Sailing the Archival Seas with MAST

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STScI

on behalf of the MAST team

Outline – Mining Archival Data

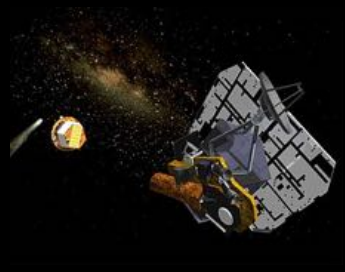
- Overview of MAST missions
- The MAST Discovery Portal
  - Cone Search
  - Advanced Search
  - Cross-Matching
  - Access to the Virtual Observatory
- MAST-led Enhanced Data Products
  - gPhoton: GALEX photon events
  - HSC: The Hubble Source Catalog

MAST Missions: Past, Present and Future

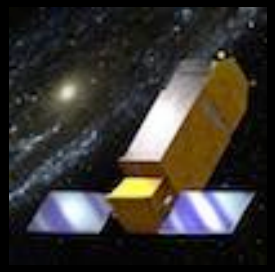
Legacy Missions

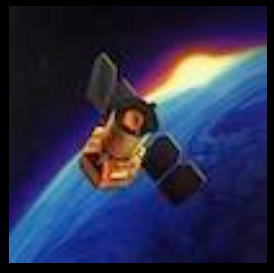

Astro

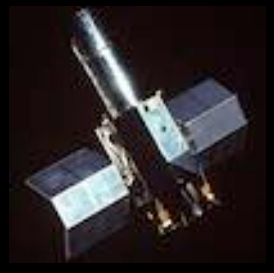

Copernicus


EPOCh


EUVE


FUSE


GALEX

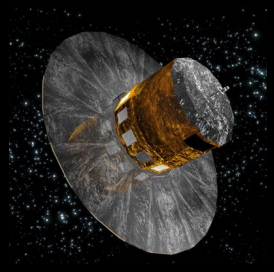

IUE


Kepler


ORFEUS


VLA - FIRST

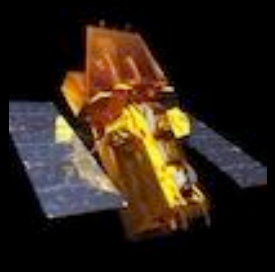
Active Missions


Gaia


Hubble


K2

Pan-STARRS


Swift UVOT

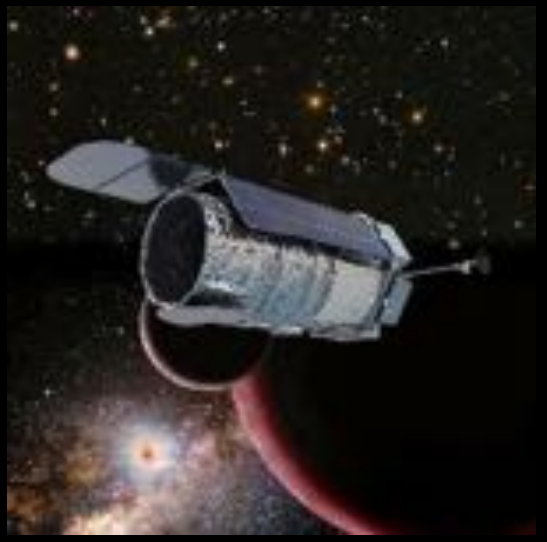

XMM OM

MAST Missions: Past, Present and Future

Upcoming Missions

TESS – Mar. 2018

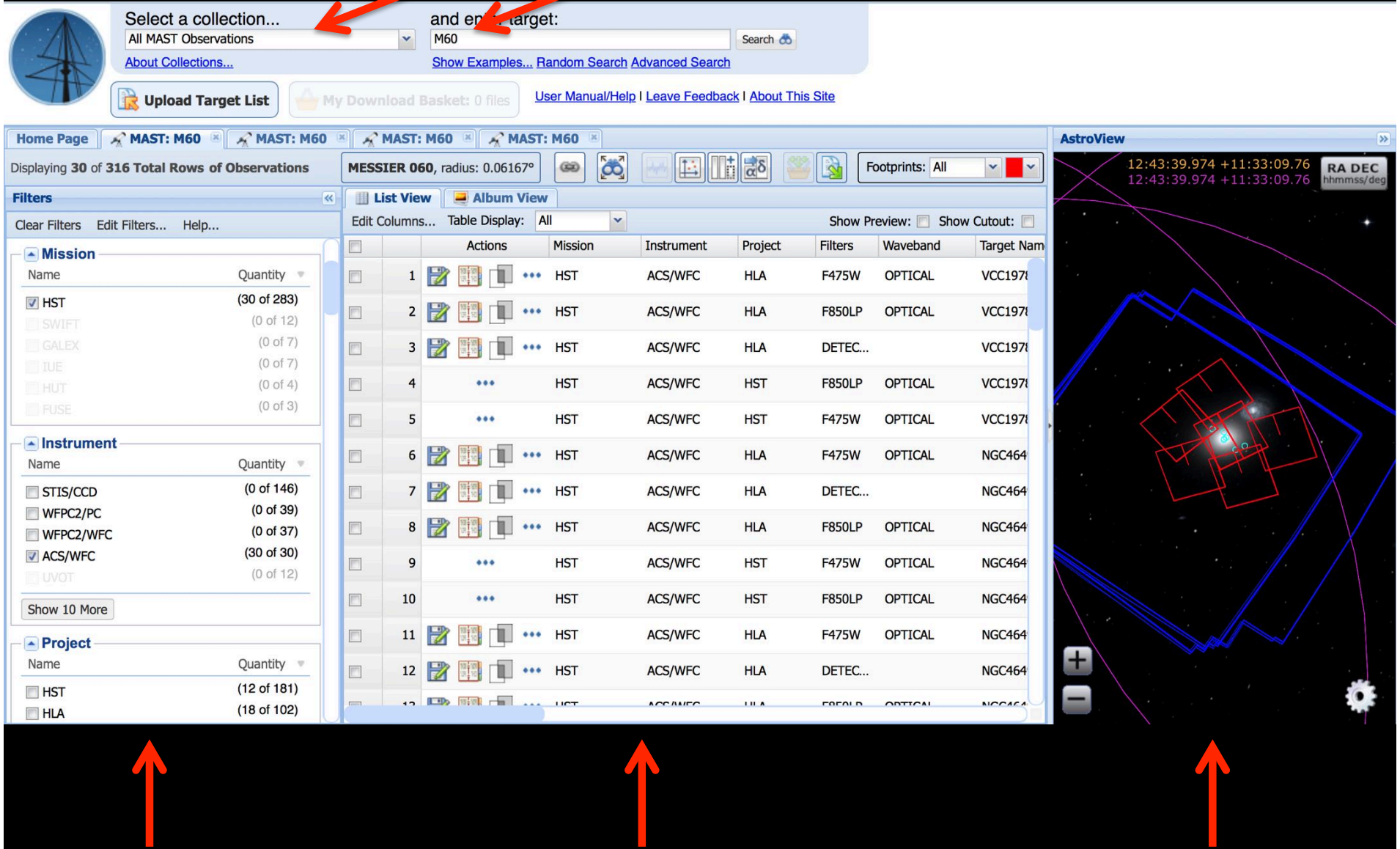
James Webb – Oct. 2018



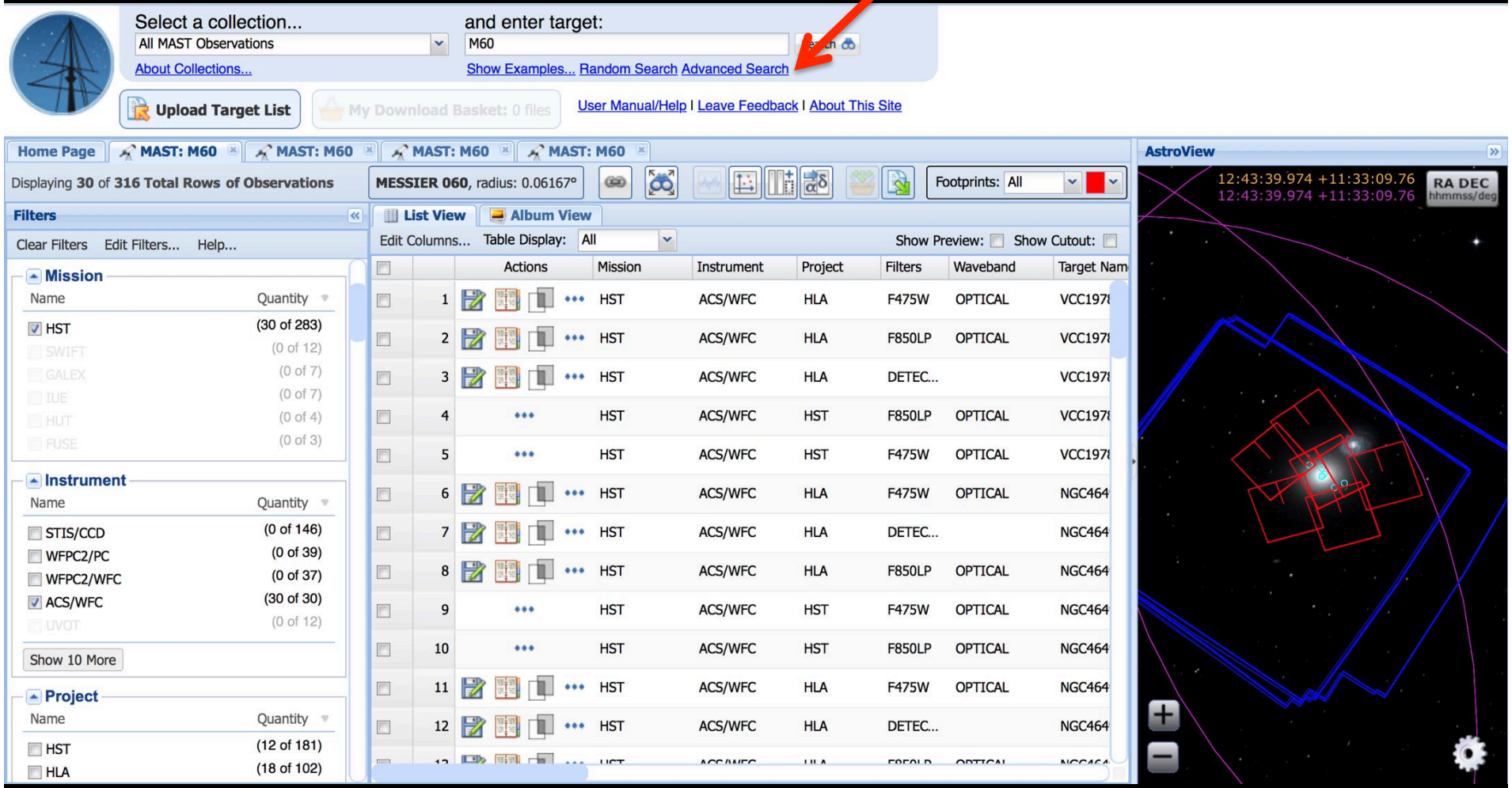
WFIRST – mid-2020s

Cross-Mission Discovery

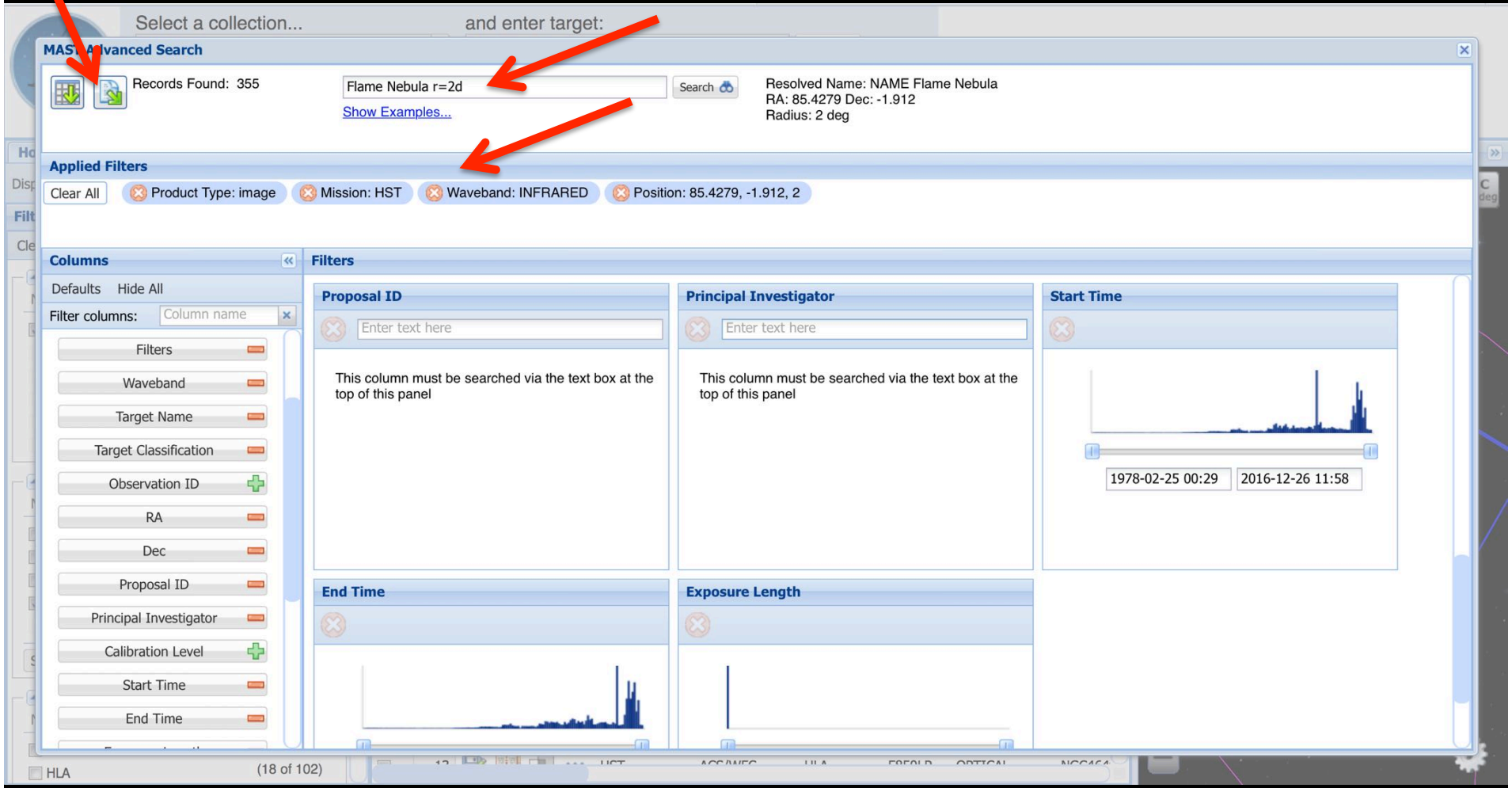
MAST Portal: Cone Search



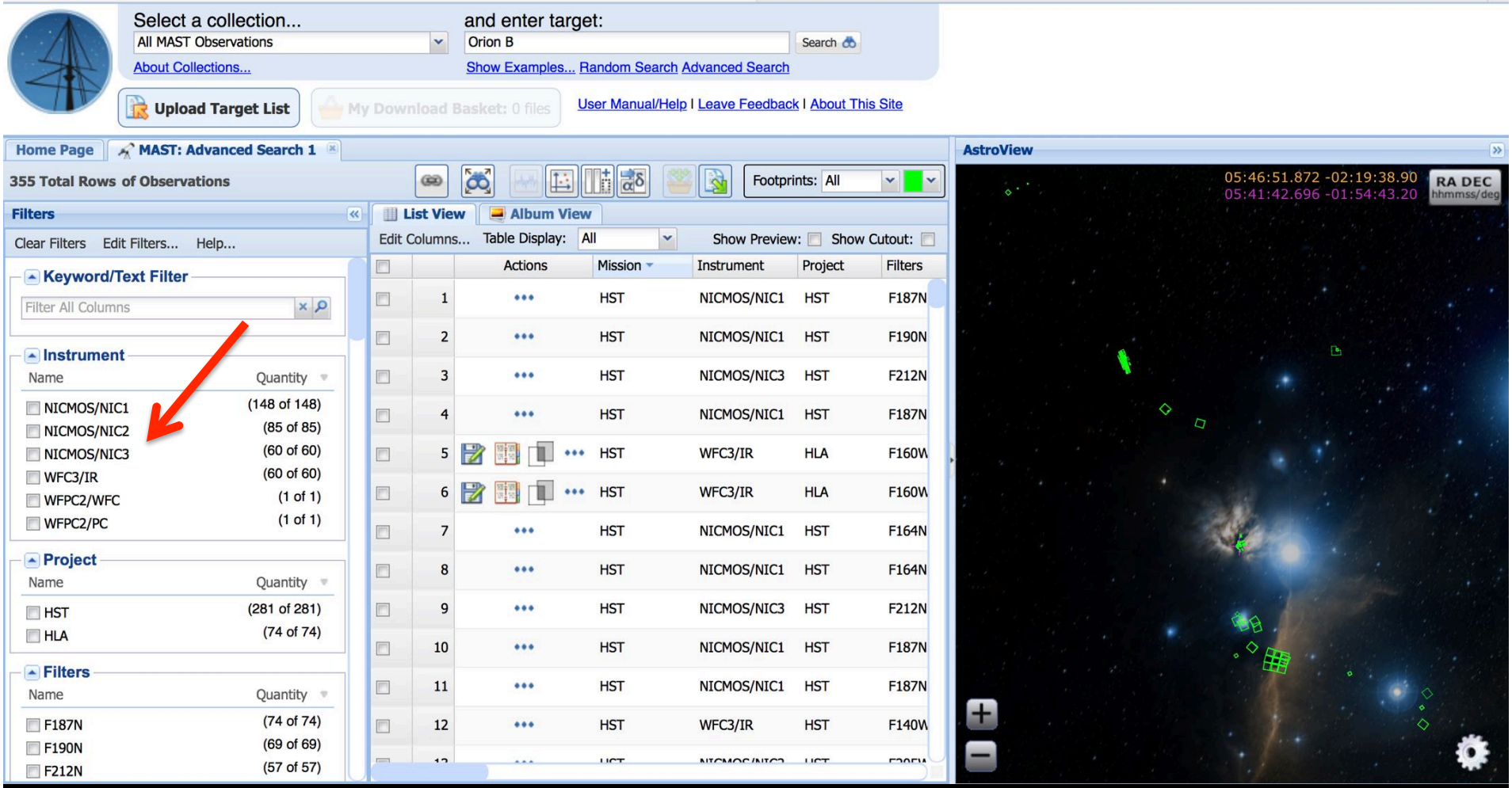
MAST Portal: Advanced Search



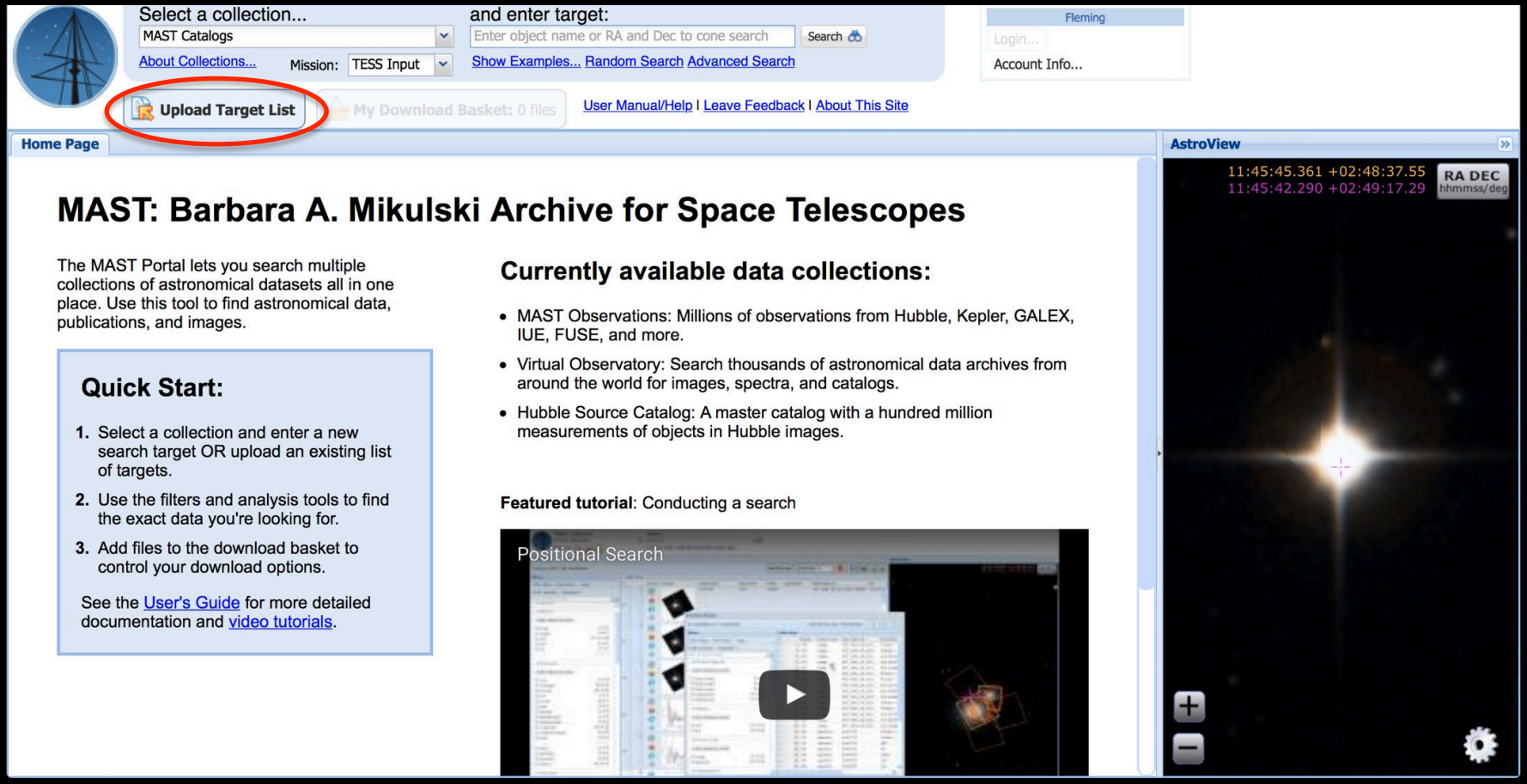
MAST Portal: Advanced Search



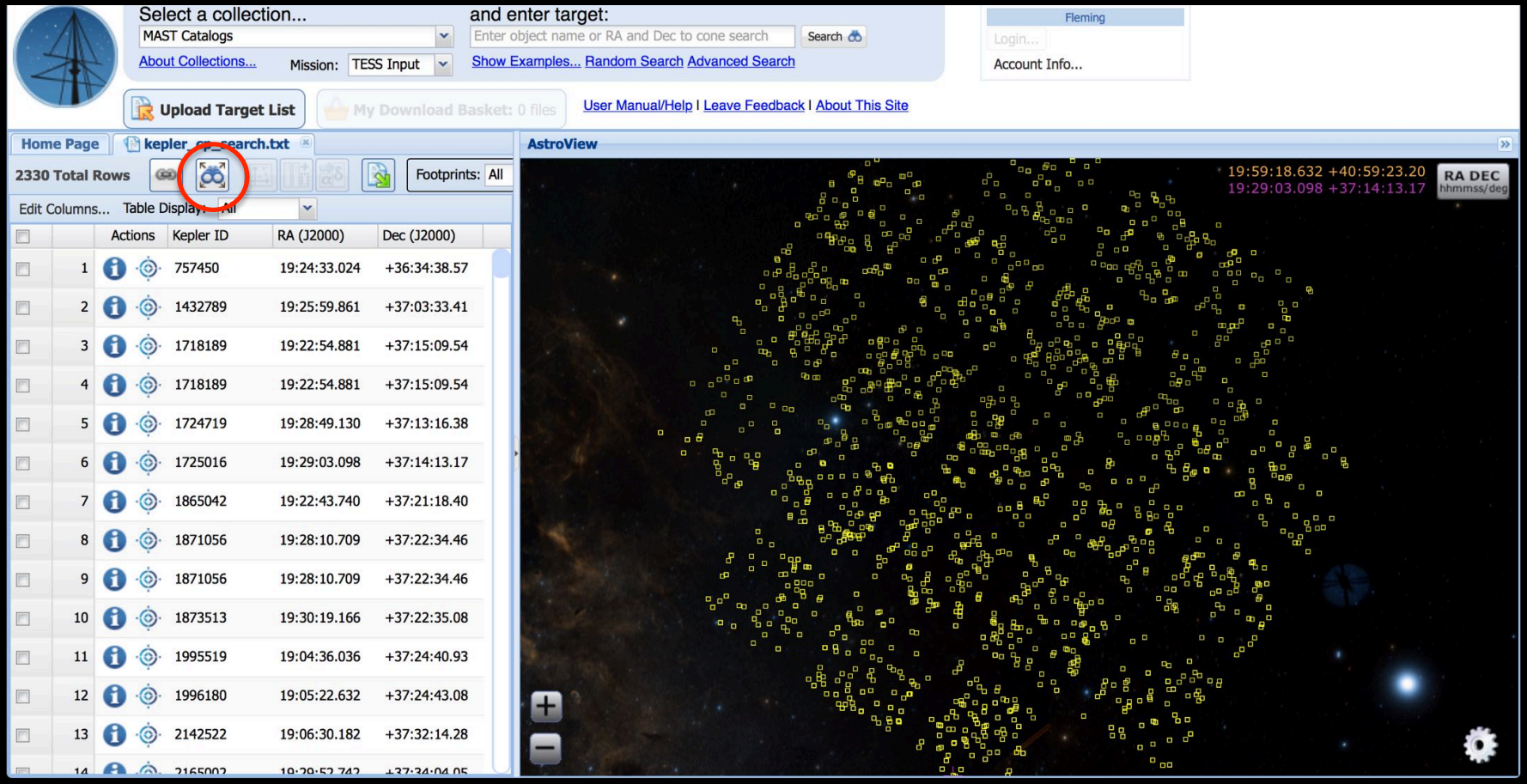
MAST Portal: Advanced Search



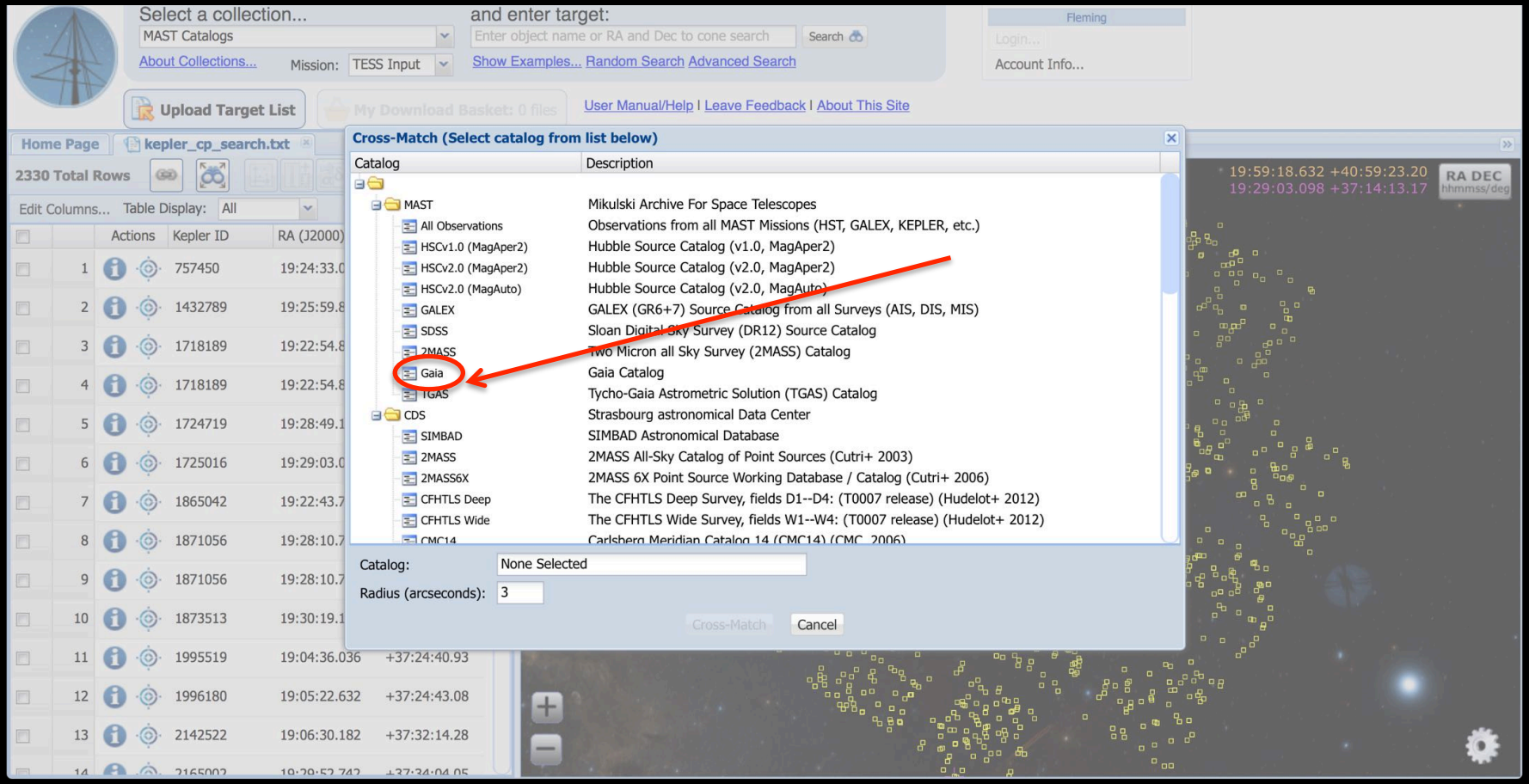
MAST Portal: Cross-Match



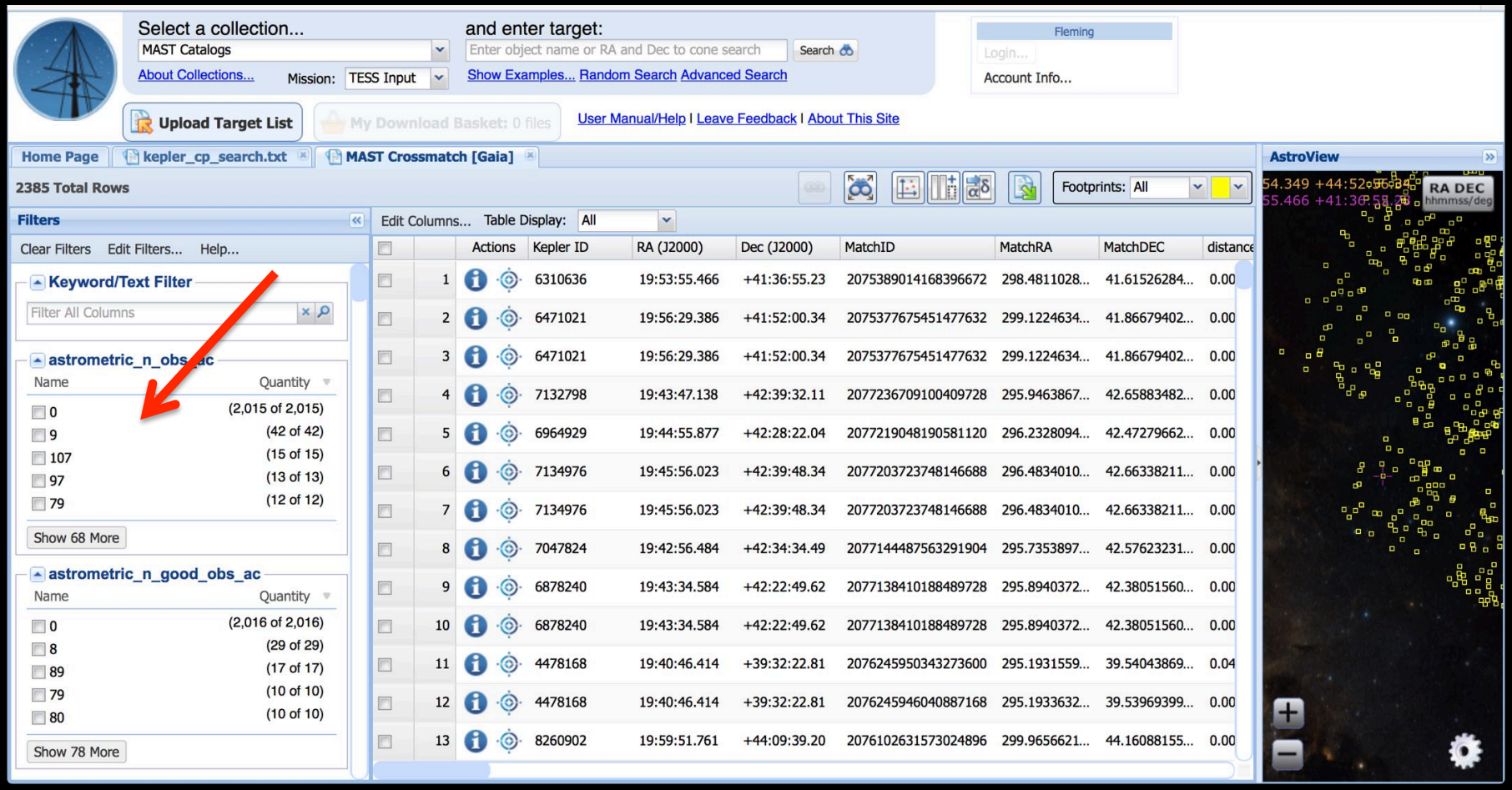
MAST Portal: Cross-Match



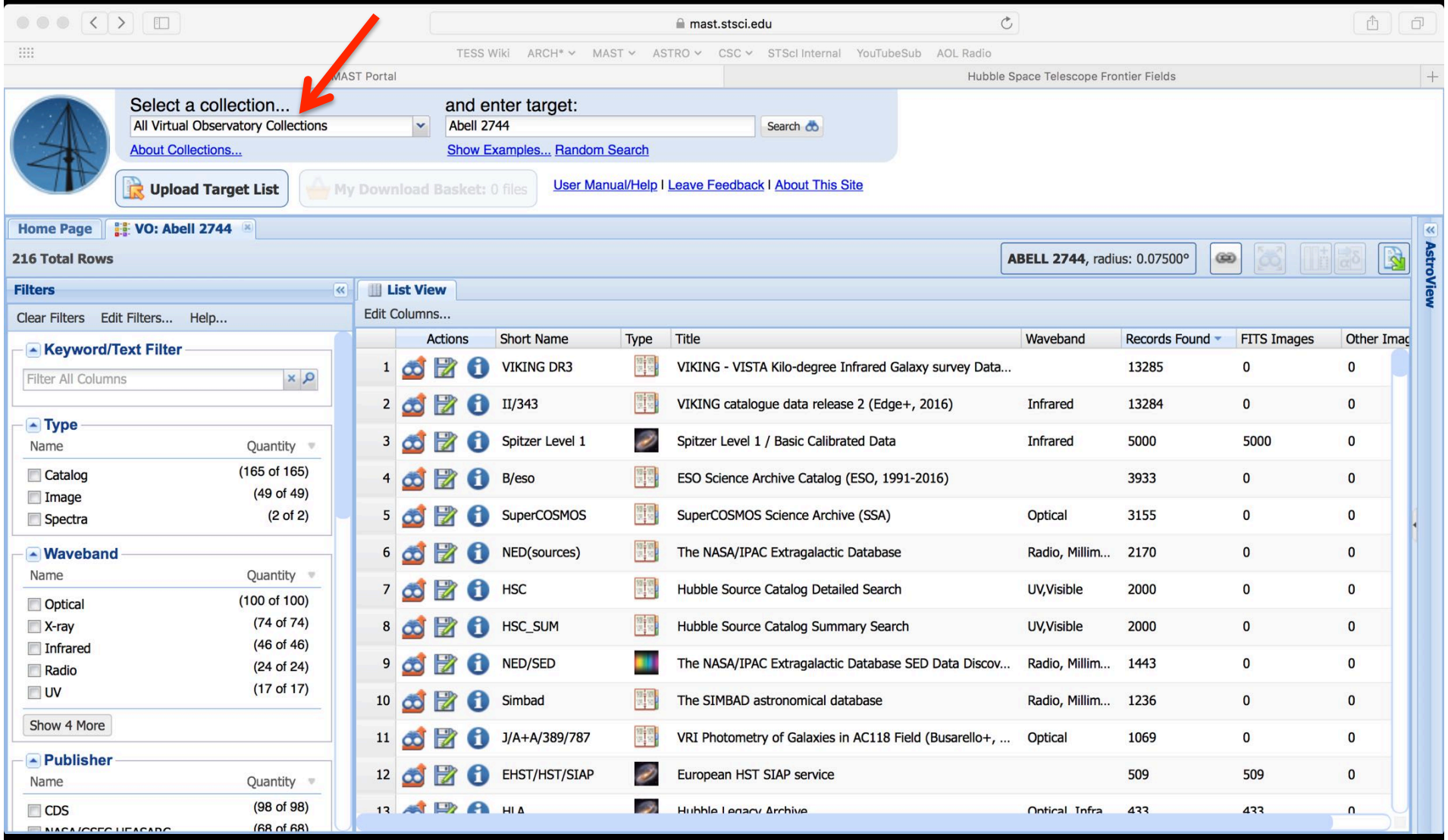
MAST Portal: Cross-Match



MAST Portal: Cross-Match



MAST Portal: Access to the Virtual Observatory



Enhancing Data Products: gPhoton

gPhoton: A 1.1 Trillion Row Database of GALEX Photon Events

GALEX Overview

- Launched 28 April 2003
- FUV + NUV (simultaneously)
- FUV = 1350-1750 Å
- Phot. (5-6” resolution)
- Microchannel Plate Detector

Retired 28 June 2013
1.2 deg. diameter FoV
NUV = 1750-2750 Å
Spec. (R ~ 100-250)
77% of the Sky at Diff. Depths

gPhoton

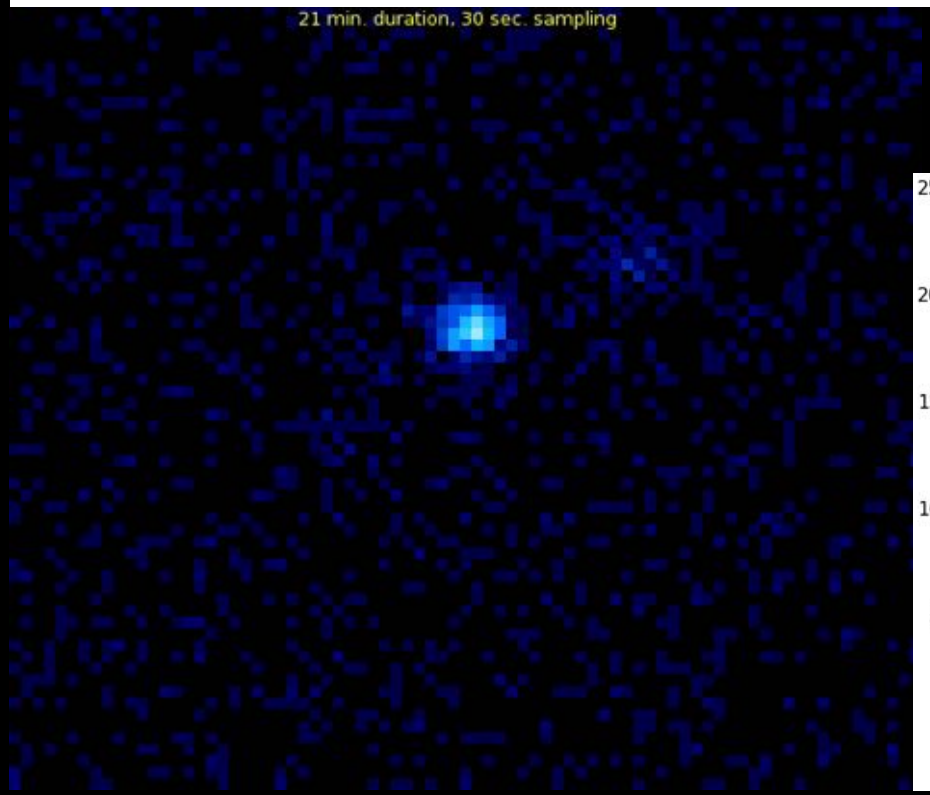
- Databse of 1.1 trillion photon events
- Open-source Python software: create cal. images and light curves
- Photon events meas. with 5 millisecond precision
- Light curves with few second sampling for any GALEX image

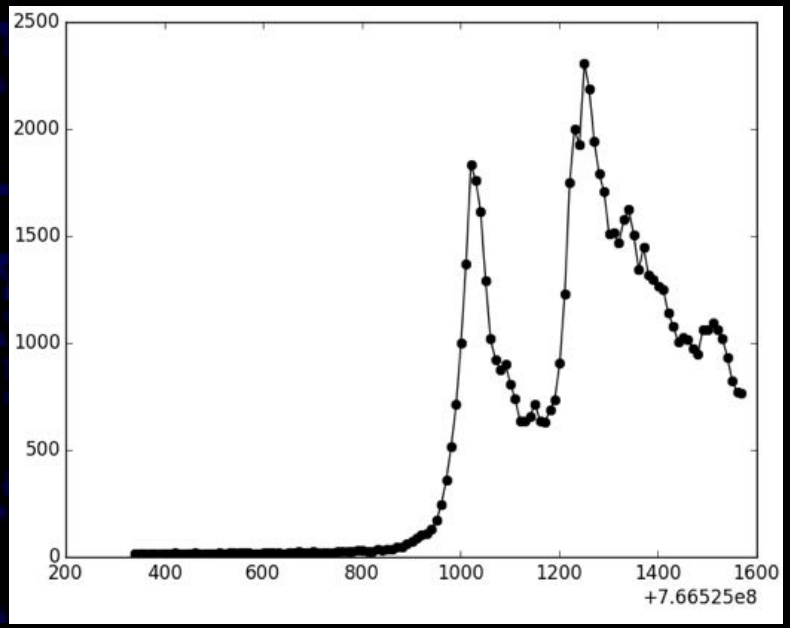
gPhoton page: https://archive.stsci.edu/prepds/gphoton/

Paper: Million, C; Fleming, S.W., Shiao, B., et al. 2016, *ApJ*, 833, 292

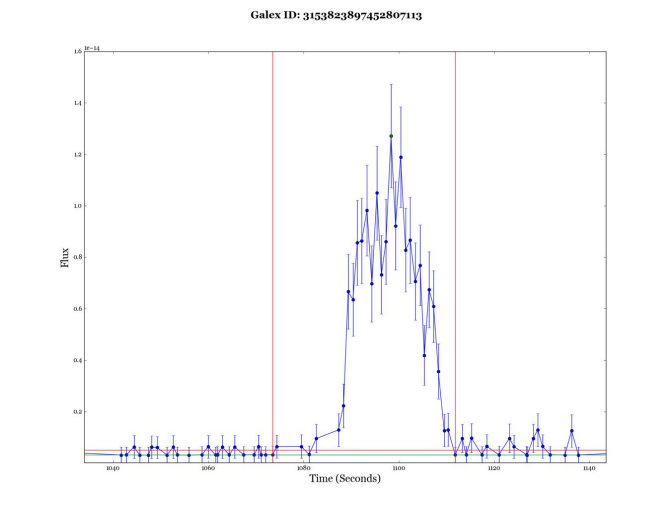
gPhoton Design Considerations

```
import gPhoton

def main():
    gPhoton.gMap(band='NUV', skypos=[176.91975, 0.25561], stepsz=30., skyrange=[0.0333,
0. 0333], cntfile='gj_3685a_movie.fits')

if __name__ == '__main__':
    main()
```

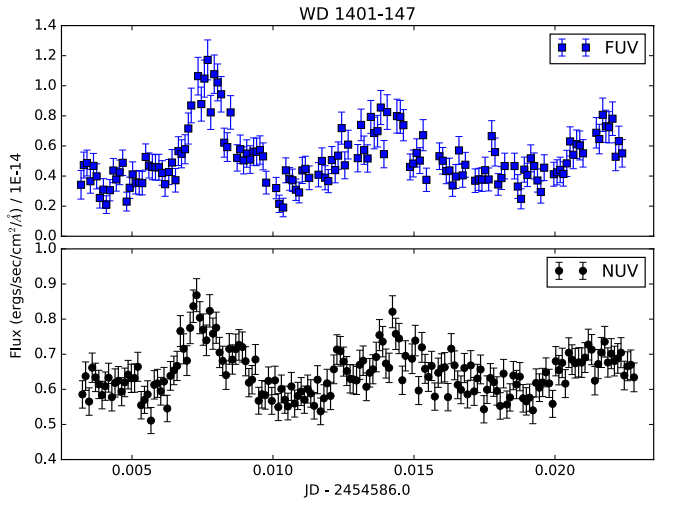




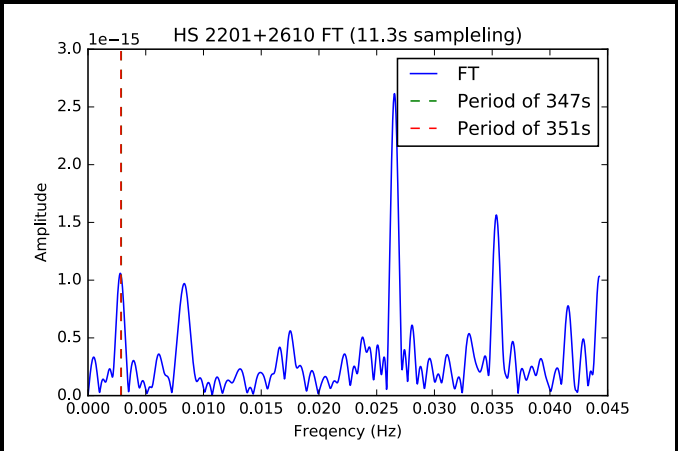
gPhoton – Early Science Examples



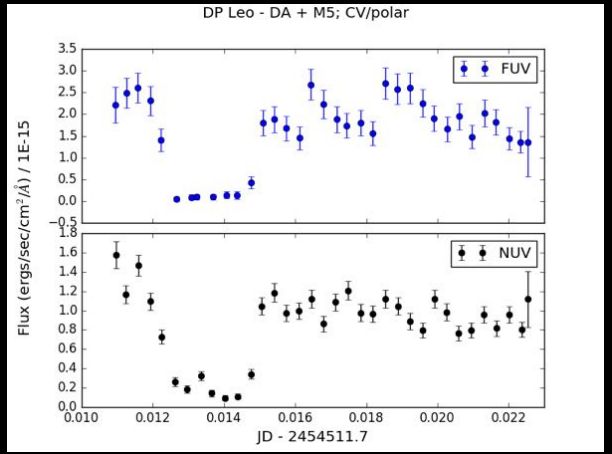
Stellar flares at low energies, w/ Rachel Osten and Clara Brasseur



White dwarf pulsations, with Michael Tucker (2015 REU)



sdB pulsation survey, with Thomas Boudreaux (2016 REU)



Eclipsing objects, including polars and WD exoplanets

Enhancing Data Products: Hubble Source Catalog

The Hubble Source Catalog (HSC)

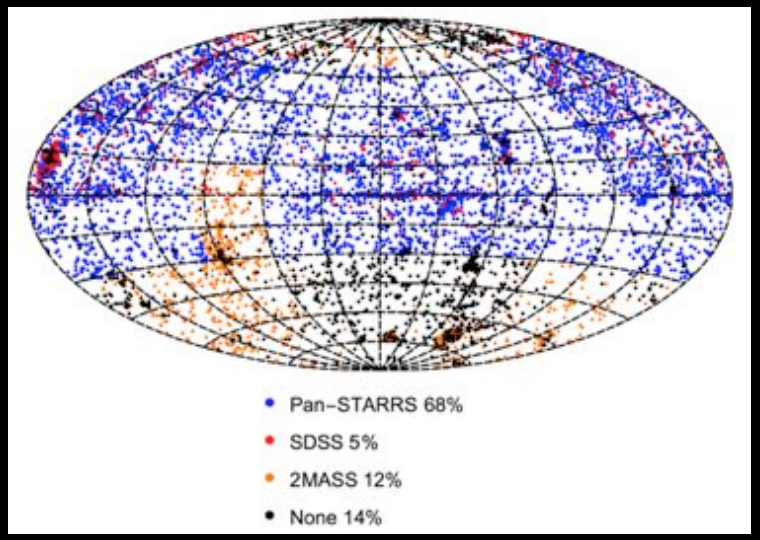
https://archive.stsci.edu/hst/hsc/

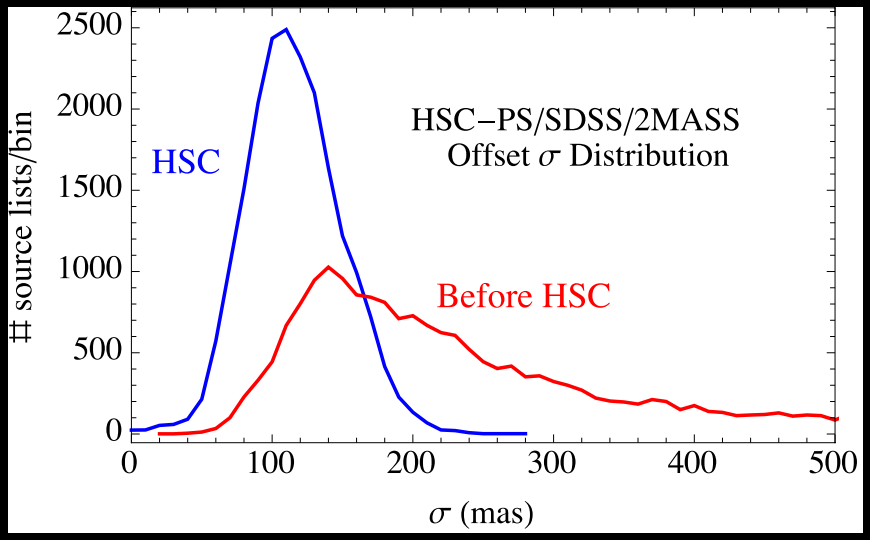
Paper: Whitmore, B.C, et al. 2016, *AJ*, 151, 134

1. Combines tens of thousands of SourceExtractor HLA source lists into a single master catalog. Uses matching algorithm from Budavari and Lubow 2012.

2. Includes WFPC2, ACS/WFC, and WFC3.

3. Absolute astrometry is good to ~100 mas (calibrated using PanSTARRS and 2MASS). This can eventually be improved to ~10 mas using Gaia observations).





HSC: Science Use Case

There are several Science Use Cases with step-by-step instructions and screen shots on the HSC webpage.

2. **Are there Use Cases available for the HSC?**

Yes. We have a variety of Use Cases:

HSC Use Case #1 - Using the Discovery Portal to Query the HSC - (Stellar Photometry in M31 - Brown et al. 2009)

HSC Use Case #2 - Using CASJOBS to Query the HSC - (Globular Clusters in M87 and a Color Magnitude Diagram for the SMC)

HSC Use Case #3 - Using the Discovery Portal to search for Variable Objects in the HSC - (Time Variability in the dwarf irregular galaxy IC 1613)

HSC Use Case #4 - Using the Discovery Portal to perform cross-matching between an input catalog and the HSC - (Search for the Supernova 2005cs progenitor in the galaxy M51)
NOTE: This use case was made using version 1. However, most of the changes are relatively minor, hence it is still quite useful.

HSC Use Case #5 - Using the Discovery Portal and CasJobs to search for Outlier Objects in the HSC - (White dwarfs in the Globular Cluster M4)

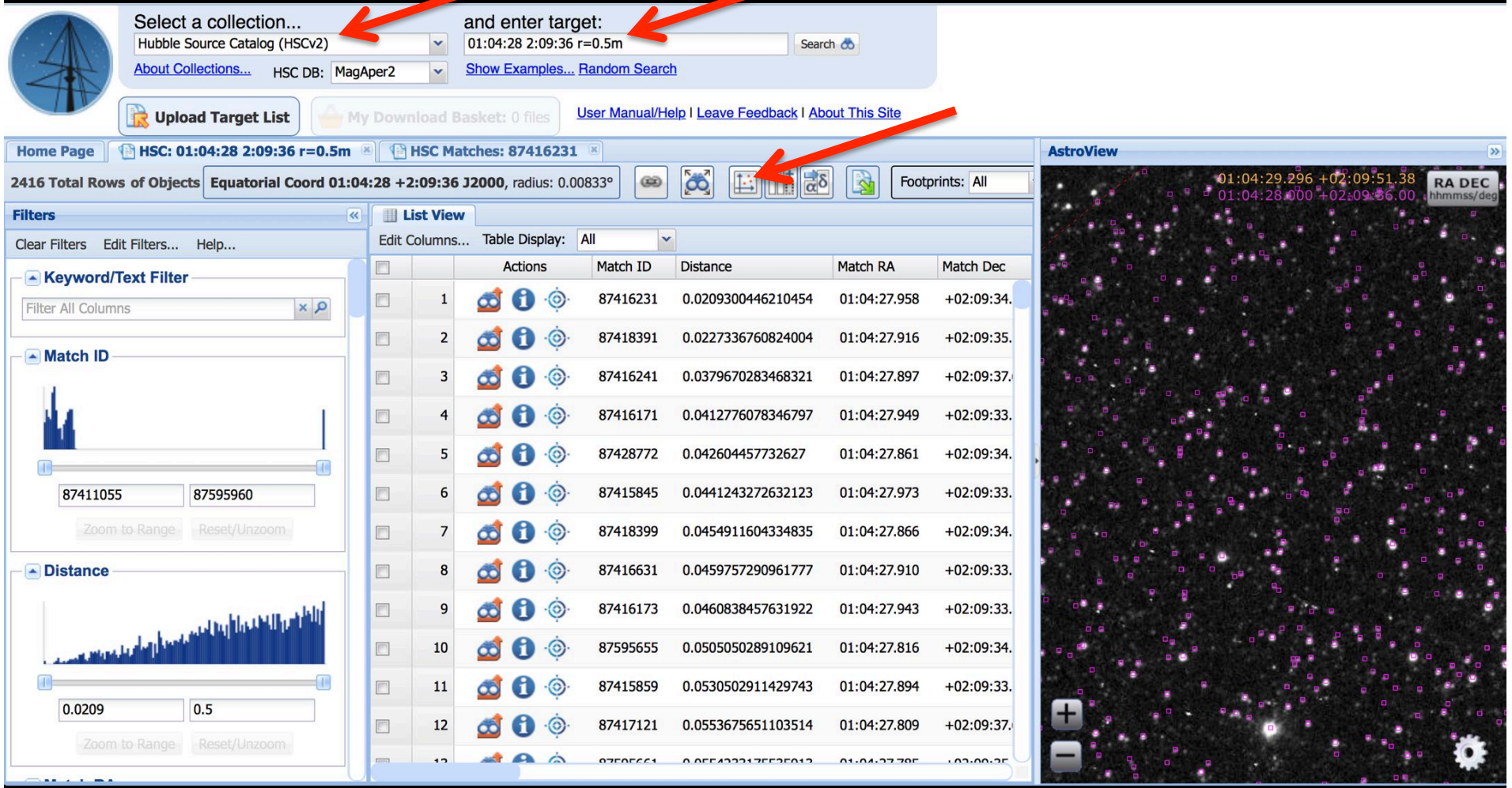
HSC Use Case #6 - Using the Discovery Portal to study the Red Sequence in a Galaxy Cluster - (The Red Sequence in the Galaxy Cluster Abell 2390)
NOTE: This use case was made using version 1. However, most of the changes are relatively minor, hence it is still quite useful.

HSC Use Case #7 - Comparing HSC "Sloan" filter magnitudes and SDSS magnitudes - (using the field around GRB110328A)<
NOTE: This use case was made using version 1. However, most of the changes are relatively minor, hence it is still quite useful.

HSC Use Case #8 - Combining HSC magnitudes and HST spectra to Investigate Objects in the HSC (using objects in the LMC Cluster R136)

HSC Use Case #9 - Searching for Objects with both HST Imaging and Spectroscopic Data

HSC: Science Use Case, Variables in IC 1613



HSC: Science Use Case, Variables in IC 1613

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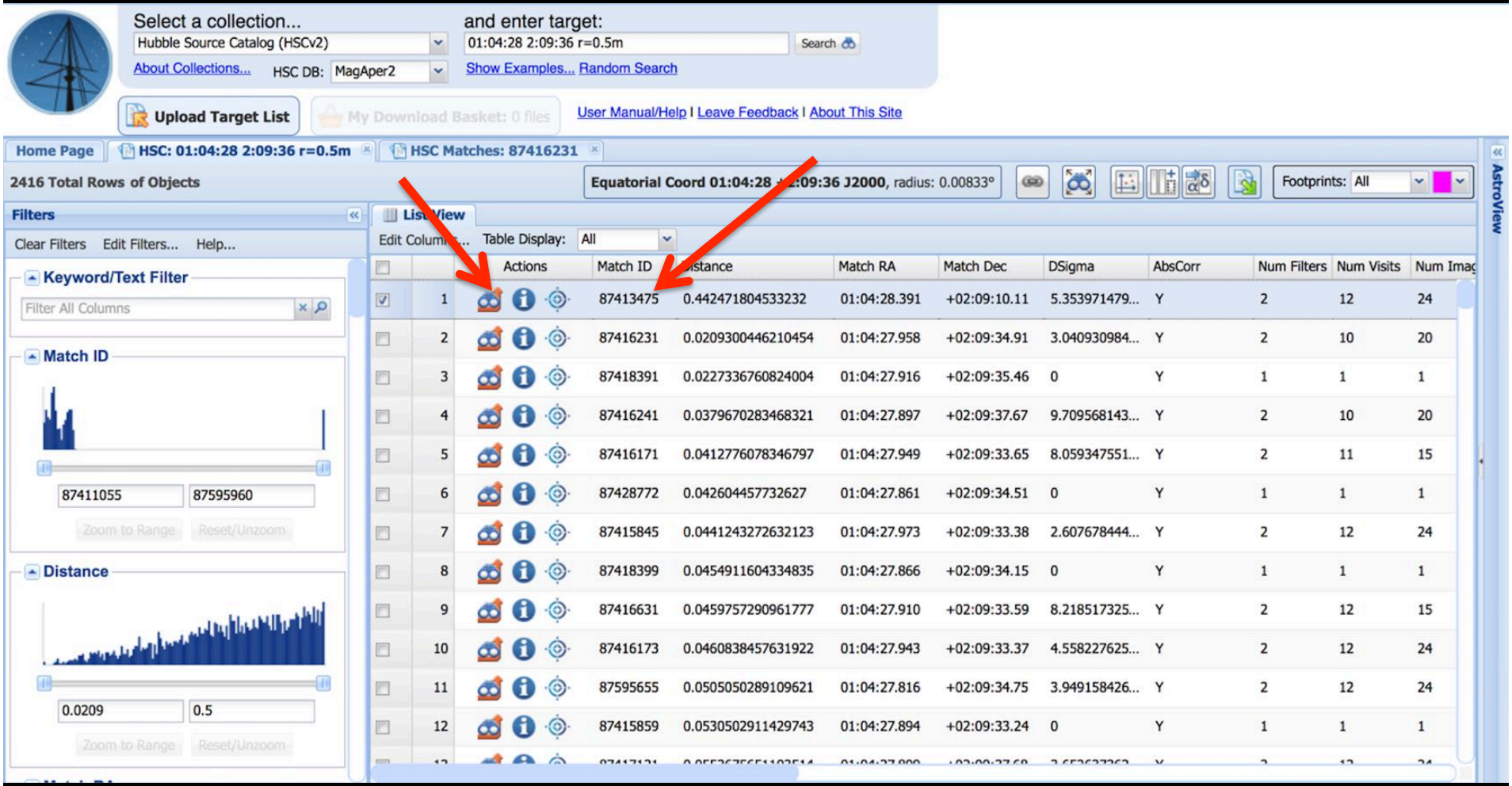
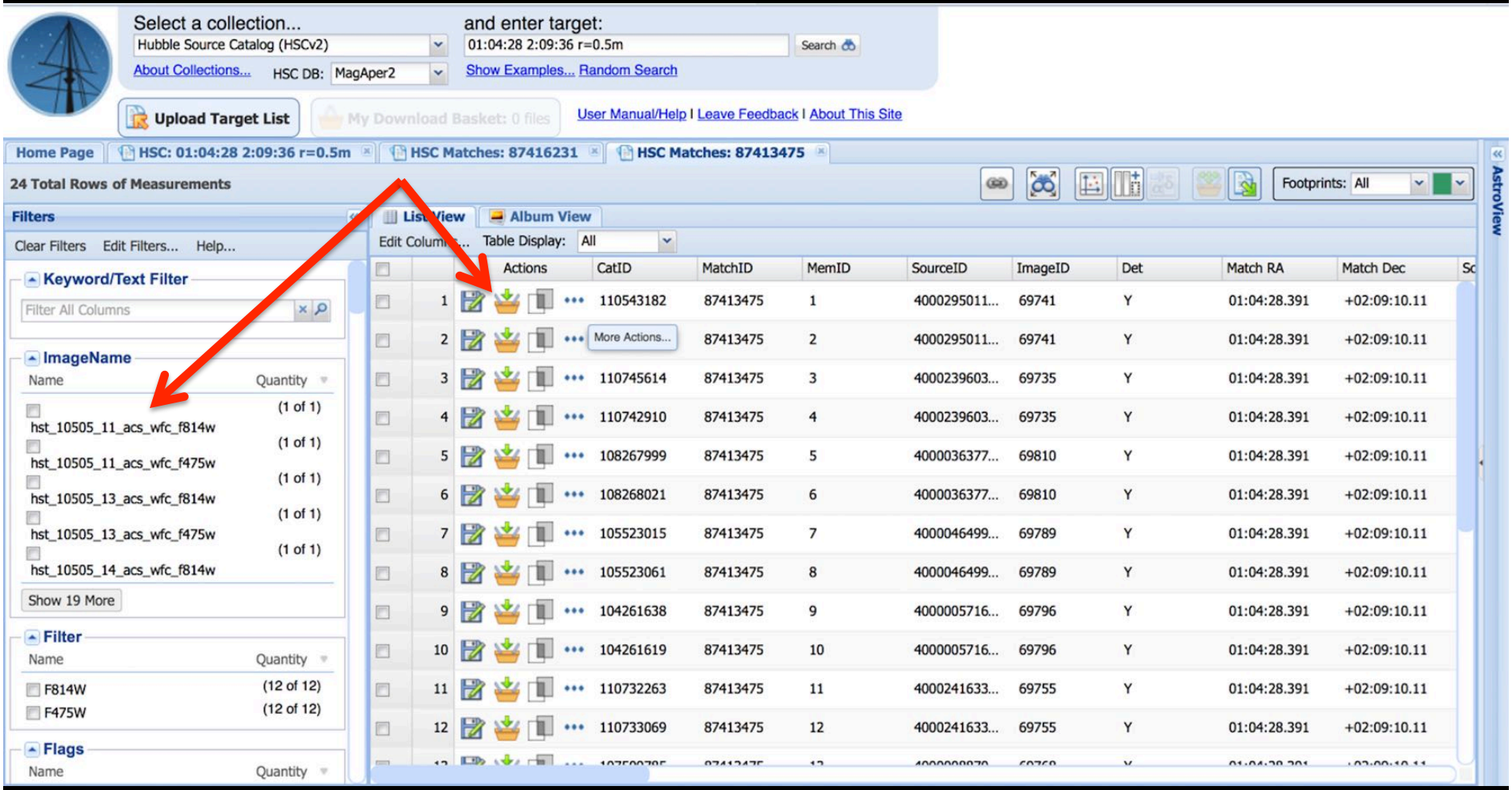
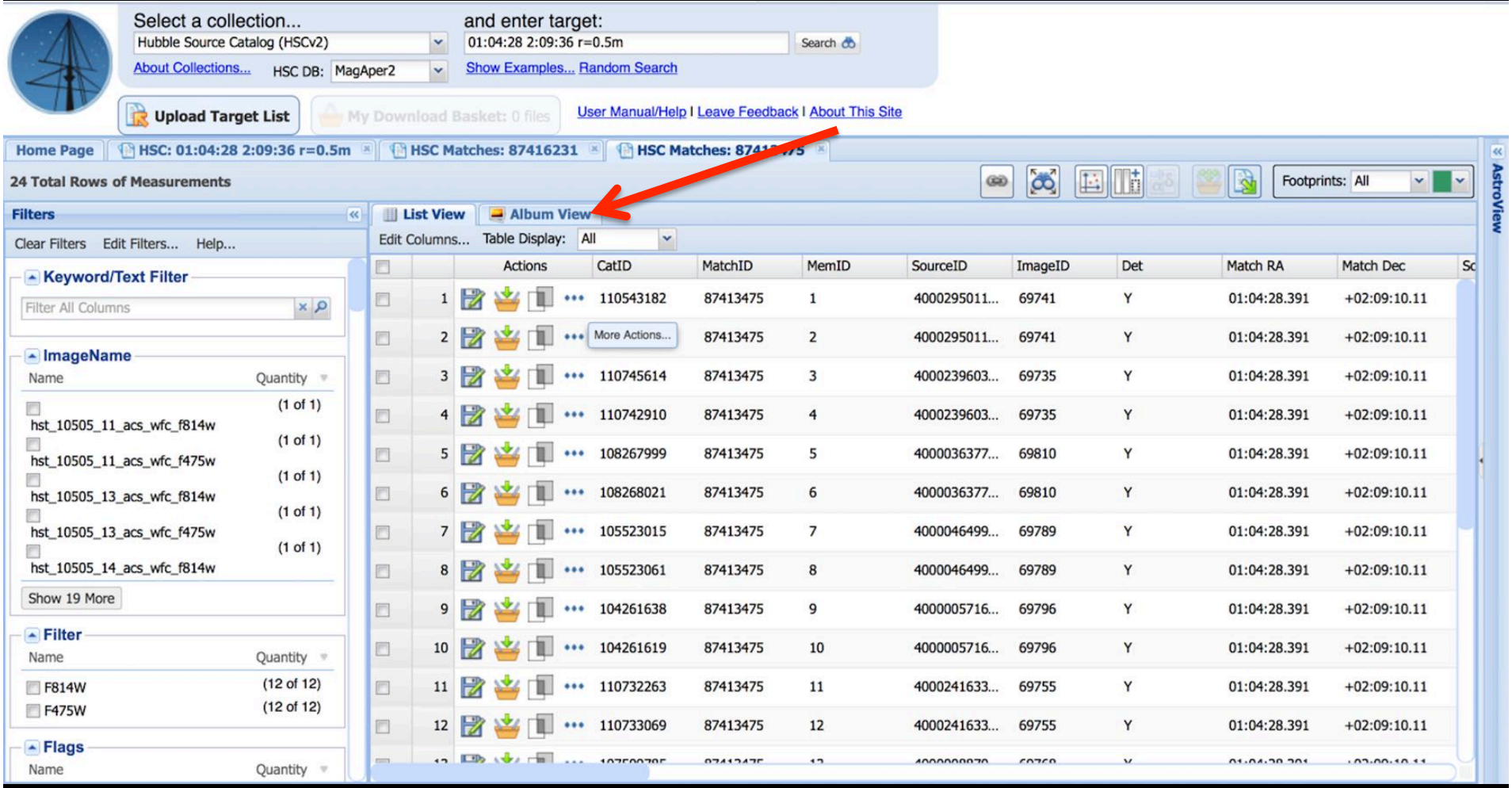


HSC: Science Use Case, Variables in IC 1613



HSC: Science Use Case, Variables in IC 1613



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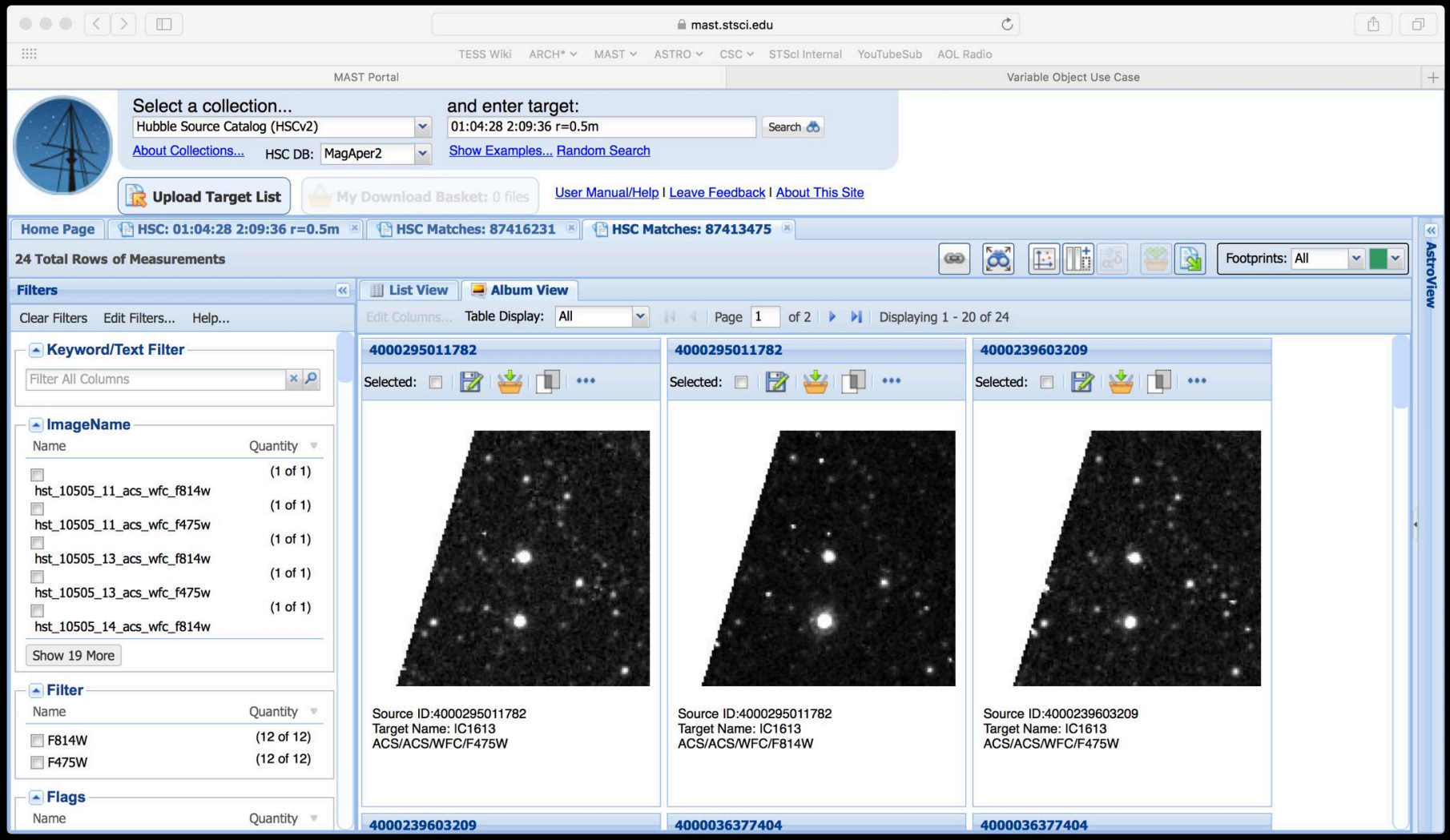

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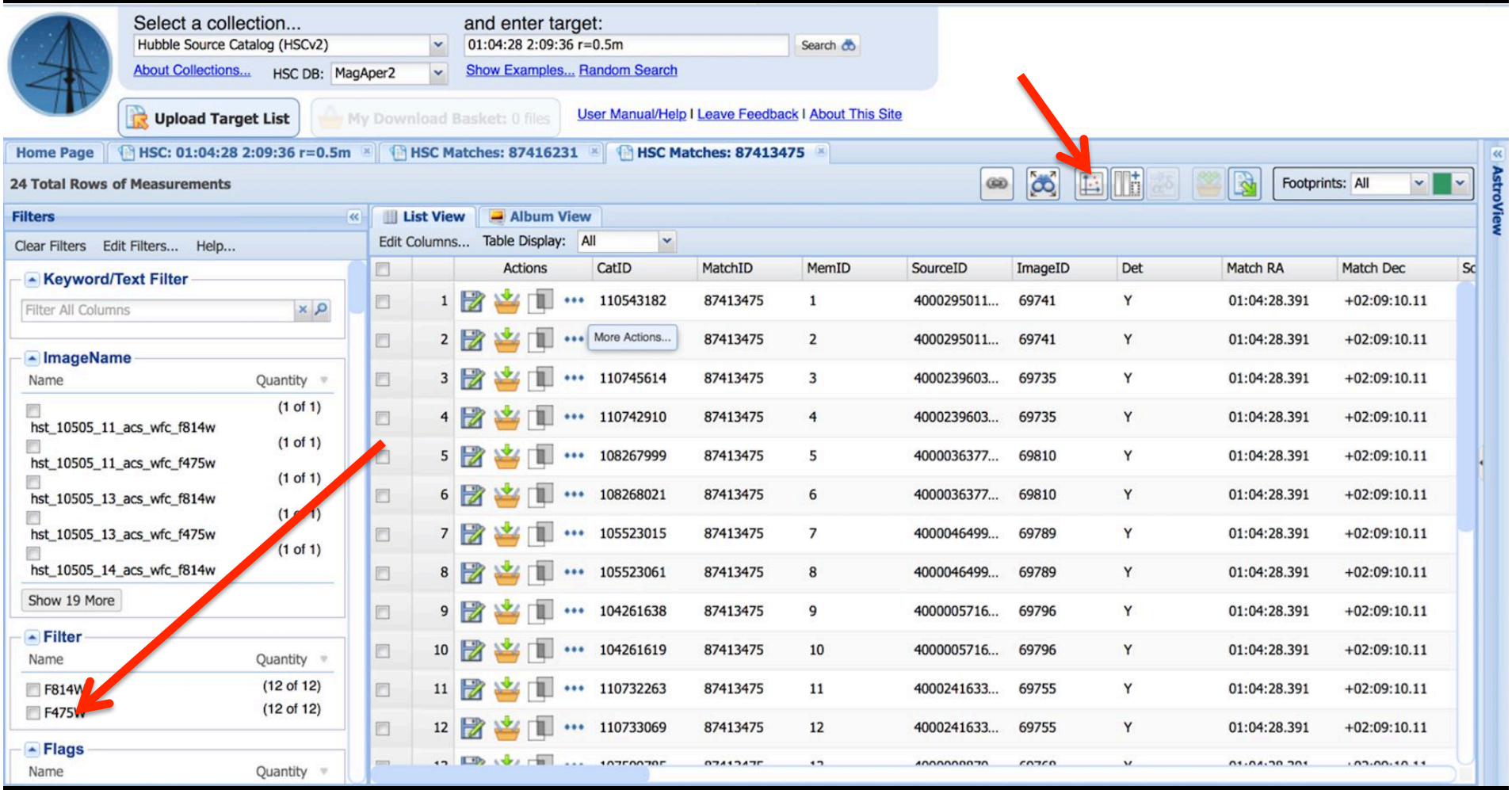

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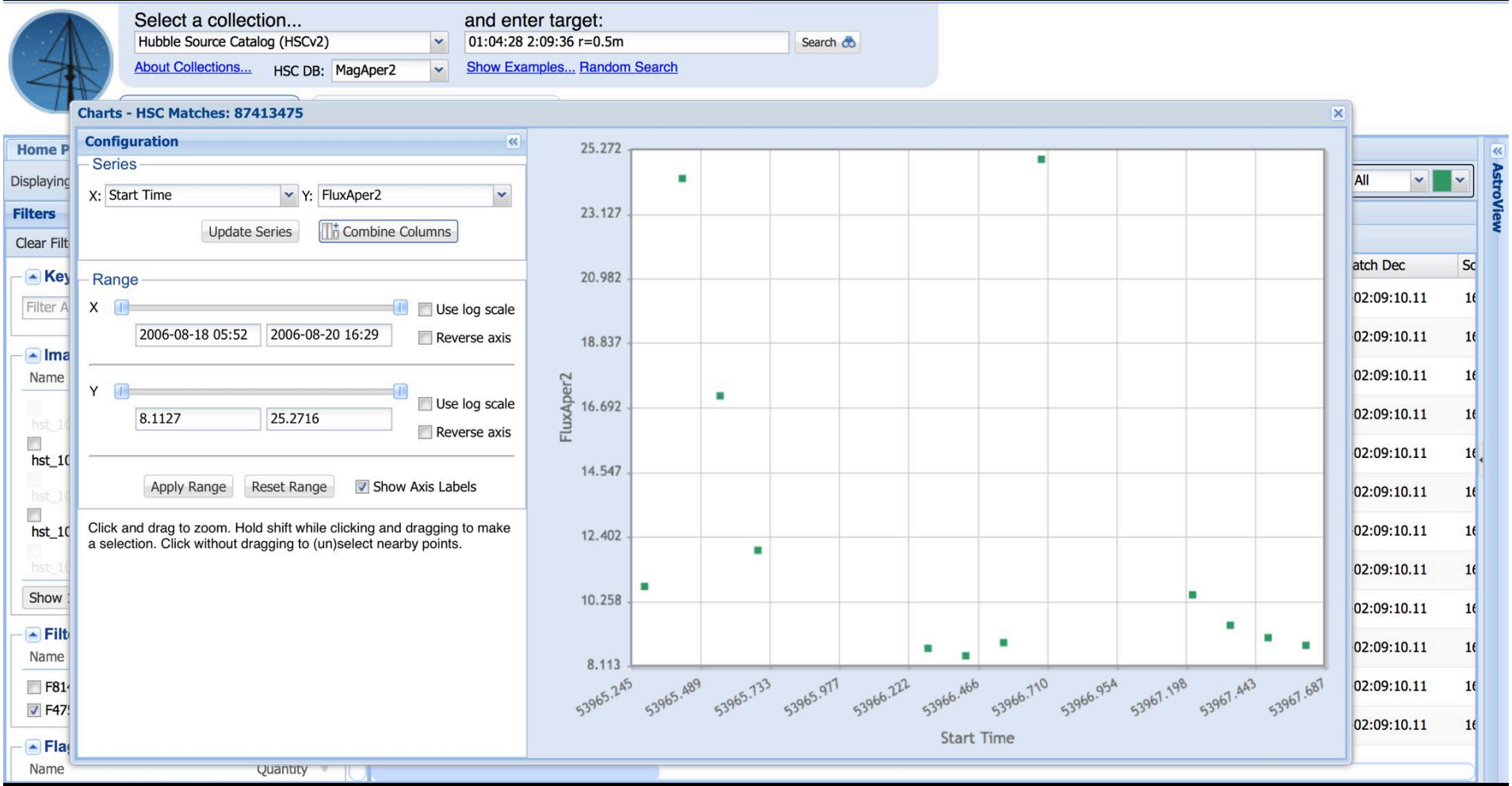

Summary

- MAST supports more than 20 missions: cross-mission discoverability is a key driver in our development efforts.
- The MAST Portal allows for searching across MAST missions and catalogs, the Virtual Observatory, and CDS catalogs.
- Beyond archving mission data, MAST also creates enhanced data products that enable new science. Recent examples are:
  - gPhoton: A time-tagged databse of 1.1 trillion GALEX photon events.
  - HSC: A master catalog of unique sources across all HST observations.
- Newly created STScI Data Mission Office, led by Arfon Smith, will begin to expand MAST capabilities into modern technological arenas, including cloud storage, “bring-code-to-the-data” environments, improved access to high performance computing resources, better support for API access to MAST resources.