Report of activities.

Title of the work:

Tests of aerogel tiles for the AMS RICH detector [1]

Student:

Antonio Ortiz Velásquez*

* *Instituto de Ciencias Nucleares, UNAM, México DF.*

Supervisor: Ph. D. Mariane Brinet

mariane@lpsc.in2p3.fr

Summer 2006.

Abstract

The Alpha Magnetic Spectrometer (AMS) experiment to be installed at the International Space Station (ISS) will be equipped with a Ring Imaging Cherenkov (RICH) detector for measuring the electric charge and velocity of the charged cosmic particles. In this report we present the methode used for the characterization of the aerogel tiles wich will conform AMS-RICH detector, in particular we report the experimental method used to study the geometry and optical properties of the aerogel tiles.

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[1] This work was supported by a HELEN program 2006.

1 Introduction

The Alpha Magnetic Spectrometer [1] (AMS) is a high energy physics experiment that will be installed on the International Space Station (ISS), where it will operate for a period of at least three years.

The long time exposure in space will allow AMS to collect an unprecedented large data sample and to extend by orders of magnitude the sensitivity reached by previous experiments on dark matter and antimatter searches. In addition, AMS will contribute to a better description of cosmic ray production, acceleration and propagation mechanisms, essential for a full understanding of the background spectra on dark matter searches.

The AMS spectrometer includes a Ring Imaging Cherenkov detector (RICH) operating between the time-of-flight and electromagnetic calorimeter (ECAL) detectors. It was designed to provide measurements of the velocity for singly charged particles with a relative uncertainty of 0.1% and of the nuclei electric charge up to Fe. Moreover, it will provide AMS with an additional contribution to the electron/proton separation. For the isotopic separation, the RICH detector will cover a kinetic energy region ranging from 0.5 GeV/n up to around 10 GeV/n for $A \leq 10$.

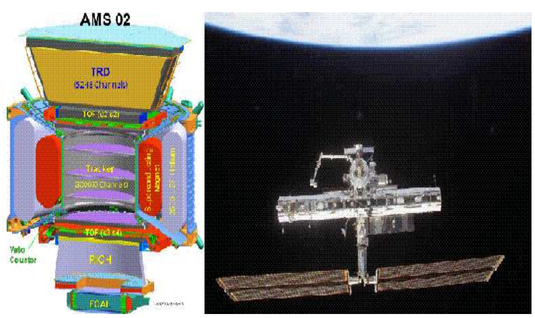

Figure 1: Left, AMS detector with all its components. Right, ISS.

2 The AMS RICH detector

The AMS RICH counter design has to meet a set of specific constraints imposed by the launch and flight conditions, on the resistance to vibrations of the structure and of its elements, and on the volume and shape of the payload, as well as by the particular experimental environment of a long duration spatial experiment. The functional architecture consists of a radiator plane placed at the top of the counter, separated from the photon detector plane at the bottom of the counter, by a photon drift space, or ring expansion gap, ~ 46 cm deep. The detector plane has an empty 64×64 cm^2 area in its centre, matching the active area of the electromagnetic calorimeter (ECAL) located below. These elements are enclosed in the volume of a conical mirror, the purpose of the latter being of maximizing the geometrical acceptance. The radiator plane is a dodecahedral polygon with a 118.5 cm internal tangent diameter (see fig. 2). It consists of an array of aerogel tiles with a refractive index with $n = 1.05$, $2.7cm$ thick surrounding a central $\approx 35 \times 35$ cm^2 region equipped with 5 mm thick sodium fluoride (NaF, $n \approx 1.33$) radiator. This radiator combination optimizes the overall counter acceptance, since the Cherenkov photons radiated by the NaF will fall within the detector area, while photons radiated by aerogel from the same location would fall in de ECAL hole. [2]

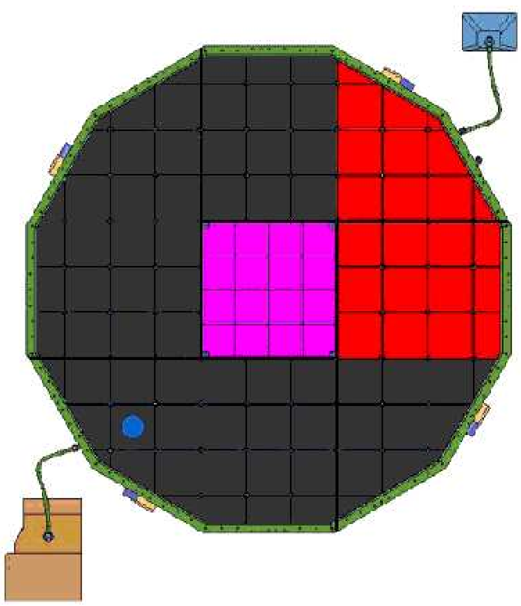

Figure 2: Configuration of the aerogel tiles in the radiator.

3 Aerogels test

We did two measurements to aerogel tiles, the first one was a metrology test to study the shape of the aerogel surface; and the second one, consisted in a optical test in order to study the refractive index variation along the tile.

3.1 Metrology test

We used a precious device to measure lengths, using its software we can establish communication between it and a PC. If we select a cell of a sheet excel, then in this cell will appear the length measured with the device. So we generate a excel file to get a matrix data array of the geometry of the tile.

There are 7 different tile shapes (see Fig.3), three of which using the same excel file since their geometry is extremely similar (almost squared)

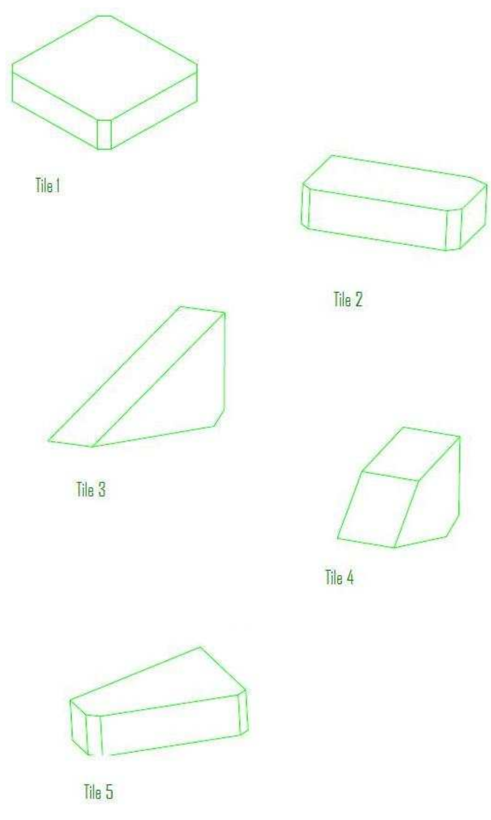

Figure 3: Differents geometries of the tiles.

At this moment we have done the metrology test to 54 tiles.

3.2 Optical test

The precise determination of the refractive index for each tile requiered the elaboration of a dedicated measurement method, by laser deviation. The vertical and horizontal deviation of the laser beam entering normally to the surface, allows a measurement of the refractive index gradient at a given position on the tile. With help of a lab view program we can collect a data array. In each file, we find information about the deviation of the laser beam in each point on the surface of tile. Figure 4, shows: the setup used to do this test, and the deviation of the beam in each position along of the tile surface. At this moment we have done the optical test to 30 square tiles.

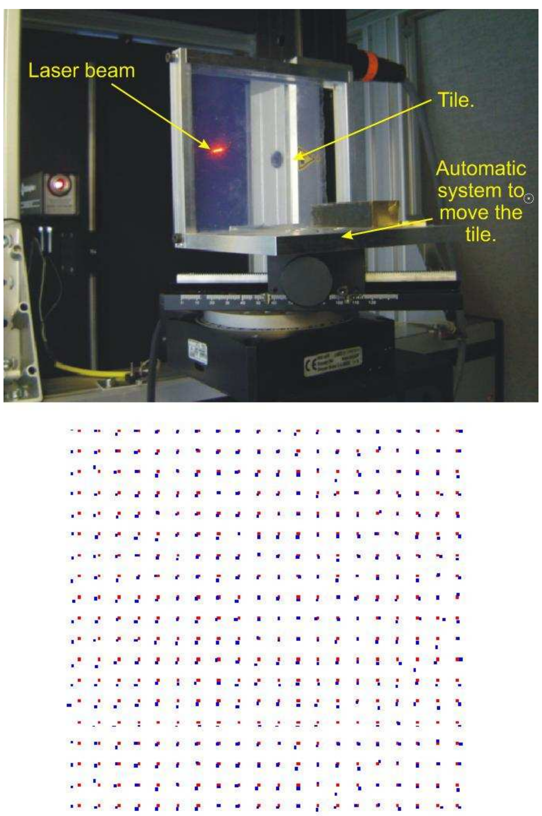

Figure 4: Top, setup used to do the optical test of the tiles. Bottom, deviation of the laser beam in each position along the tile surface. The red points correspond with the incident beam and the blue points correspond with the refracted beam.

The data of both tests will be analyzed after.

References

[1] M. Aguilar et al., *The Ring Imaging Cherenkov detector (RICH) of the AMS experiment*, Proc. 29th ICRC, Pune.

[2] P. Aguayo et al,. *Prototype study of the Cherenkov imager of the AMS experiment*, Nucl. Instr. and Meth. A 560 (2006) 291-302.