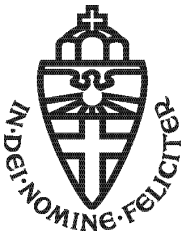
LOFAR Workshop 2014 Summary



Radboud University Nijmegen

Heino Falcke

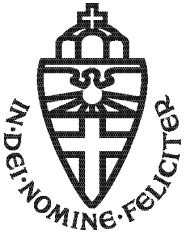
(Chair of the ILT Board)

Radboud University Nijmegen

ASTRON, Dwingeloo

ILT Board: M. Garret (ASTRON), H. Rottgering (NL), H. Falcke (NL),
M. Brüggen (D), J. Conway (S), P. Best (UK), M. Tagger (F)
R. Vermeulen (Dir.)

Keynote sucks …



- Apple is the new Microsoft …
- People punished for using latest version of Keynote that wants to force me buying a new version:
  - Heald
  - de Gasperin
  - Rowlinson

The Enemy

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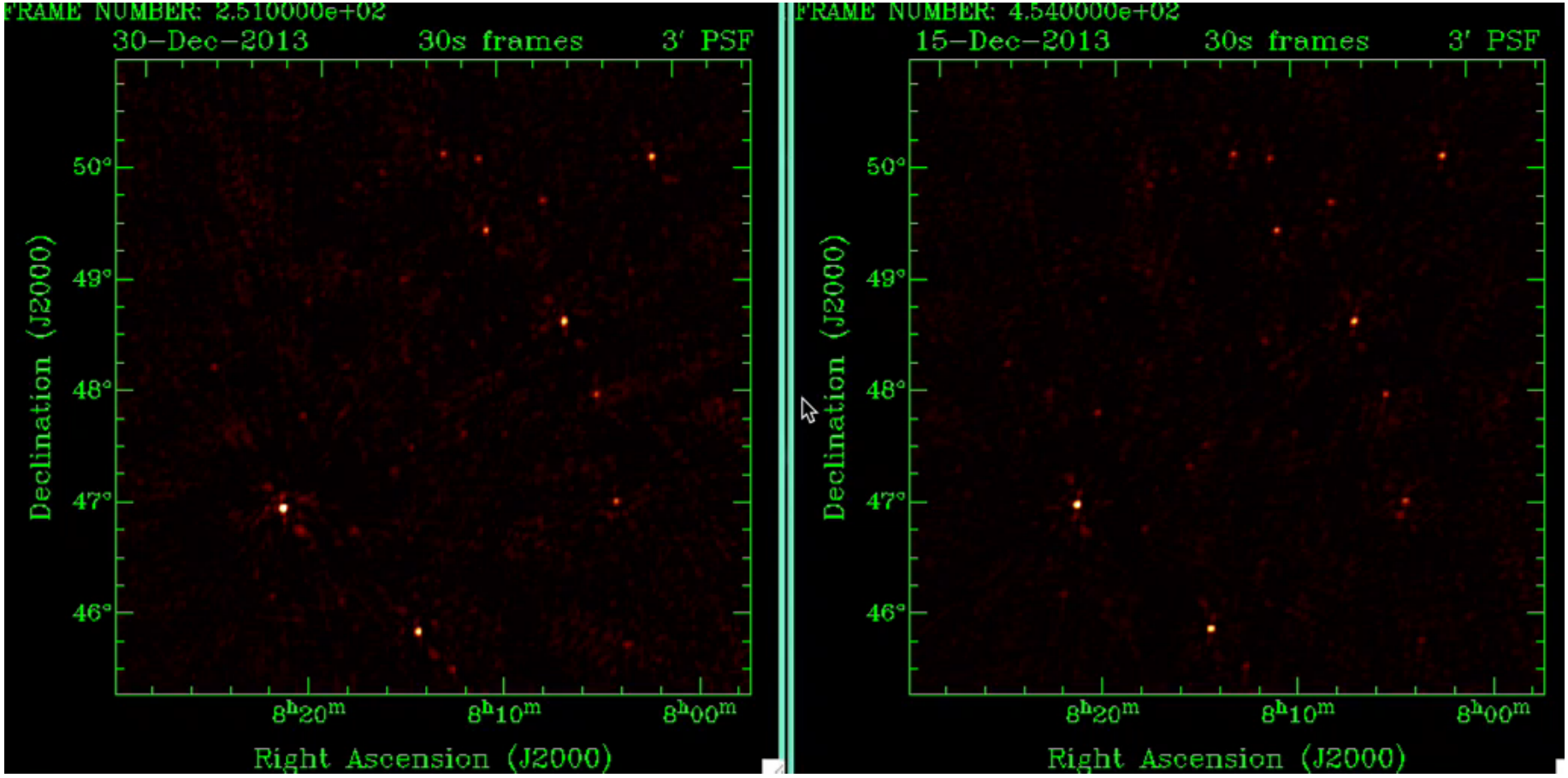
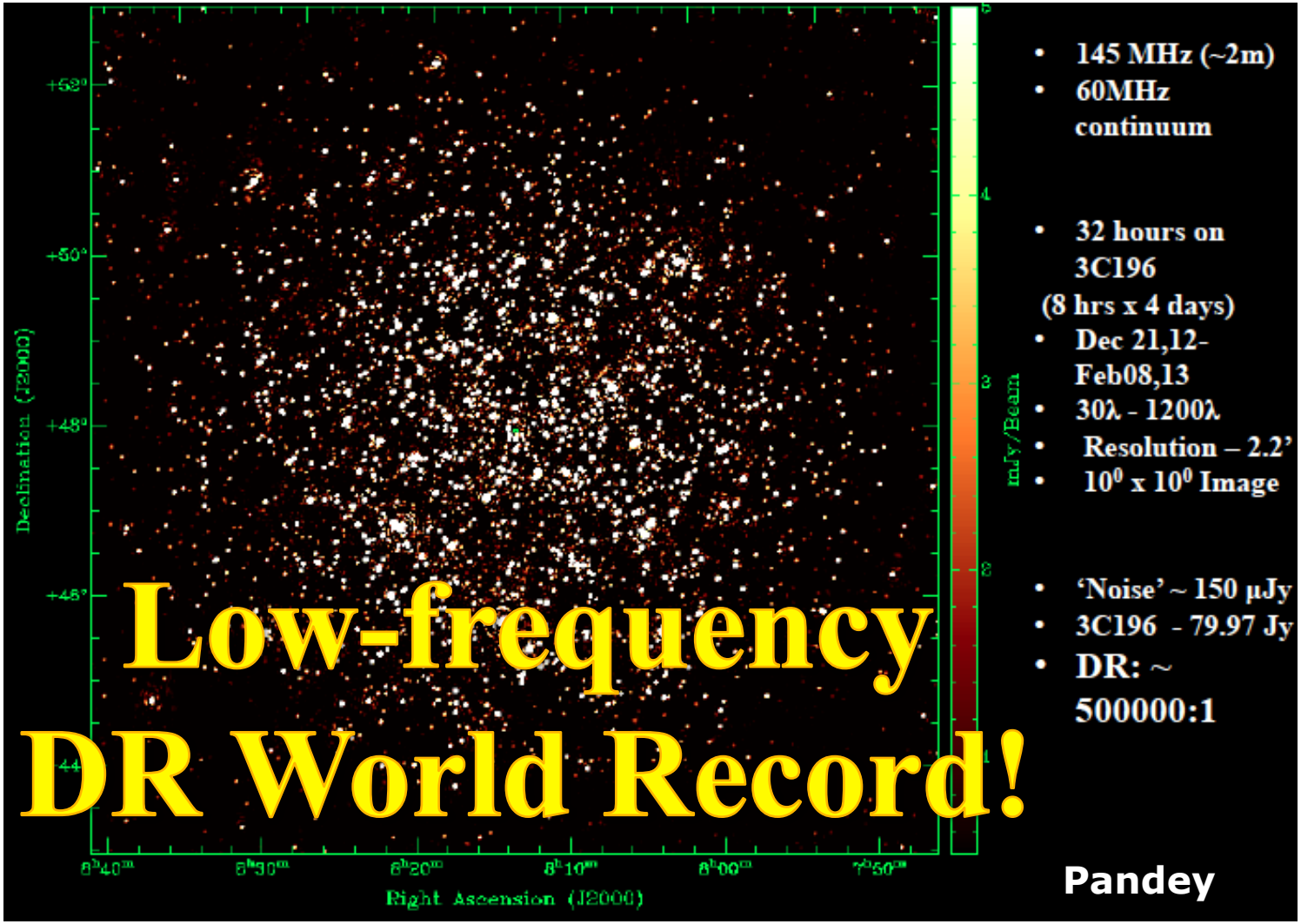


The good guys/gals: **de Gasperin, Mevius, ...** (van Weeren)

EOR 3C196 – Million:1 DR



EOR NCP

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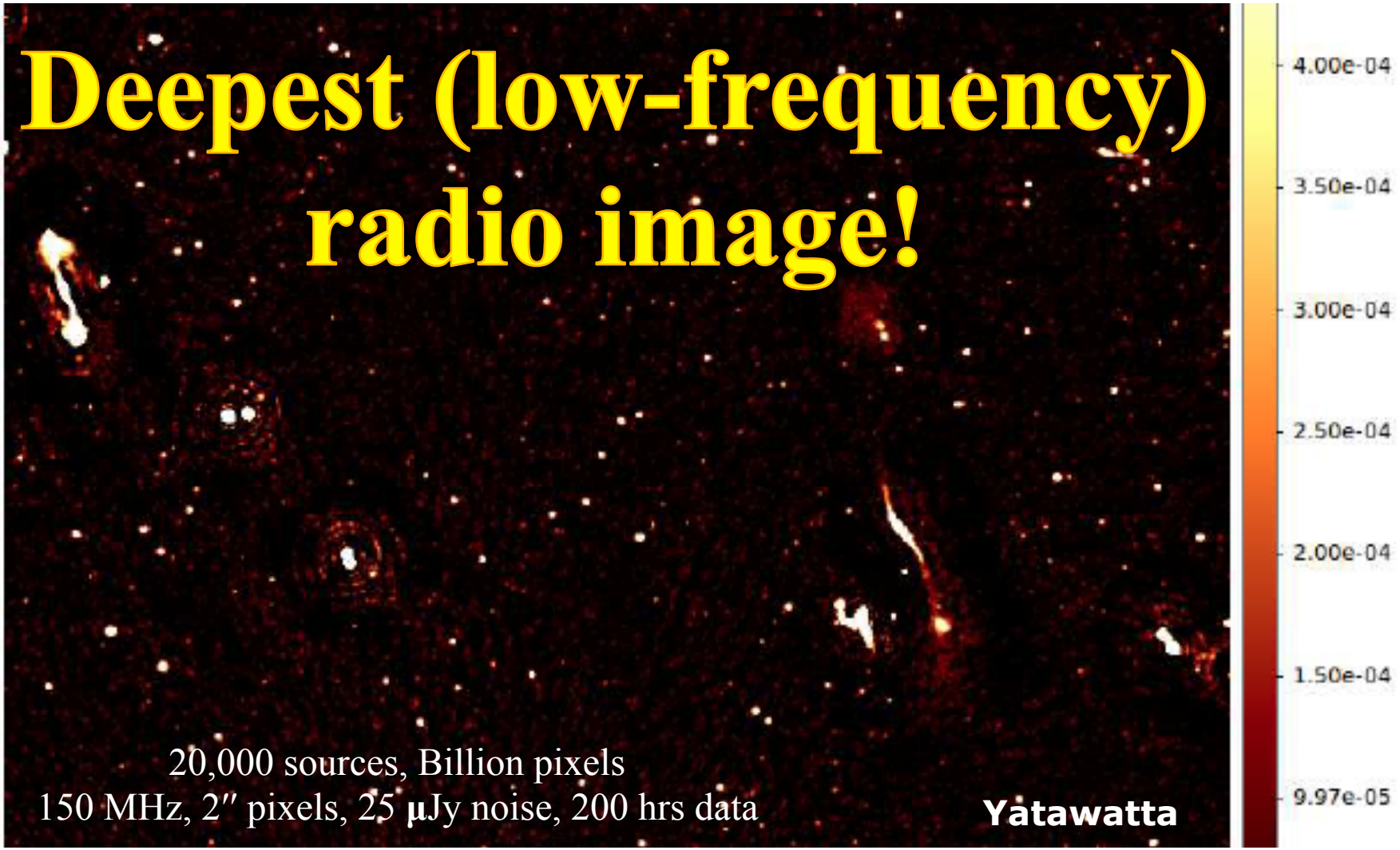


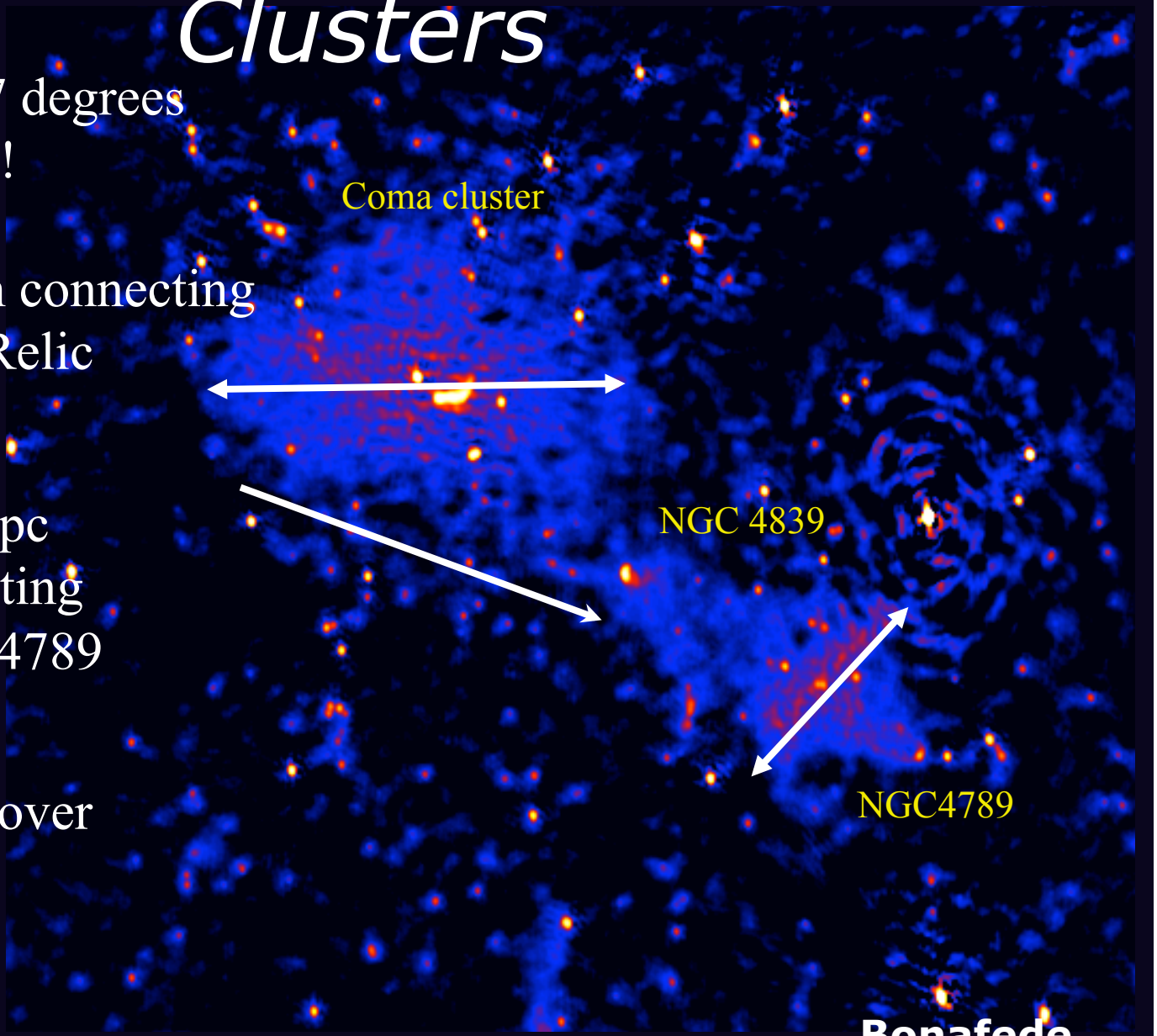
Clusters

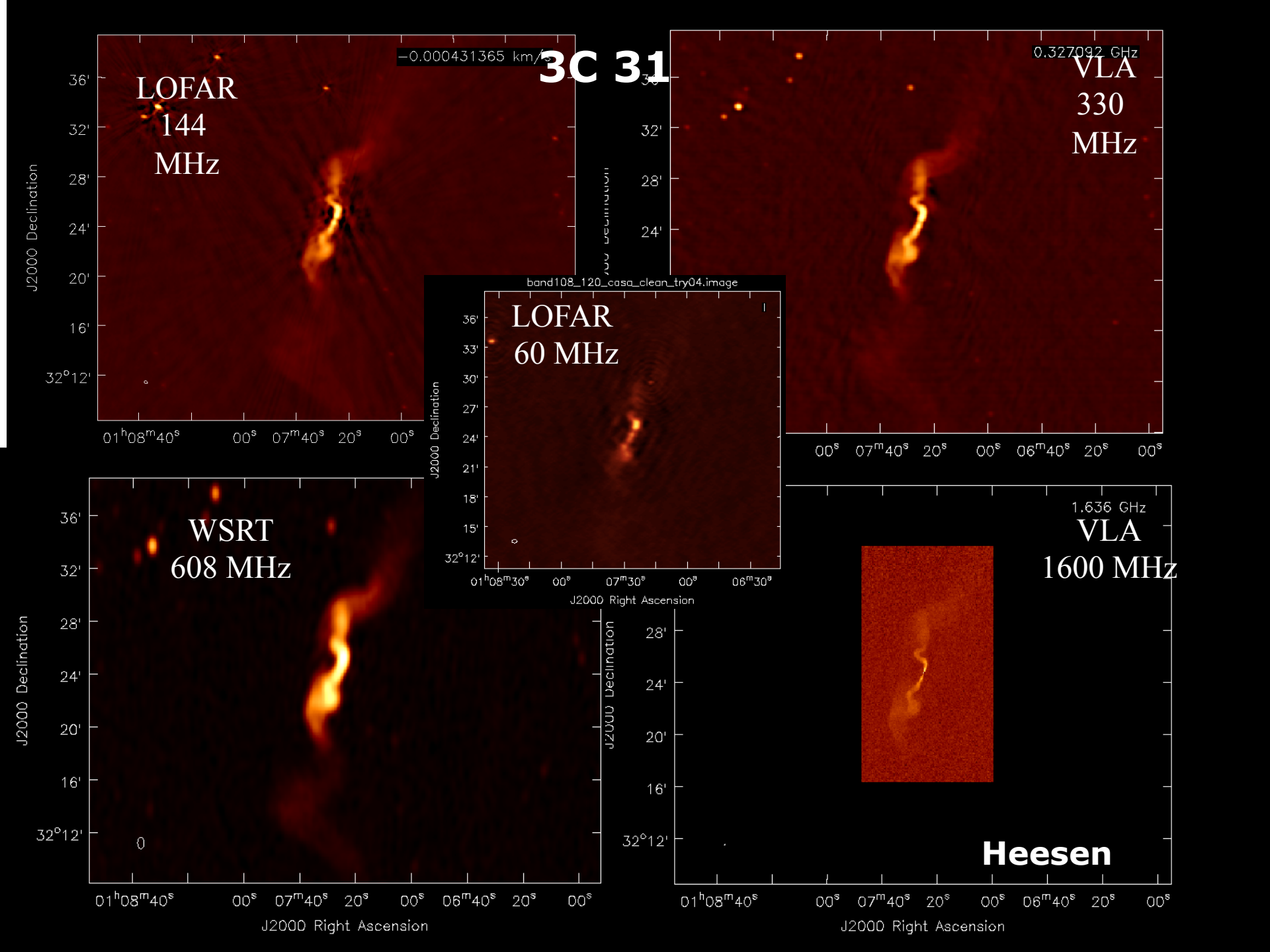
Halo E-W ~1.07 degrees
1.8 Mpc!

Bridge of emission connecting
Halo and Relic

Relic ~800kpc
Bridge connecting
relic and NGC4789

Radio emission over
2 degrees
~3.3 Mpc




3C 31
LOFAR
144
MHz
−0.000431365 km/s
VLA
330
MHz
0.327092 GHz
LOFAR
60 MHz
band108_120_casa_clean_try04.image
WSRT
608 MHz
VLA
1600 MHz
1.636 GHz
Heesen
J2000 Declination
J2000 Right Ascension

Large Fields

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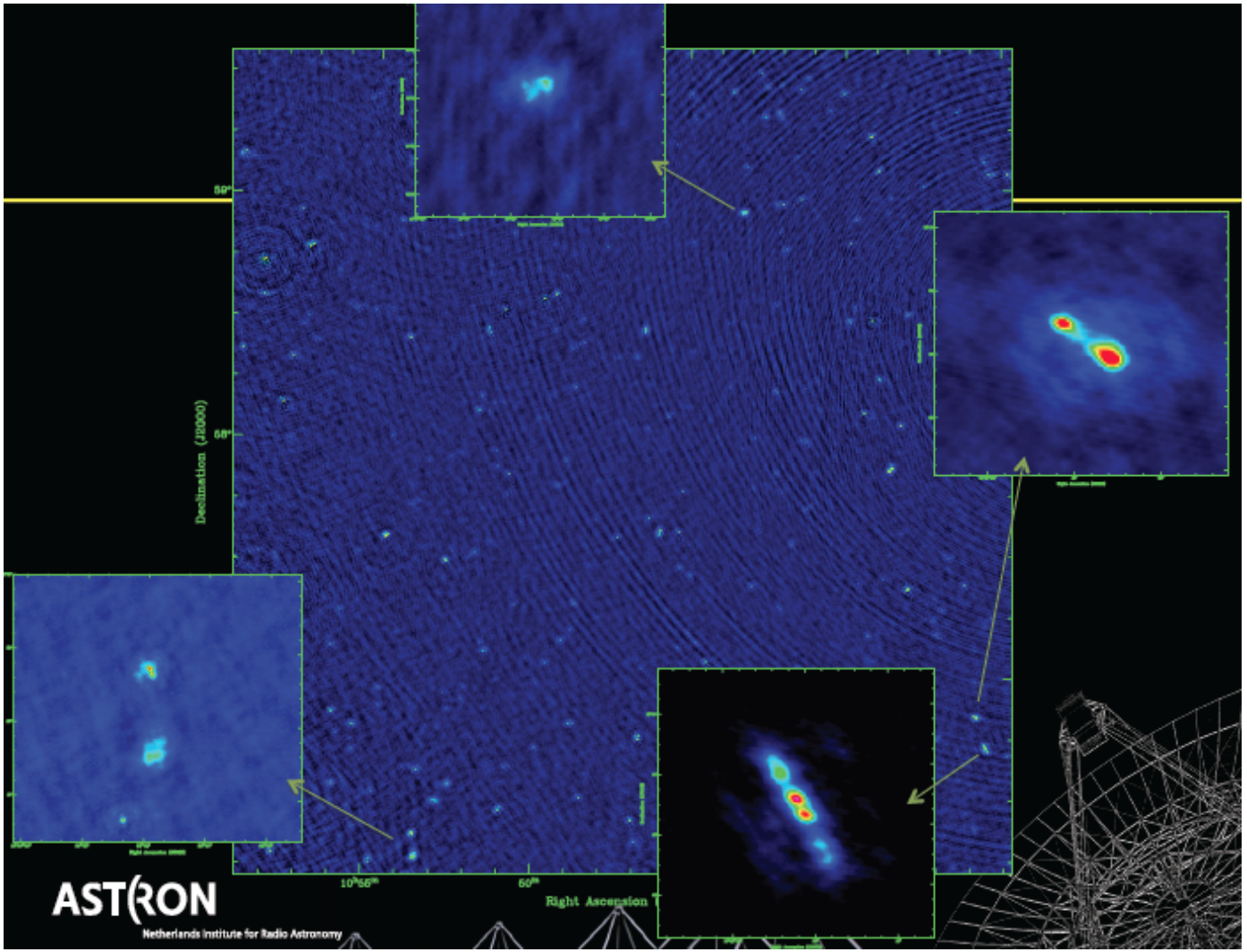

Lockman: Mahony Bootes: Coppejans

Spectral aging … Radio Archeology

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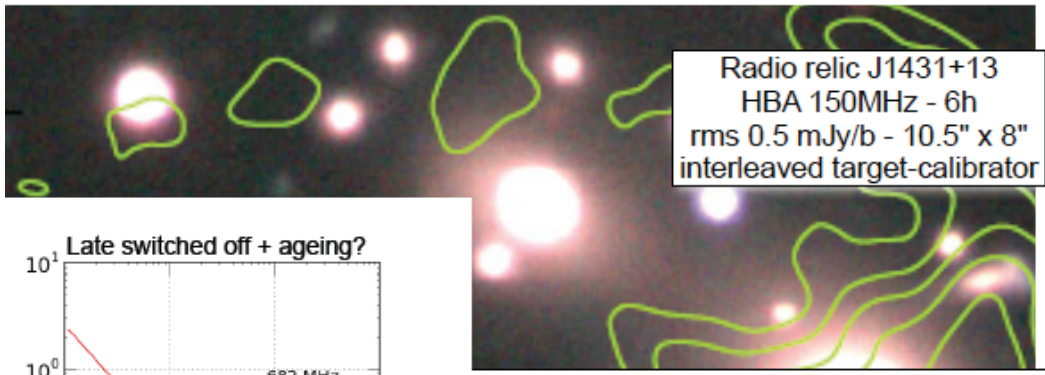
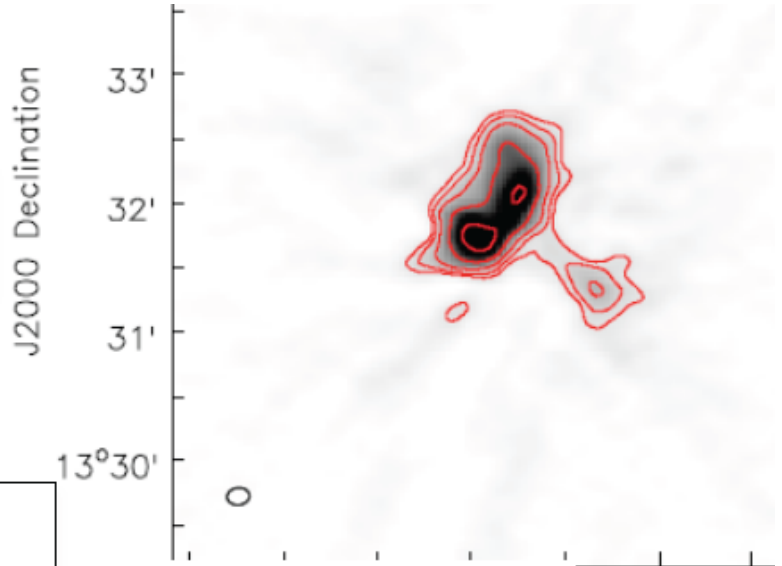
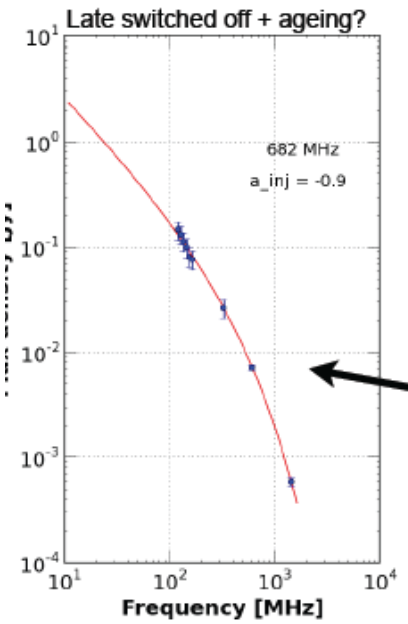
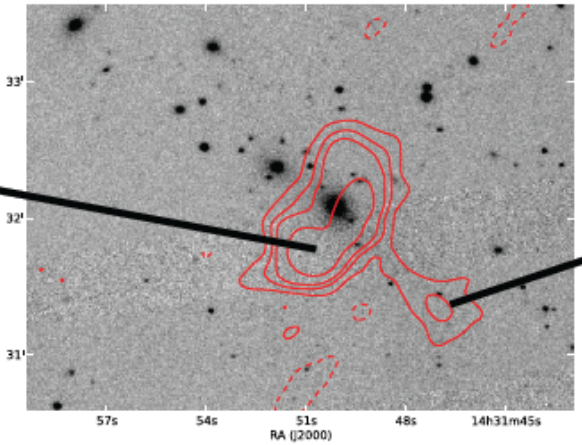
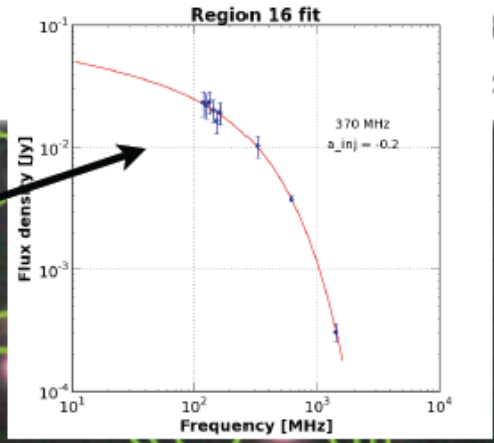
LOFAR Cycle 0 data

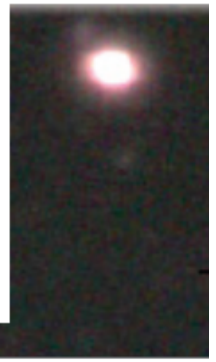












Shulevski et al. in prep.

Morganti, Shulevski

Magnetism

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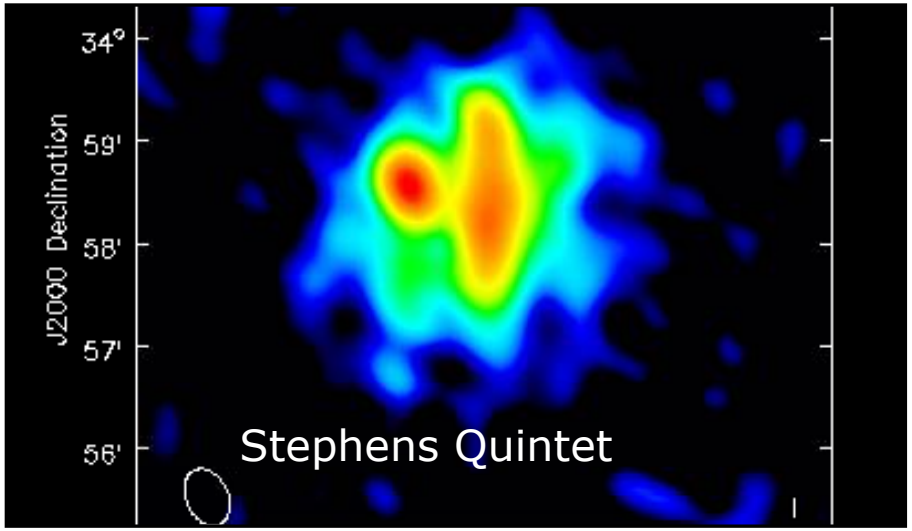
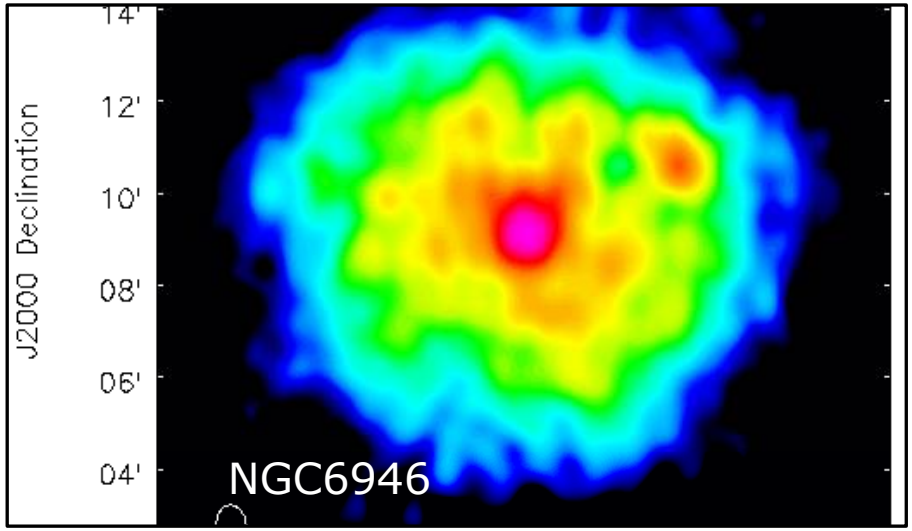
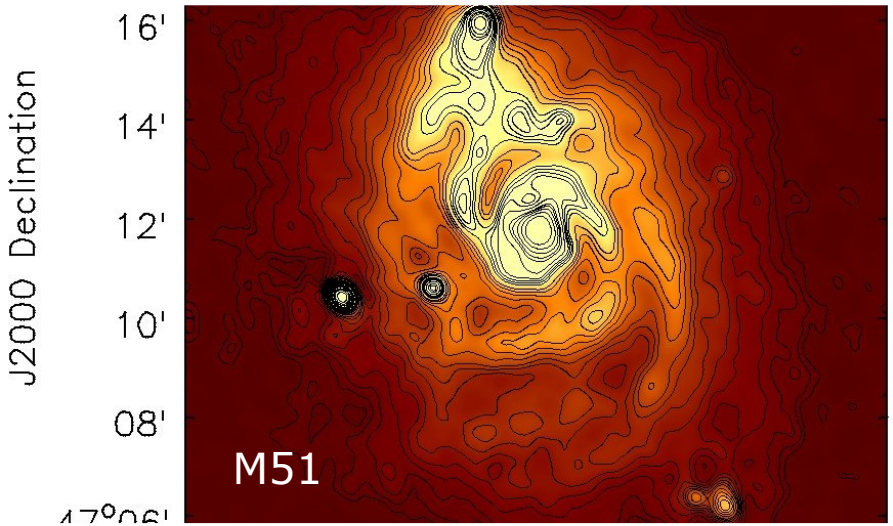
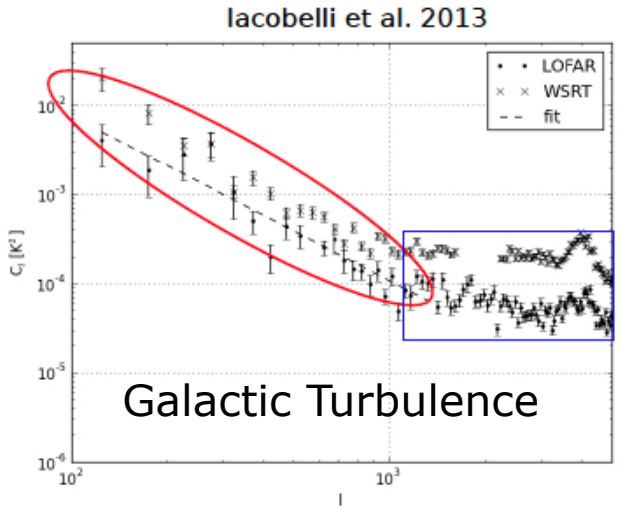






Mulcahy

Beck



Iacobelli, Jelic

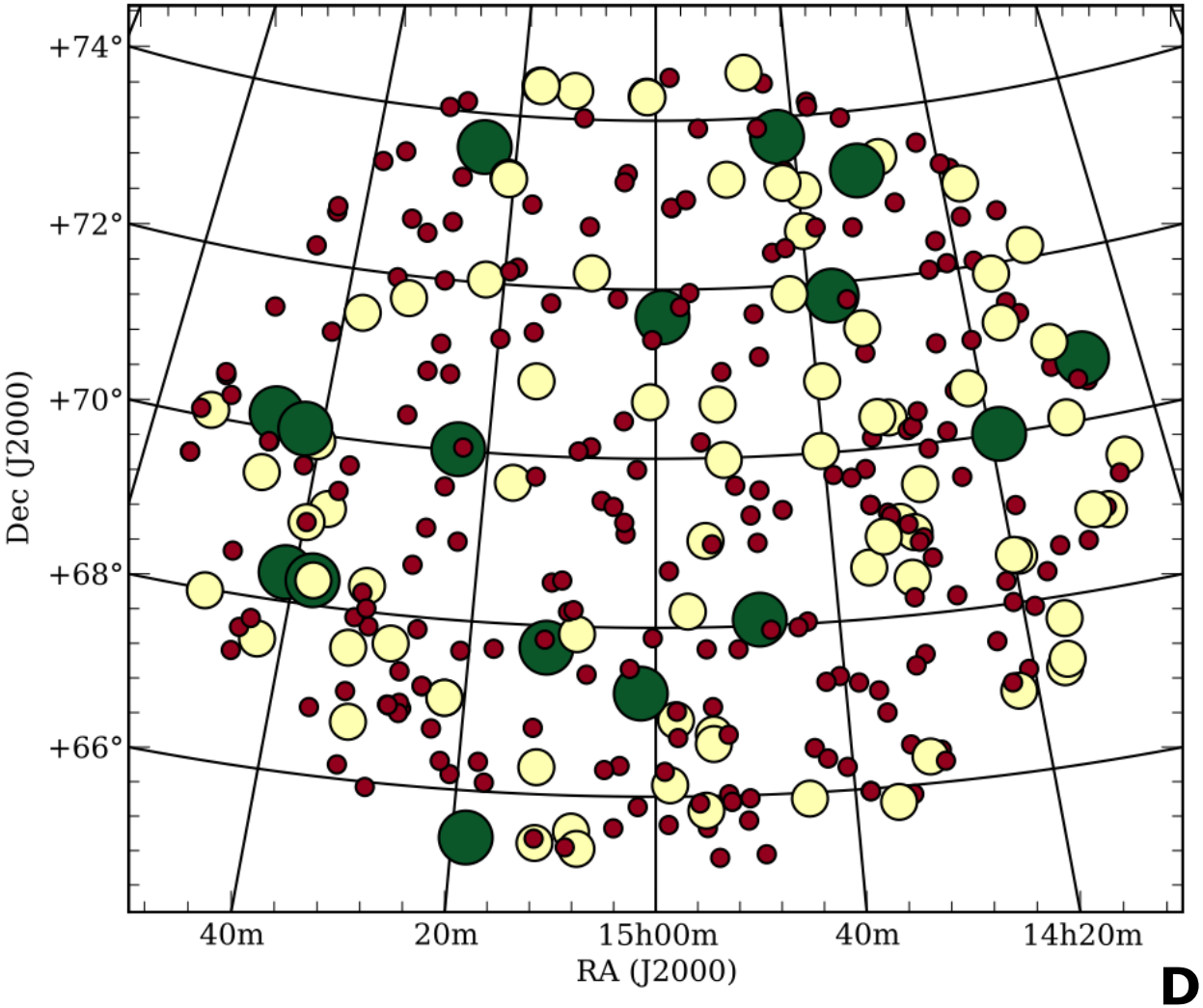
Long baselines
LOFAR LB Snapshot survey

Radboud University Nijmegen

~1 LB calibrator per squaredeg!

That is just what we need!

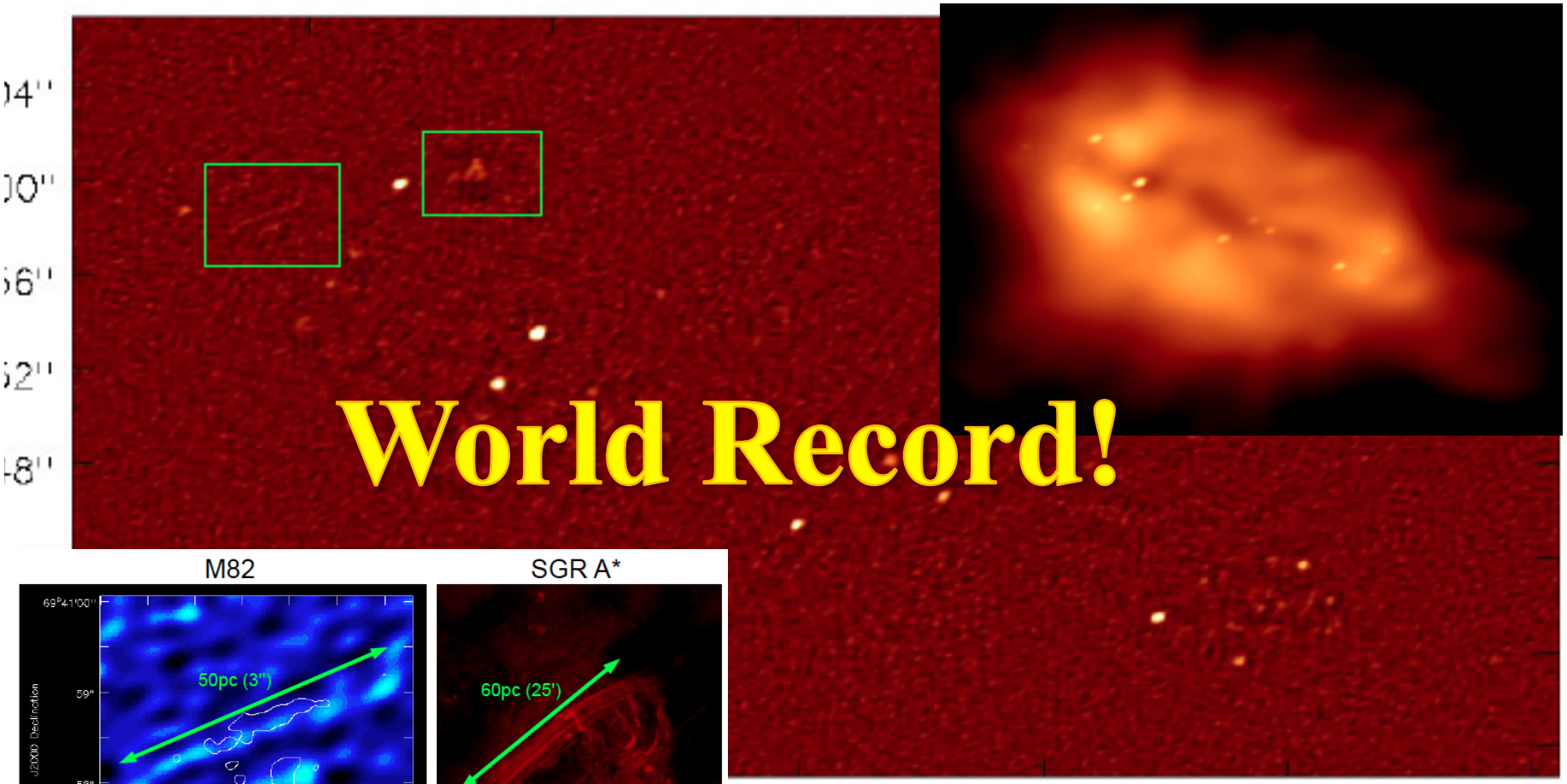
LOFAR LBI has a great future!



Deller

Long Baselines M82

Radboud University Nijmegen



World Record!

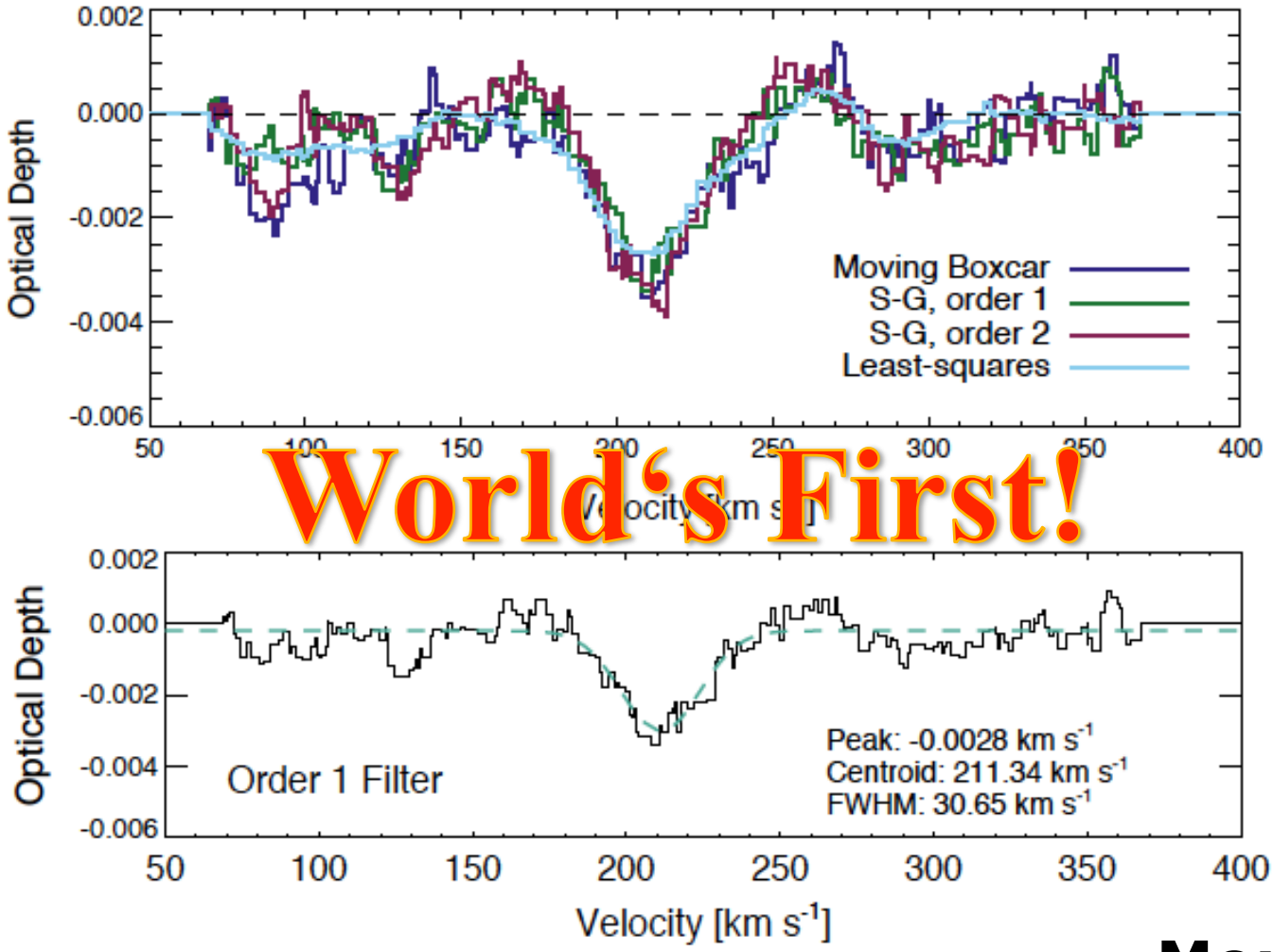
M82

SGR A*

Varenius

Spectroscopy(!): 1st Extragalactic Carbon Radio Recombination Line in M82

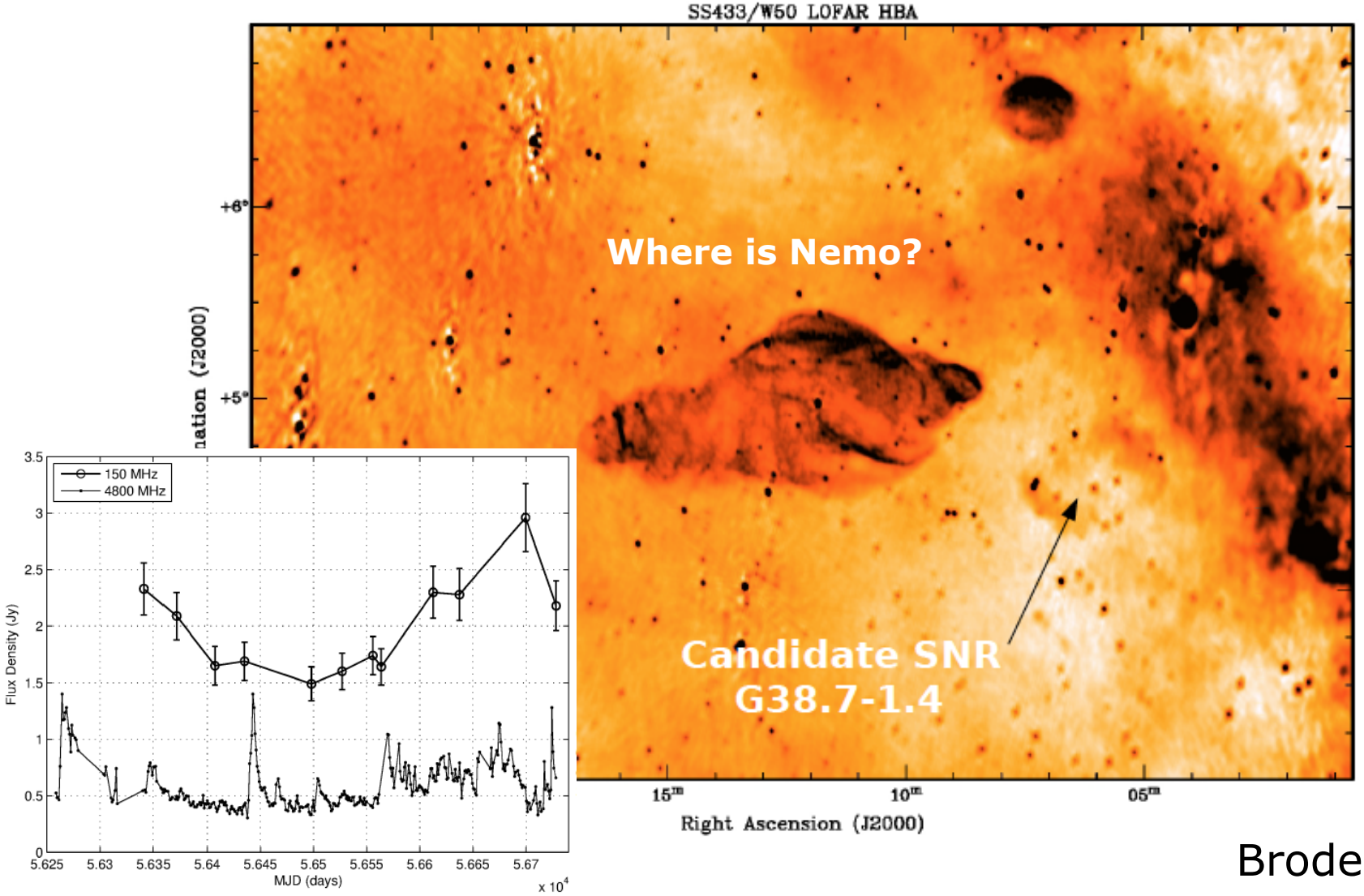
Radboud University Nijmegen



World's First!

Morabito

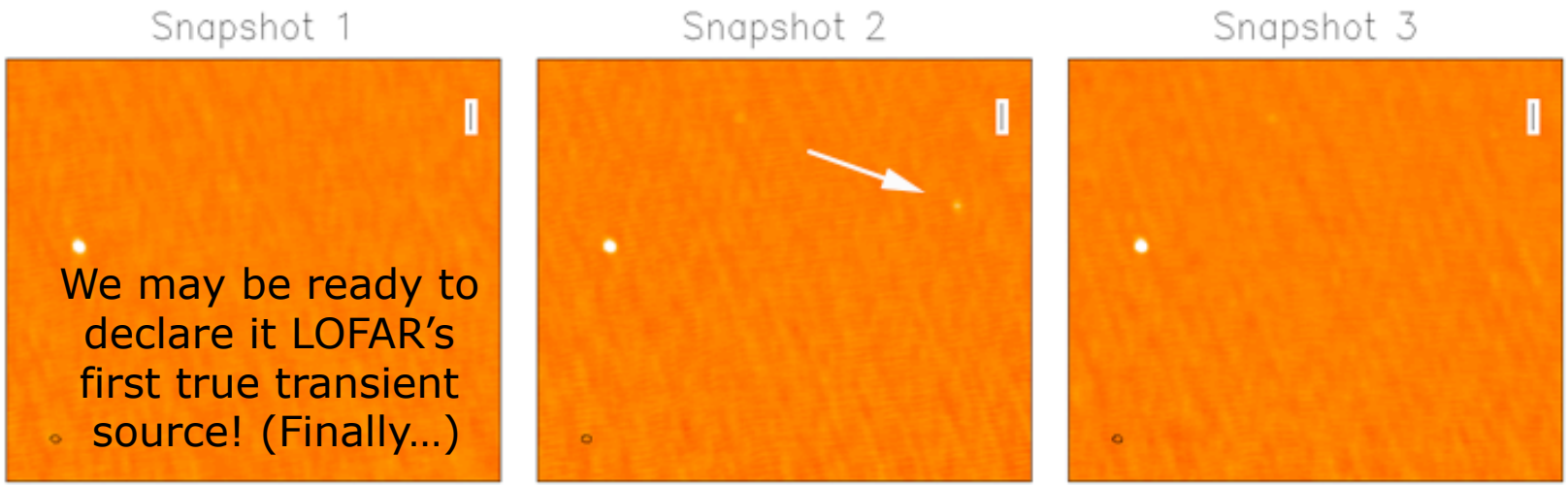
Transients – something is varying …

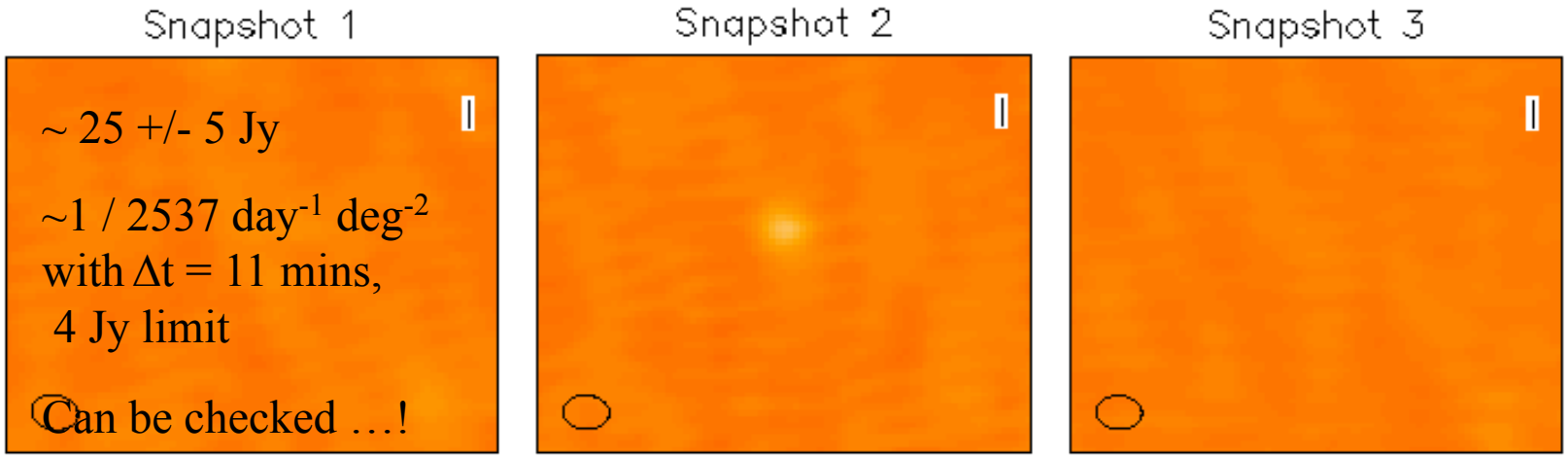


Broderick

"Trapping" Ghosts …

Radboud University Nijmegen





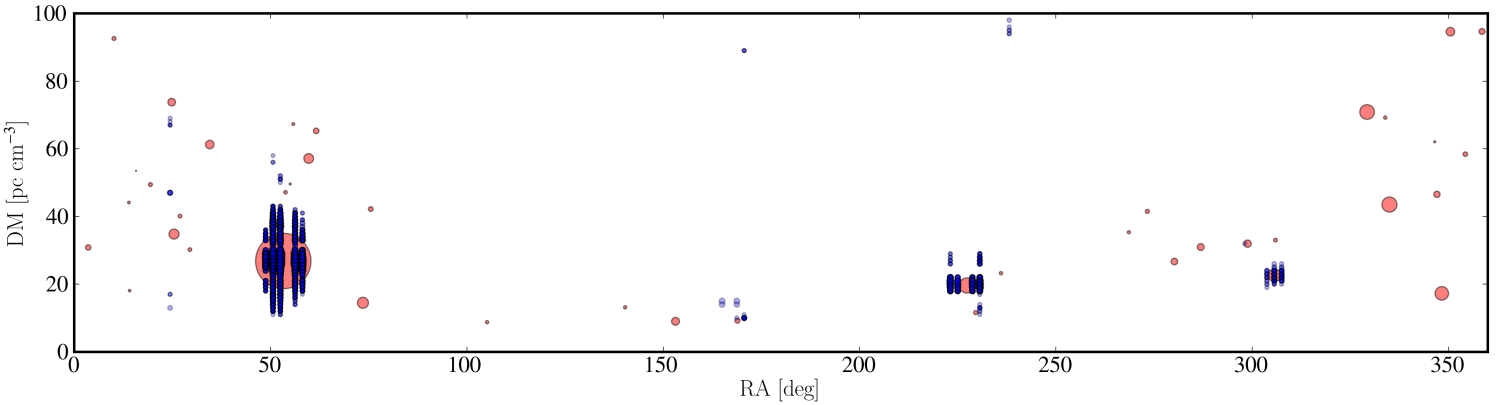
Stewart/Rowlinson

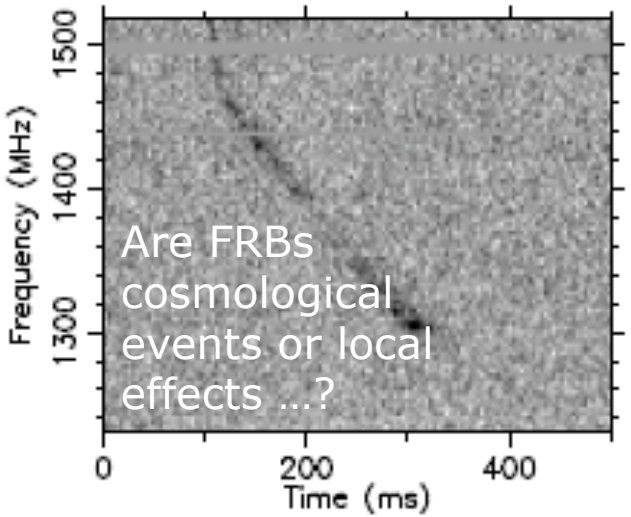
Fast Radio Transients

Radboud University Nijmegen

DM vs RA and DEC vs RA for pulsar(red) and coincidence triggers(blue)

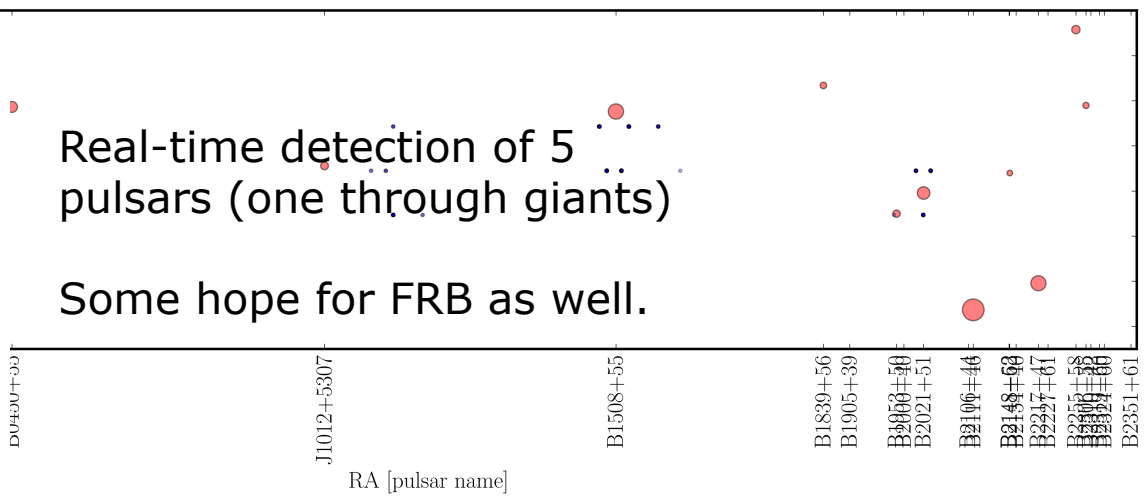
We are in principle ready to look for Fast Radio Bursts regularly …





Real-time detection of 5 pulsars (one through giants)

Some hope for FRB as well.



Ter Veen, Enriquez

Two more pulsars found

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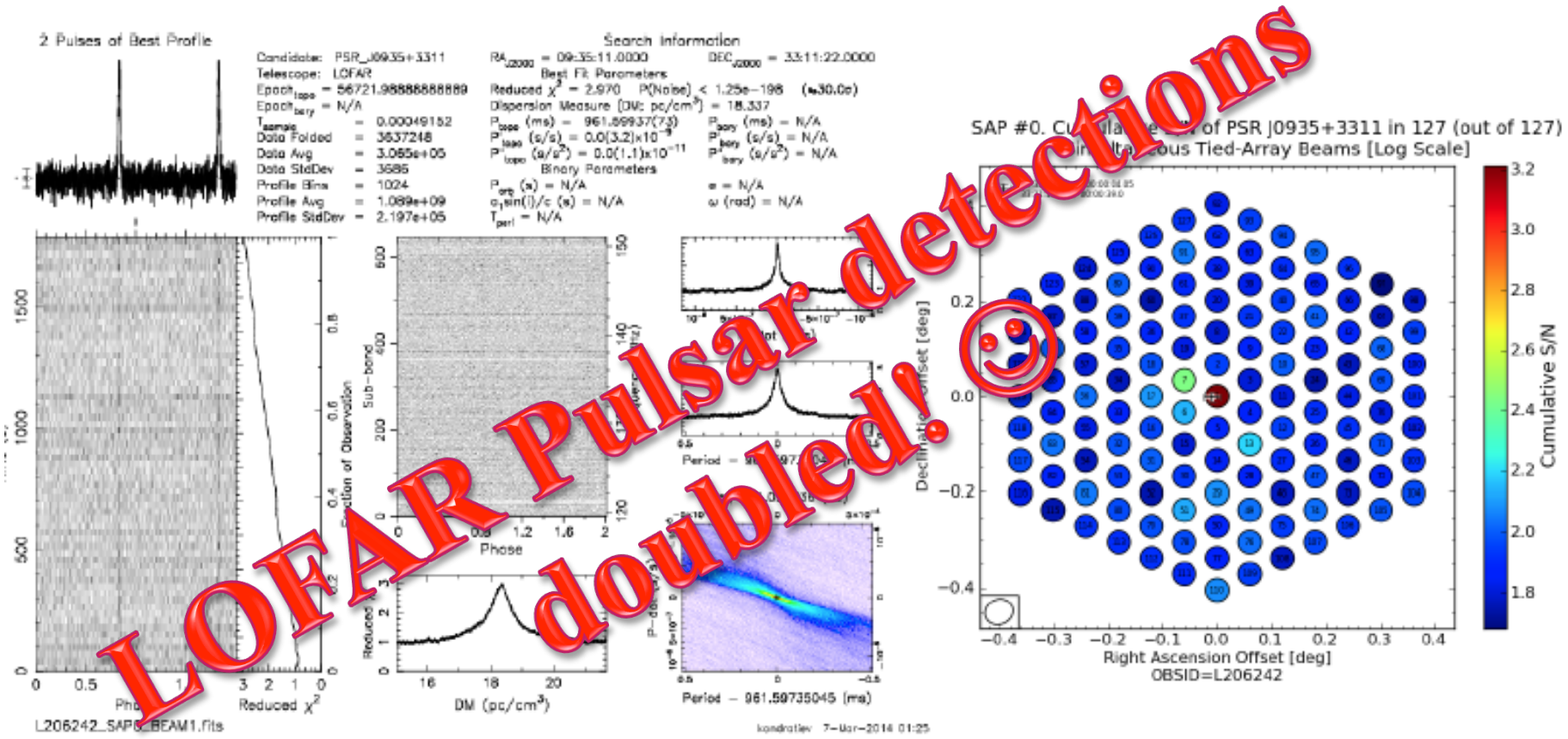
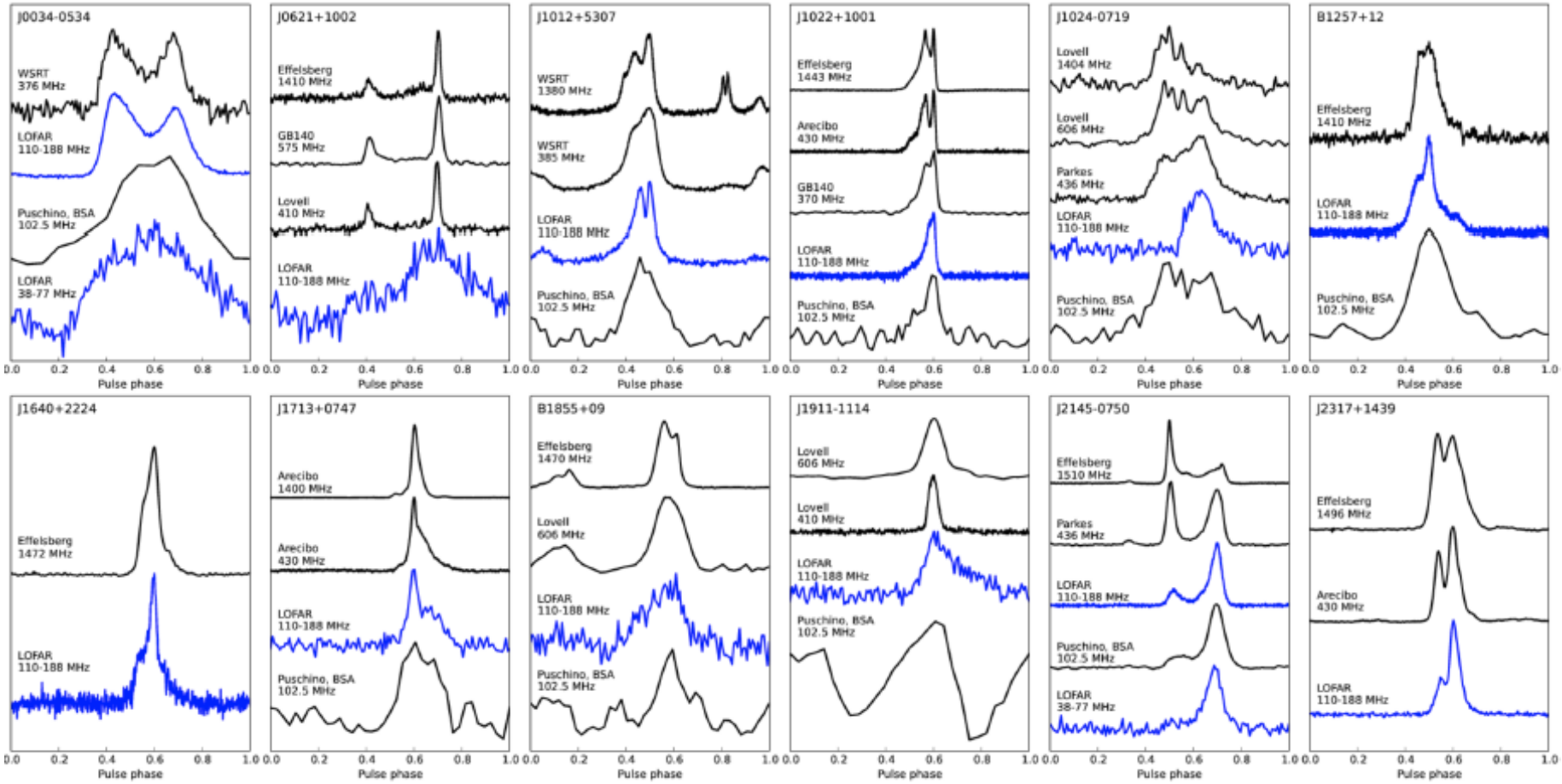


Cooper

100.000 pulsar candidates scanned …

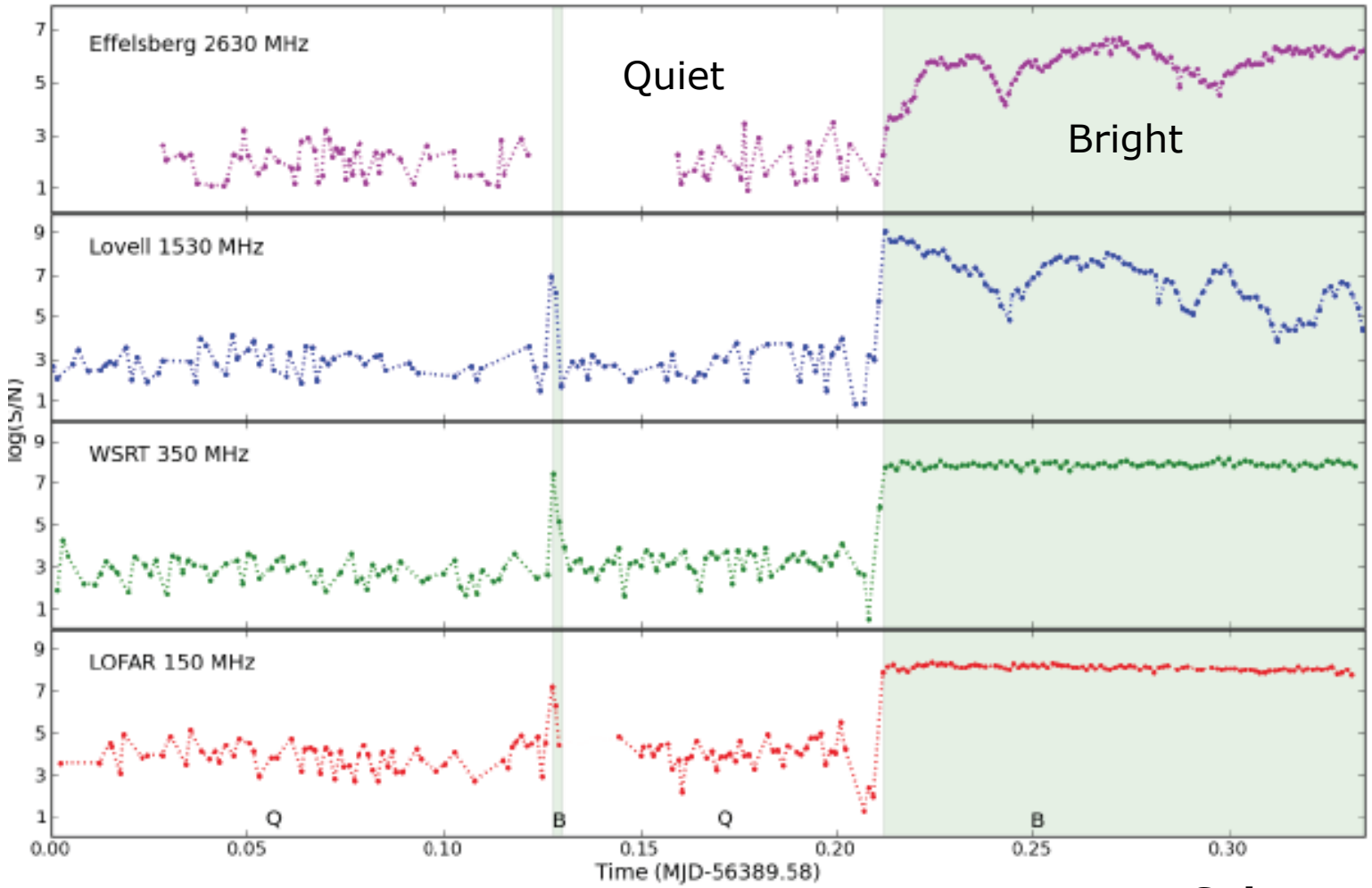
Millisecond Pulsars well detected (39/55)

Kondratiev



- Can scattering be overcome (**Archibald, Stinebring**)?

Mode switching



Sobey

B0943+10: Mode changing but what is changing?

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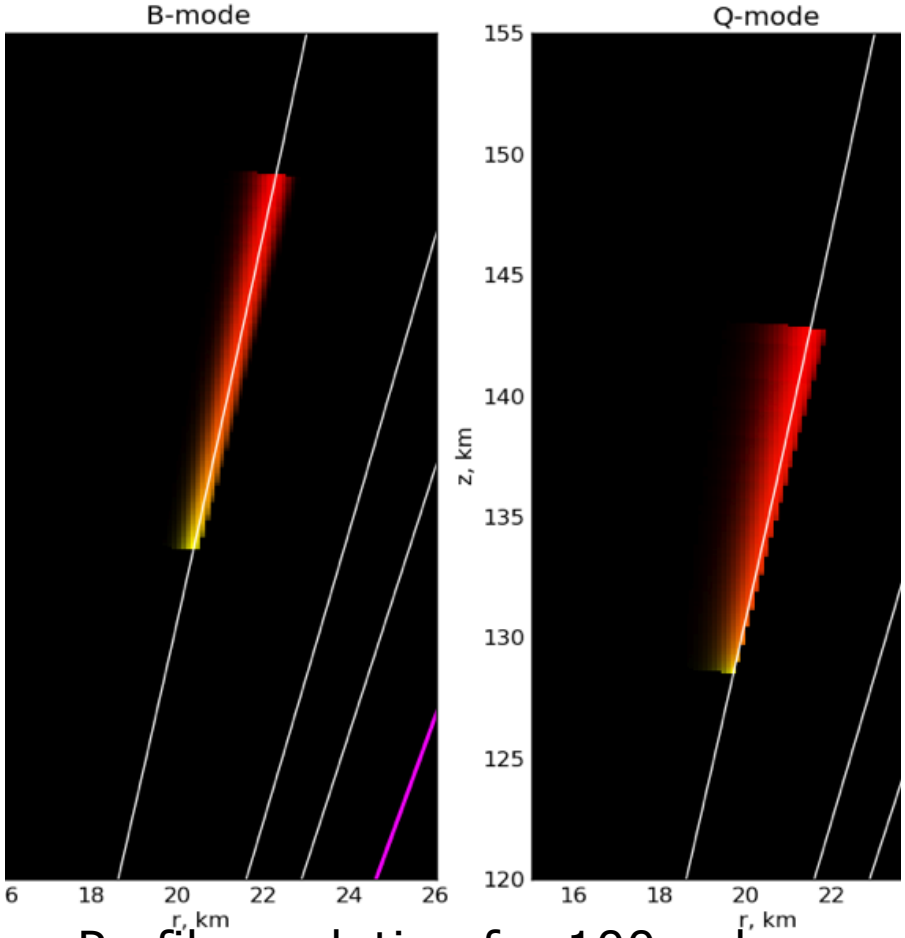
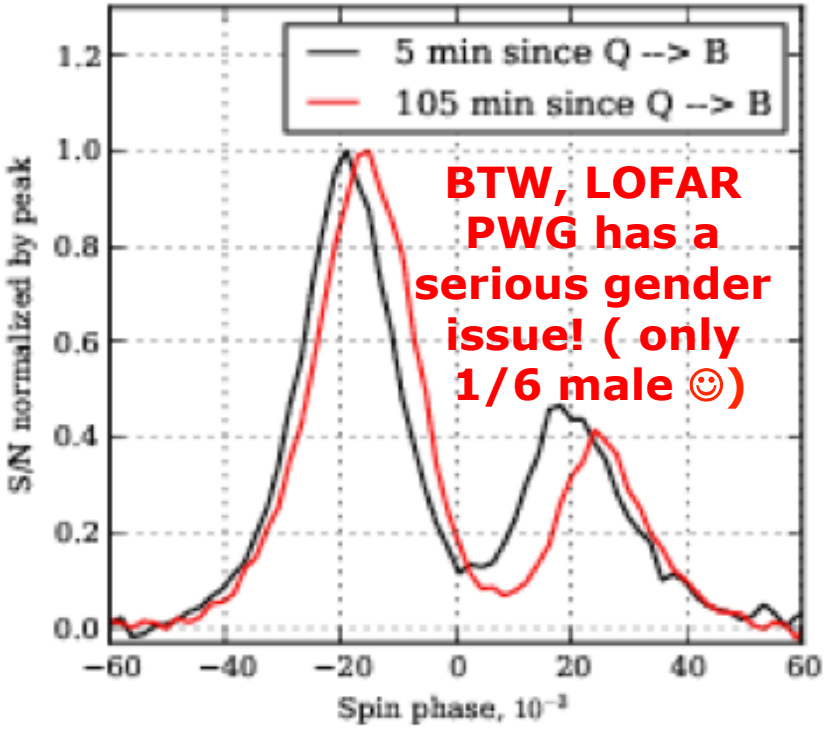
Emission height changes by 6% only



Polar gap height changing by 5%?

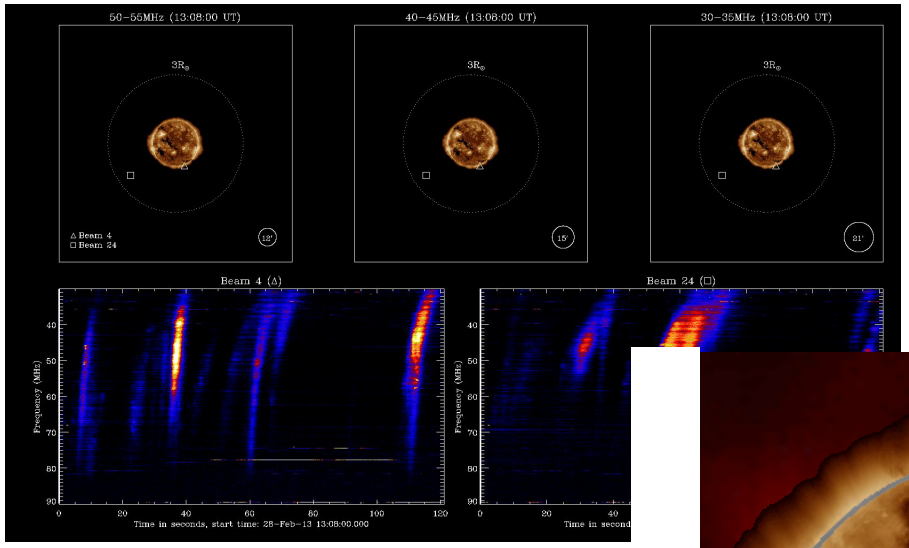
Bilous

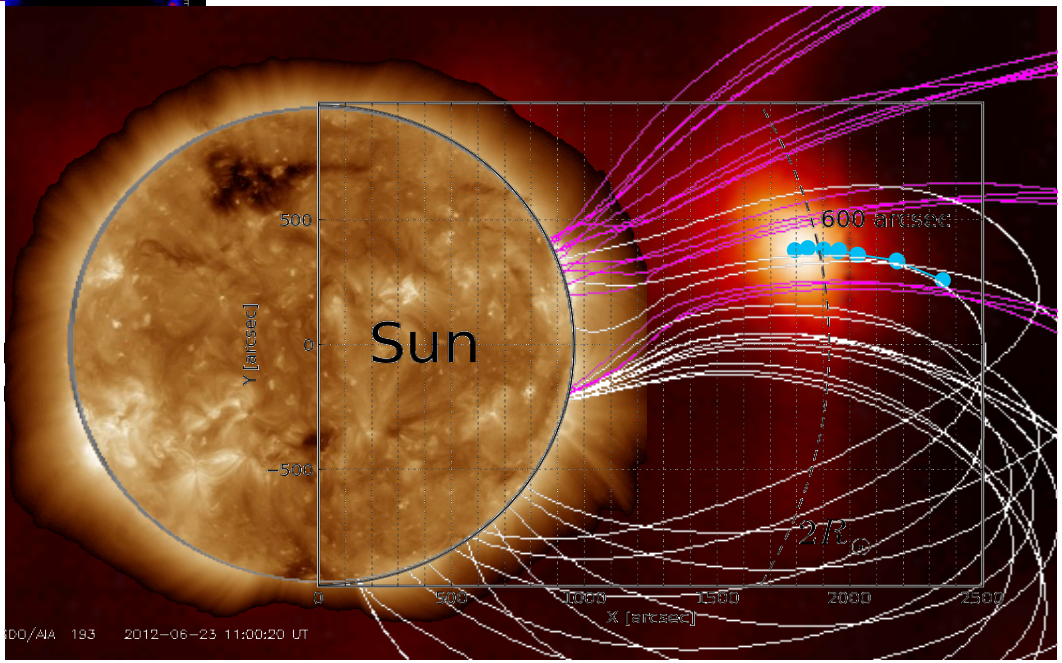


- Profile evolution for 100 pulsars over wide frequency range (**Pilia**)
- Polarization properties of pulsars and birefringence (**Noutsos**)

Solar Imaging Bonanza

Radboud University Nijmegen

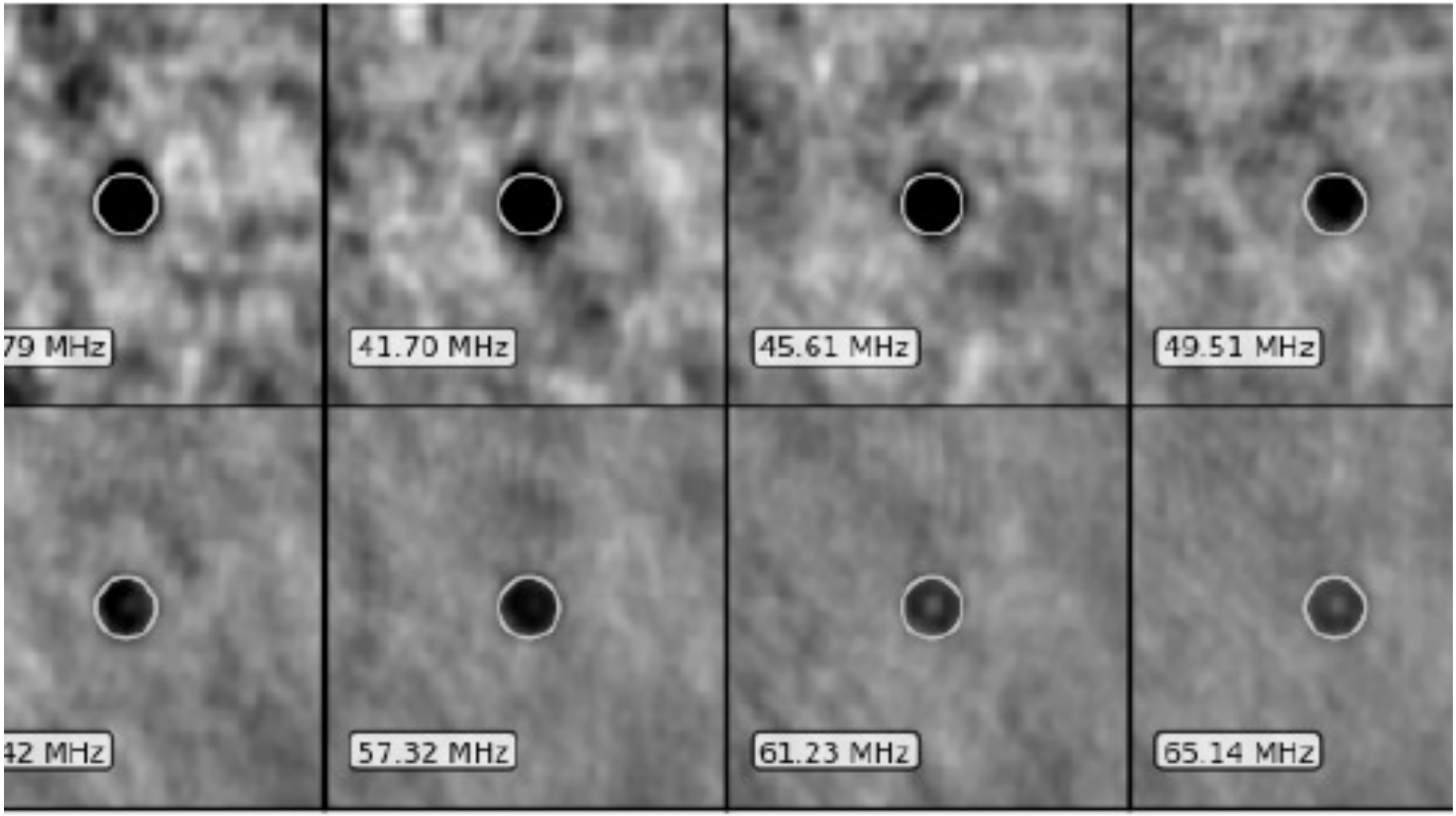




Morosan, Breitling, Mann

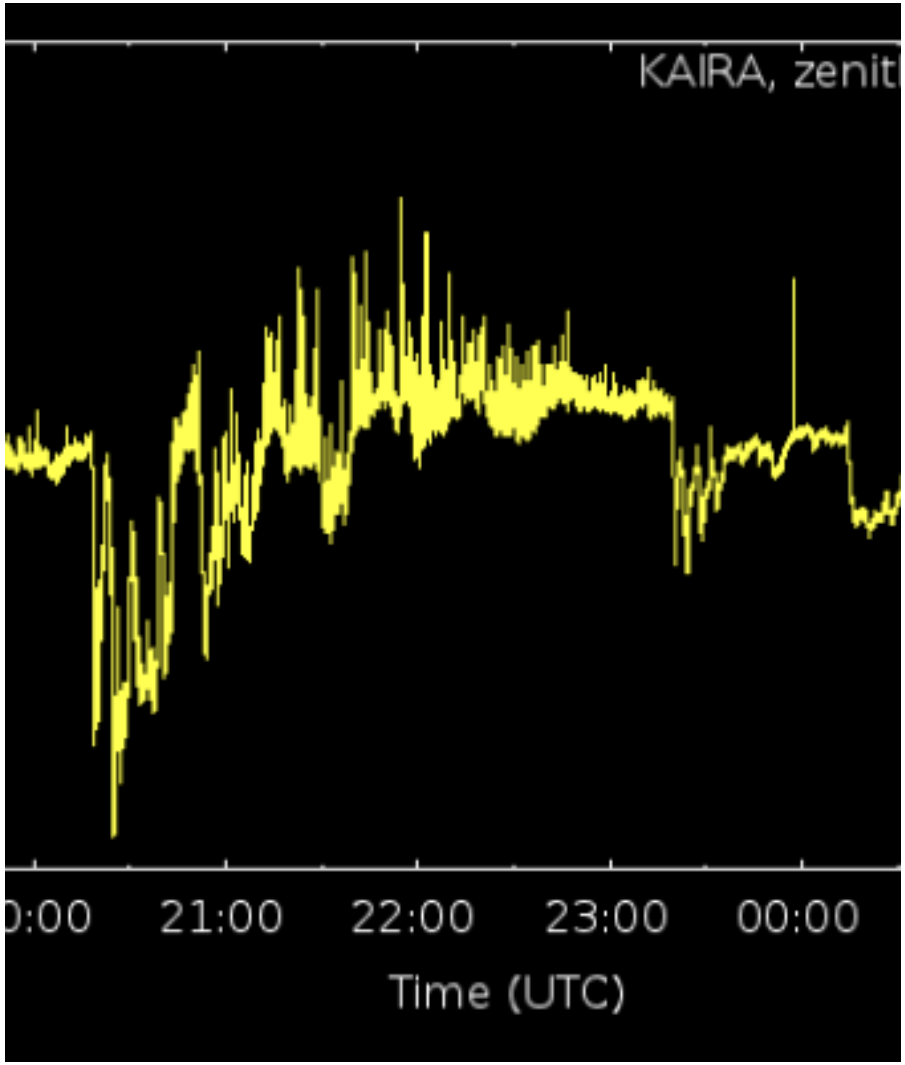
Lunar Imaging Bonanza

Radboud University Nijmegen

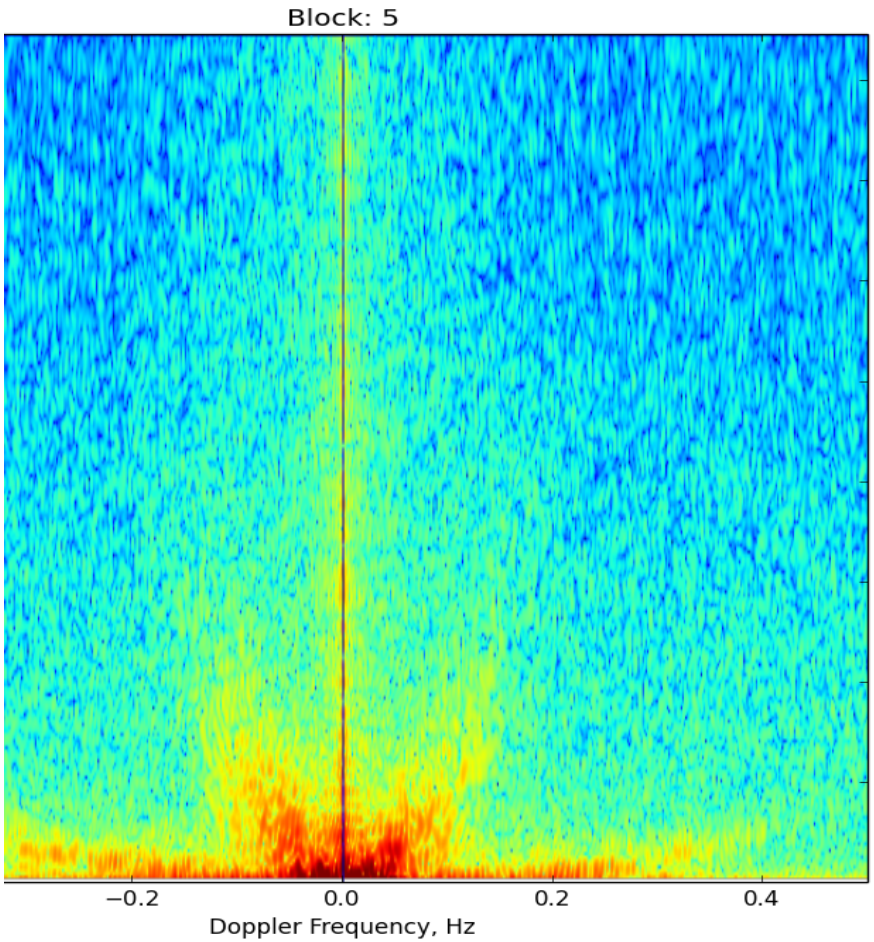


Vedantham

Ionosphere: Absorption & Scintillation



McKay-Bukowski



Fallows

Radio Emission from Cosmic Rays

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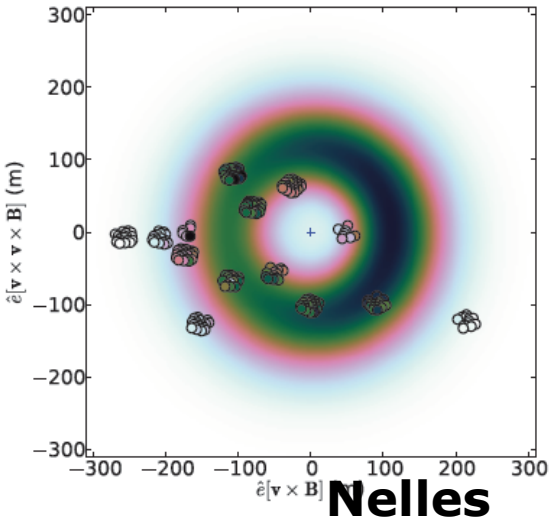
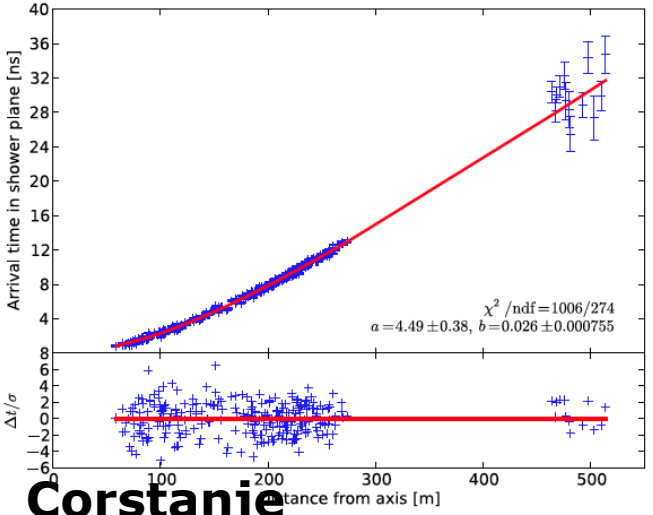


Nelles

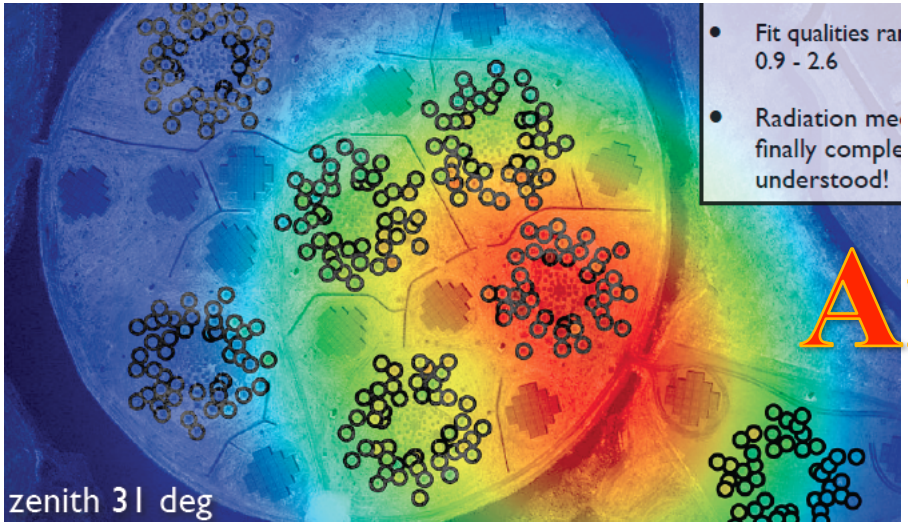
Properties understood

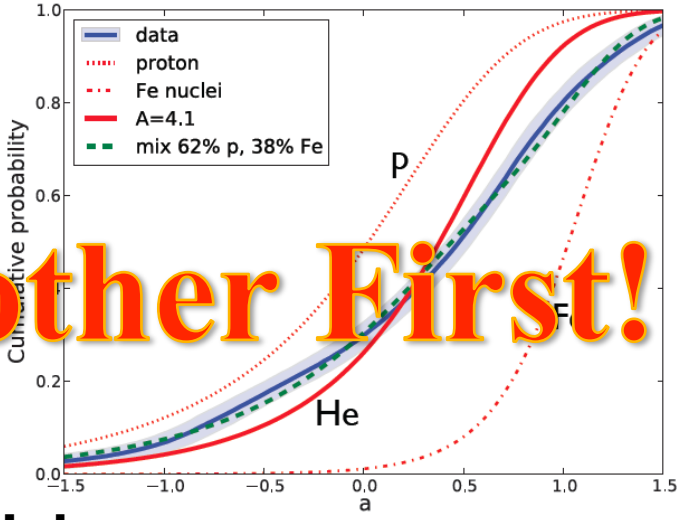
Composition measured!

Electric fields to come … (**Trin**)



Schellart **Corstanje**





Another First!

Buitink

SETI@LOFAR

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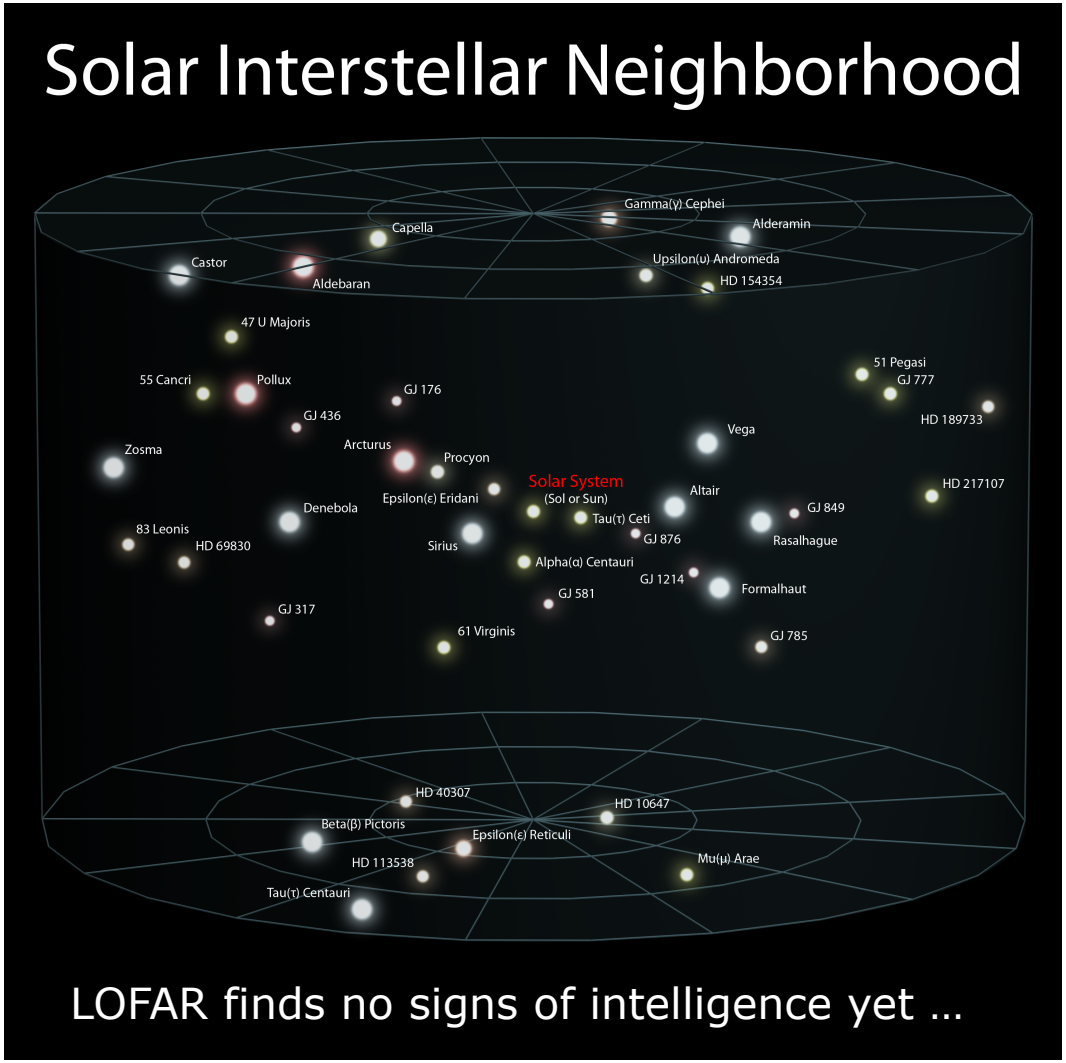
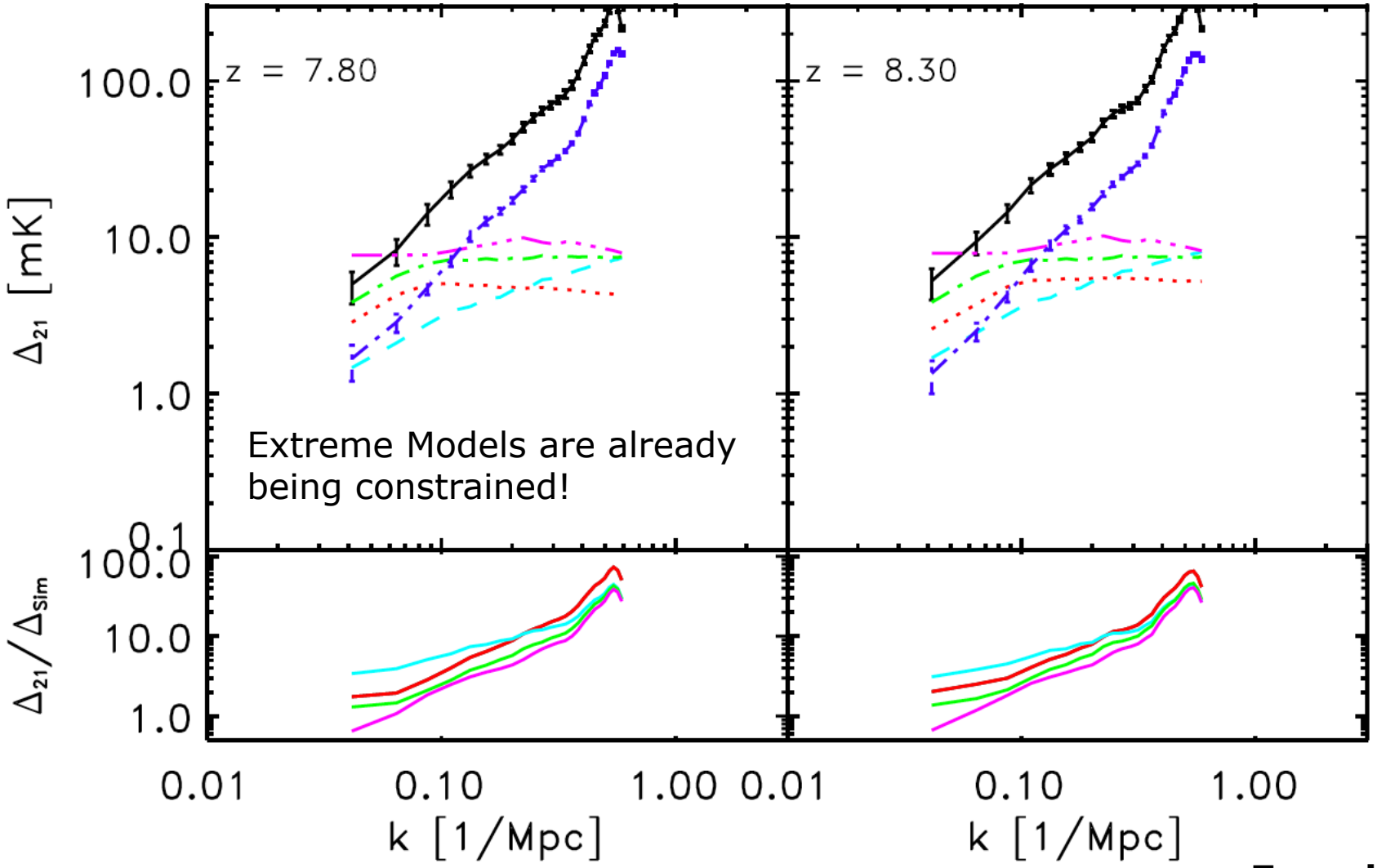


Siemion

EOR Limits



Zaroubi

LOFAR keeps growing

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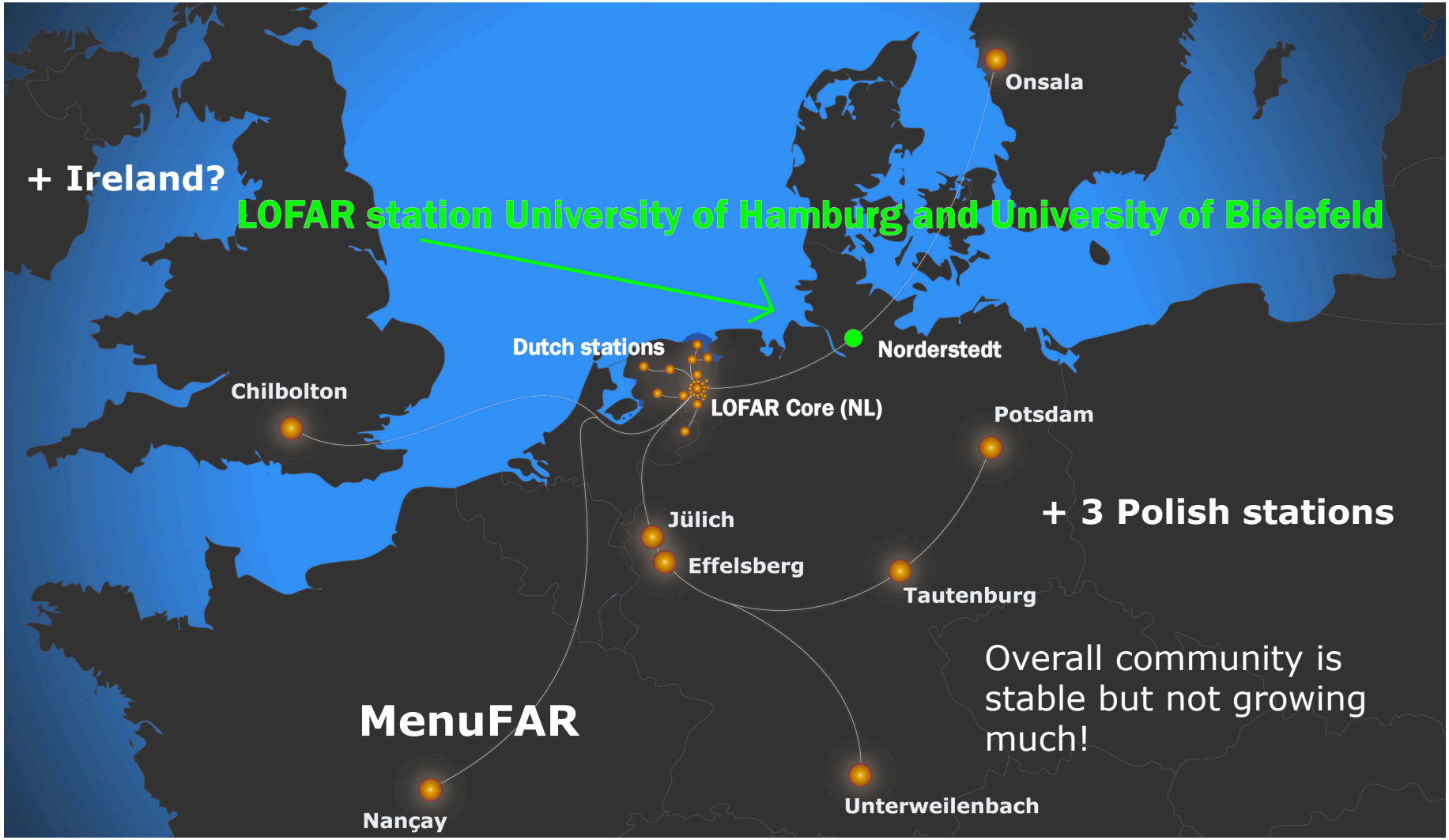


Science Output

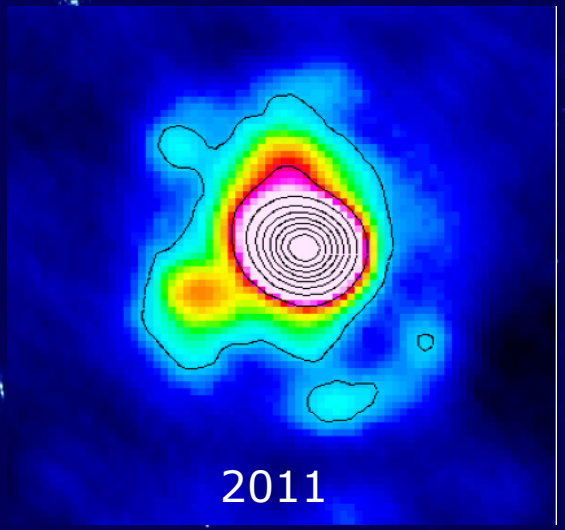
- Refereed commissioning papers
  - 15 since 2011, 201 cites
  - Top Cited:
    - Stappers 2011 (pulsars) 67 cites
    - Van Haarlem 2013 (LOFAR) 53 cites
    - Van Weeren 2012 (Abell 2256) 18 cites
  - High Impact: 1x Science (Hermsen) + 1x Nature??
- Papers mentioning LOFAR (title/abtract):
  - 747 papers with 4869 cites
  - Expectation management needed …

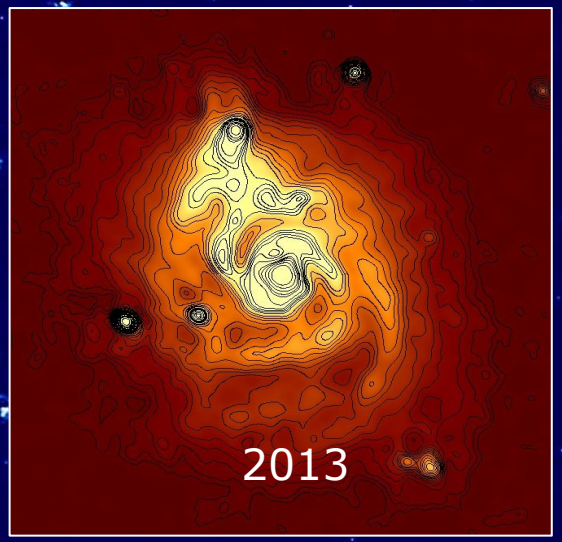
Top 8 "LOFAR" papers

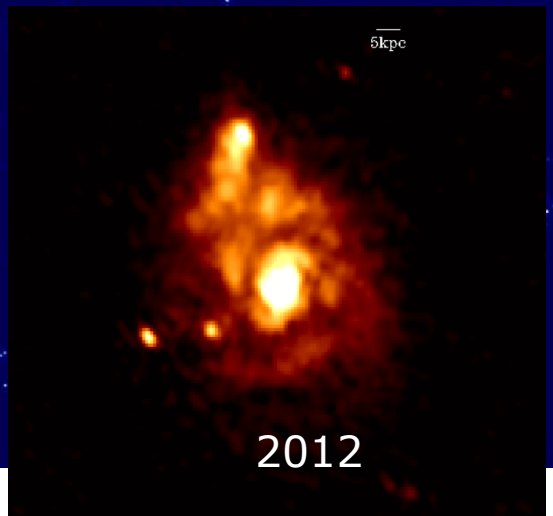
Radboud University Nijmegen

1	2007MNRAS.377.1043M McQuinn, Matthew; Lidz, Adam; Zahn, Oliver; Dutta, Suvendra; Hernquist, Lars; Zaldarriaga, Matias	164.000	05/2007	A Z F G X R C U	The morphology of HII regions during reionization
2	2004ApJ...615....7M Morales, Miguel F.; Hewitt, Jacqueline	124.000	11/2004	A Z E F X R C U	Toward Epoch of Reionization Measurements with Wide-Field Radio Observations
3	2003MNRAS.346..871O Oh, S. Peng; Mack, Katherine J.	113.000	12/2003	A Z F G X R C U H	Foregrounds for 21-cm observations of neutral gas at high redshift
4	2002ApJ...572L.123I Iliev, Ilian T.; Shapiro, Paul R.; Ferrara, Andrea; Martel, Hugo	112.000	06/2002	A Z E F X R C U	On the Direct Detectability of the Cosmic Dark Ages: 21 Centimeter Emission from Minihalos
5	2006ApJ...638...20B Bowman, Judd D.; Morales, Miguel F.; Hewitt, Jacqueline N.	109.000	02/2006	A Z E F X R C U	The Sensitivity of First-Generation Epoch of Reionization Observatories and Their Potential for Differentiating Theoretical Power Spectra
6	2003APh....19..477F Falcke, Heino; Gorham, Peter	97.000	07/2003	A Z E X R C U	Detecting radio emission from cosmic ray air showers and neutrinos with a digital radio telescope
7	2006MNRAS.369.1577C Cassano, R.; Brunetti, G.; Setti, G.	96.000	07/2006	A Z F G X R C S N U	Statistics of giant radio haloes from electron reacceleration models
8	2008MNRAS.385.1211P Pfrommer, Christoph; Enßlin, Torsten A.;	94.000	04/2008	A Z F G X R C S O U	Simulating cosmic rays in clusters of galaxies - II. A unified scheme for radio haloes and relics with predictions of the γ-ray emission

Progress

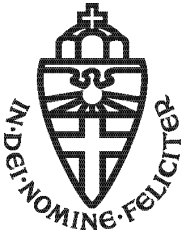






Mulcahy

Progress (Imaging)



- There is progress!
- It seems slow, but from year to year we make huge progress:
  - MSSS detecting 10 src/sqdeg (~200.000 sources) fully automatic (**Heald**)
  - LOFAR users are able to get to 1-2 mJy images "routinely" (with quite some effort still)" (**Coppejans, Heesen, Mahony, Bonafede**)
  - Several experimental methods available that allow to go to science quality thermals noise imaging (**de Gasperin**)
    - "Extreme peeling" (van Weeren) actually exercised on HBA data
    - LBA data still needs some work but also progress

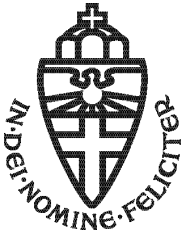
Breakthroughs

- Historical "technical" breakthroughs
  - Thermal noise-limited science quality imaging
  - Highest resolution low-frequency images (VLBI)
- Unique LOFAR science breakthroughs:
  - Deepest EOR limit
  - 1st extragalactic Carbon RRL
  - Cosmic ray radio emission finally understood, composition measurement with highest precision and duty cycle
- A wealth of impressive pulsar results
  - New pulsars, intermittency, emission process and location

Lots of science

- Many more (potential) science results
  - MSSS – lots of great science opportunities (!)
  - First LOFAR transient: What is this? Where is the rest?
  - Beautiful images (workshop banquet!)
  - Magnetic fields turbulence, CR diffusion
  - Resolved low-freq. solar imaging, tracing type III bursts
  - Spectral aging, spectral curvature (needs more work: many sources don't look much different from VLA … find rare birds!)
- Overall science output still relatively low …
  - So much data, so little to publish? Pick low-hanging fruits!
  - Better is the enemy of good (and also enemy of excellent)

Final thoughts



- We are not done yet
  - Transient capabilities
  - Implement new calibration schemes
  - long baselines (user software, reliability)
  - Polarization calibration
  - Publish papers, watch out for new things …
- Fantastic progress by a very dedicated, highly-qualified, young generation of radio astronomers
  - We are in the final half-time of the match – that is the tough one …
  - We need perseverance and more smart ideas
  - But thanks to PhD students, postdocs, science support (!) and staff …