

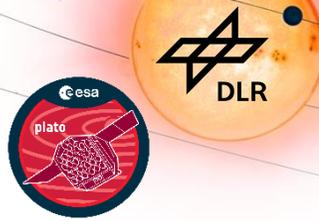


Real-Time Hardware-in-the-Loop Test Configuration

Use Case for the Fine Guidance System of
PLATO

Dona Sandu, Gabriel Jörg Schwarzkopf, Ulrike Witteck, Gisbert Peter,
Claas Ziemke, Denis Grießbach, Karsten Westerdorff, Eilke Santjer, and
Bernd Ulmer

Agenda



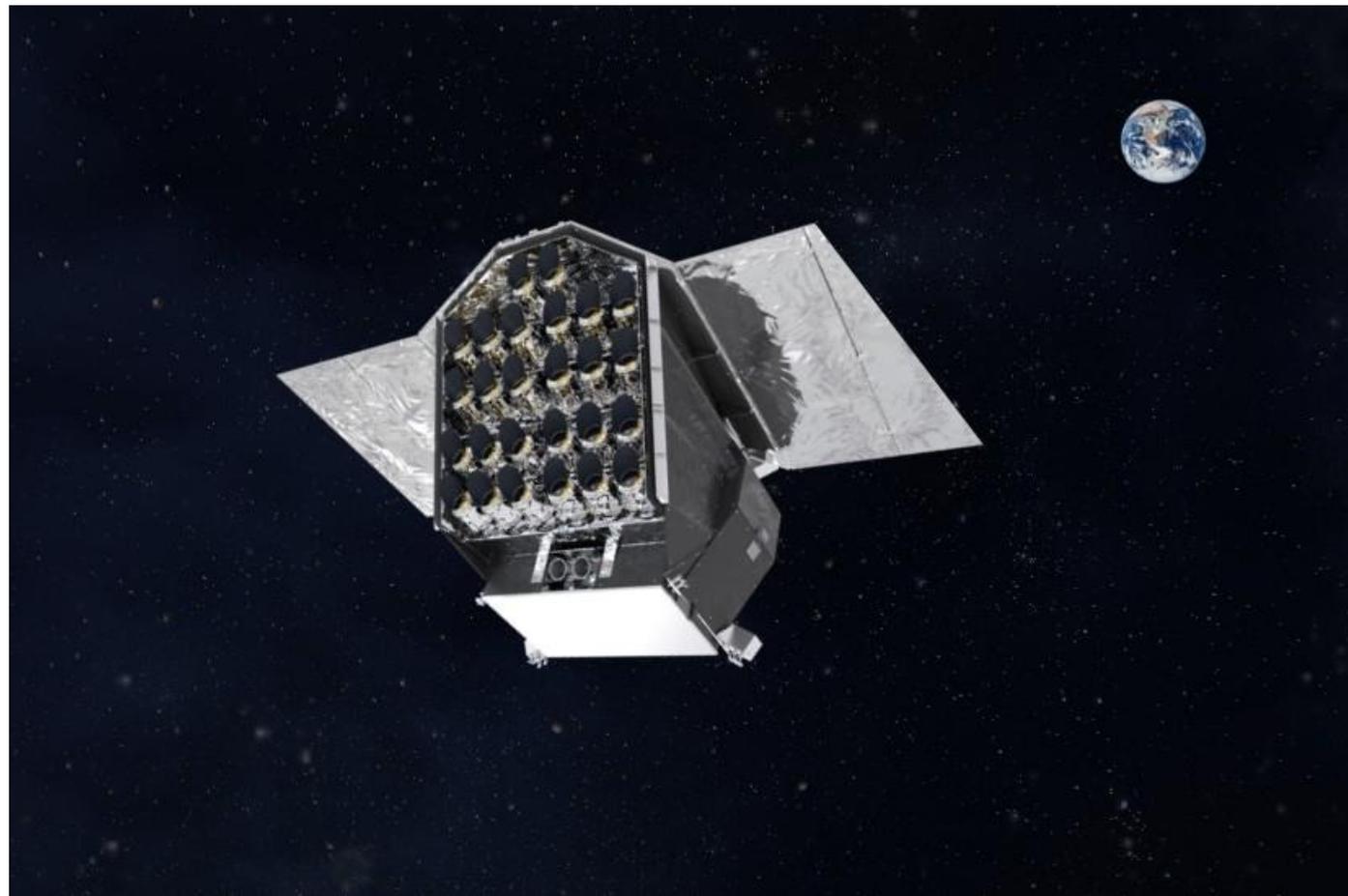
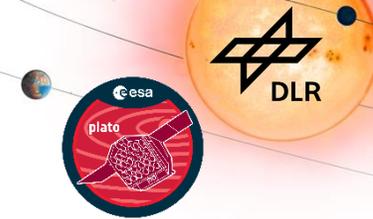
1. Motivation
2. PLATO Data Processing and the Fine Guidance System
3. Hardware-in-the-Loop Test Configuration
4. Test Automation
5. Test Data Archiving
6. Summary



Real-Time Hardware-in-the-Loop Test Configuration for the Fine Guidance System of PLATO

MOTIVATION

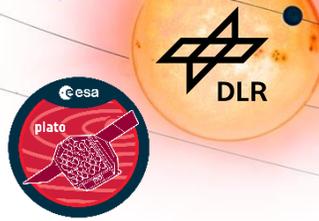
Motivation



PLATO Spacecraft

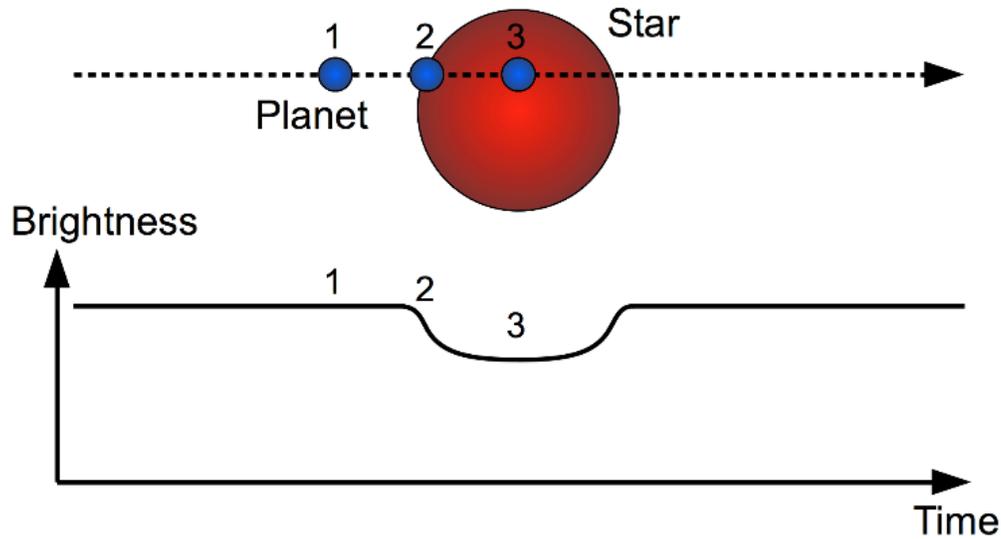
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Motivation

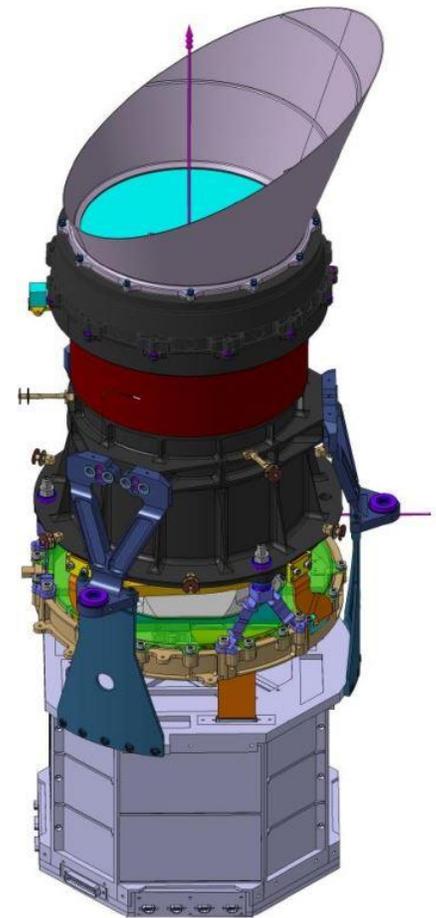


PLANetary Transits and Oscillation of stars (PLATO)

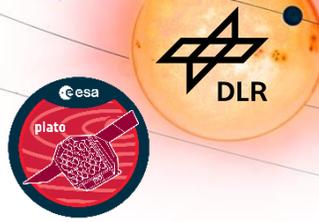
- characterization of exoplanets
 - radius
 - mass
 - age
- multi-camera approach
 - 24 normal cameras
 - 2 fast cameras



© Hans Deeg



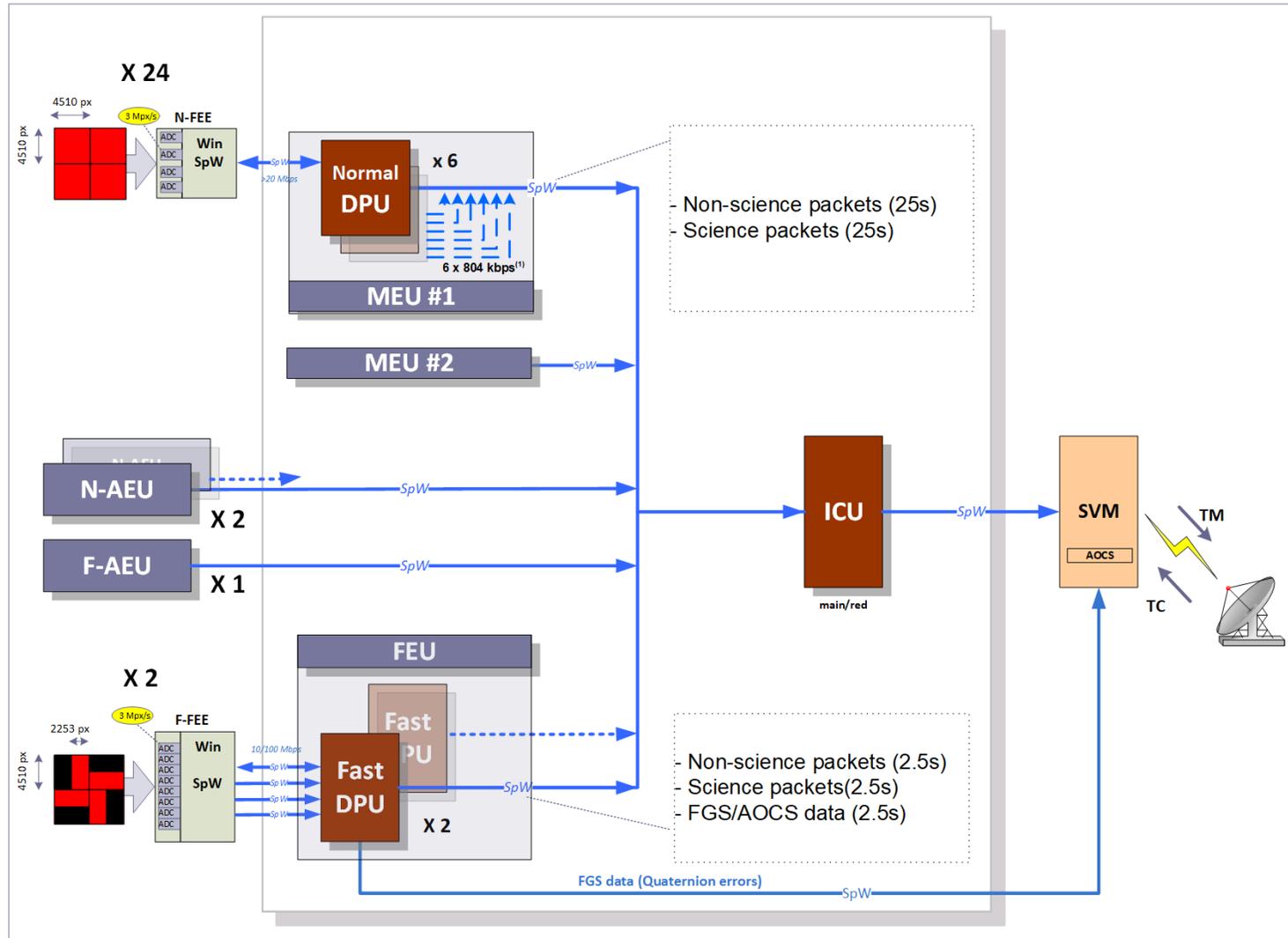
PLATO Fast Camera



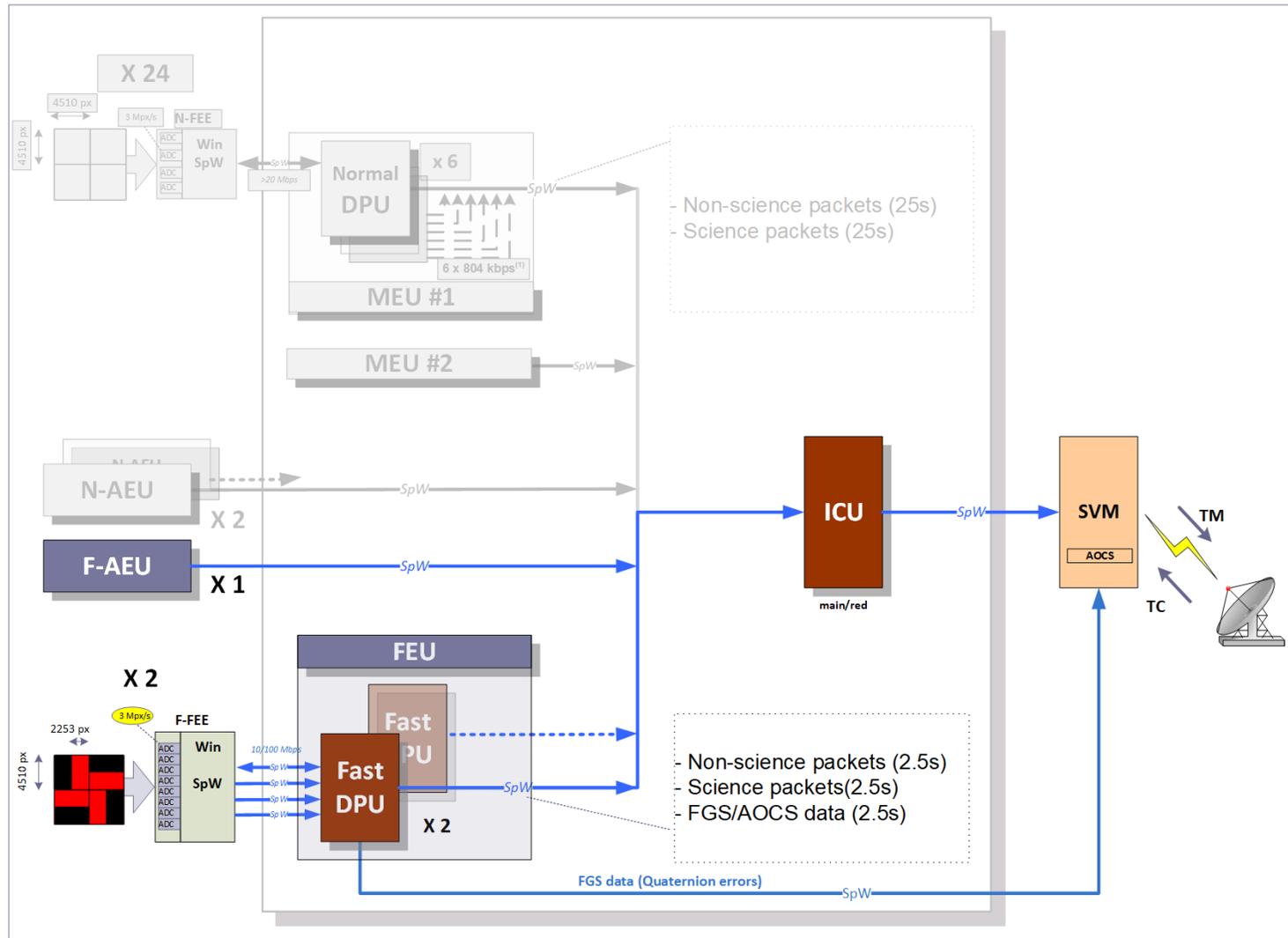
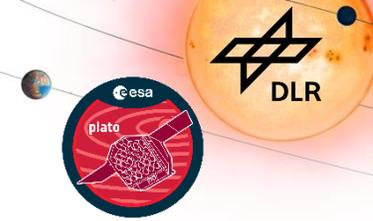
Real-Time Hardware-in-the-Loop Test Configuration for the Fine Guidance System of PLATO

PLATO DATA PROCESSING AND THE FINE GUIDANCE SYSTEM

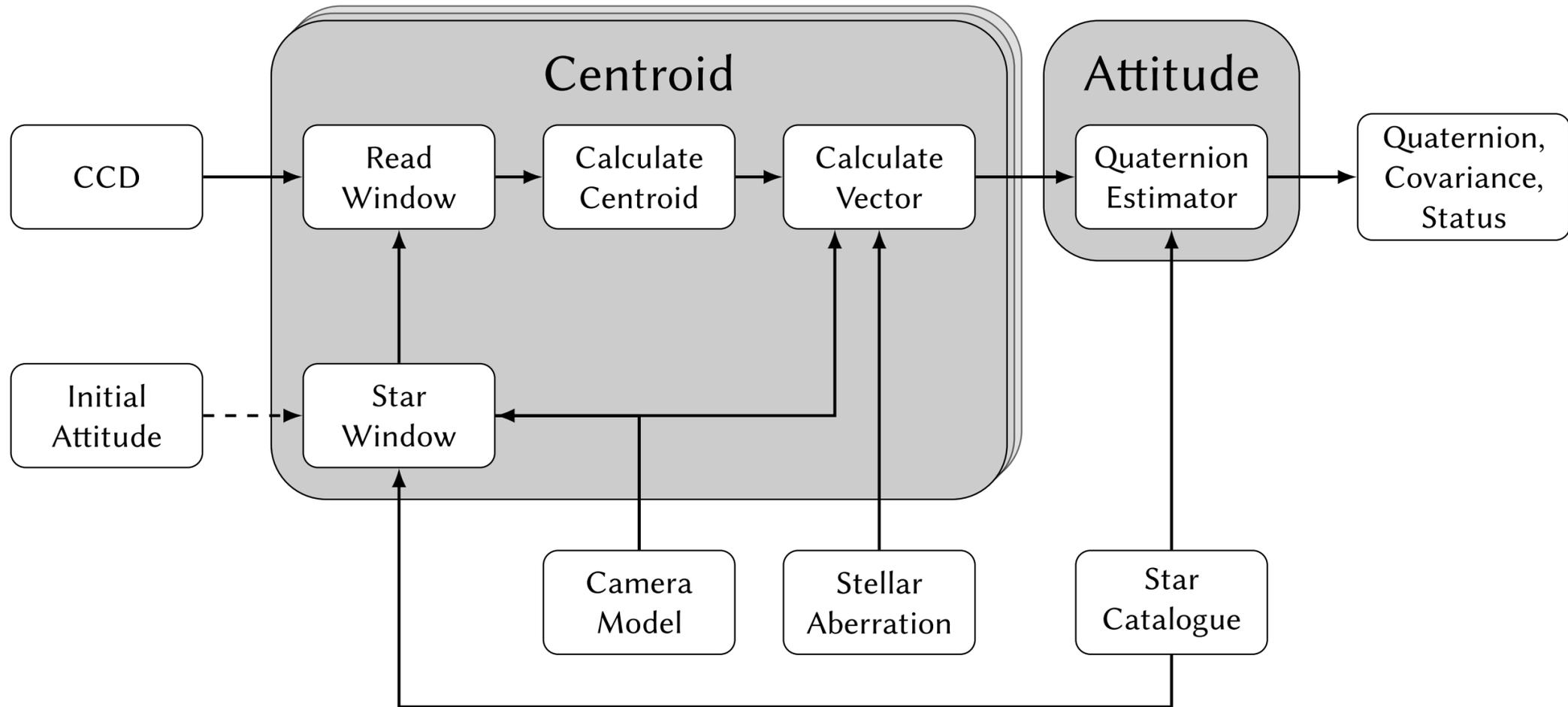
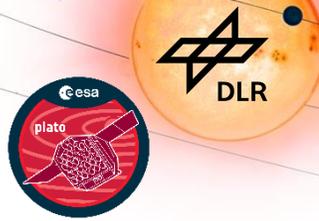
Data Processing System (DPS)



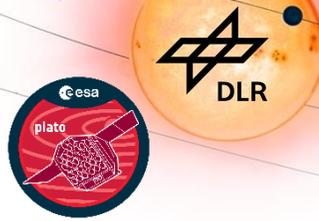
Data Processing System (DPS)



Fine Guidance System (FGS)



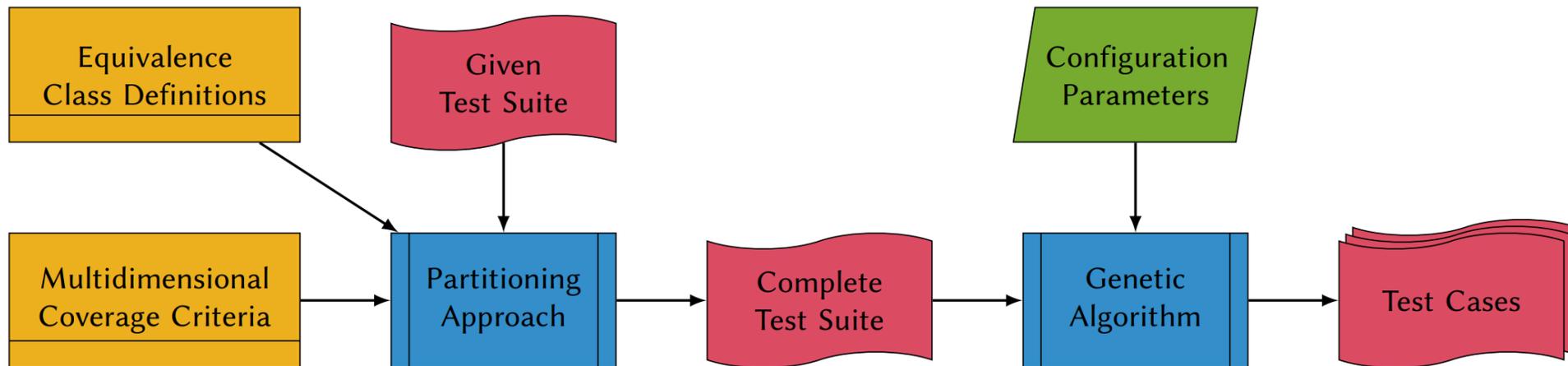
FGS Verification



Problem: impossible to execute all possible test cases

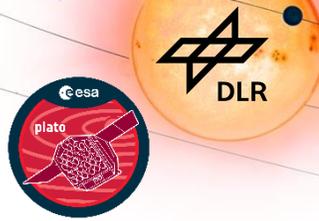
Goal: automatically and systematically select test cases that cause critical behavior

Solution:



Ref.1 "Equivalence Class Definition for Automated Testing of Satellite On-Board Image Processing": https://link.springer.com/chapter/10.1007/978-3-030-52991-8_1

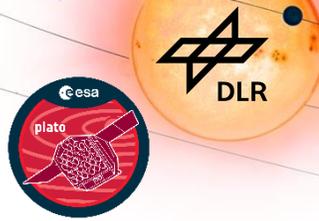
Ref.2 "A Genetic Algorithm for Automated Test Generation for Satellite On-board Image Processing Applications": <https://www.scitepress.org/PublicationsDetail.aspx?ID=4L4FNRbfcX0=&t=1>



Real-Time Hardware-in-the-Loop Test Configuration for the Fine Guidance System of PLATO

HARDWARE-IN-THE-LOOP TEST CONFIGURATION

Why Simulators & Hardware-in-the-Loop?



- Availability of missing units
 - Cameras
 - Spacecraft
- Non-representative optical stimulation of cameras on-ground

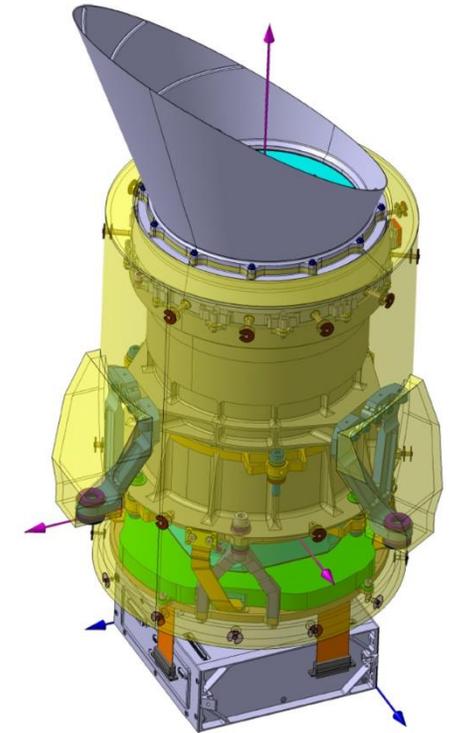
PLATO Spacecraft



Payload Module (PLM)



Service Module (SVM)

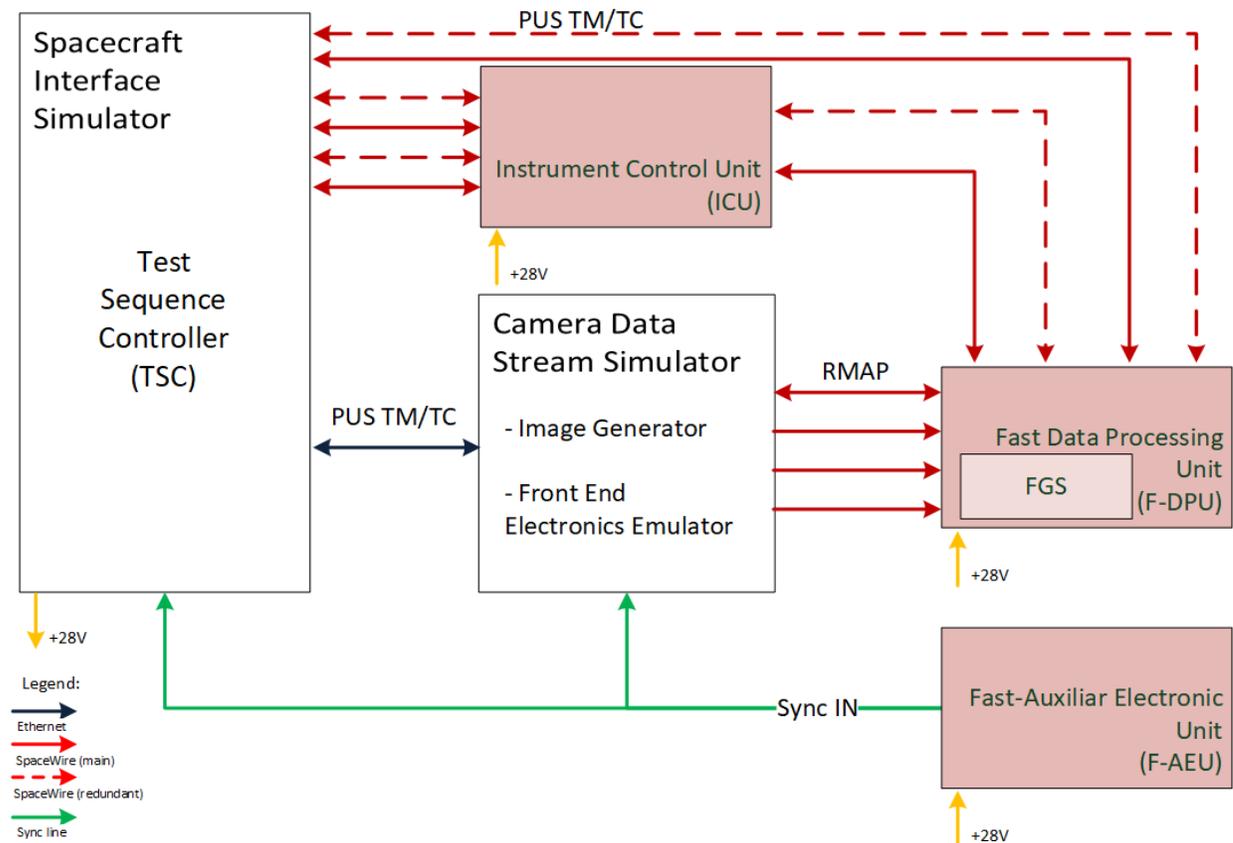


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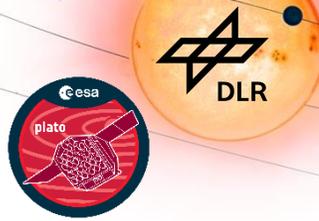
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Hardware-in-the-loop Environment

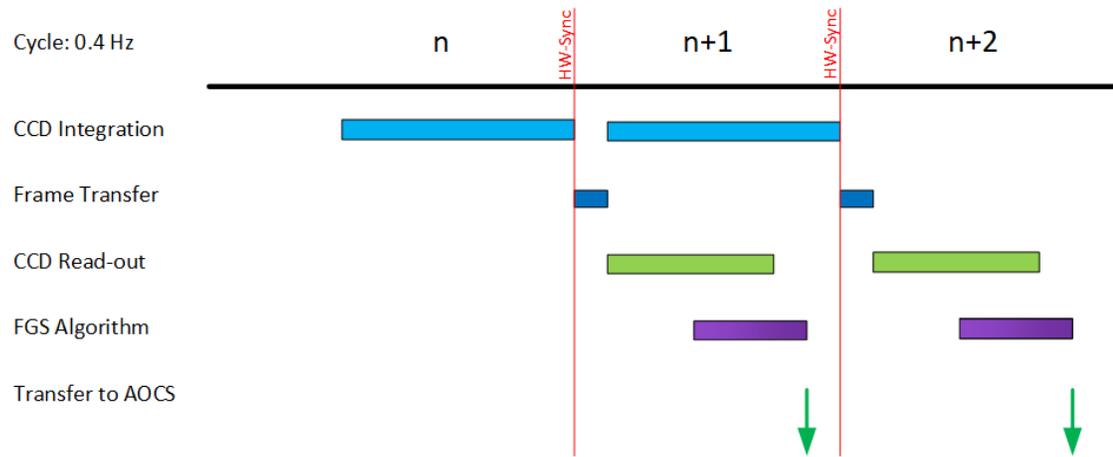
1. Real payload units
2. Simulate spacecraft interface
3. Simulate camera
4. Simulate camera effects
5. Simulate sky



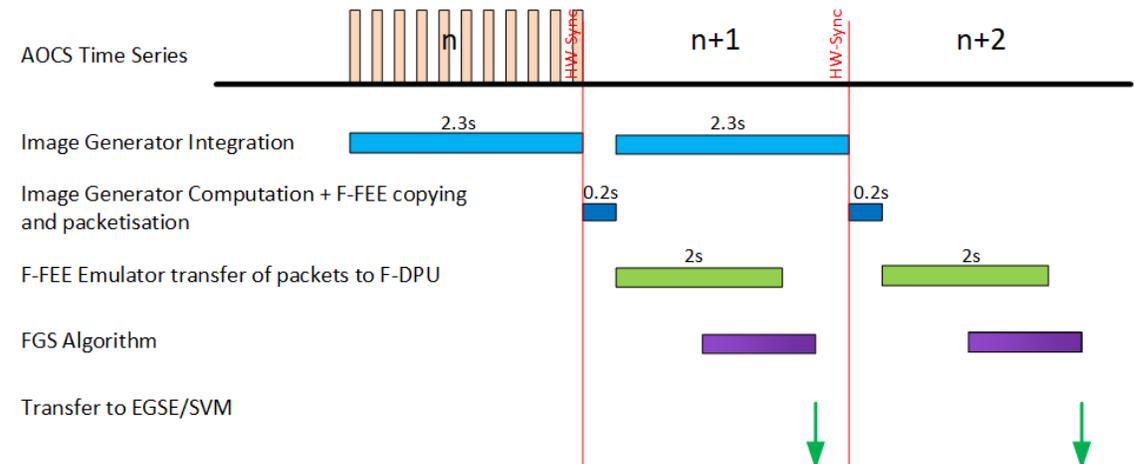
Timing



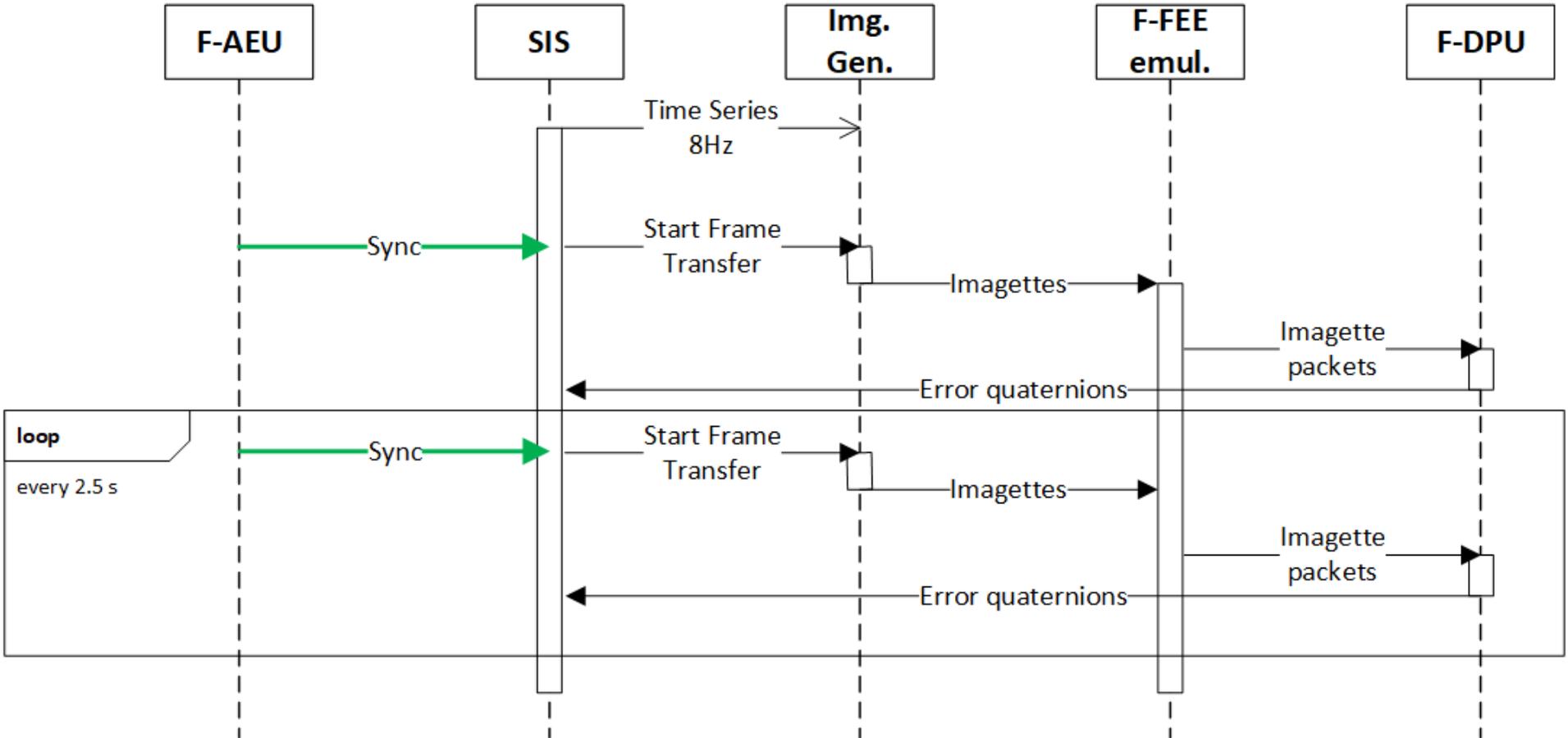
Real system



Simulated system



Synchronization Strategy

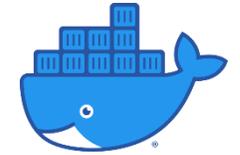
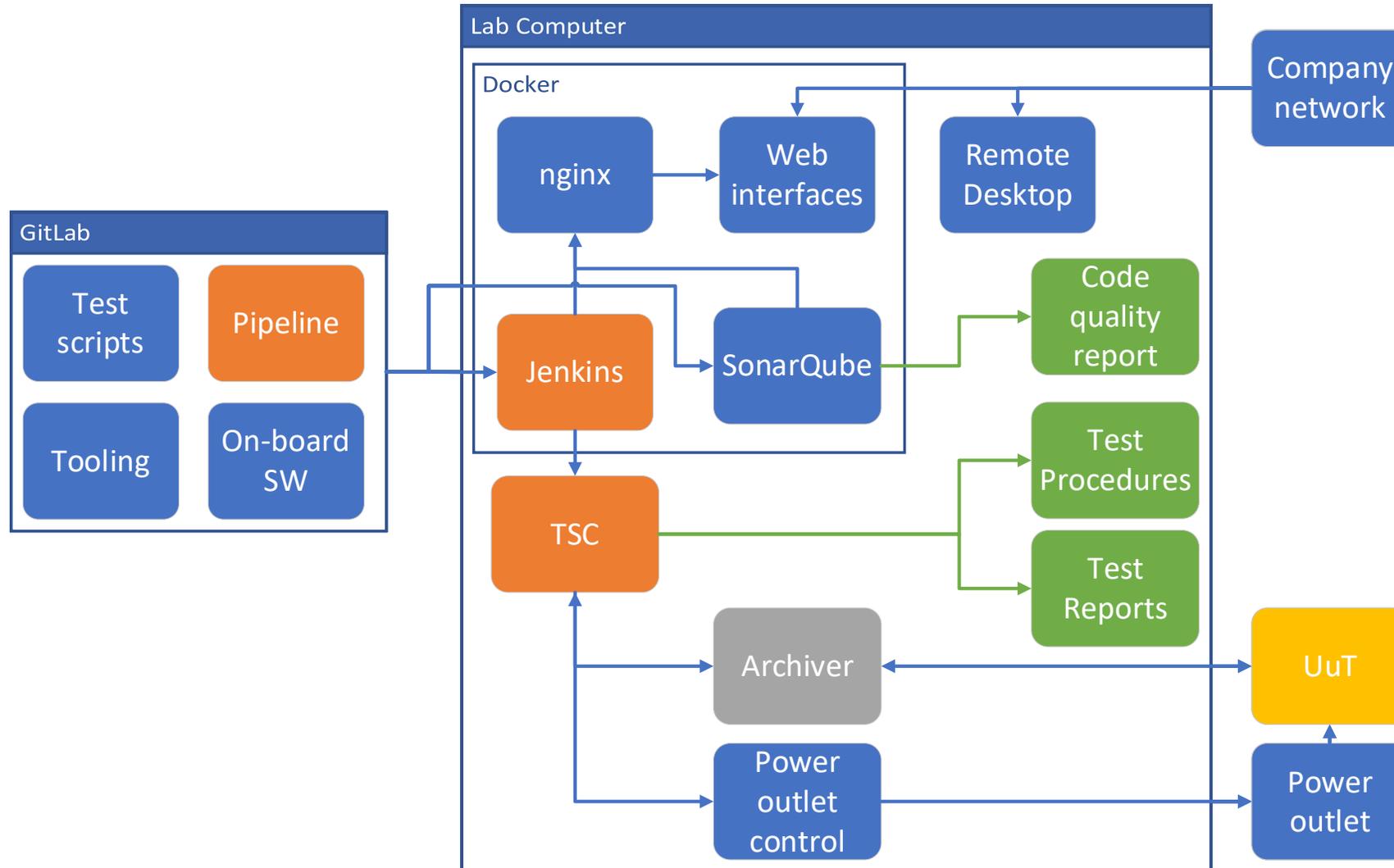
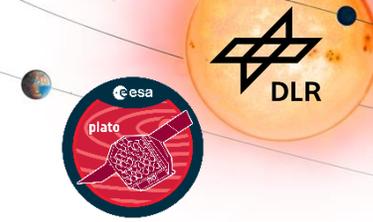




Real-Time Hardware-in-the-Loop Test Configuration for the Fine Guidance System of PLATO

TEST AUTOMATION

Test Automation Environment



Jenkins

sonarqube

NGINX

GitLab

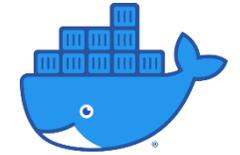
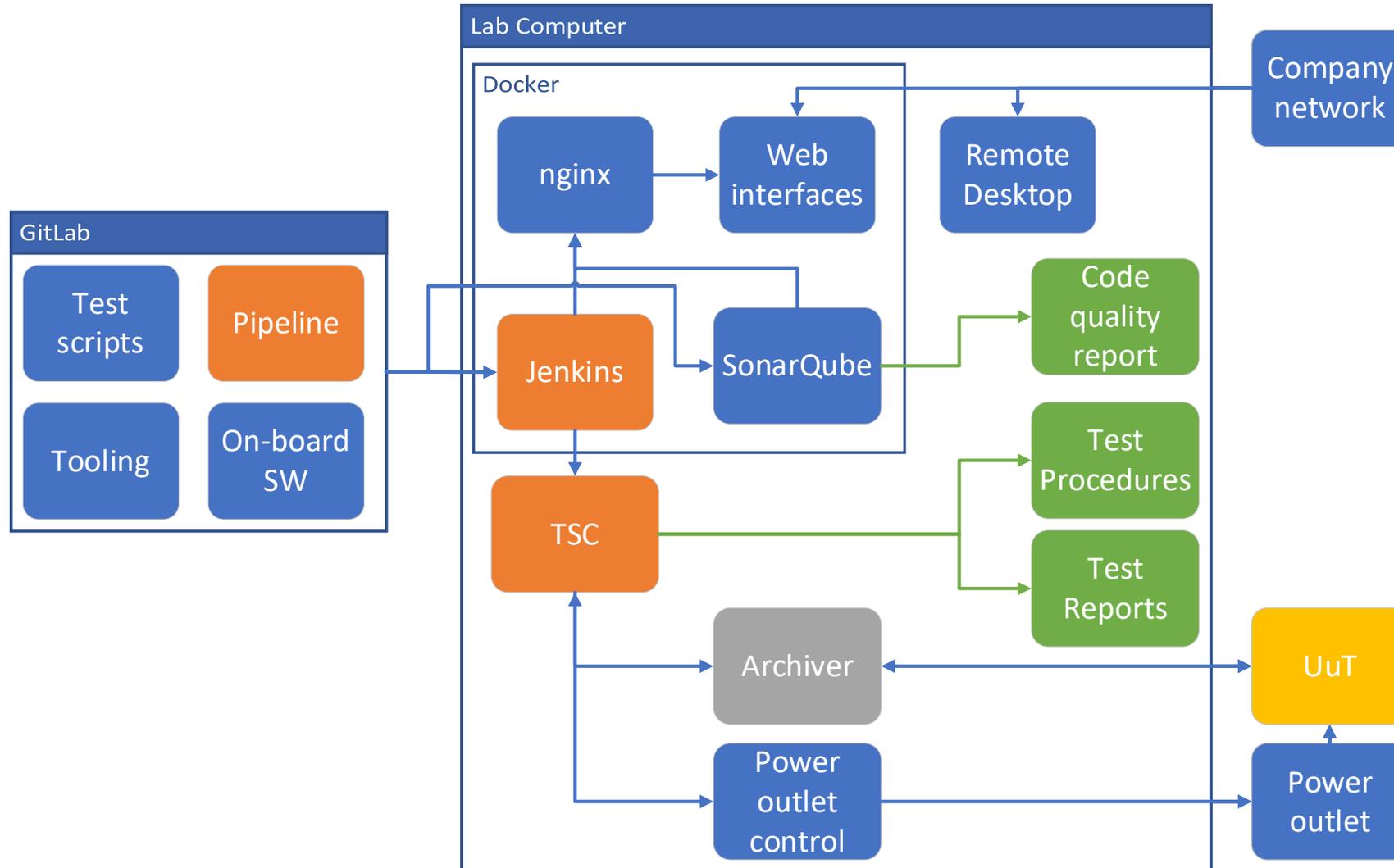
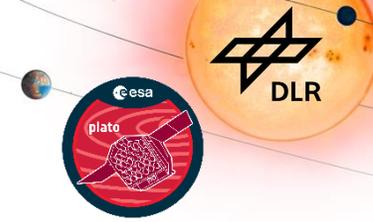




Real-Time Hardware-in-the-Loop Test Configuration for the Fine Guidance System of PLATO

TEST DATA ARCHIVING

Test Automation Environment



Jenkins

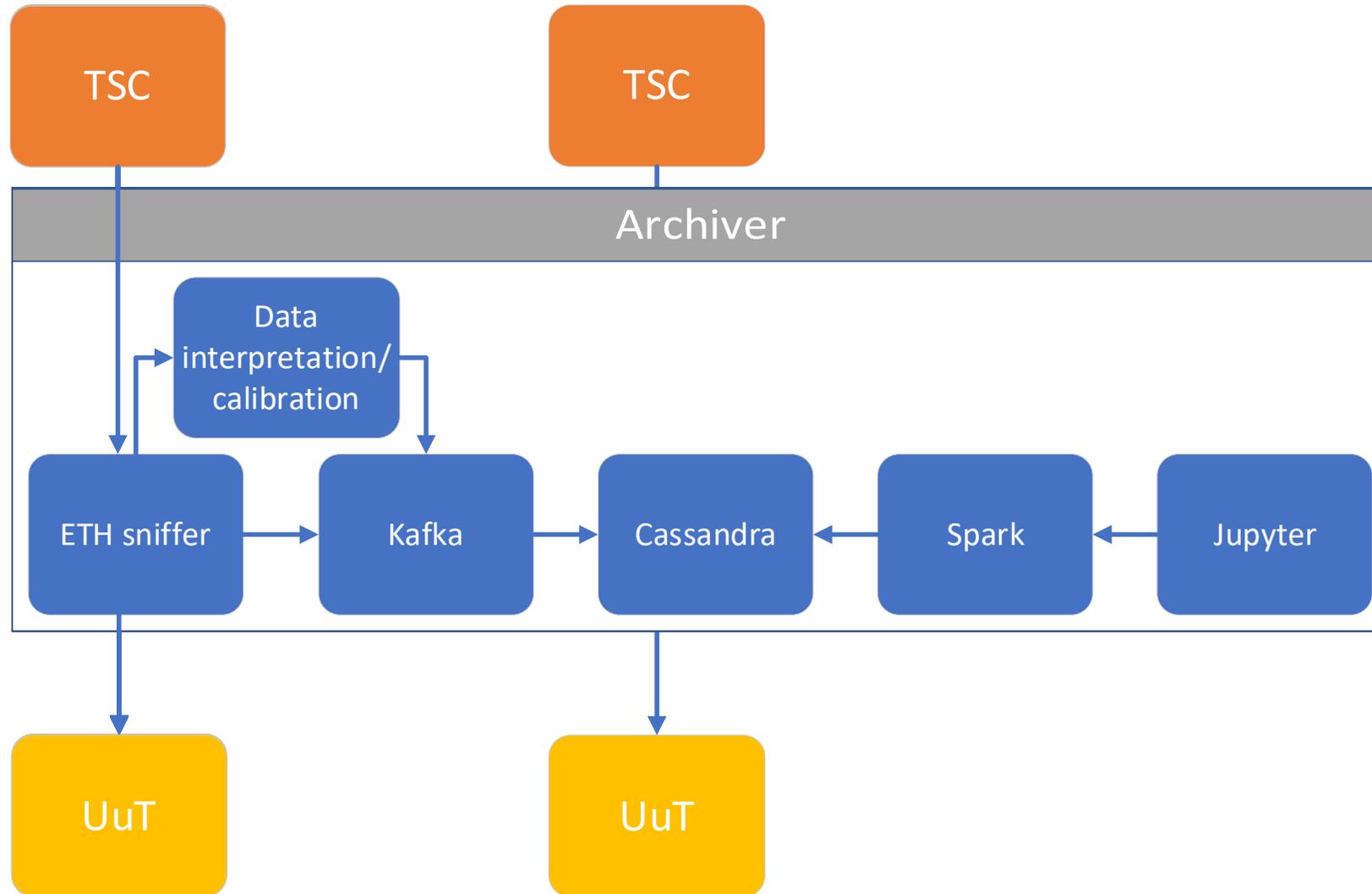
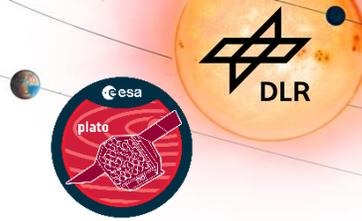
sonarqube

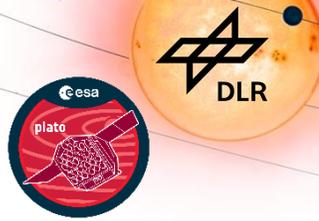
NGINX

GitLab



Data Archiving

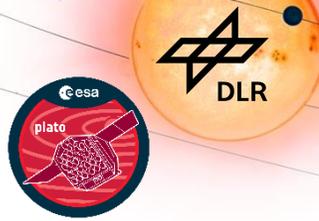




Real-Time Hardware-in-the-Loop Test Configuration for the Fine Guidance System of PLATO

SUMMARY

Summary



Challenge

Complex image processing algorithm on-ground verification

- ★ Hardware-in-the-Loop Test Configuration with simulators
- ★ Test automation for reproducibility
- ★ Single source of truth – test scripts
- ★ Data archiving for offline analysis at any time
- ★ Technologies deployable in other projects