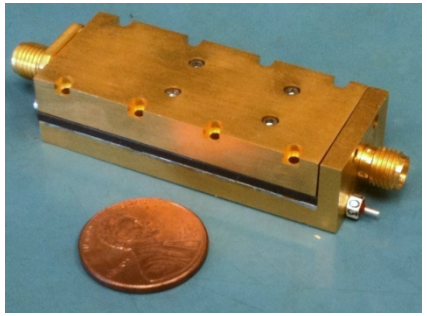
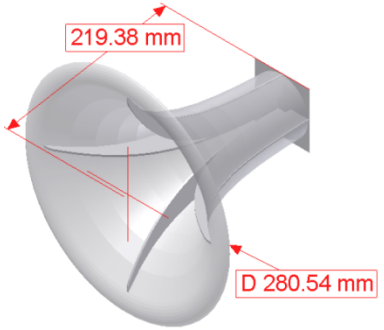
Progress Report: SKA LNA's and Feeds

Ahmed Akgiray and Sander Weinreb
Albuquerque, Oct 12, 2010

1. Accomplishments
2. Room temperature 0.3 to 1.4 GHz
3. New quad-ridged flared horn (QRFH) feeds
4. QRFH performance in DVA-1



TDP Accomplishments



1. **First SiGe LNA's for Radio Astronomy** - 3K noise to 5 GHz with very reproducible low-cost silicon process. Foundry run started in 2010 for higher frequencies

2. **Room temperature LNA's for 0.3 to 1.4 GHz**. – Enormous impact on SKA cost and power consumption!

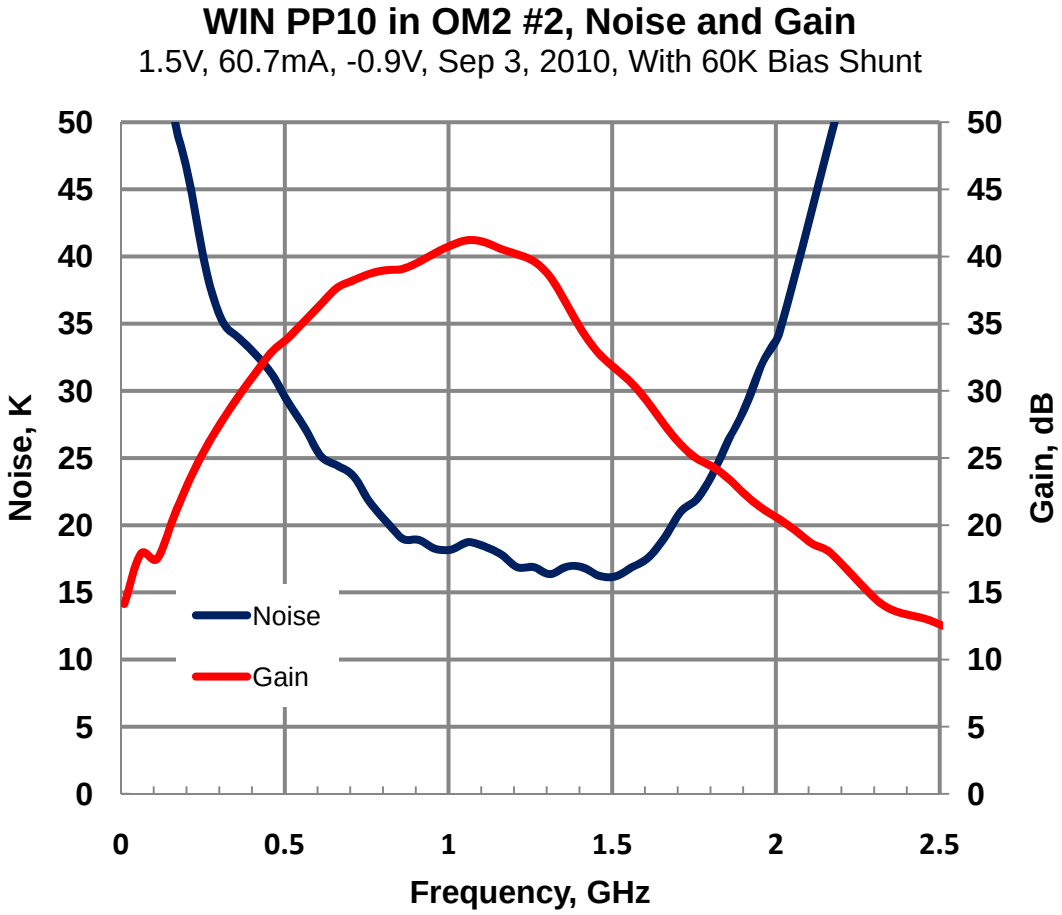
3. **InP HEMT LNA manufacturability** – Hundreds of cryogenic 1 to 12 GHz LNA's built and infused into radio astronomy- yield problem investigated.

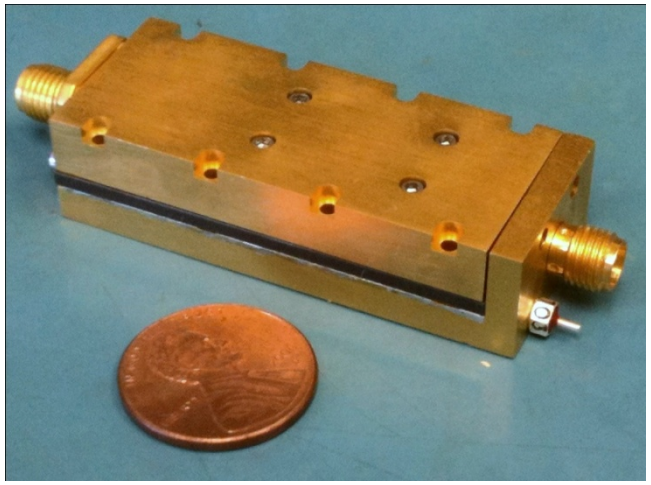
4. **Wideband quadridge horn feeds** highly developed

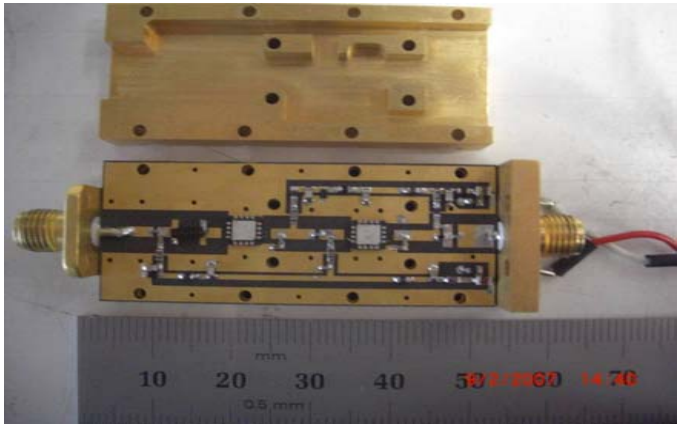
5. **Future instrumentation leaders** - Two Ph.D's completed (Jones and Bardin) and two more on the way (Akgiray and Russell).

Room Temperature Very Low Noise Amplifier for 0.3 to 1.7 GHz

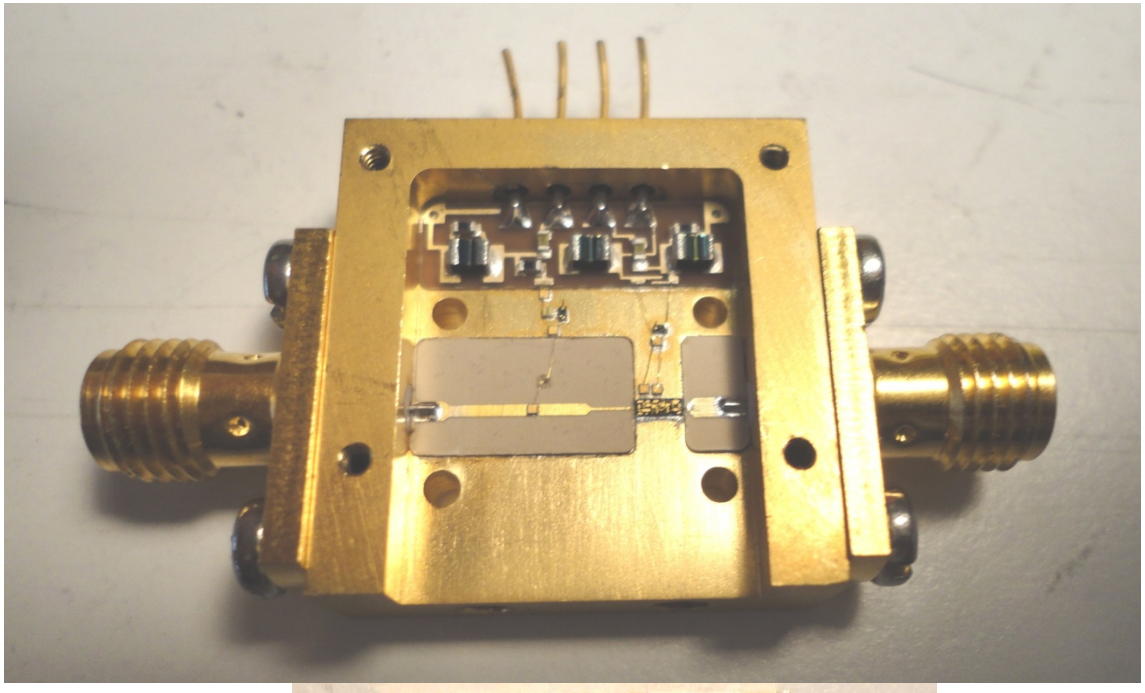
- Measured noise < 20K from 0.8 to 1.6 GHz
- SKA construction and operations costs would be reduced due to the elimination of cryogenics for this frequency range,

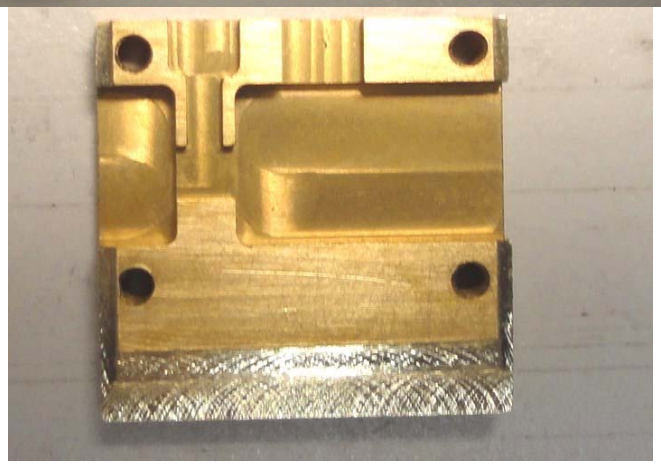






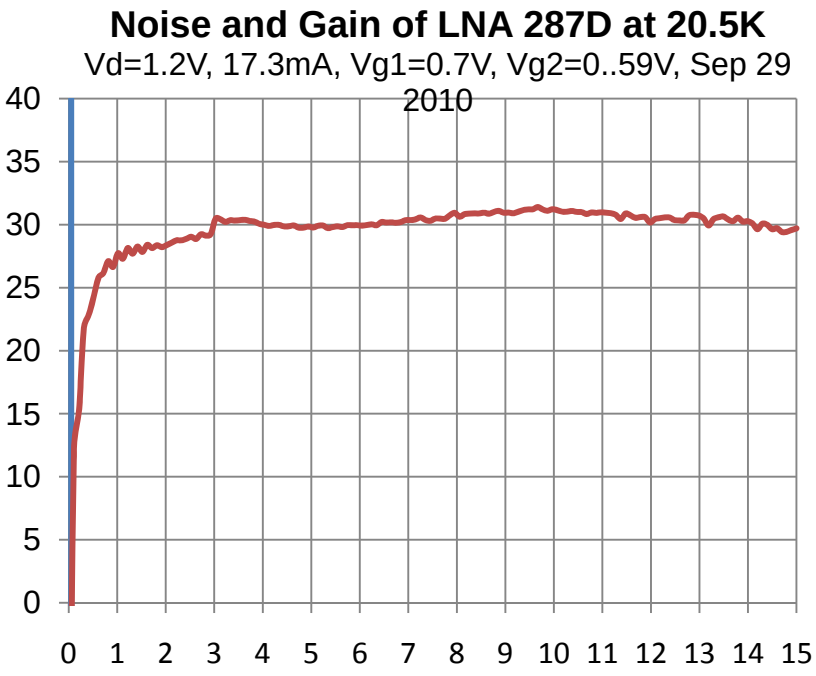
1 to 12 GHz LNA Module



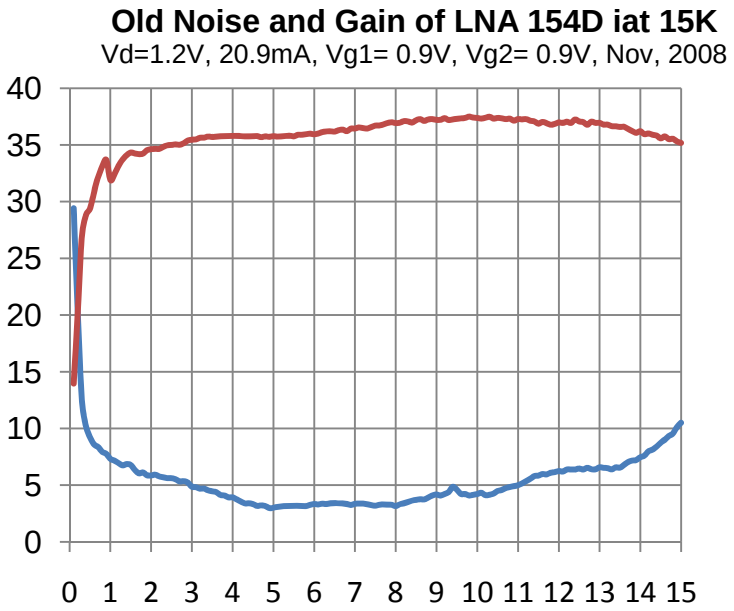


Caltech Cryo1-12 Module Performance

Typical Oct 2010 Module



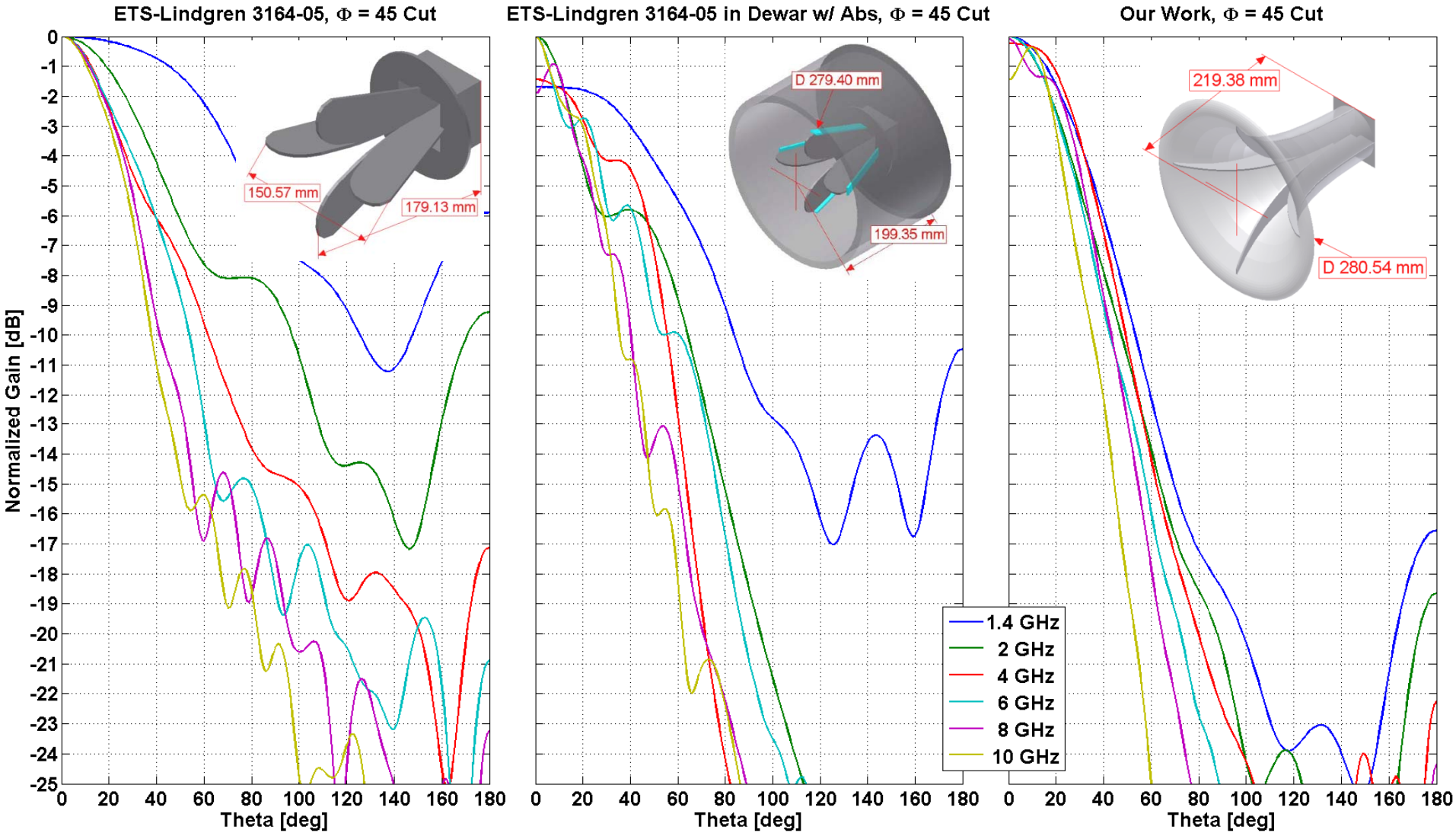
Best Nov 2008 Module



Quick Intro to Recent Caltech Feed Work

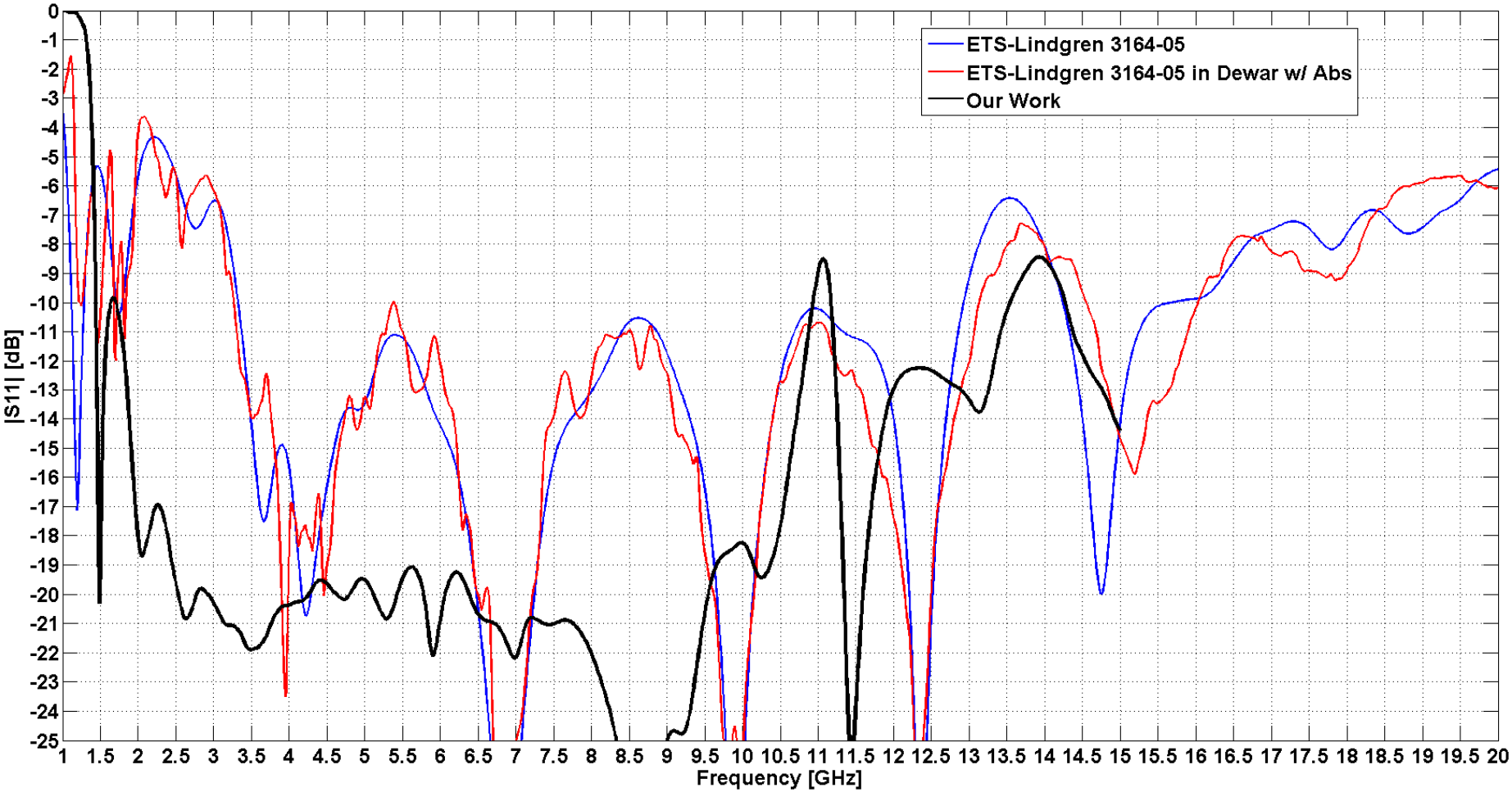
- Achieved 6:1 impedance and pattern bandwidth from quad ridge loaded flared horn (pushing to get > 7:1)
- Horn can easily be redesigned for half angles anywhere between 30 to 60 degrees
- Wideband feed work at Caltech evolved from a stock ETS-Lindgren quad-ridge design to current design over the course of a few months
- 6000+ (and counting!) simulation runs completed on almost as many different configurations

Evolution of Quadridge Feed Designs: Farfield Pattern Comparison



Return Loss Comparison

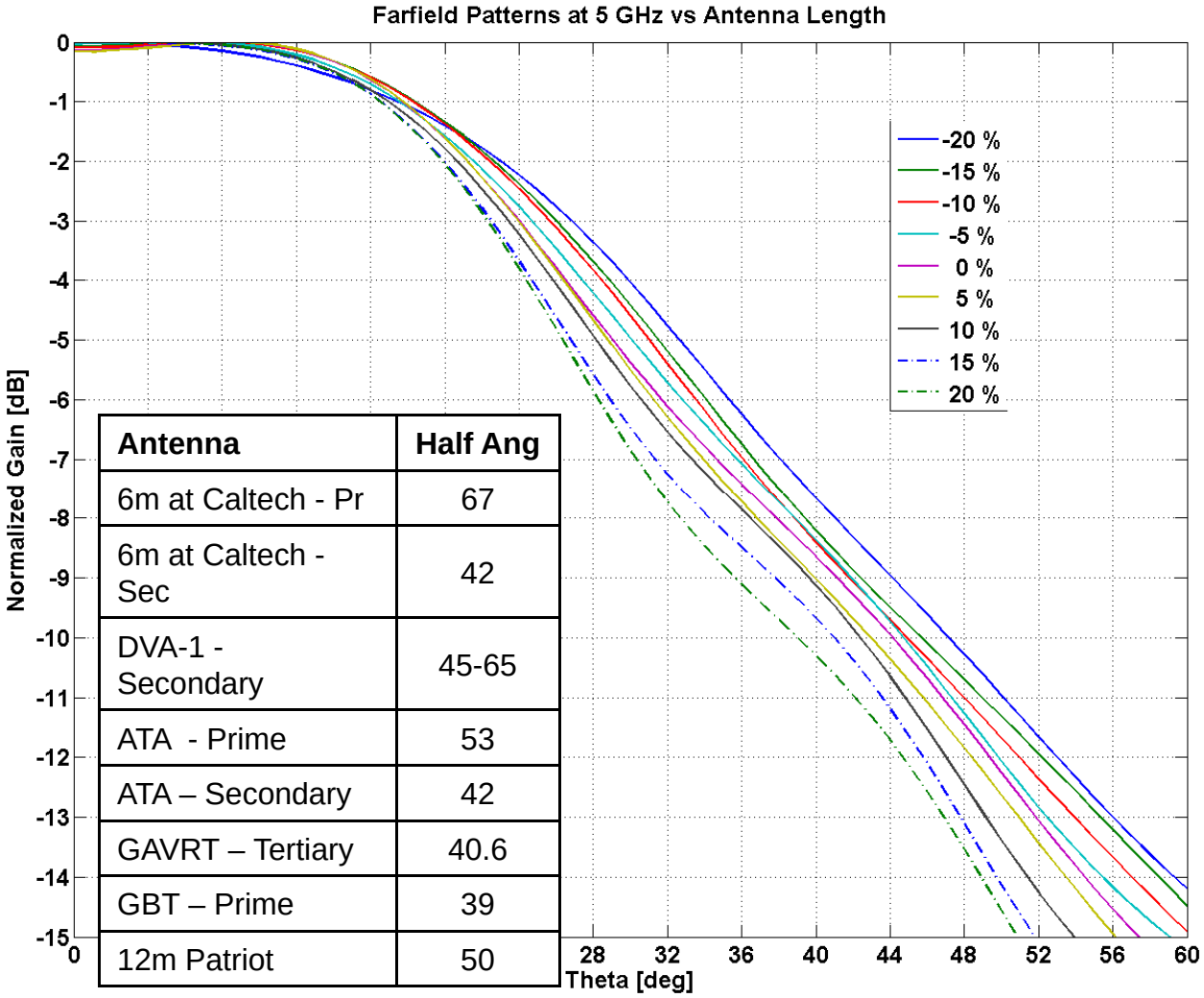
Much improved return loss in the band of interest (1.4 to 10 GHz) in addition to much improved patterns



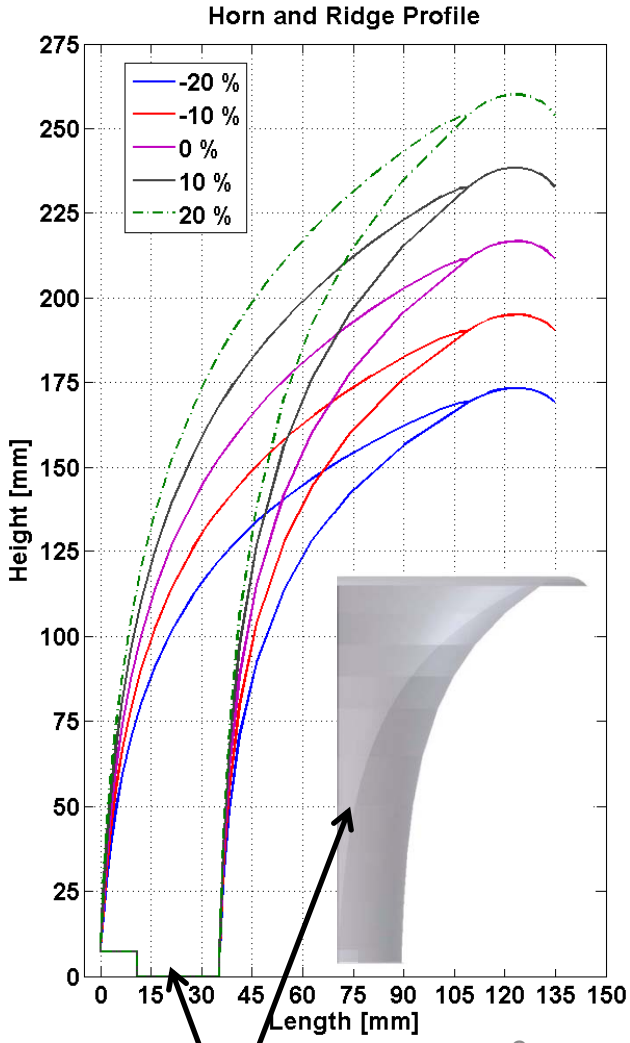
Note: Lindgren RL is with respect to the spec of 50 Ohm
That of QRFH is with respect to 100 Ohm

Manipulating Beamwidth

By only varying one parameter, significant beamwidth manipulation is possible.
More parameters -> even more beamwidth control



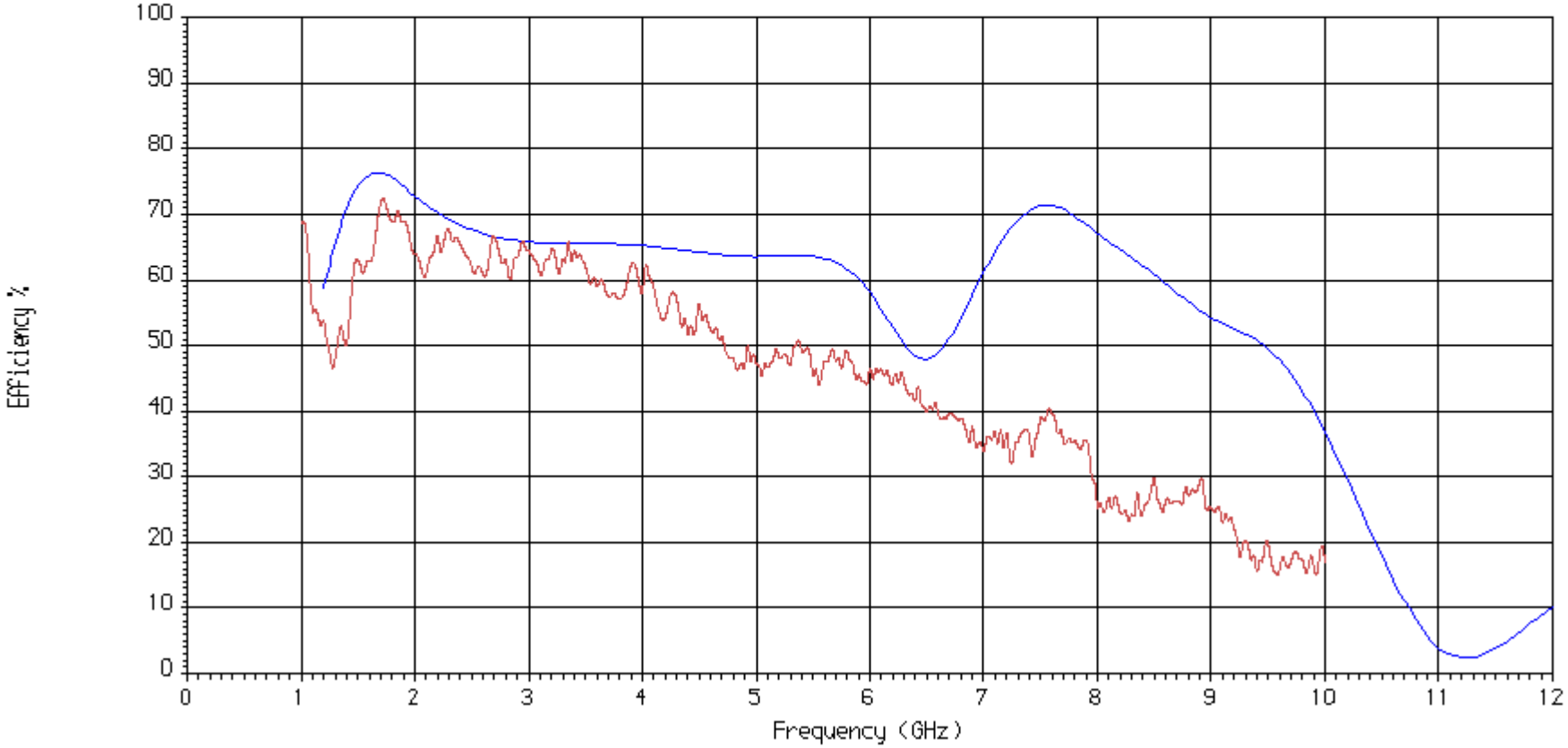
Antenna	Half Ang
6m at Caltech - Pr	67
6m at Caltech - Sec	42
DVA-1 - Secondary	45-65
ATA - Prime	53
ATA – Secondary	42
GAVRT – Tertiary	40.6
GBT – Prime	39
12m Patriot	50



Side view of horn and ridge

Aperture Efficiency in DVA-1

- Blue curve is new flared horn; red curve is for Lindgren feed.
- Computed ‘by W.Imbriale using physical optics for DVA-1 subreflector and reflector.
- We believe with further optimization the efficiency dip at 6.5 GHz can be removed to give > 60% efficiency over a 7: 1 frequency range, 1.4 to 10 GHz.



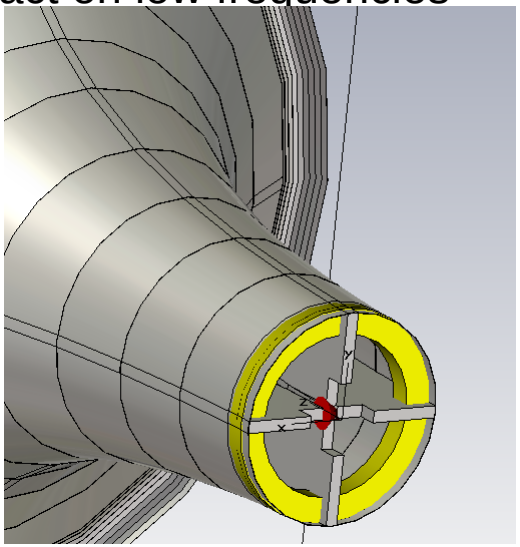
New development: Mode suppressor

We recently discovered the cause of efficiency dip mid-band.

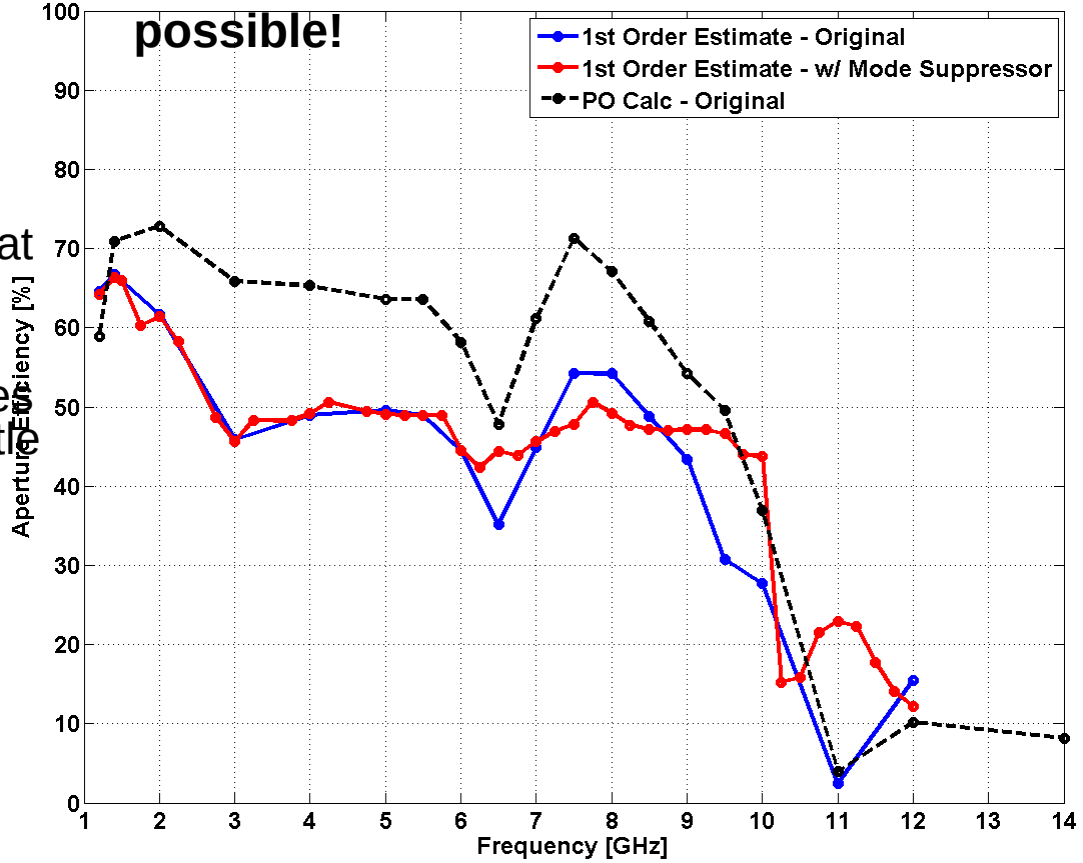
Sudden beamwidth narrowing was causing a drop in aperture efficiency.

Culprit was higher order modes excited at the feed point of horn.

Solution: ring around feed input increases cutoff freq of higher order modes with little impact on low frequencies

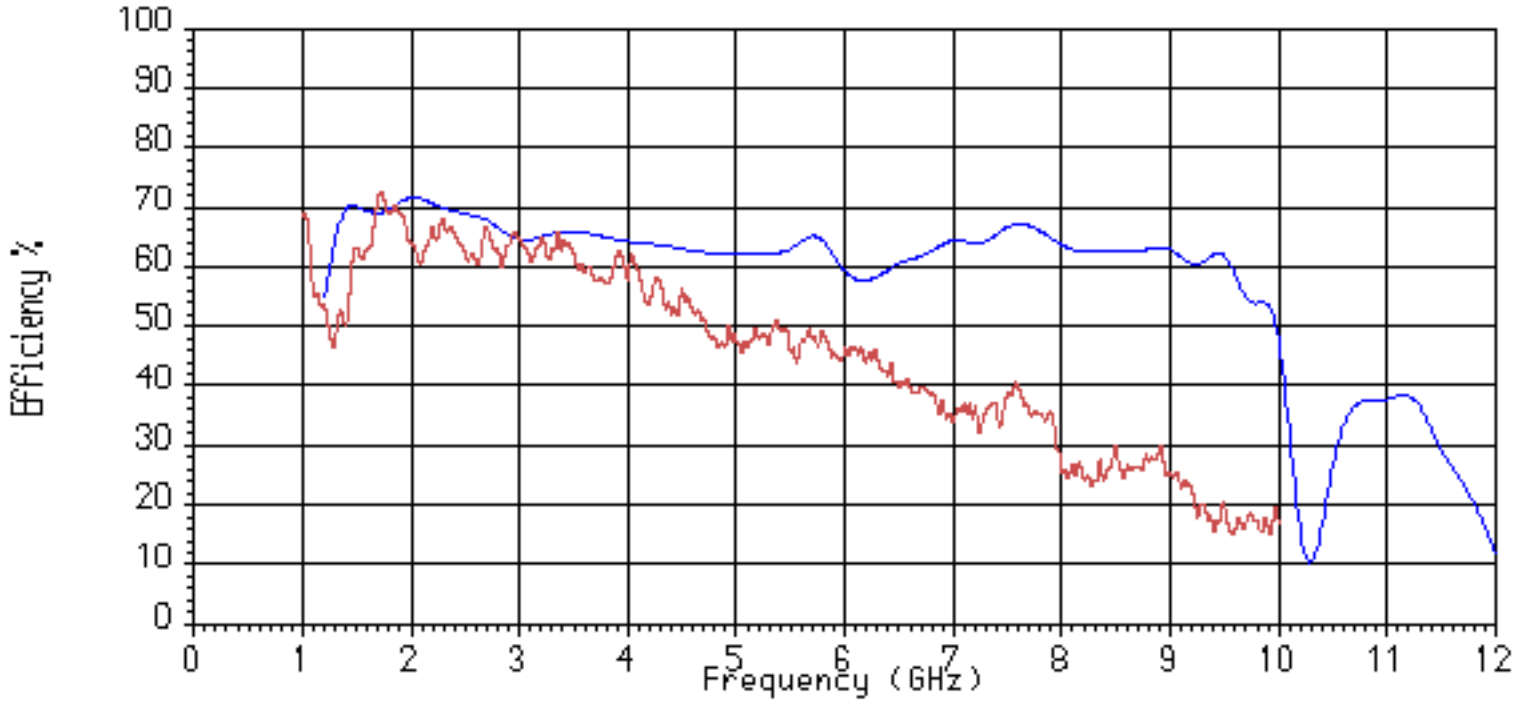


Better than 55% aperture efficiency and very little spillover quite possible!



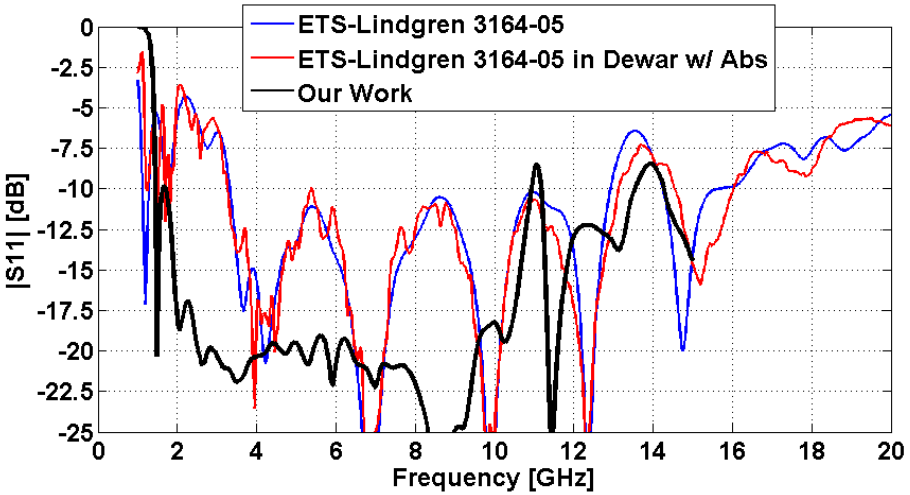
Solid curves are 1st order estimates of efficiency (not calculated by PO). We expect PO efficiency in shaped optics to be 5-10% higher throughout the band as suggested by difference in blue solid and black dashed

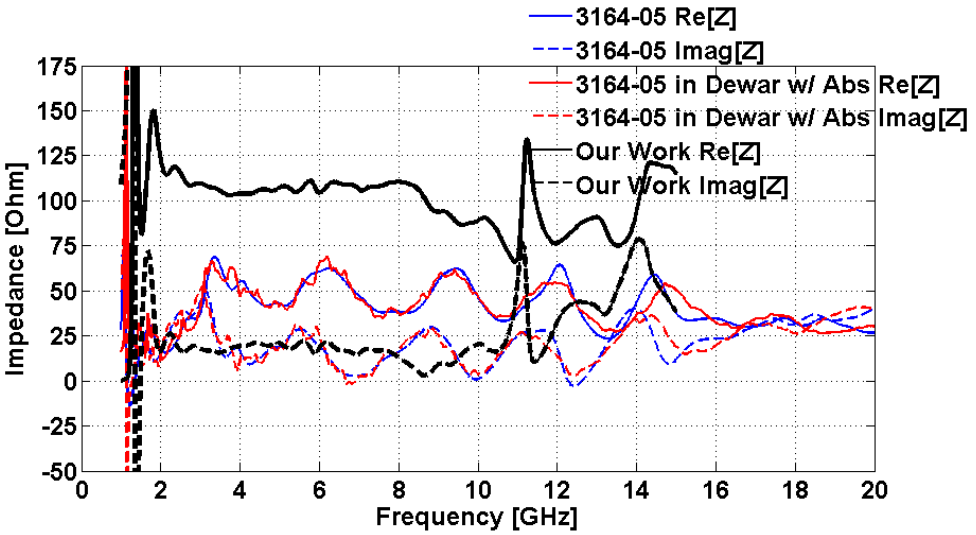
Updated efficiency in DVA_1

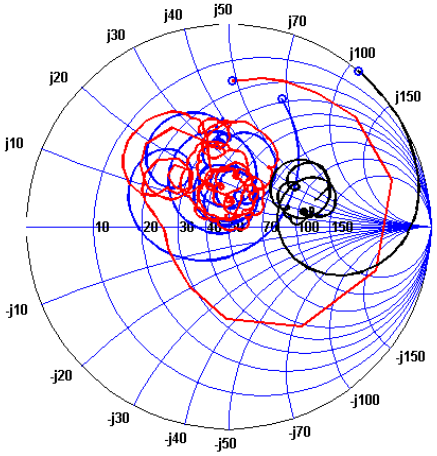


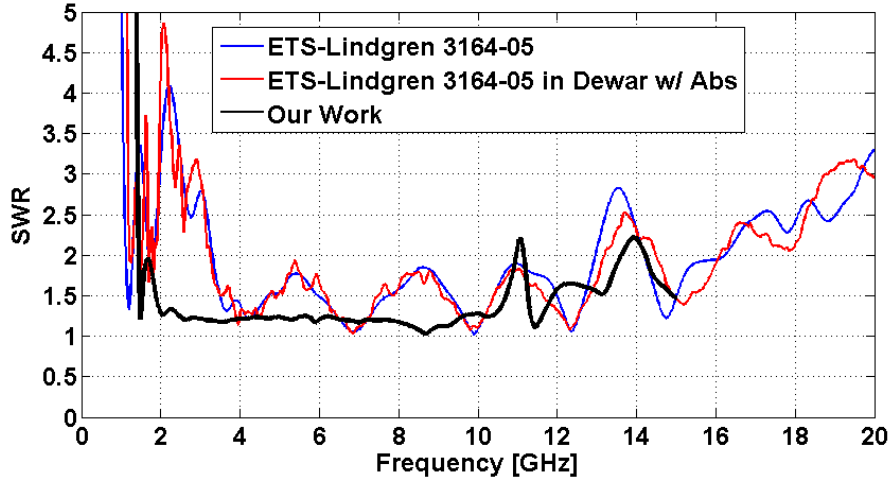
Backup

Return Loss Comparison









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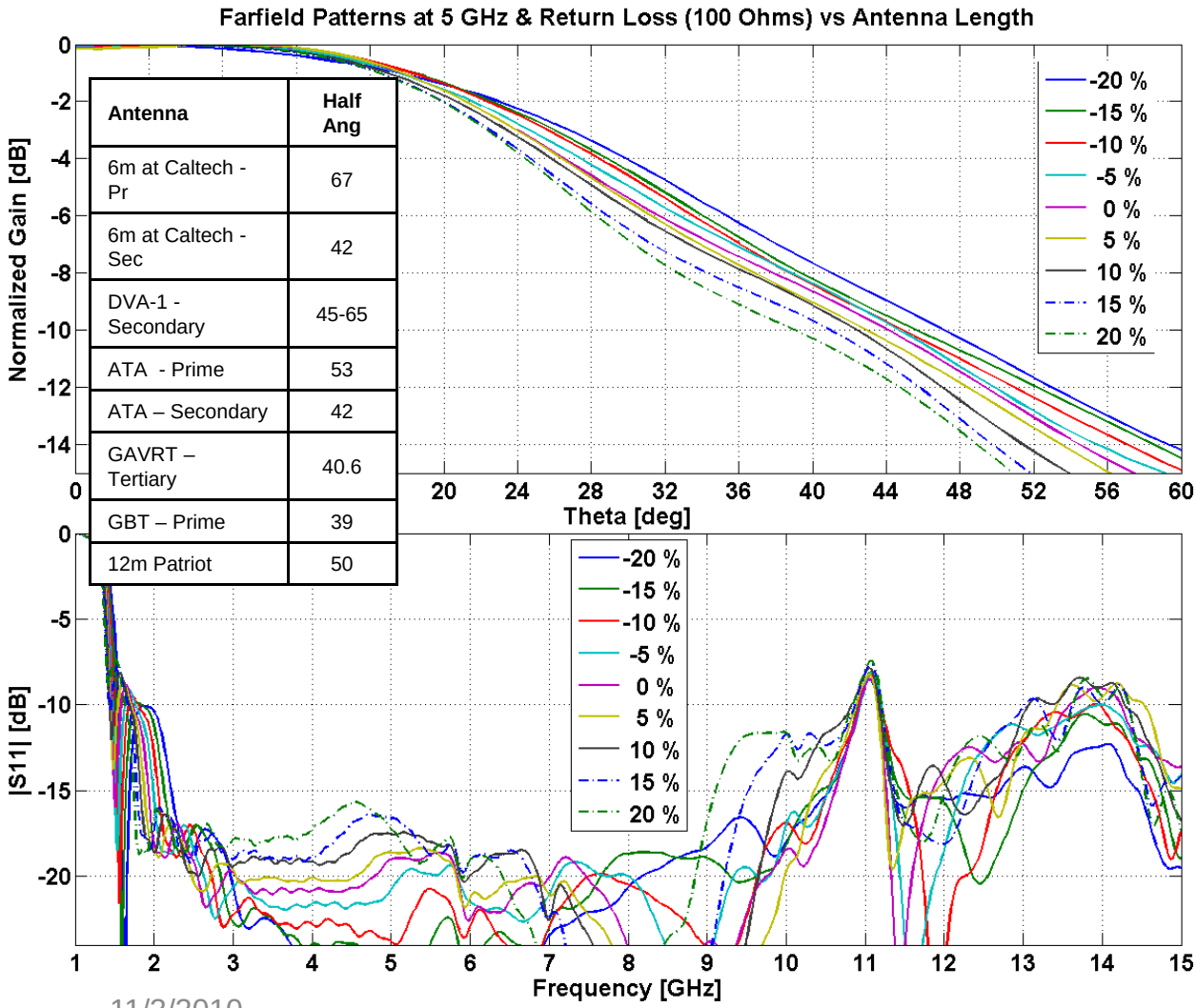

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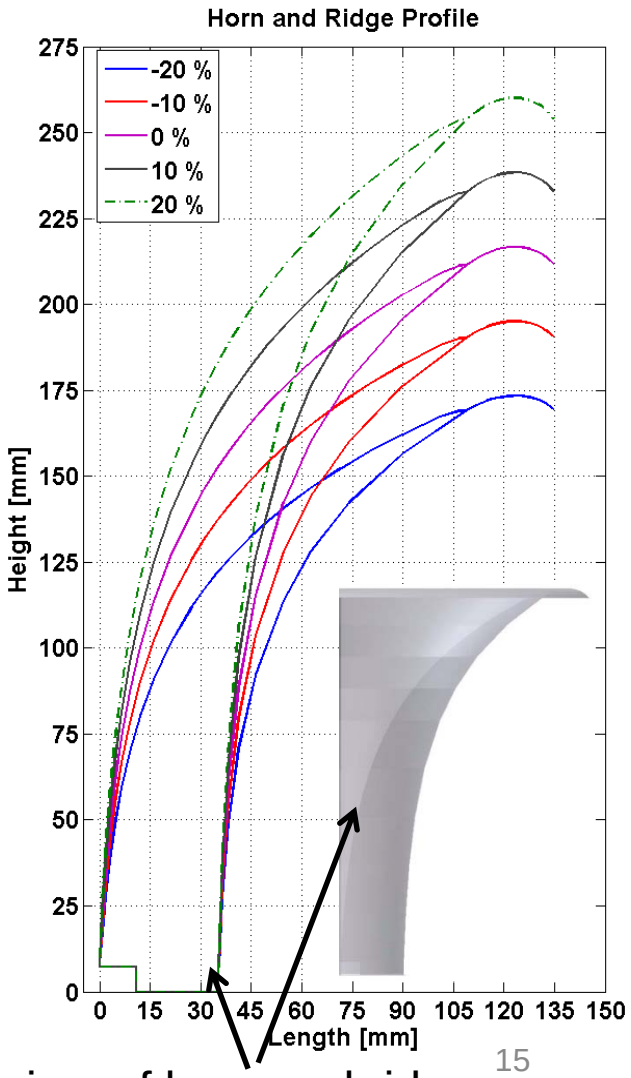

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