"PhD Research and Development Plan: Year 1 Achievements and Next 2 Year's Objectives"

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PhD 1st Year - 39th Cycle

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Alpha Magnetic Spectrometer (AMS 02)

AMS purpose is to perform high precision, high statistics, and log measurement of charged cosmic rays in .5GeV to 1.5 Tev
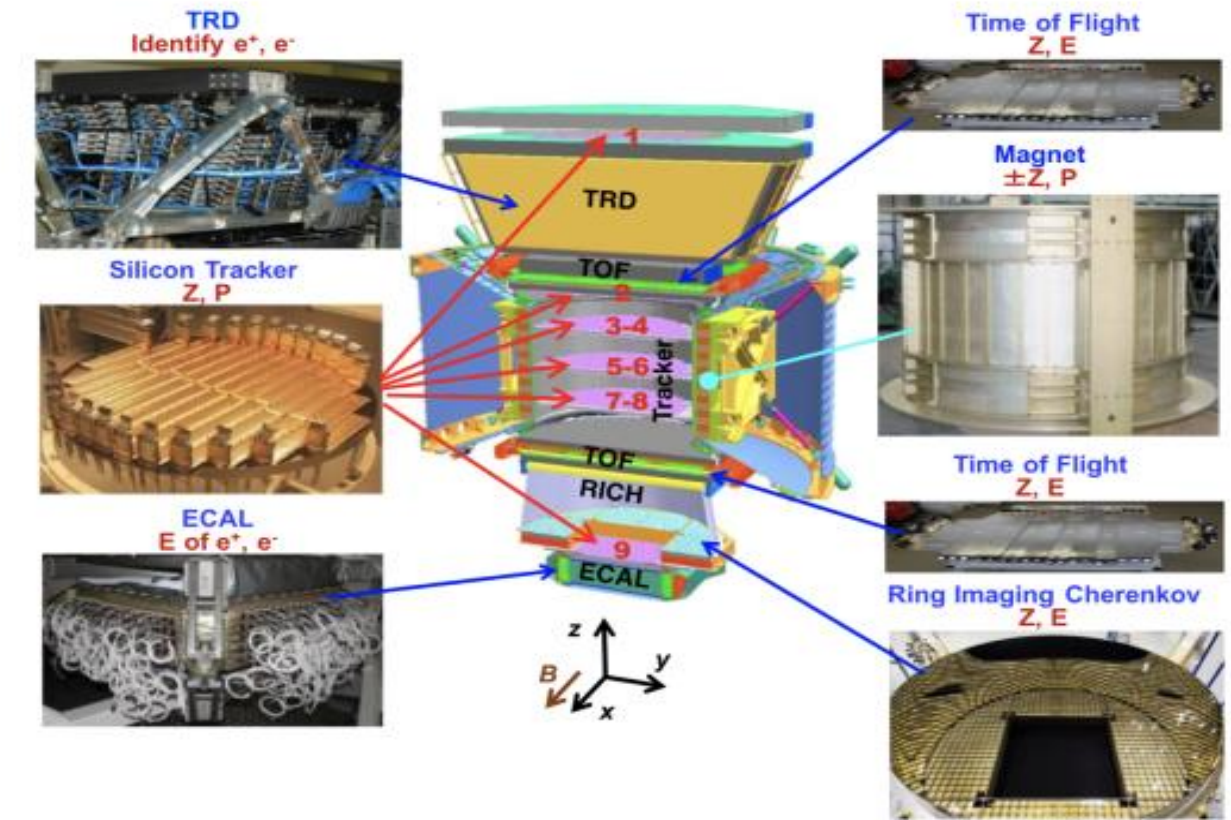

AMS 02 Launch Date : 16th May 2011 by NASA
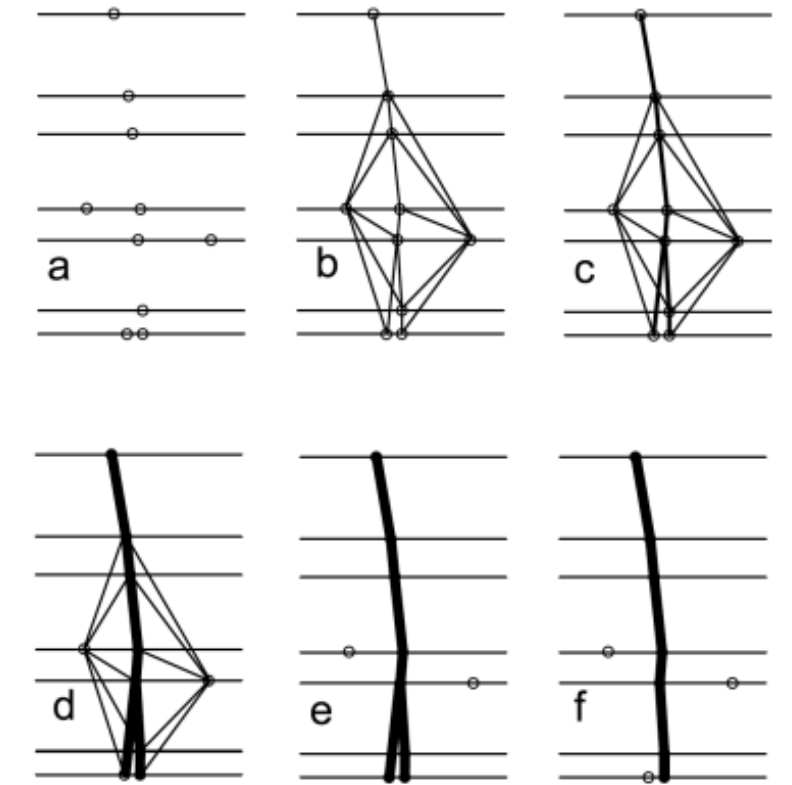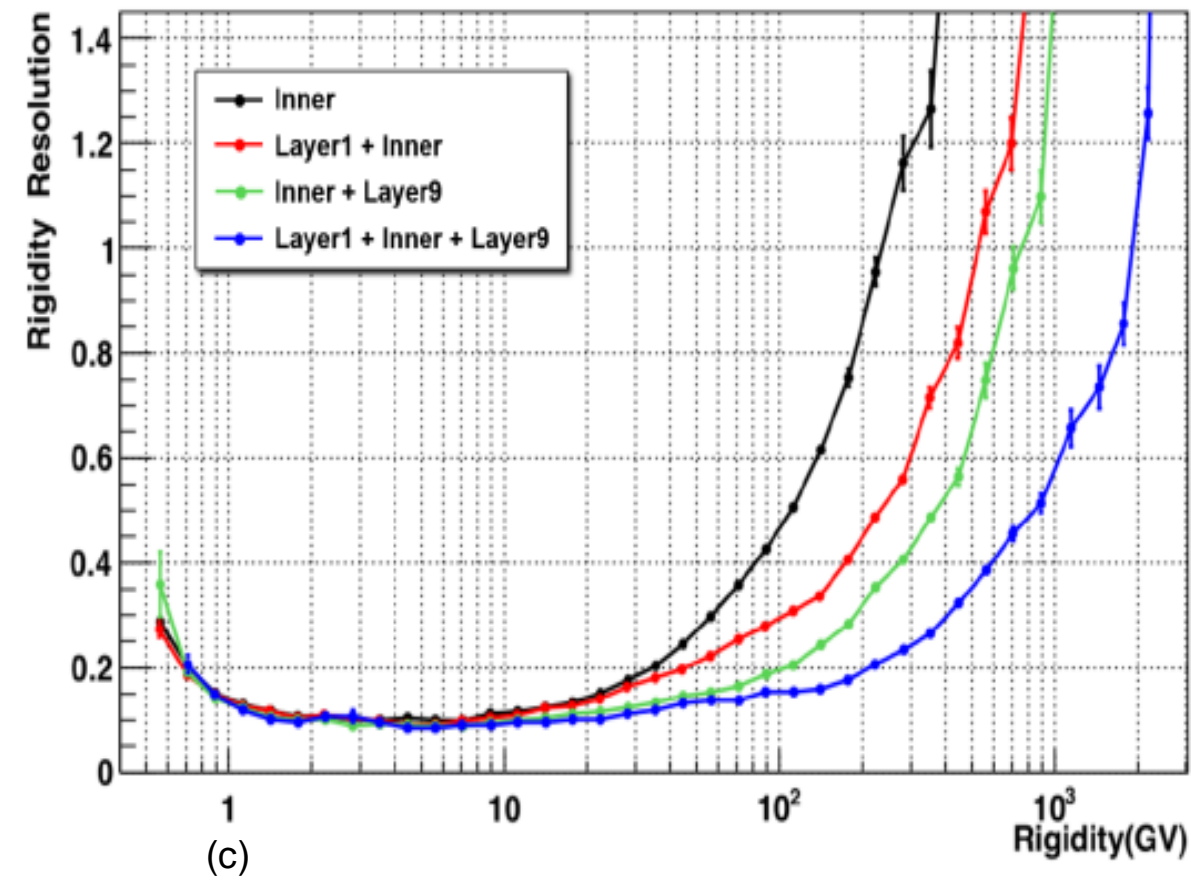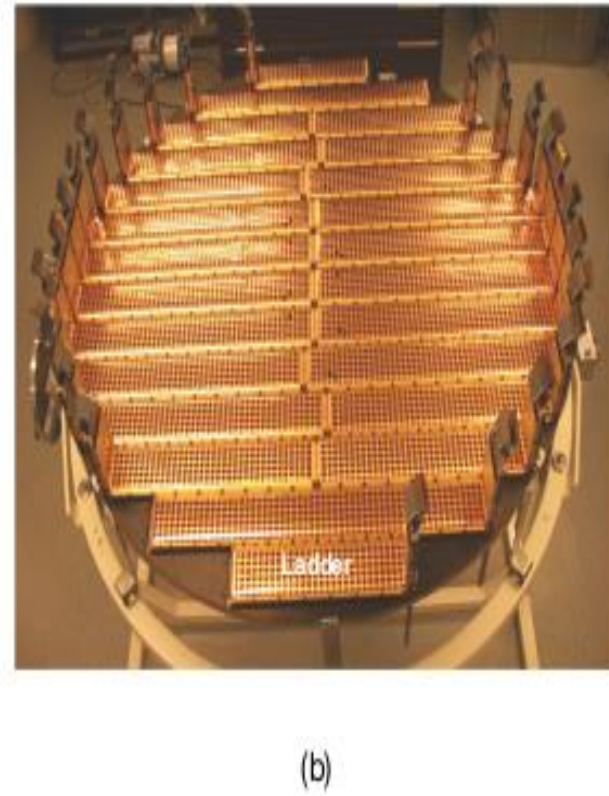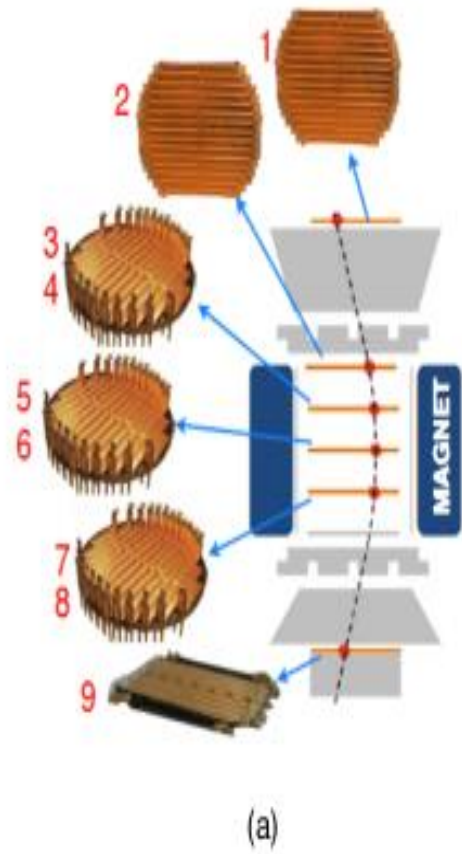 400 km above the ground
 3m*4m*6*m in volume

AMS Scientific Goals are :
* Search for cosmic matter
* Search for Dark matter signatures
* Measurment of cosmic ray spectra, relative abundances, and isotopes
* Search for new form of matter

Silicon Tracker (STK) & Magnet

(a)

(b)

(c)

d) Illustration of cellar automaton reconstruction

a) The AMS-02 STK 9 layers
b)Real view of a silicon tracker inner plane
c) STK rigidity resolution for protons as estimated from the Monte Carlo simulation
d) Illustration of cellar automaton reconstruction

- Functions are Momentum **P**, Charge **q**, and Magnetic Rigidity **Z= P/Z.**
- It accurately **reconstructs the charged particle trajectory** traversing the apparatus.
- **charge-sign** can be determined with the complementary direction information from the **TOF**
- Working Principle
- Alignment
- Track Trajectory

# Graph Neural Network (GNN) in Particle Tracking

Track finding & Track fitting

- Identify and group measurements (hits) from same particle trajectory
- Estimating the trajectory of a particle using the hits

• Deep Learning (DL)

- Convolutional Neural Networks (CNNs) works Grid-like data (images)
- Recurrent Neural Networks (RNNs) deals with sequential data (Text, Time series)

Geometric Deep Learning (GDL)

Graph Neural network (GNN)is designed for data that can be represented as graphs (nodes connected by edges)

- Node Classification
- Edge Classification
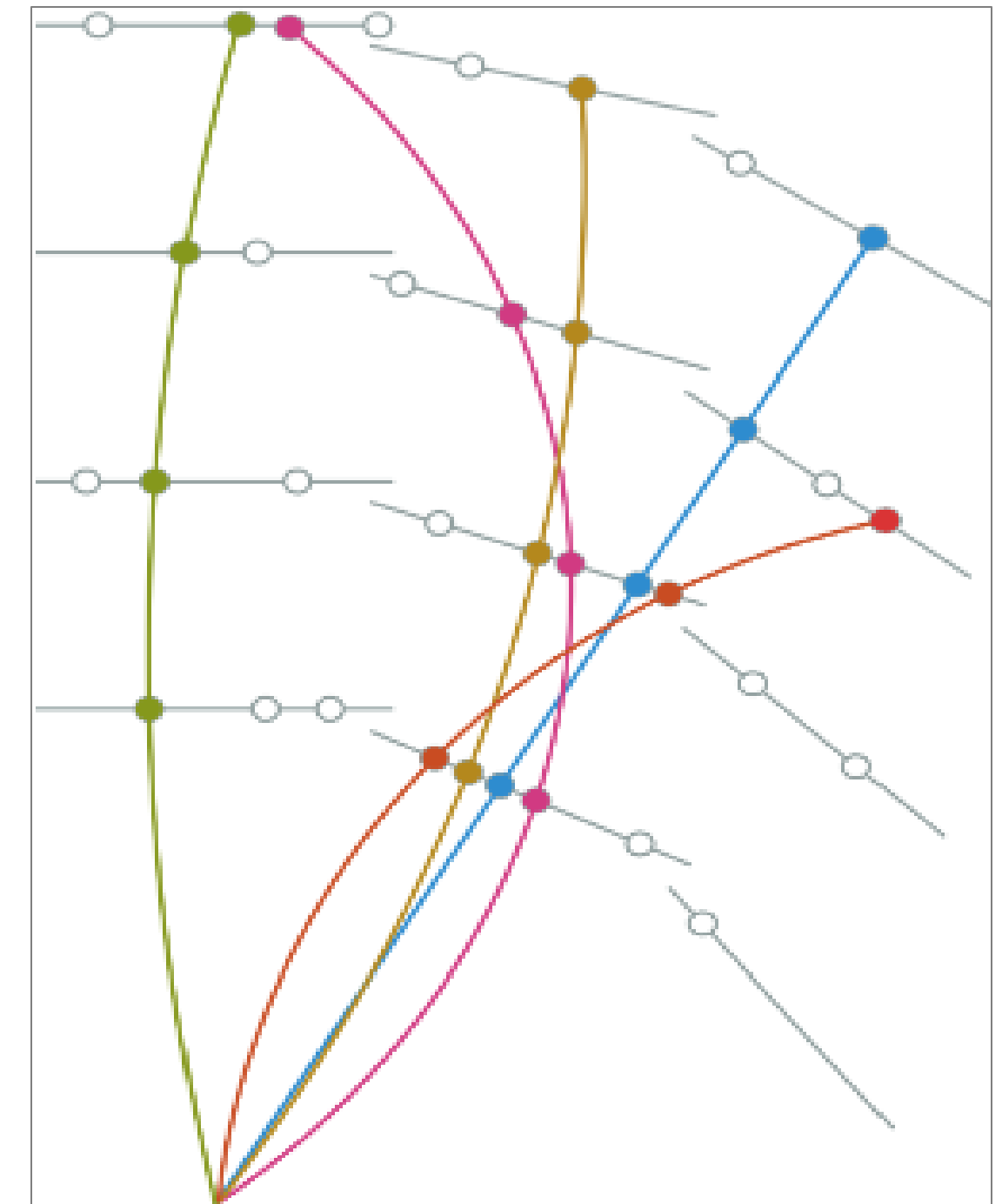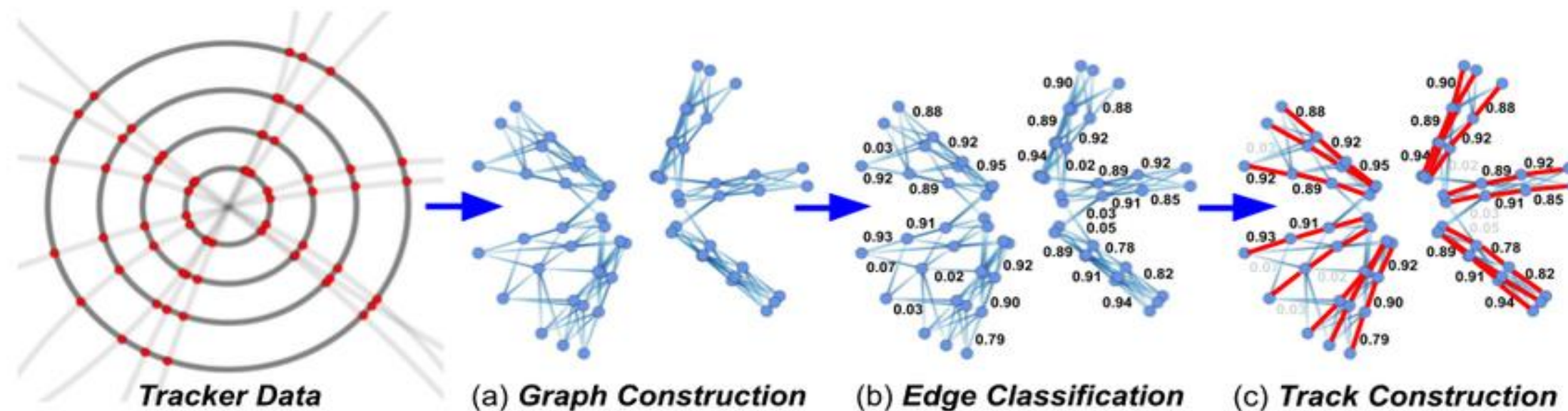
- Colored curve are trajectory of a charged particle in cons **B**
- solid circles are hits by the particle
- Empty circles are noise hits not created by a reconstructible particle.

Tracker Data   (a) Graph Construction   (b) Edge Classification   (c) Track Construction

Courses In 1st Academic Year of PHD

High-Energy Particle Physics Detectors In Space
By
Prof. Serena Loporchio

Course Content

- Theoratical introduction of particle Physics
- Detector Operations
- Particle Interaction with matter and detectors
- Cosmic rays
- Enviromental Tests on the detector Systems

Presentation Topic:

- Unveiling Cosmic Mysteries: " Alpha Magnetic Spectrometer (AMS 02) - Exploring the Universe Particle by Particle

Course Completed

Machine Learning for Physics
By
Prof. Pierluigi Bortignon

Course Content

- Introduction to Machine learning, Regression. Classification, Supervised/Unsupervised/Reinforcement learning.
- ML Techniques and Algorithems.
- Evaluation Metrics and optmization of Model parameters
- Neural Networks/ Transfer Learning

Project Status
- working on **Higgs search with the CMS detector** dataset

Project Objective
- ROC curve for the different ML architectures

Complex Networks: Big Data modelling and learning
By
Lecturer: Nicola Amoroso

This course has not been started yet.

PHD PLAN FOR 3 YEARS

FIRST YEAR

I arrived in Italy in last week of March.

- Course Work

- Literature Review for Cosmic Rays

- Particle identification pipeline in AMS 02 detector and subdetector

SECOND YEAR

- 2-Courses to complete 10 cfu benchmark

- Shifts duties at CERN

- GNN application on Test Beam Dat

- Test the ML models to a benchmark analysis (measuring Carbon and Silicon fluxes)

- Efficiency evaluation of the model on existing results

- International/National Schools related to the objective of PhD scope

THIRD YEAR

- Application of GNN pipeline to evaluate fluxes of heavier nuclei like Sulphur in the AMS 02 data

- Thesis Writing

- Thesis Submission

Thank You