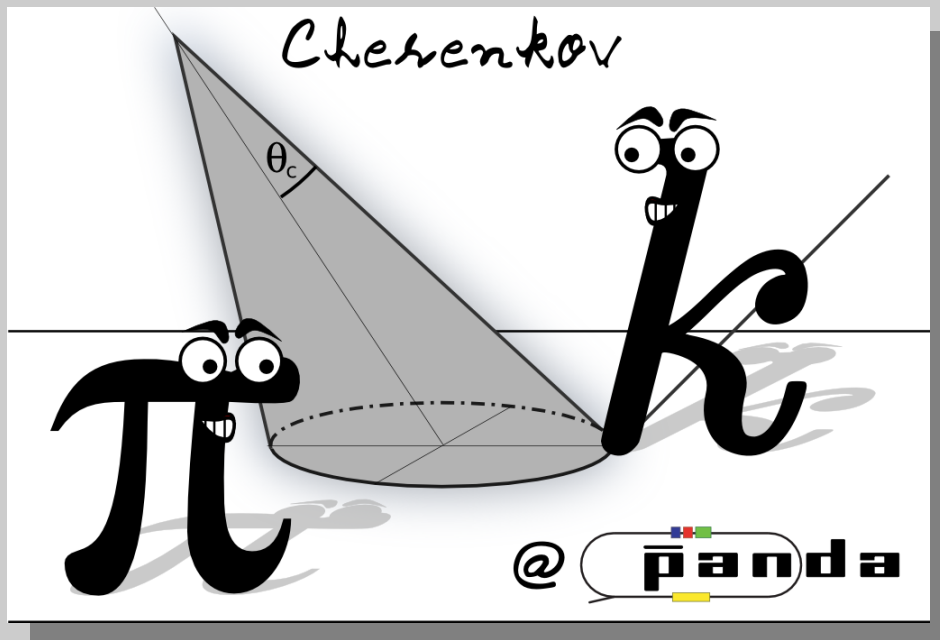


Simulation and reconstruction of the $\bar{\text{P}}\text{ANDA}$ 3D Disc DIRC



JUSTUS-LIEBIG-



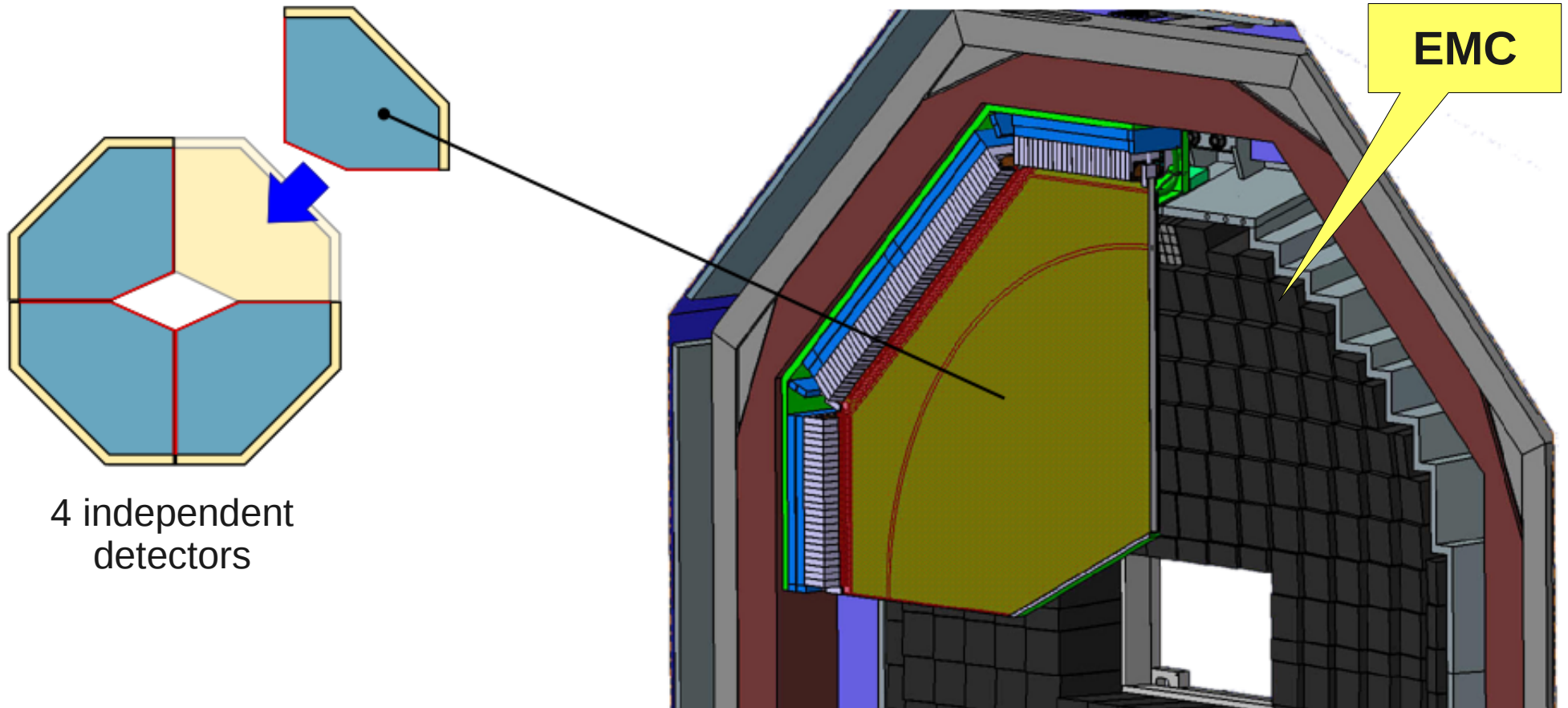
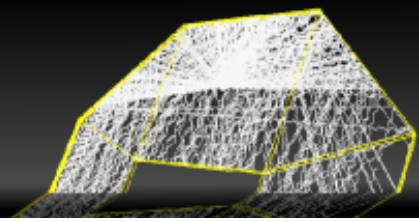
UNIVERSITÄT
GIESSEN

GEFÖRDERT VOM



Bundesministerium
für Bildung
und Forschung



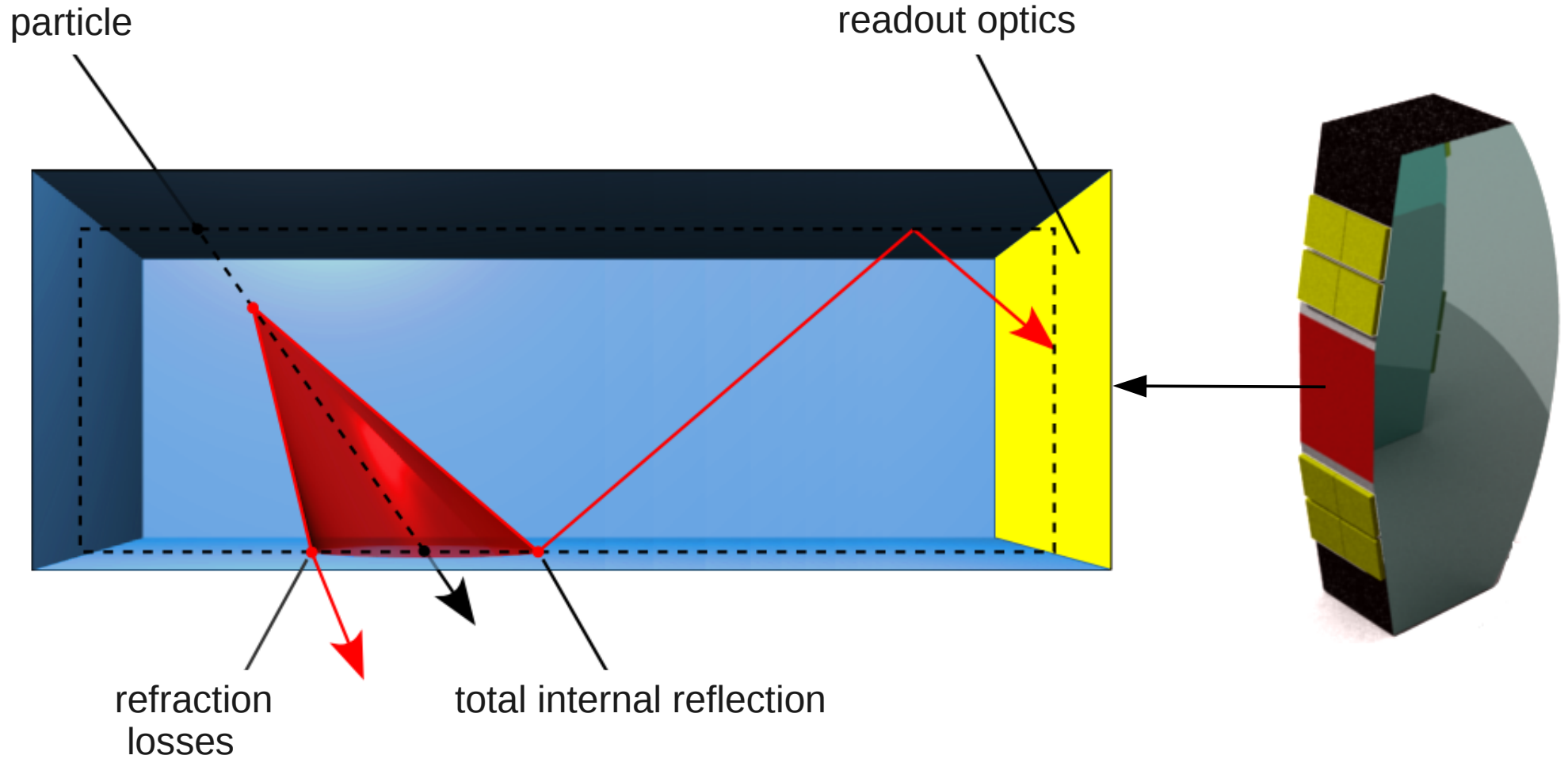
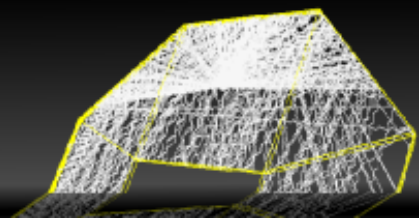


4 independent
detectors

EMC

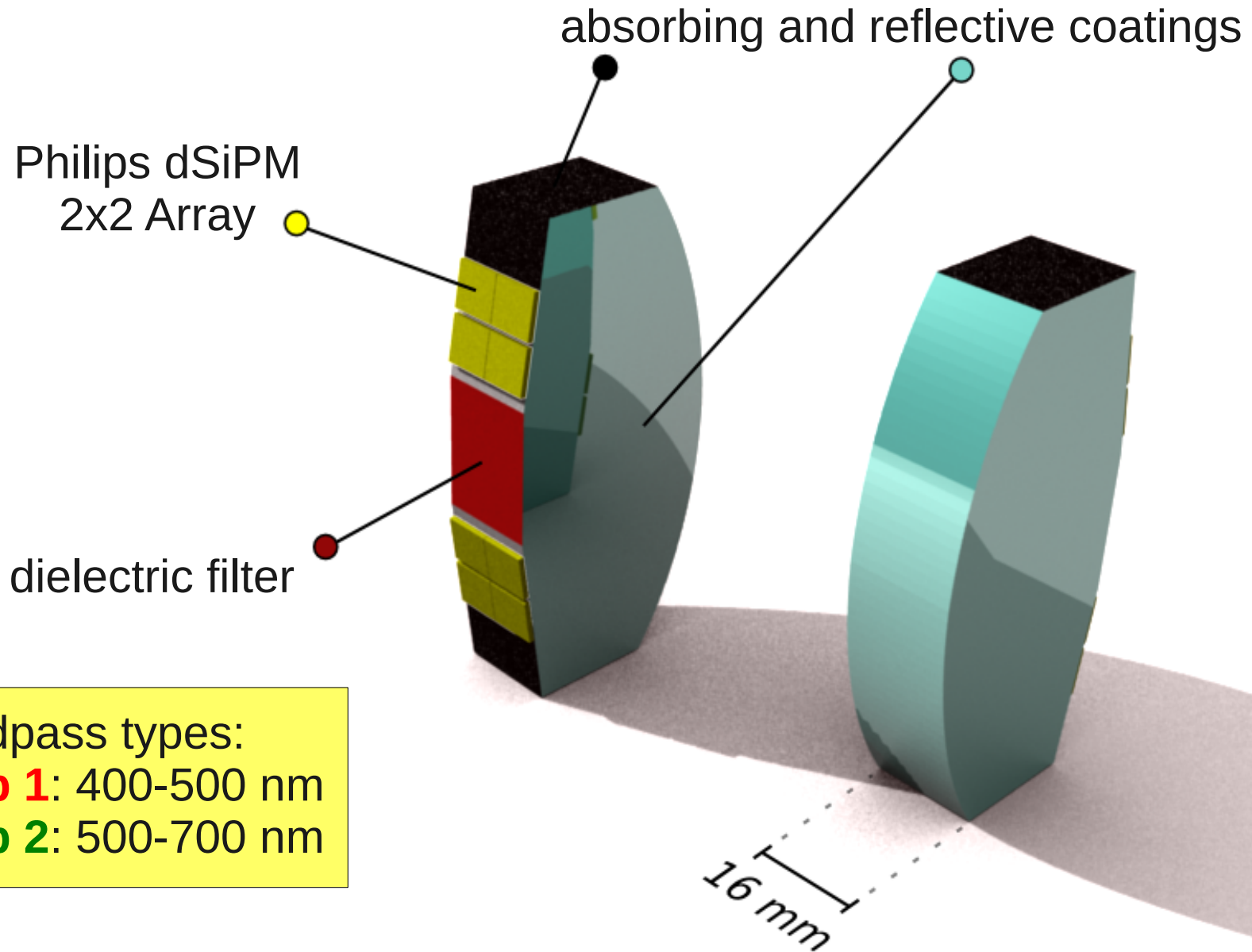
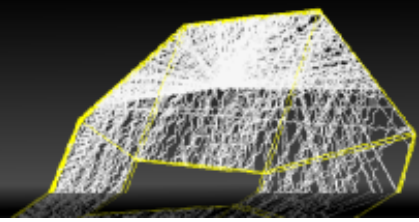
Working principle

A 3d Disc DIRC
for \bar{P} ANDA



Working principle

A 3d Disc DIRC
for \overline{PANDA}



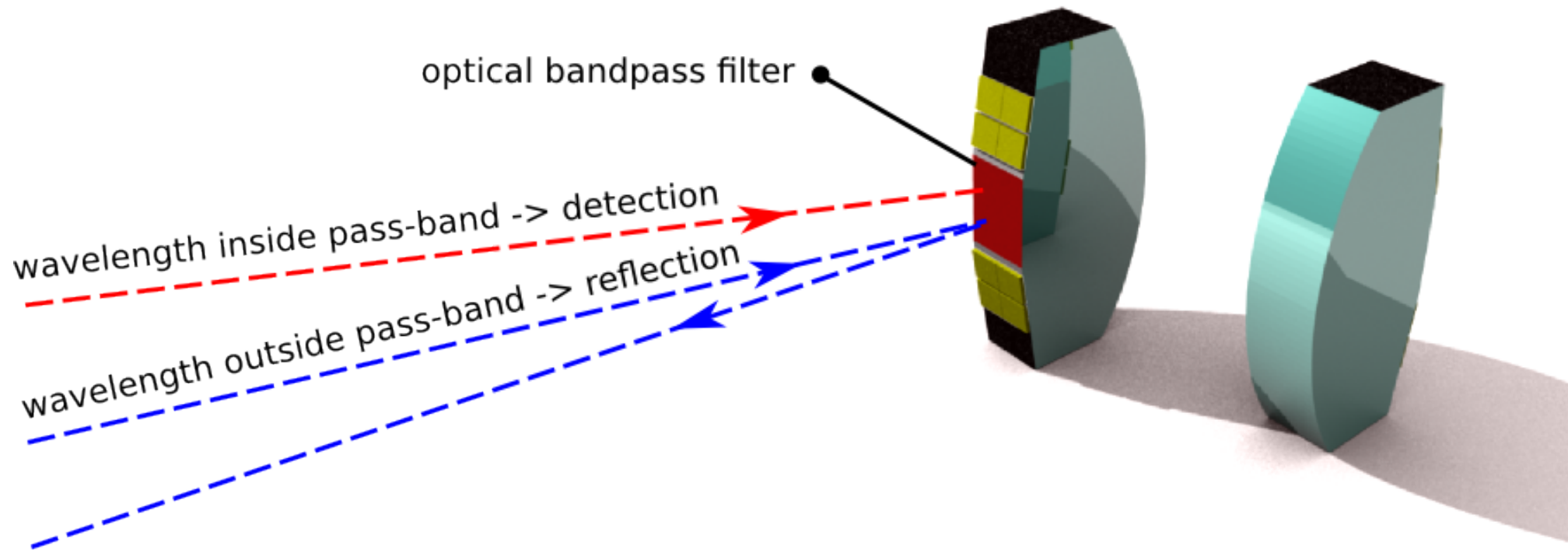
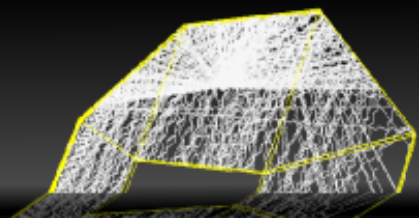
bandpass types:

Typ 1: 400-500 nm

Typ 2: 500-700 nm

Working principle

A 3d Disc DIRC
for \bar{P} ANDA



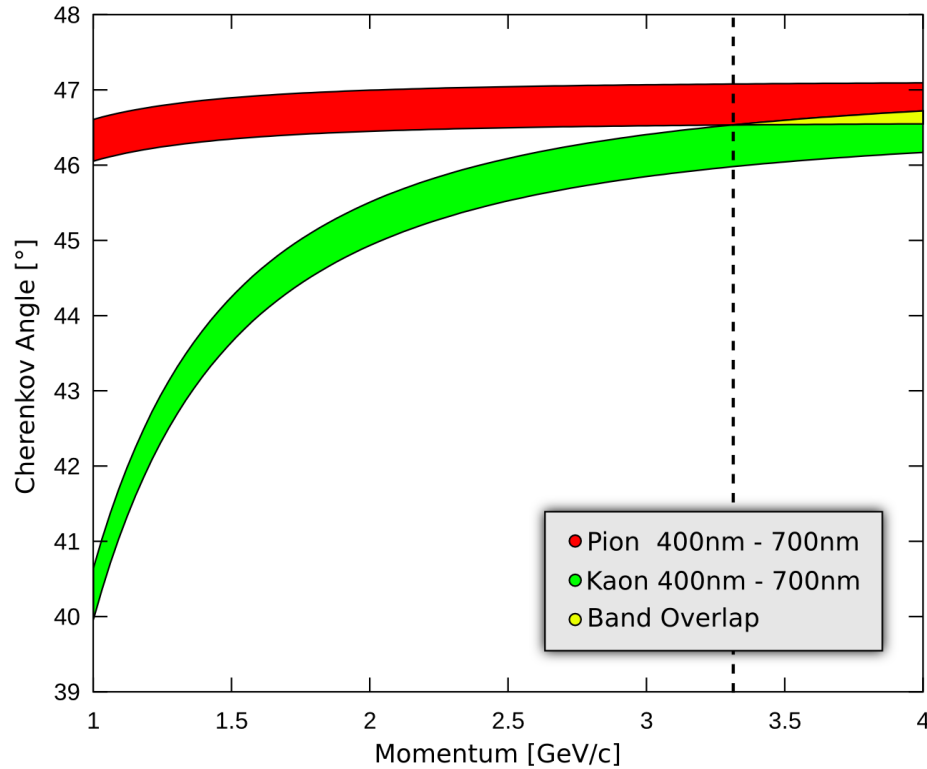
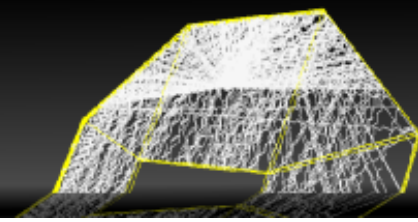
bandpass types:

Typ 1: 400-500 nm

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Working principle

A 3d Disc DIRC for \overline{PANDA}

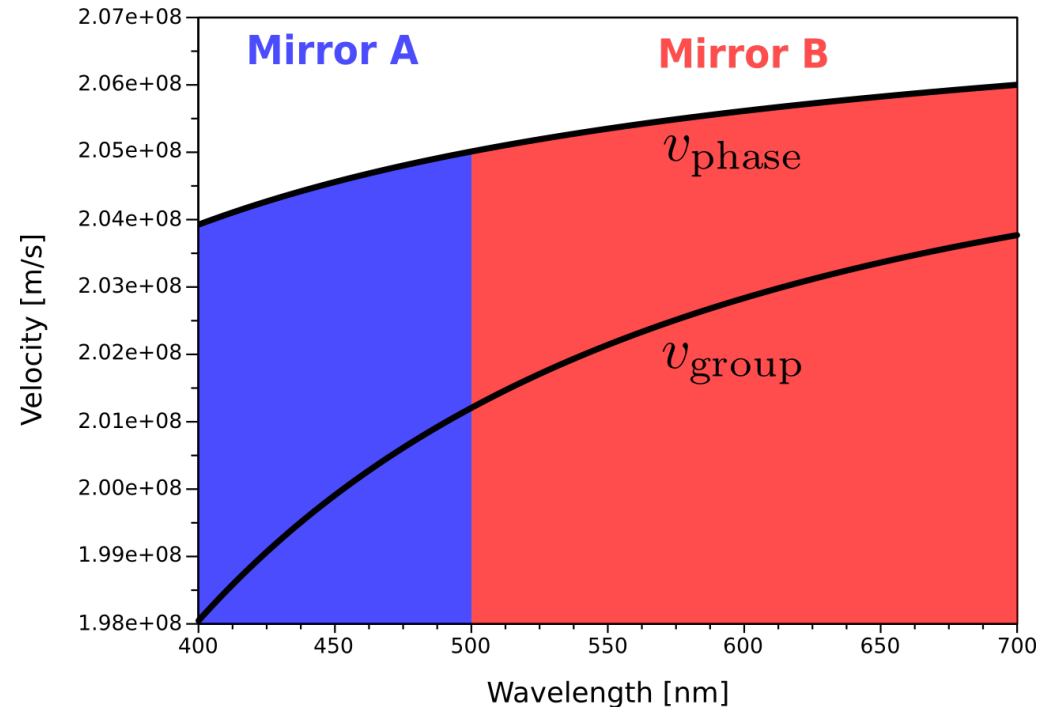


$$\cos \theta_c = \frac{1}{n\beta} = \frac{v_p}{\beta c}$$

$$t_{\text{top}} = s_{3d} / v_g = \frac{s_{2d}}{v_g \cdot \cos \varphi}$$

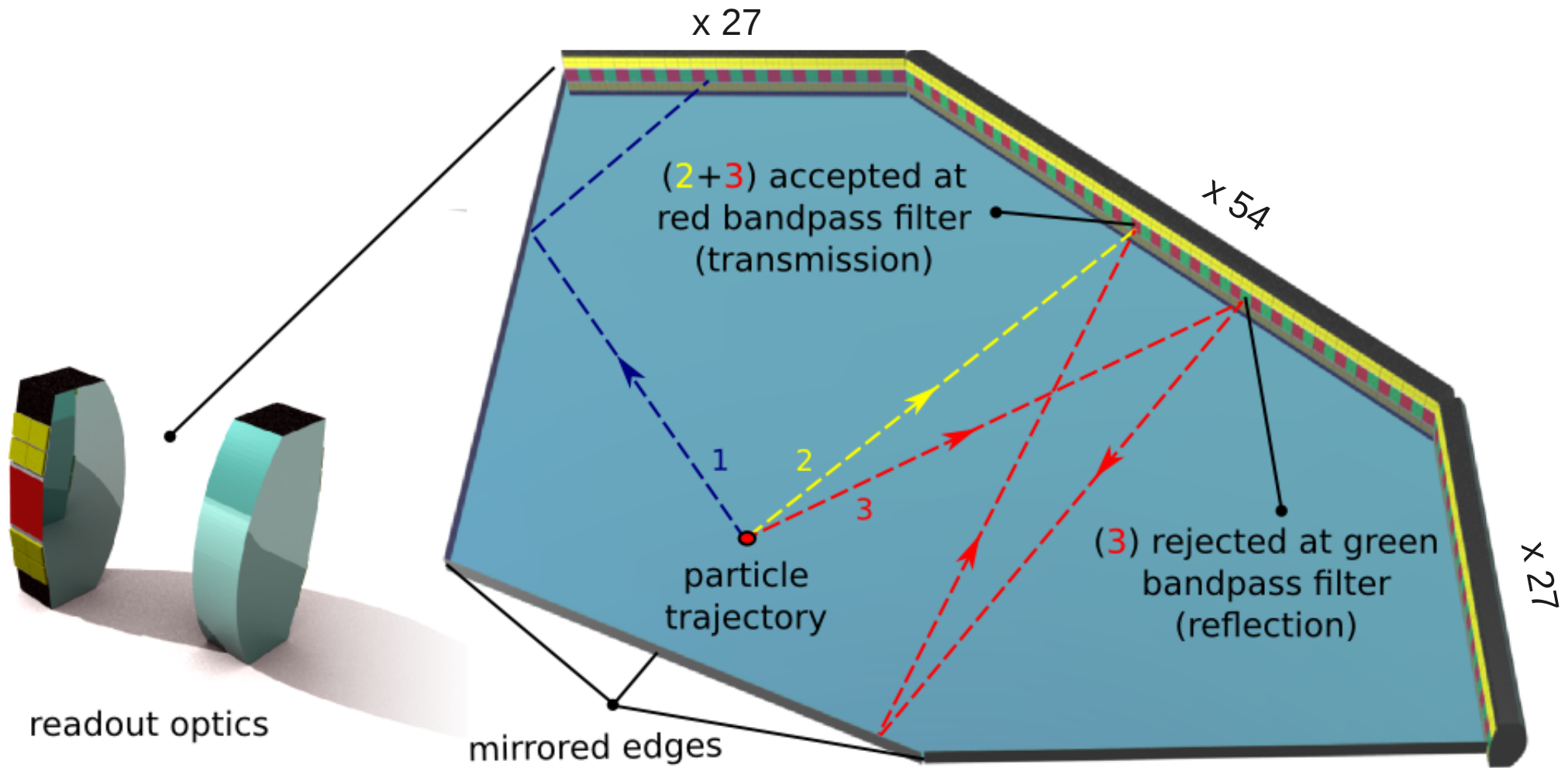
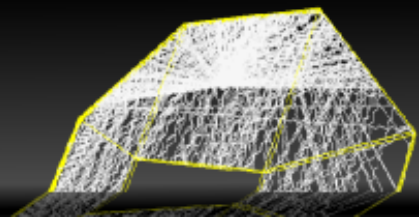
Dispersion correction

- Dielectric filter (bandpass):
 - restricts wavelength visible to the sensor
 - enables correction of angle **and** time



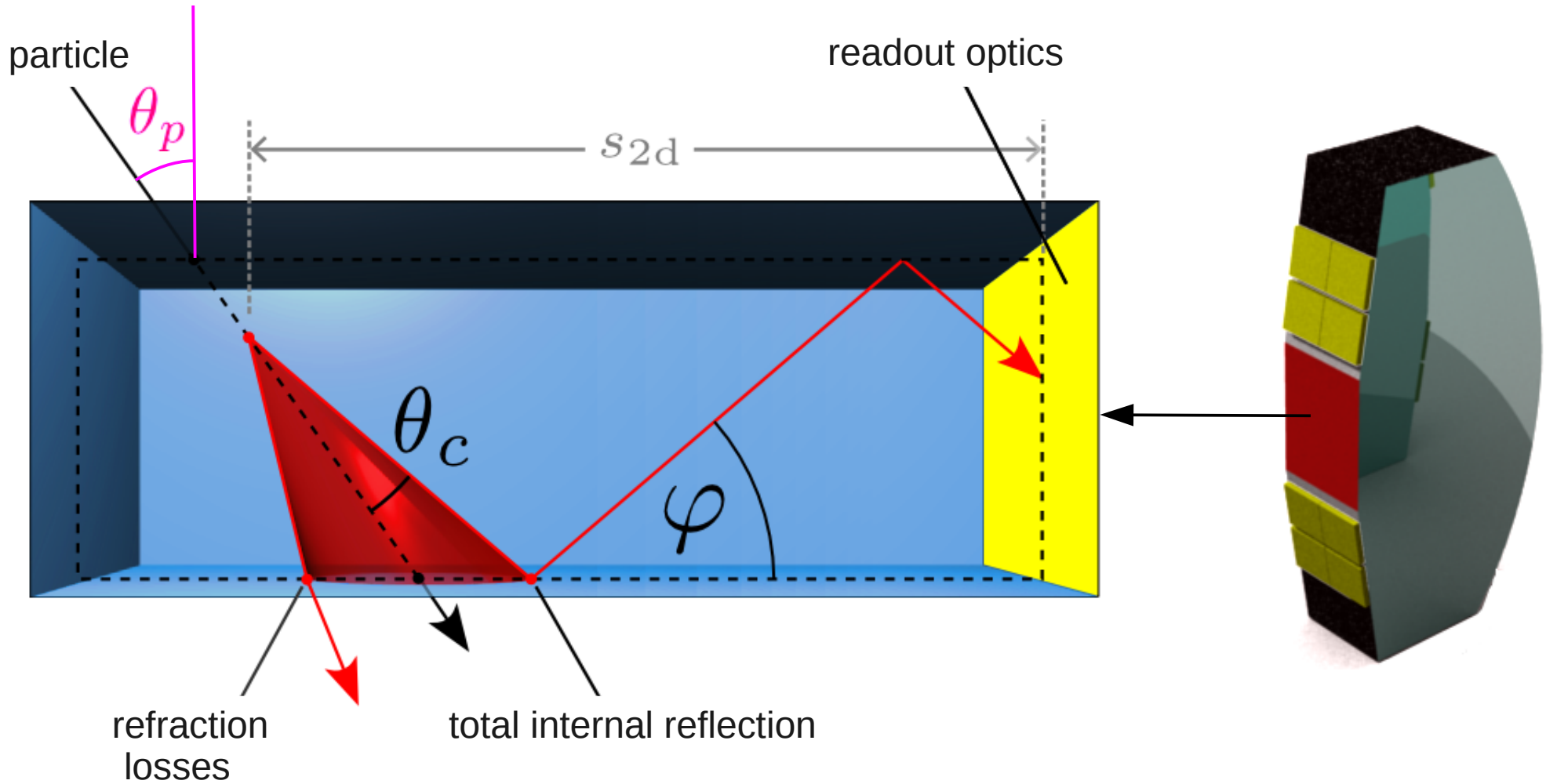
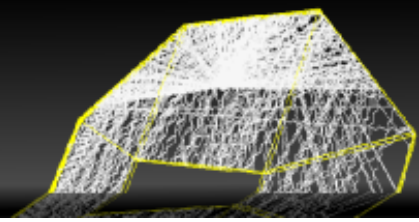
Working principle

A 3d Disc DIRC for \overline{PANDA}



Working principle

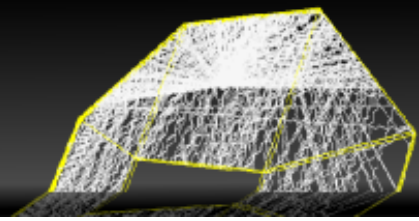
A 3d Disc DIRC
for \overline{PANDA}



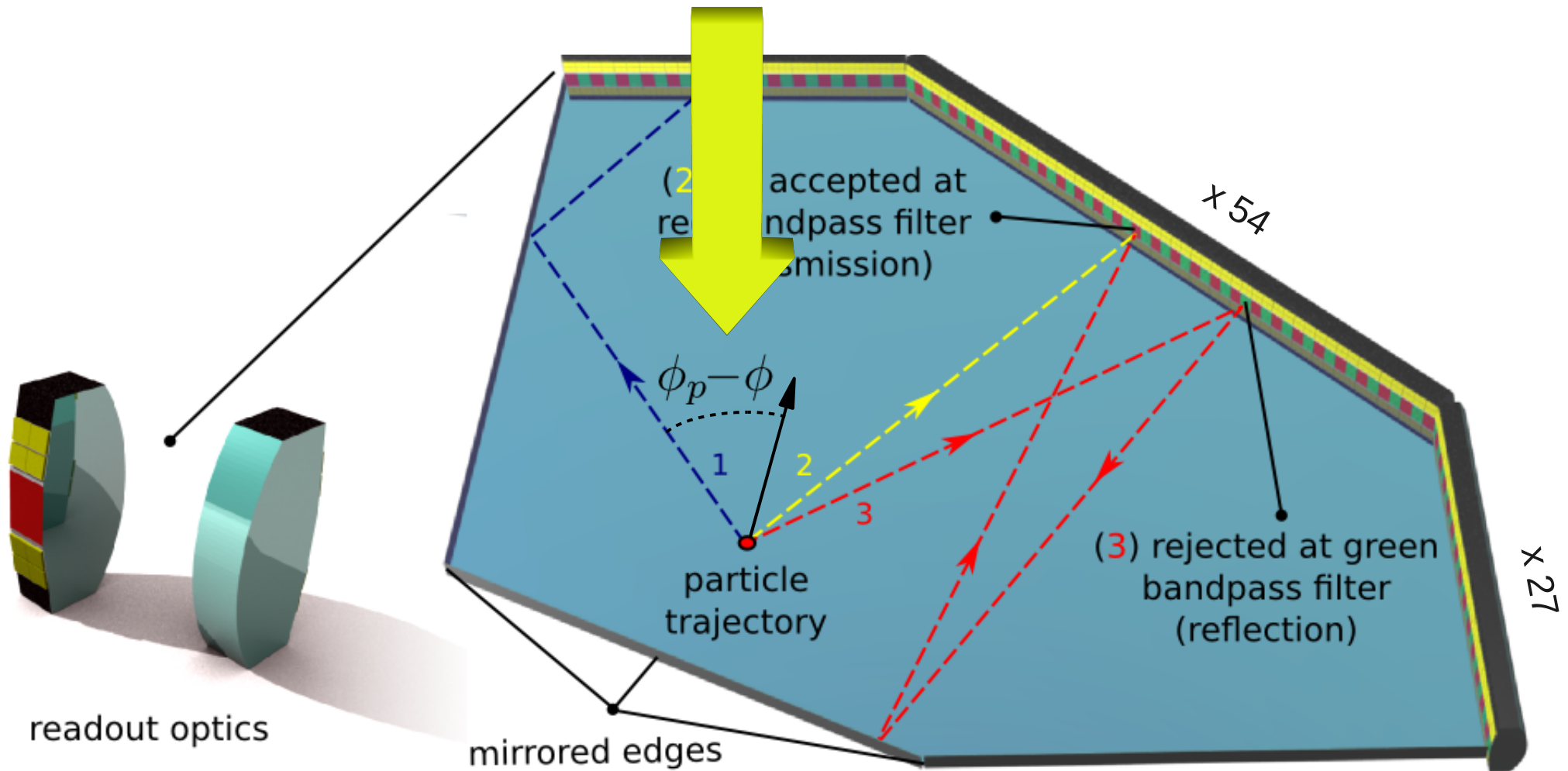
$$\cos \theta_c = \sin \theta_p \cos(\phi_p - \phi) \cos \varphi + \cos \theta_p \sin \varphi$$

Working principle

A 3d Disc DIRC for \overline{PANDA}

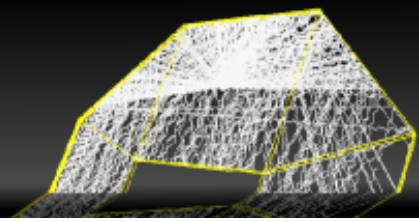


$$\cos \theta_c = \sin \theta_p \cos (\phi_p - \phi) \cos \varphi + \cos \theta_p \sin \varphi$$



Lightguide imaging

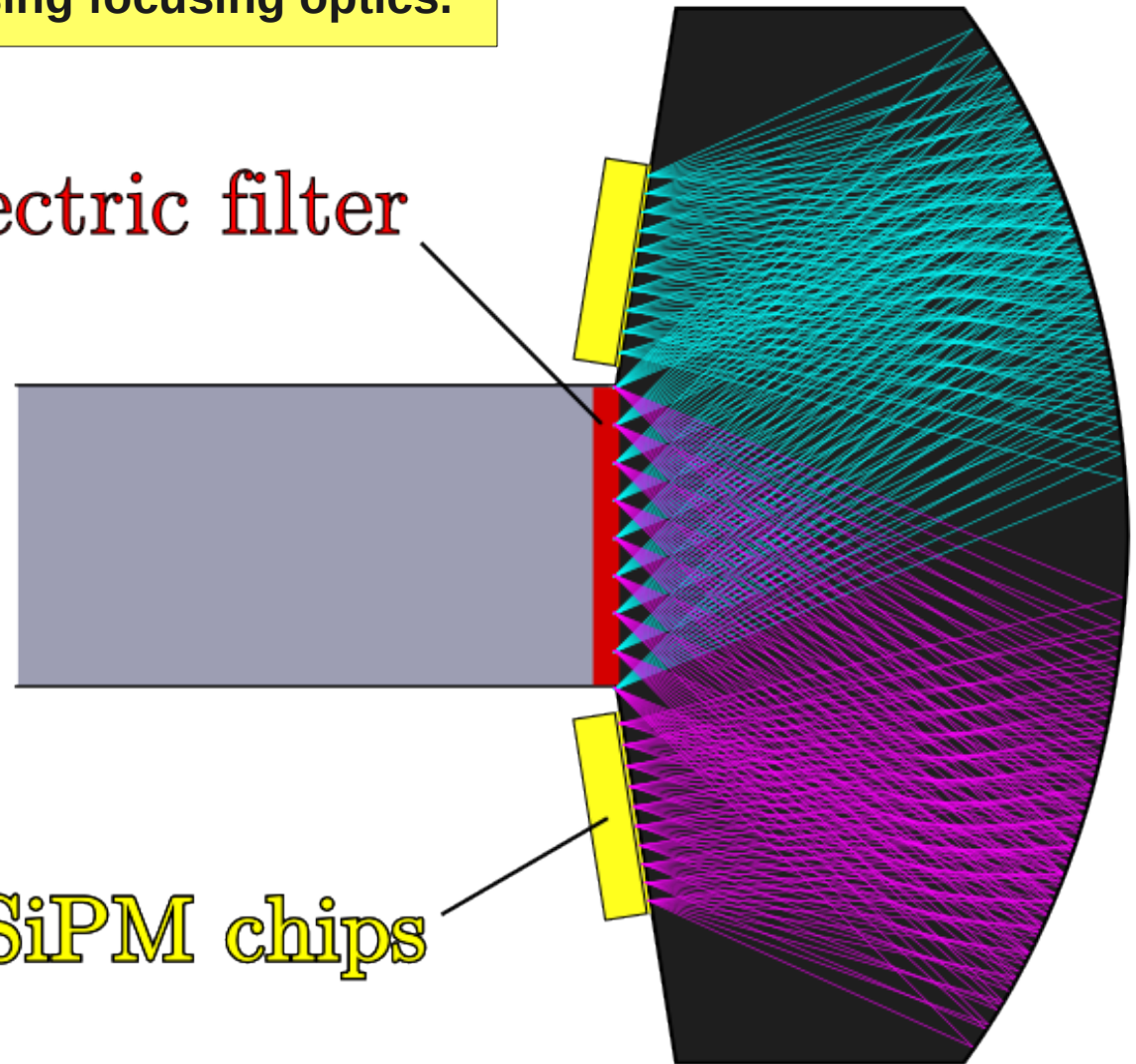
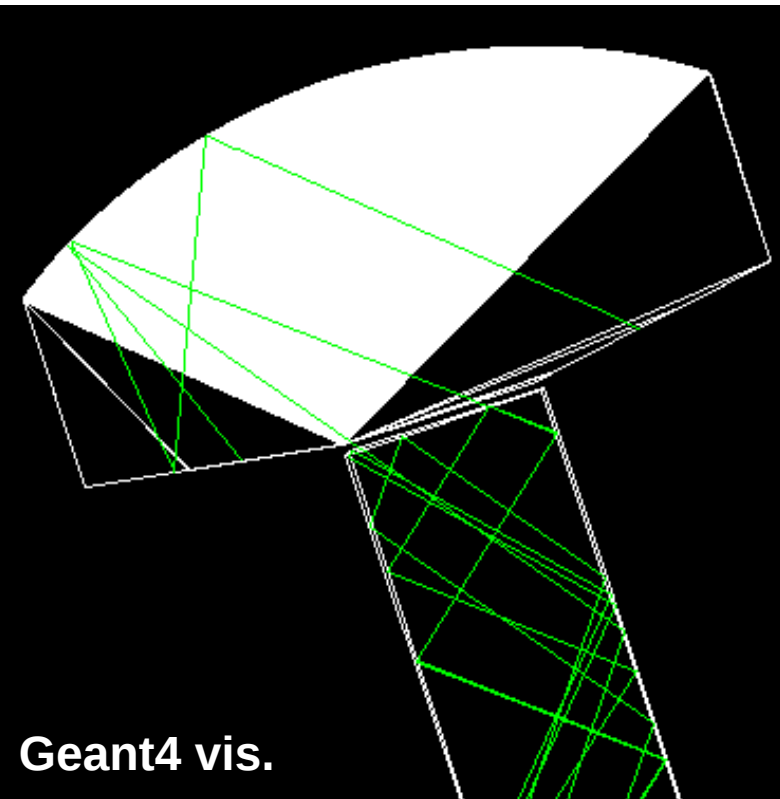
A 3d Disc DIRC
for \overline{PANDA}



Angle (φ) to position conversion using focusing optics.

dielectric filter

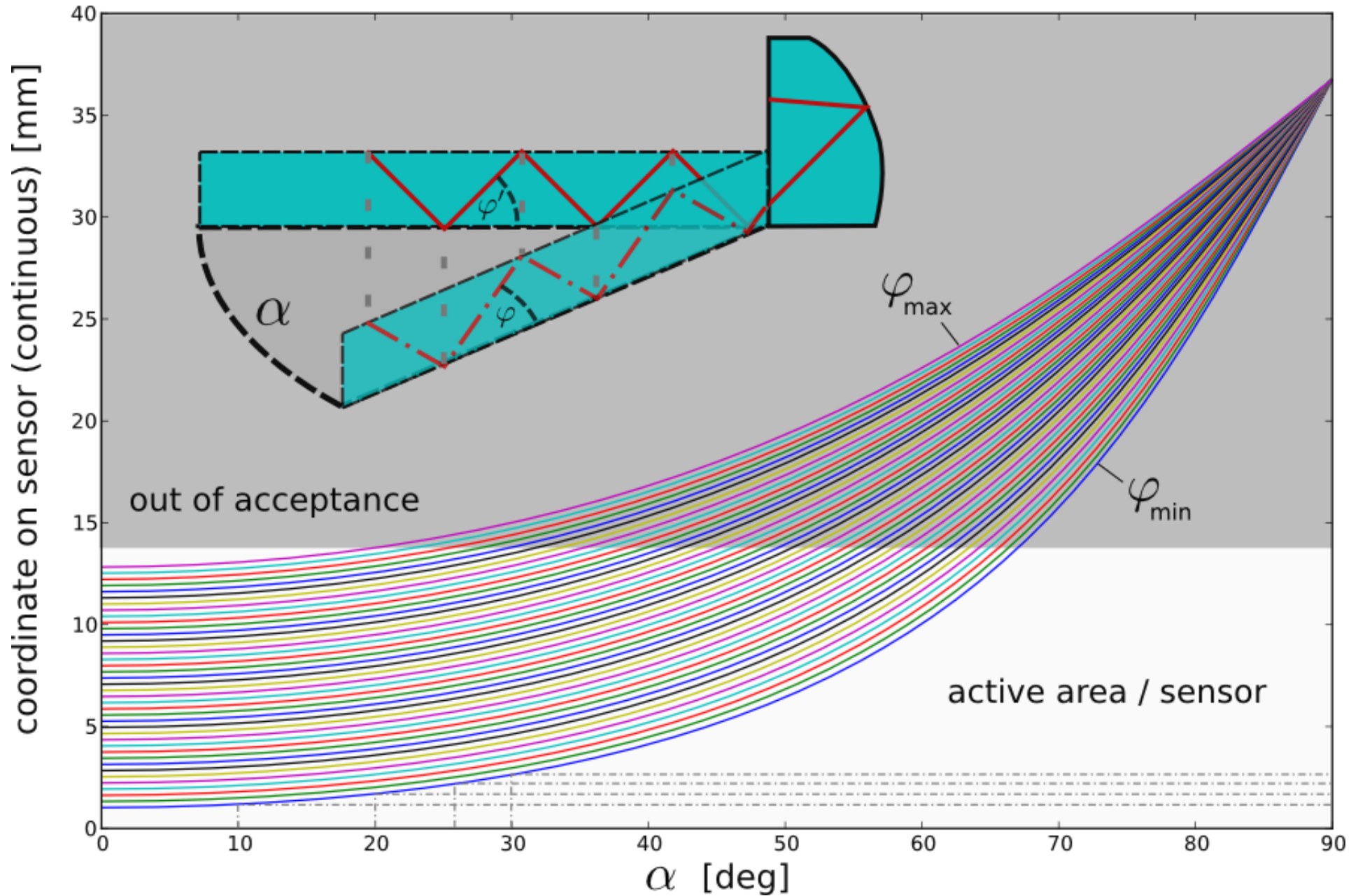
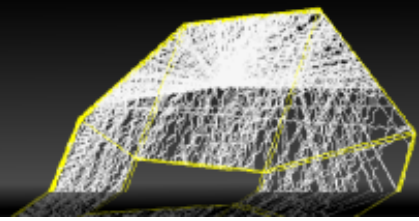
SiPM chips

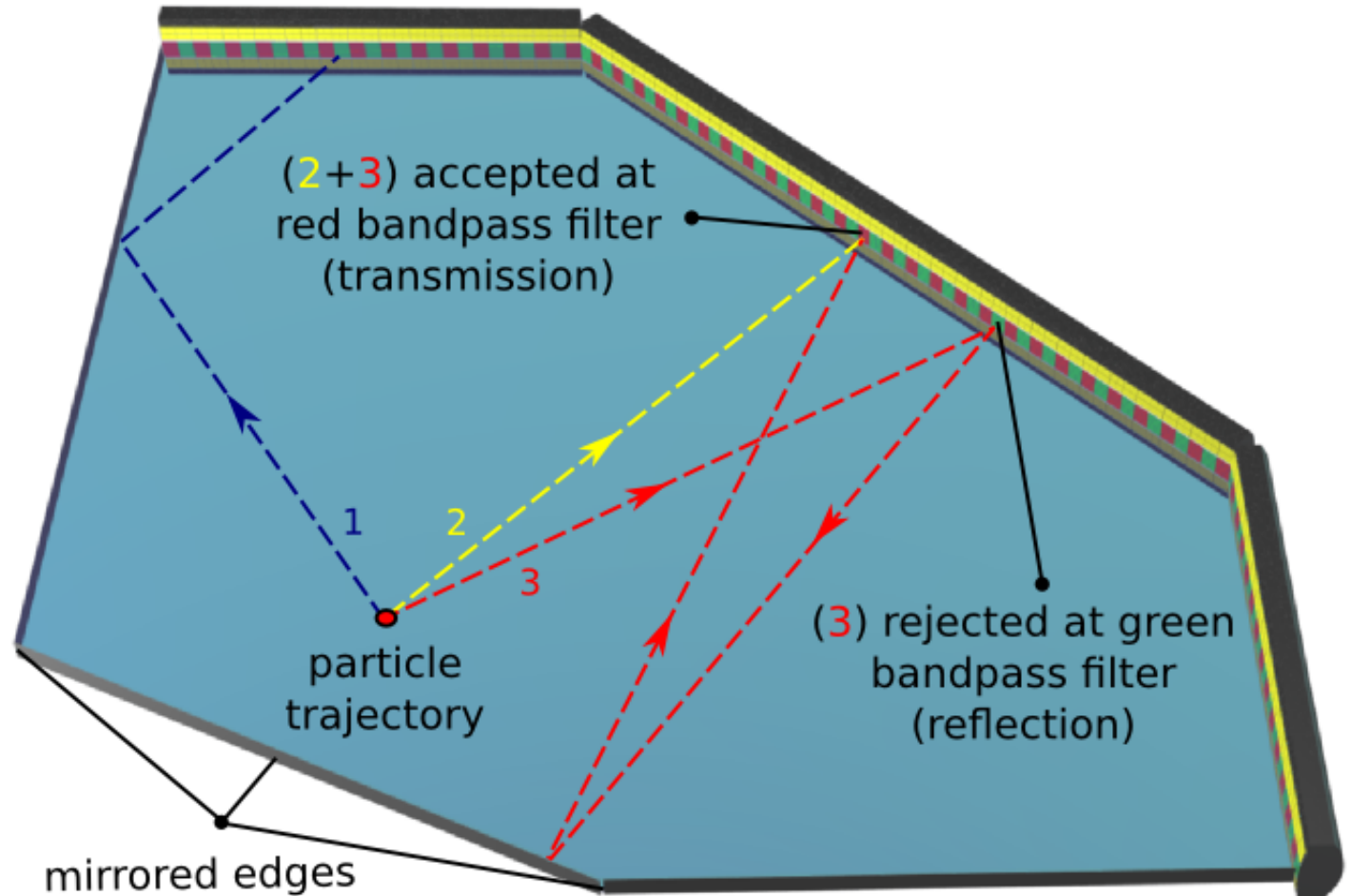
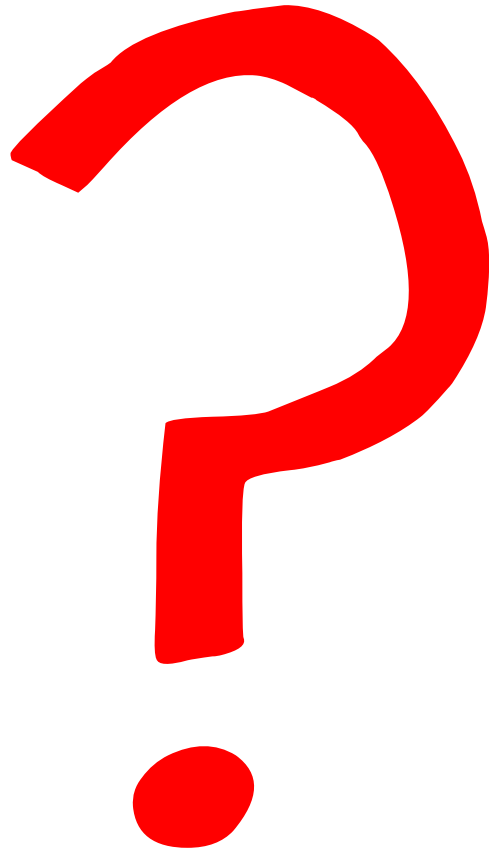
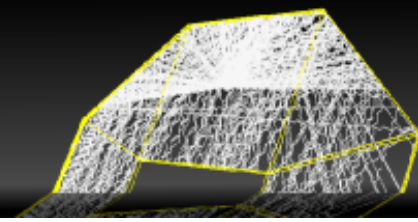


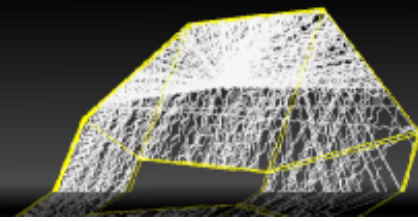
Geant4 vis.

Lightguide imaging

A 3d Disc DIRC
for \overline{PANDA}







It's as simple as that ...

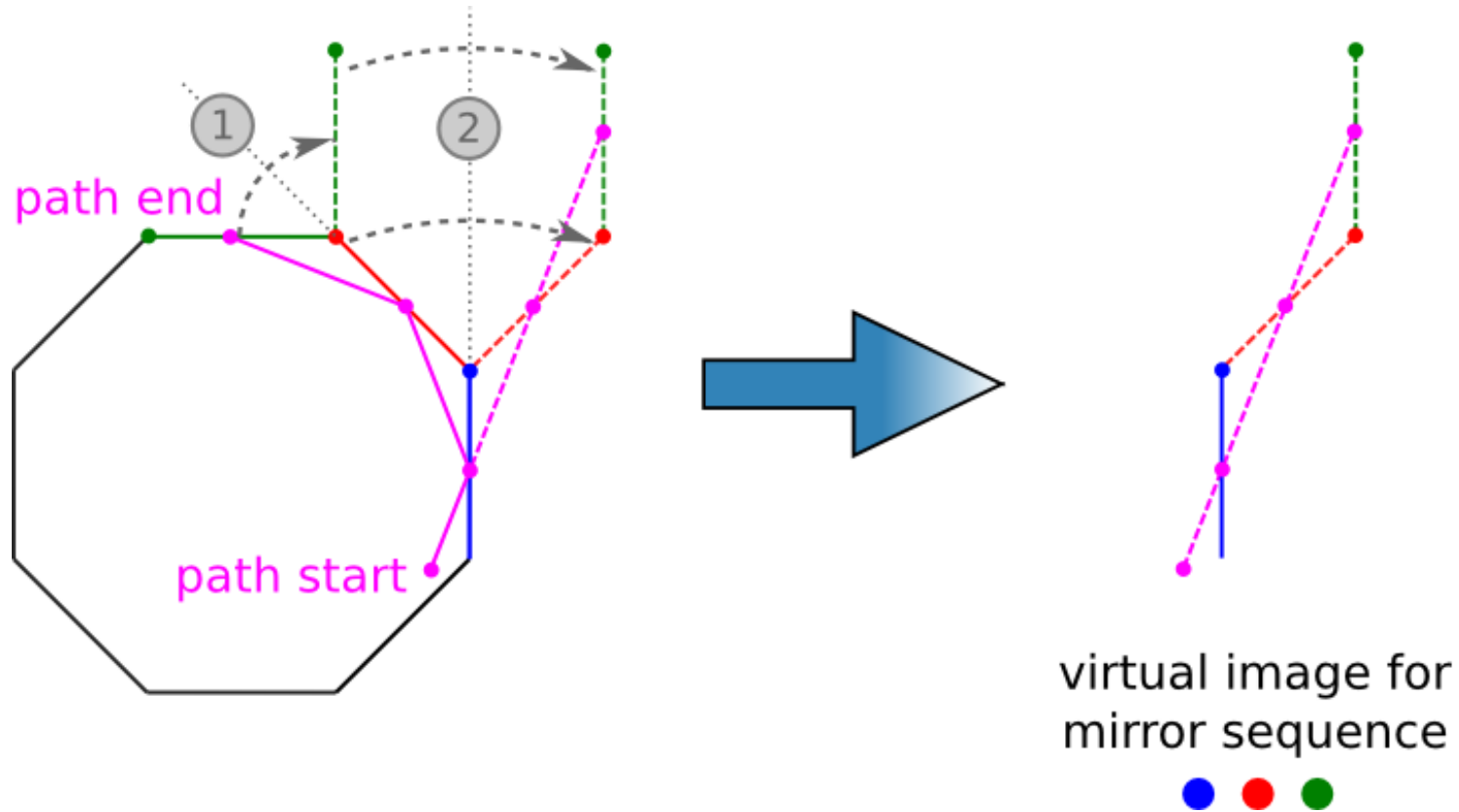
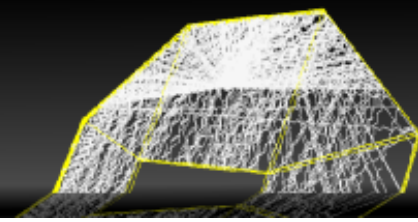
real image



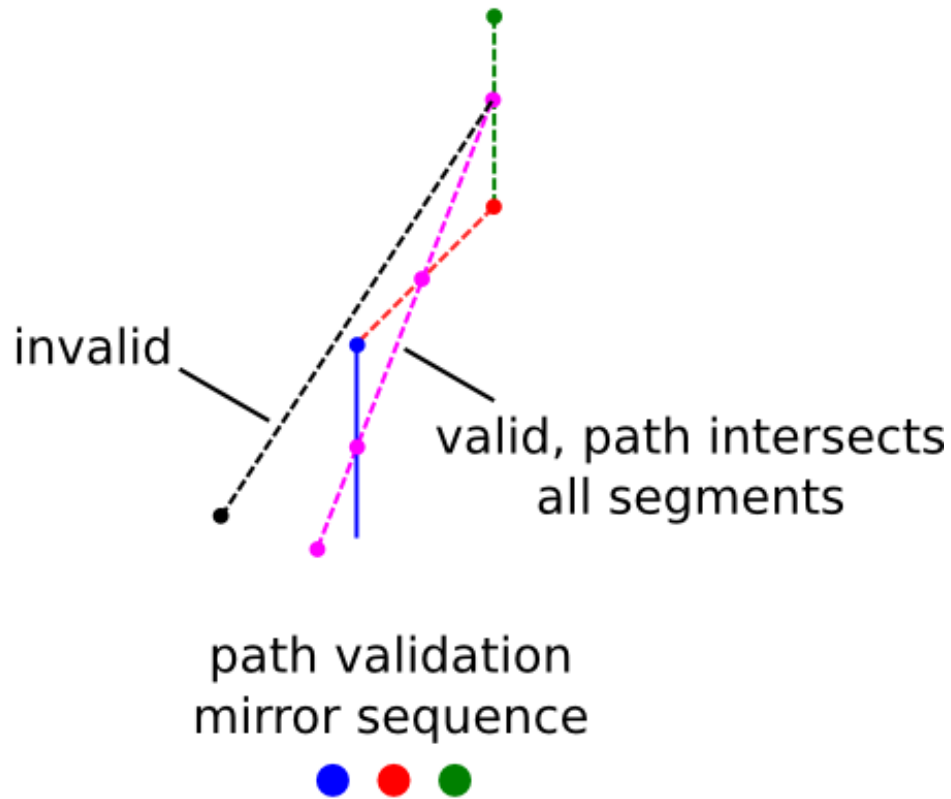
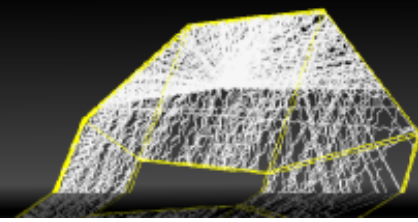
virtual image



Mirror

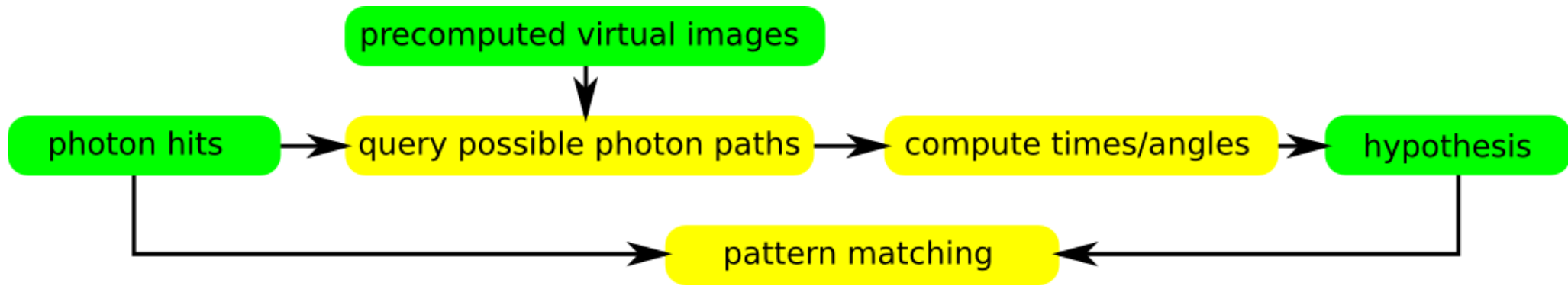
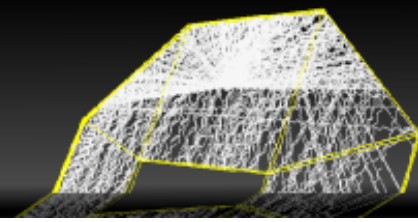


- Before transformation: simple geometry, complex photon paths
- After transformation: simple photon paths, complex geometry



- Transformation preserves all necessary parameters:
 - Length of the photon path
 - Photon emission angle ϕ
 - Angle to optical element α
- Query of possible paths reduced to simple linear operations.
- Only the detectors geometry is transformed \Rightarrow precomputation.

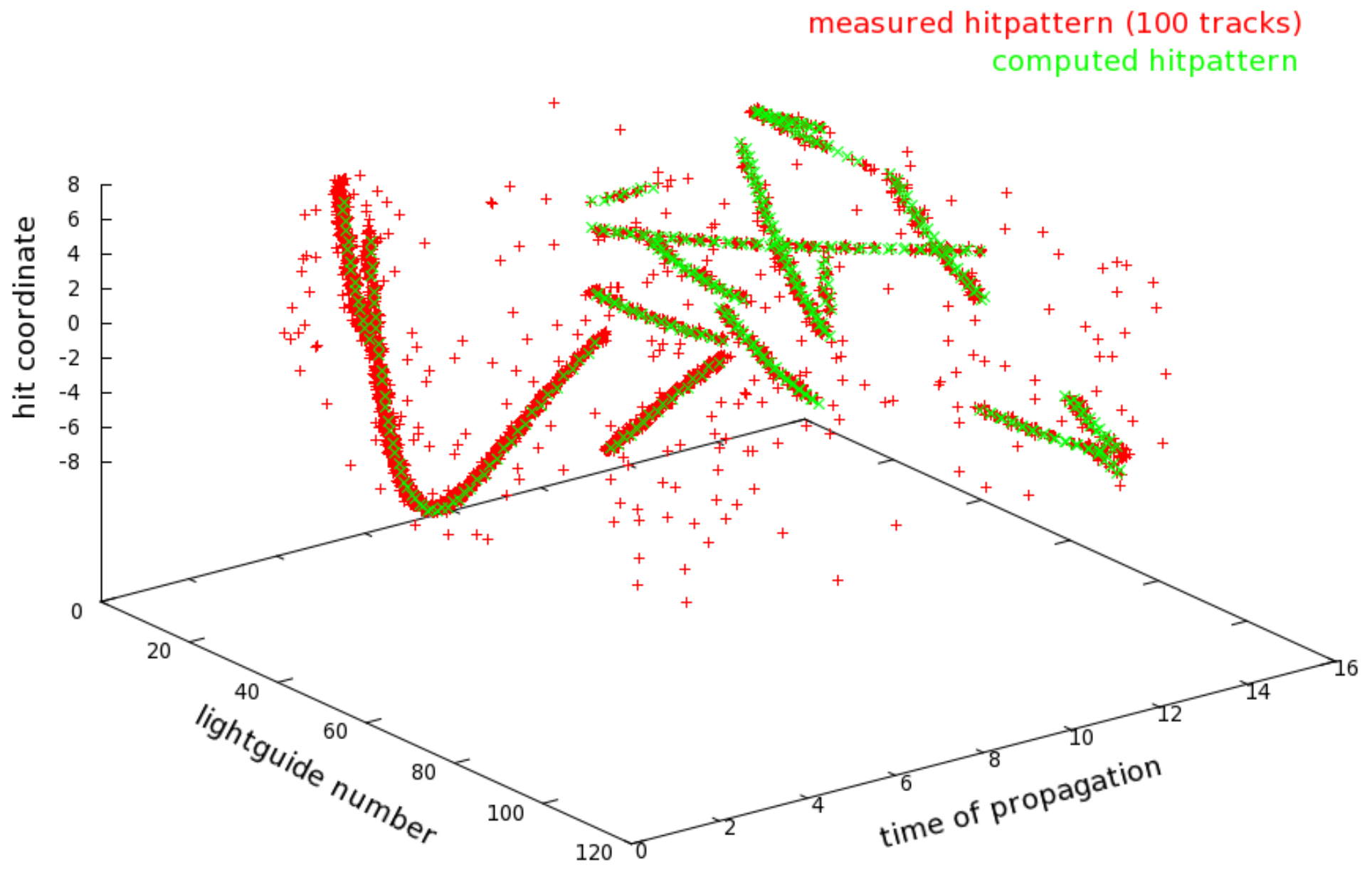
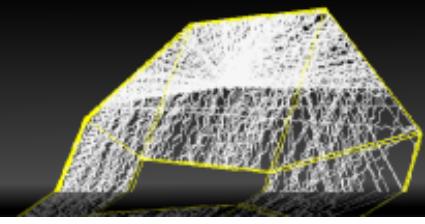
Simple validation of photon paths by line/segment intersections

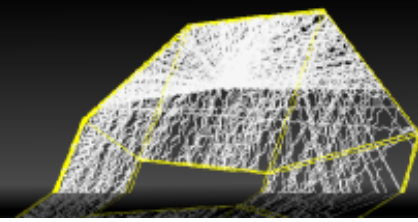


- Current reconstruction approach
 - Is independent of simulation code (computed patterns)
 - Uses space and time coordinates
 - Cuts to separate coincident hitpatterns
 - Pattern matching uses likelihood methods

Preliminary results

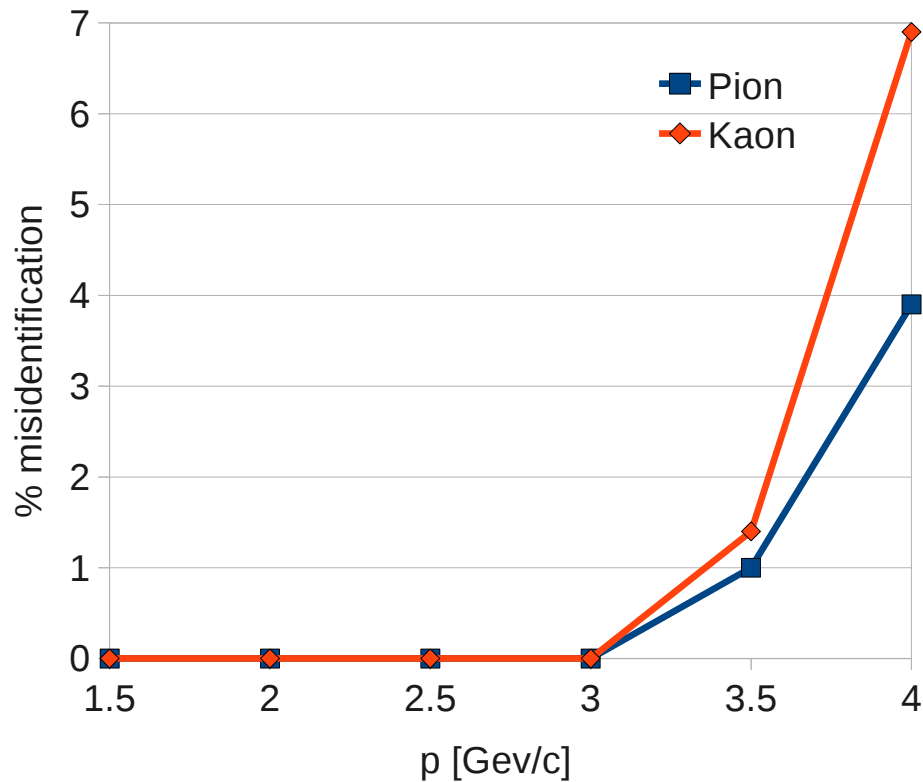
A 3d Disc DIRC
for \overline{PANDA}





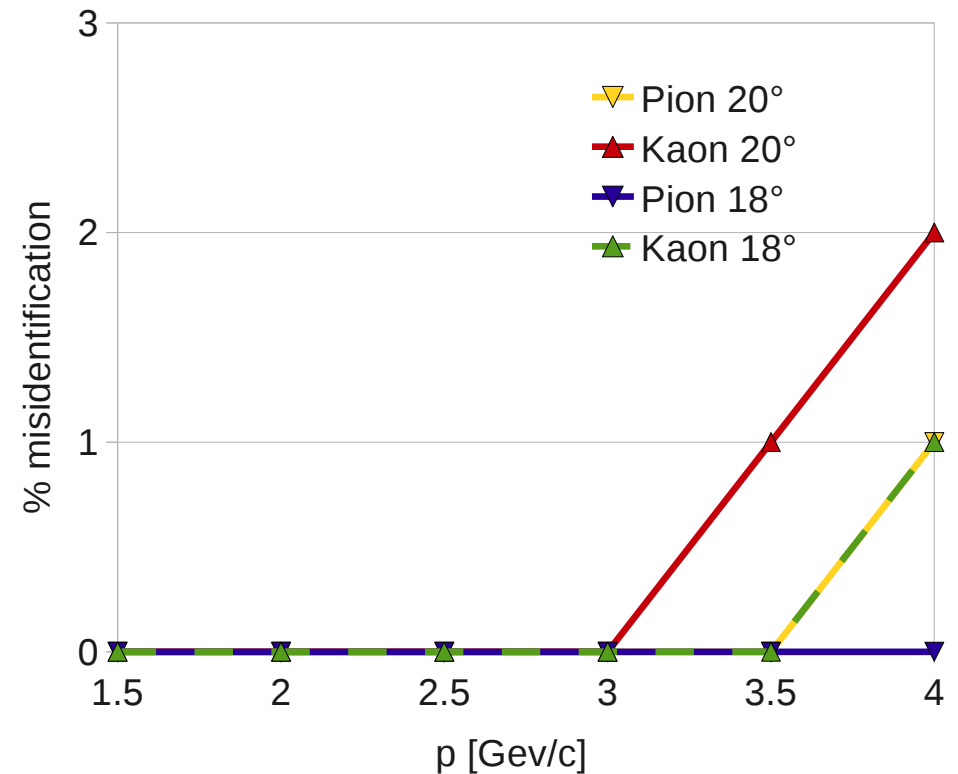
Reconstruction of simulated data (plain Geant4 – no PandaROOT/VMC)

$\theta = 22^\circ$; $\varphi = 45^\circ$
1000 tracks / marker

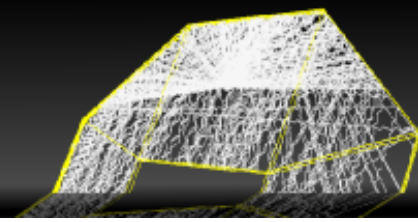


Close to acceptance limit ($\theta=22^\circ$)

$\varphi = 45^\circ$
100 tracks / marker

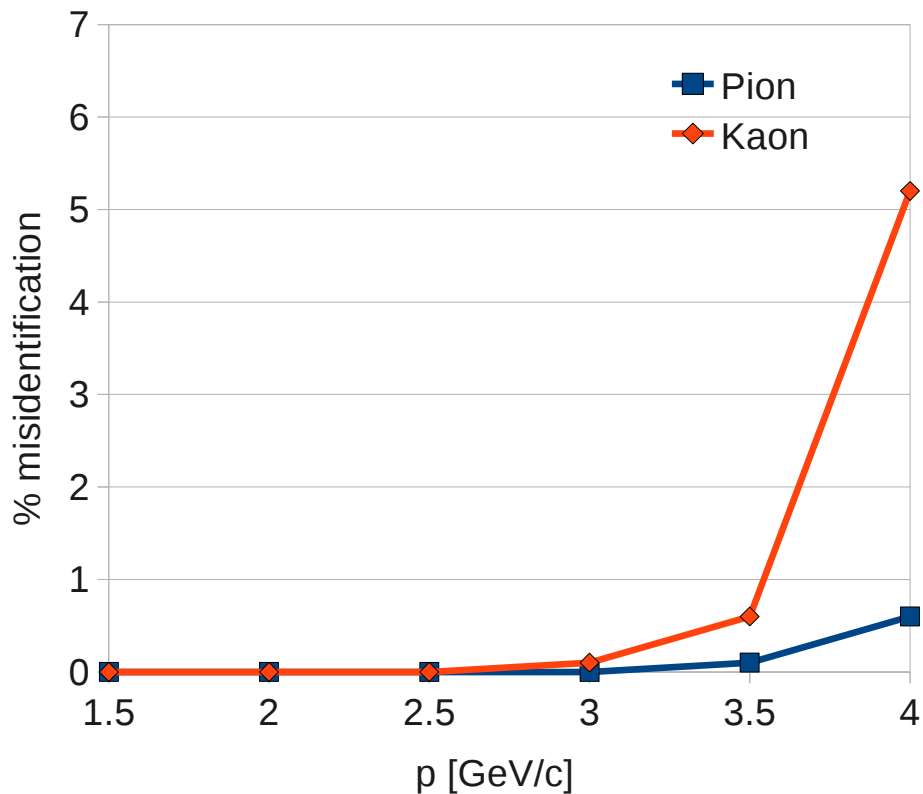


Increasing performance for smaller θ



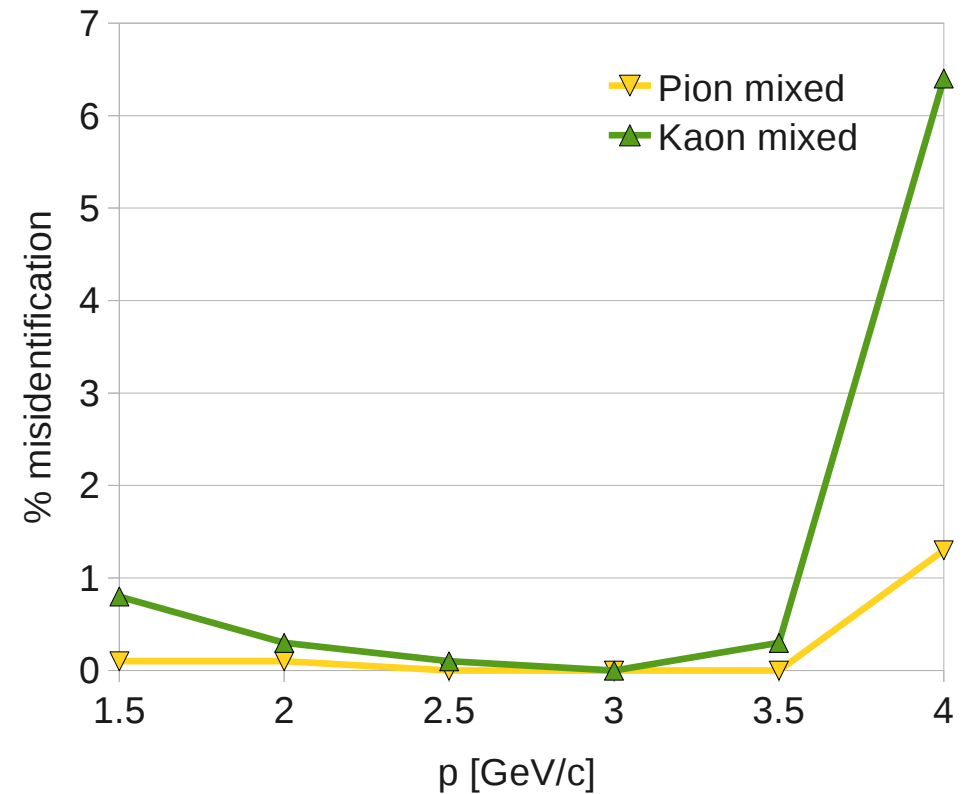
Coincident tracks - (results of a design with smaller radiator)

Small quarter (2x44 LG) - theta=15°; phi=45°
1000 tracks / marker



single particle track

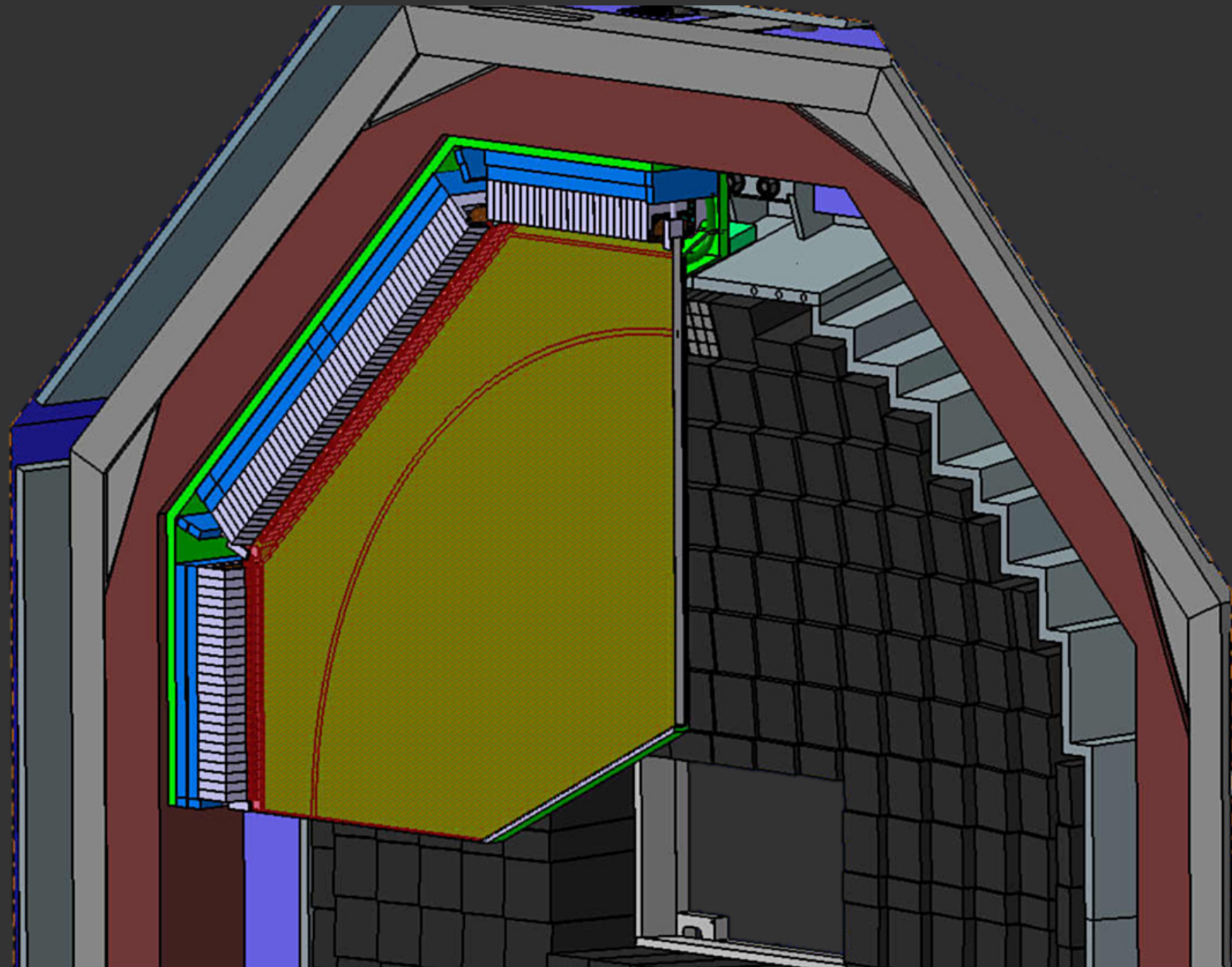
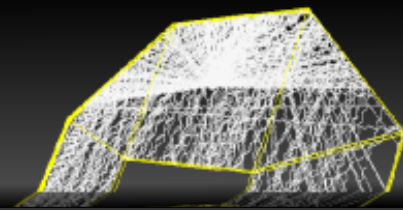
Small quarter (2x44 LG) - theta=15°; phi=45° - mixed tracks
1000 tracks / marker - 1 background track



two coincident particle tracks

Questions

A 3d Disc DIRC
for \overline{PANDA}



Lightguide imaging

A 3d Disc DIRC
for \overline{PANDA}

