



# Introduction to AstroDrizzle

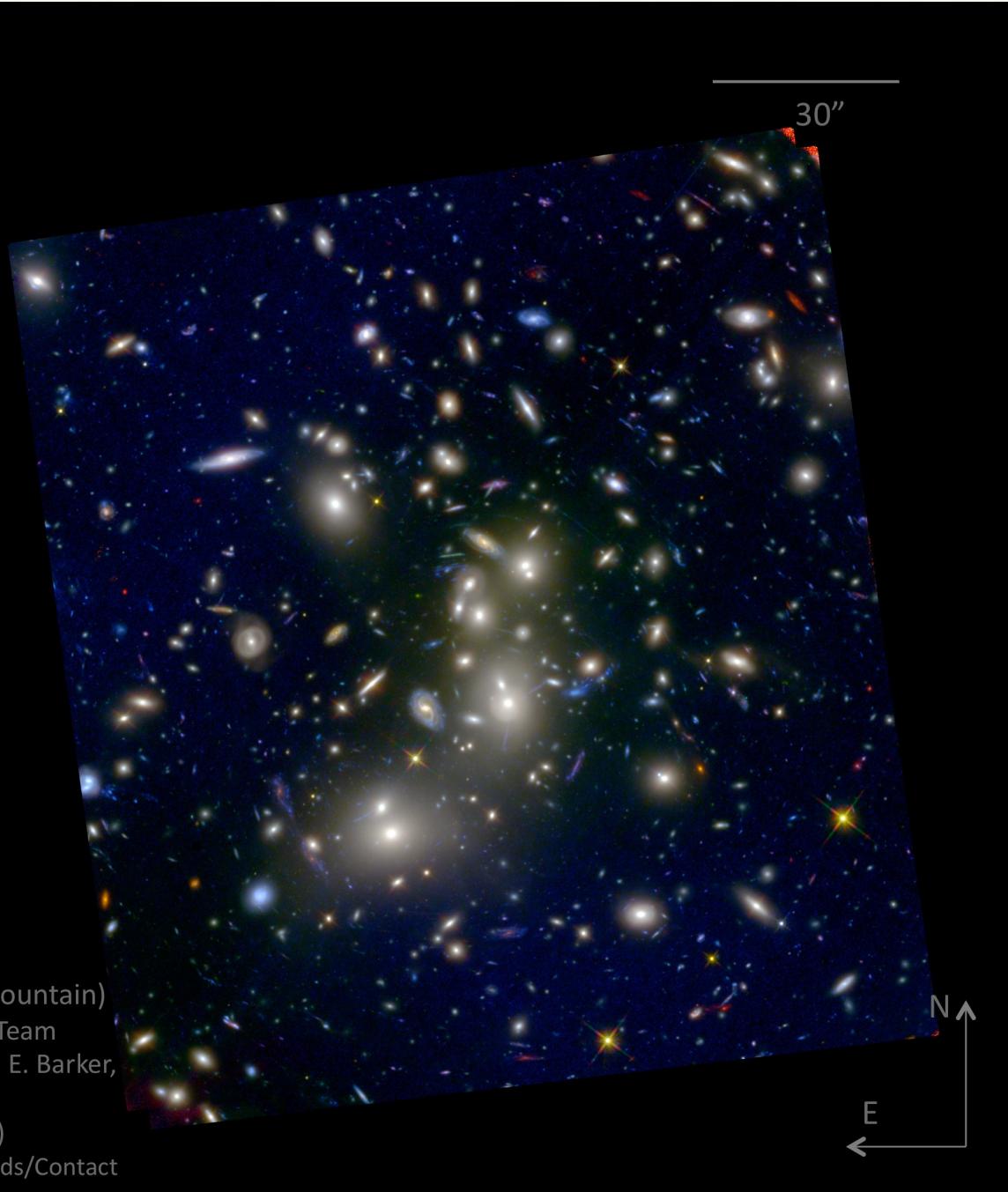
Roberto J. Avila

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*July 16, 2014*

# First of all.....

Frontier Fields Cluster Abell 2744  
Hubble Space Telescope  
ACS/WFC F435W + F606W  
ACS/WFC F814W + WFC3/IR F105W  
WFC3/IR F125W + F140W + F160W



HST Data from:  
• 11689 (PI: R. Dupke)  
• 13386 (PI: S. Rodney)  
• 13495 (Frontier Fields: PI: J. Lotz & M. Mountain)  
Image: Frontier Fields Science Data Products Team  
(A. Koekemoer, J. Mack, J. Anderson, R. Avila, E. Barker,  
B. Hilbert, R. Lucas, S. Ogaz, M. Robberto,  
and the Frontier Fields Implementation Team)  
<http://www.stsci.edu/hst/campaigns/frontier-fields/Contact>

- HST Frontier Fields > 800 orbits
- HST LEGUS 154 orbits
- Resolved stellar population studies
- Really any kind of imaging

We need AstroDrizzle experts!

# Topics:

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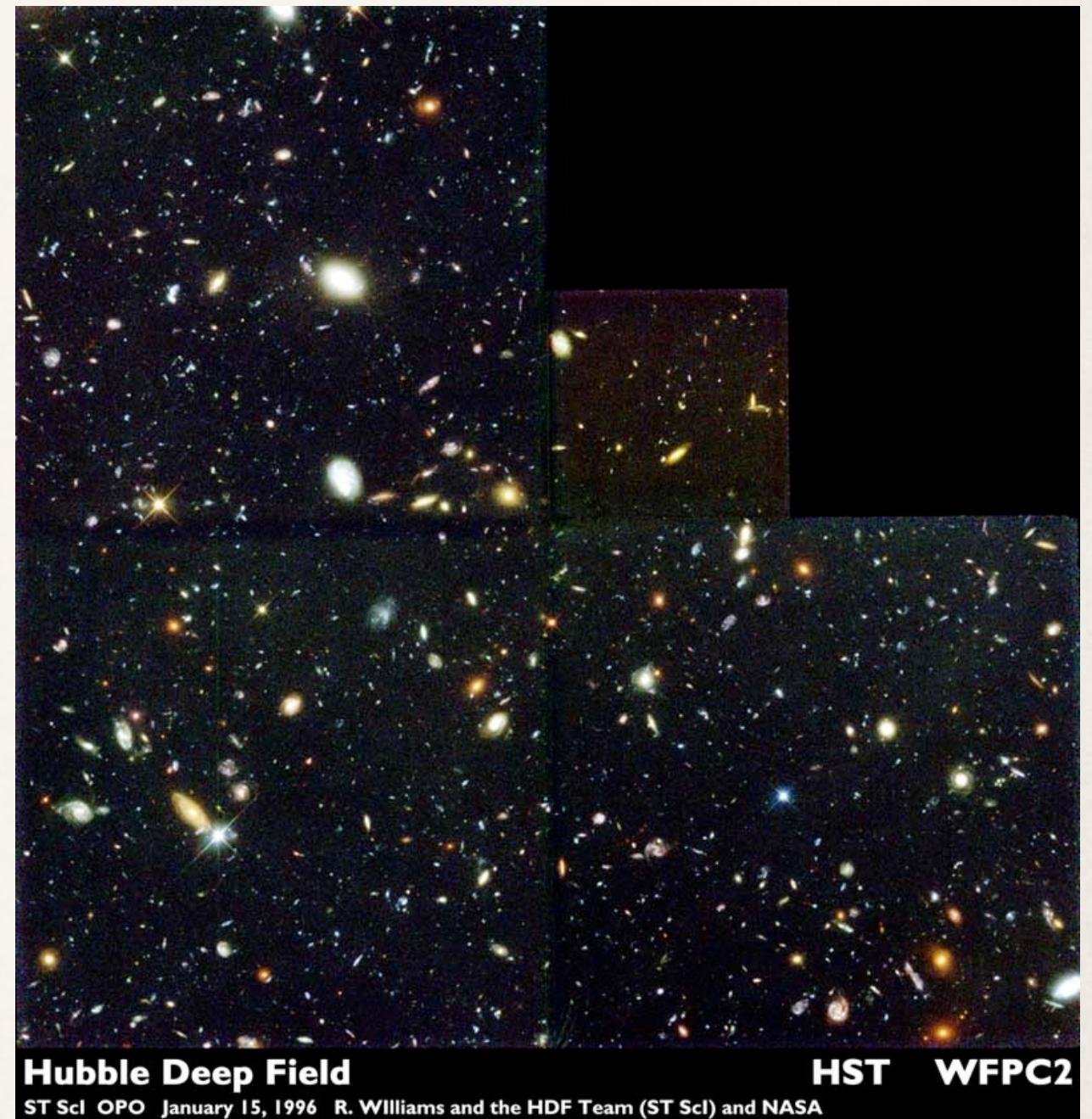
- Intro and history
- Why Drizzle?
- Dithering
- The drizzle concept
- The drizzle process
- The drizzle software
- Demo

# Introduction & History

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When talking about drizzling, you may be referring to one of several things:

1. the drizzling algorithm
2. the drizzling software (Drizzlepac)
3. the drizzling task (AstroDrizzle)



**Hubble Deep Field**

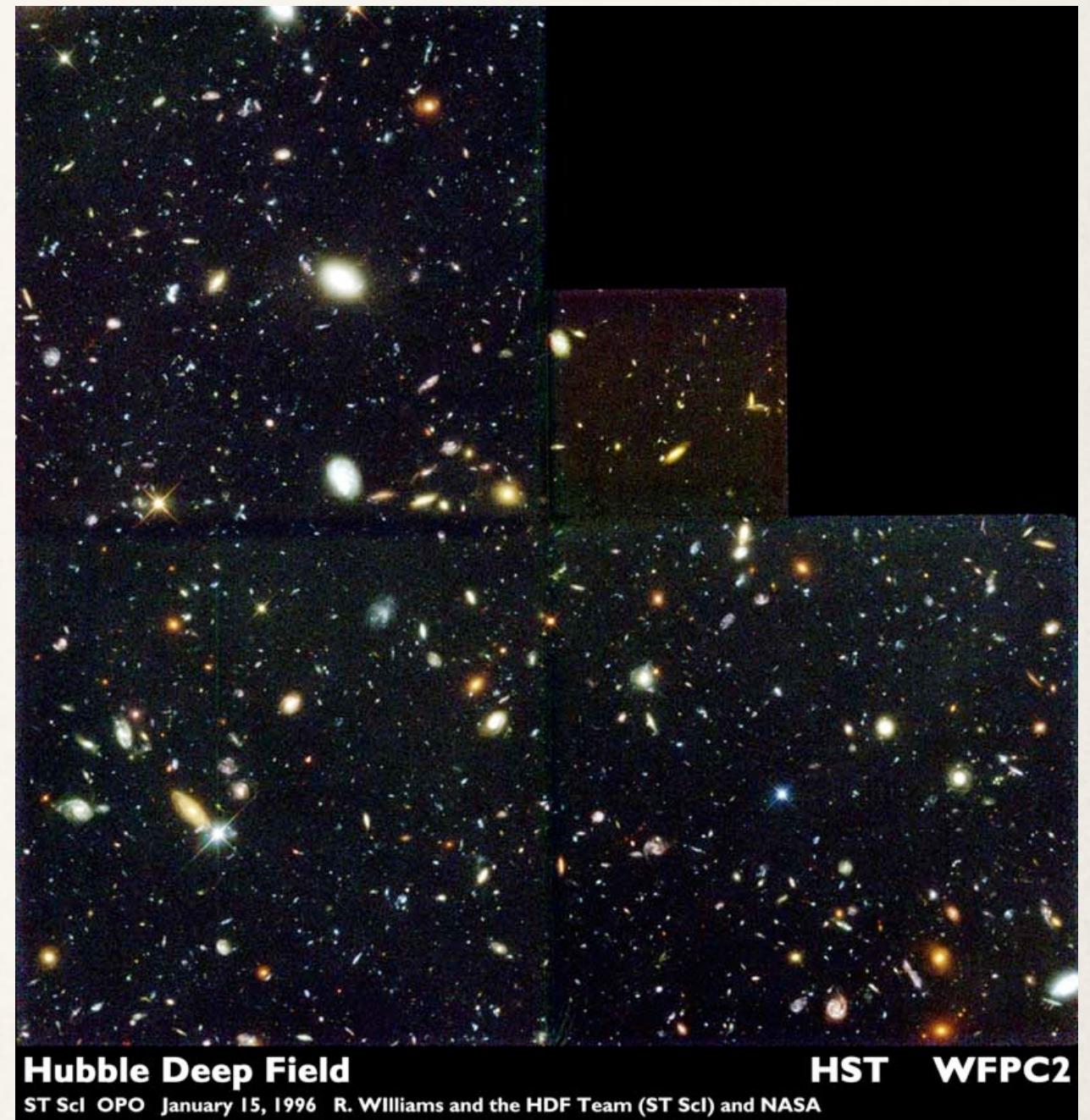
ST Scl OPO January 15, 1996 R. Williams and the HDF Team (ST Scl) and NASA

**HST WFPC2**

# Introduction & History

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- Drizzle algorithm developed to combine UDF images
- Multidrizzle was developed as a wrapper to complete tasks necessary for drizzling
- AstroDrizzle is the newest version of this software (released 6/2012)
- V2.0 coming later this summer



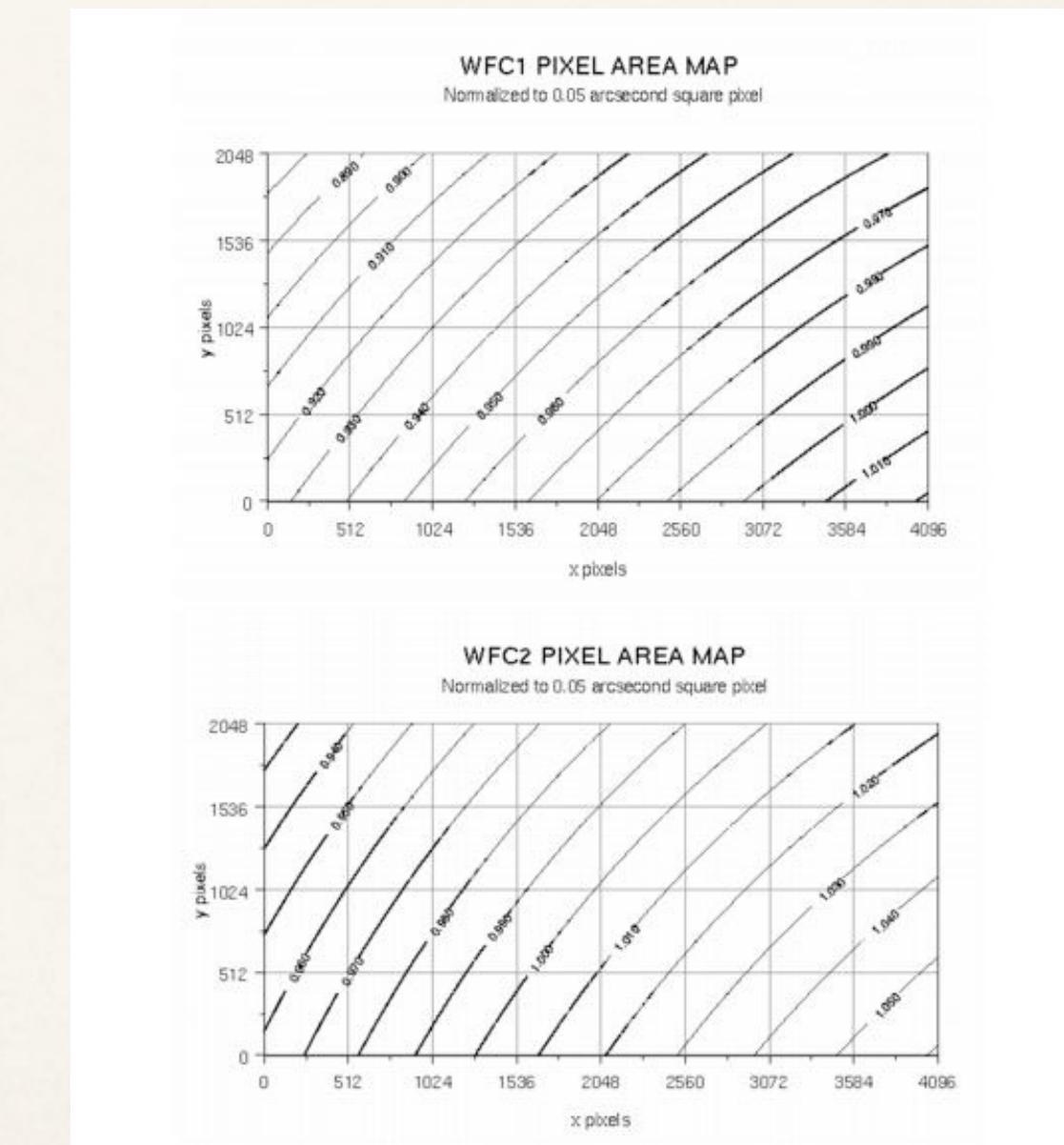
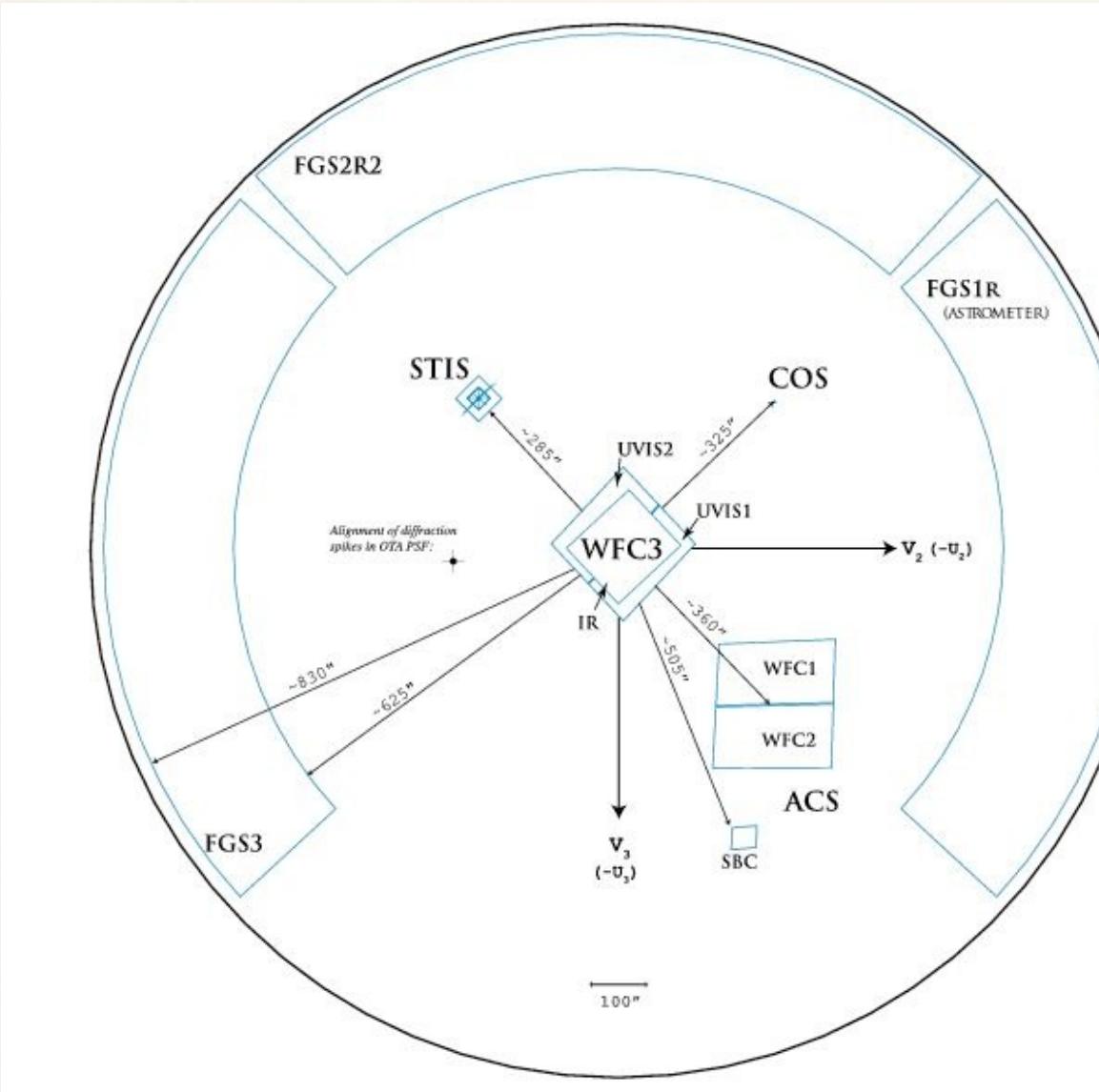
**Hubble Deep Field**

ST Scl OPO January 15, 1996 R. Williams and the HDF Team (ST Scl) and NASA

**HST WFPC2**

# Why Drizzle?

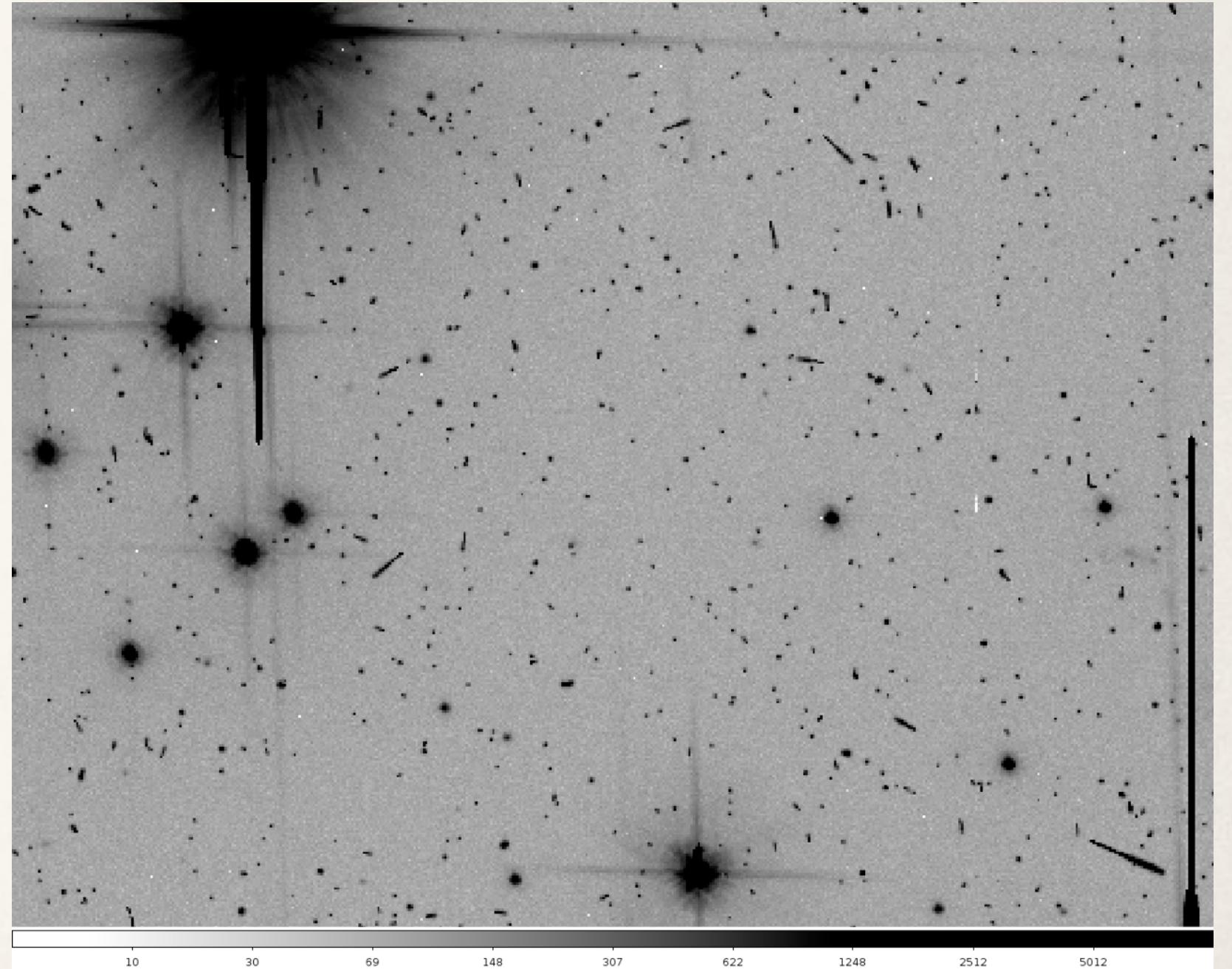
- Optics to reduce spherical aberration introduce geometric distortion to each image



# Why Drizzle?

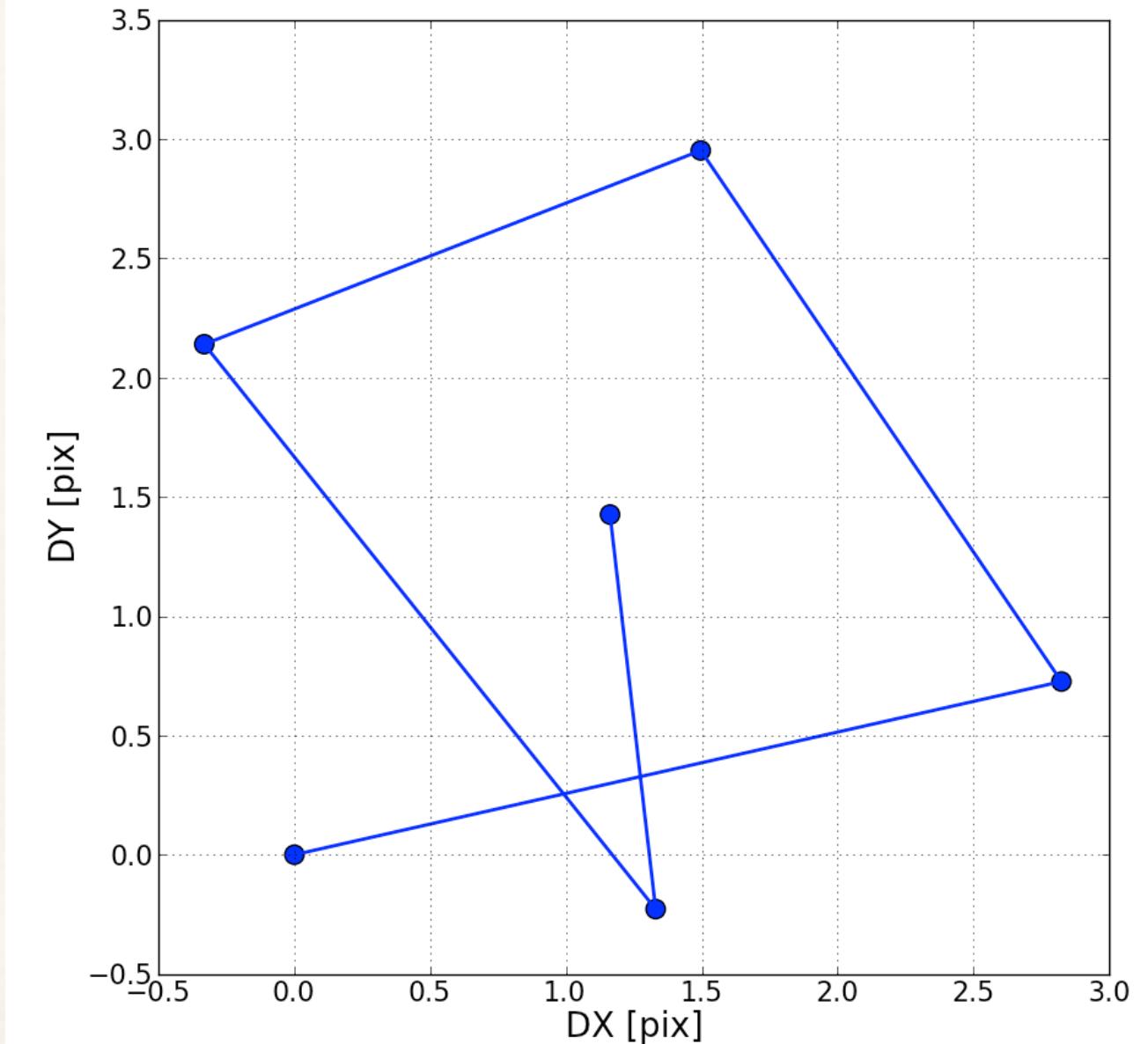
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- Pipeline calibrated images still contain artifacts: bad pixels, bad columns, cosmic rays, blobs in IR images, etc.



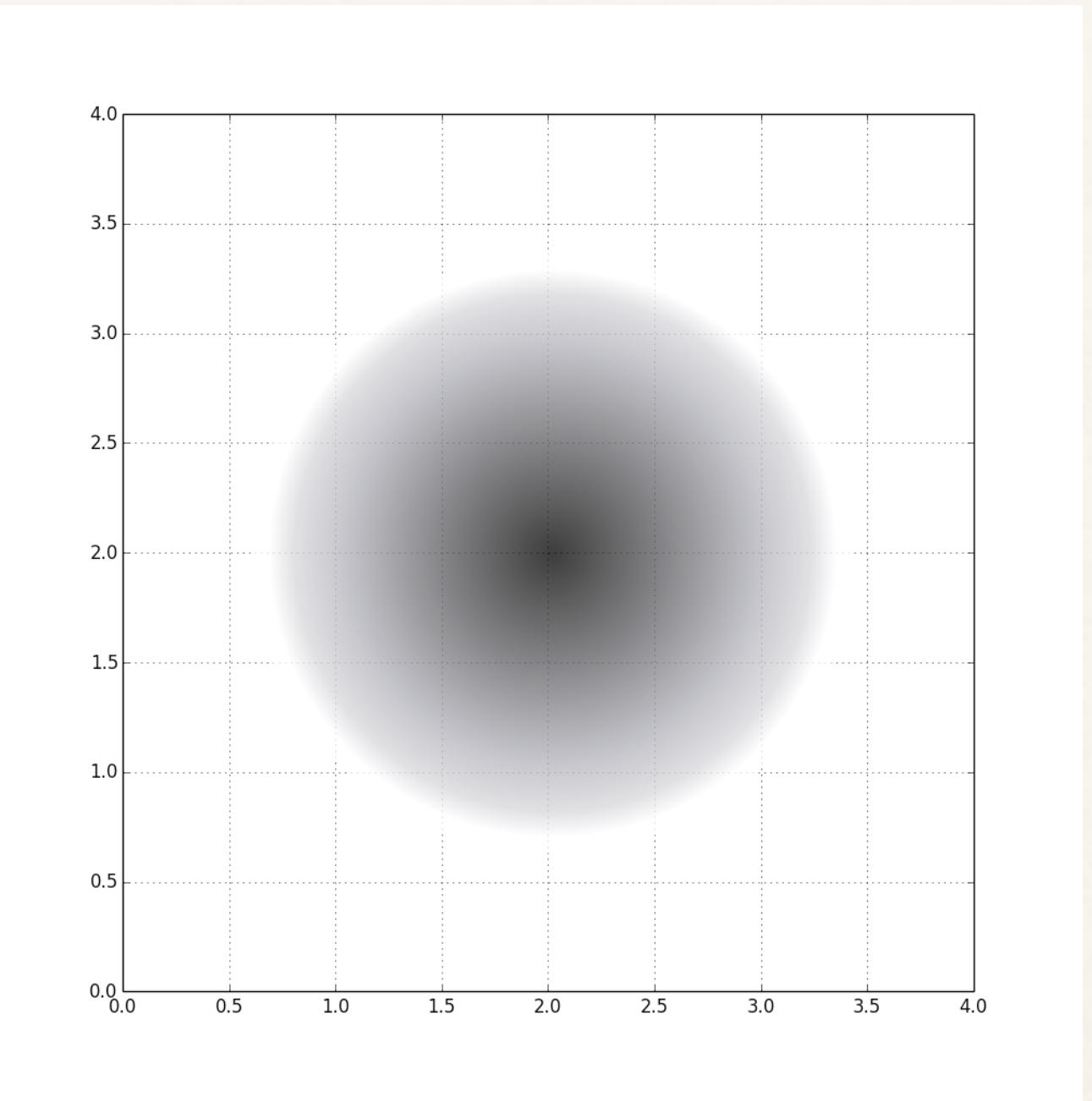
# Dithering

- ❖ Dithering is when you spatially offset the telescope
- ❖ Places targets at different locations on the detector
- ❖ Remove detector artifacts (bad pixels & columns, chip gaps, blobs in IR detector, etc)
- ❖ If shifts are sub-pixel you can improve PSF sampling



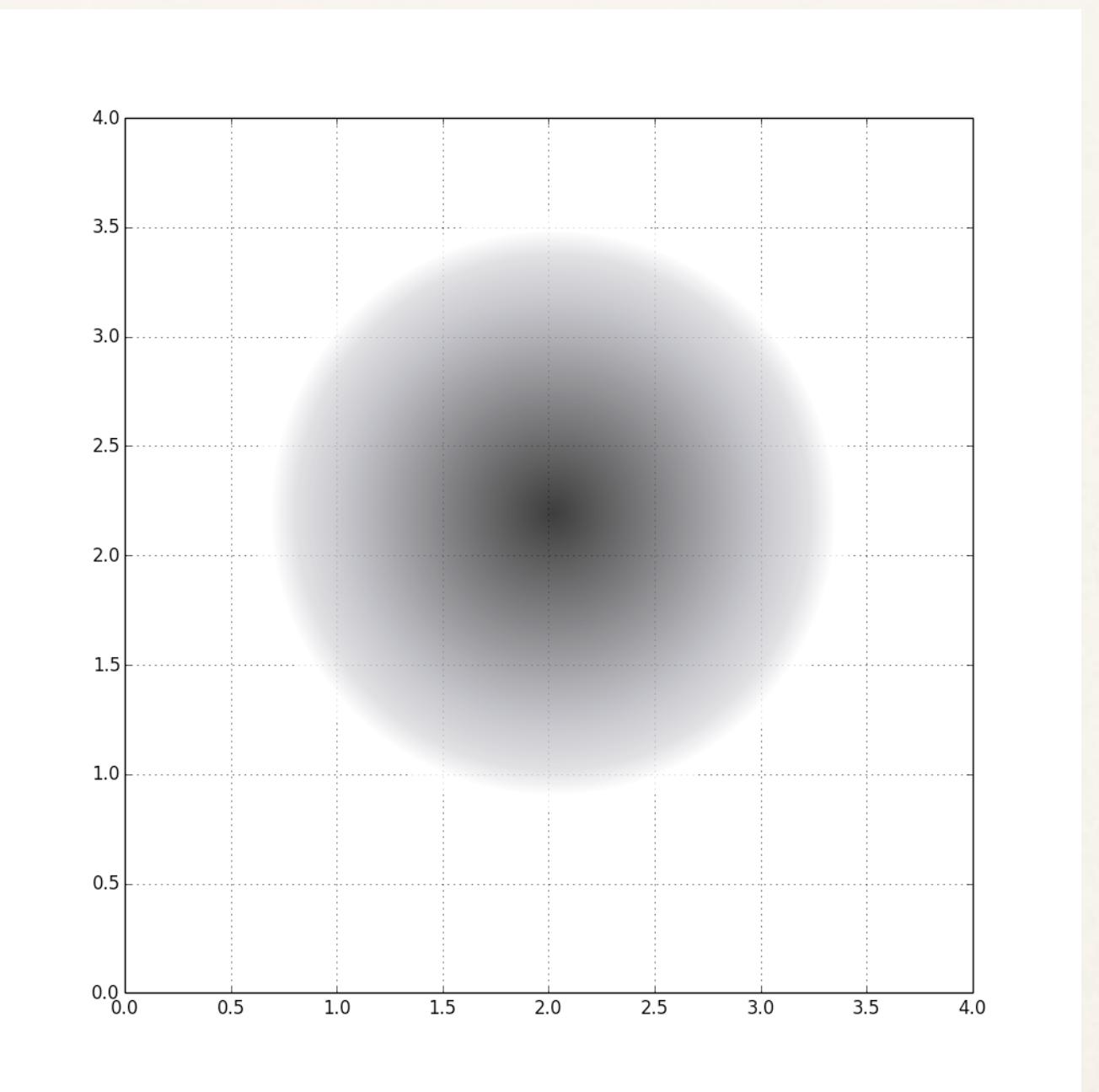
# Dithering

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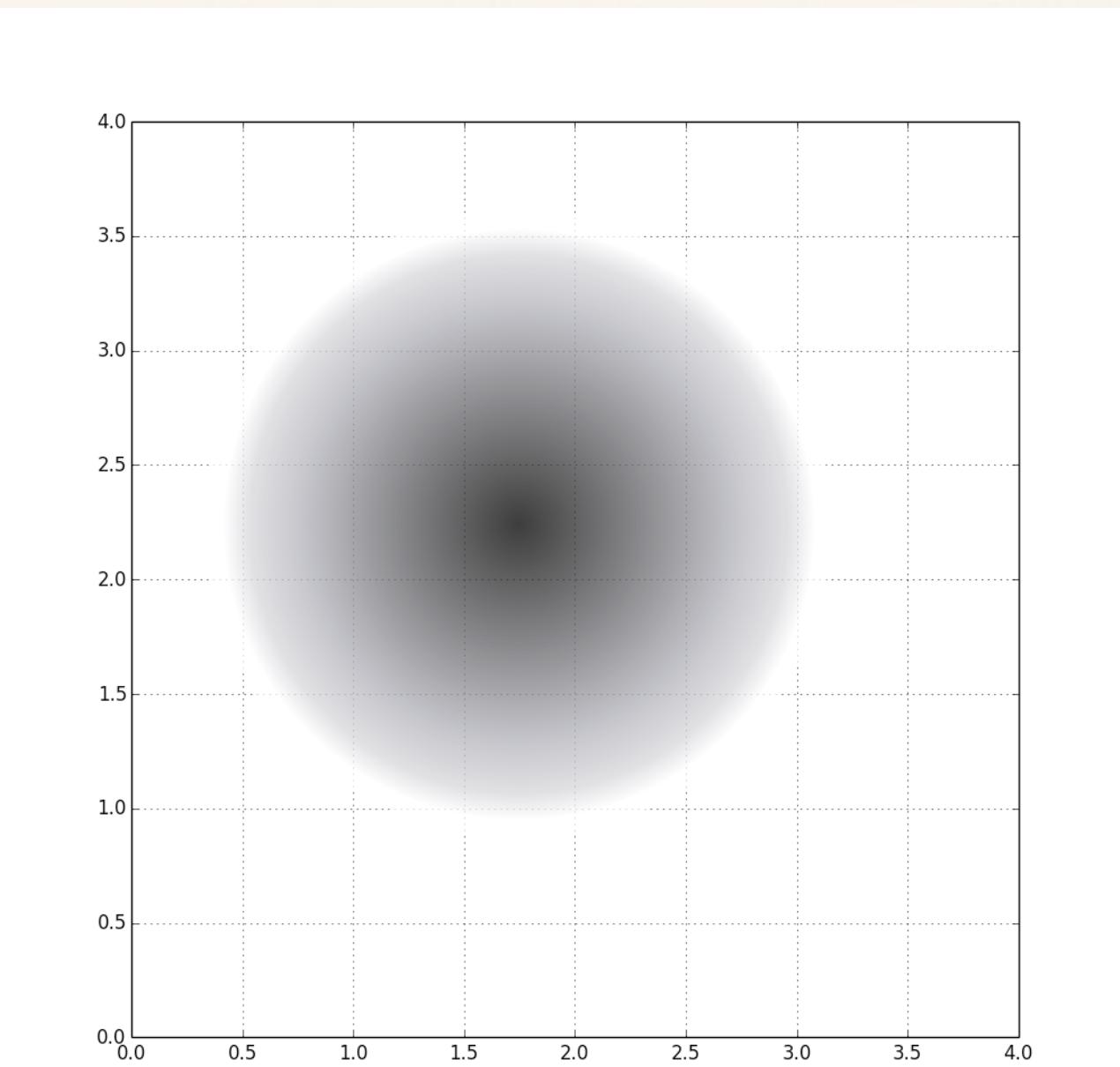
# Dithering

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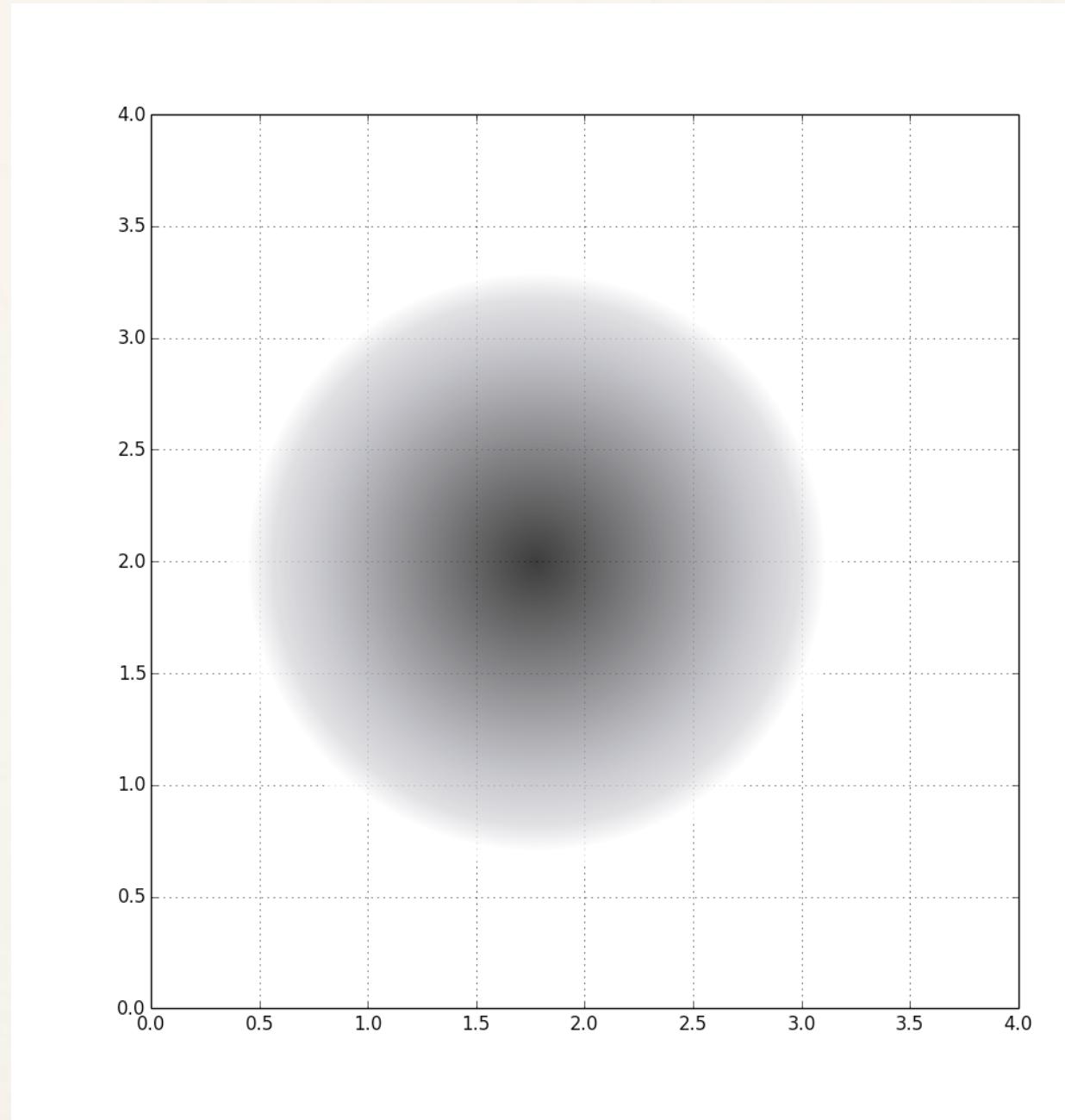
# Dithering

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# Dithering

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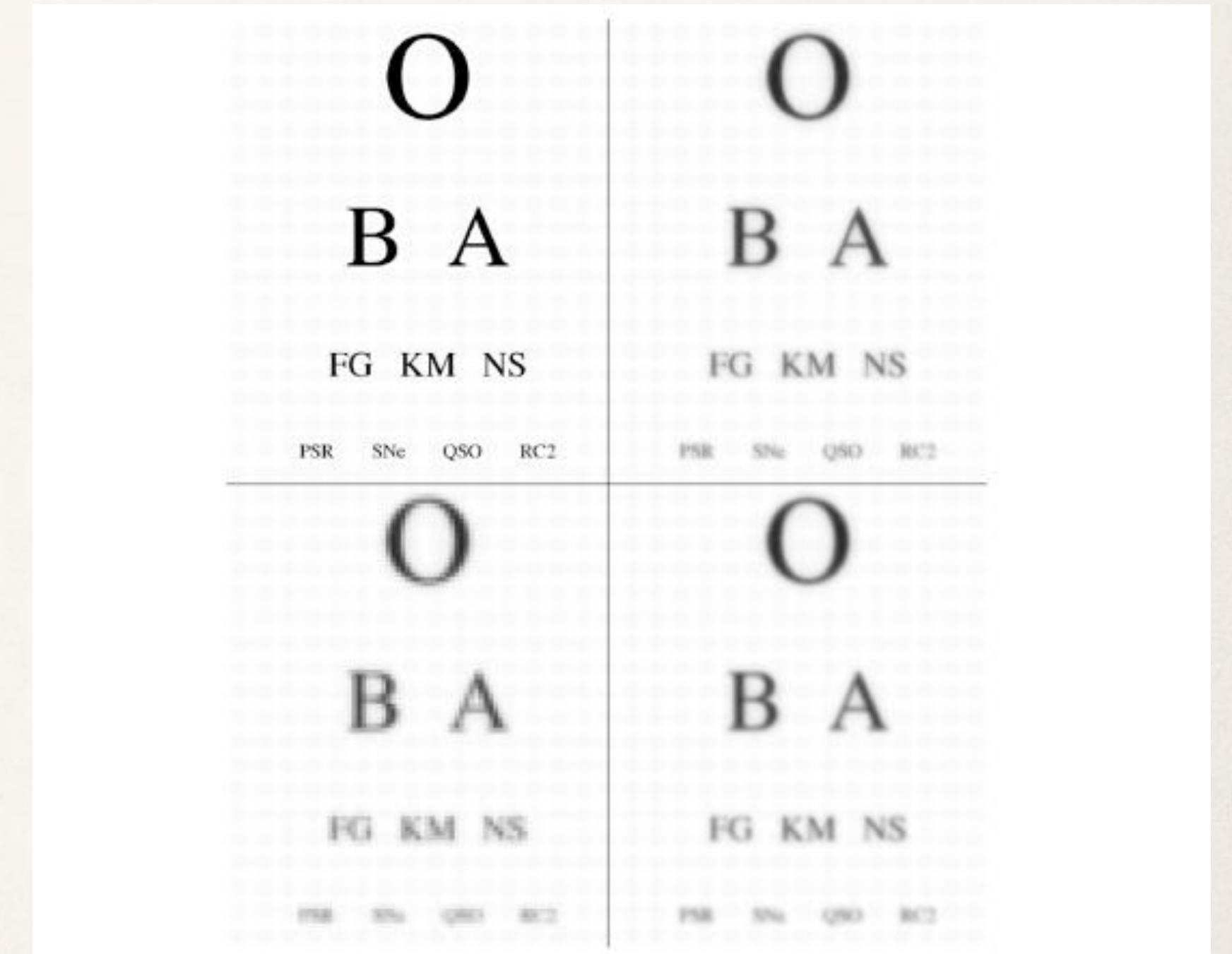
# The Drizzle concept

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- Two ways to combine images:
  - Interlacing - Pixels from input images are alternated in the output image. This is usually not feasible because of pointing and distortion.
  - Shift and add - Pixels from input images are replicated onto a grid with smaller pixels. This blurs PSF and has correlated noise
- Drizzling is a compromise between these two methods.
- Pixels are shrunk and then placed on the output grid.
- Improves resolution and decreases correlated noise.

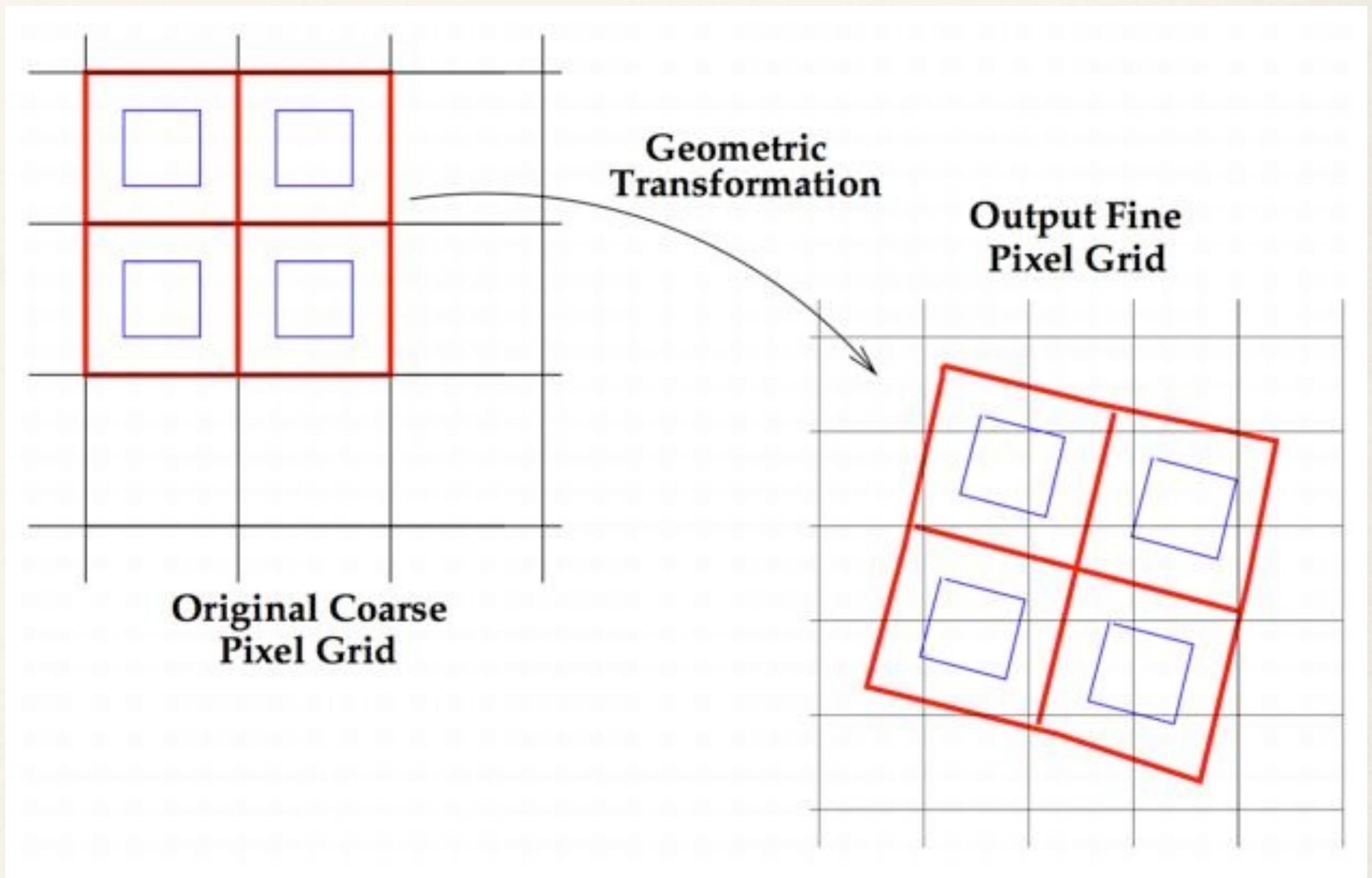
# The Drizzle concept

- Most HST instruments are undersampled
- Dithering samples different parts of the PSF
- You can reconstruct PSF with drizzling



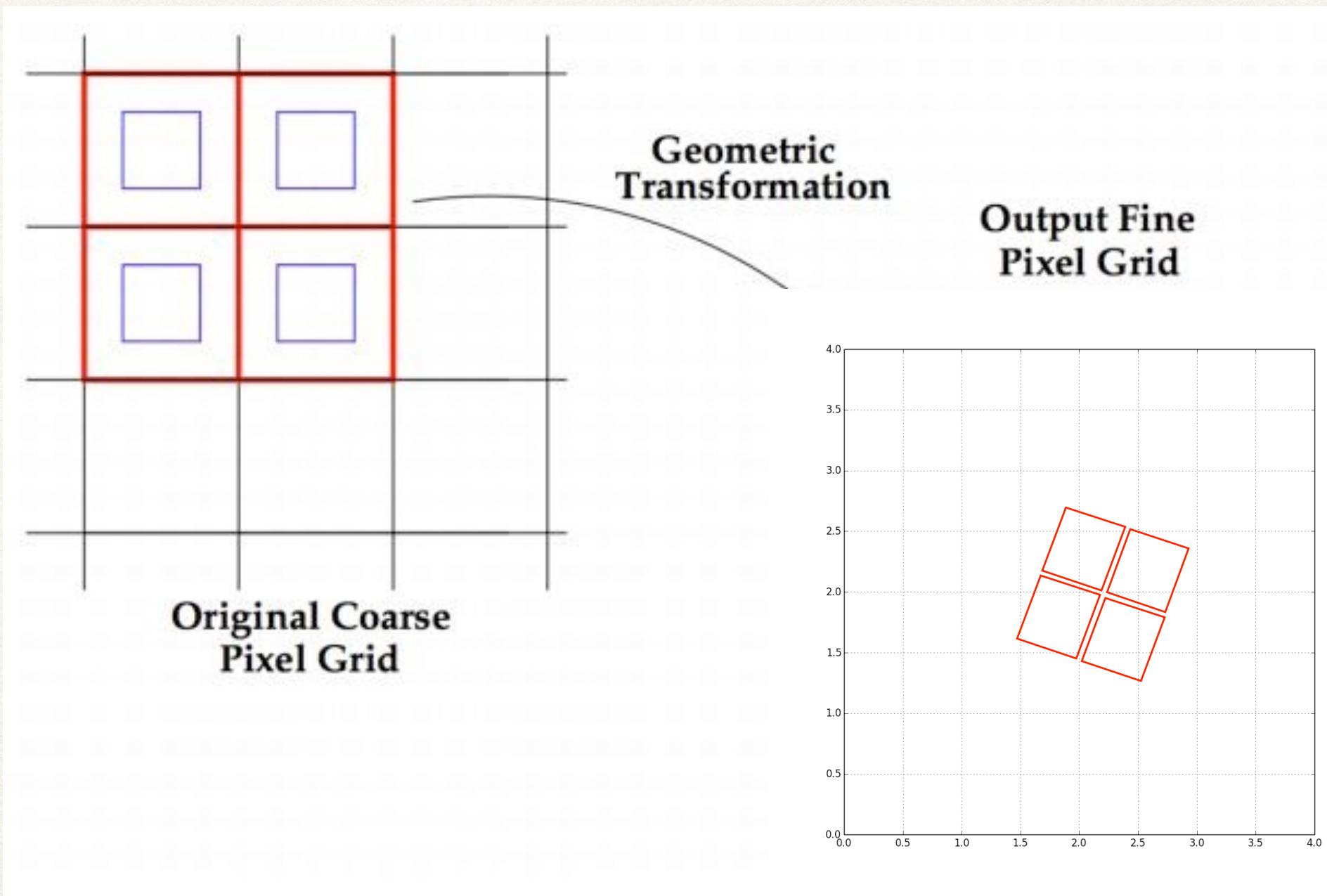
# The Drizzle concept

- How much pixels are shrunk by is controlled by *pixfrac* parameter
- 0 --> interlacing
- 1 --> shift and add
- Contribution of input pixels to output pixels is weighted by area
- Shrink to reduce correlated noise, but not so much you leave holes

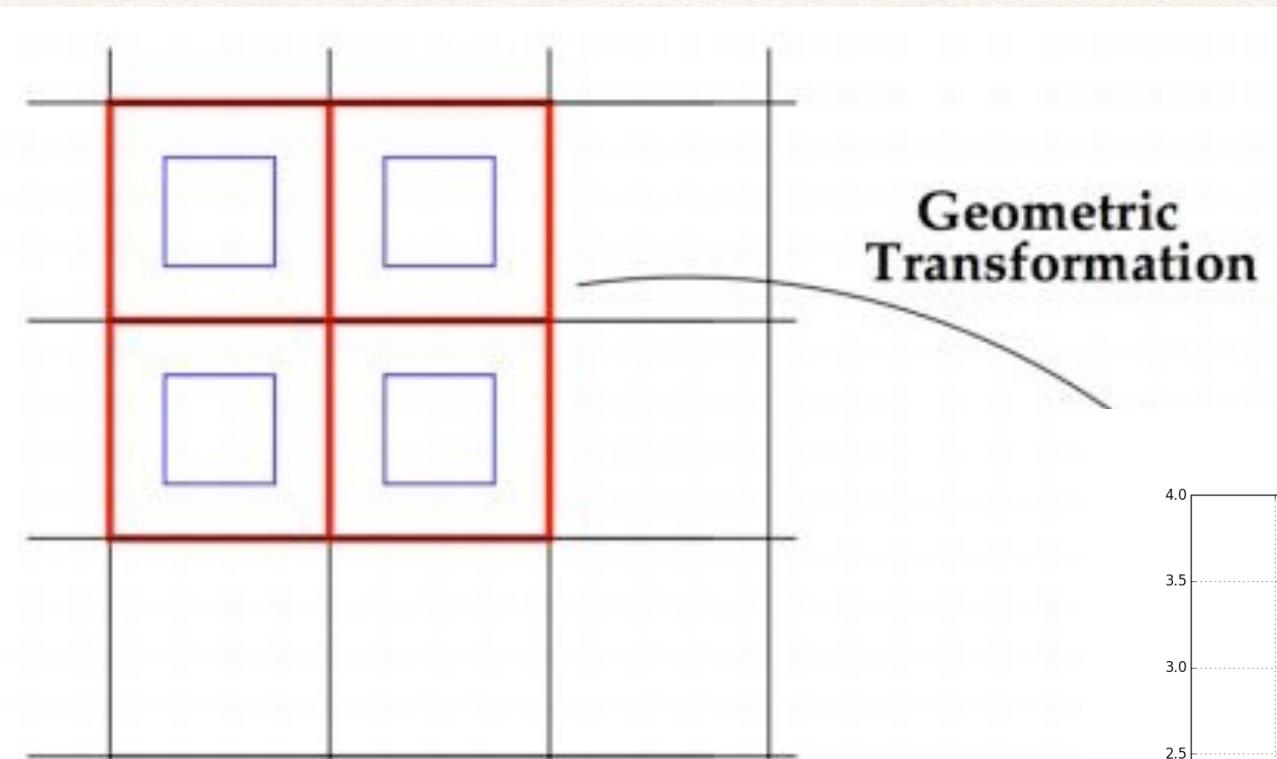


`pixfrac=1` (Shift and add)

Image 1

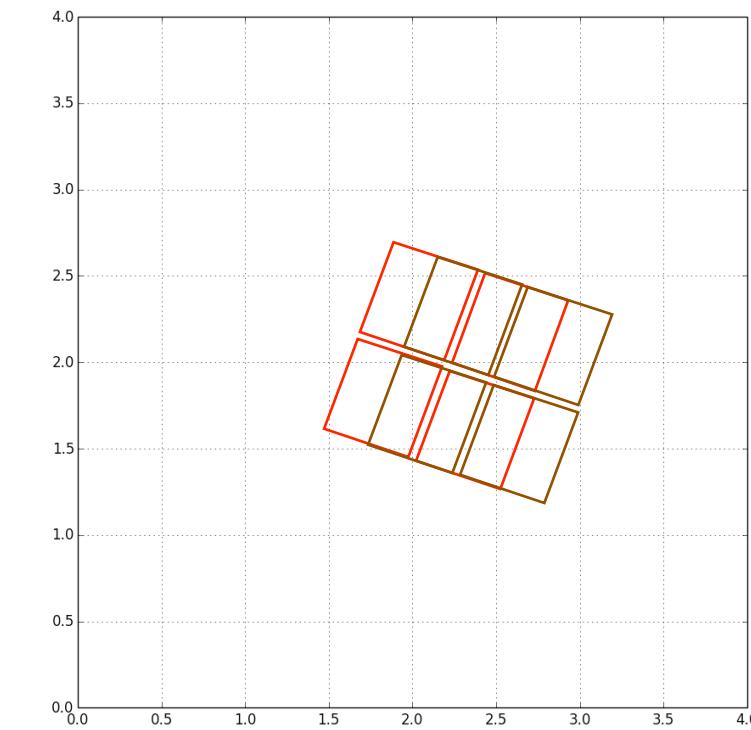


`pixfrac=1` (Shift and add)



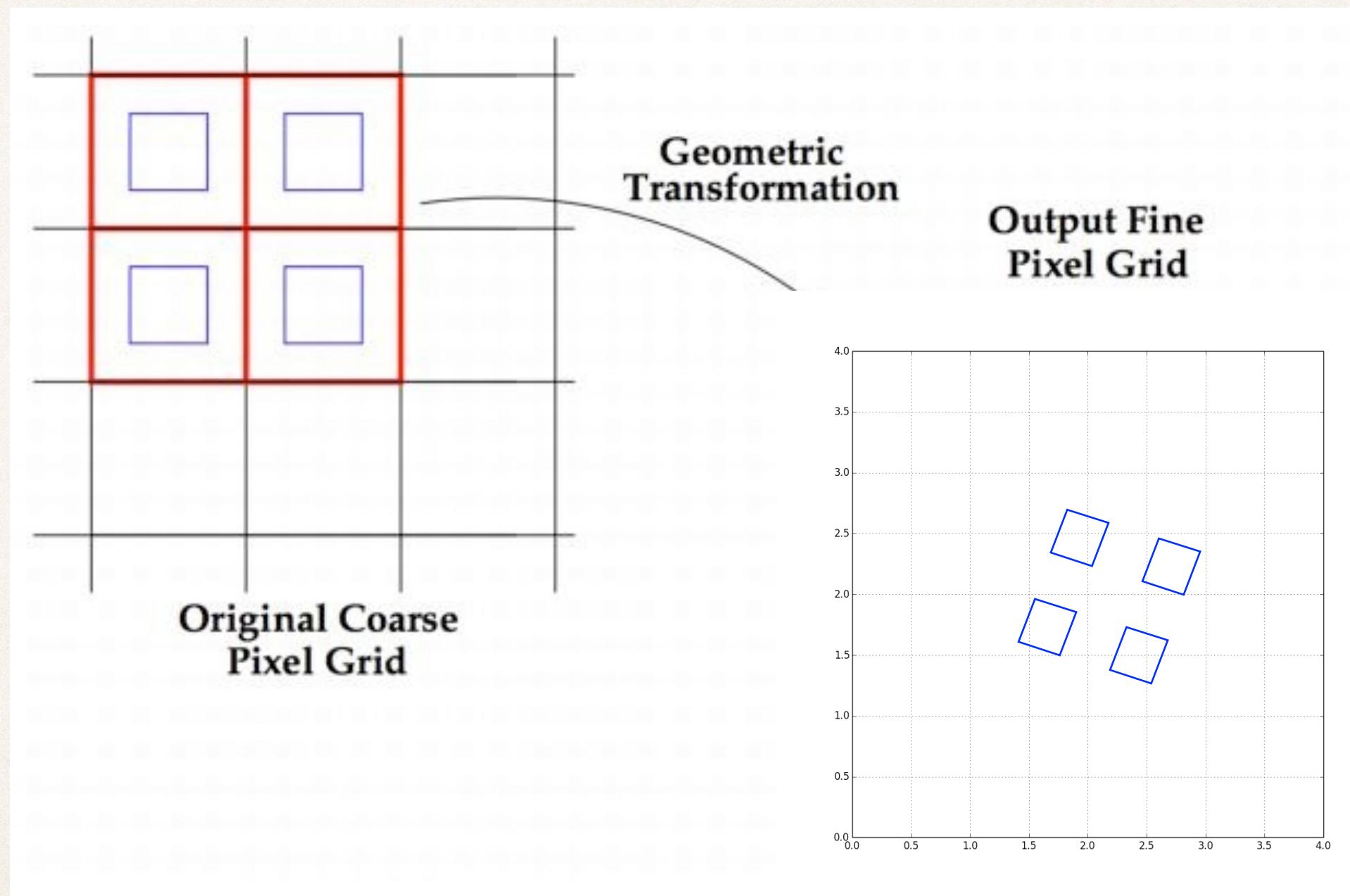
**Image 2**

**Output Fine  
Pixel Grid**



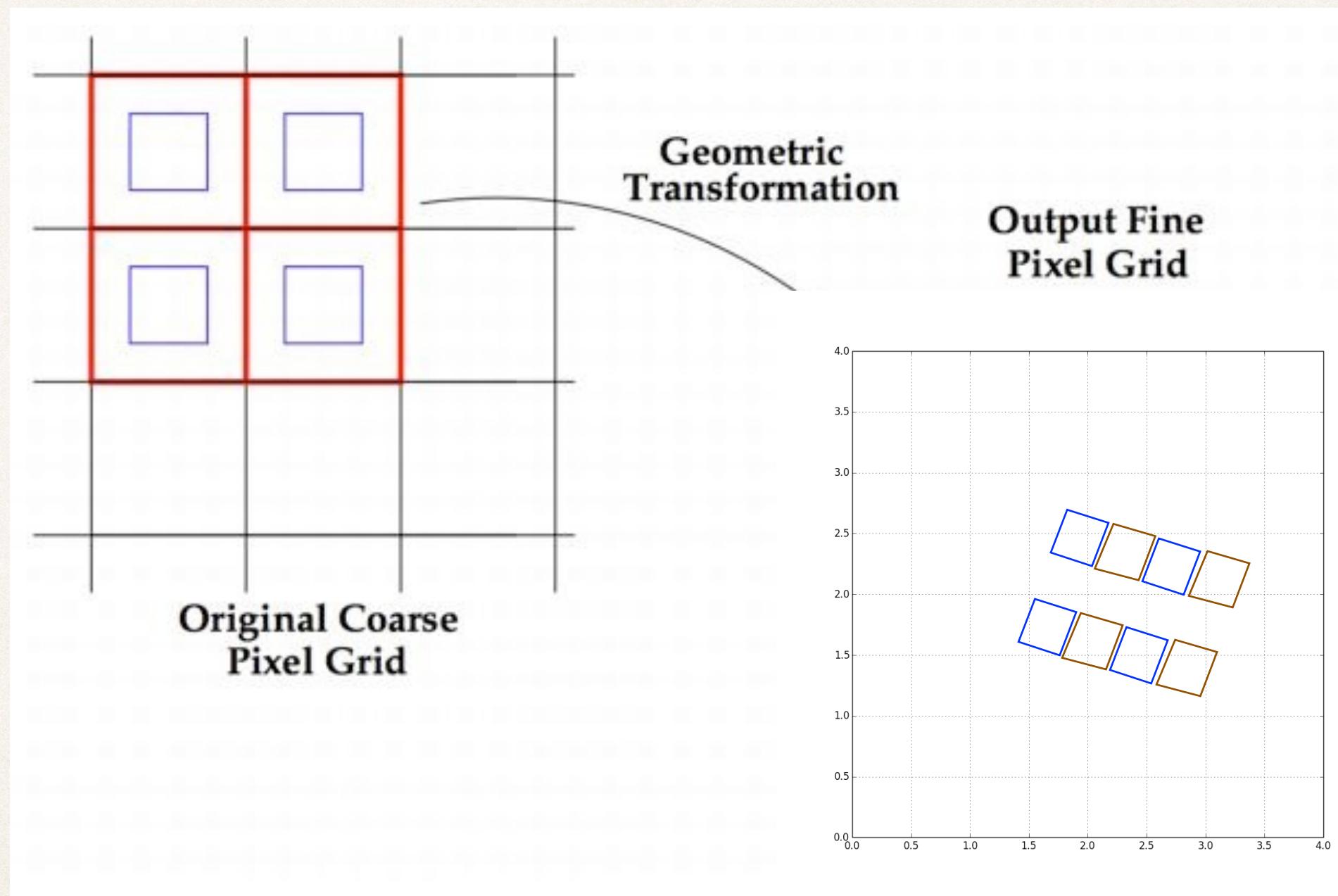
`pixfrac<1` (Drizzle)

Image 1



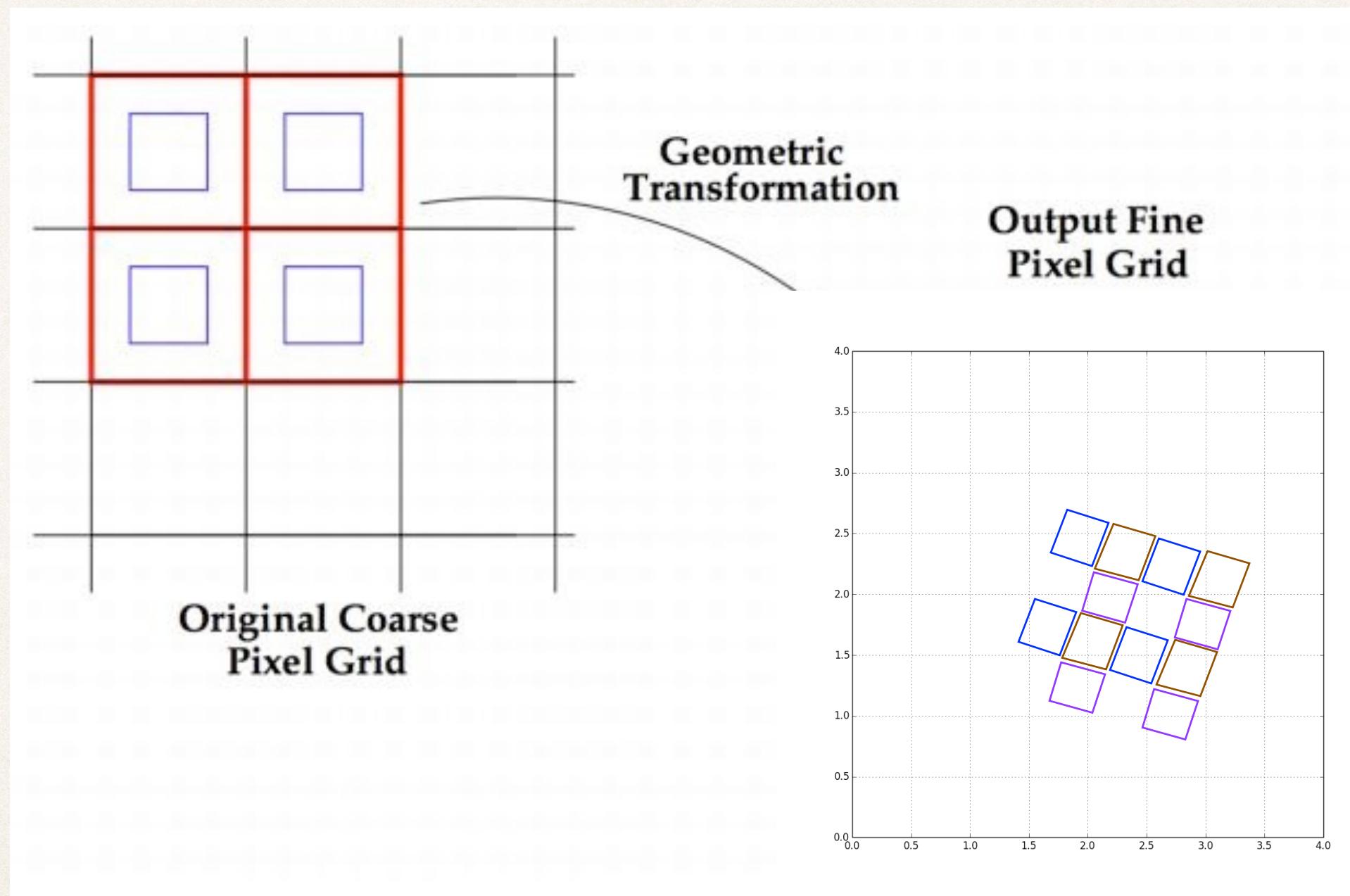
`pixfrac<1` (Drizzle)

Image 2



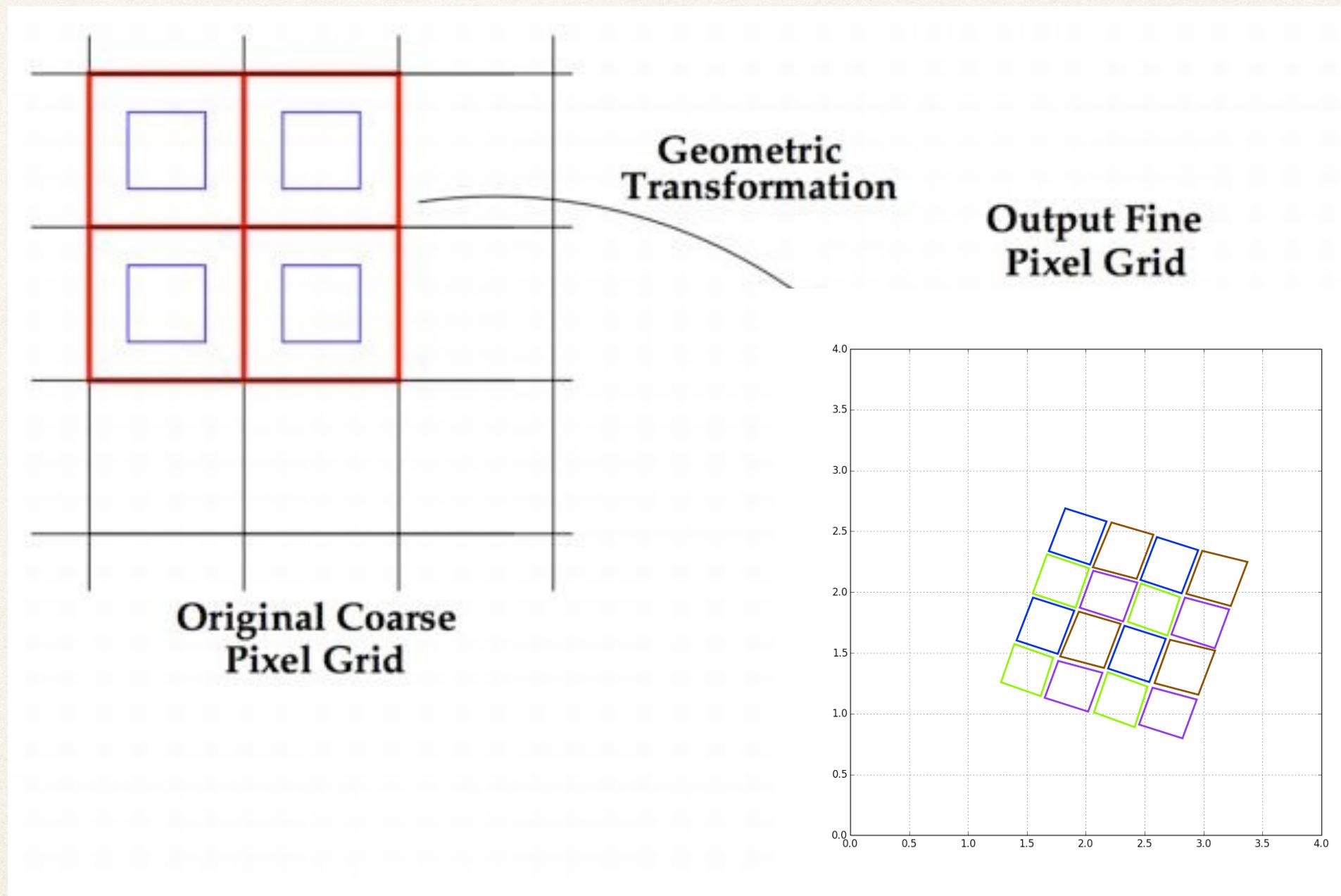
`pixfrac<1` (Drizzle)

Image 3



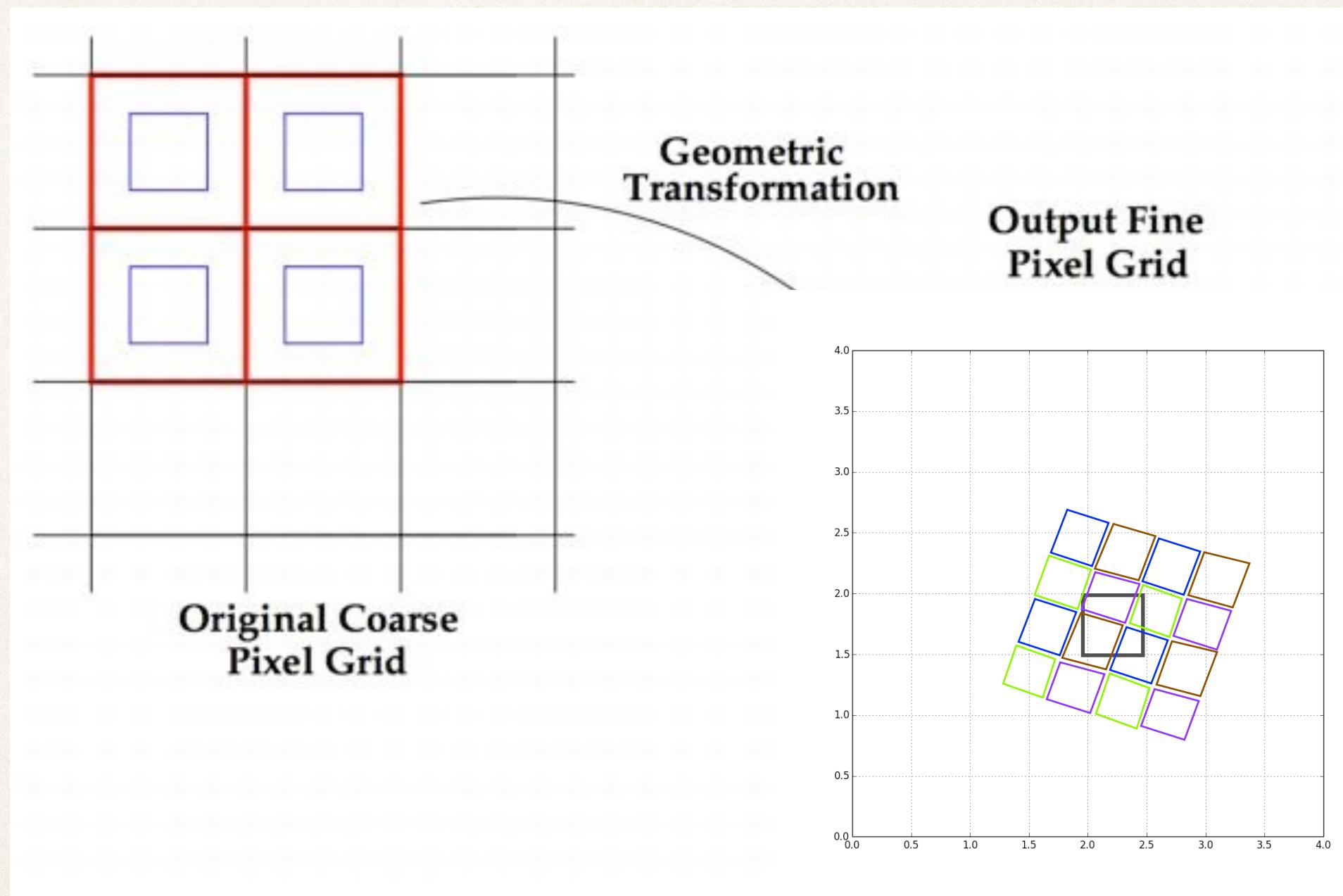
`pixfrac<1` (Drizzle)

Image 4

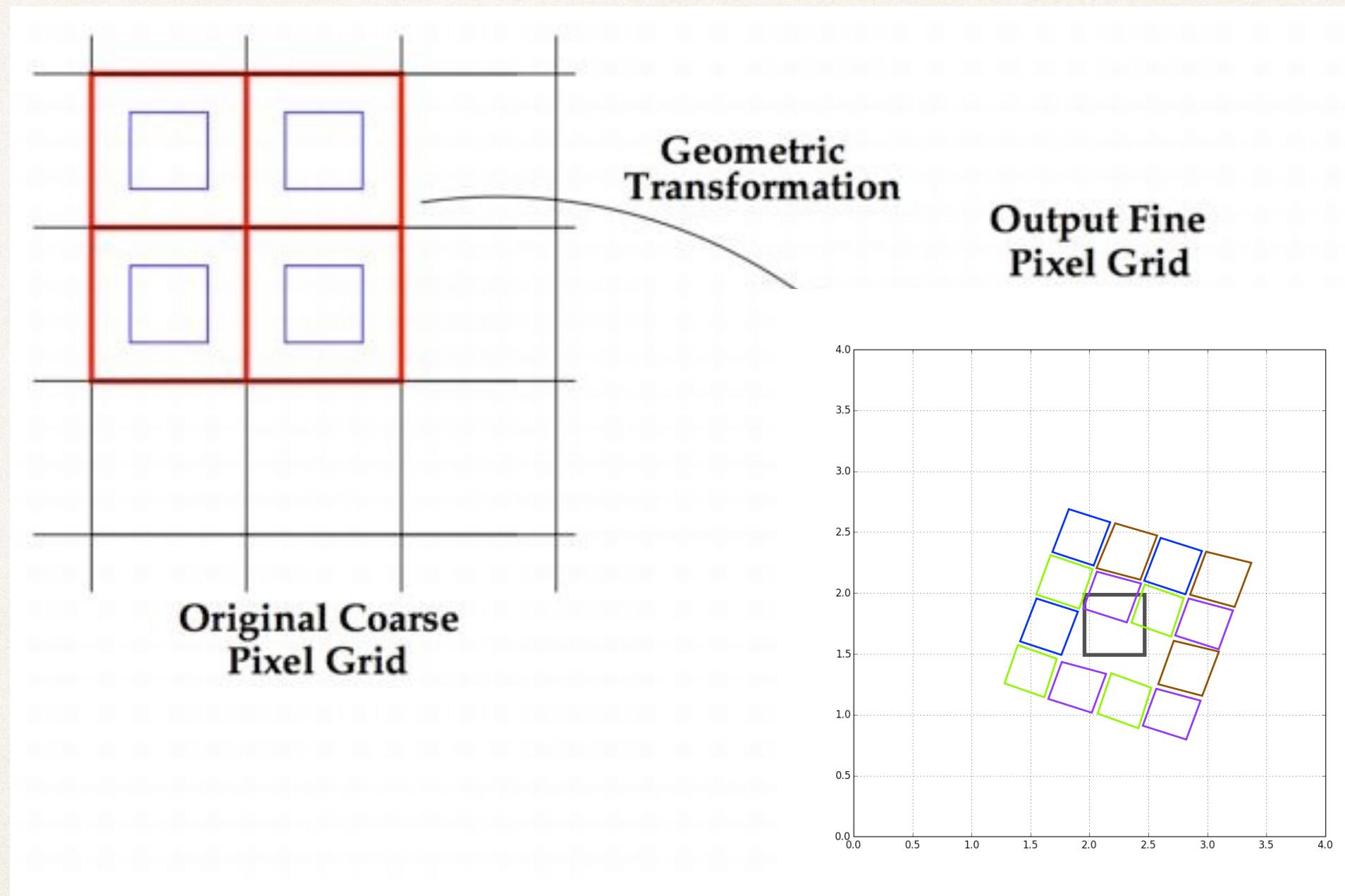


`pixfrac<1` (Drizzle)

Image 4



Flagged pixels get thrown out



# The AstroDrizzle process

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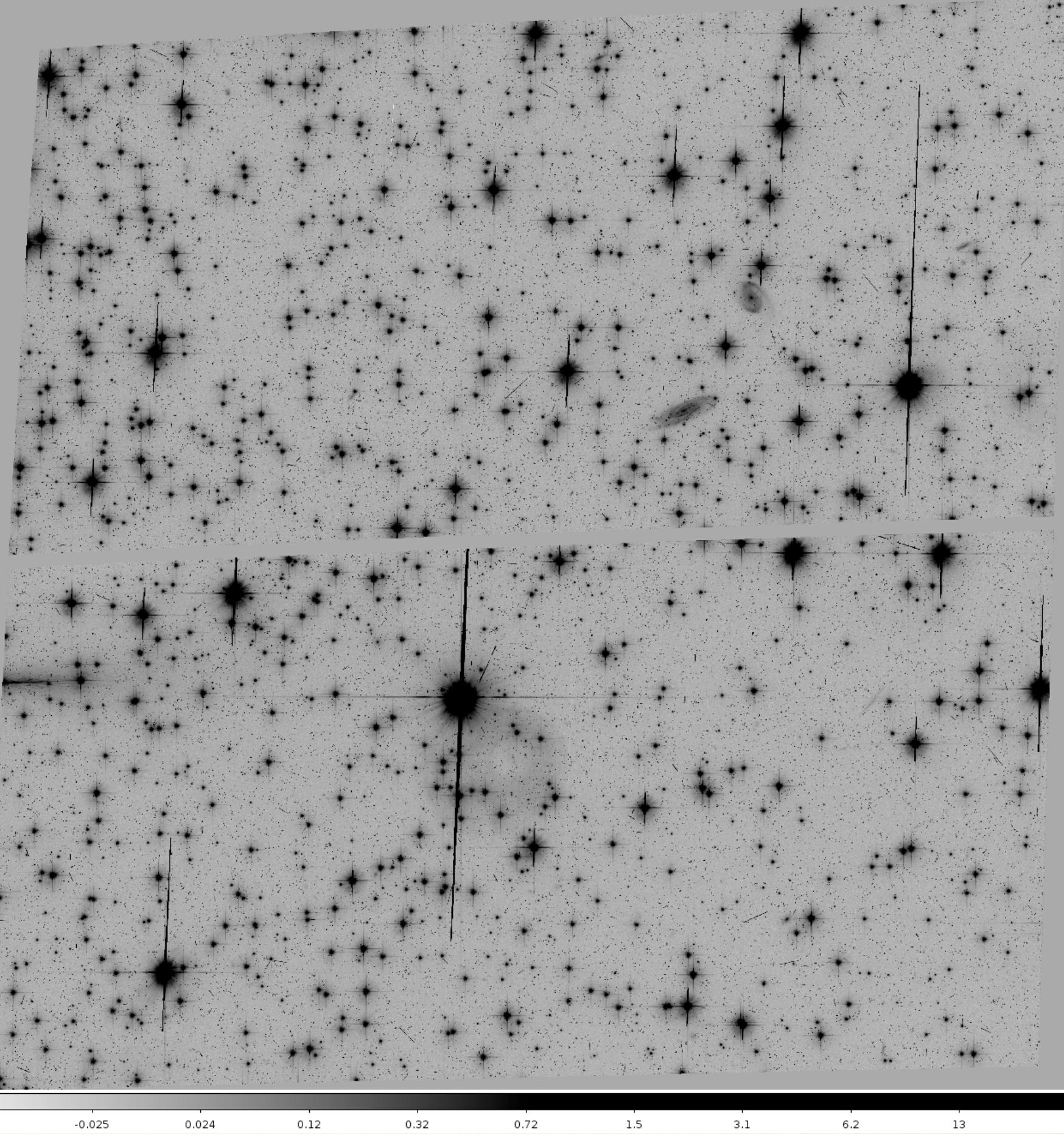
- In practice drizzling requires a number of steps which are all performed by several tasks in the Drizzelpac package:

# The AstroDrizzle process

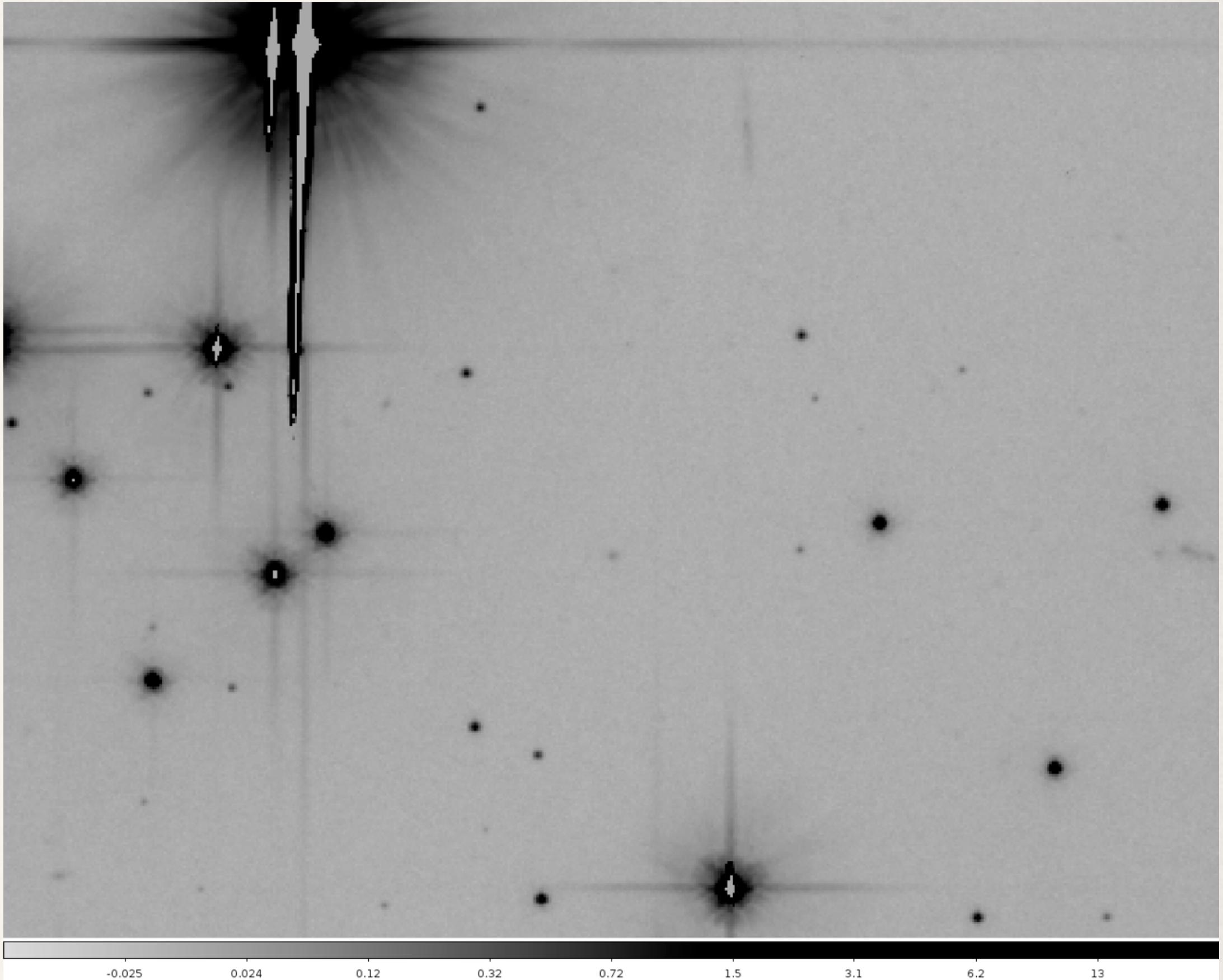
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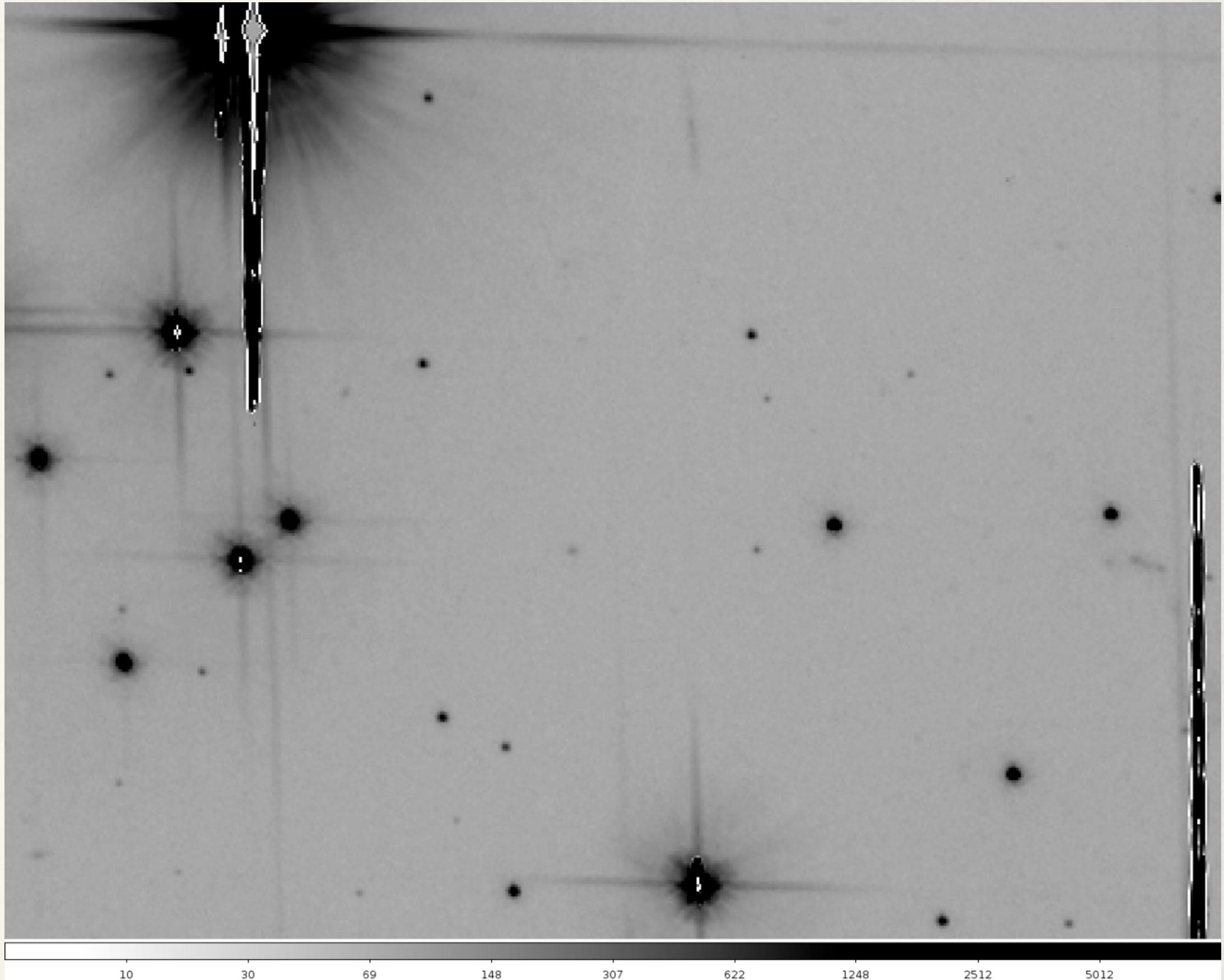
- Geometric distortion is removed from each input image
- DQ flags are used to mask out bad pixels and columns from the next step
- \*single\_sci.fits



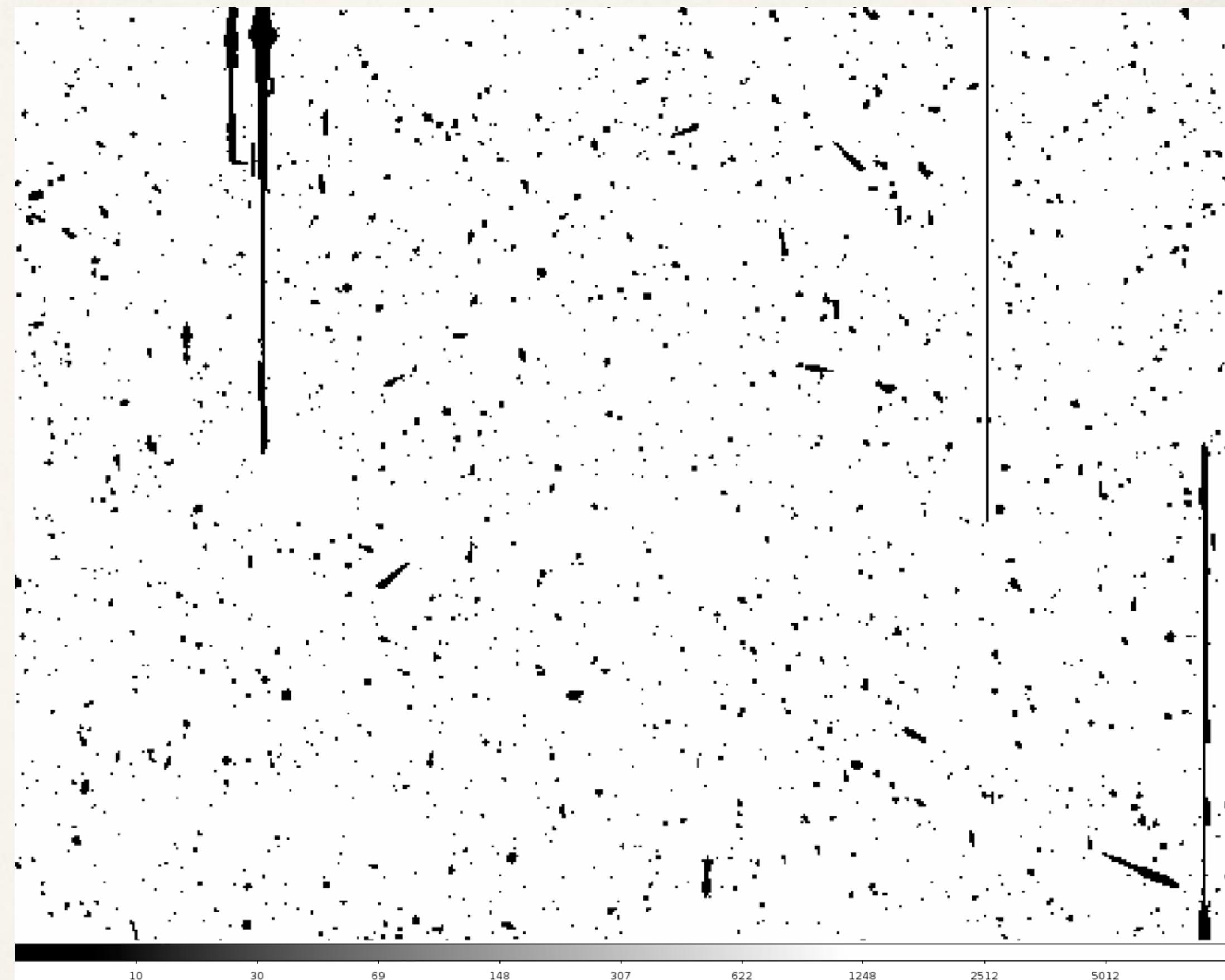
- Use all the images in your stack to make median (clean)
- Note diffraction spikes are perpendicular
- med.fits

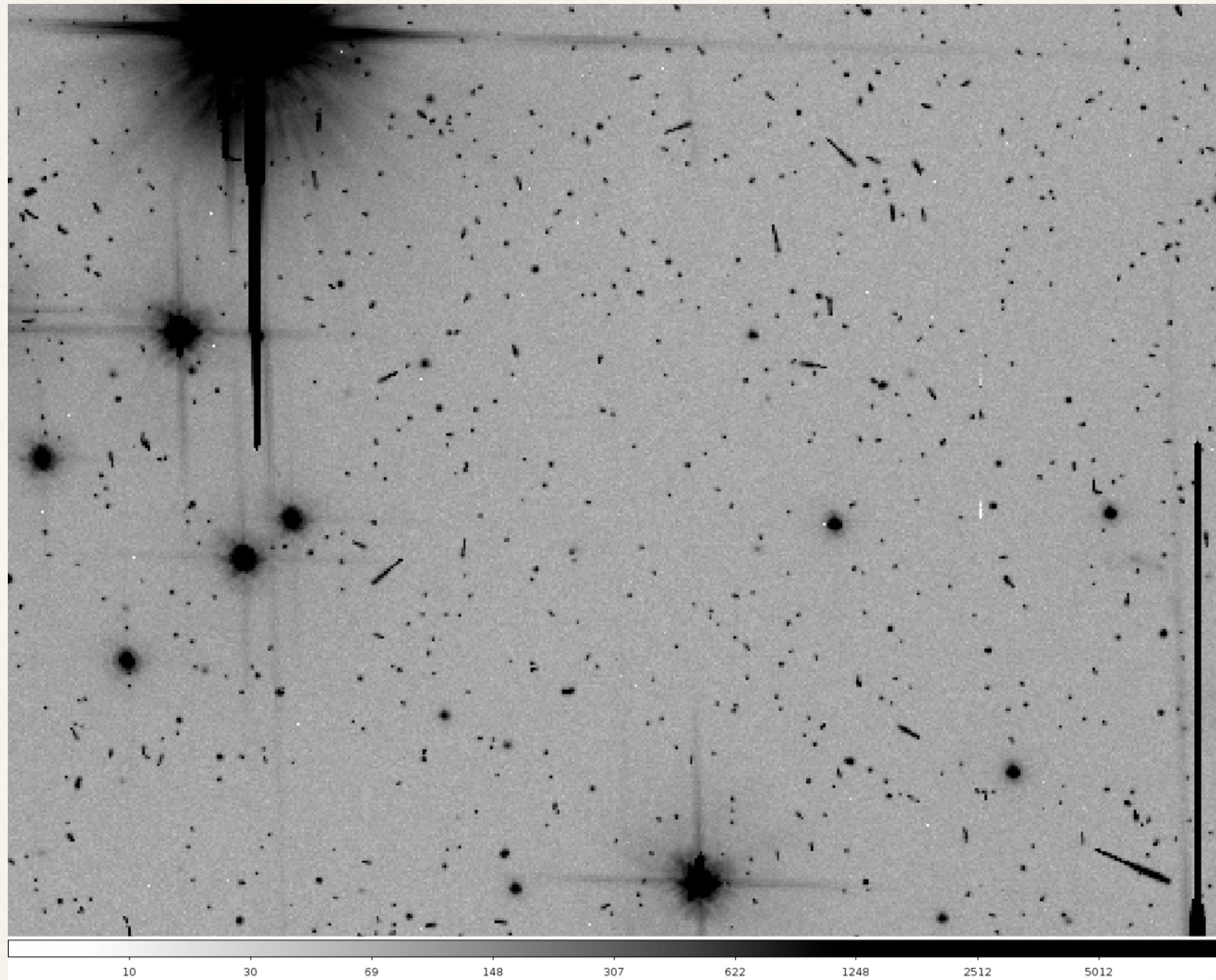


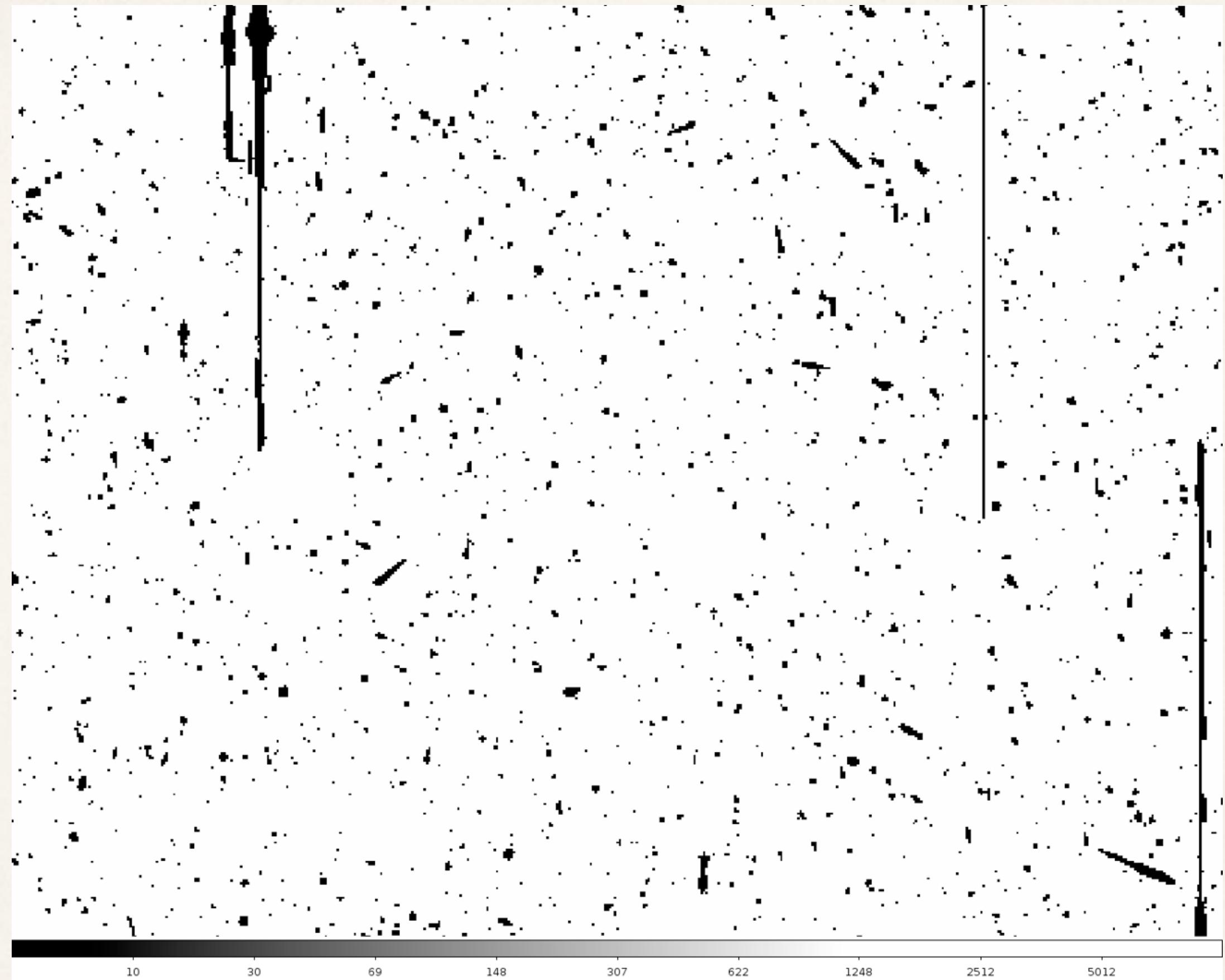
- Median image is blotted (reverse drizzled) back to original frames
- Diffraction spikes are not perpendicular
- \*\_sci#\_blt.fits



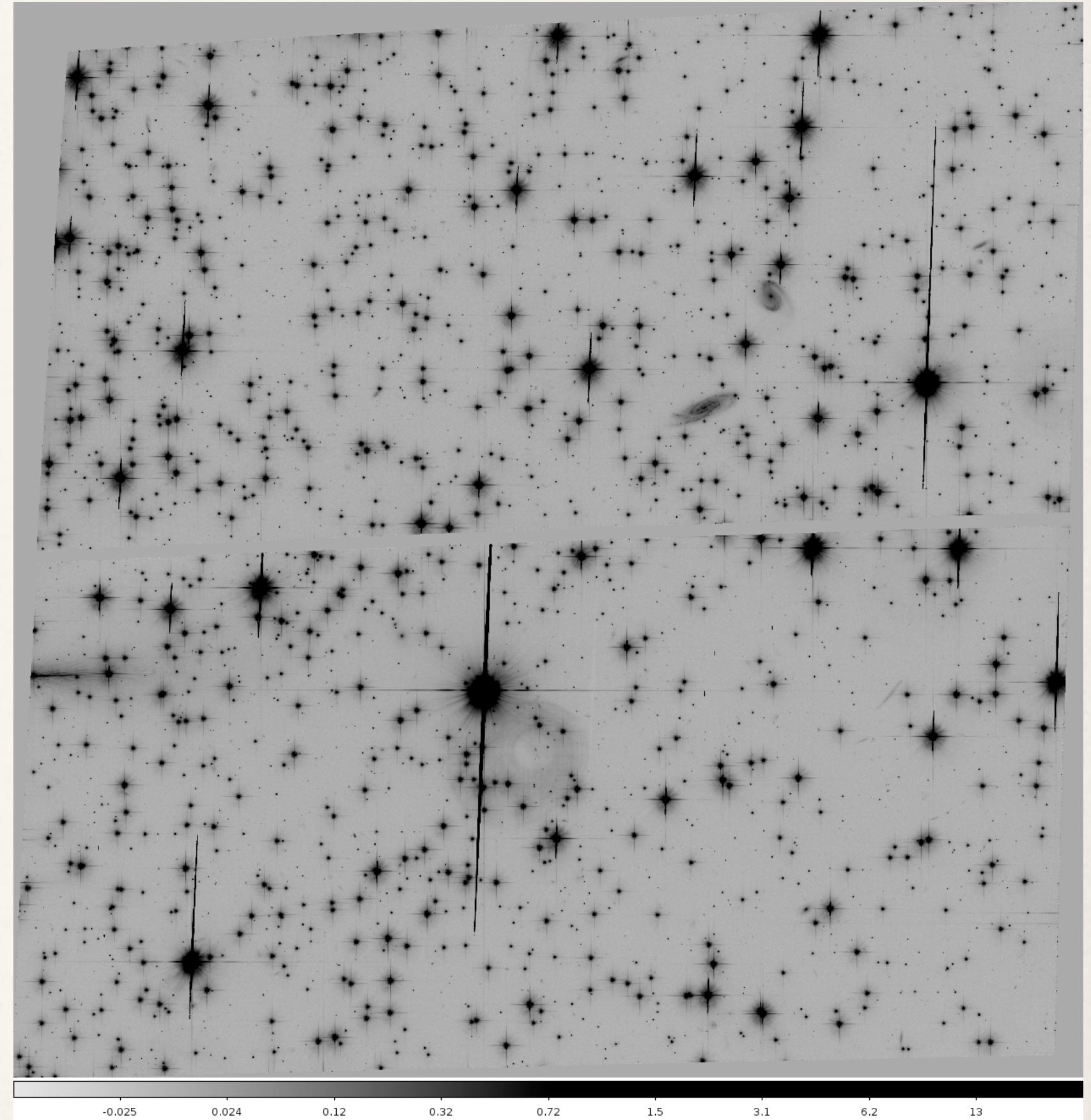
- Blotted image is compared to input images
- CRs flagged when:
  - $|data\ image - blotted\ image| > scale \times deriv + SNR \times noise$
  - Single mask + CR mask = final mask
  - `_sci#_final_mask.fits`

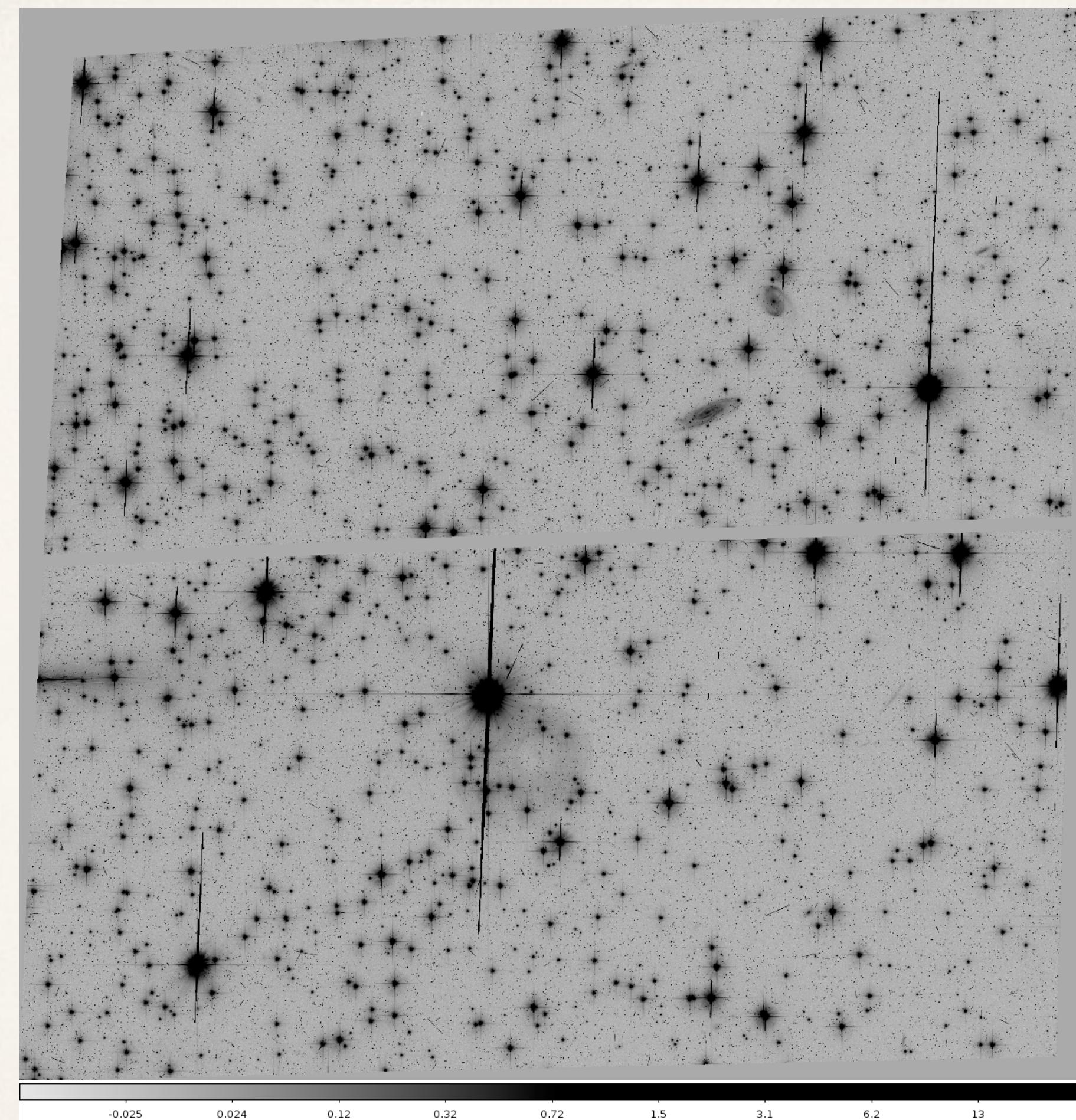


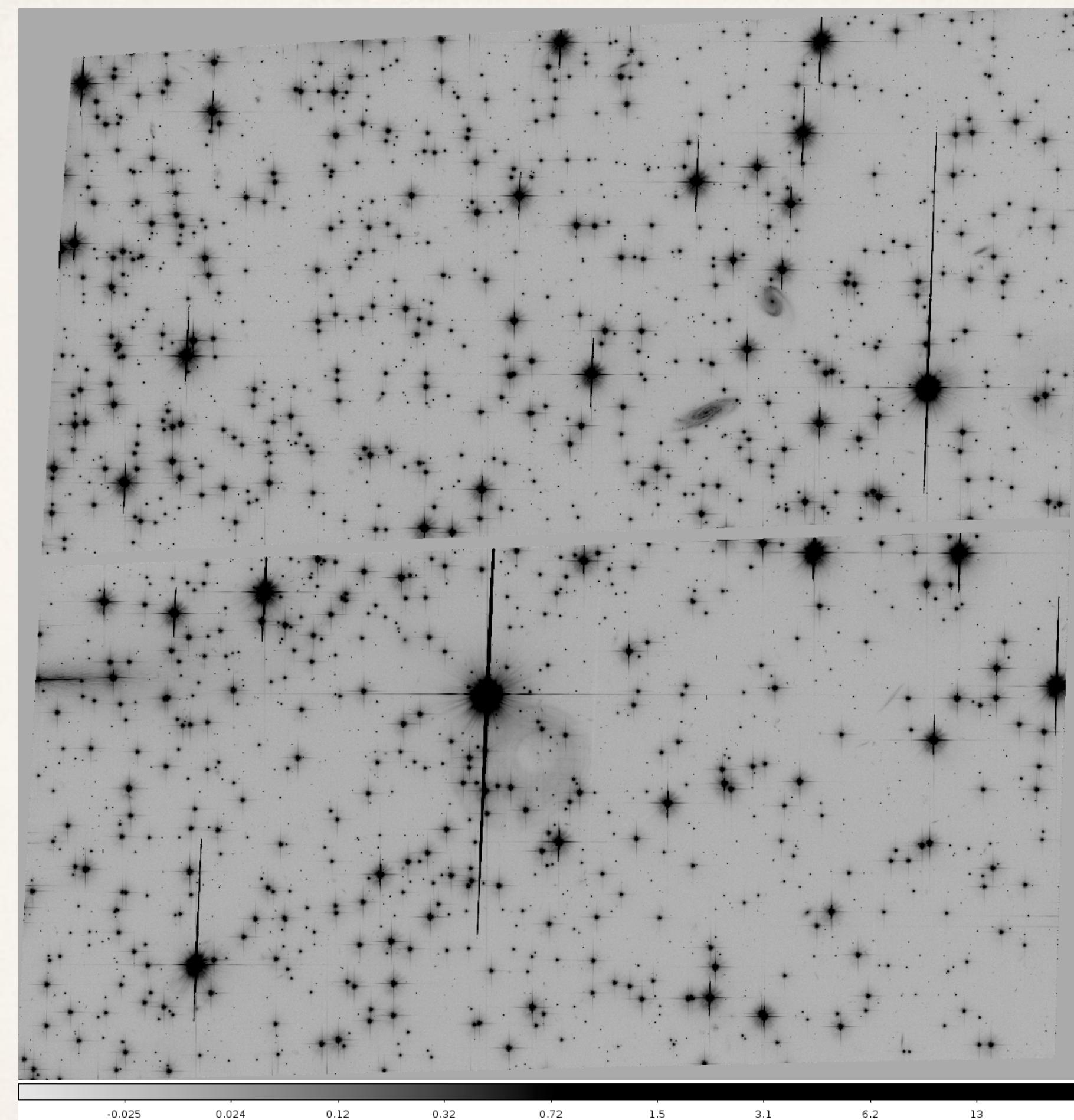




- Using mask file, input images are drizzled into final science product
- `_drc_sci.fits`







# The AstroDrizzle process

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- To recap the steps involved in the AstroDrizzle process:
- Distortion is removed from each individual image
- Undistorted images are median combined into a clean image
- Median image is blotted back to the distorted frame of each input image
- Mask files are created by comparing input images to blotted images
- Science product is created by using information from mask files and input images

# Demo

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Training document contains exercises

See Drizzle Lunch presentations in confluence:

- 4/21/2014 Tweakreg
- 5/5/2014 Astrodrizzle

File	Date-obs	Filter	Exptime (s)	Postarg_x	Postarg_y
j8ny01svq_flc.fits	2003-07-16	F606W	1142.0	0.0000	0.0000
j8ny01szq_flc.fits	2003-07-16	F606W	1142.0	0.1412	0.0363
j8ny01t5q_flc.fits	2003-07-16	F606W	1185.0	0.0748	0.1476
j8ny01t9q_flc.fits	2003-07-16	F606W	1185.0	-0.0166	0.1070
j8ny01tfq_flc.fits	2003-07-16	F606W	1185.0	0.0665	-0.0114
j8ny01ttq_flc.fits	2003-07-16	F606W	1185.0	0.0581	0.0713
j8ny02yvq_flc.fits	2003-07-17	F814W	1142.0	0.0000	0.0000
j8ny02z1q_flc.fits	2003-07-17	F814W	1142.0	0.1412	0.0363
j8ny02zdq_flc.fits	2003-07-17	F814W	1185.0	0.0748	0.1476
j8ny02zkq_flc.fits	2003-07-17	F814W	1185.0	-0.0166	0.1070
j8ny02ztq_flc.fits	2003-07-17	F814W	1185.0	0.0665	-0.0114
j8ny02zyq_flc.fits	2003-07-17	F814W	1185.0	0.0581	0.0713