

## PIGIS' PULSE FIELDS MODULATION

N.N. SCHITOV

*Dukhov Automatics Research Institute (VNIA), 22 Sushevskaya Ul., Moscow 127055, Russia,  
nschitov@mail.ru, phone.: 89160820555*

The investigations' onset of pulsed fields influence on Penning ion sources (PIGIS) in pulse or frequency regimes was described in [1, 2]. This modulation was carried out by pulse fields generated by the storage capacitance discharge through flat spiral antennas being cathodes of a Penning cell in H<sub>2</sub>. In [1] experiments were carried out with Al wire coils. In [2] all PIGIS electrodes including anode were fabricated from metalized ceramics with lathe cut grooves. The number of possible fields' combinations (mutual direction etc) rose up to 9 in [2]. However, this technology – diamond lathe cutting – is far from perfect or actual. For instance, it is impossible to make the twin or double antennas [1] this way. Laser grooves cutting or chemical etching through mask are much more attractive. The next step discharge construction with laser cut grooves is actually in progress.

To complete the research the funnel-shaped coils made of Al wire as in [1] are investigated. In [3] is shown that the magnetic field distribution may improve the current pulse time characteristics, decrease discharge current and increase the extraction coefficient. In the case of funnel-shaped coils the magnetic field's axial component maximum is drift to the center of the Penning cell so that changing the funnel cone half-angle one may superpose it with the ionization coefficient maximum. The gas discharge becomes "combined" – the hollow cathode and the Penning ones. Besides, the existence of cell axe's length dependence in such antennas leads to the appearance of curl axial electric fields absent in the case of the flat one. Finally, the radial components of the funnel-shaped coils are significantly higher near cathodes than that of the flat ones. It means that the asymmetry relative to polarity is higher for the formers. It may be useful from the ion's extraction point of view.

The last discussed aspect of pulsed fields' modulation concerns the discharge key's (vacuum lightning arresters) location [1, 2]. In experiments described earlier it was mounted just between the storage capacitance connected with grounded cathodes and the power supply so that the stationary PIGIS' electric field distribution took place during the whole discharge period. But when cathodes are isolated by the key from a ground all electrodes are equipotential at the initial moment that is no fields exist. During the capacitance discharge the gas discharge's form turns out from the TCP (transformer coupled plasma) one into the Penning one due to the cathode's potential drop through discharge. In this case the pulsed magnetic field is in phase synchronism with the storage capacitance discharge whereas the azimuthally curl electric field changes its sign twice during the period.

Total pulse fields generated in the gas discharge chamber during the store capacitor discharge are calculated. Using these calculations electrons trajectories and correspondingly ionization probabilities are estimated for various fields' directions' combinations. These estimates are compared with the experimental results carried out in the experimental unit described in detail in [1], still slightly changed.

### REFERENCES

- [1] N N Schitov 2019 J. Phys.: Conf. Ser. **1393** 012053. doi:10.1088/1742-6596/1393/1/012053
- [2] N N Schitov 2020 7<sup>th</sup> International Congress on Energy Fluxes and Radiation Effects (EFRE-2020 online): Abstracts.— Tomsk: Publishing House of IAO SB RAS, 2020. — 98 p.
- [3] N V Mamedov et al *Plasma Sources Sci. Technol.* **29** (2020) 025001

This work was partly supported by Russian Foundation for Basic Research under grant #12-02-13513 – ofi\_m\_RA.