

Post Launch Calibration and Testing of The Geostationary Lightning Mapper on GOES-R Satellite



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Mission Overview

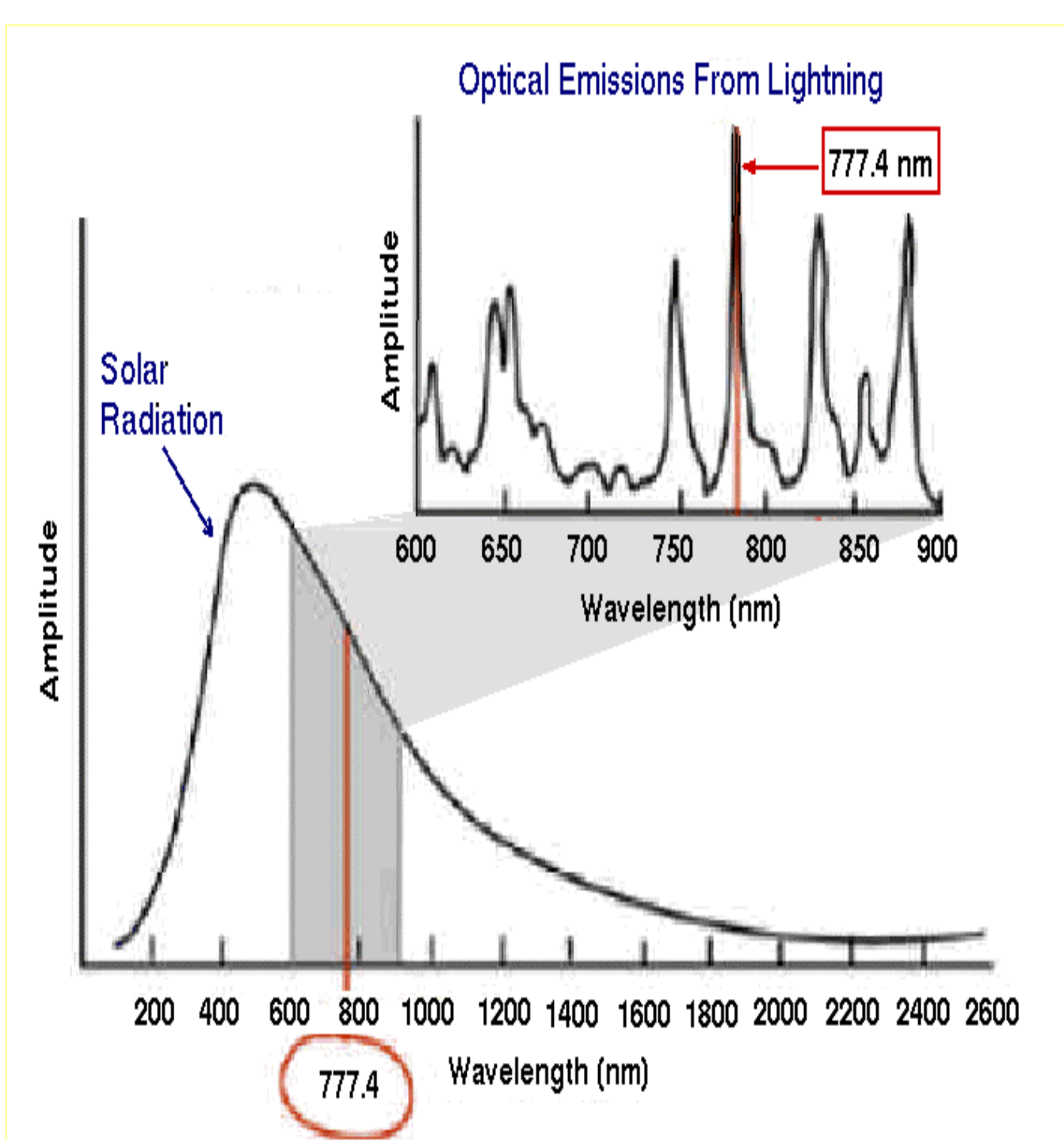
The GOES system is the United States operational geosynchronous meteorological constellation. GOES provides continuous, real-time monitoring of Western hemisphere weather.

GLM Instrument Objectives

- Provide continuous full-disk lightning measurements for storm warning and nowcasting.
- Provide longer (advance) warnings of tornado activity.
- Accumulate a long-term database to track decadal changes in lightning activity.

Theory of Operation

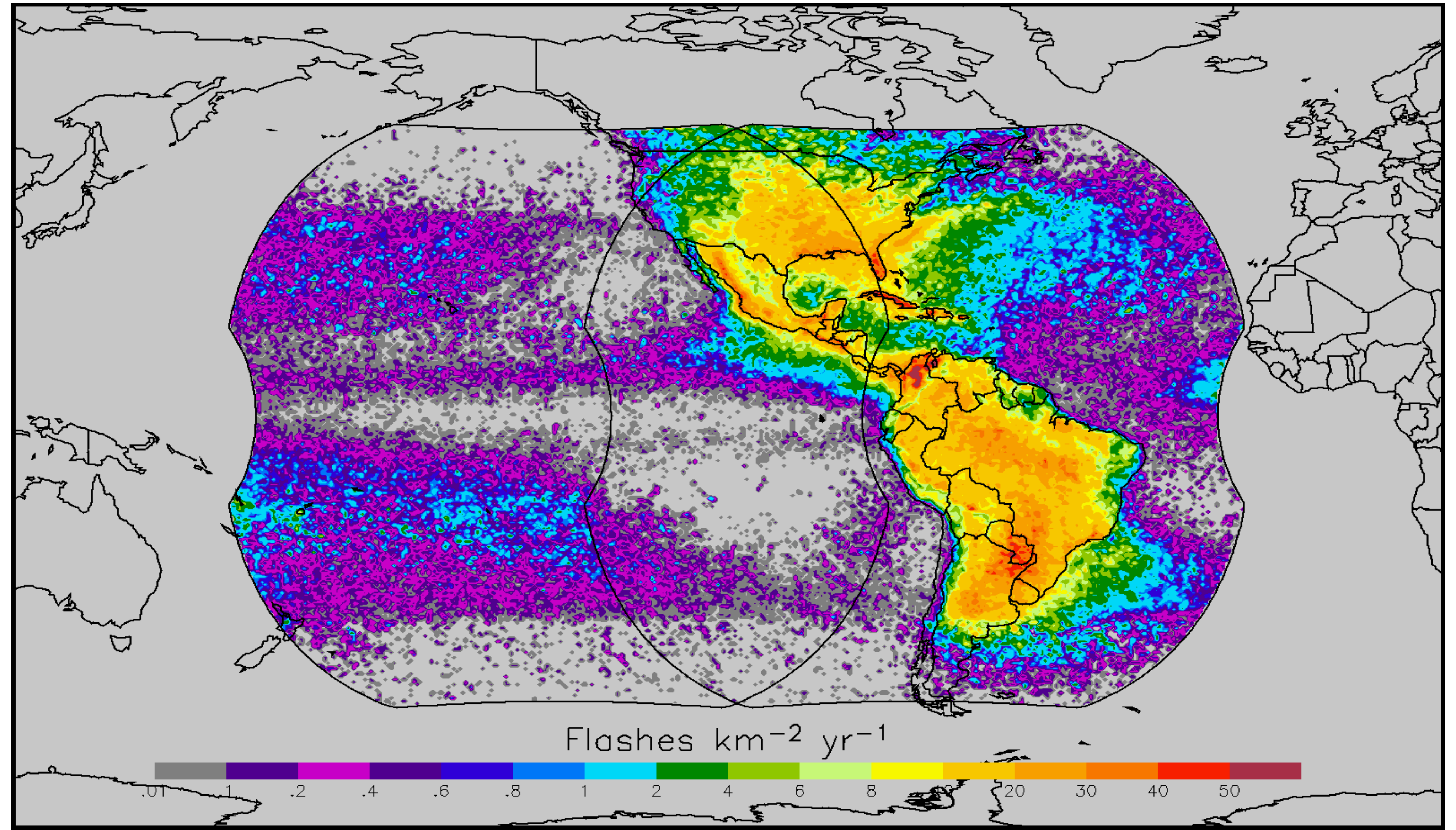
Phenomenon	Instrument	Ground Processing
<ul style="list-style-type: none"> • O* optical transients • 2 ms event duration • 600+ events / second 	<ul style="list-style-type: none"> • Narrow-band near IR • 503 Hz Frame Rate • Background subtraction 	<ul style="list-style-type: none"> • False event filtering • Correlate in space / time



Ground Test

Static Response	Transient Response	Electronics Noise
<ul style="list-style-type: none"> • Integrating sphere • Measured for each CCD sub-array • Measure background tracking • Measure static response in high-albedo environment 	<ul style="list-style-type: none"> • Integrating sphere with triggered LED pulse • Pixel-by-pixel response • Simulates lightning in the presence of high background 	<ul style="list-style-type: none"> • Shot noise (CCD) • Analog / Digital Converter (14-bit) Noise • RTEP pre-processing event threshold over weighted average background

Photos Credit: Lockheed Martin ATC



Post Launch Hardware Tests

- Real Time Event Processor (RTEP) onboard event threshold setting
 - Optimize Threshold to Noise (TNR) ratio [counts]
- Stray light / gain characterization
 - Instrument throughput
 - Saturation headroom by season (detected total radiance = event + background)
- Navigation alignment characterization with ground control beacons
 - Tuned lasers targeted at the instrument aperture
 - Monument Peak, CA
 - NASA GSFC Greenbelt, MD

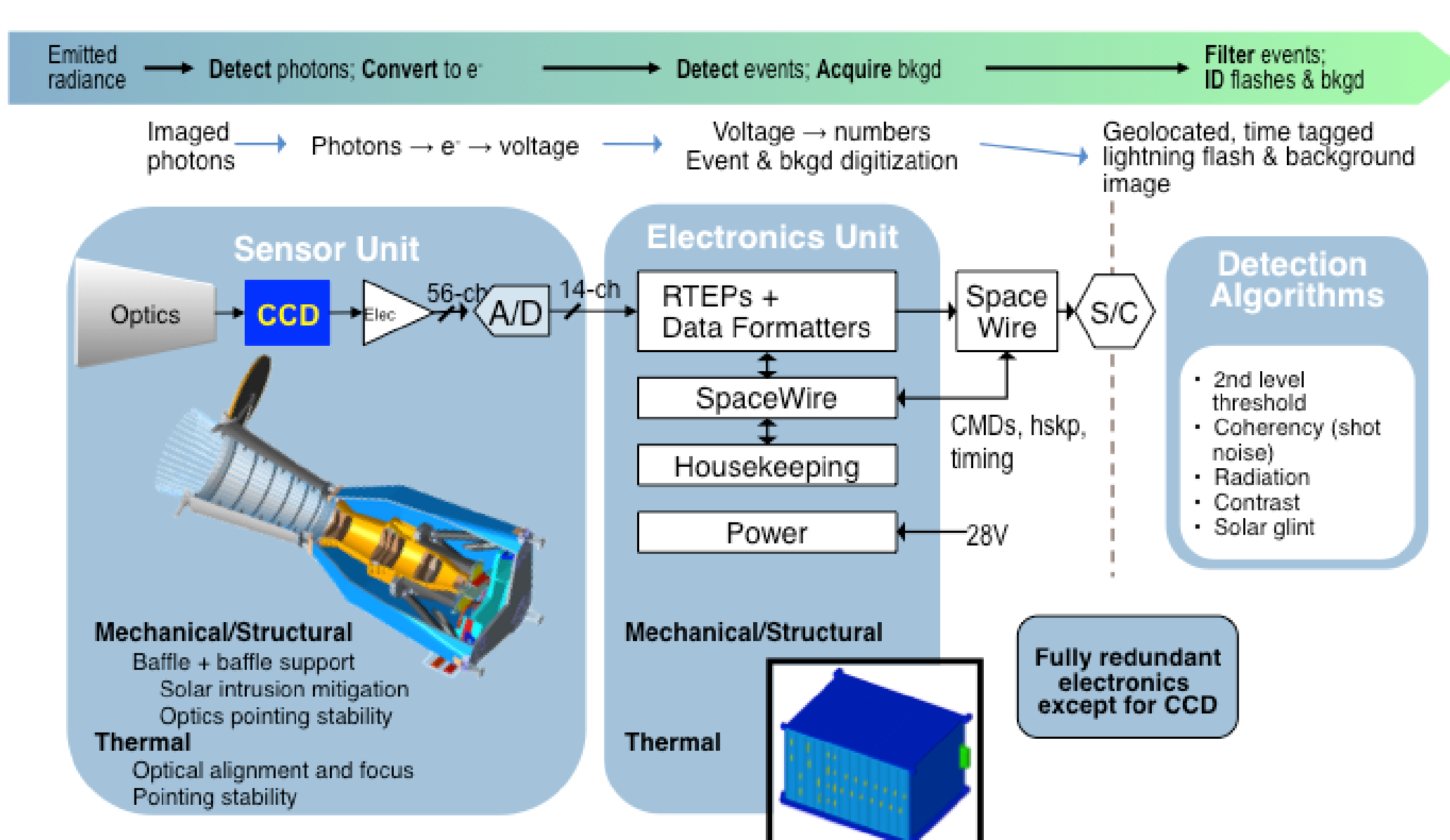
Post Launch GPA Tuning

- Image Navigation & Registration
 - Coarse / Dynamic alignment characterization
 - Coastline identification and tracking for dynamic navigation
- Second Level Threshold
 - Software defined threshold for known "hot" pixels in ground processing
- Contrast Leakage
 - Mechanical jitter-induced false lightning events on high-contrast boundaries (bright clouds)
- Radiation Filter
 - Phenomenological filter removes "streaks" of radiation induced events
- Solar Glint Filter
 - Removes false events from specular reflection
- Coherency Filter
 - Identifies real lightning events based on close space / time correlation to other events
 - Persistency parameter (time)
 - Adjacency threshold (pixel distance)
- Clustering Product
 - Collects events into Groups and Flashes

Analysis Objectives

- Set thresholds for each RTEP
- Validate camera timing parameters
- Verify / validate optical throughput and sensitivity
- **Science validation of Clustering Product based on correlation from other sources**
 - **Lightning UHF signature detecting ground-based networks**
 - **Lightning Imaging Sensor aboard International Space Station**
- **Weather forecasters, using lightning rate data, more accurately predict severe storm escalation, Air Traffic Control and public alerts**

GLM Schematic



Further Reading

- "Optical Observations of Lightning from a High-Altitude Airplane", H.J. Christian and S.J. Goodman, *J. of Atmospheric and Oceanic Technology*, vol. 4, December 1987, pp. 701-711
- "The Detection of Lightning From Geostationary Orbit", Hugh J. Christian, Richard J. Blakeslee and Steven J. Goodman, *J. of Geophysical Research*, vol. 94, no. D11, September 1989, pp. 13329-13337
- "Laboratory Calibration of the Optical Transient Detector and the Lightning Imaging Sensor", William J. Koshak, Mike F. Stewart, Jugh J. Christian, James W. Bergstrom, John M. Hall, and Richard J. Solakiewicz, *J. of Atmospheric and Oceanic Technology*, vol. 17, July 2000, pp. 905- 915