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# VV16: the First VEGA Rideshare Mission: lessons learnt after successful flight

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AVIO
€322M
Revenues
2020
1000
Employees
€350M
Mkt Cap
60% free float
VEGA
Prime
Contractor
ariane 6
Partner
Supplier

# What we do - European Fleet

| ***Capacity*** | **10,5 t** | **1,2 t** | **2,3 t** | **6 t** | **11 t** | **2,8 t** |
|---|---|---|---|---|---|---|
| *Reference Orbit* | GTO | SSO, 700 km | SSO, 700 km | GTO | GTO | SSO, 700 km |

| Today | | 2022 | 2022 | | 2025 |
|---|---|---|---|---|---|
| **Ariane 5** | **Vega** | **Vega C** | **Ariane 62** | **Ariane 64** | **Vega E** |

# SSMS - Introduction

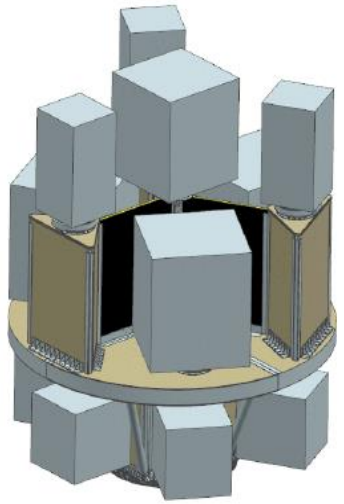

## SSMS (Small Spacecraft Mission Service) program

- new multi-launch concept for the **VEGA** & **VEGA-C** launchers
- thanks to a new modular dispenser for the Small Satellites Market

VV16 **POC** (Proof Of Concept) of SSMS

- **VEGA** 16th flight performed on September 3rd, 2020
- with a complex configuration of **43 satellites**

(43 separated by VEGA. One of the satellites released 10 Cubesats. Totally 53 satellites)



# Plan

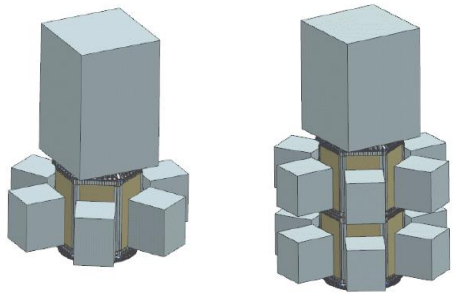
Presentation focused on **Post flight lessons learnt**

- SSMS keywords
- Configuration
- Trajectory & Mission profile
- Mechanical & Thermal conditions
- Separation conditions
- Conclusion

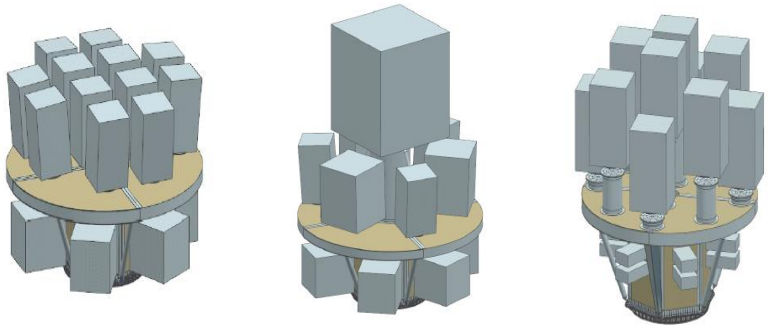
# SSMS Keywords

**Standardization** of
- Dimensions and masses of the satellites
- Separation systems,
- Interfaces
- Operational constraints

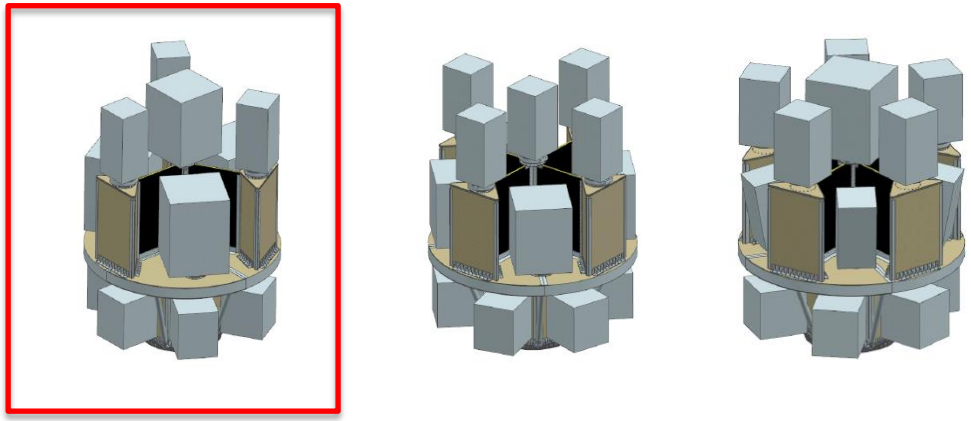
**Modularity** of the dispenser
- to fit a wide set of possible aggregates



HEX 1, HEX 2



PLAT 1, PLAT 2, PLAT 3



FLEX 3, FLEX 4, FLEX 5

# CONFIGURATION: SATELLITES LOCATION

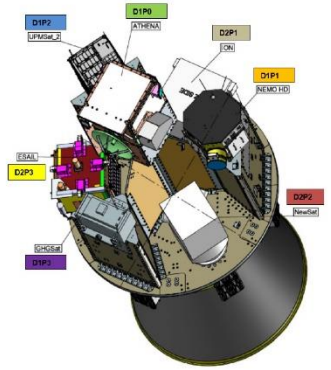
**Microsatellites**

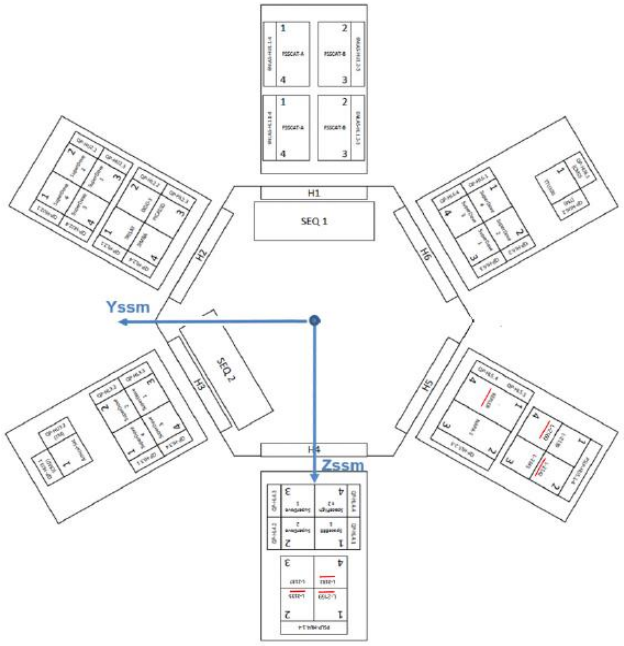
on **DECK** structure

**Cubesats**

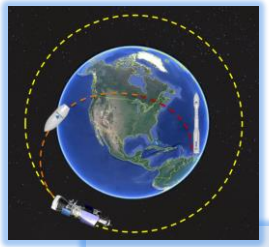
on **HEX** structure

| Location | Sat names |
|---|---|
| D1P0 | ATHENA |
| D1P1 | NEMO HD |
| D1P2 | UPMsat-2 |
| D1P3 | GHGsat |
| D2P1 | ION |
| D2P2 | NewSat |
| D2P3 | ESAIL |
| HU1 | TYVAK-1 LEFT<br>TYVAK-1 RIGHT |
| HL1 | FSSCAT-A<br>FSSCAT-B |
| HU2 | 4 x SUPER DOVES |
| HL2 | PICASSO<br>+ SIMBA<br>+ DIDO3<br>+ TRISAT |
| HU3 | AMICalSat |
| HL3 | 4 x SUPER DOVES |
| HU4 | 4 x SPIRES (Lxxxx) |
| HL4 | 2 x SUPER DIVES<br>+ SpaceBEE-1<br>+ SpaceFlight-2 |
| HU5 | 4 x SPIRES |
| HL5 | NAPA1 + KEPLER |
| HU6 | TTU100 |
| HL6 | 4 x SUPER DOVES |

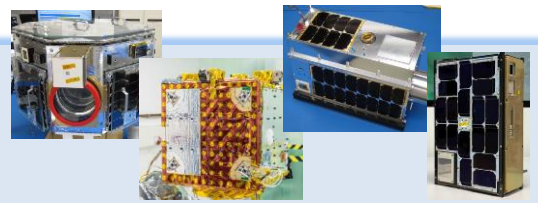


# Trajectory & Mission Design: MASSES & PERFO

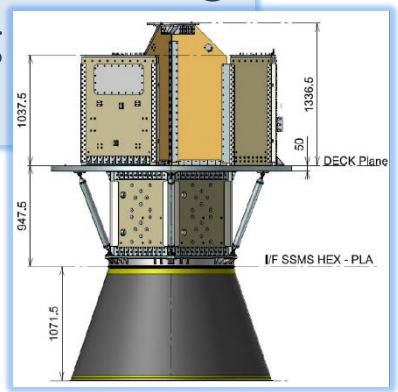


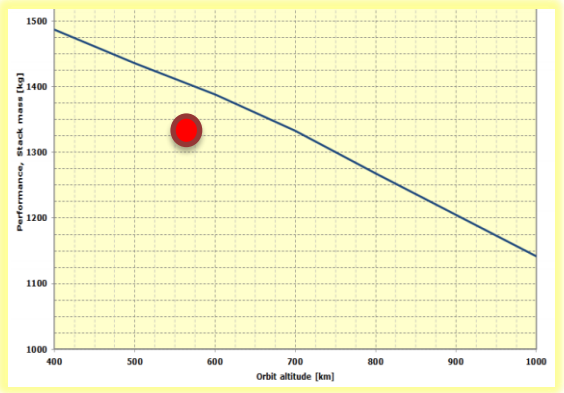
**Orbits altitudes :** about 530 km



## Masses

- Satellites : Total mass to be separated = 759 kg
- SSMS dispenser: Total mass = 540 kg
- (including PL Adapter 1194 of 81 kg)




## VEGA Performance Map

- **SSO** type
- **Multi-PL** type (2 orbits)

**Compatible with VEGA capabilities**

(including de-orbiting boost for safety purpose)

# Trajectory & Mission Design: OPTIMIZATION

| Parameter | Nominal |
|---|---|
| a : Semi-Major Axis (km) | 6893.137 |
| e : Eccentricity | 0.0012 |
| i : Inclination (deg) | 97.4585 |
| ω : Argument of Perigee (deg) | 90 |
| LTDN | 10:30:00 |

Mean orbital parameters for the first released microsatellite (ATHENA)

| Parameter | Nominal |
|---|---|
| a : Semi-Major Axis (km) | 6908.137 |
| e : Eccentricity | 0.0012 |
| i : Inclination (deg) | 97.5158 |
| ω : Argument of Perigee (deg) | 90 |

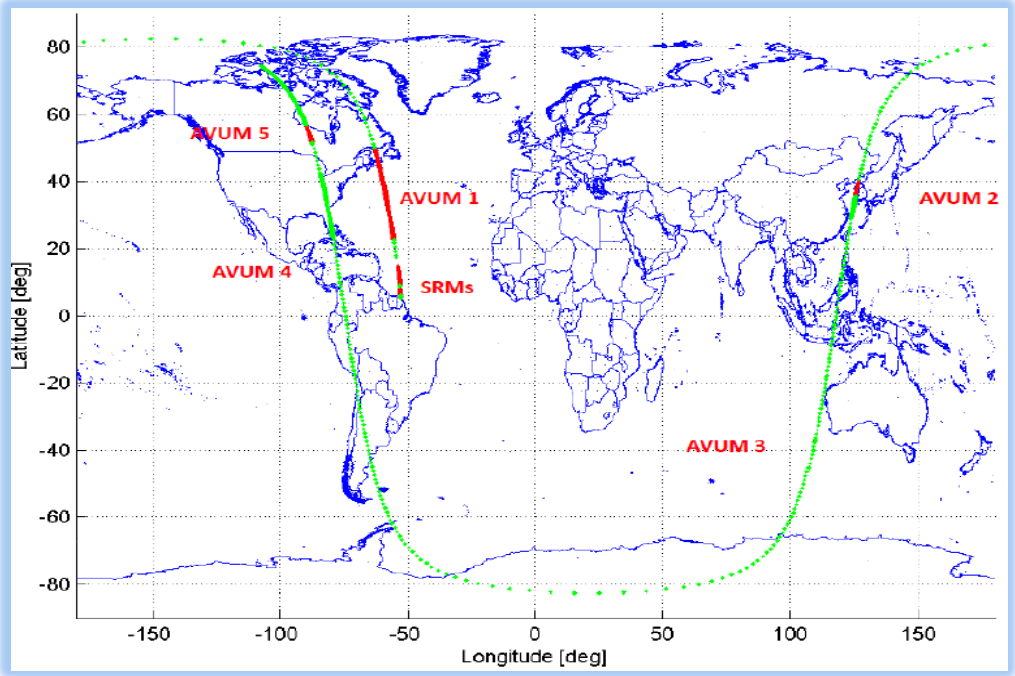
For the first released Cubesat

**Requirements: 2 target orbits**

- P/L to be grouped into subsets
- VEGA allows 5 main engine ignitions ⇔ 2 circular orbits

**Constraints (standard for VEGA)**

- Safety
- Visibility
- System (aero, mechanical, thermal, control…)

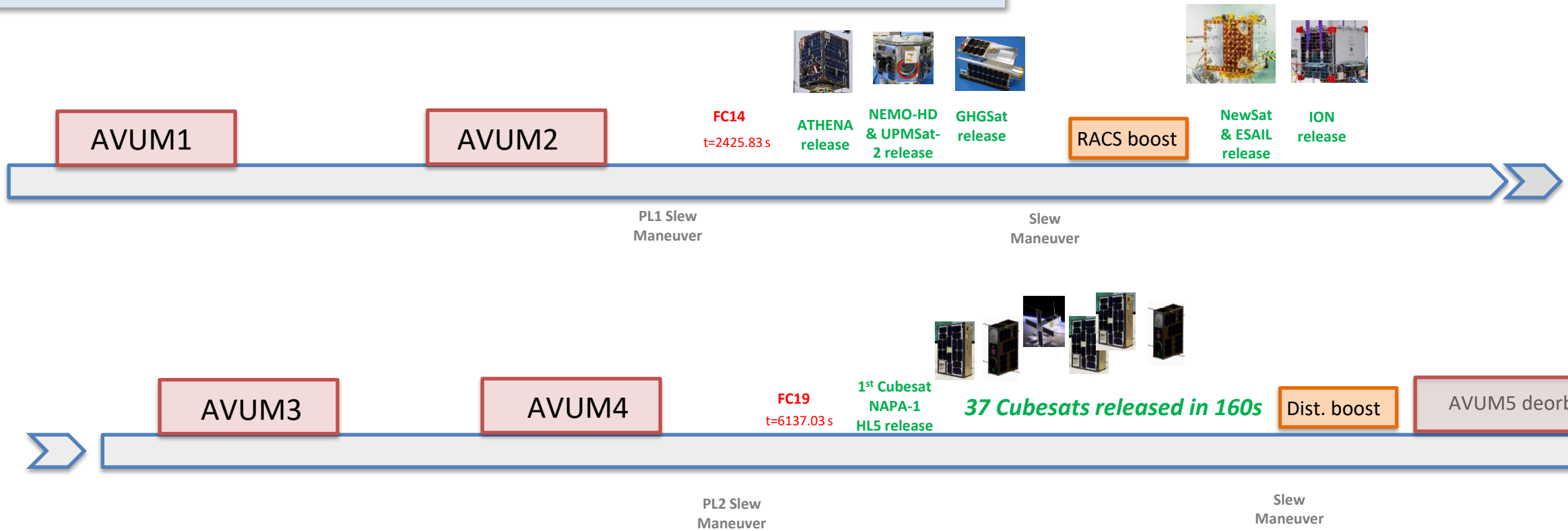


# Trajectory & Mission Design: MANEUVERS & TIMELINE

In addition to AVUM boosts, other degrees of freedom:

- PL release times & separation DV (norm, direction)
- Boosts by the thrusters of the Roll & Attitude Control System (RACS)

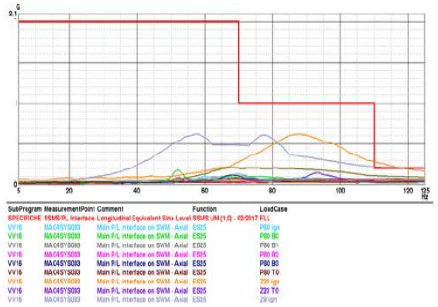
=> Longitudinal boosts to distance the PL => to reach different, though close, orbits.

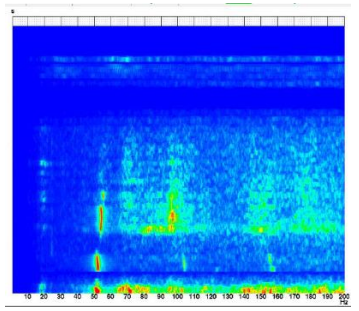


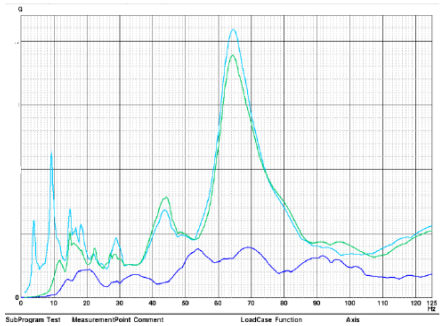
# MECHANICAL & THERMAL EVIDENCES

## Low Frequency

11 accelerometers located on the upper stage.
Specific sensors close to Deck structure & to the main Payloads
Acceleration level covered by pre-flight analysis
Good correlation of local modes



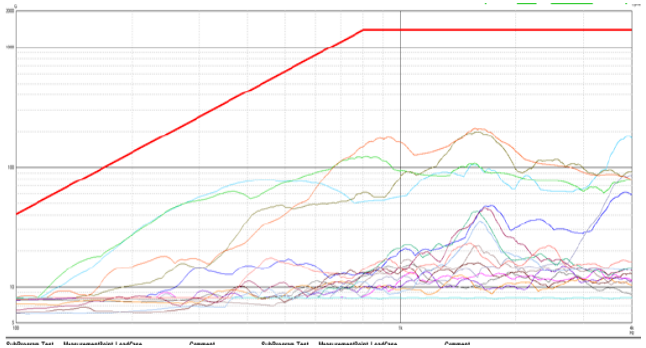




## Shocks

Shock sensors for flight exploitation.
Main events: fairing, 3rd stage separation, and P/Ls separations.

- 1st P/L batch release (on SSMS Towers), shock levels detected on Main Deck & HEXA panel.
- 2nd P/L batch release very well observed.
- 3rd batch (Cubesats separation) shock waves hardly detectable

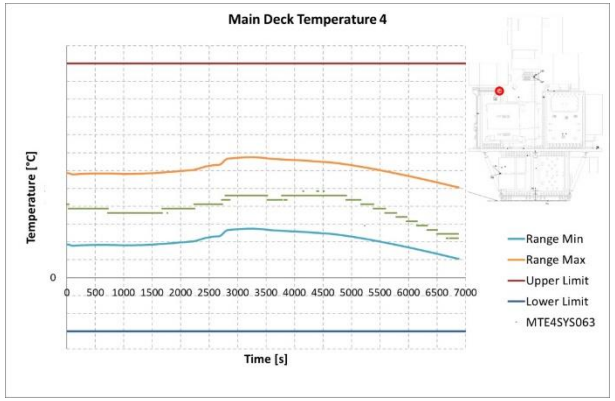


## Thermal

Sensors:

- 27 thermal sensors located in LV structures
- 20 sensors to monitor the thermal environment on the SSMS structures & P/L located on SSMS equipment (deck, towers, HEXA module).

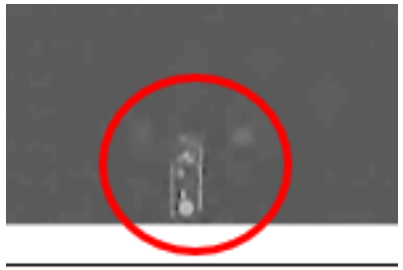
Thermal environment of SSMS structures & P/Ls inside the requirements



# SEPARATION EVIDENCES

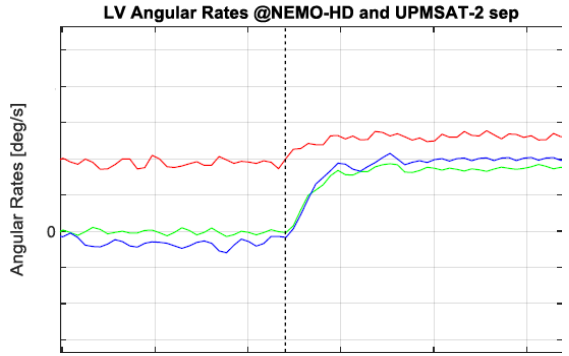
**Reconstruction from camera**

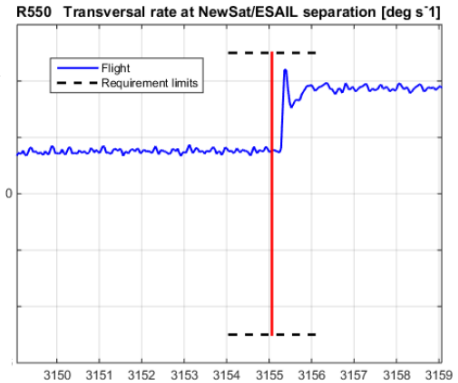
- 1° batch
- 2° batch
- 3° batch

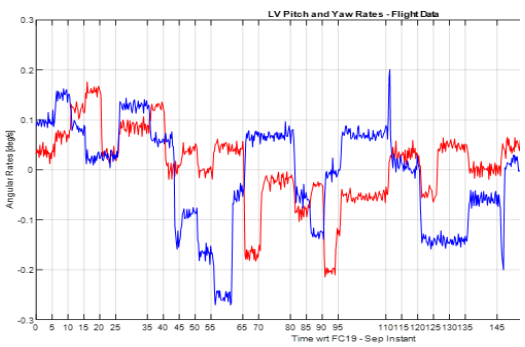


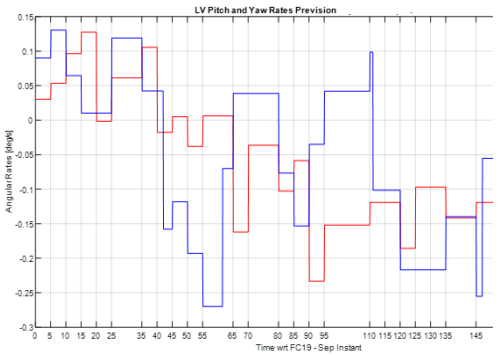

**Reconstruction from IRS measurements (angular velocity)**

- 1° batch
- 2° batch
- 3° batch: good observation on each separation (directions & DVs)



# VV18 MISSION

## VV18 Mission successfully flown on 2021 April 29th

It was partially a SSMS Mission:

- Main PL VHR2020-B1L on the Deck
- HEX Module located on the 1194 Payload Adapter
- 3 auxiliary P/Ls:
  - NORSAT3 30 kg
  - PSL12U-3w 28 kg
  - TYVAK0182A-6U 17 kg

This final configuration is the result of a last-minute change in the Cubesat configuration. This change of missionization (impacting the total mass, the COG and the separation logic) has been assessed in very reduced time, thanks to the lessons learnt from VV16 flight and from the specific tools dedicated to this kind of missions.

# CONCLUSION

## SSMS POC VEGA, a complex mission

The FLEXI-3 dispenser allows the separation of 43 satellites grouped into:

- 7 Microsats separated in two subsets on a quasi-circular orbit
- and then 36 Cubesats separated in a short phase of 160s on a 2nd quasi-circular orbit.

## Mission design

- compliant to requirements (propellant budget, injection accuracy, probability of non-collision and non-contamination, safety rules)

## VV16 Flight

The POC mission has been successfully flown on 2020 September 3rd. The post-flight analysis has shown compliance with respect to the Mechanical and thermal requirements, orbital accuracy and condition at separation.

## VV18 Mission

The mission VV18 has successfully flown on 2021 April 29$^{th}$ with SSMS. For its missionization the lesson learnt from VV16 was useful to cope with a last minute change of Cubesats configuration, solved and assessed in a very short time.


THANK YOU FOR
YOUR ATTENTION