Fermi Large Area Telescope

"Running Monte Carlo for the Fermi Telescope using the SLAC farm"

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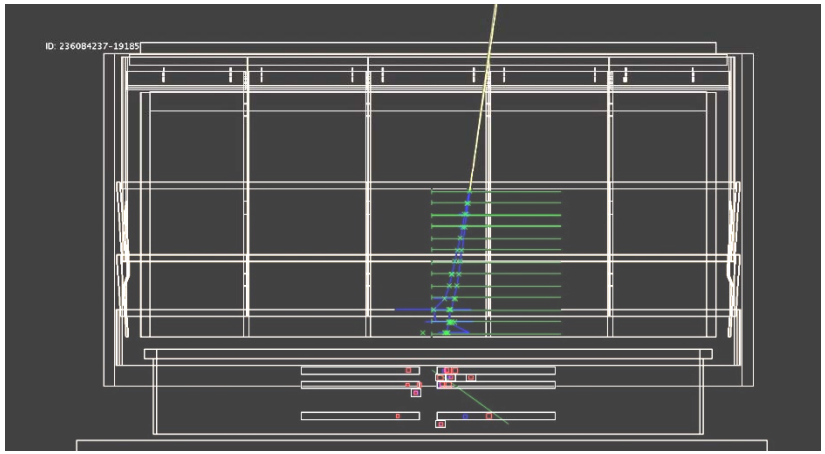
http://glast-ground.slac.stanford.edu/DataPortal

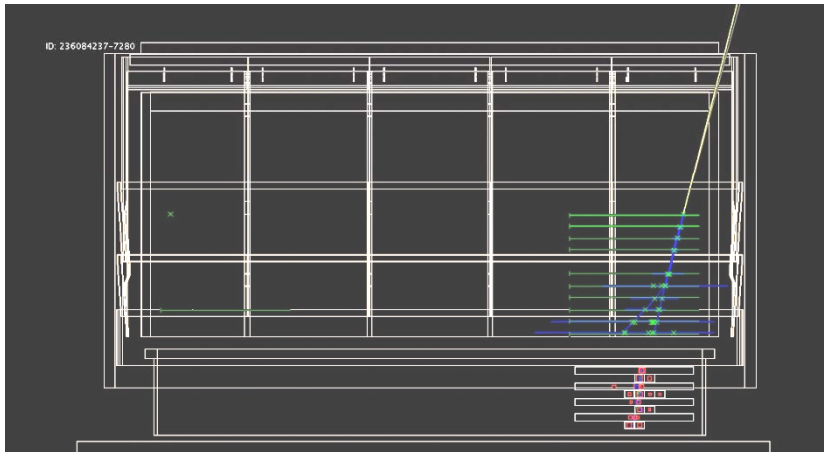
Contents

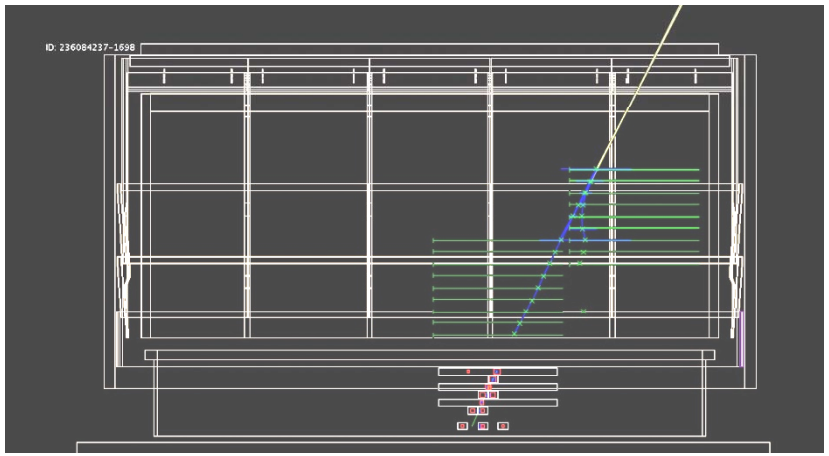
- Fermi Data Handling Overview
- Fermi Processing Pipeline Overview
  - Using Pipeline for MC processing
- Future plans for Fermi pipeline

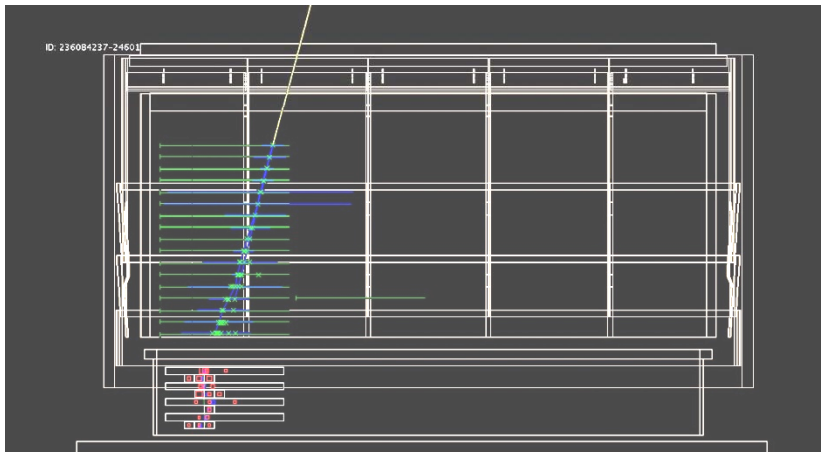
Launched 11 June 2008 – LAT activated 25 June

In Orbit: Single Events in the LAT





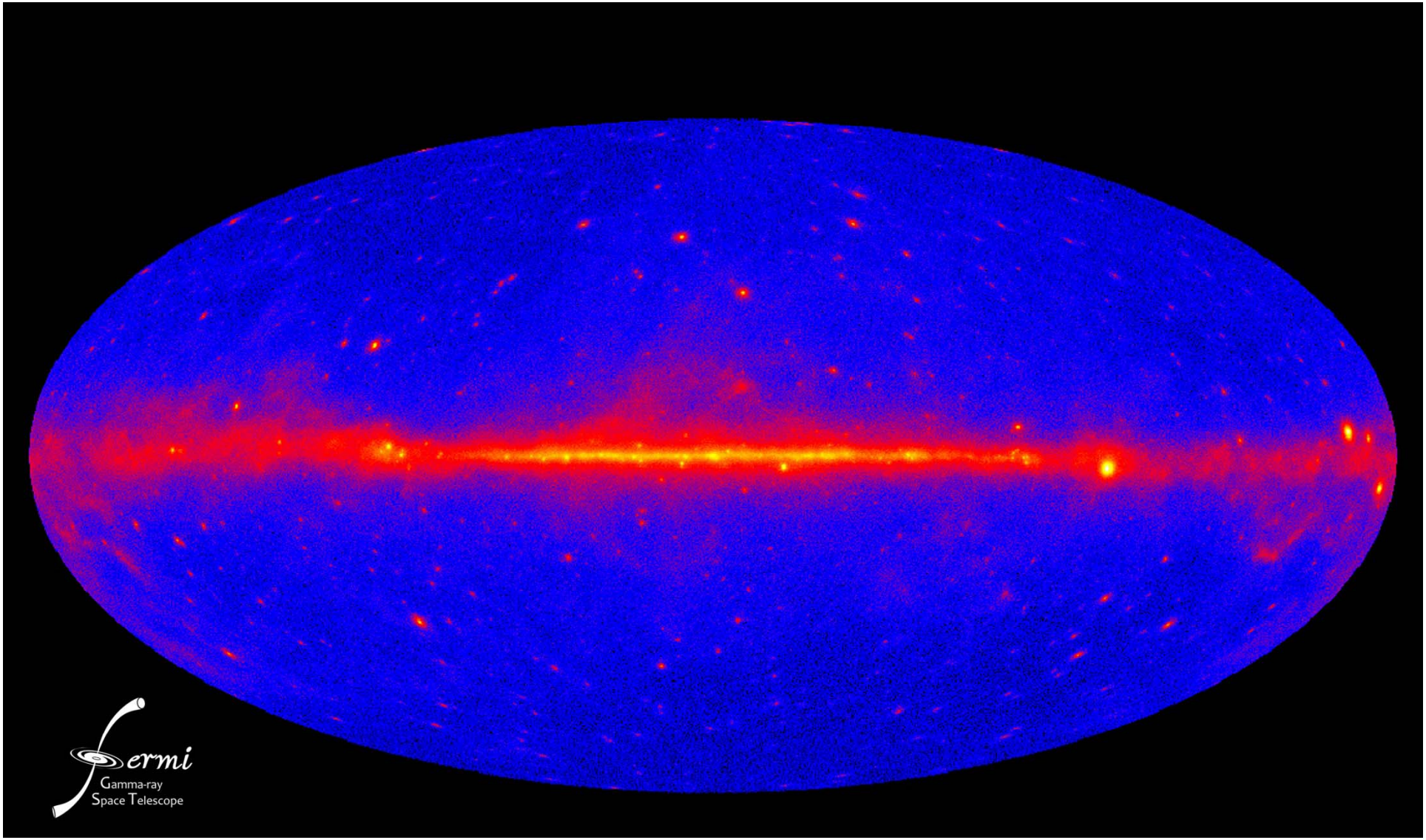


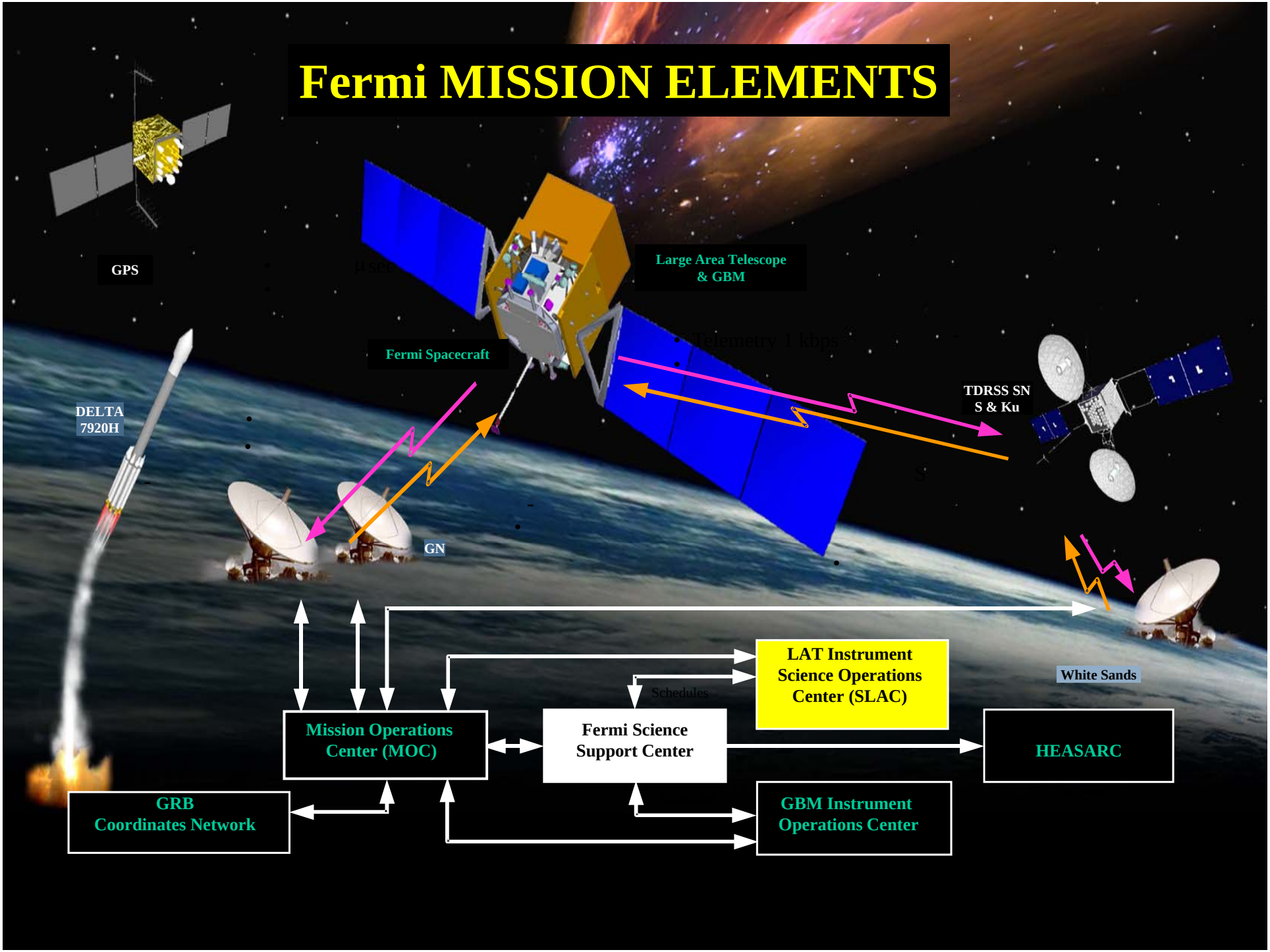


The green crosses show the detected positions of the charged particles, the blue lines show the reconstructed track trajectories, and the yellow line shows the candidate gamma-ray estimated direction. The red crosses show the detected energy depositions in the calorimeter.

0.25 CPU sec/event to reconstruct: downlink 500 Hz
Each photon event independent of others

Fermi One Year All Sky Map

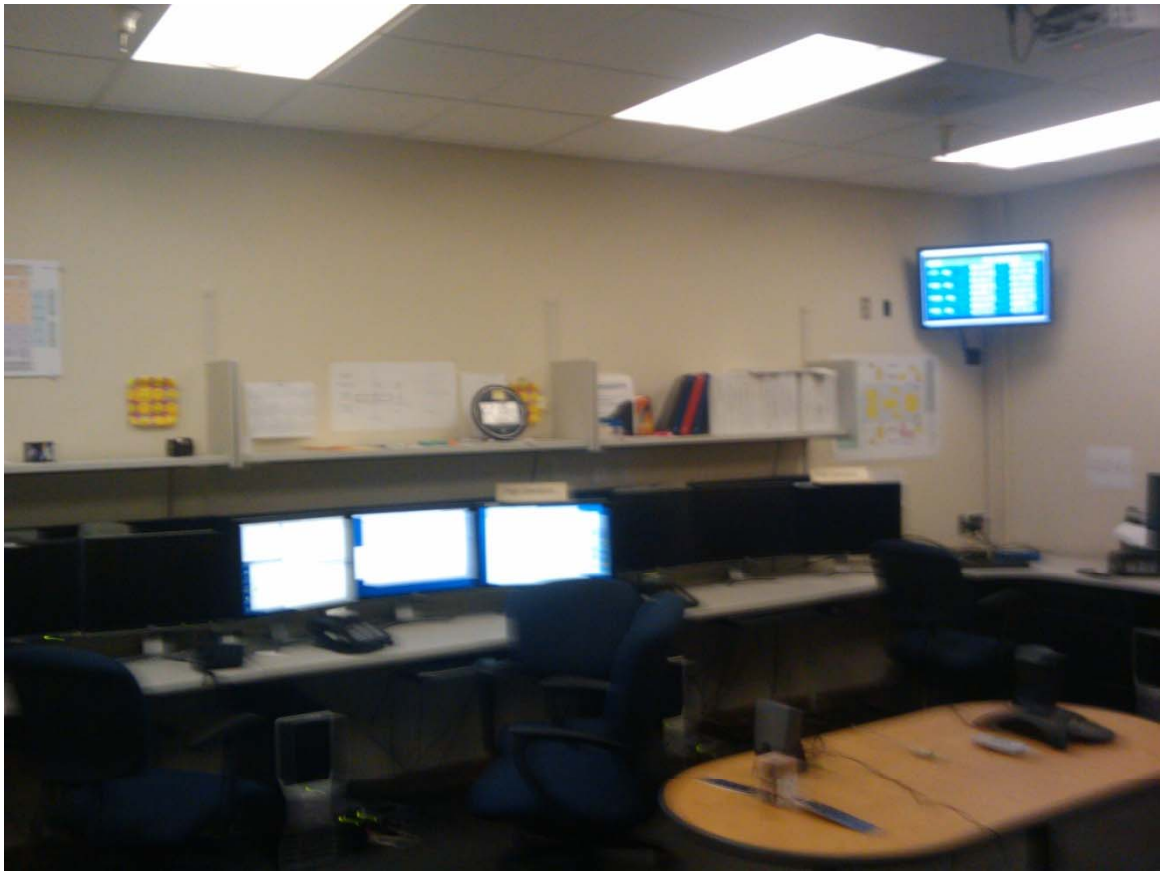



Fermi MISSION ELEMENTS
GPS
Large Area Telescope
& GBM
Fermi Spacecraft
DELTA
7920H
TDRSS SN
S & Ku
GN
White Sands
LAT Instrument
Science Operations
Center (SLAC)
Schedules
Mission Operations
Center (MOC)
Fermi Science
Support Center
HEASARC
GRB
Coordinates Network
GBM Instrument
Operations Center

Data Processing Flow at SLAC

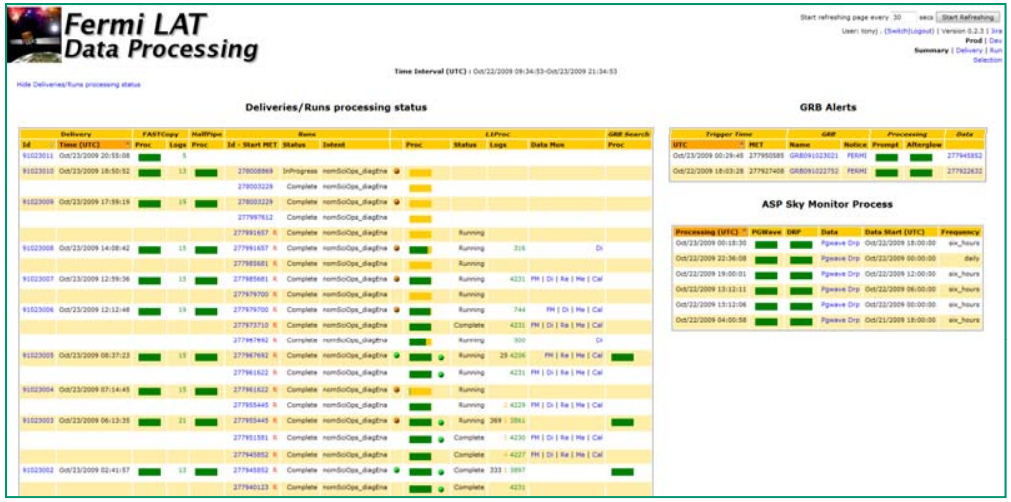
- Downlink from Goddard Space Flight Center ~8/day
  - 15 GB total daily
- Half-pipe
  - Automatic launched as data arrives at SLAC
  - Decode & repackage incoming data
    - Split science data from telemetry data
- Level 1 Processing
  - Full event reconstruction: factor ~x50 expansion on raw data! 750 GB/day
    - To turn around data in required timeframe we typically use ~800 cores
  - Data Quality Monitoring
  - Transfer science summary files to Goddard Science Support Ctr - 200 MB/day
  - Processing requirements
- ASP (Automated Science Processing)
  - GRB and Flare detection
  - Spectral analysis

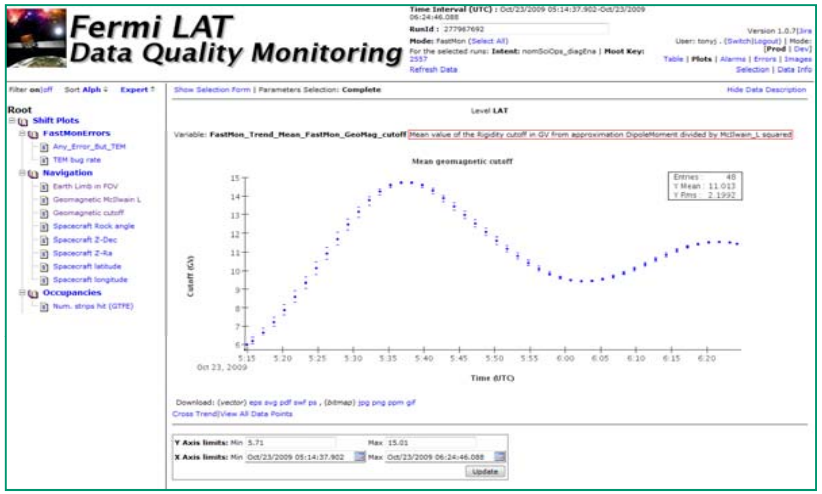
ISOC Control Room

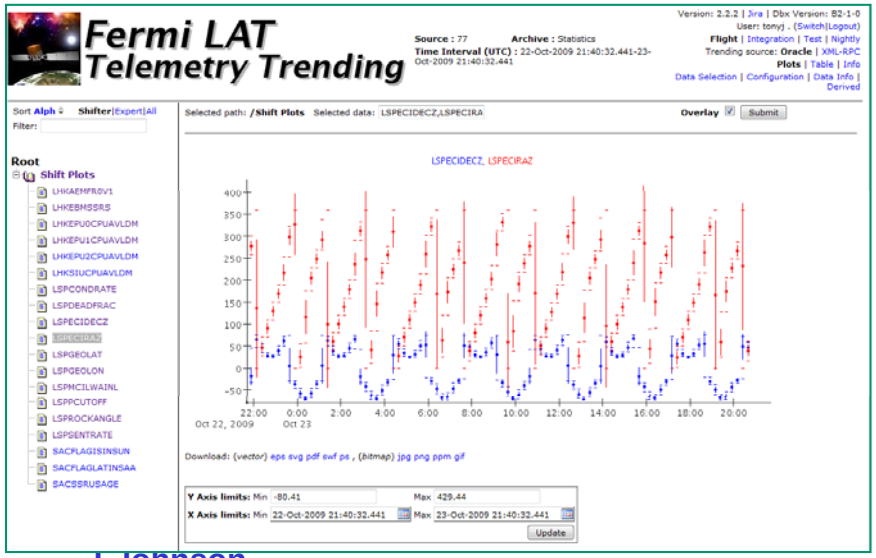


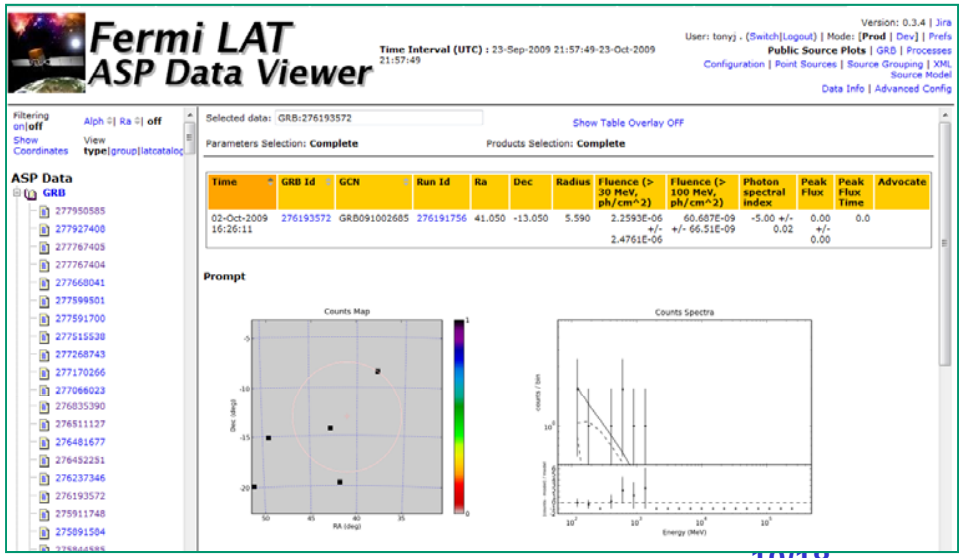
- All of the data processing and data quality monitoring can be done from the web
  - No need for anyone in the control room, monitoring load shared globally

Monitoring Pipeline + Data Quality

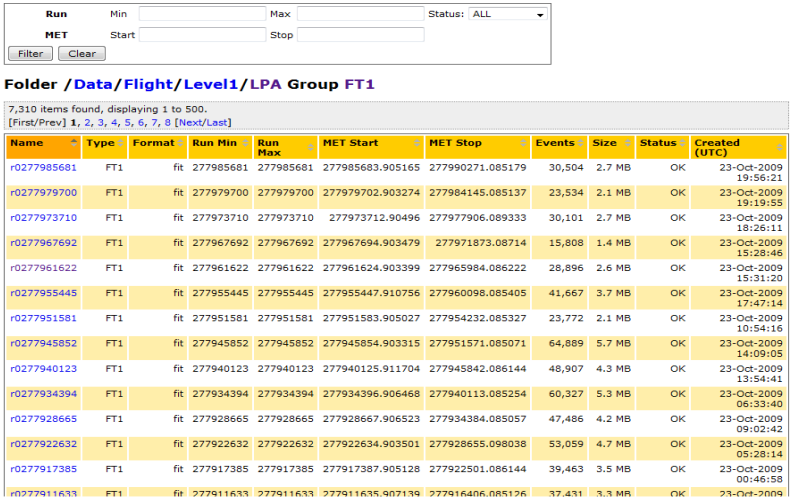








Data Access


Run Min Max Status: ALL
MET Start Stop
Filter Clear
Folder /Data/Flight/Level1/LPA Group FT1
7,310 items found, displaying 1 to 500.
[First/Prev] 1, 2, 3, 4, 5, 6, 7, 8 [Next/Last]
Name Type Format Run Min Run Max MET Start MET Stop Events Size Status Created (UTC)
r0277985681 FT1 fit 277985681 277985681 277985683.905165 277990271.085179 30,504 2.7 MB OK 23-Oct-2009 19:56:21
r0277979700 FT1 fit 277979700 277979700 277979702.903274 277984145.085137 23,534 2.1 MB OK 23-Oct-2009 19:19:55
r0277973710 FT1 fit 277973710 277973710 277973712.90496 277977906.089333 30,101 2.7 MB OK 23-Oct-2009 18:26:11
r0277967692 FT1 fit 277967692 277967692 277967694.903479 277971873.08714 15,808 1.4 MB OK 23-Oct-2009 15:28:46
r0277961622 FT1 fit 277961622 277961622 277961624.903399 277965984.086222 28,896 2.6 MB OK 23-Oct-2009 15:31:20
r0277955445 FT1 fit 277955445 277955445 277955447.910756 277960098.085405 41,667 3.7 MB OK 23-Oct-2009 17:47:14
r0277951581 FT1 fit 277951581 277951581 277951583.905027 277954232.085327 23,772 2.1 MB OK 23-Oct-2009 10:54:16
r0277945852 FT1 fit 277945852 277945852 277945854.903315 277951571.085071 64,889 5.7 MB OK 23-Oct-2009 14:09:05
r0277940123 FT1 fit 277940123 277940123 277940125.911704 277945842.086144 48,907 4.3 MB OK 23-Oct-2009 13:54:41
r0277934394 FT1 fit 277934394 277934394 277934396.906468 277940113.085254 60,327 5.3 MB OK 23-Oct-2009 06:33:40
r0277928665 FT1 fit 277928665 277928665 277928667.906523 277934384.085057 47,486 4.2 MB OK 23-Oct-2009 09:02:42
r0277922632 FT1 fit 277922632 277922632 277922634.903501 277928655.098038 53,059 4.7 MB OK 23-Oct-2009 05:28:14
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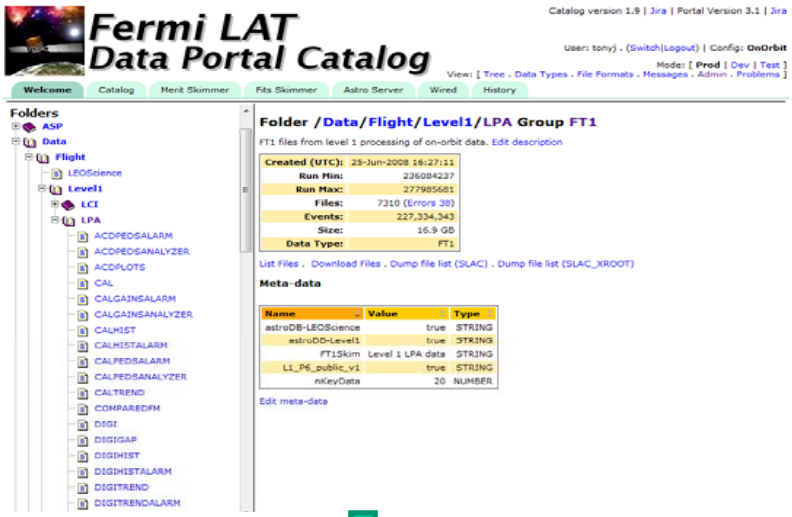
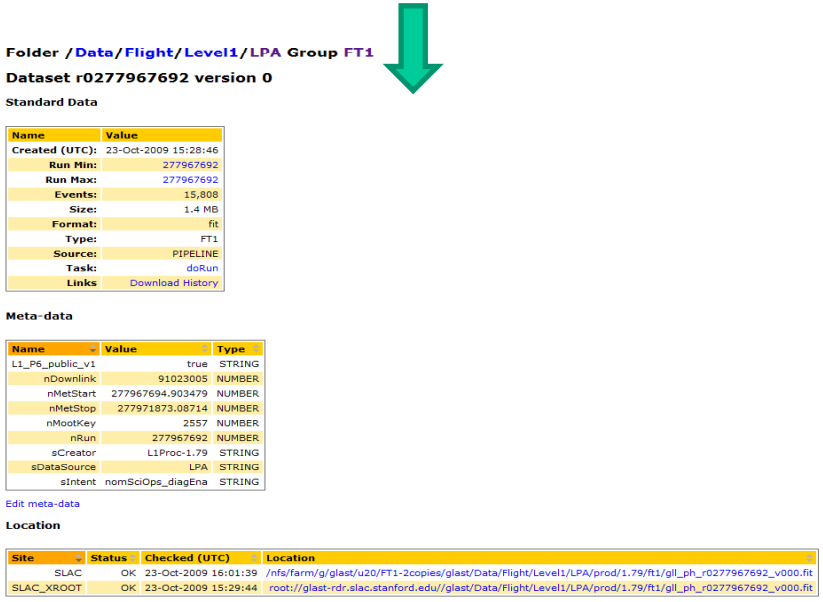

Fermi LAT Data Portal Catalog
Catalog version 1.9 | Jira | Portal Version 3.1 | Jira
Welcome Catalog Merit Skimmer Fits Skimmer Astro Server Wired History
Folders
ASP
Data
Flight
LEOScience
Level1
LCI
LPA
ACDPEDSALARM
ACDPEDSANALYZER
ACDPLOTS
CAL
CALGAINSALARM
CALGAINSANALYZER
CALHIST
CALHISTALARM
CALPEDSALARM
CALPEDSANALYZER
CALTREND
COMPAREDFM
DIGI
DIGIGAP
DIGIHIST
DIGIHISTALARM
DIGITREND
DIGITRENDALARM
Folder /Data/Flight/Level1/LPA Group FT1
FT1 files from level 1 processing of on-orbit data. Edit description
Created (UTC): 25-Jun-2008 16:27:11
Run Min: 236084237
Run Max: 277985681
Files: 7310 (Errors 38)
Events: 227,334,343
Size: 16.9 GB
Data Type: FT1
List Files . Download Files . Dump file list (SLAC) . Dump file list (SLAC_XROOT)
Meta-data
Name Value Type
astroDB-LEOScience true STRING
astroDD-Level1 true STRING
FT1Skim Level 1 LPA data STRING
L1_P6_public_v1 true STRING
nKeyData 20 NUMBER
Edit meta-data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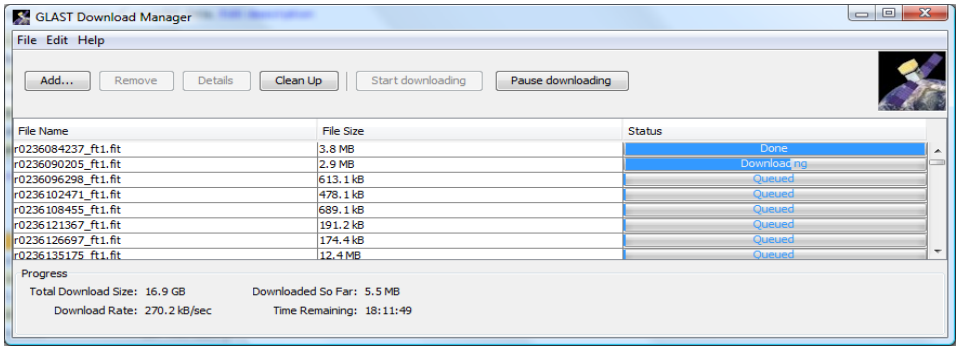
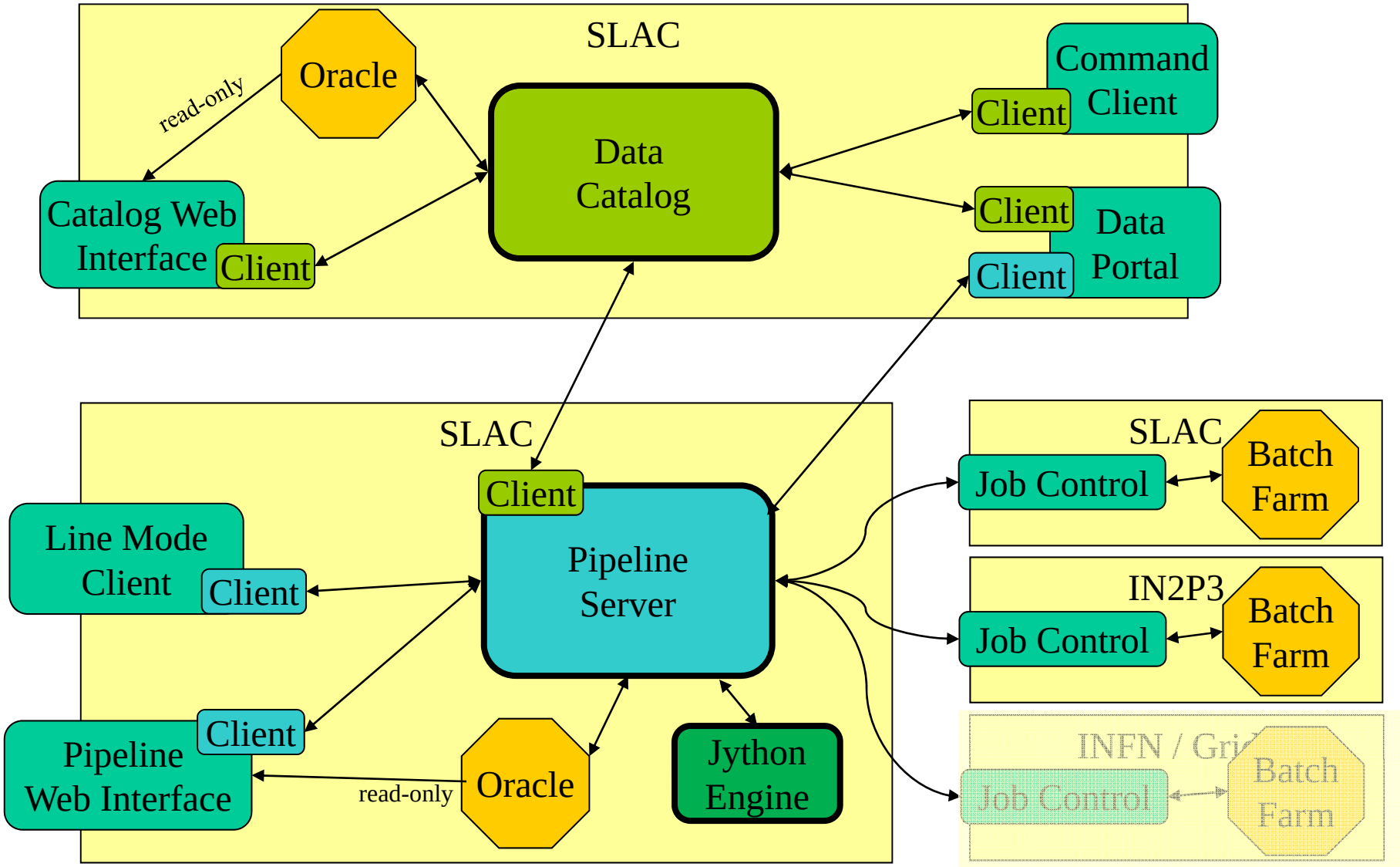
Dataset r0277967692 version 0
Standard Data
Name Value
Created (UTC): 23-Oct-2009 15:28:46
Run Min: 277967692
Run Max: 277967692
Events: 15,808
Size: 1.4 MB
Format: fit
Type: FT1
Source: PIPELINE
Task: doRun
Links Download History
Meta-data
Name Value Type
L1_P6_public_v1 true STRING
nDownlink 91023005 NUMBER
nMetStart 277967694.903479 NUMBER
nMetStop 277971873.08714 NUMBER
nMootKey 2557 NUMBER
nRun 277967692 NUMBER
sCreator L1Proc-1.79 STRING
sDataSource LPA STRING
sIntent nomSciOps_diagEna STRING
Edit meta-data
Location
Site Status Checked (UTC) Location
SLAC OK 23-Oct-2009 16:01:39 /nfs/farm/g/glast/u20/FT1-2copies/glast/Data/Flight/Level1/LPA/prod/1.79/ft1/gll_ph_r0277967692_v000.fit
SLAC_XROOT OK 23-Oct-2009 15:29:44 root://glast-rdr.slac.stanford.edu//glast/Data/Flight/Level1/LPA/prod/1.79/ft1/gll_ph_r0277967692_v000.fit


GLAST Download Manager
File Edit Help
Add... Remove Details Clean Up Start downloading Pause downloading
File Name File Size Status
r0236084237_ft1.fit 3.8 MB Done
r0236090205_ft1.fit 2.9 MB Downloading
r0236096298_ft1.fit 613.1 kB Queued
r0236102471_ft1.fit 478.1 kB Queued
r0236108455_ft1.fit 689.1 kB Queued
r0236121367_ft1.fit 191.2 kB Queued
r0236126697_ft1.fit 174.4 kB Queued
r0236135175_ft1.fit 12.4 MB Queued
Progress
Total Download Size: 16.9 GB
Downloaded So Far: 5.5 MB
Download Rate: 270.2 kB/sec
Time Remaining: 18:11:49

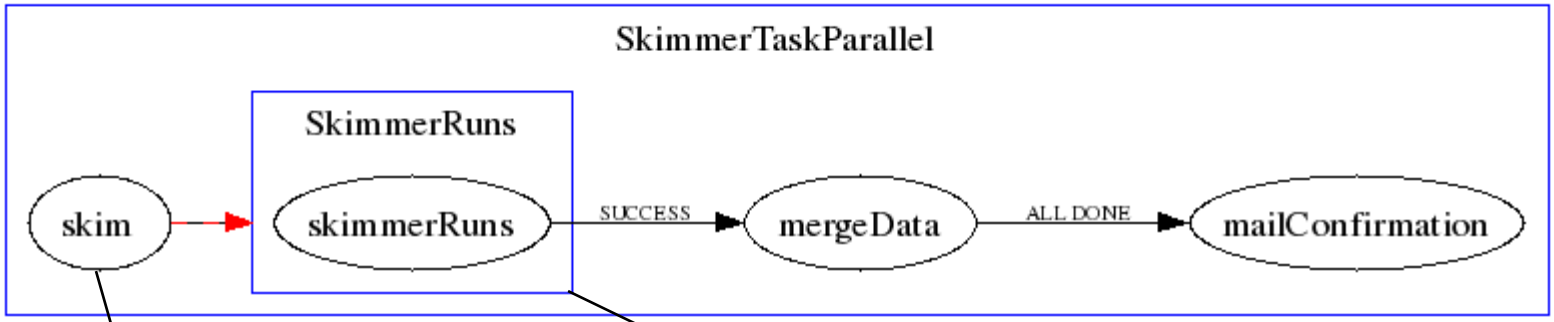
Pipeline Introduction

- Pipeline design goals
  - Automated submission and monitoring of batch jobs
    - Very high reliability
  - Ability to define graph of jobs to be run
    - Ability to parallelize processing tasks
    - Ability to perform simple computations as part of job graph
      - E.g. Compute how many parallel streams to create as a function of the number of events to be processed
  - Ability to “Roll Back” jobs (whether successful or not)
    - Capability to automatically compute sub-graph of jobs to rerun
  - Maintain full history of all data processing
  - Data catalog to keep track of all data products
  - Web interface for monitoring jobs and submitting new tasks
    - Plus command line client, and programmatic API

Pipeline and Data Catalog Components



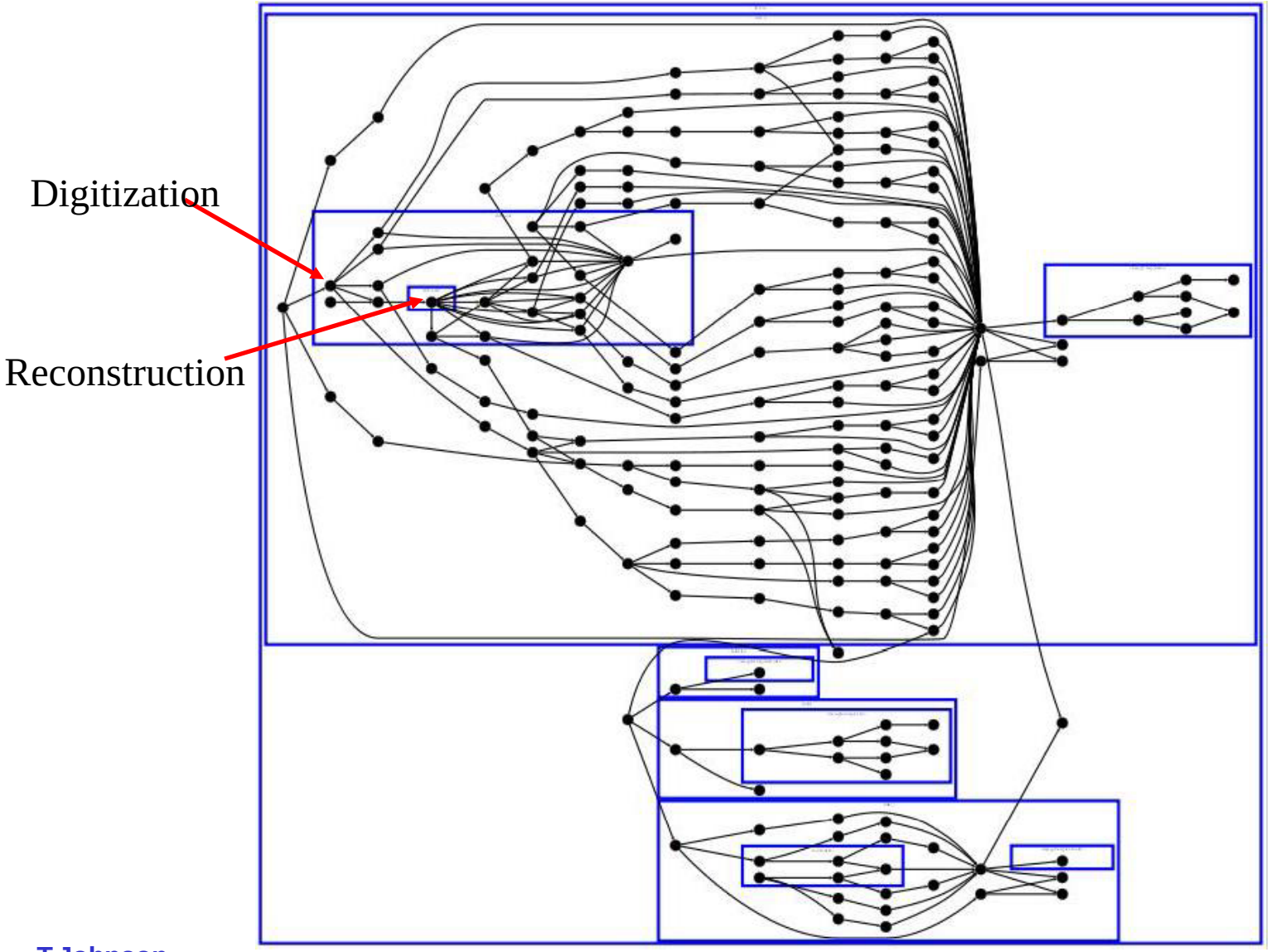
Pipeline Task specification (XML)



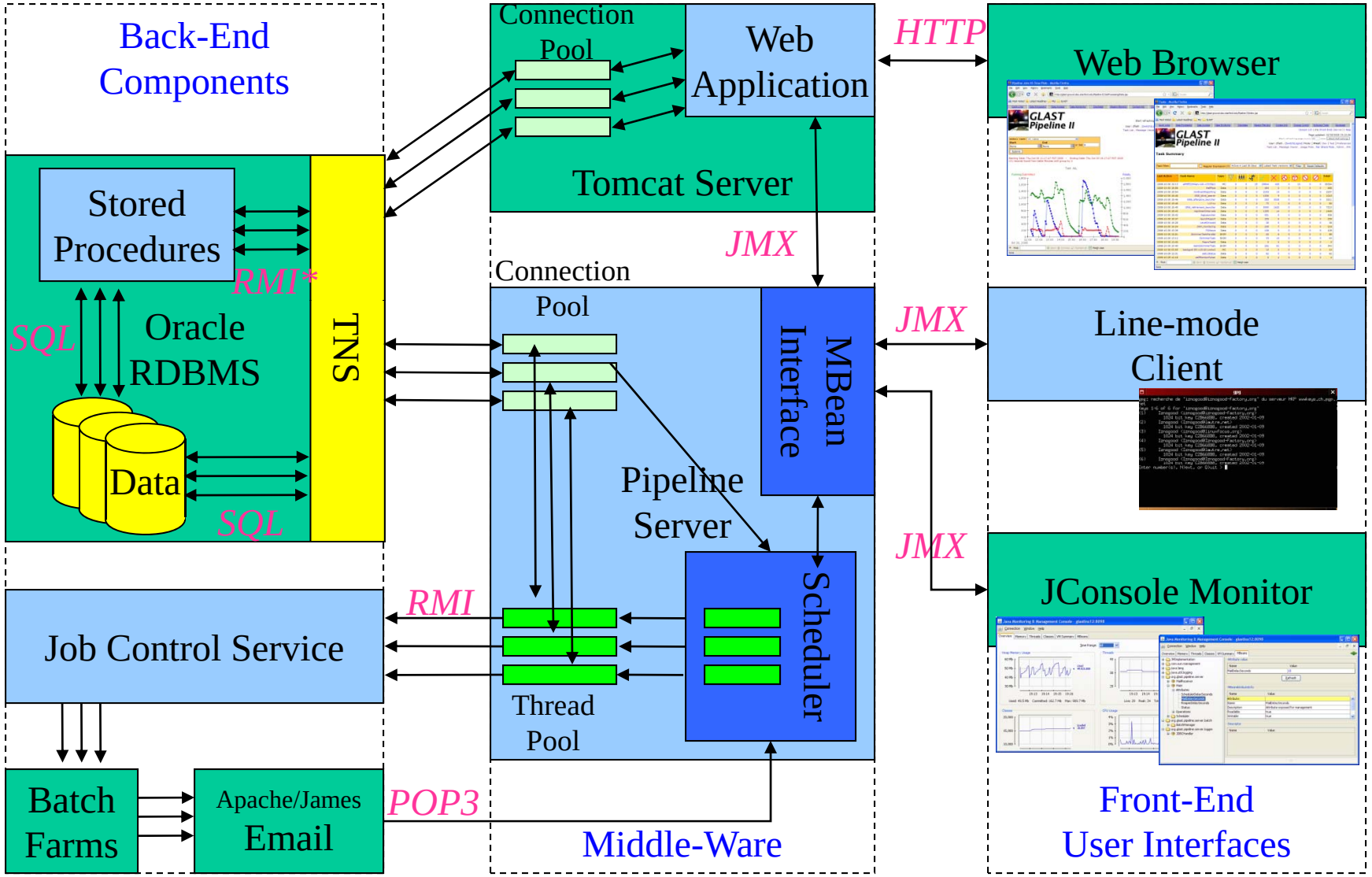

```
<process name="skim">
    <script>
        <![CDATA[
 from java.util import HashMap
 start = 0
 chunk_size = DP_FILE_LINES/DP_SUBTASKS + 1
 for i in range(DP_SUBTASKS):
    vars = HashMap()
    vars.put("DP_START", start)
    end = min( start + chunk_size, DP_FILE_LINES )
    vars.put("DP_END", end)
    if end>start:
       pipeline.createSubstream("SkimmerRuns",i,vars)
    start = end
 ]]>
    </script>
    <createsSubtasks>
        <subtask>SkimmerRuns</subtask>
    </createsSubtasks>
</process>
```

```
<task name="SkimmerRuns" type="Data" version="1.0">
    <process name="skimmerRuns">
        <variables>
            <var name="streamID">${format(pipeline.stream,"%04d")}</var>
        </variables>
        <job maxCPU="${DP_SKIMMER_MAXCPU}">
            cat ${DP_FILE_LIST} | head -${DP_END} | tail -$((DP_END-DP_START)) > partlist
            export SK_FILE_LIST_FILE=partlist
            export SK_OUT_DIR=${DP_OUT_DIR}/${streamID}
            export SK_ENFORCE_OUTPUT_FILES=false
            export SK_MAX_FILE_SIZE=0
            export SK_OUT_FILE_BODY=${DP_JOBNAME}-${streamID}
            mkdir -p ${SK_OUT_DIR}
            $SK_DIR/bin/skimmer
        </job>
    </process>
</task>
```

Level 1 Task Specification



Pipeline Implementation



Pipeline Web Interface

Task Filter: [ ] Regular Expression (?) Active in Last 30 days | Latest Task Versions | Filter | Reset Defaults

Last Active	Task Name	Type										Total
2008-10-30 23:12	L1Proc	Data	0	0	5	78	1	0	0	0	0	84
2008-10-30 22:47	HalfPipe	Data	0	0	0	488	0	0	0	0	0	488
2008-10-30 22:39	nonEventReporting	Data	0	0	0	2207	14	0	0	0	0	2221
2008-10-30 22:13	GRB_blind_search	Data	0	0	0	1008	9	0	0	0	0	1017
2008-10-30 22:13	GRB_afterglow_launcher	Data	0	0	0	283	3034	0	0	0	0	3317
2008-10-30 22:12	GRB_refinement_launcher	Data	0	0	0	5596	1620	0	0	0	0	7216
2008-10-30 22:10	AspInsertIntervals	Data	0	0	0	1397	14	0	0	0	0	1411
2008-10-30 22:10	AspLauncher	Data	0	0	0	408	5	0	0	0	0	413
2008-10-30 21:31	DRP_monitoring	Data	0	0	0	211	7	0	0	0	0	218
2008-10-30 20:23	PGWave	Data	0	0	0	110	0	0	0	0	0	110
2008-10-30 19:47	allHEE200GeV-GR-v15r39p1	MC	0	0	0	29861	427	0	16	0	0	30304
2008-10-30 18:37	launchReport	Data	0	0	0	255	0	0	0	0	0	255
2008-10-30 16:28	Level0Xrootd	Data	0	0	0	38	0	0	0	0	0	38
2008-10-30 15:01	SkimmerTaskParallel	SKIM	0	0	0	80	8	0	0	0	0	88
2008-10-30 13:12	SkimmerTask	SKIM	0	0	0	33	10	0	0	0	0	43
2008-10-30 12:42	ReproTest8	Data	0	0	0	0	2	0	0	0	0	2
2008-10-30 10:40	AstroSkimmerTask	SKIM	0	0	0	262	81	0	0	0	0	343
2008-10-30 03:55	backgnd-GR-v15r40-Limbo2	MC	0	0	0	10	0	0	0	0	0	10
2008-10-29 12:31	setL1Status	Data	0	0	0	62	0	0	0	0	0	62
2008-10-29 12:16	aeffMonitorPulsar	Data	0	0	0	0	4	0	0	0	0	4
2008-10-29 08:12	GRB_afterglow	Data	0	0	0	137	3	0	0	0	0	140
2008-10-29 08:07	backgnd-GR-v15r40-Limbo	MC	0	0	0	3610	0	0	0	0	0	3610
2008-10-29 07:55	backgnd-GR-v15r39p1-FullDay	MC	0	0	0	70000	0	0	0	0	0	70000
2008-10-29 02:44	GRB_refinement	Data	0	0	0	107	11	0	0	0	0	118

GLAST Pipeline II

Version 2.8 | Jira (Front-End) (Server) | Help

Page updated: 10/31/2008 00:07:15

Start refreshing page every 60 secs | Start Refreshing

User: dflath . (Switch|Logout) Mode: [**Prod** | Dev | Test] Preferences

Task List . Message Viewer . Usage Plots . Fair Share Plots . Admin . JMX

Message Viewer

Task: -- Severity: INFO

30/Oct/2008 23:57:14 | None | Filter | Default

623 items found, displaying 1 to 500.

[First/Prev] **1**, 2 [Next/Last]

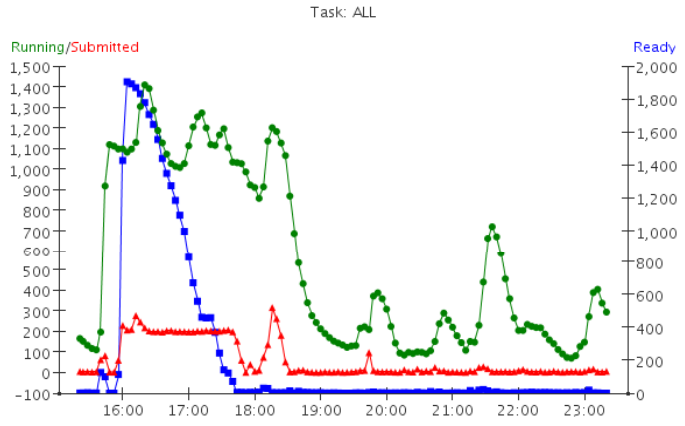
Time	Level	Task	Process	Stream	Message	Detail
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.4.1	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	L1Proc.doRun.doChunk.doCrumb	recon	81031004.247111885.5700176.7280	Received status report: ENDED rc=0	
31-Oct-2008 00:06:28	INFO	L1Proc.doRun.doChunk	reconTrend	81031004.247117860.15155	Received status report: ENDED rc=0	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.4.0	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.10.1	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	L1Proc.doRun	mergeDigiHist	81031004.247111885	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.10.0	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis	sourceAnalysis	247082400.11	Received status report: ENDED rc=0	
31-Oct-2008 00:06:28	INFO	L1Proc.doRun.doChunk	fastMonTrend	81031004.247111885.6032090	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.13.0	Received status report: STARTED	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis	sourceAnalysis	247082400.27	Received status report: ENDED rc=0	
31-Oct-2008 00:06:28	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.13.1	Received status report: STARTED	
31-Oct-2008 00:06:26	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.14.1	Submitted job to SLACDATA, id=427316	
31-Oct-2008 00:06:26	INFO	DRP_monitoring.roiAnalysis.energyBandAnalysis	fitEnergyBand	247082400.14.0	Submitted job to SLACDATA, id=427315	

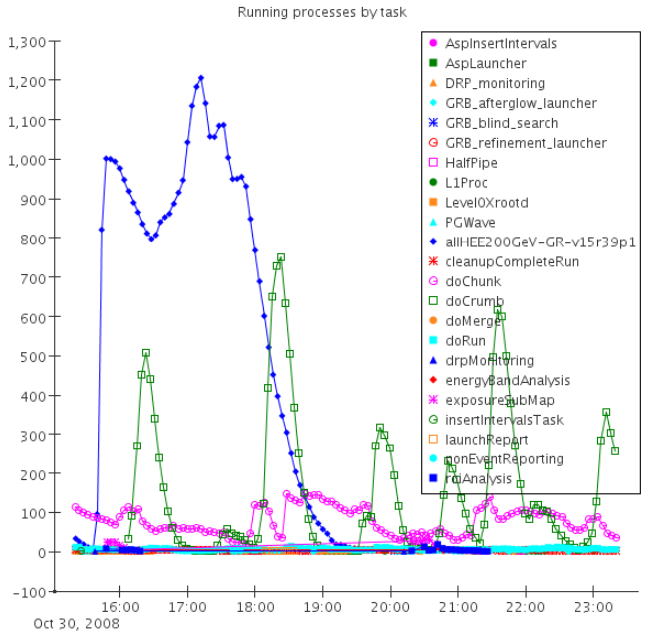
Select Task: All Tasks

Start None **End** None or last 8

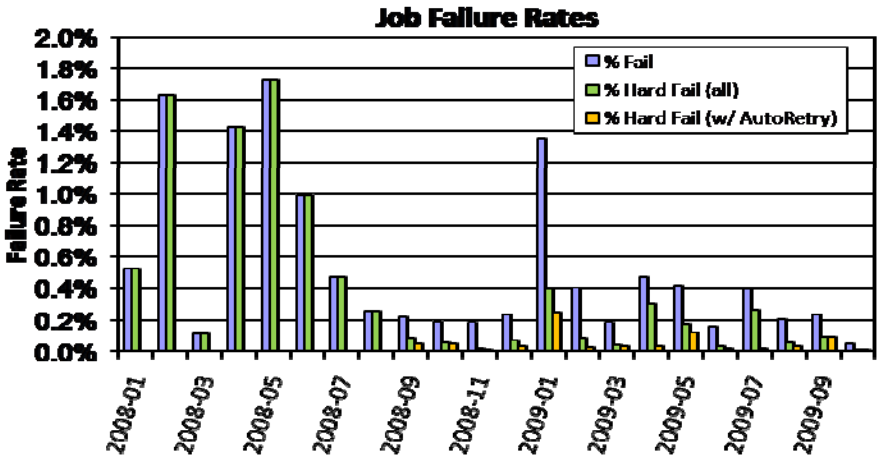
Submit

Starting Date: Thu Oct 30 15:20:00 PDT 2008 - Ending Date: Thu Oct 30 23:20:00 PDT 2008
121 records found from table Minutes with group by 4

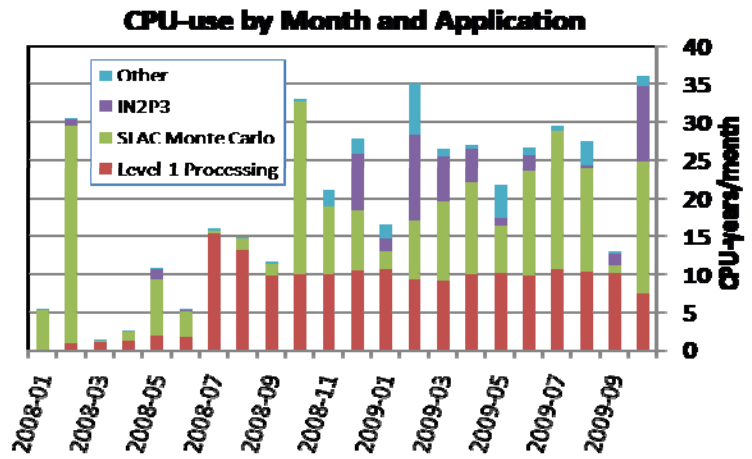




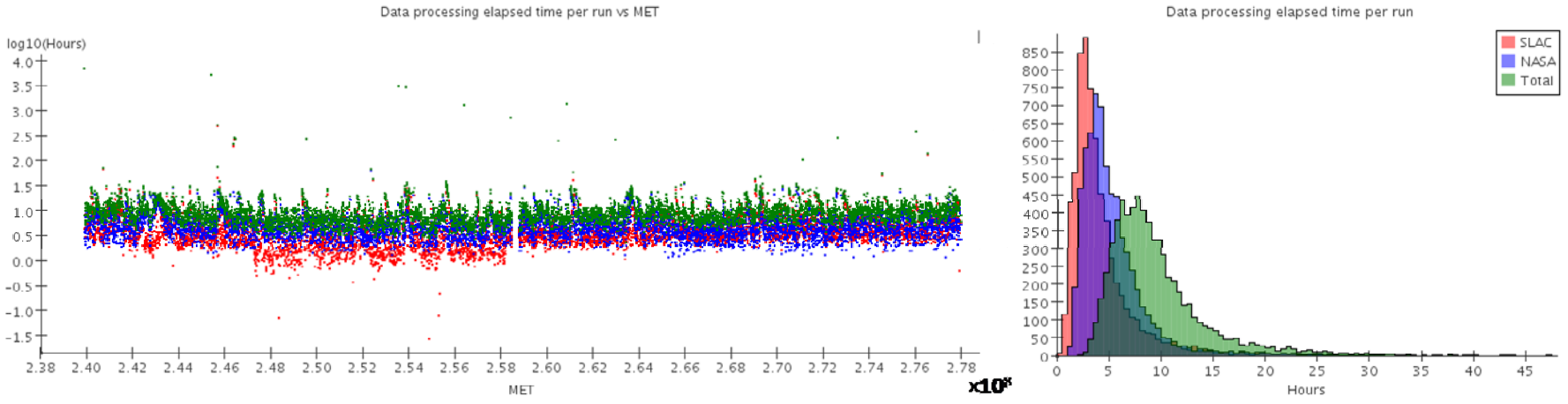
Pipeline Performance and Reliability



Pipeline reliability. AutoRetry allows failed jobs to be rerun without manual intervention.



CPU-years delivered by the pipeline per month.

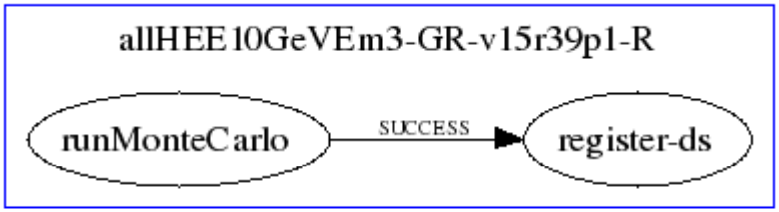


Elapsed time between data being recorded on satellite and arriving at SLAC (red), and between arriving at SLAC and being totally processed (blue), and total elapsed time (green). Most data is fully processed <24 hours after being taken.

Pipeline for MC production

- Why use the pipeline for MC production?
  - Automated submission of thousands of jobs
  - Complete bookkeeping and access to log files from web
  - Ability to easily rerun failed jobs (automatically or manually)
  - Data catalog + download manager simplifies access to data products
  - Useful facilities not directly pipeline related
    - “xrootd” alternative file system which scales to large number of readers/writers much better than NFS
    - GPLTOOLS: Set of python utilities for staging input/output from scratch disk to/from NFS/xrootd
- Fermi has used pipeline for all MC production
  - 250 CPU-years of MC production in last two years

Pipeline for MC production




```
<process name="runMonteCarlo">
   <job
        executable="python ${GPL_CONFIGDIR}/${GPL_PRIMARYSCRIPT}"
        queue="${GPL_QUEUE}"
        batchOptions="${GPL_BATCHOPTIONS} ${GPL_XTRABATCHOPTIONS} -R  &amp;quot;${GPL_BATCHRESOURCES} ${GPL_XTRABATCHRESOURCES}
   />
</process>
```

```
      <process name="register-ds">
         <scipt><![CDATA[
parentPI = pipeline.getProcessInstance('runMonteCarlo')
tStart = parentPI.getVariable("startTime")
tStop  = parentPI.getVariable("endTime")
datasource = "MC"

attributes = ':'.join([
   "nMetStart=%f"   % tStart,
   "nMetStop=%f"    % tStop,
   "sDatasource=%s" % datasource
   ])

  dcMerit   = datacatalog.registerDataset("MERIT",    GPL_meritLD,    GPL_xrootdMERIT+"@SLAC_XROOT",    attributes)
  dcCal     = datacatalog.registerDataset("CAL",      GPL_calLD,      GPL_xrootdCAL+"@SLAC_XROOT",      attributes)
  dcMc      = datacatalog.registerDataset("MC"   ,    GPL_mcLD   ,    GPL_xrootdMC+"@SLAC_XROOT",       attributes)
  dcDigi    = datacatalog.registerDataset("DIGI" ,    GPL_digiLD ,    GPL_xrootdDIGI+"@SLAC_XROOT",     attributes)
  dcRecon   = datacatalog.registerDataset("RECON",    GPL_reconLD,    GPL_xrootdRECON+"@SLAC_XROOT",    attributes)
          ]]>
         </script>
         <depends>
             <after process="runMonteCarlo"></after>
         </depends>
      </process>
```

Pipeline + Data Catalog Plans

- We have already set up a second “non-Fermi” version of pipeline server and data catalog
  - Currently starting to be used for EXO and AGIS
    - EXO will use pipeline for data processing starting next summer
    - AGIS will use pipeline for MC data processing
- We are working with Fermi Italian collaborators to create a job submission daemon to work with the Grid
  - We would like to extend pipeline to be able to submit jobs to the “Cloud”
- Improved Data Catalog web interface with more “AJAX” features.