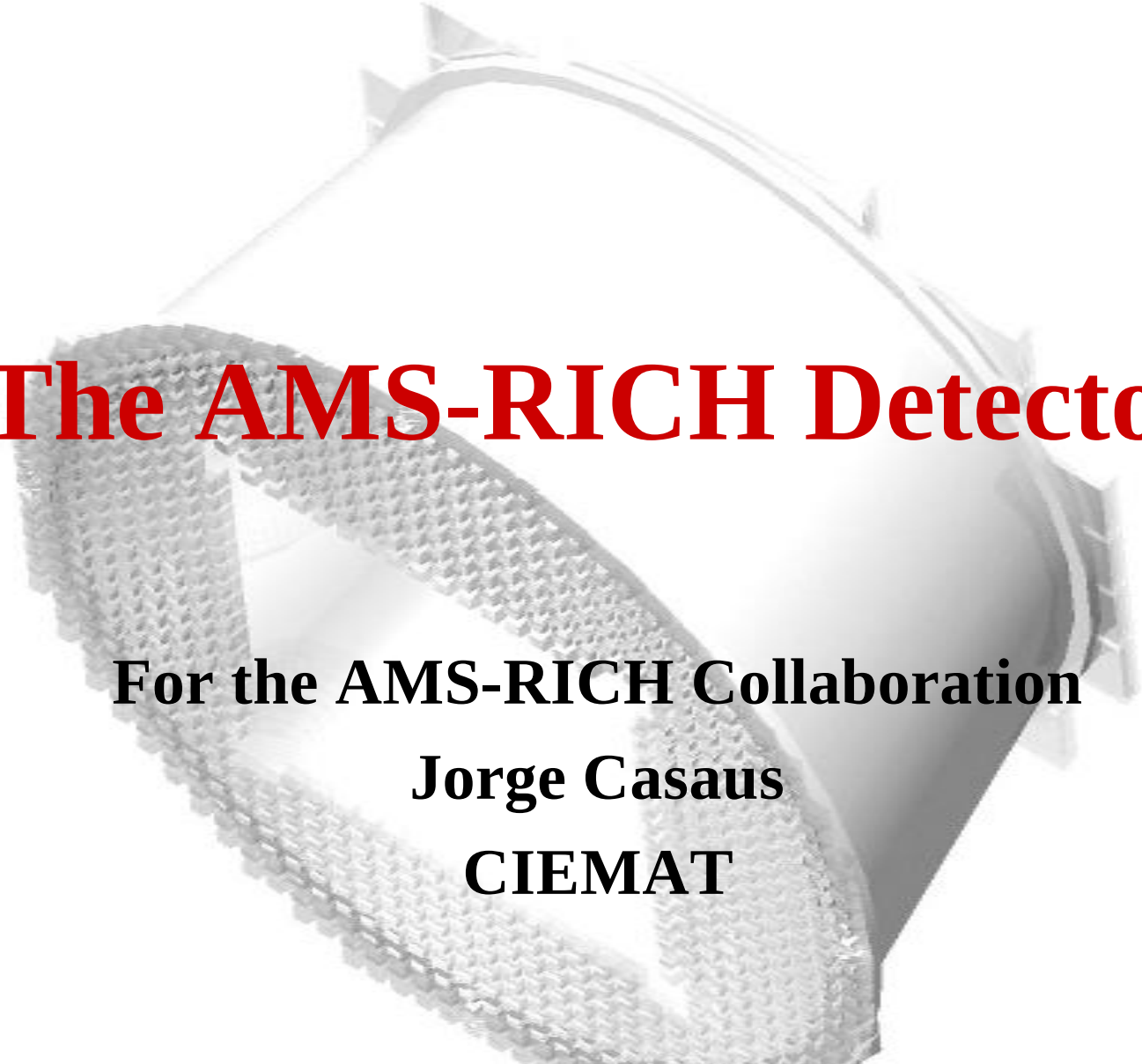


The AMS-RICH Detector

For the AMS-RICH Collaboration

Jorge Casaus

CIEMAT

1st International Conference on Particle & Fundamental Physics in Space
Isola d'Elba, May 16th 2002

Outline

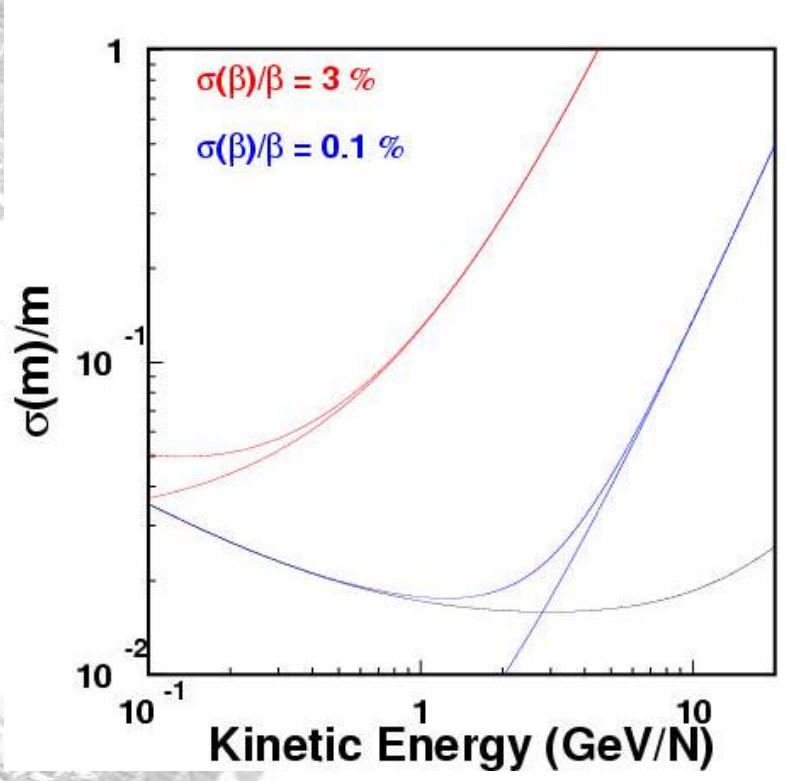
- Introduction
- Detector Description
- Expected Performances
- RICH prototype
- Prospects & conclusions

Introduction

In a magnetic spectrometer mass is determined by simultaneous measurement of particle rigidity, charge and velocity

$$\frac{\sigma(m)}{m} = \frac{\sigma(R)}{R} \oplus \gamma^2 \frac{\sigma(\beta)}{\beta}$$

$$m = \frac{ZR}{\beta\gamma}$$

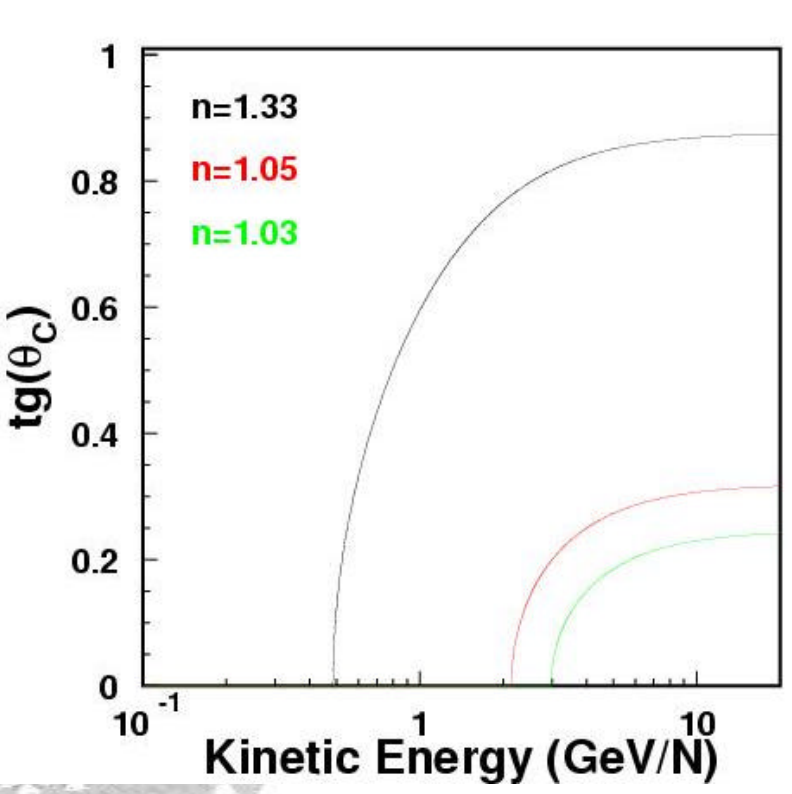


Introduction

A Ring Imaging Cerenkov Detector (RICH) measures the Cerenkov cone emitted in a radiator when a particle velocity is above the local speed of light, i.e., $\beta > 1/n$

$$\cos(\theta_c) = 1/n\beta$$

The choice of the radiator refraction index determines the energy range measurement



Introduction

And since

$$N_{p.e.} \sim Z^2 \sin^2(\theta_c)$$

Photon counting within a Cerenkov Ring provides us with a measurement of the particle Charge (Z)

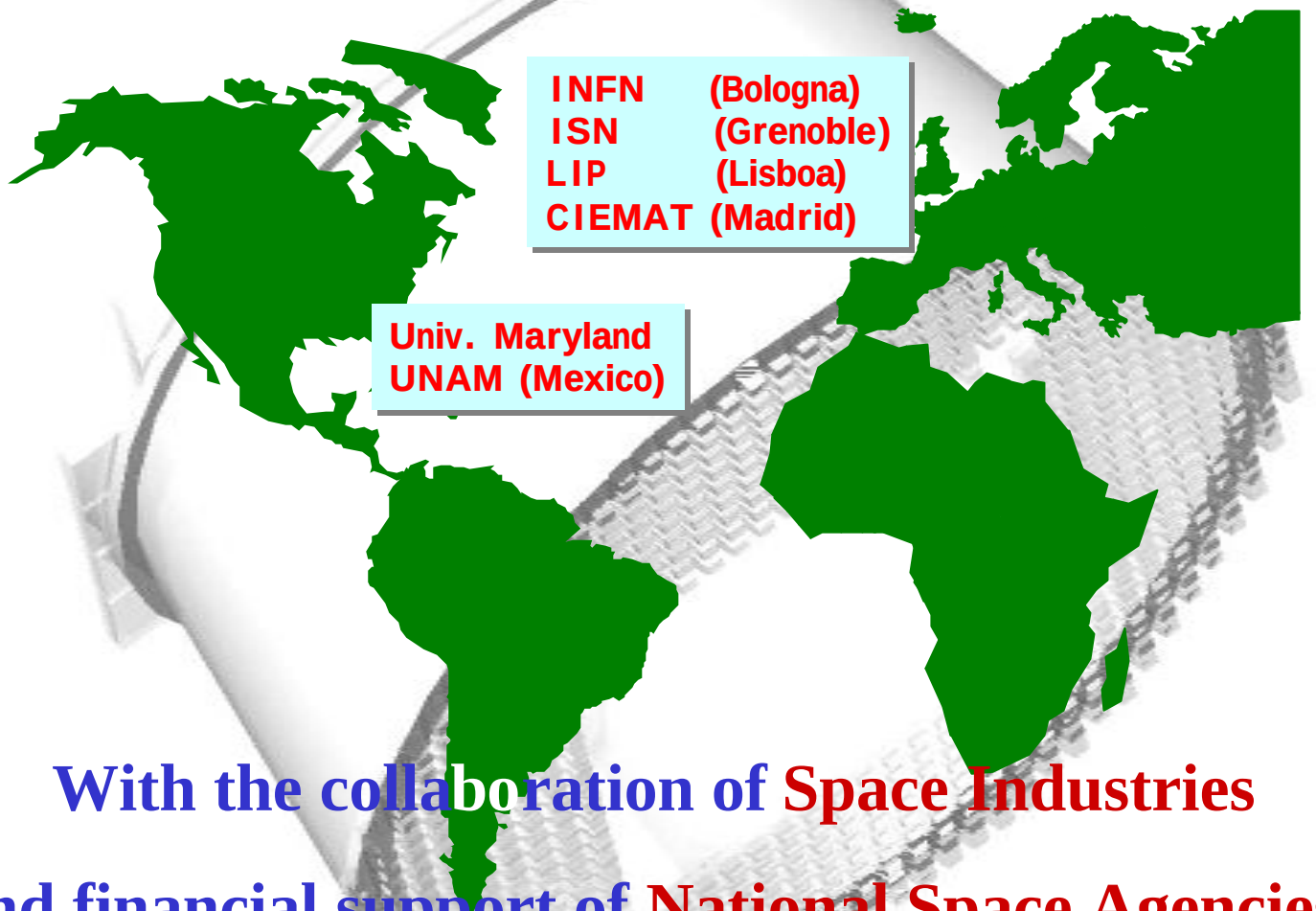
RICH detectors have already been flown in balloons, never in space

Physics Goals

With a large acceptance Ring Imaging Cerenkov Counter (RICH) AMS will perform precise mass measurements over an extended energy range, allowing light isotope identification up to O(10GeV/n)

This measurements will constraint the models for Galactic Cosmic Ray Propagation

The AMS/RICH Collaboration

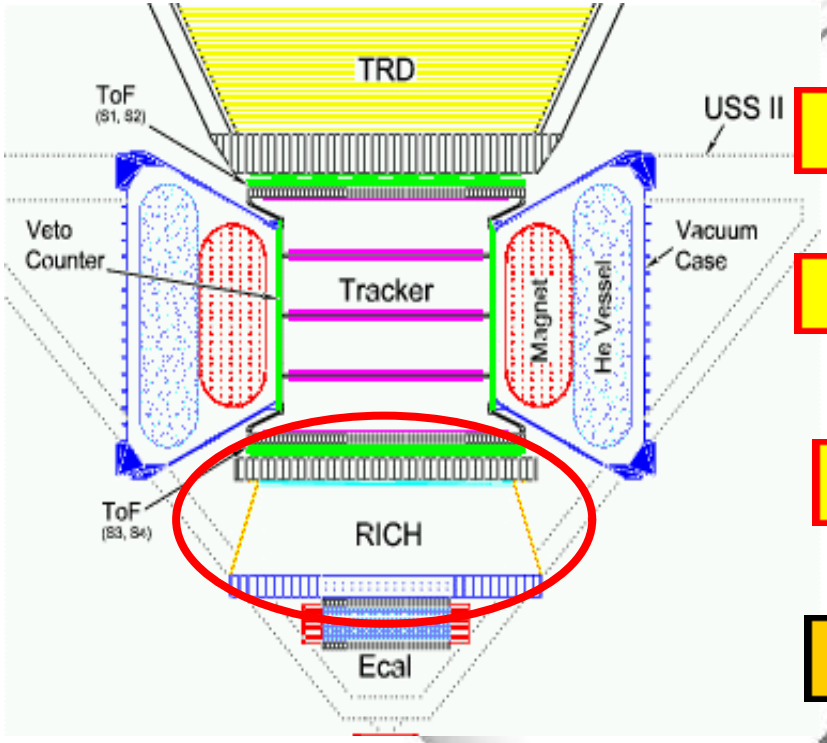


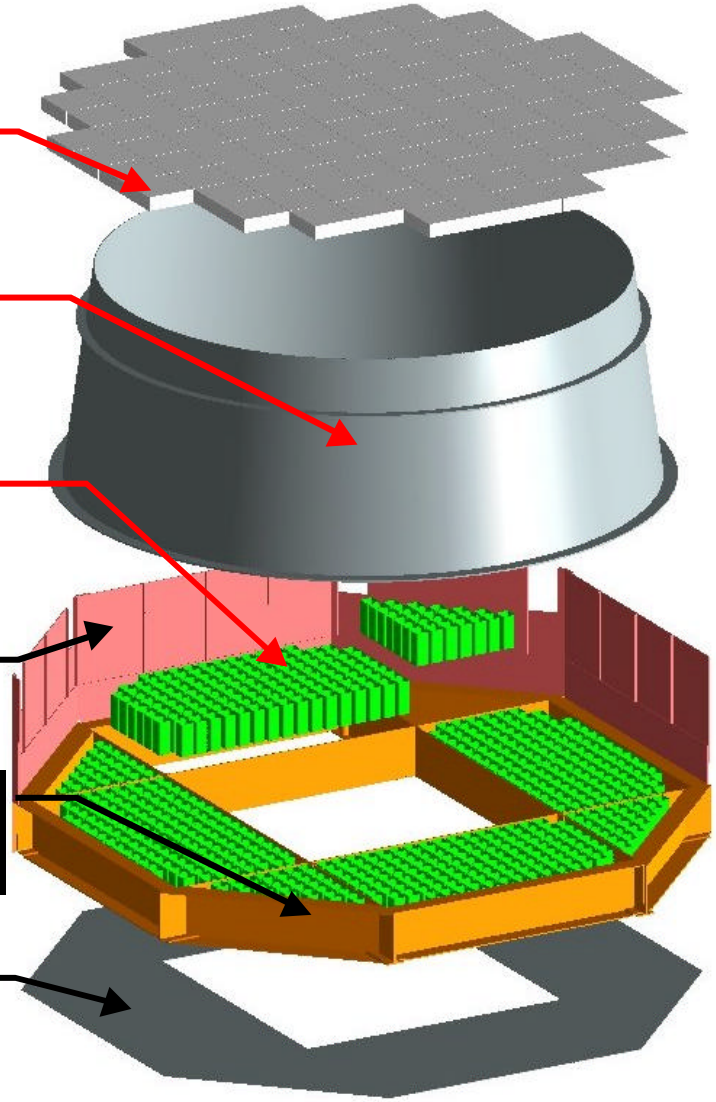
With the collaboration of Space Industries

and financial support of National Space Agencies

J. Casaus, May 16th 2002, Elba

Detector Description





WEIGHT 184 KG

POWER 110 W

Radiator

Baseline:

3 cm Silica Aerogel from Matsushita Electric Works (n=1.05)

11.3 x 11.3 x 1 cm tiles

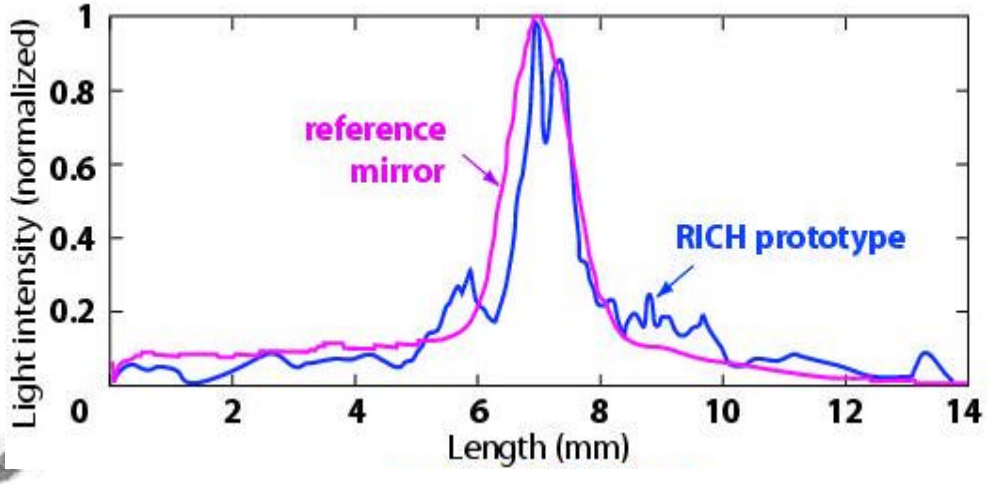
Options:

- **3 cm Matsushita Aerogel (n=1.03)**
- **Complement dynamic range with NaF (n=1.33)**

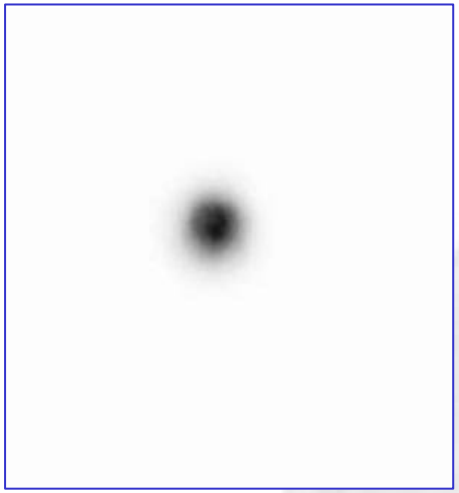
Reflector

Multilayer Structure deposited on a Carbon Fiber Reinforced Composite (CFRC) Substrate

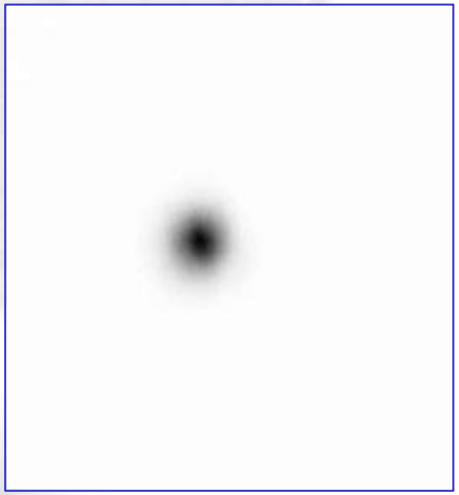
- Al_2O_3/TiO_3 (1 mm)
- Epoxy resin (400 mm)
- Gold (0.2 mm)
- Chromium (150 mm)
- Aluminum (0.1 mm)
- Quartz (0.1 mm)



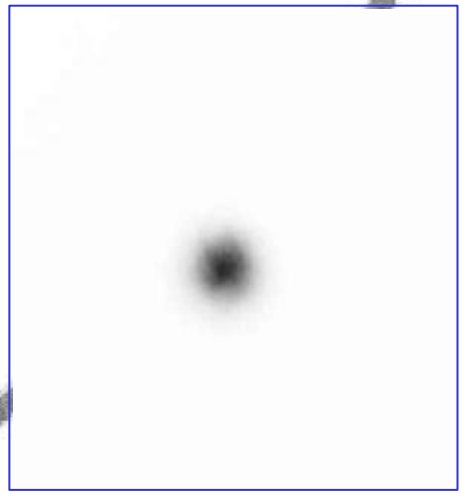
Reflector Tests



Measurement point 1

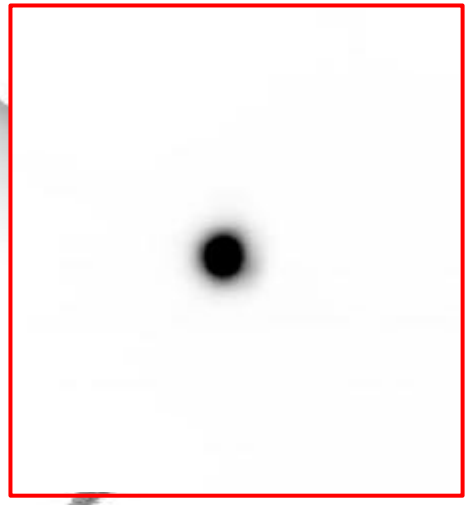


Measurement point 2



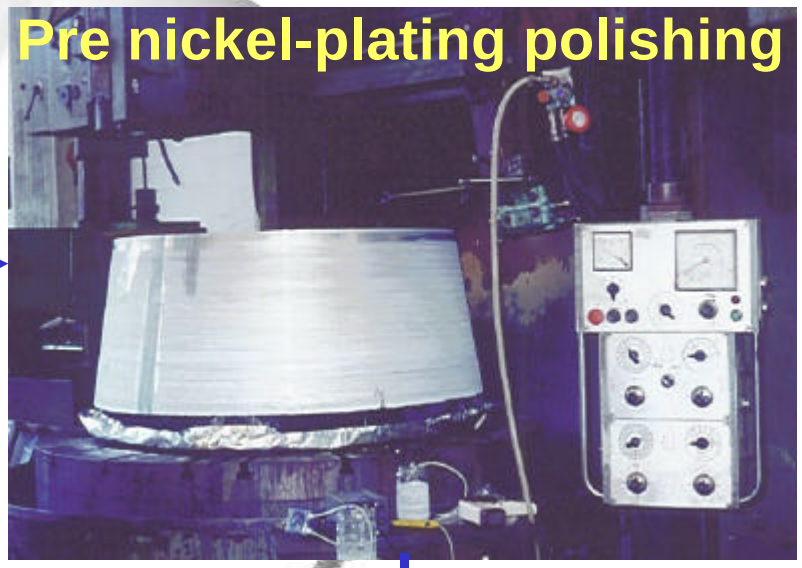
Measurement point 3

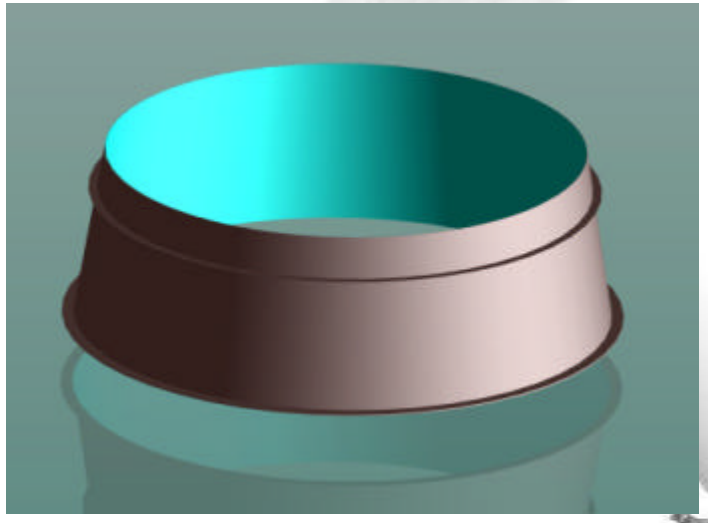
Reference mirror (roughness = 2 A RMS)



CMA sample
Æ = 150 mm

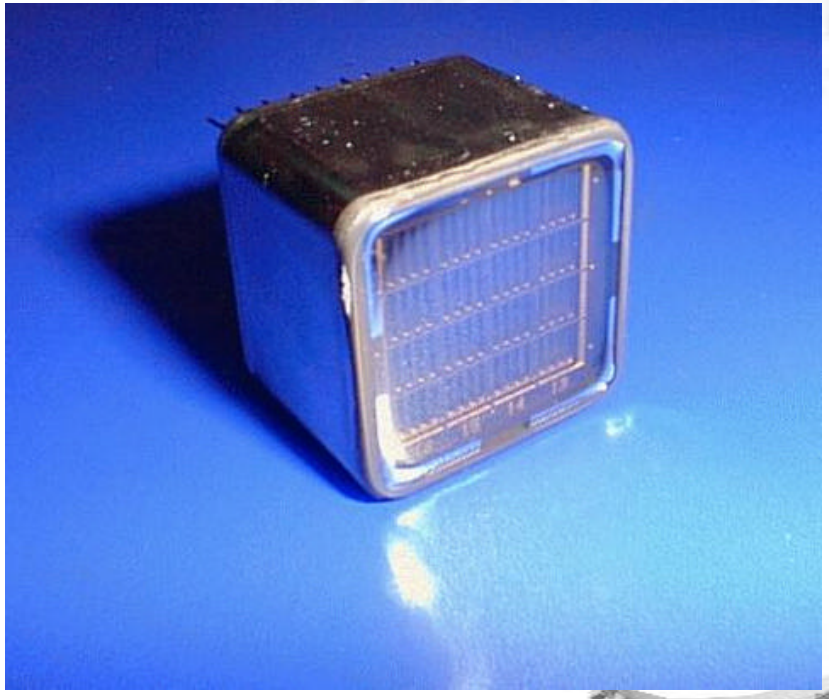
Mandrel Manufacturing

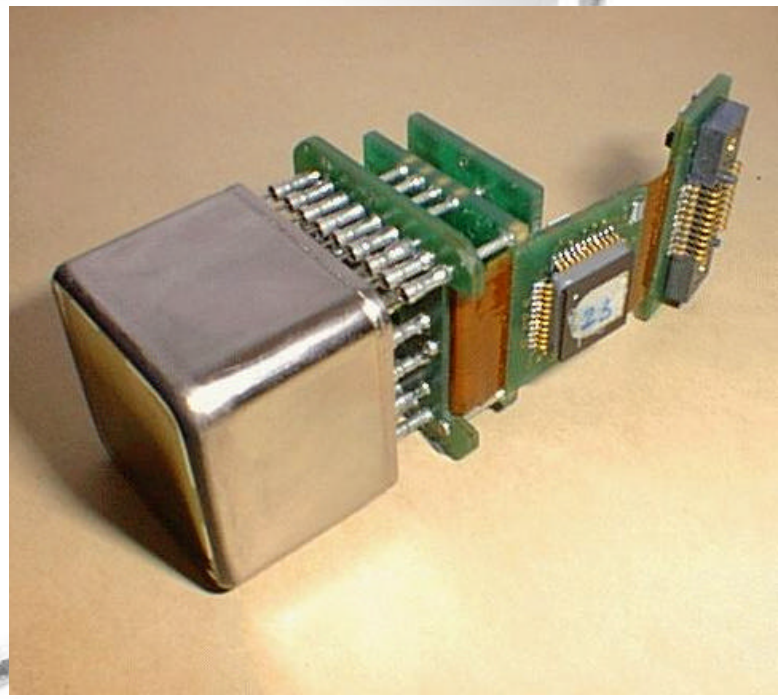




Detection System

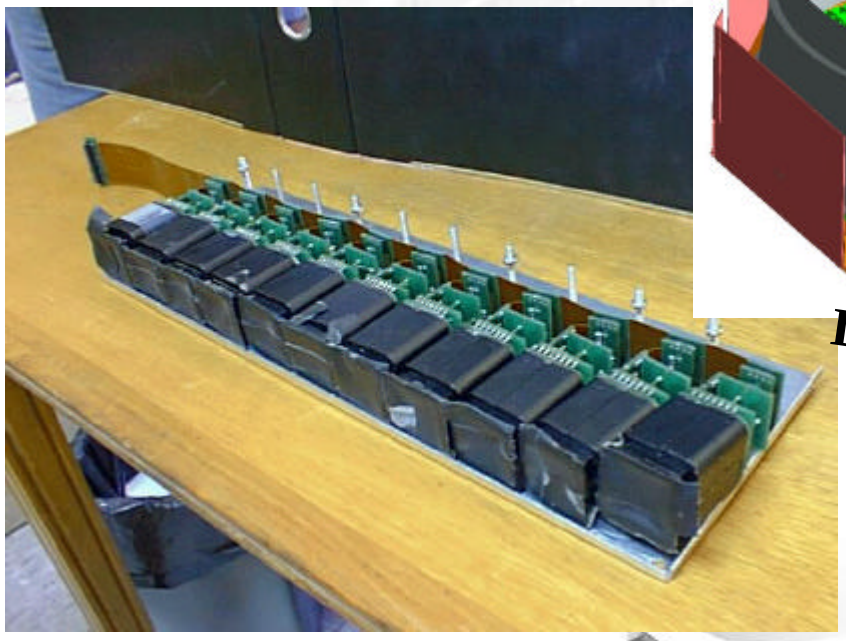
- **680 PMT Hamamatsu R7900-M16 (multianode 4x4)**
- **Gain ~10^6 @ 800 V**
- **FE Electronics (3 mini PCB: Signal, HV Divider & Connection)**
- **FE Chip (2 Gains) Å 12 bit ADC (AD7476)**

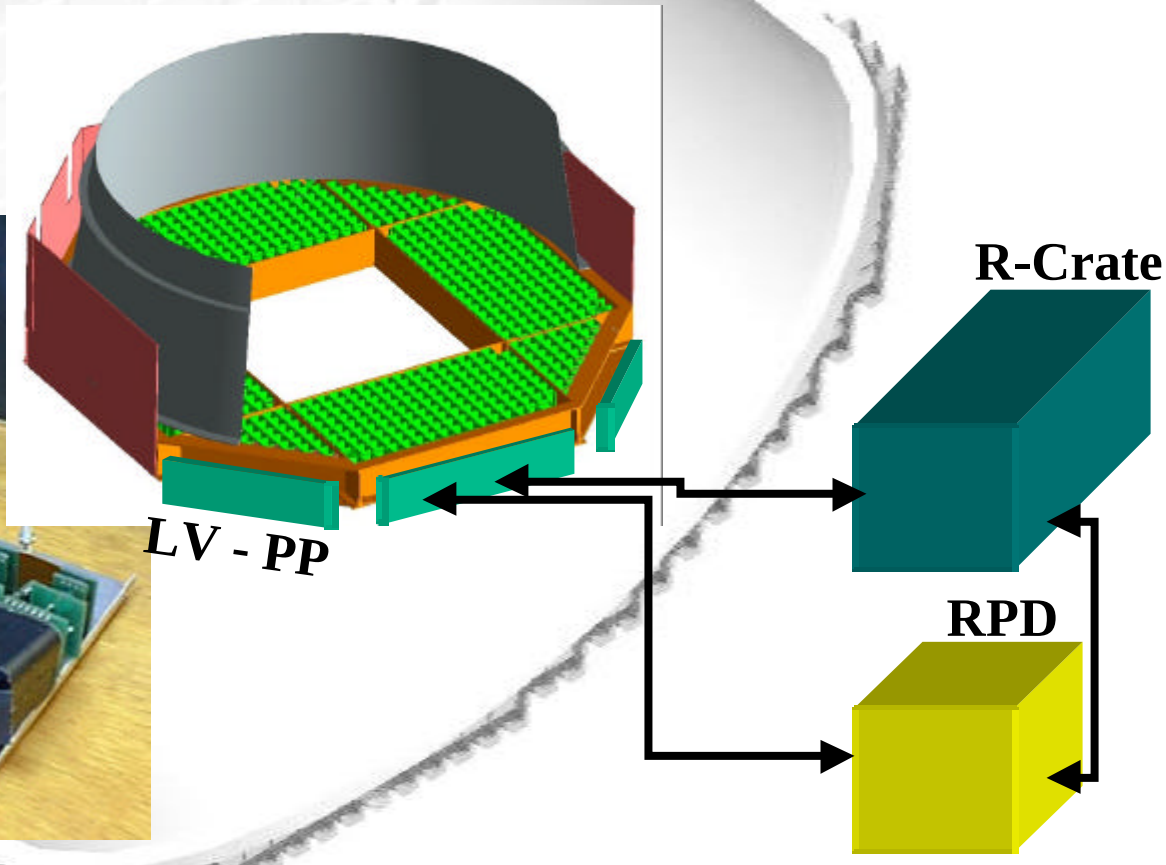




Read-out Overview

PMT raw read through flat kapton cable
sent to the RICH DAQ Electronics for data reduction

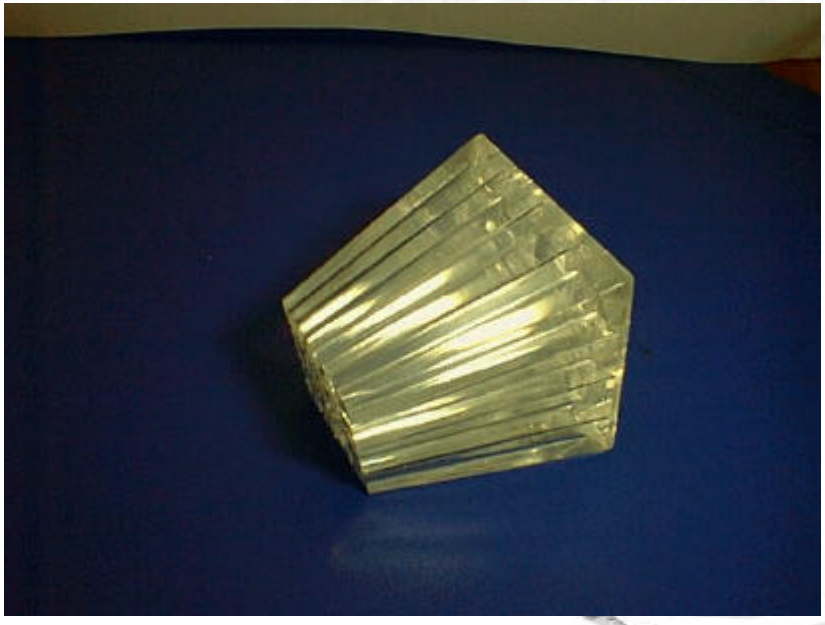




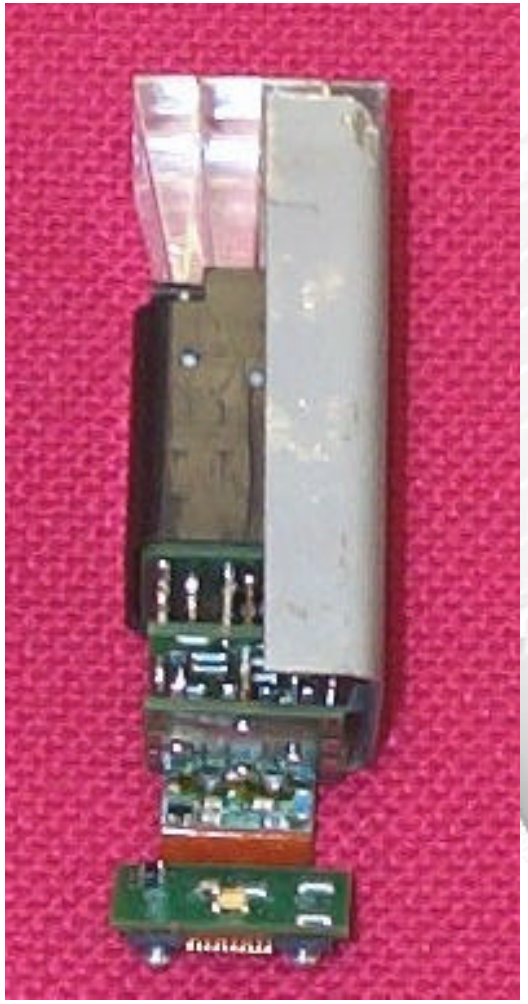
Light Guide

Acrylic Plastic free of UV absorbing additives

Kevlar wire fixation



PMT Assembly



Light guide

Kevlar wire

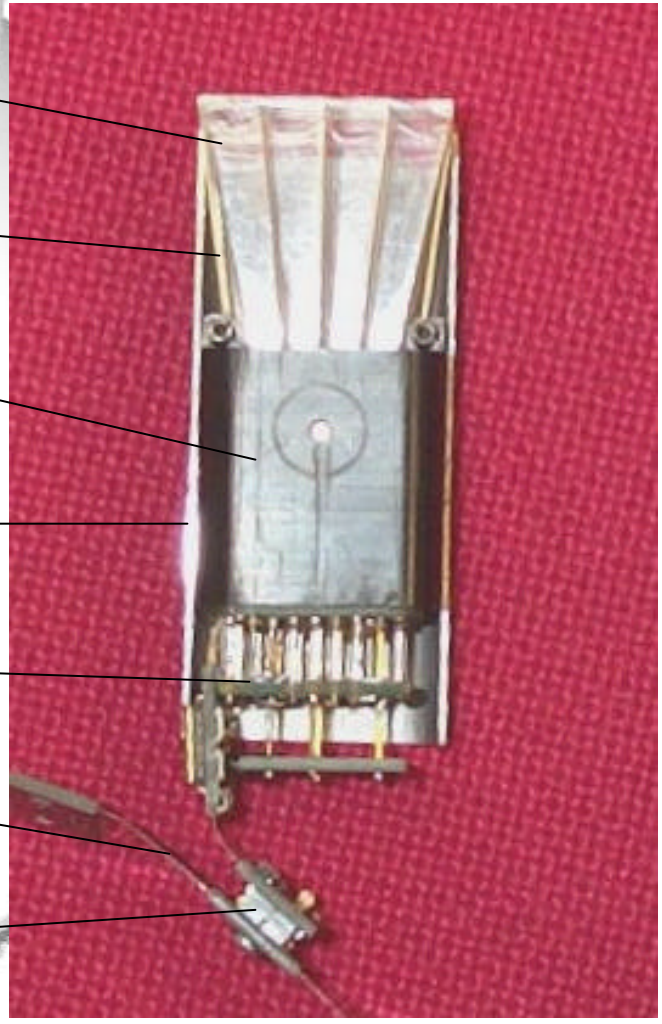
Housing

Shielding

Electronics

Kapton flex

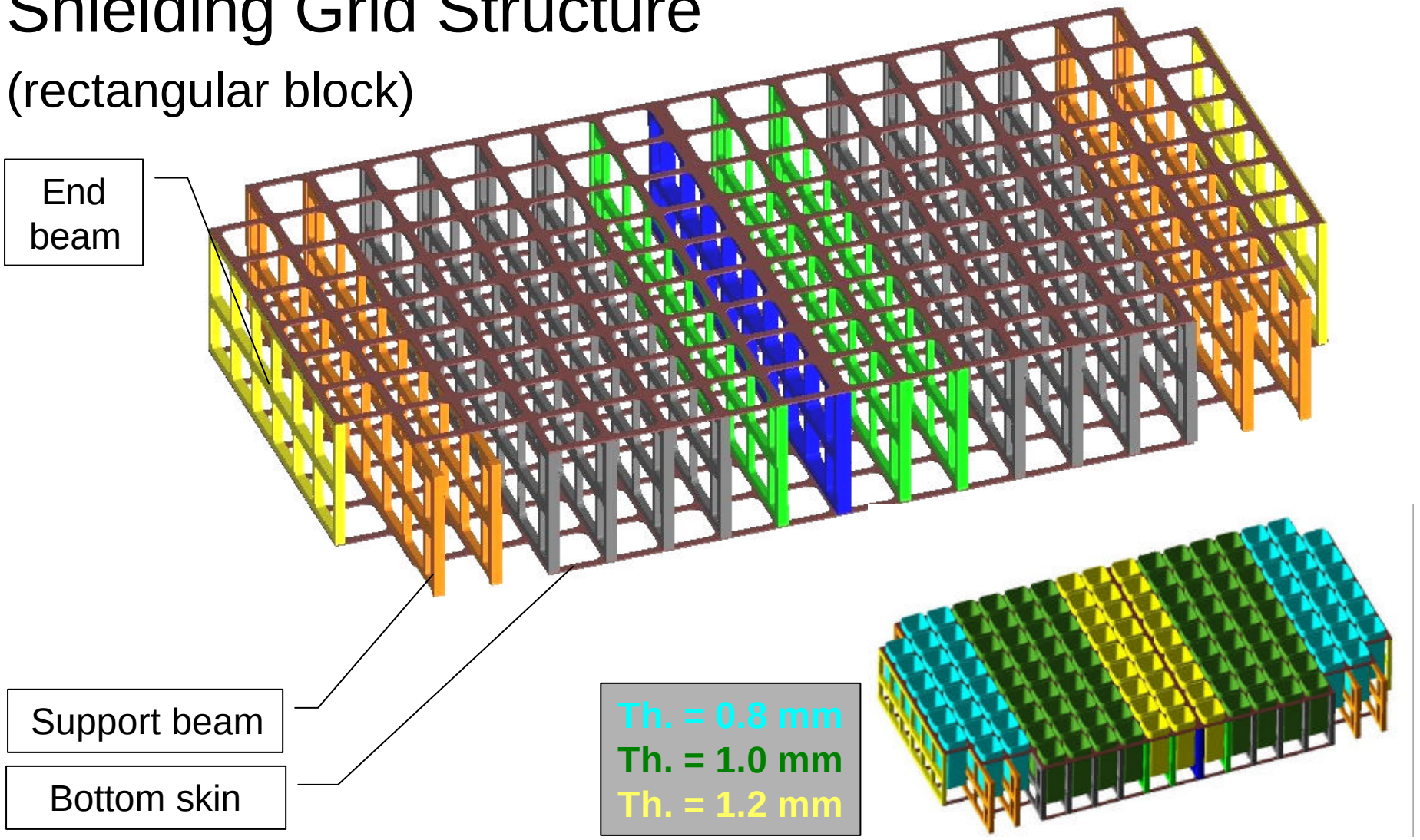
Connector



RICH mechanics

Shielding Grid Structure

(rectangular block)



Expected Performances

The RICH will provide AMS with

- **precise measurement of charged particle velocity**

$$\sigma(\beta)/\beta \approx 0.1\% \ @ \ \beta = 1 \ \text{(protons)}$$

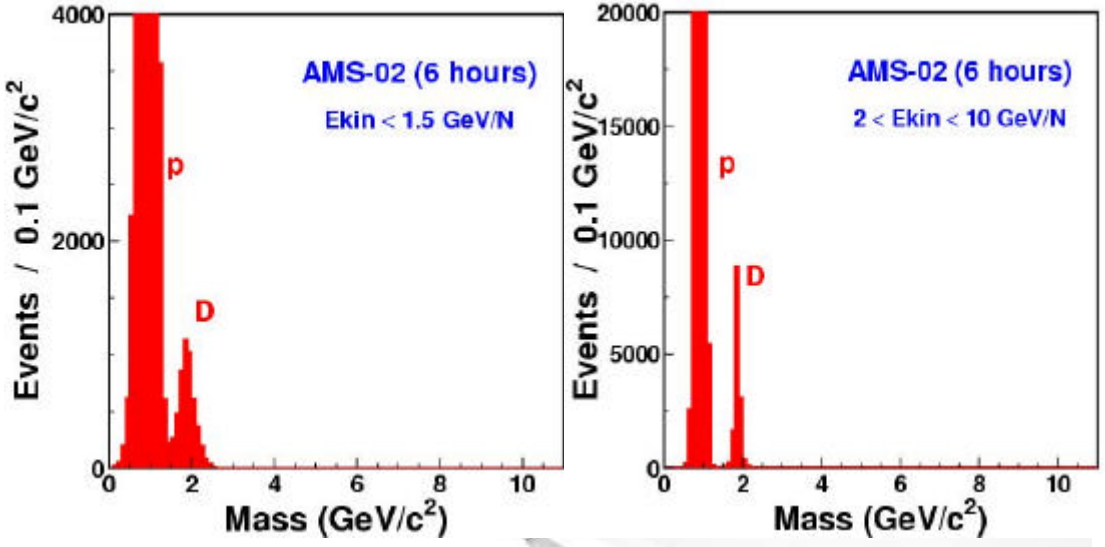
- **charge identification**

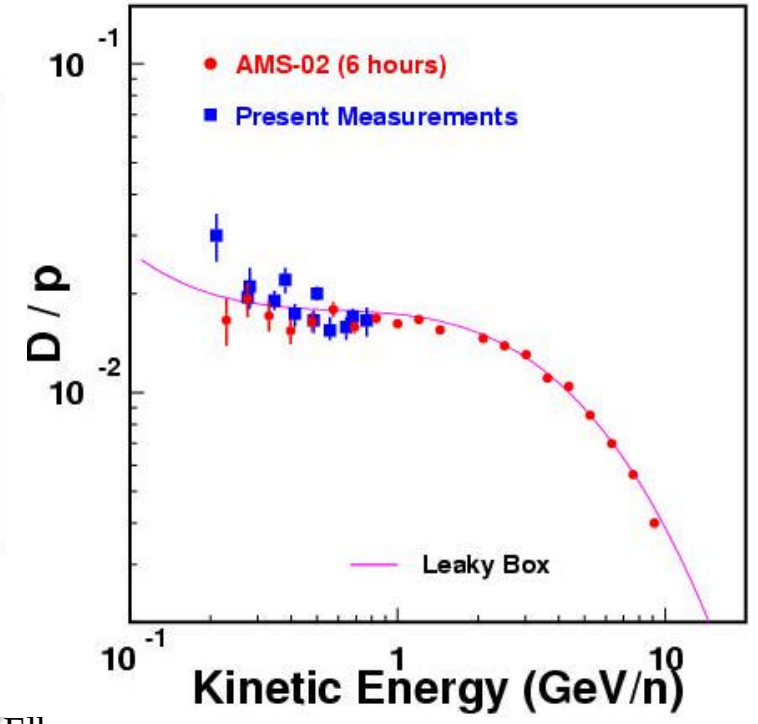
$$Z \ \text{Confusion} \lesssim 10\% \ \text{for} \ Z \lesssim 26$$

Light Isotopes (1/3)

AMS will identify D up to 10 GeV/n

after 3 years will collect »10^8 D

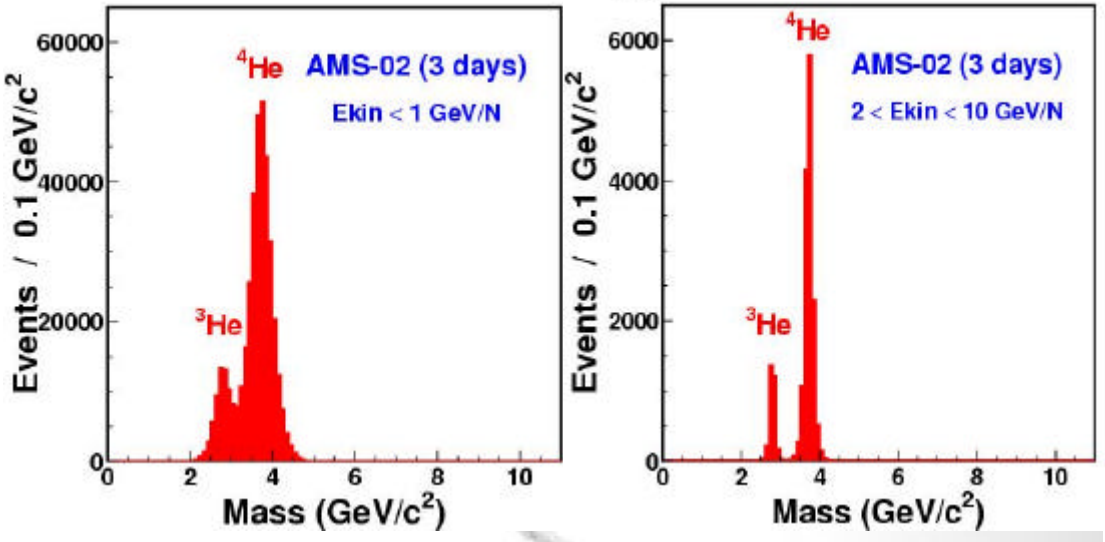


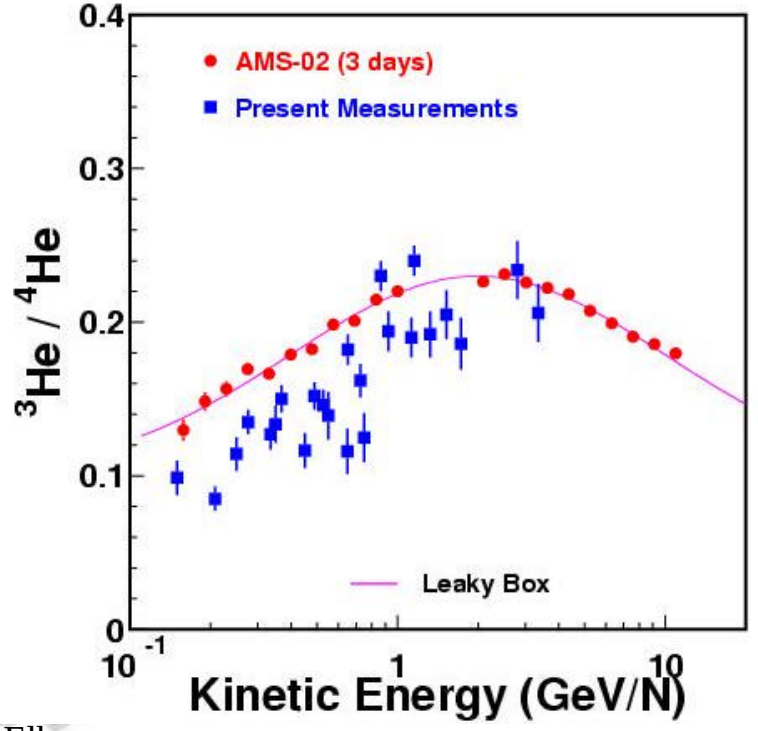


Light Isotopes (2/3)

AMS will identify ^{3}He up to 10 GeV/n

after 3 years will collect »10^8 ^{3}He



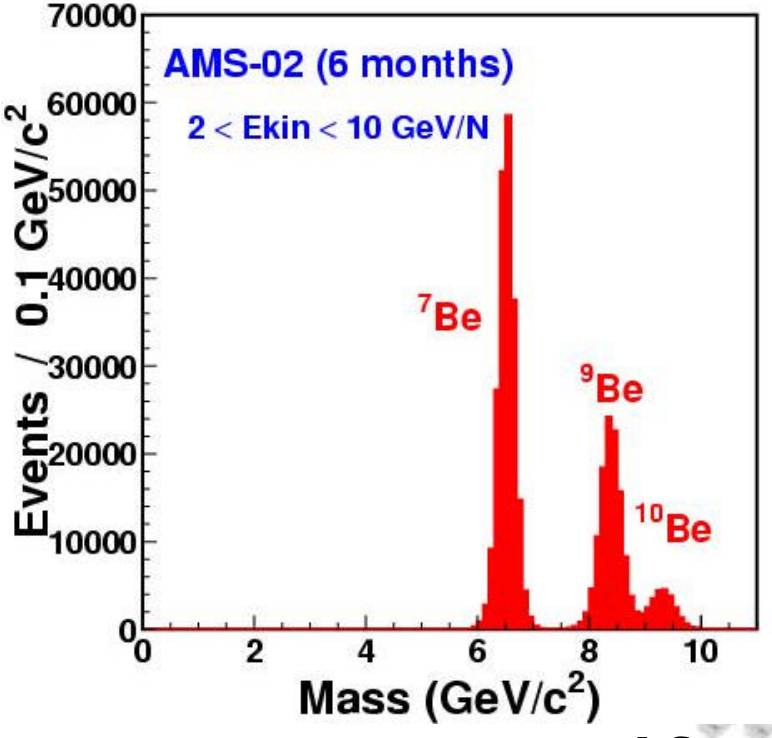


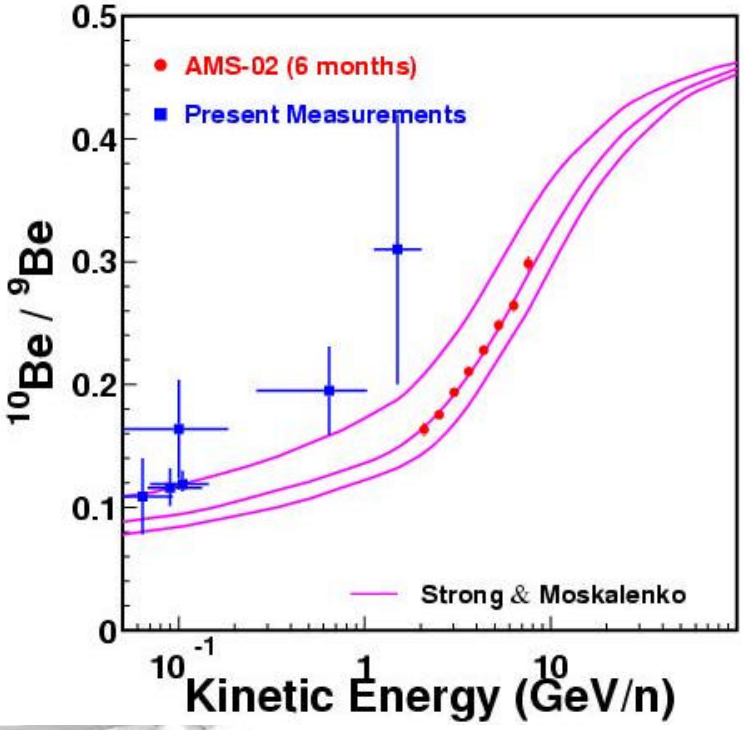
Light Isotopes (3/3)

AMS will separate ^{10}Be from ^{9}Be for

2 GeV/n < E < 10 GeV/n

after 3 years will collect »10^5 ^{10}Be





RICH Prototype

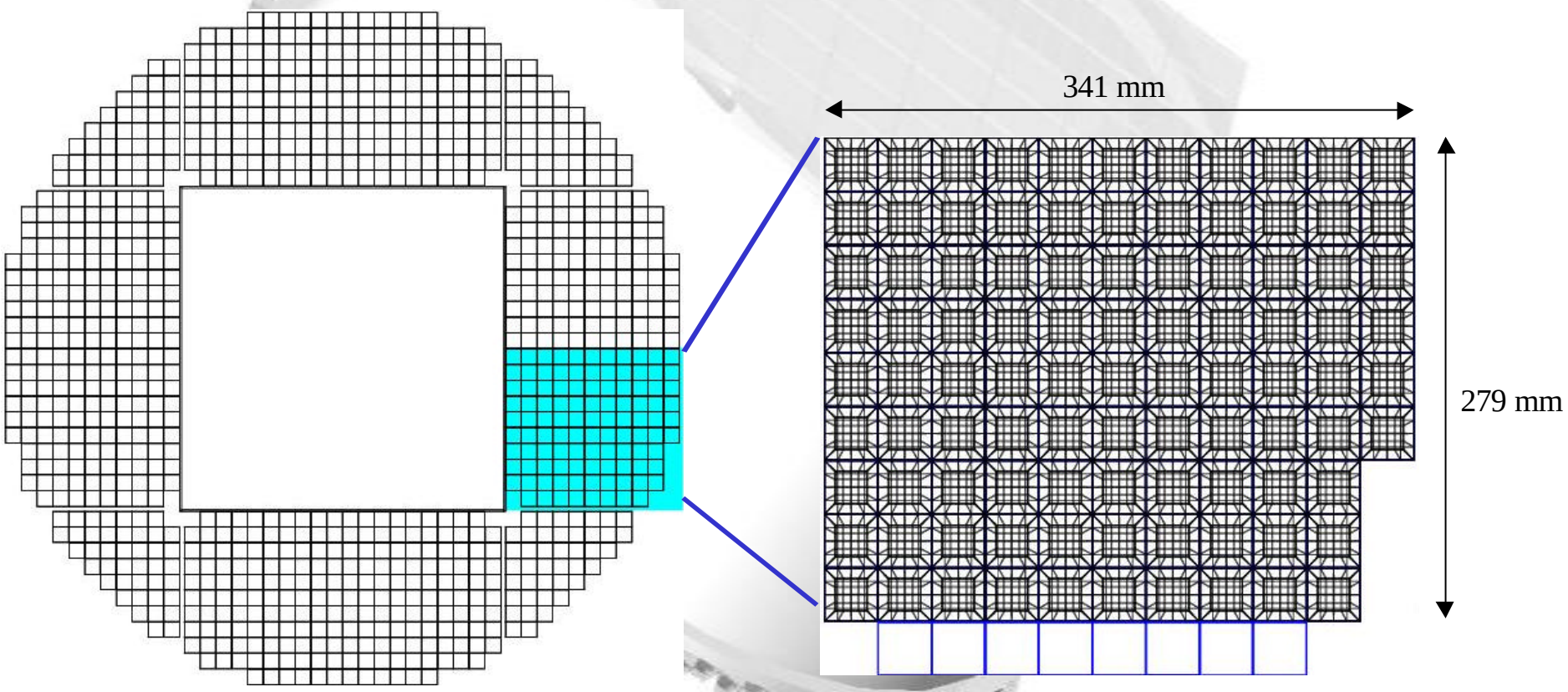
In order to test the expected performances a prototype has been built including

- **Significant amount of final PMT**
- **LG Prototypes**
- **Final FE Electronics design**
- **DAQ & Data Reduction prototype**
- **Different radiator materials**

cosmic runs have just started !

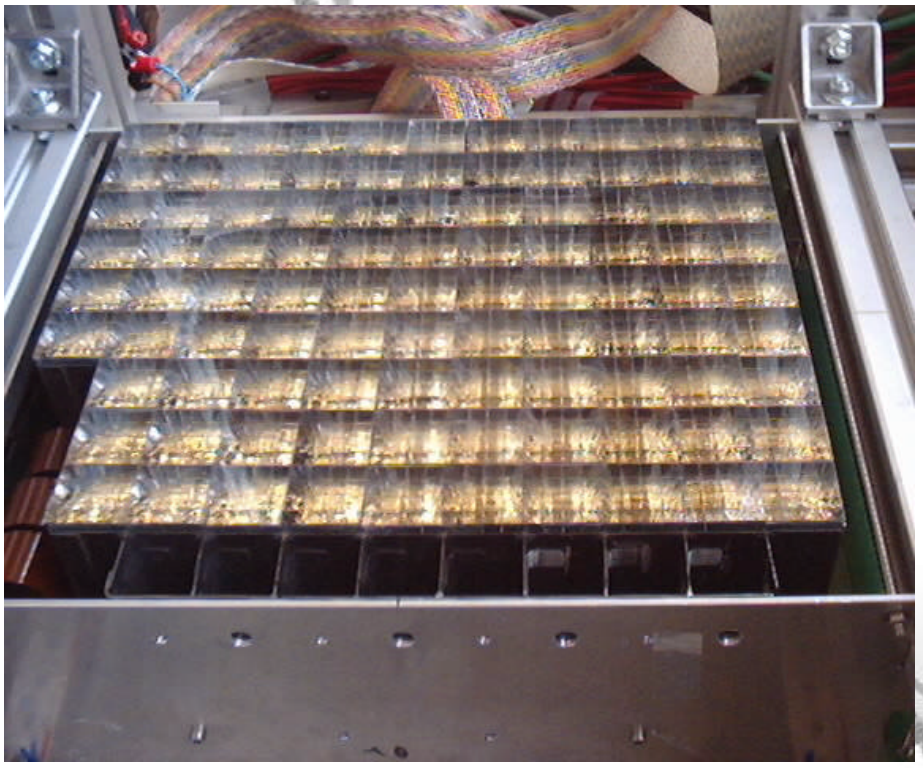
RICH Prototype

96 PMT with a pitch of 31mm



Prototype Assembly

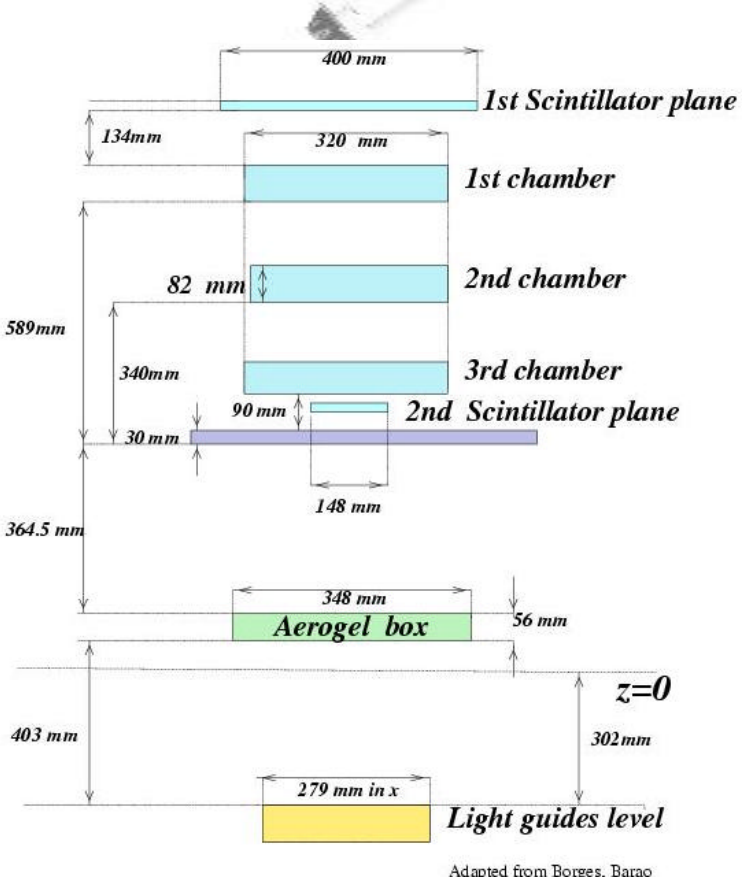
PMT + FE Electronics + LG arrangement

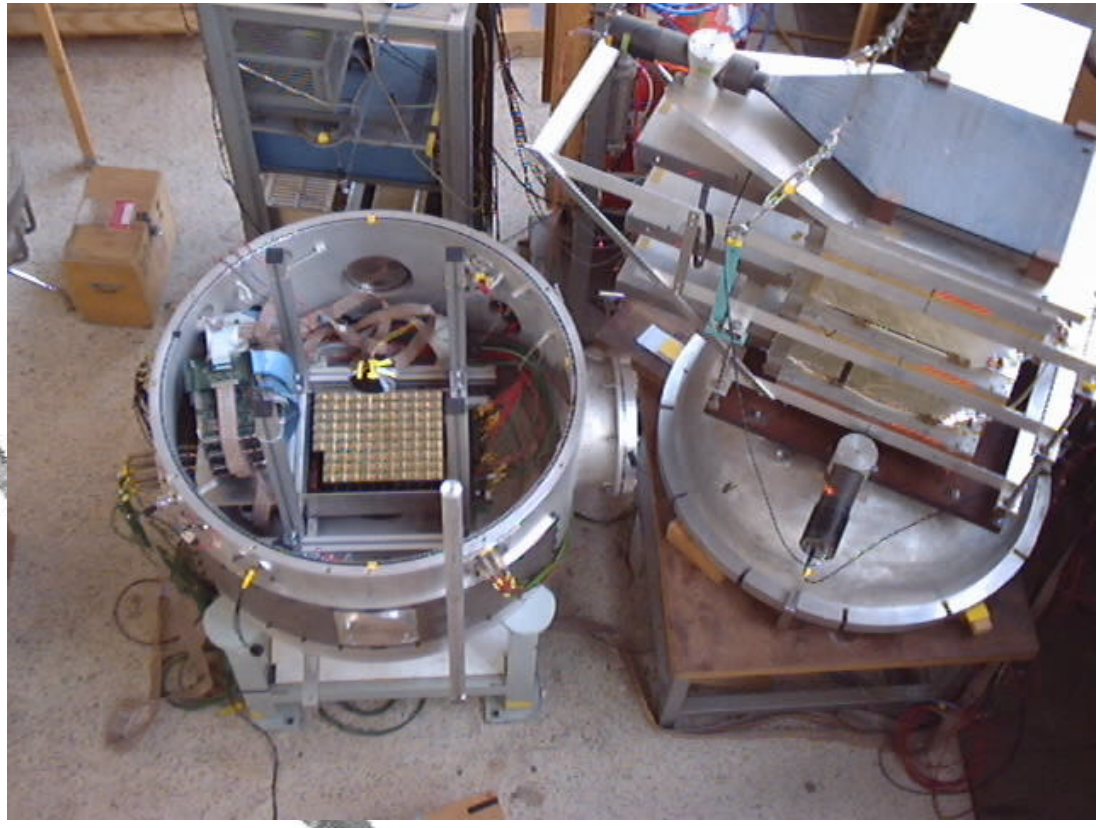


Radiator handling

Prototype Layout

Complemented with scintillator planes for triggering and MWPC for tracking

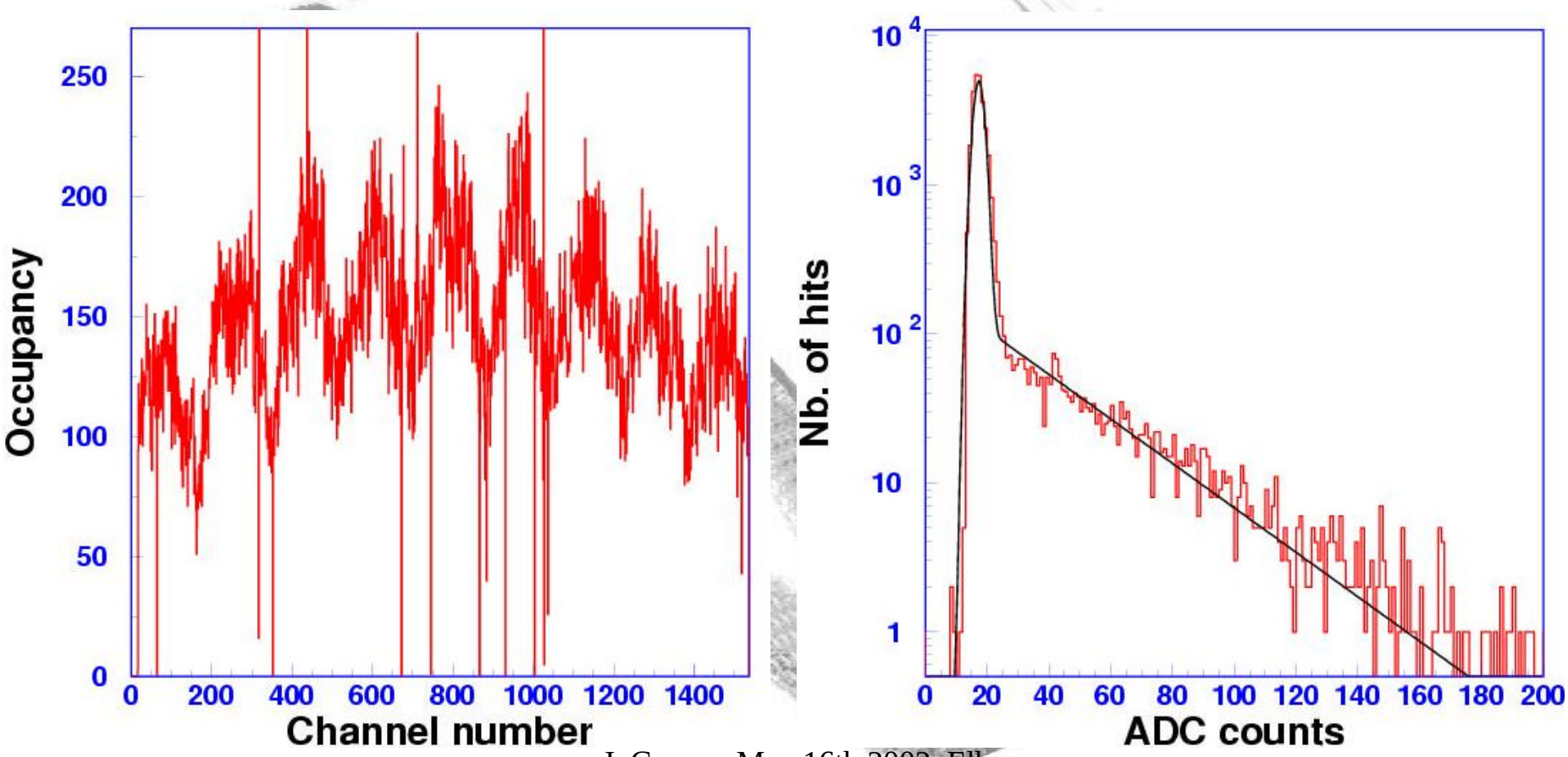




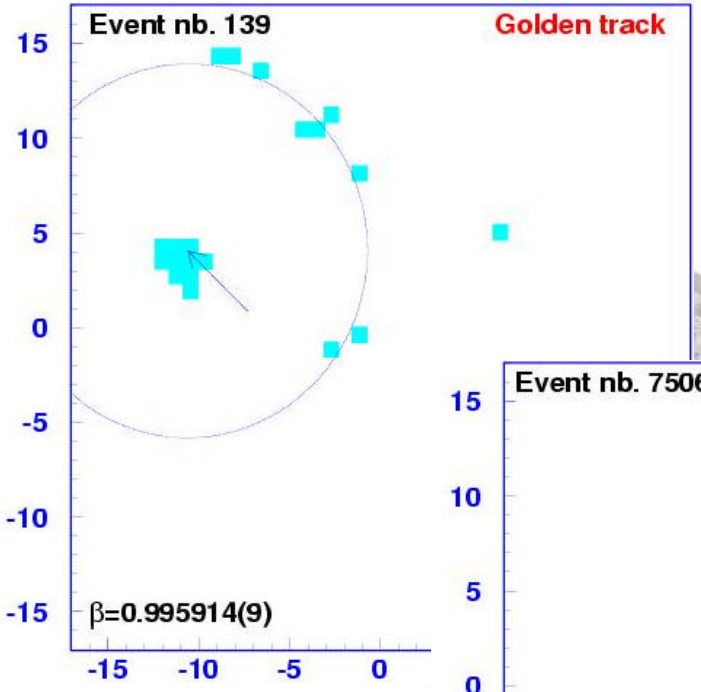
J. Casaus, May 16th 2002, Elba

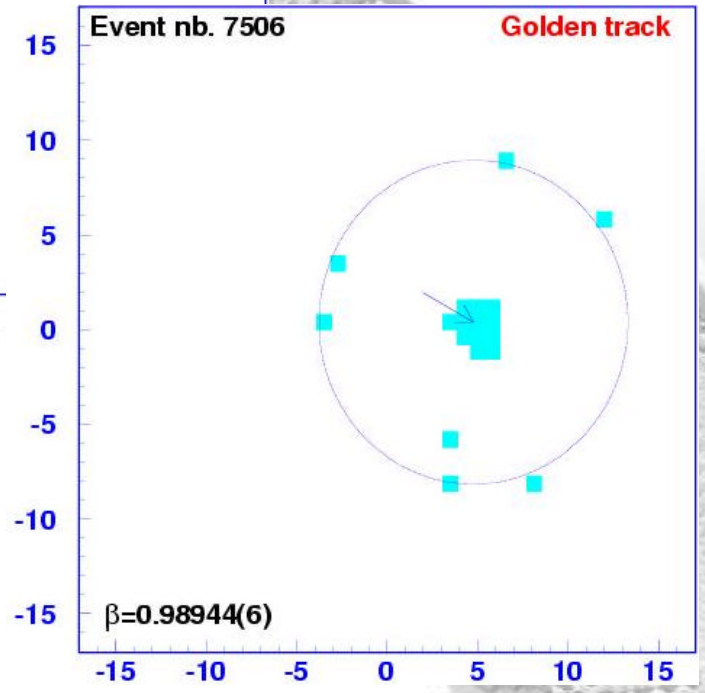
Prototype Performances

- 1% bad channels
- El. noise & PMT DC according to the expectations

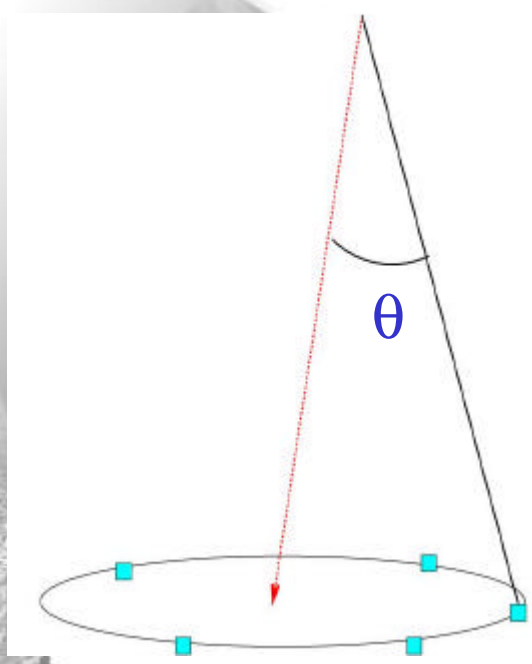


Cerenkov Rings

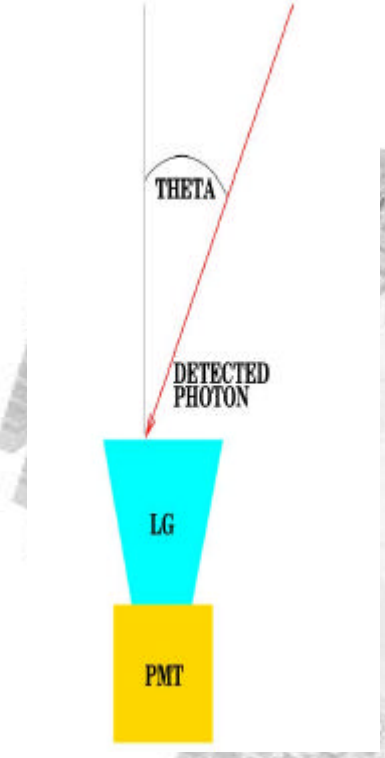


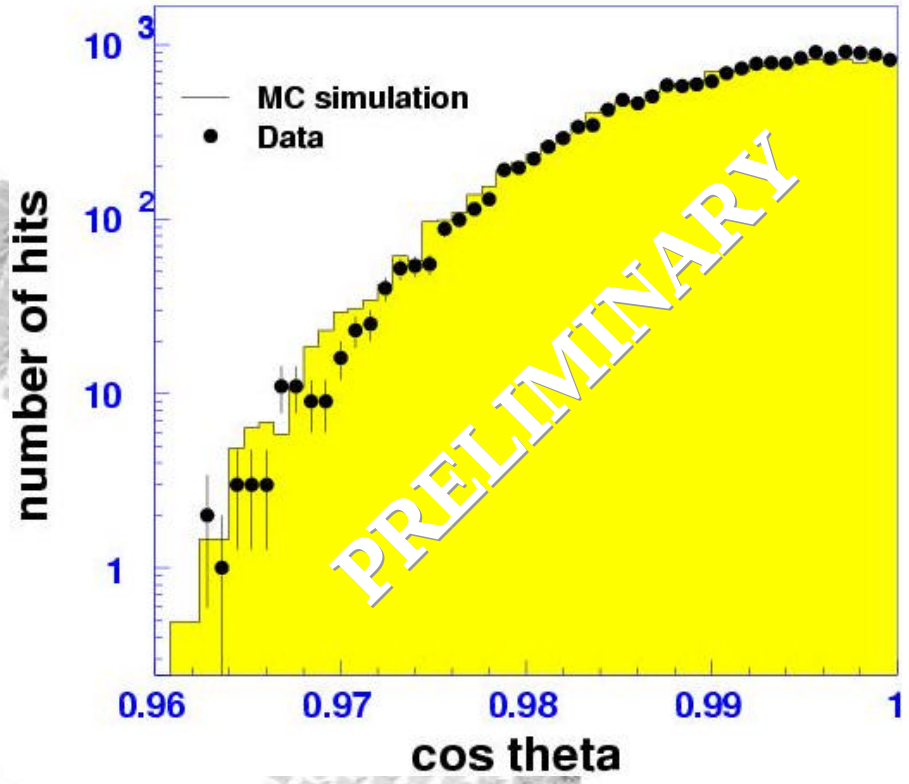


From the track parameters and the detected hit positions the Cerenkov angle is determined



LG Efficiency



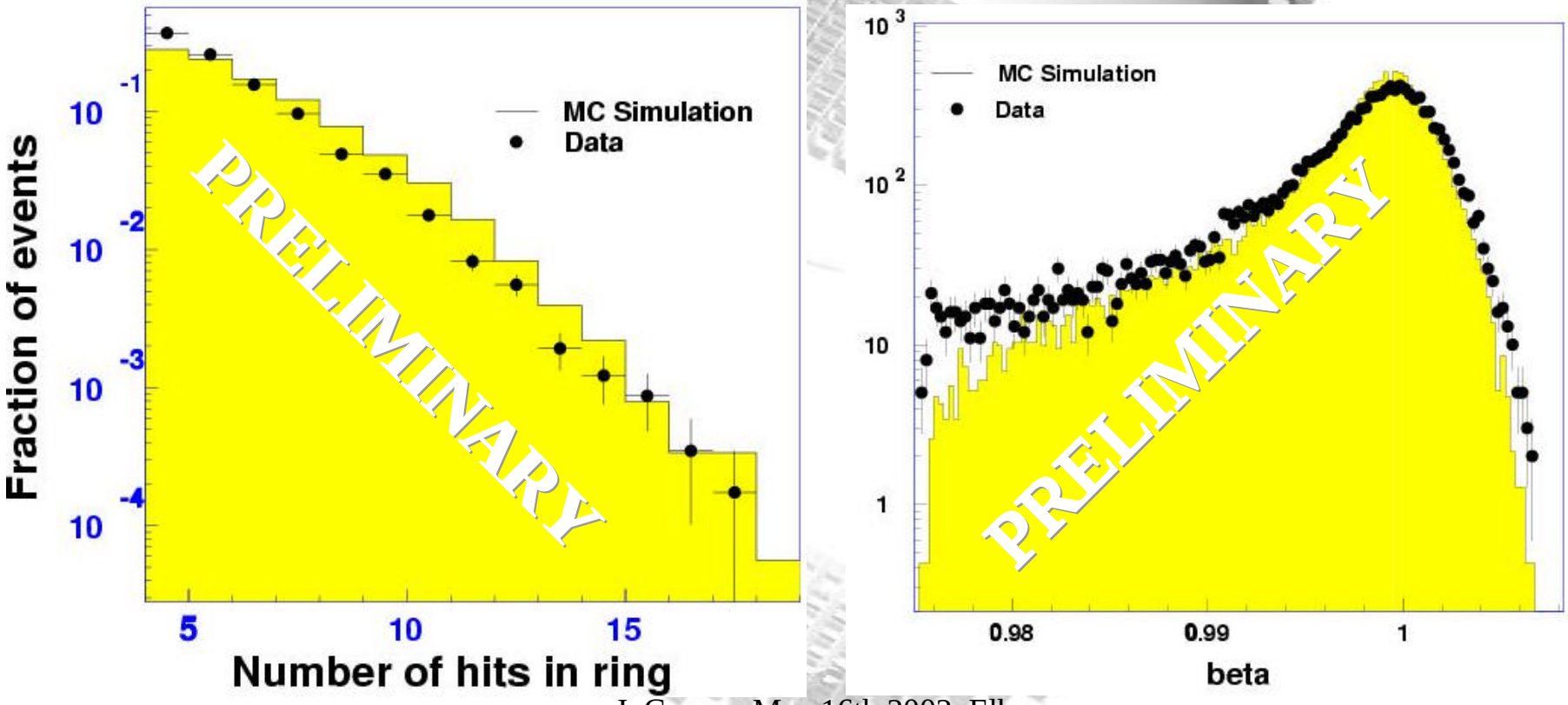


The light guide angular response agrees with the expectations

Photon Yield & b Spectrum

Radiator yield in agreement with the expectations

Estimated b-Resolution 25% worse than ideal simulation….



Prospects

- Tests with cosmics in different conditions (radiator refraction index, thickness…) will be run for two more months
- In order to have get more reliable estimations of the detector performances (Efficiency & Resolution), an ion test beam is scheduled in September/October 2002
- Pb beam (20GeV/n and 158 GeV/n) from the SPS colliding on a production target (Be)
- Fragments can be selected with a transport beam line to $\sigma(R)/R = 1.5\%$

Conclusions

- **The RICH detector will provide precise measurement of**

  particle velocity

  $$\sigma(\beta)/\beta \approx 0.1\% \text{ @ } \beta = 1 \text{ (protons)}$$

  particle charge

  $$\text{Z Confusion} \lesssim 10\% \text{ for } Z \lesssim 26$$

- **A 1/10th prototype has been built and is being tested with cosmic muons. Preliminary results look promising**
- **An ion test beam @ CERN is scheduled in September**