

# Experience with the DIRC for WASA

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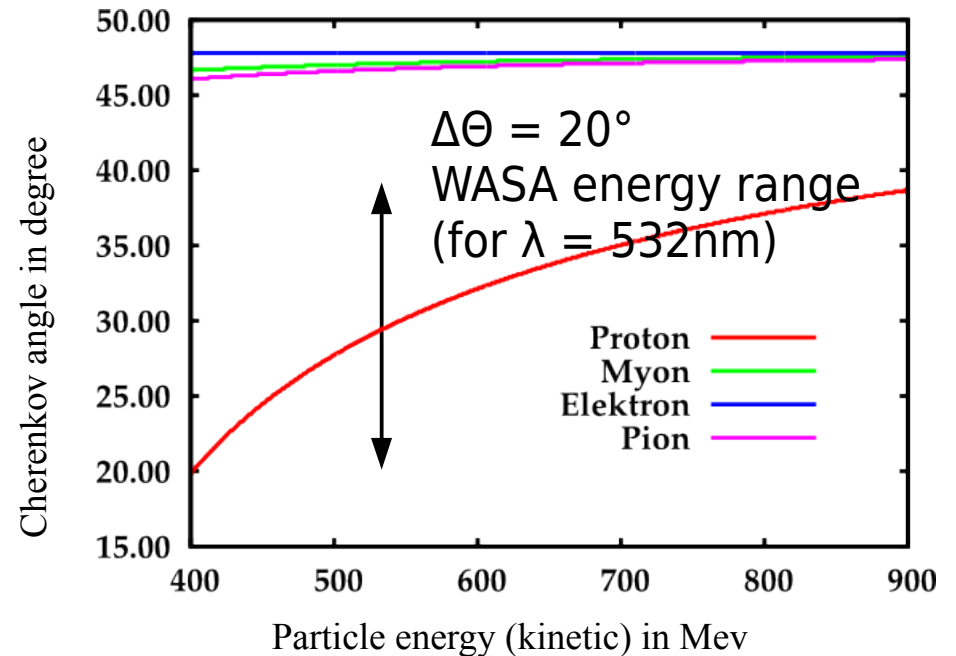
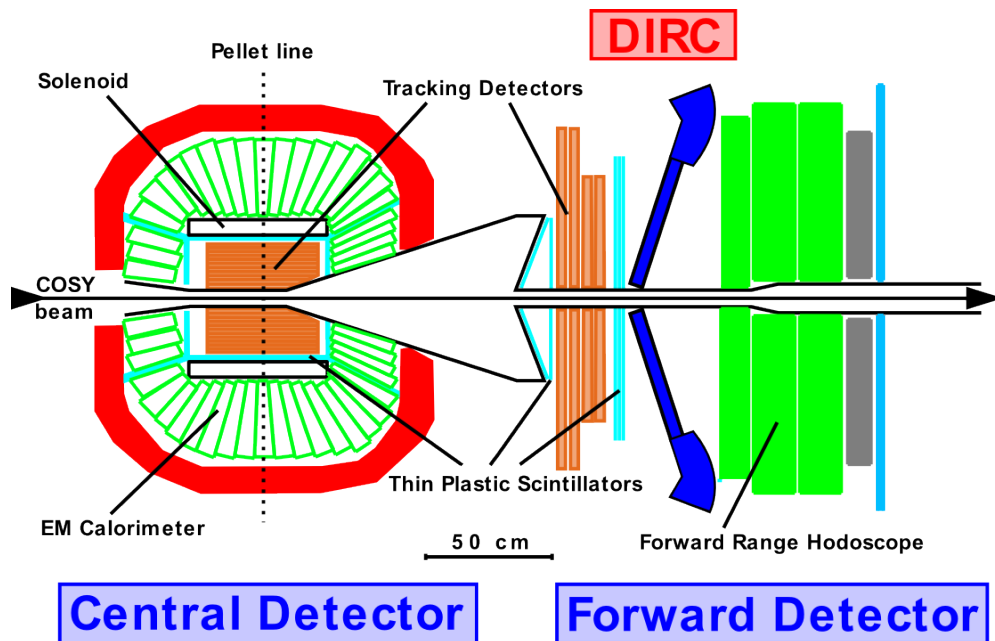


# Outline

- 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

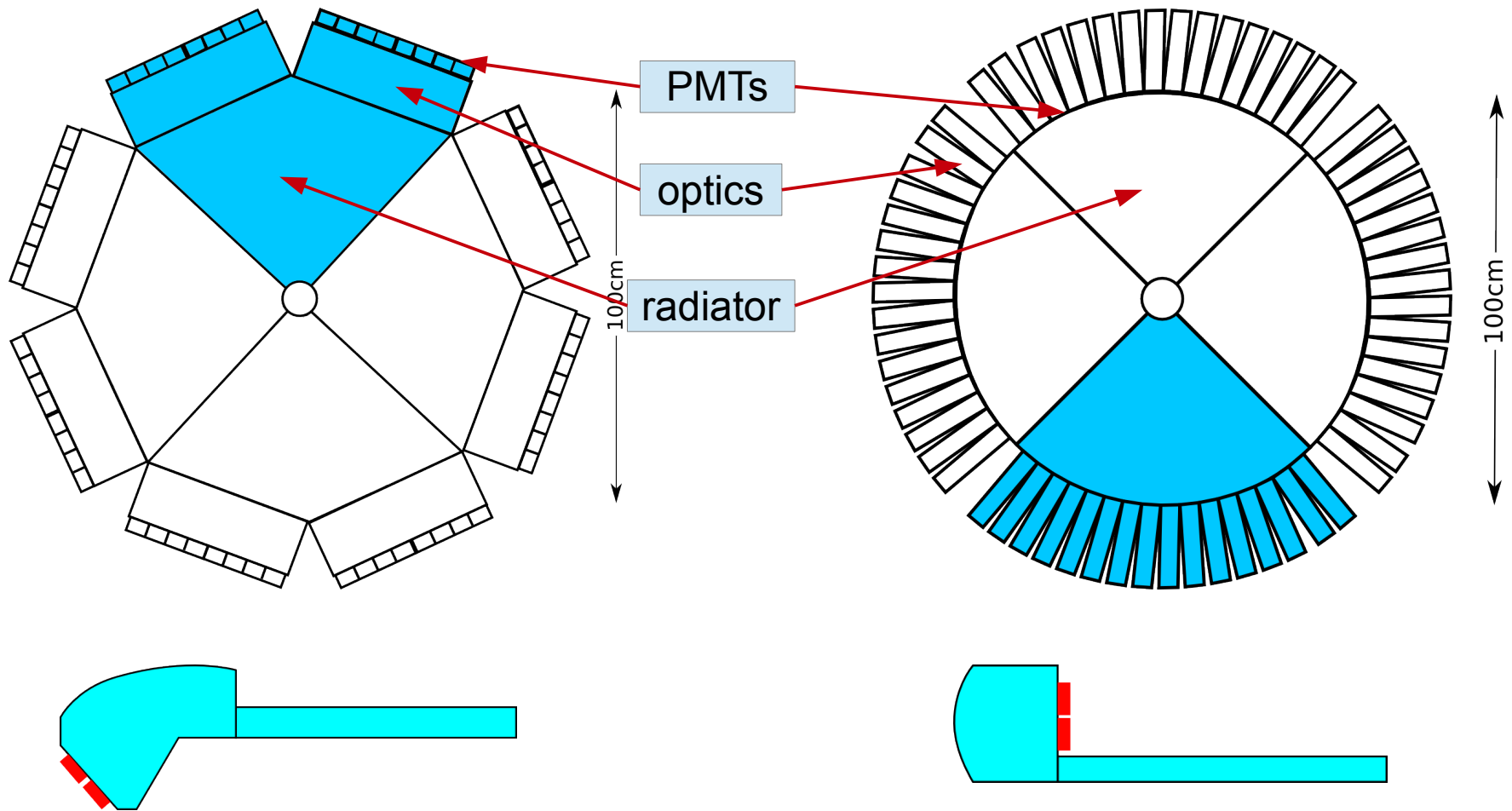
# Motivation - DIRC@WASA

- 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



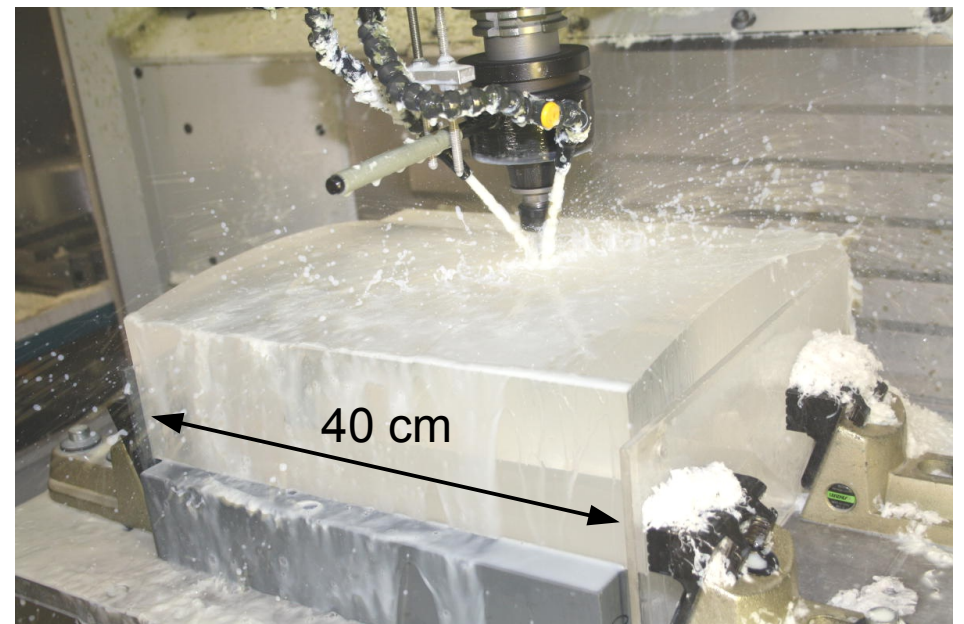
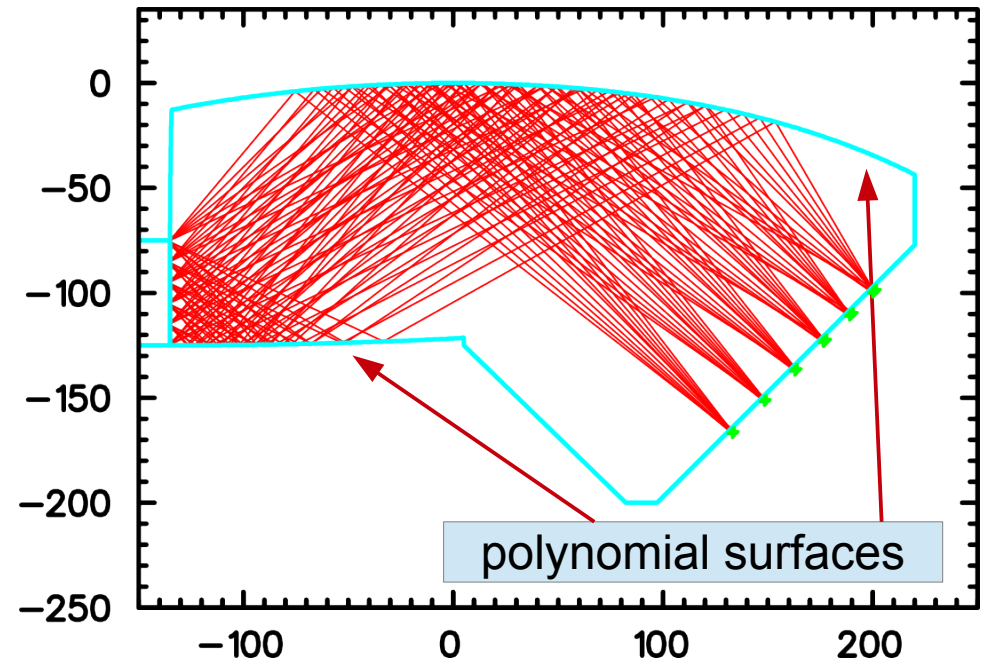
# Test - DIRC prototypes

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



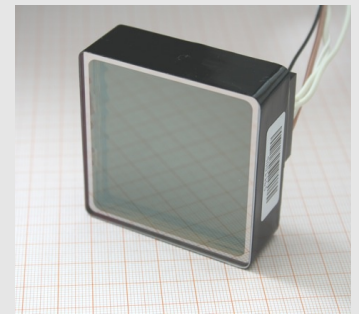
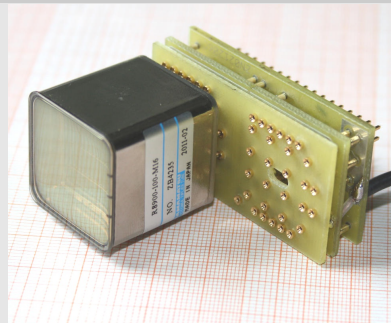
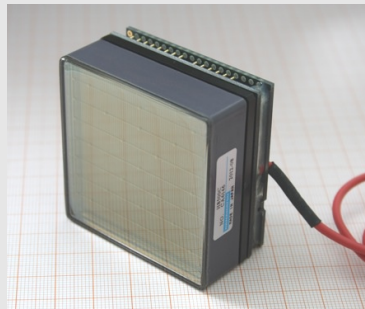
# Test - Optics and radiator

- 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

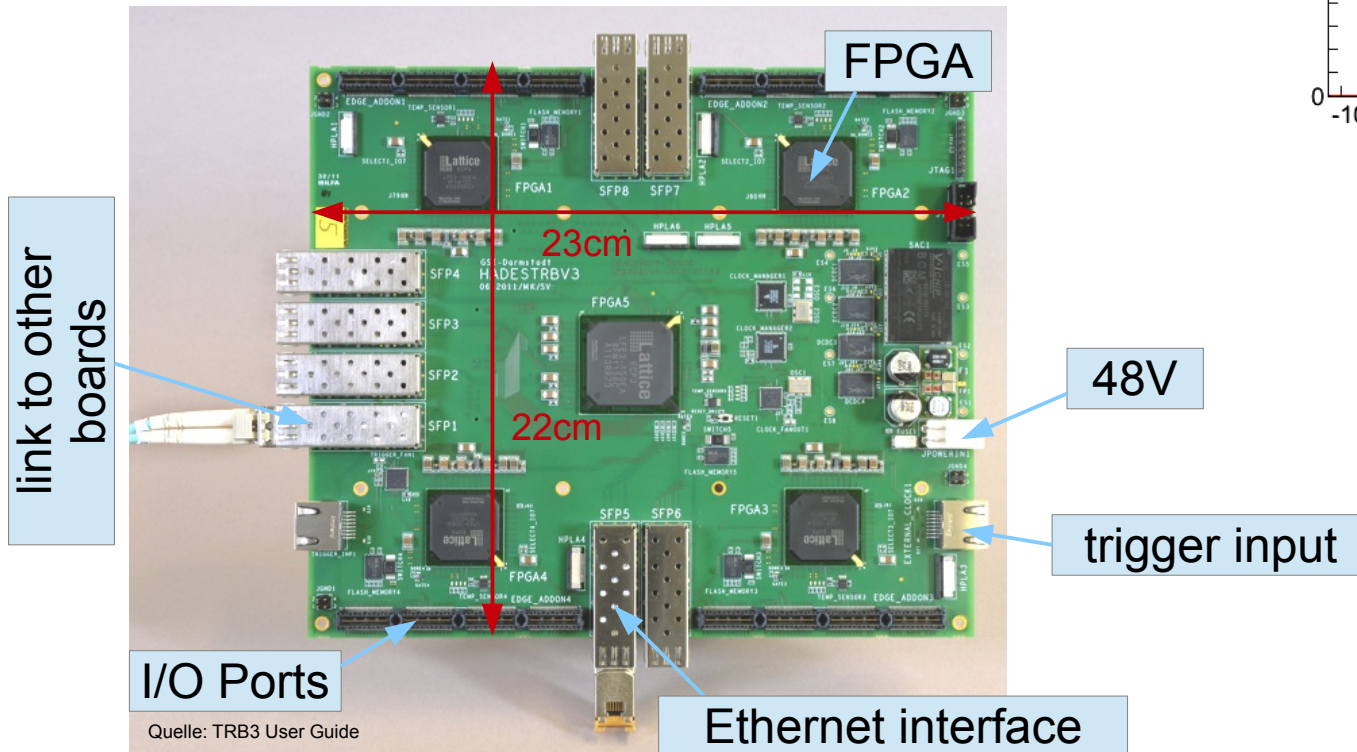
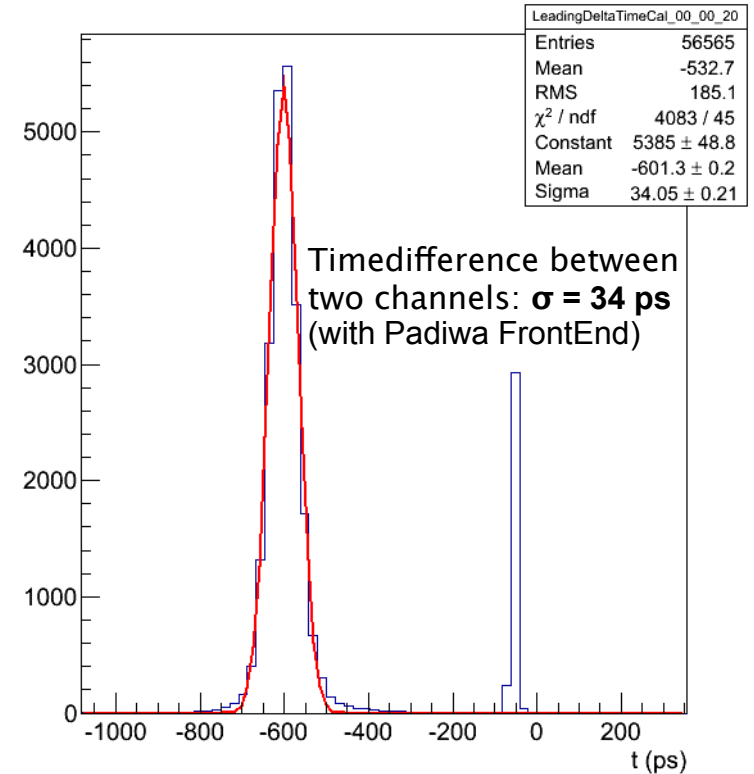
typ	Hamamatsu H8500C	R8900-100-M16	R11265-100-M16	Photonis XP85012
art	Flatpanel PMT 12 Dynoden normal cathode	12 dynodes Supercathode	Flatpanel PMT 12 dynoden Supercathode	Microchannel plate 2 steps, 25 $\mu$ m pore <b>Usable in B field</b>
channels	64 (8x8)	16 (4x4)	16 (4x4)	64 (8x8)
area	52x52mm <sup>2</sup>	52x52mm <sup>2</sup>	52x52mm <sup>2</sup>	59x59mm <sup>2</sup>
→ active	<b>89%</b>	81%	77%	81%
gain (max. V)	2x10 <sup>6</sup>	7x10 <sup>6</sup>	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>



# Test - used electronics TRBv3

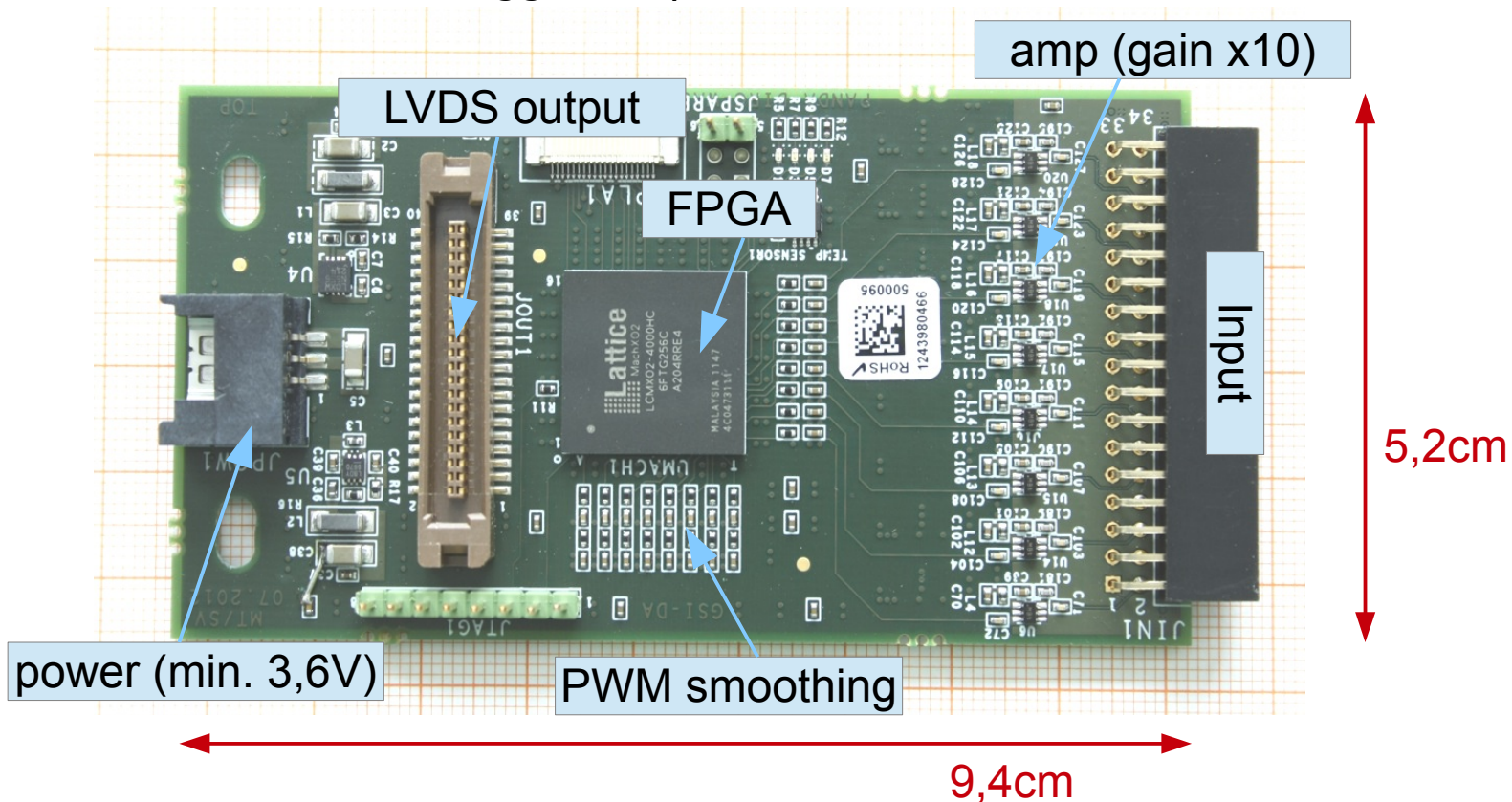
Delta time Leading edge calibrated TRB 00 TDC 00 Channel 20

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



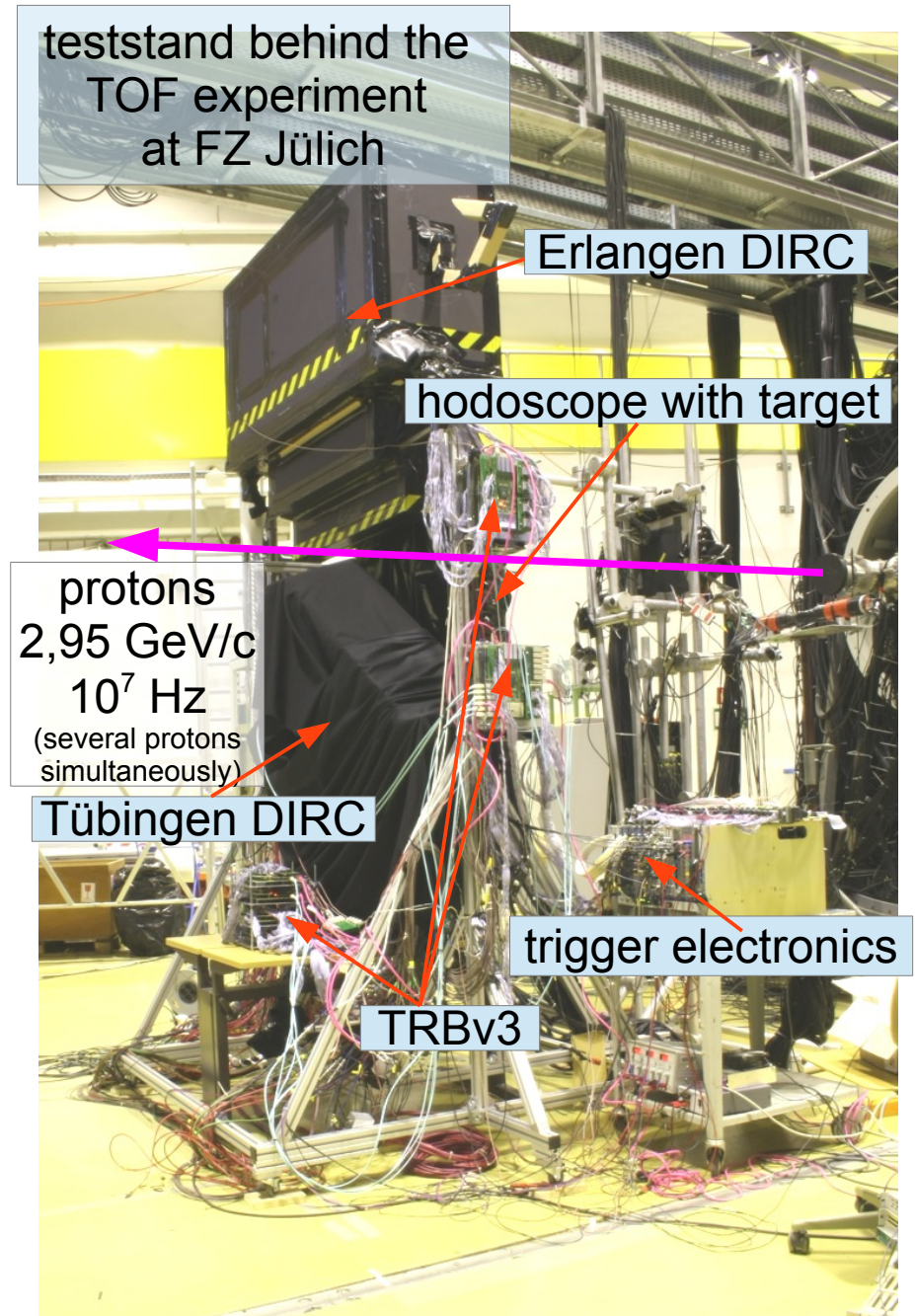
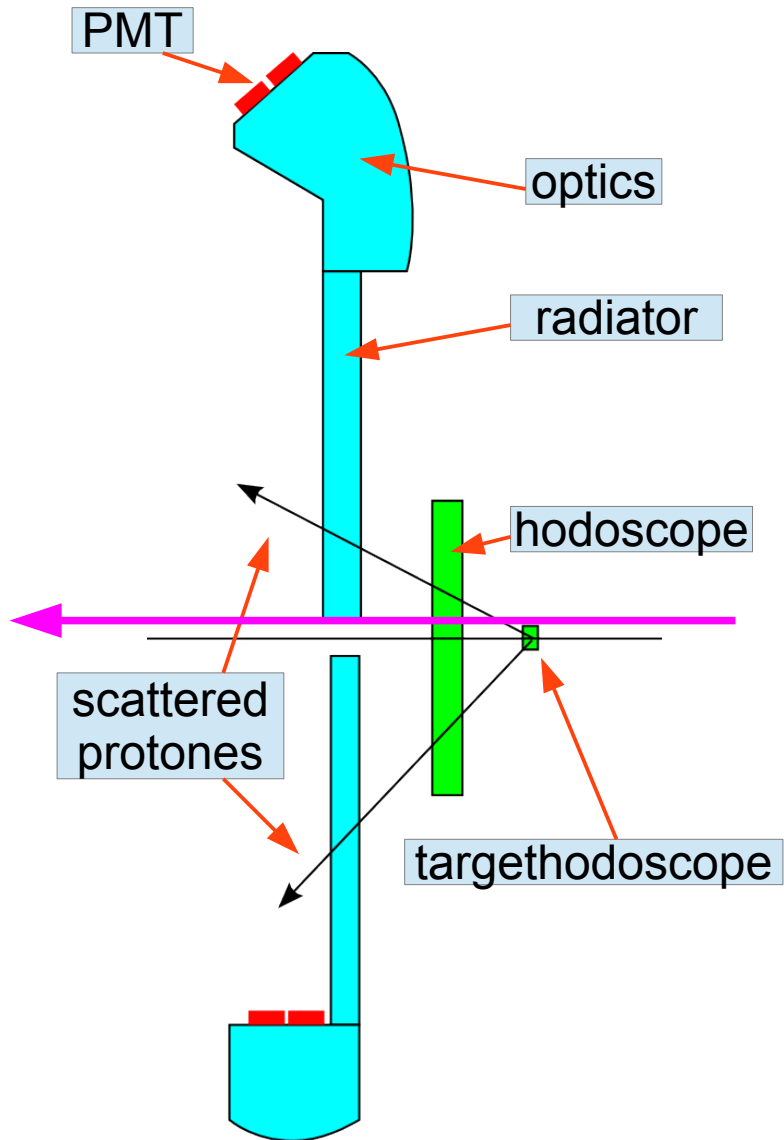
# Test - used electronics Padiwa (PAndaDIrcWAsa)

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



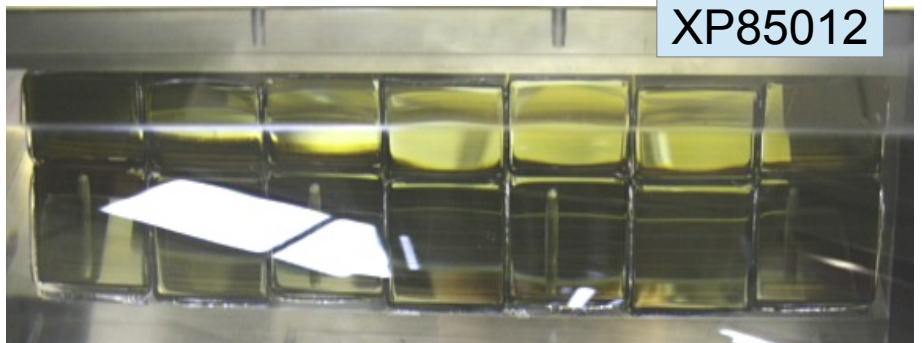
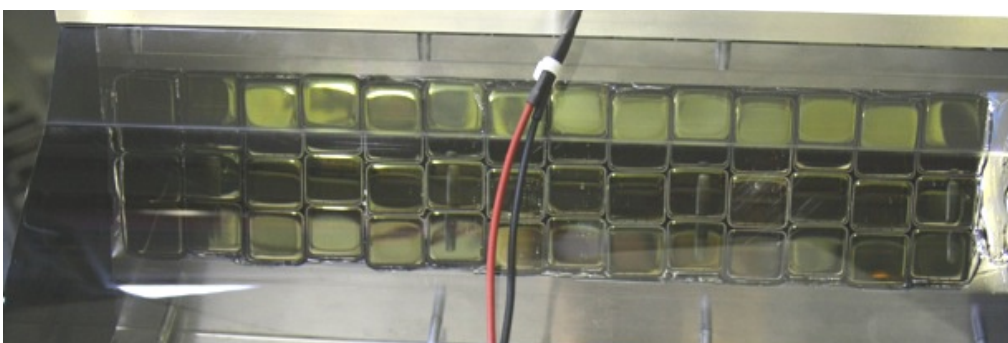
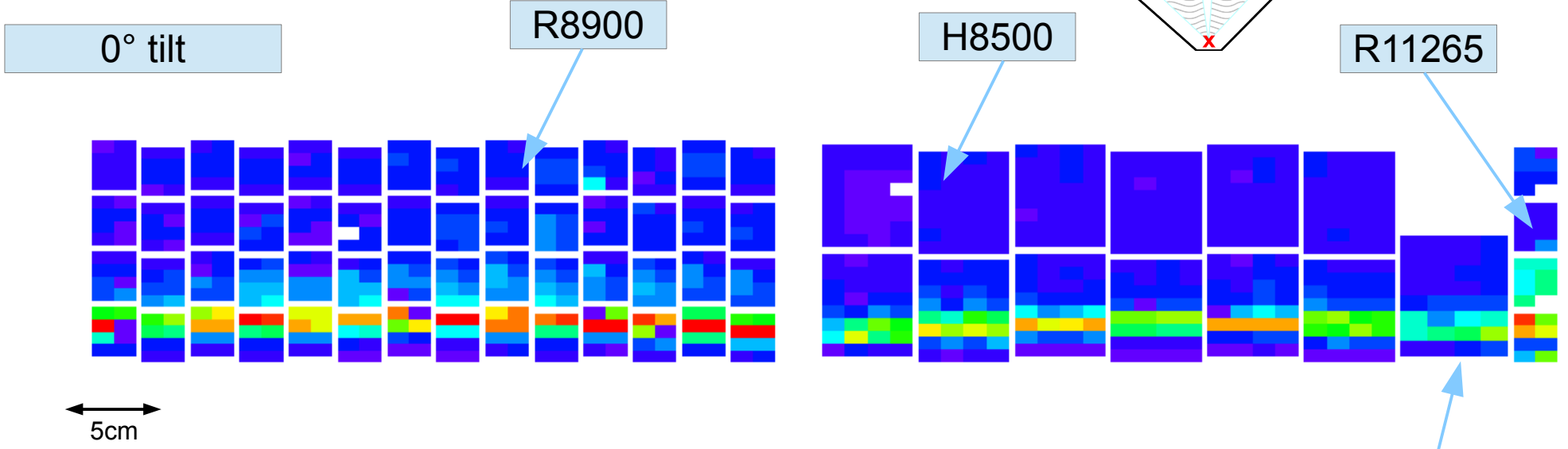
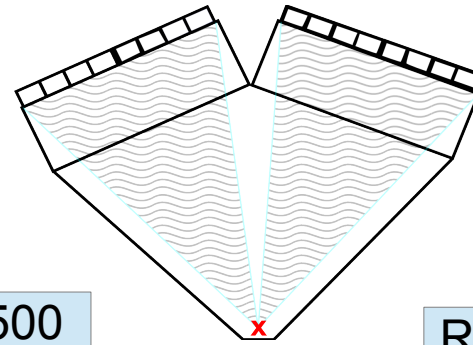


# Demonstrator - scheme of the test setup



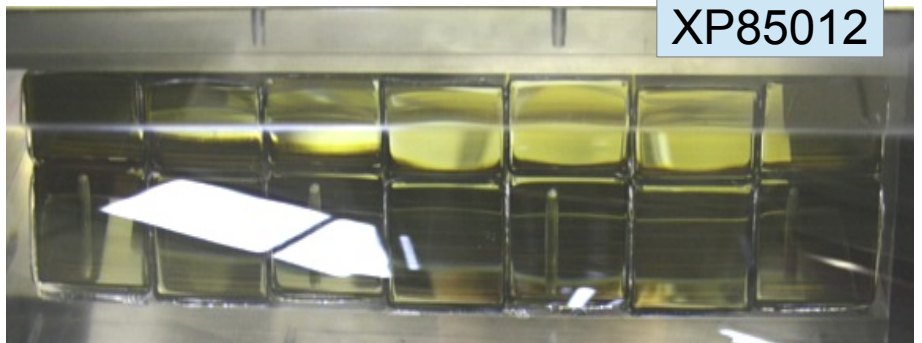
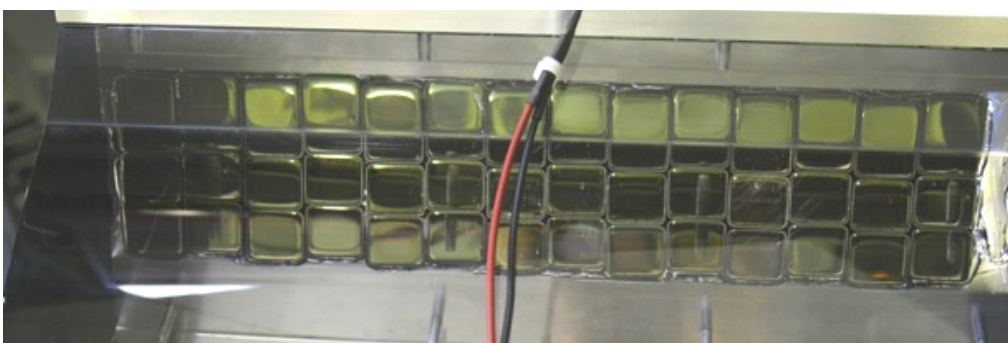
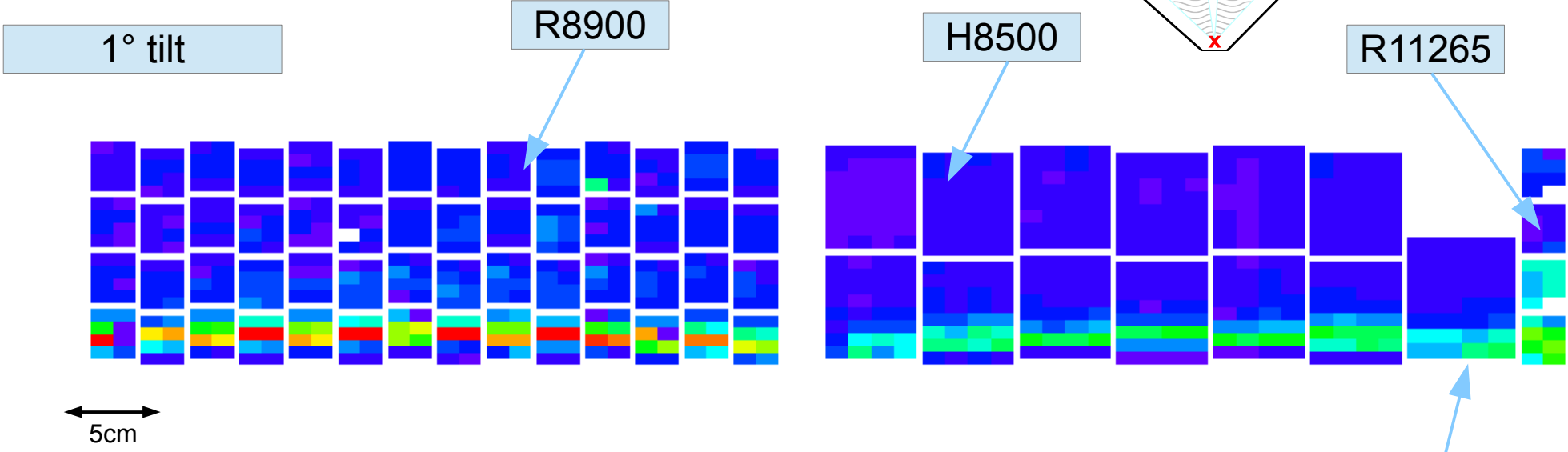
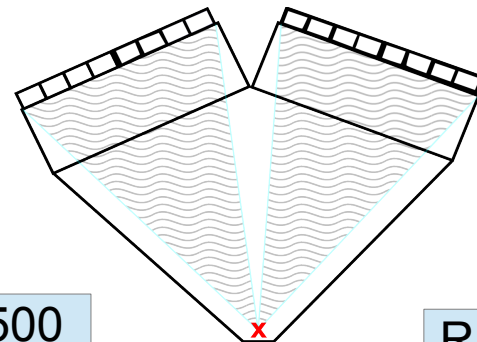
# Results - Hitpatterns

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



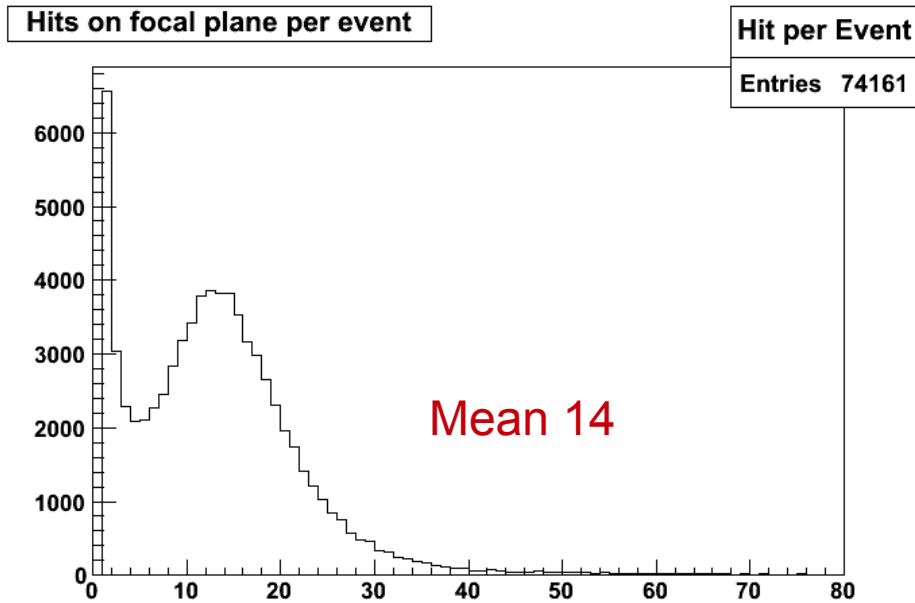
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# Results - Hitpattern

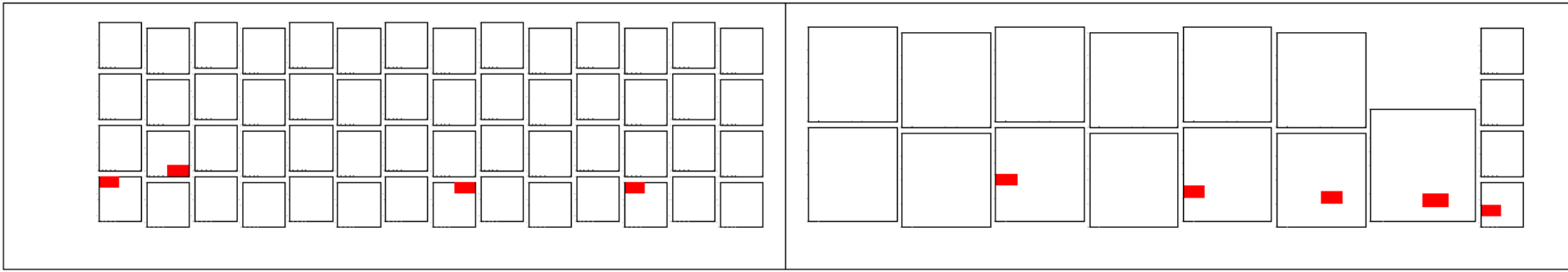
- Hits per event (Erlangen DIRC)



# Results - Single events

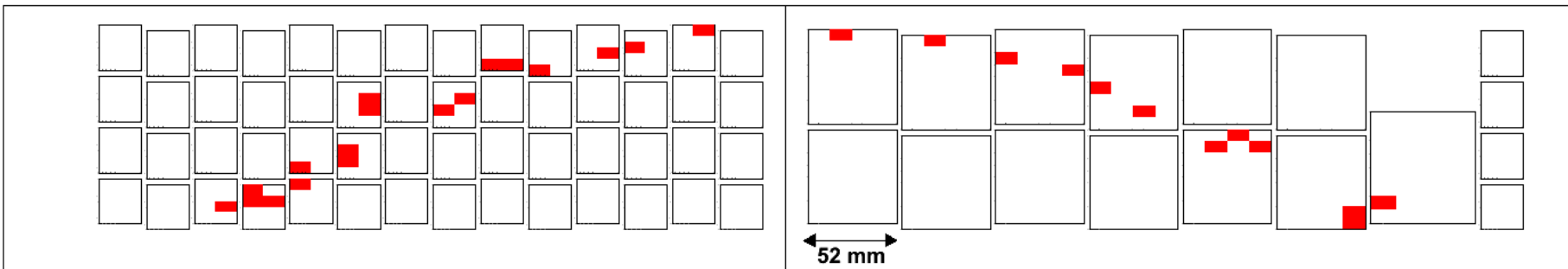
- Beam proton

Run 999  
2,95 GeV/c



- scattered proton

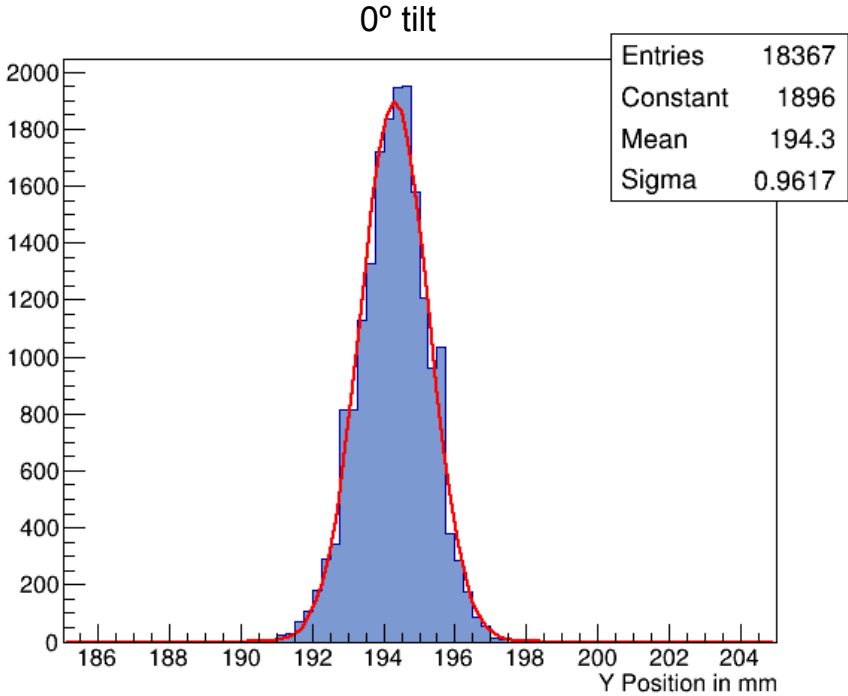
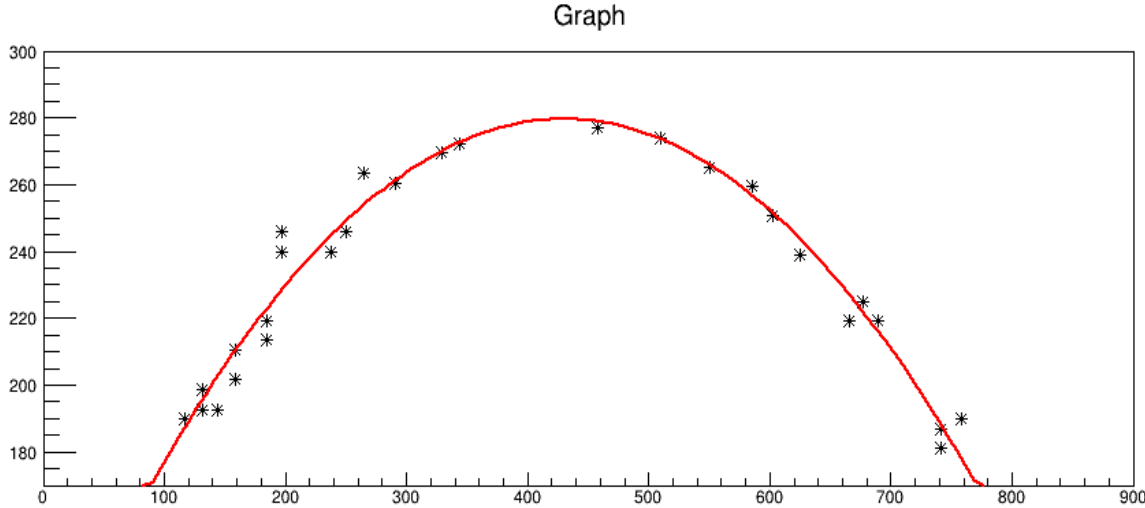
Run 999  
2,95 GeV/c



# Results - Single events

parabola fit (for upper part)  
 \*\*\*\*\*  
 Minimizer is Minuit / Migrad

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° = 3mrad



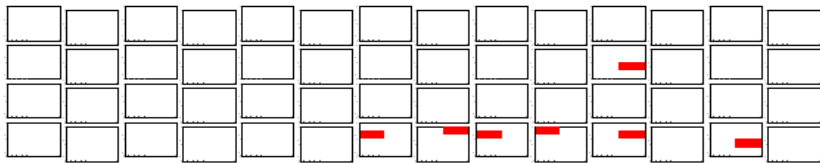
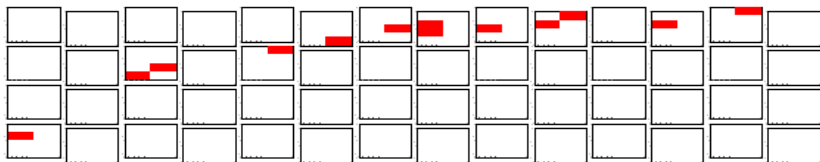
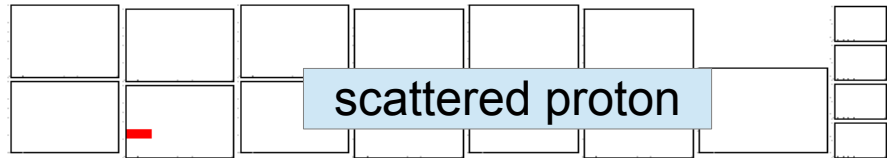
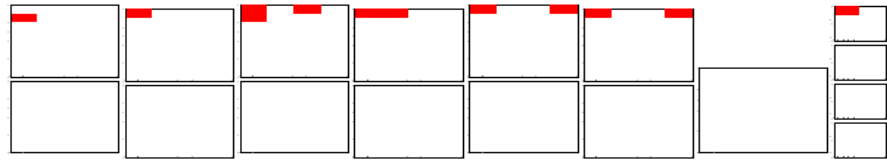
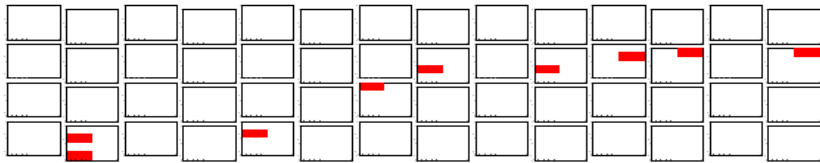
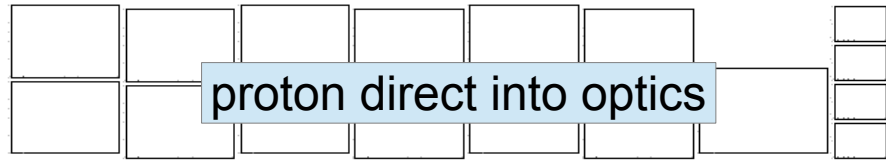
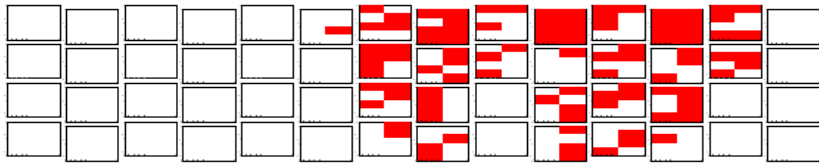
constant fit - direct hits

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

Cherenkov angles at 2.95 GeV/c

Proton	45.2°
Kaon	47.1°
Pion	47.8°

# Results - Single events



beam proton

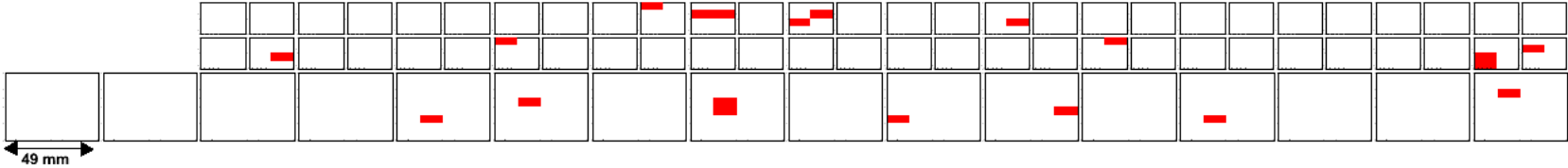
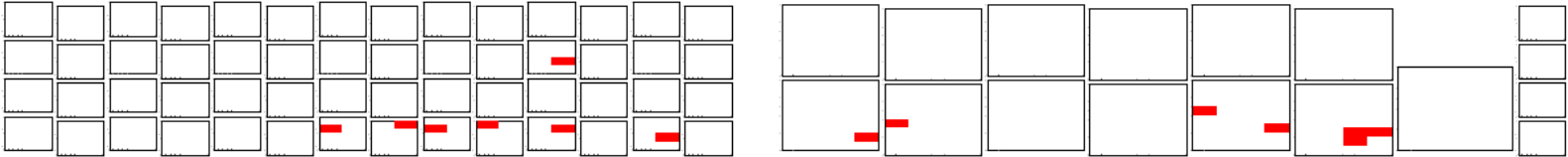
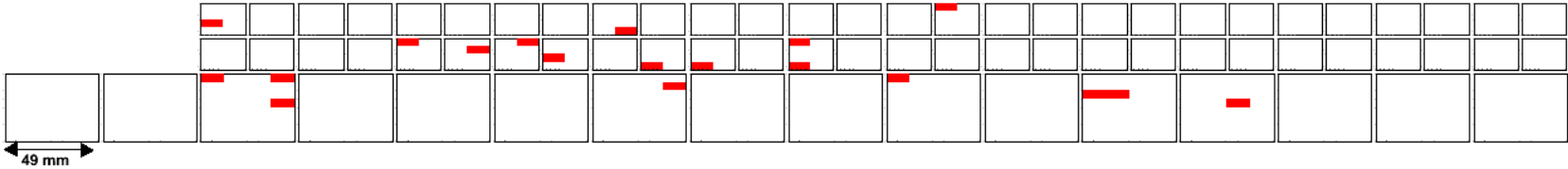
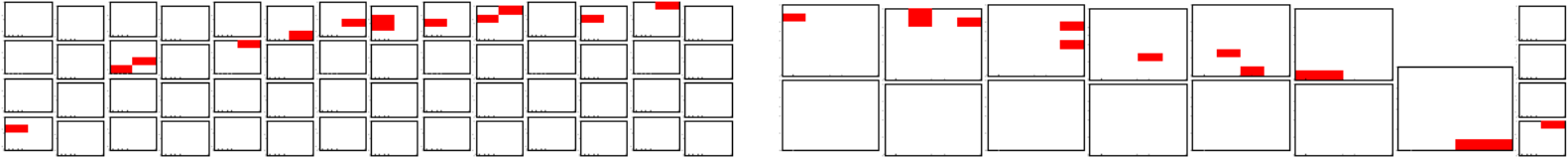
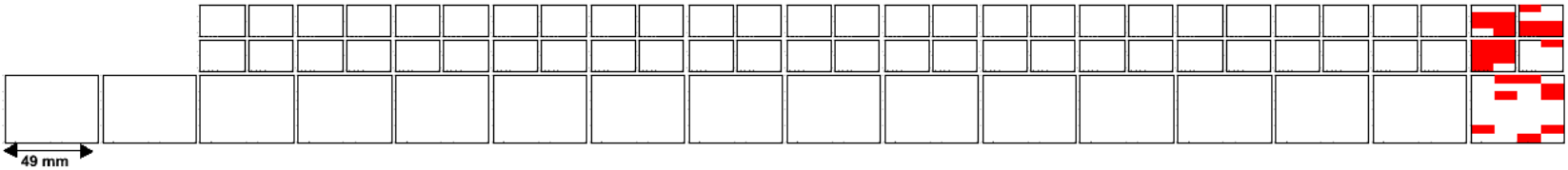
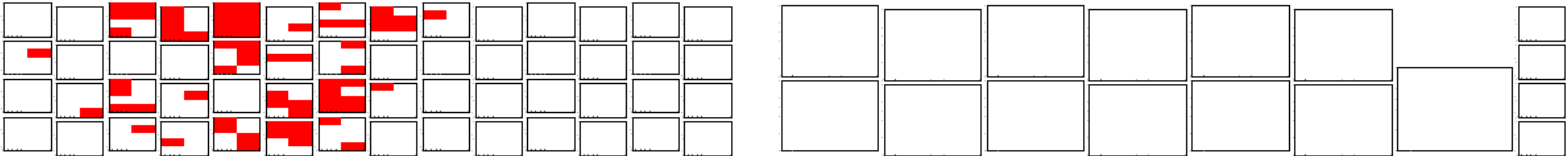
# Conclusion and outlook

- 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 autumn
  - Further development particular of electronics for the PANDA experiment  
(and other experiments)



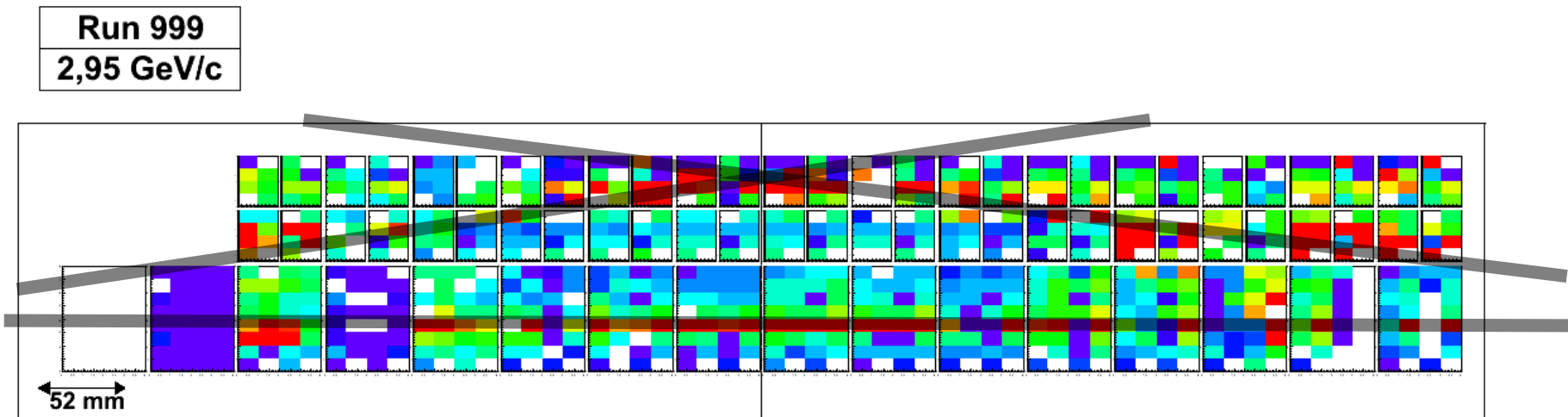
# Backups

# Pattern both DIRCs



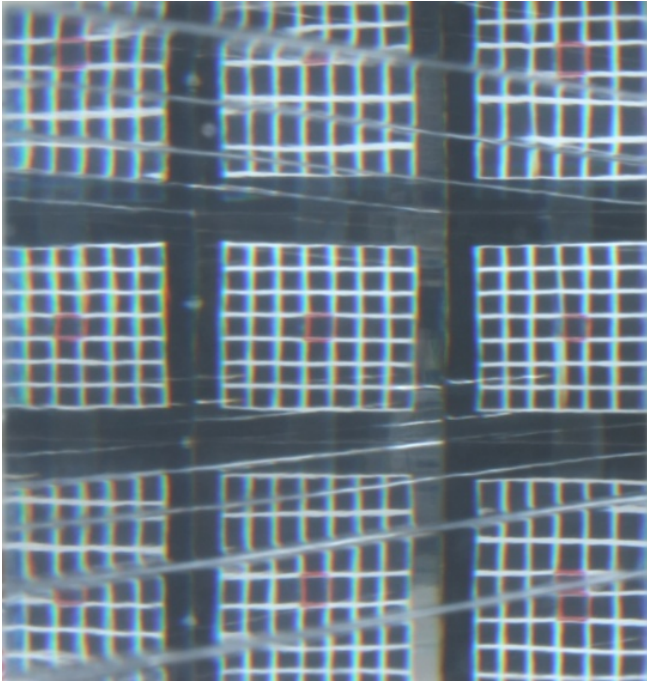
# Results - Hitpattern

- Tübingen DIRC

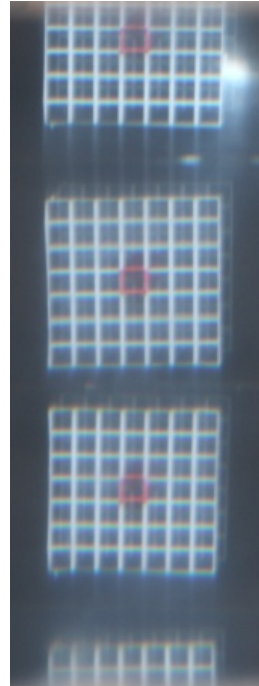


# Optical properties

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

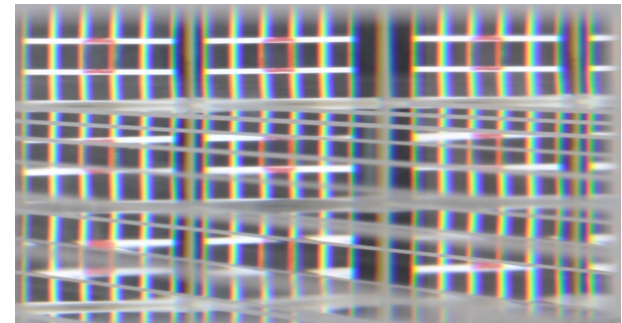


Plexiglas sheet 50mm (~800€/m<sup>2</sup>)



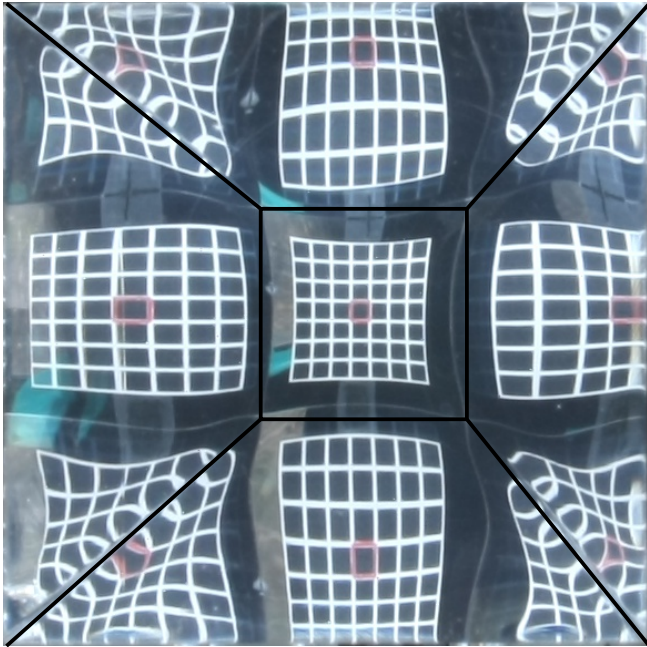
**tilt**

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

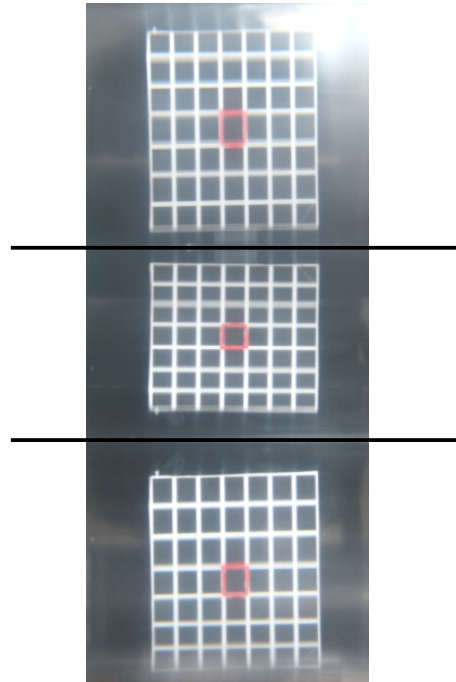


# Optical properties

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



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



**straight**

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

