Optimierung einer Diskriminatorschwelle der DiRICH MAPMT Auslesekette

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Jörg Förtsch
for the HADES and CBM-Collaborations
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DiRICH Concept

- Readout of 3x2 64ch Multianode Photomultiplier (MAPMT)
- Time over threshold (ToT) for each channel via 12 DiRICHs
- Combiner gathers data of all DiRICHs
- Power module supplies all modules and MAPMTs with HV and LV
DiRICH Concept

- DiRICH receives signal-times via “triggering” on differential input-lines of FPGA
- No information on signal-charge available
- Only rate (for different threshold) and ToT available
- Motivation: Find optimal threshold to discriminate between signal and noise without charge information via robust automatic procedure
Measurement Principle (Threshold Scans)

- Threshold ("comparator" voltage)
- PMT-Signal
- Baseline
- Noise
- Optimal Threshold
- Different Thresholds
Baselines of one DiRICH from Rate Measurement

Threshold (voltage at comparator)

Baseline

Full noise width (@50kHz)

Rate above Threshold in Hz

Channel Nr.
“Statistical” ADC-Spectrum

- Measure rate at different thresholds
- “ADC Spectrum” from slope: not on event by event basis

![Diagram showing rate above threshold as a function of threshold voltage. The slope of the curve at the single photon peak indicates the d/dThreshold of the rate.]
ADC-Spectra comparison

⇒ same 64 ch MAPMT using different readouts

“Statistical” pulse height distribution from DiRICH

Charge distribution from integrating ADC
Derivation of Good Threshold @ -1000V MAPMT-HV

Measured Rate

Rate above Threshold

7000
6000
5000
4000
3000
2000
1000
0

Threshold

Combined fit from two error-functions (erfc)

Measurement data

single fit (erfc) to noise

Optimal threshold from fit

Optimal threshold from data

Signal-valley/ Optimal spot for threshold

Combined fit from two error-functions (erfc)
Derivation of Good Threshold @ - 1000V MAPMT-HV

Measured Rate

- Combined fit from two error-functions (erfc)
- Measurement data
- single fit (erfc) to noise

Differentiated Rate

- Derivative of the combined erfc-fits
- Derived measurement data
- Signal-valley/ Optimal spot for threshold

Optimal threshold from fit

Optimal threshold from data

Combined fit from two error-functions (erfc)

Single fit (erfc) to noise
Derivation of Good Threshold @ - 1000V MAPMT-HV

Measured Rate

Differentiated Rate

Second derivative

Combined fit from two error-functions (erfc)

Measurement data

Single fit (erfc) to noise

Rate above Threshold

Threshold

Measurement data

Derived measurement data

Signal-valley/ Optimal spot for threshold

Optimal threshold from fit

Optimal threshold from data

Combined fit from two error-functions (erfc)

Derived of the combined erfc-fits

Derivative of the combined erfc-fits

Optimal threshold from fit

Optimal threshold from data

Derivative of the combined erfc-fits

Derived measurement data

Measurement data

Optimal threshold from data

Optimal threshold from fit
Derivation of Good Threshold @ - 900V MAPMT-HV
Derivation of Good Threshold @ - 1100V MAPMT-HV

Measured Rate

Differentiated Rate

Second derivative
Summary

- Differentiating the rate spectra:
  - Gives good information about the average received signals

- Fitting an error function to the rate spectra:
  - Immediate access to the optimal threshold
  - Robust method

- Signals with higher average amplitude:
  - Adaptation via third error-function under consideration

- “Long procedure”:
  - Optimal threshold will be determined once before every physics-run
Thank you for your attention
Threshold vs. Efficiency

![Graph showing the relationship between threshold and efficiency with different lines indicating different voltages and number of hits.](image)