VLTI Memo

AMBER

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`Dest.`	:	all AMBER
`Copy to`	:	
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`Subject` : **Commissioning of the AMBER UV-plane and phases.**

`Presents` :

Scope of this memo

This memo summarizes the tests related to the commissioning of the phase and the UV-plane of the AMBER instrument (VLTI + AMBER + `amdlib`).

Conclusions

- The baseline name for base13 have to be reversed in the reduced OIFITS (A0-K0 instead of K0-A0 for instance).
- A final check of the UV-plane with respect to the station may be a plus, especially the consistency for the station order in the baseline name.
- Most importantly, we believe that `amdlib-2.99` provides phases in agreement with the UV-plane, and that `amdlib-2.2` provides wrong, opposite phases.

1 – Consistency between ISS (angle, length), OIFITS (u,v) and baseline name

The UV-plane as written in the RAW file header by ISS is defined by the angle (angISS) and length (lenISS) of the baselines ISS12, ISS23 and ISS13. By design of the VLTI laboratory, they correspond to the AMBER baselines AMB12 (smallest frequency), AMB23 (intermediate frequency) and AMB13 (highest frequency).

According to OIFITS standards (Cotton et al. PASP, 117, 1255), the baselines in the reduced data product should be coded by their projections u (East) and v (North). According to the document, the baseline named “1-2” should define the projected vector TEL2 - TEL1.

`amdlib` uses the following relations to convert ISS baselines into AMBER baselines:

- u = lenISS . cos(angISS)
- v = lenISS . sin(angISS)

Which means that the angle angISS is defined East to North (to be confirmed). The North to East angle is defined by:

- angUV = atan(u,v)

1.1 – Tests done

We performed these test for several configuration and several dates ranging 2006 to 2008:

- In the header of the RAW data, the following UV-plane triangle closes:
  ISS12+ISS23-ISS13
- In the OIVIS table of the OIFITS data, the following UV-plane triangle closes:
  u12+u23-u13=0
  v12+v23-v13=0
- However, the STA_INDEX columns of the OIFITS data are not compatible since the baselines names closes with the following triangle:
  name12+name23+name31
  The name of the third baseline has to be corrected to follow the same convention than the u and v quantities: name31 → name13.

1.2 – Tests to be done

- Test the UV-plane with respect to another software to check the global orientation (North/East).
- Test the sign of angUV with respect to the STA_INDEX (are the stations listed on the correct order ?).

2 – Consistency between the UV-plane, the differential-phases and the closure-phase

2.1 – Tests done

In fig. 1 we checked that the differential phases close with the same relation than the UV-plane, that is that the phase of the third baseline has to be reversed:

- phi12+phi23-phi13 = 0

We checked that, within an emission-line showing closure-phase variation with wavelength, the *differential closure-phase* and the *closure of the differential-phase* give the same result:

- phi12+phi23-phi13 = closure123

2.2 – Tests to be done

Note that all phase signs (differential-phases and closure-phase) are reversed between *amdlib-2.2* and *amdlib-2.99*. Another test is required to conclude about this global sign (see following section).

3 – Consistence with the real orientation on sky

Even if all triangle close properly, we need a final check to ensure the phases and the UV-plane are properly oriented together, so that the resulting astrophysical quantities are described in the correct (North,East) reference frame. Such test ensures that sec. 1.2 and 2.2 are consistent together, which is the most important aspect.

I assume the following formula to link the astrometric position $\vec{d}$ with the group-delay and so with the derivative of the differential-phase:

$$\frac{d\phi_{ab}}{d\lambda} = \frac{\vec{d}.\vec{b_{ab}}}{\lambda^2}$$

The sign of this formula can be checked with fig. 2: a minus sign come from $\vec{d}.\vec{b_{ab}} \rightarrow$ GD and another minus sign come from GD $\rightarrow d\phi/d\lambda$.

I extracted the projected baselines $\vec{b_{ab}}$ (as u,v) as well as the differential-phases ϕ_{ab} from the OIFITS produced by `amdlib-2.99`. For each observation, I performed a linear regression of the 3 differential-phases into a 2D value for the astrometric shift $\vec{d}$ (therefore in the same reference frame than the baselines).[1]

In Fig. 3, I plot the astrometric shift $\vec{d}(\lambda)$ in the plane of the sky (left), as well as in a map of the full sky (shift are relative to the star position). Blue is for 2.0μm and red is for 2.2μm. Hour-Angle and Declination of each observation is also displayed.

It is clear that the blue is shifted toward the zenith while the red is shifted toward the horizon, which is expected from atmospheric dispersion. Therefore, *assuming the previous equation is correct*, the signs between the UV-plane and the differential-phases of `amdlib-2.99` are consistent with the (North,East) reference frame.

[1] By the way, I checked that the 3 phases are properly fitted into a 2D astrometric shifts. Reversing the sign of whatever differential-phase leads to a significantly reduced fit quality. This re-validates the first point of sec. 2.

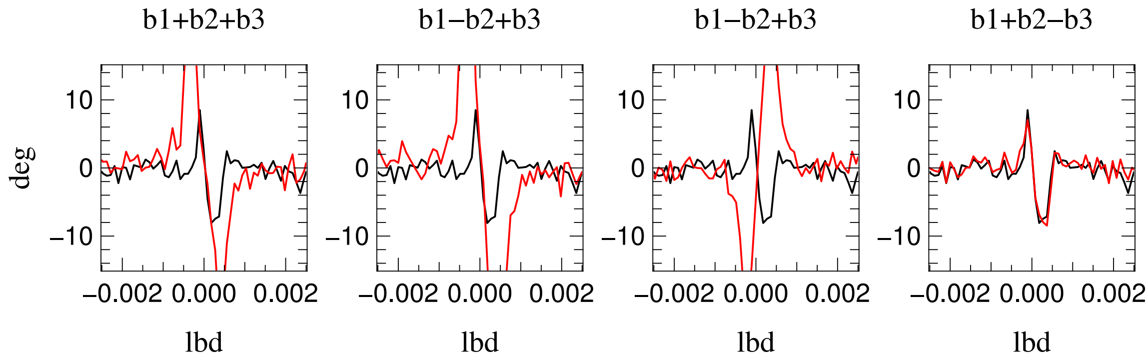

Figure 1*: Red: closure of the differential-phases computed with 4 different triangle (see titles). Black: differential closure-phase. Only the triangle b1+b2-b3 is closed and reproduces well the closure-phase.*

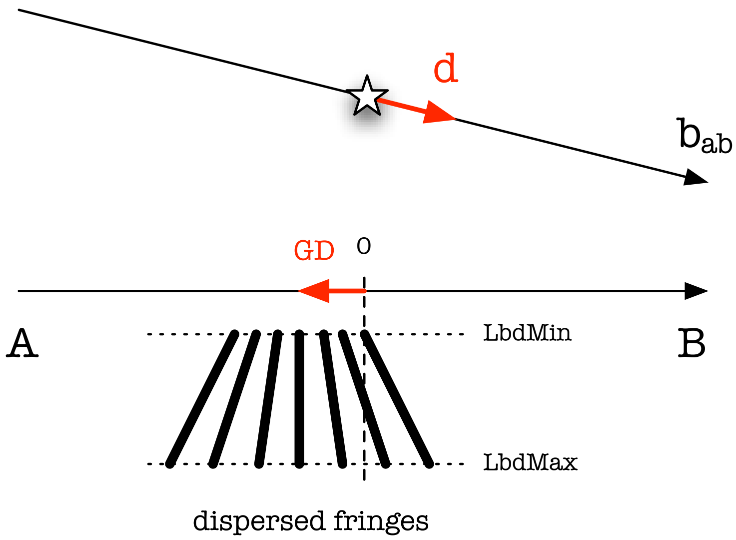

Figure 2*: A positive astrometric shift d along the baseline creates a negative group-delay displacement GD, corresponding to a positive phase derivative in the dispersed fringes.*

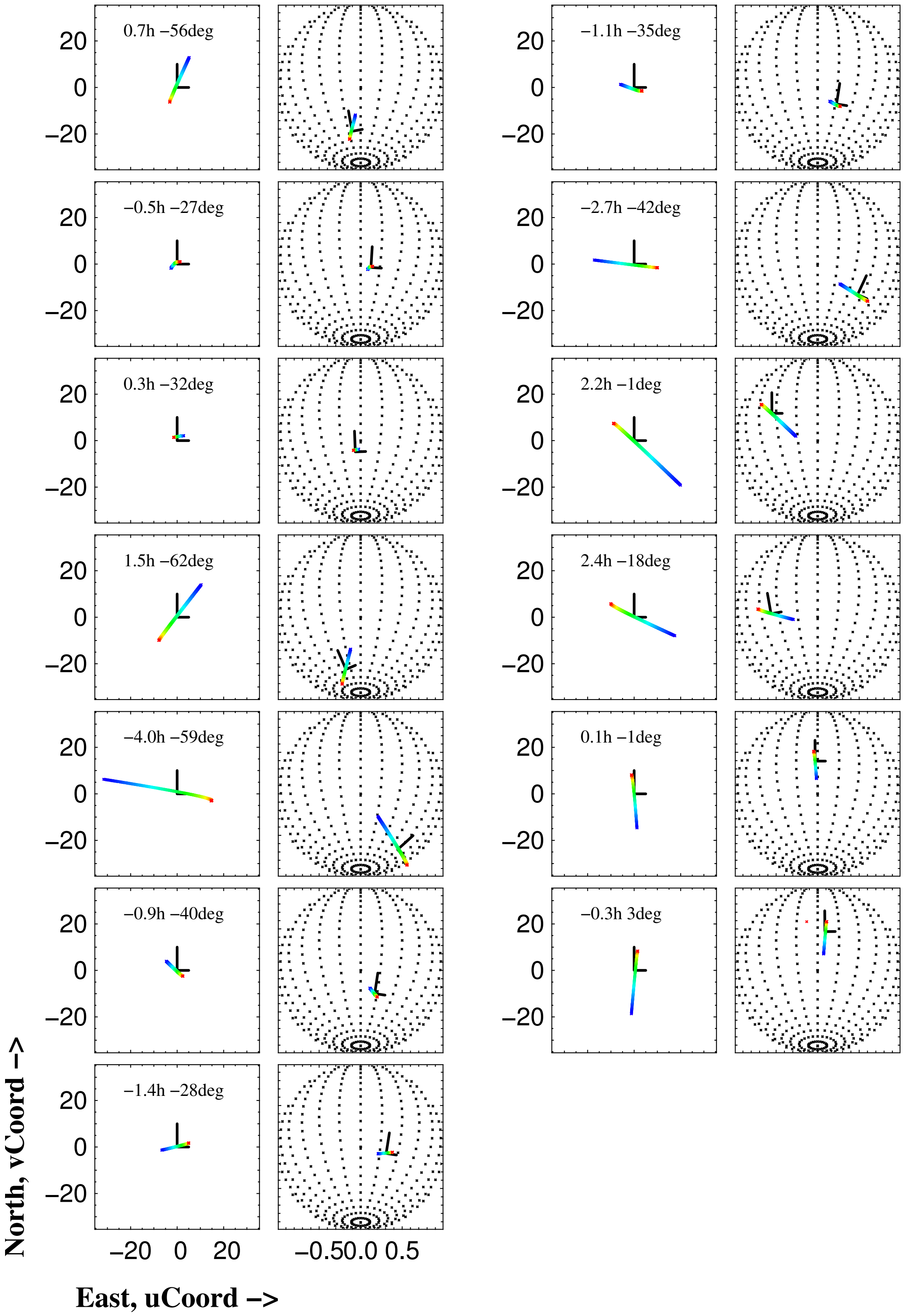

Figure 3: *Astrometric shift as measured by* `amdlib-2.99` *and assuming equation of sec. 3 Blue is* 2.0μm *and red is* 2.2μm. *The shift is represented in a reference frame attached to the star (left) and on a map of the all-sky (right). North is Up and East is right. HA and dec of each observation is displayed.*