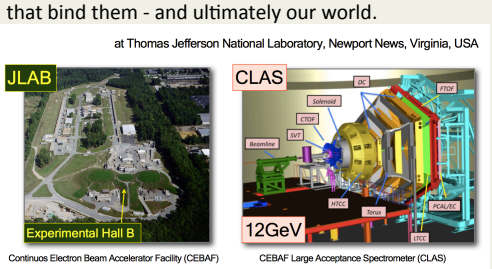
# The Ring Imaging Cherenkov detector of CLAS12

## 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.



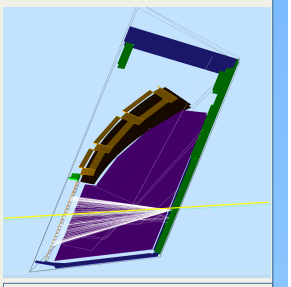

The Hall B houses the CLAS12 large acceptance magnetic spectrometer. It is composed by drift chambers to measure the momentum of the particles and calorimeters, scintillators and Cherenkov counters for the particle identification.

## 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 $m^2$
- photodetectors: 391 Multi-Anode Photo-Multiplier tubes with 64 pixels each
- readout electronics: binary readout on the 25024 channels with optical fiber data transfer

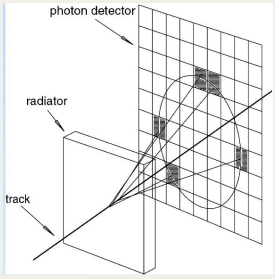


Computer simulation of one kaon (yellow line) producing Cerenkov light inside RICH. The white lines are photons produced in the aerogel and detected by the photo-sensors on the left

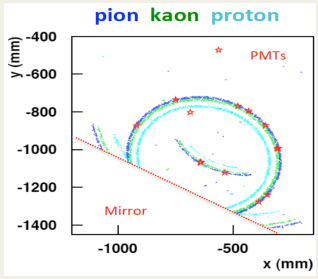
## THE CHERENKOV LIGHT AS A MEAN TO IDENTIFY PARTICLES

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.

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




The Cherenkov light cone is imaged as a ring on the photodector plane.

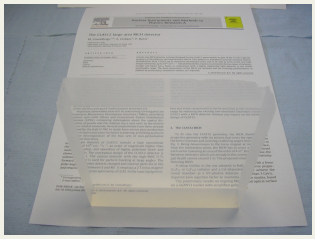



Simulation of rings produced by a pion, a kaon and a proton of the same momentum.

## THE AEROGEL

Silica aerogel is an amorphous solid network of $SiO_2$ nanocrystal with an extremely low density.
It is widely used for insulating houses or even the astronaut suits.

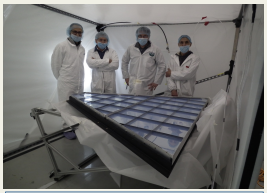
Many particle physics experiments in the world utilize the aerogel as Cherenkov radiator.
It is produced in tiles of various thicknesses and shapes that can be stacked to cover large areas.



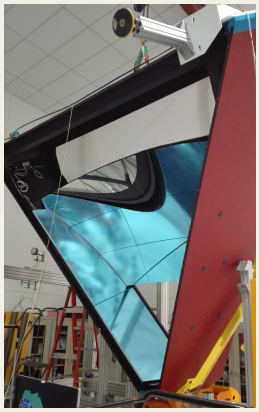
The aerogel is so transparent that one could read a paper through it

## BUILDING AND INSTALLING THE RICH

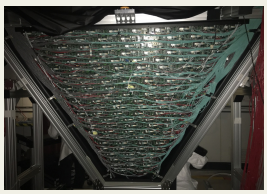
Installing the aerogel tiles.



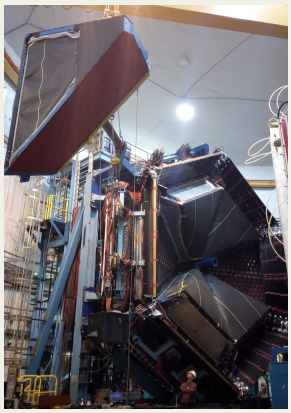
The installation of the lower section of the aerogel on the frontal mirror is completed.



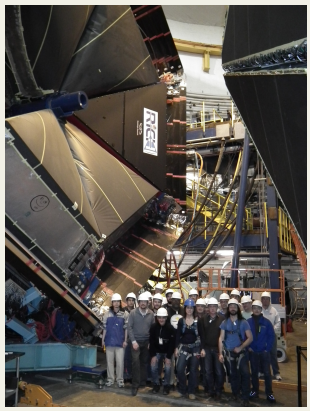
All RICH mirrors installed in the frame.



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

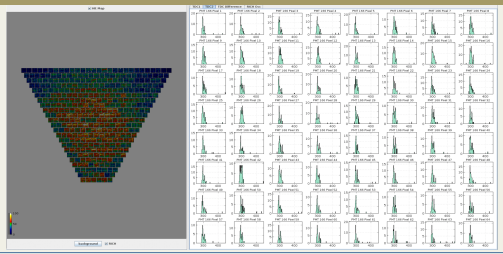


The RICH is lifted up during the final installation in CLAS12.



The RICH installed in CLAS12.

## THE RICH AT WORK



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

## 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


**CONTACTS** Marco Mirazita Email: marco.mirazita@lnf.infn.it Tel.: 06 9403 2549
Vincenzo Lucherini Email: vincenzo.lucherini@lnf.infn.it Tel.: 06 9403 2408