

An E310, GNU Radio, and a NASA Sounding Rocket

VT RockSat-X 2016 Payload

Z. J. Leffke, S. D. Hitefield, K. N. Brosie

GNU Radio Conference, CU Boulder, 2016

1. Background - RockSat-X Program

- Undergraduate student design team from Space@VT
- Multiple university payloads on a dedicated NASA Terrier-Improved Malemute suborbital sounding rocket
- Launch from NASA Wallops Flight Facility
- Managed by the Colorado Space Grant Consortium

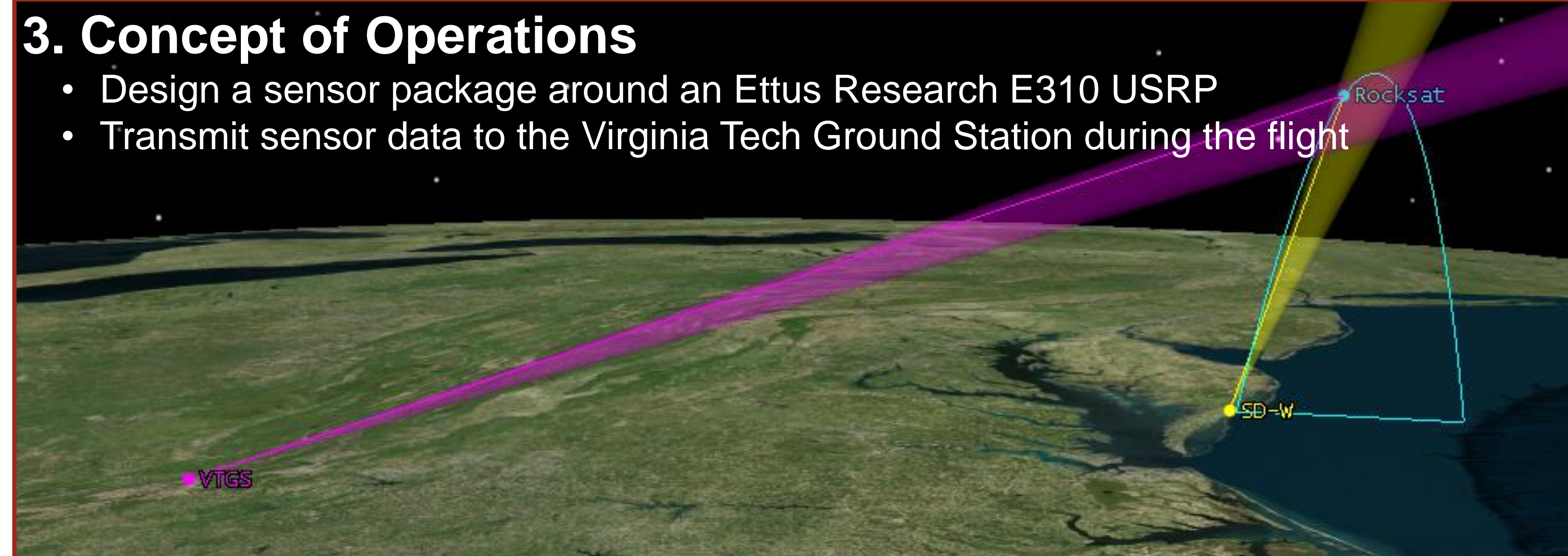


2. VT Mission Goals

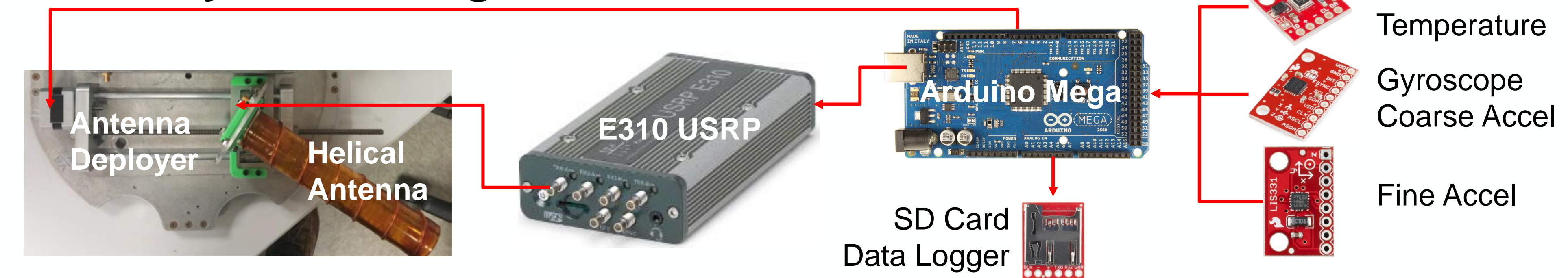
- Launch an unmodified COTS SDR on a NASA sounding rocket
- Demonstrate feasibility of SDR technologies for space communications
- Emulate Space Ground Link System (SGLS) waveforms
- VT team sponsored by Orbital-ATK and AI Solutions

3. Concept of Operations

- Design a sensor package around an Ettus Research E310 USRP
- Transmit sensor data to the Virginia Tech Ground Station during the flight

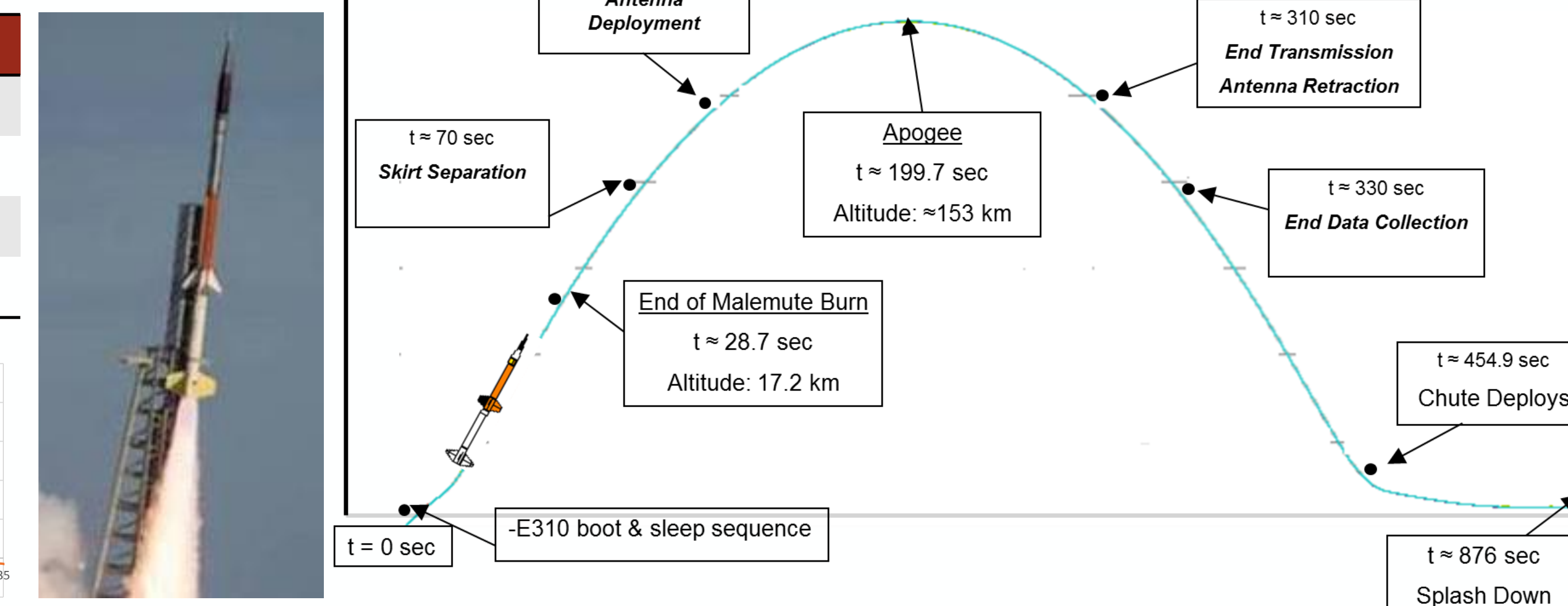
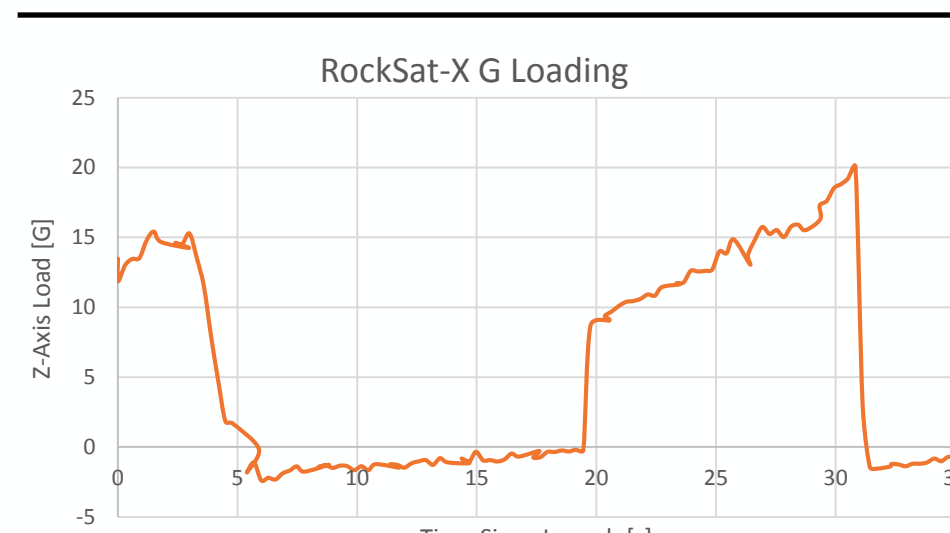


4. VT Payload Design



5. Flight Characteristics

Flight Characteristics	
Apogee Altitude [km]	153
Peak Acceleration [G]	+20.06
Peak Velocity [Mach]	5.6
Peak Range [km]	119



6. Results

- 182 packets detected
- 7 unique packets demodulated
- 14 unique sensor measurements
- MISSION SUCCESS!!!**

7. Future Work

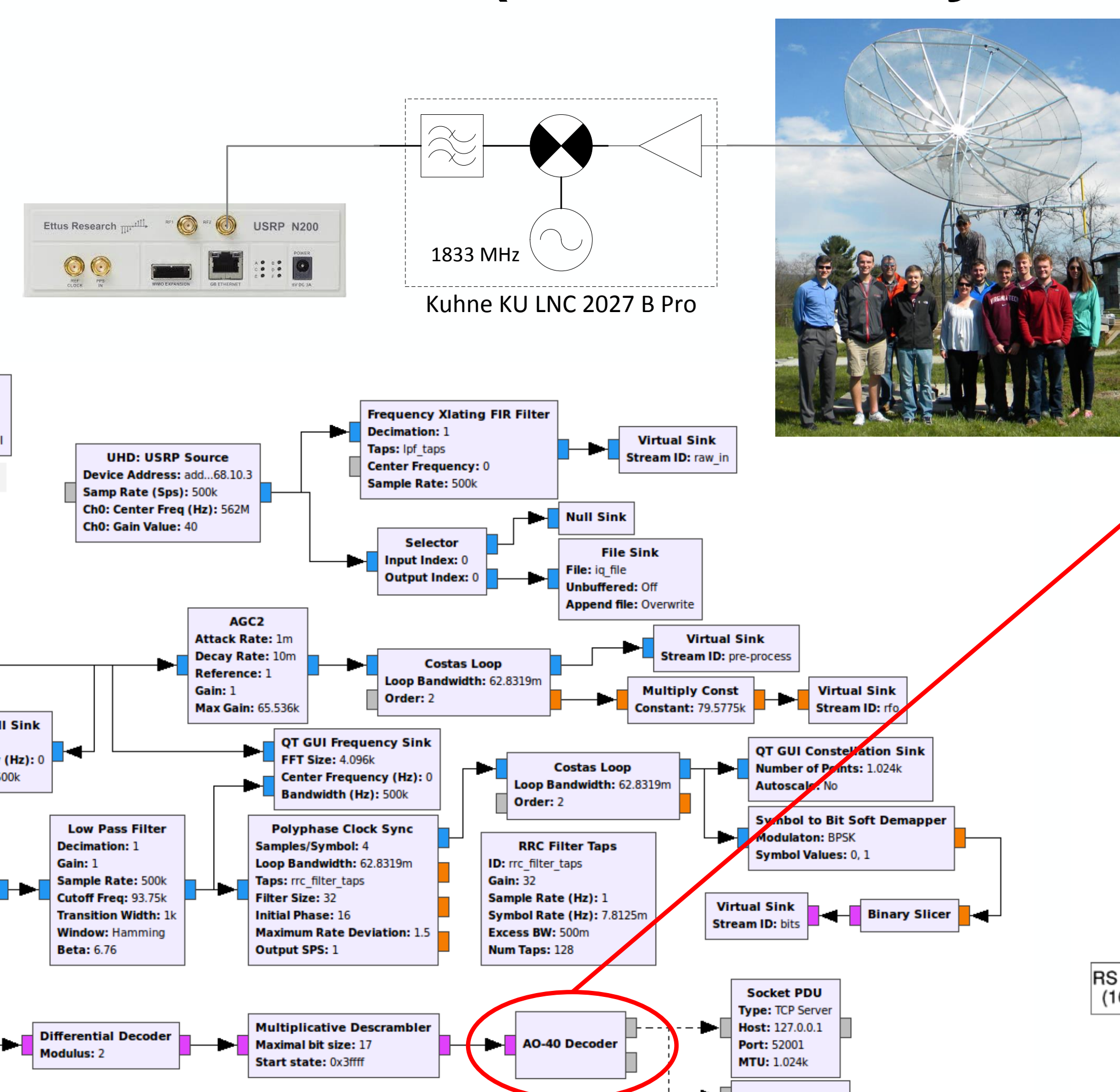
- Integration with RFNoC
- Full duplex communications
- Use E310 onboard GPS + IMU
- Omni antennas & PAs on payload

Receiver: Virginia Tech Ground Station (S-Band Subsystem)

Transmitter: E310 + GNU Radio

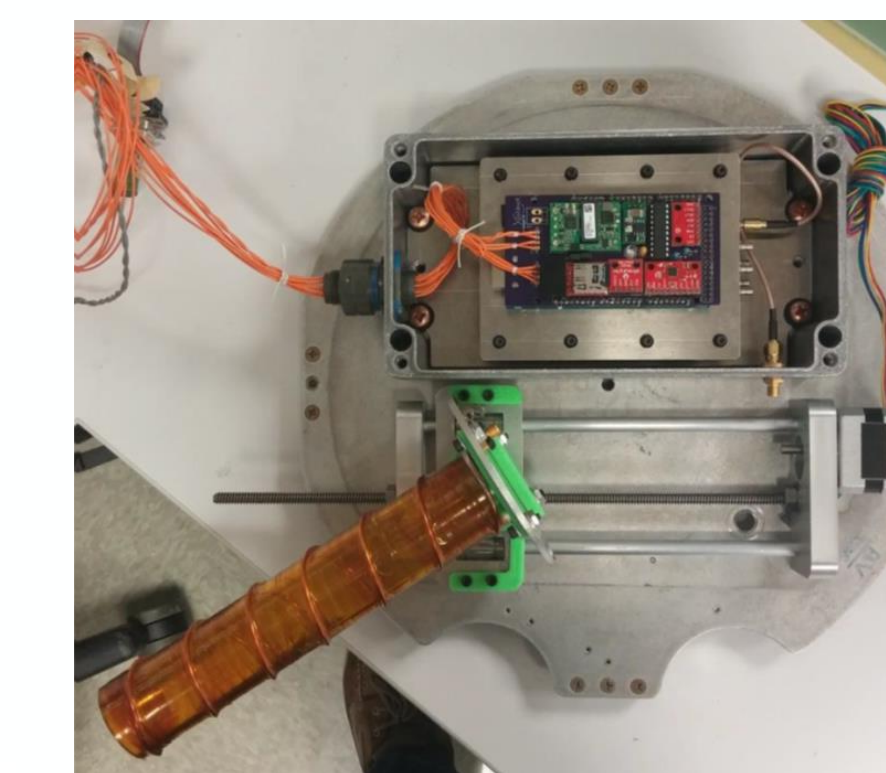
VTGS RX Characteristics

USRP Model	N210 w/ WBX
VTGS Elevation to RS [deg]	~14
RX Antenna Gain [dBi]	32.0
RX Antenna Type	3.0m Dish (RHCP)
System Noise Figure [dB]	2.2



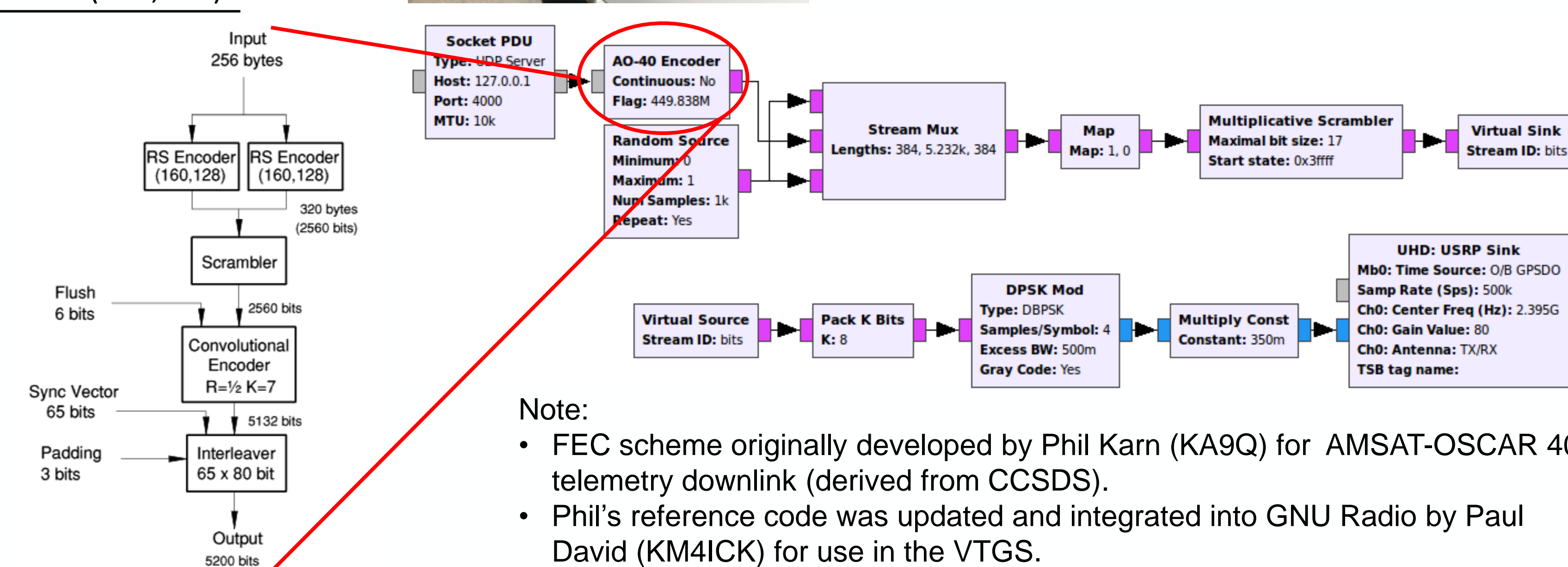
Link Characteristics

Slant Range[km]	~500
TX Frequency [MHz]	2395
Symbol Rate[kcps]	125
Modulation	DBPSK
Inner Code	Conv 1/2 Rate
Outer Code	RS (160,128)



Payload TX Characteristics

USRP Model	E310
E310 TX Power [dBm]	10
TX Antenna Gain [dBi]	11.0
TX Antenna Type	Helical (RHCP)
Sample Rate [ksps]	500



Note:

- FEC scheme originally developed by Phil Karn (KA9Q) for AMSAT-OSCAR 40 telemetry downlink (derived from CCSDS).
- Phil's reference code was updated and integrated into GNU Radio by Paul David (KM4ICK) for use in the VTGS.

VT RockSat-X Undergraduate Team Roster: Sebastian Welsh (Senior, CS), John Mulvaney (Senior, AOE), Kyle Simmons (Senior, CS), Seth Austin (Senior, AOE), Ryan Ligon (Senior, AOE), Alex Dixon (Senior, ME), Greg Scott (Senior, CE), Johnny Jaffee (Freshman, GE), Tony DeFilippis (Sophomore, AOE), Ethan Ohriner (Junior, AOE), Genevieve Gural (Junior, ME), Ishan Arora (Freshman, GE), Emma Manchester (Junior, CS), Sean Roberts (Junior, ME), Ramy Armanous (Senior, ESM)

