

Report on hardware tests, MC studies, next steps and activities towards the TDR

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Hardware activities

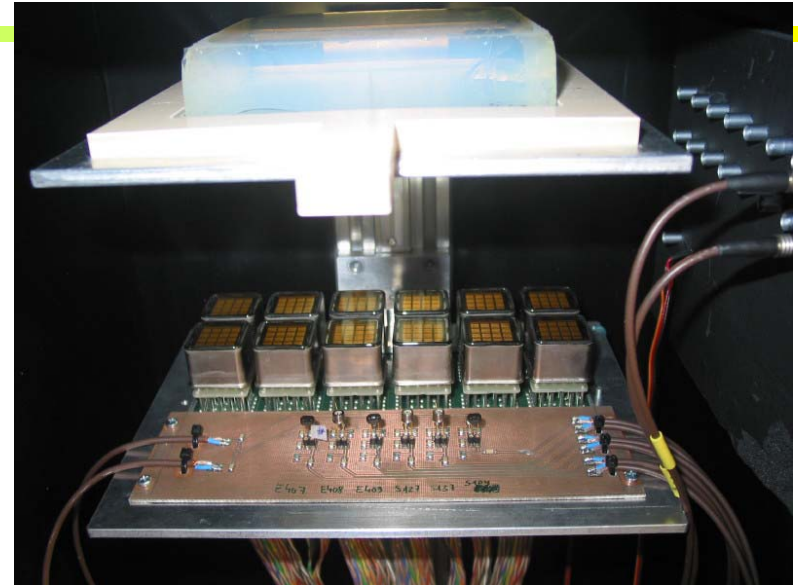
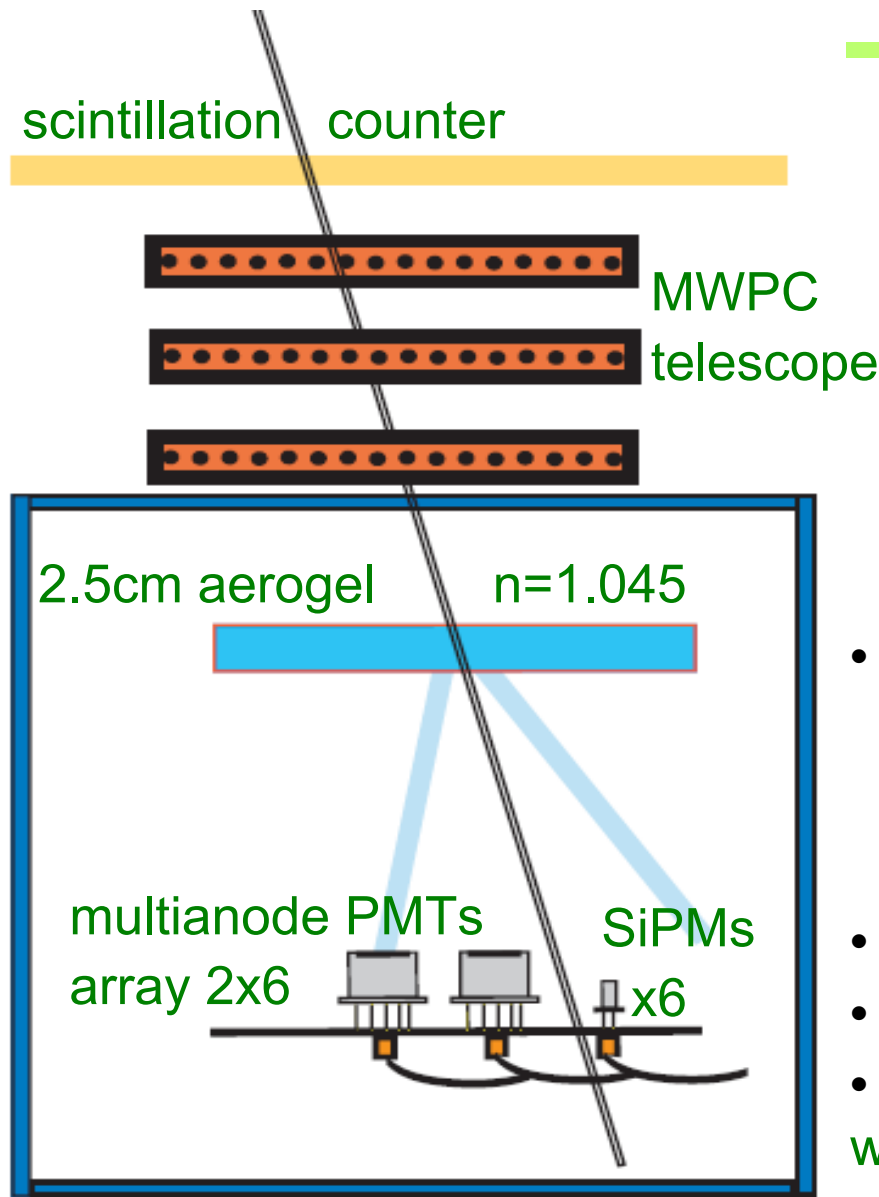
Photon detectors

- MCP PMTs
- SiPMs

MC studies

- Aerogel RICH
- Barrel PID device

SIPMs: Cosmic test setup



- 6 Hamamatsu SiPMs used:
 - ➔ 2x 100U; background ~400kHz
 - ➔ 2x 050U; background ~200kHz
 - ➔ 2x 025U; background ~100kHz
- signals amplified (ORTEC FTA820),
- discriminated (EG&G CF8000) and
- read by multihit TDC (CAEN V673A) with 1 ns / channel

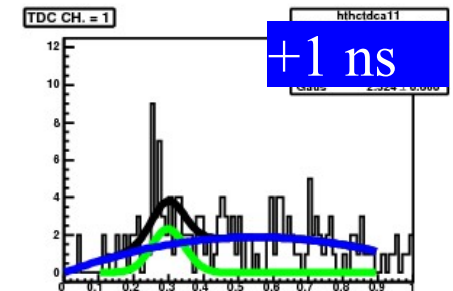
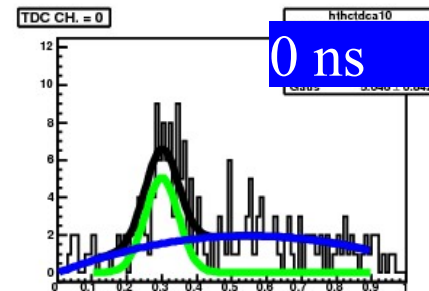
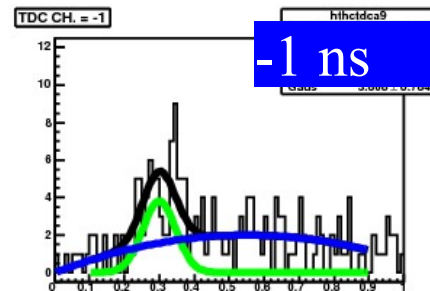
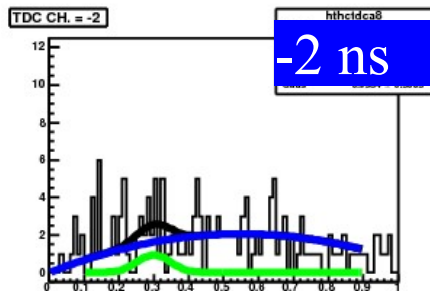
SiPM: Cherenkov angle distributions for 1ns time windows

-6 ns

-5 ns

-4 ns

-3 ns



+2 ns

+3 ns

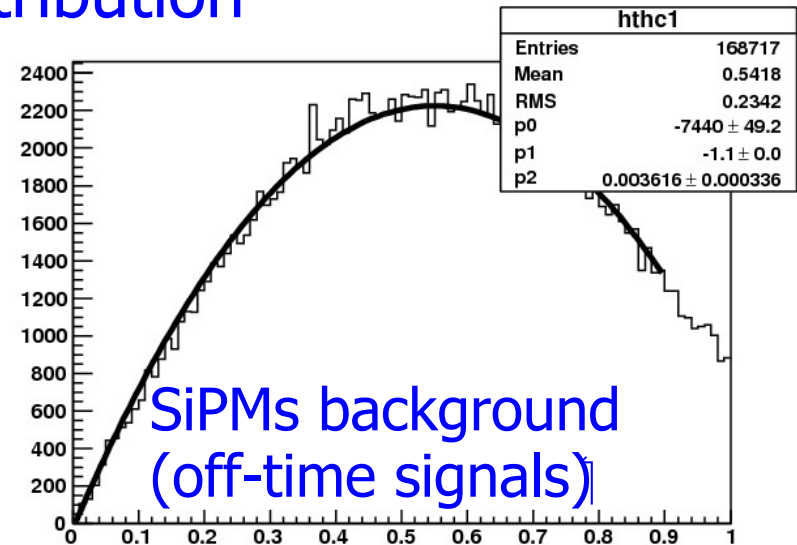
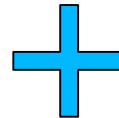
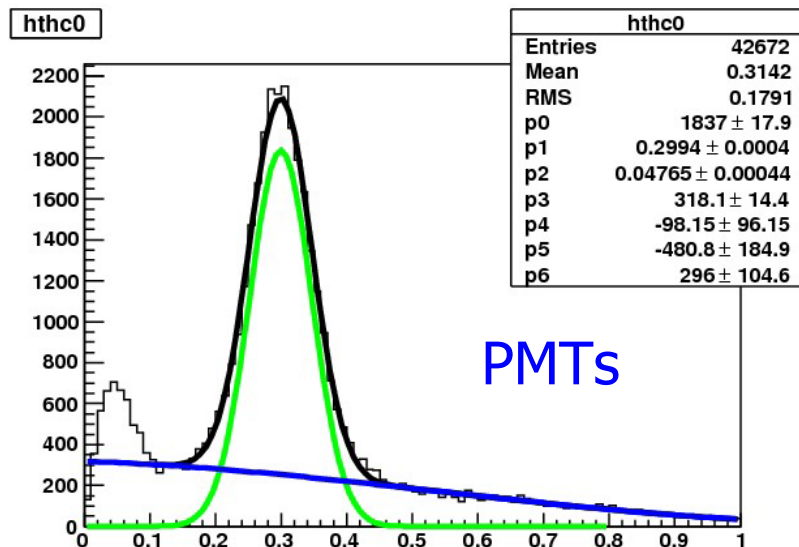
+4 ns

+5 ns

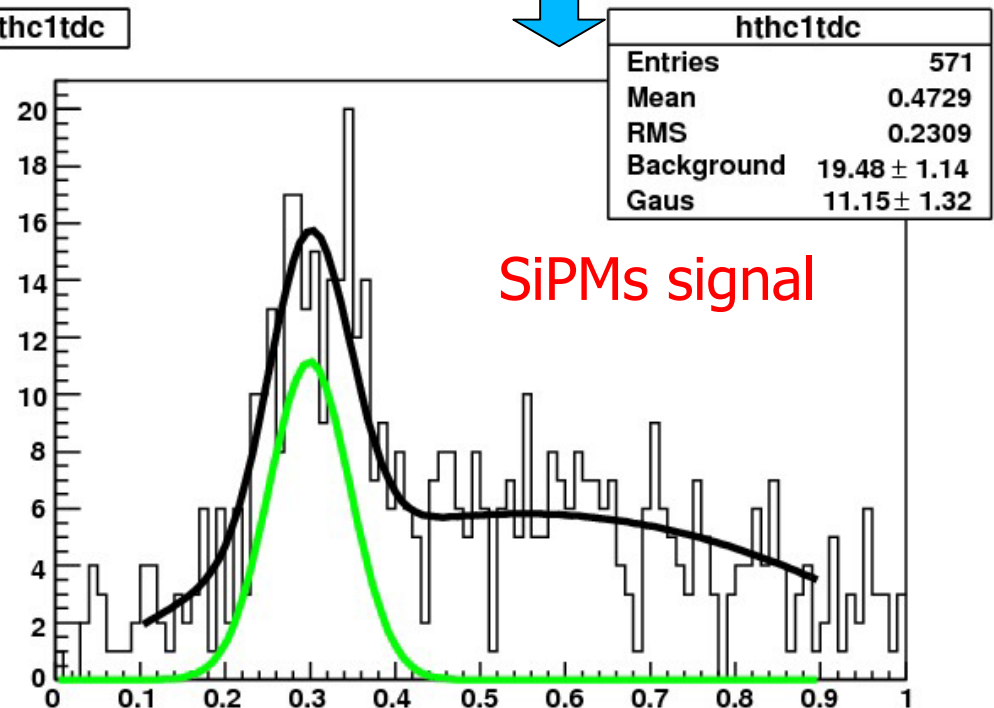
Cherenkov photons appear in the expected time windows →

First Cherenkov photons observed with SiPMs!

SiPM Cherenkov angle distribution



hthc1tdc



Fit function is a combination of

- a background (quadratic) and
- a signal (Gaussian).

Only scale parameters are free – others fixed.

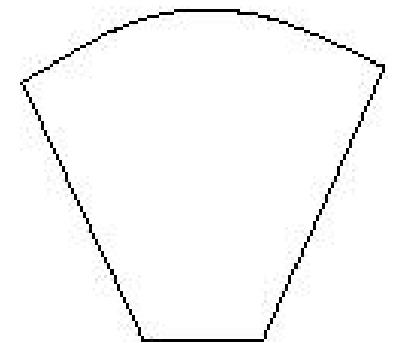
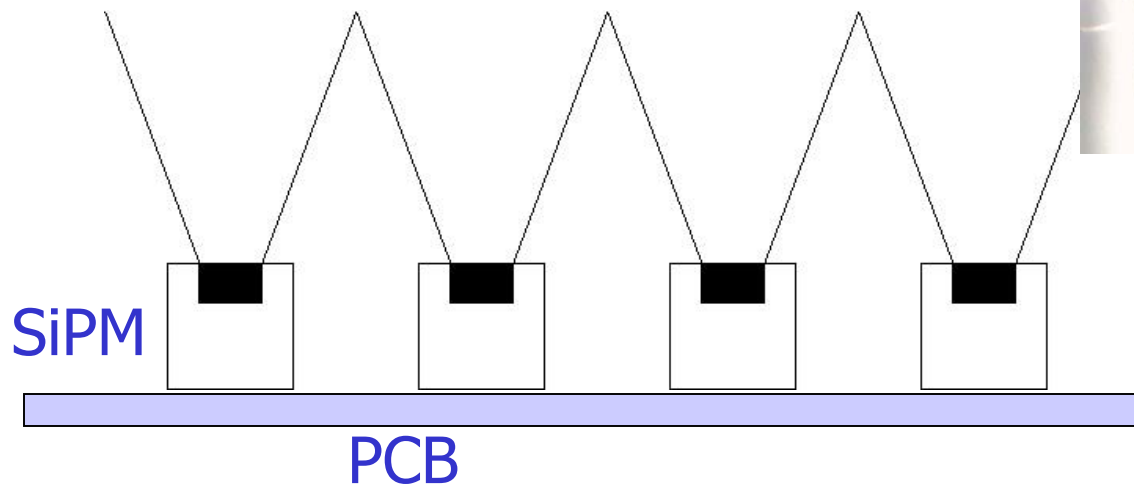
→ SiPMs give 4 x more photons than PMTs per photon detector area – in agreement with expectations

SIPMs: improving signal/noise

Improve the signal to noise ratio:

- Reduce the noise by a narrow (few ns) time window
- Increase the number of signal hits per single sensor by using light collectors and by adjusting the pad size to the ring thickness

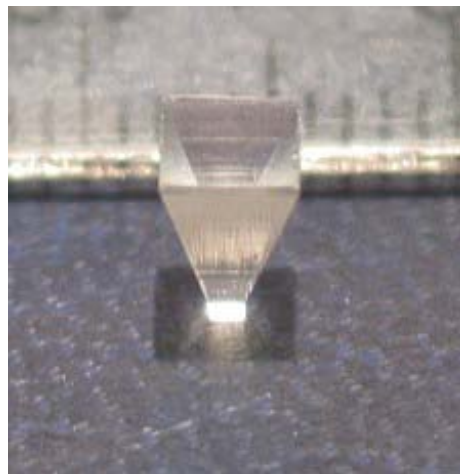
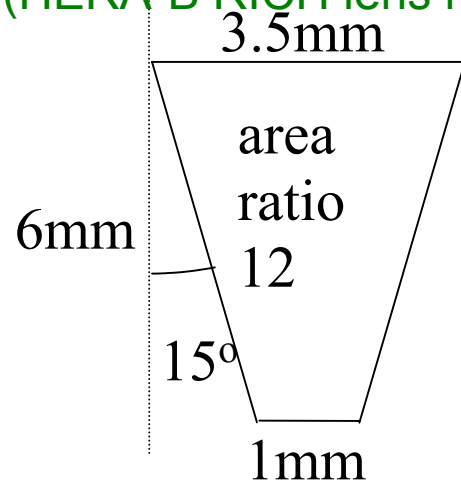
Light collector with reflective walls



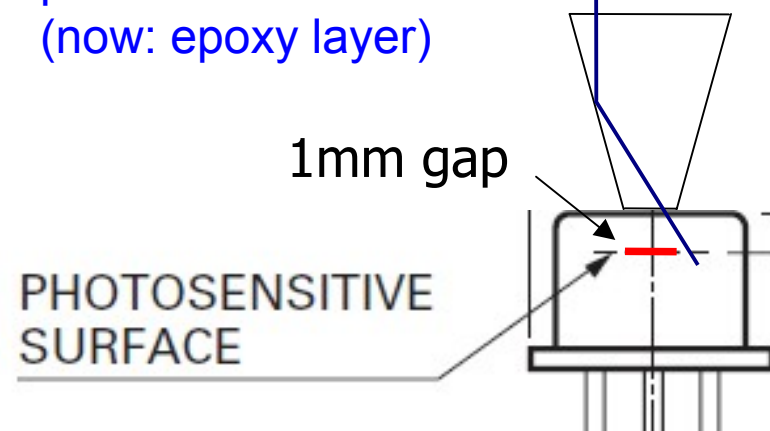
or combine a lens
and mirror walls

Light collection: improve signal to noise ratio

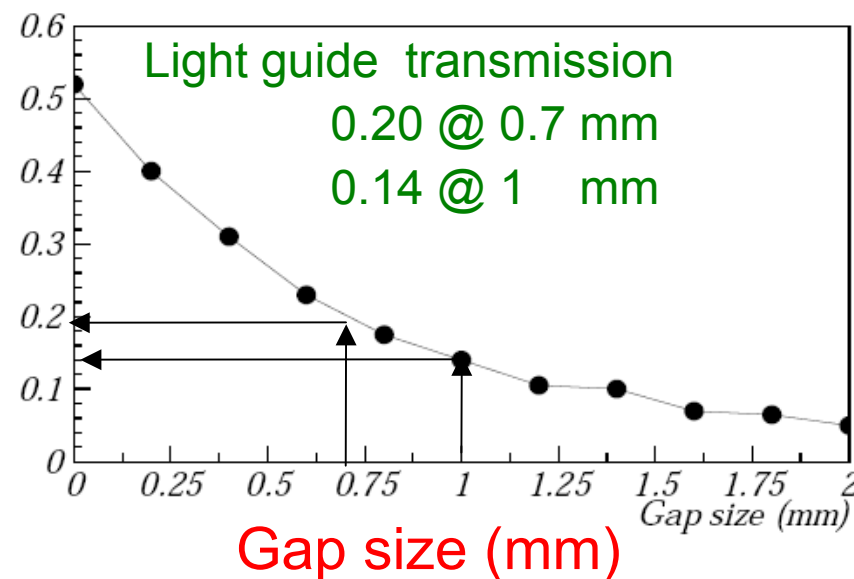
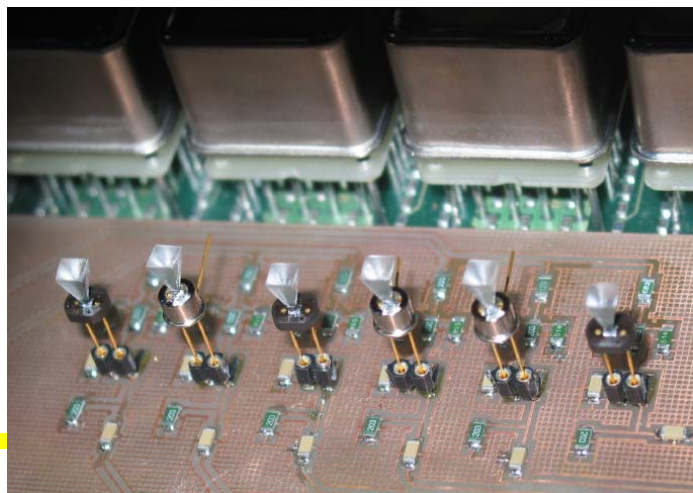
Machined from a plastic plate
(HERA-B RICH lens material).

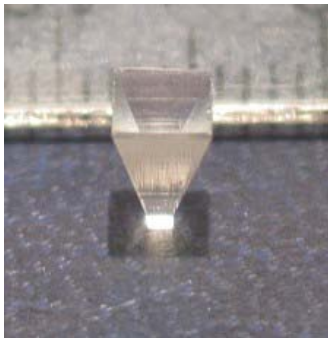


Light guide should be as close as possible to the SiPM surface
(now: epoxy layer)



- average transmission 0.52

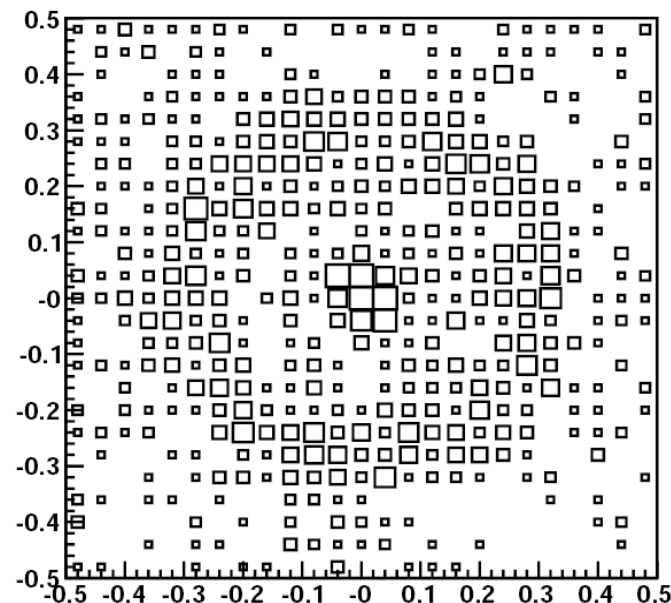
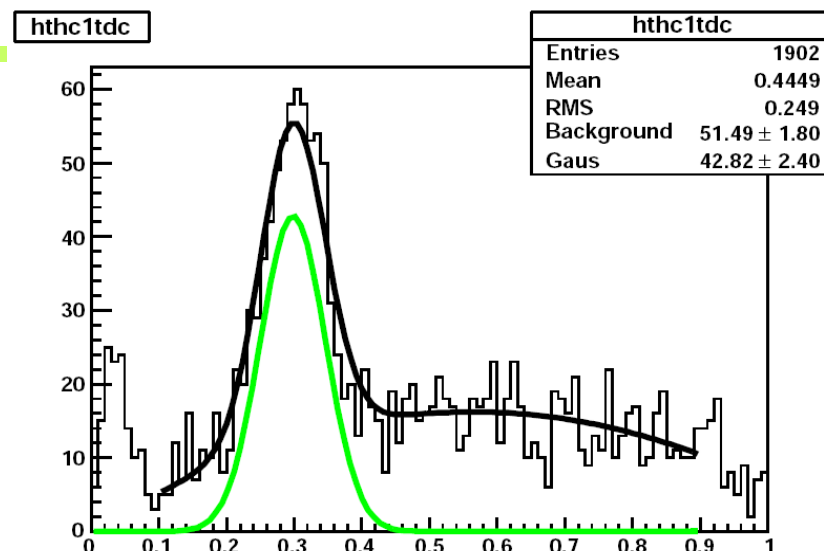
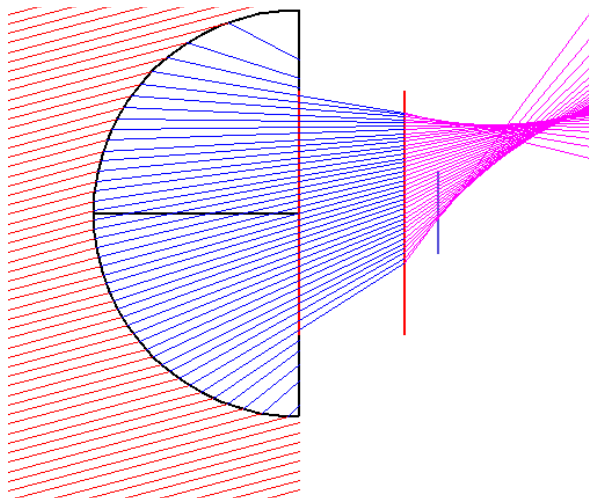




Cherenkov photons with light collectors

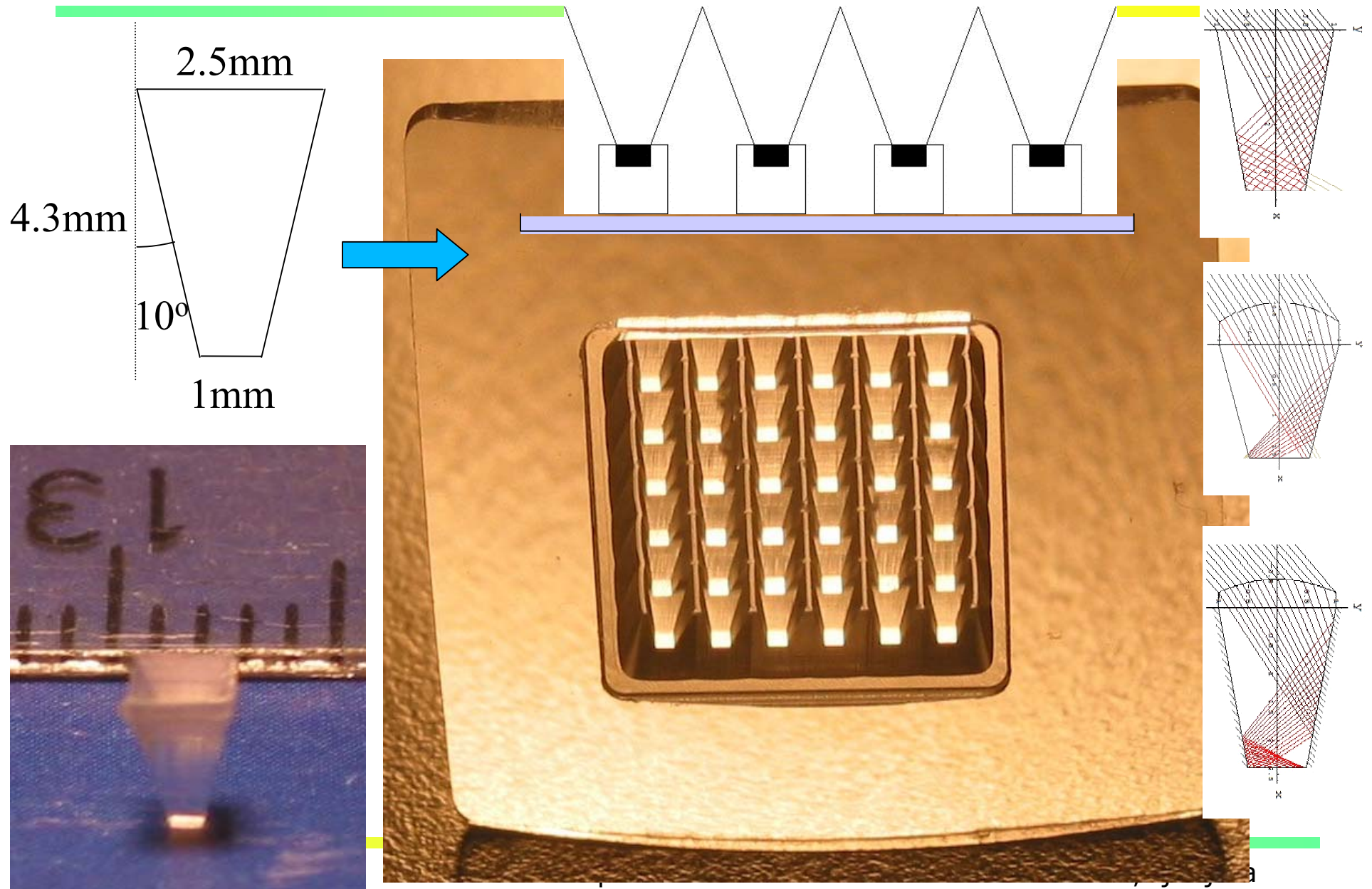
$$N_{\text{with}} / N_{\text{without}} \sim 2.2$$

- ★ in agreement with the expectations
- ★ Further improvements possible by
 - reducing the epoxy protective layer
 - using better light collector



Detector module design

SiPM array with light guides



Photon detectors, summary

BURLE 85011 MPC PMT (see my report on Dec 13)

- Best understood, beam and bench tested, excellent timing
- Open issues: ageing, read-out for fast timing
- How well can we determine TOF start time at IP?

SiPM (G-APD)

- Very good first results
- Open issues: radiation hardness, read-out with narrow time window

→ Plan:

- Beam (March and June) and bench (ageing) tests in spring.
- Measure n flux inside Belle

MC studies

Barrel device

- Simple MC of Time-Of-Propagation counter
- Reconstruction and likelihood function construction
- Could be adapted to the focusing DIRC needs

Forward RICH

- Full Geant4 MC
- Reconstruction

A 3D visualization of a particle detector structure, likely a Ring Imaging Cherenkov (RICH) detector. It features a central blue cylindrical volume, surrounded by a green hexagonal radiator layer, and an outer yellow hexagonal photon detector layer. The entire structure is composed of many small hexagonal cells. The background is a solid blue color.

Aerogel RICH full G4 MC available

- Aerogel radiator (hexagons)
- Photon detectors

→ added the support structures, approx. electronics

Reconstruction

- Get track parameters from the reconstructed track list
- Construct the likelihood functions for 5 hypotheses

Next steps

Photon detector tests: establish which type survives in the detector, and is affordable; test the read-out options

- Beam and bench tests in the next half a year
- Tests of electronics (wave sampling with Gary, ASIC with KEK/TMU)

MC:

- Refine the description for the forward device
- Work on the reconstruction for the full MC of the barrel device (if time available...)