# LOCATION AND BEAMING PATTERNS OF AURORAL KILOMETRIC RADIATION INFERRED FROM MULTI-SPACECRAFT WBD CLUSTER OBSERVATIONS

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## ABSTRACT

The Wideband Data (WBD) instrument on Cluster [1] has been used to monitor the location and beaming pattern of auroral kilometric radiation (AKR) bursts by analyzing differential delays and dynamic spectra at multiple spacecraft. Using this technique we have determined the location of more than twenty AKR bursts. We find that burst locations are consistent with emission occurring at or near the local gyrofrequency, and that the bursts tend to occur along magnetic field lines located above regions of bright regions in the auroral oval. These observations are the first direct 3-dimensional measurement of AKR source location.

## ANALYSIS TECHNIQUE

The source location technique consists of cross-correlating waveforms from pairs of spacecraft to determine the differential delays of AKR impulsive bursts [2]. This is done on each of several independent baselines with sub-millisecond accuracy. The delays are combined to solve for source location by triangulation. The accuracy of the technique depends on the Cluster orientation and distance from Earth, but typical uncertainties are approximately 300-500 km in a plane perpendicular to the source-Cluster line of sight, and somewhat larger along this direction. Fig. 1 shows a typical dataset observed on 27 Jun 2001 at 6:32 UT. The upper panel shows the cross-correlation on three pairs of spacecraft which were separated by several thousand kilometers. The lower panel shows the dynamic spectra on each of the three spacecraft over a 30 second period. The cross-correlated signal was derived from the 300 msec x 1 kHz time-frequency box indicated. This burst was located by triangulation above the southern auroral zone at a radial distance of 2.2 Earth radii from the Earth's center.

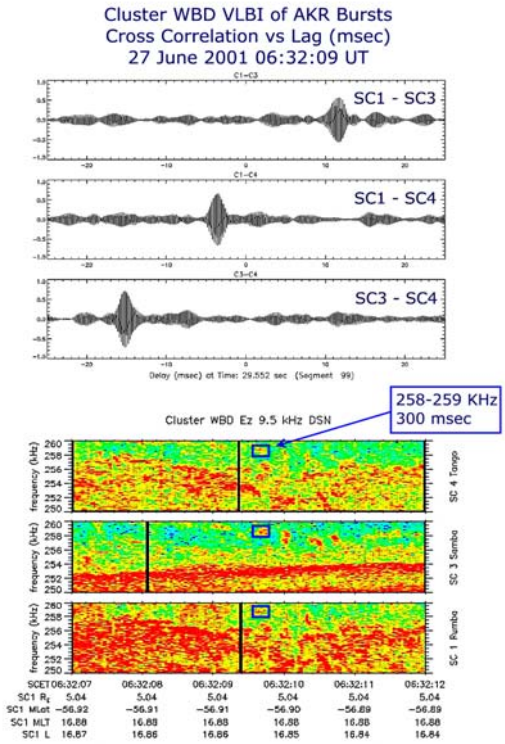


Fig.1 Cross-correlation function and dynamic spectra of AKR burst on 27 June 2001 at 258 KHz.

The beaming patterns of individual AKR bursts can be inferred by comparing dynamic spectra at each spacecraft. There is a strong shadowing of AKR emission at low magnetic latitudes ($\varphi < 15°$). The angular power pattern inferred from widely-spaced spacecraft is 40°- 60° (FWHM). This is much larger than that expected from beam patterns from electron-cyclotron maser emission from a homogeneous region, and may indicate that the radiation originates in an extended region with a inhomogeneous magnetic field or has undergone significant scattering along the propagation path.

## REFERENCES

[1] Gurnett, D.A., et al., "First results from the Cluster wideband plasma wave investigation", in *Annales Geophysicae*, **19**, pp. 1-14, 2001.
[2] Mutel, R., Gurnett, D., and Huff, R., VLBI studies of auroral kilometric radiation and solar type III bursts using the wideband data plasma wave instrument, in *Proc. Cluster II Workshop on Multiscale/Multipoint Plasma Measurements*, ESA SP-449, February, 2000.