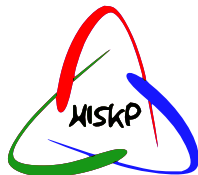


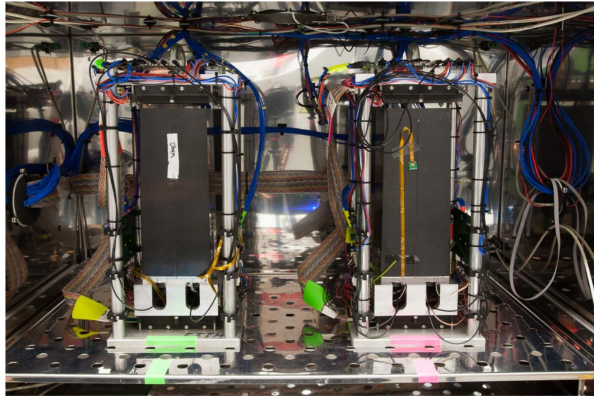
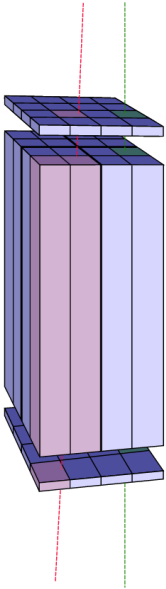
Status of the precalibration measurements using the Bonn detector module teststation

Tobias Seifen



01.06.2022

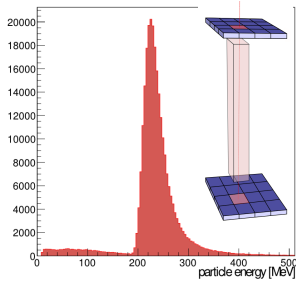
Measurements with cosmic radiation



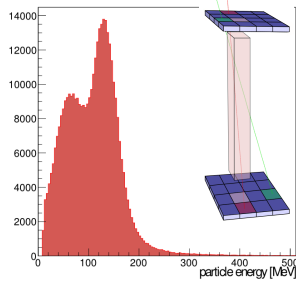
- ≥ 96 h measurement per submodule
- 4 identical Teststations (2 in 2 chambers)
- trigger modules with 16 channels \rightarrow distinguish track types

Examples of track types

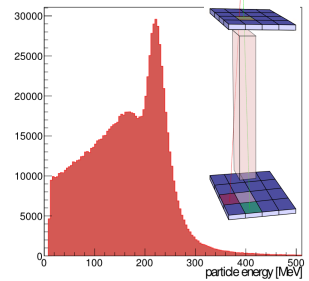
track type 0



track type 4



track type 7

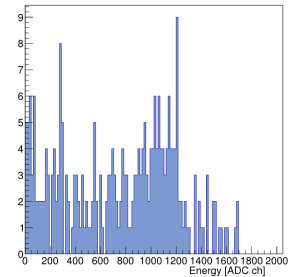
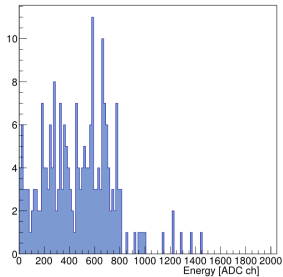
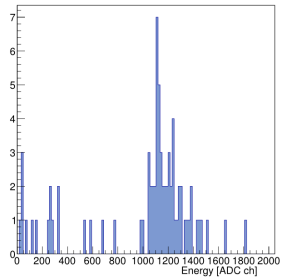
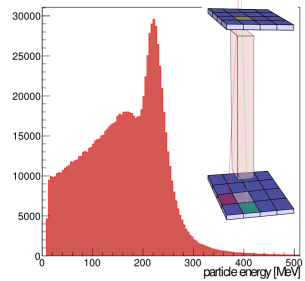
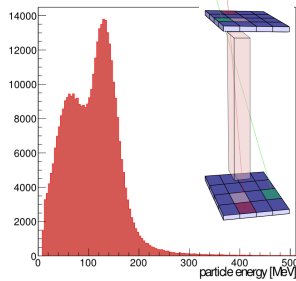
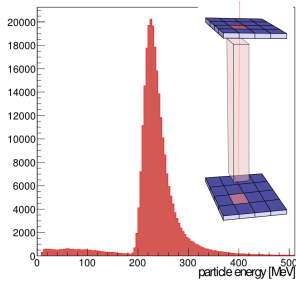


Examples of track types

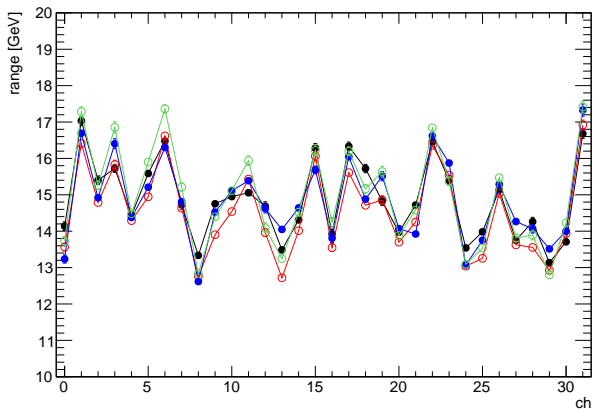
track type 0

track type 4

track type 7



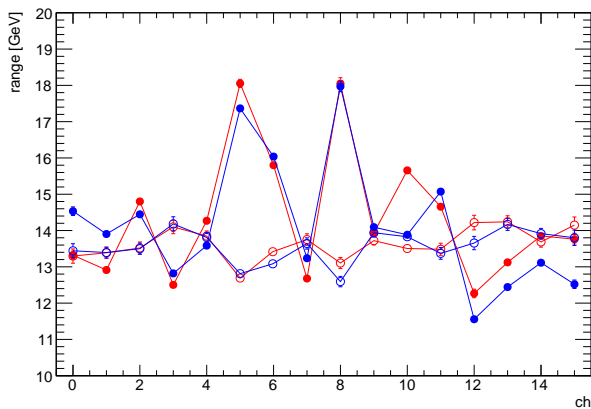
Stability of the measurement



- submodule 1-X1Y6 measured on different positions
- consistent results
- systematic differences between stations between 0.4% and 3.0%

two APDs per crystal,
ch0-15: APD A, ch16-31: APD B

Maximally detectable energy



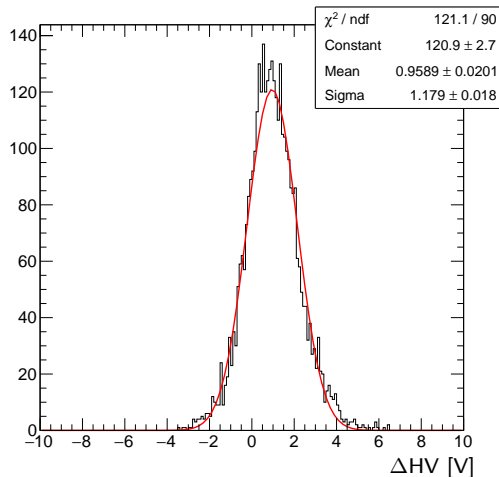
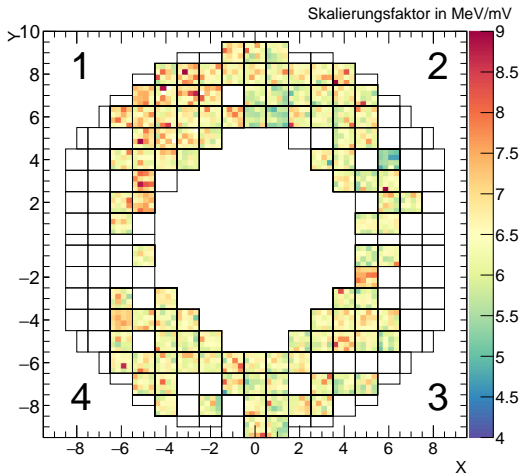
- /●: before HV adjustment
- /○: after HV adjustment

- measured scaling factor proportional to maximally detectable energy E_{\max}
- adjustment possible through variation of HV

$$\bullet \Delta \text{HV} = \frac{\ln \left(\frac{E_{\max}}{E_{\max}^{\text{ideal}} \cdot 1.09^{\Delta T/\text{K}}} \right)}{\ln \left(1 + \frac{\partial g}{\partial U} \right)}$$

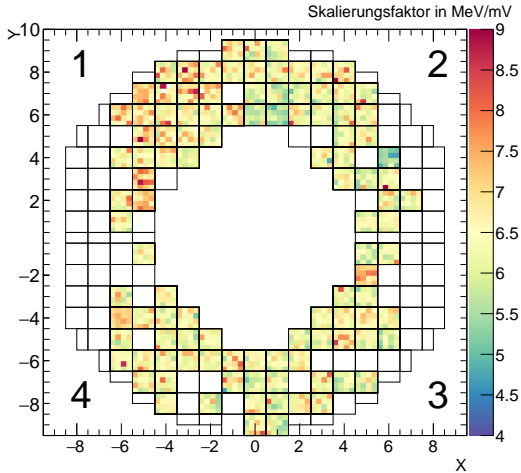
Maximally detectable energy

108 APD-equipped submodules measured (total: 172 full sized + 42 half sized)
necessary HV adjustment for 12.5 GeV



Maximally detectable energy

108 APD-equipped submodules measured (total: 172 full sized + 42 half sized)



issues encountered were:

- 13 submodules with interchanged signal \leftrightarrow HV cable(s)
- 13 submodules with a dead channel, partly noticed before measurement, partly only visible when cold
- 6 submodules have a channel with very low signal yield

\Rightarrow to be repaired and (re-)measured

Summary

Results of the precalibration measurements

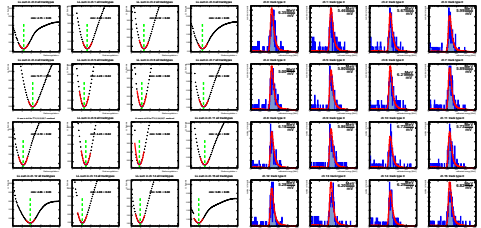
- 108 APD-equipped submodules measured
- submodules with broken channels being repaired in Bochum
- temperature dependent voltage adjustment
- range of 12.5 GeV can be achieved with adjusted HV

2021-04-16 19:08:14

Alveole: 2-X2Y7 Station: RIGHT_A Run number: 200593 Date: 10-03-2021 Duration: 141.19h

position	scsf in MeV/cv	range in GeV	U in V	position	scsf in MeV/cv	range in GeV	U in V
2-X2Y7-0	6.28±0.03	13.84	357.01	2-X2Y7-8	6.21±0.03	13.87	357.46
2-X2Y7-1	5.58±0.03	13.28	357.41	2-X2Y7-9	5.97±0.03	13.73	357.59
2-X2Y7-2	5.98±0.03	13.29	356.68	2-X2Y7-A	6.72±0.03	14.79	356.68
2-X2Y7-3	6.07±0.04	13.23	356.63	2-X2Y7-B	5.72±0.03	13.60	356.77
2-X2Y7-4	5.08±0.03	13.09	357.62	2-X2Y7-C	5.21±0.04	13.68	357.41
2-X2Y7-5	6.88±0.03	13.22	357.60	2-X2Y7-D	6.29±0.03	13.81	357.20
2-X2Y7-6	6.38±0.03	13.38	356.78	2-X2Y7-E	6.58±0.04	14.61	356.73
2-X2Y7-7	5.88±0.03	13.14	356.67	2-X2Y7-F	6.80±0.05	14.36	356.65

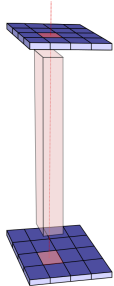
2-X2Y7-0 2-X2Y7-1 2-X2Y7-2 2-X2Y7-3
2-X2Y7-4 2-X2Y7-5 2-X2Y7-6 2-X2Y7-7
2-X2Y7-8 2-X2Y7-9 2-X2Y7-A 2-X2Y7-B
2-X2Y7-C 2-X2Y7-D 2-X2Y7-E 2-X2Y7-F



every submodule equipped with summary of the measurements

Definition of all Track Types

Track Type 0



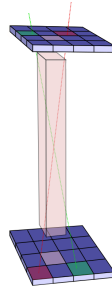
Track Type 1



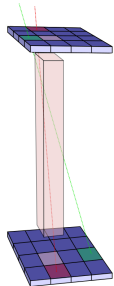
Track Type 2



Track Type 3



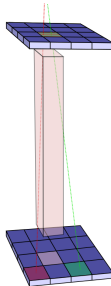
Track Type 4



Track Type 5



Track Type 6

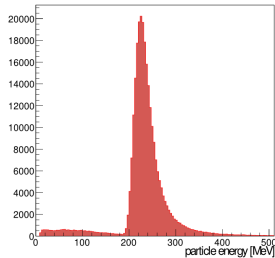


Track Type 7

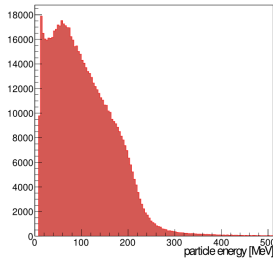


Simulated Spectra of all Track Types

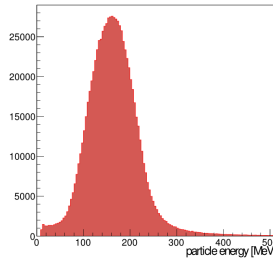
Track Type 0



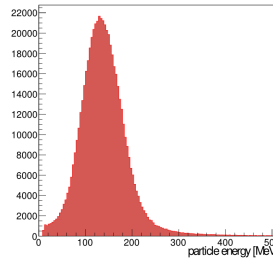
Track Type 1



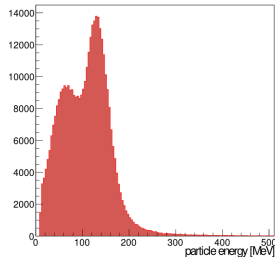
Track Type 2



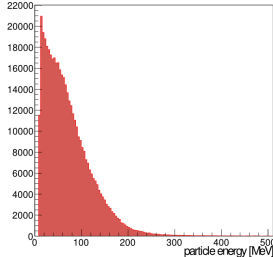
Track Type 3



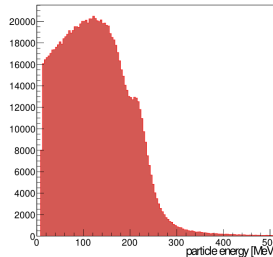
Track Type 4



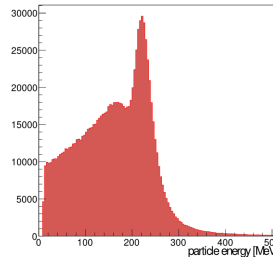
Track Type 5



Track Type 6



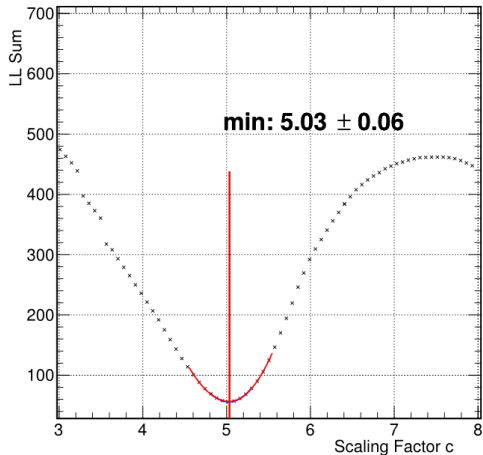
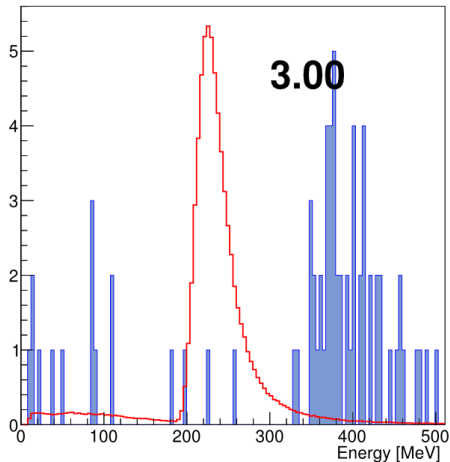
Track Type 7



Combining Measurement and Simulation

Example Track Type 0

LL sum in ch 5 for TT 0

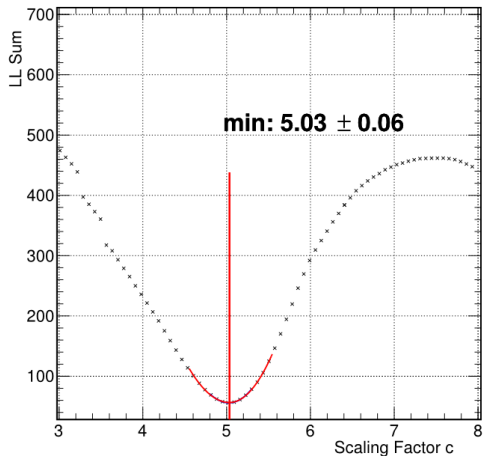
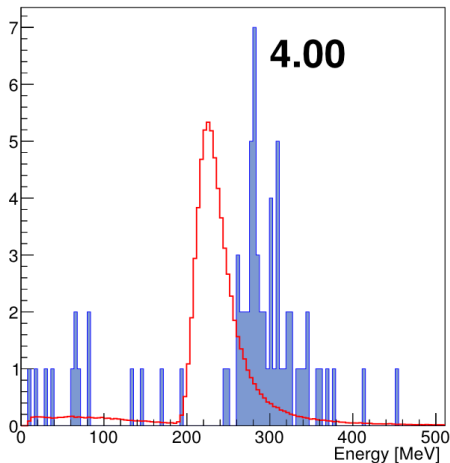


Rescaling measured spectrum \Rightarrow calculating $\sum_{\text{TT}} \ln \mathcal{L} \Rightarrow$ finding minimum in $\ln \mathcal{L}$

Combining Measurement and Simulation

Example Track Type 0

LL sum in ch 5 for TT 0

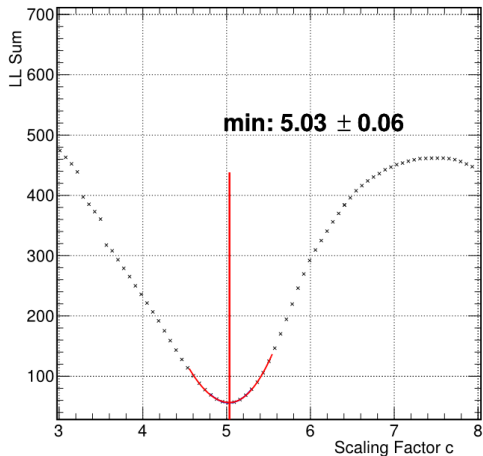
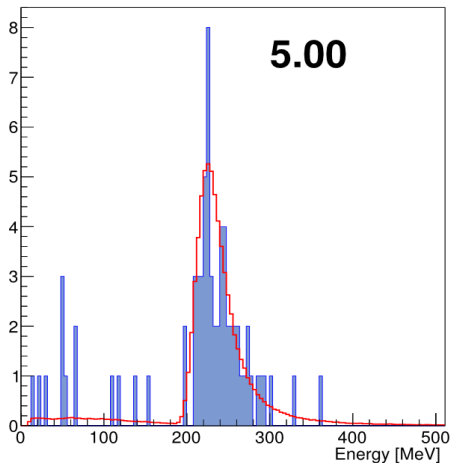


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Combining Measurement and Simulation

Example Track Type 0

LL sum in ch 5 for TT 0

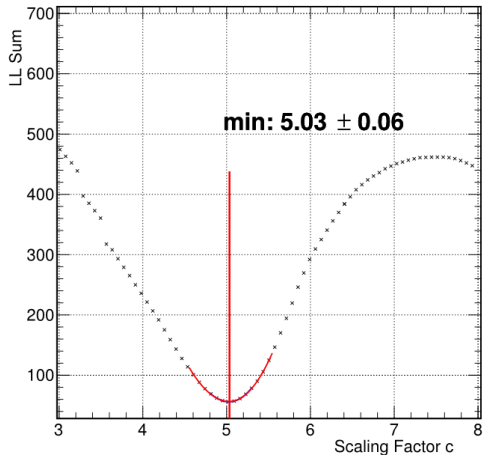
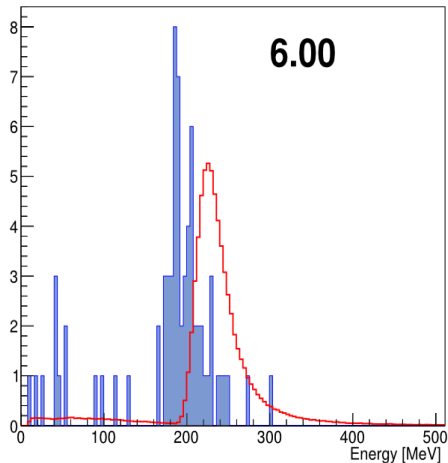


Rescaling measured spectrum \Rightarrow calculating $\sum_{\text{TT}} \ln \mathcal{L} \Rightarrow$ finding minimum in $\ln \mathcal{L}$

Combining Measurement and Simulation

Example Track Type 0

LL sum in ch 5 for TT 0

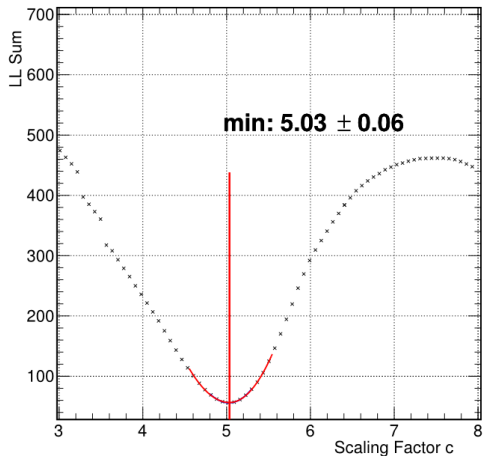
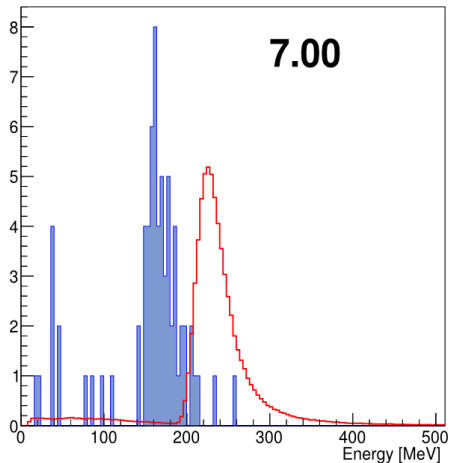


Rescaling measured spectrum \Rightarrow calculating $\sum_{\text{TT}} \ln \mathcal{L} \Rightarrow$ finding minimum in $\ln \mathcal{L}$

Combining Measurement and Simulation

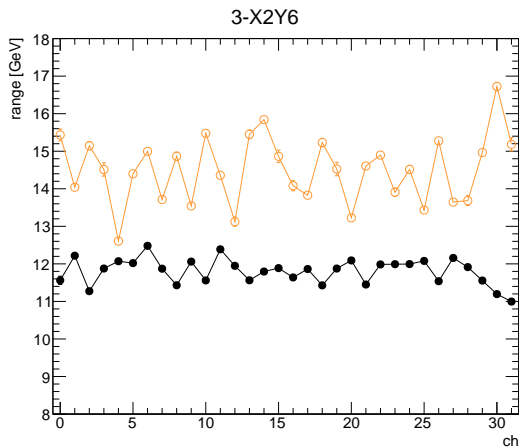
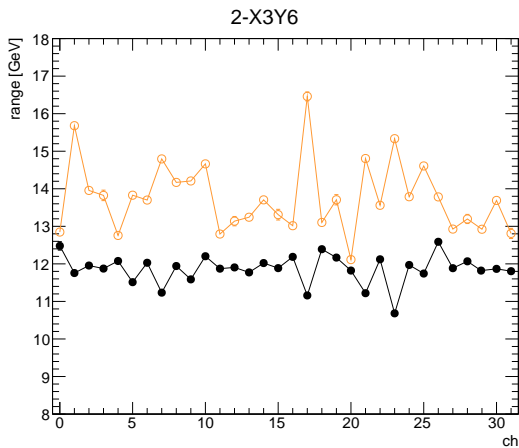
Example Track Type 0

LL sum in ch 5 for TT 0



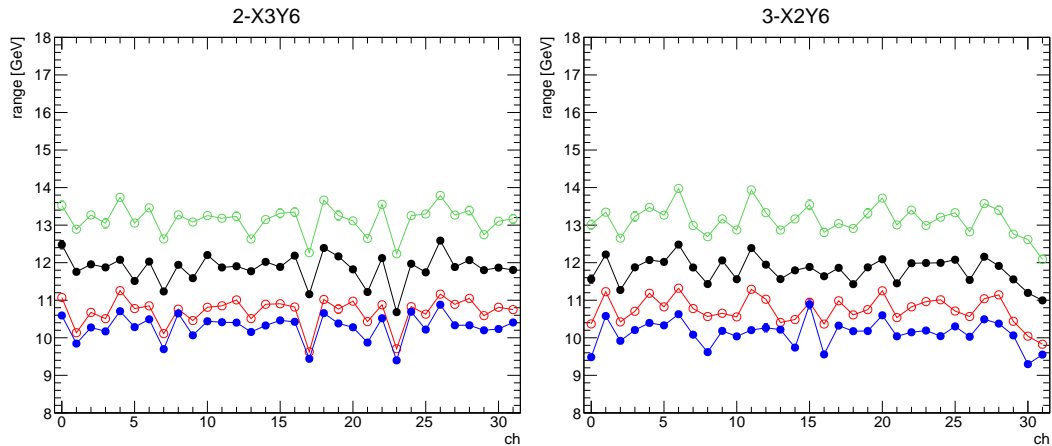
Rescaling measured spectrum \Rightarrow calculating $\sum_{\text{TT}} \ln \mathcal{L} \Rightarrow$ finding minimum in $\ln \mathcal{L}$

Maximally detectable energy



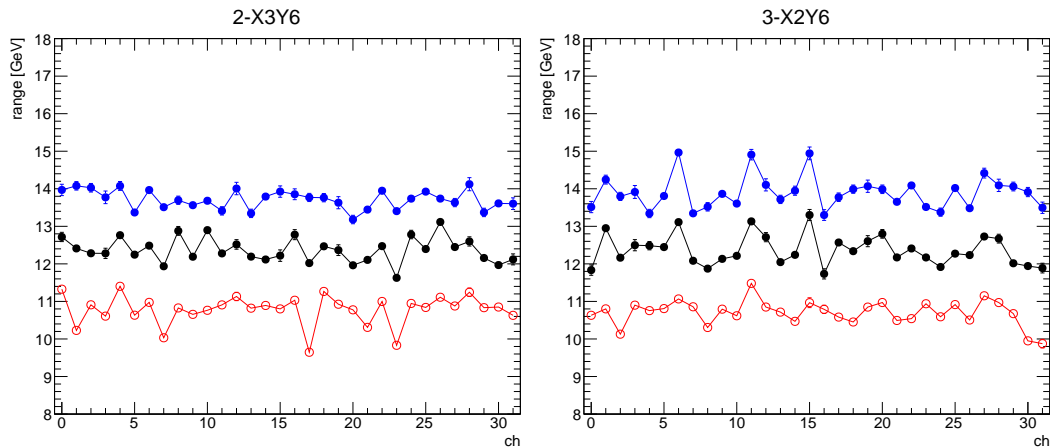
use gain slope to adjust HV to reach 12 GeV

Maximally detectable energy



measurements at different T : -23°C , -24°C , -25°C , -25.5°C

Maximally detectable energy



measurements at different voltages: such that range is at **10.8 GeV**, 12.5 GeV, **14 GeV**