VLA Test Memo No. 231

Phase stability of AstroLab flex cables

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C and Ku band cryogenically cooled LNAs located in the VLA "A-rack dewar" occasionally go bad and require replacement. Because of the size and mounting of the dewar, it is highly preferable to perform the LNA swap in the field in the antenna vertex room. Because the LNAs supplied by NRAO-Charlottesville have gone through a number of revisions over the years, spare LNAs available for use often have a different mechanical form and fit than the LNA currently in the dewar. We usually don't know which LNA package outline is in any particular antenna without opening the dewar and checking it out. Opening the A-rack dewar usually requires an overnight warm-up, and an overnight cool-down, which leaves the antenna without a working C, Ku, and sometimes K band receiver for as long as 2 days.

Because of the differences in package outline it is difficult to fit replacement LNAs into the dewar. One of the most time-consuming tasks of the LNA replacement involves attempting to re-connect the 0.141 inch diameter semi-rigid coax to the input and output of the amps. The semi-rigid is difficult to bend into the new position required by a changed LNA package. As a result, the Socorro Front End Group was considering using short runs of pre-made, high quality microwave cable assemblies in place of the semi-rigid.

Most of the better quality cables (Gore, Storm, Astrolab) claim lower loss and better amplitude flatness across the advertised frequency range than is possible with 0.141 inch semi-rigid. That improved specification, and the possibility of greatly reducing the difficulty of swapping out the LNAs in the field led us to consider using such cables. The one cable parameter that concerned us however, was the phase stability of the flexible cables under conditions of mechanical vibration.

In order to determine the suitability of the flexible cables to front end dewar or IF applications, a few simple tests were run using the HP8510 vector network analyzer. A 7" long sample of the Astrolab "minibend" cable assembly, and a 4" long sample of the Astrolab "minibend-L" cable assembly was tested using the following 8510 set-up:

start frequency:	12 GHz
stop frequency:	16 GHz
S-parameter:	S21
Mode:	Phase display vs. frequency
# Points:	401
Smoothing:	on

PROCEDURE:

Two hand vises were used to hold the 8510 cables rigid at the mating connectors.

The Astrolab test cable was installed between the two 8510 cables.

A sweep from 12 to 16 GHz was allowed to occur.

The sweep was stored in memory.

The 8510 was programmed to display DISPLAY/MEMORY while additional sweeps occurred.

A plastic pen was used to "continuously" impact the Astrolab cable assembly under test during the next sweep.

The test was performed with straight and coiled lengths of the flex cable.

The test was repeated with a straight 0.141" semi-rigid cable assembly approximately 8" long, a single coil 0.141" semi-rigid cable assembly approximately 4" long, and a 10" long 0.085" semi-rigid cable assembly with a number of bends in it.

RESULTS:

7" Astrolab "minibend", straight, change in phase: <= 500 m degrees.
7" Astrolab "minibend", coiled, change in phase: <= 300 m-degrees.
6" Astrolab "minibend-L", straight, change in phase:<= 500 m-degrees.
6" Astrolab "minibend-L", coiled, change in phase: <= 200 m-degrees.

8" 0.141 semi-rigid, straight, change in phase: <= 100 m-degrees.
4" 0.141 semi-rigid, coiled, change in phase: <= 200 m-degrees.

10" 0.085 semi-rigid, bent, change in phase: <= 100 m-degrees.

A side note to be mentioned is that the measured phase through the flexible coax was very sensitive to changes in tension applied by pulling the two support vises further apart.

Another note is that both cable types, flex and semi-rigid, were very sensitive to even minor temperature changes. Touching the cables for any length of time with fingers would cause the phase difference (DISPLAY/MEMORY) to vary by two to three degrees.

CONCLUSIONS:

We do not believe it will be possible to use the Astrolab flex coax in front end Dewars due to the nearly 5X greater phase sensitivity to mechanical vibration. (It is our understanding that the VLA system cannot tolerate random phase variations in the 0.5 to 1.0 degree range.) We would also caution other NRAO designers in the use of such flexible coax cable assemblies in applications that require any degree of phase stability.

I would welcome any comments on the test procedure performed and the conclusions I drew from the test results obtained.