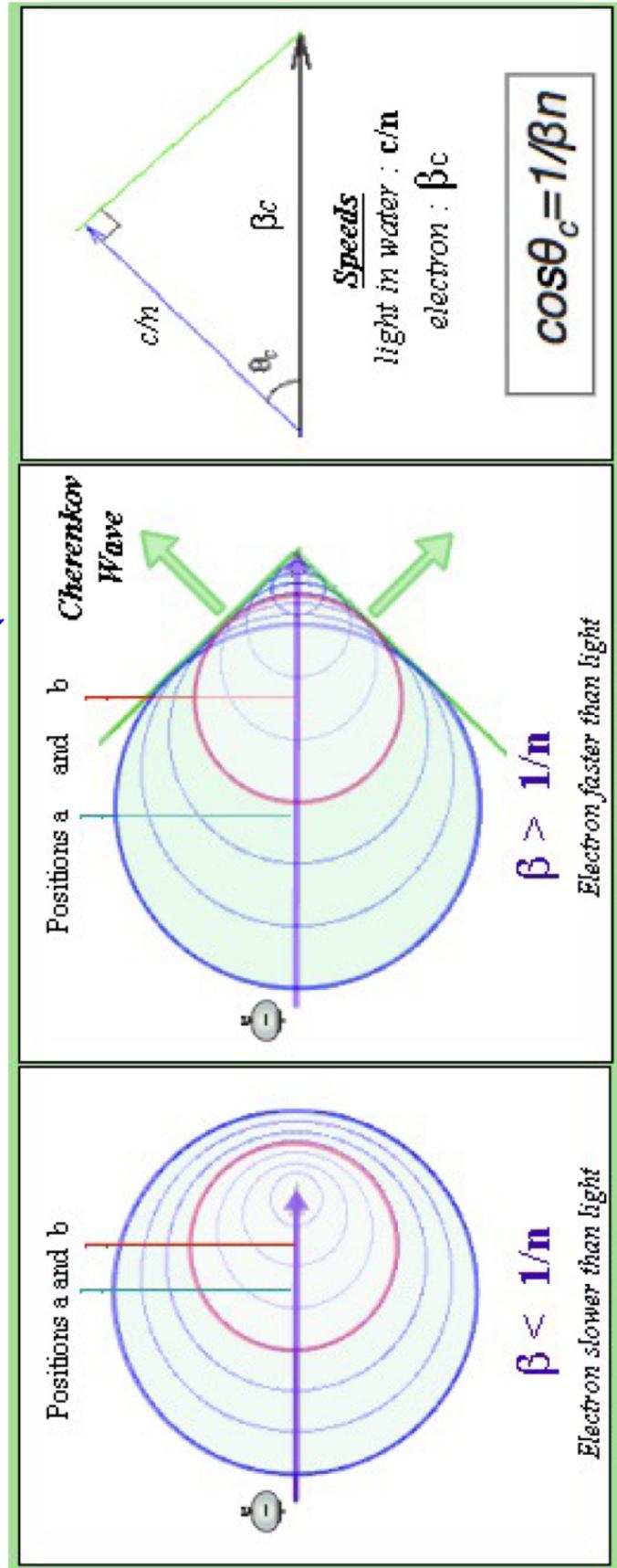
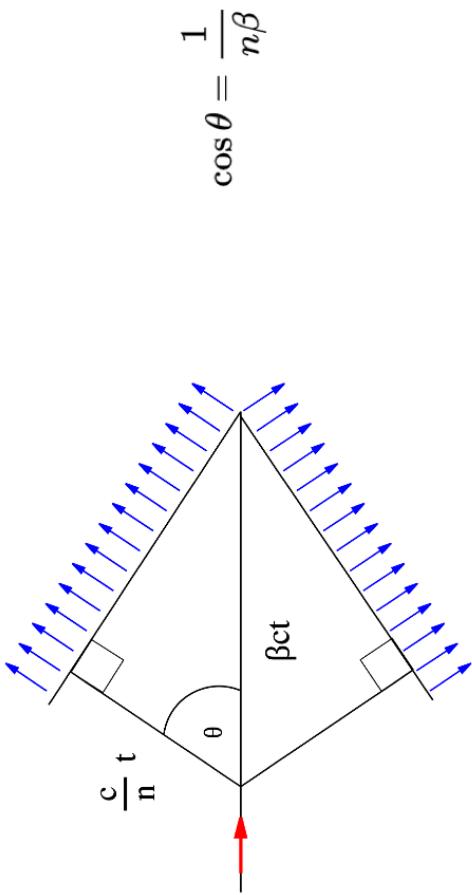


# KTAG calibration model

# Introduction

- NA62 is a kaon physics experiment located in the CERN North Area (NA)
- The NA62 collaboration study decays of  $K^+$  particles using a decay-in-flight technique
- Each  $K^+$  is identified by the CEDAR/KTAG detector
- CEDAR (Cherenkov Differential counter with Achromatic Ring Focus) produces a ring of light each time a kaon passes through
- KTAG (Kaon tagger) detects the light in 8 sectors, to identify kaons and record the time

# Cherenkov light



# CEDAR

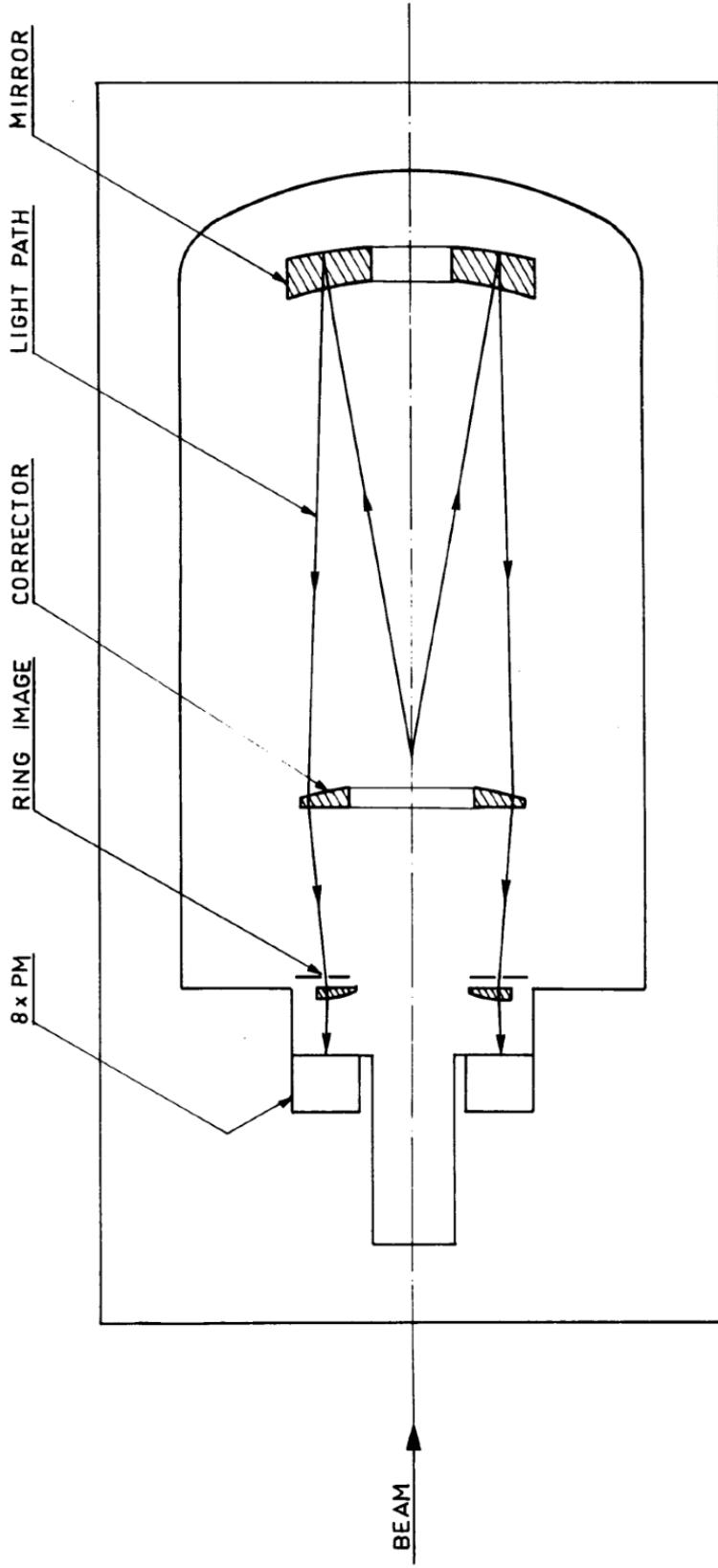
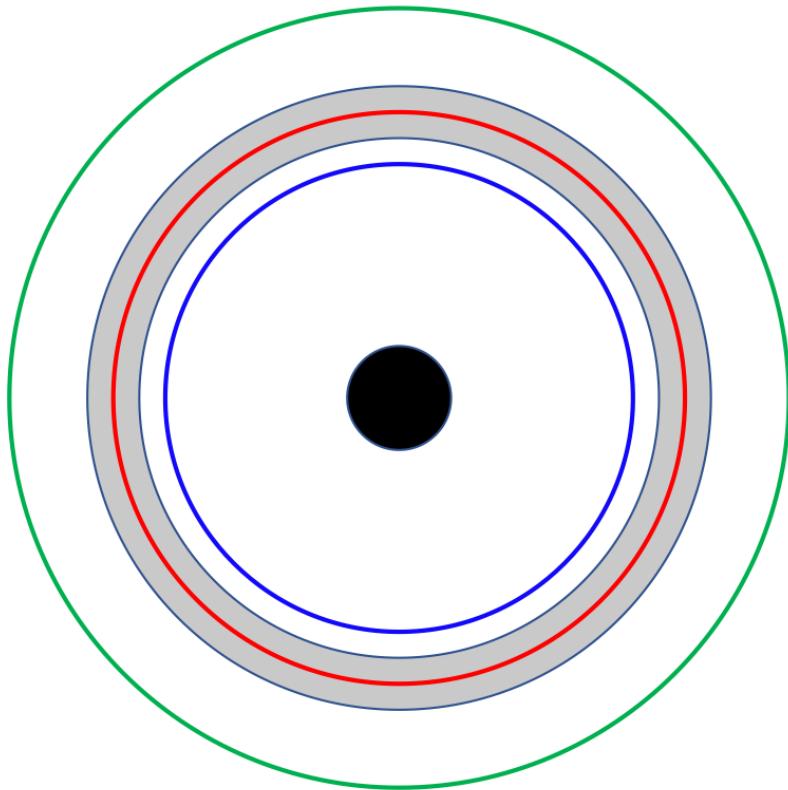


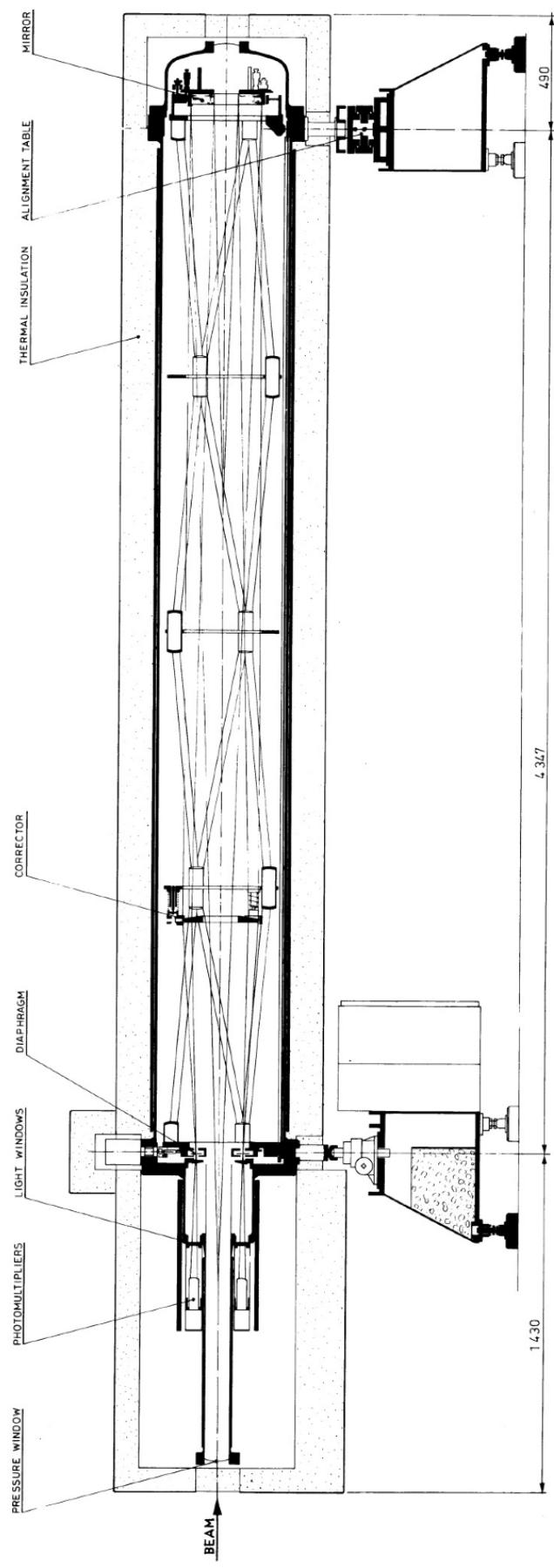
Fig. 2 Schematics of the optics of a differential Čerenkov counter (distorted scale)

# CEDAR diaphragm

- "Differential counter" comes from the fact that the CEDAR only collects light from one particle, thanks to a small diaphragm (grey area)
- Light from  $K^+$  (red ring) falls inside the aperture, light from pions (blue ring) and protons (green ring) fall outside the aperture



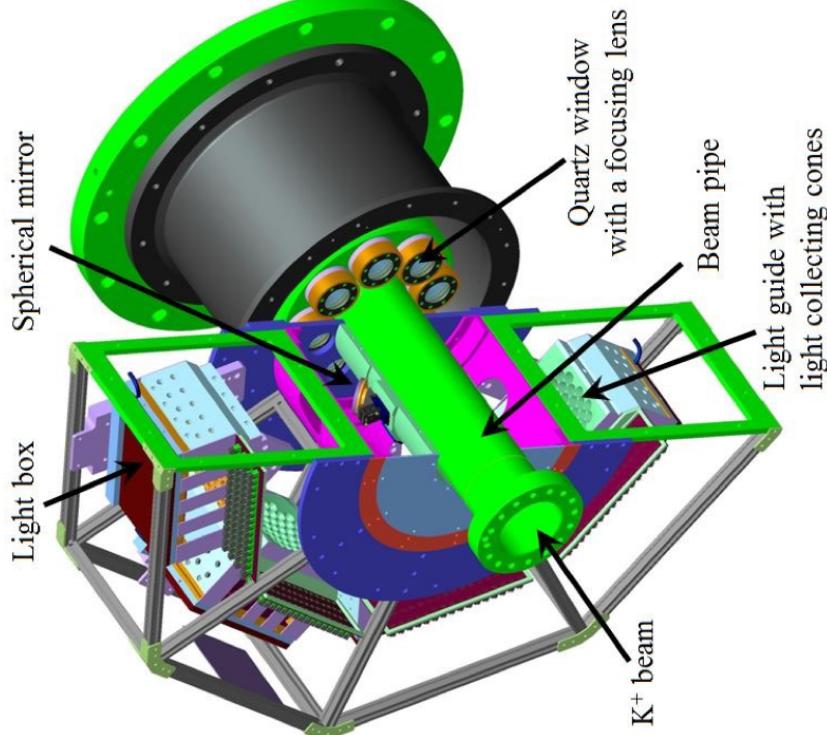
# CEDAR in detail





CEDAR

# KTAG

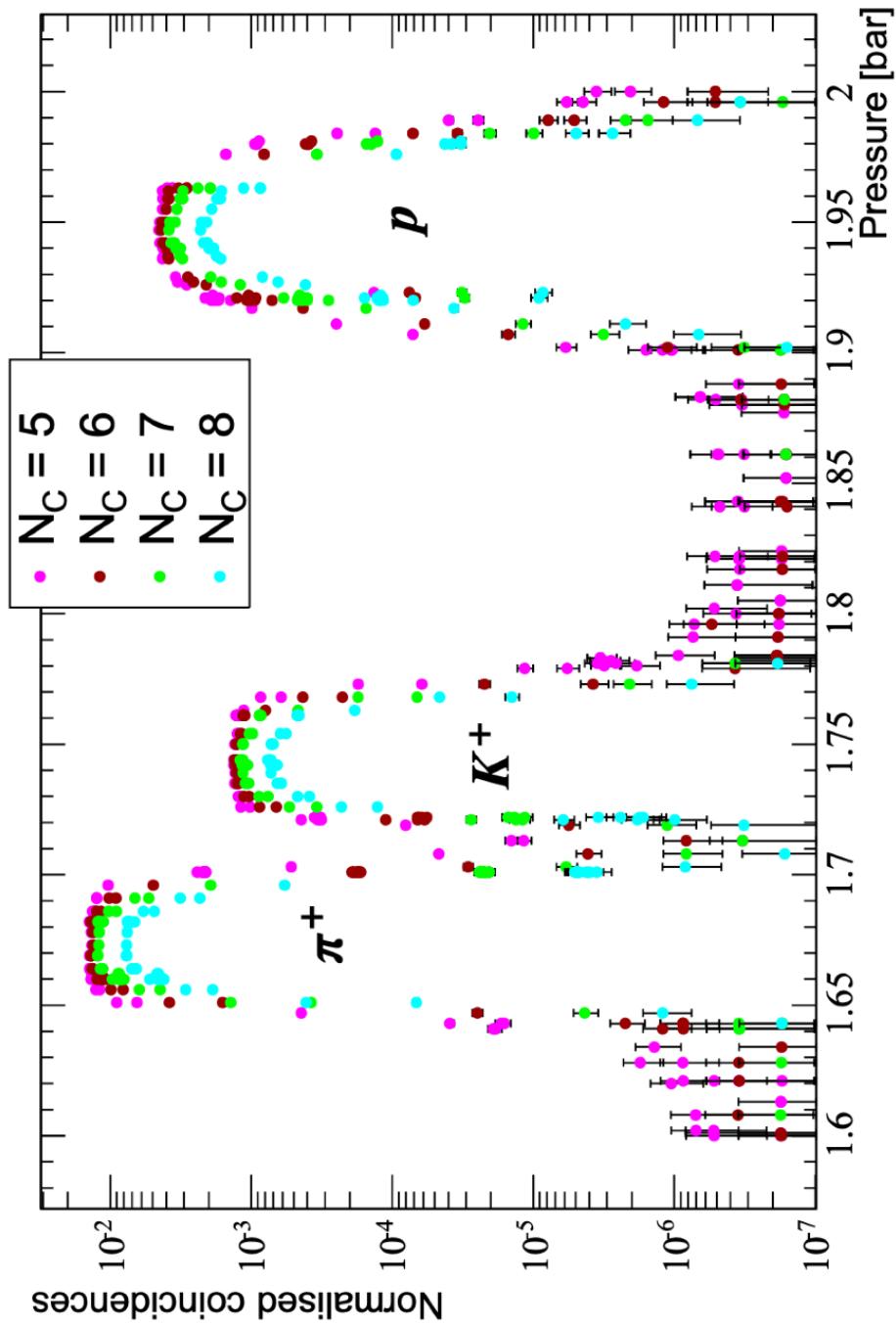


# CEDAR/KTAG operating principle

- Due to the aperture, only the kaon light can enter the KTAG.
- We expect a full ring to be seen, leaving signals in all 8 KTAG sectors
  - In practice, we require  $>=5$  sectors for “good” kaon candidates
- For each  $K^+$  we expect 18 photons to be detected by KTAG.
  - The KTAG photo-detectors have a time resolution of 280ps
  - With 18 independent measurements, then  $280\text{ps} / \sqrt{18} = 66\text{ps}$

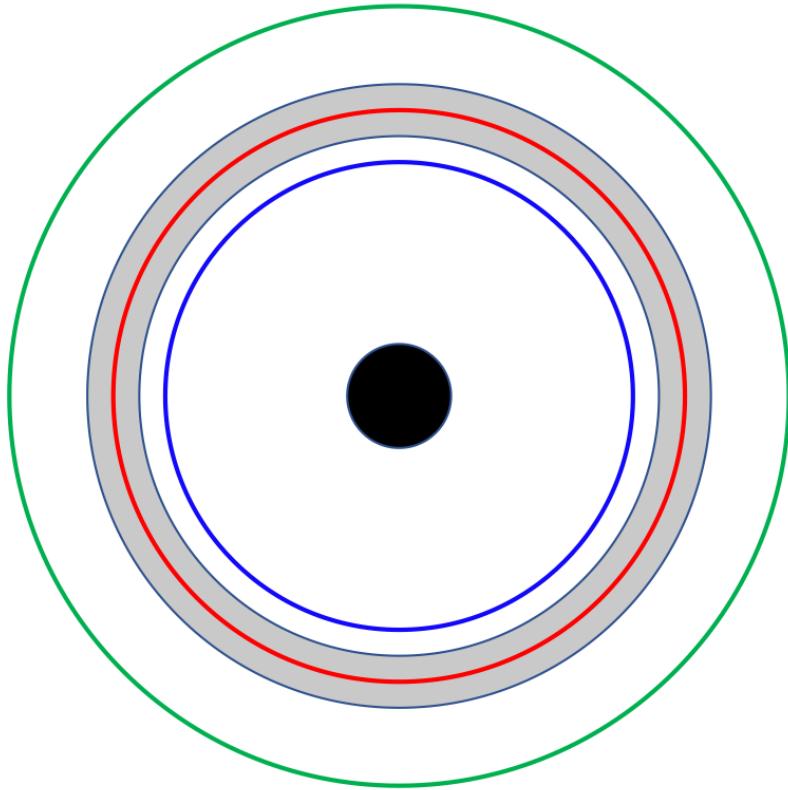
# CEDAR/KTAG operating principle

- Varying the gas pressure makes the rings bigger/smaller, so we can also see other particles “pressure scan”



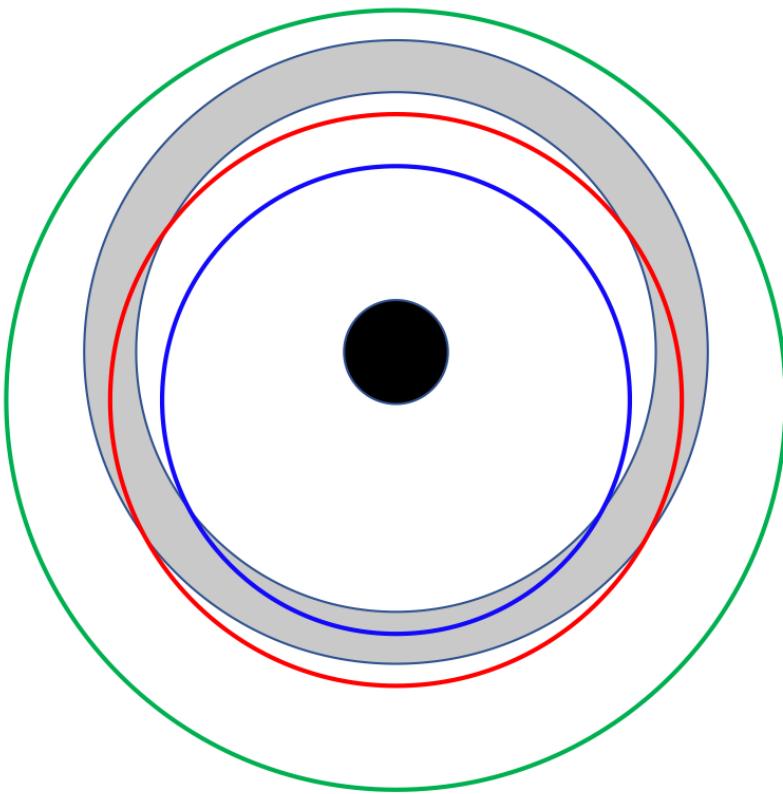
# Alignment

- Mis-alignment of the CEDAR with the beam can cause:
  - Light from  $K^+$  to miss the aperture
    - Light from  $\pi^+$  and  $p$  to enter the aperture
  - This spoils the time resolution and particle identification power of the KTAG
  - Good CEDAR alignment is critical for NA62



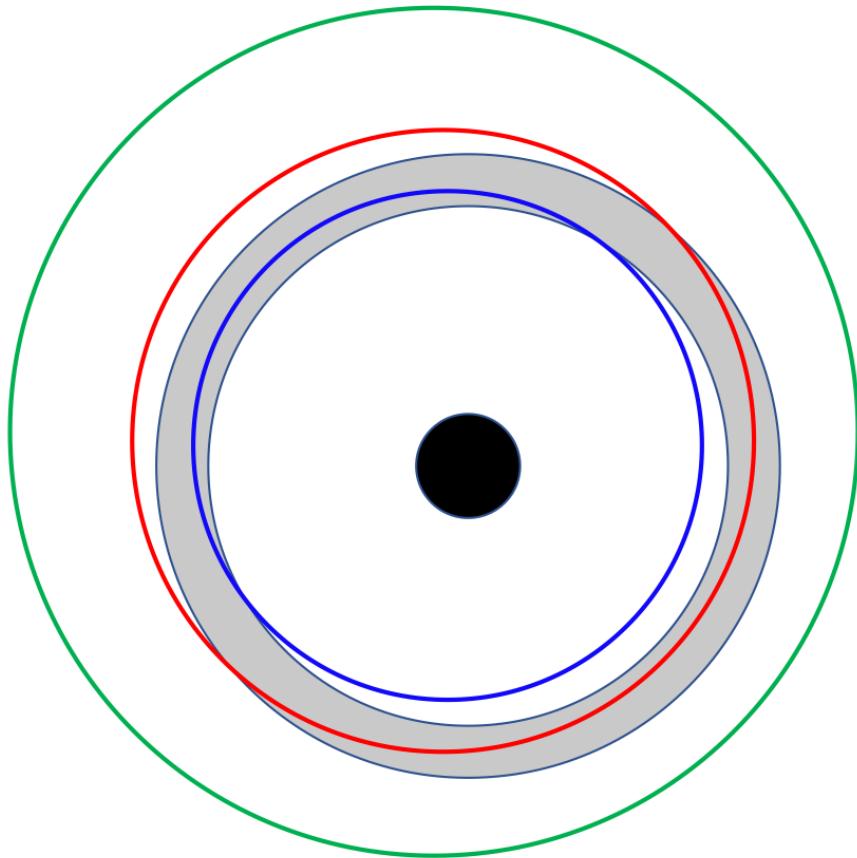
# Alignment

- The alignment of the CEDAR is controlled by motors that change the (X,Y) position of the 'upstream' end of the CEDAR
  - Upstream: the end where the beam enters, where the KTAG is located
- If the CEDAR is mis-aligned, things can look like this →



# Pressure

- But the mis-alignment is confusing when the pressure may also be wrong
- Example of bad pressure →
- Not easy to tell the difference between bad pressure and bad alignment
- And it can be both at the same time



# Why this project

- This project aims to gain some intuition of the relationship between CEDAR mis-alignment and/or wrong-pressures, and the effects seen in the amount of light collected, and in which sectors the light is collected.
- It is particularly important this year as:
  - We will test a new CEDAR in a CERN test-beam in October
  - IF appropriate, we will install the new CEDAR in the experiment next year

## References

- CEDAR/KTAG chapter of the technical design
  - [https://na62.web.cern.ch/documents/Chapter\\_Cedar\\_extract\\_full\\_doc\\_v10.pdf](https://na62.web.cern.ch/documents/Chapter_Cedar_extract_full_doc_v10.pdf)
- NA62 detector paper
  - <https://iopscience.iop.org/article/10.1088/1748-0221/12/05/P05025>
- CERN CEDAR paper from 1982
  - <http://cds.cern.ch/record/142935/files/CERN-82-13.pdf>
- NA62 KTAG paper
  - <https://arxiv.org/pdf/1509.03773.pdf>