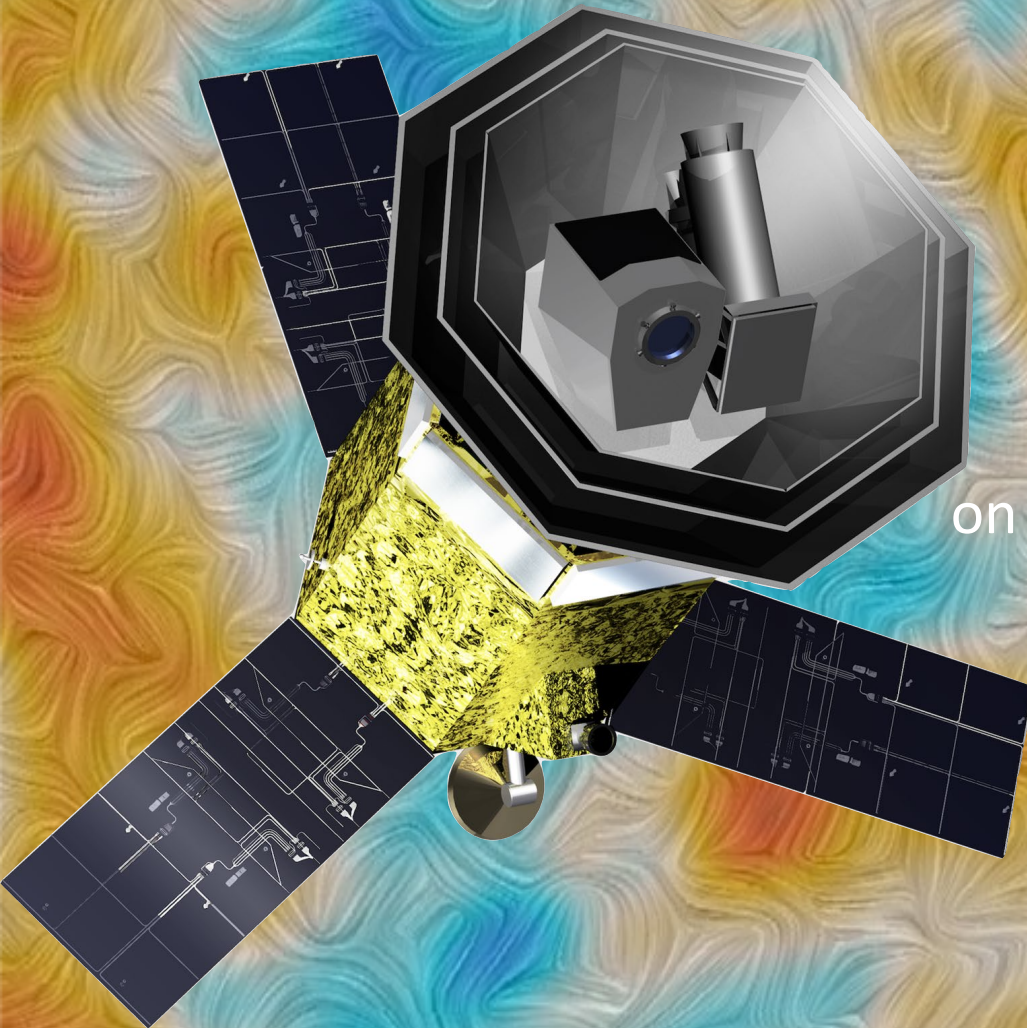


SQUID Controller Unit Schedule, Model Philosophy, AIV/T



Michele Pinchera
INFN-Pisa (Italy)

on behalf of LiteBIRD/INFN group

Workshop LiteBIRD-Italia 2023

@ INFN-LNF

24/05/2023



Outline

- Product Tree
- Model philosophy
- Verification - Test Matrix
- Development Plan
 - Deliverables
 - Master Schedule
- AIV/T Plan
- Next steps

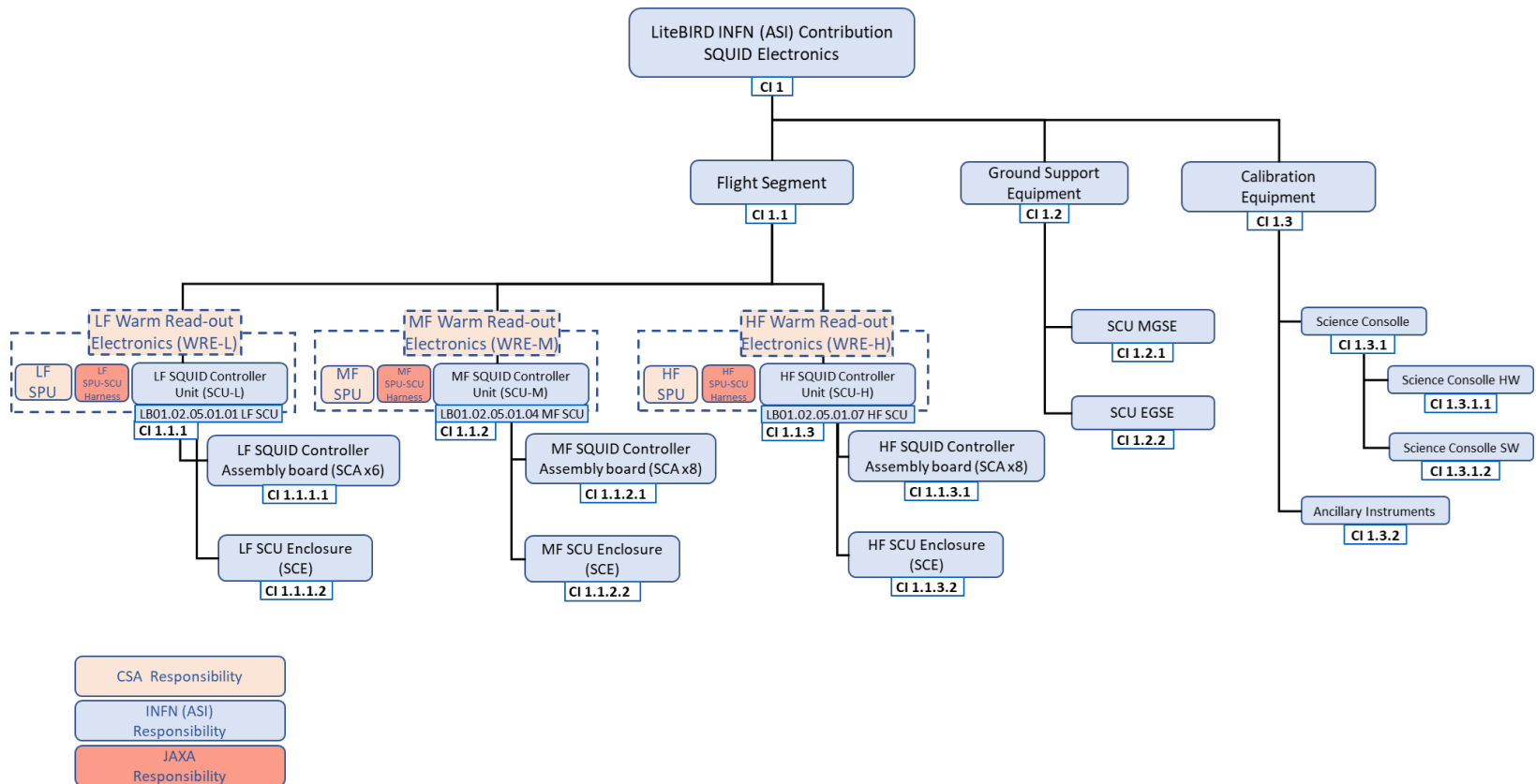


Product Tree

Three SCUs (INFN/ASI responsibility) shall be delivered: SCU-L, SCU-M and SCU-H. The three units will be identical, except for the fact that SCU-L will host 6 operating boards instead of 8.

The SCU Enclosure (SCE) has been designed to host 8 boards and the same enclosure will be used for all the three SCUs to simplify the total costs and verification and qualification plan. In case of SCU-L, suitable dummy boards will occupy the 2 extra slots in the enclosure.

The WRE (SCU+SPU) is currently of CSA responsibility versus JAXA, whereas the WRE harness (internal and external) is of JAXA responsibility.





Model Philosophy

Proto-flight model/flight model (PFM/FM) approach will be used as model philosophy:

- Verification/Validation at sub-unit level of the major constituent assemblies of SCU
- One Engineering Model of SCU for performance validation at unit level
- Three Proto-Flight/Flight Models and one Flight Spare of SCU

A set of SCU BBMs (three GSE SCUs + one STM SCU) will be used for the early verification/validation at sub-unit level (SCA). The BBMs will be manufactured with commercial components and the tests performed on these models will be used to verify the SCA Technology Readiness at Level 6 .

The EM, in accordance with the LiteBIRD model philosophy at system level, shall accomplish a full environmental test and performance campaign. It is in fact an EQM, so it should be built to full flight standard (EEE parts with a lower standard may be used).

First produced FM unit will be delivered to CSA/JAXA after tests at the environmental condition for PFM (TBC). Recurrent Proto-Flight/Flight Models will be delivered to the CSA/JAXA after test campaign at Acceptance environmental conditions

LiteBIRD SCU HW Matrix	BBM				EM		PFM/FM			Flight Spare	Total qty	
	GSE LFT	GSE MFT	GSE HFT	STM***	EM1**	EM2**	LFT	MFT	HFT		COTS ver	Flight Quality
SQUID Controller Assembly (SCA)	6 (+2dummies)	8	8	1 (+ 7dummies)	4	4	6 (+2dummies)	8	8	8*	29 (+11dummies)	30
SCU Enclosure (SCE)	1	1	1	1	1		1	1	1	1	5	4

* flight spare SCAs as baseline are 8 (4 deliverables as a minimum). The Flight Spare SCAs will be qualified at SCU level.

** EM1 is a set of 4 SCAs deliverable to CSA/JAXA for the integrated WRE/Instrument EM env test campaign

** EM2 is a separate not deliverable EM set of 4 SCAs

The 2 SCA EM sets will be tested at unit level using 1 EM SCE

*** STM is a not deliverable model



Verification - Test matrix

The **verification methods** are inspection, analysis, demonstration, test, or a combination of them. **Analysis and Testing** are the primary methods used to verify performance.

The **test matrix** for the assumed **model philosophy**:

LiteBIRD SCU Test Matrix		BBM	EM	PFM (2)	FM (3)	FS (4)
Functional & Performance						
	Functional	T	T	T	T	T
	Performance	Tsca	T	T	T	T
Physical Properties						
	Mass	T	T	T	T	T
	CoG	A	A	A	A	A
	Mol	A	A	A	A	A
Structural Test						
	Vibration	T (1)	T	Tp	Ta	Ta/Tp
	Shock		T(5)	Tp(5)	Ta(5)	Ta/Tp(5)
	Acoustic	At Satellite level only				
Thermal Test	TV/TB	T (1)	T	Tp	Ta	Ta/Tp
EMC/EMI			T	Tp(5)	Ta(5)	Ta/Tp(5)
ESD			T(5)			

Legend

T	Test
A	Verification by analysis
Tq	Test @ Qualification level
Tp	Test @ ProtoFlight level
Ta	Test @ Acceptance level
Tsca	Test at SCA level

- (1) Test with a STM consisting of SCE BBM + 1 SCA BBM + SCA dummies
- (2) The **Protoflight** specified tests are performed for the **first FM unit** of the SCU (SCU#1)
- (3) **Acceptance level** tests will be performed on **subsequent 3 FMs** (SCU#2, SCU#3, SCU#4)
- (4) The Flight Spare will be 1 of the 4 SCU PFM, so it will be qualified at acceptance level as a minimum
- (5) Test is TBC . The **verification** of the equipment must **not induce an overstress** which can jeopardize the unit and system level tests



Development Plan - Deliverables

The SCU preliminary master schedule until phase D is reported in the next slide.

Herein are showed the key milestones and the main goals that have to be satisfied to ensure the milestone achievement.

The SCU key milestones dates have to be agreed on the basis of a consolidated schedule from JAXA/prime team.

In this preliminary master schedule are considered the WRE delivery need dates provided by JAXA in Dec 2022.

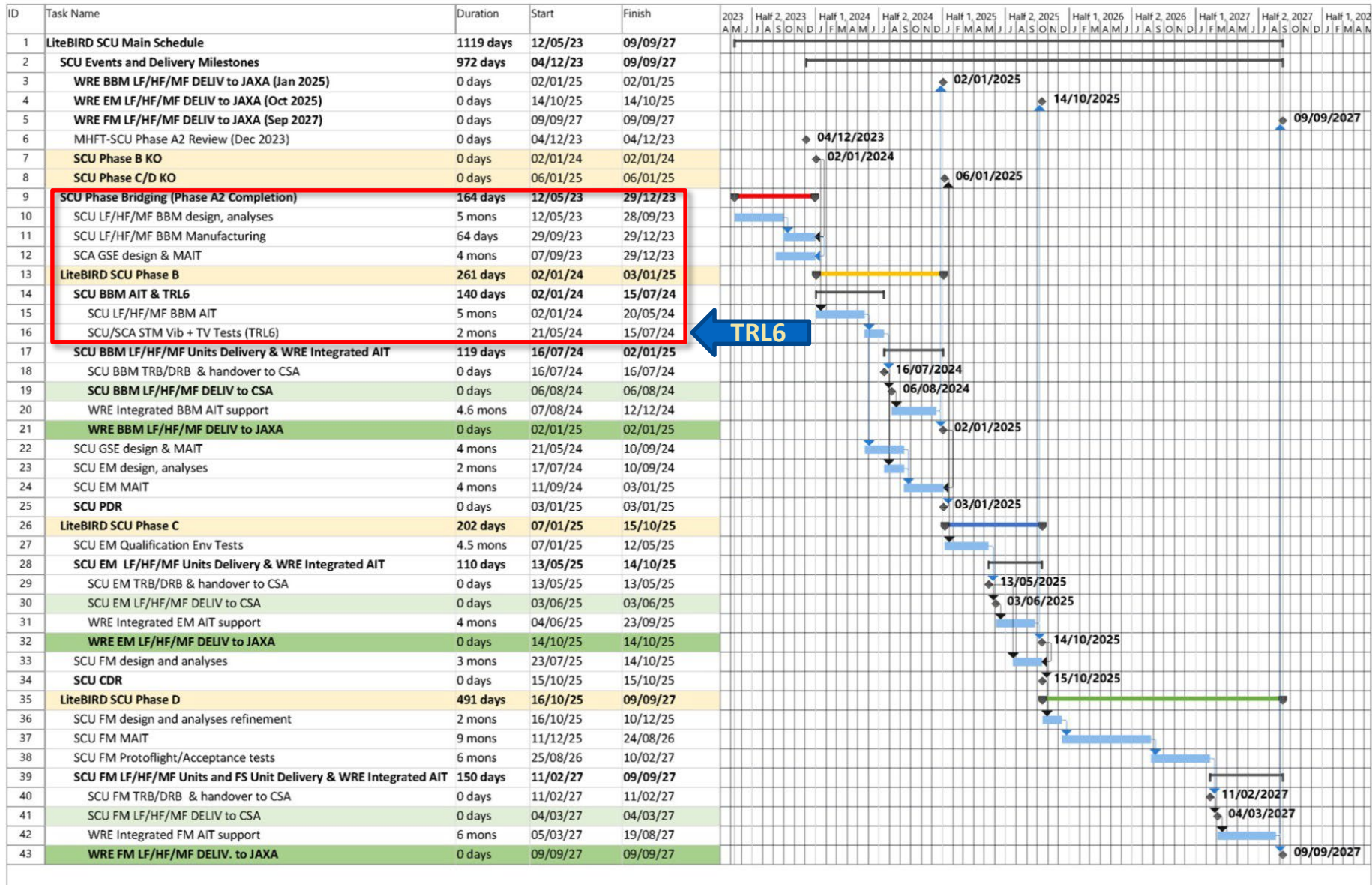
Event or Milestone	Date
SCU Phase B KO	02/01/2024
SCU BBM TRB/DRB & handover to CSA	16/07/2024
SCU BBM LF/HF/MF DELIV to CSA	06/08/2024
WRE BBM LF/HF/MF DELIV to JAXA (Jan 2025)	02/01/2025
SCU PDR	03/01/2025
SCU Phase C/D KO	06/01/2025
SCU EM TRB/DRB & handover to CSA	13/05/2025
SCU EM LF/HF/MF DELIV to CSA	03/06/2025
WRE EM LF/HF/MF DELIV to JAXA (Oct 2025)	14/10/2025
SCU CDR	15/10/2025
SCU FM TRB/DRB & handover to CSA	11/02/2027
SCU FM LF/HF/MF DELIV to CSA	04/03/2027
WRE FM LF/HF/MF DELIV to JAXA (Sep 2027)	09/09/2027



JAXA updates (March 31 2023, Dotani): Japanese system companies (NEC and Melco) cannot accept an order from JAXA in FY2024 due to the conflict with their manufacturing plan/capability → delay of the launch by a year or two (from January 2031). The start of phase B will also be delayed. JAXA will keep the schedule of SRR as much as possible → timing to fix the interfaces will not change.



Development Plan – Master Schedule





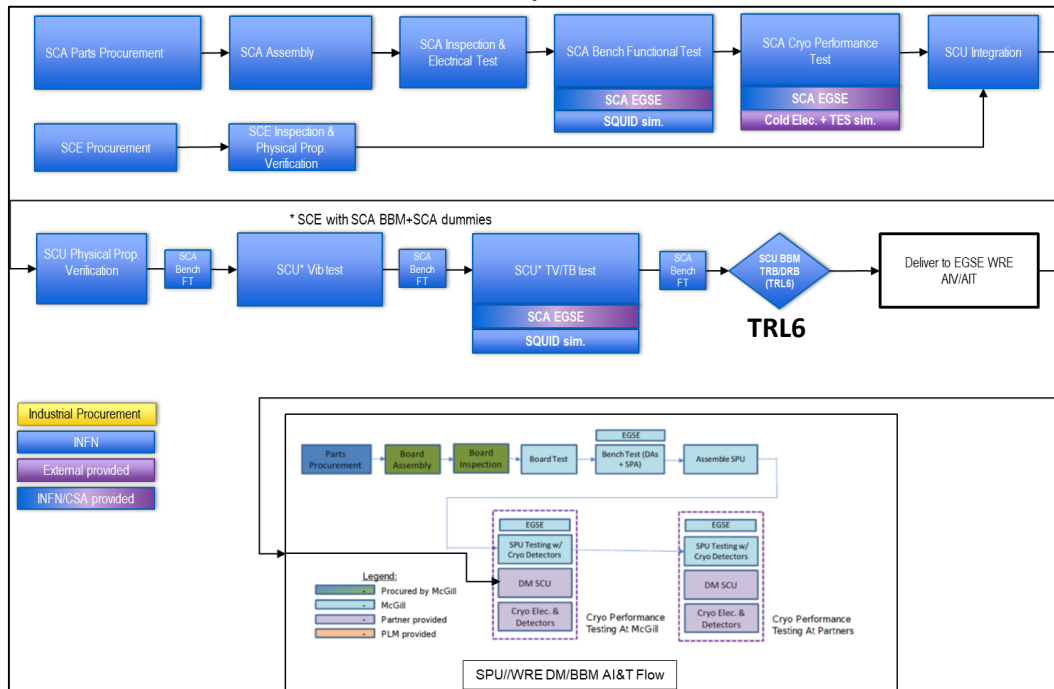
AIV/T Plan (BBM)

The SCU AIV/T campaign is to demonstrate that:

- the SQUID Controller design at unit level is **qualified** at the environmental condition;
- the SCU is **free from** material and workmanship **defects**;
- the overall SQUID Controller (including procedures and resources) is able to **fulfil the mission requirements**, providing all the performances requirement during the mission period;
- the SCU verified in **conjunction** with the other WRE units and LiteBIRD Instruments works properly;
- the Final Model is **delivered** in due time;

The SCU AIV flow is **matched with CSA** WRE AIV/T flow for testing at **WRE Integrated Level**

BBM AIV/T Flow

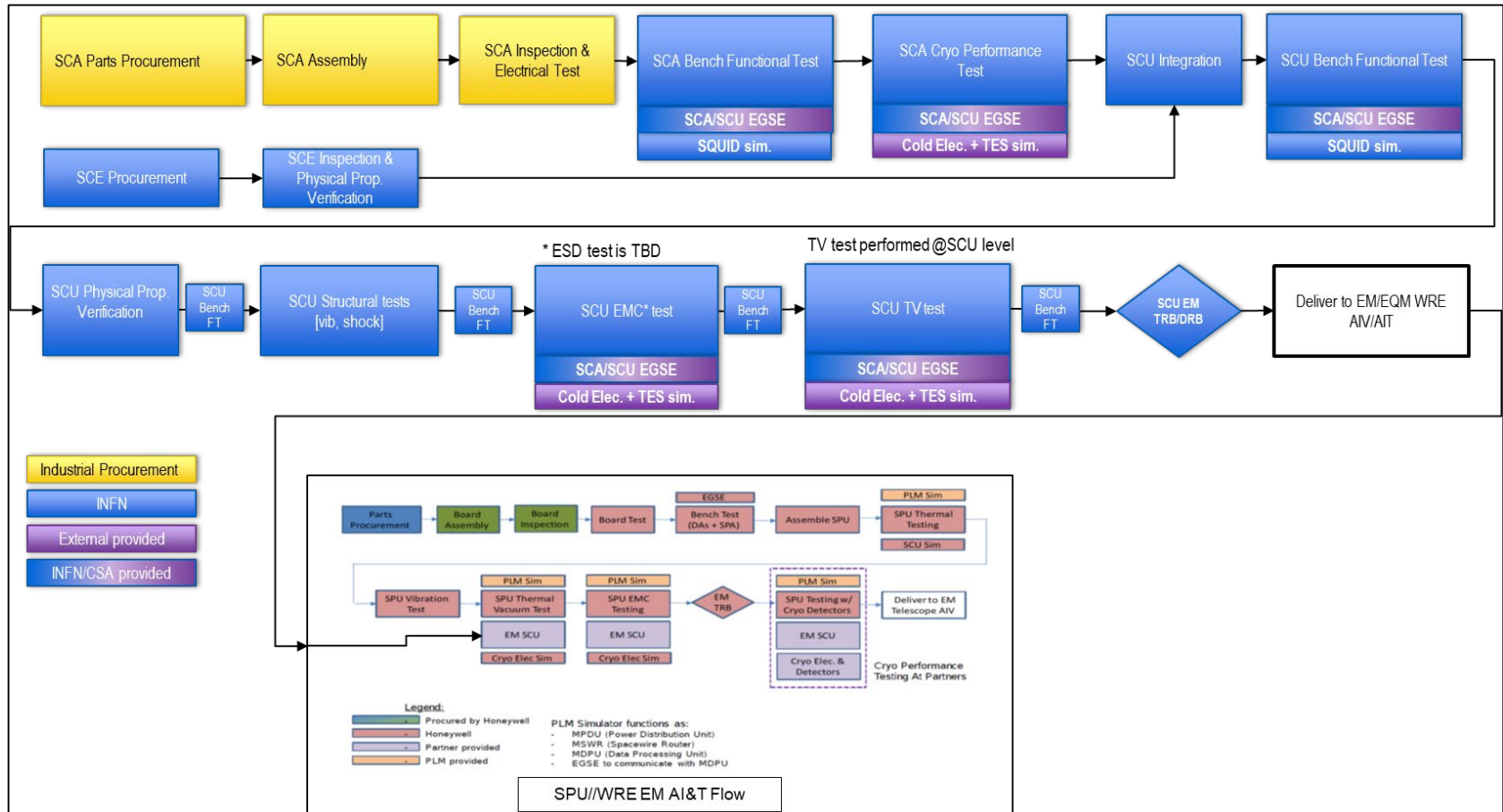




AIV/T Plan (EM)

The **AIV/T flow** for EM and PFM/FMs takes in consideration the **procurement** of the SCAs from industrial partners, while all subsequent activities will be carried out within INFN responsibility.

EM AIV/T Flow

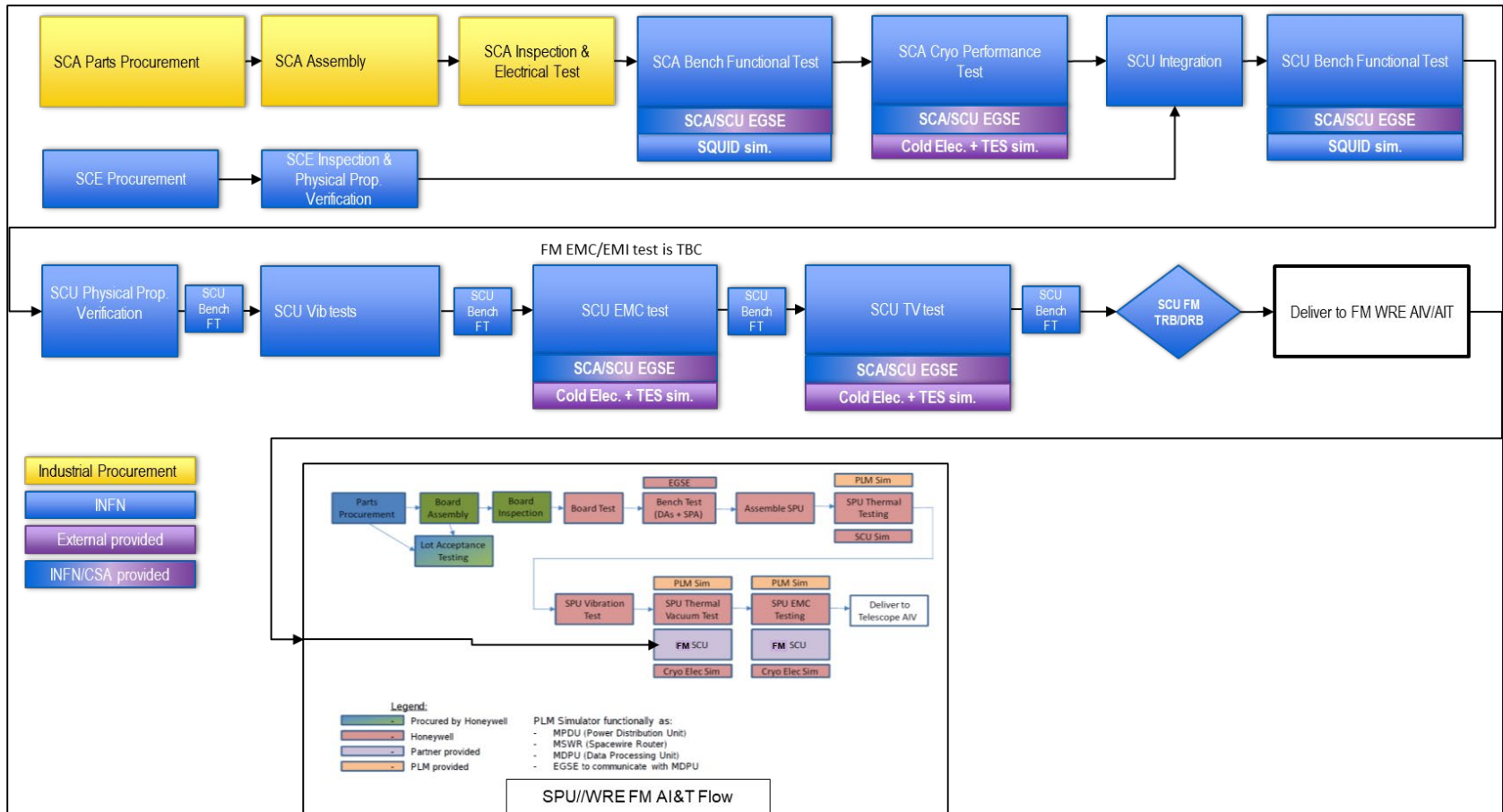




AIV/T Plan (FM)

The **AIV/T flow** for EM and PFM/FMs takes in consideration the **procurement** of the SCAs from industrial partners, while all subsequent activities will be carried out within INFN responsibility.

FM AIV/T Flow





Next steps

- ❑ **JAXA schedule consolidation** (hopefully by the beginning of June, as an outcome of the LiteBIRD MDR) → update of the SCU development plan and master schedule.
 - We expect a possible **bridging phase** between the end of Phase A2 (Dec 2023) and the ASI Phase B KO (April 2024?)
- ❑ **SCU model philosophy refinement** based on the WRE/SCU EGSE configuration (to be agreed with McGill) and on consolidation of the LiteBIRD system level AIV/T plan.
- ❑ The WRE and **SCU requirements** definition and consolidation is **still in process** through Interface Requirement Documents (**IRDs**) and Interface Control Specifications (**ICS**) that will specify the interfaces applicable between INFN/CSA and JAXA. Currently, we are waiting for a document of **environmental design and test specification** from JAXA and a clear reqs flow from L3 to L5 unit level (see the MHFT Phase A2 **KeyPoint Panel recommendations** presented by Francesco)
 - At the end, we have to agree a **SCU specifications document** with a clear correspondence with the reqs at integrated level, so to permit the compliance can be verified and documented with a **VCD (Verification Control Document)**.

