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The *e-MERGE* e-MERLIN/VLA/EVN wide-field deep radio survey of GOODS-N

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The initial description paper for the e-MERGE deep (~1μJy/bm), narrow (30x30 arcmin^2 field) high-resolution (~1.5"→0.25") radio survey of GOODS-N is now published [1]. Images are now available to the e-MERGE consortium from Data Release-1 (*DR1*) covering the inner central 15'x15' arcmin.^{2} region. This release involves a VLA 5.5GHz mosaic (~0.5" beam, 1.5μJy/bm) + a VLA (42-hrs) + 25% of the deep e-MERLIN 1.5GHz data (108hrs, 4.5/18 days). The latest results from joint e-MERLIN+VLA 1.5GHz imaging are presented along with a short discussion of combination imaging with datasets with differing sensitivities, and a suite of combination images chosen for optimum science extraction. Issues covered include the point-spread function (PSF) of such datasets in combination imaging – and the problems encountered in flux measurements when such PSFs are significantly non-Gaussian. The e-MERGE results demonstrate the ability of high-resolution imaging at 1.5GHz to spatially resolve regions of radio emission associated with star-formation within the 848 DR1 catalogued radio sources out to $z\geq3$ and differentiate such regions from those associated with actively accreting AGN-jet systems.

The DR2 enhancement is under way utilizing all the e-MERLIN+VLA 1.5GHz (unaveraged) data and imaging out to the full 30x30 arcmin^2 field of view, which will produce a single wide-field image to a depth of ~500nJy/bm in the inner 7.5 arcmin diameter field and ~1μJy/bm in the surrounding outer annulus – a factor of x4 increase in field size and x2 increase in depth in the inner region. Challenges include TB size datasets, combination images with 16Mpixels (4000x4000@45mas separation), deep (~0.5M) cleaning deconvolution cycles, and primary beam corrections in the presence of heterogenous radio arrays with 25m, 32m, and 76m antennas – together with multiple weighting schemes. Image delivery is expected in 2022.

Additional 24-hrs of (associated) e-MERGE 1.5GHz data were observed with the EVN [2] providing mas-scale resolution at 582 correlation positions centered on e-MERLIN field, the vast majority of which lie within the DR1 area (central sensitivity ~9μJy/bm, bm~5mas.) Initial results for combination EVN+e-MERGE 1.5GHz imaging from a sample of 31 AGN-dominated radio sources are discussed with regard to the majority being compact core+(galactic-scale) extended radio structures, possibly the high-redshift tail to the local Universe FR0-type radio structures [3], the most common form of radio AGN systems found in the Universe (Example: Figure 1 (Right)).

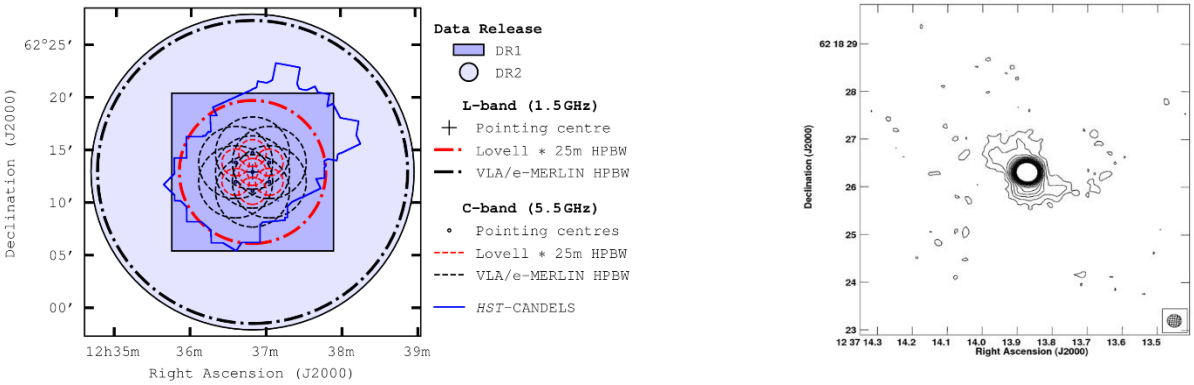

Figure 1. (*Left*) Diagram of e-MERGE survey area. (*Right*) DR1 1.5GHz image of 637μJy AGN system at z=3.44

1. T.W.B. Muxlow, *et al.*, Monthly Notices of the Royal Astronomical Society **495**, 8, May 2020, pp 1188-1208.

2 J.F. Radcliffe, *et al.*, Astronomy & Astrophysics **619 A48**, 31, July 2018, pp. 1-14.

3 R. D. Baldi, A. Capetti, & F. Massaro, Astronomy & Astrophysics **609 A1**, 22 August 2017, pp. 1-10.