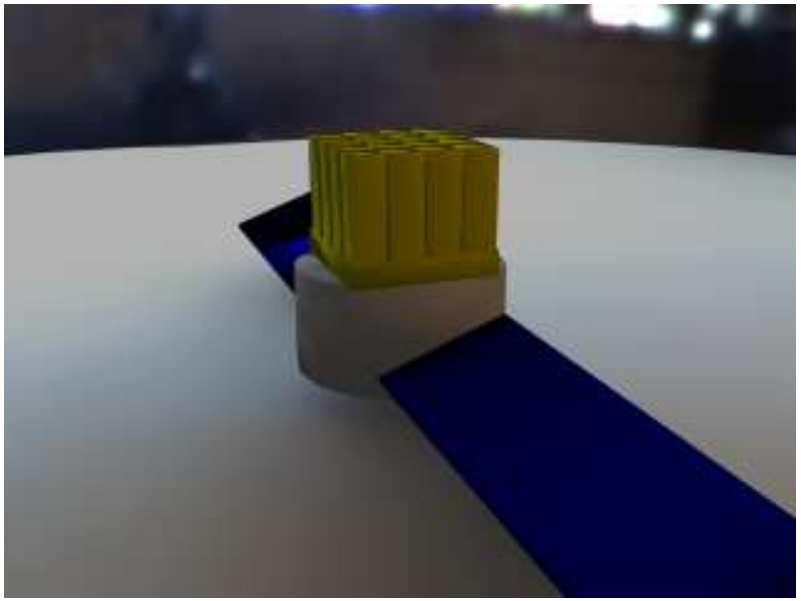
Overview of the GLAST software activities in Italy

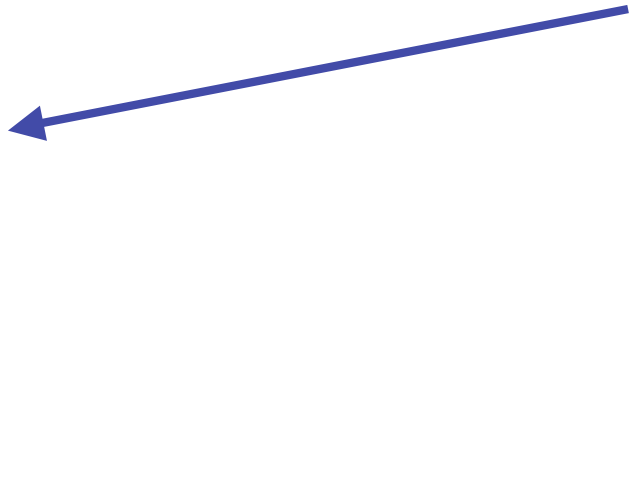
Alessandro De Angelis (Ud/Ts) for the

Glast Italian Software Group



Who / What

- ~20 people corresponding to ~10 FTE from Bari, Padova, Perugia, Pisa, Roma2, Udine/Trieste
- Involved in
  - Construction-related software (online, det/constr DB)
  - Infrastructure
    - Detector description
    - Simulation
    - PR
    - Visualization
  - Science Tools
    - Source simulators
    - Instruments for Data Analysis
    - Physics studies

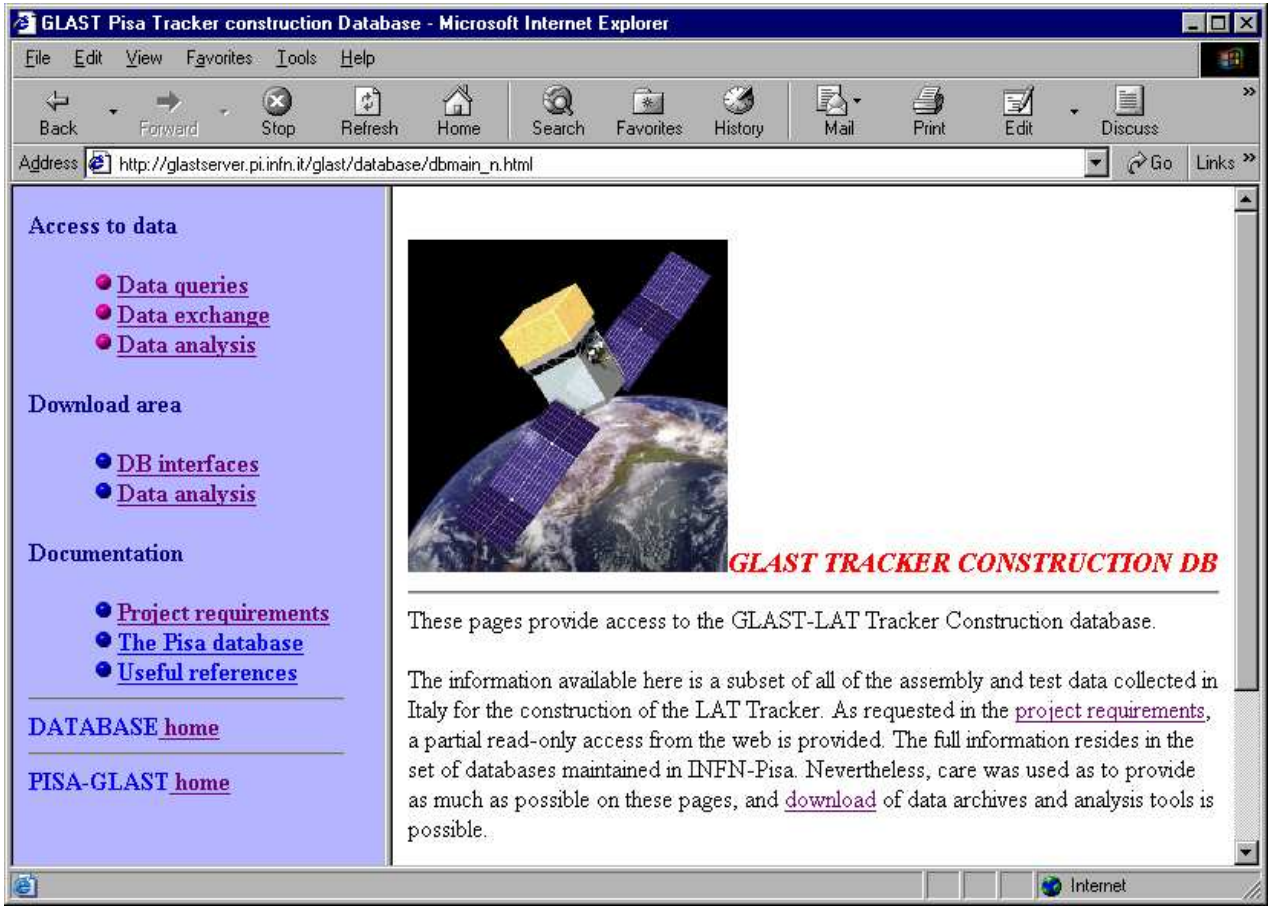


Tracker construction SW (DB & DAQ)

Available on the web from:
http://glastserver.pi.infn.it/glast

- SSD DB and Ladder DB take data from test stations in Pisa, Perugia/Terni, G&A, Mipot – automatic analysis and parts selection
- NCR in use for SSD and Ladders
- Tray DB in construction

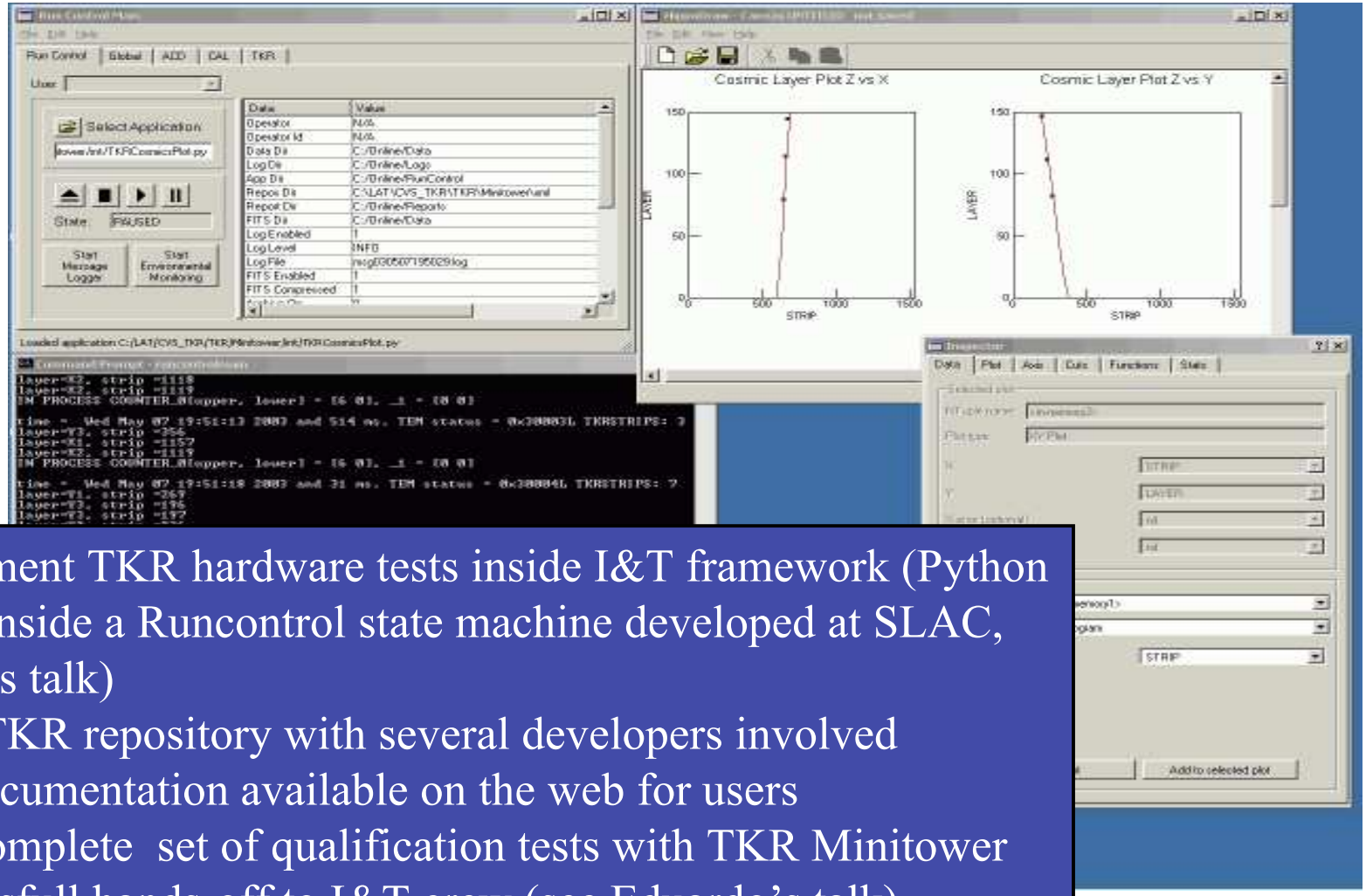
- Ba: DAQ sw for environmental tests (thermal/vibrational)



Talk

Online SW (mostly Pisa)

Talk



- implement TKR hardware tests inside I&T framework (Python scritps inside a Runcontrol state machine developed at SLAC, see Ric's talk)
- CVS TKR repository with several developers involved
- full documentation available on the web for users
- first complete set of qualification tests with TKR Minitower
- successfull hands-off to I&T crew (see Eduardo's talk)

Plus some core online software for tracker tests from Pisa, Perugia, Bari (with Ric, Selim)

Infrastructure

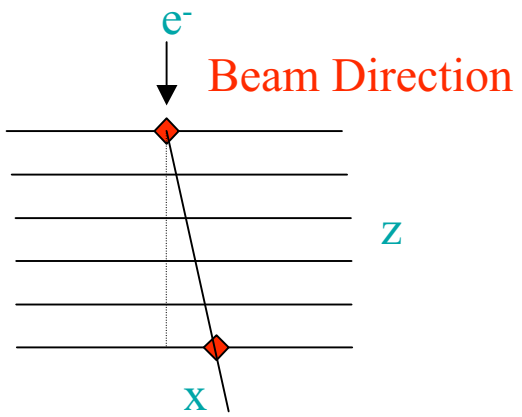
- Activities on infrastructure software have been heavy in the past years, now we are relaxing on this
- Some infrastructure software maintenance
  - G4Generator update
    - Last adjustments to the digitizations
  - Relational tables update
- Joanne will stay 2 weeks in Udine in October
  - Some work on data base
  - Possibly GUI and graphics tools for geometry debugging

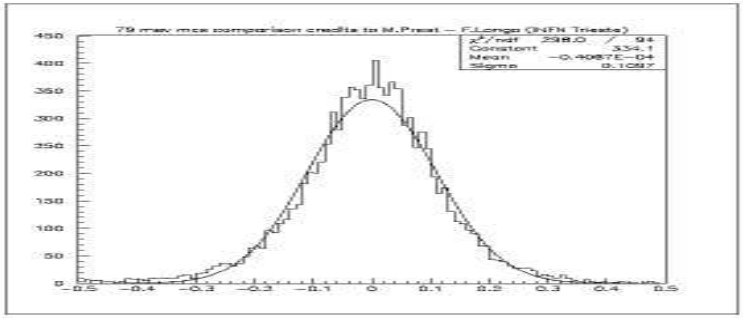
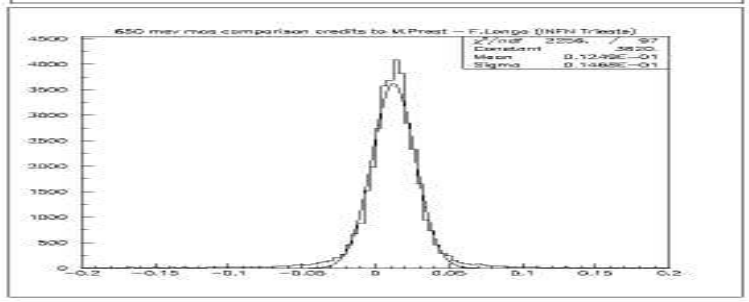
Geant4 validation

- After long planning (and a few problems with Geant4 physics) we started a Geant4 validation task
  - Triggered by the Data Challenge
  - Lots of interactions with Geant4 people
  - Need for new tools
  - Need for some real data comparison

G4 Validation: Multiple Scattering

- Electron test beam for AGILE in Frascati (2003) [Francesco, M. Prest]
- Geometry:
  - 6 planes with 300 □m of W
  - Inter-plane distance 1.6 cm
- Analysis:
  - Require single cluster on the 1st and 6th plane
  - plot x/z



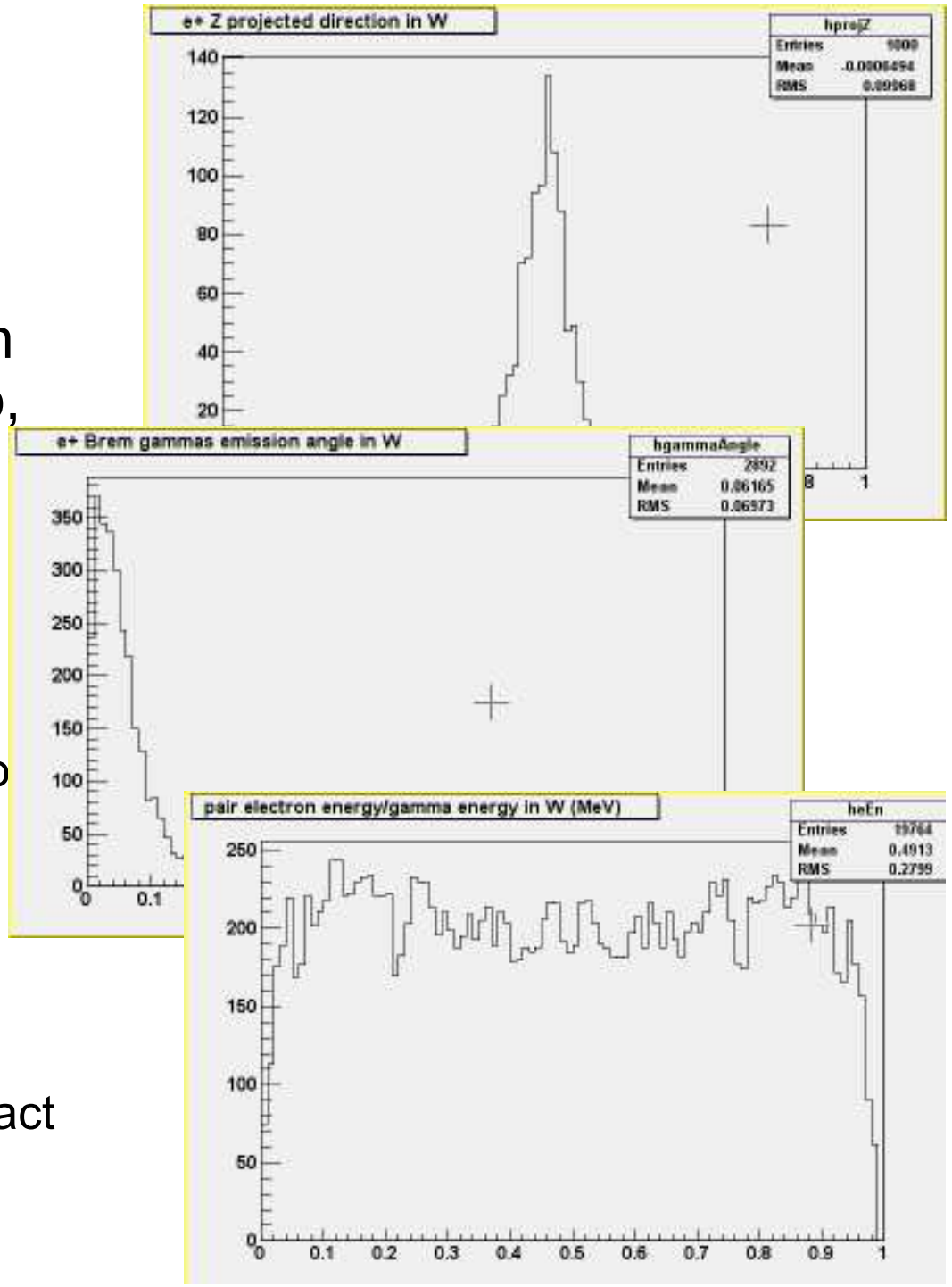
Energy (MeV)	Data: x/z distribuition	Fit sigma deflection (mrad)			
		Expt	G3	G4 5.2	G4 3.2
79		109	104	81	101
650		14.6	13.3	8.4	14.2

G4validation: “trust, but verify”, by setting up systematic monitoring of:

- Photon processes: Photoelectric, Compton and Pair Production
- Cross Section, Angular and Energy Distribution
- Charged particles processes
  - Ionisation
    - Landau and Bethe Bloch
    - Range, Straggling, Stopping Power
  - Multiple Scattering
    - Angular distribution, Energy Dependence
  - Bremsstrahlung
    - Cross Section, Angular and Energy Distribution
  - Delta Ray production
    - Energy distribution, Multiplicity
  - Positron Annihilation
- EM shower development
- Muon-nucleus interactions
- Neutron interactions
- HE hadron-nucleus interactions
- Nucleus-nucleus elastic scattering
- Hadronic showers in CsI
- Radioactive decay

G4 validation: A test package

- Interaction mostly between Toby, Praveen, Francesco, Johann, Riccardo R. (Pd)
- GEANT4TEST
  - A new package in the repository
  - Stand alone Geant4 customizable application (no GAUDI stuff)
  - Easy to change the Geant4 version
  - Produce directly ROOT files with ntuples
  - Provide some macro to extract relevant histograms from ROOT files

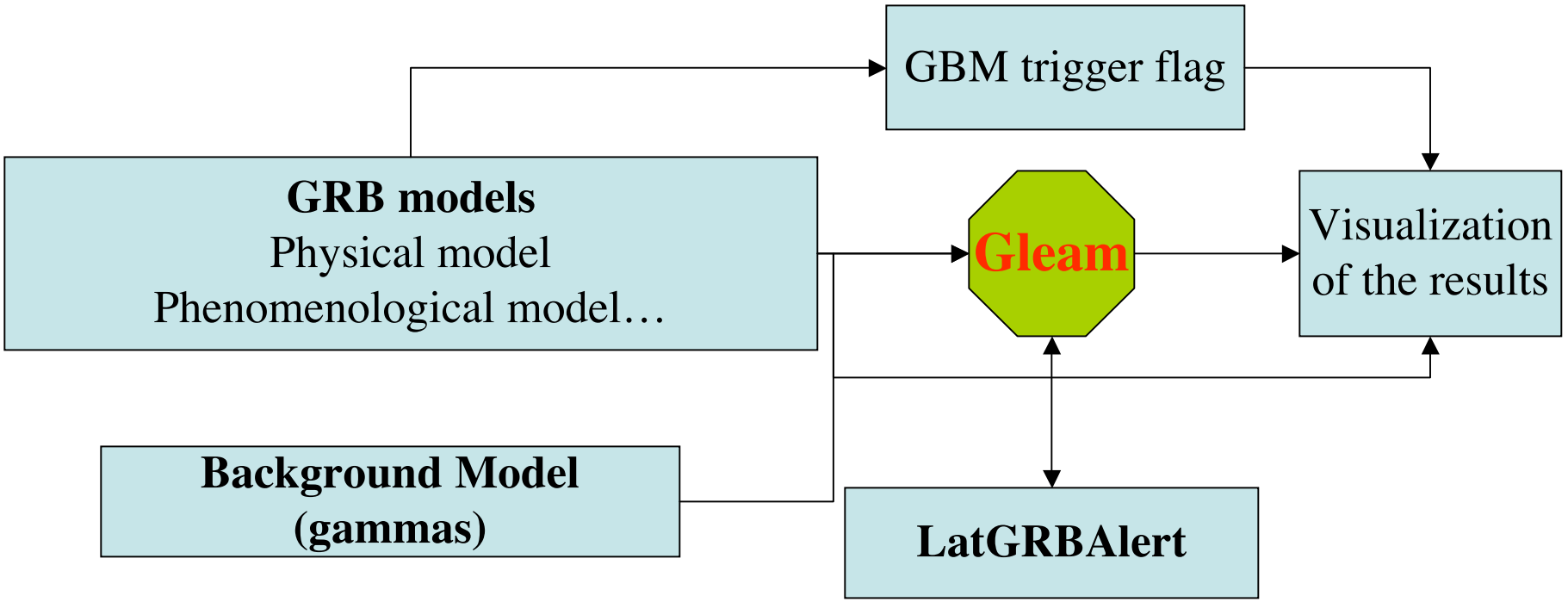


Pattern Recognition / Reconstruction

- Pattern recognition: revival of NeuralNet, studies in progress (Pisa with Tracy, Bill)
- Event shape analysis (Pisa with Leon)
- TkrReconTestSuite
- Refinement of the digitization package, to be submitted after DC1 (Pisa, Bari, Leon)

Inside the GRB Science Group
Fast PR _ Trigger And Alert

Talk



The **LatGRBAlert** algorithm compute the **joint likelihood** (spatial and temporal)
LatGRBAlert is now real time (to be put in **GlastRelease**) and works with a **buffer of events**
(some refinement and test are needed)
This scheme works fine with the simulation + full reconstruction
-> next step is a **Fast reconstruction for GRBAlertTrigger, possibly to be exported to the onboard sw (*OnboardFilter*).**

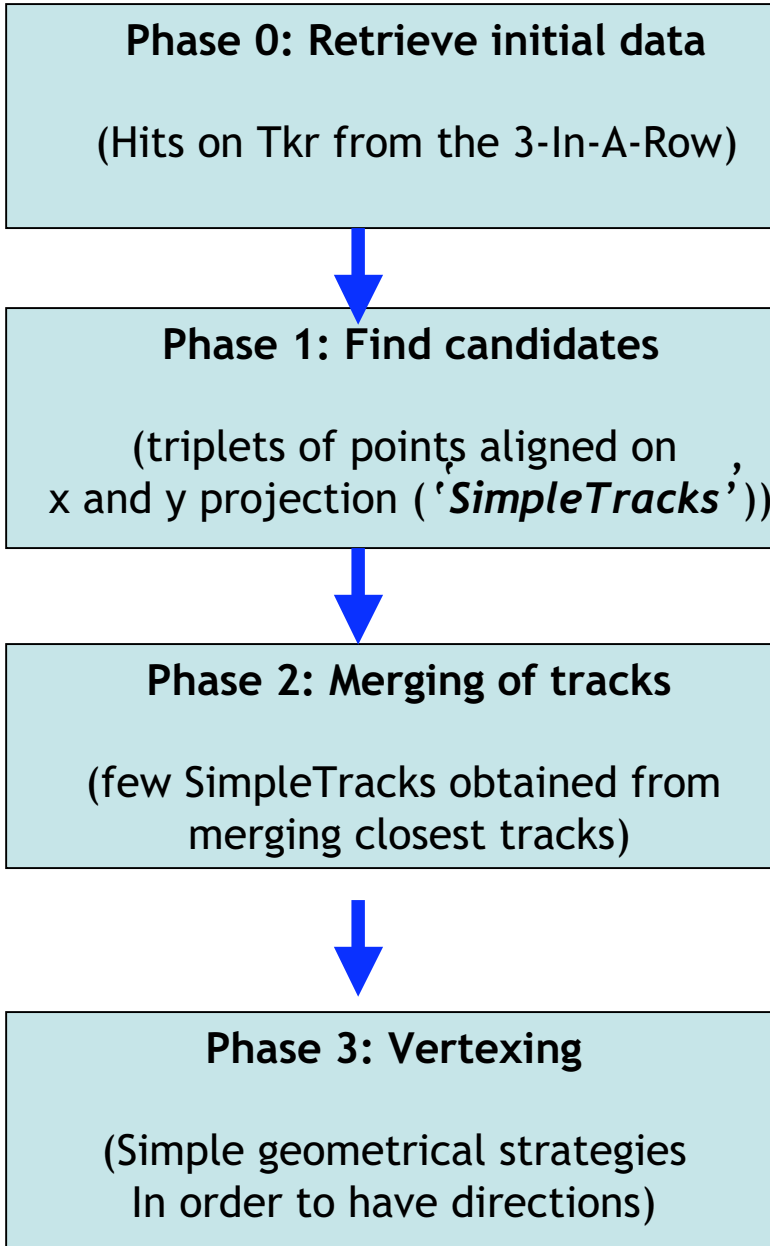
A fast reconstruction method for OnBoard GRB Alert

- In the full reconstruction most of computing time is spent in find good tracks candidates (Pattern Recognition)
  → **Simple and fast way to select the candidate tracks**
- Reduce the number of iterations over the points
  → **Filters to select only interesting candidates.**
- Identification of general classes of events based on different phenomenology of the shower
  → **Very simple and specific methods for finding direction of gamma.**

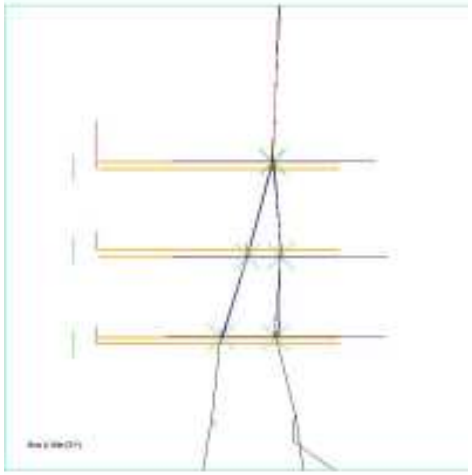
In the GRBs spectrum we expect many events with low energy (20-100 MeV), and consequently not too many hits in the TKR.
We want to reduce the error due to propagation of particles in the detectors (multiple scattering, Compton, etc..)

AND

Reduce the number of iterations operations between the points
→ **use only the first layers hits**



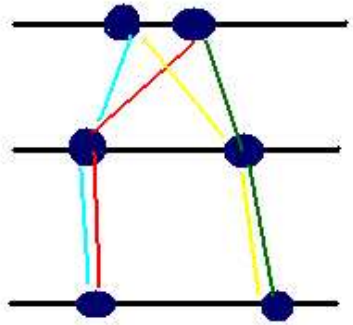
How it works: some preliminary results



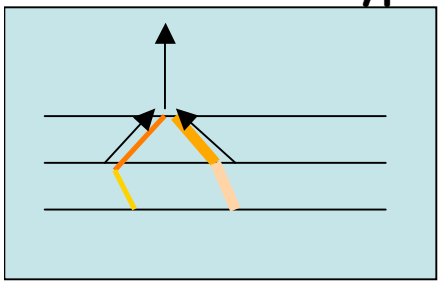
Start from 4 SimpleTracks

(4 possible combinations of aligned triplets)

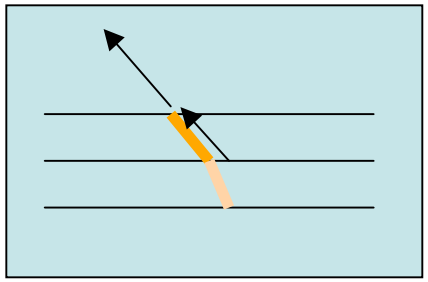
Then merge (0,2) and (1,3)



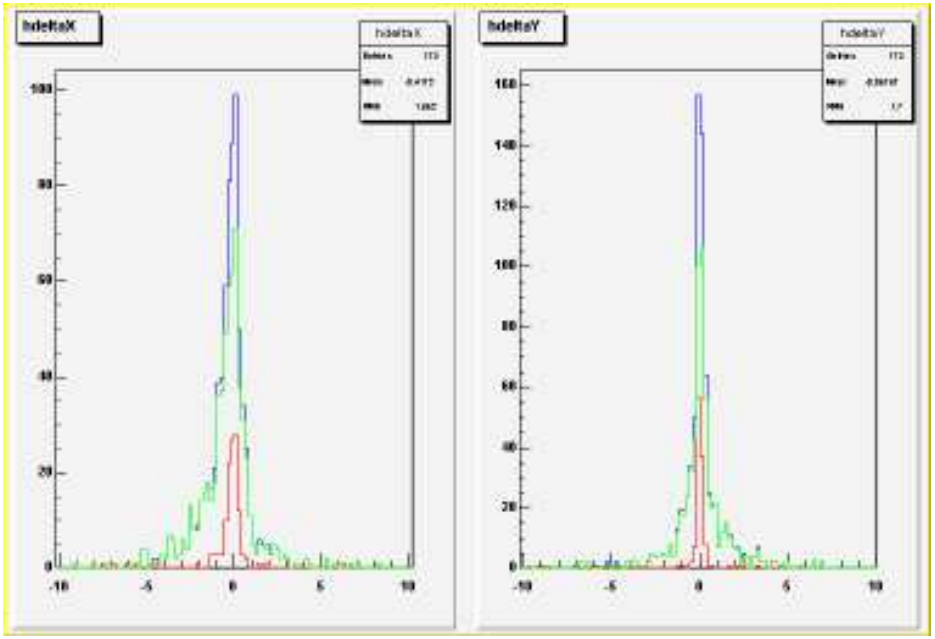
Find the direction depending on 2 types of event classes



Type 1 event:
2 or more tracks



Type 0 event:
1 track

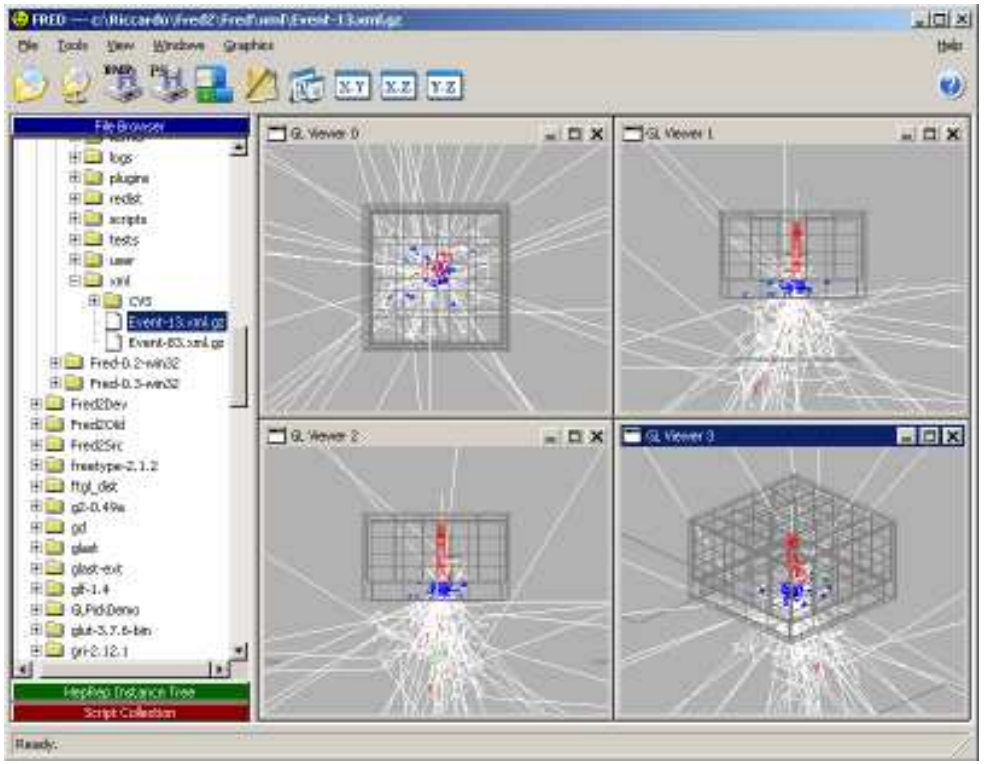


Angular distribution with fast reconstruction of a photon beam of 500 MeV (θ=0 deg, φ = 30 deg)

Event display

- FRED has been presented at the last CHEP conference
- Stable version released in July (only Windows for now)
- No comments for now
  - Please install and test it
  - Documentation, tutorials and some fine tuning missing: contact Riccardo G.
- Linux version will be ready after GLAST migration to 3.2 gcc completed
- Interaction with HepRep people (mostly Joe Perl)

Talk



Migration to Science Tools

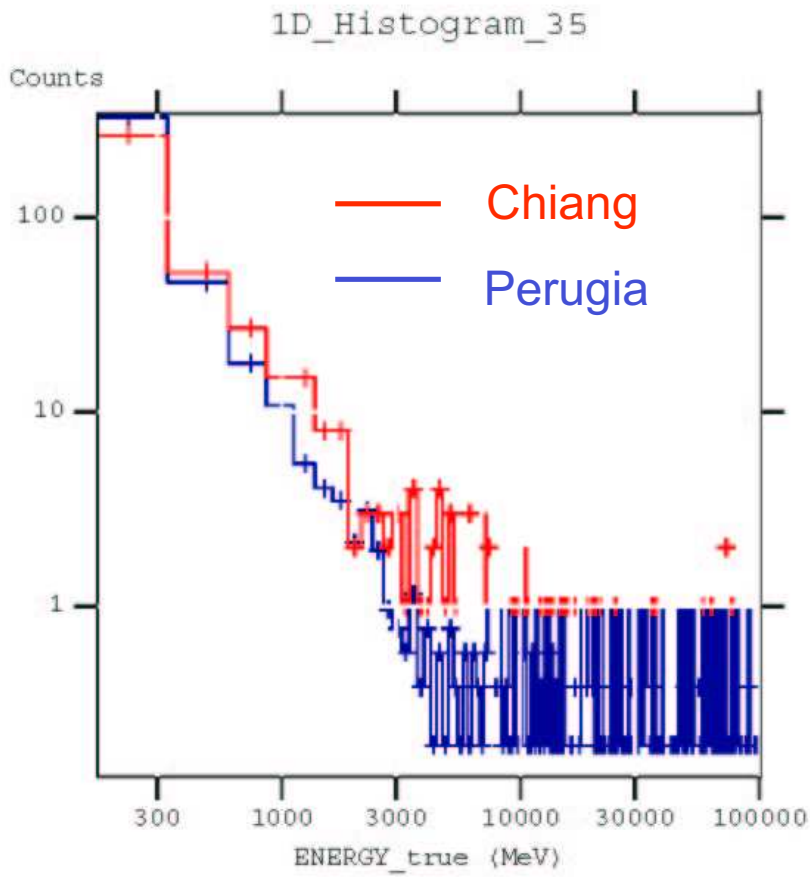
- After the workshop in Perugia

- Main topics
  - Core
    - Generation of simulated events
    - Fast simulation → Response functions
    - A1 : supporting tools (source models)
  - GRB
  - Data mining
  - Classification

Fast simulator (Perugia)

O2 & interim simulated data set
→ observation simulator

- New since Software meeting at SLAC (July):
  - light_sim package → few changes in time calculation
  - GlastIRF new package → apply LAT response to photon energy, angles,...



Comparison between light_sim and ObsSim (J.Chiang simulator):
in progress; 1st look at the data shows some differences (mostly in the number of photons) - under study.

A1 and supporting tools →

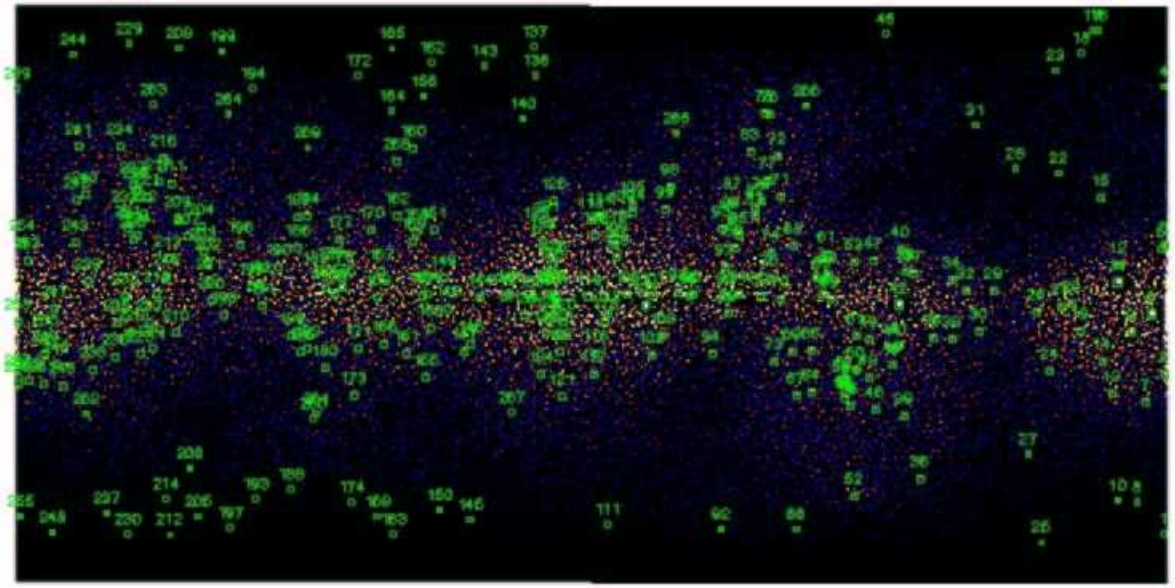
exposure calculation, ICA, wavelets

Talk

- Exposure new package → exposure calculation and maps

- ICA (Independent Component Analysis) → linear method applied to EGRET and simulated data (low energy) is not able to disentangle between background and sources. Application of non linear methods under study

- Wavelets (application to EGRET data) →
recognized 269 sources (80% in common w/ 3EGC)

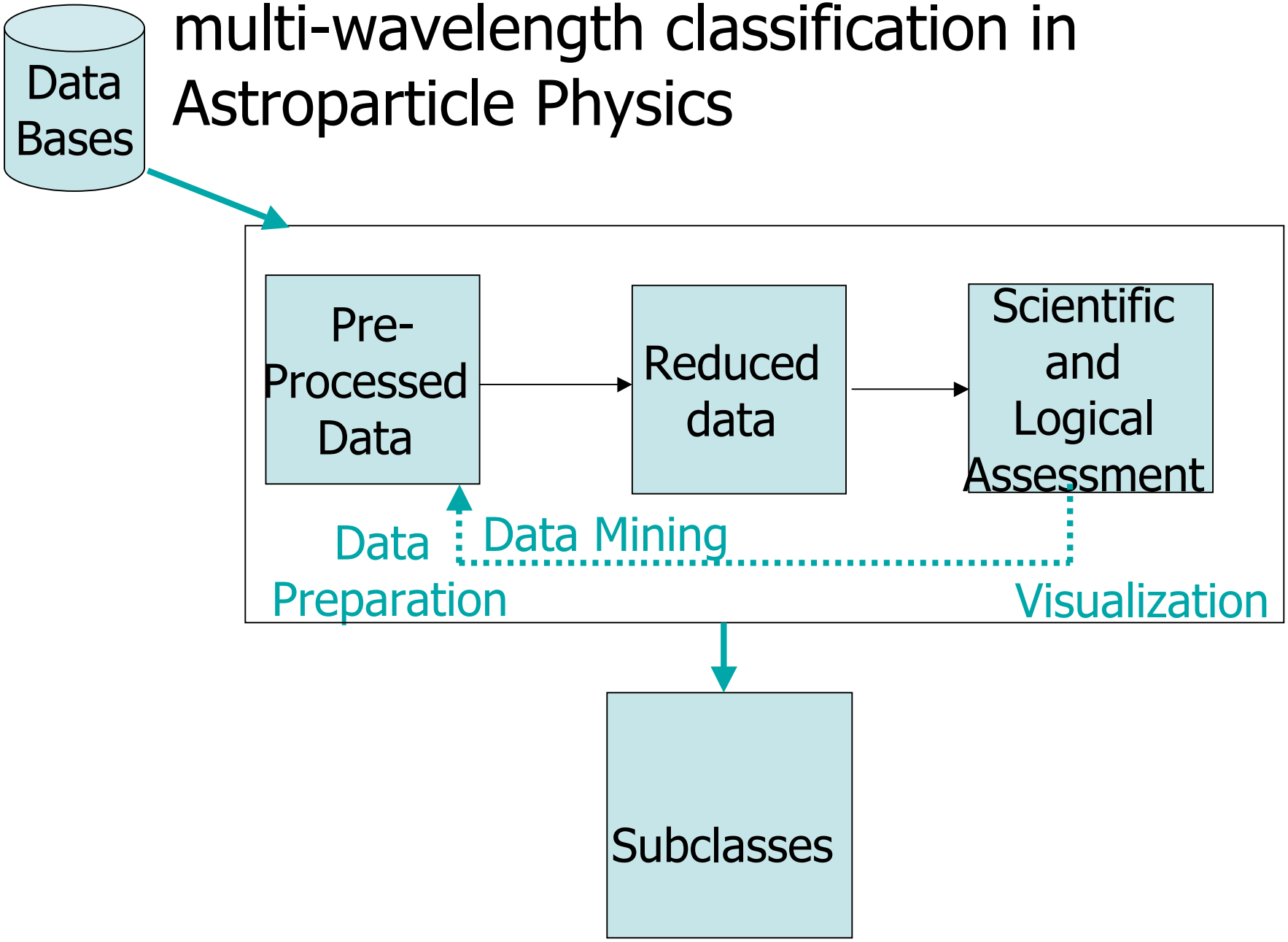


Response function → PSF and IRF study

- Work just started in Perugia after the new version of GlastRelease

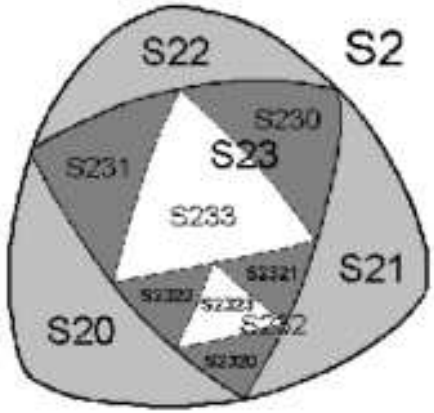
- Planning:
  - continue with O2 (light_sim) and A1 (supporting tools)
  - hope to have first results on the PSF end of October

We started working on a framework for multi-wavelength classification in Astroparticle Physics



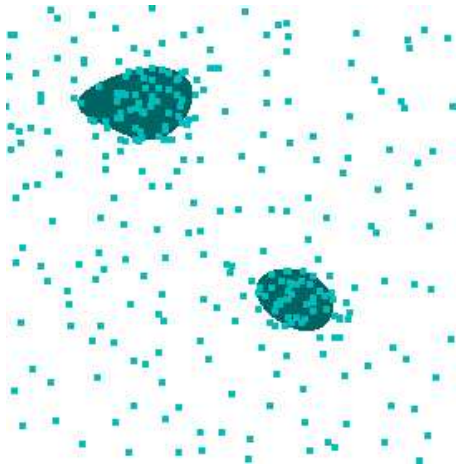
Data management and mining

- Efficient multi-dimensional access methods
  - Possible combinations with HTM (see Sloan Digital Sky Survey)
  - To index both photon lists and source catalogs: coordinates, time, energy, flux, error measures, etc.
- Fast clustering algorithms on large datasets
  - Cure, Clique (scale linearly with the data size)
  - To find the regions of interest
- Interaction with Joanne next week



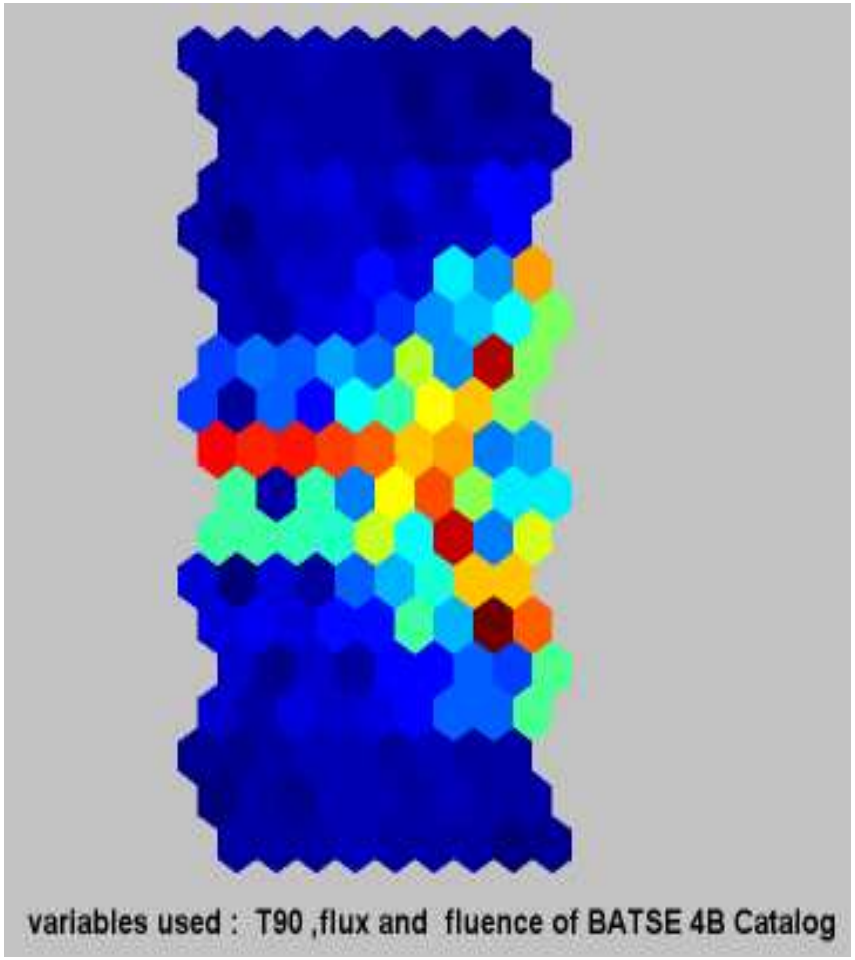
Kernel machines

- Increasingly popular tool for data mining tasks
  - Training involves optimization of a convex cost function (no local minima)
  - For classification (SVM), Principal Component Analysis (Kernel PCA), clustering
- Support Vector Clustering
  - Finds the support of a distribution
  - For novelty detection
  - Possible application to source detection



Classification of sources using Self-Organizing Maps (SOM)

- A prototype (proof-of-principle) has been built and tested on GRB classification with SOM (using BATSE catalog)
- Working on Hybrid Neural Network Models based on nonlinear clustering



GRB Simulation

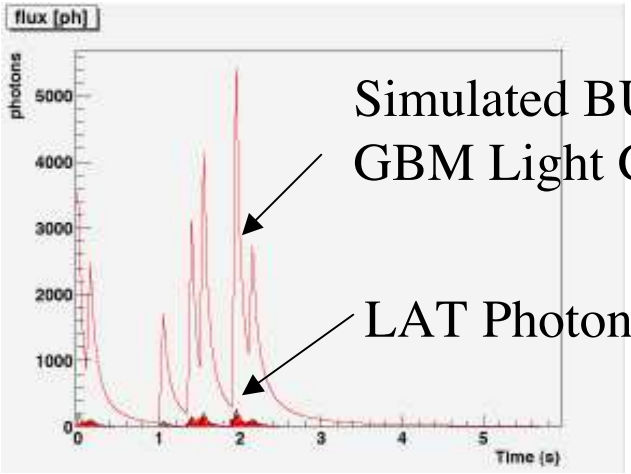
Talk

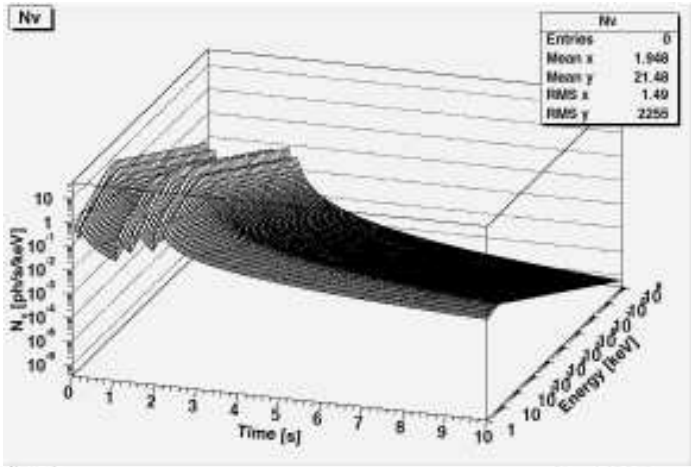
Starting from the experience of the development of the GRB physical model (GlastRelease/GRB – Pisa, Ts/Ud)

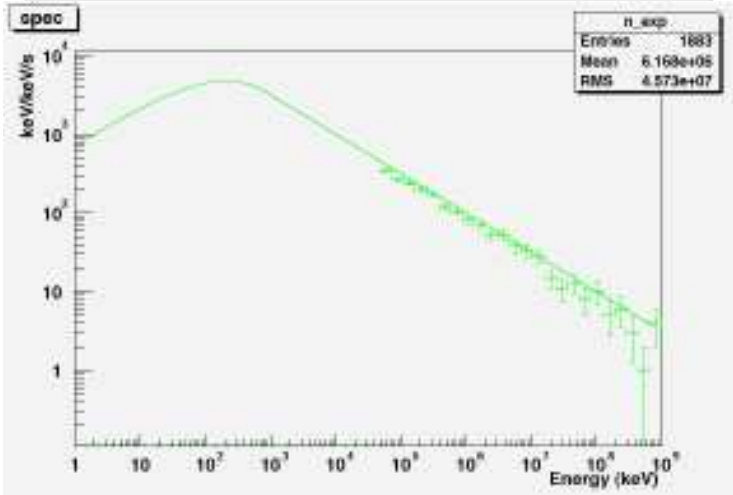
new model for fitting GRB signals.

The basic idea is to parameterize the spectrum as a function of time - **spectral/temporal fitting:**

1) **Temporal evolution of the spectrum**
2) Spectrum for **GBM** and **LAT** energies.
3) The model is **integrated in FluxSvc -> Photons at LAT energies can be use to feed the GLAST simulator**





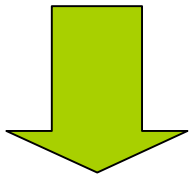


Time integrated spectrum

- Properties of blazars (Pg)

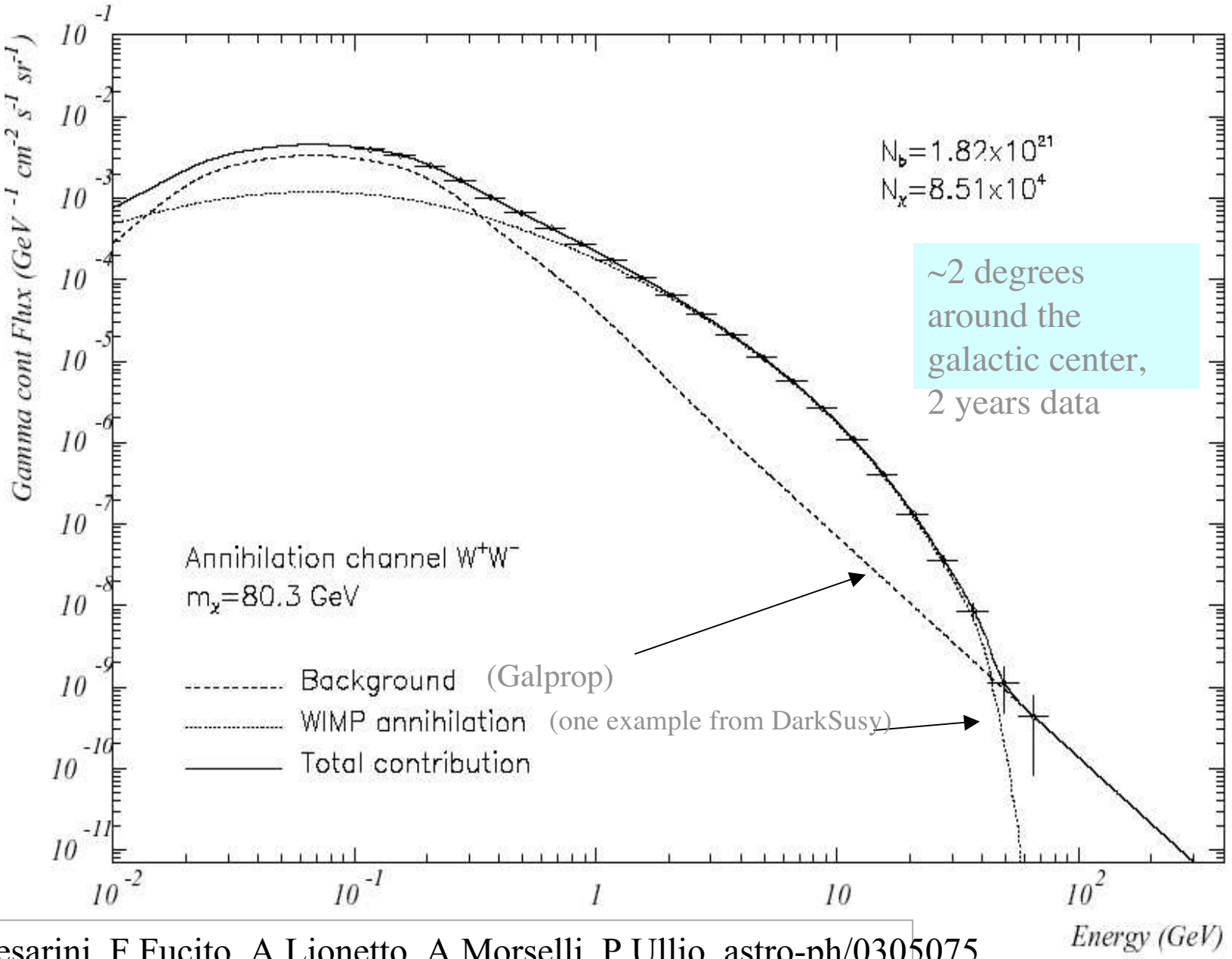
Work on fundamental physics with GLAST is progressing

- Bulk of the group coming from HEP
  - DM detection (Roma2, Ullio)



  - Photon oscillations/effects on photon propagation
    - Mirror matter, models w/ Lorentz violation

GLAST Expectation & Susy models



A.Cesarini, F.Fucito, A.Lionetto, A.Morselli, P.Ullio, astro-ph/0305075

Next directions

- Guarantee a robust validation of the simulation
  - Comparison with construction/test data
    - Basic physics & digi lumped together
  - Software for automatic checks
    - Test in
- Work on pattern recognition & fits
- Progress on the event display

- Progress on the migration to science tools; set up of instruments for the analysis (PSF, fast simulation, analysis tools, physics models, data management)

Partial bibliography

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