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A 3D tomographic reconstruction method to analyze Jupiter's electron-belt emission observations

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Multi-dimensional reconstruction techniques of Jupiter's synchrotron radiation from radio-interferometric observations were first developed by Sault et al. [Astron. Astrophys., 324, 1190-1196, 1997]. The tomographic-like technique introduced 20 years ago had permitted the first 3-dimensional mapping of the brightness distribution around the planet. This technique has demonstrated the advantage to be weakly dependent on planetary field models. It also does not require any knowledge on the energy and spatial distributions of the radiating electrons. On the downside, it is assumed that the volume emissivity of any punctual point source around the planet is isotropic. This assumption becomes incorrect when mapping the brightness distribution for non-equatorial point sources or any point sources from Juno's perspective. In this paper, we present our modeling effort to bypass the isotropy issue. Our approach is to use radio-interferometric observations and determine the 3-D brightness distribution in a cylindrical coordinate system. For each set (z, r), we constrain the longitudinal distribution with a Fourier series and the anisotropy is addressed with a simple periodic function when possible. We develop this new method over a wide range of frequencies using past VLA and LOFAR observations of Jupiter. We plan to test this reconstruction method with observations of Jupiter that are currently being carried out with LOFAR and GMRT in support to the Juno mission. We describe how this new 3D tomographic reconstruction method provides new model constraints on the energy and spatial distributions of Jupiter's ultra-relativistic electrons close to the planet and be used to interpret Juno MWR observations of Jupiter's electron-belt emission and assist in evaluating the background noise from the radiation environment in the atmospheric measurements.