PSA Performance Analysis and Optimization
DPG Frühjahrstagung 2014 Frankfurt

Lars Lewandowski, Benedikt Birkenbach, Bart Bruyneel and Peter Reiter for the AGATA collaboration

IKP Cologne

20.03.2013
Content

1. Introduction
2. PSA Optimization
3. Results
Introduction

- No Compton veto detectors ⇒ tracking
- Position resolution necessary for tracking and Doppler correction
- ⇒ Pulse Shape Analysis (PSA)
PSA working principle

Pulse Shape Analysis Concept

791 keV deposited in segment B4
PSA working principle

Pulse Shape Analysis Concept

791 keV deposited in segment B4

(10,10,46)

z = 46 mm
PSA working principle

Pulse Shape Analysis Concept

791 keV deposited in segment B4

(10, 15, 46)
PSA working principle

Pulse Shape Analysis Concept

791 keV deposited in segment B4

(10, 20, 46)

z = 46 mm
PSA working principle

Pulse Shape Analysis Concept

791 keV deposited in segment B4

(10, 25, 46)

z = 46 mm

measured

calculated

Lars Lewandowski

PSA Performance Analysis and Optimization
PSA working principle

Pulse Shape Analysis Concept

791 keV deposited in segment B4

z = 46 mm
Introduction

- Isotropic radiating single source
- PSA favors certain areas of the detector
- Structure of Segments visible

Lars Lewandowski
PSA Performance Analysis and Optimization
Optimization method

- Choosing the Distance Metric
- Preamplifier Response function
- Differential Crosstalk

Methods and observables

- Doppler correction and FWHM
- Homogeneity of distribution of hits
- Correlation of neighbouring grid points (⇒ Clustering)
Results using Doppler corrected Peaks

Distance Metric

Figure of Merit = \( \sum \sum |A_{i,j}^m - A_{i,j}^s|^p \)

Behaviour of \( A_{i,j}^m - A_{i,j}^s \) gaussian?

Doppler correction for \(^{136}\text{Xe} \) (Benedikt Birkenbach and Andreas Vogt)
Analysis

- New Method: Deviation from the mean
- Bin content of grid points
- Mean bin content $Mean = \sum_{i,j}^{N} BinContent_{i,j} \cdot \frac{1}{N}$
- N number of bins

**Error of single Measurement**

$$\sigma = \sqrt{\frac{\sum_{i,j} (BinContent_{i,j} - Mean)^2}{N - 1}}$$

For comparison the Error has to be normalized by the Mean value.
Consider Clustering

\[ BC = \text{Bin Content}, \ E(BC_{i,j}) = \text{Expectancy Value for the bin (i,j)} \]

\[ Cov = E[(BC_{i,j} - E(BC_{i,j}))(BC_{i,j+1} - E(BC_{i,j+1}))] \]

To get a comparable Correlation Coefficient one has to normalize the Covariance

\[ \text{Corr. Coeff.} = \frac{Cov}{\sigma_{i,j} \sigma_{i,j+1}} = \frac{Cov}{\sigma^2} \]
Distance Metric with the Correlation Coefficient

- Consistent behaviour with Doppler correction method
- More accurate
Convolution of real signal and detector response

- Preamplifiers and digitizers smear out measured signal
- Deconvolution with exponential decay parametrized by decay parameter $\tau$
- Older value 35 ns
Differential Crosstalk

With $Z_{\text{in}} = \frac{1}{sAC_{\text{fb}}} + \left(\frac{1}{sC_{\text{ac}}} + R_{\text{cold}}\right)\frac{1}{s}$

$\text{Xtalk} \sim \frac{Z_{\text{in}}}{Z_{01}}$

$\sim \frac{C_{01}/AC_{\text{fb}} + (C_{01}/C_{\text{ac}}) + s \cdot R_{\text{cold}} C_{01}}{s}$

- Proportional
- Differential Xtalk

**Crosstalk**
- Differential Crosstalk derived from Prop. Crosstalk
- One free parameter

---

Lars Lewandowski

PSA Performance Analysis and Optimization
Comparison

AllEnergies_z_13_det_0

AllEnergies_z_13_det_0
Outlook

- PSA performance was investigated and optimized
- Optimization of distance metric, preamplifier response, differential crosstalk
- Clustering still exists. Exclude investigated parameters
- Investigate the ADL bases - use scanning table data?
Thank you for your attention
Appendix
Further Quantization

Minimization

Figure of Merit = \[ \sum_{\text{Segments } j} \sum_{\text{Timesteps } t_i} |A_{i,j}^m - A_{i,j}^s|^p \]

- \( \chi^2 = \chi^2(E) \)
- \( \Rightarrow \) distinguish between good and bad matching of traces
Further Quantization

Gate on $\chi^2/E$

- On the right: 40% statistics
- Local Minimum