LOFAR facetselfcal

Reinout van Weeren

Leiden Observatory, Leiden University

European Research Council

NWO Vidi scheme

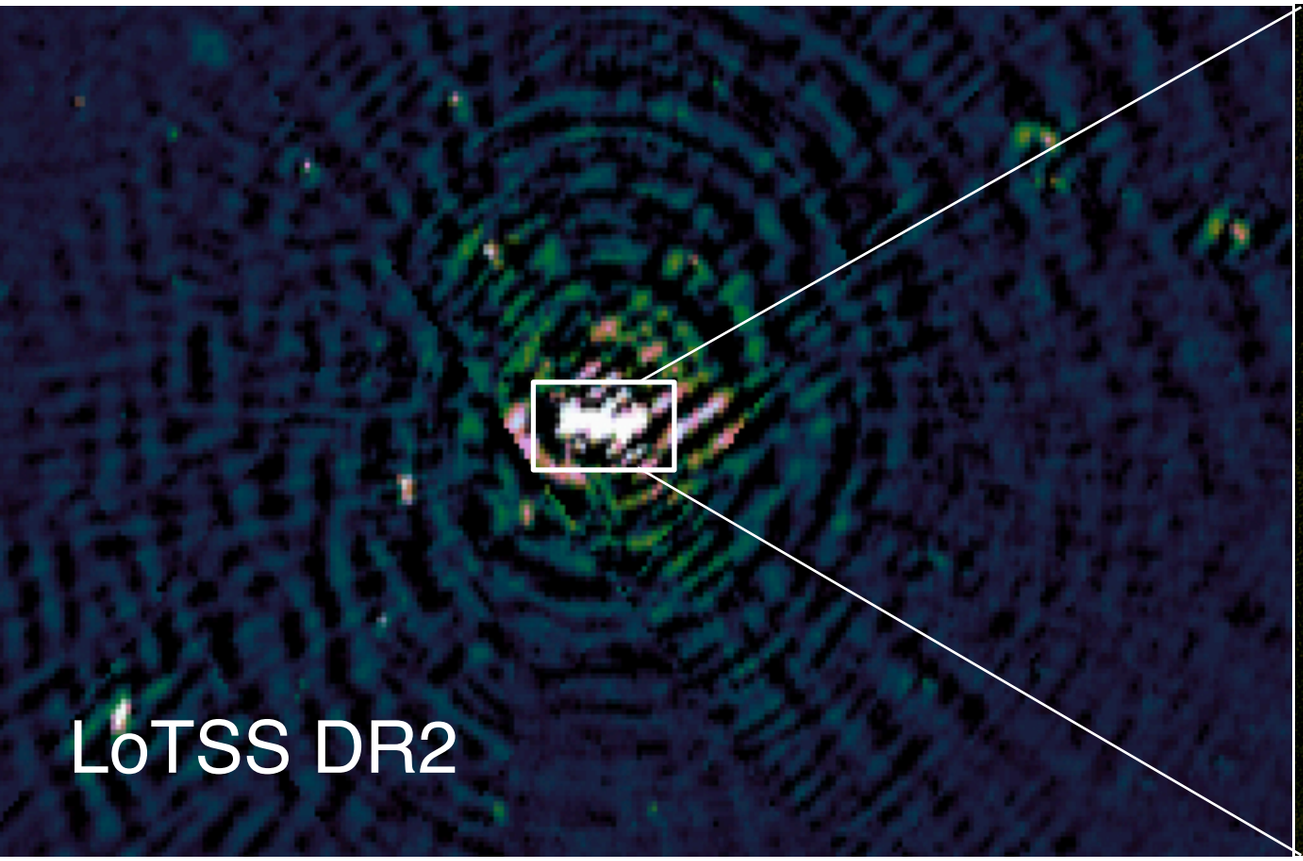
Outline

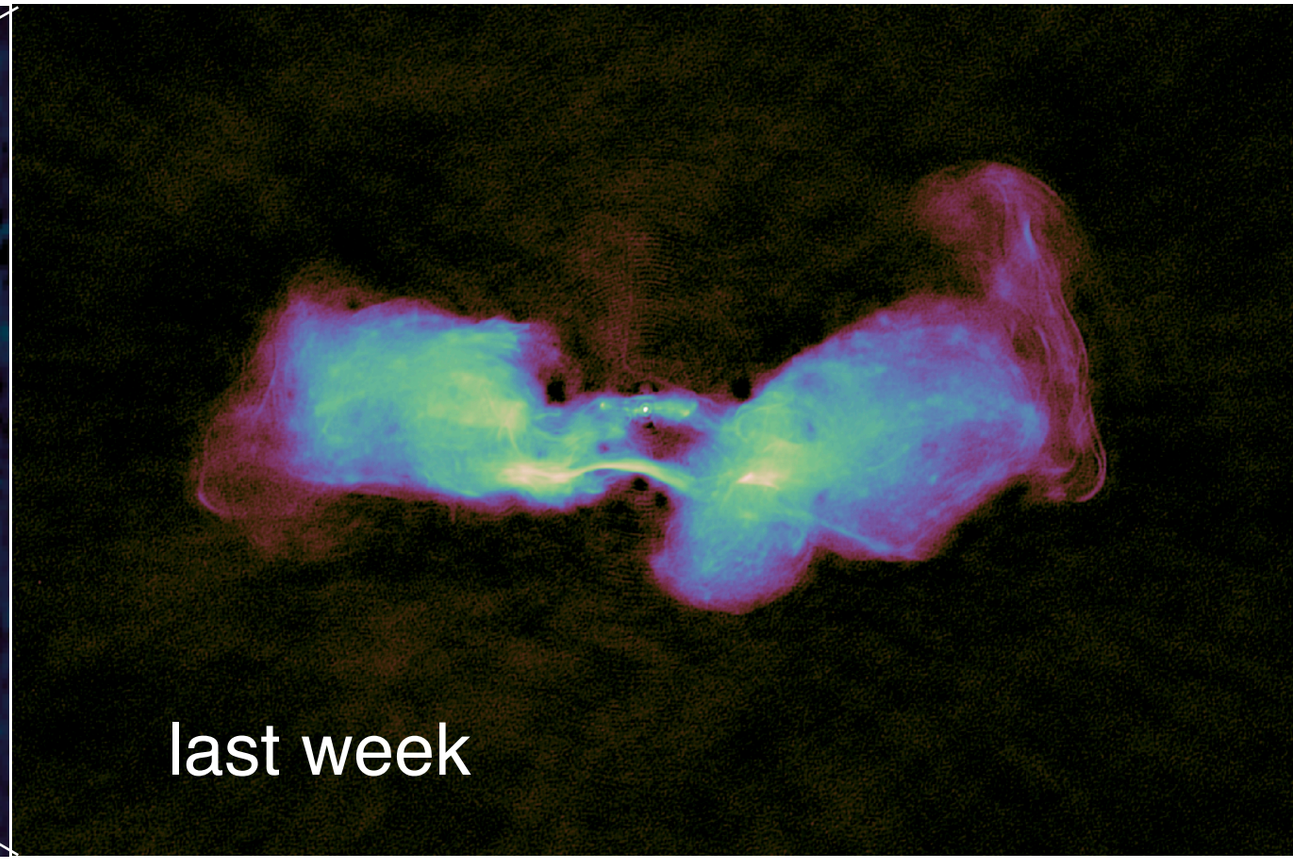
- Surveys reprocessing
- ILT calibration and polarization imaging

- *LBA decameter band: Christian Groeneveld & Erik Osinga*

Potential

3C338



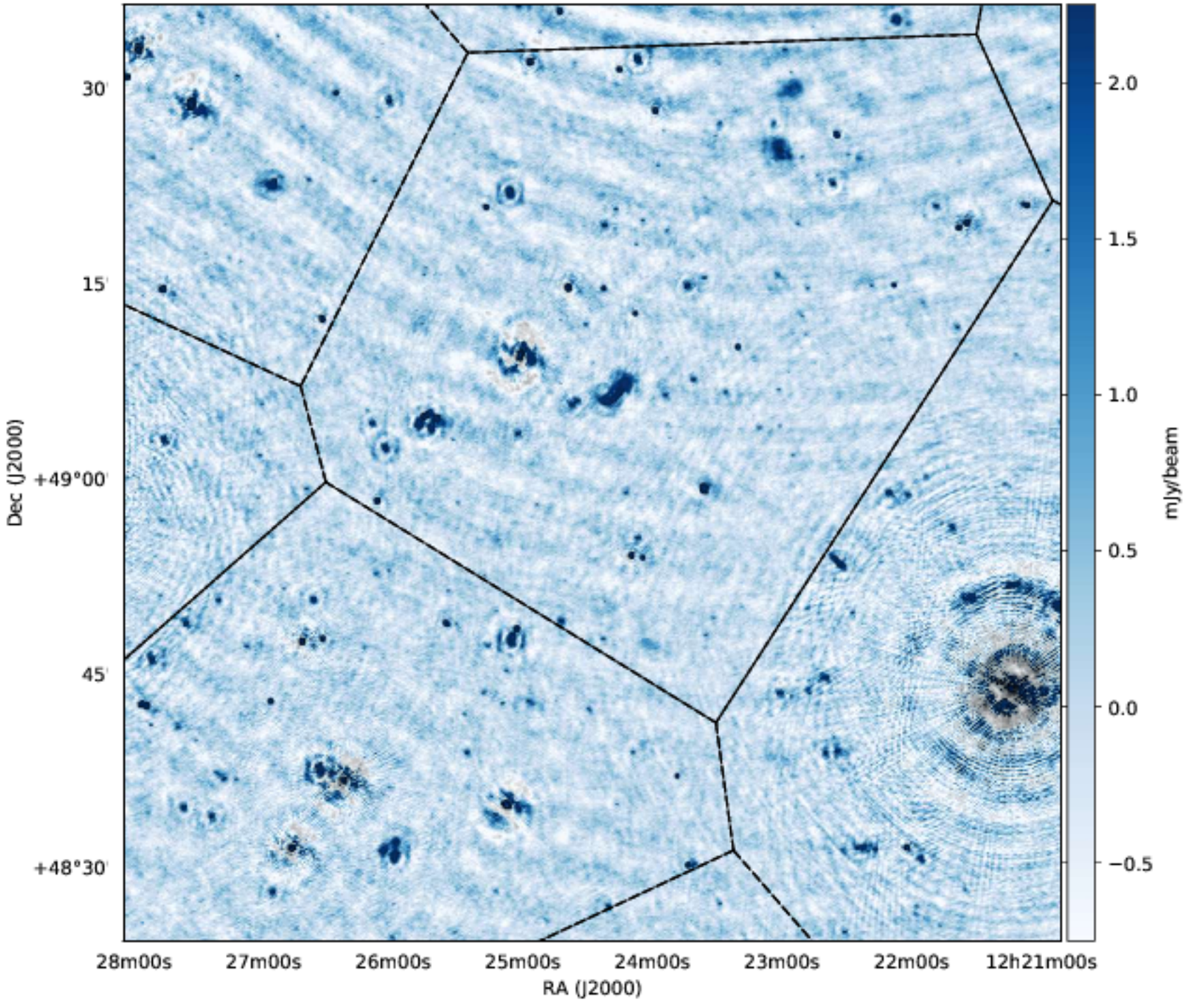


Roland Timmerman
120-168 MHz — 0.3″ resolution

LoTSS & LoLSS post-processing

slide: Tim Shimwell

- Facet layout can be non-optimal for target-of-interest given that DDE corrections work on a per-facet basis
- Target can be located in two or more overlapping pointings
- Weightings scheme and uv-cuts might not be ideal for science case
- Re-imaging is expensive (uv-tapers, weightings, different deconvolution)

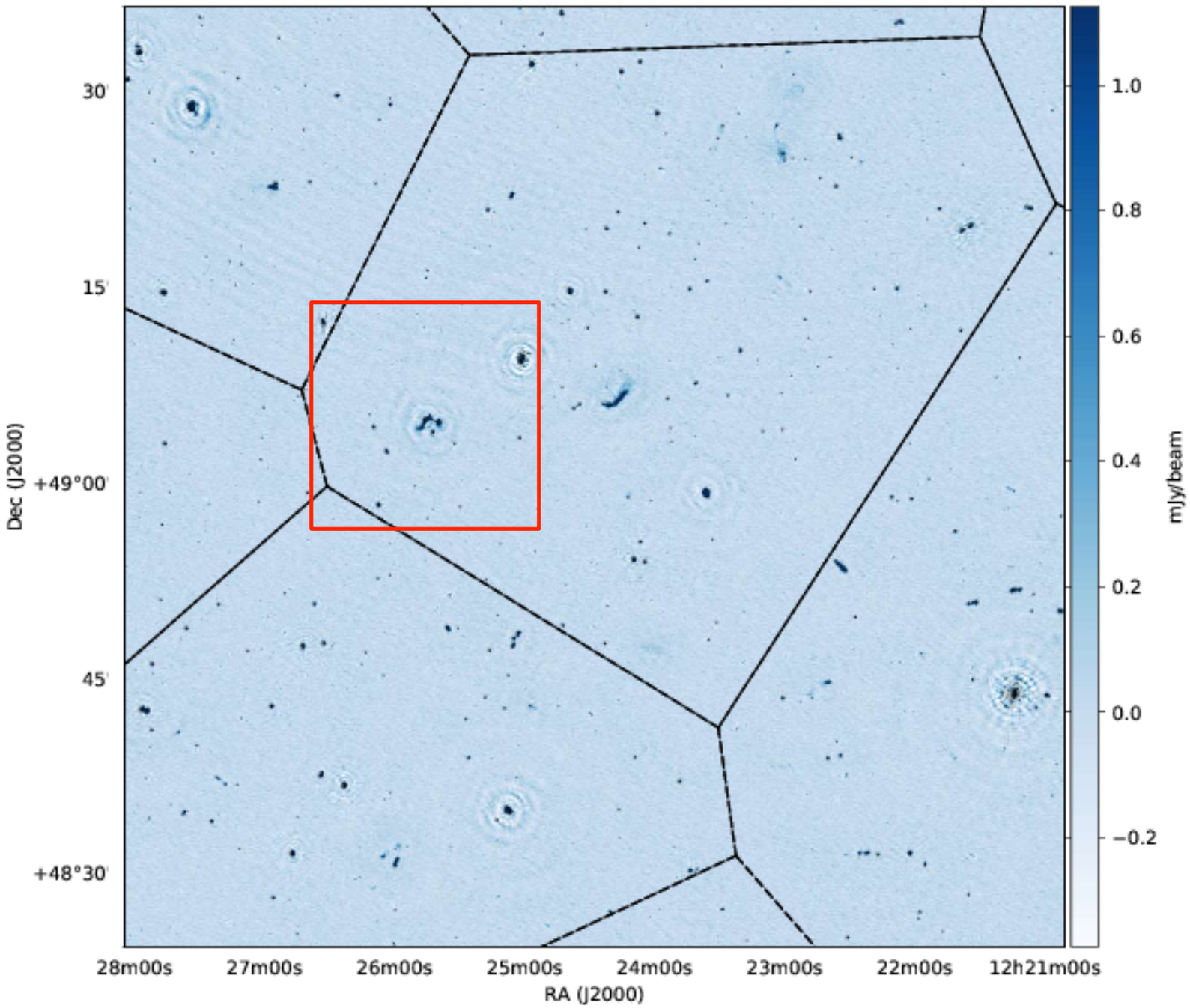


DDF-pipeline (Tasse+ 2021) makes use of DDFacet and kMS for calibration and imaging (Tasse+ 2014; Smirnov+ 2015; Tasse+ 2017). LoLSS pipeline (de Gasperin+2019,2020,2021) makes use of DDFacet, WSClean (Offringa+ 2014; Offringa & Smirnov 2017) and DP3 (van Diepen+ 2018).

LoTSS & LoLSS post-processing

slide: Tim Shimwell

- Facet layout can be non-optimal for target-of-interest given that DDE corrections work on a per-facet basis
- Target can be located in two or more overlapping pointings
- Weightings scheme and uv-cuts might not be ideal for science case
- Re-imaging is expensive (uv-tapers, weightings, different deconvolution)



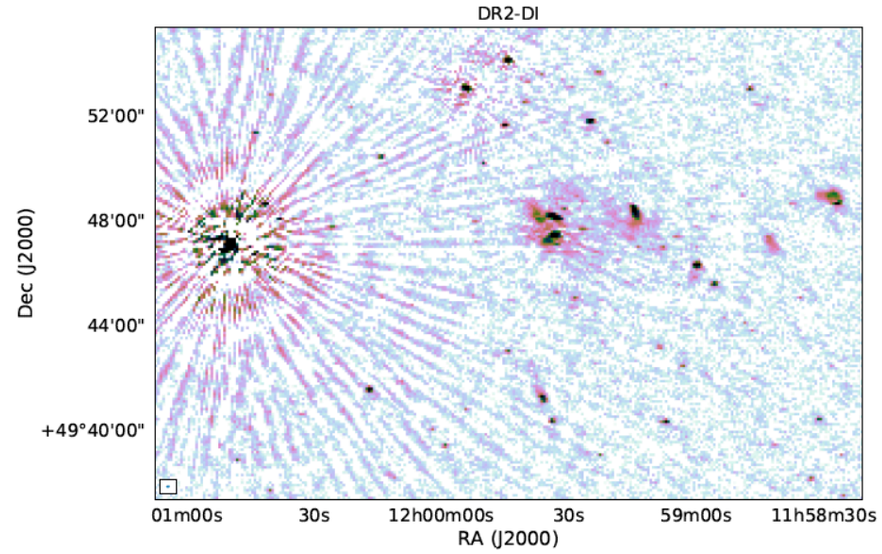
DDF-pipeline (Tasse+ 2021) makes use of DDFacet and kMS for calibration and imaging (Tasse+ 2014; Smirnov+ 2015; Tasse+ 2017). LoLSS pipeline (de Gasperin+2019,2020,2021) makes use of DDFacet, WSClean (Offringa+ 2014; Offringa & Smirnov 2017) and DP3 (van Diepen+ 2018).

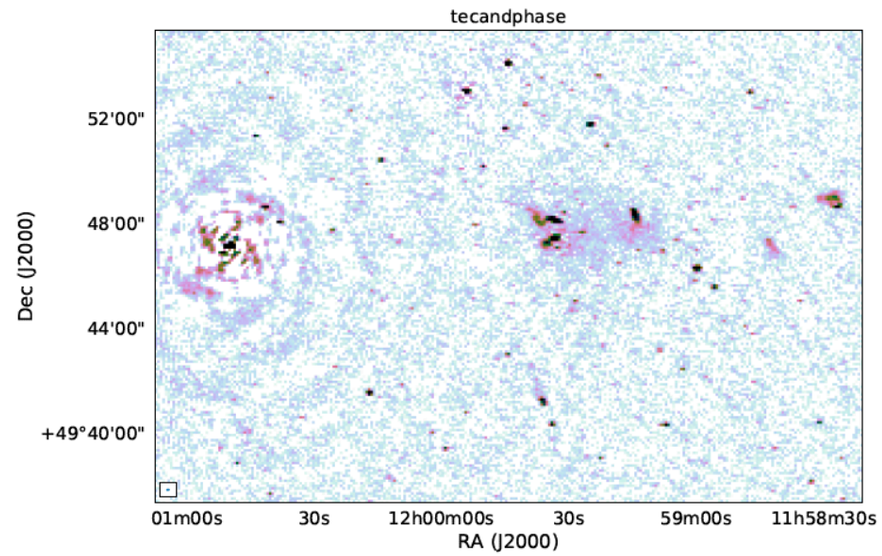
“facetselfcal”

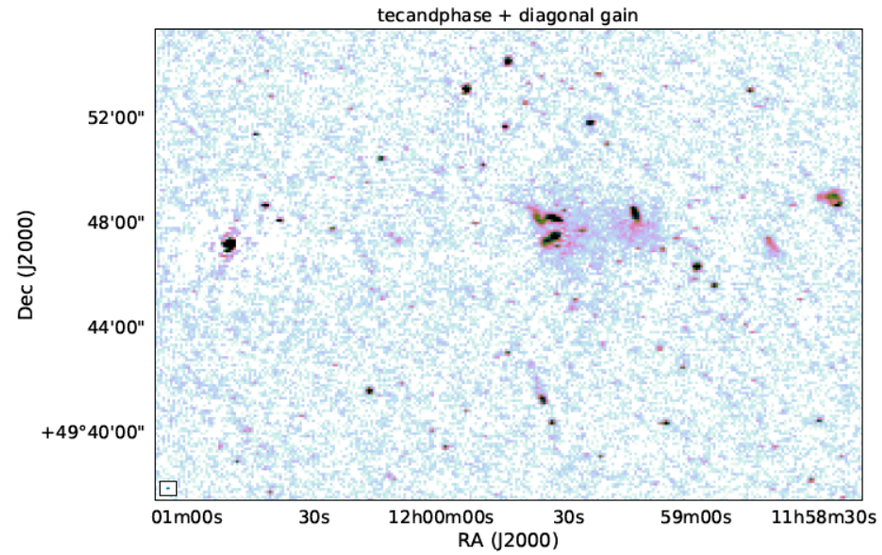
van Weeren+ (2021)

1. Perturbative solves (+ automated selfcal)
2. Start with biggest effect first
3. Continue with next biggest effect
4. Solution interval computed based on visibility noise and model flux
5. Arbitrary number of perturbative steps possible without needing to write code (e.g., ILT infield calibrator uses 6th order perturbation)
6. Options 5 makes it a powerful tool to hunt down calibration limitations and test ideas

https://github.com/rvweeren/lofar_facet_selfcal

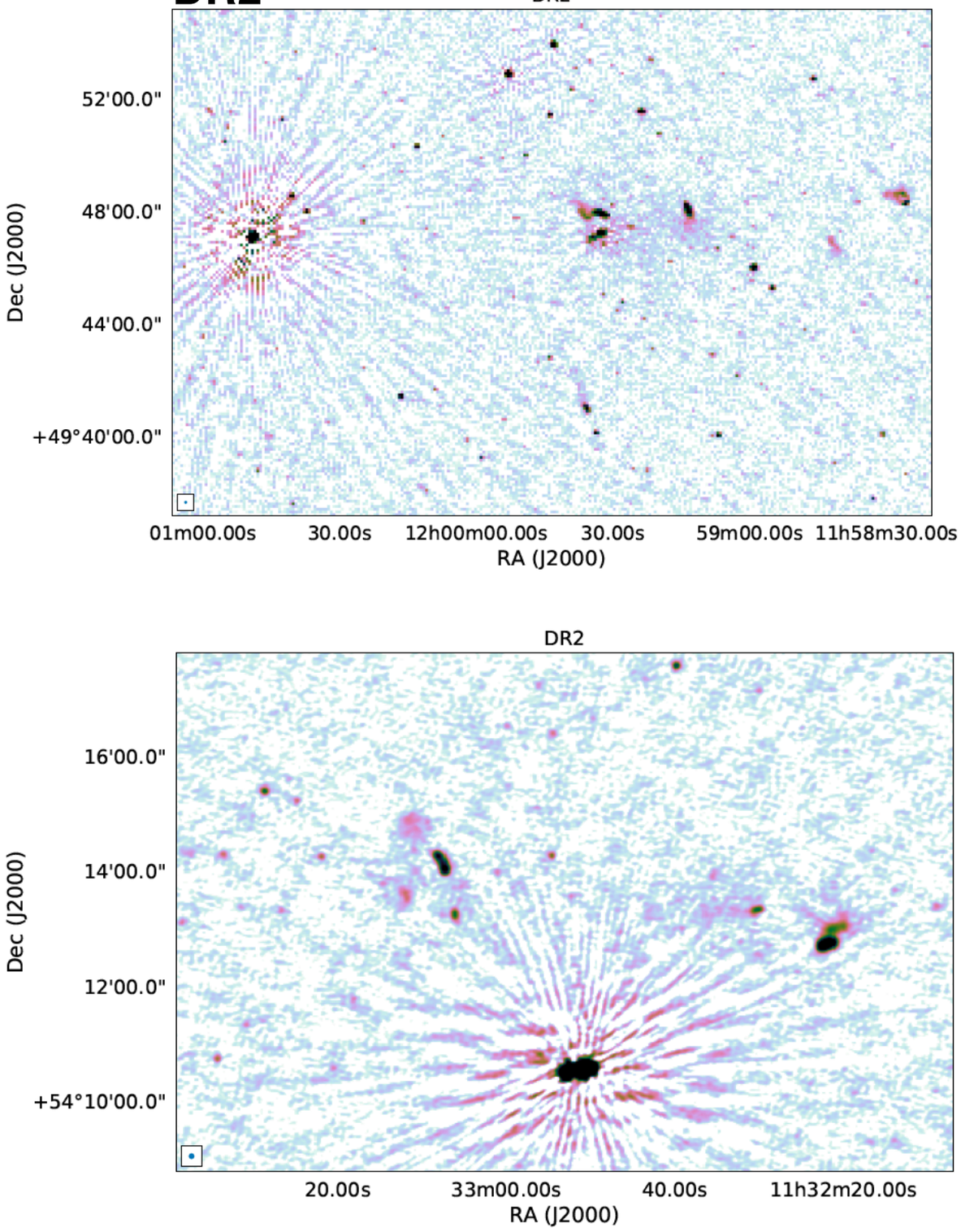




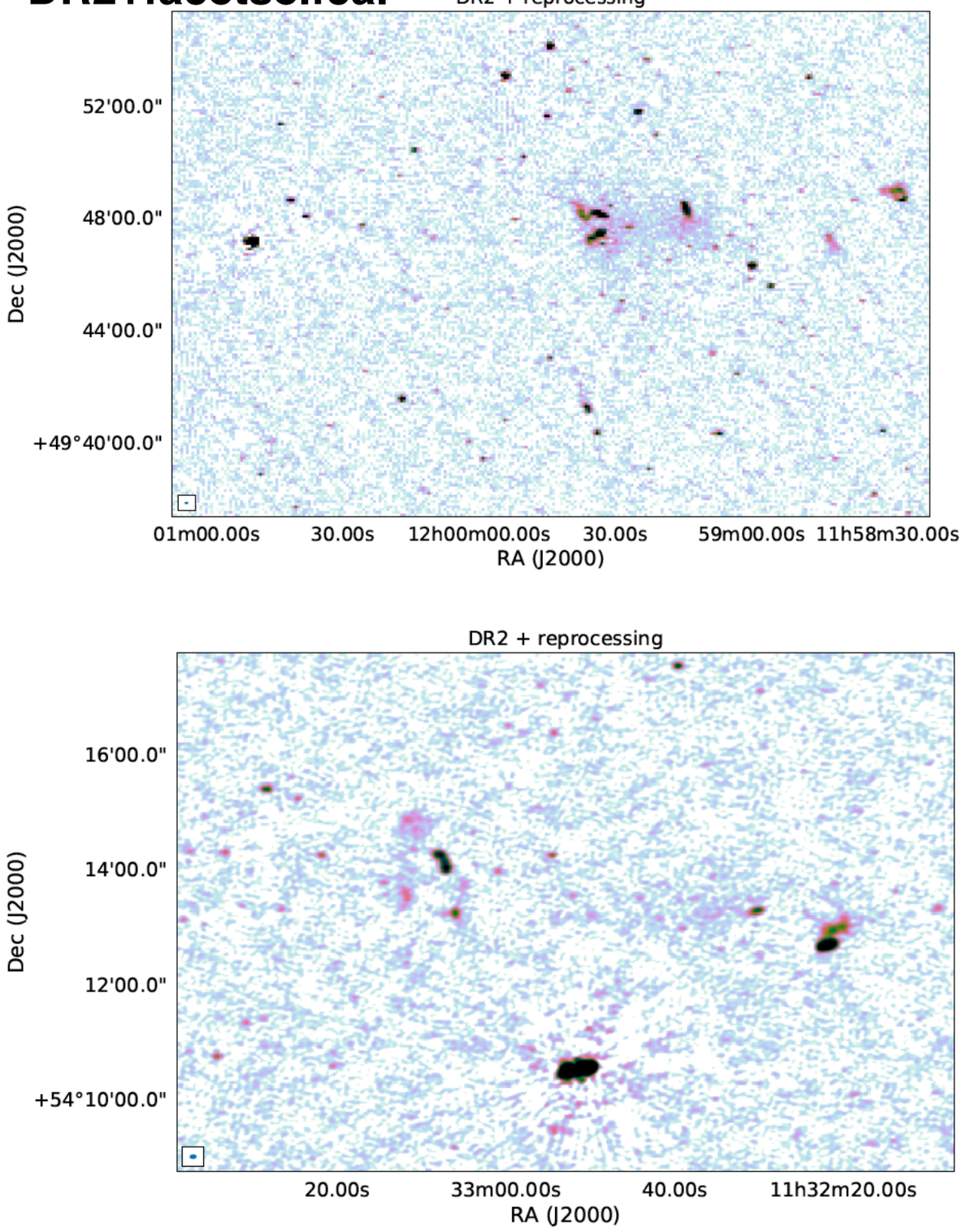


LoTSS DR2 re-processing

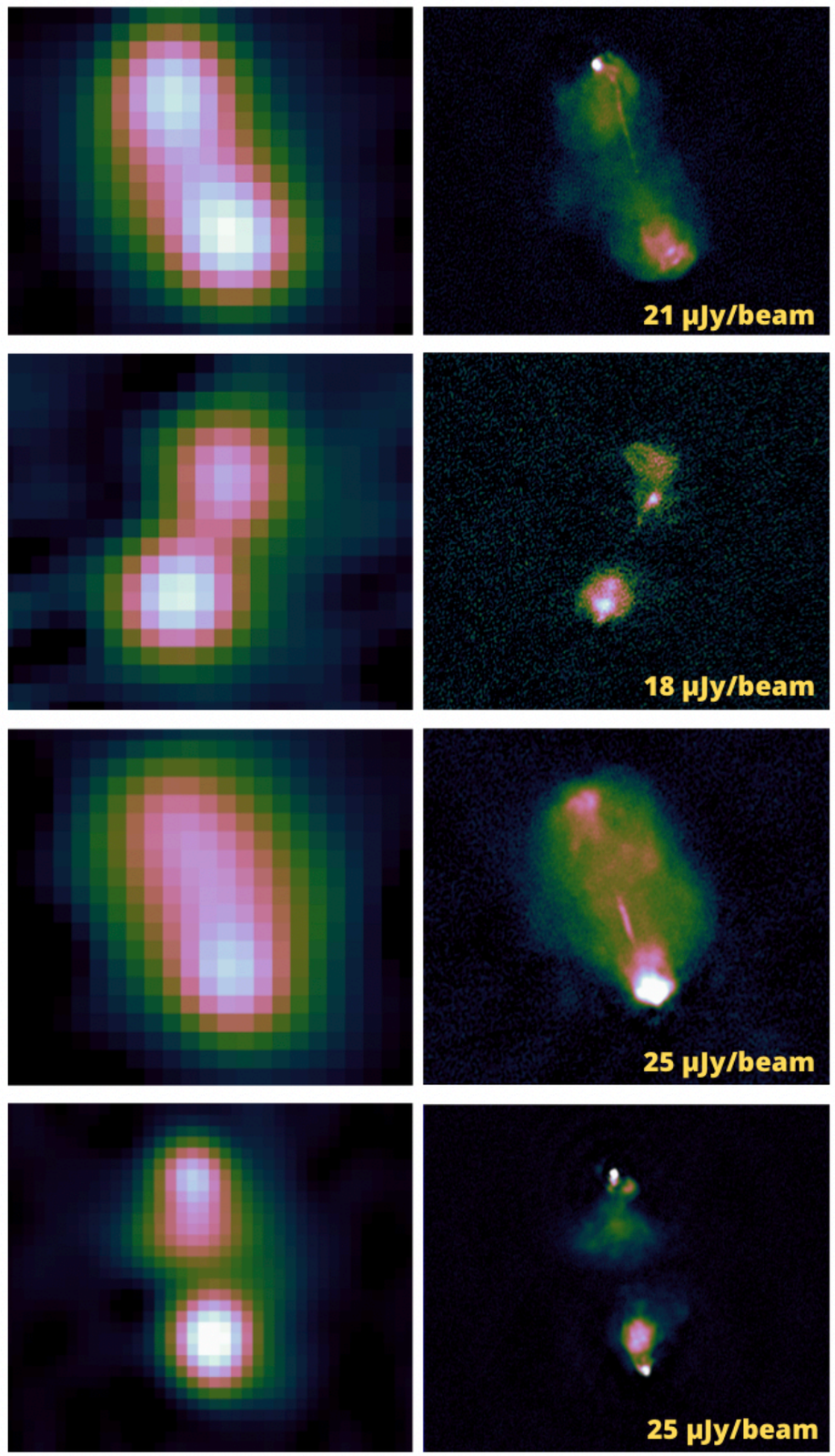
DR2



DR2+facetselfcal



ILT: long baselines



ELAIS-N1 Jurjen de Jong (poster)

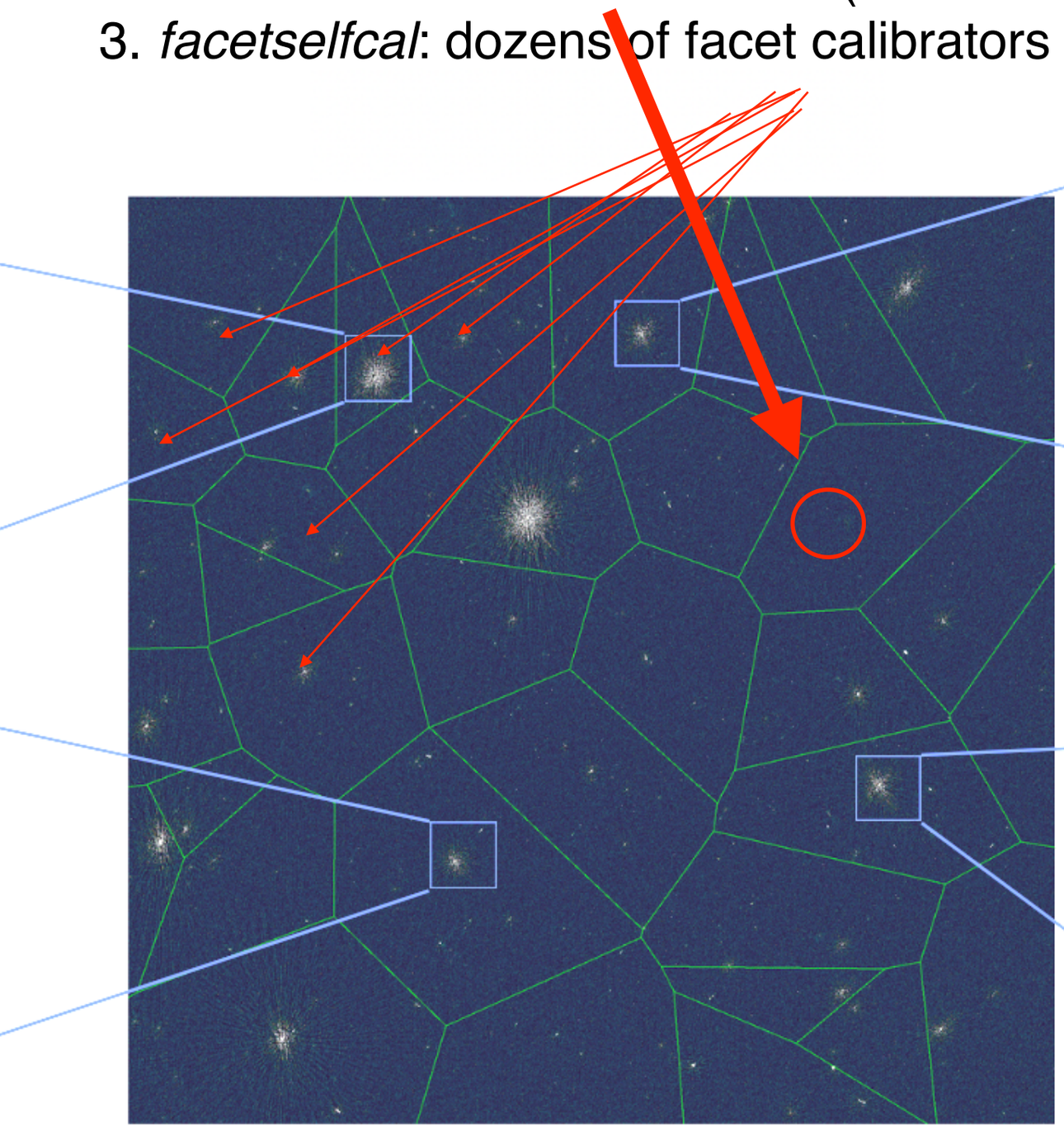
ILT: ELAIS-N1

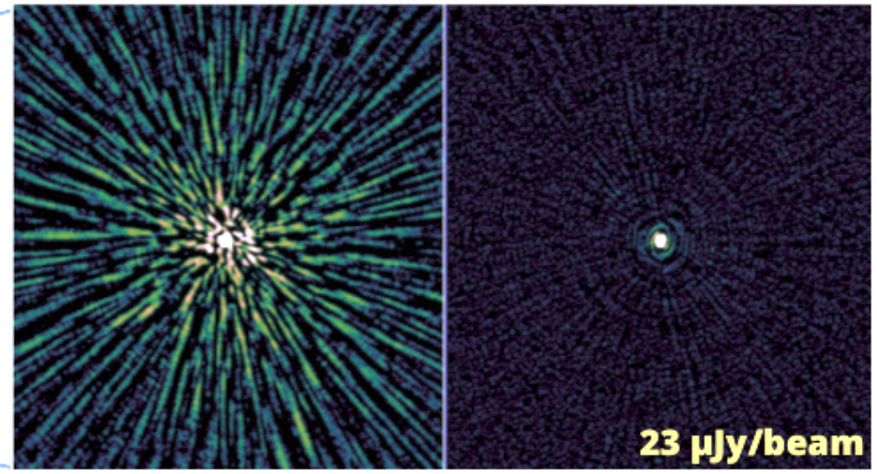
Jurjen de Jong

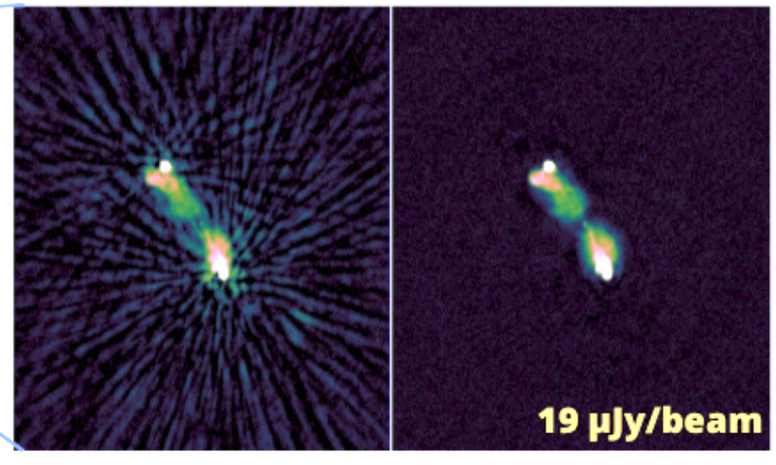
ILT calibration: triple-step calibration approach

Morabito+ (2022)
Sweijen+ (2022)

1. primary calibrator: instrumental effects
2. *facetselfcal*: in-field calibrator (corrects bulk of the ionosphere and clock)
3. *facetselfcal*: dozens of facet calibrators (DDE ionosphere+beam)

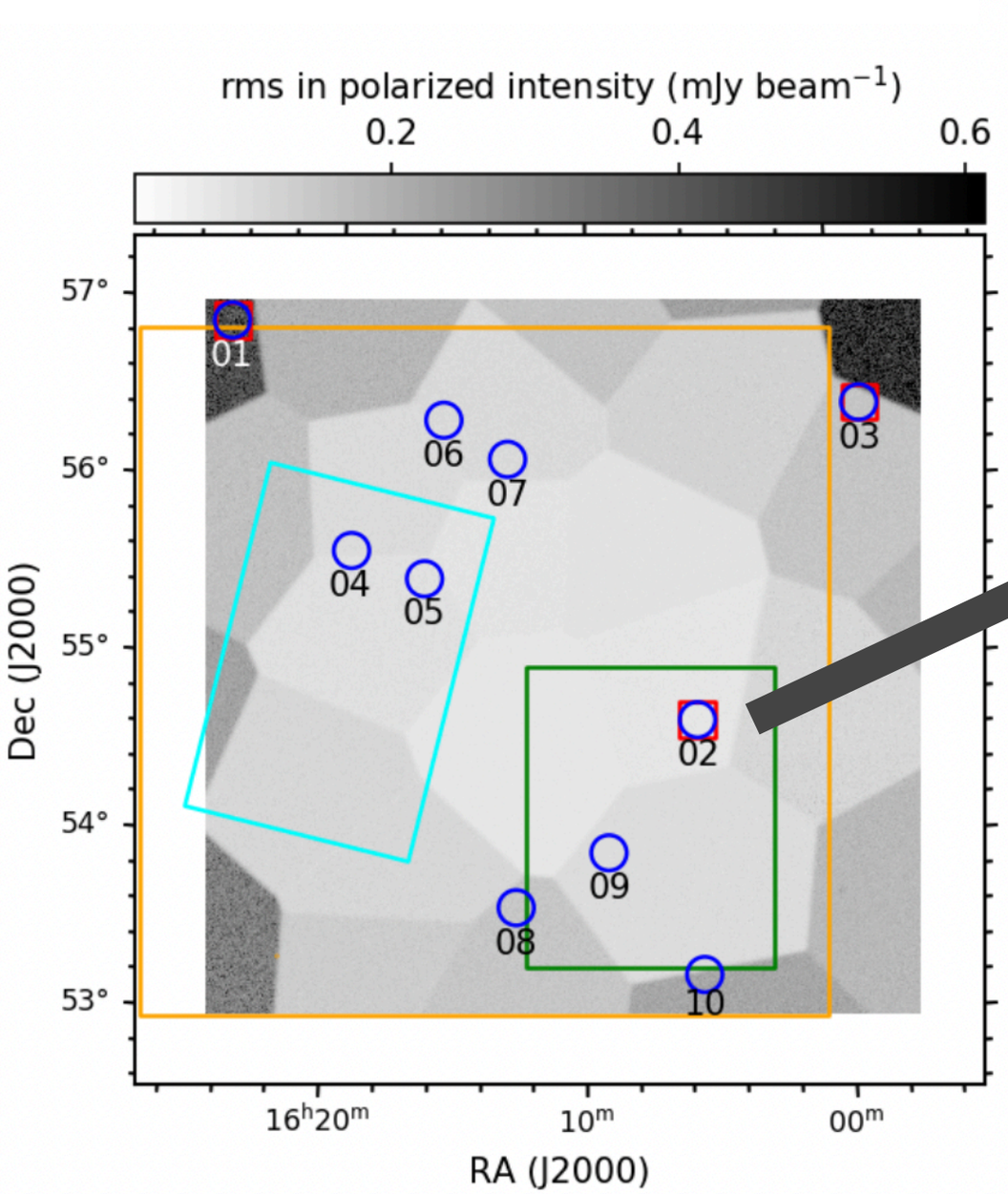


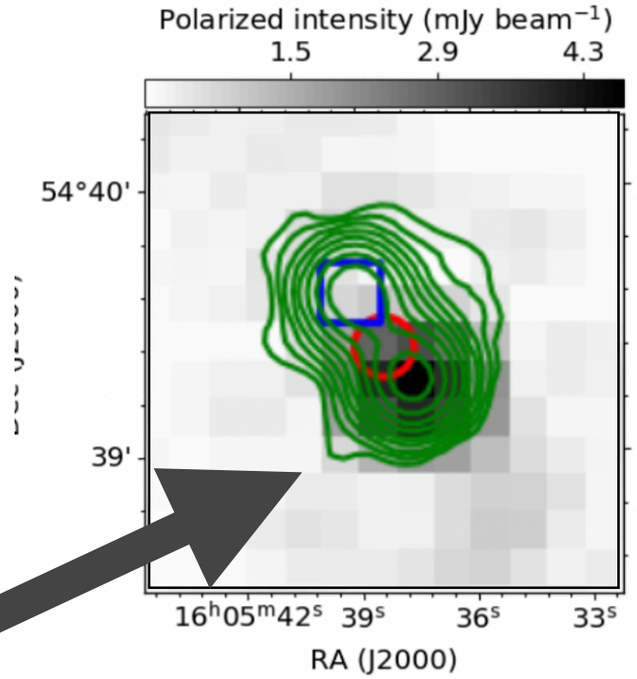


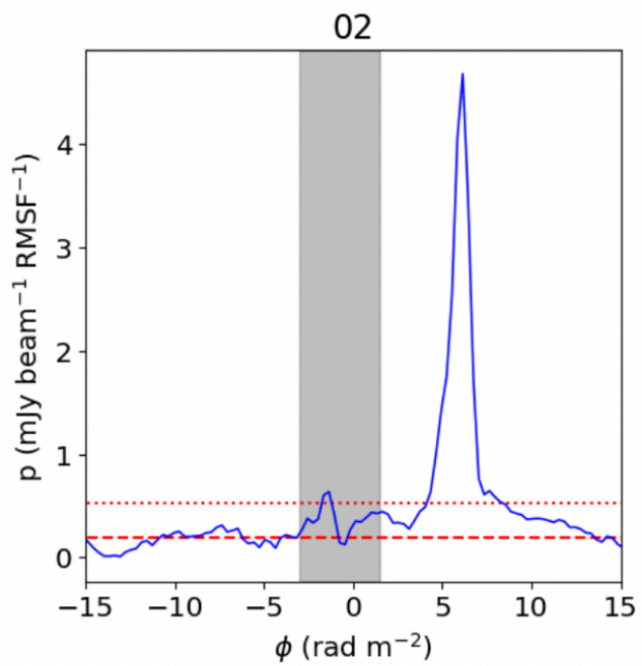


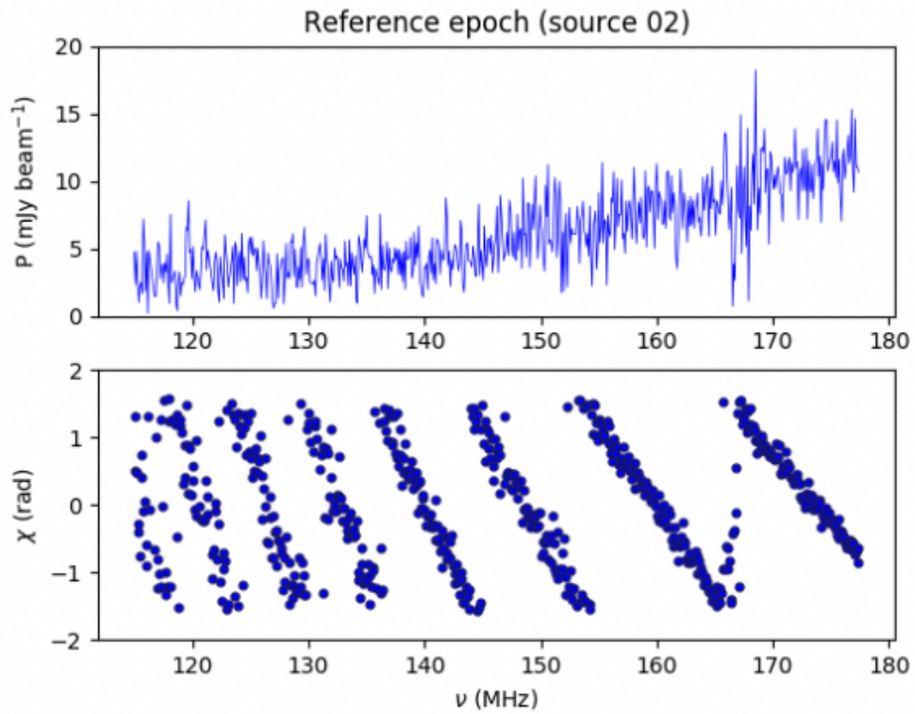
ELIAS-N1 polarization at 20″

Herrera Ruiz+ (2021)

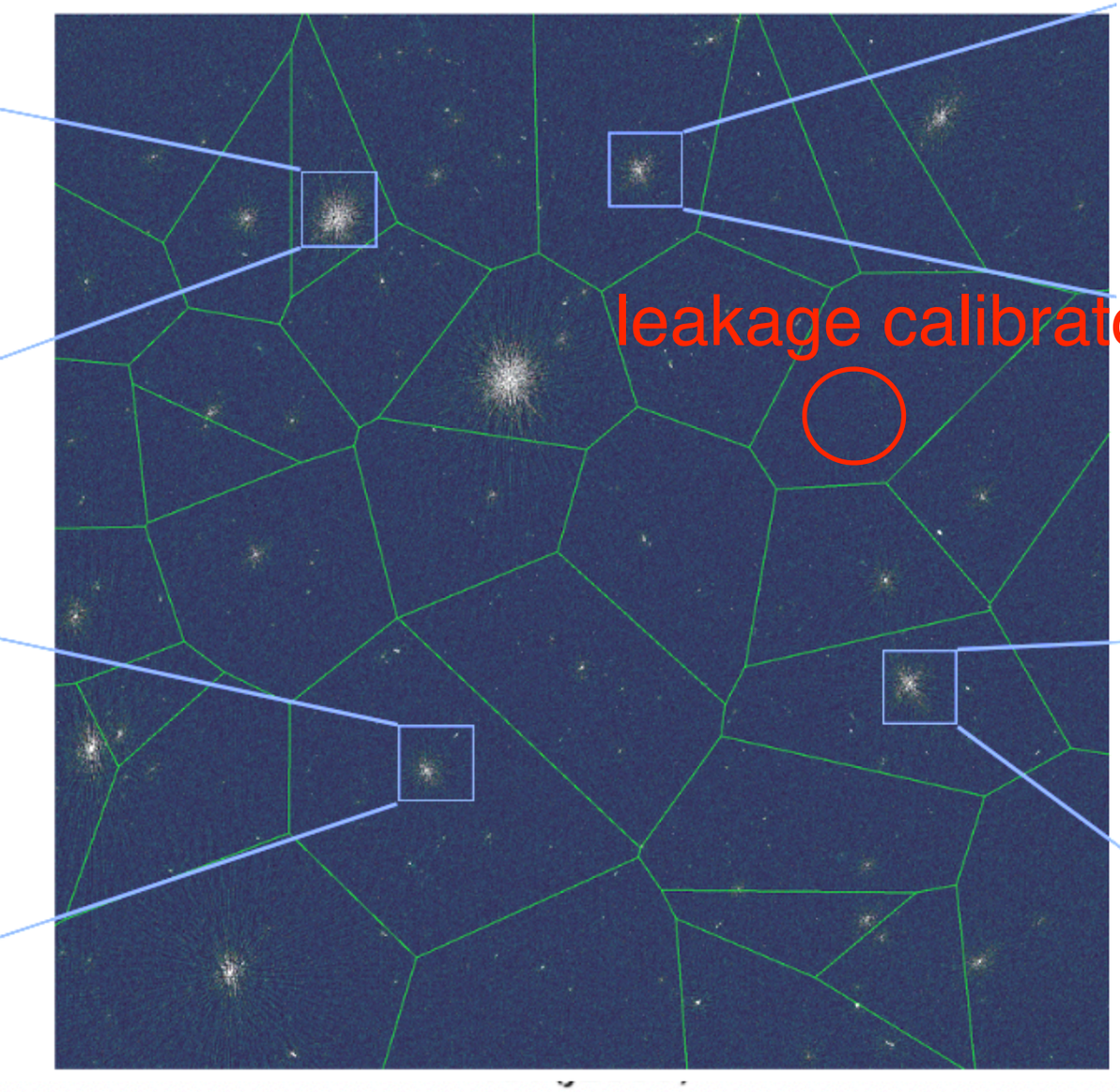


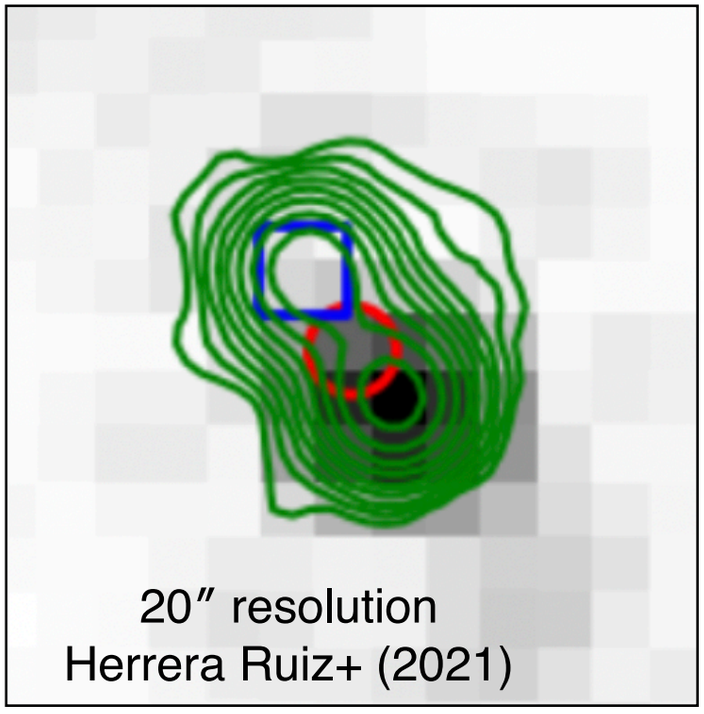




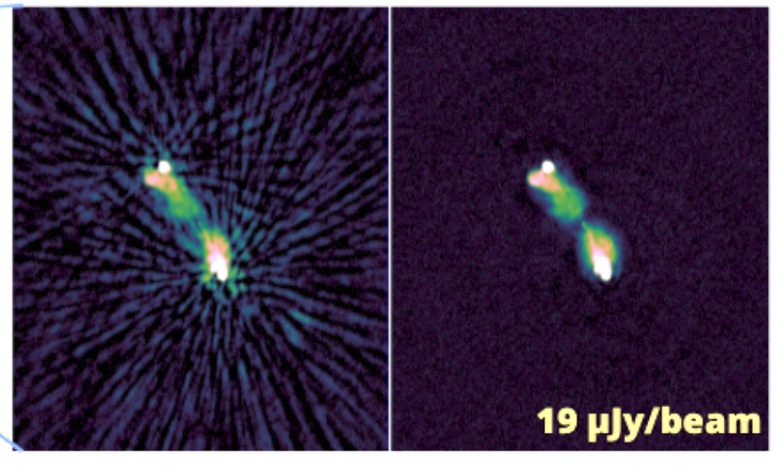


ELIAS-N1 polarization at 20″



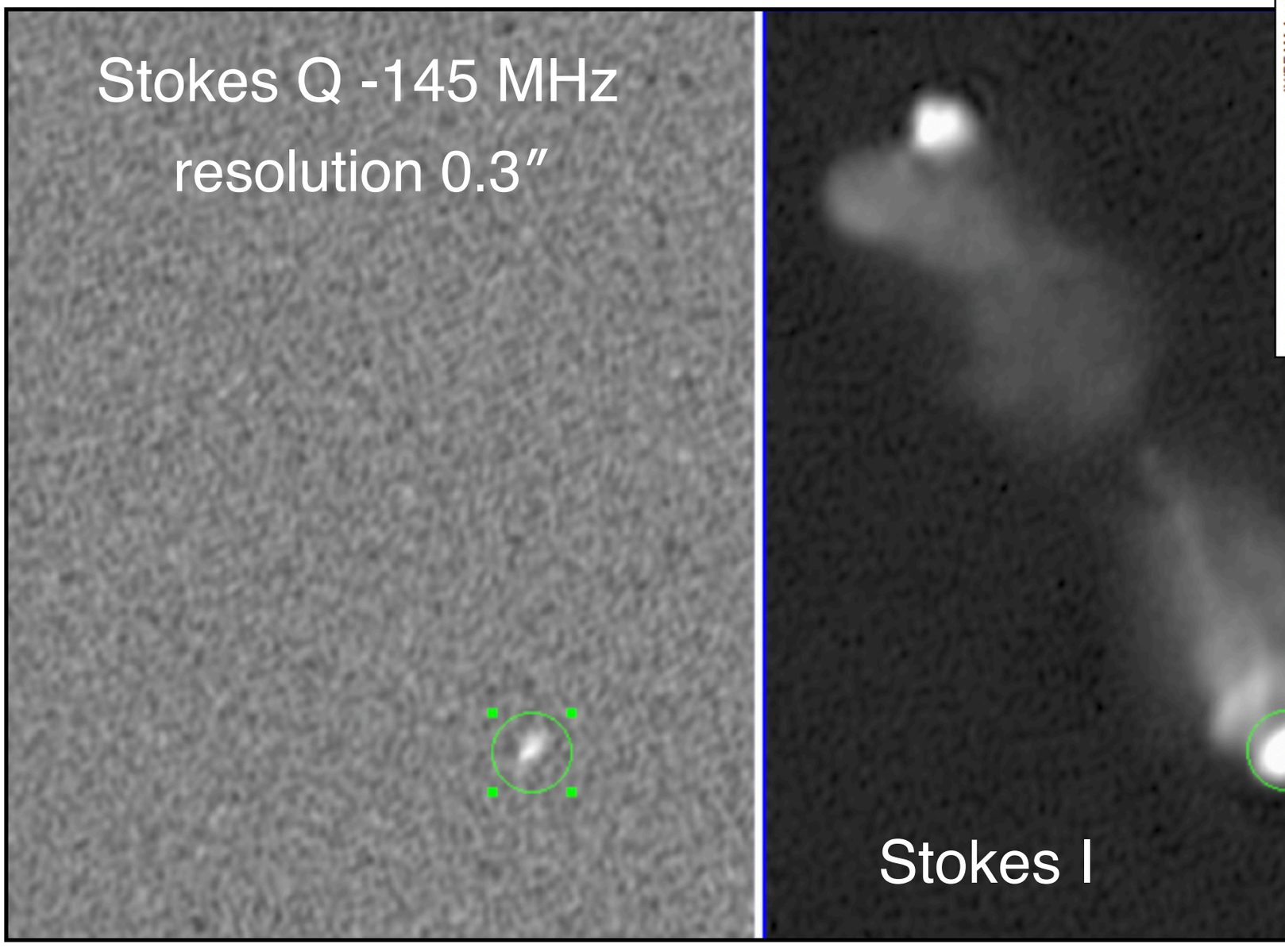


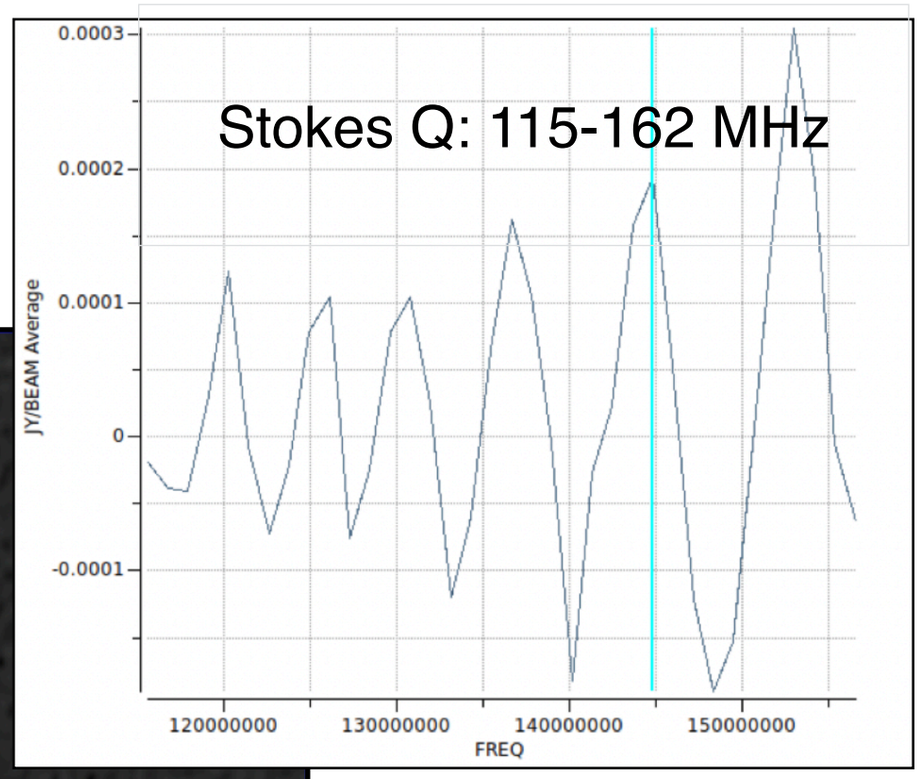
20″ resolution
Herrera Ruiz+ (2021)



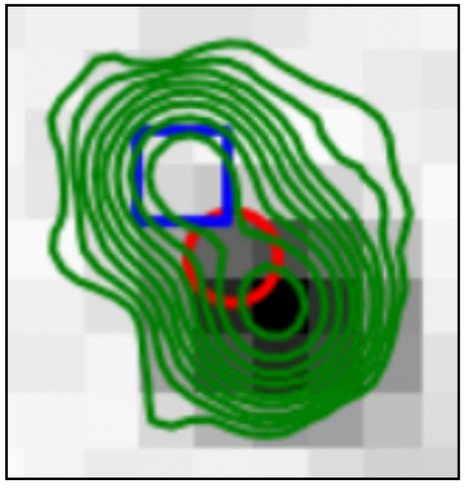
Jurjen de Jong
0.3″ resolution

ELIAS-N1 polarization at 0.3″

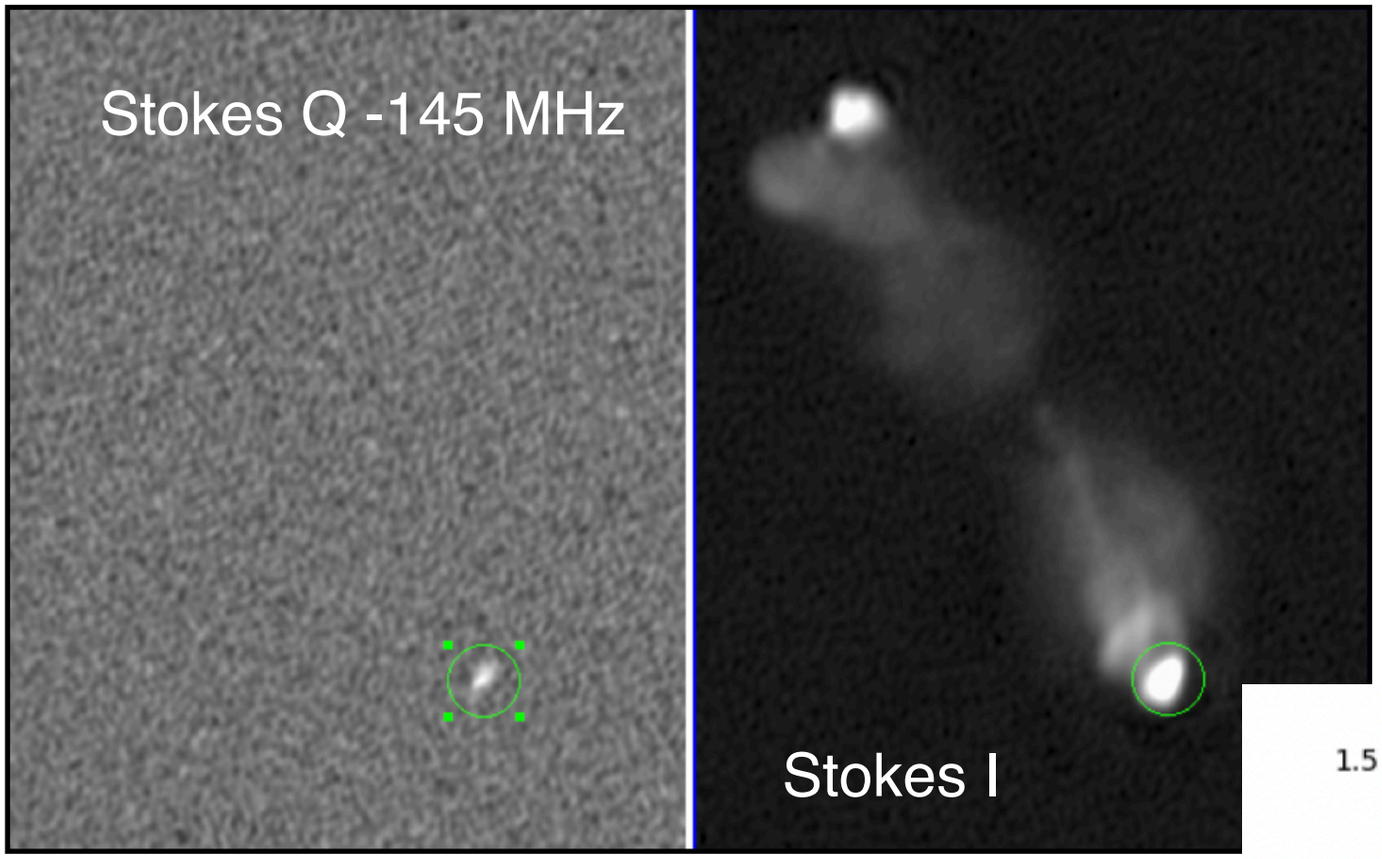




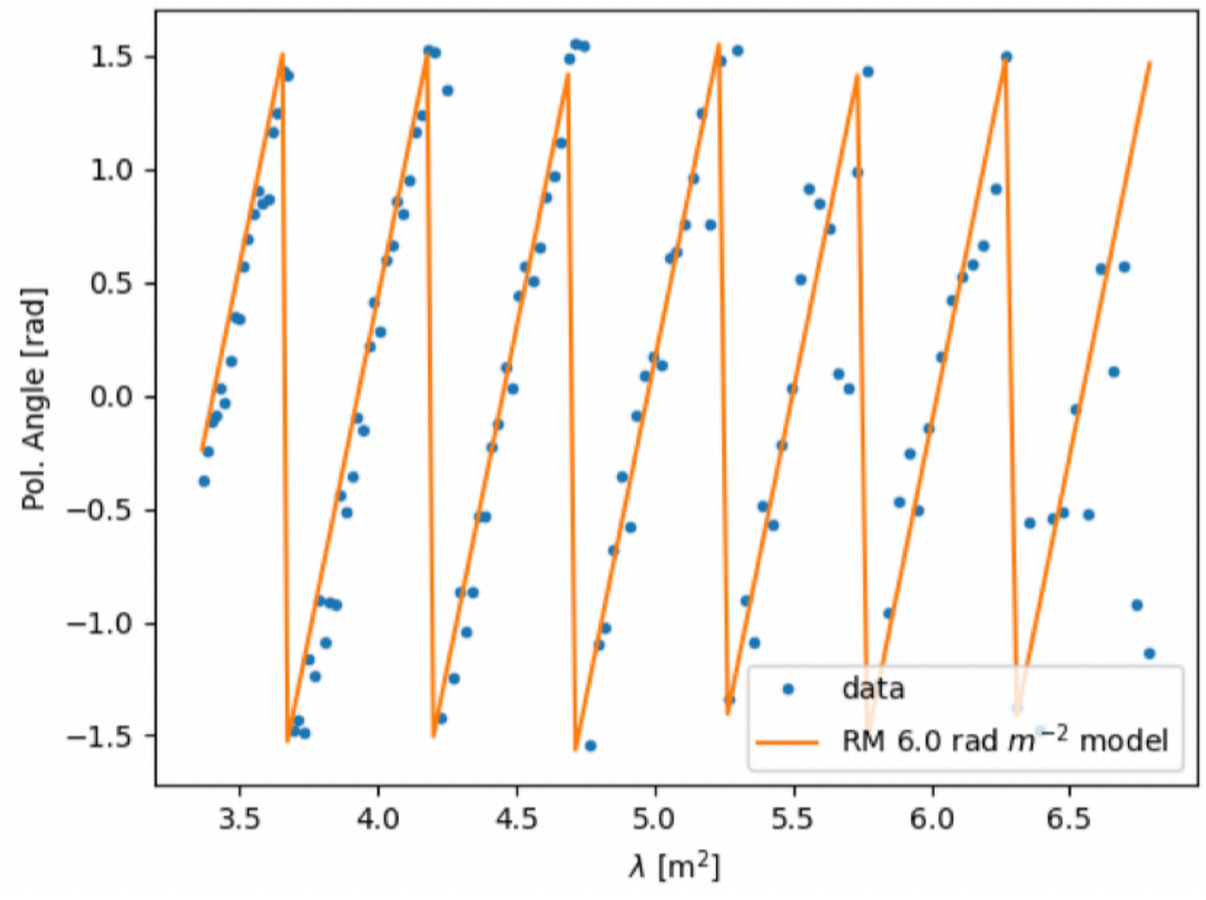
Herrera Ruiz+ (2021)



ELIAS-N1 polarization at 0.3″



- Polarization signal comes from the hotspot
- RM in good agreement with Herrera Ruiz+ (2021)



Herrera Ruiz+ (2021)

Epoch	Date	λ_0^2 [m^2]	RM [rad m^{-2}]	$\Delta\chi_{\rm corr}$ [deg]
020	2015-06-07	4.412	5.86 ± 0.03	17.8 ± 1.7
024	2015-06-19	4.371	5.91 ± 0.03	"Reference"
027	2015-06-29	4.414	5.94 ± 0.03	-1.7 ± 1.7
028	2015-07-01	4.413	5.95 ± 0.02	-10.3 ± 1.8
030	2015-08-07	4.346	5.99 ± 0.05	-25.8 ± 1.8
031	2015-08-22	4.413	6.03 ± 0.04	-15.5 ± 1.8

Summary

facetselfcal: van Weeren+ (2021)

- *facetselfcal*: single target calibration can optimize science return from the LOFAR surveys
- *facetselfcal*: enables high-quality ILT imaging
- Subarcsecond resolution polarization studies can be done with the ILT
- *facetselfcal:* tackle calibration challenges and develop new ideas