IVS Memorandum 2006-018v01

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“Source Structure Examples”

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Source Structure Examples

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1. Introduction

The change in interferometer phase as a function of frequency due to source structure will affect the possibility of connecting phase across a large frequency range, such as 2 GHz to 15 GHz, as proposed for a means of obtaining good delay precision at low signal to noise ratio (SNR). Calculation of visibility magnitude and phase was described in V2C memo 2006-017V01.

In this memo the visibilities are calculated for a sample of sources of varying structure indices (SI). The structures of the sources were constructed from the Gaussian component models of Fey and Charlot (2000). Only a few examples are shown because of the time it takes to generate a spectral model from the S and X components. Furthermore, caution should be exercised in interpreting the results since the models are not well constrained at frequencies other than S- and X-band.

2. Sources

The modeled sources and their structure indices at S and X band are listed in the following table.

	Structure Index	
Source	S	X
0014+813	1	1
0113-118	2	3
0149+218	2	2
0202+149	2	2
0248+430	2	4

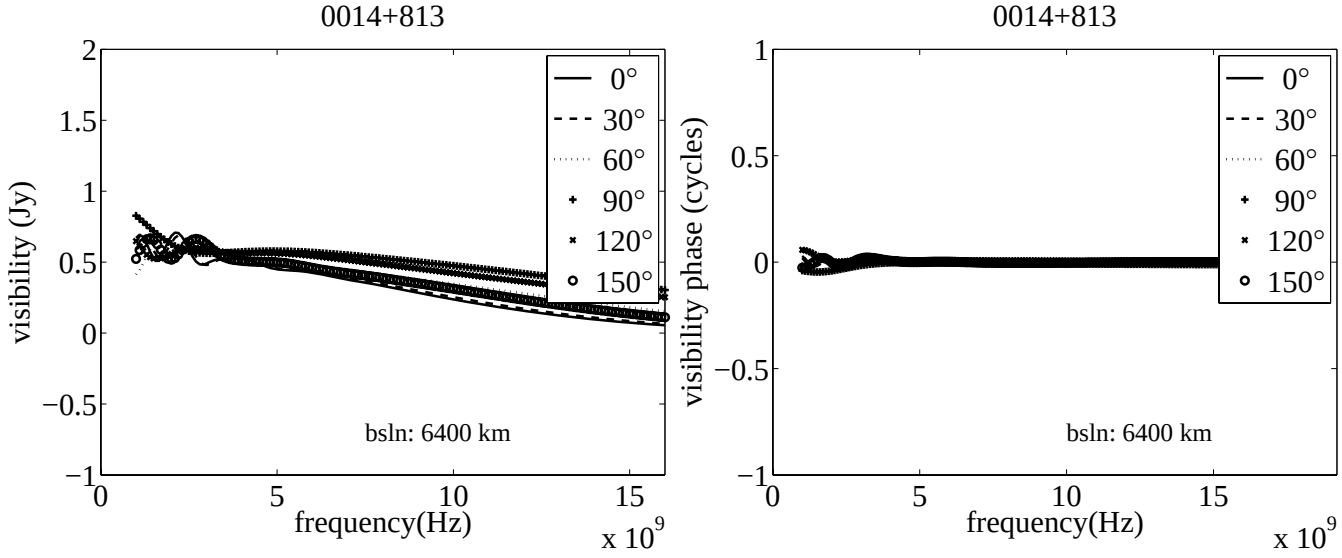
3. Visibilities

The visibilities are calculated for frequencies from 1 GHz to 16 GHz for six position angles of the baseline. The magnitudes of the visibilities are given in Jy, so they actually represent correlated flux density and not visibility. The visibilities for each source are shown in the following figures with correlated flux density on the left and phase (in cycles) on the right. For each source the Gaussian components of the model precede the figures.

The visibilities for all position angles are also written to a file. Send me a note for the visibility files. I am also glad to share my *matlab* scripts that calculate the visibilities and create the figures.

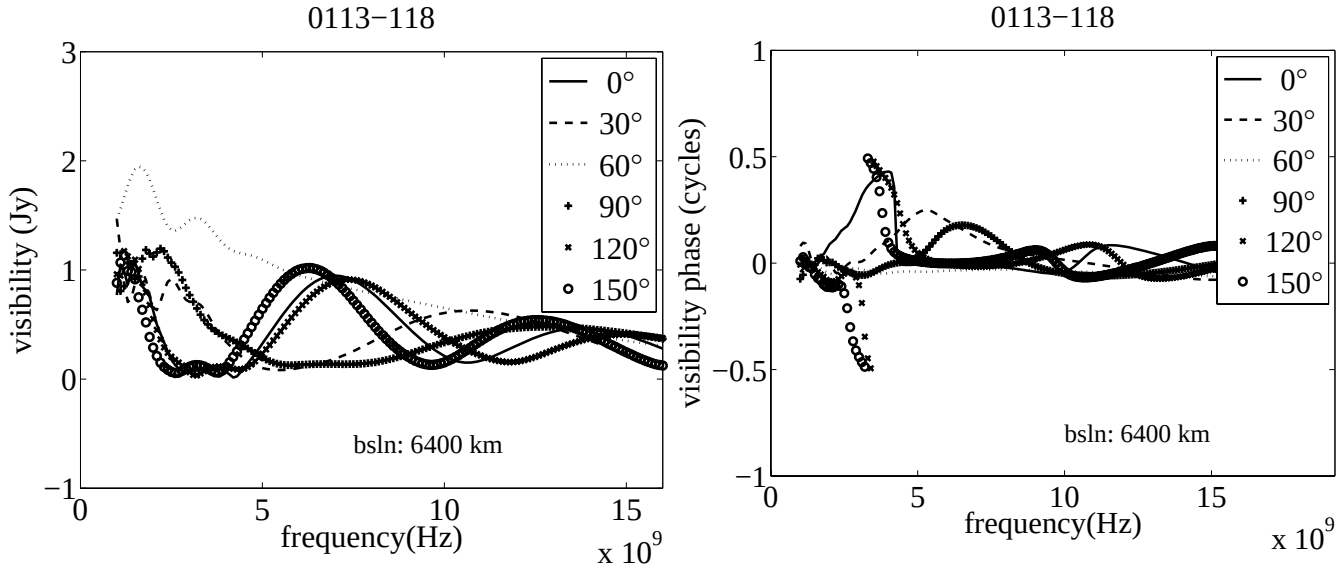
0014+813 S.I. = 1/1

```
%  S0   f0   alfa_a alfa_b  r_comp pa_comp  size ax_ratio  pa_ax
% (Jy) (GHz)                (mas)   (deg)  (mas)          (deg)
  0.6  1.0  2.5     -0.0    0.0    0.0     0.5    0.5    -170.0
  0.03 8.0  2.5     -0.7    1.0 -170.0     0.9    0.01   -170.0
  0.1  2.0  2.5     -1.0    4.9 -166.0     1.5    1.0      0.0
  0.22 1.0  2.5     -1.0    8.8 -171.0     2.5    1.0      0.0
```



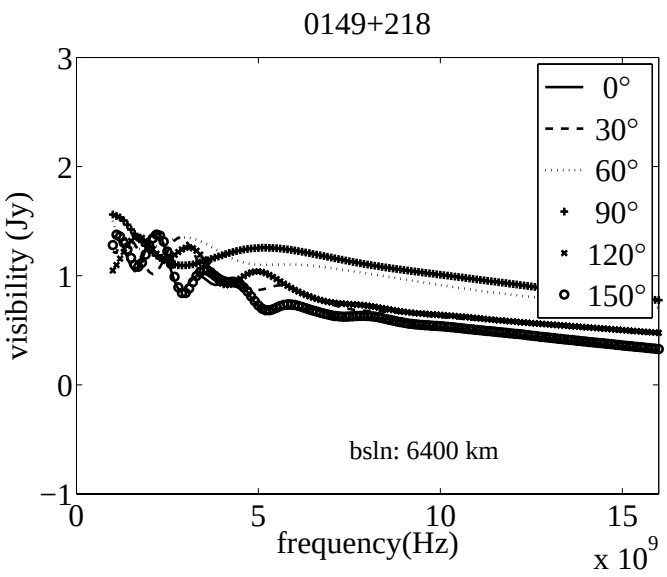
0113-118 S.I. = 2/3

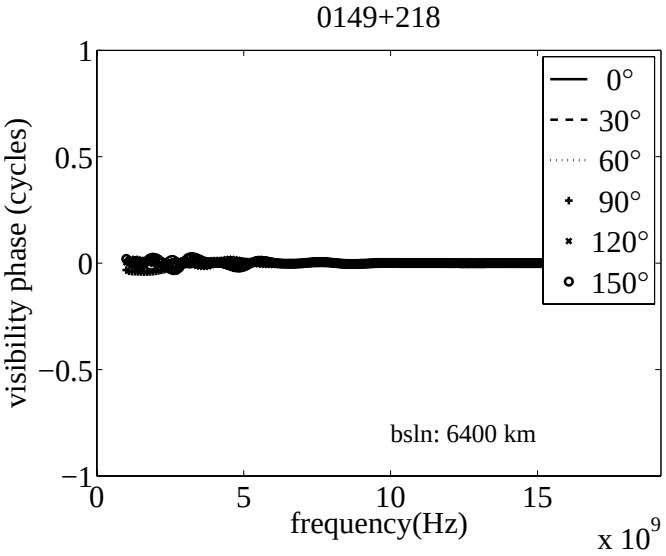
```
% From Fey-Charlot 225 sources
% 0113-118 (approximation)
%  S0   f0   alfa_a alfa_b  r_comp pa_comp  size ax_ratio  pa_ax
% (Jy) (GHz)                (mas)   (deg)  (mas)          (deg)
0.6  7.0   2.5   -0.5    0.0    0.0     0.3    1.0    0.0
0.3  2.0   2.5   -0.5    1.5  155.0     0.3    1.0    0.0
0.5  5.0   2.5   -0.5    1.5  -30.0     0.7    1.0    0.0
0.4  3.0   2.5   -0.5    7.0  -35.0     3.0    0.3  -35.0
0.4  2.0   2.5   -0.5   33.5  -40.0     5.5    0.3  -40.0
```



0149+218 S.I. = 2/2

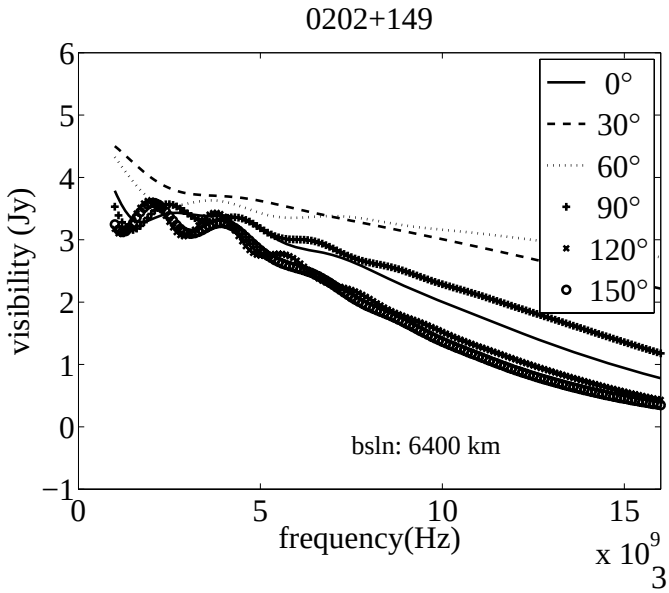
% S0 (Jy)	f0 (GHz)	alfa_a	alfa_b	r_comp (mas)	pa_comp (deg)	size (mas)	ax_ratio	pa_ax (deg)
0.74	8.5	2.5	-0.7	0.0	0.0	0.3	0.2	-14.0
0.61	2.3	2.5	-1.0	0.0	0.0	1.42	0.23	-12.0
0.04	4.0	2.5	-0.7	2.5	-17.0	0.77	1.0	0.0
0.16	1.0	2.5	-1.0	4.8	-18.0	1.0	1.0	0.0
0.24	1.0	2.5	-1.0	8.8	-11.0	1.5	1.0	0.0
0.4	1.0	2.5	-1.0	40.1	20.0	7.5	1.0	0.0

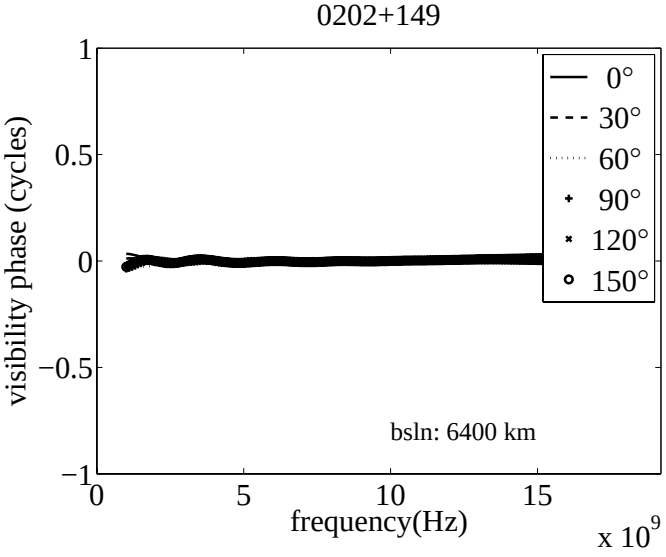




0202+149 S.I. = 2/2

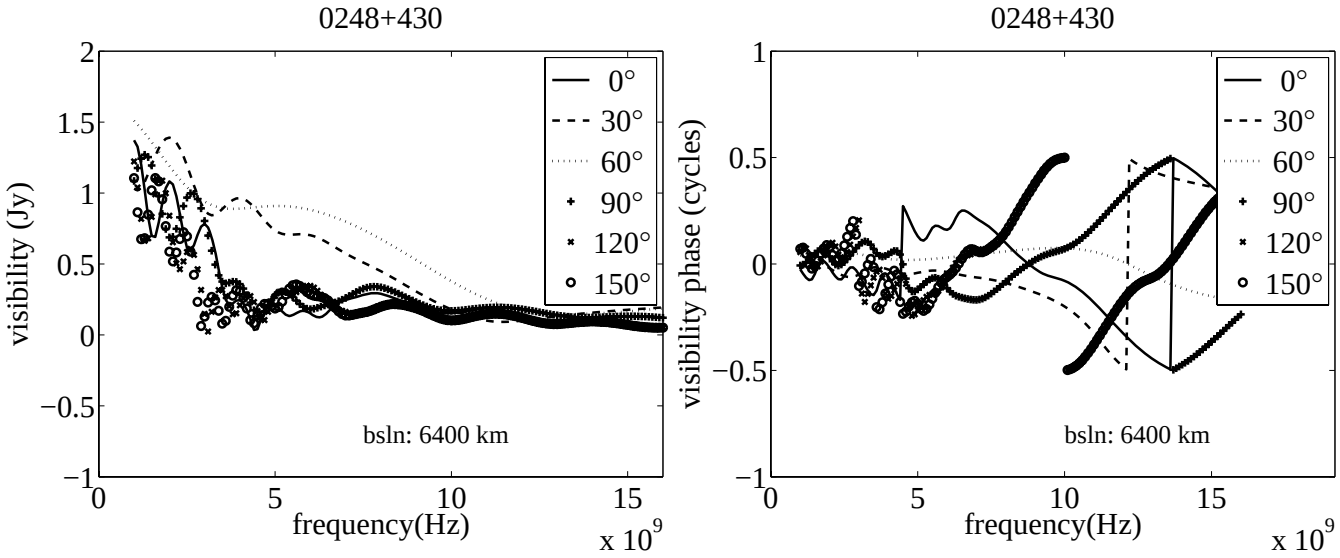
% S0 (Jy)	f0 (GHz)	alfa_a	alfa_b	r_comp (mas)	pa_comp (deg)	size (mas)	ax_ratio	pa_ax (deg)
3.6	1.0	2.5	-0.3	0.0	0.0	0.5	0.3	-40.0
0.07	8.0	2.5	-0.7	0.7	-76.0	0.28	1.0	0.0
0.6	2.3	2.5	-0.7	2.5	-52.0	2.15	1.0	0.0
0.24	2.0	2.5	-0.7	5.0	-60.0	0.96	1.0	0.0
0.27	1.0	2.5	-0.5	5.1	-40.0	1.42	1.0	0.0





0248+430 S.I. = 2/4

```
%  S0   f0   alfa_a alfa_b  r_comp pa_comp  size ax_ratio  pa_ax
% (Jy) (GHz)                (mas)   (deg)  (mas)          (deg)
  1.0  2.0  2.5     -0.5    0.0    0.0     1.5    0.2 -40.0
  0.25 2.0  2.5     -0.5    1.5  135.0     0.4    0.1 135.0
  0.1  1.0  2.5     -0.7    5.0  135.0     0.5    1.0 135.0
  0.3  1.0  2.5     -0.7   12.0  143.0     1.35   1.0   0.0
  0.03 1.0  2.5     -0.7   26.0  166.0     9.0    1.0   0.0
```



4. Possible inferences

The (1/1) and (2/2) sources chosen as examples were selected only by being near the beginning of Table 3 of Fey and Charlot (2000). The (2/3) and (2/4) sources were selected with the expectation that the visibility phases might have a range of a cycle or more. Although only two examples were created in the (2/2) structure index groups, it appears that there is a large increase in complexity of the visibility phase when the SI is greater than 2.

An optimistic interpretation would be that by selecting sources with SI <3 the probability will be small that the structure phase will seriously impair the absolute phase determination from the broadband approach. On the other hand, since so few sources were modeled, there is the nagging possibility of having selected at random only “good” sources from those having SI = 2/2. Clearly it would be valuable to model more sources of the (2/2), (2/3), and (3/2) classes.

In a world of greater resources it would also be useful to calculate structure indices at S- and X-band from these models and compare them with those of Fey and Charlot.

5. References

Fey, A., and P. Charlot, VLBA Observation of radio reference frame sources. III. Astrometric suitability of an additional 225 sources, Ap. J. Supp. Series, **128**:17-83, 2000 May.