Report of the SSC-LAT Software Working Group

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for the SSC-LAT Software Working Group

SSC-LAT Software Working Group

- **Charter (Ormes & Michelson):**
  - **"The WG is responsible for defining the relevant level-2 science analysis software tools to support astrophysics data analysis, developing the requirements and the standards to which this software will conform…"**
- **Membership**
  - **D. Band, J. Norris, R. Schaefer (SSC)**
  - **T. Burnett, S. Digel, R. Dubois (LAT)**
  - **J. Peachey (HEASARC) joined in November**
  - **H. Kelly (LAT) has also participated**
- **Our presentation today is a progress report**

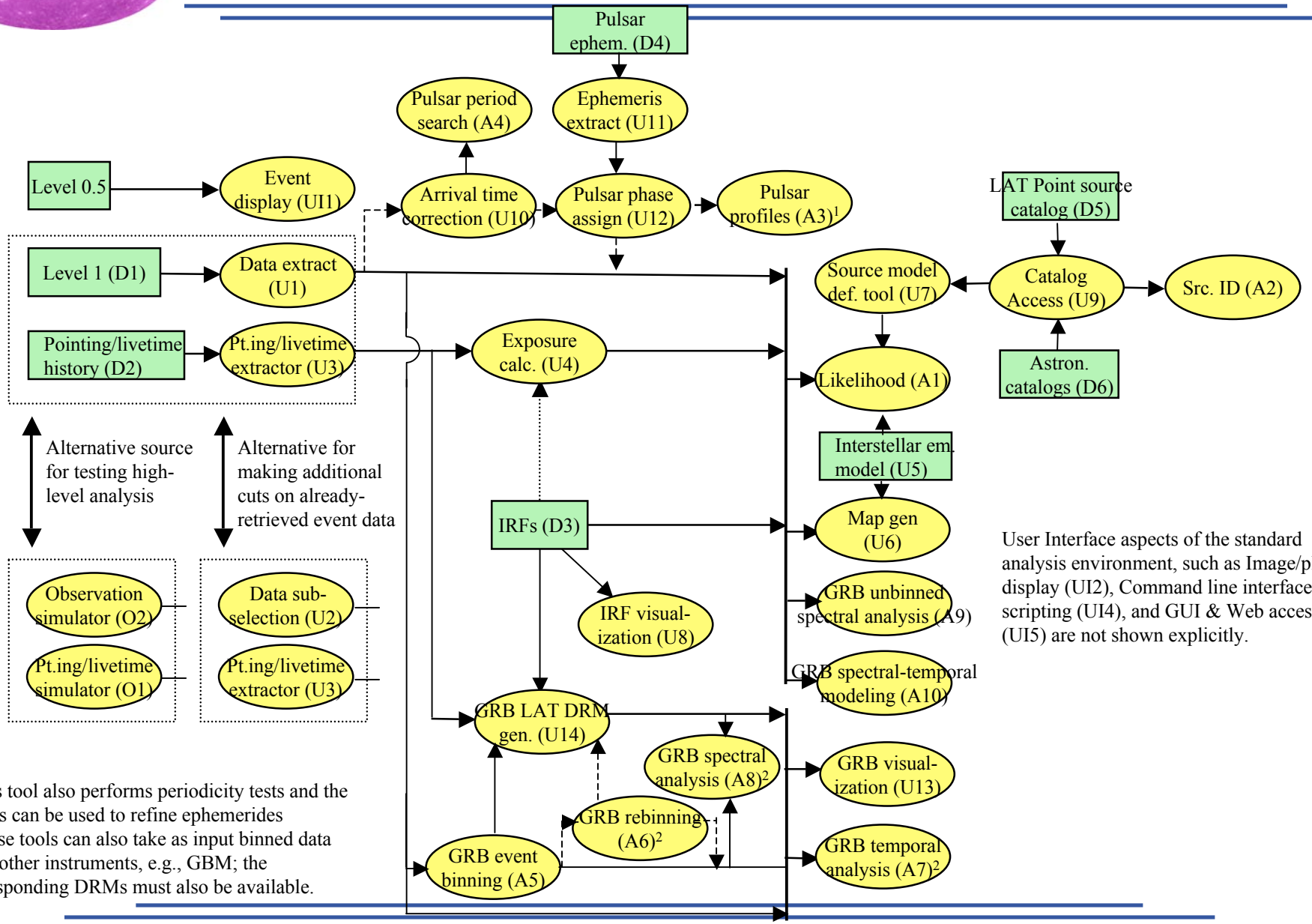
Outline

- Overview of the Standard Analysis Environment
- The Review of the Standard Analysis Environment
- Recent Developments
  - Software Paradigm
  - Existing Software
  - Tool Development
- Current Issues

The Standard Analysis Environment

- The standard analysis environment consists of the tools and databases needed for routine analysis of LAT data by both the LAT team and the general scientific community.
- This environment was defined jointly by the LAT team and the SSC, and will be developed under the LAT team's management with SSC participation.
- The analysis environment does not support all possible analyses of LAT data. Not included, for example:
  - Analysis of multi-gamma events or cosmic rays
  - High-resolution spectroscopy
  - Software for developing the point source catalog
- This environment was described in detail at the LAT team meeting; a detailed document can be found at http://www-glast.slac.stanford.edu/ScienceTools/reviews/sept02/
- Following is a 1-page diagram and tables listing the tools and databases.

COMPONENTS OF THE ENVIRONMENT (§2)



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.

Databases

ID	Name	Description	Size after 1 year
D1	Event Summary (level 1)	Summary information (i.e.	

Utilities

ID	Name	Description
U1	Basic front end to the event summary database	

Utilities, Cont.

U8IRF	visualizationExtracting PSF, effective areas, and energy distributionsfrom the CALI	

Analysis Tools

ID	Name	Description
A1	Likelihood analysis	Point source detection, characterization (positior

Observation Simulators

ID	Name	Description
O1	Livetime/pointingsimulator	Generates simulated pointing, livetime, a

User Interface

ID	Name	Description
UI1	Event display	Displays the tracks of an individual event, requires ac

Review of the Standard Analysis Env.

- Our plans were reviewed in September 2002 by a panel chaired by Frank Marshall.
  - No holes were found in the capabilities we plan to provide the scientific community.
- Some concerns resulted from misunderstandings or details we left out of our ~100 page document.
  - Searching the database of LAT photons will be sufficiently fast (before invoking Moore's Law!).
  - We fully intend to use existing tools where possible (see later).
  - We have defined the file types flowing between tools.
- We are adopting other recommendations.
  - We will import EGRET data (photons, livetime & pointing history, and response functions) into the LAT analysis environment both to test the LAT tools and to facilitate future (possibly joint) analyses.

Review, Cont.

- 'Automatic scripting' (via session transcripts) will be available
- Alternate models for diffuse Galactic emission will be accommodated

Summary of Recent Developments

- **The most important policy decisions have been made regarding development of the software**
  - **Our tools will be FTOOLs and use the HEADAS libraries:**
    - **Data I/O through FITS files; existing types will be used as possible**
    - **IRAF parameter interface for prompting & specifying default parameter values**
    - **FITS I/O and IRAF parameter interface (an enhanced version of ISDC's PIL) code will come from HEASARC-developed HEADAS**
  - **The LAT software development environment will be used:**
    - **CVS for storing the software**
    - **CMT for configuration and build management**
    - **DOXYGEN for documenting the code**
    - **C++ for most new code**
    - **Support for Windows and Linux platforms**
  - **Scripting language: Python (probably)**
  - **Graphics (& GUI): Root (or plplot, with DS9)**

Recent Developments, Cont.

- A systematic design approach for the tools is being pursued (with the science tools developers)
  - The detailed requirements for the tools will be defined via use cases
  - Common functions (to be developed once) will be identified
  - The use cases will also be useful for defining tests
- In the Science Tools development effort in general:
  - Existing software that we could use is being evaluated
  - One new tool has been developed as a testbed
  - The likelihood analysis method is being prototyped
  - A prototype of the Level 1 database residing on a Beowulf cluster has been designed

Existing Software: Beg, Borrow, Steal

- Existing FTOOLS (e.g., from the XRONOS suite) can do most of the pulsar analysis (e.g., A3, U10, U12).
- Online access to astronomical catalog is provided at many data centers (e.g., CDS, HEASARC). HEASARC's Browse may be the core of U9 and A2.
- XSPEC can be used to fit GRB spectra binned in time and energy (A8).
- Chandra's SHERPA will be able to do GRB physical model fits (A10).
- As already mentioned, graphics, image display (e.g., DS9), GUI interface, and scripting will of course come from existing software
- Other tools will be considered.

Current Tool Development

- SSC has developed the tool to bin event lists in time and energy for studying GRBs (A5).
  - This tool can bin background-less LAT photons, GBM counts with a background model, and Swift mask-tagged events.
  - The tool can use user-supplied time bins or create its own time bins using a S/N criterion or Bayesian Blocks.
  - The energy bins are user-supplied.
  - The output is formatted for fitting by XSPEC.
  - Development methodology: IDL prototypes written by scientists, C++ code written by programmer.

Status of the Likelihood Tool

- The standard LAT analysis will model a region around the source(s) of interest using a likelihood methodology (A1).
- Likelihood analysis development group members have been formulating this methodology through a series of internal memos.
  - Evaluating the necessary accuracy and the resulting resource requirements.
  - A key issue is factoring out terms that need be calculated only once for a given analysis ("exposure" factors).
  - A number of prototype calculations have been performed.
- The design of this tool is also being carefully considered, as the most complicated LAT-specific tool that needs to be developed

Current Issues for the SSC-LAT Working Group

The following decisions are necessary before science tools development (in addition to the design work already discussed)

- **Which GUI/graphics package?**
  - **ROOT is the leading candidate, but its Windows support must improve**
- **Which scripting language, and how should it be used?**
  - **Python is main contender**
  - **Should scripts link tools into the standard analysis environment?**
  - **Should tools be embedded in the scripting language?**
- **What existing software should be incorporated?**
  - **For major packages (e.g., Sherpa), integration with the standard analysis environment needs to be considered**

Current SSC-LAT WG Issues, Cont.

- The interfaces between the tools must be defined in detail; FITS files transfer data between FTOOLS.
- How shall we move from definition to development of the science tools, making the most effective use of contributed labor from across the LAT collaboration and the sizeable resources of the SSC?
  - The role of the SSC-LAT working group in defining the standard analysis environment is nearly complete
  - Managing the development effort is not the role of the SSC-LAT working group
    - However relevant policy issues will undoubtedly arise
    - The working group will also oversee software acceptance

Moving from Definition to Development

- Essential features of the schedule (a strawman version was presented at the review in September)
  - The core likelihood analysis tool (A1), and the observation simulator tools (O1 and O2) need to be developed early
  - The schedule will be geared toward supporting 2 Mock Data Challenges (approx. 6-12/04 and 6-12/05), essentially end-to-end tests of the standard analysis environment (with incomplete functionality at the time of the first test)
- We have organized the tools into 7 development areas, each with a manager overseeing definition and prototyping

Databases and related utilities	R. Schaefer (SSC), K. Young (SLAC)
Analysis tools	
Source detection	P. Nolan (SU)
Catalog analysis	I. Grenier (CEA/Saclay) , D. Petry (SSC)
Pulsar analysis	M. Hirayama (SSC)
GRB analysis	D. Band (SSC)
Observation simulation	T. Burnett (UW)
User interface	J. Chiang (SSC), H. Kelly (GSFC/LAT)

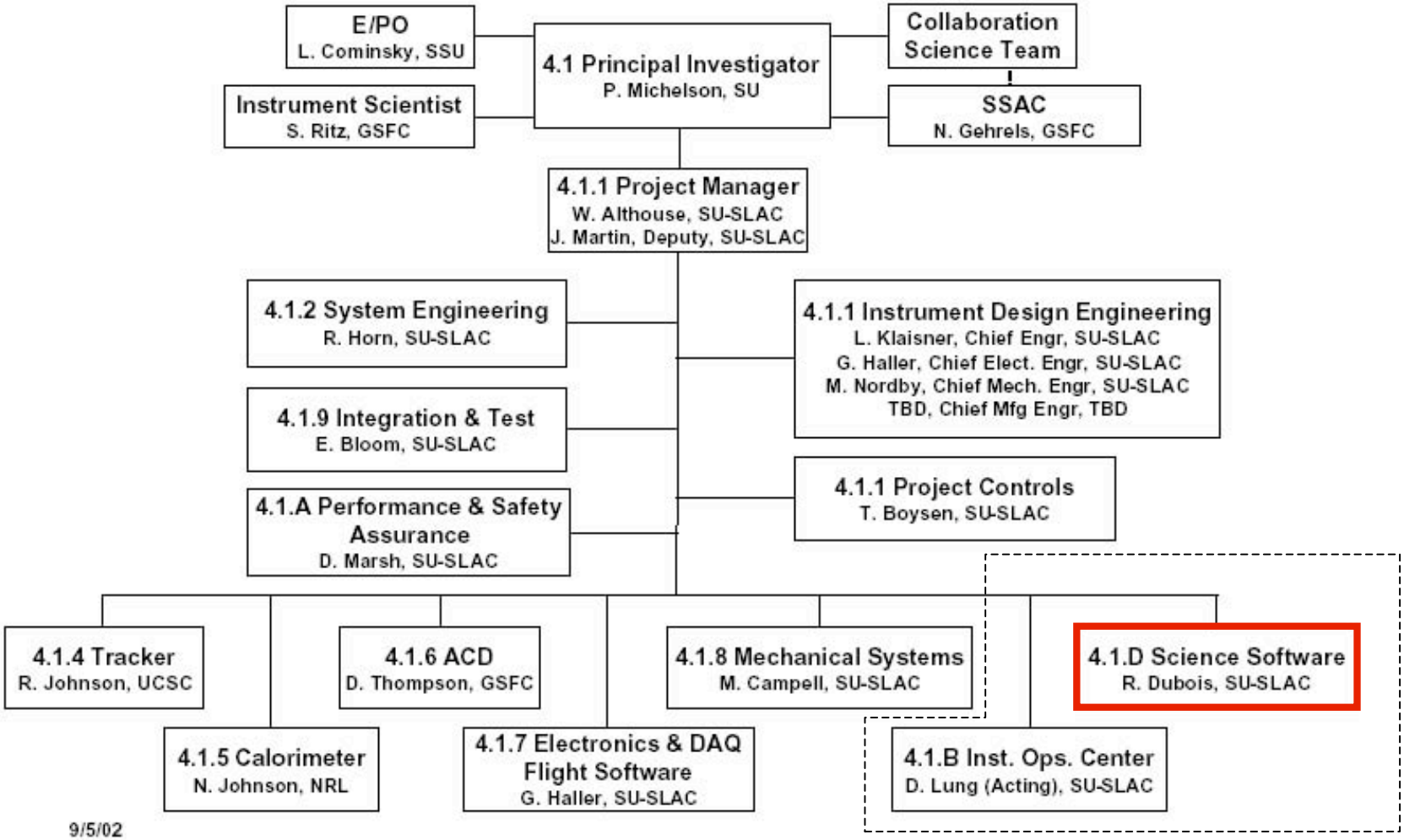
- We are reassessing the labor available from the SSC and across the LAT collaboration for development of the science tools

Backup slides follow

User Interface Details

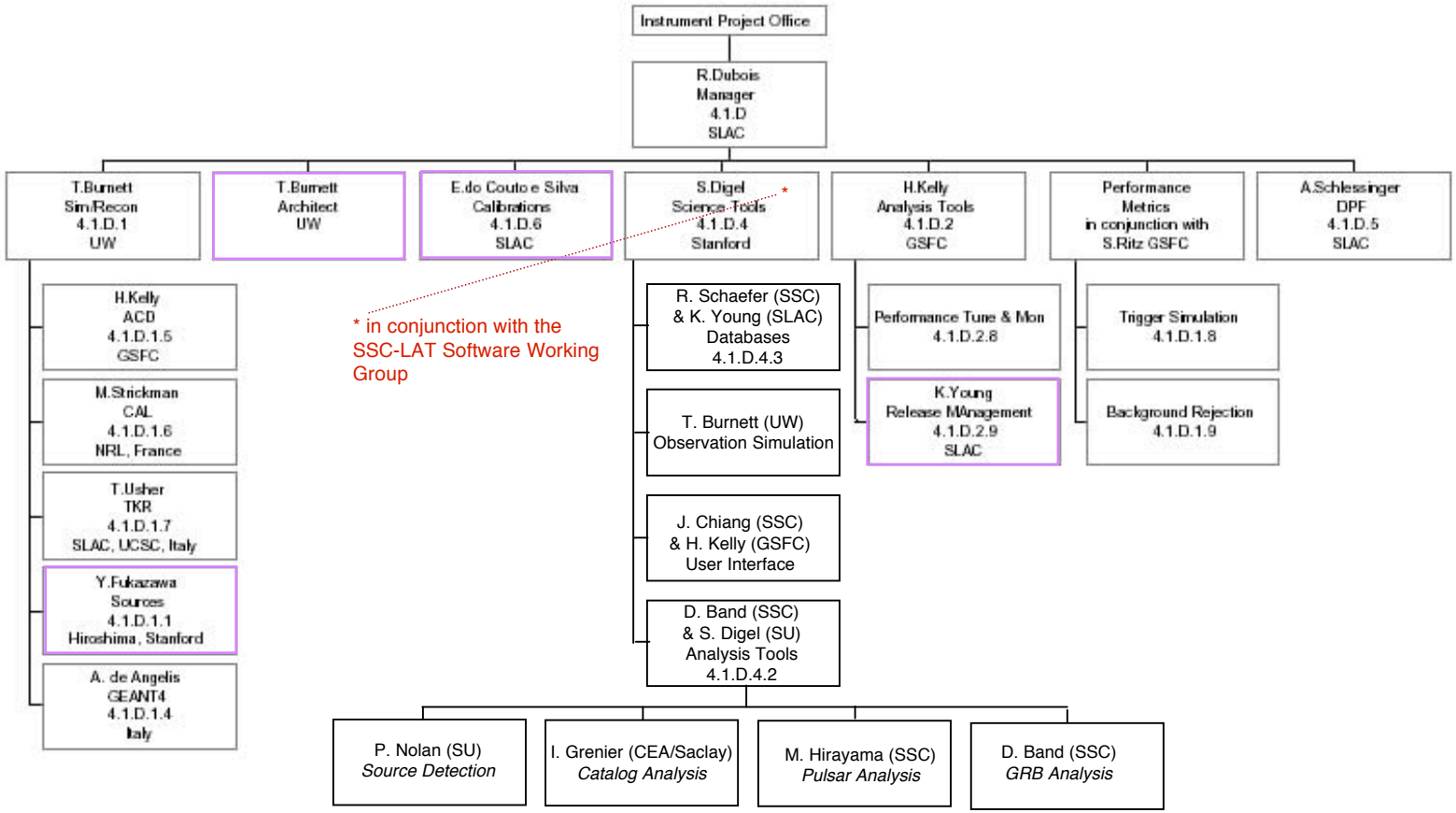
- Users will be able to run the tools from a command line or through an over-arching GUI system. Both interfaces are common in high-energy astrophysics.
- The command line interface lends itself to scripting by the user to automate certain analyses.
- The PIL interface for prompting will be extended to work with GUIs.
- The GUIs will have a common look and feel: common terminology, standard placement of buttons, etc.

GLAST LAT Project Organization



'LAT IOC' for GLAST Project Office

SCIENCE TOOLS WITHIN LAT SAS



~~9/5/02~~

- Science Tools also relates to *Architect, Calibrations, Release Management,* and *Sources* boxes of the LAT instrument simulation effort
- Details of organization will be discussed with management plan

Members of the SSC

The following are present full and part-time SSC members

- Jay Norris—manager
- David Band—science lead
- Dave Davis—databases
- Yasushi Ikebe—calibrations
- Masaharu Hirayama—LAT scientist
- Dirk Petry—user services
- Jim Chiang—ambassador to LIOC
- Valerie Connaughton—GBM scientist, ambassador to GIOC
- Jerry Bonnell—GRBs/PR
- Bob Schaefer—databases
- Cathie Meetre (part time)—operations
- Robin Corbet (part time)—operations
- Sandhia Bansal—programmer
- Chunhui Pan—programmer
- Sandy Barnes—administrator
- JD Myers (part time)—webmaster