

Activities of UCM-GAE within the Task 3.2 D-GEX

J. Rosado, J.L. Contreras, M. López, F.J. Franco



Participation in OBELICS

UCM staff in ASTERICS:

- José Luis Contreras (PI): 4.1 PM
contrera@gae.ucm.es
- Marcos López: 3 PM
marcos@gae.ucm.es
- Francisco Javier Franco: 3.3 PM
fjfranco@fis.ucm.es
- Jaime Rosado: 18 PM
jaime_ros@fis.ucm.es

Co-leader of **WP3.2 D-GEX** (Data Generation and information EXtraction)

Survey of data formats to be used in ESFRI projects and development of software solutions.

Participation in **WP3.3 D-INT** (Data systems INTgration)

Scaling-up existing databases and storage architectures beyond the Peta-scale level.

Members of **CTA**

Data model coordination, among other tasks.

Work Plan for D-GEX (ideal)

1. Data Format Survey

Survey and comparison of standards used in ESFRI projects and related pathfinders.

2. Prototype Development

Prototypes of Data Access Libraries (DAL) for selected formats, tests of libraries on CTA and evaluation of results.

3. Extension to other ESFRI Projects

Proposal for Standard DAL (SDAL) to support ESFRI projects, training sessions and documentation.

4. Final Evaluation

Development of SDAL library, implementation on ESFRI projects and final evaluation and lessons learnt reports.

More info at the pages of the group in the ASTERICS wiki (internal):

<https://www.asterics2020.eu/dokuwiki/doku.php?id=intra:wp3:task3.2ucm>

Data Format Survey

- Formal **deliverable** of the project (del. number D3.3).
- Revised by members of OBELICS and **approved on 3rd May**.

II. DELIVERY SLIP

	Name	Partner/WP	Date
Author(s)	Jaime Rosado and José Luis Contreras	UCM/WP3	21/04/2016
Amendments	Tammo Jan Dijkema, Tamas Gal, Dominique Boutigny	ASTRON/WP3 FAU/WP3 CNRS/WP3	26/04/2016
Reviewed by	Rob van der Meer	ASTRON/WP1	03/05/2016
Approved by	Rob van der Meer	ASTRON/WP1	03/05/2016

- Available at the internal wiki pages:

<https://www.asterics2020.eu/dokuwiki/doku.php?id=intra:wp1:deliverables>

- Working document made for this Survey also available at:

<https://www.asterics2020.eu/dokuwiki/doku.php?id=intra:wp3:task3.2ucm>

Contents of the Survey

- Experiments classified according to the **type of data**:
 - **Image-based** experiments: VIS and NIR telescopes (E-ELT, EUCLID, etc.).
 - **Event-based** experiments: gamma-ray, neutrino and cosmic-ray observatories (CTA, KM3NeT, Auger, etc.).
 - **Signal-based** experiments: radio interferometric arrays and GW detectors (SKA, LOFAR, Virgo, etc.).
- Possible **synergies** are identified:
 - Science-ready products from **all types of experiments** in formats compliant with the **VO framework**.
 - **Common file formats and standards** for data of experiments within the **same category**.

HDF5 for raw data

- HDF5 has advantages for management of **large amount of data** and is being establishing as a standard with many available **tools and libraries**.
- We plan to test it for **CTA raw data** and think it is suitable for other event-based experiments (not only):
 - **Metadata** stored along with data.
 - Well suited for **hierarchical data**, e.g.,
array event → camera event → pixel signal.
- Would be a contribution to **WP3.3 D-INT**.

Standards for high-level data

- Data from **event-based experiments** for distribution to users are basically:
 - **Event lists**: type of particle, energy, direction...
 - **IRFs**: effective area, point spread function...
- Recent initiative to define a **unified standard based on FITS for Imaging Atmospheric Cherenkov Telescopes**: CTA, MAGIC, H.E.S.S., etc. (see talk of T. Hassan).
<https://gamma-astro-data-formats.readthedocs.io/>
- The UCM group has proposed to extend this standard for **other gamma-ray observatories** (e.g., HAWC) as well as for **neutrino and cosmic-ray** observatories (e.g., KM3NeT).

Motivations of the proposal

- **Open data** promoted by EU and goal of ASTERICS.
- **Crosscheck analyses** by the scientific community.
- Profit from **common (open) tools**.
- **Multi-messenger** analyses.
- **Already happening**: event sets are already being made available (web, electronic journals).

Example for IceCube data

IceCube Public Data Access: <https://icecube.wisc.edu/science/data>

Livetimes and effective areas also provided in HDF5 for different detector configurations and particle types.



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Public Data Access (last release on 24 Jun 2016)

Featured release

A new release is available related to searches for sterile neutrinos using the IceCube detector. The atmospheric muon neutrino spectrum as a function of zenith angle and energy has been measured to search for the oscillation signatures of light sterile neutrinos. No evidence for anomalous muon neutrino disappearance is observed and the IceCube collaboration has set new limits on light sterile neutrinos.

Download: [Search for sterile neutrinos with one year of IceCube data](#)

Data Use Policy

IceCube is committed to the goal of releasing data to the scientific community. The following links contain data sets produced by AMANDA/IceCube researchers along with a basic description. Due to challenging demands on event reconstruction, background rejection and systematic effects, data will be released after the main analyses are completed and results are published by the international IceCube Collaboration. During the construction phase of IceCube we expect that final data sets can be released within a few years after the data have been taken.

More Information

The following two links give more information about IceCube data formats and policies.

[IceCube Open Data](#)

[IceCube Policy on Data Sharing](#)

Download Datasets

The pages below contain information about the data that were collected and links to the data files. We ask that you provide your contact information so that we may notify you if we revise the datasets in the future.

Dataset	Release Date
Search for sterile neutrinos with one year of IceCube data	2016 Jun 24
The 79-string IceCube search for dark matter	2016 Jan 05
Observation of Astrophysical Neutrinos in Four Years of IceCube Data	2015 Oct 21
Astrophysical muon neutrino flux in the northern sky with 2 years of IceCube data	2015 Aug 20

1. IceCube Event ID
2. Right Ascension, degrees
3. Declination, degrees
4. Modified Julian Day, days
5. Energy Proxy, arbitrary units
6. Most probable muon energy for best-fit, TeV
7. Most probable neutrino energy for best-fit, TeV
8. Signal Probability for best-fit

116357,6324295	254	16.3	55421.5	289916	755	1693	0.96
116807,9493609	88.5	0.2	55497.3	199981	604	880	0.83
119136,66932419	37.1	18.6	55911.3	157871	397	713	0.88
116883,17395151	285.7	3.1	55513.6	147002	422	709	0.8
116701,6581938	331	11	55478.4	140113	317	466	0.81
116026,44241207	346.8	24	55355.5	139728	339	442	0.86
116574,20123342	267.5	13.8	55464.9	131950	302	400	0.82
119739,41603205	238.3	18.9	55987.8	130382	326	394	0.85
118210,47538807	235.2	19.3	55702.8	106898	252	393	0.77
118719,53077538	277.5	52.7	55829.3	91292	156	198	0.66
116269,59516168	323.3	2.8	55405.5	66558	134	193	0.41
116876,63208734	110.5	0	55512.6	64650	147	206	0.45
118631,36844560	9.4	7.8	55806.1	63994	139	179	0.5
117927,15766169	207.2	6.7	55642	60582	125	185	0.45
118475,52691508	152.2	6.8	55768.5	56734	124	156	0.45
116147,14170716	310.5	21.9	55387.5	53805	112	178	0.55
117639,30571557	307.9	1	55589.6	53542	116	184	0.33
118741,43101116	267.6	-4.4	55834.4	51756	116	191	0.56
119037,60175569	221.9	3.2	55896.9	51631	109	158	0.58
116082,62251639	138.9	47.6	55370.7	51112	109	189	0.37
118615,37865356	31.2	11.8	55803	50376	109	190	0.49

Other activities on data model within CTA

- Definition of contents of raw data and metadata.
- Testbed for the different raw data formats proposed so far.
- Array configuration database.
- Modeling of data production and analysis.
- Use cases for continuous observation (slewing).

Many interactions with OBELICS tasks →

How to make all this **compatible with OBELICS**:
deliverables and products ?

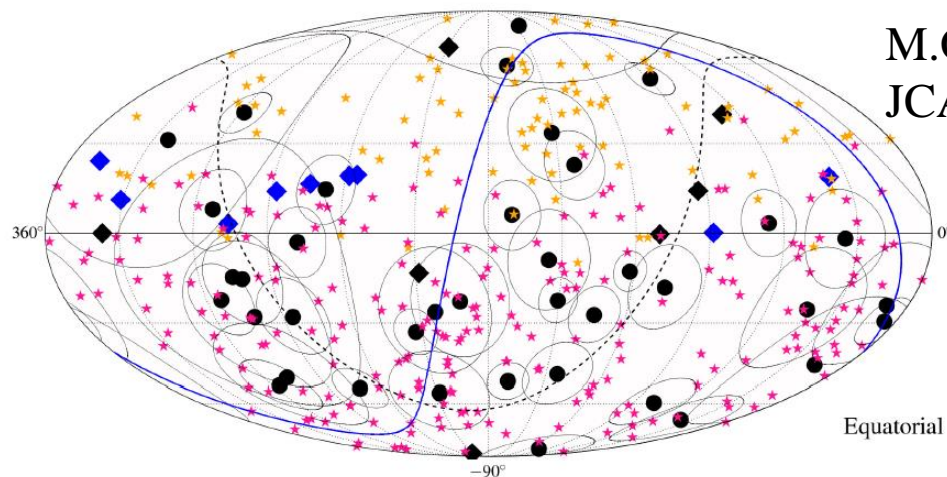
THANKS !

BACKUP SLIDES

Use case

“Search for correlations between the arrival directions of **IceCube** neutrino events and ultrahigh-energy cosmic rays detected by the **Pierre Auger Observatory** and **Telescope Array**”.

- HE **event lists** for selected observation periods.
- **Angular resolutions**: average values for Auger and TA, while event-dependent for IceCube.
- Model for an energy dependent Gaussian deflection of cosmic rays.
- Average **relative exposures** of Auger and TA as a function of declination.



M.G. Aartsen et al.,
JCAP01 (2016) 037

Open data sets from Auger

Auger Document Center: <https://www.auger.org/index.php/document-centre>

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Xmax Data 2014

Xmax Data 2014 DOWNLOAD

Pierre Auger Collaboration

Keywords: Xmax Data 2014 [.TAR]

contact person 2015-05-07 13:08:25 English 7.67 KB

List of ultra-high energy cosmic ray events (2014)

List of ultra-high energy cosmic ray events (2014) DOWNLOAD

Pierre Auger Collaboration

Keywords: List of ultra-high energy cosmic ray events (2014), Auger UHECR 2014 [.TXT]

contact person 2015-05-07 13:08:50 English 14.57 KB

```
#####  
## (c) Copyright by Pierre Auger Collaboration 2014 ##  
## ##  
## Publications using or referring to these data should cite the following ##  
## reference: ##  
## ##  
## A. Aab et al. (The Pierre Auger Collaboration), "Searches for Anisotropies in ##  
## the Arrival Directions of the Highest Energy Cosmic Rays Detected by the ##  
## Pierre Auger Observatory", arXiv:1411.6111 ##  
## ##  
## Data are provided as is and might be subject to future changes. ##  
## ##  
## These data are released under the Creative Commons Attribution-ShareAlike 4.0 ##  
## International License (CC BY-SA 4.0). For more details see ##  
## http://creativecommons.org/licenses/by-sa/4.0/ ##  
## ##  
#####
```

YYYY	DDD	Theta	E	RA	dec	Glon	Glat
2004	125	47.7	62.2	267.2	-11.4	15.5	8.4
2004	142	59.2	84.7	199.7	-34.9	-50.8	27.7
2004	177	71.5	54.6	12.7	-56.6	-56.9	-60.5
2004	239	58.3	54.0	32.7	-85.0	-59.1	-31.8
2004	282	26.3	58.6	208.1	-60.1	-49.5	1.9
2004	339	44.6	78.2	268.4	-61.0	-27.6	-16.9
2004	343	23.3	58.2	224.7	-44.0	-34.1	13.1
2005	50	67.5	60.2	29.0	-14.0	174.9	-70.0
2005	54	34.9	71.2	17.5	-37.8	-76.0	-78.6
2005	63	54.4	71.9	331.2	-1.3	58.7	-42.4
2005	81	17.1	52.1	199.1	-48.5	-52.8	14.1
2005	186	57.5	108.2	45.6	-1.7	179.5	-49.6
2005	233	65.4	61.9	278.4	-1.3	29.7	3.4
2005	295	15.3	54.9	333.0	-38.1	4.4	-55.0
2005	306	14.2	74.9	114.8	-42.8	-103.9	-10.0
2005	347	65.6	77.5	18.3	29.2	128.6	-33.4
2006	5	30.9	78.2	18.9	-4.7	138.3	-66.8
2006	35	30.8	72.2	53.6	-7.8	-165.9	-46.9
2006	55	37.9	52.8	267.6	-60.6	-27.5	-16.4
2006	64	66.6	64.8	275.2	-57.2	-22.6	-18.6
2006	81	34.0	69.5	201.1	-55.3	-52.3	7.3
2006	100	33.7	54.7	28.8	-16.4	-179.9	-71.8
2006	118	57.3	56.3	322.5	-2.0	51.6	-35.6
2006	126	65.2	82.0	299.0	19.4	57.6	-4.7

Parameters in Event Lists

IACT open format	IceCube	Auger
EVENT_ID [integer]	EVENT_ID [float]	
TIME [s]	TIME [day]	YYYY DDD
RA & DEC	RA & DEC	RA & DEC
ALT [elevation]		THETA [zenith angle]
GLON & GLAT		GLON & GLAT
ENERGY [TeV]	ENERGY PROXY [arb. units]	ENERGY [EeV]
	MUON ENERGY [TeV]	
	NEUTRINO ENERGY [TeV]	
EVENT TYPE [event quality]	SIGNAL PROBABILITY	
TELESCOPE		
OBSERVER		
OBS_MODE		
...		