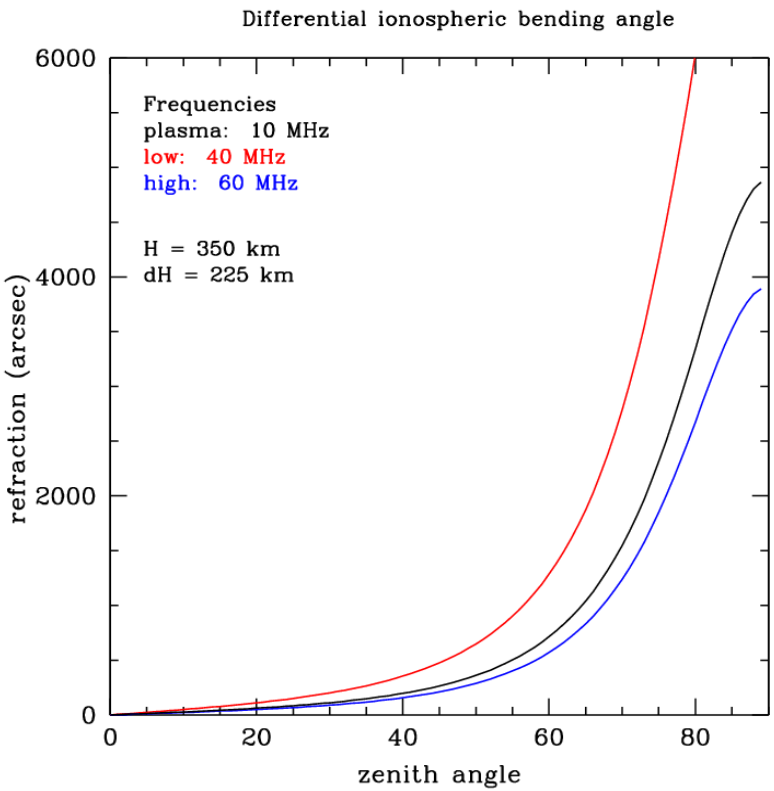
Observing and processing European LOFAR data

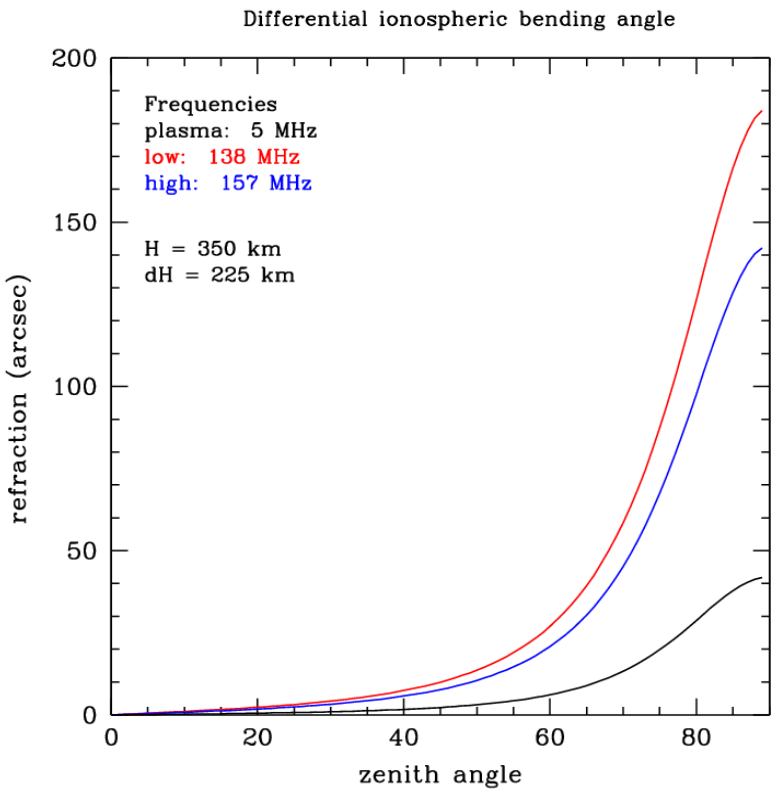
- Some issues brought up by Jaap Bregman (draft memo 9jul08)
- Mixed with my own (EoR-biased) thoughts

Ionospheric refraction at LBA/HBA frequencies

Differential effects based on TMS2000 ‘analytic’ model

Results are shown for a ‘high’ (ν_p = 10 MHz) and a ‘low TEC’ ionosphere (ν_p = 5 MHz)

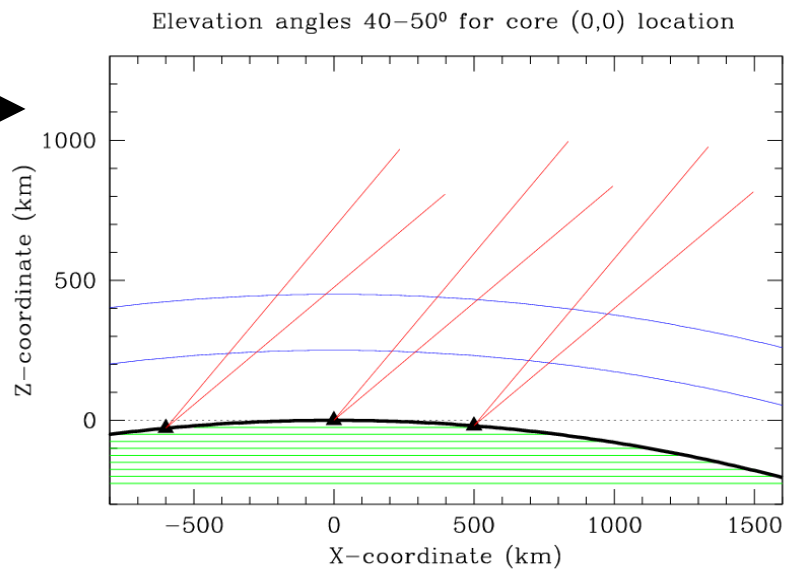




Non-overlapping ionospheric screens

Basic problems of European LOFAR:

1) isoplanatic patch small (~ 3-15' ?)
2) ~10x fewer calibrator sources
3) non-overlapping screens
4) datavolumes (0.2s, 1 kHz?)

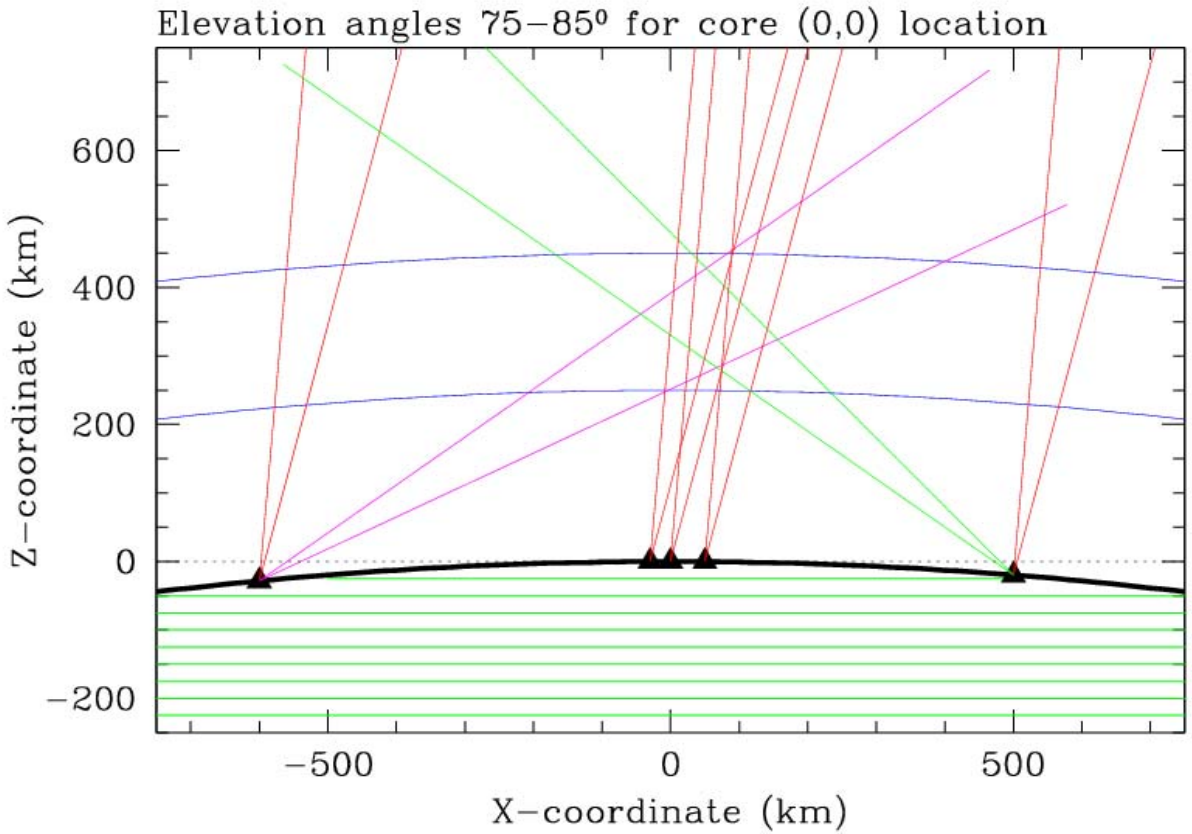


A possible solution (for HBA)

1) solve for NL screen in NL-LOFAR
2) correlate ~ 10-20 superstation tiedarray beams with each Eu-station (sensitivity ~ 10x better)
3) dynamically track the screen motion using ~ 10-20 probes
4) 1m x 600 km/h ~ 10 km ~ 2^o at 300 km height

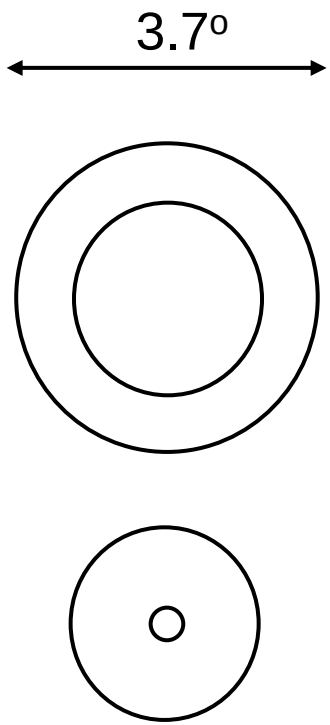
'default' mode for EoR KSP on much smaller scales ('rapid' all-sky calibration mode)

Thick ionosphere ? Tomography situation complex



European calibration issues (HBA 150 MHz)

#antennas	noise (Jy) (10s,15 MHz, 2pol)	FOV (HPBW,deg)
Eu96 - NL48 (65m - 40m)	0.07	2.3x3.7
Eu96 - SS288 (65m - 300m)	0.03	2.3x0.5



Required on line:

- known positions to attempt correlation, or coherent addition of complex 0.2s visibilities, using SS6 ionospheric screen)

- global TEC model to predict refraction

Compact source ? Daytime observing and IPS!

European baselines : 800 km

=> 400 kλ at 150 MHz => 0.5” fringe

=> 160 kλ at 60 MHz => 1.25” fringe

During daytime compact sources with sightlines within ~ 45^{o} from Sun will be affected by scintillation due to the Inter Planetary Medium (IPM). This causes amplitude fluctuations on timescales of seconds ! Only sources that contain structure <1” will scintillate

A program to identify IPS scintillating sources, with core or superstation data, would be an interesting TRANSIENT and SolarSystem KSP program during MS^{3} . They could find out which compact sources are suitable for European scrutiny !

Smearing effects at long baselines

Vogt and Anderson, 2007

LOFAR baseline	Angular distance from the phase centre at which 1% reduction in relative peak response occurs		Angular distance from the phase centre at which 10% reduction in relative peak response occurs	
	$\Delta\nu$ = 1 kHz	$\Delta\nu$ = 10 kHz	$\Delta\nu$ = 1 kHz	$\Delta\nu$ = 10 kHz
500 km	3.4°	0.34°	11°	1.1°
1000 km	1.7°	0.17°	5.6°	0.56°

Table 2: Summary of the effect of the bandwidth smearing on the relative peak response for various baseline lengths and bandwidth $\Delta\nu$ at LOFAR observing frequencies (assuming a Gaussian band pass filter).

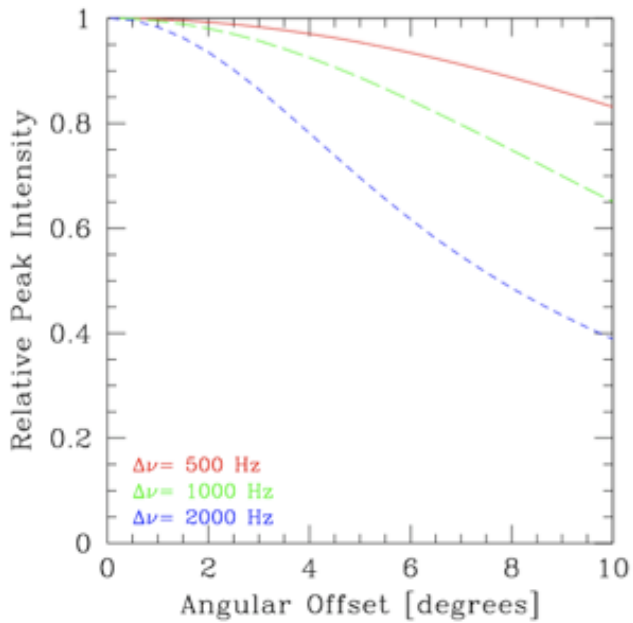


Figure 5: Demonstration of the effect of bandwidth and time average smearing on the relative peak intensity. The relative peak intensity is shown as a function of angular offset from the phase centre. For these 50 MHz observations using 0.25s integration time, curves are shown for three different channel bandwidths. Uniform weighting is used.