Characterization of IOTA-IONIC for Closure phase measurements

Sam Ragland dated on 9th July 2003

During last couple of AGB runs this year, I observed several calibrators primarily to characterize the IOTA-IONIC instrument. I investigate issues such as stability and chromatism of the instrument, role of instrumental parameters on closure phase estimation, etc.

Here I present some results based on my narrowband measurements. I will present the results on broadband H filter separately. Photometric corrections have been explicitly applied to all scans knowing the coupling coefficients of IONIC couplers.

(a) Chromatism:

I find that the instrumental ***closure phase is independent of the spectral type*** of the observed star (within the observational errors). Fig.1&2 show this result based on narrowband measurements taken in May 2003 and March 2003 respectively. The left column corresponds to PICNIC pixels: 0, 2 & 4 (closing triangle 1) and the right column corresponds to the complementary outputs (triangle 2).

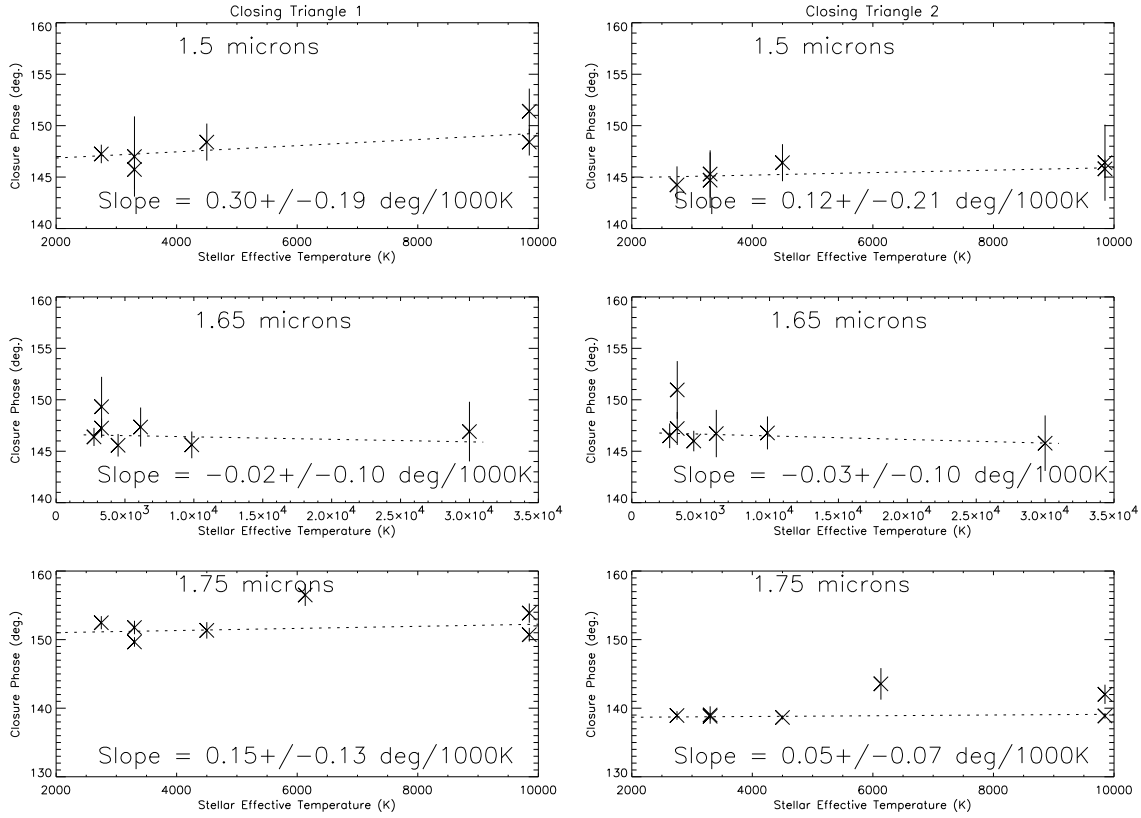

Fig.1: Narrow band closure phase measurements of calibrators observed during AGB run in May 2003 are plotted against stellar effective temperature.

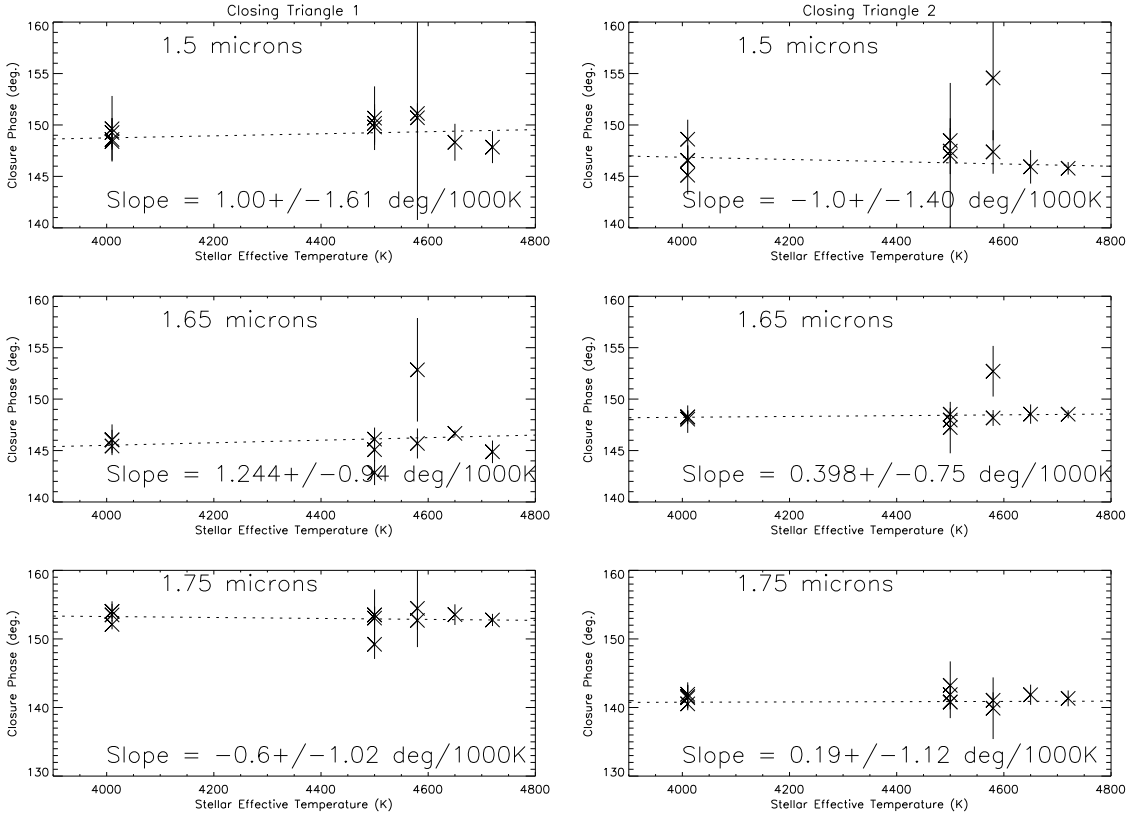

Fig.2: Narrowband closure phase measurements of calibrators observed during AGB run in March 2003 are plotted against stellar effective temperature.

(b) <u>A Split in the Closure phase estimation:</u>

I find that the ***<u>instrumental closure phase differs significantly between the two complementary closing triangles</u>***, especially at the longer wavelengths.

Shown below (Fig.3 & Fig.4) are the closure phase measurements of calibrators (of various spectral types) observed (with same instrumental settings) as a function of wavelength of observations. These plots clearly show a split in the instrumental closure phase between the complementary closing triangles. For clarity, I separately plotted data that correspond to triangle 1 and triangle 2 in the top & middle row. Data from both triangles are shown again (together) at the bottom (for clarity, only mean values are shown here).

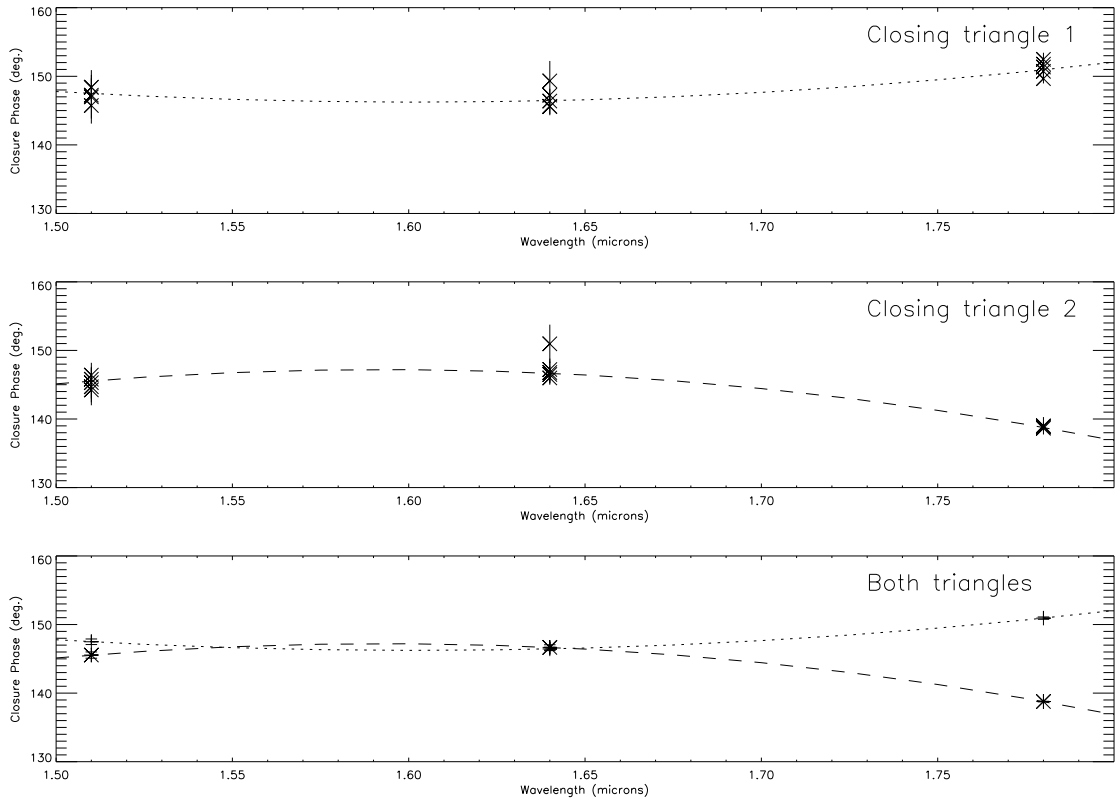

Fig.3: Narrowband closure phase measurements of calibrators observed during AGB run in May 2003 are plotted against wavelength of observations.

As you see, the split is about 2 degrees at 1.5 microns and about 12 degrees at 1.75 microns and null at 1.65 microns (Mar 2003 data show an offset value of ~ 2 degrees at 1.65 microns as well). Typically, for a bright calibrator, I estimate the closure phase with a precision of less than one degree. Since, several calibrators (of different spectral type) observed during a run are used here, I get a relatively larger error in the mean instrumental closure phase.

I think that the IONIC beam combiner may have been well tuned at around 1.6 microns and hence the behavior of IONIC couplers differs significantly at the shorted and longer wavelengths (outside 1.55-1.65 micron region).

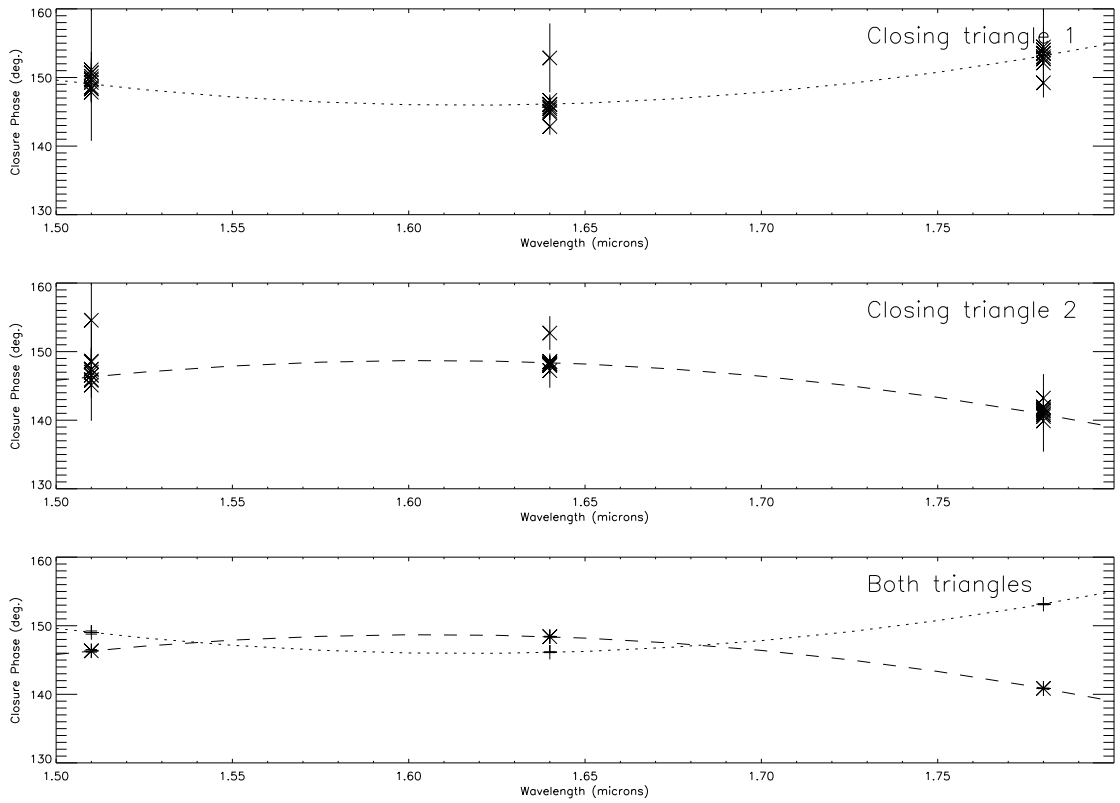

Fig.4: Narrowband closure phase measurements of calibrators observed during AGB run in Mar 2003 are plotted against wavelength of observations.

(c) <u>Stability of IOTA-IONIC:</u>

I find that the **<u>IOTA-IONIC enables extremely stable run-to-run closure phase measurements</u>** (better than a degree). Fig.4 & Table 1-3 show these results.

Table 1: Instrumental closure phase during May 2003

Wavelength (microns)	Closure phase (degrees)		
	Triangle 1	Triangle 2	Mean value
1.5	147.79 +/- 0.61	145.58 +/- 0.67	146.7
1.65	146.52 +/- 0.47	146.63 +/- 0.58	146.6
1.75	151.48 +/- 0.38	138.88 +/- 0.20	145.2

Table 2: Instrumental closure phase during Mar 2003

Wavelength (microns)	Closure phase (degrees)		
	Triangle 1	Triangle 2	Mean value
1.5	149.01 +/- 0.47	146.34 +/- 0.43	147.7
1.65	146.14 +/- 0.24	148.41 +/- 0.23	147.3
1.75	153.14 +/- 0.28	140.87 +/- 0.19	147.0

Table 3: Instrumental closure phase during Mar-May 2003

Wavelength (microns)	Closure phase (degrees)		
	Triangle 1	Triangle 2	Mean value
1.5	148.55 +/- 0.37	146.11 +/- 0.36	147.3
1.65	146.21 +/- 0.21	148.17 +/- 0.21	147.2
1.75	152.56 +/- 0.28	139.94 +/- 0.14	146.3
		Mean	**146.9**

The mean ***instrumental closure phase of IOTA-IONIC is 147 +/- 1 degrees*** (for 1 loop & 4 reads, and a scanning range of 80 microns) - almost independent of the wavelength of observations. This means that the complementary outputs of PICNICs may be combined at the beginning (to correct for scintillation like noise present in the data) in spite of the observed 'splitting'.

I shall soon discuss the role of instrument settings on the derived instrumental closure phase.

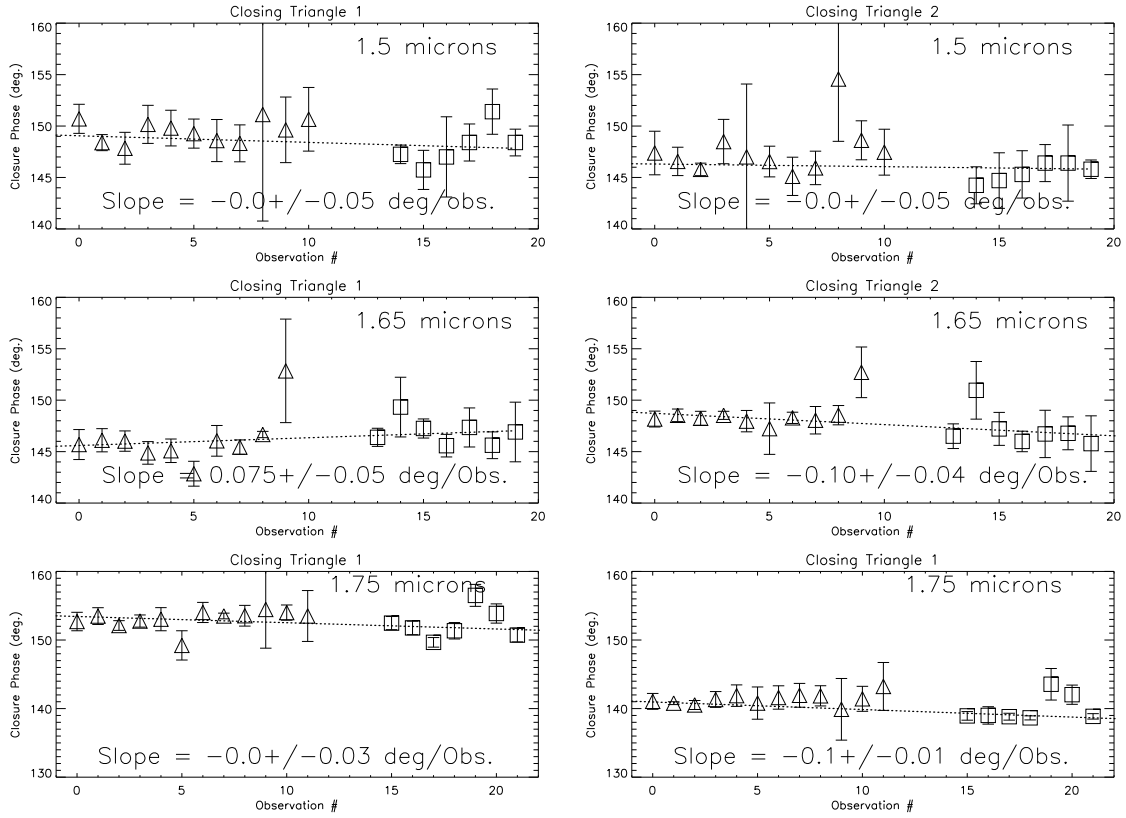

Fig.5: Narrowband closure phase measurements of calibrators observed during AGB run in Mar 2003 (triangles) & May 2003 (squares) are plotted here. Run-to-run stability of IOTA-IONIC for closure phase measurements is about 1 degree.