MIT Haystack VGOS Signal Chain Feed & Receiver characteristics

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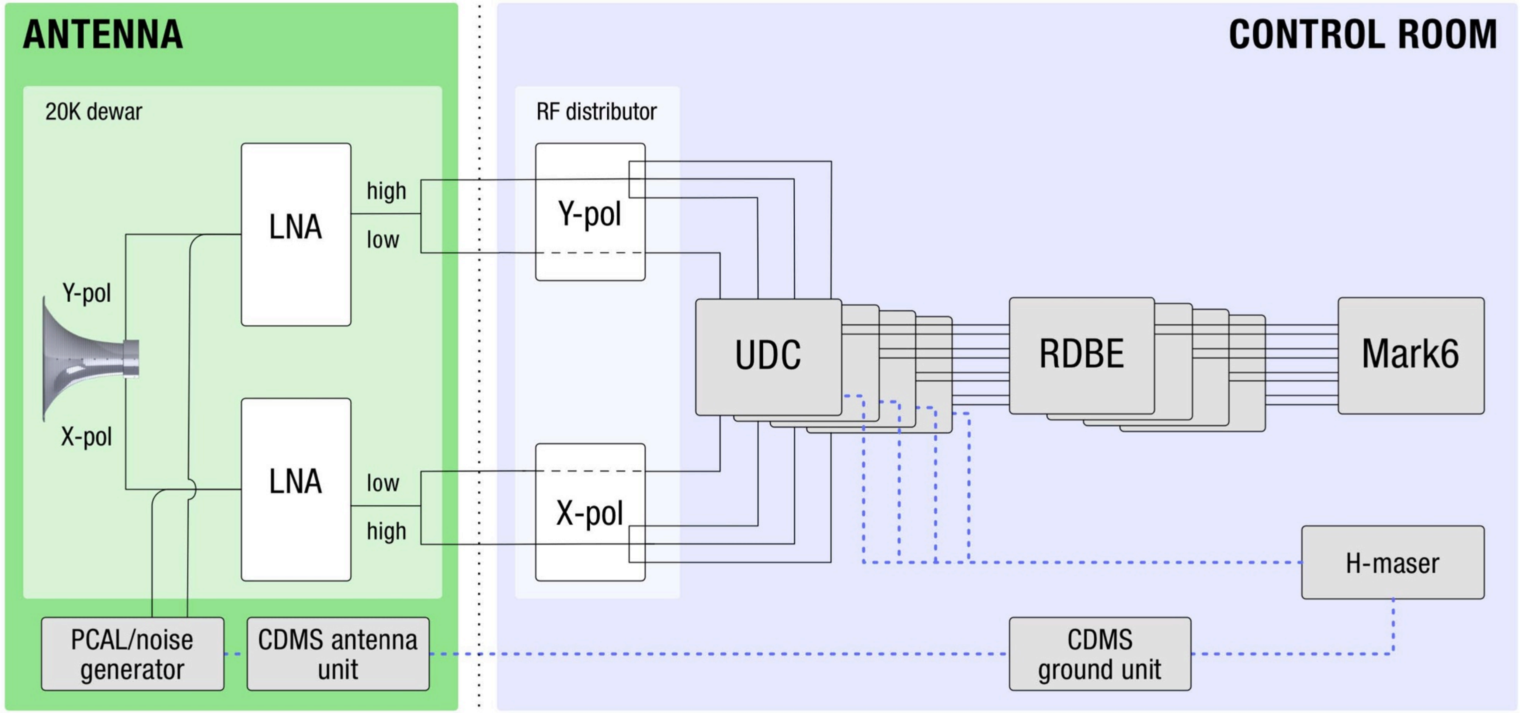
A typical VGOS 2.2-14 GHz broadband cryogenic front-end and back-end signal chain diagram



- VGOS observations use four 0.5 GHz or 1 GHz bands in the 2.2-14 GHz range
- Frequency Agile Up-Down Converter (UDC) enables tuning to different frequencies within the 2.2 to 14 GHz frequency range

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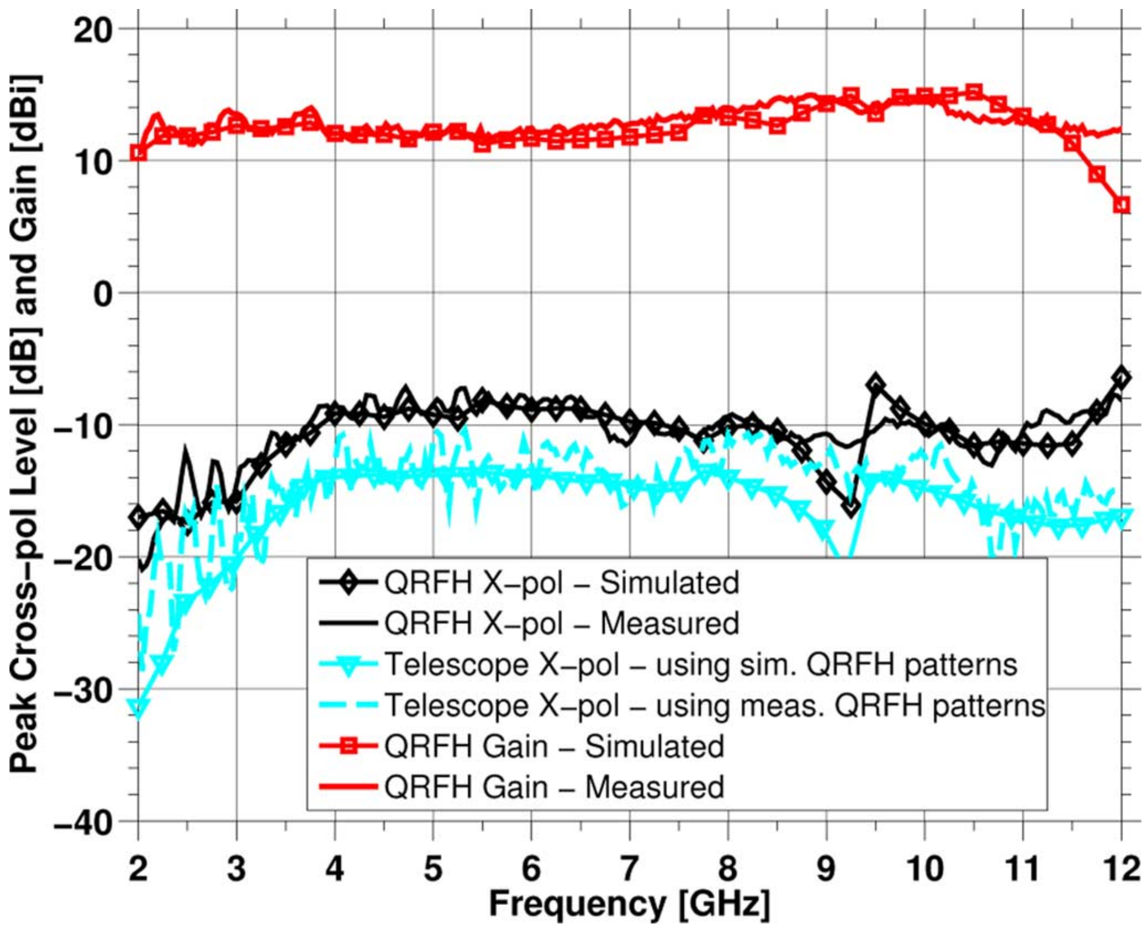
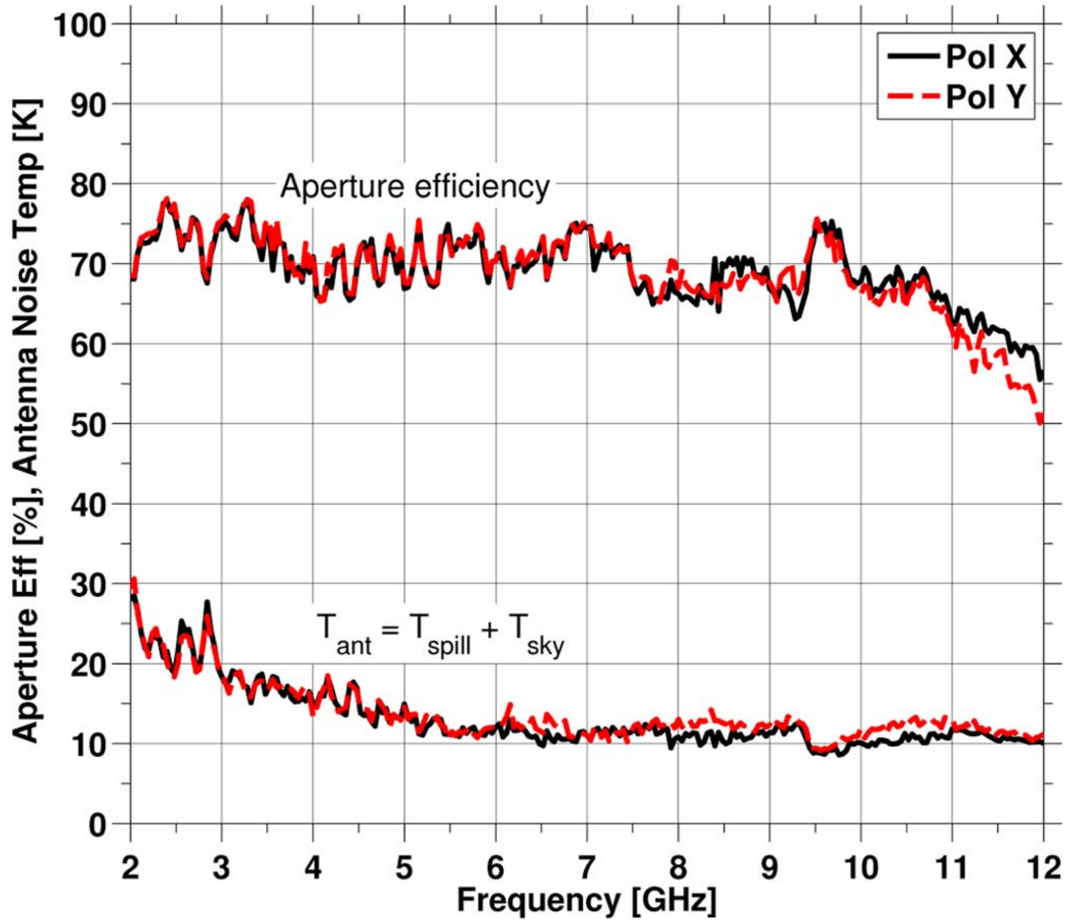
2-12 GHz GGAO QRFH Feed Gain, Efficiency and Antenna temperature from simulation and measurements





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Akgiray, A. *et al.* (2013) 'Circular quadruple-ridged flared horn achieving near-constant beamwidth over multioctave bandwidth: Design and measurements', *IEEE Transactions on Antennas and Propagation*, 61(3), pp. 1099–1108. doi: 10.1109/TAP.2012.2229953.

Left: The measured and simulated gain of the QRFH (top two curves) and peak cross-polarization level of the QRFH (in the plane) and the GGAO telescope when illuminated by the QRFH.

The predicted antenna noise temperature is ~ 20 -30 K up to 3 GHz. Estimating the receiver noise temperature to be about 20K, you can see why I am hesitant to accept your 30K requirement for Tsys over 2.3-14 GHz.

Right: Predicted aperture efficiency and antenna noise temperature of the circular QRFH designed for the GGAO 12 m telescope. Both are calculated using physical optics at an elevation angle of 48 . Losses due to strut and Subreflector blockage and r.m.s. surface error are not included in the PO calculations. The sky noise temperature is calculated per the method outlined in [32], and is 5.5 K at 4 GHz and 6.5 K at 10 GHz.

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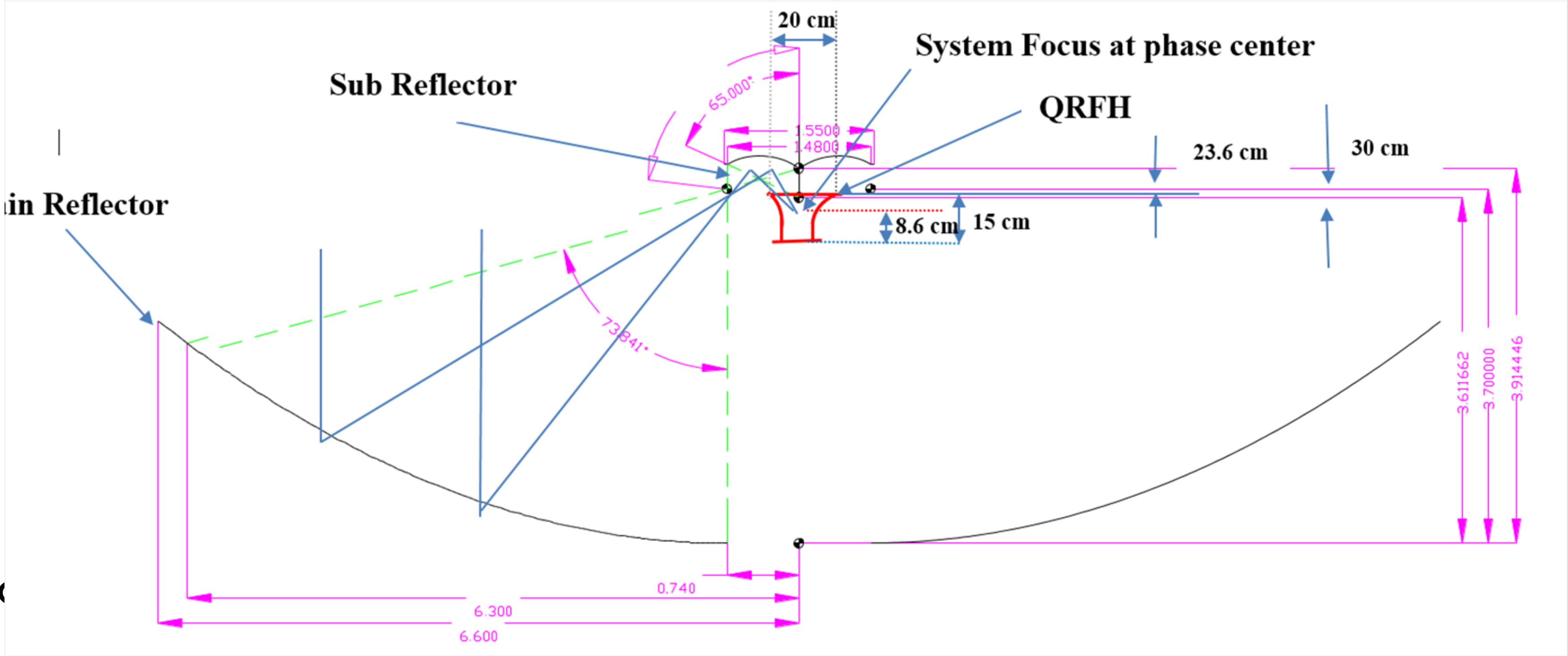
QRFH Feed in Ring Focus Reflector

. A. Soliman and S. Weinreb, Feb 24, 2016

- Feed phase center at 14 GHz is 6.4 cm back from front surface of feed
- To place feed center at maximum efficiency the front surface of the feed should be 23.6 cm from the subreflector surface
- ***The efficiency is not a strong function of distance between feed phase center and paraboloid focus because the subreflector is in the near field of the feed*.**



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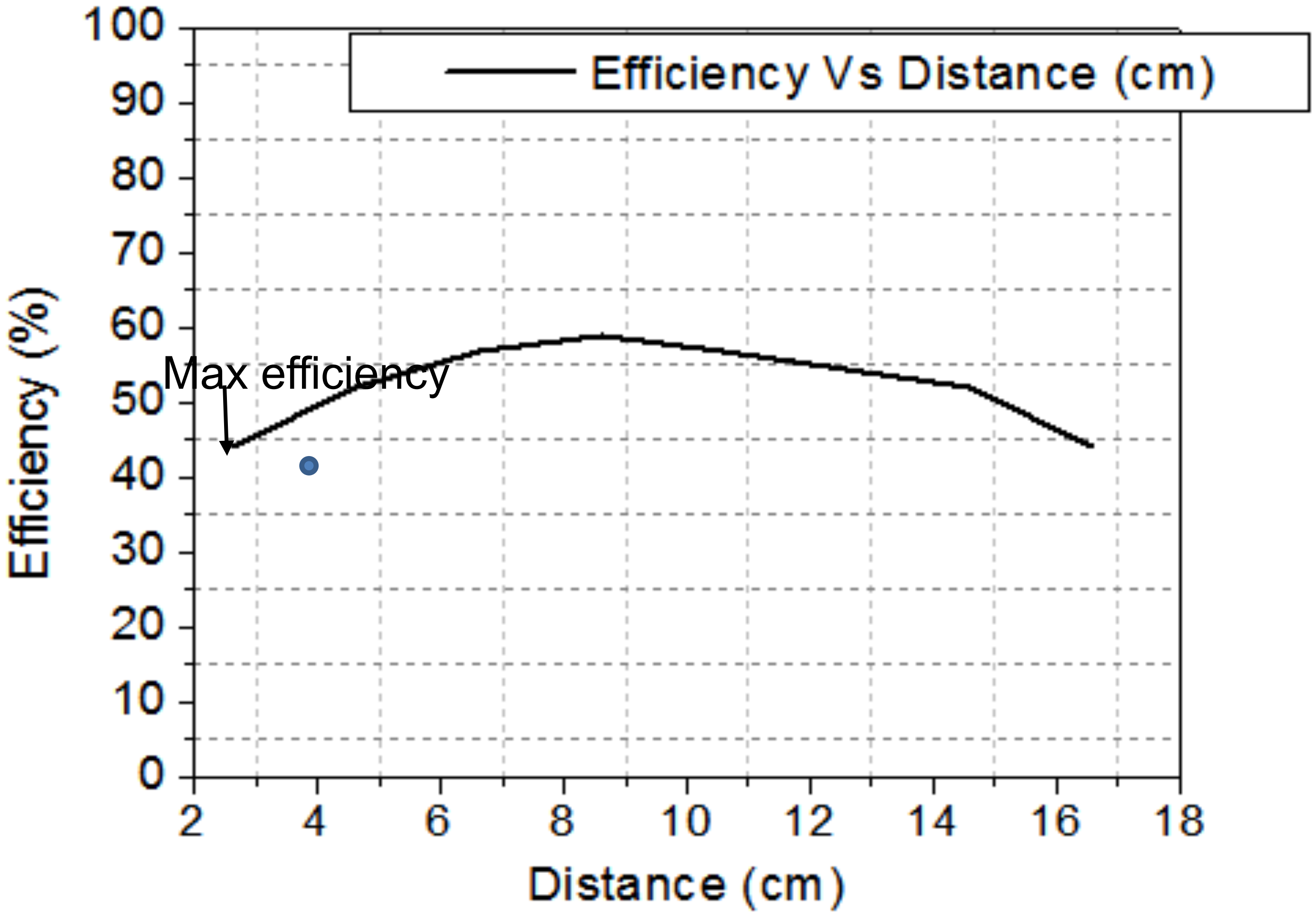
Total efficiency versus focal position at 14 GHz.

- **Distance shown below is between back of QRFH feed and focus of parent paraboloid in MTM ring focus optics**
- **Efficiency computed by physical optics in Grasp software**



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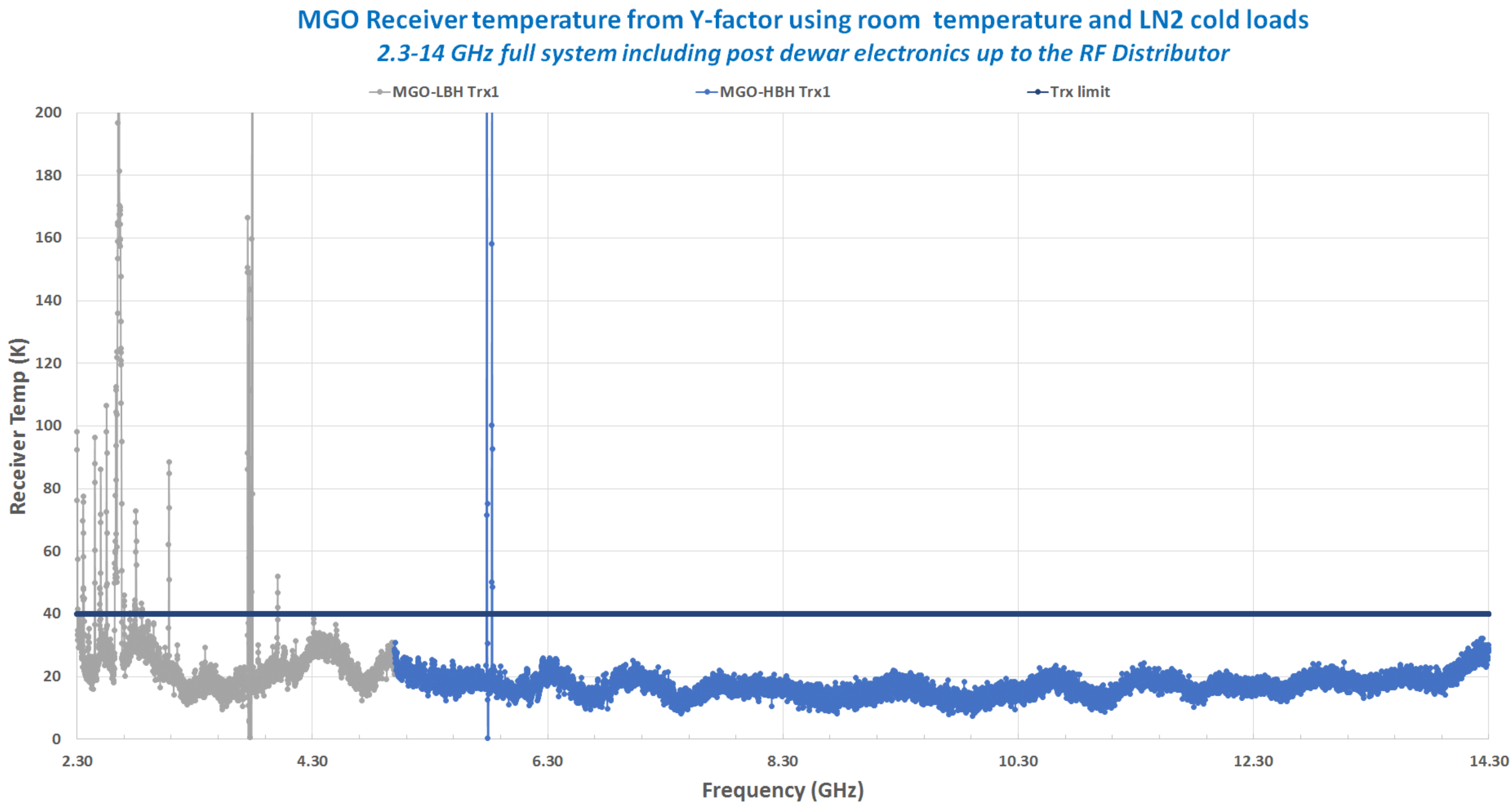
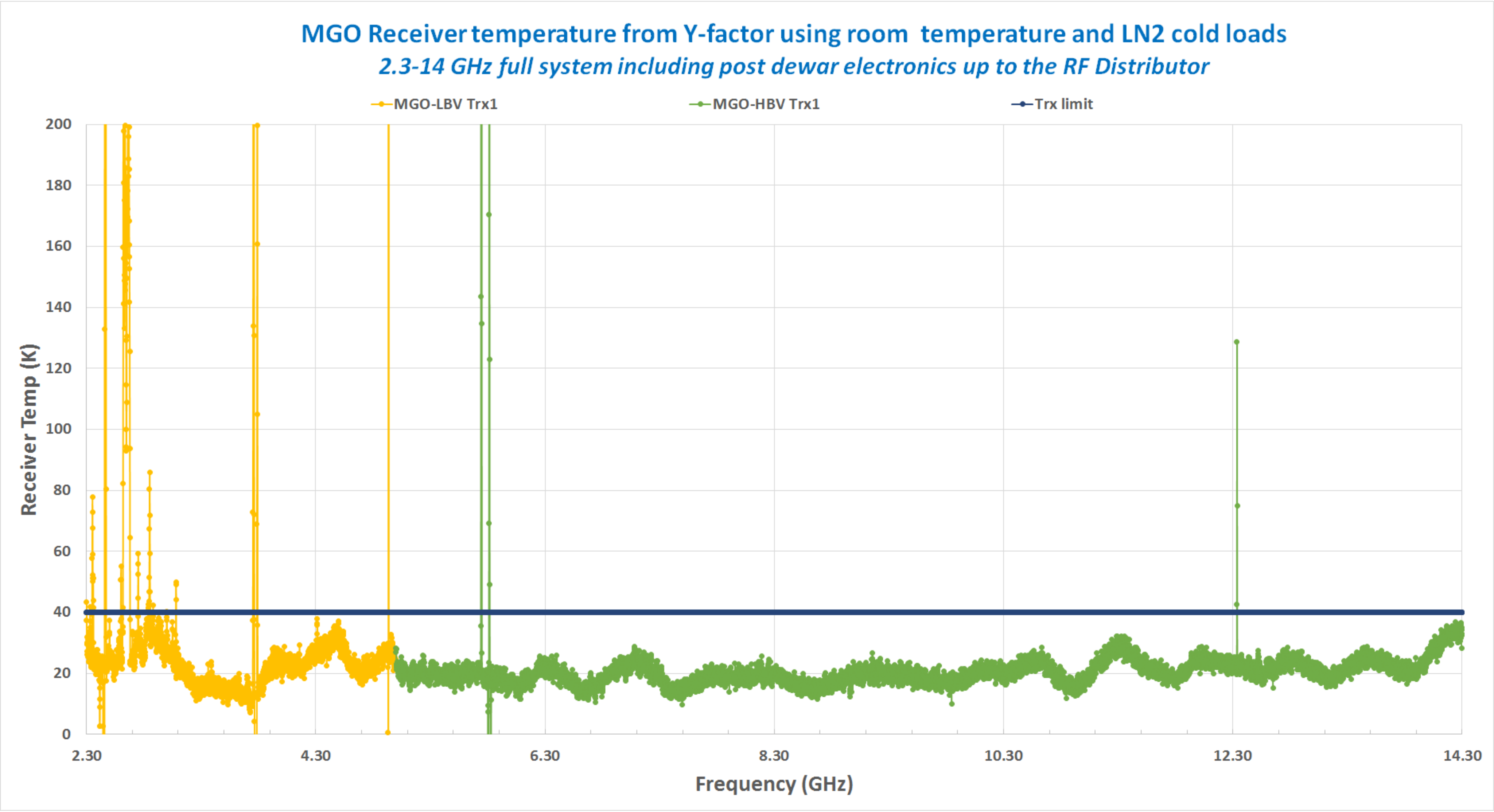

MGO Receiver temperature from Y-factor using room temperature and LN2 cold loads
2.3-14 GHz full system including post dewar electronics up to the RF Distributor
MGO-LBH Trx1
MGO-HBH Trx1
Trx limit
Receiver Temp (K)
200
180
160
140
120
100
80
60
40
20
0
2.30
4.30
6.30
8.30
10.30
12.30
14.30
Frequency (GHz)



MGO Receiver temperature from Y-factor using room temperature and LN2 cold loads
2.3-14 GHz full system including post dewar electronics up to the RF Distributor
MGO-LBV Trx1
MGO-HBV Trx1
Trx limit
Receiver Temp (K)
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6.30
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10.30
12.30
14.30
Frequency (GHz)