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

Spoke 2 WP3 - Design and development of science-driven tools and innovative algorithms for Experimental Astroparticle Physics and Gravitational Waves

Regular meeting - 19 January 2023

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Marco Landoni (INAF)

Use cases statistics - Received up to now

We currently have 25 use cases received so far

- Univ. Salento: 4
- UniCal: 3
- INFN: 4
- INAF: 5
- Federico II: 2
- UniMiB: 1
- Univ. Firenze: 2
- Univ. Ferrara: 2
- Sapienza: 1
- Univ. Trieste: 1
- UniNa 1

UniCt, UniBo, UniPd, UniBa still missing (?)

Summary of the use cases (1 / 5)

Project Title	Institute	Person	Science case	Keywords tech
JUNO	INFN	Giuseppe Adronico	Characterization of the instrument with advanced calculation techniques	GPU + CUDA
Virgo/LIGO	INFN	Pia Astone	Optimization of algorithms for GW (continuous) signal detection	GPU + CUDA
LISA	UniMiB	Riccardo Buscicchio	Advanced data analysis for Gibbs sampling (LISA)	GPU Massive/paralle I/O
GRB-GW	Federico II	Fabio Garufi	GRB-GW signal correlation	Neural Networks for pattern recognition
GAPS	Uni Firenze	Massimo Lenti	GPU porting of code in charge of the event recognition	GPU

Summary of the use cases (2 / 5)

Titolo Progetto	Ente	Persona di Riferimento	Tematica Scientifica	Keywords tecnologiche
ET+Virgo	UniFi	Massimo Lenti	Searching transients GW event in Virgo+ET	GPU Machine Learning for pattern recognition
Virgo	UniTS	Edoardo Milotti	Transient event analysys with machine learning + code accelleration	GPU Machine Learning for pattern recognition
Pierre Auger for MM Astronomy	Uni Salento	Lorenzo Perrone	Optmise event reconstructions	Huge I/O Machine Learning for pattern recognition
EUCLID	Uni Salento	Achille Nucita	Simulations and analysis for recognition faint sources in the VIS Euclid data	Huge I/O Machine Learning for pattern recognition

Summary of the use cases (3 / 5)

Titolo Progetto	Ente	Persona di Riferimento	Tematica Scientifica	Keywords tecnologiche
Theory of GW	Uni Salento	Claudio Corianò	Codes for the identification of signals in models of modified gravity and, within a collaborative data analysis framework, to study and optimize the existing codes	GPU (optional)
DAMPE+HERD	Uni Salento / INFN Lecce	Francesco de Palma	Development of new techniques for event /particle reconstructions	Machine Learning for pattern recognition
ASTRI + JEM-EUSO	INAF	Antonio Pagliaro	Image recognition and event classification for ASTRI and JEM-EUSO	Extension of current ML to Deep Learning GPU

Summary of the use cases (4 / 5)

Titolo Progetto	Ente	Persona di Riferimento	Tematica Scientifica	Keywords tecnologiche
JWST, LSST and VST	Uni. Federico II	Maurizio Paolillo	Simulations of images and light curves of Active Galactic Nuclei for scientific cases of VST, LSST and/or JWST	Code optimization (possibly with GPU)
Pipelines	INAF	Roberto Peron	General complex pipeline scaling	-
Turbulence Navier Stokes equations (MHD,...)	UniCal	Leonardo Primavera	PDE solving	GPU Machine Learning
BH and GW numerical simulations	UniCal	Sergio Servidio	EFE solving. Use of computational resources and optimisation of SFINGE code	GPU - CUDA

Titolo Progetto	Ente	Persona di Riferimento	Tematica Scientifica	Keywords tecnologiche
Plasma simulations	UniCal	Francesco Valentini	Code optimisation in Plasma Physics -	GPU - CUDA
ASTRI Stellar Inteferometry	INAF	Luca Zampieri Marco Landoni	Porting of code for stellar interferometry in the context of ASTRI Mini Array	Massive I/O GPU - CUDA
LiteBIRD	Uni Ferrara	Luca Pagano Paolo Natoli	CMB Map Making per Lite BIRD	GPU Optimisation
Likelihood for CMB/LSS	Uni Ferrara	Luca Pagano Paolo Natoli	Likelihood optimisation in CMB/LSS topics	GPU - CUDA
LIGO/VIRGO	Roma - Sapienza	F. Pannarale	Pipeline optimization for GW signal detection	GPU Machine Learning
IACT telescopes	INAF	Ciro Bigongiari, F. Visconti	IACT data analysis	Machine Learning

Titolo Progetto	Ente	Persona di Riferimento	Tematica Scientifica	Keywords tecnologiche
CYGNO	INFN-LNF	Giovanni Mazzitelli	Deploy a complete environment for the management, analysis and simulation of data that can be generalized to small and medium experiments of the astroparticle community (CSN2)	SaaS On demand platforms (?)
NASA COSI	INAF	Valentina Fioretti	Geant4 simulations for the design and calibration of the Anticoincidence Subsystem (ACS) of the NASA COSI gamma-ray mission	CPU based parallelizatio (e.g. Open MPI, MPICH, Intel MPI) and Database Management Systems (e.g. SQlite)
AI for syntethic production of IACT telescopes images	INAF	Francesco Visconti	Use of AI to accelleate and improve simulation of IACT images	GPU Machine Learning

The proposed "Group by"

1. **Boosting the analysys of GW signals.**

Pia Astone - INFN Roma 1 - LIGO/VIRGO
Riccardo Buscicchio - MiB - LISA
Fabio Garufi - UniNa — GW+GRB
Edoardo Milotti - UniTS - VIRGO
Gianluca M. Guidi - UniURB (+UniFi) VIRGO
Francesco Pannarale - Sapienza - LIGO/VIRGO

The proposed "Group by"

2. Analysis techniques for astroparticles and high energy photons

Massimo Lenti - UniFi - GAPS
Antonio Pagliaro - INAF - ASTRI/ JEM-EUSO
Lorenzo Perrone - UniSalento - Pierre Auger
Francesco Visconti - INAF - IACT
Ciro Birongiari - INAF - IACT
Francesco De Palma - UniSalento/INFN Le - DAMPE / HERD
Valentina Fioretti (INAF) - NASA COSI
Luca Zampieri - INAF - Interferometria Ottica con ASTRI/CTA

The proposed “Group by”

3. Numerical Modelling for Earth and Space

Claudio Corianò - UniSalento - GW Theory

Leonardo Primavera - UniCal - Turbulence in geophysics and heliosphere

Sergio Servidio - UniCal - Numerical GW and BH

Francesco Valentini - UniCal - Turbulence in space plasma

The proposed “Group by”

4. Pipeline optimization for space and ground based experiments

Roberto Peron - INAF - Pipelines for space gravity missions

Giuseppe Andronico - INFN CT - Pipeline for JUNO and similar experiments

Giovanni Mazzitelli - INFN LNF - Pipeline per CYGNO and similar experiments in CSN2

The proposed “Group by”

5. Optimization techniques in Astrophysics and Cosmology

Achille Nucita - UniSalento - EUCLID (LLO)

Maurizio Paolillo - UniNa - AGN from VST, LSST e/o JWST

Luca Pagano - UniFe - LiteBIRD Map Making

Luca Pagano - UniFe - CMB Likelihood

Required resources (preliminary)

Preliminary, to be updated

Macro tematica	Richieste CPU	Richieste GPU	Richieste storage + I/O
Gravitational Waves	7 milioni CPU/hrs equivalenti	TBD	100 TB
Particle and astroparticle physics	10 milioni CPU/hrs equivalenti	TBD	700 TB
Cosmology	10 miloni CPU/hrs	TBD	20 TB
Theory - XTalk use cases	8 milioni CPU/hrs	TBD	1 TB

Grand total (preliminary)

- Storage: Approx 1 PB (some use cases still missing estimates)
- CPU: 30 milioni core/hrs equivalenti (depends on the use of GPU)
- Scaling on GPU could reduce a lot the CPU requirements but this is still to be defined (also at the level of the design of each use cases, as far as we have understood).