EISCAT_3D radar performance requirements by science topics, version 21.2.2011

Science topic	Parameter for which res. given	Temp. res. (s)	Horis. res. (km)	Vert. res. (km)	Height range (km)	Latitudinal coverage at 100 km alt.	Optimal location of radar	Other info	Supporting ground-based instruments
Meso-scale plasma convection	Vi	10	20	20	90-400	As wide as possible (30^o elevation with all azimuths)	Within auroral oval	Multistatic meas.	Magnetometers, tomography radio receivers, SuperDARN
Meso-scale electric currents	Ne, Vi	10	20	20	85-200	As wide as possible (30^o elevation with all azimuths)	Within auroral oval	Multistatic meas.	Magnetometers, itomography radio receivers, SuperDARN
Joule heating	Ne, Vi	10	10	2	85-300	As wide as possible (30^o elevation with all azimuths)	Within auroral oval	Multistatic meas.	Magnetometers, tomography radio receivers
Dynamics of an auroral arc	Ne	1	1	0.5	70–400	100 km	Within auroral oval	Clear sky, Multistatic meas.	Optical equipment, rockets
	Te, Ti, Vi	- " -	- " -	- " -	85–400				- " -
Small-scale auroral structures	Ne, Te, Ti	0.1	0.1	0.2	70-200	20 km	Within auroral oval	Clear sky, Multistatic meas., Interferometric studies also	Optical equipment, rockets
	Vi	0.1	0.1	5	200-400	20 km	- " -	- " -	- " -
Auroral streamers and poleward boundary intensifications	Ne, Te, Ti, Vi	1	1	1	80–400	30^o elevation to north (from ESR to the main oval)	Oval with look direction to north	Clear sky, Multistatic meas.	Optical equipment, rockets
Ion outflow	Ne, Te, Ti, Vi, ion comp.	10	10	20	200-1500	100 km	Within auroral oval		Optical equipment, rockets
NEIALs	raw data	0.03	0.05	0.2	100-1500	20 km	Within auroral oval	Interferometric meas., plasma line meas.	Optical equipment, rockets
Ionospheric irregularities	Ne, Te, Ti, Vi	1	1	1	90-800	As wide as possible	Within auroral oval		GPS scintillation measurements, rockets
High-energy particle events (SEPs etc.)	Ne	1	10	1	As low as possible e.g.50-400	As wide as possible	Oval and just equatorward of the oval		VLF, riometers, MF radar, satellites (POES, GOES,

									LANL etc), rockets
	Te, Ti, Vi	- " -	- " -	- " -	100-400		- " -		- " -
Atmosphere-ionosphere coupling (AGW, winds)	Ne, Te, Ti, Vi, Vn	<1min	1	0,3	As low as possible – 120	As wide as possible	Auroral oval and at the edge of the polar vortex		MST radar, MF radar, meteor radar, lidar, aitglow imager, FPI, sounding rockets
Mesosphere-lower thermosphere small-scale dynamics, MST	vector neutral wind, Ne	<1min	1	0.3	As low as possible – 110	As wide as possible	Location inside the polar winter vortex favourable for some questions	Additional low power TX mode, Dual freq. (200 – 1000 kHz separ.) for interferom. distance determ.	MST radar, MF radar, meteor radar, lidar, airglow imager, sounding rockets
D-region phenomena	Ne, Te (=Ti) Vi (=Vn)	1	1	0,3	70-90	As wide as possible		Oval and just equatorward of the oval	Riometer, VLF, MF radar, rockets
PMSE, PMWE	Raw data, Doppler velocity, spectral width	<1min	1	0,3	75-95	As wide as possible			MST radar, additional ISR at much higher frequency, lidar, sounding rockets
Meteoroids, and effects on the background (Es, PMSE etc.)	Raw data, Polarization matrix, and Ne, Te, Ti, Vi	1 ms	0.010	0.010	(30)70-130(1000)	All azimuths	Good geometry of receivers around, Dark and clear sky location	Dark and clear sky, continuous measurements, Multistatic meas. for trajectory	Meteor radar, MST radar, optical networks
Interplanetary scintillation	Raw data	0,01				Low elevation with all azimuths, particularly to south		BW> 20 MHz, minimal RFI and/or ability to clip out in individual narrow frequency bands prior to integration over the bandwidth	Other radio receiver networks, incl. LOFAR and eMERLIN.
Heating experiments	Ne, Te, Ti, Vi	1	1	1	100-2000	20^{o} zenith angle	Auroral oval	Dark and clear sky location	MST radar, airglow imager, FPI, sounding rockets
Space debris and Satellite tracking	Raw data, Power, Doppler velocity	10 MHz sampl.		15 m		25^{o} elevation with all azimuths	North for satellite tracking	Multistatic meas. for trajectory, Multiple overlapping receiver beams for interferom. angle determ., Dual freq. (200 – 1000 kHz separ.) for interferom.	

								distance determ.	
Planets and asteroids	Raw data, Power, Polarization matrix	10 MHz sampl.		15 m		Low-elevation look direction to south, min. 25^{o}	As south as possible	Dual linear polarization RX, high-stability clocks	

Table 1. Some science topics to be studied by the EISCAT_3D radar and related radar performance requirements. Location on the Fennoscandian mainland is assumed and therefore science topics related to polar cap and cusp phenomena are not included. Phased array system with fast pointing, multiple beams and calibrated signal are also assumed.

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