Technology Roadmap for the HEterodyne Receiver for Origins (HERO)


The Origins Space Telescope is one of four large missions studied by NASA, which have been submitted to the 2020 Decadal Survey on Astronomy and Astrophysics. The Origins Space Telescope is a mid to far-IR satellite with a cooled 5.9 m primary mirror. Origins has three bolometer arrays as the baseline instruments and one upgrade instrument, the HEterodyne Receiver for Origins (HERO). HERO [1] is designed to study the trail of water from the ISM to protoplanetary disks. It covers a continuous wavelength range of 486 to 2700 GHz in only 4 bands. Each band has 29-pixel focal plane arrays, one for each polarization. Hero can carry out dual-polarization and dual-frequency observations. We aim for DSB receiver temperatures around 50 K for the 486 to 756 GHz band, 100K for the 756 - 1188 GHz band, 200K for the 1188 - 1782 GHz band and 300K for the 1782 to 2700 GHz. HERO has at least 6 GHz IF bandwidth (goal 8 GHz).

Sub-system | Component | HIFI | HERO |
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**Local Oscillator** | Synthesizer Technology | YIG-based Ka-Band+Active Frequency Multipliers + GaAs W-band power amps | CMOS or YIG-based W-band synthesizer + GaN. amps |
| Multiplied LO | Cascaded GaAs frequency multipliers | Cascaded Multipl. + On-chip Power Combining + 3D integ. |
**Cryogenic Detectors** | Mixer Technology | SIS, HEB | SIS, HEB |
| SIS sensitivity | 2 - 6 hv/k | 2 hv/k |
| HEB sensitivity | 13-18 hv/k | 3 hv/k |
| LNA Technology | lnP HEMT | Low-power SiGe HBT |
| Number of pixels | 1 | 2x9 |
| DC power/pixel | 10 mW | 0.5 mW |
| Mixer. Assembly | Quasi-optical | Waveguide |
**Backend** | IF Processing | GaAs HEMT amplifiers |
| Spectrometer Tech. | FFT FPG | CMOS based SoC |
| DC Power/pixel | 10 W | 2W |
| IF Bandwidth | 1.5 GHz | 6 GHz goal 8GHz |
| Total DC power per pixel | 35 W | 3.5 W |

Fig. 1. HERO builds on the successful HIFI/Herschel mission, but carries it to new dimensions by proposing the first heterodyne array receiver for a satellite.

On a satellite, resources are scarce and we require a drastic reduction in cooling power and electrical power with improved instrument performance (see table above). HERO builds on promising recent developments, and we propose a dedicated technology roadmap to reach TRL 5 in 2025 for all components.

REFERENCES


NOTES:

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