PACS-IRAS comparison at 100 μm

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NHSC

Why IRAS

- Pros:
  - All sky, calibrated survey
  - Color-corrections are minimal or none
  - Wavelength corrections is 0.
- Cons:
  - Beam are vastly different
  - Source Confusion and beam comparison provide plenty of pitfalls

Introduction

- Compare PACS surface brightness values pixel-by-pixel directly with those measured by IRAS at 100 microns.
  - We expect surface brightness zero-points to differ.

Methodology

- Follows PICC-NHSC-TN-029
  - Use IRIS images, instead of originals

Step 1: Unit conversion

- For PACS nominal pixels

$$\text{Blue or Green}: \quad 1 \frac{\text{Jy}}{\text{Pixel}} = 4154.80 \frac{\text{MJy}}{\text{SR}}$$

Methodology

Step 2: Color- and Wavelength Corrections

- Both data report at 100μm, no λ correction needed.
- Relative color correction values
  - ISM: 1% (PICC-NHSC-TN-029)
  - Galaxies: ? 2-3% ?

Methodology

Step 3: Beam Convolution

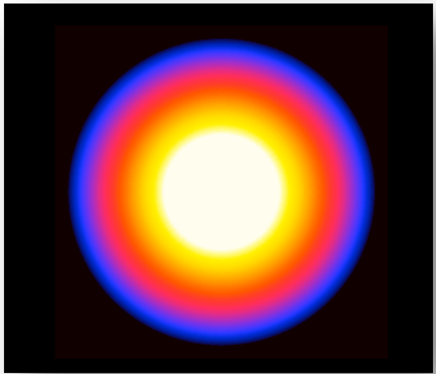
- IRIS images resampled to Homogenous beams

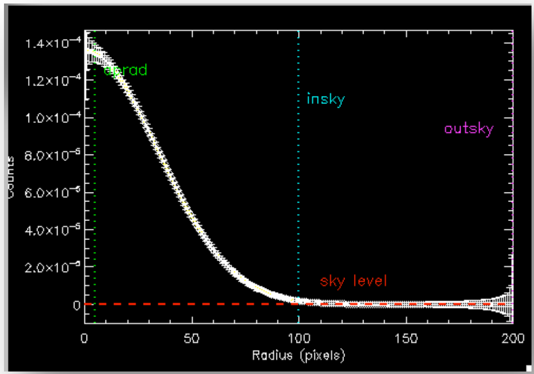
TABLE 1
COMPILATION OF IRIS RELATED QUANTITIES

Quantity	Wavelength 12 μm	25 μm	60 μm	100 μm
1. *IRAS* resolution (arcmin)	0.75 × 4.5	0.75 × 4.6	1.5 × 4.7	3.0 × 5.0
2. IRIS resolution (arcmin)	3.8 ± 0.2	3.8 ± 0.2	4.0 ± 0.2	4.3 ± 0.2
3. ISSA noise level (MJy sr^{-1})	0.04 ± 0.01	0.05 ± 0.02	0.04 ± 0.01	0.07 ± 0.03
4. IRIS noise level (MJy sr^{-1})	0.04 ± 0.01	0.05 ± 0.02	0.03 ± 0.01	0.06 ± 0.02
5. DC/AC	0.78	0.82	0.92	1.00
6. G_λ	1.06 ± 0.02	1.01 ± 0.02	0.87 ± 0.05	0.72 ± 0.07
7. DIRBE *S*(gain) (%)	5.1	15.1	10.4	13.5
8. DIRBE *S*(offset) (MJy sr^{-1})	6.0×10^{-5}	8.3×10^{-5}	0.027	0.027

Methodology

- For this comparison:
  - Using Gaussian kernels to represent IRIS beams
  - Normalized to unity to 7.5' radius



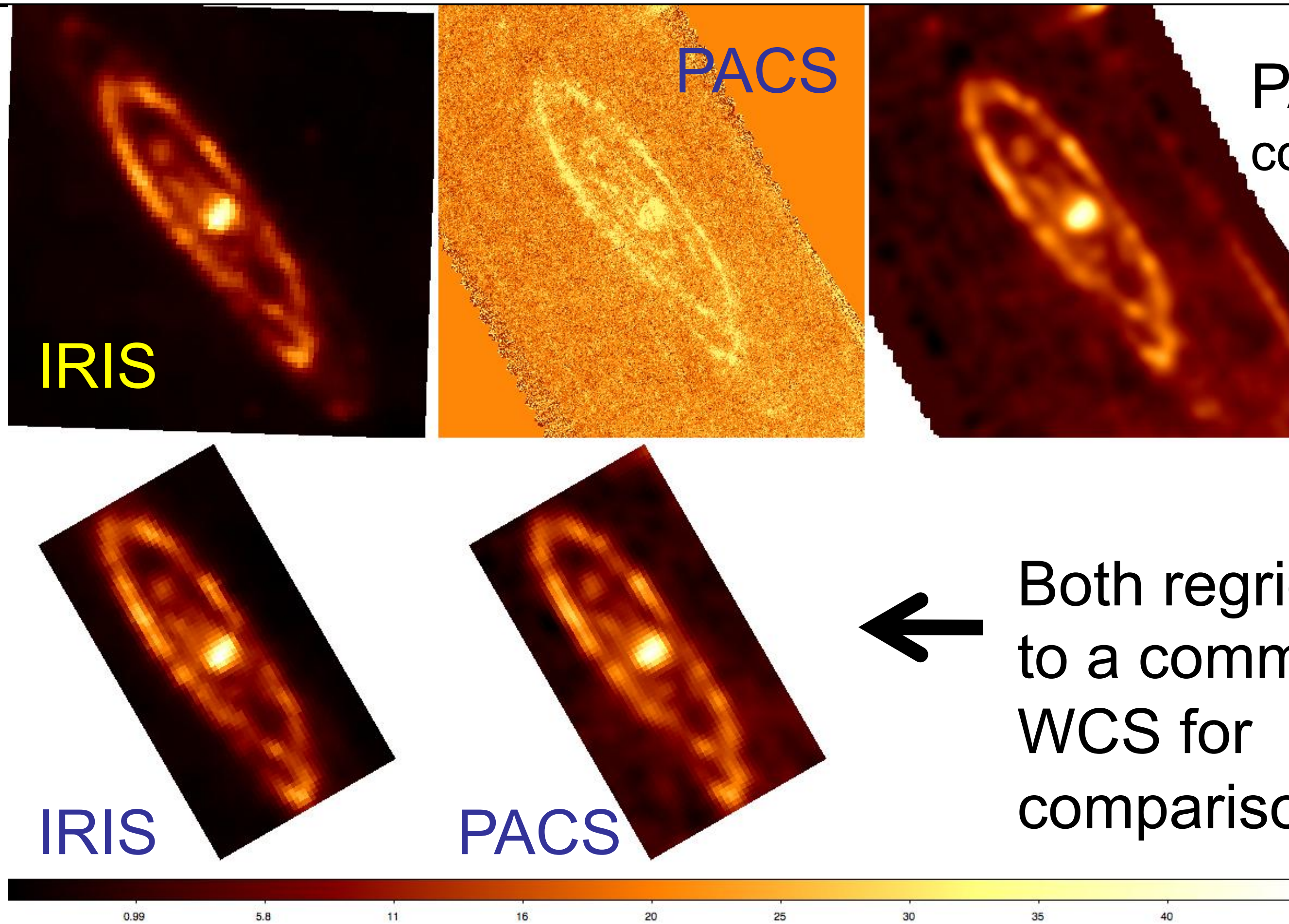


Methodology

Step 4: Regrid to a common WCS

- Allows pixel-by-pixel comparison
- Use IDL/Astrolib code 'HASTROM'

Steps 1-4 illustrated



PACS
convolved

Both regridded to a common WCS for comparison

Methodology

Step 5: Check for astrometry differences

- Use peaks in emission to identify astrometry shifts

Methodology

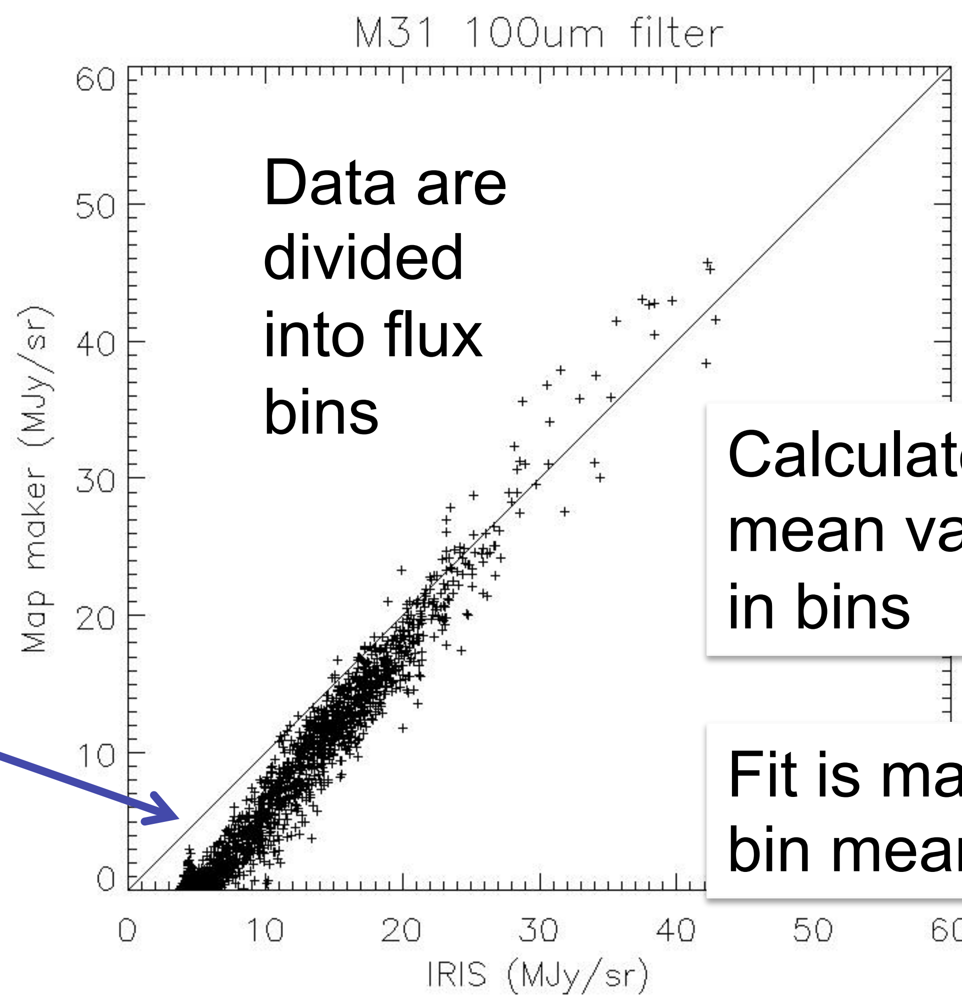
Step 6: Model pixel-by-pixel comparison as:

$$I_\lambda^{\mathrm{X}} \;=\; G_\lambda \times I_\lambda^{\mathrm{PACS}} + B_\lambda$$

- Where, X=IRIS, in this case.
- We expect B (zero-points) to vary.
- We expect G, to be near unity.

Pixel-to-pixel comparison

Start as scatter plots, then manipulated



Data are divided into flux bins

Calculate mean values in bins

Fit is made to bin means

Zero-level, offset is removed

Available Fields

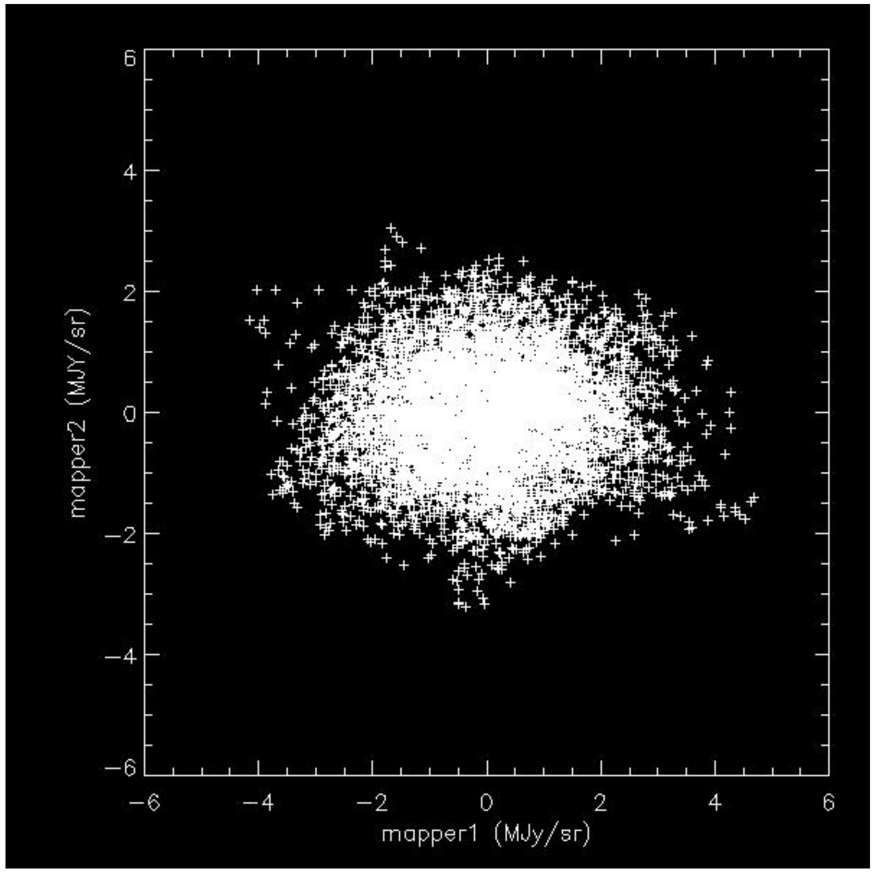
- Five 100μm images included

Atlas field	(cosmology field)
M31	(very large galaxy)
NGC 6946	(large galaxy)
Polaris	(ISM field)
Sa 187-188	(Galactic regions)

Results: Atlas

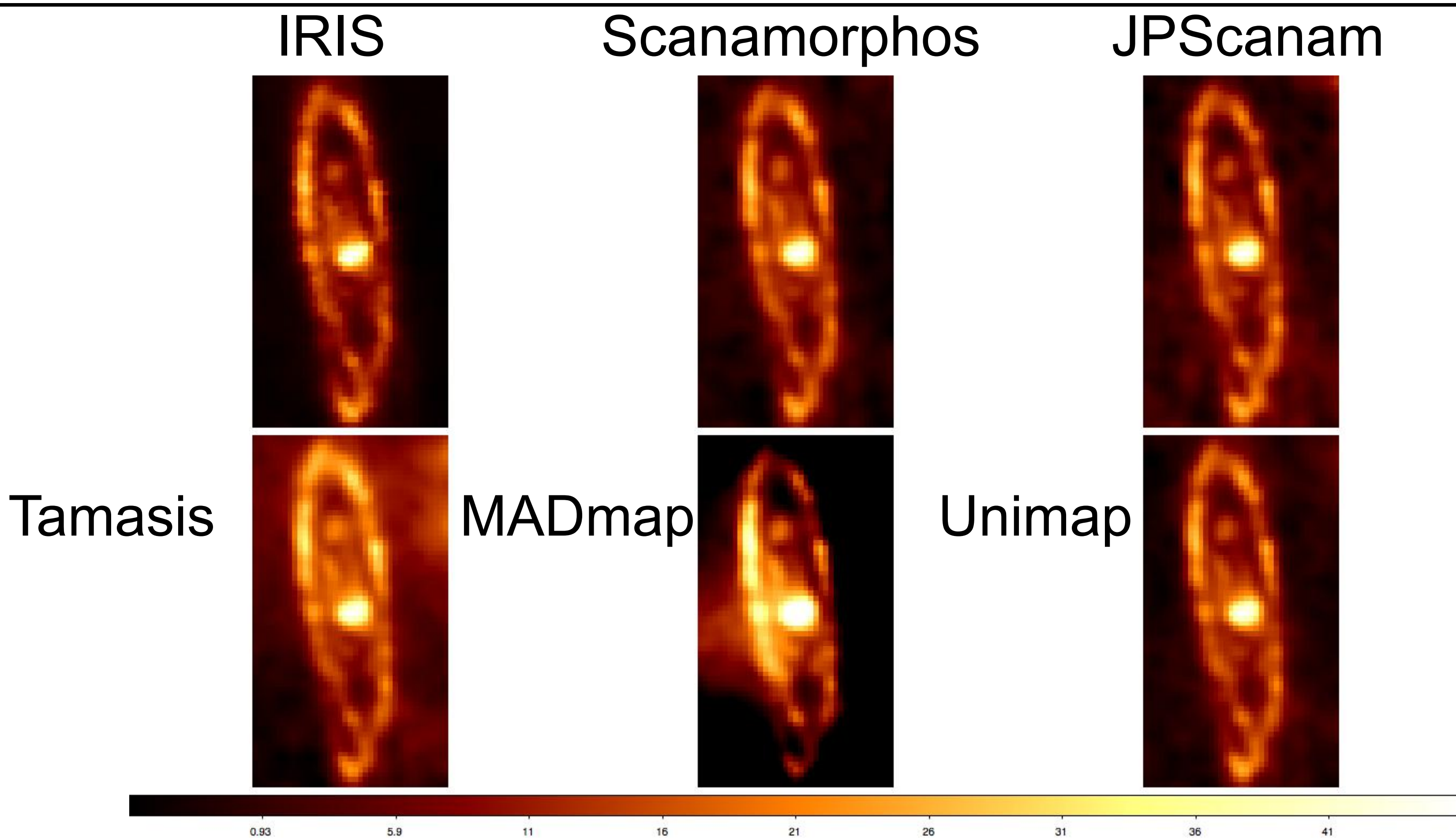
Too faint.

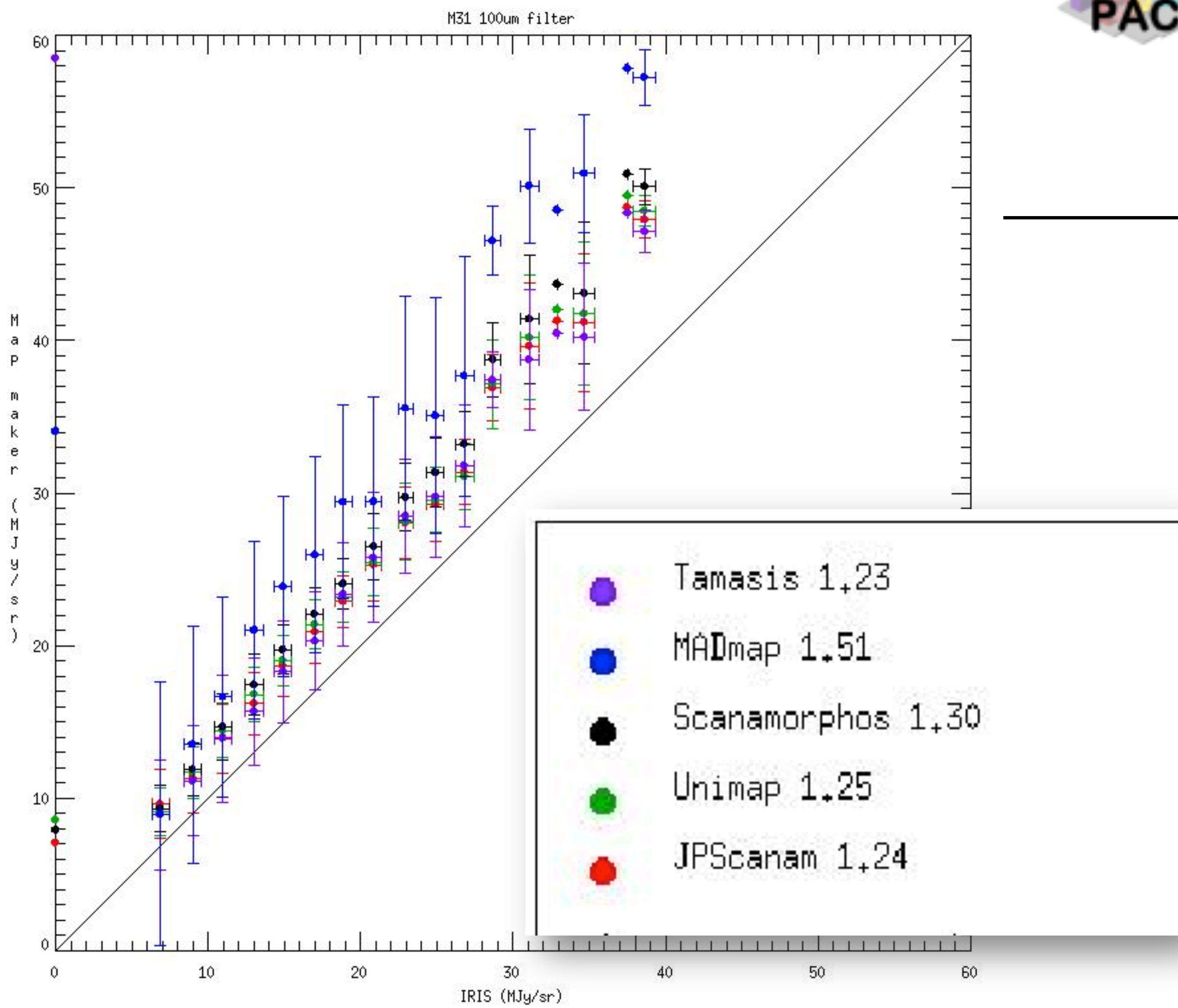
<5MJy / sr



Not useful for comparison.

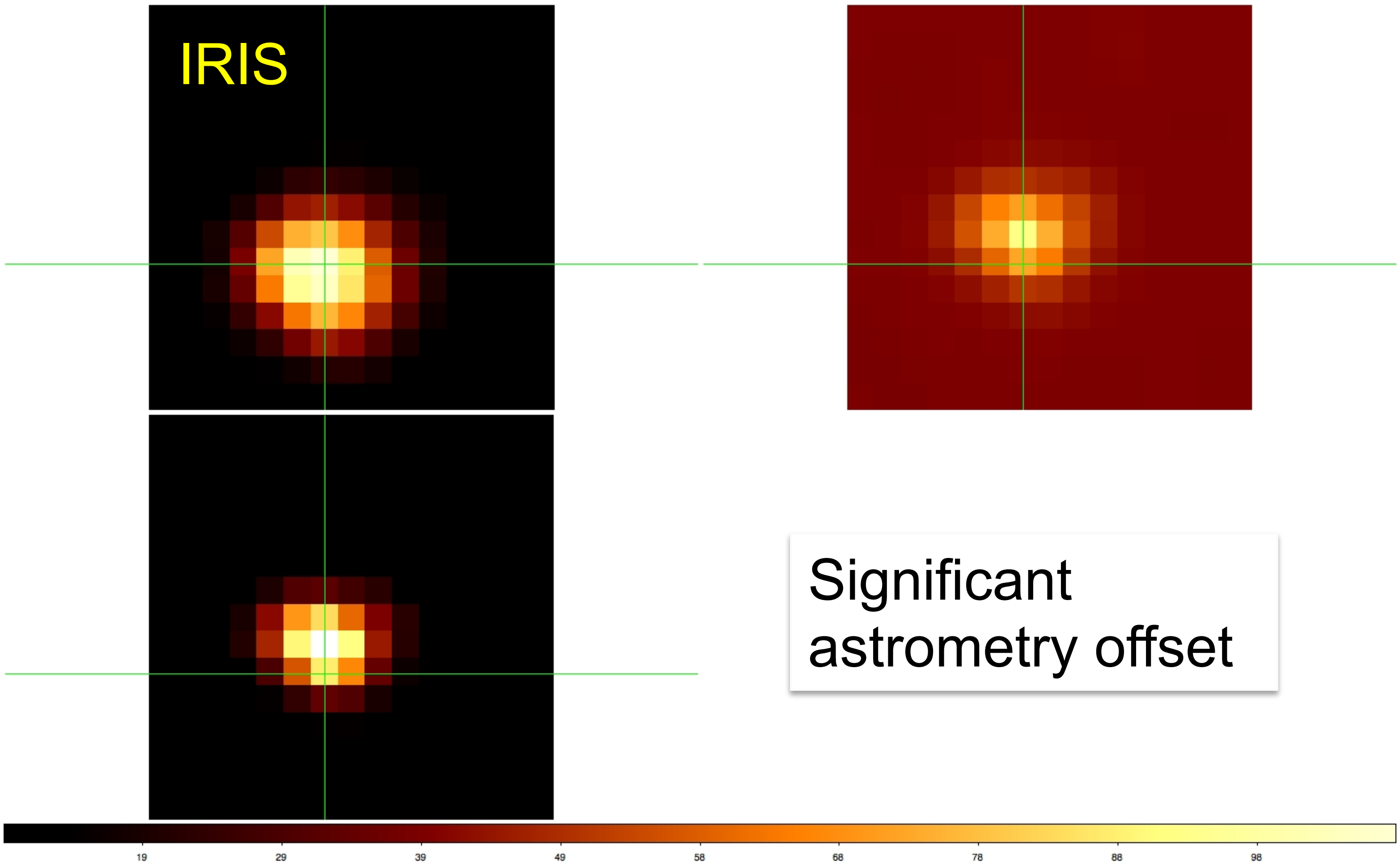
Results M31


IRIS
Scanamorphos
JPScanam
Tamasis
MADmap
Unimap
0.93
5.9
11
16
21
26
31
36
41

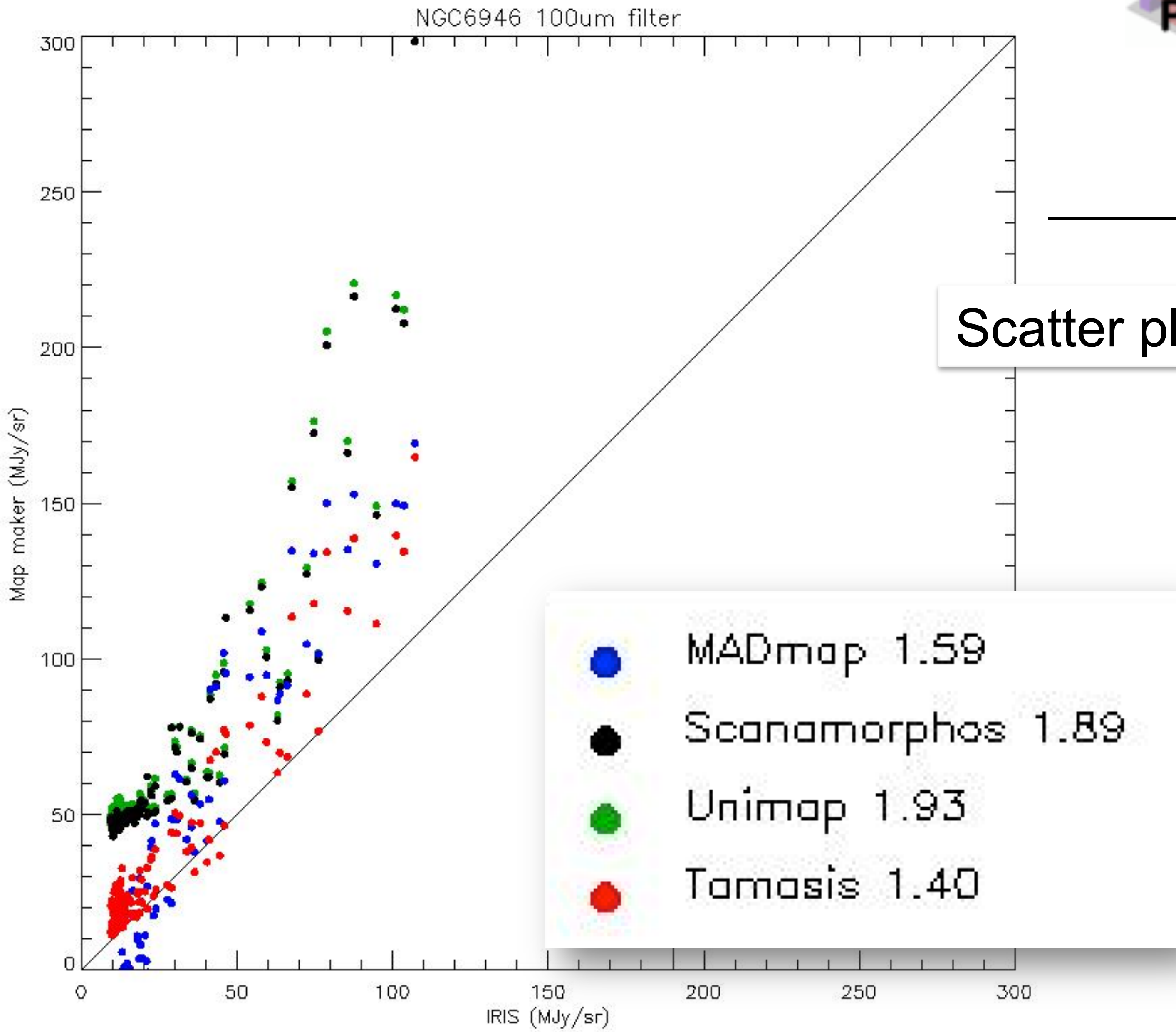


M31 100um filter
Map maker (MJy/sr)
IRIS (MJy/sr)
0
10
20
30
40
50
60
Tamasis 1.23
MADmap 1.51
Scanamorphos 1.30
Unimap 1.25
JPScanam 1.24

Results NGC 6986

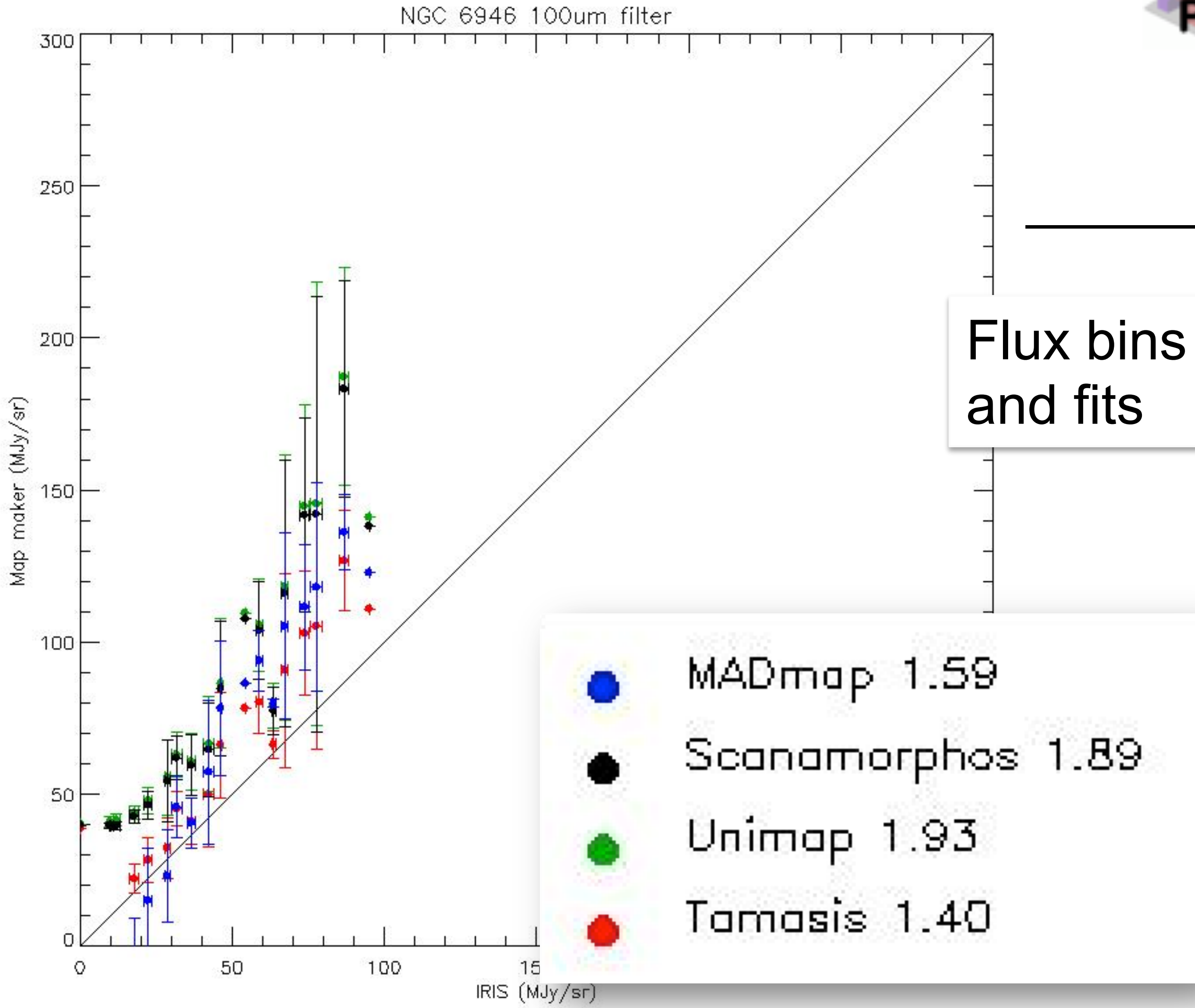


Significant astrometry offset



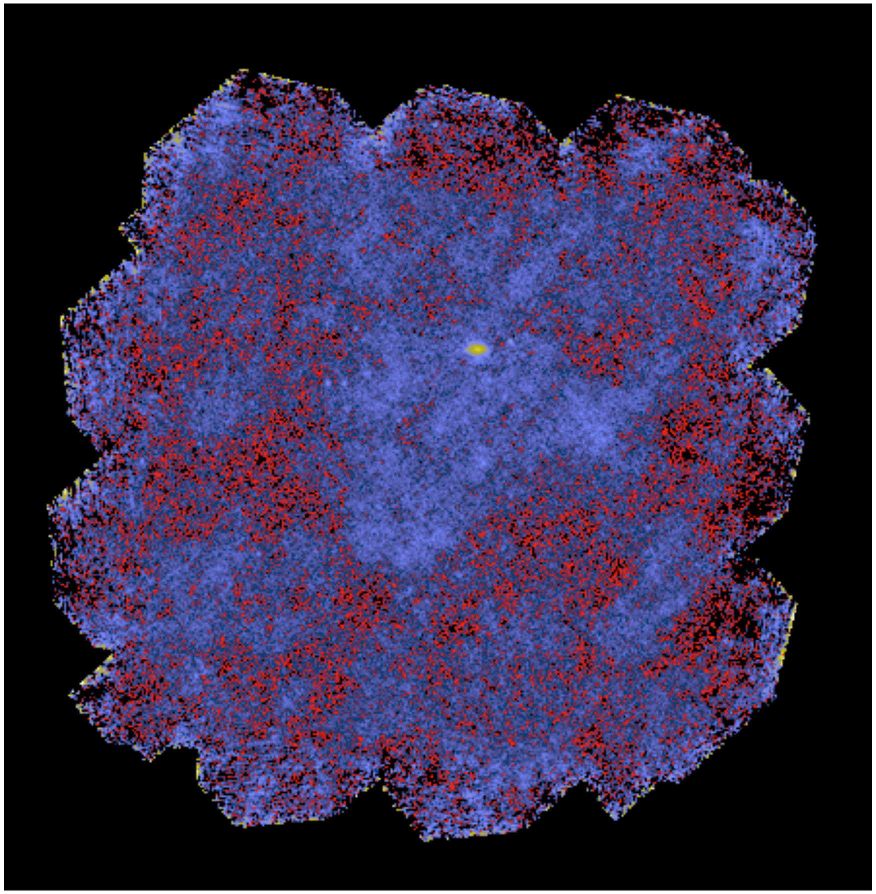
Scatter plot

Flux bins and fits

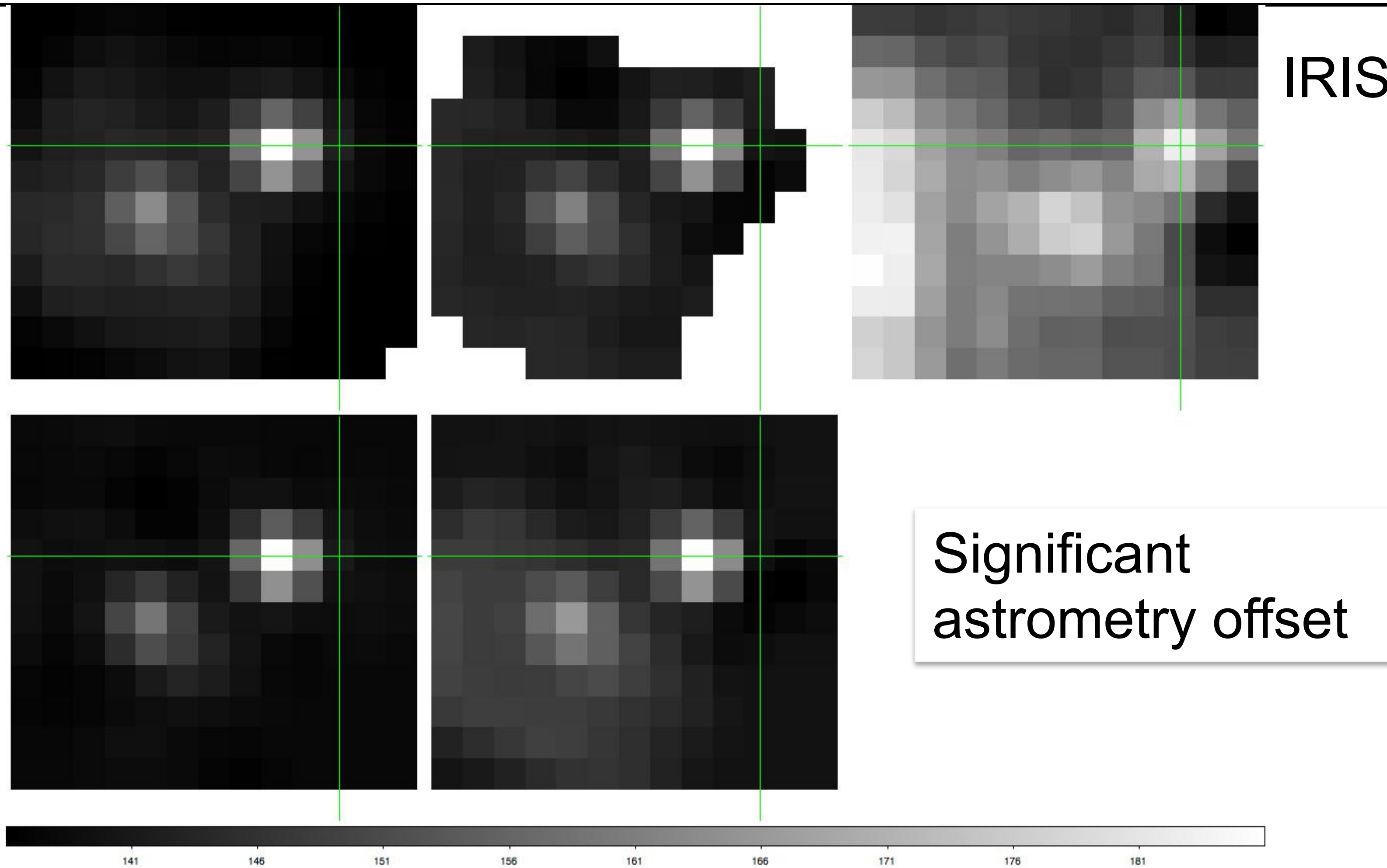


Results Polaris

Too faint, better suited for other comparison metrics.

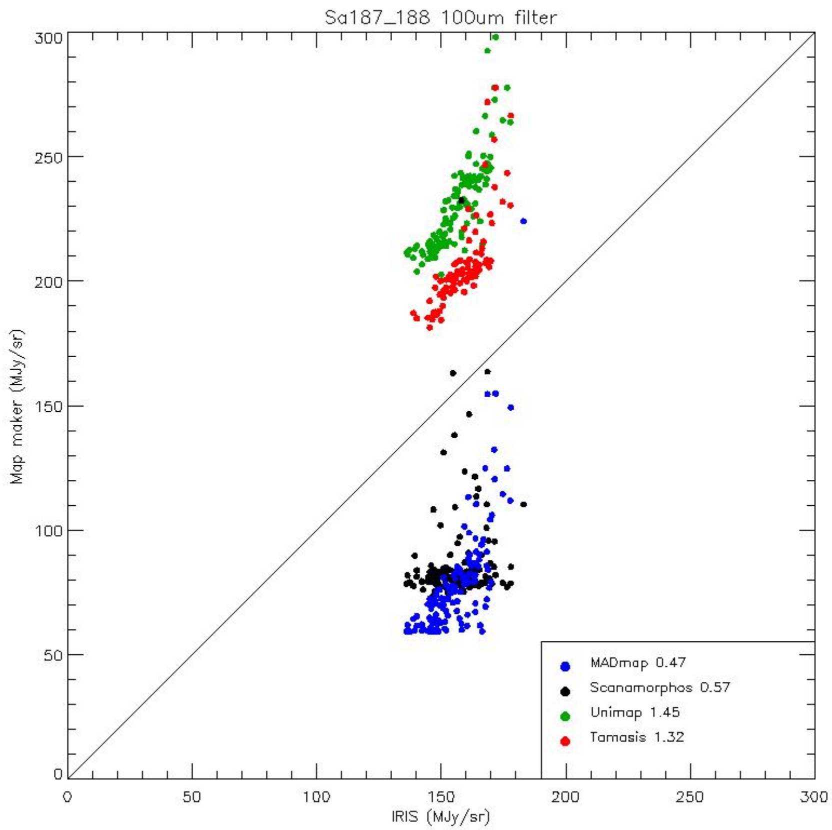


Sa 187-188 Field



Significant astrometry offset

Sa 187-188 Field



But, no meaningful correlations. Not understood.

Summary

- Five 100μm images included

Atlas field	(too faint)
M31	(ok)
NGC 6946	(ok)
Polaris	(too faint)
Sa 187-188	(bad fits)

Gain Factors

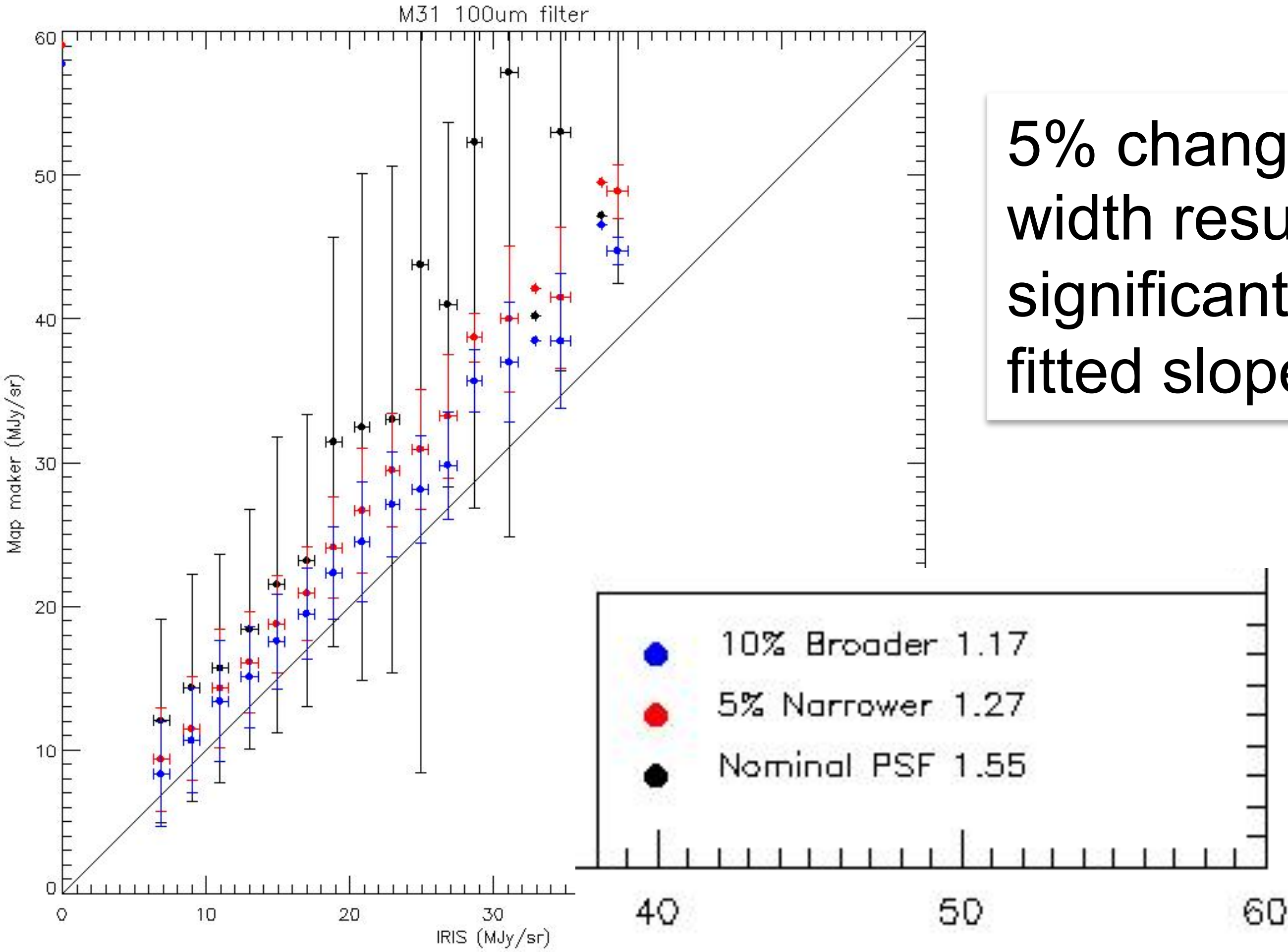
Field	Scanam	MADmap	Unimap	Tamasis	JPScanam
M31	1.30	1.51	1.30	1.23	1.24
NGC 6946	1.89	1.59	1.93	1.40	-

This comparison

	Gain Factors
SAp-PACS-MS-0718-11	20-30%
PICC-NHSC-TN-029	1.14-1.27

Previous Results

Is this a beam effect?



5% change in beam width results in significant change in fitted slope values

What about IRIS calibration?

the DC/AC factor (responsivity at $5'$ scale) and the responsivity at scale of $1\overset{\circ}{.}25$ (deduced from the comparison of *IRAS* and DIRBE with scale and brightness—see § 4.3). The largest responsivity difference between these two scales is in bright regions where it reaches ∼20% (see Fig. 8). We estimate that the typical uncertainty on the responsivity at scales smaller than $1\overset{\circ}{.}25$ is ∼5% for the four bands.

In comparison with DIRBE:

Typical uncertainty ~5%

Largest ~20%

Conclusions

- Only two useful 100μm comparison fields in this selection.
- Difficult to interpret the results:
  - Accurate beam profiles are critical for comparing the results to IRAS
  - We are likely seeing effects of beam inaccuracies
  - Combined Calibration uncertainties are of the order of discrepancy in Gain factor. Or,
  - Too few data points available for proper fits

Conclusion

- Current effort is not sufficient.
  - dominated by IRIS, PACS and beam uncertainties dominate the comparison
- We require:
  - A dedicated, large, study of several large (>1 degree) fields at 100 μm to beat down the systematic errors.

For map-making purposes …

- Mappers are generally consistent with each other:
  - Within the small number statistics available here.
  - For M31, MADmap slightly higher than others
  - For NGC 6946, large dispersion of Gain factor values within the map-makers