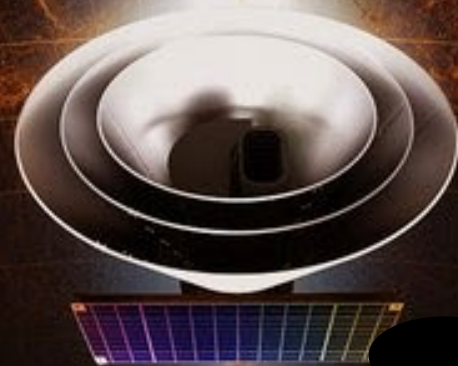




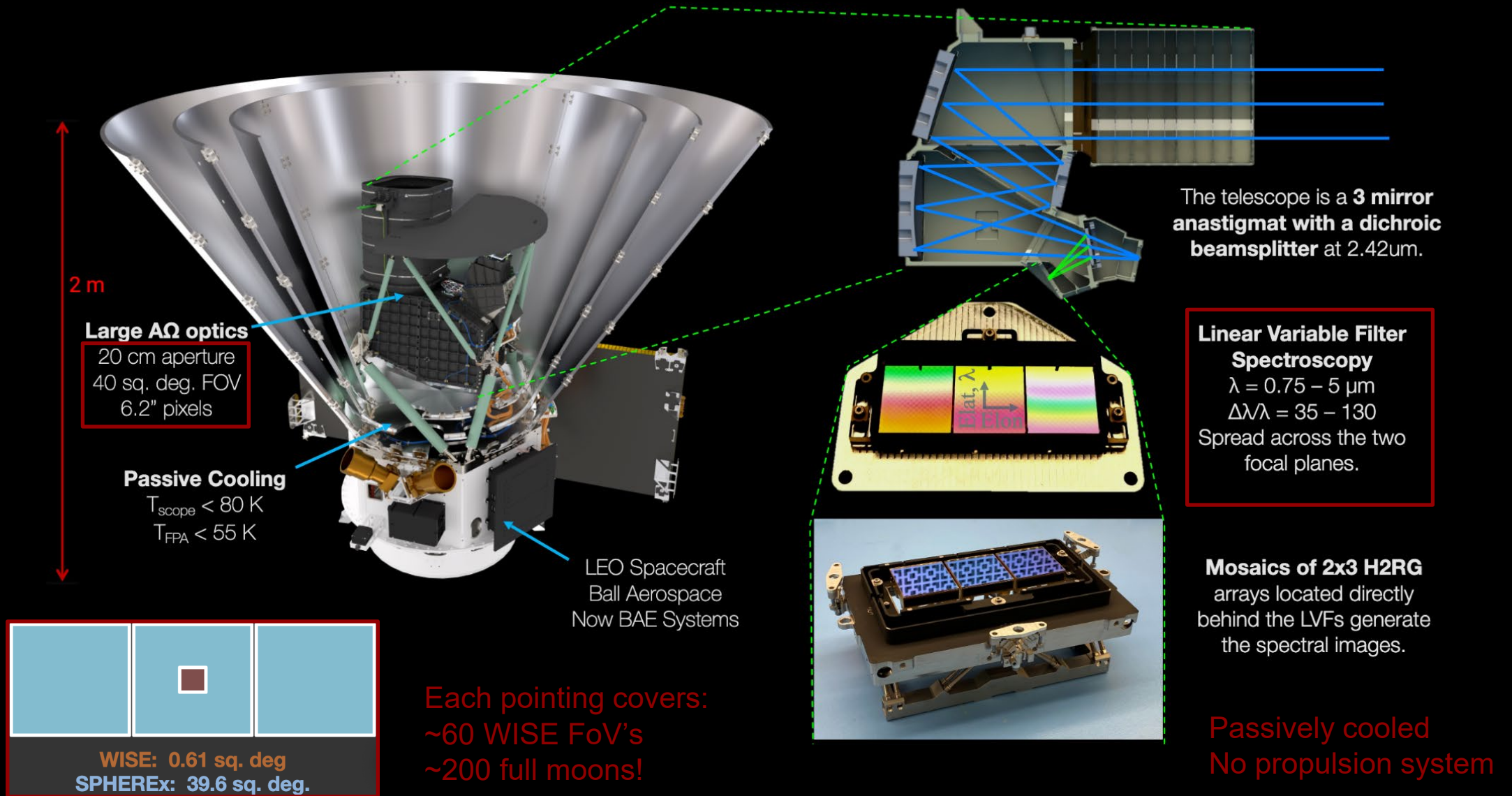
SPHERE^X

Mission Update

October 6, 2025

Rachel Akeson, SPHERE Science Data Center
Lead, Caltech/IPAC

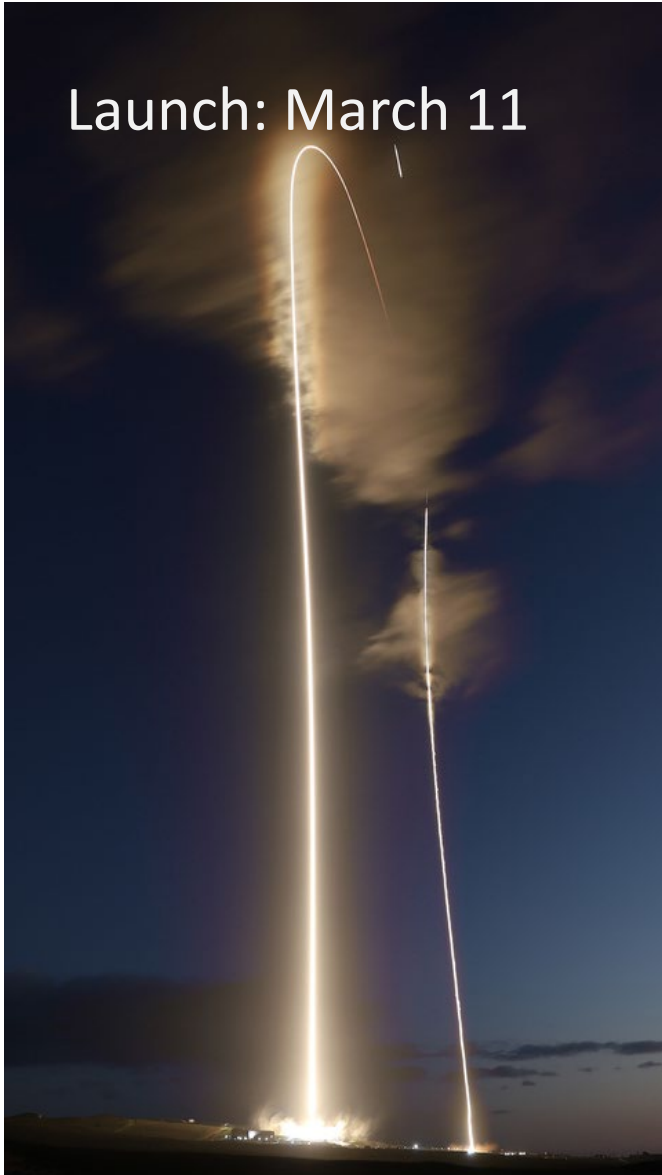
SPHEREx at a Glance



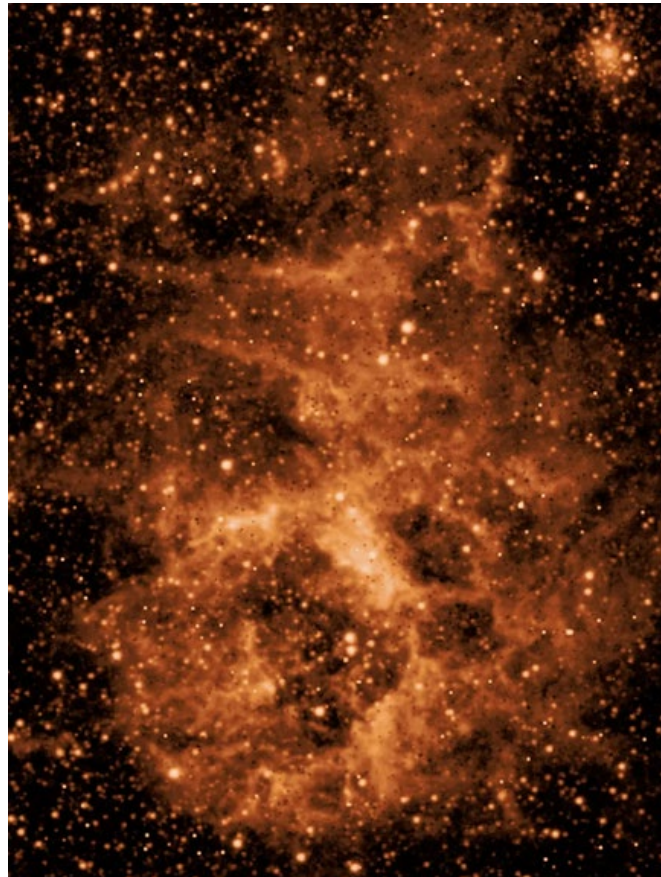


SPHEREx Milestones

Launch: March 11



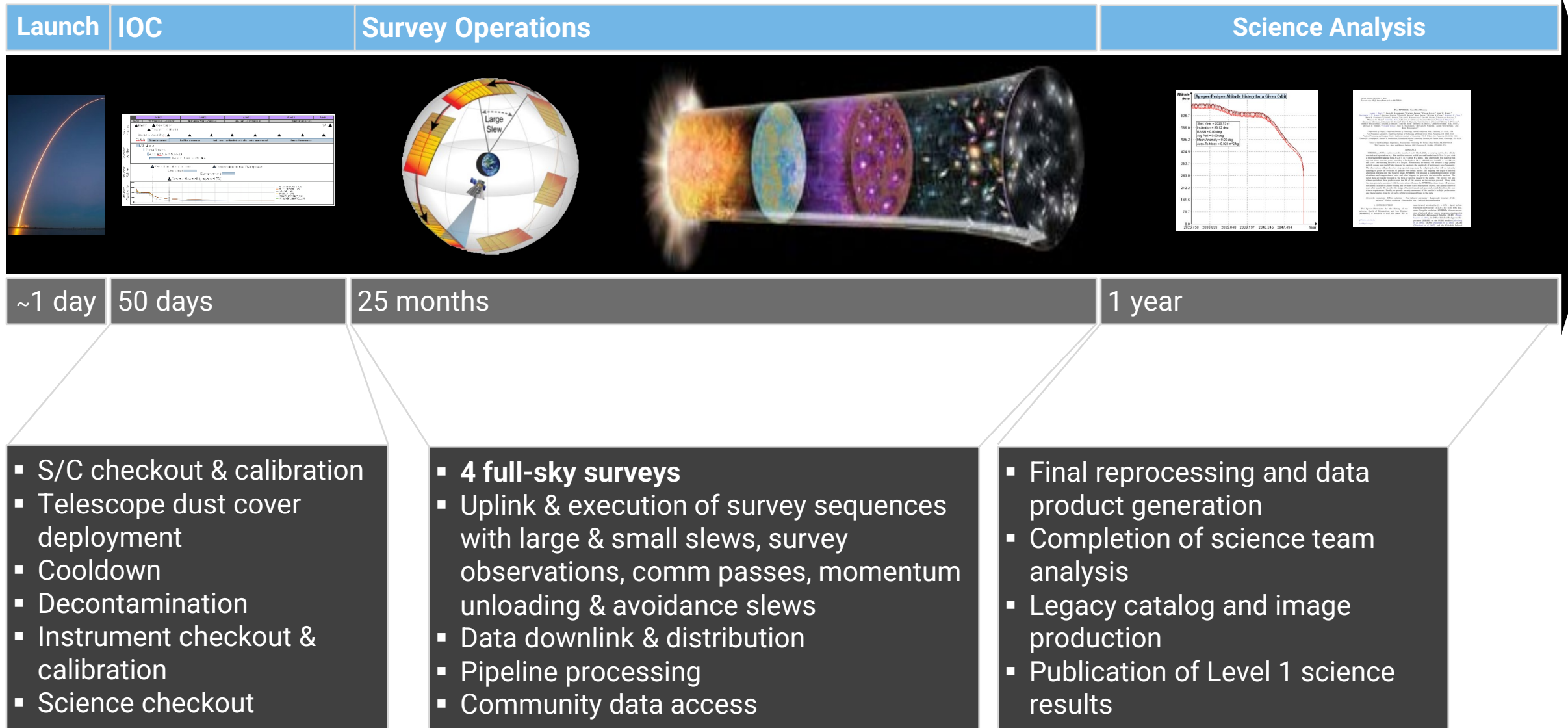
Start of Science Survey:
May 1



First Data Release:
July 2

SPHEREx: An All-Sky Spectral Survey	
	
SPHEREx Data Explorer	Documentation
Mission Characteristics	
Lifetime:	2025 - 2027 (planned)
Wavelength:	0.75-1.1 microns, R=39 1.1-1.6 microns, R=41 1.6-2.4 microns, R=41 2.4-3.8 microns, R=35 3.8-4.4 microns, R=112 4.4-5.1 microns, R=128
Area Coverage (planned):	100% of sky
Instruments:	Wide Field Linear Variable Filter (LVF) Imaging Spectrograph
Funding Agency:	NASA
Contributing Institutions:	JPL, Caltech, RIT, Harvard/CFA, Arizona State, University of Arizona, Ohio State University, KASI, UC Irvine, Johns Hopkins, ASIAA
Canonical Papers:	Dore et al. (2014) Korngut et al. (2018) Crill et al. (2020) Please include the following acknowledgement in any published material that makes use of SPHEREx data products: "This publication makes use of data products from the Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer (SPHEREx), which is a joint project of the Jet Propulsion Laboratory and the California Institute of Technology, and is funded by the National Aeronautics and Space Administration."
SPHEREx Releases:	July 2025: First Quick Release Products available at IRSA

Mission Timeline



Survey strategy: Whole sky plus deep fields



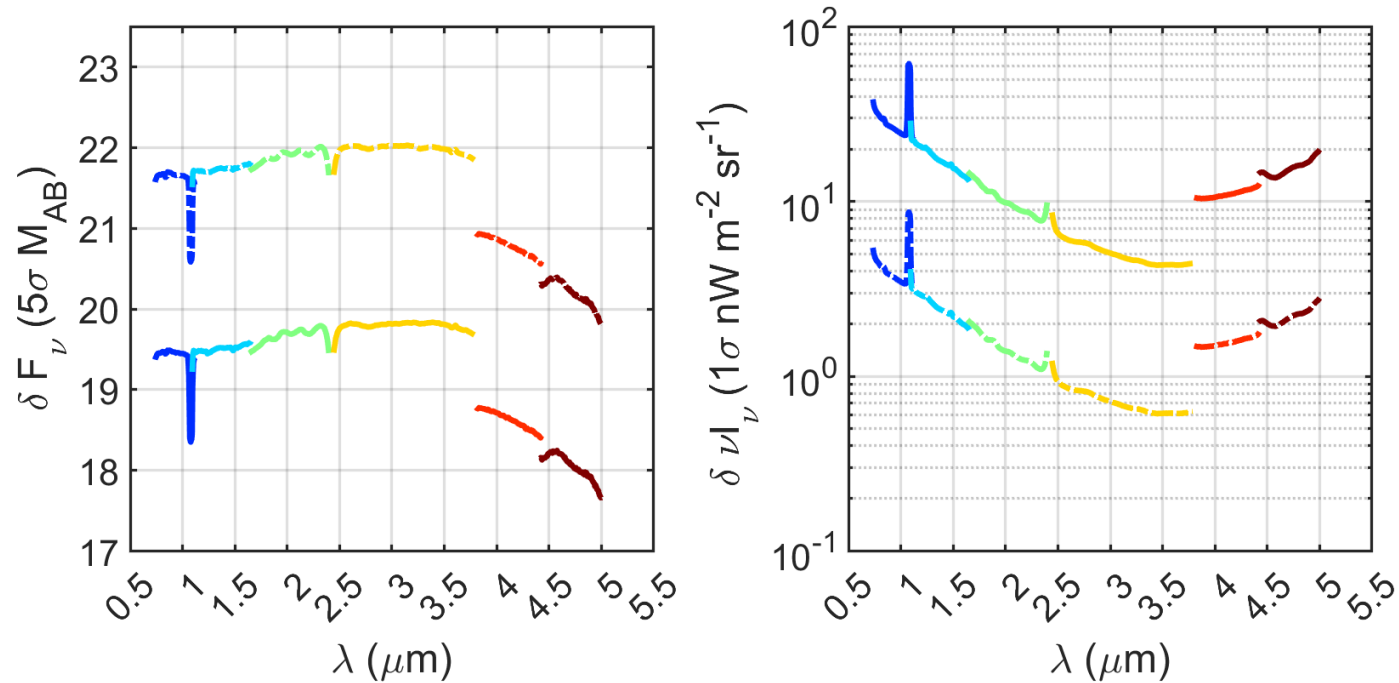
- SPHEREx will survey the whole sky 4 times in 2 years during the prime mission in each of 102 wavelength bands
- North and south deep fields will have ~400 visits each



SPHEREx is easily meeting all instrument performance requirements

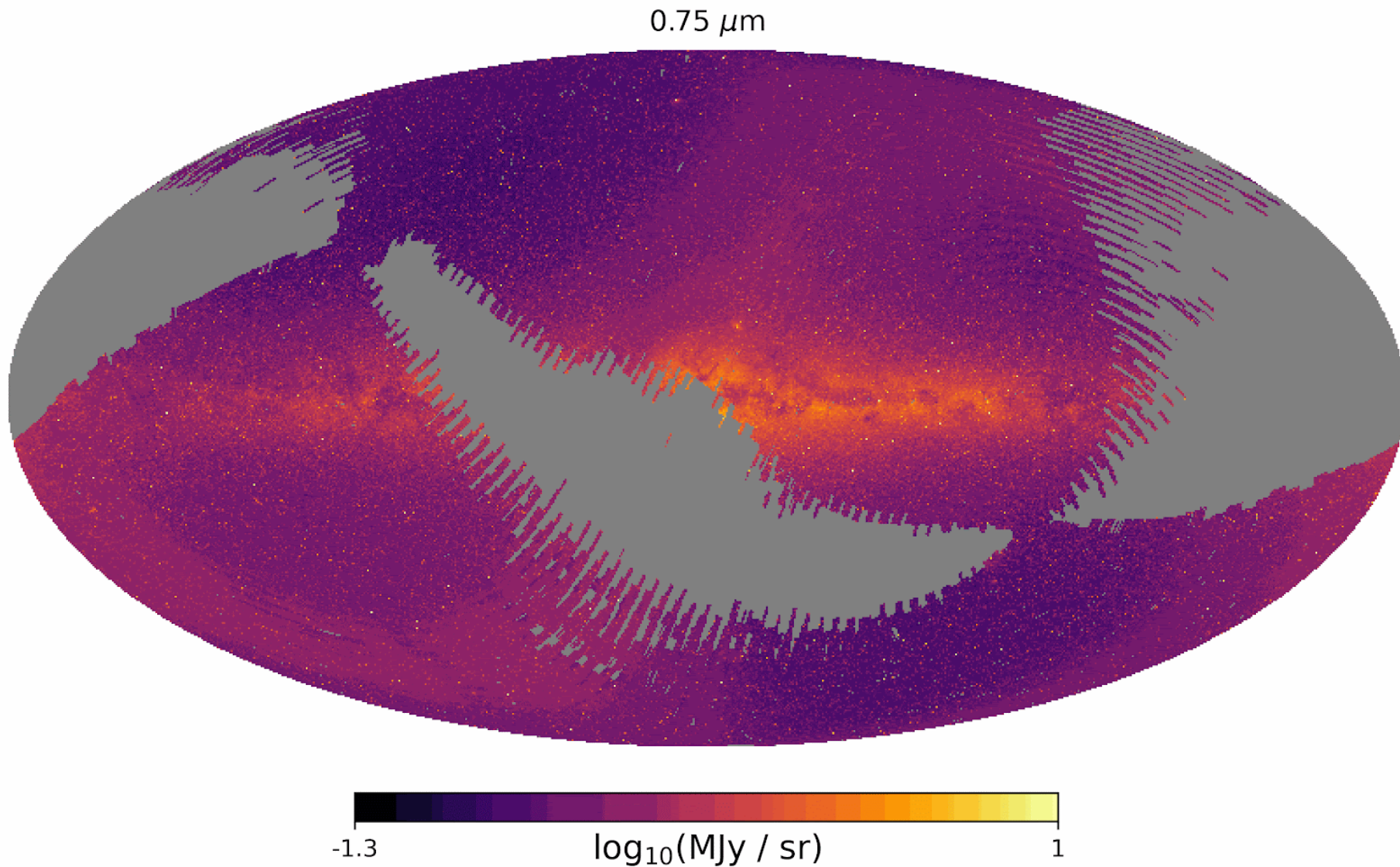
Deep fields

All-sky



Exquisite pointing control - changed our survey planning strategy during IOC to leverage less slew settle time to get longer exposures and less shuttle glow

All Sky Mosaic Movie on 10' pixels, Survey Data as of Sept. 23



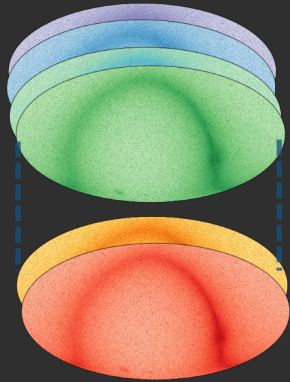
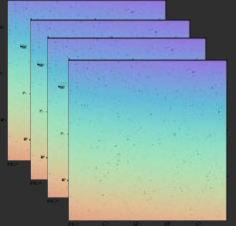
SPHEREX DATA AT THE NASA/IPAC INFRARED SCIENCE ARCHIVE



- SPHEREx public data is hosted at the NASA/IPAC Infrared Science Archive (IRSA)
- Standard IRSA capabilities
 - Includes search, visualization and download capabilities
 - Web-based and application programming interfaces (APIs)
 - Uses community data access and metadata standards
- Custom Tools
 - Spectrophotometry (available now: uses same method as project pipeline)
 - LVF Image Cutout
 - Source Discovery
 - Custom Mosaic
 - Spectral Cube Cutout

Data Products

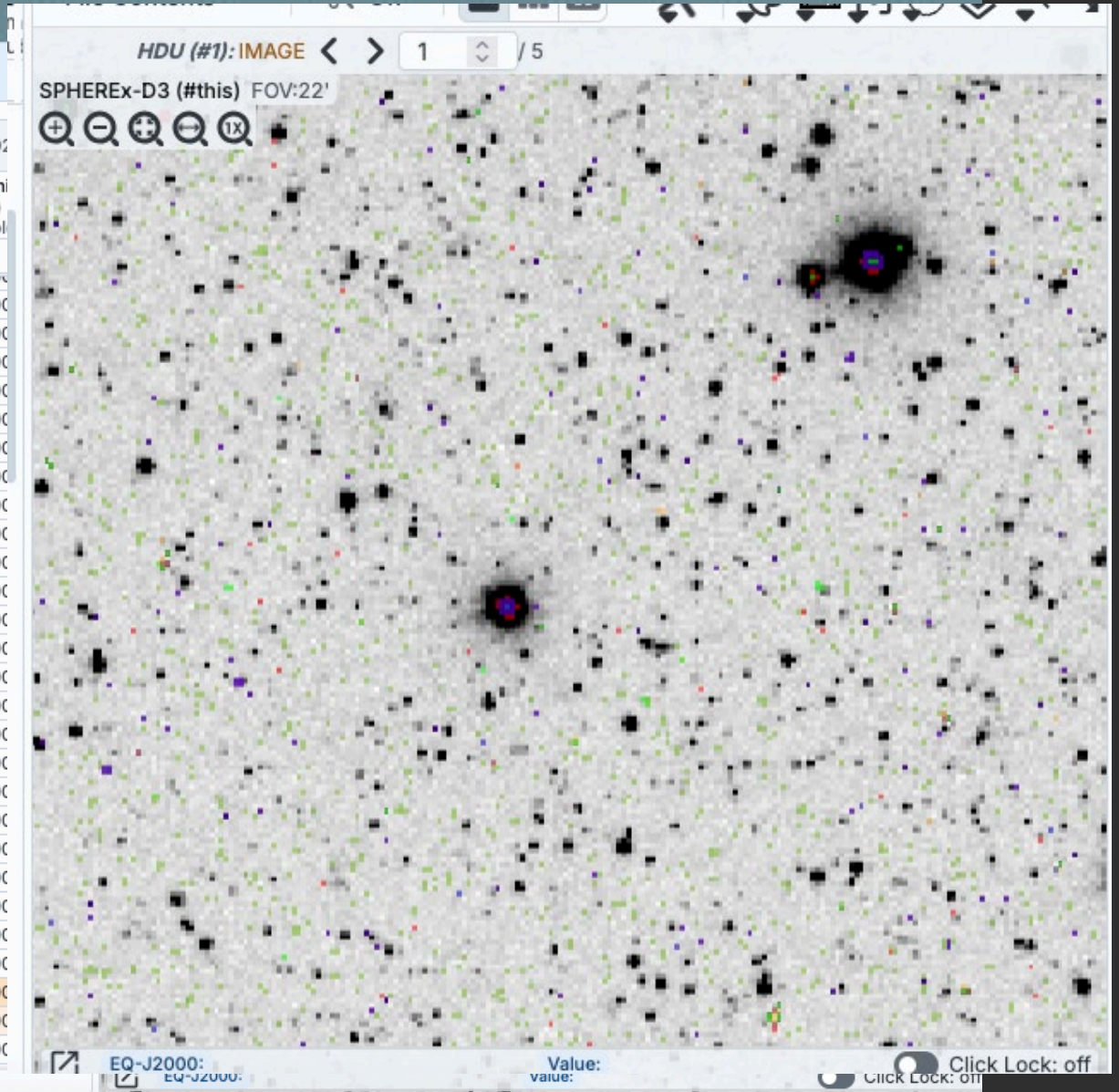
- Calibrated Spectral Image Data
 - Available in archive within 60 days
- 102 All-sky Data Cubes
 - Part of Year 1 and 2 Data Release
- High Reliability Source Catalog
 - Photometry measurements at native wavelengths and binned over 102 spectral channels
 - Sources selected from input catalog
 - Created after 3 sky surveys
- Legacy Data Products
 - Released at end of mission
 - Legacy Deep Field Mosaics
 - Legacy Galaxy Catalog
 - Legacy Stellar Type/Ice Column Density Catalog
 - Stellar, Galaxy Cluster and Solar System Catalogs



CALIBRATED IMAGE EXAMPLE



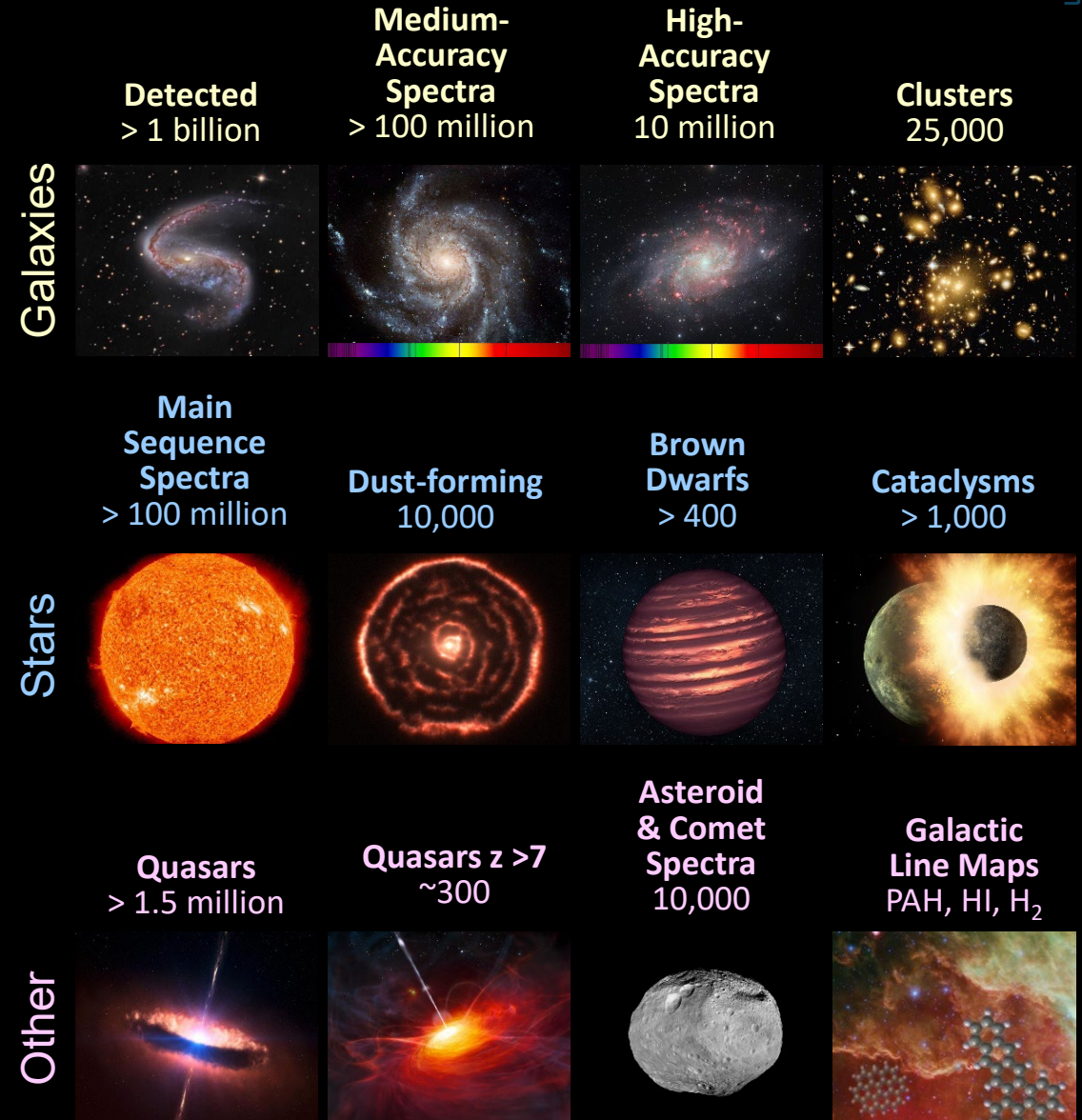
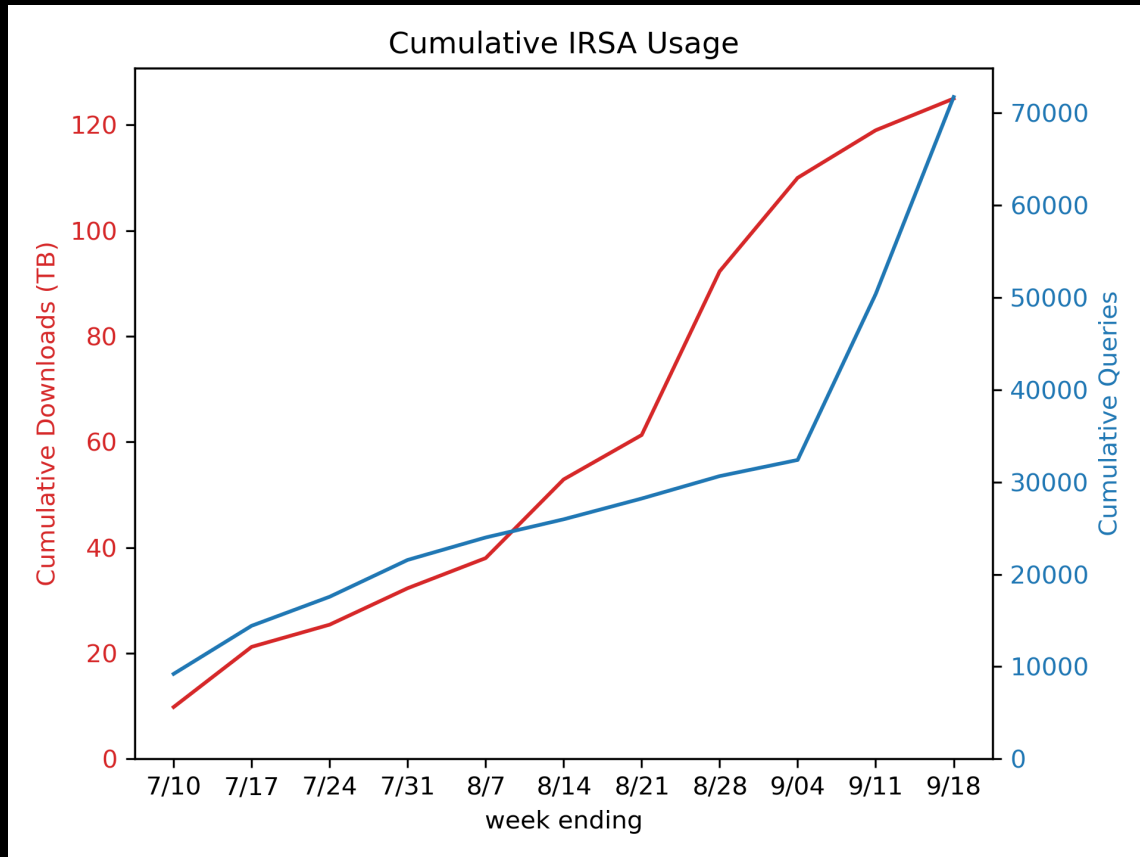
Spectral Images ×		Spectral Images ×	
Generate		Generate Download Script	
obs_id	s_ra	obs_id	s_ra
char	(deg)	char	(deg)
	double		double
I25W18_2B_0194_1	157.286	I25W18_2B_0194_1	157.28643336
I25W18_2B_0194_1	157.275	I25W18_2B_0194_1	157.27507157
I25W18_2B_0247_1	157.188	I25W18_2B_0247_1	157.18872461
I25W18_2B_0247_1	157.200	I25W18_2B_0247_1	157.20010058
I25W18_2B_0247_2	157.1106	I25W18_2B_0247_2	157.11067976
I25W18_2B_0247_2	157.099	I25W18_2B_0247_2	157.09927220
I25W18_2B_0247_3	157.021	I25W18_2B_0247_3	157.02178916
I25W18_2B_0247_3	157.010	I25W18_2B_0247_3	157.01033919
I25W18_2B_0247_4	156.921	I25W18_2B_0247_4	156.92189923
I25W18_2B_0247_4	156.933	I25W18_2B_0247_4	156.93336295
I25W18_2B_0338_1	154.151	I25W18_2B_0338_1	154.15148759
I25W18_2B_0338_1	154.162	I25W18_2B_0338_1	154.16259452
I25W18_2B_0338_2	154.064	I25W18_2B_0338_2	154.06498315
I25W18_2B_0338_2	154.076	I25W18_2B_0338_2	154.07610900
I25W19_1B_0171_1	154.163	I25W19_1B_0171_1	154.16371767
I25W19_1B_0171_1	154.152	I25W19_1B_0171_1	154.15260136
I25W19_1B_0171_2	154.066	I25W19_1B_0171_2	154.06605511
I25W19_1B_0171_2	154.077	I25W19_1B_0171_2	154.07718716
I25W19_1B_0171_3	153.991	I25W19_1B_0171_3	153.99141470
I25W19_1B_0171_3	153.980	I25W19_1B_0171_3	153.98024953
I25W19_1B_0171_4	153.905	I25W19_1B_0171_4	153.90598504
I25W19_1B_0171_4	153.894	I25W19_1B_0171_4	153.89480180
I25W19_1B_0351_1	154.450	I25W19_1B_0351_1	154.45094506
I25W19_1B_0351_1	154.444	I25W19_1B_0351_1	154.44401554
I25W19_1B_0351_2	154.370	I25W19_1B_0351_2	154.37022666
I25W19_1B_0351_2	154.363	I25W19_1B_0351_2	154.36327564
I25W19_1B_0351_3	154.283	I25W19_1B_0351_3	154.28335416
I25W19_1B_0351_3	154.290	I25W19_1B_0351_3	154.28335416



COMMUNITY DATA USAGE



- Community downloads of SPHEREx data are strong
 - Downloads = 5 x of data available (21 TB)
- New data available ~weekly



SPHEREx Core Science



How did the Universe begin?

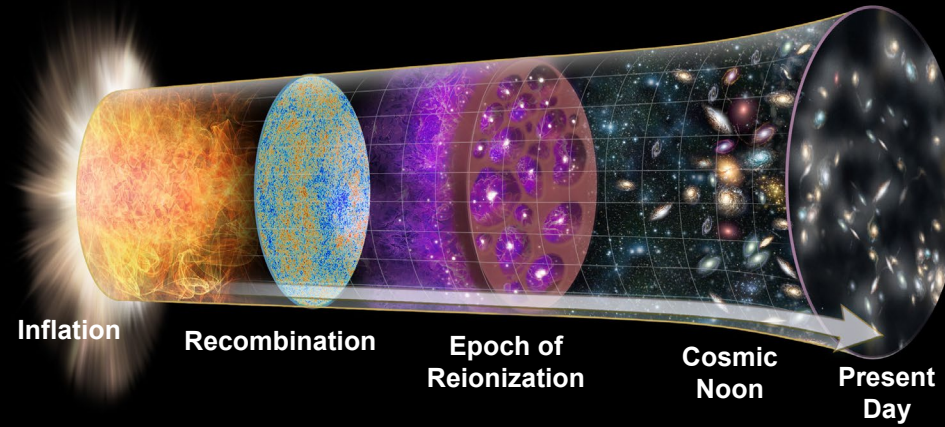


Improve accuracy on inflationary non-Gaussianity by a factor of 10

Measure 400+ million redshifts over the full sky



How did galaxies form & evolve?

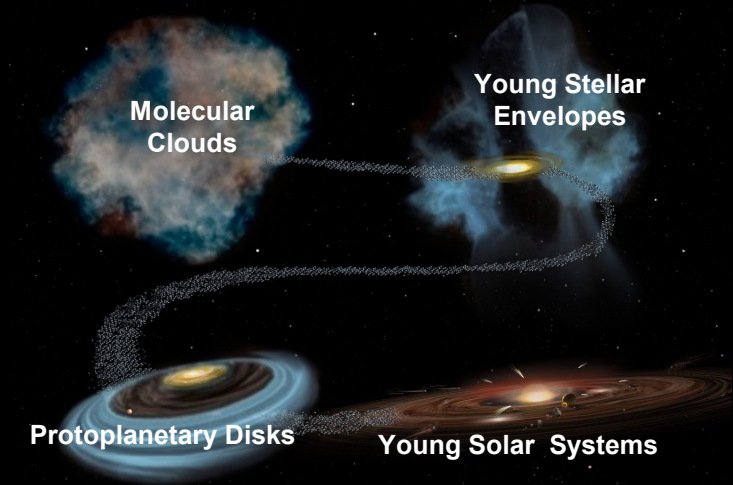


Trace the light produced by galaxies from today to the epoch of reionization

Measure galaxy clustering in deep maps of the extragalactic background light



Where is the water in our Galaxy?



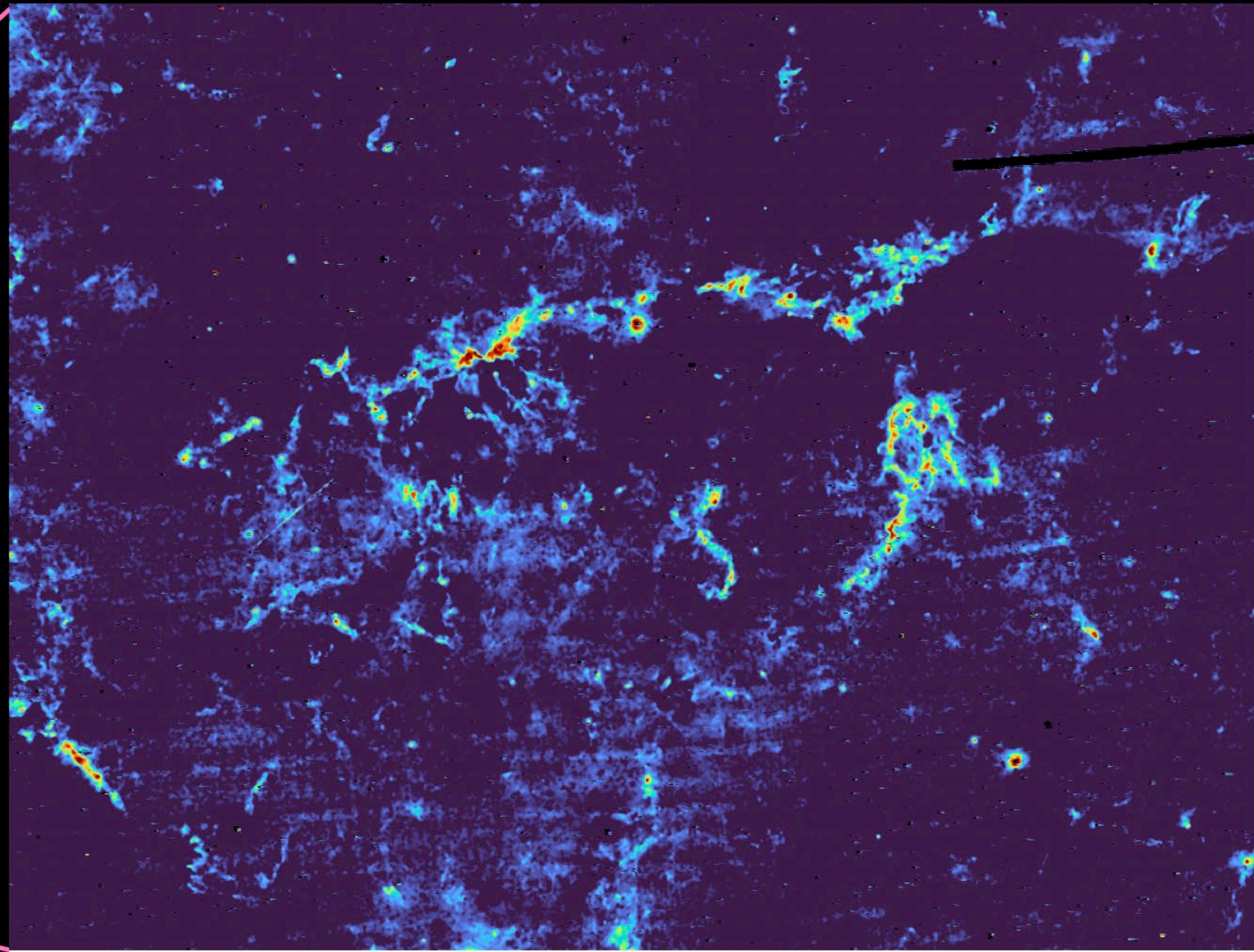
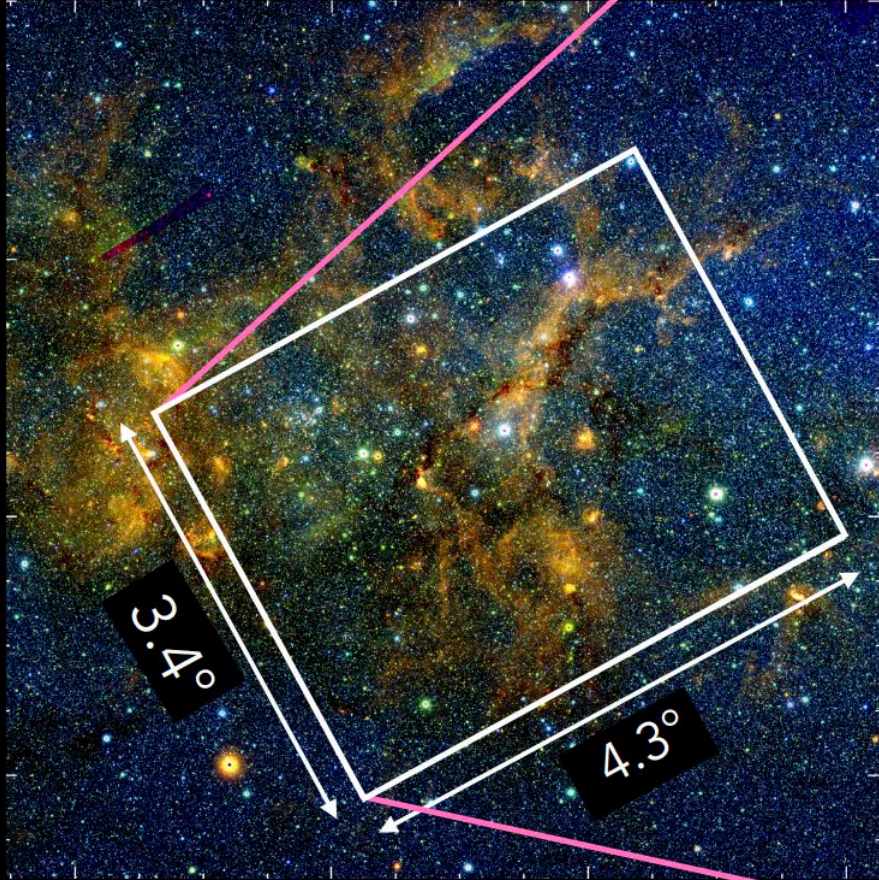
Find the amount of water and biogenic *ices* in a large sample of environments

Measure ice absorption spectra in at least 20,000 lines of sight

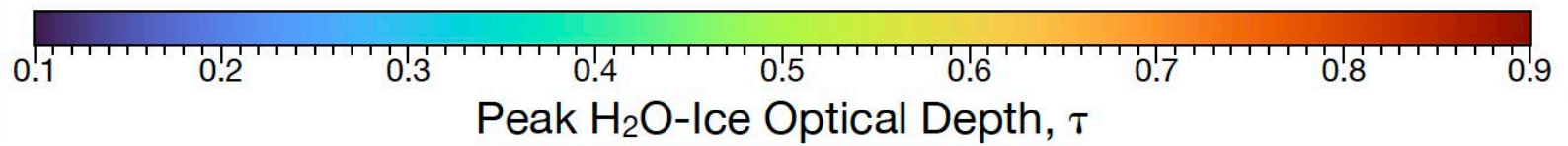


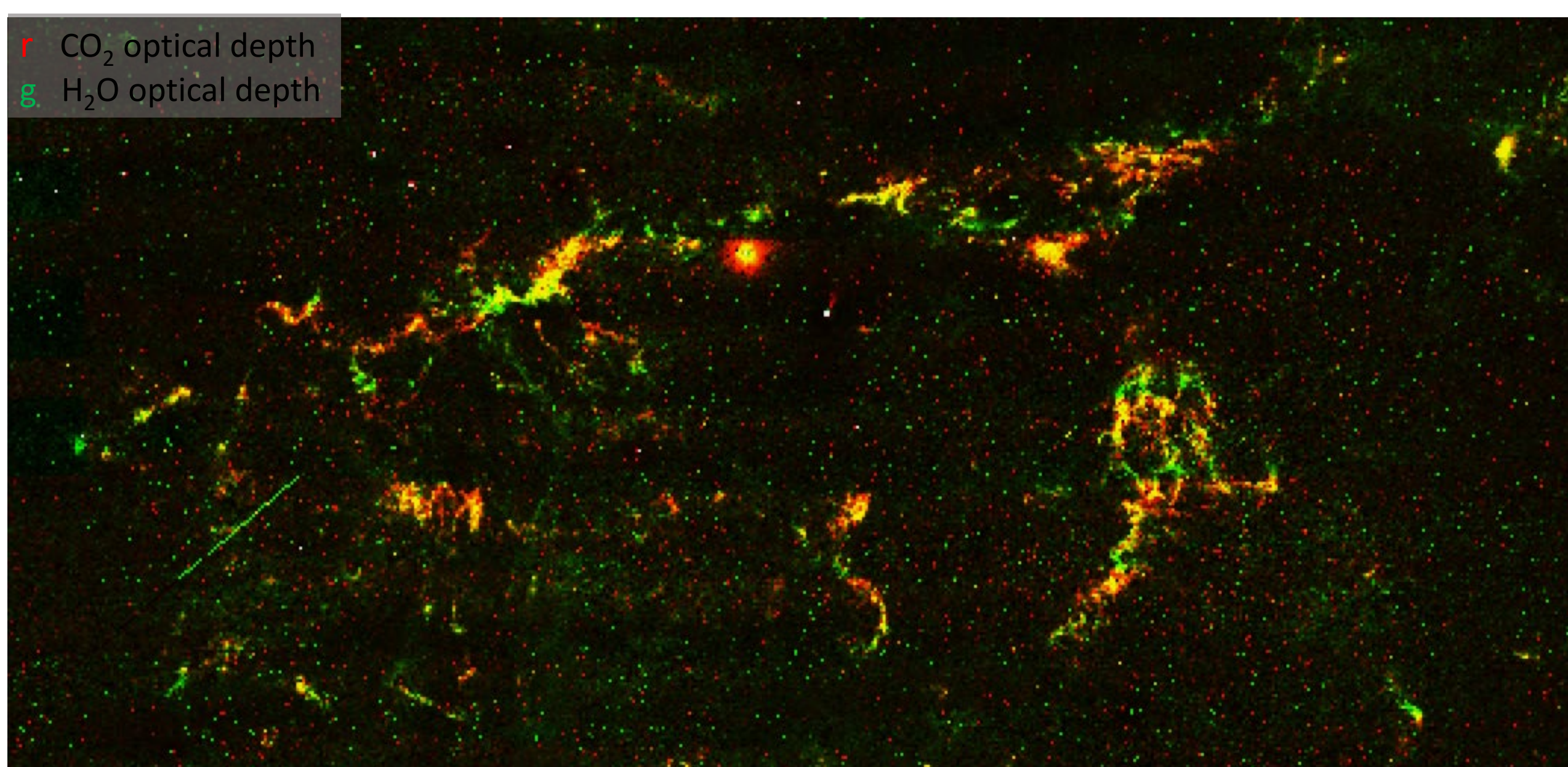
Each theme has its own dedicated Level-4 analysis pipeline
Annual reviews of status by panel of community experts

Peak Water-Ice Optical Depth in Cygnus Molecular cloud



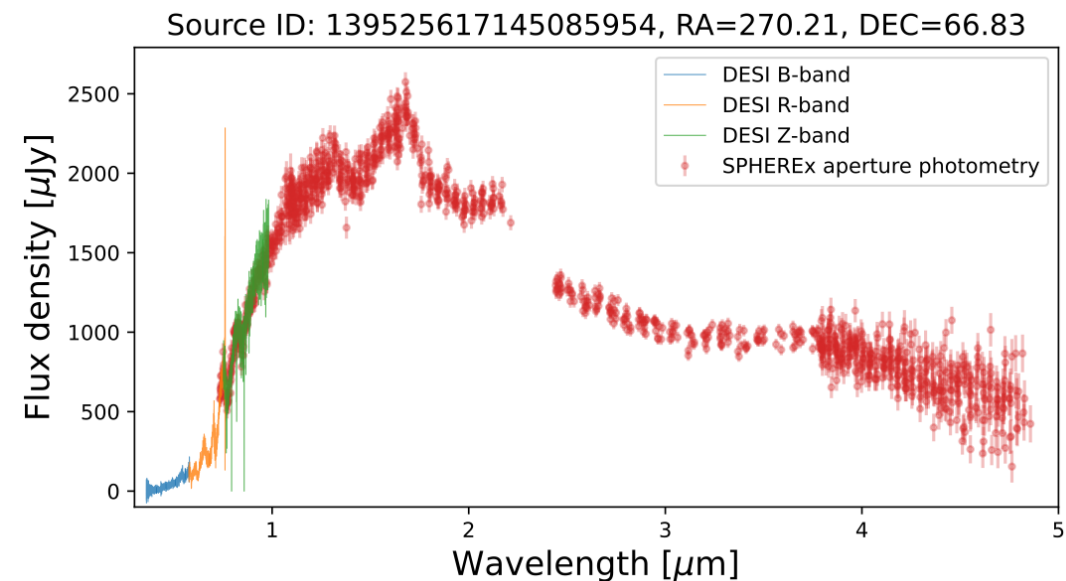
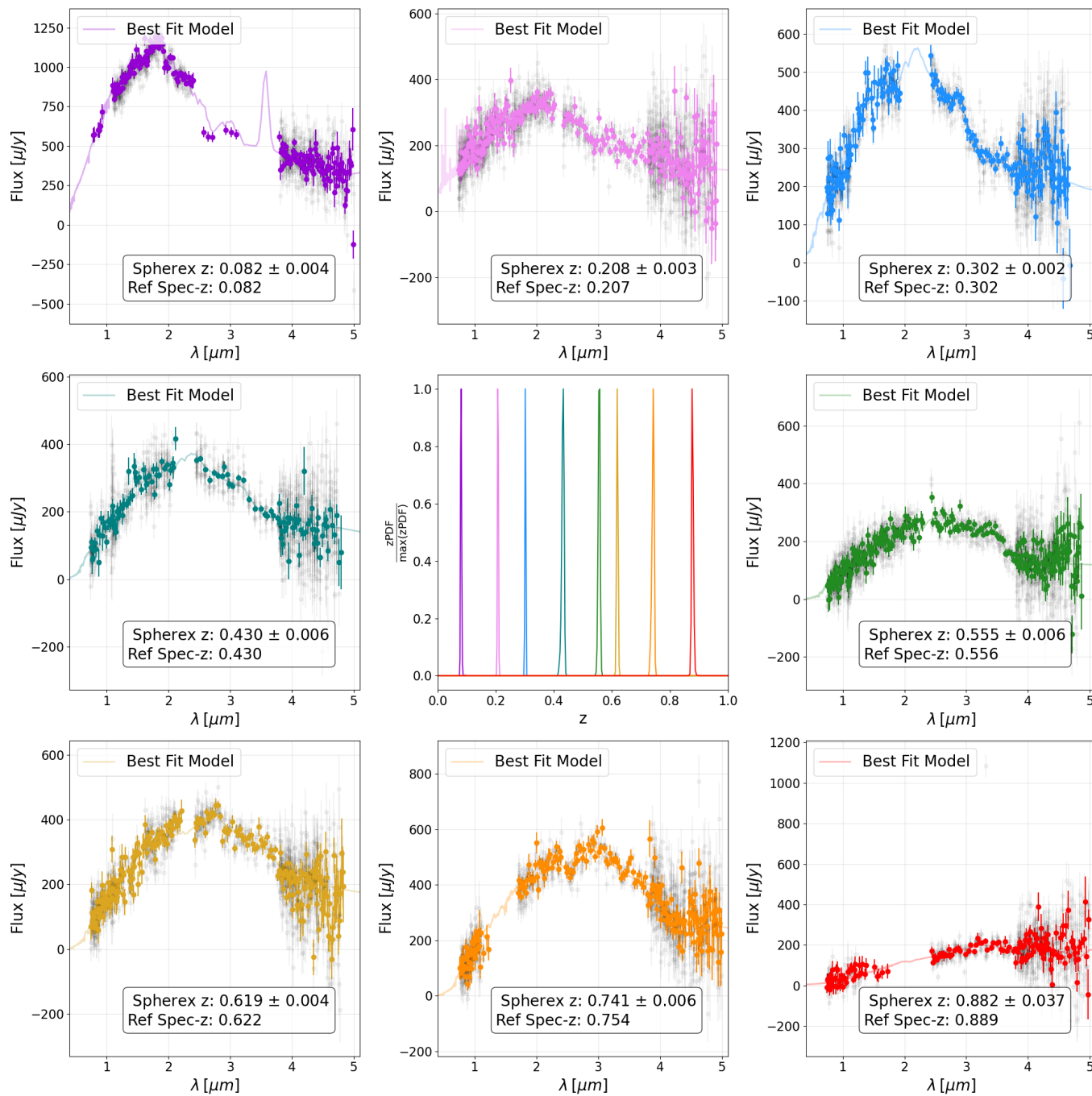
Credit: Joe Hora, Gary Melnick (CfA)





Mission L1 Requirement on 20,000 Ice lines of sight is nominally met in this one image.

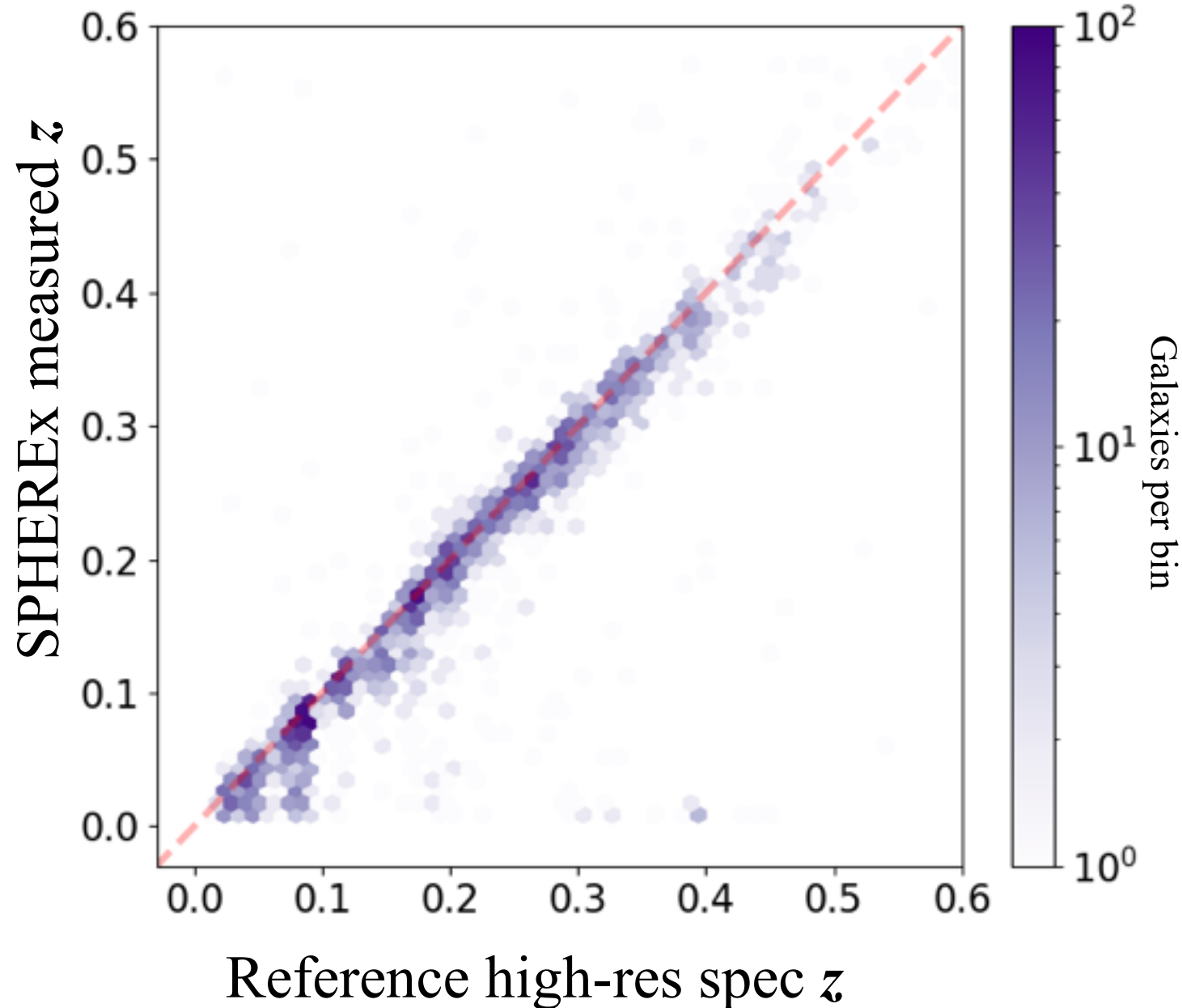
Galaxy Spectra and Redshift Validation



The first sample of galaxy spectra were used to test the SED and redshift fitting pipeline.

Excellent agreement with reference spectra from the ground is observed.

Redshift Validation of a large sample



Thousands of galaxy spectra were analyzed in the first test, and have yielded a purity of 90% with $\Delta z < 0.05$.

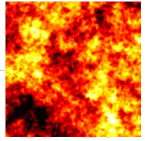
NEP Deep field - 25 square degrees



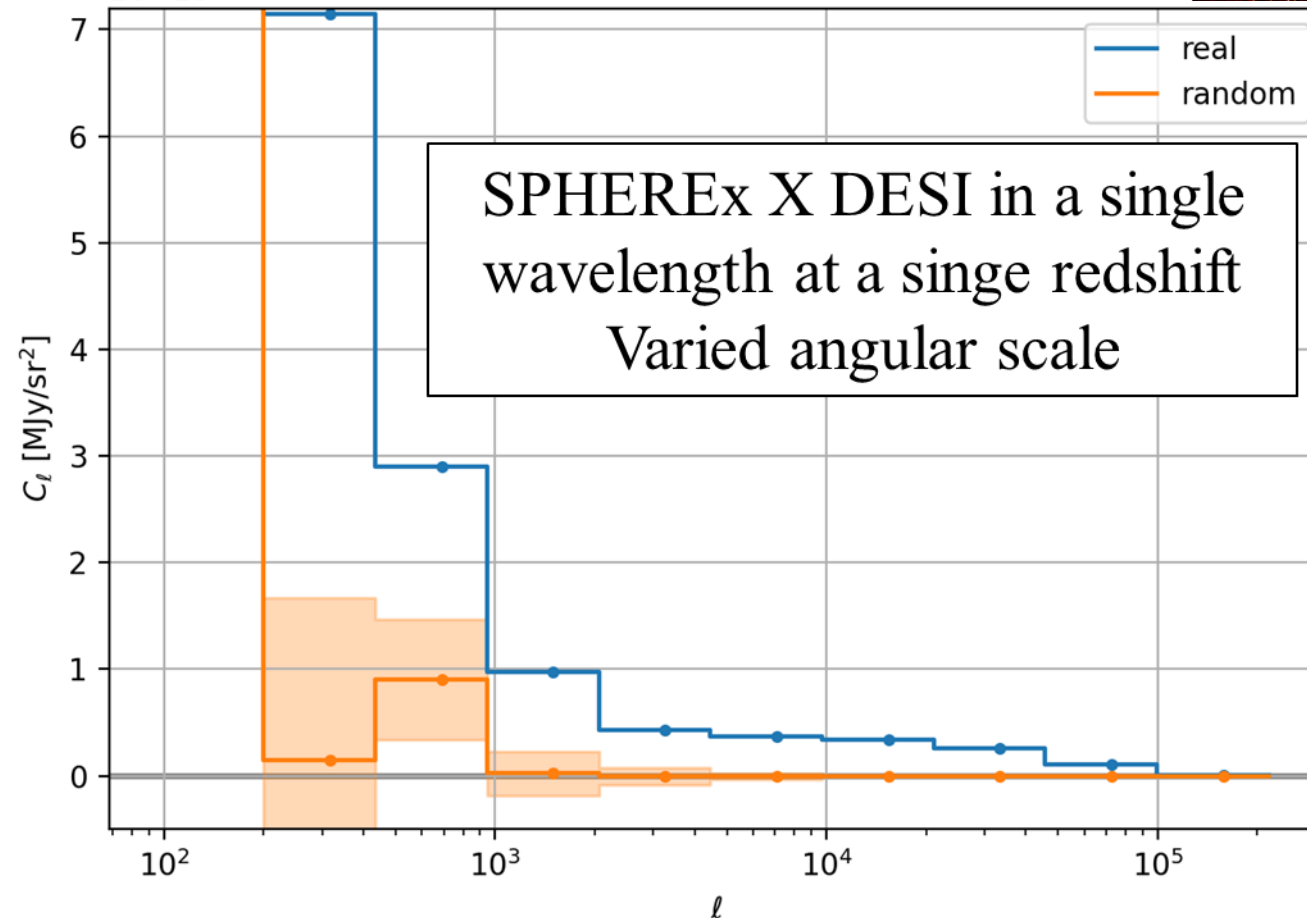
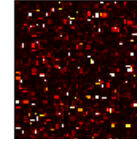
$0.75\mu\text{m} < \lambda < 1.5\mu\text{m}$
 $2.0\mu\text{m} < \lambda < 3.0\mu\text{m}$
 $4.0\mu\text{m} < \lambda < 5.0\mu\text{m}$

EBL early Science, Cross Correlation

“Puffy” large structure



Compact sources



Multipole ($\sim 1/\text{Angular Scale}$)

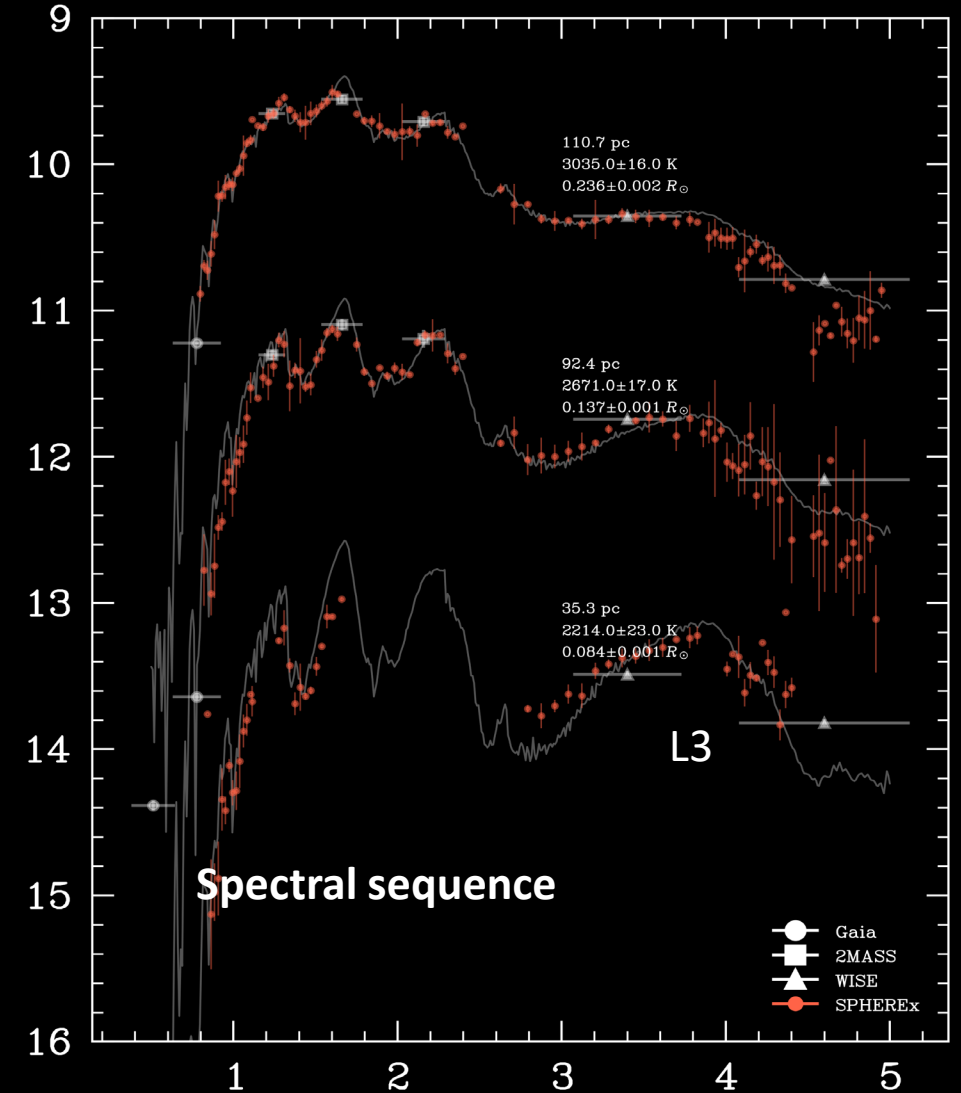
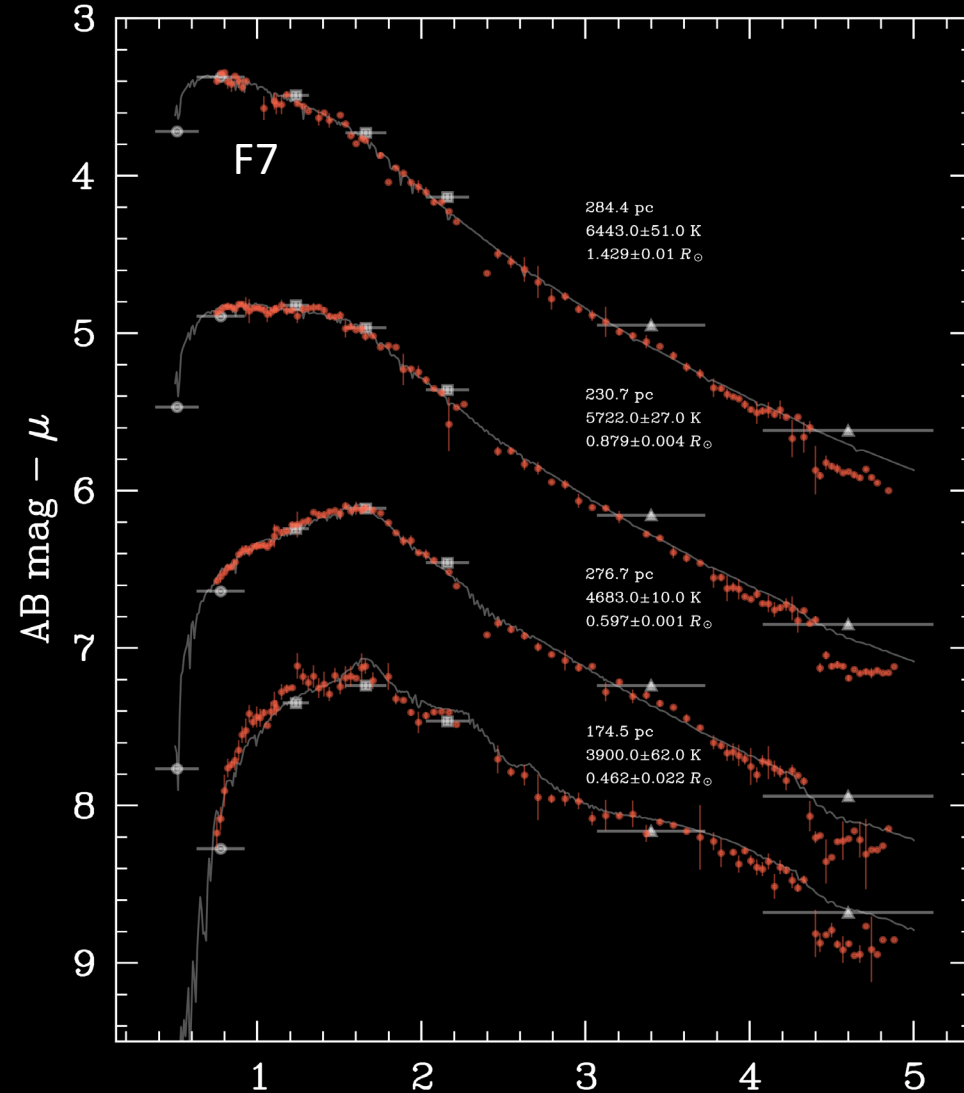
SPHEREx deep field data cross correlated with DESI galaxy locations. Orange line is random positions, to show the noise. Blue line is on-sky data, showing a clear detection of structure above the noise.

Highlighting work from Shuang-Shuang Chen
(Caltech Grad student)

Stellar catalog: SPHEREx measurements of a sequence of stars and brown dwarfs



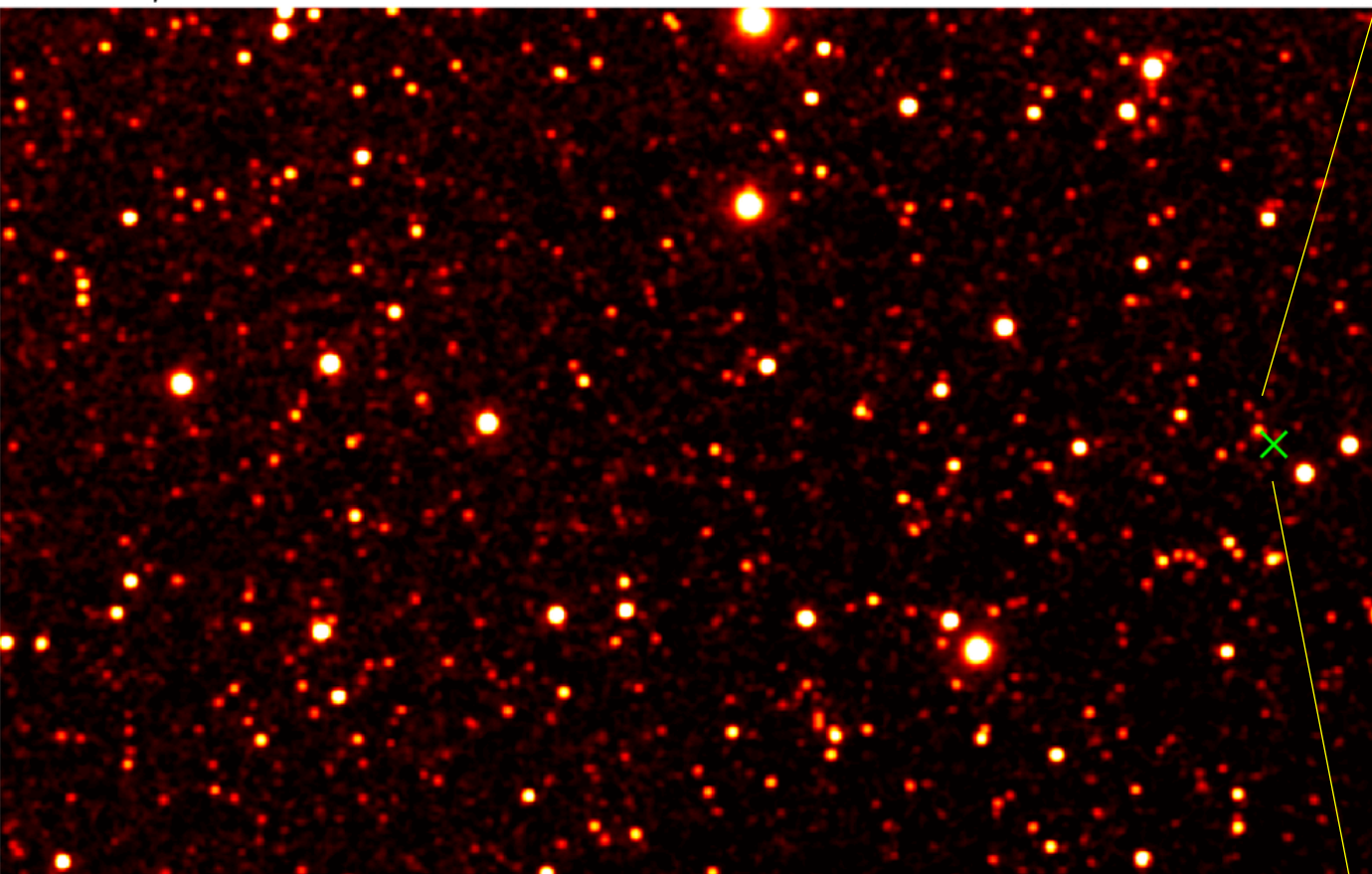
- Filling in spectral features
- Analysis using public data



Solar System: SPHEREx discovers a CO₂ coma in the interstellar object

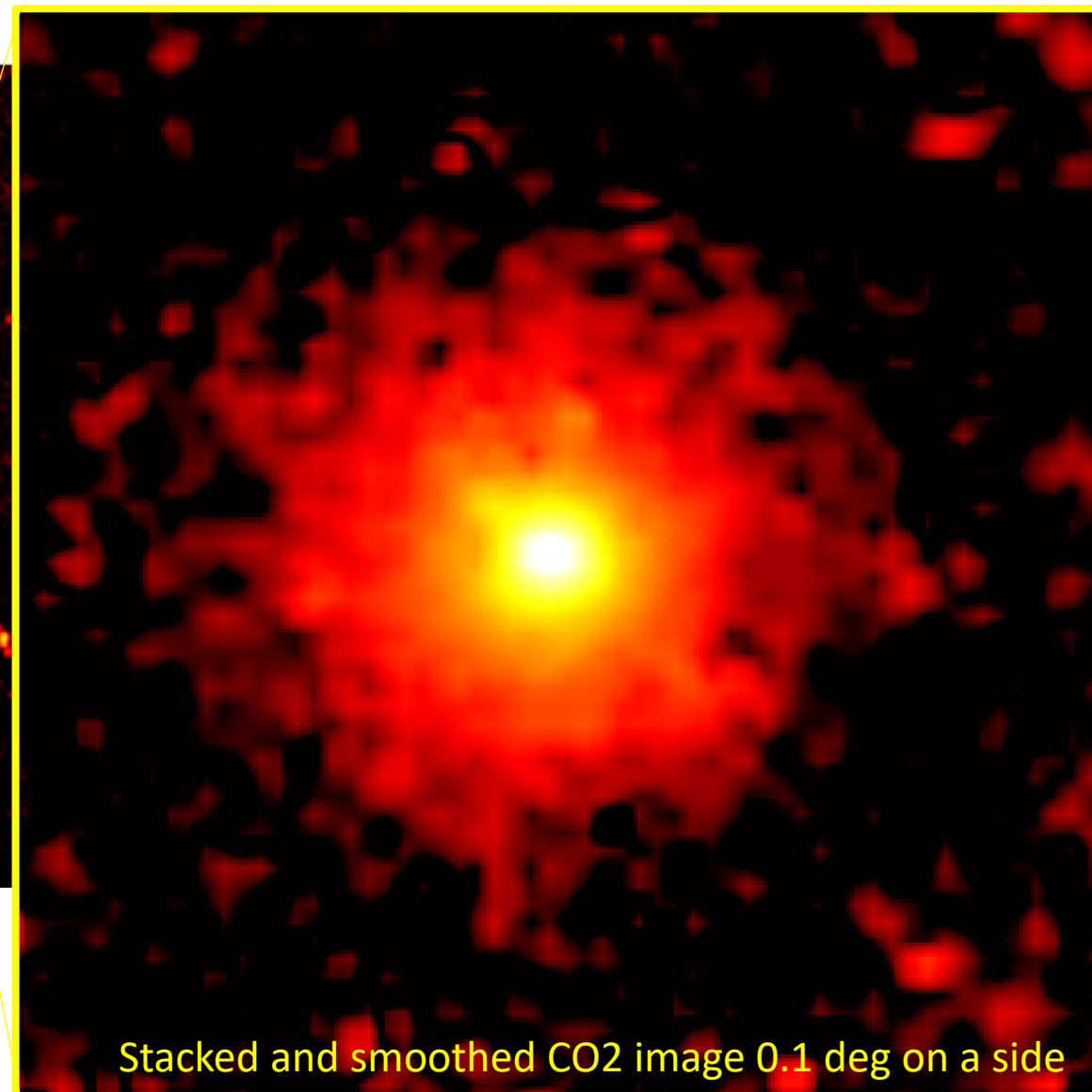


$\lambda = 4.121 \mu\text{m}$ Orbit = 1

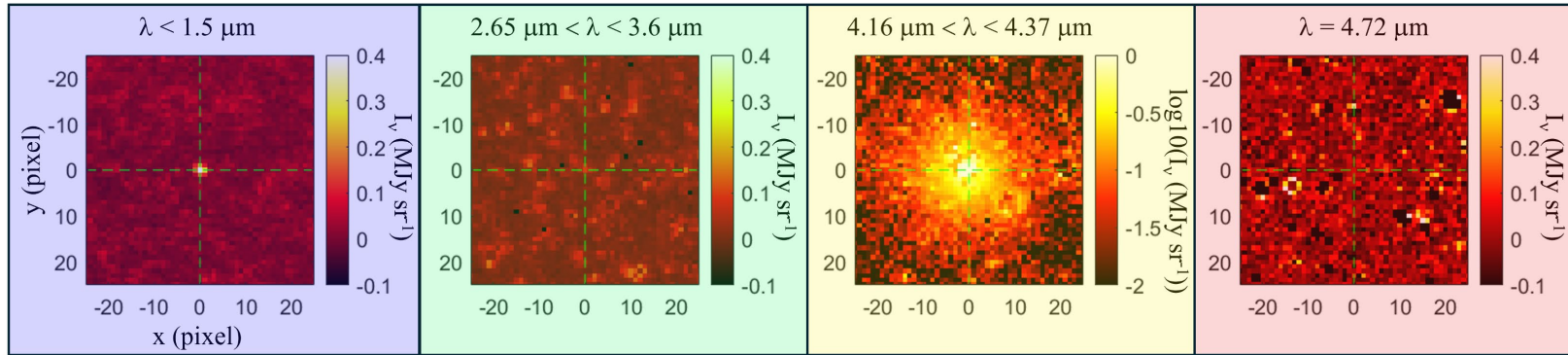


Published in RNAAS: Lisse et al, SPHEREx Discovery of Strong Water Ice Absorption and an Extended Carbon Dioxide Coma in 3I/ATLAS

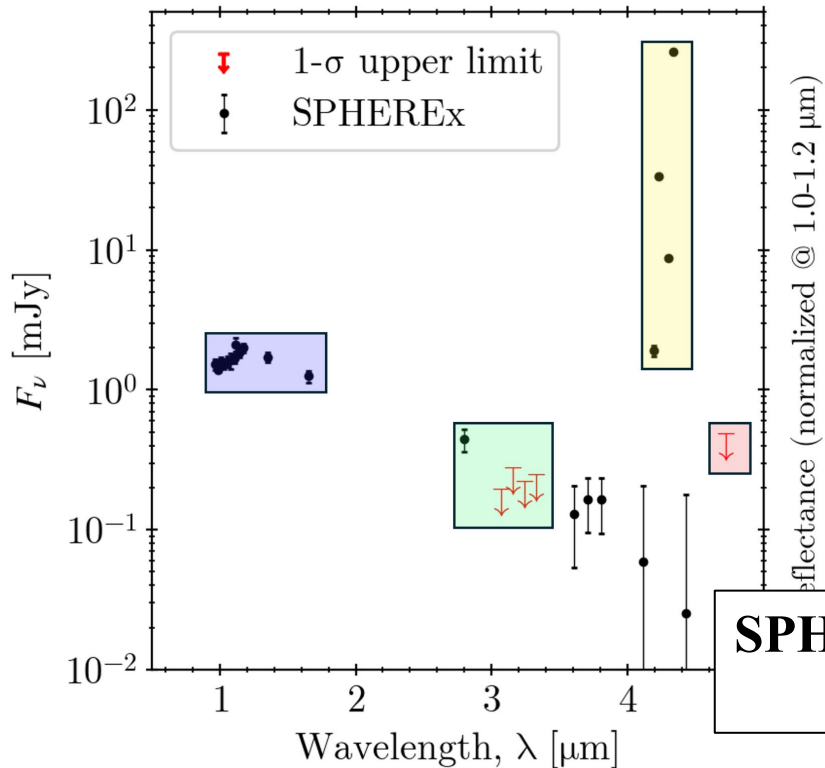
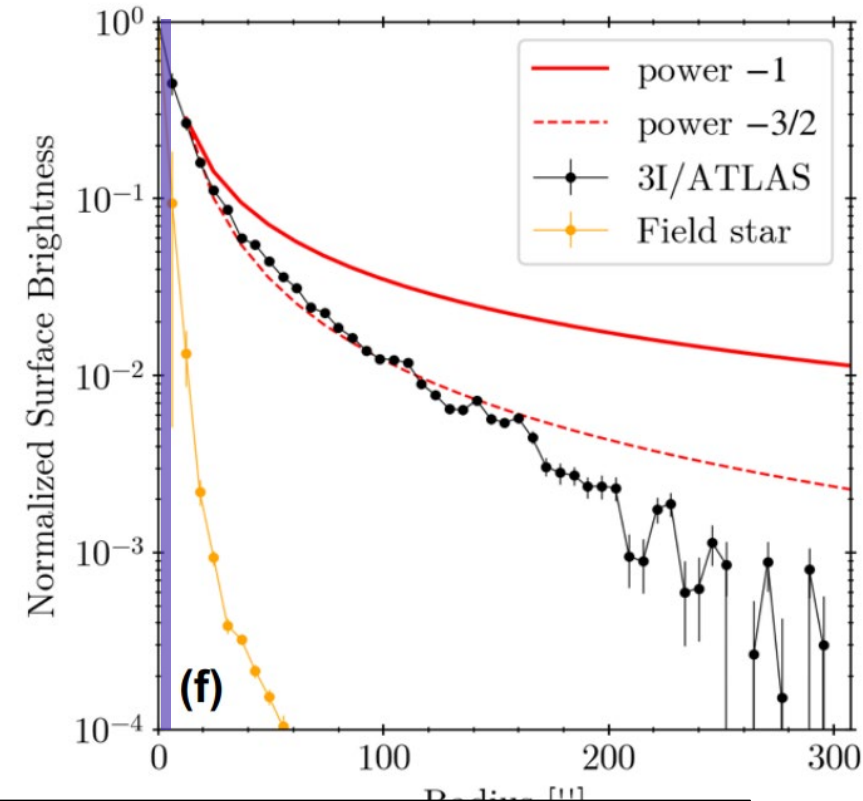
Submitted 10 days after completion of observations



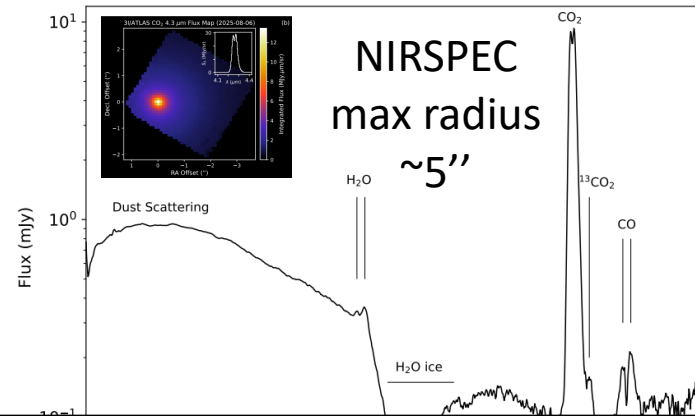
Imaging Spectroscopy of 3I Atlas: Discovery of an enormously bright CO₂ coma and water ice absorption in the core.



Enormously Extended CO₂ Emission



Beautiful JWST NIRSPEC data confirm results in the core ~3 days later

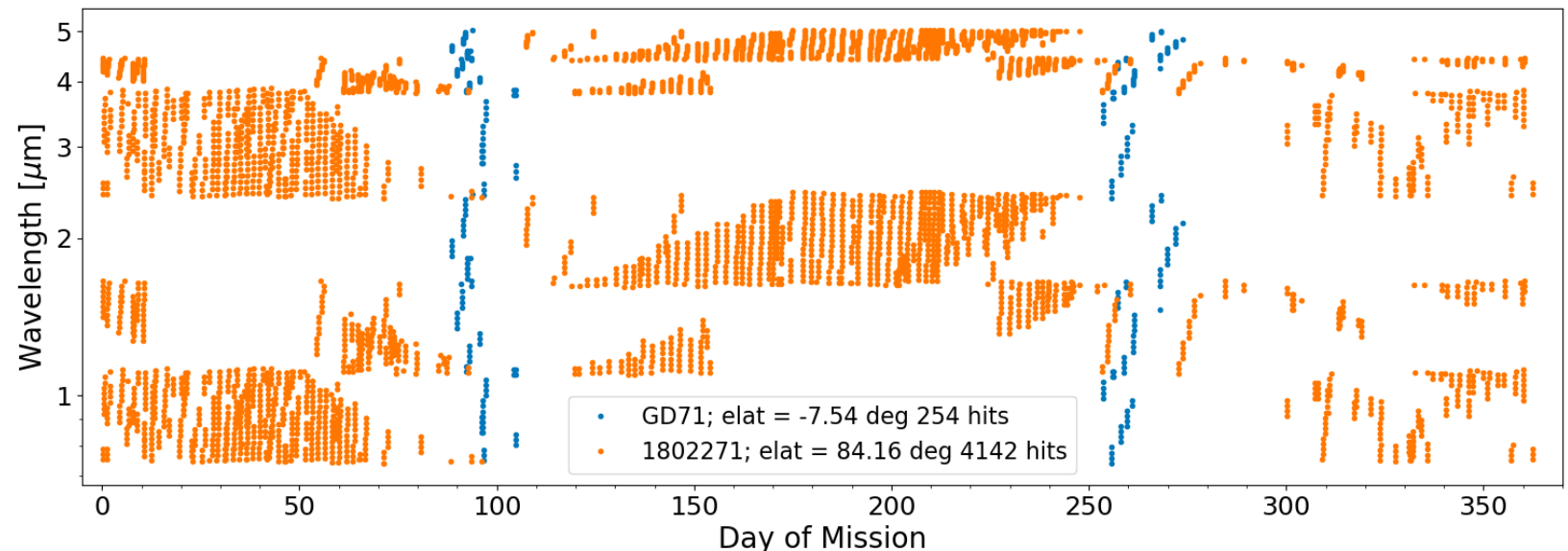


NIRSPEC
max radius
~5''

SPHEREx will Observe 3I again in Nov/Dec after perihelion (Oct 29).

Complementary Science and Time Domain

- SPHEREx's all-sky survey is complimentary to higher spectral and spatial resolution missions
 - SPHEREx will identify objects with unusual colors which can be followed-up with JWST. Cycle 5 proposals are being written based on SPHEREx data.
- SPHEREx provides critical cross-calibration data to Large Scale Structure surveys from Euclid, Roman and DESI
- Time domain studies: Repeated sky surveys provide 4 observations for the whole sky and several hundred for the deep fields
- Extended Mission
 - SPHEREx has no cryogen or fuel and can operate for many years after the prime mission
 - This would provide more overlap with other missions and increase the time domain utility



Spectral data vs time for example all-sky (blue) and deep field (orange) objects

Summary

- Observatory is working well - Instrument performance meets or exceeds design and allows team to start the exciting core science themes
- Science team analysis has started
- Community has access to calibrated data, updated weekly
 - Downloads and tool usage are strong
- SPHEREx data will impact many areas of astronomy and has already made some discoveries.
 - Mission overview, instrument testing and pipeline papers targeted for October submission.
 - Team at work on early science papers
 - First community science paper submitted, others expected soon.

