

## MULTIBEAM INCOHERENT SCATTER RADAR OBSERVATIONS WITH EISCAT, KAIRA AND EISCAT\_3D

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Incoherent scatter radars are high-power radar systems detecting radio wave scattering from thermal fluctuations in the ionospheric plasma. The scattered signal carries information of properties of the scattering plasma, such as electron density, temperatures of electrons and ions, and plasma bulk velocity. By means of antenna steering or multiple receiver sites, one can estimate also 3D plasma velocity vectors, neutral winds and ion temperature anisotropies. Such measurements have been carried out with the EISCAT incoherent scatter radars since 1980's.

The EISCAT system relies on large dish antennas, which produce one beam per receiver site and can be mechanically steered to different directions. EISCAT is working towards replacing the present system with a new one, EISCAT\_3D. The new system will replace the dish antennas with arrays of numerous antenna elements. Digitally sampled signal from the individual elements will be numerically combined to produce several simultaneous antenna beams. Also extremely fast beam steering will be possible, because the steering process will not involve any mechanical movement.

Kilpisjärvi Atmospheric Imaging Receiver Array (KAIRA) [1] is a wide-band radio receiver, based on LOFAR (Low Frequency ARray) technology. KAIRA is being used as a technology test bed for EISCAT\_3D, as well as as a scientific instrument of its own right. KAIRA can produce numerous simultaneous receiver beams and its reception band covers the 224 MHz frequency of the EISCAT VHF radar, which is located about 80 km away from KAIRA. By means of combining data from several EISCAT radar sites and KAIRA, we have been able to conduct first multistatic, multibeam incoherent scatter observations. While already the existing system is a valuable tool for ionospheric physics, the multiple multibeam sites and fast beam steering of EISCAT\_3D will allow us to benefit from these technique in full.

In this talk, we show result from some recent incoherent scatter observations with EISCAT and KAIRA. We compare the data products from our "multistatic analysis" [2] with those produced by standard EISCAT analysis tools without the KAIRA data, and discuss how similar measurements could be accomplished with EISCAT\_3D.

- [1] D. McKay-Bukowski et al., IEEE Transactions on Geoscience and Remote Sensing **53** (3), 1440-1451 (2015).
- [2] I.I. Virtanen, D. McKay-Bukowski, J. Vierinen, A. Aikio, R. Fallows, and L. Roininen, Journal of Geophysical Research (Space Physics) **119** (12), 10528-10543 (2015).