INTERNATIONAL PHD PROJECTS IN APPLIED NUCLEAR PHYSICS AND INNOVATIVE TECHNOLOGIES

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BPD analysis/calibration

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BPD clusters

Threshold:
max(THRESH, 0.15*max_signal)
where THRESH = 100 for the picture on the left (old value) and THRESH = 50 is currently used

Cluster:
adjacent strips with signal>threshold

Good cluster:
3 <= width (number of strips) <= 8, not a multi hit and no ADC overflow
BPD reconstruction

BPD position:

\[
\bar{x} = \frac{\sum_{\text{cluster}} w_i S_i}{Q} = \sum_{\text{cluster}} w_i \\
Q = \sum_{\text{cluster}} w_i \\
w_i = \text{ADC}_i - \text{PED}_i \\
S_i - \text{strip } i \text{ position}
\]

cluster rms width:

\[
rms = \sqrt{\frac{\sum_{\text{cluster}} w_i S_i^2}{Q} - \bar{x}^2}
\]

cluster error:

\[
\sigma(\bar{x}) = \frac{rms \sqrt{2}}{\sqrt{Q}}
\]

Naming conventions (RMS) which is not really RMS, but standard deviation inherited from NA49; same as in ROOT TH1 class, where it is said to be taken from PAW.

Calculation as in TH1::GetMean(), TH1::GetRMS(), TH1::GetMeanError(), apart from \( \sqrt{2} \) ! in cluster error
BPD reconstruction

Tracks assumed to be straight lines

\[ x(y) = a_x (a_y) \cdot z + b_x (b_y) \]

fitted with ordinary least squares method with weights

\[ W_i = \frac{1}{\sigma^2(\bar{x})} \]

using only good clusters (thus fit has sometimes 0 dof).

Covariance matrix stored as shown by Nicolas:

\[
\begin{align*}
\sigma^2_{bx} &= \frac{\sum z_i^2 W_i}{\sum z_i^2 W_i \sum W_i - (\sum z_i)^2} \\
\sigma^2_{ax} &= \frac{\sum W_i}{\sum W_i \sum W_i - (\sum z_i)^2}
\end{align*}
\]
BPD phenomenological simulation

- Parametrisation of strip $j$ response in an event:

$$U_j = \text{Landau}(MPV, \sigma_L) \cdot \frac{1}{N} \int_{S_j-d/2}^{S_j+d/2} e^{-\frac{(x-x_p)^2}{2\text{Gaus}^2(\sigma, \delta)}} dx$$

- $S_j$ – position of strip $j$
- $d$ – strip width < pitch
- $x_p$ – simulated beam hit (beam has gaussian profile of $X$, $Y$, slope $xz$, slope $yz$)
- $\sigma, \delta$ – width of charge distribution fluctuates
- $N$ – normalisation constant

$$ADC_j = \text{round}[U_j + \text{Gaus}_j(\text{ped}_j, \sigma_{\text{ped}_j})]$$

- simulation, reconstruction and analysis of 100k events takes 20 seconds! :-(
BPD phenomenological simulation

- Fast fit to 100k 2007 thin target data
BPD phenomenological simulation

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**BPD1x signal strength**

- **Counts**
- **Max ADC-Ped value**

- **Data**
- **MC**

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**BPD1y signal strength**

- **Counts**
- **Max ADC-Ped value**

- **Data**
- **MC**

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**BPD2x signal strength**

- **Counts**
- **Max ADC-Ped value**

- **Data**
- **MC**

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**BPD2y signal strength**

- **Counts**
- **Max ADC-Ped value**

- **Data**
- **MC**

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**BPD3x signal strength**

- **Counts**
- **Max ADC-Ped value**

- **Data**
- **MC**

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**BPD3y signal strength**

- **Counts**
- **Max ADC-Ped value**

- **Data**
- **MC**
BPD phenomenological simulation

- Only good clusters
BPD phenomenological simulation

- Only good clusters
BPD phenomenological simulation

Beam divergence X

Beam divergence Y

BPD vertex X profile

BPD vertex Y profile
Smoothing corrections (ZF corrections)

- It is known since 80's that determination of particle positions in MWPC with centroid methods yields a systematic shifts from real values that depend on detector geometry (strip width, anode-cathode distance) and distance from strip center and ...

- In the paper of Endo et all. NIM (1981) the shifts are calculated in a given model of detector response for
  - 2 detector geometries
  - 6 centroid methods: center of gravity with 3,4,5 strips, gaussian, lorentzian, parabolic curves fitting

- This yields a non-physical comb-like beam profiles
Smoothing corrections (ZF corrections)

- Raw beam profiles, only good clusters
Smoothing corrections (ZF corrections)

- On the level of MC, knowing the true positions of particles, one can get the shifts (thus corrections) directly for various cluster widths as a function of dx – distance of reconstructed position to center of the strip or the middle between nearest strips.
Smoothing corrections (ZF corrections)

- **MC obtaining correction**
Smoothing corrections (ZF corrections)

- **MC after correction**

![Graphs showing smoothing corrections](image-url)
Smoothing corrections (ZF corrections)

- MC after correction
Smoothing corrections (ZF corrections)

- MC
Residuals

- MC is much too narrow
- Correction makes the distribution narrower as expected
Pulls

<table>
<thead>
<tr>
<th>data set</th>
<th>BPD1x</th>
<th>BPD1y</th>
<th>BPD2x</th>
<th>BPD2y</th>
<th>BPD3x</th>
<th>BPD3y</th>
</tr>
</thead>
<tbody>
<tr>
<td>data</td>
<td>1.21</td>
<td>0.98</td>
<td>2.85</td>
<td>2.38</td>
<td>2.37</td>
<td>2.69</td>
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<td>MC no corr</td>
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<td>0.32</td>
<td>1.07</td>
<td>0.95</td>
<td>0.94</td>
<td>1.01</td>
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<tr>
<td>MC with corr</td>
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<td>0.16</td>
<td>0.58</td>
<td>0.49</td>
<td>0.51</td>
<td>0.51</td>
</tr>
</tbody>
</table>
Chi2

- Residuals with cut on $\chi^2/\text{n dof}$ < 10 in both X and Y directions
Missing channels and lower gains

- Only temporary solutions for several runs (e.g. run 5661).
- Developing a common method – idea exists, real development after finishing smoothing corrections.
- MC will allow for reliable method validation.
BPD3x problem for 2007 LT runs

- beam profiles for cut 5
BPD3x problem for 2007 LT runs

- beam profiles for cut 5 after recovery
Status

• recalculation of survey results, geometry calibration
• phenomenological BPD MC in progress
• smoothing corrections (ZF corrections) in progress
• gain/dead channel calibration soon to be developed
  MC will allow for reliable validation of method
• miniclient upgrade work ongoing with a new student
• database will go along with miniclient upgrade