DRD project proposal via STFC Early-Stage Research scheme
Studies towards ARC – a compact, lightweight RICH detector for a future e^+e^- collider

There is a growing realisation of the importance of hadron identification at a future e^+e^- collider, such as FCC-ee or the ILC. An experiment with this attribute will not only be well-equipped for high precision flavour-physics measurements, but will also have enhanced capabilities for tagging the flavour of jets in Higgs, W/Z and top decays, enabling, for example the search for Higgs decays to strange quarks.

The ARC (Array of RICH Cells) is a proposed RICH detector for inclusion in a barrel e^+e^- experiment, such as would operate at the FCC [1]. It must be compact, taking no more than 20cm of space in the radial direction, and low mass, so it does not compromise the calorimeter performance. It should provide π/K separation from low momentum to about 40 GeV/*c*. These goals will be met by an ensemble of cells consisting of an aerogel and gaseous radiator (current baseline C_4F_{10}, with more environmentally friendly gases under consideration), a lightweight focusing mirror and a photodetector, with SiPMs being the current baseline technology. A schematic of an ARC cell, together with a simulation of a region of the detector, is shown in Fig. 1.

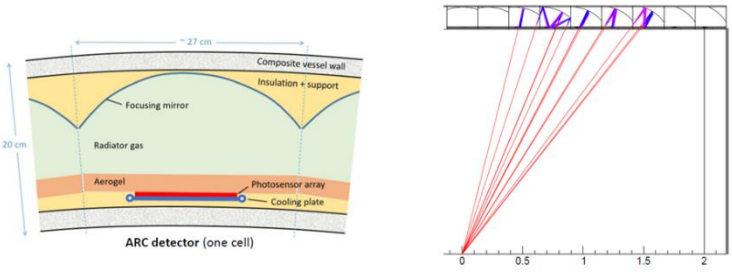

Figure 1: Schematic of a single ARC cell (left) and ray-tracing simulation of an ensemble of cells in the barrel region (right) [2].

Studies towards the development of the ARC concept are a recognised goal of the DRD4 collaboration, with an ultimate deliverable (Work Package 4.3.4) being the evaluation of a prototype ARC cell. Achieving this aim will involve:

- Evaluation of compact photodetectors with high geometrical efficiency, with SiPMs being the current baseline technology;
- Evaluation of the clarity and photon yield of currently available aerogel samples;
- Effectiveness of aerogel in thermally insulating a cooled SiPM module from a gas volume;
- Design of lightweight, possibly pressurised vessel;
- Investigation of environmentally friendly alternatives to fluorocarbons as a radiator gas;
- Investigation of lightweight mirror technology;
- Construction of a prototype cell and evaluation at a beam test;
- Software optimisation studies.

Although pursuing all of these goals together lies beyond the scope of the current call, it will be possible to pursue a subset of them and thereby make a meaningful impact within international DRD4. A prioritisation will be made following discussions within UK DRD4 should this proposal be chosen for further consideration.

Currently interested groups include Bristol, Cambridge, Oxford, the Rutherford Lab and Warwick. Other collaborators are welcome.

[1] Originally proposed by Roger Forty, CERN.
[2] Optimisation studies performed by Martin Tat, University of Oxford.

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