An Overview of the EXCALIBUR Public Portal

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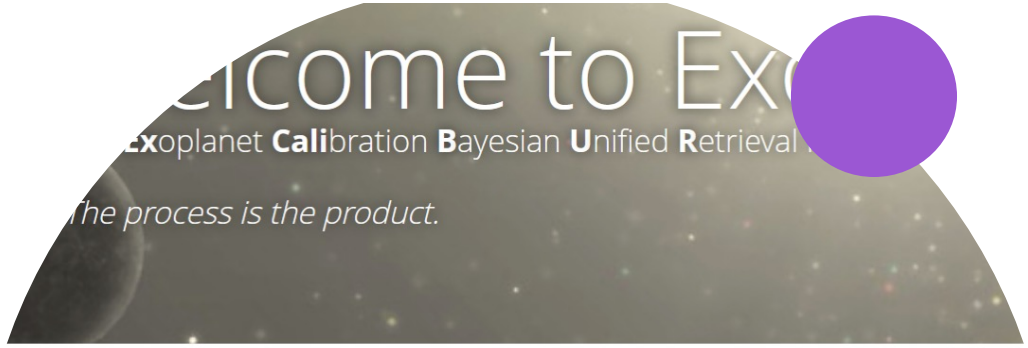
The Public Portal

- EXCALIBUR was developed by a science-team to do science
- Goal is to give public access to the products and results the EXCALIBUR team has published
- The EXCALIBUR public portal is a static release of the EXCALIBUR catalog
- This is an early release – working to turn a science team-oriented service into a public consumable service



EXCALIBUR

Exoplanet Calibration Bayesian Unified Retrieval Pipeline.

EXCALIBUR reduces extrasolar system data into an exoplanet spectrum. It include plane parallel radiative transfer code modeling exoplanet atmospheres and a Ba / model selection package.

EXCALIBUR is an event driven pipeline where the events are defined as chan vents are detected, dependencies affected by the changes are re-process sparent and quantified using a combination of accessible intermedi al diagnostics.

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https://excalibur.ipac.caltech.edu

The Public EXCALIBUR Portal

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We are working on a collection of documents describing the EXCALIBUR services and data.

See EXCALIBUR Notes for a quick overview.

Primary Table

An overview of all the targets, state vectors, and run IDs available, in different permutations.

Search Database

Search for a specific target or state vector by name. Drill down to specific plots and tables.

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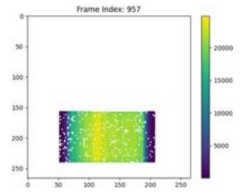
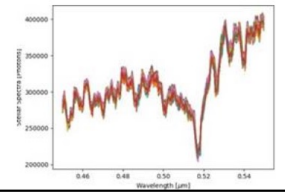
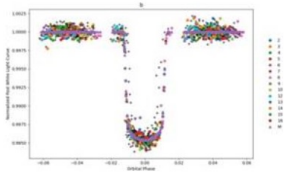
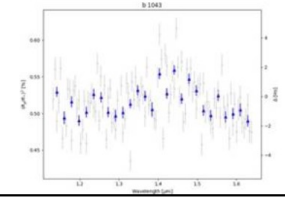
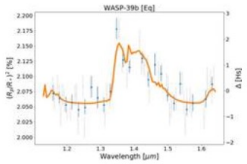
What's In EXCALIBUR?

- 60 targets observed with HST WFC3
  - Published in Swain et al. 2021, Roudier et al. 2021, Estrela et al. 2021, 2022
- Periodically update the catalog for release as team work progresses

Data Product	Description	State Vector Name	Examples
Level 1	Uncalibrated photometric/spectral science frames. Detector data in instrumental units with pointing metadata established and instrument artifact compensation.	data.calibration.HST-WFC3-IR-G141-SCAN	
Level 1.5	Calibrated photometric/spectral images. Calibrated, background subtracted, bad pixel masked, wavelength calibrated.	data.calibration.HST-WFC3-IR-G141-SCAN	
Level 2	Target light curves. Exoplanet system spectral light curves for transit, eclipse, and phase curve observations.	transit.whitelight.HST-WFC3-IR-G141-SCAN	
Level 2.5	Exoplanet spectra for the primary and secondary eclipse at full spectral resolution with uncertainty estimates, residuals, and flags attached	transit.spectrum.HST-WFC3-IR-G141-SCAN	
Level 3	Retrieval products: model parameter estimates and posteriors, most probable model examples, correlation plots.	cerberus.release.HST-WFC3-IR-G141-SCAN	

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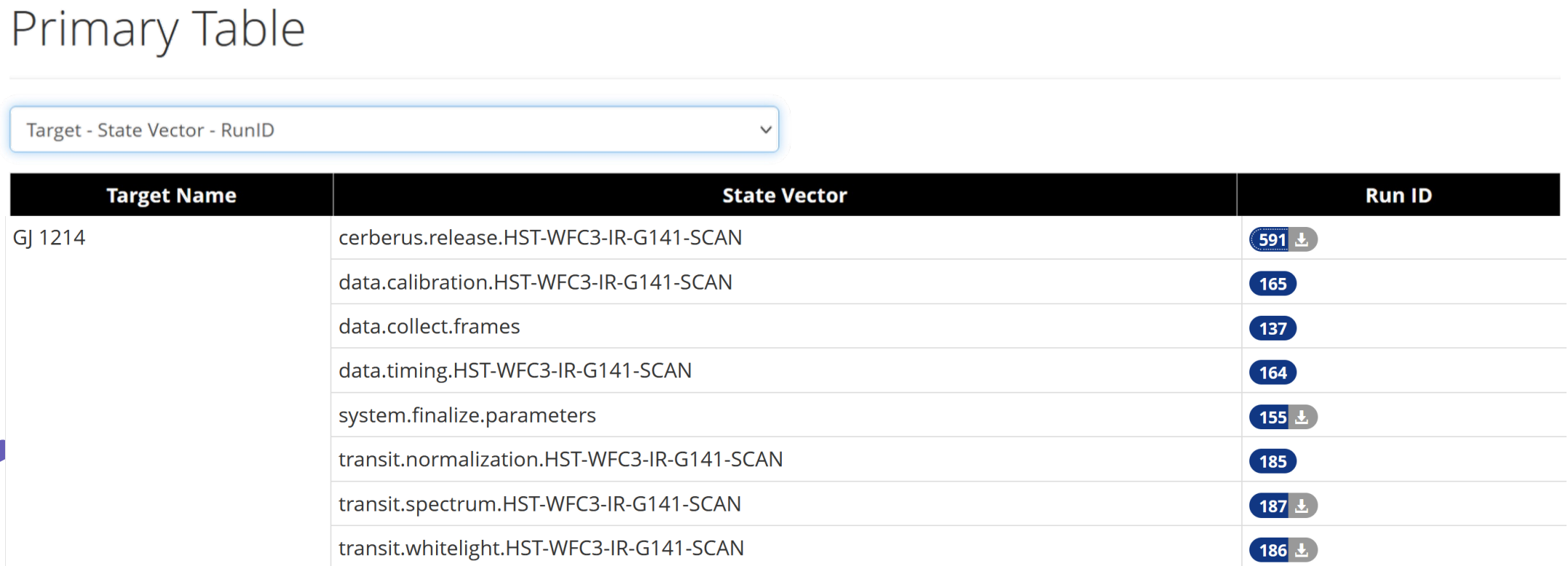
- List of all the targets and data products
- Links to
  - Visualization page for each data product per target
  - Download of data product in JSON format for the high level data products (working to make all available)



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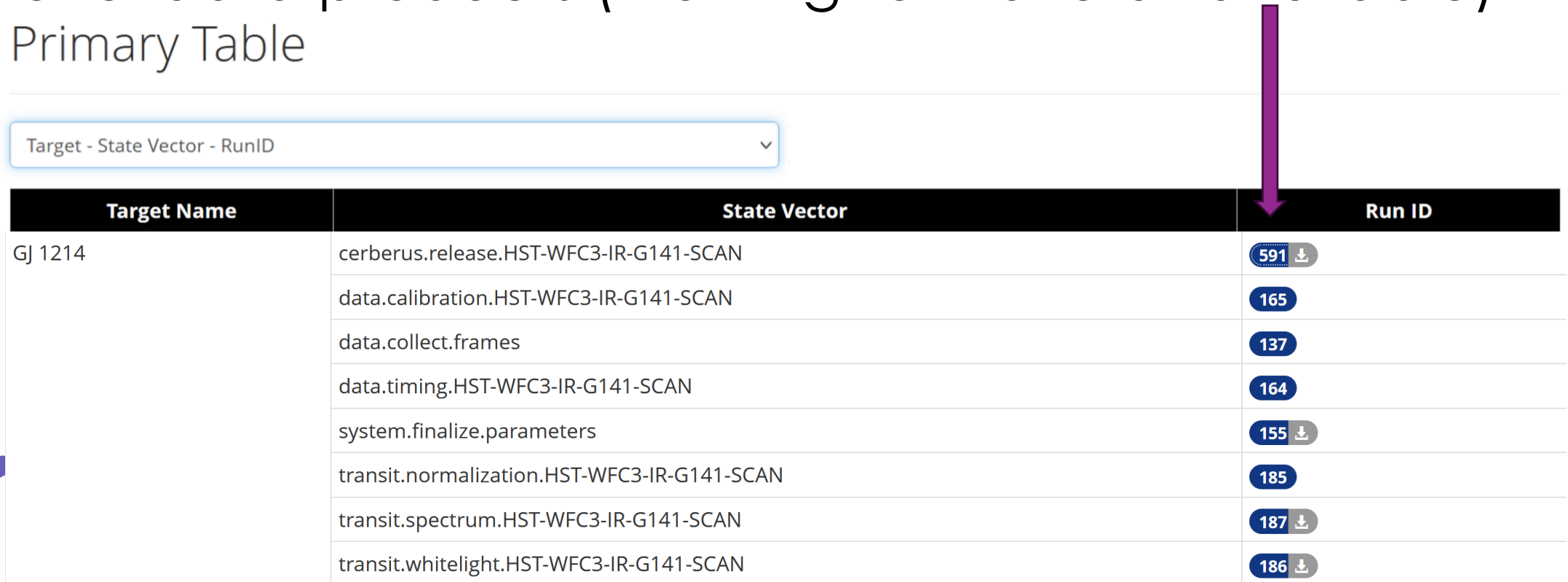

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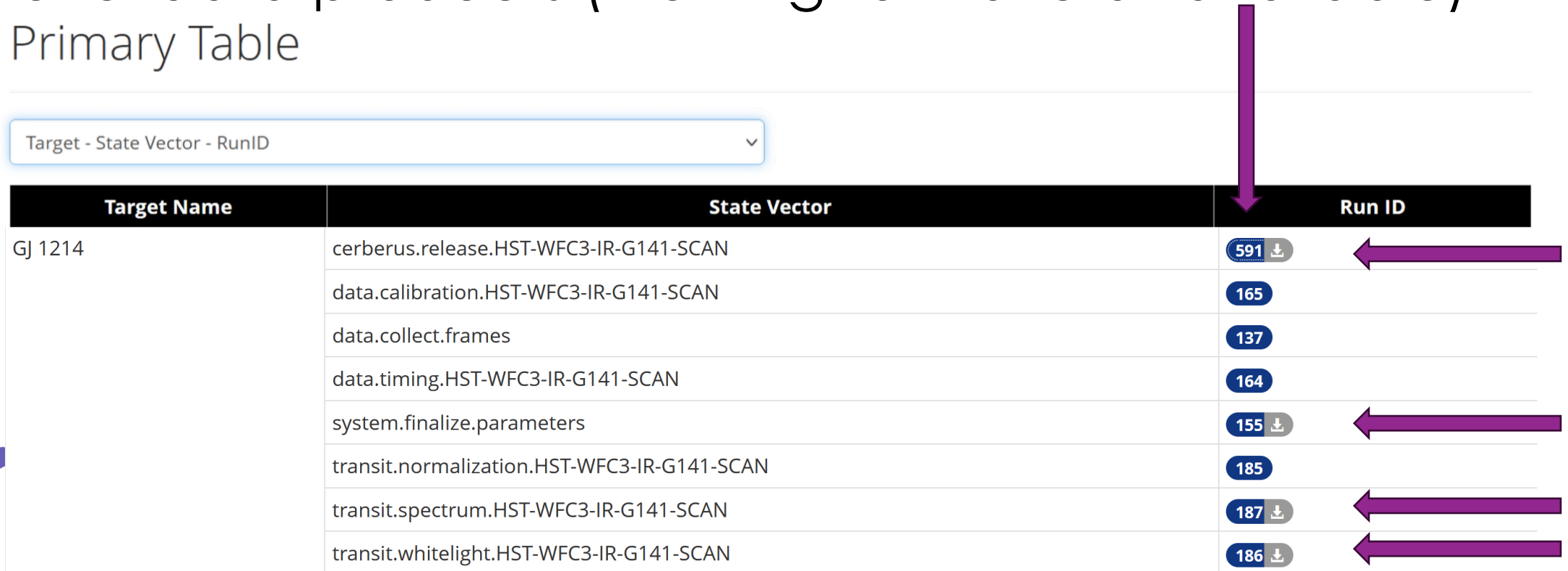


Visualization Pages and JSON Downloads

Viewing State Vector:

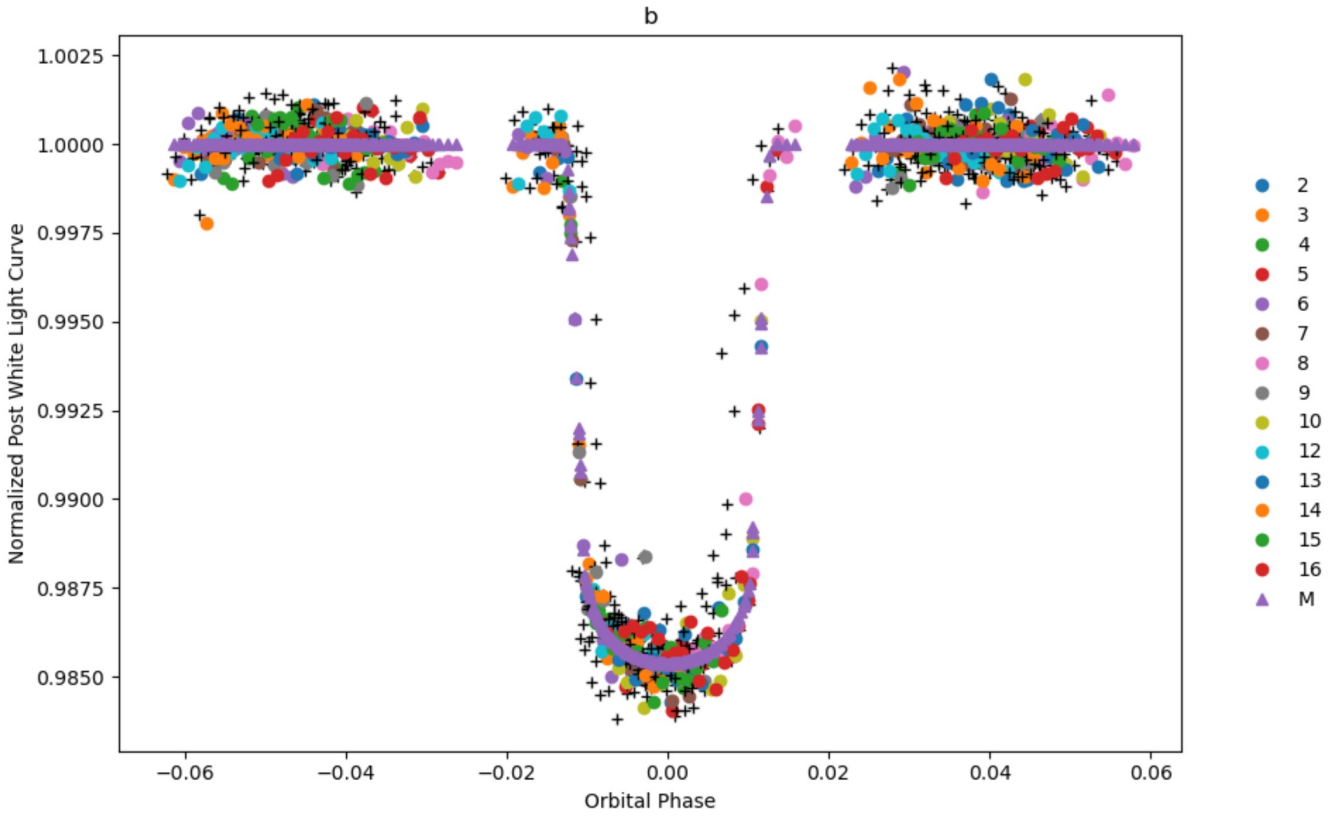
Run ID: 186

Target: GJ 1214

Task: transit

Algorithm: whitelight

State Vec: HST-WFC3-IR-G141-SCAN



JSON Raw Data Headers

Save Copy Collapse All Expand All (slow) Filter JSON

```
planet: "b"
visits:
  0: 2
  1: 3
  2: 4
  3: 5
  4: 6
  5: 7
  6: 8
  7: 9
  8: 10
  9: 12
  10: 13
  11: 14
  12: 15
  13: 16
allwhite:
  0:
    0: 1.0007841287726154
    1: 1.0004308939498403
    2: 0.9865160192746302
    3: 0.9991351810541895
    4: 0.9848827691273517
    5: 0.9995453356225554
    6: 1.0001503013198367
    7: 0.9993532763394994
    8: 0.9871589781307769
    9: 0.99902096149902
    10: 0.9856341344914857
    11: 0.9992962784501837
    12: 0.9996755590929887
    13: 0.9847445191159141
    14: 1.000387873928634
```

Visualization Pages and JSON Downloads

Viewing State Vector:

Run ID: 591

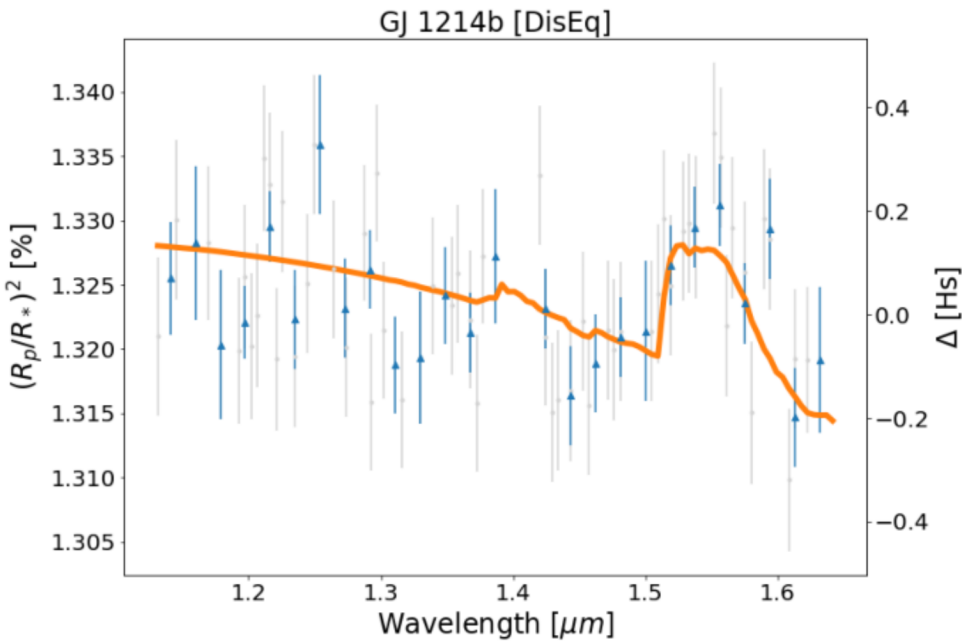
Target: GJ 1214

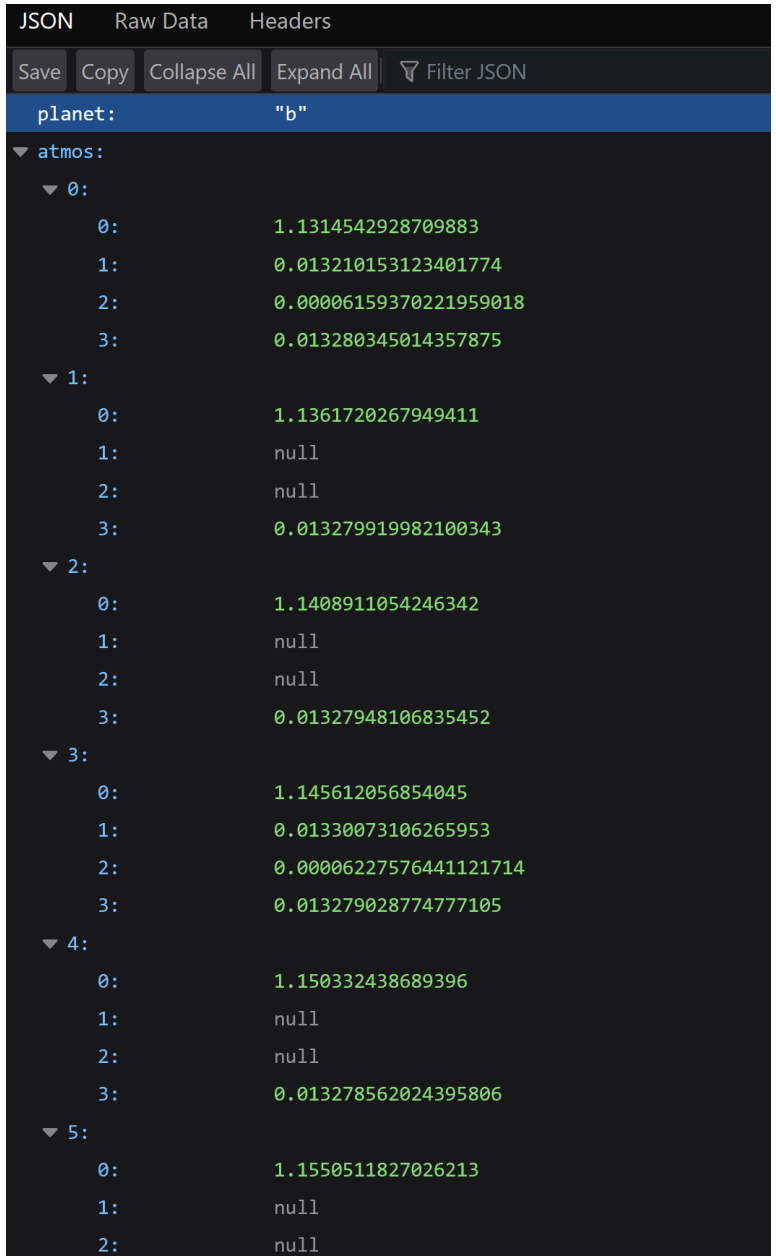
Task: cerberus

Algorithm: release

State Vec: HST-WFC3-IR-G141-SCAN

b: Atmos results





Visualization Pages and JSON Downloads

Viewing State Vector:

Run ID: 155

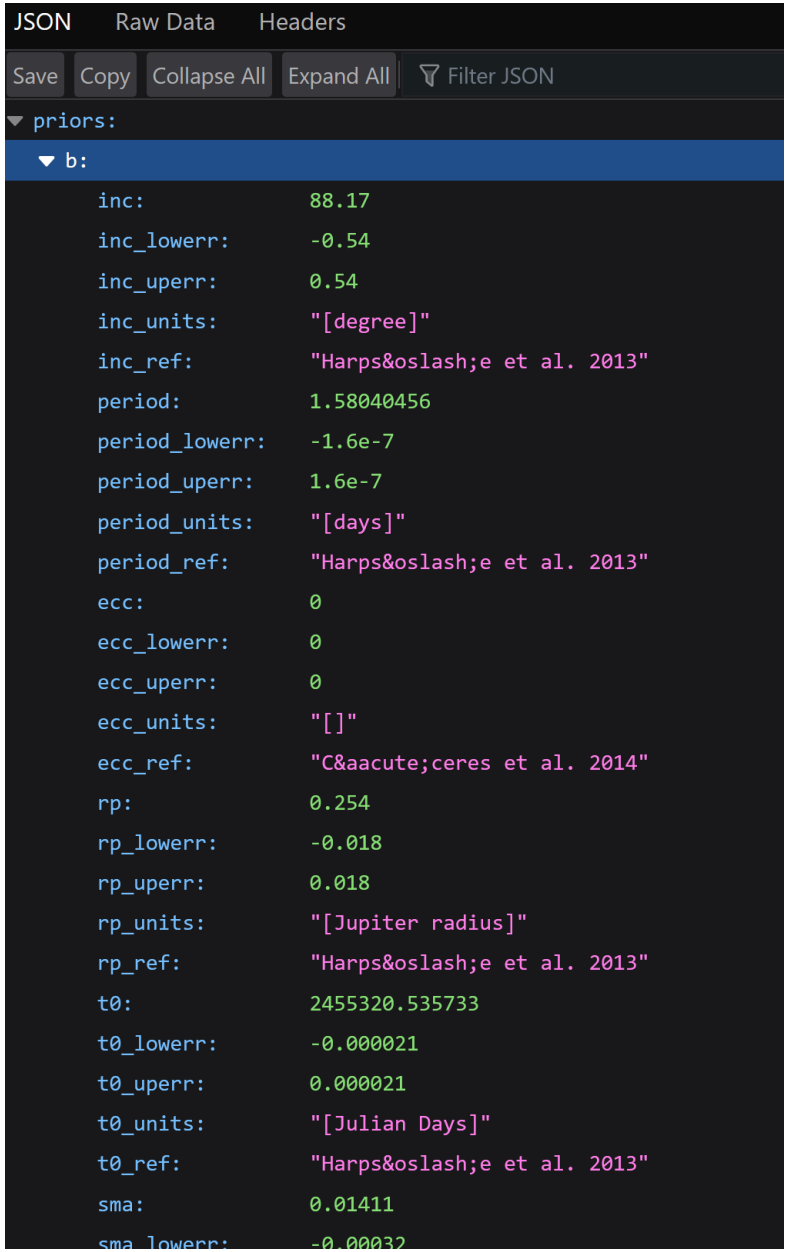
Target: GJ 1214

Task: system

Algorithm: finalize

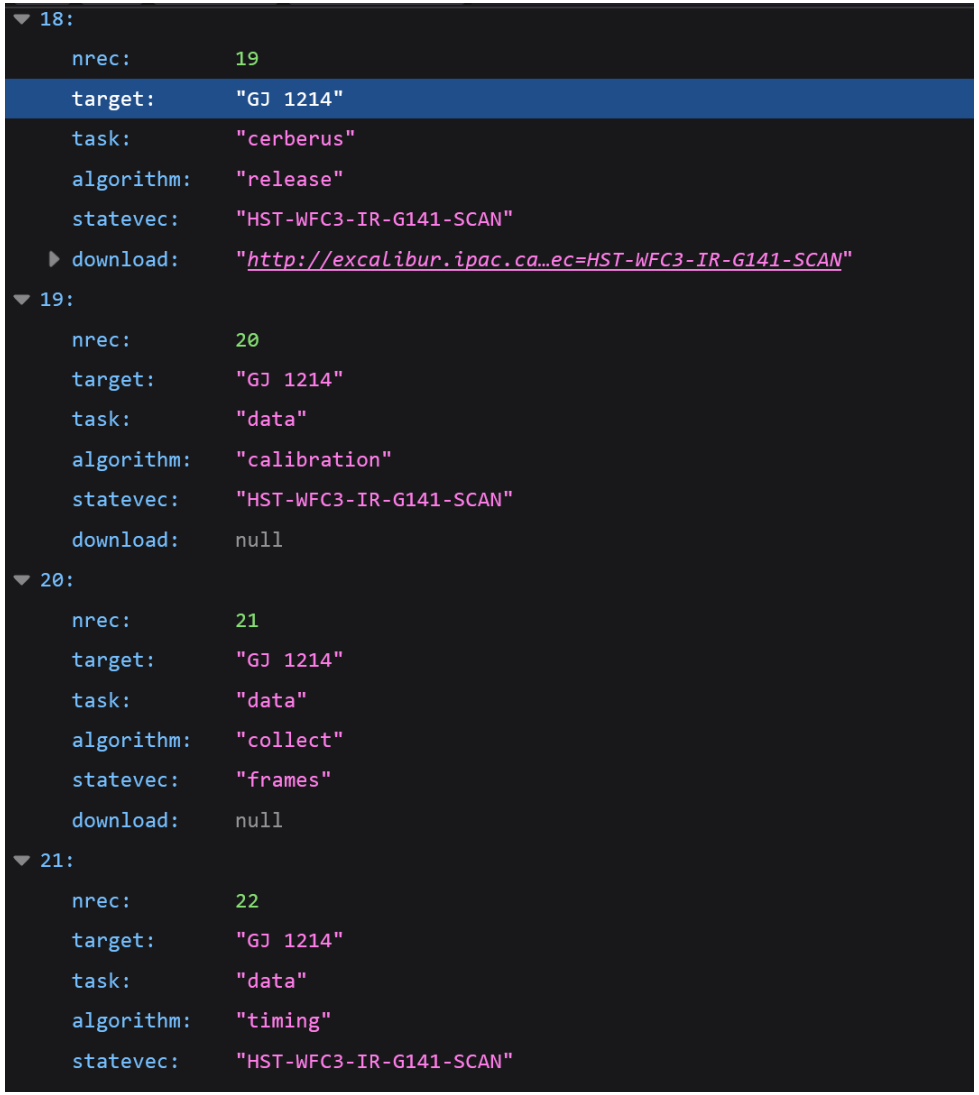
State Vec: parameters

STAR	UPPER ERR	LOWER ERR	UNITS	REF
R*	R*_uperr	R*_lowerr	R*_units	R*_ref
0.22	0.01	-0.01	[Rsun]	Harpsøe et al. 2013
T*	T*_uperr	T*_lowerr	T*_units	T*_ref
3026.0	150.0	-150.0	[K]	Harpsøe et al. 2013
FEH*	FEH*_uperr	FEH*_lowerr	FEH*_units	FEH*_ref
0.39	0.15	-0.15	[Fe/H]	Harpsøe et al. 2013
LOGG*	LOGG*_uperr	LOGG*_lowerr	LOGG*_units	LOGG*_ref
4.94	0.01	-0.01	log10[cm.s-2]	Harpsøe et al. 2013



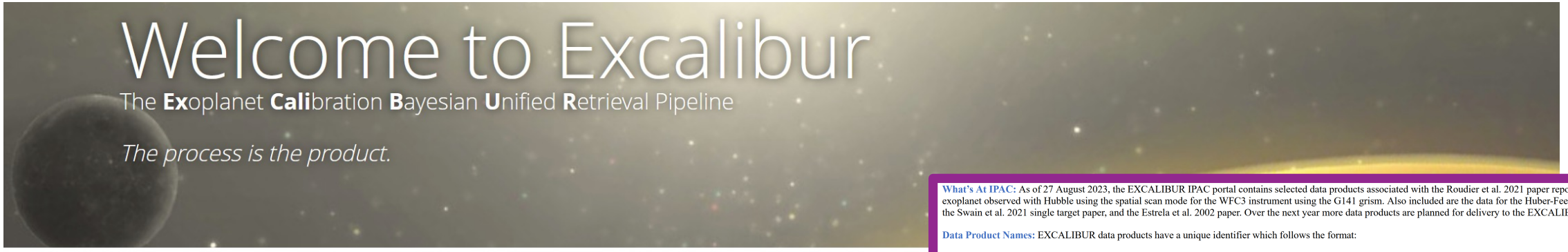
JSON Structure Summarizing the Content

- There is a holdings tool that summarizes the content in JSON format… and, in particular, has urls to each of the downloadable products



https://excalibur.ipac.caltech.edu/holdings.json

Beginnings of a Tutorial Page



What's At IPAC: As of 27 August 2023, the EXCALIBUR IPAC portal contains selected data products associated with the Roudier et al. 2021 paper reporting a population wide analysis fo exoplanet observed with Hubble using the spatial scan mode for the WFC3 instrument using the G141 grism. Also included are the data for the Huber-Feely et al. 2022 calibration analysis pa the Swain et al. 2021 single target paper, and the Estrela et al. 2002 paper. Over the next year more data products are planned for delivery to the EXCALIBUR portal.

Data Product Names: EXCALIBUR data products have a unique identifier which follows the format:

RunID.Target.Task.Algorithm.State Vec

- **RunID** is the unique identifier that determines the state of the software (tied to a specific GitHub change set) and all of the input data for a specific processing instance and thus repres the complete state of the software and data used to generate the output state vector
- **Target** is the name of the system host star.
- **Task** identifies the EXCALIBUR task used to create the data product.
- **Algorithm** identifies the EXCALIBUR algorithm used to create the data product.
- **State Vec** (short for state vector) identifies the specific data product, tied to the specific processing needs of a mission/instrument/mode. For example, Hubble WFC3 instrument spati scan observations needs different processing than some other observations.

An example data product: 165.HAT-P-26.data.calibration.HST-WFC3-IR-G141-SCAN

- **165** is the RunID used to construct the data product
- **HAT-P-26** is the name of the exoplanet host
- **data** is the task used to produce the data product. The dataflow task structure can be seen by using the "Dependency Trees" tab and selecting "Tasks" on the pull down menu.
- **calibration** is the algorithm used to produce the data product. The dataflow algorithm structure can be seen using the "Dependency Trees" tab and selecting "Tasks" on the pull down menu.
- **HST-WFC3-IR-G141-SCAN** denotes the state vector for a specific observatory/instrument/mode corresponding to the data.

Architecture: EXCALIBUR detects changes in the tasks and algorithms it knows about, builds a run-time directed graph, and processes downstream of the change node. As a result, the Run values need not be the same for a parent and child data products. Thus, a sequence of EXCALIBUR processing steps that lead to particular product, an exoplanet transmission spectrum for example, may have different Run ID values. Since the flow of processing (steps involved, calibrations implement, models applied, and so on) can change over time, the Run ID ties a data pr to a specific computational instance, which can be traced to a specific GitHub change set used to generated that computational instance.

Viewing Data Products: To retrieve visualizer plots for EXCALIBUR data products:

- Point your browser to http://excalibur.ipac.caltech.edu
- This shows the EXCALIBUR main page, select Primary Table to brows the data base
- Search for data products for a specific planet by selecting the Search Database button
- In the Target Name field, enter the name of the host star, *e.g.* HAT-P-26
- A list of available state vectors (data products) will appear; these can be individually selected for visualization by selecting the blue numbered buttons in the Run ID column
- To view the transit spectrum, select the Run ID button adjacent to transit.spectrum.HST- WFC3-IR-G141-SCAN
- A visualization of the transmission spectrum data products will open in a new browser tab and clicking inside of the images to select save and view options
- Some data products have the option for a machine readable download indicated by a grey download extension of the blue run ID buttons
- The other data products associated with the host star name are selected similarly
- For *multi-planet systems*, there are multiple planet-based instances of transmission spectra within the transit.spectrum.HST-WFC3-IR-G141-SCAN visualizer view

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- Add in content from today's tutorial

And with that …

- Let's learn some details about the EXCALIBUR data processing and products and how folks are using it

Time	Title	Speaker
9:00 am	Welcome to the EXCALIBUR Tutorial	David Ciardi (Caltech/IPAC-NExScI)
9:10 am	Philosophy and Overview of Excalibur	Mark Swain (JPL)
9:30 am	Excalibur Public Interface	David Ciardi (Caltech/IPAC-NExScI)
9:45 am	Overview of the Excalibur Data Products Working Example	Raissa Estrela (JPL)
10:15 am	Overview of the Atmospheric Retrieval and its application to the Excalibur datasets	Gael Roudier (JPL)
11:00 am	Break	
11:15 am	Validating the Transit Spectra: An Automated Flagging System	Kate McCarthy (JPL/Univ. of Virginia)
11:30 am	Engaging with the Excalibur Team	Mark Swain (JPL)
12:00 pm	Engagement Examples	Lorenzo Mugnai and other Excalibur contributors
12:15 pm	Ending Comments	David Ciardi (Caltech/IPAC-NExScI)
12:30 pm	adjourn	