Expression of interest in DRD4 'Photon Detectors and Particle Identification (PID)'

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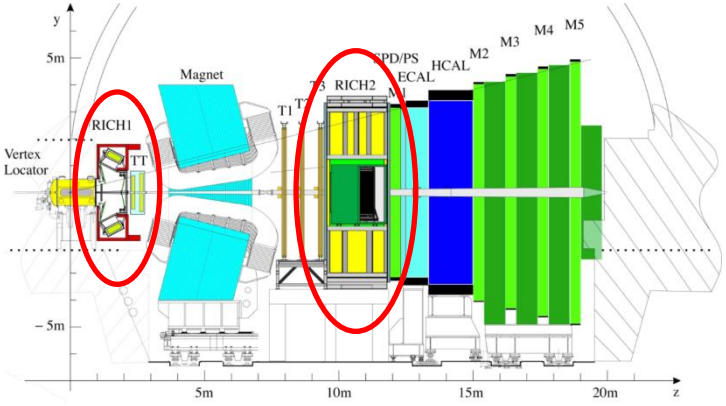
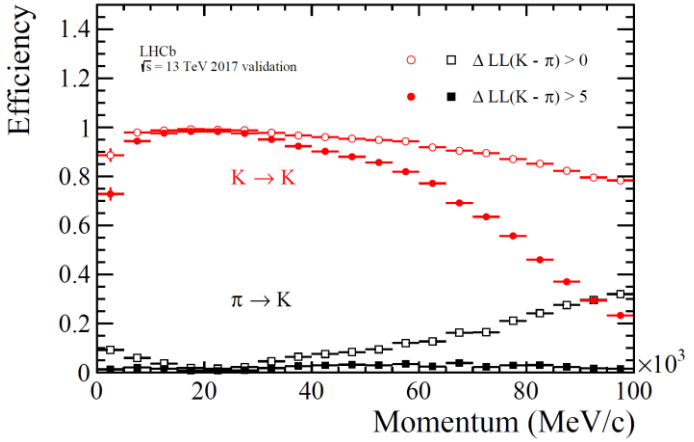
DRD discussion, RAL

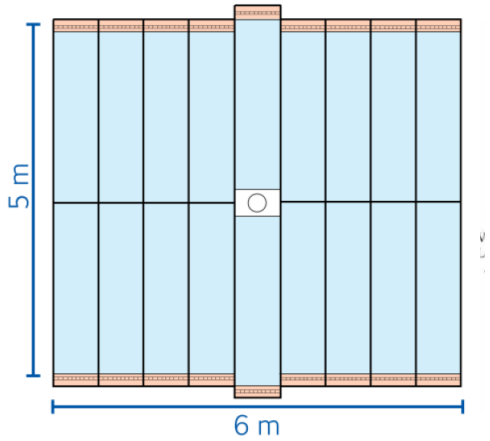
Ongoing UK tradition in PID

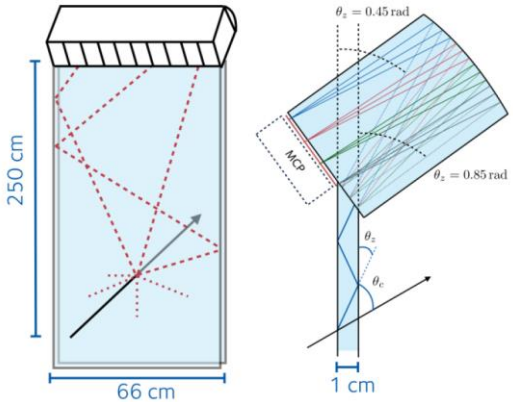
UK groups: central role in LHCb RICH detectors – past, present & future.





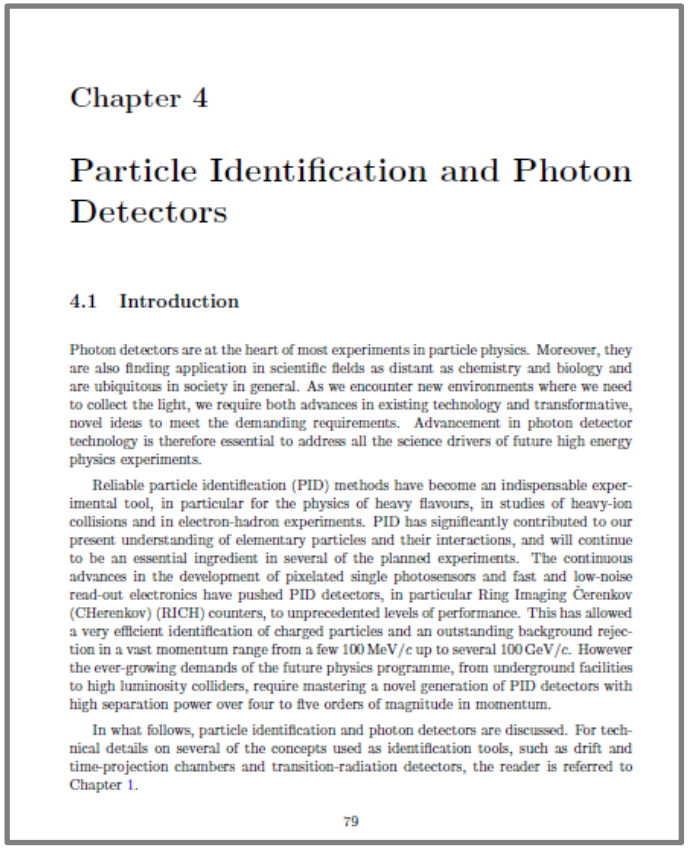
Also leading R&D on TORCH: novel Cherenkov based TOF system, which will provide low-momentum PID and fast-timing for LHCb Upgrade II.





Ongoing UK tradition in PID

UK expertise in this area internationally recognised
e.g. Neville Harnew co-convened TR4 of ECFA detector roadmap.



Chapter 4

Particle Identification and Photon Detectors

4.1 Introduction

Photon detectors are at the heart of most experiments in particle physics. Moreover, they are also finding application in scientific fields as distant as chemistry and biology and are ubiquitous in society in general. As we encounter new environments where we need to collect the light, we require both advances in existing technology and transformative, novel ideas to meet the demanding requirements. Advancement in photon detector technology is therefore essential to address all the science drivers of future high energy physics experiments.

Reliable particle identification (PID) methods have become an indispensable experimental tool, in particular for the physics of heavy flavours, in studies of heavy-ion collisions and in electron-hadron experiments. PID has significantly contributed to our present understanding of elementary particles and their interactions, and will continue to be an essential ingredient in several of the planned experiments. The continuous advances in the development of pixelated single photosensors and fast and low-noise read-out electronics have pushed PID detectors, in particular Ring Imaging Čerenkov (CHerenkov) (RICH) counters, to unprecedented levels of performance. This has allowed a very efficient identification of charged particles and an outstanding background rejection in a vast momentum range from a few 100 MeV/c up to several 100 GeV/c. However the ever-growing demands of the future physics programme, from underground facilities to high luminosity colliders, require mastering a novel generation of PID detectors with high separation power over four to five orders of magnitude in momentum.

In what follows, particle identification and photon detectors are discussed. For technical details on several of the concepts used as identification tools, such as drift and time-projection chambers and transition-radiation detectors, the reader is referred to Chapter 1.

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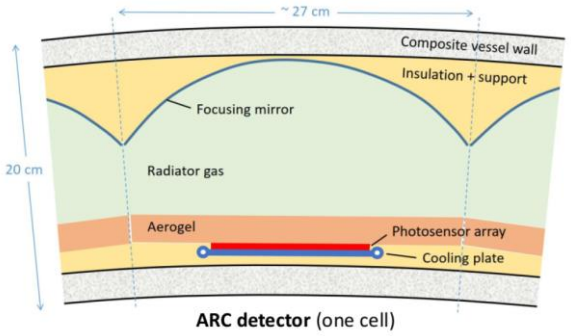
Future PID opportunities

- Future kaon experiments (*e.g.* HIKE)
- LHCb Upgrade II
- EIC
- Super Tau Charm Factory
- FCC-ee
- FCC-hh

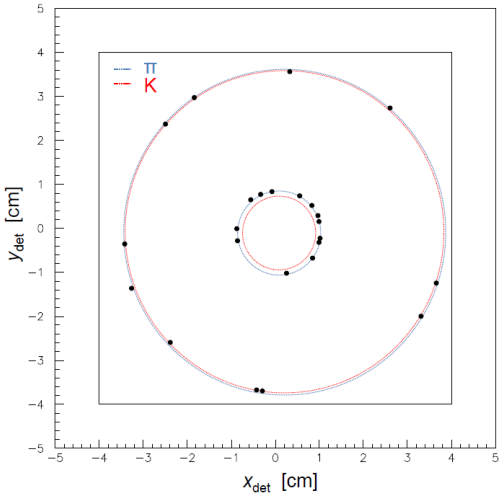
Remember, hadron PID is ***essential*** for serious beauty and charm studies.
Many applications elsewhere, *e.g.* flavour tagging in Higgs, W and top jets.

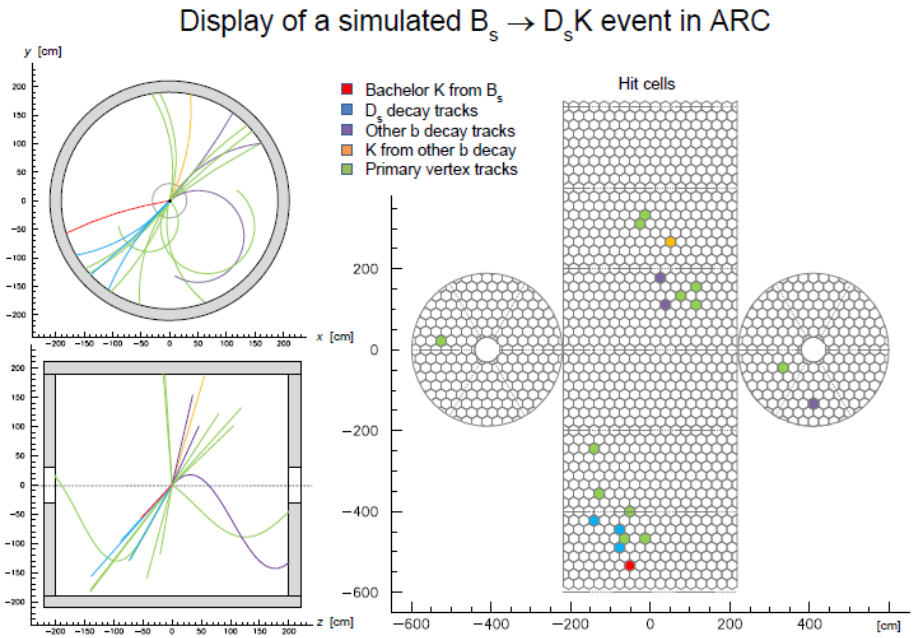
PID at FCC-ee: ARC (Array of RICH Cells)

Conceptual development & optimisation of compact two-radiator RICH to provide PID over wide momentum range at FCC-ee (Forty [CERN], Tat, Wilkinson [Oxford])



ARC detector (one cell)





>3σ π-K separation from 2-50 GeV

Likely areas of interest (my guess)

UK institutes most likely interested in developing technologies suitable for next-generation RICH detectors and Cherenkov-based TOF systems.

- Photodetectors: SiPMs, MCP-PMTs….
  High geometric & quantum efficiency / spectral range, position & time resolution most interesting attributes.
- Radiators
  - eco-friendly gaseous radiators
  - meta-materials
  - large area quartz, quartz substitutes…
- Low mass mirror systems and gas vessels
- *etc.*

Next steps

Contact potential interested groups in UK (*e.g.* Edinburgh, Cambridge, Warwick, Bristol, Imperial, Oxford…) to gauge level and topics of interest

Discuss with DRD4 (launch) convenors (Peter Krizan & Christian Joram).
- informal Zoom discussions foreseen during March
- community workshop, most likely in May
- proposal to be submitted by end of July (tight !)

In parallel, maintain active involvement in future projects where these technologies will have application, in particular FCC-ee detector studies.