NEOCam Instrument Design

Mark Lysek
Instrument System Engineer
Instrument at a glance

- 50 cm unobscured aperture, wide FOV telescope
- Optimized to detect NEOs at wavelengths where they are bright, but background stars and galaxies are dim
- Passively cooled
  - Enabled by
    - mission design: L1
    - HgCdTe high temperature detectors
      - 57K for NC1 (4-5.2 µm)
      - 40K for NC2 (6-10 µm)
      - 2K x 8K mosaic for each channel
- A simple and robust design with no expendables

*Single instrument optimized for detecting moving objects; no moving parts save for the aperture cover*
• Detect two-thirds of Potentially-Hazardous Asteroids (PHAs) >140 m in within five years
• Determine the effective spherical diameters of asteroids and inactive comet nuclei
Instrument Subsystems

CEA – Camera Enclosure Assembly
FPM – Focal Plane Module
FPE – Focal Plane Electronics
NC1 – NEOCAM Channel 1:
  4 – 5.2 µm
  2K x 2K pixels
  1x4 focal plane mosaic
NC2 – NEOCAM Channel 2:
  6 – 10 µm
  2K x 2K pixels
  1x4 focal plane mosaic
CEU – Central Electronics Unit

Instrument has clearly defined subsystems and interfaces
Instrument Block Diagram

Instrument subsystems and implementation responsibilities are well defined

JPL
- FPM / FPE
- Enclosure
- Thermal
- Mechanical

Teledyne
- SCA
- SIDECARs

U of R
- SCA Test

L3 / SSG
- Telescope

SDL
- CEA
- CEU
- I I & T

Ball
- Radiators
- Bipods
- Shields
- Aperture Cover
- ETB Test

IPAC
- Data System
10 µm Detector Development

- Development
  - 1995 - U Rochester / Teledyne work on MCT detectors
  - 2010 - NASA APRA grant to UR, NEOCam Tech grant to develop 13+ µm 1K x 1K arrays
  - 2015 - Substrate Removal Experiments at Teledyne
  - 2015 - Smaller format arrays produced: 14x 1K x 1K SCAs; 7x 2K x 1K “Duplex Arrays”
  - 2016 - 2K x 2K arrays

- Ongoing Risk Reduction Efforts
  - 11 µm cutoff detector fabrication
  - Low Doping
  - Large-format MBE machine for HgCdTe growth

- Production Status
  - Flight Pathfinder CDR/MRR held in Dec 2017
  - Additional wafers to be fabricated upon start of Phase B
CEA-FPM Prototype at SDL

- CEA Engineering Development Unit
  - NC2, long wavelength channel only
  - 4 non-flight SCAs
  - Flight-like NC2 FPM mount
  - Flight-like Ge beamsplitter in mount
  - Hand worked flight-like SCA cables
  - Non-flight Cryo-kit SIDECAR ASICs

- Objectives / outcome
  - Verified NC2 FPM temperatures and radiator heat load
  - CEA Light leak test found $5 \times 10^{-8}$ attenuation
  - Preliminary test of detector cable crosstalk
Near-Term Priorities (1)

Focal Plane Modules
- Large-format MBE machine
- Flight pathfinder build
- Cable Prototype
- FPE / FPM mechanical design

Electronics and Firmware
- Readout algorithm development
- Preliminary design and parts selection
- FPGA functional blocks
- Conceptual design and requirements review

Camera Enclosure Assembly
- Vibe test EDU CEA
- Add NC1 hardware
- Beamsplitter image quality and thermal cycling tests

Telescope
- Refine Mechanical, thermal, optical interfaces
- Update ATLO plan
- Pre-PDR level peer review

Overall instrument stray light analysis and baffle design
Near-Term Priorities (2)

Instrument Enclosure
- Preliminary mechanical design with all features
- MICDs for radiators, aperture cover, telescope
- Panel fabrication process

Thermal
- Improve model fidelity
- Low-E surface implementation
- Refine thermal I/F requirements and ICDs
- Design of external and internal thermal balance tests

Radiators, thermal shields and bipods
- Preliminary mechanical designs
- L 4/5 requirements

Aperture Cover
- Interface definition

Instrument I&T
- Detailed AI&T plan
- Preliminary EMI / EMC test design & plan
- Refine stray light test plan
NEOCam is an instrument project
Currently in extended phase A
34 month phase B, planned to start in August 2019
35 month phase C
May 2025 delivery
Backup Slides
Instrument Org Chart

Organization is aligned with deliverable products
Focal Plane Module Development

- Initial Release of MWIR / LWIR SCA Requirements to Teledyne
- Prototypes Builds
  - LWIR FPM – fully populated FPM
  - FPM Cable – Hand Wired prototype
  - Tayco building prototype cables
- FPM/CEA/Cable interface re-design
- 4x flight pathfinder SCAs currently in assembly/test
- Flight detector package (FRSBE) production
- Performance Testing at UR
  - Modulation Transfer Function, Persistence, Temperature Stability, Photometric Stability
- SIDECAR / FPE
  - EUCLID mission heritage