The *JWST* North Ecliptic Pole Survey Field for Time-domain Studies

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ABSTRACT

The *JWST* North Ecliptic Pole (NEP) Time-Domain Field (TDF) is located within *JWST*'s northern Continuous Viewing Zone (CVZ), will span ∼14′ in diameter (∼10′ with NIRISS coverage) and will be roughly circular in shape (initially sampled during Cycle 1 at 4 distinct orientations with *JWST*/NIRCam's 4.4′×2.2′ FoV – the *JWST* "windmill") and will have NIRISS slitless grism spectroscopy taken in parallel, overlapping an alternate NIRCam orientation. This is the *only* region in the sky where *JWST* can observe a clean extragalactic deep survey field (free of bright foreground stars and with low Galactic foreground extinction A_V) *at arbitrary cadence* 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 Oort Cloud Objects, and of nearby Galactic brown dwarfs, low-mass stars, and ultracool white dwarfs. We therefore welcome and encourage follow-up through GO programs of the initial GTO observations to realize its potential as a *JWST* time-domain *community field*. The *JWST* NEP Survey field was selected from an analysis of *WISE* 3.4+4.6 μm, 2MASS *JHKs*, and SDSS *ugriz* source counts and of Galactic foreground extinction, and is one of very few such ∼10′ fields that are devoid of sources brighter than $m_{\rm AB}$ = 16 mag. We have secured deep ($m_{\rm AB} \gtrsim 26$ mag) wide-field (∼23′×25′) *Ugrz* images of this field and its surroundings with LBT/LBC, and have scheduled MMT/MMIRS *YJHK*, as well as VLA 3 GHz and VLBA 4.5 GHz radio observations. Requests for *HST* WFC3/UVIS and ACS/WFC ultraviolet–visible and *Chandra*/ACIS X-ray images are pending, and proposals for *SOFIA* far-IR and IRAM30m (sub)mm observations are planned. We anticipate that ancillary data across the electromagnetic spectrum will exist for this field when *JWST* science operations commence in Spring 2019.

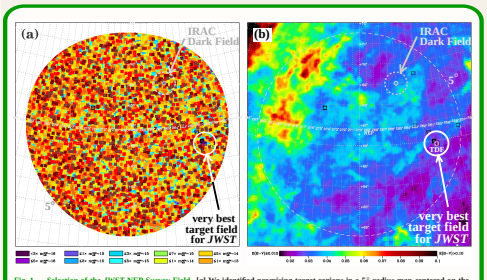


Fig. 1 — Selection of the *JWST* NEP Survey Field. [a] We identified promising target regions in a 5° radius map centered on the NEP of *WISE* ∼4 μm source count penalties to identify the best region for a *JWST* NEP extragalactic survey. *Very few 10′×10′ regions exist that are free of sources brighter than $m_{\rm AB}$ = 16 mag.* The white arrow points to the *very best* region (small magenta contour within the white circle). For reference, we also indicate the location of the *Spitzer*/IRAC Dark Field (grey arrow and dashed circle).

[b] Map of $E(B-V)$ values (from Schlafly & Finkbeiner 2011) in the 11°×11° area around the NEP. The very best 10′×10′ region is indicated by a small magenta contour (within the white circle). The dashed circle with a radius of 5° indicates the *JWST* CVZ. In the best target field near (α, δ) = (*263°*, *+66°*), Galactic foreground extinction is very moderate at $E(B-V) \lesssim 0.028$ ($A_K \lesssim 0.015$ mag), proving that the paucity of 4μm-bright sources is *not* due to foreground dust.

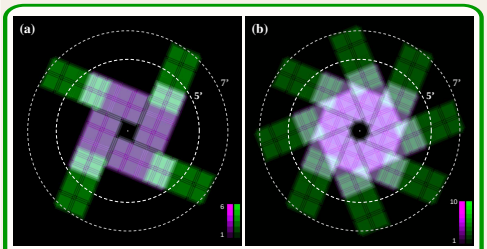
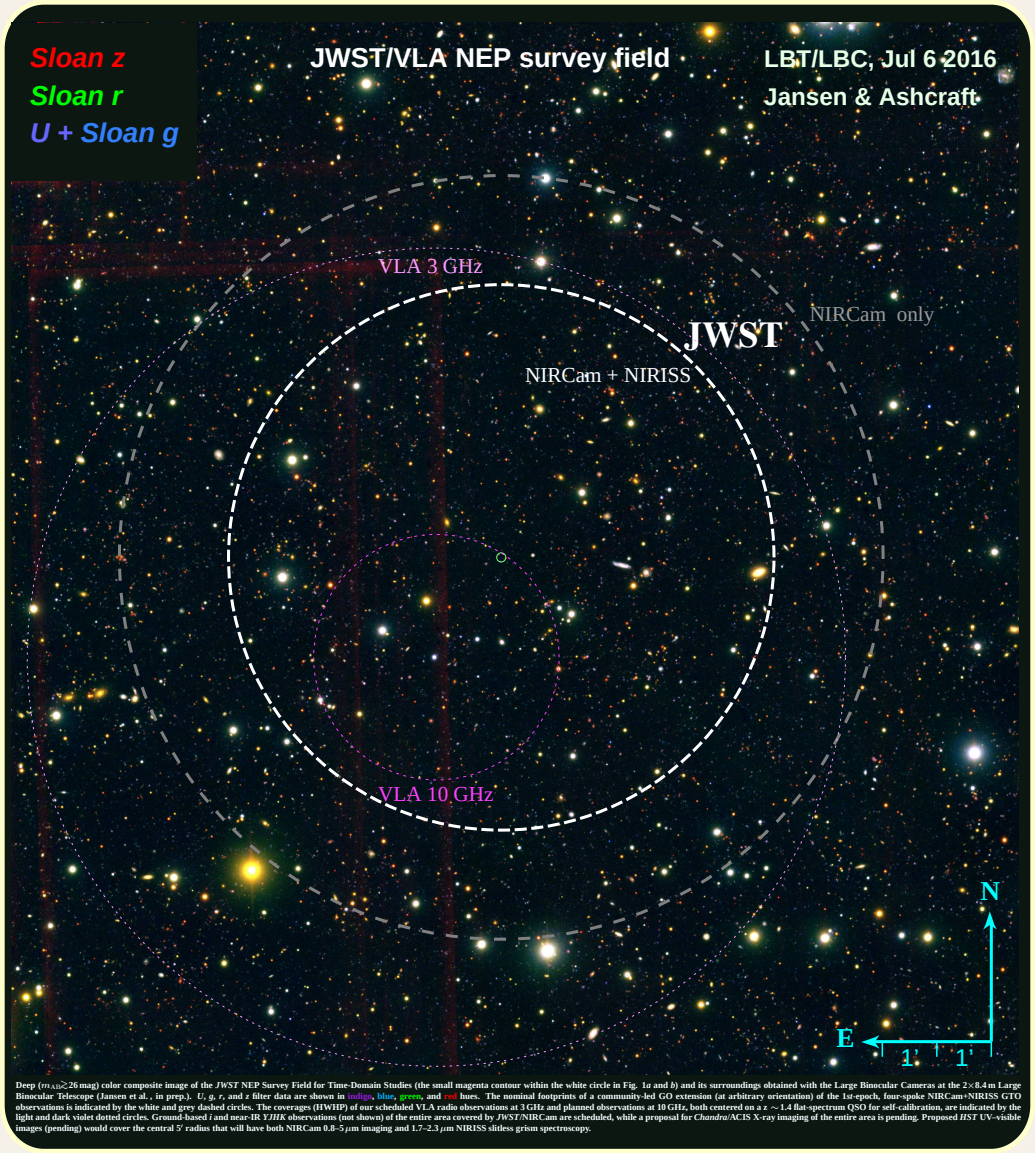


Fig. 2 — 15′×15′ exposure maps of [a] the core GTO *JWST* NEP survey, with parallel NIRISS slitless grism observations overlaid (purple-pink hues) on the exposure map of the primary NIRCam observations (in green), and of [b] an anticipated community-driven GO extension of the *JWST* NEP survey. The ΔPA with respect to the core footprint may be (but does not need to be) 45°, and the field may be revisited at any given orientation or cadence. The circles with 5′ and 7′ radius are also shown in the large LBT/LBC *Ugrz* color composite image at right. This NEP CVZ survey field is the *only* relatively empty region in the sky where *JWST* can observe at *arbitrary cadence* and *arbitrary orientation*, and will be the best field for time-domain studies with *JWST*.



Deep ($m_{\rm AB} \gtrsim 26$ mag) color composite image of the *JWST* NEP Survey Field for Time-Domain Studies (the small magenta contour within the white circle in Fig. 1*a* and *b*) and its surroundings obtained with the Large Binocular Cameras at the 2×8.4 m Large Binocular Telescope (Jansen et al. , in prep.). *U*, *g*, *r*, and *z* filter data are shown in indigo, blue, green, and red hues. The nominal footprints of a community-led GO extension (at arbitrary orientation) of the 1*st*-epoch, four-spoke NIRCam+NIRISS GTO observations is indicated by the white and grey dashed circles. The coverages (HWHP) of our scheduled VLA radio observations at 3 GHz and planned observations at 10 GHz, both centered on a $z \sim 1.4$ flat-spectrum QSO for self-calibration, are indicated by the light and dark violet dotted circles. Ground-based *i* and near-IR *YJHK* observations (not shown) of the entire area covered by *JWST*/NIRCam are scheduled, while a proposal for *Chandra*/ACIS X-ray imaging of the entire area is pending. Proposed *HST* UV–visible images (pending) would cover the central 5′ radius that will have both NIRCam 0.8–5 μm imaging and 1.7–2.3 μm NIRISS slitless grism spectroscopy.