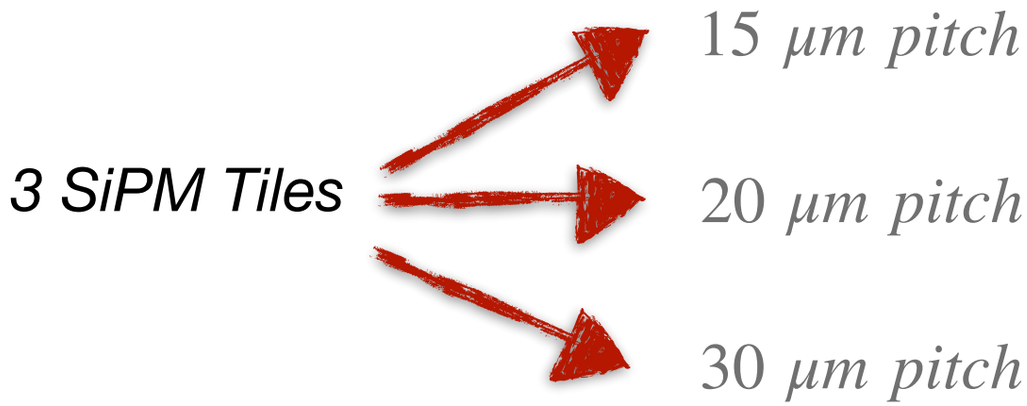
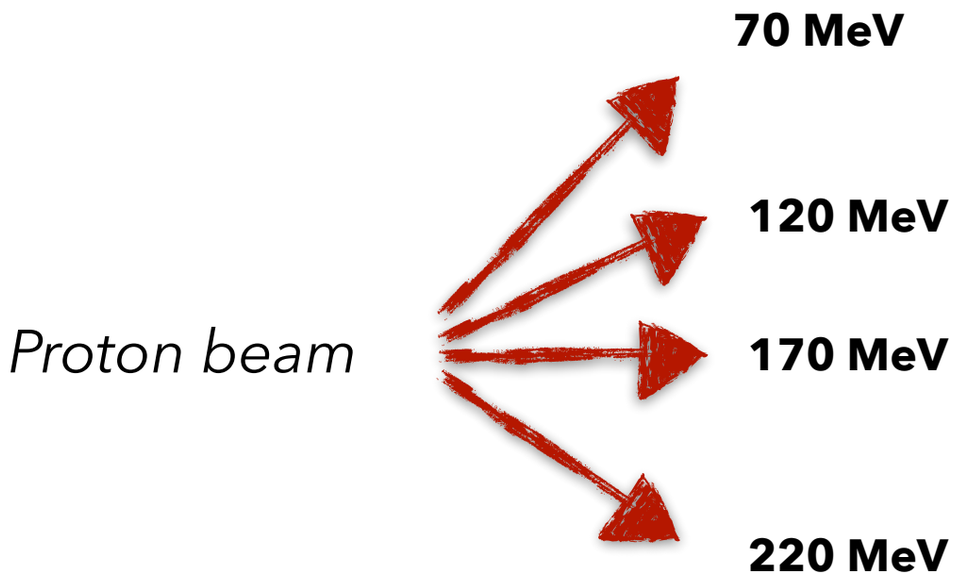
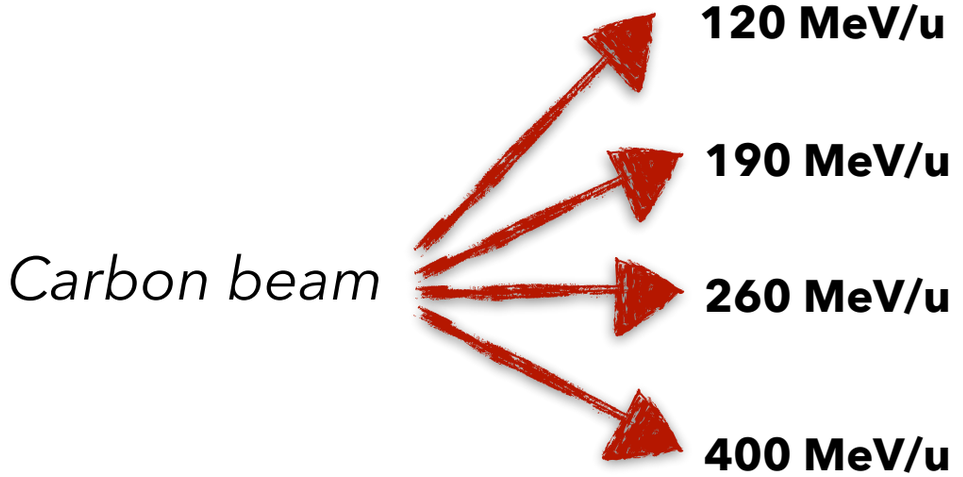
Performance of SiPMs readout for FOOT calorimeter prototype

Lorenzo Scavarda, Nazar Bartosik, Piergiorgio Cerello

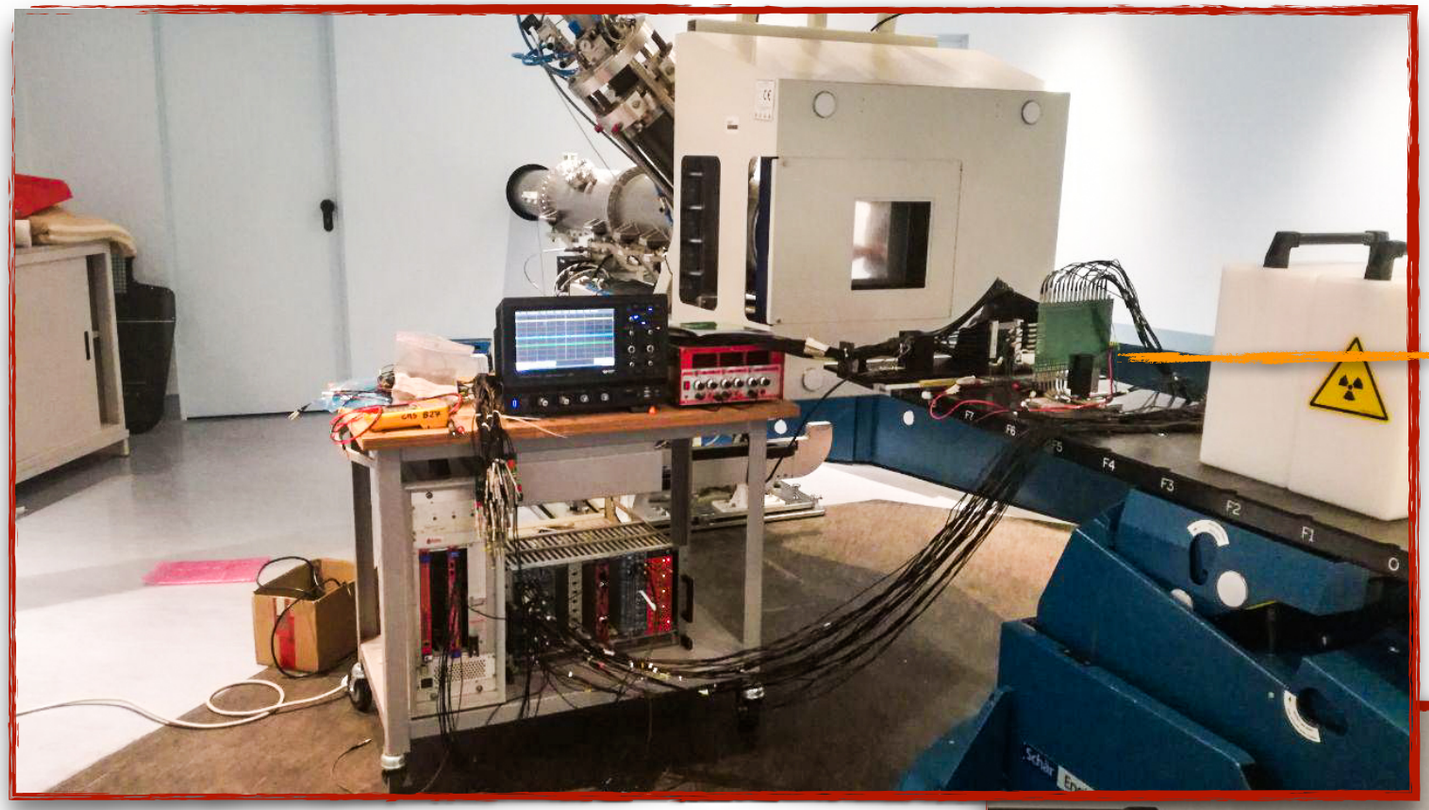
Data Acquisition



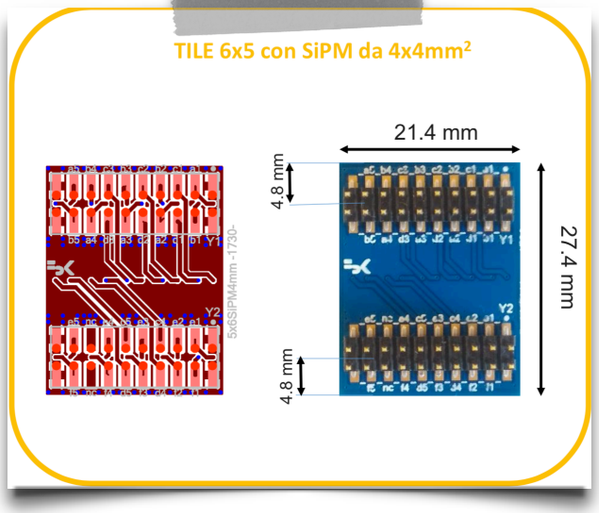


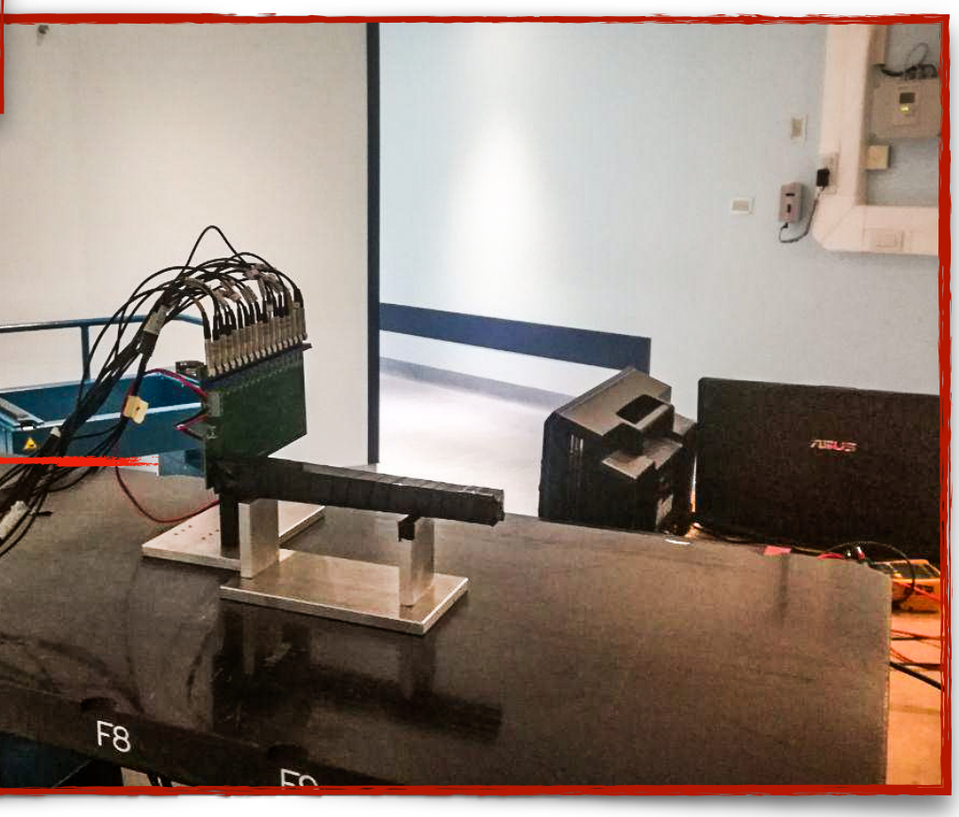


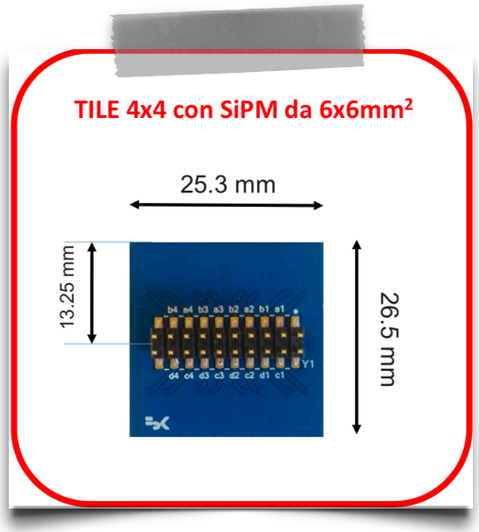
Experimental Setup



15 – 20 *μm pitch*

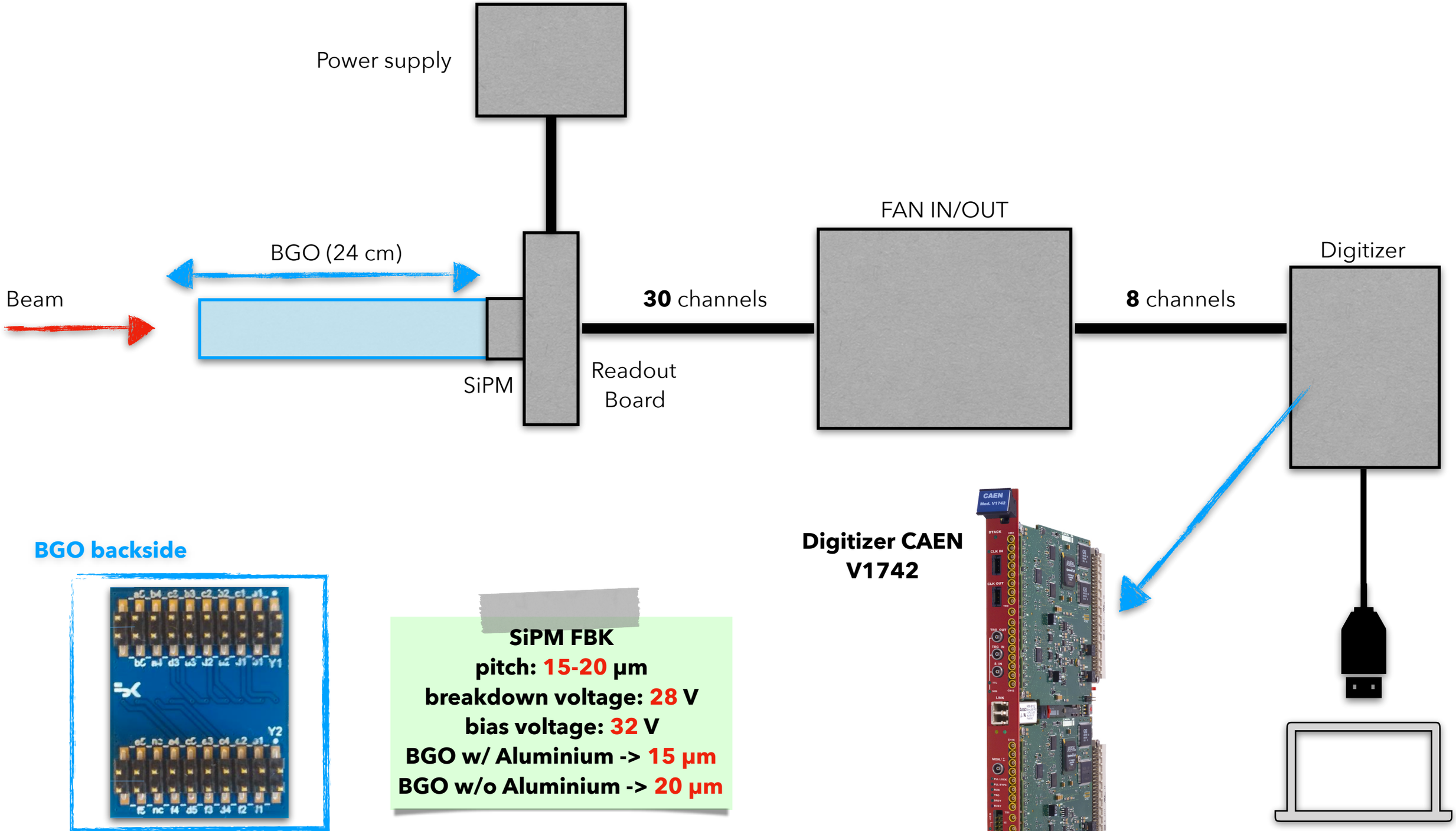






30 *μm pitch*

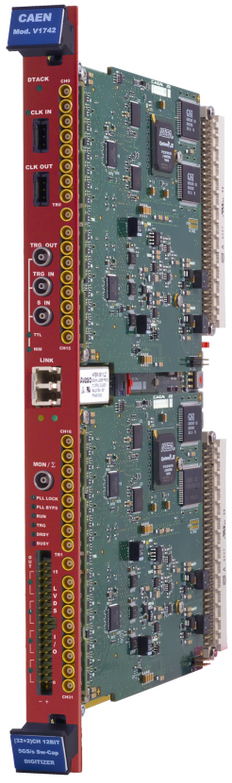
Experimental Setup



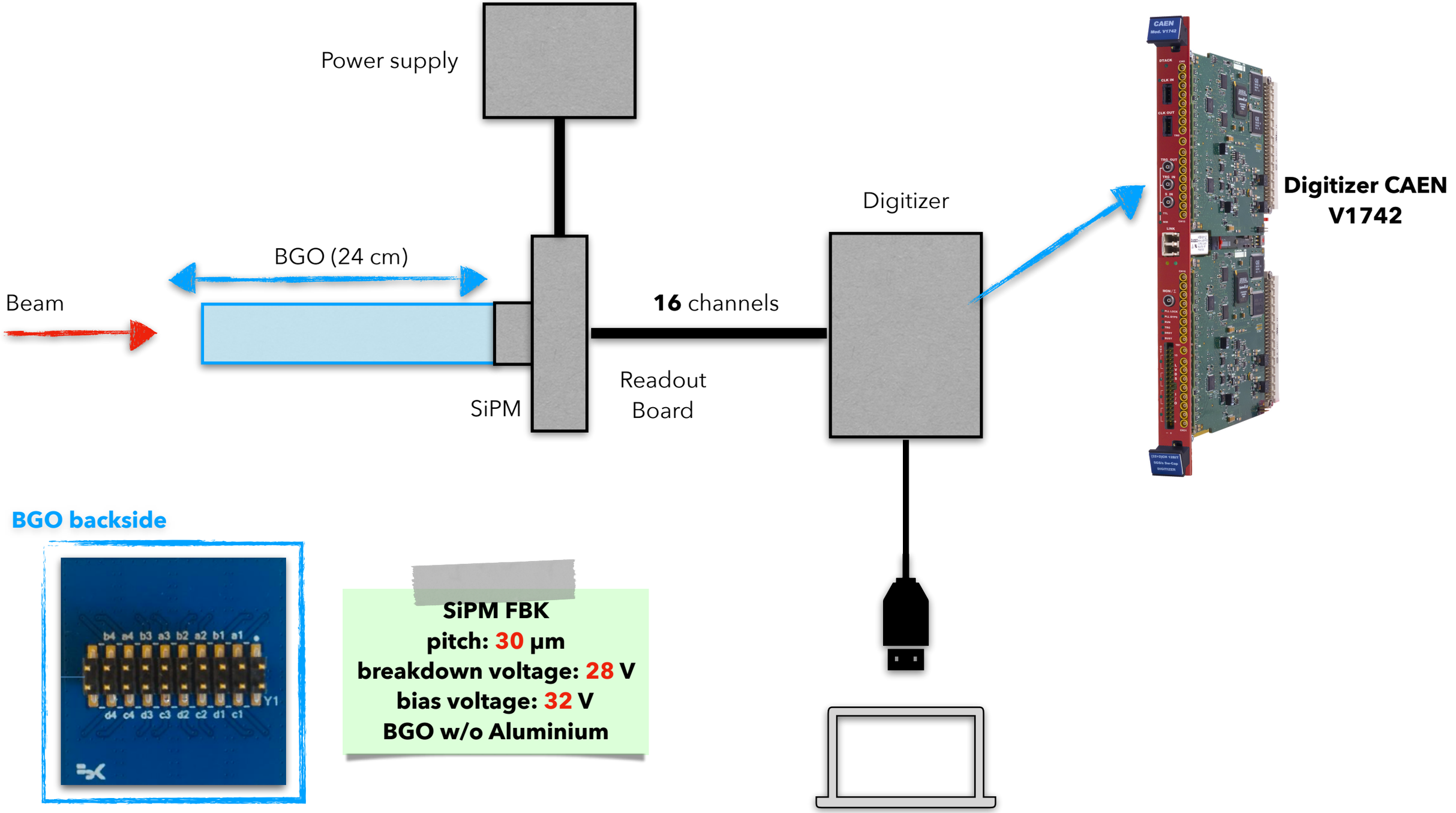
BGO backside

SiPM FBK
pitch: 15-20 μm
breakdown voltage: 28 V
bias voltage: 32 V
BGO w/ Aluminium -> 15 μm
BGO w/o Aluminium -> 20 μm

Digitizer CAEN V1742



Experimental Setup

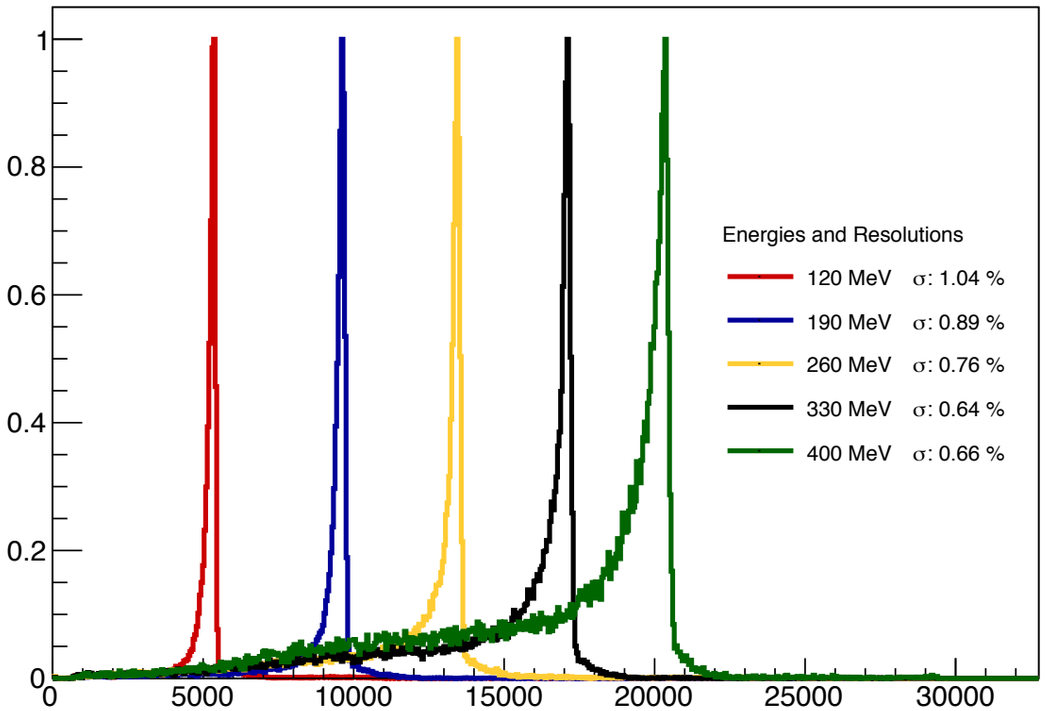


BGO backside

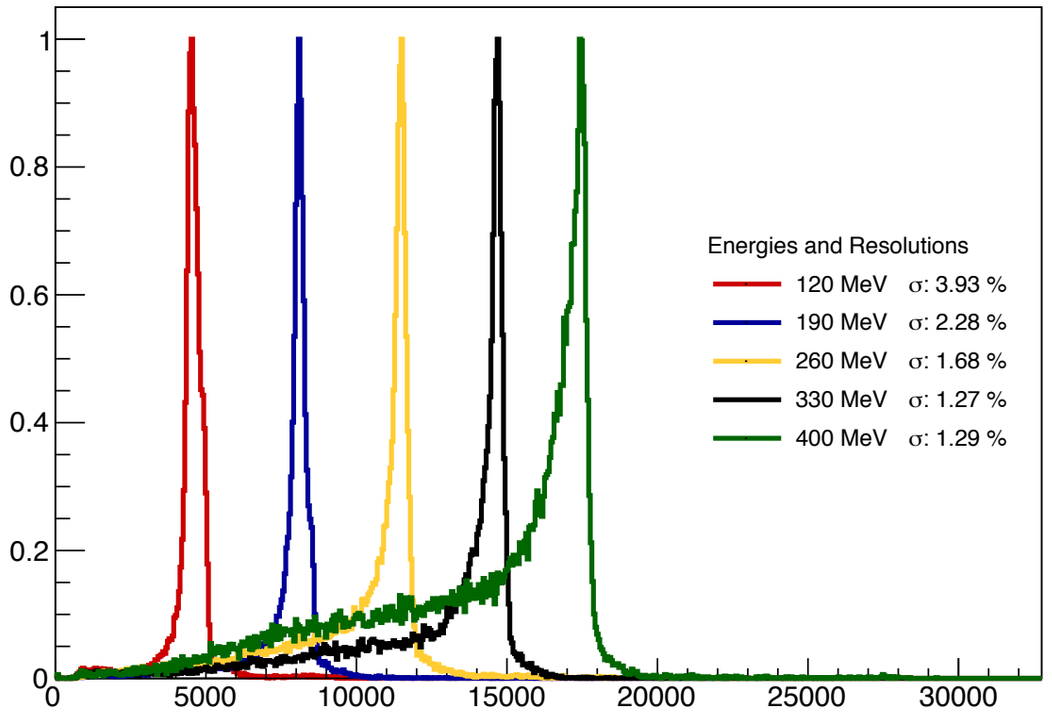
SiPM FBK
pitch: 30 µm
breakdown voltage: 28 V
bias voltage: 32 V
BGO w/o Aluminium

Amplitude Analysis - Carbon

Amplitude distributions of 15mu Tile **+Al**

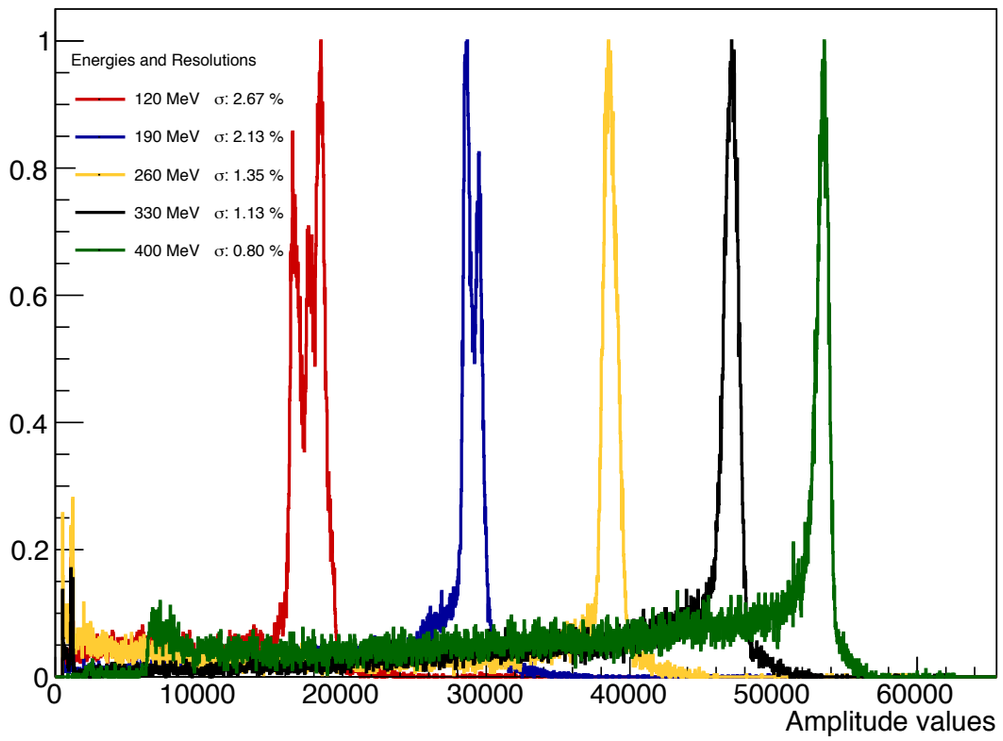


Amplitude distributions of 20mu Tile



The distributions are normalised to the maximum peak height

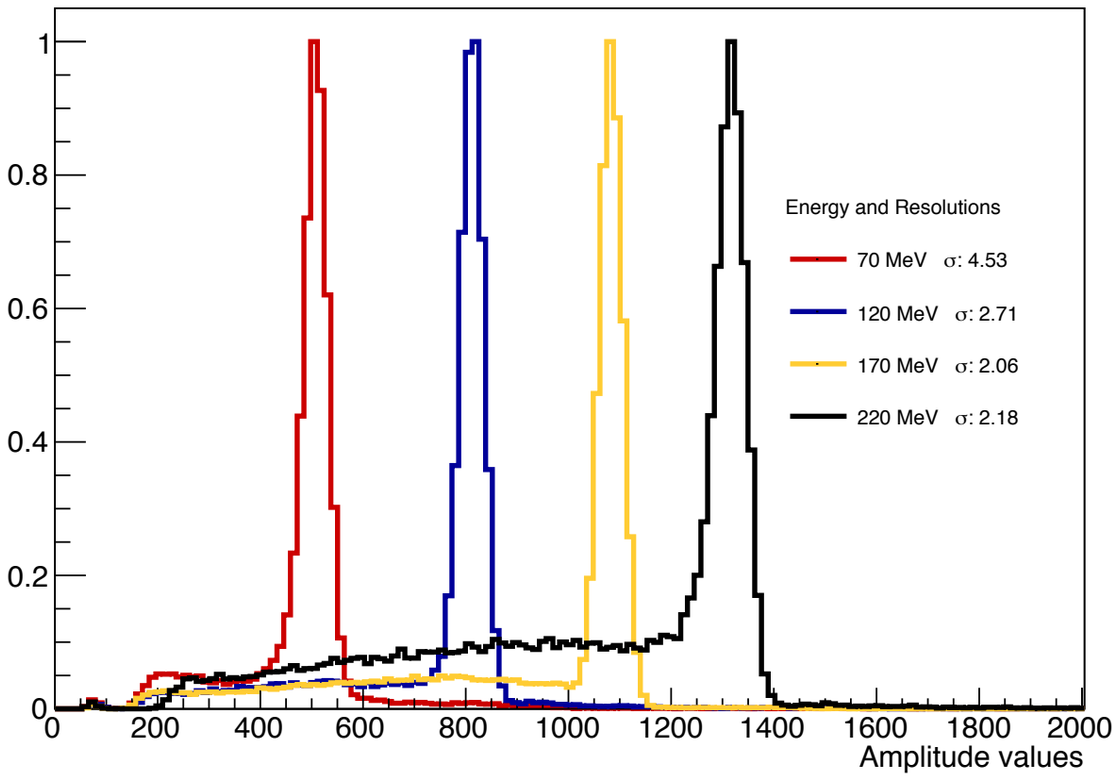
Amplitude distributions of 30mu Tile



A crystalball function was used for the fits.

Amplitude Analysis - Proton

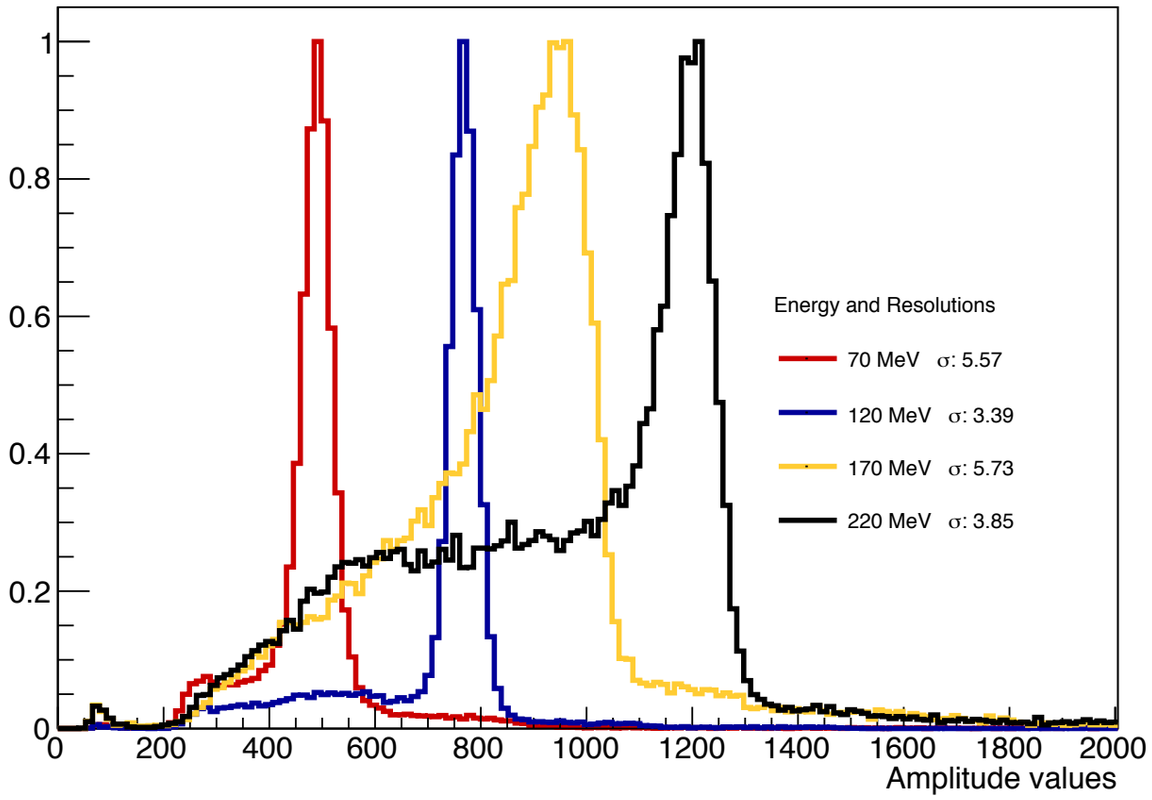
Amplitude distributions of 15mu Tile



The distributions are normalised to the maximum peak height

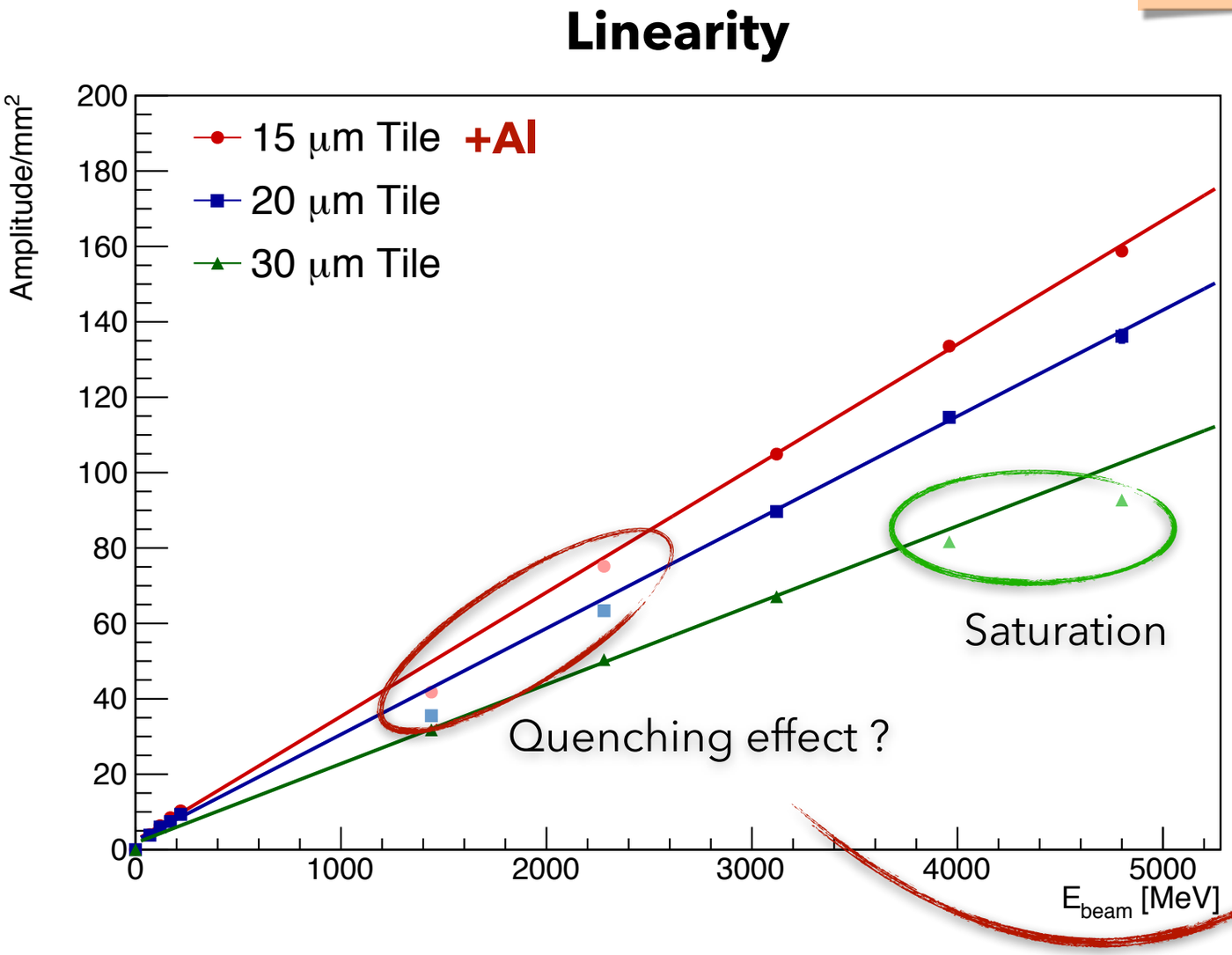
The sum of a polynomial 3rd degree and a gaussian function was used for the fits.

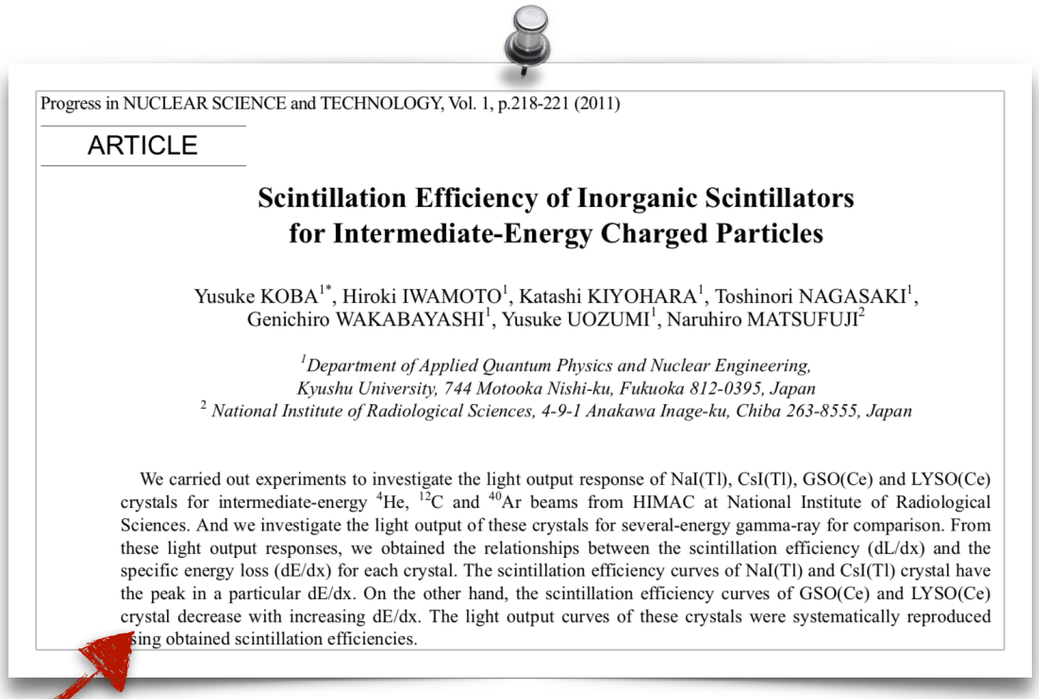
Amplitude distributions of 20mu Tile



Amplitude Analysis - Linearity

The points are normalised to the Tile size





Progress in NUCLEAR SCIENCE and TECHNOLOGY, Vol. 1, p.218-221 (2011)

ARTICLE

Scintillation Efficiency of Inorganic Scintillators for Intermediate-Energy Charged Particles

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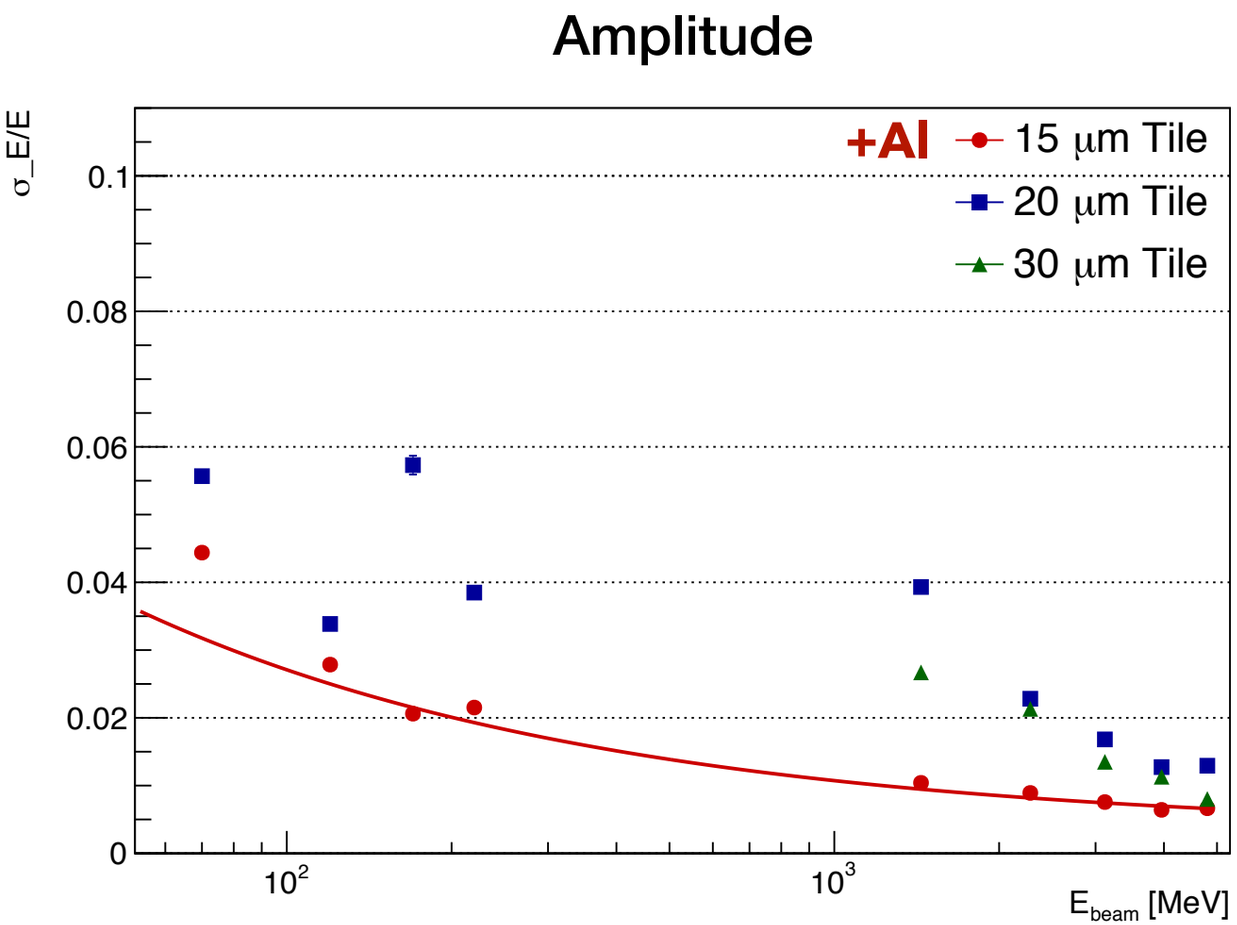
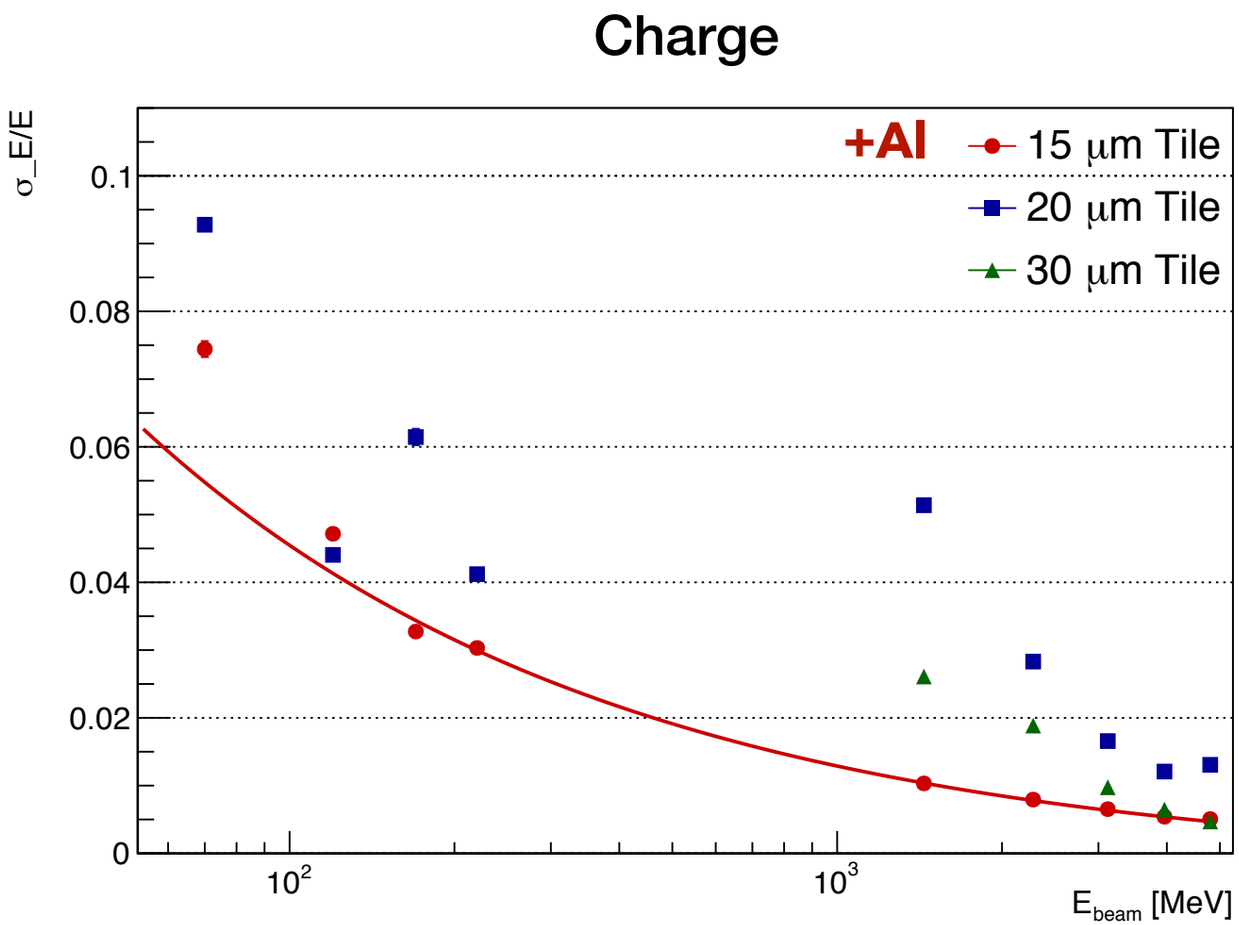
[1]*Department of Applied Quantum Physics and Nuclear Engineering, Kyushu University, 744 Motooka Nishi-ku, Fukuoka 812-0395, Japan*
[2] *National Institute of Radiological Sciences, 4-9-1 Anakawa Inage-ku, Chiba 263-8555, Japan*

We carried out experiments to investigate the light output response of NaI(Tl), CsI(Tl), GSO(Ce) and LYSO(Ce) crystals for intermediate-energy ^{4}He, ^{12}C and ^{40}Ar beams from HIMAC at National Institute of Radiological Sciences. And we investigate the light output of these crystals for several-energy gamma-ray for comparison. From these light output responses, we obtained the relationships between the scintillation efficiency (dL/dx) and the specific energy loss (dE/dx) for each crystal. The scintillation efficiency curves of NaI(Tl) and CsI(Tl) crystal have the peak in a particular dE/dx. On the other hand, the scintillation efficiency curves of GSO(Ce) and LYSO(Ce) crystal decrease with increasing dE/dx. The light output curves of these crystals were systematically reproduced using obtained scintillation efficiencies.

The lighter painted points are excluded from the linear fits

Amplitude & Charge Resolution





$$\sigma/E = a + b/\sqrt{(E)}$$

Conclusions & Next Steps

Conclusions

- The energy resolution is less than 1% for carbon and less than 3% for proton, except for 70 MeV
- Aluminium reflecting layer improves significantly the energy resolution (by factor 2)
- Better energy resolution was achieved with the pulse amplitude compared to charge
- Linear trends for all Tiles were found, except for a saturation effect for the two highest energies of Carbon (330-400 MeV/u) on the 30mu Tile.
- Quenching effect on carbon to be investigated

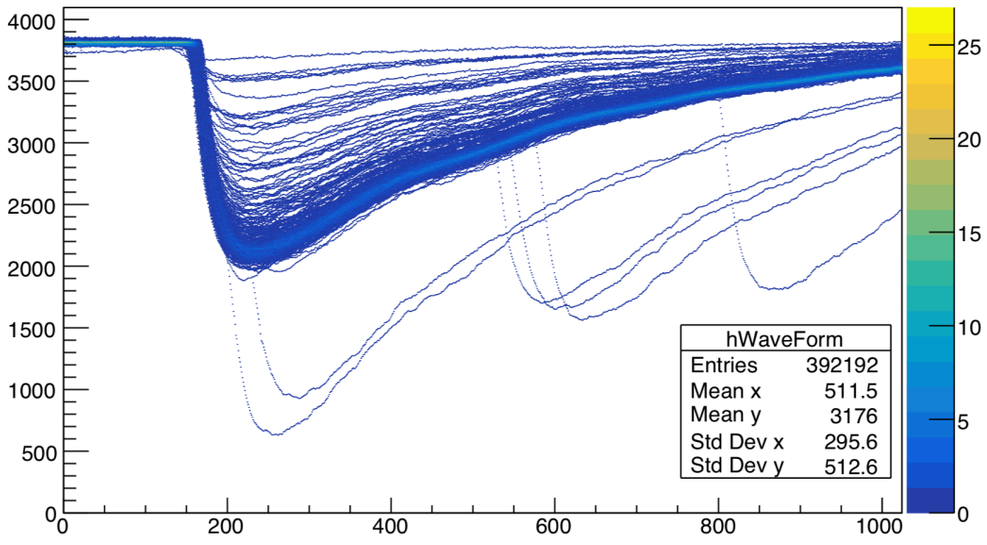
Next Steps

- Repeat the measurements on 15-20mu Tile with two BGO crystals painted with reflecting surfaces
- Design the readout board

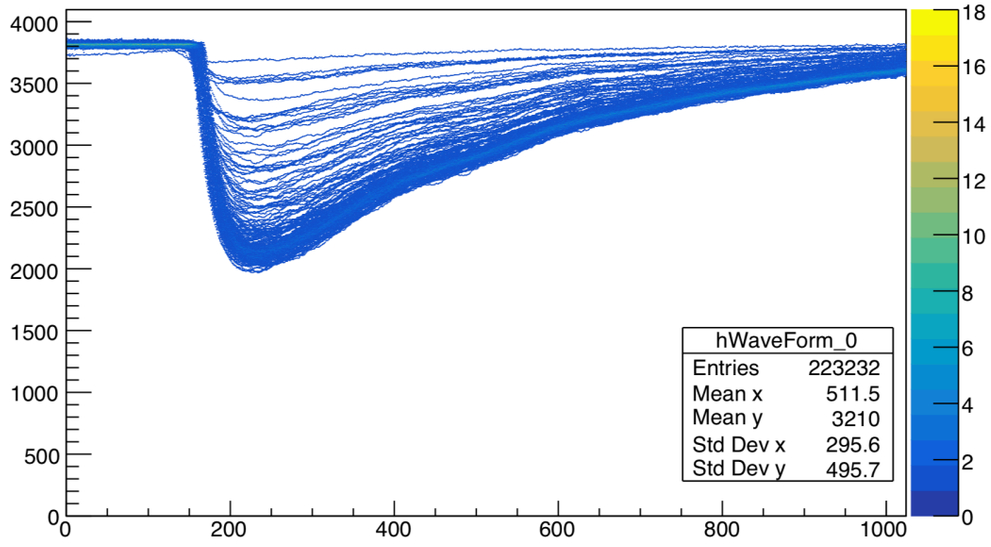
Backup Slides

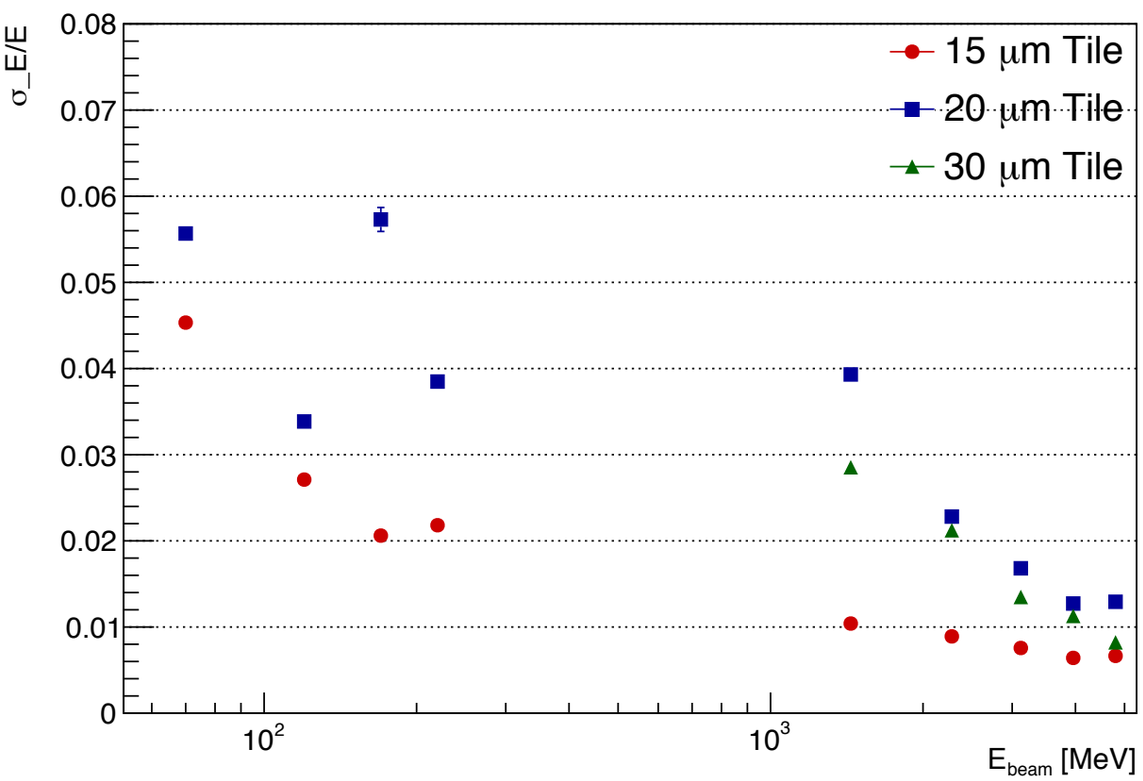
Amplitude Analysis - Excluding pile up events

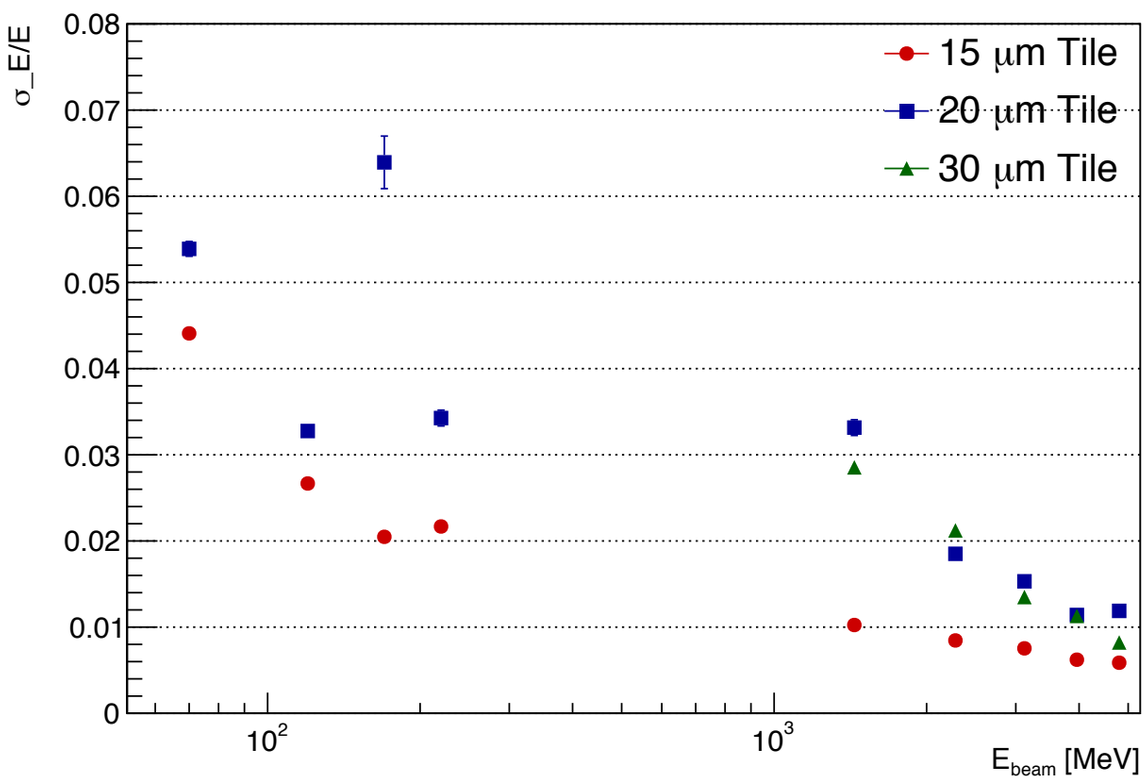
190 MeV/A on 15 mu Tile



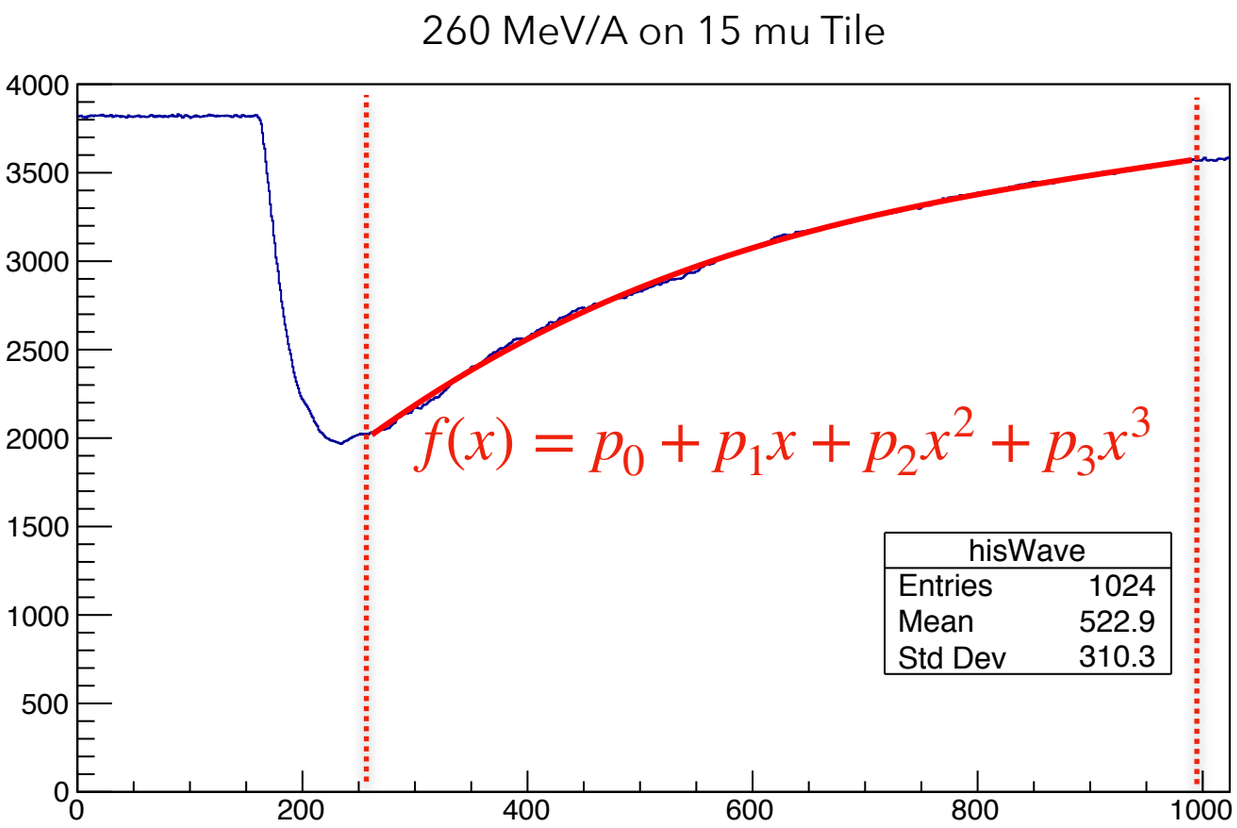
190 MeV/A on 15 mu Tile

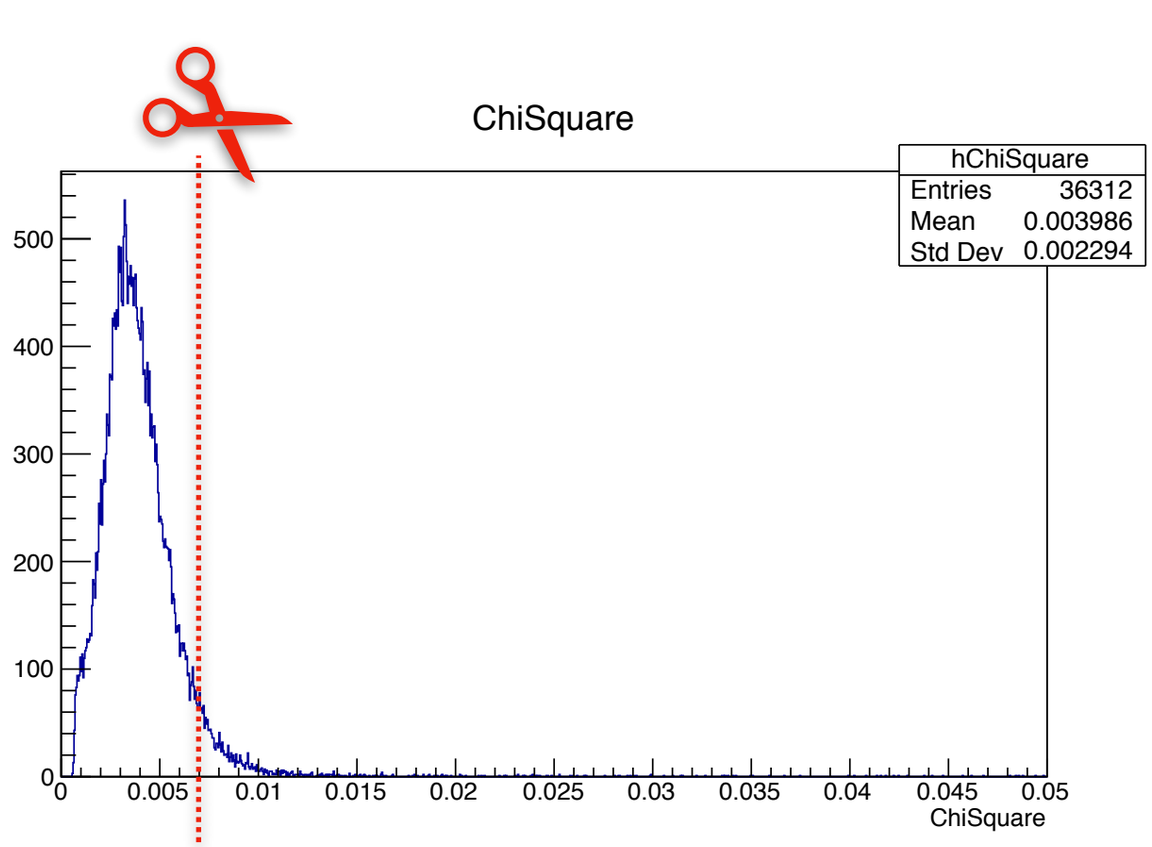




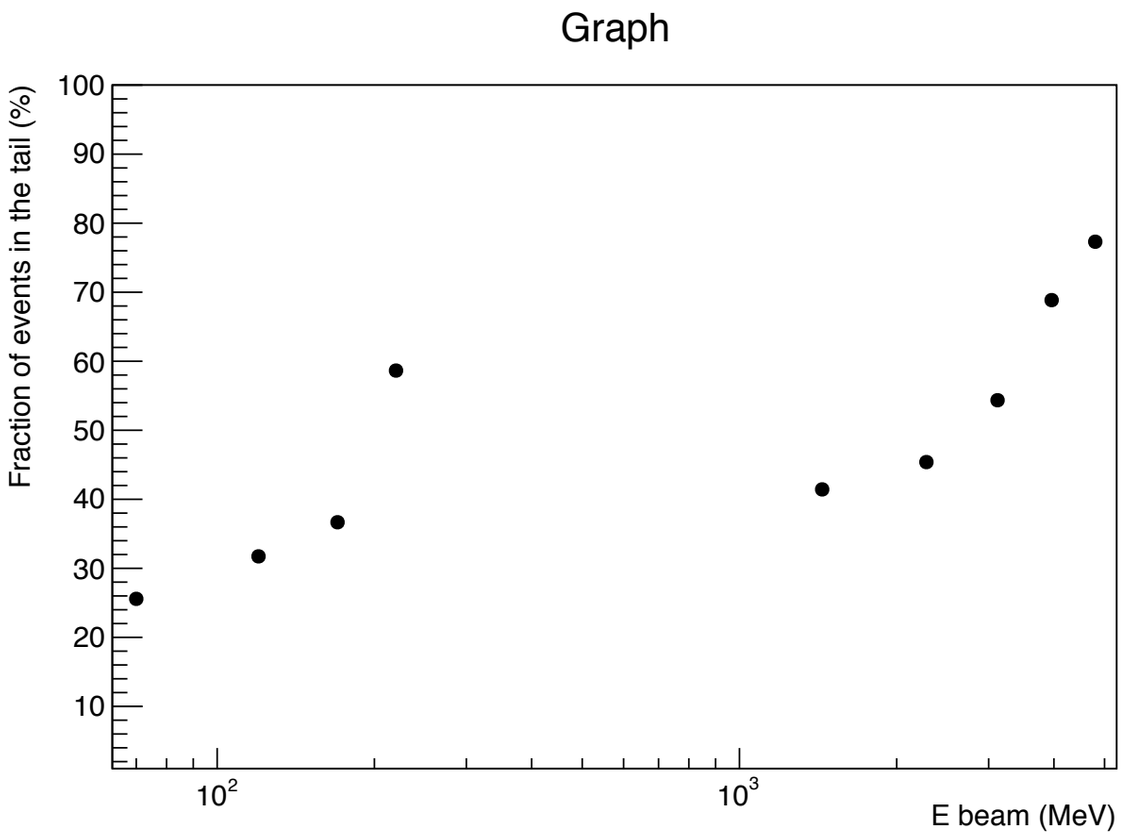


Amplitude Analysis - Excluding pile up events

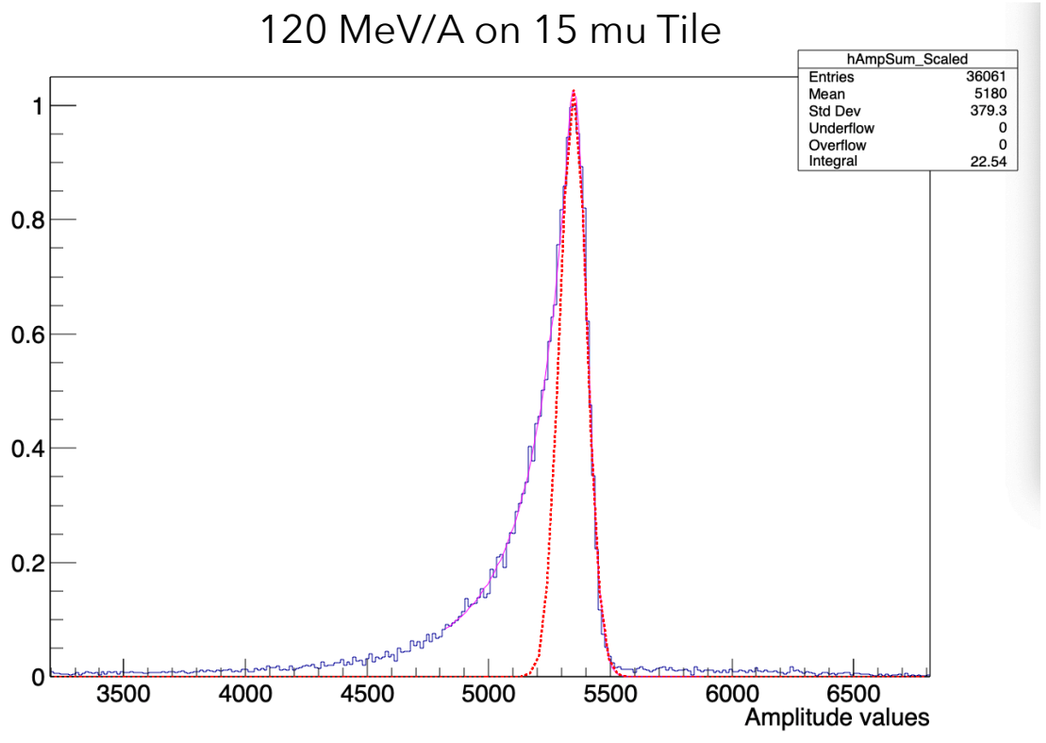




Amplitude Analysis - Fraction of events in the tail

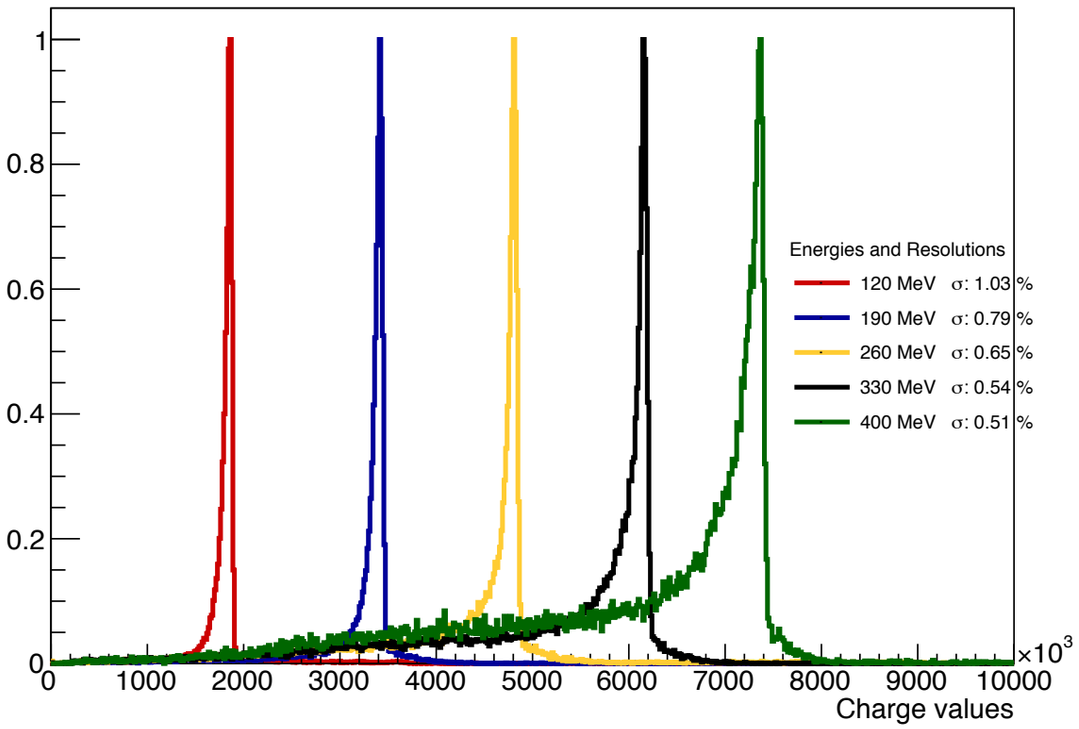


15 mu Tile

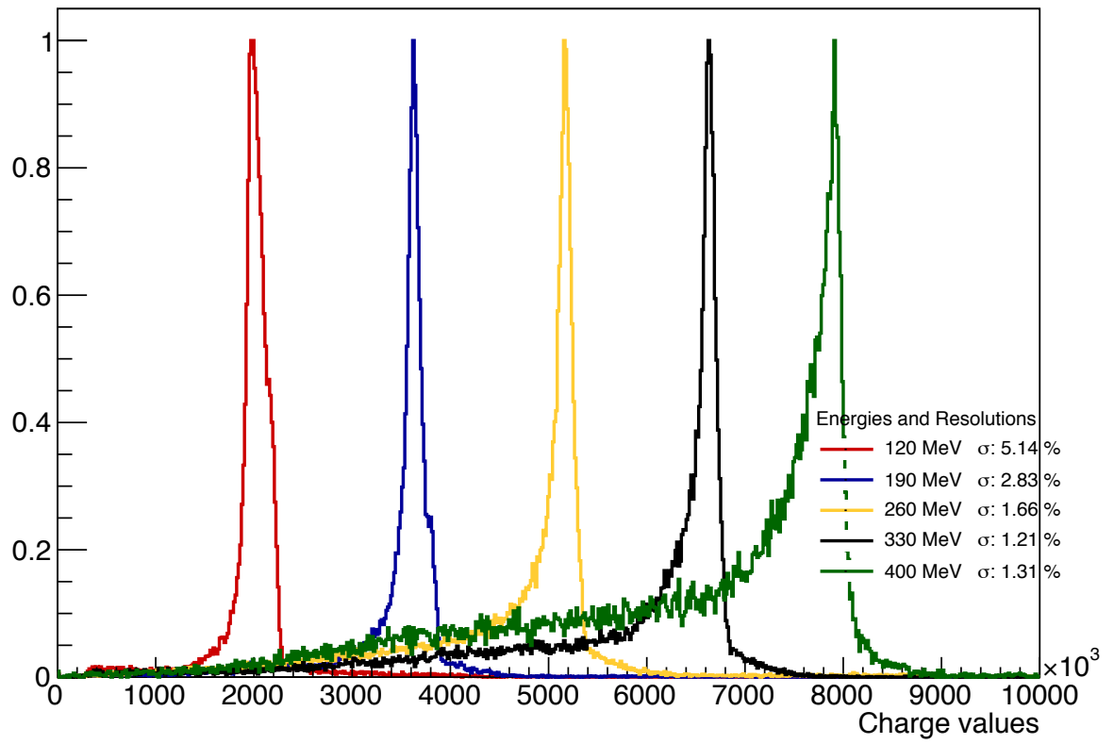


Charge Analysis - Carbon

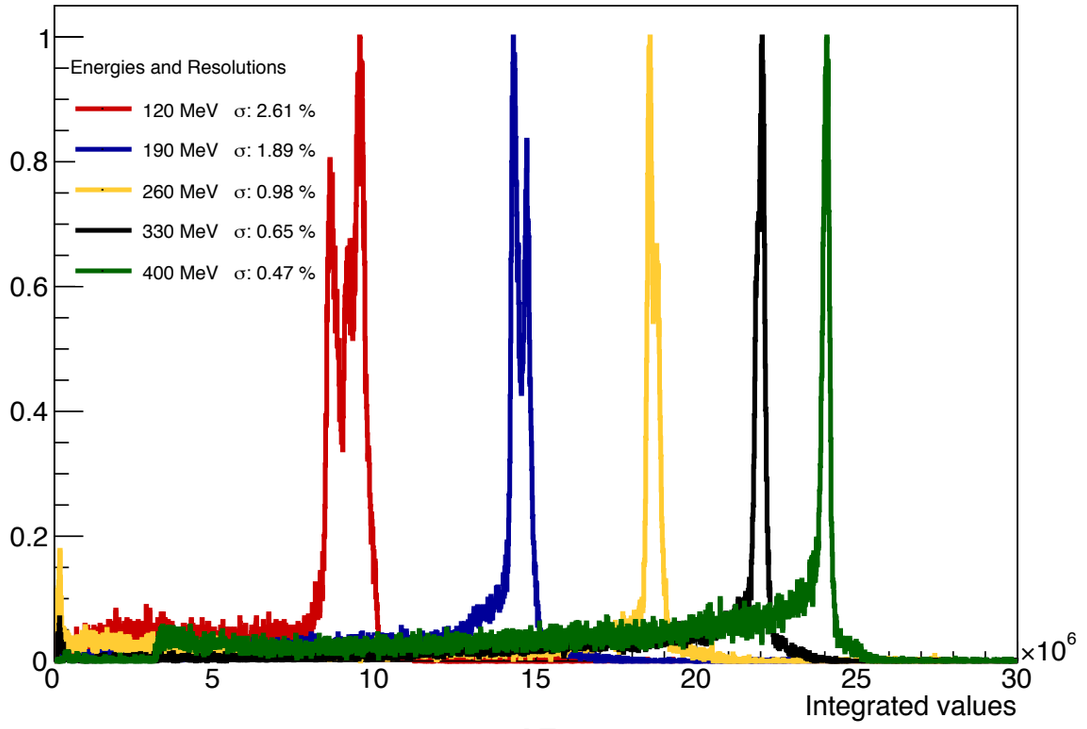
Charge distributions of 15mu Tile



Charge distributions of 20mu Tile

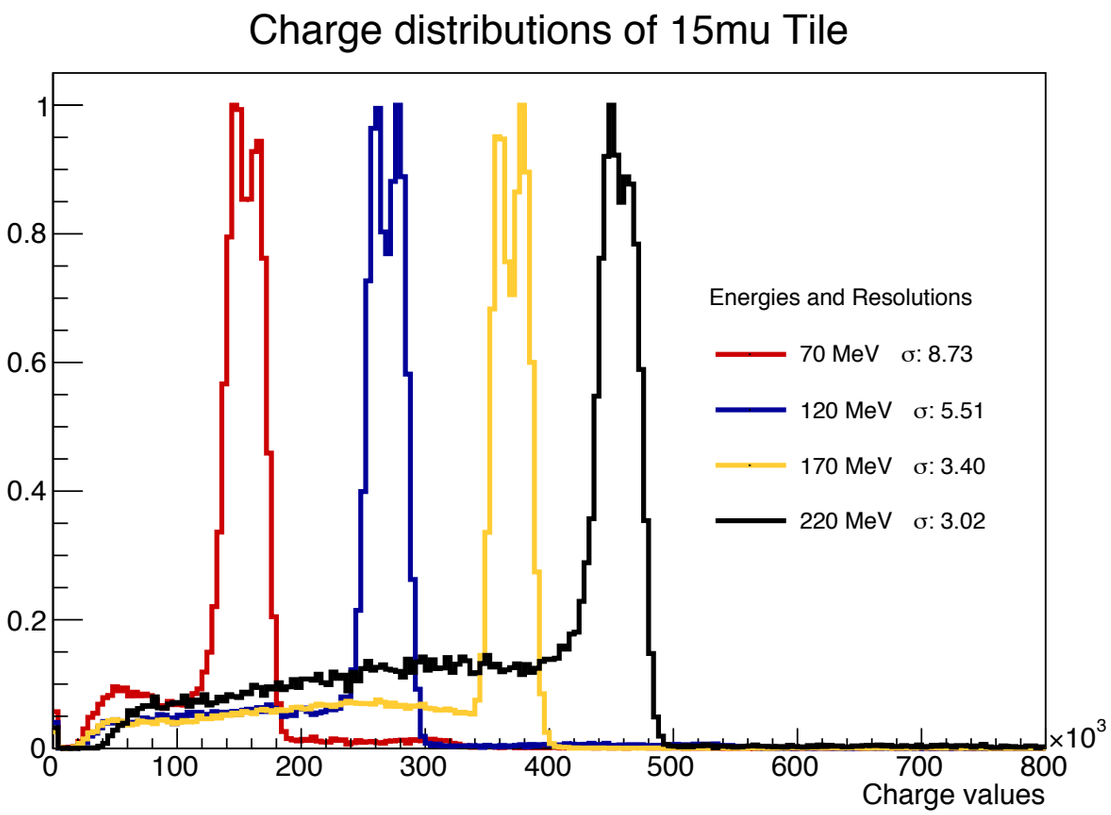


Charge distributions of 30mu Tile



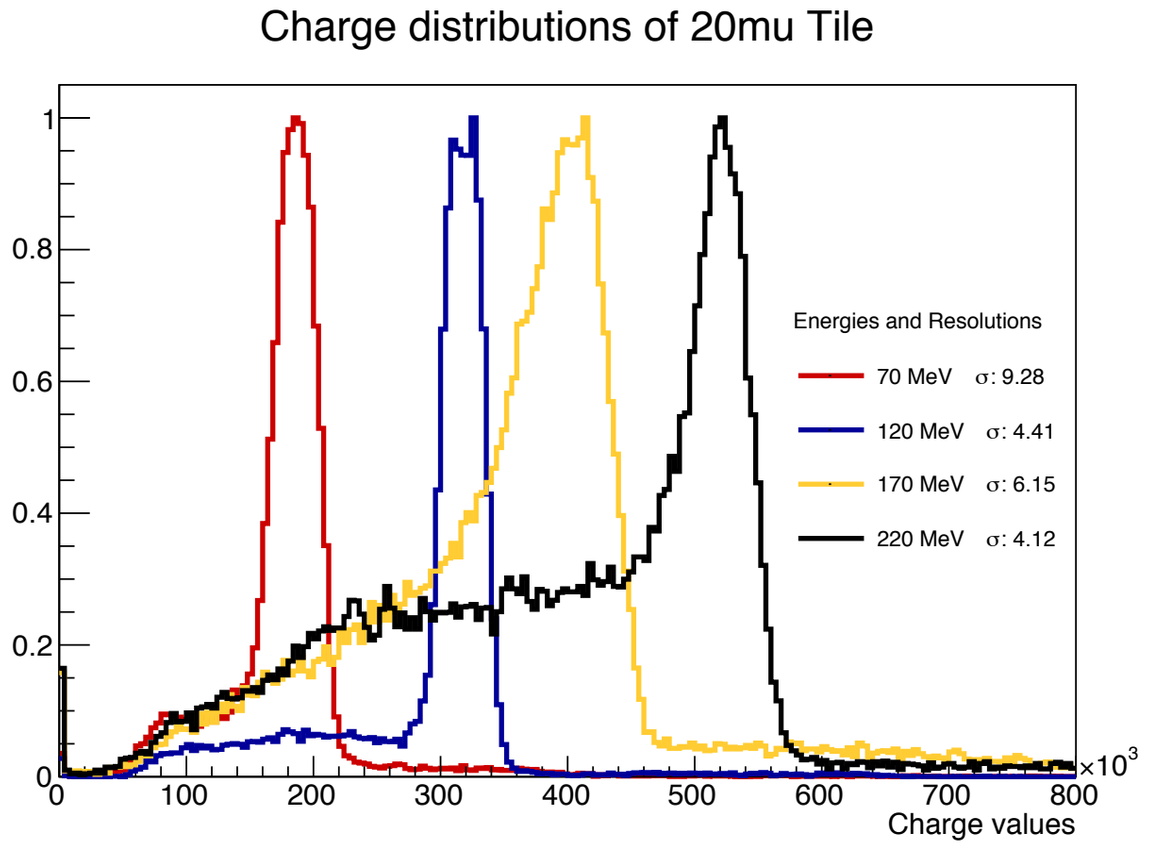
Lorenzo Scavarda

Charge Analysis - Proton



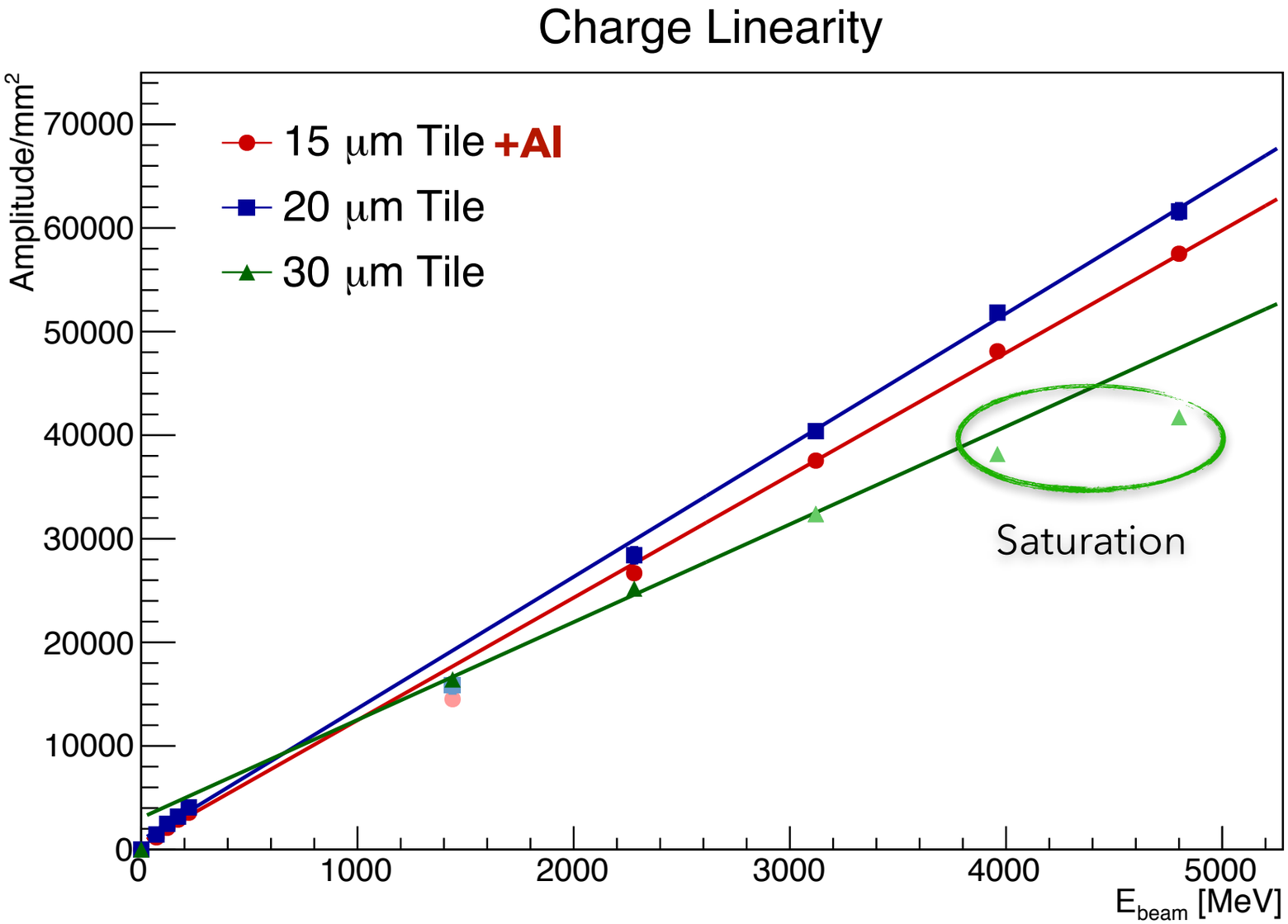
The distributions are normalised to the maximum peak height

The sum of a polynomial 3rd degree and a gaussian function was used for the fits.



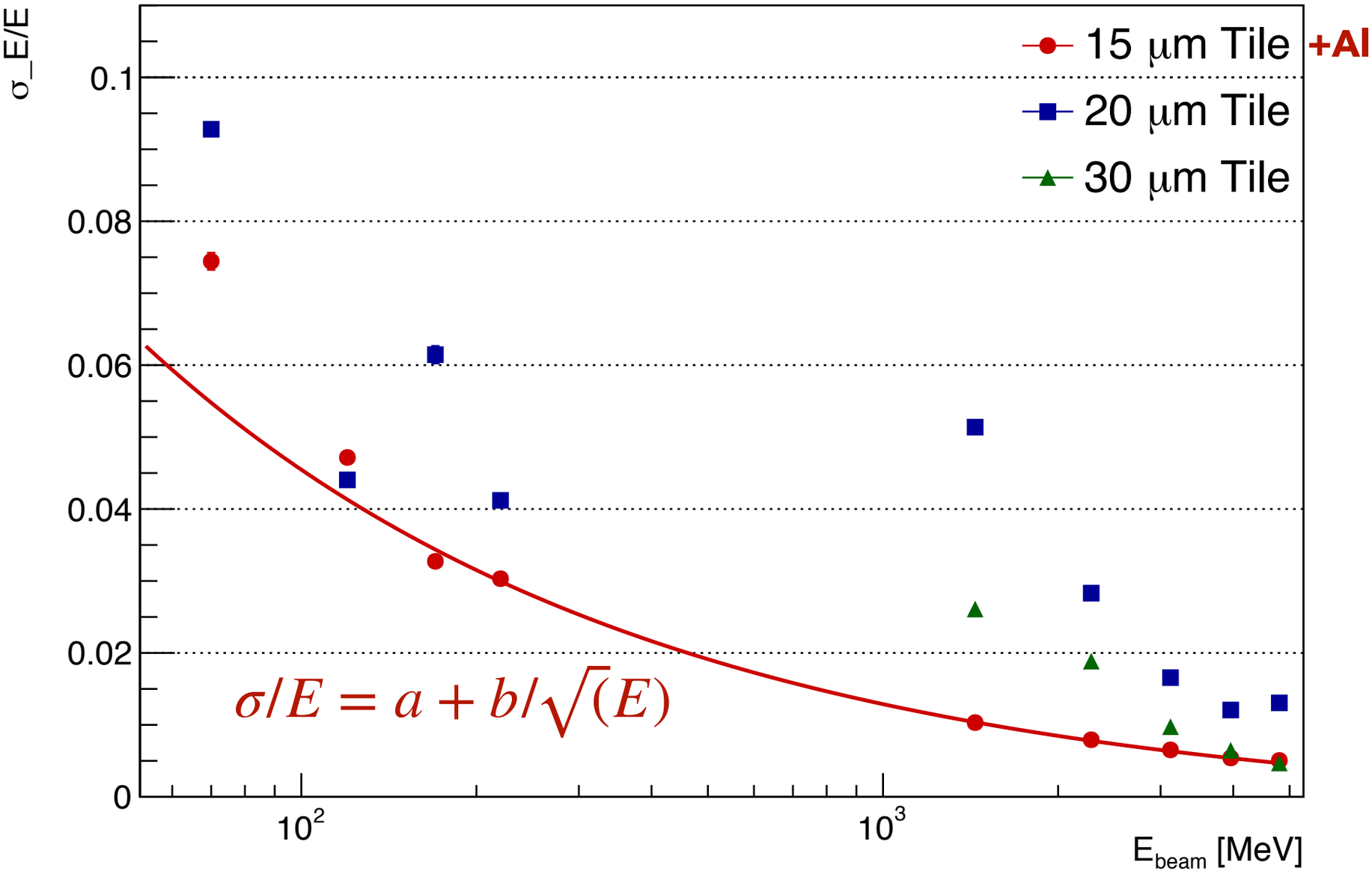
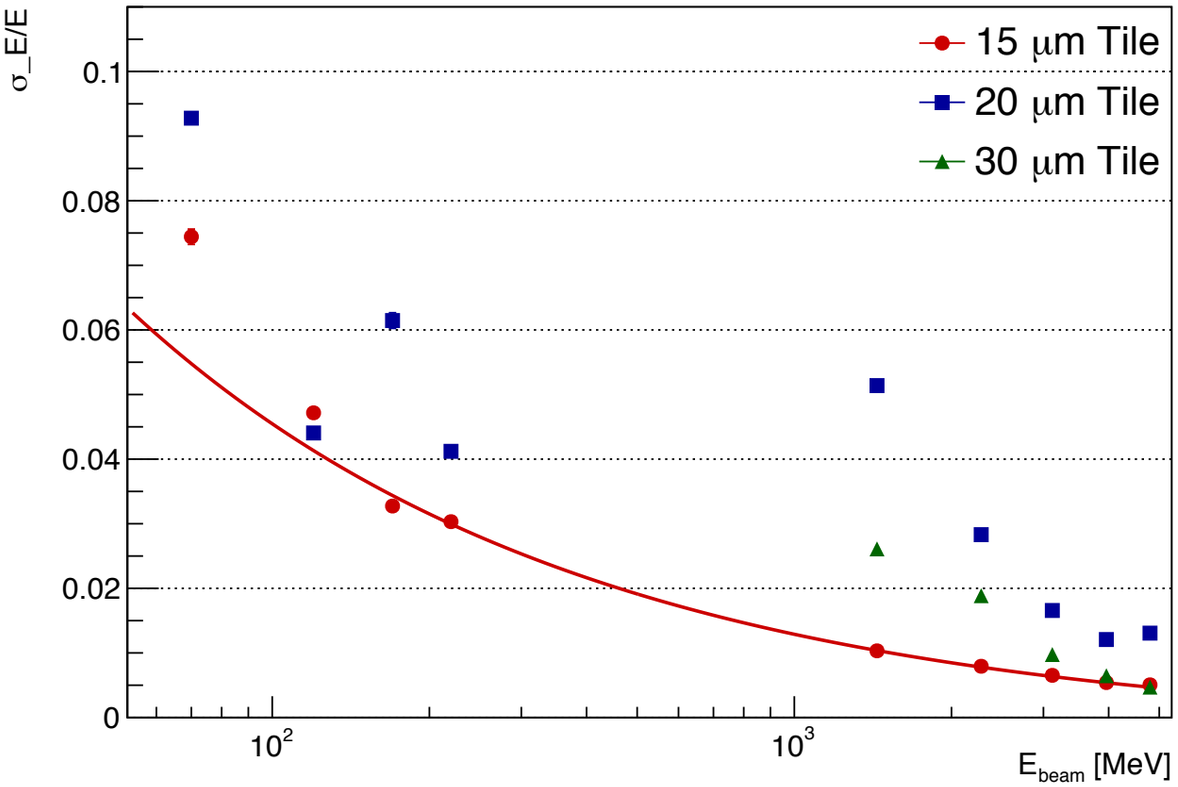
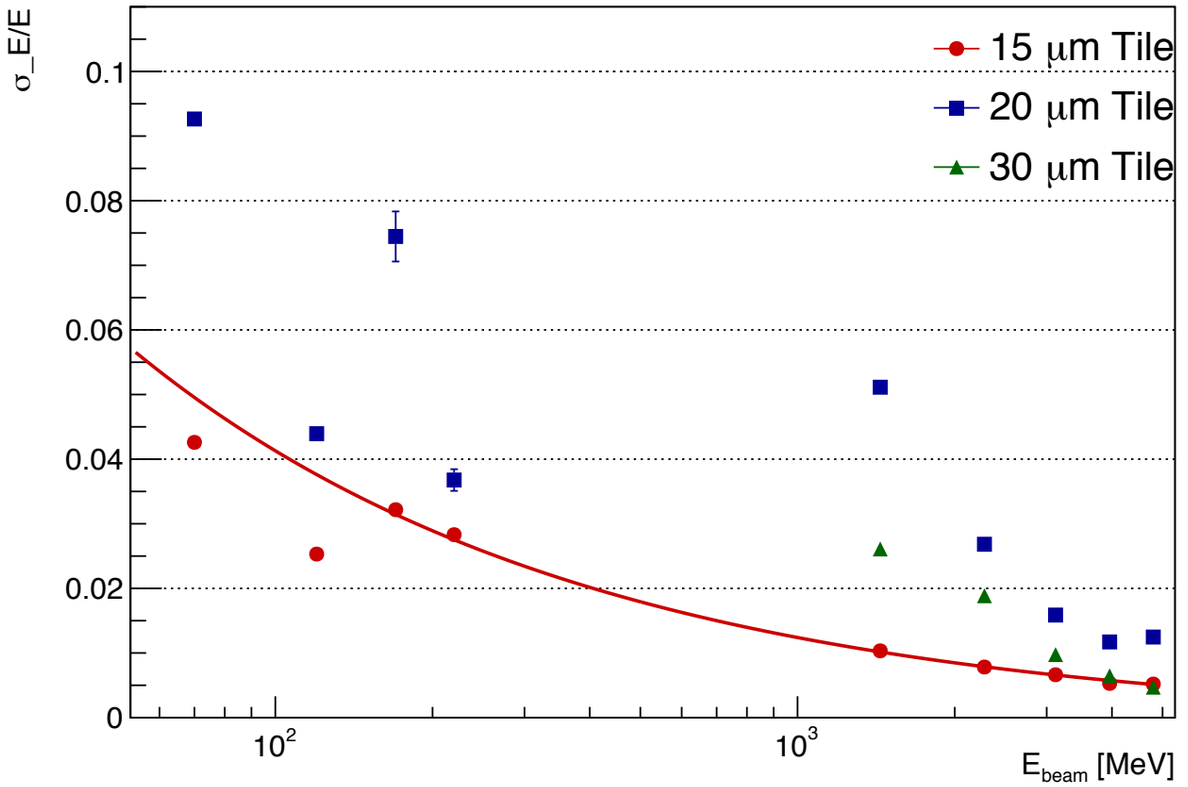
Charge Analysis - Linearity

The points are normalised to the Tile size



The lighter painted points are excluded from the linear fits

Charge Analysis - Resolution



Charge Analysis - Excluding pile up events