AUTHOR: ALETHA DE WITT
HARTRAO / NRF

Co-Authors:
Alessandra Bertarini, IGG & MPIfR
Christopher Jacobs, JPL, Caltech/NASA
Jonathan Quick, HartRAO / NRF
Shinji Horiuchi, Tidbinbilla / CSIRO
Taehyun Jung, KASI
Jim Lovell, UTAS
Jamie McCallum, UTAS
Geraldine Bourda, University of Bourdeaux
Patrick Charlot, University of Bourdeaux

COMPLETING THE K-BAND CELESTIAL REFERENCE FRAME IN THE NORTH

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ABSTRACT

K-band (22 GHz) radio observations have the potential to form the basis for the most accurate celestial reference frame ever constructed. Relative to the standard S/X (2.3 / 8.4 GHz) observing bands, K-band is expected to exhibit a reduction in extended source morphology and core-shift. This reduction in astrophysical systematics should allow for a more stable celestial reference frame at K-band and should also be advantageous in tying the VLBI radio frame to the Gaia optical frame. The current K-band catalogue consists of only 274 sources from a few VLBA sessions and uncertainties in source positions at the ~100 micro-arcsecond level. Modern 2 Gbps data rates are 16 times better than previous observations, yielding a four fold increase in sensitivity. Southern observations to reduce astrometric systematics and to complete the sky coverage at K-band are under way. However, new astrometric and imaging observations are also required in the North to improve K-band precision and spatial coverage, and to map the intrinsic source structure so that their astrometric quality can be evaluated. A proposal for astrometric and imaging observations using the Very Long Baseline Array (VLBA) at K-band is now in progress. We discuss some of our first results from our K-band VLBA campaign.

BACKGROUND

At the standard S/X frequencies, many ICRF radio sources exhibit spatially extended structure that may vary in both time and frequency, degrading the accuracy of estimated source positions.

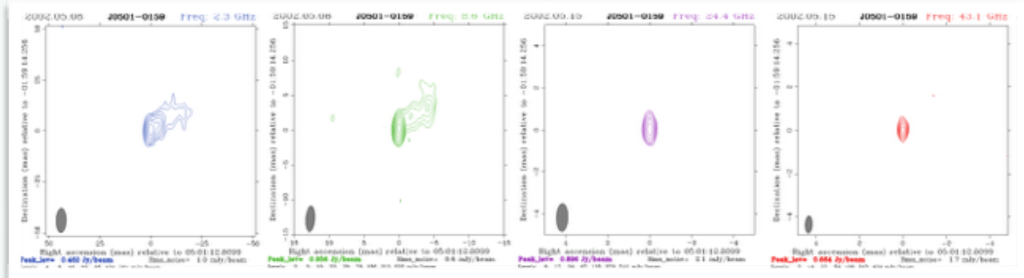

Fig. 1 Source structure vs. frequency (Charlot, 2010)

On VLBI scales sources tend to become more compact and show reduced core-shift at shorter wavelengths (higher frequencies).

Both these improvements allow for a more well-defined and stable reference frame at higher frequencies, such as 22 GHz (K-band).

This will be particularly advantageous in tying the VLBI reference frame to future optical reference frames such as Gaia.

Astrometric and imaging observations by Lanyi et al. (2010) & Charlot et al. (2010) provide a foundation for the development of a reference frame at K-band.

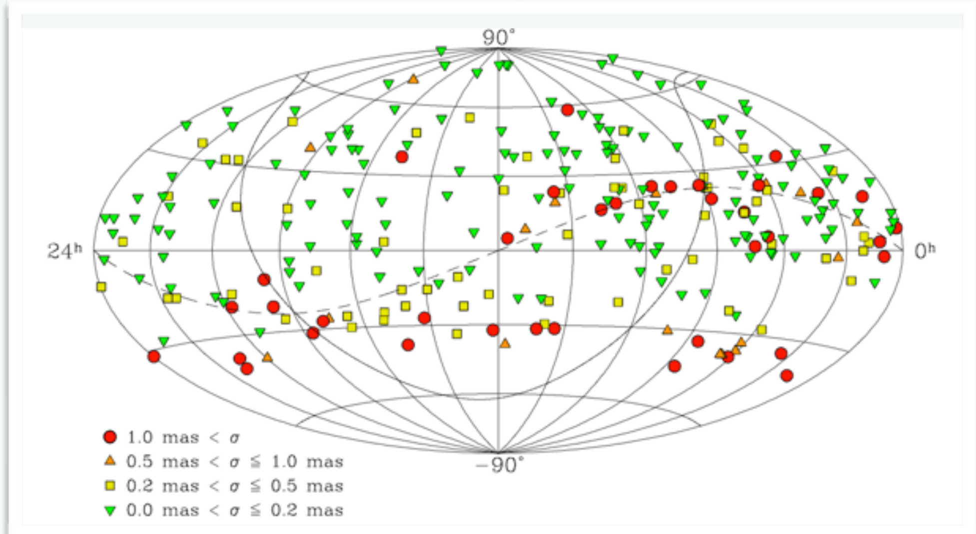

Fig. 2 The distribution of CRF sources at 24 GHz from ten, 24 observing sessions with the VLBA (Lanyi et al., 2010).

The current K-band catalogue (see Fig 2.) consists of only 279 sources with weak coverage in the Southern Hemisphere, several localised regions with no sources, and uncertainties in source positions at the ~100 micro-arcsecond level.

Dedicated observations to improve the precision and spatial coverage of the K-band CRF are currently underway !

GOALS

> The realisation of a full-sky, K-band celestial reference frame by 2018, in time for the Gaia optical reference frame.

> To obtain comparable density and accuracy in the south to that obtained from the astrometry that was done with the VLBA in the north.

> Further densification of the K-band celestial reference frame in the north using the VLBA.

> Our ultimate goal is to reach accuracies better than 70 µas to match the Gaia predicted accuracy for V=18 visual magnitude quasars.

K-BAND CRF IN THE NORTH

> Astrometric and Imaging Observations (proposal code BJ083, 4 x 24 hours), using the Very Long Baseline Array (VLBA), in progress.

> 246 sources north of about -30° declination.

> The source list is based upon the X/Ka catalogue (Jacobs, 2014) and the flux cut-off is set to be 100 mJy.

> **Completed observations for BJ083a and BJ083b.**

> Data reduction using PIMA (L. Petrov) and imaging using DIFMAP.

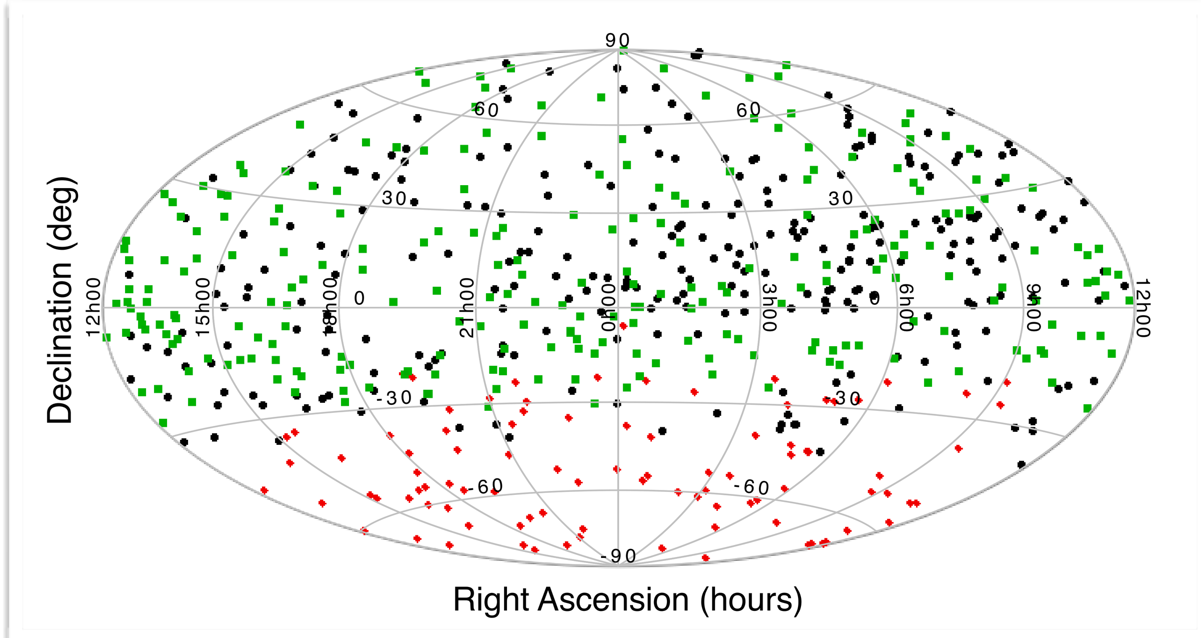

Fig. 5 The 279 sources from Lanyi et al. (2010) & Charlot et al. (2010) are shown in black. The 246 sources being observed using the VLBA are shown in green. The 106 sources from the southern astrometric observations are shown in red (EVGA Azores 2015).

PRELIMINARY IMAGING RESULTS FROM THE VLBA

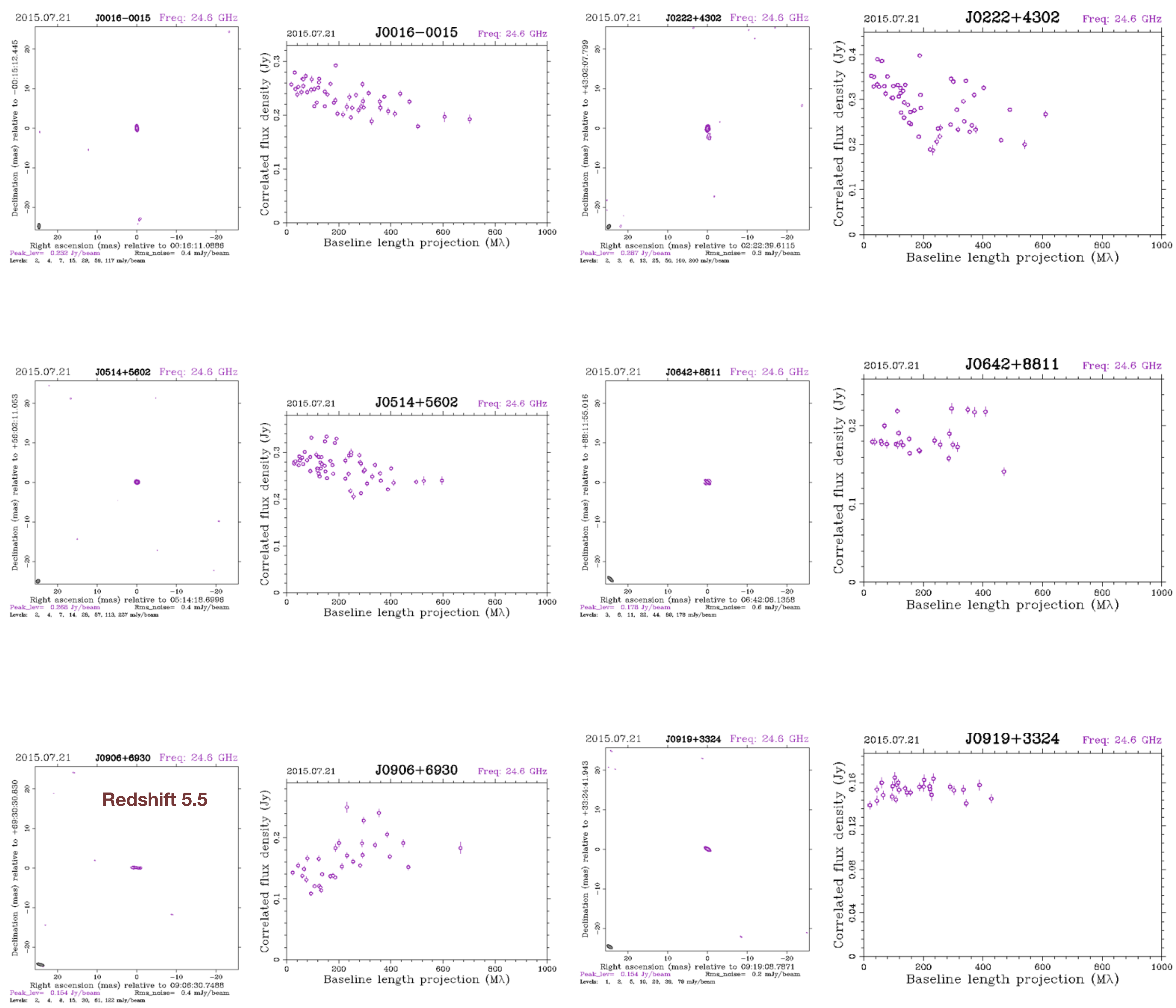

Fig. 2 Representative (from 108 total maps from BJ083a) preliminary maps and visibility amplitude vs uv-distance plots. North is up and East is to the left.