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GOES-R L1b Readiness Implementation and Management Plan

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Outline

- What is a RIMP?
- Data Product Validation Overview
- ABI
- GLM
- Space Weather
- Summary

What is a RIMP?

Readiness, Implementation and Management Plan

- Readiness Implementation and Management Plan (RIMP)
  - *Provides a top-level plan for Cal/Val of GOES-R (GOES-16)*
    - Team developed a L1b data product RIMP for each instrument
  - *Documents top-level activities planned within each product maturity phase:*
    - Beta: Post-Launch Tests (PLTs)
    - Provisional: Post-Launch Product Tests (PLPTs)
    - Full Validation: Post-Launch Product Tests (PLPTs)
  - *PLPTs are defined by the Cal/Val teams for each instrument*
  - *Defines an overall guiding schedule of events*
    - Changes to plan are expected
  - *Documents roles, responsibilities and PoCs for activities during all three levels of product maturity for each instrument*
  - *Connects primary tools and software packages to each PLPT that requires them*
  - *Defines output artifacts and Success Criteria to achieve each level of data product maturity*
  - *Identifies data sets and ground truth that are required by each PLPT*
  - *Provides background pre-launch activities relevant for post-launch data product testing*

Level 1b RIMPs define the path for post-launch data product validation

What makes the GOES RIMP(s) special?

Coordination of Data Product Validation Plans

- Application of System Engineering Practices
  - *Mapping program requirements to the plan (PLPTs) in order to justify activities*
  - *Identification of requirements to execute each PLPT such as:*
    - S/W and analysis tools
    - Data requirements
    - Schedule and product interdependencies
  - *Structured 'global' view of Cal/Val*
- Provides a structured set of required Validation Events (VEs)
  - *VE's are PLTs (provided by the flight project) and PLPTs (provided by the Cal/Val team)*
  - *Identifies timing, scope tools needed, personnel, scheduling, required outputs/artifacts*
- Identifies required validation reference data for each instrument to ensure diverse interdependencies are identified in Cal/Val planning
  - *Data access and storage summary*
  - *Spatiotemporal coverage needs*
  - *Science and programmatic points of contact*
  - *Data availability and contingencies*

GOES-R RIMPs incorporate systems engineering practices to organize, justify and plan validation activities while identifying needed resources for successful completion

What makes the GOES RIMPs 'special' (Cont'd)

Coordination of Data product Validation Plans

- Software tools required for each instrument
  - *Provides description, development schedule and person responsible*
  - *Required testing and validation of each primary tool*

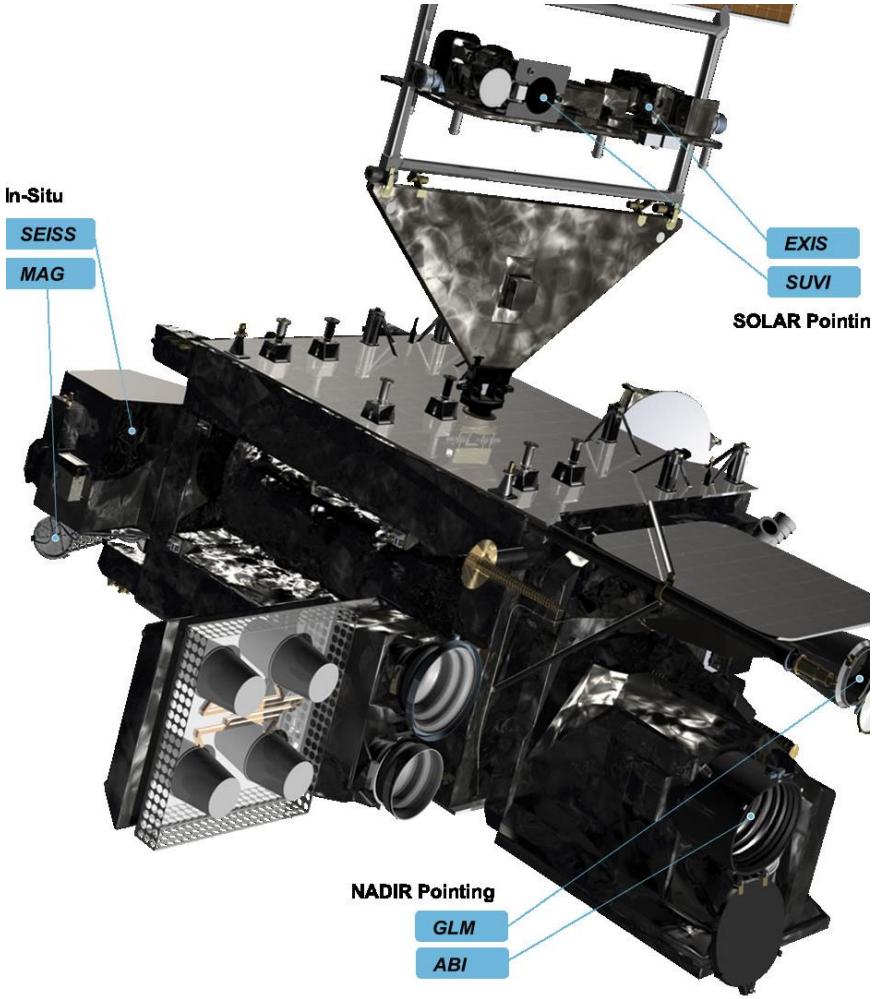
- RIMPs identify and connect multiple interdependencies in order to define a robust path for data product validation
  - *Increase potential for successful and timely data product validation*

GOES-R RIMPs incorporate systems engineering practices to organize, justify and plan validation activities while identifying needed resources for successful completion

GOES-16 Instrument Complement

Satellite pictorial

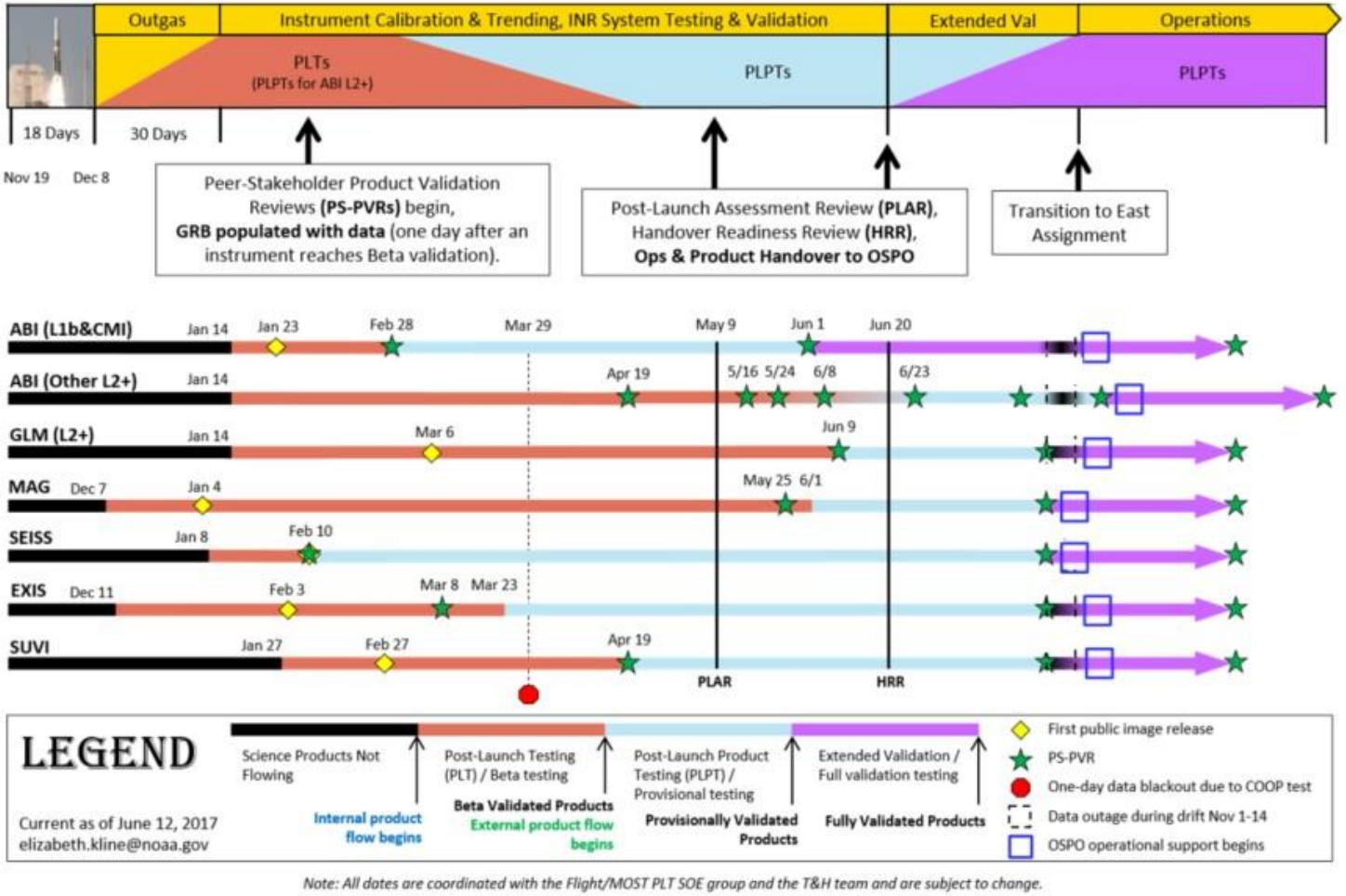
- GOES-16 Contains 6 sensors grouped into 3 categories
  - *Nadir pointing (ABI and GLM)*
  - *Solar pointing (EXIS and SUVI)*
  - *In situ (SEISS and MAG)*
- Post-Launch tests (PLT) addressed by flight project
- Post-Launch data Product Tests (PLPTs) addressed by GOES-Product Readiness and Operations
  - *Provisional data product maturity requires completion of several PLPTs*
  - *Full validation maturity extends the observations period and adds PLPTs*
- RIMPs document the validation plan identify inter-dependencies, coordinate s/w tools and schedules



http://www.goes-r.gov/spacesegment/instruments.html

GOES-16 Post-Launch Science Product Validation

June 2017



Note: All dates are coordinated with the Flight/MOST PLT SOE group and the T&H team and are subject to change.

Schedule updated as of June 2017

SOE: System Operation Exercise
MOST: Mission Operation Support Team
OSPO: Office of Satellite and Product Operations

ABI Test Description Summary

Advanced Baseline Imager

- A comprehensive suite of tests was developed to verify required on-orbit performance for the GOES-16 ABI
  - *Inter-satellite, ground, and airborne comparisons*
  - *On-board calibration tests*
  - *Vicarious calibration targets – Moon, deserts, clouds*
  - *Landmarks – stars, coastlines*
  - *Self-consistency tests – frame-to-frame, channel-to-channel, swath-to-swath*

- The tests use a combination of on-board and vicarious targets and comparisons with other coincident satellite and terrestrial measurements to assess ABI imagery
  - *Radiometric calibration*
  - *Spatial resolution*
  - *Geolocation accuracy*

ABI Validation Overview

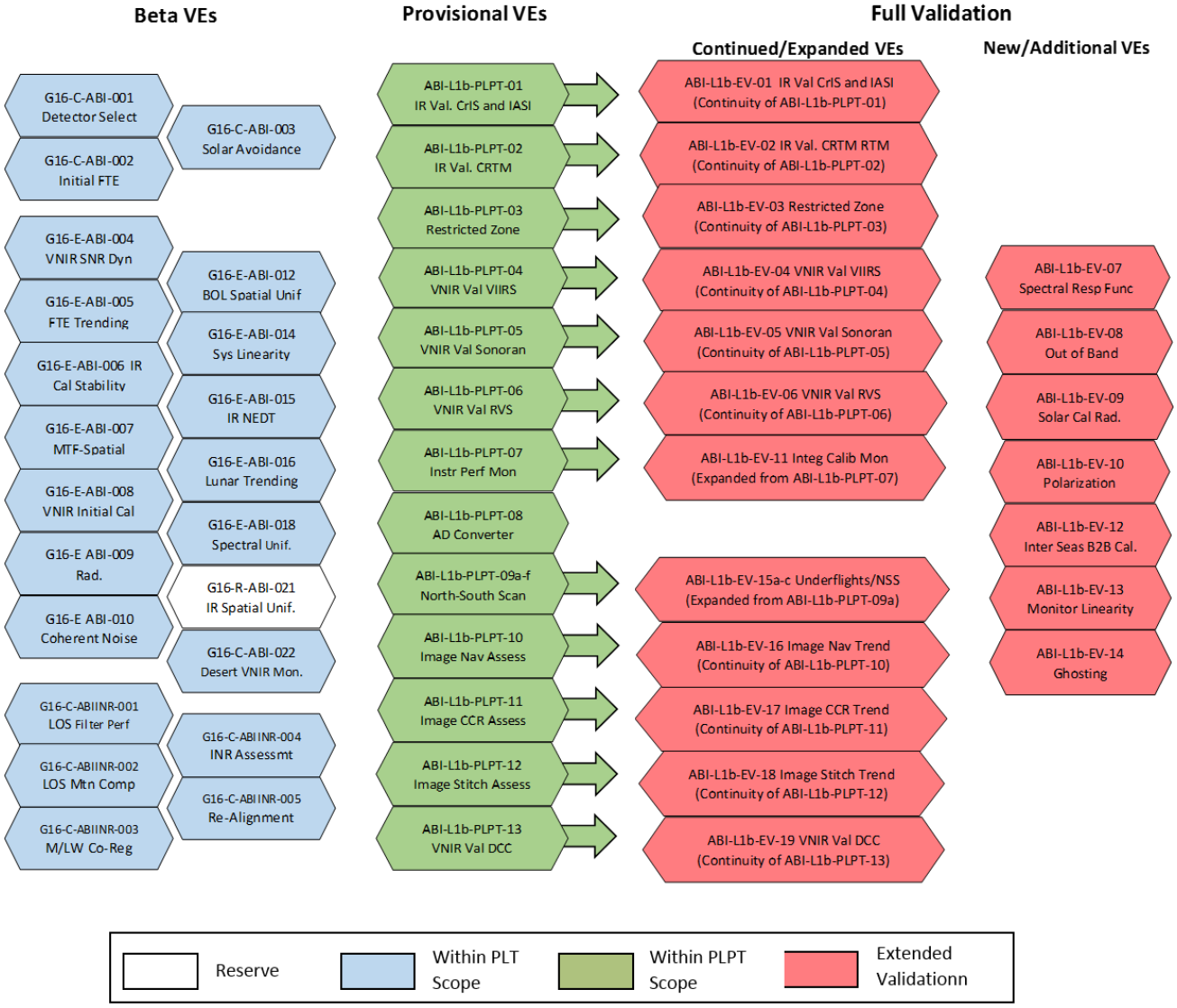
Advanced Baseline Imager

- ABI post-Launch Product Tests (PLPTs)
  - *Provisional validation requires 13 tests or 'validation events'*
  - *All events except PLPT 09 are performed with routine imagery – N/S scans to measure detector uniformity*
- Graphic of ABI Validation Events
  - *PLT tests (blue)*
    - 'C' implies part of Radiometric Calibration
    - 'E' is defined as an Engineering test
    - 'R' denotes a reserve test
  - *PLPT tests for Provisional (Green)*
    - IR sounding and VNIR validation utilizing other instruments and models
    - Data and performance monitoring
    - Image co-registration and navigation
    - North/South scans
  - *PLPT tests for Full maturity (Extended Validation) – 12 months to assess product maturity*
    - Extends period of evaluation to include full range of on-orbit and scene conditions
    - Adds refinement of spectral response functions and instrument characterization
- Considering Cal/Val as collection of validation events helps focus supporting efforts

RIMPs provide a detailed breakout of each validation event in order to identify needed models, tools, data flow, scheduling and other logistical and technical details

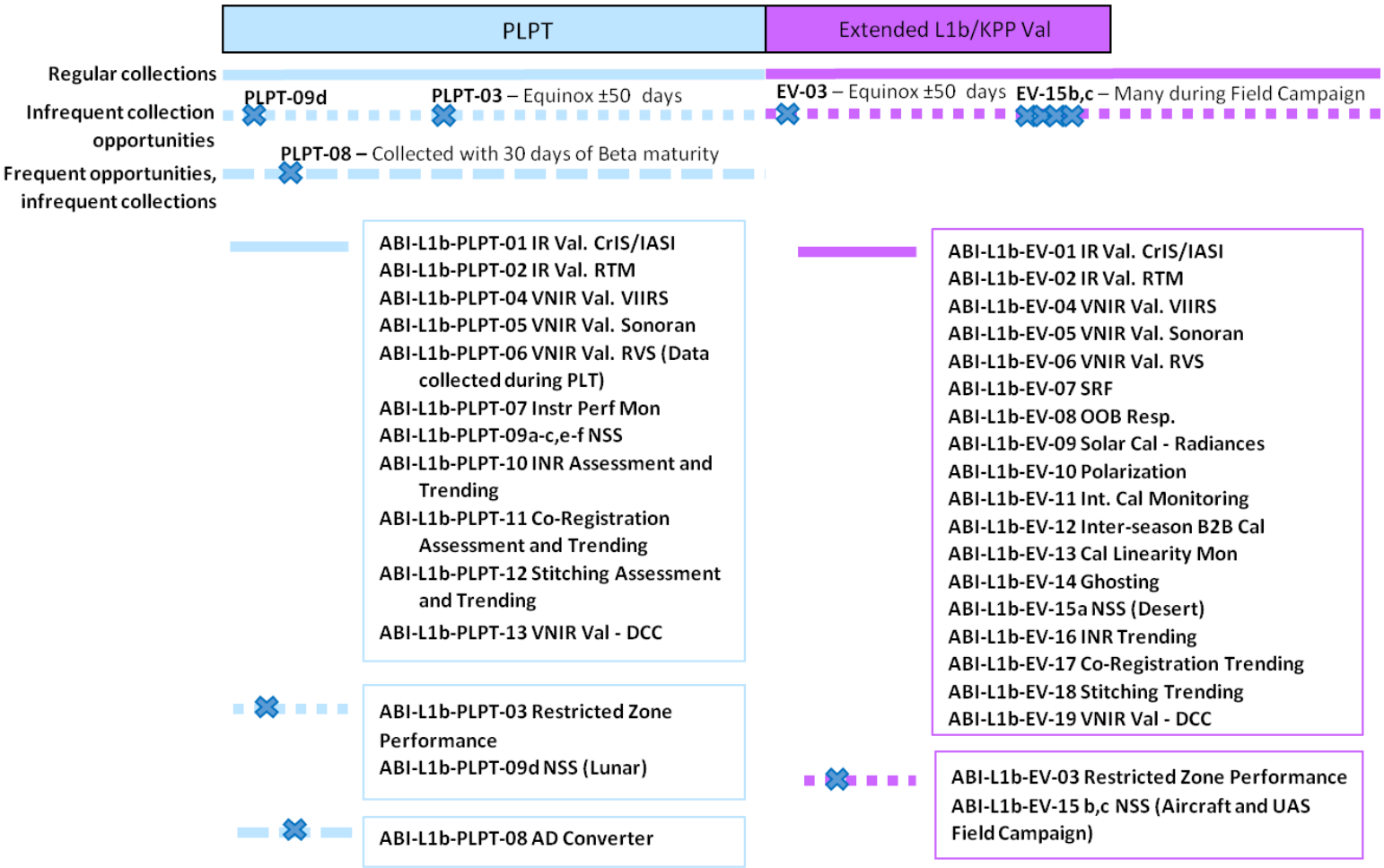
Post-Launch Product Tests (PLPTs) for ABI

Graphics representation of PLT and PLPT Validation Events for ABI



PLPT Schedule for ABI Science Data Products

Provisional and Full Validation Periods



GLM Test Description Summary

Global Lightning Mapper

- Assess system performance for
  - *Events (PLT)*
  - *Strokes (PLPT)*
  - *Flashes (PLPT)*
- 9 PLTs and 12 PLPT series differentiated by the attributes of the verification system, site locations and the performance to be characterized
  - *System attributes*
    - Short range networks with high detection efficiencies and low false alarm rates
    - Very long range systems with low flash detection efficiencies but medium storm detection efficiencies, etc.
  - *Performance assessment*
    - False alarm/event rates
    - Detection efficiency
    - Filter algorithms
    - INR
    - Cloud radiance and trends
    - Event energy and trends

Large number of sites minimize the effects of the vagaries of weather on the Cal/Val assessment

EXIS Test Description Summary

Solar Monitoring

- Extreme ultraviolet and X-ray Irradiance Sensors
  - *X-Ray Sensor (XRS)*
  - *Extreme Ultra-Violet Sensor (EUVS)*
  - *Solar Pointing Sensor (SPS) measures pointing of XRS*
- Heritage sensors were part of pervious GOES satellites
  - *XRS and EUVS instrument has been modified slightly*
- PLPT continues initial PLT checkout tests
  - *Further in-depth analysis of EXIS calibration*
  - *Establishes a snap-shot of calibration in an on-orbit environment*
  - *Initial benchmark for long-term trending of EXIS performance*
- Validation Events
  - *EUVS model baseline and uncertainties*
  - *Bootstrap Degradation*
  - *XRS cross-over threshold*
  - *Scaling factors*
  - *Pointing and flare location*

SEISS Test Description Summary

In Situ Monitoring

- SEISS Instruments Include
  - *Magnetospheric Particle Sensor – Low energy (MPS-LO)*
  - *Magnetospheric Particle Sensor – High Energy (MPS-HI)*
  - *Solar and Galactic Proton Sensor (SGPS)*
  - *Energic Heavy Ion Sensor (EHIS)*
- GOES-R period leveraged expertise from previous GOES
  - *Energetic Particle Sensor / High Energy Proton and Alpha Detector (EPS/HEPAD)*
  - *Leveraged mature documentation*
- PLPT Validation Events Include
  - *SGPS Contamination Correction*
  - *MPS Cross comparisons*
  - *Cross-satellite comparison of trapped particles*
  - *Background trending*
- Solar Conditions
  - *Quiet and disturbed conditions needed*

MAG Test Description Summary

In-Situ Monitoring

- GOES-16 Magnetometer
  - *Magnetic field measurements with 5 times the temporal resolution (10 Hz) as previous*
  - *Two boom-mounted flux-gate magnetometers (6.3 and 8.5m from the boom baseplate)*
  - *Measurements from the two sensors are combined using the gradiometer algorithm in order to improve knowledge of the ambient fields*
- GOES-R Cal/Val Planning leveraged expertise from previous instruments
  - *Nearby spacecraft magnetometer measurements form the basis for validation*
- PLPT Validation Events for provisional maturity
  - *Comparison to models under quiet conditions*
  - *Low resolution cross-satellite inter-comparisons (1 minute data)*
- Full Validation
  - *Full resolution cross-satellite intercalibration (10 Hz data)*
  - *Detailed comparisons using gradiometer algorithm to other methods*
  - *Intercalibration (MLT) 90 quiet days required*
- Time series of trending parameters are the primary validation artifacts

SUVI Test Description Summary

Solar Monitoring

- SUVI Instrument
  - *Normal incidence telescope in the Ritchey-Chrétien*
  - *Charge coupled device (CCD) at the Cassegrain focus*
  - *Six narrow wavelength bands image different features of the Sun*
  - *Baffles block stray light and energetic particles from reaching the CCD*
- SUVI Heritage
  - *Has commonality with:*
    - Solar and Heliospheric Observatory / Extreme Ultra-violet imaging Telescope (SOHO/EIT)
    - Solar Dynamic Observatory / Atmospheric Imaging Assembly (SDO / AIA)
  - *Breaks with previous GOES heritage and the Solar X-Ray Imager (SXI) by adding Imaging of the extreme U-V portion of the spectrum and evolving solar forecasting*

SUVI Test Description Summary (cont'd)

Solar Monitoring

- PLPT Validation Events (Provisional Maturity)
  - *Defines 5 transitional PLTs that continue into Provisional validation PLPTs*
  - *Dark Current Characterization, Defective Pixels, Shutter Light Leakage*
  - *Guide telescope calibration and characterization*
  - *CCD temperature and detector performance trending*
  - *Begin intercalibration with well-known sources of established accuracy; Solar Dynamics Observatory (SDO) Atmospheric Imaging Assembly (AIA)*
- Full maturity validation
  - *Six months Intercalibration with SDO/Extreme Ultraviolet (EUV) Variability Experiment (EVE) and EUV SpectroPhotometer; begin long term trending*
  - *Six months intercalibration with GOES 12 – 14 EUVS instrument*
  - *SUVI – EXIS intercalibration*
  - *Examine 6 months of data for predicable relationships and transfer calibration standard to SUVI*
- Performance requirements verification is restricted to the data available
  - *Range of solar conditions*
  - *Solar off-pointing may aid analyses*

Summary

- The RIMPs apply System Engineering principles to GOES-R (-16) L1b science data product validation to facilitate Provisional and Fully Validated Maturity
  - *Plans were developed for each sensor: ABI, EXIS, GLM, MAG, SEISS, and SUVI*
- Product Readiness and Operations (PRO) team implemented these RIMPs in order to address the full scope of Cal/Val activities
  - *Required for successful validation demonstration of GEOS-16 L1b data product quality*
  - *Provides evidence that a given product maturity stage has been reached*
- The RIMPs include:
  - *Description of every post-launch data product test and required artifacts to demonstrate successful completion of the tests*
  - *Timing and schedules when each stage is expected to be complete*
  - *Roles and responsibilities of organizations and personnel*
  - *Upstream and downstream dependencies and interdependencies*
  - *Analysis methods and tools to be employed during validation*