Multifunctional Sensors

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for presentation at Lincoln Lab Sensors Workshop on 25 May

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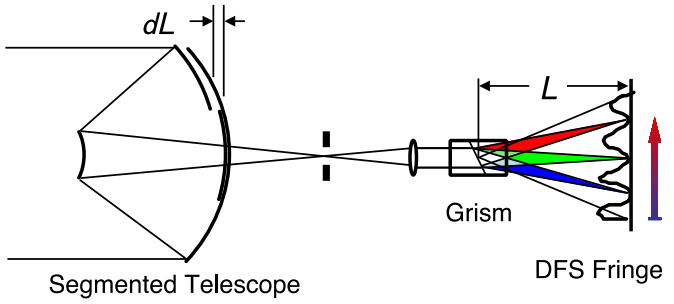
Multifunctional Sensors: *GRISMs for Segmented Mirror Phasing and Slitless Spectroscopy*

A GRISM inserted into the imaging path can be used as a *Dispersed-Fringe Sensor*

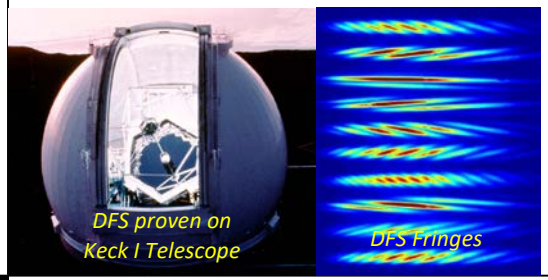
- Creates a spectrum of a star
- Piston differences between segments are modulated by the varying wavelength of the spectrum, creating fringes
- Fringe analysis measures piston errors

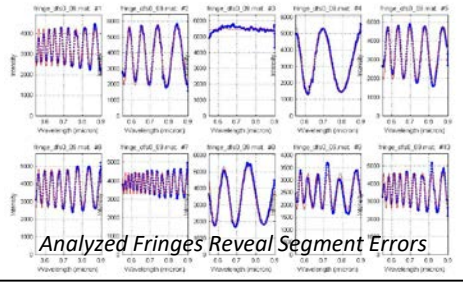
The same GRISM can be used for Slitless Spectroscopy on isolated stars

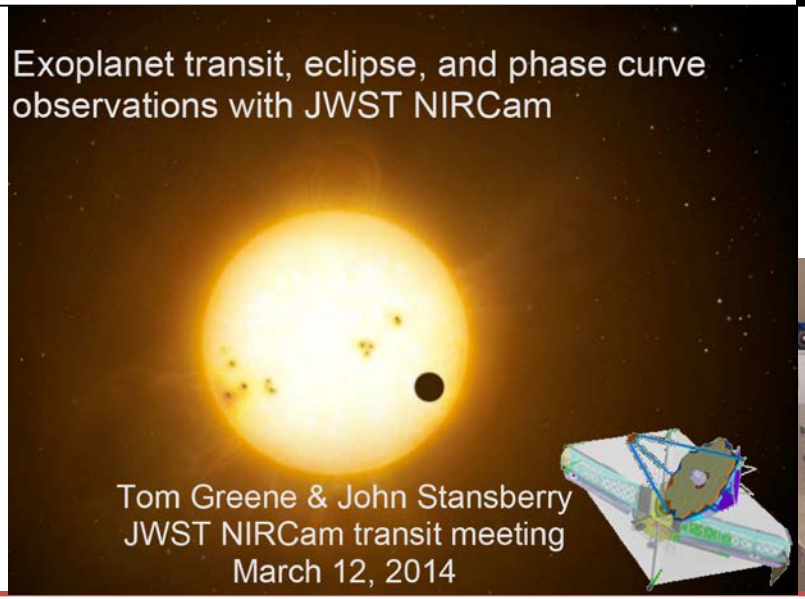
- JWST will use GRISMs for segment phasing and for *Exoplanet Transit Spectroscopy*



- Fringe period is a measure of *dL*
- *dL* is corrected by segment actuators

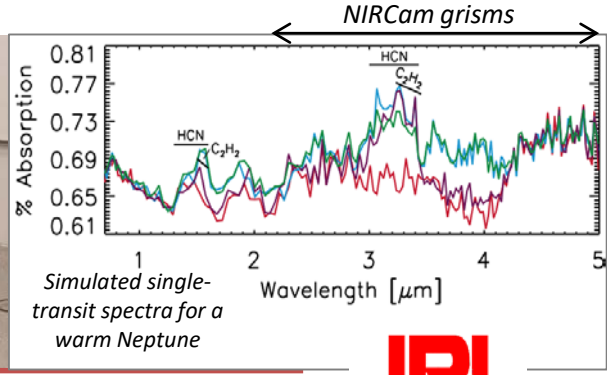






As a planet passes in front of a distant star, the star's light dims differing amounts across the spectrum

- Due to absorption by the planet's atmosphere
- These signals measure the atmospheric chemistry



Simulated single-transit spectra for a warm Neptune

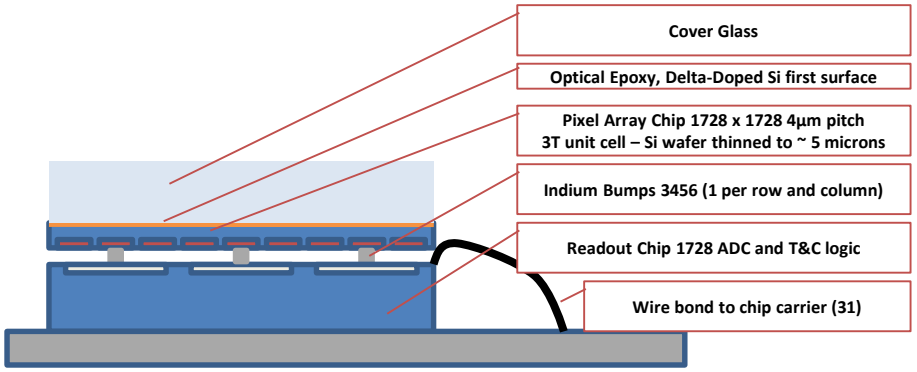
Multifunctional Sensors: *Ultralow-power Visible Imager*

Description

3 Mpix (1728 x 1728) Visible CMOS imager w/digital readout & storage

- 4 µm 3T unit cell, back side illumination
- Unique 3D stack architecture
  - Only require 3456 interconnects between pixel wafer and ADC/DSP wafer
- 1728 ADC (one per column)
- ADC incorporated non-linear transfer function, providing analog signal companding/compression (10b to 8b) & very lower power/energy comsumption per image
- Additional ASIC & NVM enables µA standby current with fast wakeup / image collect / data storage

Photo(s)/Drawing



Mission/Utility

- Imager system with extremely low power and energy consumption, "lossless" image companding, long data storage retention, rapid turn on / turn off
- Cubesats or other small sats with limited power, data throughput and thermal management capabilities
- Battery operated unattended or drop off sensors on planetary surfaces
- Borehole imaging or end of arm robotic sensor, or similar applications where energy is limited and high quality imaging (high QE, MTF, NEI) is needed

Next steps/Growth path

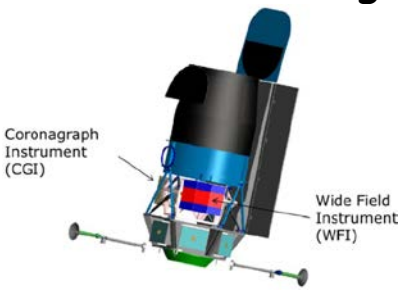
- Development of 4T unit cell to provide global shutter
- Addition of on chip centroiding / windowing processing for location / tracking of objects
  - E.g. low power star trackers
  - Robotic sensors for navigation
- Large format UV/VIS image sensors
  - Low interconnect density allows separate optimization of pixels and mixed signal circuits

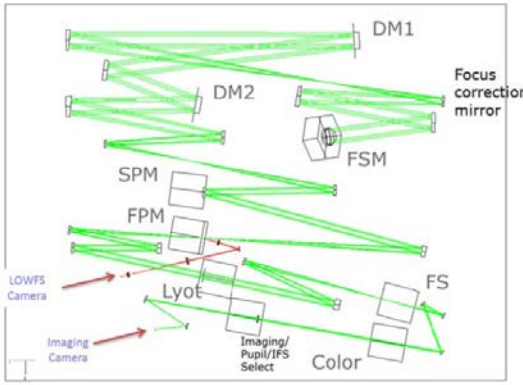
Multifunctional Sensors: *High Contrast Coronagraph*

Description

- The coronagraph images faint planets adjacent to bright stars.
- It supresses veiling glare caused by imperfect optics and diffraction.
- Engineering function: It senses wavefronts at multiple focal planes to derive a wavefront control signal.
- Science Functions: It images the planet and does spectral characterization in a search for biomarkers.

WFIRST Coronagraph

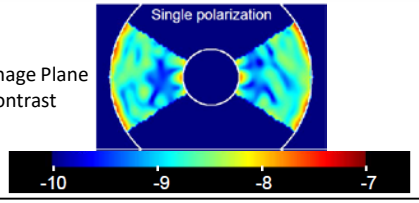




Pupil Mask

Image Plane Mask

Image Plane Contrast



Mission/Utility

- The coronagraph is part of the WFIRST instrument suite.
- LUVOIR and HABEX studies both include coronagraphs. Exoplanet science is critical to these missions.
- Probe class missions (Exo-C) have been studied as well and do science comparable to WFIRST coronagraph.

Next steps/Growth path

- WFIRST is in Phase A.
- Technology development underway with a series of Milestones through MDR.
- SRR/MDR June 2017
- KDP-B Sept/Oct 2017
- Mid 2020 Launch