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Development of a Cost-Effective RICH Detector for MARQ Spectrometer Using SiPM Technology

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We are developing a Ring Imaging Cherenkov (RICH) detector for the MARQ spectrometer at J-PARC's Hadron Hall, specifically designed for particle identification in the momentum range of 2-18 GeV/c. The detector, with dimensions of 4x6x2 m^3, employs a dual-radiator configuration, combining Aerogel (n=1.04) and C3F8O gas (n=1.00137), to discriminate among scattered particles such as pions, kaons, and protons/antiprotons. A key feature of our design is the use of Silicon Photomultipliers (SiPM), chosen for their significant cost advantage over traditional photomultiplier tubes.

Despite SiPM's benefits, they present notable challenges, including a limited sensitive area and a high dark count rate. To mitigate these issues, we are integrating a light concentrator and a thermoelectric cooling system supported by a water chiller to regulate the SiPM's temperature at approximately 0℃ or below. This innovative approach aims to enhance the detector's performance while maintaining a low production cost, making it the most economical option in its class.

Our development represents a significant step toward building high-performance particle detectors using cost-effective and scalable solutions, offering a versatile tool for future experiments at J-PARC and beyond.

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