

S520-26

Observation of electron number density and plasma wave spectra by NEI/PWM

1. Instrument name

Number density measurement of Electron by Impedance probe (NEI)
Plasma Wave Monitor (PWM)

2. Purpose

In order to clarify the micro processes in the interaction between atmosphere and plasma in the ionospheric E- and F-regions, NEI/PWM measures electron number density and plasma wave spectra along the rocket trajectory. The data will contribute to the evaluations of the effects of Lithium gas release from the rocket to the ionosphere.

3. Method

NEI: BeCu ribbon antenna with a length of 1.2m and a diameter of 1.2 cm is deployed into the surrounding plasma. Electron number density along the rocket trajectory can be determined by detecting probe capacitance minimum at upper hybrid resonance (UHR) frequency.

PWM: Plasma waves in a frequency range from 300 Hz to 22 MHz are detected by the inflatable antenna and preamplifier of Electric field detector (EFD). The signal is fed to PWM and converted to spectrogram by applying Fourier transform.

4. Instrument

NEI/PWM consists of electron number density measurement unit with standard impedance probe (NEI), and plasma wave monitor unit (PWM). In order to avoid interference between them, the frequency sweep in the two units are operated synchronously.

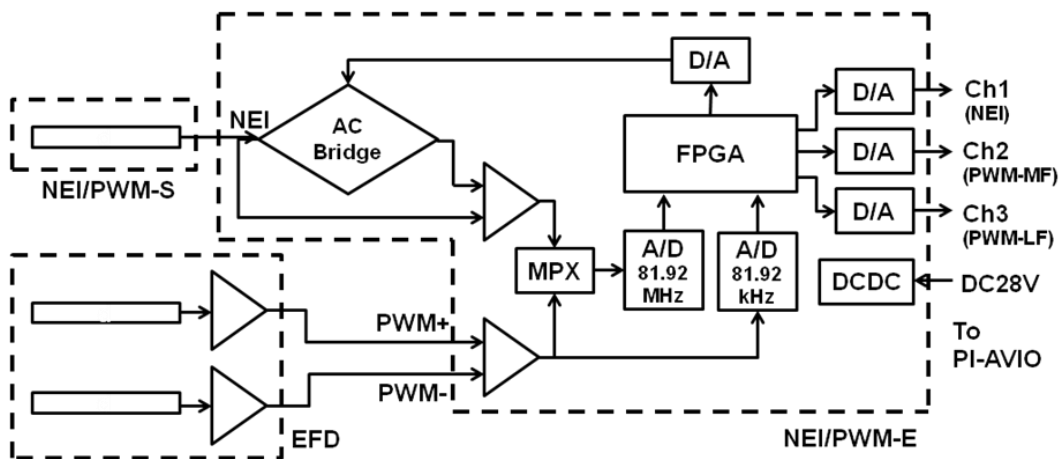
Specifications

NEI	Sensor:	BeCu ribbon antenna with a length of 1.2 m and diameter of 1.2cm
	Freq. span:	0.1 - 13.0 MHz (before Li gas release) 0.1 - 24.8 MHz (after Li gas release)
	Sweep time:	250 msec
	C range:	1 - 1000 pF
	Ne range :	$10^3 - 2 \times 10^6$ el/cc

PWM-MF Sensor: Inflatable antenna (EFD)
 Freq. span: 20 kHz - 22 MHz
 Interval: 250 msec
 Sensitivity: -110 - 0 dBm (10 kHz - 7 MHz, 50 Ω input)
 -90 - 0 dBm (7 - 22 MHz, 50 Ω input)

PWM-LF Sensor: Inflatable antenna (EFD)
 Freq. span: 300 Hz - 20.3 kHz
 Interval: 250 msec
 Sensitivity: -110 - 0 dBm (50 Ω input)

Block diagram



Definition of frequency step (NEI)

<< Before Li gas release >>

0.10 MHz	0 kHz/step	0 - 4 step
0.12 - 0.80 MHz	20 kHz/step	5 - 39 step
0.81 - 2.10 MHz	10 kHz/step	40 - 169 step
2.12 - 4.00 MHz	20 kHz/step	170 - 264 step
4.05 - 8.00 MHz	50 kHz/step	265 - 344 step
8.10 - 13.0 MHz	100 kHz/step	345 - 394 step
0.10 MHz	0 kHz/step	395 - 399 step

<< After Li gas release >>

0.10 MHz	0 kHz/step	0 - 4 step
0.12 - 0.80 MHz	20 kHz/step	5 - 39 step
0.81 - 1.90 MHz	10 kHz/step	40 - 149 step
1.92 - 4.30 MHz	20 kHz/step	150 - 269 step

4.40 - 8.80 MHz	100 kHz/step	270 - 314 step
9.00 - 24.8 MHz	200 kHz/step	315 - 394 step
0.10 MHz	0 kHz/step	395 - 399 step

Definition of frequency step (PWM-MF)

0.02 - 7.0 MHz	20 kHz/step	0 - 349 step
7.3 - 22.0 MHz	300 kHz/step	350 - 399 step

Definition of frequency step (PWM-LF)

0.30 - 20.25 kHz	50 Hz/step	0 - 399 step
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Telemeter

Normal commutation channel (1600Hz)

NEI	W004	Probe capacitance
PWM-MF	W005	MF receiving level
PWM-LF	W006	LF receiving level

Timer control

NEI antenna deployment:	X+57.5 (1.5 s after NC release)
NEI freq. range change:	X+388 (3 s before LES-IG1)

Mass

NEI/PWM-S (Sensor, Wire cutter):	0.23 kg
NEI/PWM-E (Electronics) :	1.05 kg

Power consumption

+28V, 200mA

5. Observation results

NEI/PWM was normally operated through NEI antenna deployment, which is 57.5 s after the launch, and EFD antenna deployment, which is 58.5 s after the launch, and until the telemeter lock off, and successfully obtained electron number density in an altitude range from 85 km to 298 km, and plasma wave spectrogram along the rocket trajectory.

Electron number density measured by NEI in ascent and decent trajectories is indicated in Fig. 1. Es layer at an altitude of 91.7 km, and some high density plasma layers at altitudes of 159.3km and 151.6 km were found in the electron number density profiles. The electron number density of Es layer was 8×10^3 /cc. The electron number density at rocket apex in the F region was 7×10^4 /cc. The NEI data below an altitude of 143 km in decent trajectory was affected by Lithium gas release.

Plasma wave spectrograms measured by PWM are indicated in Figs. 2 and 3. Plasma wave

stimulated around the rocket wake were observed in a frequency range from 1.5 to 2.5 MHz. Improvement of PWM measurement interval to 250 ms enabled us to discuss the propagation directions and source locations of the plasma waves.

6. PI and manufacturer

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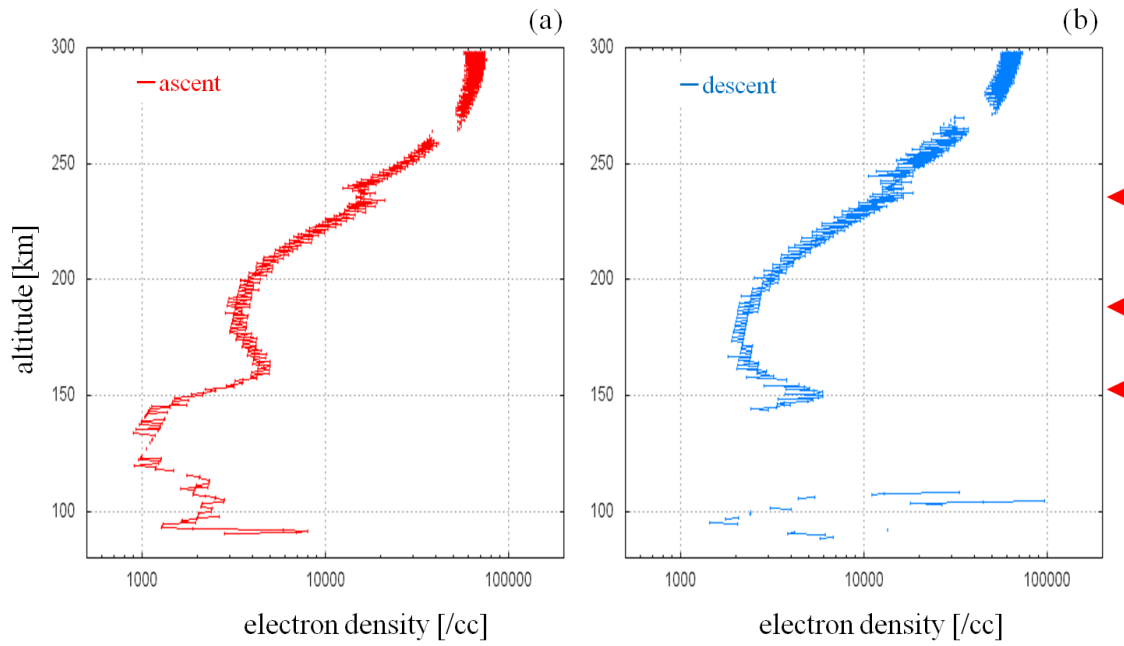


Fig.1: Vertical profile of electron number density based on NEI (a) in the ascent trajectory, and (b) in the descent trajectory

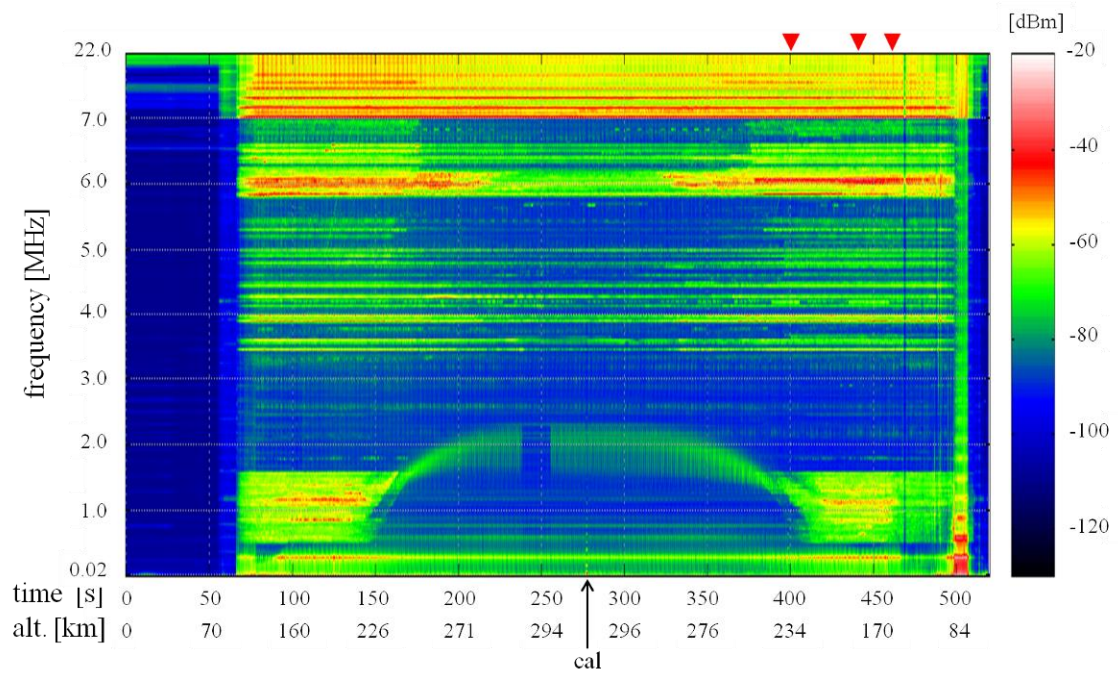


Fig.2: Spectrogram of plasma waves measured by PWM (20 kHz - 22 MHz)

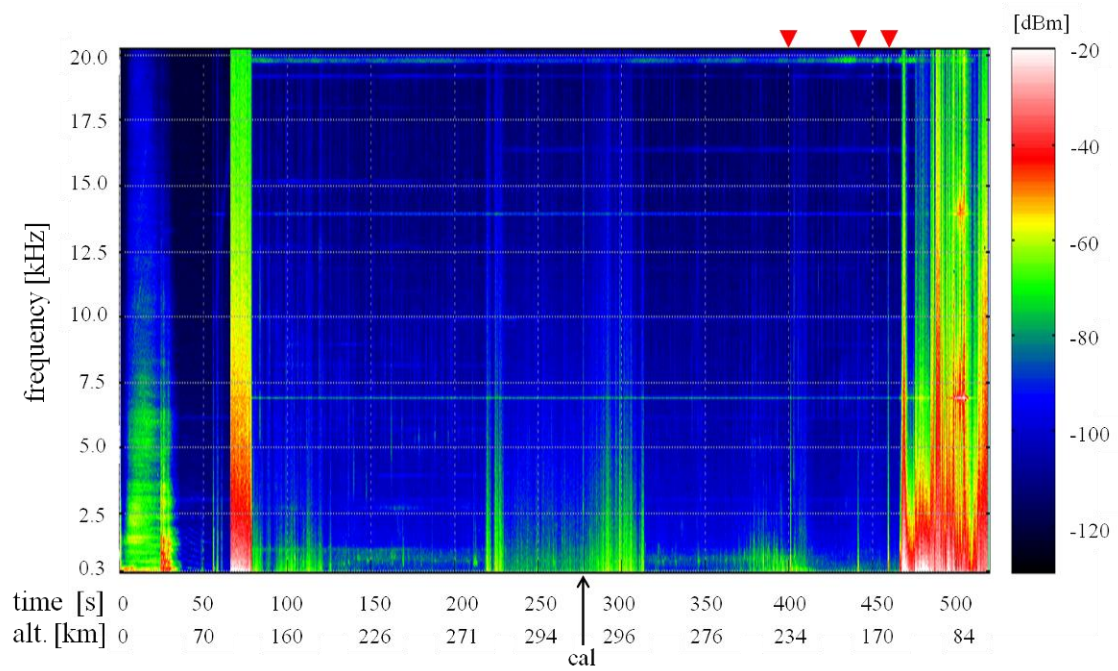


Fig.3: Spectrogram of plasma waves measured by PWM (300Hz - 20kHz)