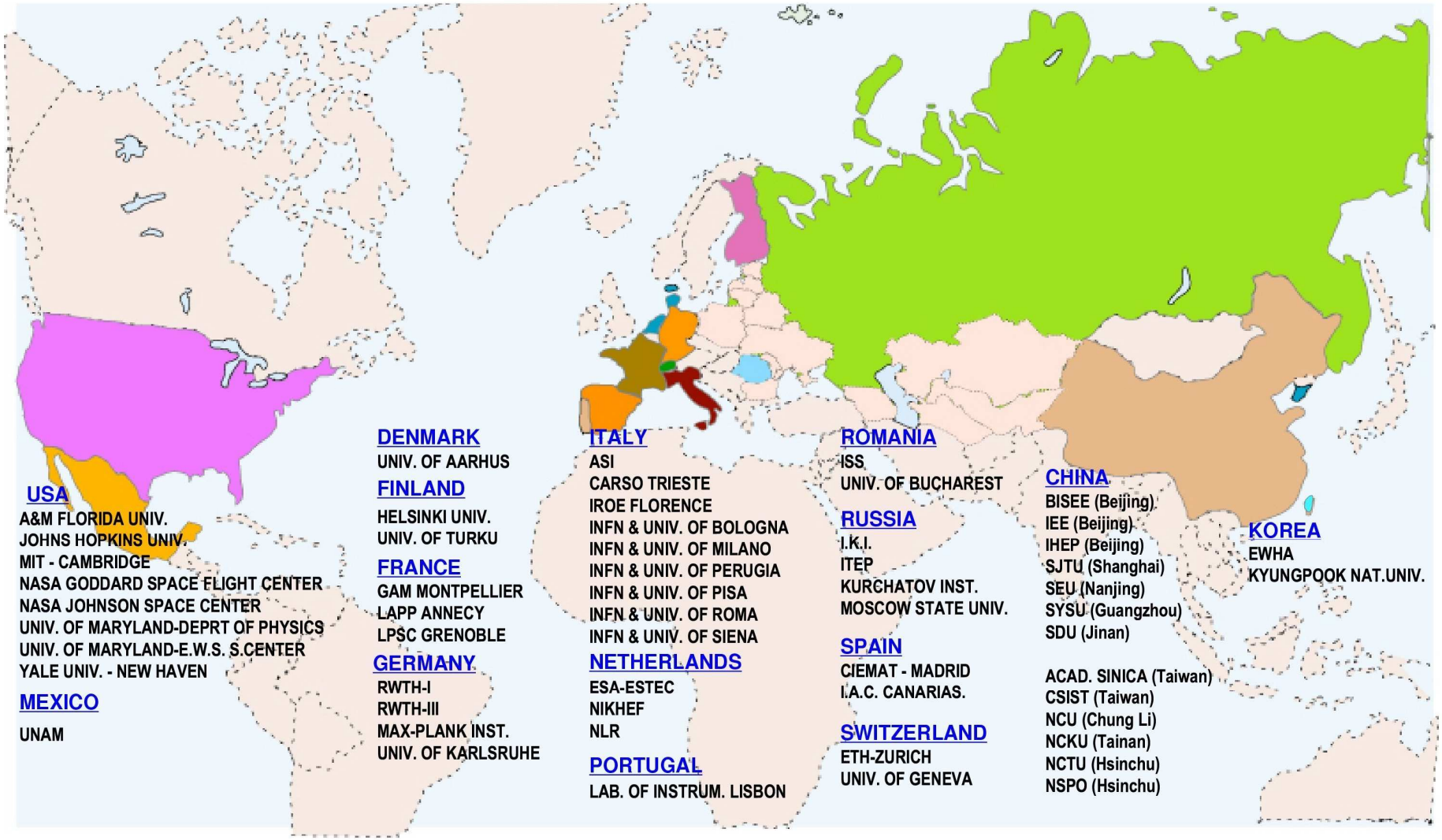
Status of AMS experiment

Divic RAPIN, *DPNC, Université de Genève*

CHIPP Meeting, PSI, october 15, 2007 *(23 vendémiaire 216)*

AMS is an International Collaboration

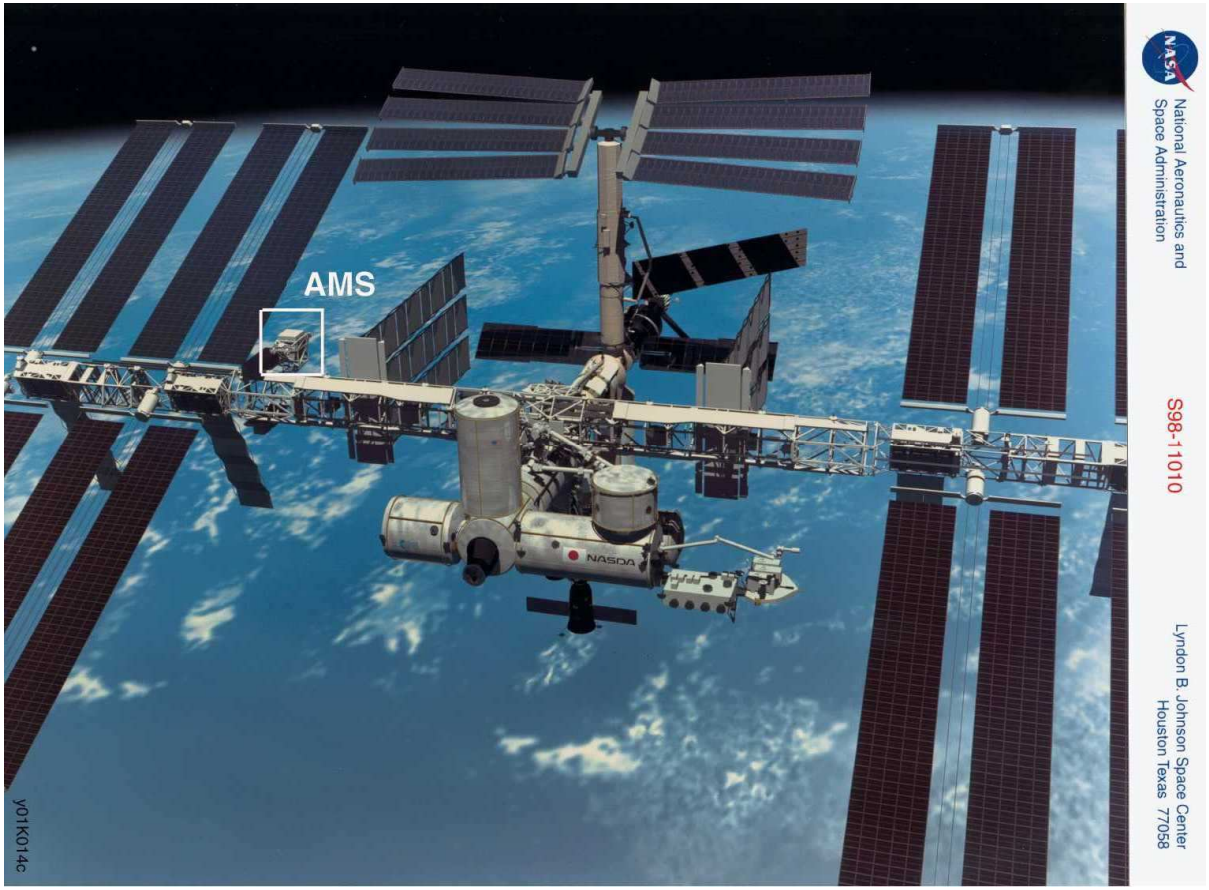


~ 500 Collaborators from 56 institutes

AMS is a magnetic spectrometer to be installed on ISS for at least 3 years for a systematic study charged and neutral cosmic rays

Physics objectives:

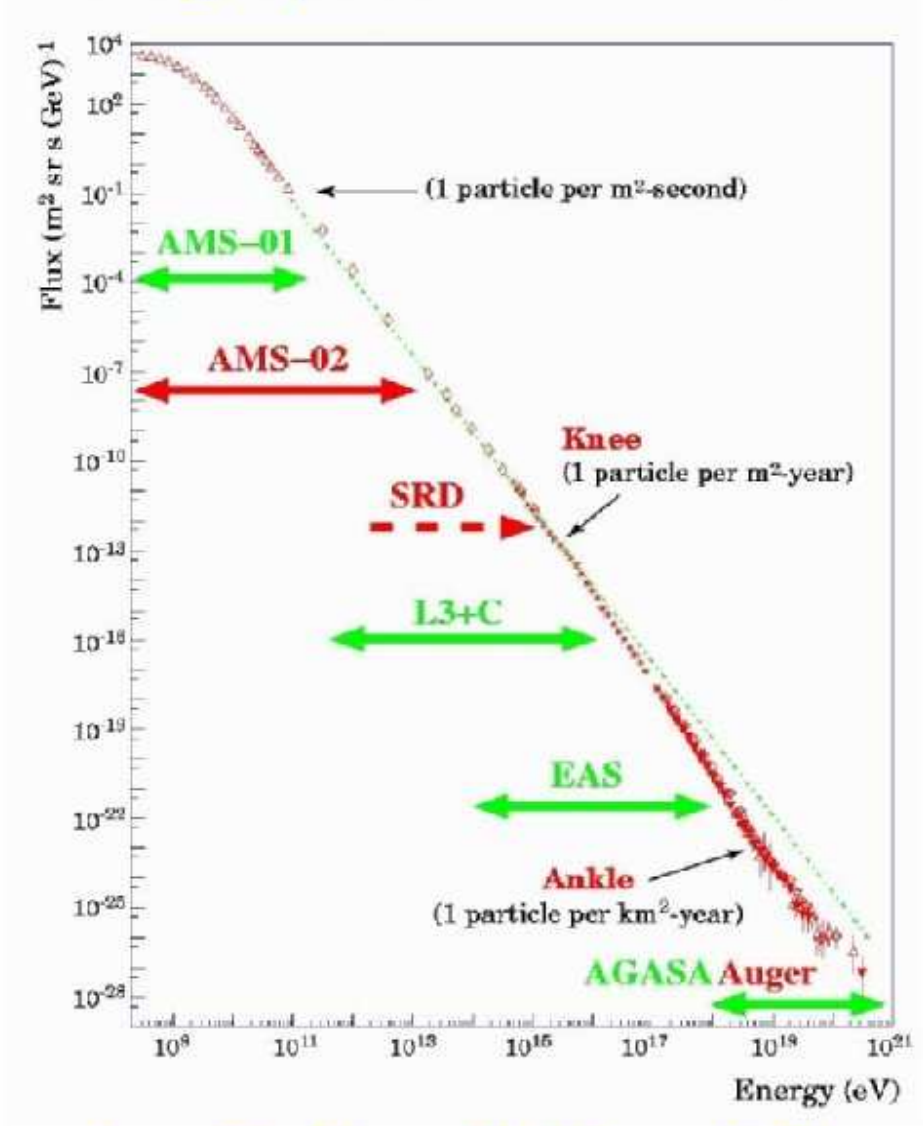
- Cosmic anti-matter search *with sensitivity ~ 10^{-9} (He)*
- Dark Matter Search *through different signatures, as anomalies in e^+, anti-p, anti-d or γ spectra.*
- Cosmic rays production and propagation mechanisms *by measurements of relative abundances of isotopes up to Fe nuclei.*
- γ ray astronomy
- Unexpected, Exotics ???



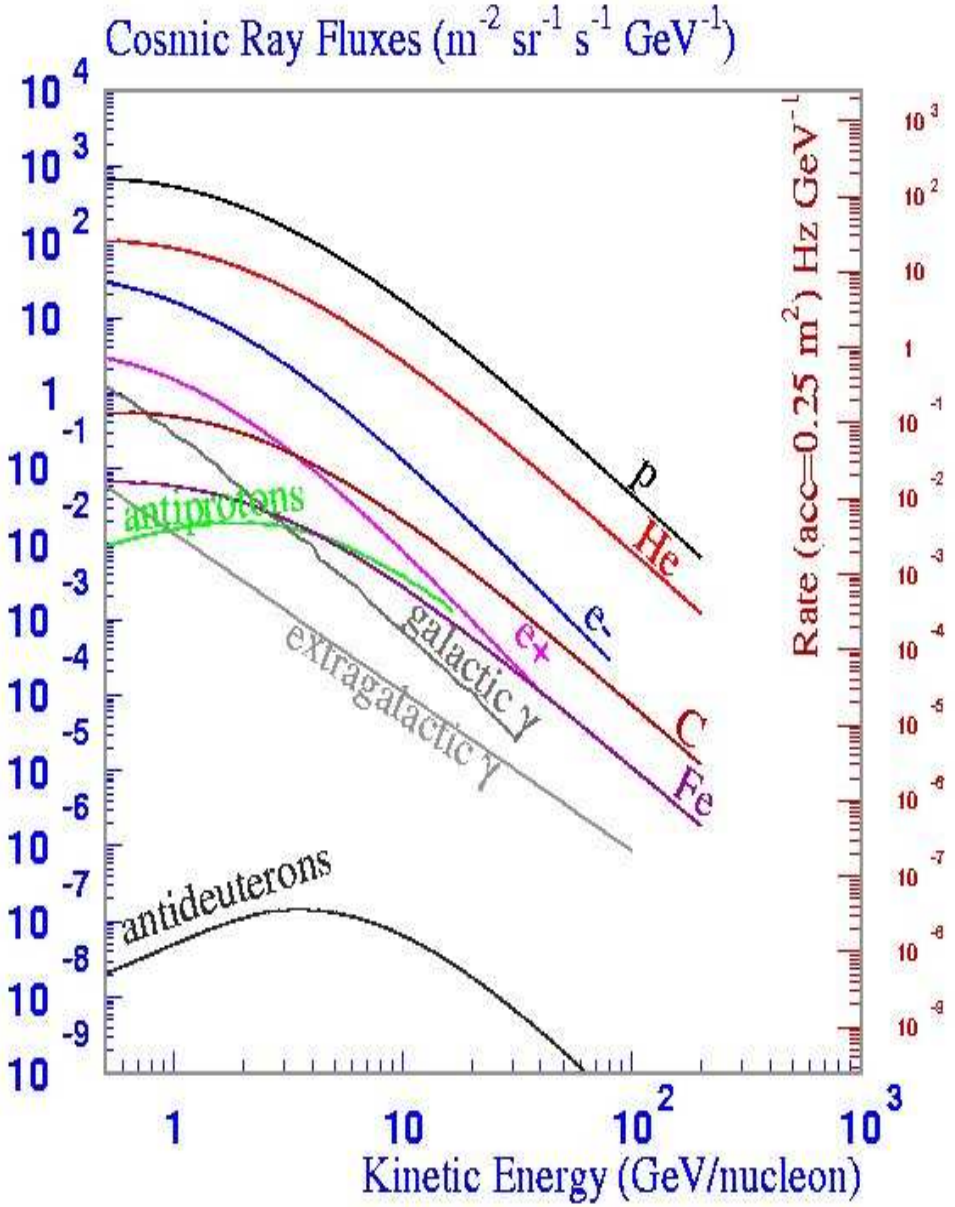
Fluxes of cosmic rays

All charged particles

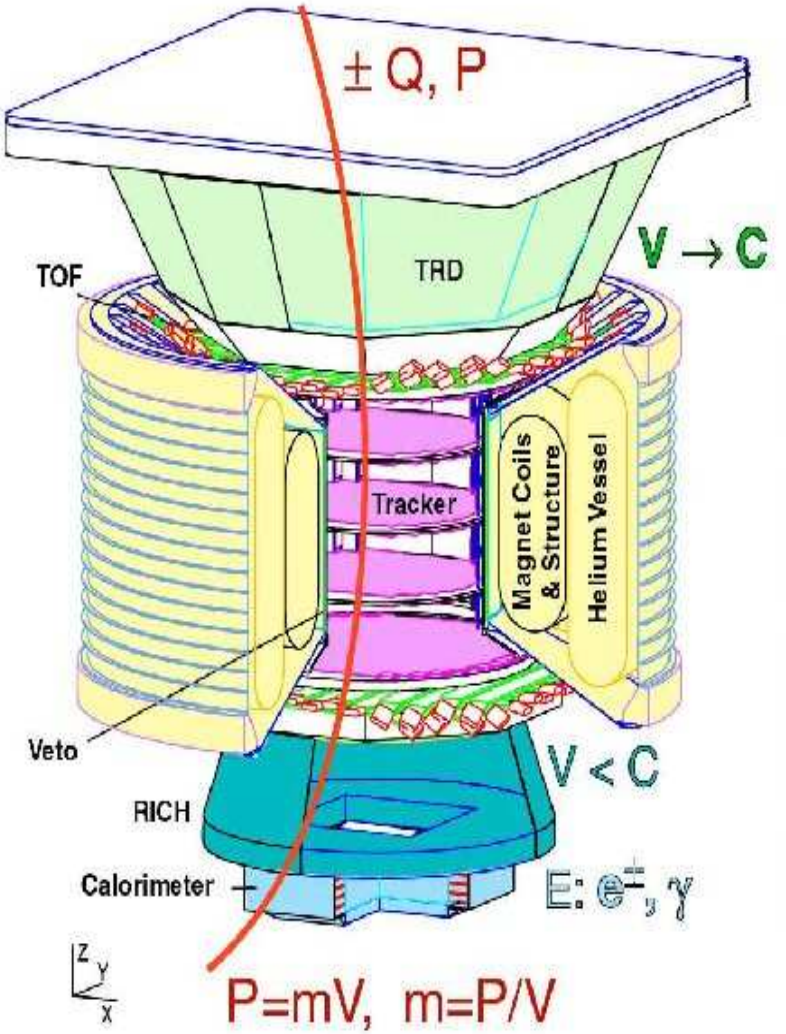
Kampert 1999

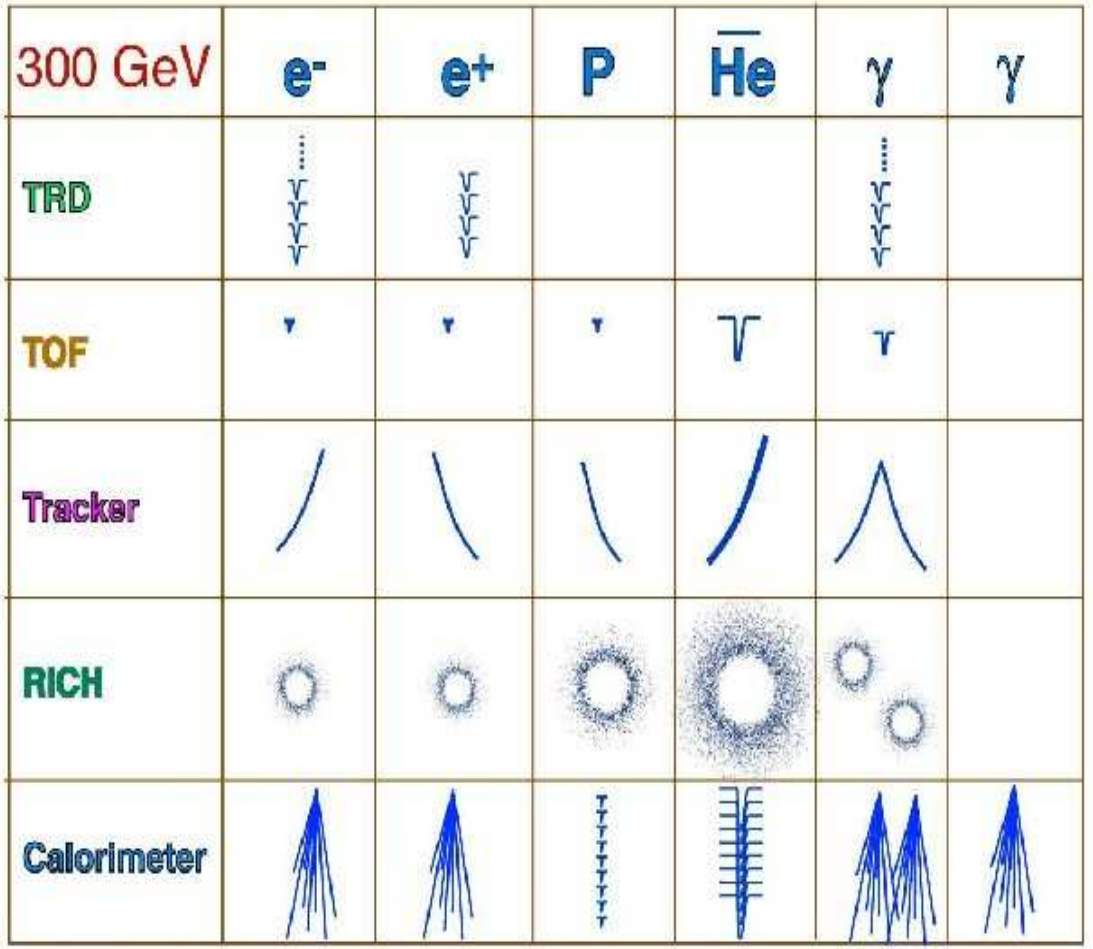


$$\Phi \sim E^{-2.8} \rightarrow E^{-3.2} \rightarrow E^{-2.8}$$



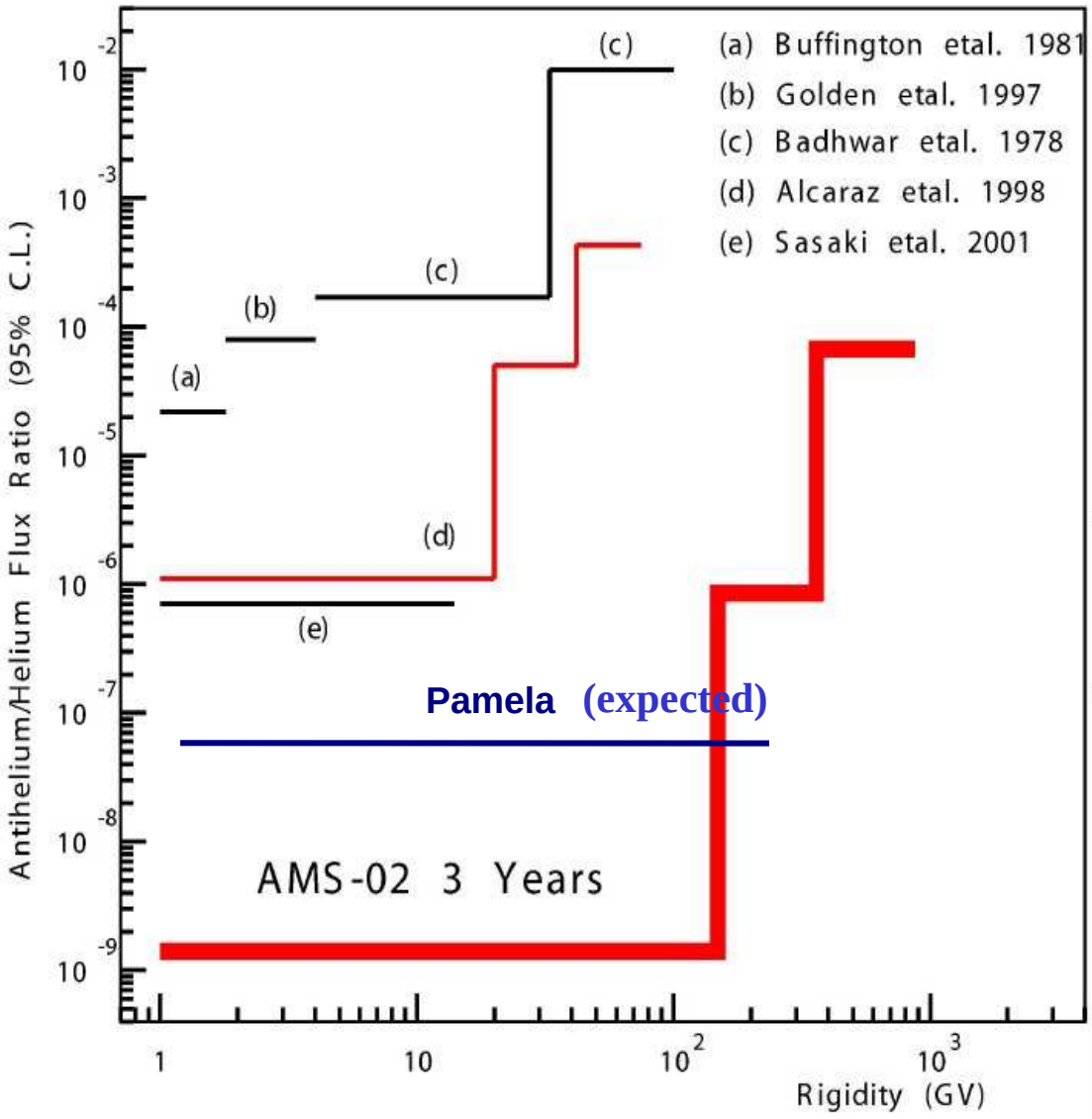
AMS-02 Particle ID

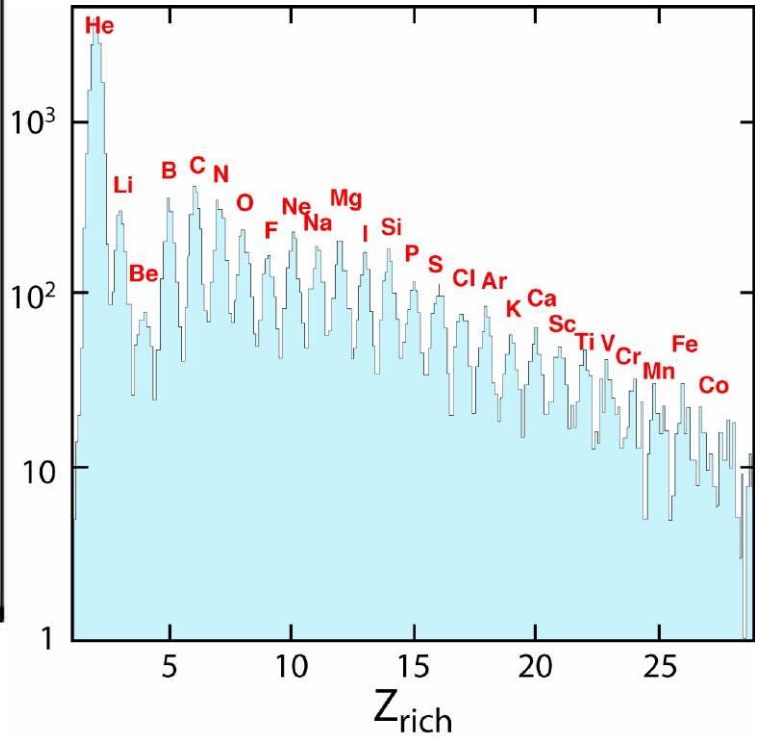




Search for anti-nuclei

Anti-He / He ratio





Search for dark matter signal

Candidates from particle physics:

SUSY neutralinos (χ^0)

Kaluza-Klein bosons (B)

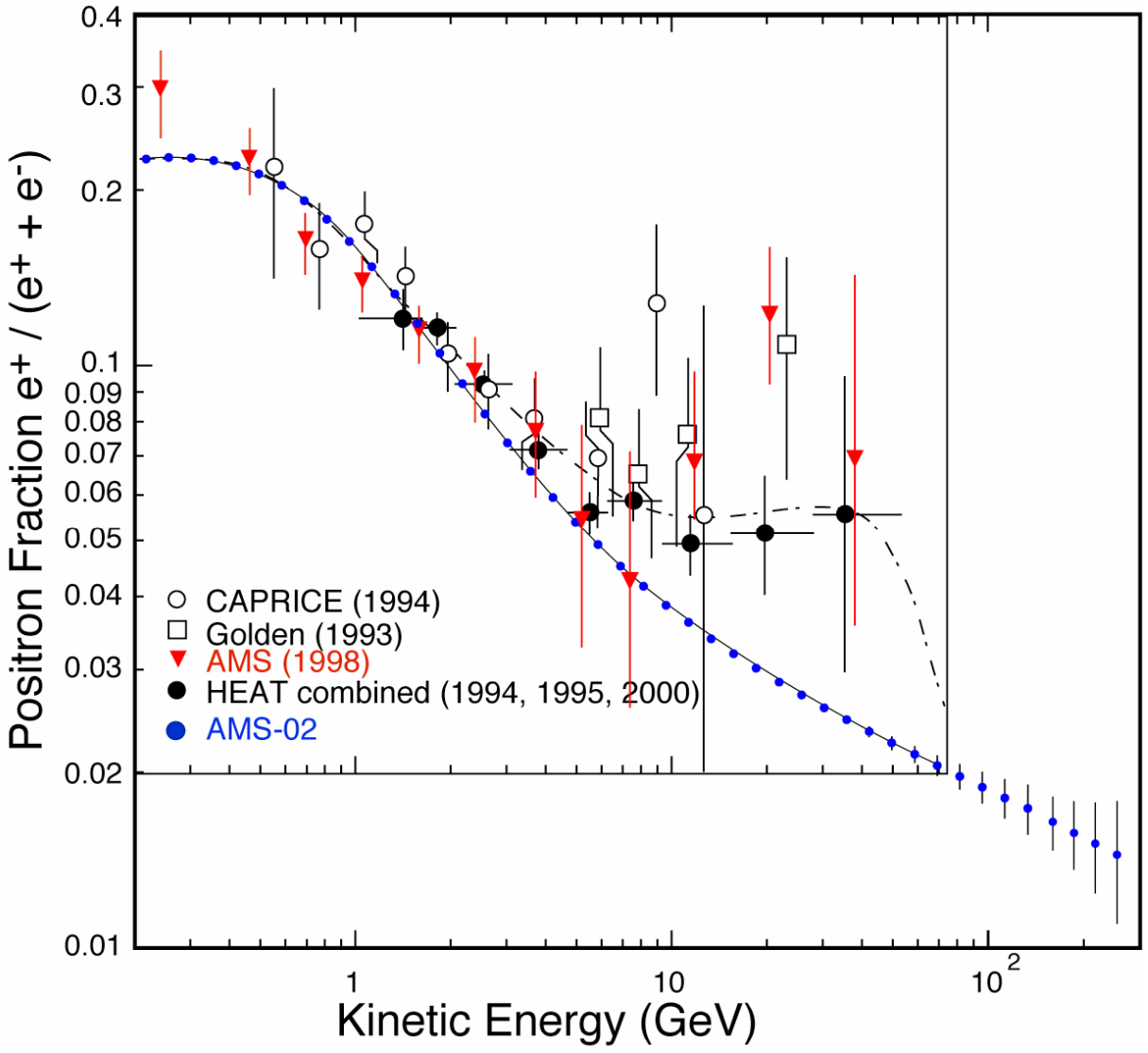
…

$\chi^0\chi^0 \rightarrow$

qq, WW, ZZ, γγ, *ll*

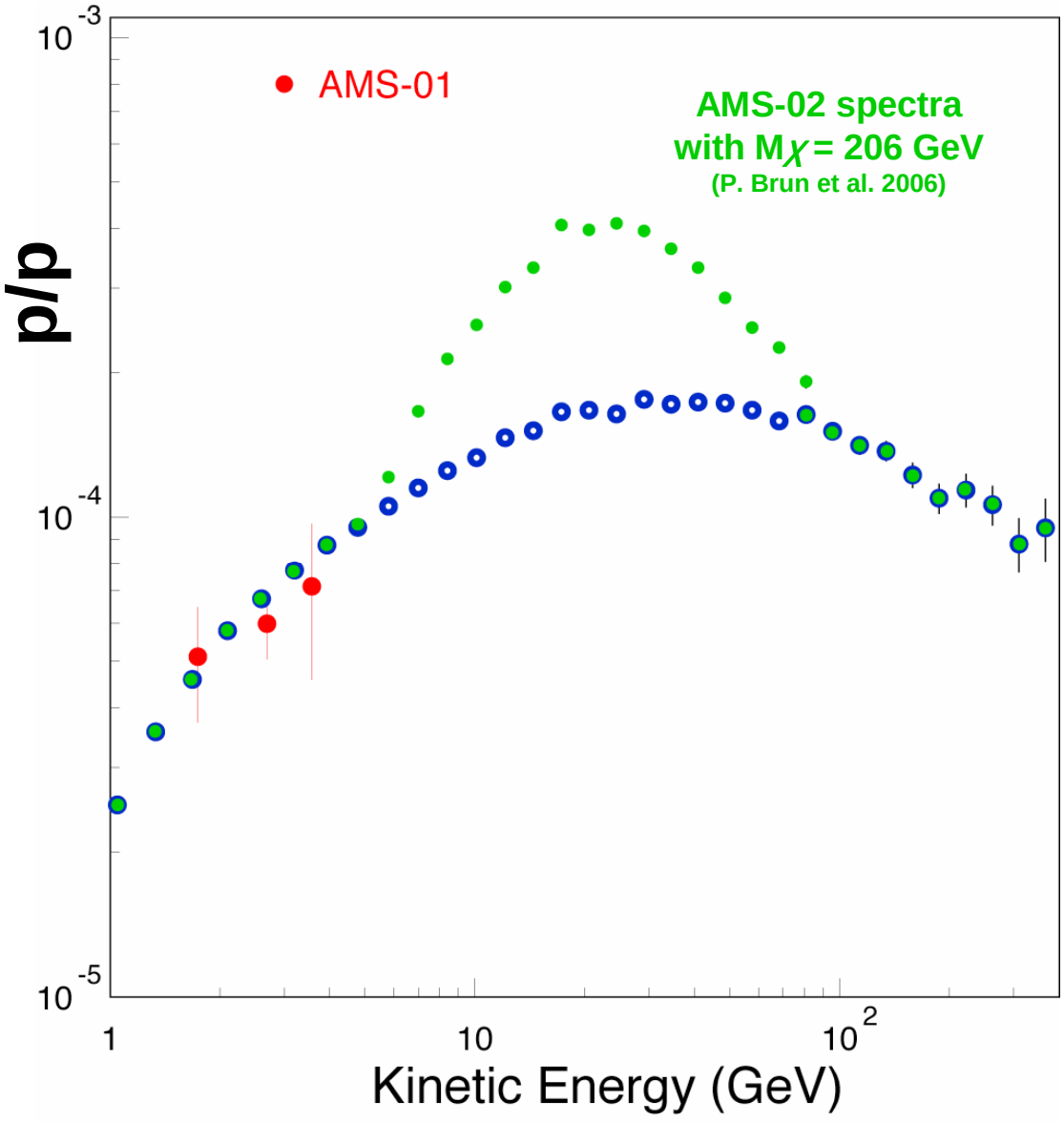
→ structures in the spectra of

e^+, *anti*p, *anti*D, γ



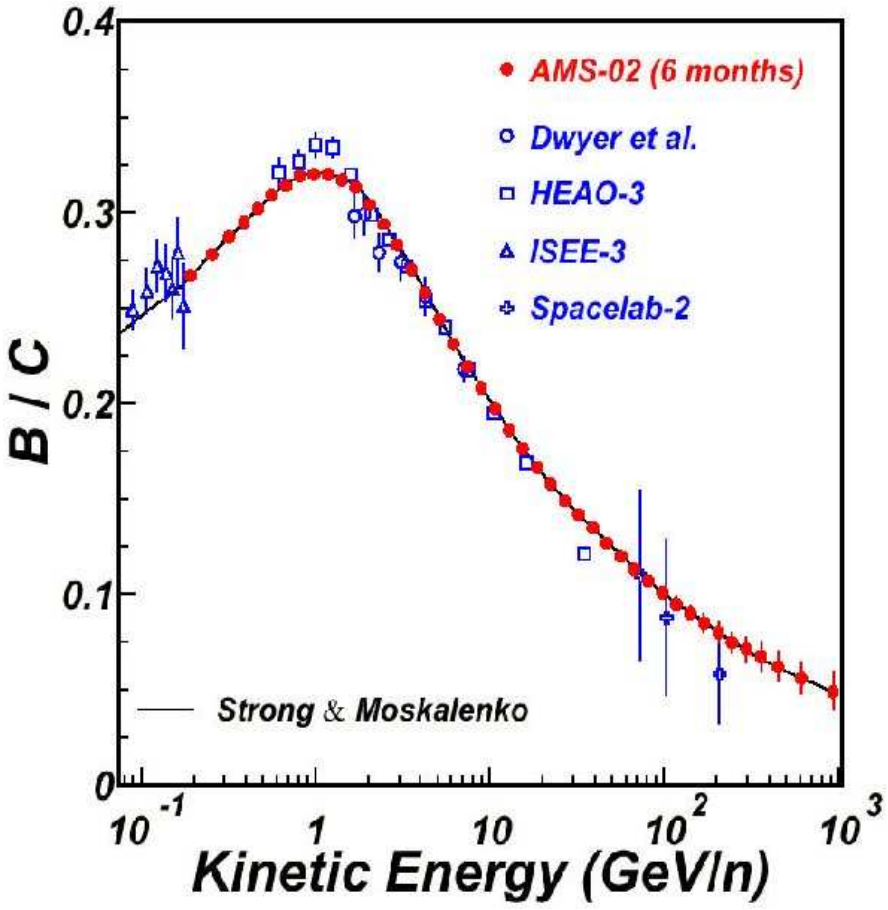
Anomalies in *anti*-proton or *anti*-deuteron spectra may also reveal something …

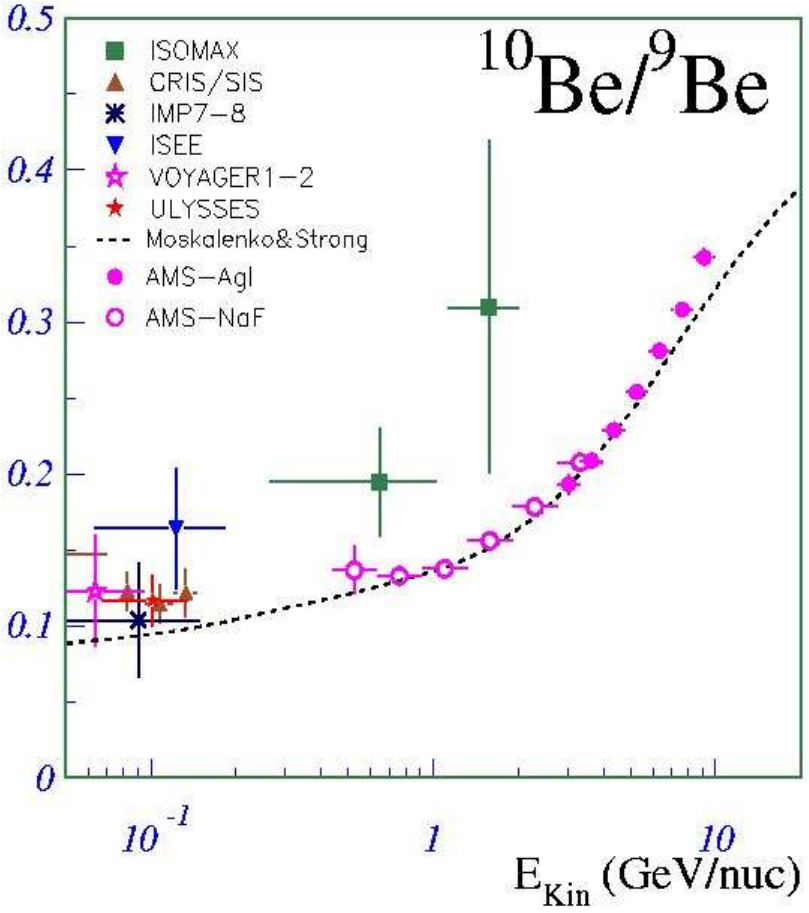
Normal spectra (*produced by secondary interactions*) depend on knowledge of primary cosmic rays and their propagation …



Models of CR propagation need to be checked

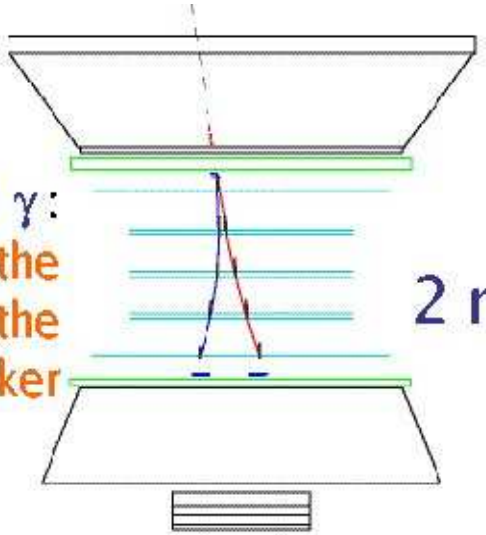
Li, Be, B are produced from CNO spallation. Unstable secondaries like ^{10}Be (τ= 2_x10^6 y) are *cosmic clocks*. Chemical composition and isotope ratios (^{10}Be/^{9}Be, ^{3}He/^{4}He, D/p) depend on confinement time and density of interstellar medium.



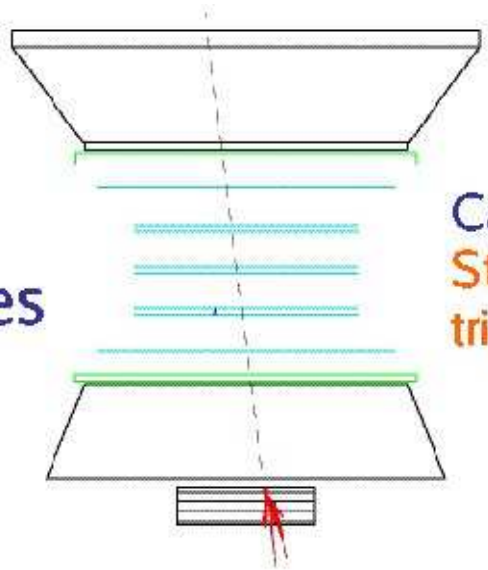


Gamma detection

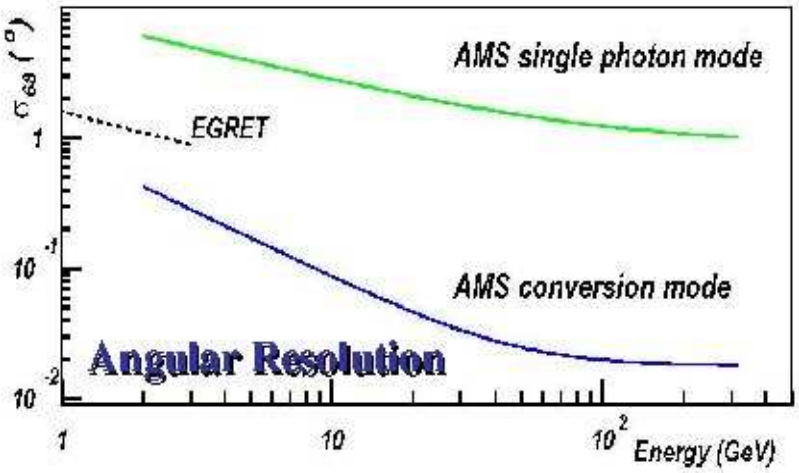
Converted γ :
Detection of the
e+e- pair in the
tracker

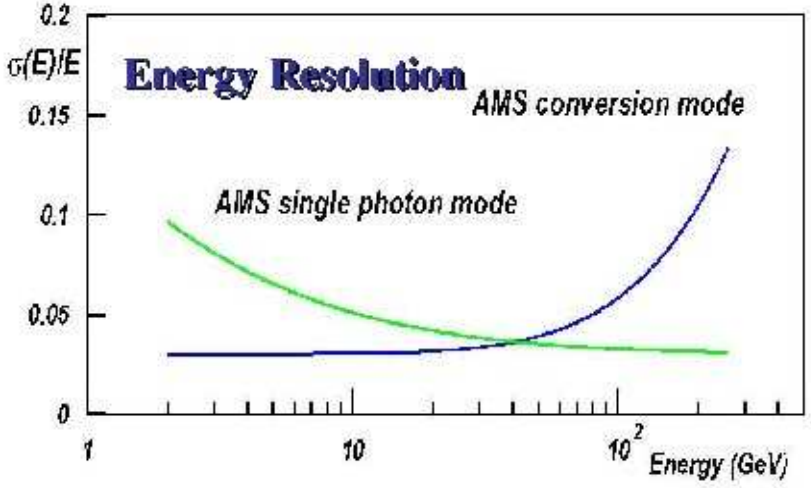


2 modes



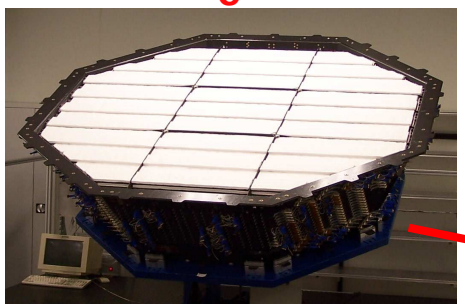
Calorimeter :
Standalone
trigger



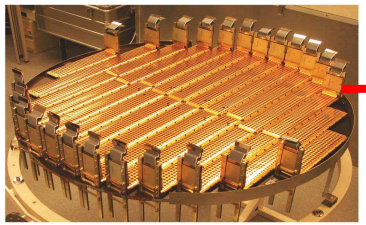


Construction of the AMS detectors is complete.

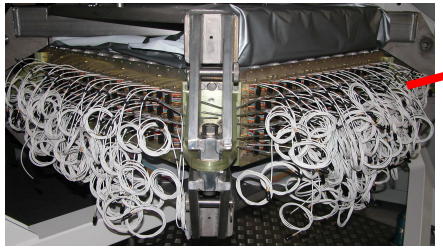
TRD
e

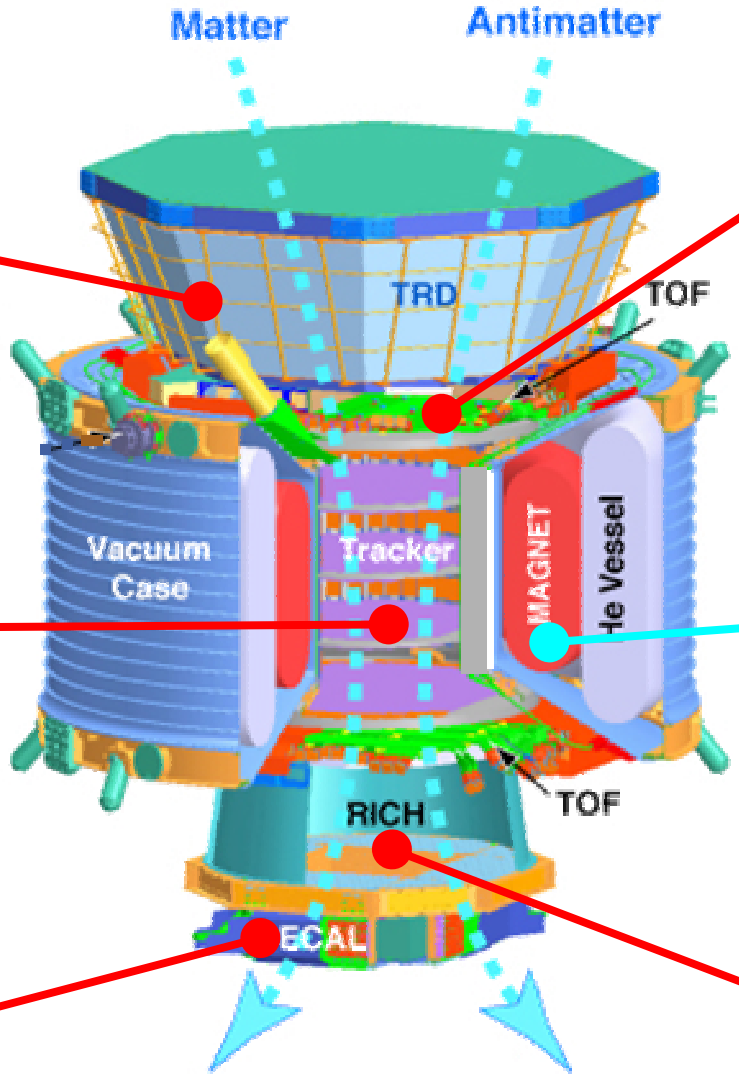


Silicon Tracker
Z, P



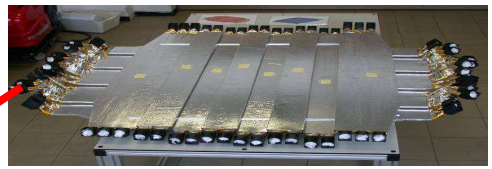
Calorimeter
e, γ



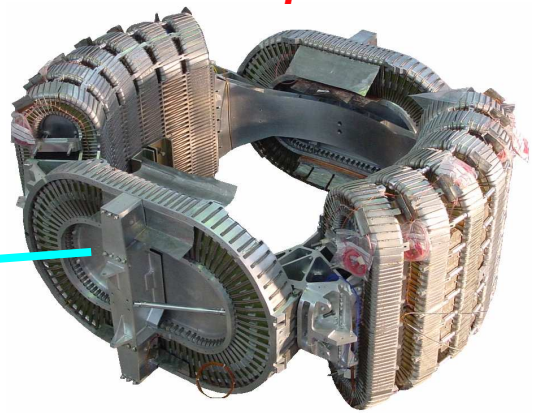


Size: 3m x 3m x 3m
Weight: 7 tons

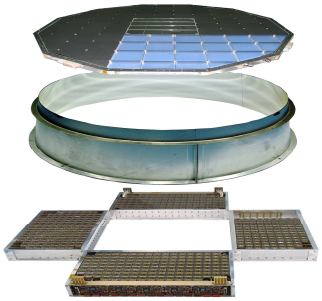
Time of Flight
v, Z



Magnet
P

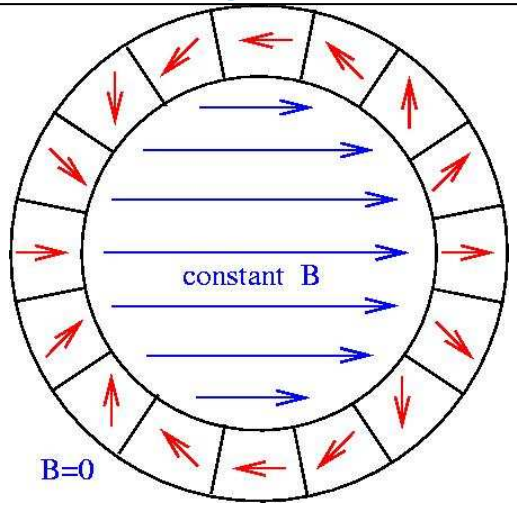


RICH
v, Z

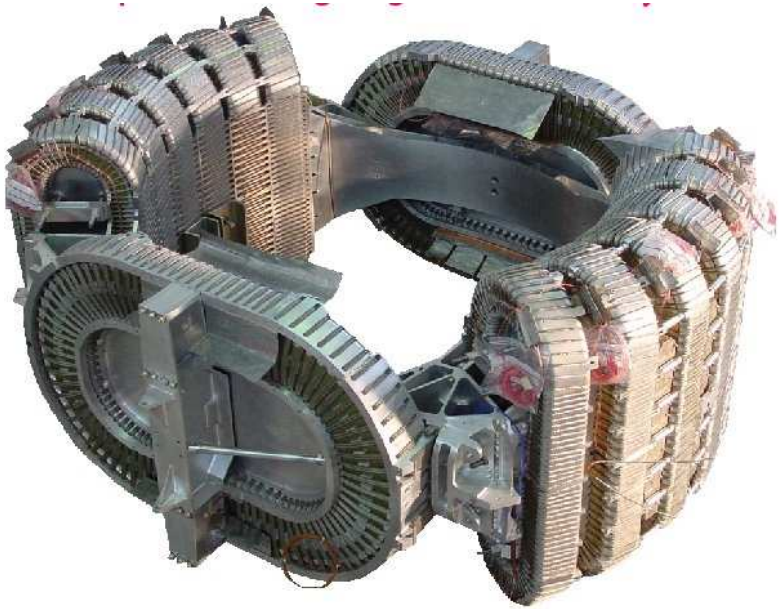


Superconducting Magnet

(with zero magnetic moment)

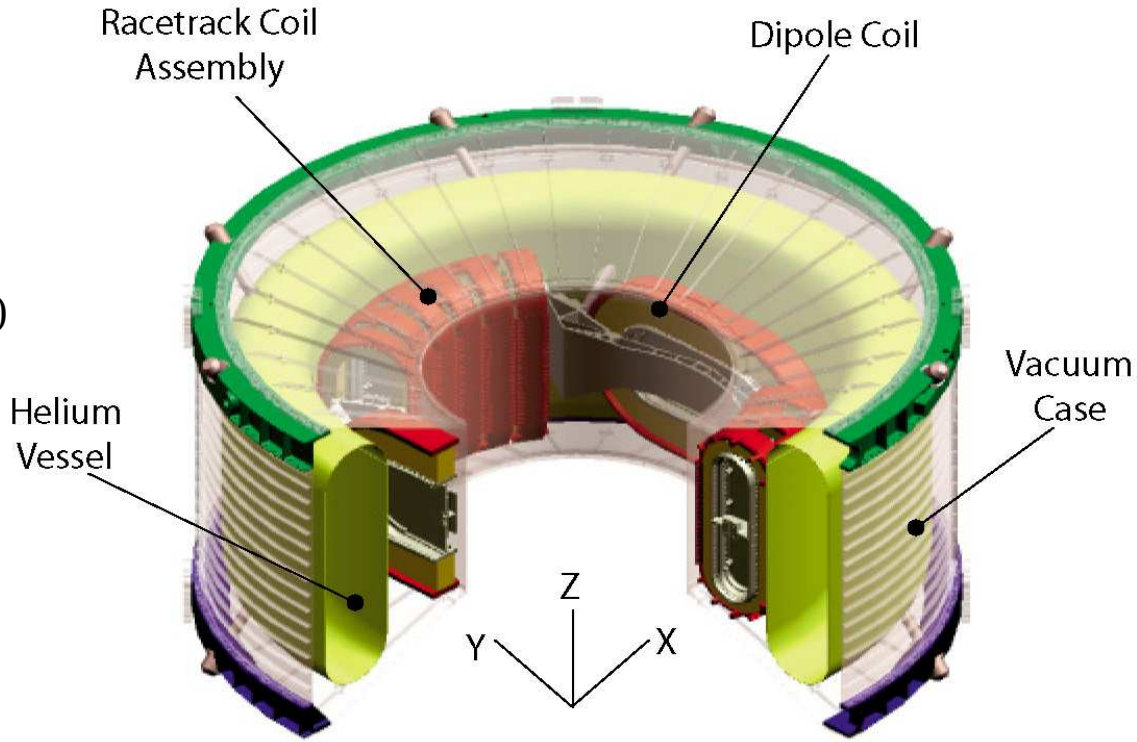


AMS01 permanent magnet (*magic ring)*



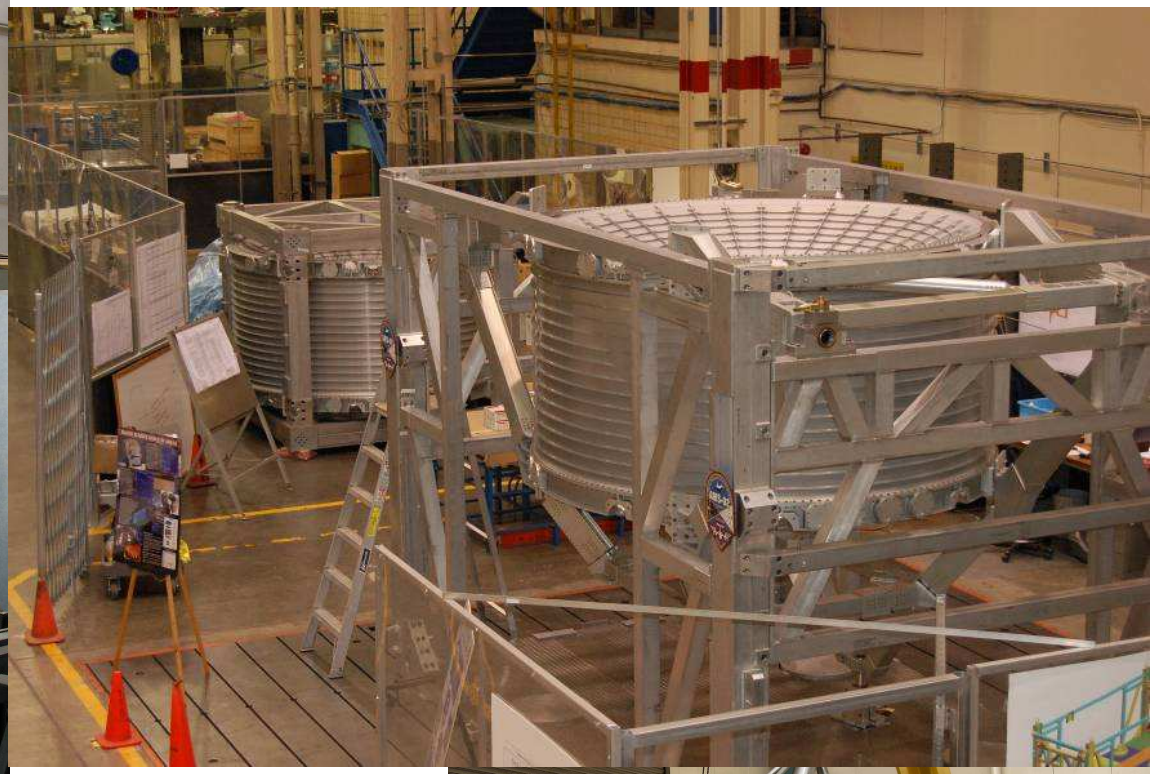
AMS02 Magnet

- 55 km of wire (NbTi/Cu embedded in Al)
- Inner diameter: 1.1 m, weight: 2360 kg
- 14 superconducting coils
- 2500 liters of liquid He (superfluid)
- B ~ 0.9 Tesla, $BL^2 \sim 0.8\ Tm^2$



Magnet in its test chamber

Two vacuum tanks produced by NASA (at JSC)

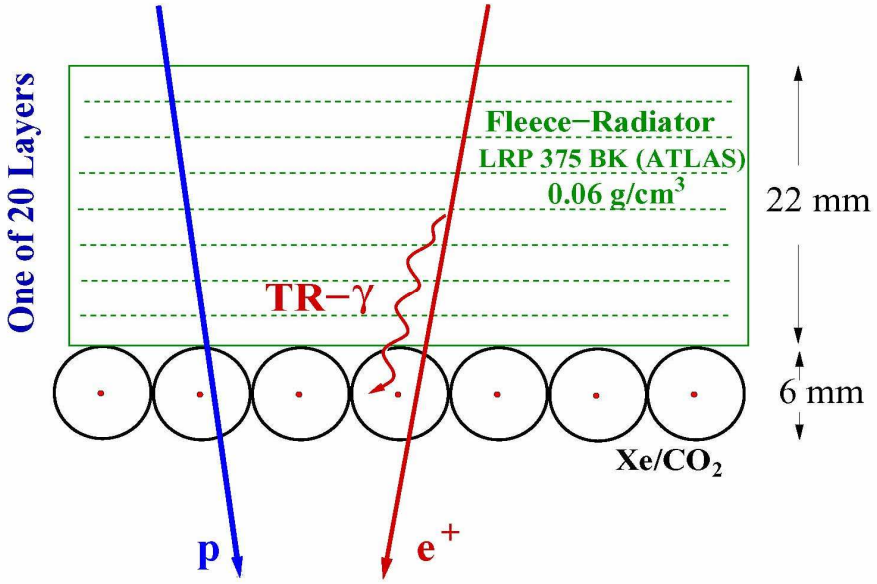


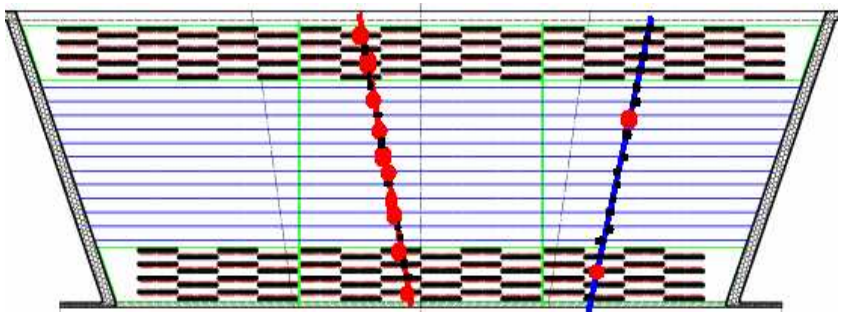
He reservoir

- Magnet has been tested at 50 % of its nominal field
- Further tests in few weeks.

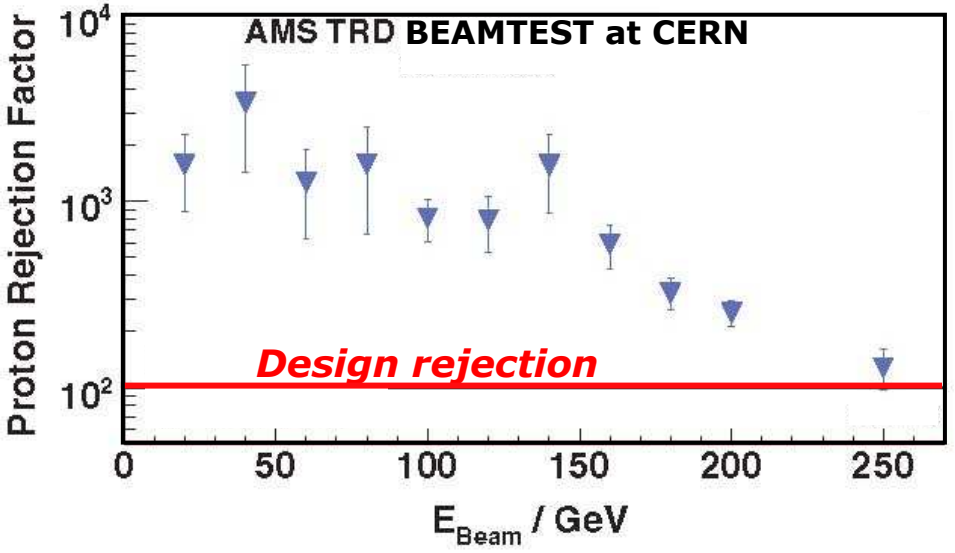
TRD: Identify e^+ reject P

Detector and gas system ready
(T+vac+vib tested)



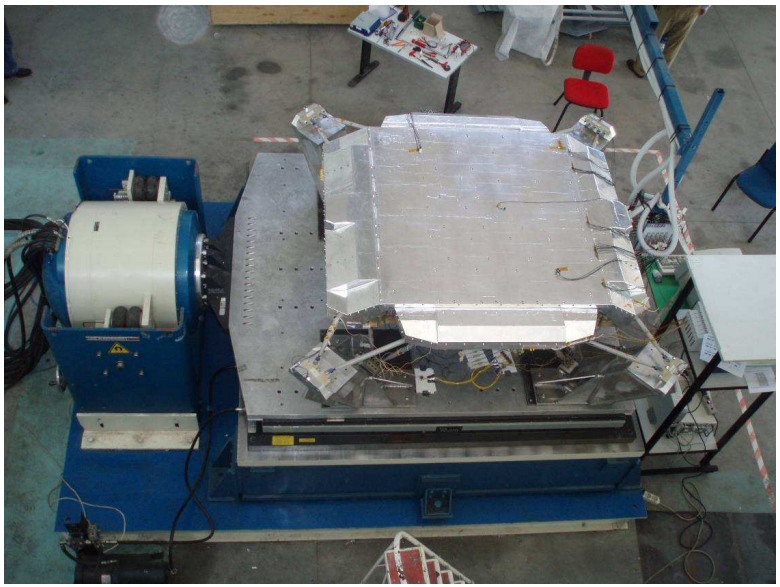


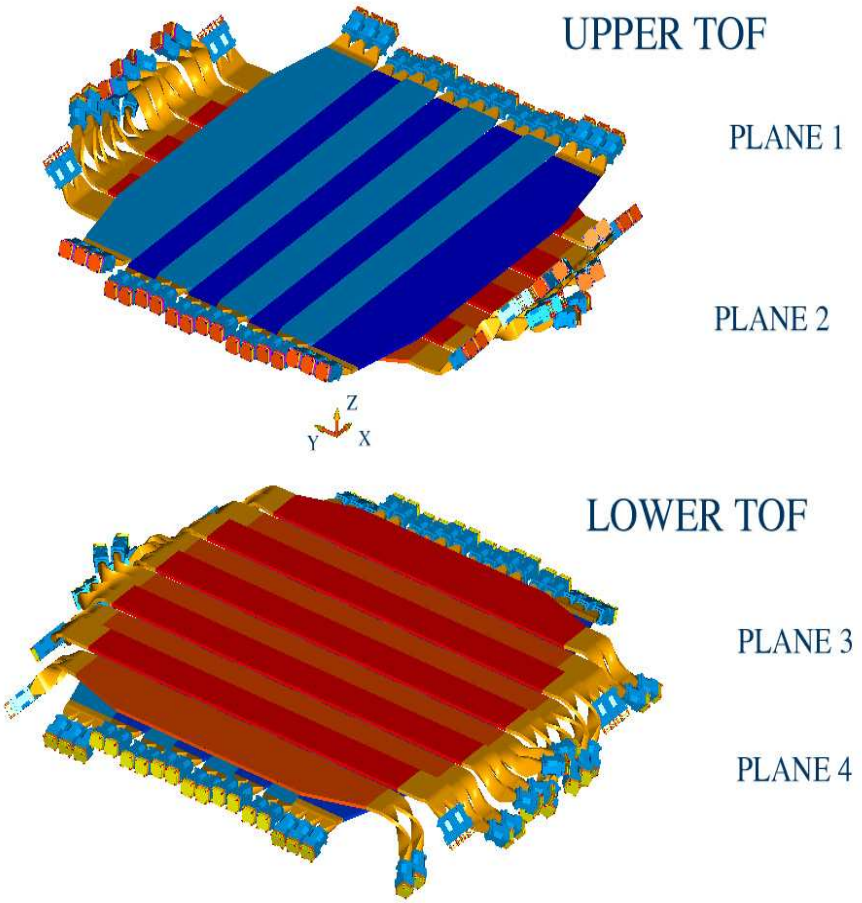
12 layers in the bending plane
8 layers in the non-bending plane



Time Of Flight Detectors

- 2x2 scintillator planes separated by ~1m
- Light guides bent, PMs aligned with B.
- Total 34 crossed paddles. 1.6 m²/plane
- Main trigger for charge particles
- Upgoing/downgoing particle separation
- $\Delta\beta/\beta=3\%$. Charge meas. up to Z=20
- Completed (T+vac+vib)

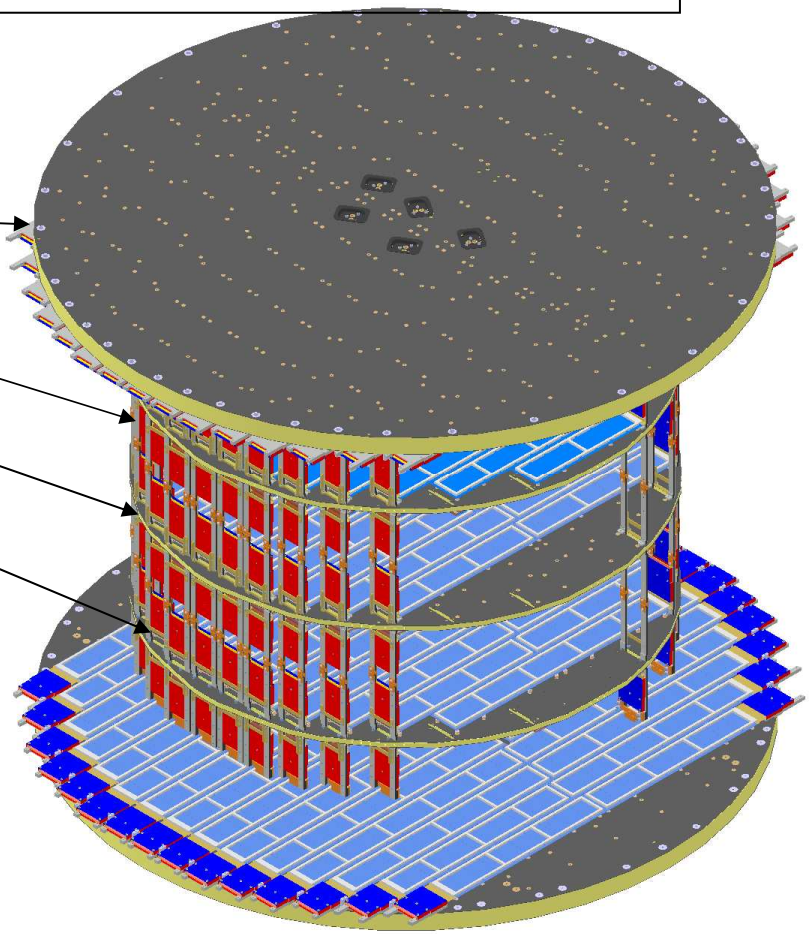




General view of Silicon tracker

- 5 planes, 8 layers

- Plane 1, layer 1
- Plane 2, layers 2&3
- Plane 3, layers 4&5
- Plane 4, layers 6&7
- Plane 5, layer 8



- 192 *ladder* modules
- 1024 electronic channel/module

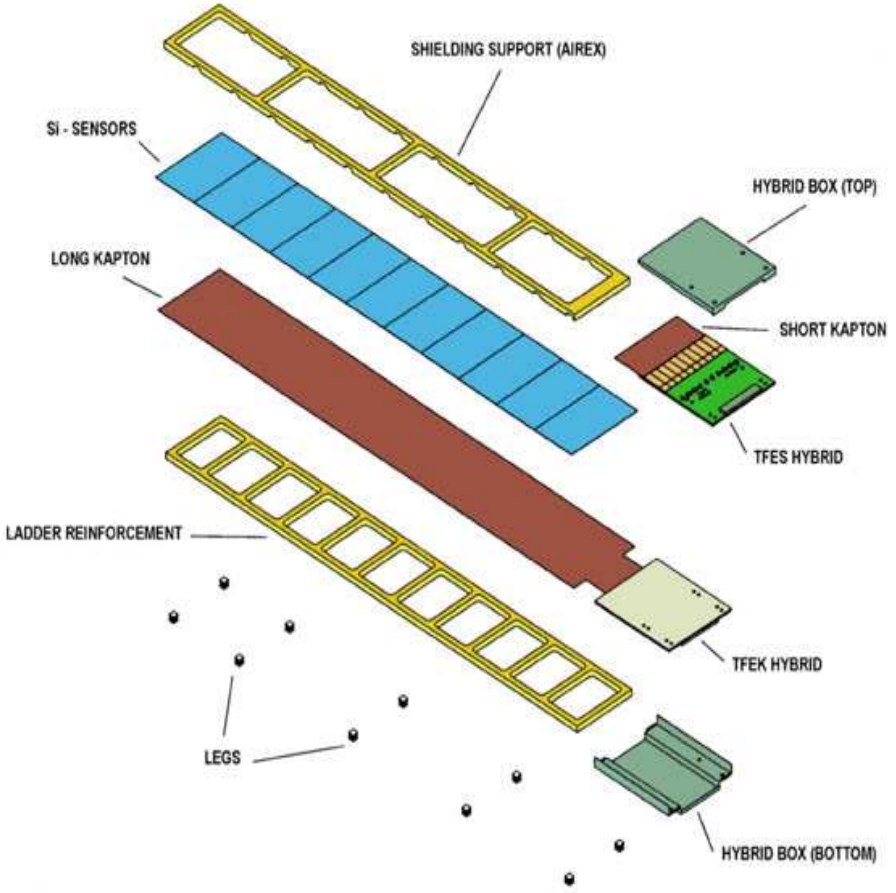
  ➔ 200'000 channels

Planes are supported by *shells* and *conical flanges*. (not shown)

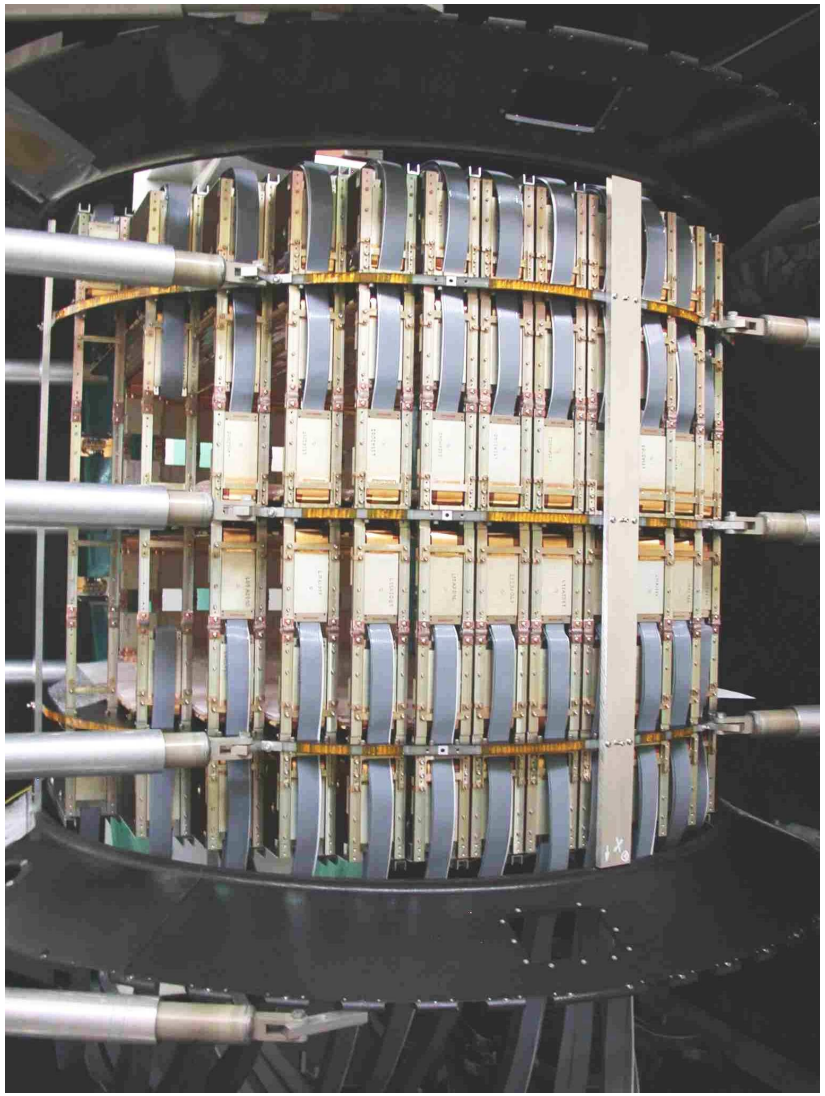
Cooling (~200 W) provided by CO2 (2 phases) under high pressure

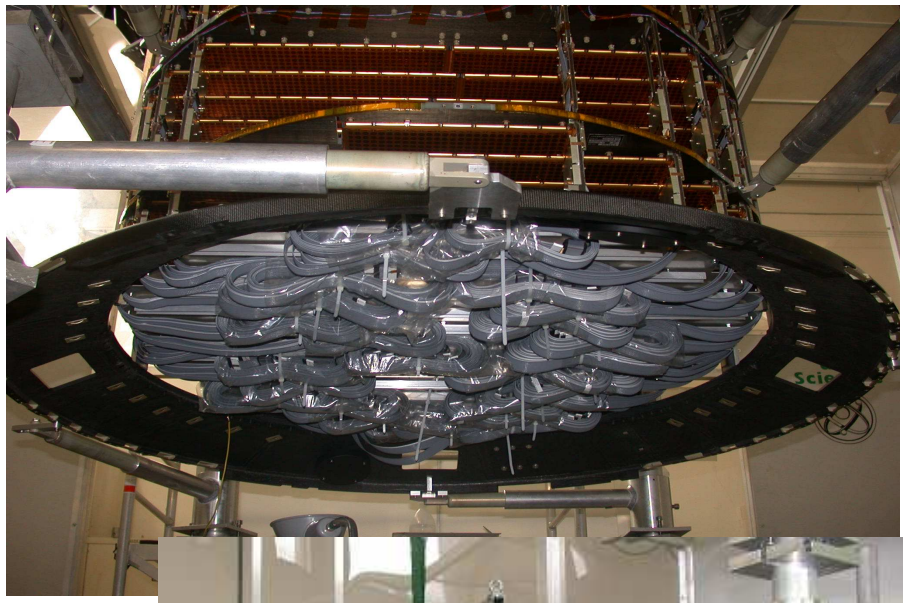
AMS Tracker: *Ladder Assembly and Integration*

- ASSEMBLY by G&A (Italy)
- ~ 210 ladders build
- INTEGRATION by UniGe
- hybrid box & legs gluing
- EMI Shielding (Kapton foil wrapping)
- Installation of ladders on support planes (on both sides)



AMS Tracker: *Mechanical assembly, cabling and delivery (UniGe)*

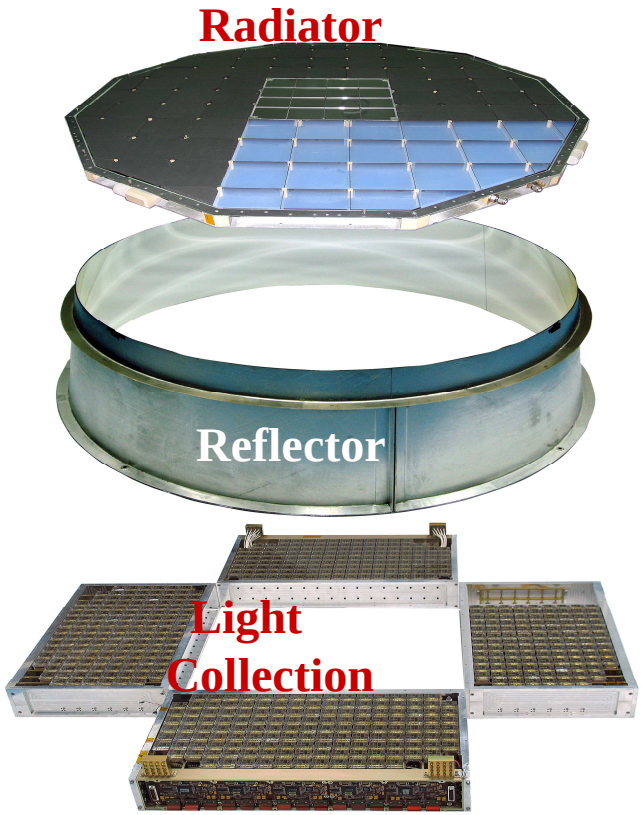




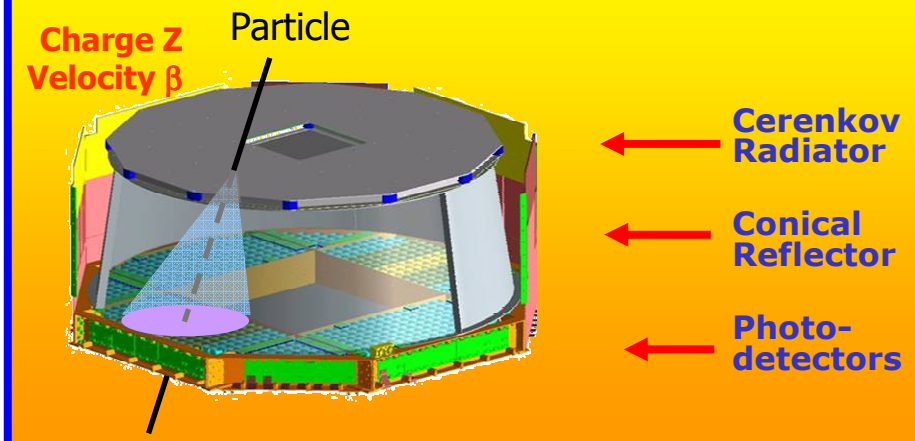
Delivery September 25, 2007

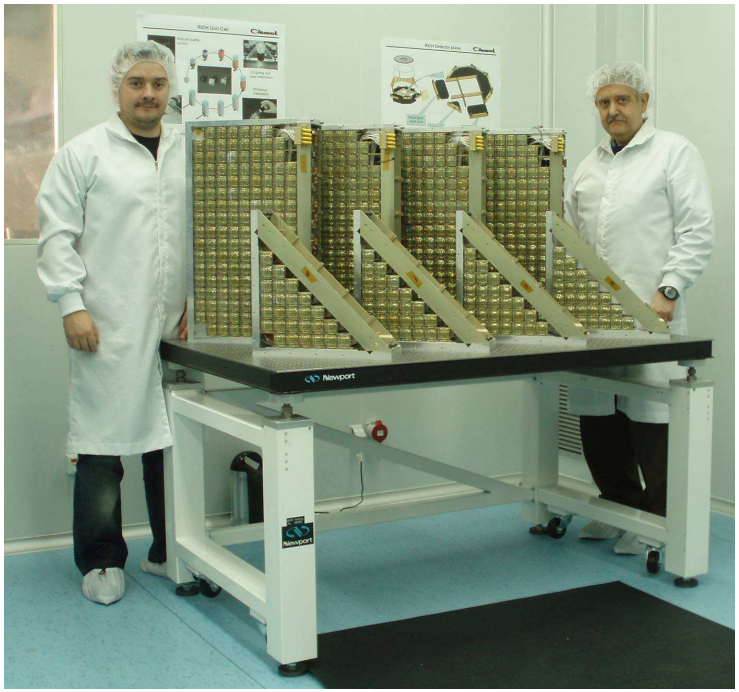
Ring Image Cherenkov

- Two radiators: Aerogel (n=1.05) and NaF (n=1.336)
- $\Delta\beta/\beta \sim 0.1\%$
- 680 x 4 x 4 channels



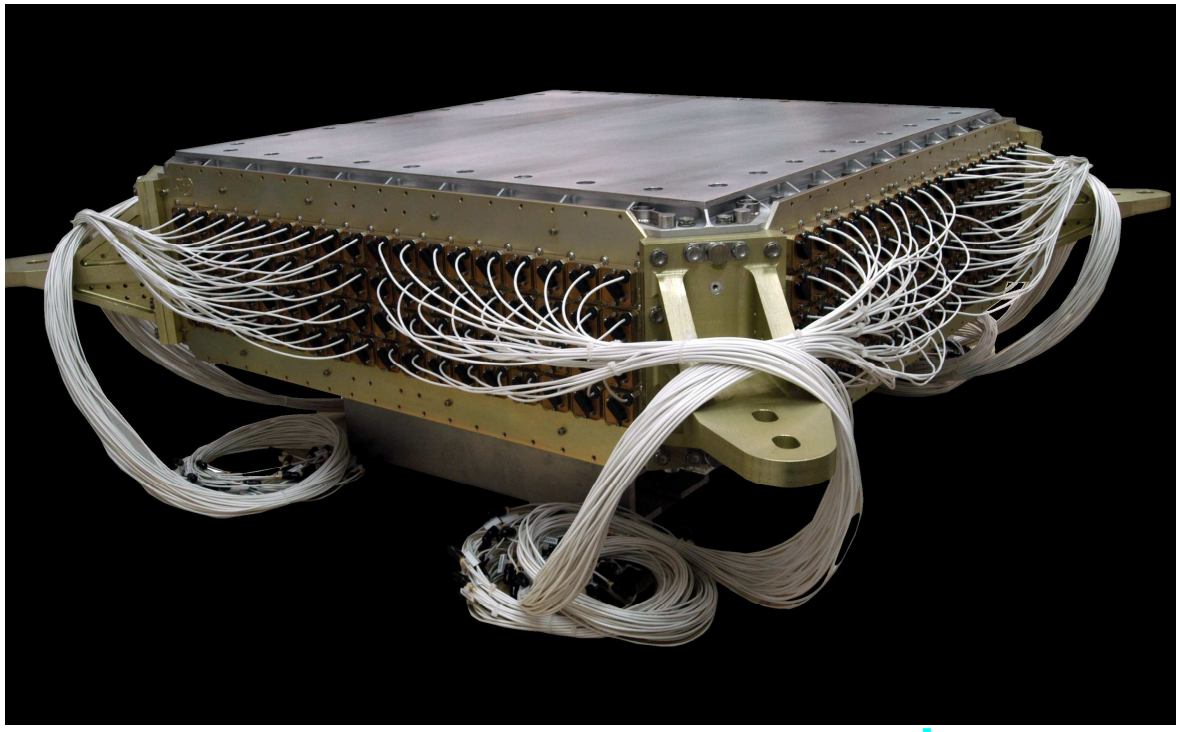
Precise measurement of the velocity & charge

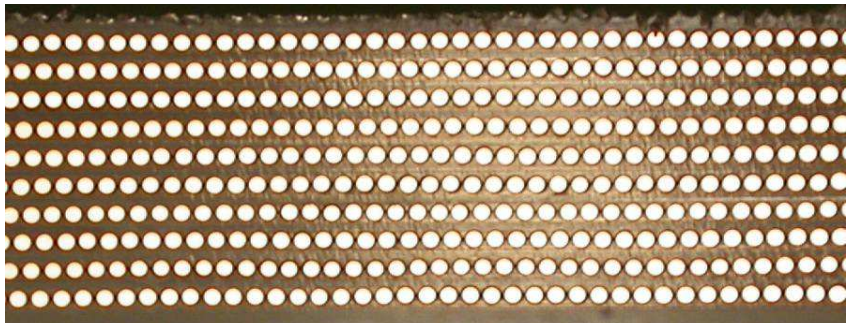




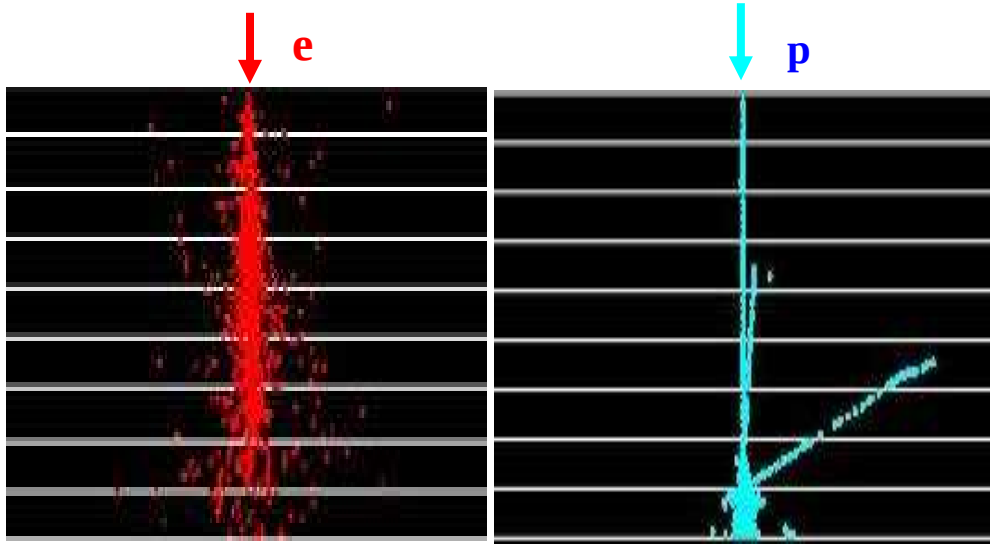
ECAL: Electromagnetic Calorimeter

- Pb/scintillating fiber sandwich (640 kg) with 3D sampling by crossed layers
- Angular resolution ~ 1°
- $\Delta E/E = 10\%/\sqrt{E} + 2.6\%$
- Proton suppression up to 10^4 at 500 GeV. (10^6 with TRD)



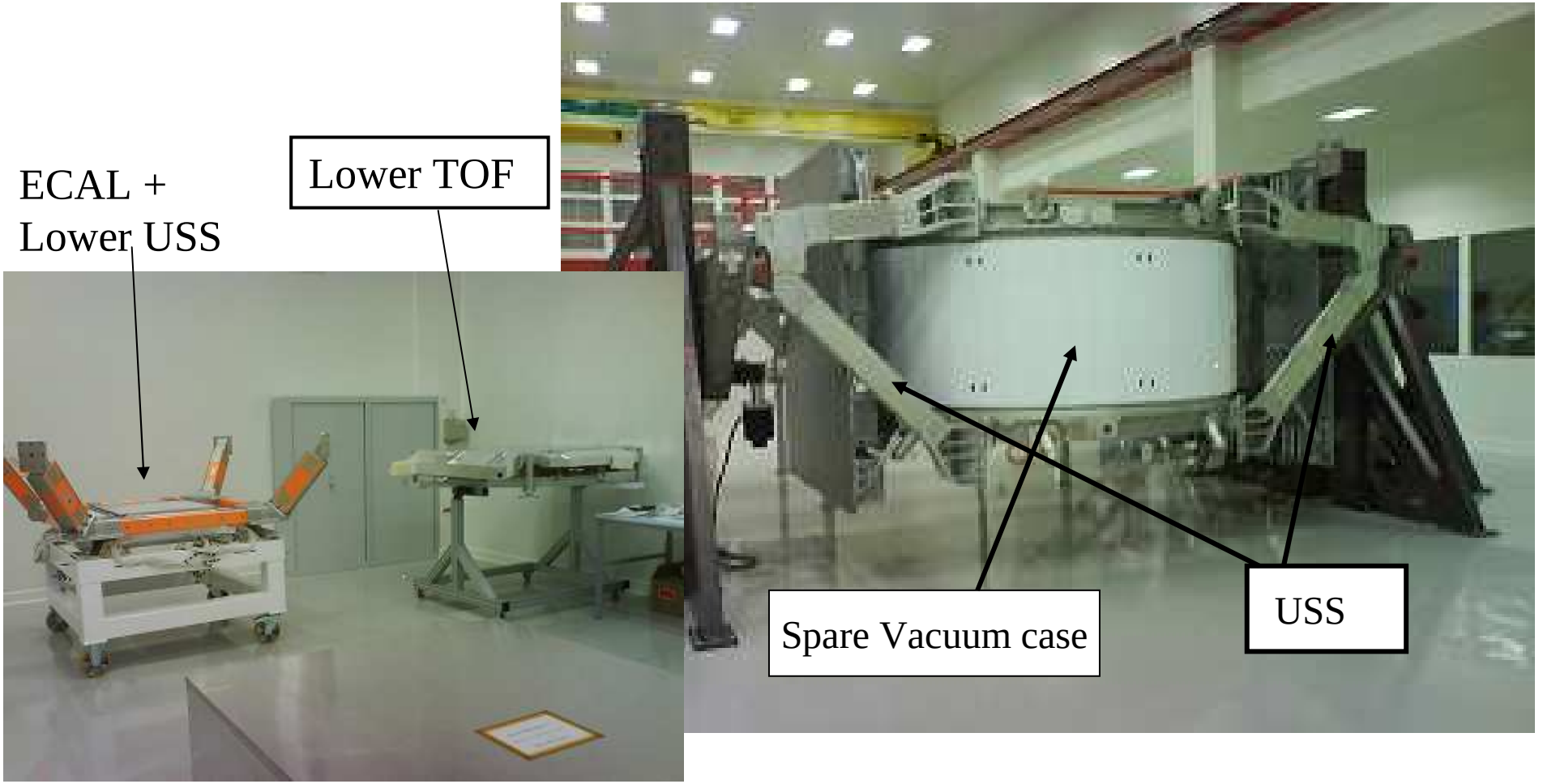


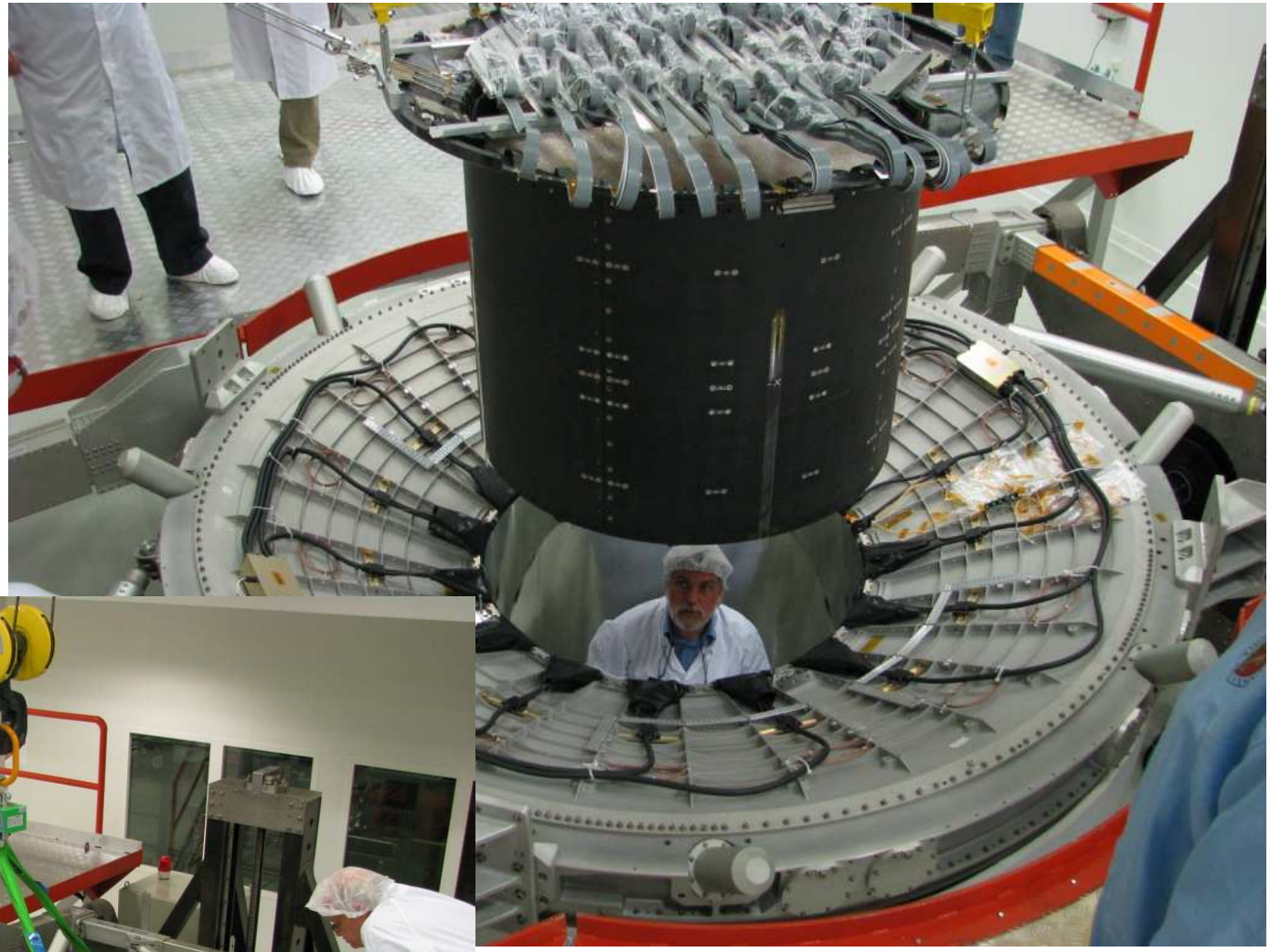
Cut-away view of fibers and lead



AMS *PRE*-INTEGRATION

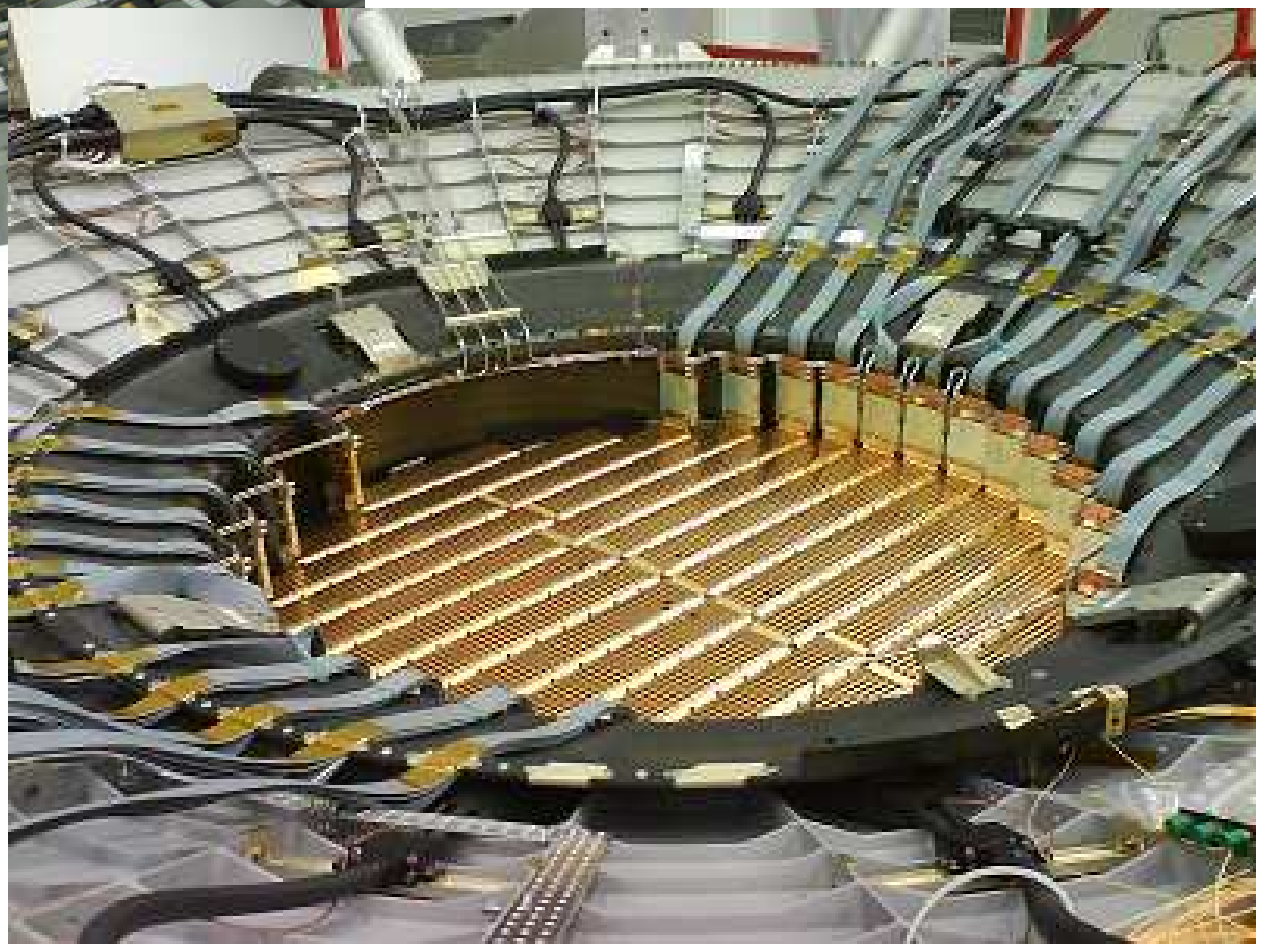
- Large clean room at CERN-Prevessin for integration.
- Integration exercise (in spare vacuum case) of all sub-detectors before magnet delivery.





Tracker Insertion

Installing lower conical flange



Opening the cables of inner tracker before installation of external upper plane (plane1)

Installation of plane 1

October 12, 2007

Future Operations

- Complete Tracker pre-Installation
- TRD and Upper TOF (end October)
- RICH + Lower TOF + ECAL + Lower USS (November)
- De-integration, final integration in magnet (1st part 2008)
- T+vac test at ESTEC (ESA) in Nordwijk, Netherland (2nd part 2008)
- Transport to KSC

House NASA Appropriations Bill: July 26, 2007
SPACE OPERATIONS:
One section of the committee report on Space Operations stated:

"The Alpha Magnetic Spectrometer (AMS) will enable an ambitious, scientifically compelling experiment to investigate antimatter. Despite NASA's long-standing commitment to this unique experiment, the NASA Administrator last year stated that NASA would no longer commit to flying AMS to the International Space Station (SS) on the space shuttle. The Committee is disappointed that NASA has chosen to cancel the flying of this highly rated scientific experiment that would make use of the unique capabilities of the ISS. *The Committee directs the Administrator* to study the possibility of delivering the AMS to the ISS. This study should include the options considered, an analysis of those options, identify the preferred option including its cost and schedule, and how such an option could be implemented. *This study should be submitted to the Committee within nine months of the enactment of this Act."*

ECAL: Verified by accelerator calibration