FIREHORN

Systems Engineering at EPFL Rocket Team

Monday, 23.09.2024

AGENDA

EPFL Rocket Team and its SEs

Quick Introduction to the ERT

Michael Fuser - Ryan Svoboda - **Samuel Wahba**

Our mission:

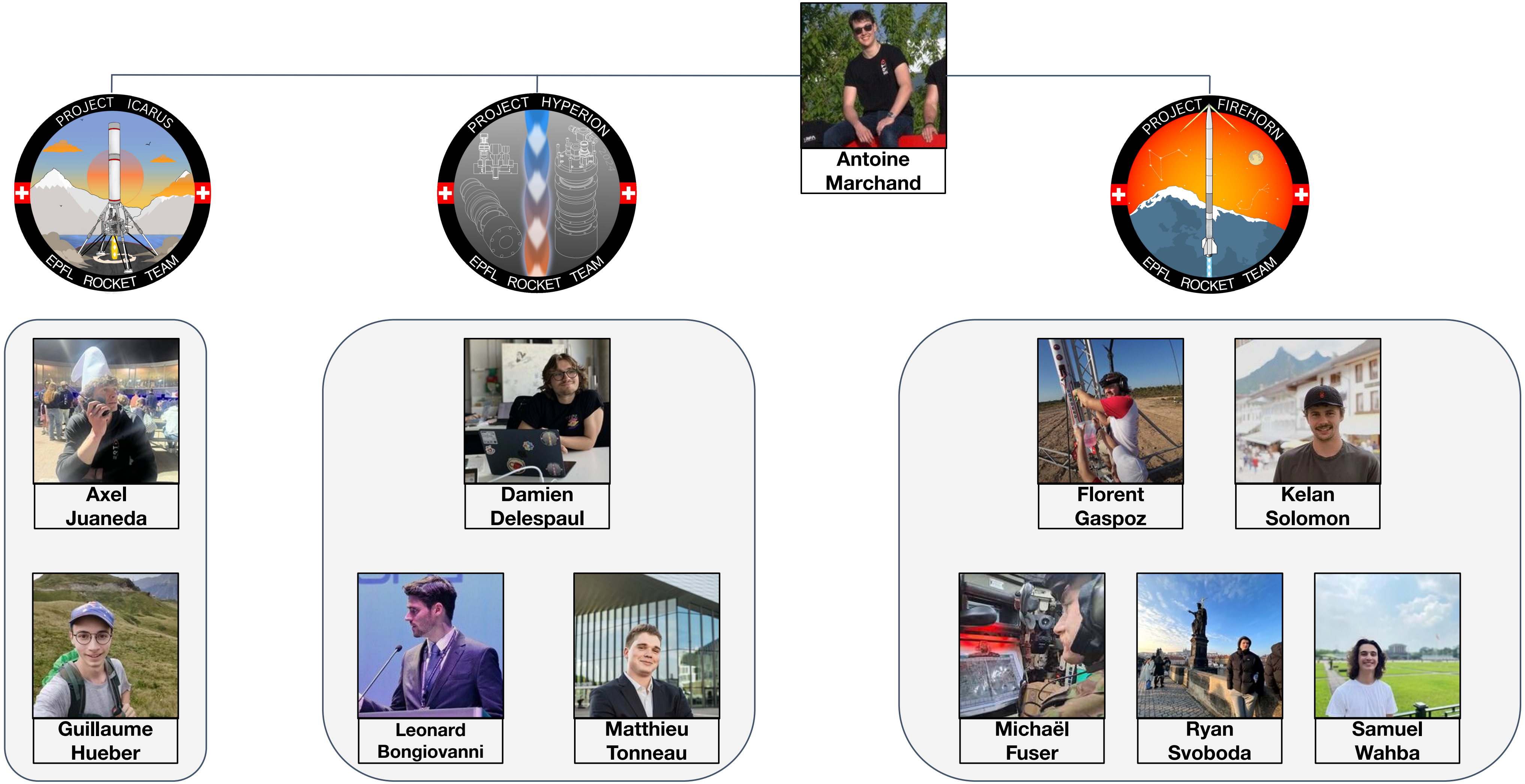
"Engaging students in space technology projects in collaboration with academia and industry partners"

THE EPFL ROCKET TEAM BY THE NUMBERS:

200+	50+	7	7
Students	Launches	Scientific publications	Awards in Competition

ERT SE Team

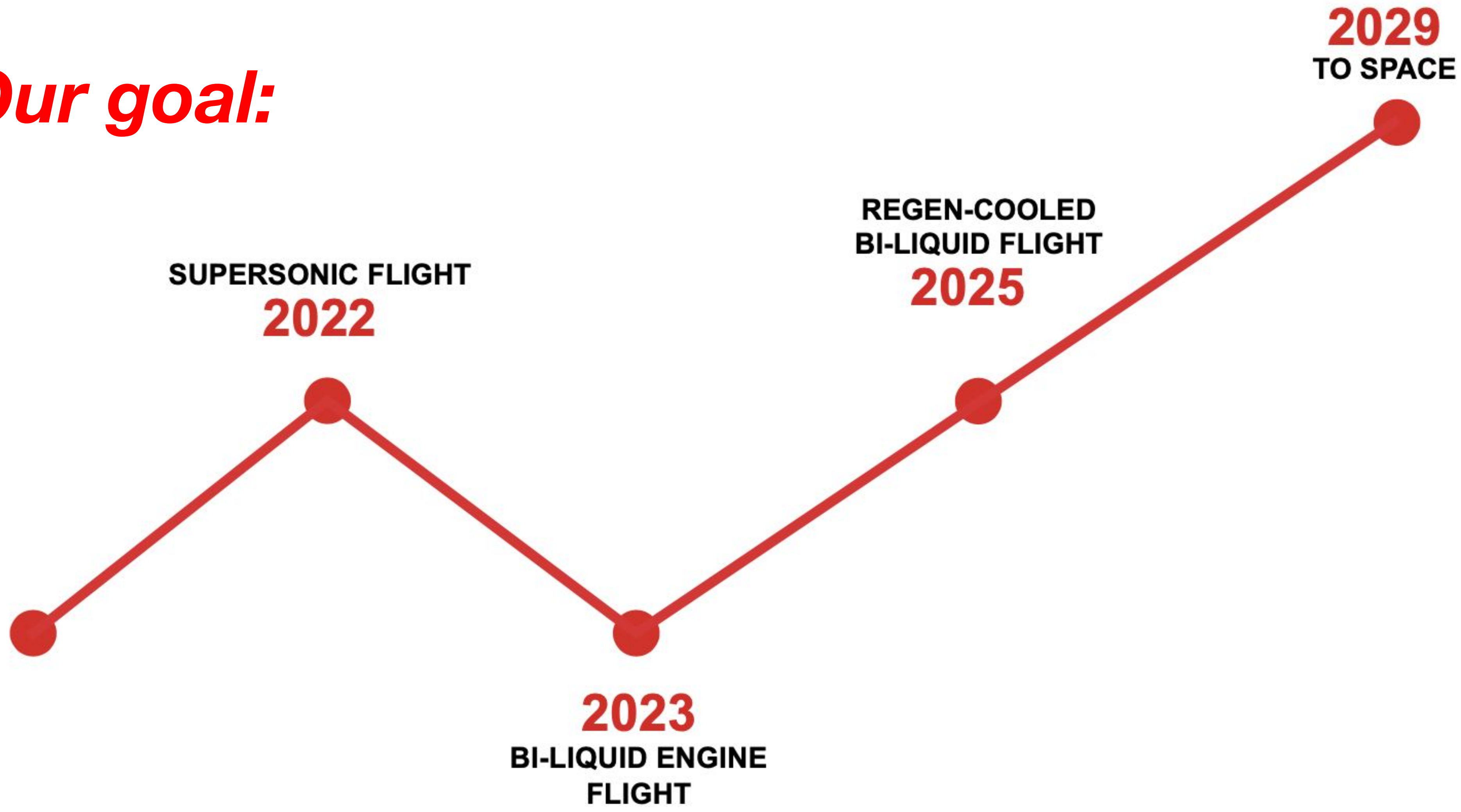
Michael Fuser - Ryan Svoboda - **Samuel Wahba**



Quick Introduction to the ERT

Michael Fuser - Ryan Svoboda - **Samuel Wahba**

Our goal:



Quick Introduction to the ERT

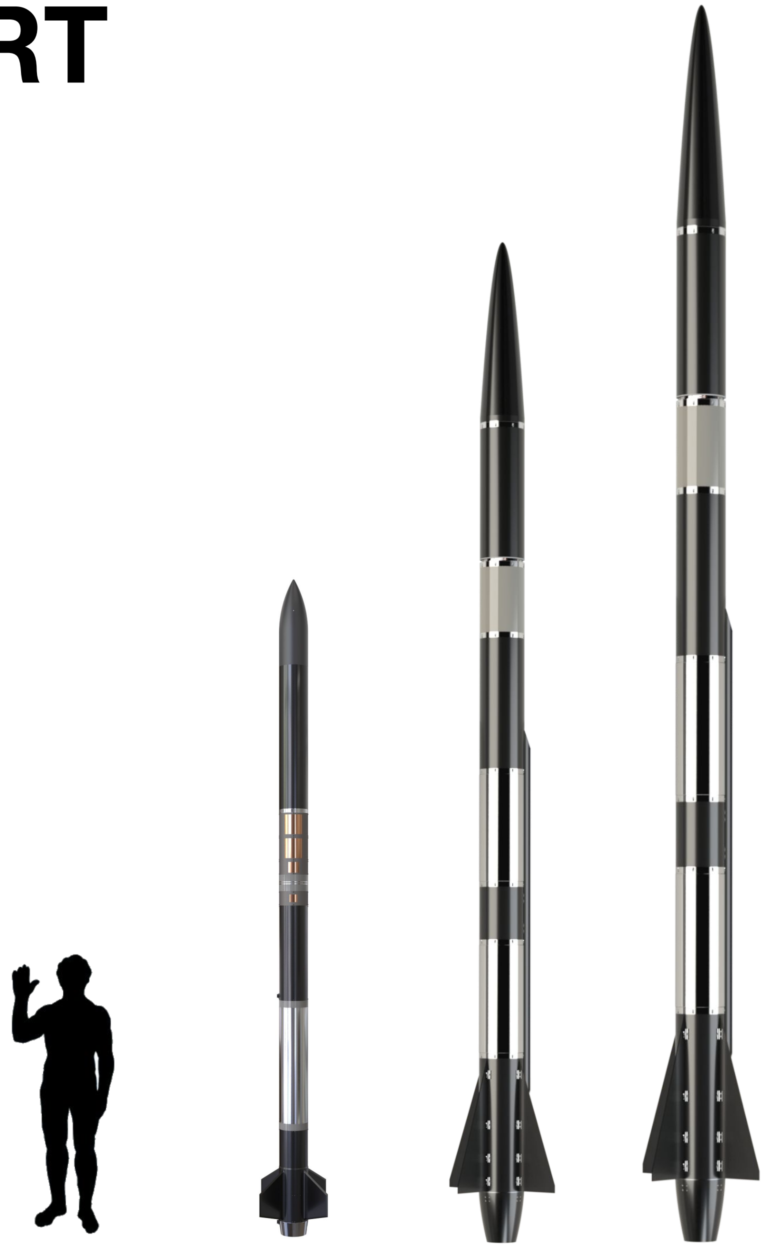
Michael Fuser - Ryan Svoboda - **Samuel Wahba**

Missions objectives

- Launch at 9[km] in 2025 with a biliquid engine
- Be ready to launch to 30[km] in 2026
- Promote learning opportunities for students
- Bring association closer to space

How we intend to proceed

- ‘Class’ of single stage launch vehicle
- Architecture dimensioned for 30[km]
- Modular design with internal structure for flexibility
- Supersonic flight
- EthaLOx propulsion

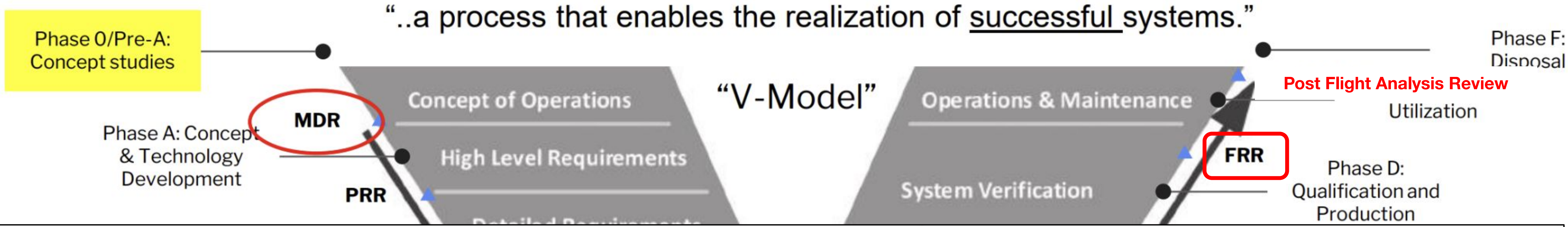


ERT SEs

Difference in Project Phases

Michael Fuser - Ryan Svoboda - Samuel Wahba

Theoretical VS In Practice



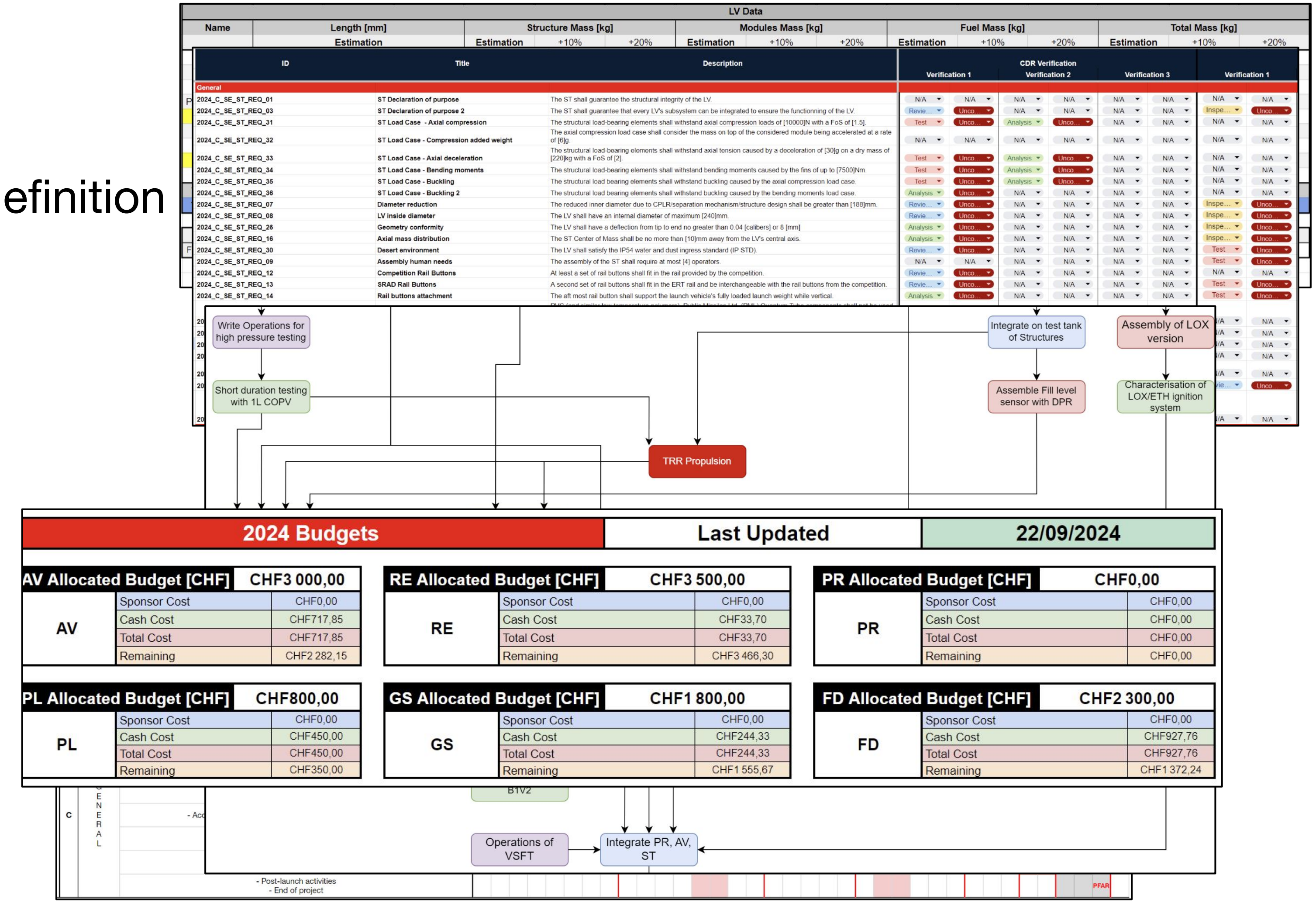
S	SS	TYPE	2024						2025											
			Summer Holidays		Autumn				Exams	Spring				Exams	Summer Holidays		Autumn			
			Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
C	GENERAL	- Development - Test preparations, MAI&T				TRR														
		- Development Test: Assembly, Sub-system, Interface - Qualification Test: Component, Sub-system								CDR										
		- Qualification Test: Interface, System											QR							
		- Acceptance: Component, Sub-system, Interface and System														SAR				
		- Pre-Flight Verification - Operations Planning and Training															ORR			
		- Launch site operations and Pre-Flight Verification - Launch																FRR LAUNCH		
		- Post-launch activities - End of project																		PFAR

Systems Engineering at ERT

Michael Fuser - Ryan Svoboda - Samuel Wahba

Main SE Tasks at ERT

- Systems Engineering
  - High-Level System Design
  - Requirements/Verification definition
  - Documentation plan
  - Interface Management
  - Operations
  - ...
- Project Management
  - Definition of timeline
  - Allocation of resources
  - Preparation of reviews
  - Logistics
  - ...



Systems Engineering at ERT

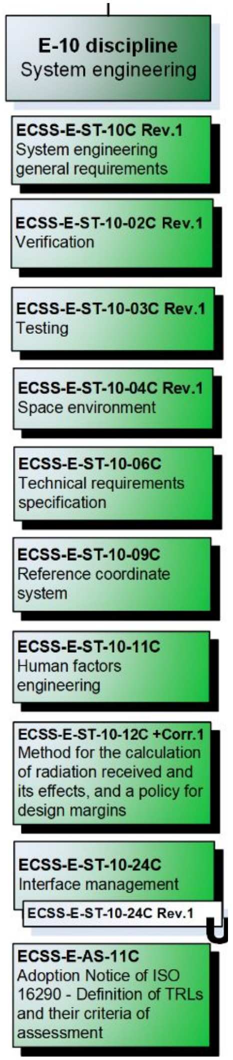
Michael Fuser - Ryan Svoboda - Samuel Wahba

Doing it for the first time and learning by doing	***Working with engineers who are also doing their job for the first time***
Working on much tighter timelines and very limited resources	***Everyone is voluntary and does their job next to their studies***

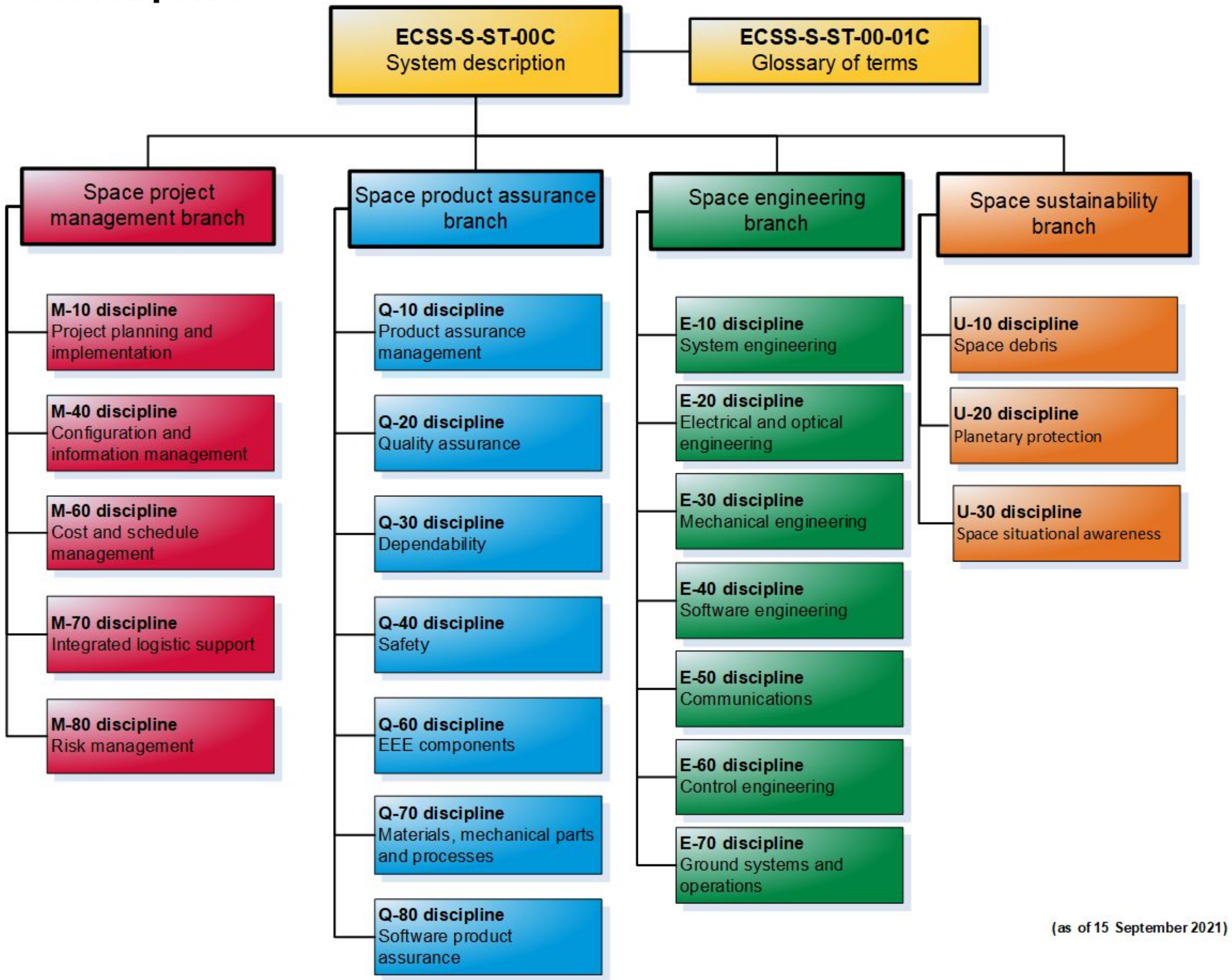
Applying ECSS

Applying ECSS

Michael Fuser - **Ryan Svoboda** - Samuel Wahba



ECSS Disciplines



Applying ECSS

Michael Fuser - **Ryan Svoboda** - Samuel Wahba

5.2 Requirement engineering

5.2.1 General

a. The system engineering function shall analyse the requirements for the system issued by the customer.

NOTE 1 This analysis enables the transformation of customer requirements into the supplier's system solution.

NOTE 2 The level of the required analysis and form of any deliverable is expressed in the business agreement.

b. The system engineering function shall derive, generate, control and maintain the set of requirements for the lower level elements, defining their design and operational constraints and the parameters of functionality, performance, and verification necessary to meet the system requirements issued by the customer.

c. The system engineering function shall ensure consistency of the requirements at system level, at lower levels, as well as amongst levels.

NOTE Consistency of requirements of different system engineering sub-functions at the same level is the responsibility of the higher level system engineering function.

d. The system engineering function shall ensure requirements generated in 5.2.1b. are in conformance with characteristics specified in ECSS-E-ST-10-06 clause 8.

e. The system engineering function shall ensure that each requirement for the lower level elements has a justification reflected in the requirement justification file in conformance with Annex O.

NOTE Tailoring of a standard in a list of applicable standards, or of a requirement in an applicable standard, is possible where each tailoring measure is duly justified.

4 Verification principles

4.1 Introduction

ECSS-E-ST-10 states that verification demonstrates, through a dedicated process, that the deliverable system meets the specified requirements and is capable of sustaining its operational role during the project life cycle.

ECSS-E-ST-10-02 establishes the requirements for the verification of a space system product. It specifies the fundamental concepts of the verification process, the criteria for defining the verification strategy and the requirements for the implementation of the verification programme. It is intended to apply to different products at different levels, from single equipment to the overall system (including space segment hardware and software, ground segment, launchers and transportation systems, Verification tools and GSE).

Concerning the scope of the standard, it is useful to address at this point some frequently asked questions posed by users, in order to emphasize certain concepts and definitions imposed by higher level standards and by the accepted European practices enshrined within the standard.

4.2 Verification versus Validation

A question often posed is why, within European space projects, we mandate a "verification" programme as opposed to a "verification and validation" programme, as practiced in other engineering disciplines (e.g. software, ground segment).

In general terms verification addresses whether a product satisfies the requirements placed upon it, whilst validation addresses whether a product will satisfy the needs of its users, or as is often more simply said,

Verification proves the product is right.

Validation proves it is the right product.

The Verification Standard does not mandate the need for a separate programme of validation of space products, since product verification is performed against a set of requirements that also address the suitability of the product to fulfil the needs of its intended use. However, the standard does not prevent the execution of a separate validation activity if this is considered appropriate, as is practiced for example, in the operation or ground segment domains. Essentially the process to be followed is the same, although it addresses mainly the use of the product.

Applying ECSS

Michael Fuser - **Ryan Svoboda** - Samuel Wahba

Main Differences

- Structure
- No customers
- Working on their spare time
- Short timeline
- Hard deadline
- Less people involved

Requirements

Requirements

Michael Fuser - **Ryan Svoboda** - Samuel Wahba

ID	Title	Description	Source	Author	Justification	Criticality	Compliance	Verification Status	Assignee
General									
2024_C_SE_AV_REQ_01	RE - AV declaration of purpose	The AV shall trigger and power the recovery events.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_02	PR - AV declaration of purpose	The AV shall be able actuate the propulsion system.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_03	AV data gathering declaration of purpose	The AV shall be able to gather data.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_04	AV Data storage declaration of purpose	The AV shall be able to save all of the data collected.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_05	GS - AV declaration of purpose	The AV shall be able to send data to the GS.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_06	Coding rules	[DEPRECATED] Shall follow the ERT Coding Rules [RD06].				TBD	TBD	#REF!	
2024_C_SE_AV_REQ_07	Power source	The AV shall be self-powered during the flight.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_08	Assembly human needs	The assembly of the AV shall require at most [2] operators.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_09	On-board power systems and rail standby time	The type of power system, the charging strategy as well as the charge level maintenance system implemented in the LV shall comply with the section 3.4 of the [RD02] document.				TBD	TBD	#REF!	
2024_C_SE_AV_REQ_10	Frequency management	Teams should be able to change GPS frequencies on their transmitting and receiving stations on site, within less than an hour.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_11	Electronics thermal design	The electronics present in the LV shall implement cooling or venting provisions and monitor at least one temperature sensor representative of the electronics temperature.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_12	Electronics thermal testing	All electronics implemented in the LV shall be tested to know the reliable operational temperature range.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_13	Official altitude logging and tracking system	The LV shall feature a mandatory operational CATS Vega Flight Computer for official altitude logging and landing site tracking.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_14	CATS transmitter call sign	The call sign assigned to the CATS transmitter shall comply with the rules presented in subsation 3.5.3 of [RD02].				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_15	Battery state reading	The states of every battery shall be displayed and visible from the exterior of the LV.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_16	Battery state logging	The battery voltage shall be measured, stored and sent to the GS.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_17	Avionics Test	The avionics system shall have [100] hours of hardware-in-the-loop simulated flight time before launch.				TBD	TBD	#REF!	
2024_C_SE_AV_REQ_18	Avionics minimum Temperature test	The avionics shall be able to run at and after being held at 0 deg celsius for 2 hours.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_19	Avionics maximum temperature test	The avionics shall be able to run at and after being held at 80 deg celsius for 2 hours.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_20	Current output safety factor	All current outputs shall be able to run at twice expected amperage.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_21	Current output time safety factor	All current outputs shall be able to run for twice the expected time.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_22	Output channels safety factor	All board output (pyro, servo, ...) shall have at least 2 spare output channels per type (bin,pw,...).				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_23	Backup assembly	A full backup avionics shall be assembled.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_24	Stenciled information	Every SRAD board design shall have it's version number and Kicad file location enscribed on it.				Low	Unkno...	#REF!	
2024_C_SE_AV_REQ_25	Cable insulation	Every cable shall be insulated with a silicon sheath.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_26	Length of cables	All cables used for I2C or SPI or UART communication shall be no longer than 10 cm				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_27	Communication protocol	All SRAD boards shall communicate using a single protocol.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_28	RF Connectors	All RF connectors shall be of the SMA type.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_29	Number of debugging operators	At least 3 operators shall be able to debug the code.				Medium	Unkno...	#REF!	
2024_C_SE_AV_REQ_30	On rail reprogramability	All board shall be able to be reflashed when the LV is on the launch rail without removing any panels.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_31	Swappable boards	Any SRAD board shall be able to be swapped when the LV is on the launch rail.				High	Unkno...	#REF!	
2024_C_SE_AV_REQ_32	LV flight test	The final inflight configuration of the avionics system shall be tested during a LV flight before launch.				Low	Unkno...	#REF!	
Mechanical									
2024_C_SE_AV_MECHANICAL_REQ_01	AV length	The avionic assembly located in the AV bay shall fit in a cylinder of [150]mm diameter and 300[mm] height.				High	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_02	Mass	The mass of the entire AV module (located in the AV Bay) shall be less than [3300]g.				Medium	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_03	Axial mass distribution	The Center of Mass of the AV Bay shall be no more that [10]mm from the LV's central axis.				Medium	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_04	Electronics accessibility	All switch, connectors and otherwise useful-to-tinker-with electronics should be accessible on the launch rail when the external panels opposite the launch rails are removed.				Low	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_05	Cable management	All safety critical wiring shall implement a cable management solution (e.g., wire ties, wiring, harnesses, cable raceways) which will prevent tangling and excessive free movement of significant wiring/cable lengths due to expected launch loads.				Medium	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_06	Secure connections	All safety critical wiring/cable connections shall be sufficiently secure as to prevent de-mating due to expected launch loads.				Medium	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_07	Cryo-compatible wire insulation	Any wiring or harness passing within close proximity of a cryogenic device (e.g., valve, piping, etc.) or a cryogenic tank (e.g., a cable tunnel next to a LOX tank) shall utilize safety critical wiring with cryo-compatible insulation.				High	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_08	Energetic device safing and arming	All energetics shall be "safed" until the LV is in the launch position, at which point they may be "armed".				High	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_09	Recovery systems energetic devices	All energetic device arming features shall be externally accessible/controllable.				Medium	Unkno...	#REF!	
2024_C_SE_AV_MECHANICAL_REQ_10	Arming device location	All energetic device arming features shall be located on the airframe such that any inadvertent energy release by these devices will not impact personnel arming them.				High	Unkno...	#REF!	
Recovery									
2024_C_SE_AV_RECOVERY_REQ_01	COTS avionic	At least one of the electronics triggering RE's events shall be COTS.				Low	Unkno...	#REF!	
2024_C_SE_AV_RECOVERY_REQ_02	First event triggering	The first event shall occur within [3]+/- 2]s after the LV reaches its apogee.				High	Unkno...	#REF!	
2024_C_SE_AV_RECOVERY_REQ_03	Second event triggering	The second event shall occur between [450] m and [150] m AGL.				High	Unkno...	#REF!	
2024_C_SE_AV_RECOVERY_REQ_04	Redundant recovery electronics	Launch vehicles shall implement redundant recovery system electronics, including sensors/flight computers and "electric initiators" — assuring initiation by a backup system, with a separate power supply (i.e., battery), if the primary system fails.				Medium	Unkno...	#REF!	

ID	TRR Verification: Verification 1		Verification 2		Verification 3		CDR Verification: Verification 1		Verification 2		Verification 3	
General												
2024_C_SE_AV_REQ_01	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_02	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_03	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	Test	Unco...	N/A	N/A
2024_C_SE_AV_REQ_04	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	Test	Unco...	N/A	N/A
2024_C_SE_AV_REQ_05	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_07	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_10	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_11	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_12	Revie...	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_14	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_15	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	Test	Unco...	N/A	N/A
2024_C_SE_AV_REQ_16	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	Test	Unco...	N/A	N/A
2024_C_SE_AV_REQ_17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_18	N/A	N/A	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_19	N/A	N/A	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_20	N/A	N/A	N/A	N/A	N/A	N/A	Analysis	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_21	N/A	N/A	N/A	N/A	N/A	N/A	Analysis	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_22	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_24	N/A	N/A	N/A	N/A	N/A	N/A	Inspec...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_27	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_28	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mechanical												
2024_C_SE_AV_MECHANICAL_REQ_01	N/A	N/A	N/A	N/A	N/A	N/A	Analysis	Unco...	Inspec...	Unco...	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_02	N/A	N/A	N/A	N/A	N/A	N/A	Analysis	Unco...	Inspec...	Unco...	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_03	N/A	N/A	N/A	N/A	N/A	N/A	Analysis	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_05	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_06	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	Test	Unco...	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_07	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_08	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_09	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_10	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
Recovery												
2024_C_SE_AV_RECOVERY_REQ_01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_RECOVERY_REQ_02	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_RECOVERY_REQ_03	N/A	N/A	N/A	N/A	N/A	N/A	Revie...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_RECOVERY_REQ_04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

ID	QR Verification: Verification 1		Verification 2		Verification 3		SAR Verification: Verification 1		Verification 2		Verification 3	
General												
2024_C_SE_AV_REQ_01	Test	Unco...	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_02	Test	Unco...	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_03	Test	Unco...	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_05	Test	Unco...	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_07	N/A	N/A	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_15	Test	Unco...	N/A	N/A	N/A	N/A	Inspec...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_16	Test	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_25	Inspec...	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_26	Inspec...	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_27	Revie...	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_30	N/A	N/A	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_31	N/A	N/A	N/A	N/A	N/A	N/A	Test	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_REQ_32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mechanical												
2024_C_SE_AV_MECHANICAL_REQ_01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_02	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_04	Inspec...	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_05	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_07	Inspec...	Unco...	N/A	N/A	N/A	N/A	Inspec...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_08	Inspec...	Unco...	N/A	N/A	N/A	N/A	Inspec...	Unco...	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_09	Inspec...	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_MECHANICAL_REQ_10	Inspec...	Unco...	N/A	N/A	N/A	N/A	Inspec...	Unco...	N/A	N/A	N/A	N/A
Recovery												
2024_C_SE_AV_RECOVERY_REQ_01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_RECOVERY_REQ_02	Test	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_RECOVERY_REQ_03	Test	Unco...	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2024_C_SE_AV_RECOVERY_REQ_04	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Requirements

Michael Fuser - **Ryan Svoboda** - Samuel Wahba

2024_C_SE_REQ_DRAFT

ID: Title

Description: Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolo pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Source: EuRoC PTS_EDU_EuRoC_ST_000455
Author: Ryan
Assignee: Florent Piton

Justification

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla paria occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Compliance

- Compliant
- Unknown
- Uncompliant

Criticality

- Low
- Medium
- High

(Requirement Criticality Definition)

Verification

Verification 1

Method: Review of Design
Deadline: PDR
Status: Complete
Report: 2024_C_ST_ENGINE-BAY_DJF

Verification 2

Method: Test
Deadline: CDR
Status: Complete
Report: 2024_C_RE_PARA_TRP

Verification X

Method:
Deadline:
Status:
Report:

Mentioned in

- 2024_C_ST_ENGINE-BAY_DJF
- 2024_C_ST_ENGINE-BAY_DDF
- 2024_C_RE_PARA_DDF
- 2024_C_RE_PARA_TRP

General Design Requirements List

General

2024_C_SE_REQ_01
LV declaration of purpose
The LV shall be a mean of testing spaceshot technologies and participate in the L9 flight category at the 2025 EuRoC competition ([9000]m apogee).

2024_C_SE_REQ_02
LV declaration of purpose
The LV shall be upgradable to fly at an [30000m] apogee outside of EuRoc competition

2024_C_SE_REQ_03
Apogee Precision
The LV shall reach apogee within a precision of [+/-5%] - ie[+/-450m].

2024_C_SE_REQ_04
Data collection
The LV shall log all raw and processed data.

2024_C_SE_REQ_05
Propulsion type
The LV shall be propelled by a bi-liquid pressure fed LV engine (9000m).

2024_C_SE_REQ_06
Icarus Upgradable
The LV shall be upgradable to include an Icarus developped active control module.

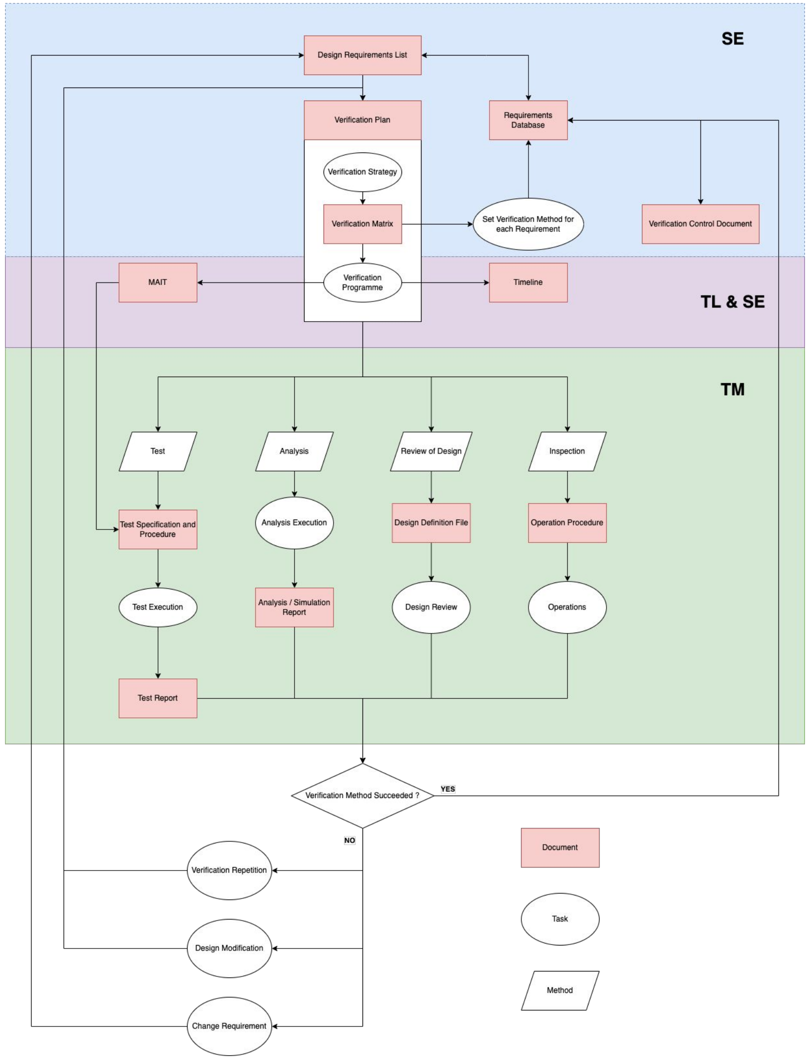
2024_C_SE_REQ_07
Payload type
The LV shall be able to carry a payload following the CubeSat standard [RD01] within the [3]U format.

2024_C_SE_REQ_08
Independent Payload
The LV shall not rely on the Payload to ensure a nominal flight.

Verification

Verification

Michael Fuser - **Ryan Svoboda** - Samuel Wahba



LV
Sizing

LVS Overview

Michael Fuser - Ryan Svoboda - **Samuel Wahba**

Content

- Mission-wise
  - Apogee
  - Ascent Time
  - Exit Veloc
  - …
- Mechanical
  - Length
  - Mass
  - …
- Elec
  - Power Budget
  - Link Budget
  - …

Nouveautés R05: Changé format pour uniquement considérer estimations de masse/longueur qui découlent de l'IR1, retiré les cases devenues obsolètes, ajout calculateur masse AC dans poids module MB

LV Data												
Name	Length [mm]	Structure Mass [kg]			Modules Mass [kg]			Fuel Mass [kg]			Total Mass [kg]		
	Estimation	Estimation	+10%	+20%	Estimation	+10%	+20%	Estimation	+10%	+20%	Estimation	+10%	+20%
Nosecone	1 000	1,60	1,76	1,92	4,00	4,40	4,80				5,60	6,16	6,72
RE Bay	770	6,64	7,30	7,97	6,55	7,21	7,86		0,00		13,19	14,51	15,83
AV Bay	350	5,00	5,50	6,00	3,50	3,85	4,20				8,50	9,35	10,20
Pressurant Bay	750	5,82	6,40	6,98	6,50	7,15	7,80	1,50	1,50	1,50	13,82	15,05	16,28
ETH Tank	625	7,40	8,14	8,88	0,00	0,00	0,00	14,40	15,30	16,20	21,80	23,44	25,08
Mid Bay	280	3,13	3,44	3,76	2,63	2,89	3,16		0,00		5,76	6,34	6,91
Aerocover	2 128	0,70	0,77	0,84	0,95	1,05	1,14					0,00	
LOx Tank	625	7,40	8,14	8,88	0,00	0,00	0,00	20,88	22,19	23,49	28,28	30,33	32,37
Engine Bay	995	8,00	8,80	9,60	11,11	12,22	13,33		0,00		19,11	21,02	22,93
TOTAL (dry)	5 395,00	45,69	50,26	54,83	35,24	38,76	42,29	0,00	0,00	0,00	80,93	89,02	97,12
TOTAL (wet)	5 395,00	45,69	50,26	54,83	35,24	38,76	42,29	36,78	38,99	41,19	117,71	128,01	138,31

+20%
784
06
5

	Estimation	+10%	+20%
MB Module mass (incl. total AC mass) [g]	4,28	4,71	5,14

Everything goes in the sizer(s)

LVS Overview

Michael Fuser - Ryan Svoboda - **Samuel Wahba**

Peak at LVS under construction

- LVS = tailor-made tool
- More precision = Better
- Fill in the data as the project goes

Battery Characteristics Overview		
Characteristc	**Low Power Circuit**	**High Power**
Series Configuration (S) [-]		
Nominal Voltage [V]	0	0
Voltage@Full Capacity [V]	0	0
Nominal Capacity [Ah]		
Cont. Discharge Rate (C) [-]		
Burst Discharge Rate (C) [-]		
Nominal Current [A]	0	0
Burst Current [A]	0	0
Min. Charge Level [%]	20%	20%
Max. Charge Level [%]	80%	80%
Nominal Power Capacity [Wh]	0	0
Nominal Power Delivery [W]	0	0

Power Consumption Analysis - Navigation Sensors Board		
Characteristc	**Standby/Shutdown**	**Operating**
ADXL375 Voltage Supply [V]	3,3	3,3
ADXL375 Current Supply [A]		
ADXL375 Consumption [W]	0	0
BMI08 Voltage Supply [V]	3,3	3,3
BMI08 Current Supply [A]		
BMI08 Consumption [W]	0	0
BMP03 Voltage Supply [V]	3,3	3,3
BMP03 Current Supply [A]		
BMP03 Consumption [W]	0	0
LT3960 Voltage Supply [V]		
LT3960 Current Supply [A]		
LT3960 Consumption [W]	0	0

Thank you !