

05.12.2019, Rome



Data analysis of the CNAO test beam on the first calorimeter module

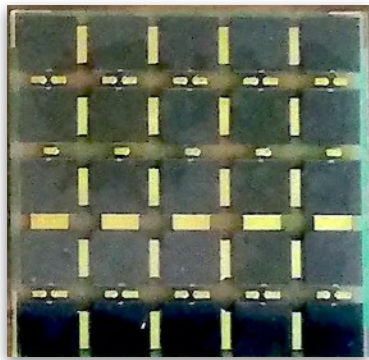
VII Collaboration Meeting

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Lopez Torres, M. Mignone, M. Pullia, L.
Ramello, L. Scavarda

Test Beam Setup & Overview



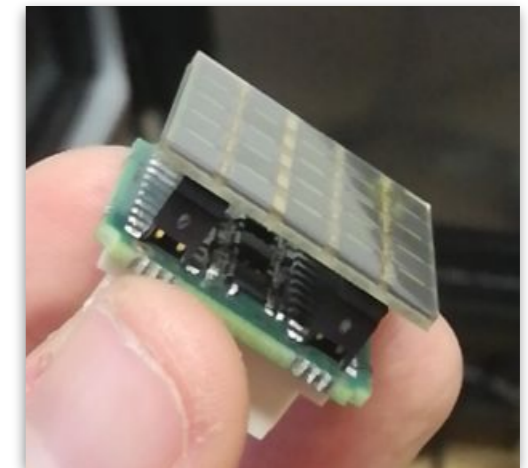
25 SiPM arrays
4x4mm² (15 μm)



- 1 Module
- 9 Crystals
- 3 wrappings:
 - 4 Tyvek
 - 3 Mylar
 - 2 WhitePainting



ReadOut Board



V1740



V1742



- First night:
 - Energy scan in cry 2,4,5,6,8. Angle between module and beam: 0°
 - Energy scan with module rotated by 30°
- Second night:
 - Energy scan with module rotated by 45°
 - Energy scan with module rotated by 15°
 - Energy scan with module rotated by 15° + digitizer V1742
 - Energy scan on single crystal (WhiteP, Tyvek, Mylar) + digitiser 1742

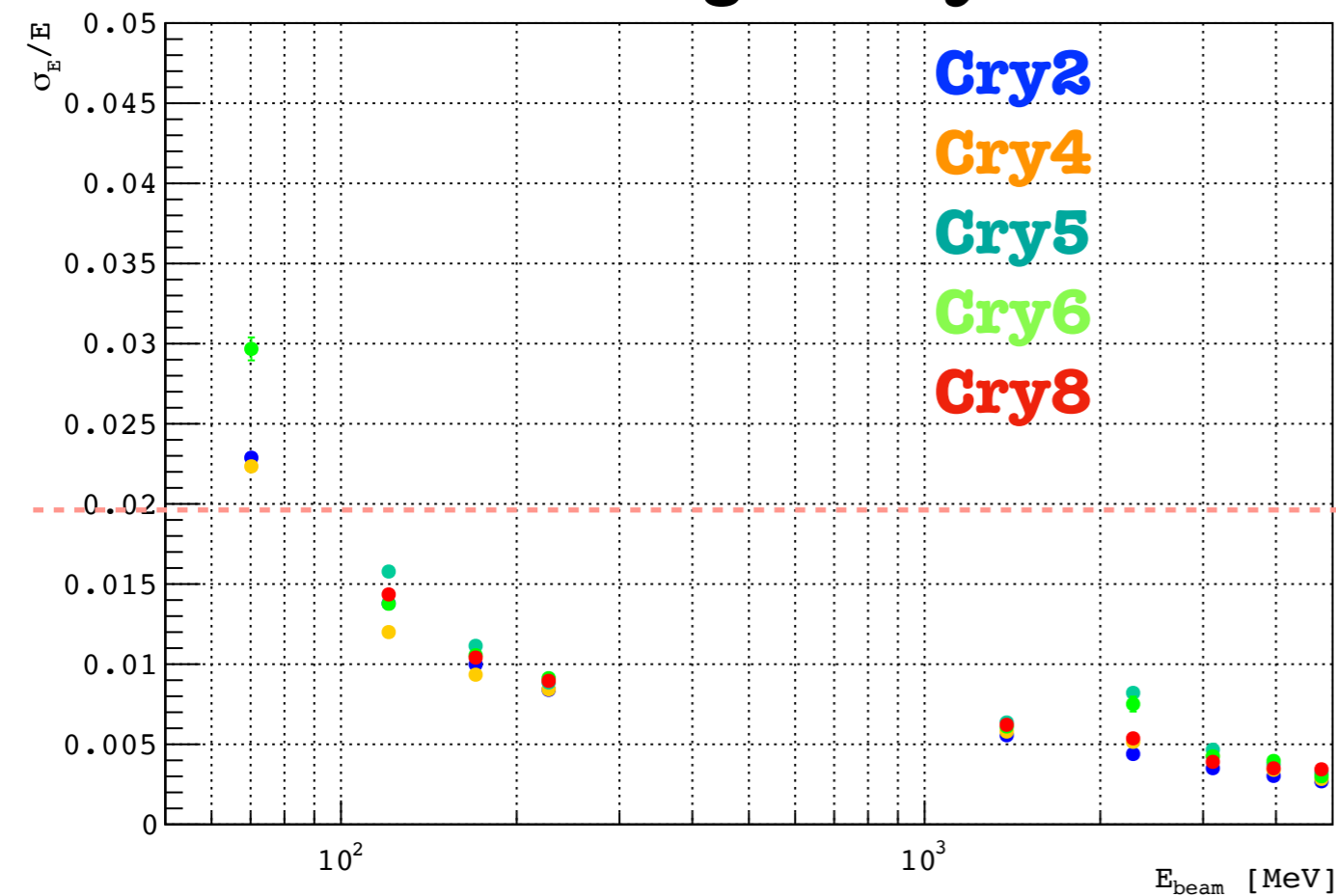
for pulse shape analysis

Energy Resolution

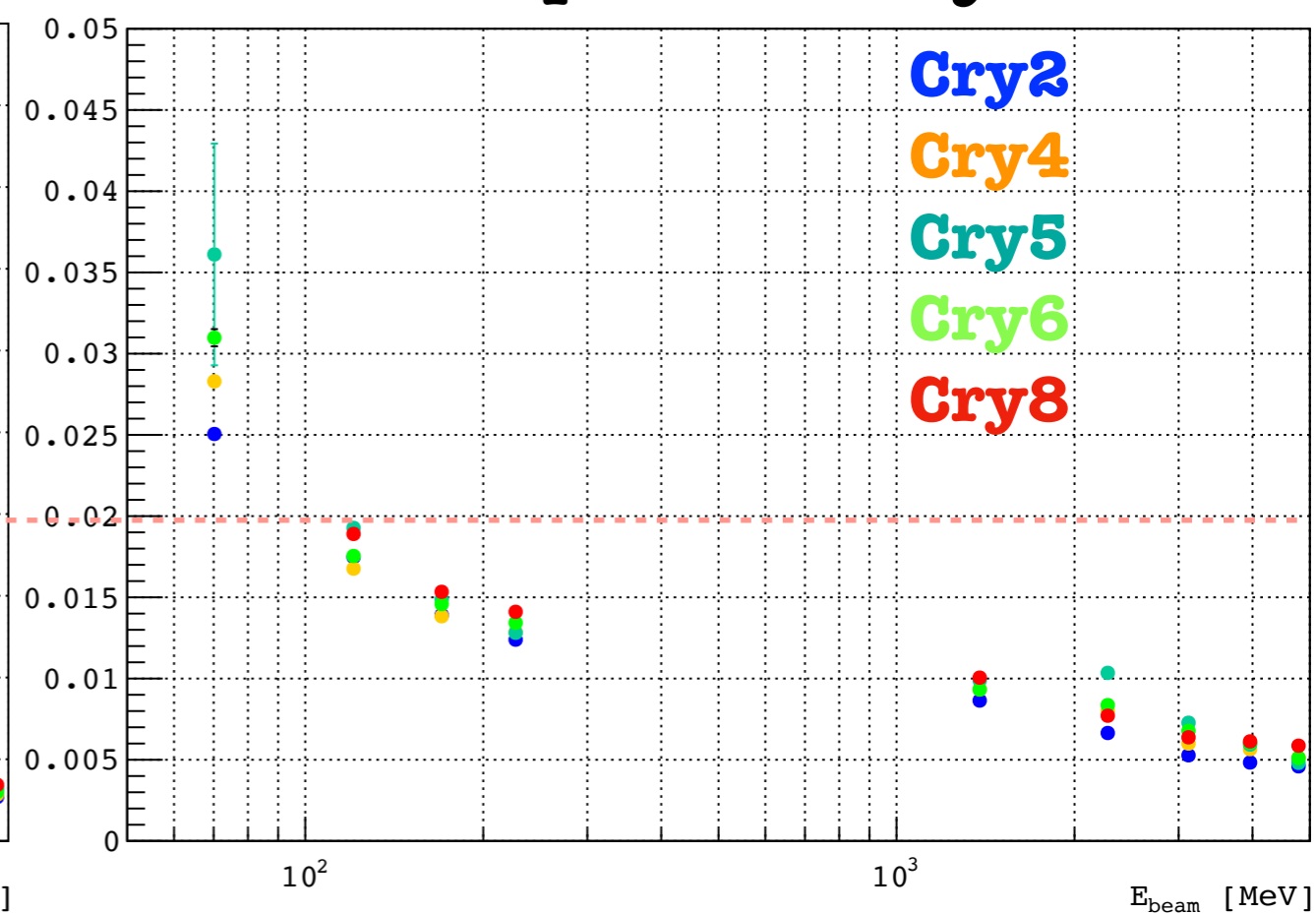


First night

Charge Analysis



Amplitude Analysis

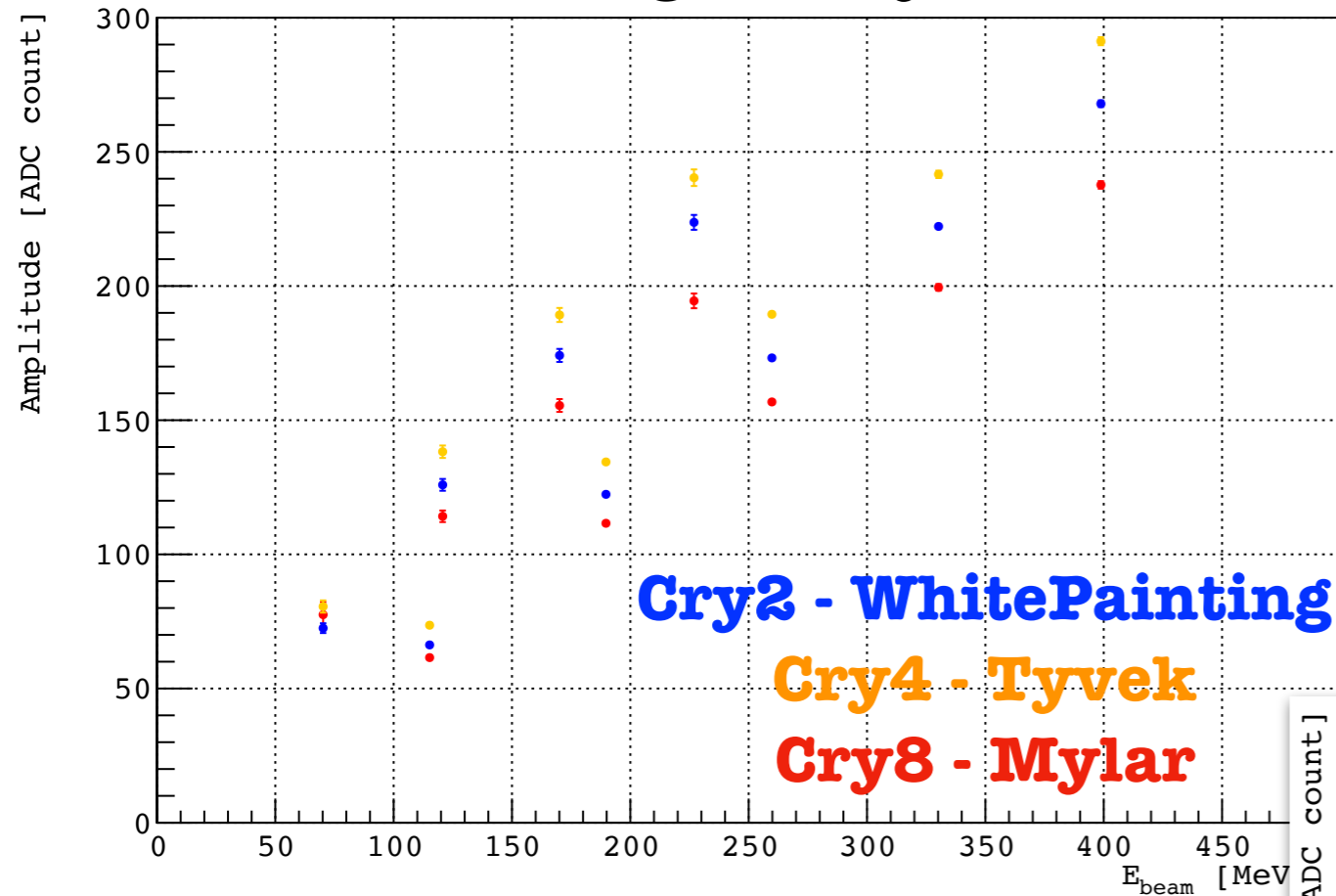


- Energy resolution below 2% for all crystals both for carbon and proton
- Too much pileup with 70 MeV proton (in particular with cry 5-6-8), untrusted points

Linearity for different wrappings

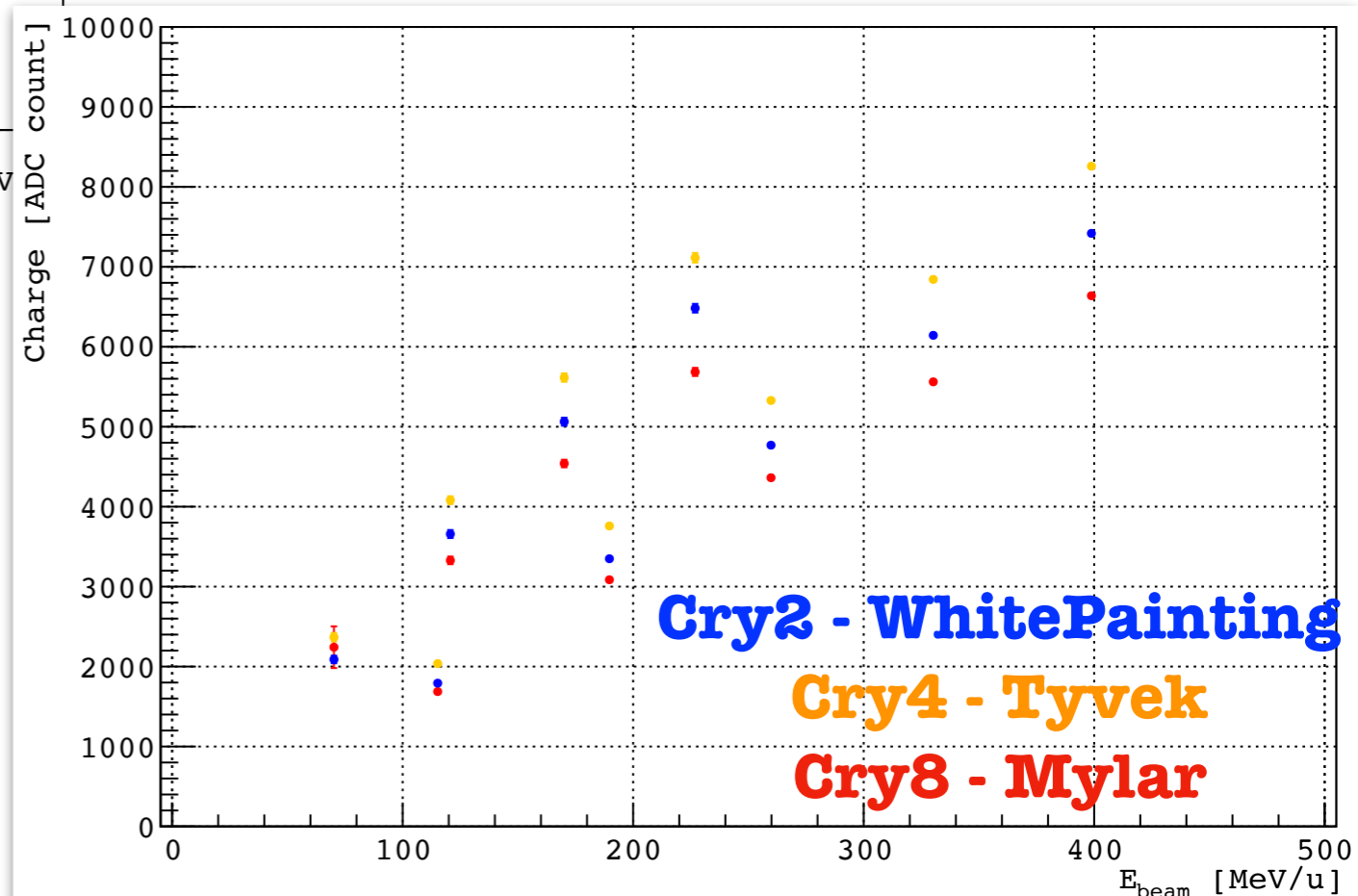


Charge Analysis

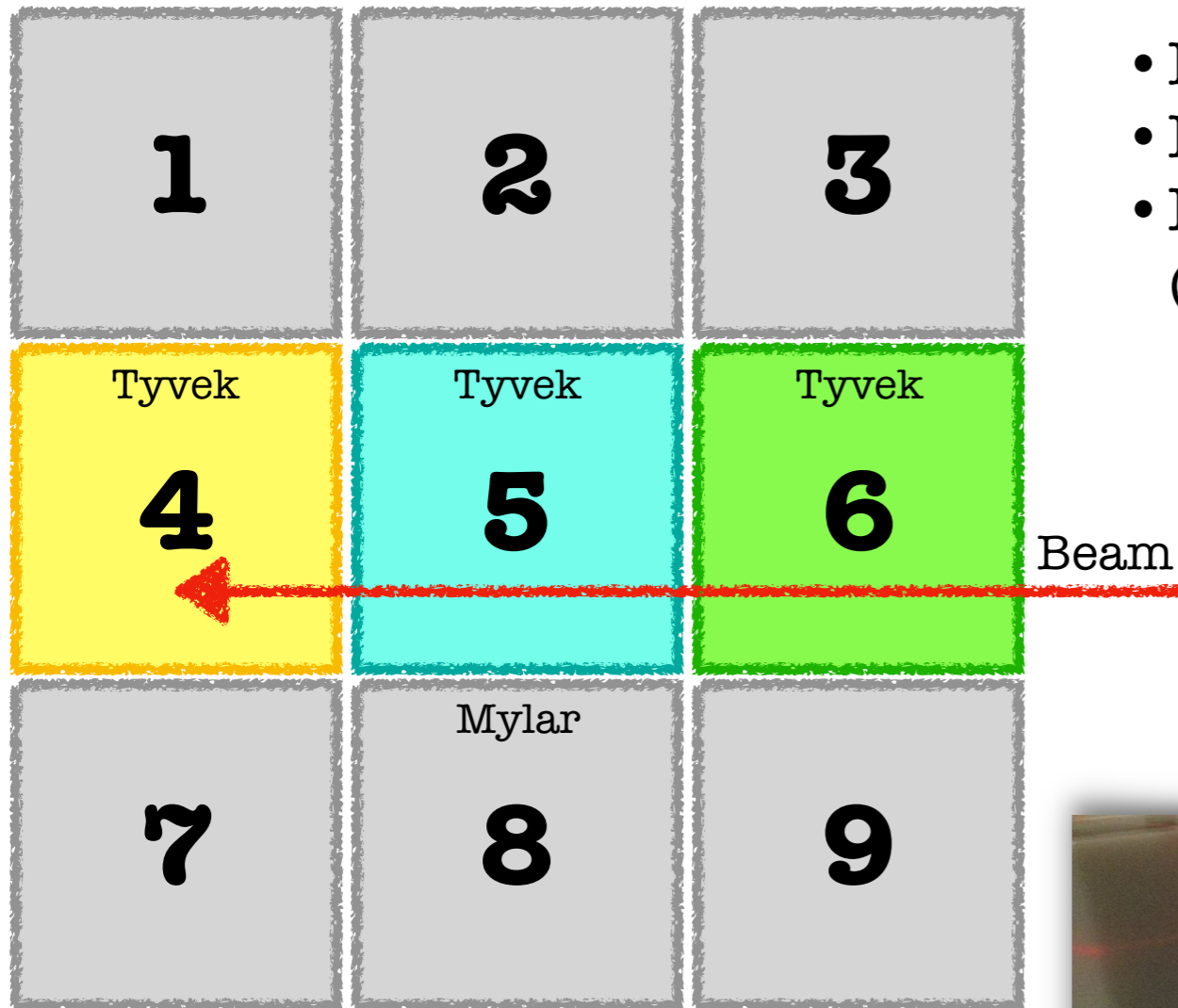


- Tyvek reflects more light with respect to mylar and white painting
- Confirmed results obtained in October

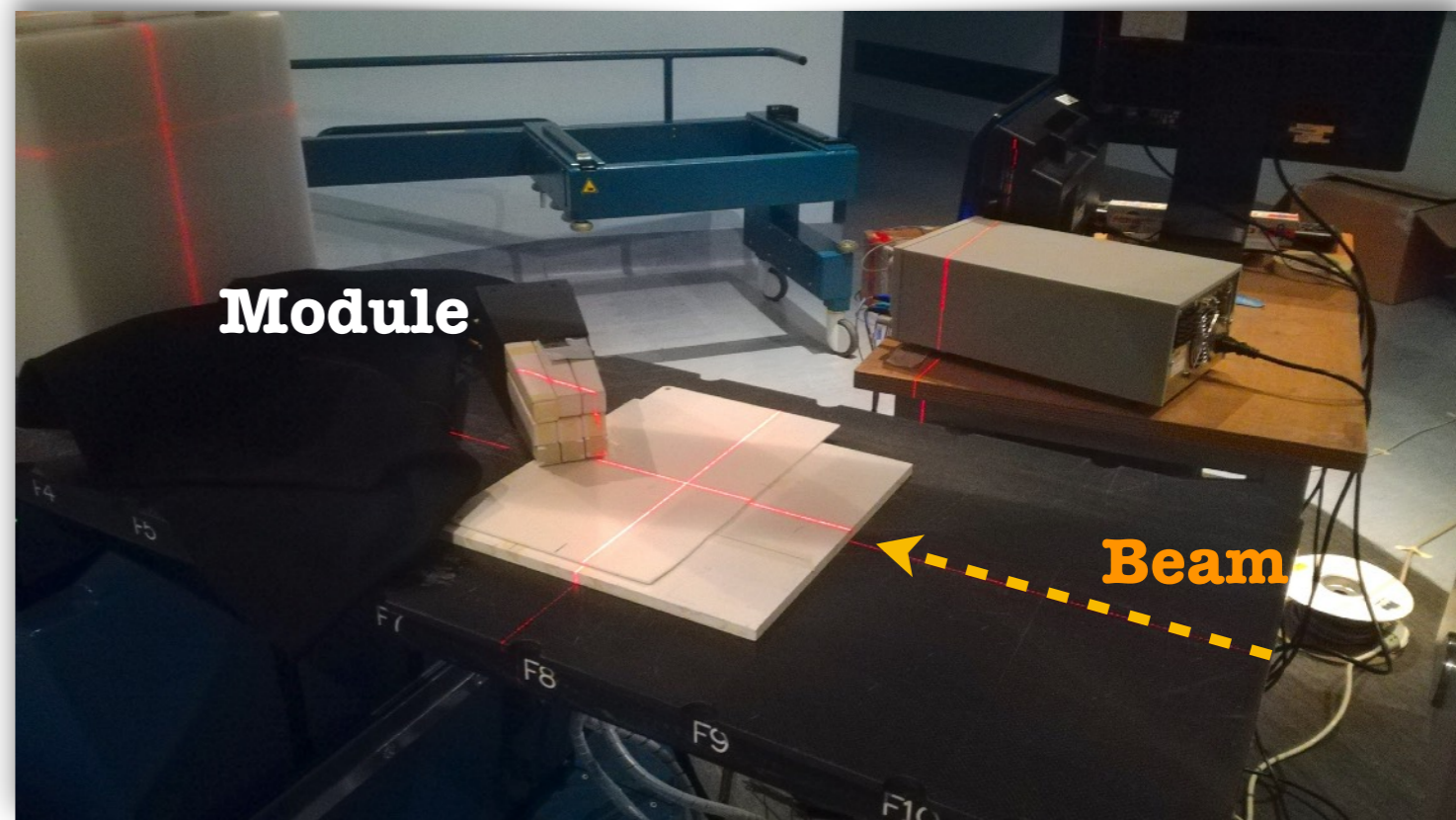
Amplitude Analysis



Module rotation



- Module rotation of 15° , 30° and 45°
- Beam enters in cry 6
- Energy released also in cry 5 and cry 4 (only for most energetic beams)

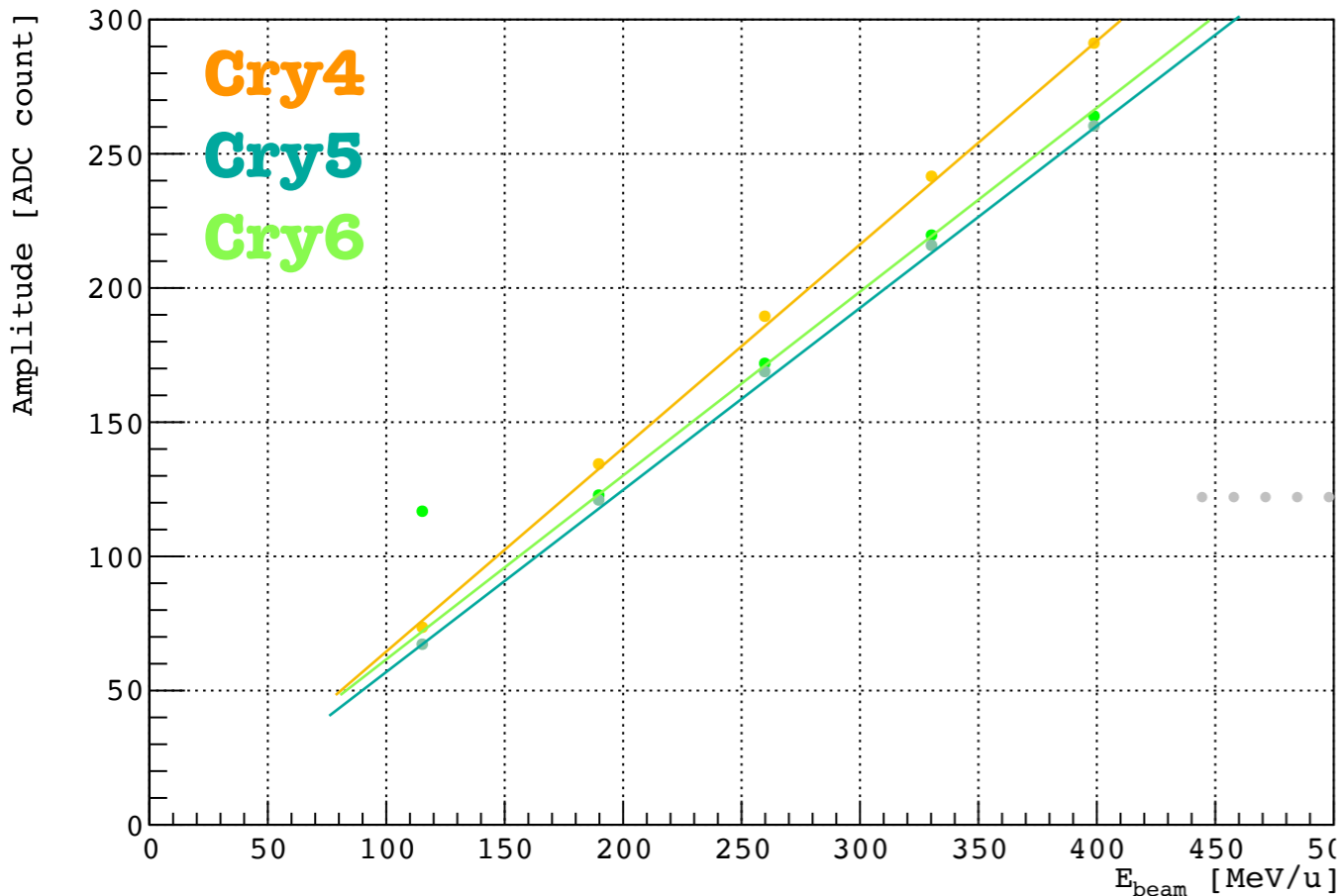


Equalisation

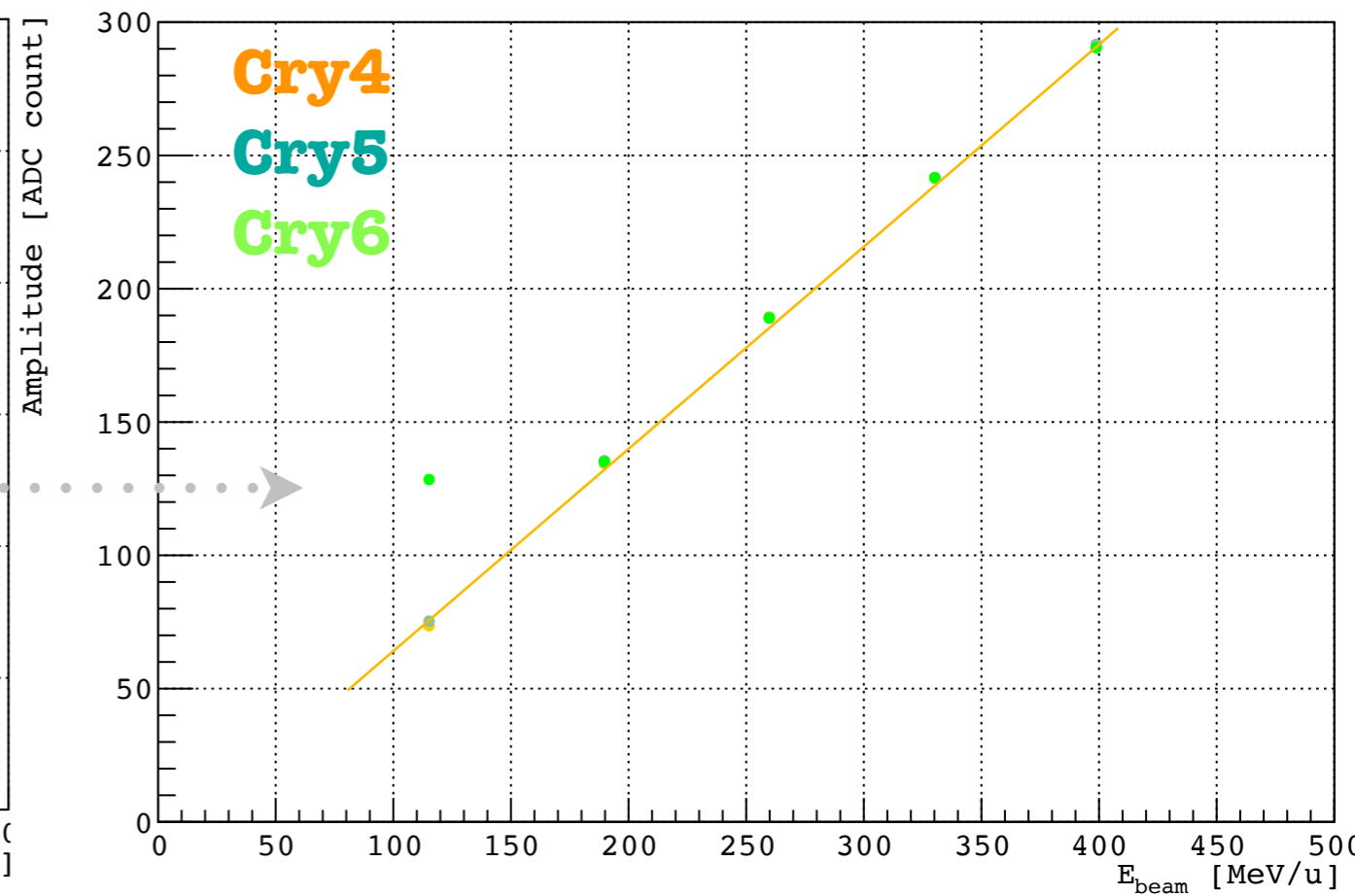


Amplitude Analysis - Carbon

Before Equalisation



After Equalisation

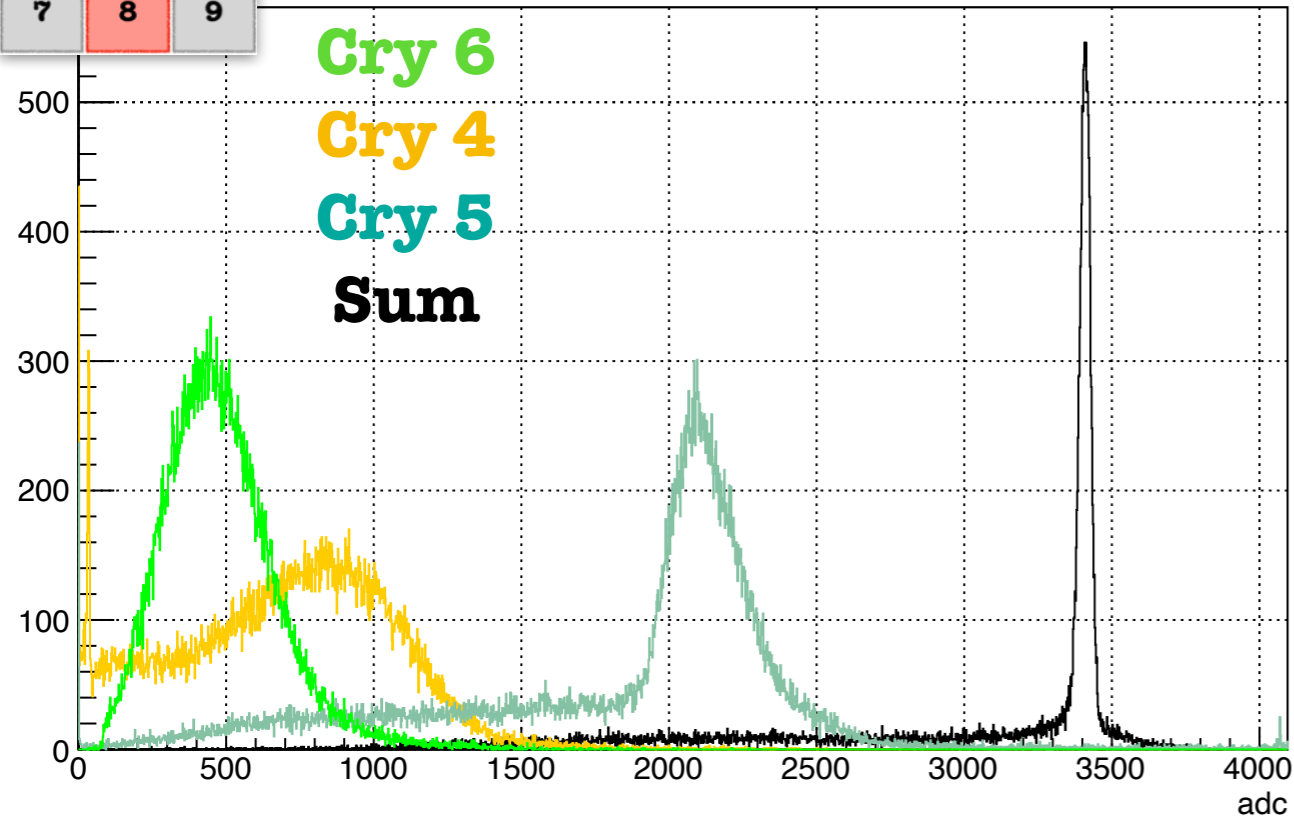


$$A_{Eq} = \left(A_{notEq} * \frac{m_4}{m_5} \right) + (q_4 - q_5)$$
$$A_{Eq} = \left(A_{notEq} * \frac{m_4}{m_6} \right) + (q_4 - q_6)$$

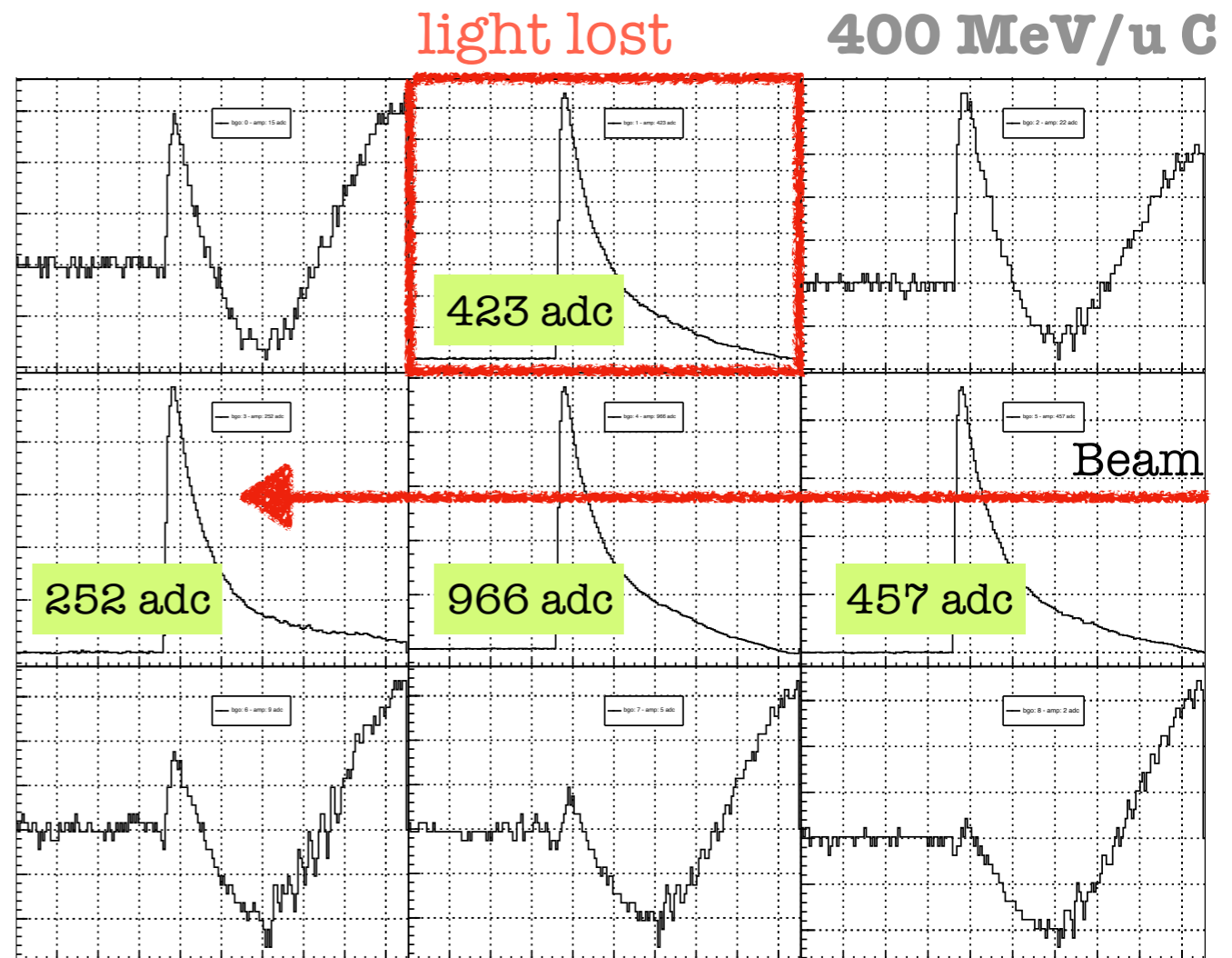


30°

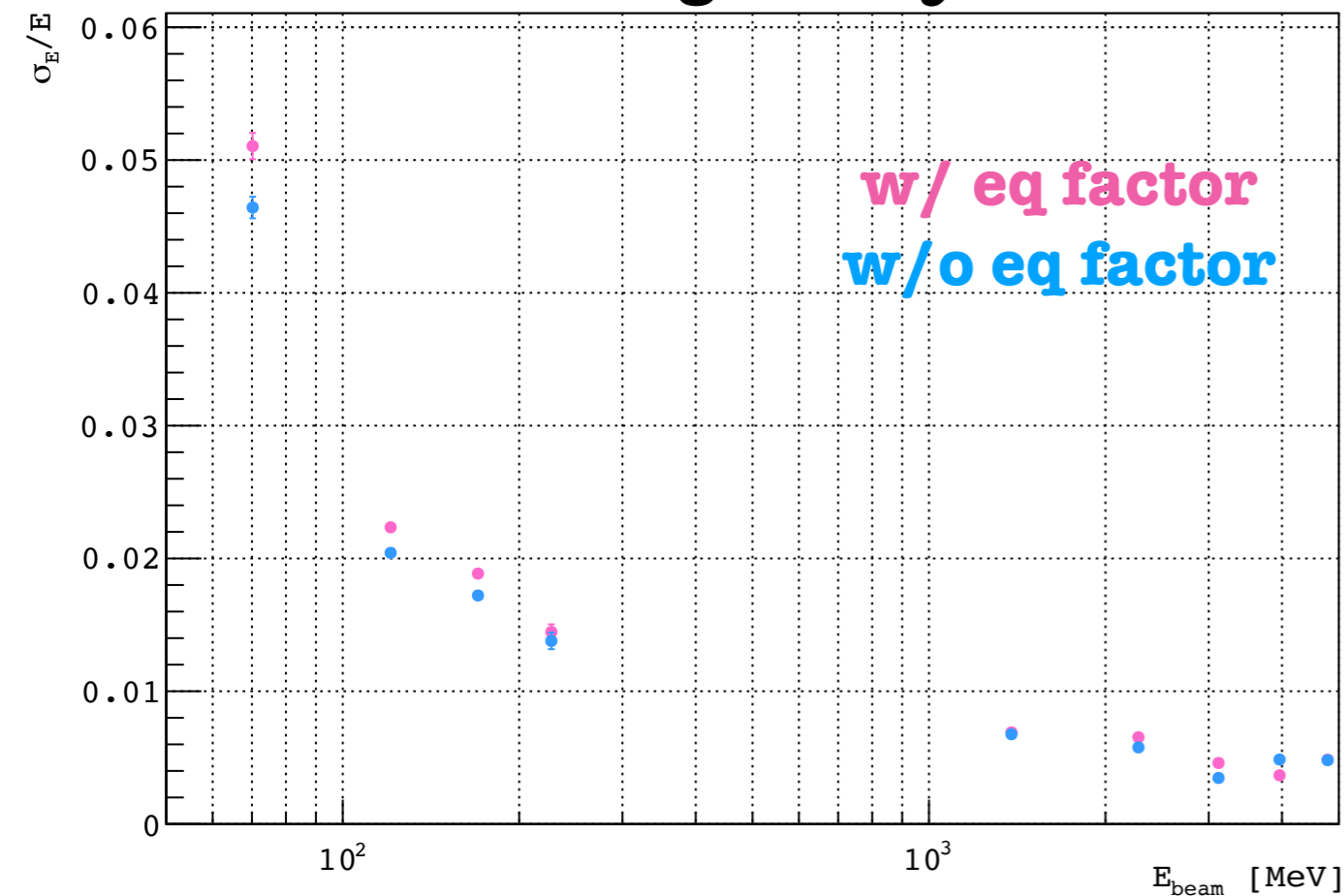
1	2	3
4	5	6
7	8	9



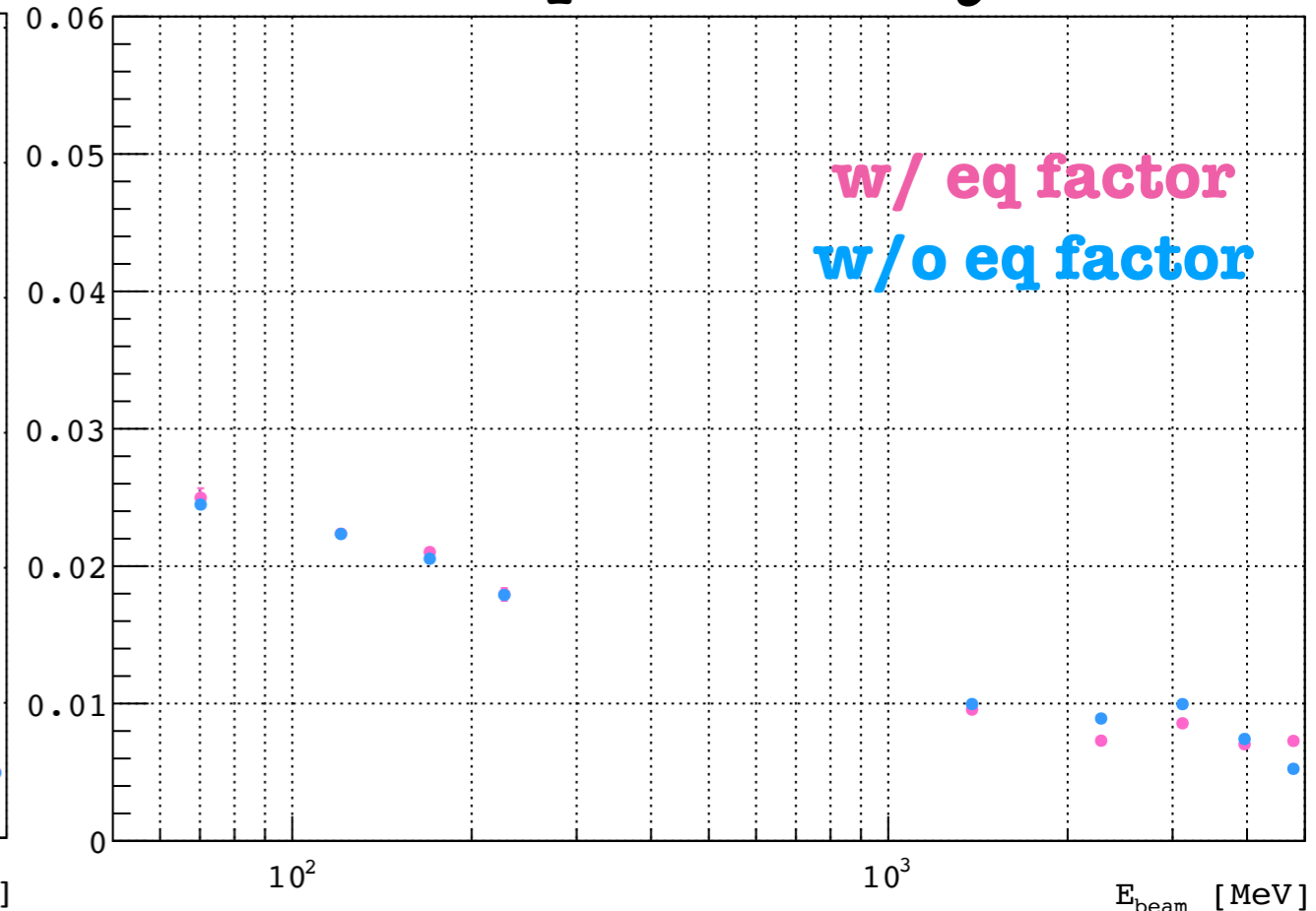
- Sum of the light in cry 6+5+4



Charge Analysis



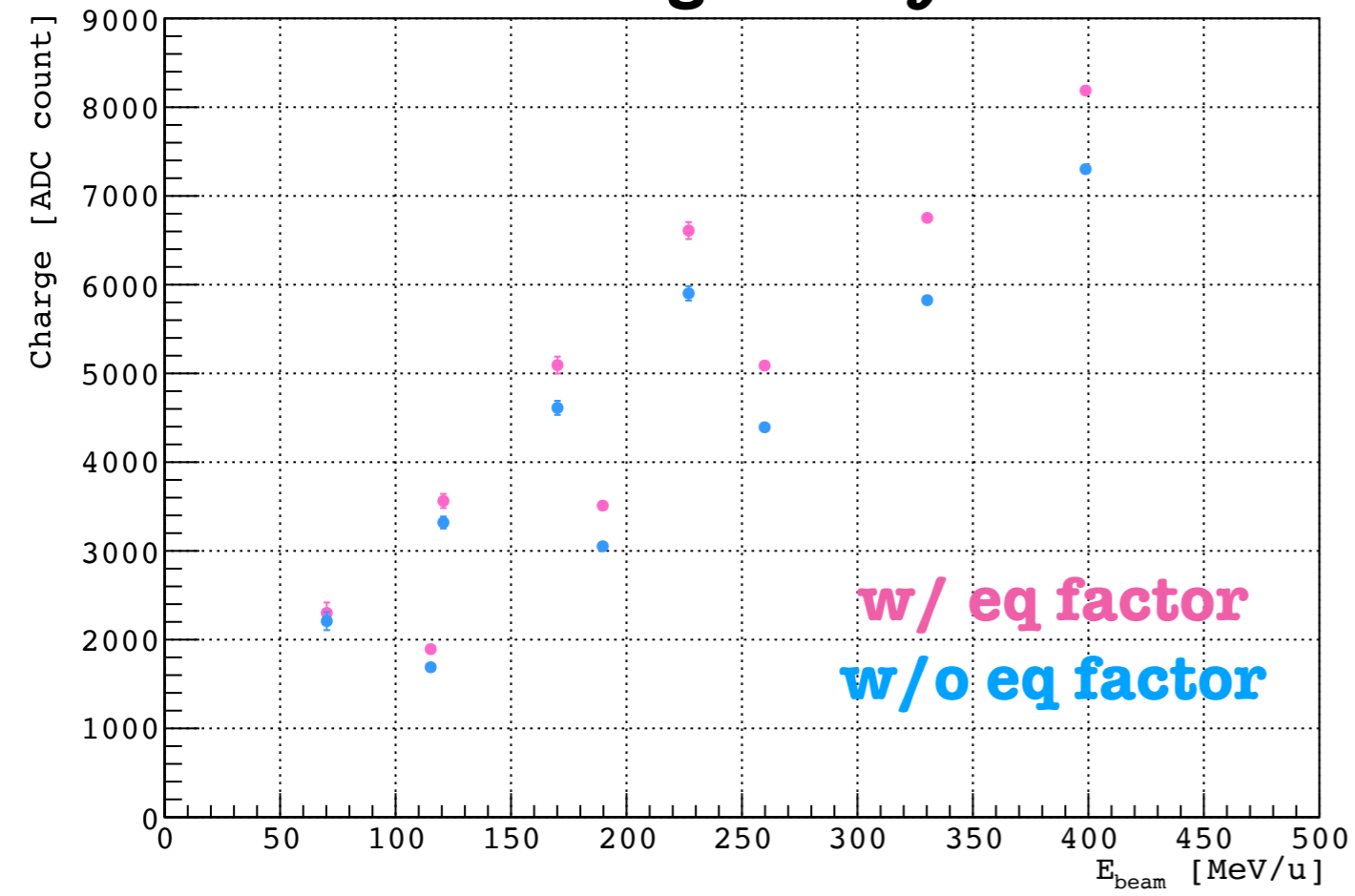
Amplitude Analysis



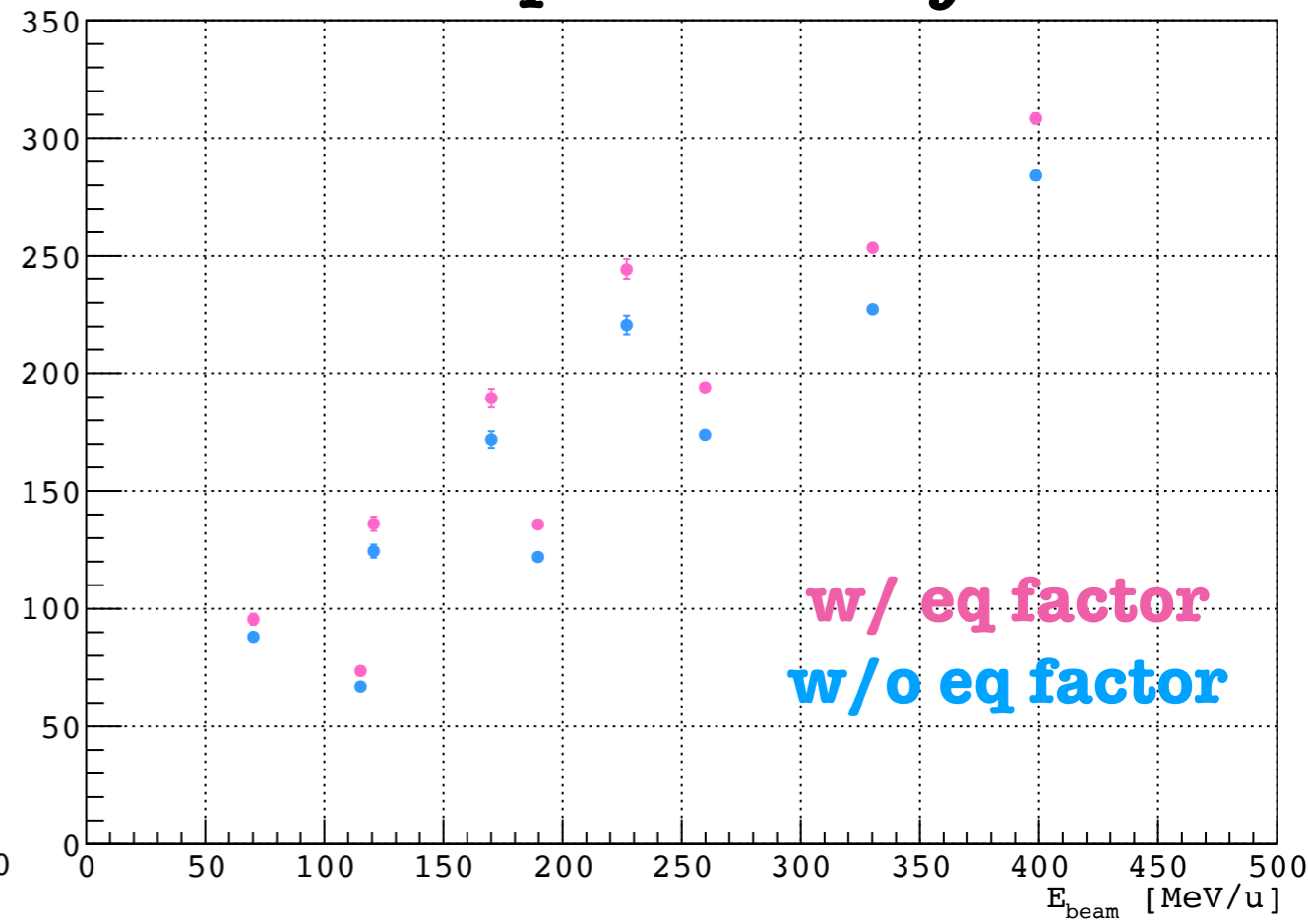
- Too much pileup with 70 MeV proton, untrusted points
- Energy resolutions $< 2\%$ summing the light released in the 3 crystals.



Charge Analysis

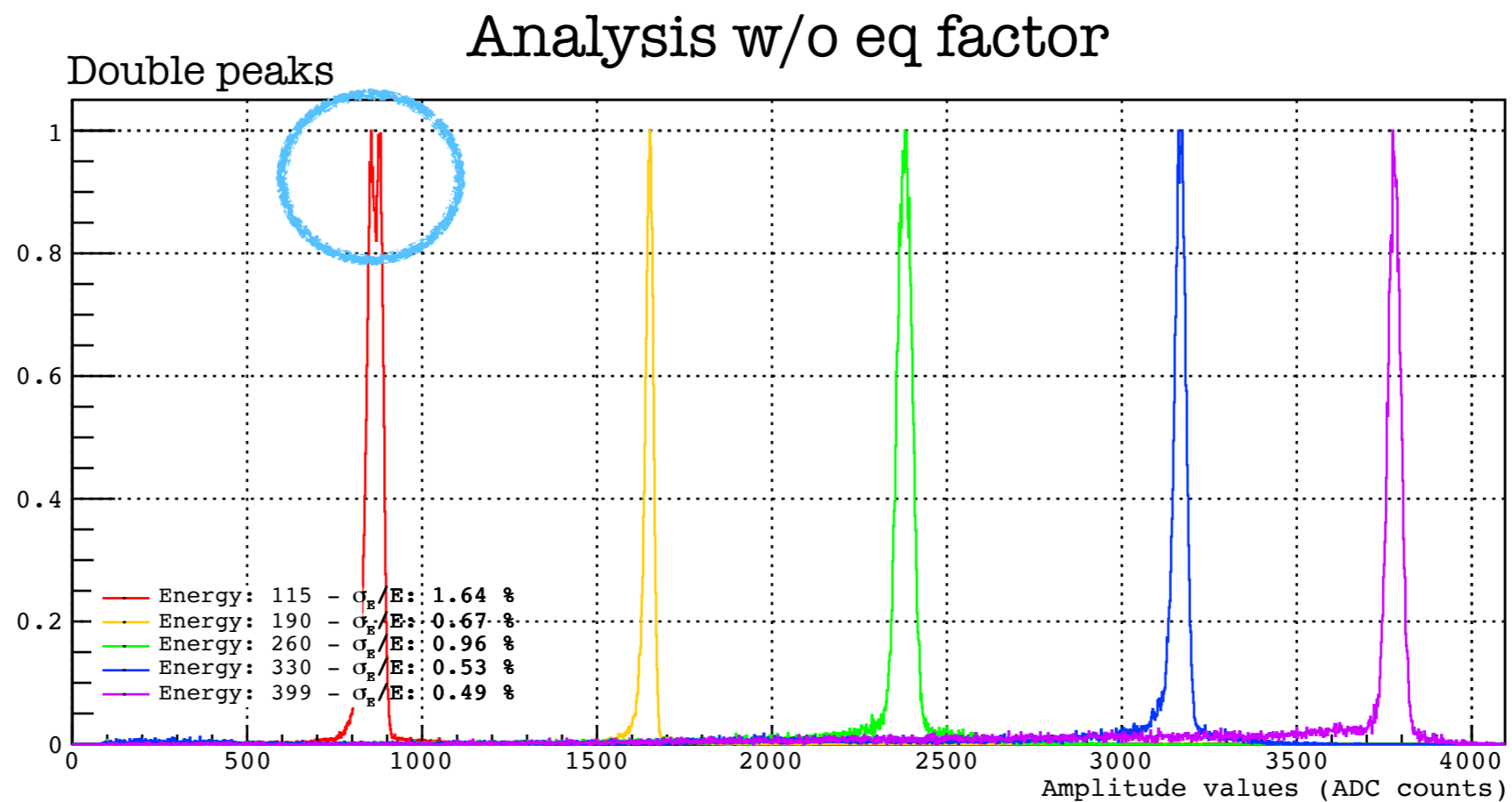


Amplitude Analysis



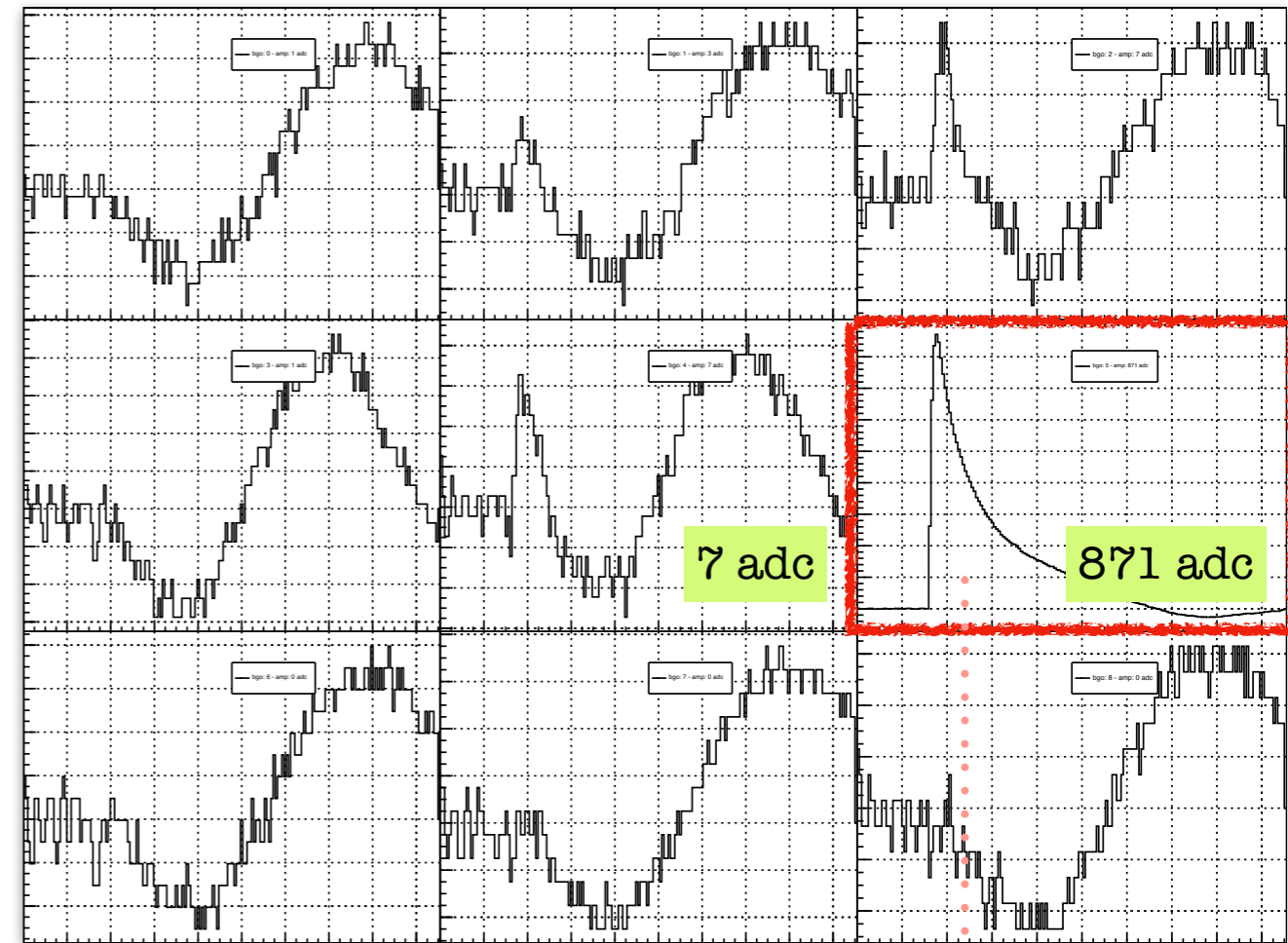
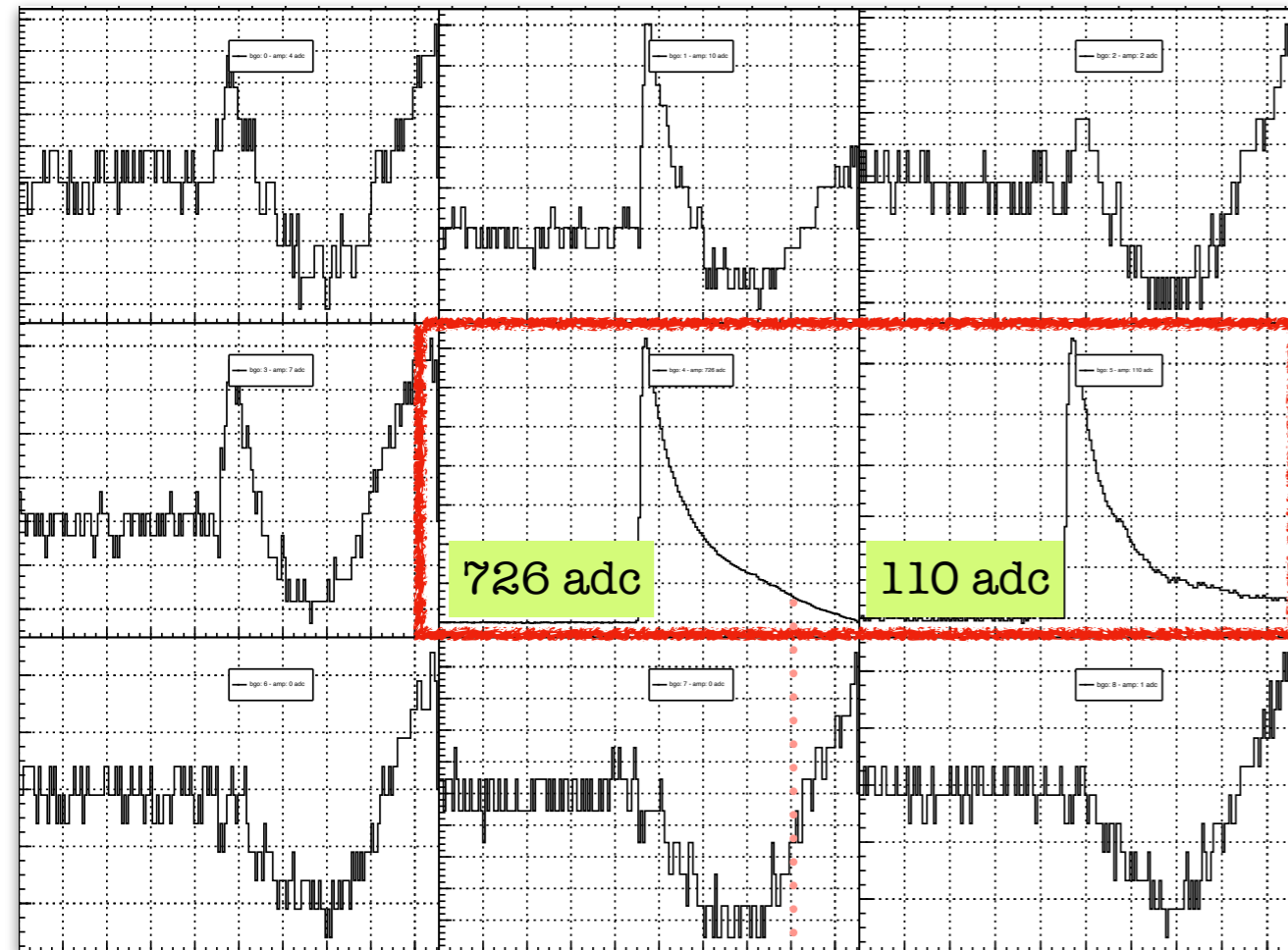
Second night

Between first and second night, we had to disconnect the setup and the equalisation factors are not fine anymore



120 MeV/u C

120 MeV/u C

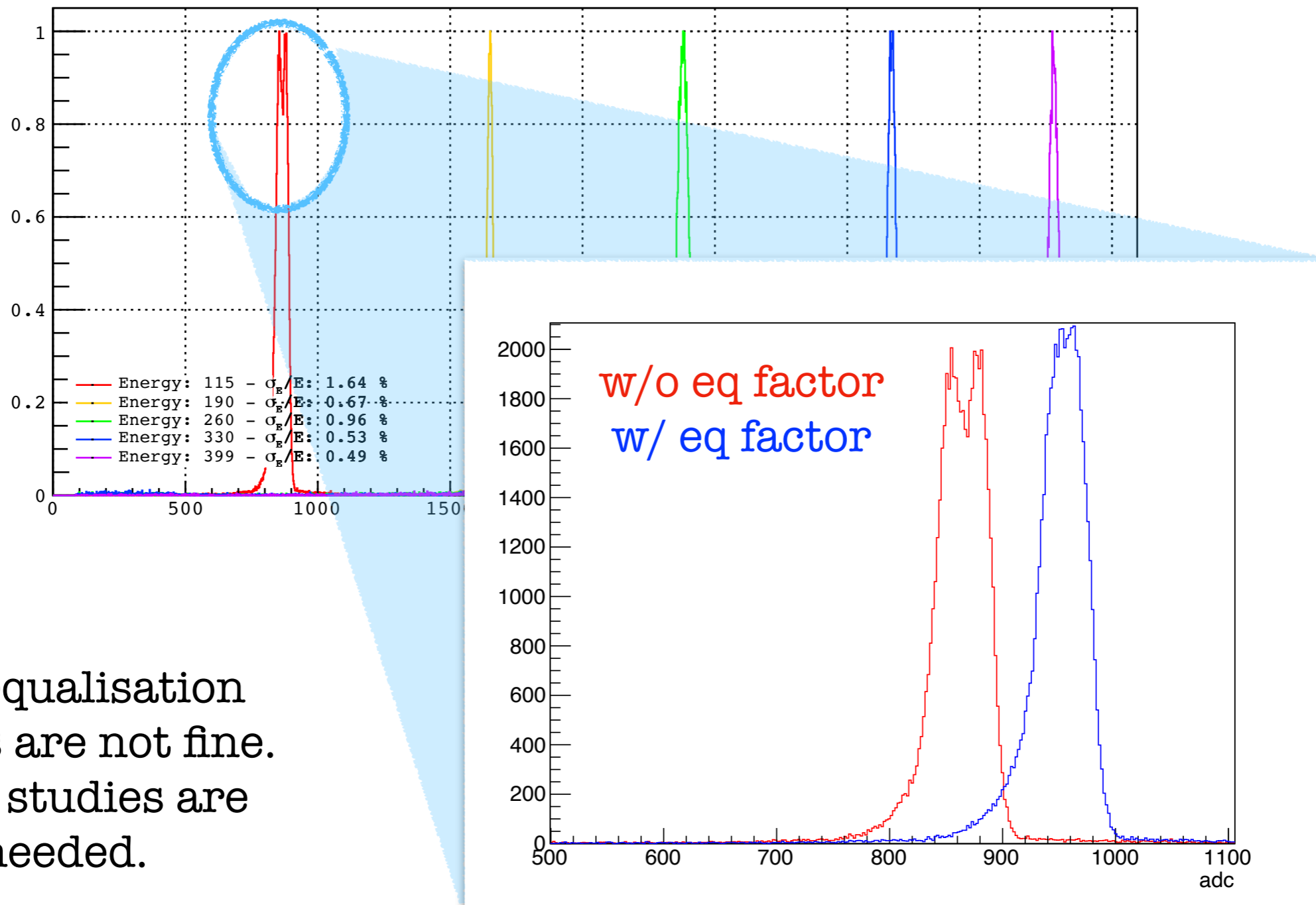


Energy released in cry 6
and 5: total light = sum of
two not equalised crystals

All energy released in cry 6:
total light = light in cry 6

Little improvements using the old equalisation factors

Analysis w/o eq factor

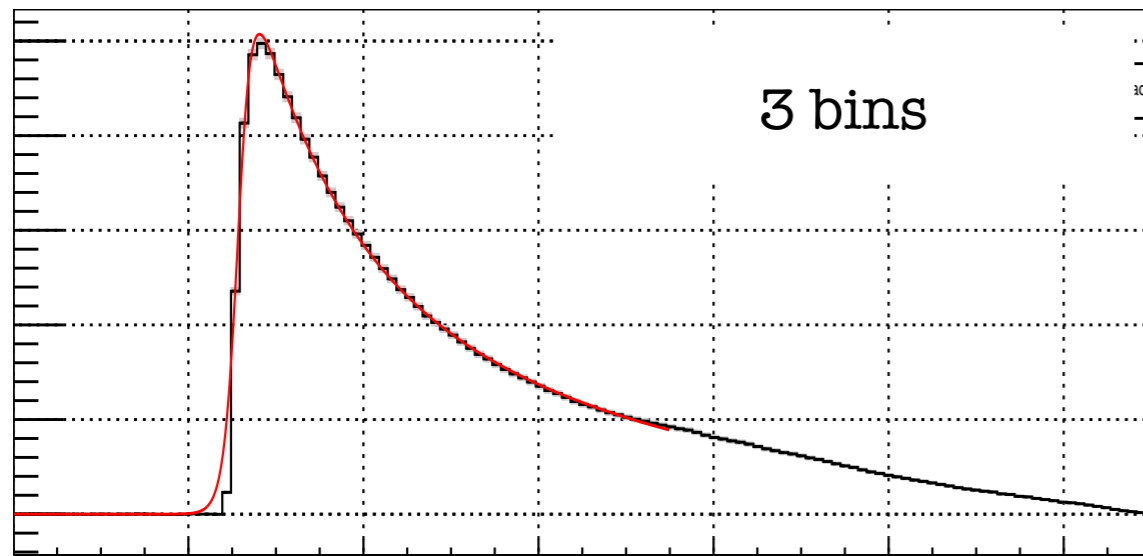


The equalisation factors are not fine. More studies are needed.

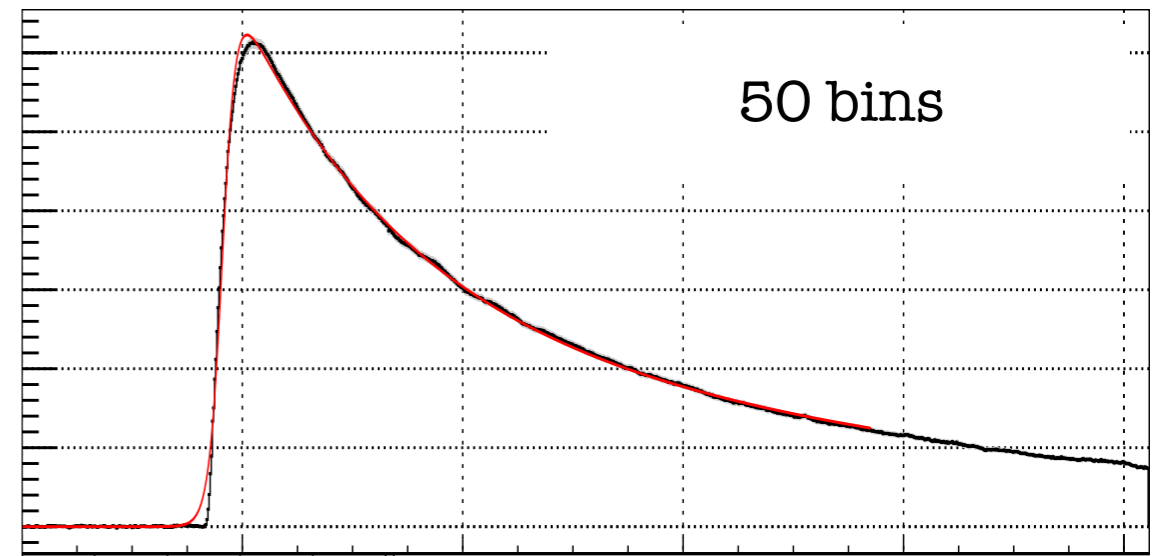
Pulse Shape Analysis



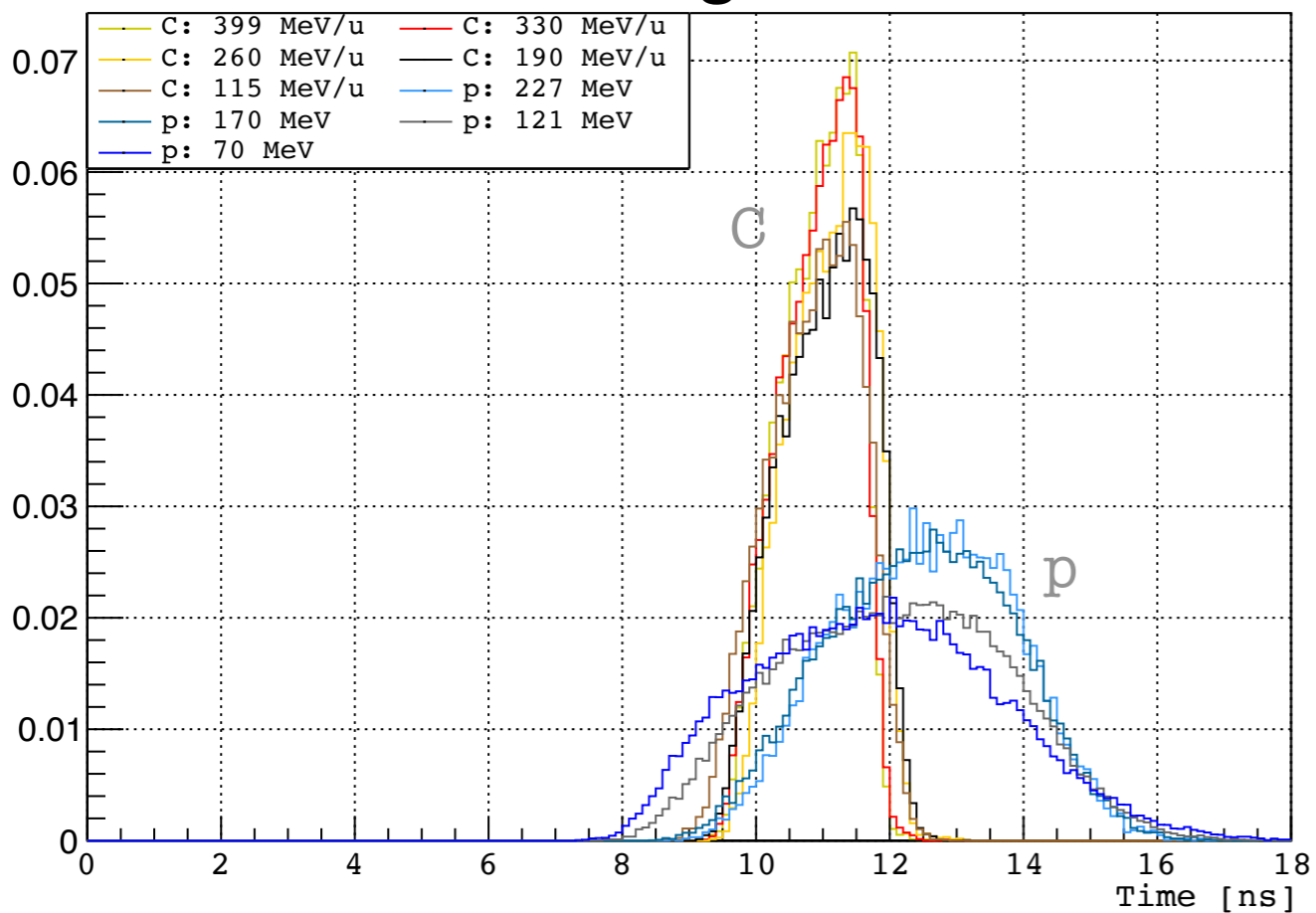
V1740 - 62.5 Mhz



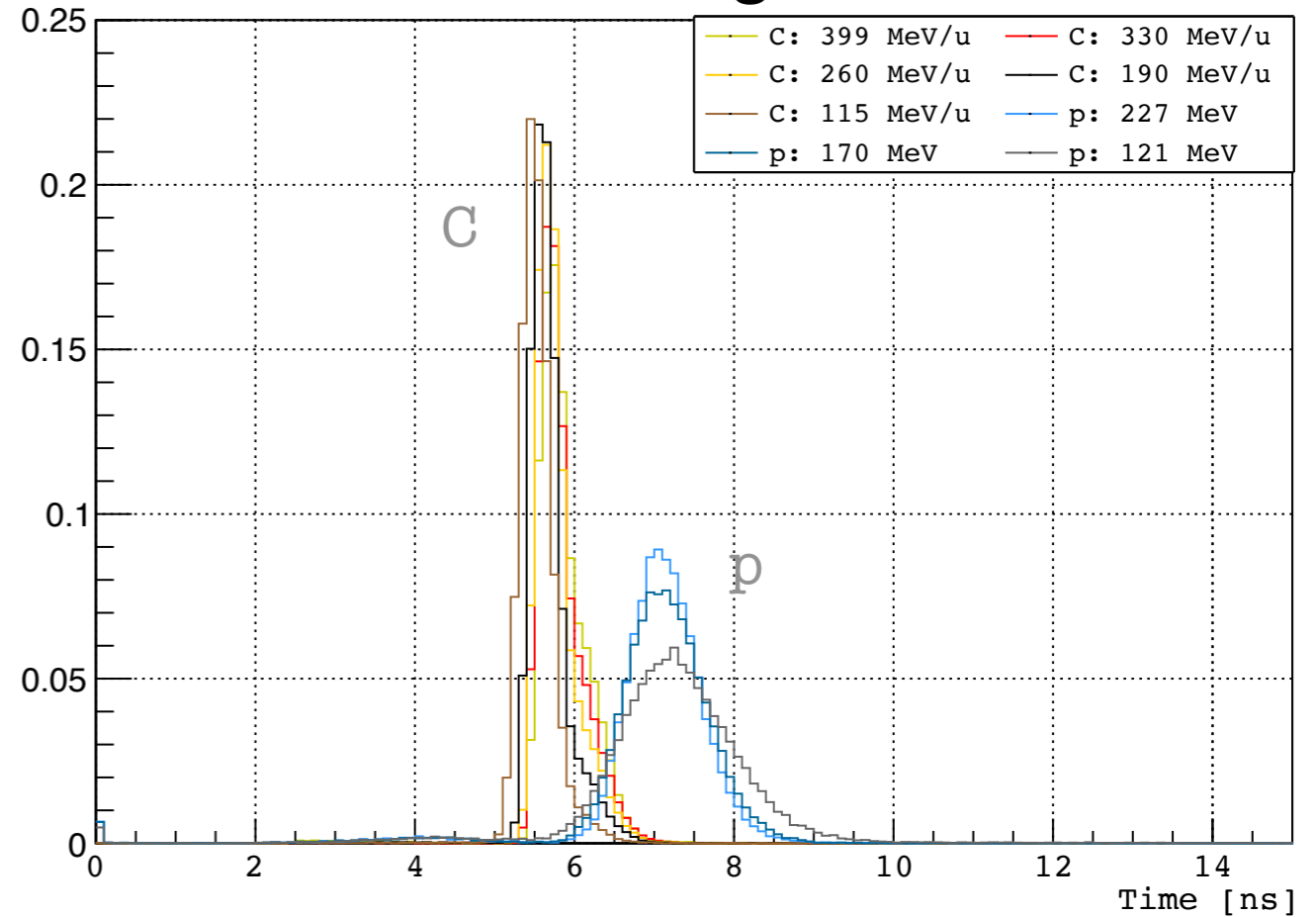
V1742 - 1 Ghz



Rising time



Rising time





Conclusions:

- Despite of the coupling between SiPMs and crystals was not perfect we have got good e consistent energy resolutions ($< 2\%$) for all crystals.
- Tyvek reflects more lights with respect white painting and mylar. This information could be useful in the choice of the wrappings for the BGOs.
- Results on rotated module are very encouraging: energy resolutions $< 2\%$ were got summing the lights released in 3 crystals.

Next steps:

- Finish the analysis on the rotated module
- Improves the equalisation of crystals
- Make the analysis on the runs with faster digitiser in order to study the shape analysis

