National Aeronautics and Space Administration

Rotating Beam Antenna Enabling Next Generation of Doppler Scatterometers

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Program: Topic Area

Project Objective:

Develop a Ka-band multi-beam, wide-swath, spinning antenna to enable a new spaceborne Doppler Scatterometer (DopplerScatt) mission for Earth Science:

- Develop an electrical design for a Ka-band antenna that can be deployed from a moderate cost launch vehicle, generates the required beams for the DopplerScatt performance, and achieves at least 50% efficiency
- Develop a mechanical concept for the antenna structure and deployment, and assess the feasibility of deploying the antenna from a range of launch vehicles and fairings
- Assess the expected performance of a Doppler scatterometer incorporating this antenna

Background:

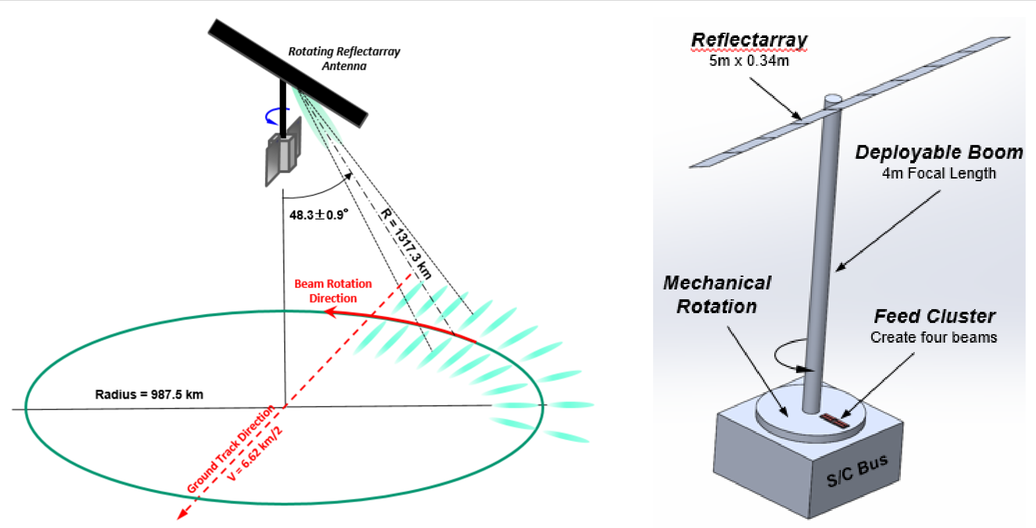
- The 2017 NRC Decadal Review identified the simultaneous measurement of winds and currents as a measurement priority, and recommended that the measurement be achieved by a Doppler scatterometer as part of the $350M Earth Explorer competed mission candidates
- The DopplerScatt measurement concept was previously demonstrated from an airborne platform, but the antenna is the key technology and cost driver for a spaceborne mission

FY19 Results:

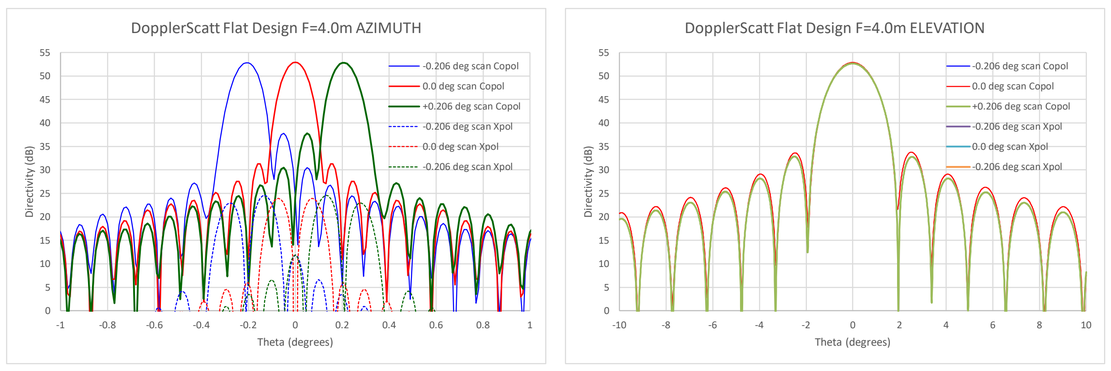
- A set of antenna requirements was generated
- An antenna concept based on the SWOT Ka-band Radar Interferometry (KaRIN) reflectarray antenna was studied
  - Shorter focal lengths were analyzed to minimize stowage volume; a 4m focal length is the minimum for the baseline bandwidth requirements
  - A piecewise parabolic version was analyzed, but the offset-fed configurations proved to have poor scan performance
  - An antenna design consisting of a 5m x 0.35m reflectarray with a 4m focal length, a transmit feed and a receive feed was baselined
- The simulated antenna patterns were processed in the Winds and Currents Mission (WaCM) radar performance model and produced acceptable results
- Mechanical stowage and deployment concepts were studied
  - Packaging into an ESPA Grande configuration will be challenging
  - A larger volume solution will most likely be necessary as either a small primary payload or a secondary payload solution with more volume

Significance of Results:

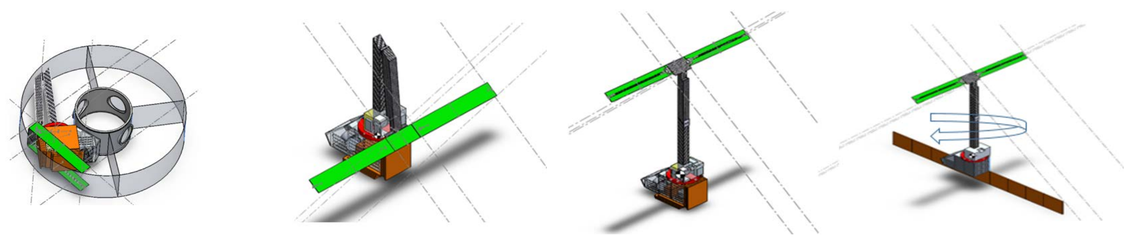
- Electrical and mechanical design concepts for the antenna were investigated and found to be technically feasible
- Packaging the mission as a secondary payload may be challenging
- Several issues requiring future investigation were identified, including:
  - Whether the radar electronics should be on the spun or despun side
  - Performance trades between antenna gain, radar power, and spacecraft altitude
  - Management of the heat from the radar electronics
  - Establishment of antenna pointing stability and knowledge requirements, which are major drivers for the antenna cost



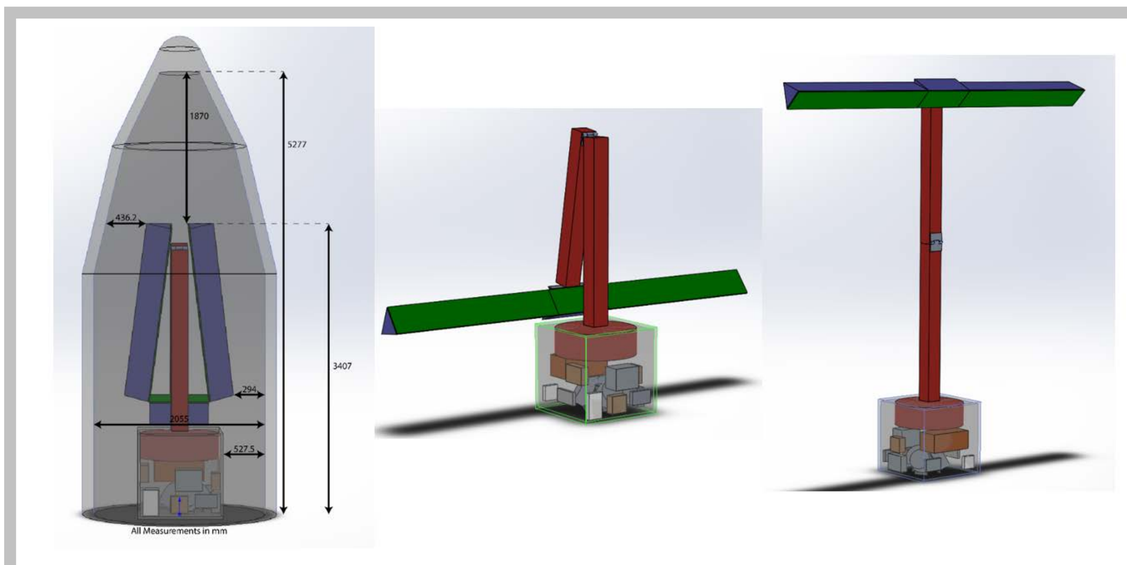
DopplerScatt Concept



DopplerScatt baseline antenna radiation patterns. Upper plots show azimuth scan performance. Lower plots show performance relative to the original bandwidth requirements. The updated bandwidth of 10 MHz does not exhibit the azimuth shoulders shown in this plot.



Solidworks model of a possible spacecraft configuration with an ESPA Grande



Solidworks model of a possible spacecraft configuration using a Minotaur-C

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Publications:

NTR 51316: "Doppler Scatterometer Antenna Deployment"

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