PLANETARY SYSTEMS CORPORATION

Lessons learned testing and flying Canisterized Satellite Dispensers (CSD) for space science missions

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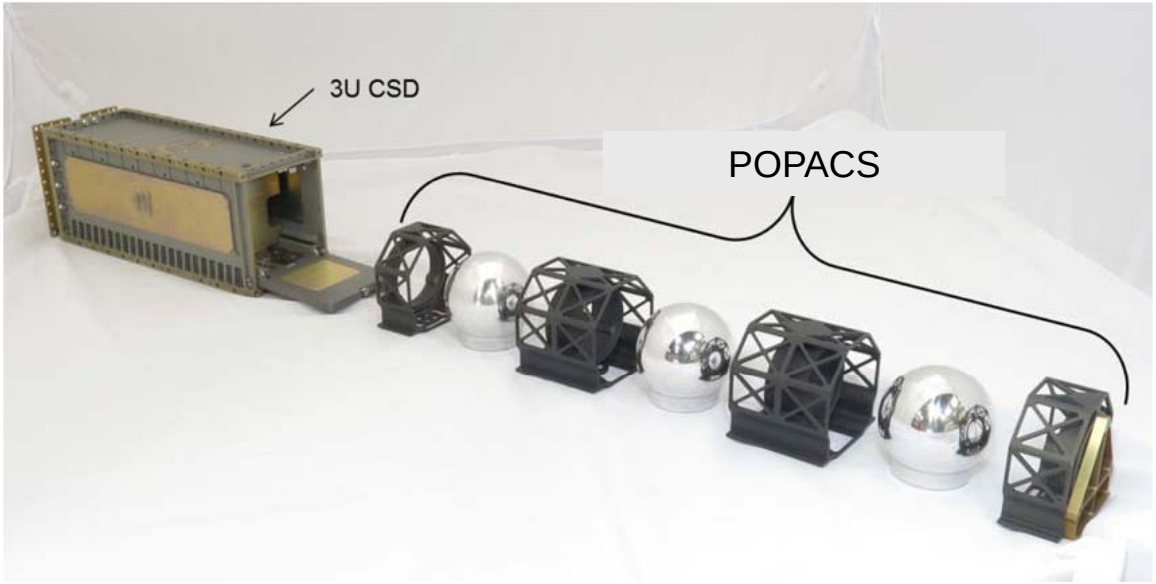
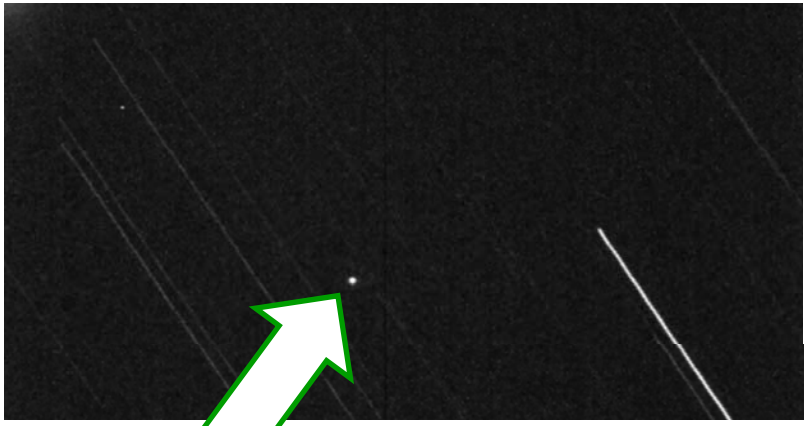
Background

- On 29 September 2013 a 3U CSD dispensed three spherical satellites dubbed POPACS* from Falcon 9 launch vehicle
  - Science mission: Atmospheric density change due to coronal mass ejections (CME) is measured by optically measuring orbit change of the three spheres of different ballistic coefficient
  - 100% success
- Low budget necessitated donated hardware and labor, minimal launch service

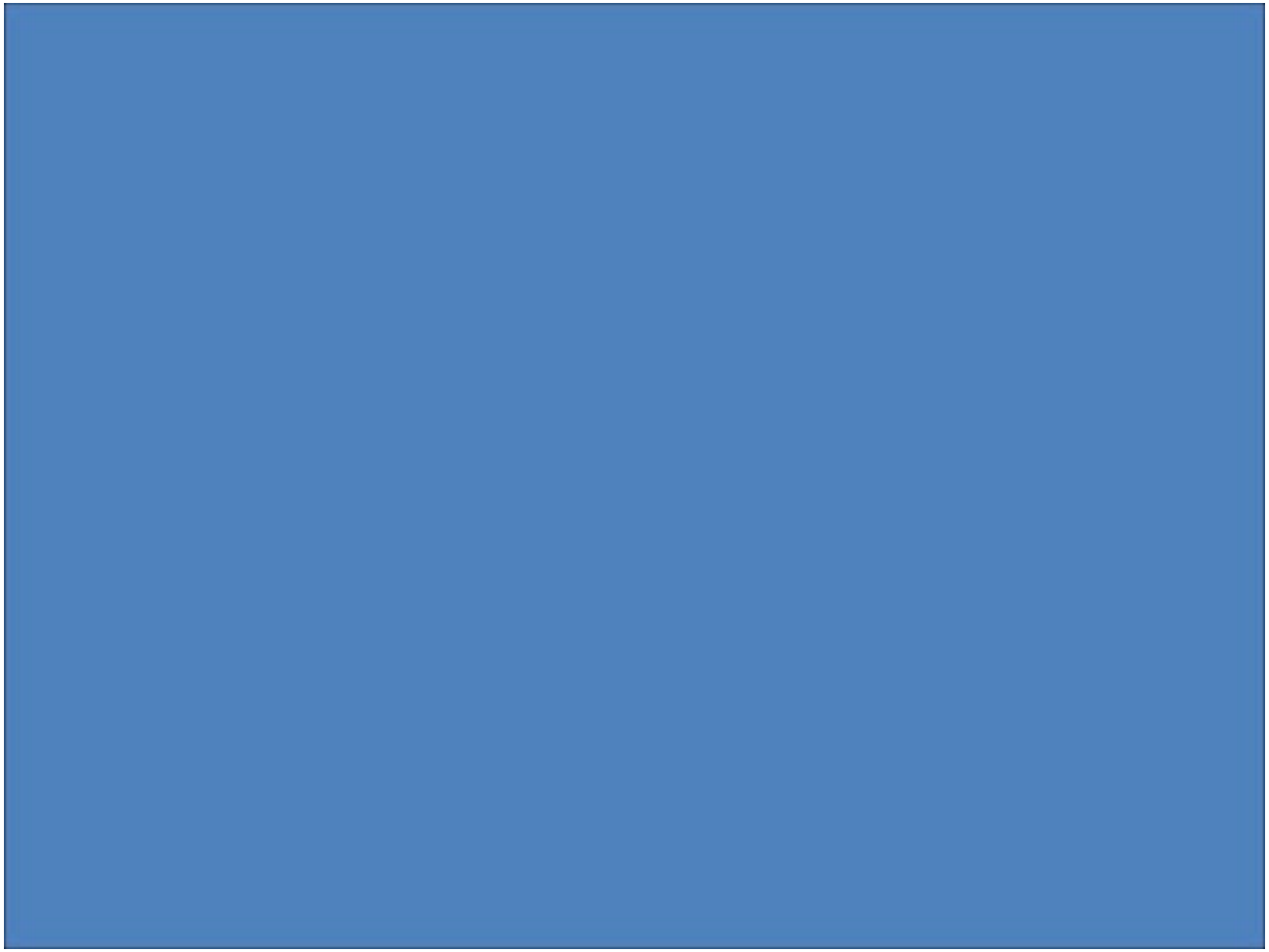




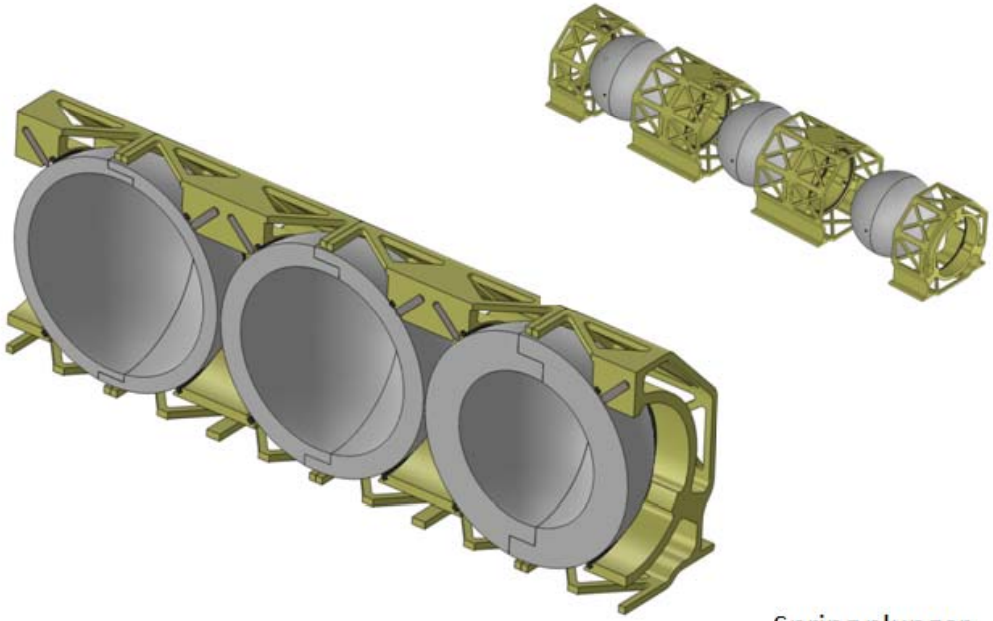
Optical tracking of orbiting sphere

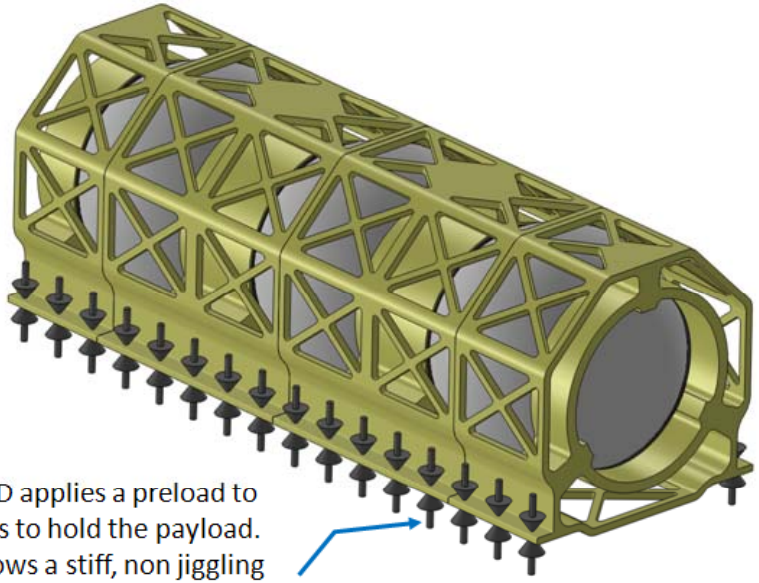
* Holemans, Moore and Kang, COUNTING DOWN TO THE LAUNCH OF POPACS (POLAR ORBITING PASSIVE ATMOSPHERIC CALIBRATION SPHERES) SSC12-X-3 26th Annual AIAA/USU Conference on Small Satellites, August 2012, Logan, UT, USA

Mission Synopsis Video

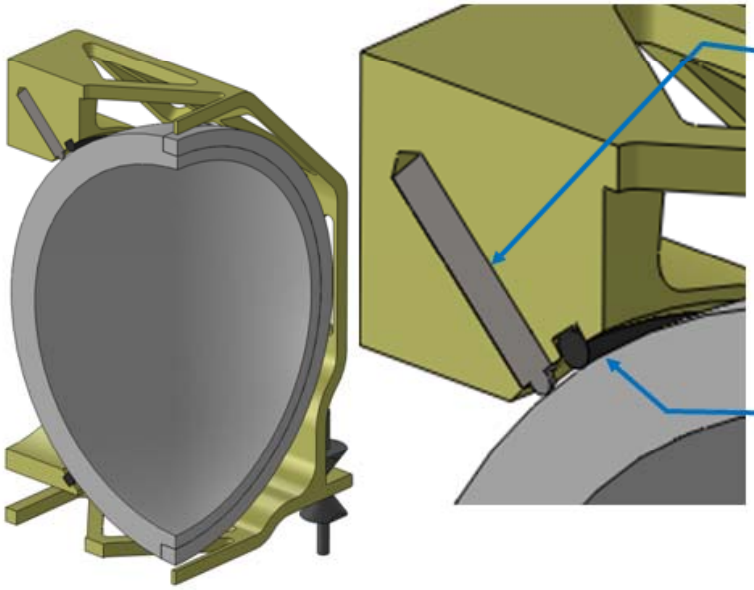


The spheres inside the CSD



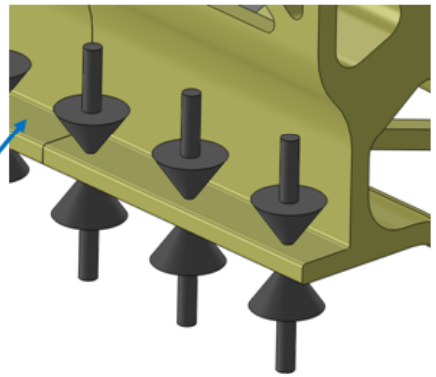


The CSD applies a preload to the tabs to hold the payload. This allows a stiff, non jiggling (modelable) load path from the launch vehicle interface to the spheres



Spring plunger separates spacer from sphere

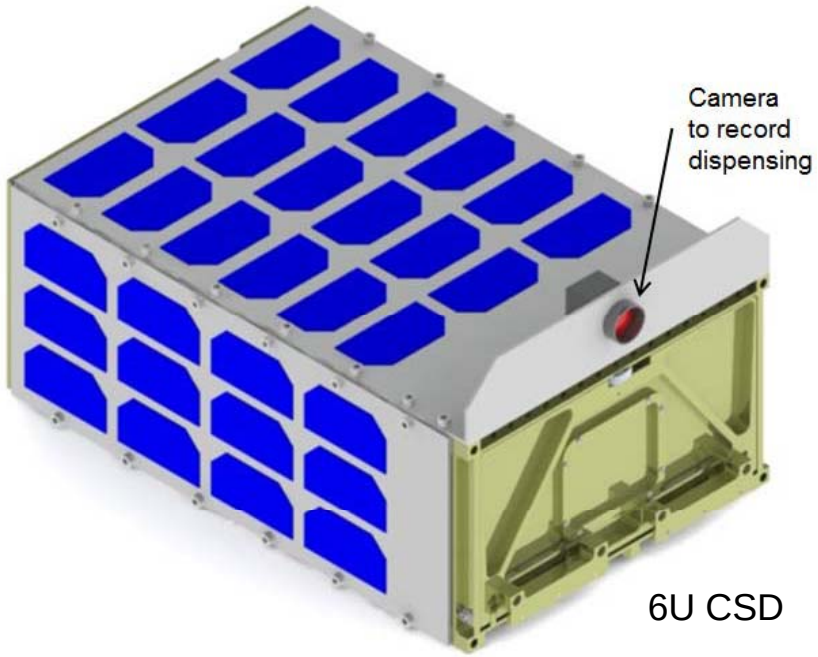
O-ring presses or sphere



Tab on both sides of payload

Lesson 1: Test dispensing from CSD

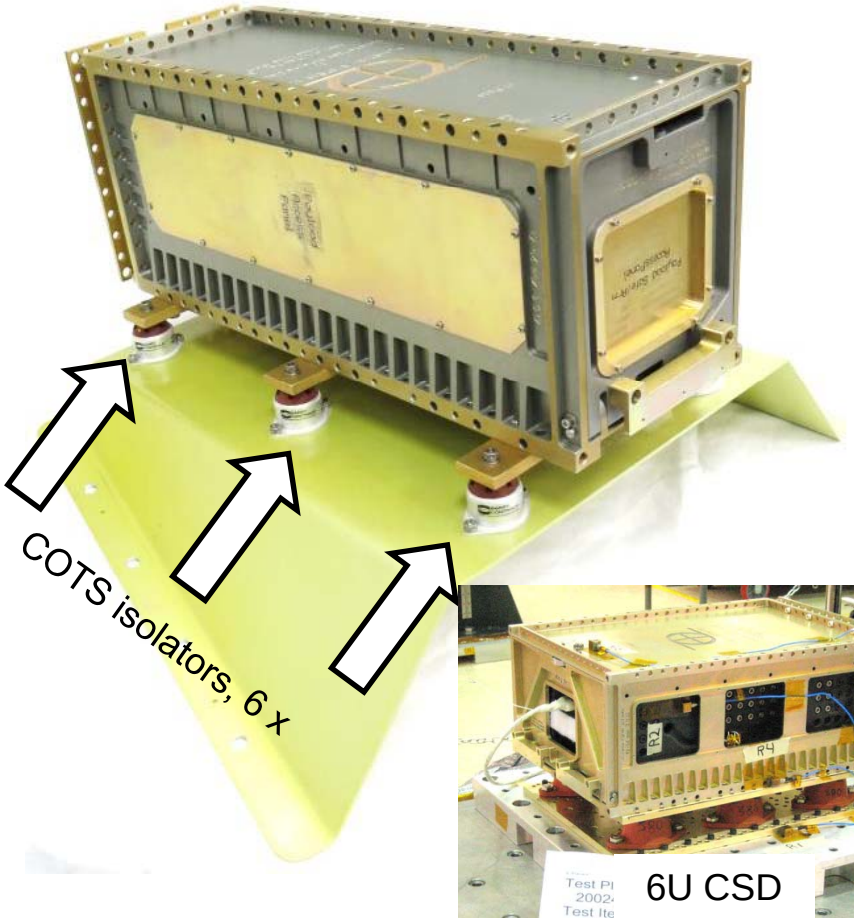
- Problem: The dispensing of seven objects with six degrees of freedom each is difficult to model.
  - But knowing how the payloads come out is essential
    - Did all of spheres come out?
    - What is the relative velocity of the spheres?
    - Are any of the spacers stuck to the spheres?
- Lesson: Test verify dispensing event on “vomit comet”
  - Employ IMU’s on as many elements as possible to help verify
  - Record ICs on-orbit with cameras

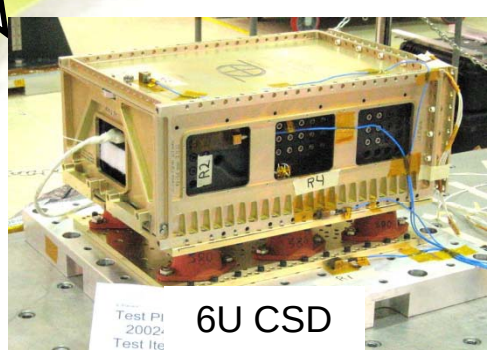


6U CSD

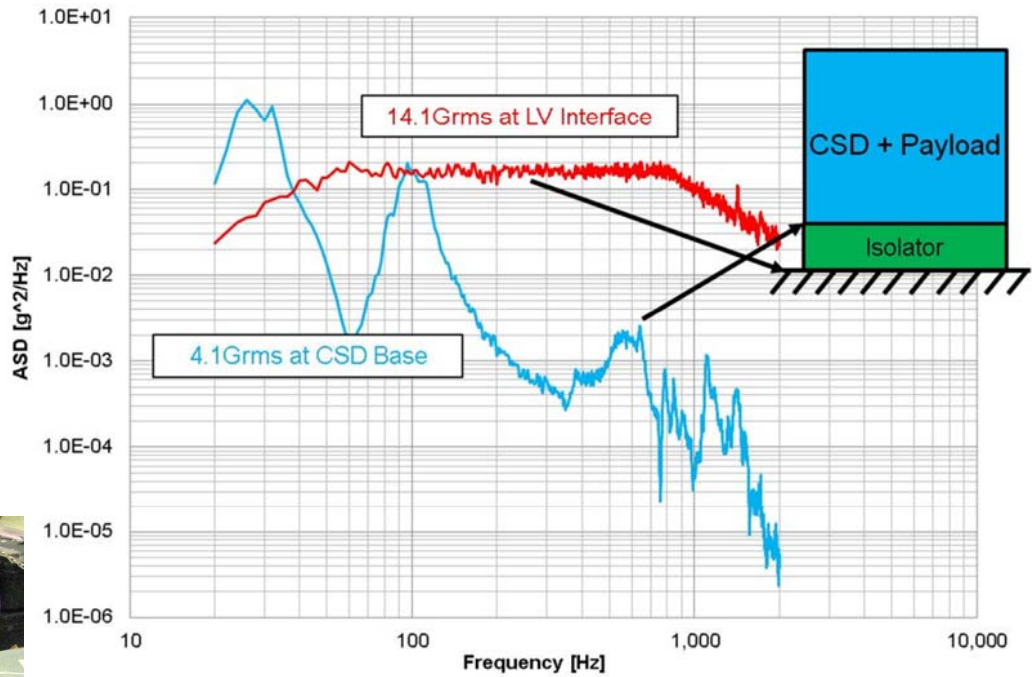
Lesson 2: Isolate whenever possible

- Problem: Vibration, shock environments and payload response imprecisely understood
  - First flight of Falcon 9 variant, CSD and POPACS
- Lesson: Isolate payload to substantially attenuate vibratory loading
  - Isolation is cheap insurance…





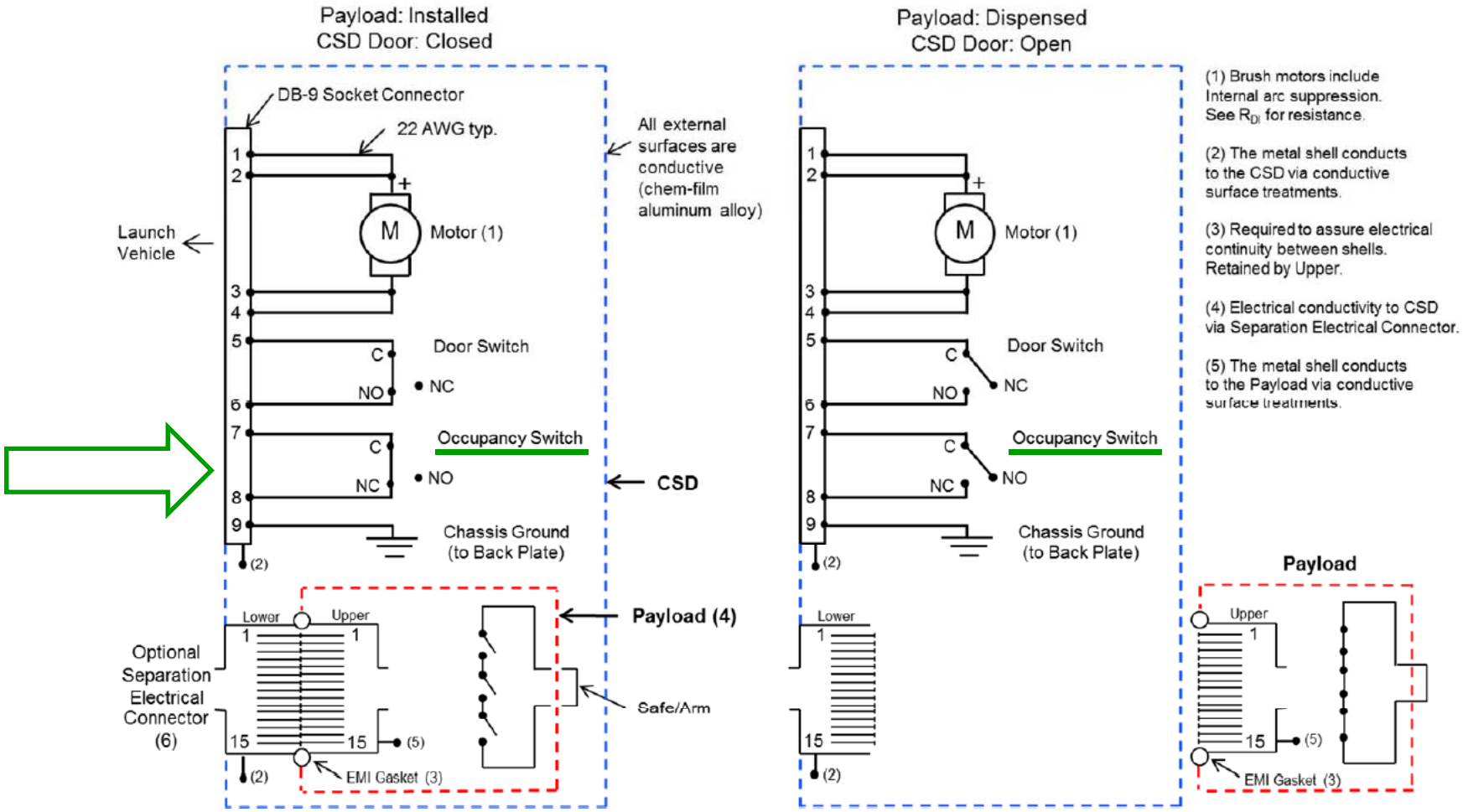
6U CSD



Isolation systems can reduce shock and isolation by orders of magnitude to protect optics, ball bearings of reaction wheels, ceramics, alignment…

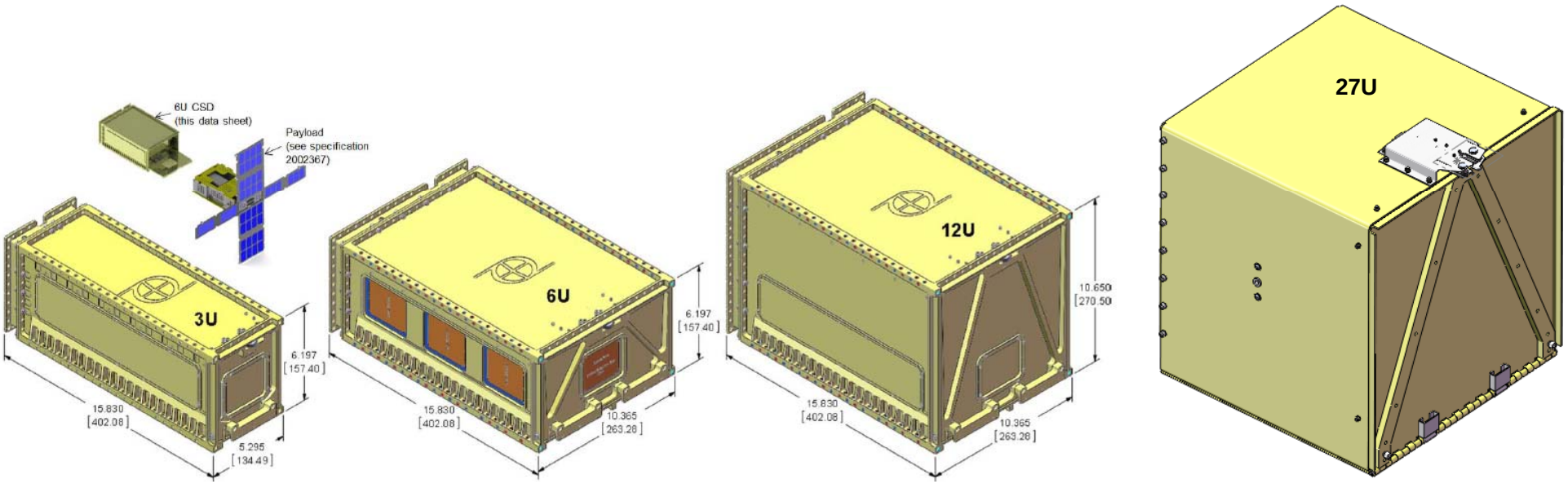
Lesson 3: Know if payload dispensed

- Problem: Mission start was delayed because the payload occupancy switch was not monitored. It took several weeks for verify the spheres where out of the CSD using ground radar
- Lesson: Monitor occupancy switch



About PSC

- PSC manufactures spacecraft separation systems
  - 3, 6, 12 and 27 U CSDs
  - Lightband



Using CSDs

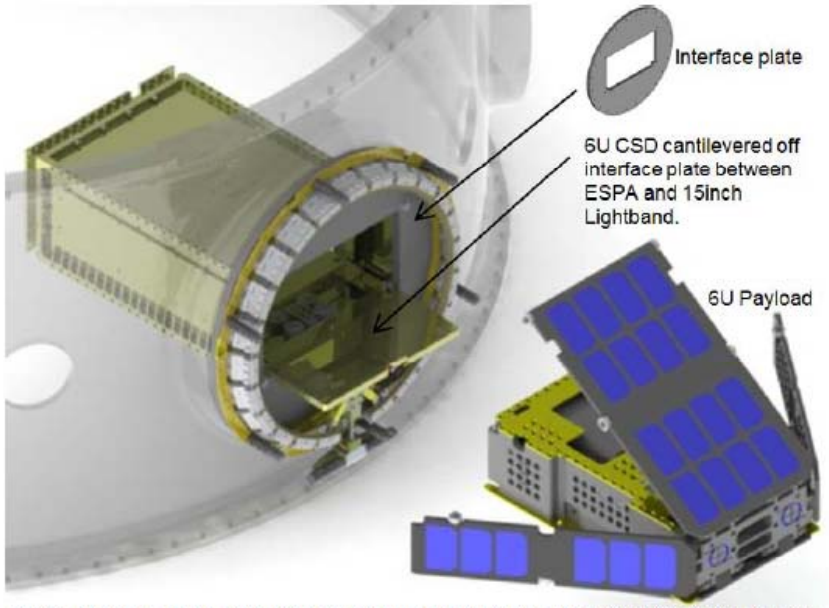


Figure 39: 6U Payload Deploying Through ESPA Port. CSD Mounted Directly via +Z Face.

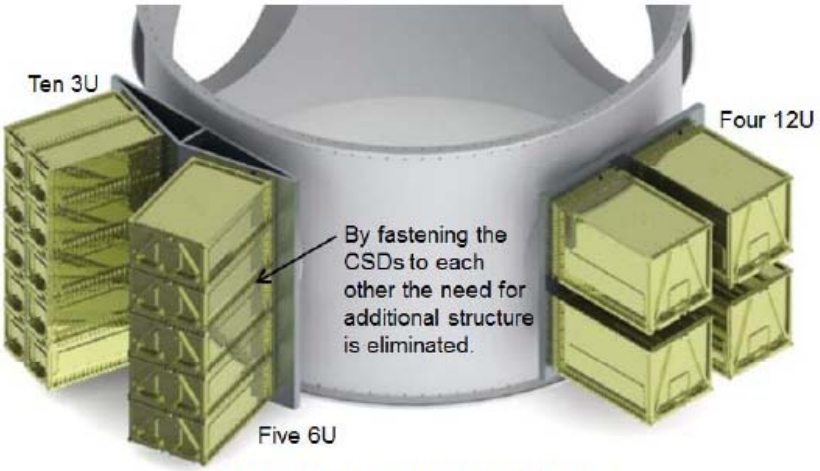


Figure 41: CSDs Mounted to ESPA Grande

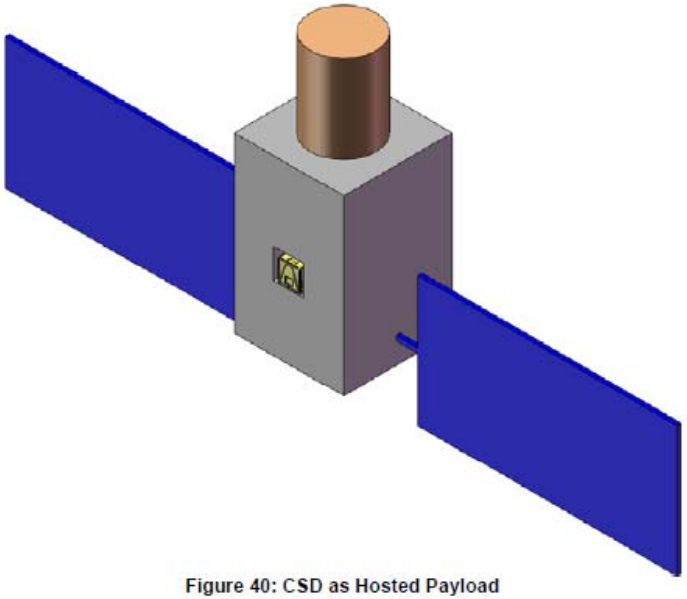


Figure 40: CSD as Hosted Payload

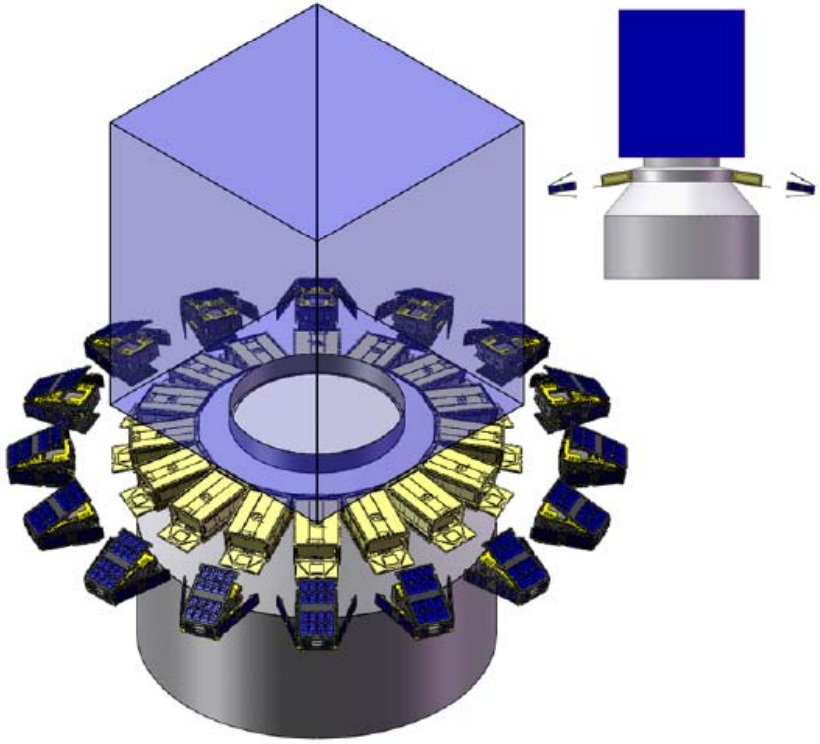


Figure 42: Sixteen 6U CSDs Mounted Underneath Primary Payload

Using CSDs

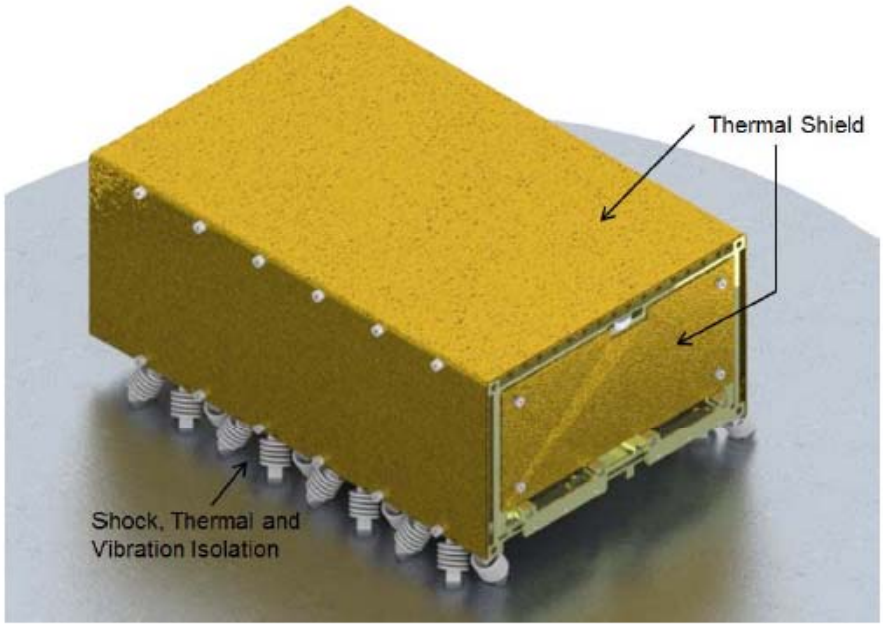


Figure 44: CSDs Easily Accept Bolt-On Vibration and Thermal Isolation

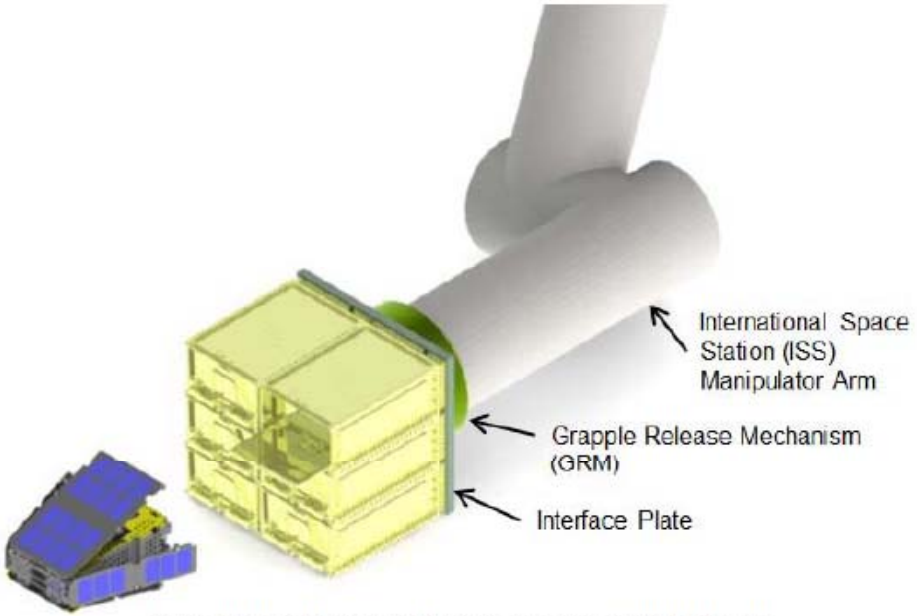


Figure 46: ISS Manipulator Arm Dispensing Six 6U Payloads

6U On ESPA


6U Canisterized Satellite
Dispenser (CSD) EPSA
Port Functionality

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Thank You

- Questions?