Status of precalibration of VPTT submodules at Bonn

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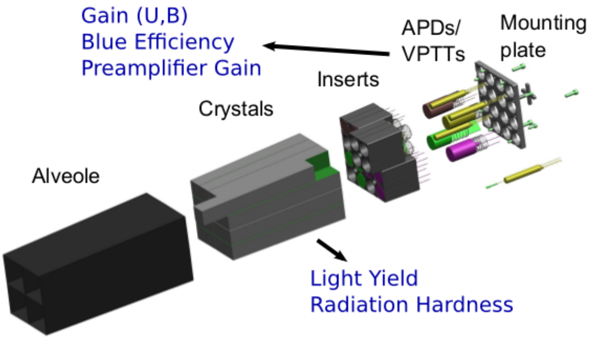
Motivation

- Function test
- Precalibration
- Check energy range

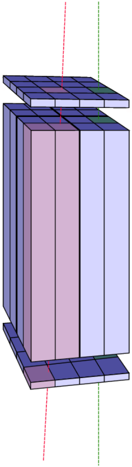
Submodule of the Forward Endcap

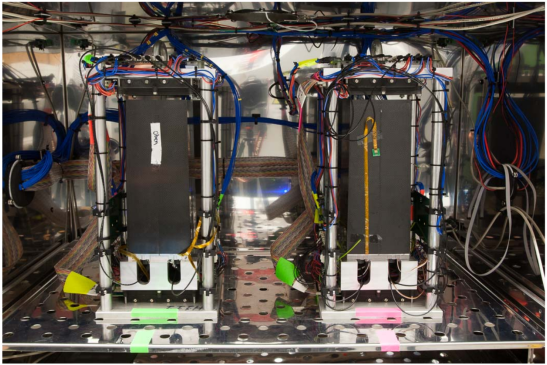


Matching provides us:

1. Position of units in FEC
2. Optimal HV for each compartment with 4 VPTTs
3. Expected quality factor Q_i

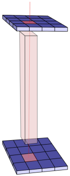
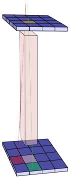
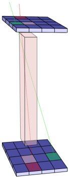
Measurements with Cosmic Radiation





- Min. 72h 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 7	Track Type 4
		

Examples of Track Types

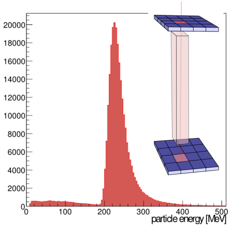
Motivation

Measurements

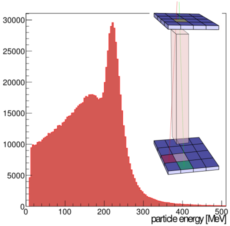
Results

Next Steps

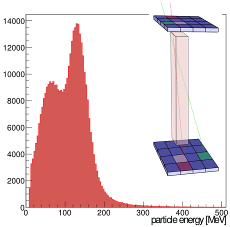
Track Type 0



Track Type 7



Track Type 4



Examples of Track Types

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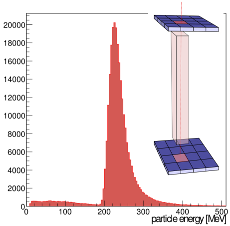

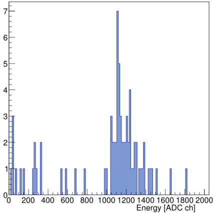

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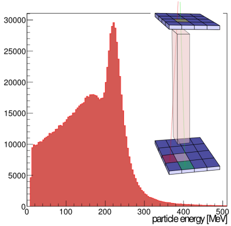
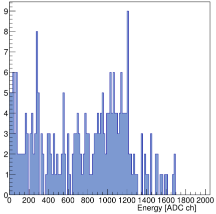
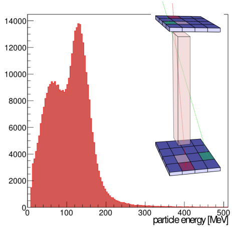
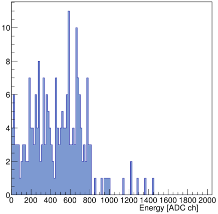




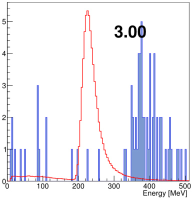
Track Type 4





Combining Measurement and Simulation

Example Track Type 0



$$\text{E[MeV]} = \frac{1}{c}\ \text{E[ADC ch]}$$

- Rescaling measured spectrum
- Calculating log likelihood sum for each step

Combining Measurement and Simulation

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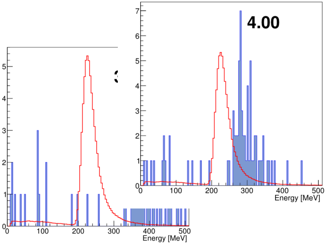

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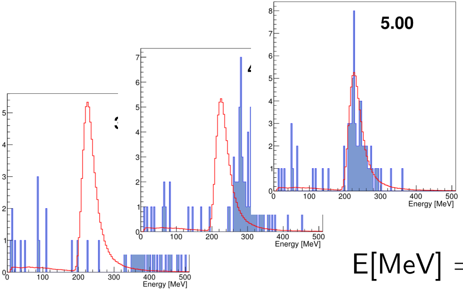

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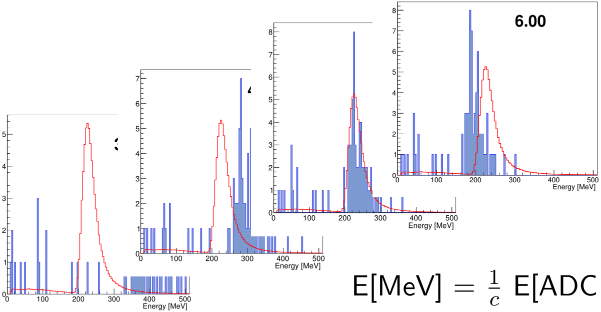

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Combining Measurement and Simulation

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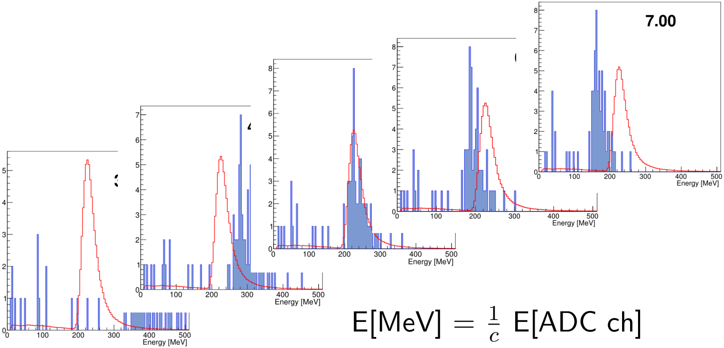

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Combining Measurement and Simulation

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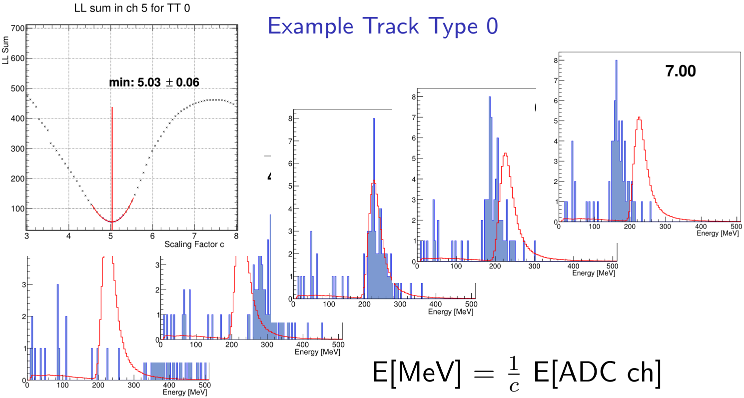
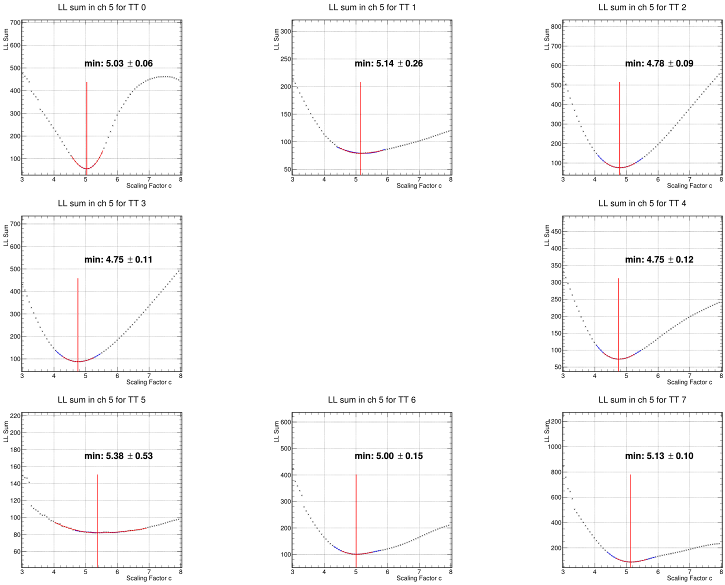


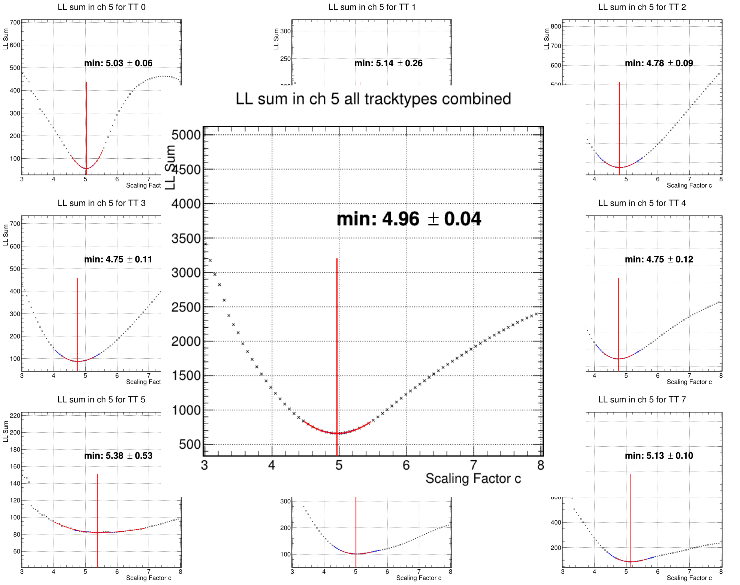
$$\text{E[MeV]} = \frac{1}{c}\ \text{E[ADC ch]}$$

- Rescaling measured spectrum
- Calculating log likelihood sum for each step
- Find best agreeing scaling factor at minimum LL sum

Combining All Track Types

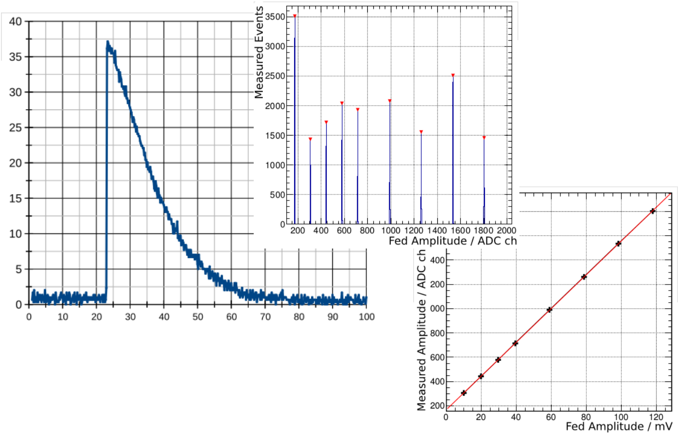


Combining All Track Types



→ receiving scaling factor c_i from combined fit to all track

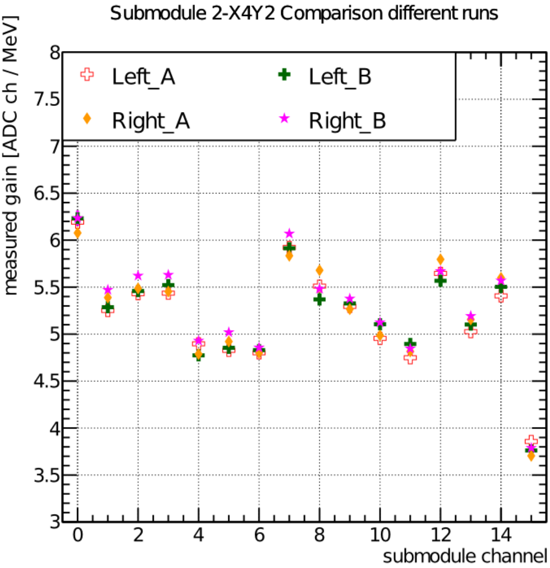
Amplitude Correction



1. Recorded cosmic waveform
2. Fed waveform into signal chain at different amplitudes
3. Correlated measured QDC values to known amplitude
   $\rightarrow$ Transmission factor T_i

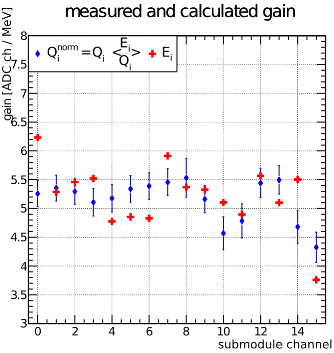
$\Rightarrow$ correct gain: $E_i = c_i \cdot \frac{<T_i>}{T_i}$

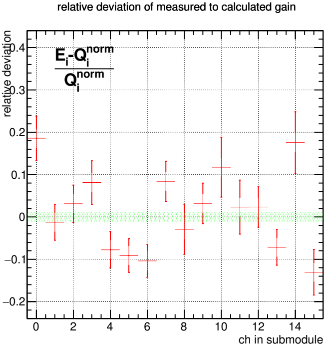
Measurement of one Alveole with all Teststations



Comparison Scaling Factor to Quality Factor

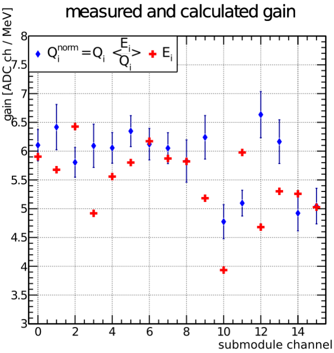
Example 2-X4Y2

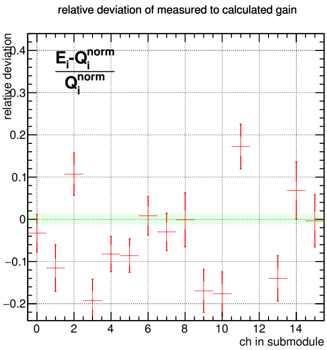




Comparison Scaling Factor to Quality Factor

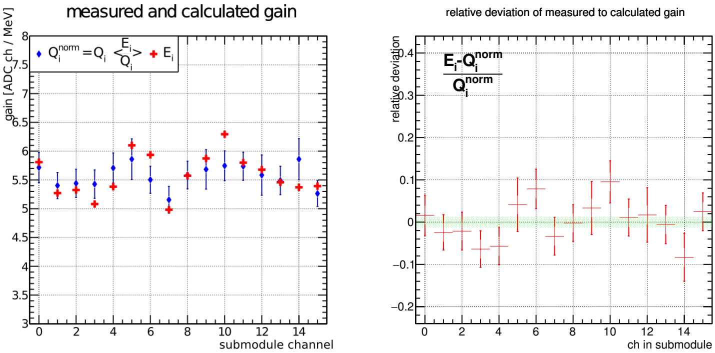
Example 1-X1Y4





Comparison Scaling Factor to Quality Factor

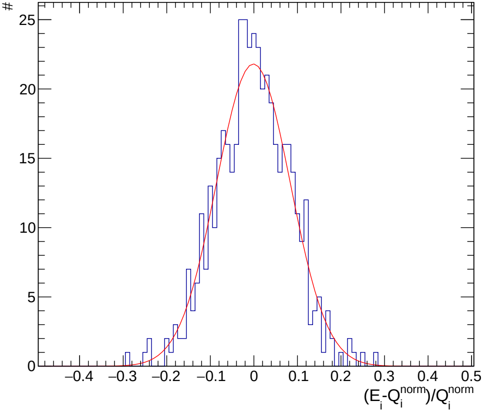
Example 1-X2Y4



Deviation of all Scaling Factors to Quality Factors

29 tested alveoles:

- Max deviation 30%
- Width of 8.5%



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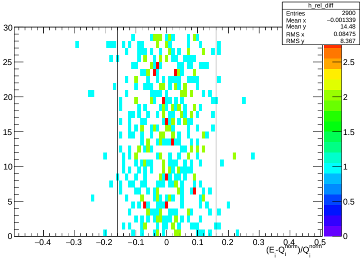
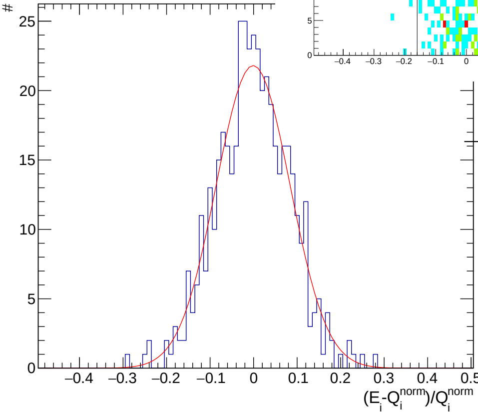
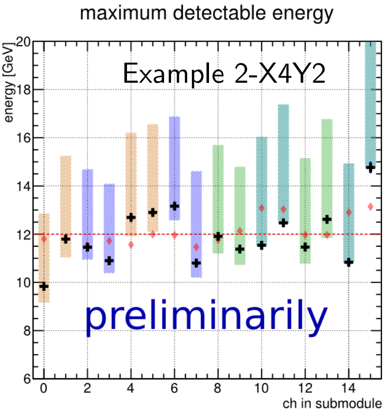




Deviation	♯ Alveoles
>10%	27
>16%	16
>25.5%	2

Energy Range



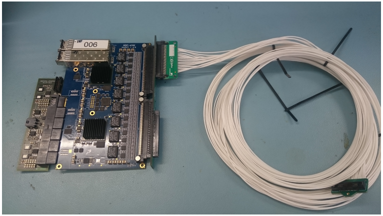
- $\overline{\text{P}}$ANDA Requirement: detect up to 12GeV
- Dynamic range: max. 2.2V
- VPTT bias range: 750V - 1000V

Adjusting energy range by VPTT bias voltage:

- Consider: HV identical for 4 VPTTs
- Tradeoff: energy range vs. resolution
- Result: 5 units cannot reach 12GeV

Next Steps

Check energy range factors with $\overline{\text{P}}$ANDA-SADC ($\rightarrow$ Bachelor Theses)



Continue measurements:

- measure last 5 of 42 alveoles
- check one alveole with a dead channel
- measure 12 half alveoles

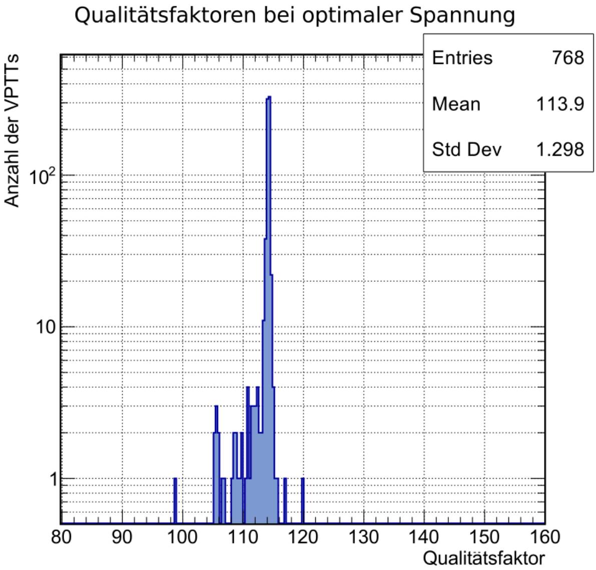
Thank you for you attention!

Quality Factor

$$Q_i = G_0 \cdot G(U,B) \cdot skb \cdot PG \cdot LY$$

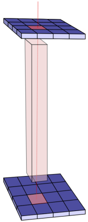
- G_0: gain of VPTT at 1000V
- $G(U,B)$: attenuation of VPTT gain due to reduced voltage and B-field
- skb: blue efficiency of VPTT
- PG: preamplifier gain
- LY: crystal light yield

Quality Factors from Matching

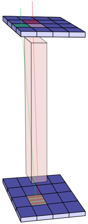


Definition of all Track Types

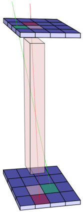
Track Type 0



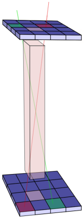
Track Type 1



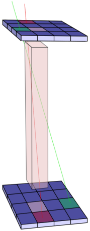
Track Type 2



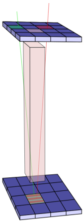
Track Type 3



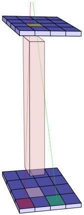
Track Type 4



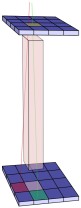
Track Type 5



Track Type 6

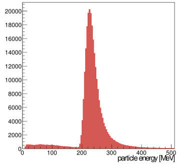


Track Type 7

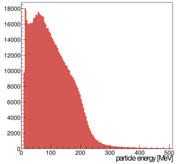


Simulated Spectra of all Track Types

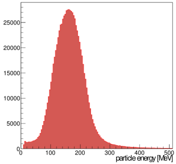
Track Type 0



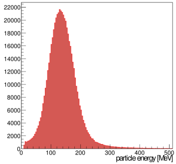
Track Type 1



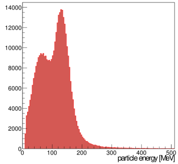
Track Type 2



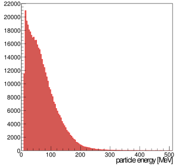
Track Type 3



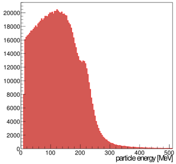
Track Type 4



Track Type 5



Track Type 6



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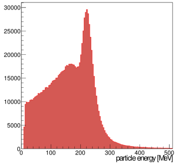
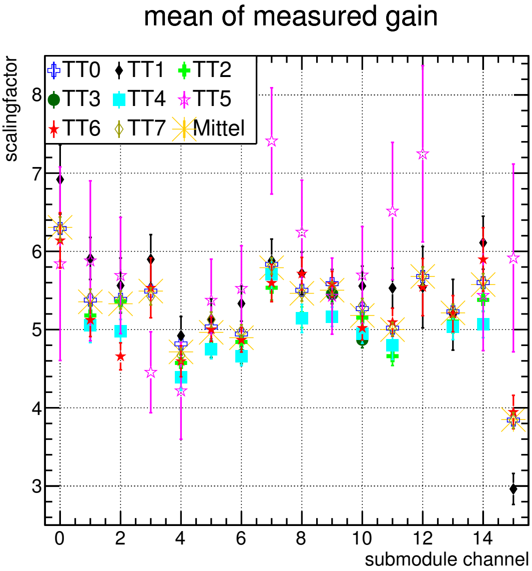


Significance of Track Types - Example 2-X4Y2



Log Likelihood Methode

General likelihood that theory **y** describes measurement **n**:

$$L_p(\mathbf{y}, \mathbf{n}) = \prod_i \exp(-y_i) \frac{y_i^{n_i}}{n_i!}$$

Ratio for estimation of quality of fit (**m** ideal measurement):

$$\lambda = \frac{L_p(\mathbf{y}, \mathbf{n})}{L_p(\mathbf{m}, \mathbf{n})} \approx \frac{L_p(\mathbf{y}, \mathbf{n})}{L_p(\mathbf{n}, \mathbf{n})}$$

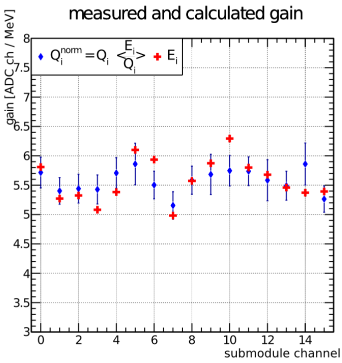
Transformation to general χ^2:

$$\chi_L^2 = -2 \ln(\lambda) = 2 \sum_i \left(y_i - n_i + n_i \ln\left(\frac{n_i}{y_i}\right)\right)$$

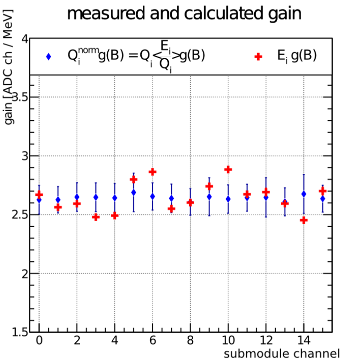
→ problem of minimising χ_L^2

Including B-field to Quality and Scaling Factors

Example 1-X2Y4



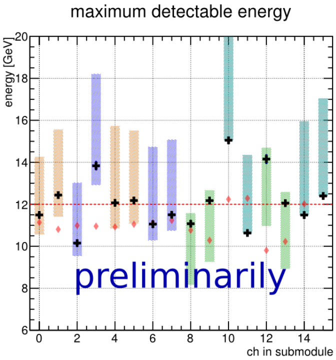
No B-field



B-field included

Energy Range

Example 1-X1Y4



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