

Studies of Electronics and Optics at Gießen and Results from Cosmics Data

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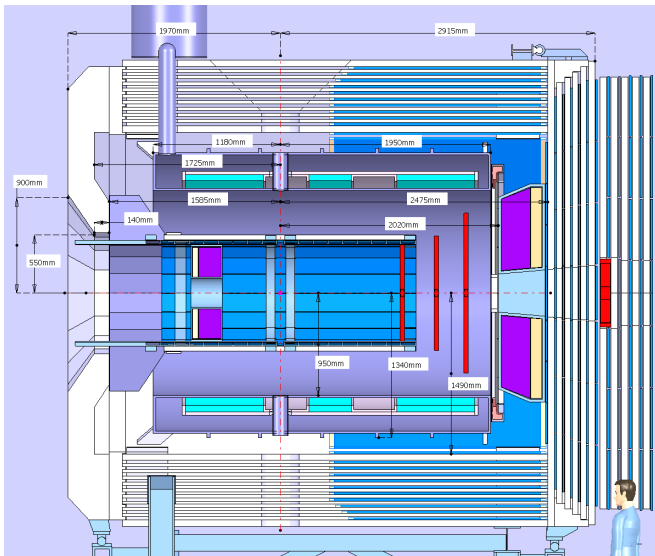
Justus Liebig Universität Gießen, Germany

PANDA Collaboration meeting, March 2009

Outline

- 1 Motivation**
 - PANDA Experiment
 - DESY Testbeam
- 2 Problems and Improvements**
 - Electronics
 - Optics
- 3 Further Investigations**
 - Measurements with Cosmic Radiation
 - G-APDs

Disc DIRC detector

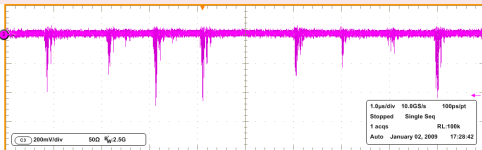


Experiences from first test beam experiment

- Prototype was working. . .
- . . .but not in an optimal way.
- Results have been presented before.

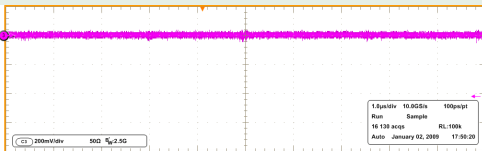
Voltage supply

Problem



Noise from high voltage modules

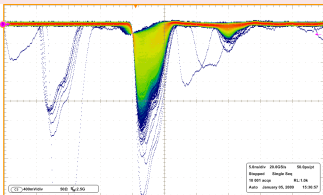
Solution



Ferrites in feed lines

Voltage divider boards

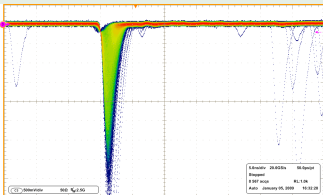
Problem



Our boards were evil:

- Capacitances
- Long unshielded parts in signal cables

Solution

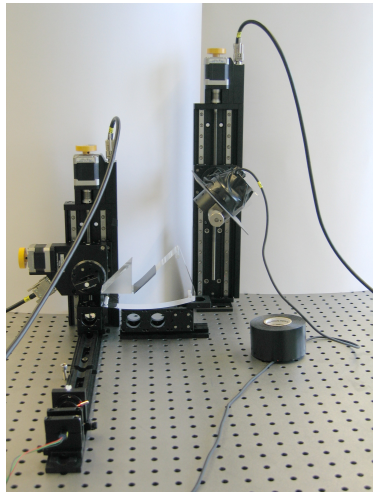
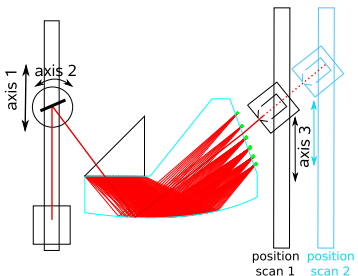


- Voltage divider resistors directly mounted on the MCPs
- Signal cables directly connected to the MCPs

Focusing light guides (by Klaus Foehl)

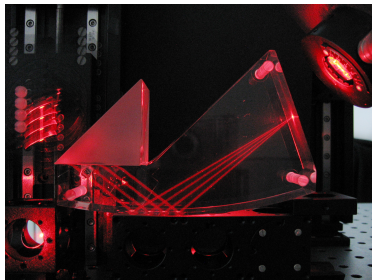
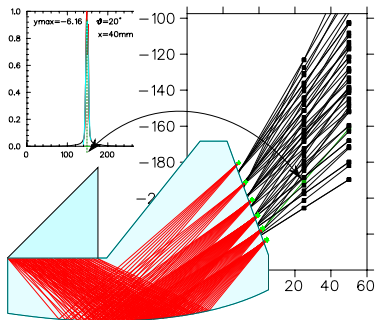
Setup

schematic setup 2009-02-25

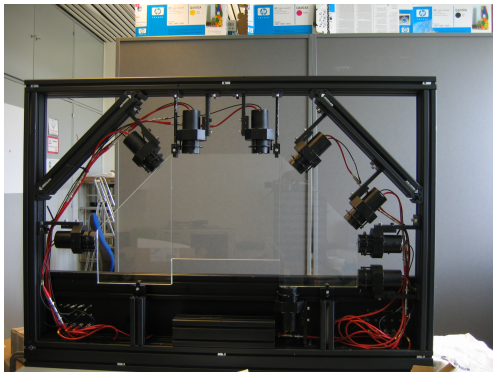


Focusing light guides (by Klaus Foehl)

Results

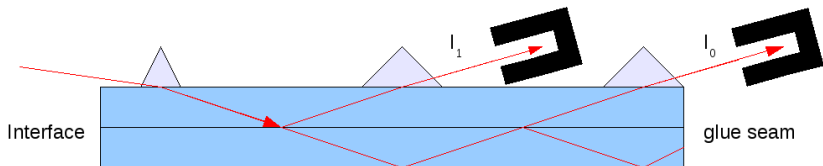


Glued edges (by Marko Zühlsdorf)



- Parts of the disc are glued together
- How good is the glue?
 - Refractive index
 - Are there reflections at the interface?

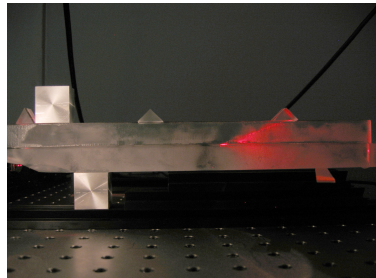
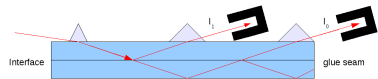
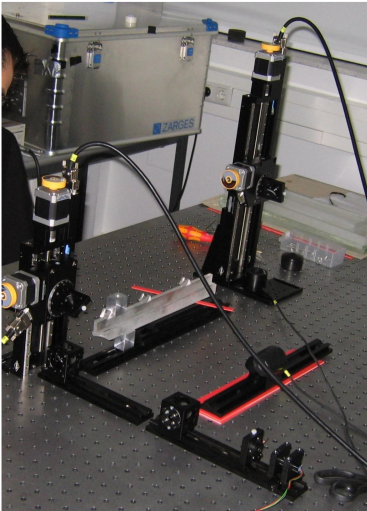
Glued edges (by Marko Zühlendorf) Setup



- Made some tests with sticks of the same material as prototype
- Used a red laser beam and measured and compared the beams coming out of the prisms

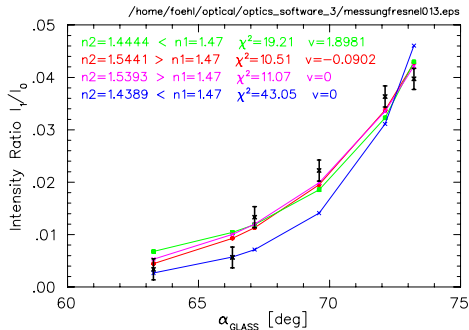
Optics

Glued edges (by Marko Zühlendorf) Setup



Glued edges (by Marko Zühlendorf)

Results



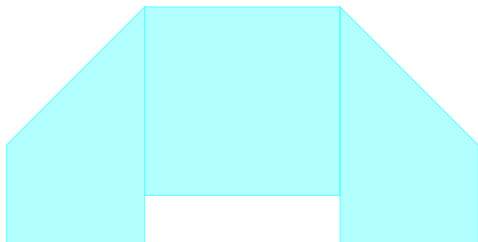
- Data sheet: refractive index should be about 1.55.
- $v = 1$: perpendicular polarised, $v = 0$: parallel polarised
 - Only $v \in [0, 1]$ physical \Rightarrow best fit with $n_2 = 1.5393$

Glued edges (by Marko Zühlendorf)

Outlook

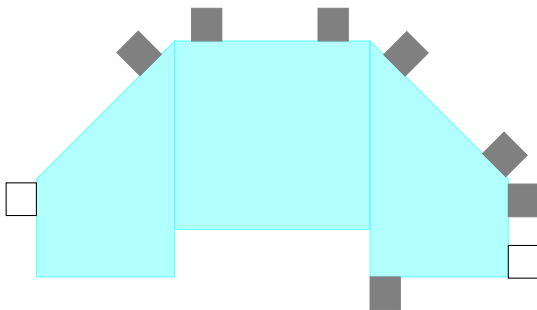
- Future tests with different polarisations
- Also testing the mix ratio of the glue
- Tests with prototype disc
 - Possible to go to higher angles

Setup



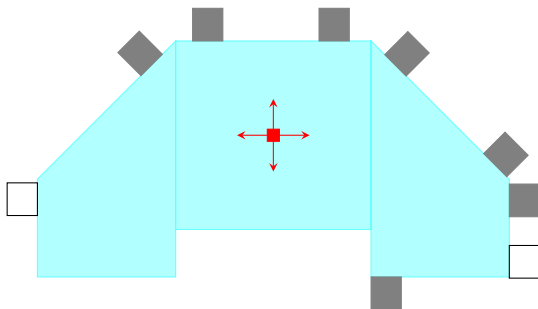
- glass plate
- 9 micro channel plate photomultiplier tubes
- 2 scintillators in coincidence as trigger

Setup



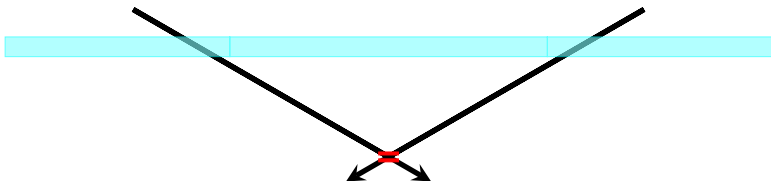
- glass plate
- 9 micro channel plate photomultiplier tubes
- 2 scintillators in coincidence as trigger

Setup



- glass plate
- 9 micro channel plate photomultiplier tubes
- 2 scintillators in coincidence as trigger

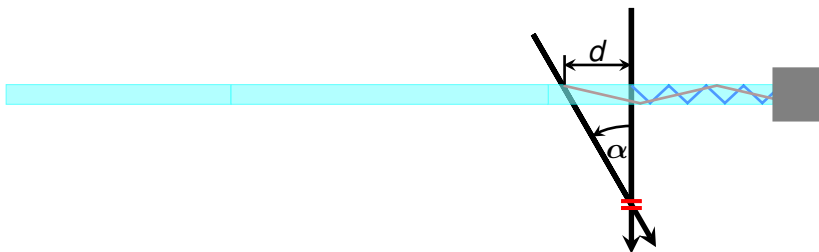
Difficulties



- Low rates
- Interaction points not well-known
- Angles not well-known
- Energies not well-known

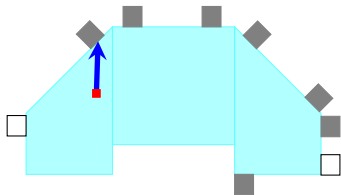
- Fortunately mainly normal incidence and relativistic energies
- Compensation of smearing

Compensation of smearing



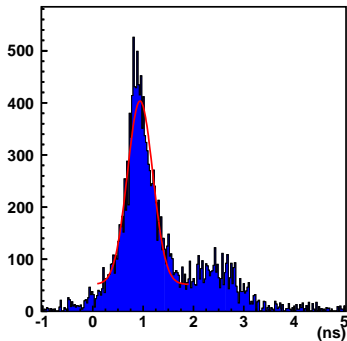
- Distance: interaction point – sensor increases
- Angle of reflexion becomes flat
- Partly compensation of time smearing

Time of propagation



- Calculated for relativistic particles:

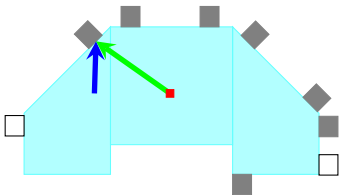
- **0.92 ns**



- Measured:

- **(0.94 ± 0.25) ns**

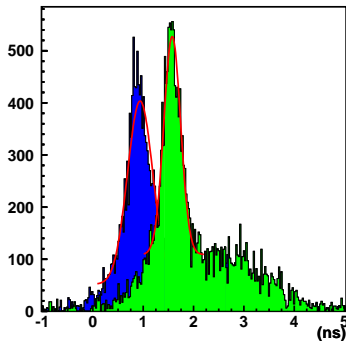
Time of propagation



- Calculated for relativistic particles:

- 0.92 ns

- 1.60 ns

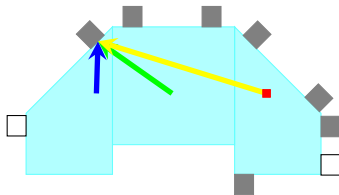


- Measured:

- (0.94 ± 0.25) ns

- (1.58 ± 0.17) ns

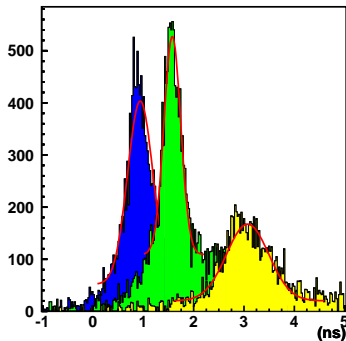
Time of propagation



- Calculated for relativistic particles:

- 0.92 ns
- 1.60 ns
- 3.12 ns

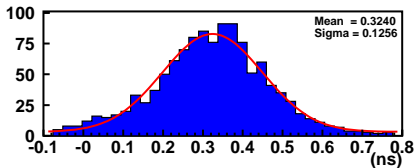
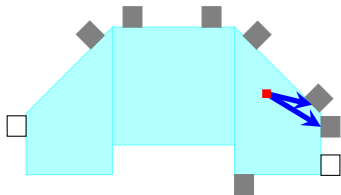
- Number of counts decreases.
- Width expands.



- Measured:

- (0.94 ± 0.25) ns
- (1.58 ± 0.17) ns
- (3.07 ± 0.42) ns

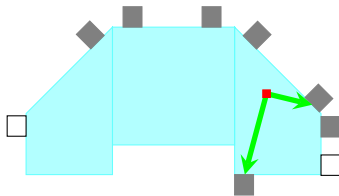
Time differences



Calculated:

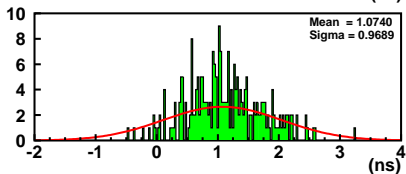
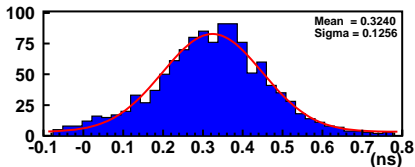
● 0.40 ns

Time differences

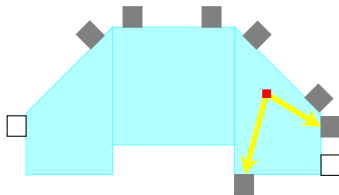


Calculated:

- **0.40 ns**
- **1.22 ns** (Low coincidence rate — due to restricted particle solid angle?)

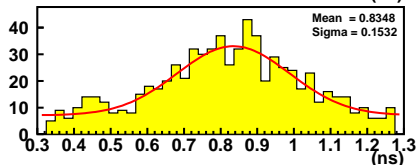
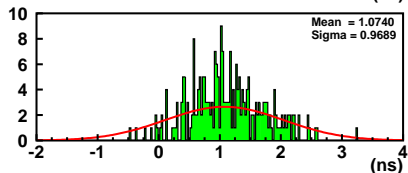
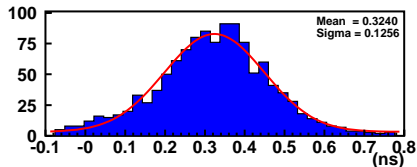


Time differences

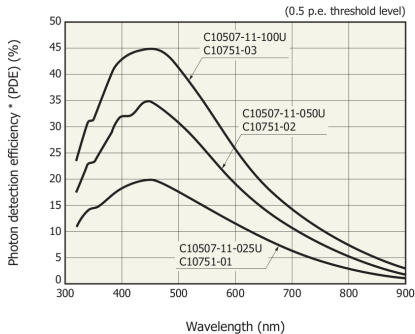


Calculated:

- **0.40 ns**
- **1.22 ns** (Low coincidence rate — due to restricted particle solid angle?)
- **0.82 ns**



G-APDs



Device

- Hamamatsu C10507-11 series
- Multi pixel photon counter

Intended tests for several temperatures

- Photon detection efficiency
- Dark current

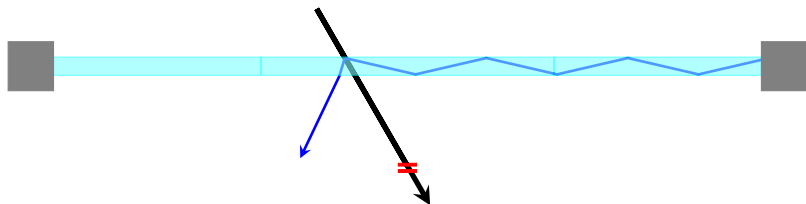
Summary

- Improvements allow reasonable new tests.
- Measurements with cosmic radiation are running.

Outlook:

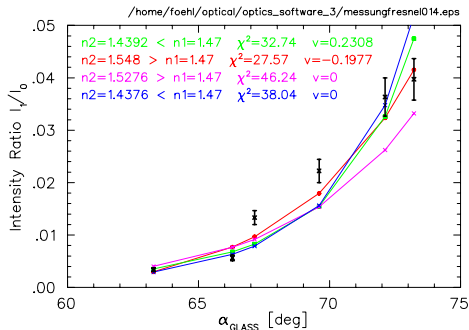
- Current measurements take a long time. We are ready for a second test beam experiment.
- We are still looking for photon sensors which fulfill all our requirements.

Angle dependence



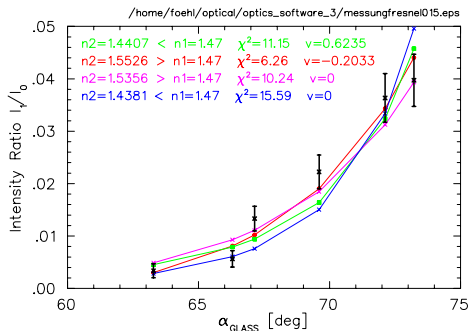
- Right sensor can see emitted cherenkov light.
- Left sensor does not see anything.

Glued edges Results



- Data sheet: refractive index should be about 1.55.
- $v = 1$: perpendicular polarised, $v = 0$: parallel polarised
 - $v < 0$ unphysical

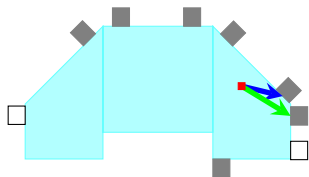
Glued edges Results



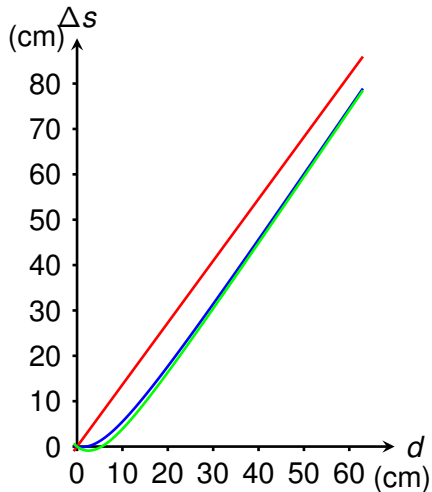
- Data sheet: refractive index should be about 1.55.
- $\nu = 1$: perpendicular polarised, $\nu = 0$: parallel polarised
 - $\nu < 0$ unphysical

Smearing of distance

Only one dimension



- Variation of optical path length
- Red curve shows particle with $\alpha = 0$.

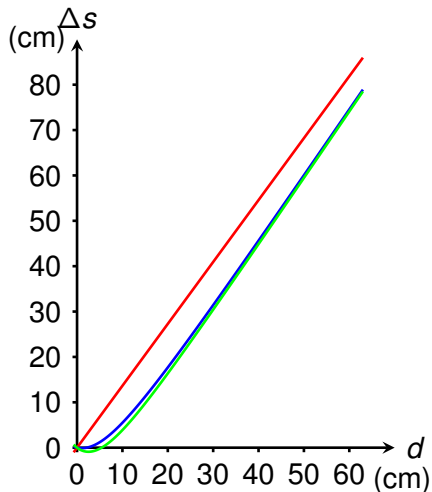


Smearing of distance

Only one dimension

Angle distribution for cosmic muons

α_{\max} ($^{\circ}$)	Rate (%)
10	29
20	48
30	64
40	78
50	88
60	95
70	99
80	≈ 100

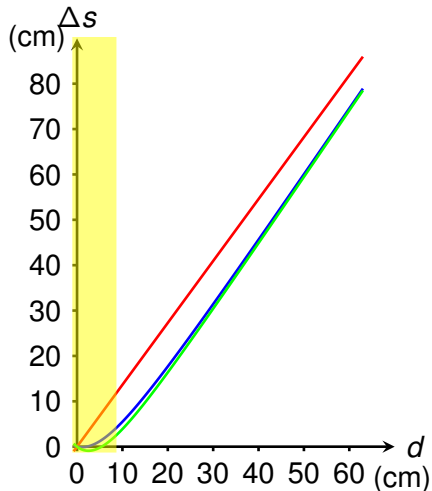


Smearing of distance

Only one dimension

Angle distribution for cosmic muons

α_{\max} ($^{\circ}$)	Rate (%)
10	29
20	48
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40	78
50	88
60	95
70	99
80	≈ 100



Time smearing

- $\Delta t_1 < 200$ ps for 78% of detected photons in first MCP.
- $\Delta t_2 < 100$ ps for 78% of detected photons in second MCP.
- $|\Delta t_1 - \Delta t_2| < 100$ ps.

