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A multi-frequency Celestial Reference Frame at S/X, K and X/Ka-band

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We present a Celestial Reference Frame (CRF) based on the combination of independent, multi-frequency radio source position catalogs using nearly 40 years of Very Long Baseline Interferometry observations at the standard geodetic frequencies at S/X band and about 15 years of observations at higher frequencies (K and X/Ka). The final catalog contains 4617 sources.

The novelty in our approach is the combination of independent, multi-frequency radio source position catalogs through a rigorous combination by carrying over the full co-variance information of each catalog through the process of accumulation of normal equation systems instead of using only the positions themselves. Through the novel process of combination, a complete co-variance matrix of the entire set of sources across the three bands is provided. Special validation routines were used to characterize the random and systematic errors between the input reference frames and the combined one.

The resulting CRF contains precise positions of 4617 compact radio astronomical objects, 4536 measured at 8~Ghz, 824 sources being observed also at 24 GHz and 674 at 32 GHz. The frame is aligned with ICRF3 within ±3 μas and shows an average positional uncertainty of 0.1 mas in right ascension and declination. No significant deformations can be identified. Comparisons with Gaia-CRF remain inconclusive, nonetheless significant differences between all frames can be attested.