

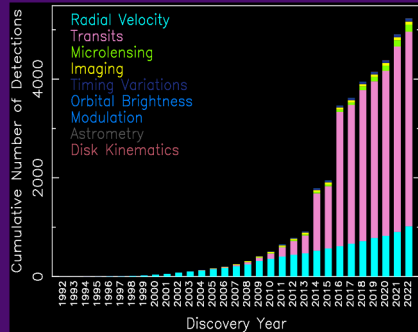
# Updates from the NASA Exoplanet Science Institute (NExSci)

David R. Ciardi  
NExSci Chief Scientist  
On Behalf of the NExSci Team  
ExoPAG-29 06 Jan 2024

Sagan Program  
& Community  
Support



Exoplanet  
Archive and  
ExoFOP



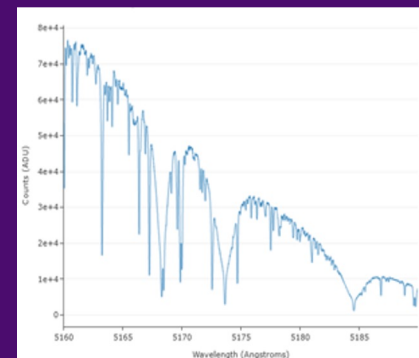
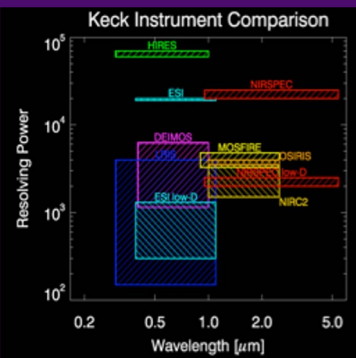
Long Term  
Archives



Keck  
Operations  
and Archive  
(KOA)



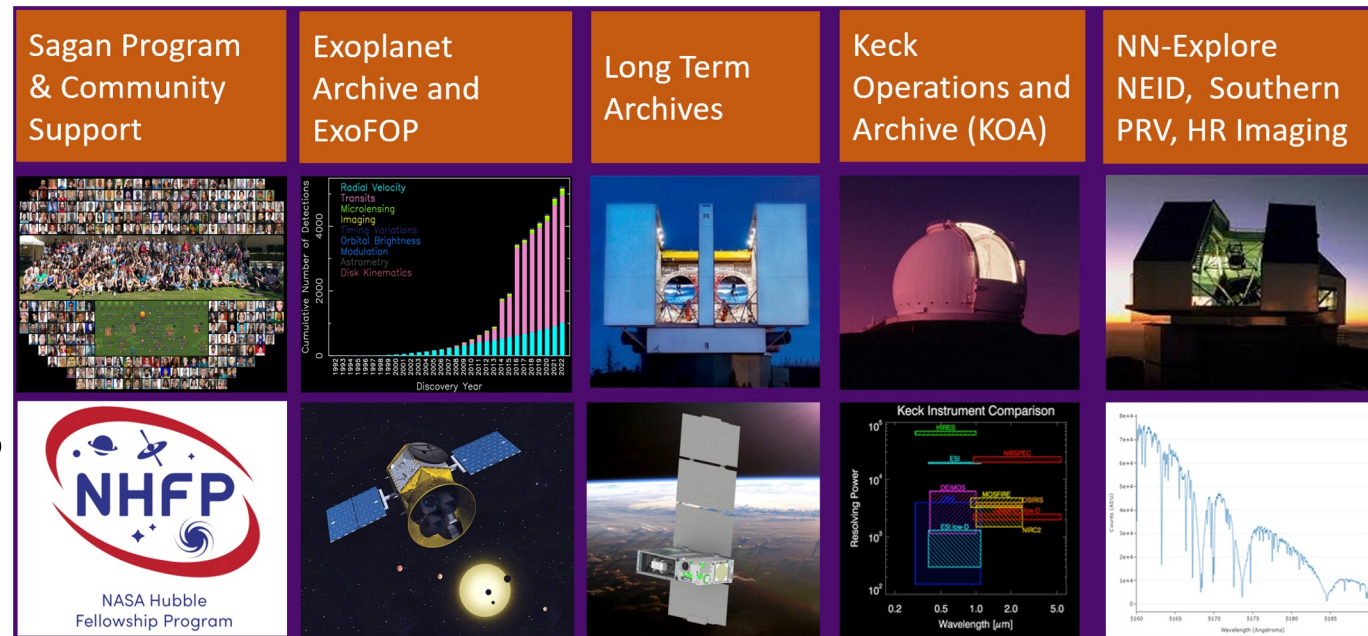
NN-Explore  
NEID, Southern  
PRV, HR Imaging





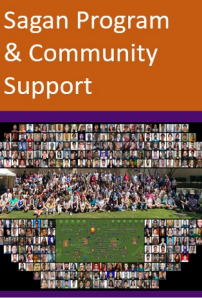
# NExSci: NASA's ExEP Science Center

- Support the scientific community in their use of NASA missions to explore questions about the formation and evolution of planetary systems
- NExSci is the community-focused science center of NASA's Exoplanet Program
- Located on Caltech campus as part of IPAC





# Fully Hybrid Sagan Summer Workshop



## Advances in Direct Imaging: From Young Jupiters to Habitable Earths

- 2024 July 22 – 26
- Scientific motivation, hardware and software fundamentals emphasizing advances in high contrast imaging of exoplanets
- On Caltech Campus and Zoom
- Hands-on data and software exercises
- Attendee posters and pops
- In-person and virtual “lunch” with the speakers
- Registration opens mid-February 2024
- <https://nexsci.caltech.edu/workshop/2024/>





# Community Observing Resources

## Community access to observing resources for exoplanets and more

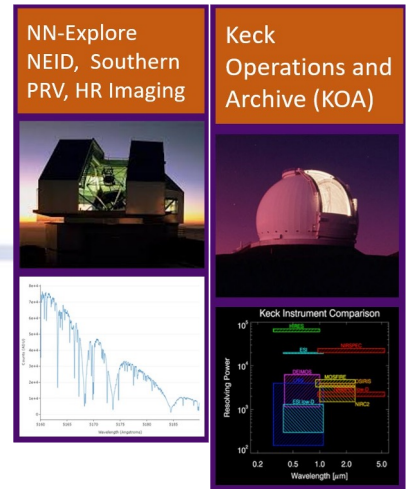
### Keck

- Supports strategic programs from all areas of astrophysics and solar system
- All instruments, both telescopes

### NN-Explore

- WIYN
  - NEID (PRV and daily solar data); <https://neid.ipac.caltech.edu/>
  - NESSI (HRI); WHIRC (NIR imaging/time series); HYDRRA (MOS)
- Southern Hemisphere PRV
  - [ SMARTS-CHIRON (stellar spectra, ~10 m/s) ]
  - Minerva-Australis (4x0.7m; ~10 m/s)
- Gemini-North/South
  - 'Alopeke (North) and Zorro (South)
  - High resolution imaging speckle cameras

[https://nexsci.caltech.edu/tools/obs\\_res.shtml](https://nexsci.caltech.edu/tools/obs_res.shtml)



### Observing Resources

NExSci provides access to a variety of observing resources in support of community research primarily in exoplanets, but also general astrophysics and planetary science.

### NASA Time on the Keck Observatory

The cornerstone of the NExSci supported observing resources is the NASA Keck Time. NExSci manages NASA's partnership with the W. M. Keck Observatory. Both Keck 1 and Keck 2 telescopes and all instruments are available to the community for exoplanet, astrophysical, and planetary science observations. More information on Keck instrumentation and how to apply for NASA Keck time can be found [here](#). In Waimea, Hawaii. The Keck telescopes are two 10-meter aperture telescopes whose primary mirrors are each composed of thirty-six 2 meter mirror segments.



### NN-Explore Program

NASA and the National Science Foundation have established the NASA-NSF Exoplanet Observational Research (NN-Explore) partnership to support community exoplanet research. The NN-Explore program was created in response to the community need for observational resources for exoplanet discovery and characterization. There are multiple resources available to the community through this partnership; more information on how to apply for time through the NN-Explore Program can be found at the [NOIRLab Call for Proposals](#)



### WIYN

The cornerstone of the NN-Explore Program is the NASA partnership on the WIYN telescope located at Kitt Peak Observatory. The premiere instrument on the telescope is the high precision radial velocity machine NEID which is a high resolution spectrometer capable of radial velocity precisions of 30 cm/s. Also available on WIYN is the high spatial resolution optical speckle imager NN-Explore Exoplanet Stellar Speckle Imager (NESSI). Other instruments available to the community include WHIRC, Hydra, and ODI.



### SMARTS-CHIRON

CHIRON on the SMARTS 1.5m telescope located at the Cerro-Tololo Observatory is a fiber-fed high resolution spectrometer capable of radial velocity precisions of a few meters per second. Through the NOIRLab partnership in the SMARTS consortium, NASA has made available time for exoplanet confirmation and characterization - especially for TESS planetary candidates.



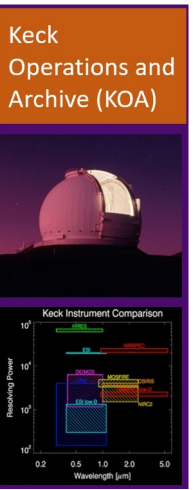
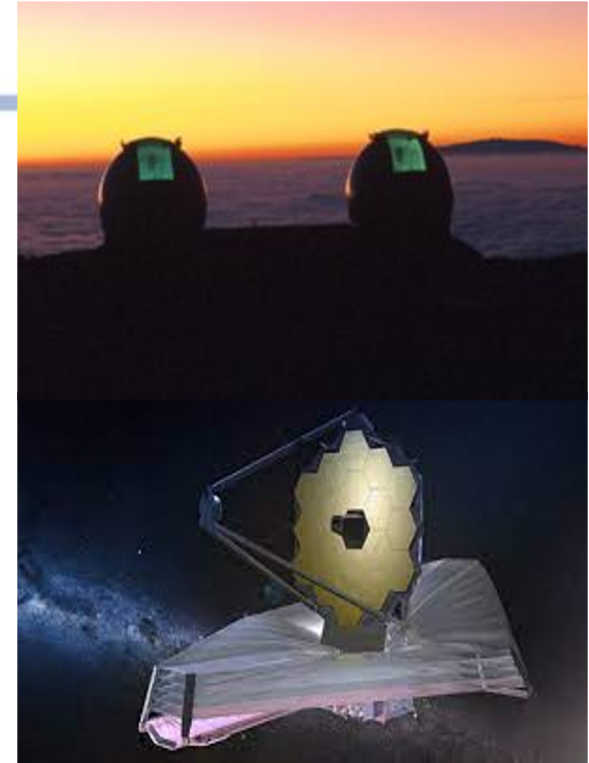
### Minerva-Australis

Minerva-Australis is an array of 0.7m telescopes all feeding a single precision spectrograph. The facility is located at Mt. Kent Mt. Kent and is able reach radial velocity precisions of a few meters per second. Through the NN-Explore partnership, NASA has made available time for exoplanet confirmation and characterization - especially for TESS planetary candidates.



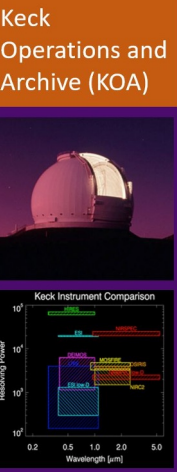
# NASA Keck Time

- 2024B Proposals Due to NExSci March 14
  - Supports all astrophysics and planetary science
  - 2024A GO oversubscription rate: ~4.7:1
  - 5 Keck Strategic Mission Support programs selected
  - KPF available for community proposals
  - DAPR compliant evaluations
  - <https://nexsci.caltech.edu/missions/KSA/>
- Joint JWST-NASA Keck Proposal Opportunity in Cycle 3
  - Up to 10-15 nights could be allocated by JWST TAC (2024B and 2025A)
  - Data from both observatories are required to meet the science goals
  - <https://nexsci.caltech.edu/missions/KeckSolicitation/jwst-keck.shtml>





# Keck Observatory Archive (KOA)



- Raw data ingested in near real time (usually within 1 minute of acquisition) for all instruments including KPF, KCWI/KCRM and NIRC2 upgrade
- Quick look reduced data ingested for 6 instruments, and science grade reduced data for three instruments.
- Guider images now ingested for all active instruments.
- Web-based Observers Data Access Portal (ODAP) enables observers to manage data while observing is in active use.
- New tool will notify NASA users 6 weeks before their period of exclusive access expires so that they can request an extension, subject to approval by the NASA Selection Official
- User Group met on December 6.

Keck Observatory Archive KOA

Observers' Data Access Portal

Receiving files from SEMIDs: NIRC2.2023B\_U059 KPF.2023B\_U151 DEIMOS.2023B\_ENG KPF.2023B\_C382 NIRC2.2023B\_ENG KPF.2023B\_ENG DEIMOS.2023B\_U051

Downloading files from level: None

● Lev0 ● Lev1 ● Lev2 ○ OFNAME ● KOAID

Observation Date (UT): 2023-08-10 Ingest Count: 818 Grant User Access

DOWNLOAD WGET SCRIPTS

Download	UT ↓	KOAID	Original Filename	Target	Image Type	RA	DEC	Ingest Type	Instrument
↓	15:37:25.54	KP.20230810.58255.83	KP.20230810.58255.83.fits	219134	object	23:13:22.90	+57:10:13.01	lev0	KPF
↓	15:34:45.73	KP.20230810.56087.13	KP.20230810.56087.13.fits	219134	object	23:13:22.90	+57:10:13.01	lev0	KPF
↓	15:31:57.92	KP.20230810.55918.32	KP.20230810.55918.32.fits	219134	object	23:13:22.90	+57:10:13.01	lev0	KPF
↓	15:29:09.62	KP.20230810.55749.72	KP.20230810.55749.72.fits	219134	object	23:13:22.90	+57:10:13.01	lev0	KPF
↓	15:26:20.81	KP.20230810.55580.87	KP.20230810.55580.87.fits	219134	object	23:13:22.90	+57:10:13.01	lev0	KPF
↓	15:23:42.40	DE.20230810.55422.40	o0810_0141.fits	to 15.00	bias	02:48:38.39	+14:54:53.89	lev0	DEIMOS
↓	15:23:42.40	DE.20230810.55422.40				02:48:38.39	+14:54:53.89	lev1	DEIMOS

Status: Connected KOA Helpdesk User Guide Current Time (UT): 2023-08-10 16:10:30 Test Test | rfluxer02 LOGOUT



# NASA Exoplanet Archive

- 5566 Exoplanets
  - 331 new planets in 2023
  - 1407 planetary solutions added or updated in 2022
- Atmospheric Spectroscopy Table & Visualizer
- System Overviews Include Hypatia Abundances
- Transiting Planets Table
- ExEP Habitable Worlds Observatory Precursor Target List
- New Contributed Datasets
  - Microlensing Observations in Astrophysics (MOA) microlensing survey – 2.4 million light curves
  - 20pc Census – every object within 20pc
  - INARA Synthetic Spectra – 3.1 million rocky worlds spectra

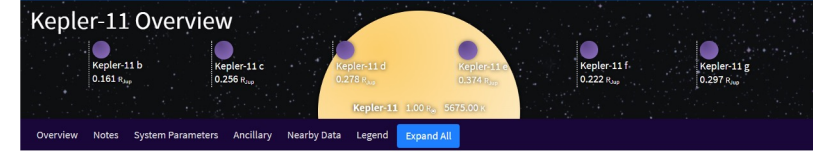
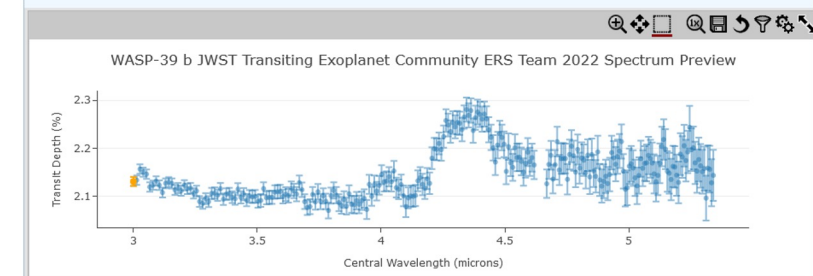
<https://exoplanetarchive.ipac.caltech.edu>

Home About Us Data Tools Support Login

User Guide Atmospheric Spectroscopy

Download All Checked Spectra Summary of Atmospheric Spectra DOI 10.26133/NEA36

rum	Reference	# Datapoints	Instrument	Central Wave. (microns)	Band Width (microns)	Transit Depth (%)
<input type="checkbox"/>	Madhusudhan et al. 2023	1010	Near Infrared Imager and Slitless Spectrograph (NIRISS)	3.00067	0.00000	2.1309
<input type="checkbox"/>	Coulombe et al. 2023	408	Near Infrared Imager and Slitless Spectrograph (NIRISS)	3.01389	0.00000	2.1338
<input type="checkbox"/>	Coulombe et al. 2023	408	Near Infrared Imager and Slitless Spectrograph (NIRISS)	3.02706	0.00000	2.1568
<input type="checkbox"/>	Coulombe et al. 2023	408	Near Infrared Imager and Slitless Spectrograph (NIRISS)	3.04017	0.00000	2.1504
<input type="checkbox"/>	Coulombe et al. 2023	408	Near Infrared Imager and Slitless Spectrograph (NIRISS)	3.05323	0.00000	2.1462
<input type="checkbox"/>	Alderson et al. 2022	344	Near Infrared Spectrograph (NIRSpec)	3.06624	0.00000	2.1196
<input type="checkbox"/>	Feinstein et al. 2022	331	Near Infrared Imager and Slitless Spectrograph (NIRISS)	3.07919	0.00000	2.1233
<input type="checkbox"/>	JWST Transiting Exoplanet Community	243	Near Infrared Spectrograph (NIRSpec)	3.09209	0.00000	2.132
<input type="checkbox"/>	Rustambekov et al. 2022	207	Near Infrared Spectrograph (NIRSpec)	3.10494	0.00000	2.1234



ARCHITECTURE

- Kepler-11
  - Kepler-11 b
  - Kepler-11 c
  - Kepler-11 d
  - Kepler-11 e
  - Kepler-11 f
  - Kepler-11 g

OTHER DATA

Bibliography

Exoplanet Archive Notes

Discovery Data

Host	Planet	Method	Year	Reference	Disposition
Kepler-11	Kepler-11 b	Transit	2010	Lissauer et al. 2011	Confirmed Planet
Kepler-11	Kepler-11 c	Transit	2010	Lissauer et al. 2011	Confirmed Planet
Kepler-11	Kepler-11 d	Transit	2010	Lissauer et al. 2011	Confirmed Planet
Kepler-11	Kepler-11 e	Transit	2010	Lissauer et al. 2011	Confirmed Planet
Kepler-11	Kepler-11 f	Transit	2010	Lissauer et al. 2011	Confirmed Planet
Kepler-11	Kepler-11 g	Transit	2010	Lissauer et al. 2011	Confirmed Planet

Exoplanet Archive Notes (6)

★ Kepler-11 Stellar Parameters (52 Solutions)

Parameter	Value	Parameter	Value
RA	19h48m27.62s	ECLIPTIC LATITUDE	61.2022 deg
DEC	-41d54m32.79s	ECLIPTIC LONGITUDE	314.75543 deg
DISTANCE	646.346±6.375 pc	GALACTIC LATITUDE	8.13328 deg
PARALLAX	1.518410±0.0151448 mas	GALACTIC LONGITUDE	76.1613 deg
TOTAL PROPER MOTION	7.0692817±0.0287745 mas/yr	PHOTOMETRY	<i>m</i> <sub>V</sub> 13.817±0.092
PROPER MOTION (RA)	-0.0379221±0.0253491 mas/yr	<i>m</i> <sub>HRS</sub>	13.2366±0.0167
PROPER MOTION (DEC)	-7.0691800±0.0287746 mas/yr	<i>m</i> <sub>I</sub>	12.548±0.024
		<i>m</i> <sub>J</sub>	12.237±0.024
		<i>m</i> <sub>Ks</sub>	12.18±0.02
		<i>m</i> <sub>Kep</sub>	13.709
		<i>m</i> <sub>01</sub>	12.053±0.022
		<i>m</i> <sub>02</sub>	12.125±0.022
		<i>m</i> <sub>03</sub>	12.119±0.191
		<i>m</i> <sub>04</sub>	9.444
		<i>m</i> <sub>Gal</sub>	13.706220±0.000271
		<i>m</i> <sub>g</sub>	14.635±0.030
		<i>m</i> <sub>r</sub>	...
		<i>m</i> <sub>i</sub>	...

ABUNDANCES (HYPATIA CATALOG)

- [Fe/H] 0.05±0.04 dex
- [C/H] 0.05±0.02 dex
- [O/H] -0.03±0.09 dex
- [Na/H] -0.07±0.04 dex
- [Mg/H] 0.04±0.02 dex
- [Al/H] 0.01±0.01 dex
- [Si/H] 0.02±0.05 dex
- [Ca/H] 0.06±0.06 dex
- [Y/H] 0.07±0.08 dex

MISSION TOOLS

- ExoPOP Target Overview Page
- IRSA Finding Chart
- Kepler Names
- KOI
- Kepler Stellar Data
- Kepler Positional Probabilities
- Q1-Q17 DR25 False Positive Probabilities
- Kepler Certified False Positive
- Q1-Q16 DR25 TCE
- Kepler Time Series
- Kepler TCE Time Series

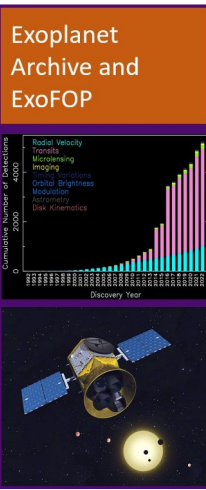


# ExoFOP

- Enables sharing of observations, data, and information on exoplanets and their host stars for all (~2 billion) stars in the TESS Input Catalog
- TESS Candidates: 7027 TOIs, 3280 cTOIs
- Community Uploads
  - 932000 Files
  - 68000 Recorded Observations
  - 31000 Recorded Notes
  - 6900 Recorded Nearby Stellar companions
- Added predicted planetary masses and Transmission/Emission Spectroscopy metrics
- Functionality Coming-Soon
  - Upload Planet Parameters for any target not just transiting planets
  - User Preferences for Customizable (and save-able) table views
  - Mission Target Lists (part of SAG22 response)

TIC ID	TOI ↑	CTOI	ESM	TSM	Predicted Mass (M <sub>Earth</sub> )	Time Series Observations
231663901	101.01	TIC 231663901.01	87.6	211.2	116.12	9
149603524	102.01		132.7	169.9	317	0
336732616	103.01		47.7	136.4	116.75	0
231670397	104.01		52.4	122.6	121.75	0
144065872	105.01		187.2	431.1	122.95	0
38846515	106.01		88.7	107.5	317	0
92352620	107.01		166	236.6	317	1
289793076	108.01		39.1	115.6	99.64	0
29344935	109.01		32.5	84.5	98.43	0
281459670	110.01		66.2	71.2	317	0
355703913	111.01		43.1	108	105.79	0
388104525	112.01		77	179	125.23	0
97409519	113.01		57.3	67.8	317	0
25155310	114.01		53.5	161.8	77.37	0
281541555	115.01		20.3	76.9	76.81	0
238176110	116.01		98.8	251.1	94.86	0
322307342	117.01		39.9	44.1	317	0

<https://exofop.ipac.caltech.edu>







# SAG22 Report: Main Recommendations

- Community-led report on the need for an archive dedicated to the characterization of stars from which the HWO targets be prioritized selected
- SAG report through the ExoPAG and presented as “analysis” to the Exoplanet Program and, by extension, NExSci as the ExEP science center
- (Final Report on SAG22 [?](#) Hinkle talk this afternoon)



# SAG22 Report: Main Recommendations

- Need for a centralized repository of curated, detailed stellar and planetary system data for a relatively small collection of nearby FGKM stars.
- Some key stellar information necessary for target selection, prioritization, and/or characterization is poorly constrained, sparse, or non-existent particularly for time-dependent quantities
  - Uniform, good-quality stellar parameters (e.g., radius, mass,  $T_{\text{eff}}$ , lum)
  - Elemental abundances beyond Fe
  - Stellar activity measurements – particularly time-dependent
  - Well quantified uncertainties on all parameters
- Community work needed for new observations and assessment of published and archival data



# SAG22 Report: ExEP Response

- NExSci's ExoFOP can be adapted to meet some of the SAG22 recommendations
- *NExSci convened community tiger team working group to prioritize work on ExoFOP in support of SAG22*
  - *23 May 2023*
  - *Panel Members: T. Henry, J. Winters, N. Hinkel, N. Tuchow, K. Cunha, E. Mamajek, J. Burt, Sam Quinn*
- NExSci scientists participating in HWO START and associated working groups to understand needs of HWO, the START and the community



# SAG22 Report: Planned ExoFOP Changes

- HWO Target Lists
  - Enable multiple versions (e.g., ExEP's, Tuchow et al.)
  - Improved handling of stellar and planetary parameters
    - Work with START WGs and community
    - Connect to other services (NASA/NOIRLab archives, Hypatia (already connected at Archive, Starchive))
    - Adding user uploads for:
      - Multiple abundances
      - Fluxes/magnitudes
      - Additional activity indicators
      - Exozodical properties
    - Relevant Gaia (DR3/4) properties
- Enable lists for other missions (e.g., EPRV, JWST, Ariel)
- Enable community generated lists
- Improve API access to content to enable community extraction and use of content
- Statistics (min/max/ave) for parameters with multiple values
- Plotting and visualization
- Work currently underway – 2024 releases include
  - Dedicated target lists
  - Ability for community to share multiple abundances, additional fluxes/magnitudes, and additional activity indicators