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PIANO NAZIONALE
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Centro Nazionale di Ricerca in HPC,
Big Data and Quantum Computing

AI-LEGS

Algorithms for Imaging of Low Energy **Gamma rays in Space**

F. Conventi, Università degli Studi di Napoli 'Parthenope'

Referee: Pasquale Lubrano (INFN sezione di Perugia),

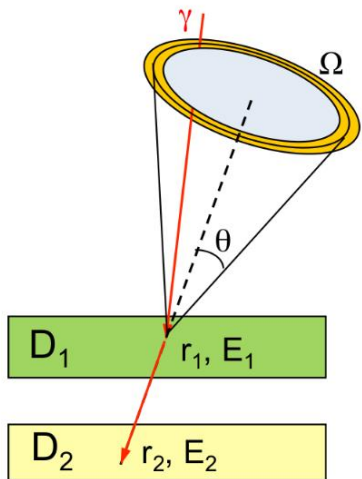
Fabio Gargano (INFN sezione di Bari)

Spoke 3 Progetti Bandi a Cascata, 24/09, 2024

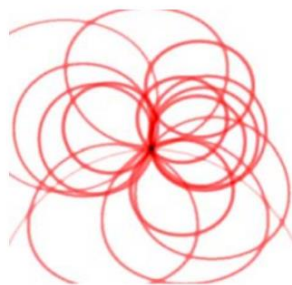
Project Overview

The instrumental developments in **gamma astronomy in the MeV** energy range are a cornerstone for various scientific topics:

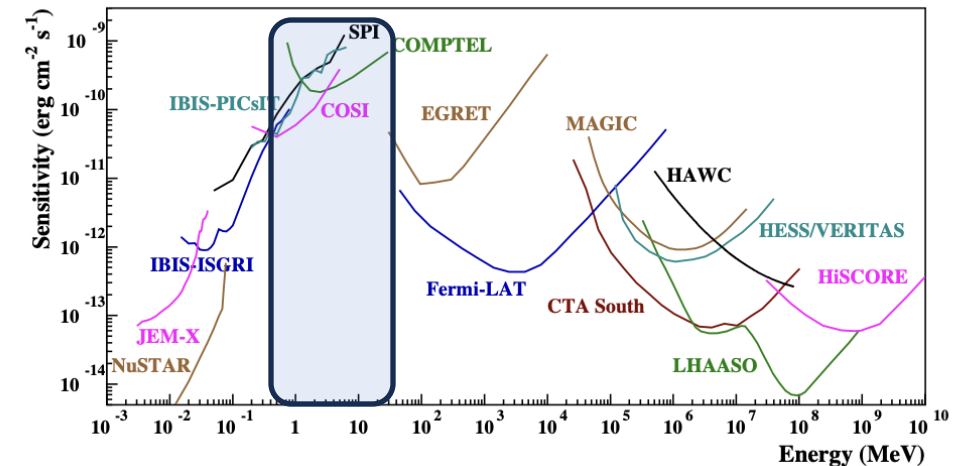
- Understanding Processes at the heart of the extreme universe
- The origin and impact of high-energy particles on galaxy evolution, from cosmic rays to antimatter,
- Nucleosynthesis and the chemical enrichment of our Galaxy



In the MeV range Compton effect is dominant, and a strong background is present.



Gamma-ray astronomy in the MeV energy range shows a lack of sensitivity compared to other gamma-ray energy bands.

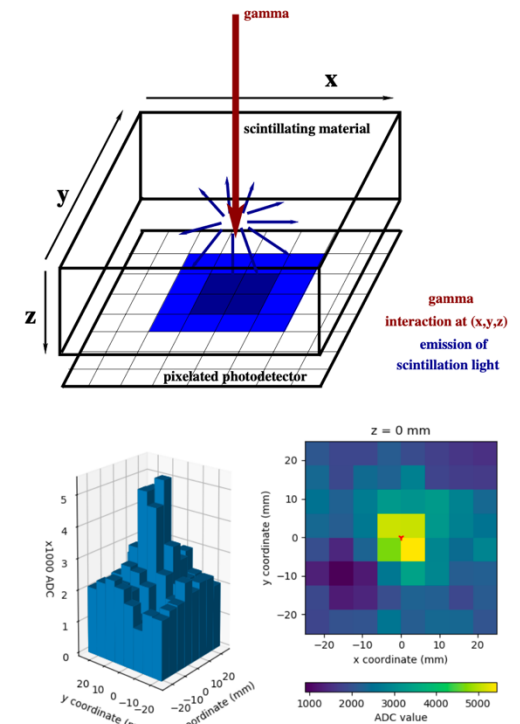


The sensitivity of a future space observatory, dedicated to the MeV energy range, should be increased by one to two orders of magnitude compared to past observatories.

Technical Objectives, Methodologies and Solutions

- The goal of this project is to develop and test a **DL algorithm** based for low energy gamma ray imaging in space calorimeters.
- Test different network as Convolutional Neural Networks (**CNN**) which show excellent performance for image classification problems as test a relatively recent development that involves the use of graph-based neural networks (**GNN**)
- Require a detailed MonteCarlo simulation of the experimental setup → HEP sw tools (Geant4, FLUKA)
- The proposed algorithms will then have to be implemented and verified on GPU (and/or FPGA) accelerated architectures to demonstrate the feasibility of using this algorithm in on-line applications as a trigger system.

(we plan to use INFN computing resources in Naples and CN resources)



The operational time to process an image using CNN increases with the image size. The ability to run a complex CNN in a System-on-Chip environment is an open task

Activities

- **Action A:** Staff recruitment, Event Simulation, Development of ML-based algorithms for calorimetric image analysis
- **Action B:** Test and performance comparison for the different proposed ML architectures
- **Action C:** Verification of the algorithms on GPU (and/or FPGA) accelerated architectures to demonstrate the feasibility of using this algorithm in on-line applications as a trigger system.

Involved Staff and new recruitments

Involved Staff (~2FTE)

Francesco Conventi Physicist, Data Analysis
(PA Università' di Napoli 'Parthenope') (A, B, C)

Camilla Di Donato Physicist, Data Analysis
(PA Università' di Napoli 'Parthenope') (A, B, C)

Andrea Buono AI Engineer
(PA Università' di Napoli 'Parthenope') (A, B)

Paola Di Donato Astrobiology, data analysis
(PA Università' di Napoli 'Parthenope') (A,B)

- **New Recruitments**: Data Scientist (10 months contract) (A,B,C)

	M1-M6	M5-M8	M9-M12	Totale
Attività A				
P. Strutturato	40 K€			
P. Arruolato	10 K€			50 K€
Attività B				
P. Strutturato		40 K€		
P. Arruolato		10 K€		50 K€
Attività C				
P. Strutturato			40 K€	
P. Arruolato			10 K€	50 K€

Timescale, Milestones, SAL

