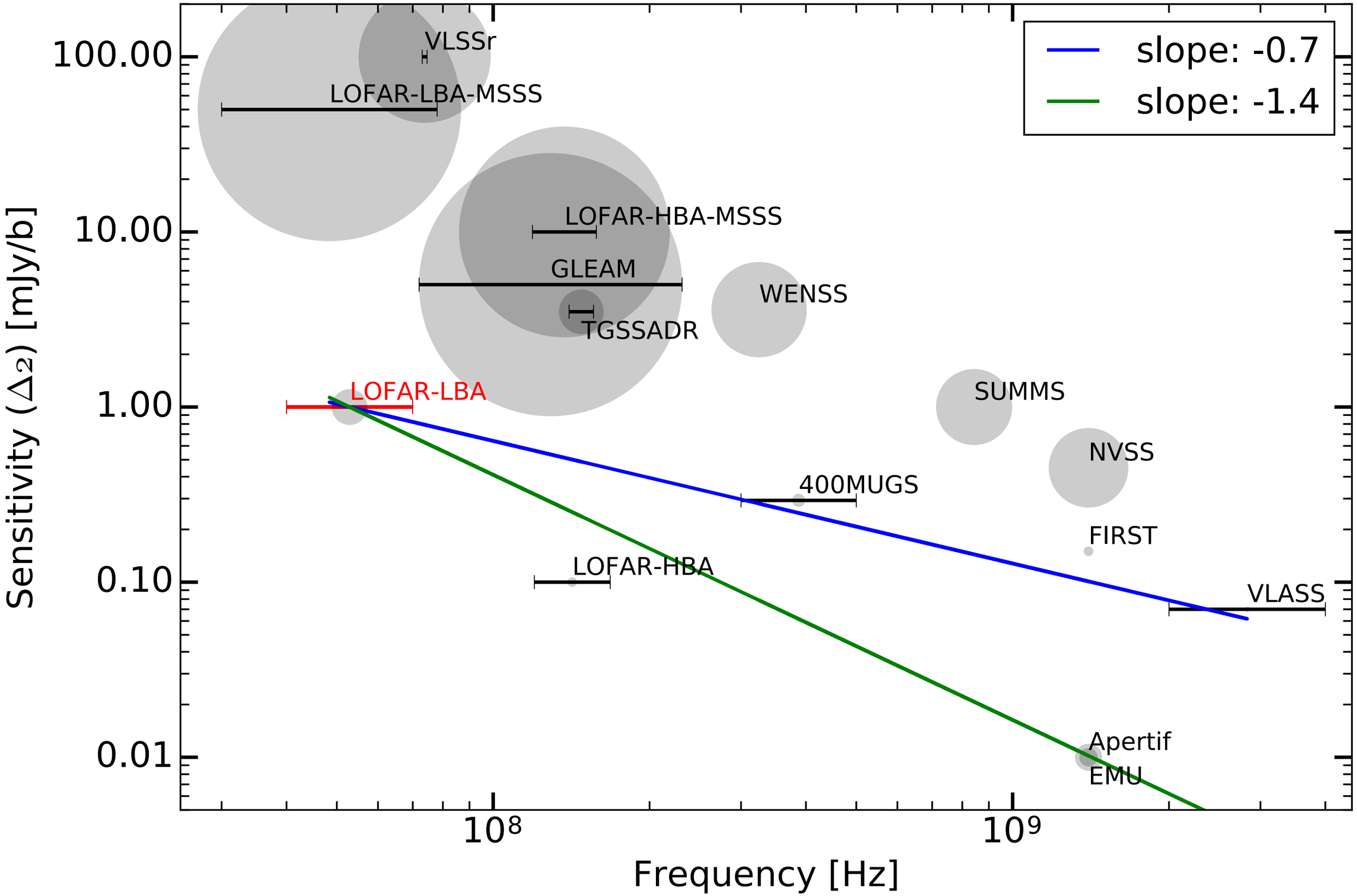
LOFAR LBA survey: first results

Francesco de Gasperin

ASTRON - Feb 2017

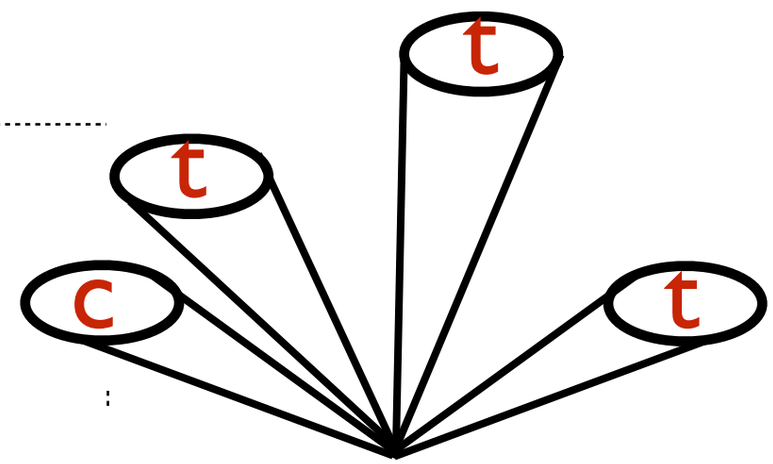


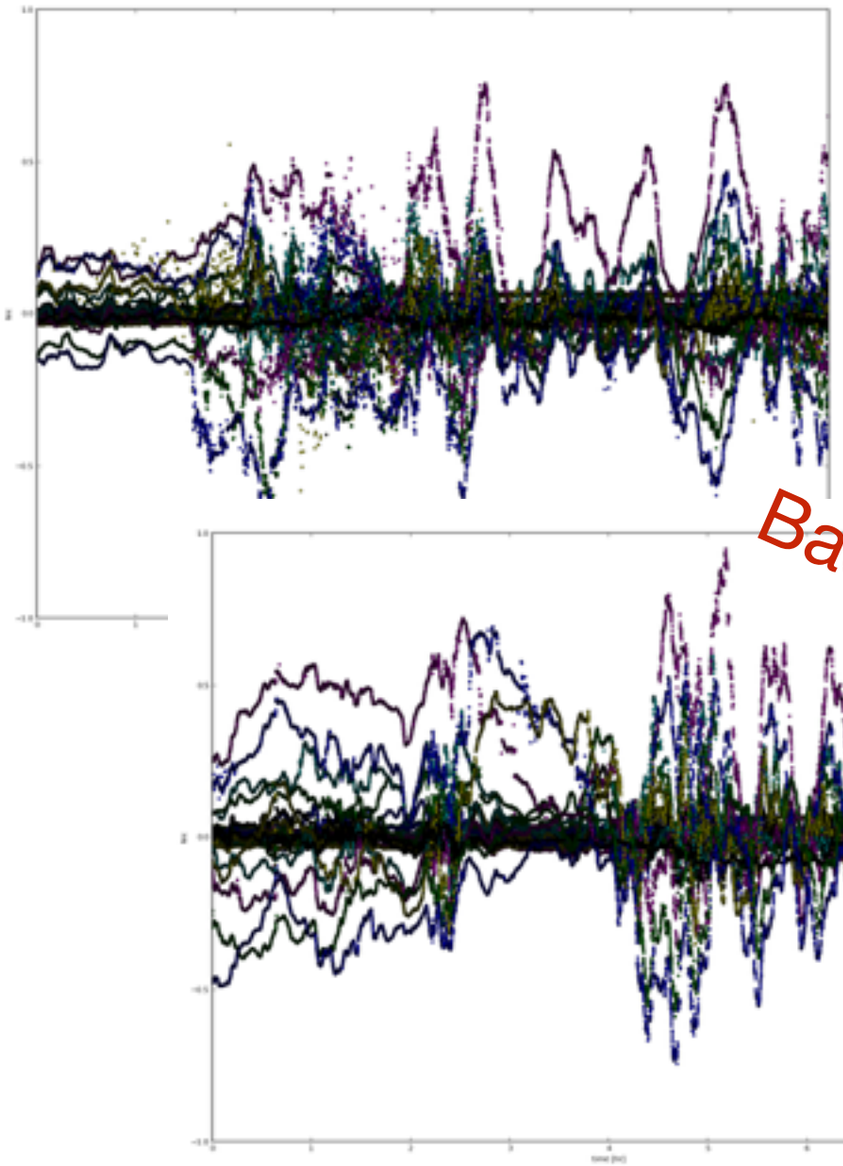
Sensitivity: 1 mJy/b

Freq: 42-66MHz

	LOFAR **LoT-ss** *(T. Shimwell+)*	LOFAR **LoL-ss** *(F. de Gasperin+)*
Frequency	120-168 MHz	**42-66 MHz**
Obs Time	8h/pointing (2 beams) 12k hours	**8h/pointing (3 beams) 8k hours**
Sky Coverage	50% (North)	**50% (North)**
Noise level	100 uJy/b	**1 mJy/b**
Resolution	5”	**15”**

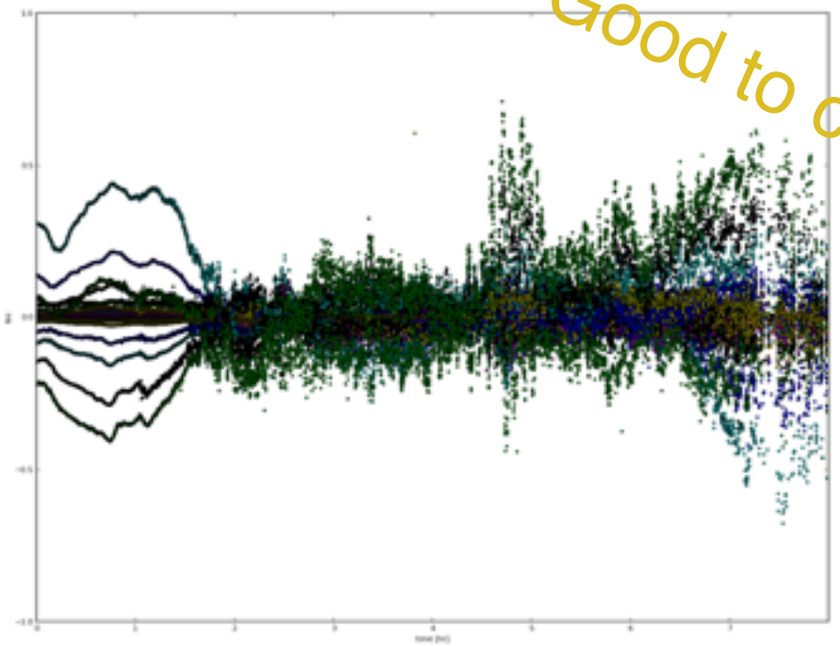
→ Lucky imaging will probably be implemented

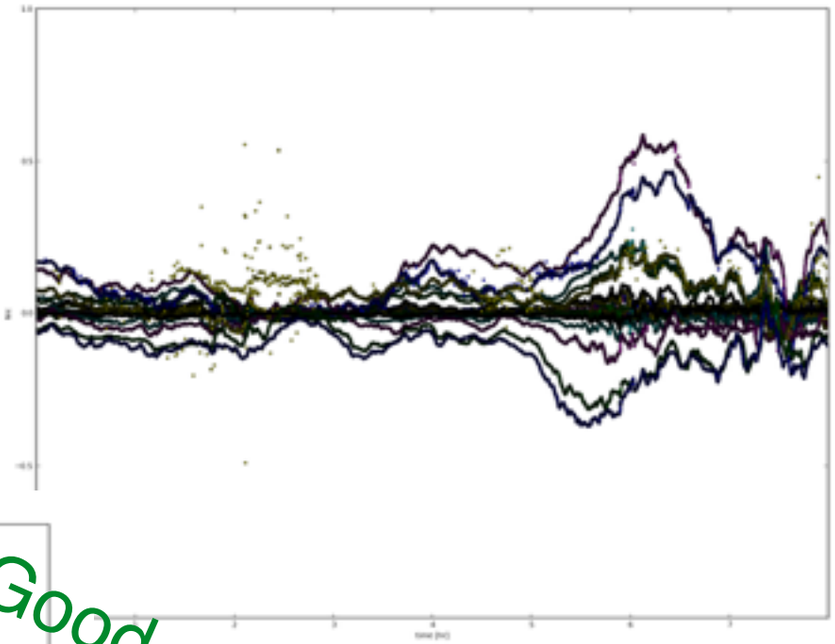




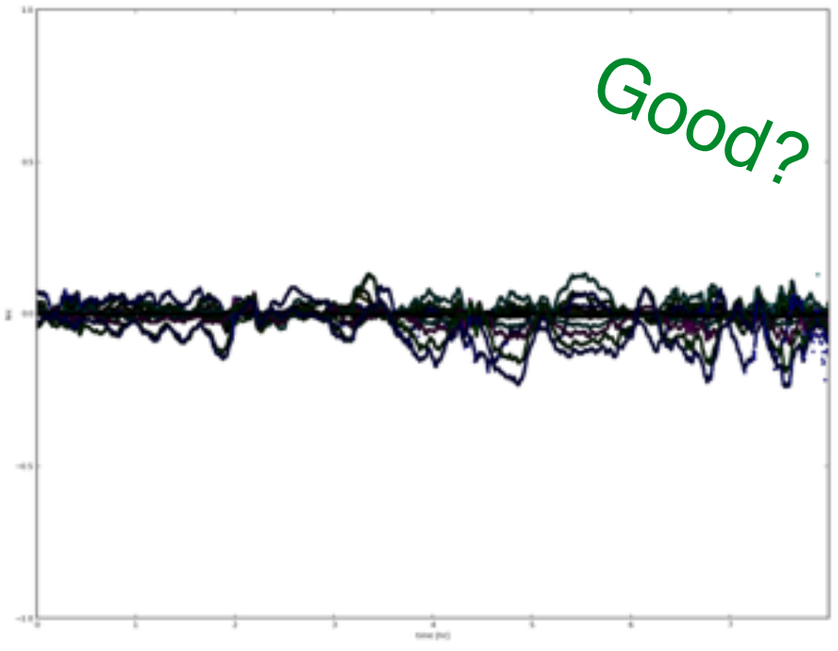
Bad

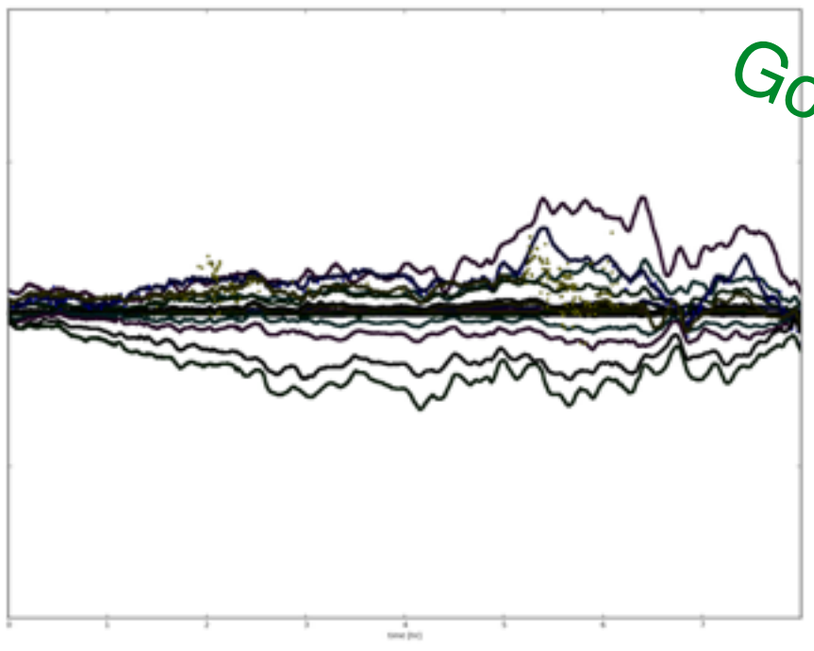
Good to crazy



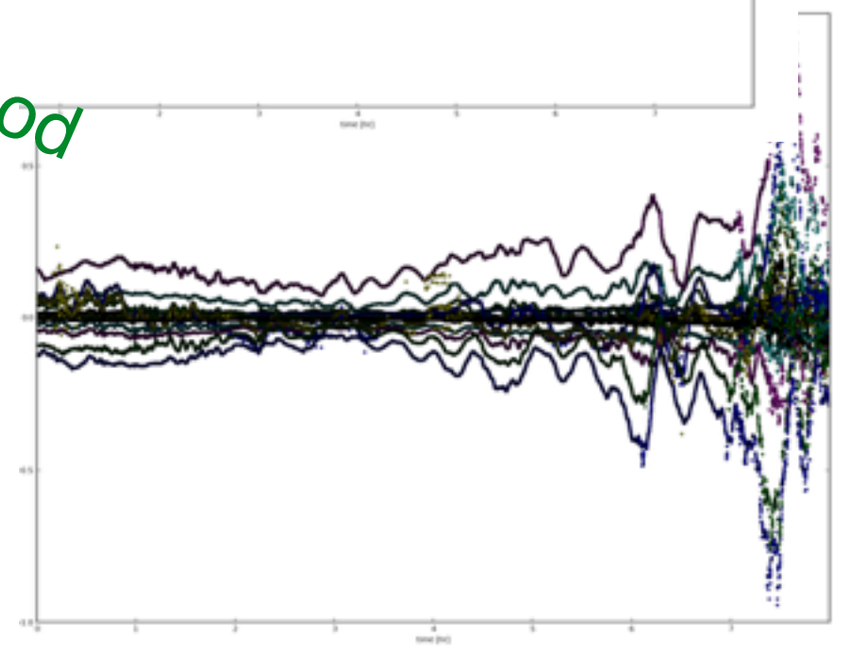


Good?





Good



32nd URSI GASS, Montreal, 19–26 August 2017

The effect of the ionosphere on astronomical observations below 100 MHz

F. de Gasperin*(1), M. Mevius(2), and H. Intema(1)
(1) Leiden Observatory, Leiden University, P.O.Box 9513, NL-2300 RA, Leiden, The Netherlands
(2) ASTRON, P.O.Box 2, NL-7990 AA, Dwingeloo, the Netherlands

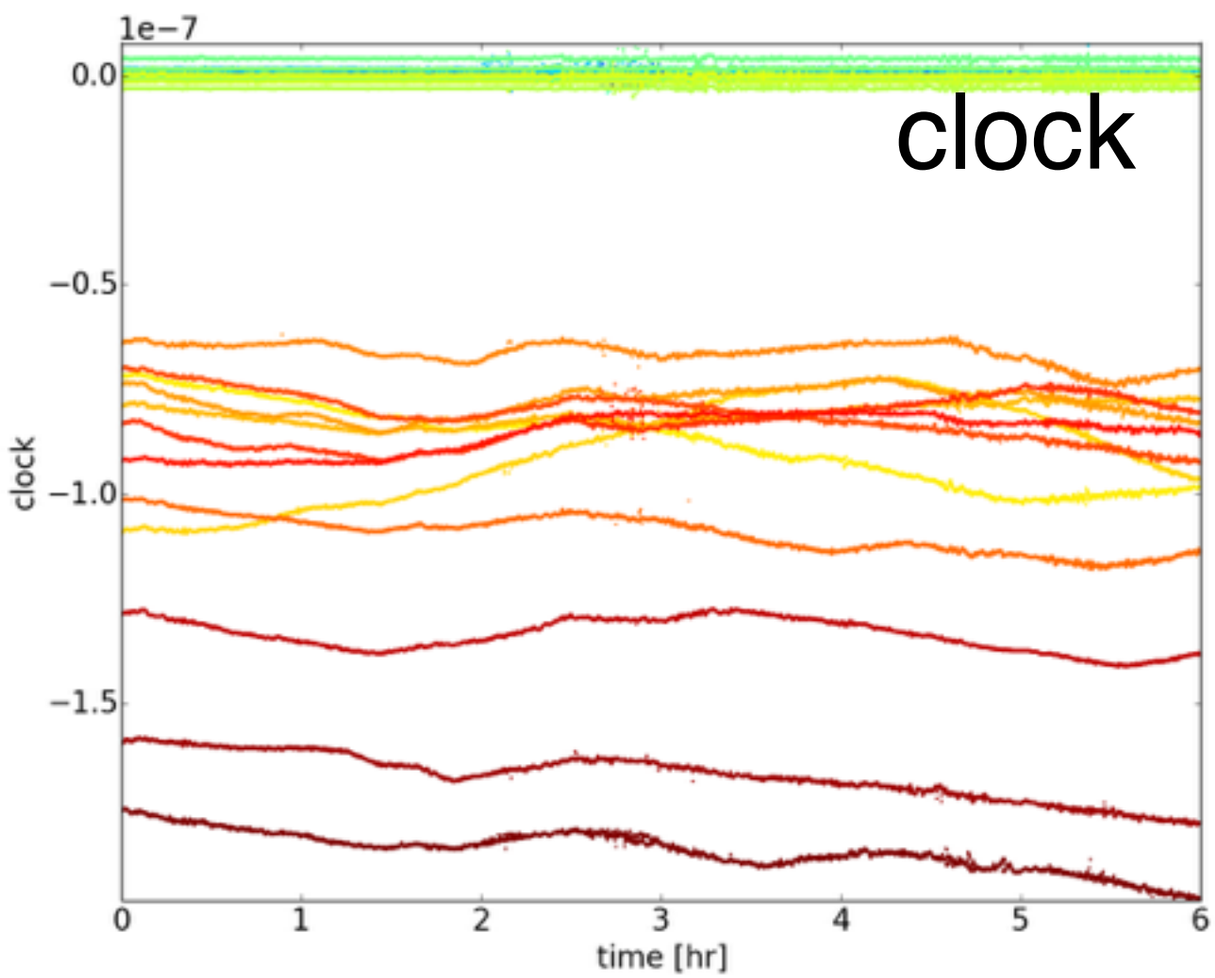
Phase error:

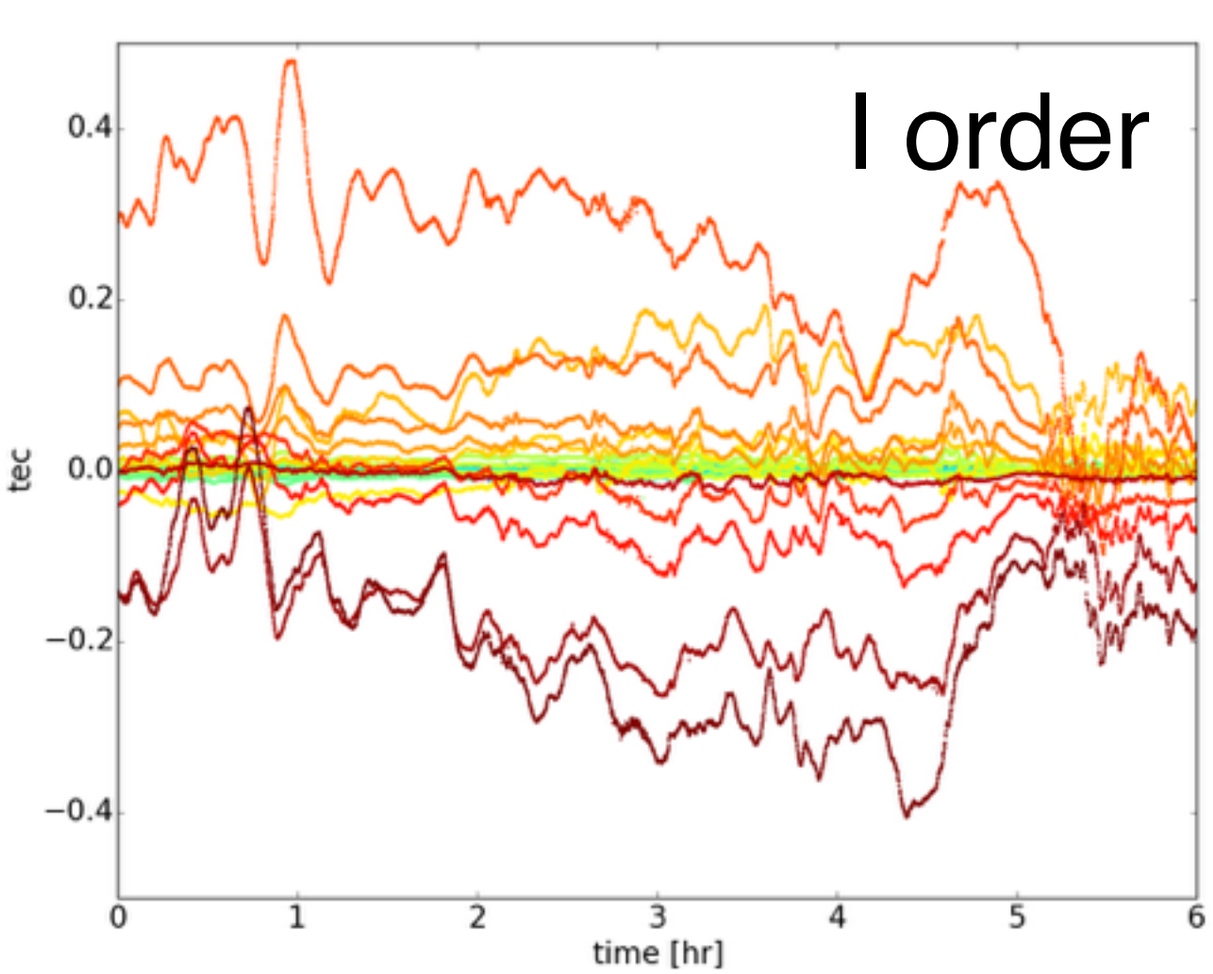
$$\Phi^{\text{ion}} = -\frac{2\pi\nu}{c}\int_{\text{LoS}}(n-1)\,\mathrm{d}l$$

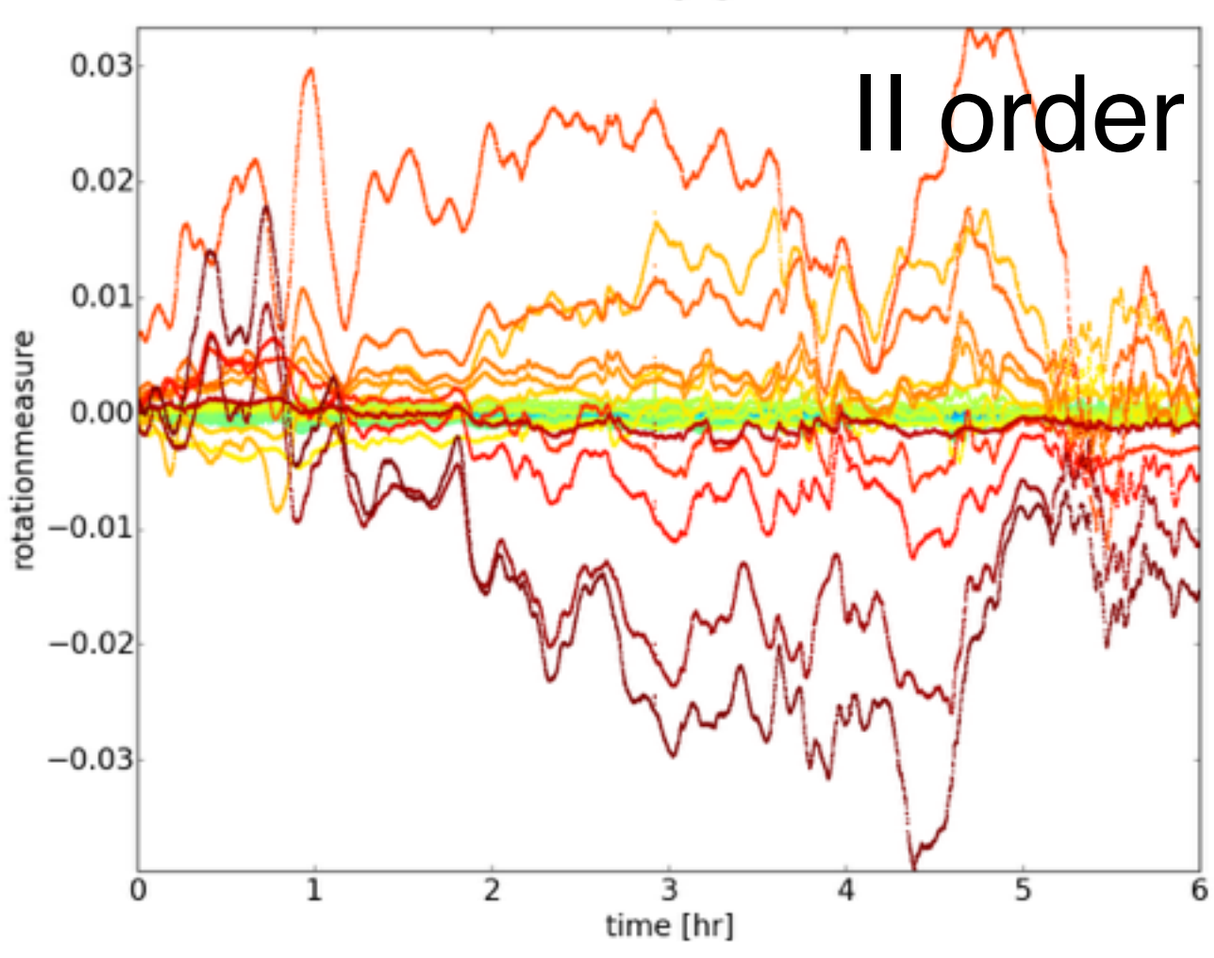
Refractive index expansion:

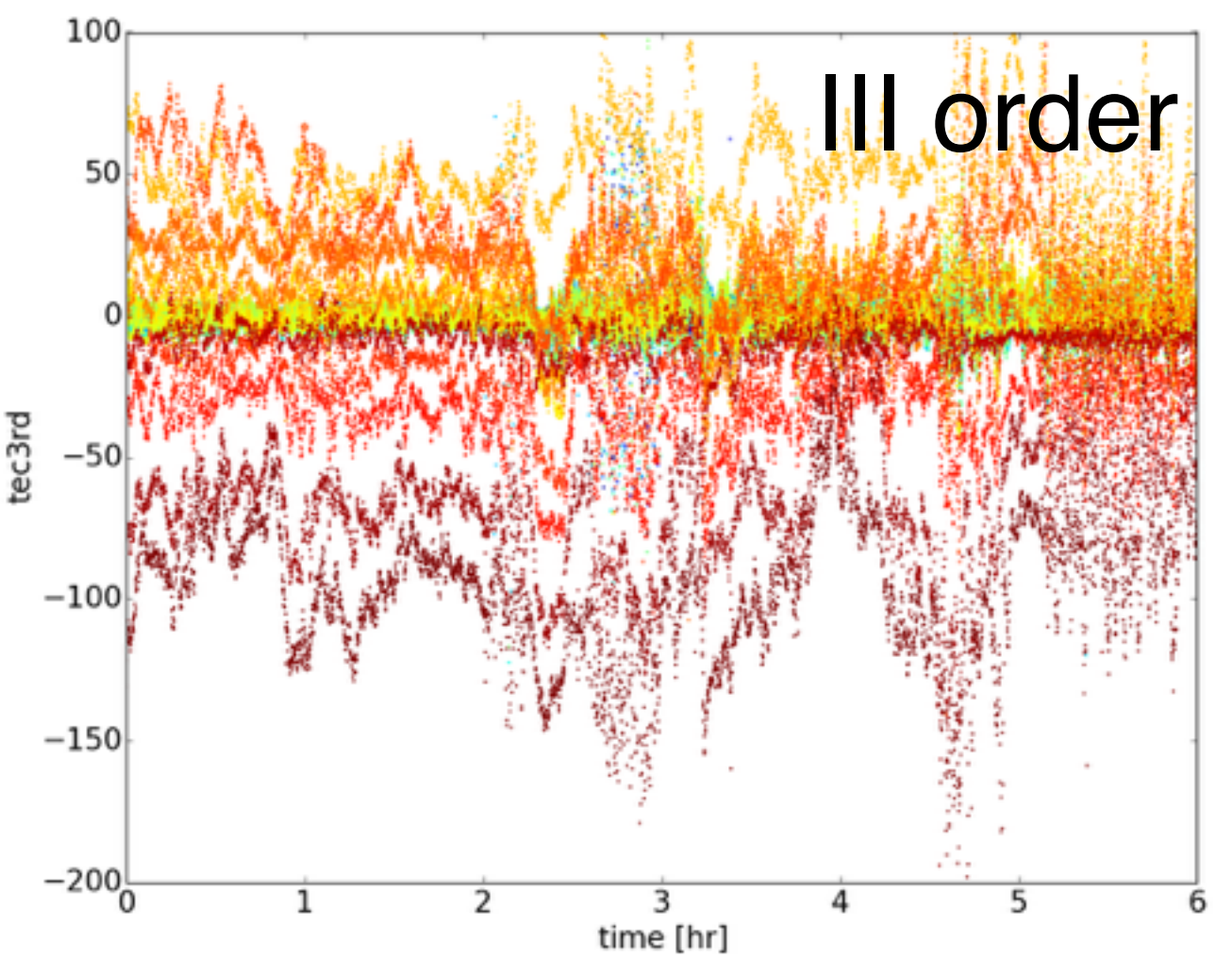
$$n = 1 - \frac{q^2}{8\pi^2 m_e \varepsilon_0}\cdot\frac{n_e}{\nu^2} \pm \frac{q^3}{16\pi^3 m_e^2 \varepsilon_0}\cdot\frac{n_e B\cos\theta}{\nu^3} - \frac{q^4}{128\pi^4 m_e^2 \varepsilon_0^2}\cdot\frac{n_e^2}{\nu^4} - \frac{q^4}{64\pi^4 m_e^3 \varepsilon_0}\cdot\frac{n_e B^2(1+\cos^2\theta)}{\nu^4},$$

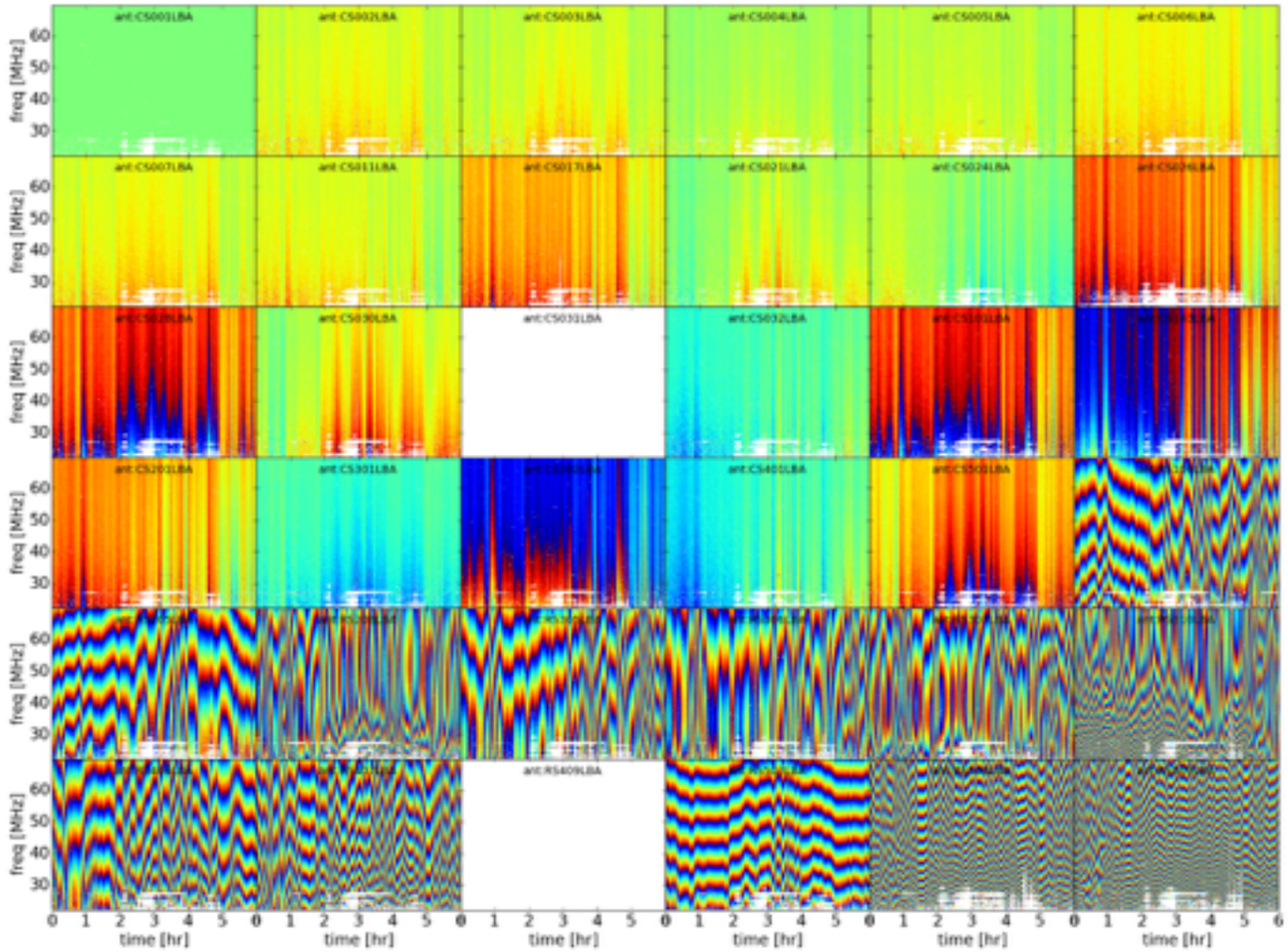
			LBA		HBA	
dTEC (TECU)	I ord 30 MHz	II ord (day/night) 30 MHz	I ord 60 MHz	II ord (day/night) 60 MHz	I ord 150 MHz	II ord (day/night) 150 MHz
0.5 (remote st., bad iono.)	8067	294 / 214	4033	73 / 50	1613	12 / 8
0.1 (remote st., good iono.)	1613	126 / 46	806	31 / 10	322	5 / 2
0.03 (across FoV)	404	97 / 16	242	24 / 4	96	4 / < 1
0.01 (core st.)	160	88 / 8	80	22 / 2	31	4 / < 1


clock
1e−7
0.0
−0.5
−1.0
−1.5
clock
0
1
2
3
4
5
6
time [hr]

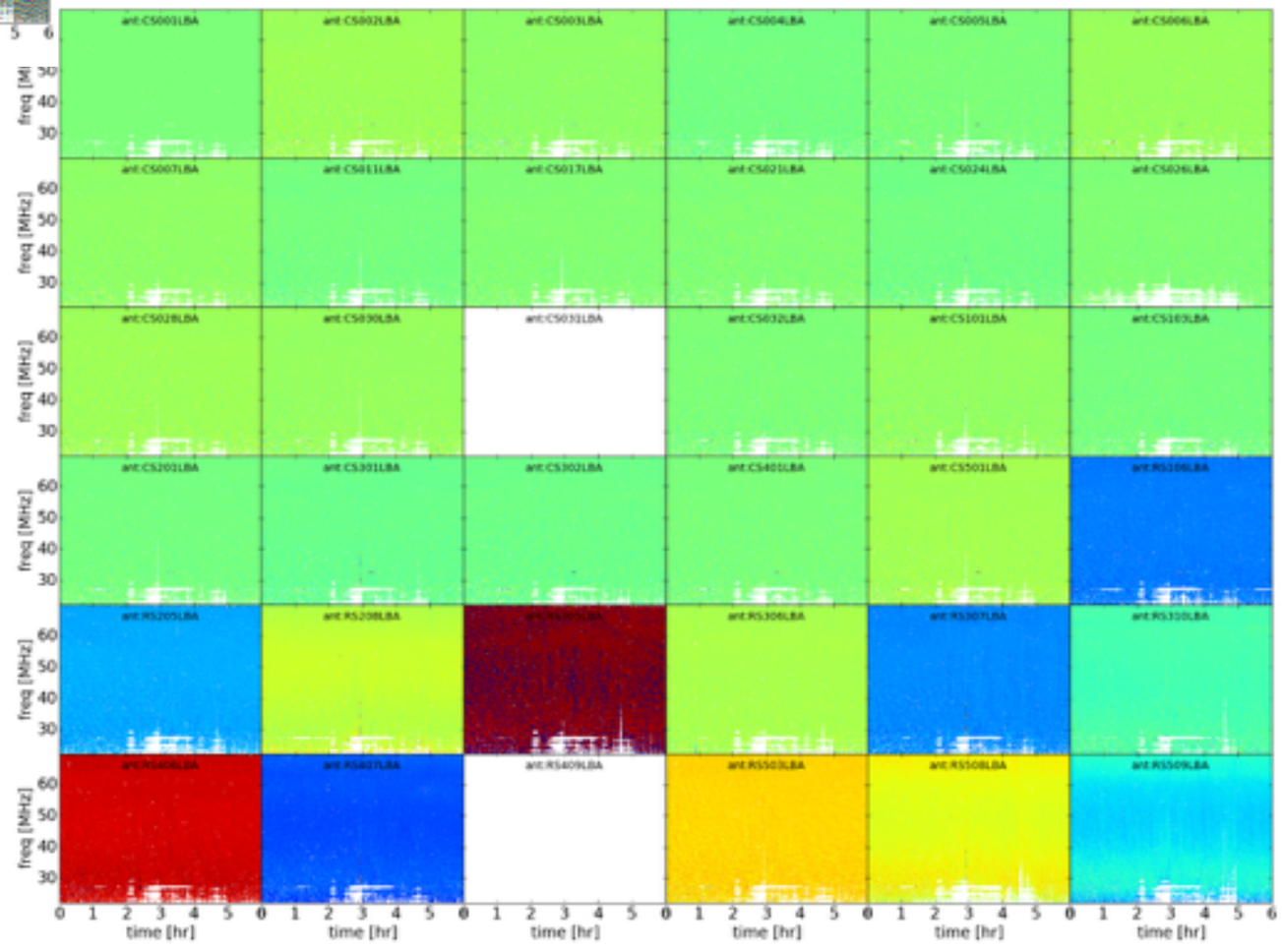

I order
0.4
0.2
0.0
−0.2
−0.4
tec
0
1
2
3
4
5
6
time [hr]


II order
0.03
0.02
0.01
0.00
−0.01
−0.02
−0.03
rotationmeasure
0
1
2
3
4
5
6
time [hr]


III order
100
50
0
−50
−100
−150
−200
tec3rd
0
1
2
3
4
5
6
time [hr]



- clock
- I order
- II order
- III order



LOFAR LBA phase systematic effects (at the phase centre) can be described by clock and ionosphere

PiLL (Pipeline for LOFAR LBA)

run time: 12h

Calibrator pipeline

- solution flagging
- separation of effects (iono1,iono2,iono3,clock)
- ionospheric FoM estimation

100% complete

run time: 6h

Timesplit pipeline

- solution transfer (BP, phases)
- combined flagging
- split in time for parallelisation

100% complete

run time: 24h

Selfcal pipeline

- BL-based smoothing
- TEC correction
- FR correction
- selfcal cycles
- auto-masking
- low-res clean up to 10°

90% complete

DD pipeline

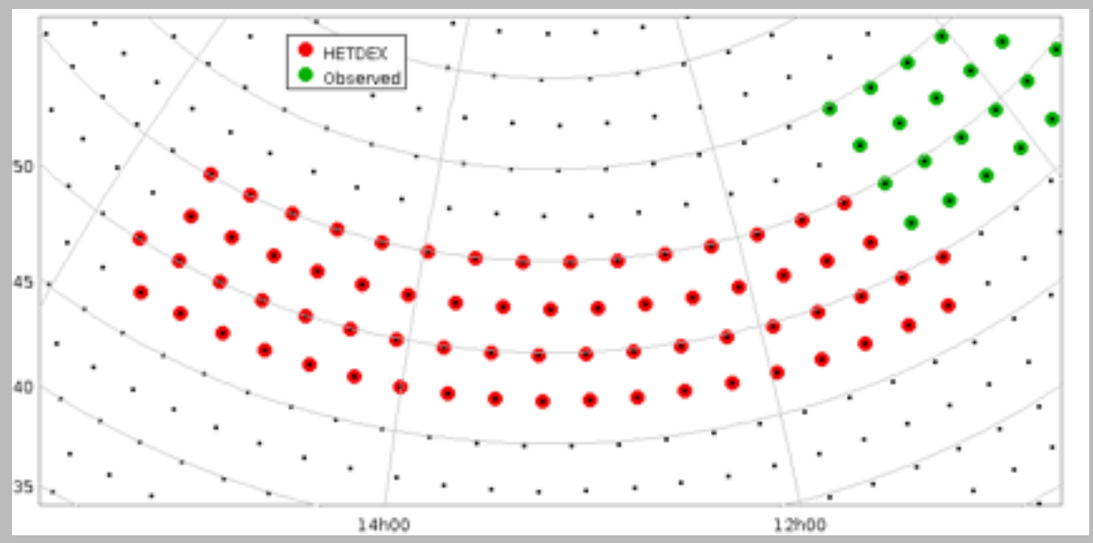
- peeling?
- DD-NDPPP?
- sagecal?

Under development

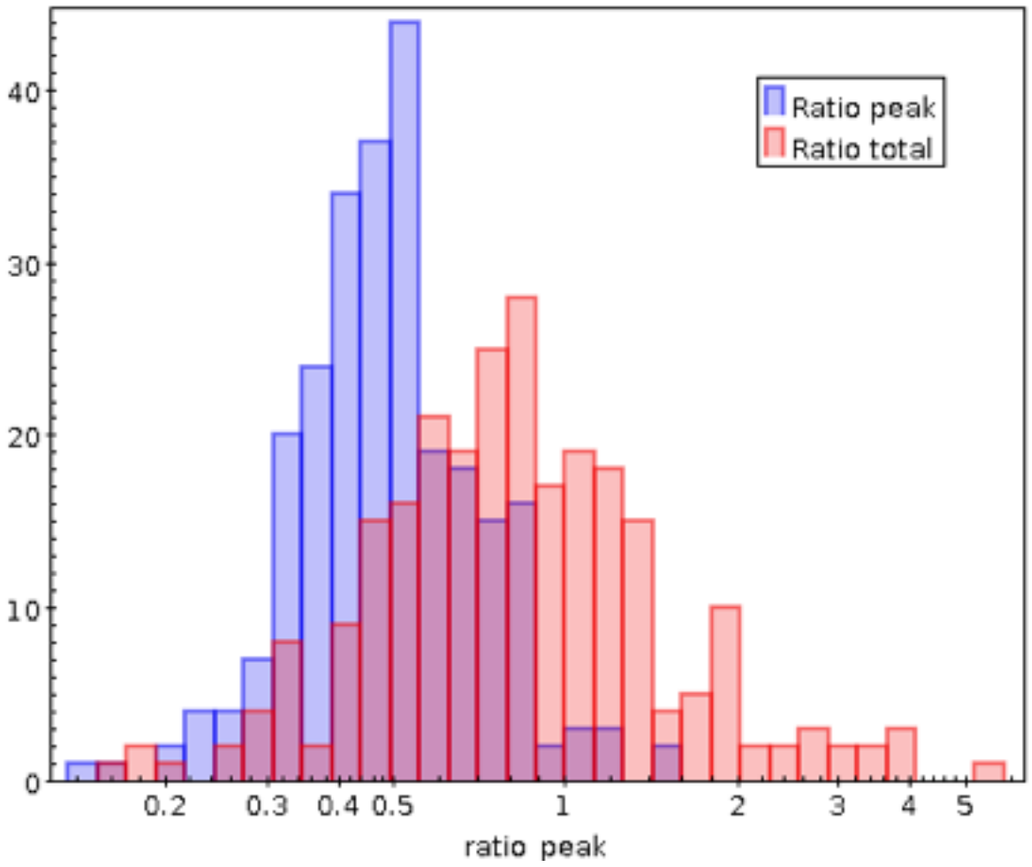
A.Drabent is porting it into standard LOFAR pipeeline

all pipelines are dysco-compressed and parallel

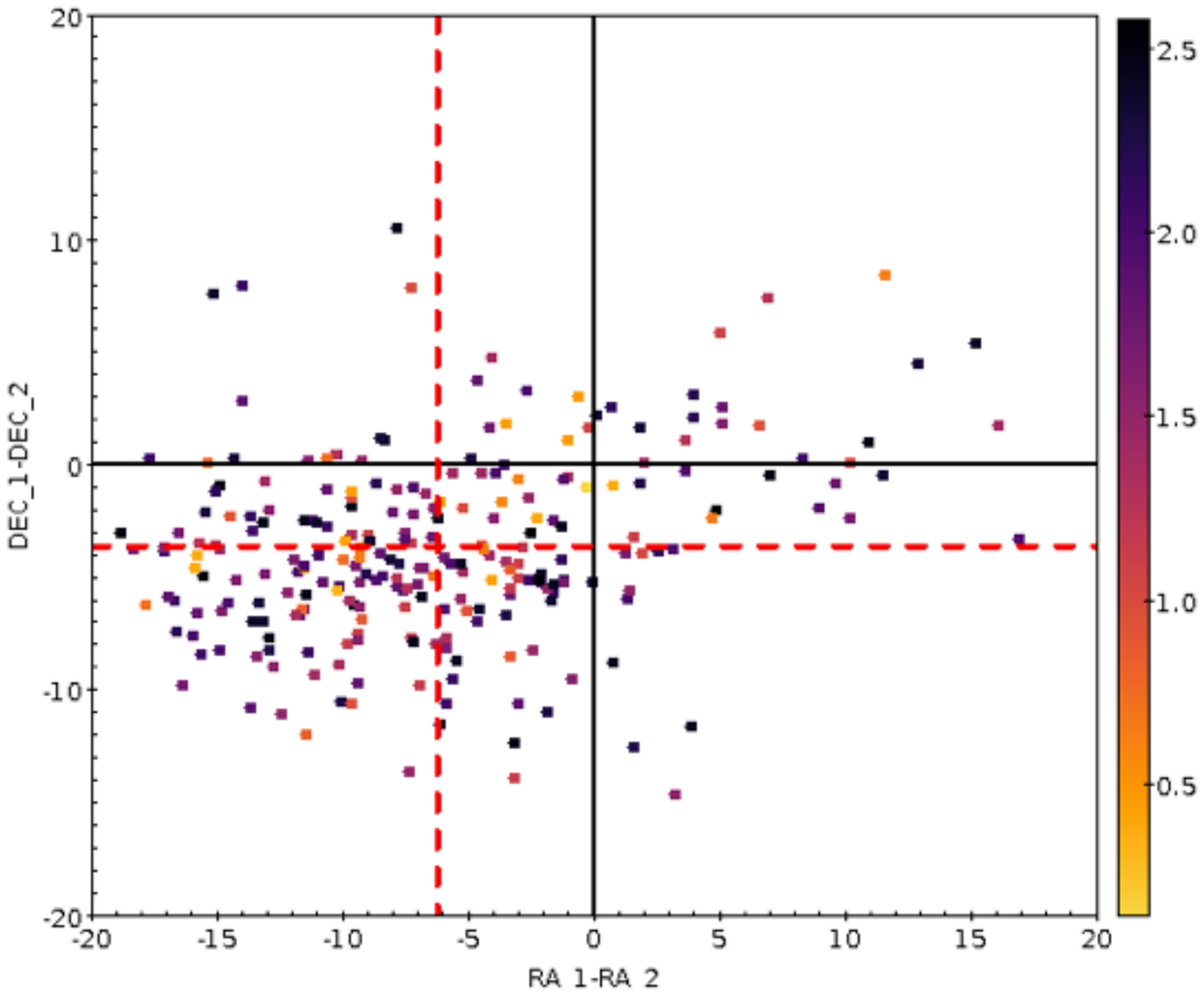
Frequency: 54 MHz
Rms noise: 4 mJy/b
Resolution: 45”
Detections: ~1500



Mean error on total flux: <3%
Mean error on peak flux: 50%

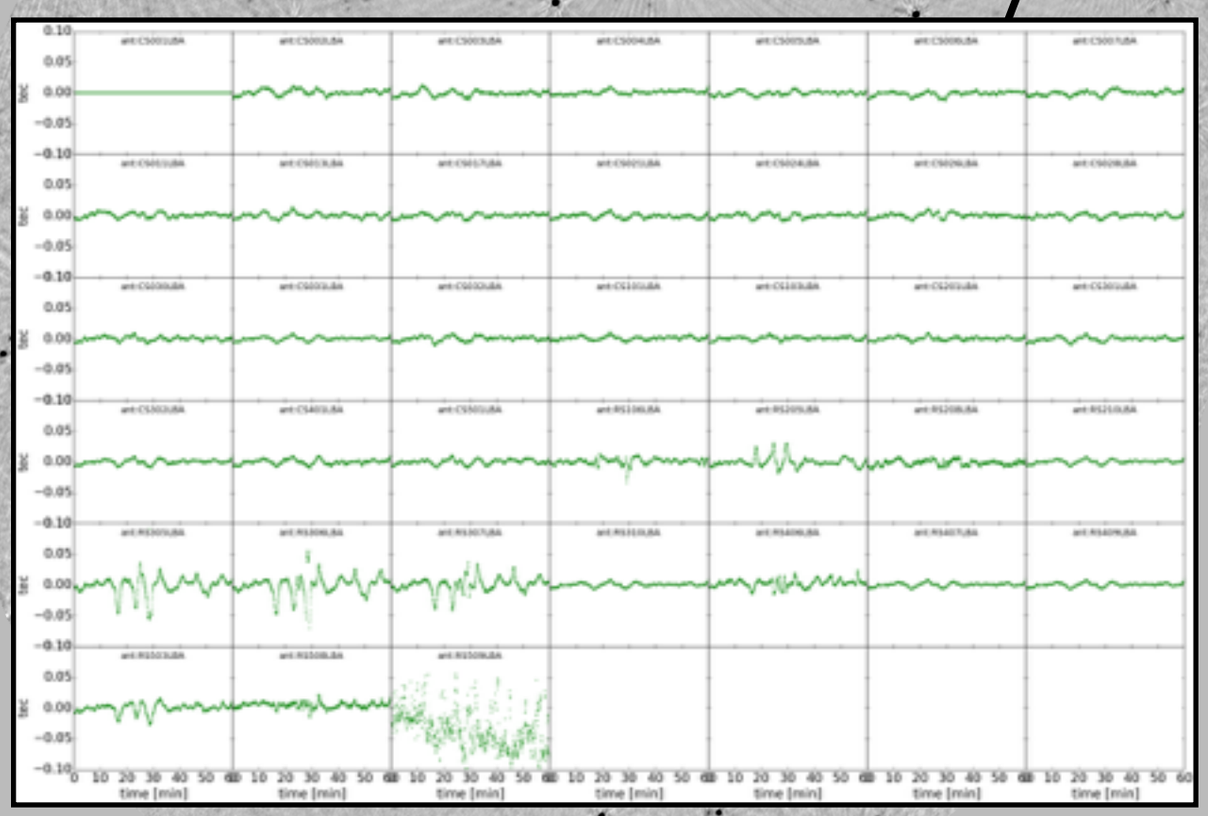


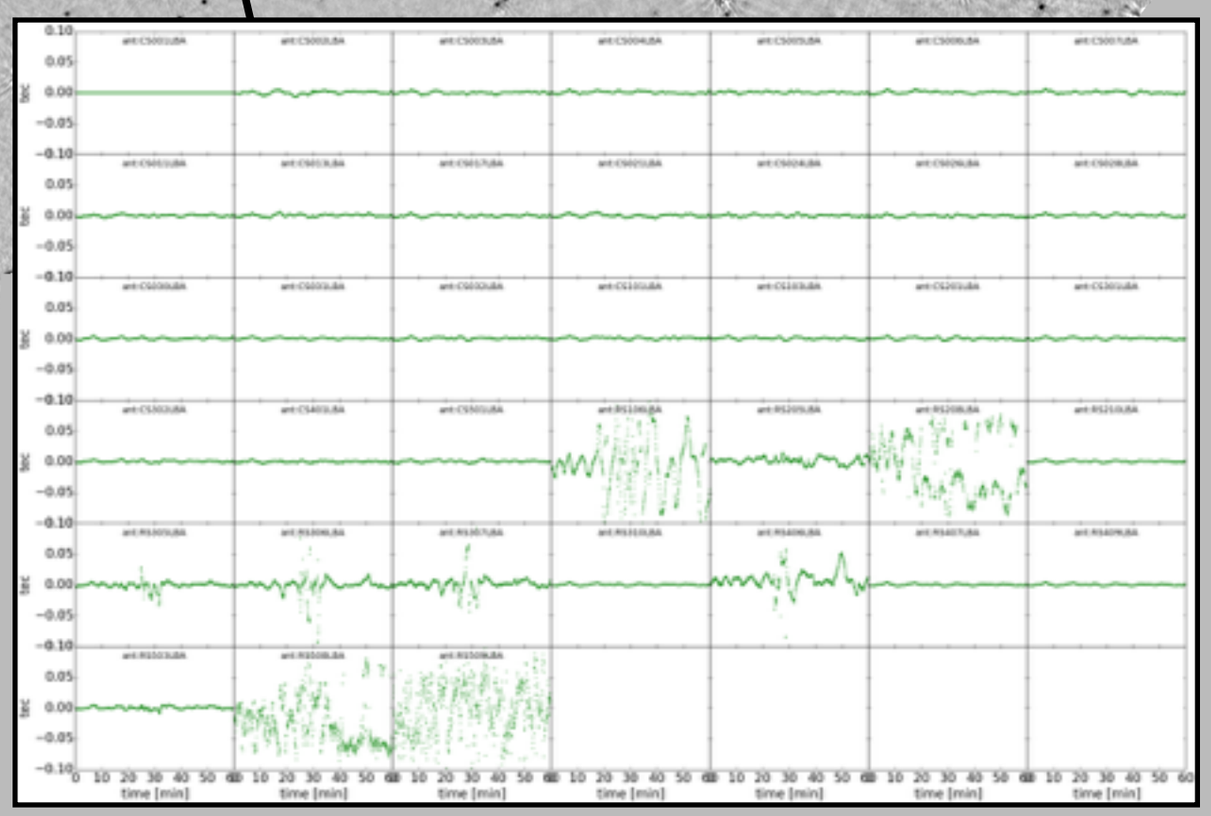
Positional error: 6” x 4”



Frequency: 54 MHz
Rms noise: 4 mJy/b
Resolution: 45”
Detections: ~1500

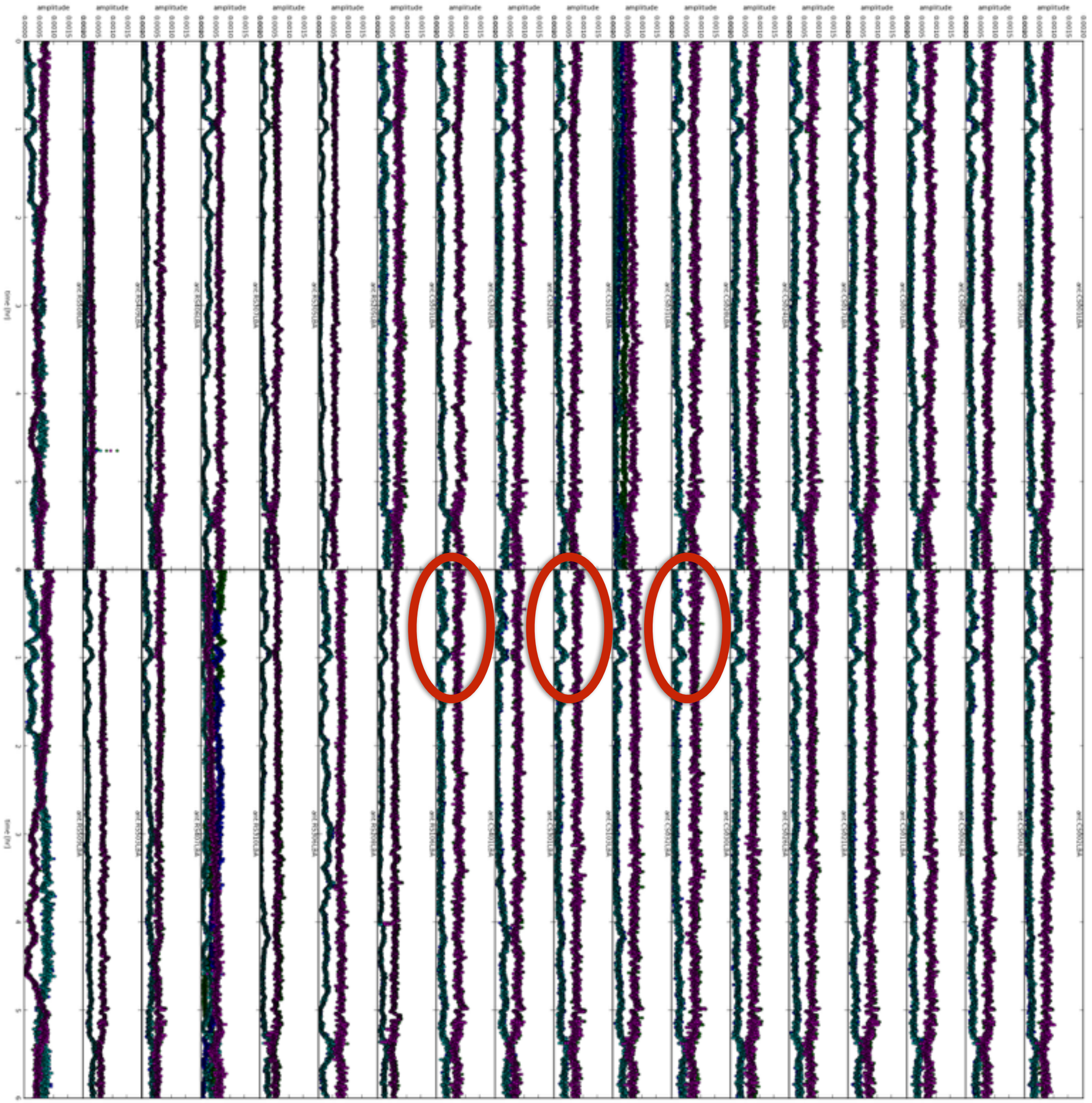
With: TammoJan, Andre’, Maaijke





A few problems to solve:

Element beam?



CS031

RS210

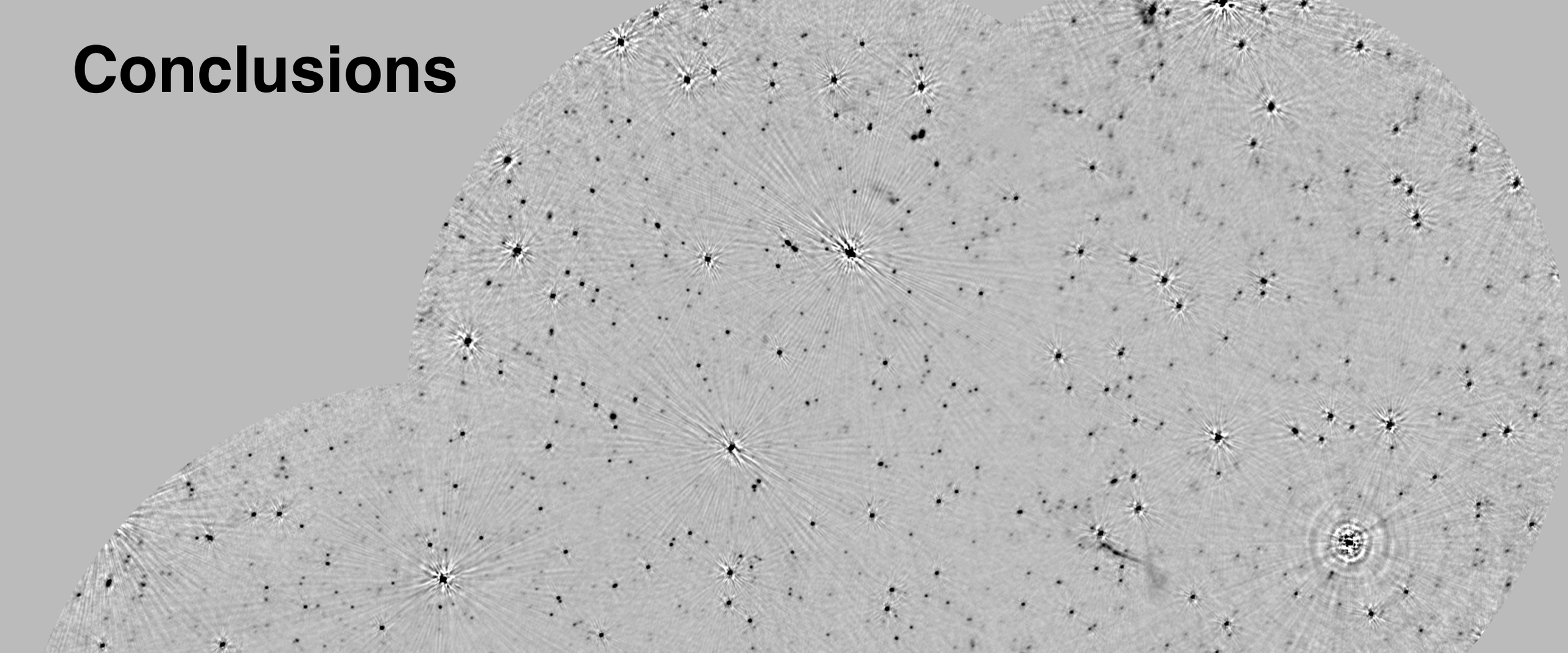
RS310

RS407

RS409

Station calibration?

Conclusions



- Understanding of systematic effects
- LFAR LBA sky survey first images
- PiLL under development and to be released soon
- DD-NDPPP first encouraging results!
- Some issues remains: beam, station calibration, observing mode…