Beam particle identification using CEDARs

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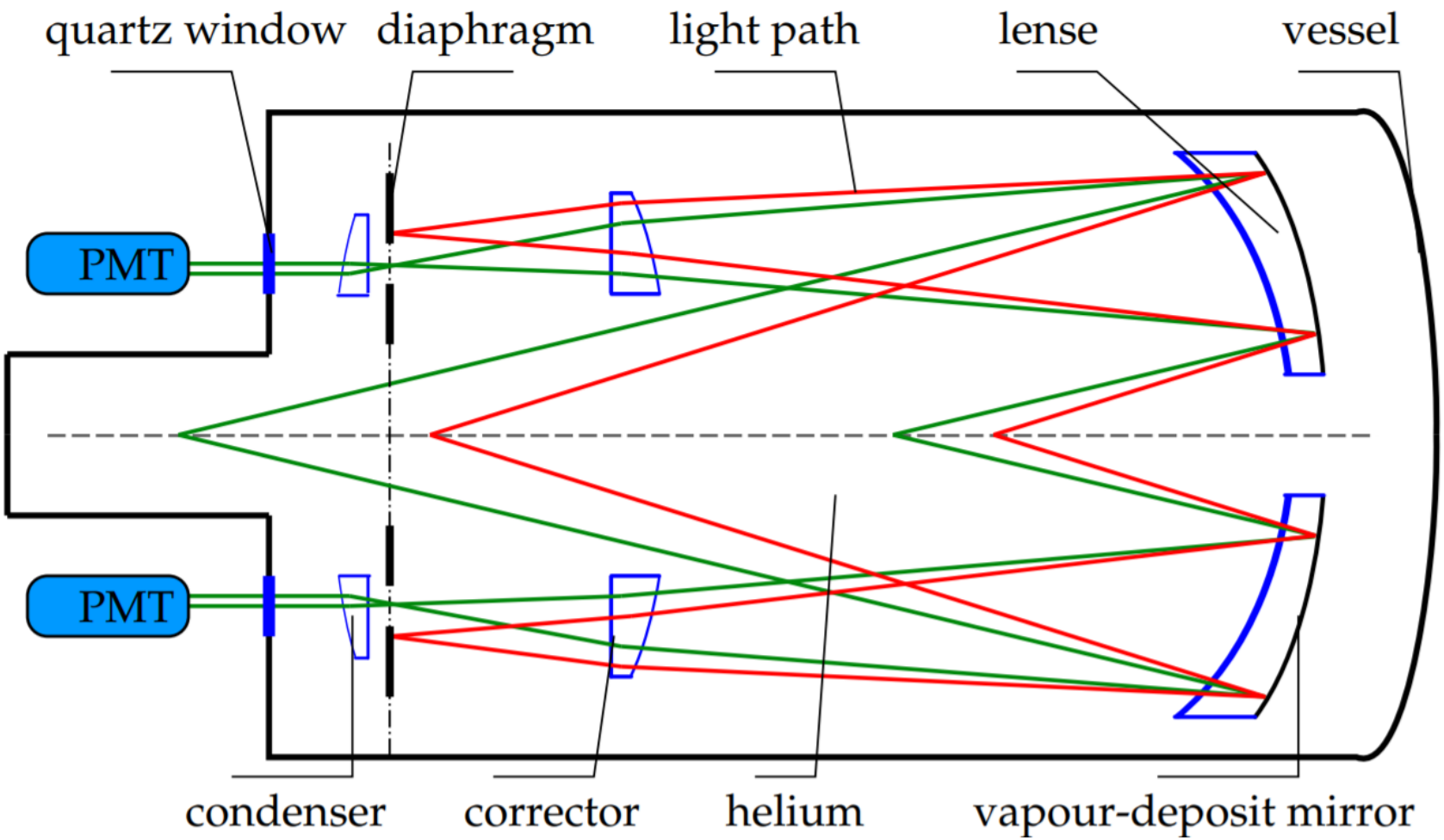
- Make use of Cherenkov radiation

CEDAR Detectors



CEDAR schematic [3]

Utilizing CEDAR information

Majority approach

- Signal in at at least 6 out of 8 PMTs to identify incoming particle
- Low efficiency of approx. 40-50 %

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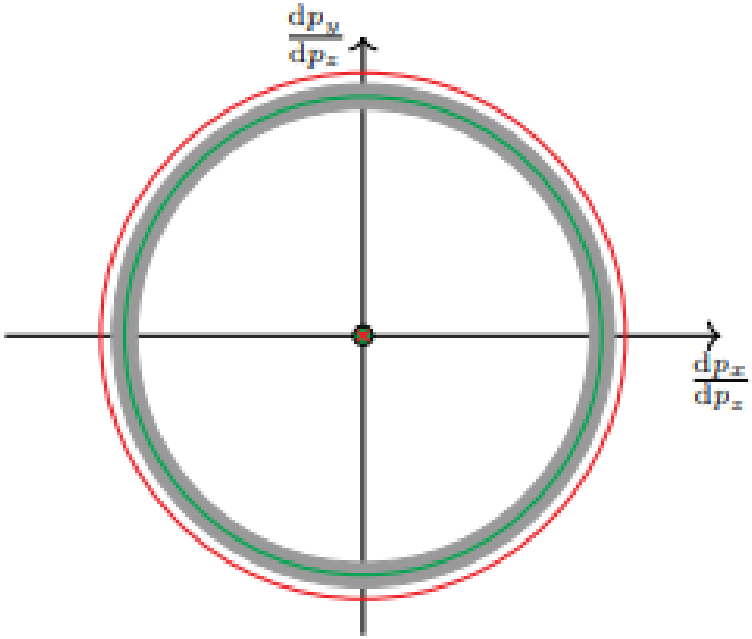
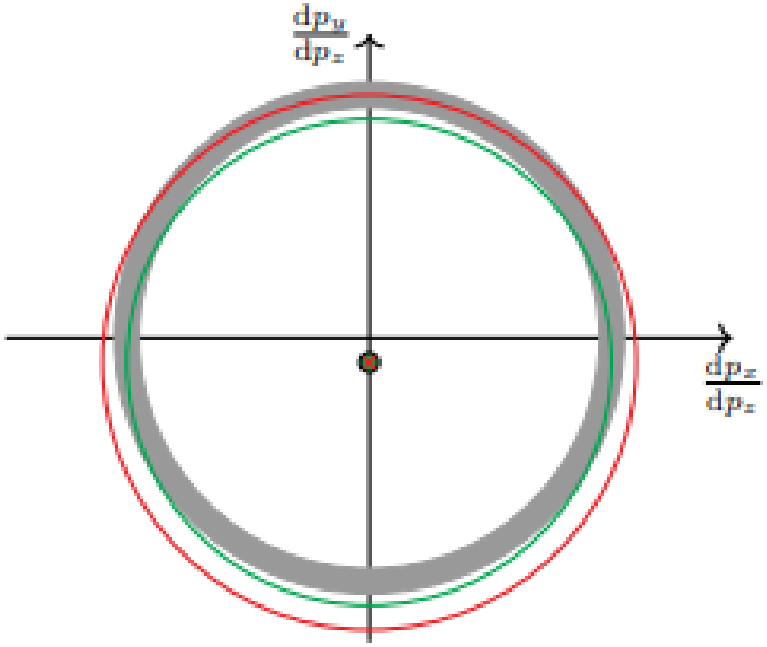
Problems with majority approach

- Not all beam particles traverse the CEDAR detectors parallel to their optical axis
- Spread in the inclination is of the order of 200 μrad - same order of magnitude as the difference between the kaon and pion Cherenkov angle (around 130 μrad for the CEDAR parameters in 2008)

Utilizing CEDAR information



Beam parallel to optical axis [1]



Beam with finite inclination with respect to optical axis [1]

Utilizing CEDAR information

Likelihood ansatz

- Response parameterized separately for each PMT as a function of the direction in which the Cherenkov light is emitted
- Independent on the particle species

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Inclination measurement

- Using silicon beam telescope at the target position
- Beam inclination at the CEDAR position is calculated using a transport matrix based on beam optics

2018 Data taking

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- 15 times higher beam intensity
- Upgrade of the frontend electronics and photomultipliers and a redesign of the corresponding firmware
- Current method for data analysis is not applicable for 2018 data

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1. Investigate whether artificial neural network (NN) techniques may help to develop a new method for beam particle identification
2. Develop a procedure in which a NN estimates the likelihood for a given particle to be a π or a K (using the KERAS toolkit with Tensorflow backend)
3. Integrate developed code back to the physics analysis environment (PHAST)

References

[1] "CEDAR PID using the Likelihood Approach for the Hadron-Beam", COMPASS Note 2017-1, https://wwwcompass.cern.ch/compass/notes/2017-1/2017-1.pdf

[2] WEISROCK, Tobias. Likelihood Methods for Beam Particle Identifi-
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[3] "The COMPASS setup for physics with hadron beams", COMPASS Coll., NIM A 779 (2015) 69. "The CEDAR counters for particle identification in the SPS secondary beams: a description and an operation manual", C. Bov
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