MBSE-based Development of the Athena WFI ICPU

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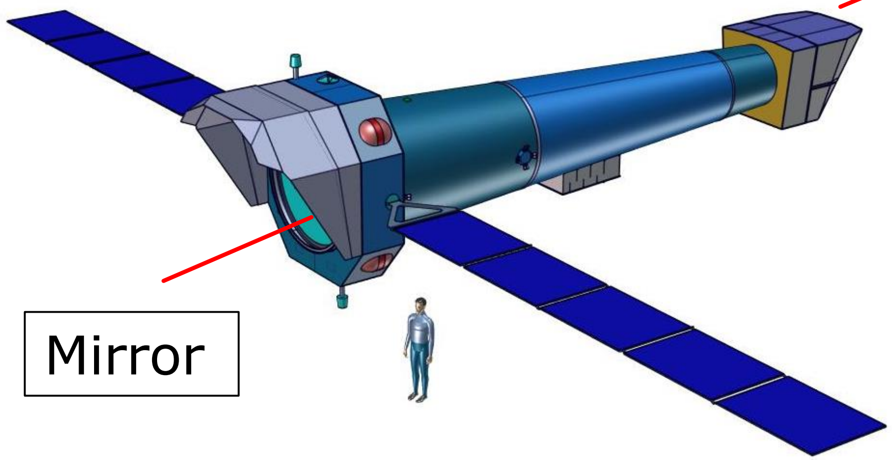
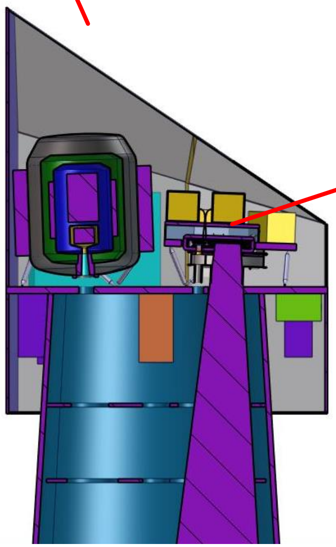
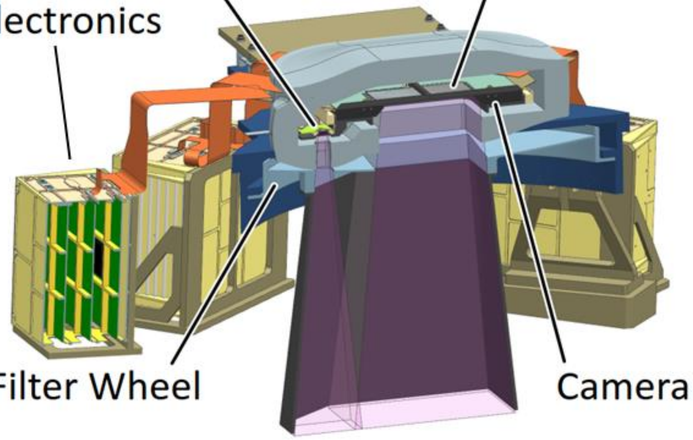
MBSE Workshop, 2020

ATHENA SATELLITE

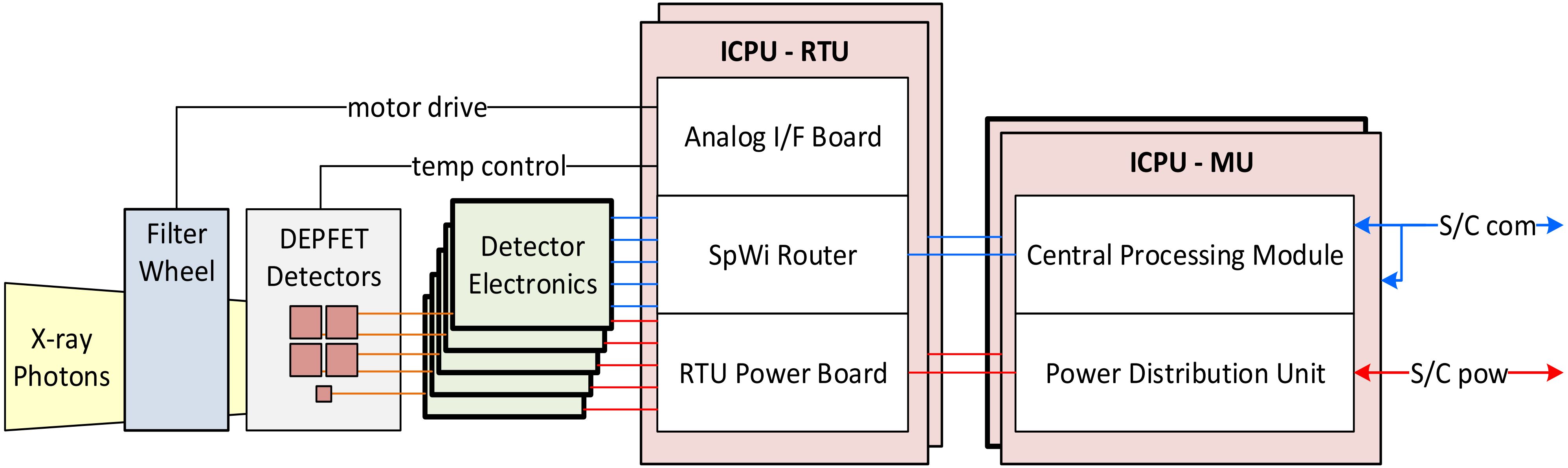






- Spacecraft mass ≈ 6 tons
- Mission lifetime 4+5 years
- Launch data ≈ 2032

WFI - ICPU

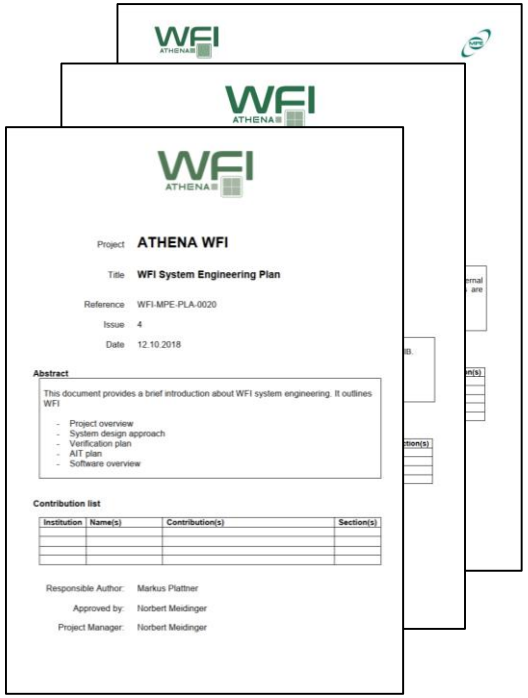


Instrument Control and Power Distribution Unit (ICPU)

- combines the data streams of the DEs
- is the secondary power supply of WFI
- controls the WFI instrument and performs house keeping

MODEL BASED SYSTEM ENGINEERING

Document based
System Engineering


ATHENA

Project ATHENA WFI

Title WFI System Engineering Plan

Reference WFI-MPE-PLA-0020

Issue 4

Date 12.10.2018

Abstract

This document provides a brief introduction about WFI system engineering. It outlines WFI

- Project overview
- System design approach
- Verification plan
- AIT plan
- Software overview

Contribution list

Institution	Name(s)	Contribution(s)	Section(s)

Responsible Author: Markus Plattner

Approved by: Norbert Meidinger

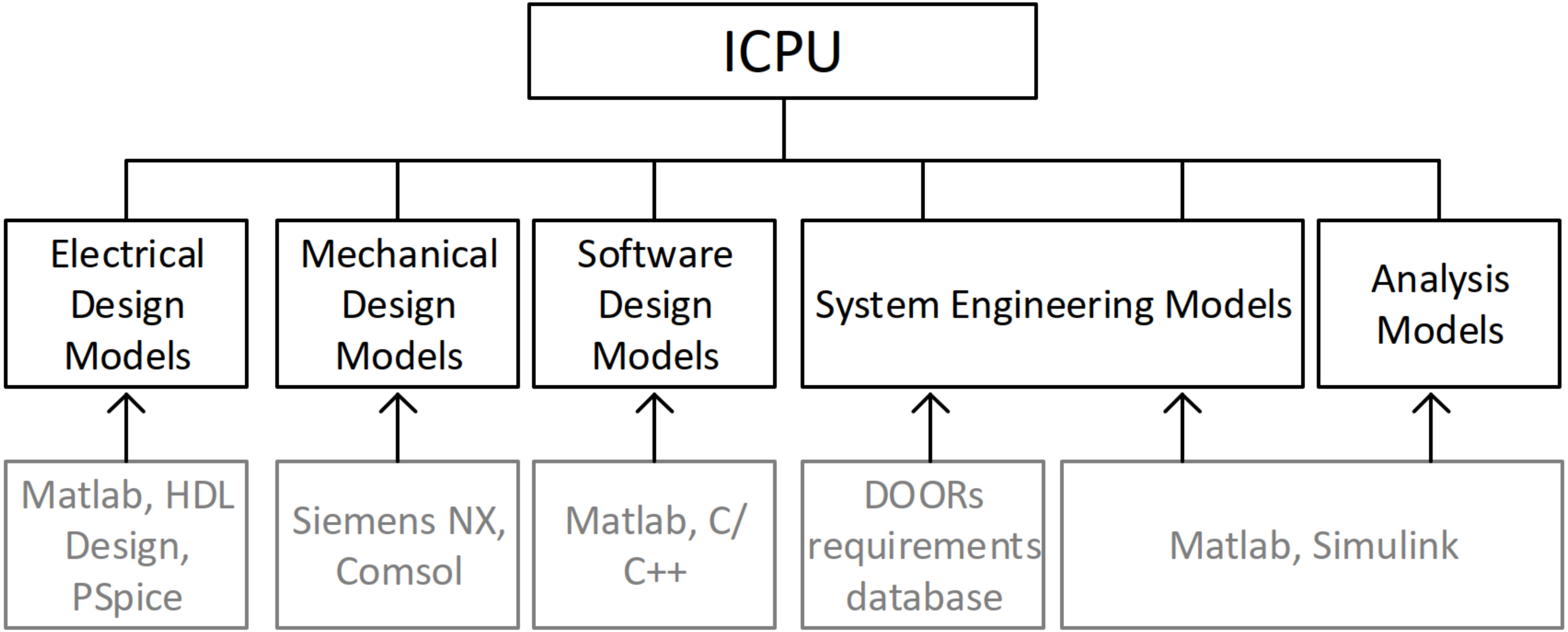
Project Manager: Norbert Meidinger

Moving from document centric to model centric

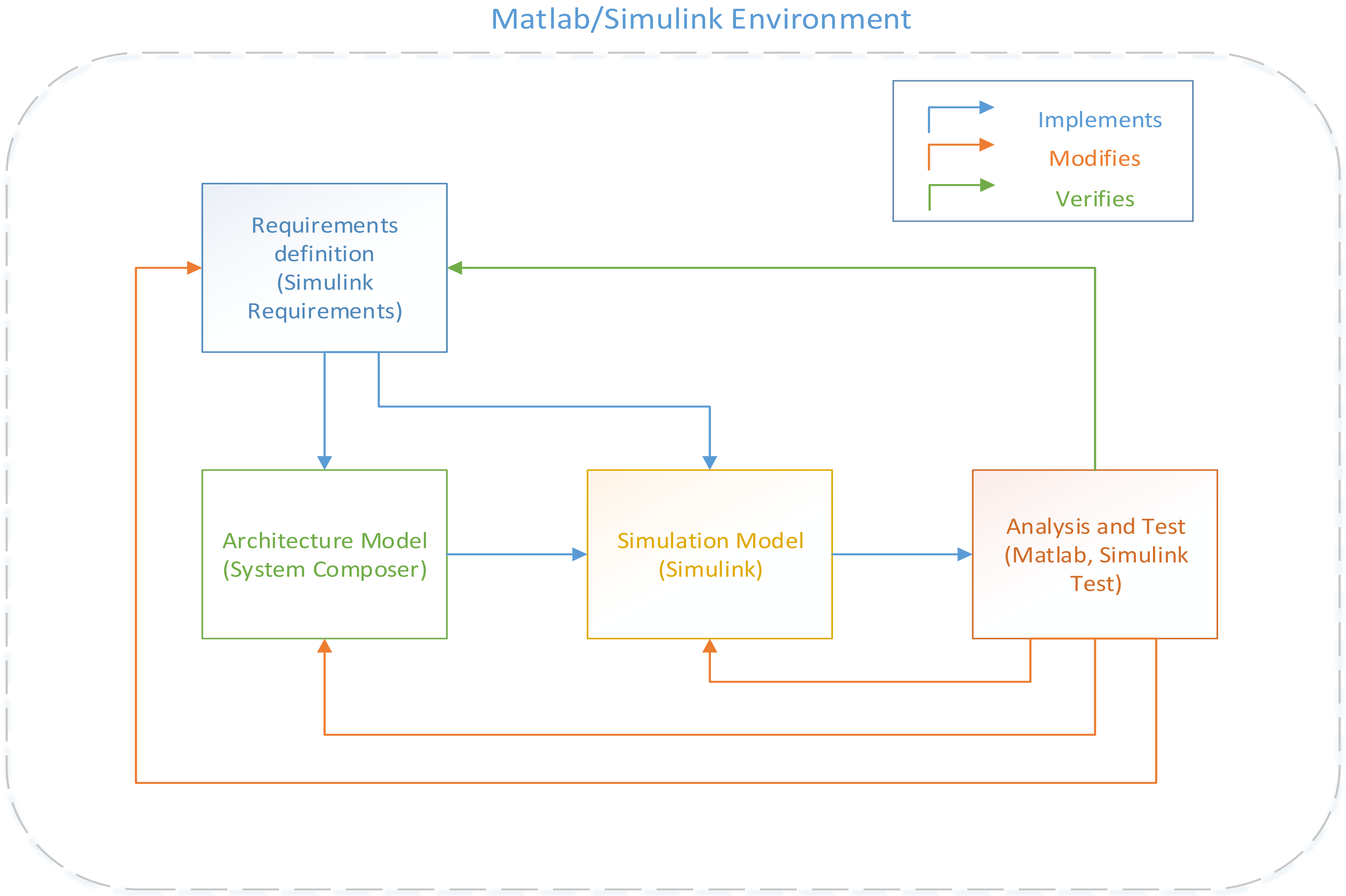
Model based
System Engineering

- Consistent and complete I/F management
- Track all changes during development and system Specification
- Capture, analyze, share and manage the requirements among the ICPU consortium
- Holistic requirements engineering

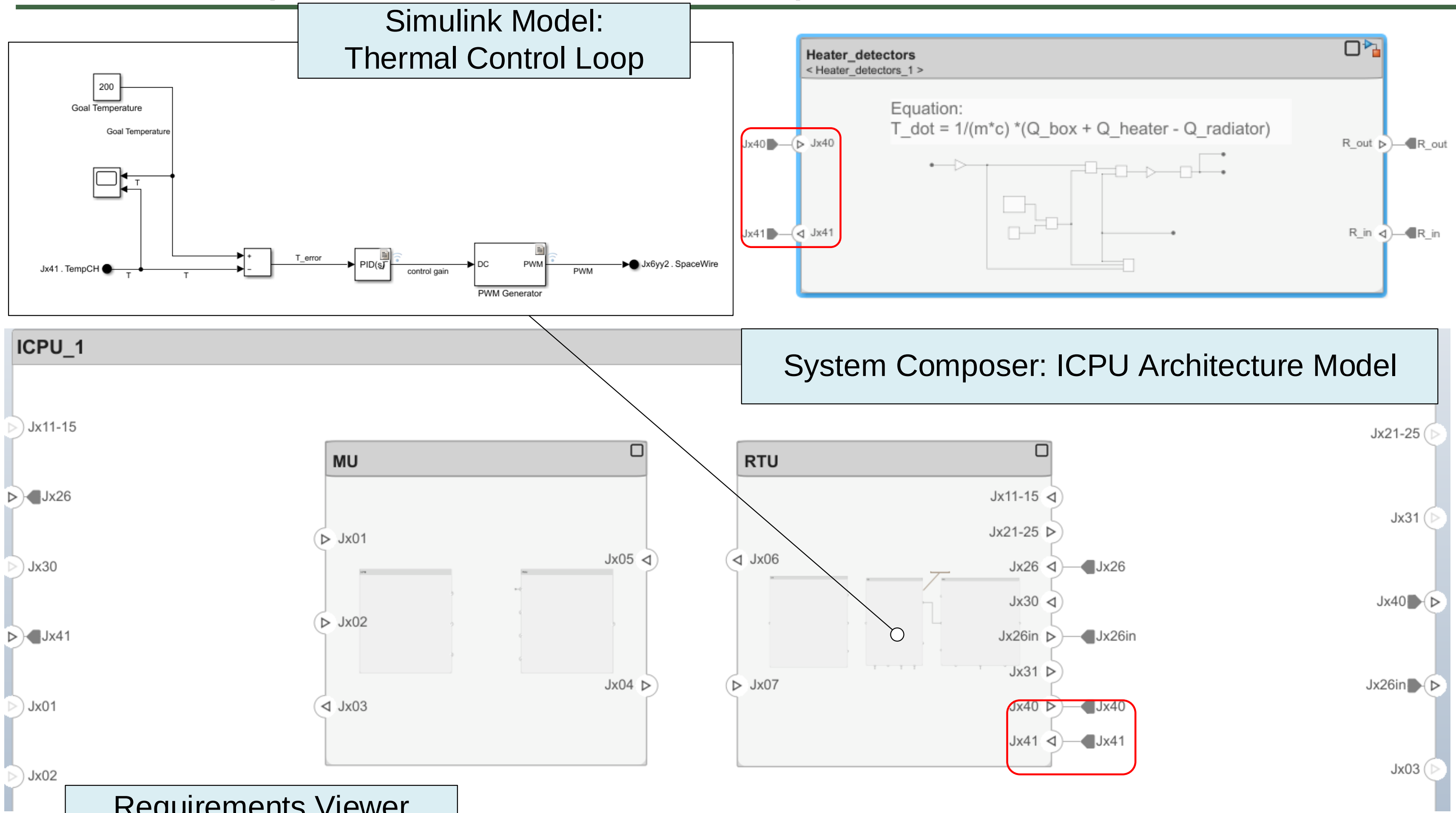
MBSE ADDRESSING MULTIPLE ASPECTS OF THE ICPU SYSTEM



MBSE WITH MATLAB/SIMULINK FOR ICPU



Case Study: Thermal Control Loop

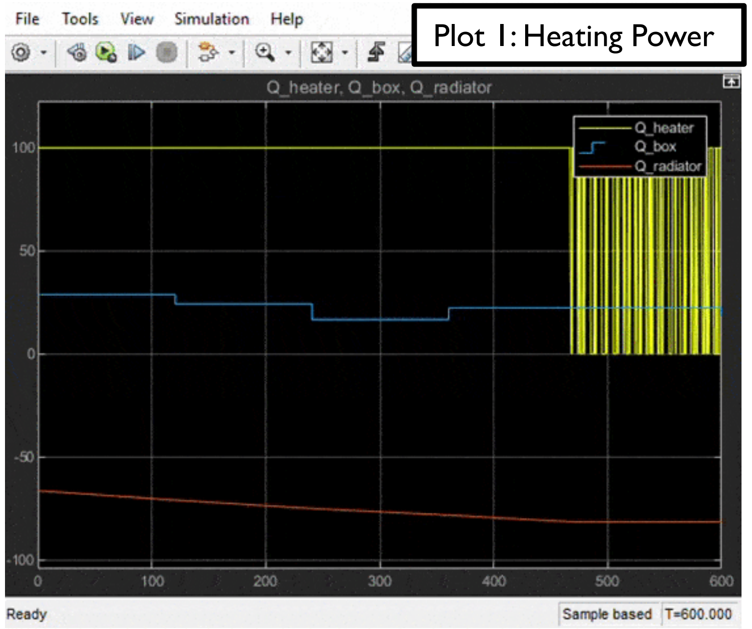


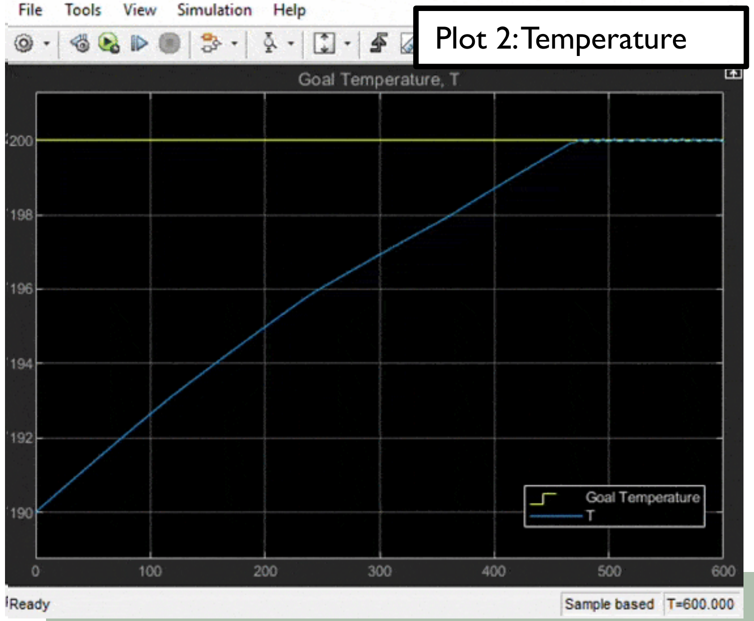
Requirements Viewer

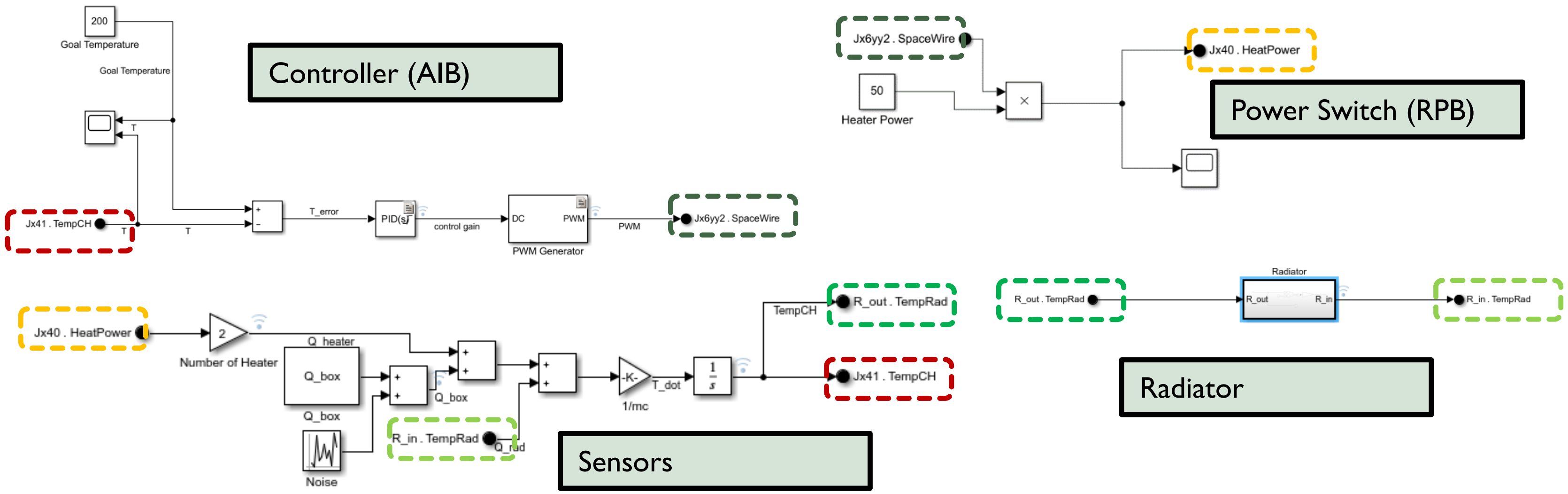
Index	ID	Summary	Description	Implemented	Verified
5.1.1.7	186	Heater Control			
5.1.1.7.1	187		The AIB shall control the DEPFET temperature by controlling a 50 W heater.		
5.1.1.7.2	213		The DEPFET temperature control shall be designed to achieve a temperature stability of ± 0.5 K at the thermal I/F.		
5.1.1.7.3	192		The AIB shall control the FEE temperature by controlling a tbd W heater. (tbd)		
5.1.1.7.4	214		The FEE temperature control shall be designed to achieve a temperature stability of ± 2 K at the thermal I/F.		
5.1.1.7.5	291		The AIB shall control the switches within RPB for heater control.		

- Sensors range: 193 K - 213 K
- PID controller (AIB) sends PWM signal to power switch (RPB) of heater
- Top-Down approach
- Architecture in System Composer
- Simulation in Simulink
- RE in Simulink Requirements linked to IBM Rational DOORS

THERMAL CONTROL SIMULATION







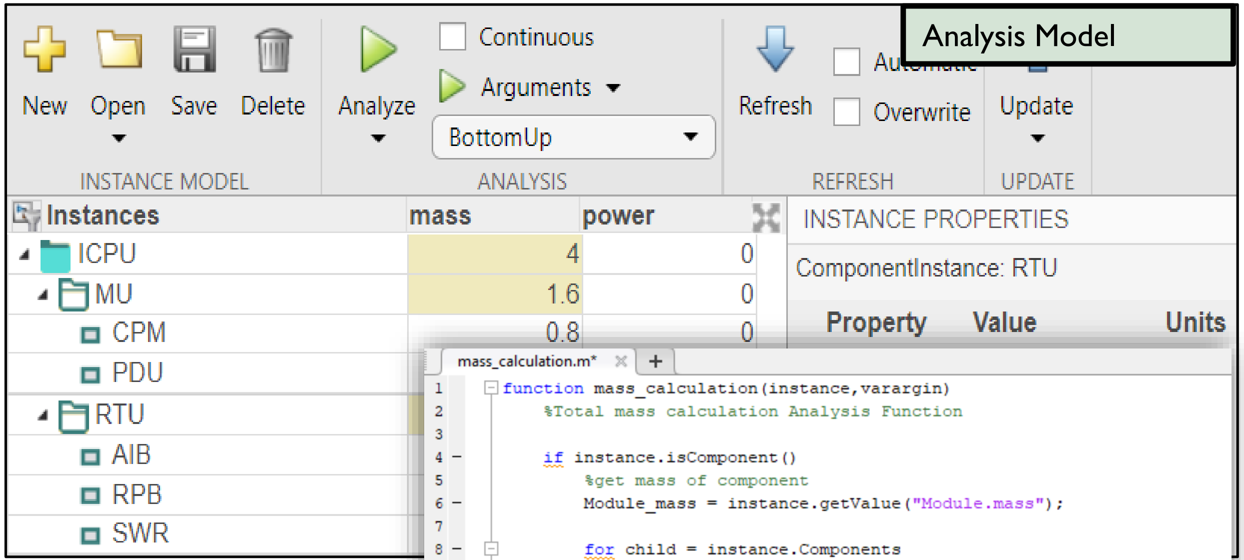
- Heat control loop simulation with 2 x 50 W heaters
- Interaction of 4 subsystems in this setup:
  - AIB
  - RPB
  - Camera Head Sensors
  - Radiators
- Change in performance, analysis and verification of loop by changing initial conditions (Temperature, number of heaters, radiator area etc.)

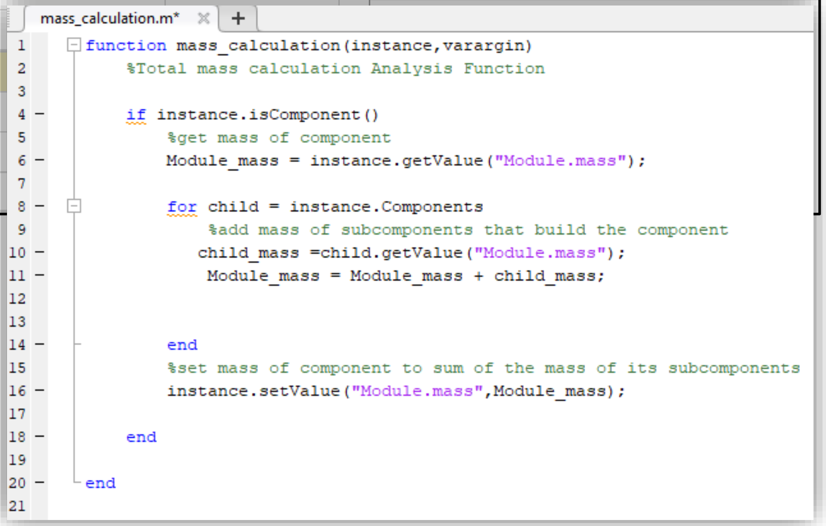
Verification & Testing

Use stereotypes to assign quantifiable characteristics of an instance (e.g. mass)

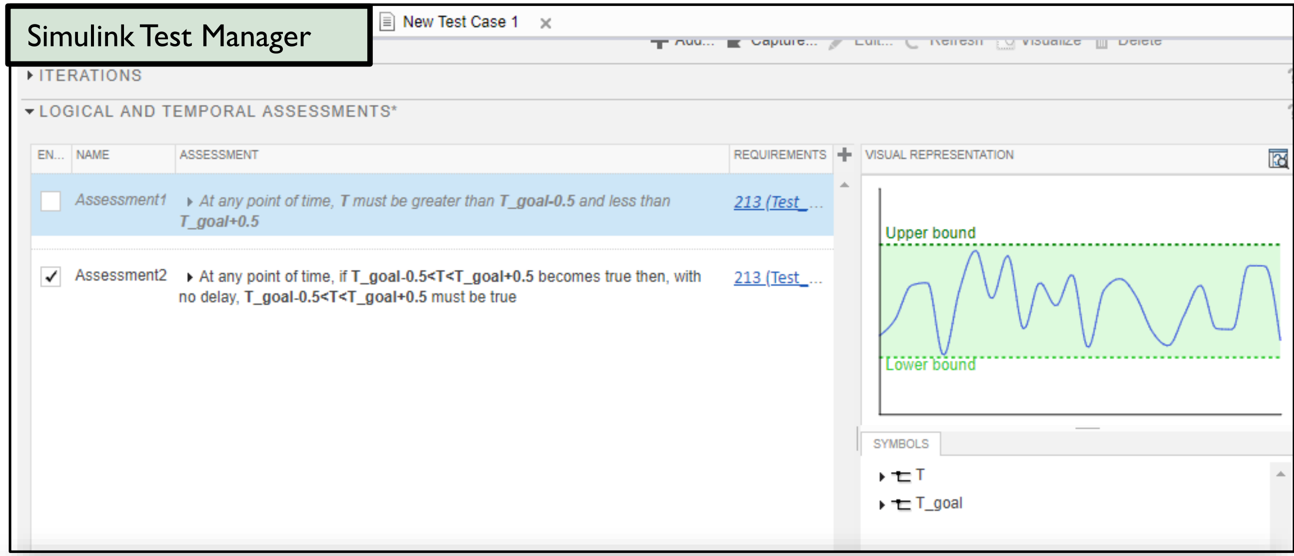
Stereotypes are used as arguments for MATLAB functions

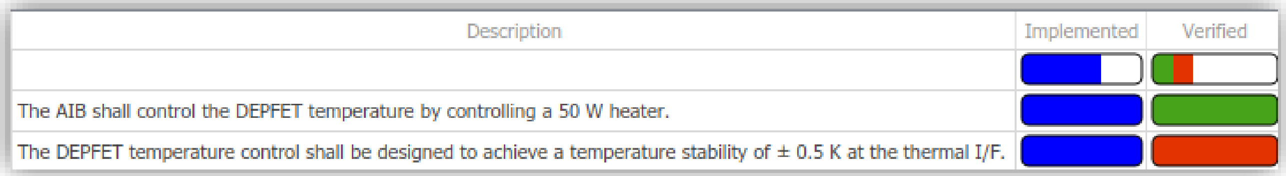
- Create Test cases on Test Manager
- Link Test to implemented Requirement
- Verify requirements and identify needed design modifications directly





Example 1: Calculate total mass of the ICPU.





Example 2: Verify Heater Control Functional Requirements.

CONCLUSION

- The MBSE approach based on MatLab Simulink and the System Composer is straight forward when having the software available and working together in a group of developers.
- It provides the possibility to connect the model with the requirements defined in an IBM Rational DOORS database.
- The software framework provides the possibility of instrument modelling, simulation and verification.
- We will investigate how reports and data packages can be generated automatically for the support of milestone reviews.