SPIRE Map-Making Test

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on behalf of SPIRE map-making test team

Goals:

- Compare SPIRE map-makers (including high resolution map-makers) objectively.
- Identify the strengths and limitations of different map-makers in dealing with known SPIRE map-making issues (e.g. “cooler burps”).

Participating Map-Makers:

- Naïve Mapper (default of SPIRE SPG until HIPE 8)
- Destriper, polynomial-order = 0 (default of SPIRE SPG since HIPE 9)
- Destriper, polynomial-order = 1
- Scanamorphos
- SANEPIC
- Unimap
- HiRes (high resolution mapper)
- SUPREME (high resolution mapper)

Test Cases: Requirements

They shall cover the following parameter space of SPIRE scanmap observations:

- observation mode (nominal/parallel, scan speed, sampling rate);
- source brightness;
- map size;
- depth;
- complexity of the extended emission.

Also, they shall include examples of:

- observations suffering from ”cooler burp" effects;
- sky regions with strong large-scale gradient.

In total: 13 test cases (5 real, 8 simulated)

Input Data:

- The TOD have the format of SPIRE Level-1 Photometer Scan Product (PSP).
- The TOD were corrected for the following instrumental effects (as the default of the SPIRE pipeline process):
  - glitches
  - electrical low-pass filter
  - non-linearity
  - bolometer time response.
- For each test case, two sets of input data were generated:

  Set-1: including also temperature drift correction; no turn-around data (used by Naïve, Destriper, HiRes)

  Set-2: no temperature correction; including the turn-around data (used by Scanamorphos, SANEPIC, Unimap, SUPREME)

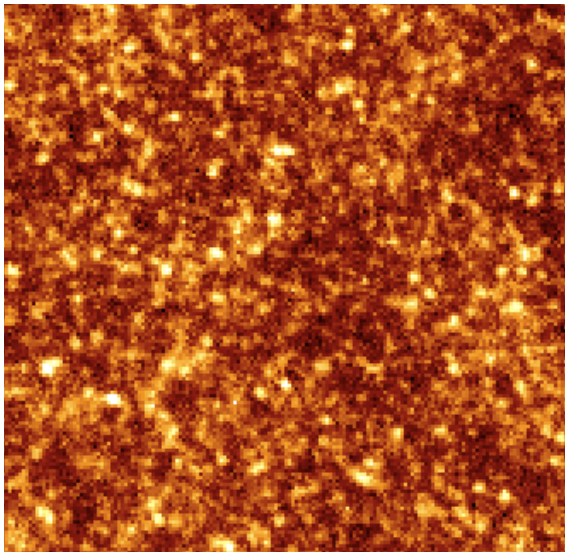
Simulations: Why do we need them?

- The "truth" maps of simulated observations provide unbiased benchmarks for map-maker comparisons.
- Allowing for the effects of noise, deviations from the "truth" are objective measures for biases introduced in map-making process.

Simulation Strategy

- All simulations have two layers: noise layer & truth layer

Noise Layer:
a real obs of a dark field



(including both instrumental noise & confusion noise)

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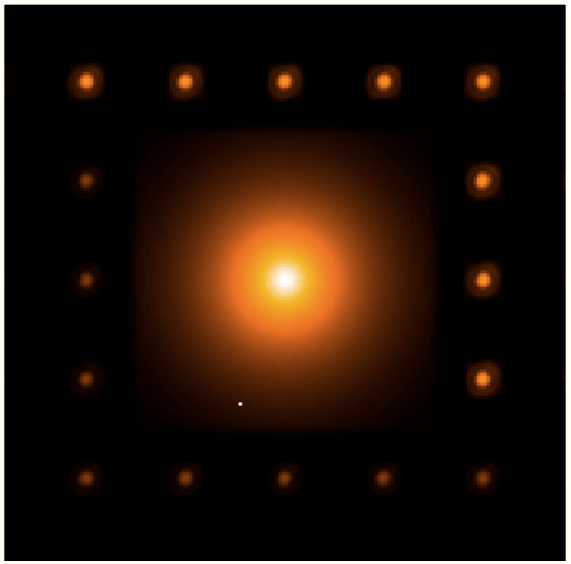
Truth Layer:
sky model map



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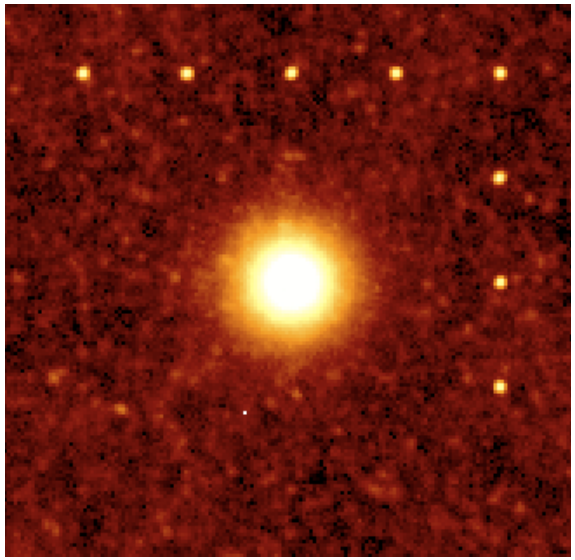
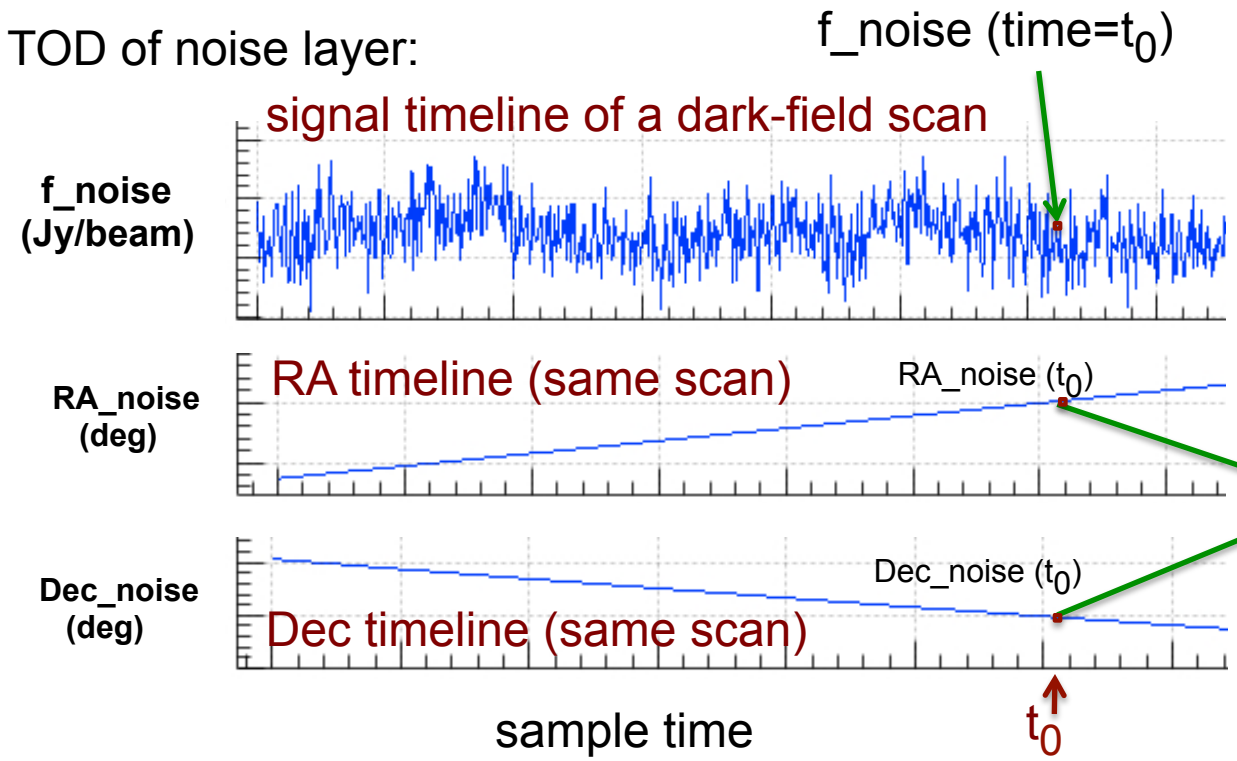
Simulated map

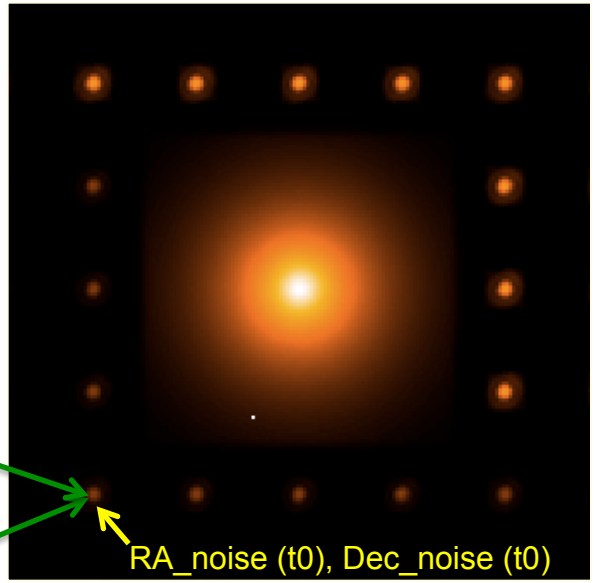


Simulating TOD (Time Ordered Data):

f_simu (time) = f_noise (time) +
f_truth [RA_noise (time), Dec_noise (time)]

TOD of noise layer:





truth map
(adopting WCS of noise map)

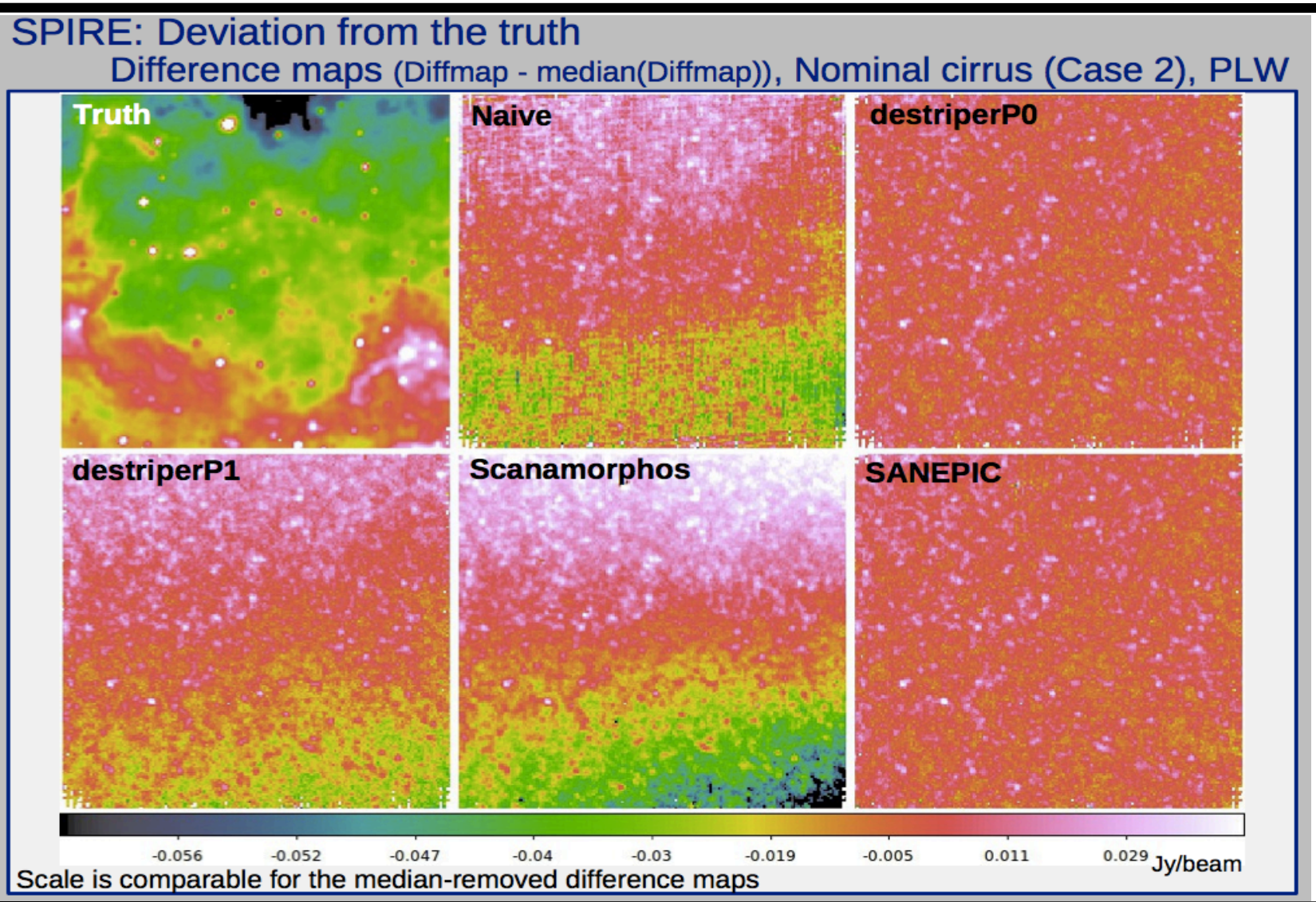
Summary of Map-Makers' Results

		Mapmaker						
Case	Description	Naive	Destriper	Scanamorphos	SANEPIC	Unimap	HiRes	SUPREME
1	Nominal sources (simu)	x	x	x	x	x		
2	Nominal cirrus (simu)	x	x	x	x			
3	Nominal dark	x	x	x	x			
4	Nominal M51 (simu)	x	x	x	x			
5	Fastscan sources (simu)	x	x	x	x	x		
6	Fastscan MK center (simu)	x	x	x	x	x		
7	Fastscan dark	x	x	x	x			
8	Parallel sources (simu)	x	x	x	x			
9	Parallel MK center (simu)	x	x	x	x			
10	Parallel cirrus (simu)	x	x	x	x	x	x	x
11	Parallel dark	x	x	x	x			
12	Nominal NGC 628	x	x	x		x	x	
13	Parallel Hi-Gal L30	x	x	x		x	x	

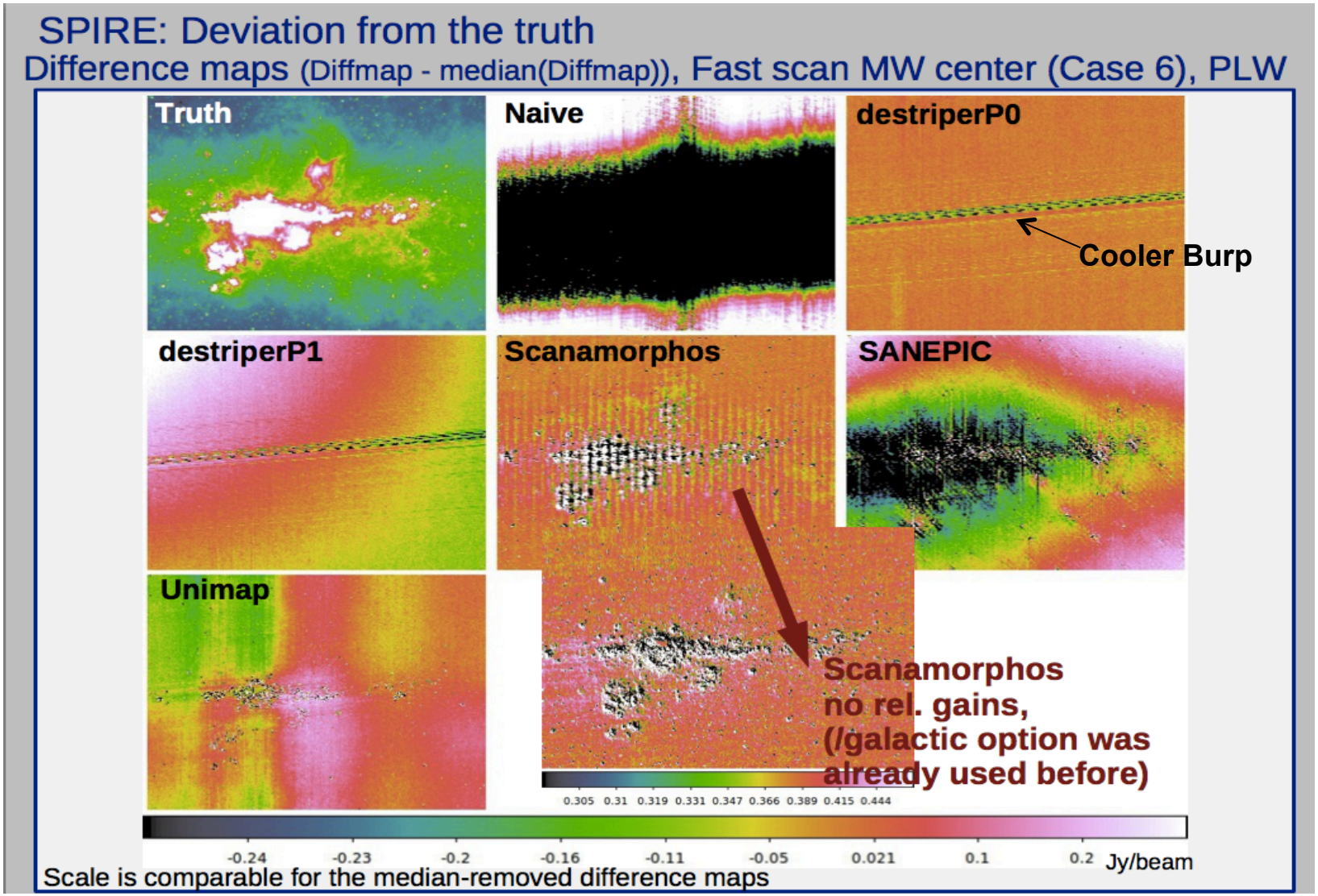
Map-Maker Comparison Metrics

(1) deviation from the truth
(2) spatial power spectra
(3) point source & extended source photometry
(4) metrics for super-resolution maps

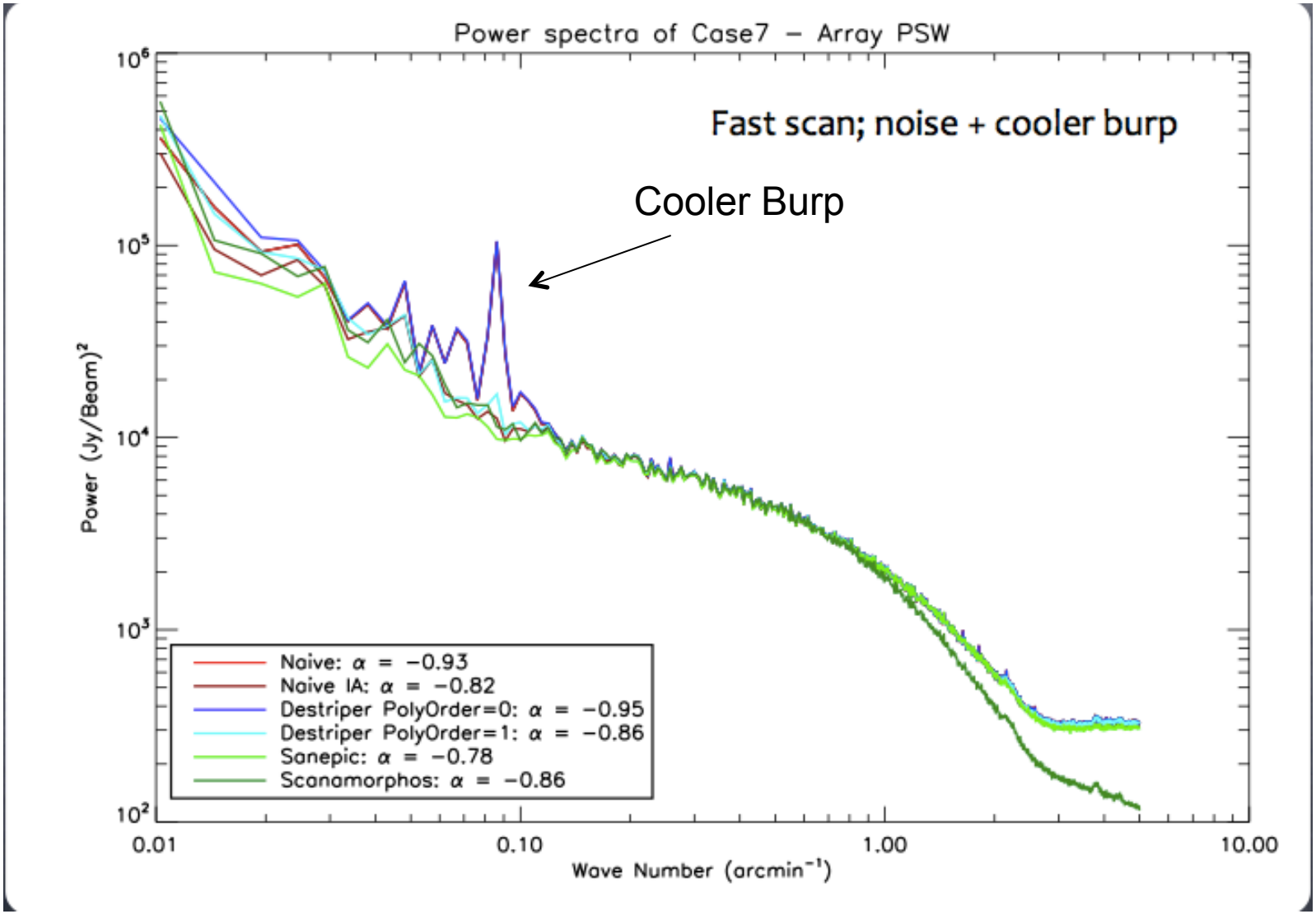
Metric 1: Deviation From Truth



Metric 1: Deviation From Truth



Metric 2: Spatial Powerspectra

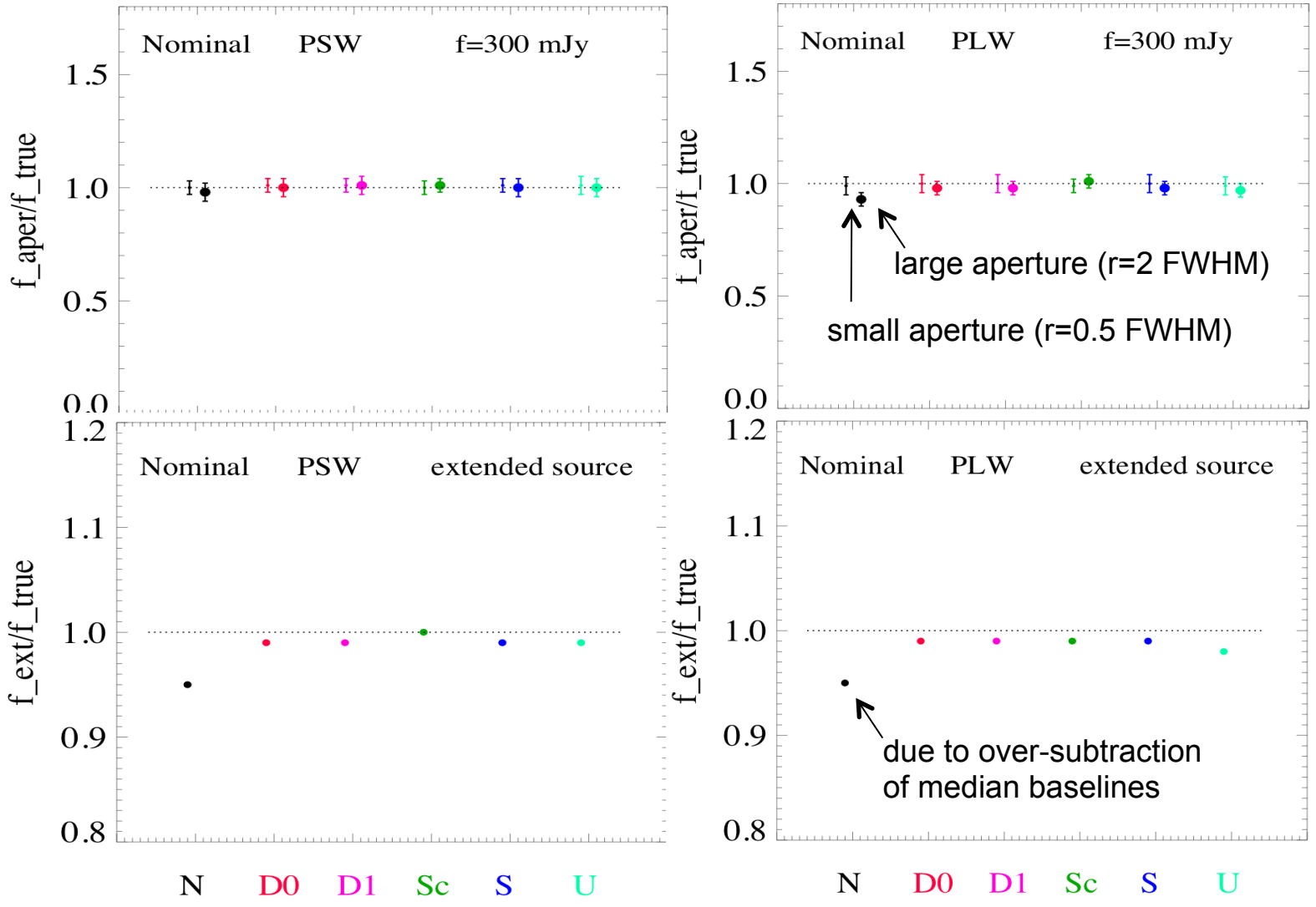


Metric 3: Point & Ext Source Photometry

Aperture photometry:

Point Sources →

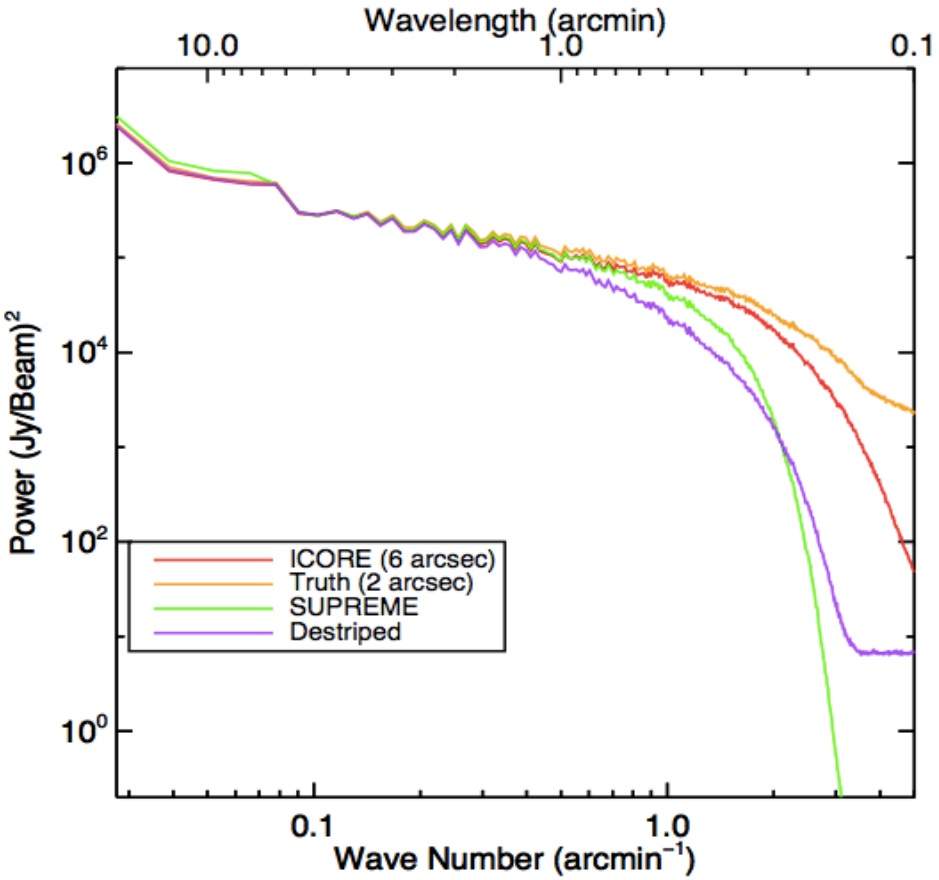
Extended Sources →



Metric 4: Super-resolution Maps

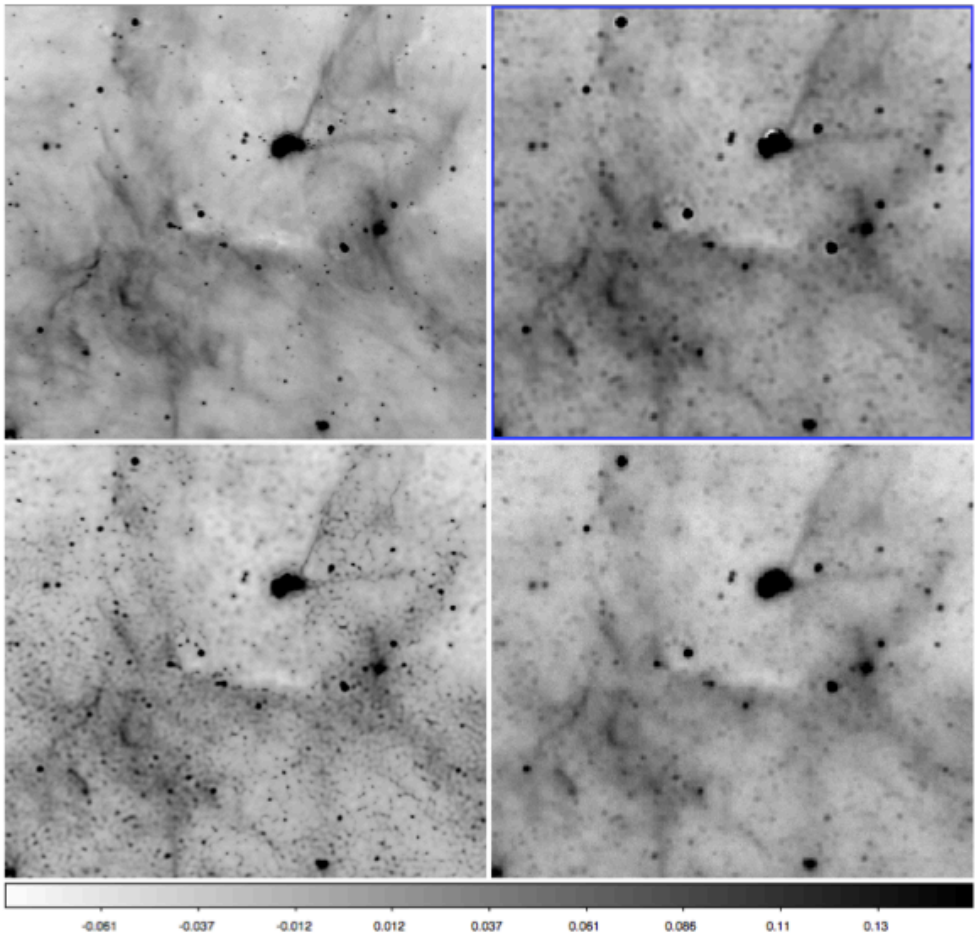
This is the fundamental power spectrum plot we want to understand

All maps at 6”/pixel except for truthimage (2”, before convolution with SPIRE beam).
ICORE image is rebinned.
No beam correction applied.



Metric 4: Super-resolution Maps

Zoom to top center of case10_PSW maps confirms the power spectra



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Summary

- Seven map-makers (including 2 hi-res mappers) participated.
- Analyzed 13 test cases (8 simulated, 5 real), covering different modes, brightness, complexity in extended structures, etc.
- Preliminary results show:
  1. In all cases except for those with “cooler burps”, Destriper (default in HIPE) did at least as well as other map-makers.
  2. Other map-makers such as Scanamorphos, SANEPIC and Unimap, can minimize the cooler burp effect, but have issues in dealing with complex background.
  3. All mapmakers except for naïve mapper behaved well in point and extended source photometry.
  4. HiRes may improve the resolution more significantly, but SUPREME may preserve better the extended emission.
- The final SPIRE map-making report is in progress.