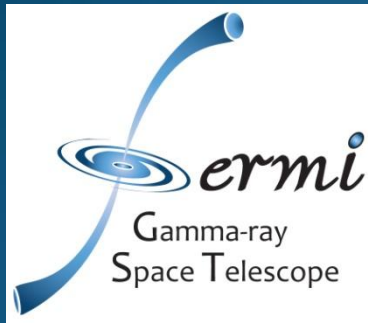


# Fermi Offline Infrastructure



Heather Kelly

[heather@slac.stanford.edu](mailto:heather@slac.stanford.edu)

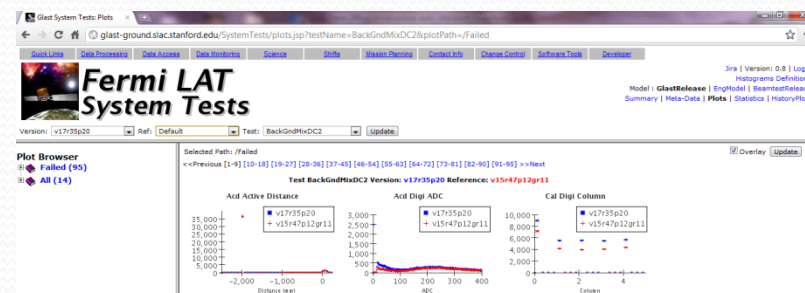
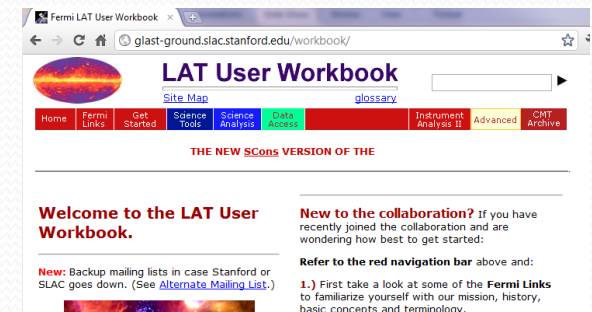
PPA Scientific Computing Apps

LAT was launched as part of the Fermi Gamma-ray Space Telescope on June 11<sup>th</sup> 2008.

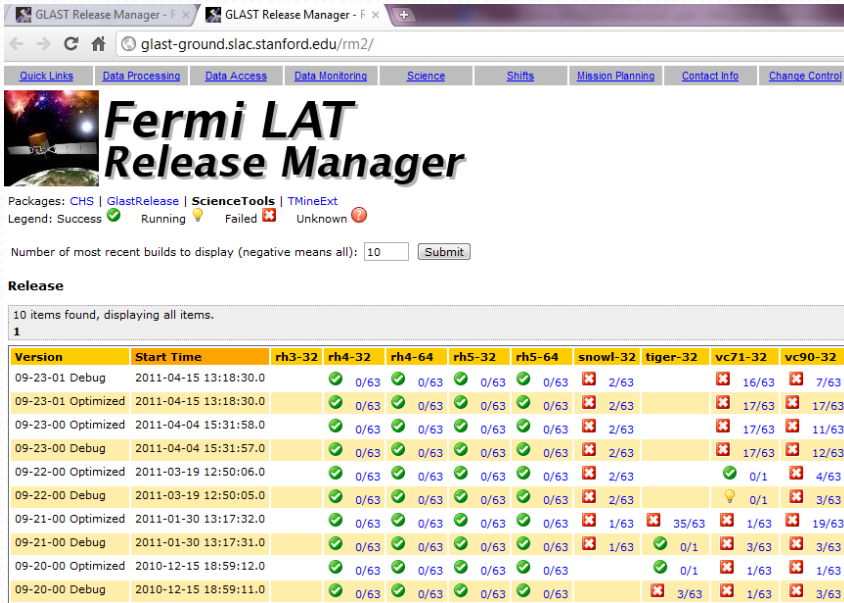
HEP Meets Astrophysics

# Philosophy

- Reuse code from the community where possible. CLHEP, Geant4, ROOT, FITS, Gaudi, Xerces, MySQL
- Custom code is made non-Fermi specific when feasible.
- One central (SLAC) CVS repository
- Code Documentation via Doxygen
- User cookbook became our online workbook
- Flexibility - runtime customization
- **ONE** code system for simulation, test data analysis and flight
- Test, Test, Test, before flight Reviews (PDR, CDR), balloon flight, multiple test beam instruments, data challenges
- Validation via system tests
- Support both Linux and Windows



# Automated Builds via RM



GLAST Release Manager - F x

glast-ground.slac.stanford.edu/rm2/

Quick Links | Data Processing | Data Access | Data Monitoring | Science | Shifts | Mission Planning | Contact Info | Change Control

## Fermi LAT Release Manager

Packages: CHS | GlastRelease | ScienceTools | TMineExt  
 Legend: Success ✔ Running ⚡ Failed ✘ Unknown ?

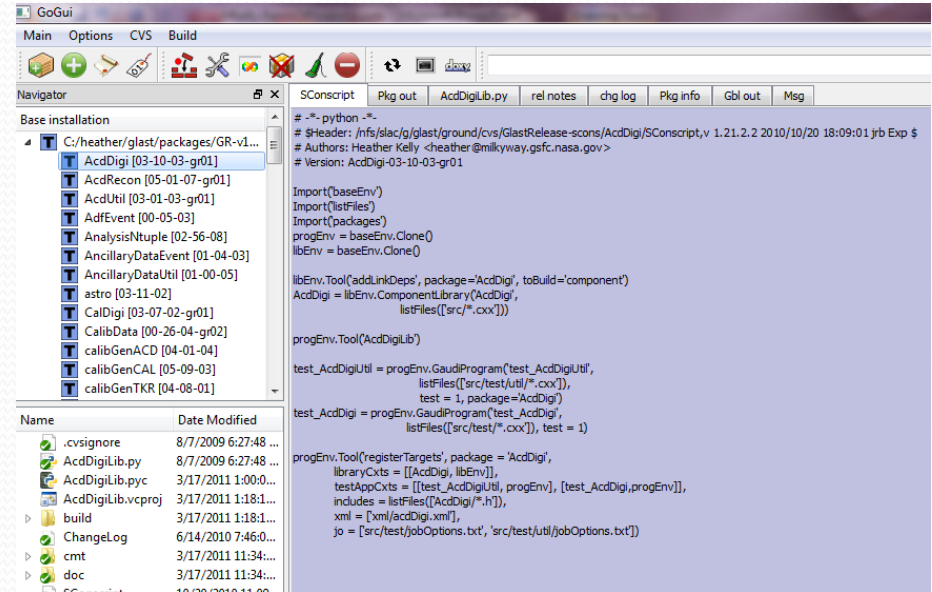
Number of most recent builds to display (negative means all):

**Release**

10 items found, displaying all items.

Version	Start Time	rh3-32	rh4-32	rh4-64	rh5-32	rh5-64	snow1-32	tiger-32	vc71-32	vc90-32
09-23-01 Debug	2011-04-15 13:18:30.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 2/63	✘ 16/63	✘ 7/63	
09-23-01 Optimized	2011-04-15 13:18:30.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 2/63	✘ 17/63	✘ 17/63	
09-23-00 Optimized	2011-04-04 15:31:58.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 2/63	✘ 17/63	✘ 11/63	
09-23-00 Debug	2011-04-04 15:31:57.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 2/63	✘ 17/63	✘ 12/63	
09-22-00 Optimized	2011-03-19 12:50:06.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 2/63	✔ 0/1	✘ 4/63	
09-22-00 Debug	2011-03-19 12:50:05.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 2/63	⚡ 0/1	✘ 3/63	
09-21-00 Optimized	2011-01-30 13:17:32.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 1/63	✔ 35/63	✘ 1/63	✘ 19/63
09-21-00 Debug	2011-01-30 13:17:31.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 1/63	✔ 0/1	✘ 3/63	✘ 3/63
09-20-00 Optimized	2010-12-15 18:59:12.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/1	✘ 1/63	✘ 1/63	✘ 1/63
09-20-00 Debug	2010-12-15 18:59:11.0	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✔ 0/63	✘ 3/63	✘ 1/63	✘ 3/63	

# Developer GUI: GoGui



GoGui

Main Options CVS Build

Navigator

Base installation

- C:/heather/glast/packages/GR-v1...
  - AcdDigi [03-10-03-gr01]
  - AcdRecon [05-01-07-gr01]
  - AcdUtil [03-01-03-gr01]
  - AdfEvent [00-05-03]
  - AnalysisNtuple [02-56-08]
  - AncillaryDataEvent [01-04-03]
  - AncillaryDataUtil [01-00-05]
  - astro [03-11-02]
  - CalDigi [03-07-02-gr01]
  - CalibData [00-26-04-gr02]
  - calibGenACD [04-01-04]
  - calibGenCAL [05-09-03]
  - calibGenTKR [04-08-01]

```

#-*- python -*-
# $Header: /afs/slac/g/glast/ground/cvs/GlastRelease-scons/AcdDigi/SConscript,v 1.21.2.2 2010/10/20 18:09:01 jrb Exp $
# Authors: Heather Kelly <heather@mikyway.gsfc.nasa.gov>
# Version: AcdDigi-03-10-03-gr01

import('baseEnv')
import('listFiles')
import('packages')
progEnv = baseEnv.Clone()
libEnv = baseEnv.Clone()

libEnv.Tool('addLinkDeps', package='AcdDigi', toBuild='component')
AcdDigi = libEnv.ComponentLibrary(AcdDigi,
    listFiles(['src/*.cxx']))

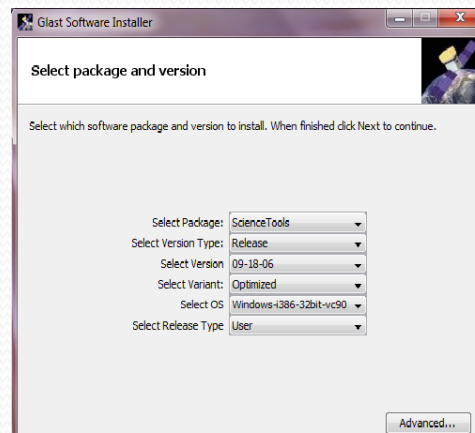
progEnv.Tool(AcdDigiLib)

test_AcdDigiUtil = progEnv.GaudProgram('test_AcdDigiUtil',
    listFiles(['src/test/Util/*.cxx']),
    test = 1, package='AcdDigi')
test_AcdDigi = progEnv.GaudProgram('test_AcdDigi',
    listFiles(['src/test/*.cxx']), test = 1)

progEnv.Tool('registerTargets', package='AcdDigi',
    libraryCtxs = [[AcdDigi, libEnv]],
    testAppCtxs = [[test_AcdDigiUtil, progEnv], [test_AcdDigi, progEnv]],
    includes = listFiles(['AcdDigi/*.h']),
    xml = ['xml/acdDigi.xml'],
    jo = ['src/test/jobOptions.txt', 'src/test/Util/jobOptions.txt'])
    
```

Name Date Modified

- cvsignore 8/7/2009 6:27:48 ...
- AcdDigiLib.py 8/7/2009 6:27:48 ...
- AcdDigiLib.pyc 3/17/2011 1:00:0...
- AcdDigiLib.vcproj 3/17/2011 1:18:1...
- build 3/17/2011 1:18:1...
- ChangeLog 6/14/2010 7:46:0...
- cmt 3/17/2011 11:34:...
- doc 3/17/2011 11:34:...
- SConscript 10/20/2010 11:00...



Glast Software Installer

Select package and version

Select which software package and version to install. When finished click Next to continue.

Select Package: ScienceTools

Select Version Type: Release

Select Version: 09-18-06

Select Variant: Optimized

Select OS: Windows+386-32bit-vc90

Select Release Type: User

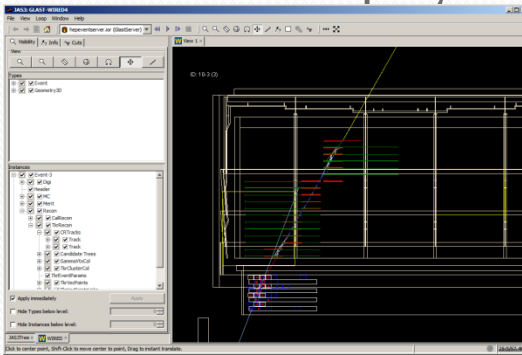
Advanced...

# GUI Installer

# Offline Software

## GlastRelease

- C++ Monte Carlo (Geant4) simulation with data-driven geometry and reconstruction software
- Gaudi framework
- Output file format: ROOT
- Utilized as part of the data processing pipeline.
- Builds via CMT  
RHEL4-32/gcc 3.4  
Windows/VC++ 7.1
- Wired Event Display



## ScienceTools

- All software related to scientific analysis of Fermi LAT data
- Written in C++ with python interfaces via swig
- Most is publicly available through the Fermi Science Support Center (GSFC)
- Builds via SCons  
RHEL4-32/RHEL4-64/gcc3.4  
RHEL5-32/RHEL5-64/gcc4.1  
Snow Leopard gcc 4.2  
Windows/VC++9
- Obeys HEASARC/OGIP standards which implies FITS files and use of parfiles to provide user input.



Giant Observer Facilities & Science Centers	
AGILE	ASCA
Astro-H	BeppoSAX
COBE	CGRO
Chandra	EDUE
Fermi	GALEX

The High Energy Astrophysics Science Archive Research Center (HEASARC) is the primary archive for NASA missions dealing with extremely energetic phenomena, from black holes to the Big Bang. Recently merged with the Legacy Archive for Microwave Background Data Analysis (LAMBDA), it includes data obtained by NASA's high-energy astronomy missions from the extreme ultraviolet through gamma-ray bands, along with missions that study the relic cosmic microwave background.

**Latest News**

- [Data Release: Chandra Finds Massive Black Holes Common in Early Universe](#) (16 June 2011)  
Using the deepest X-ray image ever taken, astronomers have found the first direct evidence that massive black holes were common in the early universe. Chandra's discovery shows that very young black holes grew more aggressively than



# Why Gaudi?

- By 1999 (pre-proposal) we had plenty of code: detailed Monte Carlo & prototype reconstruction with ASCII ntuple output.
- Gaudi provided a framework for our code
  - Clear lines of division
  - Separation of data from algorithms
  - Standard interfaces for algorithms
- Basic Services:
  - Event loop, Logging
  - Transient Data Store (TDS)
  - Job options, where input ASCII file contains job parameters
- We utilize the core functions of Gaudi
- Gaudi and G4 can play nice, despite that both want to control event loop. We usurp G4's RunManager and instead use our custom interface to G4 to request one event at a time.
- Using Gaudi led us to CMT.
- <http://proj-gaudi.web.cern.ch/proj-gaudi/>



# Why ROOT?

- ROOT provided more robust file format which could accommodate storage of MC data, as well as digitization and full reconstruction, as well as ntuples.
- Object Oriented I/O fit our OO design
- 5 star support ★★★★★
- Python interface (PyROOT)
- ROOT has grown substantially since we adopted it. Fortunately, it has remained modular.
- Certainly a learning curve for those wanting publication quality plots.
- <http://root.cern.ch>



# Challenges

- Changing build systems (CMT -> SCons)
- Maintaining multiple branches of MC/recon in CVS  
This is also a plus, in that L1 processing is shielded.
- Aging externals and the need to push ahead to modern versions of compilers and operating systems (OBF, Gaudi...)
- Brain Drain

# Successes

- Testing before flight paid off
- Early start provided ample time to write code and refactor
- Technical Writer produced Online Workbook
- Use of HepRep as our interface to Event Display
- Distributed, diverse group works well together  
Instant messaging, EVO, yearly face-to-face meetings  
In 2005, we had 25 developers spread over 9 time zones.