**THE EUROPA IMAGING SYSTEM (EIS) FLIGHT INSTRUMENTS IN SPACECRAFT AND ENVIRONMENTAL TESTING FOR EUROPA CLIPPER.**

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**Introduction:** The Europa Imaging System (EIS; Fig. 1) for NASA's Europa Clipper Mission [1–3] combines a narrow-angle camera (NAC) and a wide-angle camera (WAC) to address high-priority geology, composition, ice shell and ocean science objectives. Both cameras have framing and pushbroom imaging capability (8 Mpixel) with broadband color filters. EIS data will be used to generate: cartographic and geologic maps; regional and high-resolution topography; GIS, color, and photometric data products; a database of plume-search observations; and control points tied to radar altimetry [4]. Our science goals are to:

- constrain the formation processes of landforms by characterizing geologic structures, units, and global cross-cutting relationships [5];
- identify relationships between surface and sub-surface structures and potential near-surface water [e.g., 6] detected by ice-penetrating radar [7];
- investigate compositional variability between and among landforms and correlate composition between individual features and regional units;
- search for evidence of recent or current activity, including potential erupting plumes [e.g., 8–11];
- constrain ice-shell thickness from global shape measurements via limb fits;
- characterize surface clutter to aid interpretation of deep and shallow radar sounding [7];
- characterize scientifically compelling landing sites and hazards by determining the nature of the surface at meter scales [12–14].

**EIS Narrow-Angle Camera (NAC):** The NAC (Fig. 2) has a 2.3° x 1.2° field of view (FOV) with a 10-µrad instantaneous FOV (IFOV), and from an altitude of 50-km achieves 0.5-m pixel scale over a 2-km-wide swath. Its 2-axis gimbal, ±30° cross- and along-track, enables independent targeting, allowing near-global (≥90%) mapping of Europa at ≤100-m pixel scale (to date, only ~14% of Europa has been imaged at ≤500 m/pixel), as well as regional stereo imaging. The gimbal slew rate is designed to be able to perform very high-resolution stereo imaging from as close as 50-km altitude during high-speed (~4.5 km/s) flybys to generate digital topographic models (DTMs) with ≤4-m ground sample distance (GSD) and ≤1-m vertical precision. The NAC will also perform high-phase-angle observations to search for potential erupting plumes [8–11]; a pixel scale of 10 km from $10^6$ km range means that the NAC can take advantage of favorable geometry for forward scattering by potential plumes even when distant from Europa. At the abstract deadline, the NAC has just completed thermal vacuum testing (TVAC) and will start final calibration before delivery to spacecraft assembly, test, and launch operations (ATLO).

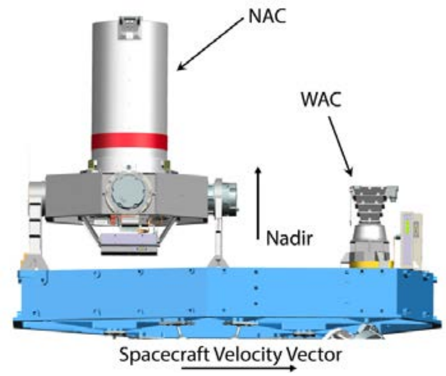


**Figure 1:** NAC (left) and WAC (right) on the spacecraft nadir deck (shaded blue).

**Figure 2:** NAC Flight Model in its off-nadir launch configuration during vibration testing at APL.

**EIS Wide-Angle Camera (WAC):** The WAC has a 48° x 24° FOV with a 218-µrad IFOV, and is designed to acquire 3-line pushbroom stereo and color swaths along flyby ground-tracks. From an altitude of 50 km, the WAC achieves 11-m pixel scale at the center of a 44-km-wide swath, generating DTMs with 32-m GSD and ≤5-m vertical precision. These data also characterize surface clutter for interpretation of radar sounding. WAC testing confirmed it meets or exceeds all requirements. The WAC was delivered in June 2022 and is now installed on the nadir deck (Fig. 3).

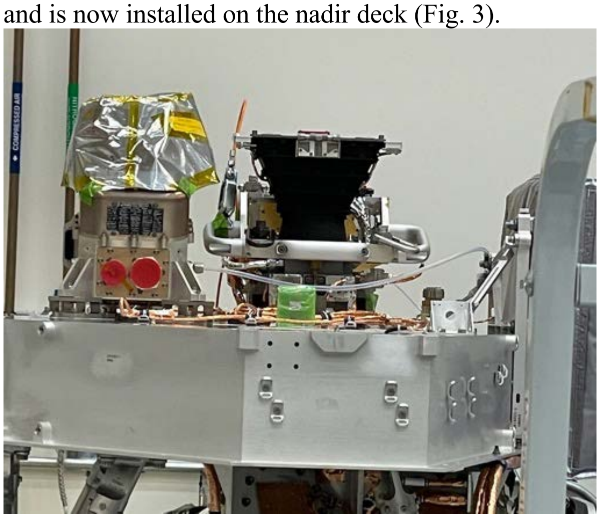

**Figure 3:** EIS WAC (center) Flight Model mounted on the spacecraft nadir deck in the clean room at JPL.

**Detectors and Electronics:** The cameras have identical rapid-readout, radiation-hardened 4k x 2k CMOS detectors [15] and can perform both pushbroom and framing imaging. Color observations are acquired by pushbroom imaging using six broadband filters (Table 1; Fig 4), allowing mapping of surface units and correlation with geologic structures, topography, and compositional units from other instruments [e.g., 16]. Radiation-hard data processing units (DPUs) take advantage of the CMOS rapid, random-access readout and use real-time processing for pushbroom imaging [17], including: WAC 3-line stereo, digital time delay integration (TDI) to enhance signal-to-noise ratios (SNR), and readout strategies to measure and correct jitter [18].

**Summary:** EIS data sets and collaborative science with other investigations will provide insight into Europa's global geology, ice shell, and the potential for recent or current activity, to fulfill the goal of exploring Europa to investigate its habitability. Updates will be provided on flight instrument performance from ground testing and expected datasets from the planned tour at Jupiter.

**Table 1:** NAC and WAC broad-band, stripe filters

| Filter | Wavelength (nm) | Key Uses |
|---|---|---|
| Clear | NAC: 350–1050<br>WAC: 370–1050 | Mapping, stereo, context imaging, best SNR for faint targets, e.g., plume searches |
| NUV | NAC: 355–400<br>WAC: 375–400 | |
| BLU | 380–475 | |
| GRN | 520–590 | (See Fig. 4) |
| RED | 640–700 | |
| IR1 | 780–920 | |
| 1µm | 950–1050 | |

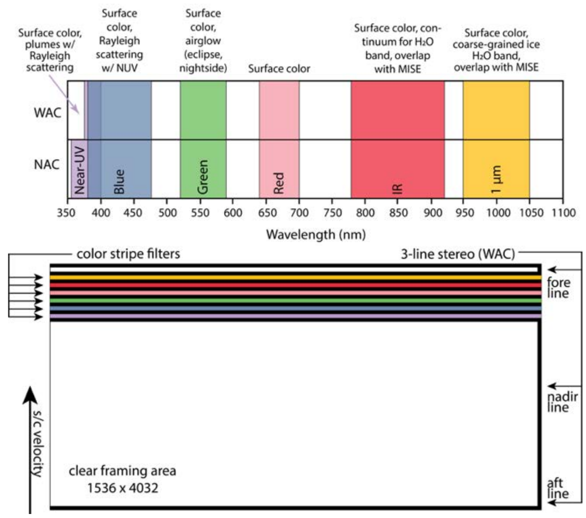


**Figure 4:** EIS broadband filter wavelengths (top) and filter layout (bottom).

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