



GLM Post Launch Test Readiness

GOES-R Science Workshop

18 November 2016

Presented by:

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NOAA/NESDIS/STAR

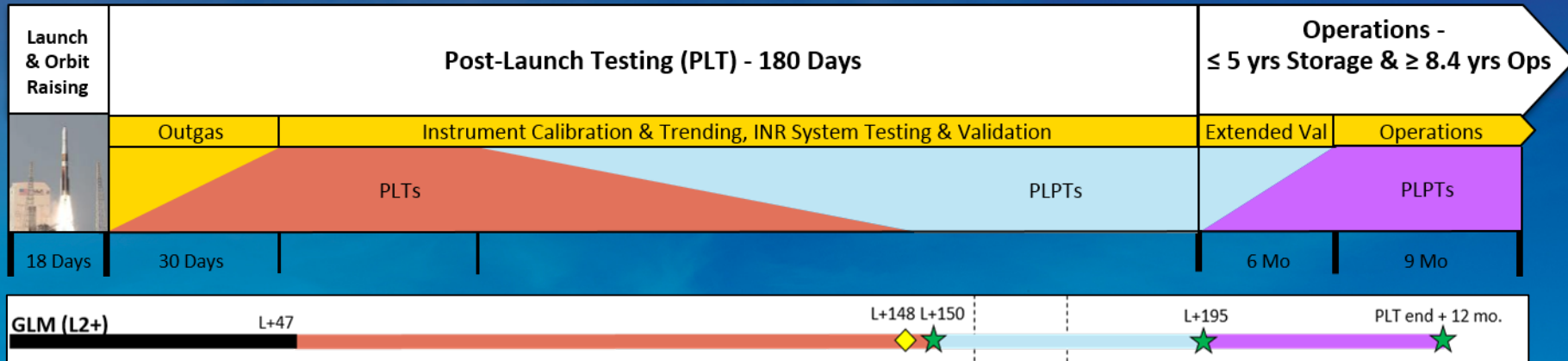
Contributions from the GLM Calibration Working
Group and the Lockheed Martin GLM Team



PLT and PLPT Schedule

Presentation Topics

1. GLM PLT – Vendor Plans and Tools
2. GLM L2 PLPT – Science Team Plans and Tools



LEGEND

- Science Products Not Flowing
- Internal product flow begins
- Post-Launch Testing (PLT) / Beta testing
- Beta Validated Products
- External product flow begins
- Post-Launch Product Testing (PLPT) / Provisional testing
- Provisionally Validated Products
- Extended Validation / Full validation testing
- Fully Validated Products
- First public imagery media outreach (Yellow Diamond)
- PS-PVR (Green Star)
- One-day data blackout due to a COOP test (Red Circle)

Current as of November 13, 2016
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Note: All dates are coordinated with Flight/MOST PLT SOE group and are subject to change.

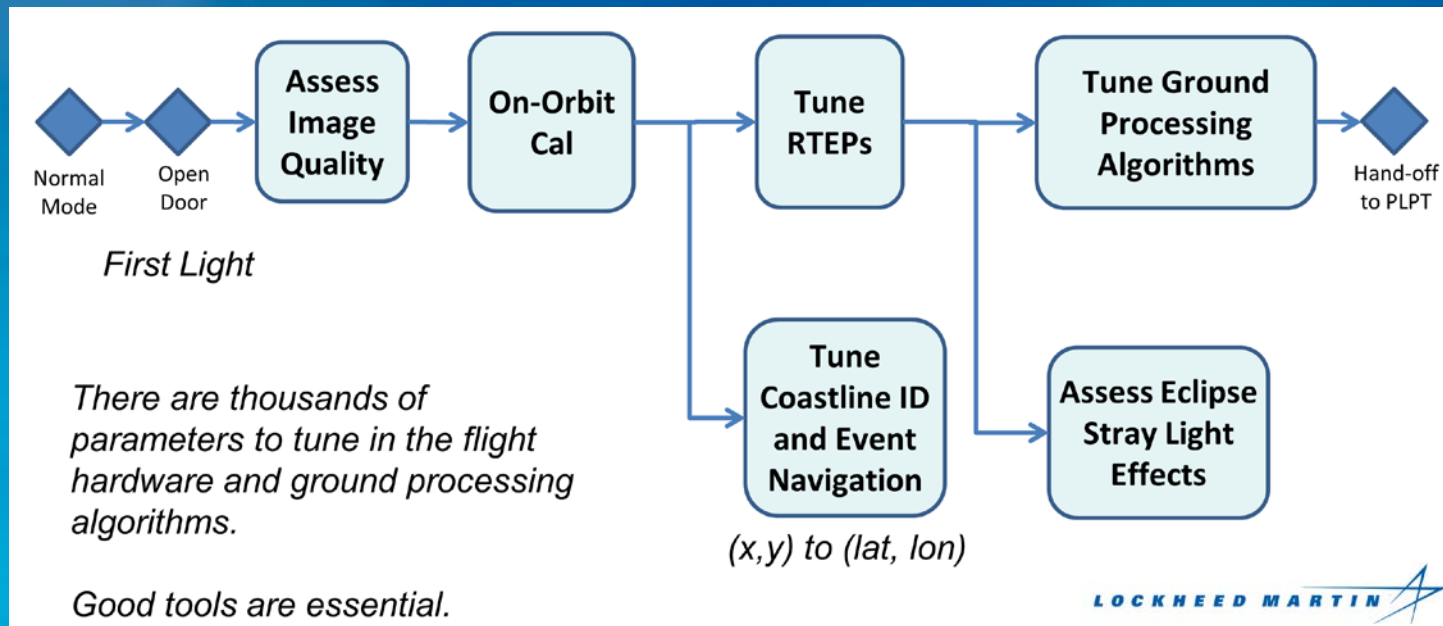
GLM PLT Vendor Plan

➤ Image Quality

- GLM periodically collects a “snapshot” of the average background radiance
- Matlab PLT tool is used to extract image metrics

➤ On-Orbit Calibration

- GLM flight software contains a macro that can “turn knobs” for the on-board camera timing, without ground commanding



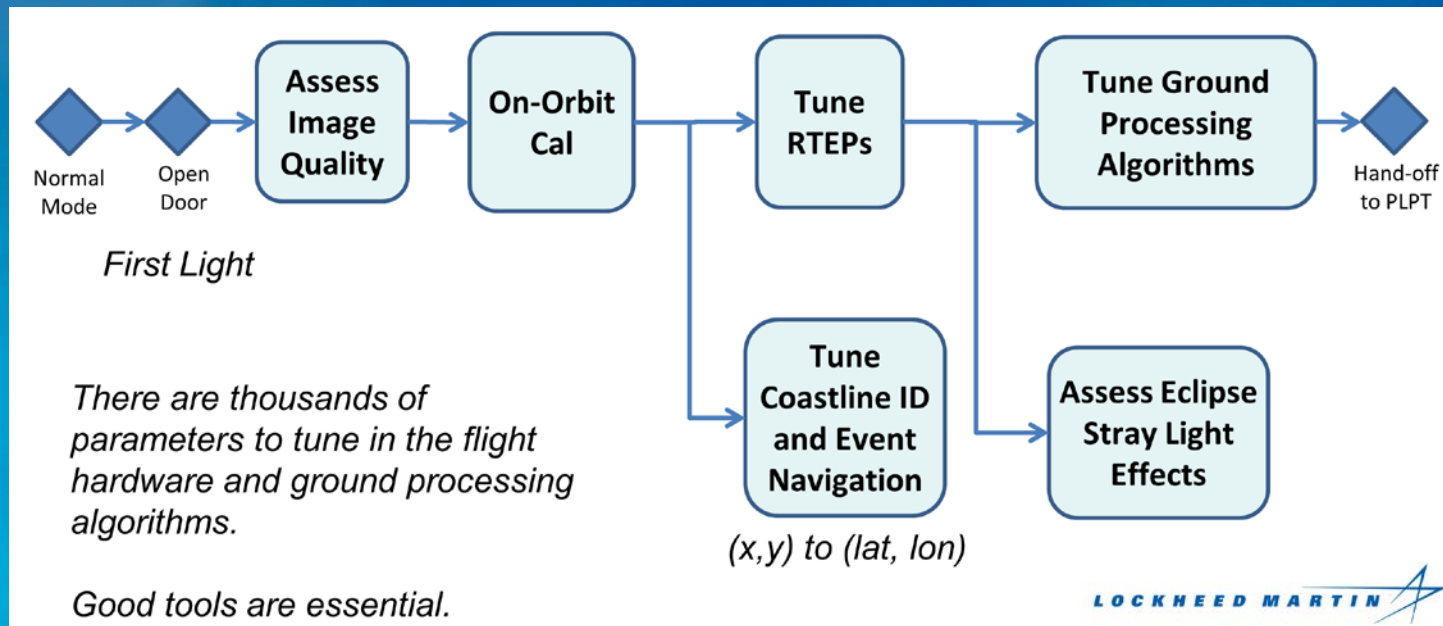
GLM PLT Vendor Plan

➤ RTEP Detection Thresholds

- Identifies any positive change in the pixel value that exceeds a programmable detection threshold. RTEP must be tuned carefully!

➤ Coastline ID and Navigation

- Coastline ID is a ground image processing algorithm applied to daytime background images from GLM that identifies coastlines to translate (x, y) to $(\text{longitude}, \text{latitude})$ for L1b lightning data



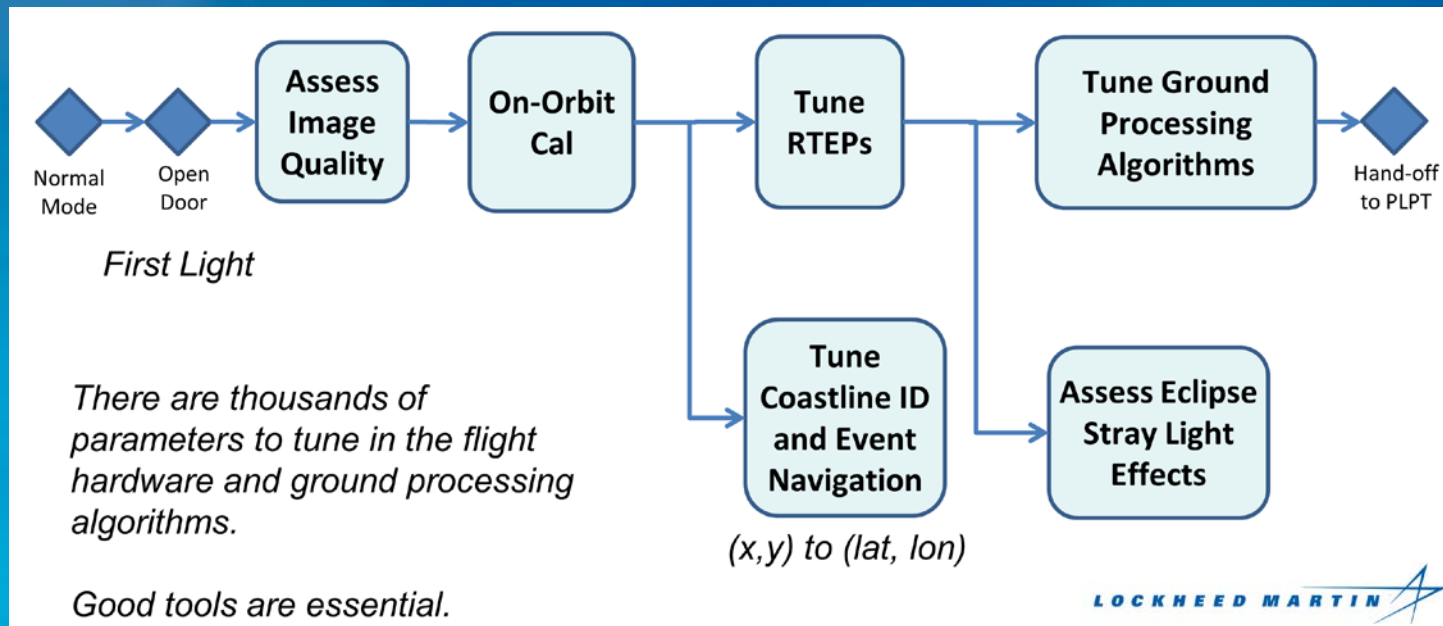
GLM PLT Vendor Plan

➤ GPA Filter Tuning

- PLT is performed in Palo Alto on GLM vendor's GPA implementation
- Matlab PLT tool for slicing and displaying event data in time and space

➤ Solar Intrusion Assessment

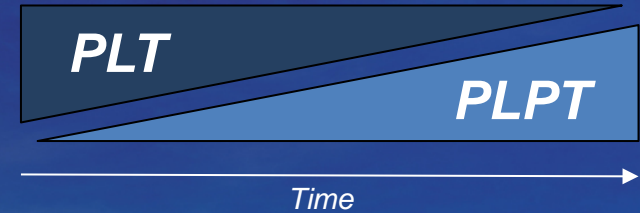
- During eclipse season, direct solar illumination enters the GLM optics and reaches almost all the way to the focal plane (results in ZRDQ)





Transition from PLT to PLPT

- PLT Outputs and PLPT Handoff
 - The output of PLT is a GLM calibration parameter file
 - PLT may result in algorithm changes, or new algorithms
 - In practice, PLPT will overlap with PLT
- Some instrument-related PLTs must be completed prior to detection efficiency (DE) and False Alarm Rate (FAR) related PLPTs
- Flexibility is required so that RTEP thresholds can be tentatively set, the DE/FAR tested using PLPT tools, then re-setting the RTEP thresholds accordingly
- This back-and-forth “tuning process” is vital for thoroughly optimizing the GLM
- All PLPTs are ready for activation – Details to follow (also available in the GLM RIMP)



```
HDF5_GLM_FM1.h5
GLM_CalibrationParameters
|-- EventFilters
|   |-- 2ndLevelThreshold
|   |-- Burst
|   |-- Coherency
|   |-- ContrastLeakage
|   |-- Crosstalk
|   |-- FrameTransfer
|   |-- Glint
|   |-- Mask
|   |-- Overshoot
|   \-- Radiation
|-- INR
|   |-- Coastline
|   |-- Navigation
|   \-- UniversalParameters
|-- InstrumentParameters
|-- RadiometricCalibration
\-- SpacecraftParameters
```




GLM PLPTs:

Four major PLPT categories

➤ Reference Data Comparisons (RDC)

- Is the GLM actually meeting specifications for detecting lightning flashes (FDE), rejecting false flashes (FFR), and locating the lightning in time and space?

➤ Algorithm Testing (AT)

- Is the GLM algorithm correctly filtering, geolocating, and clustering the raw Level 0 (LO) data, both backgrounds and lightning, so that GLM is meeting specifications?

➤ Instrument Navigation and Registration Testing (INRT)

- Is the GLM navigation meeting specifications?

➤ Long Term Baseline Testing (LTBT)

- What is the current sensitivity of GLM, how does it compare to the Lightning Imaging Sensor (LIS) and the Optical Transient Detector (OTD), and how is it changing over time?



GLM PLPTs:

How Each Contributes to GLM Validation

PLPT Categories	GLM Characteristics
Reference Data Comparisons	Location, Time, Energy, FDE, FFR
Algorithm Testing	Location, Time, Energy, FDE, FFR
Instrument Navigation and Registration Testing	Location, Time
Long Term Baseline Testing	FDE, FFR, Energy

- **All PLPT tests can contribute to all three data levels**
 - 1) Beta – minimally validated, may still contain significant errors
 - 2) Provisional – analyses are sufficient for qualitative and limited quantitative determination of product fitness-for-purpose
 - 3) Fully Validated – analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose
- **More data, better statistics, more locations = more confidence in the GLM lightning product**



PLPT Details

➤ RDC Series (6 Series)

- 001 Series, Medium-Long Range Radio, Moderate Detection Efficiency (7 networks)
- 002 Series, Short Range Radio, High Detection Efficiency (14 networks)
- 003 Series, Very Long Range Various, Low to Zero Flash Detection Efficiency (4 networks)
- 004 Series, Very Short Range Optical, Very High Detection Efficiency (1 instrument)
- 005 Series, Orbital Based Optical, High (to Moderate) Detection Efficiency (2 sensors)
- 006 Series, Short Range Electric Field, High Detection Efficiency (2 networks)

➤ AT Series (2 Series)

- 009 Series, L1b-L2 Code Verification
- 009c, Lightning Cluster/Filter Algorithm (LCFA)
- 010 Series, L0-L1b Code Verification

➤ INRT Series (1 Series)

- ABI Colocations, LASER Beacon, Landmarks, Lightning Locations

➤ LTBT Series (2 Series)

- 012 Series, Background Radiation Trending
- 013 Series, Event Radiation Trending



GLM PLPT Tools

Tool/Application	Developer	Language
VaLiD (Validate Lightning Data)	Monte Bateman	C
Lightning Cluster/Filter Algorithm (LCFA)	Douglas Mach	Matlab, C
L0-L1b Code Validation	Douglas Mach	Matlab, C
HAMMA User Data Analysis Technology (HUDAT)	Phillip Bitzer	IDL
Trending Tool for Deep Convective Clouds (TT/DCC)	Dennis Buechler	IDL
Trending Tool for Lightning (TT/Lightning) analyses	William Koshak	IDL
24/7 Lightning Monitoring Tool (LMT)	NSOF Contractors	Various
Compare LLS (Compare Lightning Location System)	Ken Cummins	Matlab
XLMA tool	P. Krehbiel, B. Rison	IDL
Lmatools	Eric Bruning	Python
INR/Parallax tool	Dennis Buechler	IDL
STorm Retrievals frOm KSC E-Fields (STROKE)	William Koshak	IDL
Fly's Eye GLM Simulator Tool (FEGST)	Mason Quick	IDL
Ancillary Dataset Tools (ADTs)	Doug Mach et al.	Various
Specialized Impromptu Tools (SITs)	Various	Various



Questions?



GLM Post Launch Tests

GLM Post Launch Tests (PLTs)	
Validate GLM Timing Settings and Image Quality	[G16-C-GLM-001]
Set GLM RTEP Thresholds	[G16-C-GLM-002]
Set GLM Second Level Thresholds	[G16-C-GLM-003]
Validate GLM GPA Parameters	[G16-C-GLM-004]
Verify Solar Intrusion Criteria	[G16-C-GLM-006]
GLM Coastline ID INR Characterization Assessment	[G16- E-GLMINR-001]
GLM Event Navigation Coarse Characterization Assessment	[G16- E-GLMINR-002]
GLM Background INR Performance Assessment	[G16- E-GLMINR-003]
GLM Alignment Assessment	[G16- E-GLMINR-004]



PLPT Categories

Series	Description
GLM_L2_001	Validate GLM DE and False Flash Rate (FFR) using Well Characterized Medium to Long Range Networks with Medium to High Detection Efficiencies and Low False Alarm Rates
GLM_L2_002	Validate GLM DE and FFR using Well Characterized Short Range Networks with High Detection Efficiencies and Low False Alarm Rates
GLM_L2_003	Validate GLM Storm Detection Efficiency (SDE) and Storm False Alarm Rate (SFAR) using Well Characterized Very Long Range Systems with Low (to no) Flash Detection Efficiencies but Medium Storm Detection Efficiencies
GLM_L2_004	Validate GLM DE and FFR using Well Characterized Very Short Range Optical Systems with Very High Flash Detection Efficiencies and Low False Alarm Rates
GLM_L2_005	Validate GLM DE and FFR using Well Characterized Orbital Based Optical Systems with High Flash Detection Efficiencies and Low False Alarm Rates



PLPT Categories

Series	Description
GLM_L2_006	Validate GLM DE and FFR using Well Characterized Ground Based Electric Field Networks with High Flash Detection Efficiencies and Low False Alarm Rates
GLM_L2_009	Validate GLM L1b-L2 Cluster/Filter Algorithm Using Specification (Spec) Code and Comparing Outputs
GLM_L2_010	Validate GLM L0-L1b Filter Algorithms Using Spec Code and Comparing Outputs
GLM_INR_011	Validate GLM INR With Comparisons to Well Located Ground Points
GLM_RAD_012	Validate GLM Background Deep Convective Cloud Radiances and Radiance Trending With Comparisons to Other Measures of Background Radiances
GLM_RAD_013	Validate GLM Event Energies and Energy Trending With Comparisons to Other Measures of Event Energy