DEVELOPMENT OF AN OPTIMIZED ANTENNA FOR AN OZONE SPECTROMETER

By Sai N. Tenneti
Mentor: Alan E. E. Rogers
Noise Figure

The noise figure is the ratio of actual output noise to that which would remain if the device itself did not introduce noise. It is a number by which the performance of a radio receiver can be specified.

\[ NF_{dB} = 10 \log \left( \frac{SNR_{in}}{SNR_{out}} \right) = SNR_{in,dB} - SNR_{out,dB} \]
LNBs/Feeds Tested

Fortec Star FSKUVN (Claim of 0.2 dB)

Invacom Antenna SNF-031 (Claim of 0.3 dB)

Invacom Flange (Claim of 0.3 dB w/ feed)

Smart Antenna (Claim of 0.1 dB)

Circular Ringed Feed Horn
Types of Absorbers Used
Ozone Spectrometer Dish and Antenna
Measuring LNB Beam Width

Two methods were used to measure the beam pattern.

- Correlation method using two LNBFs
- Method using signal generator and spectrum analyzer
Received Power vs. Angle for LNBFs

\[ B(\theta) = e^{-0.693(\theta / 21.5)^2} + 0.002 \]
Main Equations

Y-factor  = \((T_{\text{amb}} + T_{\text{LNA}})/(T_{\text{sky}} + T_{\text{LNA}})\)

- \(NF = 10\times\log_{10}(T_{\text{LNA}}/290 + 1.0)\)
Liquid Nitrogen Calibration
Preliminary Y-factor Measurements in dB

Ratio of Absorber on/absorber off power in dB, for each particular voltage, LNB, absorber, and frequency

13 V voltage

<table>
<thead>
<tr>
<th>Absorber 1</th>
<th>Absorber 2</th>
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</thead>
<tbody>
<tr>
<td>800 MHz</td>
<td>1300 MHz</td>
</tr>
<tr>
<td>Fortec #1*</td>
<td>6.3</td>
</tr>
<tr>
<td>Fortec #2*</td>
<td>5.9</td>
</tr>
<tr>
<td>Invacom</td>
<td>4.4</td>
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</tbody>
</table>

*Two different LNBs of the same type were tested in case of defective equipment

17.46 V voltage**

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**The voltage changes the polarization of the LNBF

The Highest Y-factor in these particular tests appears to be the Fortec Star LNB with a Y-factor of 6.6 dB, which converts to a noise figure of 0.42 dB.

LNBs with actual noise figures between 0.2-0.3 dB are preferred.
Fluorescent Lamp Calibration

Curve for Ratio of on power over off power, vs. time

Power vs. Time curve when lamp is off
Y-lamp and Sensitivity Graphs

Equal when the lamp temperature is assumed to be about \(7.33 \, \text{K}\)
AND THE WINNER IS...

Smart 0.1 dB, itself with a Y-factor of 7.3 dB, and when a metallic funnel mouth was placed around the feed, the LNB produced Y-factors of up to 7.5 dB, which converts to a noise figure of about 0.23 dB!
Results and Future Work

- Smart 0.1 dB outperformed all the other antennas in terms of noise figure.
- We were able to obtain reduced noise figures down to 0.23 dB.
- Using mouth of a metallic funnel does help to reduce noise, but only by a minor amount.
- In the future, more practical solutions must be investigated to reduce spillover from the ground.
Major thanks to Alan Rogers, for outstanding mentoring and tireless support throughout the entire summer.

Rich Crowley, for all the software and technical help

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Haystack staff and other REU students
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