Space-Deployed Inflatable Dual Reflector Antenna: Design and Prototype Measurements

Jesse Mills

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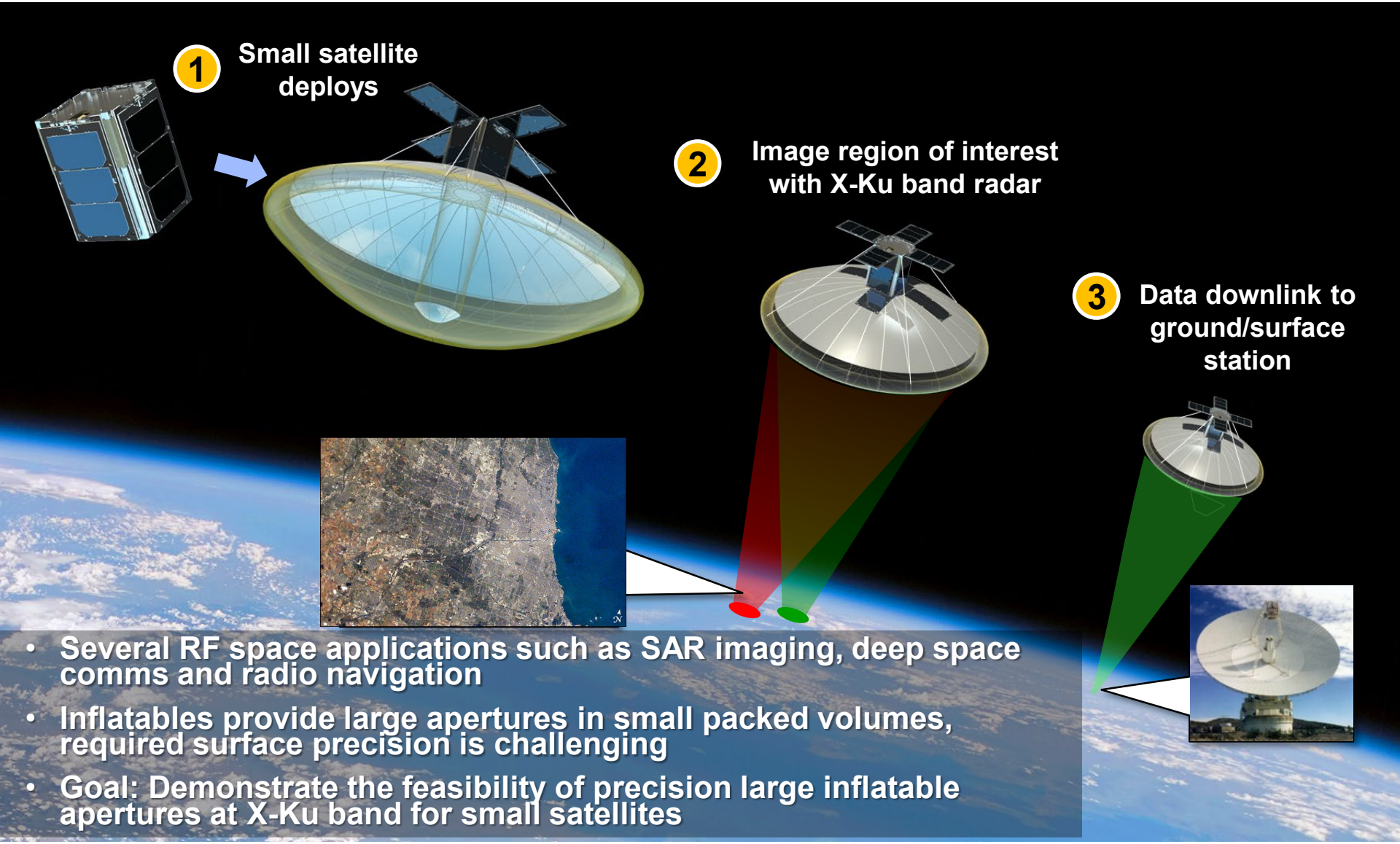
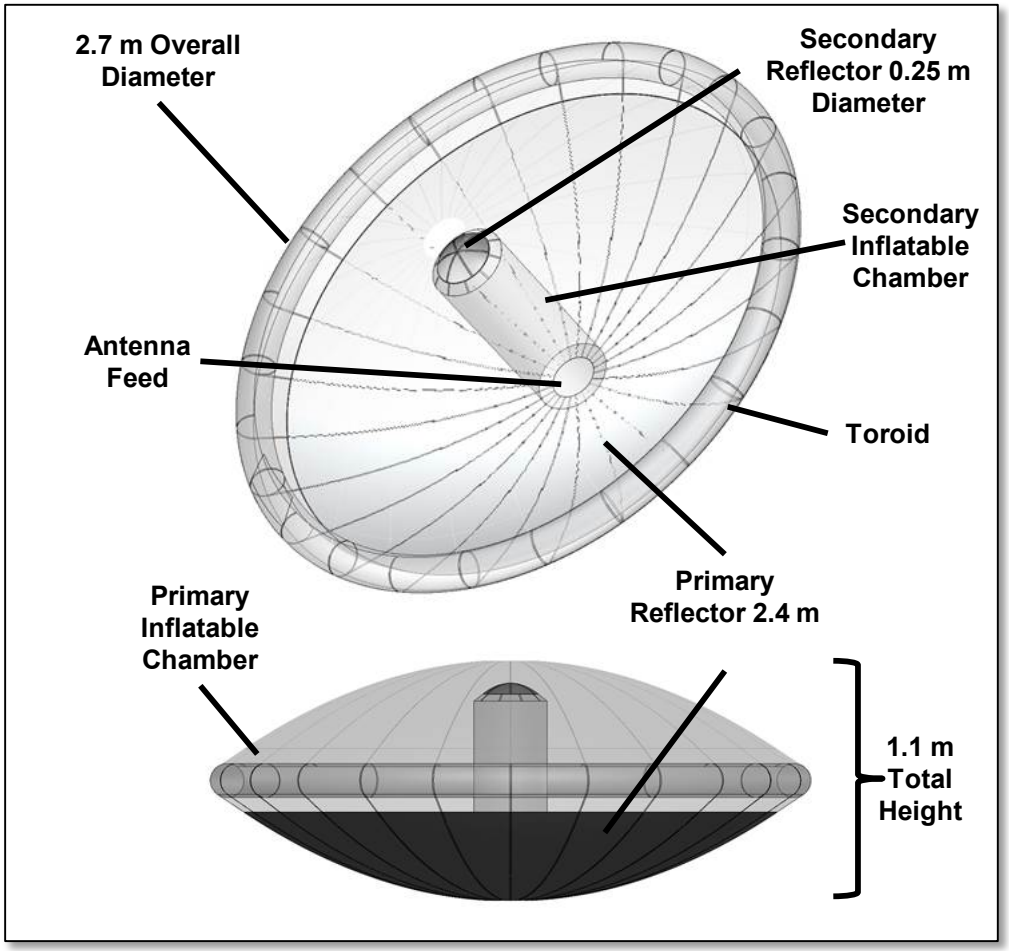
Large Aperture Space Based RF Applications

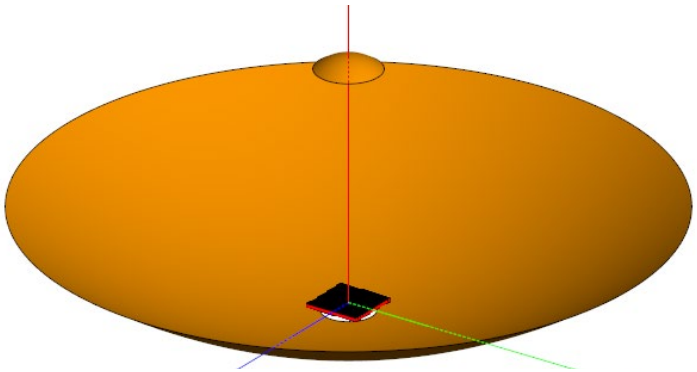


- Several RF space applications such as SAR imaging, deep space comms and radio navigation
- Inflatables provide large apertures in small packed volumes, required surface precision is challenging
- Goal: Demonstrate the feasibility of precision large inflatable apertures at X-Ku band for small satellites

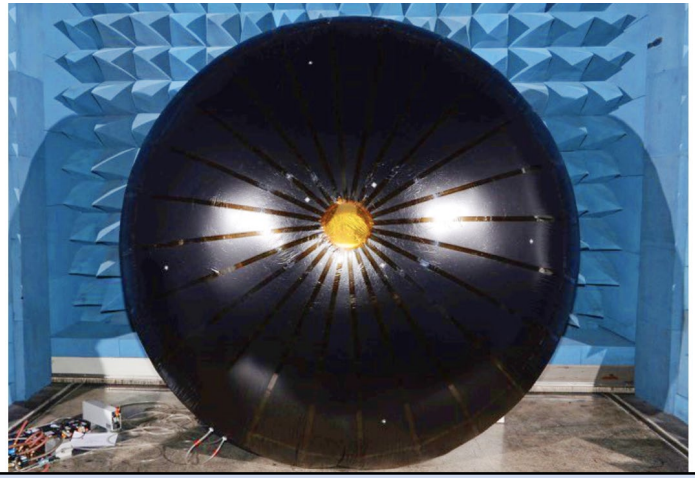
Dual-Reflector Gregorian Inflatable Antenna Design



Dual Reflector Gregorian Design



Inflatable Antenna Prototype in the Compact Range

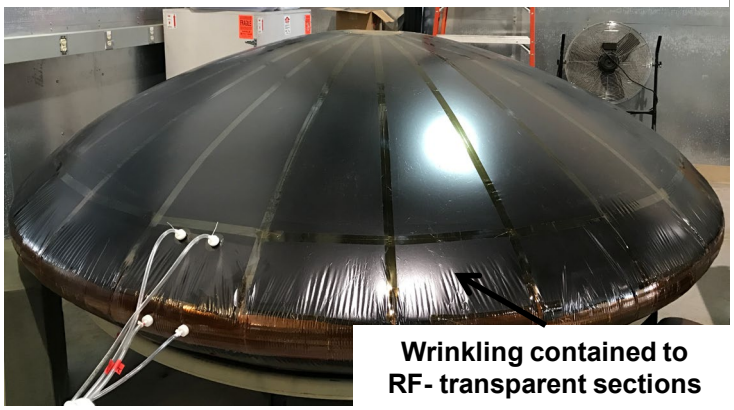


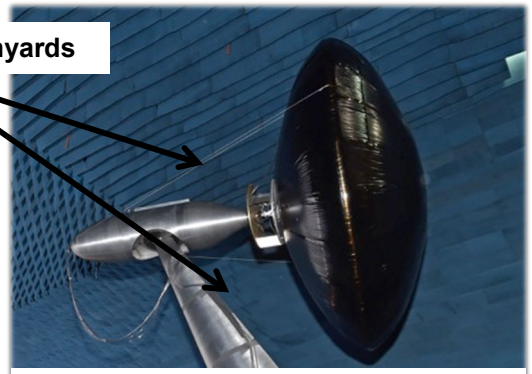
Novel dual-reflector Gregorian inflatable antenna, designed, fabricated, and characterized

Key Design and Fabrication Insights

- Gregorian layout removes satellite body beam obscuration
- Three independent inflation chambers allow for post-fab antenna tuning
  - Tuned pressures for optimal surface quality
  - Adjustable focal lengths for secondary
  - Reverse thermoforming to correct fab defects
  - Post-deployment primary-secondary alignment
- Pragmatic mechanical design obviates need for high precision design/fab

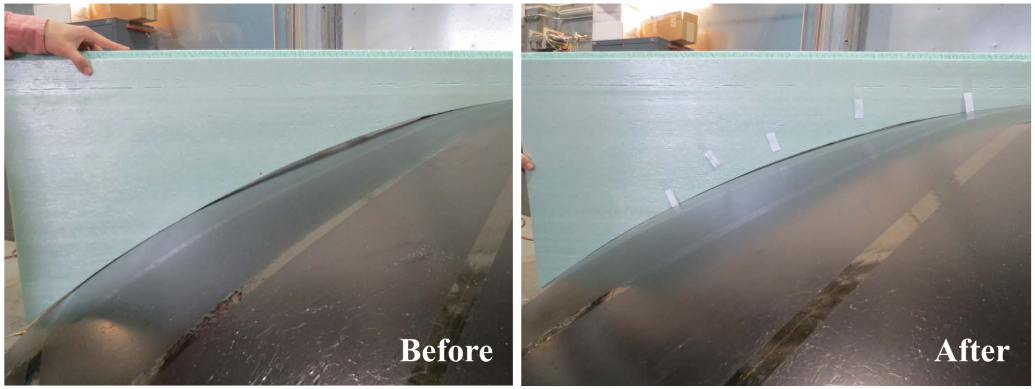
RF-Transparent Sections at Interfaces



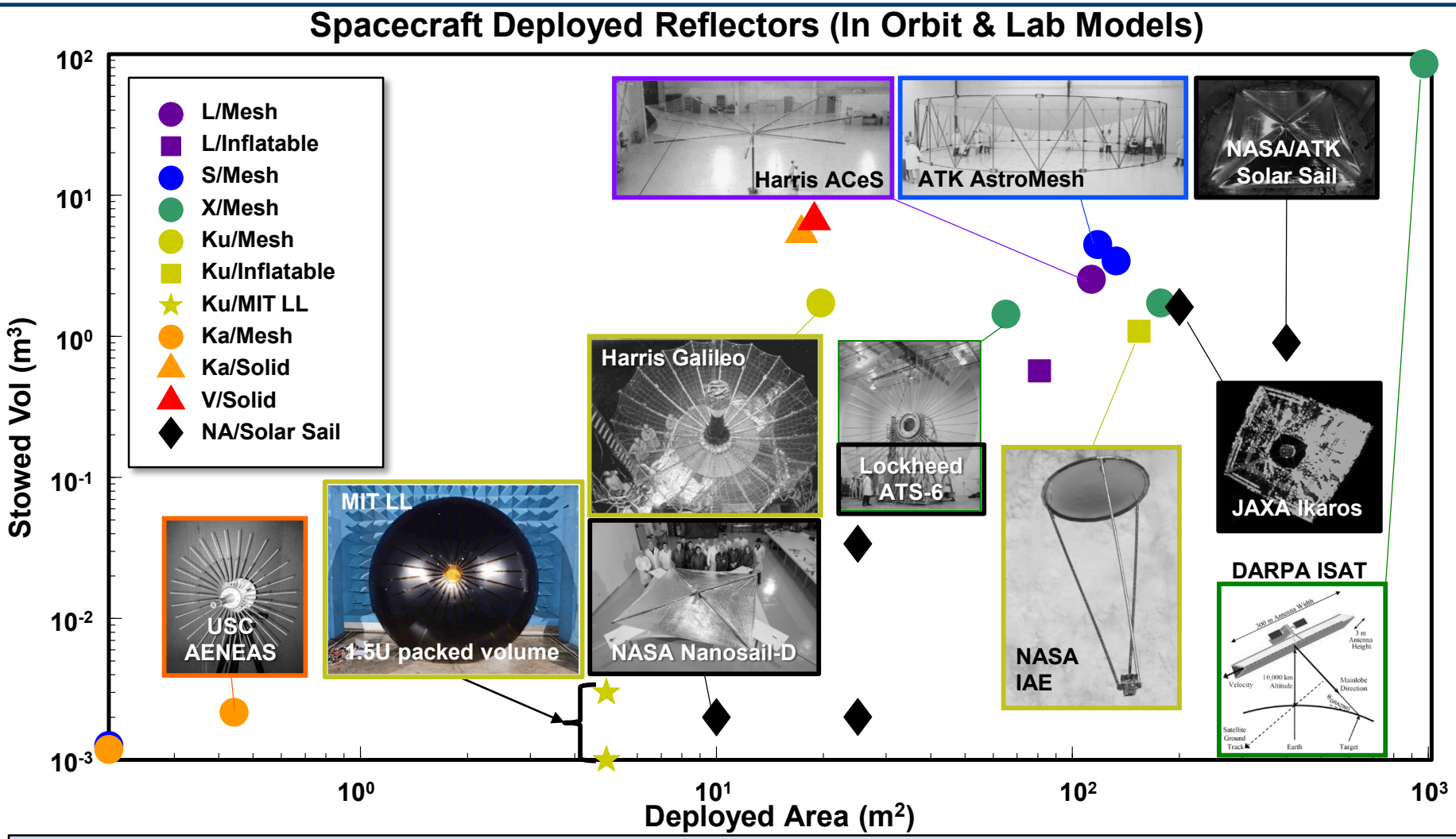


Co-alignment of Reflective Surfaces

Post-Fabrication Reverse Thermoforming



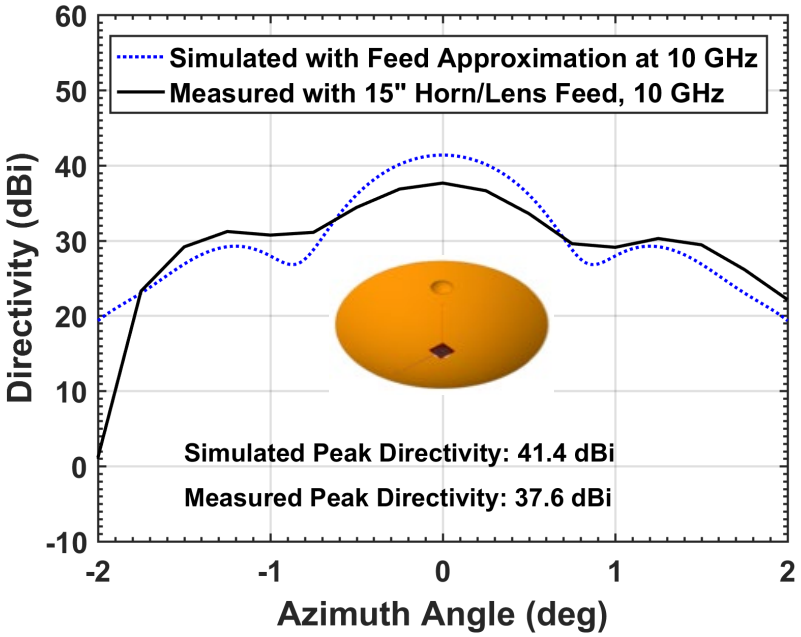
Deployed Area vs. Stowed Volume

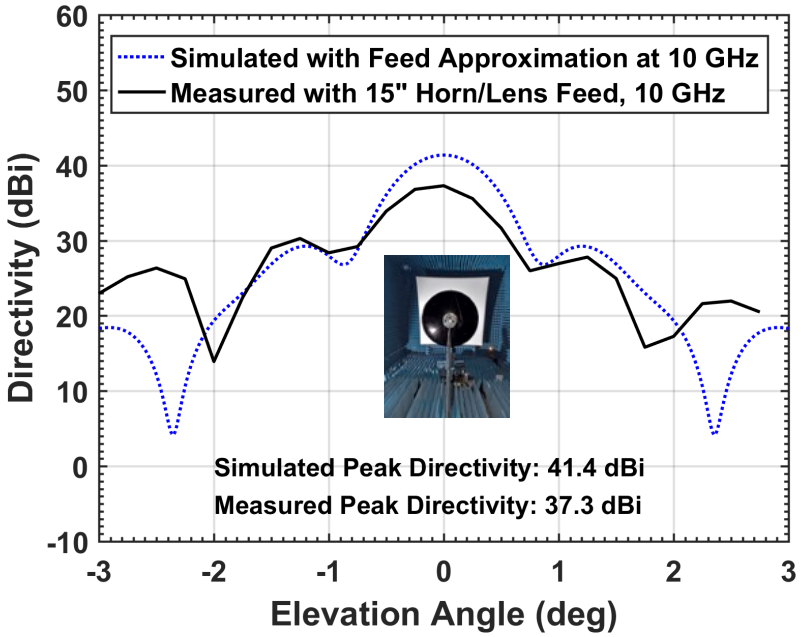


Demonstrated: Inflatable X-Ku band antenna with stowed volume similar to solar sails

Simulated and Measured Gain (1 of 2)
Inflatable Gregorian Reflector Antenna

Simulated and Measured Gain at 10 GHz

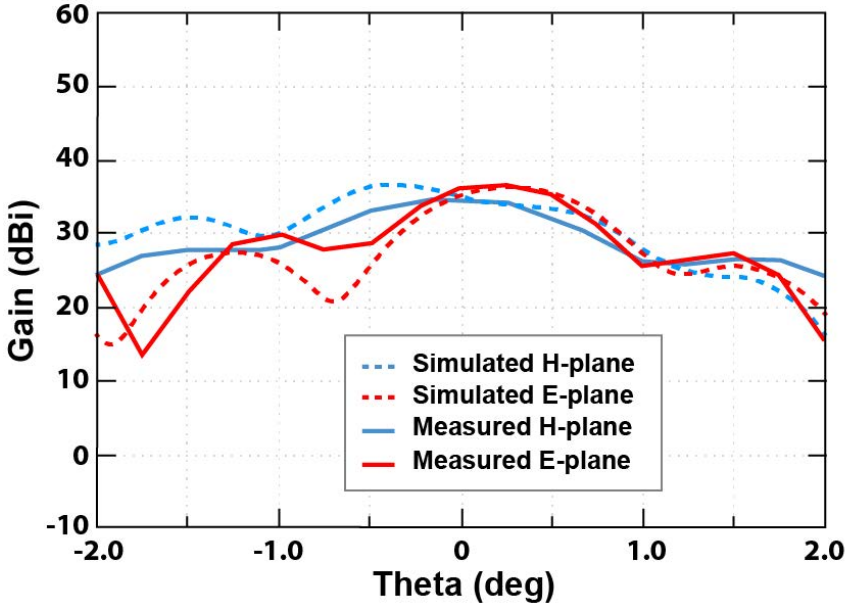




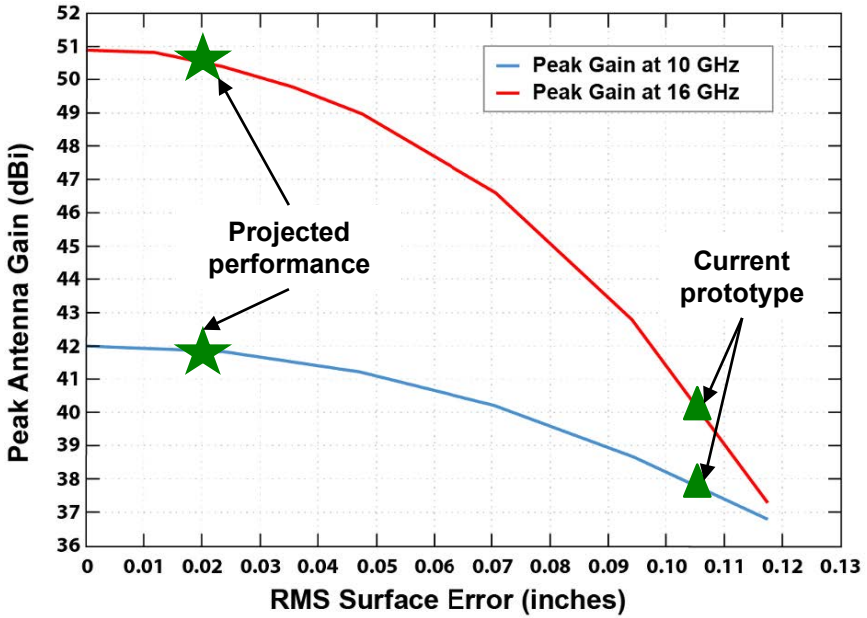
- Measured antenna gain shows good performance at X-band
  - 37.6 dBi gain, ~1° beamwidth at 10 GHz
  - Peak directivity within 4 dB of ideal
- Improvement in primary reflector design and fabrication required to achieve directivity within 1 dB of ideal

Simulated and Measured Gain (2 of 2)
Inflatable Gregorian Reflector Antenna

EM Model of Laser Scanned Surface vs. RF Chamber Measurements



RMS Surface Error vs. Peak Gain



- 3D laser scans of prototype and root mean square (RMS) surface error analysis helped identify error sources
  - All errors associated with primary surface shape
- Improvements in primary fab design and integration fixtures expected to bring performance within 1 dB of ideal

Summary and Path Forward

- **Designed, prototyped, and characterized a novel dual-reflector Gregorian multi-chambered inflatable antenna for X-Ku band**
  - **Successfully demonstrated good RF performance at X-band, very high deployed area to stowed volume ratio**
- **Identified opportunity for improvements in mechanical design and fabrication design**
- **Implementation of identified improvements expected to bring X-Ku band inflatable antenna within 1 dB of ideal performance**
- **Aperture diameters up to 10 meters likely feasible with these design and fabrication approaches at X-Ku band**

Enabling technology for SAR imaging, deep space communications and radio navigation on small satellites

Questions?