Cherenkov angle reconstruction

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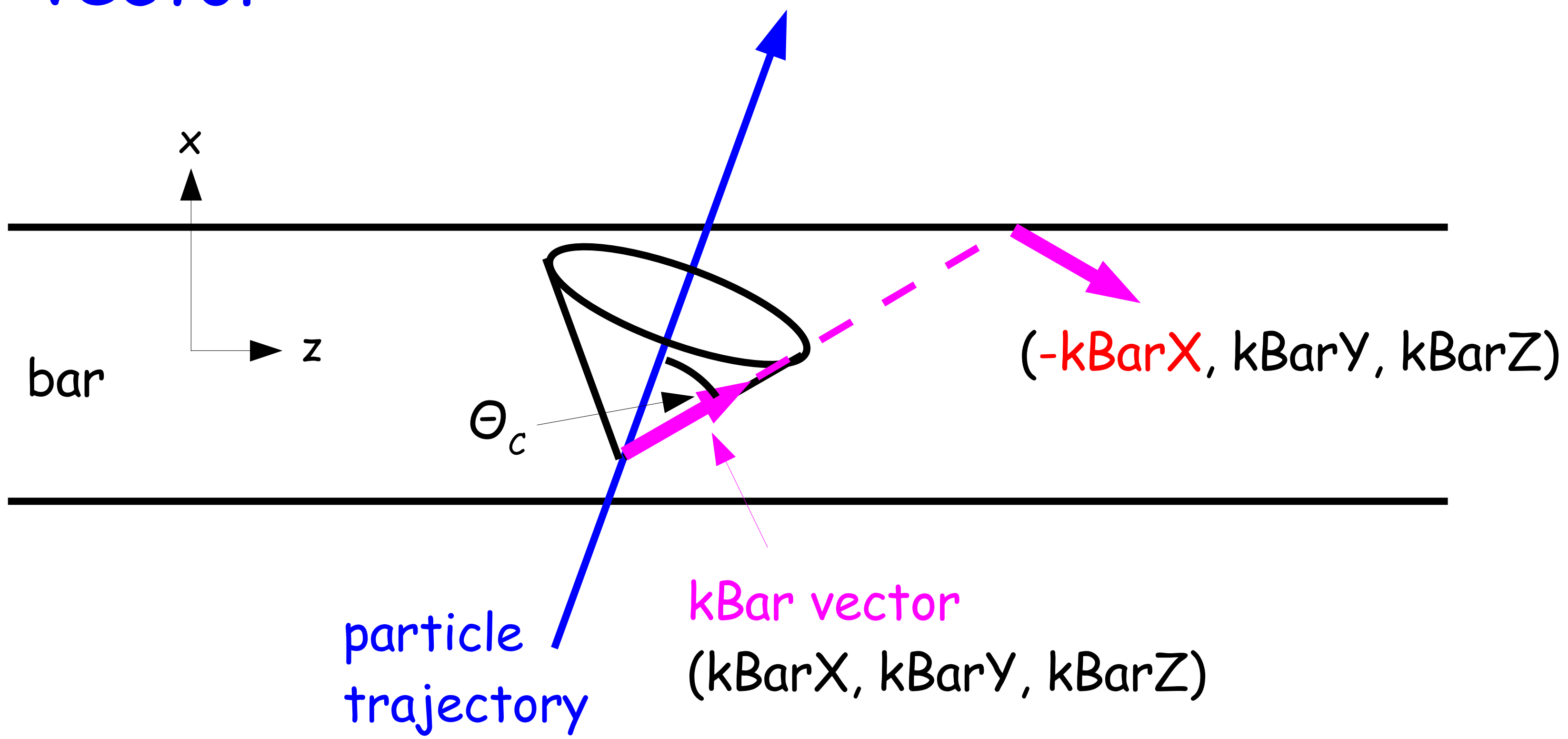
Outline

- Cherenkov angle reconstruction via BaBar ("kBar") method
    - Pixel & bar information (position, time)
    - Look-up table (kBar map)
    - Particle track
    - => Θ_c
- This method could be a candidate for the PANDA reconstruction (see Dipanwita's talk in the Computing Session)

- Only beamtest simulation are used
    - 400 nm (Cherenkov photons)
    - [300, 700] nm

kBar vector



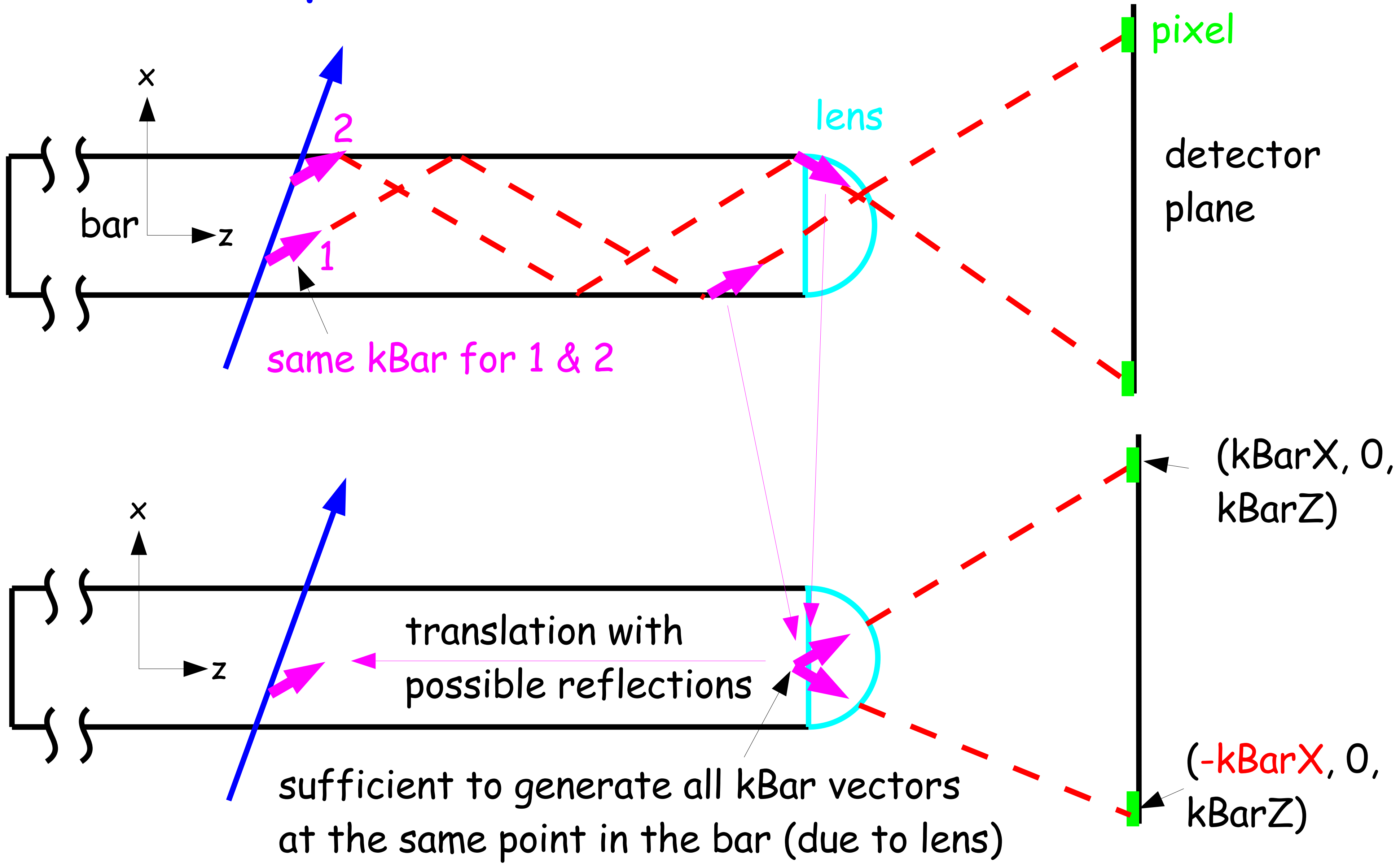
kBar vector: - photon direction at production
- unit vector in bar coordinate system

particle direction & kBar vector => Θ_c

(known) (unknown)

=> determine unique kBar vector for each detector pixel

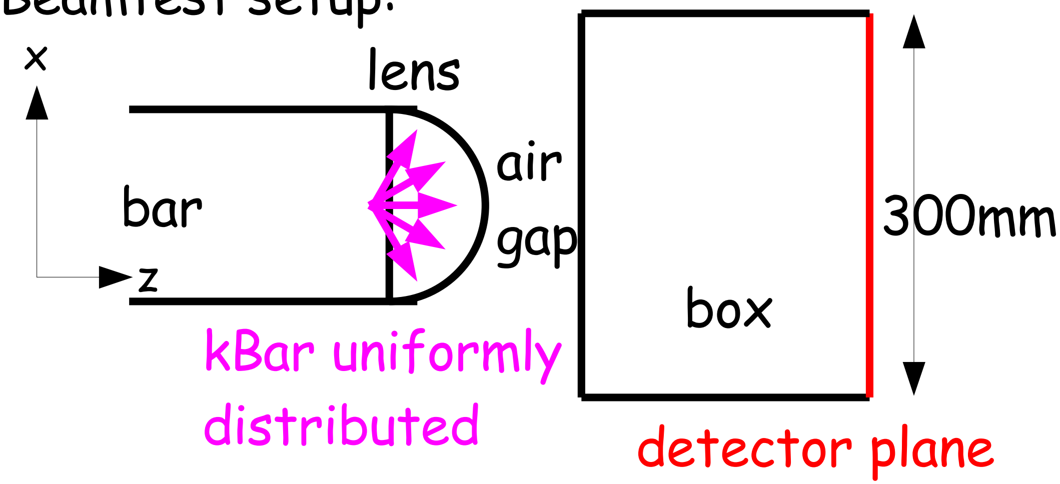
kBar vector production



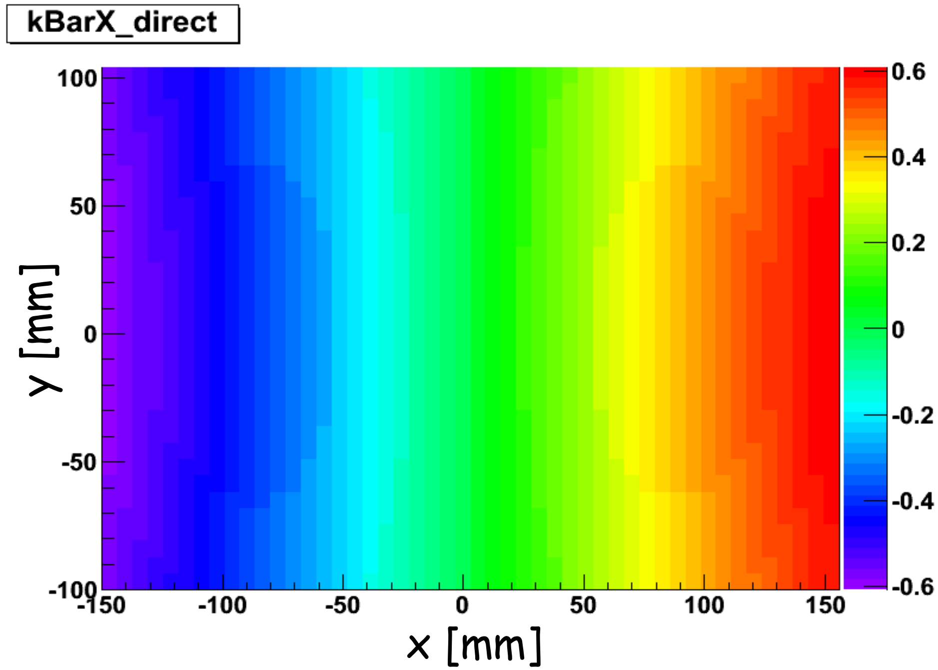
generate kBar vectors => kBar map on detector plane

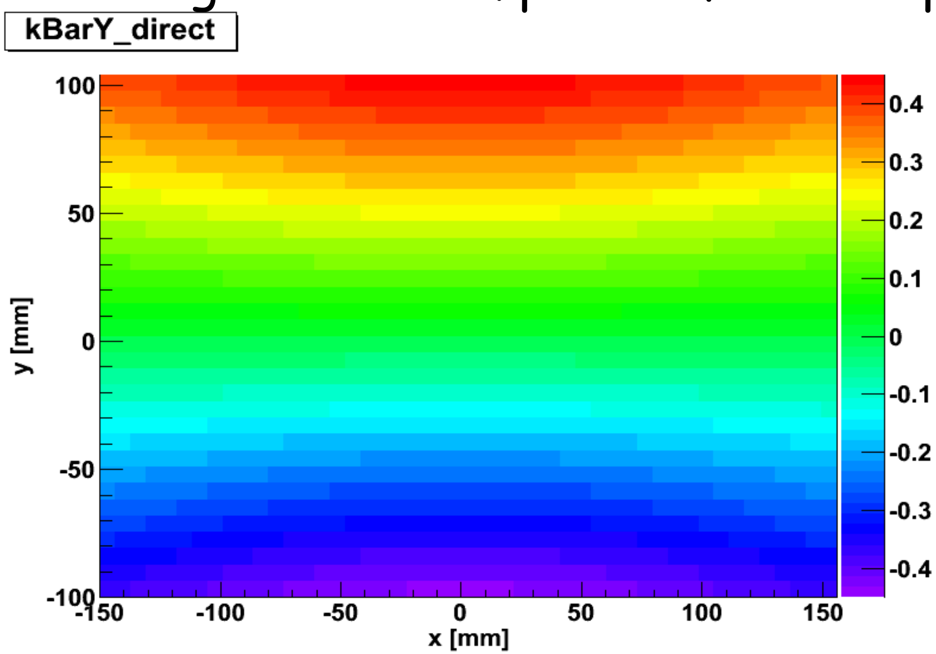
kBar map

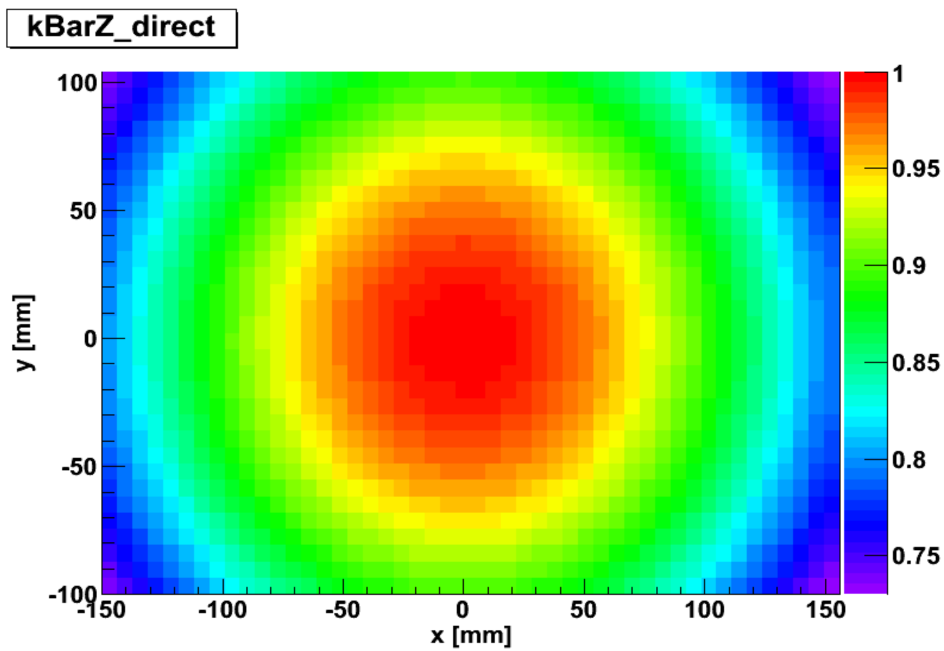
Beamtest setup:



- $2*10^7$ photons hit the detector plane
- averaged kBar component for each pixel



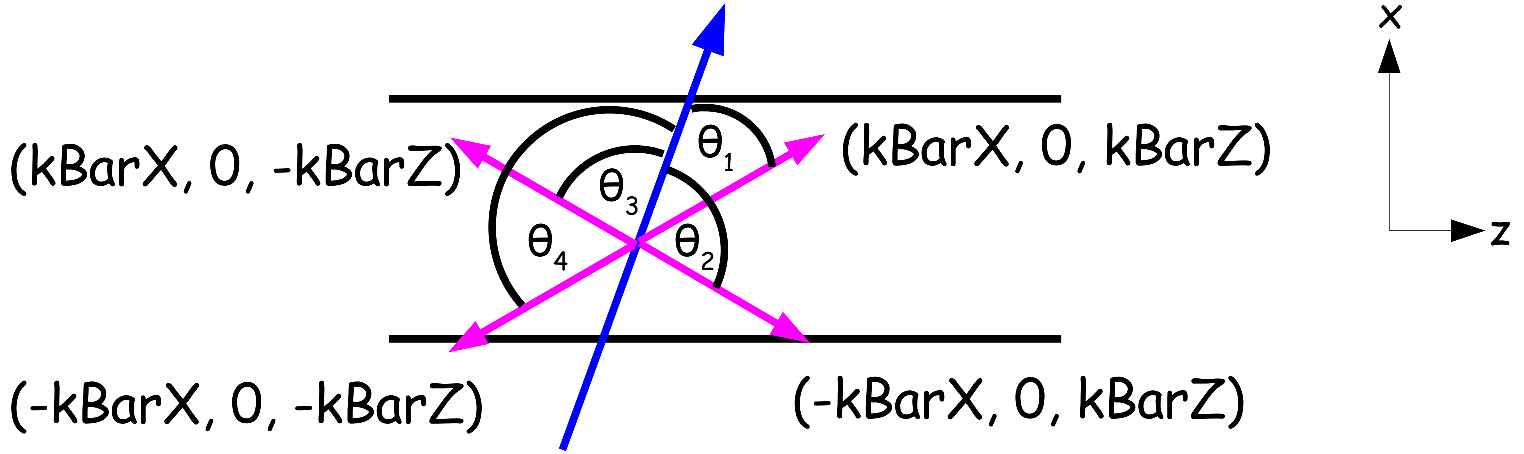




Ambiguities

pixel hit => possible ambiguities => more than 1 solution

Example: pixel: (kBarX, 0, kBarZ) from kBar map
left/right, back/forward = > 2*2 = 4 solutions



Solution elimination:

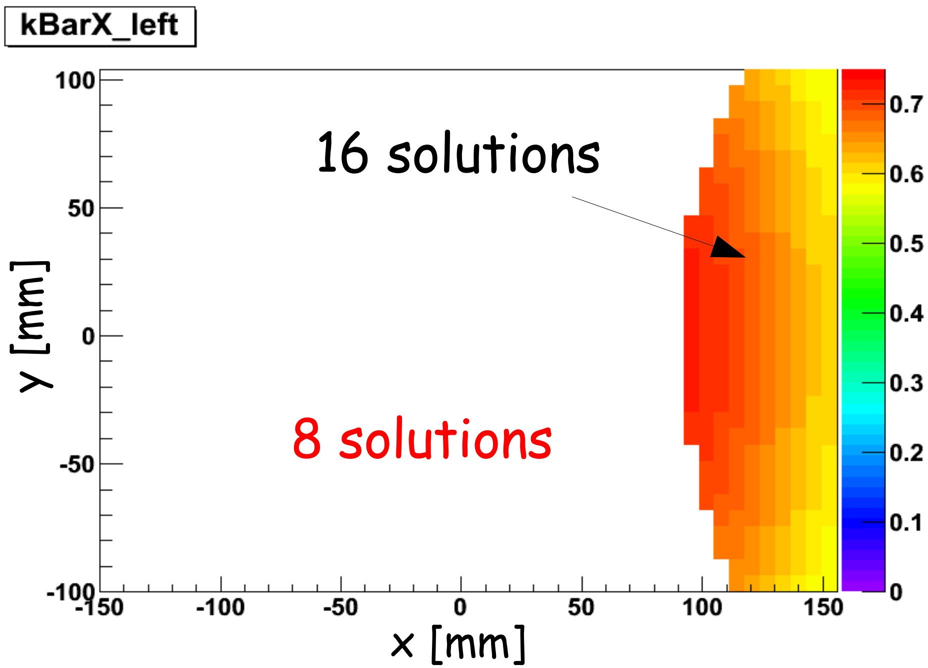
- Symmetry: $\theta_1 = 180° - \theta_4$ & $\theta_2 = 180° - \theta_3$ => $\theta < 90°$
- Time: can resolves back/forward ambiguity ($\theta_2 > 90°$)
- Physics: Cherenkov angle e.g. θ_c(300nm) = 47.8°

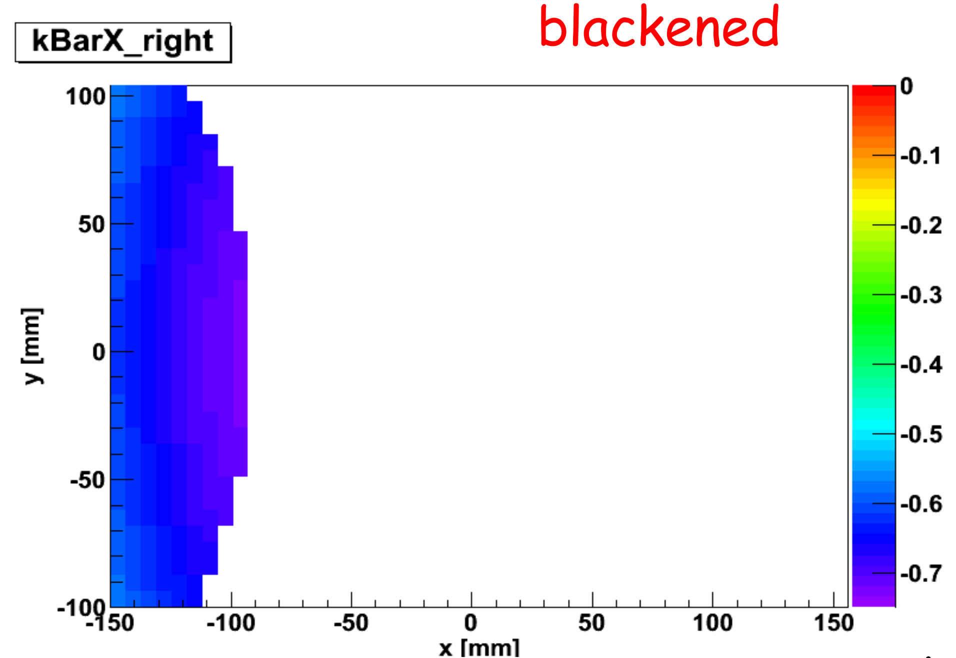
Additional kBar solutions in the box

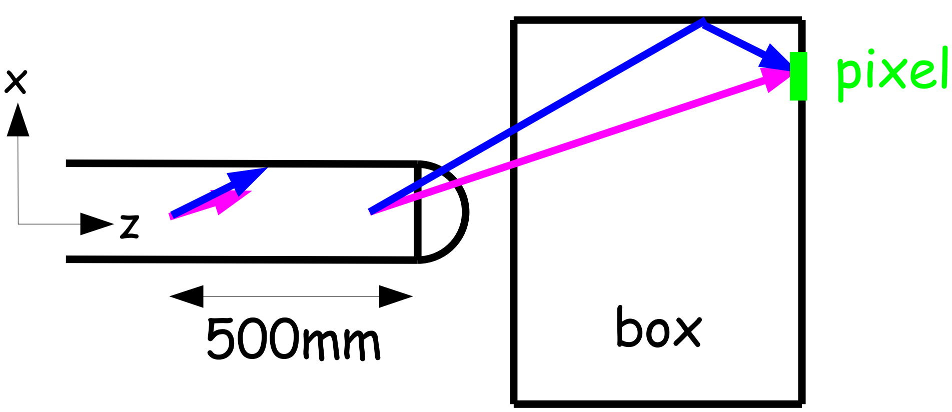
left/right, back/forward, up/down, box(direct, left/right, up/down)

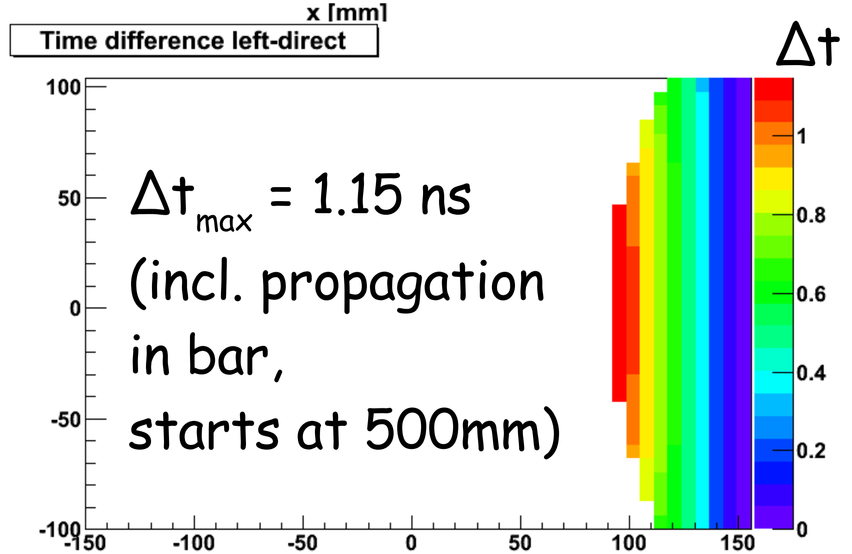
= > 2*2*2*2 = 16 solutions (max.)

blackened



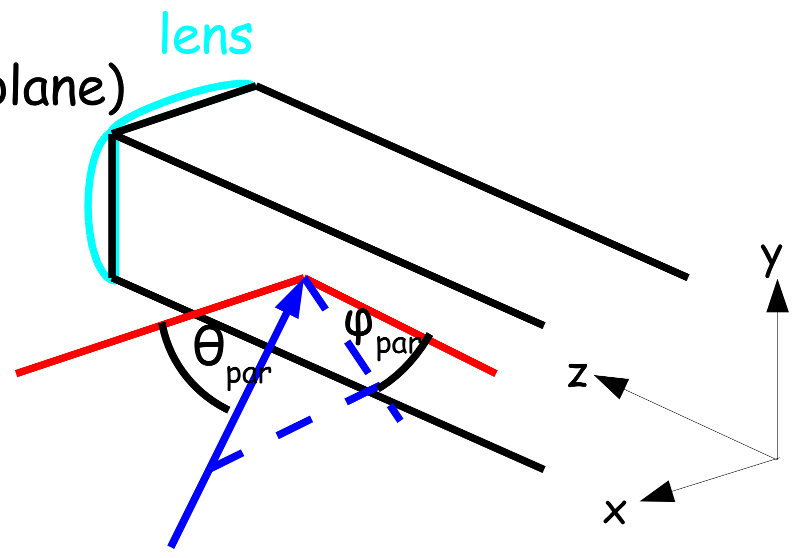






Ideal Cherenkov angle resolution (400nm)

simulation: - protons with T = 2 GeV &
θ = 30° & φ = 0° (track in x-z plane)
- box walls are blackened
(top/bottom, left/right)

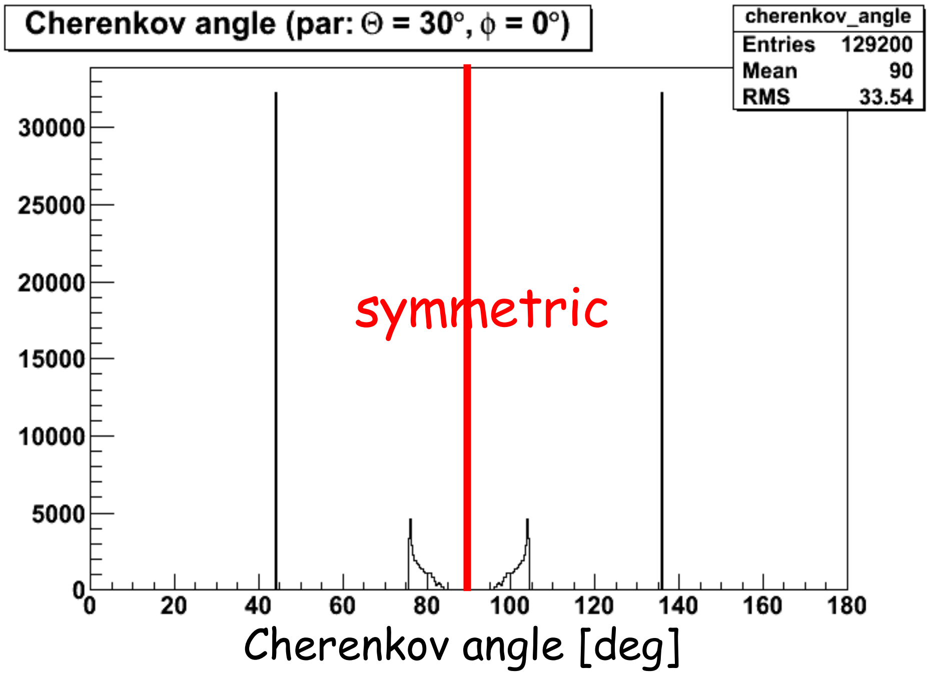


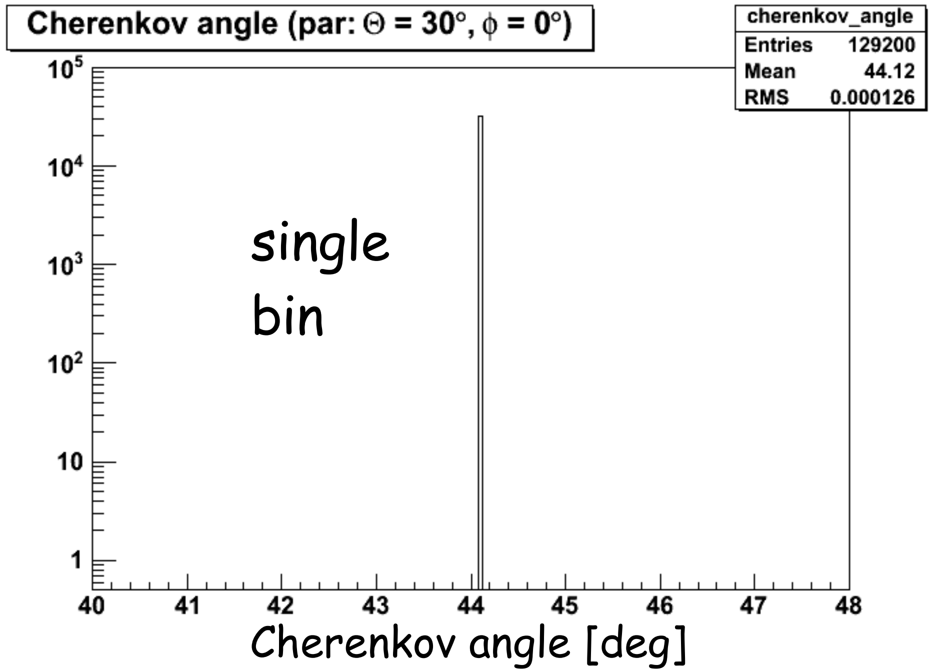
use true kBar-vectors => no pixel effect

no box ambiguity => 8 solutions

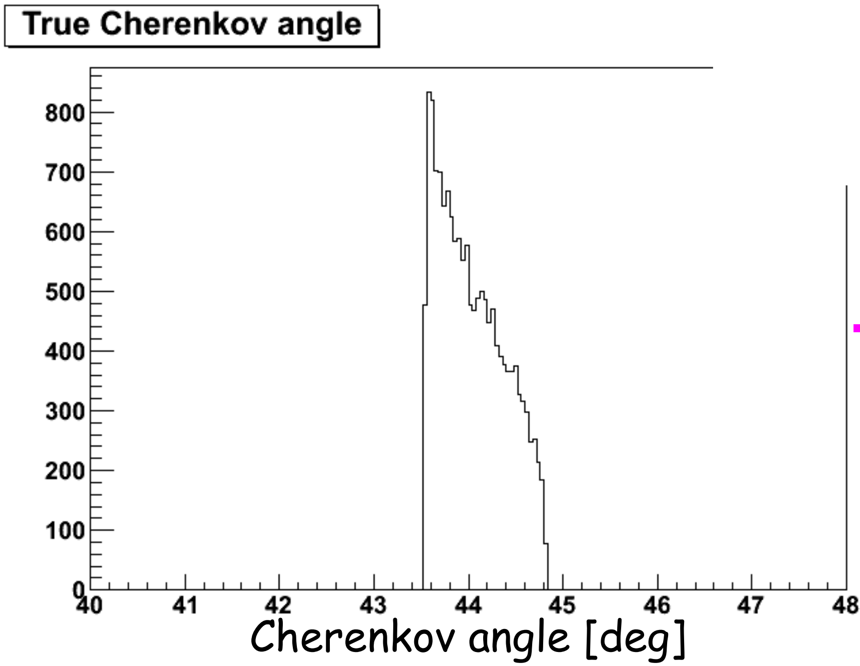
φ = 0° => same θ_c for up/down ambiguity

=> 4 solutions remain

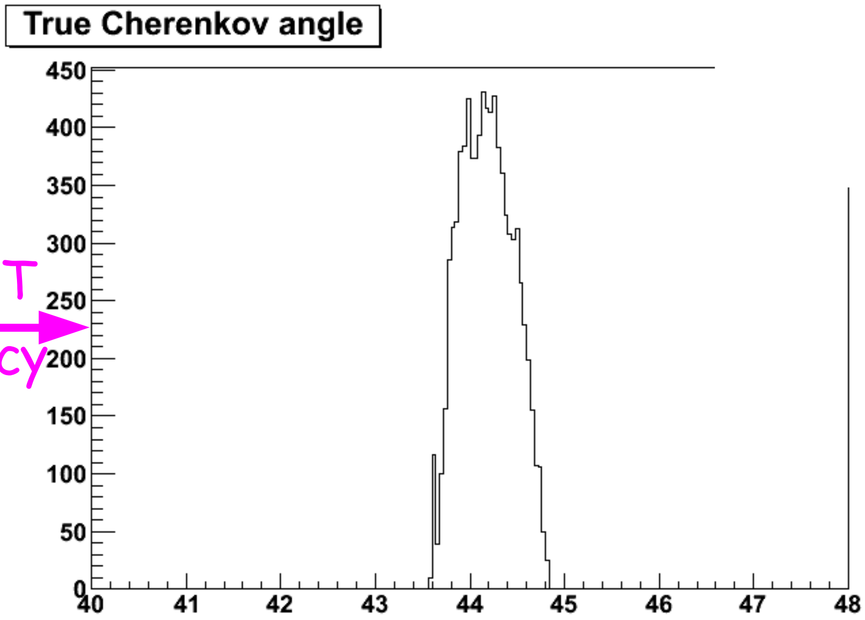




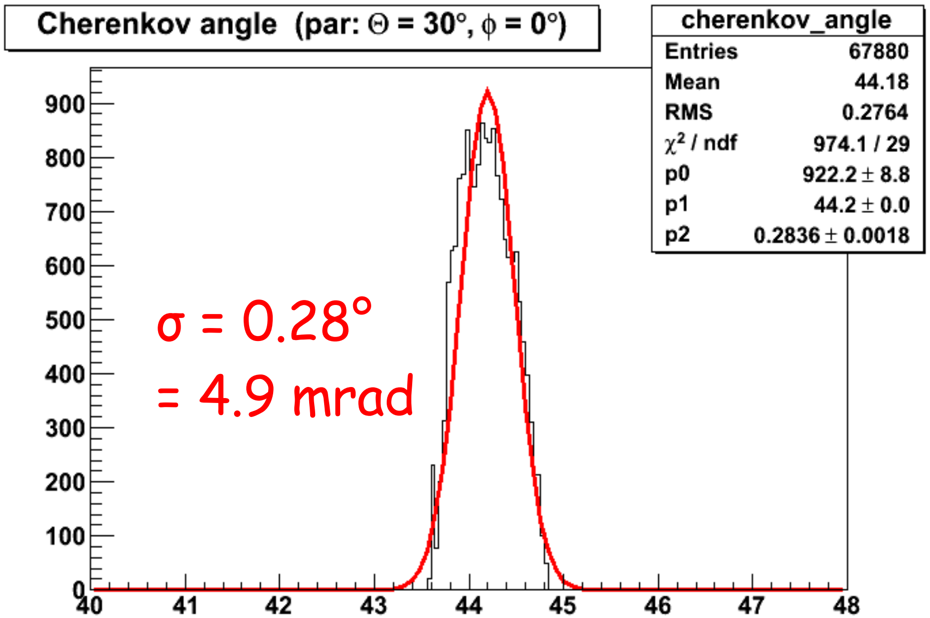
Ideal Cherenkov angle resolution (300-700nm)



MCP-PMT efficiency



same shape

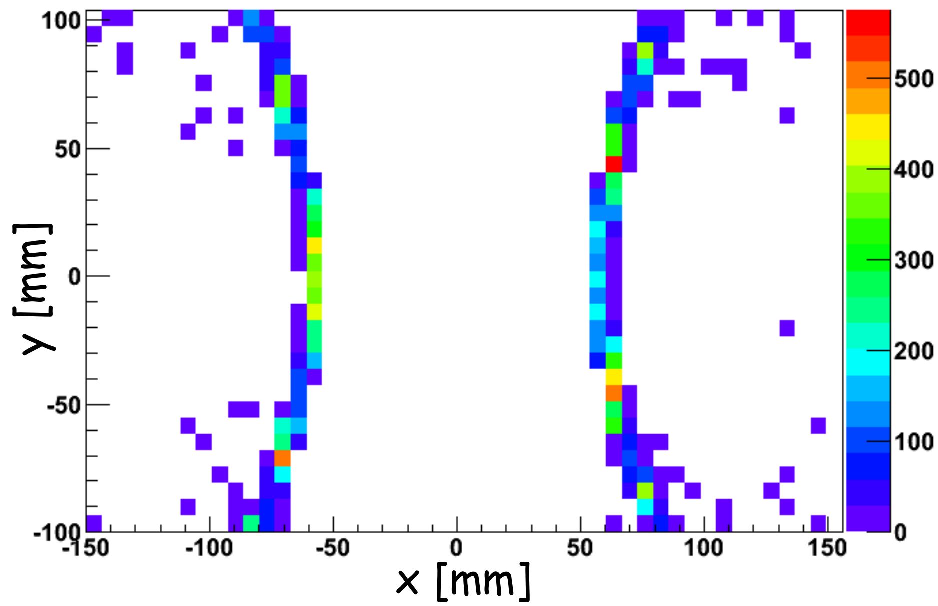


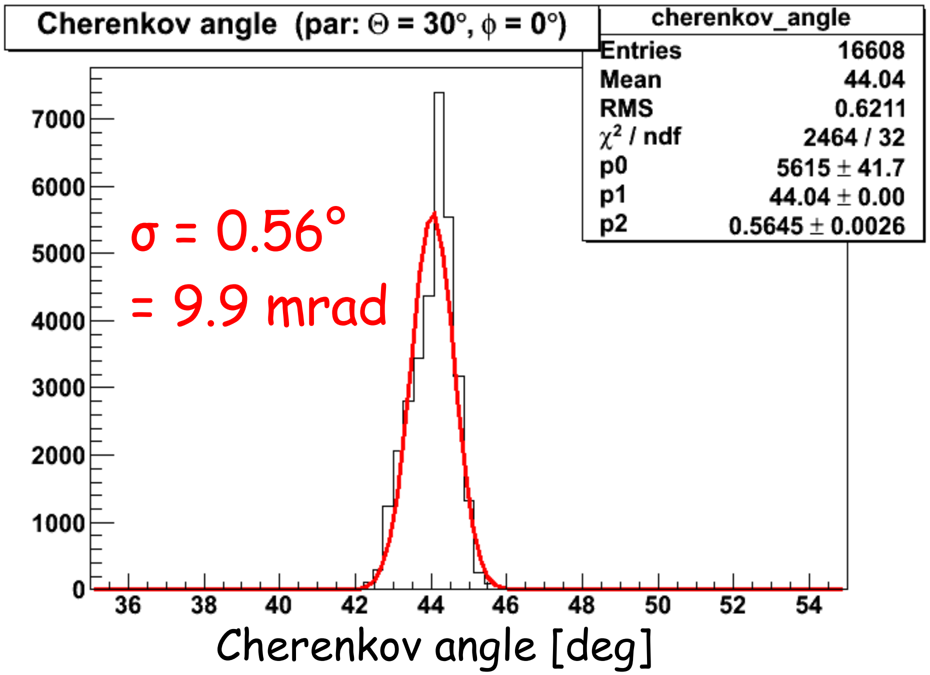
dispersion (300-700 nm)

=> 4.9 mrad contribution

to the Cherenkov angle resolution

Angle resolution with pixelization (400nm)





- pixel size: 6.375 mm (MCP-PMT pixel)
- same size for the kBar map

- w/o pixel effect => single bin

expected: $$\sigma_{pixel} = \frac{6.375\ mm}{\sqrt{12}}$$

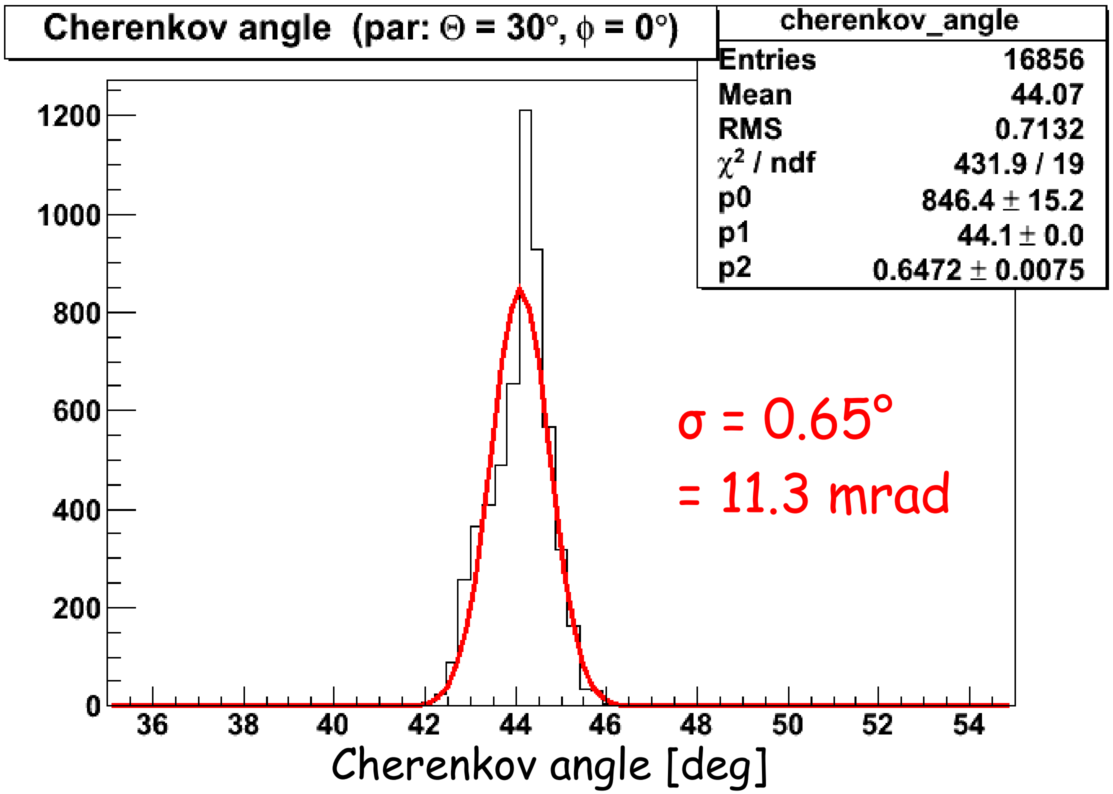
$$\sigma = \frac{\sigma_{pixel}}{200\ mm} = 9.2\ mrad$$

box depth

MCP-PMT pixelization + lens error => 9.9 mrad resolution

lens error contribution: 3.7 mrad

Angle resolution with pixelization (300-700nm)



expected: MCP pixelization + lens + dispersion => 11.0 mrad resolution

MCP pixelization + lens: 9.9 mrad

dispersion: 4.9 mrad

Conclusion & outlook

- First test of the kBar reconstruction method with beamtest simulation was successful

- kBar method useful as a performance check (Cherenkov angle resolution)

- In future apply method to real beamtest data