Logiciels d'accès ouvert pour les analyses scientifiques des rayons gamma

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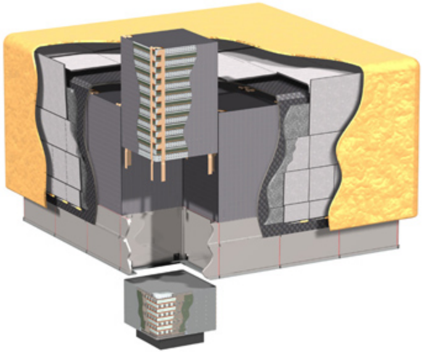
LAPP

17 septembre 2013

Large Area Telescope

Détecteur de rayons γ entre 100 MeV et 300 GeV



LAT :

- 4×4 array of identical towers
- Each one including a Tracker, a Calorimeter and an Electronics Module
- Surrounded by an Anti-Coincidence shield to reject charged particles

Analysis software (ScienceTools) and Data provided by the NASA

Introduction

Buts :

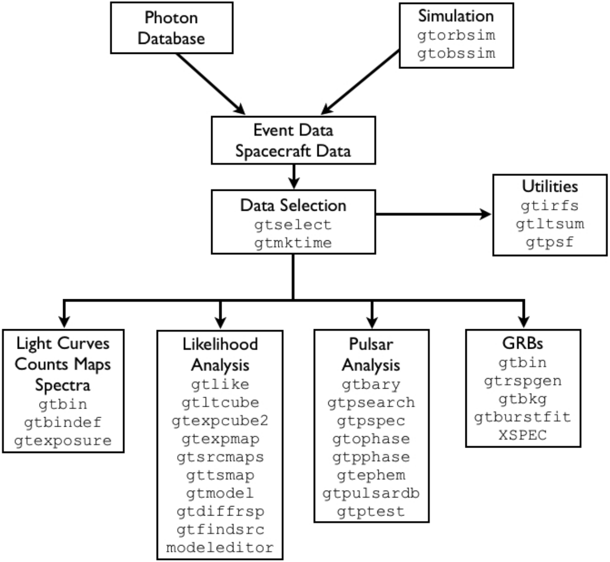
- Faire un analyse de donnée sur un source : obtenir un spectre
- Découverte du package Enrico

Notations

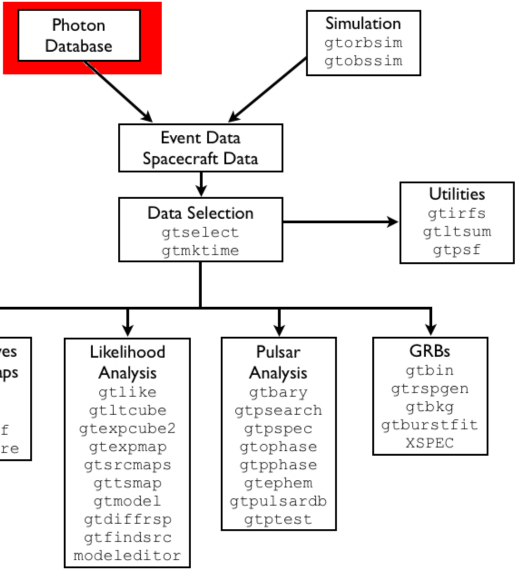
Event file == Photon file == FT1 file
Spacecraft file == FT2 file

L'analyse est fait par maximum de vraisemblance (likelihood)
Analyse BINNED
Source : Crab (83.633083,22.0145)

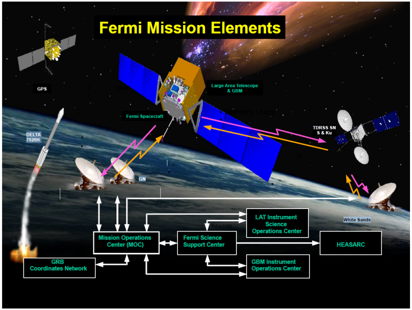
Chaîne d'analyse



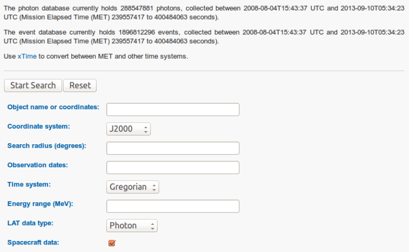
Chaîne d'analyse



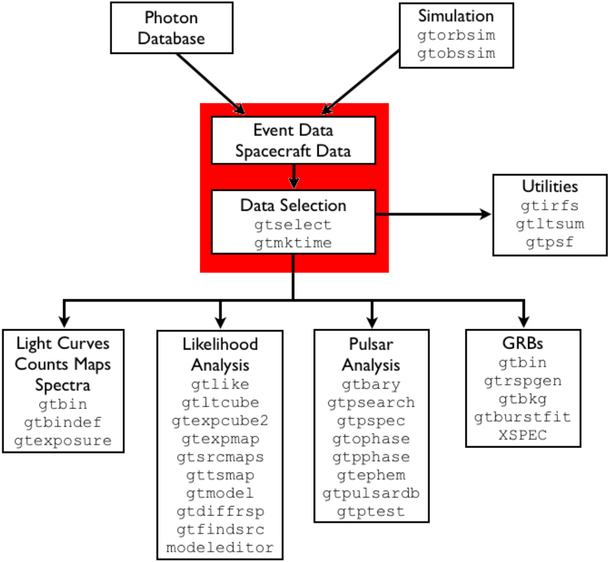
Données *Fermi*



Disponibles aussi sous un FTP



Chaîne d'analyse

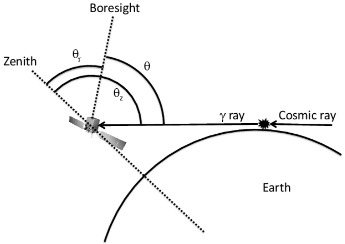


Data selection

Données dans des fichiers FITS (`Flexible Image Transport System`).
Outils de visualisation : `ToCat`, `fv` or `ds9`

gtselect

- `evclass` = 2, 3 or 4
- `zmax` = 100 : Coupure sur l'angle zenithal pour eviter l'albedo
- definition de la ROI



ROI : balance entre CPU et précision

---

gtselect

Selection en temps, espace et énergie

```
gtselect evclass=2
```

gtmktime

- GTI : Good Time Interval
- filtre=`DATA_QUAL==1 && LAT_CONFIG==1 && ABS(ROCK_ANGLE)<52`
- ROI cut=yes

---

gtmktime

Quand les données sont valables ?

```
gtmktime
```

Count Map, cube map

Carte en coup avec gtbin : visualisation des données

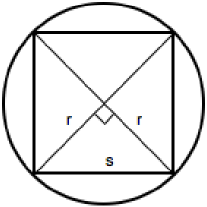
gtbin option CMAP

```
gtbin
```

gtbin :

Bin les donnée en energie et espace

- 10 bins par decade
- binsize = 0.1, npix = ROI/($\sqrt{2}$*binsize)

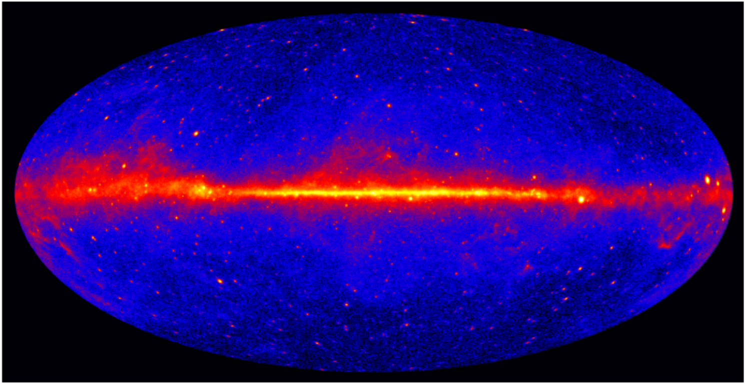


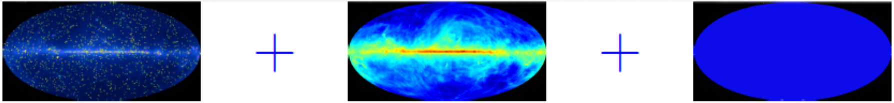
$s = r * \sqrt{2}$

gtbin option CCUBE

```
gtbin
```

Modèle du ciel





Resolved sources:

point vs. extended

Galactic diffuse:

Cosmic-ray interactions with

Isotropic diffuse

Unresolved sources

Modèle du ciel


```
-<source_library title="source library">
 -<source name="IsoDiffModel" type="DiffuseSource">
  -<spectrum file="iso_p7v6source.txt" type="FileFunction">
```


Diffuse Source


```
     <parameter free="1" max="1000" min="0.001" name="Normalization" scale="1" value="1"/>
   </spectrum>
  -<spatialModel type="ConstantValue">
     <parameter free="0" max="10" min="0" name="Value" scale="1" value="1"/>
   </spatialModel>
  </source>
 -<source name="GalDiffModel" type="DiffuseSource">
  -<spectrum type="ConstantValue">
     <parameter free="1" max="10" min="0.01" name="Value" scale="1" value="1"/>
   </spectrum>
```


Free parameter


```
  -<spatialModel file="gal_2yearp7v6_v0.fits" type="MapCubeFunction">
     <parameter free="0" max="1000" min="0.001" name="Normalization" scale="1" value="1"/>
   </spatialModel>
  </source>
 -<source name="Crab" type="PointSource">
```


source ponctuelle, model poxer-law

Scale

Valeur

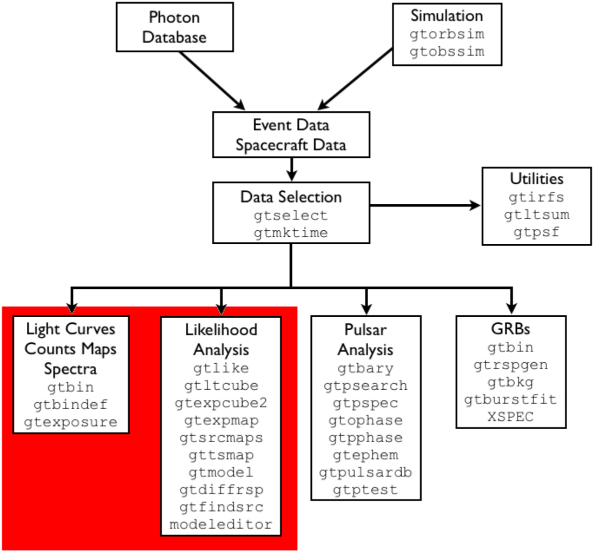

```
  -<spectrum type="PowerLaw">
     <parameter free="1" max="1000" min="1e-05" name="Prefactor" scale="1e-09" value="1"/>
     <parameter free="1" max="-0.5" min="-5" name="Index" scale="1" value="-2"/>
     <parameter free="0" max="300000" min="30" name="Scale" scale="1" value="100"/>
   </spectrum>
  -<spatialModel type="SkyDirFunction">
     <parameter free="0" max="360" min="-360" name="RA" scale="1" value="83.6331"/>
     <parameter free="0" max="90" min="-90" name="DEC" scale="1" value="22.0145"/>
   </spatialModel>
  </source>
 -<source name="2FGL J0440.4+1433" type="PointSource">
```


Spectre


```
  -<spectrum type="PowerLaw">
     <parameter free="0" max="1000" min="1e-05" name="Prefactor" scale="1e-12" value="1.22753"/>
     <parameter free="0" max="-0.5" min="-5" name="Index" scale="1" value="-2.3513"/>
     <parameter free="0" max="300000" min="30" name="Scale" scale="1" value="910.467"/>
   </spectrum>
  -<spatialModel type="SkyDirFunction">
     <parameter free="0" max="360" min="-360" name="RA" scale="1" value="70.1037"/>
     <parameter free="0" max="90" min="-90" name="DEC" scale="1" value="14.5619"/>
   </spatialModel>
  </source>
```


Position

Chaîne d'analyse



gtltcube

Amount of time that the source spent at a given inclination angle during an observation

```
gtltcube
```

P7 IRF name	Event Class (evclass)	Conversion Type	Description
P7ULTRACLEAN_V6	4	0+1	Highest quality and lowest background selection - somewhat overconservative, this entails a significant loss of effective area. Recommneded mainly to use as a cross check that observed features are not due to cosmic-ray contamination
P7ULTRACLEAN_V6::FRONT	4	0	Front converting events
P7ULTRACLEAN_V6::BACK	4	1	Back converting events
P7CLEAN_V6	3	0+1	Very high quality and low background selection - recommended for analyses that integrate large regions of the sky. Reduces non-photon spectral features to very low levels.
P7CLEAN_V6::FRONT	3	0	Front converting events
P7CLEAN_V6::BACK	3	1	Back converting events
P7SOURCE_V6	2	0+1	High quality selection - recommended for most analysis
P7SOURCE_V6::FRONT	2	0	Front converting events
P7SOURCE_V6::BACK	2	1	Back converting events
P7SOURCE_V6MC	2	0+1	Monte Carlo PSF - for studies of short term (<1 month) variability
P7SOURCE_V6MC::FRONT	2	0	Front converting events
P7SOURCE_V6MC::BACK	2	1	Back converting events
P7TRANSIENT_V6	0	0+1	Lower quality selection - used for certain transient or timing analysis
P7TRANSIENT_V6::FRONT	0	0	Front converting events
P7TRANSIENT_V6::BACK	0	1	Back converting events

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gtexpcupe2

Binned exposure map : Calcul sur la totalité du ciel

```
gtexpcupe2
```

gtsrcmap

Model count maps

```
gtsrcmap
```

gtlike

Minimization step

```
gtlike ftol=1e-6 sfile=Result.xml plot=yes
```

- tolérance (ftol) :
- Optimizer : MINUIT, NEWMINUIT

- Test Statistic (i.e. significance)
- Sortie graphique
- Resultats dans des fichiers xml ou/et ascii

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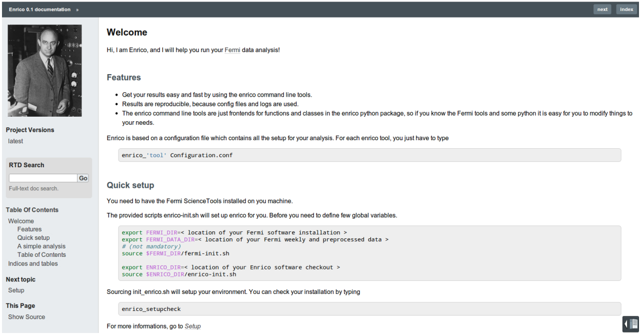
LAT data analysis : Enrico python package

https ://github.com/gammapy/enrico

ArXiv : http ://arxiv.org/abs/1307.4534



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Setup

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Welcome

Hi, I am Enrico, and I will help you run your Fermi data analysis!

Features

- Get your results easy and fast by using the enrico command line tools.
- Results are reproducible, because config files and logs are used.
- The enrico command line tools are just frontends for functions and classes in the enrico python package, so if you know the Fermi tools and some python it is easy for you to modify things to your needs.

Enrico is based on a configuration file which contains all the setup for your analysis. For each enrico tool, you just have to type

```
enrico_'tool' Configuration.conf
```

Quick setup

You need to have the Fermi ScienceTools installed on you machine.

The provided scripts enrico-init.sh will set up enrico for you. Before you need to define few global variables.

```
export FERMI_DIR=< location of your Fermi software installation >
export FERMI_DATA_DIR=< location of your Fermi weekly and preprocessed data >
# (not mandatory)
source $FERMI_DIR/fermi-init.sh

export ENRICO_DIR=< location of your Enrico software checkout >
source $ENRICO_DIR/enrico-init.sh
```

Sourcing init_enrico.sh will setup your environment. You can check your installation by typing

```
enrico_setupcheck
```

For more informations, go to *Setup*

Features :

- Front-end pakage for the ST tools
- One configuration file for `Spectrum`, LC, `TS map`
- Debug plots

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Enrico python package