LOFAR Source Finders Working Group

Chiara Ferrari

with :

R. Breton, D. Carbone, A. van der Horst, G. Heald, A. Mints, G. Macario, R. Paladino, D. Rafferty, J. Swinbank

and the collaboration of :

P. Carroll, H. Garsden, E. Orrù, R. Pizzo, A. Rowlinson, A. Shulevski, M. Wise, S. van Velzen, S. Yatawatta

LOFAR SOURCE FINDERS WIKI PAGE

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Trace: » commissioning:source_finders

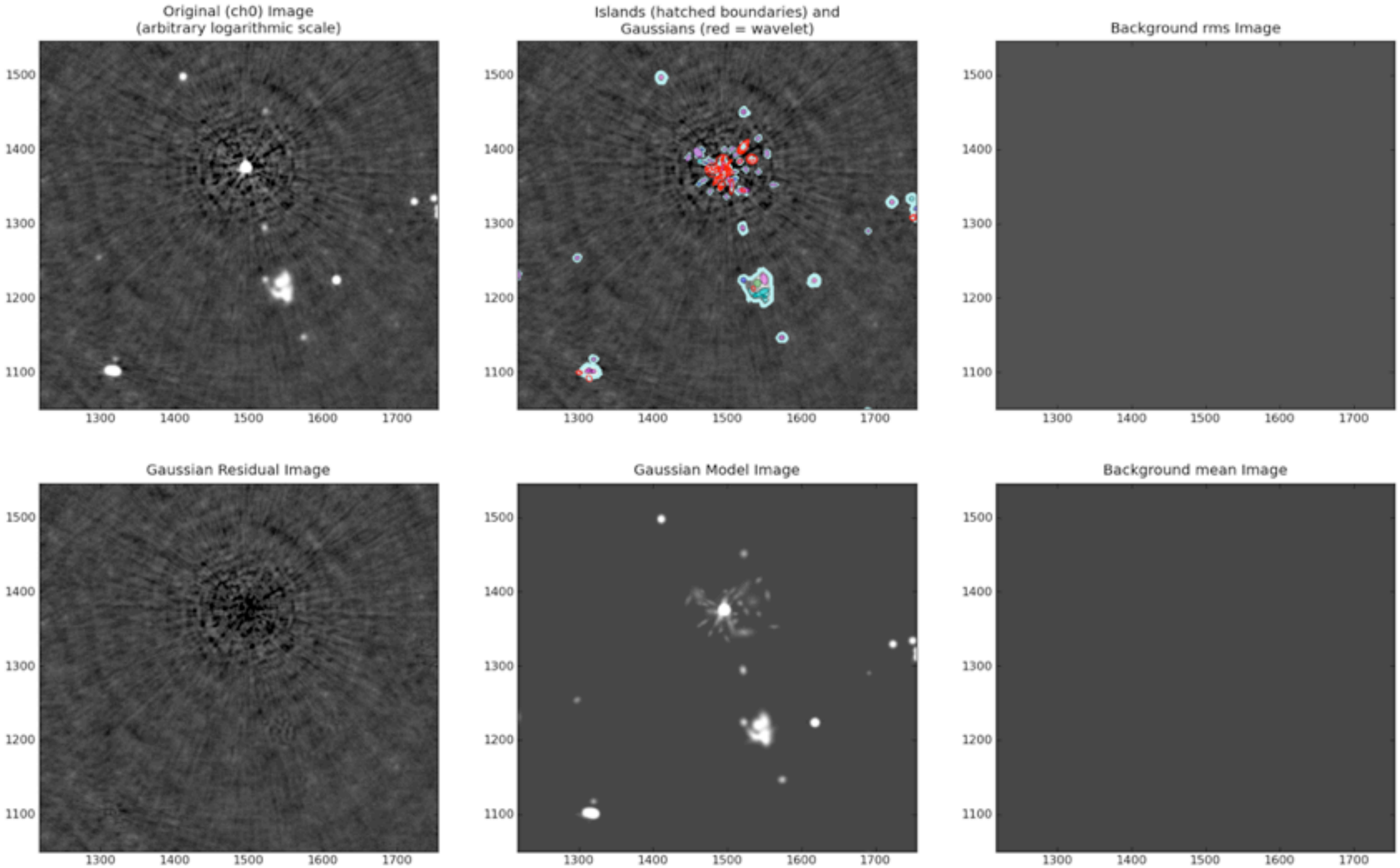
A ***'Source finders Working Group'*** was formed and started his activities.

The group is leaded by *C. Ferrari* and currently hosts (in alphabetic order): *R. Breton*, *D. Carbone*, *P. Carroll*, *A. Dabbech*, *H. Garsden*, *A. van der Horst*, *G. Macario*, *A. Mints*, *R. Paladino*, *D. Rafferty*, *A. Rowlinson*, *A. Shulevski*, *J. Swinbank*, *S. van Velzen*. Updates on the activities of the Source finders WG will be given regularly at the LSMs and at the Busy Thursdays. If you would like to join the group or for any question, please contact chiara.ferrari@oca.eu.

Main current aims

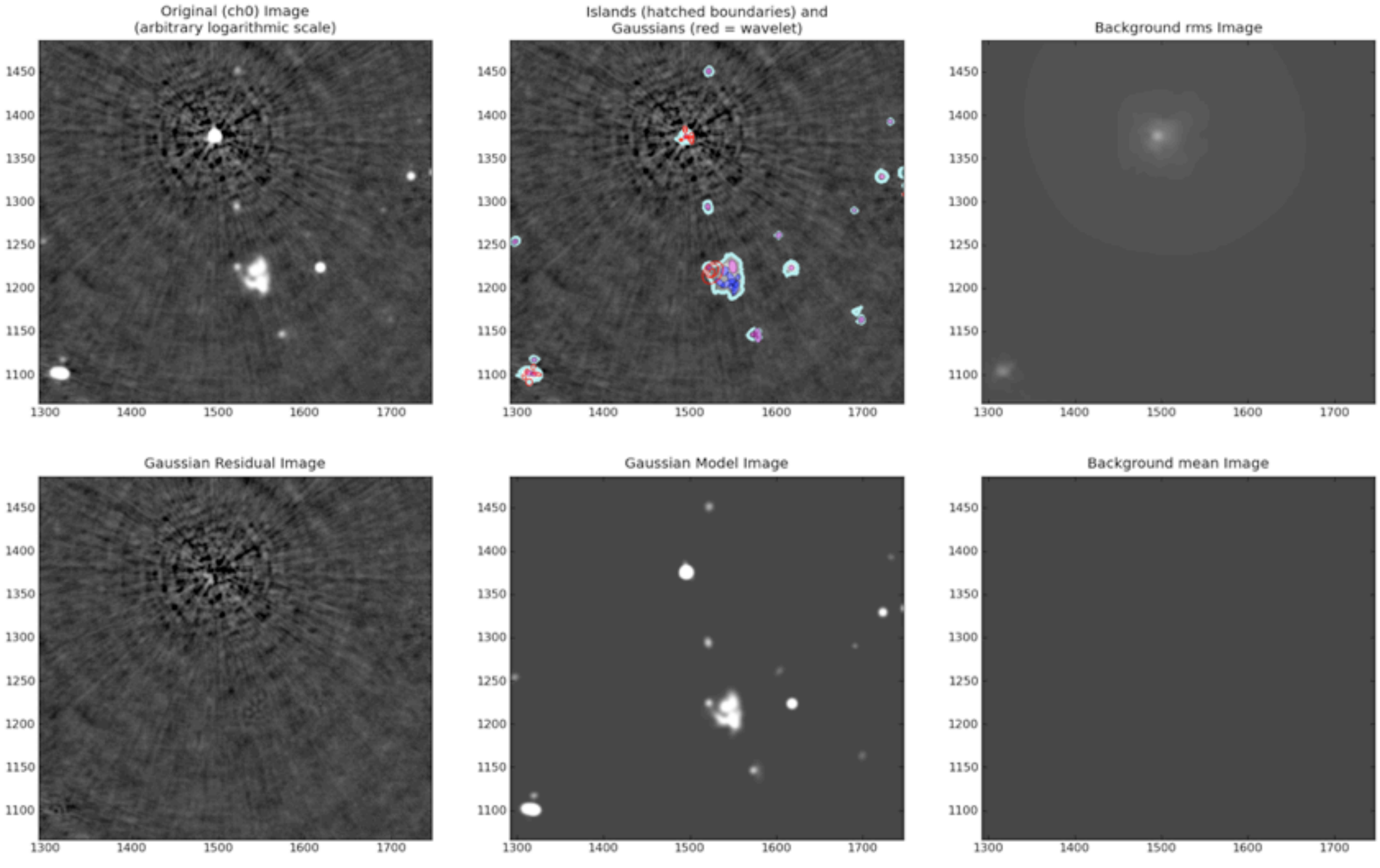
- report bugs and needs to developers of available source finders
- provide support to LOFAR users
- LOFAR representative in the international radio source finding joint discussion
- identify the best settings for automatically run source finders in LOFAR / MSSS pipelines

Tests and developments



ATCA map (Ferrari et al. 2006) with sources found by an old version of PyBDSM

Tests and developments



New developments introduced by D. Rafferty in PyBDSM to deal with deconvolution errors

Support to LOFAR users

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LOFAR Wiki

2) Identify statistics to state if automatic source extraction was successful or not [edit]

Recent results about a possible automatic strategy for source extraction with PyBDSM are reported here

Results: [edit]

Problematic cases to be tested by the group: [edit]

Case 1)

I found out that I ran PyBDSM with the artous_do=True on the LOFAR map of GRS1915 more than 2 months ago. It didn't improve the source extraction and I had put in an angle. I ran it again after our meeting and it worked differently… It worked pretty well with the detection_threshold set to 5. It didn't work with the detection threshold set to 10, neither running it again on the residual map. Moreover, PyBDSM keeps crashing when I try to run it with atrous_do=True on the WSRT map.

You can find the .fits file of the LOFAR image & the DS9 .reg files of the PyBDSM runs I made today with atrous_do=True on my home on CEP2: /home/carbone/GRS1915/PYBDSM

DARIO

I have now tested Dario's LOFAR image of GRS1915, and have found it to be very difficult to pick up the faint extended emission, as its brightest peak is <5 sigma when a smaller rms_box (< 200 pixels) is used. I had the best results using the new adaptive rms_box scaling.

Here are the parameters that gave the best fit (some of these parameters are only available in the newest version, available in /home/rafferty/PyBDSM or in the LUS build starting on 20/4/2012):

- adaptive_rms_box = T (to use smaller rms_box near bright sources to avoid detecting artifacts while still allowing a large rms_box everywhere else to pick up diffuse sources)
- adaptive_thresh = 50 (to set compact sources with peaks above 50 sigma as bright sources, around which the smaller rms_box will be used)
- rms_box = (500,200) (this sets the large-scale box size that is used far from bright sources; the small scale box size is calculated internally, but can be set using rms_box_bright)
- atrous_do = T (to pick up extended emission missed in initial fitting)
- thresh_isl = 2 (needed to detect enough of the extended emission to get good fits)

Below are some plots of the fit (red Gaussians are from fits to wavelet images)

DAVID

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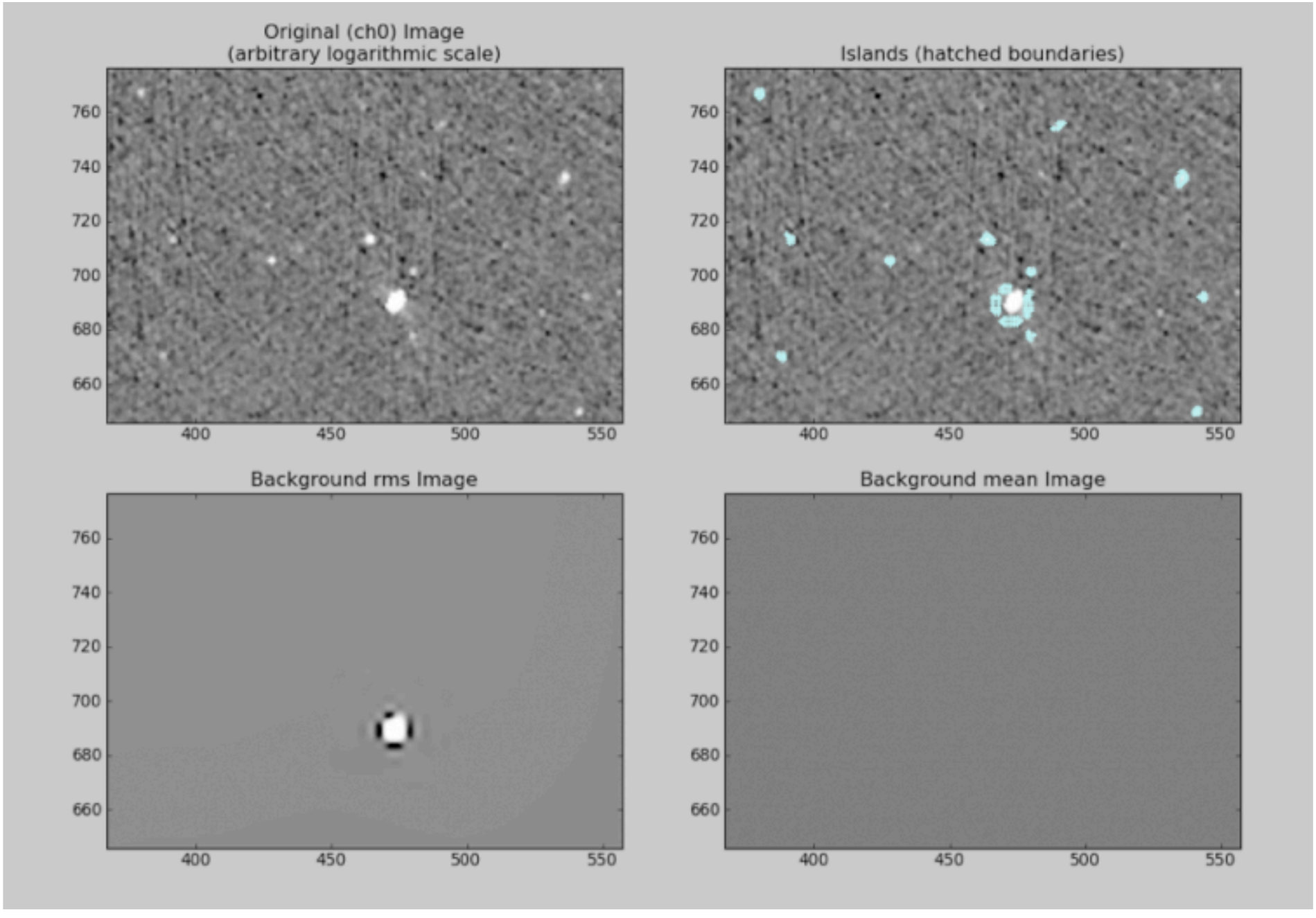
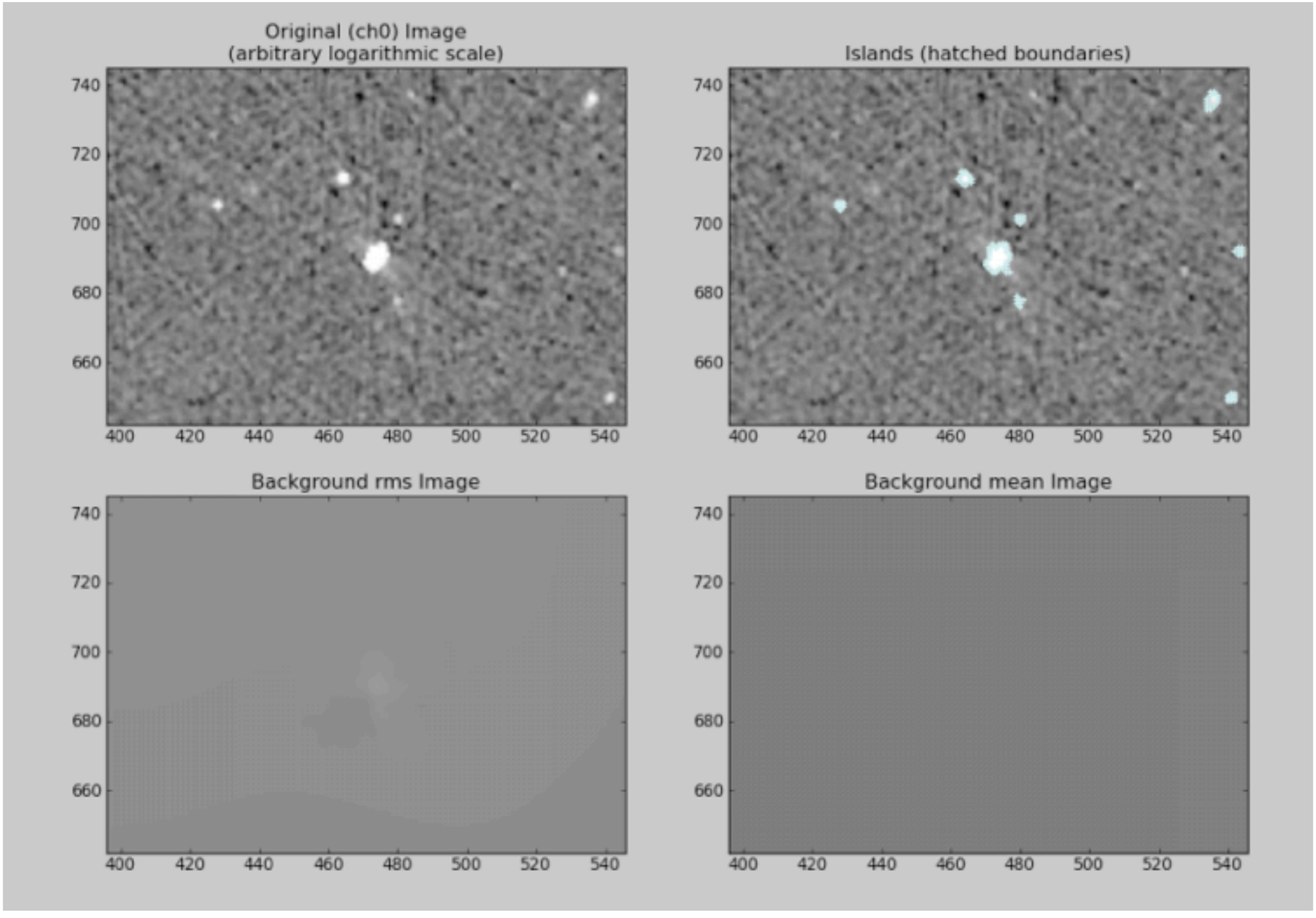
Example extracted from the Source Finders wiki page

Tests & Developments ⇔ Support



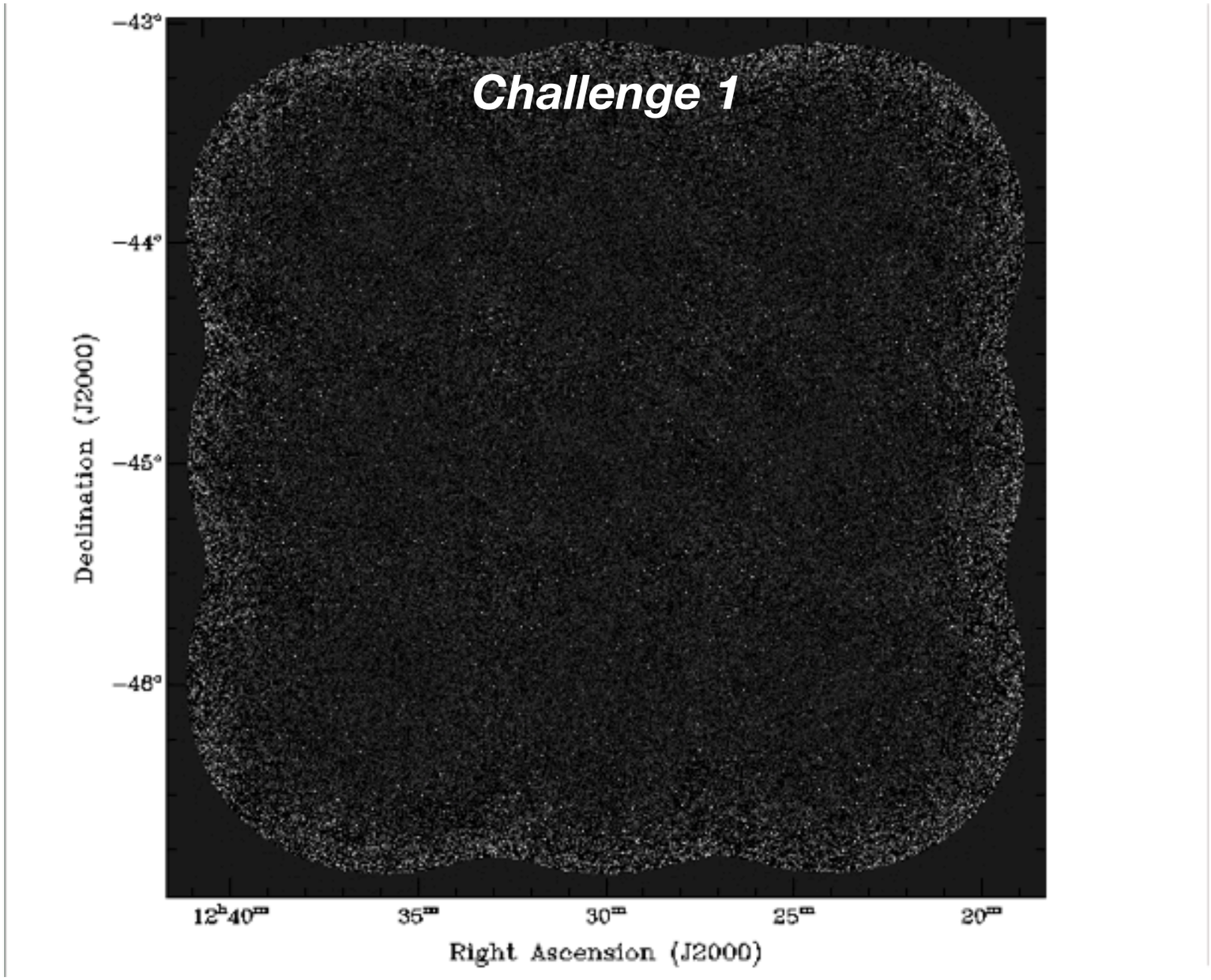
WENSS map posted by R. Pizzo

Tests & Developments ⇔ Support



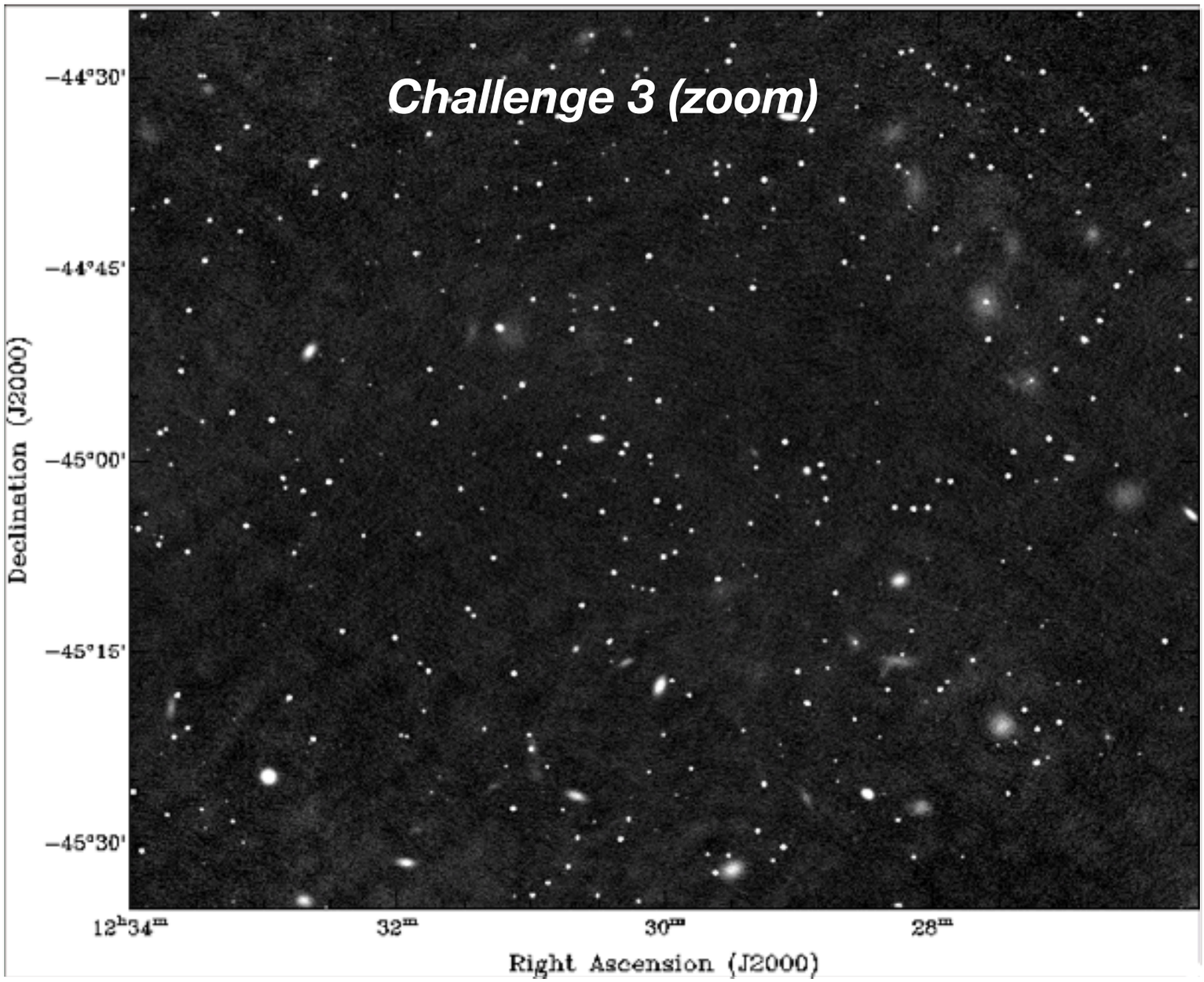
Test and source finders development by D. Rafferty and C. Ferrari

International data challenge



Simulations & Coordination by A. Hopkins, N. Seymour and M. Whiting

International data challenge



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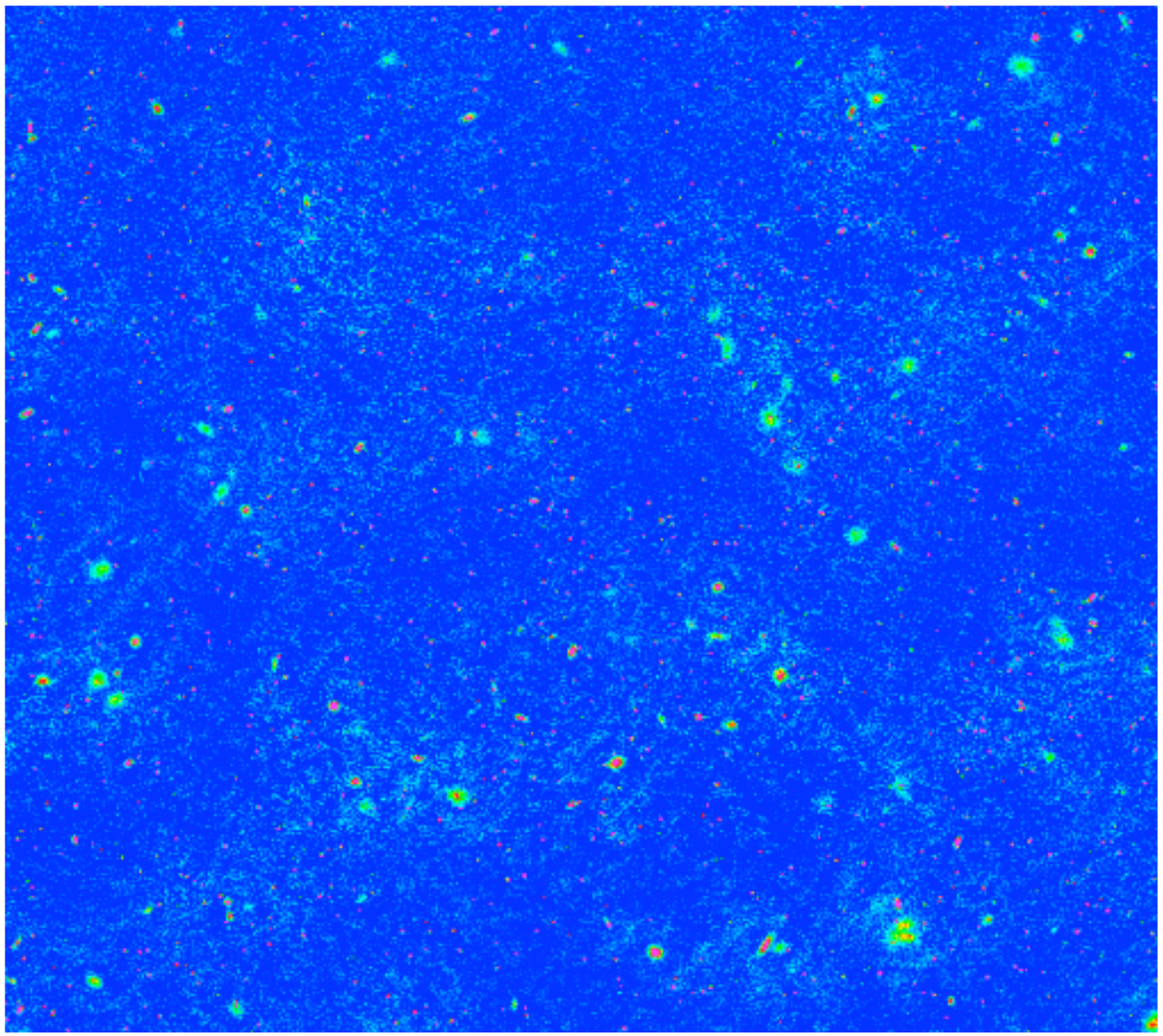


ASKAP simulations:

- Visibilities created with ASKAP simulator
- Visibilities imaged with ASKAPsoft imager

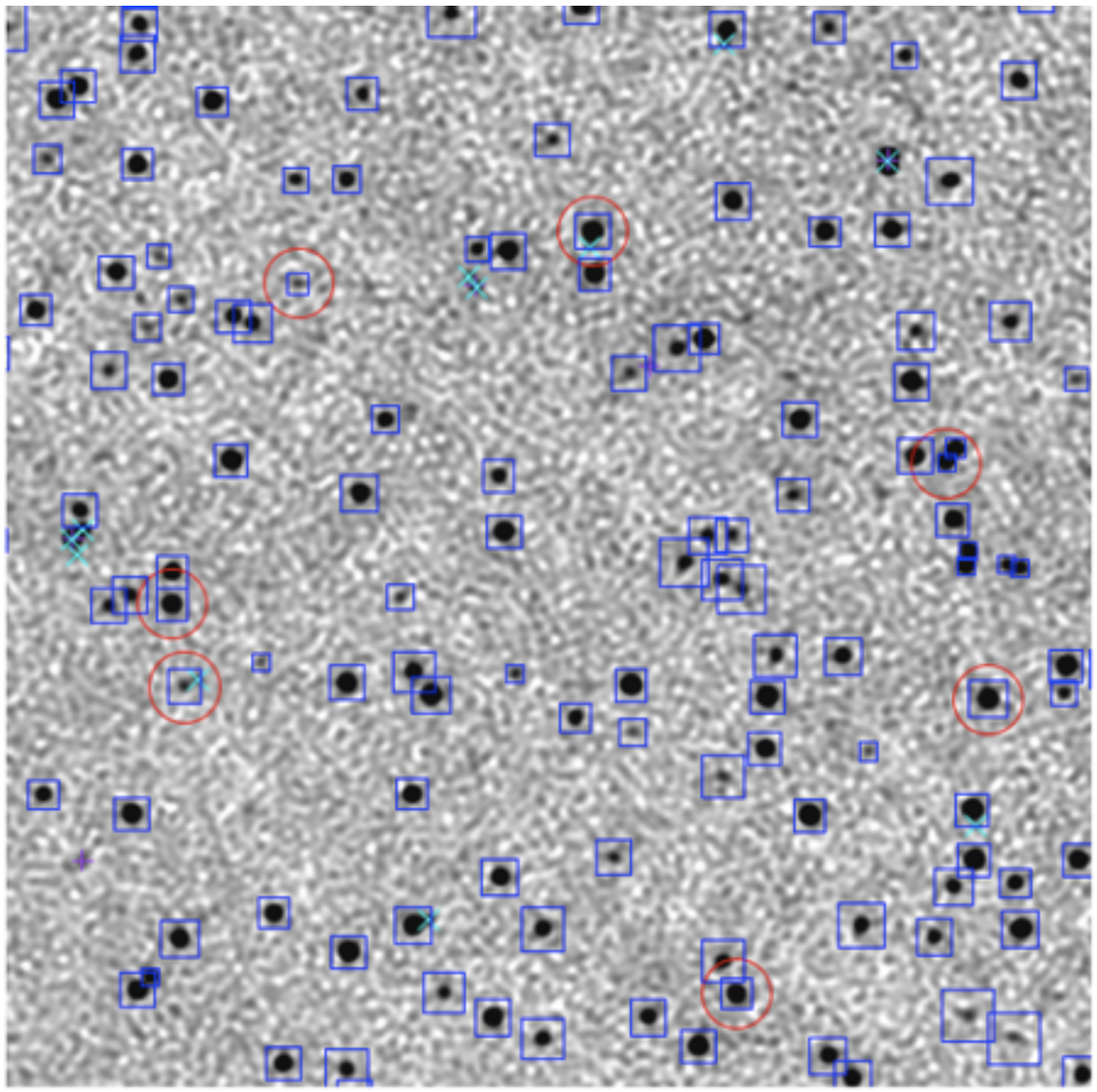
Hopkins et al., in prep.

- C. Ferrari, R. Paladino, D. Rafferty: *PyBDSM*
- D. Carbone, A. van der Horst, J. Swinbank: *PySE*
- R. Breton, A. Mints: *source association*

+ A. Shulevski, G. Heald, R. Pizzo, E. Orrù, H. Garsden, H. Röttgering, N. Mohan

International data challenge: PyBDMS vs. PySE results

Challenge 1 (zoom)



Number of Detections

	sources
d5_a3_debl_grid50_dtre90	13747 \ 14035
fdr01_debl_grid50_dtre90	12884 \ 14035

Legend: PySE \ PyBDSM

Nearest-Association Matching

	sources
d5_a3_debl_grid50_dtre90	13389 (0.974 \ 0.954)
fdr01_debl_grid50_dtre90	12618 (0.979 \ 0.899)

Legend: total match (% PySE \ % PyBDSM)

Flux Statistics for Nearest-Association Matching

	sources
d5_a3_debl_grid50_dtre90	1.0010 / 1.0030 / 0.0592
fdr01_debl_grid50_dtre90	1.0023 / 1.0035 / 0.0533

Legend: mean flux ratio / median flux ratio / standard deviation

Statistics on the PySE / PyBDSM flux ratio.

Successful PyBDSM & PySE detections

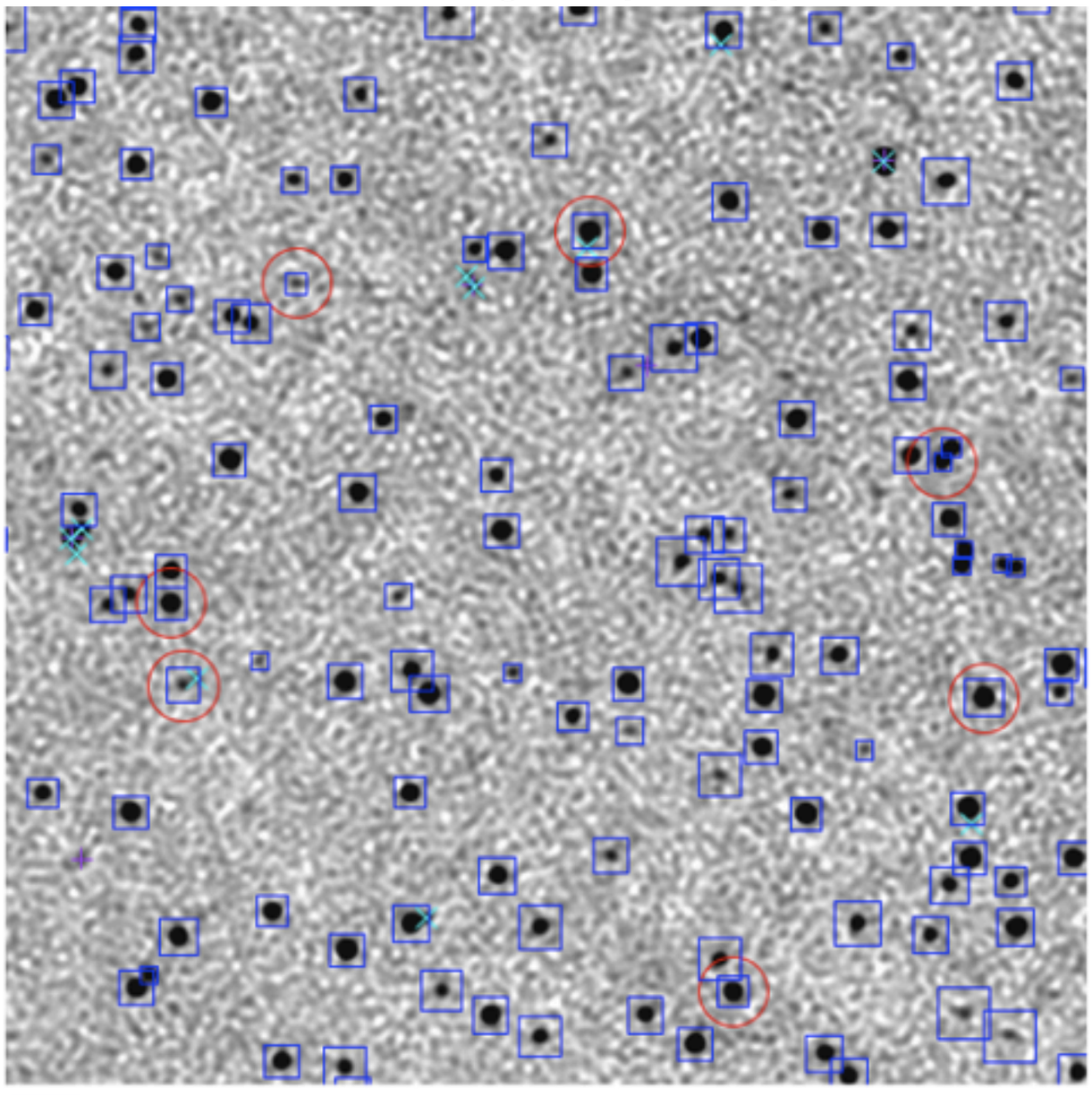
PyBDSM & PySE detections but significantly different flux values

PyBDSM detection - no PySE detection

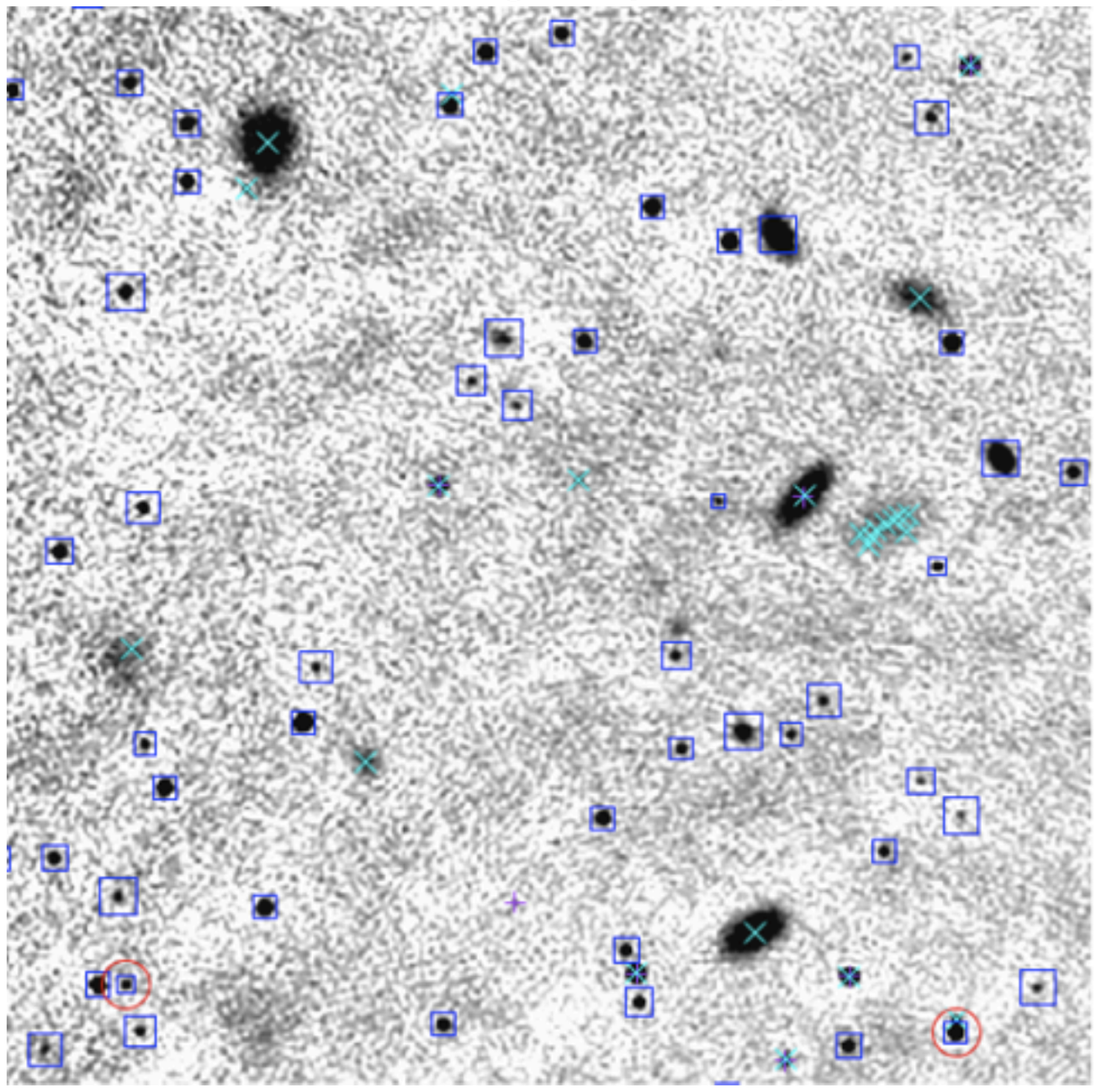
PySE detection - no PyBDSM detection

International data challenge: PyBDMS vs. PySE results

Challenge 1 (zoom)



Challenge 3 (zoom)

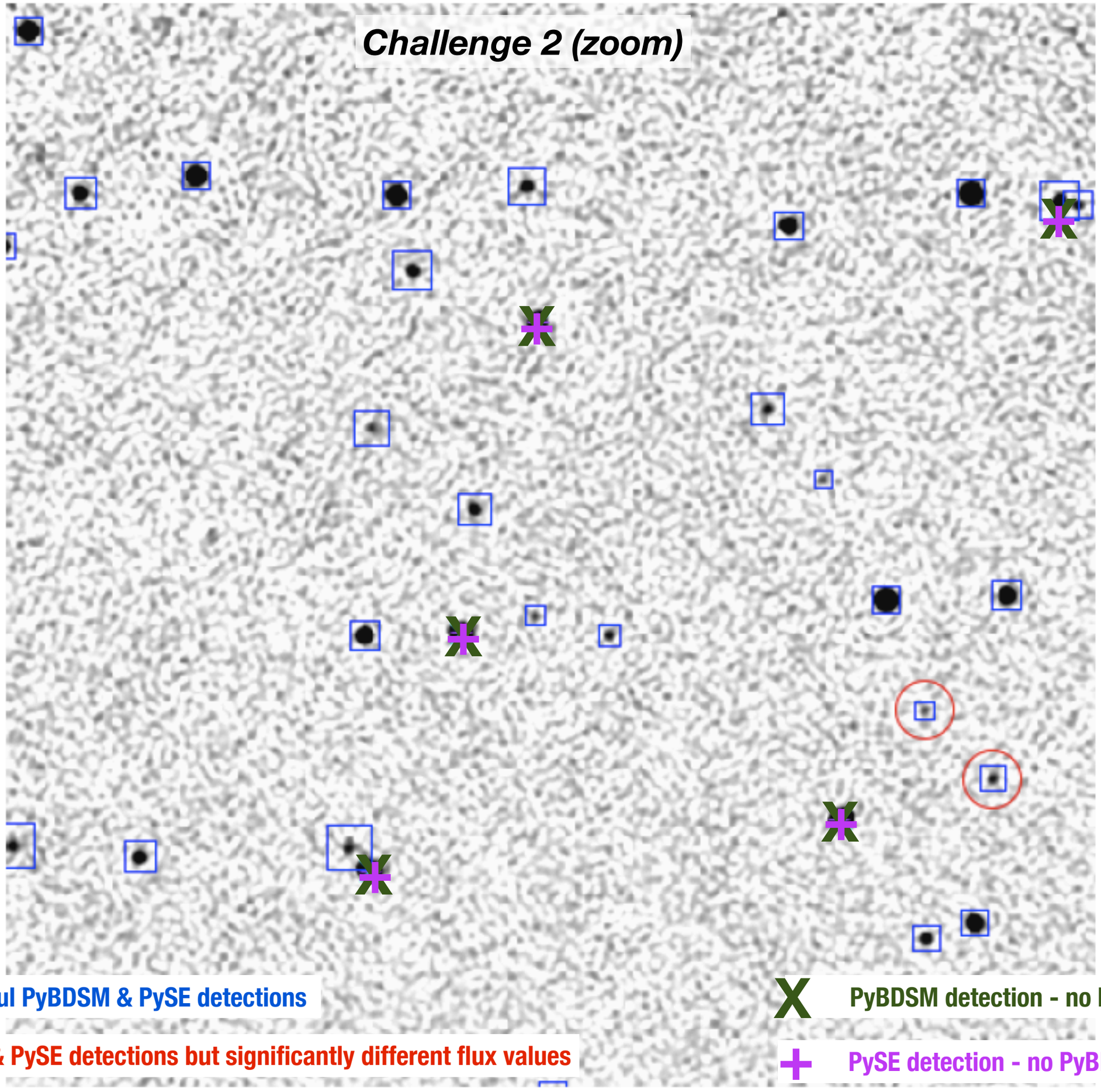


Successful PyBDSM & PySE detections

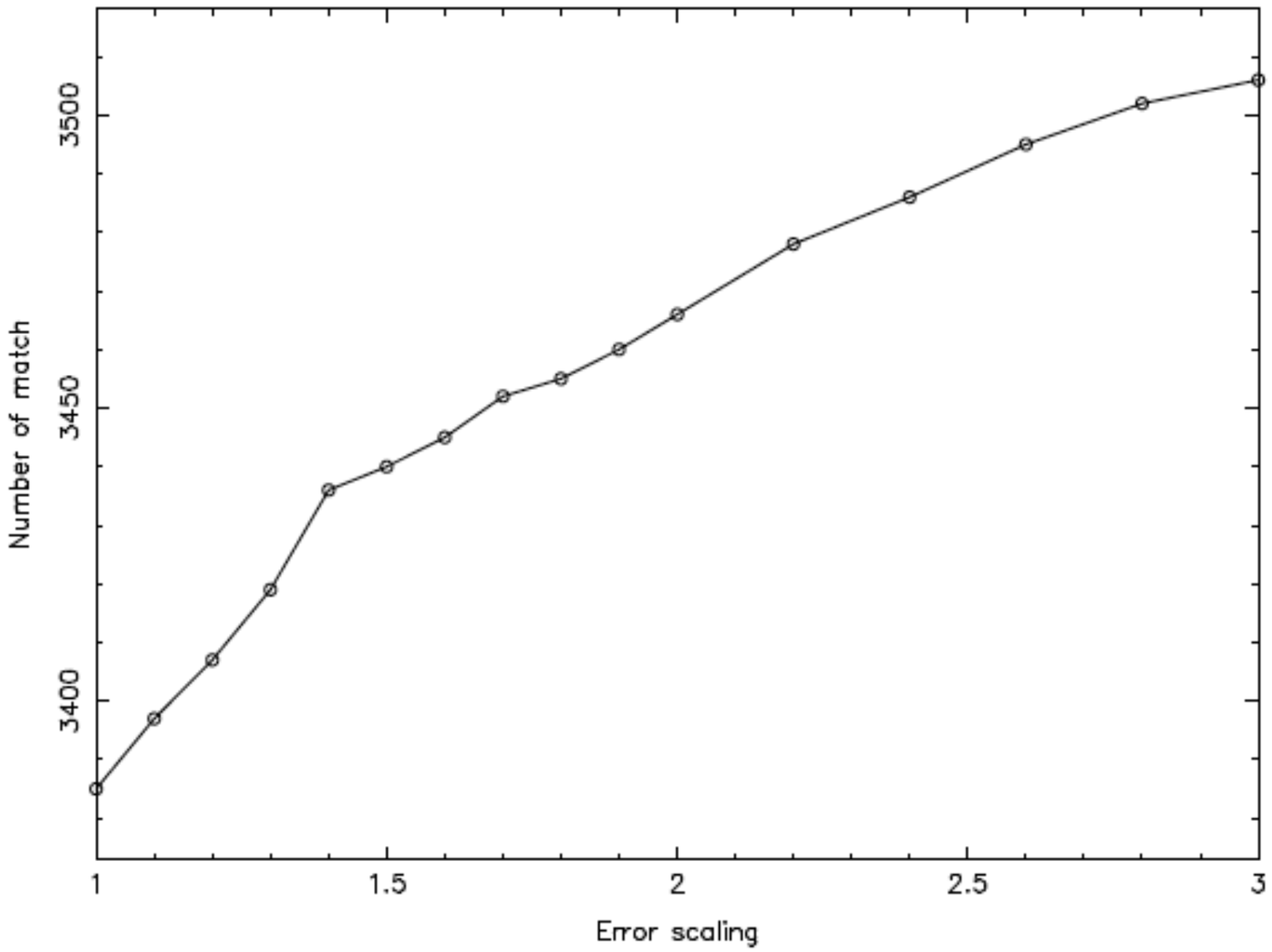
PyBDSM & PySE detections but significantly different flux values

PyBDSM detection - no PySE detection

PySE detection - no PyBDSM detection


Challenge 2 (zoom)
Successful PyBDSM & PySE detections
PyBDSM & PySE detections but significantly different flux values
PyBDSM detection - no PySE detection
PySE detection - no PyBDSM detection

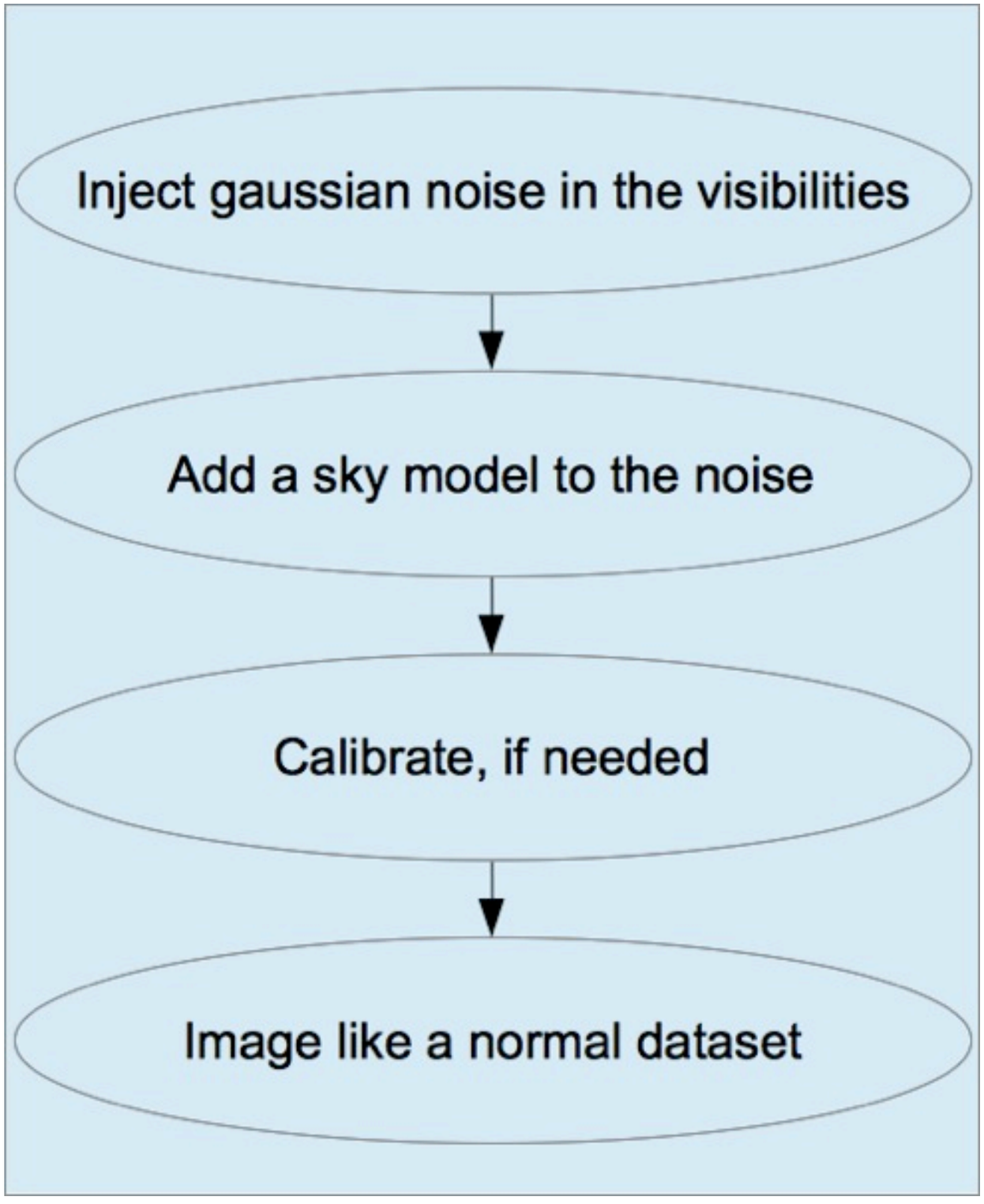
International data challenge: PyBDMS vs. PySE results



Curve of growth of the number of PyBDSM/PySE matches as a function of error scaling (with respect to fiducial values returned by the source finders)

Courtesy: R. Breton

Current strategy for simulated LOFAR maps



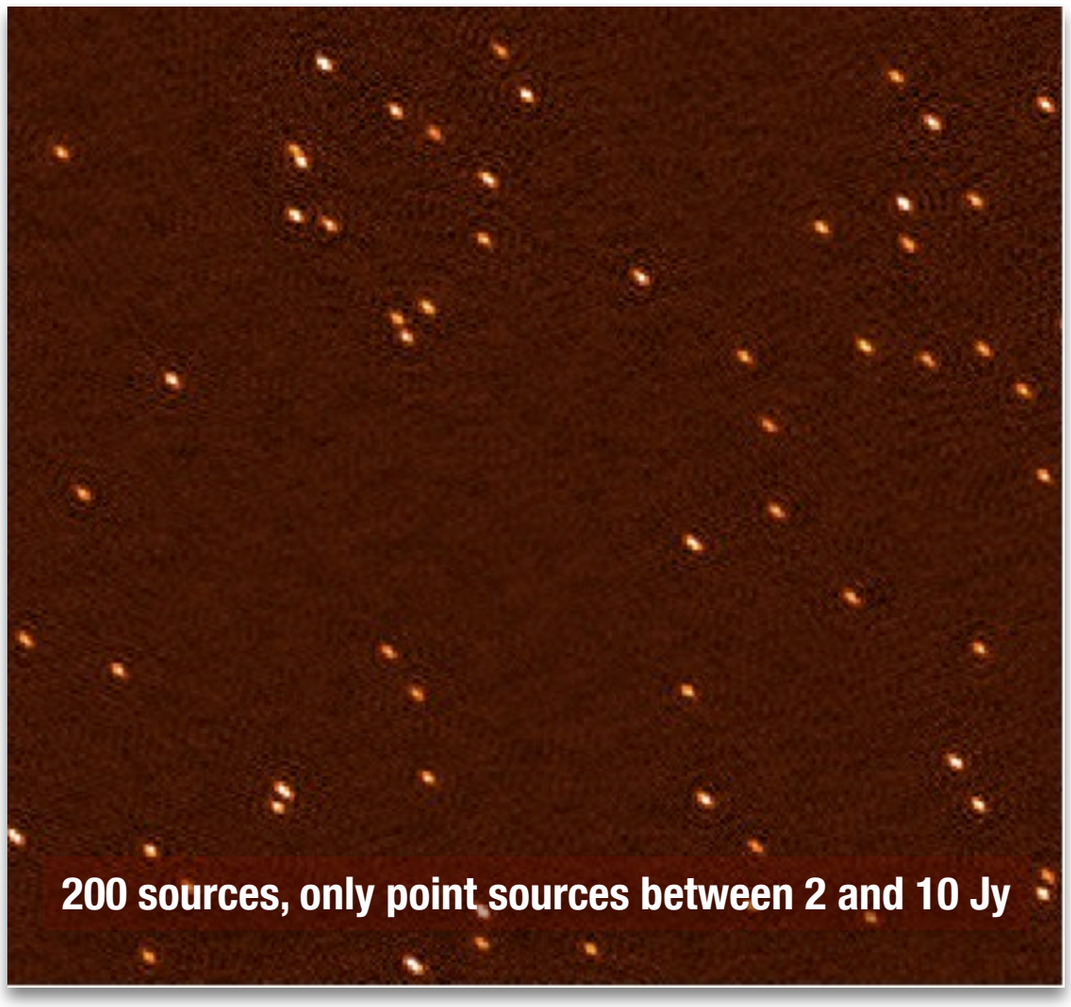
- Start from an existing LOFAR observation to have the gains in place
- Generate a sky model with requested features and power law distribution of fluxes
- Input gaussian noise into the visibilities and add the simulated sources
- Calibrate and image

Current limitations:

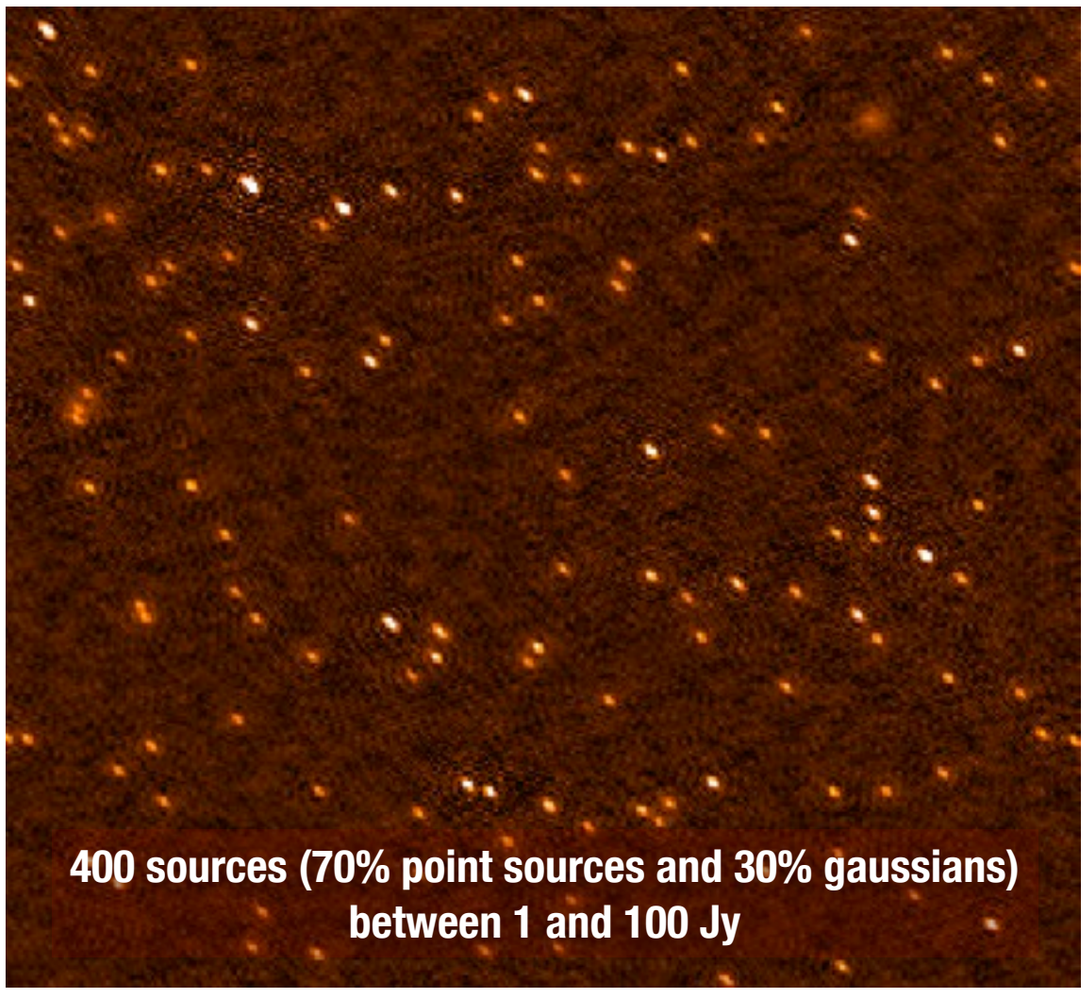
- Ionospheric 3D effects are not yet in place.
- De-calibrate the injected noise is not yet in place

Courtesy:
D. Carbone and A. van der Horst

Examples of simulated maps



200 sources, only point sources between 2 and 10 Jy

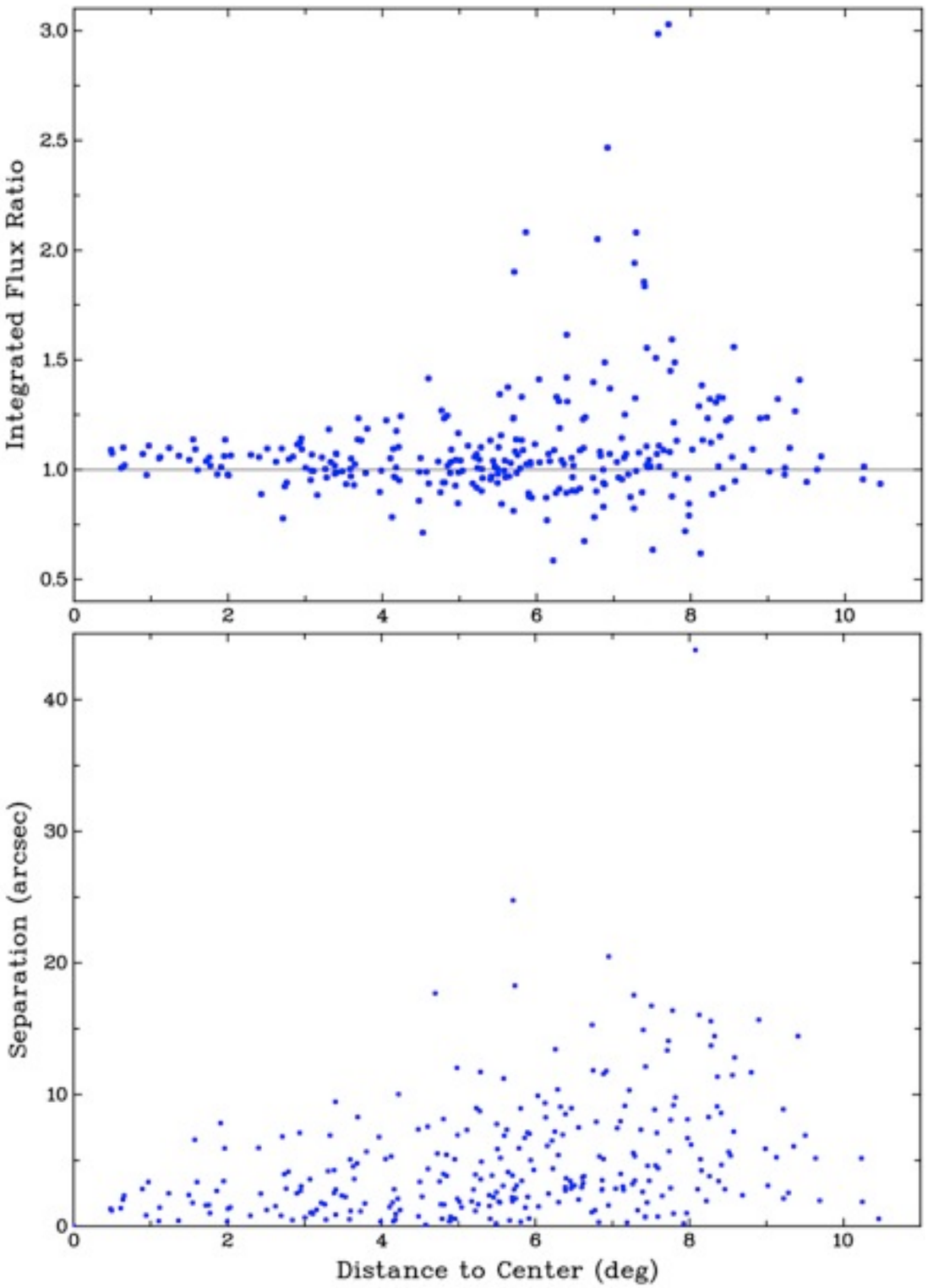


400 sources (70% point sources and 30% gaussians) between 1 and 100 Jy

- Simulations with different number of sources
- Simulations with sources of different fluxes
- Simulations with sources of different shape

Courtesy:
D. Carbone and A. van der Horst

Source finding on simulated maps



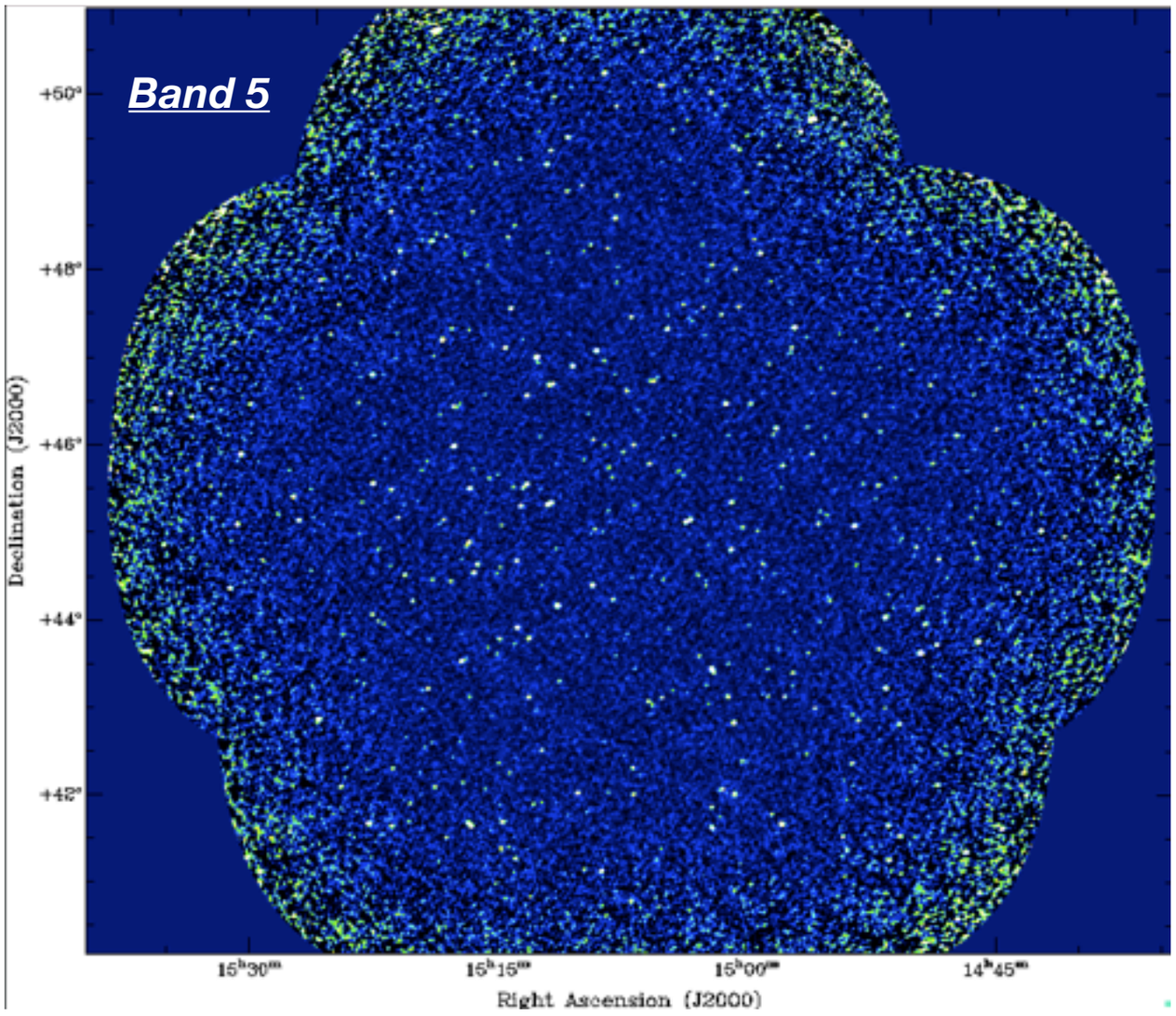
- The average value of the integrated flux ratio is about 1 up to about 4 degrees from the pointing center

- Most of the sources have an offset of less than 20 arcsec (pixel size = 30 arcsec/pixel)

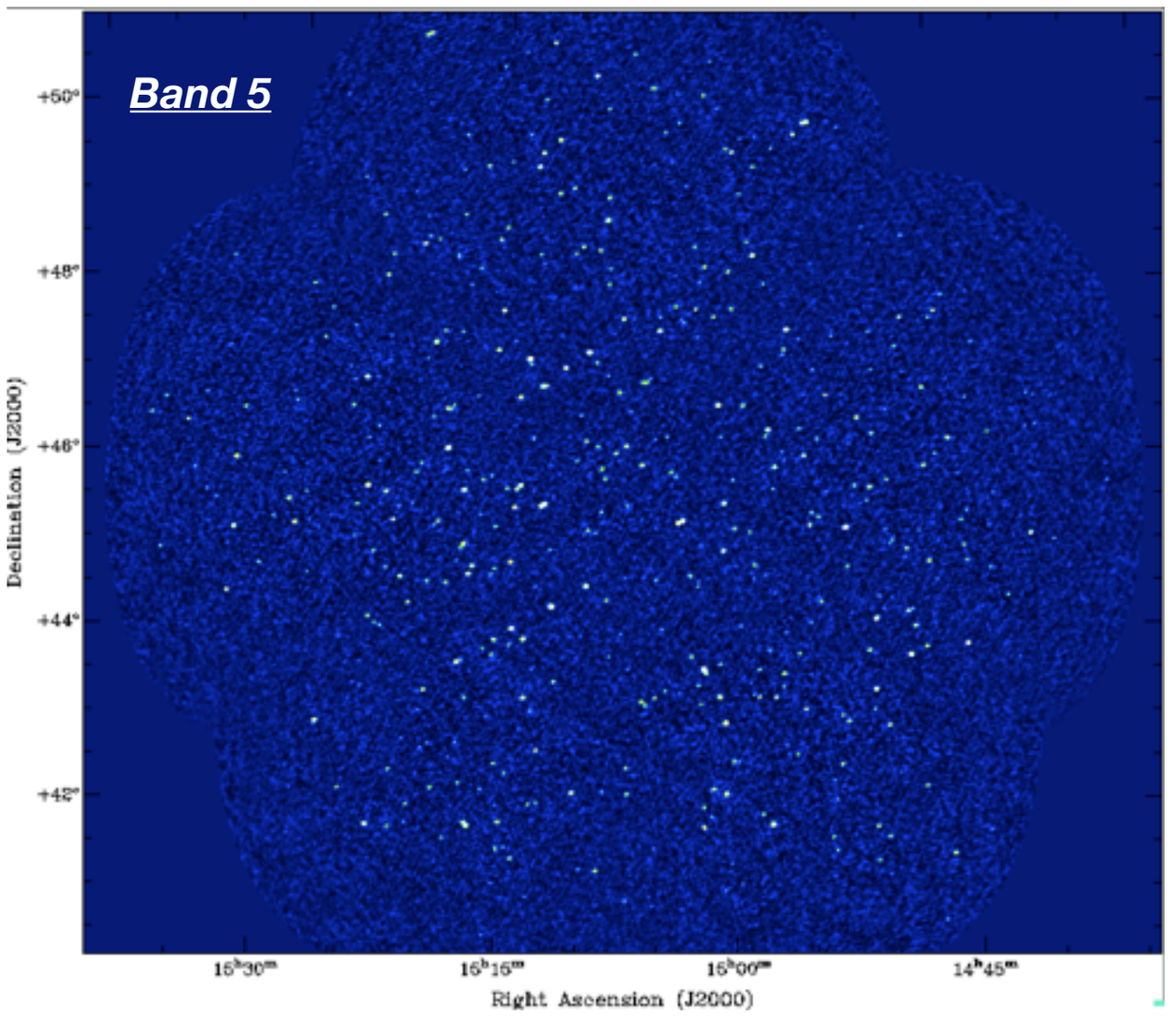
Courtesy:
D. Carbone and A. van der Horst

Source finding on MSSS maps

Corrected for primary beam = Analysis map



Not corrected for primary beam = Detection image

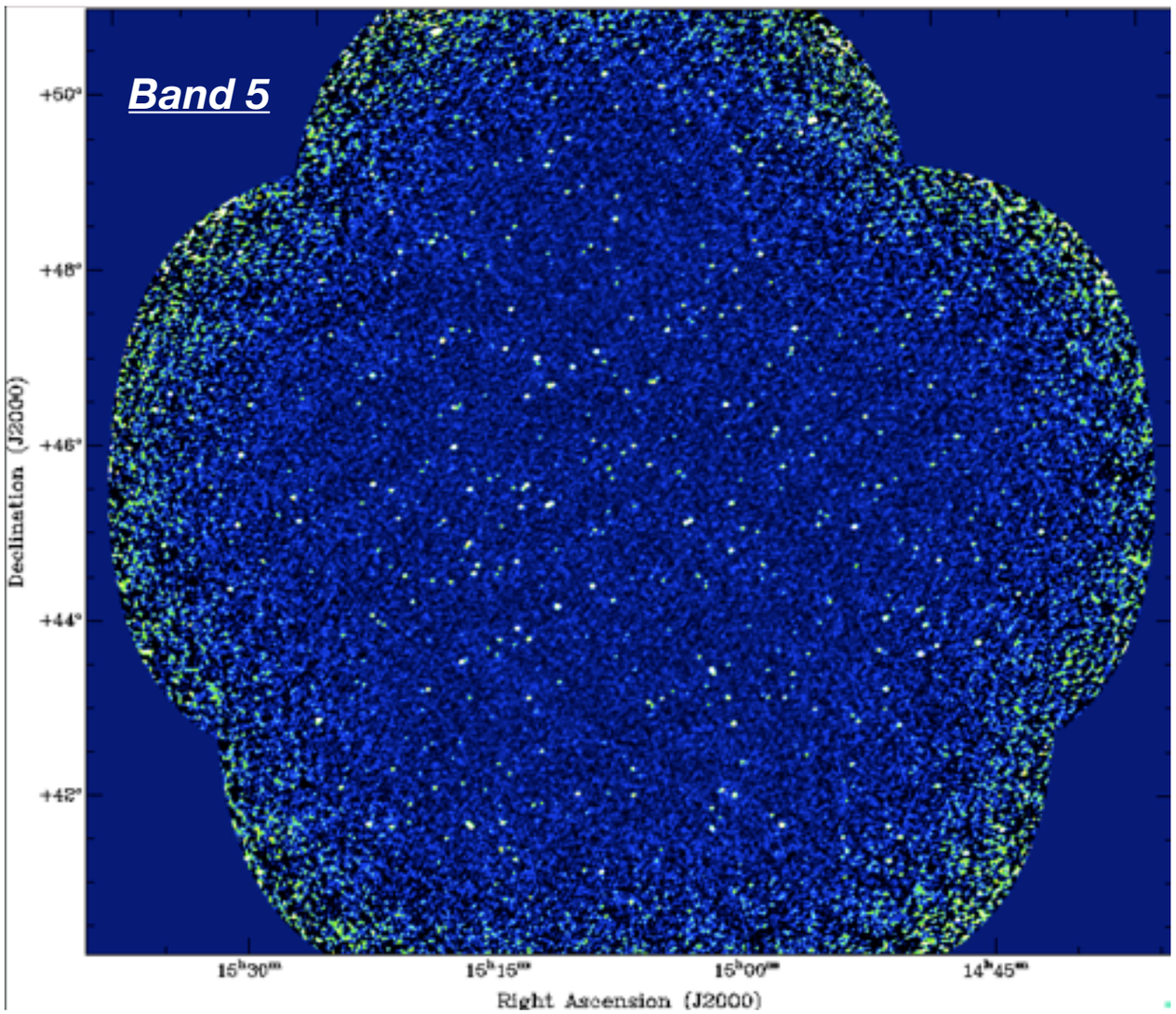


On-going tests on MSSS maps by C. Ferrari, G. Macario & G. Heald - PyBDSM developments by D. Rafferty

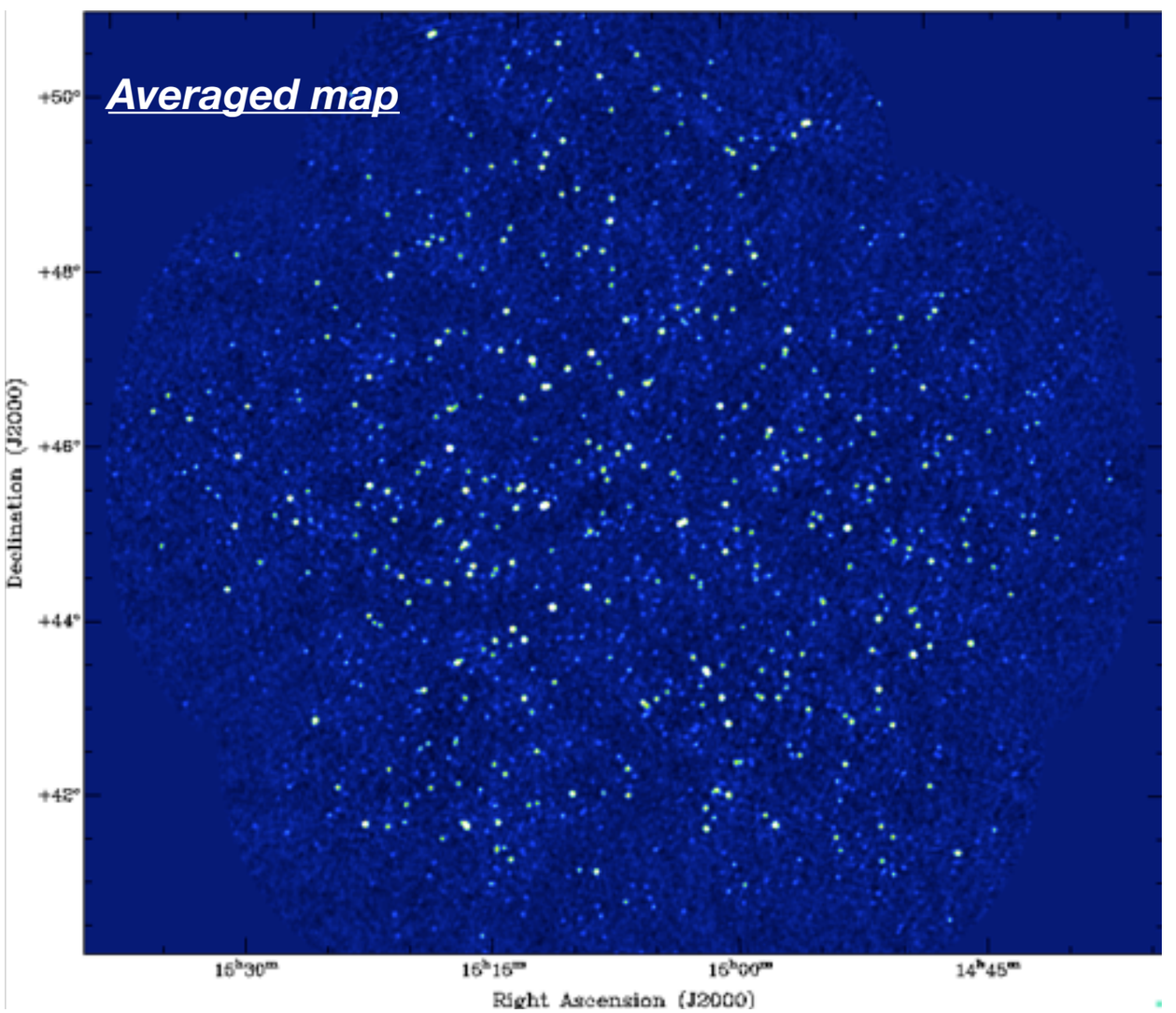
MSSS Mosaic Field (Obs. Date 15 Feb 2013)

Source finding on MSSS maps

Corrected for primary beam = Analysis map



Not corrected for primary beam = Detection image

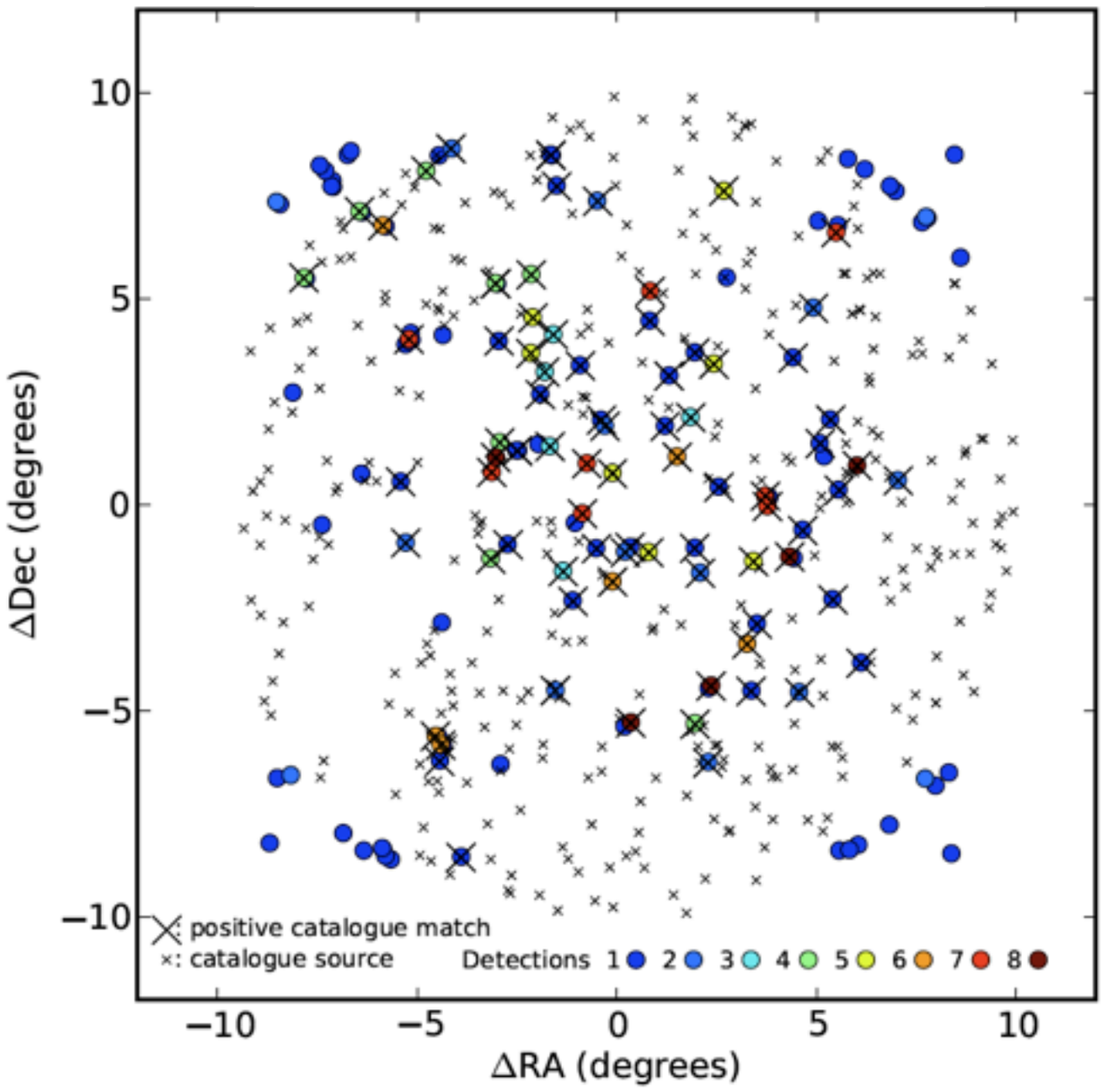


On-going tests on MSSS maps by C. Ferrari, G. Macario & G. Heald - PyBDSM developments by D. Rafferty

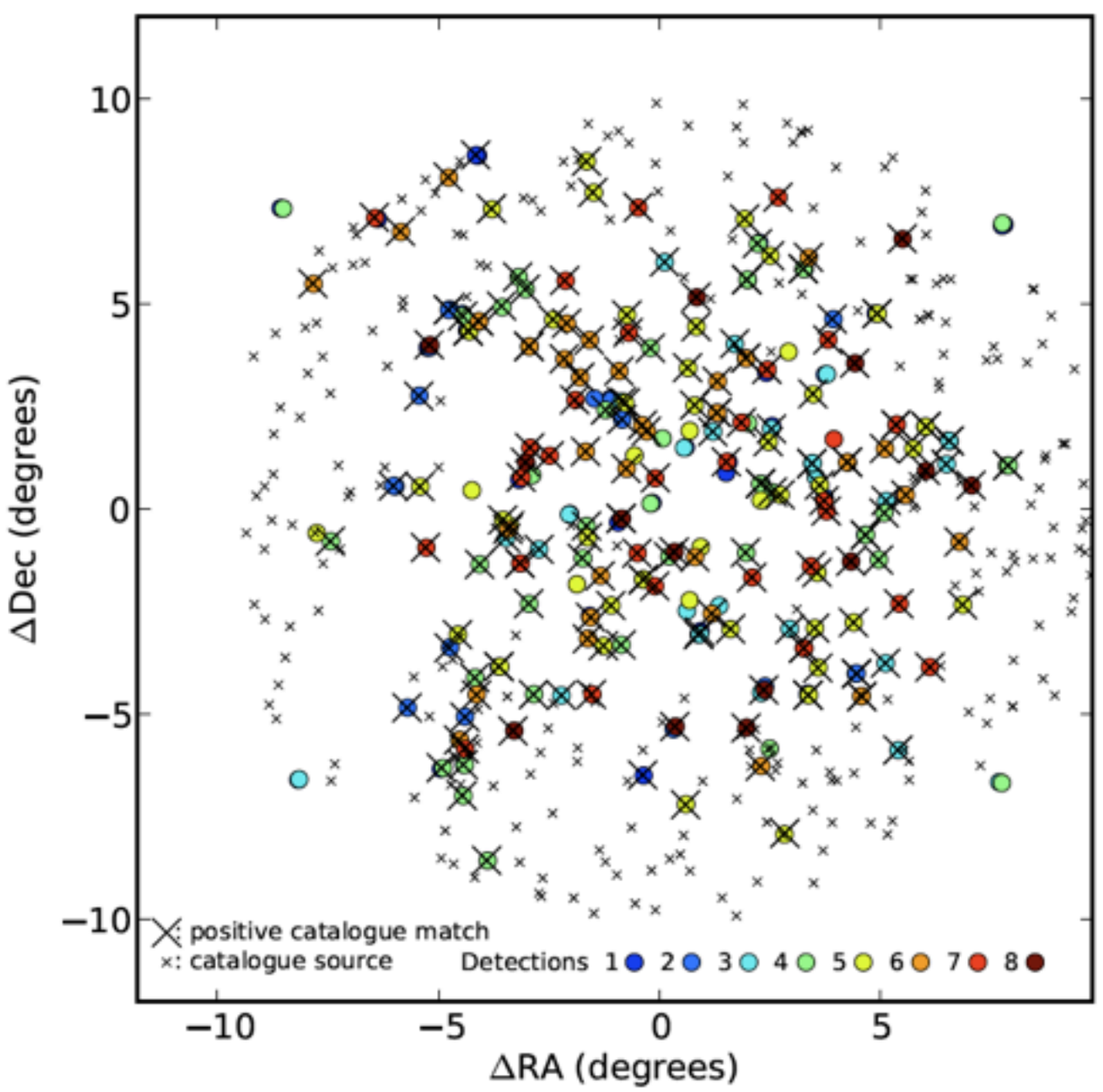
MSSS Mosaic Field (Obs. Date 15 Feb 2013)

More detections &
More multi-band associations !!!

Detection image = Single band maps
+
Catalogs association

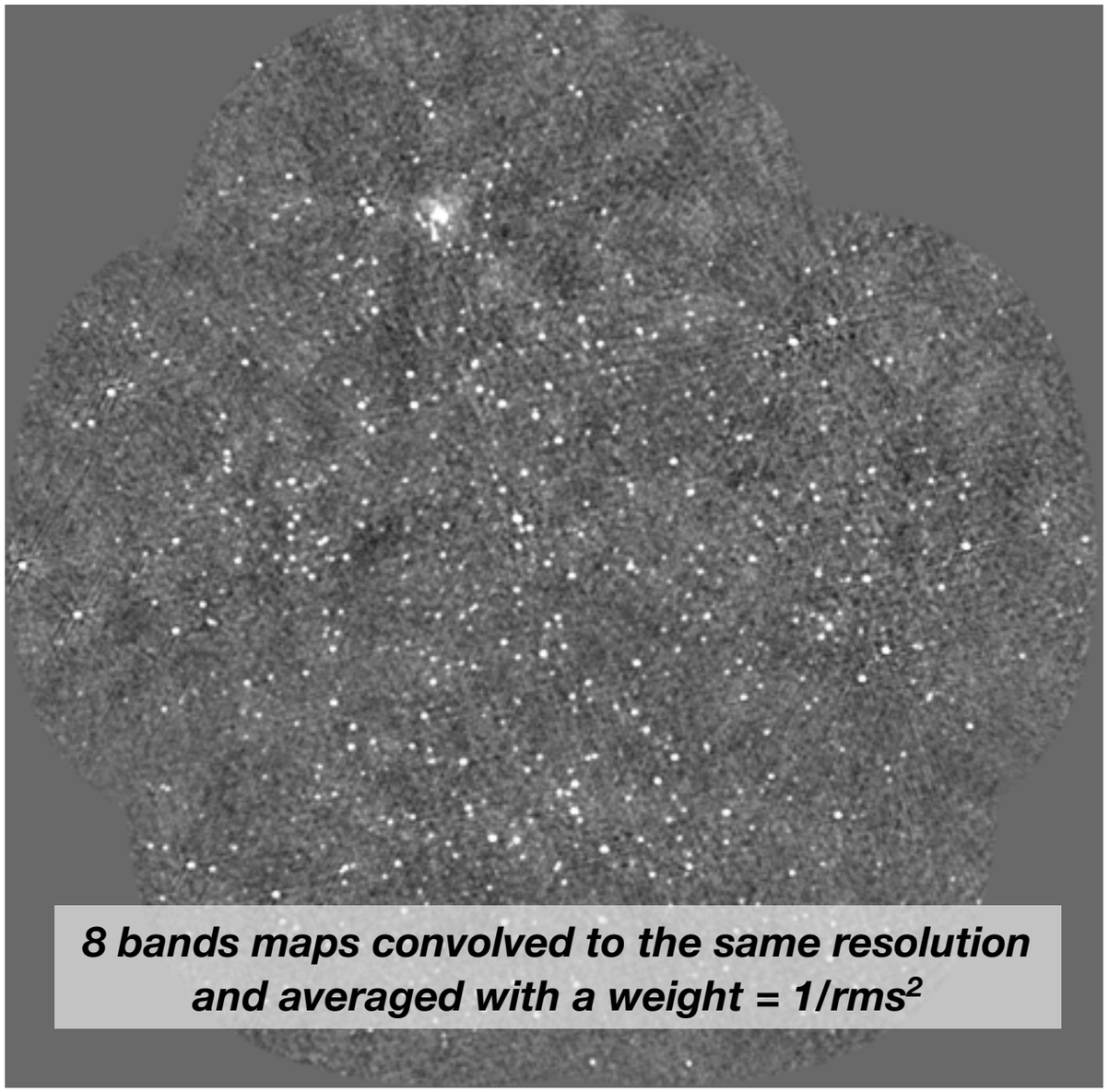


Detection image = Averaged map
+
Catalogs association

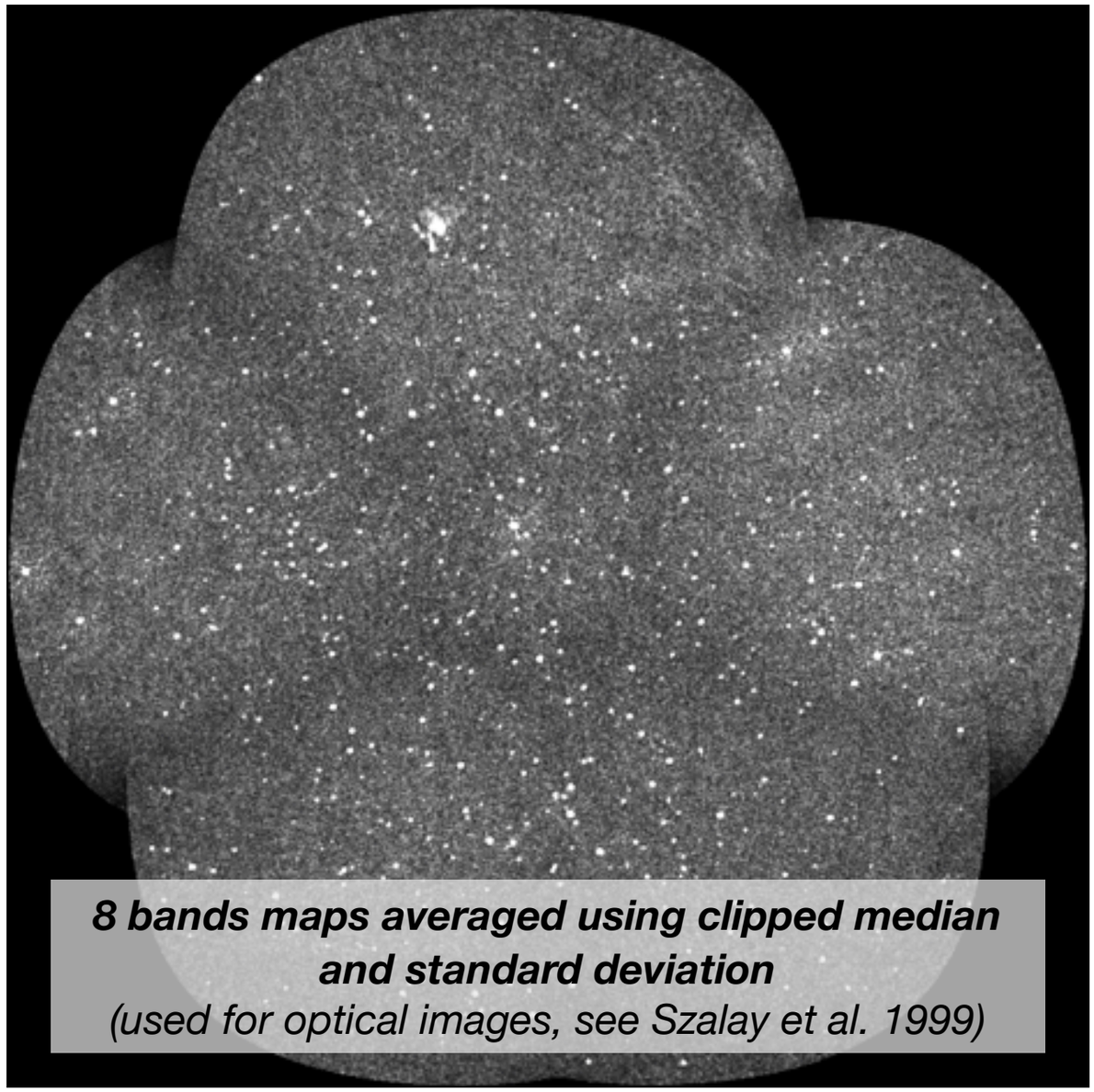


MSSS 2012 week 16 report by R. Breton

How to combine maps ?



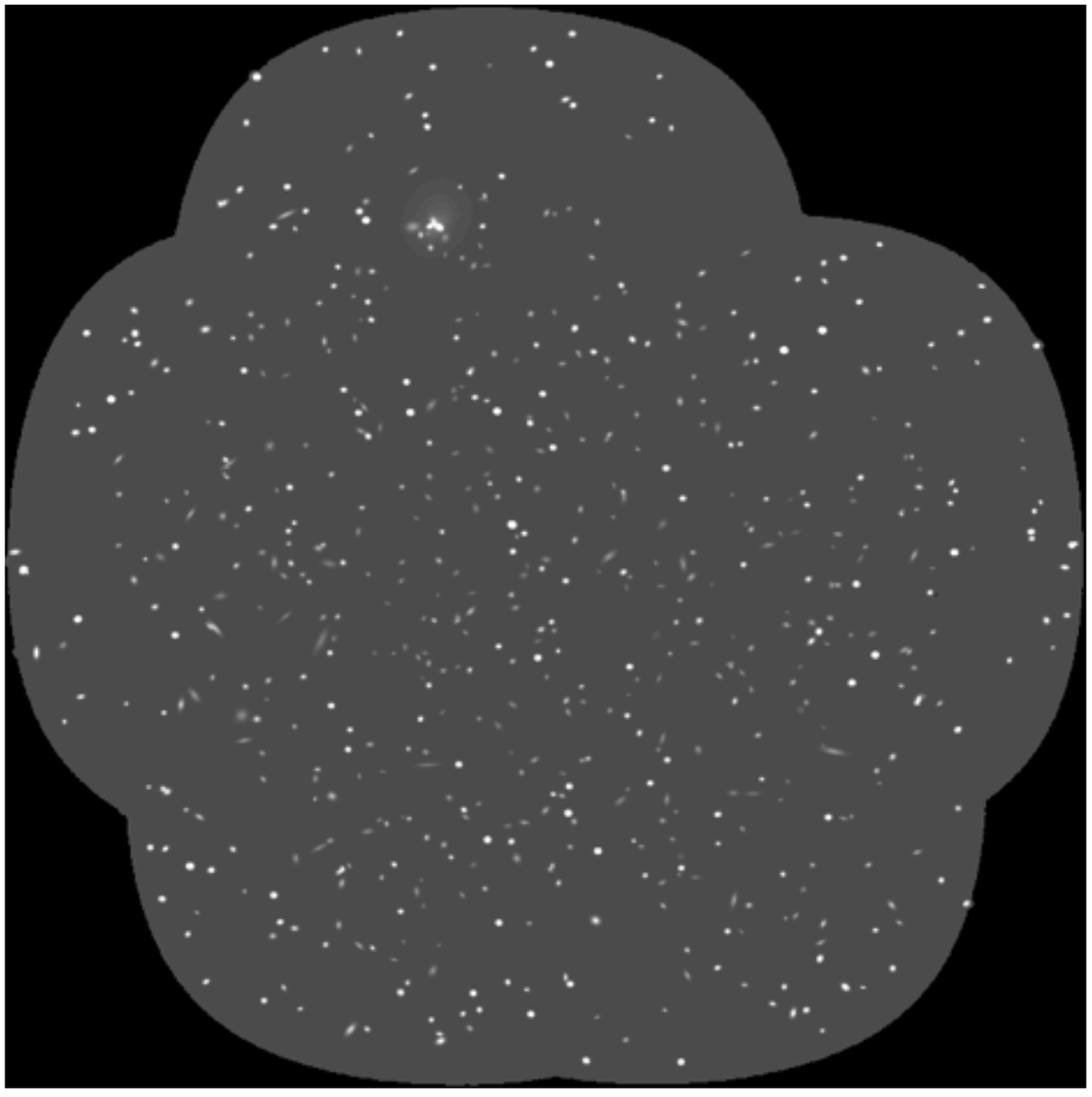
8 bands maps convolved to the same resolution and averaged with a weight = $1/rms^2$

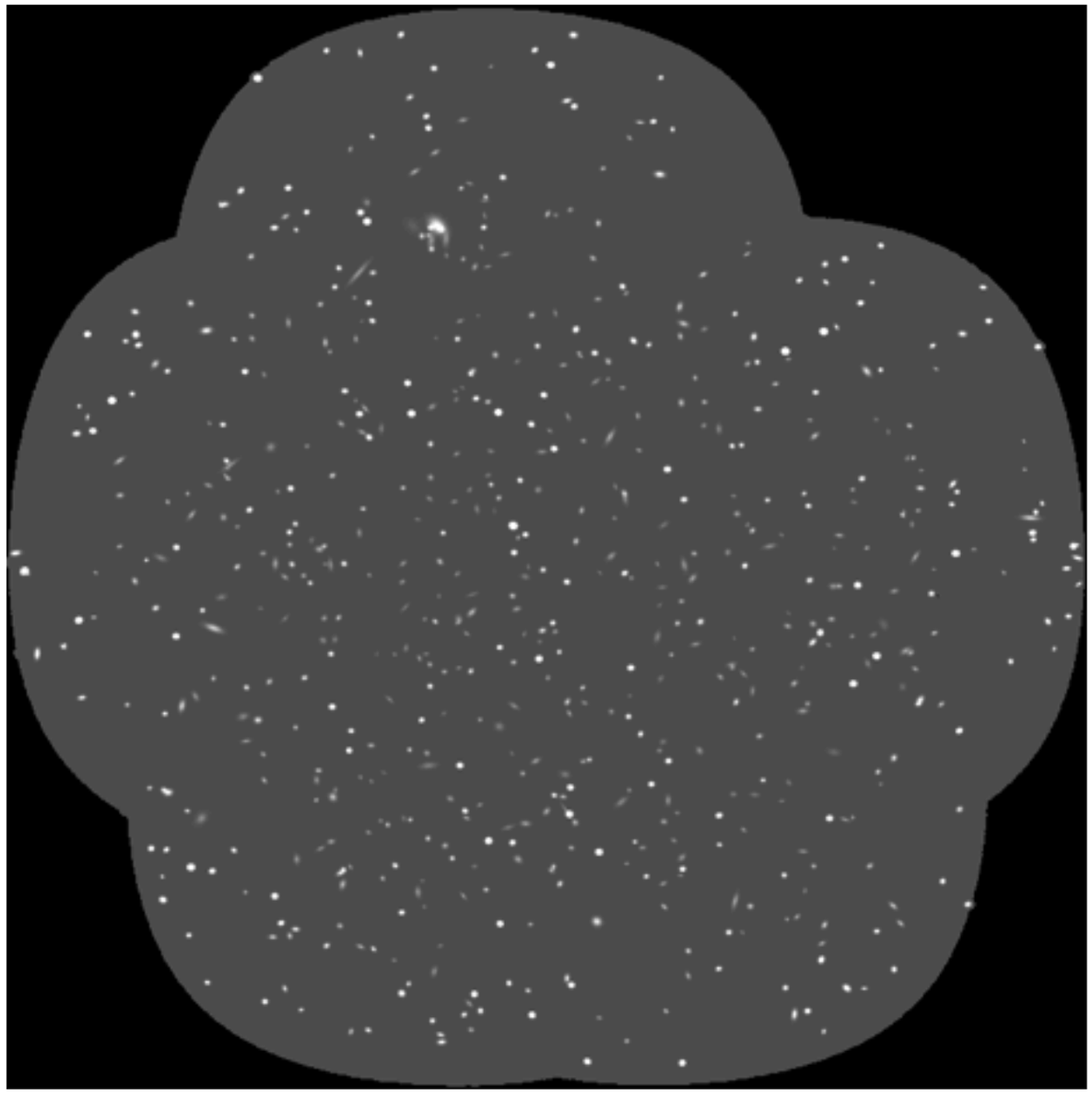


8 bands maps averaged using clipped median and standard deviation
(used for optical images, see Szalay et al. 1999)

Test on source finders by C. Ferrari and G. Macario - In collaboration with G. Heald and the MSSS team
Field including the galaxy cluster Abell 2255 (Obs. Date: 08 Feb 2013)

How to combine maps ?





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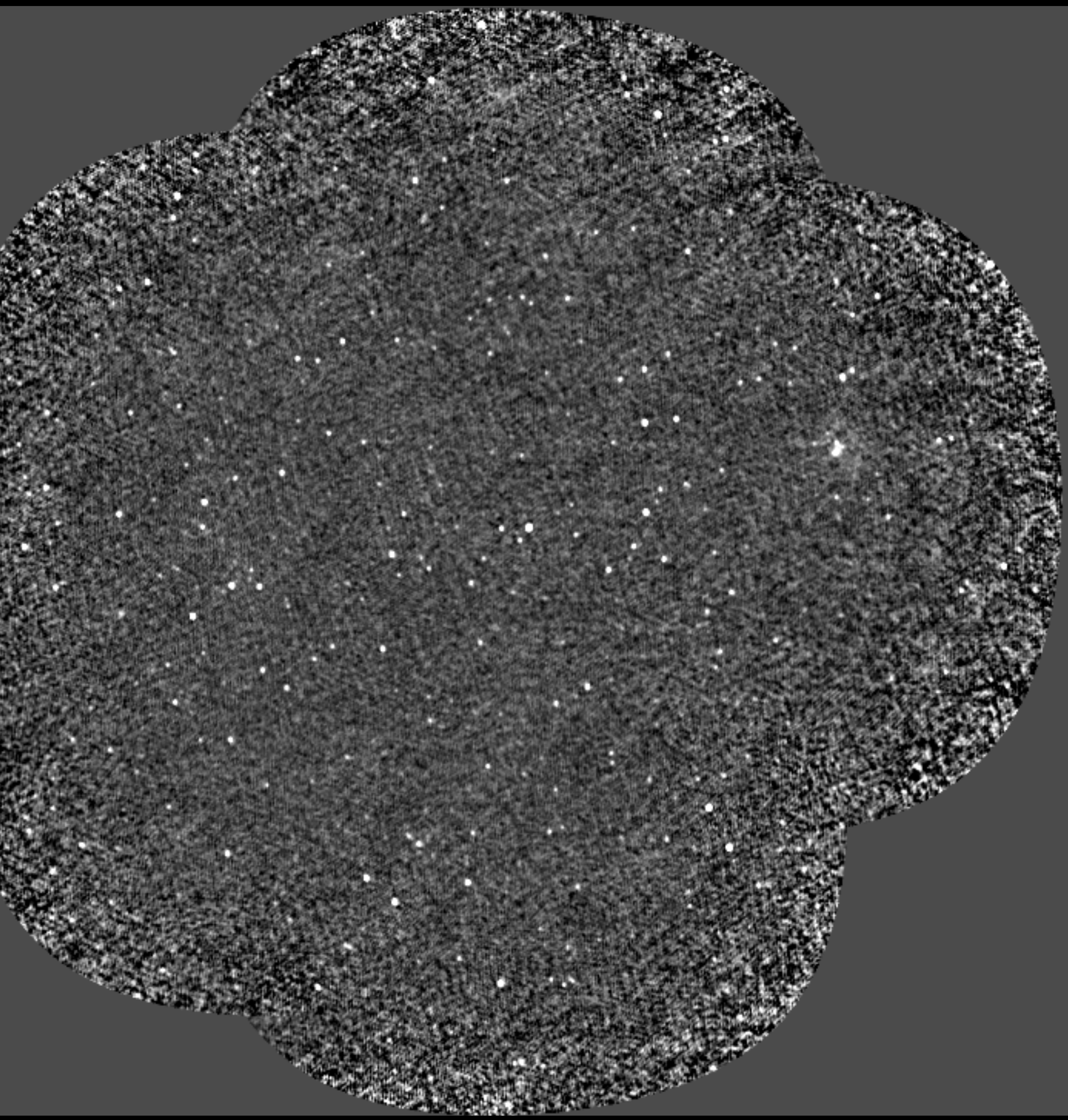
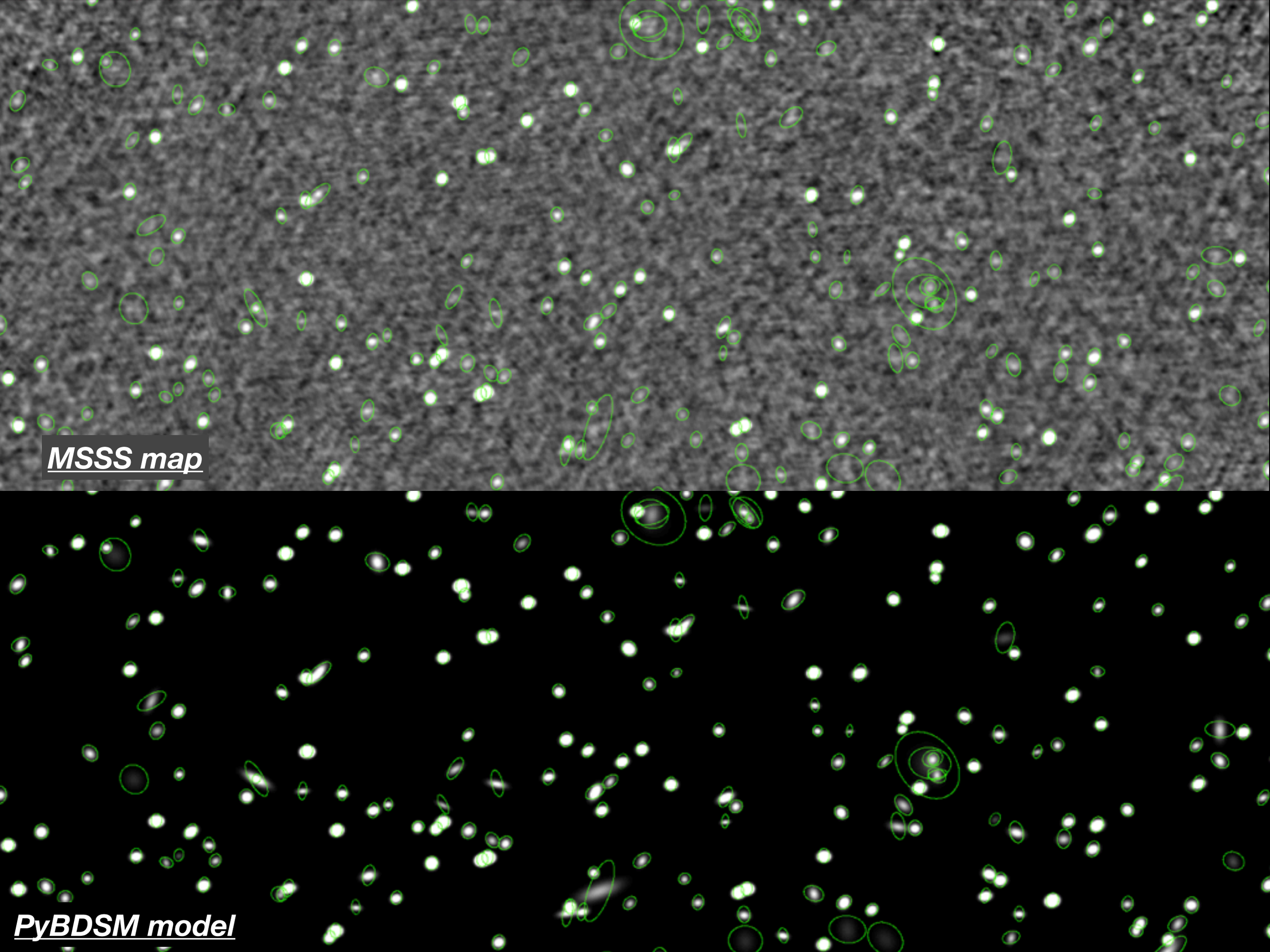
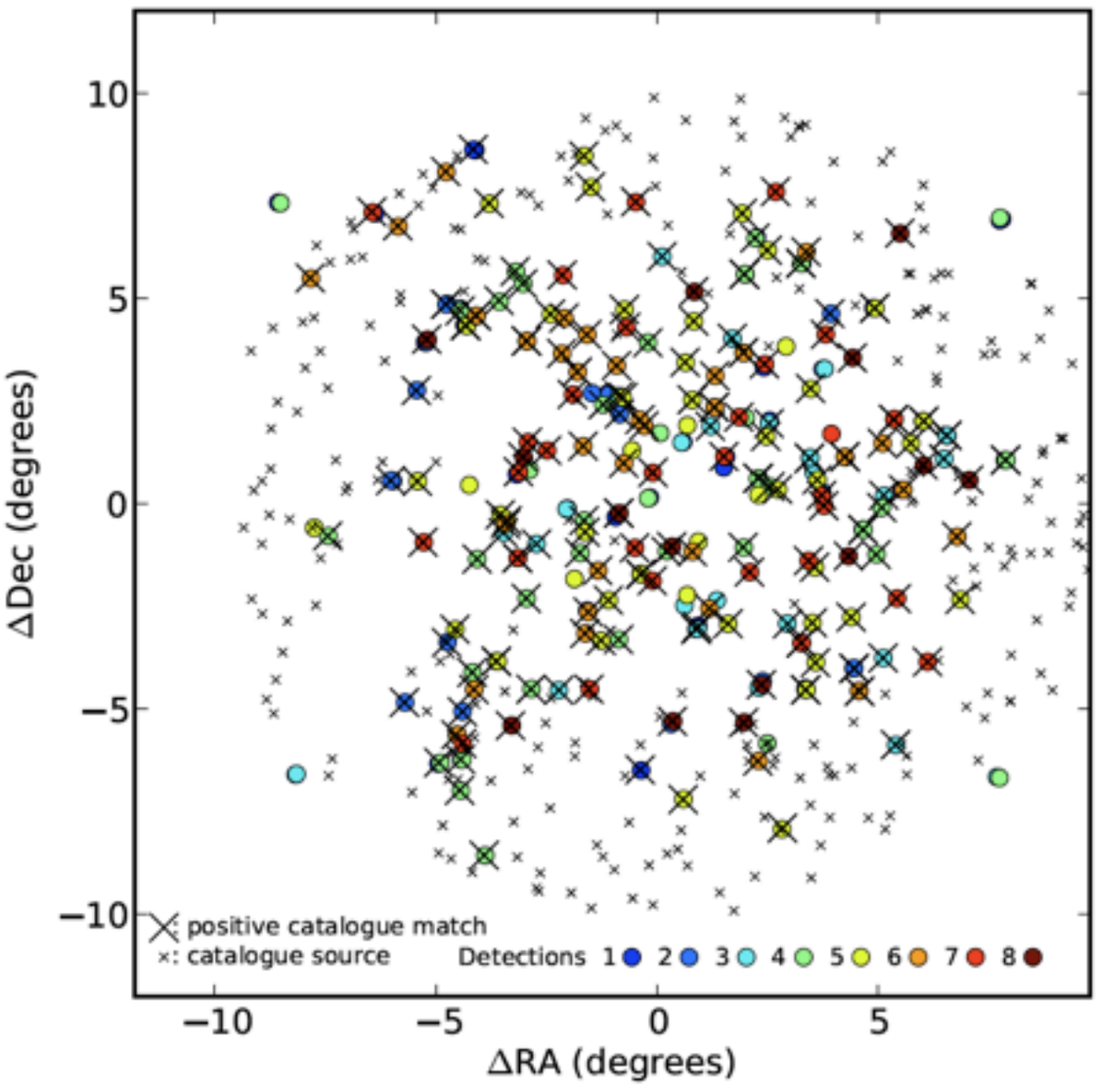
Field including the galaxy cluster Abell 2255 (Obs. Date: 08 Feb 2013)




MSSS map
PyBDSM model

Need of different quality flags in the final catalog



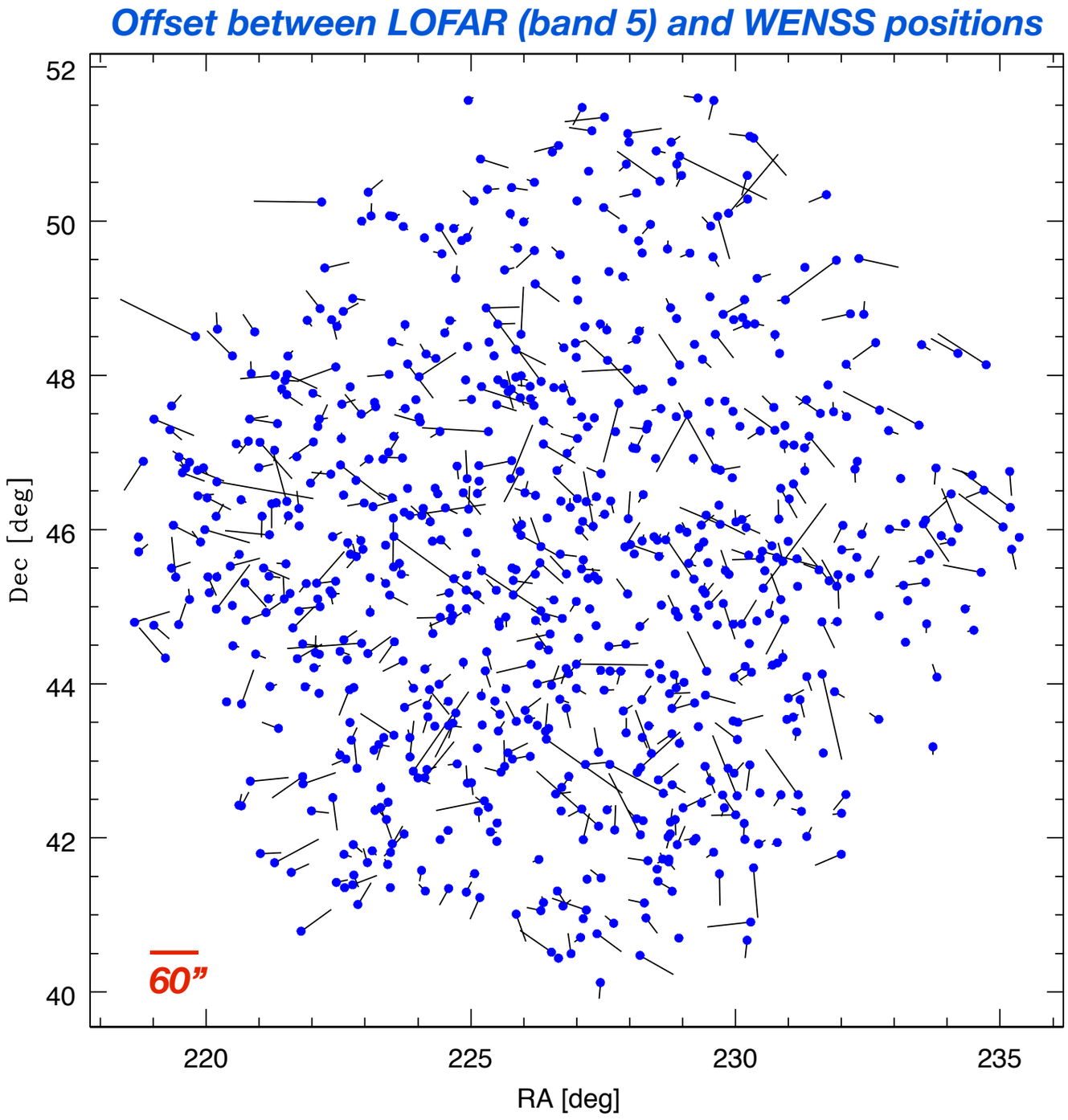
For MSSS:

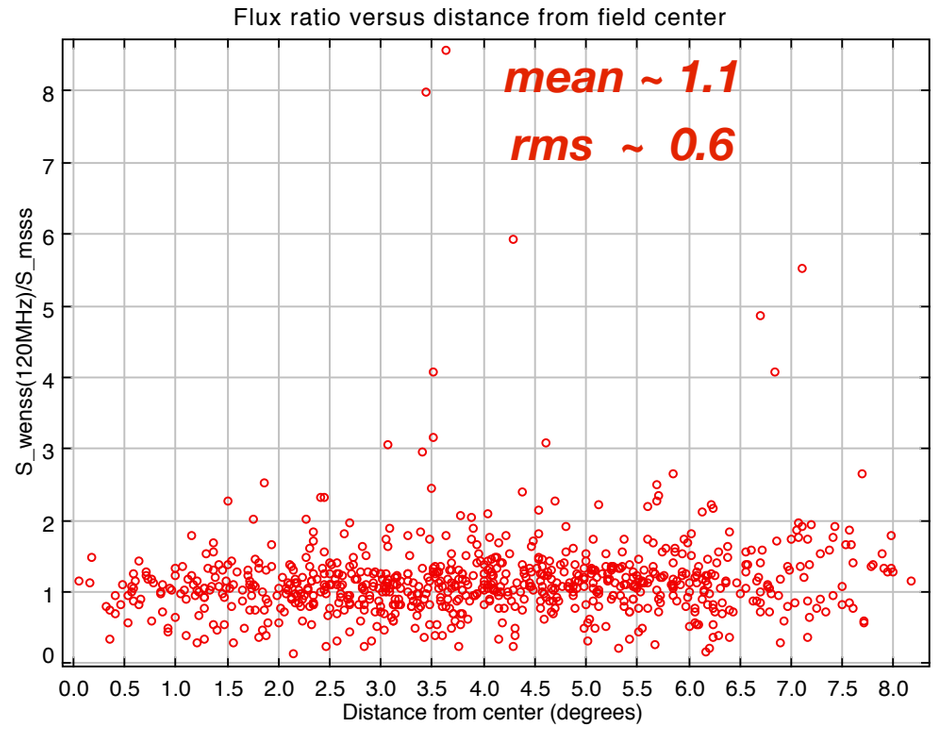
- ***Q.F. = good*** ⇒ source detected in MSSS & in WENSS/NVSS
- ***Q.F. = mean*** ⇒ source detected in MSSS & in WENSS/ NVSS, but with a flux difference higher than n_sigma
- ***Q.F. = poor*** ⇒ point source detected only in MSSS
- ***Q.F. = extended*** ⇒ diffuse source detected in MSSS

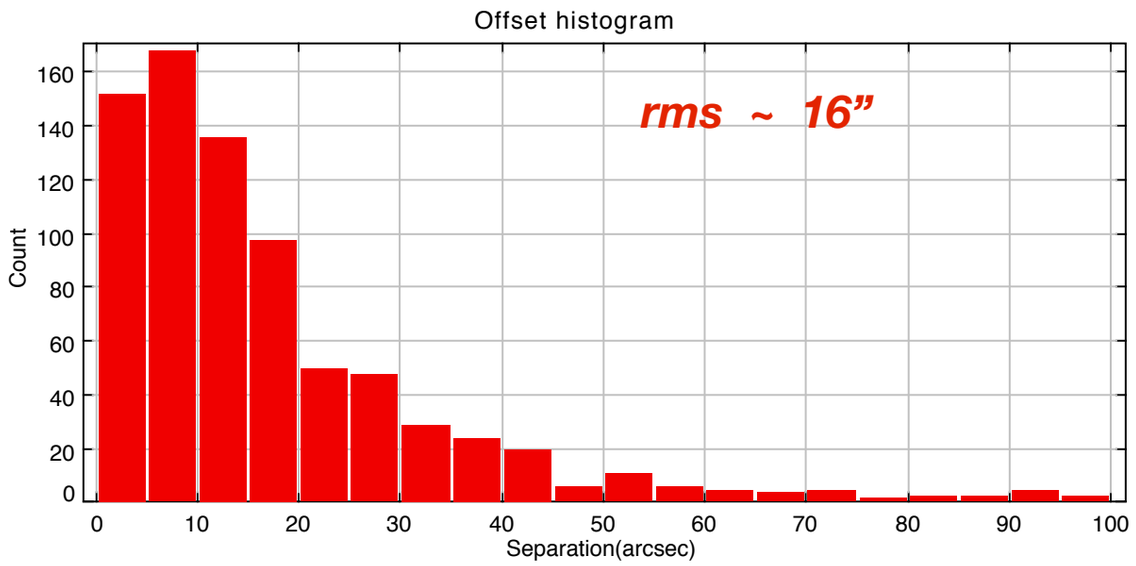
For deeper Surveys:

- Take advantage of the possibility to ***use both PyBDSM and PySE*** (see also results of the ***Data Challenge***)
- Use joint ***multi-band detections***

Comparison with WENSS catalog

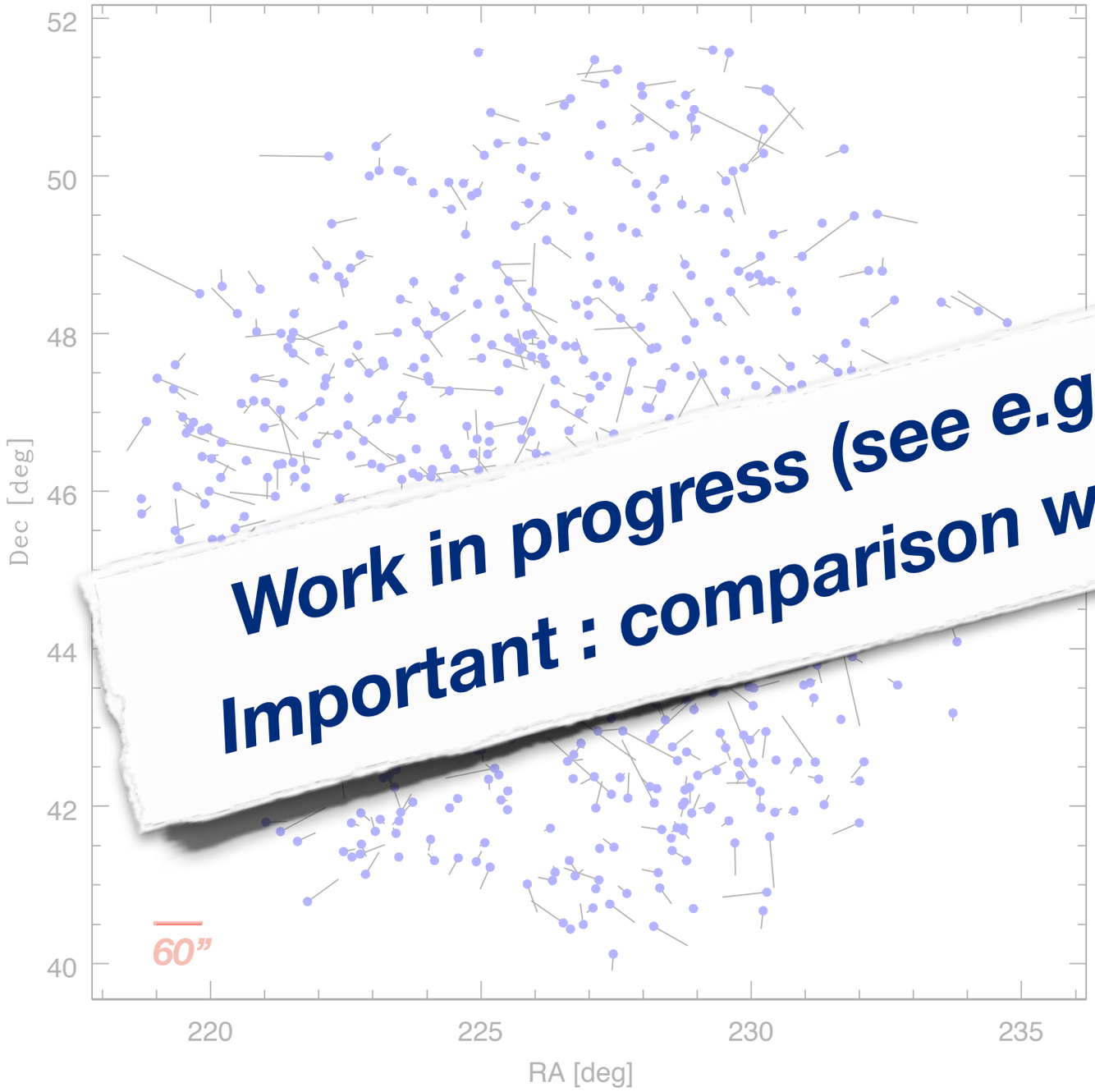


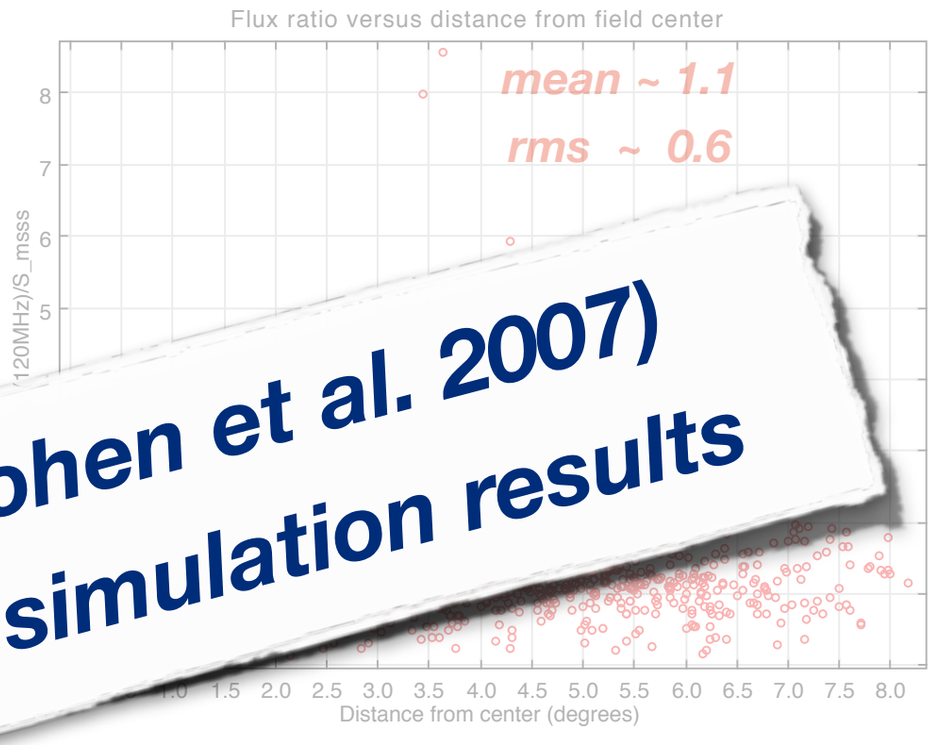




Comparison with WENSS catalog

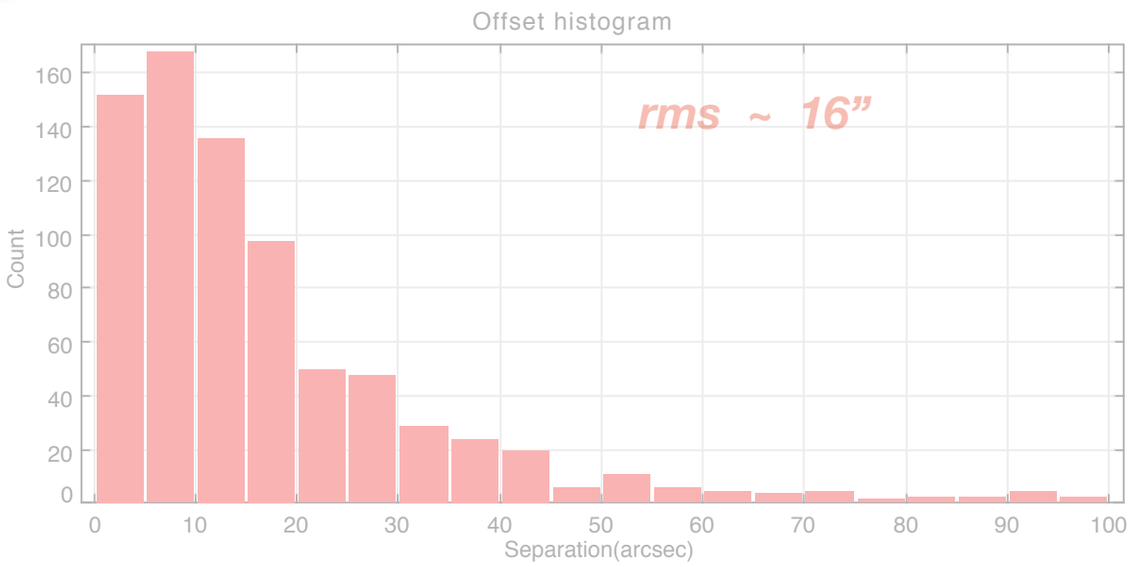
Offset between LOFAR (band 5) and WENSS positions





Work in progress (see e.g. Cohen et al. 2007)

Important : comparison with simulation results



Main points to be answered

- Which are the parameters that are important to set for optimizing source finders ?
- Which corrections should we introduce in theoretical error bars given by the source finder tools ?
- Which source extraction and association strategy should we use for multi-band LOFAR catalogs ?
- How to build a very reliable and complete catalog from LOFAR surveys ?

→ *Need of more complex simulated LOFAR maps*

→ *Importance of current tests on MSSS maps*

→ *Man power welcome in the group !*