



CubeSats for the VEGA Maiden Flight

An opportunity offered by the
ESA Education Office

2010 CubeSat Developers' Workshop
Cal Poly, San Luis Obispo
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www.esa.int/education

European Space Agency - Education

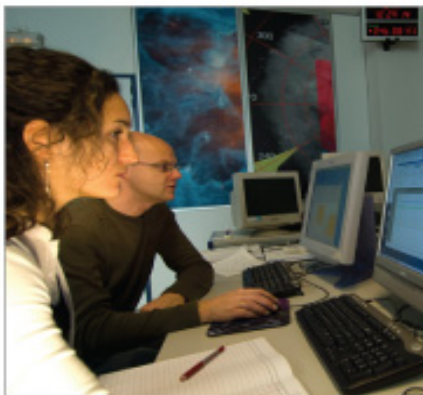
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Objectives of the ESA Education Office

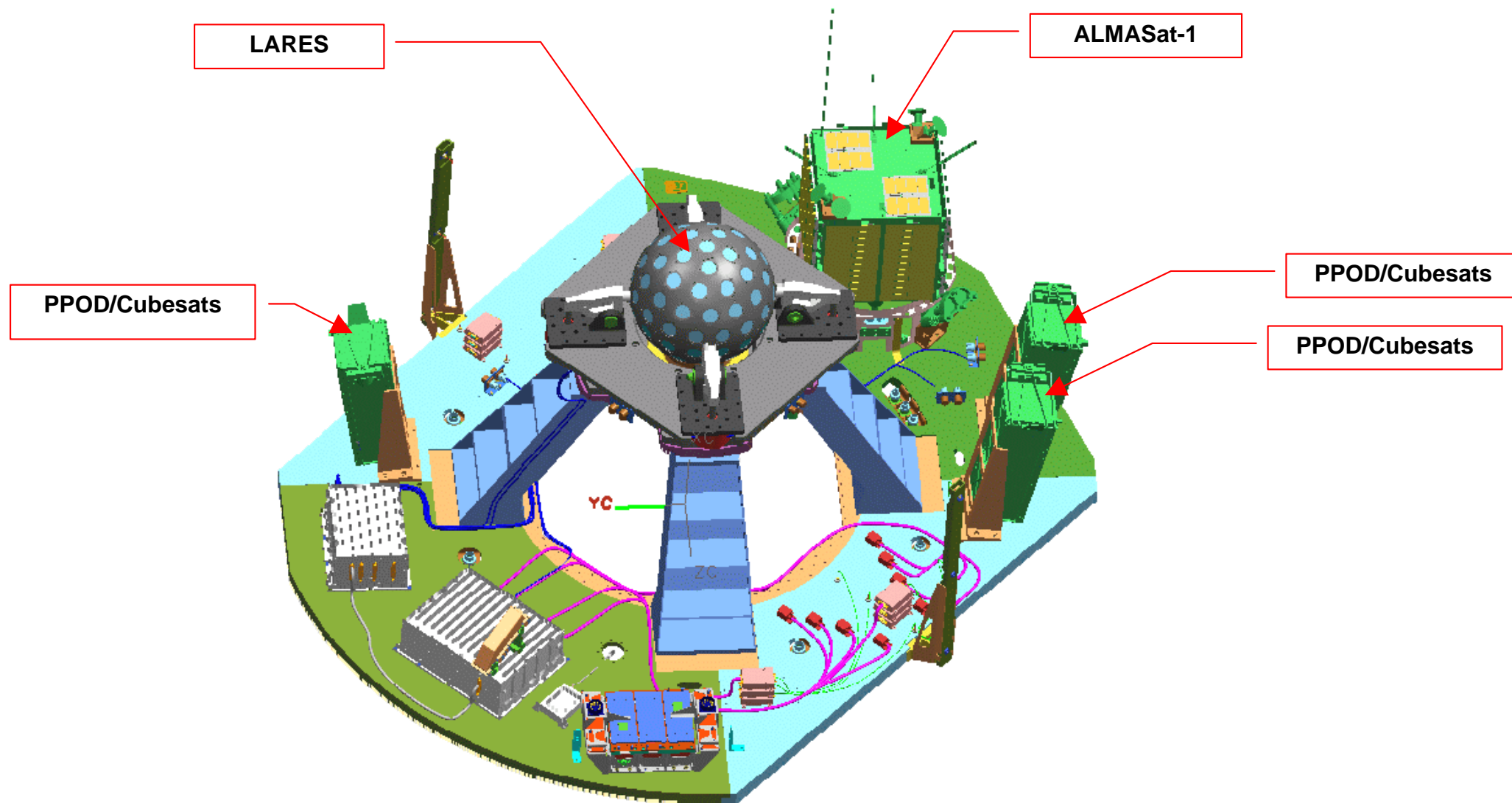


- **Serve the primary needs of the European Space Agency and European Industry for the future recruitment of a work force highly qualified in space research and technology**
- **Support the establishment of co-operation with countries that are not yet ESA Member States**
- **Federate all ESA educational activities**



- Currently scheduled by end 2010 / early 2011
- The complete payload complement of the VEGA Maiden flight will be installed on the LARES System.
- Carlo Gavazzi Space (CGS), working under a contract of the Italian Space Agency (ASI) is:
 - The developer of the LARES System and,
 - The integrator of the payload complement with the LARES System
- Primary payload: **L**aser **R**elativity **S**atellite (LARES), developed by CGS under contract with the ASI
- Secondary payload:
 - AlmaSat-1 developed by University of Bologna
 - 12.5 kg educational satellite
 - CubeSats
 - (up to) 9 CubeSats installed inside P-PODs, developed by universities located in ESA member or cooperating states

Accommodation of CubeSats onboard VEGA Maiden Flight



(image credit: Carlo Gavazzi Space)

1. The upper stage (AVUM) reach a circular orbit of 1450x1450 km
 2. The LARES satellite is deployed
 3. The AVUM performs orbital manoeuvres to lower the perigee to around 350km (the apogee remains at about 1450km)
 4. AlmaSat-1 and the CubeSats are deployed into the elliptical orbit
 5. After separation of the 10 educational satellites, the AVUM is passivated to prepare it for de-orbiting
- The above sequence injects all the educational payloads into an orbit which will ensure that the satellites will naturally de-orbit within less than 25 years (approximately 12 years for CubeSats)

CubeSats for the VEGA Maiden flight : Brief summary of the mission



- February 2008: Announcement of opportunity for a free of charge launch with the VEGA Maiden Flight
- June 2008: Selection of 9 primary and 2 backup CubeSats
- Low earth orbit
 - Approx. 350x1450 km
 - 71° inclination
 - RAAN and LTAN are free parameters (TBD closer to launch)

Cubesats for the VEGA Maiden Flight: 11 Universities from across all Europe



Belgium

- **Oufti-1, Liege**
(Test D-STAR amateur radio protocol in space)



France

- **Robusta, Montpellier**
(Radiation effects on bipolar transistors)



Germany

- **UWE-3, Würzburg**
(Development of an active attitude control system)



Italy

- **AtmoCube, Trieste**
(Space weather measurements)
- **E-St@r, Torino**
(Test an active 3-axis Attitude Control)
- **UniCubesat, Roma**
(Atmospheric neutral density measurements)



Poland

- **PW-Sat, Warsaw**
(Deployable drag augmentation device)



Romania

- **Goliat, Bucharest**
(Earth imaging; space environment measurements)



Spain

- **XatCobeo, Vigo**
(Software-defined radio; solar panel deployment)

Back-up nr.1:



Norway

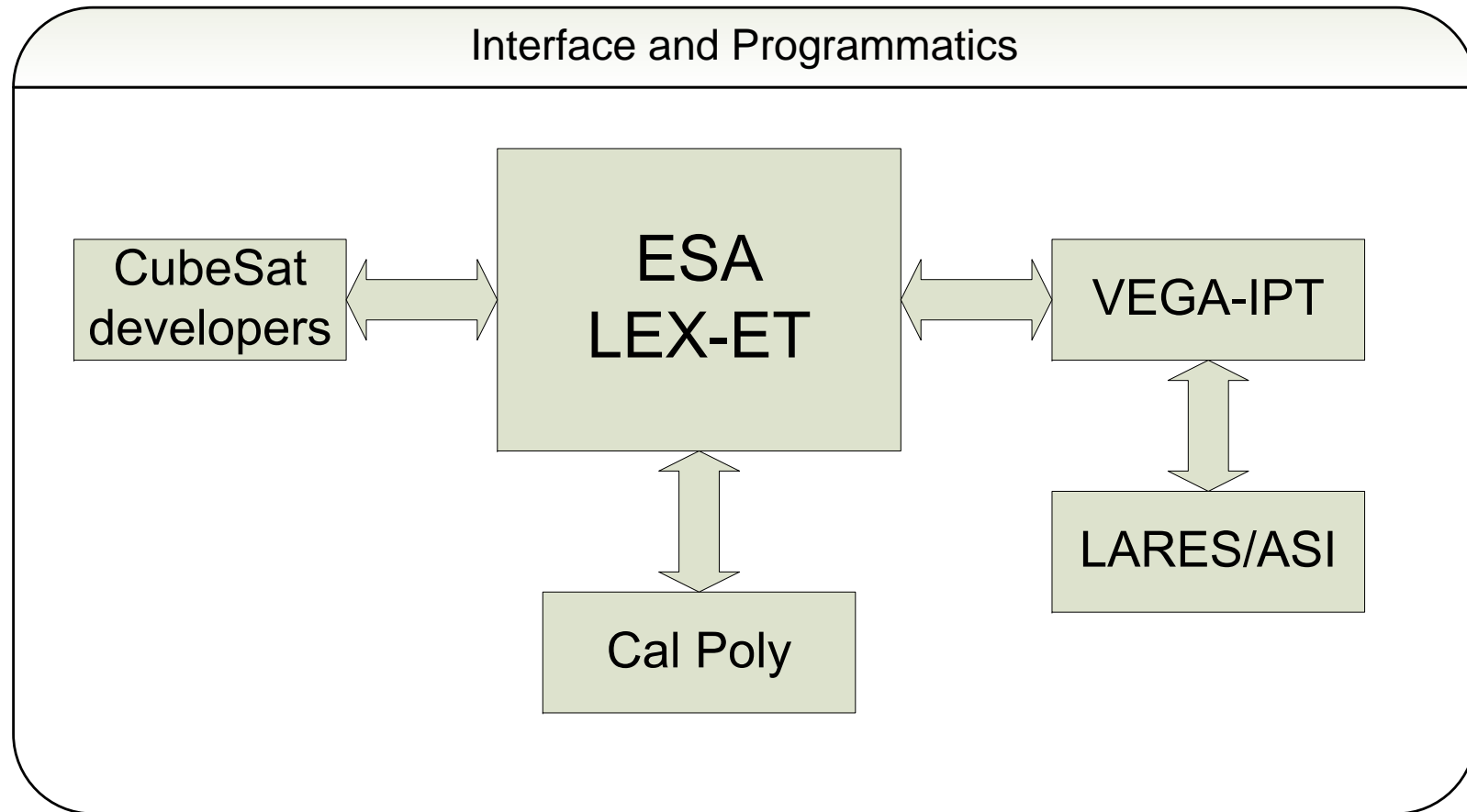
- **HiNCube, Narvik**
(Earth imaging; definition of a pico-satellite platform for future applications)

Placeholder (Back-up nr.2 , TBC):

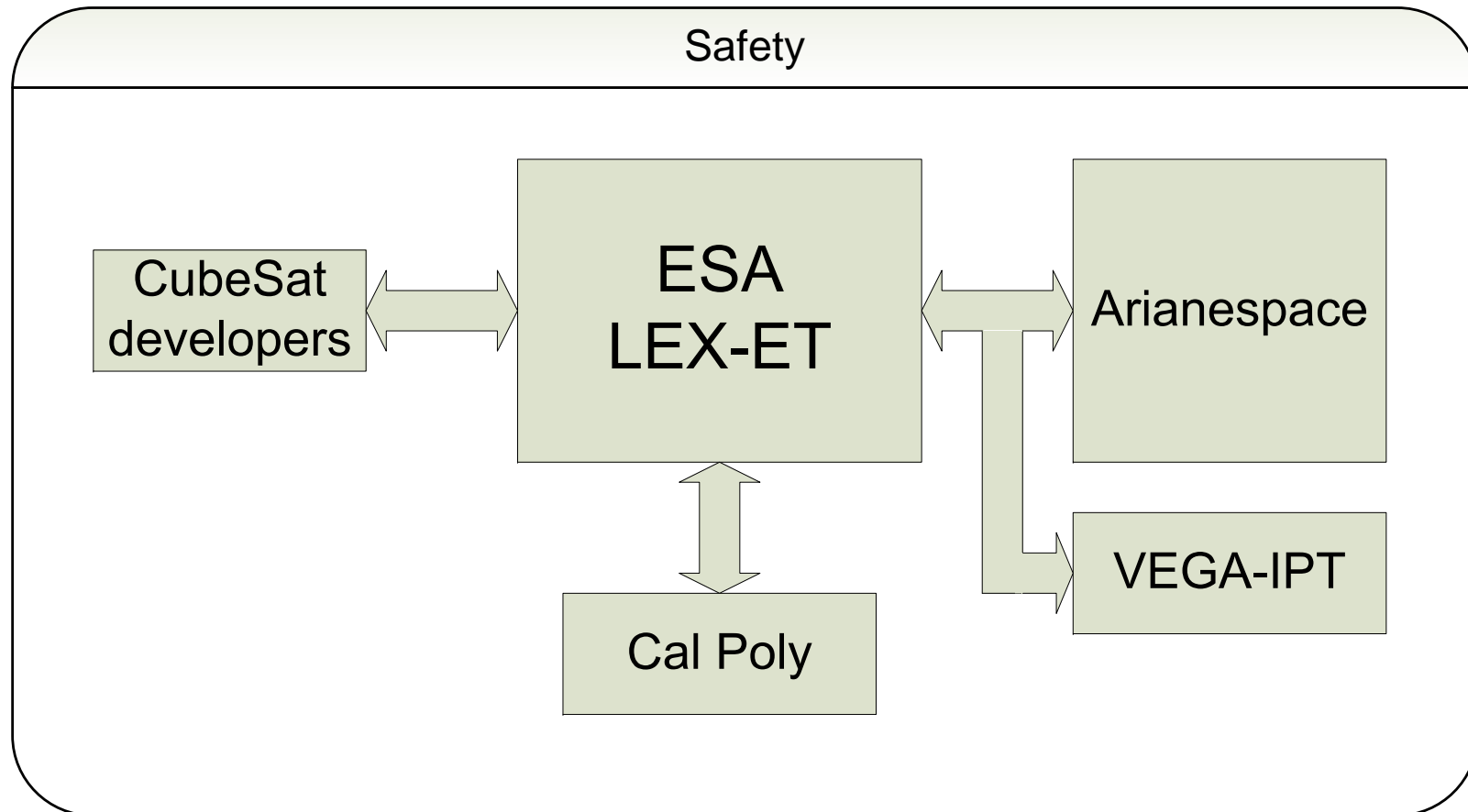


Switzerland

- **SwissCube2, Lausanne**

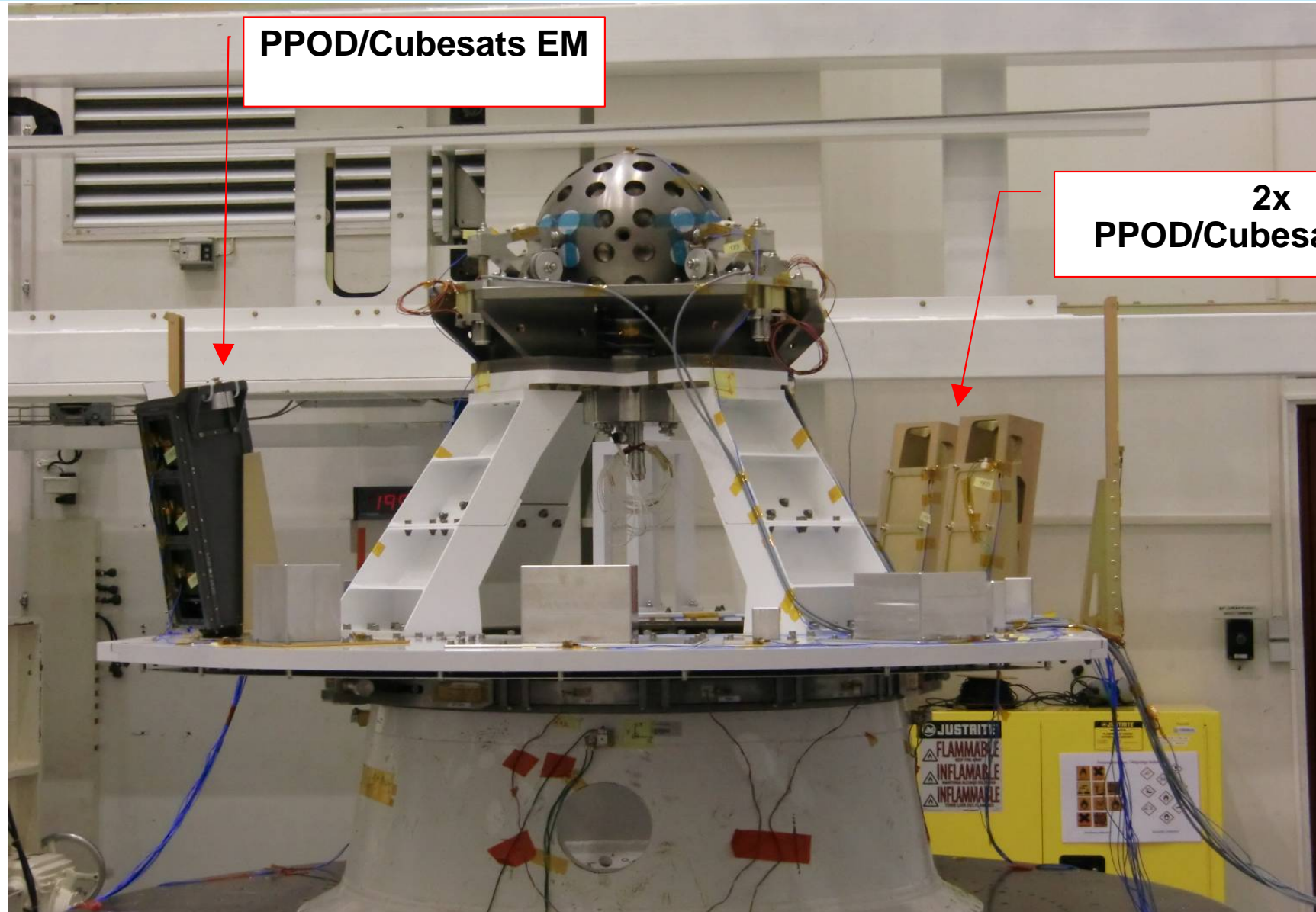


Organisational links (Safety)



- The acceptance review for the P-PODs is expected to be performed by the end of May
- The CubeSats are at very different stages of development:
 - Earliest availability of a CubeSat is around July 2010
 - Most CubeSats expect to be ready to deliver around end 2010
(Delivery of CubeSat includes the deliverable documentation and not just the flight HW)
- LARES System has completed their structural qualification tests using 1 P-POD EM and 2 P-POD Mass Dummy Units (MDU)

LARES System during Structural Qualification Test



- Consolidation of the ESA interface and verification requirements
 - Assessment of the thermal interface during launch
 - Consolidation of the structural interface loads (based on the LARES System Qualification Test results)
- Contamination control for the CubeSats (LARES includes optical sensitive surfaces)
- FMECA for the CubeSats (in particular undesired premature activation during ground processing and launch)
- Closing out the Safety Submissions (Phase 1/2/3 for ground and flight safety) for all CubeSats and P-PODs in order to allow for launching with VEGA and processing at Kourou Space Centre

- Performing the acceptance reviews of up to 9+2 CubeSats, and their integration with the P-PODs in a short time is a rather big challenge:
 - It must be ensured that the Acceptance Data Package for each CubeSat is concise, complete, and structured accordingly to a common standard
 - Limited time can be allocated by ESA reviewers to each individual CubeSat documentation
 - Time spent by reviewer to locate information must be minimised
 - Universities may not have great experience with the verification approach and with preparing the documentation normally required by organisations like ESA
- Dealing with the VEGA Maiden Flight provides the educational opportunity to the university students to familiarise with the working methodologies that normally ESA applies to organise the verification approach and to prepare the related documentation.

Aligning the Verification Process and Documentation with the ESA Requirements



- The ESA requirements for the CubeSats are based on two sources:
 - CubeSat Design Specification (Cal Poly, Rev 12)
 - VEGA Maiden Flight specific requirements, incorporated in an ICD prepared by the ESA Education Office based on the VEGA and LARES System requirements

=> this implies that two Verification Control Documents (VCD's) will be required
- The templates of the two VCD's have been prepared by the ESA Education Office
- A Workshop was held at ESTEC (7th-9th April 2010), with the participation of representatives from the CubeSat university teams, with the purpose of instructing all CubeSat developers about the ESA requirements on how the verification documentation and the acceptance data package should be prepared.

CubeSat Integration Approach



1. Acceptance Review of the P-PODs
2. Delivery of the P-PODs to ESA/ESTEC
3. Acceptance Reviews of the CubeSats
4. Delivery of the CubeSats to ESA/ESTEC
5. Integration of the CubeSats with the P-PODs (at ESTEC, with Cal Poly assistance)
6. Integrated tests performed on integrated P-POD/CubeSats
7. Preparation of Data Packages for the three integrated P-POD/CubeSats
8. ADP's submittal to LARES/VEGA
9. Shipment to LARES Integrator
10. Integration of P-POD/CubeSats with LARES
11. LARES Integration with VEGA
12. Launch

→ THANK YOU

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