

# The DIRC prototype for the WASA experiment at COSY

- Adrian Zink on behalf of the WASA-DIRC group

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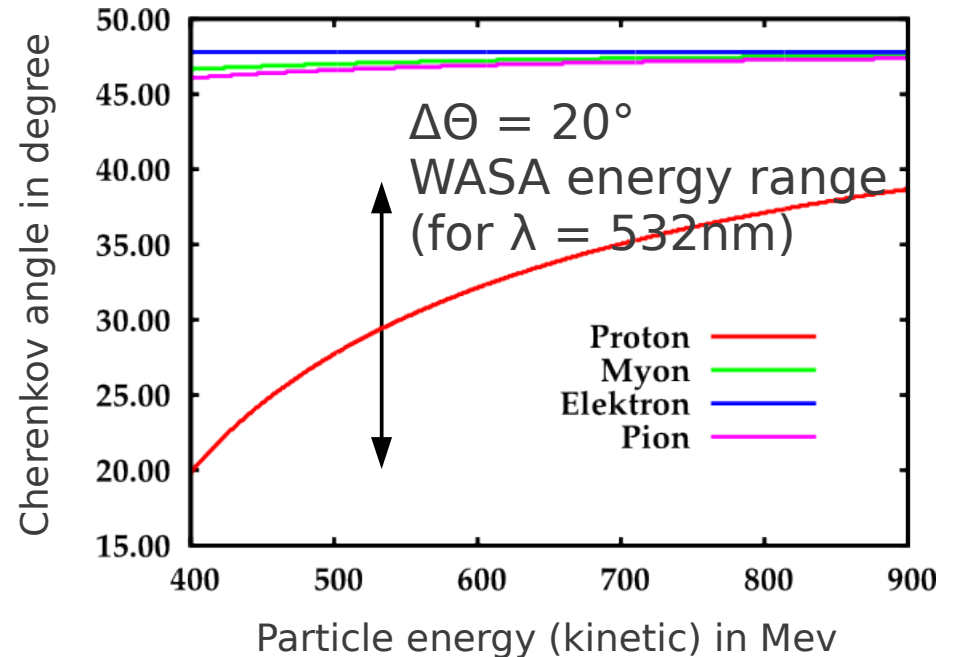
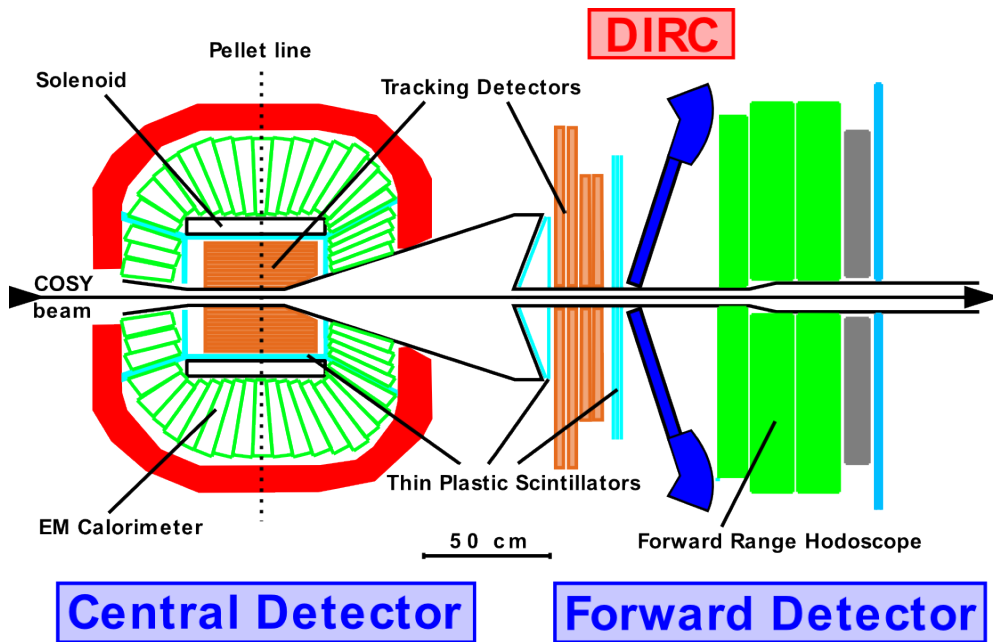


# Outline

- Motivation for a DIRC detector at WASA
- The demonstrator at the COSY beam at FZ Jülich
  - optical elements
  - photomultipliers
  - electronics
  - test setup
- Results of the test
  - hitpatterns
  - single Events
- Conclusion and outlook

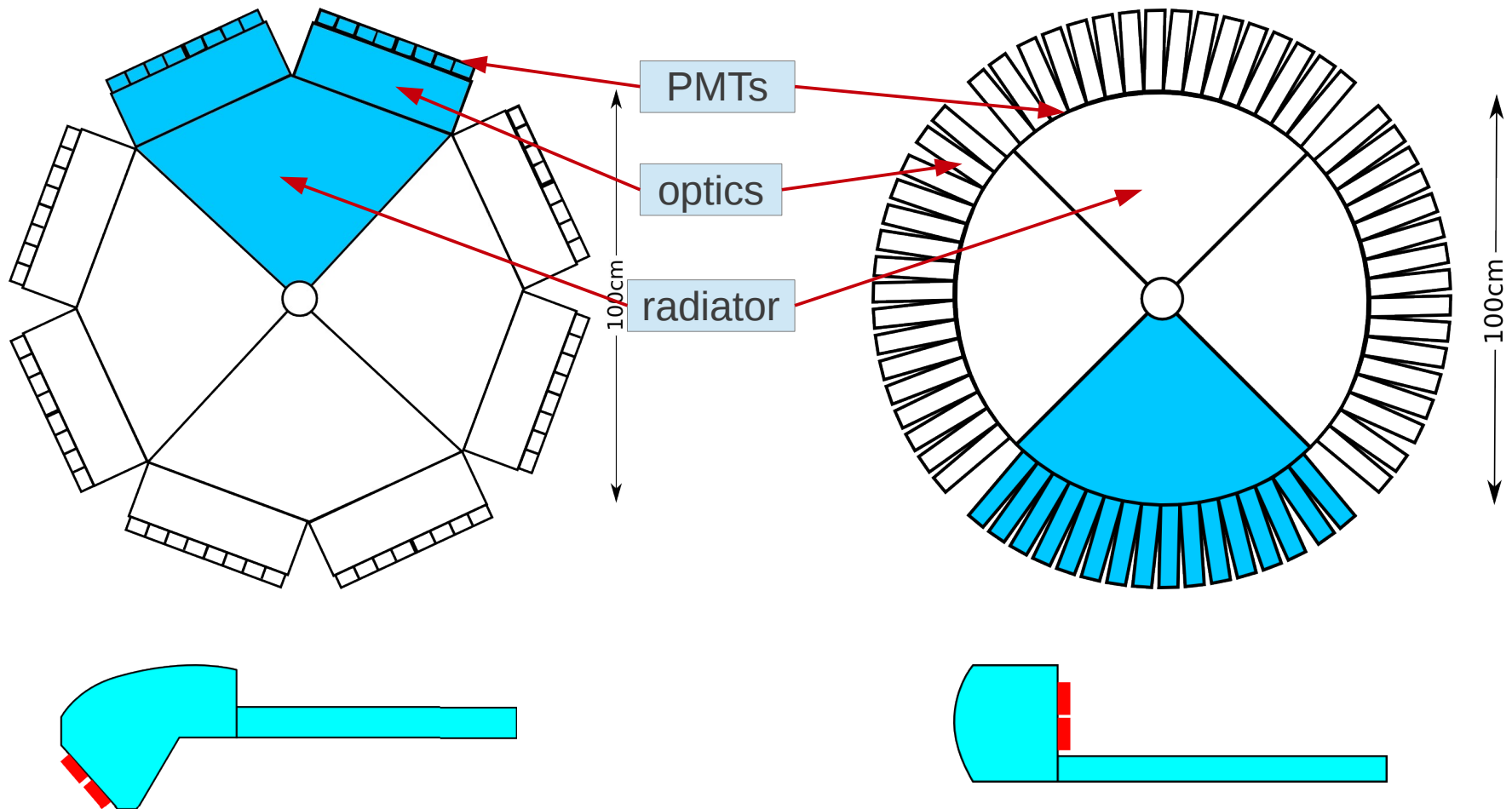
# Motivation - DIRC@WASA

- Cherenkov detector for particle ID and improvement of energy resolution
- Small space  $\rightarrow$  DIRC
- @WASA large change of Cherenkov angle
  - $\rightarrow$  less demands on material and optics  $\rightarrow$  use of Plexiglas

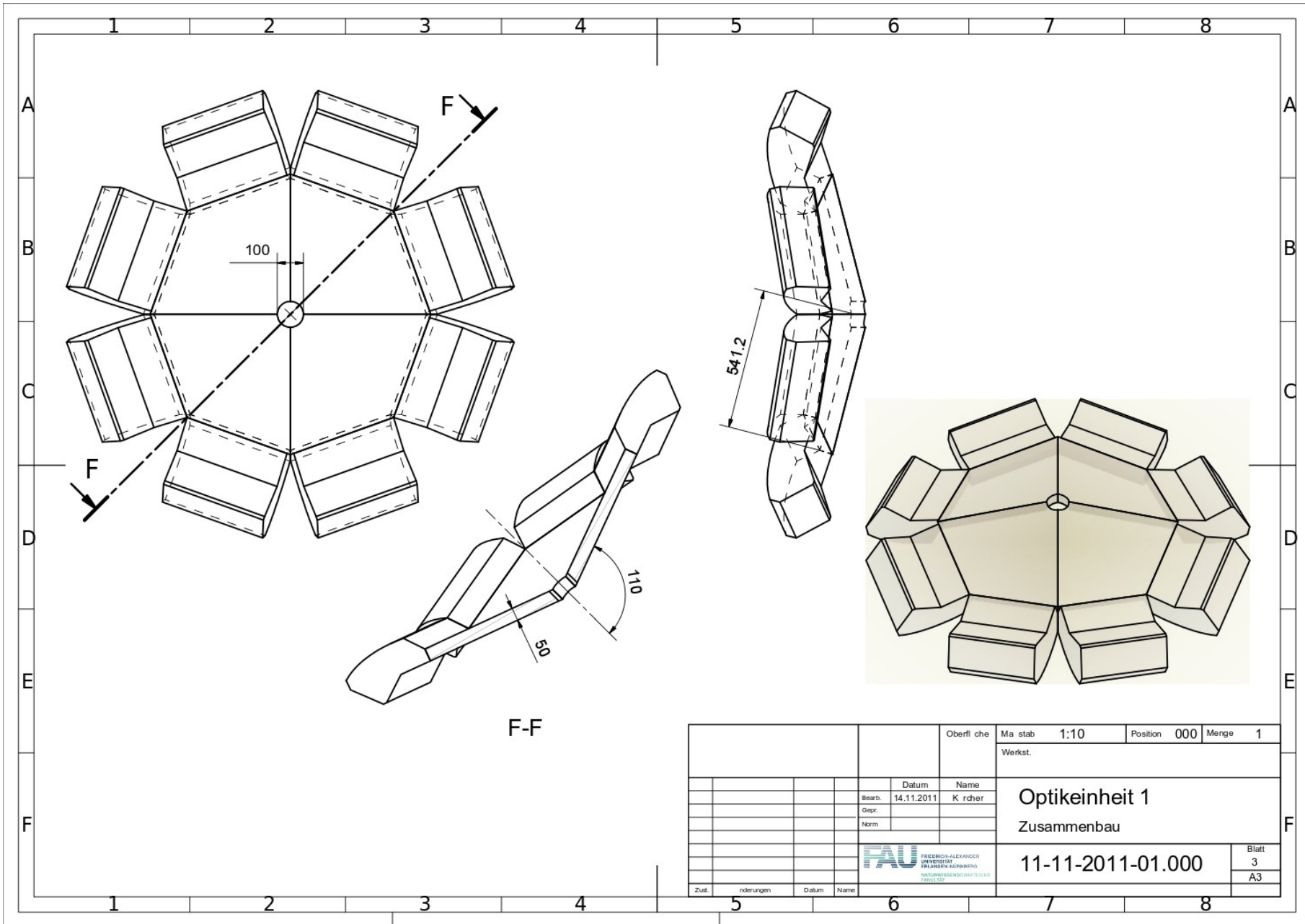


# Test - DIRC prototypes

- 2 quadrants equipped with PMTs and MCPs
  - Circular disc with single optics with mirror coated surface (Tübingen)
  - Octagonal disc with internally reflecting optics (Erlangen)



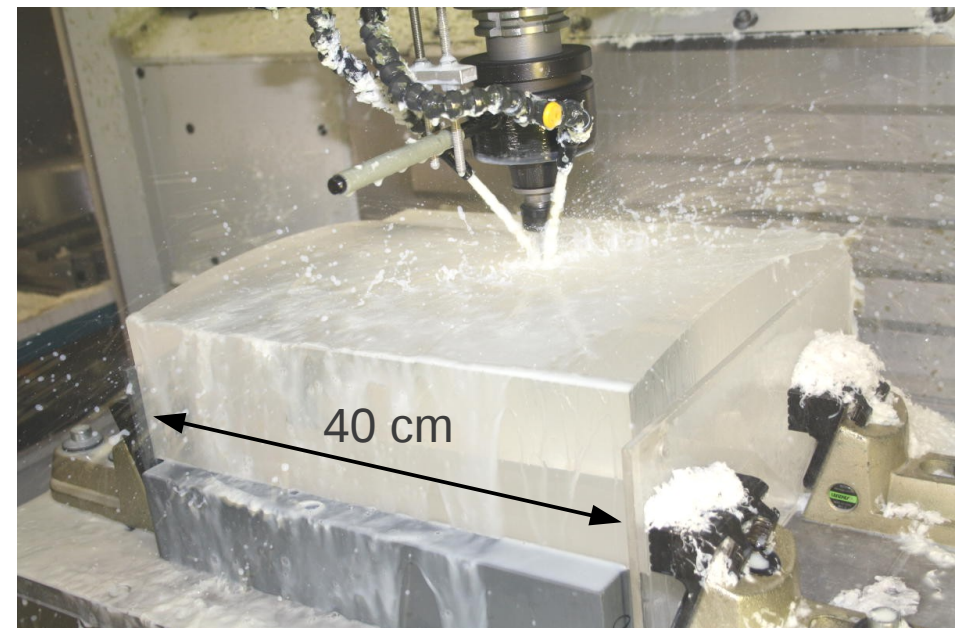
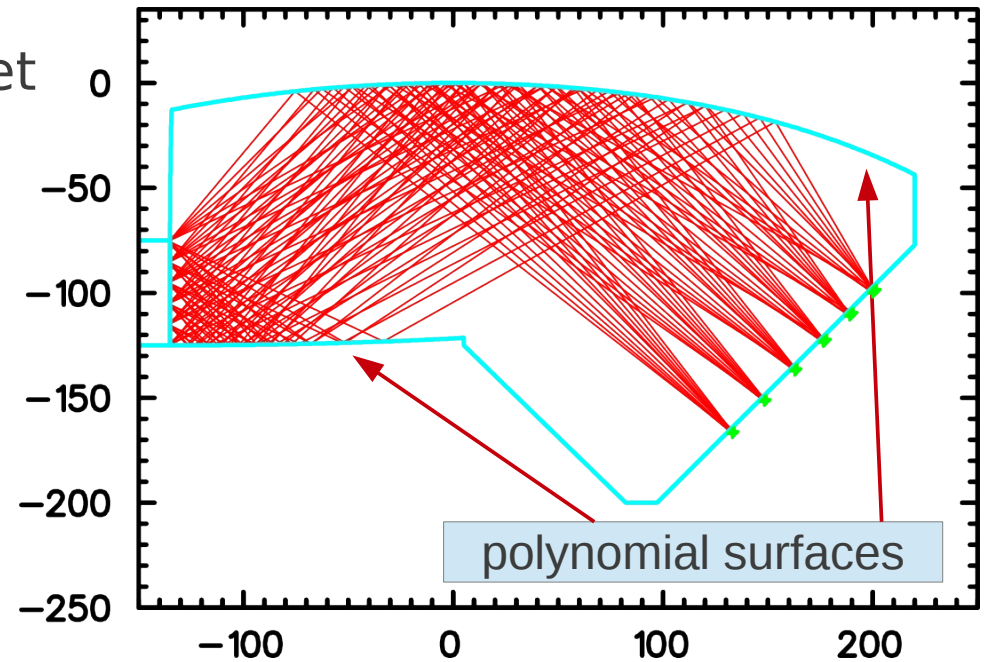
# Test - DIRC prototypes



		Oberfläche	Maßstab	1:10	Position	000	Menge	1
		Werkst.						
		Datum	Name					
		Bearb.	14.11.2011	K. rcher				
		Gepr.						
		Norm						
		 FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG NATURWISSENSCHAFTLICHE FACHFACULTÄT						
Zust.	Änderungen	Datum	Name		11-11-2011-01.000			Blatt 3 A3

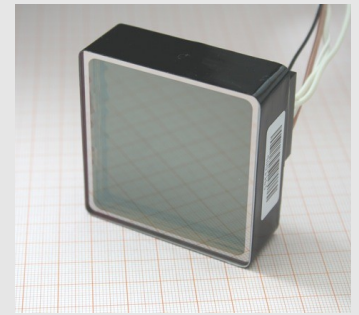
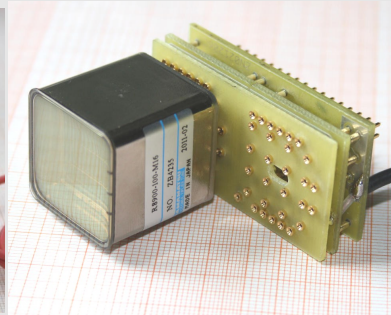
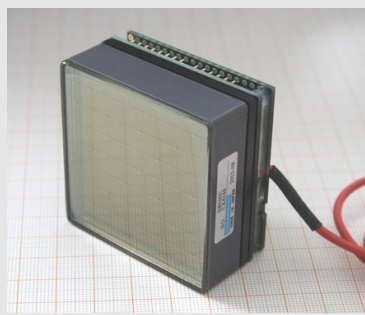
# Test - Optics and radiator

- Radiator cut of 5cm Plexiglas sheet with cast surface
  - reflectance  $\approx 99\%$
  - transparent from about 400 nm
- Optics from block machined in 3D technique and polished
  - focus smaller 1 mm



# Test - used PMTs

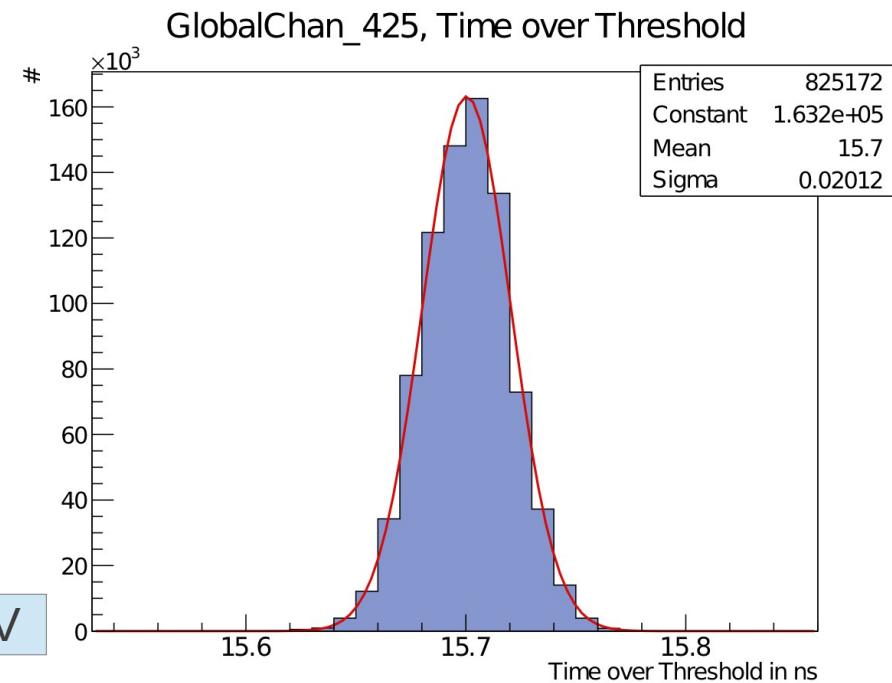
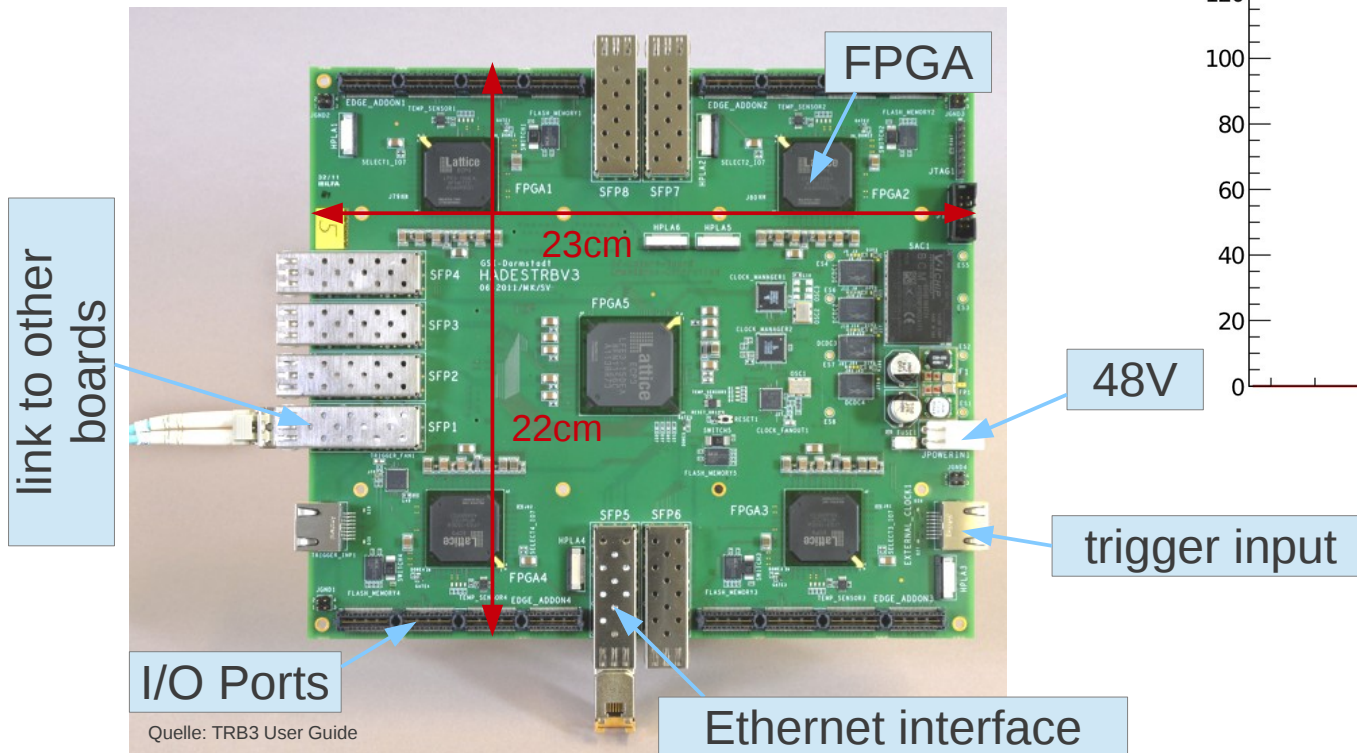
typ	Hamamatsu H8500C	R8900-100-M16	R11265-100-M16	Photonis XP85012
art	Flatpanel PMT 12 Dynoden normal cathode	12 dynodes Supercathode	Flatpanel PMT 12 dynoden Supercathode	Microchannel plate 2 steps, 25 $\mu$ m pore <b>Usable in B field</b>
channels	64 (8x8)	16 (4x4)	16 (4x4)	64 (8x8)
area	52x52mm <sup>2</sup>	26.2x26.2mm <sup>2</sup>	26.2x26.2mm <sup>2</sup>	59x59mm <sup>2</sup>
→ active	<b>89%</b>	82%	812	81%
gain (max. V)	2x10 <sup>6</sup>	7x10 <sup>6</sup>	2.5x10 <sup>6</sup>	1.5x10 <sup>6</sup>
QE (typ. @400nm)	25%	<b>38%</b>	<b>38%</b>	23%
time resolution $\sigma$	150ps	230ps	105ps	<b>50ps</b>
used in test	30	120	4	2



large number of channels (ca. 2000 DIRC + 400 hodoscope)  
→ new electronics

# Test - electronics TRBv3

- FPGA based TDC and trigger board
  - 256 TDC channels/board
  - up to 3ps time resolution possible (typ. 14ps with 256 channels)
  - high rates (up to 700kHz recorded, 50MHz hits)
  - easy handling
    - connected to PC via ethernet
    - 48V powersupply

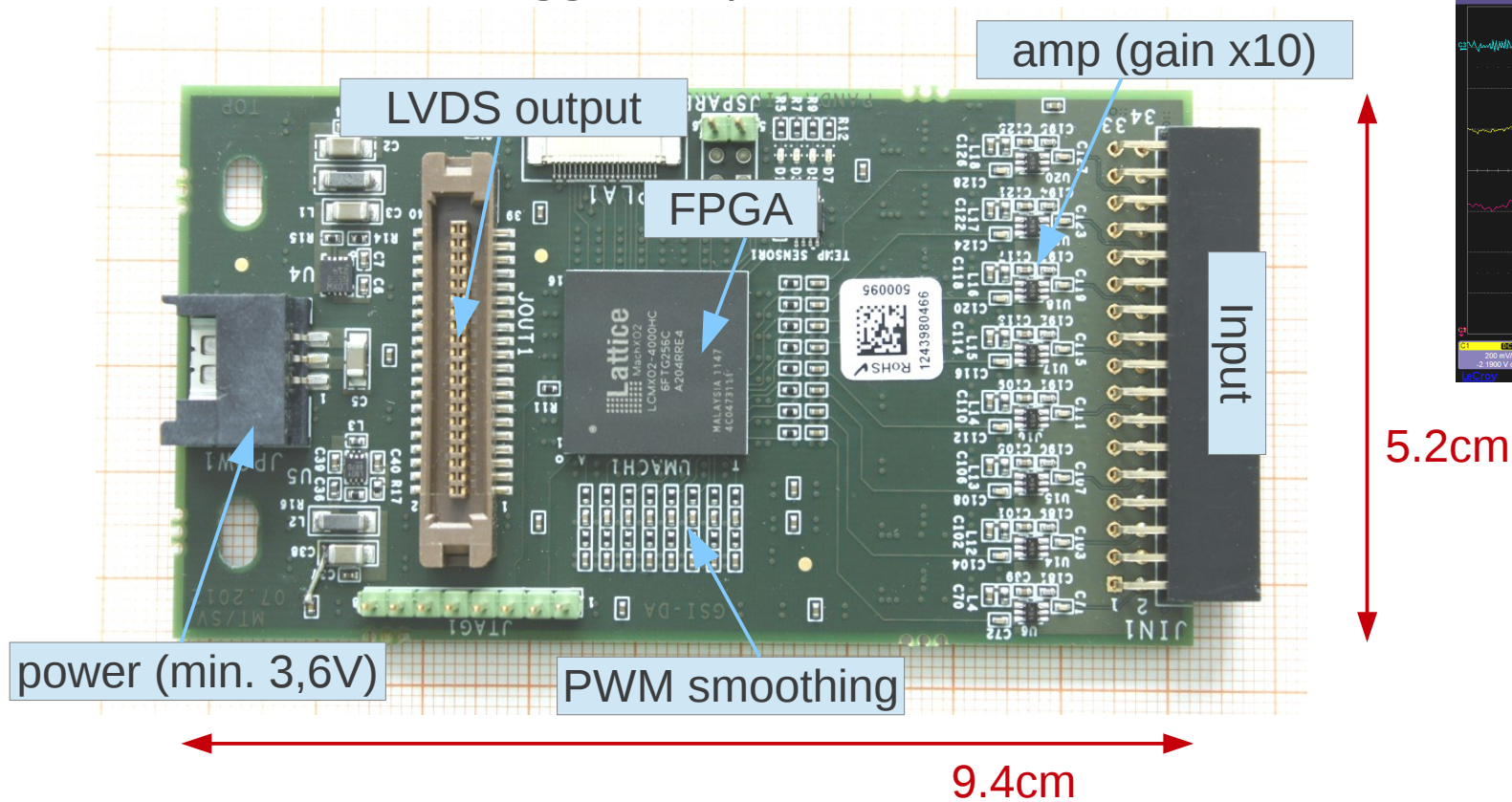


TOT spectra of Lasertrigger:  
 $\sigma = 20 \text{ ps}$  (with Padiwa FrontEnd)



# Test - electronics Padiwa (PAndaDIrcWAsa)

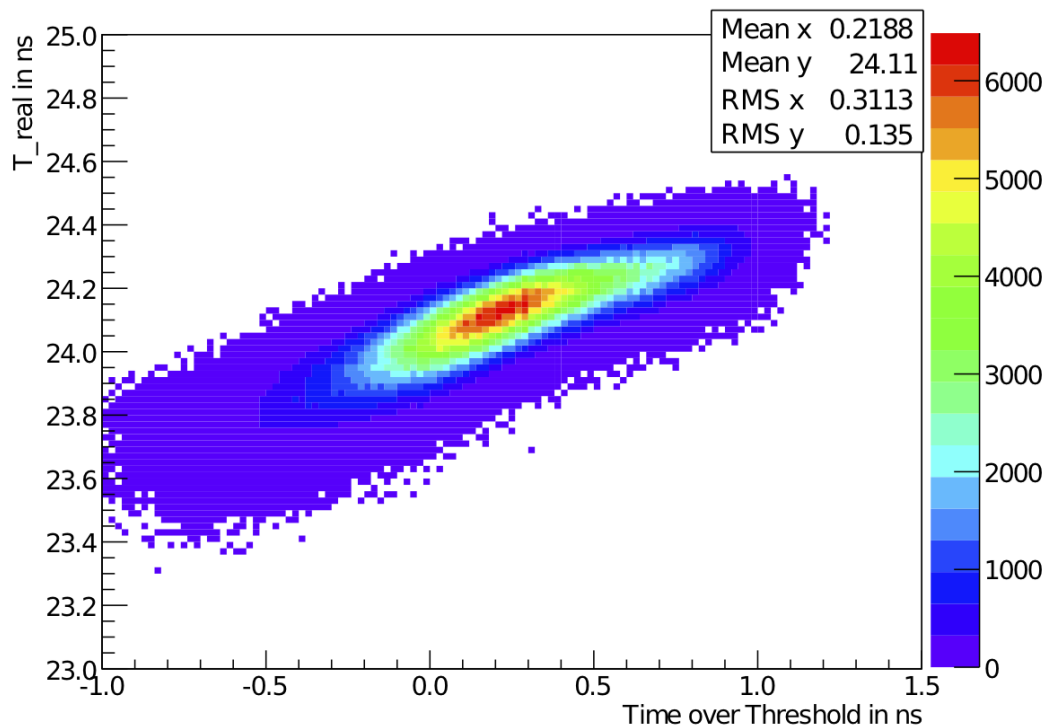
- New developed FPGA based discriminator board
  - 16 channels (single ended input (+ or -))
  - Threshold by PWM (puls width modulation) direct from
  - Threshold selection and other settings via TRB3 board
  - LVDS output
  - Monitor und trigger output



# Test - electronics performance

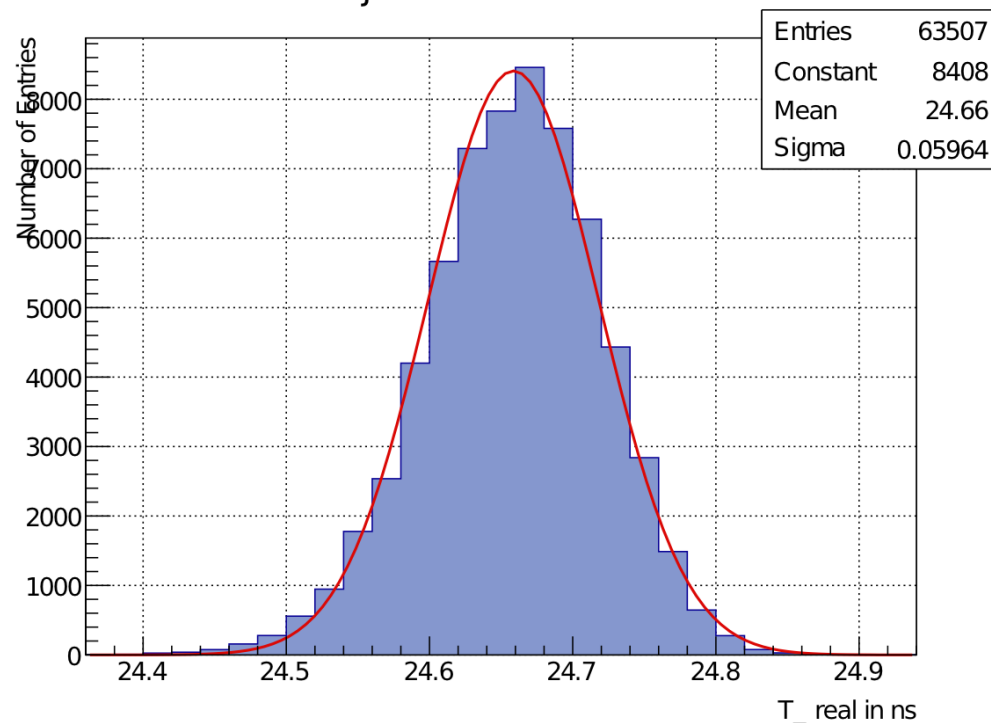
- Single and multi photon time resolution, tested with laserpulsers and MCP

MCP, Tot vs T\_real, Laser 20kHz, ND 3, hohe Schwelle

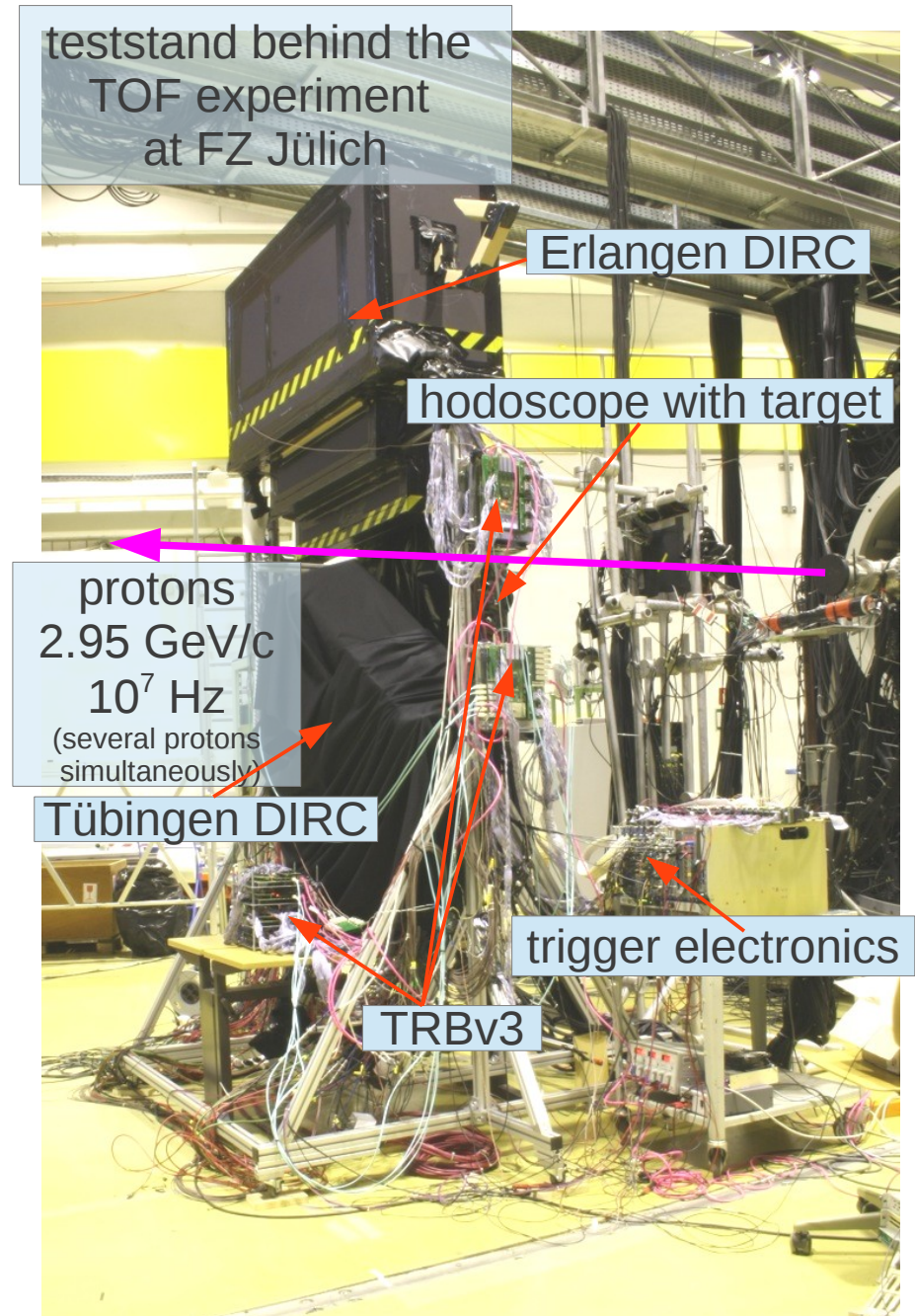
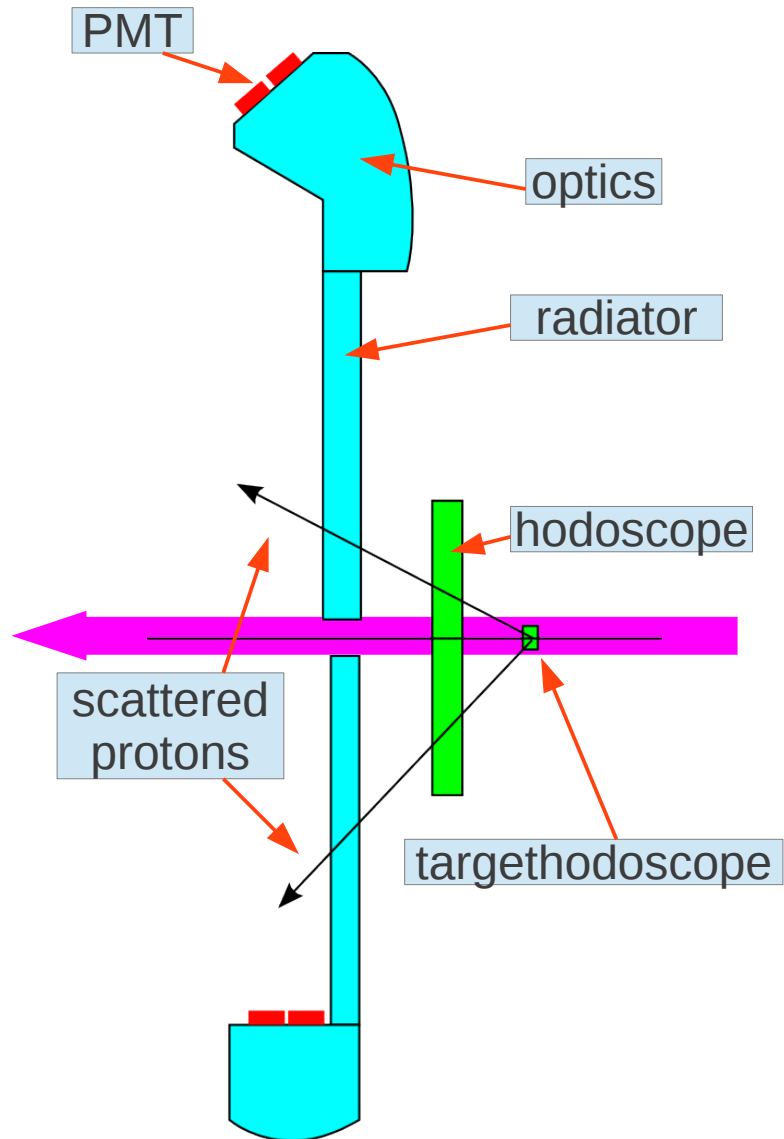


$\sigma = 60$  ps for multi photons  
 $70$  ps for singles

ProjectionY of binx=128

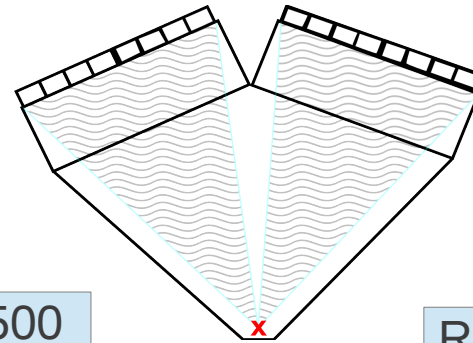


# Demonstrator - scheme of the test setup



# Results - Hitpattern

- Focal plane of the Erlangen DIRC
- $2.95\text{GeV}/c \rightarrow 45.2^\circ$  opening angle

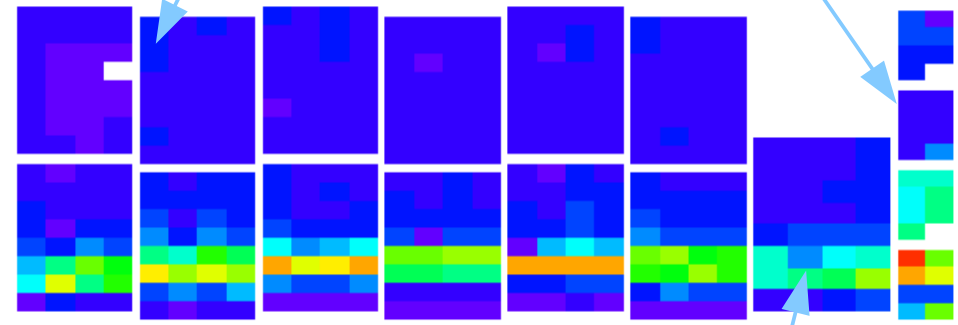
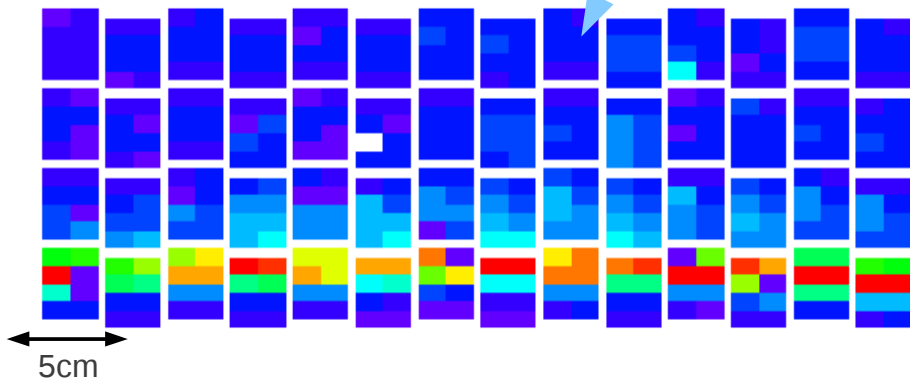


0° tilt

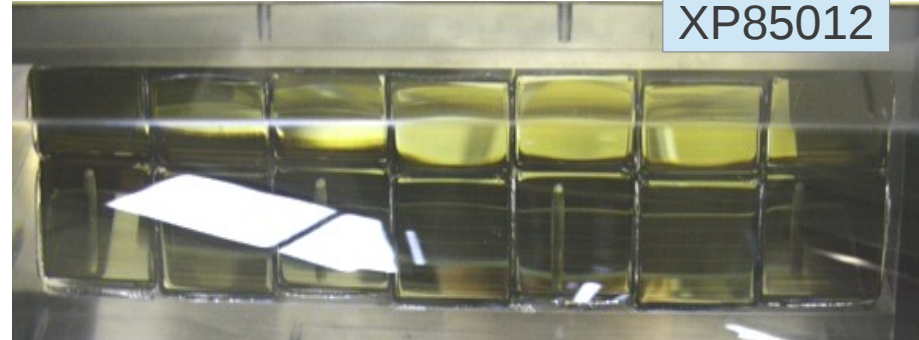
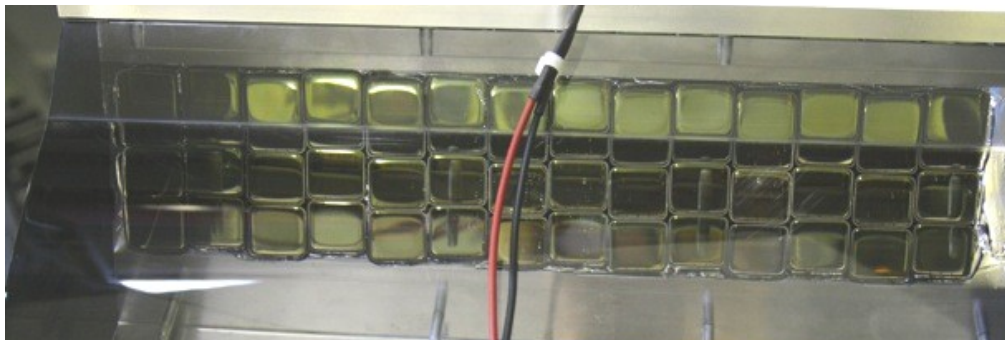
R8900

H8500

R11265

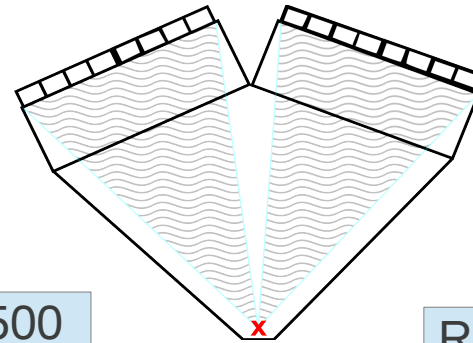


XP85012



# Results - Hitpattern

- Focal plane of the Erlangen DIRC
- $2.95\text{GeV}/c \rightarrow 45.2^\circ$  opening angle

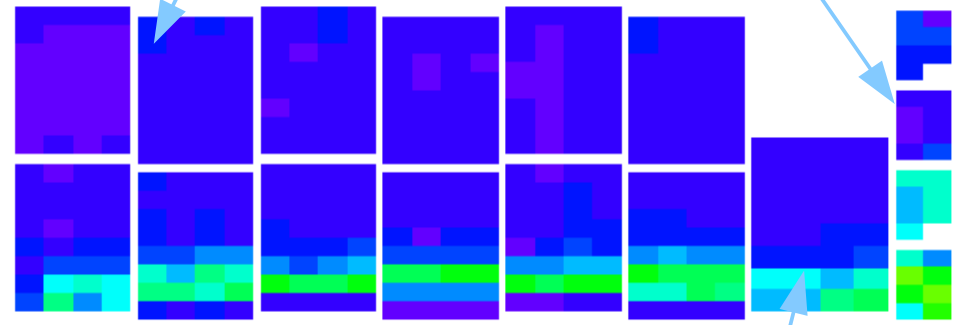
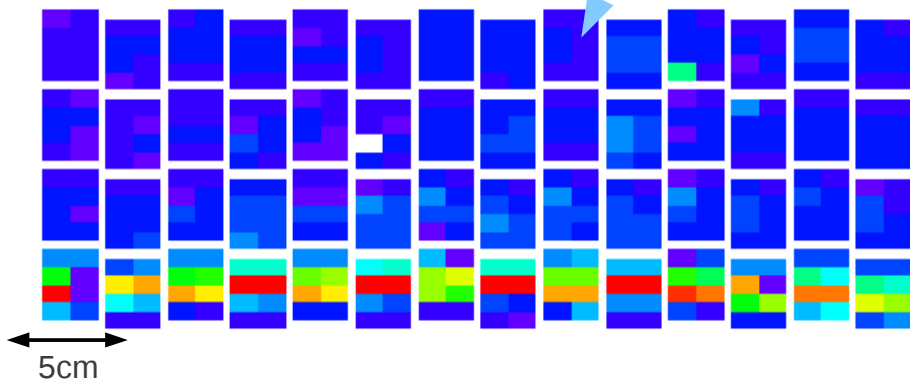


1° tilt

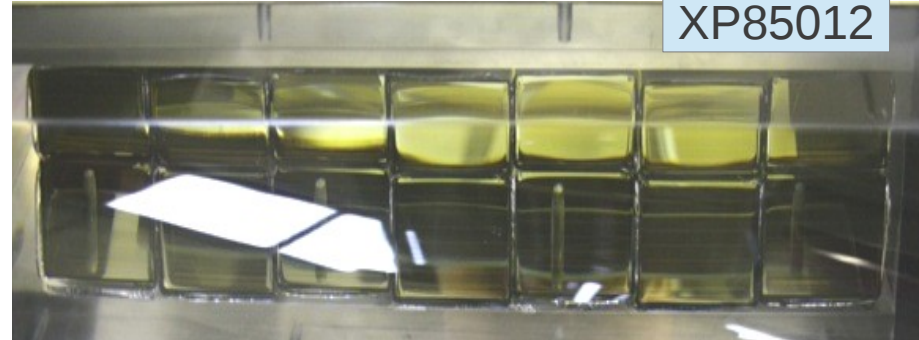
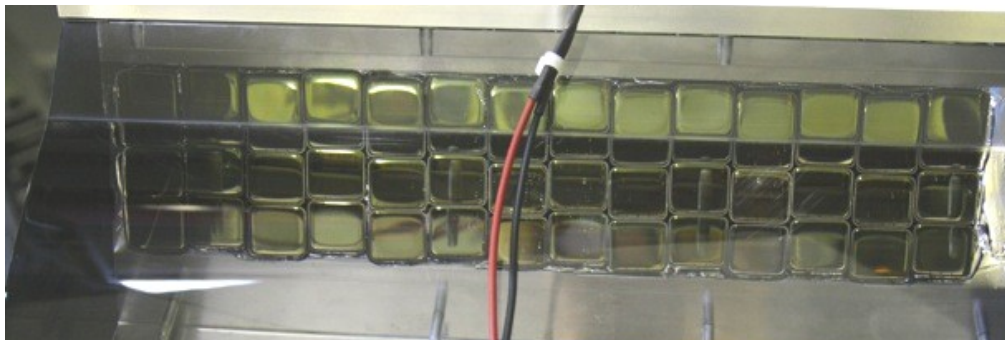
R8900

H8500

R11265

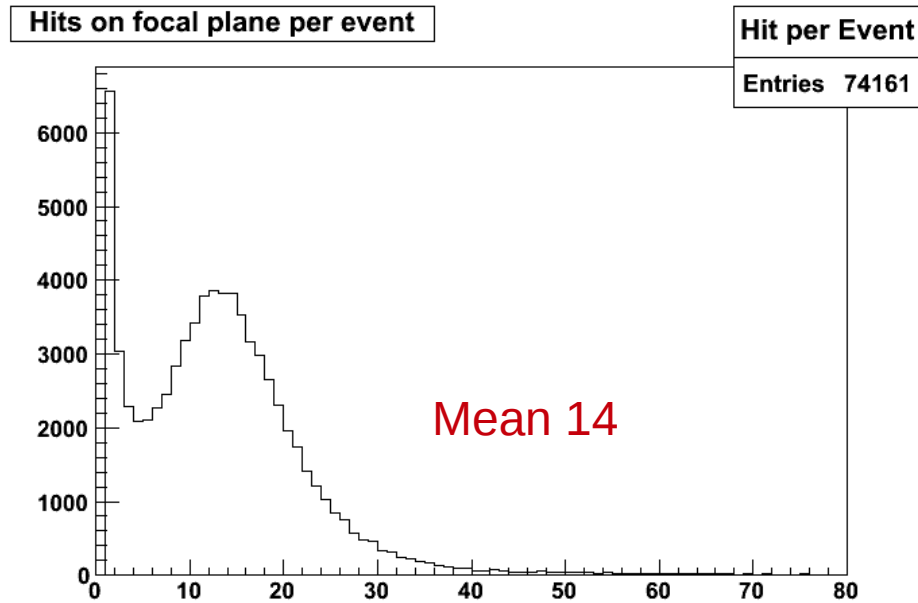


XP85012



# Results - Hitpattern

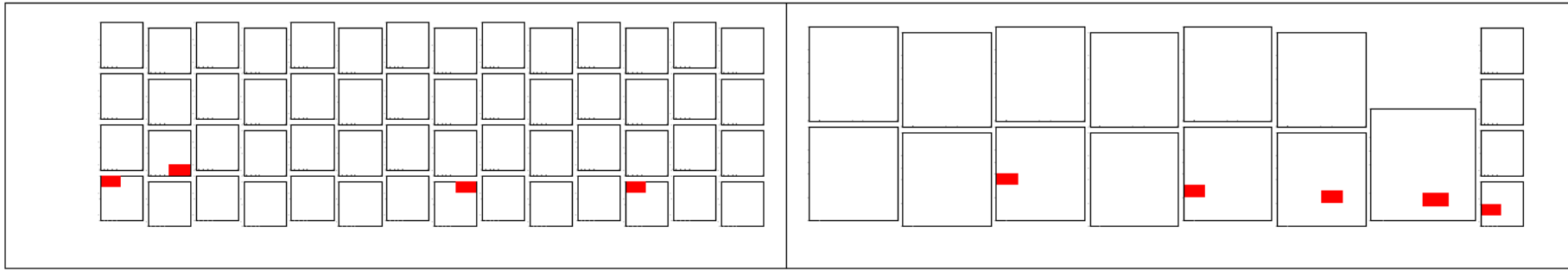
- Hits per event (Erlangen DIRC)



# Results - Single events

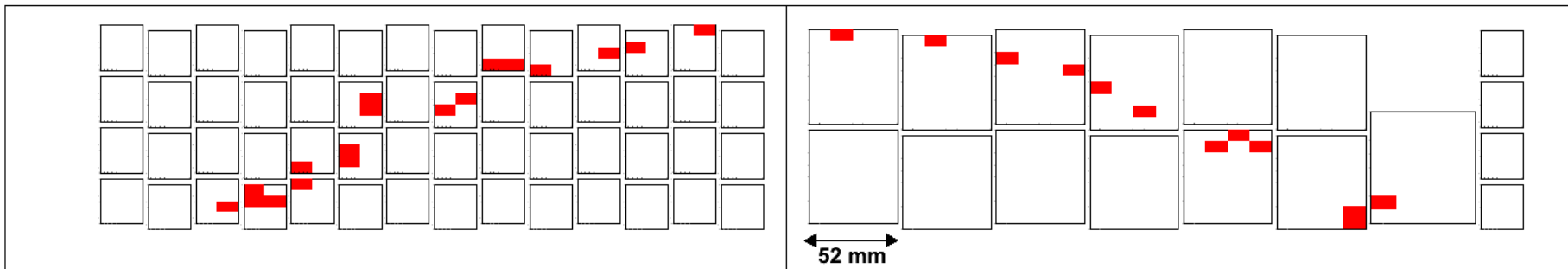
- Beam proton

Run 999  
2,95 GeV/c



- scattered proton

Run 999  
2,95 GeV/c



# Results - Single events

## parabola fit (for upper part)

\*\*\*\*\*

Minimizer is Minuit / Mgrad

Chi2 = 2.502

NDf = 3

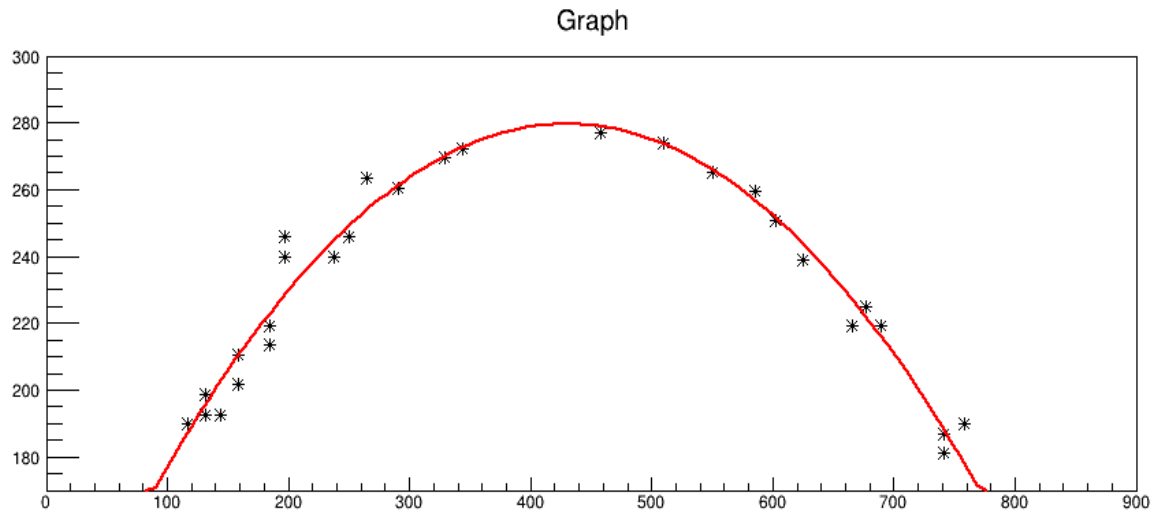
Edm = 1.91435e-07

NCalls = 65

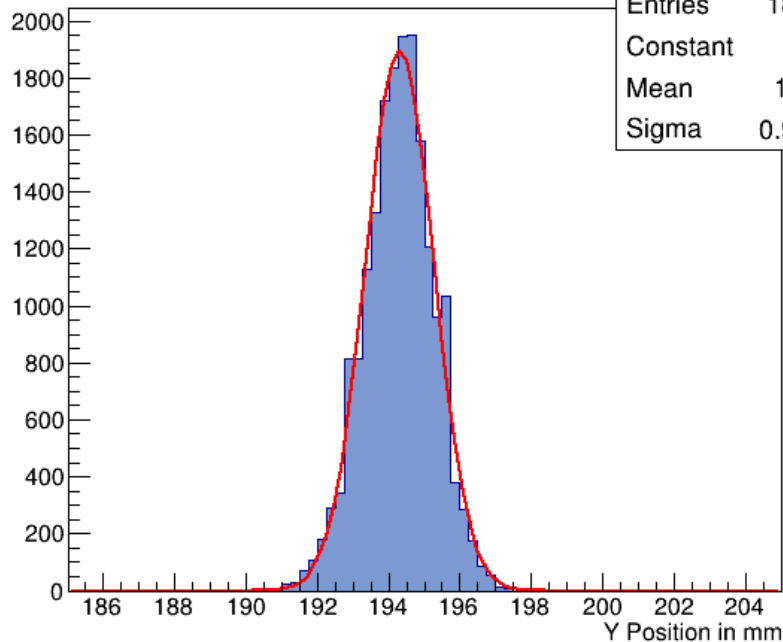
p0 = -0.000918933 +/- 6.65152e-05

p1 = 430.972 +/- 2.23034

p2 = 278.766 +/- 0.730212  
 equals  $0.175^\circ = 3\text{mrad}$



## 0° tilt



Entries	18367
Constant	1896
Mean	194.3
Sigma	0.9617

## constant fit - direct hits

$\sigma = 0.23^\circ = 4\text{mrad}$

Cherenkov angles at 2.95 GeV/c

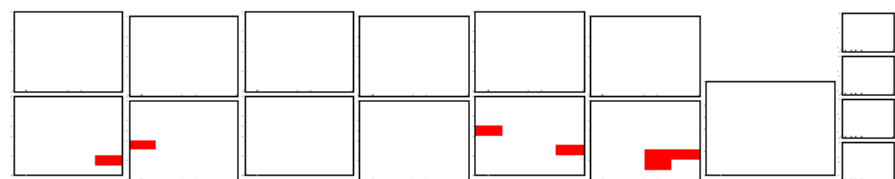
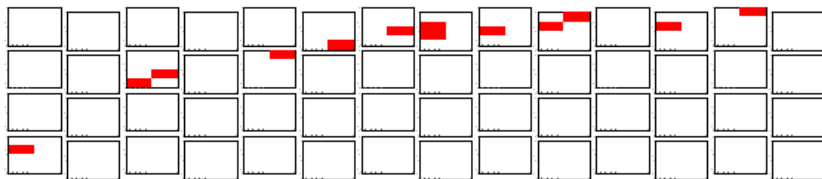
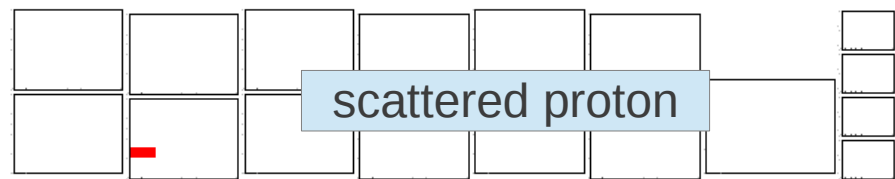
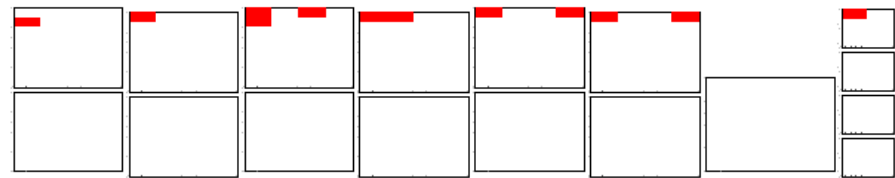
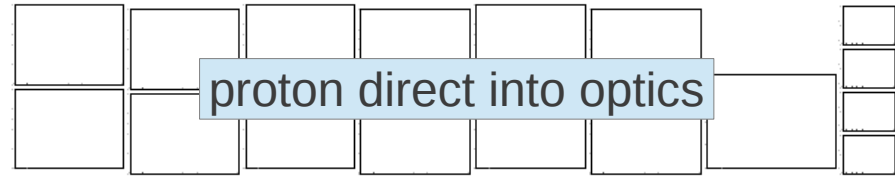
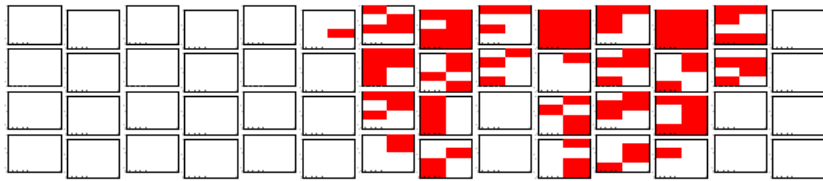
Proton 45.2°

Kaon 47.1°

Pion 47.8°



# Results - Single events



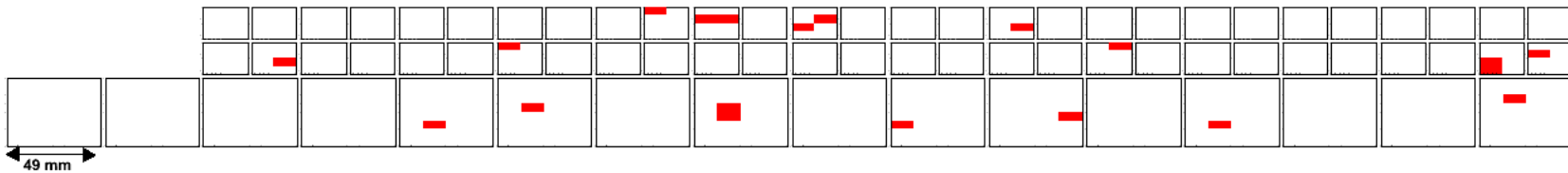
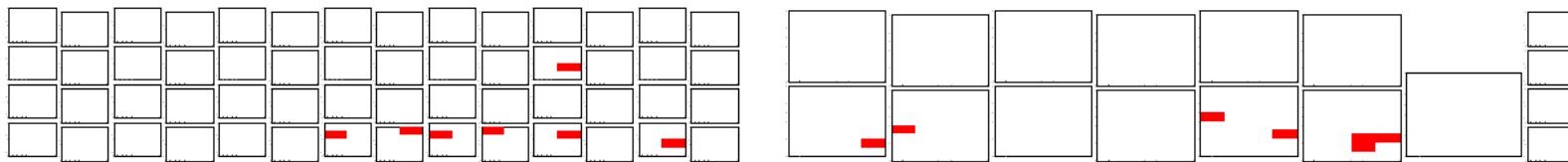
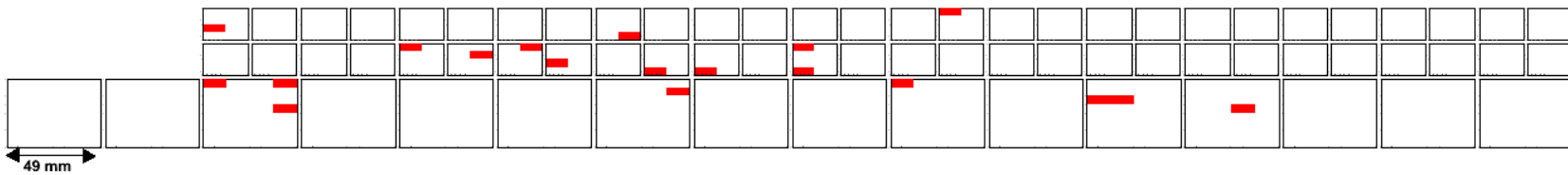
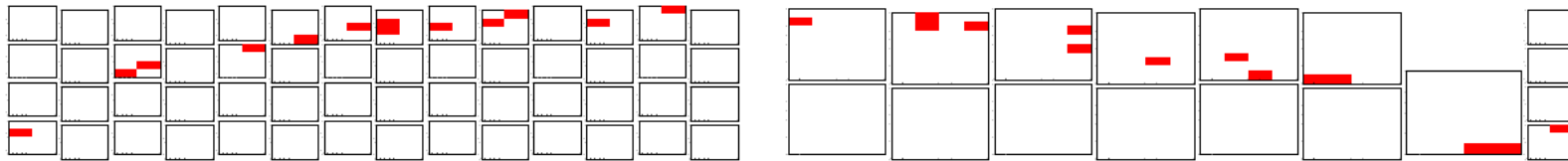
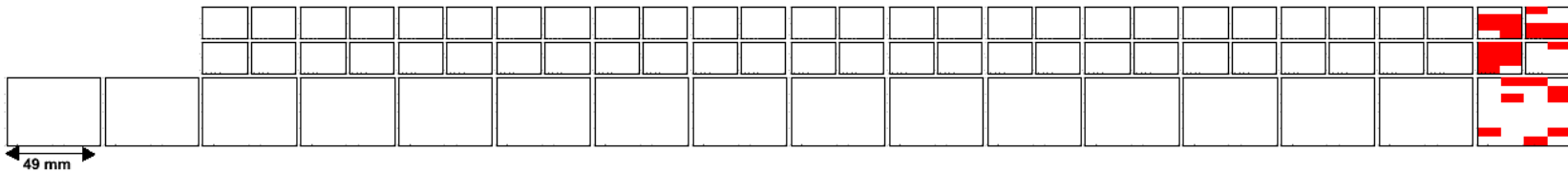
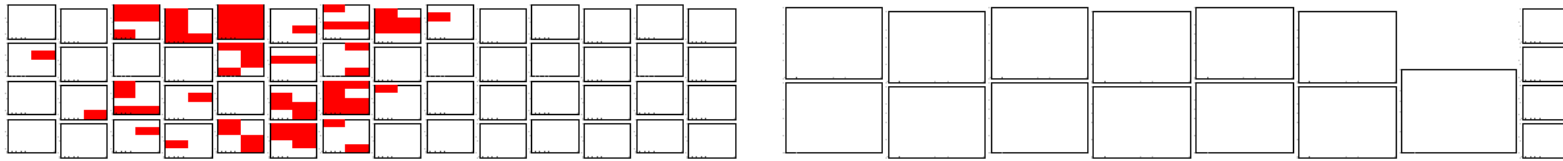
beam proton

# Conclusion and outlook

- Summary
  - Demonstrator with 2 different prototypes was tested, both work as expected
  - TDC and FrontEnds working, largest TRBv3 setup up to now
  - high rate → single events can be separated
  
- Future
  - More detailed analysis of data
  - Enhanced test in october
  - Further development particular of electronics for the PANDA experiment  
(and other experiments)

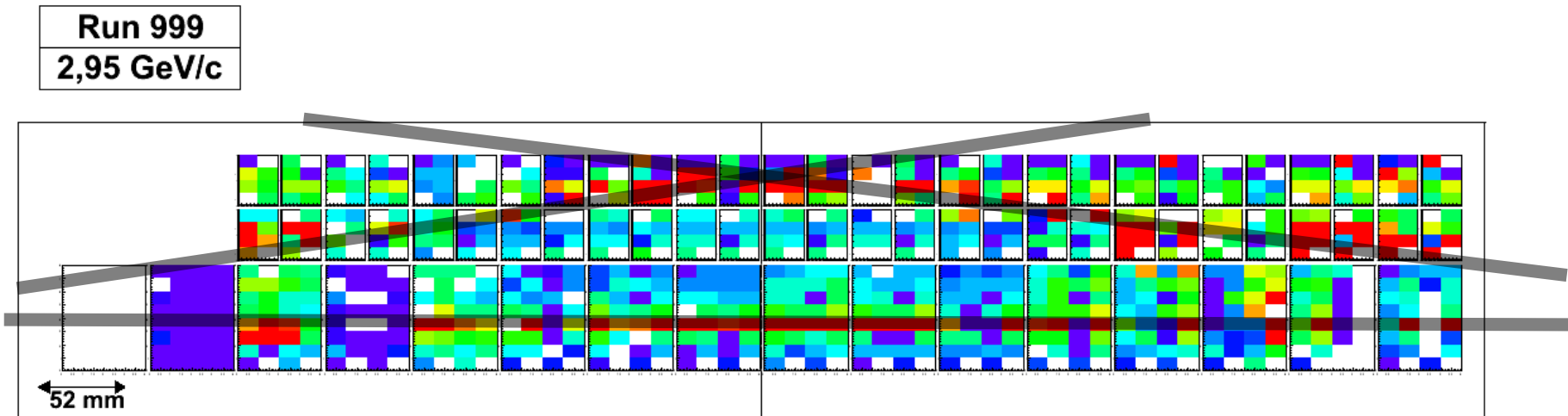
# Backups

# Pattern both DIRCs



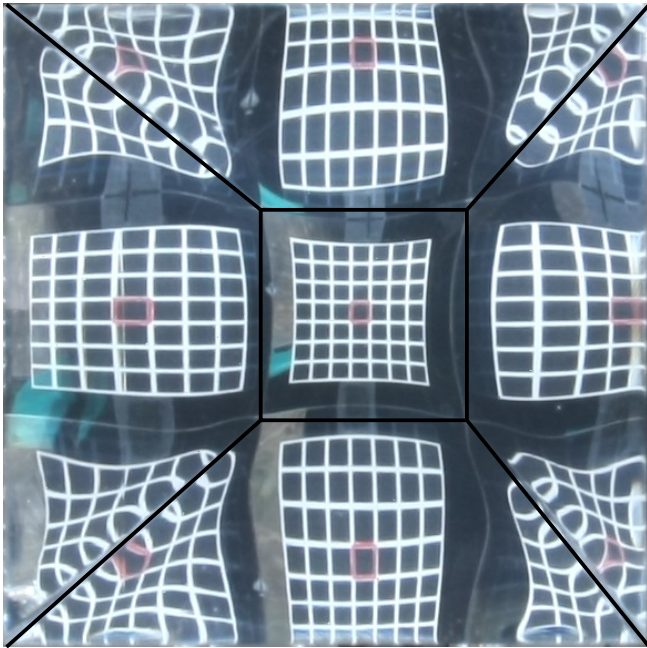
# Results - Hitpattern

- Tübingen DIRC

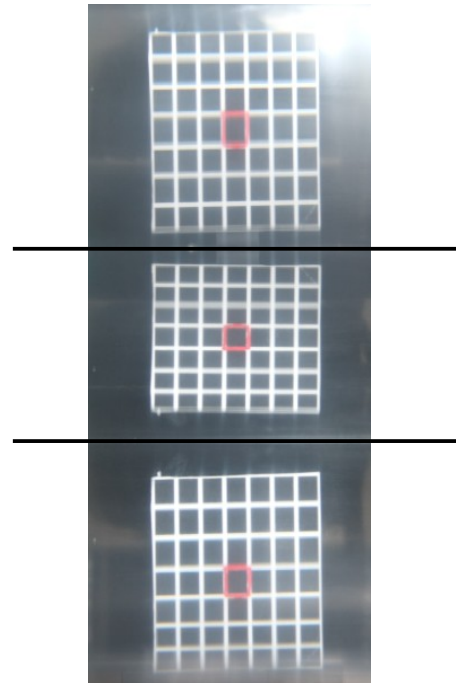


# Optical properties

Plexiglas bar 50x50x700mm<sup>3</sup> (~25€)

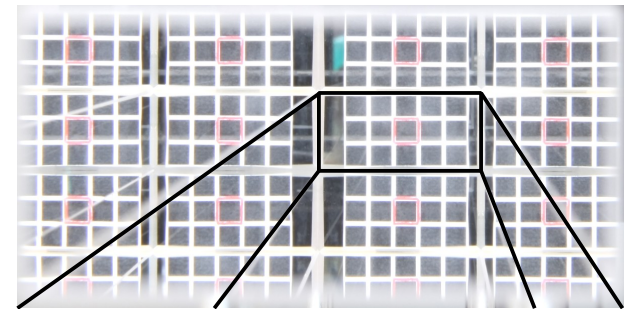


Plexiglas sheet 50mm (~800€/m<sup>2</sup>)



**straight**

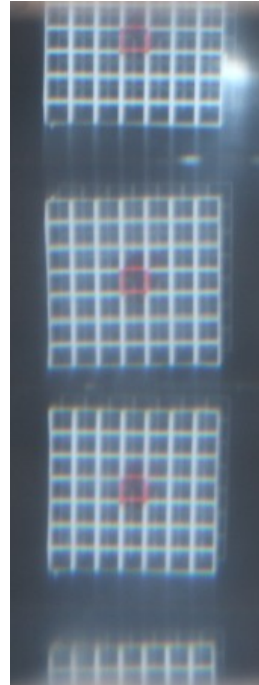
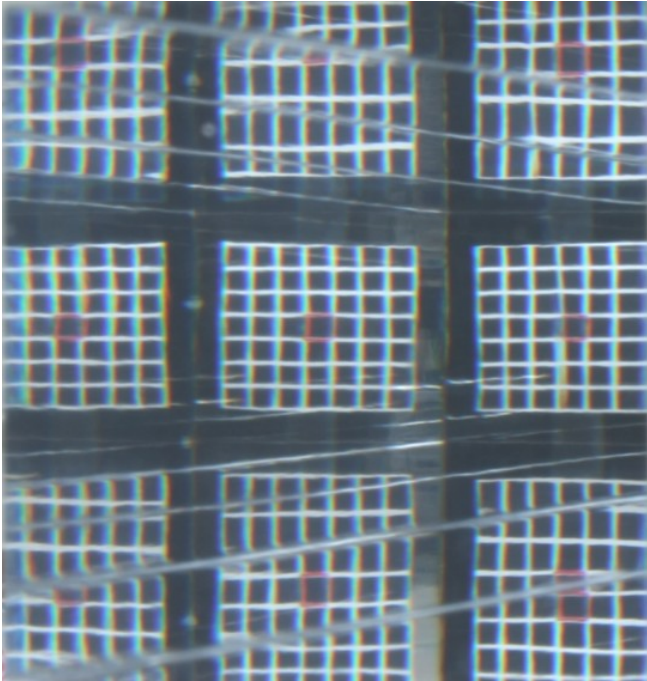
fused silica bar 17x35x700mm<sup>3</sup> (~2000€)



# Optical properties

Plexiglas bar 50x50x700mm<sup>3</sup> (~25€)

Plexiglas sheet 50mm (~800€/m<sup>2</sup>)



**tilt**

fused silica bar 17x35x700mm<sup>3</sup> (~2000€)

