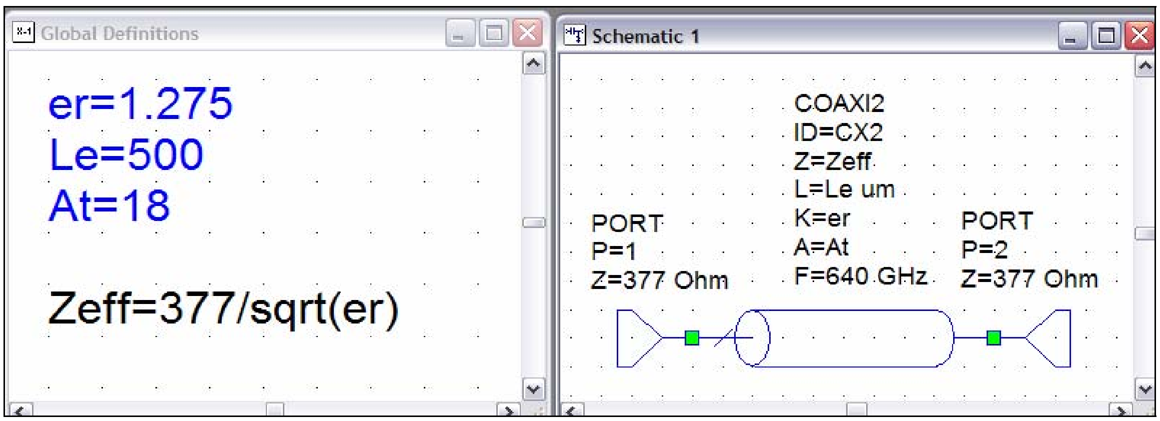
Dear Richard,

There are some old versions of the RF membrane requirements at EDM. I found the one that I referenced at:
http://www.cv.nrao.edu/~awootten/mmaimcal/ALMARF_A2.pdf.
Seem to be the last version.

Regarding the calculations:
A) I did calculate the transmissivity factor of the membranes based on a transmission line model where the free space was considering as a 377ohms impedance port and the membrane as a transmission line with a characteristical impedance of 377/sqrt(Er) and dielectric constant equal to Er. The attenuation constant of the transmission line is considered independently and equals the attenuation constant reported for the material under study.



So the shown transmissivity includes, as you noted, both reflections and absorption.

B) The expression to calculate the required transmissivity of the membrane to meet the "overall loss of sensitivity no grater than 3%" was taken from the RF membrane requirements document, pg 6: "*The factor for loss of sensitivity is calculated from ([(Tsys+(1- t)*Tmembrane)/(Tsys*t)]- 1)*100%, where t is the fraction of transmission **through** the membrane and Tmembrane is assumed to be 300K*".
I assumed that the "fraction of transmission through the membrane" is the **total** fraction of transmissivity including both reflections and absorptions and so was shown together with the total transmission of the membrane for an overall loss o 3%.

Anthony J. Remijan or Al Wootten could give us more information about the assumptions they made in order to get this formula.

C) With respect to the loss in the membrane, I used a value of 18dB/m which is smaller than yours following your suggested loss tangent of 0.001. The effect of using a constant of attenuation of 30dB/m or even more is nearly imperceptible in the transmission (due the small thickness of the membrane), but sure could have an important effect in the contribution to the noise temperature due the thermal emission of the membrane, especially at low frequencies.

New approach

I split the contributions and calculated (using the same transmission line model) the coefficients of Transmission, Reflection and Emission for the Gore-Tex membrane.

Following the formula you proposed in the Excel sheet, I calculated the Loss of Sensitivity as:

Loss of sensitivty (%)

$$\mathrm{LoS}\ (\%) = 100\left\{(1 - \mathrm{Tr_m}) + \frac{T_{add}}{T_{sys}}\right\}$$

With $T_{add} = T_m \, \mathrm{Es_m} + \frac{1}{2} T_{cabin} \, \mathrm{Re_m}$

Where

$T_{add} =$ Added temperatue

$T_m =$ Membrane Temperature

$T_{cabin} =$ Antenna Cabin Temperature

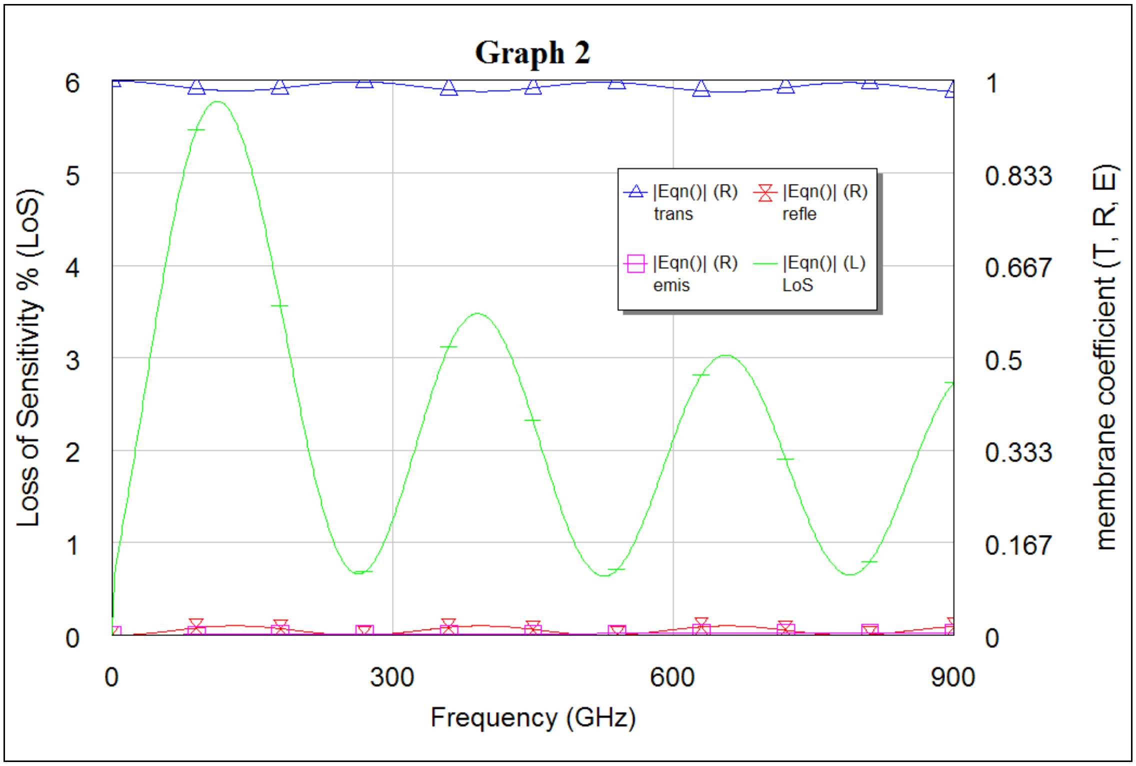
$\mathrm{Tr_m} =$ Membrane Transmissivity

$\mathrm{Re_m} =$ Membrane Reflectivity

$\mathrm{Es_m} =$ Membrane Emissivity

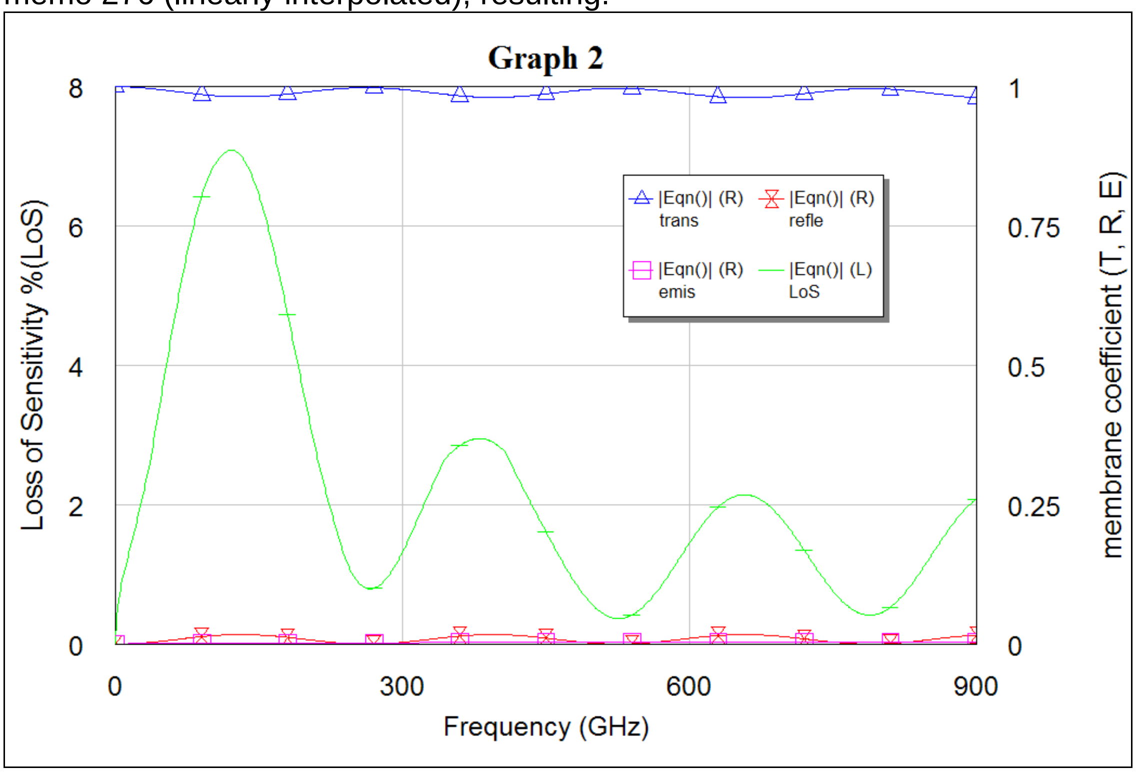
I obtained figures very similar to your results, with a modest improvement of performance.

I used Er=1.3 and Att=30dB/m which seems to me the worst cases.



Loss of sensitivity Er=1.3 , Att=30dB/m, L=500um (linear model for Tsys)

I did replace your linear model for Tsys=10+0.5*f(GHz) by the Tsys data of memo 276 (linearly interpolated), resulting:



Loss of sensitivity Er=1.3 , Att=30dB/m, L=500um (Tsys Memo 276 data)

We could improve these calculations considering the reflections of the membrane outside the cabin, accounting for the attenuation of the atmospheric and spill-over noise contributions due the membrane.

In this case we should calculate T_{add} as:

$$T_{add} = T_m \, Es_m + \frac{1}{2} \, T_{cabin} \, Re_m - (1 - Tr_m) \, T_{outside}$$

with $T_{outside} = T_{sys} - T_{reciever}$

And the loss of sensitivity in the same way:

$$LoS\,(\%) = 100 \left\{ (1 - Tr_m) + \frac{T_{add}}{T_{sys}} \right\}$$

Cheers,
Ricardo.