

## Will the next generation of VLBI instruments allow for an order of magnitude improvement in Astrometry?

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We are at the cusp of a generational shift in the power of radio interferometers, with both the SKA and ngVLA planning for exciting new and powerful instruments. These will be used in conjunction with other radio telescopes to provide VLBI with an order of magnitude greater sensitivity. Furthermore, the new frequencies that will be covered will allow enhanced VLBI observations of sources that can only be observed at high frequencies (e.g. various maser lines) or low frequencies (e.g. pulsars slightly misaligned with our line of sight). We have been exploring the implications of these new instruments, as sensitivity alone will not improve over the current astrometric limits - these being systematic.

Traditional techniques for differential phase referencing will not be able to significantly overcome the systematic limits, nor extend the current moderate range of frequencies where such methods can be expected to work. Fortunately, new methods such as Source/Frequency Phase Referencing and/or MultiView Astrometry both reduce the systematic limits and extend the range of operating frequencies [1].

By returning to the fundamental parameterisation we are able to express all the current and in-development methods of (relative) micro-arcsec astrometry in a common format. This highlights the opportunities and possibilities for next-generation instruments, such as application at frequencies ranging between hundreds of GHz to hundreds of MHz (using very different solutions) and increasing the astrometric accuracies (per epoch) by an order of magnitude to ~1µas above 8GHz, ~10µas at 1.4GHz and ~100µas at 0.3GHz.



**Figure 1**: Theoretical astrometric accuracy for the next generation instruments. Curves are shows for the thermal limits at a dynamic range of 1000:1 (black) and various calibration methods: conventional phase referencing with an in-beam reference (red), MultiView (blue) and Source/Frequency Phase Referencing (yellow). Potential science objectives suitable for ~µas resolution are marked.

Preliminary steps have been taken to confirm that these new methods will deliver on their promise; future applications that make full use of these capabilities will allow for major improvements in the astrophysical understanding of our Universe.

## References

 M. Rioja and R. Dodson, "Precise Radio Astrometry and New Developments for the Next Generation of Instruments", A&ARv, 2020, 28, 6