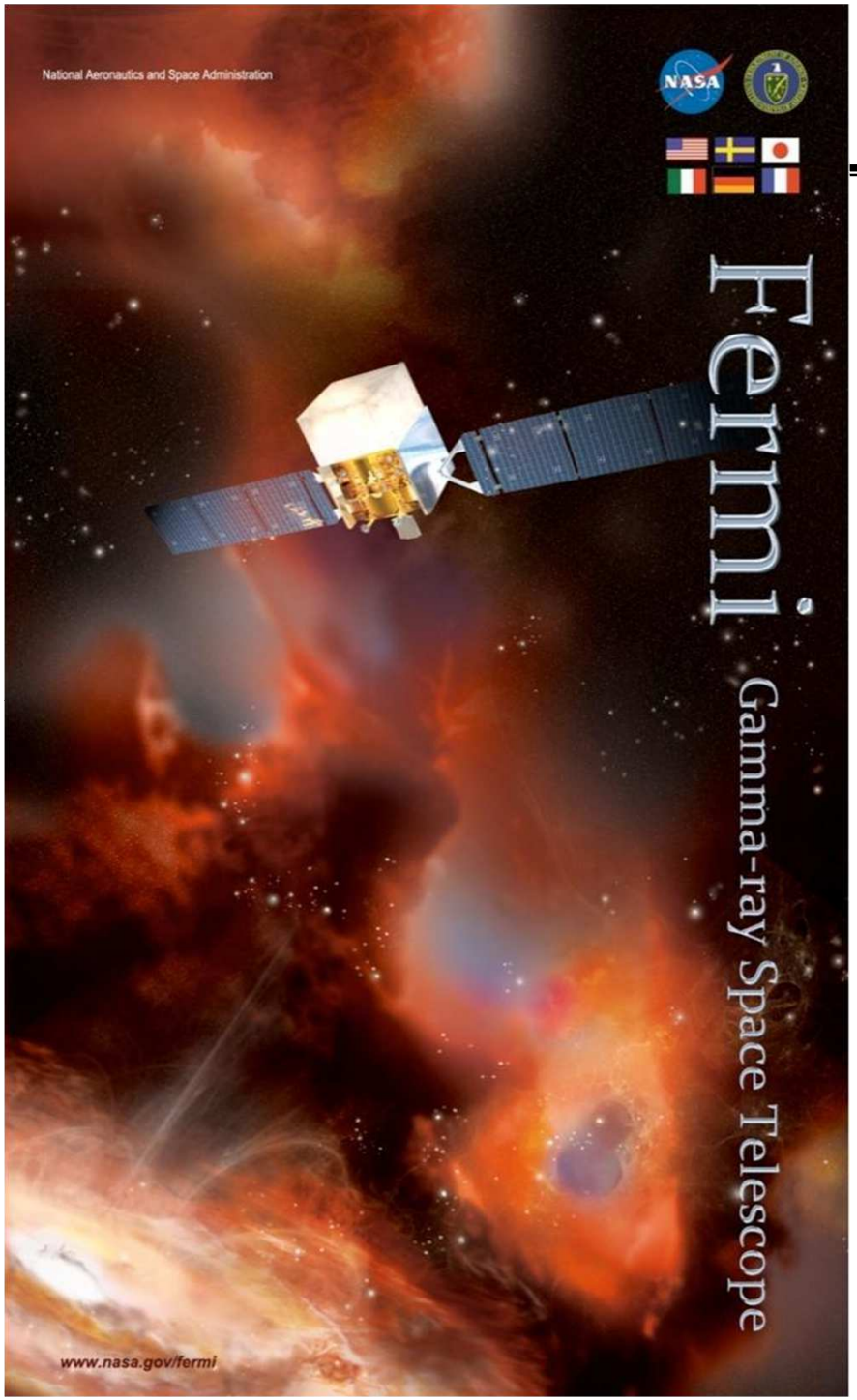
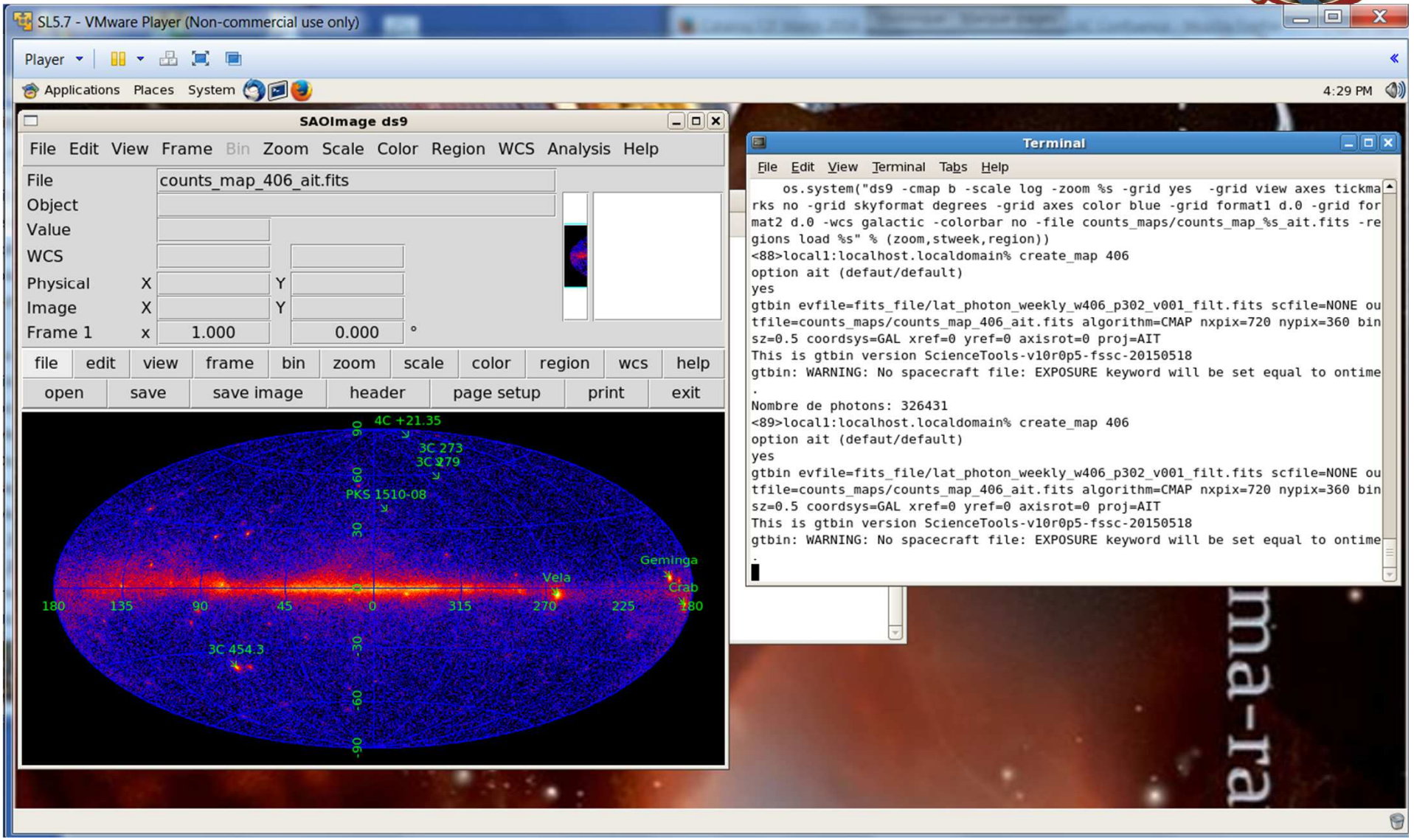


Fermi Masterclasses in France

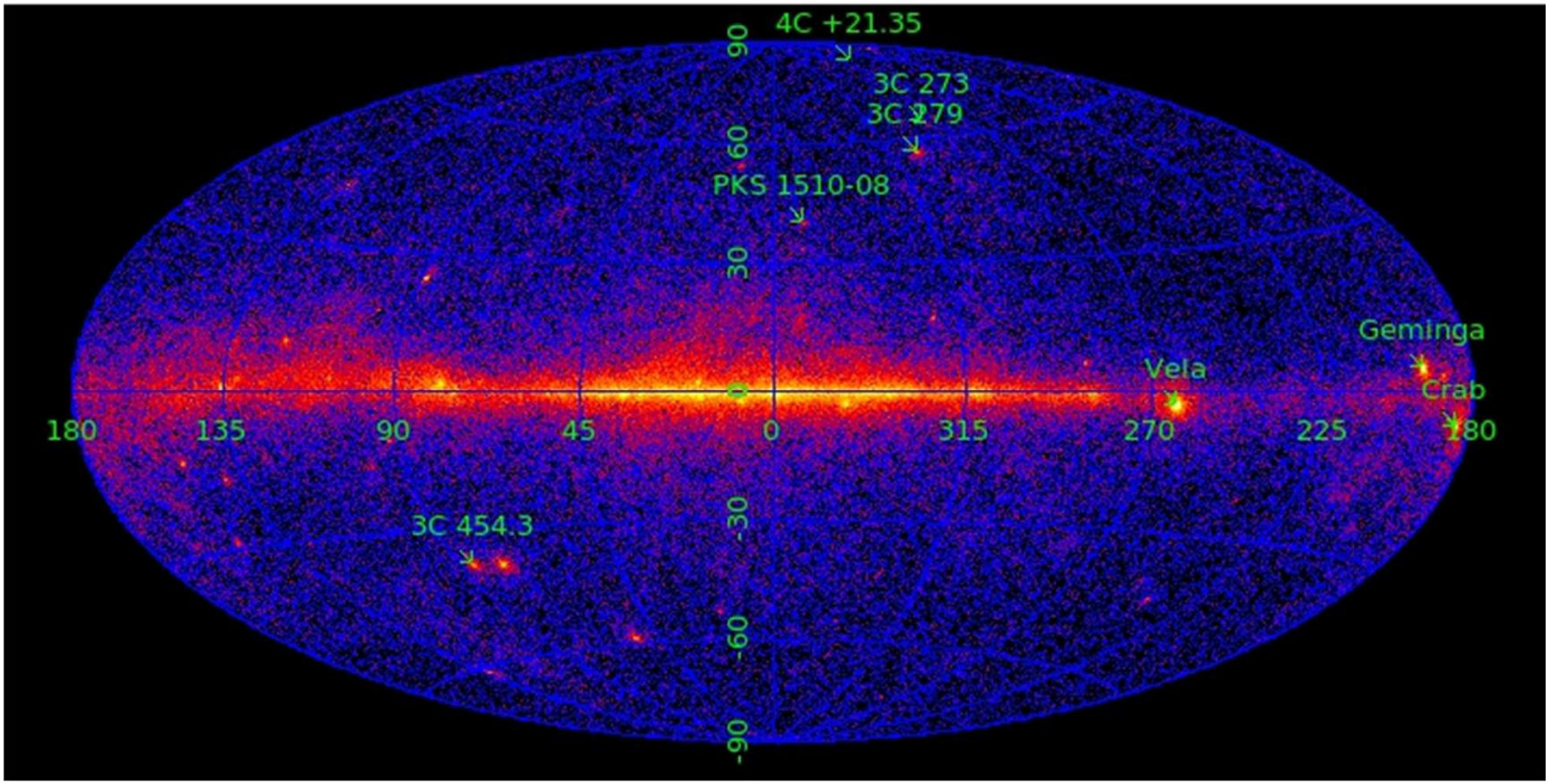
Denis Dumora, Benoît Lott
CEN Bordeaux-Gradignan

Eric Nuss
LUMP, Montpellier

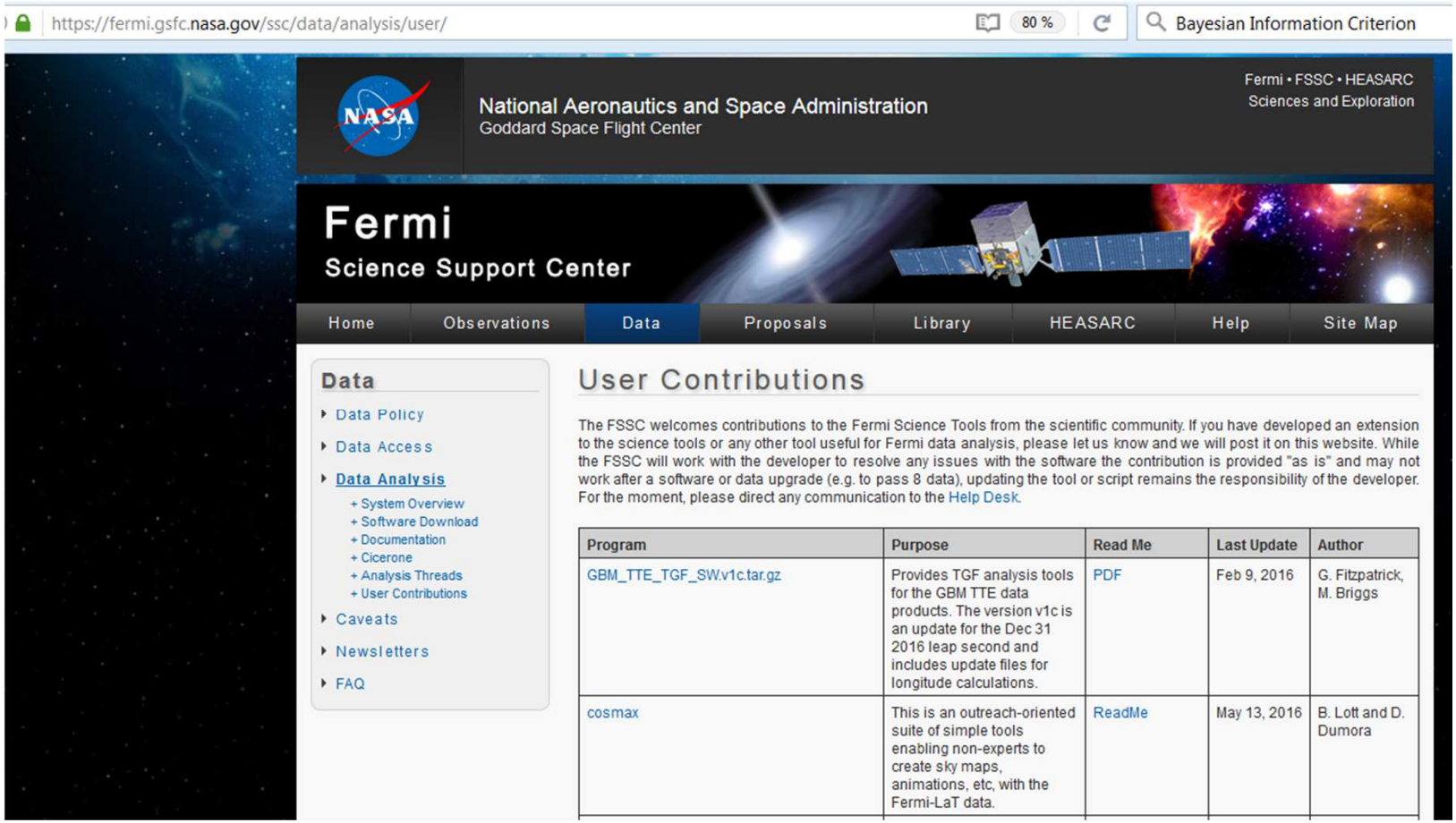
Cosmax (VMWare/Virtual Box/ Linux)



The current sky (week 460)



Cosmax: contributed software



http://www.cenbg.in2p3.fr/COSMAX-Cosmic-accelerators-at-home

ftp://www.cenbg.in2p3.fr/astropart/VM/cosmax_english.pdf

Fermi masterclasses

https://confluence.slac.stanford.edu/display/SCIGRPS/Masterclass+with+the+Fermi-LAT+data

Fermi Masterclasses in France

- 2015: Three high-school classes, two in the Bordeaux area, one in the Montpellier area (~70 students)
- 2016: Two high-schools classes, in the Bordeaux

and Montpellier area (60 students) in November.

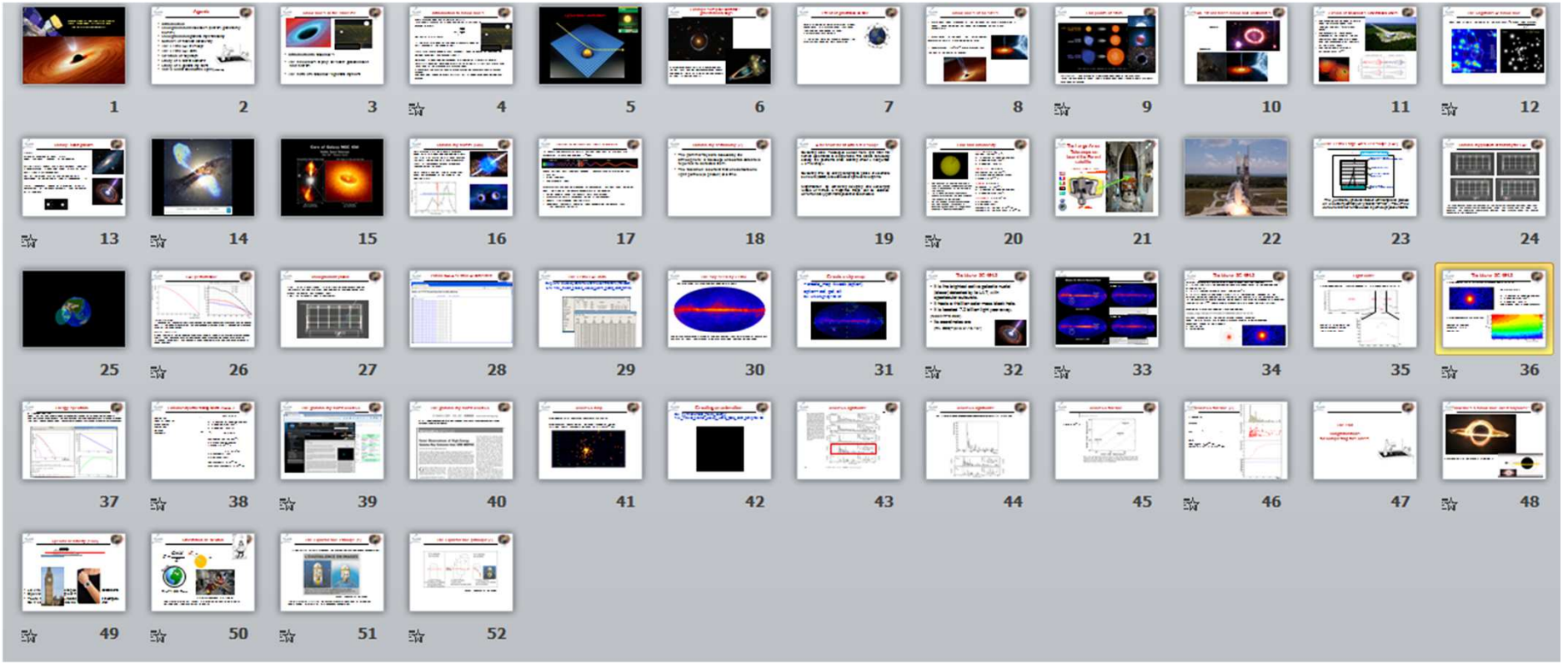
- Theme: « Black holes » (as seen by the Fermi-LAT)
- Study of the bright flare of 3C454.3 in Nov. 2010 and GRB 080916C (maps, lightcurves, computation of luminosity or fluence), Some published results/figures were replicated.
- Very positive experience according to all parties
- Thanks to Roopesh Ojah for devoting some his time to answering questions!

Agenda

- **Introduction**
- **Background on black holes (blazars, gamma-ray bursts)**
- **Background on gamma-ray astronomy**
- **Notions of flux and luminosity**
- **The Fermi-LAT telescope**
- **The Fermi-LAT data**
- **Creation of sky maps**
- **Study of a blazar outburst**
- **Study of a gamma-ray burst**
- **Video connection with D.J. Thompson/R. Ojha (NASA)**

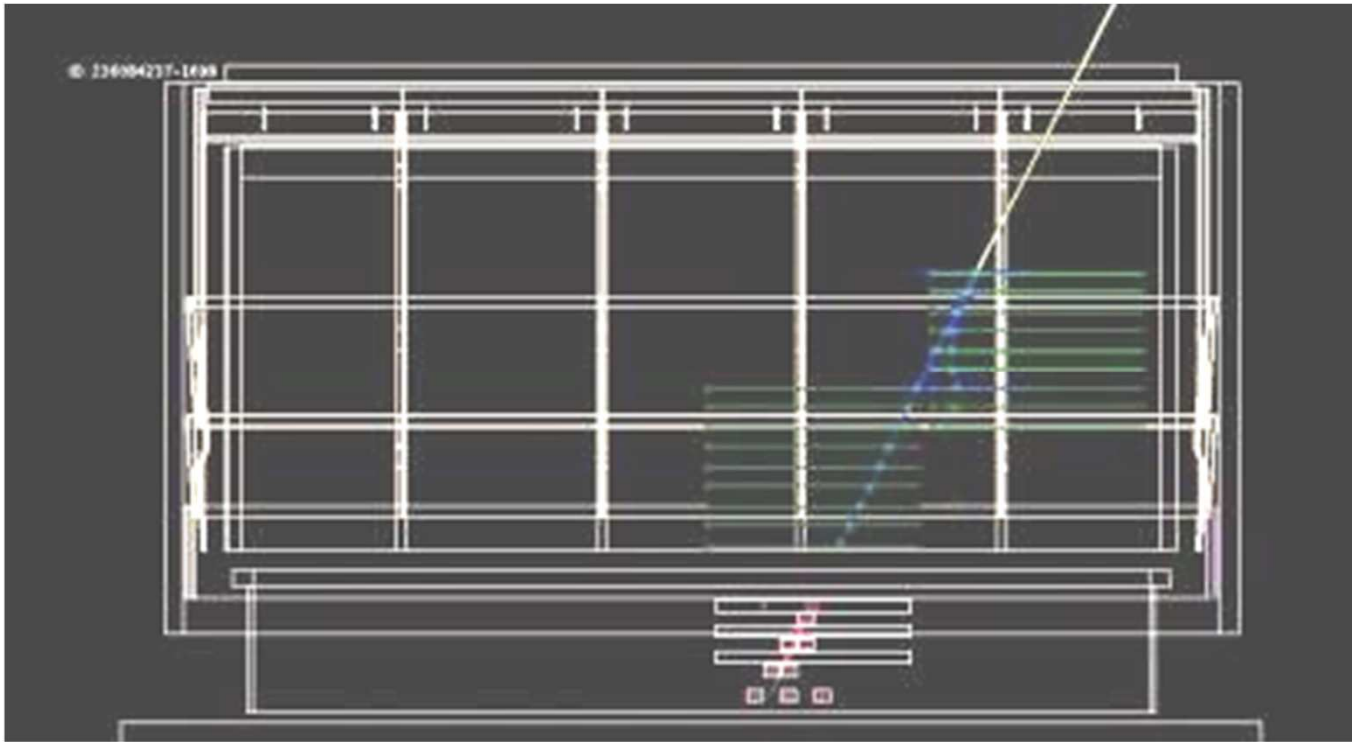
Full presentation:

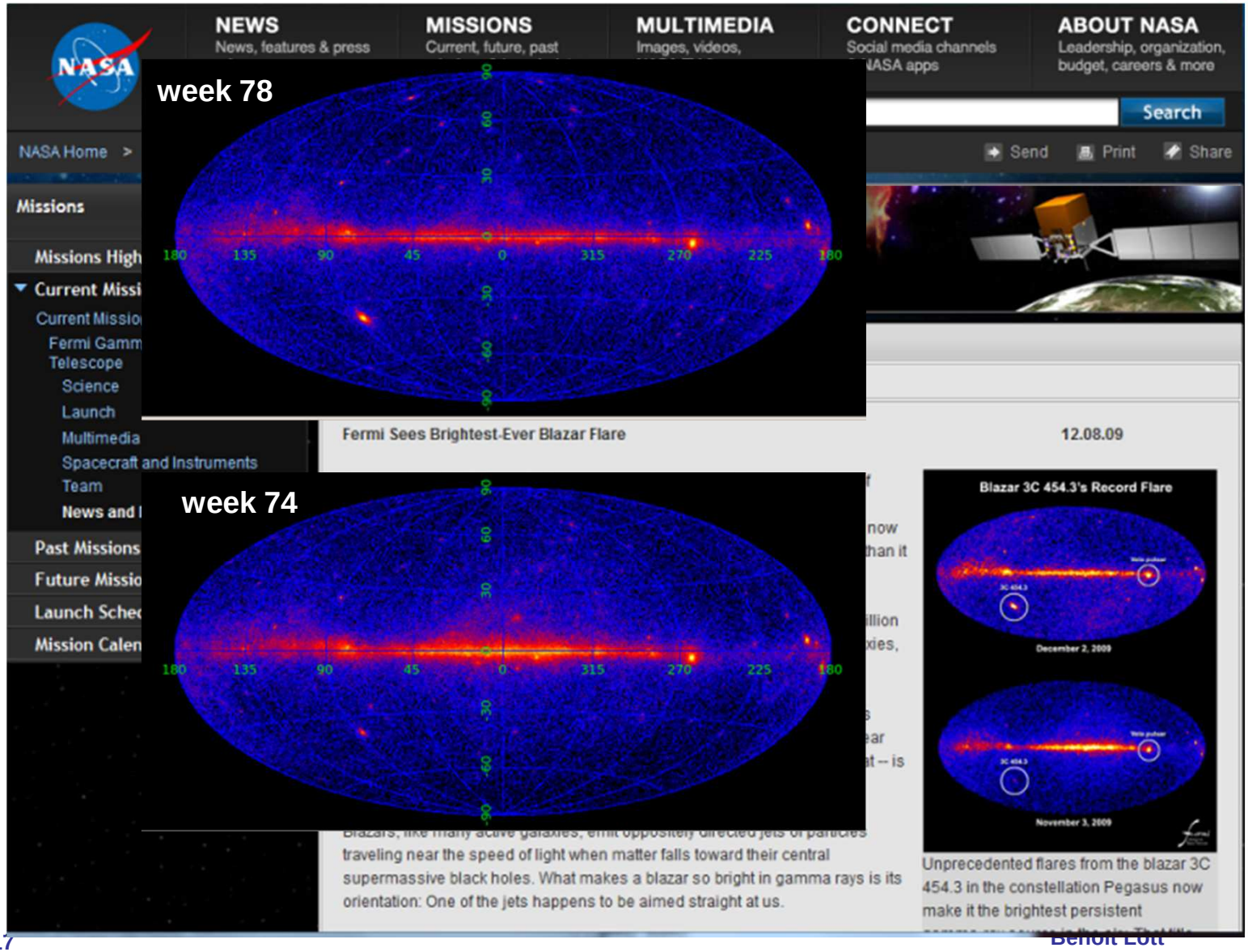
https://confluence.slac.stanford.edu/download/attachments/209365302/Masterclasse_2015_eng.pptx



Background rejection (project)

Goal: After a quick training, try to tell from the event displays whether the primary particles are most likely photons or charged cosmic rays.
Guess the energy: low, medium, high?
(Do it for 20 events. What is your score?)




NEWS
News, features & press
MISSIONS
Current, future, past
MULTIMEDIA
Images, videos,
CONNECT
Social media channels
ASA apps
ABOUT NASA
Leadership, organization, budget, careers & more
Search
NASA Home >
Send
Print
Share
Missions
Missions High
Current Missi
Current Missio
Fermi Gamm
Telescope
Science
Launch
Multimedia
Spacecraft and Instruments
Team
News and
Past Missions
Future Missio
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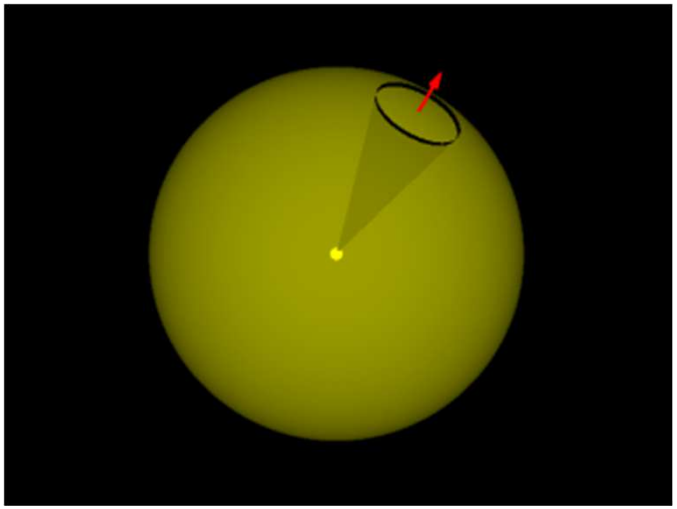
Mission Calen
week 78
week 74
Fermi Sees Brightest-Ever Blazar Flare
12.08.09
Blazar 3C 454.3's Record Flare
December 2, 2009
November 3, 2009
traveling near the speed of light when matter falls toward their central supermassive black holes. What makes a blazar so bright in gamma rays is its orientation: One of the jets happens to be aimed straight at us.
Unprecedented flares from the blazar 3C 454.3 in the constellation Pegasus now make it the brightest persistent

Flux and luminosity



- *The number of photons emitted in a cone per second remains constant and thus is independent of the distance to the source.*
- *At a given distance, the area of a sphere intercepting the cone scales as the square of the distance.*
- *So the number of photons per square cm and second (= the flux) is inversely proportional to the distance squared ("inverse-square law").*

Flux $F_p = N / S\,T$

F_p= Flux (ph cm^{-2} s $^{-1}$)

N = Number of collected photons

S = Collecting area (cm^2)

T = Collecting time (s)

Energy flux $F_E = F_p\,E$

F_E= Energy flux (W cm^{-2})

E = Mean photon energy (MeV)

1 MeV= 1.6 10^{-13} J

Fluence $F = N\,E / S$

F= Fluence (J cm^{-2})

N = Number of collected photons

S = Collecting area (cm^2)

Luminosity $L = 4\,\pi\,d^2\,F_E$

L = Luminosity (W)

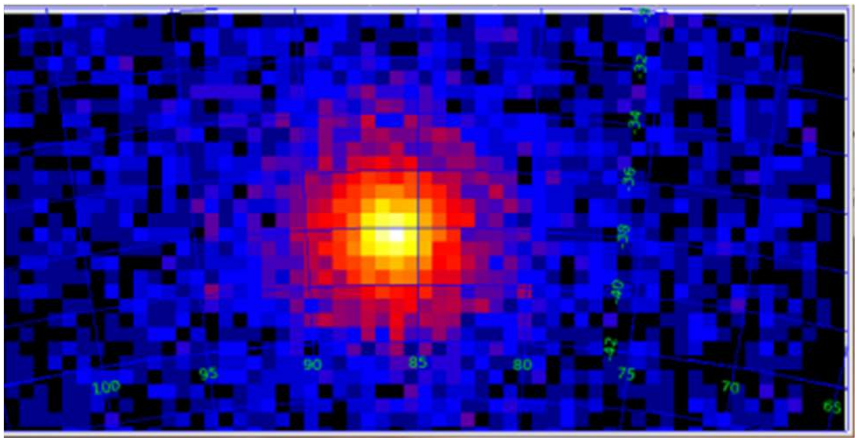
d = distance (cm)

Luminosity of the Sun: 4 10^{26} W

Luminosity of the Milky Way: 5 10^{36} W

The blazar 3C 454.3

> create_map 129 ait 311731200 311990400 343.5 16.15 15

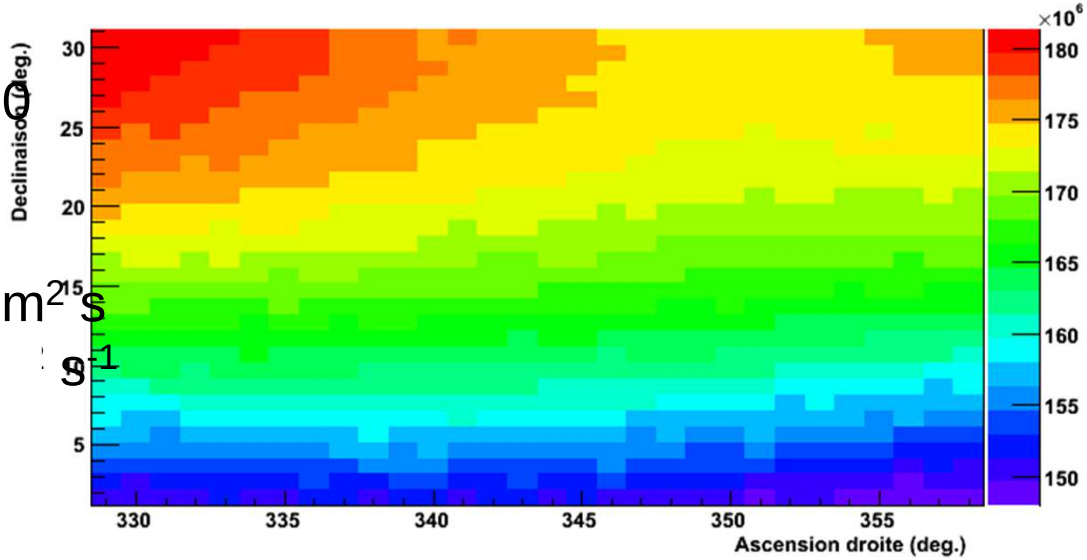


$F_p = N / (S \, x \, T)$

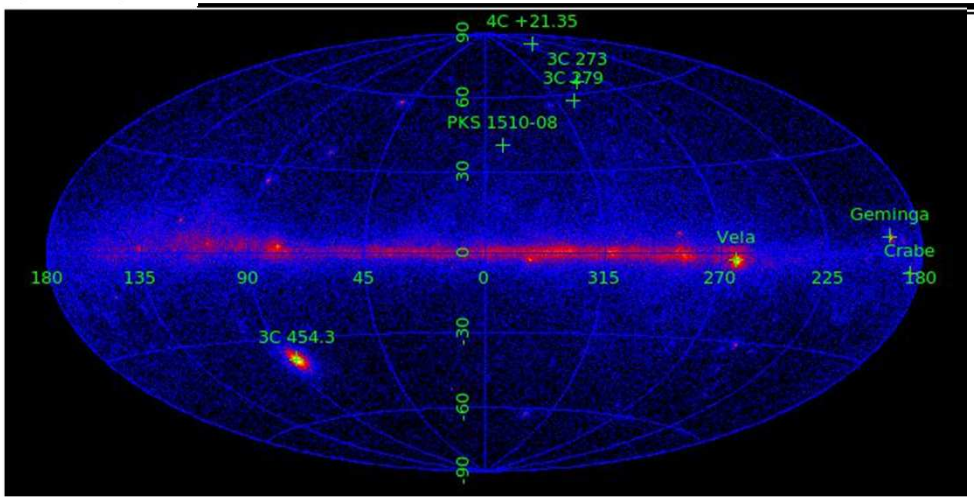
N = Number of collected photons
S = Collecting area (cm^2)
T = Collection time (s)
The product $S \, x \, T$ is called *exposure*.

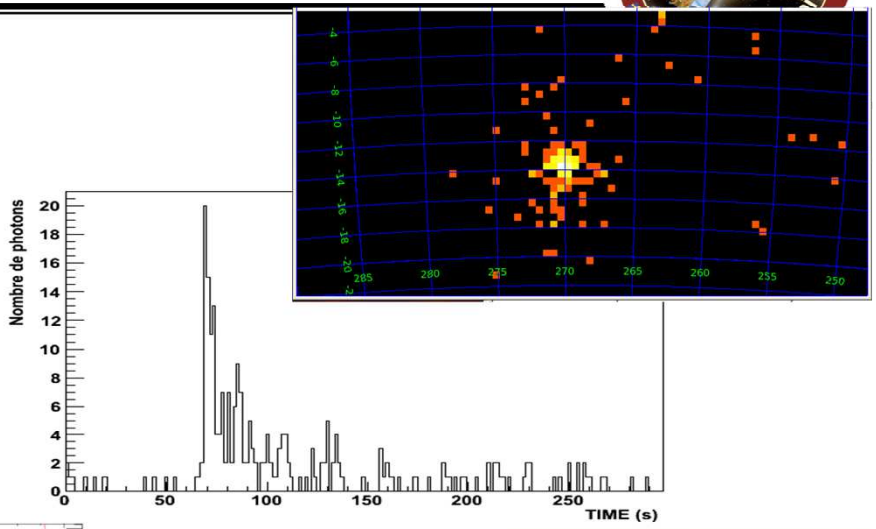
> create_exposure 129 map 200

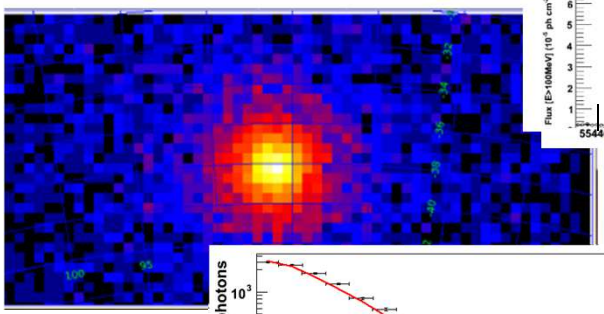
Number of photons: 5
Exposure (S x cm² s
Photon flux s⁻¹

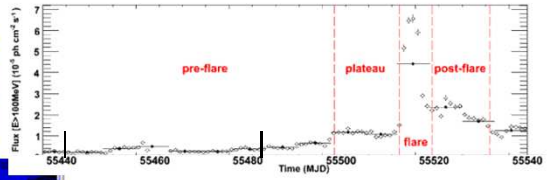


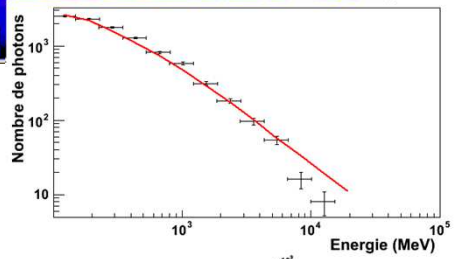
Some highlights

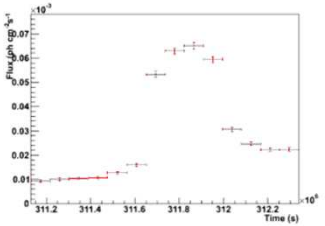


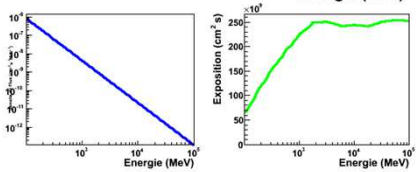


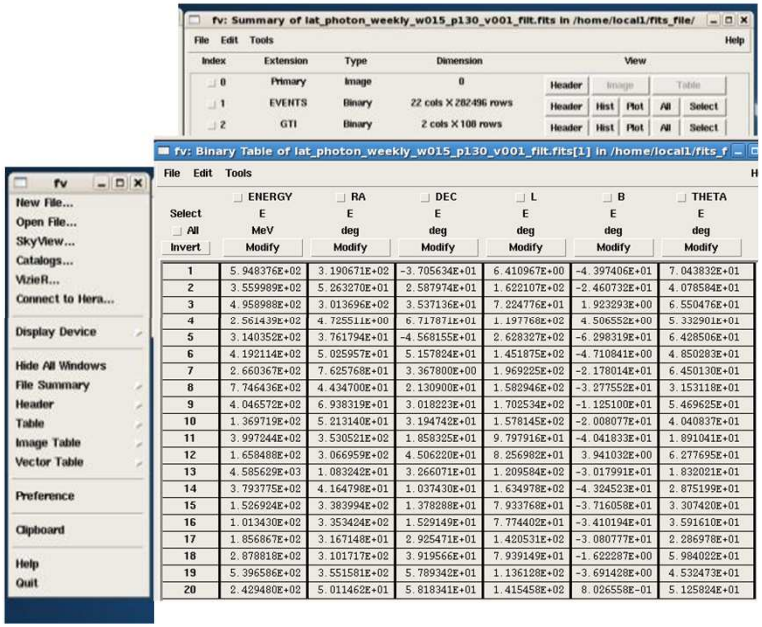












Conclusions

- **Interested in using cosmax?**

  Feedback, suggestions welcome.

- **We are promoting the masterclasses at the local and national levels.**

The COSMIX kit