Creating High Quality All-sky Visualizations Of Astronomy Image Data Sets: HiPS And Montage

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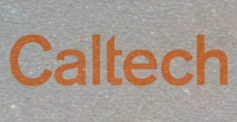
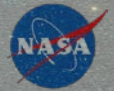


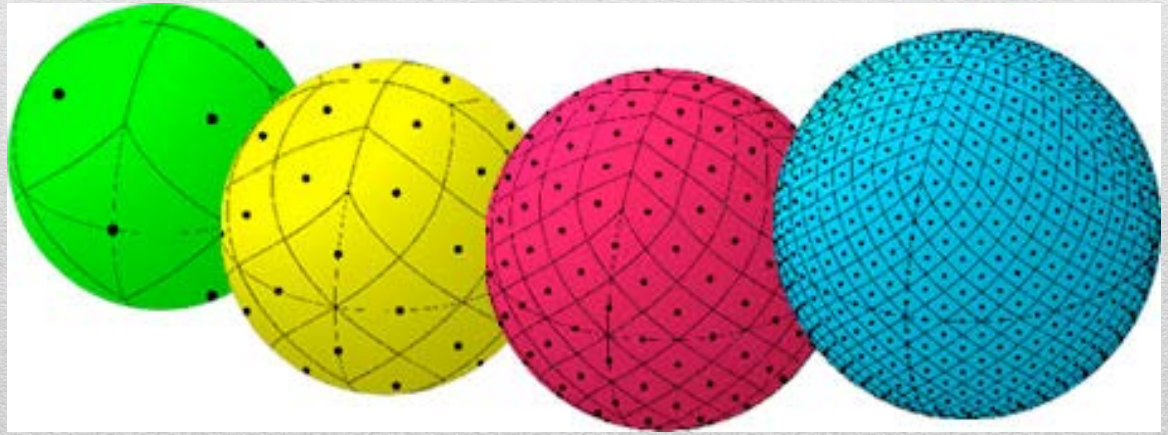


Hierarchical Progressive Survey – HiPS

- Pioneered at CDS.
- Progressively higher spatial sampling of images as you zoom in.
- Recommended VO Standard.
  - http://www.ivoa.net/documents/HiPS/20170406/PR-HIPS-1.0-20170406.pdf

HiPS Is Based on HEALPix

- **H**ierarchical **E**qual **A**rea iso**L**atitude **Pix**elation of a Sphere.
- **Subdivision of a spherical surface** in which each pixel has the same surface area.



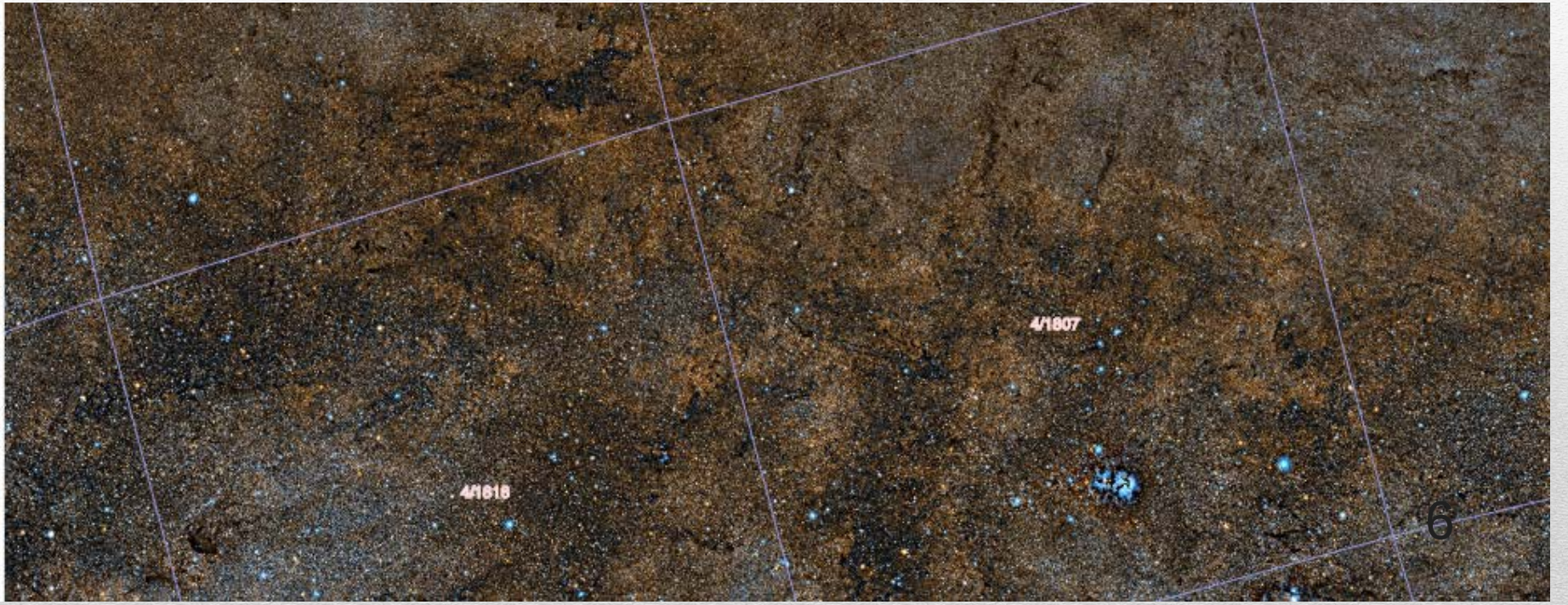
Approach @ CDS: Speed

- Simple design for **efficient** creation of HiPS maps of large image data sets (Fernique et al. 2015. A & A, 578, A114).
- HiPSGEN is the only published tool for creating HiPS maps
  - Few days processing time for 0.2” pixels for full sky.
  - Background estimation uses constant value or value estimated from a subset of pixel values.
  - Bilinear pixel resampling - averages values of pixels in HEALPix target grid.

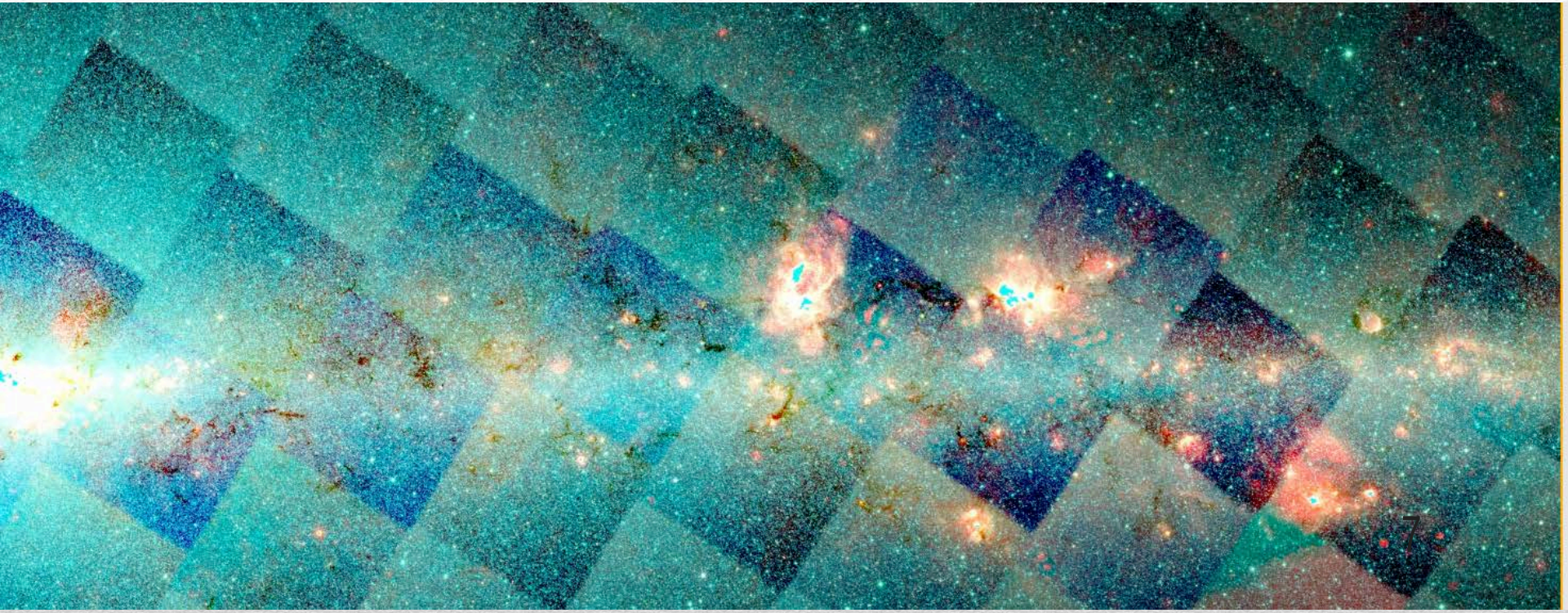
Approach @ CDS: Speed

- Impressive collection of 676 HiPS maps and 21 servers.
- Maps at infrared wavelengths hard to do this way because background radiation is high.

Pan-STARRS 3-color HiPS Level 4

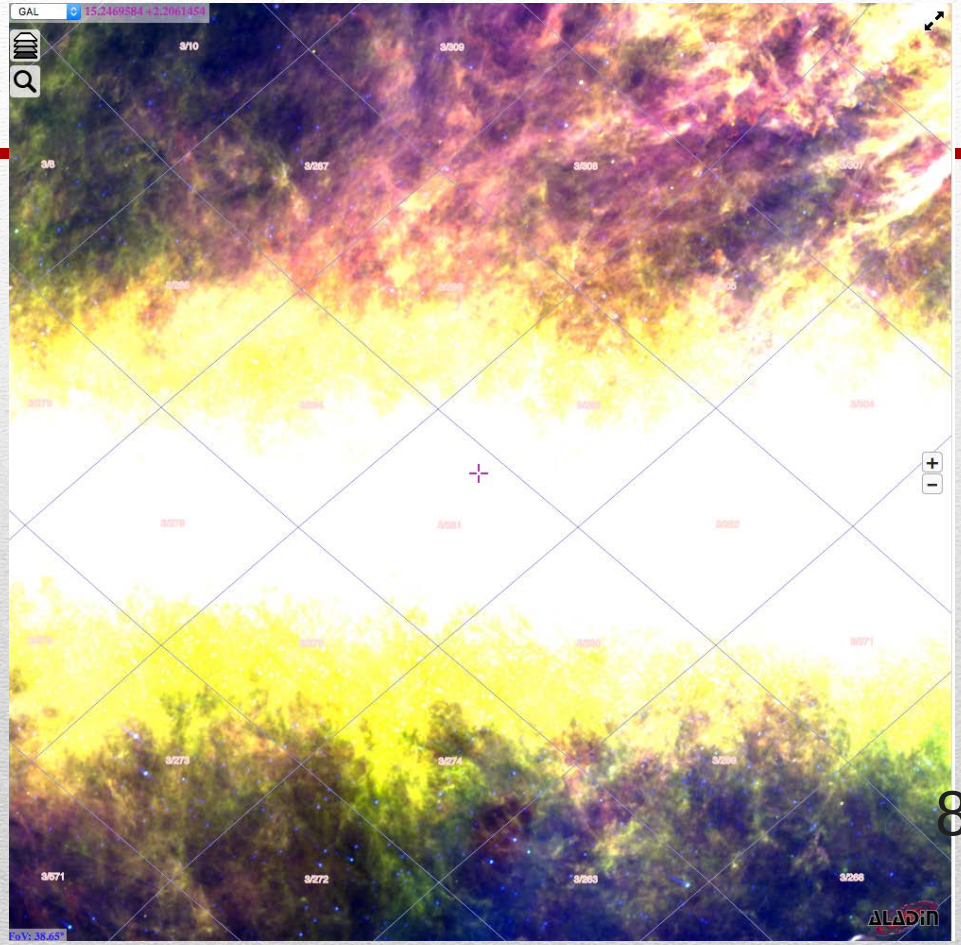


ALLWISE Bands 1,3,4 CDS HiPS Level 3



IRIS

12 µm , 25µm, 60 µm
HiPS Level 3



What Is Montage?

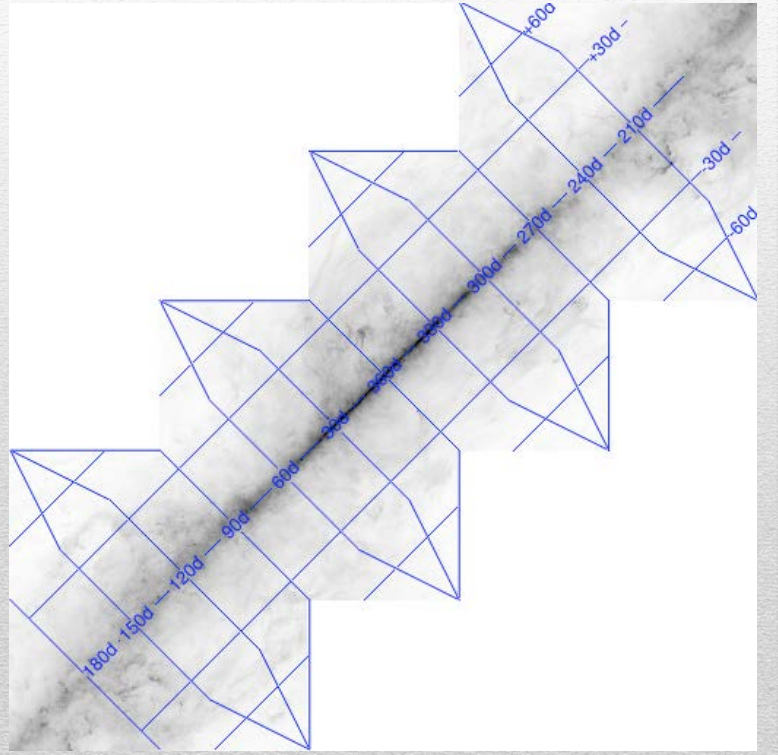
- Open source image mosaic engine (BSD 3-clause).
- Written in ANSI-C for performance and portability.

http://montage.ipac.caltech.edu

https://github.com/Caltech-IPAC/Montage

What Can Montage Bring to HiPS?

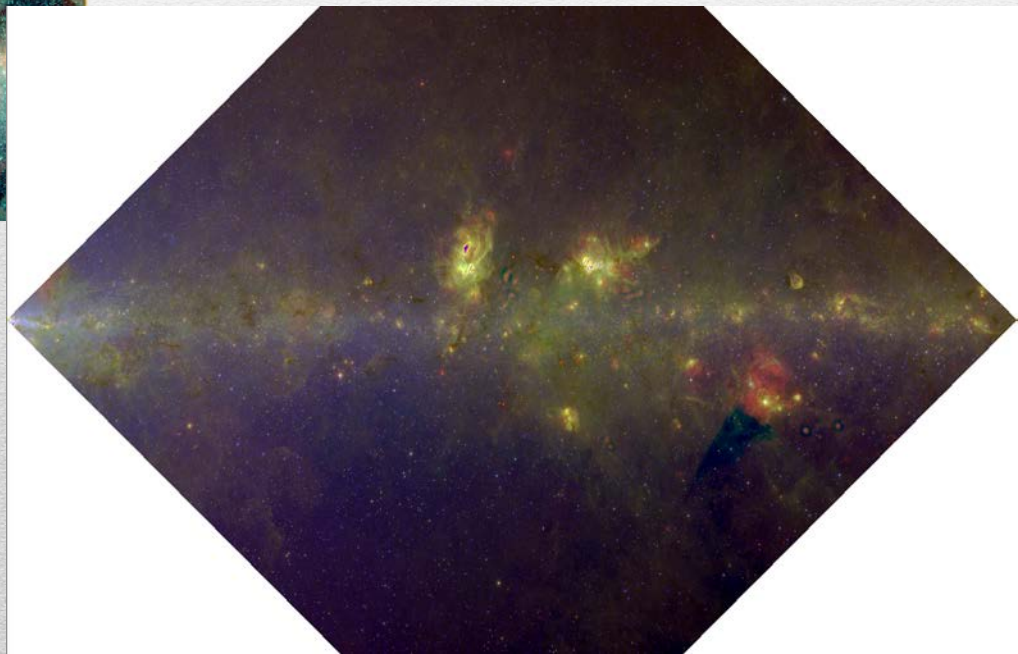
- Supports HEALPix.
  - Treat as rotated projection in WCS library.
- Models differences between images.
- Adaptive stretch
- Designed for accuracy.
- Highly parallelizable.

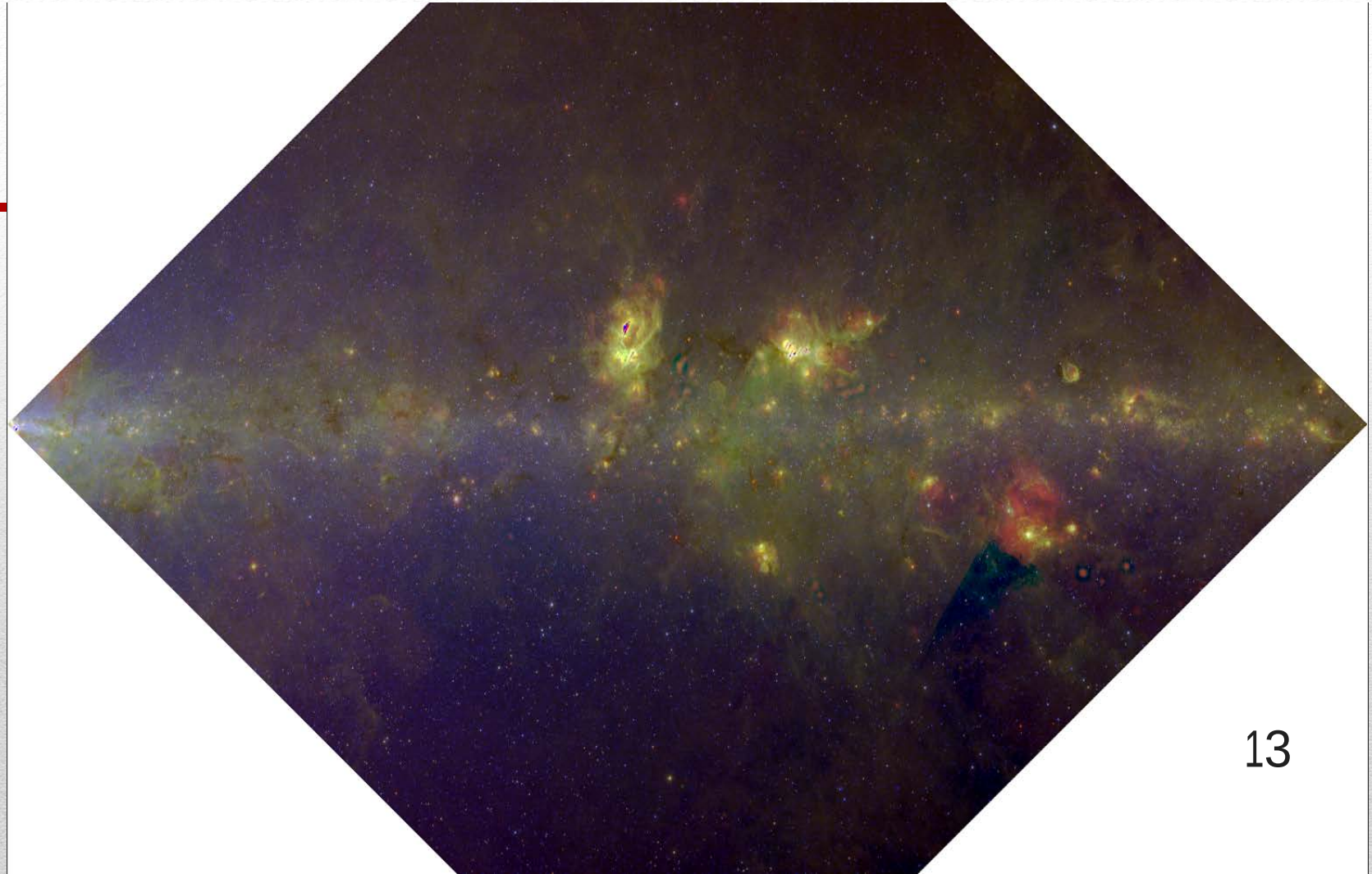


Creating a HiPS Map

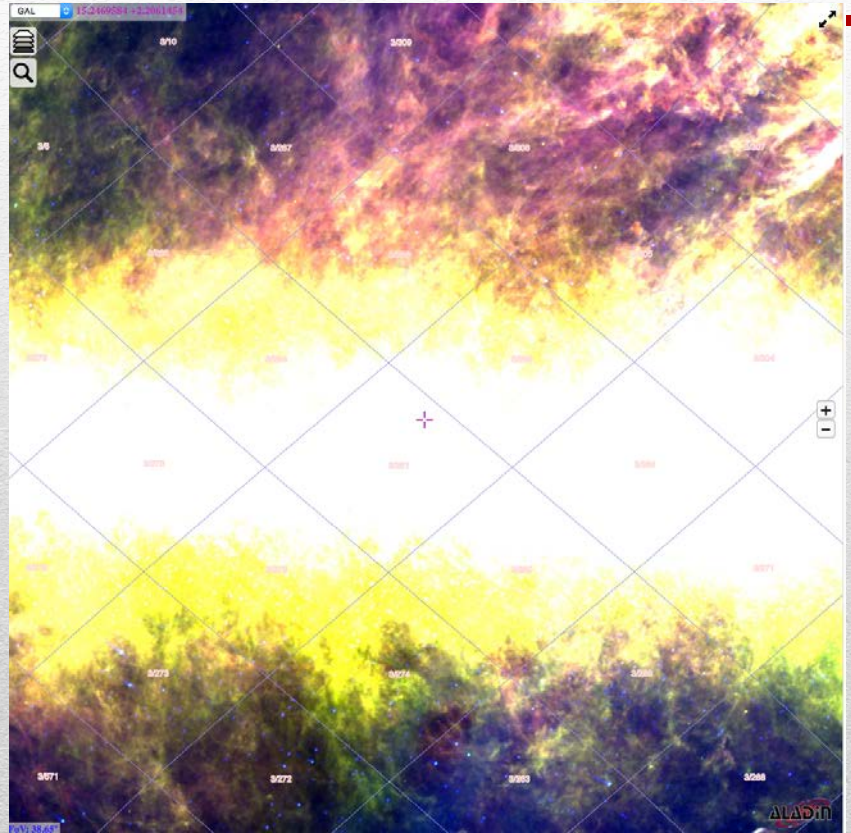
- Compute HEALPix mosaic.
  - This is the hard part!
- Create HiPS tiles from the HEALPix mosaics.
- Optimize use of hardware resources for large data sets.

ALLWISE 3-color comparison

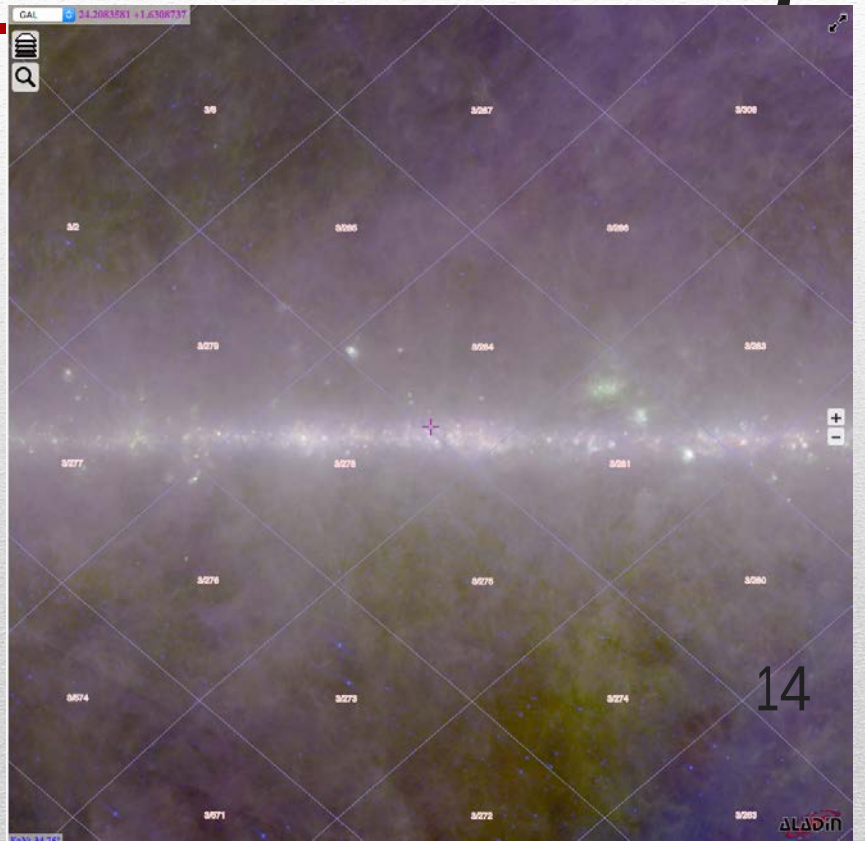


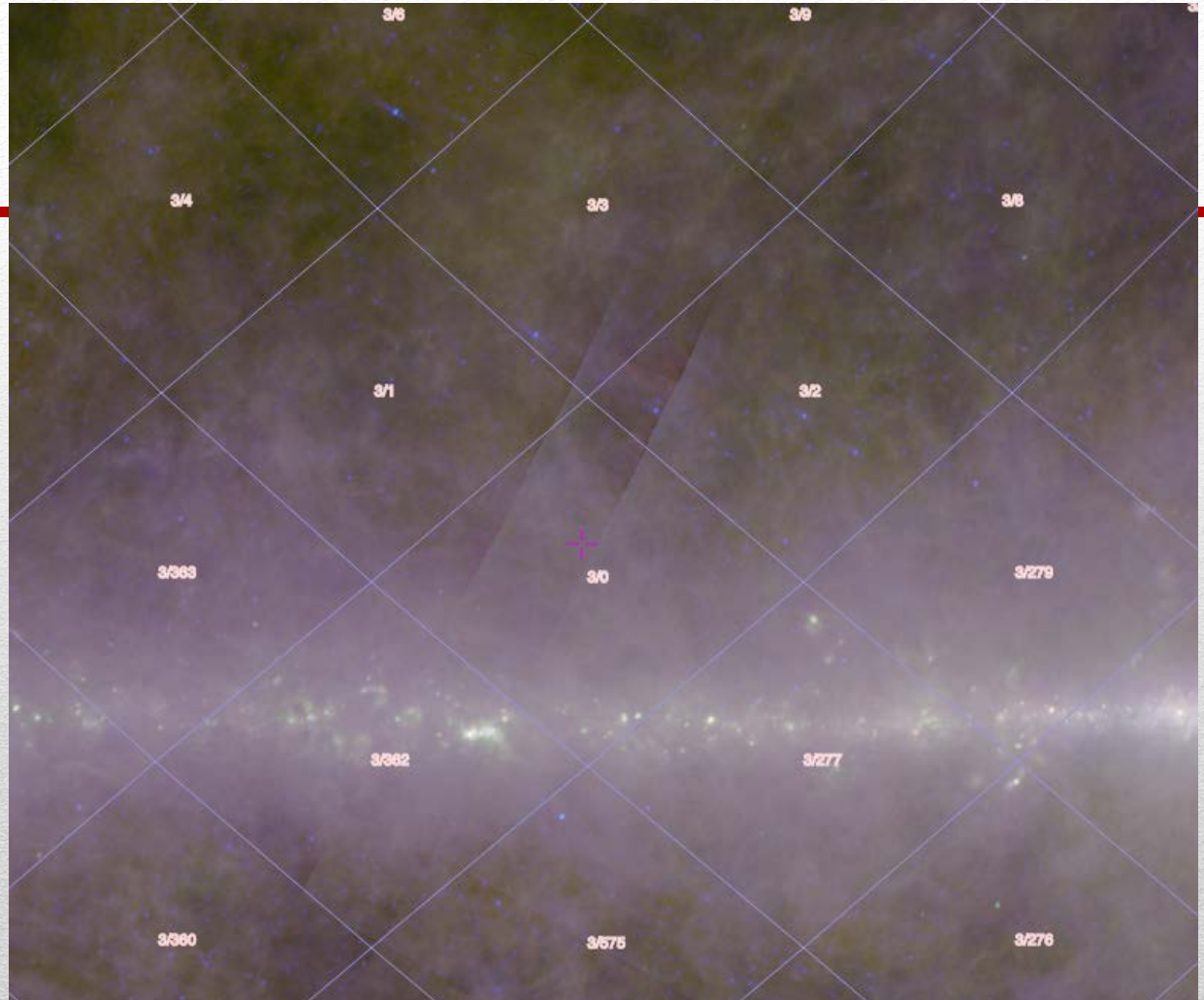


IRIS CDS



IRIS Montage




3/6
3/9
3/4
3/3
3/8
3/1
3/2
3/363
3/0
3/279
3/362
3/277
3/360
3/575
3/276

Creating The ALLWISE Mosaic - 1

- **Problem 1: Size!**
- A single file would be 1,310,720 pixels square (0.8 arcsec) ➔ 2 TB file hard to handle. So …
- Define a set of plates in a 80 x 80 grid
  - 16,384 x 16,384 pixels per plate
  - 32 x 32 HiPS tiles per plate
  - ➔ 2GB per file

Creating the ALLWISE Mosaic - 2

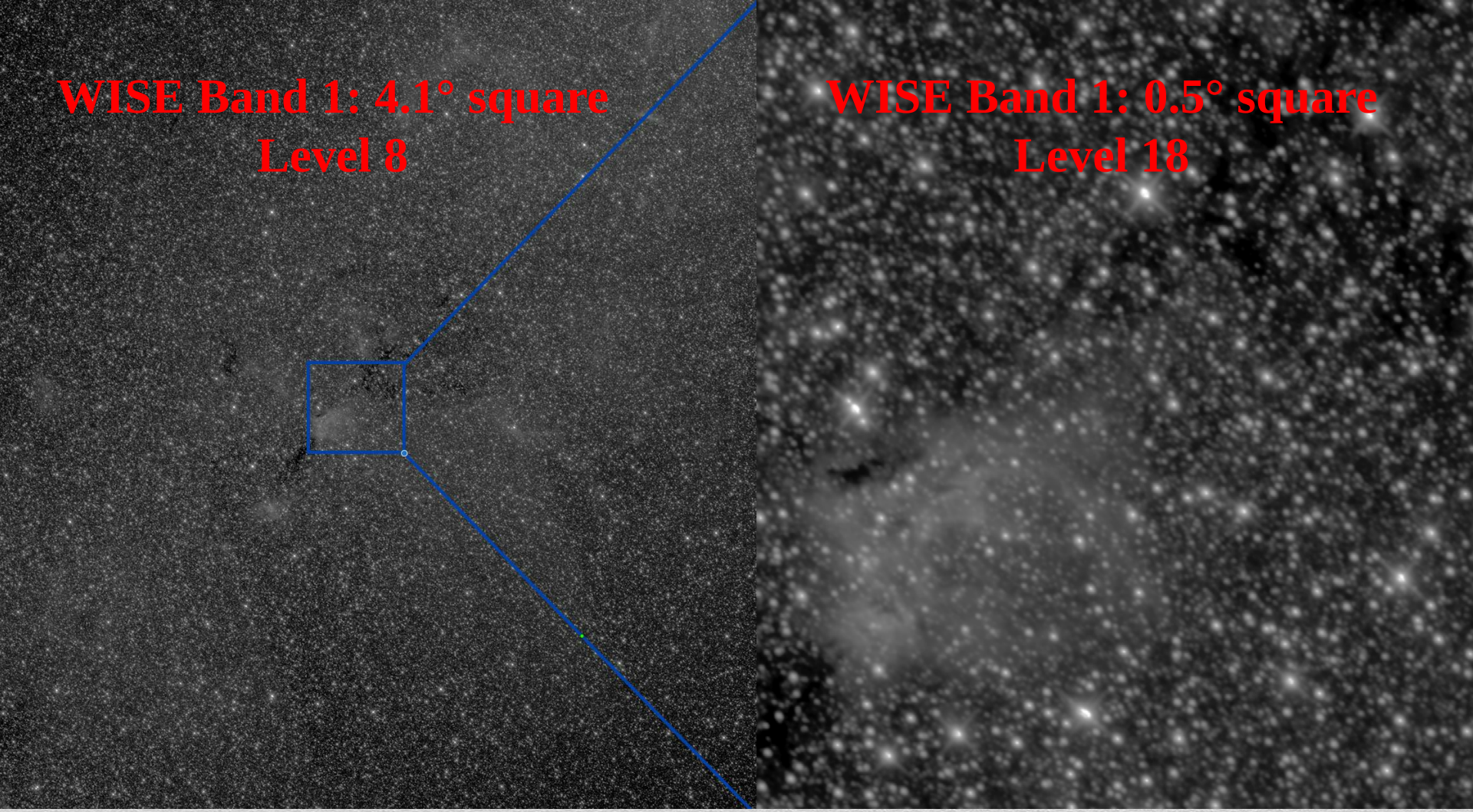
- **Problem 2: Backgrounds**.
- Background rectify all the images processed to make a plate, then
- Do background rectification between plates and this across the sky.

Cutting out HiPS Tiles

- Organized specified in HiPS standard.
- Prescription:
  - Create HiPS tile header.
  - Co-add images.
  - Shrink and repeat.
  - Generate PNGs.
- Create all-sky histogram to determine image stretch for display.

Processing Times On A SLURM Cluster

Process	Time /plate (seconds)
Reprojection	1,800
Background modeling/rectification	450
Coaddition	50
PNG generation	220
Total time per plate	**2,520**
Total time per band (80 cores)	**1.2 days**
Total time for 4 bands	**~1 week**


WISE Band 1: 4.1° square
Level 8
WISE Band 1: 0.5° square
Level 18

Four New Modules

Name	Function
mHiPSSetup	Create directory tree for HiPS maps
mHPXMosaicScripts	Make the scripts that reproject the data into a set of plates.
mHPXShrinkScripts	Build plates in the other orders.
mHiPSPNGs	Make color JPEG/PNG tiles.

Public Release Winter 2019

- Formally test new HiPS modules … C and Python binary extensions.
- Presentation of HiPS maps at NASA Hyperwall, AAS Jan 2020.
- Cloud processing; Spitzer, Herschel … maps.

Special thanks to

Pierre Fernique and Thomas Boch

and

Thank-you all for listening

Grab me for a test-drive!