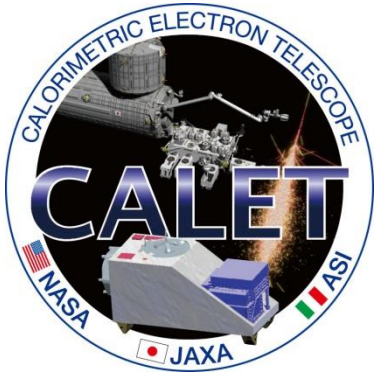


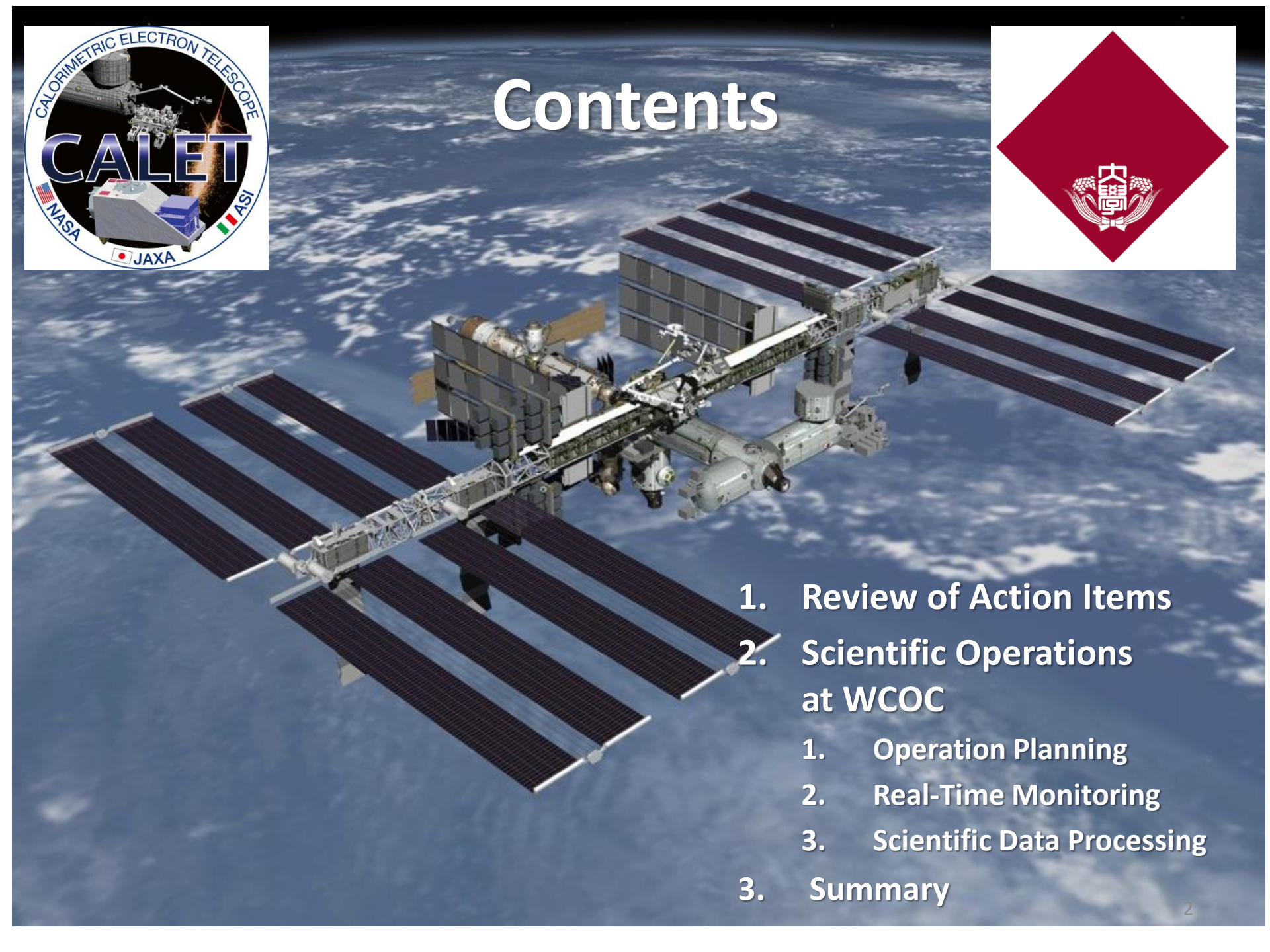
WCOC Status

Waseda CALET Operations Center

DH&A Japan Y. Asaoka

2015.6.24 CALET-TIM @ Pisa Univ.

Contents



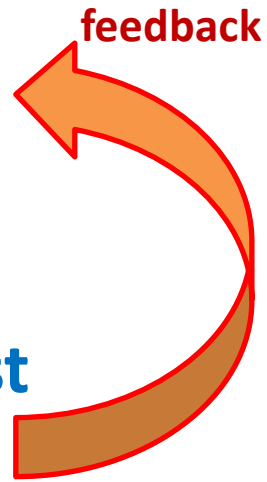
1. Review of Action Items
2. Scientific Operations at WCOC
   1. Operation Planning
   2. Real-Time Monitoring
   3. Scientific Data Processing
3. Summary

List of Action Items

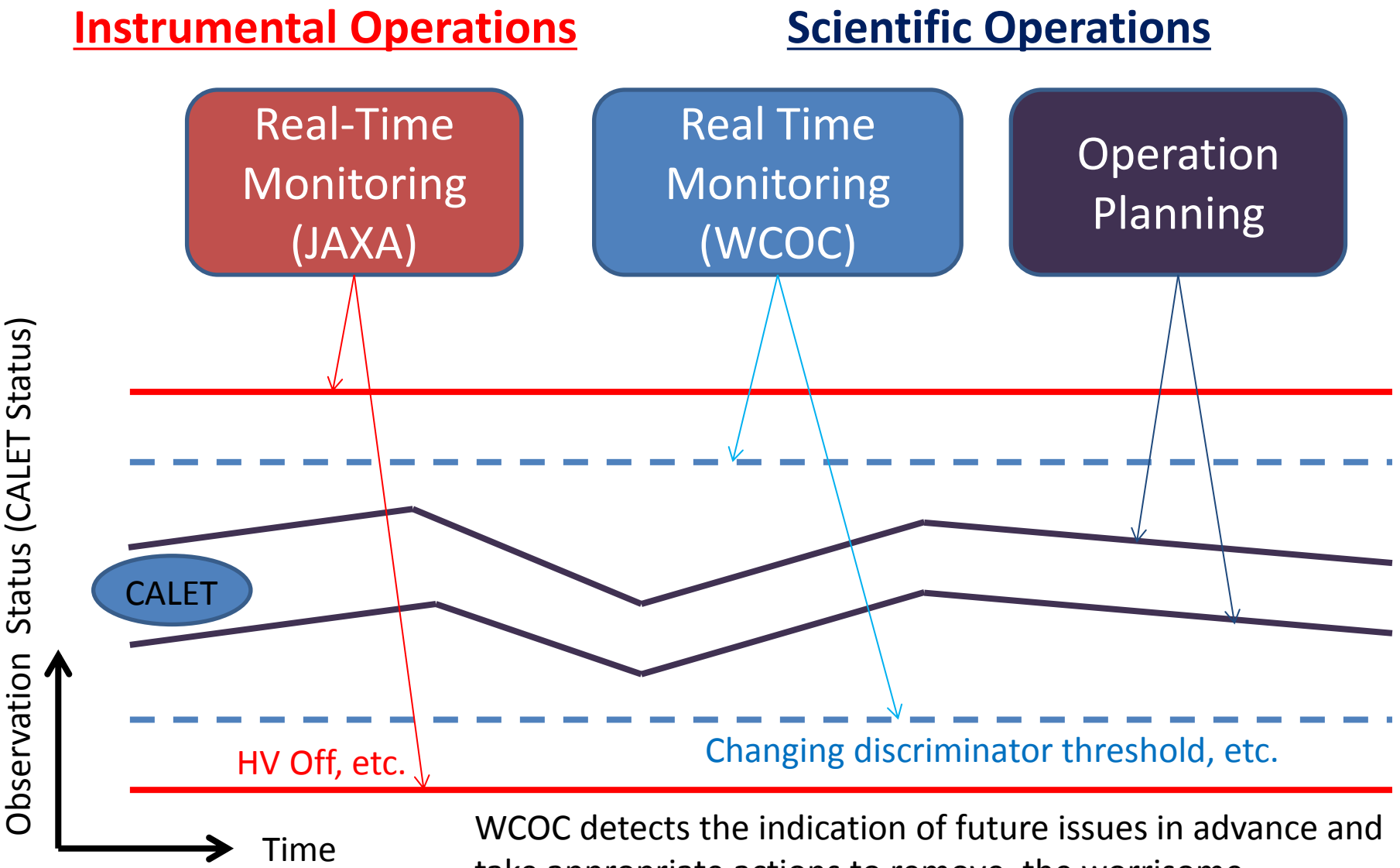
1. 24-hour Long Simulation Data => DONE
   - FEC-to-Physical Assignment correction done (6/23)
2. Description of trigger system => DONE
   - WCOC-2015-001
3. Description of coordinate system => DONE
   - WCOC-2015-002
4. Finalize Level1 format DUE: 6/M => DONE
   - WCOC-2015-007,008,009,010,011,012
5. Final telemetry list (+file ICD) DUE: 6/M => DONE
   - JMX-2015-079NC (in Japanese; sent to Co-PIs only)
   - ASC-DTU-ICD-3004
6. **Ground muon data** **DUE: 6/M** **=> DONE**
7. UV laser calibration parameters DUE: until TIM => working
8. Draft of ICRC Proceedings DUE: 6/23 => Sent
   - "Development of the Waseda CALET Operations Center (WCOC) for Scientific Operations of CALET".

Scientific Operations at WCOC

1. **Observation Planning**
   - **Using Schedule/Macro Command File**
   - **Controlling Operation Mode**
2. **Real-Time Monitoring**
   - **Receiving CALET Telemetry**
   - **Monitoring w/ QL ⇒ Command Request**
3. **Scientific Data Processing**
   - **Receiving Level0 Data⇒ Validation**
   - **Level1 Data Production ⇒ Distribution**



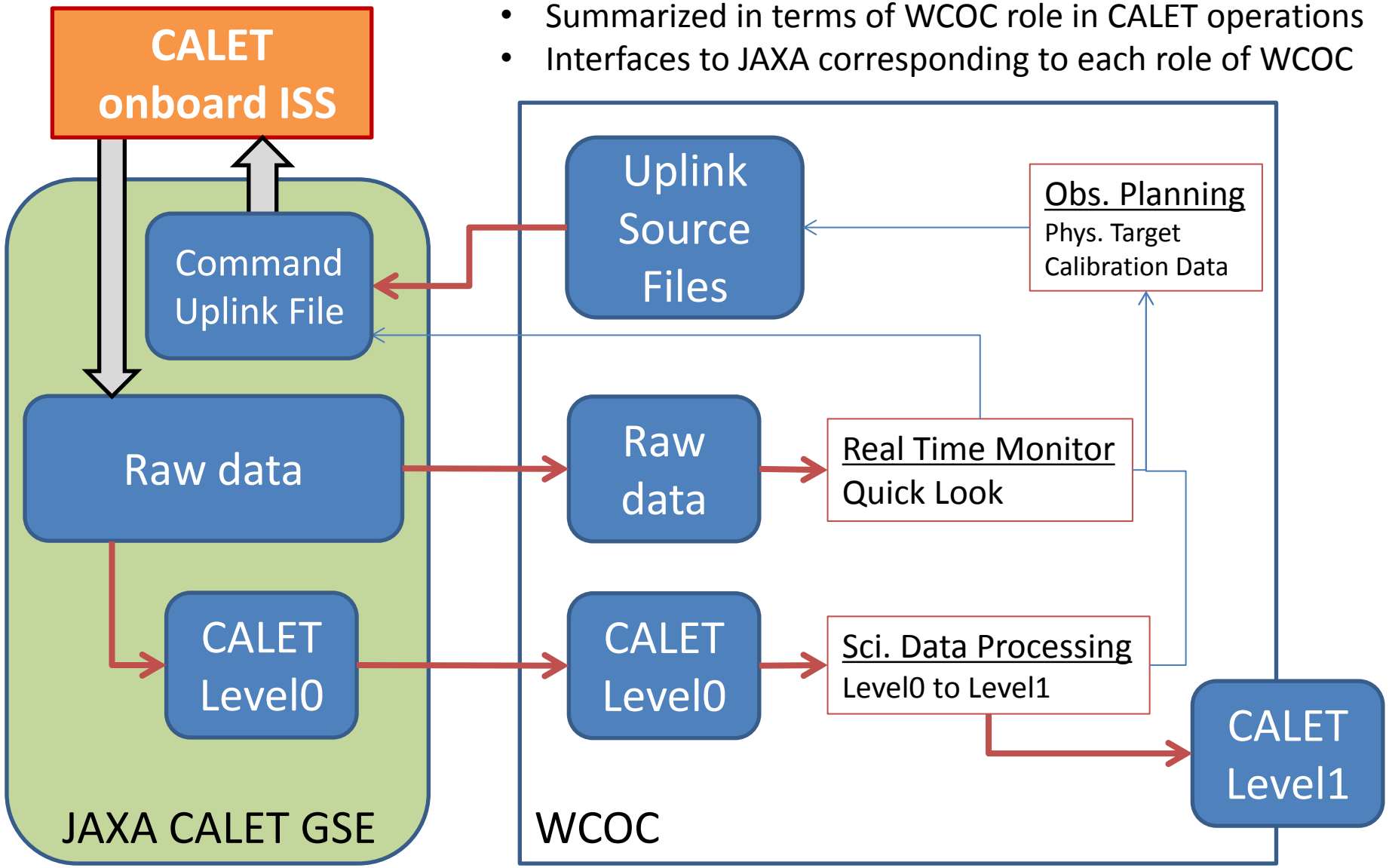
CALET Operations Image



WCOC detects the indication of future issues in advance and take appropriate actions to remove the worrisome.
It ensures high-efficiency observation.

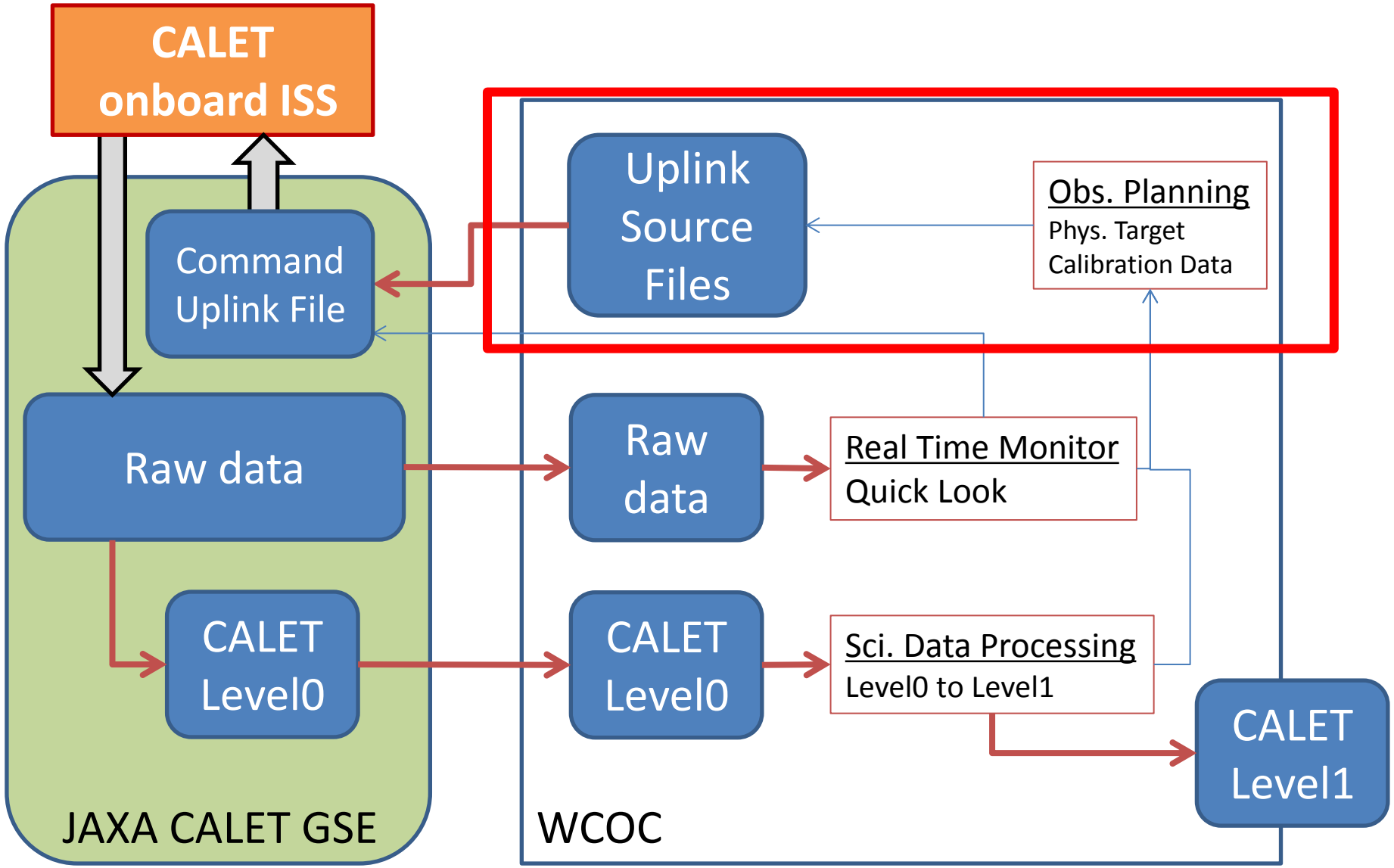
CALET Ground System Dataflow Summary

- Summarized in terms of WCOC role in CALET operations
- Interfaces to JAXA corresponding to each role of WCOC



GSE: Ground Support Equipment

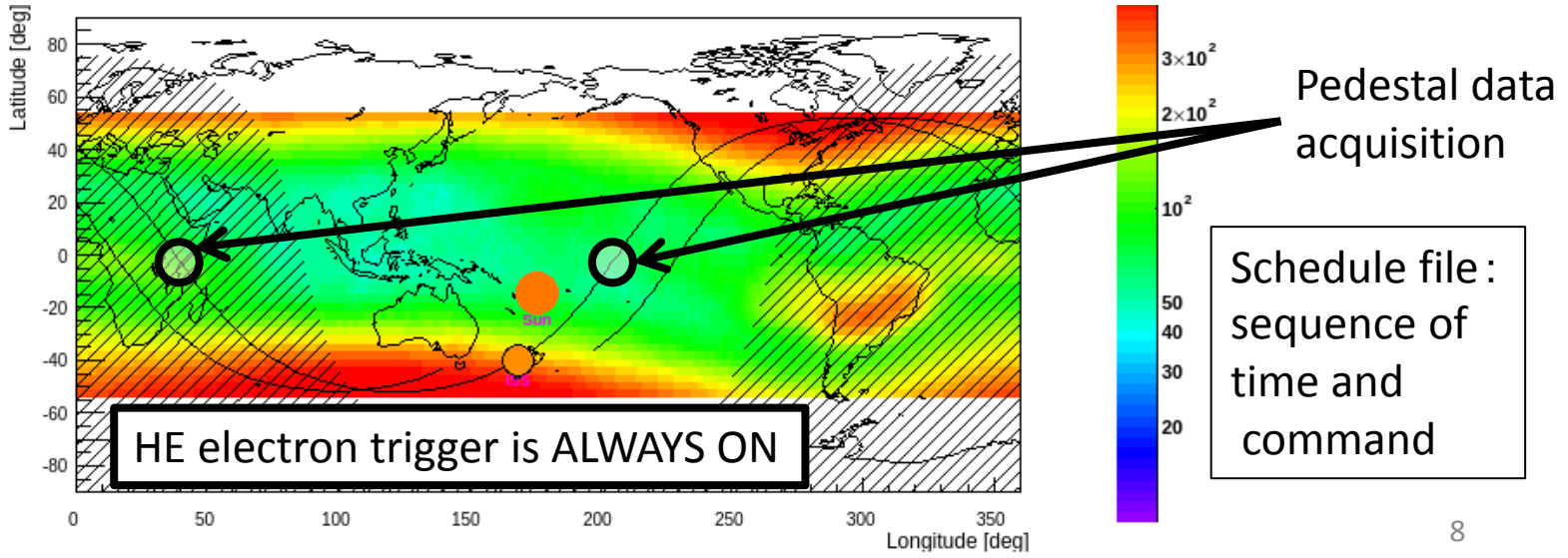
CALET Ground System Dataflow Summary



GSE: Ground Support Equipment

Operation Planning

- Optimization of observation condition
  - Stable and continuous data taking to accumulate HE electron events is the primary and the most important task of the nominal operation.
  - Need to schedule calibrations runs (pedestal, penetrating p/He)
  - We can think of other trigger mode as long as it does not affect high energy electron data statistics to maximize the outcome
- Every day observation plan
  - realization with schedule command file
    - changing of observation mode



Overview of Trigger modes for CALET

High Energy Shower Trigger (HE) →
- High energy electrons (10GeV ～20TeV)
- High energy gamma rays (10GeV ～10TeV)
- Nuclei (a few10GeV～000TeV)

Low Energy Shower Trigger (LE) →
- Low energy electron at high latitude(1GeV ～10GeV)
- GeV gamma-rays originated from GRB (1GeV ～)
- Ultra heavy nuclei (combined with heavy mode)

Single Trigger (Single) →
- For detector calibration : penetrating particle (mainly protons and heliums)

(*) In addition to above 3 trigger modes, heavy modes are defined for each of the above trigger mode. They are omitted here for simple explanation.

Auto Trigger (Pedestal/Test Pulse) →
- For calibration: ADC offset measurement (Pedestal), FEC's response measurement (Test pulse)

Predominantly, timestamped changes of trigger setting are described in schedule command file. It makes possible to take pedestals, penetrating particles, low energy electrons at high latitude, and other dedicated data taking in addition to the most important high energy shower data.

High Energy Shower Trigger (HE)

Trigger mode can be set independently for HE, LE and Single (SI)

1. Trigger Mask

Selects trigger mode for which data acquisition is initiated. (logical OR)

2. LD* Mask

Selects LDs to be required in the coincidence for trigger

3. LD* threshold

Discriminator threshold for each LD is adjustable (for simplicity shown in MIP)

(* LD: Lower Discriminator)

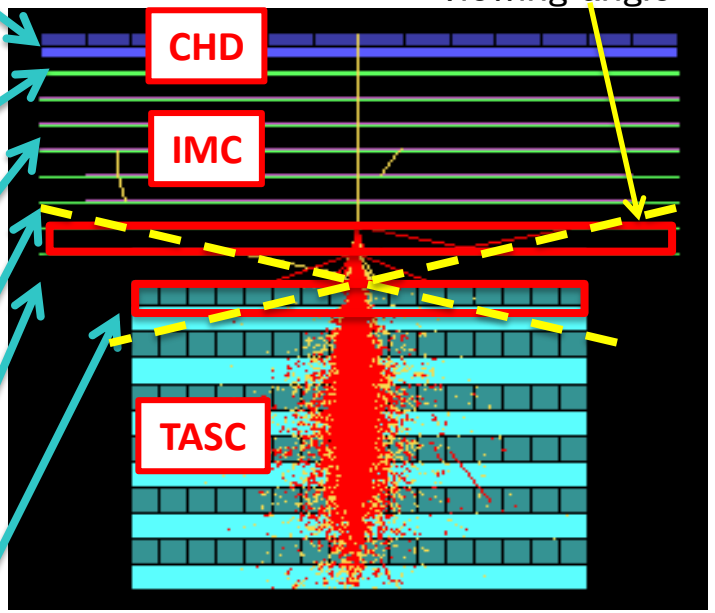
Considering the shower development, large energy deposit is required in the middle of the detector

- Selects shower events
- Severely suppress background
- Realizes large viewing angle

Example of Trigger Setting

High Energy Shower Trigger

HE	LE	SI
–	0.7	0.7
–	0.7	0.7
–	0.7	0.7
–	0.7	0.7
7.5	2.5	0.7
55	7	0.7



Nominal trigger setting to take electron data above 10 GeV
(Trigger efficiency is 95% at 10GeV)

Low Energy Shower Trigger (LE)

Flexible setting of coincidence to be requiis possible with LD mask

1. Trigger Mask

Selects trigger mode for which data acquisition is initiated. (logical OR)

2. LD* Mask

Selects LDs to be required n the coincidence for trigger

3. LD Threshold

Discriminator threshold for each LD is adjustable (for simplicity shown in MIP)

(* LD: Lower Discriminator)

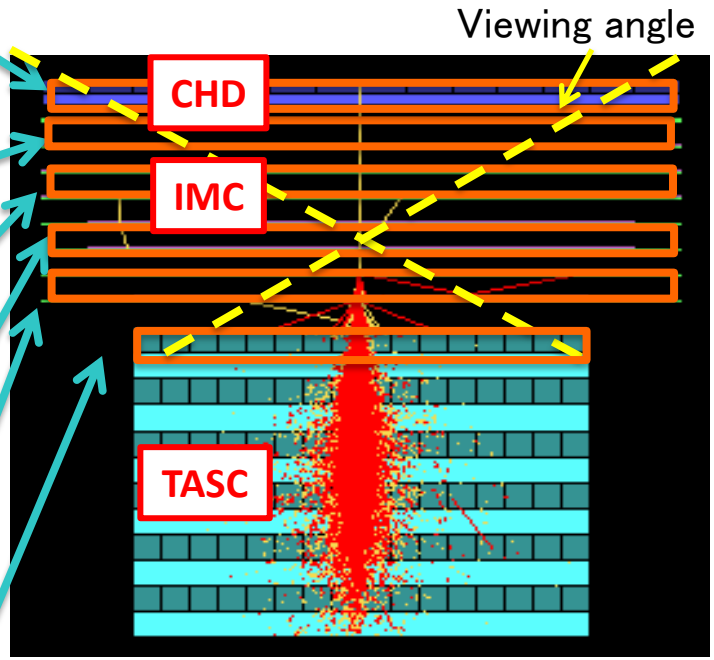
Same as HE, but requiring all LD to generate trigger signal

- Selects shower events
- Severely suppress background
- Suppresses trigger rate

Example of Trigger Setting

HE	LE	SI
–	0.7	0.7
–	0.7	0.7
–	0.7	0.7
–	0.7	0.7
7.5	2.5	0.7
55	7	0.7

Low Energy Shower Trigger



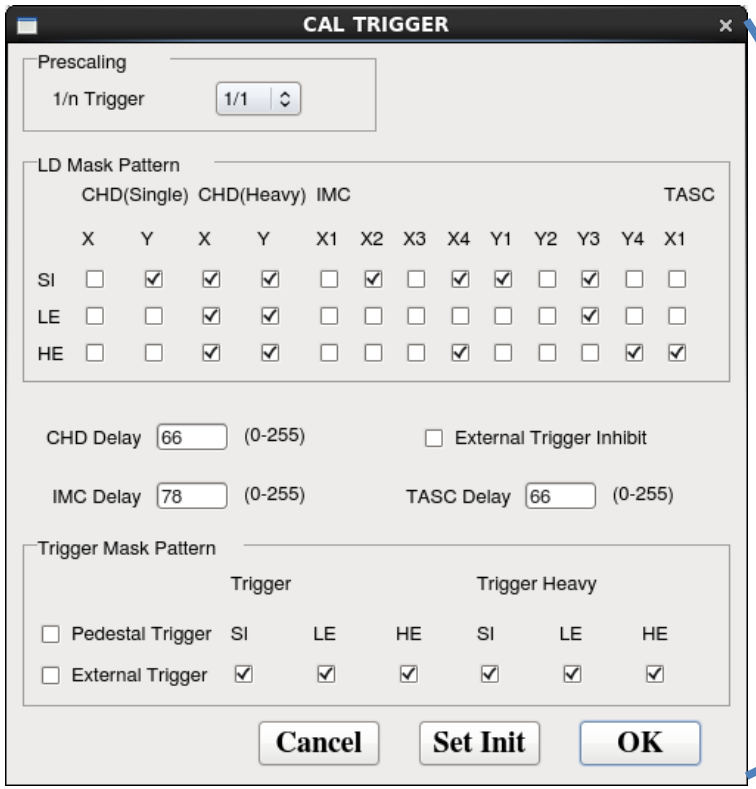
Nominal trigger setting to take electron data above 1 GeV at high latitude (Trigger efficiency is 95% at 1GeV)

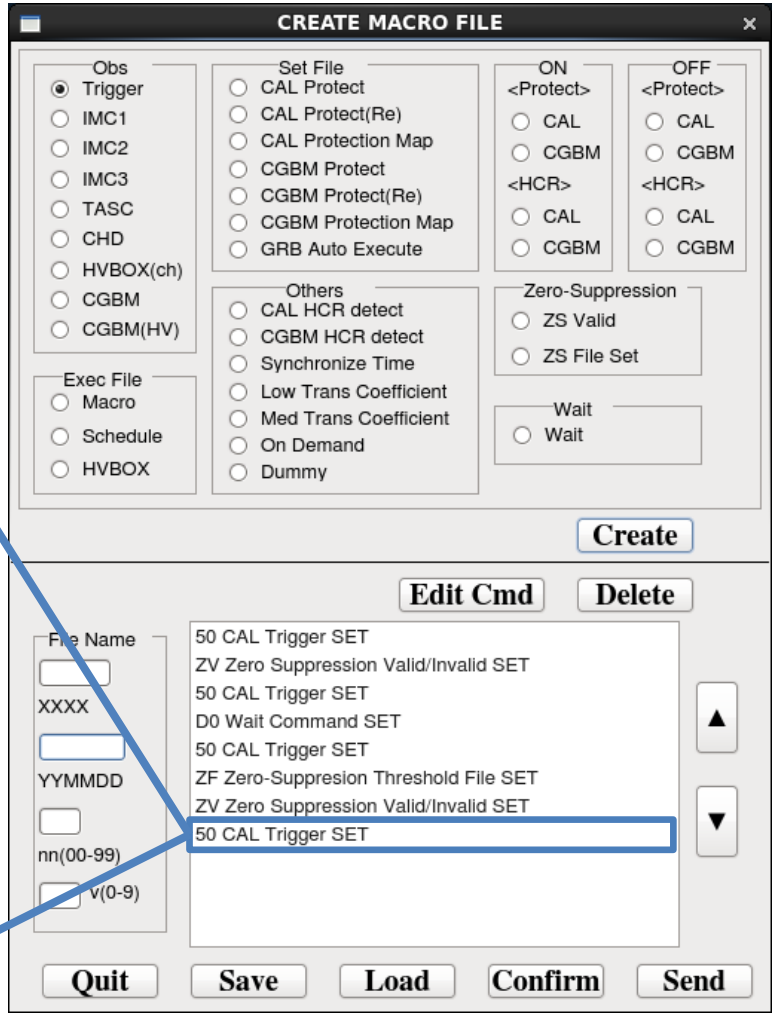
Macro Command File

- Every day observation schedule is put into shape by schedule command file
  - Schedule command file is made of macro command file

⇒ command generation tool based on GUI is developed.

Example of macro command file





Macro Command File

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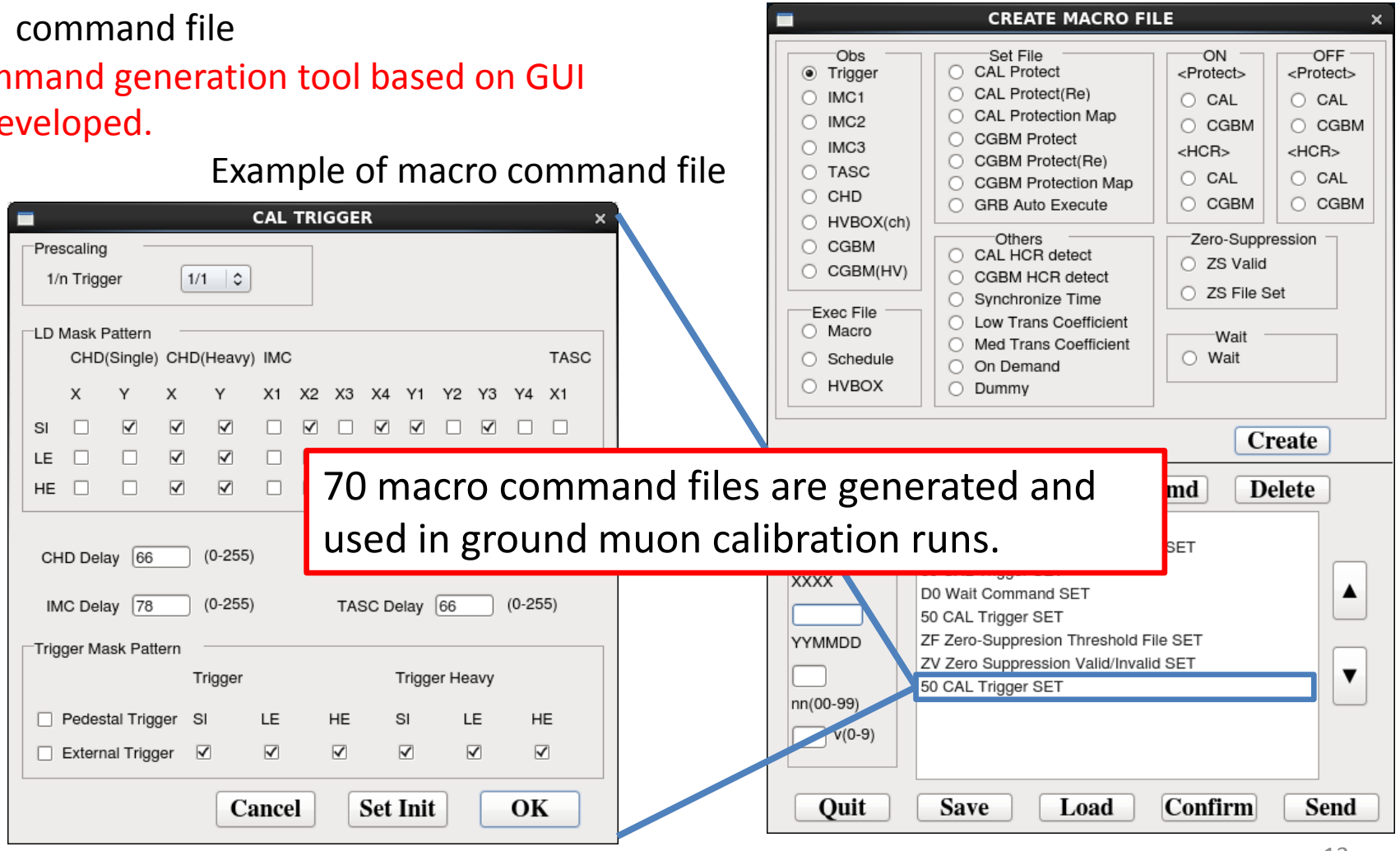
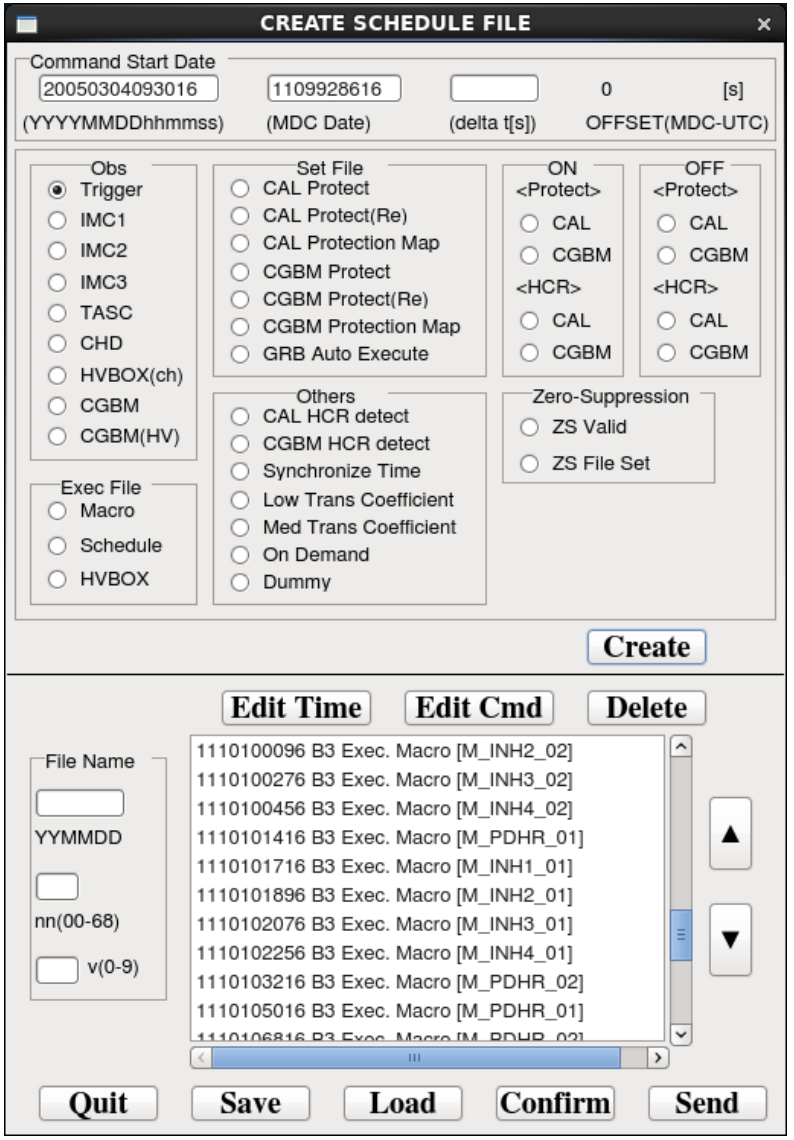


70 macro command files are generated and used in ground muon calibration runs.

Schedule Command File

- Schedule command file was generated to be used in the ground muon run
  ⇒ combination of 70 macro command files
- Changes of trigger modes which simulates the onboard operation were tested over and over again
  - simulation of high rate environment
  - periodic pedestal data taking

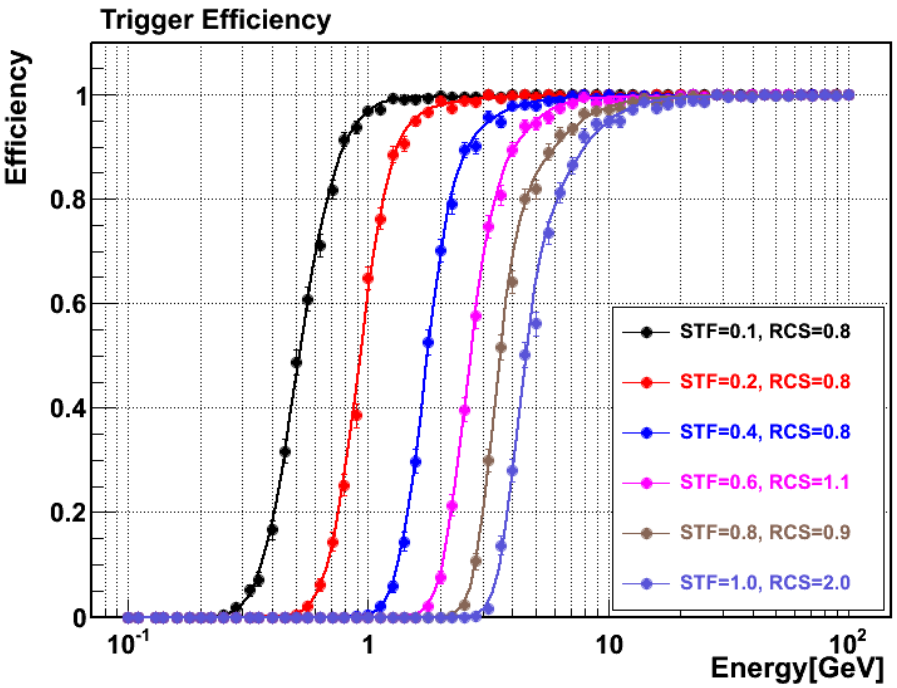
- Envisioned performance was confirmed.
- Experimental proof of scientific operations based on schedule command file.



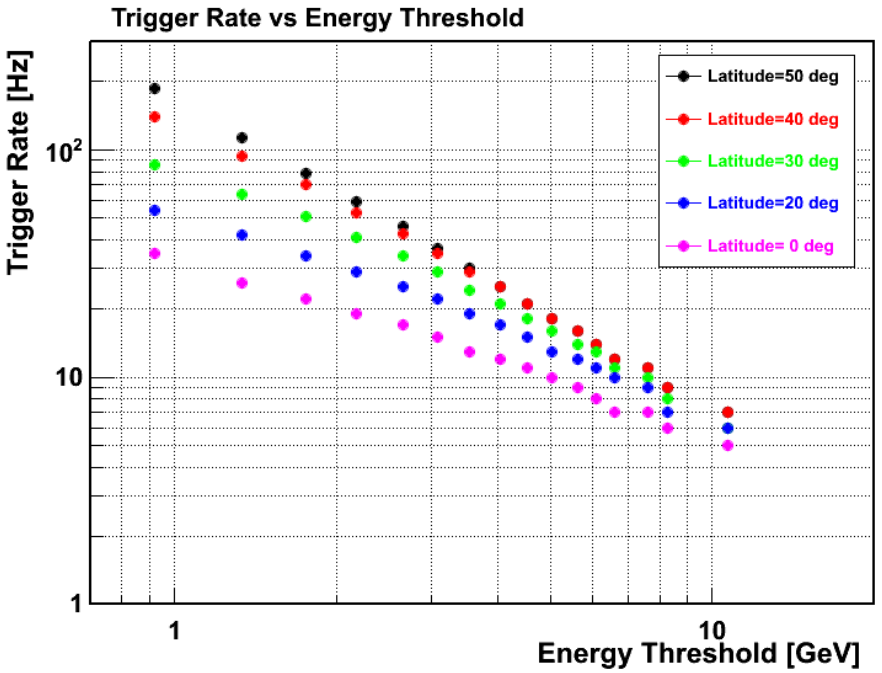
Example of generated schedule command file

Estimation of Shower Trigger rate in ISS Environment

- What to be controlled: DAQ rate (dead time) and data rate (at maximum 600kbps)
- To predict the trigger rate on orbit, threshold dependence of trigger rate was studied using detailed simulation of CALET telemetry data onboard ISS.
- Fundamental knowledge to plan scientific observation

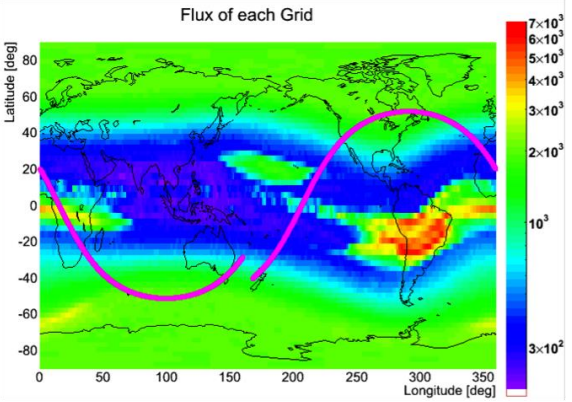


Trigger efficiency for electrons at different LD threshold settings, where an energy threshold is defined as the energy corresponding to the 50% efficiency.

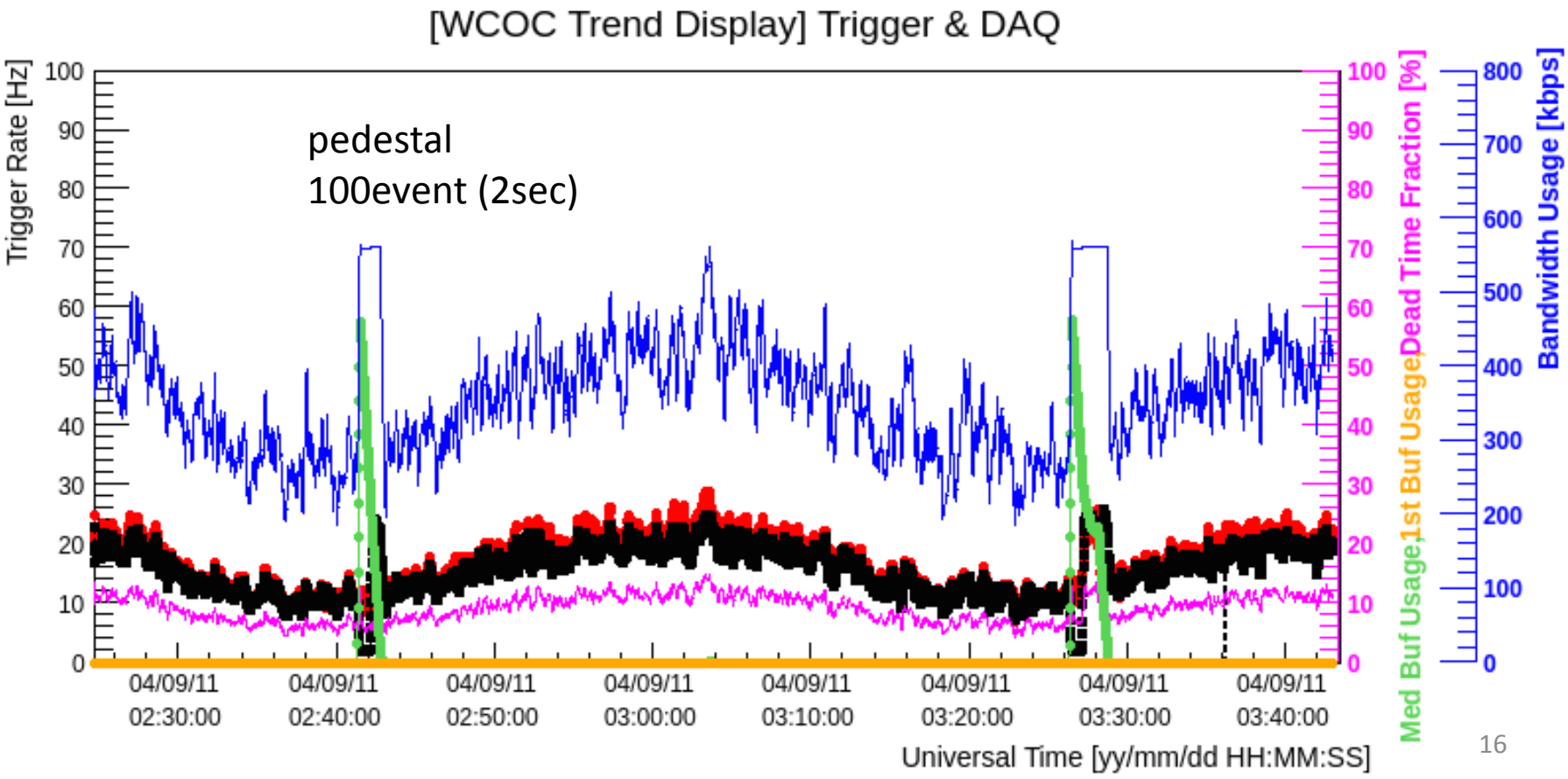


the dependence of trigger rate on energy threshold. Geomagnetic latitude dependence is also shown as different colors.

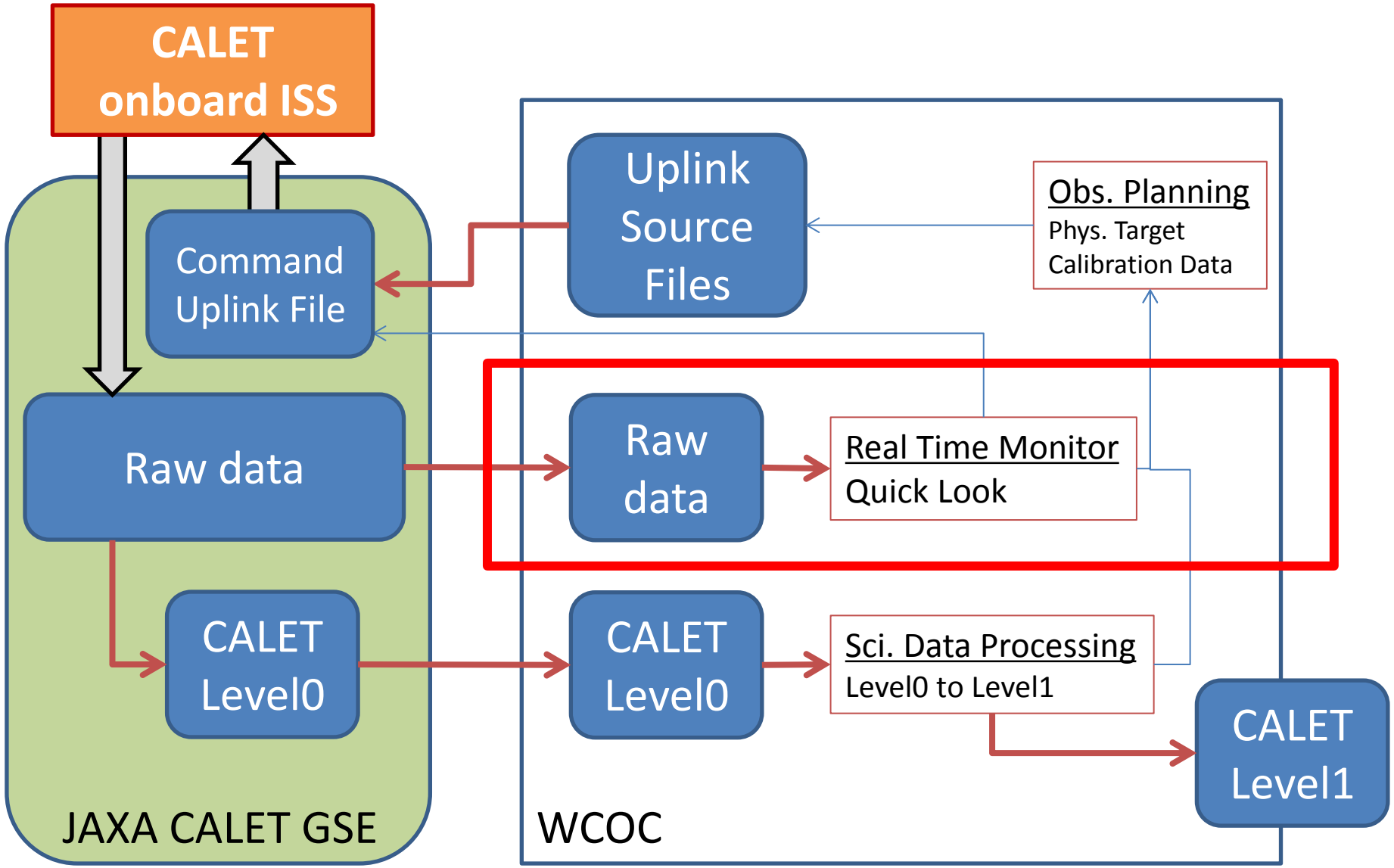
Simulation of Nominal Operation



- Data rate is also checked using simulated telemetry data.
- Nominal HE trigger mode is within data rate limit of 600kbps.
- Not zero-suppressed pedestal data will make the data rate 600kbps, but buffering of the data enables to take data without break and to smear out the data downlink.



CALET Ground System Dataflow Summary



GSE: Ground Support Equipment

Requirements on Real-time Monitoring at WCOC

Temperature

In total 80ch
(Example)
- Panel（7ch）
- CHD（8ch）
- IMC（12ch）
- TASC（14ch）

HV

In total 134ch
(Example)
- CHD-PMT（14×2ch）
- IMC-MaPMT（3×8ch）
- TASC-PMT（16ch）
- DCDC-PMT（2×2ch）

Trigger Rate & LD Count Rate

In total 37 items
(Example)
- Single Trigger Rate
- LE Trigger Rate
- HE Trigger Rate
- CHD LD Count Rate（4 items）

MDC Setting/Status

(Example)
- Power Status
- Trigger Setting
  - Trigger Mask
  - LD Mask
  - LD Threshold
- ISS Orbit Info.

ADC Data

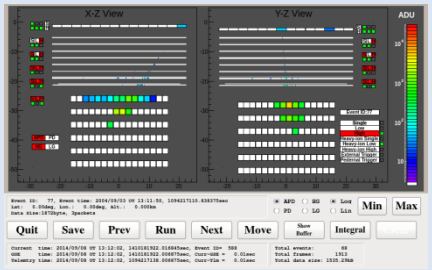
Event Data from CAL
In total 8164ch
- CHD 2×14ch
- IMC 2×4×28 ×33+2×4ch
- TASC 1×12×16+ 11×4×16ch

To monitor the observation status of CALET in real-time, a QL system which summarize and visualizes cosmic-ray event data and housekeeping data was developed.
Since large amount of data must be monitored in real-time in a comprehensive manner, it is necessary to have a capability of automatic detection of malfunctions as well as summarize the data.

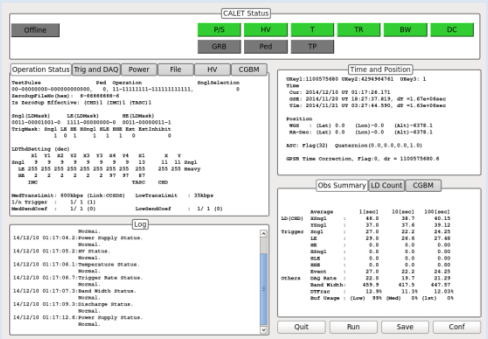
Summary of Real-time Monitoring

Concept of QL Monitoring System

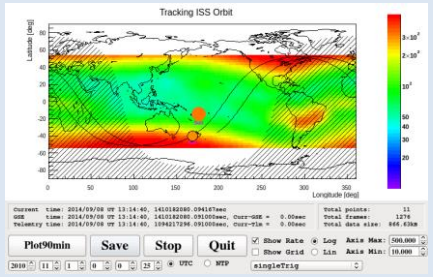
Event Display



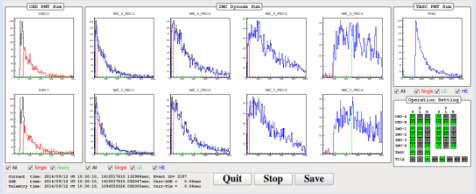
Summary Display



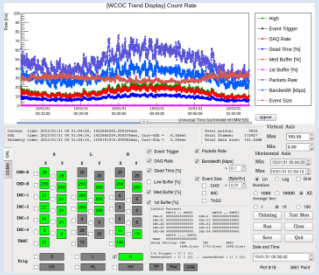
ISS Orbit Monitor



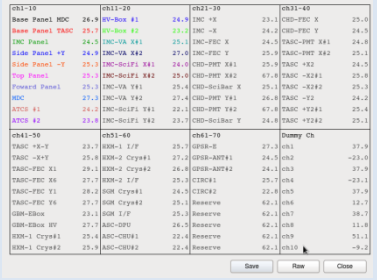
Histogram Monitor



Trend Monitor



Current Data Monitor



Real-time Monitoring of CALET Observations

- WCOC monitors CALET Observation status using Quick Look (QL) Monitor
- 24hr shift will be organized to ensure scientific operations of CALET

Summary of Real-time Monitoring

Concept of QL Monitoring System

Event Display
- Intuitive understanding of the detector status
- Sensor health (dead/noisy channels)

Summary Display
- Showing CALET operation status in ONE WINDOW. Alerting operator by color and sound if something unexpected happens.

ISS Orbit Monitor
- Inform scheduled operation based on orbit prediction
- Check geomagnetic position.

Histogram Monitor
- Obtaining detailed information
- Distributions

Trend Display
- Check temporal variation
- Predict future malfunction and estimate the cause

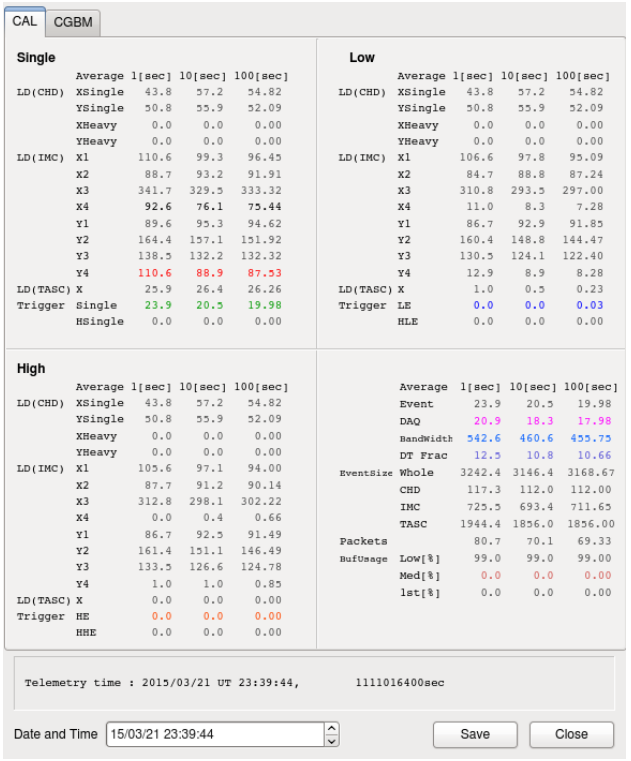
Current Data Monitor
- Obtaining detailed information

Real-time Monitoring of CALET Observations

- WCOC monitors CALET Observation status using Quick Look (QL) Monitor
- 24hr shift will be organized to ensure scientific operations of CALET

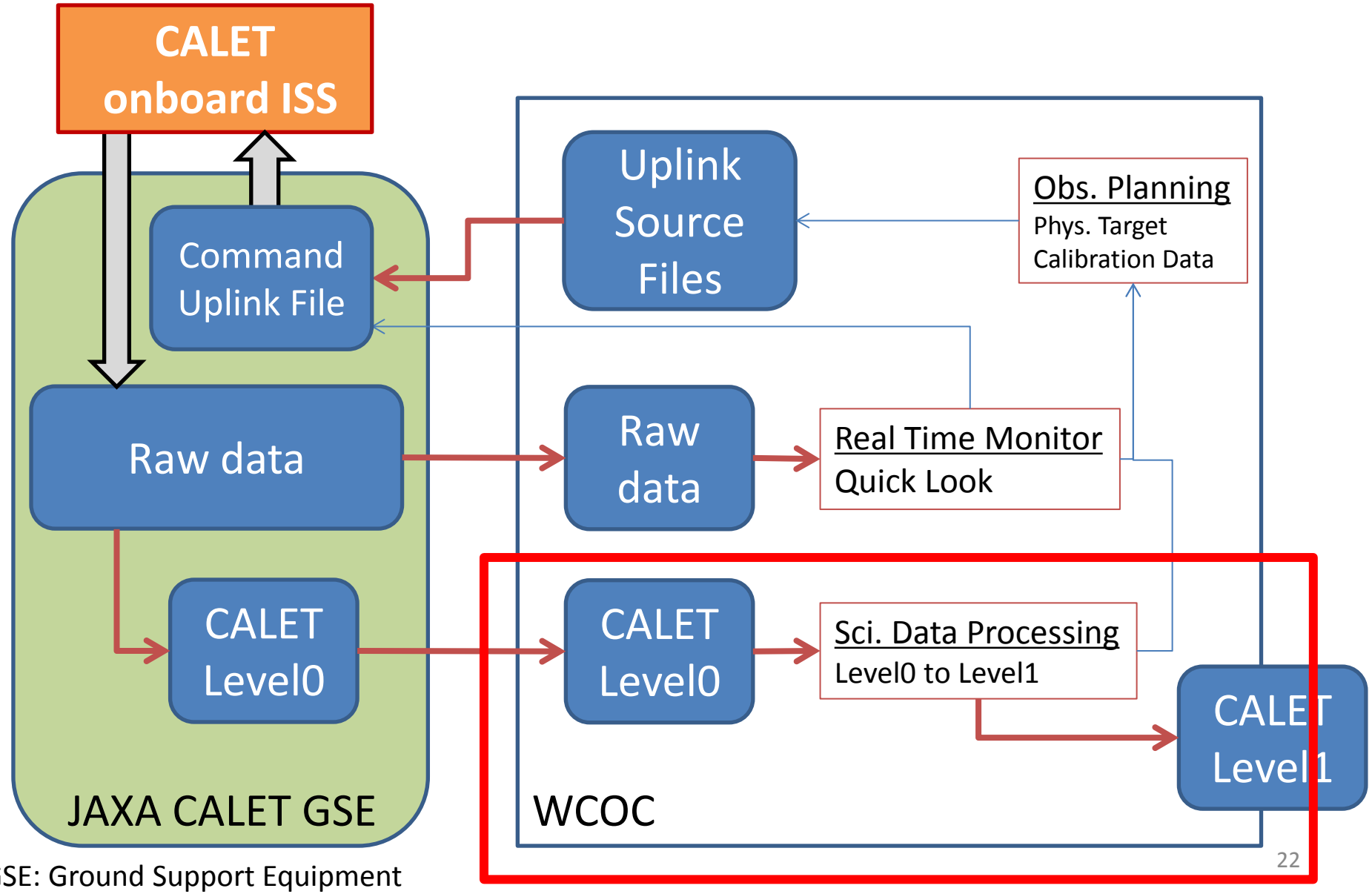
QL Example: Trigger Trend Display

current data monitor



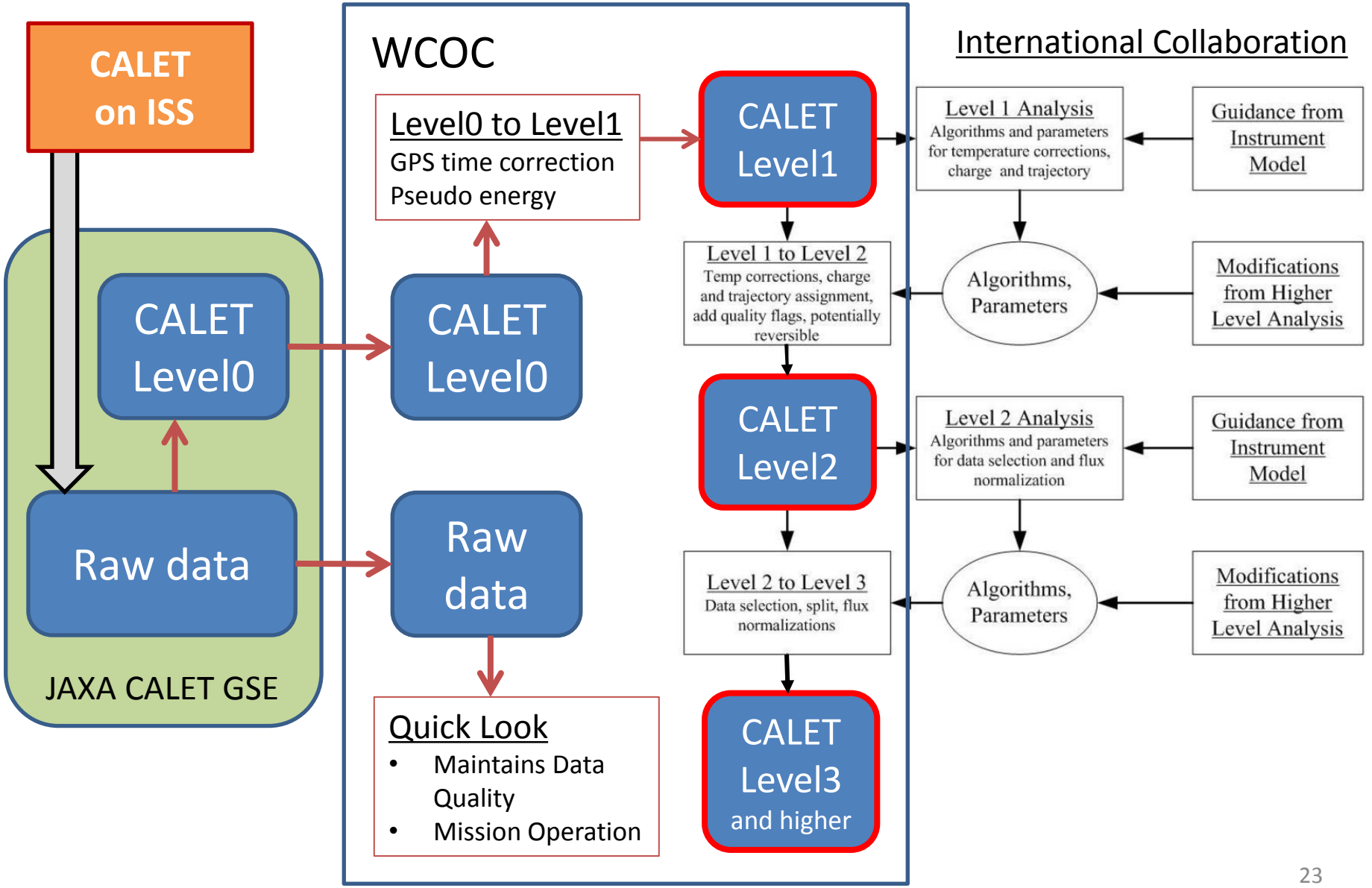
it is possible to check the previous data with slider function. It is also possible to read L0 data as well as real-time socket data

CALET Ground System Dataflow Summary



GSE: Ground Support Equipment

Analysis Procedure (As defined in DPAP)



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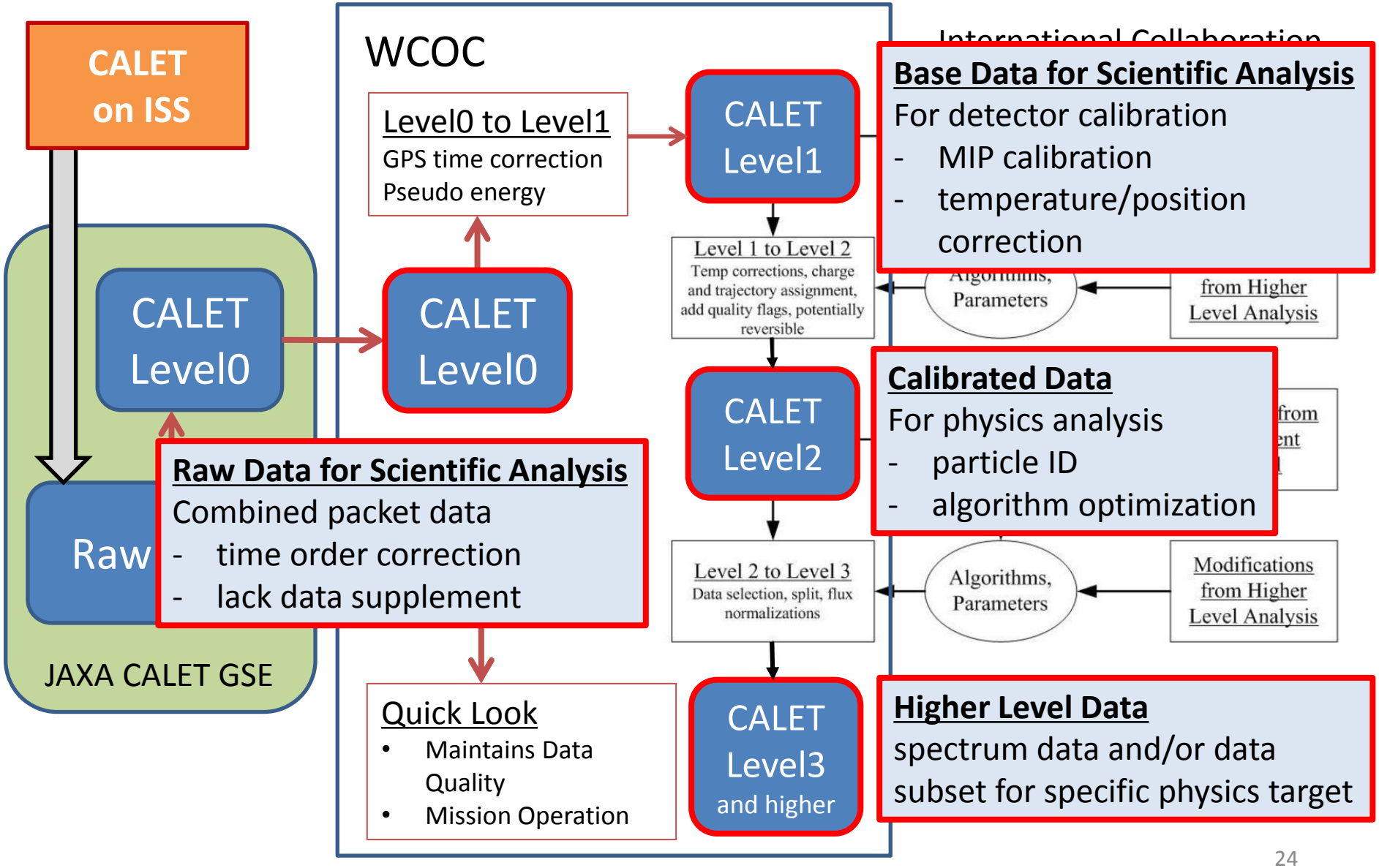

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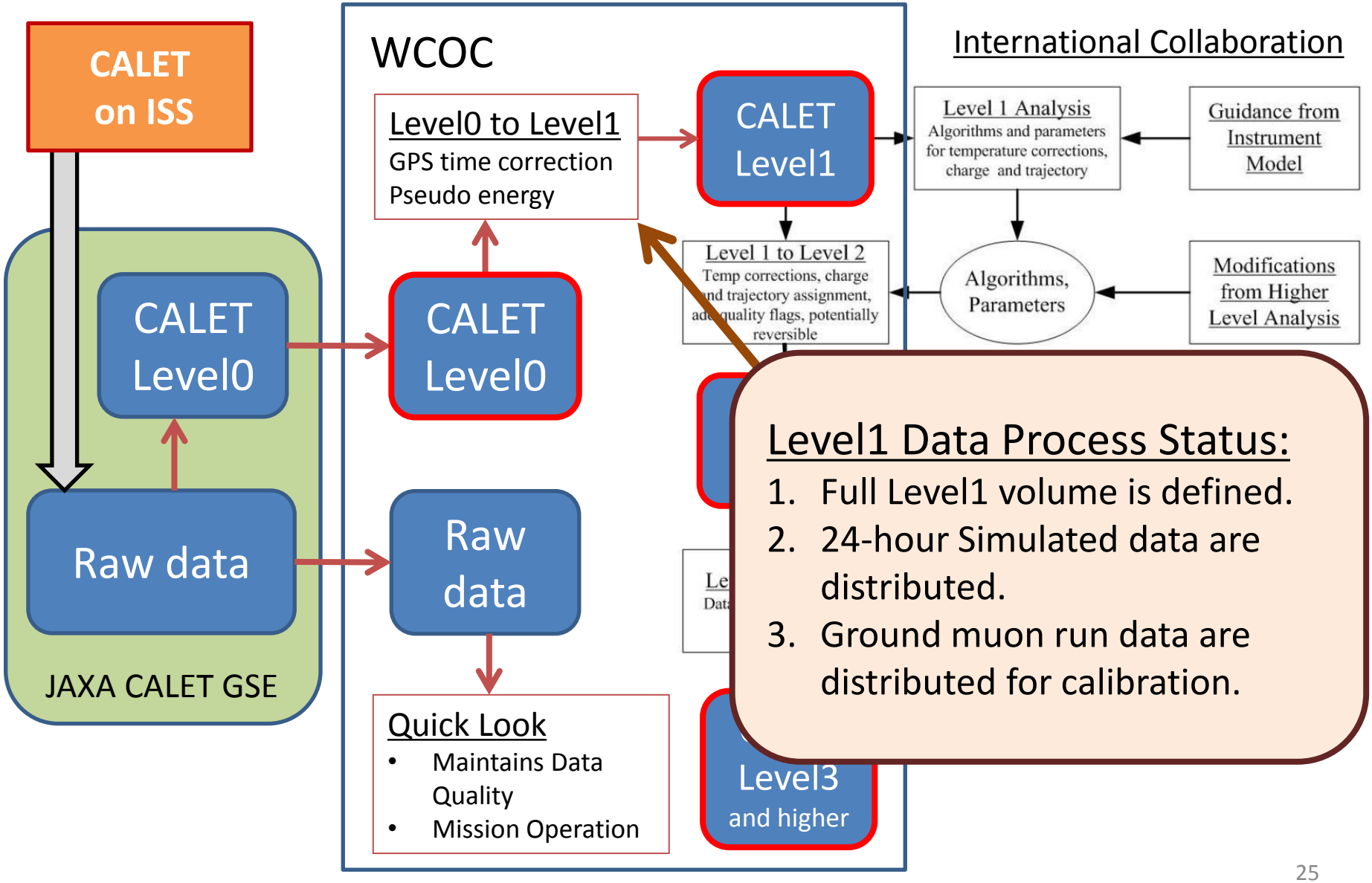

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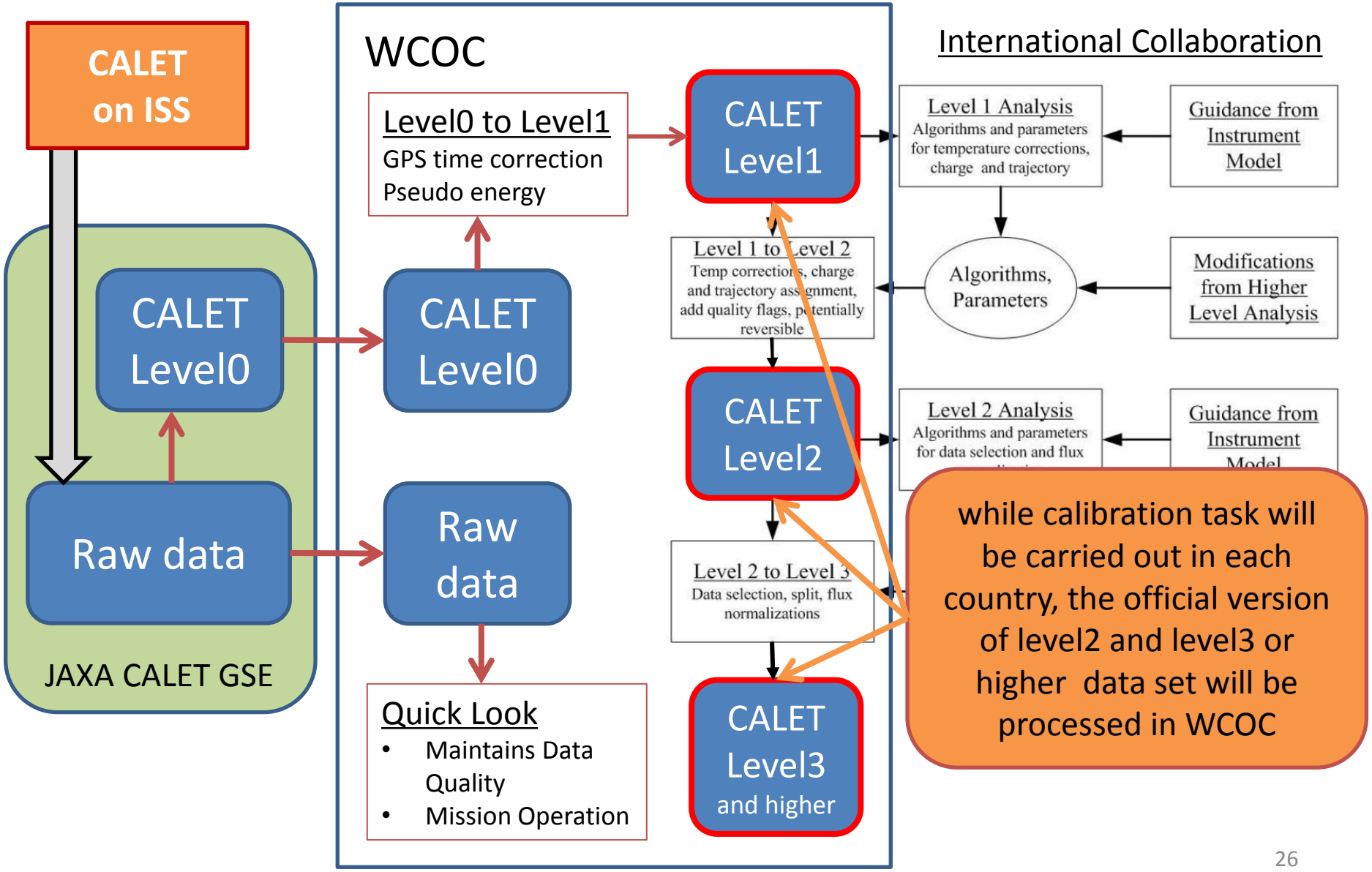

Summary and Prospects

1. Roles of WCOC

1. Operation Planning
2. Real-Time Monitoring
3. Science Data Processing

Scientific Operations of CALET

2. WCOC Preparation Status

1. Completed whole test including End-to-End Test using CALET PFM.
2. Completed the development of Real-Time Monitoring system and Level1 data production system.
3. Preparation of operation planning made a significant progress, and remaining part will be finalized during checkout phase.
4. Operation training is in progress with science team members in Japan and will be finished in July.

Consistent with the schedule of CALET project