GKMP
RESEARCH & PRODUCTION COMPANY

TURNING IDEAS
INTO REALITY!

Research and Production Company "Machinery and Tools Engineering Group" LLC
NPO GKMP LLC

www.gkmp32.com

ABOUT COMPANY

Transforming ideas into reality

NPO "Machinery and Tools Engineering Group" LLC (OOO NPO GKMP LLC) is a manufacturer of a contemporary, reliable high technology equipment, process and control automation equipment and tools, cryogenic complexes, metal hoses, bellows and fittings, vacuum systems and installations.

Project documentation development, all types of engineering works, equipment manufacturing, after-sales service.

Полный спектр услуг

Own production

The production base of the enterprise undergoes an annual planned modernization, special attention is paid to the updating of systems and equipment.
Over **250 machine-tools** with modern equipment.

Complex solutions

We provide a full range of services from development and production to construction and installation works and commissioning.

Well-coordinated team of professionals

The number of employees is more than **750 people**, a team of highly qualified specialists in the field of integrated design, as well as effective management and project management has been assembled.

There are more than **110 engineering experts** in our company.

Quality assurance and control

Extended warranty for our products and services, as well as post-warranty service

Manufacturing approvals

Availability of all necessary permits, official approvals and licenses

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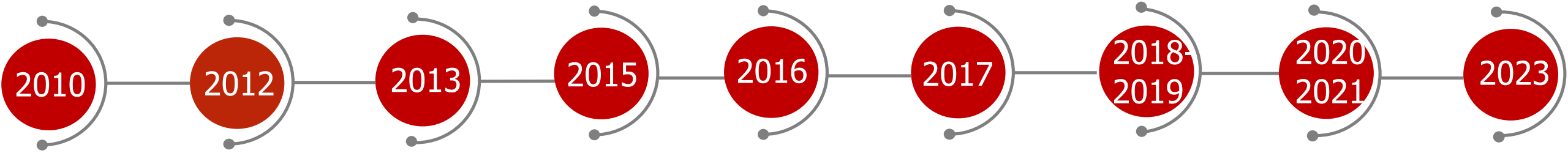
EVOLUTION OF BUSINESS



2010 — Establishment of the company

2012 — Searching for development directions and production of promising samples of science-intensive products

2013 — Mastering the technologies of winding superconducting coils of electromagnetic systems for Tokamak T-15 MD

2015 — Mastering the technologies for the production of large-sized chambers (2000-6000 mm) of vacuum systems

2016 — The range of equipment produced by GKMP company was supplemented by road-building equipment from JSC "Irmash", which became part of the holding.

2017 — Development and manufacturing of equipment for the nuclear fuel cycle

2018-2019 — Manufacturing and development of vacuum test stands according to the ROSCOSMOS technical assignment

2020-2021 — The company became a participant in the project to create an international experimental thermonuclear reactor (ITER).

Adaptation of TBK-110, development of the production base, development of vacuum shut-off valves

2023 — Design and manufacture of equipment for space simulation (thermal vacuum installations) and solar radiation simulators

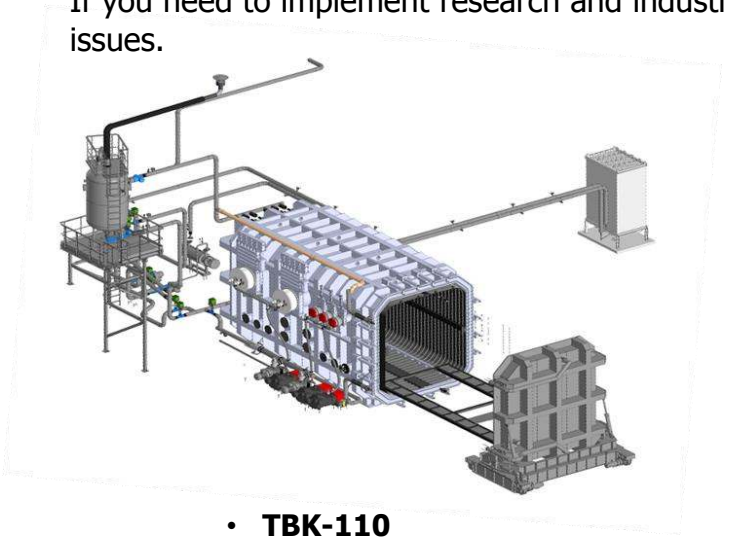
COMPANY PROFILE

- Design and construction process, development of technical specifications, strength calculation;
- Manufacturing;
- Shipping equipment;
- Installation supervision and commissioning works;
- Customer service training;
- Warranty and post-warranty service;
- Utilization;

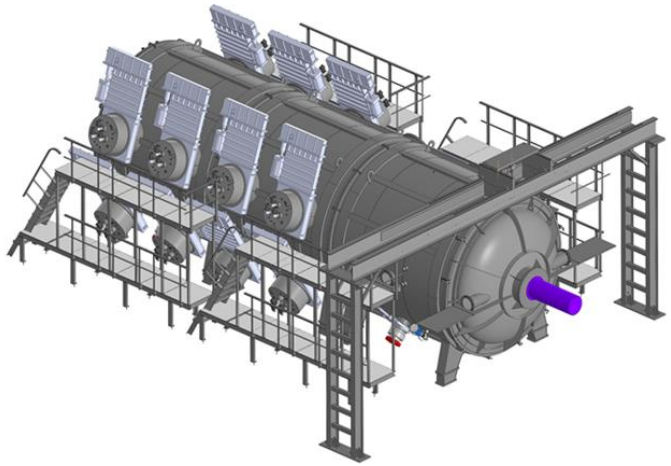
We carry out the production of prototypes, pilot batches, small series of high technology products.

Based on the goals, budget and wishes of the Customer, we will carry out a high-quality and quick comprehensive analysis of the project, develop technical and project documentation, help draw up a schedule for the supply of equipment and work.

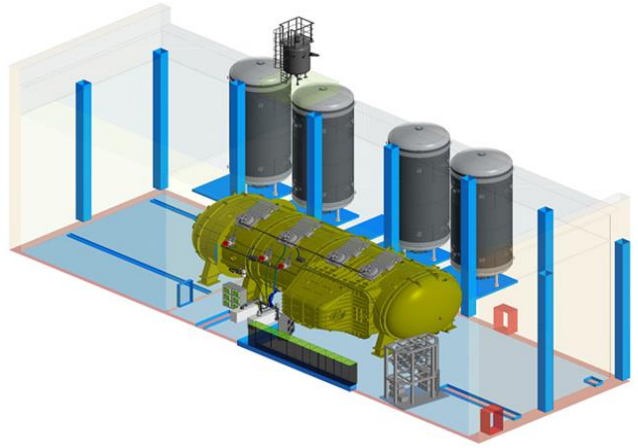
If you need to implement research and industrial installations and equipment, then the engineers of our company will provide you with advice on specific issues.



- **TBK-110**



- **Vacuum stand for testing powerful plasma engines**



- **Thermovacuum test stand**

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TYPES OF MANUFACTURING EQUIPMENT

№	NAME
1	Vacuum chambers, pumping systems and special technological equipment;
2	Space simulation equipment;
3	Industrial thermal equipment and system (pusher-type furnace, gas-filled furnace, vacuum furnace, moving-belt furnace);
4	Single-crystals growing equipment;
5	Magnetic coils and magnet facilities;
6	Stainless steel metal bellows and hoses;
7	Products from refractory metal and alloys;
8	Road construction equipment;
9	Magnetic systems and elements of large-size magnetic systems;
10	Vacuum and thermal equipment spare parts.

CERTIFICATES, PATENTS, LICENSES

- Our company has a certified quality management system.
- QMS covers design and development, production, sale, maintenance, repair of weapons and military equipment and the following types of products:
- EKPS codes: 4410, 4420, 4470, 4480, 4720, 4920, 4940, 4960, 4970, 6636, 6920, 6930

QMC according ISO 9001-2015

QMS certification with annex sheet 1

QMS certification with annex sheet 2

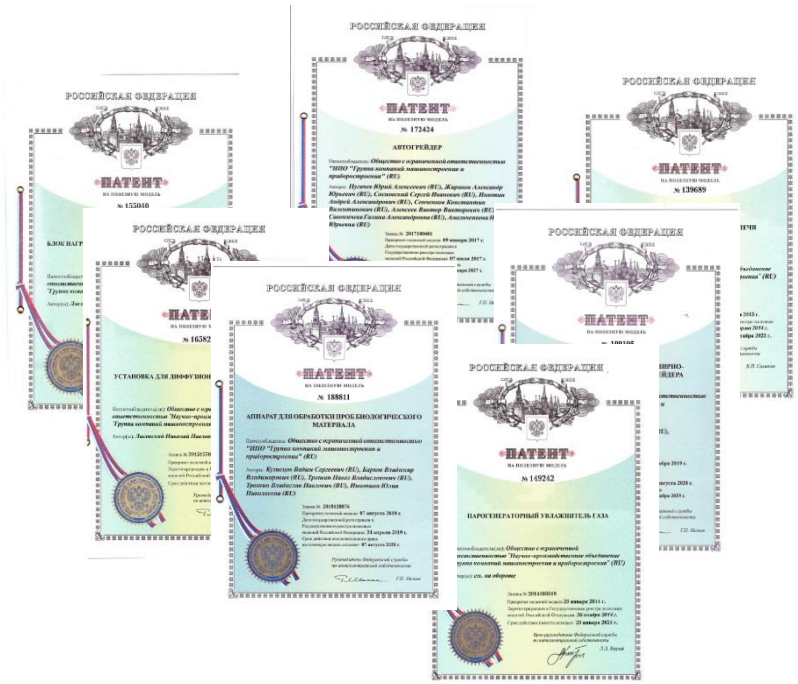
QMS Certification Road equipment

Quality management system

Quality policy

CERTIFICATES, PATENTS, LICENSES

- NPO “Machinery and Tools Engineering Group” LLC (OOO NPO GKMP LLC) successfully passes external inspection audits every year.
- Also, the organization regularly conducts internal audits of the quality management system. Availability of licenses for design and construction, manufacture of equipment for the nuclear fuel cycle, fuel storage, waste storage.
- Company has got 8 utility model patents.



Non-standard vacuum and thermal equipment according to the Customer's specifications

- 75 completed projects in the scientific research industry, tool engineering, nuclear power, mechanical engineering, space industry.

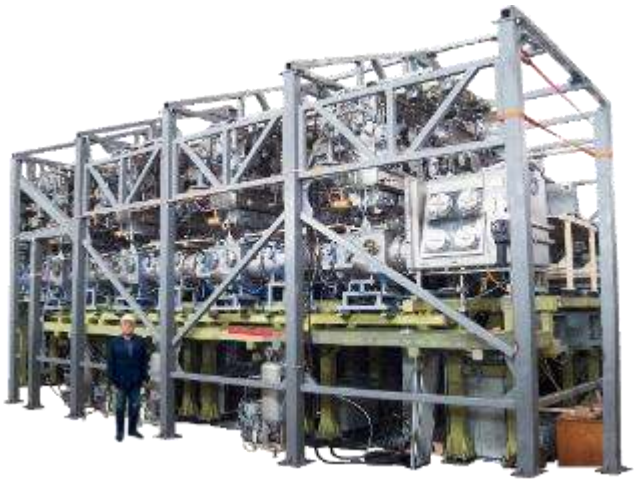
You can learn more and fill out an application by using our order form on the website or contact us at info-msk@gkmp32.com

We provide our Customers with high-quality equipment with the maximum level of service support.

- **Thermal vacuum testing equipment for space simulation STVI-2**

- **Experimental thermonuclear installation Tokamak T-15MD**

- **Two-bell type vacuum furnace**



- **Carbothermic synthesis system**

UNIQUE PRODUCTS FOR OUR CLIENTS

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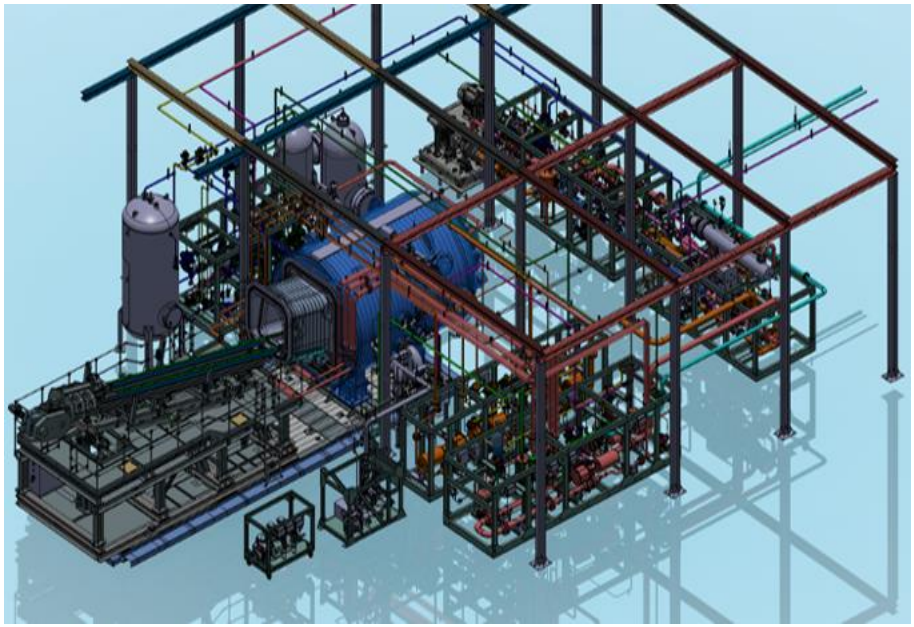


- **Port plug test facilities of ITER**

Expert opinion from the ITER experts

Russian nuclear industry successfully passed Manufacturing Readiness Review for the main component of the Port Plugs Test Facility production.

International ITER Organization has officially admitted the readiness of the Russian industry to manufacture the most important component of PPTF (Port Plug Test Facility) for the ITER machine. Following the results of MRR (Manufacturing Readiness Review) an international expert team concluded that NPO "Machinery and Tools Engineering Group" LLC (OOO NPO GKMP LLC) ready to manufacture PPTF test tank. PPTF is a stand aimed at carrying out vacuum, heat and functional tests of port plugs before installation into ITER vacuum vessel. In accordance with the Procurement Arrangement signed in 2011, GKMP has to manufacture and procure four Port Plug Test Facilities by 2024.

Test tank is the most important and complicated component of test facilities. Functional tests in conditions close to the operating conditions of the ITER machine will take place inside the test tank, contacting with port plug.

According to international ITER Organization requirements, test tank has to provide a vacuum indicated 10^{-6} Pa, which is close to the space conditions. At the same time, a console position of port plugs (25 and 50 tones) inside the tank test constructed by other ITER members assuming very precise technological and design solutions for the stand.

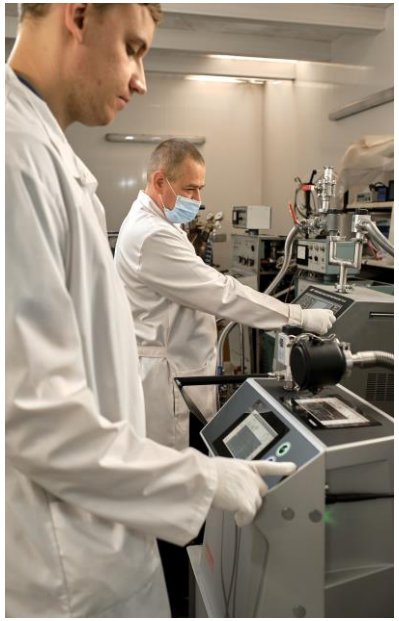
In accordance with the schedule, the first Russian PPTF has to be manufactured by the end of the 2021 year.

MANUFACTURING CAPACITY

- Own production, laboratory and design facilities;
- Warehouses for finished products, 2 warehouses for raw materials;
- 4 office buildings;
- One certified vacuum laboratory, one certified non-destructive testing laboratory;

• **Modernized P-50 tensile testing machine**

• **X-ray machine RPD-200**



• **Vacuum laboratory**

- Mastered mass spectrometric methods of tightness control, capillary method of non-destructive testing (testing of defects of welded joints at a thickness of 300 mm on stainless steel was carried out experimentally) and methods of destructive testing (availability of equipment for destructive testing);
- Assembly workshops and the final assembly line;
- The personnel of workshops and laboratories underwent appropriate training and certification in the framework of NAKS ROSATOM and ISO standards;
- Non-destructive testing laboratory with ultrasonic inspection system based on phased array technology, radiographical laboratory;
- Mastered ultrasound control, classical and X-ray control, X-ray fluorescence analysis;
- Production tasks for precision machining is carried out on modern high-tech CNC machines with CNC technologies;
- Industrial cleanroom with an area of 1700 m^2 , ISO 8 Cleanroom;
- Machine tools and equipment: rollers, waterjet cutting machines, turning, drilling, milling, boring machines, hydraulic presses, cranes, beam cranes, sheet bending machines, roll forming machines, semi-automatic welding equipment, manual argon-arc welding, thermal cutting machines for plasma or gas cutting of sheet metal, braiding equipment, etc.

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MANUFACTURING CAPACITY. MORE THEN 300 MACHINING STATION WITH PRESENT-DAY RIGGING

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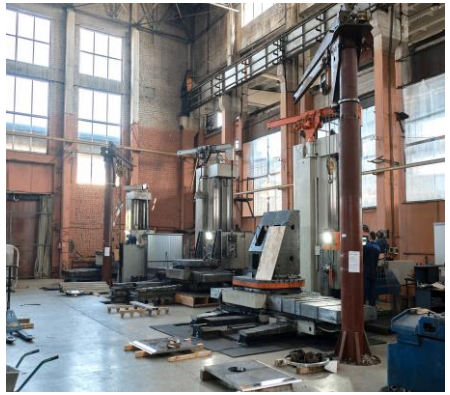
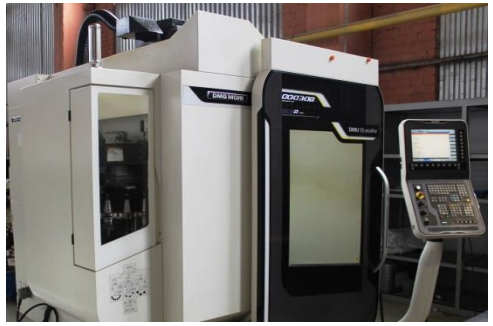
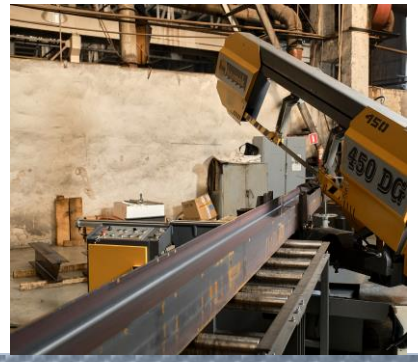
MANUFACTURING CAPACITY








- Water Jet machine
- Bending equipment
- Cutting, turning, polishing, boring, drilling, sharpening, bandsawing and other machining tools
- Welding equipment
- CNC equipment

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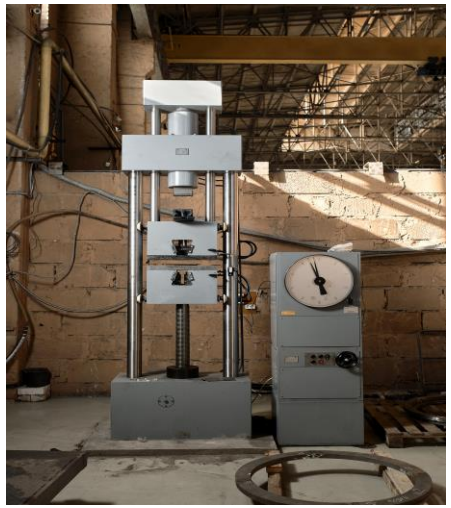
QUALITY CONTROL. TESTING AND MEASUREMENT EQUIPMENT CERTIFIED LABORATORY OF NON-DESTRUCTIVE CONTROL



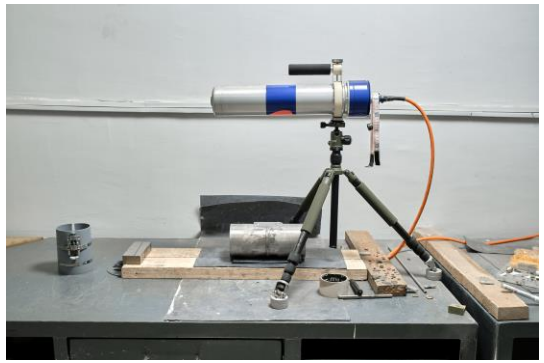
- Modernized P-50 tensile testing machine

- Mass spectrometric leak detector

- Ultrasonic flaw detector USD 50

- DFS-500 spectrometer optiko-issue for the analysis of metals

- X-ray machine RPD-200



- X-ray machine ARSENAL 160 HC

- Digital radiography complex
- FOSFOMATIK-40,

TYPICAL MANUFACTURING TECHNOLOGY

1. Blank production:

1.1. Flattening of sheet metal on flattening machining tool.
1.2. Cutting of sheet metal to separate blanks by cutting facility and following flattening on rolling mills.
1.3. Blanking.
1.4. Stamping.
1.5. Gas cutting.
1.6. Rolling.
1.7. Bending.
1.8. Polishing.
1.9. Sawing.

2. Welding procedure of separate parts on special welding facilities with after-welding control. Pre-painting polishing.

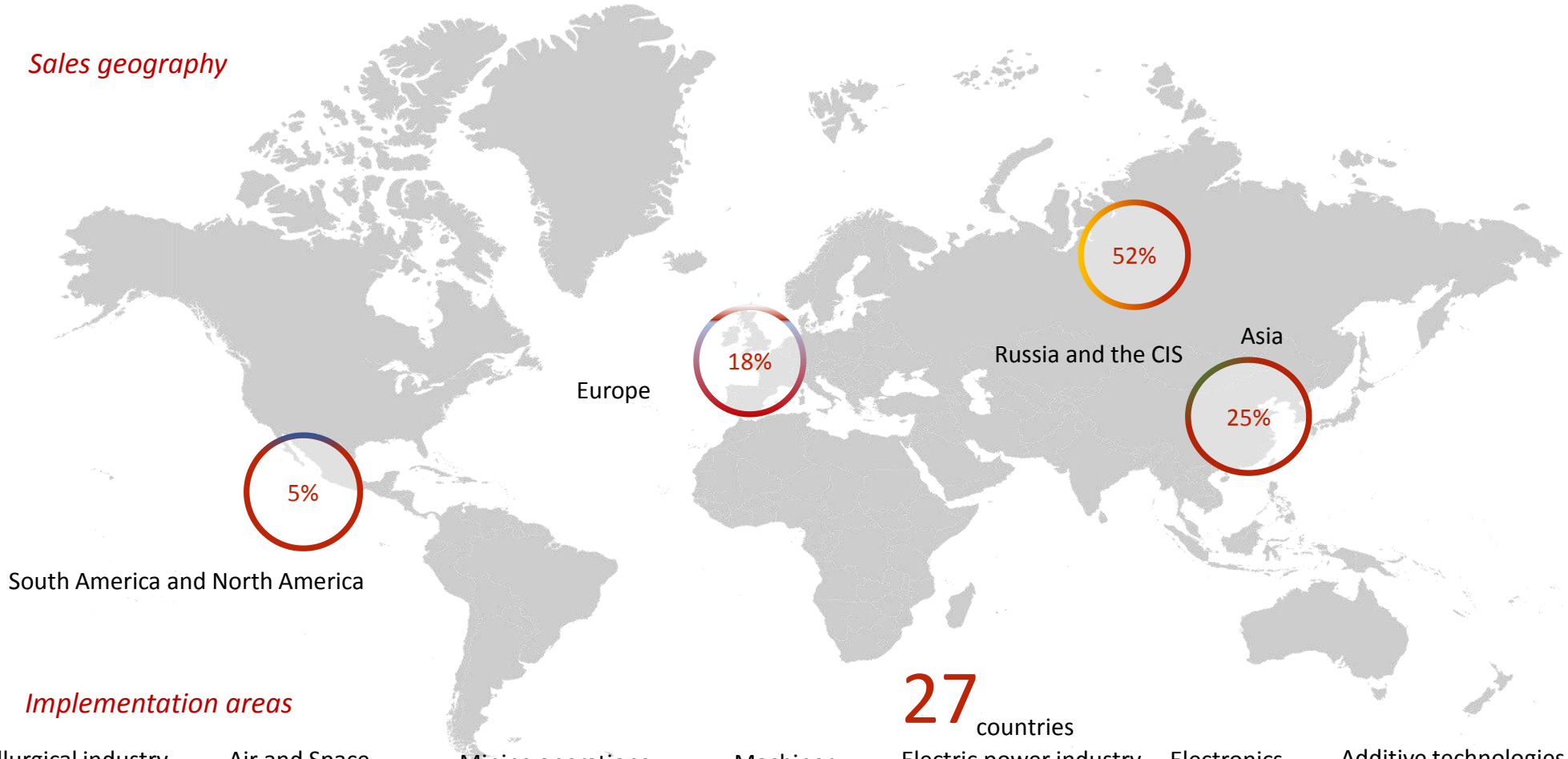
3. Machining:

3.1. Machining of parts on CNC equipment (токарные, turning, drilling equipment).
3.2. Machining by the unique equipment
3.3. Finishing procedure.
3.4. Heat treatment.

4. Assembling, painting, testing

SALES GEOGRAPHY AND IMPLEMENTATION AREAS

Sales geography



Implementation areas

27 countries

Metallurgical industry | Air and Space | Mining operations | Machinery | Electric power industry | Electronics | Additive technologies | Medecine

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OUR CUSTOMER'S SATISFACTION IS OF THE UTMOST IMPORTANCE TO US

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VACUUM TECHNOLOGY AND SPECIAL TECHNOLOGICAL EQUIPMENT

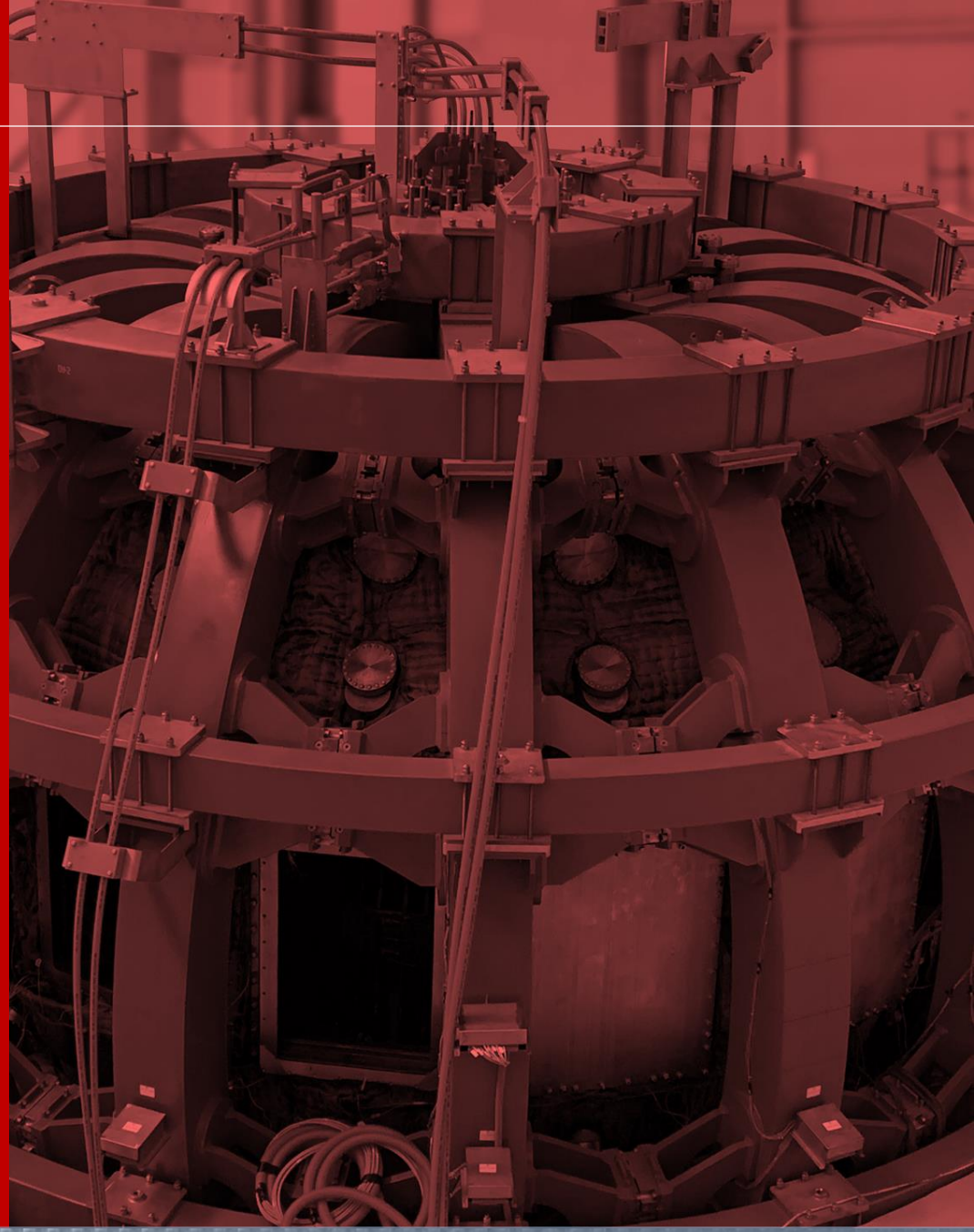
We have knowledge and resources in the following areas:
- R&D; - advanced engineering; - product engineering/manufacturing.

We develop and manufacture the following vacuum technology:

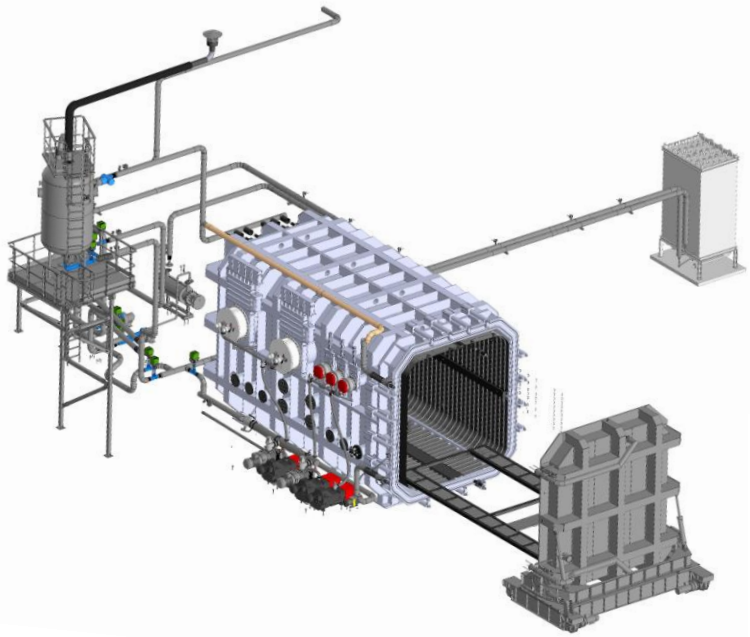
automatic control systems, cryovacuum installations, vacuum test benches (STVI-2, TBK-110), thermal vacuum test benches, vacuum pumping systems, vacuum locks, etc.

As well as special technological equipment:

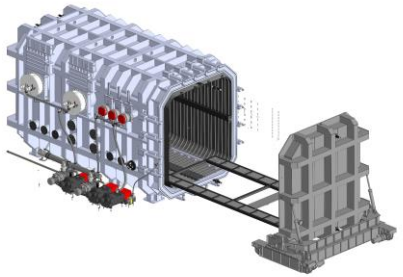
Bell-type furnaces, two-bell furnaces, conveyor furnaces, vacuum shaft furnaces, chamber furnaces, pusher-type furnaces, etc.

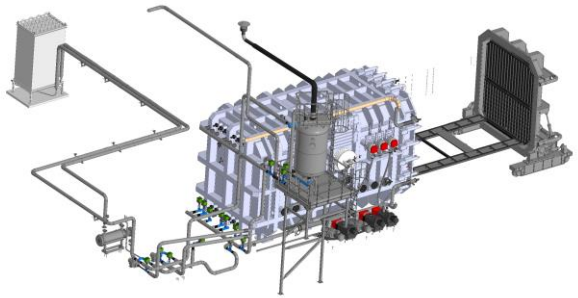


THERMAL VACUUM CHAMBER TBK-110



- horizontal vacuum chamber
- cover moving device
- control system
- vacuum pumping system
- depressurization system
- lighting system for routine maintenance
- technological table with a set of technological equipment
- heat flow simulators
- technological equipment
- tightness control system





- **TBK-110 - 3d-model developed by NPO GKMP LLC**

Термовакуумная камера ТБК-110

Description:

The TBK-110 chamber is equipped with a vacuum pumping system, a set of cryogenic screens, heat flow simulators with a system that allows you to simultaneously monitor and control 160 channels of thermometry and electric power supply. The internal dimensions of the chamber are: 7.5 mx 4 mx 4.5 m, the useful volume is 110 m³. A distinctive feature of the TBK-110 is the rectangular shape of the structure, which allows optimal use of the internal volume of the chamber when testing honeycomb panels.

Specifications:

Working pressure at nitrogen cryoscreen temperature	$<1 \cdot 10^{-6}$ mm Hg
Working pressure at temperature of nitrogen cryoscreens +20 °C	$<1 \cdot 10^{-5}$ mm Hg
Monitor Cryo temperatures	-180 ±10 °C
Material	12X18H10T
Total leakage	not more than 5 l · μm Hg. st./s.
Continuous work time	46 days
Heat flux density	up to 1400 W / m²
Internal dimensions , mm:	- width 4000 - length 8100 - height 4500

THERMAL VACUUM TESTING EQUIPMENT FOR SPACE SIMULATION STVI-2

- **Vacuum shaft-type furnace – the model was developed at OOO NPO GKMP LLC.**

Description:

Thermal vacuum chamber consist several sections made from stainless steel (AISI 321). Inner surface finishing Ra 0.63 and welding seams finishing Ra 2.5. There are two Viton O-rings between section's flanges of vacuum chamber. Vacuum chamber mounted on vibration-damping supports to avoid external affection on optical apparaturs.

There is rectangular door width 2500 mm and height 3500 mm for loading and unloading procedure. There are two Viton cord with using for door sealing. All vacuum pumps using for vacuum chamber evacuation are series-produced.

Simulation of space temperature in vacuum chamber provide by cryogenic shrouds filled by liquid Nitrogen. The liquid Nitrogen supply system consist from filling facility, storage tank, cryogenic pipelines with vacuum isolation and liquid Nitrogen separator for coolant circulation.

Specifications:

Ultimate vacuum	$1x10^{-4}$ Pa
General dimensions, mm:	
Outside diameter, mm	5300
Height, mm	1000
Inside diameter, mm	5000

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VACUUM SHAFT-TYPE FURNACE

- **Vacuum shaft-type furnace – the model was developed at OOO NPO GKMP LLC.**

- We accept orders for annealing.
- And we also can manufacture the furnace of such type.

Description:

During production of welding constructions especially vacuum chambers it may observe an internal stress. It may destruct the welding area and led to leak appearance.

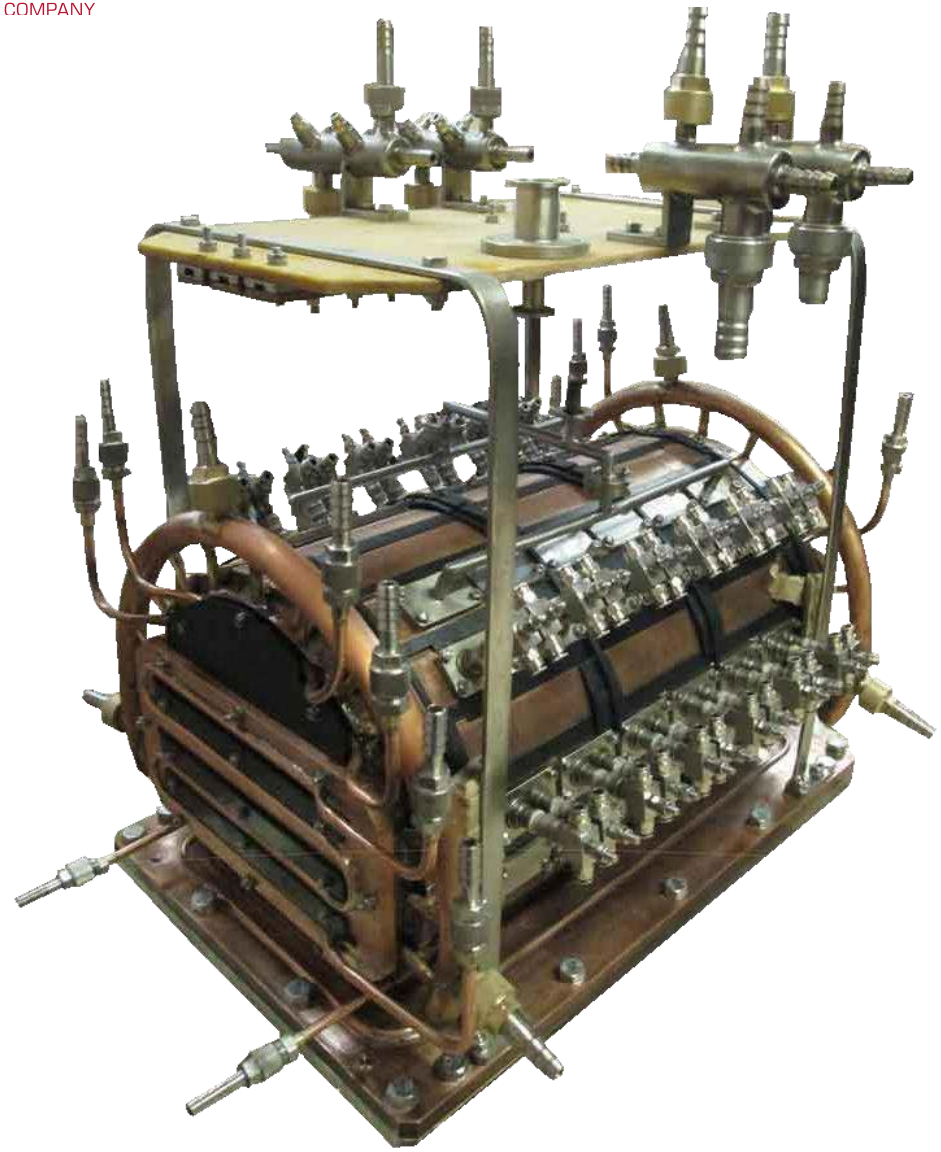
To avoid an internal stress appearance the vacuum shaft-type furnace was designed and developed. This furnace allows to make a high-temperature anneal a tempering of producing constructions. Maximum dimensions of cylindrical parts of vacuum chambers with diameter up to 6.5 m and height up to 4 m.

Vacuum chamber of furnace is a cylindrical body with lining material and zig-zag shaped nichrome heaters. The deck of furnace has ten shields made from heatproof steal. Work space of vacuum furnace has a twelve heating zone.
For temperature measurement in each zone used a thermo-electric transducers (thermocouples). To prevent damaging of lining the cast iron grinds was mounted on the floor.

Specifications:

Max. temperature, °C	Up to +1000
Dimensions with electrical equipment , mm:	
Length, mm	16600
Width, mm	15000
Height, mm	6100

VACUUM SHAFT-TYPE FURNACE



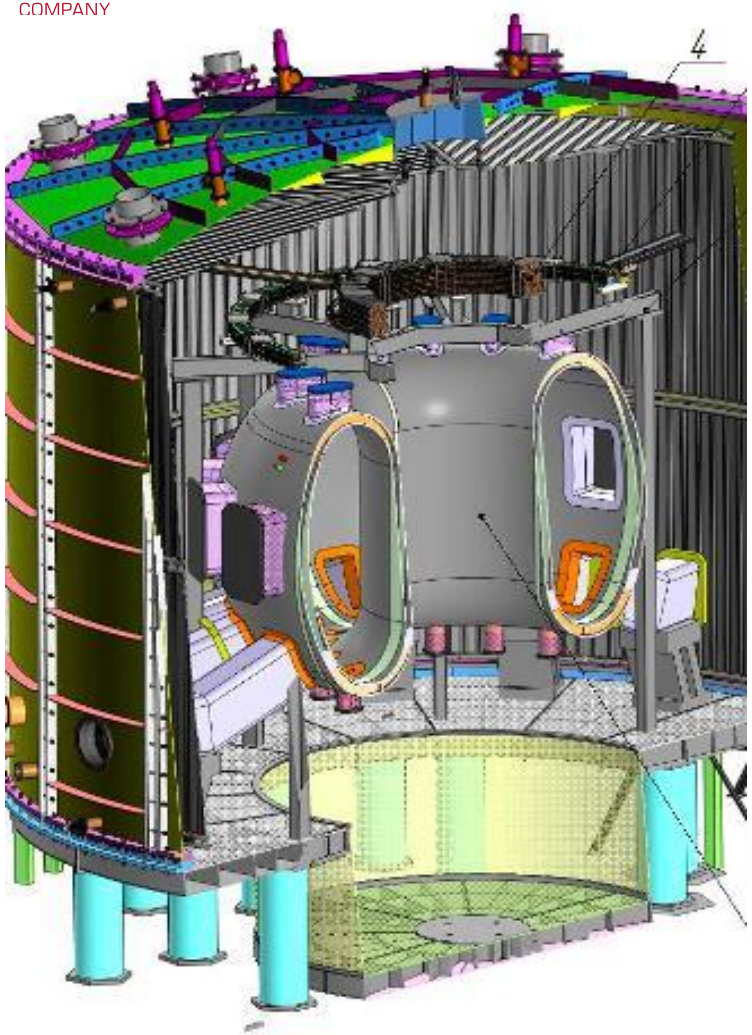
Description:

The chamber is designed to generate plasma flux and manage it via an embedded ion-optical system; it forms an integral part of the experimental particle accelerator.

Application area:

Inside the gas discharge chambers plasma discharges of the required density are ignited. Then by using an ion-optical system, a cloud of charged particles is divided into ions and electrons that are further driven to the system.

THERMONUCLEAR FACILITY TEST SYSTEM (SFT)



Description:

Thermonuclear facility test system SFT is designed to test cryogenic system, pumping system and power supply system within the framework of the infrastructure in order to demonstrate efficiency and functional capacity of the thermonuclear facility SFT.

Configuration:

- Thermostatic cooler
- Vacuum chamber
- WindingOU1
- WindingOU2
- Coil support plate
- Coil feeder OU1
- Coil feeder OU2
- Coil feeder support OУ
- Coil feeder support OУ2

The SFT test system also enables to test magnet systems and magnetic coils based on low and high temperature superconductors, as well as cryoresistive coils.

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CARBOTHERMIC SYNTHESIS SYSTEM

- Carbothermic synthesis system– the model was developed at OOO NPO GKMP LLC.

Description:

The complex consists of eight gas and vacuum furnaces, as well as a product transportation system between the furnaces. The installation is completely leak tight and equipped with two lock chambers for putting workpieces and outputting products.

NPO GKMP LLC produces specialized technological lines of any complexity and purpose, including for the implementation of complex and dangerous technological processes.

The main advantages of technological lines:

- The possibility of full implementation of the technological cycle of processing inside one closed complex
- Minimizing personnel interaction with processed products, elimination of the influence of the human factor on the manufacturing process
- Full complex automation of the production process
- Highest reliability and accuracy of processing
- Resource saving, energy efficiency and safety

Scope: any fully automated production, where human intervention is optional or undesirable.

Technological lines produced by NPO GKMP LLC comply with the Industry 4.0 international standard.

CONVEYOR BELT FURNACE

Description:

Conveyor belt electric furnace – electric resistance furnace of a continuous type with a continuously or periodically moving conveyor.

The main advantage of conveyor electric furnaces is the ability to process large volumes of products in a protective or protective-reducing atmosphere. This type of furnace is perfectly suited for serial and mass production. NPO GKMP LLC produces conveyor furnaces with a direct and curved (humpback) type of channel.

Conveyor electric furnaces leaky, with a partially controlled atmosphere, continuous operation.

Area of application:

mass production of ceramic substrates, metal recovery, sintering of the same type of products, etc.

Main advantages:

- the possibility of continuous operation in several shifts;
- processing of large batches of products in a continuous process; the possibility of implementing several technological operations in one cycle;
- simplicity in service and repair;
- modular design.

BATCH-TYPE INDUSTRIAL ELECTRIC FURNACES

A distinctive feature of the use of resistance chamber electric furnaces produced by NPO GKMP LLC is a low temperature zone gradient and high purity of the medium inside the chamber.

Chamber electric furnaces are batch furnaces.

Chamber electric furnaces are divided into the following groups:

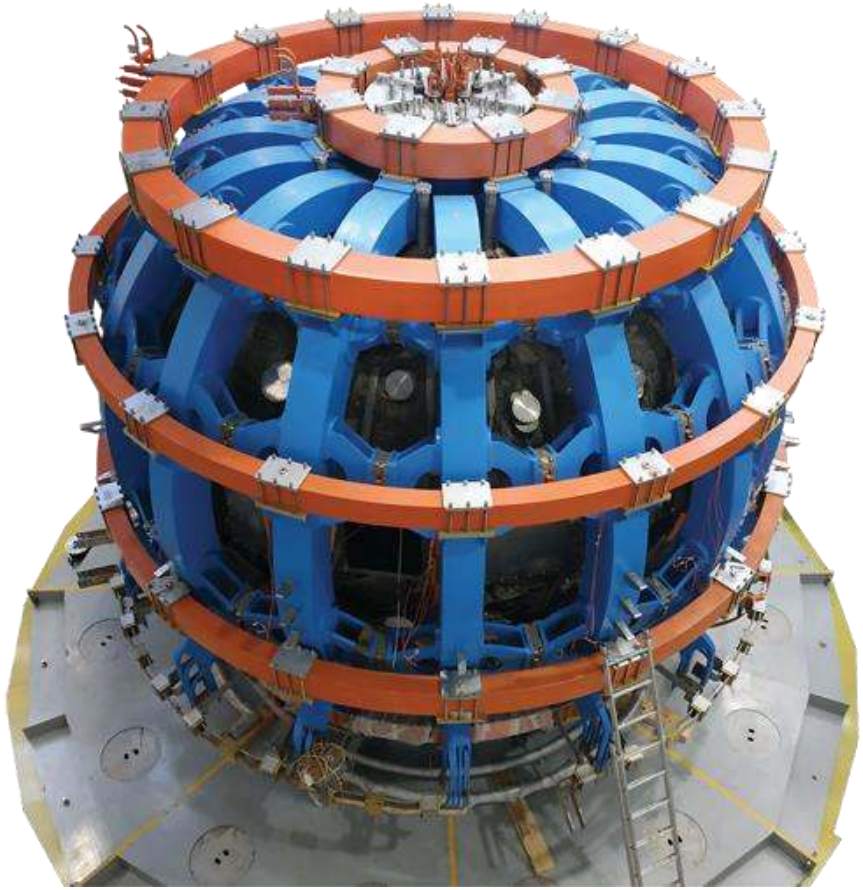
- **According to the design of the chamber:** bell-type, shaft
- **On the environment inside the chamber:** vacuum, gas-filled

Main advantages

- high effective
- the possibility of processing small batches of products;
- resource saving and energy saving;
- process flexibility;
- the ability to select the optimal processing conditions;
- a wide range of technological applications.

Area of application :

Especially clean processes in the manufacture of electronic equipment, soldering in a protective atmosphere, heat treatment of precision parts, recovery of metal powders, etc.



Tokamak T-15 MD

The T-15 MD toroidal plasma magnetic confinement facility was built at the Kurchatov Institute in the late 1980s. In 2012, the T-15 reactor was temporarily decommissioned in connection with plans for a deep modernization. The increased energy requirements were to be met by a new power supply system.

A radical restructuring of the existing installation with the replacement of all key systems was carried out at the OOO NPO GKMP factory in Bryansk. The modernization consisted in the creation of a completely new electromagnetic system and vacuum chamber, a new powerful power supply system - that is, in fact, in the creation of a completely new tokamak. After the physical launch of the tokamak in May 2021, it became known that in 2021-2024. the existing tokamak will be supplemented with new systems for various purposes.

LLC NPO GKMP, in turn, continues to work actively on the development and manufacture of four stands for testing the port plugs of the reactor of the large-scale ITER project.

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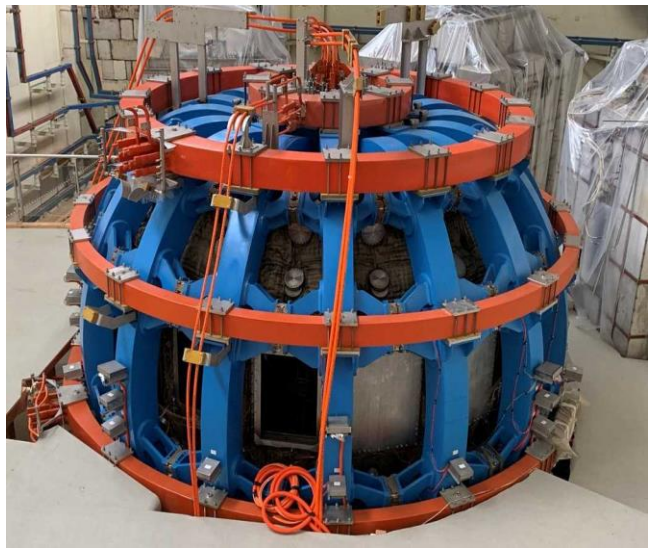
PRODUCTION OF ELECTROMAGNETIC COILS ON THE EXAMPLE OF THE TOKAMAK T-15 MD



Tokamak T-15MD

Tokamak – is an experimental facility for research of processes thermonuclear fusion.

Configuration:

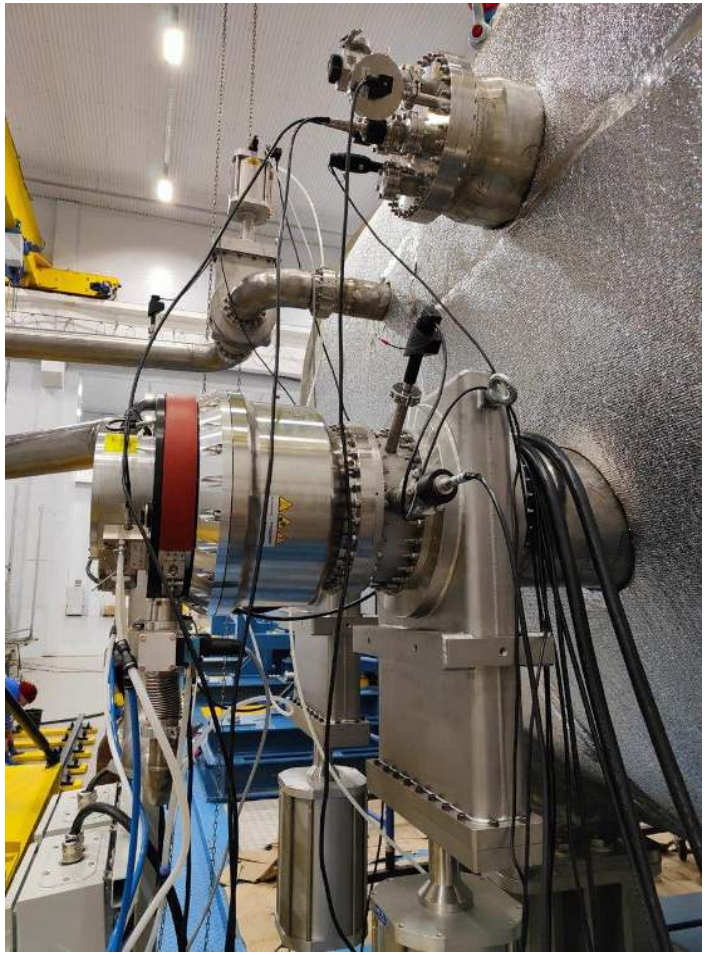
- Inside height of vacuum chamber 3.39 m
- Wall width of vacuum chamber 5 … 8 mm
- Vacuum chamber volume 47m^3
- Ultimate pressure 10^{-5} Pa
- Protective material on the wall – graphite FP479
- Material of vacuum chamber – stainless steel AISI 321

Magnet system is designed for holding a hot plasma in divertor configuration. Magnetic coils produced from square-shape silverized copper tube. Cooling water circulate inside the coils. The copper wires are wrapped by isolation material and baked in vacuum furnace.

Pilot coils has the following dimensions:

- Inside diameter from 5050 mm to 6322 mm
- Outside diameter from 5170 mm to 6640 mm
- Height from 210 mm to 277 mm
- Weight from 4050 kg to 6950 kg

PORT PLUG TEST FACILITY



Project name:

ITER PPTF Project is part of International Thermonuclear Experimental Reactor located in Cadarache, France.
Construction Completion (phase 2)–2035year
First Plasma (phase 1)–2025year

https://www.iter.org

General Contractor and End User:
ITER Organization, Building 81/253B, RoutedeVinon-sur-Verdon-CS 90 046 -13067 St Paul LezDuranceCedex-France

Site: ITER construction site, Cadarache, France.

Customer for Russian Suppliers: Russian Domestic Energy, «Rosatom»,123182, Moscow, Kurchatov square, 1/3

http://iterrf.ru

Port Plug Test Facility for ITER Project
Port Plug Test Facility

Test Facility for Equatorial and Upper Port Plugs with PP Handling system is intended for functional and climate tests of the Port Plugs before their direct work in ITER Tokamak.

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PLASMA JET ENGINES TEST BENCHES

If you need to implement research and industrial installations and equipment, then our engineers will be happy to provide you with advice on specific issues.

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PLASMAJET ENGINES TESTING EQUIPMENT

- **Plasmajet engines testing equipment**

Description:

Equipment is intended for hot tests of high-performance inboard plasmajet engines designed by LPSC (India).

To test ion engines, it is necessary to create conditions close to space on Earth. To do this, vacuum chambers of a sufficiently large volume are manufactured with a powerful pumping system, dispersion devices and protection against plasma flow.

For ease of maintenance and operation, the test engine is placed in a pre-chamber, which can be cut off from the main vacuum chamber.

Specifications:

Ultimate vacuum	$1 \cdot 10^{-6}$ mbar
Dynamic vacuum	$2 \cdot 10^{-5}$ mbar
Xenon rate (before modernization)	20 mg/s
Plasmajet engine power (before modernization)	20 kW
Xenon rate (after modernization)	60 mg/s
Plasmajet engine power (after modernization)	60 … 80 kW
Dimensions:	
Inside diameter of general vacuum chamber	6000 mm
Length of general vacuum chamber	9000 mm
Inside diameter of pre-chamber	2000 mm
Lengthofpre-chamber	2500 mm

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ADDITIONAL SECTION OF VACUUM VESSEL

- **Additional section of vacuum vessel**

Description:

Additional section is intended for extension of existent vacuum chamber for ion engines tests. Section material is stainless steel. It has a set of stiffening bands. Inside diameter – 3800 mm, length – 3870 mm.

Specifications:

Inside diameter, mm	3800
Height, mm	3870

There are five vacuum flange ISO120-F for cryogenic pumps.

Dynamic vacuum in test process is $1 \bullet 10^{-5}$ … $1 \bullet 10^{-6}$ Torr. It depends on task.

CHAMBER for conducting fire tests of plasma and ion engines.
The modular design of the vacuum chamber allows you to change the required working volume by mounting / dismantling the annular sections (spacers) of the chamber on your own directly on the territory of the Customer

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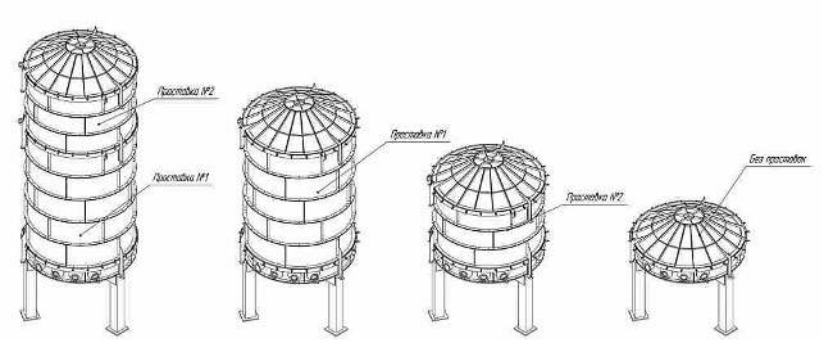
THERMAL VACUUME QUIPMENT VU-180



Description:

The VU-180 vacuum chamber with an internal diameter of 5200 mm and a height of up to 13100 mm is designed for testing products in simulated outer space. The camera is modular, which allows you to change the required working volume.

Configuration:

- modular vacuum chamber
- vertical testing tableсистема
- service lighting system
- vacuum equipment
- cryogenic shrouds
- LN2 supply system
- control system

Specifications:

Ultimate vacuum	$1.3 \cdot 10^{-3}$ Pa
Working pressure	$5 \cdot 10^{-4}$ Pa
Degas rate	$15 \cdot 10^{-3}$ Torr·l/s
Cryogenic shroud temperature	-190±5 °C
Working table diameter	4300 mm
Loading capacity	2500 kg
General dimensions:	5540
Outside diameter with stiffening band	5200
Inside diameter	800
Height of fixed segment	6700
Height of cylindrical section №1	3300
Height of cylindrical section №2	13100

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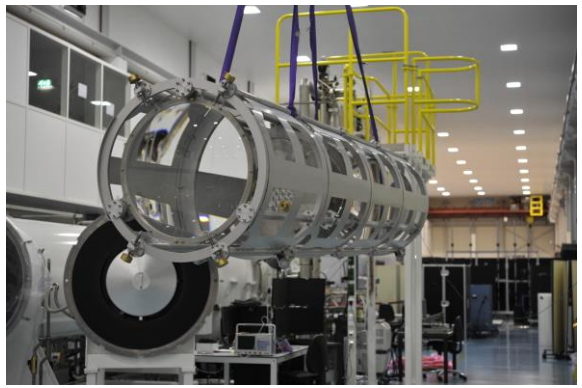
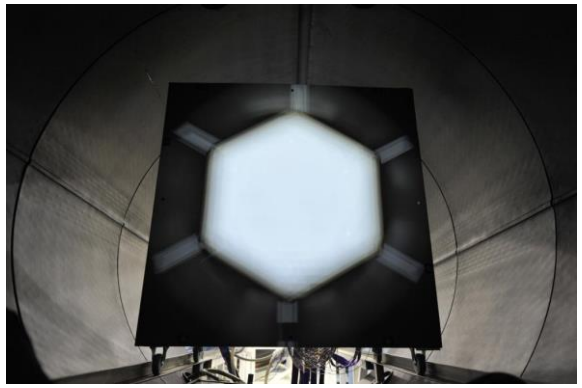
THERMAL VACUUM AND SOLAR SIMULATOR SYSTEMS

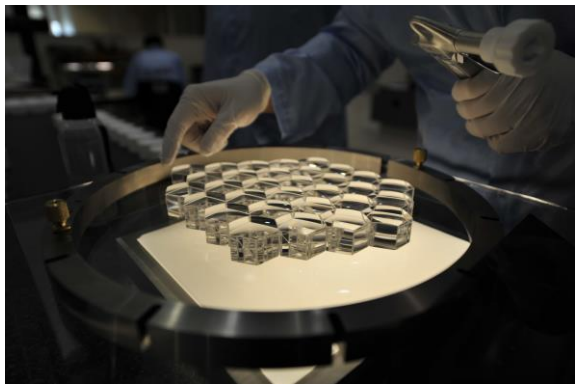
Solar Simulators are designed and produced for use in laboratory production and testing applications requiring an exposure to or process within a controlled vacuum environment at specific temperature involving solar simulation.

VTC1.5 THERMAL VACUUM TESTING FACILITY



- **The VTC 1.5 Thermal vacuum testing facility enables missions to be tested from near-solar orbits to the orbit of Mars.**





- **According the specification new design shall provide 18 kW/m2 in diameter of 500 mm in three planes: FRONT, MID and BACK with non-uniformity better than ±5%**
- **Hexagonal shape of light spot has an advantage of placing the fluxmeters in the bottom corner resulting no additional shadowing of a specimen**

Description:

- VTC1.5 (ESA/ESTEC) is a thermal-vacuum facility chamber equipped with High Flux Solar Simulator
- This is dedicated to S/C equipment testing in the condition of high radiant flux density up to 20 SC
- The original Sun Simulator delivered imperfect beam in the terms of spatial and temporal stability

Specifications:

Average irradiance:	
With lamp module 25 kW	8-13 Solar Constant
With lamp module 32 kW	10-17 Solar Constant
With 7-lamp module	0.3-4 Solar Constant
Non-uniformity measurement	±4%
Non-parallelism	> 90% power at an angle of ±2.5°
Spectrum	Unfiltered Xe

SOLAR SIMULATOR STVI-2

- **The solar simulator has special air mass filters and lamps to simulate the sun's solar spectrum. Solar simulator tunable in terms of illumination angle for testing space-based optoelectronic systems.**

Description:

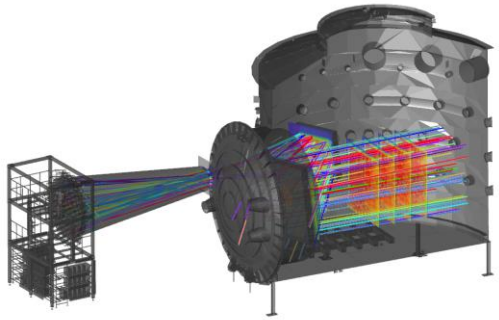
The Solar Simulator STVI-2 is a part of a unique test bench for thermal vacuum testing of space-based optoelectronic systems. Together with the solar simulator, the stand is also equipped with a collimator for carrying out optical measurements of the parameters of the tested systems under conditions of imitation of space factors.

The Sun Simulator is distinguished by a cold main mirror, which is thermostated to -60 °C during the tests, and the ability to redirect the solar beam to different zones of the test object.

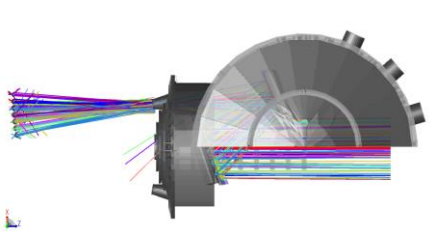
The main parameters:

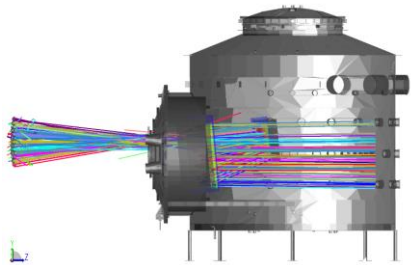
Spot size	1,5 x 2 m
Maximum irradiance	2000 W / m2
Spectrum	Unfiltered Xe
Standard deviation	1.5 x 2.5°
Non-uniformity measurement	±7.5%

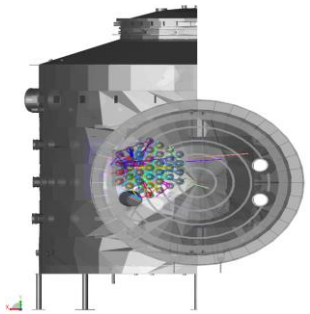
SOLAR SIMULATOR ISI KVU-1500

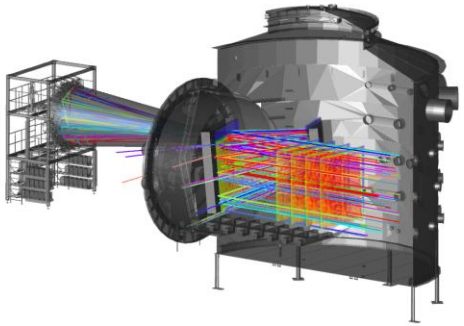


- **The optical design of the ISI KVU-1500 provides high uniformity and minimum non-parallelism of the light beam in the area of the test object.**









- **Integration with the KVU-1500 stand**

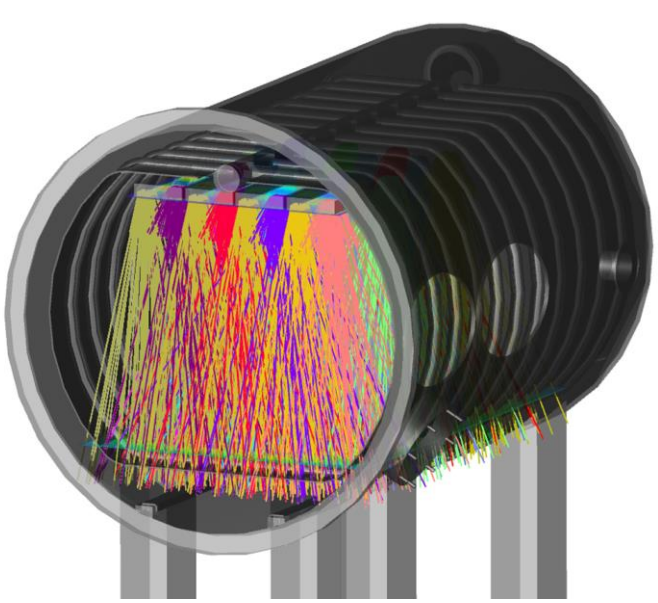
Description:

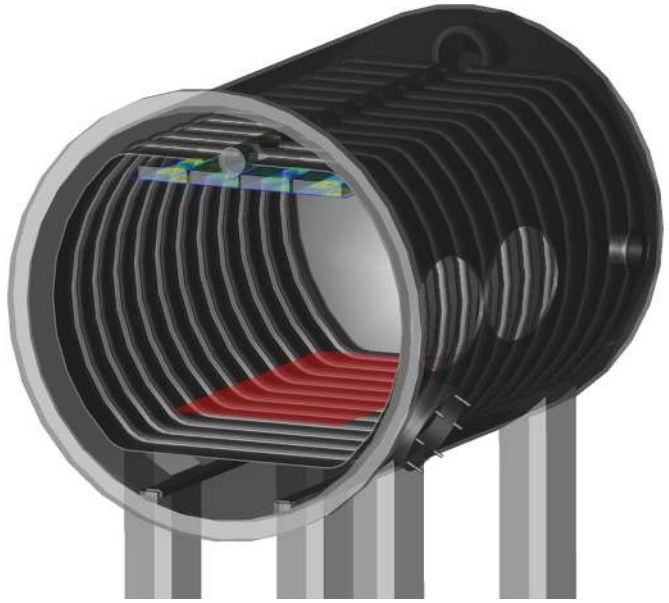
Development Solar Simulator Testing Facility KVU-1500 pretends to be the most perfect of those operated by **JSC Information Satellite Systems named after acad. M.F.** Reshetnyov. The Solar Simulator provides unprecedentedly high performance in terms of volumetric uniformity of the light beam and its non-parallelismt. The combination of these characteristics ensures the highest accuracy of reproduction of the acting factors outer space and allows for experimental testing of the most modern space platforms.

Specifications:

Spot size	4 x 4 m
Irradiance	200...2000 W / m2
Spectrum	Unfiltered Xe
Non-uniformity measurement	±10%
Non-parallelism	±1.5°

SOLAR SIMULATOR ISI KVU-1500



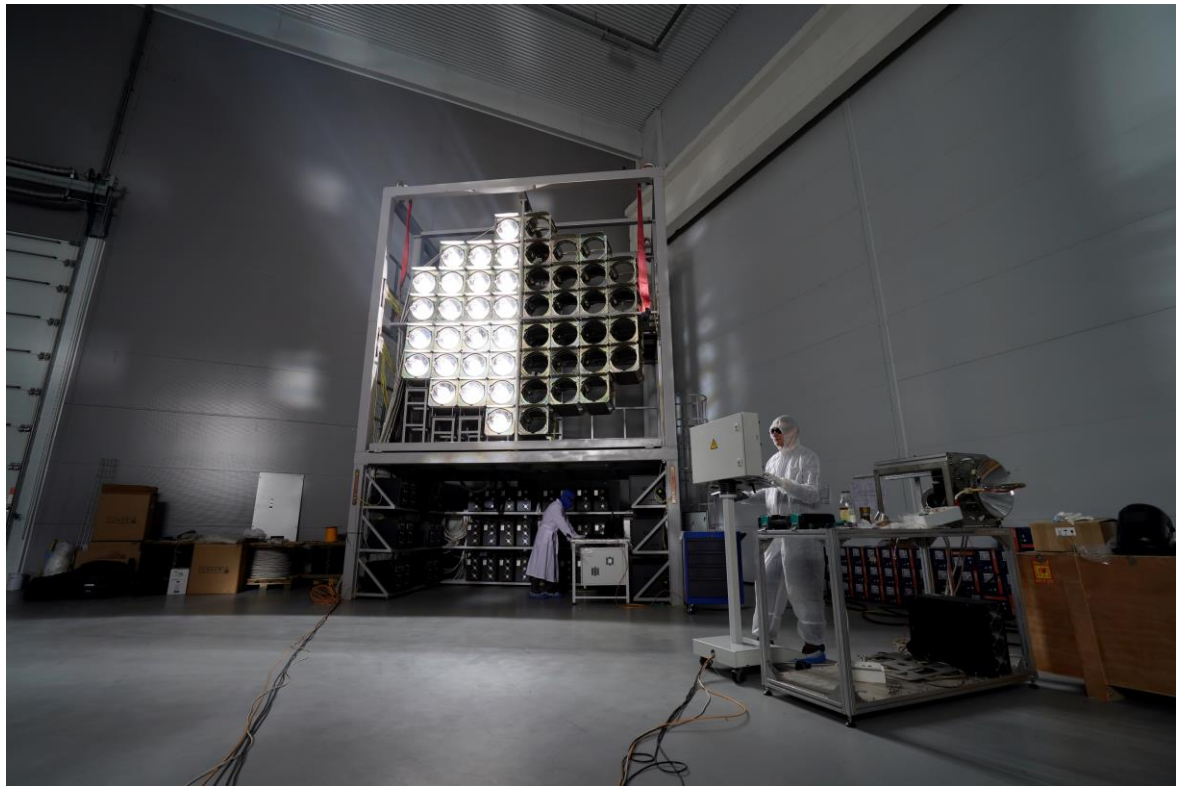


We also completed a set of works on modeling the light-optical scheme of the IS-500-1 solar simulator, within which we obtained a good agreement between the simulation results and experimental data.

The presence of such a verified calculation model, combined with experience in creating various lamp modules and other components of the ISI, allows us to confidently approach participation and guarantee the successful completion of work

- **At the moment, our company is working on a project to equip the "Helios"**
- **installation with a new generation solar simulator (based on LEDs and low-power halogen lamps)**

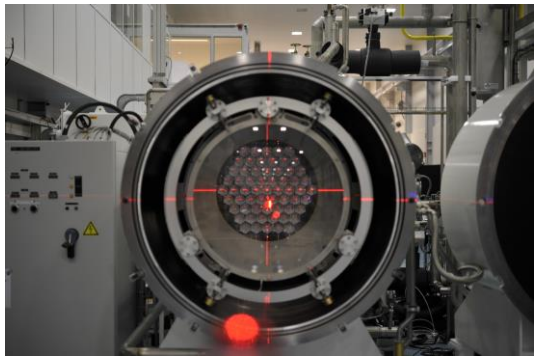
SOLAR SIMULATOR ISI KVU-1500

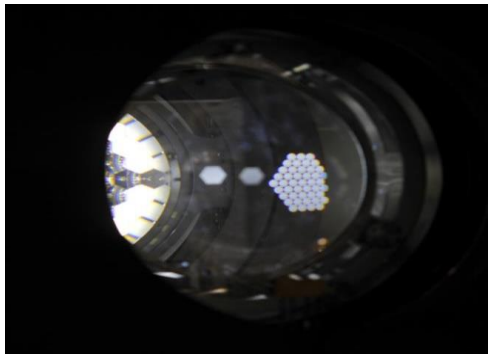


- **Solar simulator ISI KVU-1500 for JSC Information Satellite Systems named after acad. M.F. Reshetnyov**

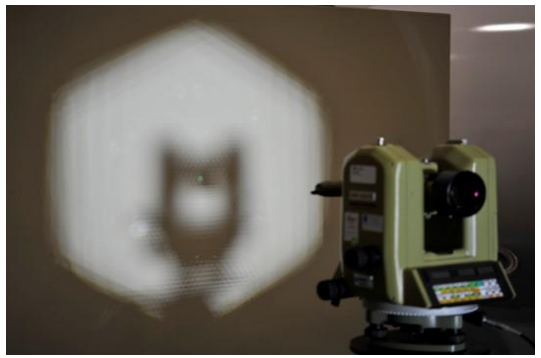
INTEGRATION AND ALIGNMENT

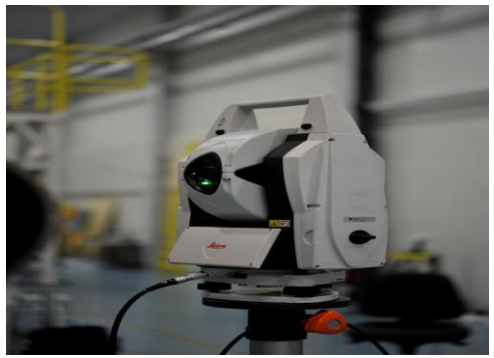
- **The solar simulator is** the main and most complicated element **of the** thermal vacuum **test**. The Sun simulator is a close approximation to the real Sun, but using it for testing spacecraft requires careful measurement of the parameters of the light beam.
- The solar simulator is a source of radiation and an optical shaping system, directing flux into the working area.





- Measurements are made using certified measuring techniques and measuring instruments that ensure traceability to primary standards.





Description:

An important stage in creating a solar simulator is its integration with a vacuum unit and the creation of a spatial model of the equipment, for example, in the Spatial Analyzer® software environment.

For this, at the stage of equipment integration, the mutual spatial position of the components of the TVI stand is adjusted and accurate measurements of their spatial coordinates are carried out. Further, the spatial model is used to plan, optimize and document the thermal vacuum experiment.

The following parameters are subject to measurement and certification:

- Distribution of irradiance (in the plane and in the volume) [W / m2]
- Non-uniformity of the distribution of energy illumination [%]
- Spectrum
- Non-parallelism of the light beam

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HEAT FLOW SIMULATION FACILITY

Heat flow simulation facility are designed to simulate thermal flows in a vacuum.

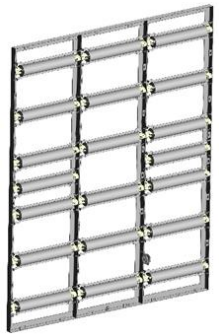
HEAT FLOW SIMULATION BASED ON IR LAMPS

- **Background heat flow panel "100"**

KGT220-1000-1 lamp - 20 pcs.

Main parameters:
Dimensions:

Height - 1420 mm
Width - 1152 mm
Depth - 94 mm
Weight: 15KG



- **Background heat flow panel "300"**

KGT220-1000-1 lamp - 10 pcs.

Main parameters:
Dimensions:

Height – 1420 mm
Width – 385 mm
Depth – 94 mm
Weight: 6,5 KG

- **Background heat flow panel "330"**

KGT220-1000-1 lamp - 3 pcs.

Main parameters:
Dimensions:

Height – 520 mm
Width – 385 mm
Depth – 172 mm
Weight: 2,5 KG

Description:

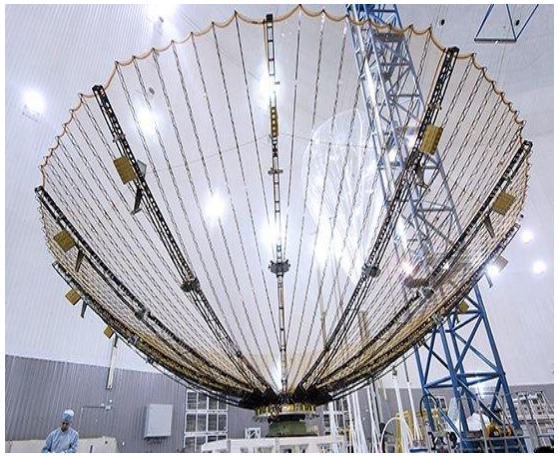
Heat flow simulation facility are designed to simulate heat flows in a vacuum. The panel body is made of an aluminum profile. Quick connectors are used to install lamps in the panel frame. The lamp is installed in a plafond consisting of a reflector and an emitter.

Reflector material sheet AMg6.BM1 GOST 21631, coating: Chemical polishing according to OST 92-1176 from all sides. Emitter material sheet AMg6.BM1 GOST 21631, coating: An. Ox. nhr. from all sides.

Panel power: 2.5 kW

Voltage: 220V

LASER LOCAL HEATING SYSTEM



Some mechanisms of deployable antennas (like actuators etc.) may require precise local heating with sharp edges

When using traditional IR-heater based on tubular lamp sharp edges can not be obtain.

Description:

In thermal vacuum testing of products with a complex spatial topology, it is required to create at the test object separate clearly localized zones of illumination with different levels of illumination. The creation of such areas of exposure is impossible either with the help of lamp simulators of a heat flow, or with the help of a simulator of the Sun. The possibility of such tests is provided by a local laser heating system. This is a multichannel system that includes laser sources, light guides for delivering radiation into the volume of a vacuum installation, and objectives that form a size-adjustable illumination spot on the object.

Features:

- Delivering of laser light into hermetically sealed V/C
- Shaping of perfectly sharp light spot on the specific zones of a S/C
- Local heating of specific zone w/o heating outside areas
- System can be easily customized by number of channels / power in each channel
- Fiber laser or diode lasers can be used as the source providing therangeof0…several hundreds W in each channel delivered to the S/C

The concept:

Perfectly sharp spot can be obtain using laser source and beam shaping optical system (beam shaper)

COMPONENTS

Lamps

Short arc Xe lamps remains "the golden standard" in space industry

- water-cooled electrodes
- air-cooled electrodes

Lamp arrays and power cabinets

Lamp array meets power cabinet to provide high efficacy Solar Simulator illumination system

Excellent opto-mechanics

Solar Simulator is the place where superior optics meets excellent mechanics to provide non compromising performance

Cold mirrors

Liquid cooling Mirror turns out to be the Solar Simulator heart forming powerful and parallel light beam onto the specimen like the Sun does

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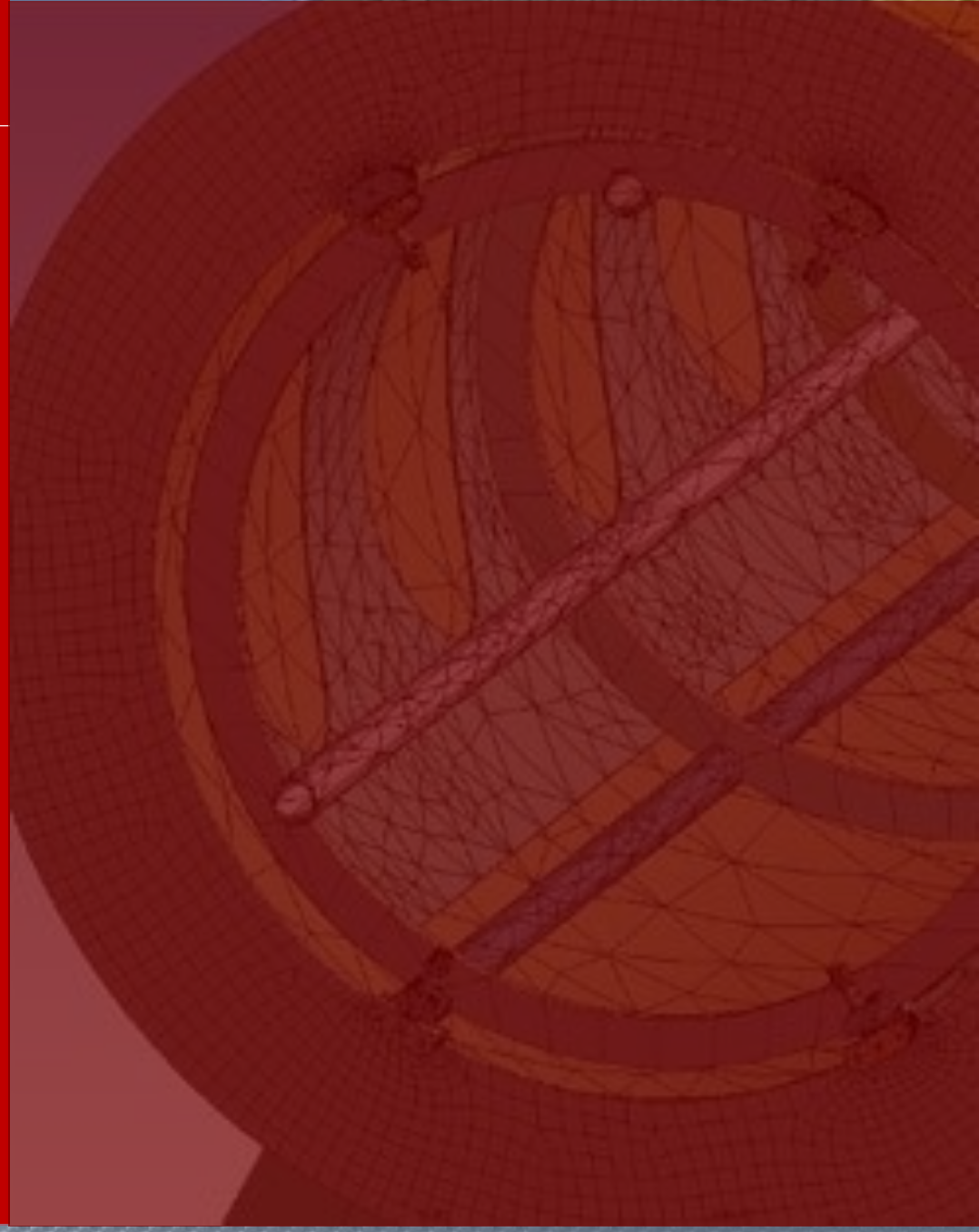
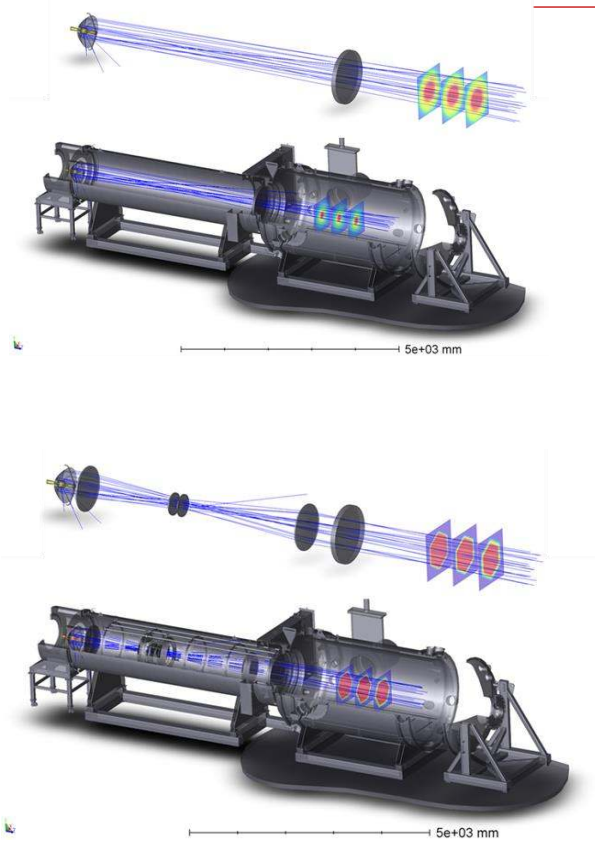
VIRTUAL LAB OF THERMAL VACUUM TESTING

The development of computer models of Solar simulators and their experimental verification led to the idea of creating a virtual laboratory of thermal vacuum testing.



VIRTUAL LAB OF THERMAL VACUUM TESTING



- VTC 1.5 Sun Simulator optical system: before and after

- The virtual laboratory is a powerful tool for modeling temperature fields at the test object and the elements of the TVI stand under the conditions of radiant fluxes generated on them from the Simulators of solar radiation and Simulators of heat fluxes. This allows you to plan thermal vacuum tests in a virtual environment and to clarify the requirements and issue recommendations for conducting real tests.

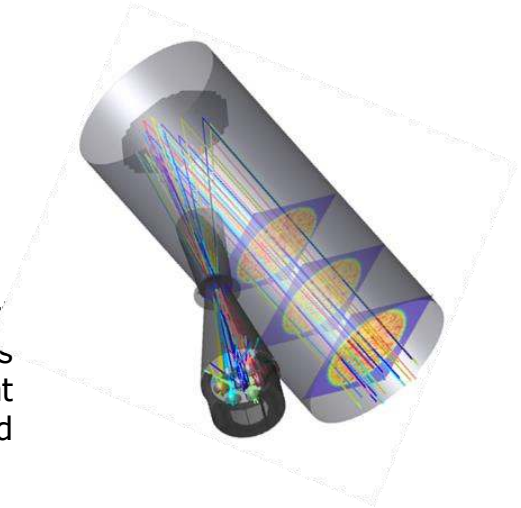
Description:

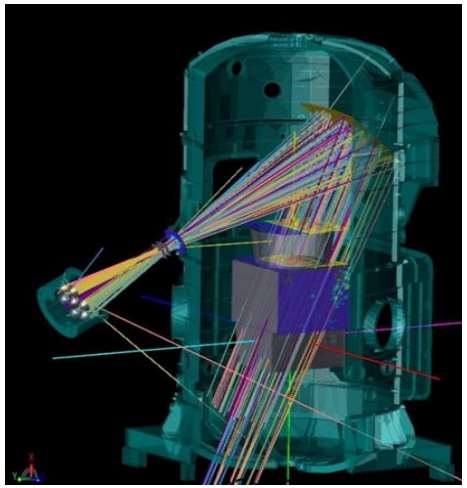
A virtual laboratory is a collection of interconnected computer models, including:
CAD model (SolidWorks®),

optical model for calculating the path of rays (LightTools®, ZEMAX OpticStudio®),

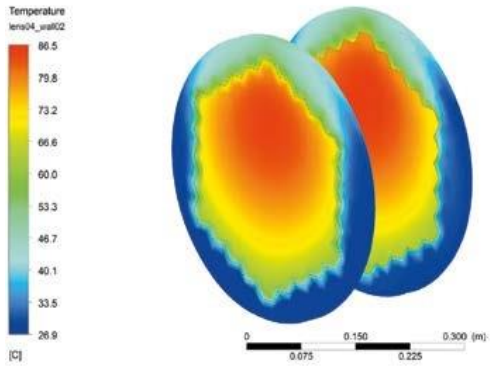
a spatial model based on the measurement of the actual dimensions and position of the elements of the optical scheme (Spatial Analyzer®)

thermophysical model of the stand and the tested object (ANSYS®, Fluent®).



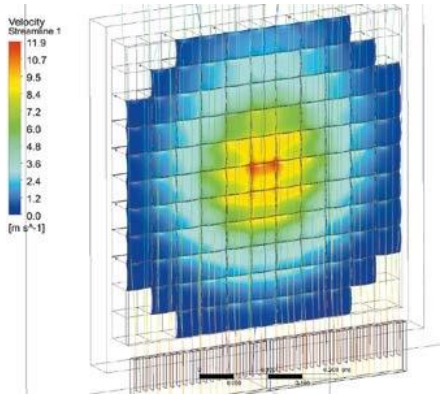


VALIDATION AND VERIFICATION



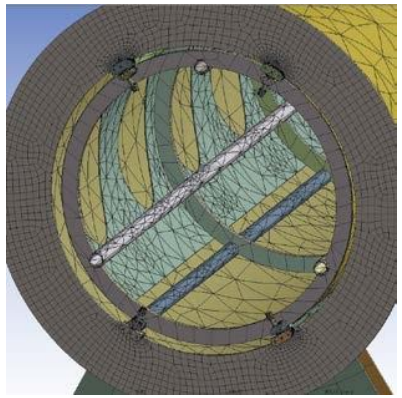
Thermal analysis Flow Simulation with Natural Convection

It is possible to simulate the thermal conditions of optical elements and reasonably approach the task of designing a proper cooling system.



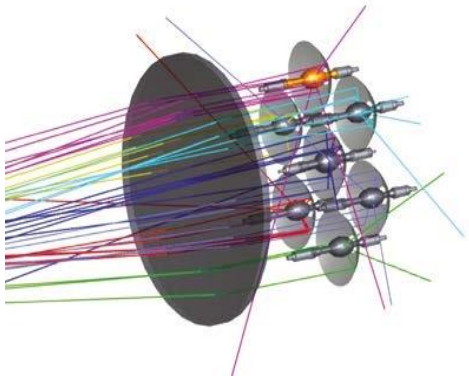
Simulation of gas dynamic processes

Allows you to choose the right equipment and predict the efficiency of the cooling system in normal and critical modes.



Strength analysis calculations

The ability at the design stage to verify the structure for rigidity, strength and dimensional stability, as well as to make sure that the simulator design does not lead to unacceptable mechanical deformations of the structures of the vacuum chamber and the TVI stand.



Design and prototyping of optical systems

Calculations for optical systems, using the method of simulation modelling.

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TECHNOLOGICAL CARBON-CARBON AND GRAPHITE SCREENS

Aerospace components commonly fabricated from carbon/carbon composites include rocket motor nozzle throats and exit cones, nosetips/leading edges and thermal protection systems. Reliable performance is the most critical requirement of these components. The carbon/carbon composites have demonstrated reliability and reduced systems costs, especially when multiple components in an assembly can be replaced with a one-piece carbon/carbon composite design.

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TECHNOLOGICAL CARBON-CARBON AND GRAPHITE SCREENS

Technological carbon-carbon and graphite screens

Parts production according to customer drawings.

Commercial applications of carbon/carbon composite materials and graphite materialsinclude furnace fixturing, heatshields, load plates, heating elements, and X-ray targets. Rocket nozzles must withstand an extremely rapid temperature increase in a highly corrosive atmosphere while maintaining a high degree of integrity. In addition to exposure to severe thermal stresses, the nozzle material must perform predictably and uniformly to provide the required accuracy and range.

Description:

Due to their unique properties, products and parts made of carbon-carbon composite materials and graphite are widely used in the field of heat treatment as heat-resistant equipment for high-temperature furnaces.

Our **carbon and graphite** materials are processed under strictly defined manufacturing processes using specified raw or treated materials.

A graphite felt cylinder is formed by combining graphite paper, carbon fiber and carbon cloth, which are then further subjected to a high-temperature cleaning treatment.

Properties:

- Corrosion resistance
- Thermal stability
- Air tightness
- Low coefficient of linear thermal expansion and thermal conductivity.

Specifications:

Density	g/cm^3	0.16-0.20
Carbon content	%	≥99
Process temperature	°C	2300
External diameter	mm	200-1500
Thickness	mm	30-120
Height	mm	300-2000

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