

## Calibrating procedure and pulse generator for electrical and magnet plasma probes

Smolina E.V.

Laboratory of Laser Electronic Systems, ILP SB RUS

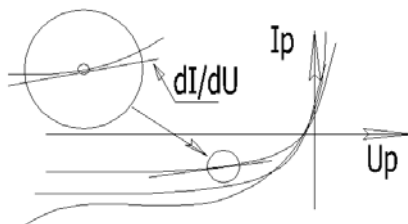
e-mail (speaker): [e.smolina@inbox.ru](mailto:e.smolina@inbox.ru)

The modeling of cosmic plasma phenomenon is the main task of KI-1 plasma installation<sup>[1]</sup> for years. Langmuir probes is widely used method of plasma diagnostic<sup>[2]</sup> due to it is local, high speed, wide range. Theoretical models are well defined<sup>[3]</sup> for different specific modes of measurement. One of the mostly important information from probe is the slope of current-voltage curve at ionic branch, as it is shown on Figure 1.

This kind of data is used to calculate an ionic concentration, temperature and charge. Obviously, high linearity of electronic is required to capture the data, and high stability of electronic is required to take into account high volume statistical data of long period of measurements.

Calibration of probes is a common procedure that guarantee the quality of experimental data taking. Plasma is strongly non-linear media as we can see on Figure 1. The slope of  $I - U$  curve varies in widely range, so effective output impedance of probe is changed in typical range of 10 to 500 Ohm. Calibration procedure should take it into account.

Calibrating the sensors is a routine procedure to ensure the quality of the experimental data collection. Since the KI-1 (Space Plasma Research) installation placed in ILP SB RAS, Novosibirsk, Russia.setup uses a high-density and high-speed (20 ns) plasma cloud generated by a laser, this has led to the reproduction of certain signal parameters. So current value of Langmuir electrode is up to 1 A, potential of plasma is up to 1 kV, magnet field change rate is up to 5 Gs per nanosecond. Special high voltage, high speed precise pulse generator was built. It provides thermal compensated to 0.02%/K 300V amplitude pulse at 50 Ohm load with 15 ns rising time front. To reproduce specific values of plasma sources, calibrating pulse from generator to be converted to. The set of converting modules was built. It allows to reproduce up to 1 kV pulse of square and exponential shapes, to calibrate potential measuring probes. High impedance current source up to 1A can be reproduced to calibrate Langmuir probes. Also, it was used to fast excite



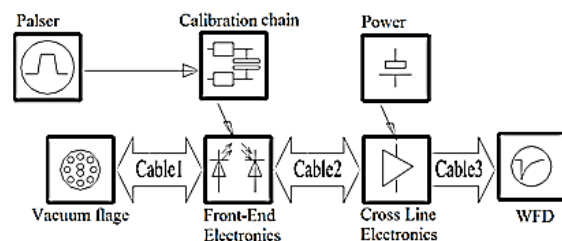
**Figure 1.** Typical  $I - U$  curve of Langmuir probe at ionic branch

Helmholtz coil to calibrate magnet probes with rapid change of magnet field. Using this equipment special procedure was designed to calibrate KI-1 probes. Total stability budget of calibrating system is about 0.5% with KI-1 experimental hall full temperature range. Absolut value of error budget is defined by primary WFD, it is better than 3%.

The calibrating generator<sup>[4,5]</sup> is the main unit in calibrating chain. It is built with a 600 V switch of power MOSFET transistor. The voltage on transistor is temperature tracked to compensate temperature drift of output resistor value, so output pulse amplitude to be stable. The block diagram of the electronic chain is shown in Figure 2. Using this equipment special procedure was designed to calibrate KI-1 probes. This procedure allows to calibrate electronic chain of Langmuir probe directly on installation before and during data taking run. Unfortunately, magnet probes can be calibrated before data run only, but it has long time stability at sufficient level.

### References

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**Figure 2.** Block diagram of the hardware complex for laser plasma diagnostics