 9 crystals read by v1740 (65 MHz, 2 V)
 - 1 crystals read by v1742 (1 GHz, 1 V)
- Digitisation part is ongoing