Results of the tests of the semitransparent vane

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This is a summary of the new results of the semitransparent vane (S/T) tests made with the 30-m telescope. In this period we tested the stability of the S/T vane installed in a new location in the beam path to check if the large changes (up to 10%) in the S/T vane absorption coefficient observed in the first tests were due to the location (just less than 3 cm from the receiver) of the S/T vane. In addition to the previous material, we have also tested a new one. **The main result is that the variations of the absorption coefficient in this location is <2% at 3 and 1.3 mm for the two materials we have used.** This indicates that the large changes in the absorption coefficient of the S/T vane measured in the first location were likely due to the influence of the S/T vane in the receiver tuning. **However, there might be some systematic effects at the 1-2% level. These systematic effects together with the difficulty of measuring the losses of the S/T vane on astronomical sources with the required precision (better than 1%) suggest that the S/T vane calibration scheme will provide a calibration system with an accuracy of about 2-3%.**

Installation

The semitransparent vane (S/T) device was installed at the 30-m telescope in location 2 (see Fig. 1) on April 29th . The new location of the S/T vane in the beam path allowed to test the S/T vane simultaneously with 4 receivers. This configuration also allows to measure the two orthogonal polarizations at 3 mm and 1.3 mm. We have measured two S/T vanes with different materials . The first one was the same used for the first tests, a dense polystyrene foam (S/T vane #1) with a thickness of about 4 cm, and the second one was a polyurethane foam (S/T vane #2) with a thickness of about 3 cm

Measurements and results

Load Measurements

We measured the absorption coefficient of the S/T vane as a function of frequency and time (tuning). The absorption coefficient of the vane was derived by combining measurements of 10 seconds on the cold (Nitrogen) load with the vane on and off and the ambient load.

Absorption coefficient versus frequency

Figs. 2 and 3 shows the absorption coefficient as a function of frequency for vane #1 and #2 respectively. Every measurement of the absorption coefficient represents the average of 9 independent measurements and the errors (not visible in these Figs.) correspond to the sigma of the average.
The absorption coefficient of the two S/T vane depend with frequency, υ, like $\upsilon^{1.2\text{-}1.3}$ but cannot be fitted by a single power law.

Stability of the absorption coefficient as function of time

Figs. 4 and 5 and show, respectively, the variation of the absorption coefficient as a function of time for the two receivers (filled triangles for receiver A and filled squares for receiver B) tuned at 86 and 215 GHz for the S/T vane #1 . The measurements were made in two different days and all measurements were made after a new tuning. Figs. 6 and 7 show the same measurements for the S/T vane #2.

The main results are:

- The peak-to-peak variations of the absorption coefficients measured for both S/T vanes for all receiver is less than 2%, much smaller than the 10% variations measured when the S/T vane was installed in position 1. This confirms that the changes of the absorption coefficient measured in the first location were due to the influence of the S/T vane in the receiver tuning.
- The peak-to-peak variations of the absorption coefficient between the two receivers is also less than 2% for the two frequencies and both S/T vanes.
- There is however a systematic trend in the variations for the measurements for each receiver and between the receivers. In general, receiver A and B shows the same trends in the absorption coefficient variations. Receiver A measures smaller values than receiver B by about 2%. Since the variations are systematic and, in most of the cases, well above the uncertainties in our measurements they are likely to be produced by the S/T vane.

Losses of the S/T vane derived from astronomical observations

Figs. 4 and 5 also show, as open stars and filled circles, the losses of the S/T vane measured using astronomical sources. For the 86 GHz measurements we used the SiO masers in R Leo and the continuum emission from Saturn. For the 215 GHz measurements, we only used the continuum emission for Saturn. Unfortunately we could only look to the sky for only a few hours because of strong winds. The typical error (as derived from 14 independent measurements) is about 5%. Although within the uncertainties, the data might indicate that the losses measured form astronomical sources might be somewhat smaller than the absorption coefficient. Measuring the losses of the S/T using astronomical sources to an accuracy of better than 1% requires excellent weather conditions at the 30-m telescope.

Summary

Although, the new measurement of the S/T vane indicates that the system can provide a calibration accuracy better than 10%, the systematic effects together with the difficulty of measuring the losses of the S/T vane on astronomical sources with the required precision (better than 1%) suggest that the S/T vane calibration scheme will provide a calibration system with an accuracy of about 2-3%.

IRAM 30m telescope receiver cabin schematic

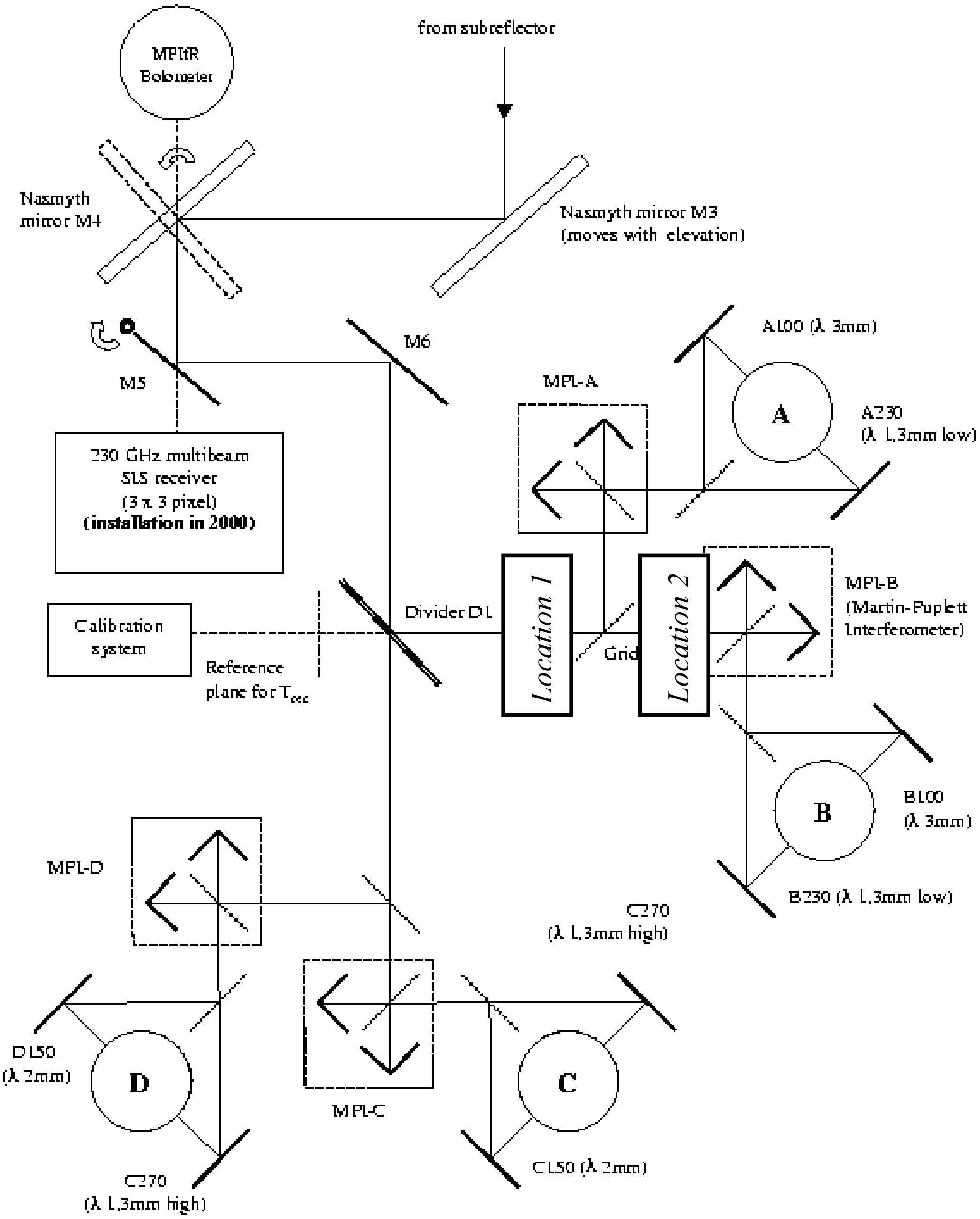

Fig. 1

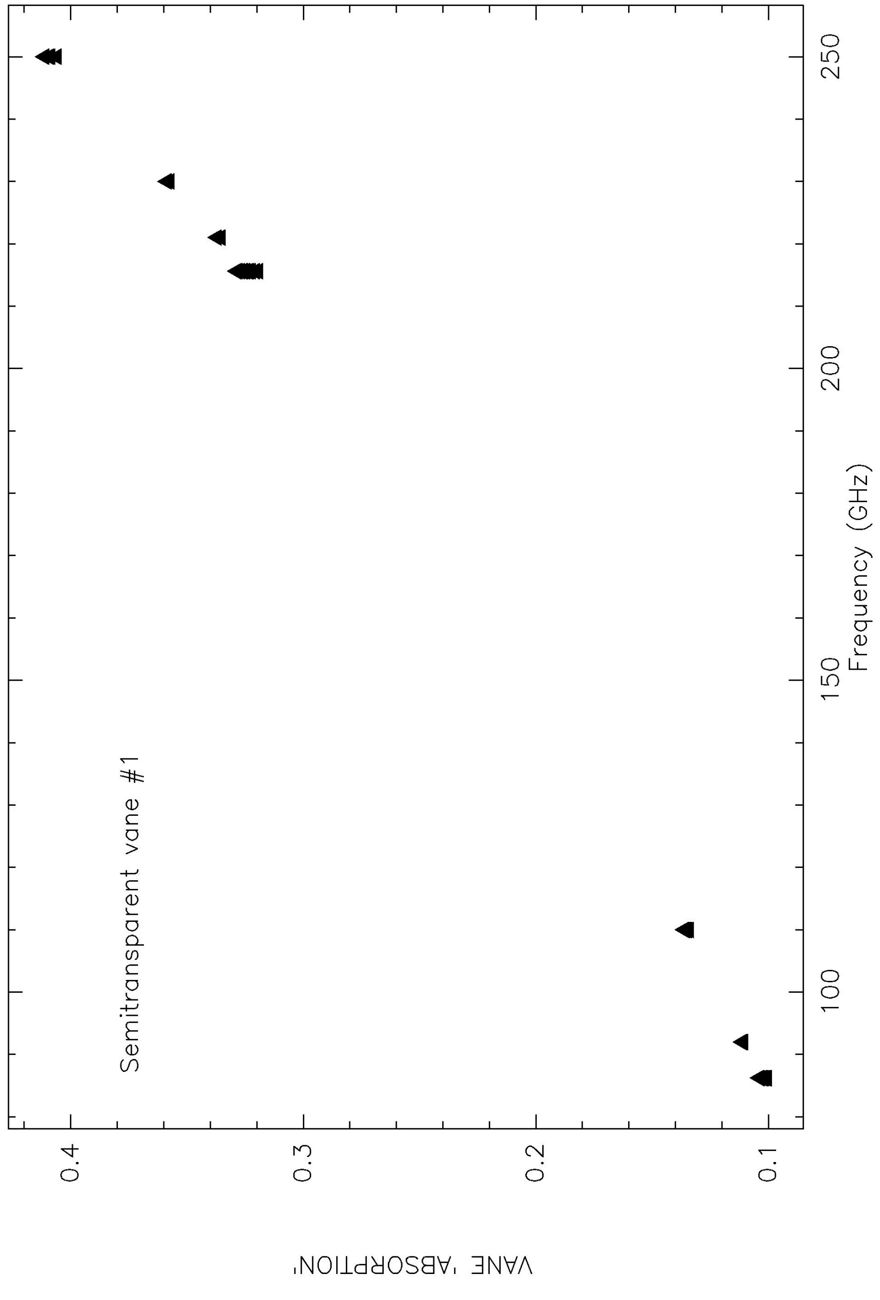
Semitransparent vane #1
VANE 'ABSORPTION'
0.1
0.2
0.3
0.4
Frequency (GHz)
100
150
200
250

Fig. 2

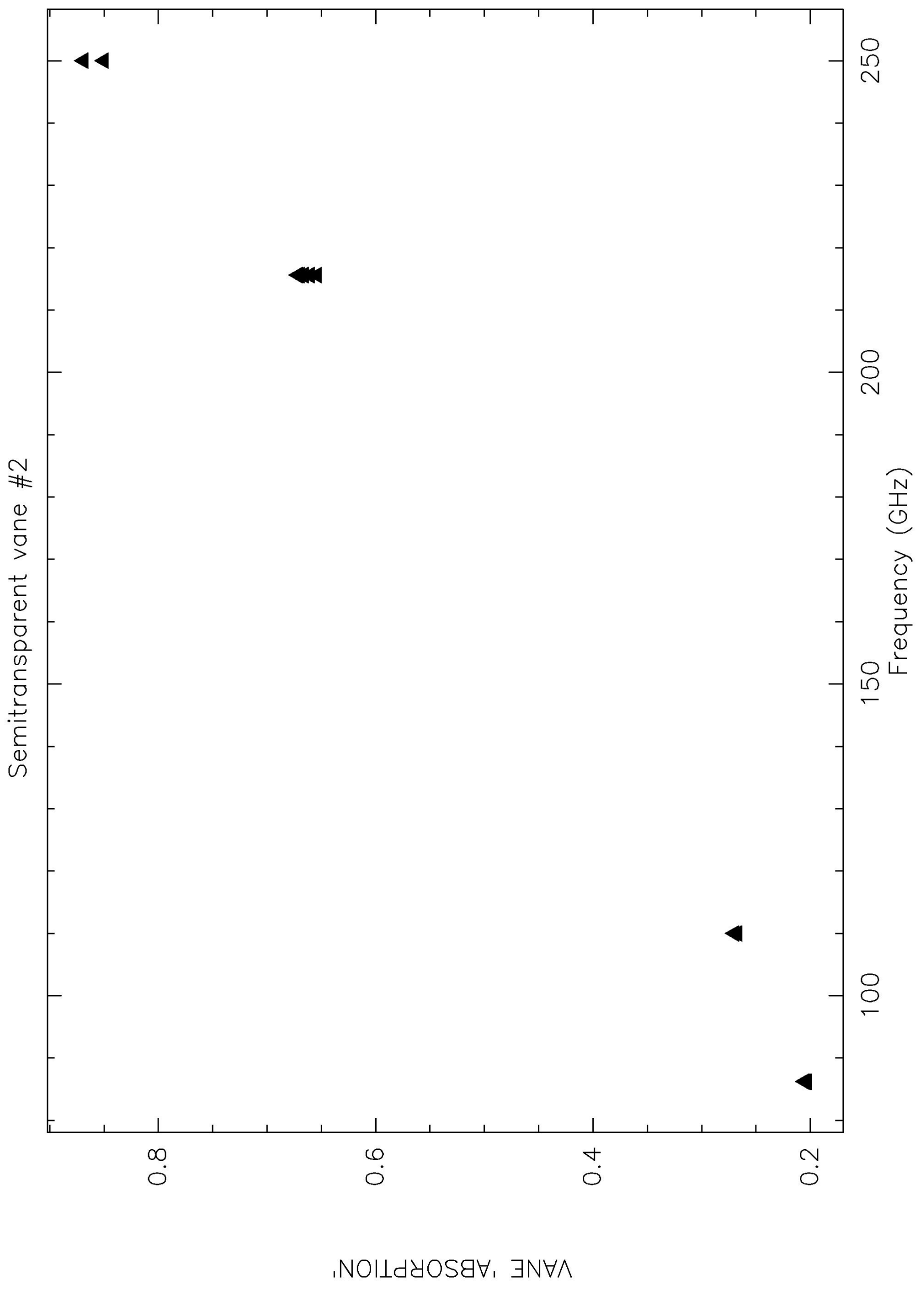
Semitransparent vane #2
VANE 'ABSORPTION'
0.2
0.4
0.6
0.8
Frequency (GHz)
100
150
200
250

Fig. 3

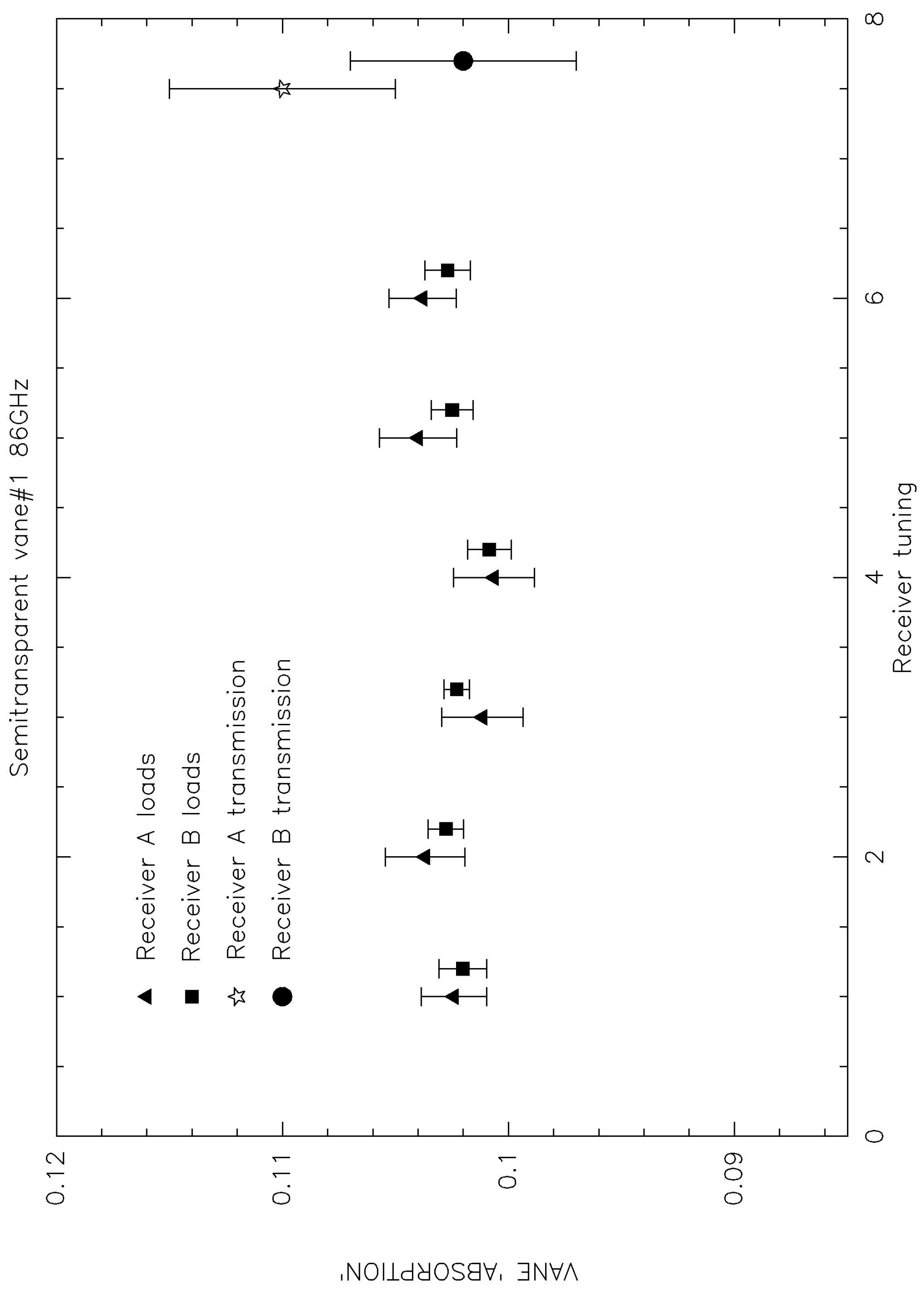
Semitransparent vane#1 86GHz
▲ Receiver A loads
■ Receiver B loads
☆ Receiver A transmission
● Receiver B transmission
VANE 'ABSORPTION'
0.12
0.11
0.1
0.09
Receiver tuning
0
2
4
6
8

Fig. 4

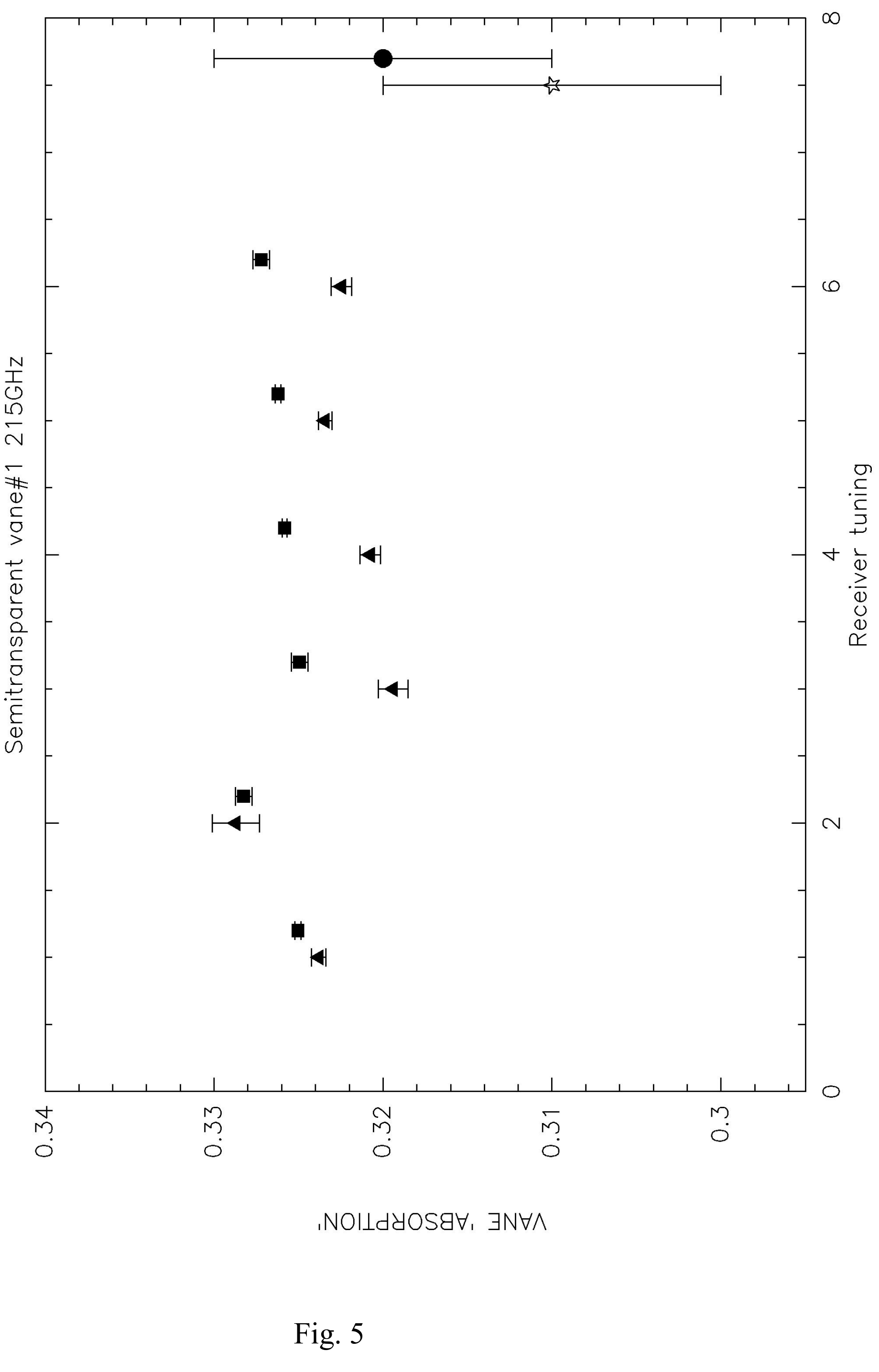
Semitransparent vane#1 215GHz
Receiver tuning
0
2
4
6
8
VANE 'ABSORPTION'
0.34
0.33
0.32
0.31
0.3

Fig. 5

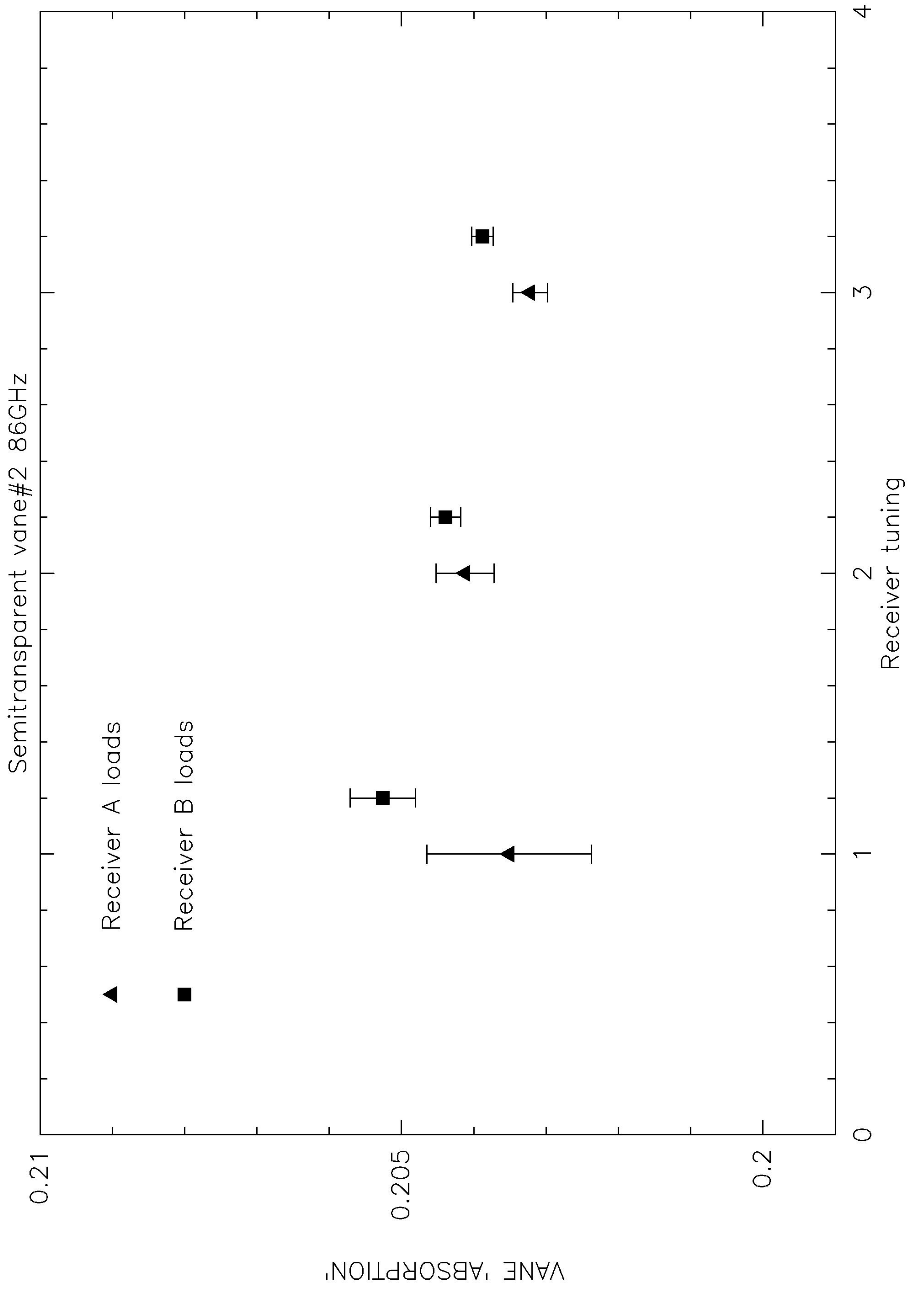
Semitransparent vane#2 86GHz
Receiver A loads
Receiver B loads
VANE 'ABSORPTION'
0.21
0.205
0.2
Receiver tuning
0
1
2
3
4

Fig. 6

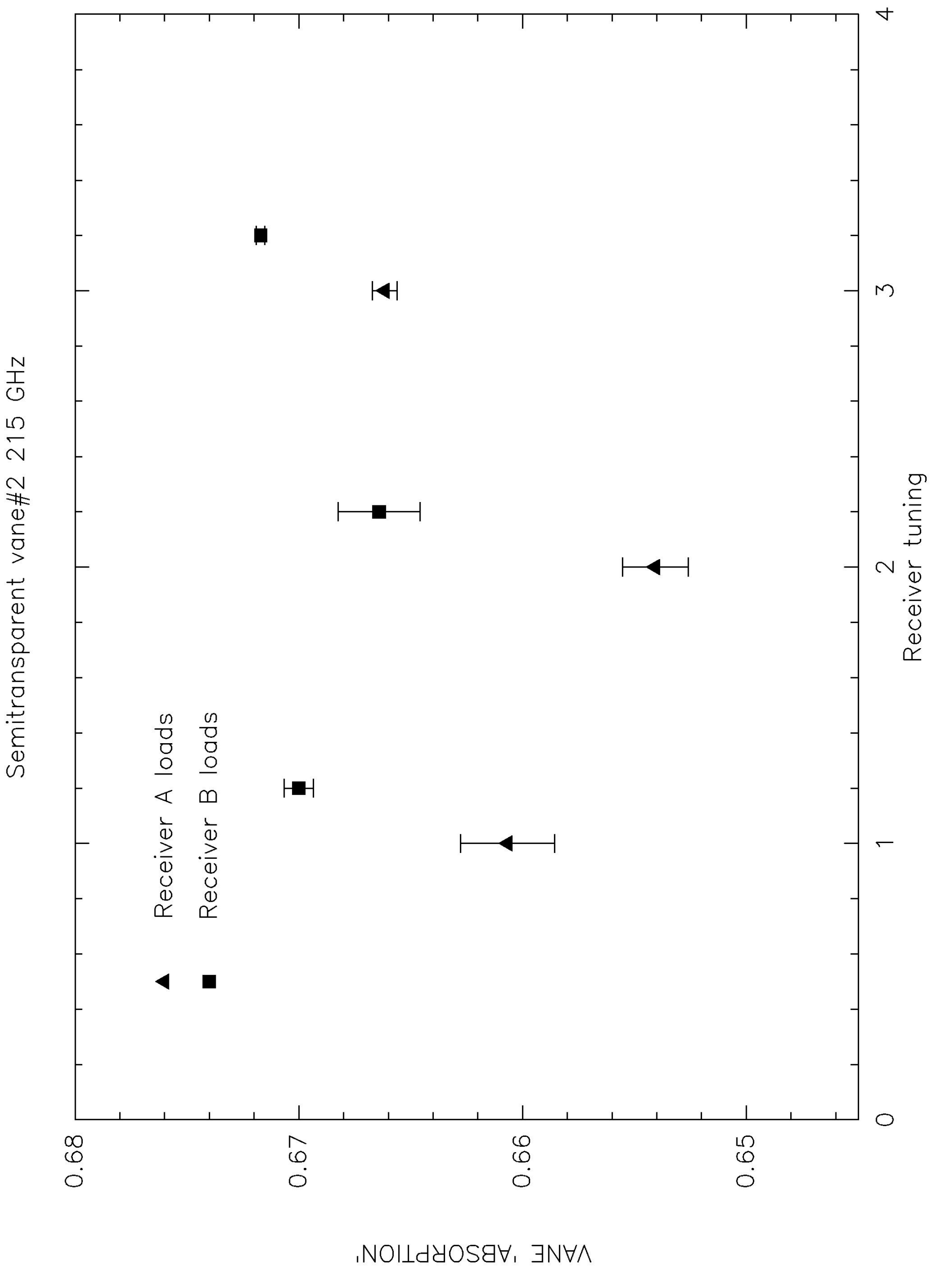Semitransparent vane#2 215 GHz
Receiver A loads
Receiver B loads
VANE 'ABSORPTION'
0.68
0.67
0.66
0.65
Receiver tuning
0
1
2
3
4

Fig. 7