VSRT MEMO #074

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To: VSRT Group

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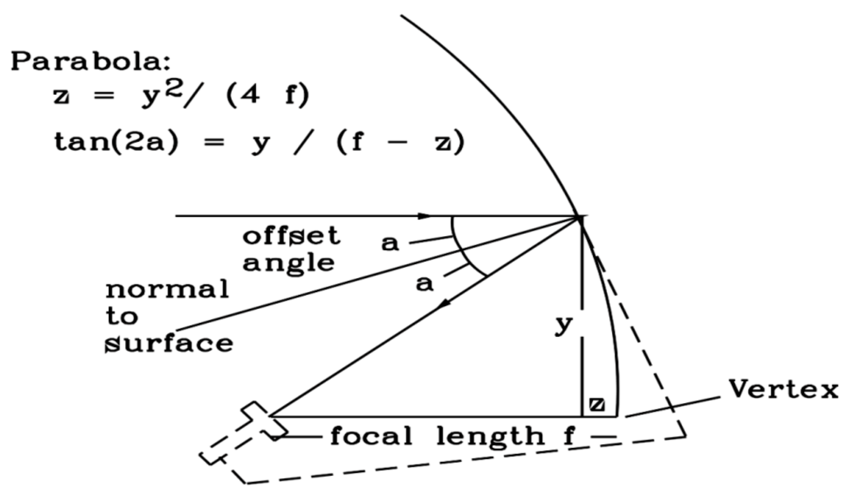
Subject: Ozone Spectrometer Construction and Hardware

The fundamental improvement needed in the system is a decrease in the signal to noise (SNR) ratio. In order to accomplish the goal, we, first, used a frequency switching pattern to factor out some of the noise. This entailed measuring the ozone line at two different frequencies and subtracting out the noise of the other one as a reference level. This enables us to more accurately separate the ozone signal from the noise. It improves the SNR by a factor of $\sqrt{2}$

Secondly, we added two additional LNBFs. Similarly to the first system the set of LNBFs will be placed a focal distance away facing the center of the dish.



Offset dish geometry

These additional channels will allow us to minimize the data collection time by a factor of $\sqrt{6}$ as well as increase resolution enough to detect wind speeds. These two LNBFs with be placed on either side of the first one with their centers about 2.25 inches apart.

The addition of the LNBFs introduces the challenge of minimizing the spillover in the outrigger ones, since most dishes are not optimized for multiple LNBFs. The spillover is the part of the feed antenna radiation which misses the reflector. It can be calculated by $1 - P_{dish}/P_{total}$. The power on the dish is found by approximating the power as a Gaussian function and integrating over the surface of the dish. The total power is found by integrating over a dish of comparatively infinite radius.

Initially we intended to use the DirecTV Slimline elliptical Dish since it appeared to be better for multiple LNBFs. However it had a focal length of about 19". Due to a large focal length only about 80% of the signal power that was picked up was from the dish. The other 20% came from other sources such ambient radiation and ground. This poses a significant problem because we only collect about 80% of the available ozone power and even if only 10% of the excess energy comes from the ground it can raise the entire system temperature by 30 K.

After discovering the inadequacy of the Slimline dish, we opted to use the 60cm Winegard DS-4060 dish, with a focal distance of 13.87". This provided a much more reasonable spillover ratio of about 5% for the central LNBF.

It is important to measure the actual noise performance of the ozone spectrometer to evaluate the efficiency of the antenna. One way of quantitatively measuring the noise performance of the spectrometer is by measuring the Y factor. The Y-factor is the ratio of the Ambient Temperature and the LNA temperature to The sky temperature and the LNA temperature.

$$Y = \left(T_{amb} + T_{LNA}\right) / \left(T_{sky} + T_{LNA}\right)$$

A high Y-factor implies a low TLNA which leads to a lower noise figure and a more efficient antenna.

The easiest way to find the Y factor is to measure the signal with an absorber in plane and divide it by the signal with the absorber removed. I ran the Y-factor three times for each LNBF at both orientations and obtained the following results.

LNBF	Middle	Middle	Left	Left	Right	Right
	Voltage		Voltage		Voltage	
	12	16	12	16	12	16
Without absorber	53.2	56.2	53.1	55.1	54.6	56.1
With absorber	58.1	60.9	57.6	59.9	59.2	60.8
Without absorber	53.3	55.8	52.9	54.9	54.6	56
With absorber	58.1	60.7	57.4	59.8	59.4	60.7
Without absorber	53.2	55.6	52.8	54.8	54.7	55.9
With absorber	58	60.7	57.4	59.8	59.4	60.6
Y Factor	4.8	4.9	4.5	4.9	4.7	4.7

For the LNBFs, We used Star Com's SR-3602 Mini digital KU-band Universal LNBFs with dual polarizations. Each LNBF has two channels which switch between the two polarizations based on the input voltage. For a voltage of 11.5-14V it is polarized vertically and for a voltage of 16-19V it is polarized horizontally. The three rear LNBF channels were powered with 16 volts to get a horizontal polarization and the three front LNBF channels were powered with 13V to get the vertical polarization.

Ideally we wanted the spectrometer to be pointed at an elevation of 8 degrees to get the strongest signal possible. However, at that elevation, the trees near the spectrometer location, would block some of the signal. As a result, an elevation of 12 degrees was used.