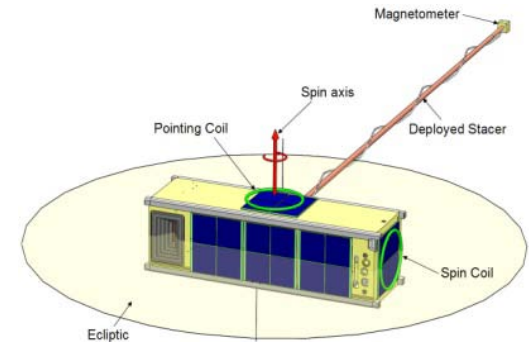# CINEMA

CubeSat for Ions, Neutrals, Electrons, MAgnetic fields

Communication System Overview and NTIA lessons learned.

Pascal Saint-Hilaire,
with Manfred Bester and the CINEMA Team

Space Sciences Laboratory
University of California, Berkeley

*CubeSat High-speed Downlink Communications (CHDC) Meeting,
CalPoly, April 19th, 2012*

Drivers:

- Large downlink rate: 1 Mbps (S-band required, because of UHF BW limitations)

- Berkeley Ground Station already had S-band license for THEMIS spacecrafts, and a separate license at the same frequency hence easier to get, once NASA concerns were appeased

- S-band receiver: too big for cubesat → Helium UHF radio for uplink

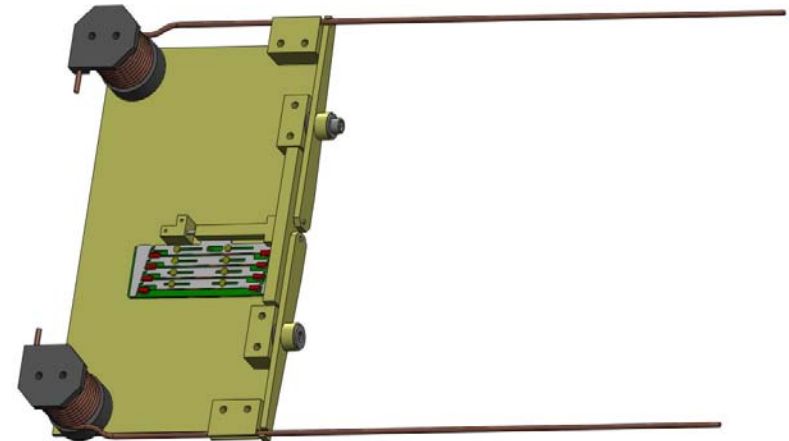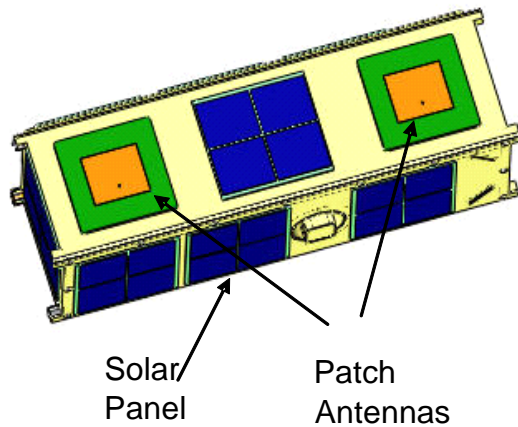Downlink (High-rate telemetry & Science data):
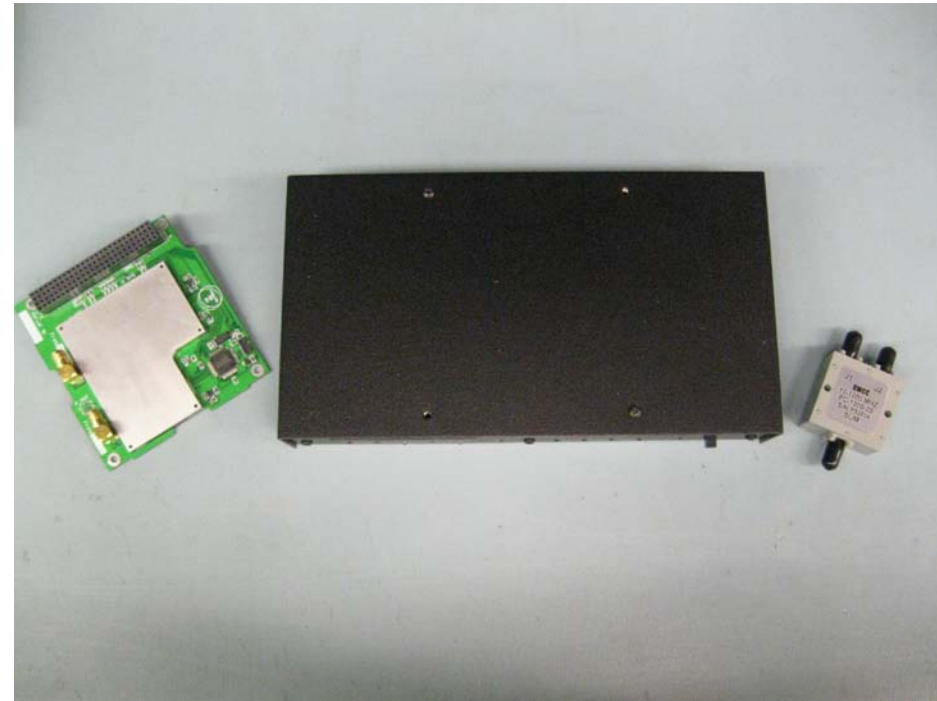S-band @ 1Mbps
LHCP, FM, Reed-Solomon encoding
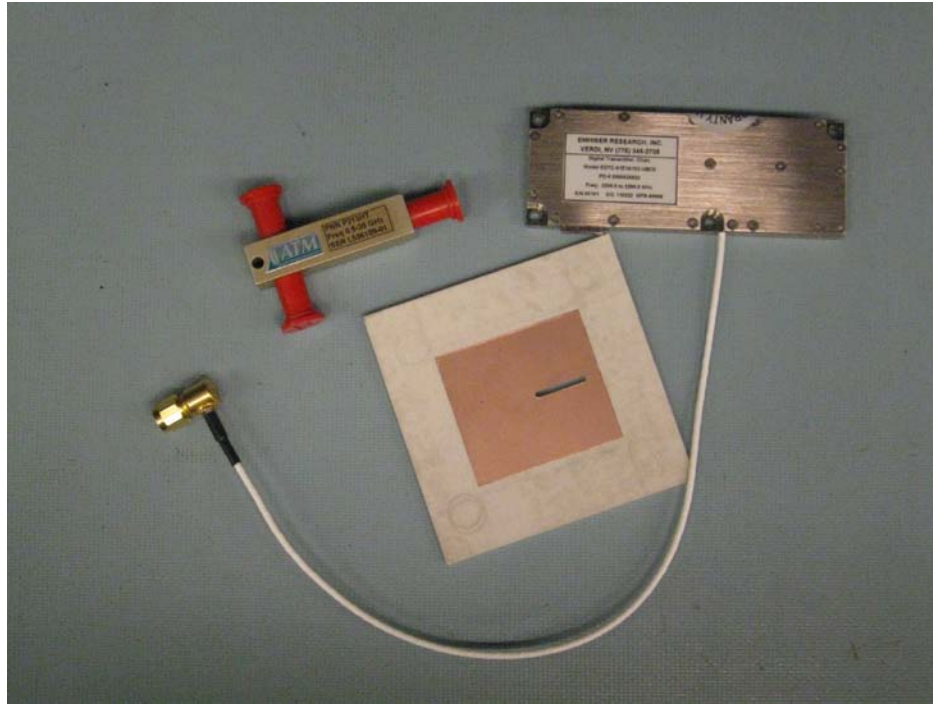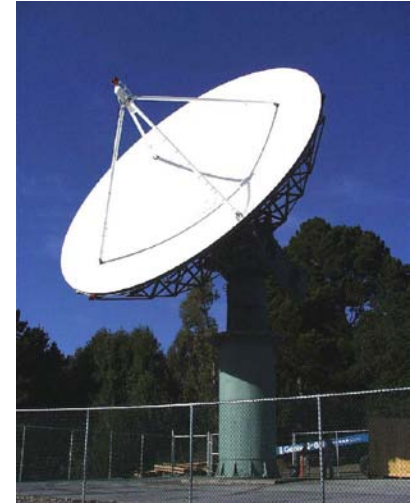
Uplink (low-rate command link):
UHF @ 9600 bps
Linear pol., FM, ~450 MHz, no encoding

Solar Panel

Patch Antennas

2x λ/4 "whip antennas"

Berkeley Ground Stations

- **S-band Ground Station**
  - 11-meter dish
  - Optimized for 2200-2300 MHz
  - LHCP/RHCP

- **UHF Ground Station**
  - Helix antenna, LHCP
  - ~450 MHz
  - Rated at 25 W
  - Under construction!

NTIA "lessons learned"

- ## Who to ask for a license?
  - For commercial applications: FCC
  - For "hobby": amateur radio band (easiest, but is it applicable…?)
  - For government (NSF, NASA, …): NTIA (National Telecommunications and Information Administration, Dept of Commerce)
- 1 NTIA license for both UHF uplink and S-band downlink
- Have applied to NTIA before: easier!
- UHF uplink frequency within 449.750 - 450.000 MHz band (U.S. Government allocation for Space Operations and Space Research (Earth-to-Space) (Footnote S5.286). (Amateur band: 420-450 MHz in the U.S.A.)
- Possible interferences with amateurs (at our frequency, apparently none in Bay Area, though)

Final words:

- CINEMA-2: same frequencies. Can we amend the CINEMA-1 NTIA license to include CINEMA-2 as well? (THEMIS mission has 5 S/C and only 1 license…)
- Special thanks to Andrew Clegg for help and sponsoring us for NTIA license!!!