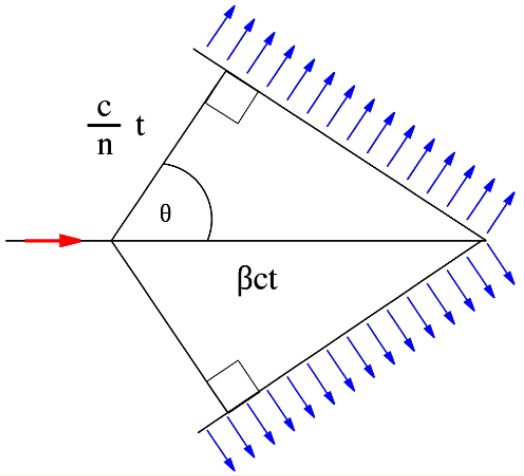
KTAG calibration model

Introduction

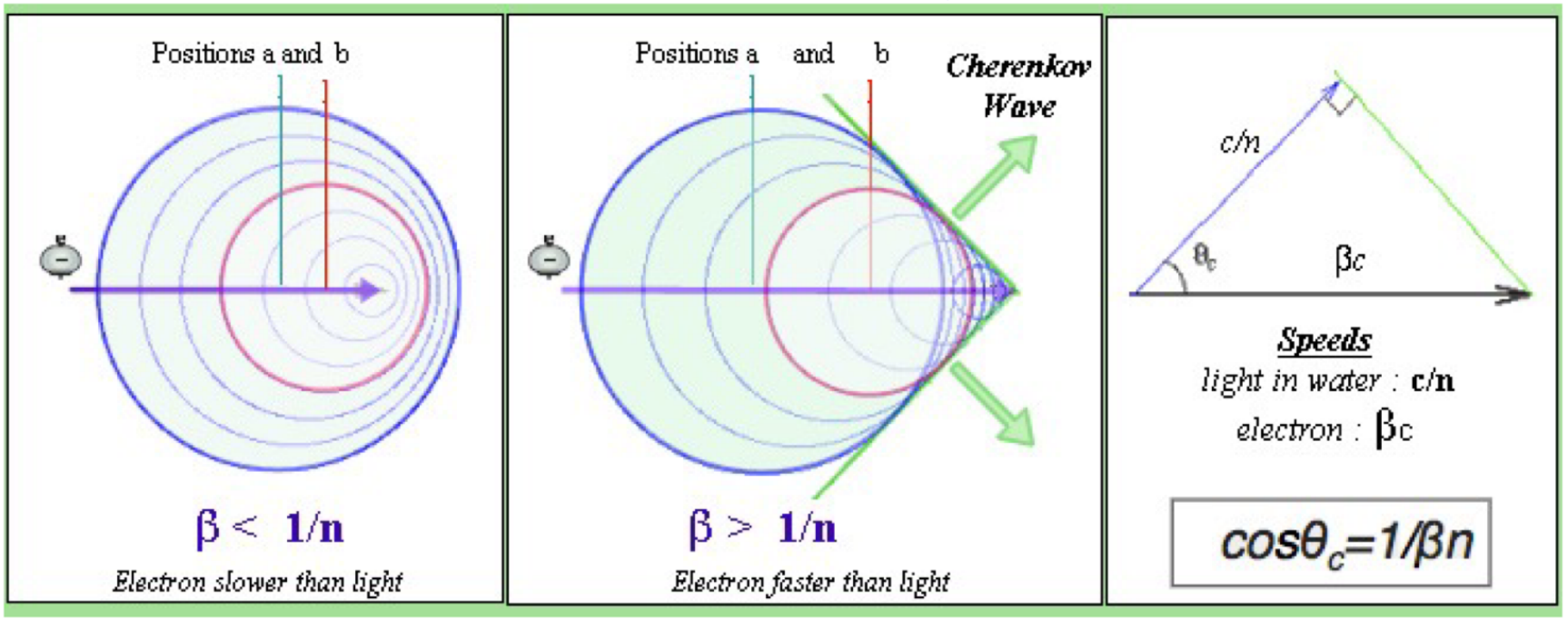
- NA62 is a kaon physics experiment located in the CERN North Area (NA)
- The NA62 collaboration study decays of K^+ particles using a decay-in-flight technique
- Each K^+ is identified by the CEDAR/KTAG detector

- 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 indentify kaons and record the time

Cherenkov light



$$\cos\theta = \frac{1}{n\beta}$$



CEDAR

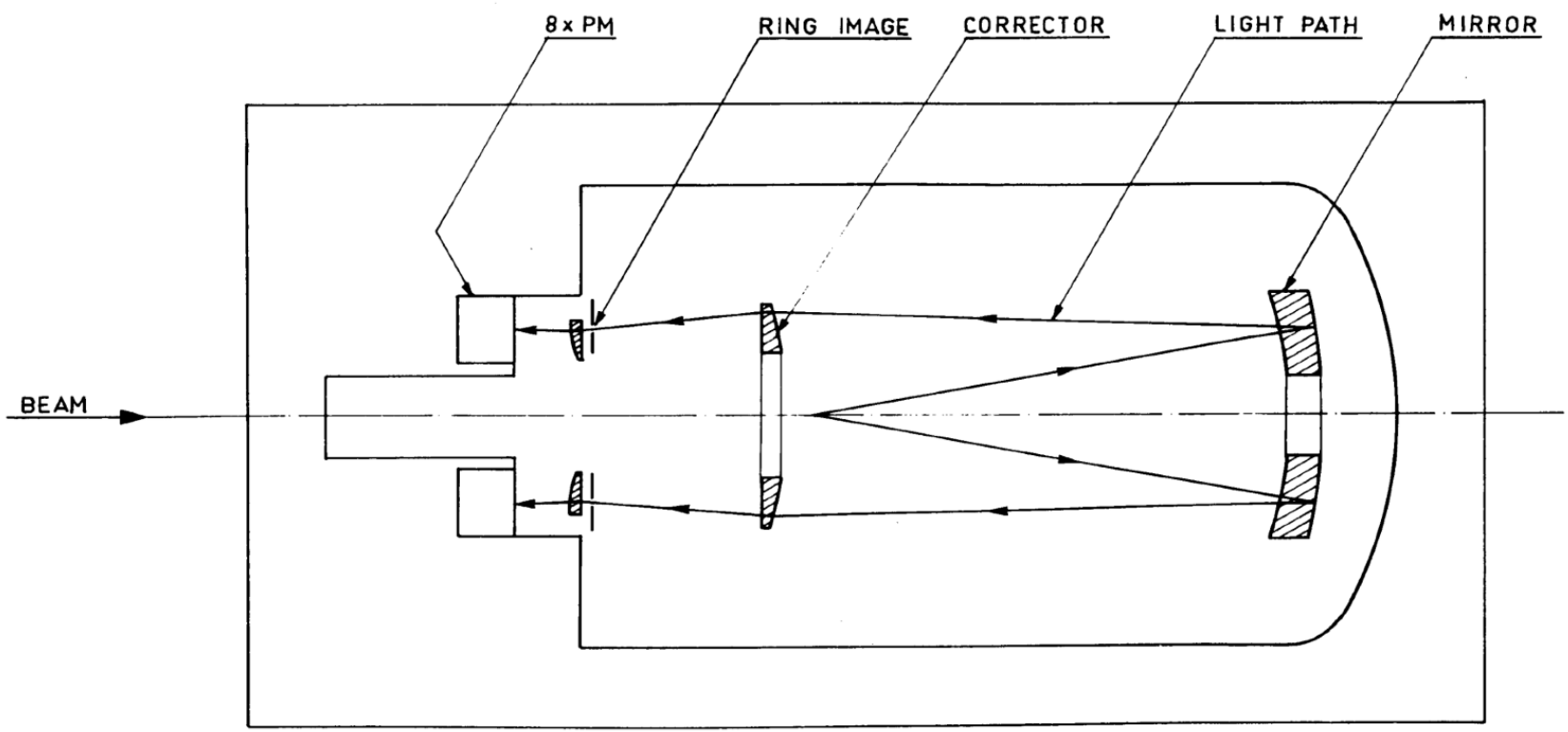
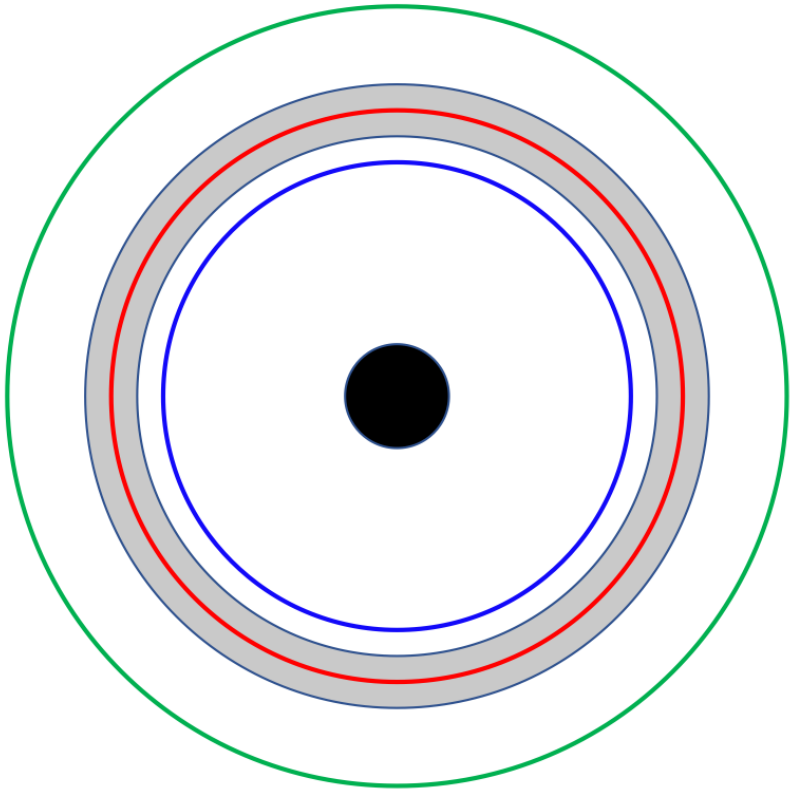


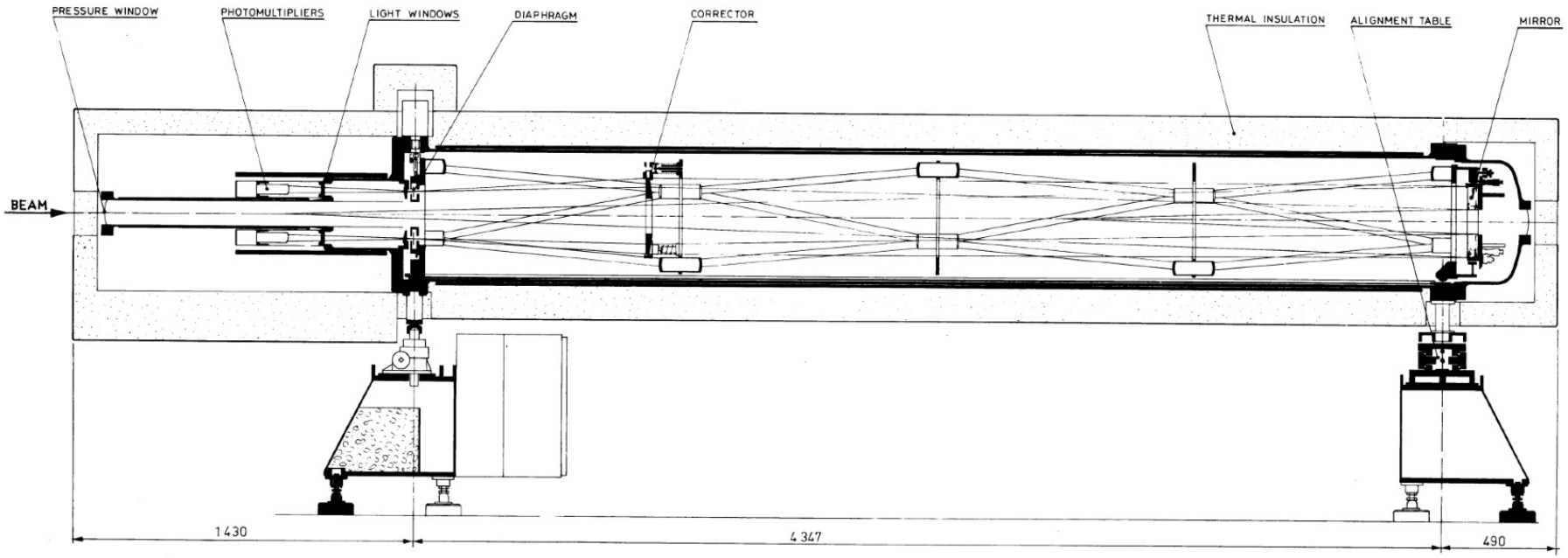
Fig. 2 Schematics of the optics of a differential Čerenkov counter (distorted scale)

CEDAR diagphragm

- ”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 aperature, light from pions (blue ring) and protons (green ring) fall outside the aperature

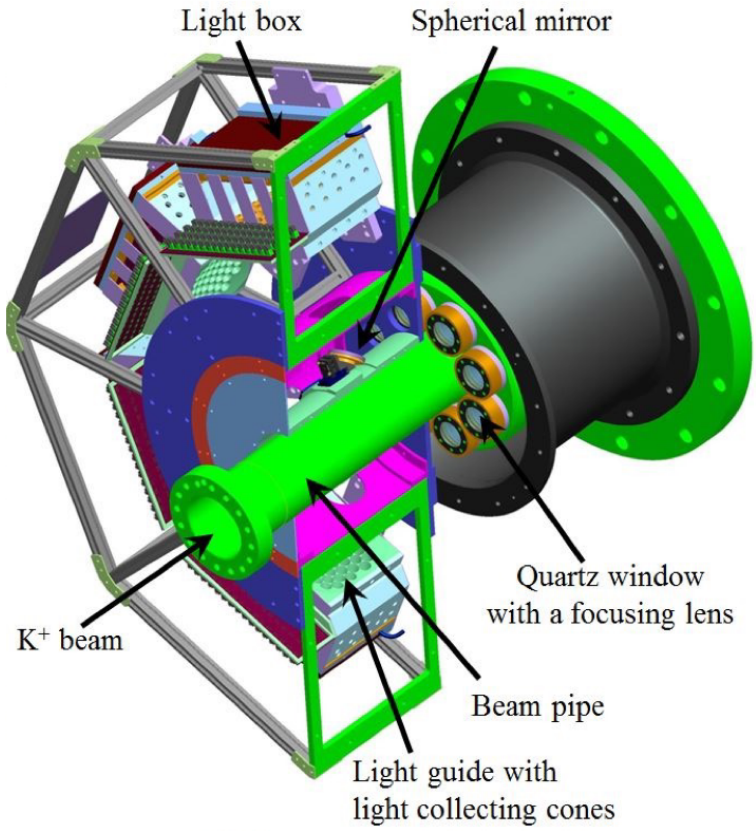


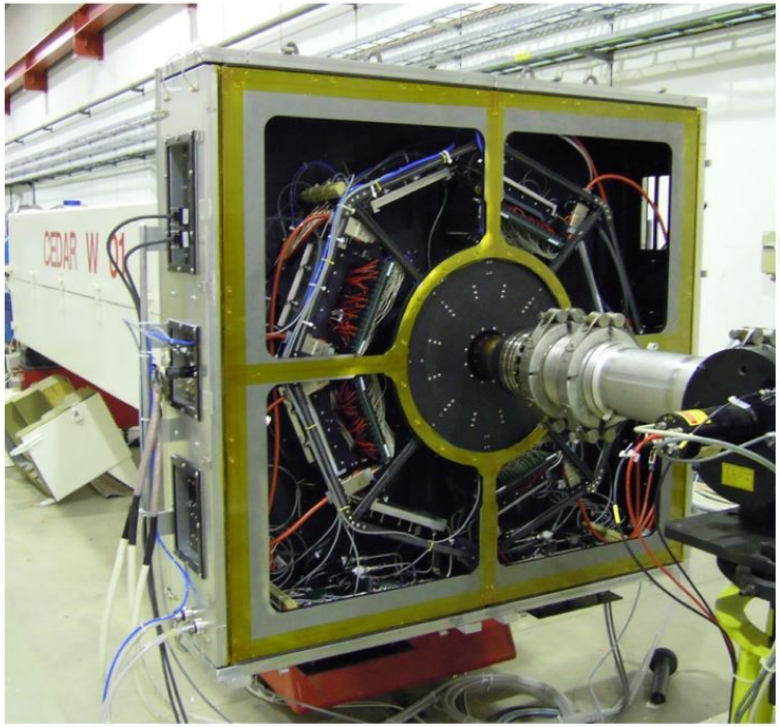
CEDAR in detail



CEDAR

KTAG


Light box
Spherical mirror
Quartz window
with a focusing lens
K+ beam
Beam pipe
Light guide with
light collecting cones



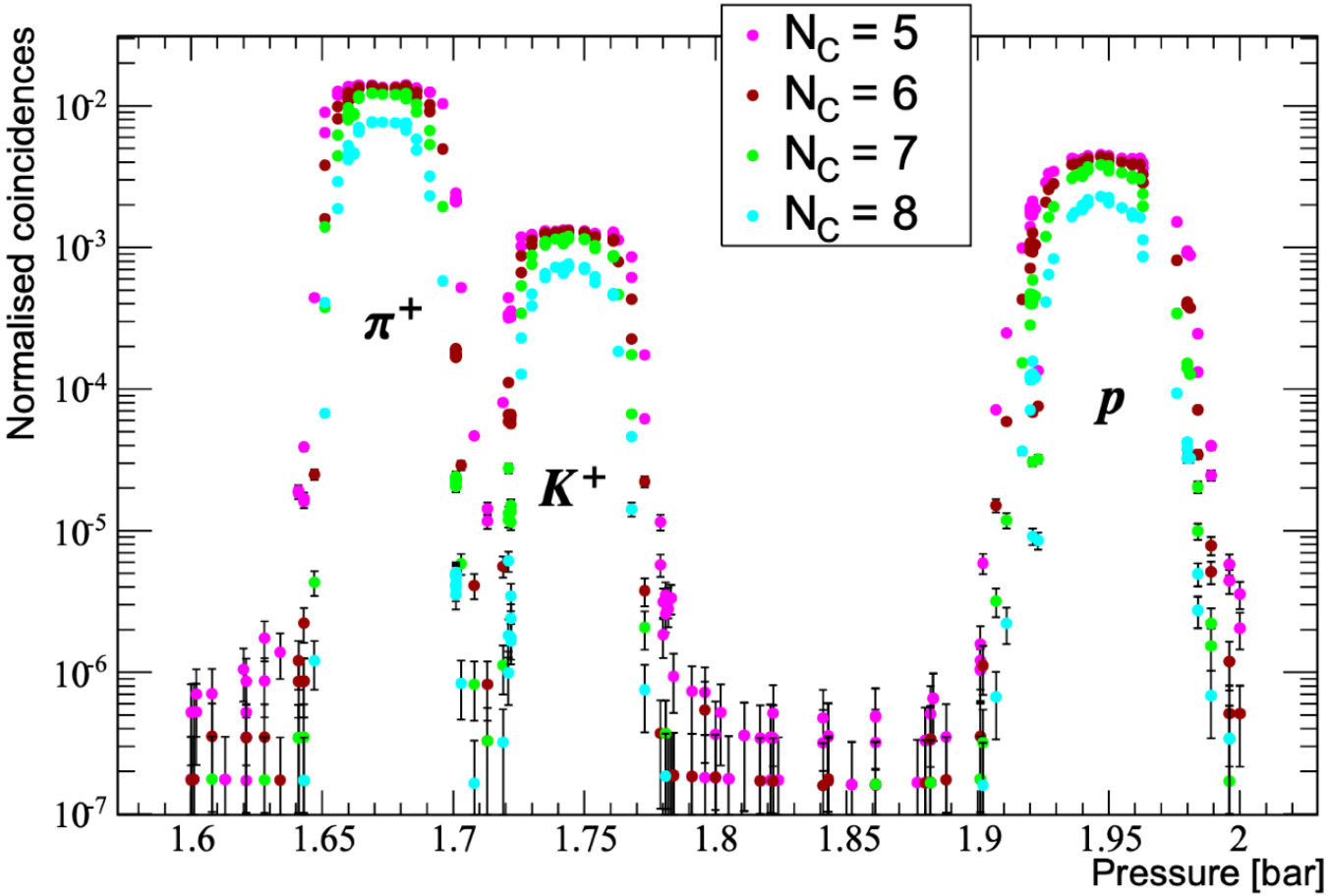
CEDAR/KTAG operating principle

- Due to the aperature, 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 280ps / $\sqrt{18}$ = 66ps

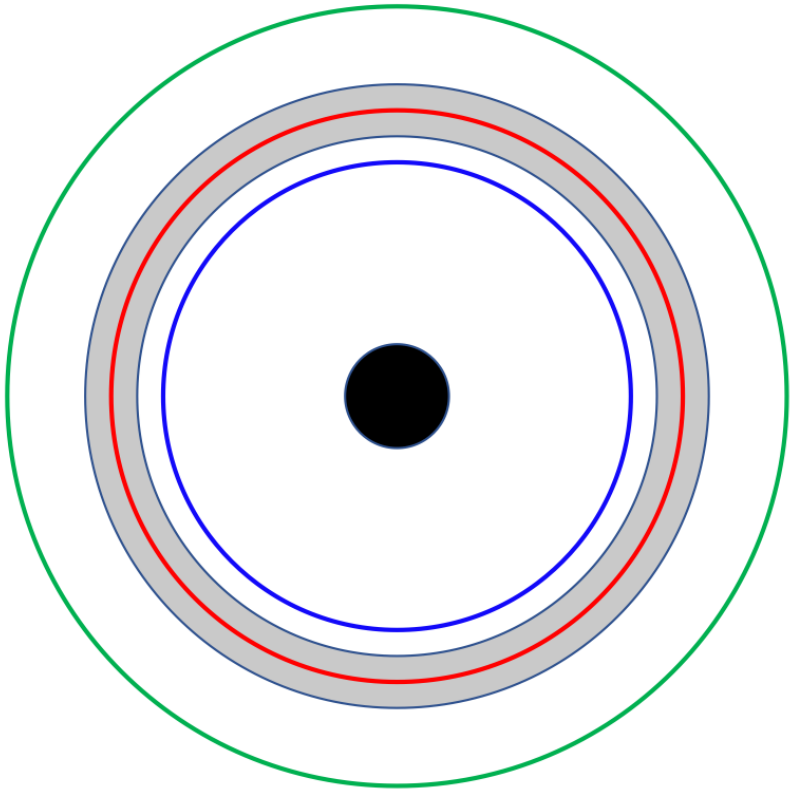
CEDAR/KTAG operating principle

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



Alignment

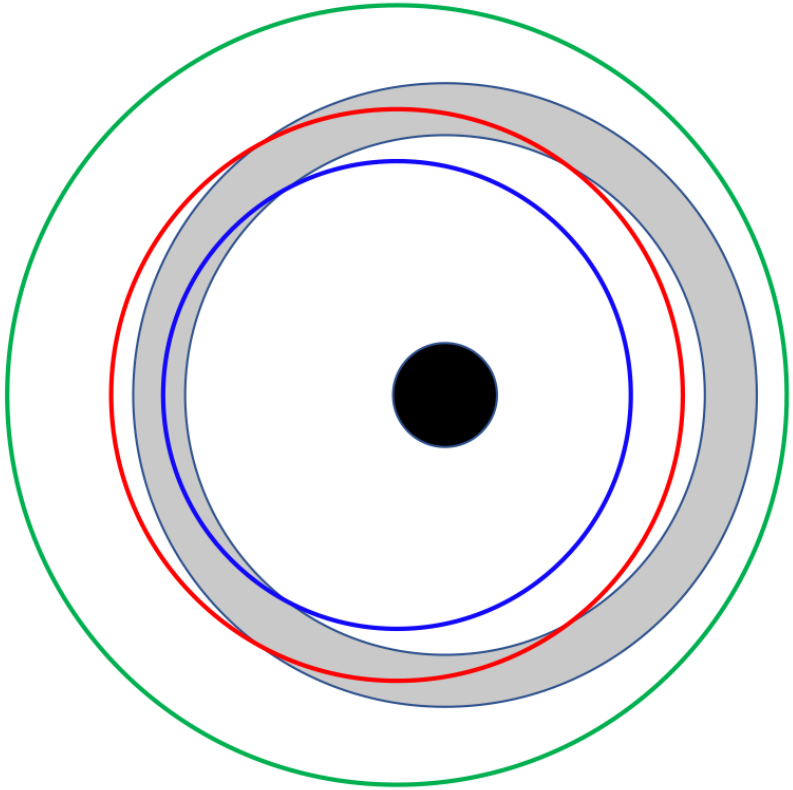
- Mis-alignment of the CEDAR with the beam can cause:
  - Light from K^+ to miss the aperature
  - Light from π^+ and p to enter the aperature
- This spoils the time resolution and particle identification power of the KTAG
- Good CEDAR alignment is critical for NA62



Alignment

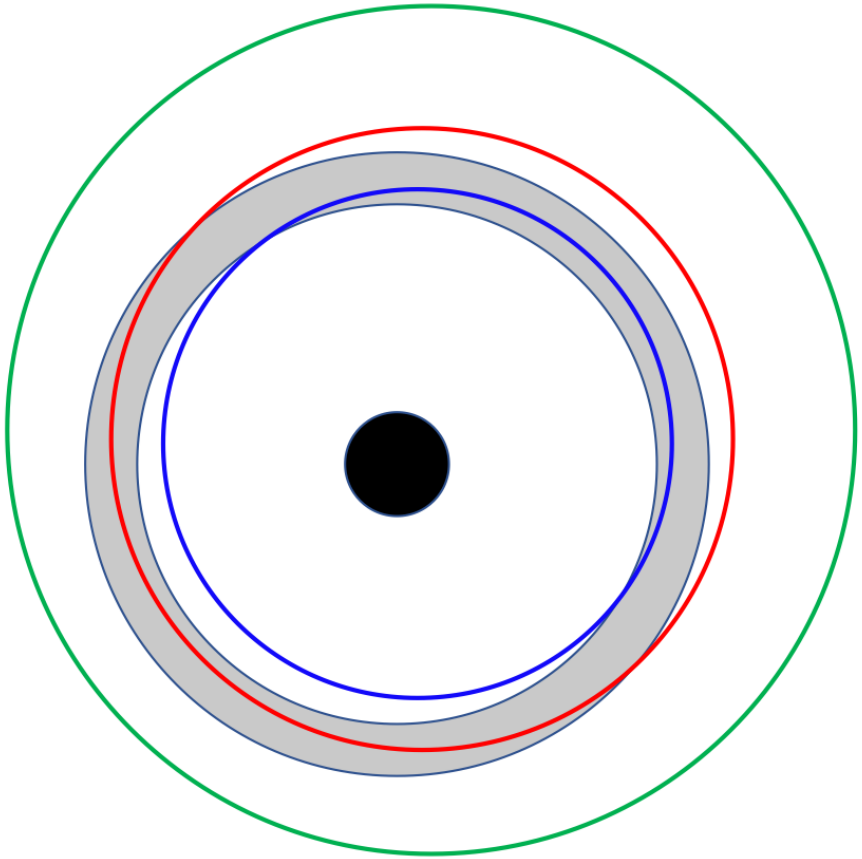
- The alignment of the CEDAR is controlled by motors that change the (X,Y) position of the ‘upstream’ end of the CEDAR
  - Upstream: the end where the beam enters, where the KTAG is located

- If the CEADAR 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
- 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