Science Analysis Software Development Status Part 2: Science Tools

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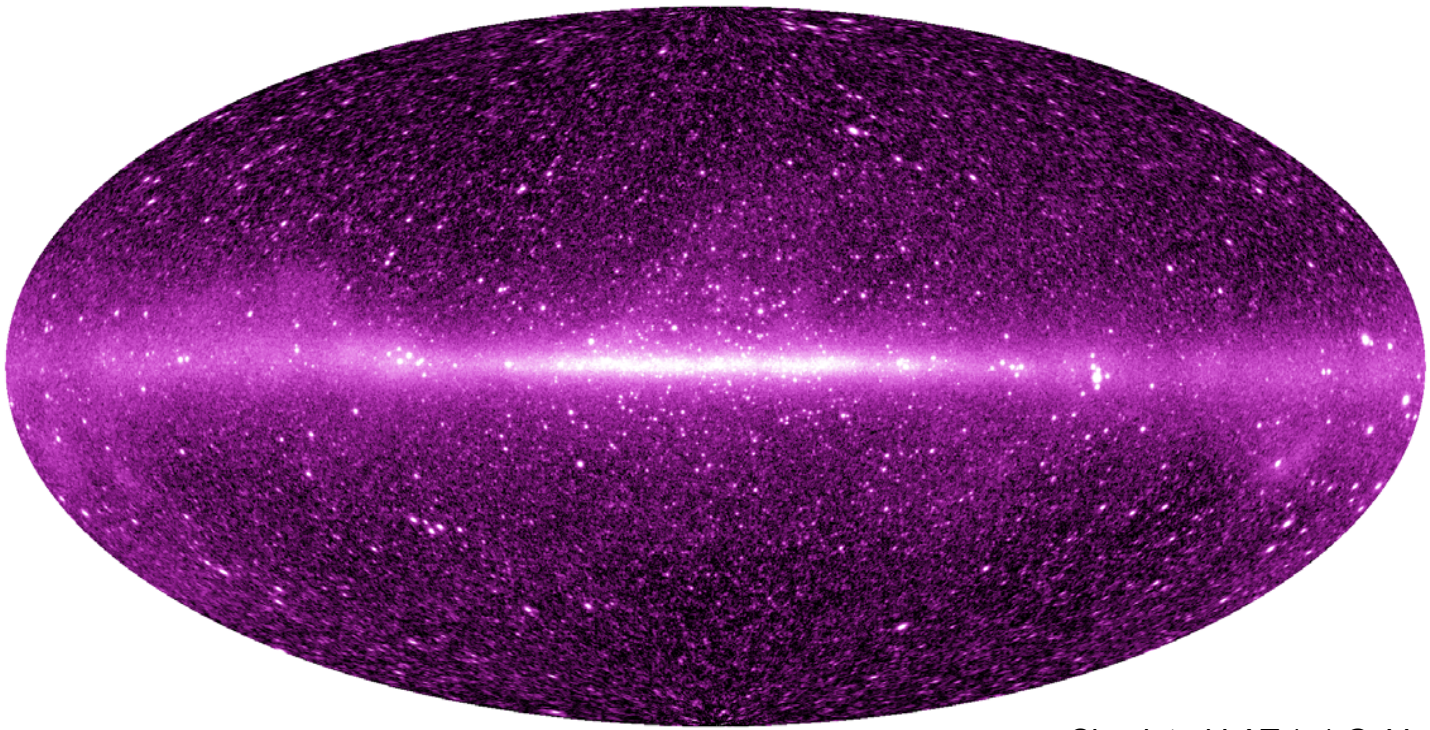
Outline

- What's a science tool?
- Where we are
- Where we are headed for DC2
- How we are getting there

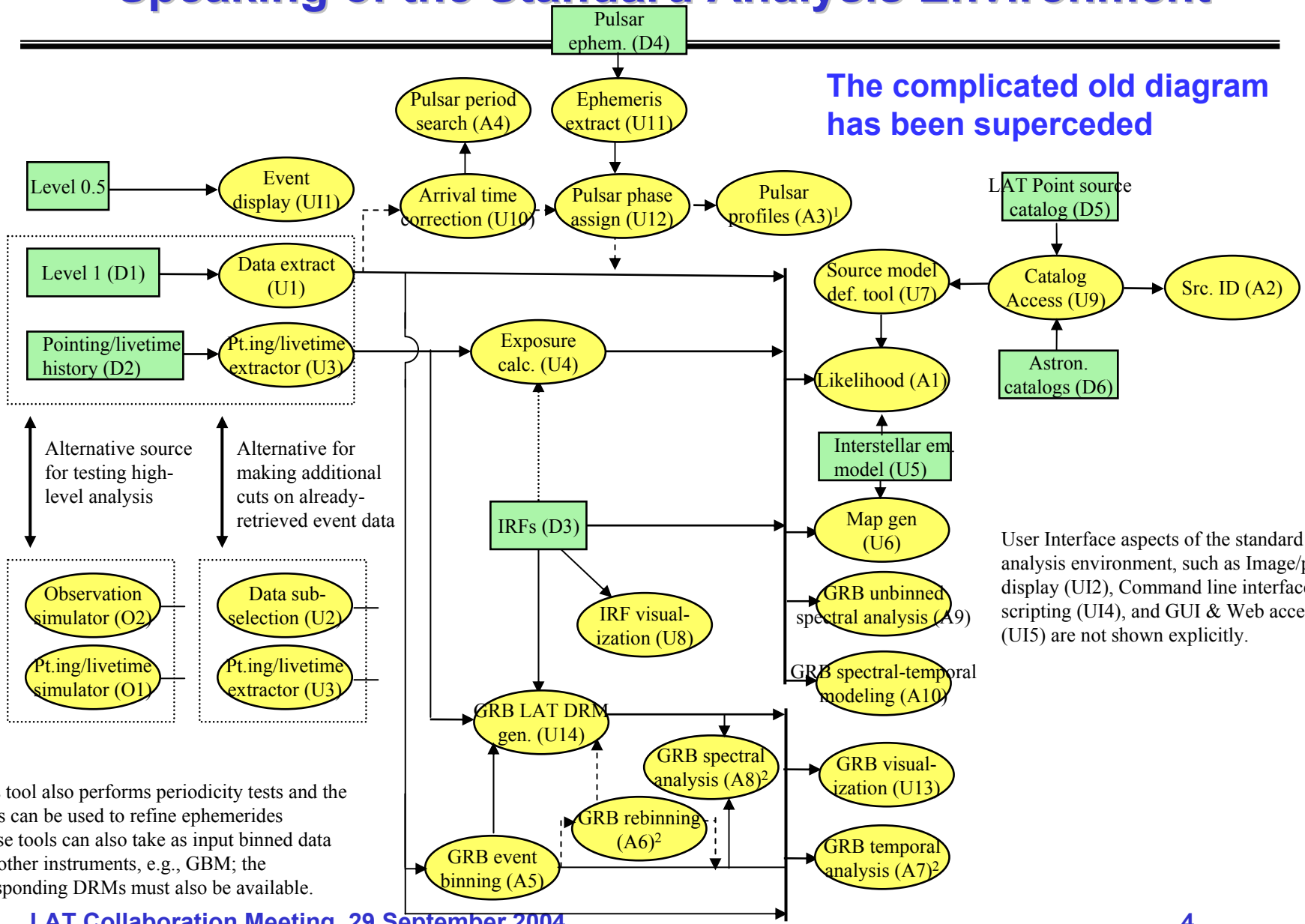


Simulated LAT (>1 GeV, 1 yr)

What's a science tool?

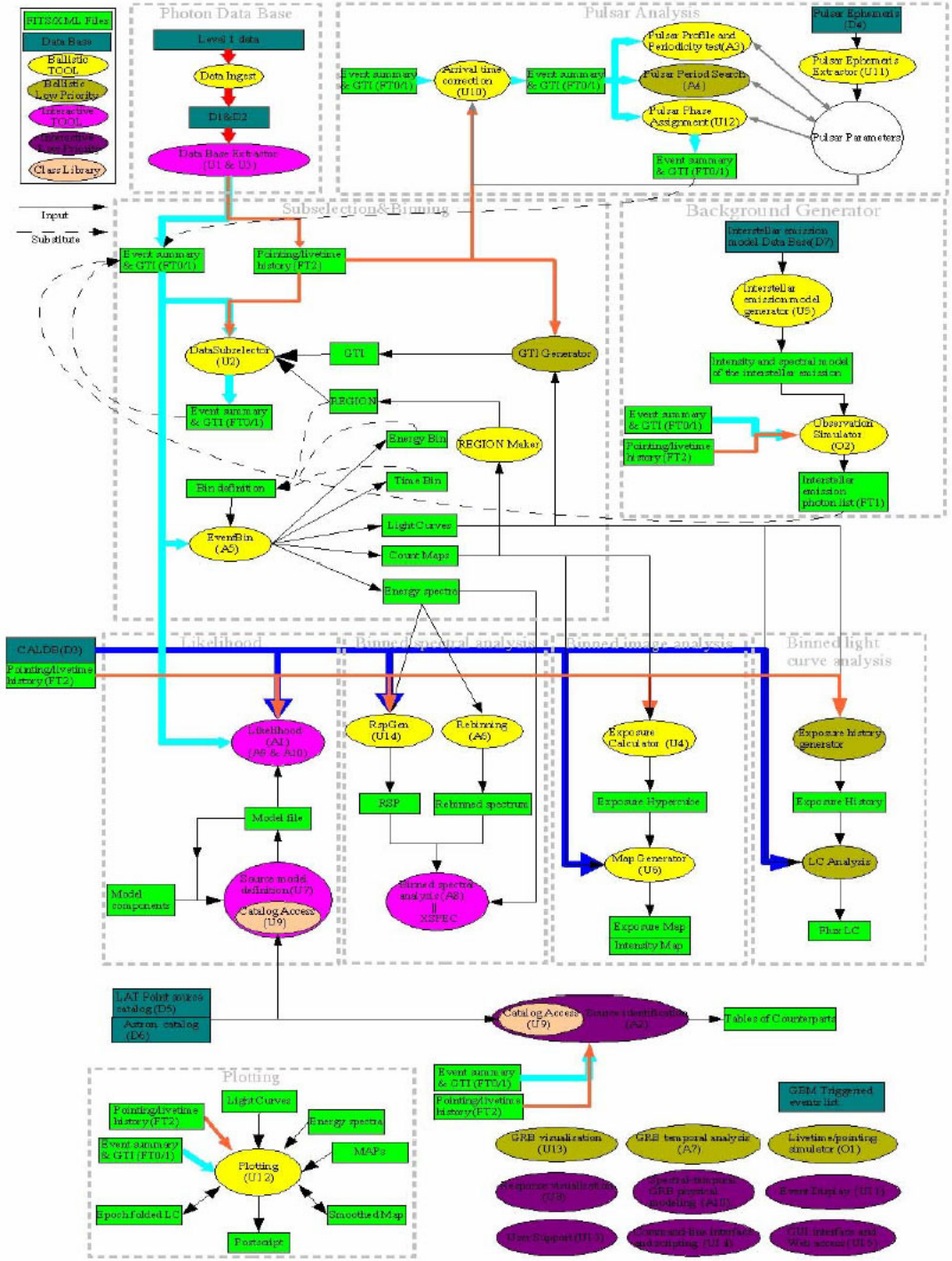
- Jargon for the analysis software and databases that we'll need for deriving scientific results from the LAT data
- Implicit in the term is that the analysis is high-level, like studying cosmic sources of γ-rays
- Also implicit in the term is that the analysis relies on an abstract characterization of the LAT – via its response functions – and to a lesser extent some faith that background rejection will meet the SRD requirements
- The Standard Analysis Environment is the group of science tools that we have agreed to develop jointly with the SSC for us and for guest investigators to use
  - Remember the big complicated diagram
- Within the LAT team we've got additional tools to develop
  - e.g., interstellar emission model, transient source searches, source catalog generation, in-flight (high-level) calibration monitoring

Speaking of the Standard Analysis Environment



User Interface aspects of the standard analysis environment, such as Image/plot display (UI2), Command line interface & scripting (UI4), and GUI & Web access (UI5) are not shown explicitly.

[1] This tool also performs periodicity tests and the results can be used to refine ephemerides
[2] These tools can also take as input binned data from other instruments, e.g., GBM; the corresponding DRMs must also be available.



Y. Ikebe

http://glast.gsfc.nasa.gov/ssc/dev/binned_analysis/SAE_design_chart.html has hyperlinks

SAE status - synposis

- Response functions
  - Still using DC1 version, with what has turned out to be awkward parameterization for numerical integrations
- Observation simulation
  - Orbit/attitude – not particularly realistic yet although as of this week, a prototype O1 tool for writing FT2 files exists
  - At least at the prototype level, GRB, blazar, pulsar, and extended sources are available within the simulation
- Data access
  - From GSSC: http://glast.gsfc.nasa.gov/cgi-bin/ssc/U1/D1WebDC1.cgi
  - From SLAC: http://www.slac.stanford.edu/www-glast-dev/cgi/index.cgi
  - Data subselector works
  - Catalog access classes (U9) have been implemented

SAE status (2)

- **Source analysis**
  - **GRB**
    - **Event binning, response matrix generation have been implemented**
    - **Joint analyses with GBM via XSPEC are now in principle possible**
  - **Pulsar**
    - **Arrival time corrections**
    - **Ephemeris database & periodicity tests**
  - **Source characterization (likelihood)**
    - **Precomputation of 'exposure'**
    - **Flexible specification of source model**
    - **Generation of TS maps**
    - **Binned likelihood (for point sources)**

SAE work for DC2

- **Response functions**
  - Need to characterize response functions after reconstruction and background rejection have converged
  - Defining parameterizations, event classes
  - Goal is for the high-level simulator (O2) produce gamma-ray distributions indistinguishable from filtered Gleam output
- **Observation simulation**
  - Orbit/attitude – we might decide that we need, say, pointed mode; also we need to keep track of earth occultations
- **Data access**
  - At SLAC: not clear yet; the data server will certainly be keeping track of more than just the low-level data
  - Event display server version of FRED will be implemented

SAE work for DC2 (2)

- Source analysis
  - GRB
    - Scripting for binned analysis via XSPEC – fits of series of spectra
    - Unbinned spectral analysis (A9) – derivative of likelihood
  - Pulsar
    - Binary pulsar timing corrections
    - Possibly a periodicity search algorithm (A4)
  - Source characterization
    - Binned analysis for diffuse sources
    - Characterization of binned vs. unbinned analysis
    - Zenith angle cuts
    - Source model definition tool – catalog access

Aside: Sensitivity vs. speed tradeoff in blind searches for periodicity

Geminga (6.2 days of VP 1.0)

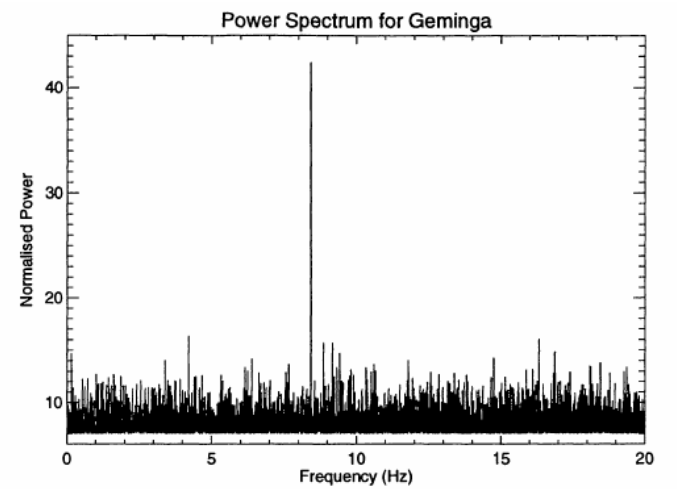


Fig. 2. The power spectrum from an FFT of 2^{28} time bins for the EGRET viewing period 1.0 observation of Geminga. The spectrum has been normalized by the average power, so that the power shown here multiplied by 2 is expected to be distributed as χ^2_2 in the absence of periodicity. The power is not plotted if the normalized power is less than 7. The Geminga pulsar rotation frequency and its 2^{nd} and 4^{th} harmonics are readily apparent at 4.2, 8.4, and 16.9 Hz. The power of the 2^{nd} harmonic dominates because of the shape of the light curve — two nearly equal peaks separated by ~180°

Direct FFT with search in period derivative
Mattox et al. (1996)

vs.

Geminga (2-day intervals)

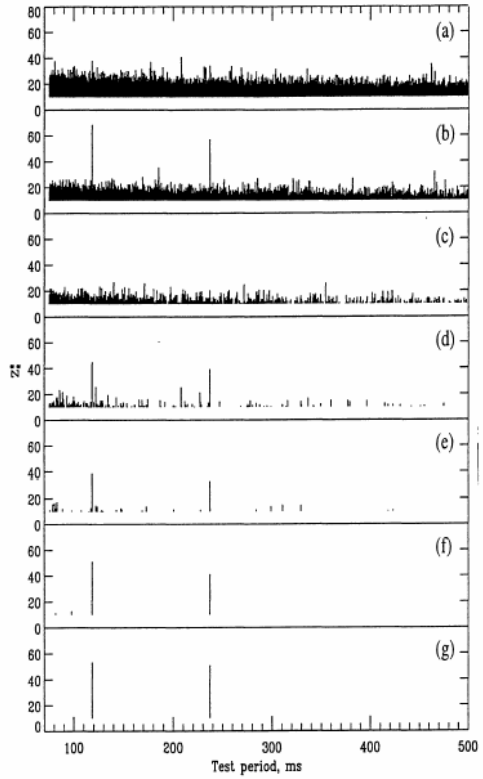


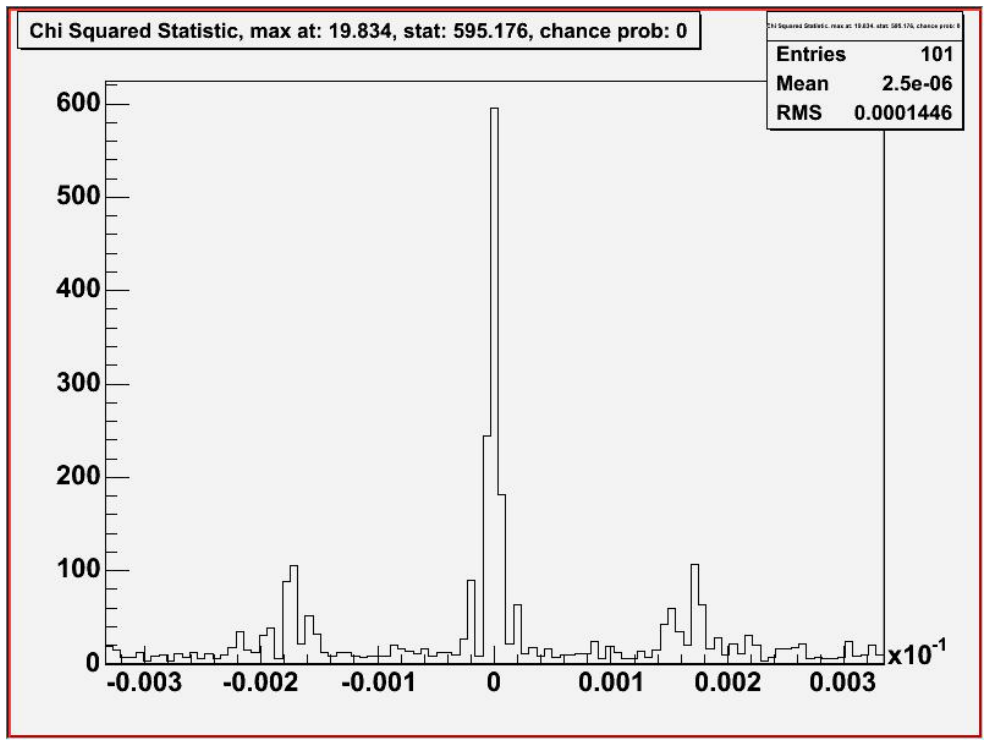
Fig. 1. Period search on Geminga, using seven consecutive 2-day data intervals. The first interval (top) is subject to a full period search; subsequent intervals are searched only at surviving frequencies. Only the test frequencies for which $Z_2^2 > 10$ are shown. Geminga's 237.1 ms rotation period and the second harmonic survive

'Evolutionary period search'
Brazier & Kanbach (1996)

SAE work for DC2 (3)

- **General & wish list**
  - **Integration of plotting in science tools**
  - **IRF visualization**

From prototype periodicity testing tool (A3)



Brown, Hirayama, Peachey

Non-SAE science tools work

Attend the splinter session this afternoon to get up to date on source catalog and interstellar emission model.

- **Interstellar emission model – Briefly, for DC2 we will have an updated model, with improvements in ISM, ISRF, models of CR distribution, and γ-ray production function, coordinated through GALPROP**
- **Source catalog generation – Briefly, the source characterization (position, flux, etc.) will be via likelihood analysis; the current plan is that we will need a faster source detection method to 'feed' likelihood; these will be scripted together with**
- **Transient source detection [i.e., finding blazar flares] is related to but distinct from catalog generation**
  - **Finding sources (on various time scales) and deciding whether they have (probably) been seen before with (probably) the same flux**
  - **GRB 'trigger' in L1 processing and prompt characterization of bursts (whether as initial alerts or refinements of alerts generated onboard)**

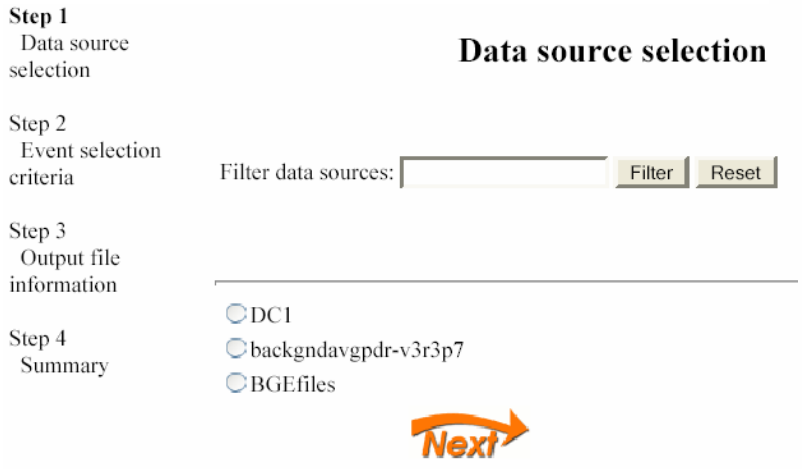
How we are getting there

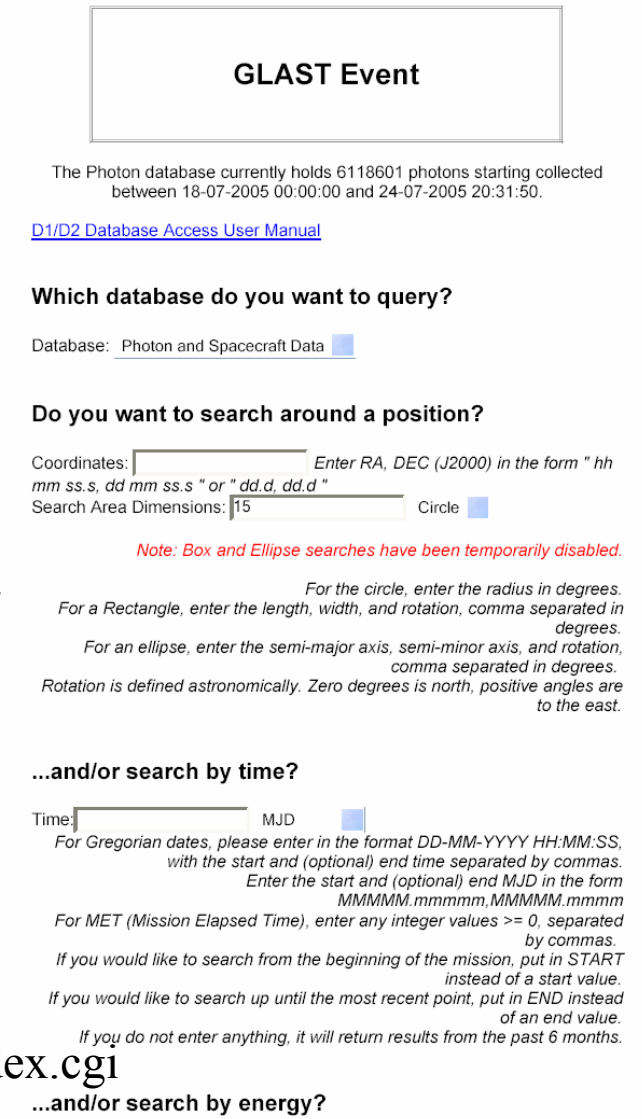
- For SAE, with the vitally important contributions from members of the GSSC
- Ideally, incrementally & steady progress, with implementation phased with the Data Challenges
  - The 6-week 'build cycle' concept has taken hold, advocated by James Peachey at the GSSC
    - Build 3 (pre DC2) is underway; we will reach build 8 before DC2
  - The idea is to build and test on short cycles, to avoid a 'train wreck' at the data challenges; of course, not everything can be worked on for every cycle
  - The current build will include a 3-week sanity 'check out' period for the newly-implemented features of the science tools

Summary

- The design of the SAE has matured – the focus is on the details
- Much of the functionality that we want for DC2 has been implemented in prototype form, and will be exercised in a 3-week ‘check out’ during this build cycle
- For the remainder of the development time leading up to DC2, specific needs have been identified in each area
- The comittment of the GSSC to the SAE has been critically important to making progress during this time of intense focus on I&T support within SAS

Potential backup slides follow





http://www.slac.stanford.edu/www-glast-dev/cgi/index.cgi