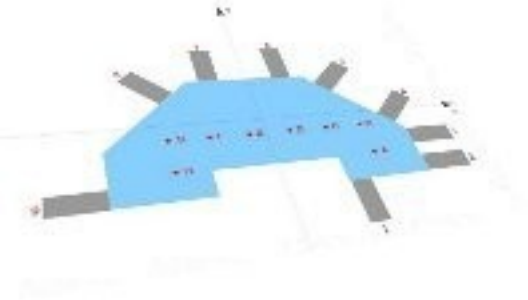
Time resolution of the TOP DIRC Prototype

Michael Sporleder
University Giessen
PANDA Collaboration Meeting March 3, 2009, Darmstadt

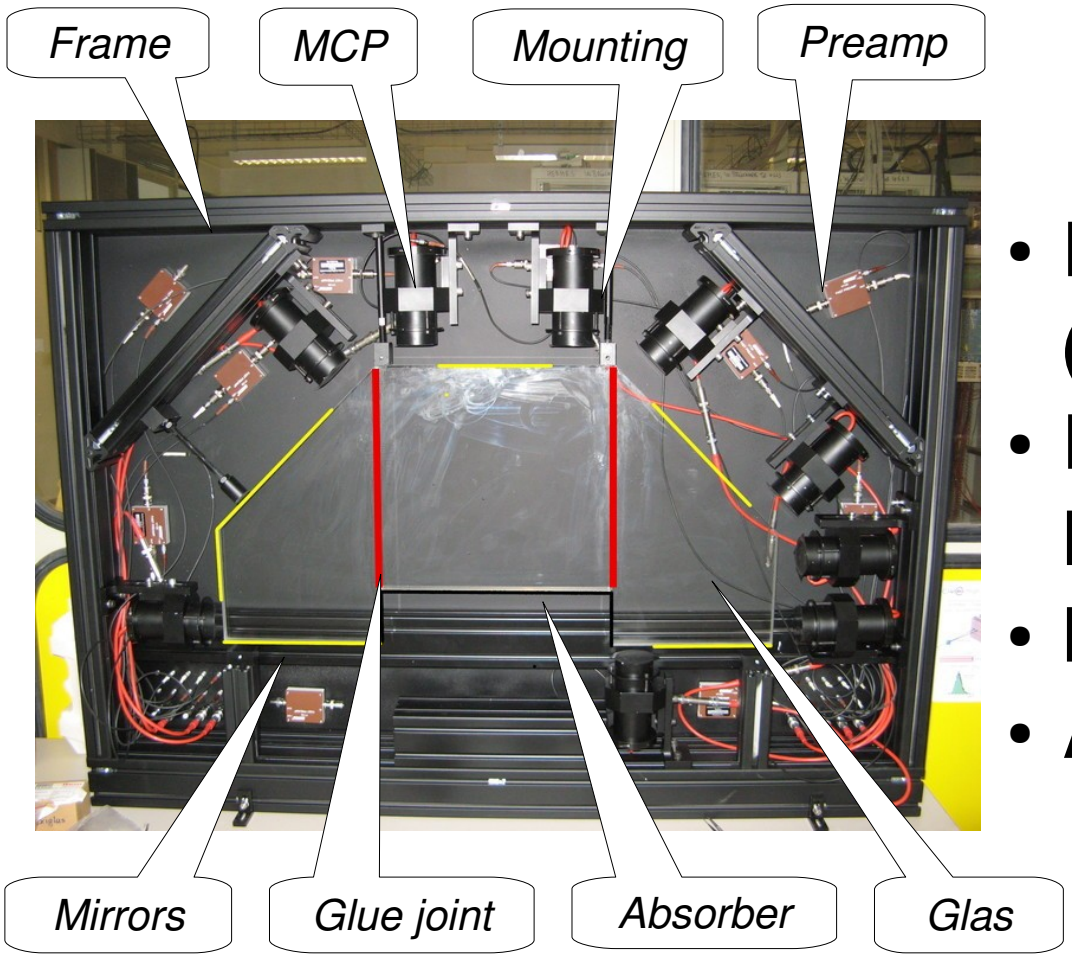
Outline

- Test beam setup
- Test beam scheme
- Closer look to the test beam data
- Comparison with Monte Carlo
- Time resolution
- Summary and outlook

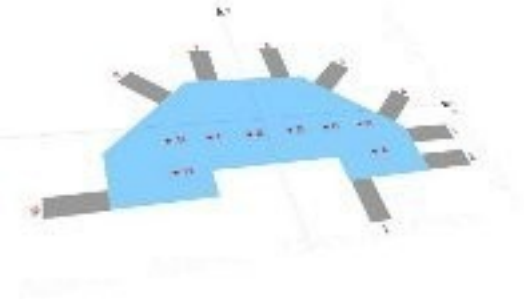


Michael Sporleder
PANDA Workgroup – Prof. Düren
University Giessen, Germany

The prototype

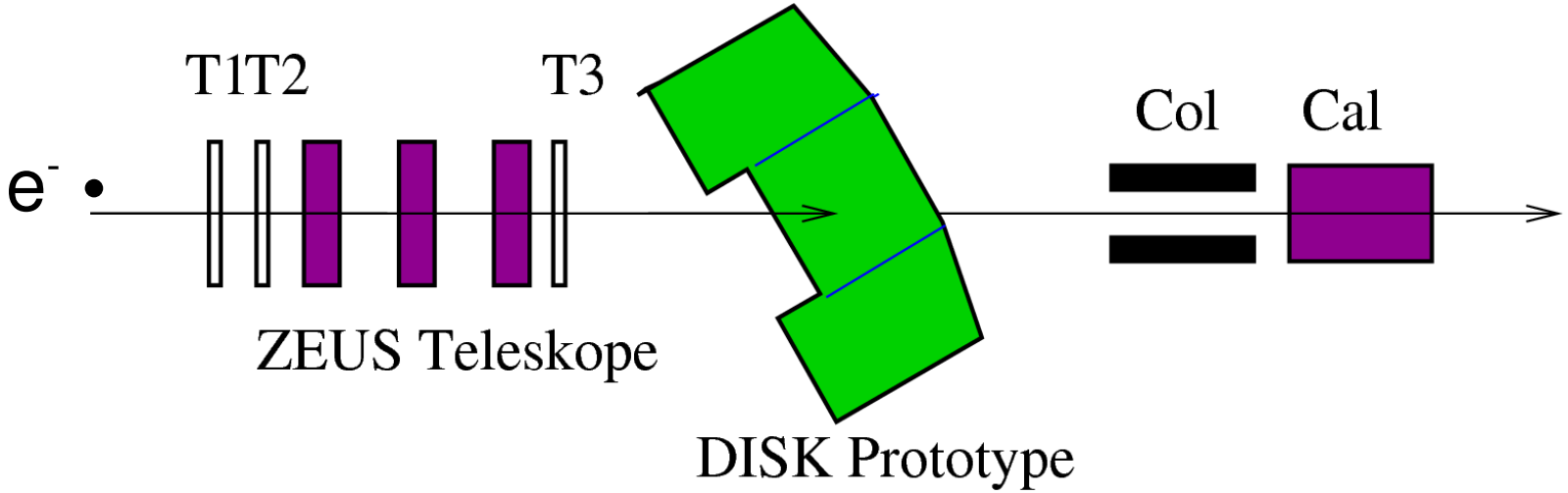


- **Borofloat 33 glas (3 pieces)**
- **BINP Multi Channel Plate MCPs with preamps**
- **Mirrors on the edges**
- **Absorber at the *beampipe***

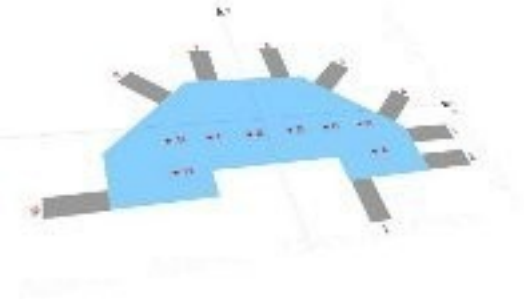


Michael Sporleder
PANDA Workgroup – Prof. Düren
University Giessen, Germany

Test beam DESY scheme



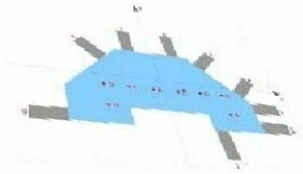
- **Trigger with ZEUS teleskope and calorimeter**
- **All devices mounted on adjustable tables**



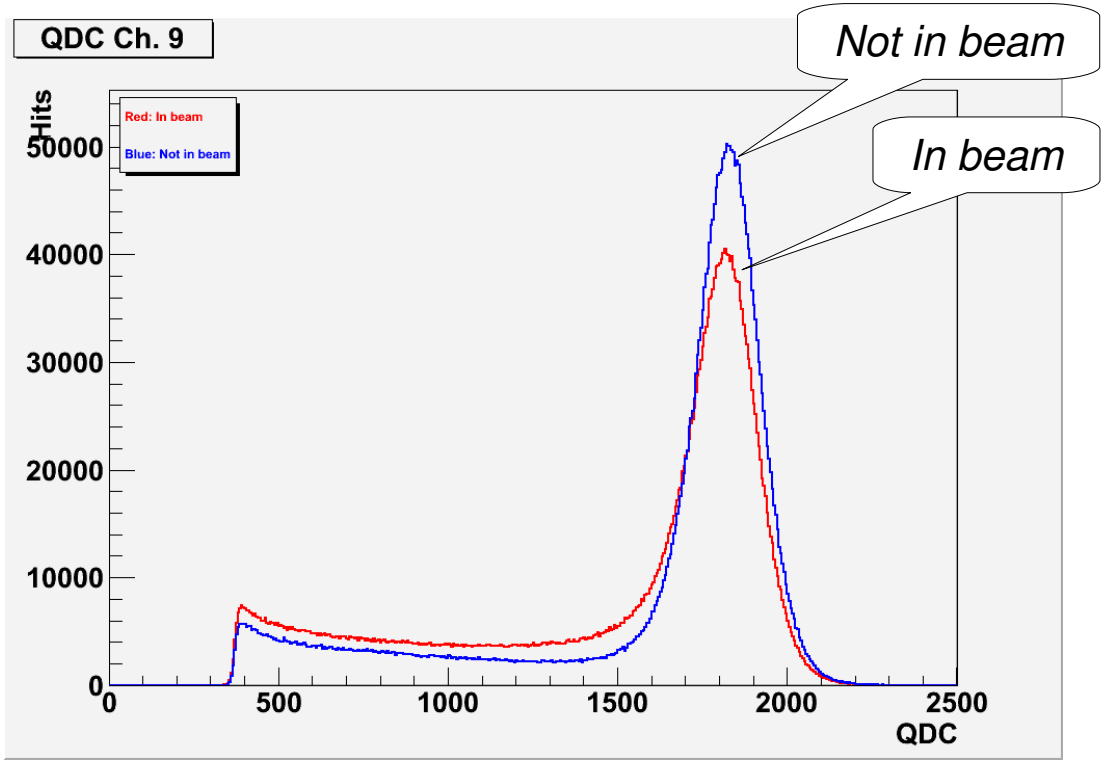
What we tried to do

Summary and outlook

- Further data analysis
- Extract time resolutions
- Trying to „reconstruct“ the data
- Further investigations about the optical properties of the glue joints

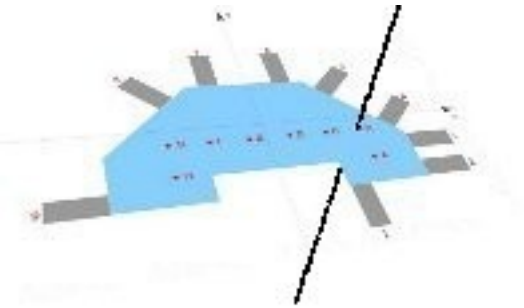


A closer look - Calorimeter



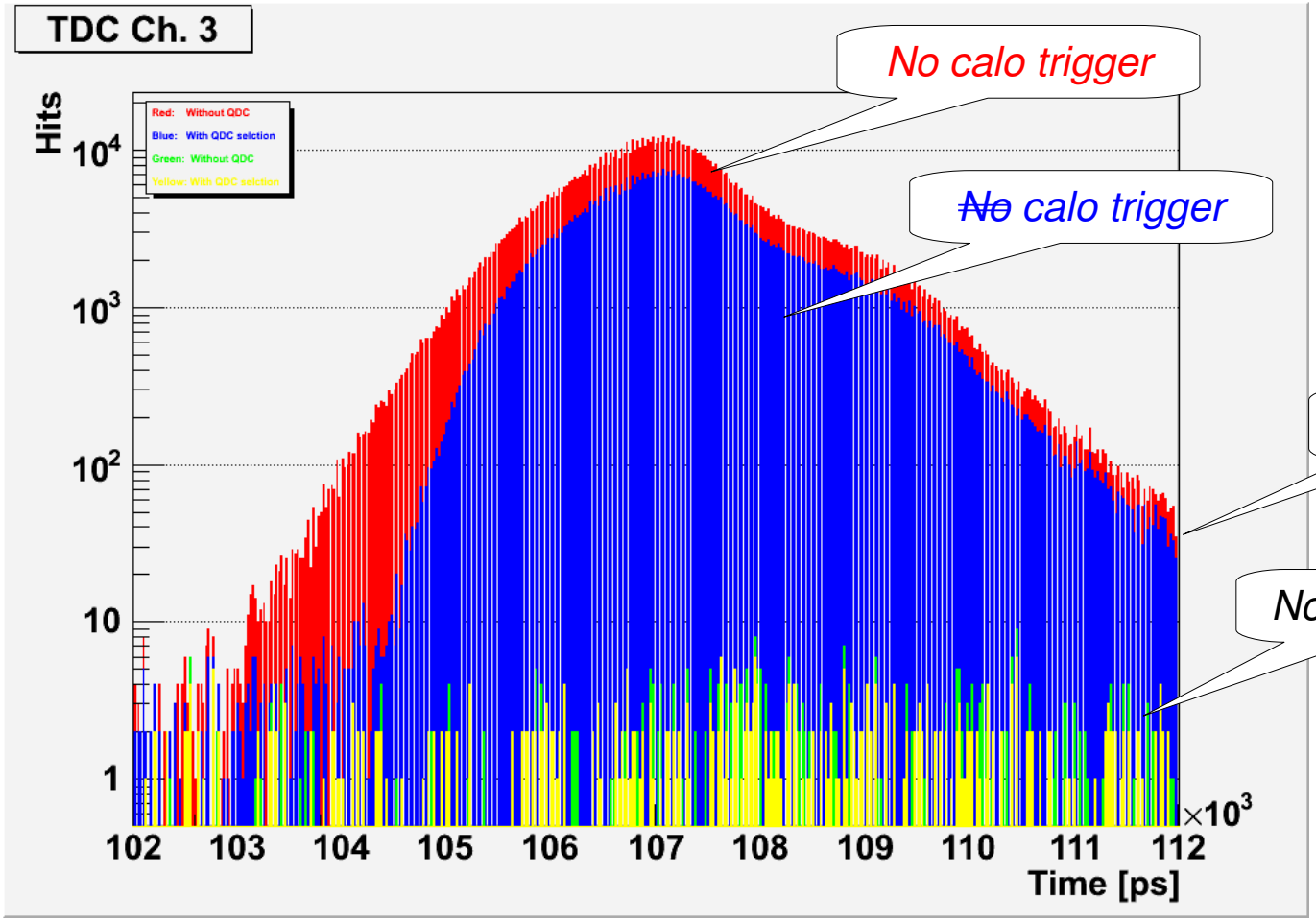
Calorimeter spectrum

- **We have showering**
- **The disc is visible in the calorimeter data**
- **Using the data to obtain cleaner beam**

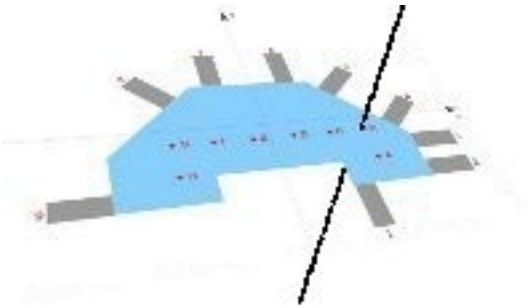


Michael Sporleder
PANDA Workgroup – Prof. Düren
University Giessen, Germany

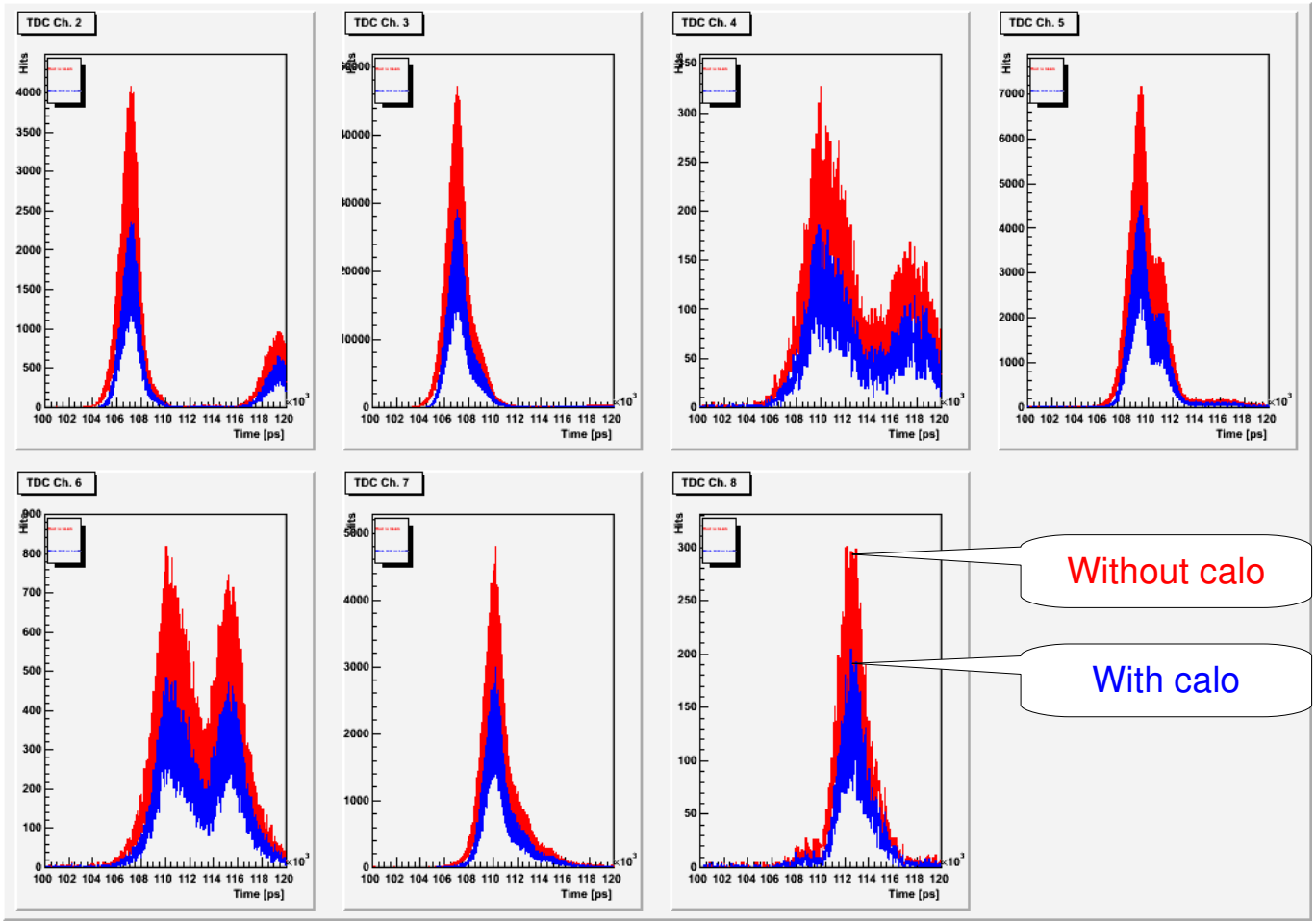
A closer look -Noise



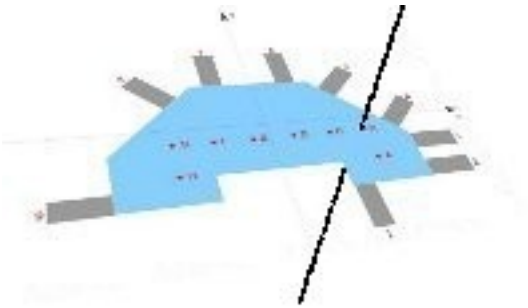
- **We have less than ~1.5% noise in a 10ns window**



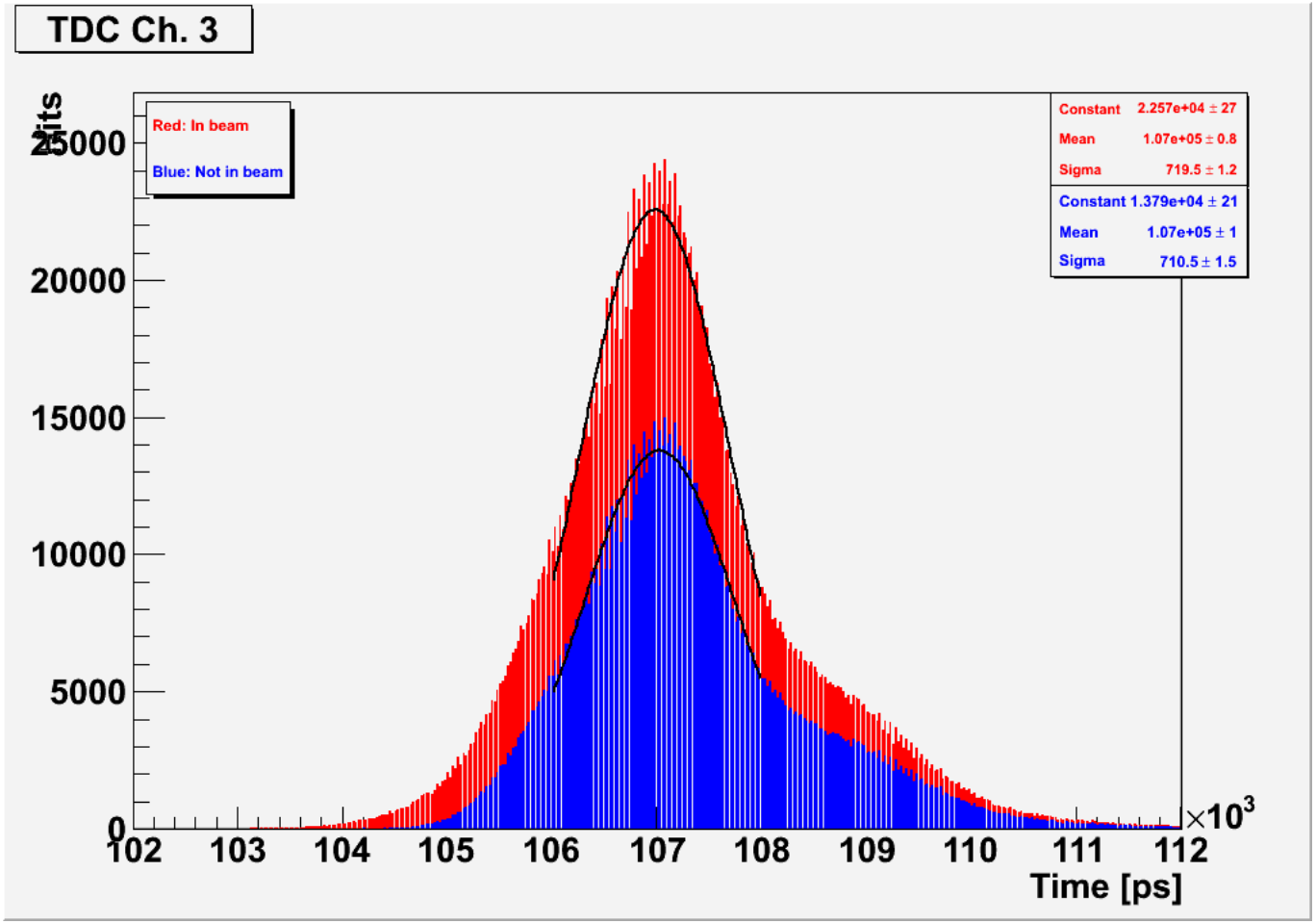
A closer look - TDC



- **Calorimeter trigger improves TDC resolution**



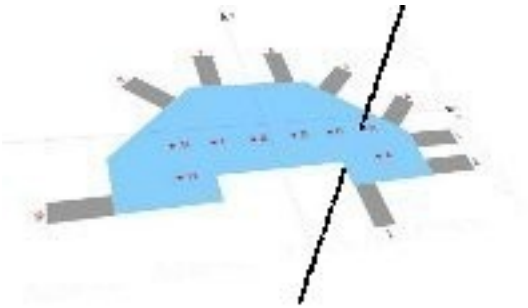
A closer look - TDC



- **Calorimeter trigger improves TDC resolution:**

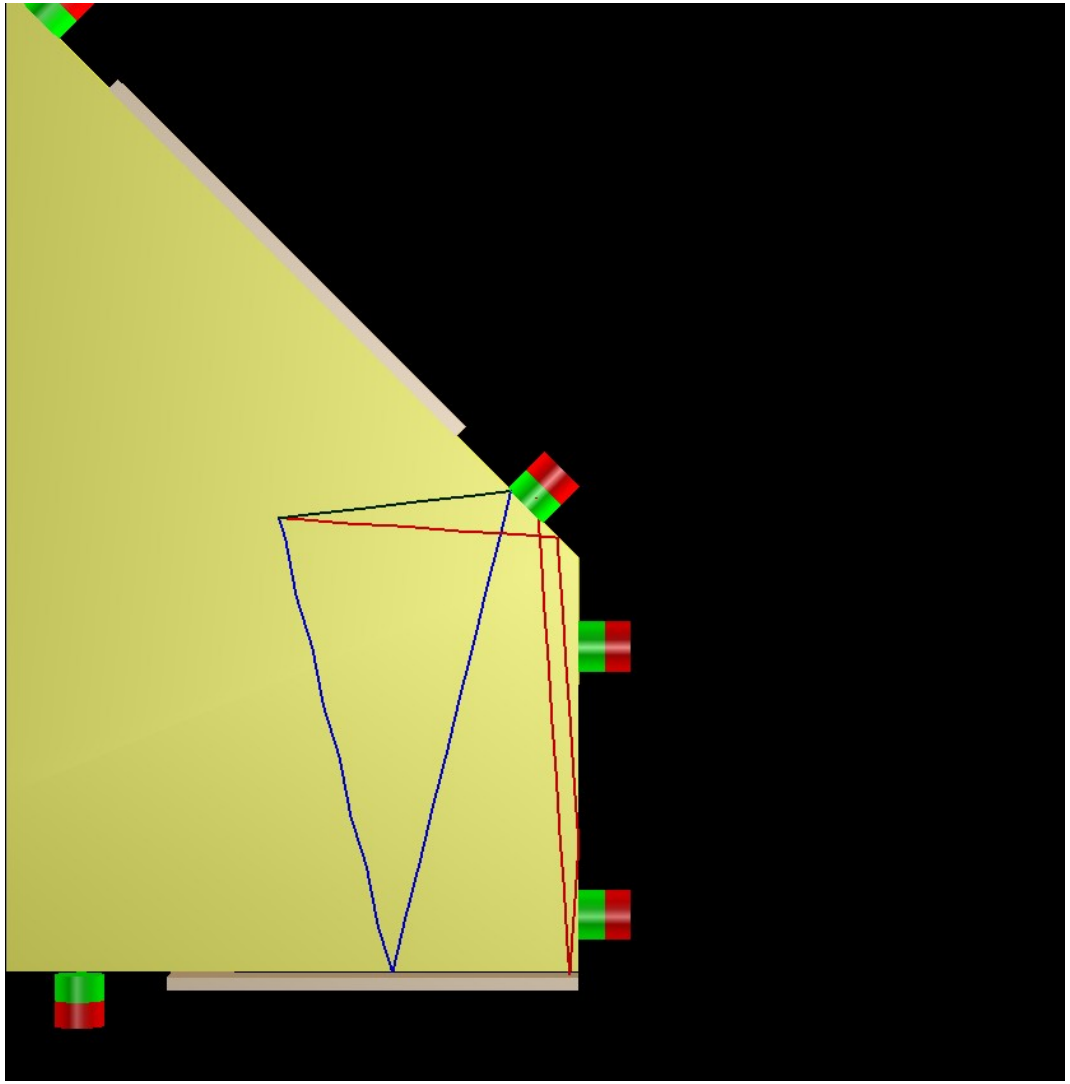
$$\sigma_r = 719.4\text{ps}$$

$$\sigma_b = 710.5\text{ps}$$



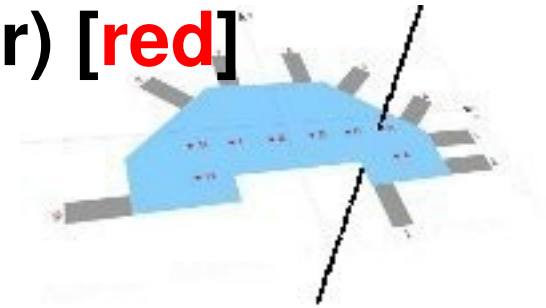
Michael Sporleder
PANDA Workgroup – Prof. Düren
University Giessen, Germany

Ray tracing from Monte Carlo (by Peter Koch)



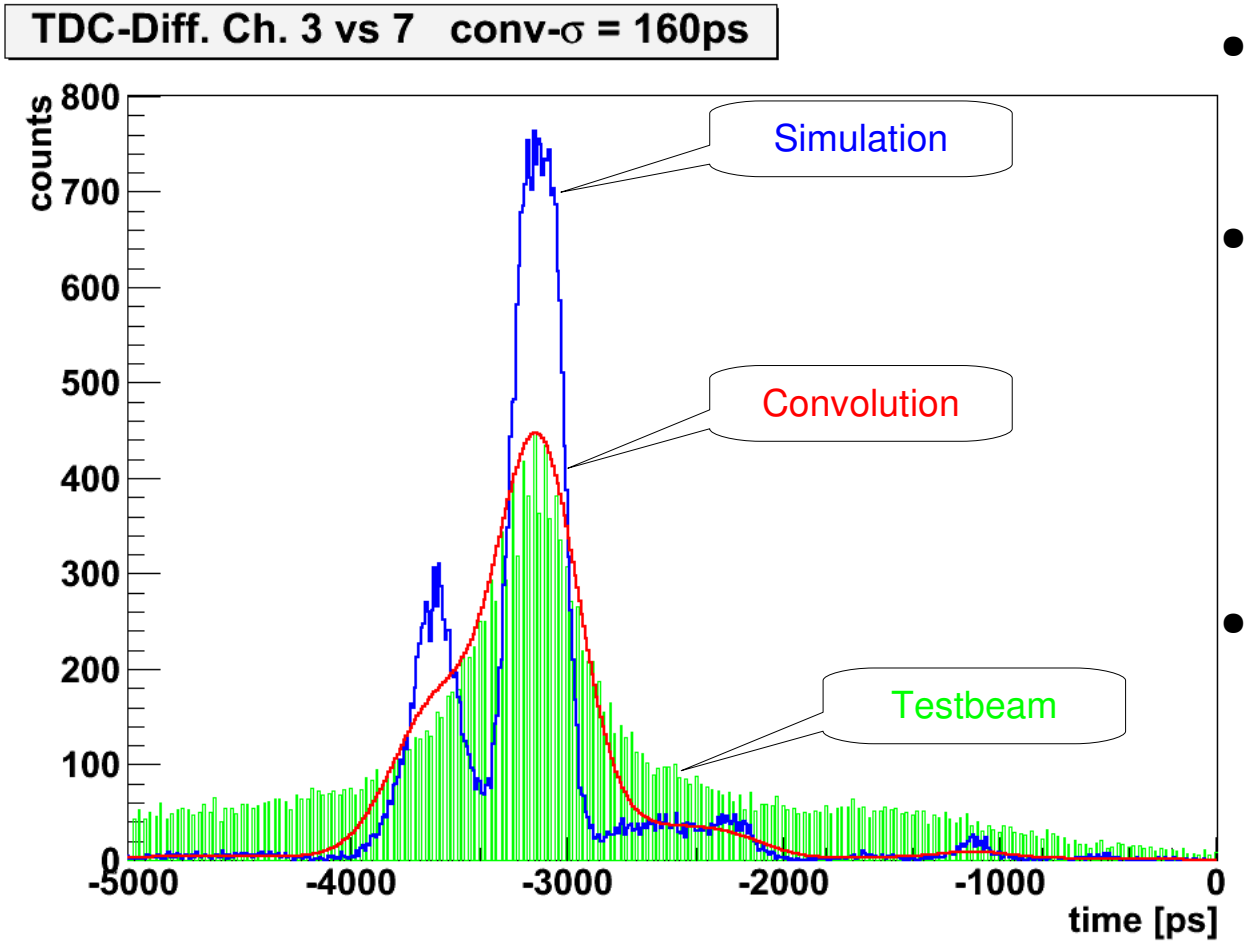
Simulation for MCP4 shows possible tracks:

- **Direct (black)**
- **With one reflection on the lower mirror [blue]**
- **With 3 reflections (2 total reflections, 1 mirror) [red]**

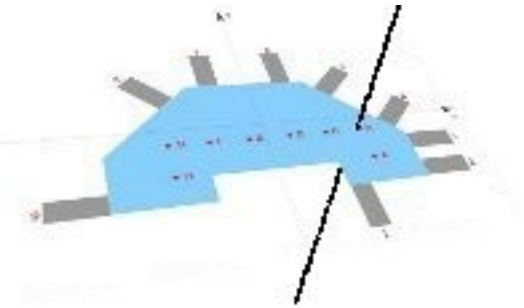


Michael Sporleder
PANDA Workgroup – Prof. Düren
University Giessen, Germany

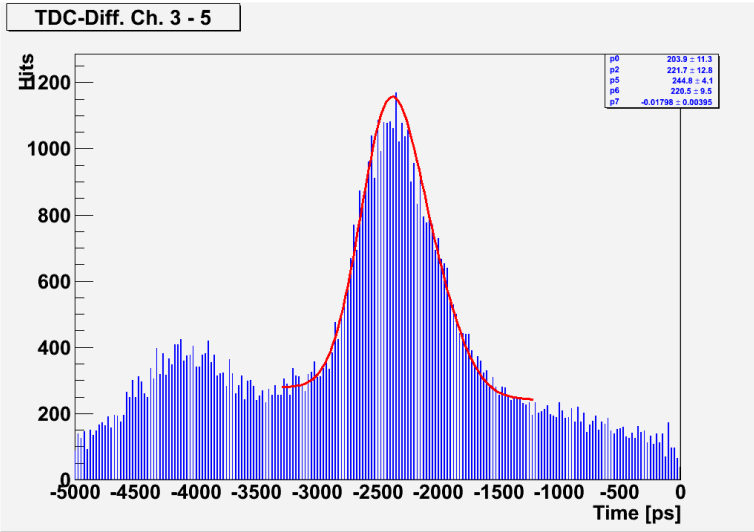
Monte Carlo vs test beam data (by Peter Koch)

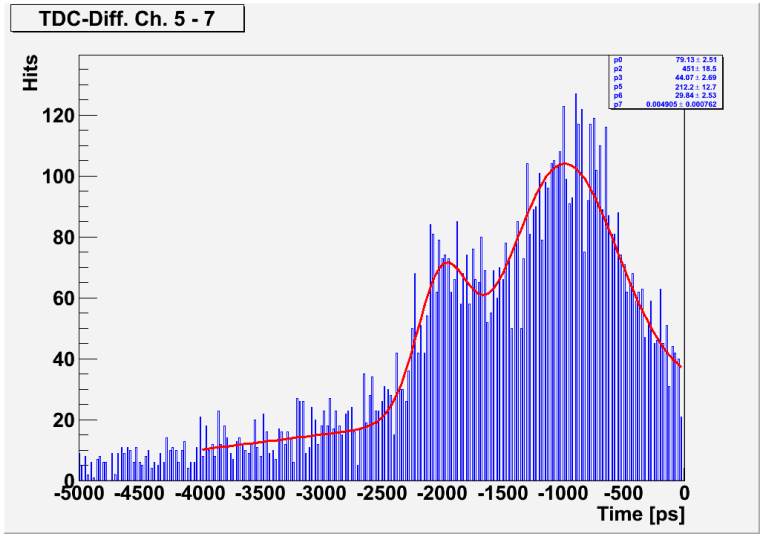


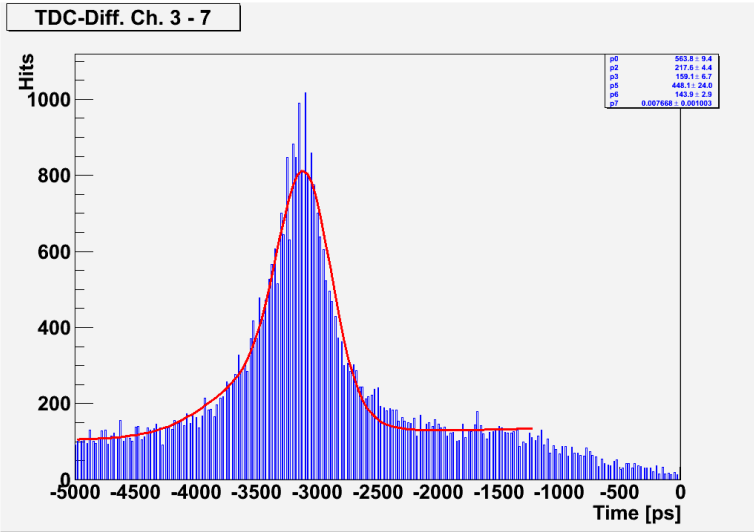
- **Simulation: Ideal MCP**
- **Convolution: Simulation & sigma =160ps MCP time resolution**
- **Comparing with testbeam**



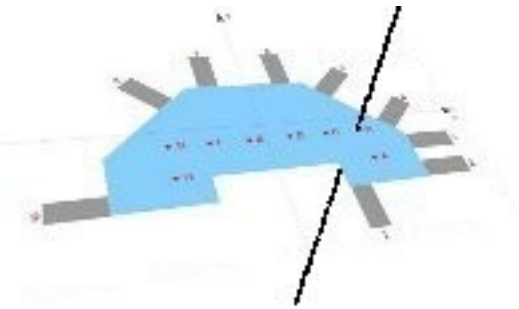
Time resolution – MCP time differences







Knowledge of underlying signal structure will help to find a reasonable fit (2 gaussian + 1 polynomial)



Time resolution

Ansatz:

$$\sigma_{35} = \sqrt{\sigma_3^2 + \sigma_5^2} = 245\,ps$$
$$\sigma_{37} = \sqrt{\sigma_3^2 + \sigma_7^2} = 218\,ps \quad \Leftrightarrow$$
$$\sigma_{57} = \sqrt{\sigma_5^2 + \sigma_7^2} = 451\,ps$$

$$Var_{35} = Var_3 + Var_5 = (245\,ps)^2$$
$$Var_{37} = Var_3 + Var_7 = (218\,ps)^2$$
$$Var_{57} = Var_5 + Var_7 = (451\,ps)^2$$

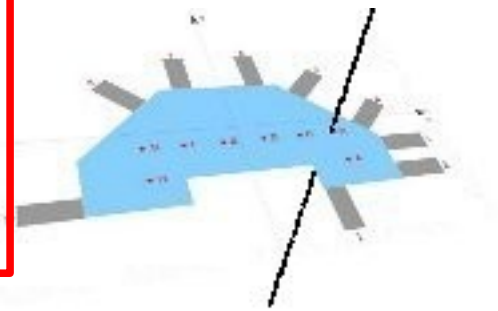
Solving the equation system:

$$Var_3 = \sigma_3^2 = -47926\,ps^2 \Rightarrow \sigma_3 = invalid$$
$$Var_5 = \sigma_5^2 = 107951\,ps^2 \Rightarrow \sigma_5 = 329\,ps$$
$$Var_7 = \sigma_7^2 = 95450\,ps^2 \Rightarrow \sigma_7 = 309\,ps$$

The solution makes no sense !

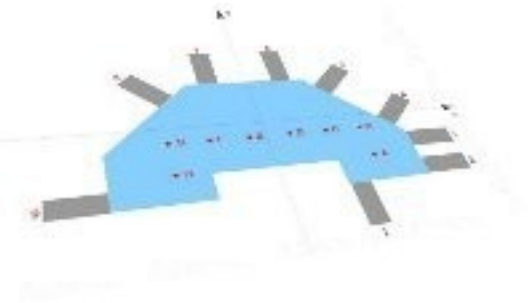
Best σ for position B :

$$\sigma = \frac{min(\sigma_{nm})}{\sqrt{2}} = \frac{\sigma_{37}}{\sqrt{2}} = 154\,ps$$



Summary and outlook

- **Ongoing data analysis**
- **Enhancing time resolution**



Good bye

Thank you very much for your attention !

Michael Sporleder
PANDA Workgroup – Prof. Düren
University Giessen
http://www.physik.uni-giessen.de/dueren
michael.sporleder@physik.uni-giessen.de