UV–Visible observations with HST in the JWST North Ecliptic Pole Time-Domain Field – III.

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ABSTRACT

We report on a UV–Visible HST imaging survey of the JWST North Ecliptic Pole (NEP) Time-Domain Field (TDF). Using nine CVZ and pseudo-CVZ opportunities, we secured observations with WFC3/UVIS in F275W and with ACS/WFC in F435W and F606W to m275 ≃ 28 mag. Our HST survey is designed to provide near-contiguous 3-filter coverage of the central 5′ × 5′ of this new community field for time-domain science with JWST (Jansen & Windhorst 2018). The JWST NEP TDF at (RA,Decl) = (22:17:47.896, +65:49:21.54) is located within JWST’s northern Continuous Viewing Zone, will span ~14′ in diameter, is devoid of sources bright enough to saturate the sensitive NIRCam detectors, has low Galactic foreground extinction, and will be roughly circular in shape. JWST GTO program 1176 will initially sample the NEP TDF during Cycle 1 at four distinct orientations (“spokes”) with JWST/NIRCam, and take NIRISS dilute grism spectroscopy in parallel such that it overlaps the coverage of an alternate NIRCam orientation. This is the only region in the sky where JWST can observe a clean extragalactic deep survey field of this size at arbitrary cadence at or at arbitrary orientation. This will crucially enable a wide range of new and exciting time-domain science, including high redshift transient searches and monitoring (e.g., SNe), variability studies from Active Galactic Nuclei to brown dwarf atmospheres, as well as proper motions of extreme scattered Kuiper Belt and comets beyond the distance of Neptune, and of Galactic brown dwarfs, low-mass stars, and ultracool white dwarfs. Ancillary data across the electromagnetic spectrum will exist for the NEP TDF and surrounding area when JWST science operations commence in 2021, ensuring a rich legacy of the UV–Visible HST observations. This deep X-ray observations; ground-based Upgr2JHK imaging, narrow-band spectrophotometry, and spectroscopy; sub/mm observations; and both short- and long-wave radio observations.

Fig. 1 — Measured astrometric offsets between the HST and Gaia DR2 astrometric reference frames as defined by 364 detected sources in common for [a] the initial pipeline-reduced drizzled and CTI-corrected mosaics, as reported by the WCS keyword values in the FITS headers, and [b] the same mosaics after correcting for systematic mean rotation and offsets resulting from the uncertainties in the absolute positions of the guide stars used in a particular visit. (Adapted from Jansen, Groggin, et al. 2020, in prep.). [c] Measured astrometric residuals with respect to the Gaia DR2 astrometric reference frame from a preliminary analysis of 24,813 objects observed in Swoosh with both LBT/LBC and Subaru/HSC within the ~23′ × 25′ area surrounding the JWST NEP Time-Domain Field. (Adapted from V. Jones 2019).

Fig. 2 — [left] Star-Galaxy separation, and [right] differential number counts. Point sources were identified and the surface brightness limit assessed in plots of source magnitude vs. fwhm for each of the three HST filters. Differential number counts of stars (red) and galaxies (black) are shown in units of number per 0.5 mag per deg2 for the ACS/WFC filters, and in units of number per mag per deg2 for the WFC3/UVIS F275W filter. The galaxy number counts follow a power law to m275 ≃ 28–29 mag, before turning over due to incompleteness, while the stellar counts follow a much shallower trend. (Figures from C. White 2019).

Fig. 3 — Exposure maps for [left] the ACS/WFC F435W and F606W images, showing the near-contiguous coverage of the central portion of the JWST NEP Time-Domain Field in these filters, as well as areas of 2- or 3-spectra overlap for cross-calibration and time-domain science, and [middle] the WFC3/UVIS F275W images, where the smaller footprint of WFC3/UVIS results in larger gaps in coverage and smaller areas of 2-spectra overlap. Each tile is labeled with its visit number, [right] Color composite of the combined exposure maps, with WFC3/UVIS F435W+606W coverage in green and WFC3/UVIS in magenta, highlighting the area with 3-filter UV–Visible coverage, which appears here as white. (Adapted from Jansen, Groggin, et al. 2020, in prep.).