### The Thomas Jefferson Laboratory

The Thomas Jefferson National Accelerator Facility (Jefferson Lab) is one of the U.S. Department of Energy Office of Science national laboratories. Scientists worldwide utilize the lab’s unique particle accelerator, known as the Continuous Electron Beam Accelerator Facility (CEBAF), to probe the most basic building blocks of matter - helping us to better understand these particles and the forces that bind them - and ultimately our world.

**THE CLAS12 RICH**

The CLAS12 RICH has been designed to identify kaons in the momentum range between 3 and 8 GeV/c.

It is made by a large trapezoidal detector, with a large base of 4.3 m, a height of 3.8 m and a depth of 1.2 m. The main RICH components are:

- **radiator:** 102 aerogel tiles with refractive index 1.05
- **mirror system:** 10 spherical mirrors and 7 planar mirrors for a total surface of about 10 m²
- **photodetectors:** 391 Multi-Anode Photo-Multiplier tubes with 64 pixels each
- **readout electronics:** binary readout on the 25024 channels with optical fiber data transfer

### Building and Installing the RICH

**Installing the aerogel tiles.**

**The installation of the lower section of the aerogel on the frontal mirror is completed.**

**All RICH mirrors installed in the frame.**

**The 391 photo-sensors (front view, top), and the readout electronics (back view, bottom).**

**The RICH is lifted up during the final installation in CLAS12.**

### The RICH at Work

**Computer simulation of one kaon (yellow line) producing Cherenkov light inside RICH. The white lines are photons produced in the aerogel and detected by the photo-sensors on the left.**

### The AEROGEL

Silica aerogel is an amorphous solid network of SiO₂ nanocrystal with an extremely low density. It is widely used for insulating houses or even the astronaut suits.

### THE CHERENOV LIGHT AS A MEAN TO IDENTIFY PARTICLES

In special material, massive particles can travel at higher velocity than the light in the same material. In that case, a cone of Cherenkov light is emitted. Measuring the opening angle of the cone allows us to identify the particle.

\[ \cos \theta = \frac{1}{\beta n} \]

Where:
- \( \theta \) is the opening angle of the Cherenkov light cone.
- \( \beta \) is the particle velocity as a fraction of the speed of light.
- \( n \) is the refractive index of the material.

**Simulation of rings produced by a pion, a kaon and a proton of the same momentum.**

### The Ring Imaging Cherenkov detector of CLAS12

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**Monitoring suite used to check the hardware status of the RICH. Top left: all channels are healthy. Right: all photo-sensors are aligned to give the same response to the same amount of light.**

**THE PROPOSED THESIS**

- **Monitor of the RICH functionality**
  - The work consists of recording the data, developing the software to analyze the data, extract the best configuration parameters to be used during the physics data taking.

- **Study of the RICH performance**
  - The work consists in the analysis of real and simulated data to optimize the particle identification algorithm.

Required skills: basic knowledge of programming languages like C, C++, java, root, etc.