



# Geant 4



## Gamma Ray Satellites Simulations with Geant4

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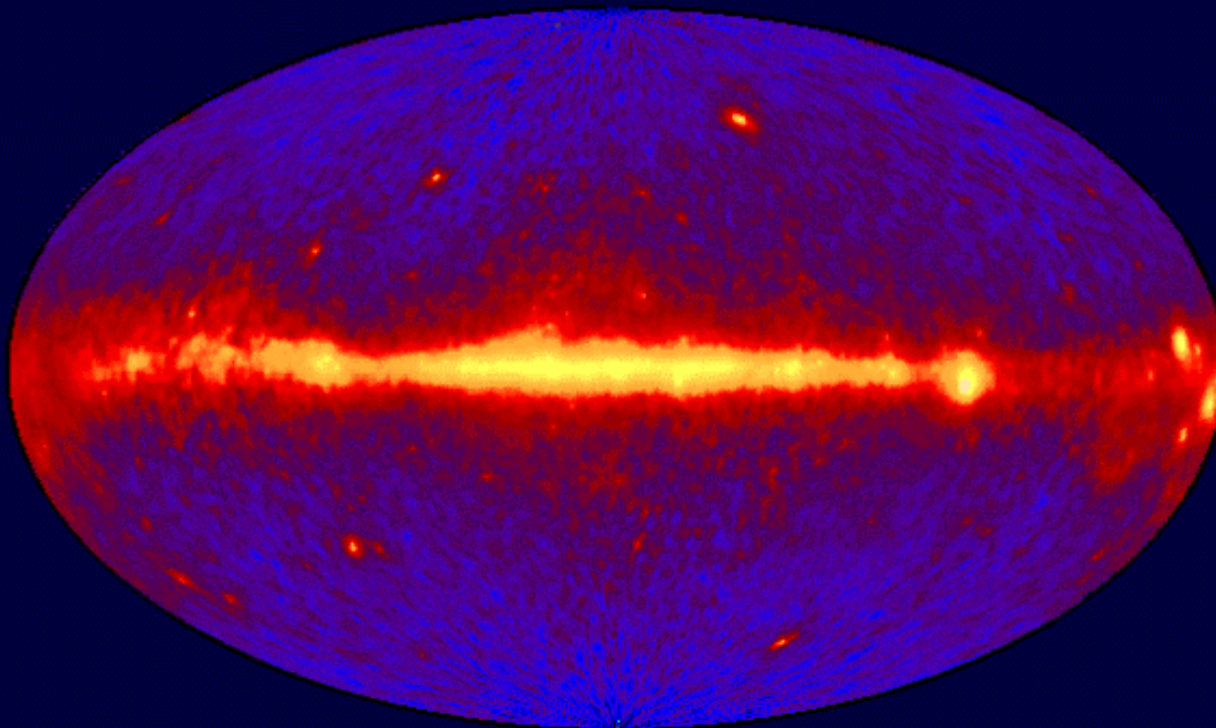
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(3) University Cordoba (Argentina) (4) University and INFN Ferrara  
(5) CERN (6) ESA/ESTEC (7) INFN, Genova

# Outline

- **Gamma Ray Satellites Science and Requirements**
  - AGILE
  - GLAST
  - ARGO
- **GammaRayTel Advanced example (a real training tool)**
  - Geometry and Physics
  - Visualisation
  - Histogramming
  - User Interface
- **Satellites Simulation**
  - XML detector description
  - Physics Processes Extensions & Validation

# High Energy Gamma Ray Astrophysics

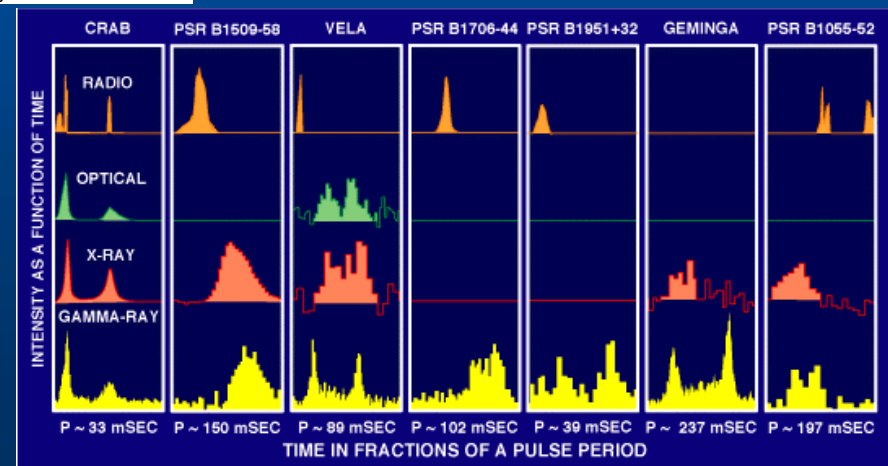
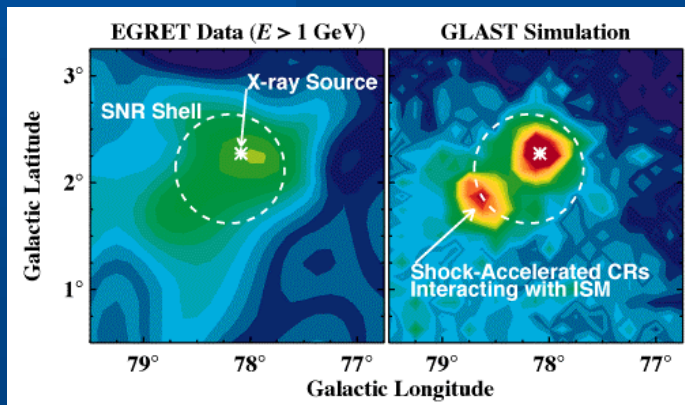
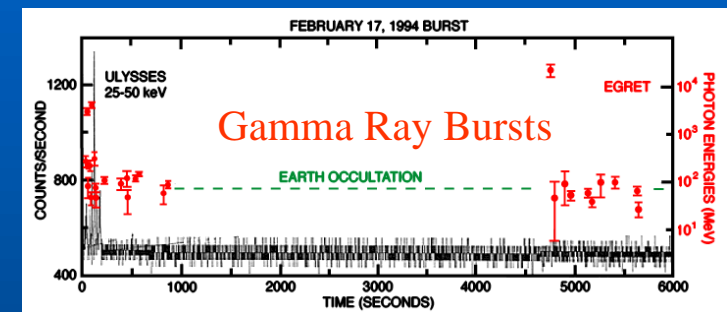
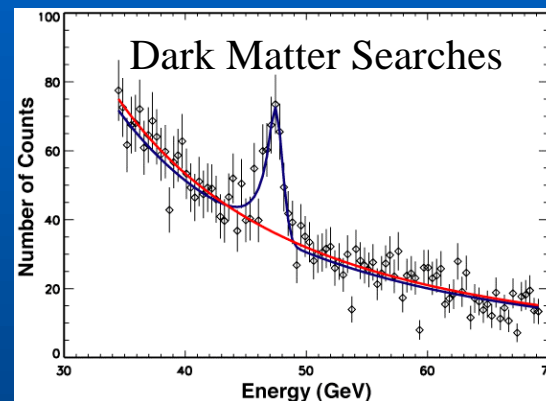
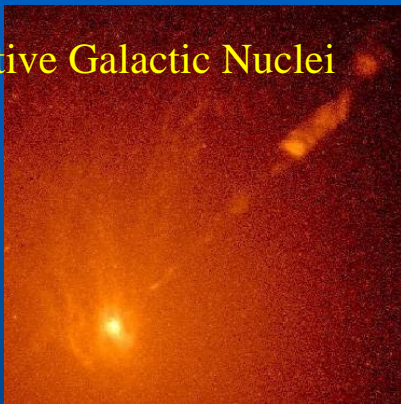
EGRET All-Sky Map Above 100 MeV



Geant4 Workshop – Genova 05 july 2001

# High Energy Gamma Ray Astrophysics

## Active Galactic Nuclei



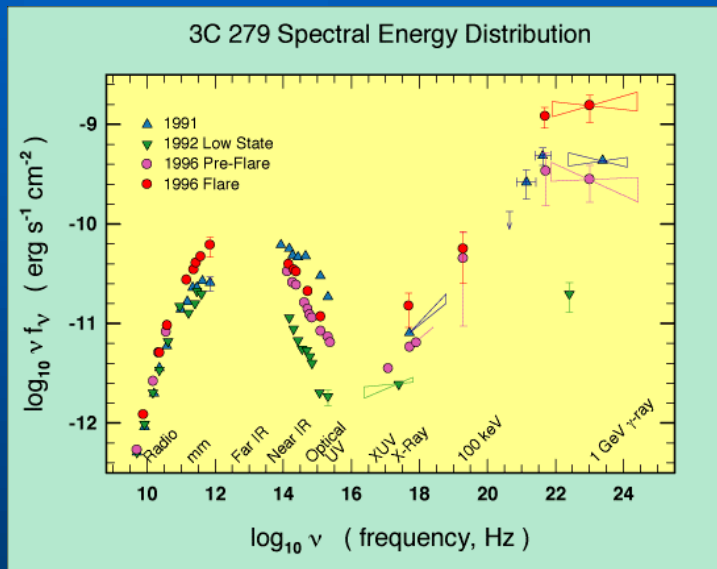
## Supernova Remnants

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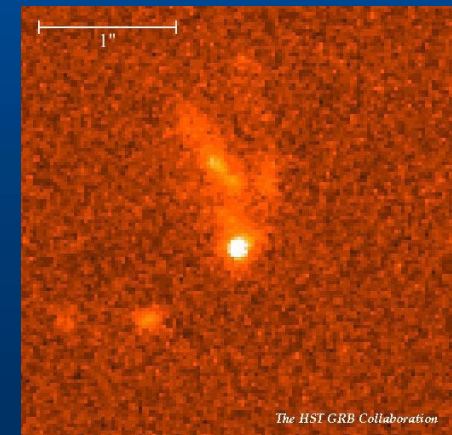
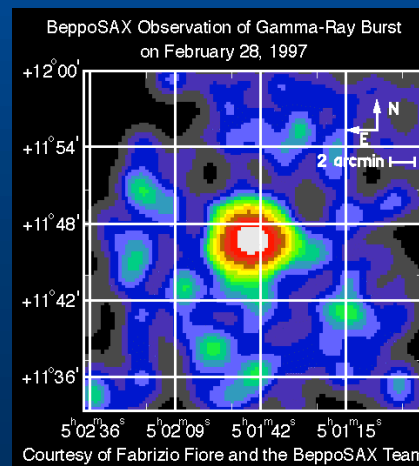
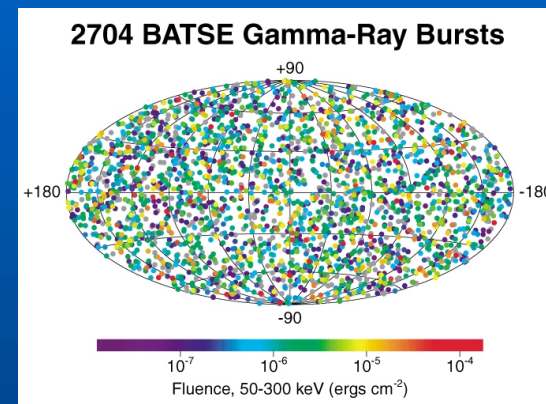
## Pulsars

# Multiwavelength Observations

GRB puzzle



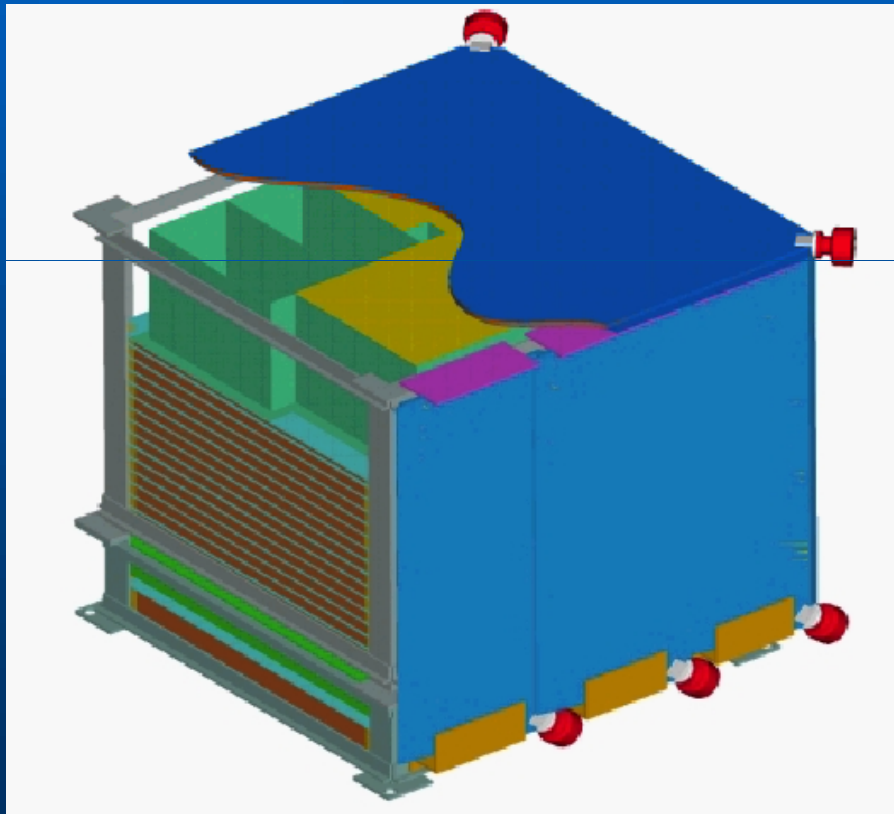
AGN wide band spectrum



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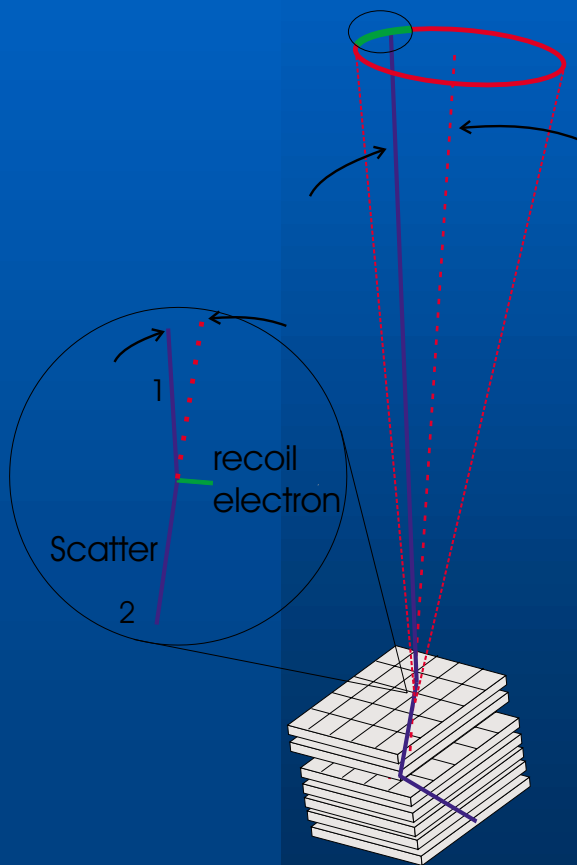


# AGILE



- Pair Conversion Telescope
- Coded Mask Imaging System
- 10 – 40 keV
- 30 MeV – 50 GeV
- Very wide Field of View
- Reaction to transients
- ASI first Small Scientific Mission (2003 – 2006)

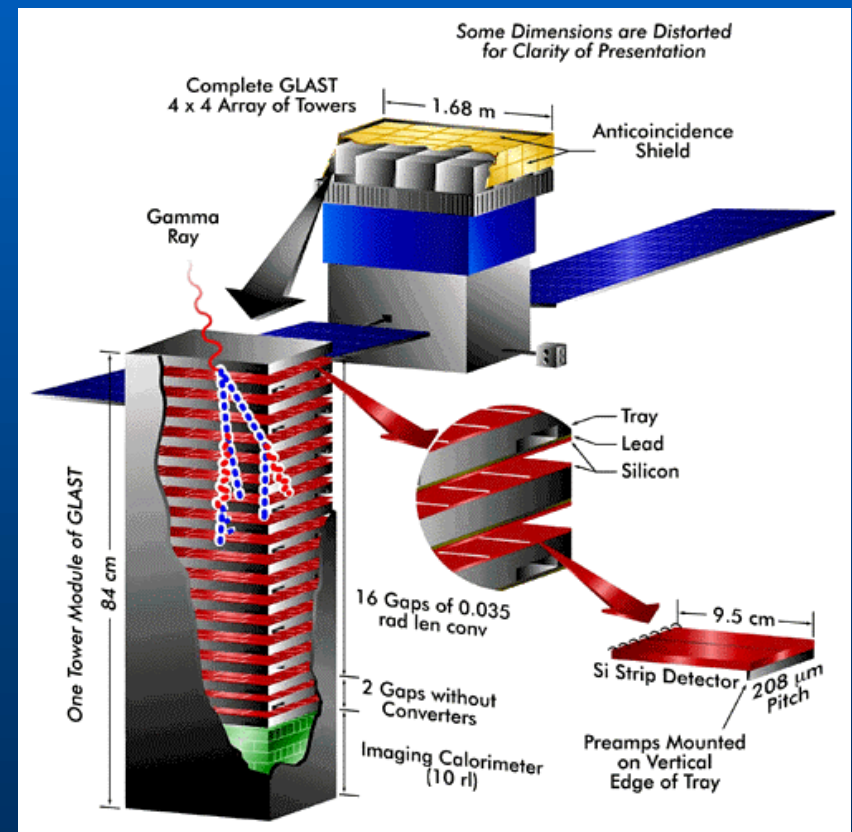
# ARGO



- **Proposal to Argentina National Agency for Scientific and Technological Development**
- **Payload weight (40-60 kg ~ AGILE)**
- **Power 60 W**
- **Use of Silicon Detectors**
- **Measurements of Polarization from Gamma Rays**

# GLAST

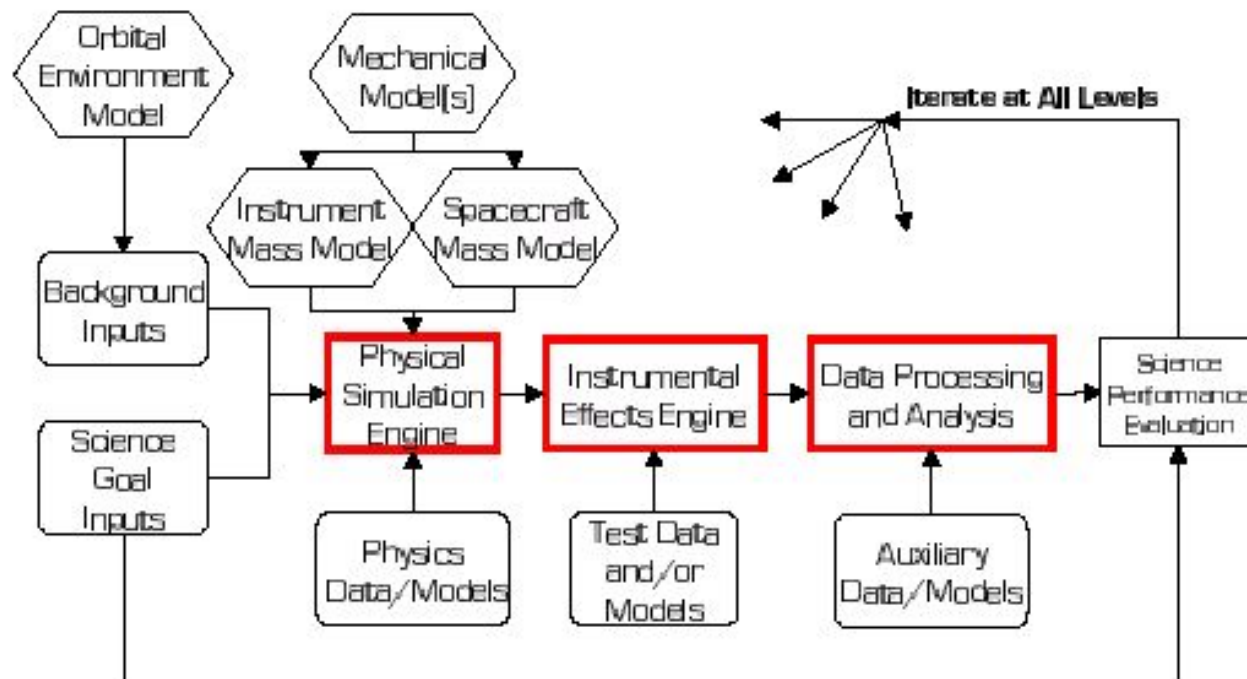
- Pair Conversion Telescope
- Gamma Ray Burst Monitor
- 30 MeV – 50 GeV
- Very wide Field of View
- Spectral Coverage GRB
- International Collaboration (USA, France, Sweden, Japan, England, Italy, Germany)
- Launch date 2006





# Simulations for Space Detectors

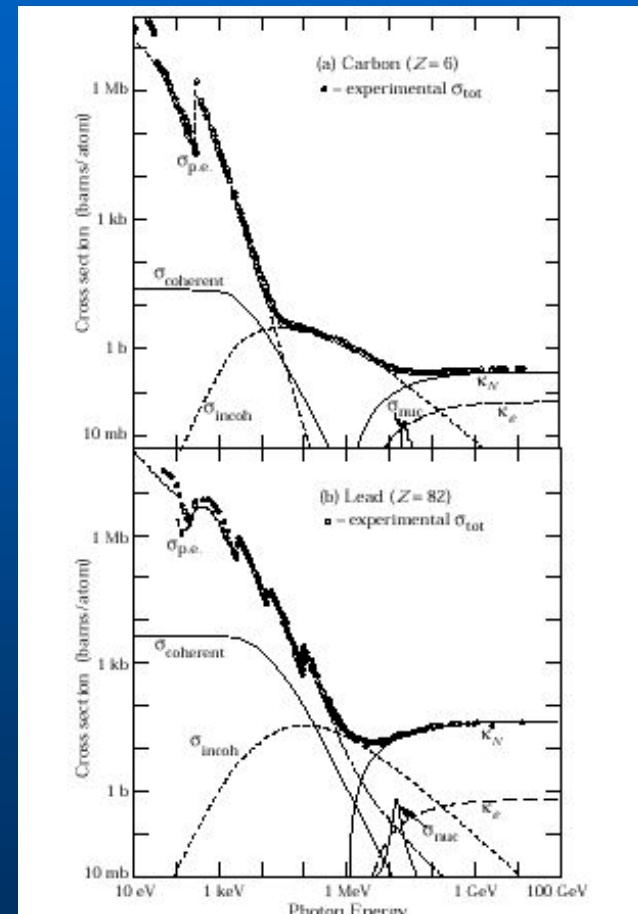
Credible Simulation Requires Credible Inputs at All Levels



# Geant4 and Space Applications

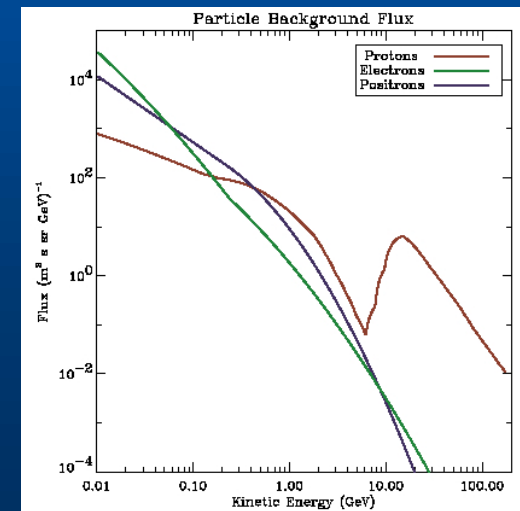
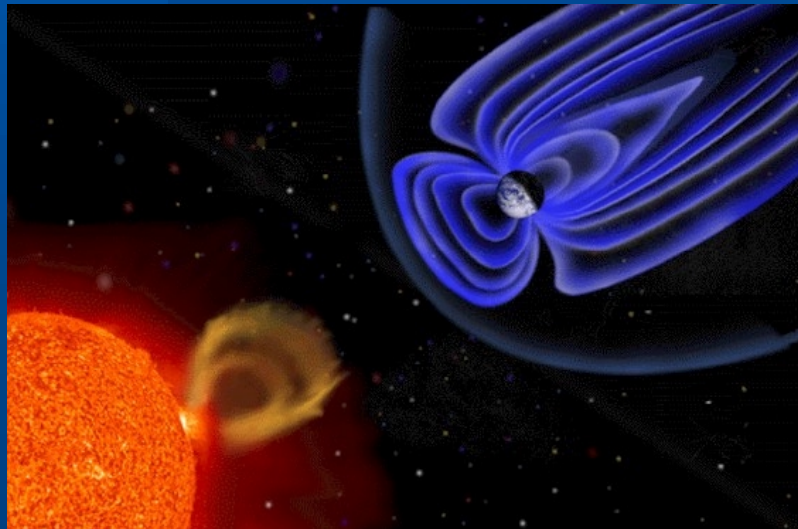
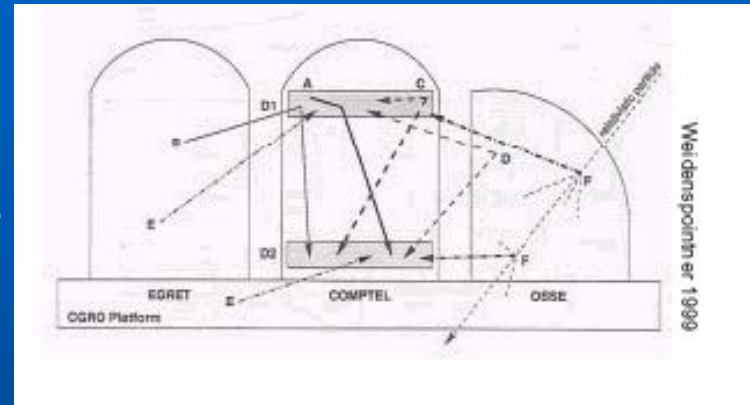
- Source detection
- Different energy bands
- Several mechanisms
- Different detectors

**Design and optimisation  
of satellites**



# Geant4 and Space Applications

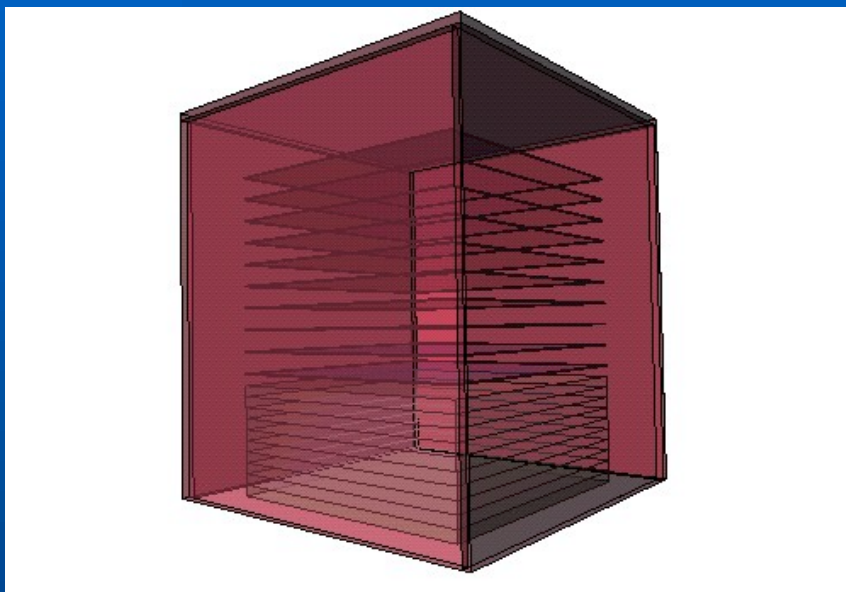
- Background Simulation
- Different sources (radioactive decay, cosmic origin, detector noise, ...)



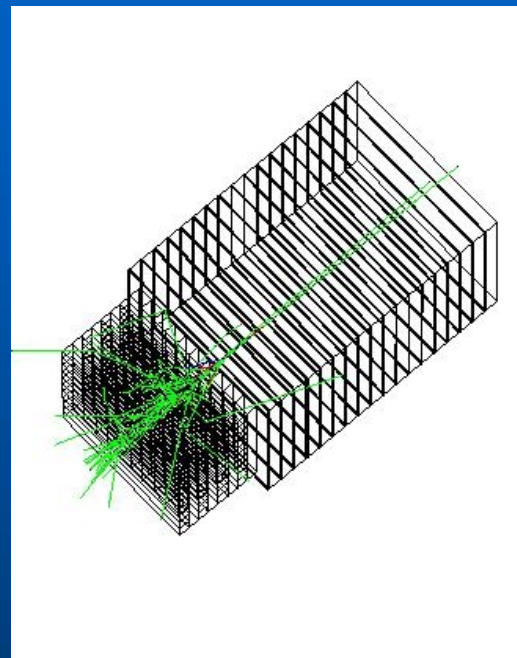
# GammaRayTel example

- **Advanced examples in the Geant4 toolkit (since release 3.0)**
- **Properties**
  - **Advanced features of Geant4 toolkit**
  - **Features of the Low Energy Electromagnetic processes in Geant4**
  - **Reliability of Geant4 in a space environment application**

# Geometry and Physics for GammaRayTel



Lead converter  
Si detectors ( $400\text{ }\mu\text{m}$ )  
CsI calorimeter  
Plastic anticoincidence



Gamma Conversion  
Electron Tracking  
Multiple Scattering  
Delta-ray production  
Charged particle tracking

# Visualisation, Histogramming, UI

- **Graphical drivers**

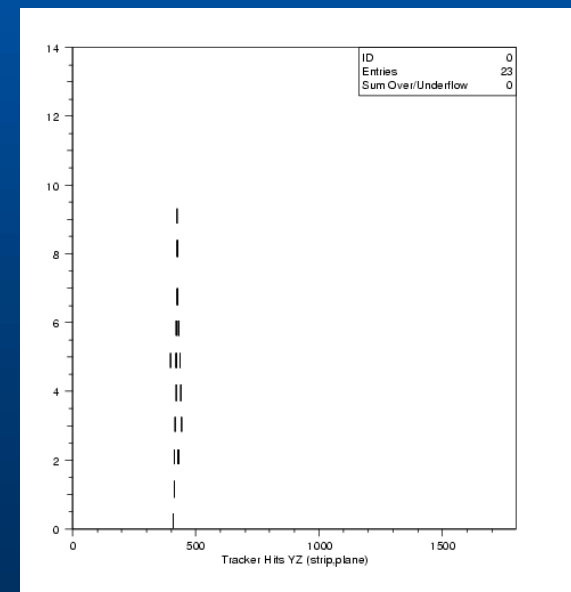
- OpenGL, VRML, DAWN

- **Histogramming using ALDA - Lizard**

- 1d and 2d histograms
- Messenger to choose modality

- **UI**

- Possibility to modify geometry and materials
- Source generation algorithms
- G4 user interface capabilities
- Histograms operations

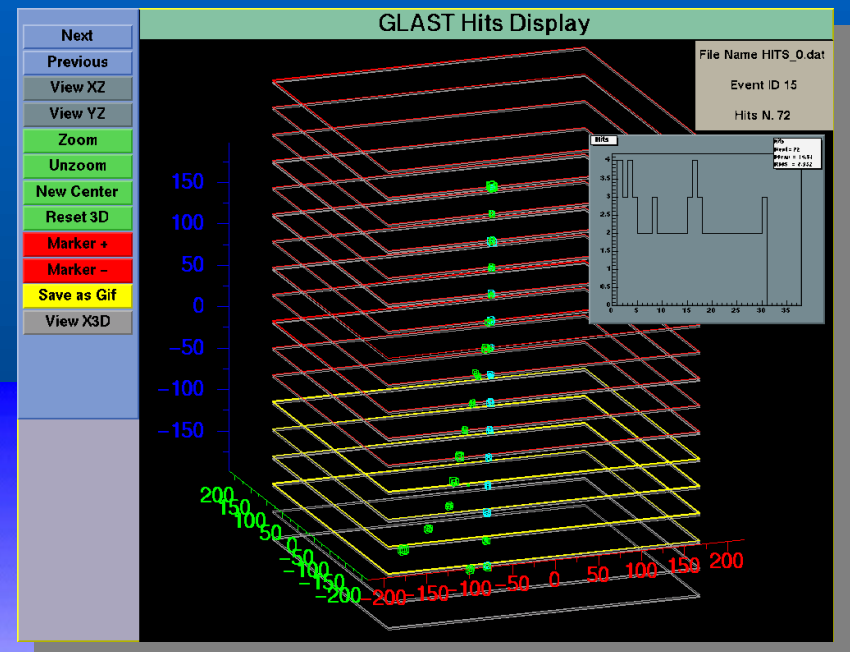
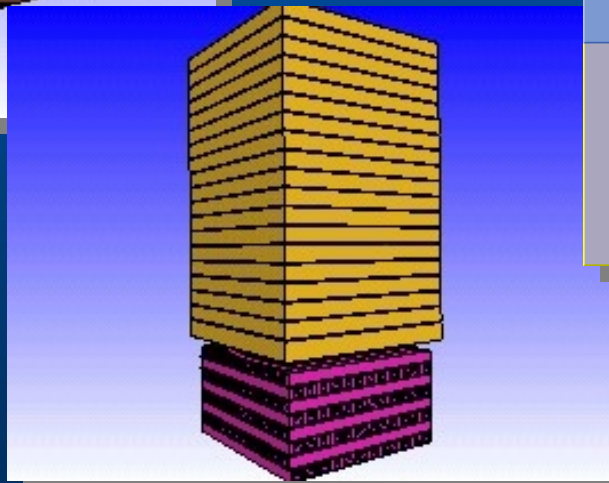
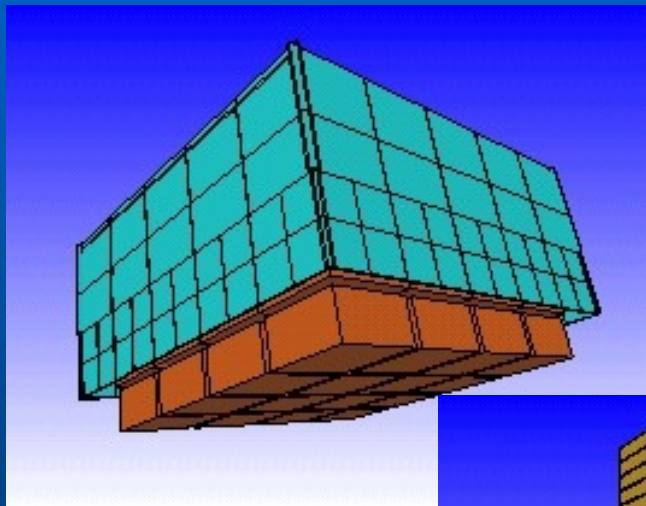




# XML and Detector Description

- GLAST collaboration has adopted the XML language for detector description
- In house DTD (derived by ATLAS one, but with a lot of modifications)
- In house C++ package to interface to the XML file
  - Lot of clients for this package
    - GEANT4
    - VRML
    - Event Display
    - Others ...

# XML



# G4 Simulation Activities

- **Physics Validation & Extensions**
  - Polarised Processes
  - Test Beam Comparisons
- **Integration**
  - Migration from G3 simulation (AGILE)
  - G4 client for XML
  - GAUDI framework

# Conclusions

- High Energy Astroparticle Physics
  - HEP and Astrophysics Communities

