

# Useful Earth Observation with Nanosatellite Platforms

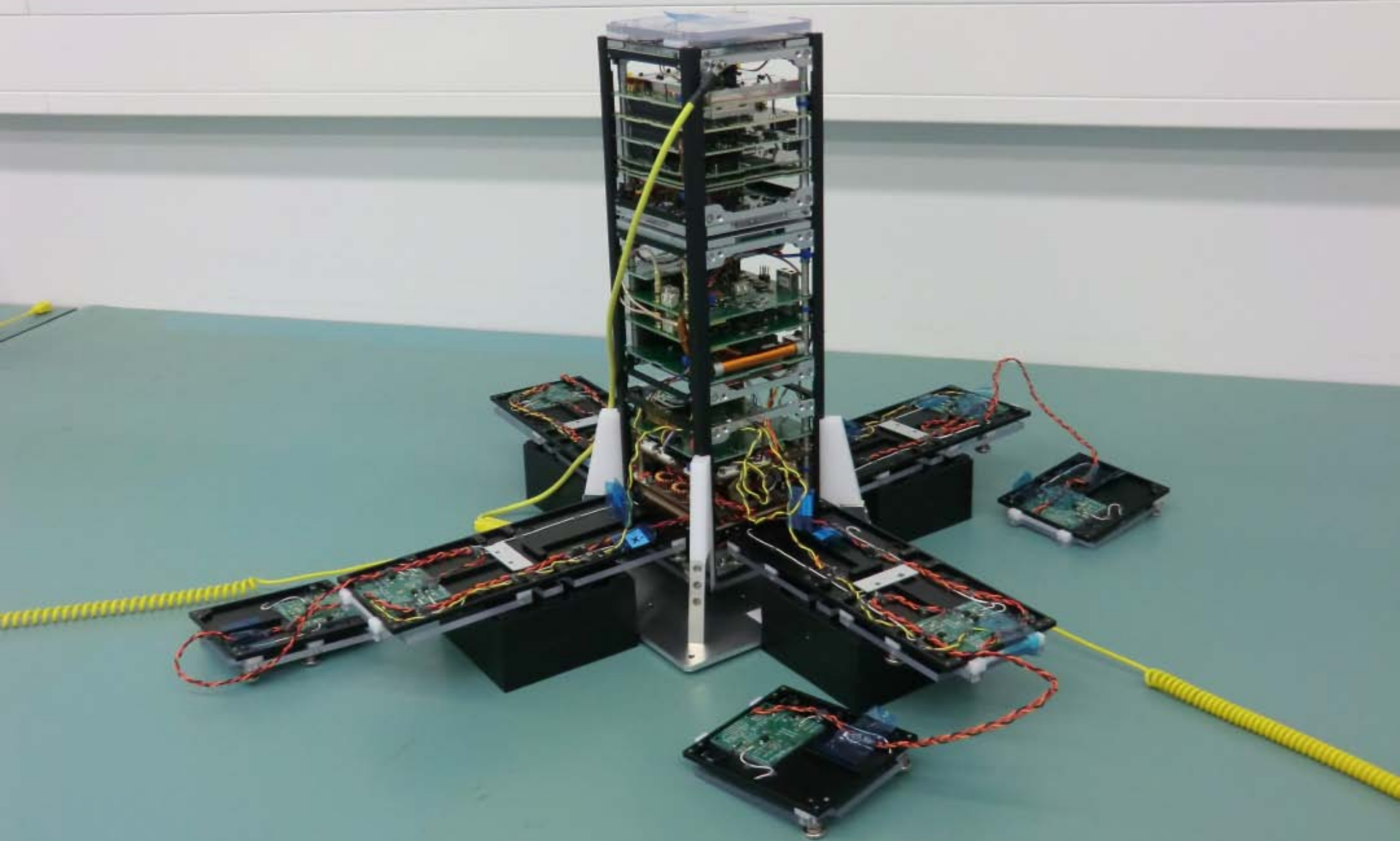


The logo for ISIS features the word "ISIS" in a white, serif font with a thin black outline, positioned to the left of a red, curved swoosh that starts under the 'I' and ends under the 'S'. Above the 'I' and 'S' are several grey circles of varying sizes, some overlapping the swoosh.

# ISIS Contents

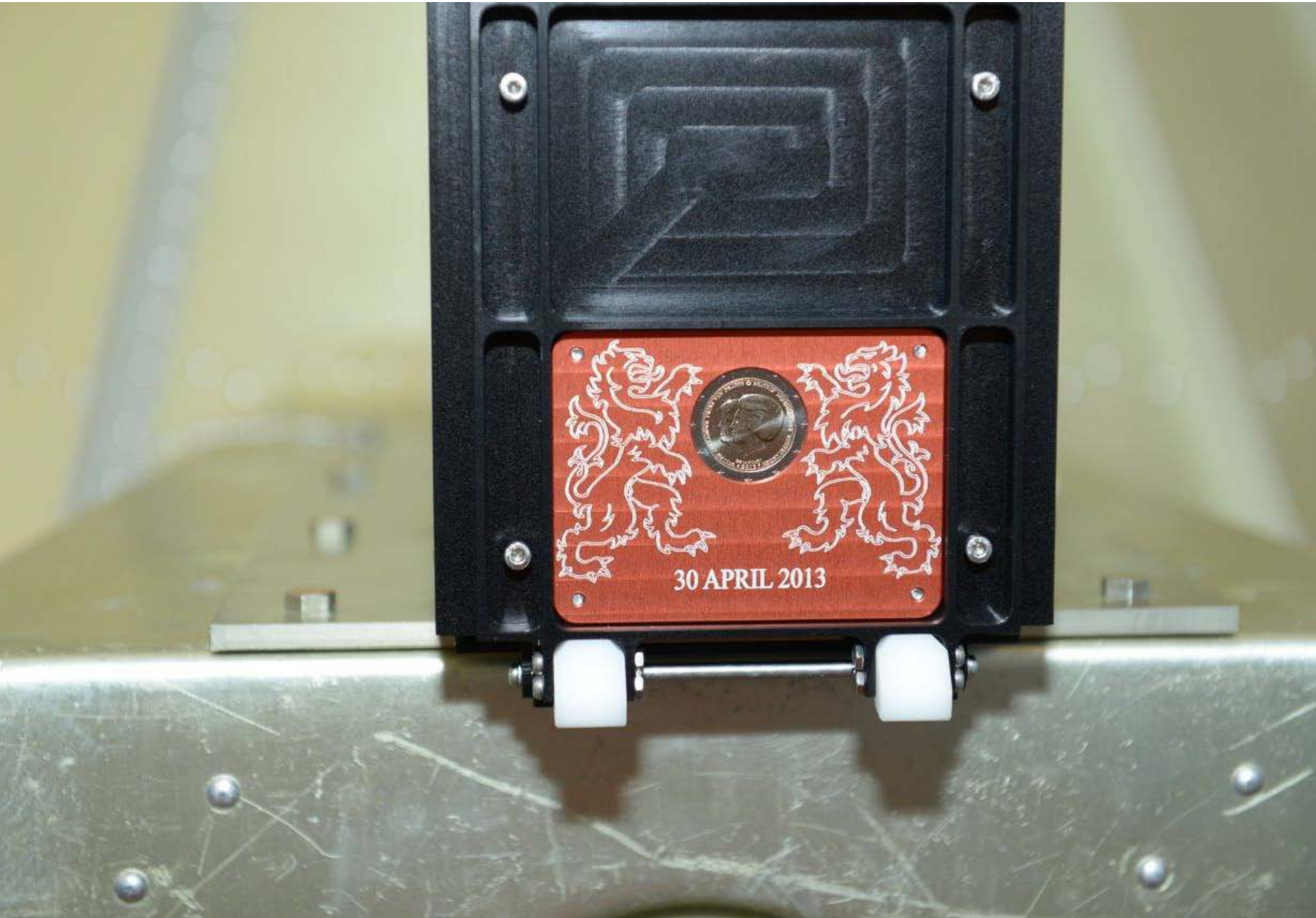
- Introduction and News
- System Overview
- Subsystem Overview
- Conclusions





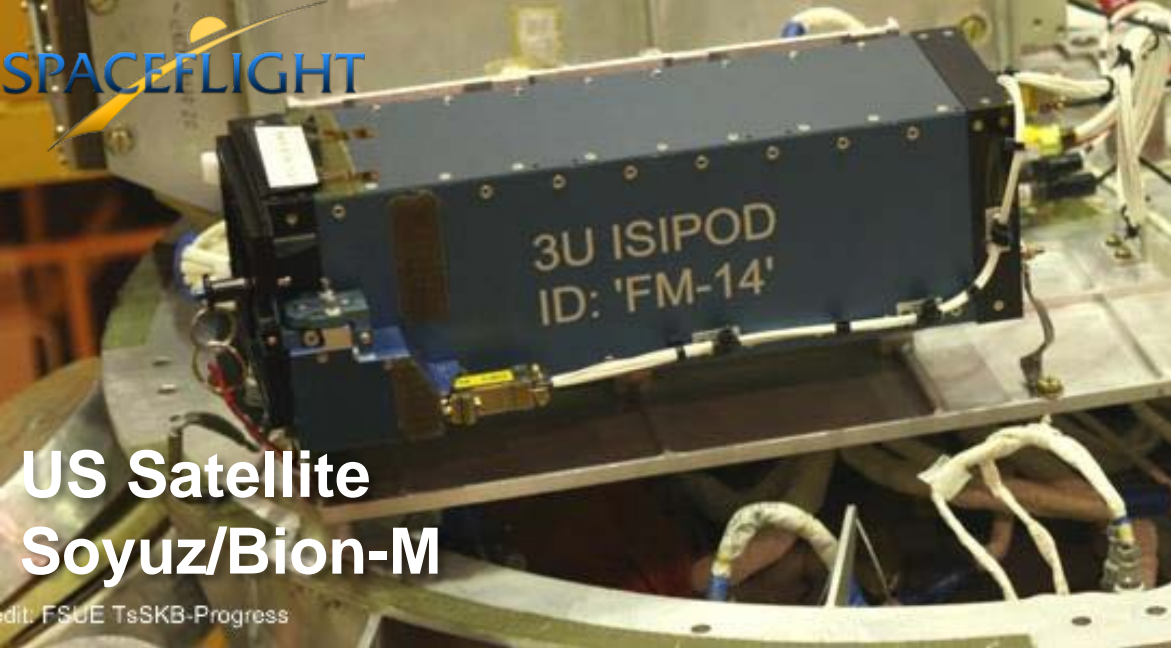






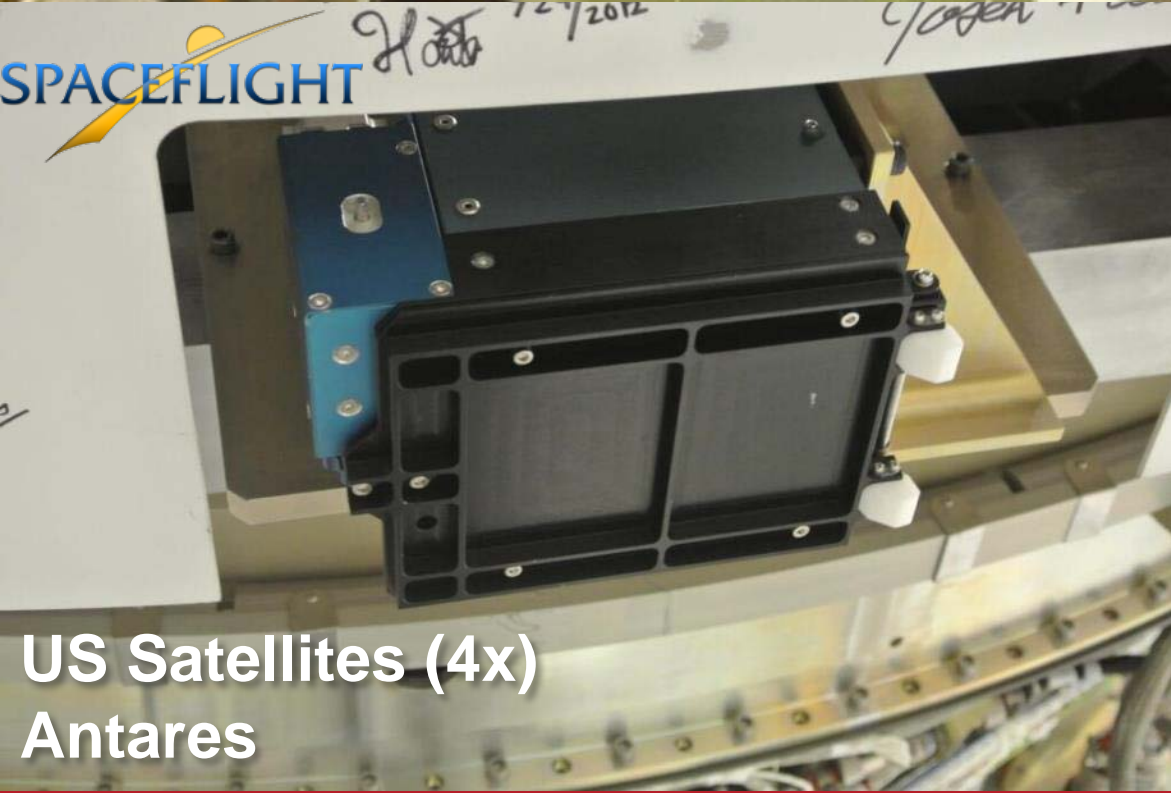
30 APRIL 2013



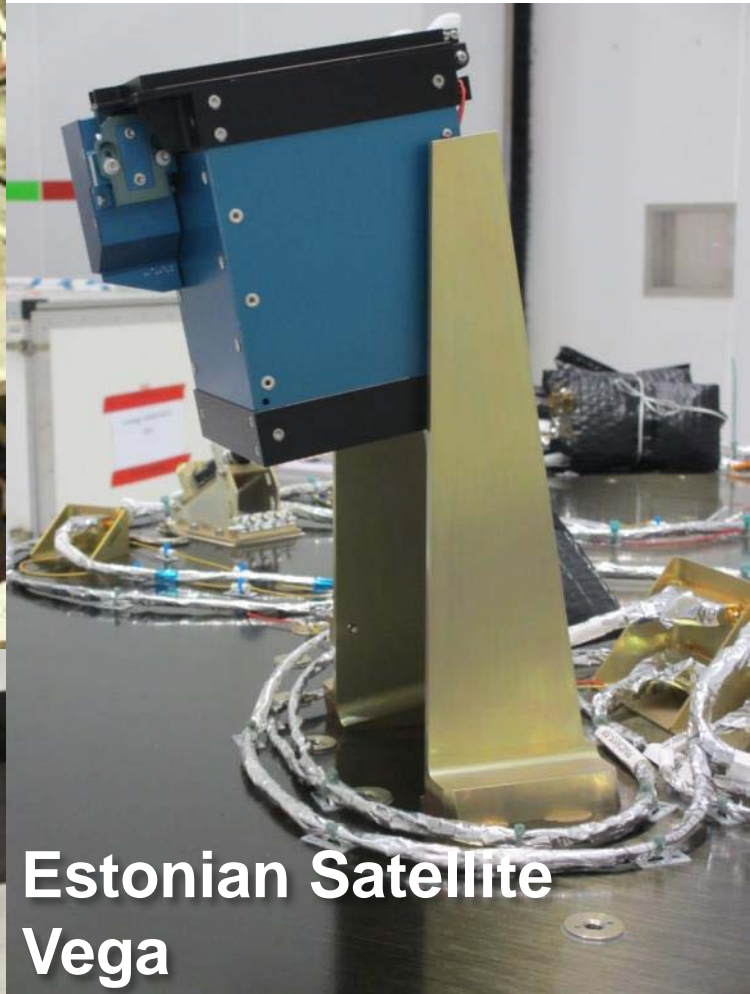


**US Satellite  
Soyuz/Bion-M**

credit: FSUE TsSKB-Progress



**US Satellites (4x)  
Antares**



**Estonian Satellite  
Vega**



**UK Satellite  
PSLV**

- What can already be achieved using existing and emerging CubeSat building blocks?
- How close can we get to conventional small satellite performance?





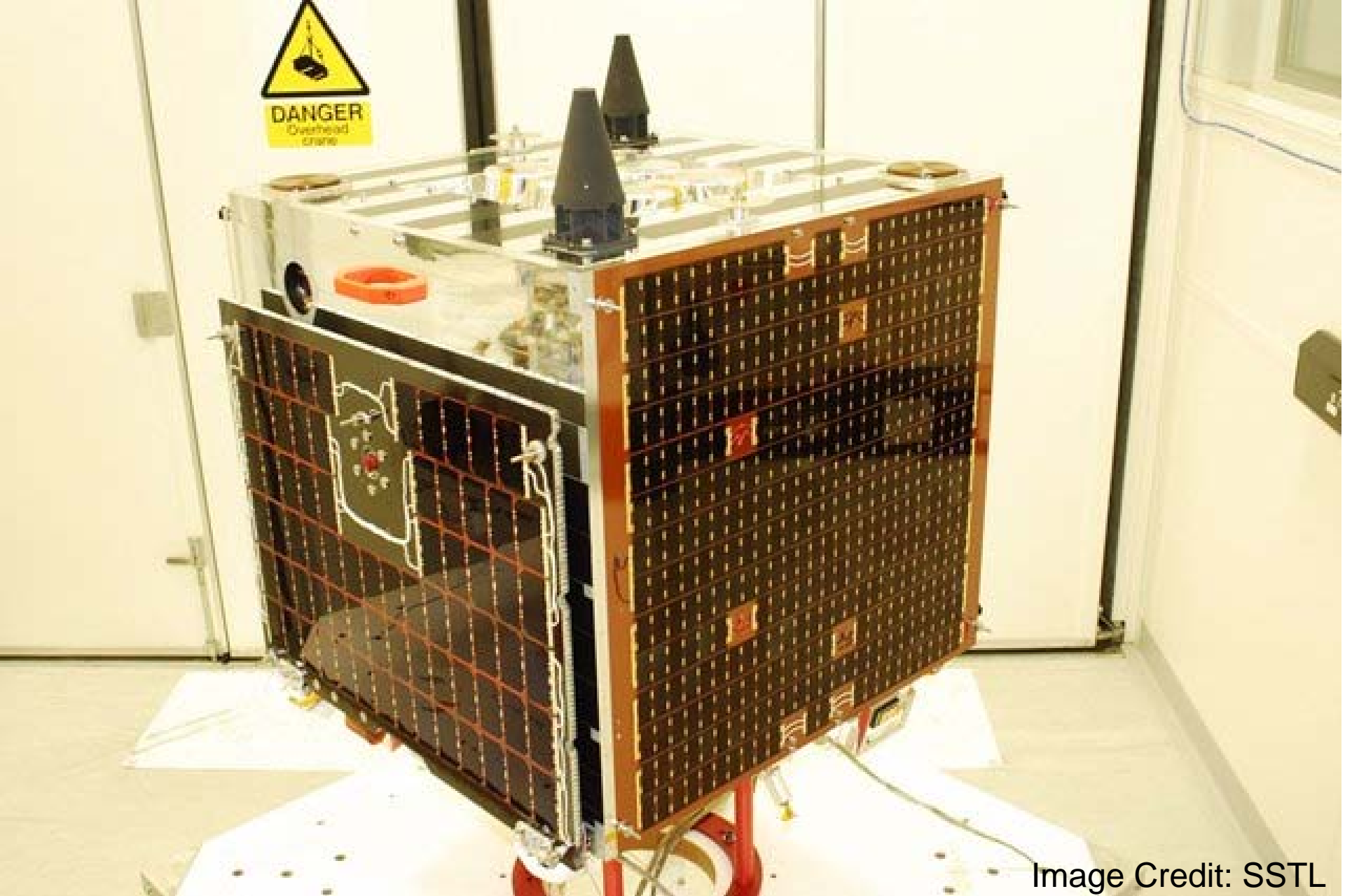
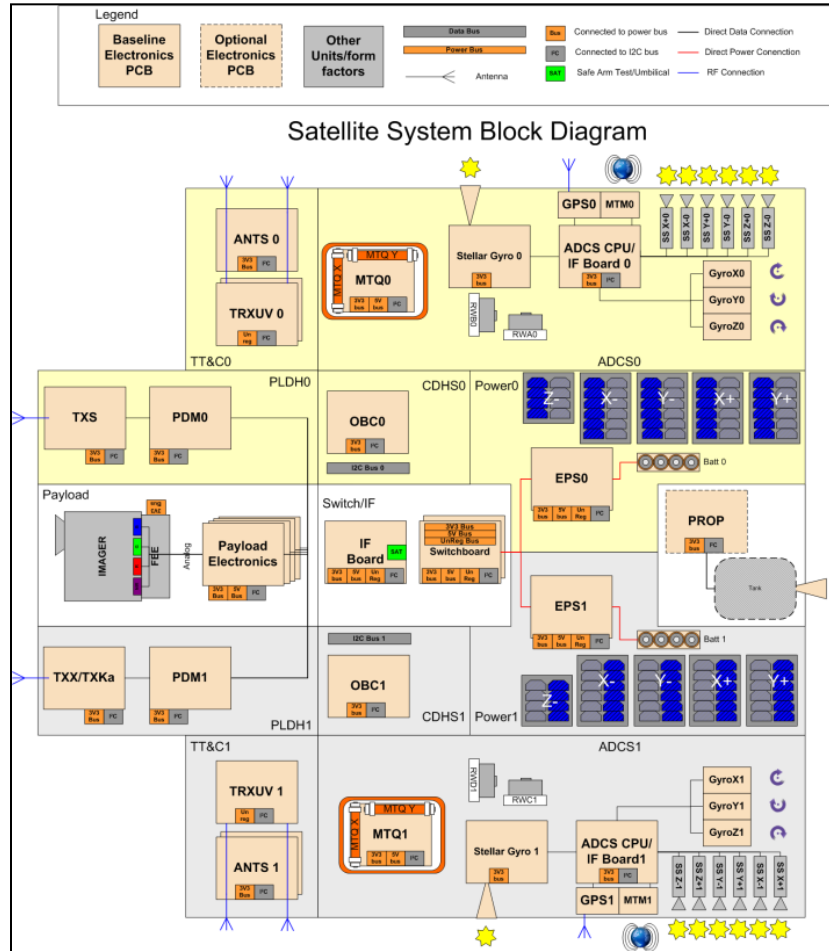


Image Credit: SSTL



# A 12 Unit EO CubeSat

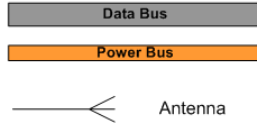


Legend

Baseline Electronics PCB

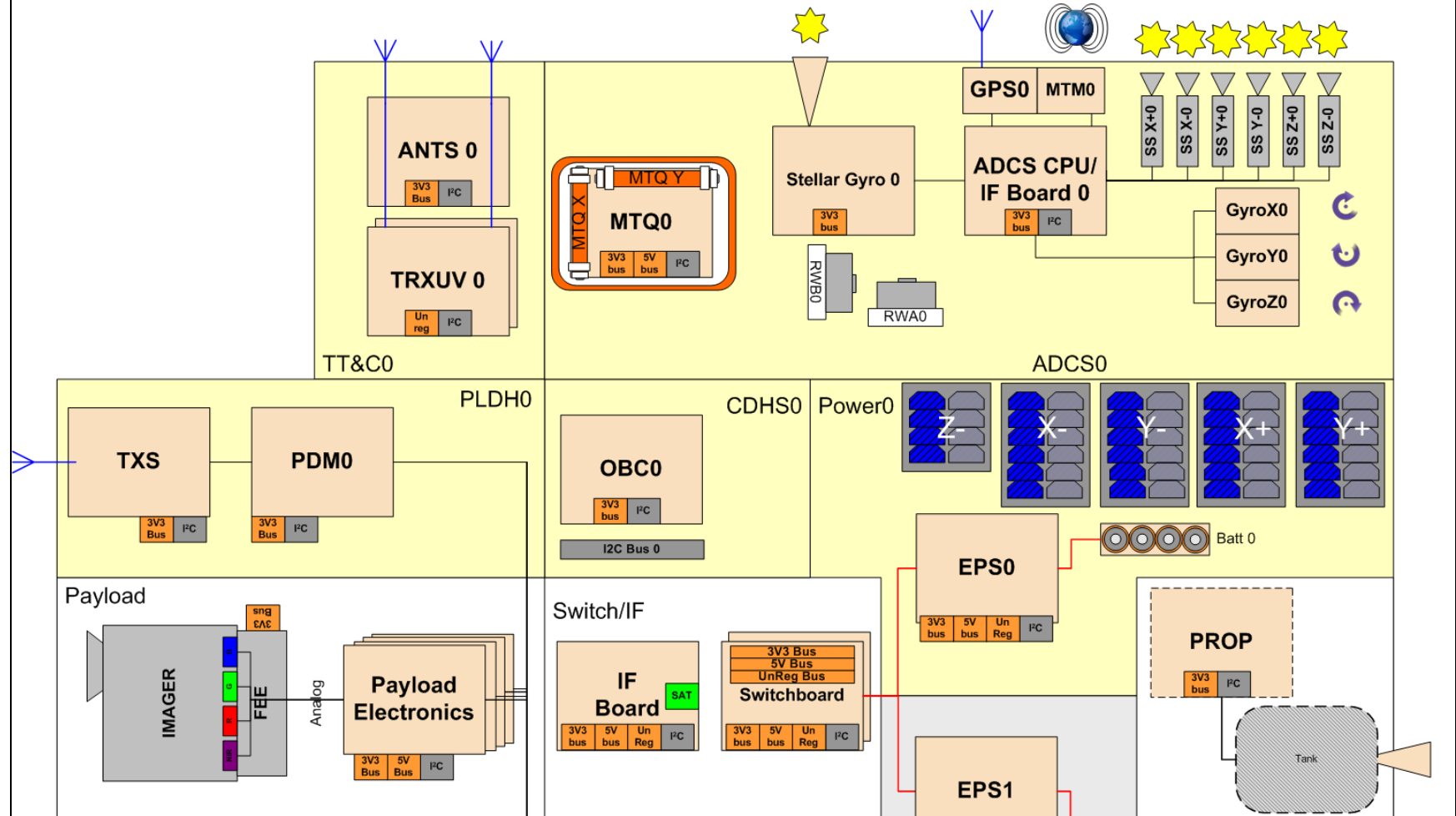
Optional Electronics PCB

Other Units/form factors



- Bus Connected to power bus
- PC Connected to I2C bus
- SAT Safe Arm Test/Umbilical
- Direct Data Connection (black line)
- Direct Power Connection (red line)
- RF Connection (blue line)

# Satellite System Block Diagram





# System Specification

---

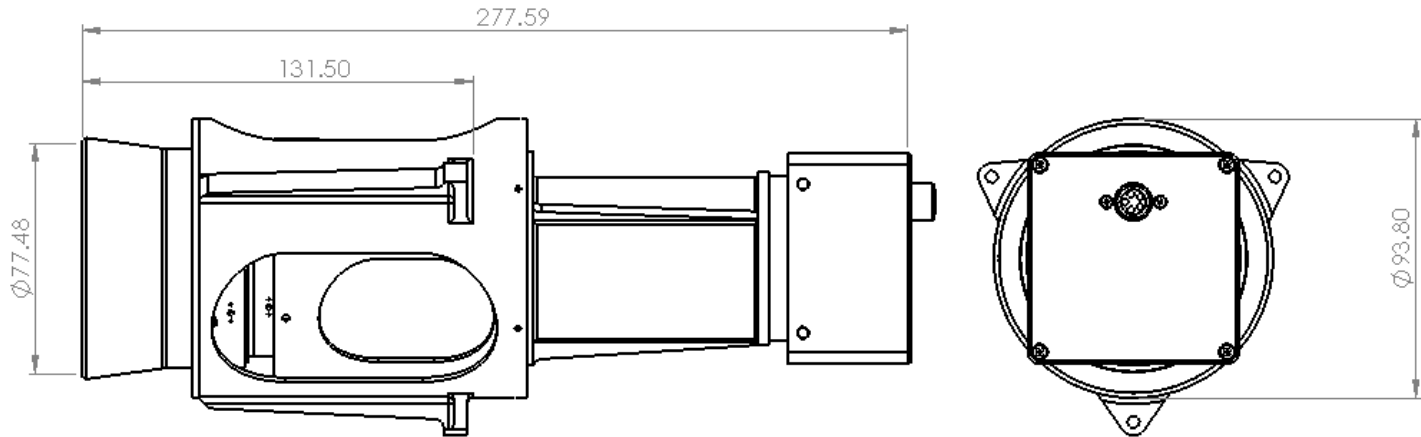
|                    | Value       | Parameter          |
|--------------------|-------------|--------------------|
| Mass               | <15         | [kg]               |
| Average Power      | 11          | [W]                |
| Size               | 330x220x220 | [mm <sup>3</sup> ] |
| Data Storage       | ~4          | [Gbyte]            |
| Downlink           | 1-100       | [Mbps]             |
| Pointing Knowledge | 0.5         | [Deg]              |
| Pointing Accuracy  | ~1-5        | [Deg]              |
| Battery Capacity   | 2x65        | [Wh]               |

---





# Subsystems – Payload MS





# Subsystems – Payload HS





# Subsystems - Payload

|                             | 1 - Video               | 2 - Line Scanner | 3 - PAN | 4 - Hyperspectral                | Comments  |
|-----------------------------|-------------------------|------------------|---------|----------------------------------|---|
| <b>Swath</b>                | 56 x 32 km <sup>2</sup> | 163 km           | 163 km  | 130 x 85 km <sup>2</sup>         | From 600 km orbit                                 |
| <b>GSD</b>                  | 29 m                    | 40 m             | 20 m    | 198 m                            |   |
| <b>Bands</b>                | PAN/RGB                 | R,G,B            | PAN     | 400 – 1000 nm, 10 nm bands       |   |
| <b>SNR</b>                  | TBD                     | > 200            | > 100   | @400 nm: ± 240<br>@1000 nm: ± 80 | Using 6s, 50% target reflectance, 45 zenith angle |
| <b>Optics MTF</b>           | > 0.5                   | > 0.5            | > 0.5   | > 0.4                            |   |
| <b>Imager mass estimate</b> | 1.8 kg                  | 1.9 kg           | 1.9 kg  | 3 kg                             | Optics and Sensor                                 |
| <b>Peak Power</b>           | <5.5 W                  | < 7 W            | < 6 W   | < 3 W                            |   |

# ISIS Power

- Power:
  - Typical Li-Ion based architecture
  - 3J cell technology cells





- **Power:**
  - Typical Li-Ion based architecture
  - 3J cell technology
- **CDHS:**
  - 400 Mhz, ARM architecture
  - I2C Bus



- **Power:**
  - Typical Li-Ion based architecture
  - 3J cell technology
- **CDHS:**
  - 400 Mhz, ARM architecture
  - I2C Bus
- **TT&C:**
  - UHF/VHF 1k2/9k6





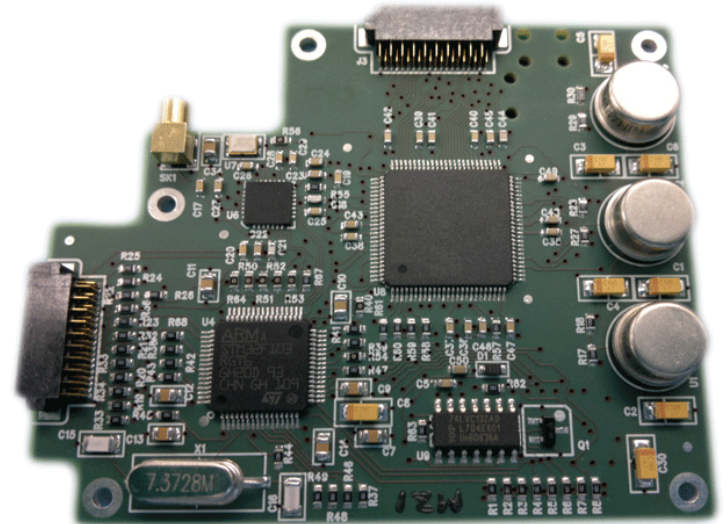
# Payload Data Handling

- Power:
  - Typical Li-Ion based architecture
  - 3J cell technology
- CDHS:
  - 400 Mhz, ARM architecture
  - I2C Bus
- TT&C:
  - UHF/VHF 1k2/9k6
- PL Downlink: S/X/(Ka) Band
  - Rates of 1-120 Mbit/s



# ISIS ADCS

- Power:
  - Typical Li-Ion based architecture
  - 3J cell technology
- CDHS:
  - 400 Mhz, ARM architecture
  - I2C Bus
- TT&C:
  - UHF/VHF 1k2/9k6
- PL Downlink: S/X/(Ka) Band
  - Rates of 1-120 Mbit/s
- ADCS:
  - Several systems offered







# Spec Comparison

|         | <b>DMC</b> | <b>12U</b> |          |
|---------|------------|------------|----------|
| Mass    | 100        | 15         | [kg]     |
| Volume  | 216U       | 12U        | [U]      |
| Power   | 30         | 10-15      | [W]      |
| GSD     | 32/22      | 20/40      | [m]      |
| Swath   | 320        | 160        | [km]     |
| DL rate | 4-100      | 1-50       | [Mbit/s] |
| ADCS    | 1          | ~0.5-5     | [deg]    |



# Conclusions

- Current COTS systems can provide a capable, reliable 15 kg class satellite
- Performance in the same ballpark as current small satellite missions
- CubeSat capabilities rapidly increasing
  - Catching up with current smallsat technology
  - Leading the way to more capable systems?

# Useful Earth Observation with Nanosatellite Platforms



Focus on turnkey solutions

- Reducing lifecycle cost
  - Building a “Satellite Factory”
  - Ticket to space
  - Standardised Operations
  - **Engineering hours main driver cost**
- Maximize Price/Performance
  - Small price vs Performance
  - Commonality vs Performance
  - Modularity vs Highly Integrated Systems