

VLBI2010 imaging and structure correction impact

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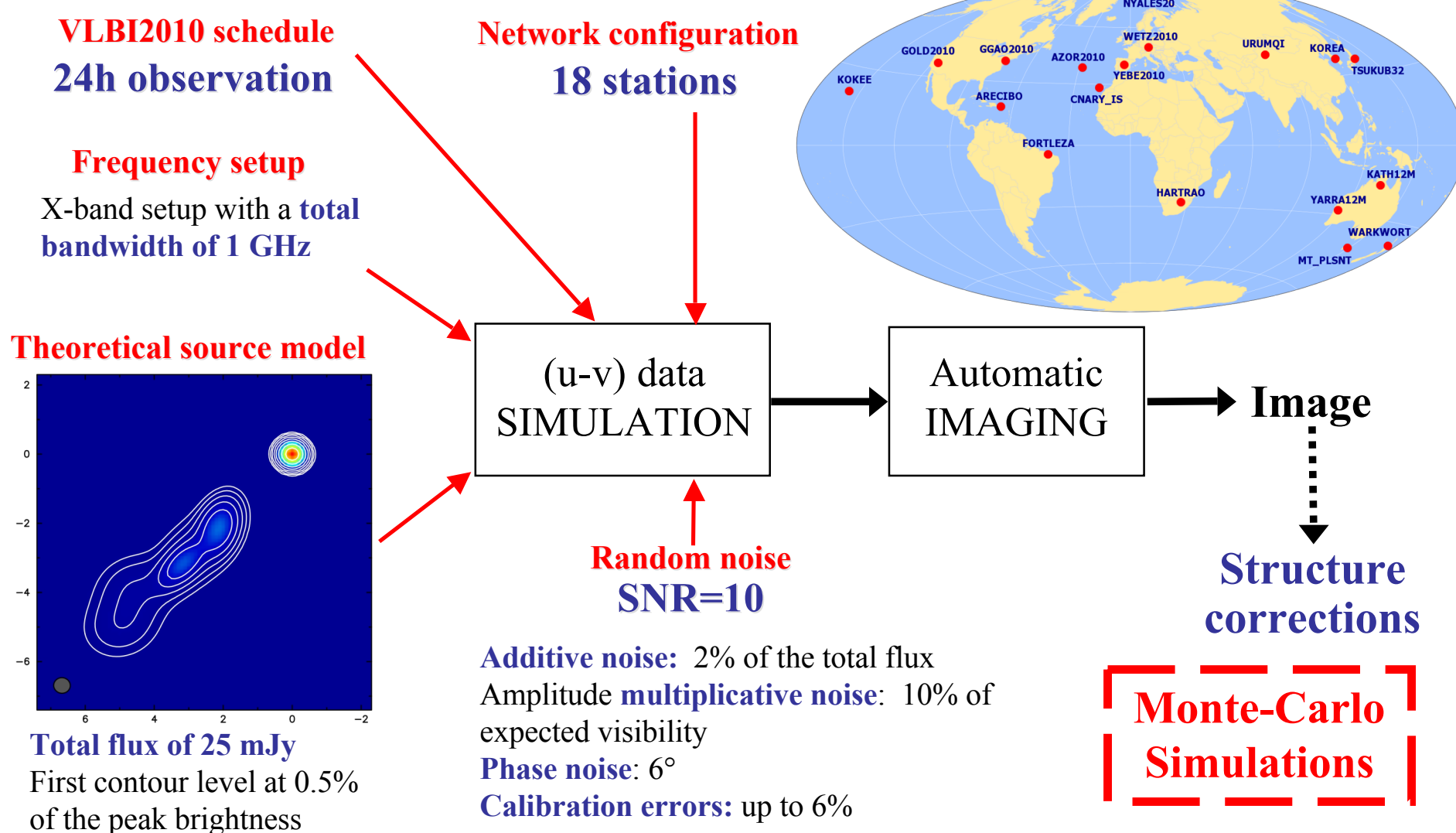


Context

The next-generation geodetic VLBI system – the VLBI2010 system – is expected to become operational in the forthcoming years. Major progresses have been accomplished in the last few years with the construction of new VLBI2010-compliant antennas in several countries and the development of compatible hardware. With this new system, significant improvements in the determination of the major IVS products are anticipated, including the **amelioration of the International Celestial Reference Frame (ICRF)**.

ICRF sources are generally not point-like on VLBI scales, which induces a **presently-unmodeled structural delay** in the group delay observable. This additional delay may range from a few picoseconds (for compact structures) to tens or hundreds of picoseconds (for more complex structures). As a systematic effect, this structural delay may be modeled if source structure is known. In the future, it is anticipated that such **structure corrections may be routinely determined and applied**, taking advantage of the denser VLBI2010 observing schedules which should permit source imaging on a daily basis. The present study discusses the **accuracy of the structure corrections** derived from VLBI2010 data based on simulations.

Imaging procedure and structure corrections calculation



Simulations are carried out using a **processing pipeline** schematised on the left-hand side. First, simulated VLBI2010 data are generated with a SNR of 10 using a 18-station 24-hour schedule and a theoretical source model. The corresponding images are then automatically produced. Example of images for sources at **three different declinations** (-40° , 0° and $+40^\circ$) are presented in the next section. The quality of these images is consistent with previous studies [1] [2] which showed that the **VLBI2010 system is generally well suited to produce high-quality images** of extragalactic radio sources.

In order to evaluate the accuracy of the structure corrections derived from VLBI2010 images, a sample of **25 similar images** was generated from the same input source model but using a **different input noise level** in each simulation (as obtained by a Monte-Carlo method). Structure corrections are then calculated as described in [3].

In a previous study [4], structure correction statistics were obtained for the whole (u-v) plane. The present analysis focuses on the **(u-v) points actually observed**. For each (u,v) point, 25 structure correction values (one per simulated image) are calculated. Then the **median** and the **standard deviation** (with respect to the theoretical structure correction value) are derived. The results obtained are presented in a graphical form in the next section.

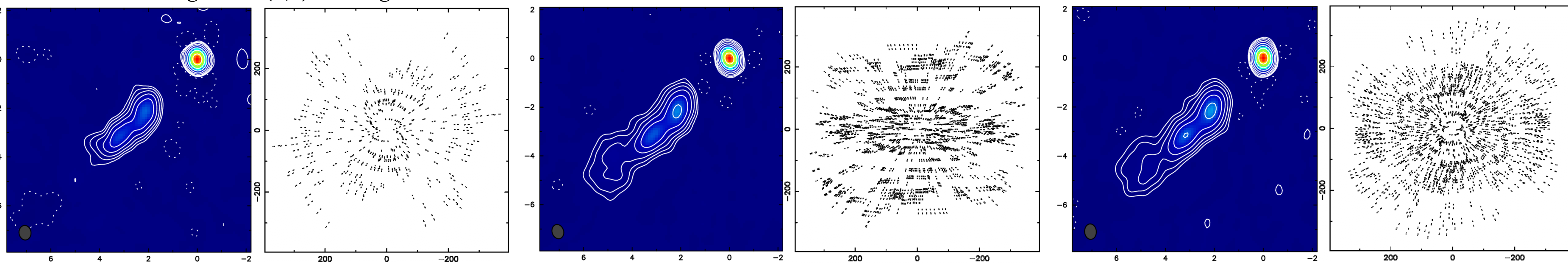
Simulated images and structure corrections

-40°

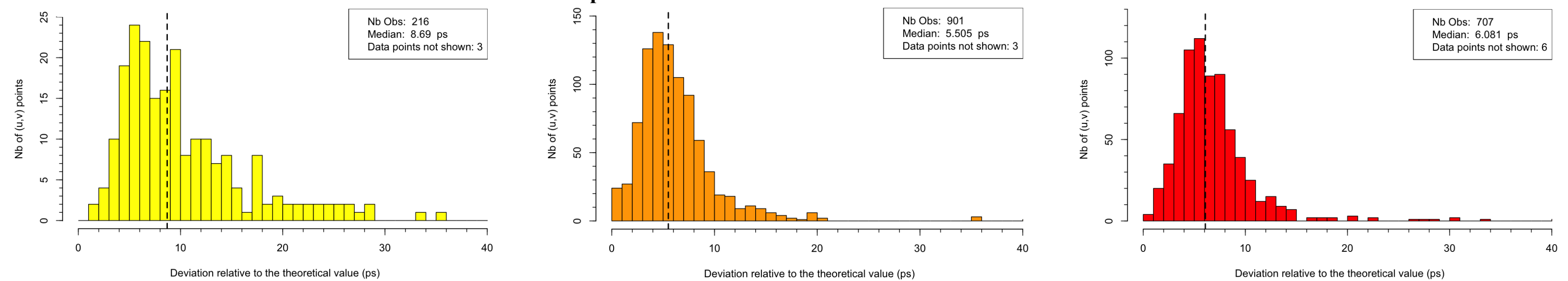
0°

+40°

• Simulated images and (u,v) coverage

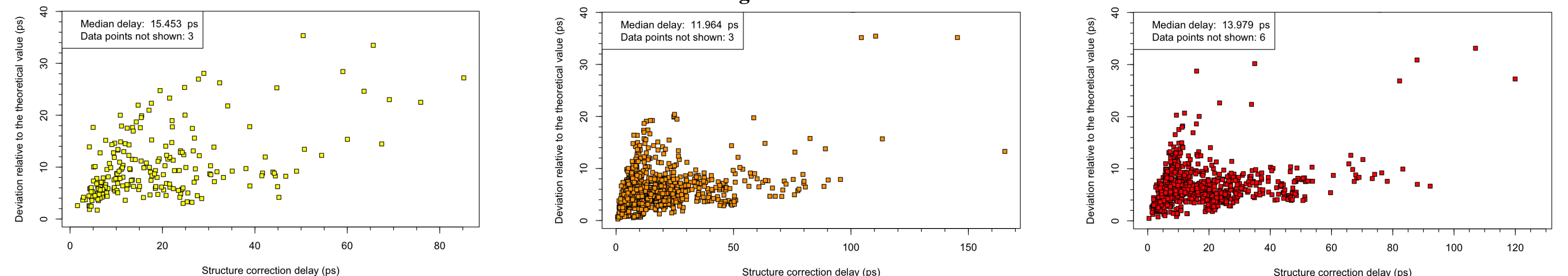


• Deviation of the simulated structure corrections with respect to the theoretical values



These histograms represent the distribution of the deviations of the simulated structure corrections relative to the theoretical values for all observed (u-v) points. The median value is plotted as a dashed line. In all, we conclude that the **structure correction delay may be estimated to approximately 6 ps in this case**, which represents a **2-mm level error**.

• Deviation of the simulated structure corrections as a function of the magnitude of the structure correction



These scatter plots represent the deviation of the simulated structure corrections relative to the theoretical delay for all observed (u-v) points as a function of the magnitude of the structure correction (i.e. the median structural delay). As expected, **the greater the magnitude of the delay, the greater the deviation**.

In the future, we plan to extend these calculations to 100 Monte-Carlo simulations to enhance the statistics. We also plan to explore different theoretical source model and VLBI2010 observing schedules.

References

- [1] Collioud & Charlot, 5th IVS General Meeting Proceedings, 2008
[2] Petrachenko et al., Design Aspects of the VLBI2010 System - Progress report of the VLBI2010 Committee, 2009

- [3] Charlot, Astronomical Journal, 99, 1309, 1990
[4] Collioud & Charlot, 6th IVS General Meeting Proceedings, 2010