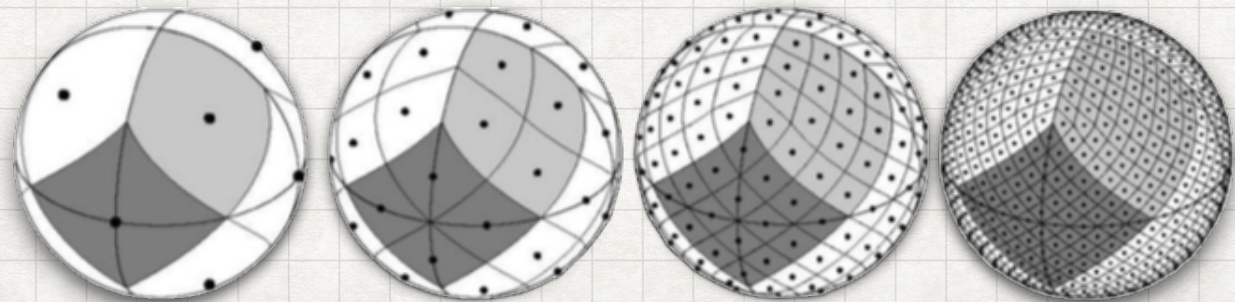


# Overview of Firefly's new HiPS support



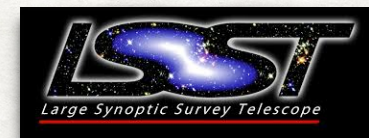
# IPAC & LSST

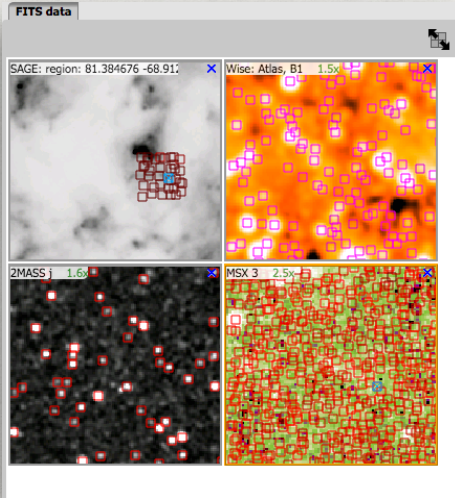
## Advancing astronomical UIs

- IPAC and LSST are collaborating to develop advanced data discovery and visualization user interfaces
- The IPAC archives and the planned LSST Science Platform are committed to the use of community standards for data access
- Areas of recent and future effort
  - Deployment of TAP services (see also Pevunova, DAL 1, Tuesday)
  - Use of CAOM2 for observational metadata
  - "Science Platform" facilities for user-driven server-side analysis
  - All-sky visualizations for data display and data discovery (this presentation)

# Introduction to Firefly

- Developed at IPAC for IRSA, LSST and NED
- Web based Archive Frontend Tool
- Data Visualization and Exploration
- In production for several years
- Actively developed, improved





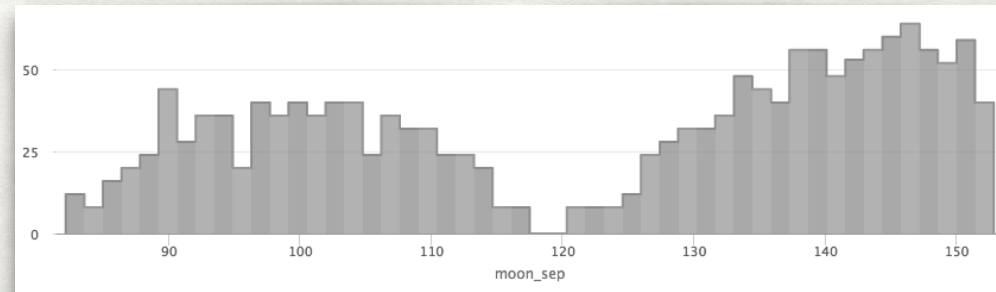
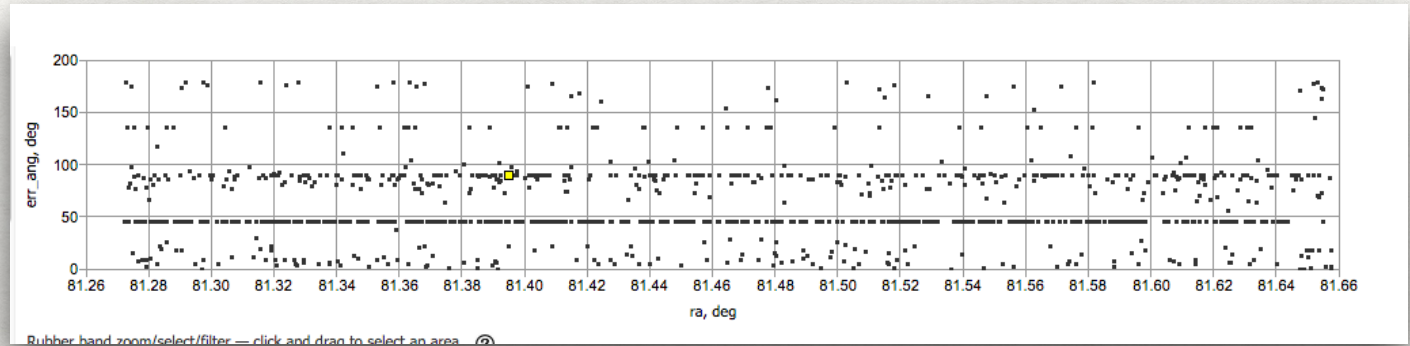
fp\_pscBox, X

9 of 21 (401 - 450 of 1015)

	ra (deg)	dec (deg)	clon	clat	err_maj (arcsec)	err_min (arcsec)	err_ang (deg)	designation	i_m (mag)	i_cmsig (mag)	i_msicon (mag)
<input type="checkbox"/>	81.279334	-68.919395	05h25m07.04s	-68d55m09.82s	0.14	0.13	2	05250704-6855098	16.027	0.089	0.089
<input type="checkbox"/>	81.370766	-68.836624	05h25m28.98s	-68d50m11.85s	0.18	0.16	13	05252898-6850118	13.504		
<input type="checkbox"/>	81.412929	-68.839584	05h25m39.10s	-68d50m22.50s	0.20	0.16	84	05253910-6850225	16.360	0.137	0.137
<input type="checkbox"/>	81.437965	-68.844025	05h25m45.11s	-68d50m38.49s	0.17	0.17	135	05254511-6850384	16.324	0.133	0.133
<input type="checkbox"/>	81.314225	-68.904945	05h25m15.41s	-68d54m17.80s	0.07	0.07	45	05251541-6854178	15.196	0.072	0.073
<input type="checkbox"/>	81.368899	-68.837242	05h25m28.54s	-68d50m14.07s	0.09	0.08	3	05252853-6850140	14.330	0.053	0.054
<input type="checkbox"/>	81.500049	-68.893616	05h26m00.01s	-68d53m37.02s	0.32	0.27	83	05260001-6853370	16.490	0.140	0.140
<input type="checkbox"/>	81.419247	-68.914131	05h25m40.62s	-68d54m50.87s	0.06	0.06	45	05254061-6854508	15.304	0.062	0.064
<input type="checkbox"/>	81.591179	-68.839294	05h26m21.88s	-68d50m21.46s	0.16	0.14	45	05262188-6850214	16.409	0.126	0.126
<input type="checkbox"/>	81.586821	-68.896202	05h26m20.84s	-68d53m46.33s	0.06	0.06	45	05262083-6853463	14.670	0.039	0.041
<input type="checkbox"/>	81.337872	-68.843903	05h25m21.09s	-68d50m38.05s	0.07	0.07	45	05252108-6850380	15.509	0.052	0.054
<input checked="" type="checkbox"/>	81.394806	-68.906075	05h25m34.75s	-68d54m21.87s	0.06	0.06	90	05253475-6854218	14.142	0.034	0.036
<input type="checkbox"/>	81.409027	-68.876686	05h25m38.17s	-68d52m36.07s	0.20	0.18	177	05253816-6852360	16.475	0.163	0.163
<input type="checkbox"/>	81.600449	-68.830826	05h26m24.11s	-68d49m50.97s	0.15	0.14	106	05262410-6849509	16.200	0.124	0.125
<input type="checkbox"/>	81.330078	-68.829193	05h25m19.22s	-68d49m45.09s	0.19	0.17	83	05251921-6849450	16.433	0.129	0.130
<input type="checkbox"/>	81.657667	-68.909805	05h26m37.84s	-68d54m35.30s	0.07	0.07	17	05263784-6854352	15.465	0.084	0.085
<input type="checkbox"/>	81.471096	-68.948822	05h25m53.06s	-68d56m55.76s	0.07	0.07	45	05255306-6856557	15.425	0.055	0.057
<input type="checkbox"/>	81.317534	-68.908012	05h25m16.21s	-68d54m28.84s	0.17	0.15	8	05251620-6854288	16.384	0.147	0.148
<input type="checkbox"/>	81.562626	-68.883179	05h26m15.03s	-68d52m59.44s	0.22	0.20	84	05261503-6852594	16.040	0.104	0.104
<input type="checkbox"/>	81.585997	-68.867485	05h26m20.64s	-68d52m02.95s	0.07	0.06	86	05262063-6852029	15.393	0.057	0.058

- WCS Readout
- Zoom
- Flip/ Rotate/ Crop
- Color / Stretch
- Grid
- Region
- Magnifier
- Distance tools
- Markers
- Fits Headers
- Crop

- Sort / Filter
- Column Controls
- Supports large tables, 10 Million+ rows
- Very fast response time
- brushing and linking



- Interactive
- Column math
- Zoom
- Filter



# Firefly Archive Visualization Library

## Code Overview

### Frontend

- JavaScript



- Modern JS

▸ ES6+, Modules



▸ NPM, Webpack



- React/Redux



*Frontend & Backend:*

*~110K Lines of code each*

*Open source on GitHub*



*<https://github.com/Caltech-IPAC/firefly>*

### Backend

- Java



- Tomcat



- Scalable

- Dockerized



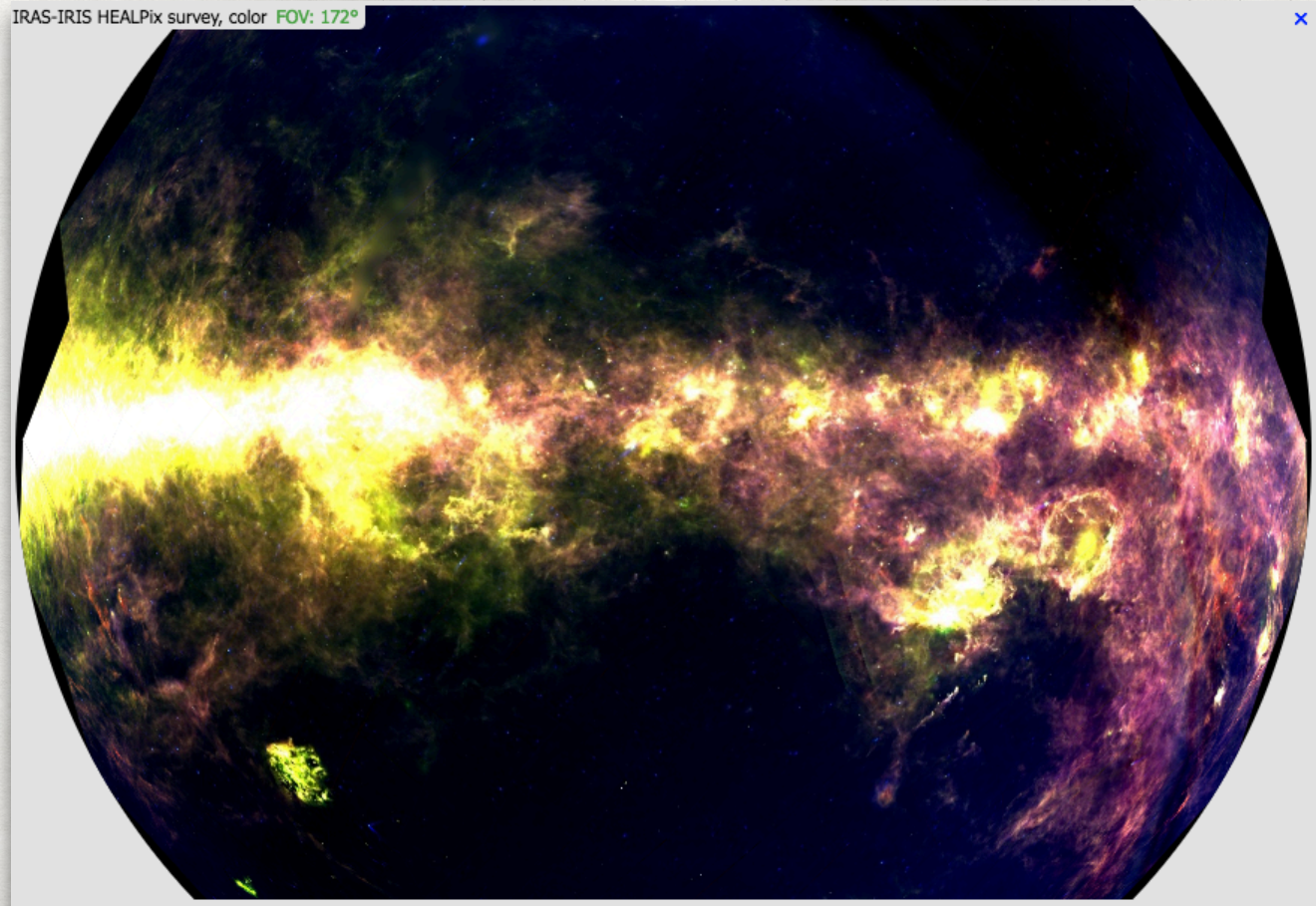
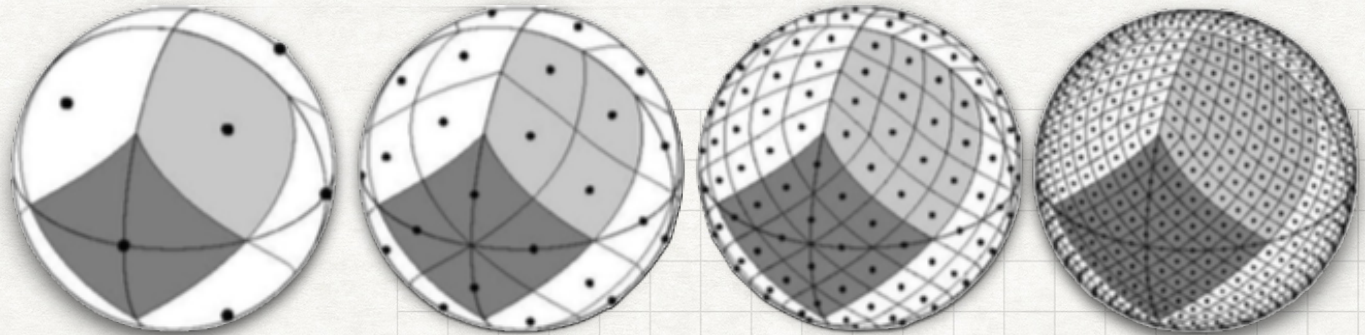
### Api

- JavaScript

- Python



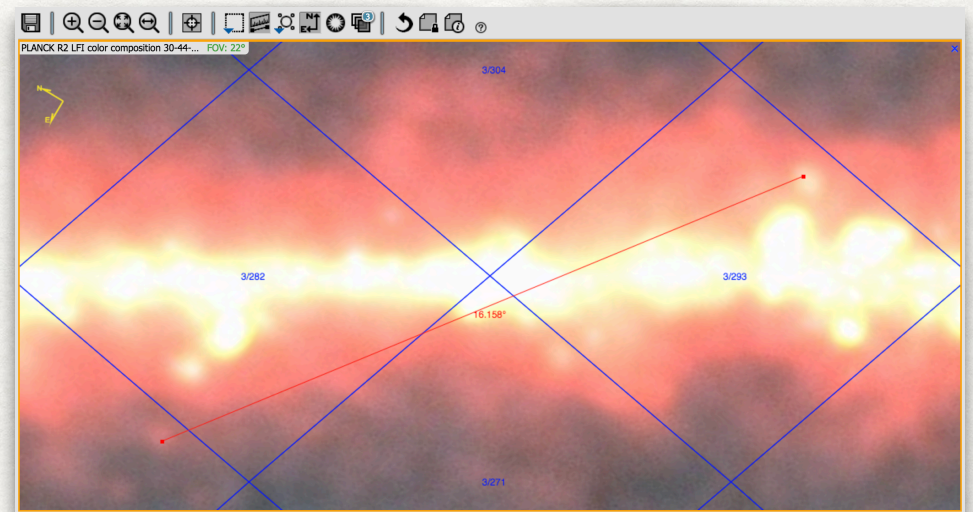
# Adding HiPS



Released  
May 2018

# Why HiPS Support

- Firefly already very good at focusing on a specific object
- The increasing importance of wide-area surveys demands new data presentations
  - Focus on the scientific content and avoid requiring the user to understand the subdivisions of the data up front
  - Allow users to put their regions / observations of interest in the context of data available from larger surveys
- HiPS is now a well-established standard in the community for all-sky data



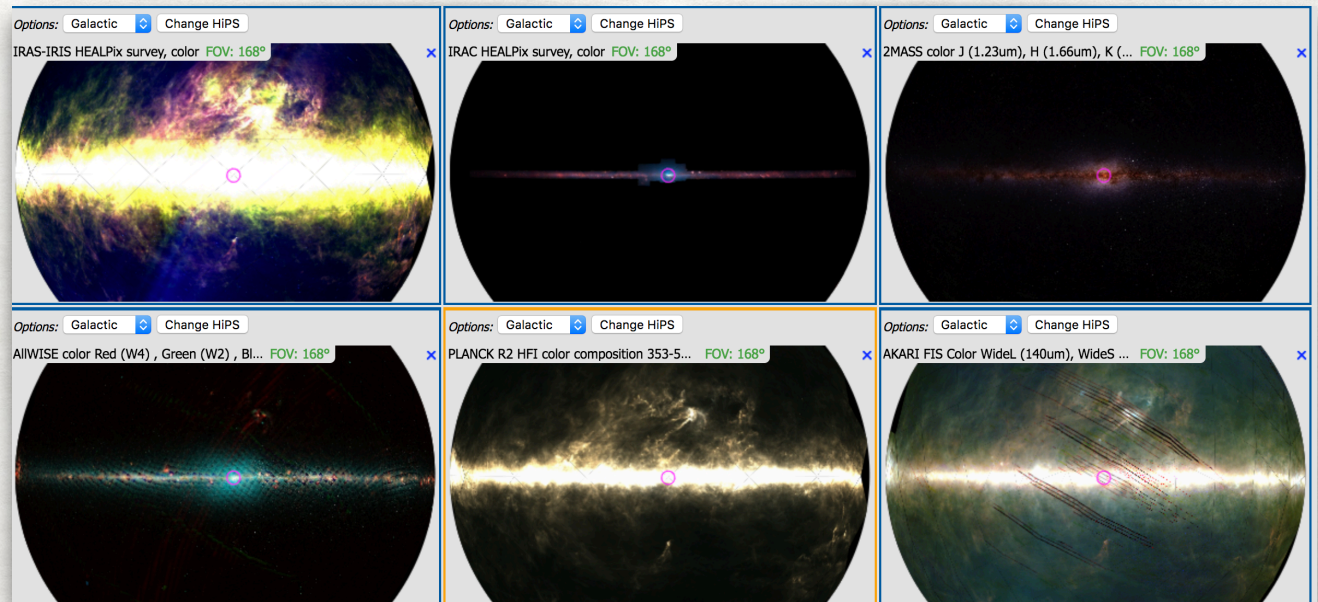


# Science / Functional HiPS Integration Goals

- Display a HiPS image map
  - Full support for panning, zooming, coordinate system changes
- HiPS images as full peers of FITS images in Firefly features
  - Make user experience as similar as possible
- Display multiple concurrent HiPS images
  - Simultaneous exploration in multiple bands
- Coordinated display of HiPS and FITS images
- Use HiPS images for data discovery
  - HiPS-to-FITS Zoom - Zoom in from a HiPS image to spatially related FITS images

# Technical HiPS Integration Goals

- Integrate very cleanly into the rest of the system
- Same look and feel
- Leverage features
  - Drawing
  - Layout
  - Tools
  - UI
  - Brushing and linking
- Preferred solution using React javascript framework

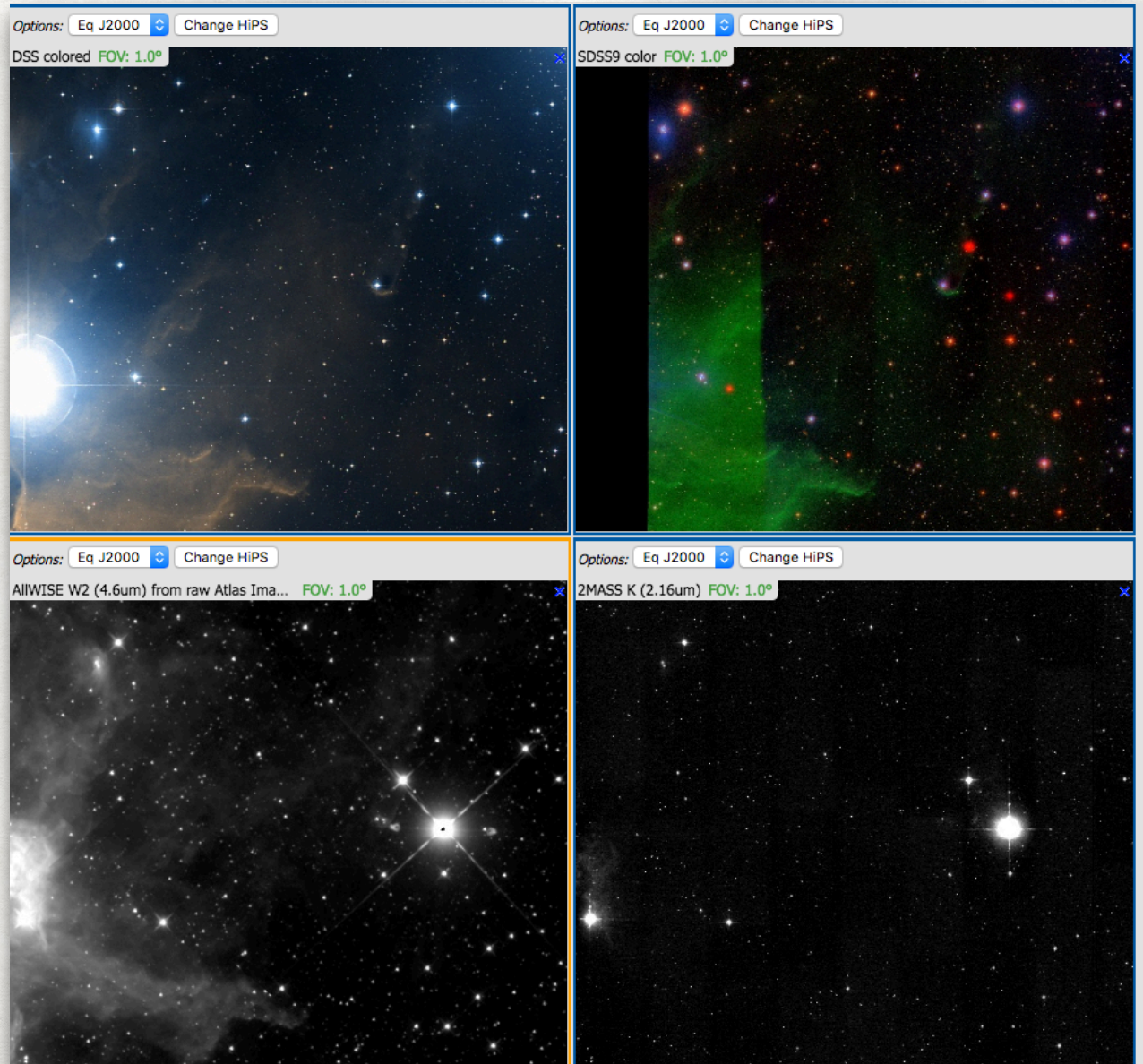


# Keys to HiPS Viewing Implementation

- Our existing visualization framework
  - Very familiar with web image rendering technology
  - Canvas, AffineTransform, etc
- High quality VO HiPS standard
  - HiPS very well defined
  - *HiPS – Hierarchical Progressive Survey - IVOA Recommendation*
- Aladin Lite code as reference implementation
- Thanks CDS!!!



# Firefly HiPS Demo



# Firefly HiPS Directions

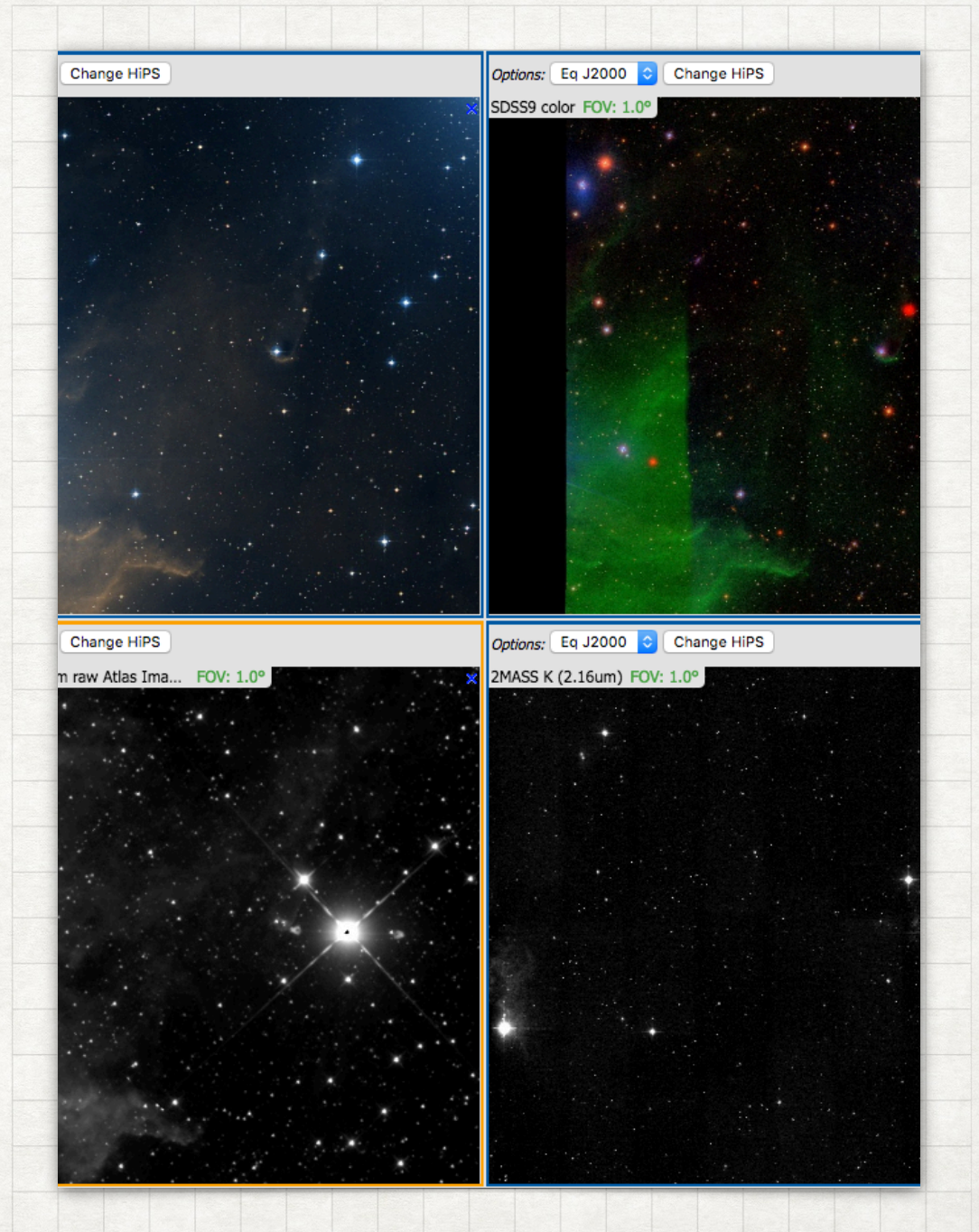
- Zoom depth to HiPS norder level 25 (*done*)
  - HealpixIndex.js updated to handle 53 bits in JavaScript
- HEALPix pixel readout and access (*done*)
- MOC (*in progress*)
- FITS Image Overlays
- Aitoff projection option
- HiPS catalogs
- Enhanced data discovery
  - Image collection explorer - show frames of multiple FITS images on a HiPS image
  - Use "HiPS progenitors" to link to specific source images (vs. spatial search)
  - HEALPixel selection and related-data search, HiPS catalog display, more...

# Exposing IRSA data using HiPS

## Ensuring "high quality"

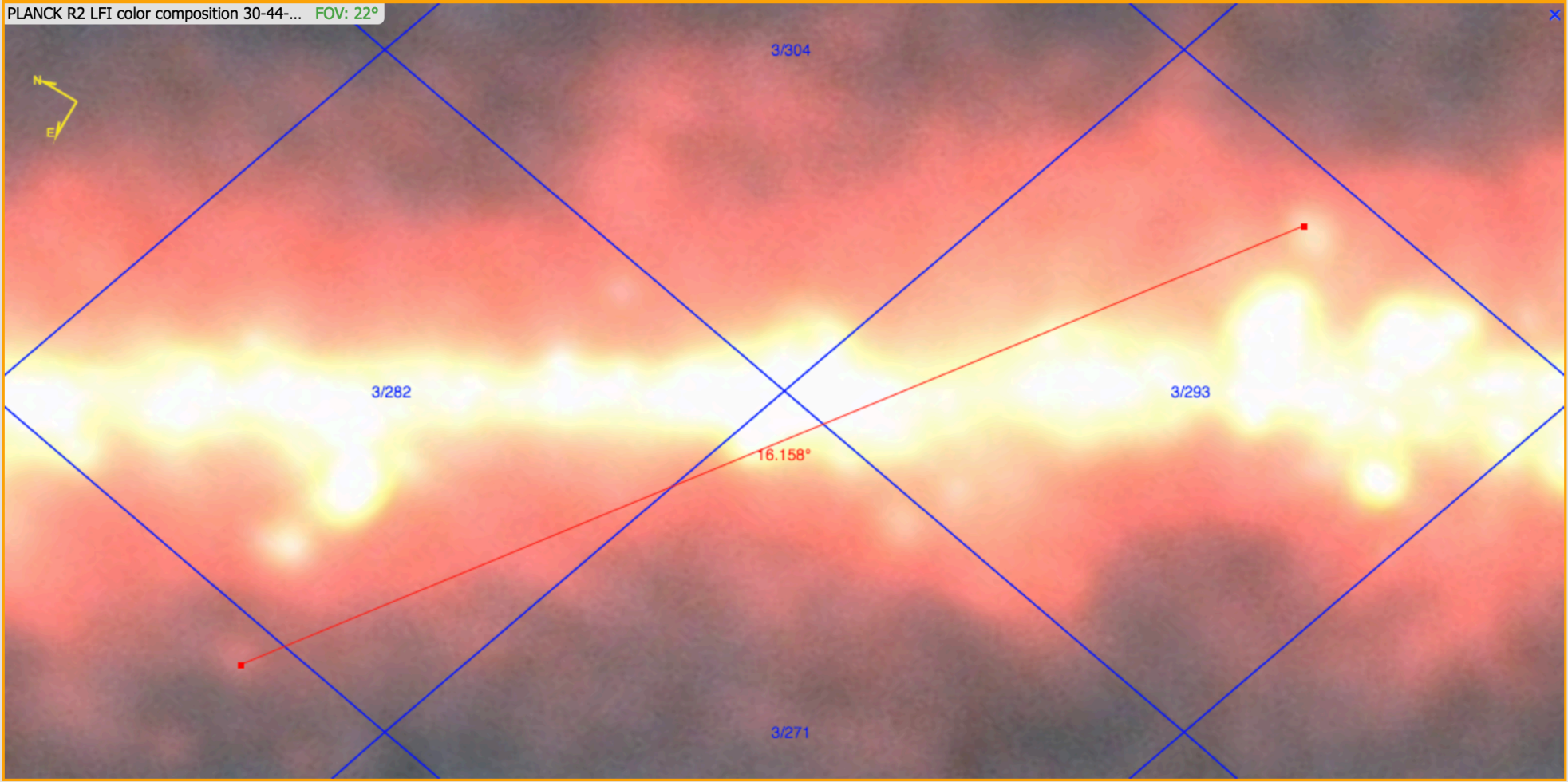
- Looking at generating new HiPS maps from a variety of IRSA-held datasets
  - Background matching between frames is difficult even with a uniform survey (e.g., WISE), especially in the Galactic Plane, where HiPS maps are especially useful.
  - The ideal stretch depends upon whether you are interested in point sources versus extended objects.
    - Multiple maps for a single data sets
    - Multiple colorizations?
    - Each optimized for a different use case
  - Because of the existence of many contributed products from a single mission and potentially multiple maps for a given product, accurate and useful metadata and **traceback to originating FITS images** is really important for users to be able to navigate the options. For example, there likely will not be a single "Spitzer" map.
  - Consider providing HiPS to resolution limit of each mission

# Appendix Demo Screenshots





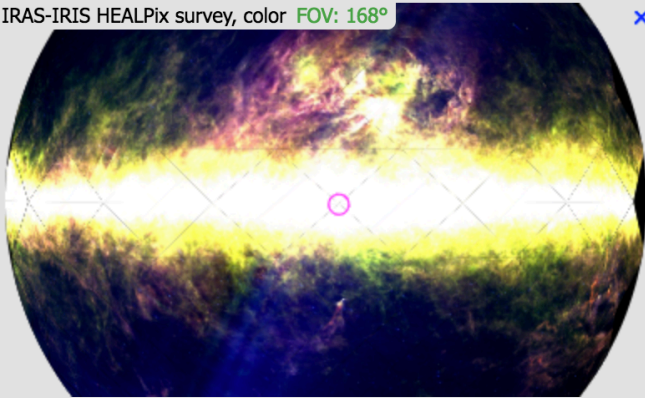
PLANCK R2 LFI color composition 30-44-... FOV: 22°





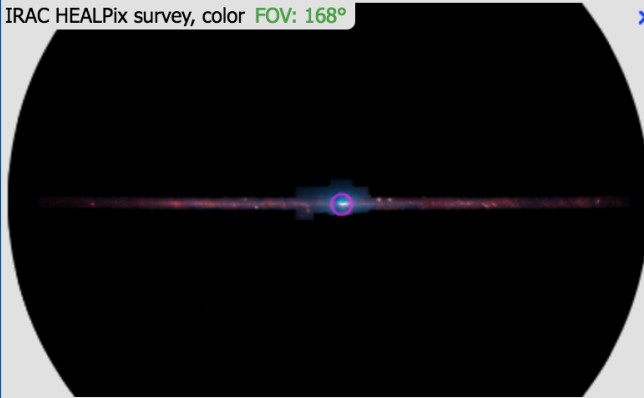
Options: Galactic

IRAS-IRIS HEALPix survey, color FOV: 168°



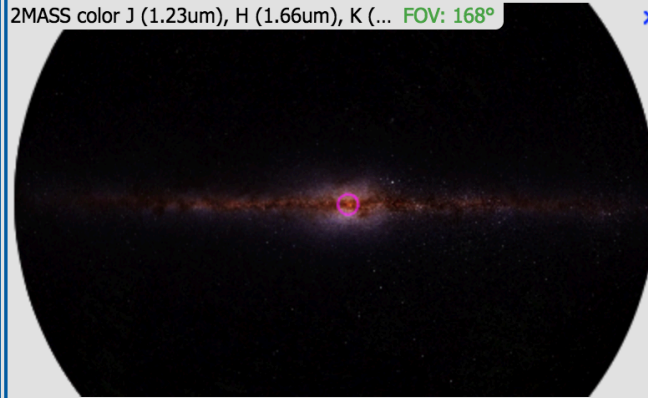
Options: Galactic

IRAC HEALPix survey, color FOV: 168°



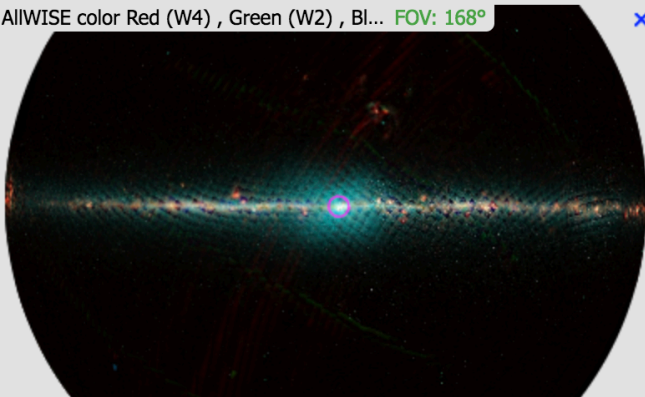
Options: Galactic

2MASS color J (1.23um), H (1.66um), K (... FOV: 168°



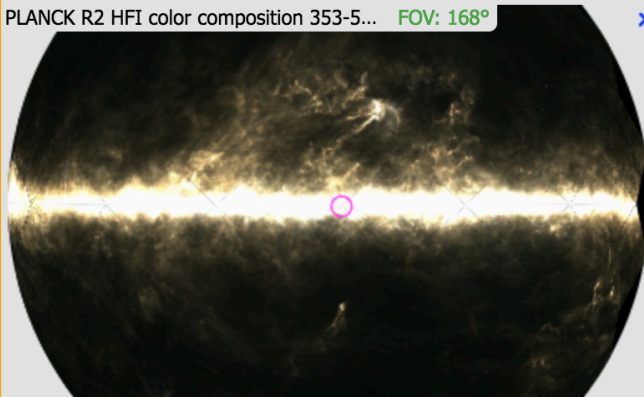
Options: Galactic

AllWISE color Red (W4), Green (W2), Bl... FOV: 168°



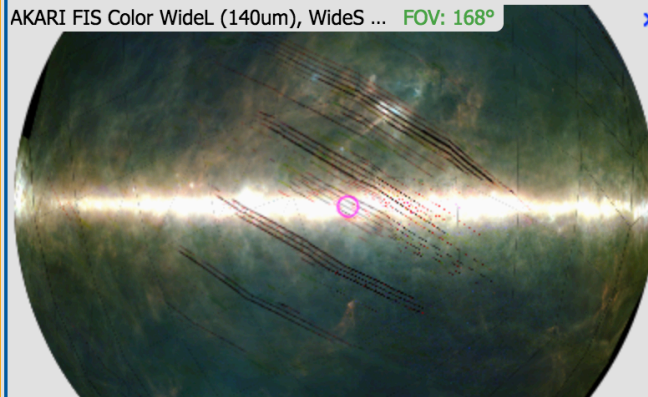
Options: Galactic

PLANCK R2 HFI color composition 353-5... FOV: 168°



Options: Galactic

AKARI FIS Color WideL (140um), WideS ... FOV: 168°



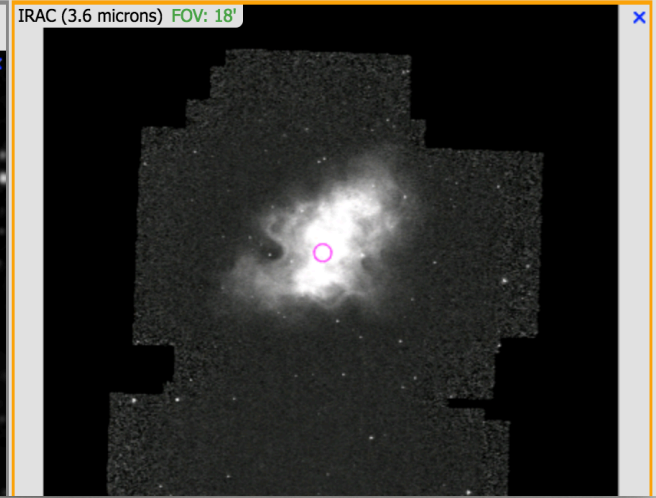
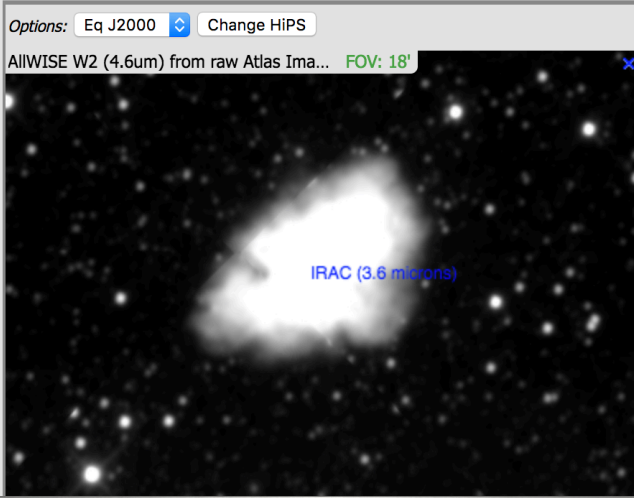
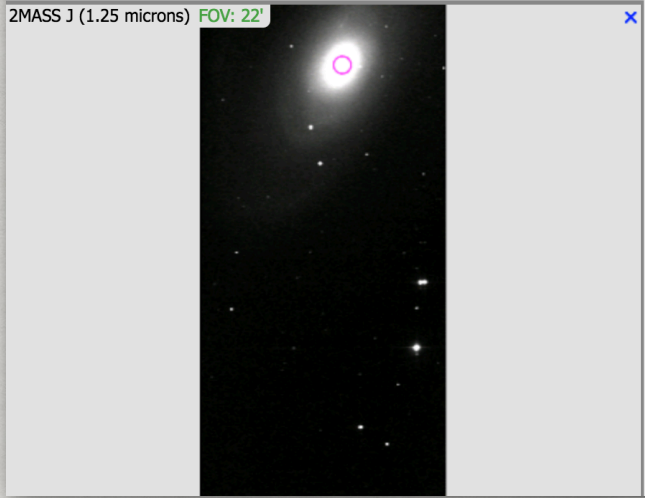
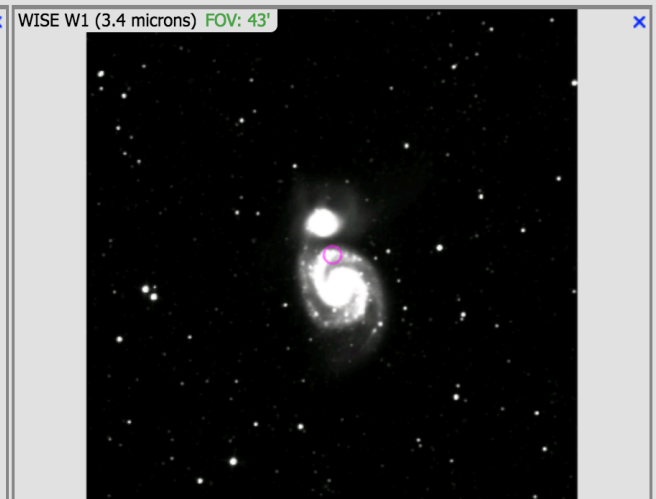
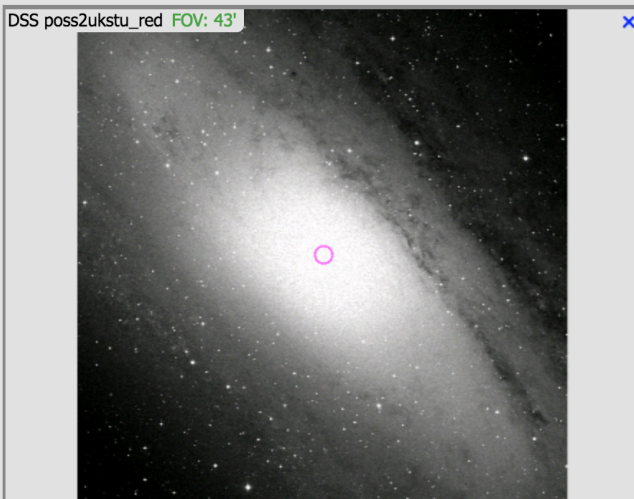
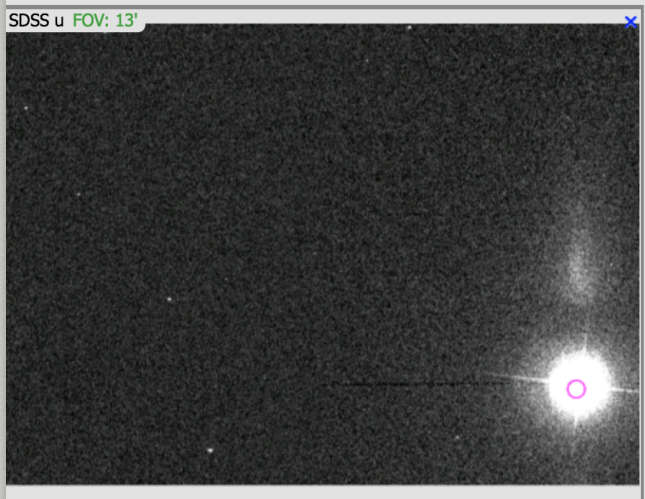


Tiled View



WCS Match  
 Target Match

Match Image to HiPS

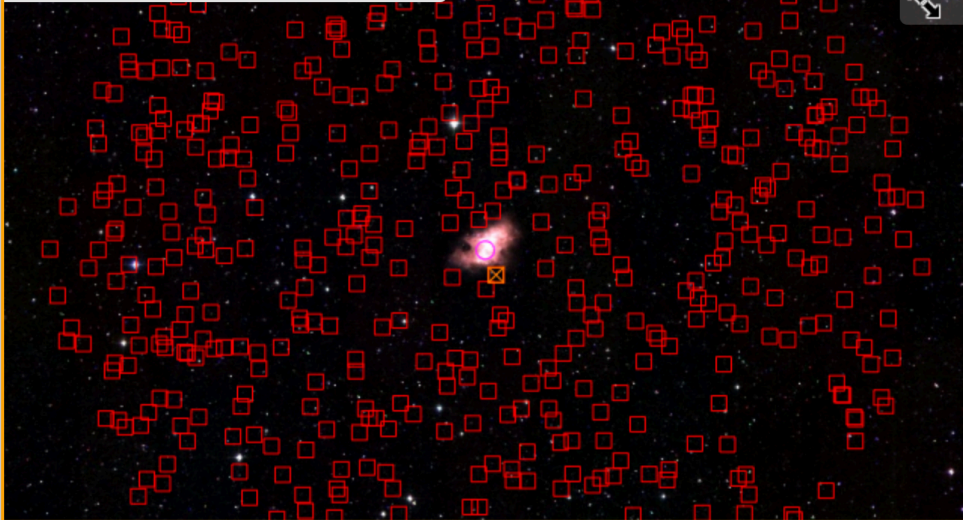




### Coverage

Options:  FITS  HiPS  Auto Eq J2000

2MASS color J (1.23um), H (1.66um), K (... FOV: 1.2°



### WISE-allwise\_p3as\_psd (Cone... x

1 of 7 (1 - 100 of 608)

<input type="checkbox"/>	designation	ra	dec	clon	clat	sigra	sigdec	sigrade
<input type="checkbox"/>	J053428.68+215900.0	83.6195100	21.9833357	05h34m28.68s	21d59m00.01s	0.0471	0.0491	0.0113
<input type="checkbox"/>	J053434.35+220313.6	83.6431549	22.0537997	05h34m34.36s	22d03m13.68s	0.0480	0.0497	-0.0042
<input type="checkbox"/>	J053431.96+215754.6	83.6331876	21.9651840	05h34m31.97s	21d57m54.66s	0.0614	0.0613	-0.0072
<input type="checkbox"/>	J053429.80+220352.6	83.6241969	22.0646147	05h34m29.81s	22d03m52.61s	0.0561	0.0572	-0.0086
<input type="checkbox"/>	J053443.05+215848.1	83.6794006	21.9800480	05h34m43.06s	21d58m48.17s	0.0508	0.0512	-0.0034
<input type="checkbox"/>	J053443.77+220258.3	83.6823987	22.0495488	05h34m43.78s	22d02m58.38s	0.0580	0.0583	-0.0107
<input type="checkbox"/>	J053438.70+220442.8	83.6612598	22.0785831	05h34m38.70s	22d04m42.90s	0.0606	0.0625	-0.0065
<input type="checkbox"/>	J053413.84+220302.7	83.5576931	22.0507660	05h34m13.85s	22d03m02.76s	0.0633	0.0642	-0.0057
<input type="checkbox"/>	J053412.33+215928.8	83.5513991	21.9913547	05h34m12.34s	21d59m28.88s	0.0589	0.0607	-0.0063
<input type="checkbox"/>	J053426.26+220528.4	83.6094307	22.0912433	05h34m26.26s	22d05m28.48s	0.0575	0.0589	-0.0081
<input type="checkbox"/>	J053427.30+215556.7	83.6137533	21.9324342	05h34m27.30s	21d55m56.76s	0.0610	0.0593	-0.0111
<input type="checkbox"/>	J053442.77+220539.6	83.6782100	22.0943468	05h34m42.77s	22d05m39.65s	0.0592	0.0601	-0.0083
<input type="checkbox"/>	J053425.38+215530.0	83.6057703	21.9250134	05h34m25.38s	21d55m30.05s	0.0651	0.0642	-0.0136
<input type="checkbox"/>	J053421.57+220610.1	83.5898954	22.1028330	05h34m21.57s	22d06m10.20s	0.0610	0.0629	-0.0030
<input type="checkbox"/>	J053421.89+220616.5	83.5912404	22.1045954	05h34m21.90s	22d06m16.54s	0.0683	0.0685	-0.0122
<input type="checkbox"/>	J053428.04+215456.4	83.6168371	21.9156877	05h34m28.04s	21d54m56.48s	0.0598	0.0576	-0.0116
<input type="checkbox"/>	J053406.04+220117.5	83.5252068	22.0215432	05h34m06.05s	22d01m17.56s	0.0600	0.0588	-0.0073
<input type="checkbox"/>	J053439.99+220700.5	83.6666269	22.1168254	05h34m39.99s	22d07m00.57s	0.0616	0.0623	-0.0117

w2mpro (mag)

