

# Multi-Slit Offner Spectrometer ESTO Instrument Incubator Program

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Agility to Innovate, Strength to Deliver



# Outline

- Introduction
- Multi-Slit Offner Spectrometer (MOS) Concept
- Instrument Incubator Program (IIP) Goals and Program Plan
- Conclusion



# GEO-CAPE Oceans Science

- The Earth Science Decadal Survey objectives for the GEO Event Imaging mission are to understand and monitor the dynamics of coastal marine ecosystems including their response to land-ocean exchanges, human activity, climate change and episodic events and hazards.
  - GEO-CAPE Ocean objectives have been defined:
    - Quantify the response of marine ecosystems to short-term physical events (e.g., storms and tidal mixing).
    - Assess the importance of high temporal variability in coupled biological-physical coastal-ecosystem models.
    - Monitor biotic and abiotic material in transient surface features (e.g., river plumes and fronts).
    - Detect, track and predict the location of hazardous materials (e.g., oil spills, waste disposal storm events, and harmful algal blooms)



HICO image: Columbia River Plume, processed to show plume details  
(N. Tuffiaro, C. Davis, OSU)



# MOS: GEO-CAPE Oceans Science with reduced mass and risk

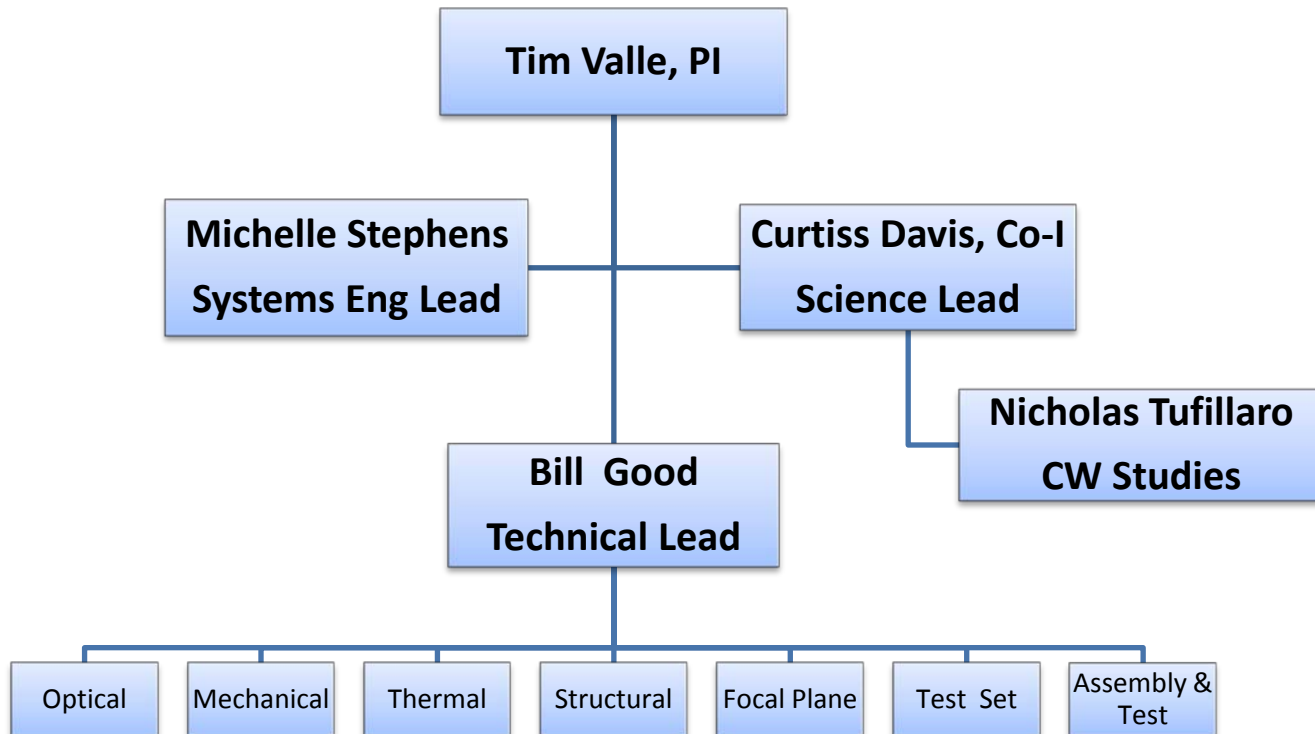
- Motivation
  - GEO-CAPE Event Imagers meeting the STM requirements tend to be large
    - Ball strawman, scale 550 kg
    - Coastal Ecosystems Dynamics Imager (CEDI), Instrument Design Lab Study scale 620 kg (Scott Janz, et al., NASA OCRT Meeting May 11-13 2010)
  - Look for approaches to reduce volume, mass, and mission cost, with  $\leq 1$  hr coverage time
- NASA Earth Science Technology Office Instrument Incubator Program 2011
  - Objective: "New and innovative technologies will lead to future flight instruments that are smaller, less resource intensive, less costly, ..."
  - Proposed a Multi-Slit Offner Spectrometer: goal of meeting GEO-CAPE Ocean requirements in a smaller, lower risk package
  - Project start- this week!

MOS goal is to meet relevant STM Instrument Requirements in a small package



# Team directive: stay relevant to the mission

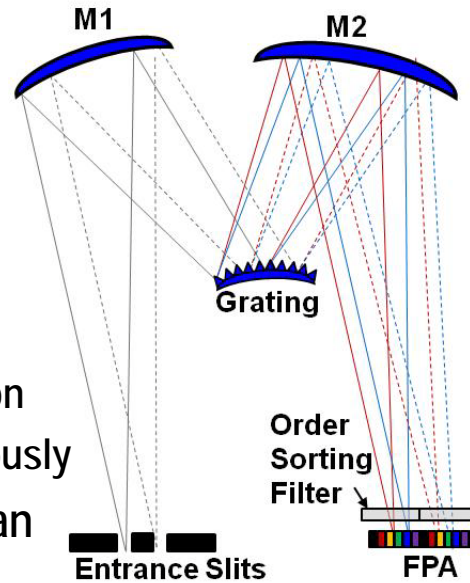
- Emphasis on maintaining traceability from the GEO-CAPE Event Imager mission to spectrometer requirements & studies
- MOS IIP team eager to engage with science team throughout the project



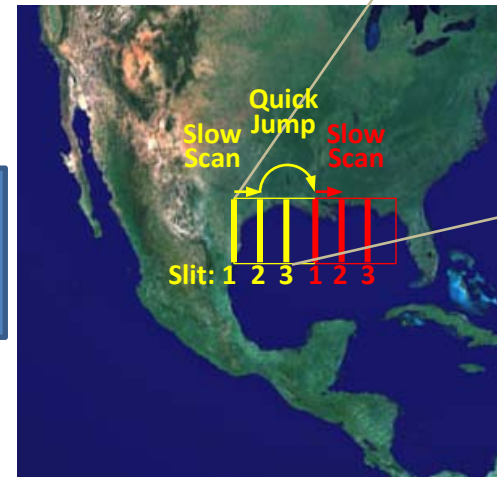
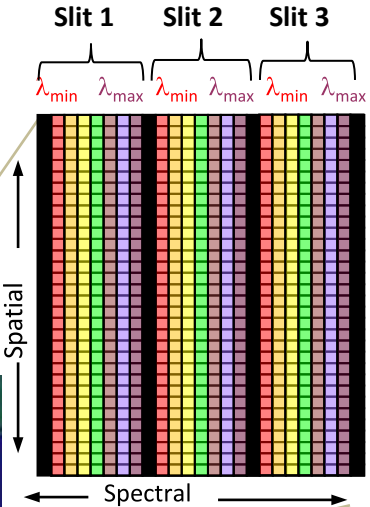


# Key: Simultaneous imaging of multiple locations

- Instrument
  - Single telescope
  - Single spectrometer
  - Single FPA
- Spectrometer
  - Multiple slits separated in dispersion direction
  - Spectrum of slit images recorded simultaneously
- Optimal number of slits for Event Imager is an output of program
- Order sorting filter & slit displacement controls the out-of-band- critical technological challenge



Instantaneous MOS FPA Image



Performs like multiple spectrometers operating simultaneously



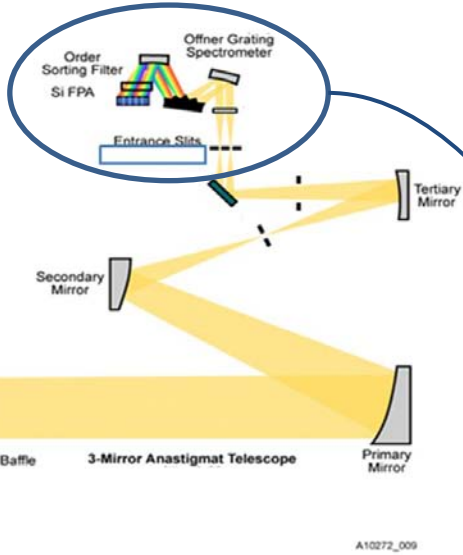
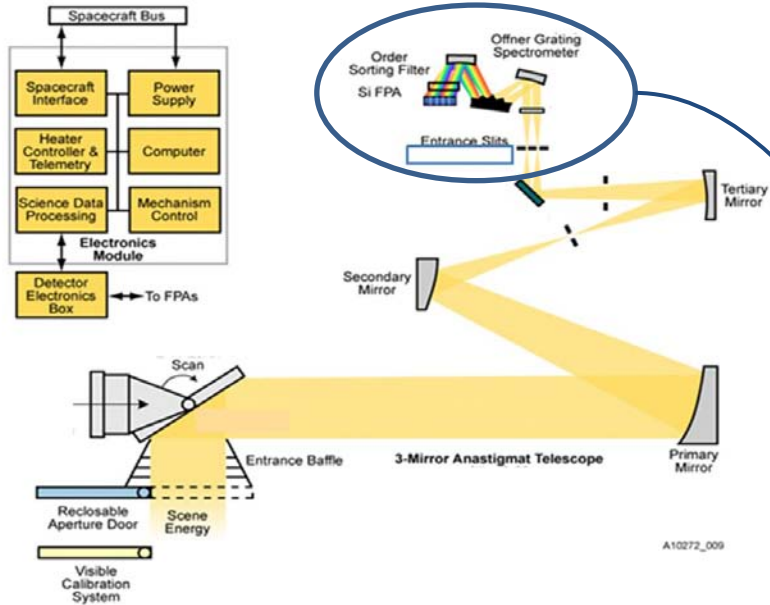
# MOS offers mission risk reduction

- Ball strawman, conventional design  
mass estimate 550 kg
- 5 slit MOS design  
mass estimate 150 kg  
~1/2 the aperture

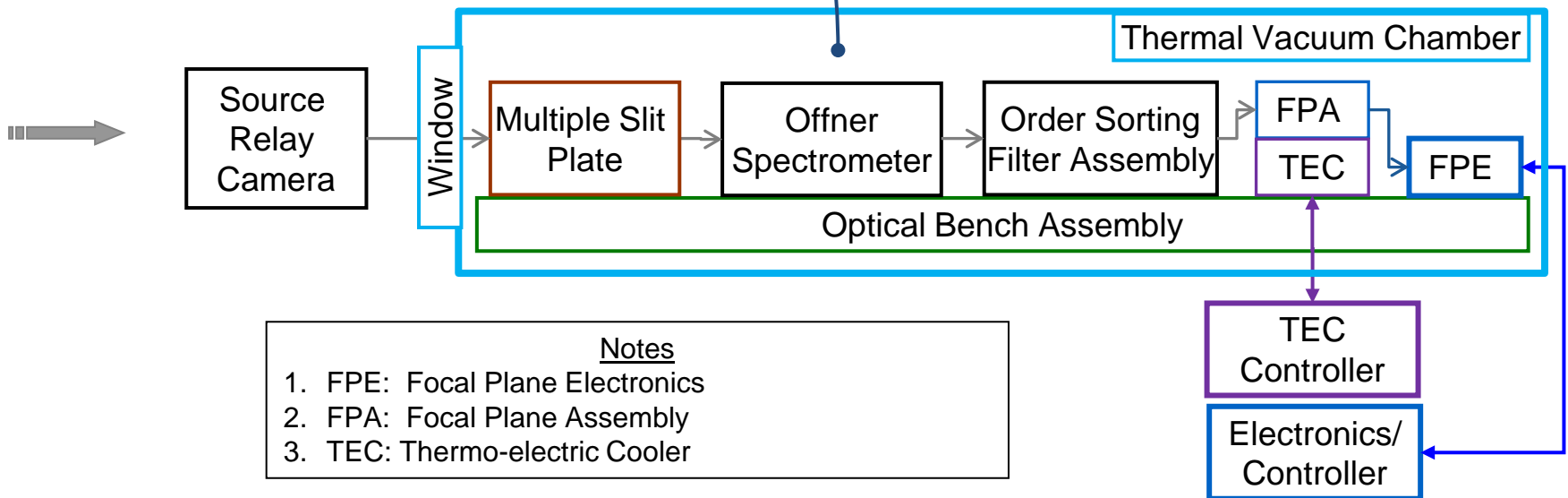
N.B., above designs have not included SWIR channels. Not a 1::1 comparison to Coastal Ecosystems Dynamics Imager (CEDI) in Instrument Design Lab Study.



# MOS IIP develops the opto-mechanical spectrometer subsystem



- GEO-CAPE Oceans STM guides spectrometer requirements
- Event Imager schematic
- MOS IIP block diagram



**Notes**

1. FPE: Focal Plane Electronics
2. FPA: Focal Plane Assembly
3. TEC: Thermo-electric Cooler

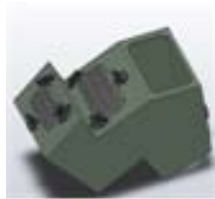




# Exit program with ready to fly technology and confidence in ability to deliver science data products

GEO-CAPE Oceans STIM

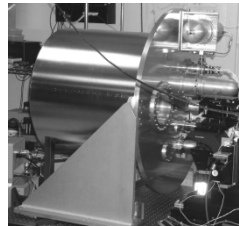
Requirements & Trades



Design, assemble, align



FPA packaging



Test  
T-Vac, vibe, T-Vac  
NASA Technology Readiness Level 6

OSU team  
Use HICO data and MOS performance measurements to simulate on-orbit imagery and assess coastal water data products.

Coastal Water Impact Studies:  
spectral sampling  
out-of-band  
SNR

Mission	
Geostationary Coastal and Air Pollution Events (GEO-CAPE)	
Launch: 2013 - 2016    Mission size: Medium	
<b>Objectives</b>	<b>Outcomes</b>
<ul style="list-style-type: none"> <li>Identification of human versus natural sources of aerosols and ozone precursors</li> <li>Dynamics of coastal ecosystems, river plumes and tidal fronts</li> <li>Observation of air pollution transport in North, Central and South America</li> </ul>	<ul style="list-style-type: none"> <li>Prediction of track of oil spills, fires and releases from natural disasters</li> <li>Detection and tracking of waterborne hazardous materials</li> <li>Coastal health</li> <li>Forecasts of air quality</li> </ul>

Mission Suitability Validation



3 year program



# Project Summary

- Earth Science Technology Office funded hardware development that supports the GEO-CAPE Event Imager mission
- Multi-Slit Offner Spectrometer has potential to greatly reduce instrument volume, mass, and program risk
- Technical challenge is out-of-band performance, largely controlled by order sorting filter assembly

Exit program with

- Ready to fly technology (TRL 6) and
- Validated ability to deliver ocean science data products