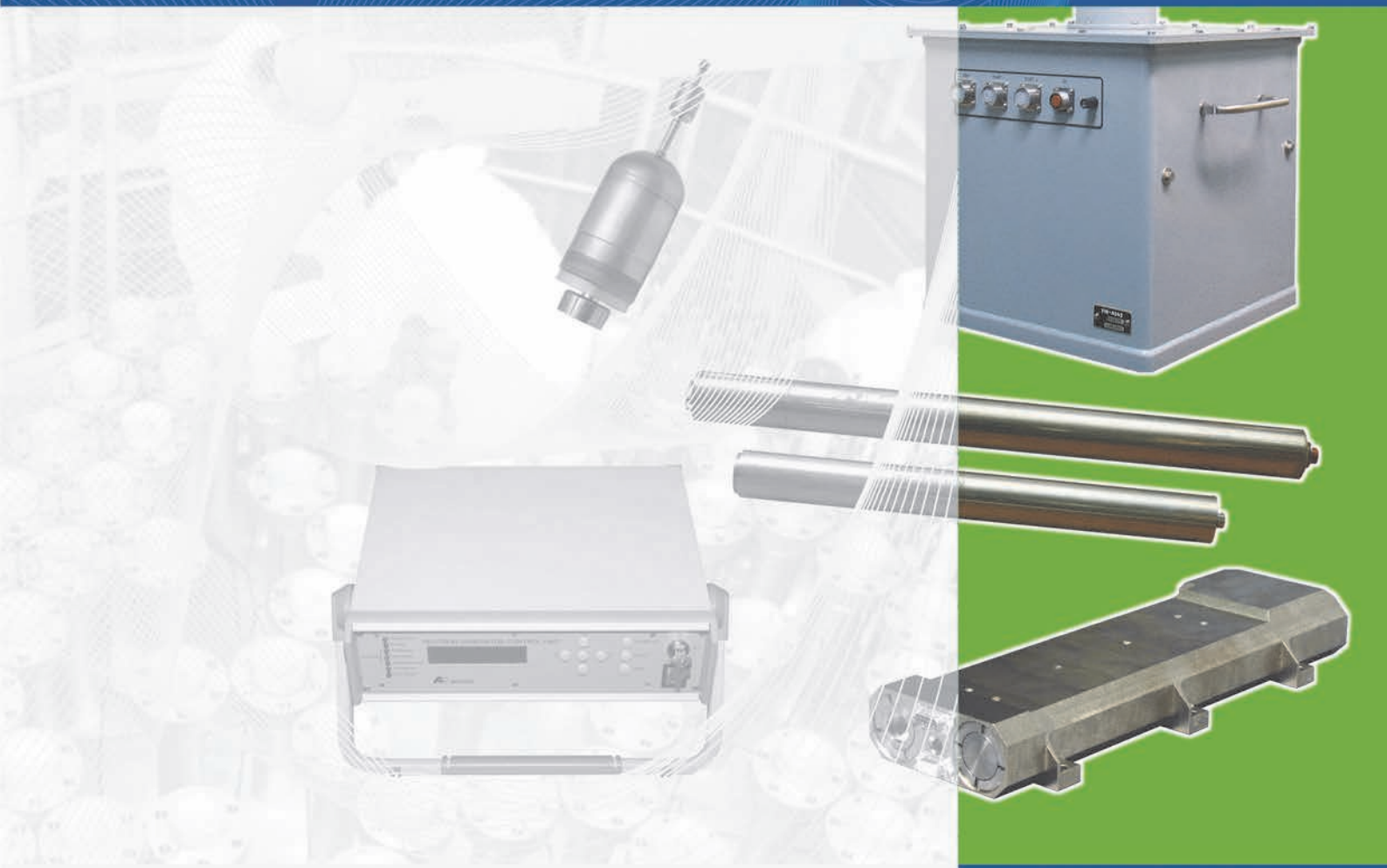
WORLDWIDE

NEUTRON GENERATORS

FOR RESEARCH ACTIVITIES



One of the high-tech areas of the Institute activities is the development of neutron generators.

The Institute is the only organization in Russia that has the full-scale research and technical capabilities and technology to develop and serially produce portable neutron generators for variety of applications. VNIIA also has the unique technology to produce the main components of the neutron generators including vacuum and gas-filled neutron tubes, plasma focus chambers, high-voltage vacuum switching components, high voltage transformers and capacitors. The developed neutron generators provide neutron radiation in the wide range of flux, frequencies and pulse widths.

VNIIA DEVELOPS AND PRODUCES:

- neutron generators for the oil-and-gas and ore boreholes pulsed neutron logging equipment;
- neutron generators for activation analysis and neutron radiography applications;
- neutron generators for research applications including research of nuclear reactors and reactor core physics;
- systems for pulsed neutron logging of oil-and-gas and ore boreholes;
- systems for active elemental analysis of materials in metallurgy, detection of toxic agents, explosives, fissile materials and drugs;
- equipment for fast and thermal neutron field radiography for non-destructive assay of various items.

All types of the neutron generators can emit 2.5 MeV or 14 MeV neutrons.

To assure safe operation all VNIIA generators are designed as hermetically sealed tubes, without external pumping system.

FEATURES OF VNIIA NEUTRON GENERATORS:

- wide range of neutron radiation parameters;
- no radiation when the generator is turned off;
- small dimensions and weight;
- adjustable neutron flux;
- easy to operate.

VNIIA neutron generators can form the basis for the development of highly informative portable equipment for direct applications in various industrial processes.

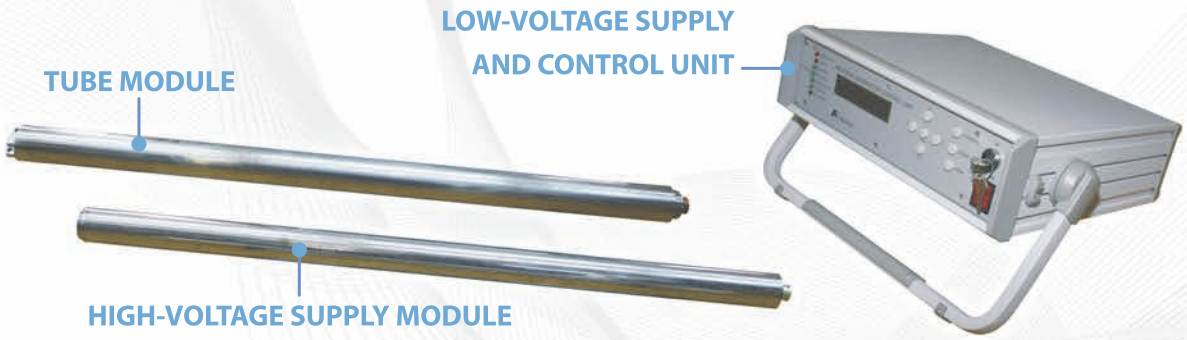
VNIIA provides services of equipment implementation, warranty and post-warranty repair as well as post-sales support in operation.

The generators are supplied to the Russian research and production companies as well as to the former Soviet Union Republics and other foreign countries.

Our customers include companies and institutions in the USA, China, Germany, United Kingdom, Japan and other countries.

ING-10

VACUUM NEUTRON TUBE BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES



- CONNECTION CABLE 25 m LONG IS INCLUDED

TECHNICAL CHARACTERISTICS:

- Average neutron yield, ***n***, neutron/pulse.....$1 \cdot 10^7$
- Neutron pulse width, μs, not more.....1.0
- Neutron pulse repetition rate, ***f***, Hz:

  in continuous emission mode.....up to 20

  in cyclic emission mode..... up to 50
- Neutron background between neutron pulses.....None
- Producted neutron flux, $F=n \cdot f$, neutron/s.....up to $5 \cdot 10^8$
- Tube module average operating lifetime*, pulse.....$1 \cdot 10^7$
- Power supply.....mains 220 V, 50 Hz
- Maximum power consumption, W.....150
- Dimensions, mm:

  neutron emission unit (tube module connected with high-voltage supply module)..... ∅34 x 1320

  low-voltage supply and control unit..... 420 x 100 x 310
- Maximum weight, kg:

  neutron emission unit (tube module connected with high-voltage supply module).....2.5

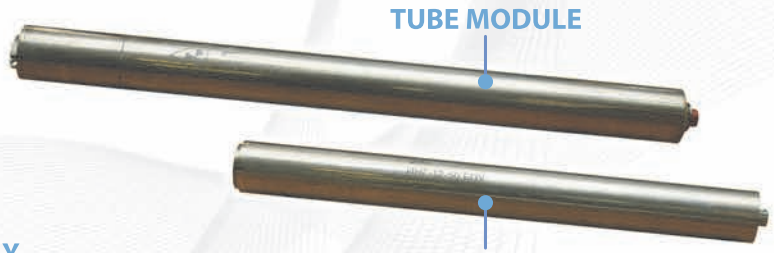
  low-voltage supply and control unit.....4.7

* tube module is a replaceable part

ING-12

VACUUM NEUTRON TUBE BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES

LOW-VOLTAGE SUPPLY AND CONTROL UNIT



TUBE MODULE

HIGH-VOLTAGE SUPPLY MODULE

- CONNECTION CABLE 25 m LONG IS INCLUDED

TECHNICAL CHARACTERISTICS:

- Average neutron yield, *n*, neutron/pulse ..... $3 \cdot 10^7$
- Neutron pulse width, μs, not more 1.0
- Neutron pulse repetition rate, *f*, Hz:

  in continuous emission mode ..... up to 30

  in cyclic emission mode ..... up to 100
- Neutron background between neutron pulses ..... None
- Producted neutron flux, $F=n \cdot f$, neutron/s ..... up to $2 \cdot 10^9$
- Tube module average operating lifetime*, pulse ..... $1 \cdot 10^7$
- Power supply ..... mains 220 V, 50 Hz
- Maximum power consumption, W 200
- Dimensions, mm:

  neutron emission unit (tube module connected with high-voltage supply module) ..... ∅49 x 1000

  low-voltage supply and control unit ..... 420 x 100 x 310
- Maximum weight, kg:

  neutron emission unit (tube module connected with high-voltage supply module) 3.5

  low-voltage supply and control unit 4.7

* tube module is a replaceable part

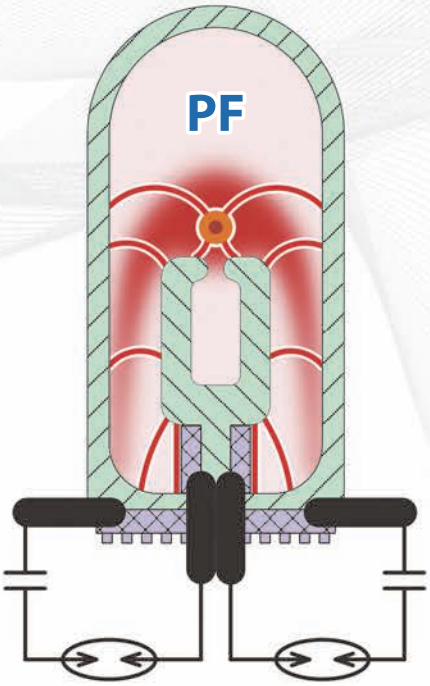
PLASMA FOCUS

Plasma focus (PF) is one of the most high-power and intensive sources of neutron radiation. PF is formed in chambers when discharge current of a certain amplitude and duration flows through gaseous atmosphere (generally the chamber volume is filled with deuterium or deuterium-tritium mixture). Short neutron and X-radiation pulses of about ten nanoseconds duration are generated while the PF forming.

Plasma focus generators operate in a single-activation mode with few-minute pauses.

GENERATOR APPLICATIONS:

- thermonuclear fusion research;
- dynamic neutron diffraction analysis;
- activation analysis;
- X-ray photolithography;
- X-ray tomography;
- nuclear particle detector calibration;
- neutron and X-ray radiography;
- dynamic flaw detection;
- radiobiology and medicine;
- materials science.

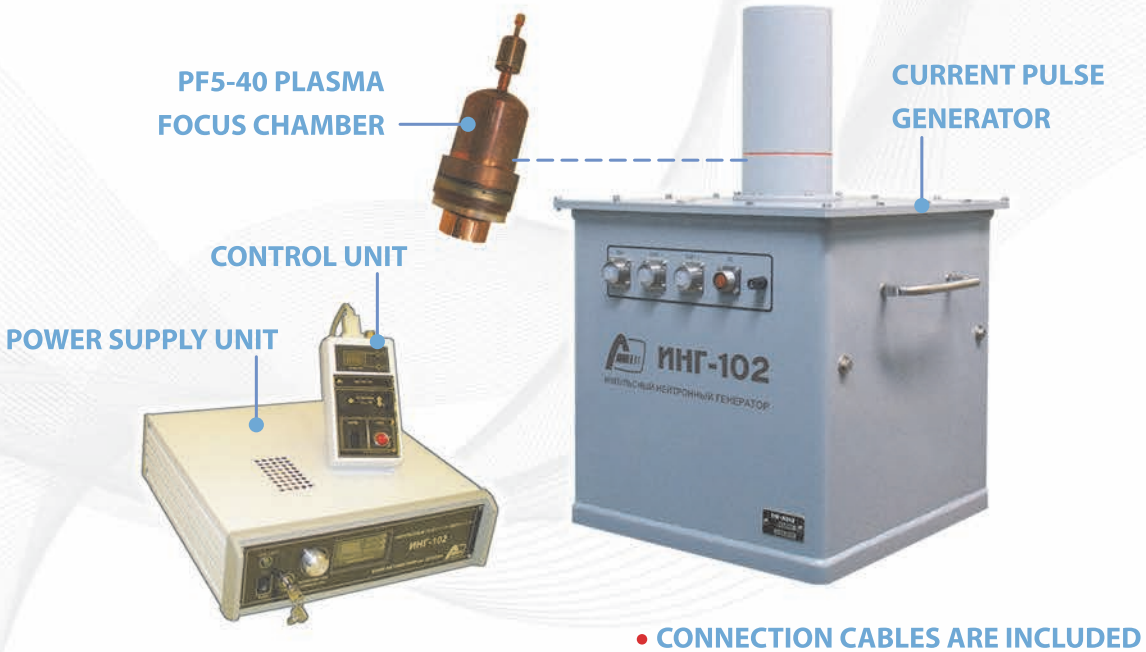


FEATURES OF EQUIPMENT:

- point radiation source (2 - 3 mm diameter emitting area);
- transportability;
- easy to operate;
- capable of synchronizing with external sources;
- no radiation when the generator is turned off;
- complete package of design documentation;
- capable of operating in X-ray generation mode.

ING-102

PLASMA FOCUS CHAMBER BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES



- CONNECTION CABLES ARE INCLUDED

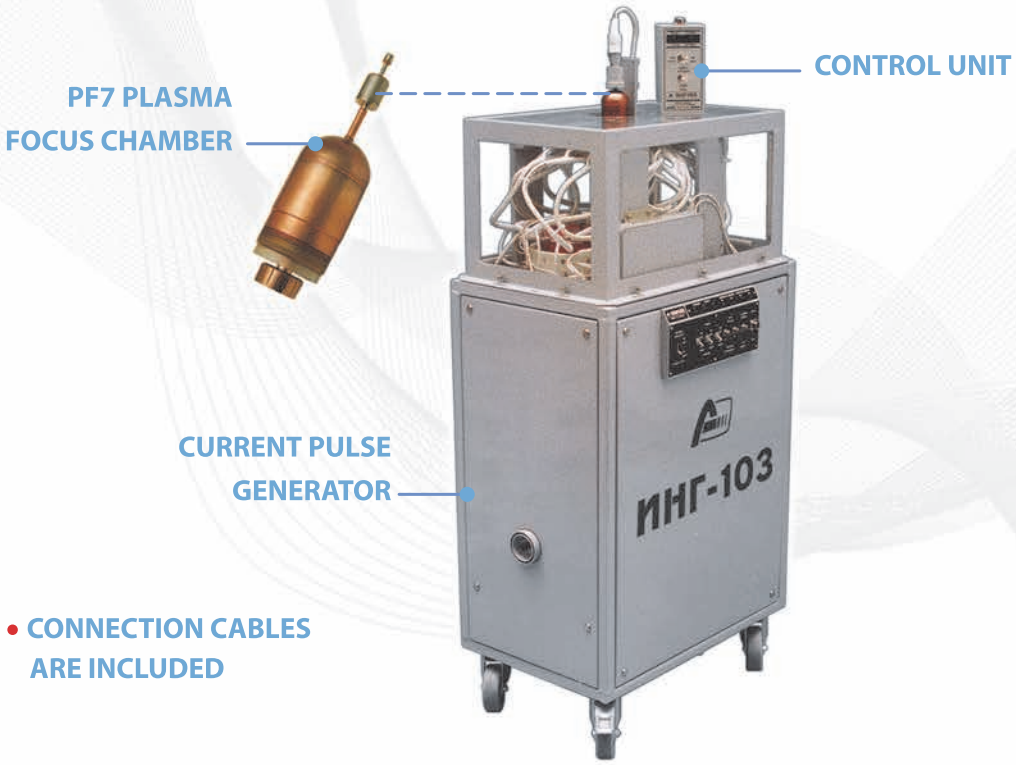
TECHNICAL CHARACTERISTICS:

- D-T neutron yield per pulse, neutron/pulse ..... $5 \cdot 10^7$
- D-D neutron yield per pulse, neutron/pulse ..... $5 \cdot 10^5$
- Yield relative root-mean square deviation from average, % 35
- Neutron pulse duration at half maximum emission intensity, ns 10
- Chamber operating lifetime (number of activations)*, at least 1 000
- Generator operating lifetime (number of activations), at least 10 000
- Interval between single activations, min 3
- Operating temperature range, °C ..... from -10 to +50
- Power supply ..... mains 220 V, 50 Hz
- Power consumption, W 50
- Dimensions, mm ..... 366 x 383 x 566
- Current pulse generator weight, kg 27
- Power supply unit weight, kg 8

* chamber is a replaceable part and it may be replaced in 5 minutes

ING-103

PLASMA FOCUS CHAMBER BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES



• CONNECTION CABLES ARE INCLUDED

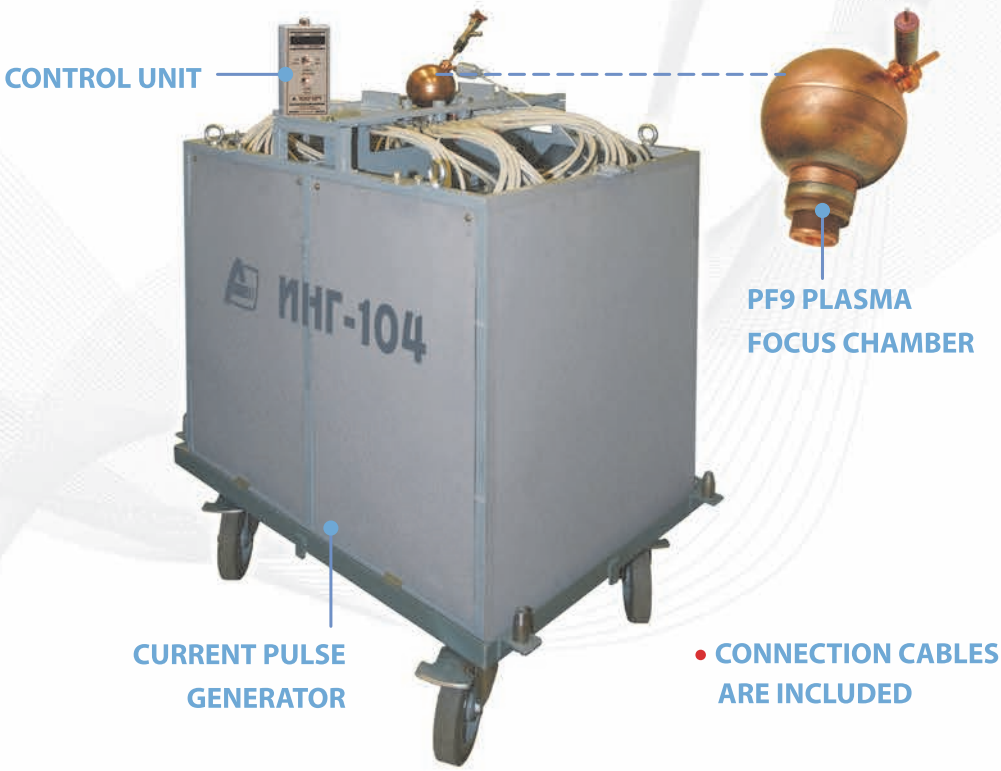
TECHNICAL CHARACTERISTICS:

- D-T neutron yield per pulse, neutron/pulse ..... $1 \cdot 10^{10}$
- D-D neutron yield per pulse, neutron/pulse ..... $1 \cdot 10^{8}$
- Yield relative root-mean square deviation from average, % 35
- Neutron pulse duration at half maximum emission intensity, ns 20
- Chamber operating lifetime (number of activations)*, at least 1 000
- Generator operating lifetime (number of activations), at least 10 000
- Interval between a single activations, min 5
- Operating temperature range, °C ..... from -10 to +50
- Power supply ..... mains 220 V, 50 Hz
- Power consumption, W 100
- Dimensions, mm ..... 600 x 400 x 1350
- Weight, kg 250

* chamber is a replaceable part and it may be replaced in 5 minutes

ING-104

PLASMA FOCUS CHAMBER BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES



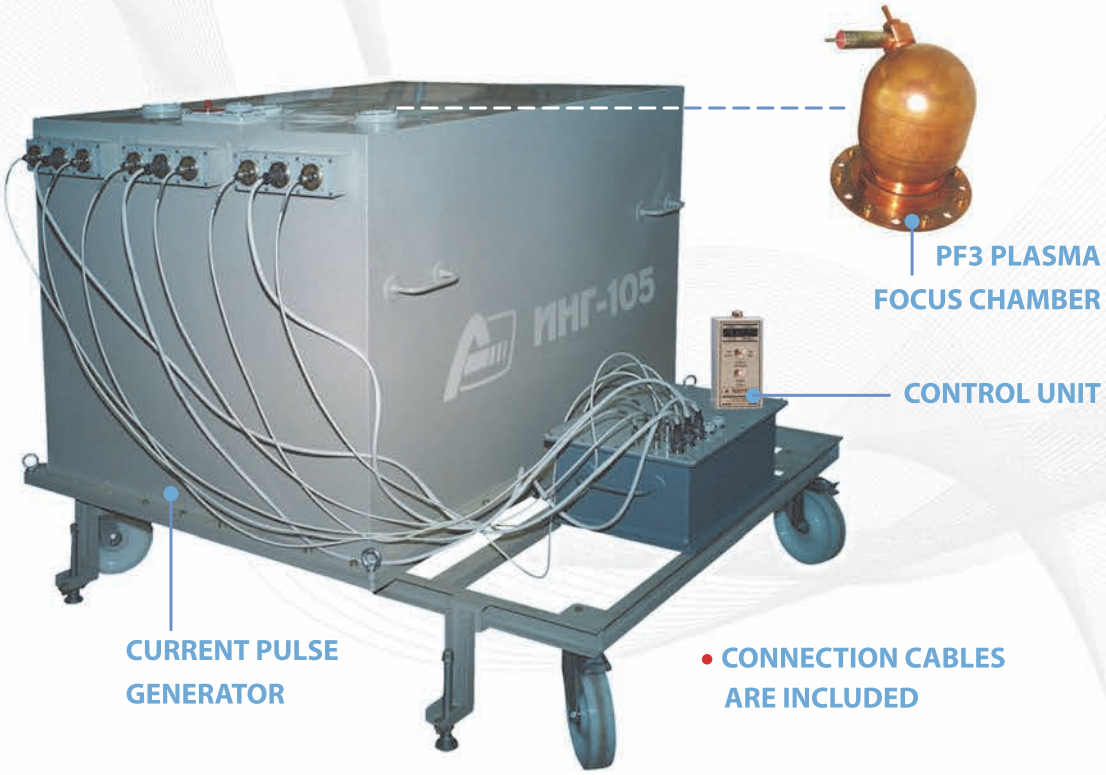
TECHNICAL CHARACTERISTICS:

- D-T neutron yield per pulse, neutron/pulse ..... $1 \cdot 10^{11}$
- D-D neutron yield per pulse, neutron/pulse ..... $1 \cdot 10^{9}$
- Yield relative root-mean square deviation from average, % 35
- Neutron pulse duration at half maximum emission intensity, ns 30
- Chamber operating lifetime (number of activations)*, at least 400
- Generator operating lifetime (number of activations), at least 2 000
- Interval between a single activations, min 10
- Operating temperature range, °C ..... from -10 to +50
- Power supply ..... mains 220 V, 50 Hz
- Power consumption, W 200
- Dimensions, mm ..... 900 x 1100 x 1400
- Weight, kg 500

* chamber is a replaceable part and it may be replaced in 5 minutes

ING-105

PLASMA FOCUS CHAMBER BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES



TECHNICAL CHARACTERISTICS:

- D-T neutron yield per pulse, neutron/pulse ..... $1 \cdot 10^{12}$
- D-D neutron yield per pulse, neutron/pulse ..... $1 \cdot 10^{10}$
- Yield relative root-mean square deviation from average, % 20
- Neutron pulse duration at half maximum emission intensity, ns 50
- Chamber operating lifetime (number of activations)*, at least 200
- Generator operating lifetime (number of activations), at least 1 000
- Interval between a single activations, min 10
- Operating temperature range, °C ..... from -10 to +50
- Power supply ..... mains 220 V, 50 Hz
- Power consumption, W 500
- Dimensions, mm ..... 1700 x 2000 x 1500
- Weight, kg 900

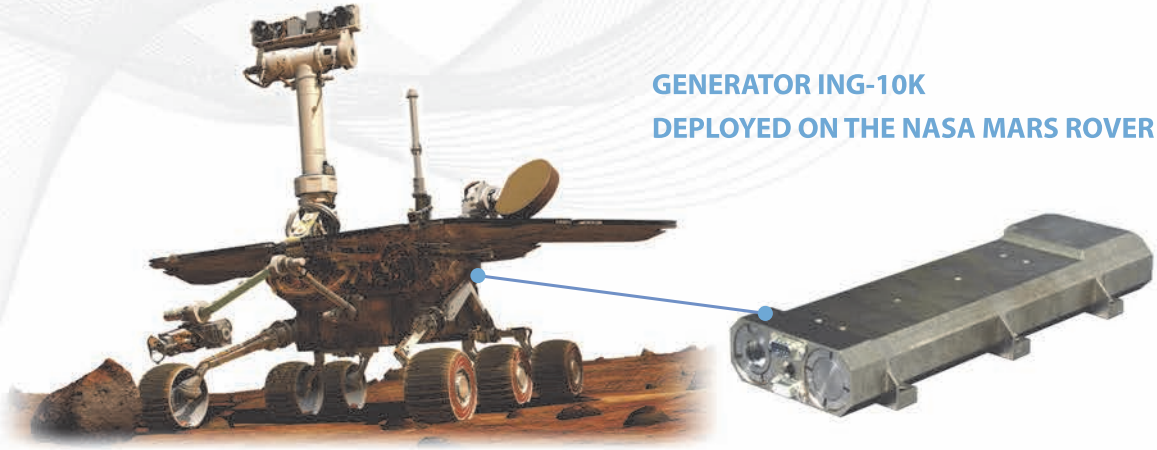
* chamber is a replaceable part and it may be replaced in 5 minutes

ING-10K

VACUUM NEUTRON TUBE BASED PULSE NEUTRON GENERATOR FOR RESEARCH ACTIVITIES

Pulsed neutron generator ING-10K is designed for the Moon and the Solar System planets surfaces exploration to detect water in the soil using nuclear-physical method.

- The generator was installed on board the NASA Curiosity Mars Science Laboratory (MSL), which was launched to Mars on November 26, 2011, and landed on Mars on August 6, 2012.
- It is planned to send ING-10K neutron generator on board the Russian and foreign spacecrafts to explore the Moon and Venus surfaces.



GENERATOR ING-10K
DEPLOYED ON THE NASA MARS ROVER

TECHNICAL CHARACTERISTICS:

- Neutron energy, MeV..... 14
- Average neutron yield per pulse, neutron/pulse, at least:
  at the beginning of lifetime.....$1 \cdot 10^7$
  at the end of lifetime.....$4 \cdot 10^6$
- Operating lifetime, at least..... 10^7 pulses during 3 years
- Operating mode.....frequency up to 10 Hz and single activations
- Operating temperature range, °C.....-40 - +50 *
- Maximum power consumption, W..... 14
- Dimensions, mm.....330 x 120 x 45
- Maximum weight, kg.....2.8

* corresponds to seasonal and daily temperature variations on Mars surface

上海沃埃得贸易有限公司
http://www.worldwide-china.com
上海市闸北区共和新路3699号A1707
电话：+86 21 66621556/7/8/9
邮箱：jerry.zhu@worldwide-china.com