AMSAT Engineering Program

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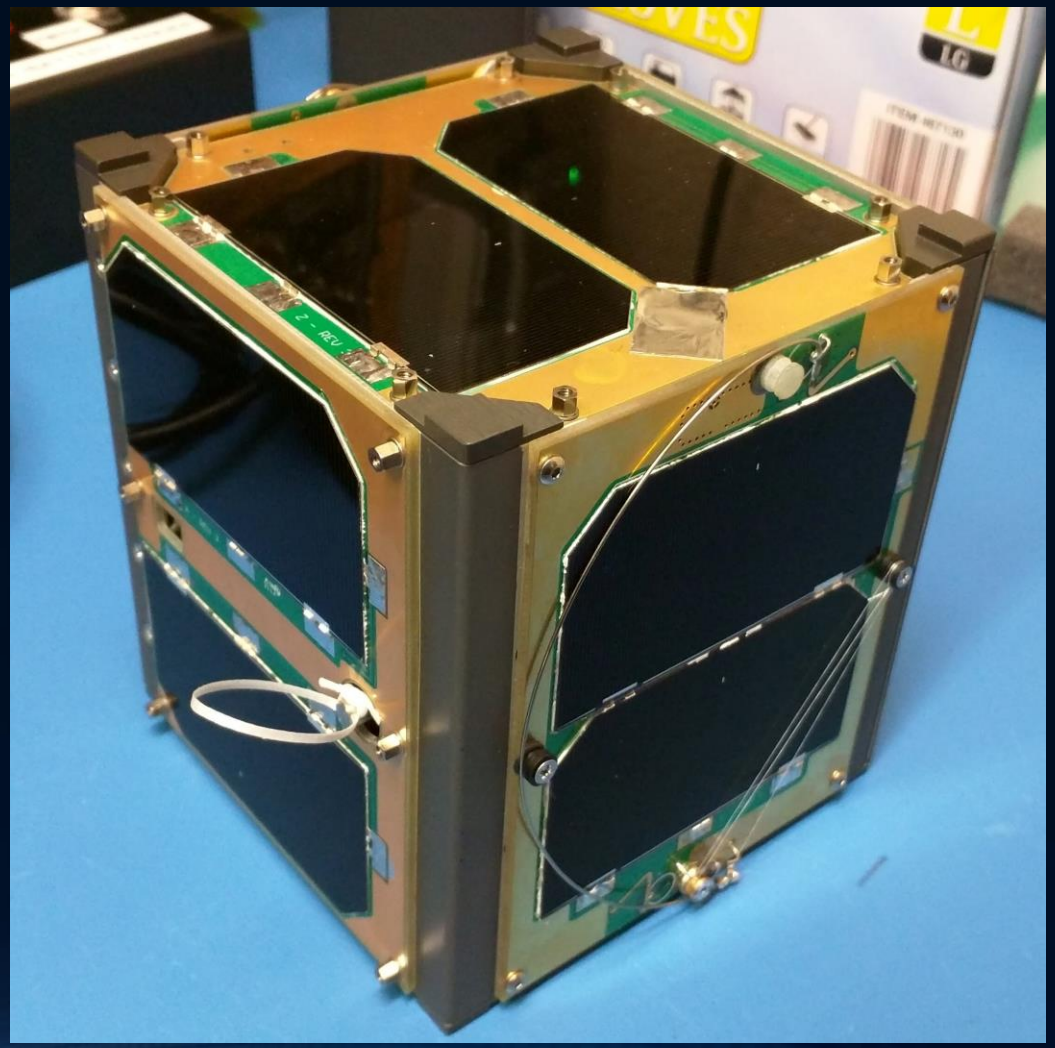
Fox-1 CubeSats



Fox-1 CubeSats

• Fox-1A	AO-85	Launched 10/08/2015	Operational
• Fox-1B/RadFxSat	AO-91	Launched 11/18/2017	Operational
• Fox-1D	AO-92	Launched 01/12/2018	Operational
• Fox-1Cliff	---	Launch by the end of 2018	
• Fox-1E/RadFxSat-2	---	Launch by the end of 2018	

Transponder
Fox-1A-D

- Single channel FM transponder
  - Mode U/v (70cm UHF uplink, 2m VHF downlink)
- AFC on receiver to help compensate for Doppler shift
  - Except Fox-1Cliff
- Fox-1Cliff and Fox-1D have L band "Downshifter"
  - Mode L/v (23cm L band uplink, 2m VHF downlink
- Telemetry downlink simultaneous with transponder voice signals
  - DUV (Data Under Voice)

Transponder
Fox-1E

- 30 kHz wide linear transponder
  - Mode V/u (2m VHF uplink, 70cm UHF downlink)
  - SSB, CW, etc. – No 100% duty cycle modulation types
- Separate telemetry channel downlink

Fox-1 CubeSats

- Lives up to the EasySat claim
- Can work with a handheld with ¼ wave COTS antenna* even on L/v
- Attracting new satellite enthusiasts
  - Cheap test drive

* Professional amateur on a closed transponder. Do not attempt on a busy pass. Your experience may vary due to local conditions, the number of satellite users, and your individual skill level.

For more insight on what it takes to get a Fox-1 in orbit

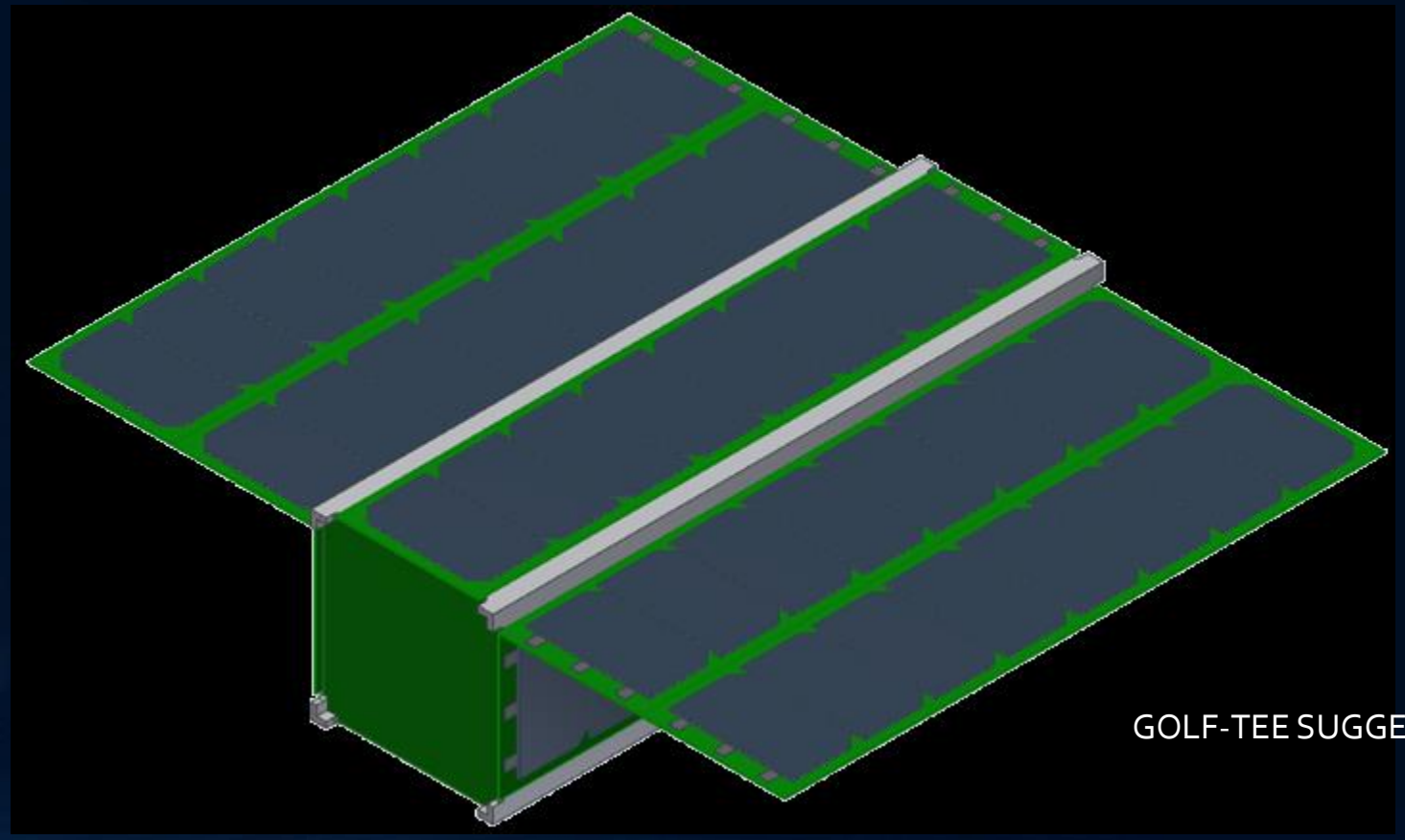
Watch live stream video of Fox-1E testing over the next two weeks at

www.twitch.tv/n0jy

Live stream archives and lots of other Fox-1 videos are available at

www.youtube.com/n0jy

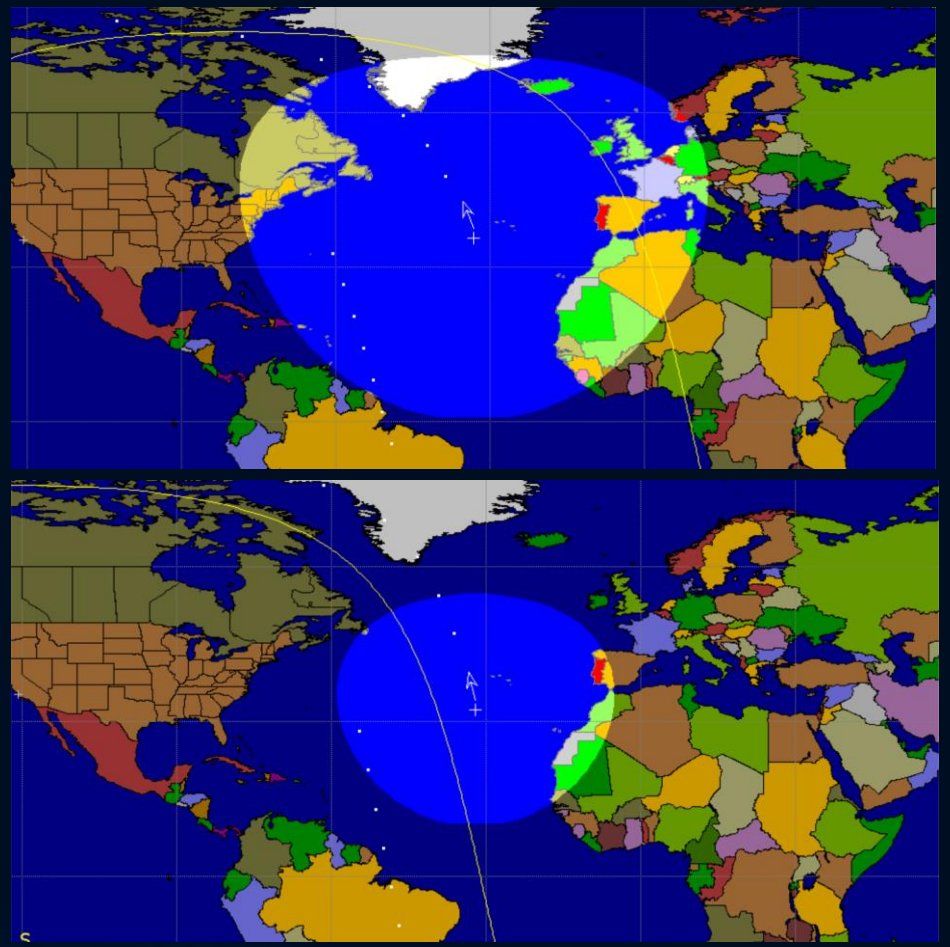
GOLF Program
Greater Orbit, Larger Footprint



GOLF-TEE SUGGESTION

Amateur Radio LEO Satellite Altitudes (voice)

- **AO-7** **≈ 1400 km.**
- FO-29 ≈ 1200 km.
- SO-50 ≈ 650 km.
- AO-73 ≈ 650 km.
- AO-85 ≈ 650 km.
- **XW-2F** **≈ 520 km.**
- ISS ≈ 400 km.



Higher is Better

- Larger footprint
  - More DX
  - More good passes per day (mid-latitude station)
- Orbit lifetime is longer
  - SSO typically 6 to 8 years
  - AO-7 will last a lifetime
- Slower motion across sky
  - Longer passes
  - Less tracking movements

GOLF Program

- 3U CubeSats
- Incremental path to MEO, HEO, GEO orbits and missions
  - Developing, testing, learning, and building proficiency for reduced risk
- New Technology
  - ADAC
  - Deployable solar panels
  - SDR and microwave bands
  - Propulsion
- Develop and learn de-orbit capability (passive or active) for all future missions
  - Any higher orbit (not including rideshare) must meet orbital debris requirements

GOLF Program

- Continued growth of CubeSat abilities
- Hands on knowledge and experience builds team capability for HEO
- Following Fox-1, continues to regularly populate amateur radio satellites providing coverage for years to come
- Continuation of CSLI educational launch opportunities and partnerships

GOLF-TEE (Technology Exploration Environment)
Target: 4Q 2019 delivery

- 500-600 km polar orbit
- Fox-1E type V/u linear transponder
- SDR with X band data downlink
  - V/x transponder option
- Attitude determination and control
- Deployable solar panels
- Radiation tolerant IHU (Integrated Housekeeping Unit)
- Vanderbilt University radiation experiment

GOLF-1
Target: 4Q 2020 delivery

- 1300 km orbit
- SDX (Software Defined radio Transponder)
  - C/x ("Five and Dime") linear transponder
  - V/u linear transponder
  - Other bands/modes possible
- Albuquerque Public Schools / Virginia Tech weather observation camera experiment
- Vanderbilt University radiation experiment
- De-orbit capability

Attitude Determination And Control - Benefits

- Solar panel pointing for best sun
- Antenna pointing for best transponder performance
  - Higher gain microwave band antennas
- Camera pointing
- Support for de-orbit mechanism performance
- Support for propulsion
- Some options for collision avoidance

Microwave Bands - Benefits

- Smaller antennas (wavelength)
  - Higher gain both space and ground segment
  - Opportunities for stations in neighborhoods with restrictions
  - Opportunities for apartment dwellers
- Lots more bandwidth available
  - 5 GHZ band – 20 MHz uplink, 20 MHz downlink (separate segments)
  - 10 GHz band – 50 MHz (combined up/down segment)
- Opportunity for a variety of signals on one band
  - FM, SSB, digital (high speed), you name it

Q&A

DOORS WILL REMAIN LOCKED UNTIL SOMEONE ASKS A QUESTION

Visit us at the AMSAT booth!