

Infrared Instrument Development for In-Situ Organic Detection

NASA EPSCoR Award: 2008-2011

NASA ASTID Award: 2008-2011

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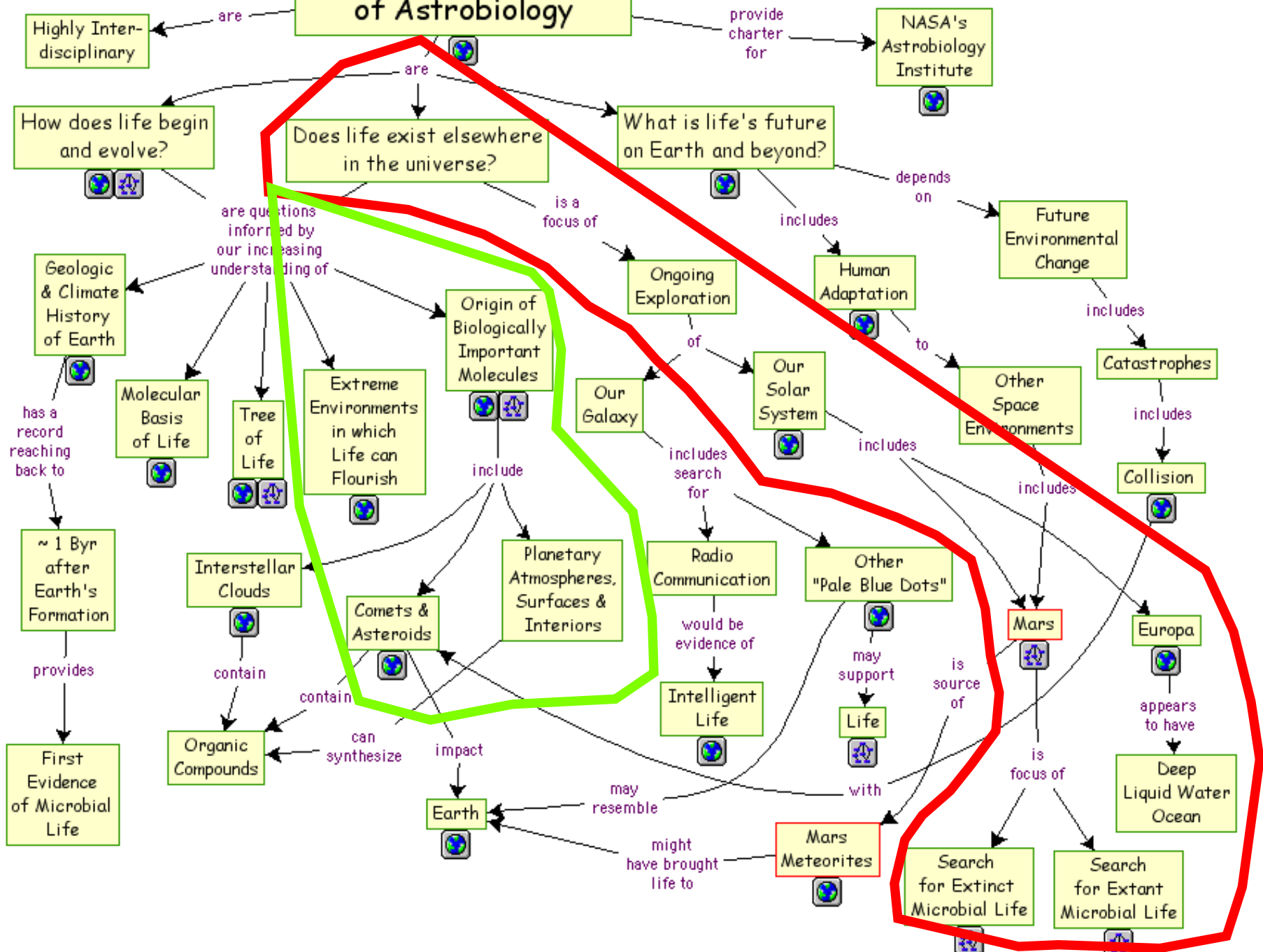
Outline

- Who we are
- Project background
- Progress to date

Project Team

- Nancy Chanover (PI), NMSU Astronomy
- David Voelz (Co-I), NMSU ECE
- David Glenar (Co-I), NMSU Astronomy (retired NASA/GSFC)
- Penny Boston (Co-I), NMT
- Graduate Students (EPSCoR: 2 NMSU, 1 NMT)
- Collaborators at NASA/GSFC

Fundamental Questions of Astrobiology

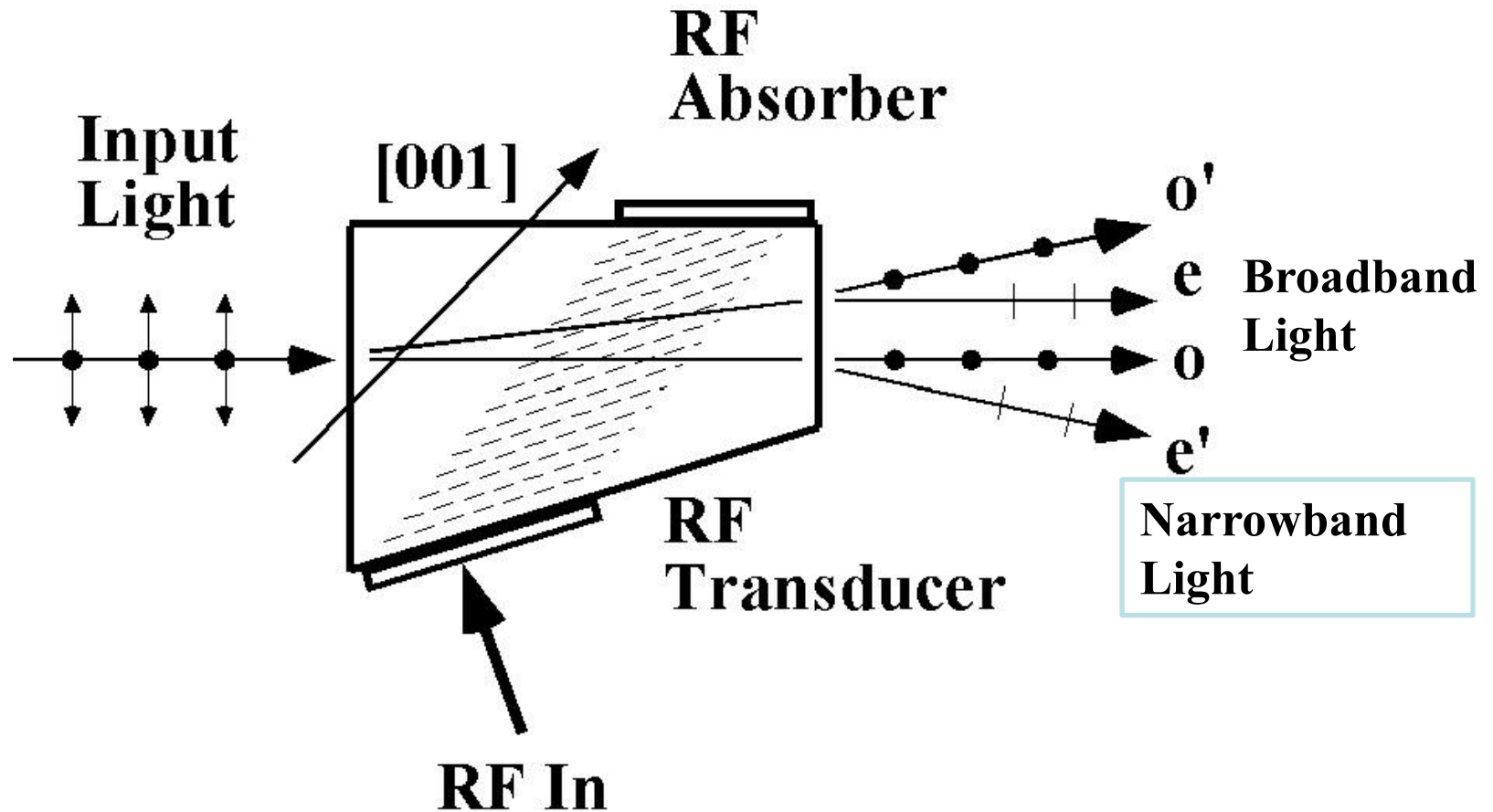


Motivation

- New Frontiers in the Solar System: Solar System Exploration Survey (“Decadal Survey”) - 2003
- Scientific Goals and Pathways for Exploration of the Outer Solar System (“OPAG Report”) - 2006
- Flagship Mission Concept Studies (Enceladus, Europa, Titan, Jupiter System) - 2007
- Revised Astrobiology roadmap - 2008
- These studies advocate for development of lander instrumentation capable of detecting organics
- Need demonstrated hardware that can operate in low-power situations

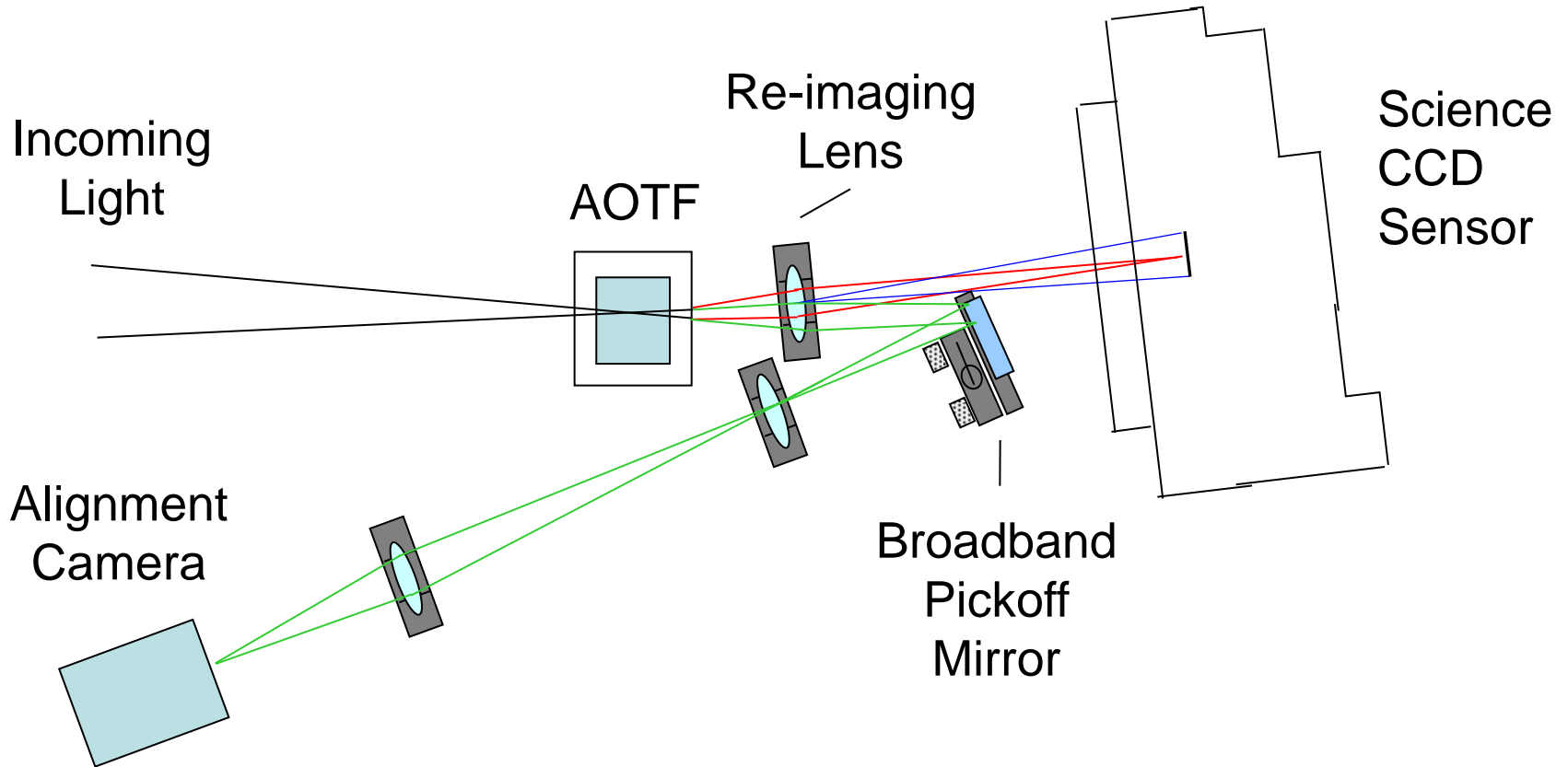
Acousto-Optic Tunable Filter (AOTF)

Tunable, agile, robust optical filtering technology



RF freq → selects wavelength out

NMSU AOTF Imaging Camera (NAIC)



AOTF Development through NASA Programs

Previous

- Mars Instrument Development Program (MIDP)
- Planetary Instrumentation Definition and Development Program (PIDDP)

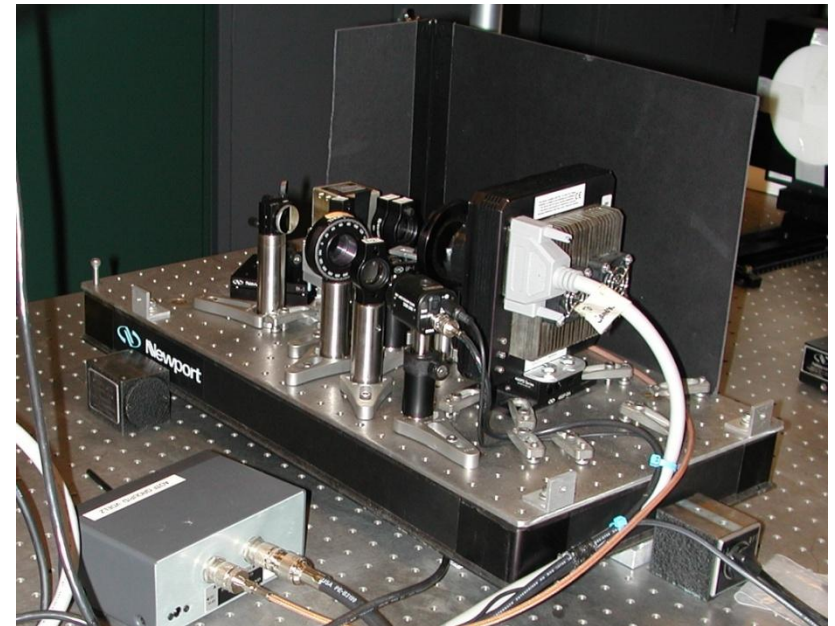
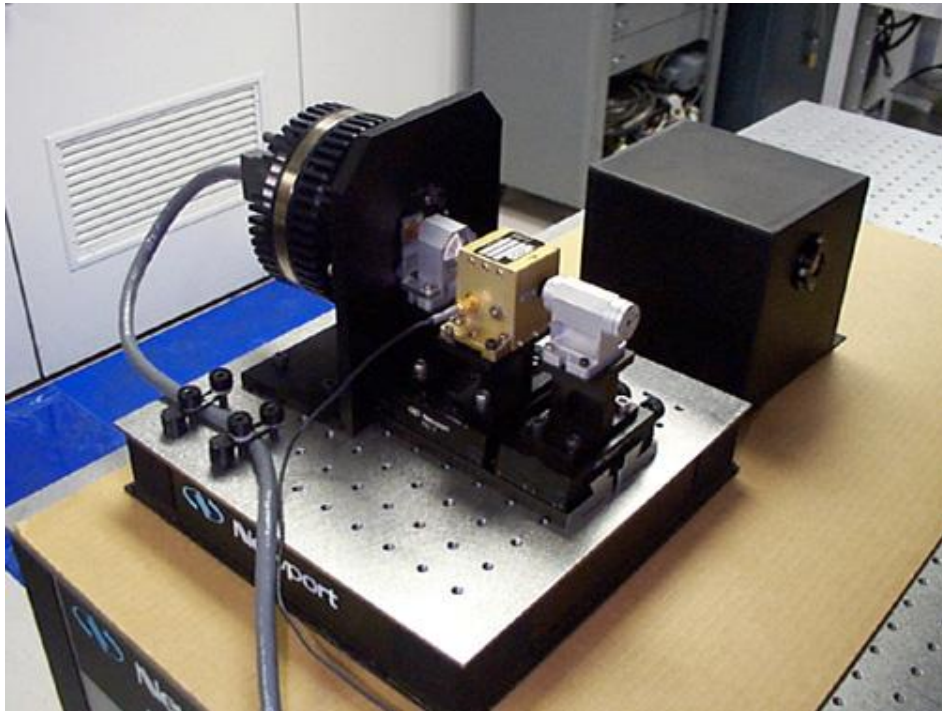
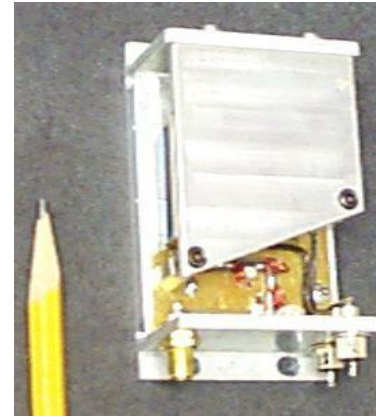
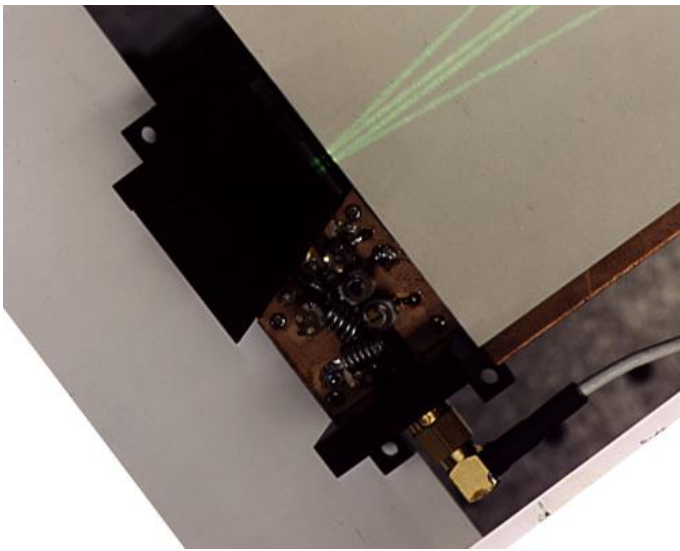
Current (in addition to EPSCoR)

- Astrobiology Science and Technology Instrument Development (ASTID)

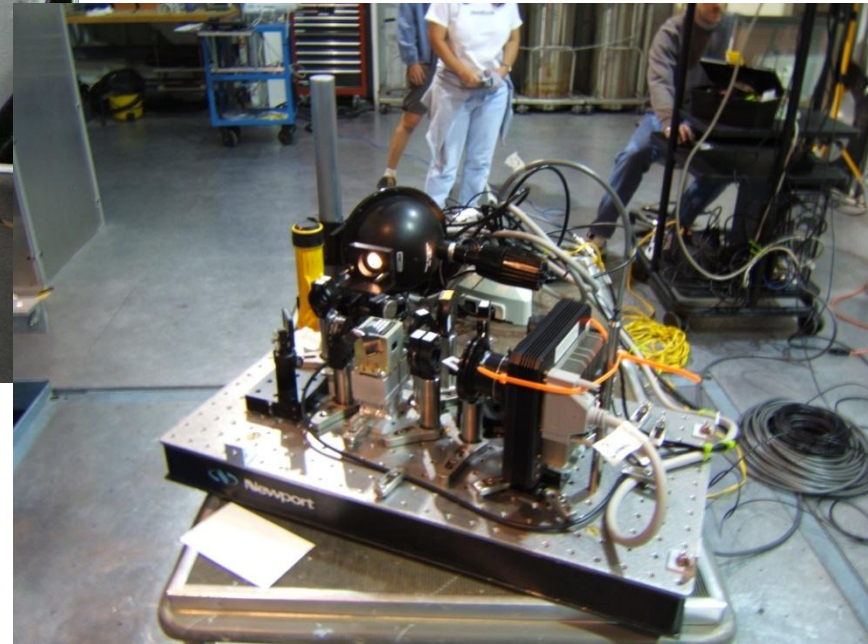
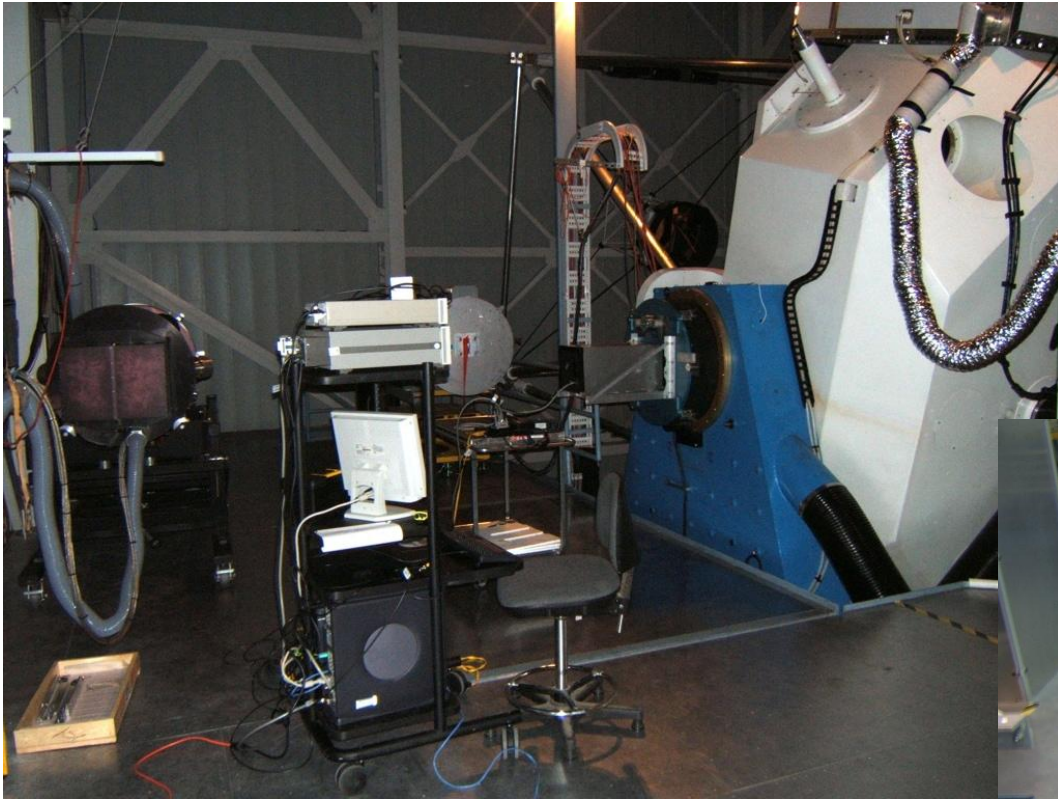
Future?

- Astrobiology Science and Technology for Exploring Planets (ASTEP)

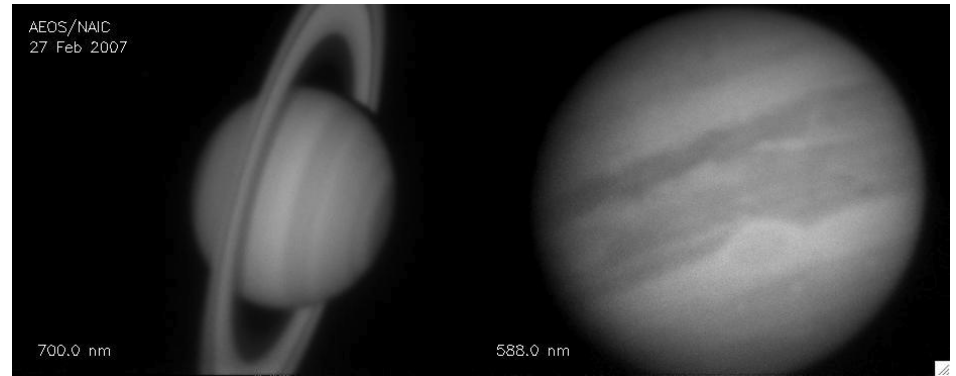
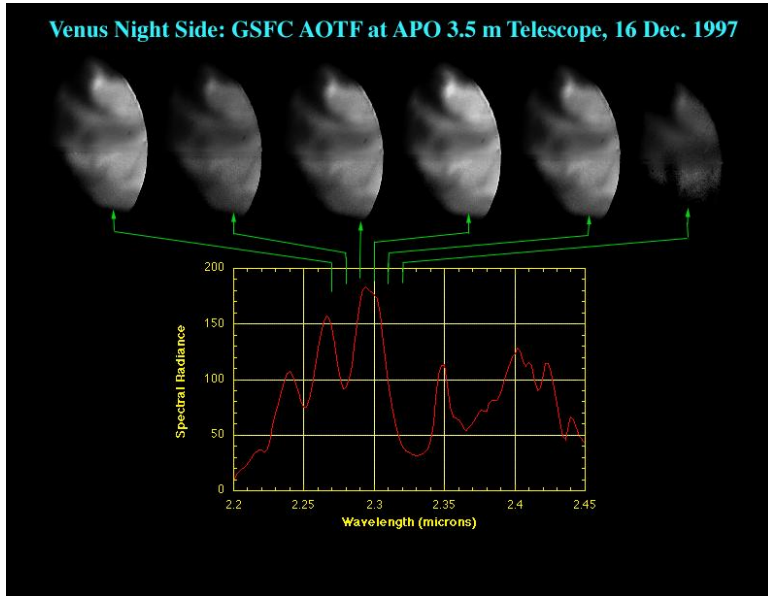
Lab Photos



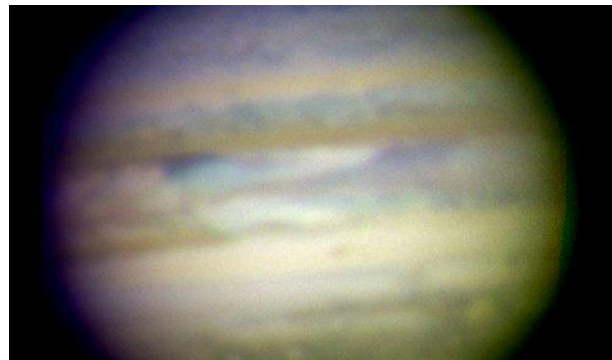
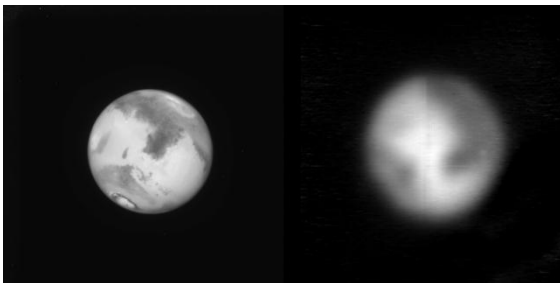
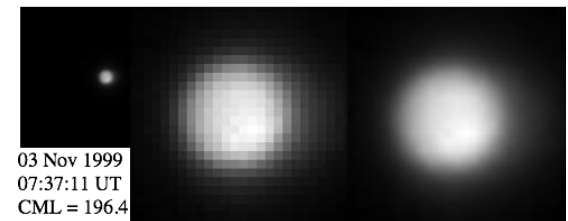
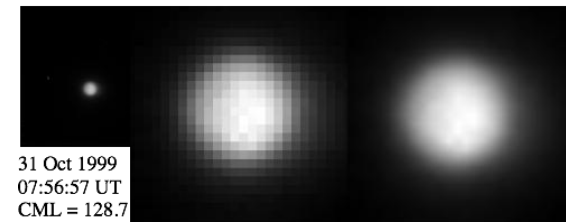
NAIC at Apache Point Observatory



Science Targets



Titan at 940 nm



Point Spectrometer being Developed under Current Effort

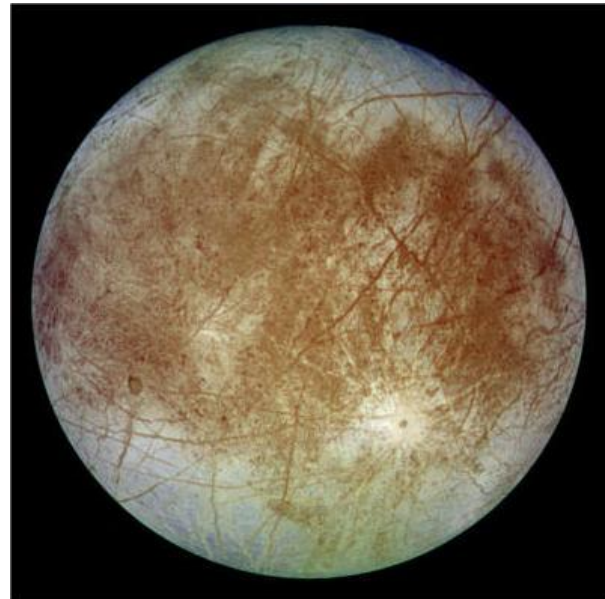
- AOTF used to select illumination wavelength
- Quick-look capability to pre-screen sample
- Pair with Laser Desorption Mass Spectrometer (LDMS) for further analysis if warranted

Science Case Suggests 3 Types of Measurement Objectives

- Detection of organics on planetary surfaces
- Identification of potential spectral biomarkers
- Detection of mineralogical alteration related to the presence of either extant or extinct organic material

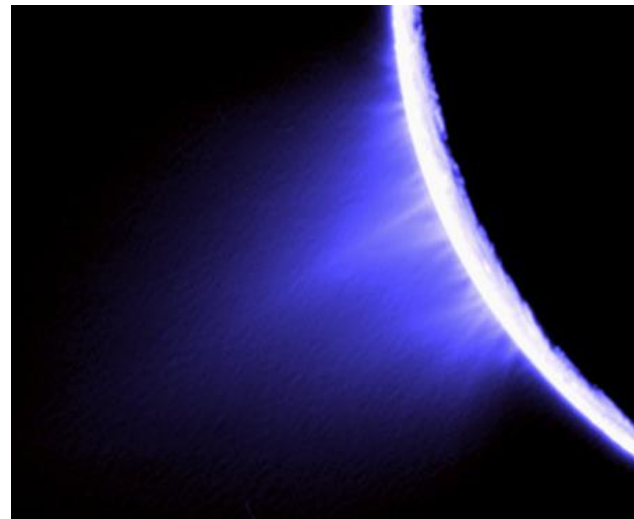
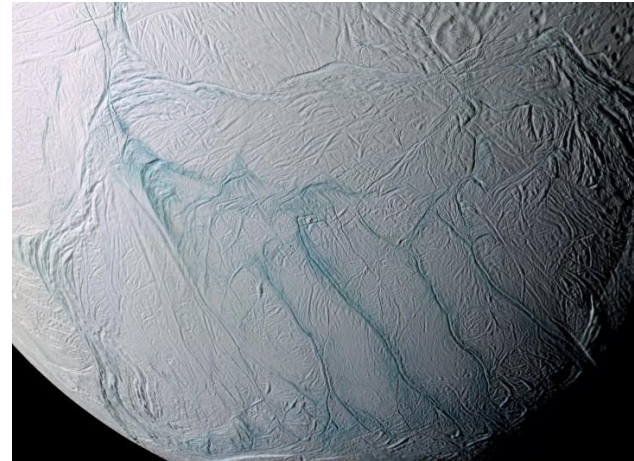
Potential Target: Europa

- *Galileo* provided evidence for a subsurface ocean
- Surface chemistry dominated by radiolysis
- Chyba & Phillips (2001) advocate for astrobiology initiative aimed at the exploration of Europa, including a lander mission to inventory the volatiles and search for organics



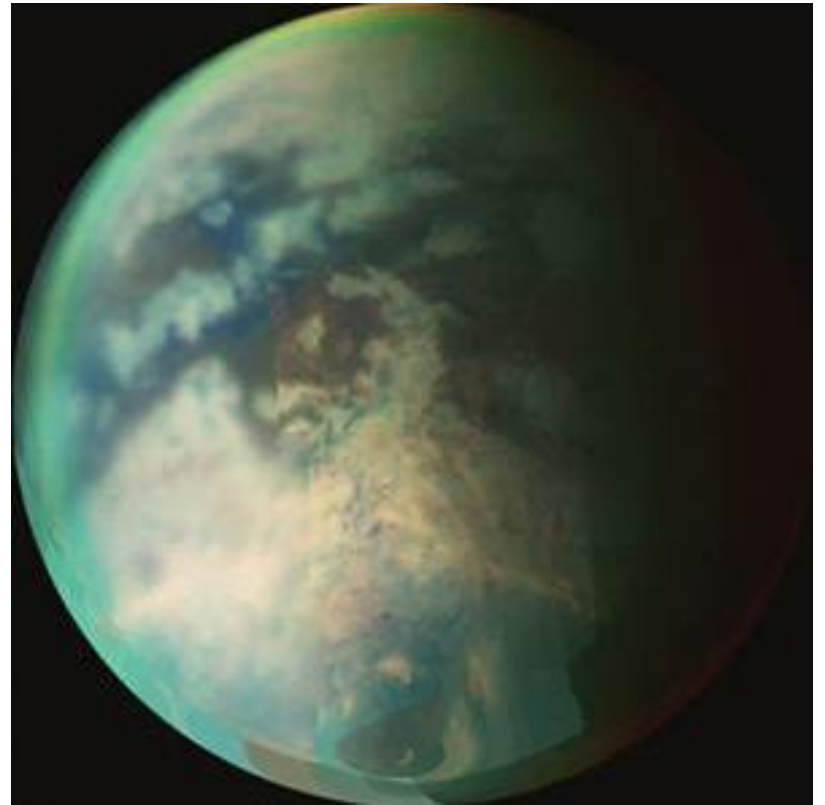
Potential Target: Enceladus

- “tiger stripes” + plume = subsurface liquid reservoir?
- Ice signatures of H₂O and CO₂ (but no NH₃)
- H₂O₂ seen; thought to play a role in evolution of oxygenic photosynthetic organisms on Earth



Potential Target: Titan

- Liquid reservoirs on surface
- Water ice mixed with mystery “dark material”
- Tholin analog already analyzed with LDMS to identify organics



Potential Target: Small Bodies

- Lab analogs & meteorite samples already in hand
- Irradiated ice experiments yields interesting hydrocarbons



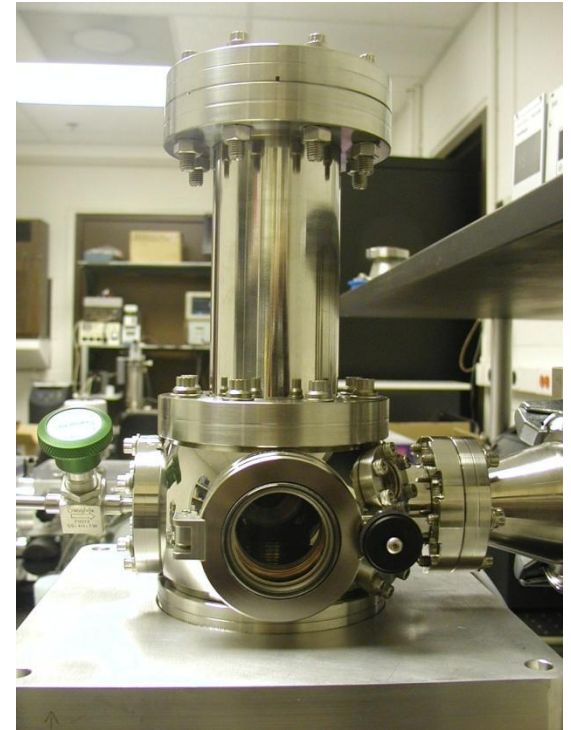
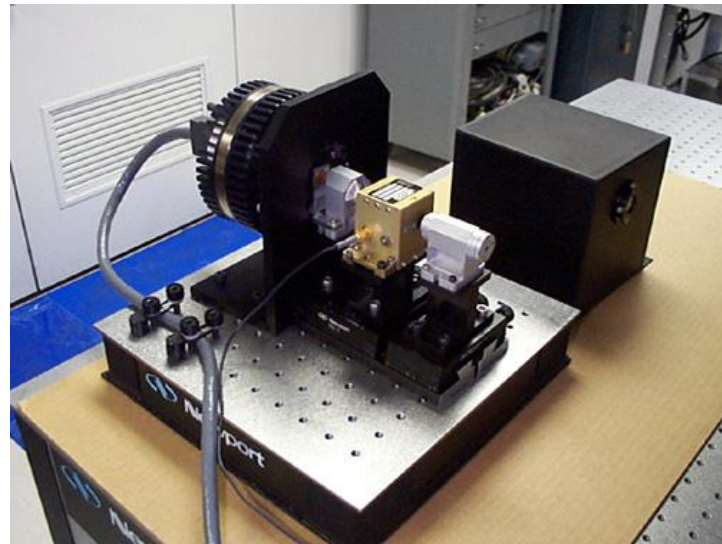
Potential Target: Mars

- Small percentage of the surface has been studied in situ
- Recent laboratory spectroscopy of terrestrial analogs of Mars surface soils indicates that the vis/NIR region is best suited for the detection of nitrate, sulfate, carbonate, and phyllosilicates

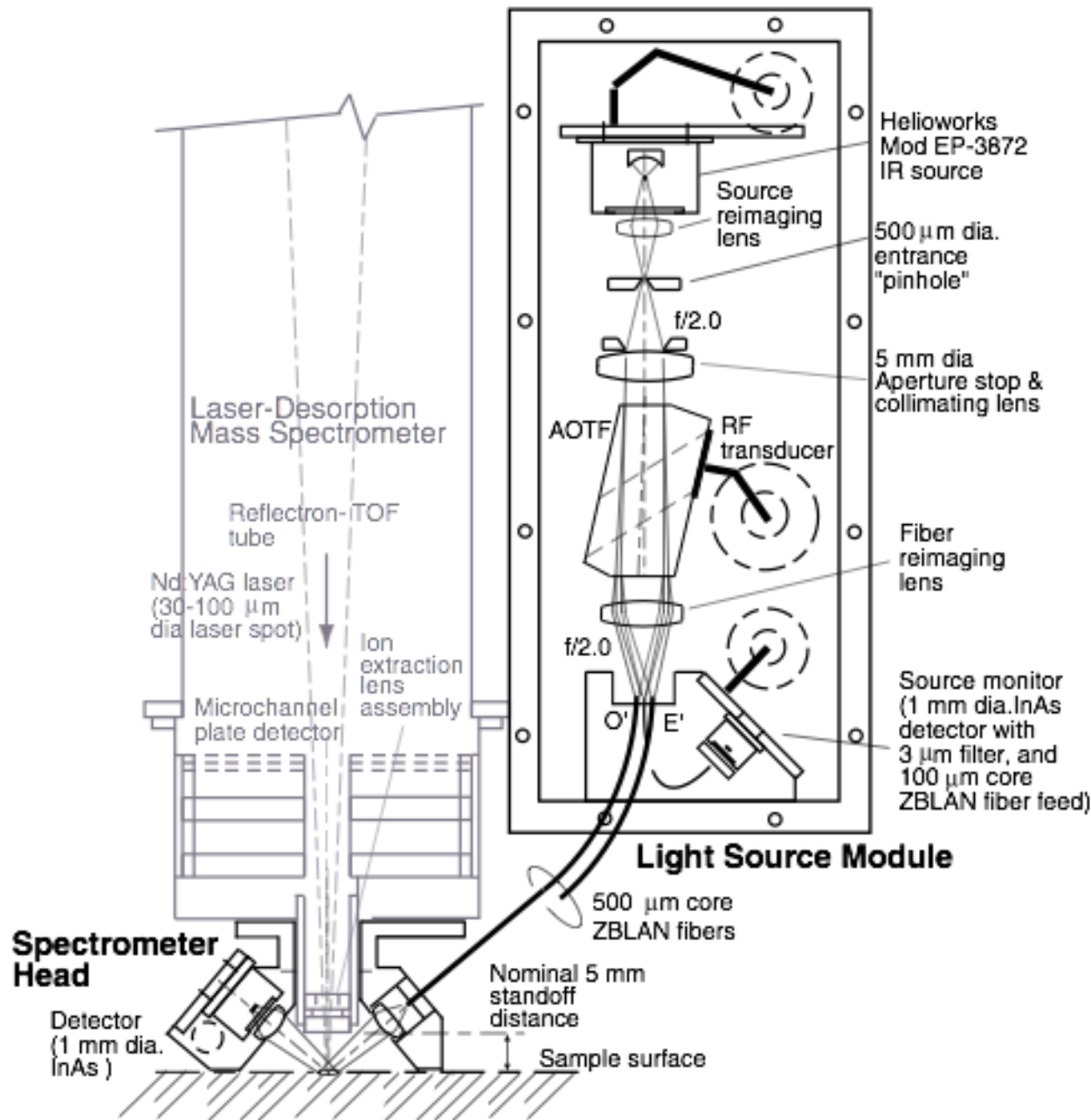


TOF-LDMS + AOTF

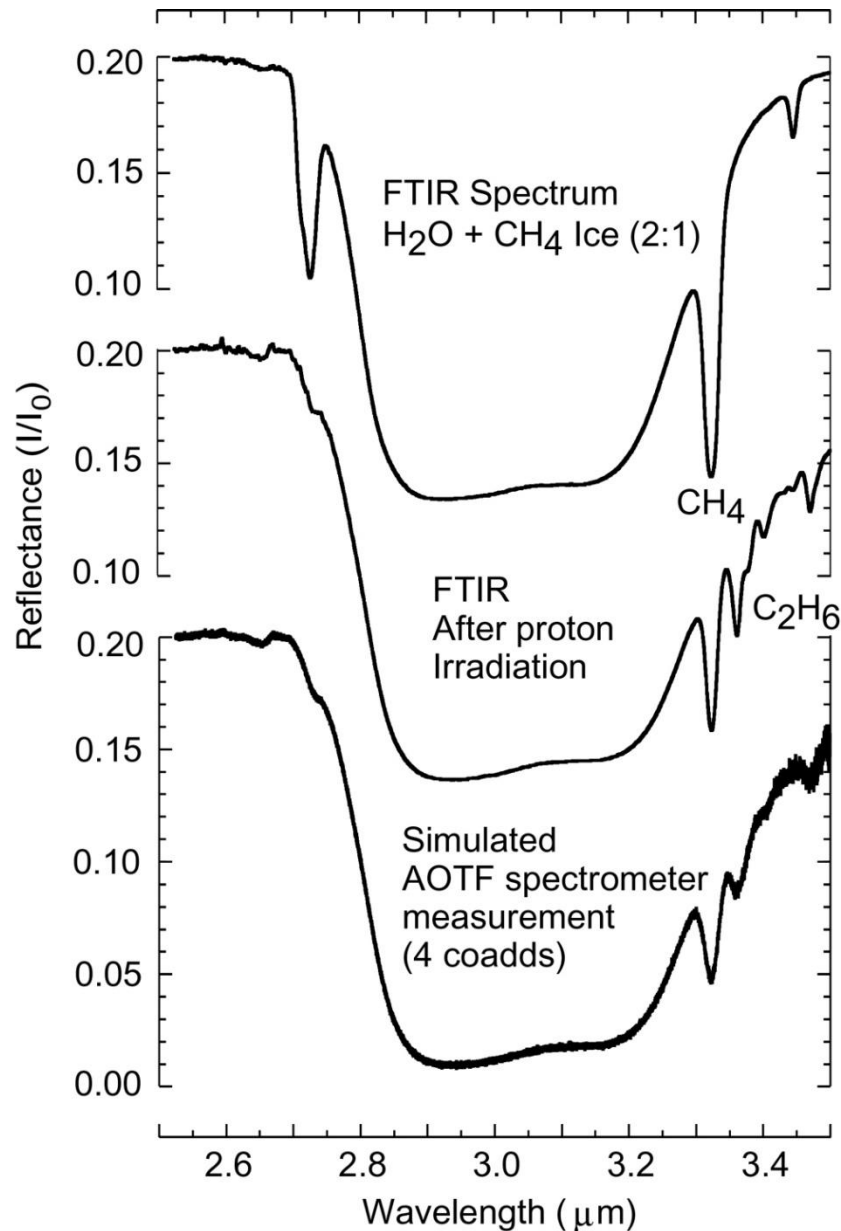
- Merge 2 technologies with significant previous investment by NASA
- Addresses stated need for pre-screening in low power environments



Point Spectrometer Illuminator Schematic



Simulations



- Thin-film IR absorbance measurements of irradiated ices in GSFC lab (to simulate radiation-processed surfaces in our solar system)
- Data convolved to our estimated instrument resolution, added detector noise
- Can still resolve features from residual ethane and methane

General Work Plan

- Year 1: Sensor development & functional testing
Design, assembly and optical testing of the AOTF breadboard & the modified TOF-LDMS breadboard
- Year 2: Measurements of natural samples and analogs
- Year 2/3: Integration with the GSFC LDMS and full-instrument operational tests
- Year 3: Instrument characterization with complex samples in a relevant environment (achieve TRL 6)

Current Status

