HWO Science Goals and Challenges

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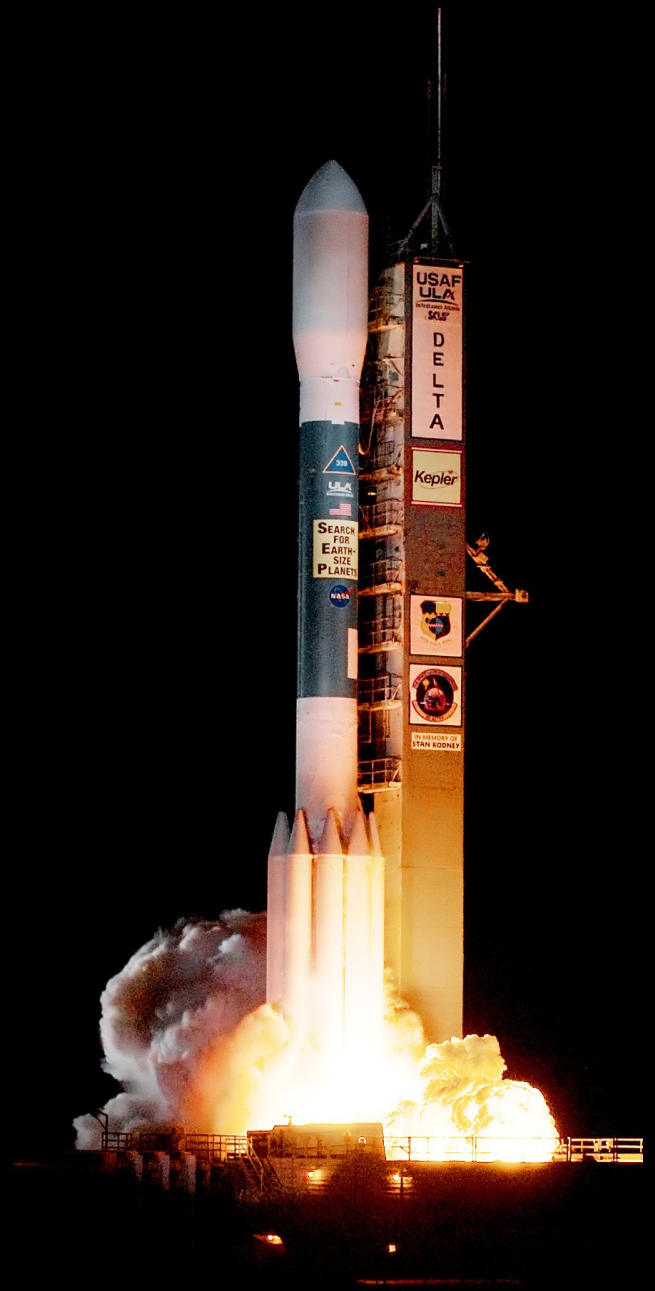
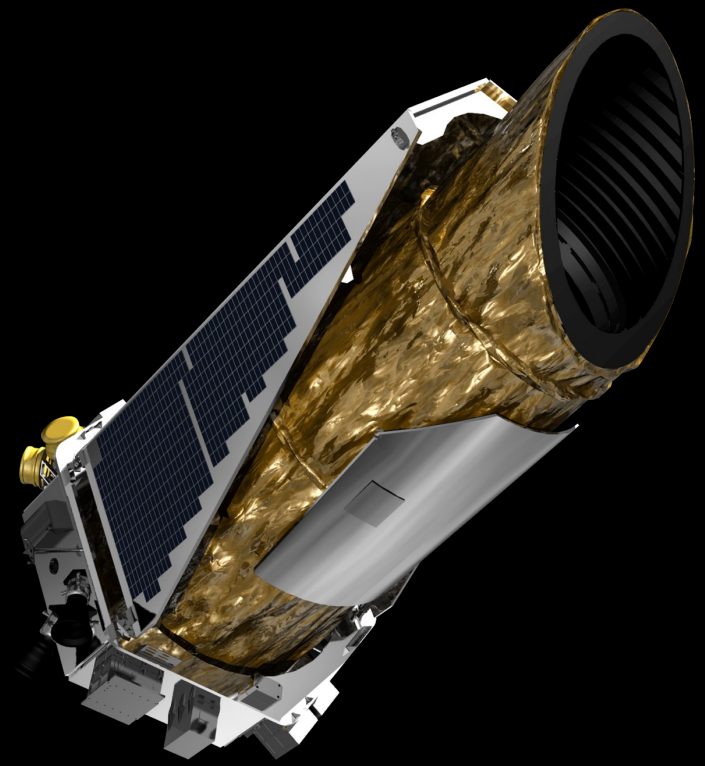
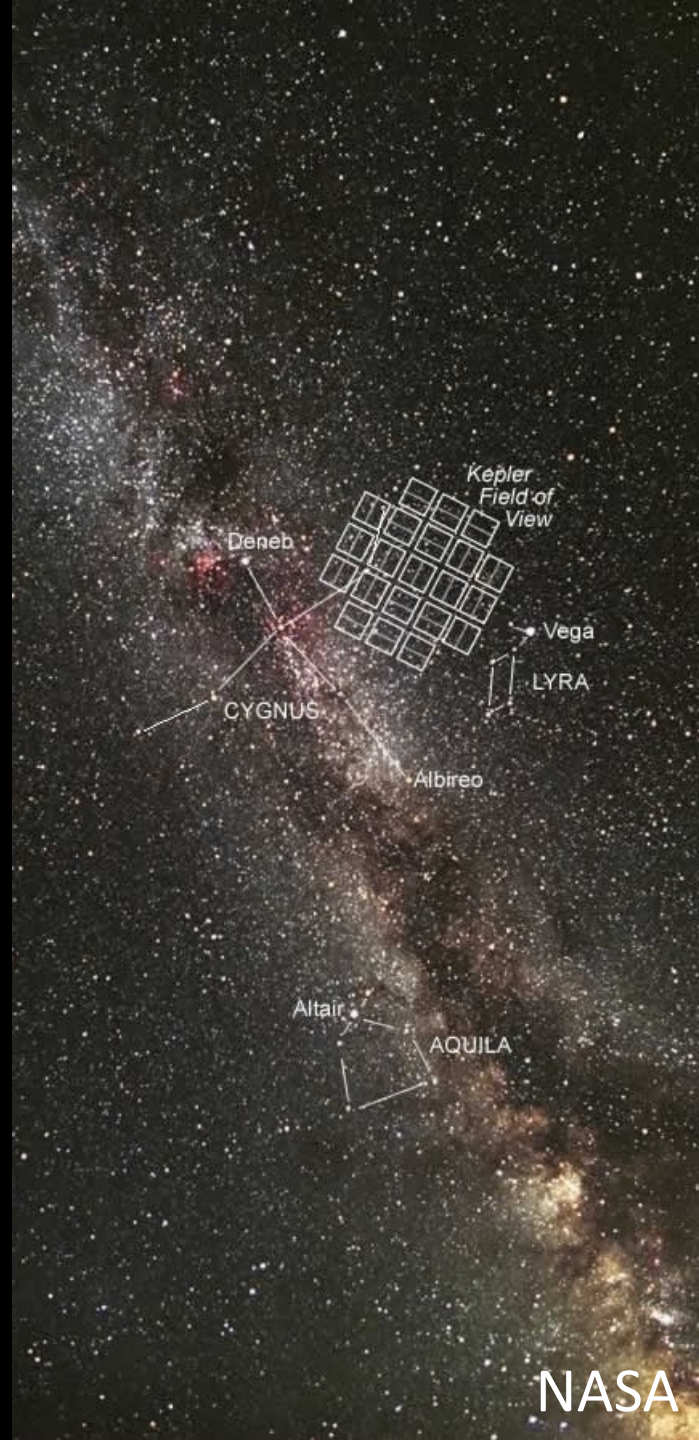
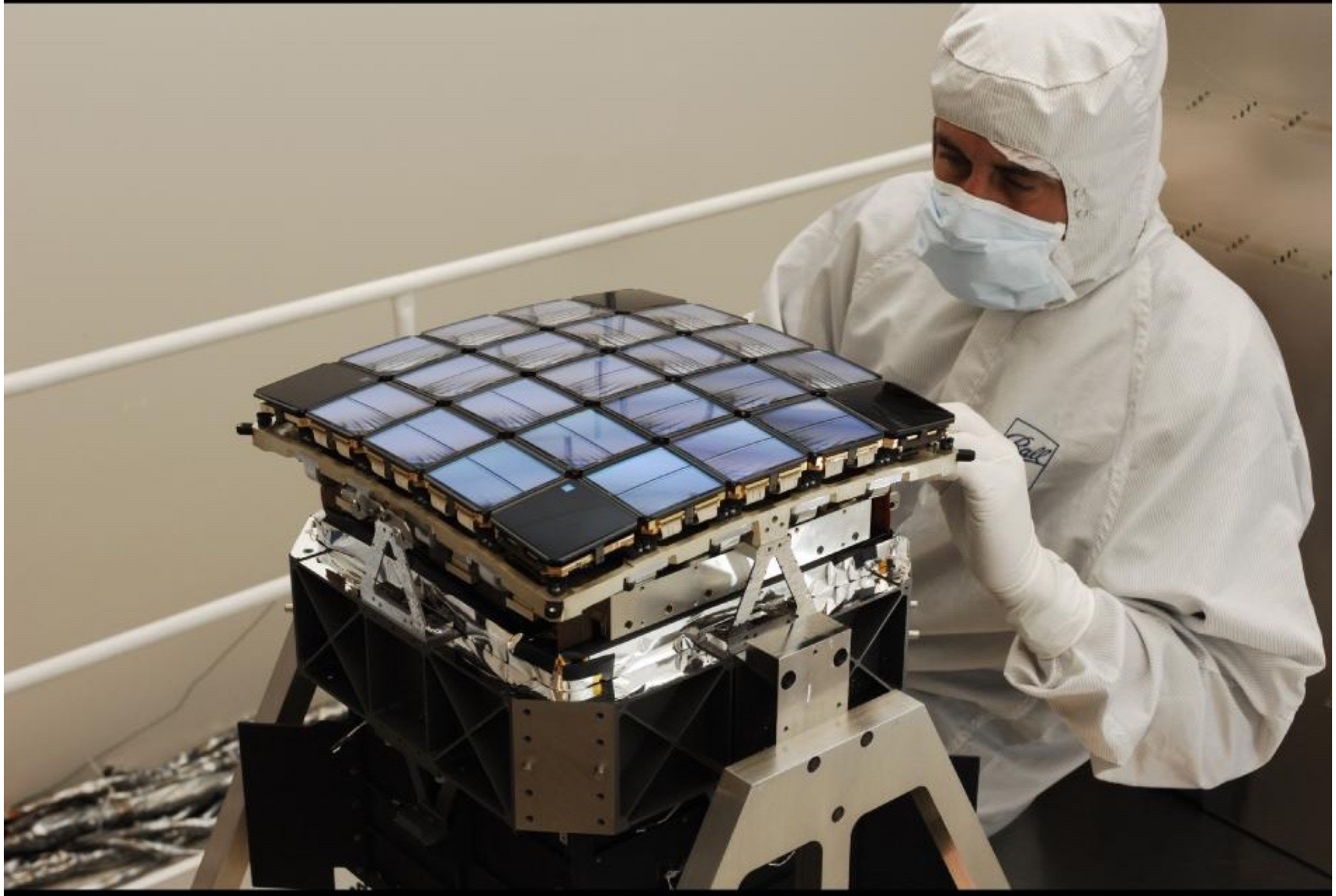
ESO

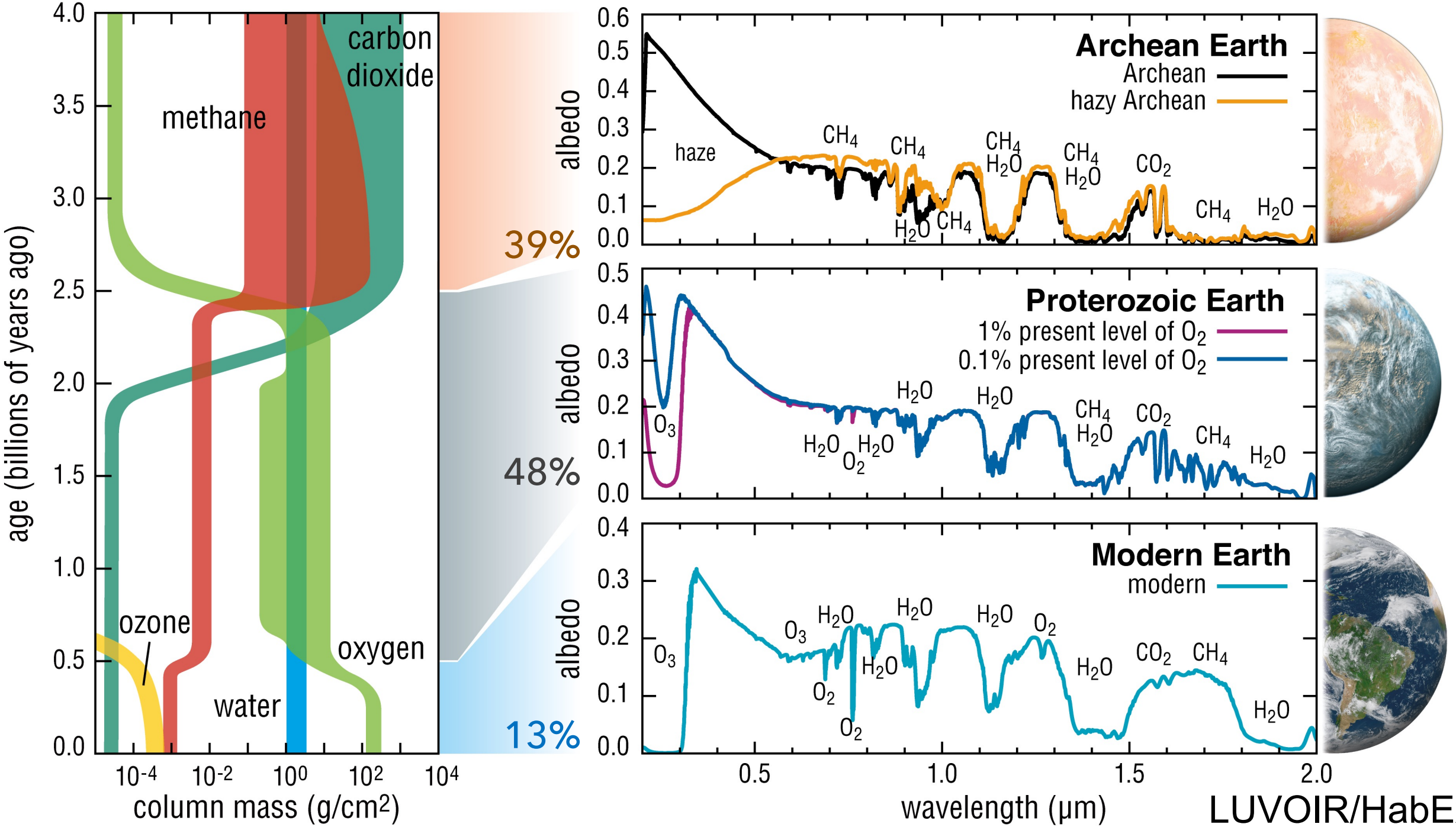

USAF
ULA
DELTA
Kepler
SEARCH FOR EARTH-SIZE PLANETS
NASA




Kepler Field of View
Deneb
Vega
LYRA
CYGNUS
Albireo
Altair
AQUILA
NASA



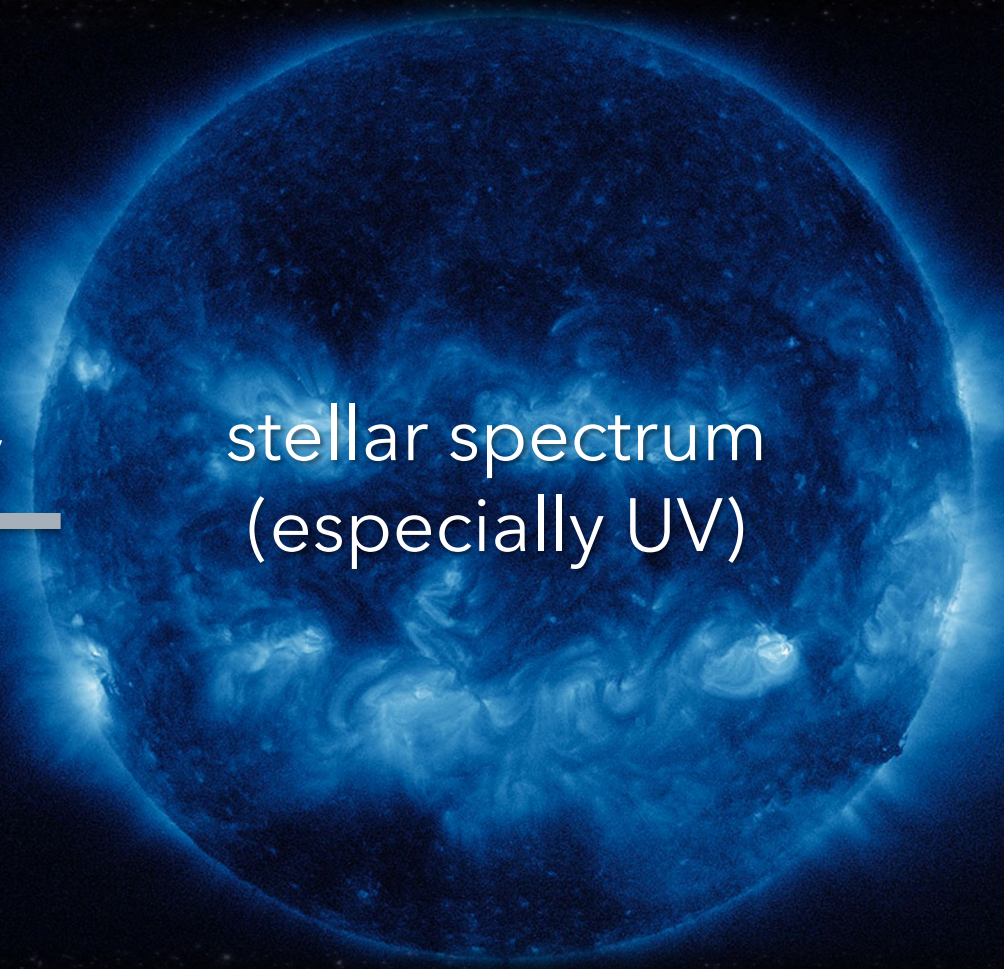
NASA


carbon dioxide
methane
ozone
oxygen
water
age (billions of years ago)
column mass (g/cm²)
39%
48%
13%
albedo
Archean Earth
Archean
hazy Archean
haze
Proterozoic Earth
1% present level of O₂
0.1% present level of O₂
Modern Earth
modern
wavelength (μm)
LUVOIR/HabEx

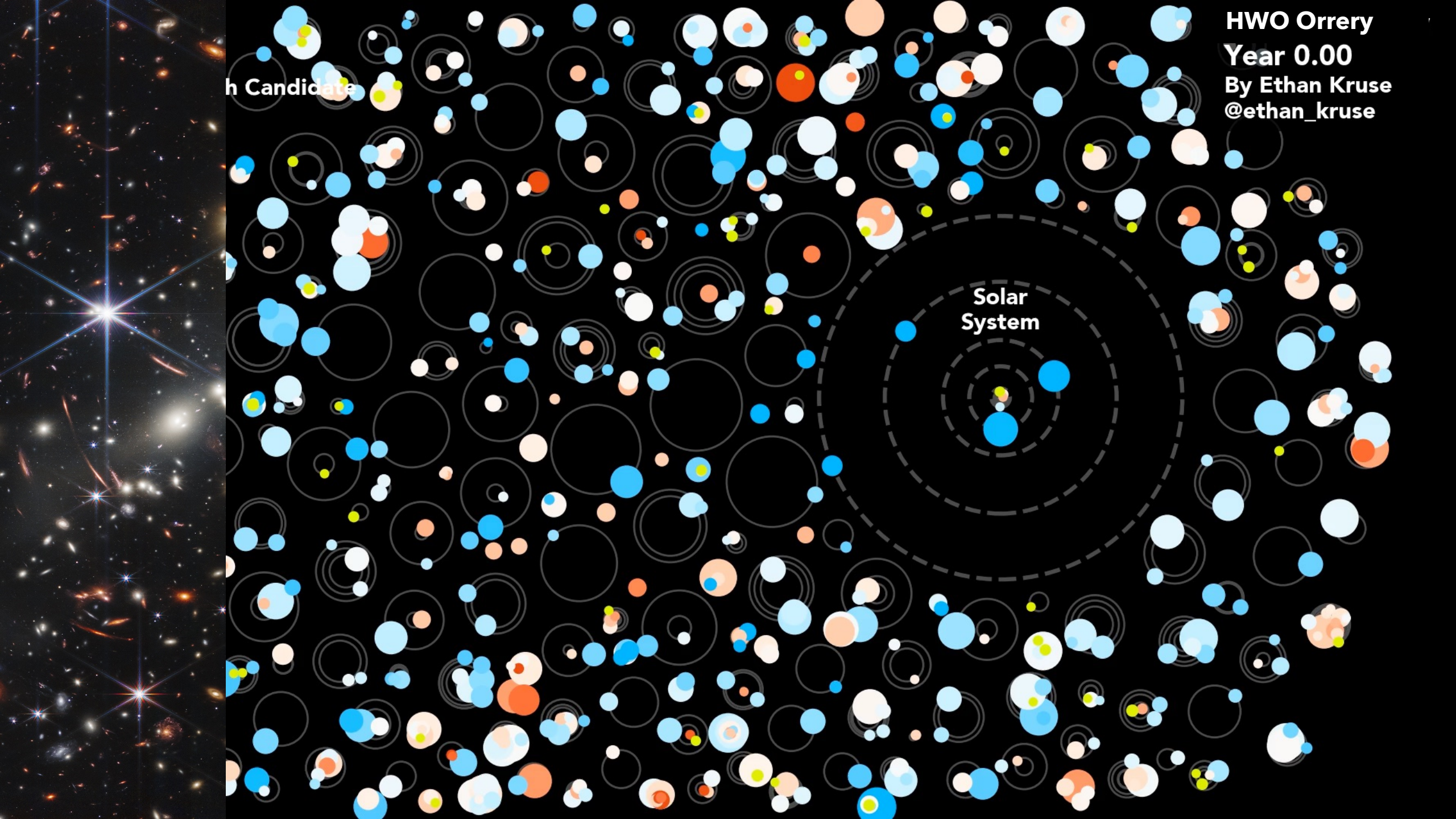
Biosignatures Need context

UV instrument
100-1000 nm spectra
of host star

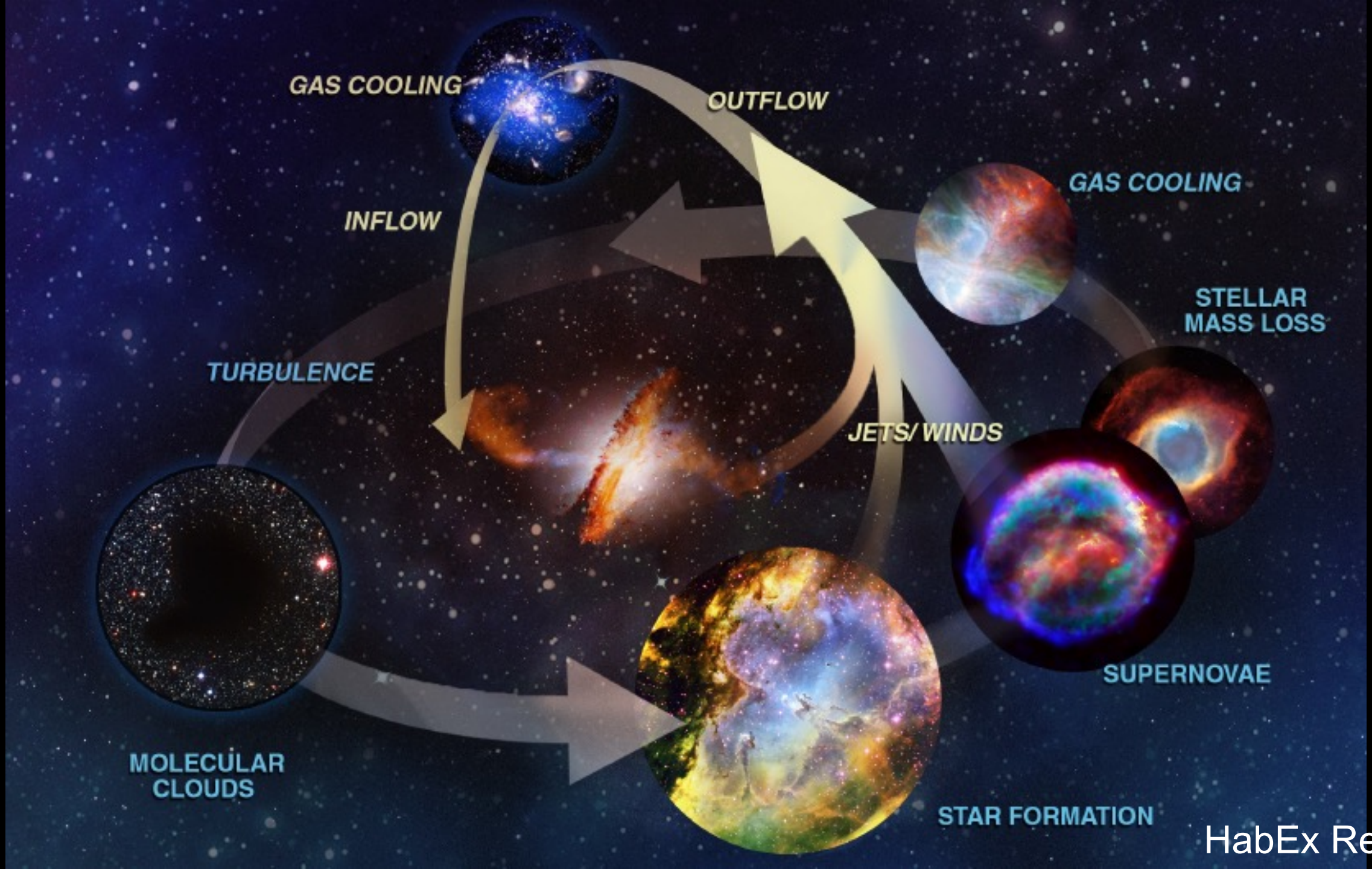
enabled by



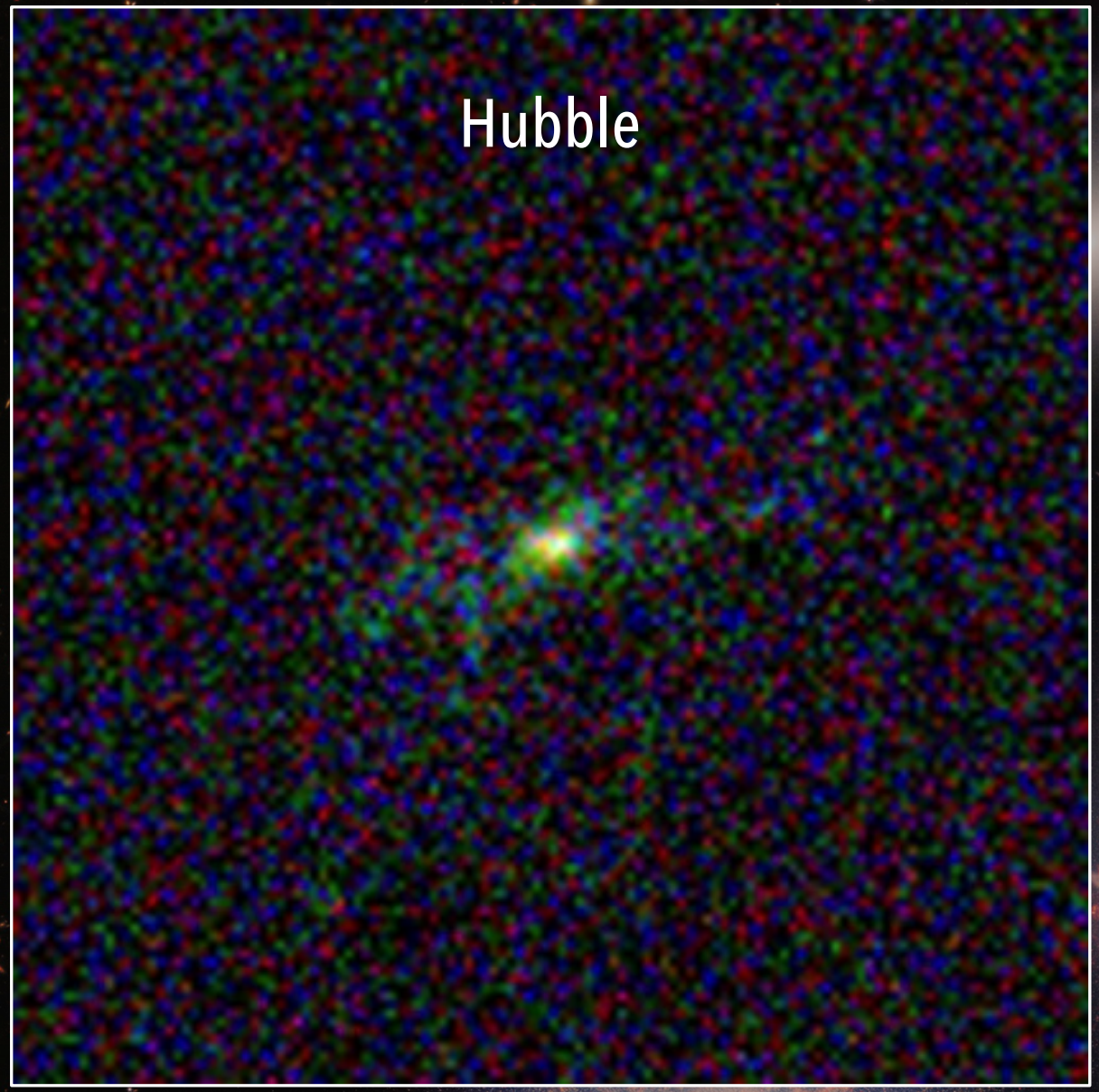
stellar spectrum
(especially UV)

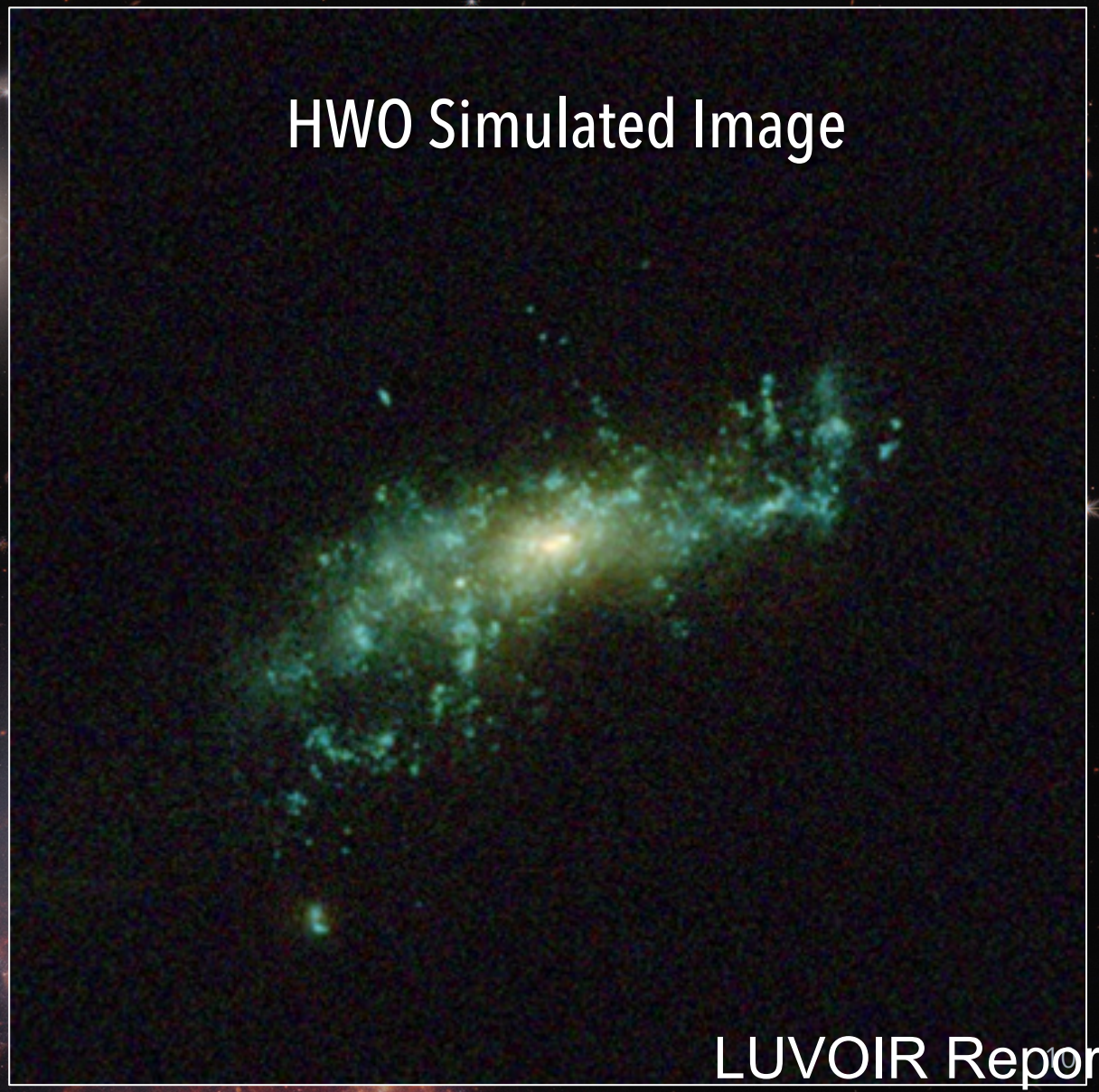

h Candidate
Solar System
HWO Orrery
Year 0.00
By Ethan Kruse
@ethan_kruse


KEEP EARTH WEIRD
E MUSIC ON BURNSIDE

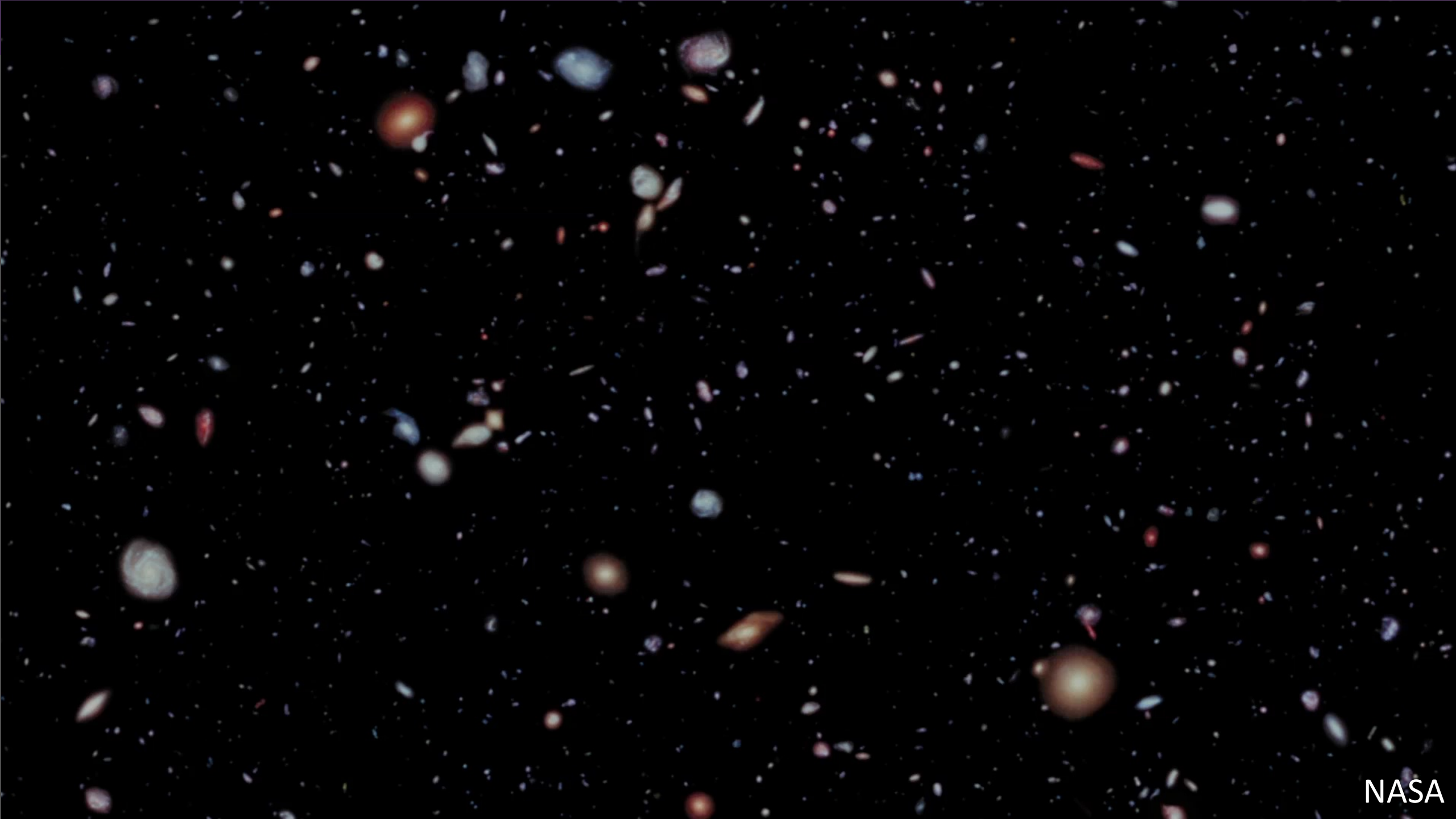

GAS COOLING
OUTFLOW
GAS COOLING
INFLOW
STELLAR
MASS LOSS
TURBULENCE
JETS/ WINDS
SUPERNOVAE
MOLECULAR
CLOUDS
STAR FORMATION

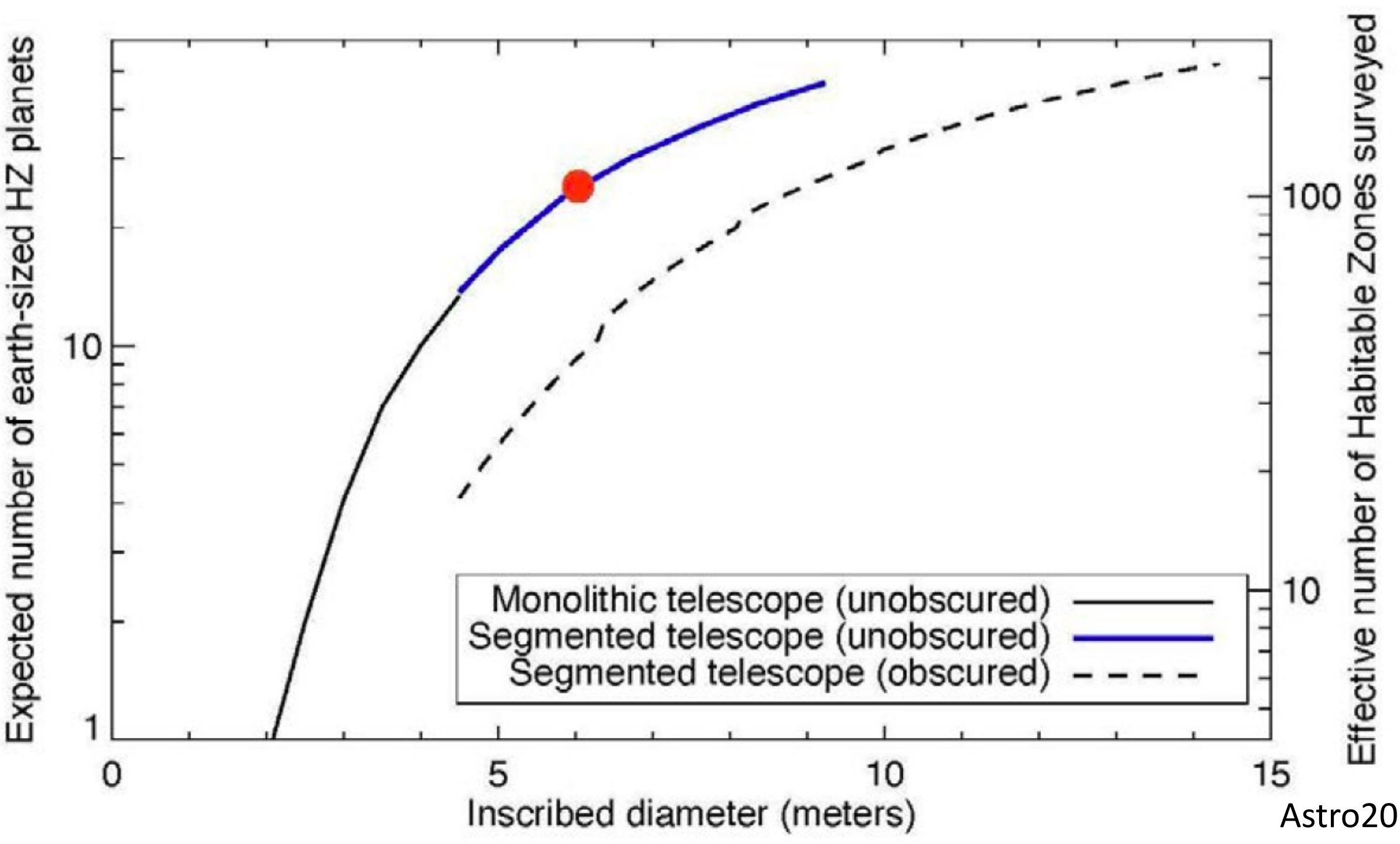
Probing the Properties of Dark Matter with Dwarf Galaxies





LUVOIR Report


NASA

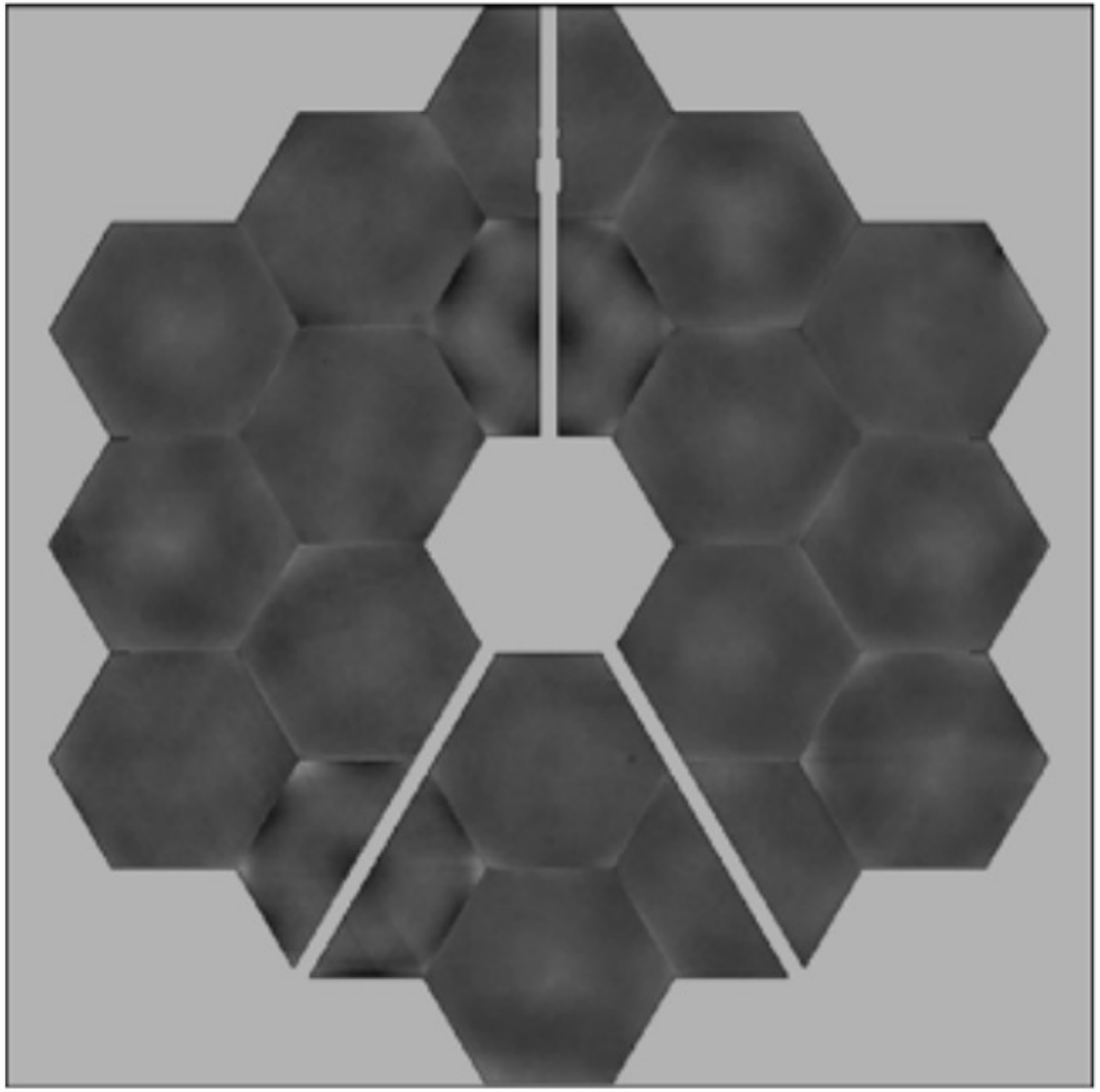

Expected number of earth-sized HZ planets
Effective number of Habitable Zones surveyed
Inscribed diameter (meters)
Monolithic telescope (unobscured)
Segmented telescope (unobscured)
Segmented telescope (obscured)
1
10
100
0
5
10
15

Astro2020

The Habitable Worlds Observatory:
Big Picture Strategy

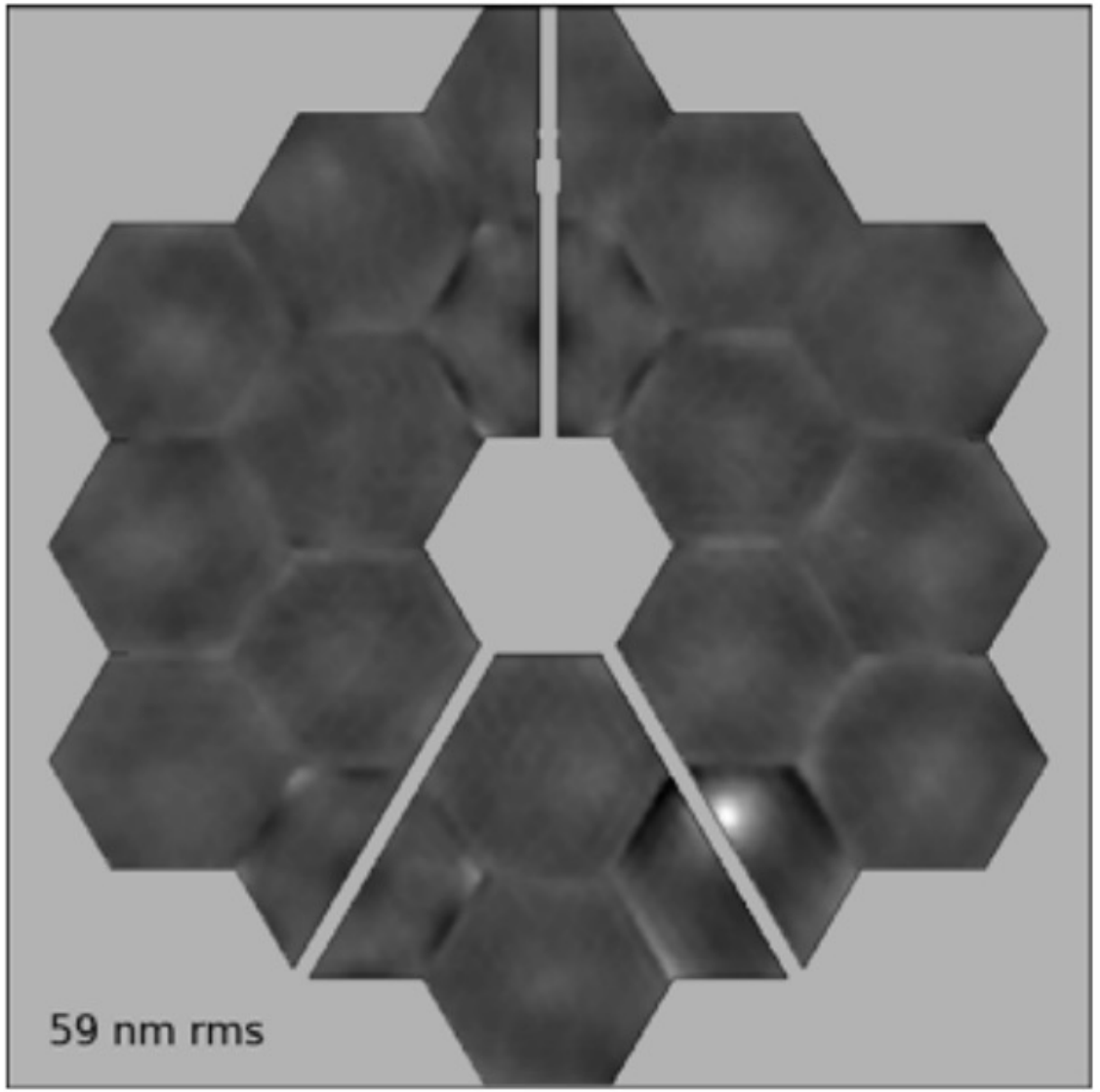
- **Build to schedule**: Mission Level **1 Requirement - like planetary**
- **Evolve technology from what we have done before**:
  - Build upon current NASA investments and TRL-9 technology
  - Segmented optical telescope system from JWST
  - Coronagraph from Roman‘s coronagraphic imager program
- **Next Generation Rockets**:
  - Larger telescope aperture sizes
  - Leverage opportunities for mass & volume trades
- **Planned Servicing**: Robotic servicing at L2
- **Robust Margins**: Large scientific, technical, and programmatic margins
- **Mature technologies first**: Reduce risk by fully maturing the technologies prior to development phase.

Ground Measurements for Individual segments



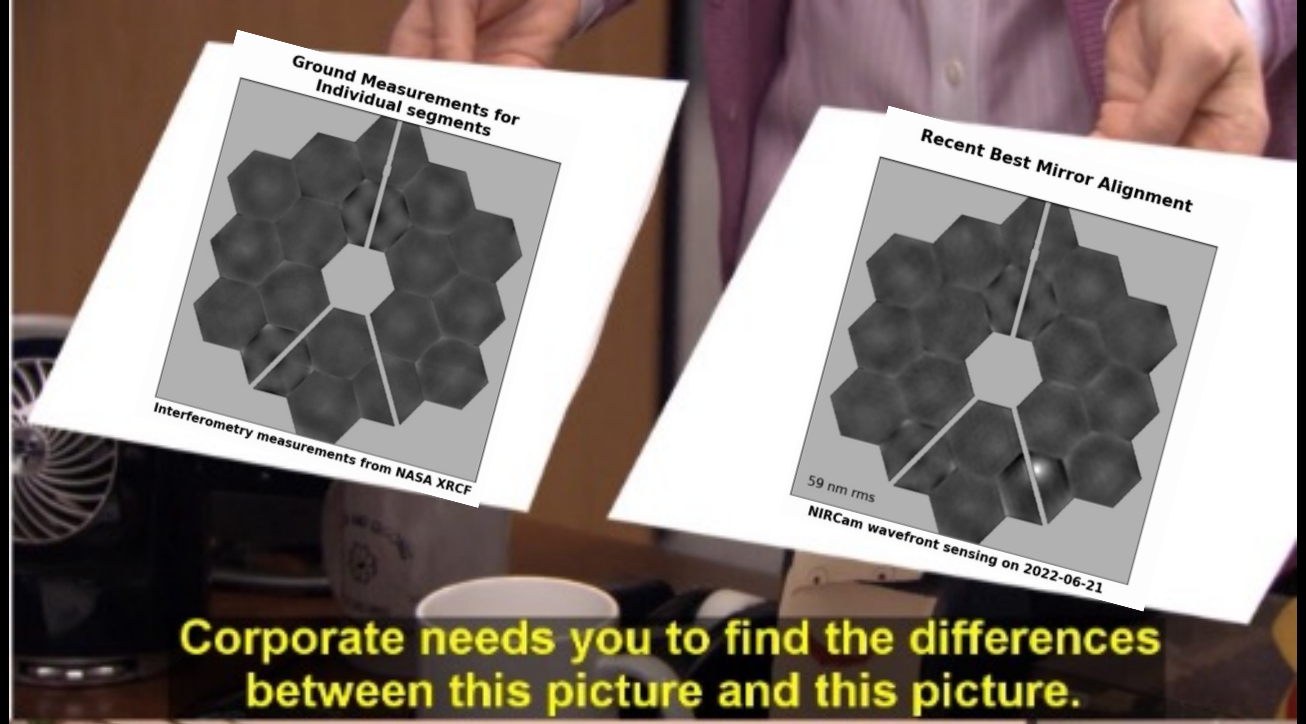
Interferometry measurements from NASA XRCF

Recent Best Mirror Alignment

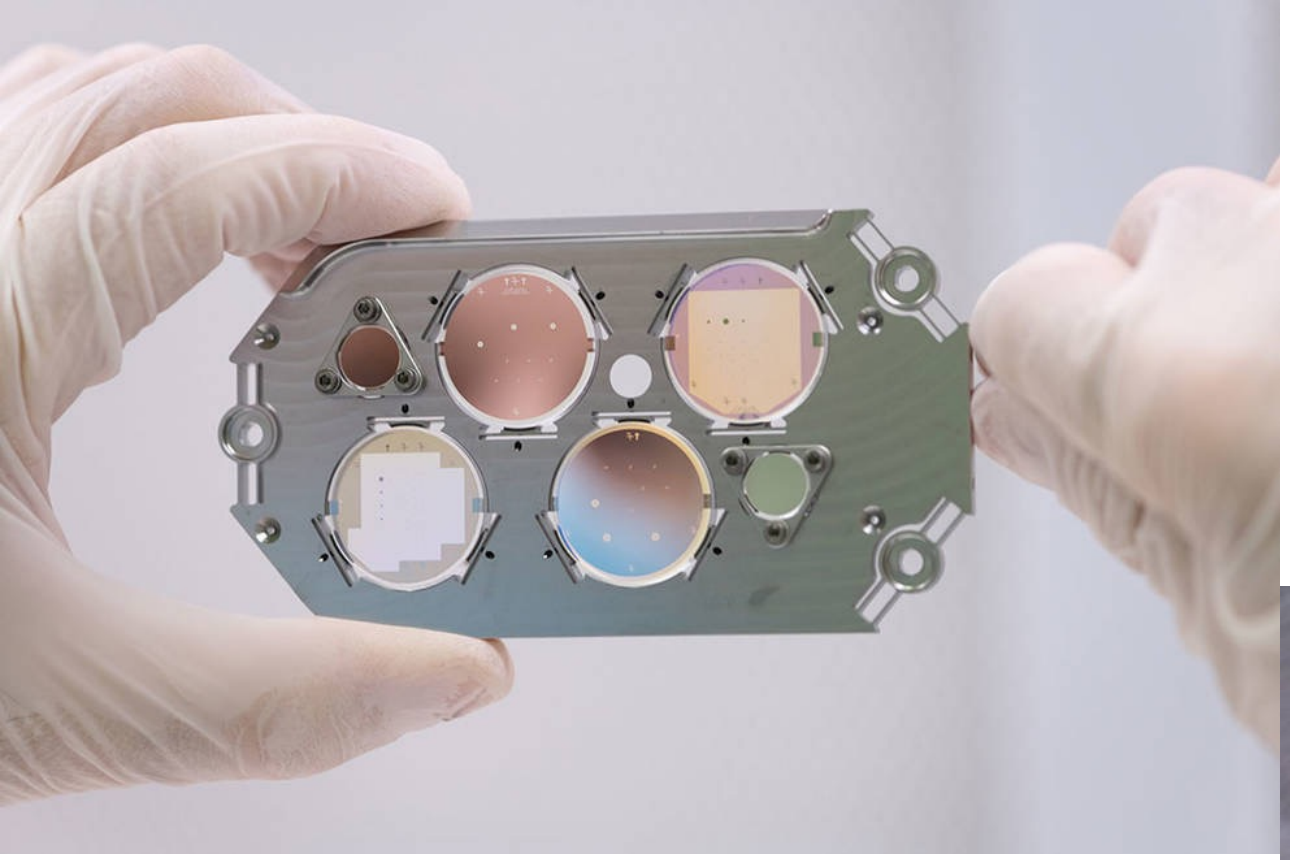


NIRCam wavefront sensing on 2022-06-21

Ribgy+ 2022


Ground Measurements for Individual segments
Interferometry measurements from NASA XRCF
Recent Best Mirror Alignment
59 nm rms
NIRCam wavefront sensing on 2022-06-21
Corporate needs you to find the differences between this picture and this picture.


They're the same picture.



WE DO THIS NOT BECAUSE IT IS EASY,

BUT BECAUSE WE THOUGHT IT WOULD BE EASY

HWO's Starlight Suppression Will be a System

We need an ultrastable telescope

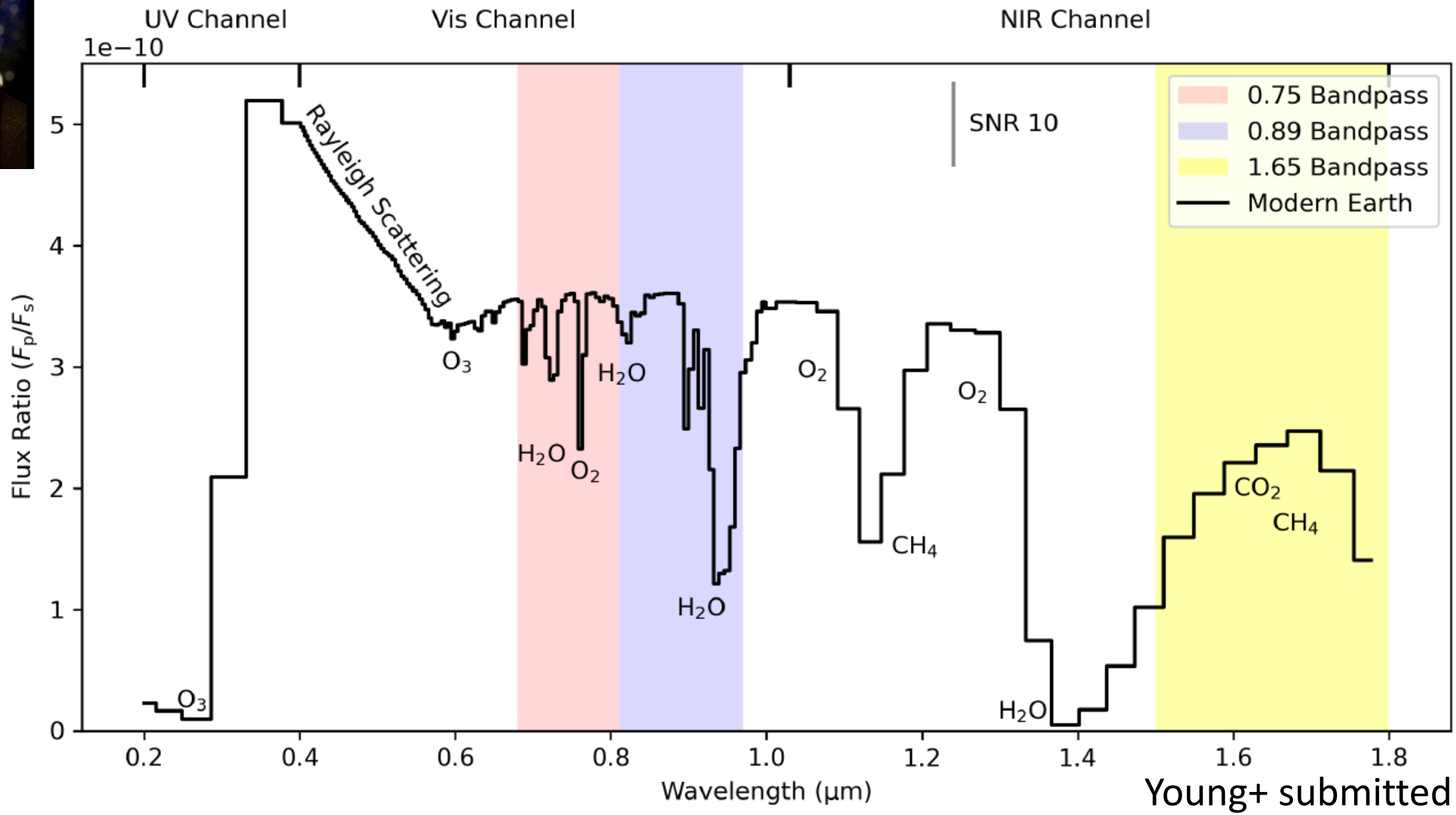
…and…

we need a high precision coronagraph

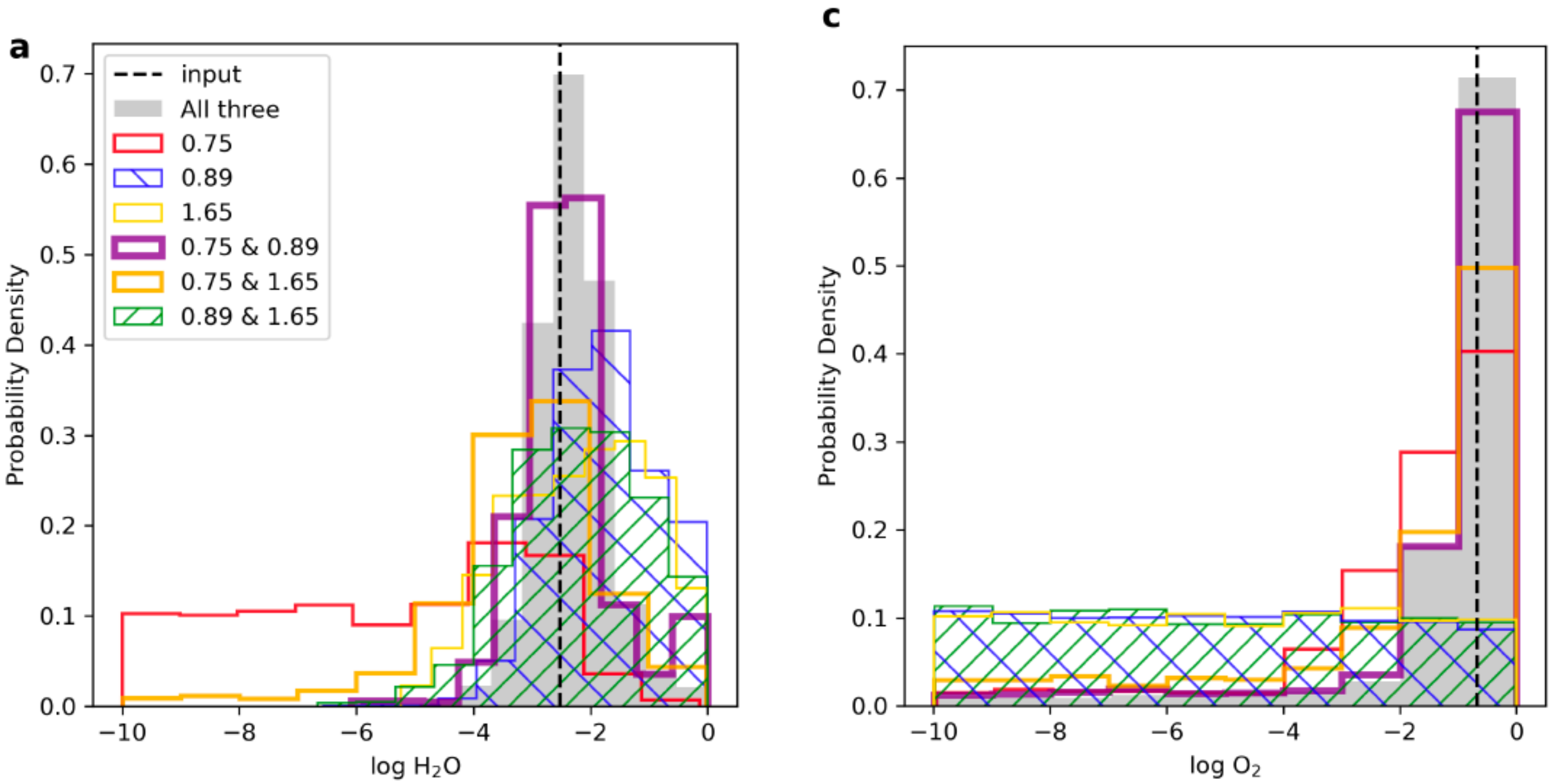
…and…

we need these two things need to be compatible!

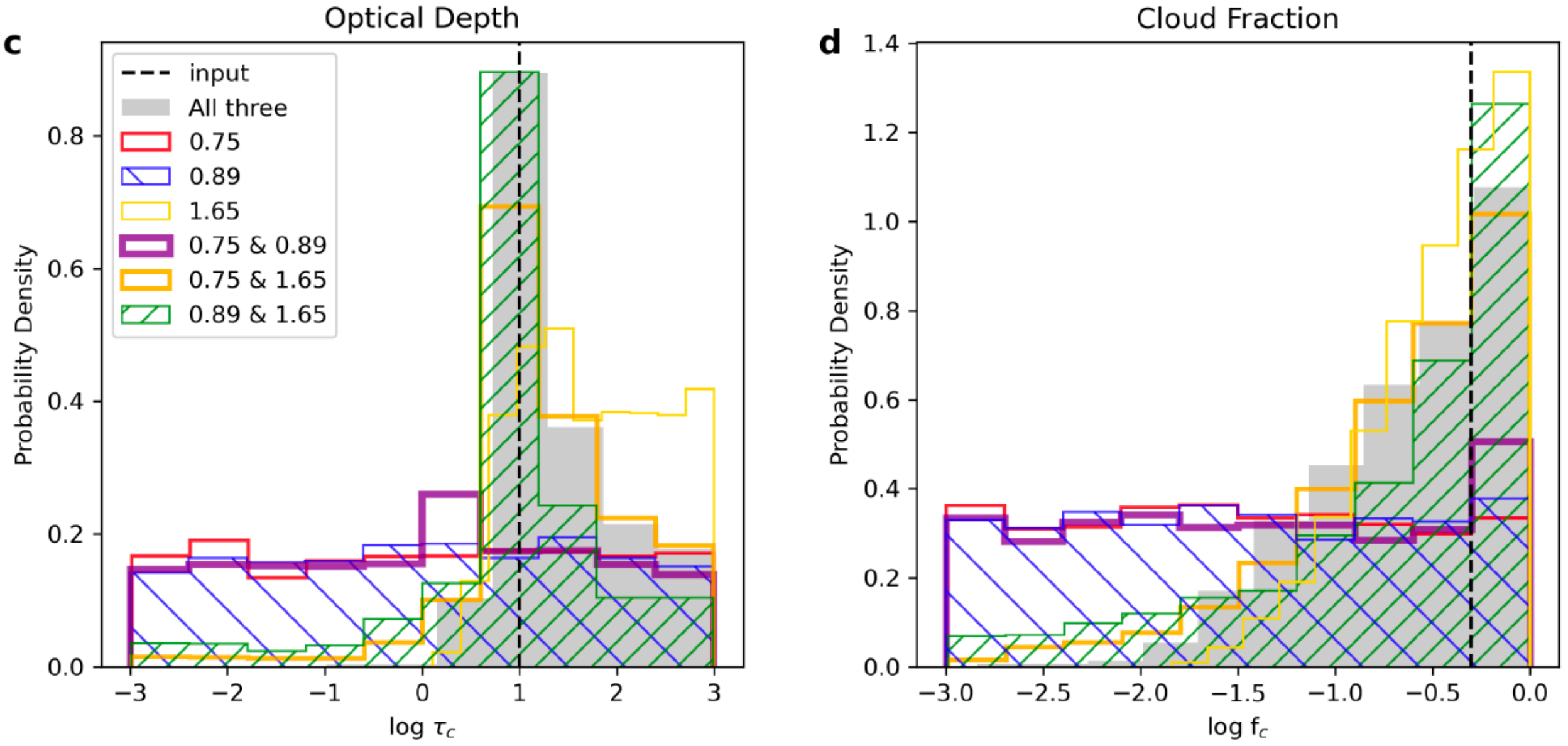
Coronagraphs can be efficient!



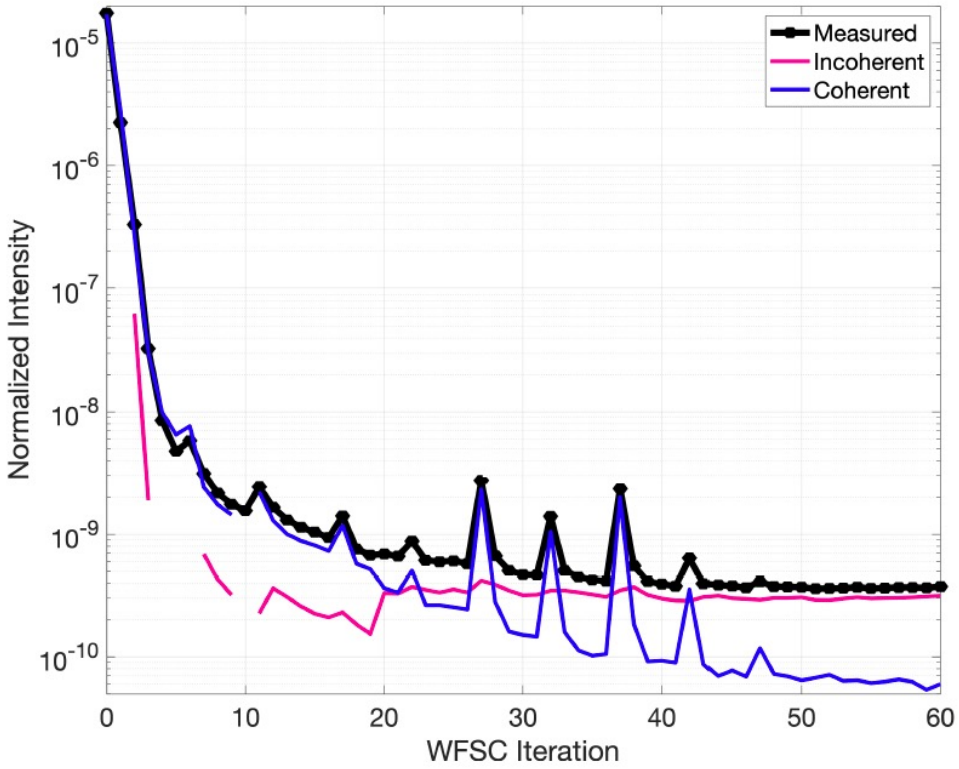
Young+ submitted



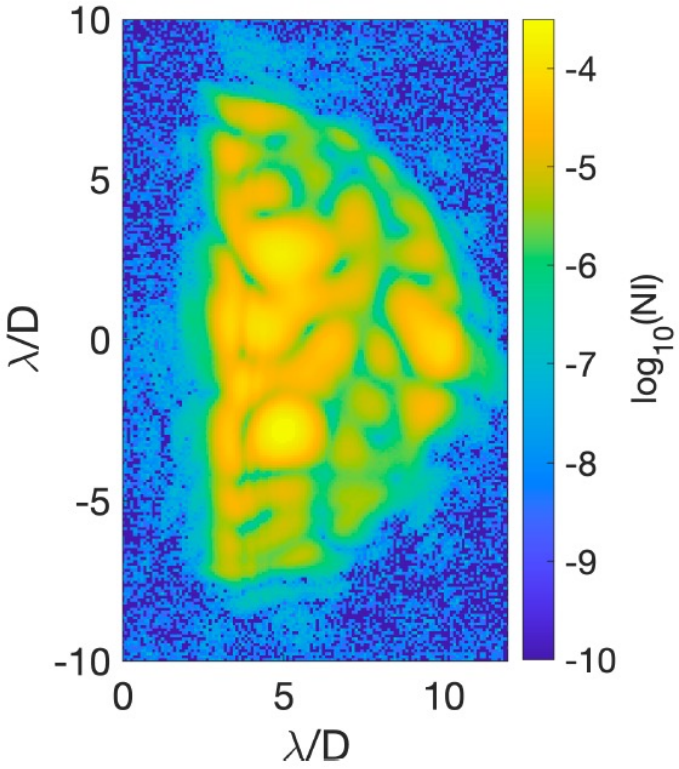
Young+ submitted



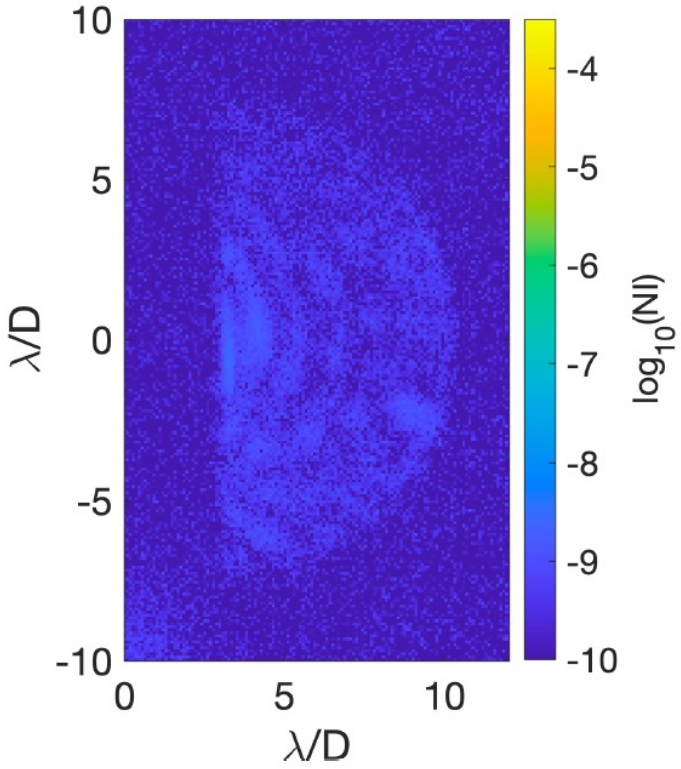
Young+ submitted



(a) WFSC History



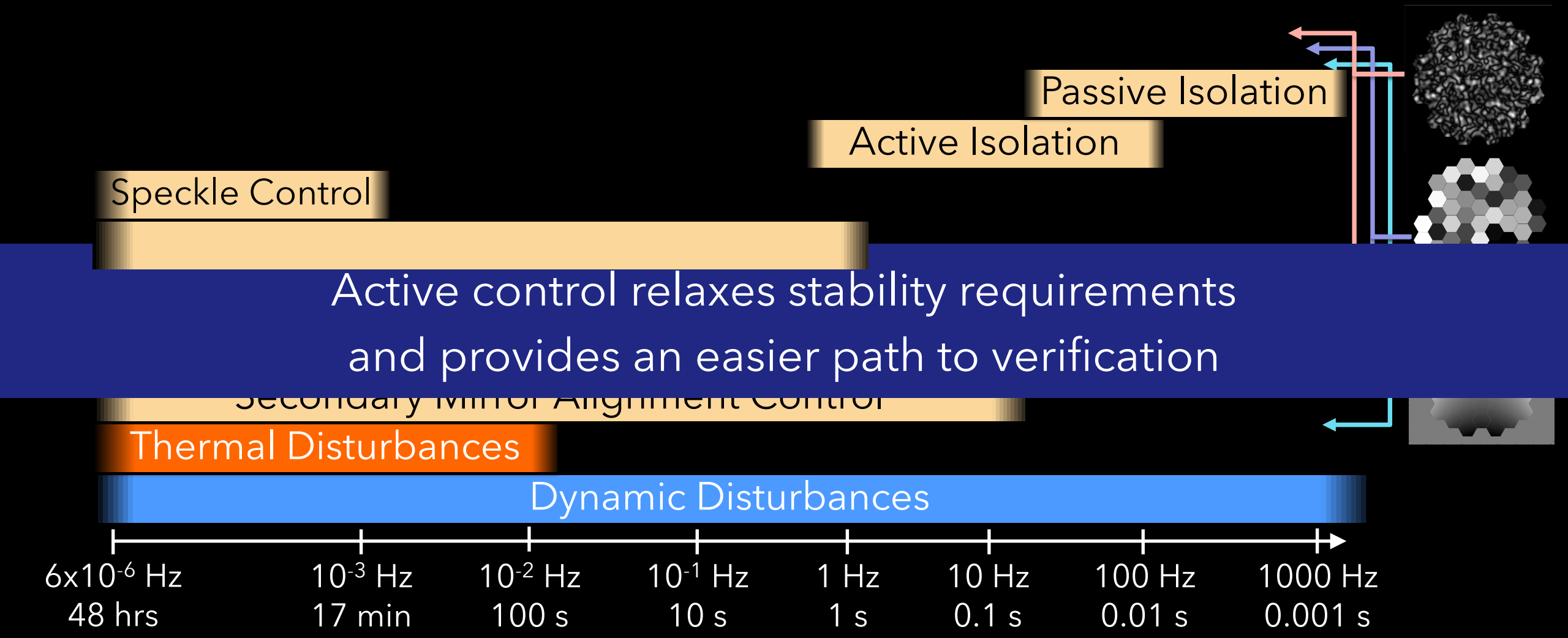
(b) Starting Dark hole



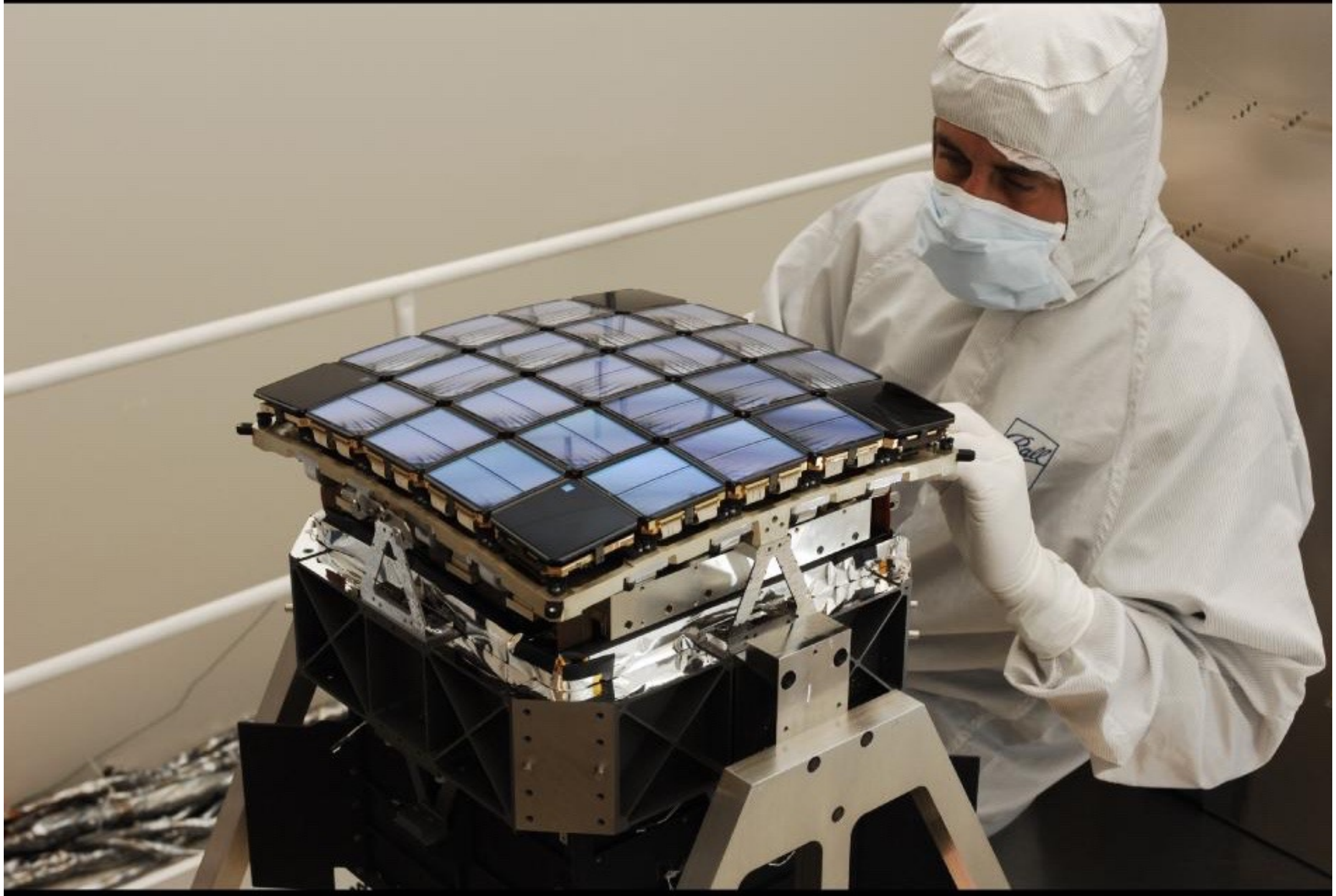
(c) Final Dark Hole

Riggs+ 2022

ULTRA-STABILITY THROUGH CONTROL



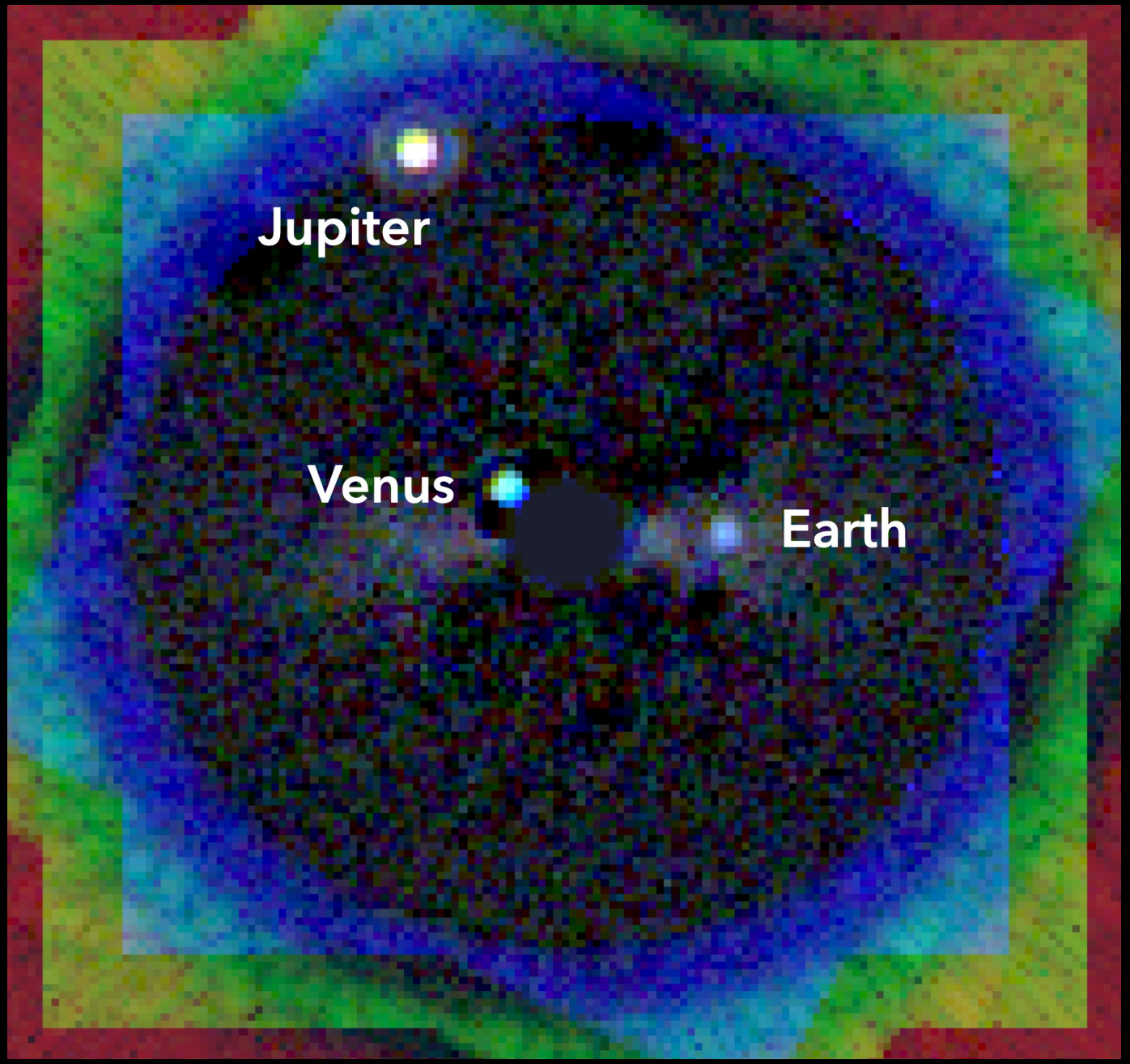
See "Ultra-stable Telescope Research and Analysis (ULTRA) Program Phase 1 Report",
Ball Aerospace, L3/Harris, Northrop Grumman, SGT, Space Telescope Science Institute



NASA


esa
EssilorLuxottica
esa
#UnfoldTheUniverse
EssilorLuxottica

NASA


Jupiter
Venus
Earth


ESO

Questions and more information

NASA Astrophysics Statement of Principles:
go.nasa.gov/3Kwn07s

NASA GOMAP website:
go.nasa.gov/4107ZzC

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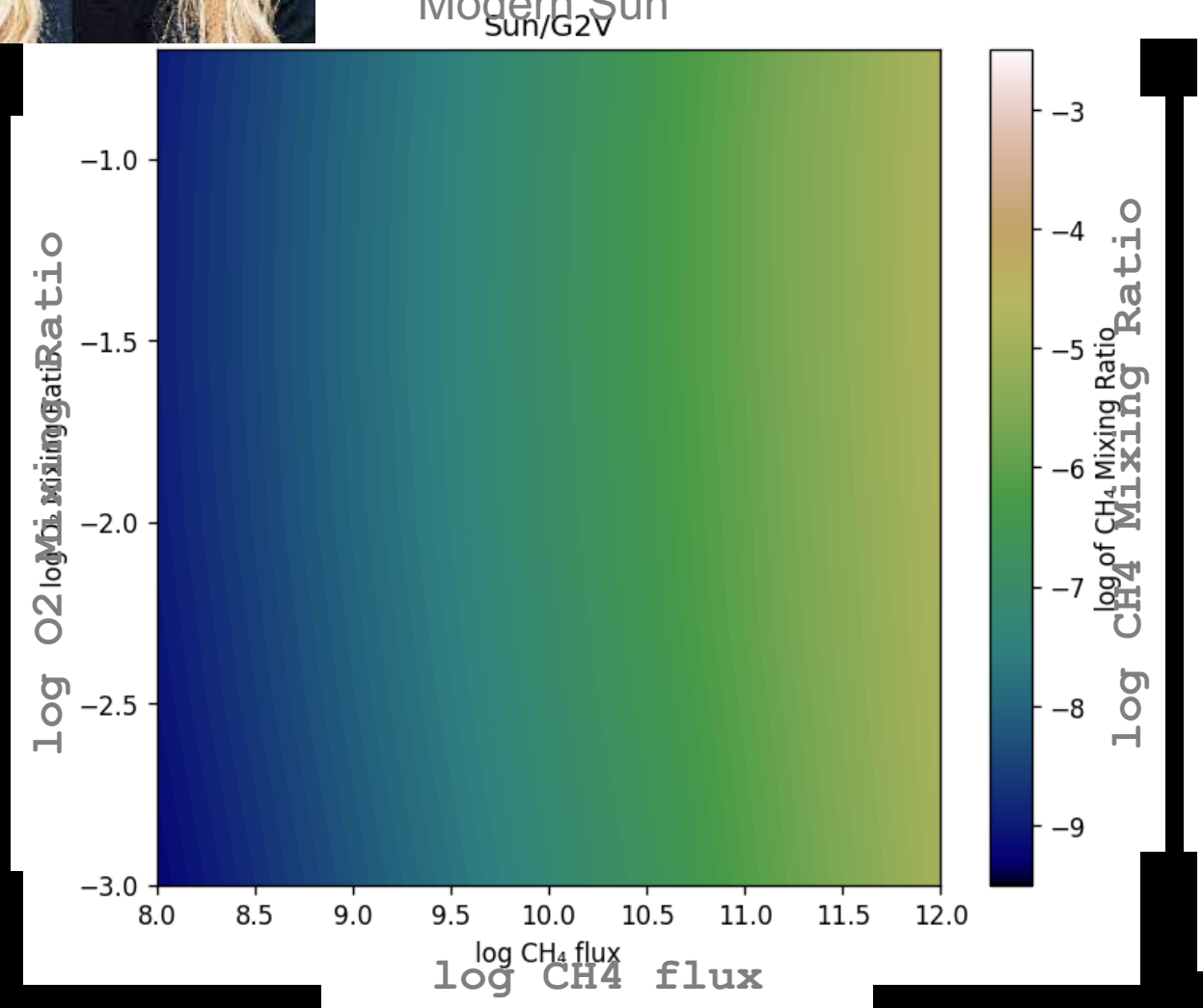
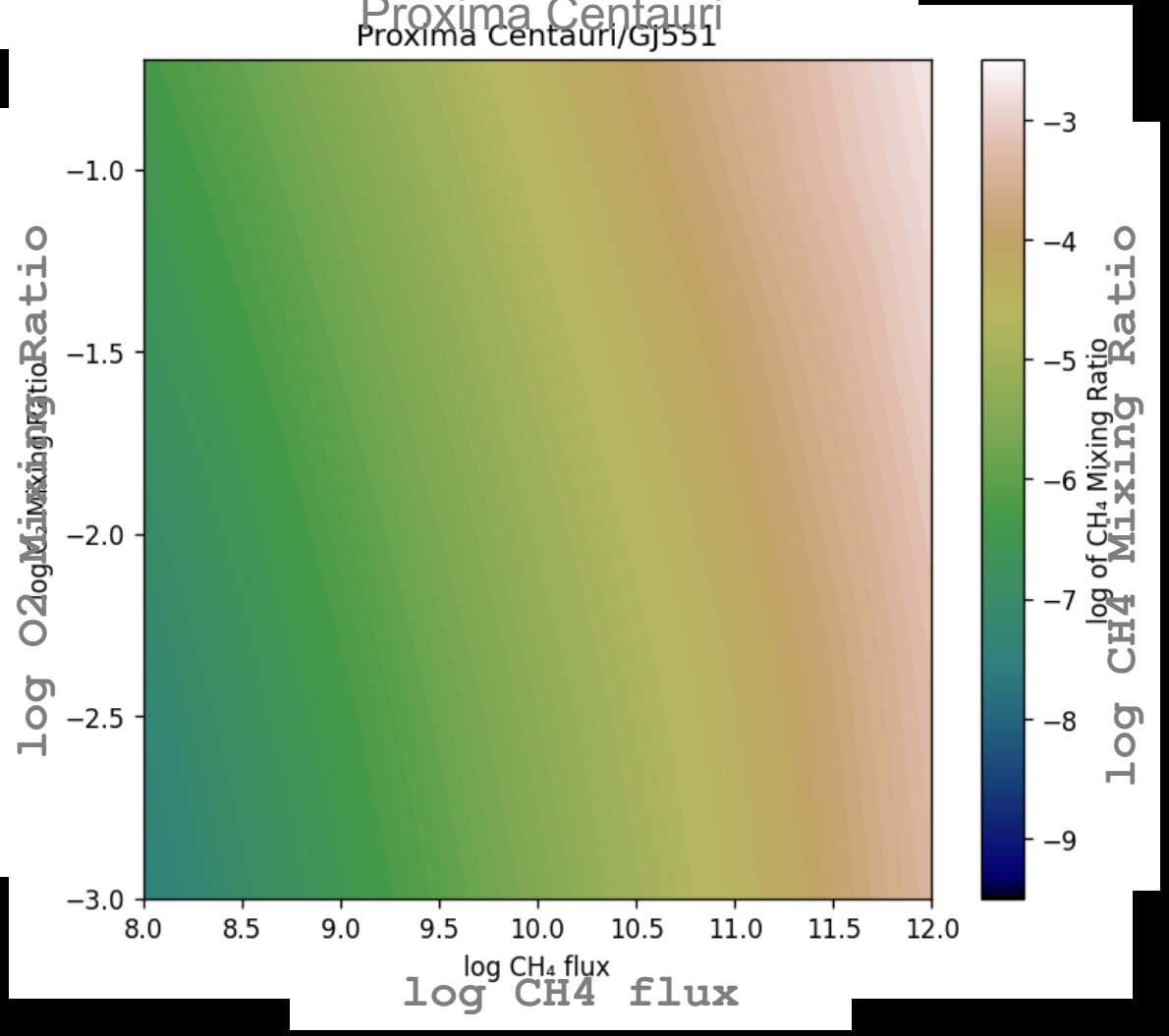
shawn.goldman@nasa.gov

BIOSIGNATURES DEPEND ON CONTEXT…

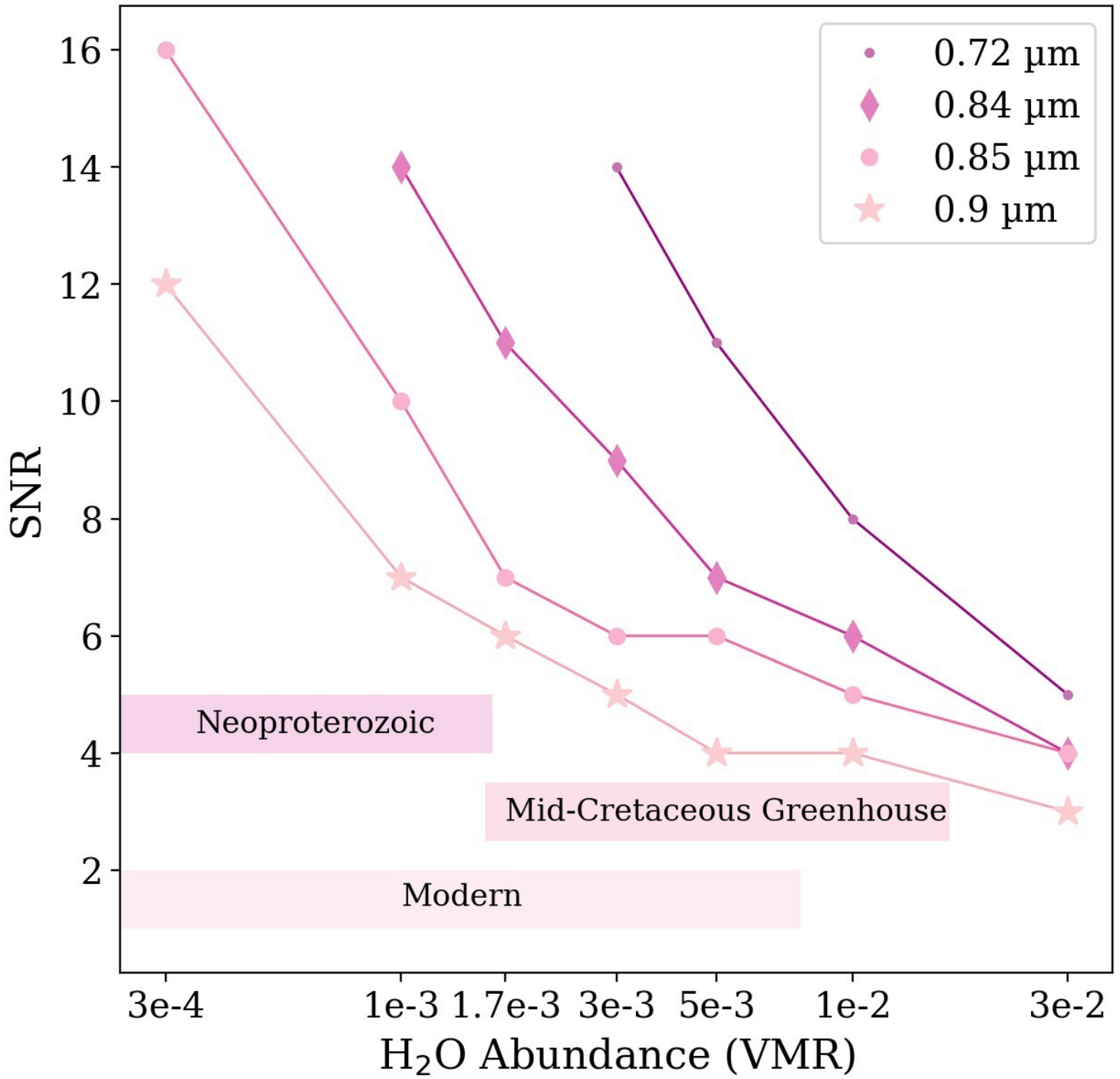
Modern Sun



Proxima Centauri




This Barbie is
available for questions!


0.72 µm
0.84 µm
0.85 µm
0.9 µm
SNR
16
14
12
10
8
6
4
2
Neoproterozoic
Mid-Cretaceous Greenhouse
Modern
3e-4
1e-3
1.7e-3
3e-3
5e-3
1e-2
3e-2
H2O Abundance (VMR)