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OPEN TECHNOLOGY FOR SPACE

# Open Source Design: Corvus-BC Spacecraft

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Brian Cooper, Kyle Leveque

9 August 2015

# Introduction



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- Corvus-BC 6U overview
- Subsystems to be open sourced
- Current development status
- Open sourced items
- Future Rollout

# Our Background

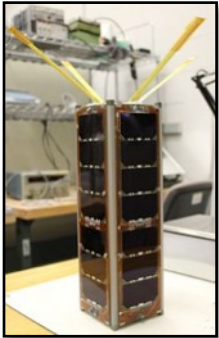


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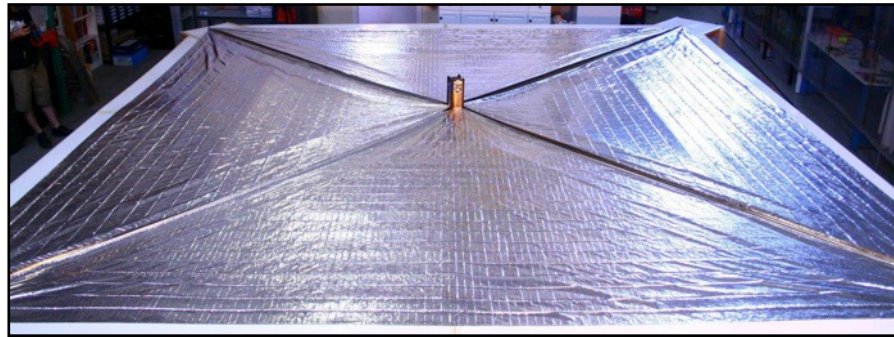
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- 17-person team in Silicon Valley
- Core engineering team worked at Canopus Systems
- 100% of current team completed Perseus-M mission
- Broad range of experience in the space industry
- Now focused on generating 22m and 2.5m multi-spectral Earth imagery

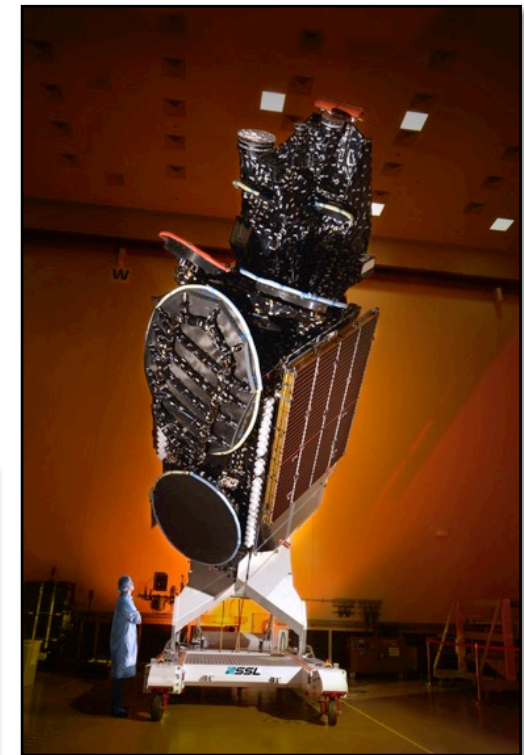
SRI –RAX 1



LightSail



SSL-ABS2



Perseus-M



AMSAT – OSCAR Series



4/23/15

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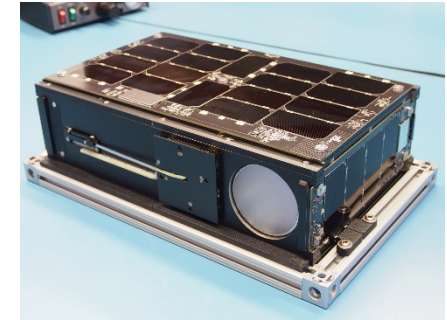
# Current Projects



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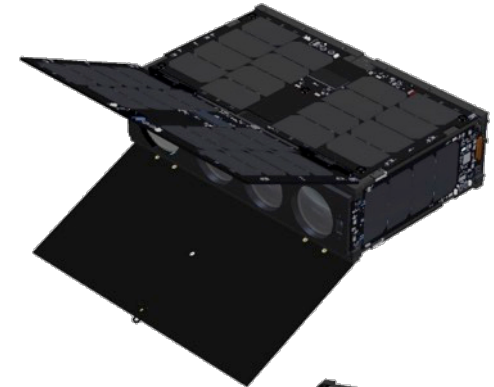
- **Perseus-M**

- Launched in June 2014
- 2x 6U Automatic Identification System (AIS) CubeSat
- Characterizing AIS payload performance
- On-orbit test bed for future missions



- **Corvus-BC**

- Launch Q1 2016
- 4x 6U Earth observation CubeSat
- Multispectral: Red, Green, NIR
- 22 m ground resolution (GSD)



- **Corvus-HD**

- Launch Q3 2016
- 4x 16U Earth observation CubeSat
- Multispectral: Red, Green, Blue, NIR, Red Edge
- 2.5 m ground resolution (GSD)



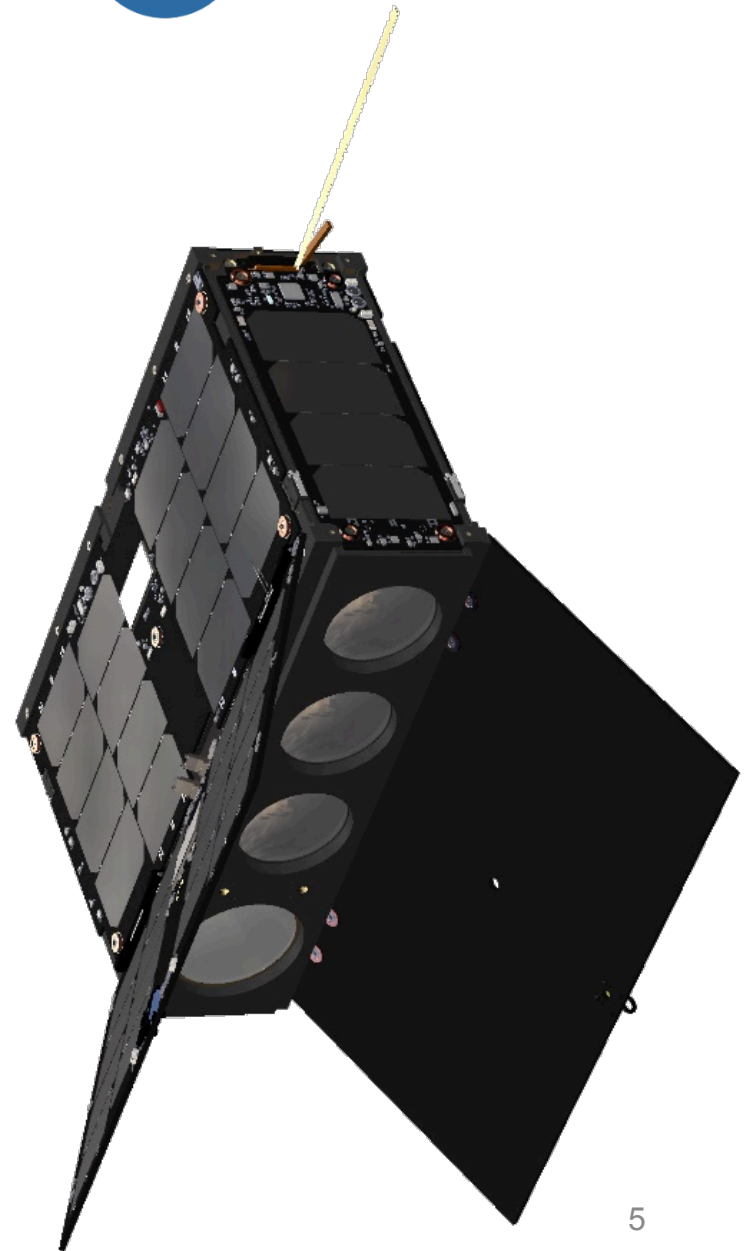
# Corvus-BC Overview

- 6U Form-factor
- 11 kg
- Imaging solution: 22 m GSD at 600 km, Red, Green, NIR spectral bands
- Flight computer: ARM A8 running Linux
- Power system: scalable 48Wh Li-Ion
- Communication: UHF transceiver running at 19.2 kbps for TT&C. Payload data is downlinked through Ka-band at 40 Mbps
- Solar panels: ARM M0+ processor, temperature, magnetometers sun sensors and magnetorquer coils
- Control: 3-axis with three reaction wheels, star tracker, GPS, gyro, magnetometers, and sun sensors
- Storage: 1 TB

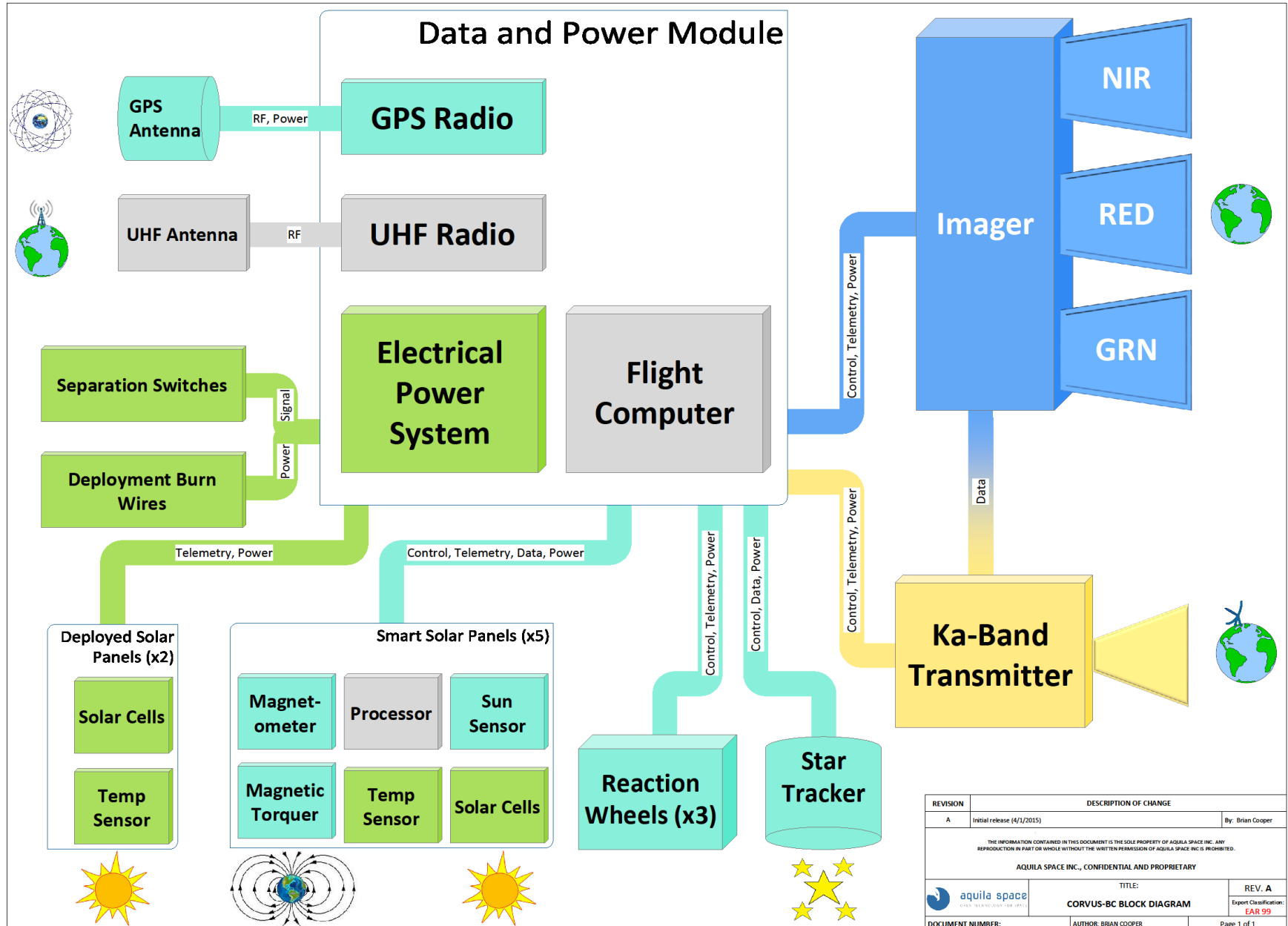


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# System Block Diagram



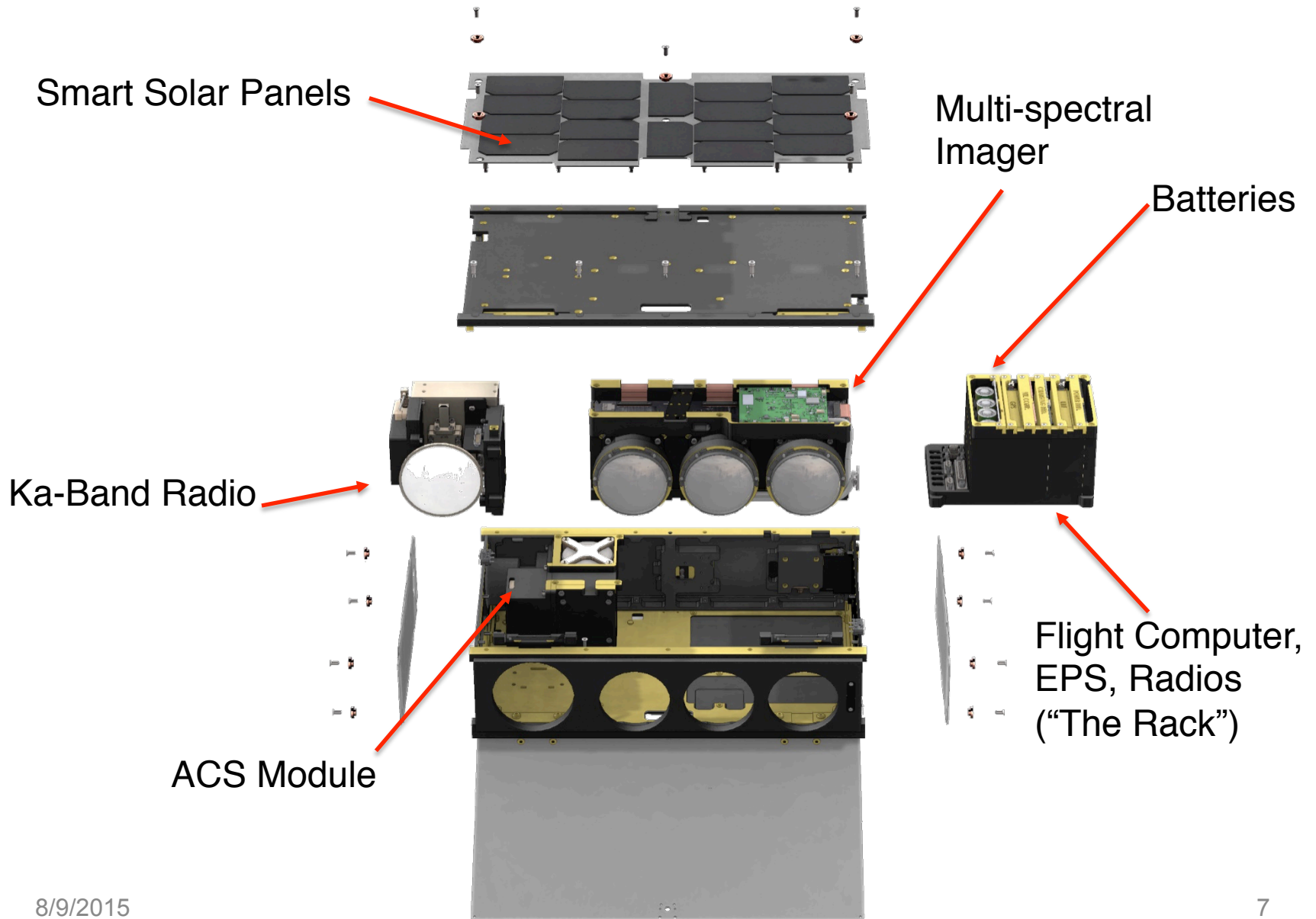
REVISION	DESCRIPTION OF CHANGE	
A	Initial release (4/1/2015)	By: Brian Cooper
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aquila space OPEN TECHNOLOGY FOR SPACE	TITLE: <b>CORVUS-BC BLOCK DIAGRAM</b>	REV. A Export Classification: <b>EAR 99</b>
DOCUMENT NUMBER:	AUTHOR: BRIAN COOPER	Page 1 of 1

# Corvus-BC Overview



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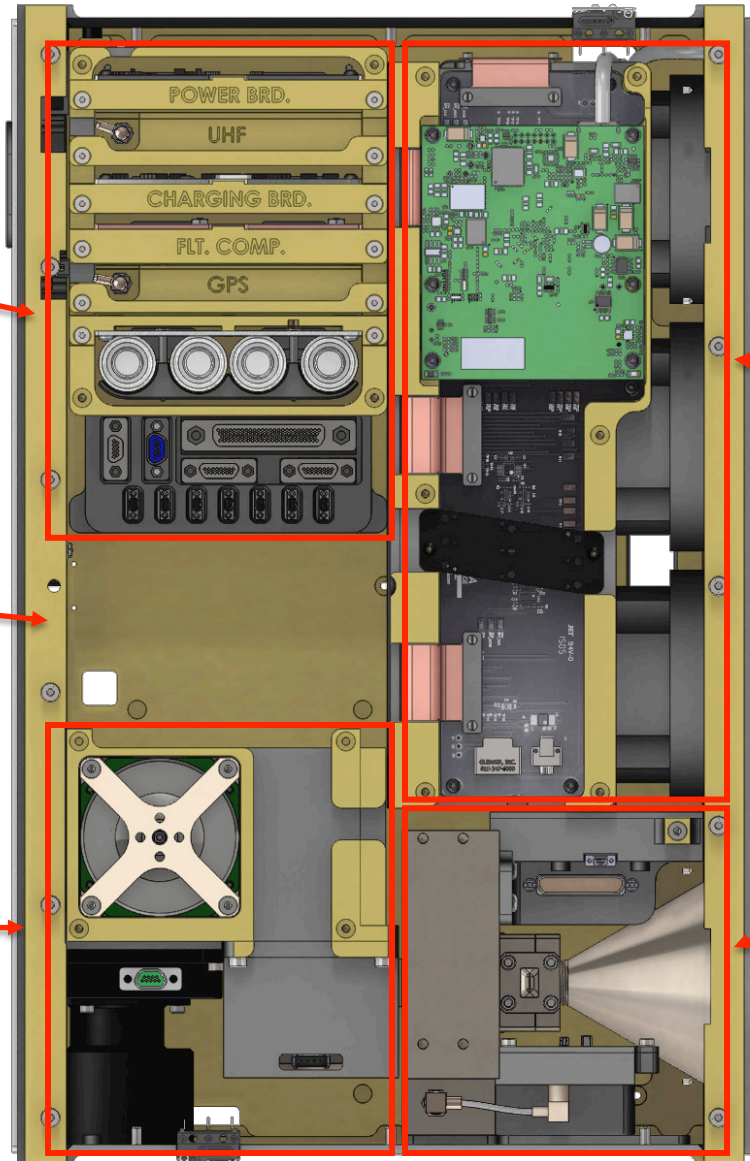


# Corvus-BC Overview



## Data & Power Module (“The Rack”)

- Flight Computer
- UHF Radio
- GPS Radio
- EPS boards
- Batteries (48 Wh)



Multi-spectral Imager

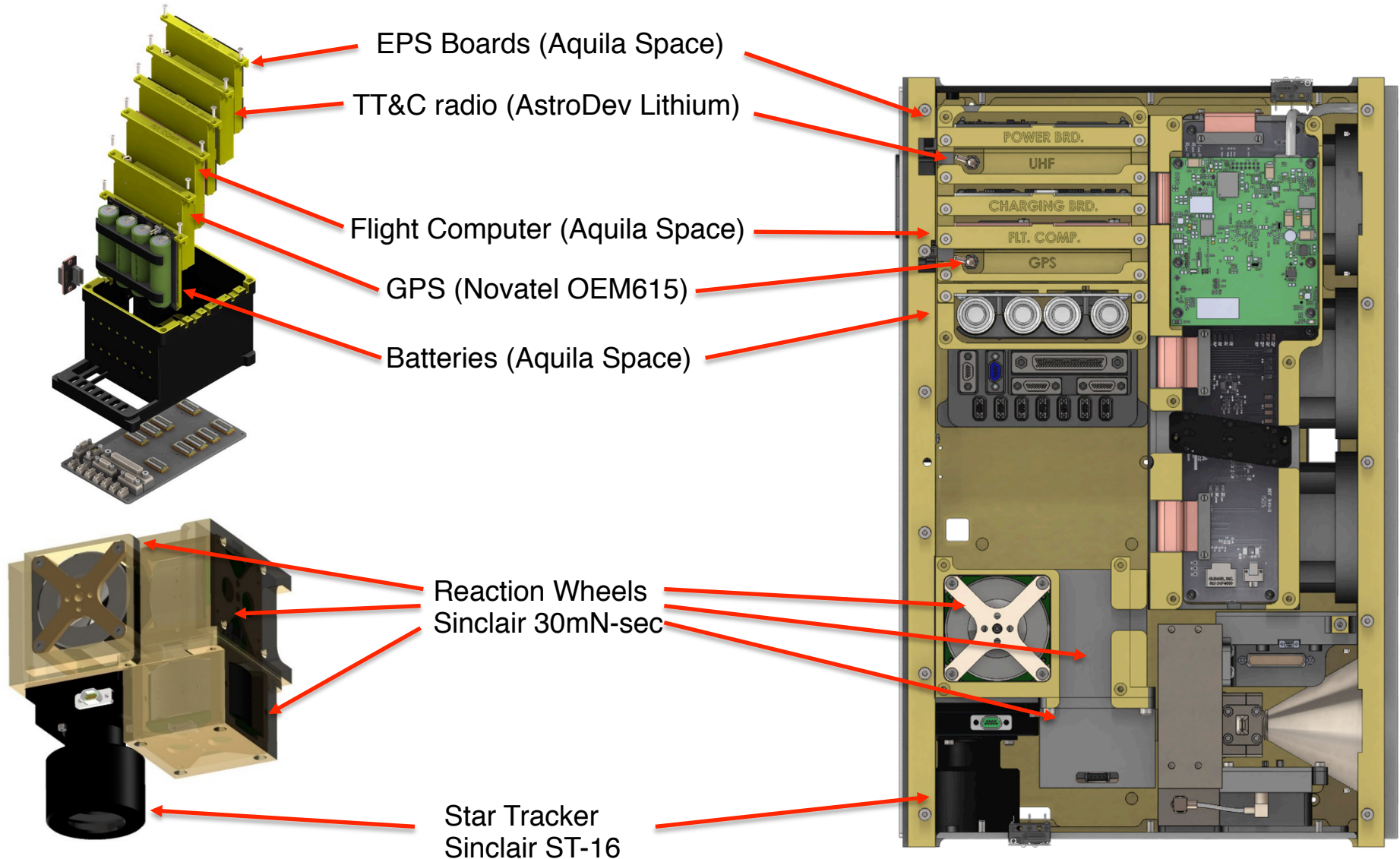
Open volume for future use (Propulsion!)

Ka-Band Radio

ACS Module



# Corvus-BC Overview

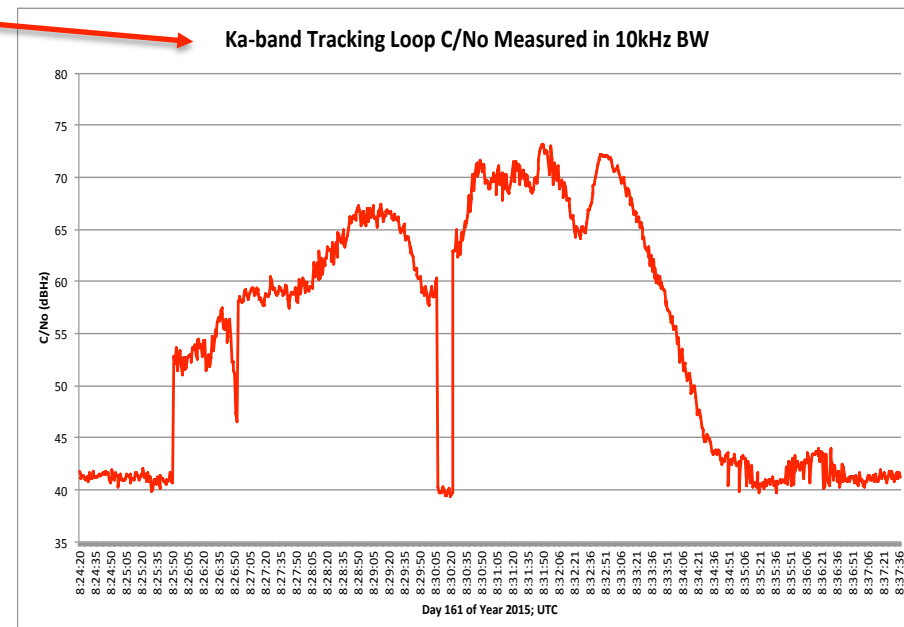
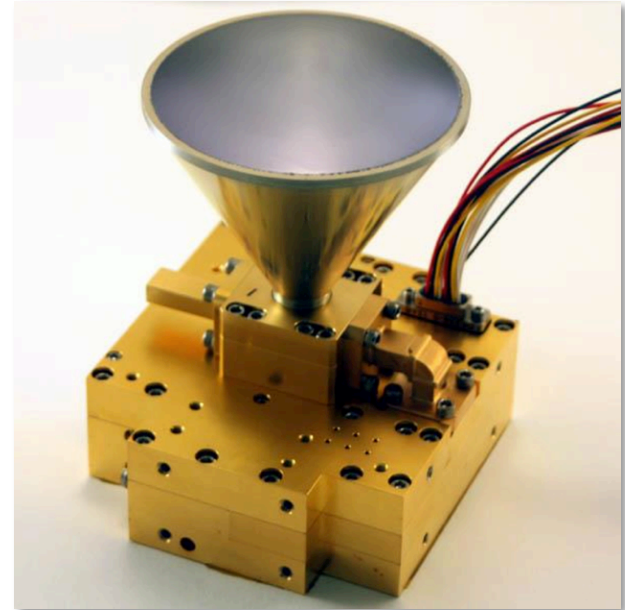


# Corvus-BC Overview



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- Custom Ka-band transmitter
- 1U, 1 kg
- Currently 40 Mbps
  - Planned upgrades to >200 Mbps
- Simple interface
  - Ethernet UDP/IP packets in
  - UDP/IP over DVB-S2 packets out
- On-orbit testing in progress
- See Jan's presentation on Tuesday afternoon for more!



# To be open sourced



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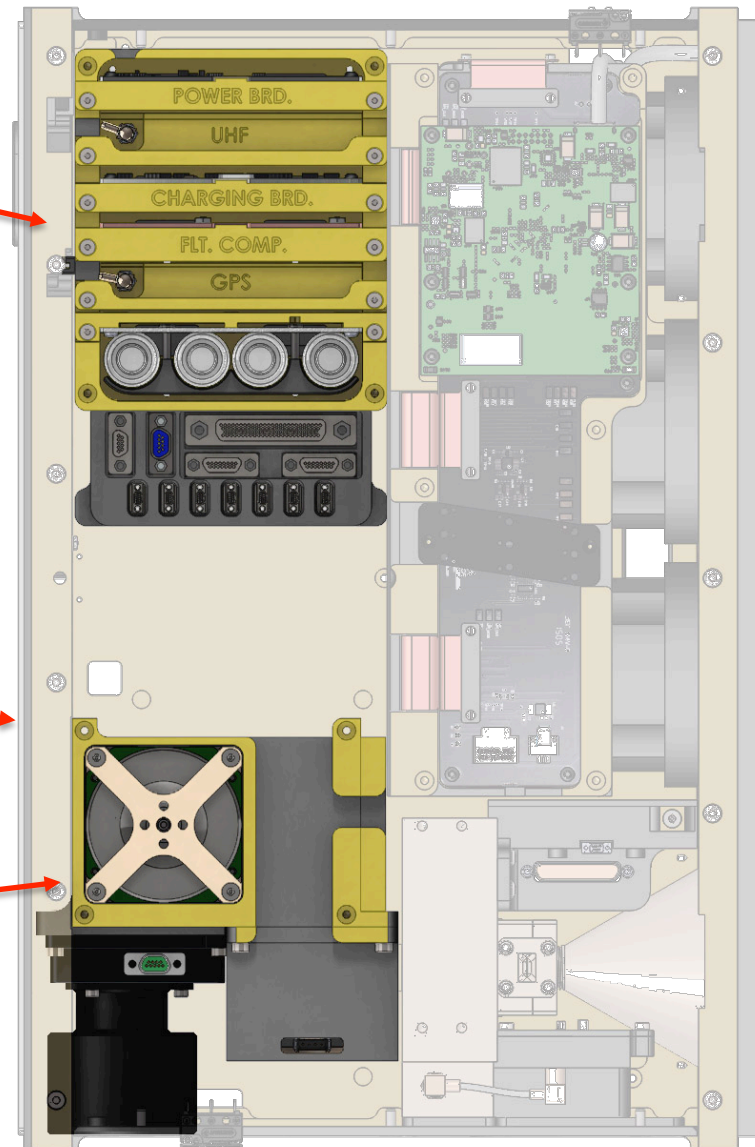
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## Data & Power Module (“the rack”)

- Full EPS
- Full Flight Computer
- GPS and UHF Structure, Interfaces, System Software

## Solar Panels

## Star-tracker & Reaction Wheels (Structure, Interfaces, System Software)

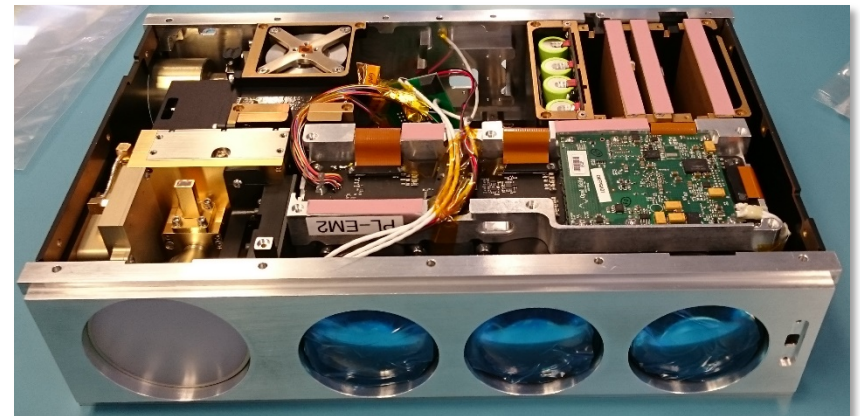
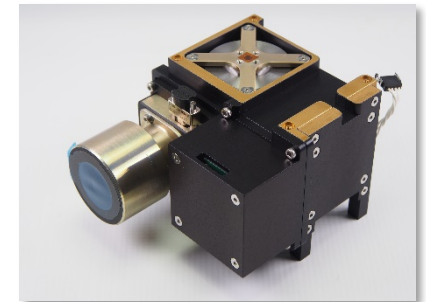
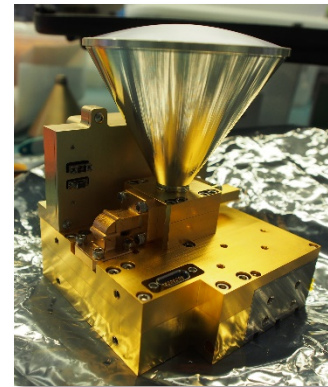
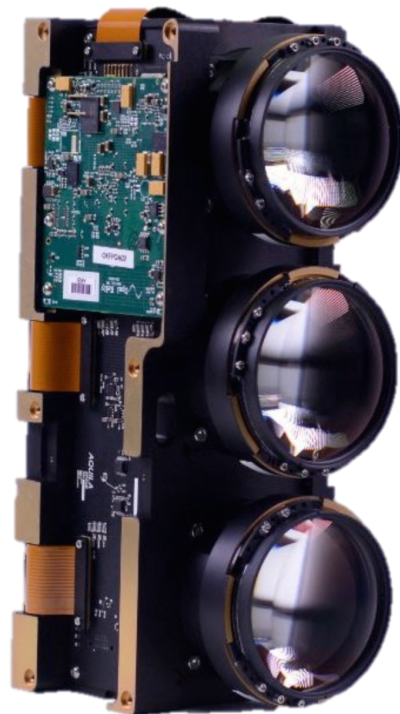
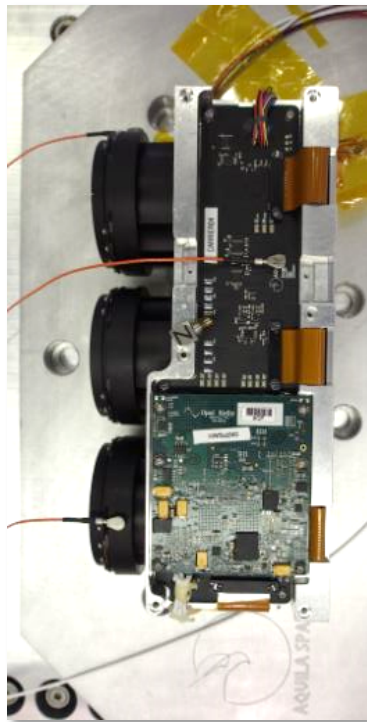


# Development Status



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- Corvus-BC hardware design work is completed
  - Flight assembly underway
- Launch is scheduled for Q1 2016
- Already preparing design improvements (backup radio, propulsion, etc.)



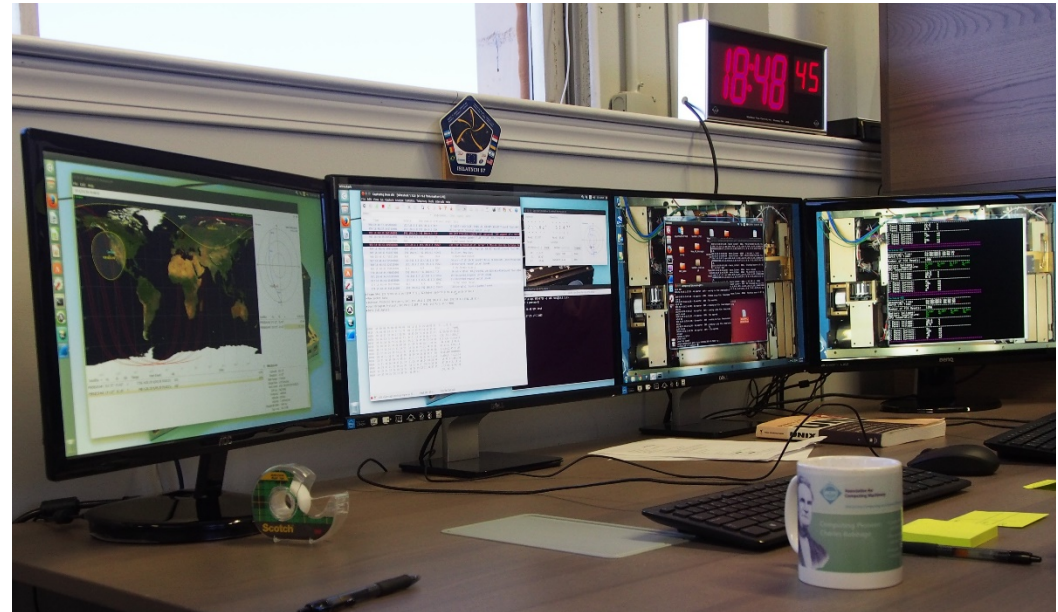
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# Software Development



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- Core Flight Computer functions ready
- EPS control using MicroPython in final development stages
- Solar panel, UHF, GPS, Star Tracker, and Reaction Wheel drivers completed
- ACS development in process on-orbit
- Plenty of potential improvements remain!
- Aquila performs on-orbit updates regularly, so it's never too late for an upgrade

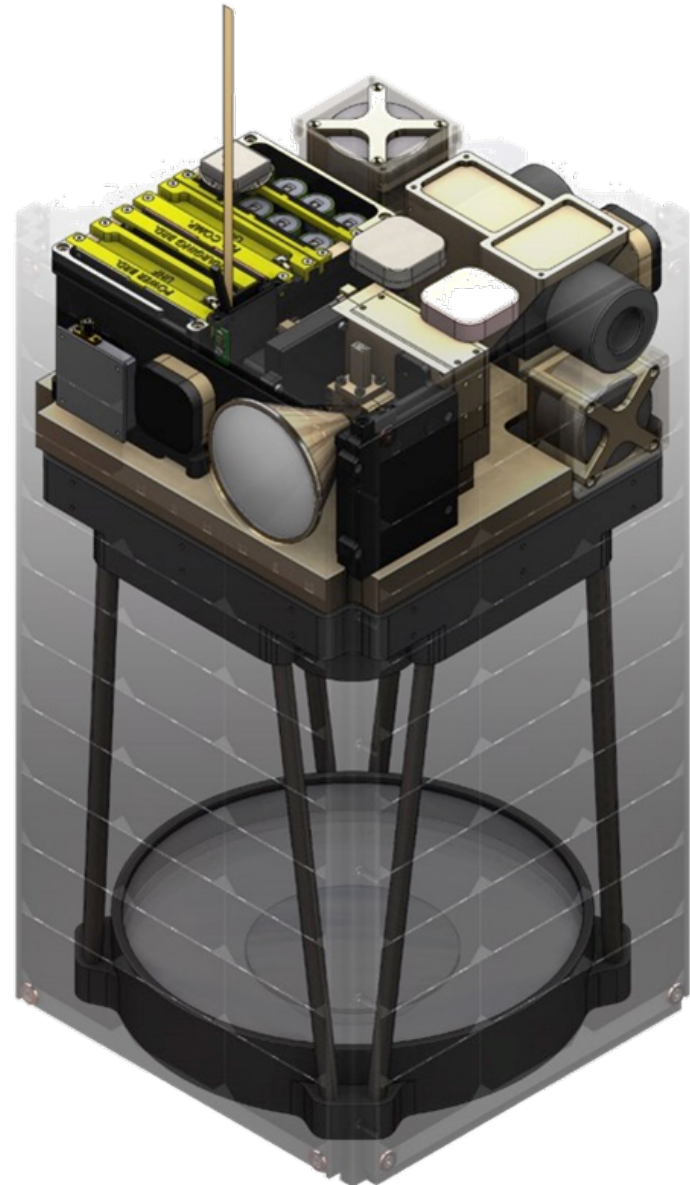


# Platform Upgrades: Corvus-HD



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- Upgraded bus to be used for Corvus-HD, launching Q3 2016
- 16U, 20 kg platform
- Improved ACS accuracy and availability
- >200 Mbps data transfer with adaptive MODCOD
- Miniaturized Ka Transmitter assembly
- S-Band, UHF, and backup TT&C radios included
- Doubled battery capacity (96 Wh)



# Technology included



The following technologies will be open sourced:

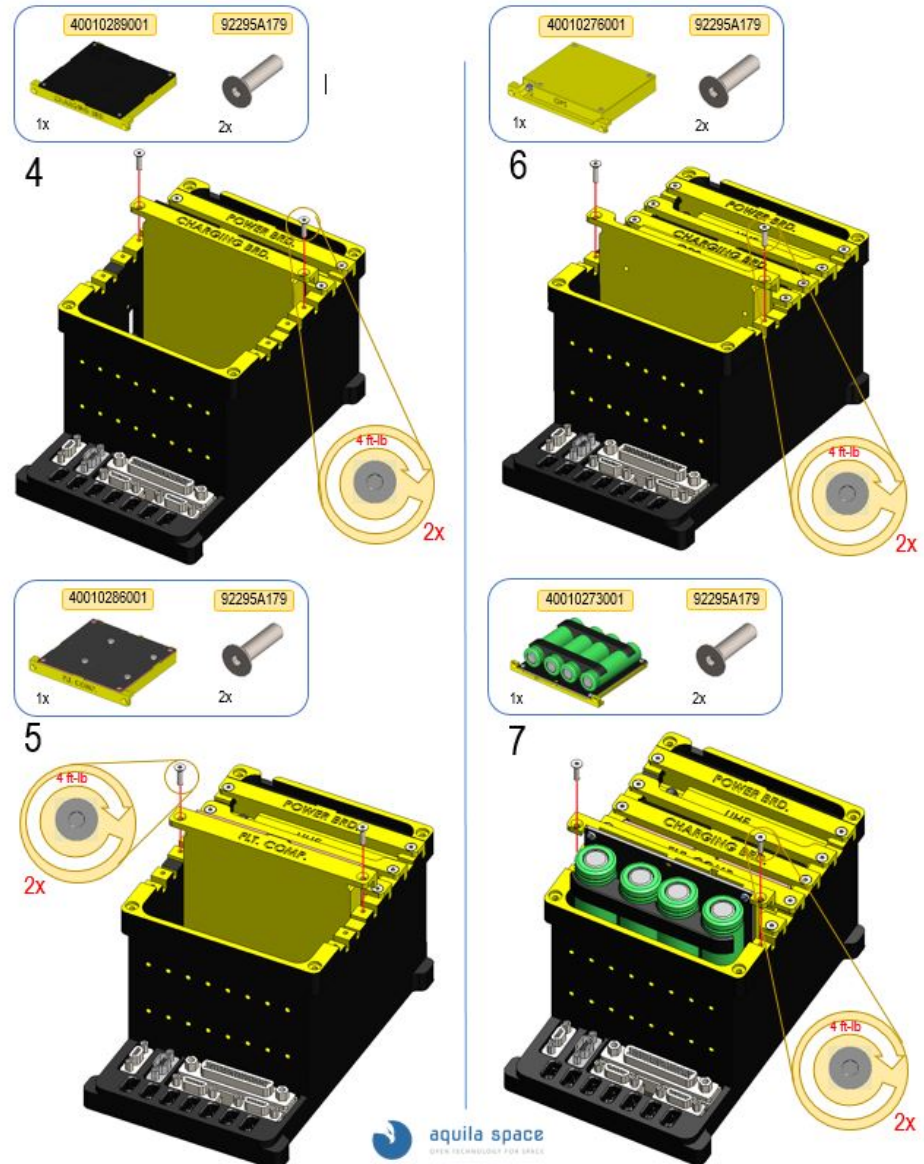
- Source Code
- Schematics (Altium)
- PCB Layout files (Altium)
- Bill of materials
- Drawings (Solidworks)
- Part files (Solidworks) – online now!
- Testing procedures
- Assembly procedures
- Harness diagrams

GPL License (add assembly procedure)

# Example: Assembly Procedures



- Unambiguous assembly procedures
- Can be used without modification, or just as a reference for design methodology
- Language barrier-proof format









- We are actively looking for early adopters
  - Universities
  - Companies
  - Individuals
- Future directions (let's brainstorm!)
  - New ADCS algorithms
  - Propulsion
  - Firecode/backdoor spacecraft reset receiver
  - S-band receiver
  - Ground segment (software & hardware)
  - What else?...

# Questions?



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