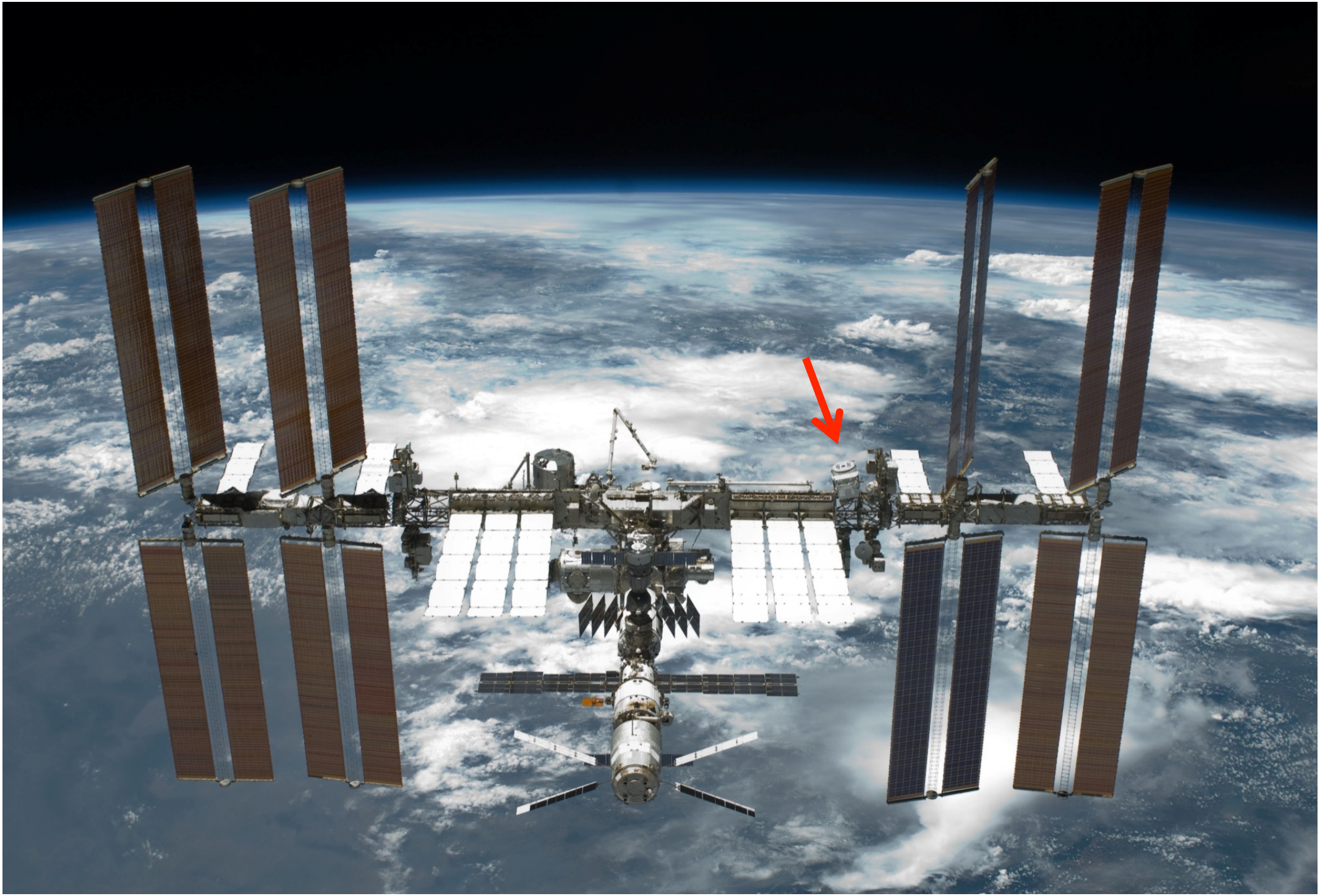
AMS-02 one year in space

Cecilia Pizzolotto

on behalf of the AMS-02 Collaboration

INFN Perugia and ASDC Frascati

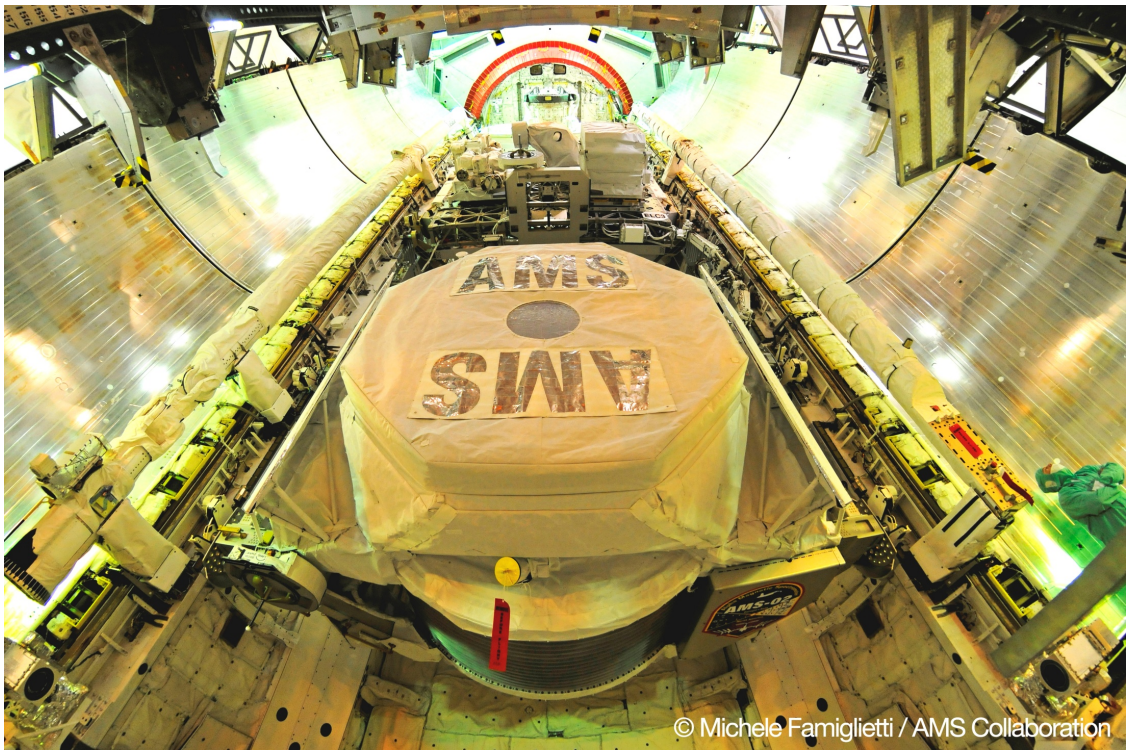
SciNeGHE 20-22 June 2012, Lecce



AMS-02 goals

The experimental challenge: perform accurate, high statistics, long term measurements of charged cosmic rays (0.5 GV – O(TV)) and γ rays (E>1GeV)

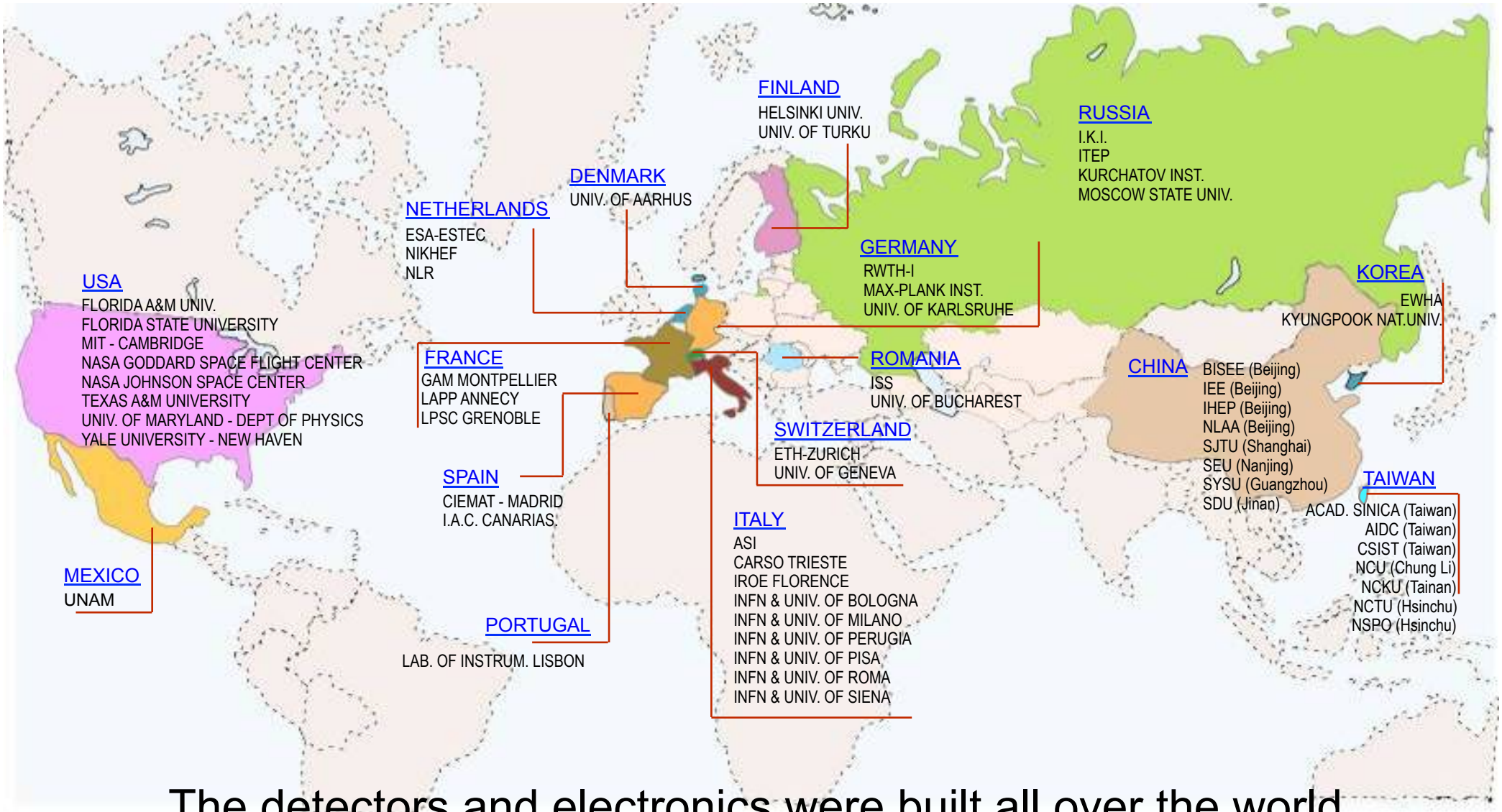
- Primordial Antimatter search with 10^{-9} sensitivity
- Indirect Dark Matter search (e^+,.., γ)
- Relative abundance of nuclei and isotopes in primary cosmic rays
- γ ray astrophysics



AMS in the shuttle cargo bay

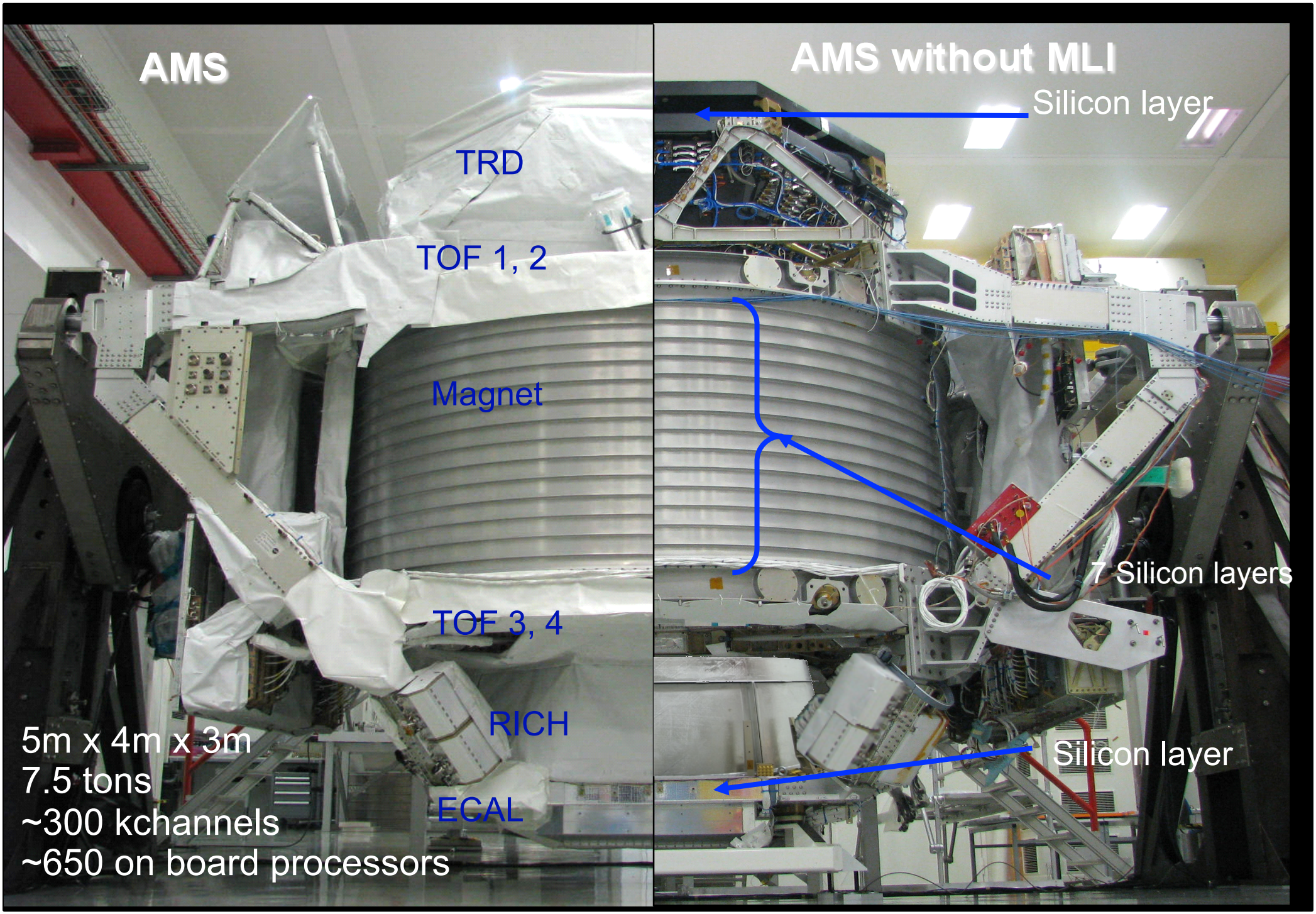
AMS international collaboration

16 Countries, 60 Institutes and 600 Physicists, 17 years



The detectors and electronics were built all over the world and assembled at CERN, Switzerland.

JSC Control Room, May 2011

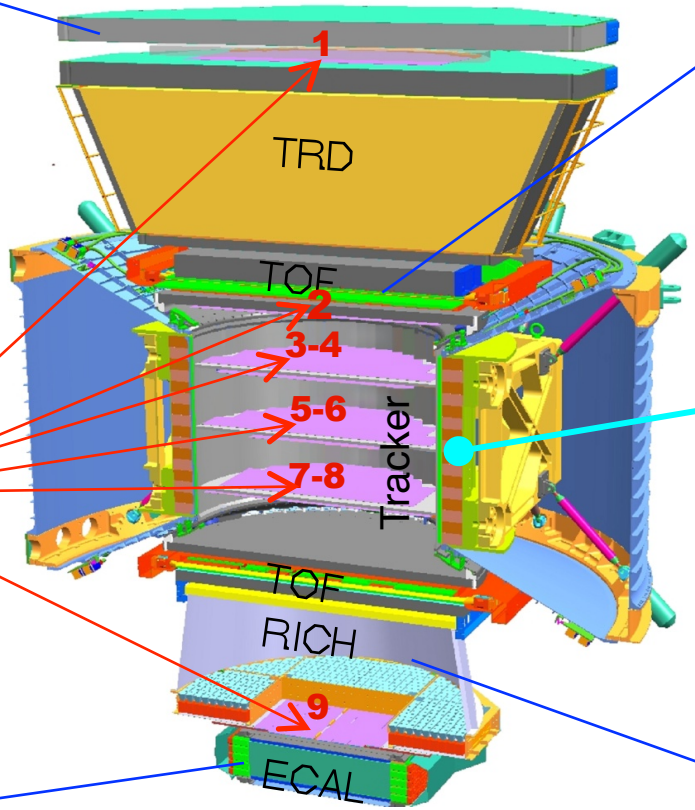

AMS
TRD
TOF 1, 2
Magnet
TOF 3, 4
RICH
ECAL
5m x 4m x 3m
7.5 tons
~300 kchannels
~650 on board processors
AMS without MLI
Silicon layer
7 Silicon layers
Silicon layer

AMS-02: A TeV precision, multipurpose spectrometer

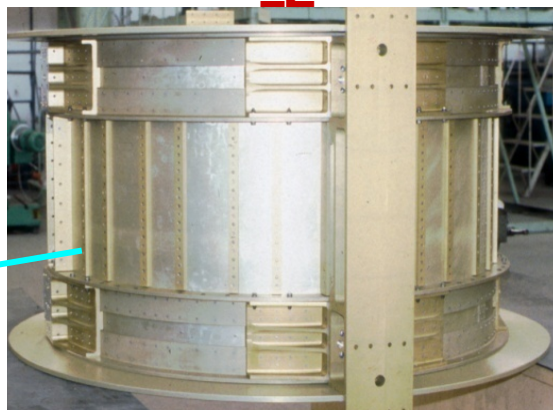
TRD
Identify e^+, e^-

Particles and nuclei are defined by their charge (Z) and energy (**E ~ P**)

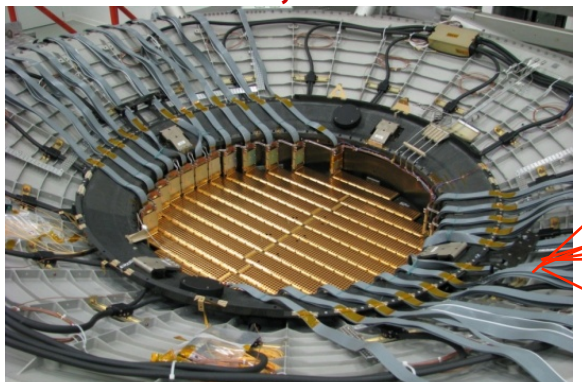
TOF
Z, E



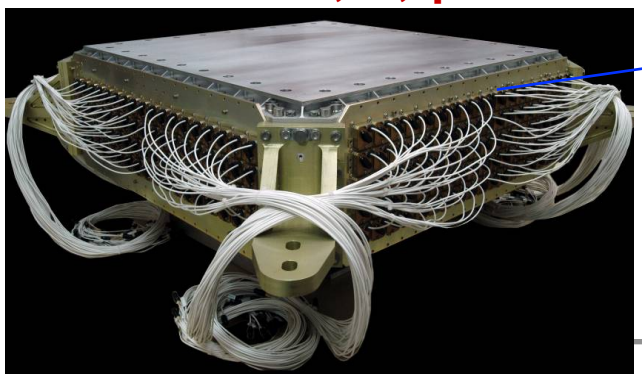
Magnet
±Z



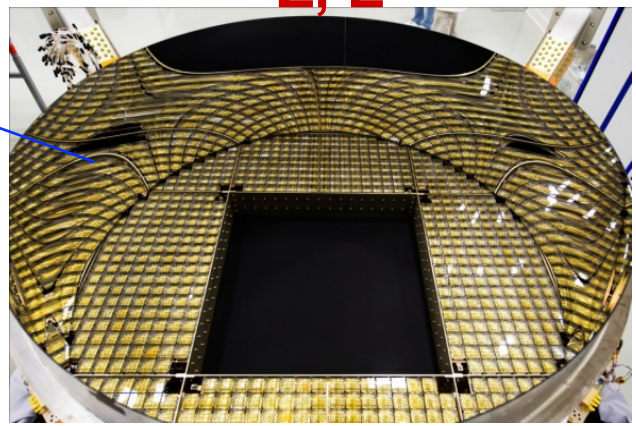
Silicon Tracker
Z, P



ECAL
E of e^+, e^-, γ



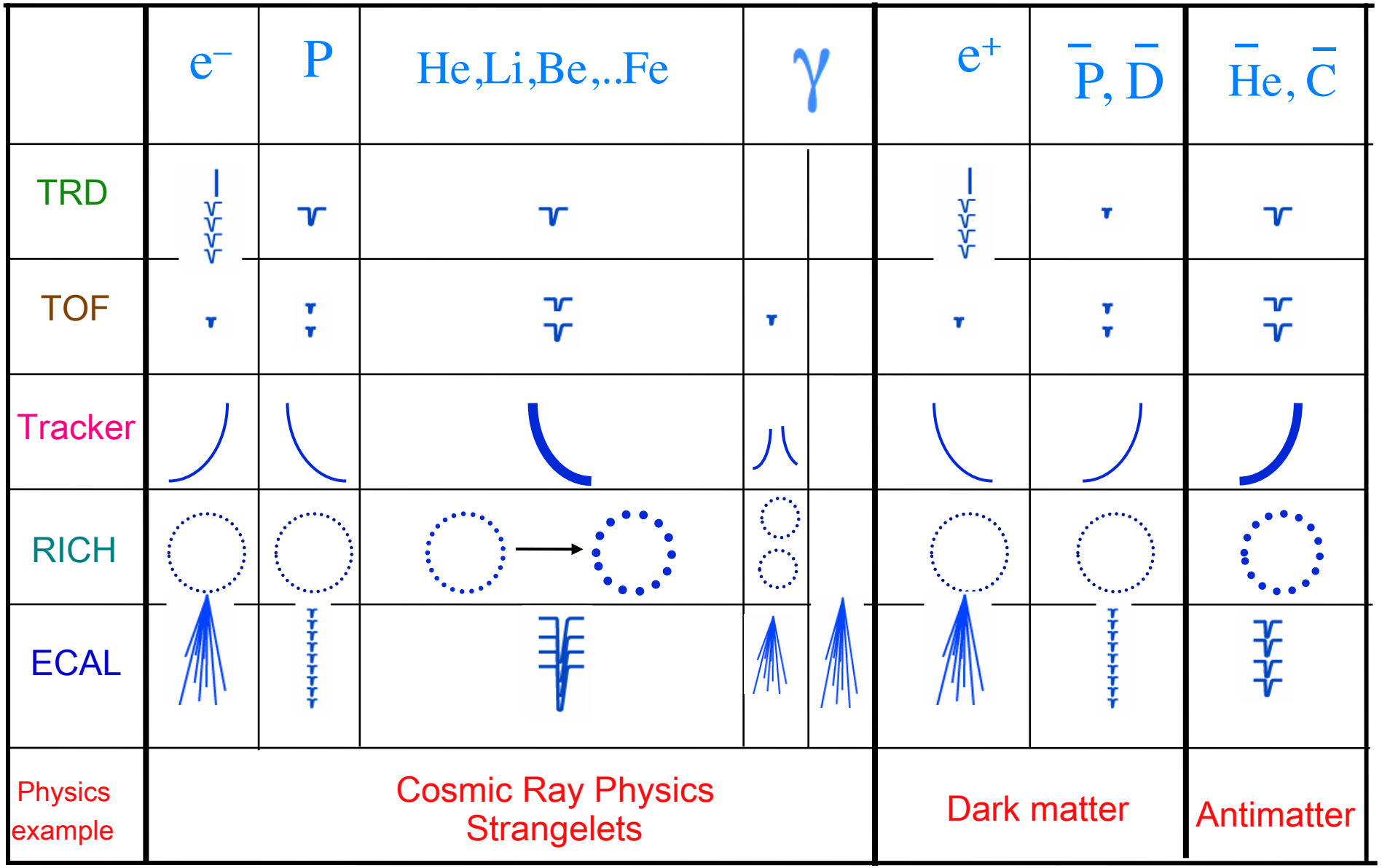
RICH
Z, E



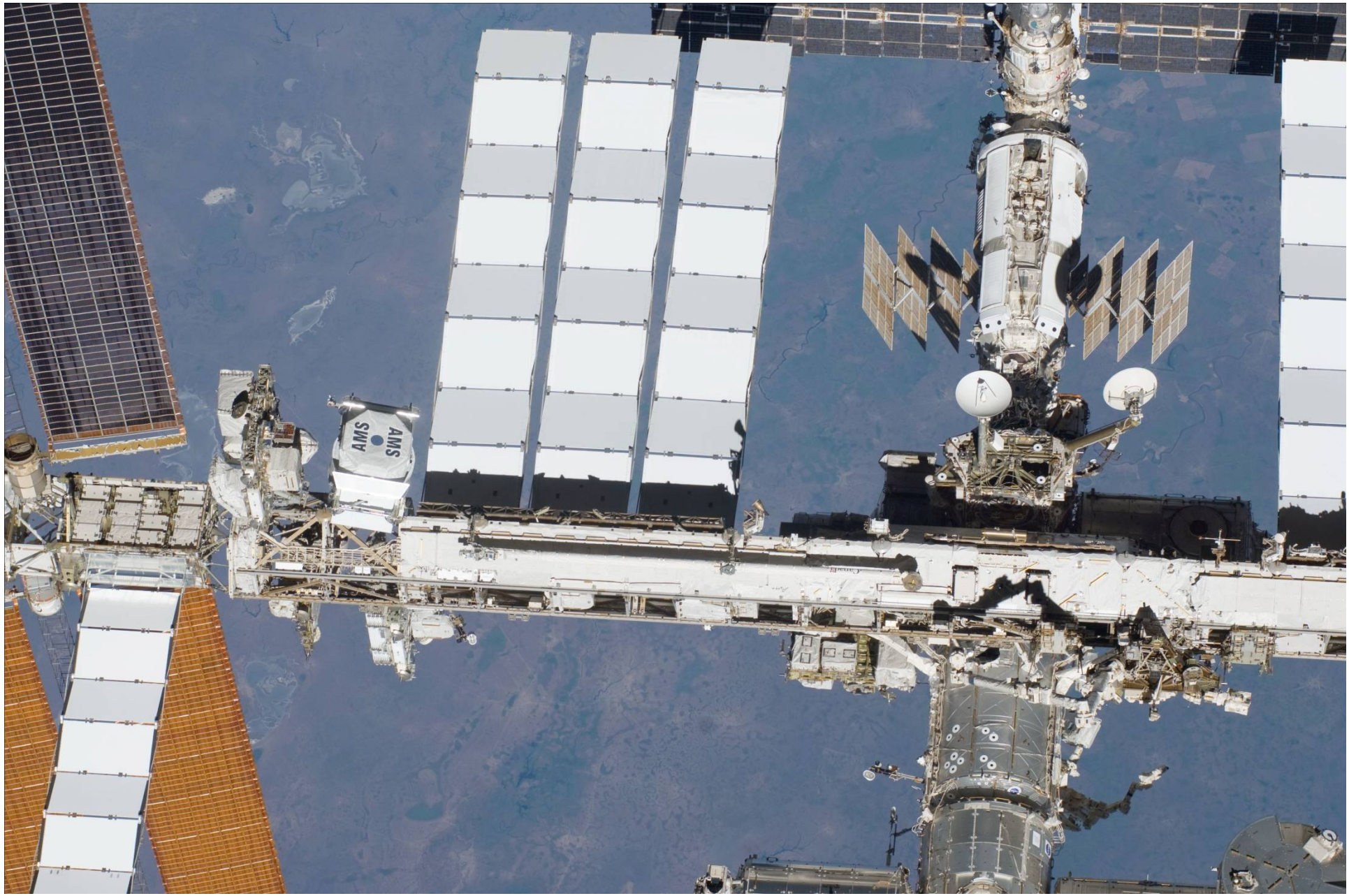
***Z, P** are measured independently by the Tracker, RICH, TOF and ECAL*

MDR = 2 TeV

Particle Identification with AMS

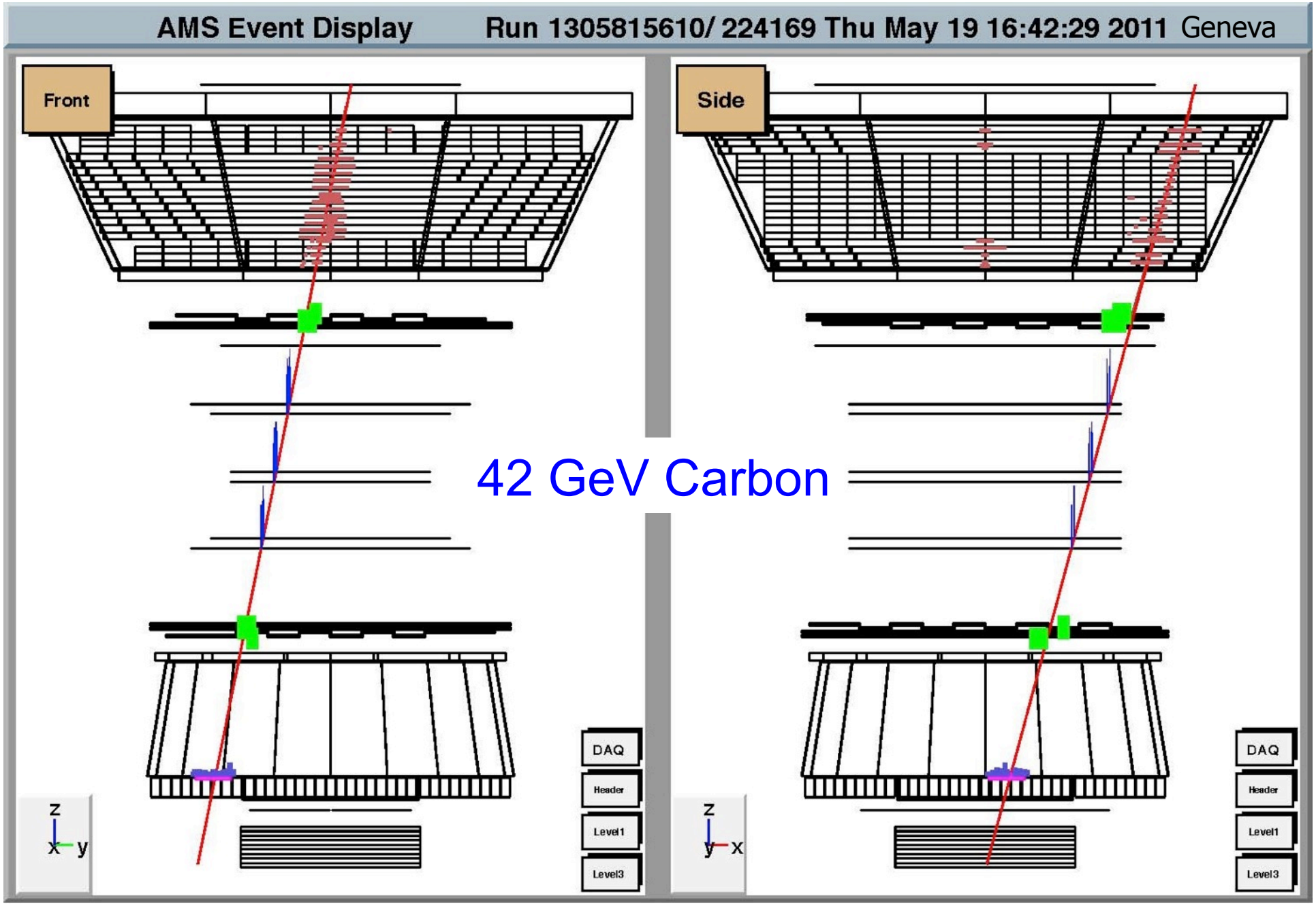



May 16, 2011 @ 08:56 AM

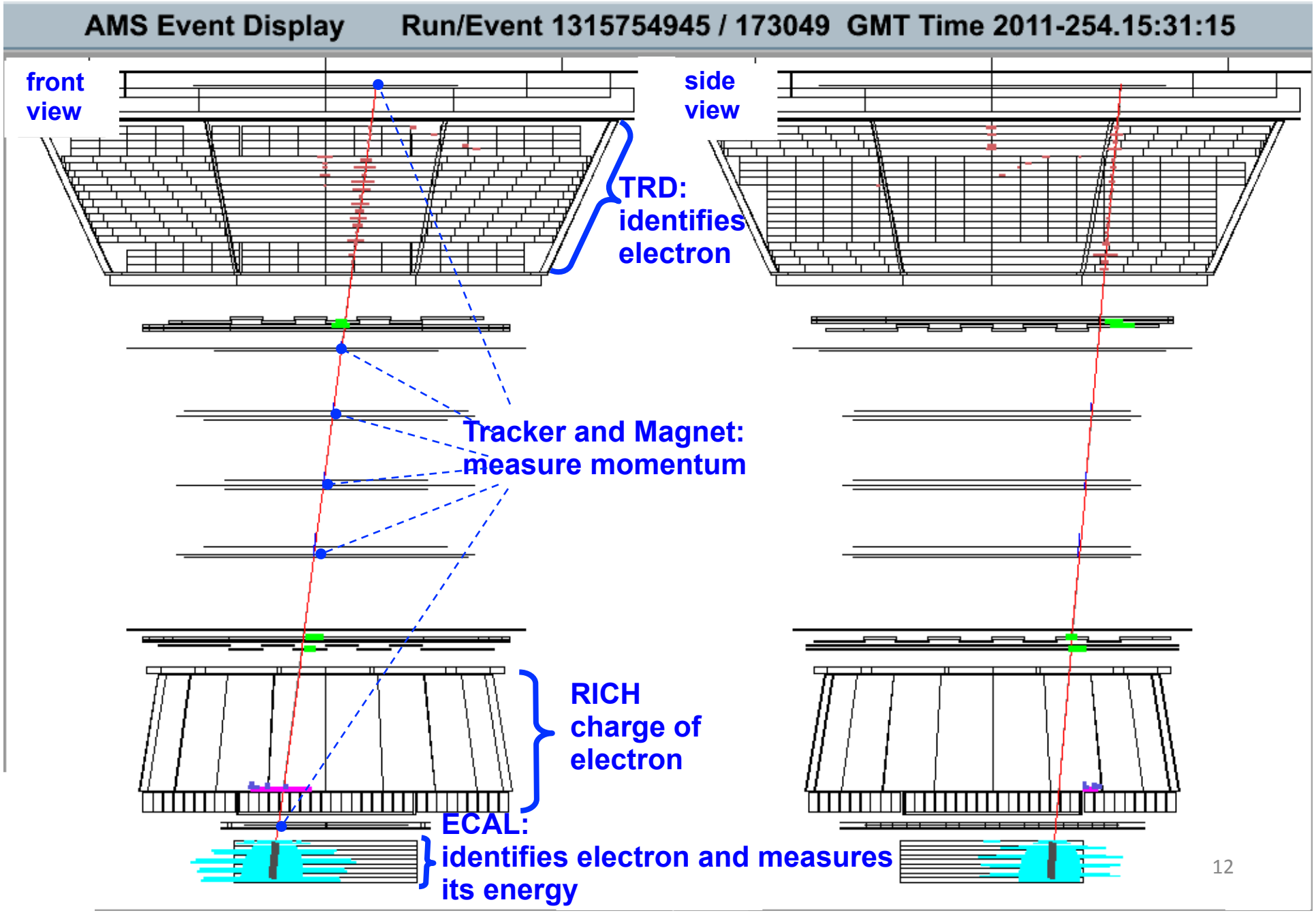


May 19, 2011: AMS installation completed at 5:15 CDT, data taking started at 9:35 CDT

May 19: AMS installed on ISS 5:15 CDT, start taking data 9:35 CDT



1.03 TeV electron

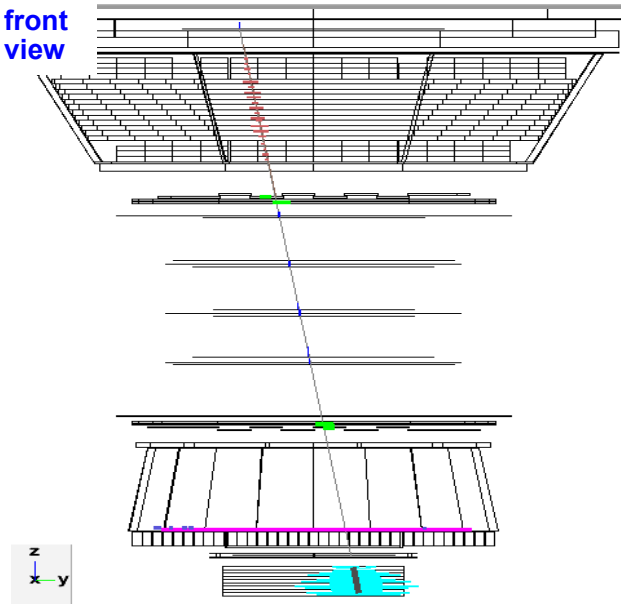


12

High energy e+

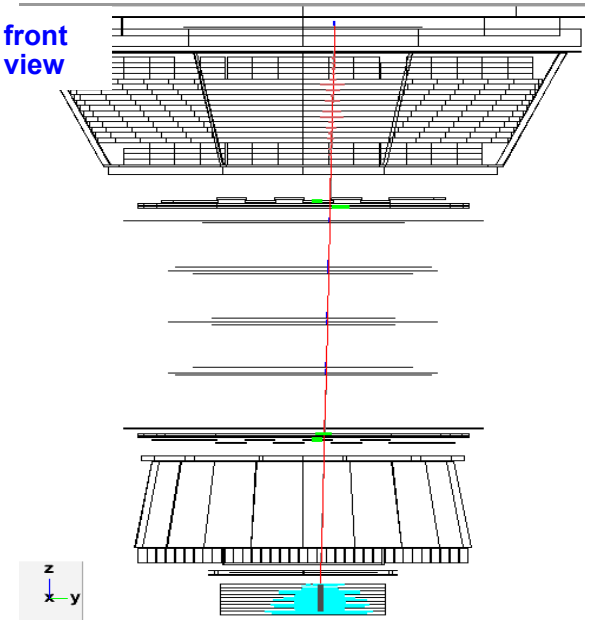
205 GeV Positron

front view



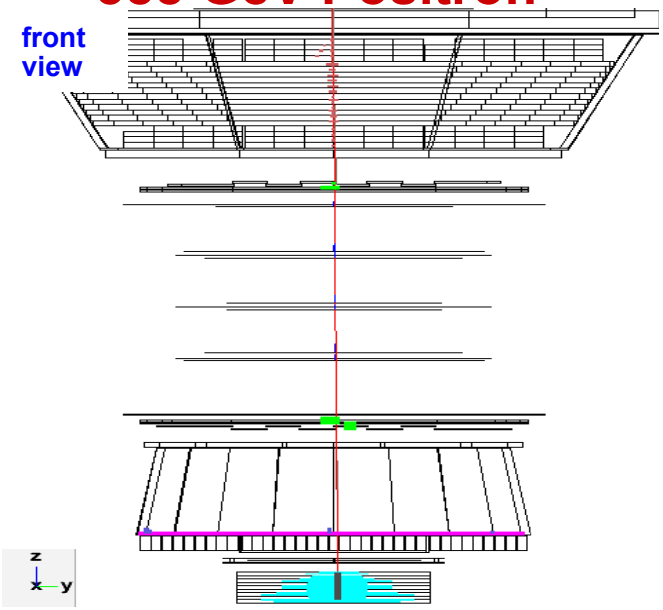
369 GeV Positron

front view



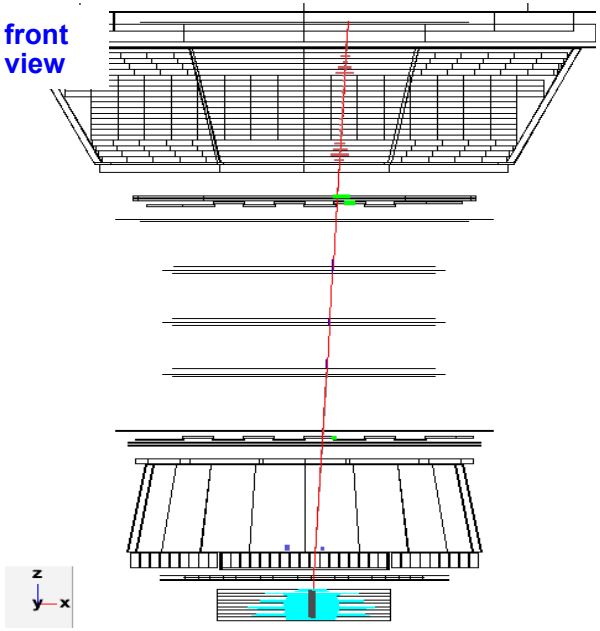
388 GeV Positron

front view

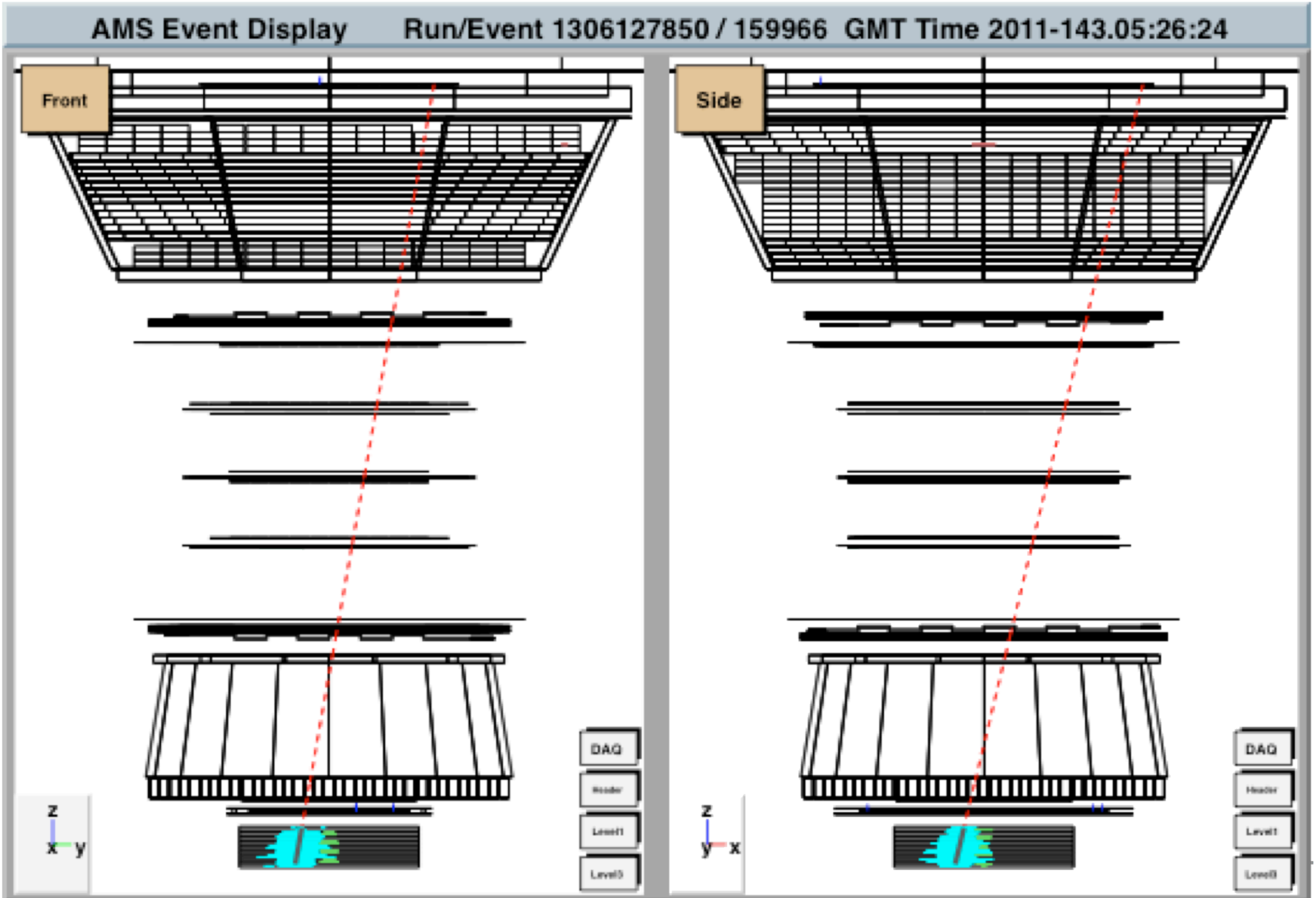


424 GeV Positron

front view

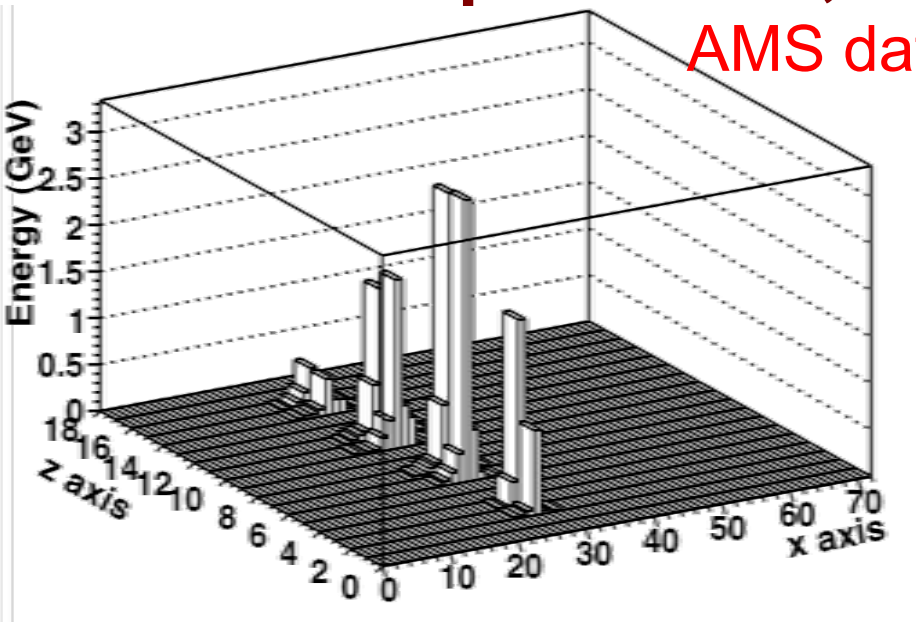


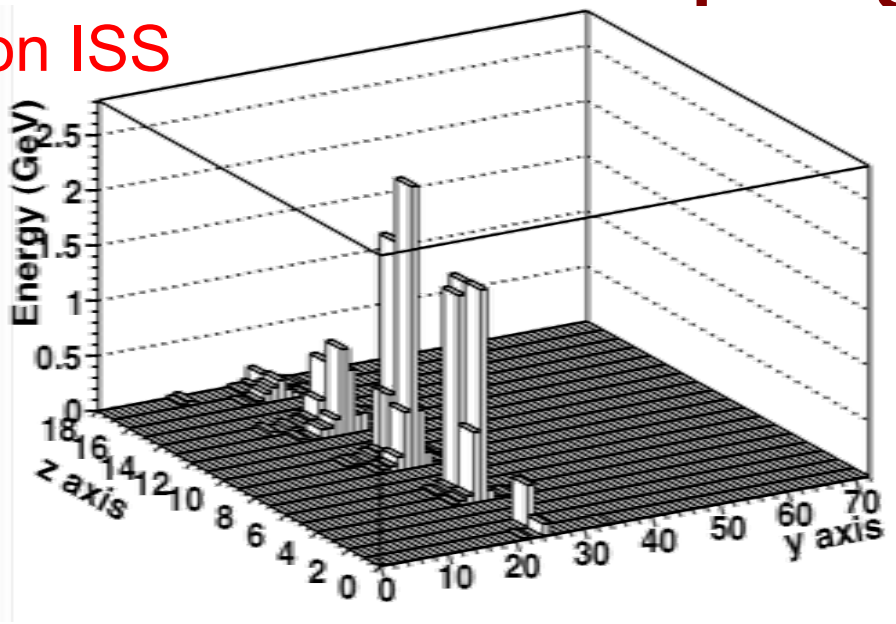
Photon 40 GeV

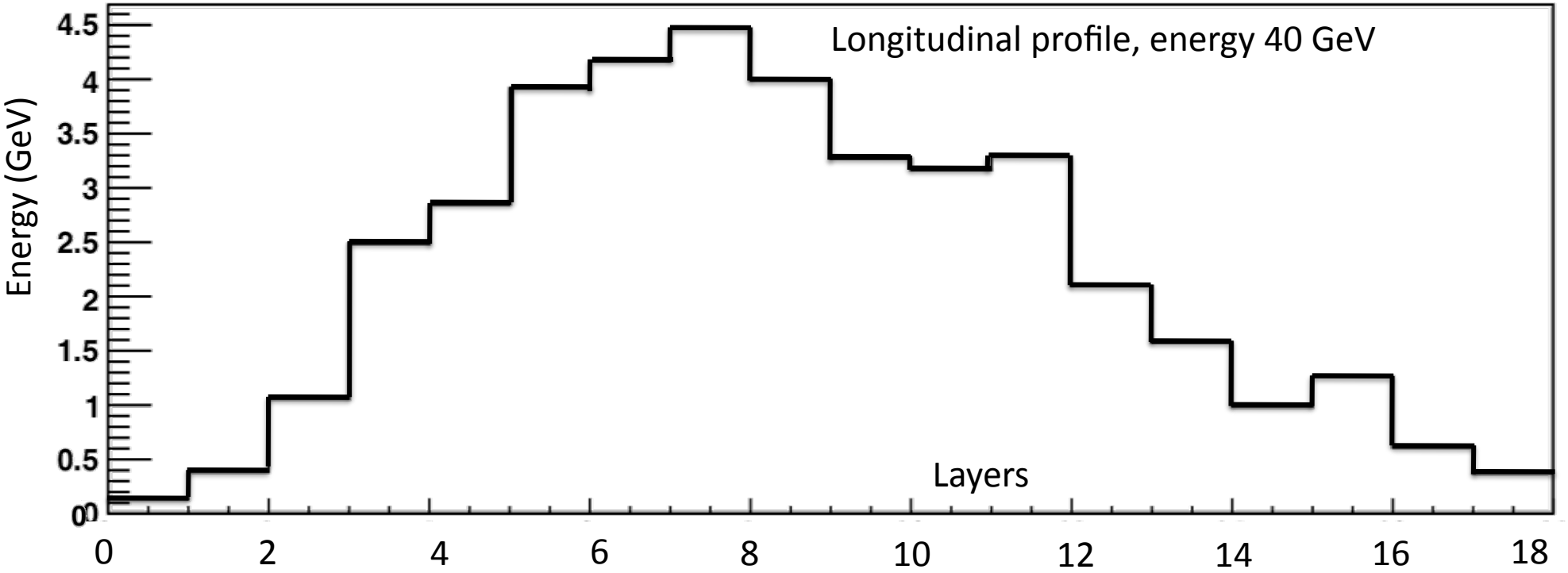


40 GeV photon, 3D shower sampling

AMS data on ISS



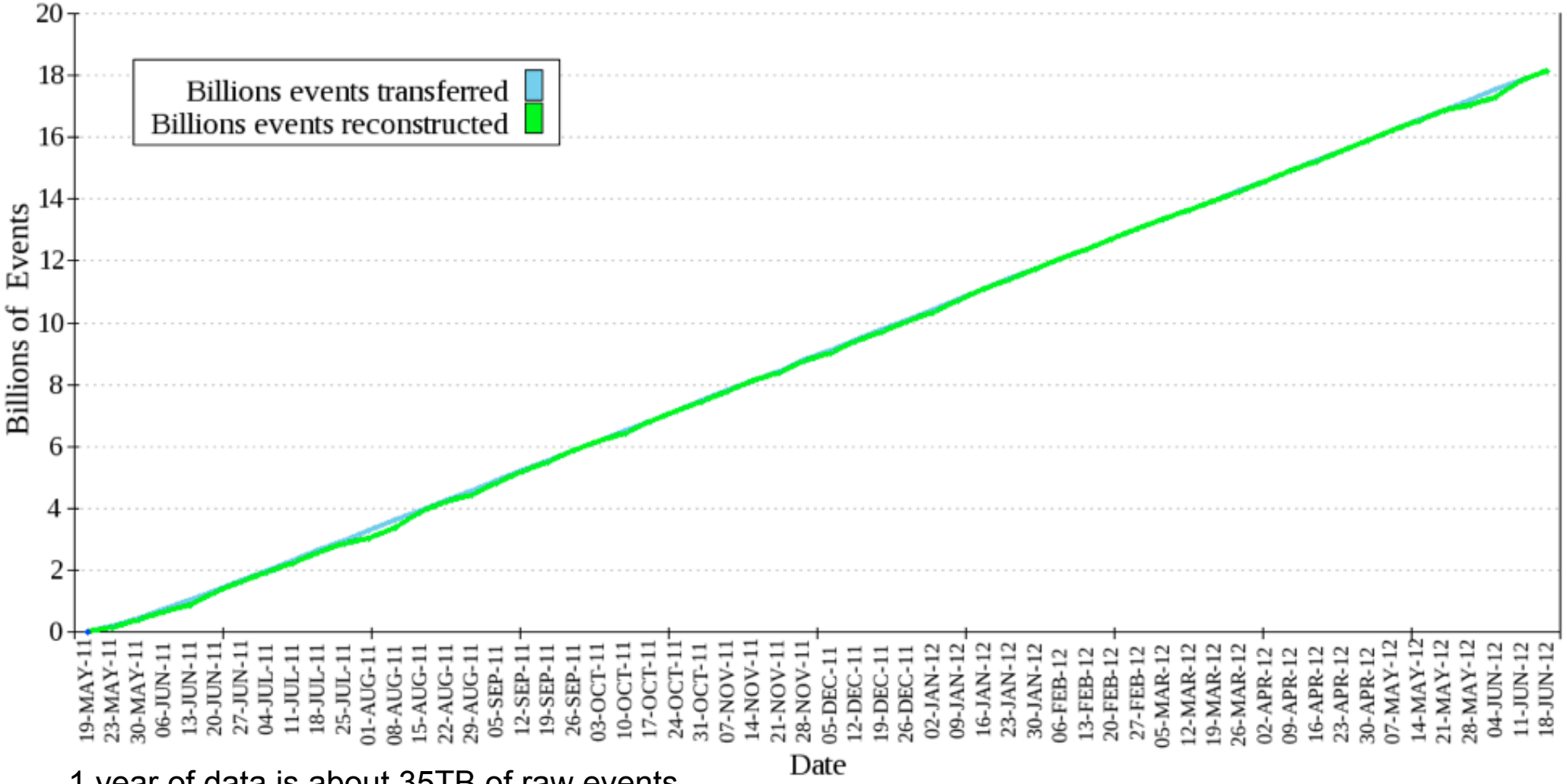




AMS collected over 18 billion of events

Every year, we will collect $16*10^9$ events

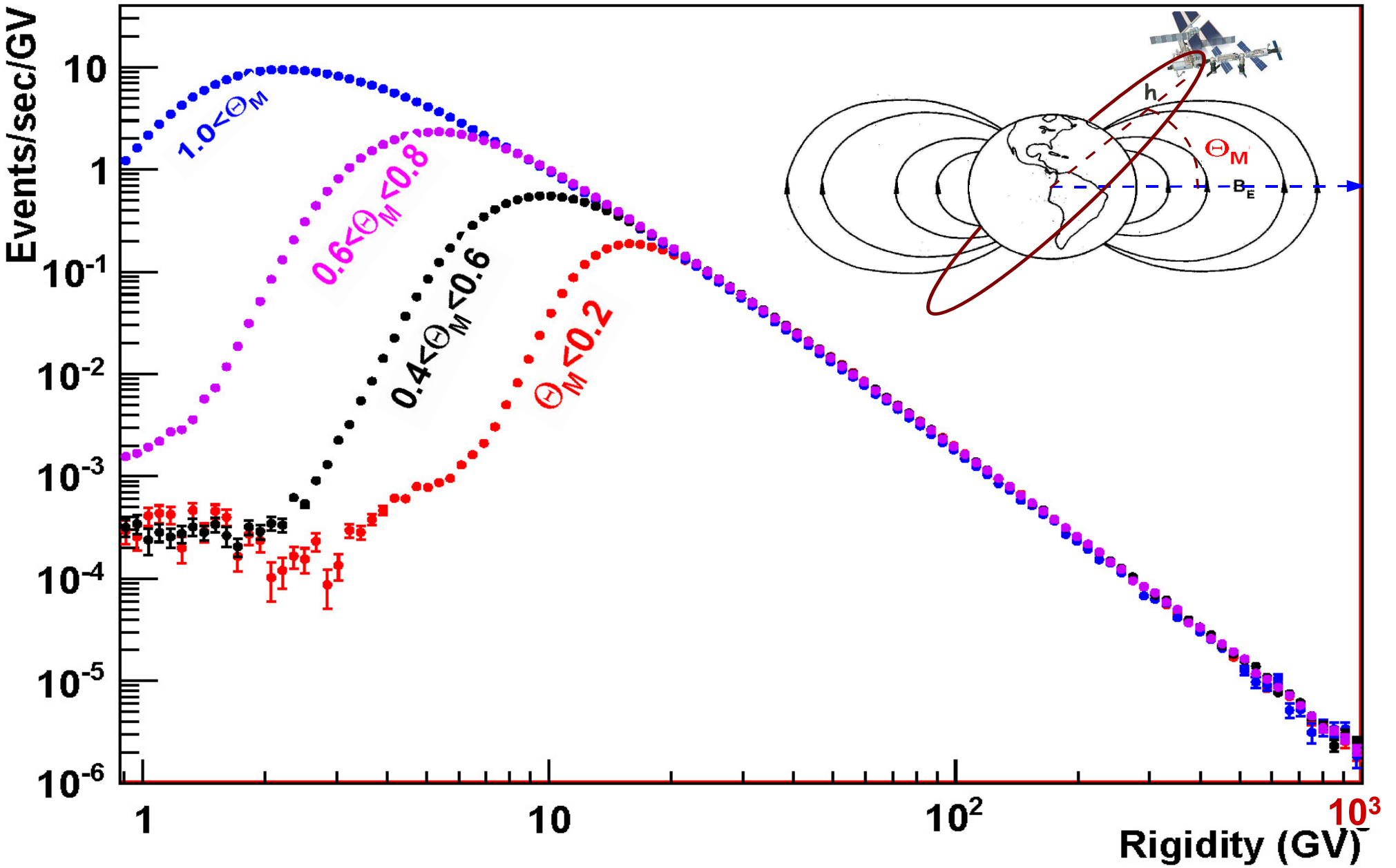
This will provide unprecedented sensitivity to search for new physics.



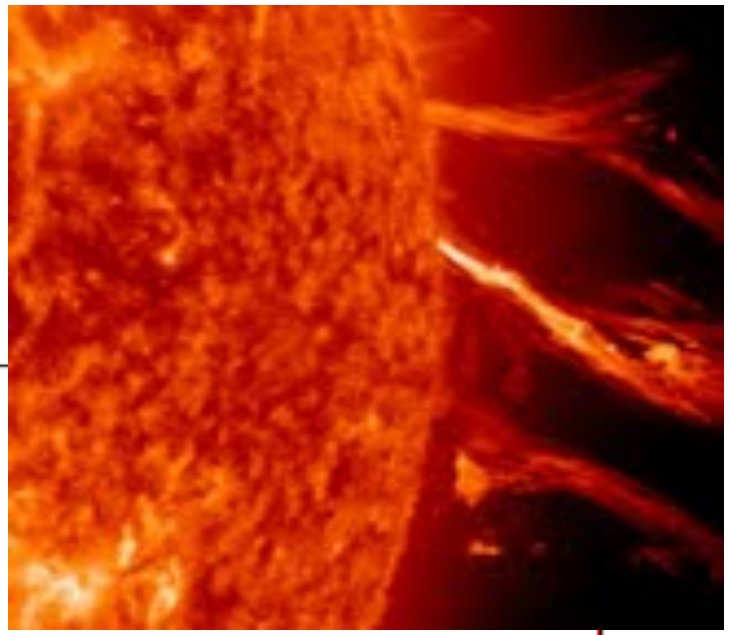
1 year of data is about 35TB of raw events

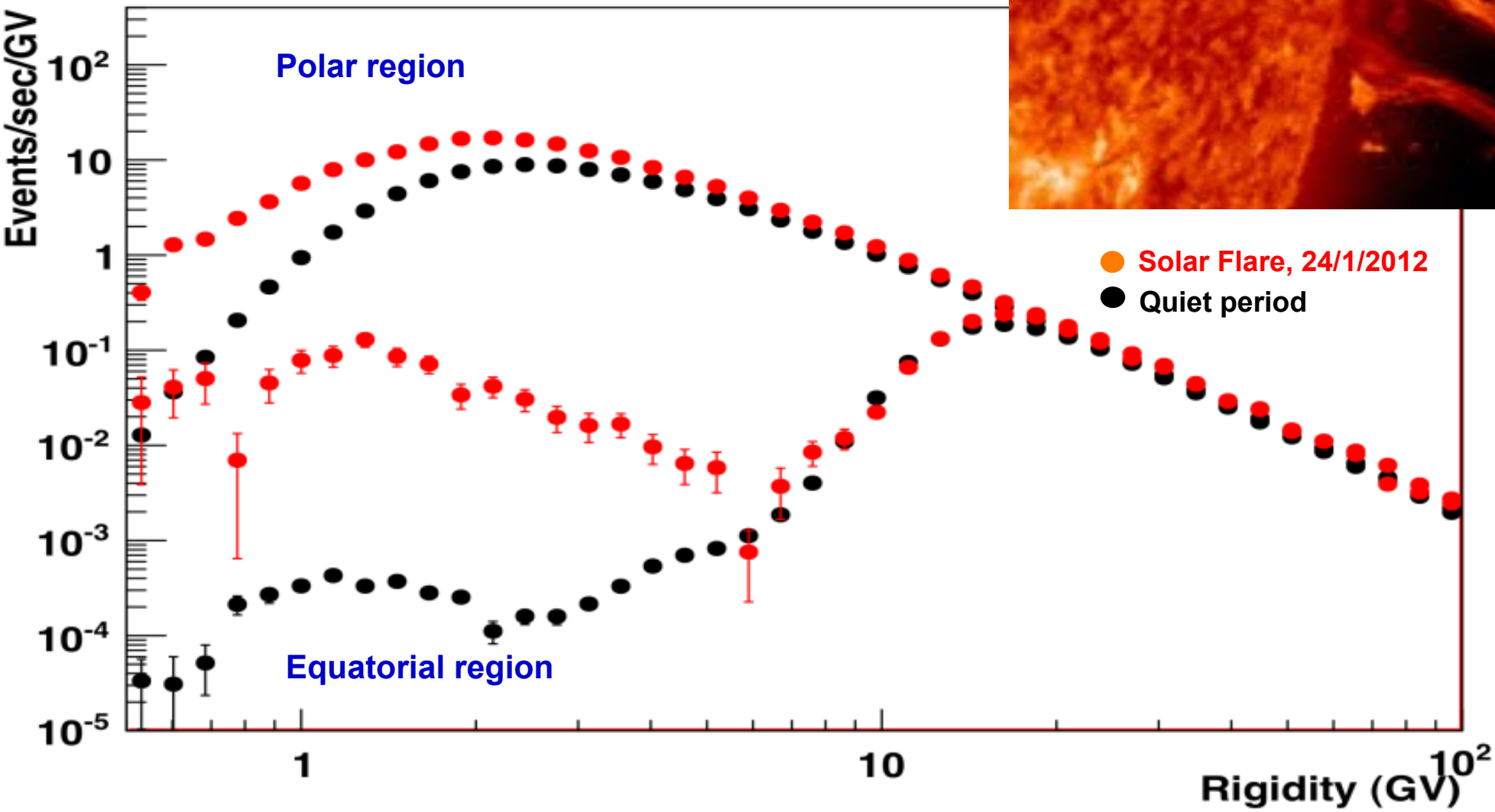
First year of data reproduction is completed after detector calibration and ready for analysis

AMS data on the ISS: He rate



AMS data:
He rate and Solar flare



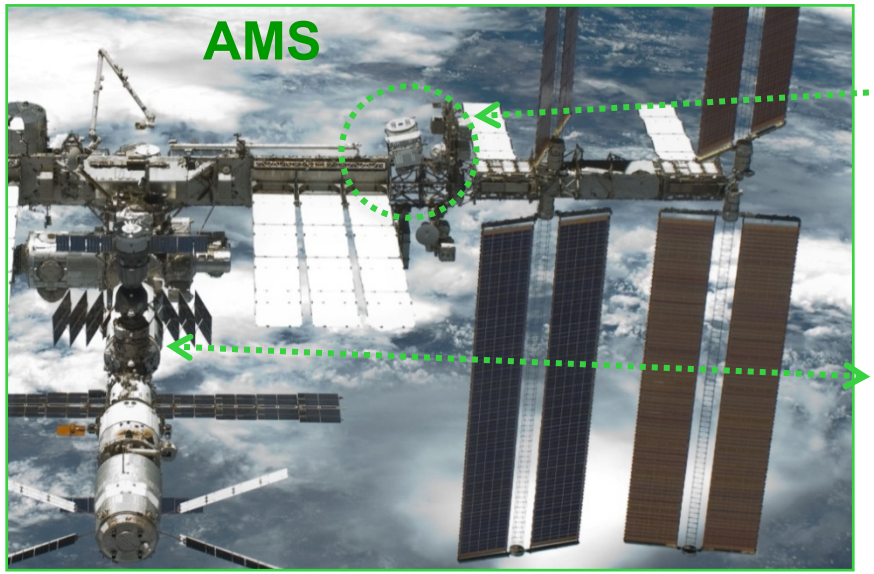


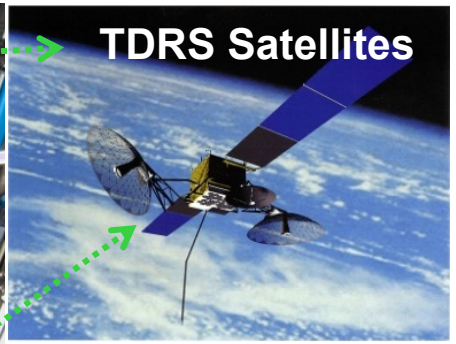
The first year:

→ Operation

→ Calibration in Space

AMS Operations





Ku-Band
High Rate (down):
Events <10Mbit/s>

Flight Operations
Ground Operations

S-Band
Low Rate (up & down):
Commanding: 1 Kbit/s
Monitoring: 30 Kbit/s

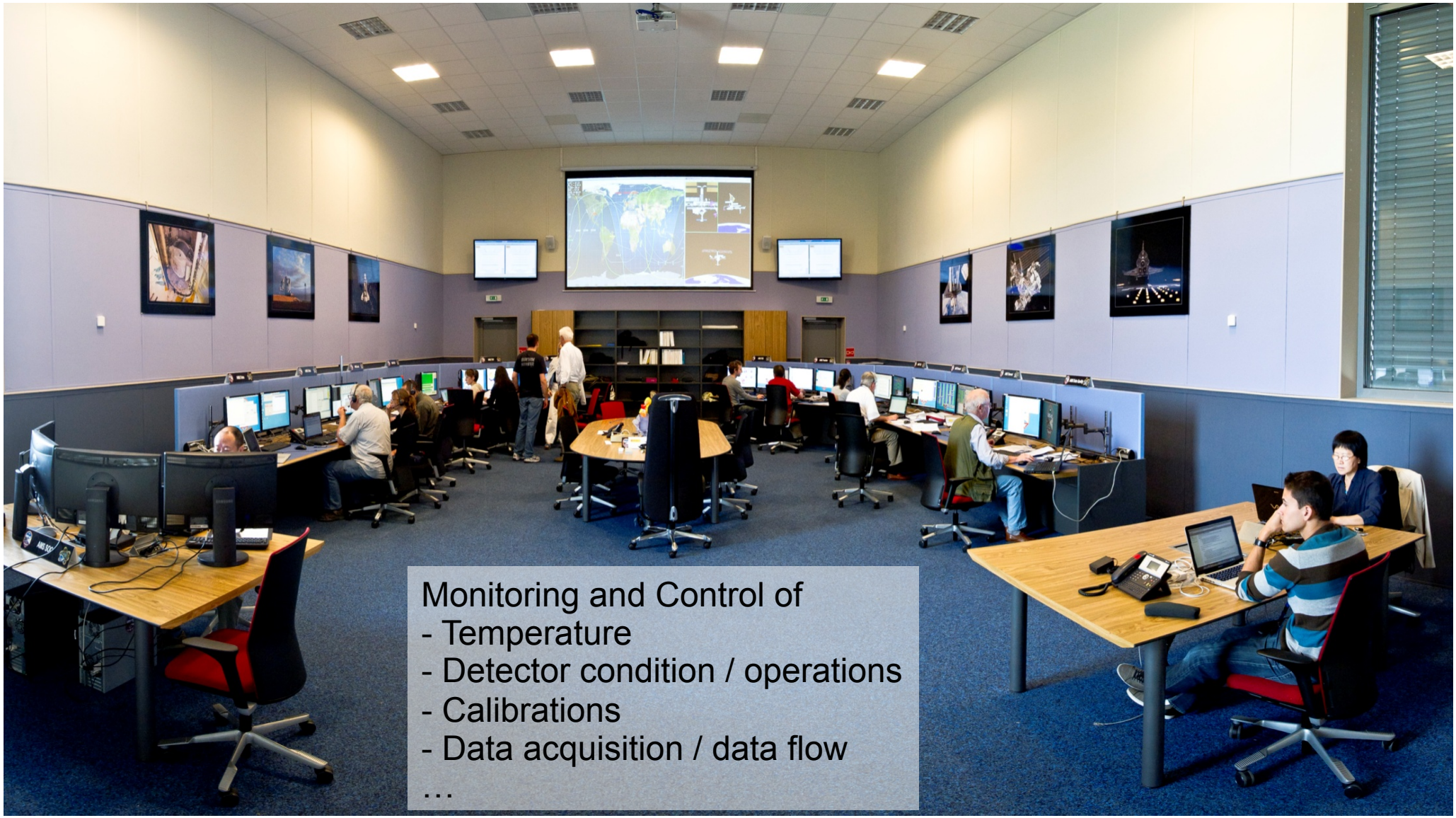
AMS Payload Operations Control and Science Operations Centers (POCC, SOC) at CERN

AMS Computers at MSFC, AL

White Sands Ground Terminal, NM

Payload Operations Control Center (POCC)

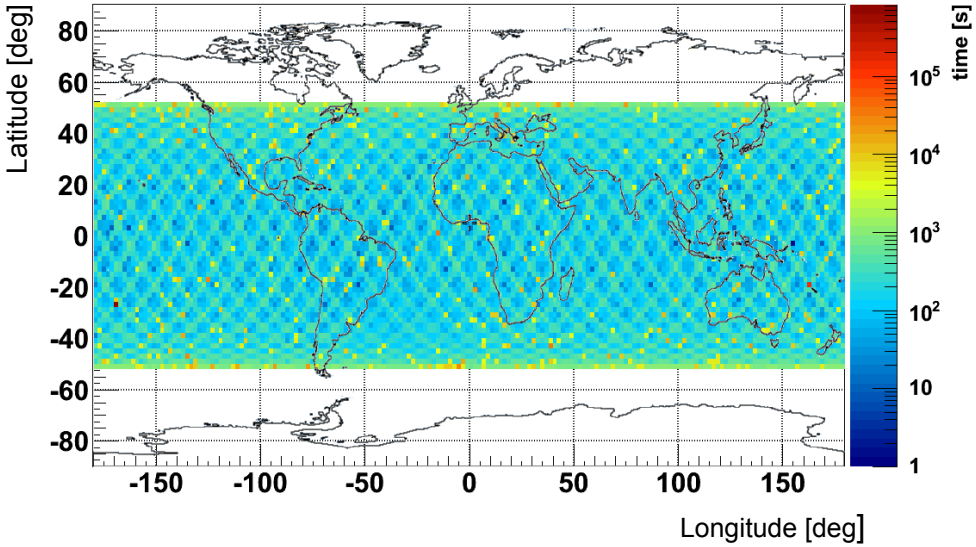
at CERN since 19th June 2011



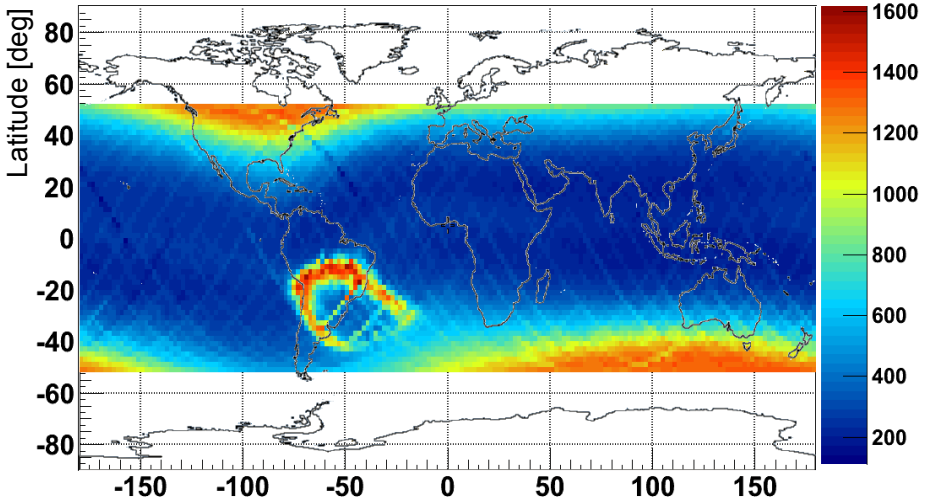
SOC (Science Operation Center): production of *root* files for science analysis

Orbital DAQ parameters

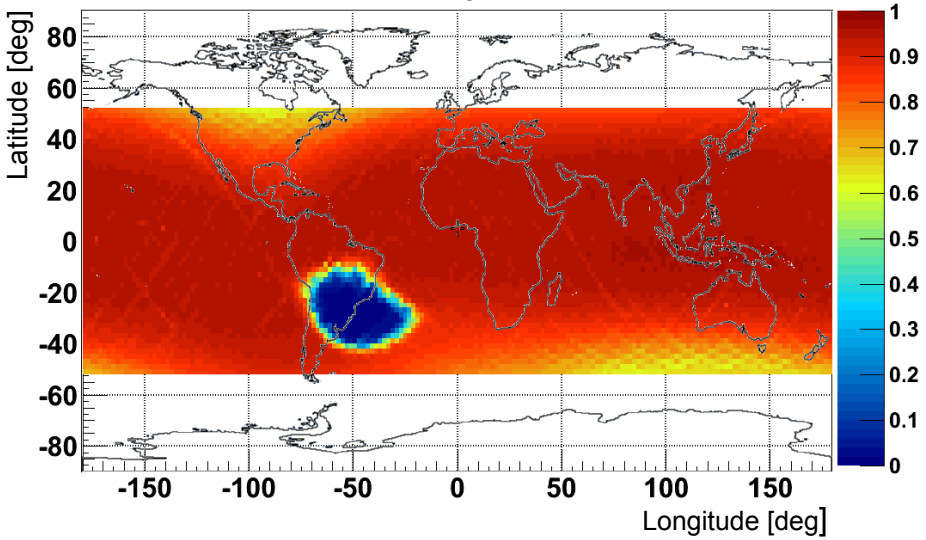
Time at location [s]



Acquisition rate [Hz]



DAQ efficiency

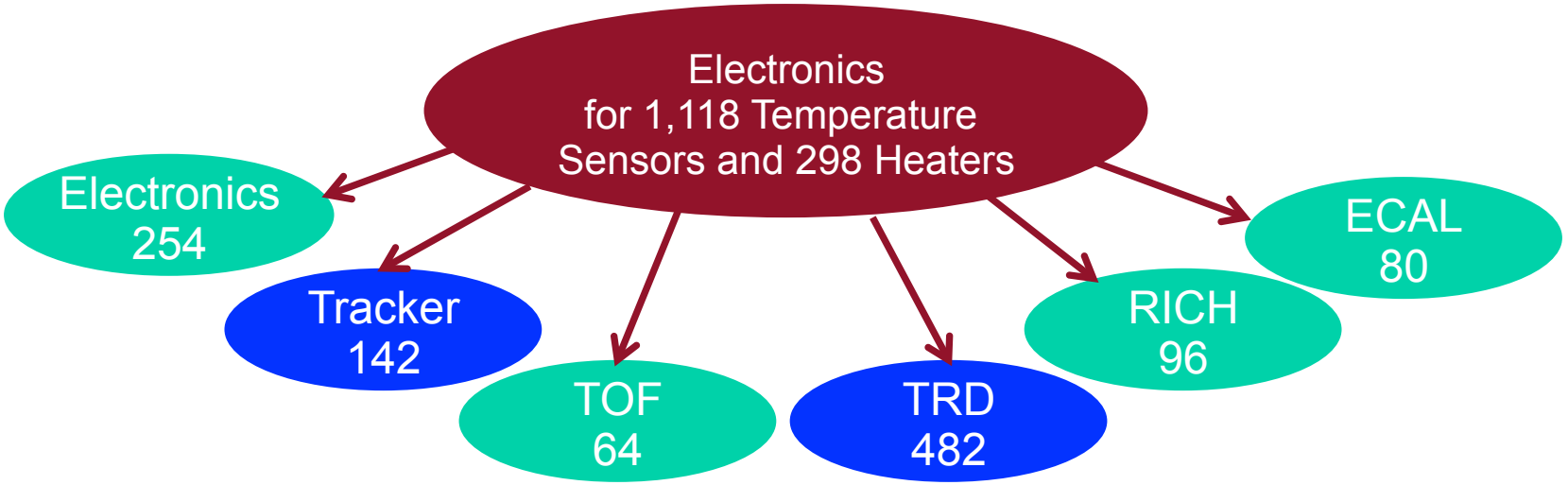


ISS orbits at about 400km
with an inclination of 51.7 degrees

Particle rates: 200 to 2000 Hz per orbit

Orbit average: DAQ efficiency 85%
DAQ rate ~530Hz

AMS Flight Electronics for Thermal Control



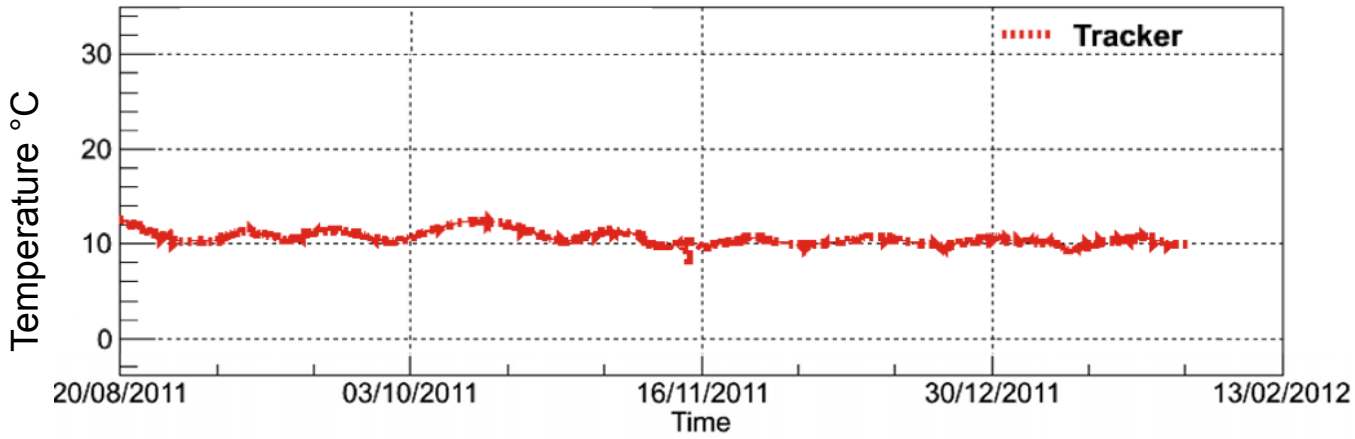
One of the major challenges of operating in space is the extreme thermal environments to which the experiment is exposed.

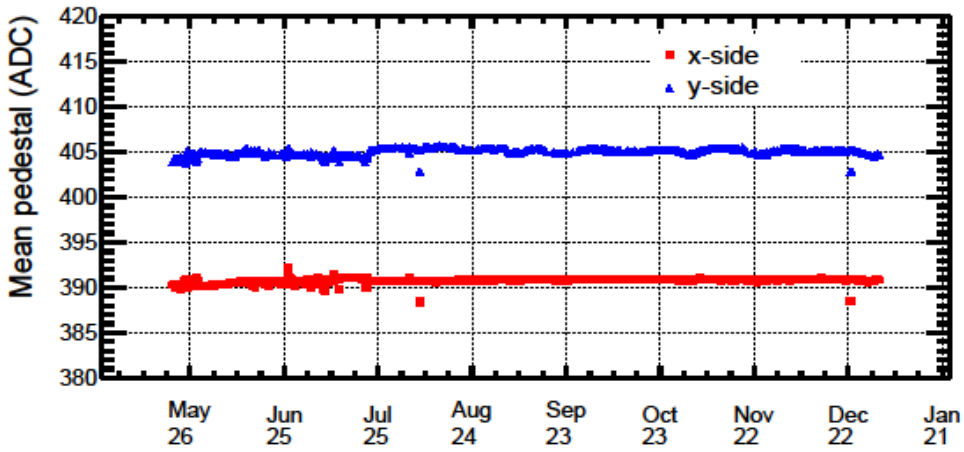
AMS developed computers which are programmable from the POCC for all the monitoring and control. They readout the 1118 temperature sensors and control 298 heaters.

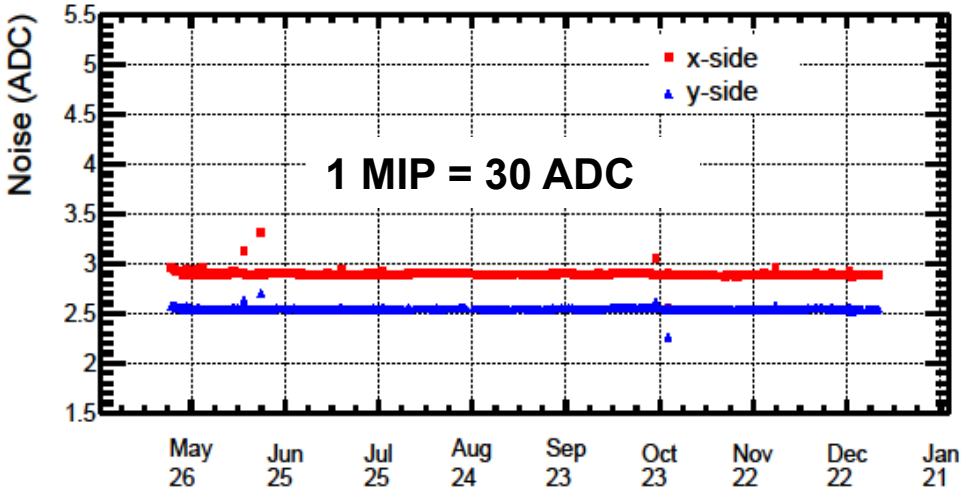
The Tracker and TRD have dedicated Thermal Control Systems. Thermal control of the other detectors is done by the Global Thermal Control System.

Tracker on orbit performance

Temperature effects

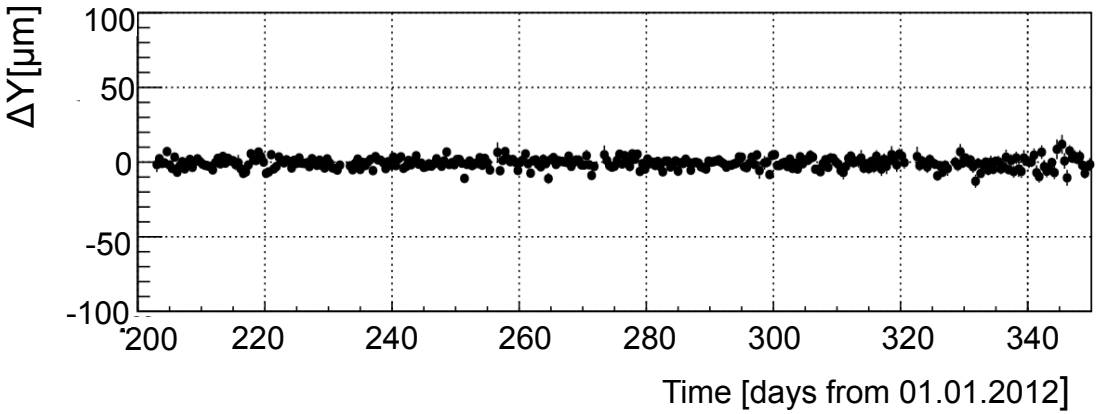


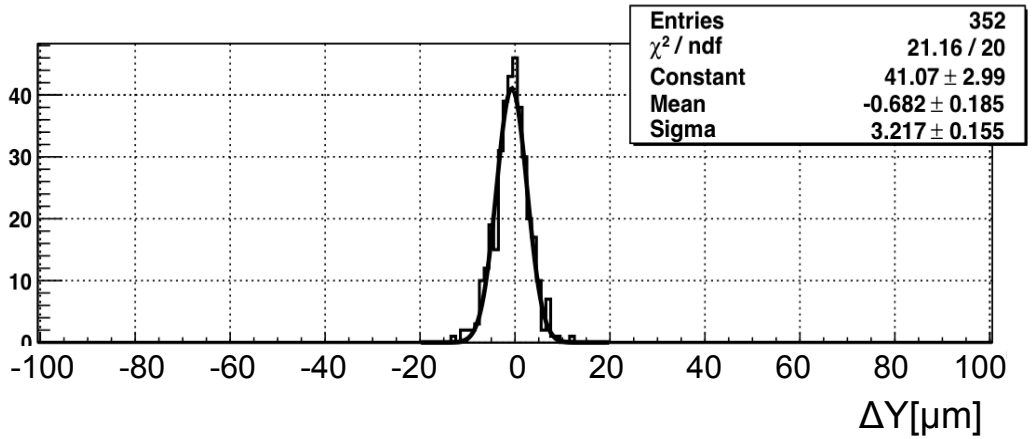


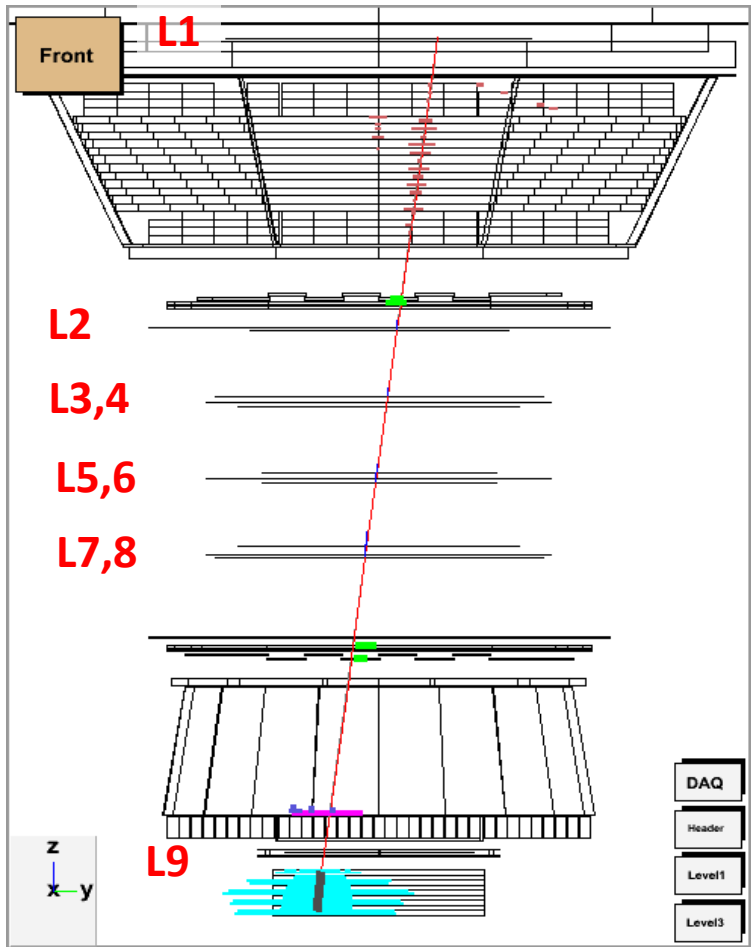


Time stability of Tracker alignment

Stability of Layer 1 alignmnent tracker alignment with respect to the inner tracker

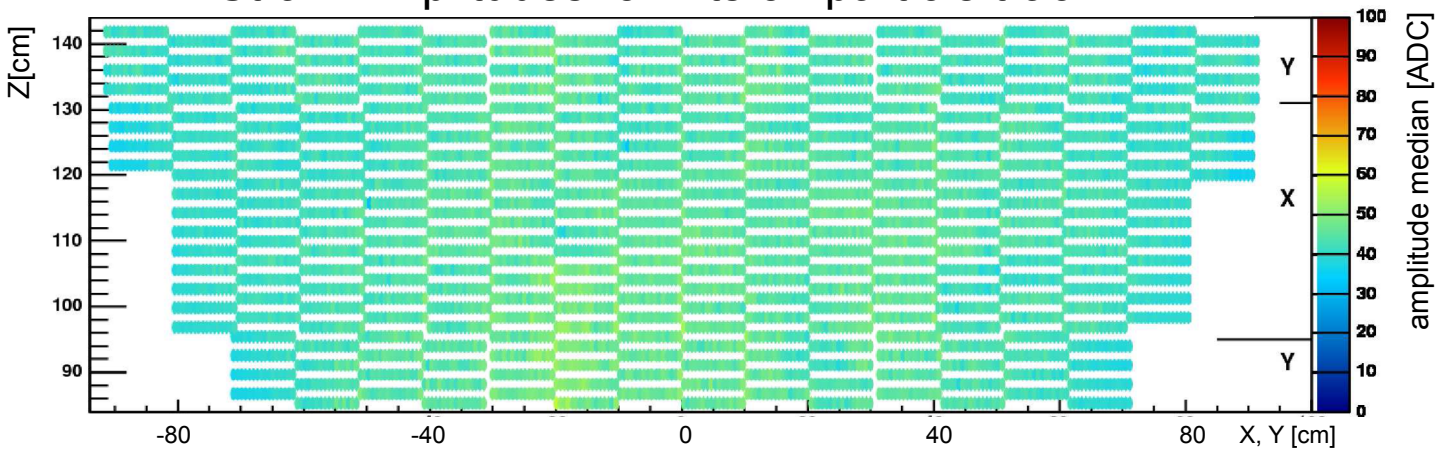






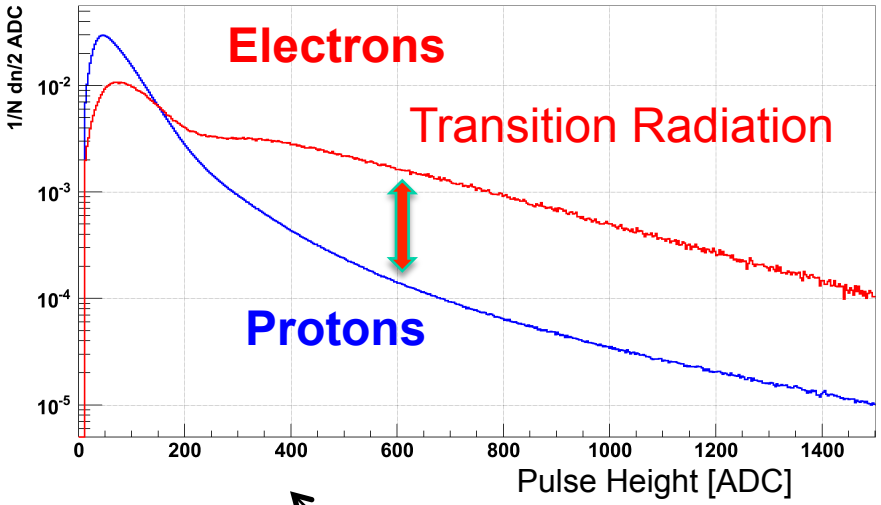
TRD on orbit performance

TRD-Straw Amplitudes for hits on particle track

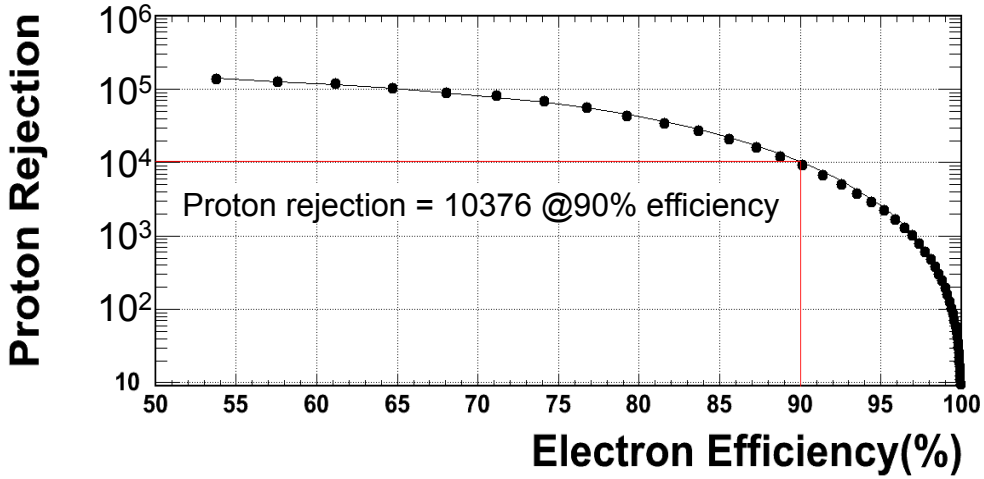


All 5248 channels operational

Typical spectrum in TRD

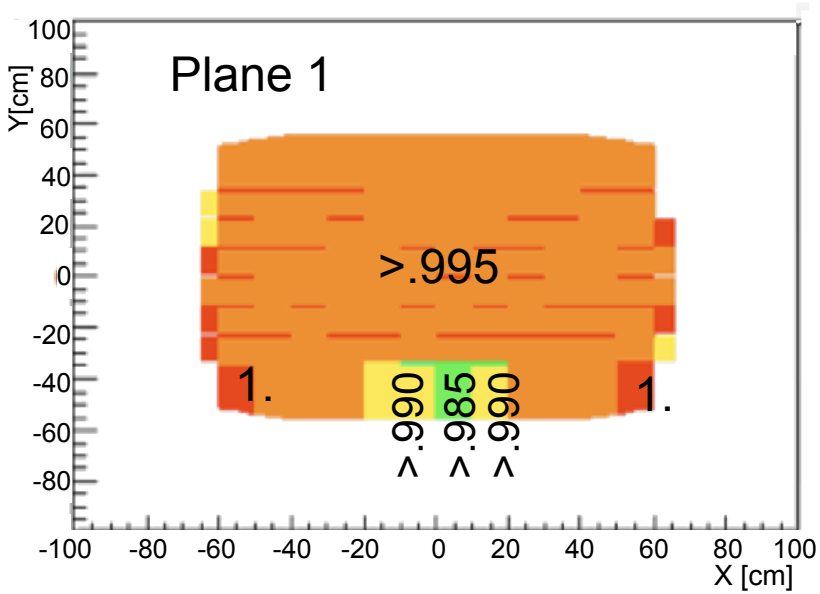


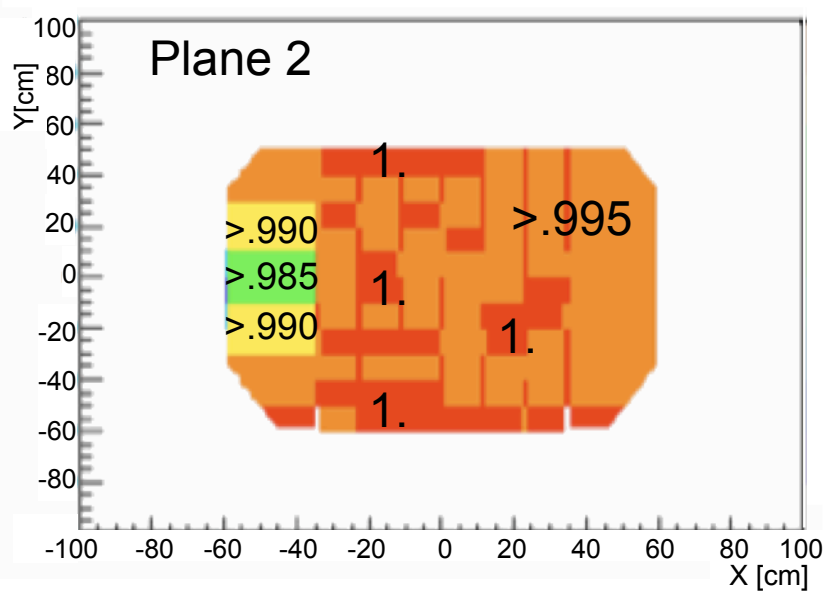
Measurement with 1 of the 20 TRD Layers

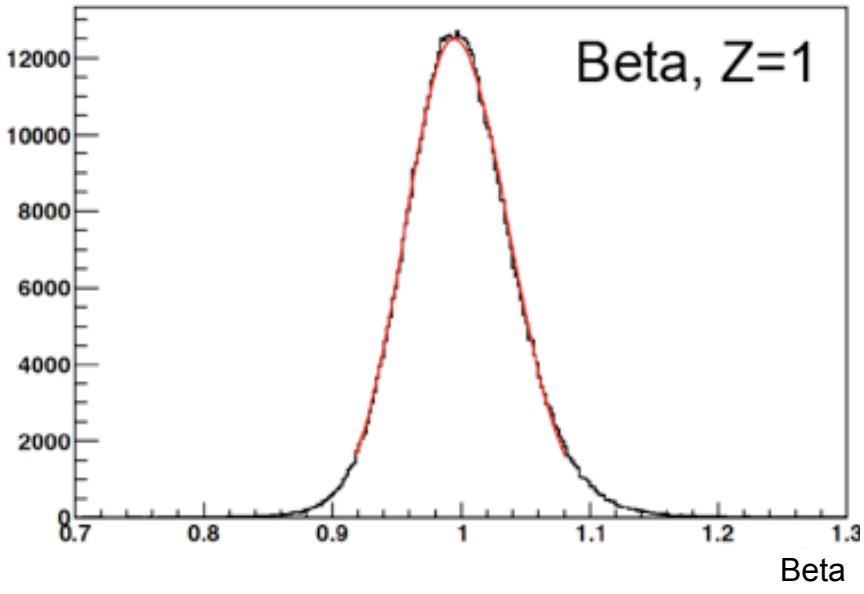


Time of Flight: Trigger & Beta

Single plane efficiencies > 99.5 %





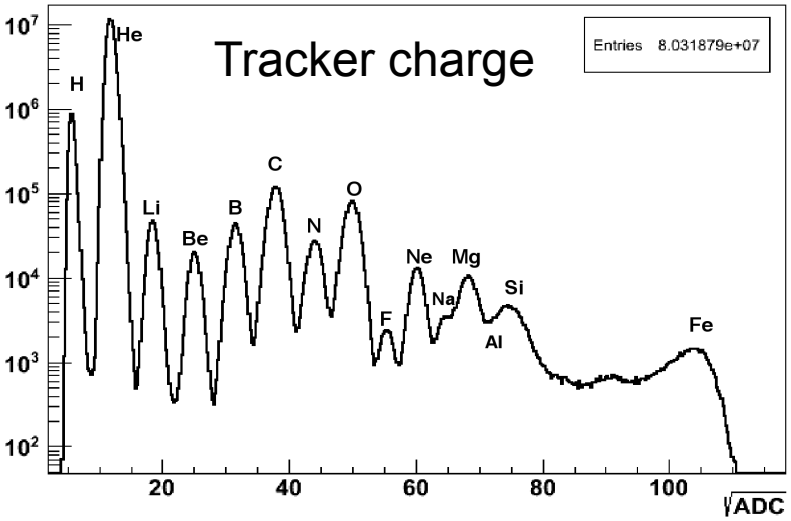


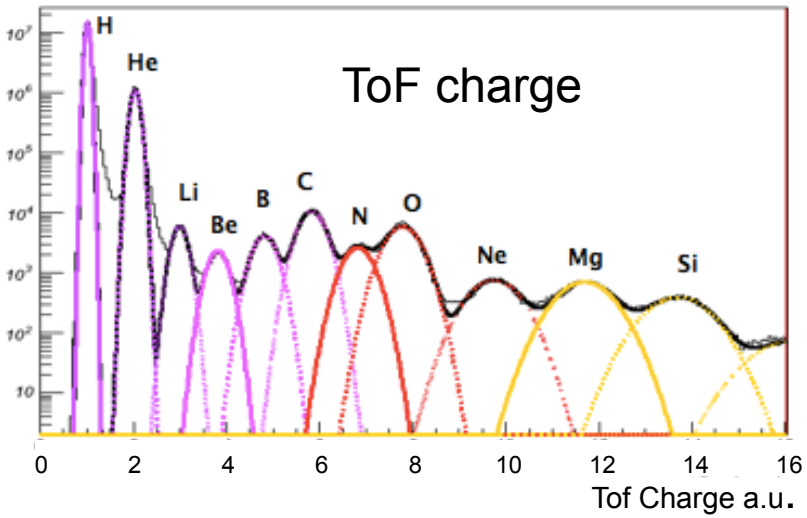
Resolution 4% for protons
and improves with higher Z

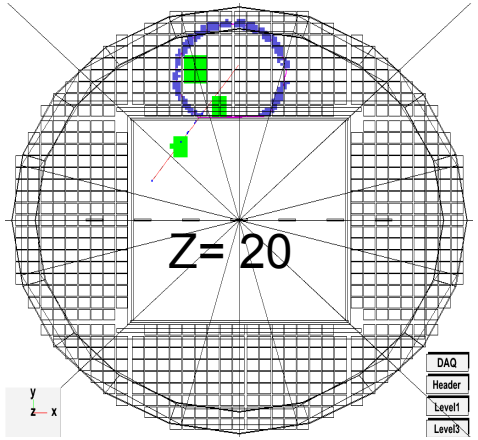
Charge identification

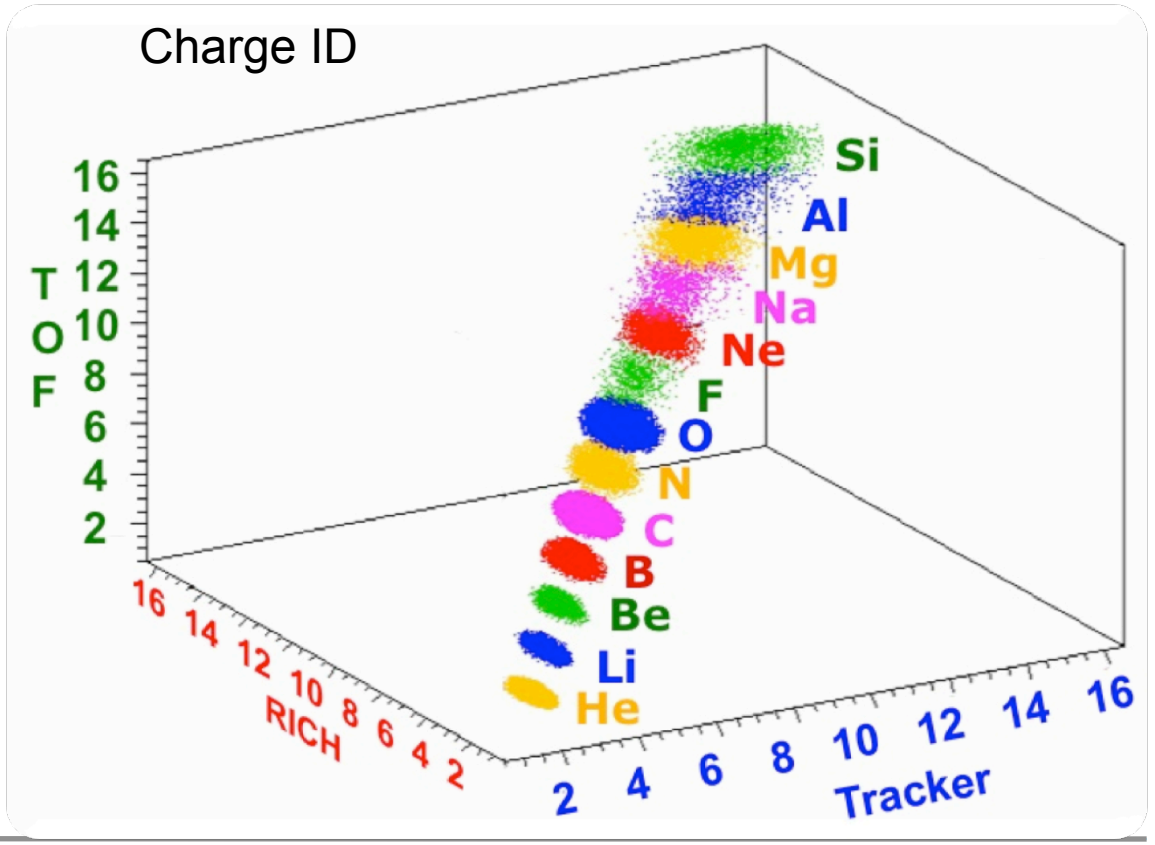
ToF, Tracker, TRD, ECAL:
$dE/dx \approx Z^2$

RICH:
$Z \approx$ #photoelectrons

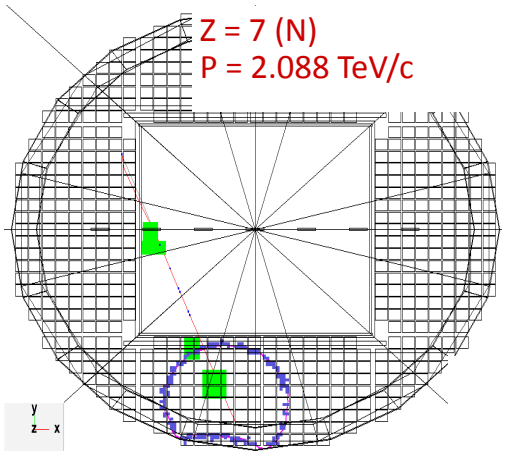


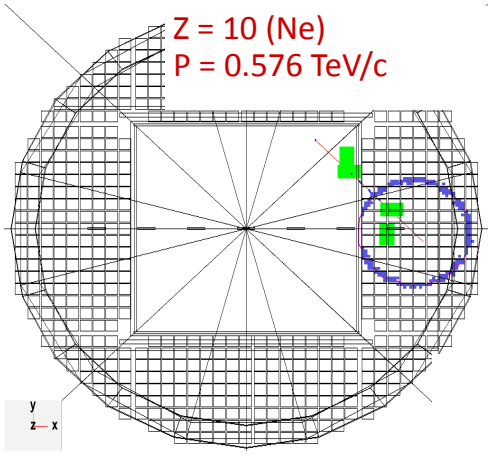


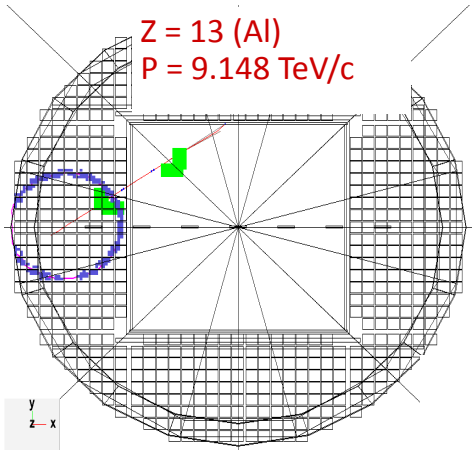


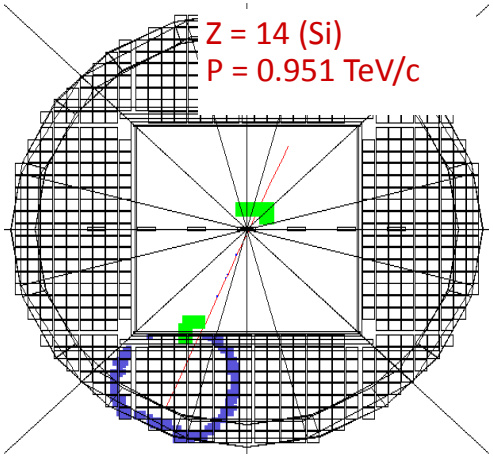


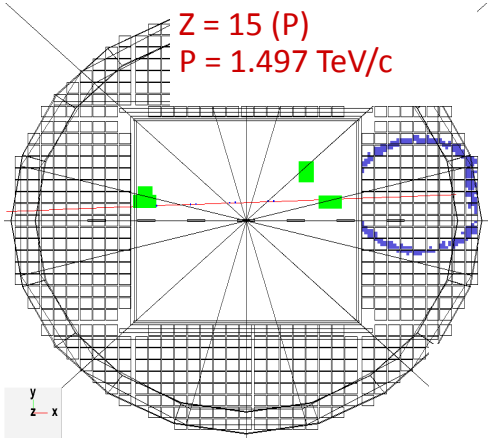
RICH: Nuclei in the TeV range

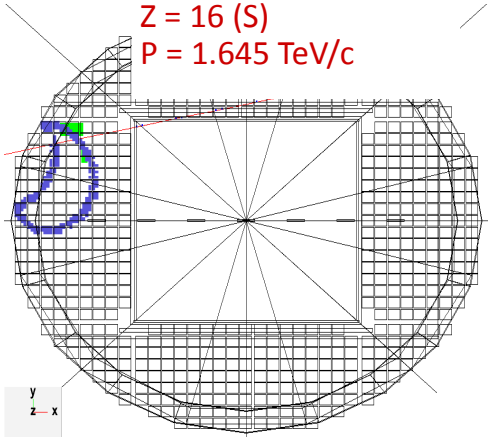


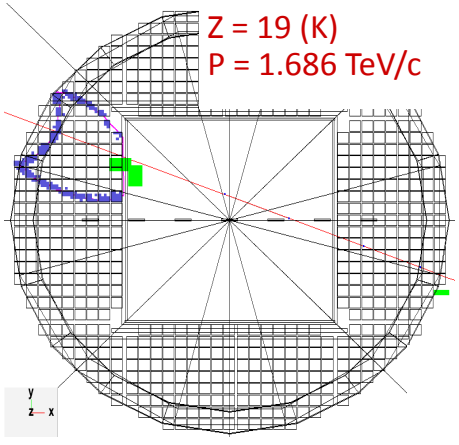


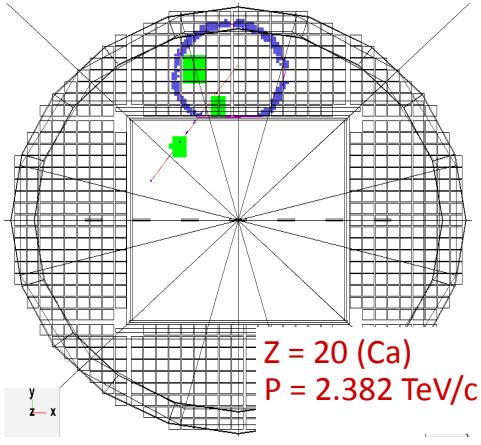


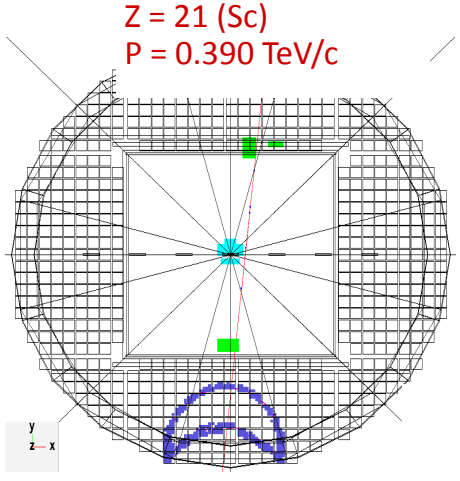


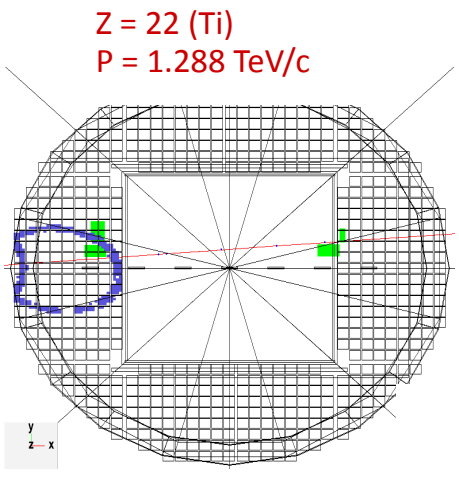


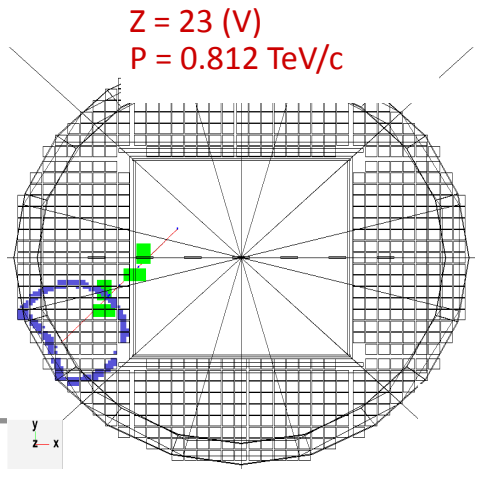


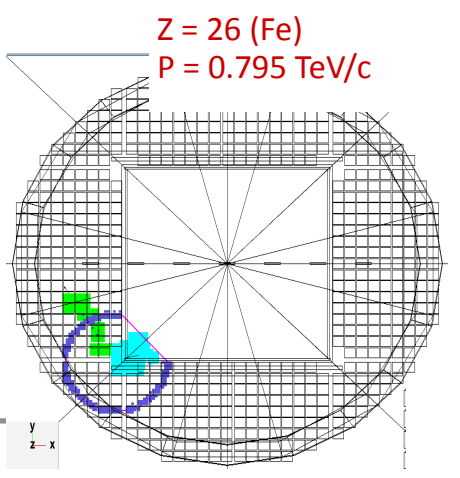




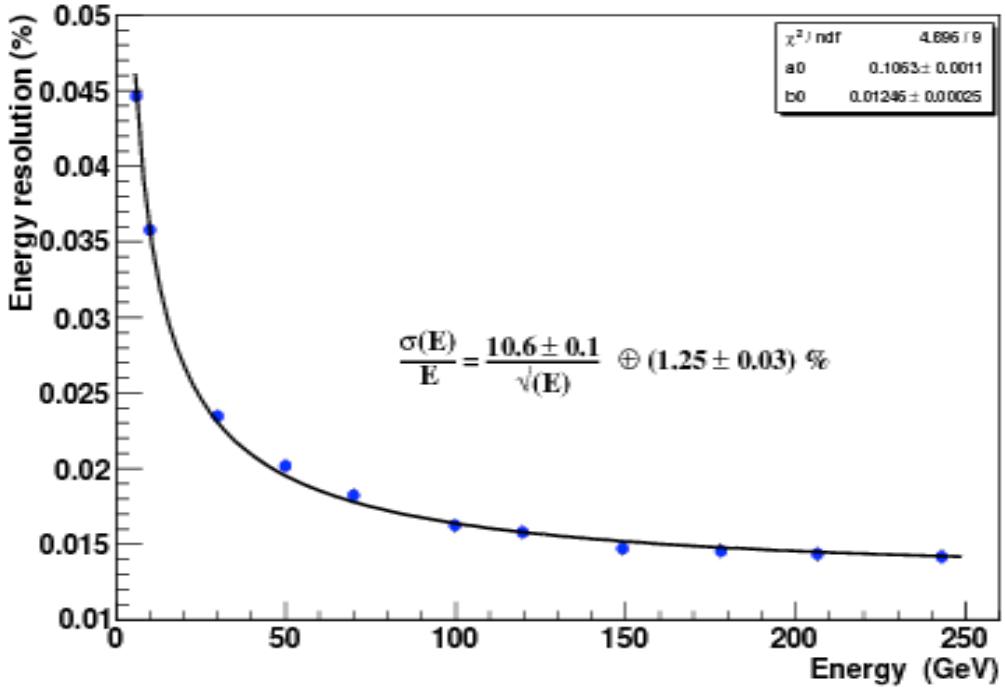






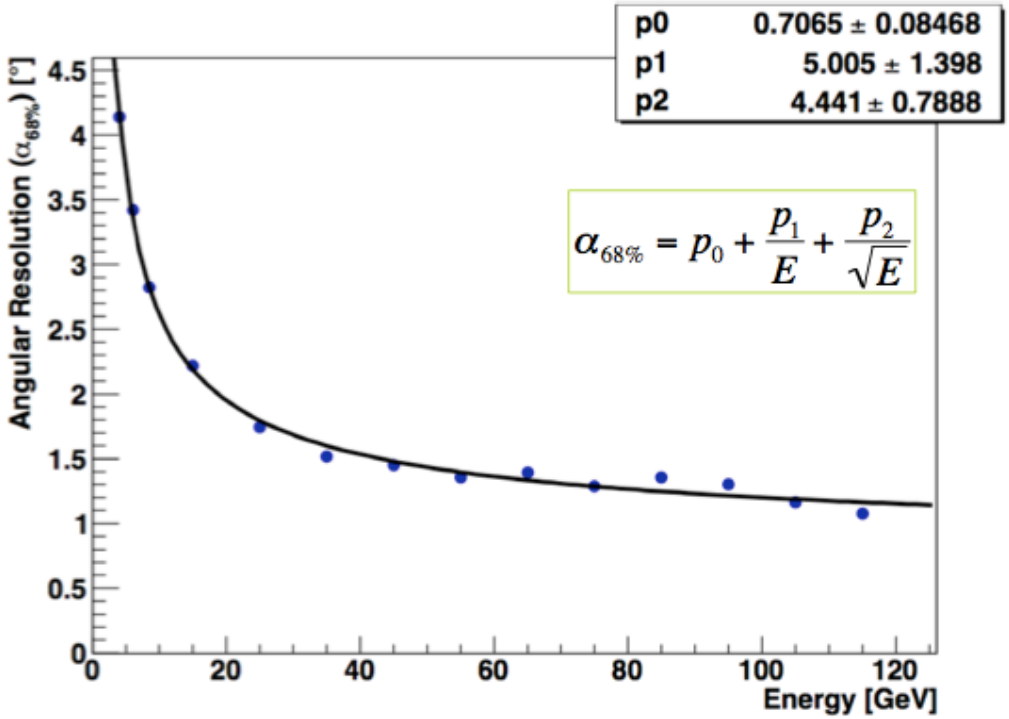


ECAL



Energy Resolution:
Test Beam

Better than 2% @ 100GeV



Angular Resolution:
Flight Data

evaluated with electrons, comparing tracker track with ecal shower axis

Better than 1.5 deg for E>40GeV

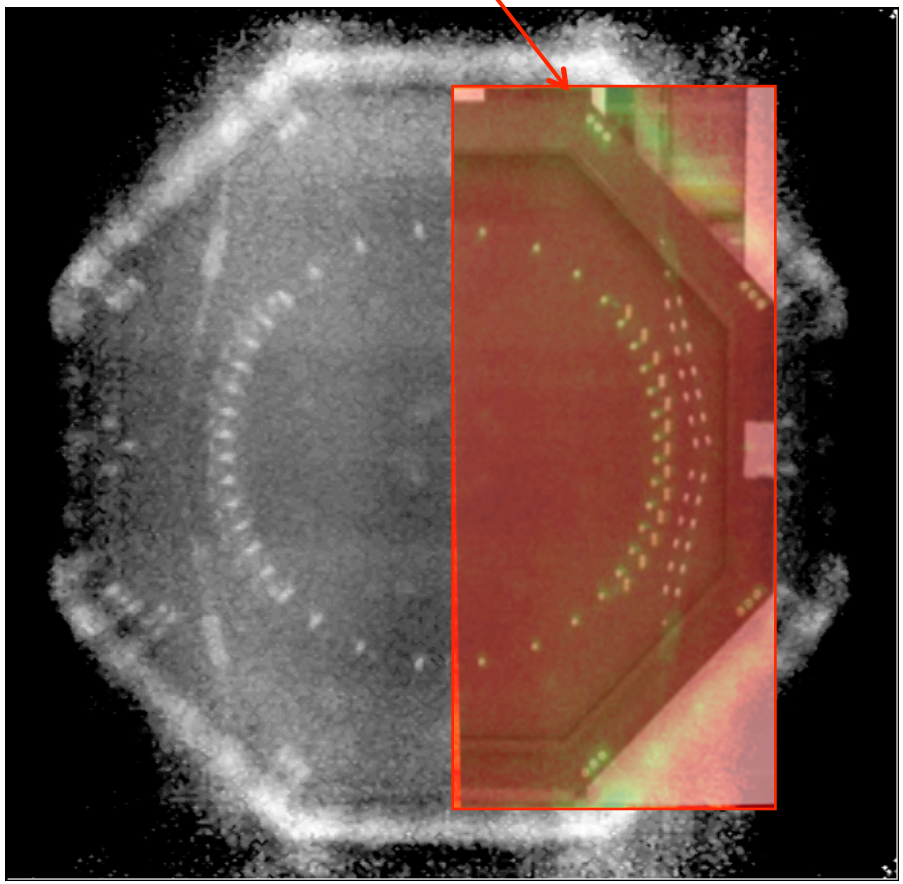
Calibration & analysis

- An intense effort on detector calibration has been developed during the past year
- Important results on stability, alignment, energy calibration have been achieved: the detectors operate smoothly with excellent performances, sometimes better than measured on earth

Tomography of support plane

Dishomogeneity of the He/p ratio
He “missing” particles extrapolated to the first mechanical Tracker support plane

Photo of the support plane



Conclusions

- AMS02 is in orbit since May 16th 2011
- No damage due to the launch stress or to the space environment, all the systems are working in both the primary and redundant part
- All the detectors are properly functioning with DAQ in nominal conditions since May 19th 2011
- Ground operations (POCC and SOC) run smoothly
- Detector calibration procedures are completed and costant monitoring will continue
- 10-20 years on board the ISS: great discovery potential


Thank you
AMS
AMS
Photo credit: NASA