Observation Applications

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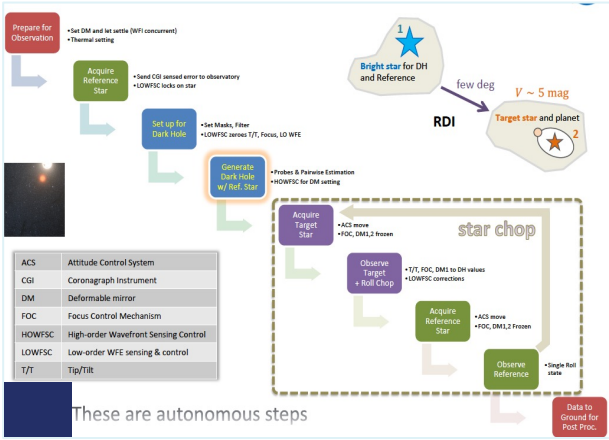
Observing campaigns: overview

- Each campaign consists of a similar slew-exposure sequence:
  - Acquire a **Reference Star** and perform High-Order Wavefront Sensing and Control (HOWFSC) with Ground in the Loop (GITL). This setup time occurs before the observation begins [1]
  - Perform sequences of **Observing Scenario** 11 (OS-11), an Observation Cycle Concept, with exposures from Reference and Target Star pairs [2]
  - Collect **calibration data** before and/or after an OS-11 cycle [3]



Notional example
HOWFSC – High Order Wavefront Sensing Control
GITL – Ground In The Loop
SOSE – Science Observation Sequence Engine

[1] See "**Observing with the Coronagraph Instrument**" and "**High Order Wavefront Sensing and Control**" talks on Day 1
[2] See "**Overview of Observing Scenarios and Their Simulated Datasets**" talk on Day 1
[3] See "**Observation Calibration**" talk on Day 1

Technology Demonstration Requirement: TTR5

- **Recall that TTR5 is the *sole pass/fail criterion* for the Coronagraph Instrument technology demonstration [1]**

- At the time of writing this presentation, there is **no identified** target star that has a known astrophysical companion satisfying the **TTR5** conditions. There is an on-going effort to identify stars with a high probability of having an **astrophysical companion** satisfying **TTR5** conditions.

- **TTR5** can also be verified **by analysis** or **by exceeding** its requirements

[1] See "**Coronagraph Instrument Overview**" talk on Day 1

Technology Demonstration Phase: beyond TTR5

- The most powerful demonstration for future exoplanet-imaging missions is one that images exoplanets

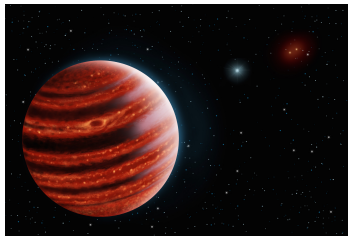
- Once **TTR5** is verified, the Roman Coronagraph will conduct several other observations during the Technology Demonstration Phase that would fulfill additional technological tests and maximize its value by looking at scientifically-interesting targets on a best effort basis **[1]**

- These are grouped under the name of **Nominal Observations**

See [1] "**Potential Science Returns Introduction**" on Day 2

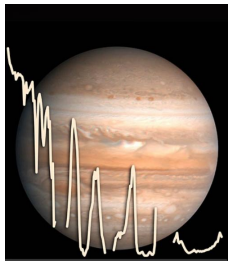
Technology Demonstration Phase: beyond TTR5

- **Nominal observations** cover direct imaging and spectroscopy of:
  - Self-luminous exoplanets **[1,2]**



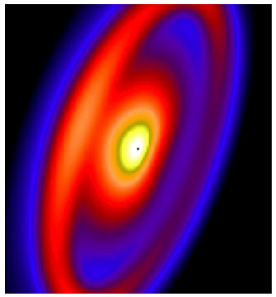
Gemini Planet Finder/Cosmic Diary

  - Reflected light exoplanets **[1,3]**



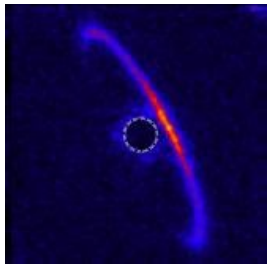
J. Madden/NASA

  - Exozodiacal dust and debris disks **[4]**



J. Debes/STScI

  - Polarization **[4]**



B. Mennesson/JPL/Caltech

See on Day 2: [1] "**Planet models, tools, science cases, and results from the MacIntosh SIT**" and "**Simulations of Orbit and Atmosphere Retrieval from the Turnbull SIT**"; [2] "**Spectroscopy Data Simulations**"; [3] "**RV Precursor Work**"; [4] See "**Disks and Exozodi: Science Case and PSF subtraction results**"

Roman Coronagraph Notional Target List [1]

Known, Self Luminous

Probably observe 1-2 systems during Technology Demo Phase

	Name	V mag
	51 Eri	5.21
	HD 984	7.32
	HR 2562	6.10
	HR 8799	5.95
	HD 95086	7.36
*	kap And	4.14
	beta Pic	3.86
*	HD 206893	6.67
	HIP 65426	6.98

Selected on host star mag, projected separation, predicted fluxes from Lacy 2020 (+Lacy private communication)

* *tentatively* higher priority for Tech Demo Phase (TDP)

Known RV, Reflected Light

Probably observe 1-2 systems during Technology Demo Phase

	Name	V mag
	14 Her	6.61
*	47 UMa	5.05
	HD 114613	4.85
	HD 134987	6.45
	HD 142	5.70
	HD 154345	6.76
	HD 160691	5.15
	HD 190360	5.73
	HD 192310	5.73
	HD 217107	6.16
*	HD 219134	5.57
	HD 39091	5.57
	tau Cet e	3.50
*	ups And d	4.10

From https://plandb.sioslab.com/ (mostly) NExScI orbits, masses + Batalha et al albedo models

Exozodi

Probably no dedicated exozodi search during Technology Demo Phase, unless opportunistic during point source search

	Name	V mag
	tau Ceti	3.50
*	eps Eri	3.82
	bet Vir	3.60
	Tet Boo	4.05
	lam Ser	4.42
	gam Ser	3.84
	72 Her	5.39
	Vega	0.00
	110 Her	4.19
	Sig Dra	4.68
*	Formalhaut	1.16

Work in progress. These are placeholders. Combo of follow-up of 10um excesses and blind search.

Debris Disk

1-2 integrated light, 1-2 polarimetry during Technology Demo Phase

	Name	V mag
	49 Ceti	5.61
	beta UMa	2.37
	beta Leo	2.13
	HD 139664	4.63
*	eps Eri	3.82
	HD 172555	4.77
	HD 15115	6.80
	beta Pic	3.86
	eta Corvi	4.29
	HR 4796	5.77
*		

Work in progress. Selected on star mag, known properties/limits from previous work. Combo of follow-up and blind search.

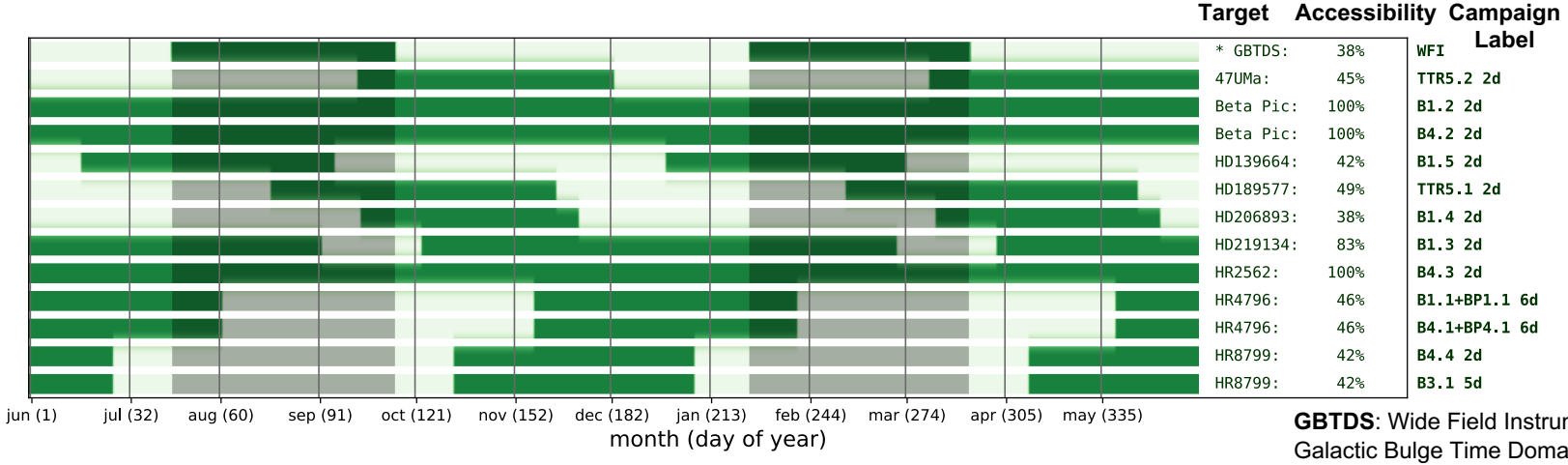
Not set in stone! Will continue to add & update as additional input becomes available

[1] Each target star needs corresponding reference star/s meeting some criteria. See **"Observing with the Coronagraph Instrument"** Color coded by V-band magnitude (b/c only required to achieve optimal performance on V<5 stars)

Technology Demonstration Phase: beyond TTR5

- Once there is a set of potential targets, they cannot be observed at any time during the mission due to their location and other constraints, e.g., orbital ephemeris. One must design an optimal **scheduling** program within the notional 90 days along the 18 months of the Technology Demonstration Phase **[1,2,3]**

- Notional example of a schedule that could potentially fulfill the Coronagraph Nominal goals



GBTDS: Wide Field Instrument(WFI) Galactic Bulge Time Domain Survey

See on Day 2: [1] "**Imaging Mission Database (plandb)**" ; [2] See "**Exposure Time Calculator for the Roman Coronagraph Instrument**"; [3] "**Exoplanet Imaging Community Data Challenge**"

Observation Applications. Future work

- Review the **target catalog** for TTR5 and other potential targets with ancillary data and other future data sets prior to Roman's launch:
  - Target vetting **[1]**
  - Do target and reference stars meet criteria outlined in **[2]**?
  - TTR5: astrophysical companions
  - Atmospheric models for both self luminous and reflected light planets
  - Updated orbital ephemeris with ancillary RV and astrometric data
  - Disk emission modeling

- Review pre- and post-processing **algorithms** that may improve science yield **[3]**
- Introducing **scheduling algorithms** into the Design Reference Mission planning
- Reviewing **calibration data** collection methods and their duration

[1] See "**Target Vetting**" on Day 2. See on Day 1: [2] "**Observing with the Coronagraph Instrument**"; [3] **Working with Simulated Datasets**" and other presentations on Day 2 mentioned before

Consult the Reference Materials that go with this talk for more details

Questions