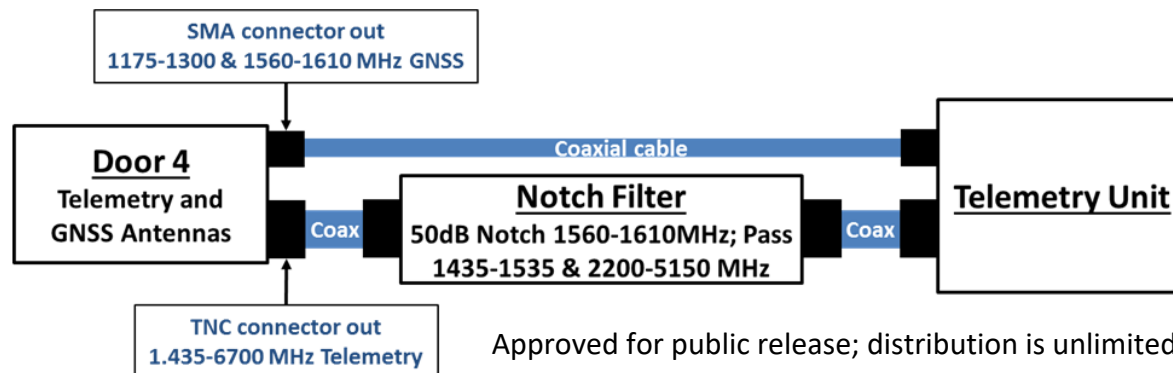




# Conformal L, S, & C Band Telemetry Antennas Goals and Objectives

- Prototype conformal, co-located L/S/C telemetry and L1/L2 GPS antennas on the door 4 panel of the F/A-18 aircraft in roughly 5.75" x 7.5" x 4" (l x w x d) of volume
  - L band 1435-1535 MHz
  - S band 2200-2400 MHz
  - C bands 4400-1900 & 5100-5150 MHz
- Prototype a L/S/C notch filter which reduces the amount of coupling at L band between the GPS antenna and the L/S/C telemetry antenna
- For the filter, the sharp roll off required between L-band telemetry and L-band GPS is challenging, the two bands are separated by only 25 MHz and 50dB of rejection is needed.
- Other technical challenges include the harsh environmental conditions associated with the F/A-18.
- When paired with an L/S/C telemetry transceiver, this filter and antenna will simplify testing on this aircraft.
- This filter and antenna combo can be retrofitted for other aerospace applications.

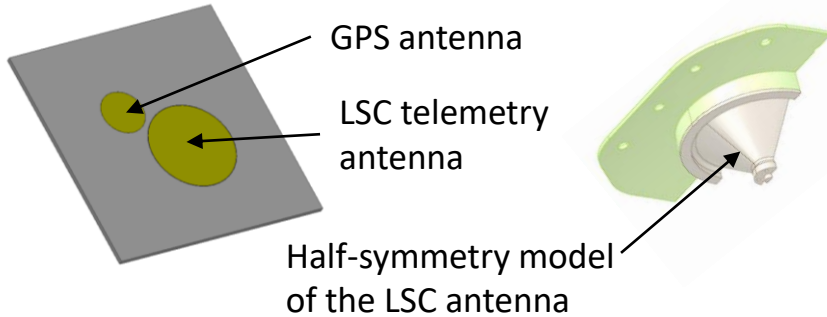


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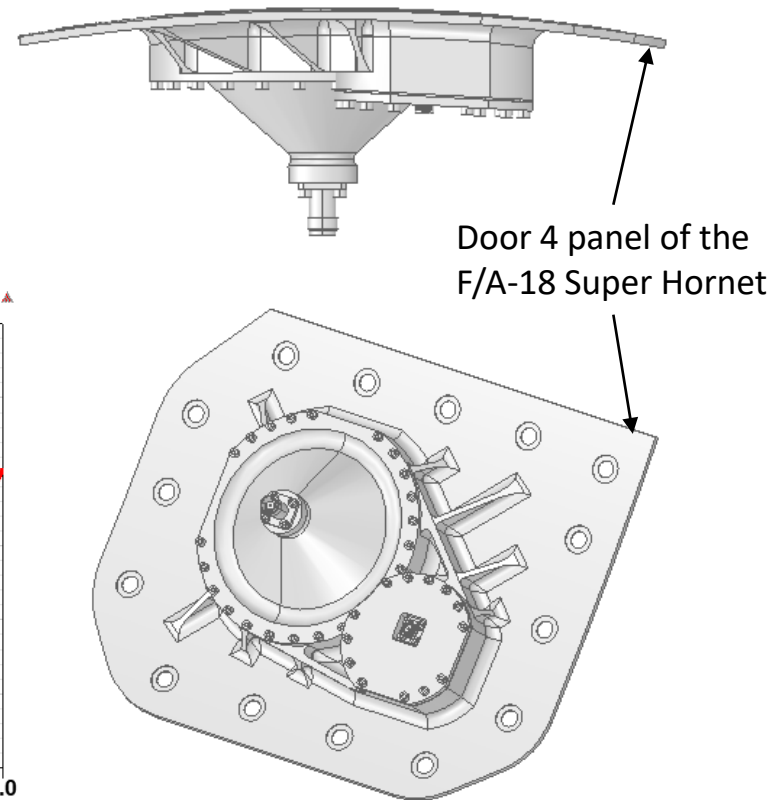
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# Conformal L, S, & C Band Telemetry Antenna with a Co-located GPS Antenna for the F/A-18

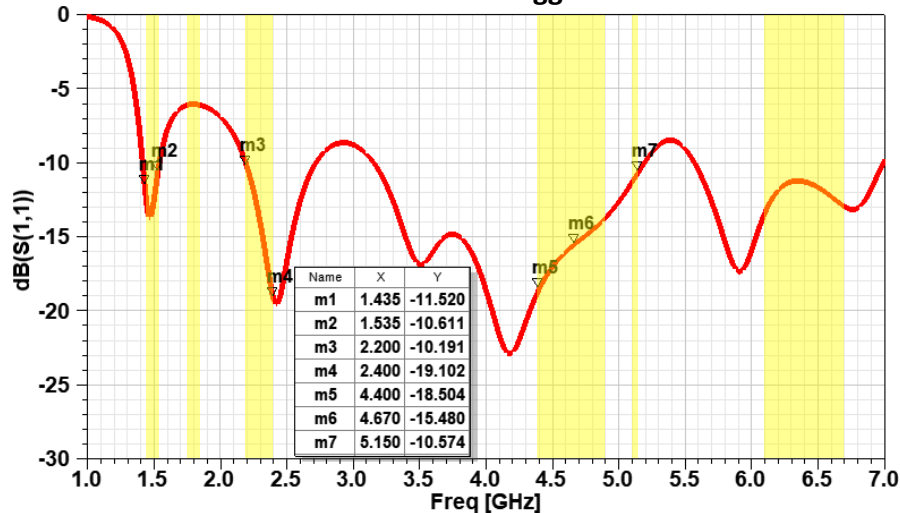
## Electromagnetic models



## Rugged mechanical design

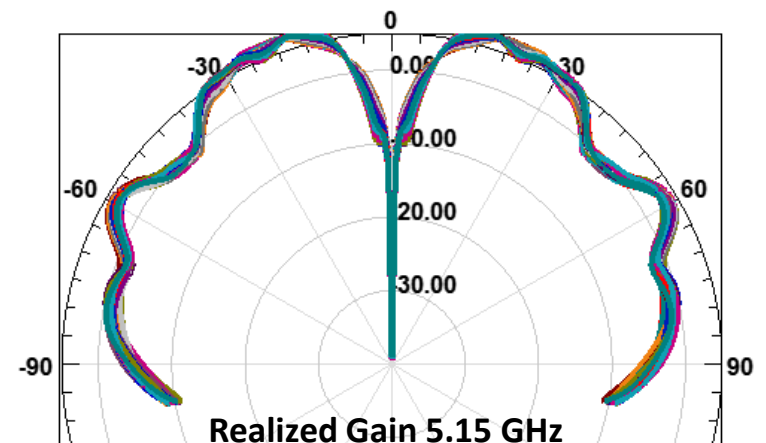
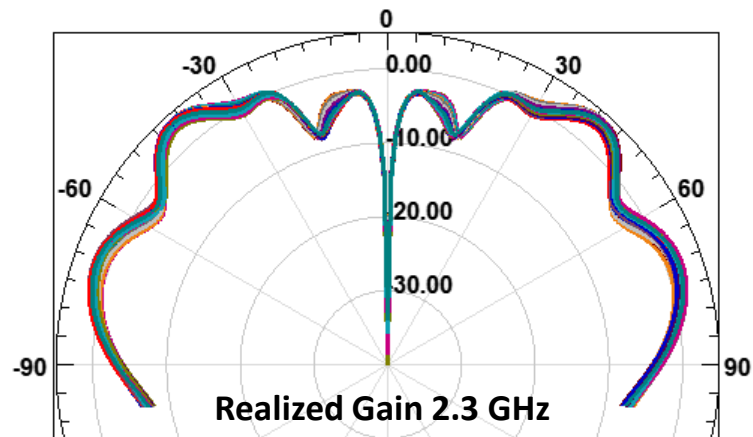
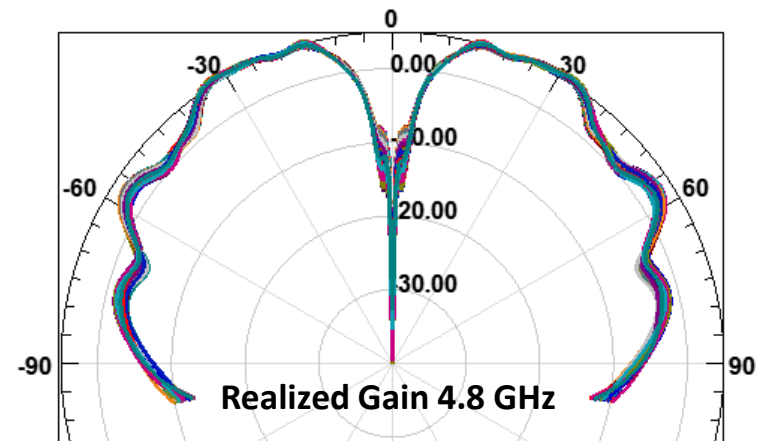
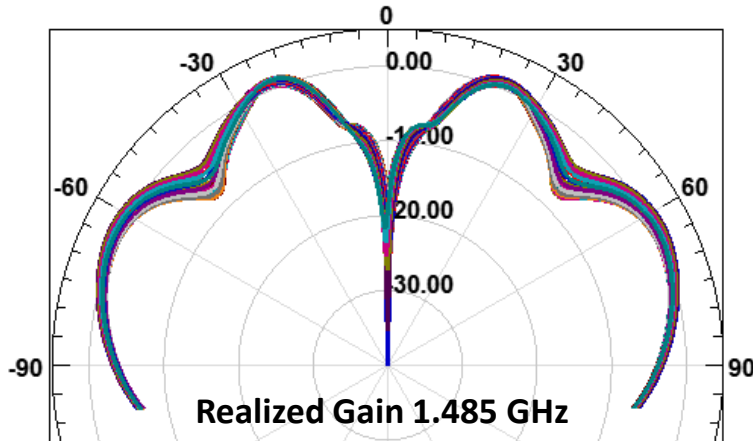
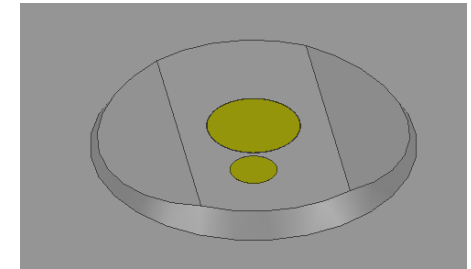


Predicted Return Loss of Rugged LSC Antenna



# Conformal L, S, & C Band Telemetry Antennas - Predicted Patterns on 3-foot Groundplane

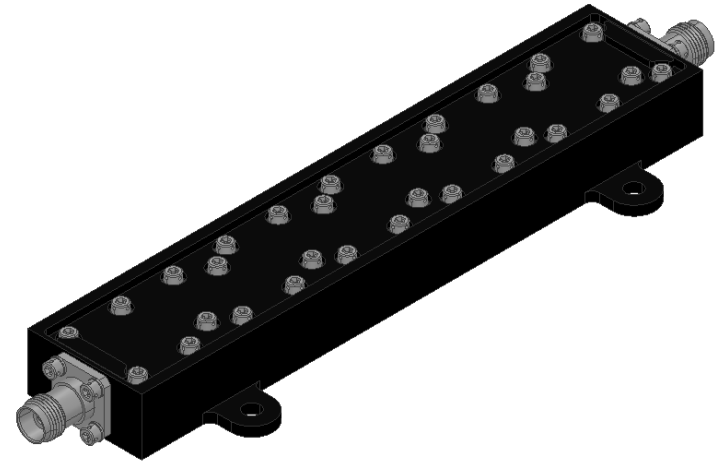
- 36 superimposed elevation cuts of the telemetry antenna, with the GPS antenna co-located, can be seen below.
- The patterns were simulated on a 3-foot groundplane
- The mounting bracket used to attach the curved antenna to the flat groundplane was included in the model



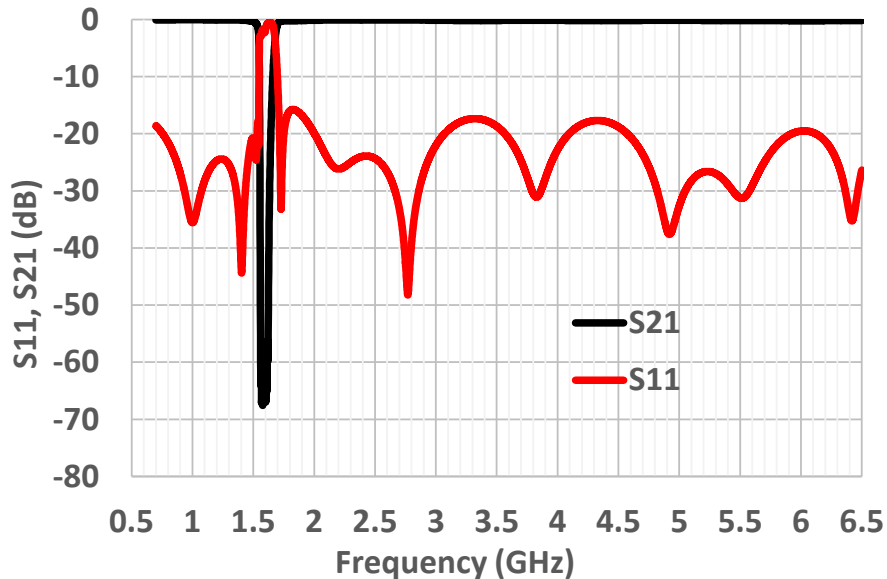
# Conformal L, S, & C Band Telemetry Antennas

## - Predicted Performance of Notch Filter

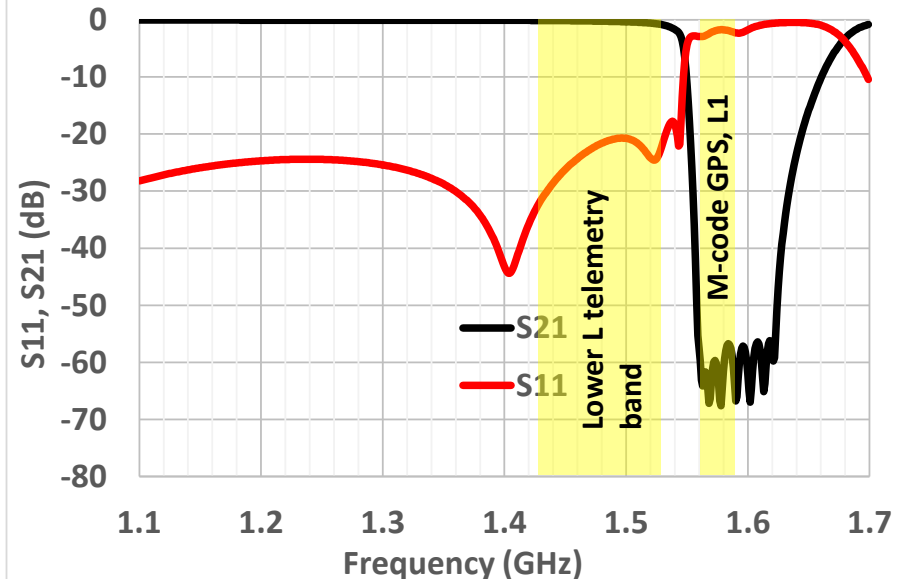
- The notch filter is a critical component in the system, preventing self jamming of the GPS receiver from noise in the telemetry L band
- Toyon will procure the notch filters from Lark Engineering, a custom filter manufacturer
- Specifications were provided to the vendor – 50dB of rejection is required at the L1 GPS band
- Not including the TNC connectors or #10 mounting flanges, the filter dimensions are 0.75" x 1.5" x 7.4"
- Toyon could explore integrating the filter onto the back of the antenna on a future effort



Predicted S11 and S21 of LSC Notch Filter

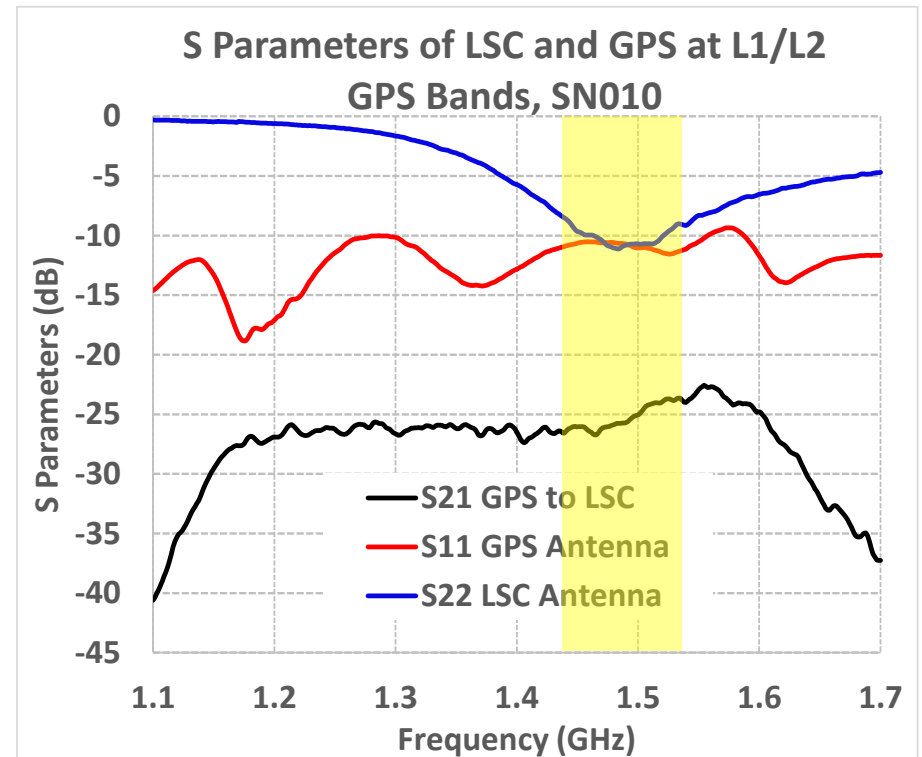
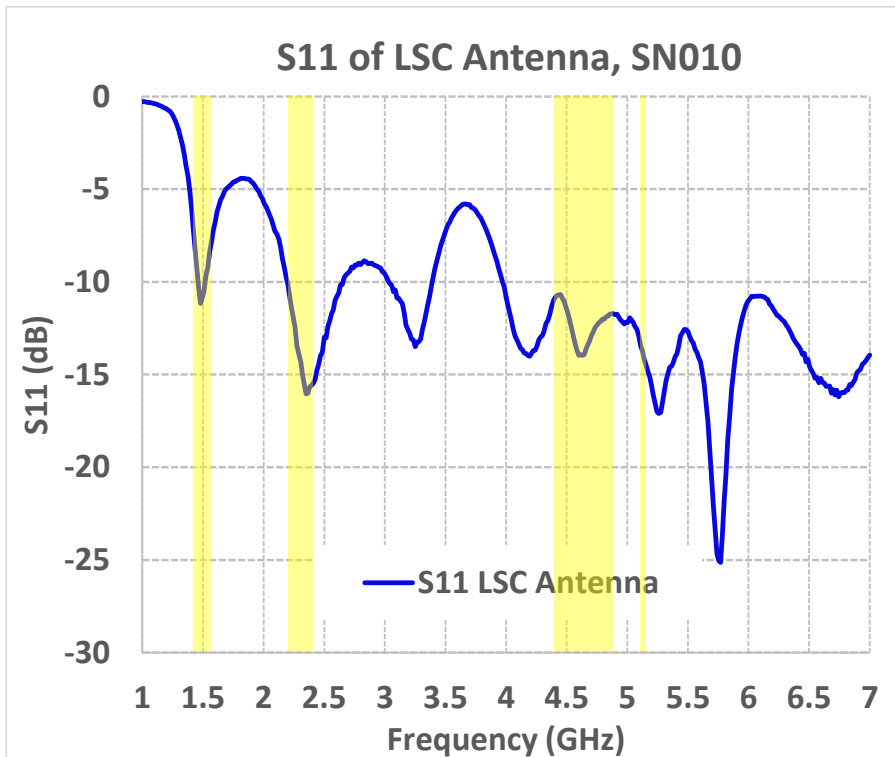
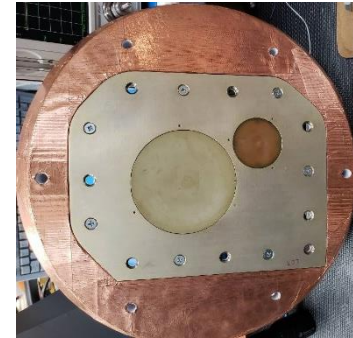


Predicted S11 and S21 of LSC Notch Filter



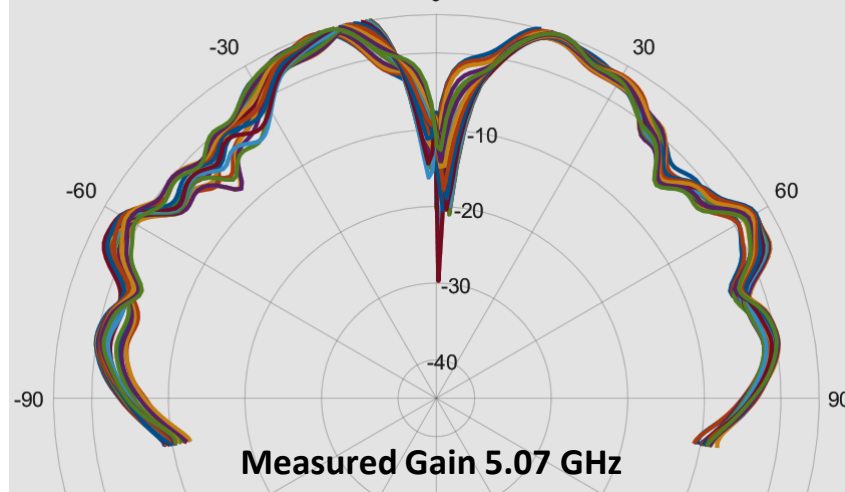
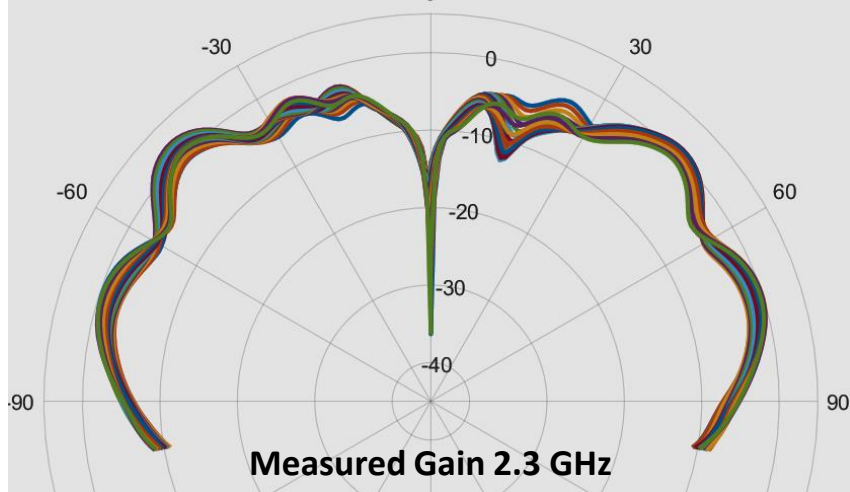
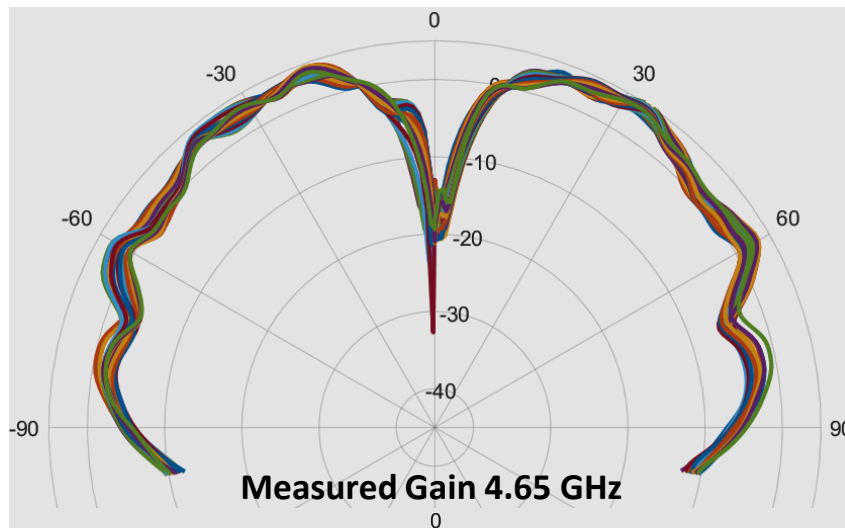
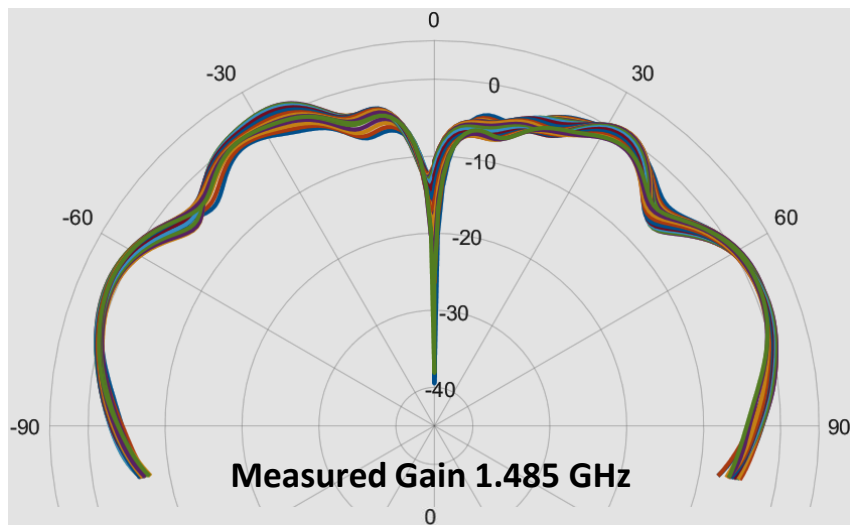
# Conformal L, S, & C Band Telemetry Antennas - Measured S-parameters of the Antennas

- The s-parameters of the LSC and GPS antennas were measured while attached to a mounting bracket
- Ten antennas were fabricated in all, and the design was robust and repeatable
- SN010 shows typical performance



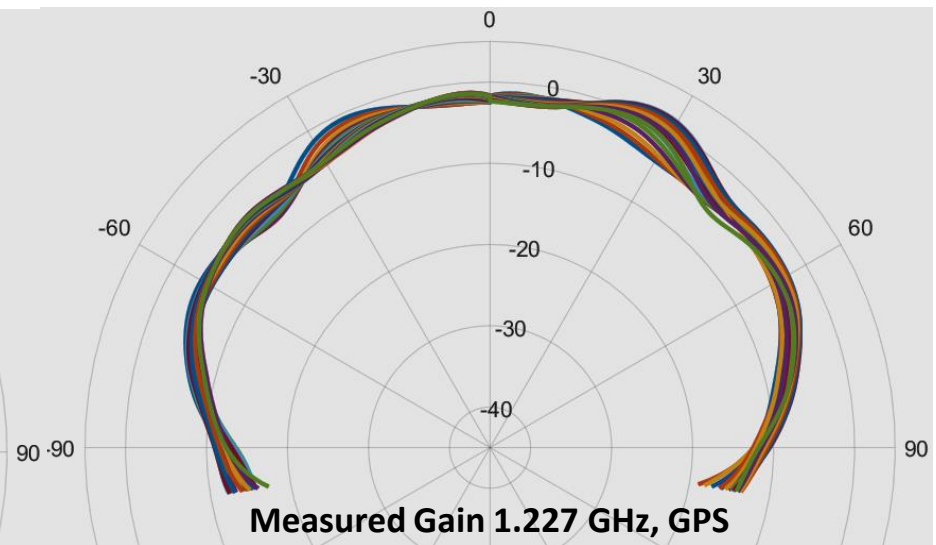
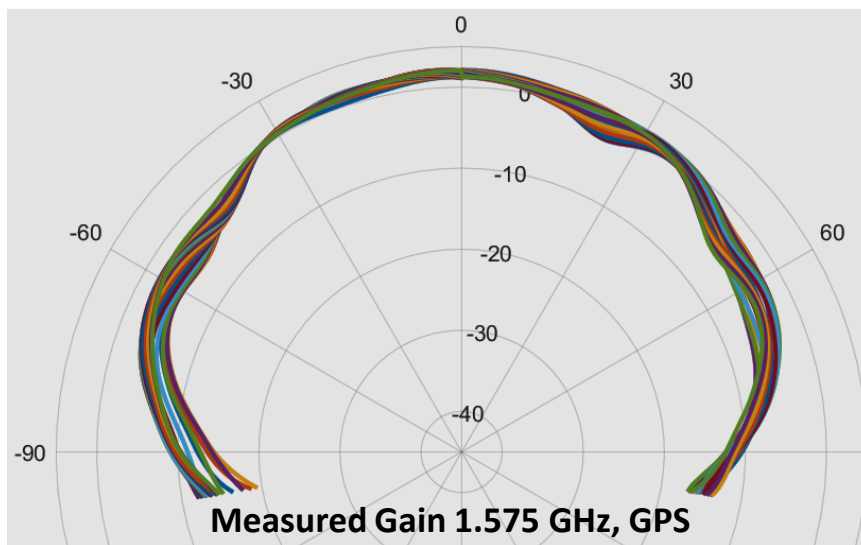
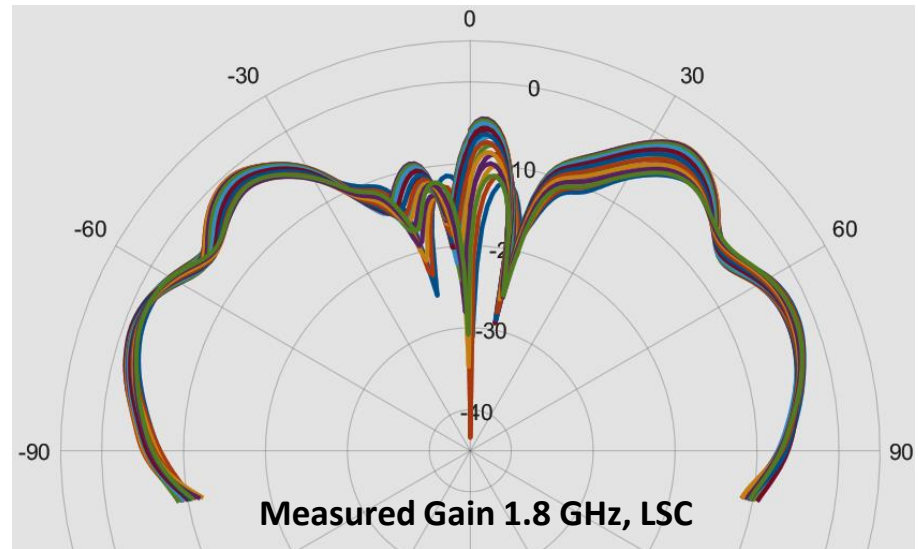
# Conformal L, S, & C Band Telemetry Antennas - Measured Patterns on 3-foot Groundplane

- The patterns of the LSC and GPS antennas were measured on a 3-foot groundplane with a mounting bracket



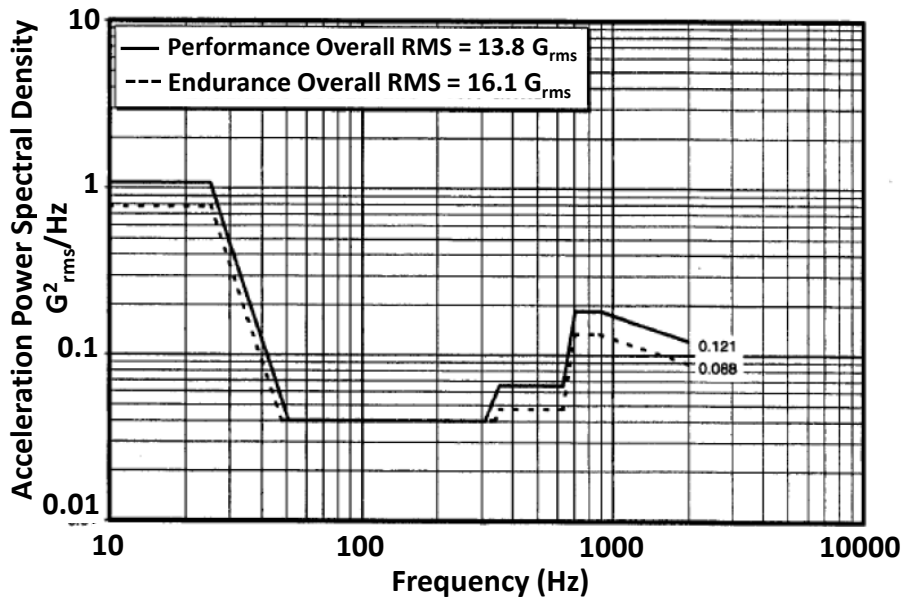
# Conformal L, S, & C Band Telemetry Antennas - Measured Patterns on 3-foot Groundplane

- The patterns of the LSC and GPS antennas were measured on the 3-foot groundplane with the mounting bracket
- Upper L-band was not a requirement for this effort since it was thought it would be re-allocated for other use
- The return loss at the upper L band is only around -4.5dB, so the gain reduction is to be expected
- Toyon could explore improving the gain at the upper L band on a future effort



# Conformal L, S, & C Band Telemetry Antennas - Environmental Testing

- The LSC and GPS antennas were tested against random vibration and shock conditions consistent with non-gunfire F/A-18 flight
- The antenna units passed all of the testing
- Additional humidity, temperature, and altitude testing is underway at China Lake



# Conformal L, S, & C Band Telemetry Antennas - Summary

- Toyon has prototyped 10 conformal, L/S/C telemetry antennas.
- The antennas work from 1.435 GHz to 7.0+ GHz
- Lark Engineering is fabricating the notch filter that goes with the antenna
- The notch filter will provide 50 dB of rejection between the LSC telemetry antenna and the L1/L2 GPS antenna
- The antennas naturally have 22 dB of isolation, so there will be a total of 72 dB of isolation between the antennas
- The antennas underwent random vibration and shock testing, China Lake is doing the humidity, altitude, and thermal testing
- Both antennas fit within a 5.75" x 7.5" x 3.2" volume.
- On their own, the LSC telemetry antenna alone can fit within a 5.1" x 5.1" x 3.2" volume, the GPS antenna can fit within a 2.7" x 2.7" x 1.5" and both antennas are flush mount
- Toyon would like to prototype additional units for other aircraft, any unique requirements you have are welcome!

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<b>14. ABSTRACT</b> NAWCWD China Lake and Pt. Mugu are seeking an L/S/C telemetry system for the F/A-18 Super Hornet. Toyon Research Corporation is under contract to design, fabricate, and deliver flush-mount antennas in support of the Navy's L/S/C telemetry effort. The telemetry antenna is approximately 5 inches in diameter and recesses into the aircraft about 4 inches. It covers the L band (1435-1535MHz), the S band (2200-2400MHz), and the C bands (4400-4900MHz, 5100-5150MHz, 6100-6700MHz). The patterns of the antenna resemble those of a blade or monopole antenna. The telemetry antenna is located on a panel on the nose section of the aircraft' fuselage and a flush-mount L1/L2/L5 GNSS antenna is co-located on the same panel. The pair of antennas require a notch filter at the L1 GPS frequency to avoid self-jamming from the L band telemetry signals to the GPS receiver. The notch filter and telemetry electronics are being fabricated by other aerospace contractors. Toyon has fabricated the antennas and characterized them in an anechoic chamber. The antennas have also been tested against environmental conditions required for flight approval on the F/A-18 Super Hornet. The telemetry antenna can easily be redesigned for other platforms.				
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