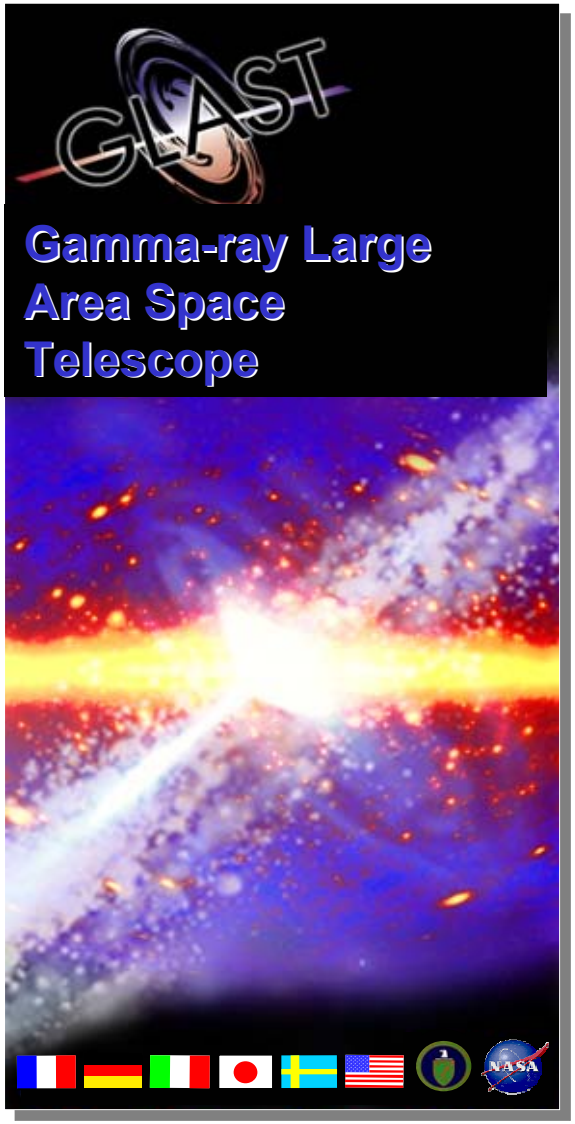

GLAST Large Area Telescope:

Integration and Test
EM Plans

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Background

- **The first minitower was tested at ~ 50% level during 5 weeks. The many problems found have mostly been solved or are underway to solution (for list of problems see June 10 presentation from Ric and Eduardo)**

- **The August minitower test is under a tight schedule**
  - **We have 2 weeks to study CAL prior to TKR arrival. Since I&T never worked with the EM CAL before, there will probably be some script migration needed.**
  - **I&T and FSW only has ~6 weeks to study the integrated system.**
  - **Not really enough time to go into the depth of study needed.**

Objectives of I&T EM Program

- Enhance the probability of success for Flight Integration
- The main objectives are
  - Receive the CAL EM, TEM EM , TEMPS EM , and TRK mini-tower EM using ADTP prototype.
  - Assemble the EM mini-tower as an integrated system.
  - Functionally test the EM Integrated Hardware using subsystem test scripts.
  - Mechanical fit check – 1x4 grid, TKR Mechanical EM, CAL EM.
  - Perform EM calibrations using pulser data, Cosmic ray muons, and Van de Graaff data.
  - Validate the experimental set-up for Data Taking and the analysis chain (includes online and offline).
  - Test Integrated tower Trigger.
  - Test Flight Software [FSW].
  - Evaluate I&T procedures and interfaces.
    - EGSE validation
    - MGSE validation

Functional Test - Goals

- Test prototype of the Acceptance Data Package
  - Are we on track for the Flight Model Integration?
- Functionally test the EM Integrated Hardware
  - Determine the operational thresholds of TKR and CAL
  - Determine the operational characteristics of the Front End calibration circuitry and the impact (if any) on data taking
  - Determine timing properties of TKR and CAL
    - separately and as an integrated system
    - with and without the calibration strobe
  - Measure deadtime of the integrated EM
  - Check that TKR and CAL and TEM play well together.
  - Check triggering in various modes including redundancy.
- Determine impacts due to any non-conformances that may exist
  - Electronics boards (including GTFE, GTRC, GCFE, GCRC)
  - TEM and DAQ electronics modules
  - MGSE

Draft Acceptance Data Test Package

- Required in LAT- MD-00408 – LAT Program Instrument Performance Verification Plan.
- LAT – MD – 01312; LAT Test Plan Directive
- Supporting Documents
  - LAT – DS – 01502; CAL Subsystem Test Descriptions.
  - LAT – PS – 02232; Users Guide to CAL Comprehensive and Limited Functional Testing.
  - LAT – TD – 00191; GLAST LAT Tracker Tower Electrical Test Plan.
  - LAT – TD – XXXX; Users Guide to Tracker Comprehensive and Limited Functional Testing.
  - LAT – TD – 01112; ACD Functional Test Plans.
  - LAT – TD – XXXX; Users Guide to ACD Comprehensive and Limited Functional Testing.
  - LAT – TD – 00786; LAT Flight Software Test Plan.
  - LAT – TD – XXXX; Users Guide to FSW Comprehensive and Limited Functional Testing.
  - LAT – DS – 1645; LAT TEM Test Procedure.
  - LAT – TD – 1652; LAT TEM Power Supply Test Procedure.
  - LAT – TD – XXXX; LAT Global Electronics Test Plan.
  - LAT – TD – XXXX; Users Guide to Electronics Comprehensive and Limited Functional Testing.
  - LAT – TD – XXXX; LAT GRID/X-LAT PLATE/RADIATOR Test Plan.
  - LAT – TD – XXXX; Users Guide to GRID/X-LAT PLATE/RADIATOR Comprehensive and Limited Functional Testing.

ADTP (continued)

Acceptance Test Data Summary Package

This package is delivered to I,T&C, Systems Engineering and the LAT Data Center with delivery of all flight units. It provides the information necessary to integrate the unit into the next higher level of assembly.

The package will contain:

- Identification
  - o Unit identification (as built drawing set /part numbers for all parts with revision level-mechanical, electrical, software).
  - o Unit serial number.
  - o Date and time of release for delivery from subsystem.
  - o Responsible subsystem engineer approval.
  - o Subsystem Quality assurance certification.
- Mechanical Summary Data for subsystem module.
  - o Mass
  - o CG
  - o Dimensions
  - o Interface features – flatness, hole sizes, placement, installation orientation, surface finish.

ADTP (continued)

- Electrical Summary Data
  - o Power consumption (steady state, minimum @ idle, maximum @ peak)
  - o Start-up voltage profile
  - o Start-up current profile
- Power Noise Measurement
  - o Steady state
  - o Minimum power
  - o Maximum power
- Unit Performance Data.
  - o Environmental test results summary.
  - o Functional performance tests summary (criteria for pass/fail are clearly indicated), including housekeeping data, and Scripts that run these tests on I&T EGSE (using TEM and TEM PS configured in standard mode). All Electronic Data Delivered in FITS Format.

    - CAL: Register functionality, Pedestals, Tack delays, Electronic Gain, Non-linearity, Electronic Noise, Noisy Channel Lists, Trigger Discriminator Settings, Zero Suppression Settings, Range Settings, Dead Channel Lists.

ADTP (continued)

  - TKR: SSD bias currents, Register Functionality, ASIC Reset, Channel Occupancy, Thresholds, Dead Channel and Chip lists, TOT Measurements, Gain and Noise, Tack Delay, Trigger Time Walk, Trigger Noise Occupancy, Muon data – efficiency, resolution and alignment, Readout Rate capability.
  - TEM: Common controller communication test, configuration register test, data masking register test, status register test, command response statistics register test, TKR trigger sequencing register test, CAL trigger sequencing register test, address register test.
  - TEM PS: CAL voltage tests, TKR voltage tests, control inputs tests.

o Calibration Data (Delivered in proper format – see slide 14,15)

  - CAL: Light Asymmetry, Light Attenuation, Light Yield.
  - TKR: Time-Over-Threshold Count Distribution.

• Subsystem Electrical Test Execution Information

o Hi-Pot tests

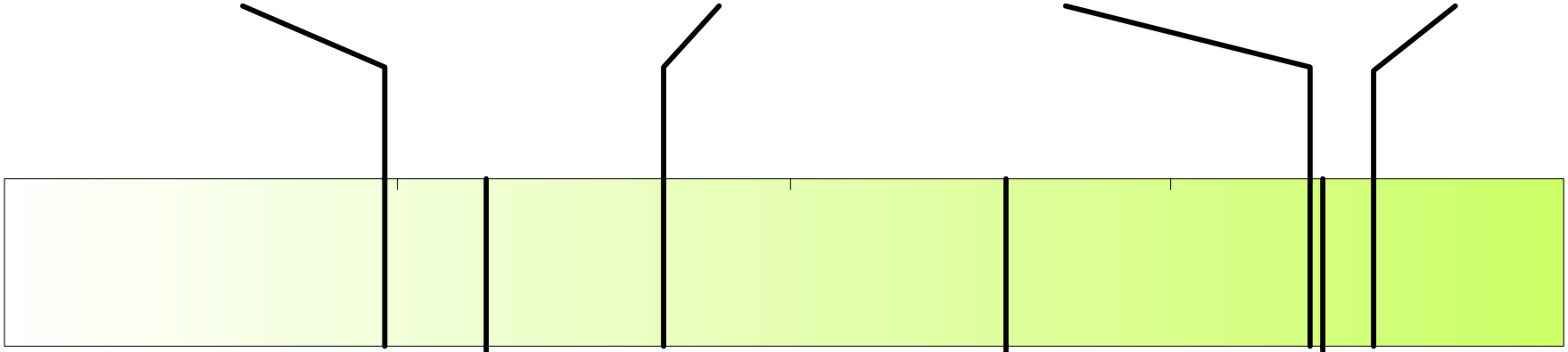
o Isolation tests

o Insulation resistance tests

ADTP (continued)

- Unit Support Data
  - o Connector designations and pinout assignments.
  - o Telemetry conversion curves (i.e. accelerometers thermistors, voltage range, etc.)
  - o Software version report
  - o Hardware installation record
  - o Mate/de-mate log
  - o On-time log with operational hours
  - o Limited lifetime items (e.g., connector cycle life)
- Quality Assurance Data
  - o Non-conformance report summary
  - o Inspection records
  - o Storage, handling, shock records
  - o Other material information as required.

EM Testing Timeline



7/31/03
EM Plan, Procedures, EGSE and MGSE Complete

8/8/03
Receive CAL EM

8/22/03
Receive TKR Mini-tower

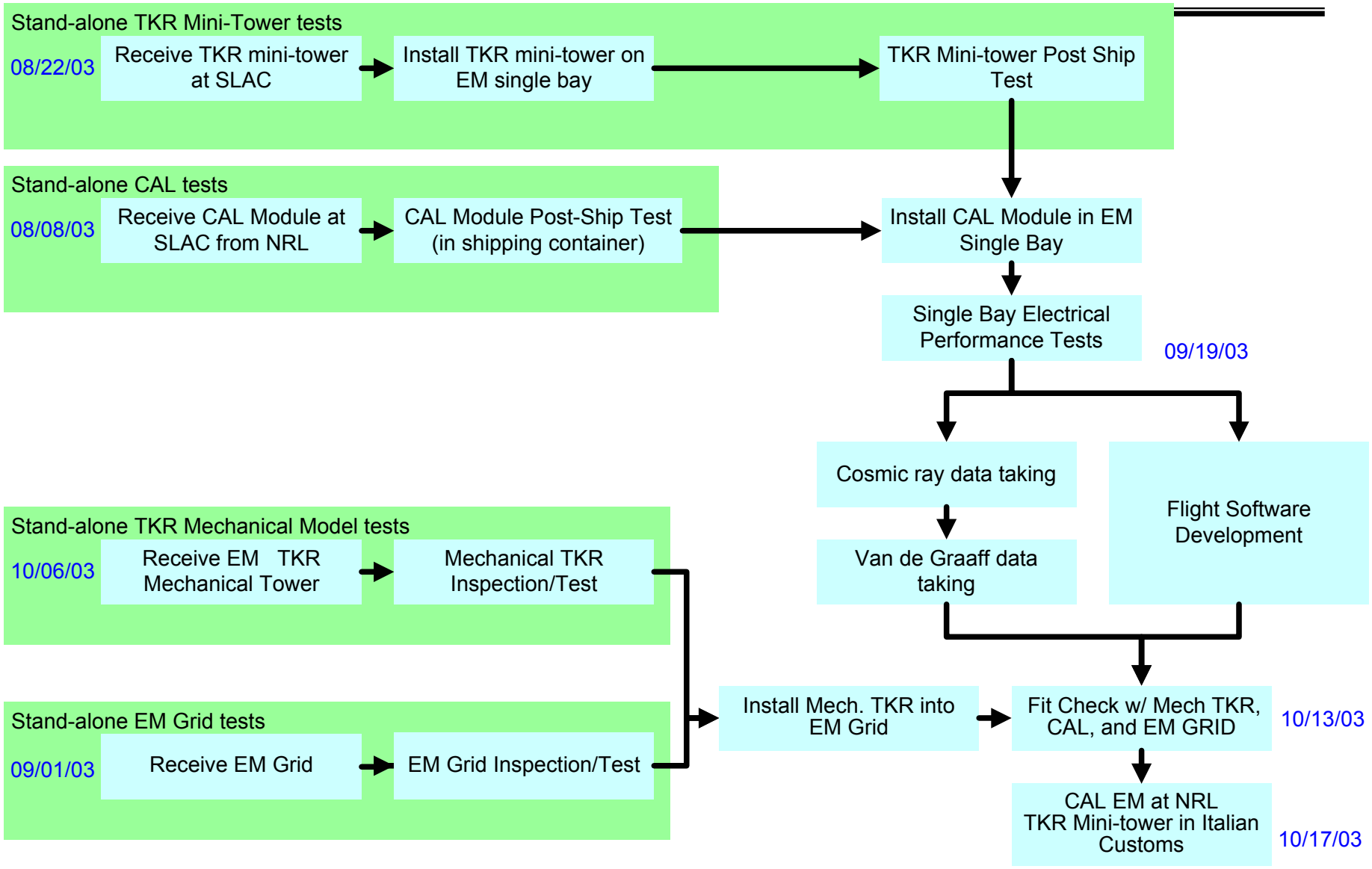
9/18/03
EM Tower Functional Tests Complete
EM Tower Available for use by Flight Software

10/12/03
EM Calibration Complete

10/13/03
EM mechanical fit check using 1X4 Grid, TKR Mech tower, CAL

10/17/03
CAL EM at NRL Loading Dock, TKR mini-tower in Italian Customs

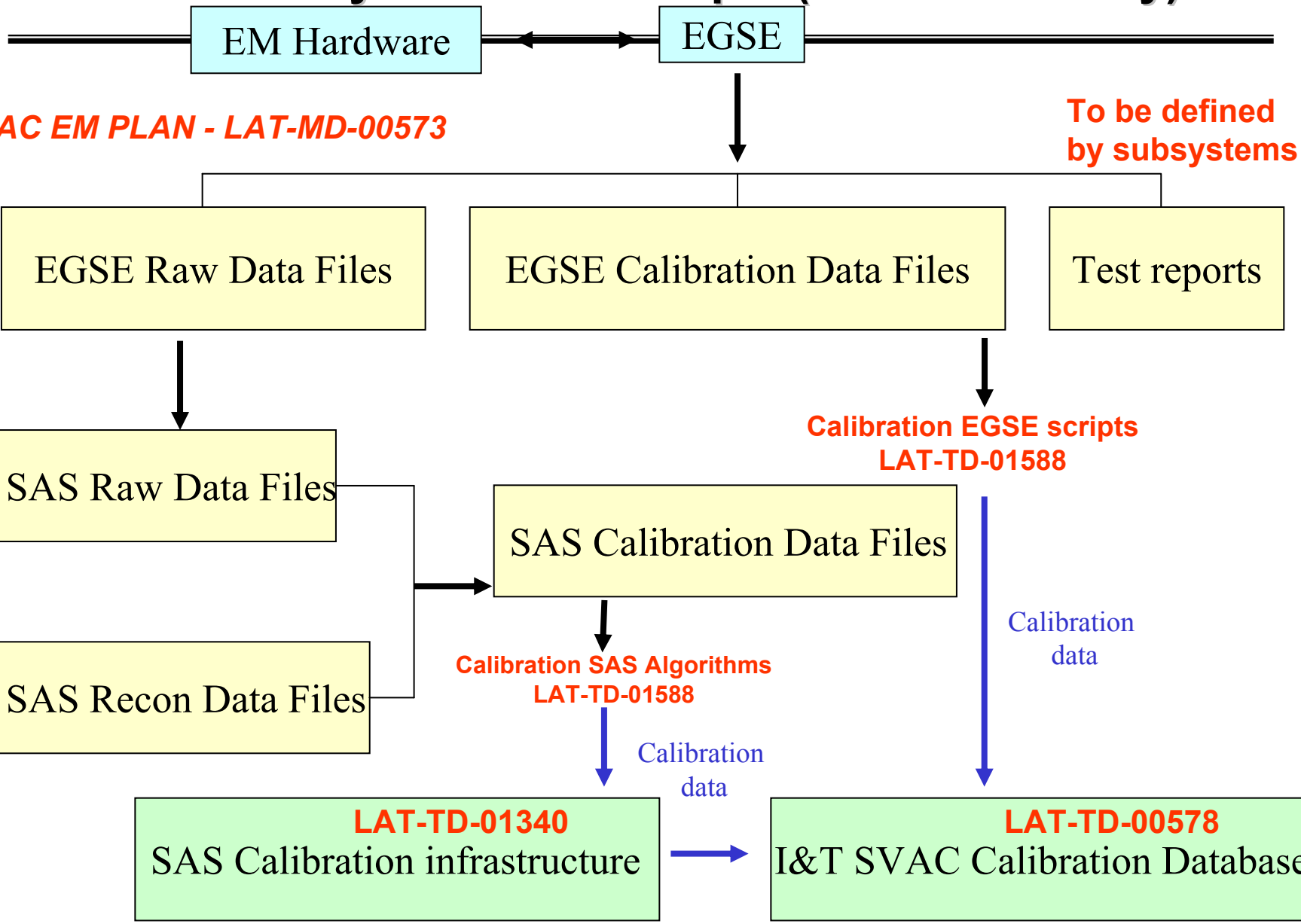
EM Test Flow


Stand-alone TKR Mini-Tower tests
08/22/03
Receive TKR mini-tower at SLAC
Install TKR mini-tower on EM single bay
TKR Mini-tower Post Ship Test
Stand-alone CAL tests
08/08/03
Receive CAL Module at SLAC from NRL
CAL Module Post-Ship Test (in shipping container)
Install CAL Module in EM Single Bay
Single Bay Electrical Performance Tests
09/19/03
Cosmic ray data taking
Van de Graaff data taking
Flight Software Development
Stand-alone TKR Mechanical Model tests
10/06/03
Receive EM TKR Mechanical Tower
Mechanical TKR Inspection/Test
Stand-alone EM Grid tests
09/01/03
Receive EM Grid
EM Grid Inspection/Test
Install Mech. TKR into EM Grid
Fit Check w/ Mech TKR, CAL, and EM GRID
10/13/03
CAL EM at NRL
TKR Mini-tower in Italian Customs
10/17/03

Calibrations - Goals

- **Perform EM calibrations *(SVAC EM Plan LAT-TD-00573)* , compare with reference data from subsystems and test SAS infrastructure.**
  - **TKR**
    - **C10 - TKR Noisy Channels**
    - **C11 - TKR Dead Channels**
    - **C12 - TKR Time-Over-Threshold Signal**
    - **C13 - TKR Time-Over-Threshold Count Distribution**
    - **C29 - TKR Threshold Scan**
  - **CAL**
    - **C14 - CAL Light Asymmetry**
    - **C15 - CAL Light Attenuation**
    - **C16 - CAL Light Yield**
    - **C18 - CAL Pedestals**
    - **C19 - CAL Electronic Gain**
    - **C20 - CAL Integral non-linearity**
    - **C22 - TKR Noisy Channels**
    - **C23 - TKR Dead Channels**
    - **C24 - CAL LO Discriminator**
    - **C25 - CAL HI Discriminator**
    - **C27 - CAL Zero-Suppress Threshold**

Data Analysis – EM Example (calibration only)



Calibration infrastructure

- We have a written agreement with SAS that ACD,CAL and TKR subsystems will provide calibration algorithms and corresponding documentation via SAS.
- We have a written agreement with SAS that a calibration infrastructure will be provided to allow automated data retrieval for storage into the SVAC database
- We have a verbal agreement with subsystems that we jointly determine the output format of the calibration data produced by the EGSE so that it can be loaded into the SVAC database. For data that can be obtained via SAS or EGSE we prefer the format to be the same. This is used as an input to *LAT-TD-00578 – "SVAC EM Calibration Database".*

Example of Output Format - CAL

Address http://www-glast.slac.stanford.edu/IntegrationTest/SVAC/meetings/c18em.htm Go

Calibration: CAL Pedestals

ID: C18 in LAT-MD-00446-04

Description: Pedestals correspond to an ADC output for zero input to front-end electronics (FEE). There is a pedestal value per energy range of each crystal face. Each pedestal is characterized by a centroid and a width of a distribution of a given (TBD) number of triggers. Since there are two diodes in each of the two crystal faces, we will have eight pedestal distributions per crystal. A combination of Tower, Column and Layer uniquely identifies a crystal, so crystal numbers vary from 0 to 95 and should also be present in the database.

Software required: SAS

Algorithm: To be Written by CAL.

Output data format:

Temporary format

	Tower	Column	Layer	Face	Range	ADC value	
						Ped	Width
	0	0-11	0-7	0-1	0-3	0-1000	0-100
Type	int	Int	Int	int	Int	float	float

Output ASCII file: To be written by CAL

Root Macro: To be written by CAL

Python script: To be written by CAL

Example of output distributions: To be written by CAL

Notes:

Table is needed for the SVAC database (would like to use the same format for online and offline)

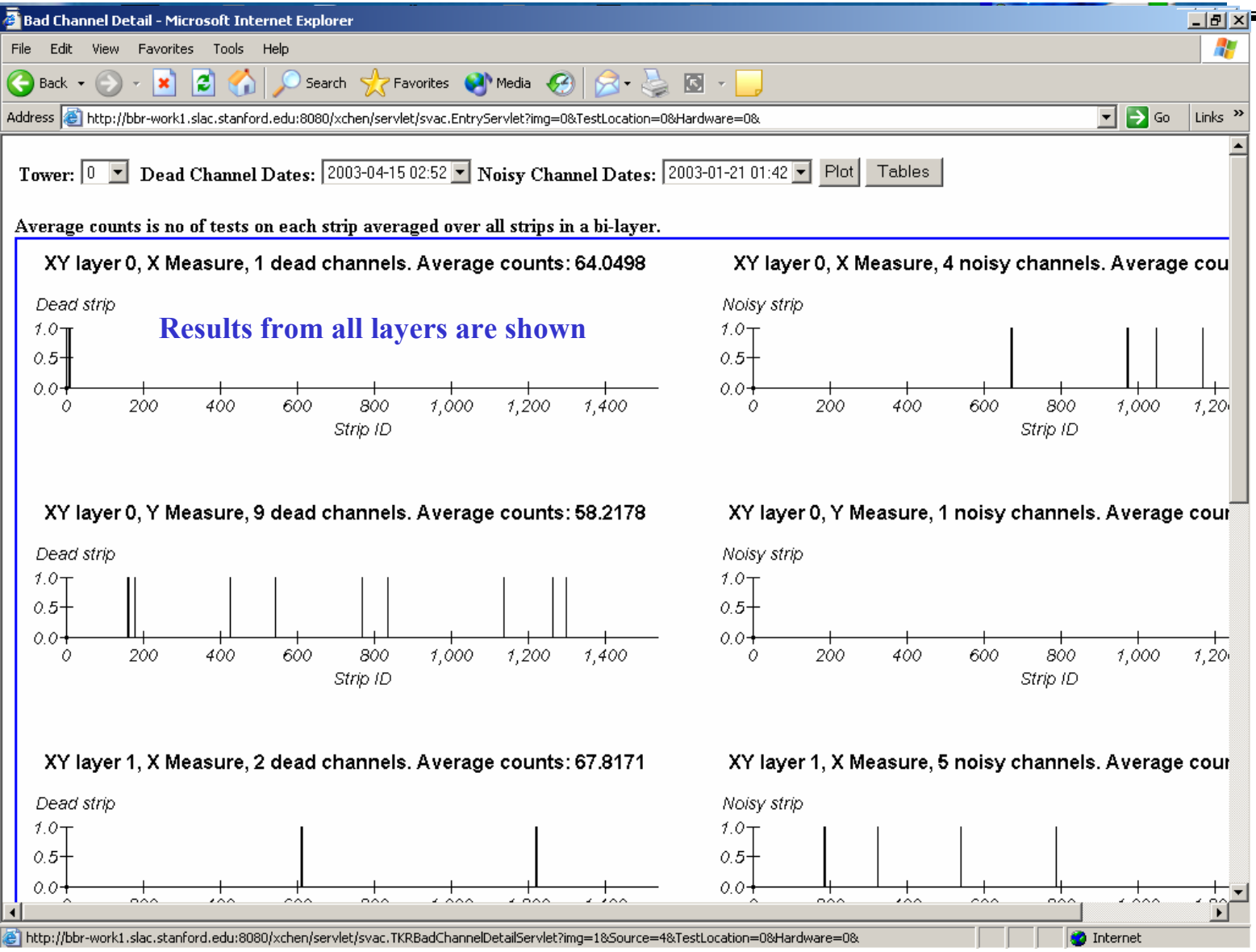
CAL has already delivered but I&T needs to update the web page

Level IV Technical Documents – Contents

Using Engineering Model as an example

- **Test Plan/Results**
  - **LAT-MD-00573 – SVAC EM Plan**
    - Describes the hardware data taking configurations, infrastructure needed for calibrations, calibration types, data analysis requirements. Run time estimation using MC simulation
  - **LAT-MD-01593 – SVAC Results from the Engineering Model Test**
    - Describes the results and how requirements were met
- **Calibrations**
  - **LAT-TD-01588 – Calibration Algorithms for the Engineering Model**
    - Describes the calibration algorithms developed in conjunction with SAS and subsystems
- **Simulations**
  - **LAT-TD-00582 – EM Geometry for the Monte Carlo Simulation**
    - Describes the geometry used in the simulation, includes table to translate nomenclature from software developers to engineers and also contains traceability
- **Database**
  - **LAT-TD-00578 – SVAC Database for the Engineering Model**
    - Describes the table schema and how a web based engine will allow access to a subset of calibration data for the purpose of tracking changes in time.
- **Interfaces**
  - **LAT-TD-00571 – SVAC/SAS Interface Control Document**
    - Describes the responsibilities between SAS and SVAC for data analysis (Statement of work)
  - **LAT-TD-01340 – SAS Calibration Infrastructure**
    - Describes SAS calibration infrastructure that hold the primary calibration data

SVAC Database - ORACLE



Experimental Set-up for Data Taking - Goals

- Random triggers
  - Use pulse generator to evaluate system noise level
- Cosmic Rays
  - Use muon telescope set-up (includes Pb shield) to filter low energy muons
  - Measure EM trigger rates
    - With both horizontal and vertical positions
    - As a function of detector thresholds
    - As a function of detector voltages?
  - Measure the position resolution from cosmic rays in the CAL using tracks from TKR (dominates the data taking time)
- van de Graaff (VDG) source
  - Measure EM trigger rates with
    - TKR trigger only
    - CAL trigger only (may need to lower it to 4 MeV/crystal)
  - Measure Energy Spectrum
    - using the array of BGO crystals
    - using the EM CAL (may need to lower it to 4 MeV/crystal)