

## Tying multiple Radio Wavelength Celestial Frames to the Gaia Optical Frame

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Very Long baseline Interferometry (VLBI) at 3.6 cm wavelength has for several decades been the only source of sub-milliarcsecond (mas) accurate celestial reference frames. The last decade has seen high accuracy VLBI work extended to 1.2 cm and 0.9 cm wavelengths which now provide independent data sets for testing reference frame accuracy. These efforts are now joined by the Gaia Data Release #2 frame at optical wavelengths providing for the first time results from a totally independent technique and thus a more stringent test of the true accuracy of celestial frames.

With four frames now available, this paper will inter-compare all the frames and attempt to set bounds on the accuracy of each frame. While precision of the tie between frames is approximately 10 to 20  $\mu$ as, we already see sign of systematic errors. In particular, the north-south imbalance in VLBI networks leaves VLBI frames vulnerable to zonal errors. We will discuss our efforts to control those errors so that astrophysical offsets between the optical and radio centroids will be exposed for scientific study at unprecedented levels of accuracy which may enable new insights into the processes within AGNs.