GLAST Large Area Telescope:

Integration and Test
Two Tower
Integration Readiness Review

Science Verification Analysis and Calibration

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OUTLINE

Planning

- SVAC requirements
- Current Status of Documentation
- Data Taking Plans

Implementation

- Data Processing Chain (pipeline)
- Data Quality Monitoring
- Calibrations
- Data Analysis

Summary

- Future Work
- Main Concerns and/or Risks

Requirements & Documentation

SVAC High Level Requirements

- Applicable to data taking from Cosmic Rays and VDG photons
  - Data Processing
    - Convert each raw data file (LDF) into analysis files
    - Archive files
  - Monitor Data Quality
    - Verify the integrity of data and test configuration
  - Calibrations
    - Generate calibrated data
    - Improve calibrations
    - Trend calibration constants used by the reconstruction
  - Data Analysis
    - Characterize Low Level Performance
    - Tune MC simulations

List of Documents

	LAT DOCS	Responsibility	Status
LAT SVAC Plan	LAT-MD-00446	SVAC	signed off
SVAC Plan for LAT Integration at SLAC	LAT-MD-00575	SVAC	signed off
SVAC Contributed Manpower	LAT-MD-00613	SVAC	released

- SVAC Plan LAT-MD-00446-06
  - Master Plan : Level 3
  - Covers pre and pos launch activities
    - Expect updates after transition into FSW (during I&T)

- SVAC Plan LAT-MD-00575-01
  - Describes implementation details : Level 4
    - Special signature cycle
      - » submitted to subsystem managers and other key people for SVAC
  - Covers all LAT integration at SLAC
    - Baseline for integration at SLAC is already described
    - Expect updates after 1 and 2 tower tests (lessons learned)

- SVAC Contributed Manpower LAT-MD-00613-02
  - Captures existing commitments – Level 3

Redundancy – Risk Reduction

- To reduce schedule risks no critical task is assigned to a single person

Redundancy achieved

- Calibrations *Xin/Anders*
- Geometry *Anders/Xin*
- Code Management *Anders/Xin*
- Data Processing and Archival *Warren/Xin*
- Data Reports *Xin/Anders*
- Event Display *Anders/Warren*

Redundancy process in progress

- Data Configuration Parser *Warren/Anders*
- LDF verification *SAS/ISOC*

Redundancy process not yet started

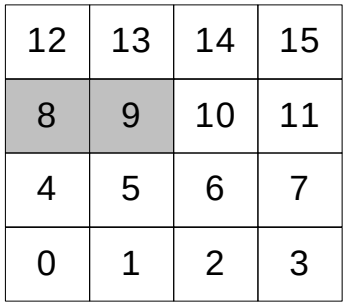
- Electronic Logbook (ORACLE) *Xin/ISOC*
- Trending Database (ORACLE/JAS) *Xin/ISOC*

Calibration trending is not so critical for two towers, During our Peer Review in July 004, ISOC agreed to take over soon since Xin is oversubscribed. Need to ramp up this effort

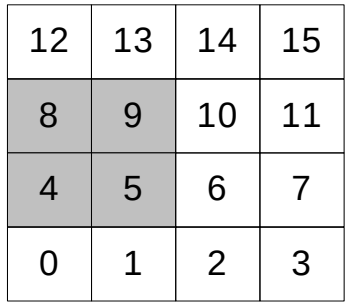
Data Taking Plans

Cosmic Ray Data Taking

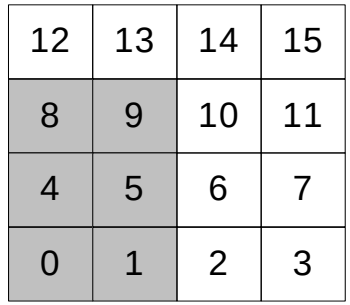
1 Tower
(Single bay, special grid)



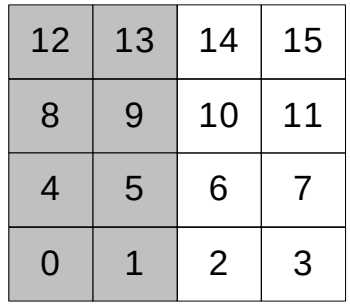
2 Towers



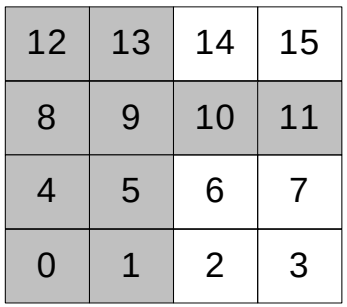
4 Towers



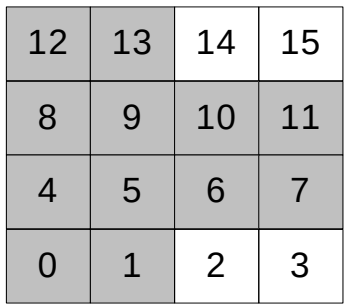
6 Towers



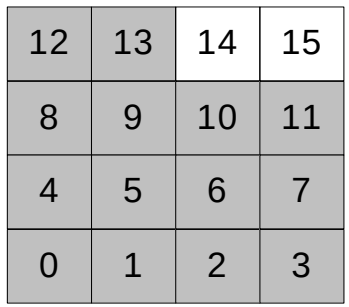
8 Towers



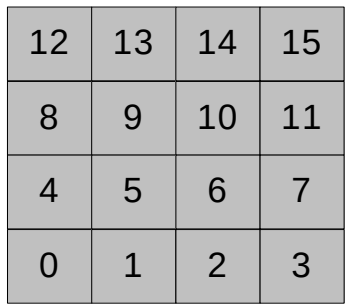
10 Towers



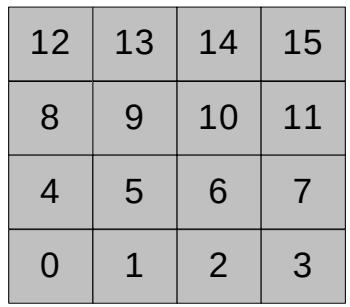
12 Towers



14 Towers



16 Towers



LAT

VDG Data Taking

1 Tower
(Single bay, special grid)

12	13	14	15
8	9	10	11
4	5	6	7
0	1	2	3

2 Towers

12	13	14	15
8	9	10	11
4	5	6	7
0	1	2	3

LAT

Overview – SVAC Tests

LAT-MD-00575

- SVAC 101
  - Data Collection with CAL high energy muon gain
- SVAC 102
  - Data Collection with CAL high energy muon gain and TEM diagnostics enabled
- SVAC 103
  - Data Collection without zero suppression
- SVAC 104:
  - Data Collection with flight configuration
- SVAC 105:
  - ACD functionality for integrated LAT
- SVAC 106:
  - Data Collection with ACD triggers only and ROI 1
- SVAC 107:
  - Data Collection with ACD triggers only and ROI 2
- SVAC 108:
  - Data Collection with ACD triggers only and ROI 3
- SVAC 204 (there is typo in LAT-MD-00575)
  - TKR Threshold Dispersion (Same as TKR TE701)
- SVAC 201
  - TKR Threshold Calibration (Same as TKR TE601)
- SVAC 202
  - TKR TOT Conversion Parameter Calibration (Same as TKR TE602)
- SVAC 203
  - CAL FLE/FHE Muon Scan

SVAC tests – Single Tower in EM bay

First tower will be used to validate estimates for number of triggers required for data analysis

- Data taking conditions
  - For most tests muon telescope participates in the trigger
  - For most of tests TEM diagnostics are enabled
  - Expected rate from 20 ~ 30 Hz
- Cosmic Rays
  - SVAC 104:(2 hours)
    - Data Collection with flight configuration, vertical orientation
  - SVAC 102 (2 hours) VDG OFF
    - Data Collection with CAL high energy muon gain with four range readout, TEM diagnostics enabled, vertical orientation
  - SVAC 102 (1 hour)
    - Data Collection with CAL high energy muon gain with four range readout, TEM diagnostics enabled, horizontal orientation
  - SVAC 103: (1 hour)
    - Data Collection with CAL high energy muon gain with four range readout, TEM diagnostics enabled, vertical orientation, without zero suppression
- Low Energy Photons
  - SVAC 102 (1 hour) VDG ON
    - Data Collection with CAL high energy muon gain and TEM diagnostics enabled, horizontal orientation

SVAC tests – Single Tower in grid

These tests are repeated for each new tower after it is installed in a grid

Expected CR rate for single tower: 30 Hz

- **Day 1:Calibrations**
  - **SVAC 201:(1 hour)**
    - **TKR Threshold Calibration – charge injection**
  - **SVAC 202:(1 hours)**
    - **TKR Tot Conversion parameter Calibration – charge injection**
  - **SVAC 204:(1 hours)**
    - **TKR Threshold dispersion – charge injection**
  - **SVAC 104:(4 hours)**
    - **TKR MIP Calibration/Trigger efficiency/Residuals**
  - **SVAC 203: (8 hours)**
    - **Determine CAL discriminator setting with muons**
- **Day 2: Calibrations (large statistical sample) and Low-level characterization**
  - **SVAC 102 (23 hour)**
    - **Data Collection with CAL high energy muon gain with four range readout, TEM diagnostics enabled, horizontal orientation**
  - **SVAC 103: (1 hour)**
    - **Data Collection with CAL high energy muon gain with four range readout, TEM diagnostics enabled, vertical orientation, without zero suppression**
- **Day 3: Low Energy Photons**
  - **SVAC 102 (13 hours) VDG ON**
    - **Data Collection with CAL high energy muon gain and TEM diagnostics enabled, horizontal orientation**
  - **SVAC 102 (3 hours) VDG OFF**
    - **Data Collection with CAL high energy muon gain and TEM diagnostics enabled, horizontal orientation**

All nominal settings for integrated instrument (e.g. time delays) are assumed to be known

SVAC Scripts

- "Requirements" for Data Taking scripts and/or LATTE
  - Shall produce several data runs
    - 30 min (TBR) : for one tower
    - 10 min (TBR) : for LAT
  - Shall produce the data taking configuration for each run with information about the hardware under test
    - external info
      - » VDG rate used, solicited trigger rate for E2E tests
    - internal info
      - » to support calibrations and data analysis
      - » e.g. zero suppression ON/OFF, etc
      - » Full list provided in LA-MD-00575
  - Shall produce data taking configuration in time reasonably small when compared with the duration of run
    - Snapshots of registers currently take ~ 1 min to be produced
    - rc.report (summary info)

Data Processing (pipeline)

Data Flow – 1 hr of Cosmics single tower (1/2)

Data Taking | **Online Pipeline**

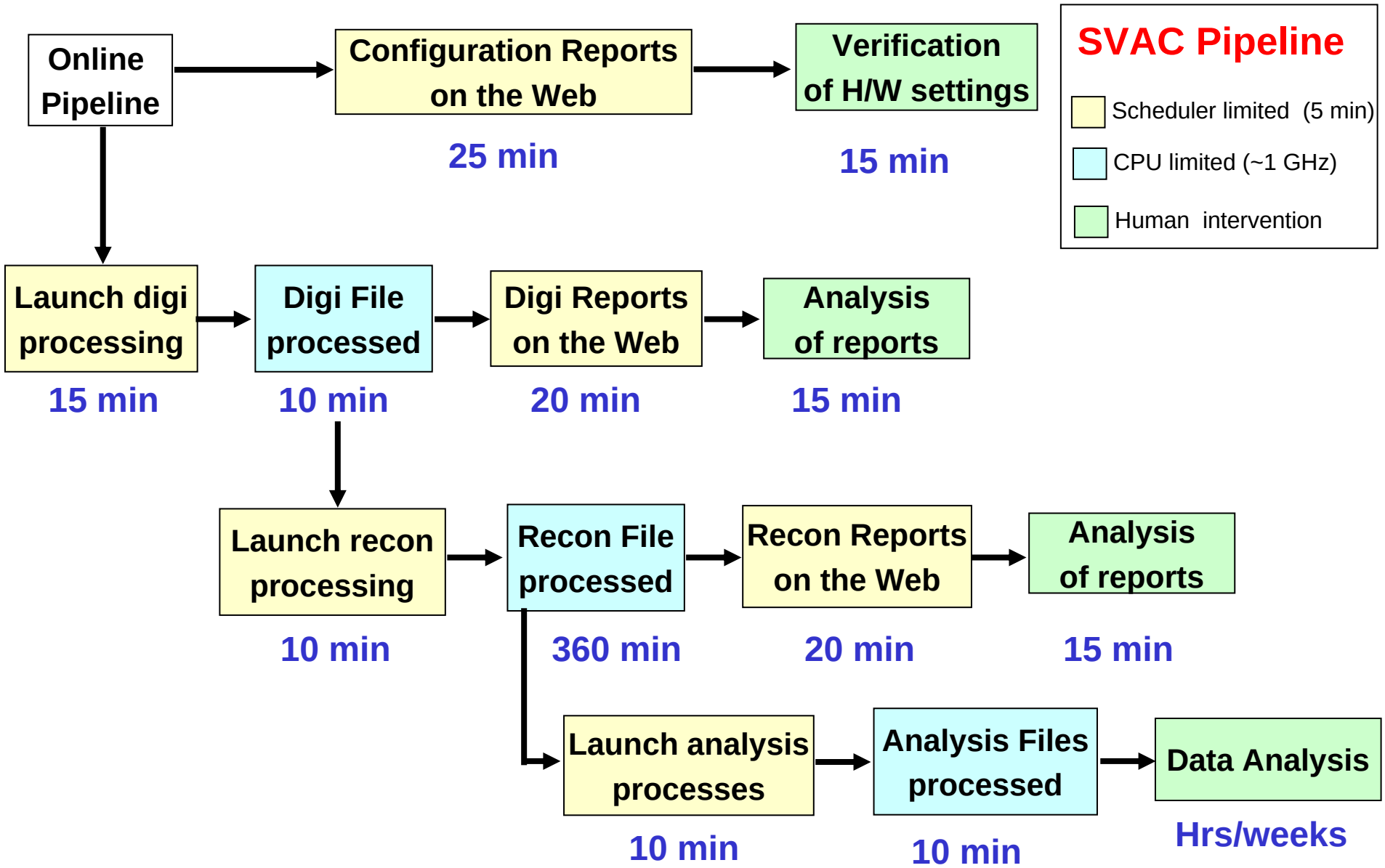
Record data → Transfer Data within Local PC → Data arrives In SLAC farm → SVAC pipeline is launched

1 hr | **20 min** | **5 min** | **10 min**

Internal problems are being fixed
Network speed is a 100 Mbits/s

Dominated by 5 min frequency within which the pipeline scheduler runs. SAS is working with SLAC computer Center on a solution to that

Data Flow – 1 hr of Cosmics single tower (1/2)



Pipeline Tasks

Rows indicate that processes are occurring at the same time

tasks	online	updateElogDb	digitization	configReport	recon	digiReport	svacTtuple	reconReport	Time (min)
1	cronjob								5
2	ldf2fits								10
3	injectSVAC								15
4		populate							20
5		LaunchDigi							25
6		LaunchConfRep	convert						30
7			LauchRecon	configTables					35
8			LauncReport	configReportUrl	recon				40
9			digiRootFile			genReport			45
10						digiReportUrl			50
11									hours
12					LaunchSVAC				+5
13					LaunchReport		svacTuple		+10
14					reconRootFile		svacRootFile	genReport	+15
15					meritRootFile			reconReportUrl	+20

Elapsed time should be reduced to seconds instead of minutes

SAS is working with SLAC Computer Center towards that goal

Data Taking Issues Related to Pipeline

- Wants to remain below 200 MB limit for LDF (digi) files because
  - Reconstructed file is 10 times larger than digitized one
  - Allow fast turn around in the results since the pipeline by has smaller jobs
  - Less of a burden on Collaborators outside SLAC to ftp files for data analysis at their local institutions

- One tower problem
  - Expected rate of 30 Hz
    - Record 100K events in 3600 seconds ~ 1 hour !
    - 100,000 events imply in about 100 MB (TKR)
      - One data file with 100K events will get reconstructed
        - » in about 18 hours for non-optimized code!
        - » in about 6 hours for optimized code!
- LAT problem
  - Expected rate of 300 Hz
    - Record 100K events in ~ 10 min !

Data Quality Monitoring

SVAC Reports

- The Quality Monitoring System
  - uses the pipeline to automatically generate reports
  - Reports are uploaded to the Web
  - We are adding more information an a per need basis

- Report format is designed for 16 towers (no ACD yet)

  - Configuration Reports (parsed from online files)
    - CAL FLE/FHE/LAC thresholds
    - TKR GTRC splits
    - Etc

  - Digitized and Reconstruction Reports (parsed from offline files)
    - Hit multiplicities
    - Number of crystals hit
    - Trigger bits set
    - Number of reconstructed tracks
    - etc

Run selection (1)

Shift Run Info - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address http://www-dev.slac.stanford.edu/cgi-wrap/eLog-test.pl/list Go Links

GLAST Shift Logbook
Shift Run Info

GLAST Home | Help | Shift Index | List Runs | Shift Schedule | Mate/DeMate

Run Range: 139000143 (e.g. 2500-2550 2567)

Date Range: taken from to (use format YYYY-MM-DD)'

Particle Type: Any

Instrument Type: Any

Orientation: Any

Completion status: Any

EBF FITS file: (e.g. *2805*)

TestName: (e.g. *TKRT*)

Duration (second) cut: (e.g. > 1000)

Number of event cut: (e.g. > 1000)

Additional query condistions:

list runs

Internet

Select a run

Run selection (2)

Shift Run Info - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www-dev.slac.stanford.edu/cgi-wrap/eLog-test.pl/list

GLAST Shift Logbook
Shift Run Info

GLAST Home | Help | Shift Index | List Runs | Shift Schedule | Mate/DeMate

Run Range: 139000143 (e.g. 2500-2550 2567)
Date Range: taken from to (use format YYYY-MM-DD)'
Particle Type: Any
Instrument Type: Any
Orientation: Any
Completion status: Any
EBF FITS file: (e.g. *2805*)
TestName: (e.g. *TKRTrg*)
Duration (second) cut: (e.g. > 1000)
Number of event cut: (e.g. > 1000)

Additional query condistions:

list runs

Run	TestReport	ConfigReport	Events	Duration (s)	Start (GMT)	End (GMT)	Status	Particle	Instrument	Orientati
139000143	TestReport	ConfigReport	14400	320	2004-06-29 17:39:31	2004-06-29 17:44:51	UNDEFINED	Cosmics	TKR EM	Vertical

Internet

Get run info produced by the online

Get digitization and reconstruction reports

Get register configuration info

Instrument Configuration (1)

Configuration for run 101 - Mozilla

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop http://www.slac.stanford.edu/~focke/ConfigTables.html Search Print

Home Bookmarks Google SLAC Seminars MapQuest Google Groups

Configuration for run 101

Created by ConfigTables version v1r0p0 from files:
snapshot: snap.xml
schema: junk

CAL register configuration

LAT globals

CAL Zero Supression is OFF.
CAL Four Range Readout is ON.

EM2 hardware (only 5 planes)

TKR GTRC Layer Readout Split Points

TKR GTRC Layer Readout Split Points (Left:Dead:Right)

Layer	Tower 2 X	Tower 2 Y	Tower 3 X	Tower 3 Y	Tower 4 X	Tower 4 Y	Tower 5 X	Tower 5 Y
5	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
4	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12
3	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12
2	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12	12:0:12
1	4:0:20	12:0:12	4:0:20	12:0:12	4:0:20	12:0:12	4:0:20	12:0:12
0	0:24:0	0:24:0	0:24:0	0:24:0	0:24:0	0:24:0	0:24:0	0:24:0

TKR GTRC Layer Readout Split Points (Left:Dead:Right)

Done

Instrument Configuration (2)

Configuration for run 101 - Mozilla

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop http://www.slac.stanford.edu/~focke/ConfigTables.html Search Print

Home Bookmarks Google SLAC Seminars MapQuest Google Groups

CAL Low Energy Trigger Discriminator (GTEM/GCCC/GCRC/GCFE/fle_dac:*)

CAL Low Energy Trigger Discriminator for Tower 2 side +X

layer	crystal											
	0	1	2	3	4	5	6	7	8	9	10	11
0	7	7	9	15	11	0	6	7	11	10	8	10
2	1	6	6	7	5	12	3	11	7	7	8	7
4	13	6	5	7	10	9	3	13	5	3	11	9
6	12	11	4	3	2	12	12	15	7	5	8	10

CAL Low Energy Trigger Discriminator for Tower 2 side +Y

layer	crystal											
	0	2	3	4	5	6	7	8	9	10	11	
1	2	0	0	2	2	0	2	1	0	2	0	
3	1	5	0	2	0	0	1	1	2	5	1	
5	0	0	0	3	5	1	4	0	0	0	0	
7	0	3	0	0	0	3	0	4	0	0	6	

CAL Low Energy Trigger Discriminator for Tower 2 side -X

layer	crystal											
	0	1	2	3	4	5	6	7	8	9	10	11
0	12	9	10	7	10	8	8	10	10	10	11	4
4	7	9	9	7	4	8	6	8	7	3	1	7
6	9	4	6	8	3	10	8	11	8	9	5	6

CAL Low Energy Trigger Discriminator for Tower 2 side -Y

layer	crystal											
	0	1	2	3	4	5	6	7	8	9	10	11
1	0	Absent	0	5	5	0	7	0	0	2	0	1
3	7	0	0	3	0	2	5	0	0	0	0	0
5	3	0	0	0	2	0	0	3	5	3	0	0
7	1	0	4	0	3	2	0	1	0	0	6	3

CAL Low Energy Trigger Discriminator for Tower 3 side +X

layer	crystal											
	0	1	2	3	4	5	6	7	8	9	10	11

CAL Low Energy Trigger Discriminator for Tower 3 side +Y

layer	crystal											
	0	1	2	3	4	5	6	7	8	9	10	11

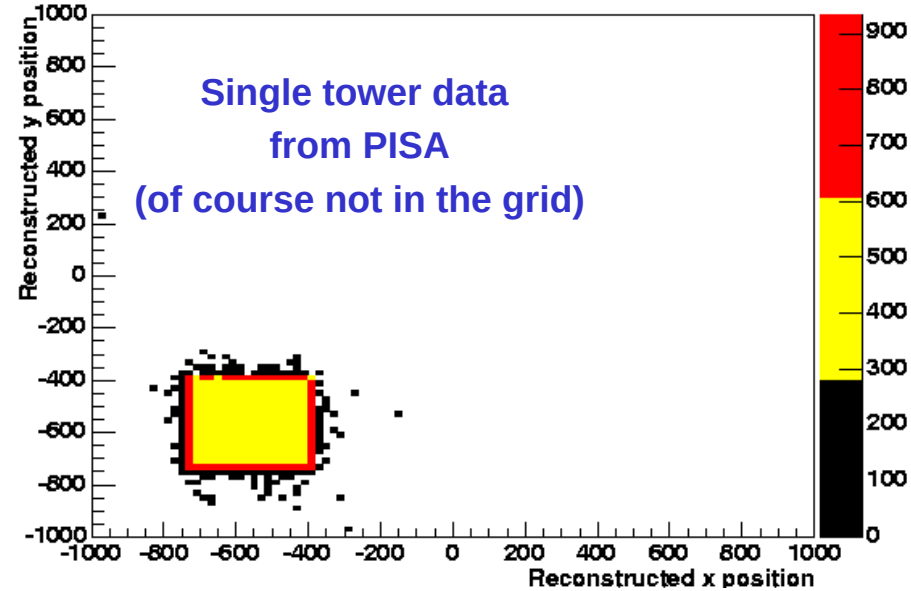
Done

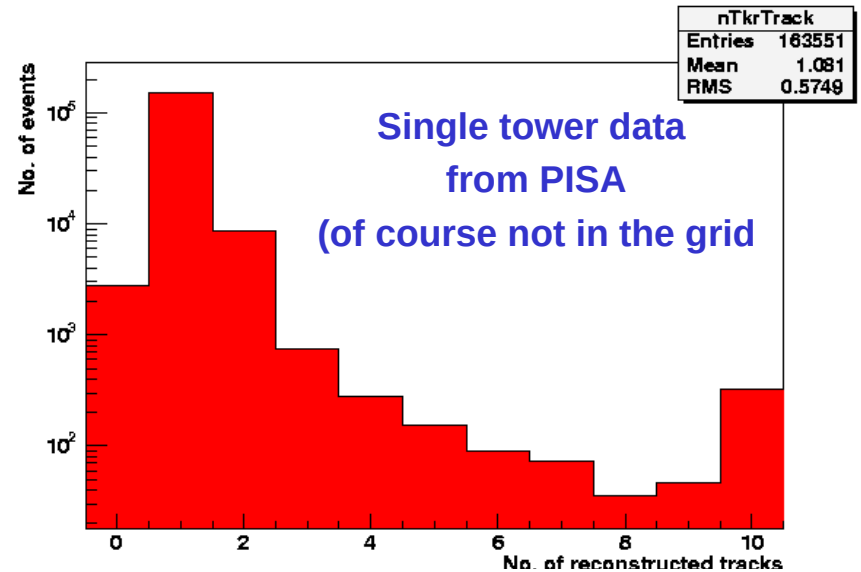
Code accommodates missing elements (just in case…)_

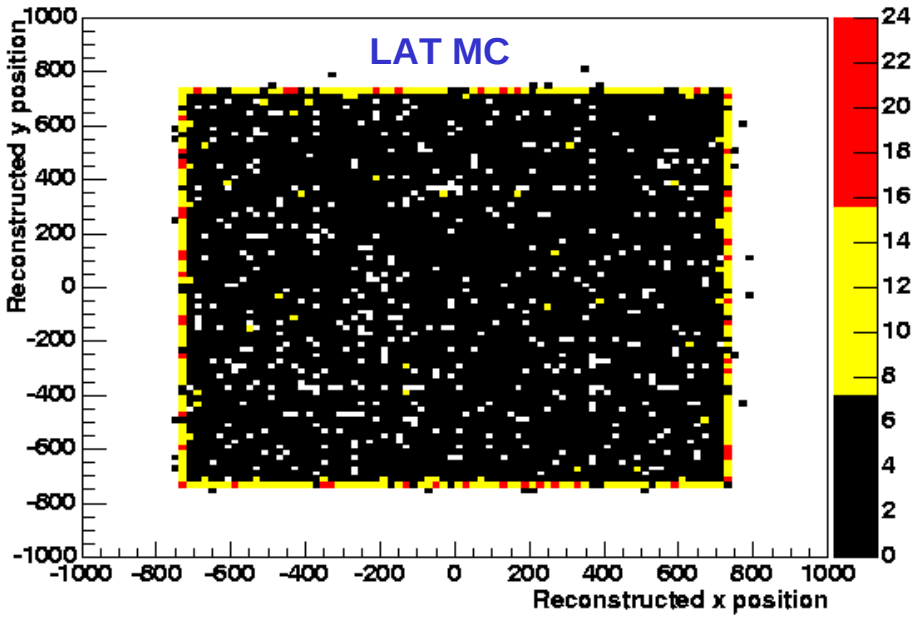
Retrieval of Large Number of Runs

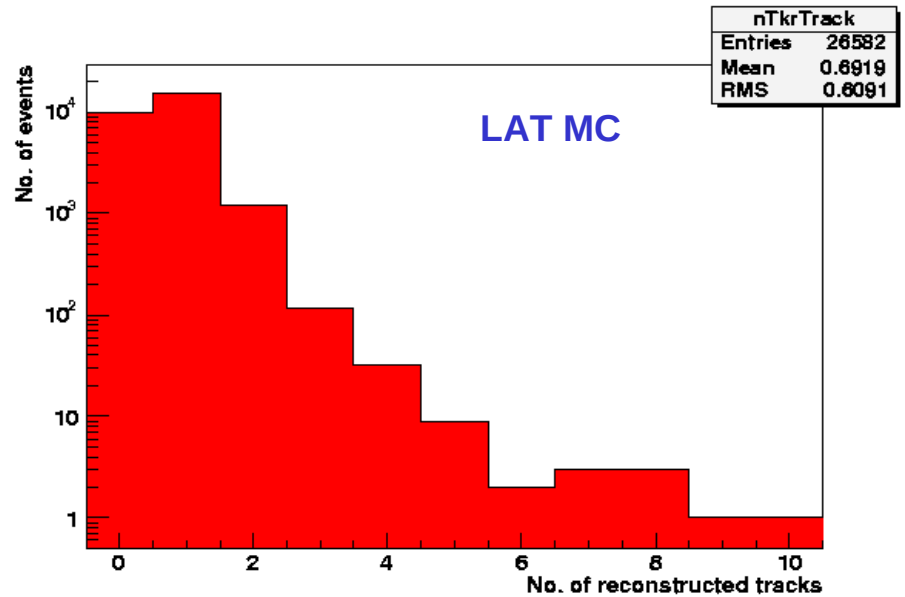
- For massive production needed for calibration all runs must be retrieved in a convenient format (application dependent)
- The infrastructure is in place and needs to be tailored to user needs

Data Quality – SVAC Reports









Calibrations

Calibration Requirements

- Calibration delivery shall include
  - Algorithms for calibrations
  - an executable that combines data from different runs
  - runs on the SLAC batch farm
  - reference datasets
  - Documentation describing usage and algorithm description
  - Metadata to address serial number and bay location in a grid

- SAS Calibration types are defined in the SVAC Plan LAT-MD-00446
  - TKR
    - Dead and Noisy strips
    - TOT Conversion Parameter (produced by EGSE scripts)
    - TOT MIP Conversion (in progress)
  - CAL
    - Pedestals
    - Gains (muon peaks)
    - Light asymmetry (muon slopes)

CAL calibration package is being rewritten.
Delivery scheduled for 1 month prior to begin of Integration

Calibrations

For Reference only

- Requirements
  - Perform calibrations involving offline analysis using SAS software
- Datasets
  - Particle Sources
    - Cosmic Rays and VDG photons
  - Data taking period
    - ~ 24 hours at nominal settings for partially populated LAT (e.g. 1 ad 2 towers)
    - ~ days at nominal settings for full LAT
  - Additional input information needed
    - From charge injection tests (e.g. TKR TOT Conversion parameter, CAL charge injection)
- Results
  - During initial phases of I&T will be manually generated
    - Automation may be possible but not for all types
  - will be used to generate calibrated reconstructed data files
- Timescale for Results
  - few hours (TBR) after completion of the data taking
    - Depends on turn arournd time of pipeline
    - Depends on complexity of calibrations
    - Experience will be developed throughout integration until final calibrations are performed when the LAT is assembled

Calibration Validation Procedure

TBW

Data Analysis

E2E Tests - Data Analysis

- Requirements
  - Support the analysis of the data from trigger and data flow tests for the LAT when is fully assembled as recommended by the End-to-end Committee report
- Datasets
  - Obtained using Cosmic Rays and VDG photons as particle sources
  - will be produced by changing configuration settings as defined in the End-to-End Committee Report and captured in LAT-MD-04136 (See Particle Test Peer Review)
- Results
  - Reports automatically generated at the end of the run
  - Reports contain tables and plots to identify *coarse* problems and establish that data is analyzable
  - Final acceptance and sign-off occurs at LAT level
- Timescale for Results
  - few hours (TBR) after completion of the data taking
    - Turn around is determined by the complexity of tasks
    - Preliminary verification will be performed for 1, 2 and 8 Towers (TBR) during LAT integration

E2E Tests - Comparisons with Baseline

- **Plot goes here**

DETAILED Analyses

For Reference only

- Requirements
  - Look for serious, and probably subtle, problems
    - Those which compromise the quality of the science data
  - Provide feedback to the LAT Integration team
    - (discussed later in this review)
- Datasets
  - particle sources
    - obtained using Cosmic Rays and VDG photons
- Results
  - Discussed on weekly basis
    - Instrument Analysis Group chaired by Eduardo
  - Reviewed biweekly
    - Analysis Group chaired by Steve Ritz
  - Final Report
    - 2 weeks after last data taking run from LAT integration
- Timescale for Results
  - 2 weeks (TBR) after completion of the data taking
  - Determined by time available between delivery of towers
  - On-going support through the Instrument Analysis Workshop Series

Monte Carlo Simulations

VDG Data Taking

1 Tower
(Single bay, special grid)

12	13	14	15
8	9	10	11
4	5	6	7
0	1	2	3

2 Towers

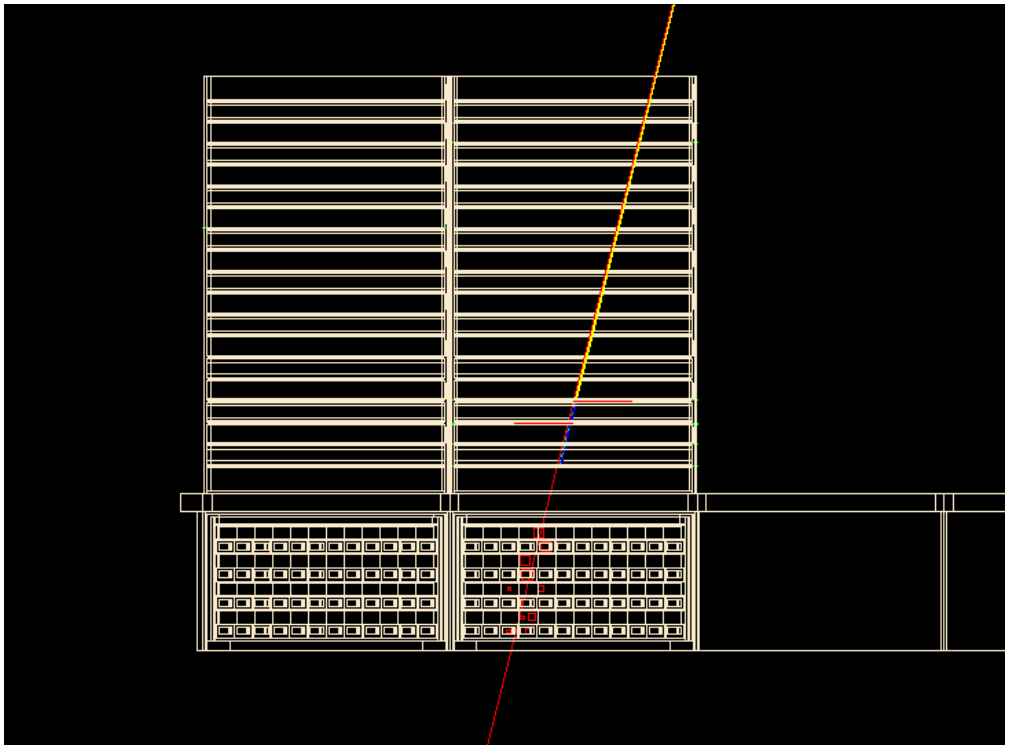
12	13	14	15
8	9	10	11
4	5	6	7
0	1	2	3

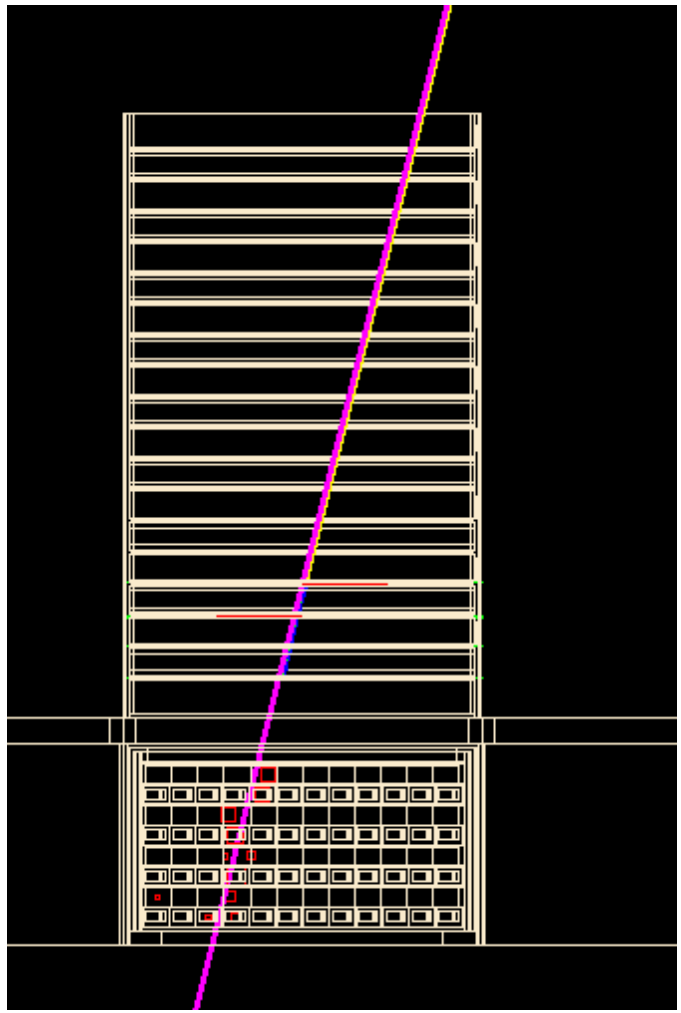
8 Towers

12	13	14	15
8	9	10	11
4	5	6	7
0	1	2	3

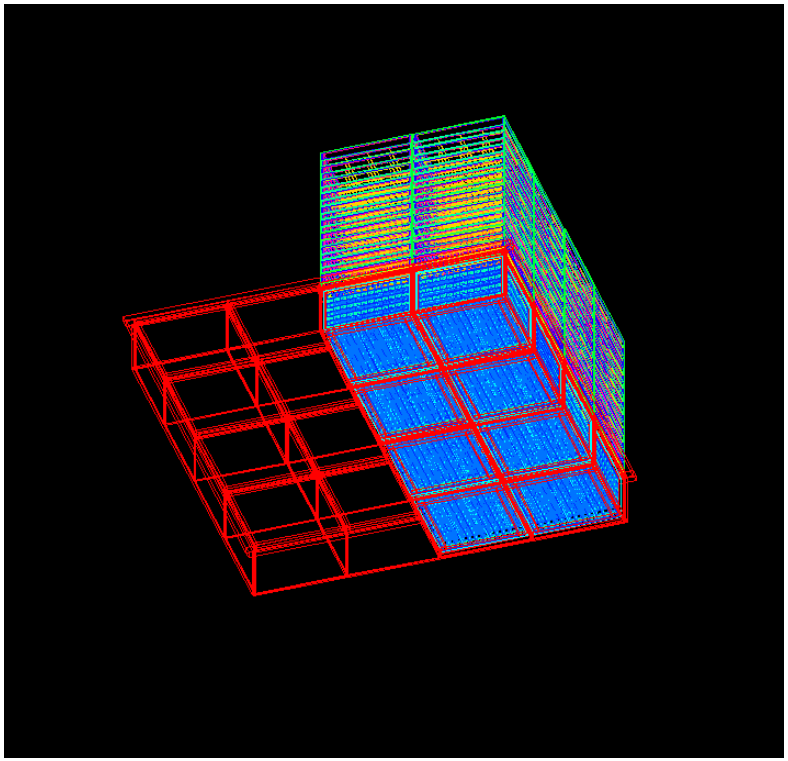
LAT

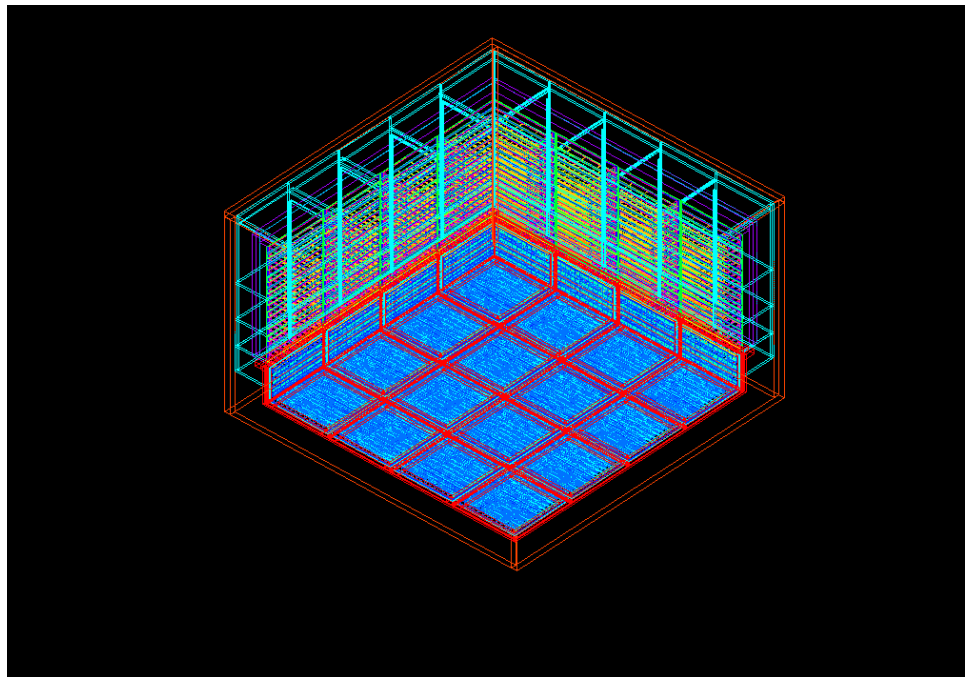
Examples with Monte Carlo Simulation (1)





Examples with Monte Carlo Simulation (2)





Wrapping it all up…

Work to do for 2 Towers

- Applicable to data taking from Cosmic Rays and VDG photons
  - Data Processing
    - Pipeline still being tailored to Integration needs
      - » Need to optimize throughput
      - » What else will we find out?
  - Monitor Data Quality
    - Get calibrated DAC settings as part of configuration reports
    - Allow a broader set of query options in the database
  - Calibrations
    - Test final scripts after delivery
    - Correlate calibration constants with housekeeping
    - Develop infrastructure for LAT calibrations (several runs)
  - Data Analysis
    - Develop cuts for E2E tests
    - Develop analysis procedures (need data)
  - Other
    - Revisit manpower plan after data taking

Areas of Concern (or Risks)

- Data Processing
  - Not sufficient testing time with pipeline
- Calibrations
  - Not sufficient time to debug infrastructure for calibration code, especially
    - correlations with metadata and housekeeping
    - Validation procedure
- Data Analysis
  - Contributed manpower is mostly of 50% FTEs
  - Need 1 or 2 full time people added to the team

Summary

- If tower delivery occurs on Dec 22
  - we will be ready to start
    - Data Processing
    - Data Quality Monitoring
    - Calibrations
    - Data analysis
- May not be so smooth because of
  - Lack of sufficient debugging time for the new tools
    - e.g. pipeline
  - Lack of sufficient testing time with real hardware
    - e.g. data analysis for E2E tests (two towers only)

SVAC tests – Single Tower in EM bay (1/2)

- Data taking runs with
  - muon telescope and the TEM diagnostics enabled
  - ~ 30 Hz
- 2 hours of cosmic rays (~ 200,000 events)
  - with the nominal flight settings at vertical orientation
    - 170 bytes/event so 38 MBytes
  - with the GND μ settings at vertical orientation
    - 270 bytes/event so 58 MBytes
- 1 hour of cosmic rays (~ 100,000 events)
  - GND μ settings with TEM diagnostics ON at vertical orientation
    - 320 bytes/event so 68 MBytes
  - GND μ settings with zero suppression off at vertical orientation
    - 1700 bytes/event so 186 MBytes
  - GND μ settings at horizontal orientation with VDG OFF
    - 270 bytes/event so 58 MBytes
  - GND μ setings at horizontal orientation with VDG ON
    - 270 bytes/event so 58 MBytes

Data Flow Overview

10 + 15 + 10 + 5 + 5 = 55 min

Offline pipeline digi

Analysis

1 hr

5 min

110 MB

Record data

Online pipeline

360 + 60 = 420 min

70 MB

70 MB

Offline pipeline recon

Analysis

1100 MB