Long-baseline LBA observations, the ionosphere and **differential** Faraday rotation

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LOFAR Status meeting, 23-Sep-09

Observations 12 Sep 2009 L2009_14319

3C196 UT 0200 - 1500 3s integration

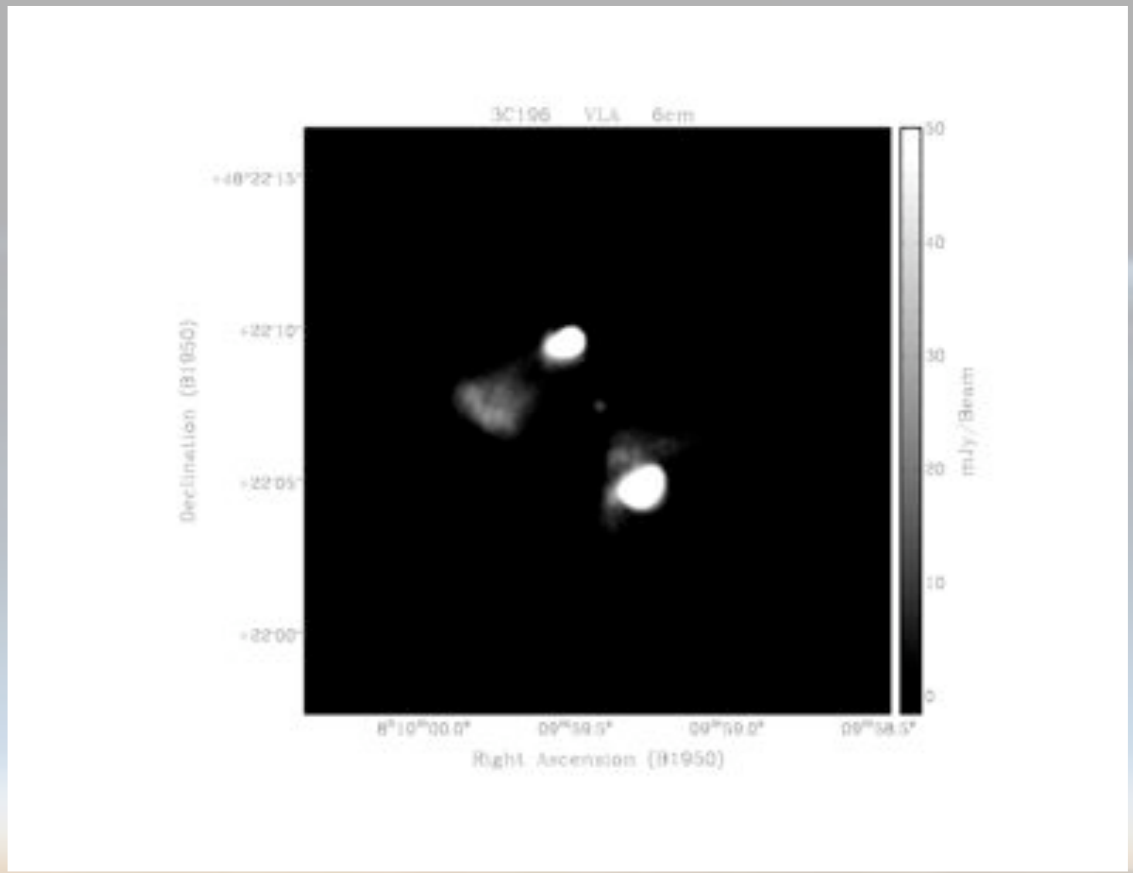
6 stations:

RS106,RS208,CS302, RS307,RS503 & DE601

120 subbands (each 2.6 Gbyte)

LBA 30-76 MHz

3C196 as an (unpolarized) VLBI calibrator (?)



Eff-Ex baseline

200-250 km

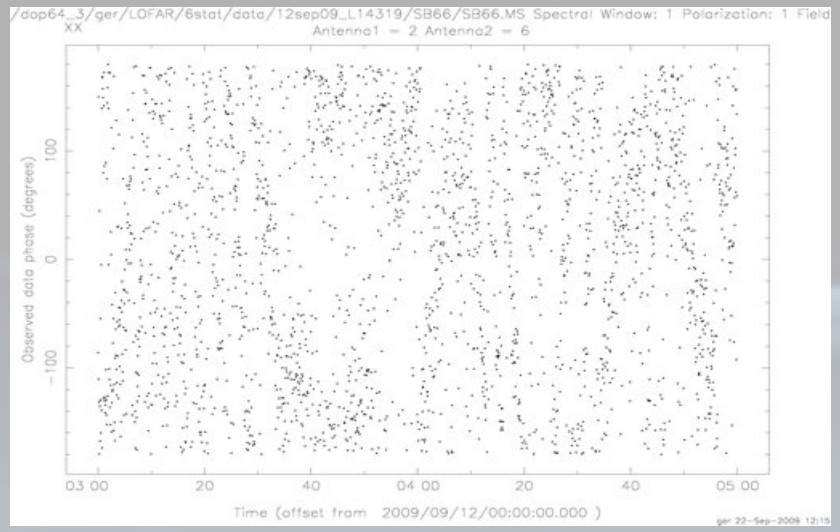
30 MHz (λ=10m)

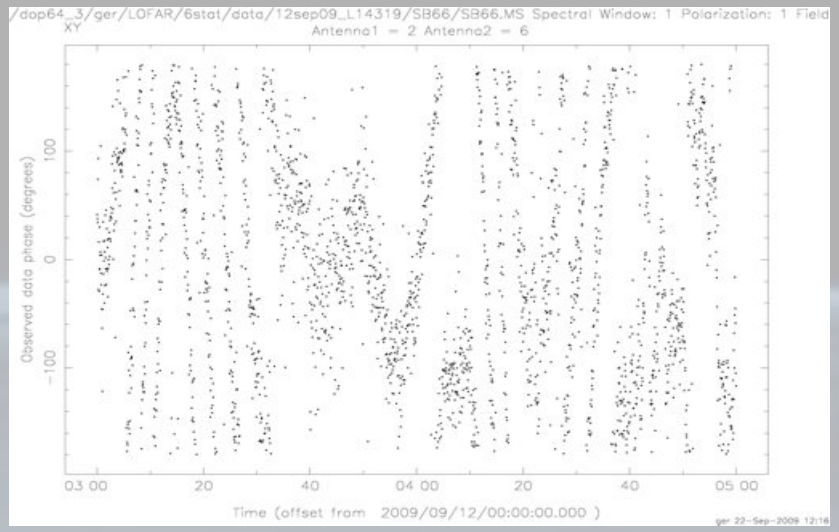
fringe spacing ~ 8”

PSF ~ 4”

slow beating between lobes/hotspots to be expected

SB66 56 MHz

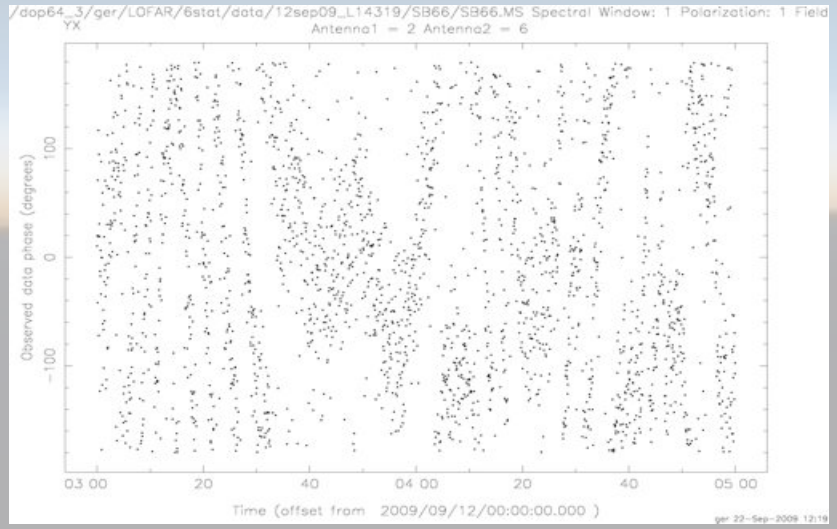


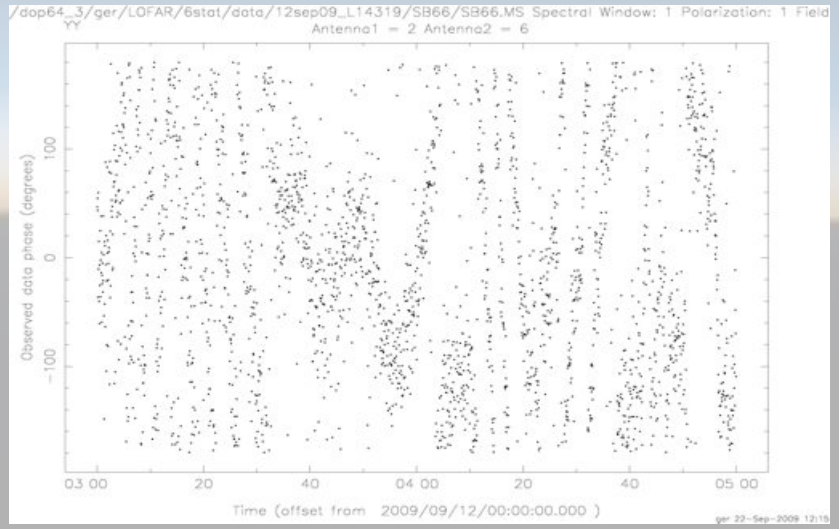


UT 03-05

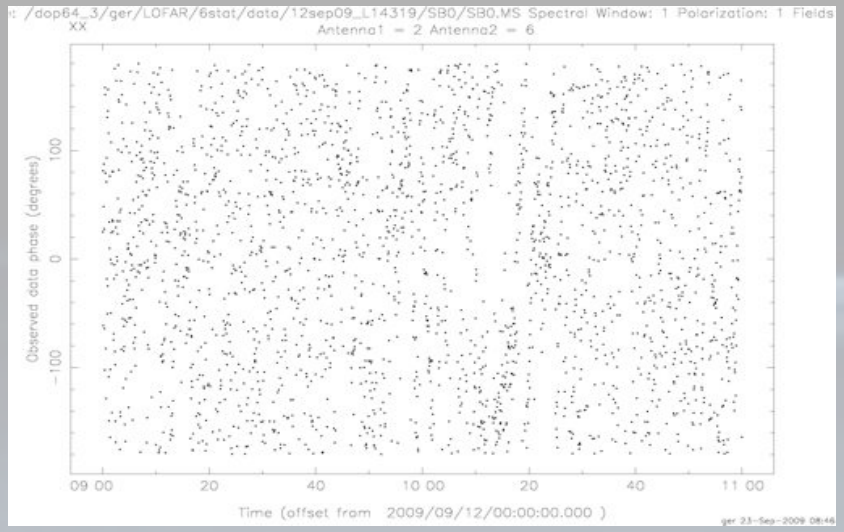
XX XY

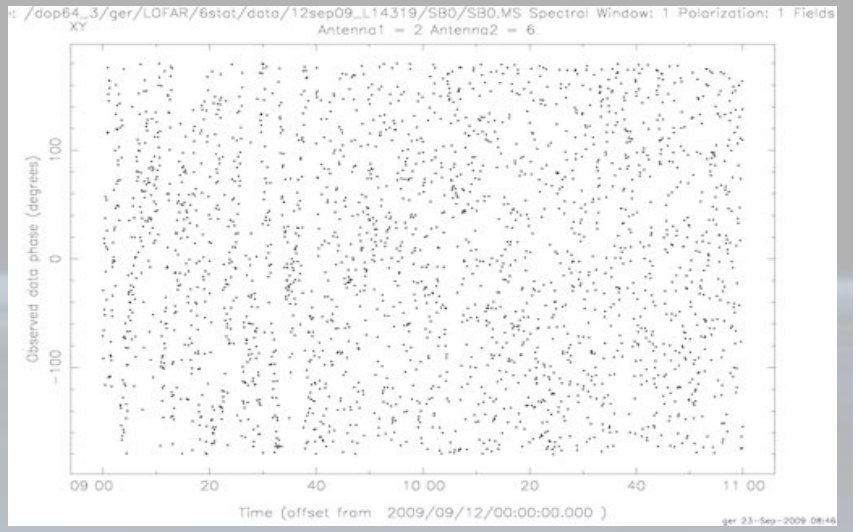
YX YY





SB0 30 MHz

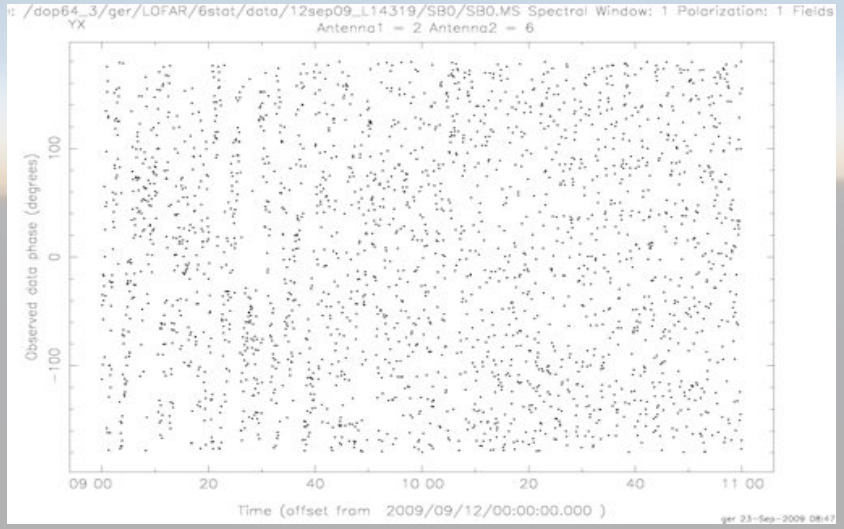


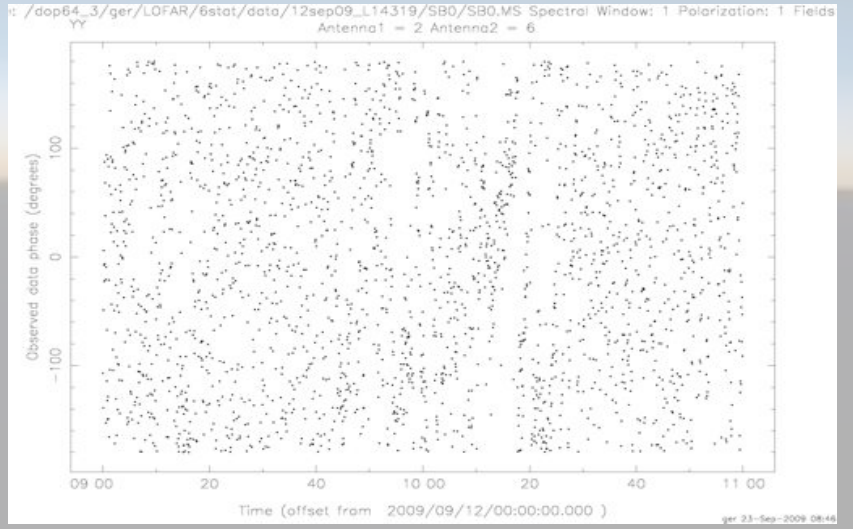


UT 09-11

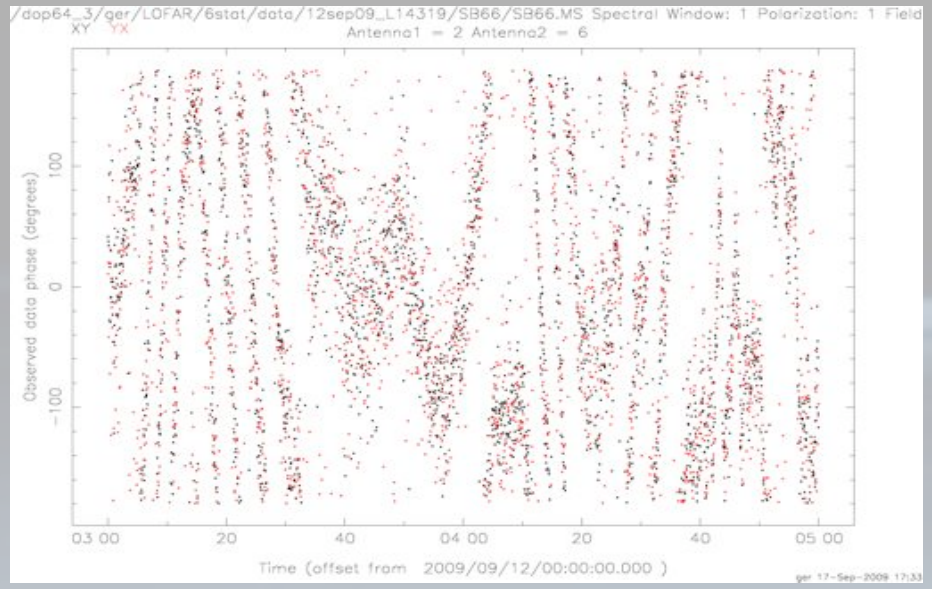
XX XY

YX YY

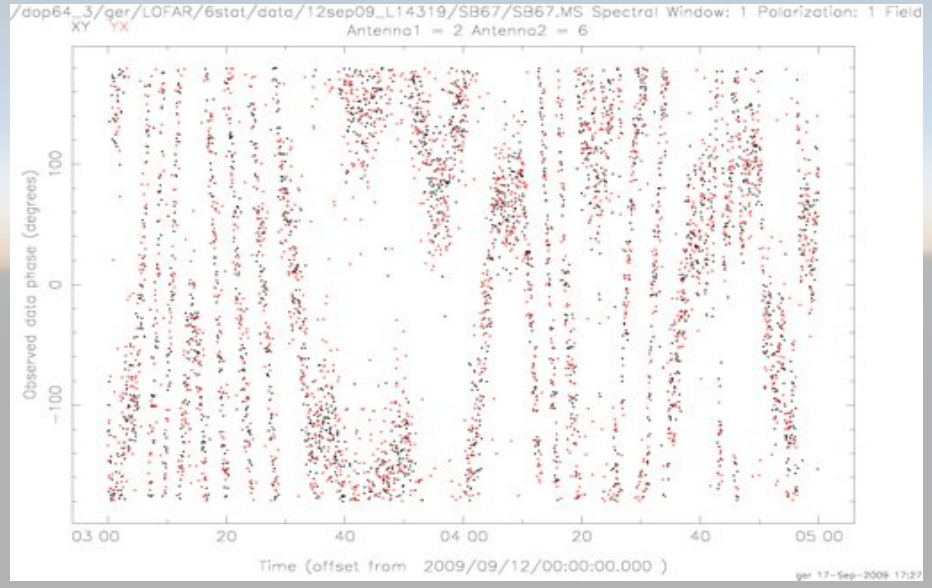




RS208 - DE601 (UT 03-05, sunrise at UT05)



XY YX superposed



SB66 56.25 MHz

~ 140^{o} phase/ 0.4 MHz

~ 1 microsec delay.

IF all due to the ionosphere:

⇒2.5 TECU differential ionospheric delay !

⇒ If $B_{||}$ ~ 0.2 Gauss (?)

⇒ ΔRM ~ 0.13 rad/m^2

⇒ Faraday rotation ~ 4 rad !

SB67 56.64 MHz

Conclusions

Timevariable differential Faraday rotation leads to dramatic changes in the correlated flux density on the XX, XY, YX and YY correlations. **This change is very strongly frequency dependent ($\propto \lambda^2$).**

Known for a long time in the VLBI community hence the conversion from linear to circular polarization.

Effects very small on NL LOFAR baselines (but not at 15 MHz !)

Note that projection effects due to the changing elevation also lead to XX,XY,YX,YY variations for an 'earth-bound' dual-dipole. These are frequency-**independent,** slow and predictable.

At very low frequencies (15-30 MHz), especially during dawn and in the coming years with increasing daytime TEC values, this effect will lead to rapid 'gain' effects (on top of ionospheric absorption, beam effects,…)…….

Should we investigate making LCP and RCP before correlation ? (Andre' Gunst) This can, however, only be done for one direction in the sky !

How to deal with this in the ME is being investigated (Noordam, Smirnov, …