

Finanziato dall'Unione europea NextGenerationEU







FERMI use case and Data Model Andrea Adelfio (INFN-PG)

Spoke 3 General Meeting, Elba 5-9 / 05, 2024

ICSC Italian Research Center on High-Performance Computing, Big Data and Quantum Computing









Scientific Rationale

To have the Fermi data products accessible from the interoperable data lake infrastructure, i.e., accessible by any astronomer who has interest in the data and in making smart cross filtering on the data.

ICSC Italian Research Center on High-Performance Computing, Big Data and Quantum Computing









Scientific Rationale



With this use case we ask to add cutout and merging services in the application side of the infrastructure.









Fermi satellite

The Fermi Gamma-ray Space Telescope is a space observatory launched by NASA in 2008 to study high-energy gamma rays.

The primary instrument on board Fermi is the Large Area Telescope (LAT) [1], which detects gamma rays in the energy range from 20 MeV to over 300 GeV.

The Gamma-ray Burst Monitor (GBM) [2], designed to observe gamma-ray bursts in the energy range from 8 keV to 40 MeV.

(1) <u>Atwood 2009 - THE LARGE AREA TELESCOPE ON THE FERMI GAMMA-RAY SPACE TELESCOPE MISSION</u> (2) <u>Meegan 2009 - THE FERMI GAMMA-RAY BURST MONITOR</u>

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ion



Data products: FT1 and FT2

Order of 10-100 Gigabytes

Index of /FTP/fermi/data/lat/weekly/1s_spacecraft

	Name	Last modified	<u>Size</u>	Description
٩	Parent Directory		-	
T	README	14-Mar-2022 10:29	453	
2	<pre>lat_1sec_spacecraft_weekly_w009_p310_v001.fits</pre>	02-Mar-2022 17:12	26M	
?	lat_1sec_spacecraft_weekly_w010_p310_v001.fits	02-Mar-2022 17:12	80M	
2	<pre>lat_1sec_spacecraft_weekly_w011_p310_v001.fits</pre>	02-Mar-2022 17:12	78M	
2	<pre>lat_1sec_spacecraft_weekly_w012_p310_v001.fits</pre>	02-Mar-2022 17:12	80M	
2	<pre>lat_1sec_spacecraft_weekly_w013_p310_v001.fits</pre>	02-Mar-2022 17:12	80M	
2	<pre>lat_1sec_spacecraft_weekly_w014_p310_v001.fits</pre>	02-Mar-2022 17:12	79M	
2	<pre>lat_1sec_spacecraft_weekly_w015_p310_v001.fits</pre>	02-Mar-2022 17:12	80M	
2	<pre>lat_1sec_spacecraft_weekly_w016_p310_v001.fits</pre>	02-Mar-2022 17:12	79M	
2	<pre>lat_1sec_spacecraft_weekly_w017_p310_v001.fits</pre>	02-Mar-2022 17:12	80M	
?	<pre>lat_1sec_spacecraft_weekly_w018_p310_v001.fits</pre>	02-Mar-2022 17:12	80M	
2	<pre>lat_1sec_spacecraft_weekly_w019_p310_v001.fits</pre>	02-Mar-2022 17:13	80M	
2	<pre>lat_1sec_spacecraft_weekly_w020_p310_v001.fits</pre>	02-Mar-2022 17:13	80M	
2	<pre>lat_1sec_spacecraft_weekly_w021_p310_v001.fits</pre>	02-Mar-2022 17:13	79M	
2	<pre>lat_1sec_spacecraft_weekly_w022_p310_v001.fits</pre>	02-Mar-2022 17:13	80M	
2	<pre>lat_1sec_spacecraft_weekly_w023_p310_v001.fits</pre>	02-Mar-2022 17:13	79M	
2	<pre>lat_1sec_spacecraft_weekly_w024_p310_v001.fits</pre>	02-Mar-2022 17:13	80M	

Index of /FTP/fermi/data/lat/weekly/photon

	Name	Last modifie	d	<u>Size</u>	Descript
٩	Parent Directory			-	
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2	<pre>lat_photon_weekly_w011_p305_v001.fits</pre>	28-Feb-2022	17:44	54M	
2	<pre>lat_photon_weekly_w012_p305_v001.fits</pre>	28-Feb-2022	17:44	58M	
?	<pre>lat_photon_weekly_w013_p305_v001.fits</pre>	28-Feb-2022	17:44	56M	
?	<pre>lat_photon_weekly_w014_p305_v001.fits</pre>	28-Feb-2022	17:44	56M	
2	<pre>lat_photon_weekly_w015_p305_v001.fits</pre>	28-Feb-2022	17:44	54M	
?	<pre>lat_photon_weekly_w016_p305_v001.fits</pre>	28-Feb-2022	17:44	53M	
?	<pre>lat_photon_weekly_w017_p305_v001.fits</pre>	28-Feb-2022	17:44	80M	
2	<pre>lat_photon_weekly_w018_p305_v001.fits</pre>	28-Feb-2022	17:44	56M	
2	<pre>lat_photon_weekly_w019_p305_v001.fits</pre>	28-Feb-2022	17:44	56M	

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Index of /FTP/fermi/data/lat/weekly/1s_spacecraft

	HDU	Extension	Ту	pe	E	Dimensio
0		PRIMARY	NULL	NU	JLL	
1		SC_DATA	table	16	4×51	4394
Ľ	lat_1sec_s	<pre>spacecraft_weekly_w009_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	26M
?	lat_1sec_s	<pre>spacecraft_weekly_w010_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w011_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	78M
2	lat_1sec_s	<pre>spacecraft_weekly_w012_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w013_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
?	lat_1sec_s	<pre>spacecraft_weekly_w014_p310</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w015_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
?	lat_1sec_s	<u>spacecraft_weekly_w016_p310</u>	<u>v001.fits</u> (02-Mar-2022	17:12	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w017_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w018_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w019_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w020_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M
?	lat_1sec_s	<pre>spacecraft_weekly_w021_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w022_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w023_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w024_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M

Index of /FTP/fermi/data/lat/weekly/photon

	HDU	Extension	Туре		Dimensio
0		PRIMARY	NULL	NULL	
1		EVENTS	table	98×16	05321
2		GTI	table	16×10	7
?	<u>lat_photon</u>	_weekly_w010_p305_v001.fits	28-Feb-2022 1	7:44 55M	
?	lat_photon	_weekly_w011_p305_v001.fits	28-Feb-2022 1	7:44 54M	
?	<u>lat_photon</u>	_weekly_w012_p305_v001.fits	28-Feb-2022 1	7:44 58M	
?	lat_photon	_weekly_w013_p305_v001.fits	28-Feb-2022 1	7:44 56M	
?	<u>lat_photon</u>	_weekly_w014_p305_v001.fits	28-Feb-2022 1	7:44 56M	
2	lat_photon	_weekly_w015_p305_v001.fits	28-Feb-2022 1	7:44 54M	
?	<u>lat_photon</u>	_weekly_w016_p305_v001.fits	28-Feb-2022 1	7:44 53M	
?	lat_photon	_weekly_w017_p305_v001.fits	28-Feb-2022 1	7:44 80M	
?	<u>lat_photon</u>	_weekly_w018_p305_v001.fits	28-Feb-2022 1	7:44 56M	
2	lat_photon	_weekly_w019_p305_v001.fits	28-Feb-2022 1	7:44 56M	









Technical Objectives: Spacecraft and Photons cross filtering

START (s) STOP (s) SC_POSITION (m) LAT_GEO (deg) LON_GEO (deg) RAD_GEO (m) **RA_ZENITH (deg) DEC_ZENITH (deg) B_MCILWAIN (Gauss)** L_MCILWAIN (Earth_Radii) **GEOMAG_LAT (deg)** LAMBDA (deg) IN_SAA RA_SCZ (deg) DEC_SCZ (deg)

RA_SCX (deg) DEC_SCX (deg) **RA_NPOLE (deg) DEC_NPOLE (deg) ROCK_ANGLE (deg)** LAT_MODE LAT_CONFIG **DATA_QUAL** LIVETIME (s) QSJ 1 QSJ_2 QSJ_3 QSJ_4 RA_SUN (deg) **DEC_SUN (deg)** SC_VELOCITY (m/s)









Technical Objectives: Spacecraft and Photons cross filtering

START (s) STOP (s) SC_POSITION (m) LAT_GEO (deg) LON_GEO (deg) RAD_GEO (m) **RA_ZENITH (deg)** DEC_ZENITH (deg) **B_MCILWAIN (Gauss)** L_MCILWAIN (Earth_Radii) **GEOMAG_LAT (deg)** LAMBDA (deg) IN_SAA RA_SCZ (deg) DEC_SCZ (deg)

RA_SCX (deg) DEC_SCX (deg) **RA_NPOLE (deg) DEC_NPOLE (deg) ROCK_ANGLE (deg)** LAT_MODE LAT_CONFIG **DATA_QUAL** LIVETIME (s) QSJ 1 QSJ_2 QSJ_3 QSJ_4 RA_SUN (deg) **DEC_SUN (deg)** SC_VELOCITY (m/s)









Technical Objectives: Spacecraft and Photons cross filtering











Index of /FTP/fermi/data/lat/weekly/1s_spacecraft

	HDU	Extension	Ту	pe	E	Dimensio
0		PRIMARY	NULL	NU	JLL	
1		SC_DATA	table	16	4×51	4394
Ľ	lat_1sec_s	<pre>spacecraft_weekly_w009_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	26M
?	lat_1sec_s	<pre>spacecraft_weekly_w010_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
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2	lat_1sec_s	<pre>spacecraft_weekly_w012_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w013_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
?	lat_1sec_s	<pre>spacecraft_weekly_w014_p310</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w015_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
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2	lat_1sec_s	<pre>spacecraft_weekly_w018_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:12	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w019_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w020_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M
?	lat_1sec_s	<pre>spacecraft_weekly_w021_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w022_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M
2	lat_1sec_s	<pre>spacecraft_weekly_w023_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	79M
2	lat_1sec_s	<pre>spacecraft_weekly_w024_p310_</pre>	<u>v001.fits</u> (02-Mar-2022	17:13	80M

Index of /FTP/fermi/data/lat/weekly/photon

	HDU	Extension	Туре		Dimensio
0		PRIMARY	NULL	NULL	
1		EVENTS	table	98×16	05321
2		GTI	table	16×10	7
?	<u>lat_photon</u>	_weekly_w010_p305_v001.fits	28-Feb-2022 1	7:44 55M	
?	lat_photon	_weekly_w011_p305_v001.fits	28-Feb-2022 1	7:44 54M	
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?	<u>lat_photon</u>	_weekly_w014_p305_v001.fits	28-Feb-2022 1	7:44 56M	
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?	lat_photon	_weekly_w017_p305_v001.fits	28-Feb-2022 1	7:44 80M	
?	<u>lat_photon</u>	_weekly_w018_p305_v001.fits	28-Feb-2022 1	7:44 56M	
2	lat_photon	_weekly_w019_p305_v001.fits	28-Feb-2022 1	7:44 56M	









Index of /FTP/fermi/data/lat/weekly/1s_spacecraft

	HDU	Extension	Туре		Dimension
0		PRIMARY	NULL	NULL	
1		SC DATA	table	in4x	14394
Ľ	lat_1sec_	<pre>spacecraft_weekly_w009_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 26M
?	<u>lat_1sec_</u>	<pre>spacecraft_weekly_w010_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 80M
2	lat_1sec_	<pre>spacecraft_weekly_w011_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 78M
2	lat_1sec_	<u>spacecraft_weekly_w012_p31</u>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 80M
2	lat_1sec_	<pre>spacecraft_weekly_w013_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 80M
2	<u>lat_1sec_</u>	<u>spacecraft_weekly_w014_p31</u>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 79M
2	lat_1sec_	<pre>spacecraft_weekly_w015_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 80M
2	<u>lat_1sec_</u>	<pre>spacecraft_weekly_w016_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 79M
2	lat_1sec_	<pre>spacecraft_weekly_w017_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 80M
2	lat_1sec_	<u>spacecraft_weekly_w018_p31</u>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	2 80M
2	lat_1sec_	<pre>spacecraft_weekly_w019_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	3 80M
2	lat_1sec_	<u>spacecraft_weekly_w020_p31</u>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	3 80M
2	lat_1sec_	<pre>spacecraft_weekly_w021_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	3 79M
2	<u>lat_1sec_</u>	<u>spacecraft_weekly_w022_p31</u>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	3 80M
2	lat_1sec_	<pre>spacecraft_weekly_w023_p31</pre>	0 <u>_v001.fits</u> 02-Ma	ar-2022 17:1	3 79M
2	<u>lat_1sec_</u>	<u>spacecraft_weekly_w024_p31</u>	0 <u>v001.fits</u> 02-Ma	ar-2022 17:1	3 80M

Index of /FTP/fermi/data/lat/weekly/photon

	HDU	Extension	Туре	2	Dimension
0		PRIMARY	NULL	NULL	
1		EVENUS	table	<u>98 x 1</u>	505321
2		GII	table	inx1()/
?	<u>lat_photon</u>	_weekly_w010_p305_v001.fits	28-Feb-2022	17:44 55M	
2	<u>lat_photon</u>	_weekly_w011_p305_v001.fits	28-Feb-2022	17:44 54M	
?	<u>lat_photon</u>	weekly_w012_p305_v001.fits	28-Feb-2022	17:44 58M	
?	lat_photon	_weekly_w013_p305_v001.fits	28-Feb-2022	17:44 56M	
?	<u>lat_photon</u>	weekly_w014_p305_v001.fits	28-Feb-2022	17:44 56M	
?	lat_photon	_weekly_w015_p305_v001.fits	28-Feb-2022	17:44 54M	
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2	<u>lat_photon</u>	_weekly_w017_p305_v001.fits	28-Feb-2022	17:44 80M	
?	<u>lat_photon</u>	weekly_w018_p305_v001.fits	28-Feb-2022	17:44 56M	
?	<u>lat_photon</u>	_weekly_w019_p305_v001.fits	28-Feb-2022	17:44 56M	









Index of /FTP/fermi/data/lat/weekly/1s_spacecraft

SIMPLE =	т	
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NAXIS =	0	
EXTEND =	т	
CHECKSUM=	'4TGG5QGI	4QGD4QGD'
DATASUM =	' 0	1
TELESCOP=	'GLAST	1
INSTRUME=	'LAT	•
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RADECSYS=	'FK5	1
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DATE-END=	2023-12-	07T00:39:24.0941
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TSTOP =	723602369	.094183
TIMESYS =	'TT	1
TIMEUNIT=	's	1
GPS_OUT =	F	

Index of /FTP/fermi/data/lat/weekly/photon

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BITPIX	=	8						
NAXIS	=	0						
EXTEND	=	т						
DATASUM	=	'0		•				
TELESCOR	<u>?</u> =	'GLAS	Т	•				
INSTRUME	2=	'LAT		•				
EQUINOX	=	2000.						
RADECSYS	3=	'FK5		•				
DATE	=	2024	-02-	22т04	:20:	58'		
DATE-OBS	3=	2024	-02-	22т01	:36:	13.	999	9'
DATE-ENI)=	2024	-02-	29100	:44:	15.	999	9'
TSTART	=	73025	8579					
TSTOP	=	73086	0261					
TIMEUNI	C=	's		•				
TIMEZERO)=	0.						

Missione 4 • Istruzione e Ricerca









Index of /FTP/fermi/data/lat/weekly/1s_spacecraft

SIMPLE =	т	
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NAXIS =	0	
EXTEND =	т	
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TELESCOP=	'GLAST	1
INSTRUME=	'LAT	1
EQUINOX =	2000.	
RADECSYS=	'fk5	1
DATE =	2023-11-	29T23:06:06'
DATE-OBS=	2023-11-	30T01:22:03.6690'
DATE-END=	2023-12-	07T00:39:24.0941'
TSTART =	723000128	.669092
TSTOP =	723602369	.094183
TIMESYS =	'TT	1
TIMEUNIT=	's	•
GPS_OUT =	F	

Index of /FTP/fermi/data/lat/weekly/photon

SIMPLE =	т	
BITPIX =	8	
NAXIS =	0	
EXTEND =	т	
DATASUM =	'0	
TELESCOP=	'GLAST	•
INSTRUME=	'LAT	1
EQUINOX =	2000.	
RADECSYS=	' FK5	•
DATE =	2024-02-	-22T04:20:58'
DATE-OBS=	2024-02-	-22T01:36:13.9999'
DATE-END=	2024-02-	-29T00:44:15.9999'
TSTART =	730258579).
TSTOP =	730860261	
TIMEUNIT=	's	1
TTMEZERO=	0	

Missione 4 • Istruzione e Ricerca









NAME	LABEL	IS CUSTOM 🔻	TO BE IMPORTED -	TO BE FILTERED 🔻	TO BE QUERIED -	IN RESULTS VIEW (DEFAULT)
NAXIS_HDU0		N	Y	N	N	N
EXTEND		N	Y	N	N	Ν
CHECKSUM_HDU0		Ν	Y	Ν	N	N
TELESCOP		Ν	Y	Ν	Y	Y
INSTRUME		Ν	Y	N	Y	Y
EQUINOX		Ν	Y	Ν	Y	Y
RADECSYS		Ν	Y	N	N	Ν
DATE		Ν	Y	Ν	Y	Ν
DATE_OBS	Observation start date	N	Y	Y	Y	Y
DATE_END	Observation end date	Ν	Y	Y	Y	Y
TSTART	Start MET (s)	N	Y	Y	Y	Y
TSTOP	End MET (s)	N	Y	Y	Y	Y
TIMEUNIT		N	Y	N	N	N
TIMEZERO		N	Y	Ν	N	Ν
TIMESYS		Ν	Υ	N	N	N
TIMEREF		N	Y	N	N	N
CLOCKAPP		Ν	Y	N	N	N
GPS_OUT	-	N	Y	N	N	N
MJDREFI		N	Y	N	N	N
MJDREFF	-	N	Y	N	N	N
OBSERVER		N	Y	N	Y	Y
FILENAME	-	N	Y	N	Y	Y
ORIGIN		N	Y	N	N	N
CREATOR		N	Υ	N	N	N
VERSION		N	Y	N	Y	Y
PROC VER		N	Y	N	N	Ν

For the data model preparation we need to select which metadata (fields) will be:

- imported in the database;
- filtered from the portal;
- queried in the SQL;
- showed as results in the portal.









Methodologies

We create a Data Model based on the metadata that we get from the headers (for now).

These metadata will be added in the database.

Then we select which fields will be used as filters in the portal (i.e. filters in the SQL query), and which will be shown as results.

Photon
id storage_path file_path file_version file_name
file_extension update_time checksum checksum_gz
NAXIS_HDU0 EXTEND CHECKSUM_HDU0 TELESCOP INSTRUME EQUINOX
RADECSYS DATE DATE_OBS DATE_END TSTART TSTOP
TIMEUNIT TIMEZERO TIMESYS TIMEREF CLOCKAPP GPS OUT
MJDREFI MJDREFF OBSERVER FILENAME ORIGIN
CREATOR VERSION PROC_VER DATASUM_HDU0

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Methodologies

To link the different data products in a unique result we need a field that is common between the two tables and unique.

We added the field "WEEK" that is populated during the extraction of the metadata from the files headers.

Photon	
id storage_path file_path file_version file_name file_extension update_time checksum	
checksum_gz	
NAXIS_HDU0 EXTEND CHECKSUM_HDU0 TELESCOP INSTRUME EQUINOX RADECSYS DATE DATE_OBS DATE_END TSTART TSTOP	
TIMEUNIT TIMEZERO TIMESYS TIMEREF CLOCKAPP GPS_OUT MJDREFI MJDREFF OBSERVER FILENAME ORIGIN CREATOR VERSION PROC_VER DATASUM_HDU0	

	Spacecraf
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DATE_END	
TSTART	
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TIMESYS	
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GPS_OUT	
MJDREFI	
MJDREFF	
OBSERVER	
FILENAME	
ORIGIN	
CREATOR	
VERSION	
PROC_VER	
NAXIS_HDU1	
NAXIS1_HDU1	
NAXIS2 HDU11	

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le_extension		
pdate_time		
hecksum		
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Solutions

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Solutions

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Next Steps

Select the new filters to add based on the astronomers needs (e.g. the most common filtering usually applied when working on both FT1 and FT2).

Extend the data model for the fields that refer to the scientific data contained in the fits files.

Implementation of the cross filtering on data via the Fermi Tools.

... see you tomorrow afternoon at the round table!

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Thank you!

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Finanziato dall'Unione europea NextGenerationEU







Gaia use case Sara Gelsumini, Deborah Busonero

Spoke 3 General Meeting, Elba 5-9 / 05, 2024

ICSC Italian Research Center on High-Performance Computing, Big Data and Quantum Computing







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

SCIENTIFIC RATIONALE

 Study and implement a prototype open source based platform tailored for supporting and allowing scientific analysis oriented of subsets of extracted Gaia data and metadata alongside the Gaia data-database and data lake at DPCT, e.g. Gaia GW use case on different platform





Credits: ESA/DPAC









OBJECTIVES

To create a database and filesystem platform capable of extracting all sources within a specific area

of the sky and associating with each source the information regarding its transits.

We need fast queries and analysis of data from different perspectives:

- ☐ Run queries at billions of rows (sources) per second for each CPU core
- □ Switching between a source oriented search by row (space) to a columnar search by transit (time) leveraging both indexing methods without the need to duplicate the DB volume;

We need also to pre-aggregating and pre-calculating the information in the database before delivering to the users.









DATA

CompleteSource: source information (180 attributes), ~ 4.8 TB with 2.793*10^9 elements.

AstroElementary: transit information (33 attributes), ~ 41 TB with 99.9*10^9 elements.

CrossMatch: association of sources and transits (8 attributes), ~ 1.4 TB with 88.997*10^9 elements.











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CHALLENGES

- DM and metadata definition to be queried on in an efficient way
- Blob attributes as links to other tables.
- □ The Data are covered by an NDA NO PUBLIC DATA









GBIN

- Used gbinreader to interpret Gaia gbin data in Python.
- Converted gbin to another format for easier usage.
- GBIN files can contain multiple
 CS/XM/AE entries.

'sourceId': 3376960784291370112, 'alpha': 1.6257970447712626, 'alphaStarError': 415.1820205532908 'delta': 0.389743536501208. 'deltaError': 304.3747106045399, 'linDecompNormalsParamSolved': 31, 'muAlphaStar': None, 'muAlphaStarError': None, 'muDelta': None, 'muDeltaError': None, 'radialVelocity': None, 'radialVelocityError': None, 'varpi': None, 'varpiError': None, 'linDecompNormals': [0.17978651002121898, 0.21658186521428793, 0.021359902368825224 0.15672888162006487, -0.007329793929945749, 0.1774723087349154, -0.12139129917298573, 0.09194578488838766, -5.103146522638524e-05, 0.01918613887682385, -0.1353116037702648, 0.09556740757878916, -5.341107177382422e-05, 0.0028955756289015286, 0.019095000561812434, 4.645244283992821e-18, -3.3773274466869448e-18, 1.875151880209317e-21, -1.0141508864111856e-19, -9.097583078950226e-20, 0.0010000000474974513], 'refEpoch': '<javaobj:gaia.cu1.tools.time.GaiaTime> 'colConstLevel': None. 'f2': 1.2288812398910522, 'noiseFlag': 8, 'solutionId': 1636042515805110273, 'bpMean': None, 'fieldOriginators': '<javaobj:java.util.EnumMap>', 'qMean': '<javaobj:gaia.cu1.mdb.cu5.photpipe.phot.dmimpl.Mean</pre> 'rpMean': None, 'Gof': 0.0. 'assumedModelOrigin': 0. Disclaimer: example with fake data

'assumedModelOrigin': 0, 'assumedPhysicalMultiple': False, 'assumedVariableCombSpec': False, 'astrometricDuplicateSourceId': 0, 'astrometricPseudoColor': None, 'astrometricPseudoColorError': None, 'astrometryFromEarlierCycle': False, 'bpIntegratedSpectrum': None, 'converged': True, 'deltaQ': None, 'emissionLinesCombined': False, 'epoch': None, 'excessNoise': 9.363175726773374, 'excessNoiseSig': 16.60973007898822, expectedSigToNoise': None, 'gRvs': None, 'gRvsConstancyProbability': None, 'gRvsError': None, 'hasRadVelSpeBarSys': False, 'inPencilBeam': False. 'inverseConditionNumber': 2.485626464476809e-05. 'ipdFracHighGof': 11, 'ipdFracMultiPeak': 0, 'ipdFracOddWin': 0, 'ipdGofHarmonicAmplitude': 194292.4375, 'ipdGofHarmonicPhase': 39.968650817871094. 'isGrvsValid': False, 'isPhotometricOutlier': False, 'isRadVelVariable': False, 'isSB2': False, 'isWeakClassification': False, 'matchedObservations': 2, 'matchedObservationsUsedByAgis': 2, 'meanFluxExcess': None, 'meanOnBoardGMag': 20.7109375, 'meanVarpiFactorAc': 0.7114633321762085, 'meanVarpiFactorAl': -0.5583772659301758









GBIN

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- GBIN files can contain multiple
 CS/XM/AE entries.

FITS FORMAT

- Initially considered FITS format butfaced challenges
- Created FITS files for each gbin,defining expected structures.
- Introduced primary header to mapSourceId/TransitId.
- Challenges with FITS rigid structure for dynamic needs.









HDF5 FORMAT

- □ Considered HDF5 for more flexible structure.
- Created HDF5 files with layered structure (metadata in first layer).
- □ Intuitive search
- Better blob integration
- Exploring size reduction strategies.
 - ~ 📴 Match_134569_0000_0.hdf5
 - - flags
 - #healPixFov
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 - transitId
 - > **body_71044336664975022**

- AstroElementary_130092_0000_0.hdf5
- - > 🗅 body_71044326901200390 transitId
- > metadata_71044326901207467
- > metadata 71044326912484631
- > metadata_71044326914437991

- ~ ScompleteSource_130097_0000_0.hdf5
 - - alphaStarError
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 - > 🗅 metadata_3376960749931617792









CONCLUSION & FUTURE STEPS

The next step will be to create queries to extract specific information about sources and transits.

- ~ ScompleteSource_130097_0000_0.hdf5
- ~ metadata_3376960745635101952

malpha

- alphaStarError
- > **body_3376960745635101952**

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- > metadata_71044326942094951
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- > metadata_71044326952179257
- > metadata_71044326956504473
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- > metadata_71044326960935735
- > 🗅 metadata_71044326963451324
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~ 5 Match 134569 0000 0.hdf5 ~ body 71044336382645929 distance flags #healPixFov msolutionId sourceId #transitId > body 71044336664975022 > body 71044336764982597 > body 71044337057535098 > body 71044337103410683 body 71044337287042108 > body 71044337326756811 > body 71044337335538798 > body 71044337373287414 > body 71044337508423526 > body 71044337567668072 > body 71044337639364409

> body_71044337700312368

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Thank you for your attention!