OOO “Center of ultrasonic technologies”

Ultrasonic devices for operation in abnormal conditions of temperatures and pressures (in space)

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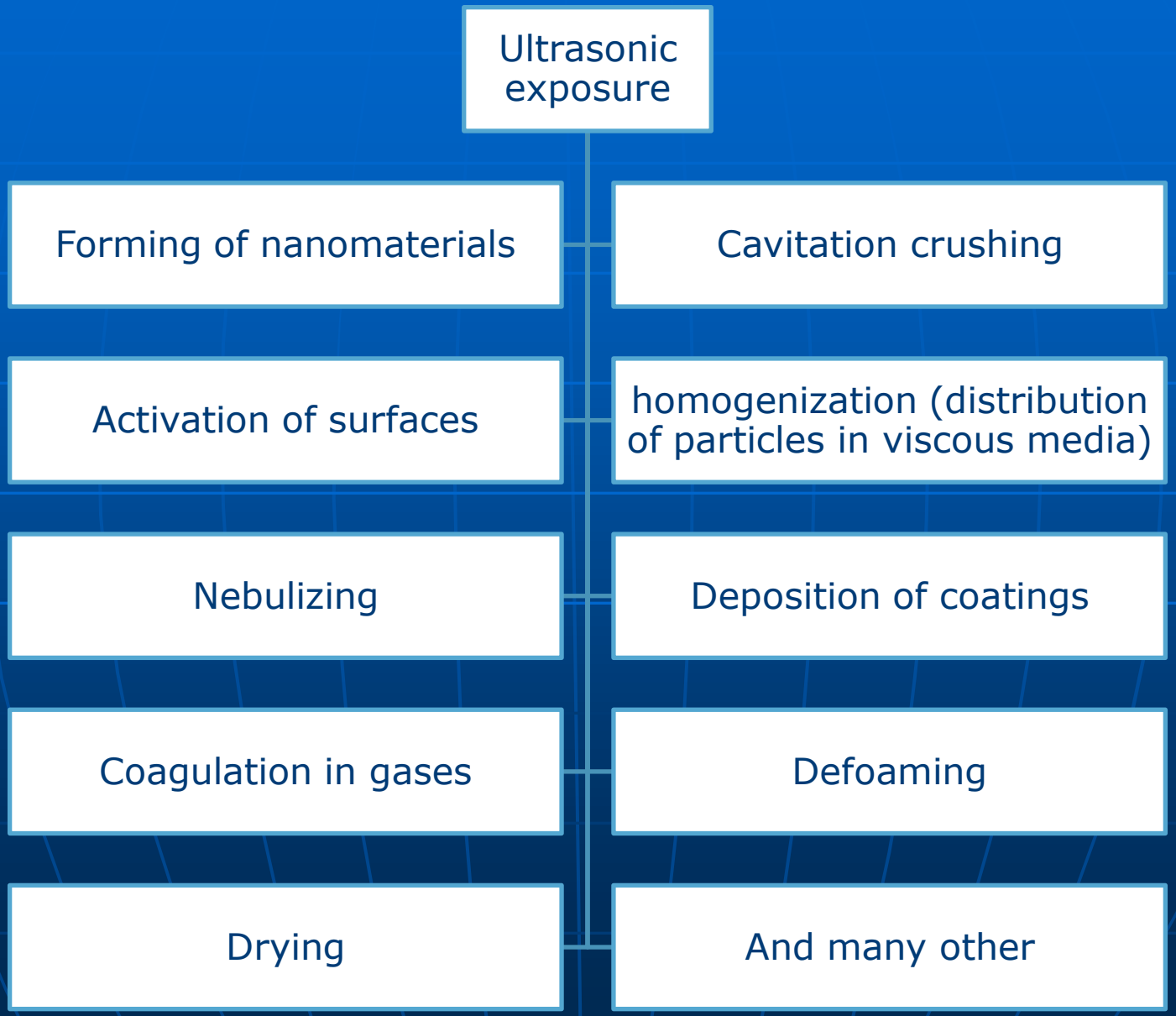
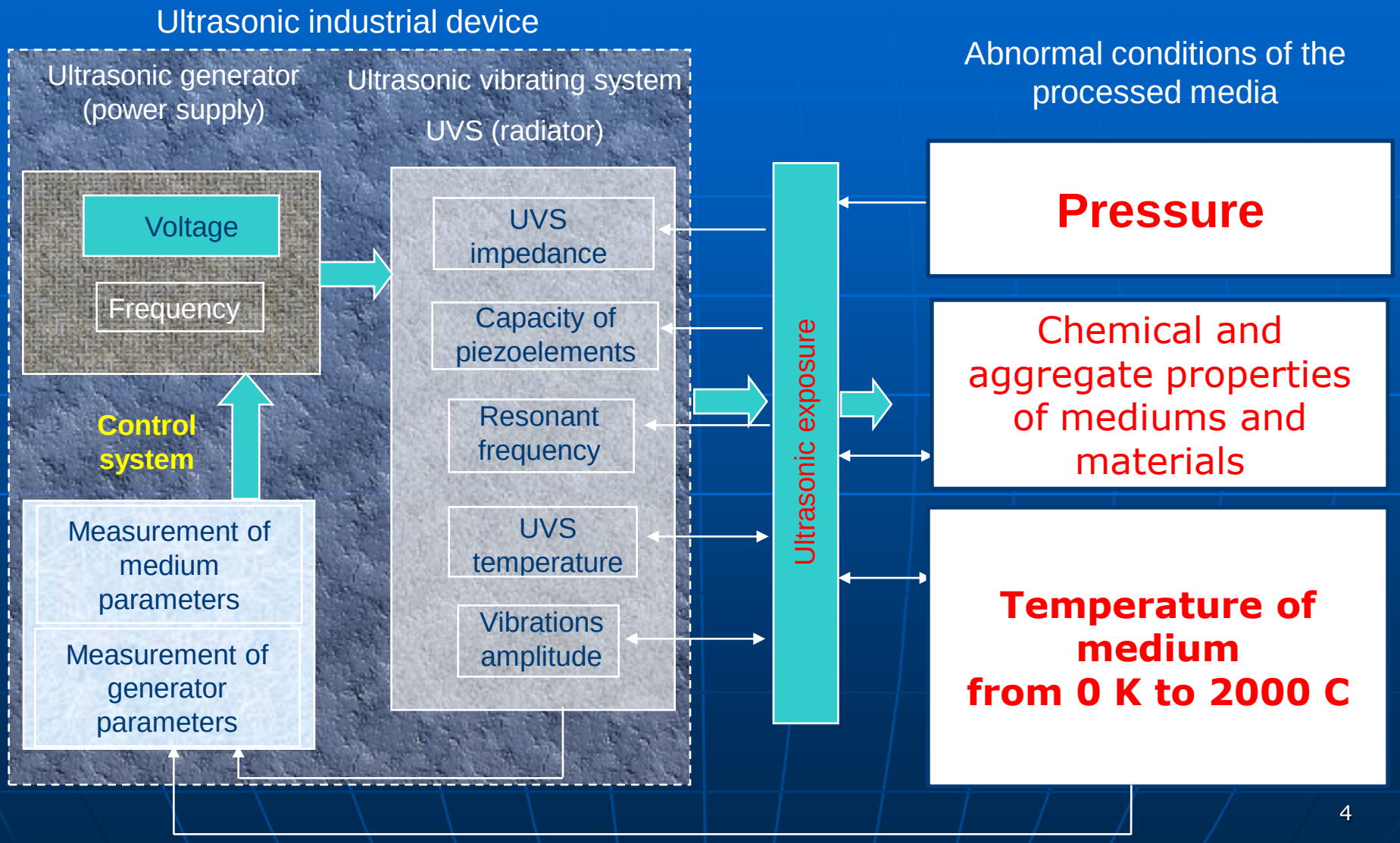
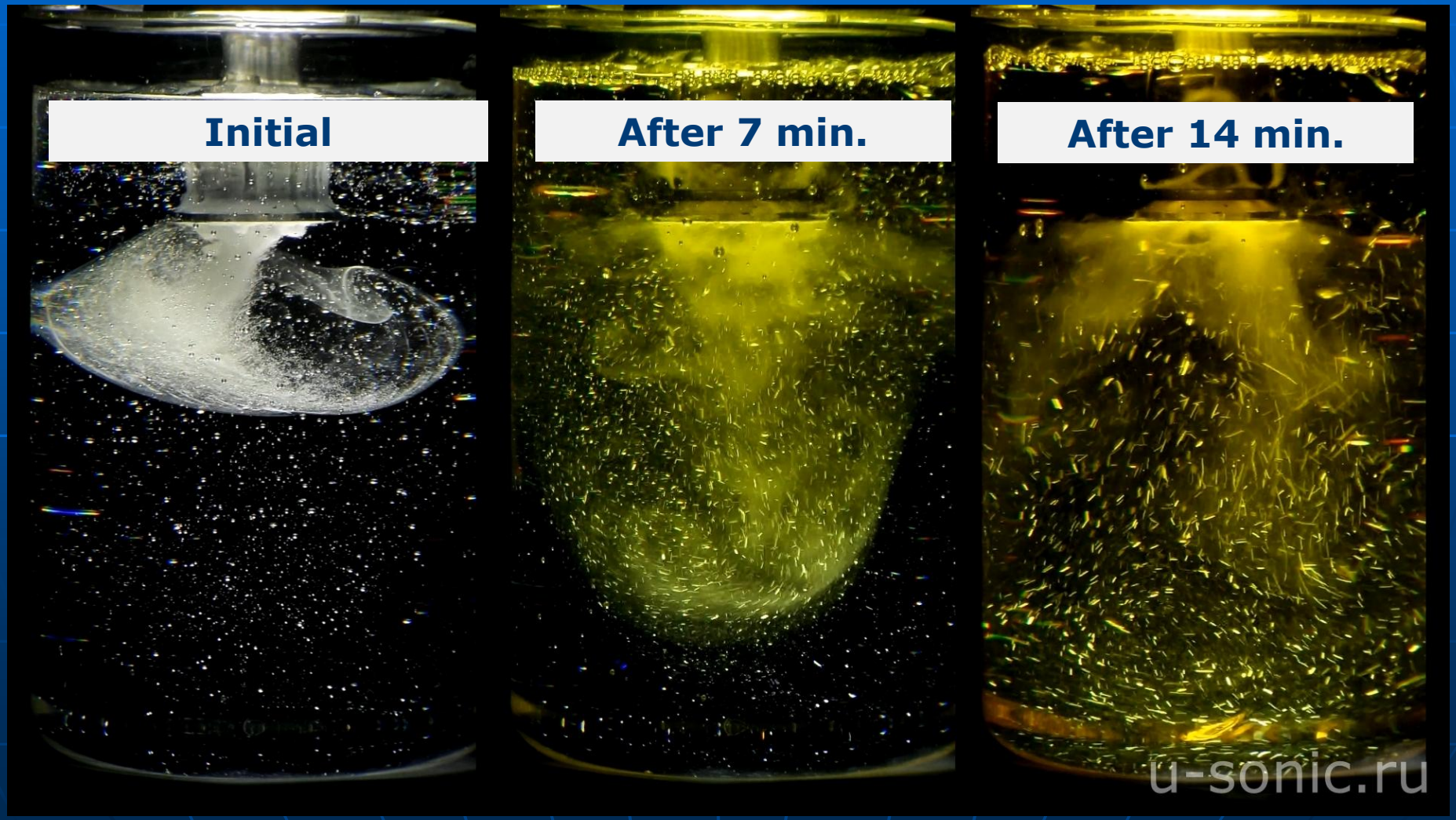
Application of ultrasonic devices in abnormal conditions



Ultrasonic exposure in abnormal conditions



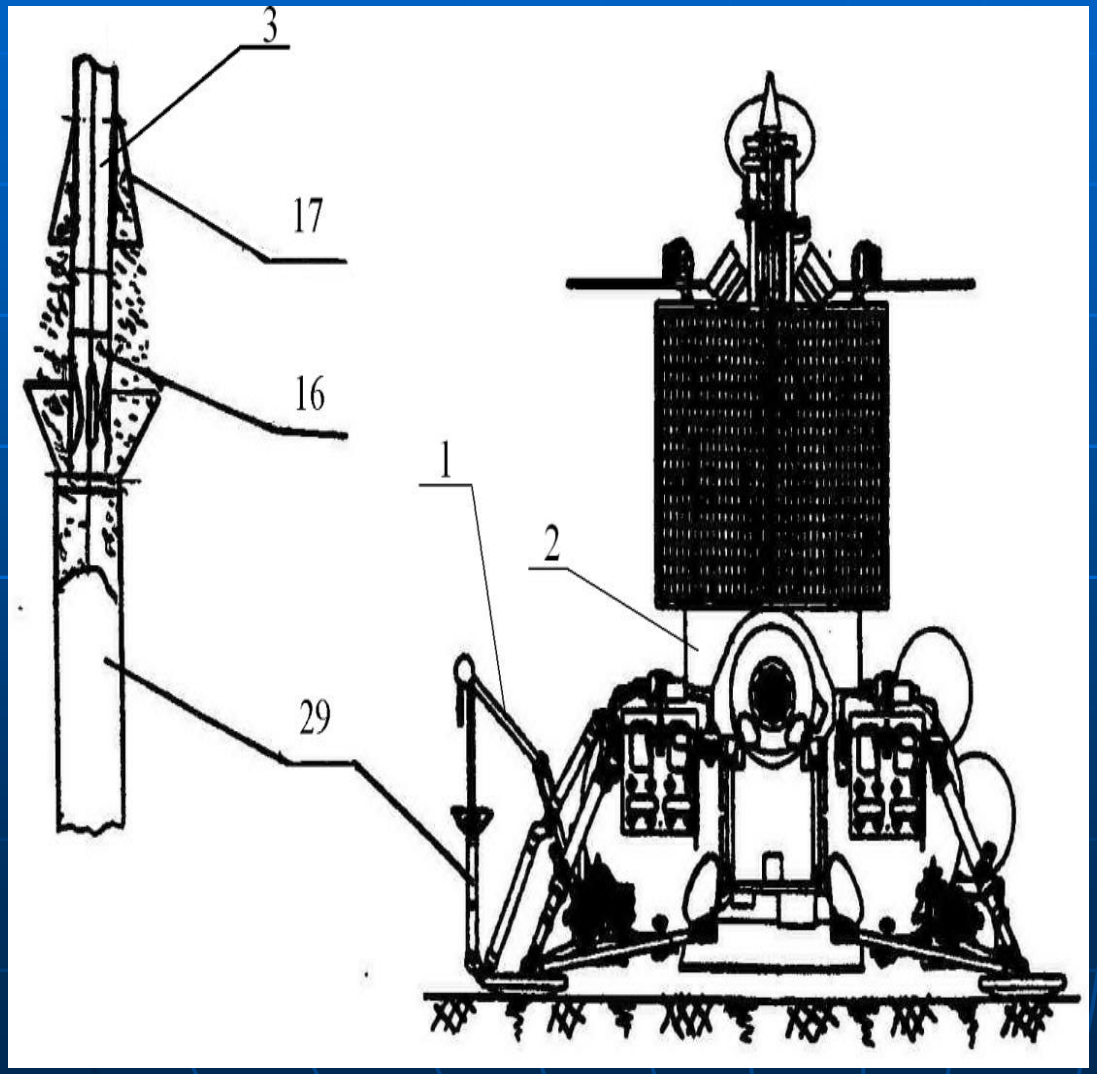
Influence of liquid medium temperature

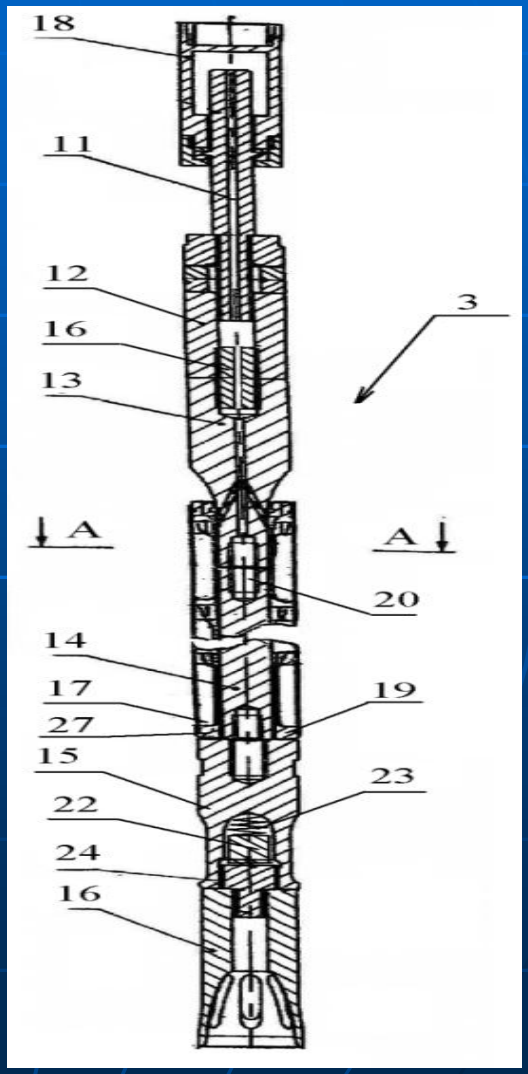


Ultrasonic exposure of melted metal (T more than 1000 C)

Drilling of frozen soil with temperature of liquid nitrogen

Drilling of soil on planets and asteroids (T from 0 K to 1000 K)



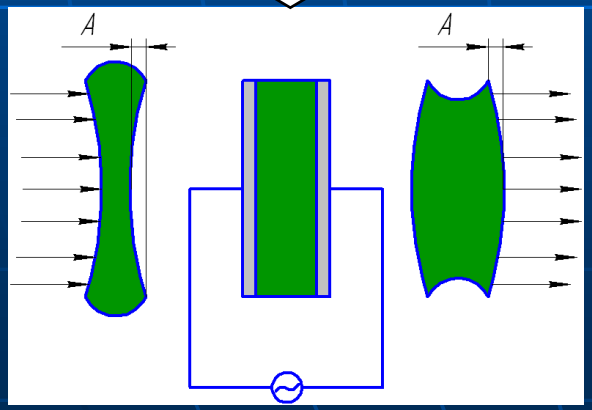


Piezoelectric transducers

Piezoelectric effect

Polarization of a dielectric at squeezing

Inverse piezoelectric effect



Piezoelectric materials

Natural quartz

1000V- 1μm/cm

Synthetic piezoelectric materials
1000V-50 μm/cm
Zirconate – titanate of plumbum
PZT-5, PZT-8 (ZTP-23), APC-841

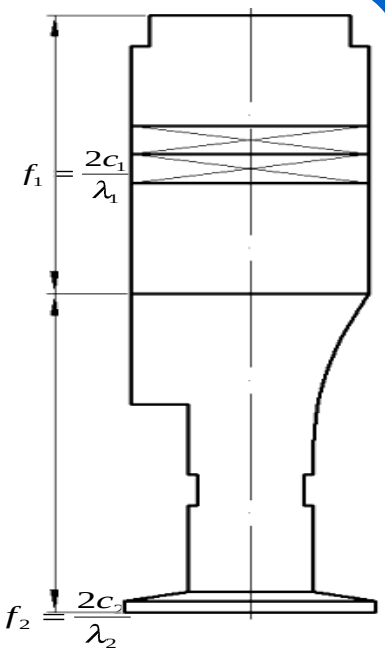
Piezoelectric elements

Influence of abnormal medium on the radiator

Temperature influence

Heating and cooling of working tool material
ΔF~f(Pac)

Heating and cooling of piezoceramic
ΔF~f(T,U)



External influence

Pressure

State of the medium (solid-liquid)

Influence of the medium (viscosity, dispersion)

Influence of technological processes (drilling)

Processing mode

Without load
23 kHz

Increased pressure
22 kHz

Increase or decrease in temperature from 24 to 20 kHz

$F_{generator}$ - ?
(22±1,65 kHz)

Low-temperature and high-temperature destruction

Destruction of piezoceramics.
Melting of metals.

Overheating of piezoceramics.

Destruction of boosters.
Ultimate strength.

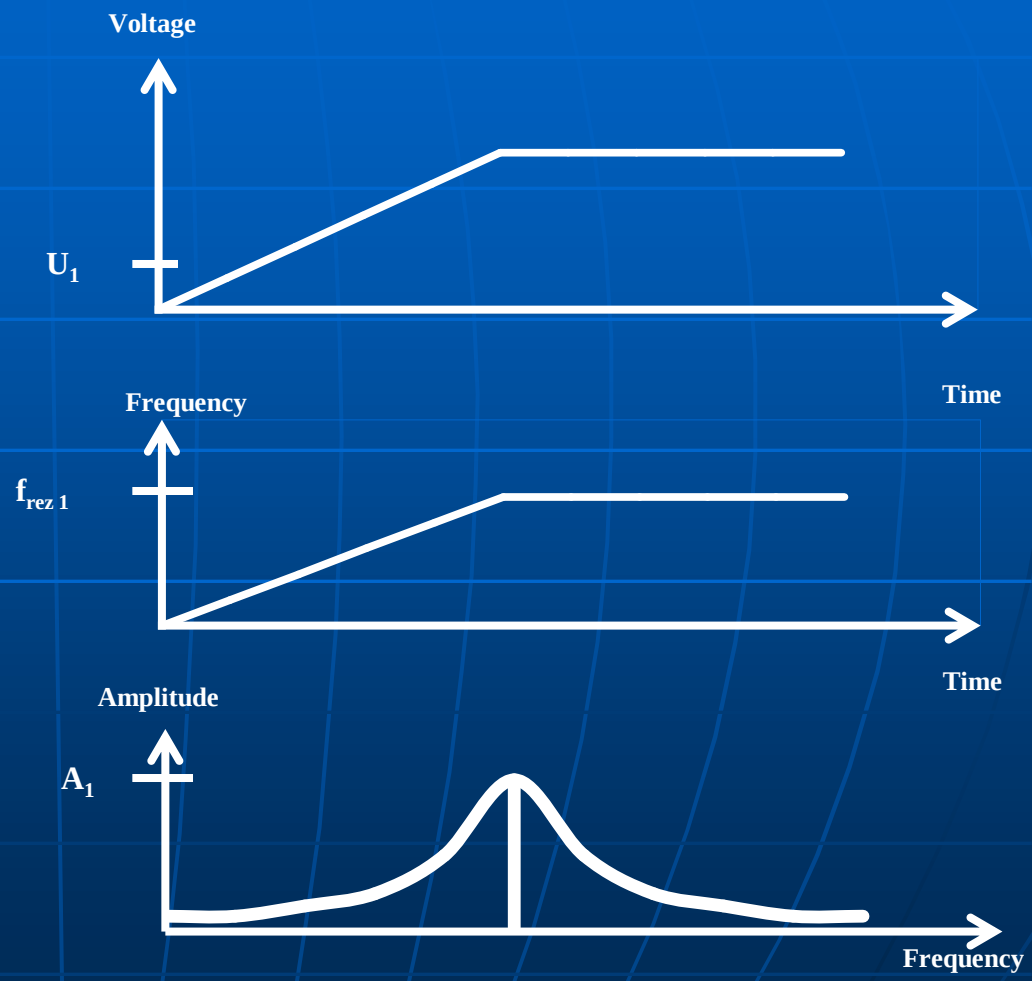
Destruction of studs.

Lack of piezoelectric properties

Piezoelectric vibratory system at low temperature (0 K)

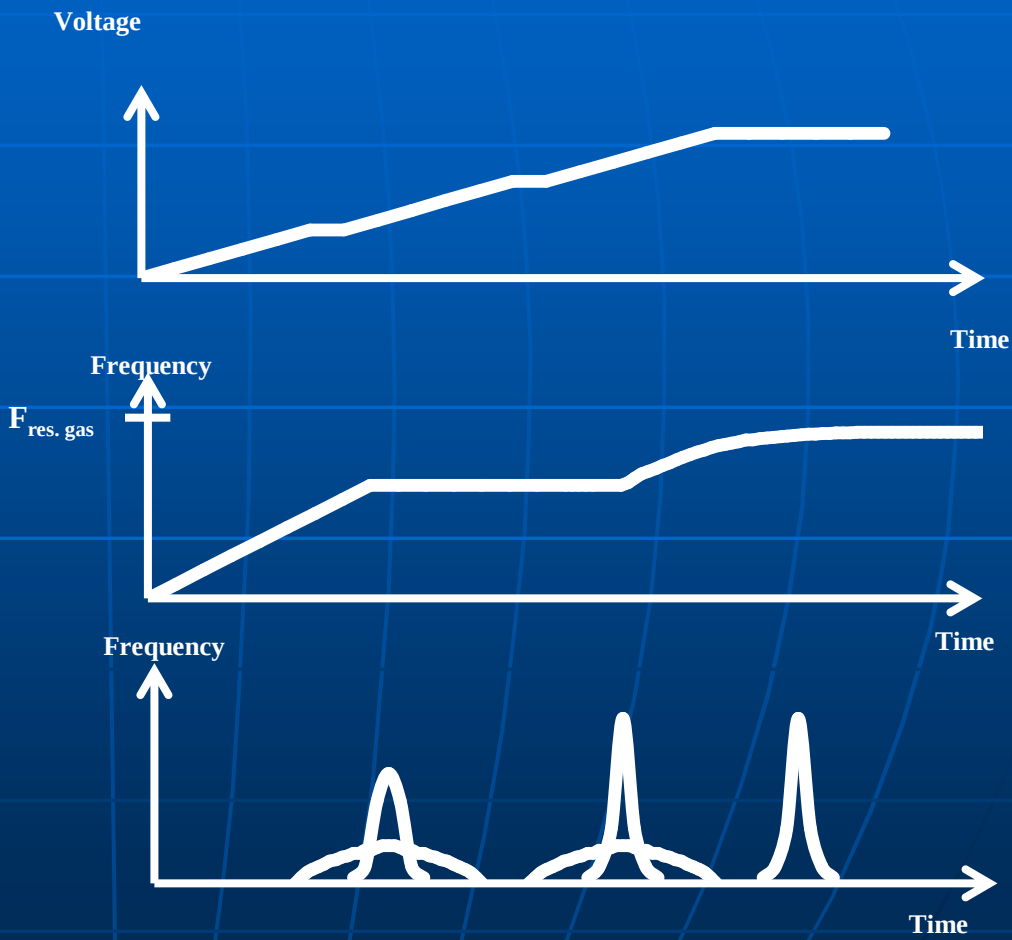
- The formation of vibrations from the moment the electric voltage is applied to the electrodes of the piezoelectric element.
- Providing the necessary increase of mechanical vibrations amplitude, provided that the frequency of the applied electrical voltages coincides with the continuously changing resonant frequency of the vibratory system.

Formation of vibrations at low temperatures



1 - pre-cavitational

Ultrasonic exposure at low temperatures



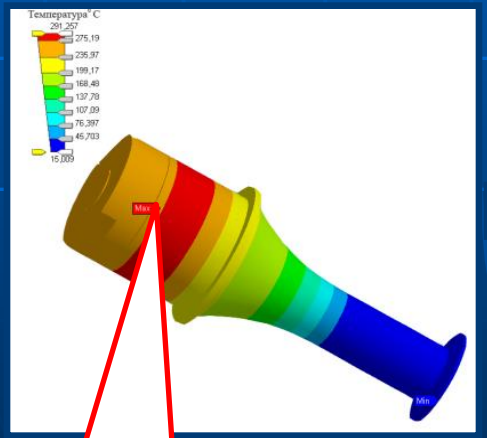
Operation of the piezoelectric transducer at high temperatures

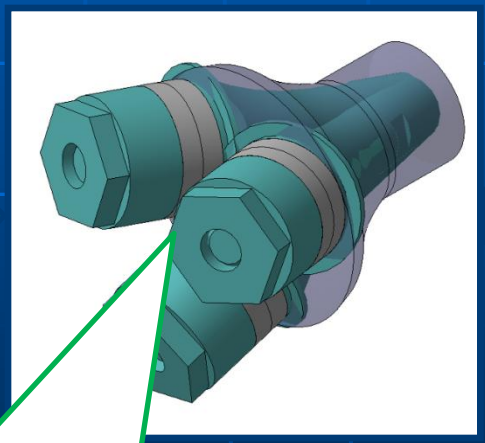
Insufficient radiation surface area

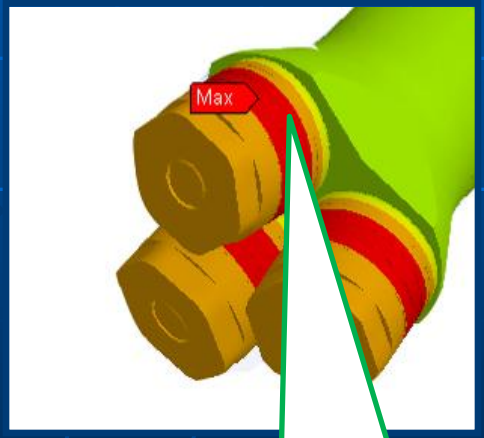
Poor alignment with the processing medium

The need to develop new designs of radiating elements

Insufficient power





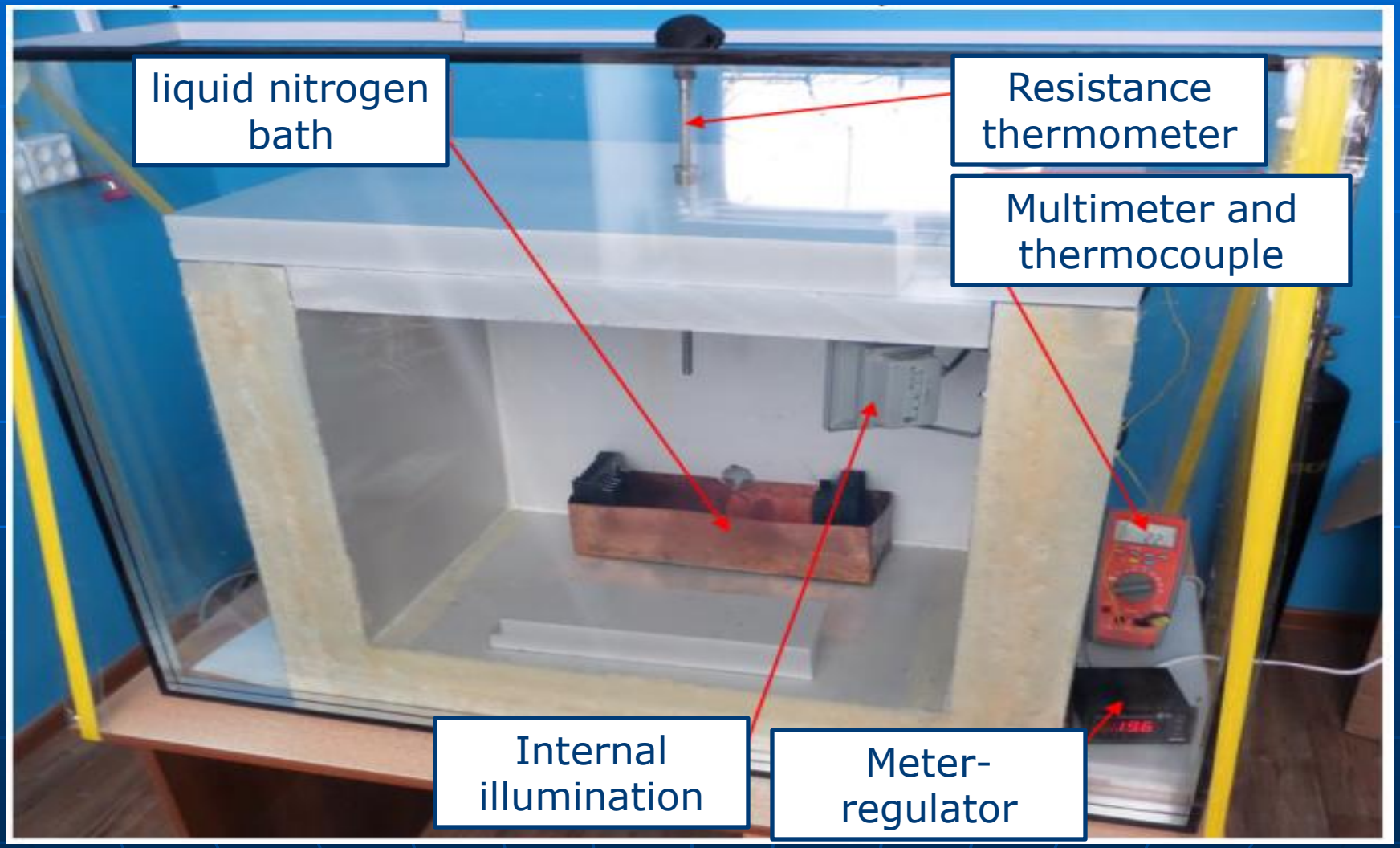


Overheating at a power of more than 150 W

Development of a multi-element transducer – electrical power is distributed among the elements, mechanical vibrations are summed up

No overheating up to 300 W without forced cooling

Stand for low-temperature research

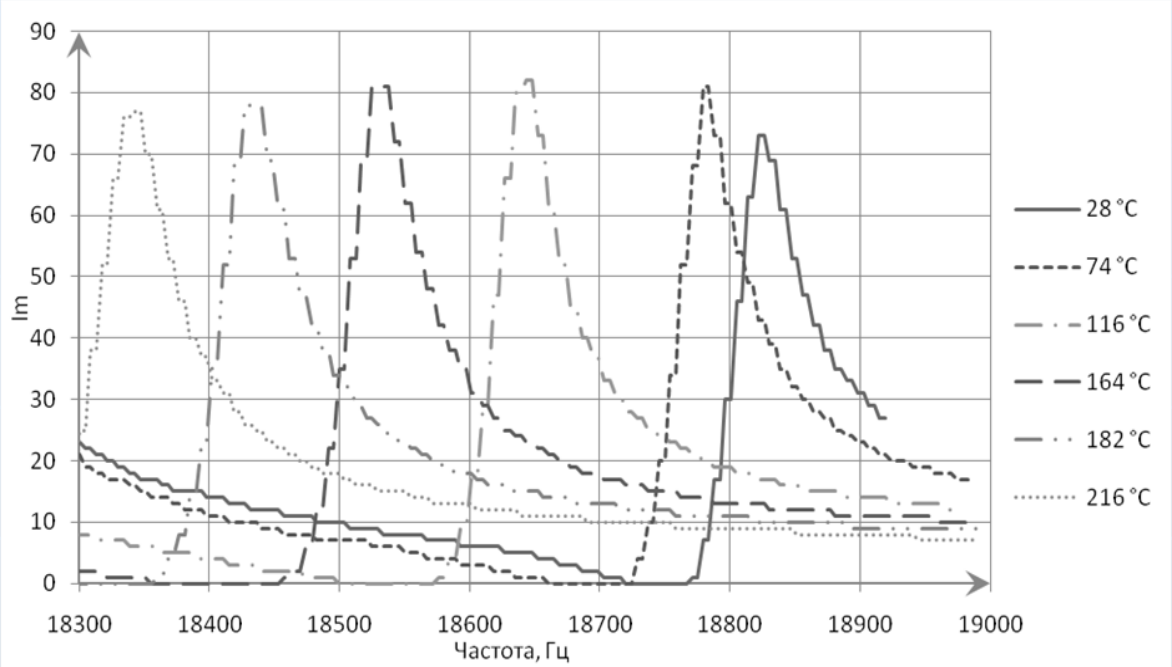


Stand for high-temperature research

Appearance of the refractory chamber

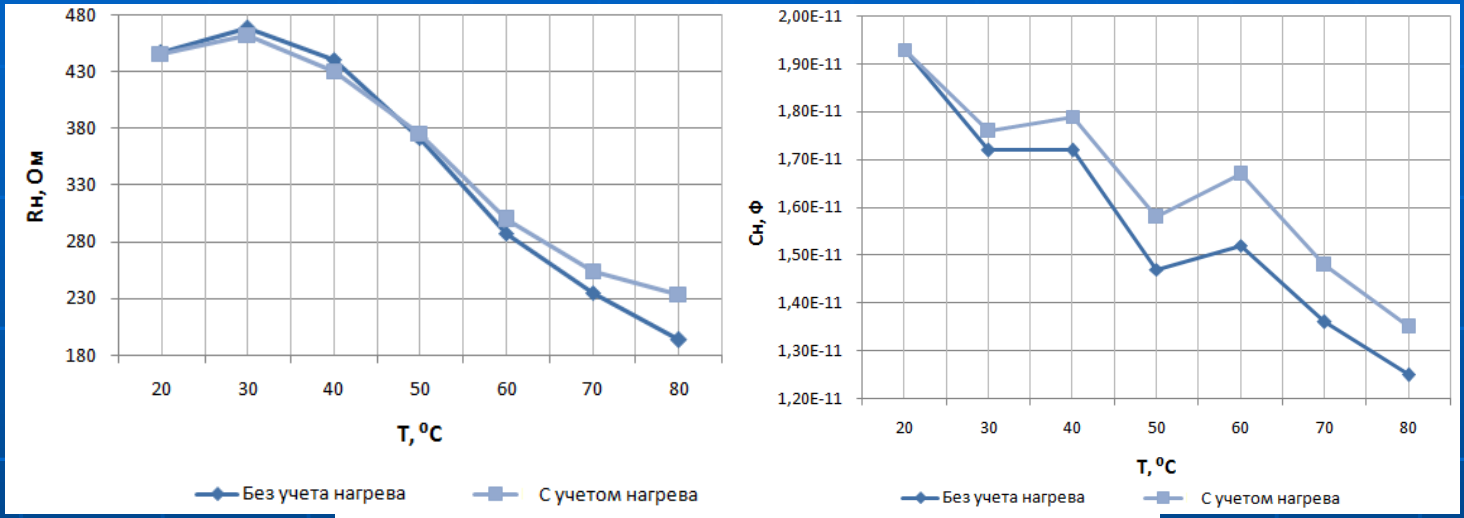
Influence of a radiating surface temperature

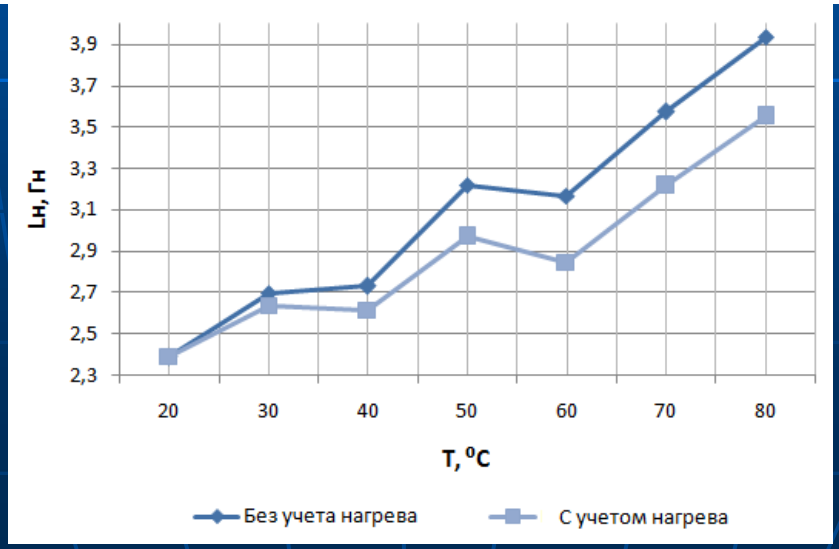
Ultrasonic device
“Solovey”



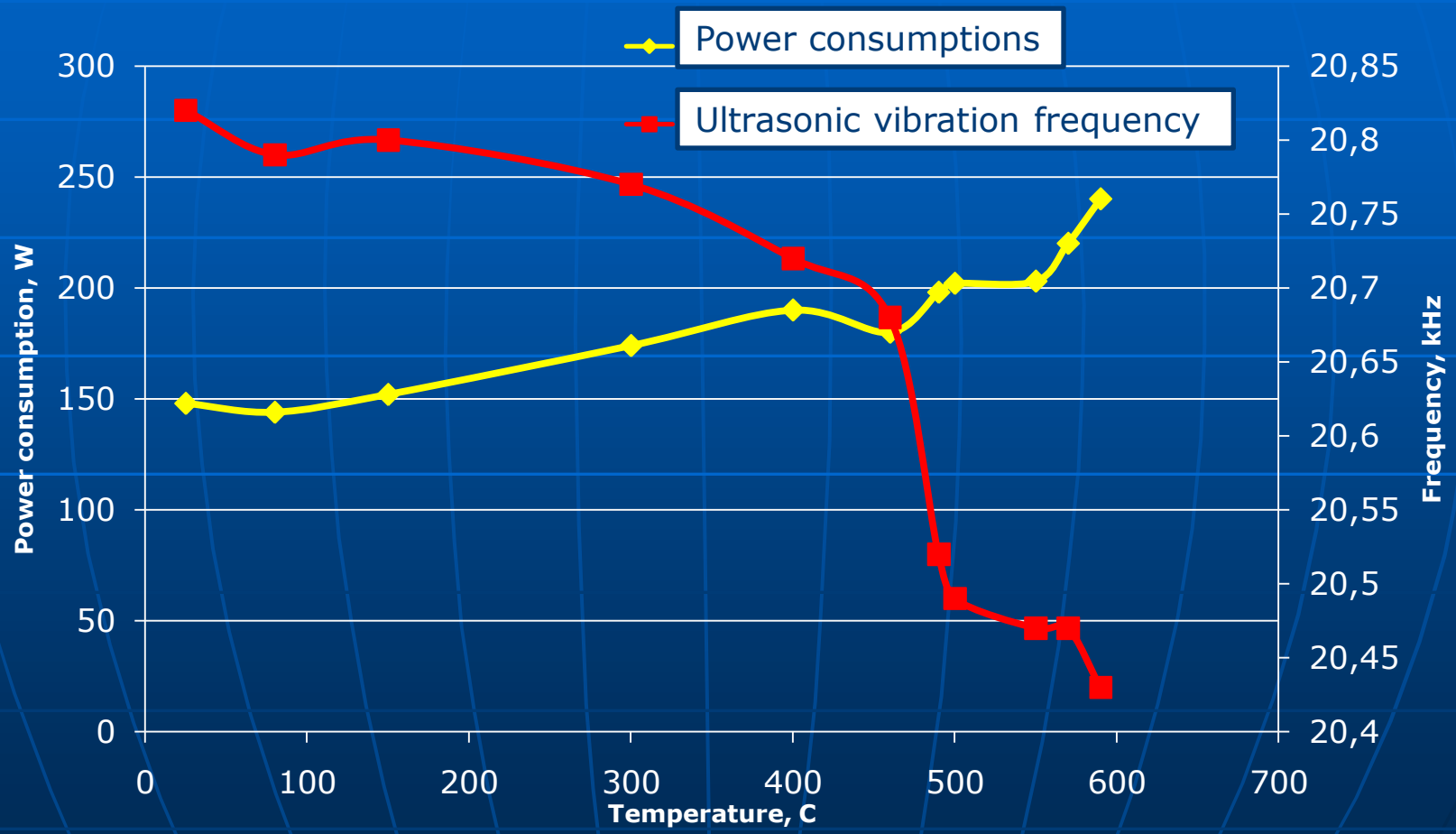
Frequency response of the current of the mechanical branch at different temperatures of the ultrasonic radiator (radiation into the gas medium)

Influence of temperature on piezotransducer

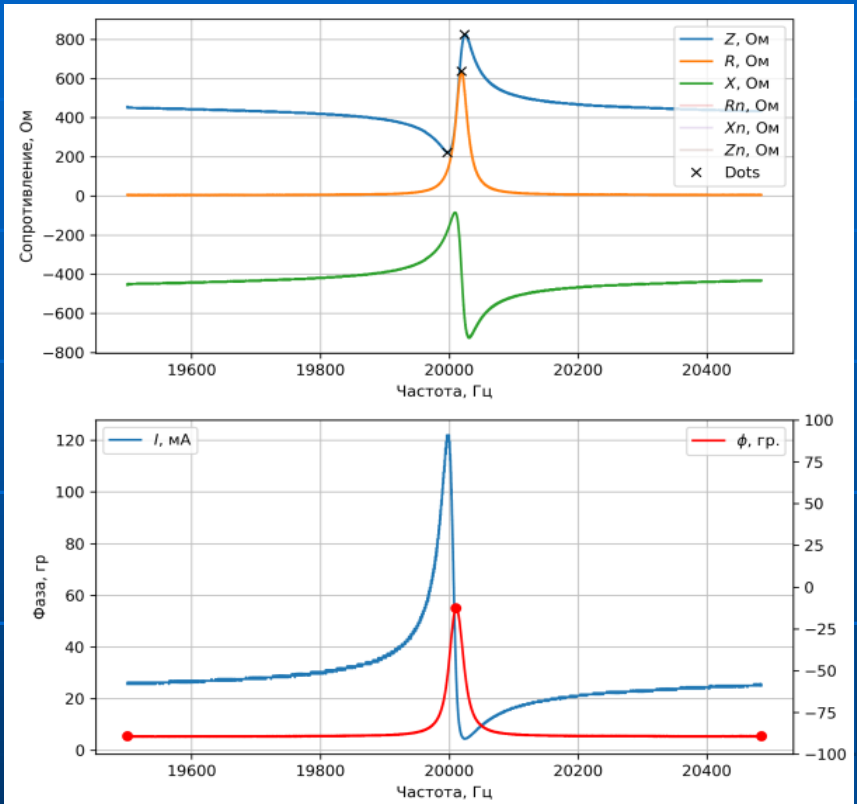


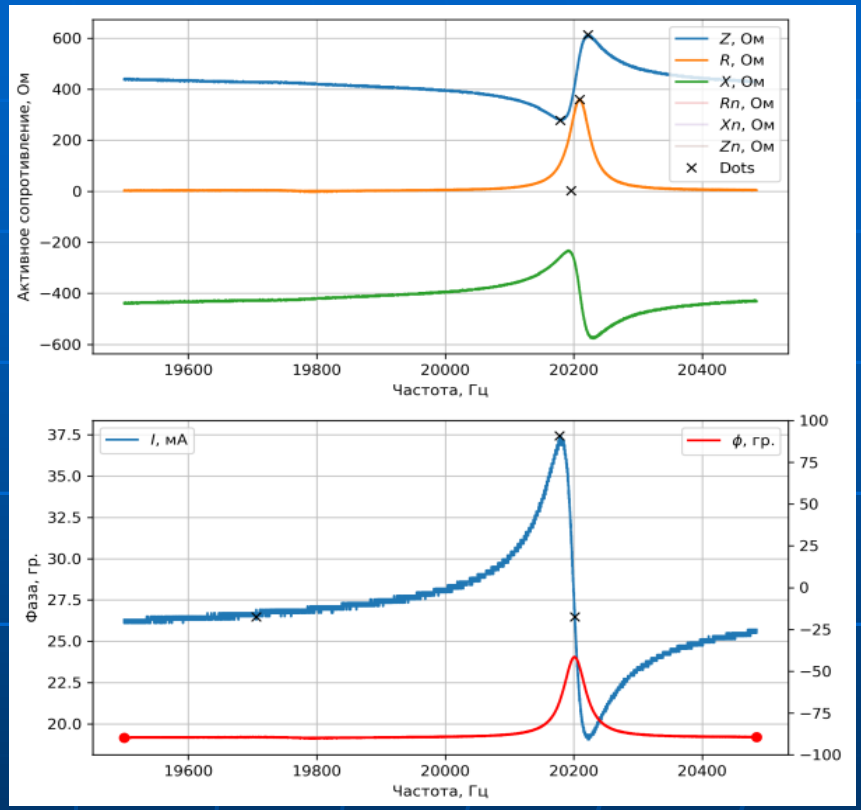


Changing of power and resonant frequency



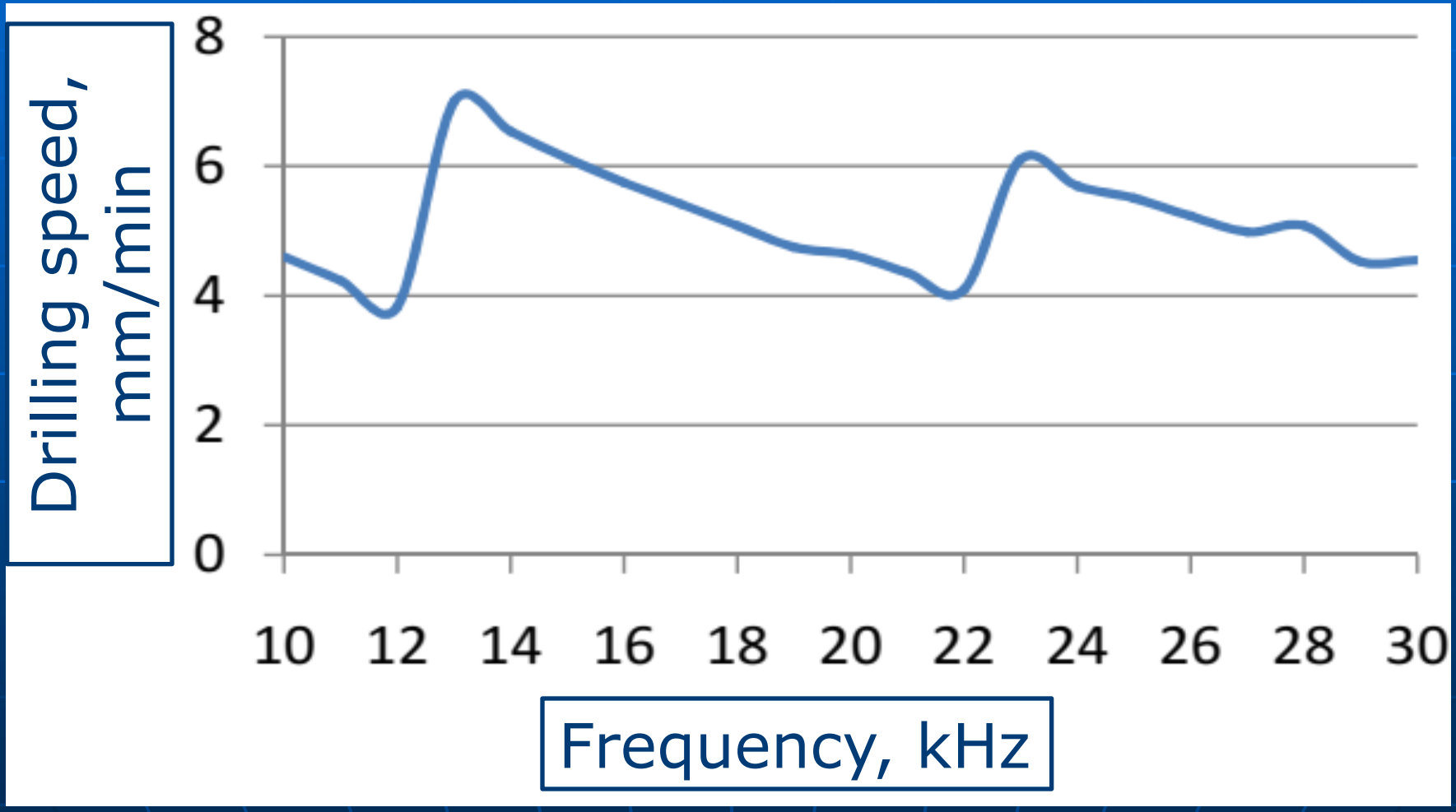
Radiator characteristics



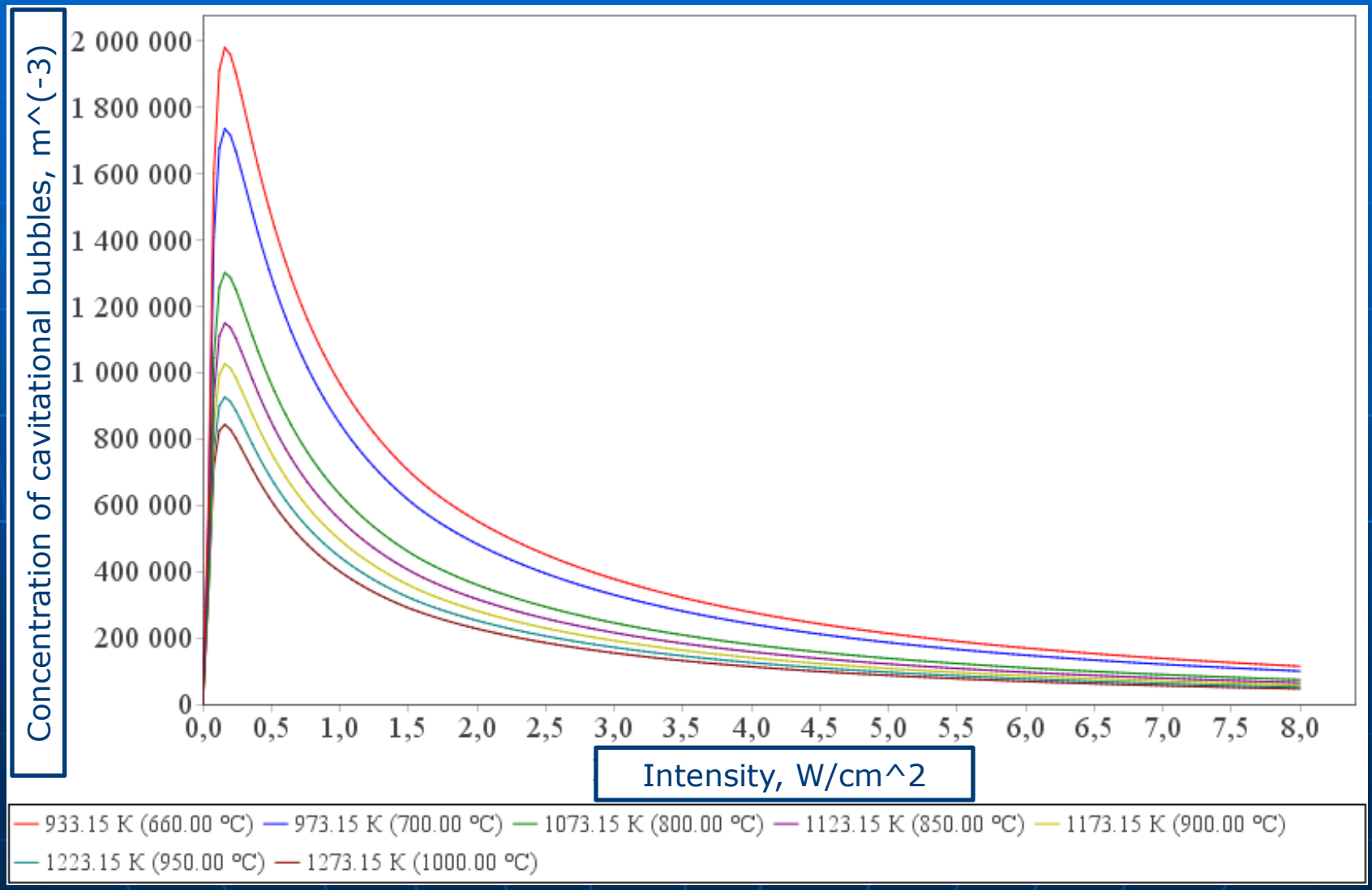


Impedance characteristics, frequency response and frequency response of vibratory system in air and when working in melted aluminum

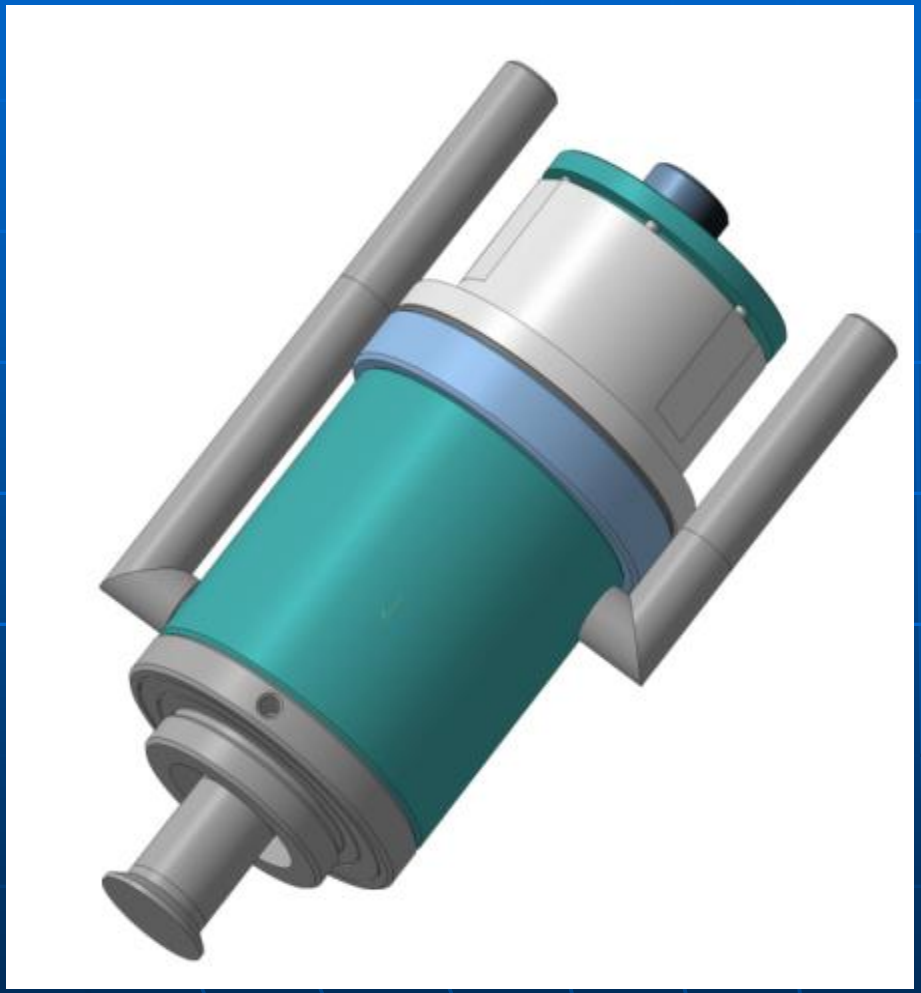
Drilling speed at various frequency

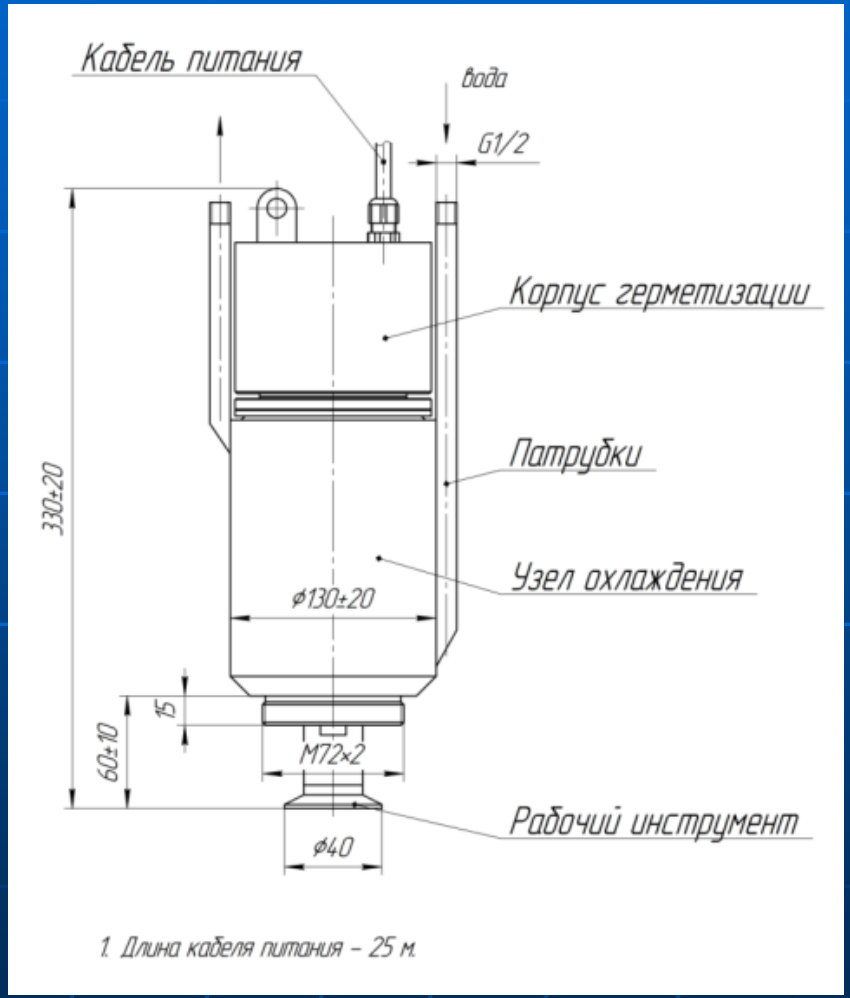


Influence of intensity and temperature on cavitation

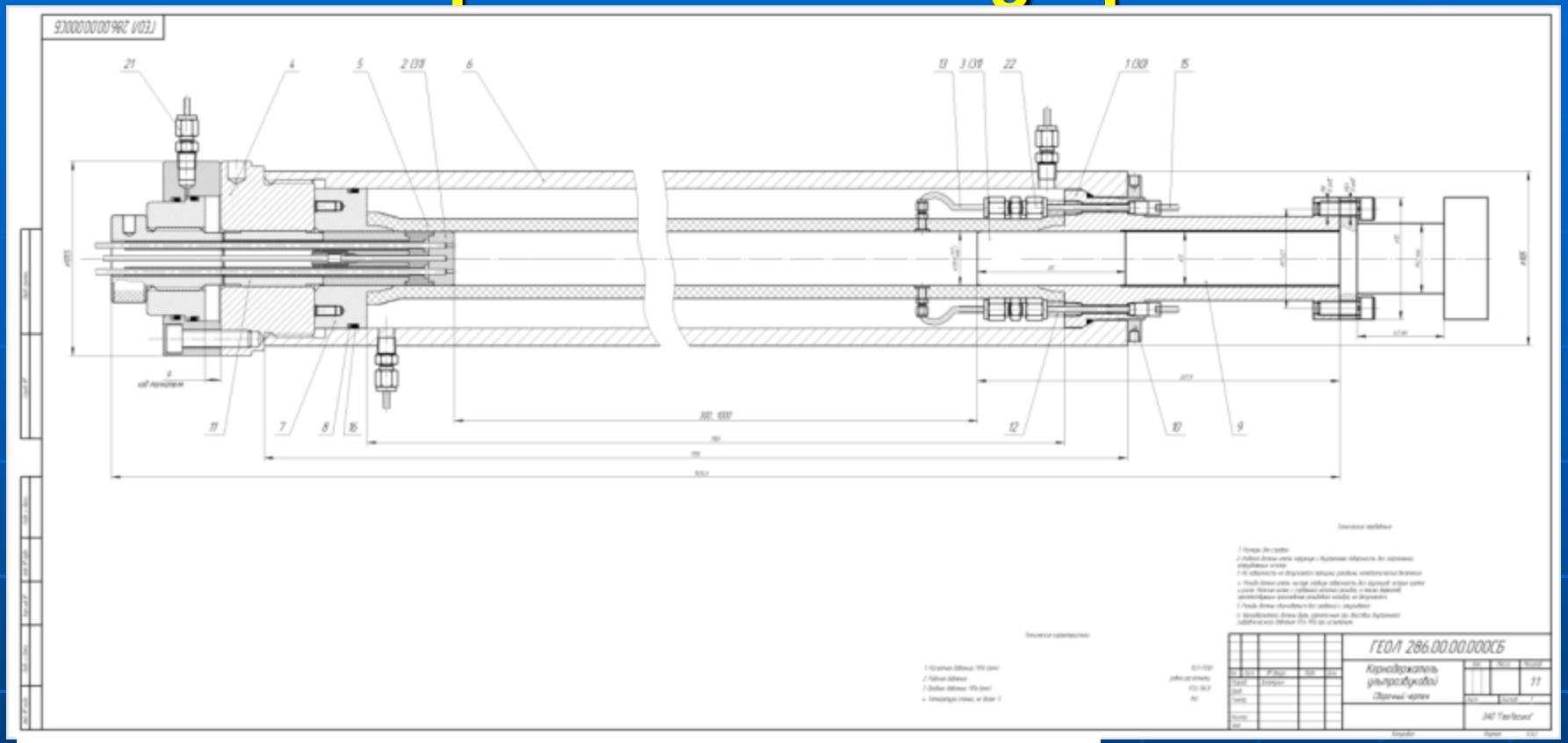


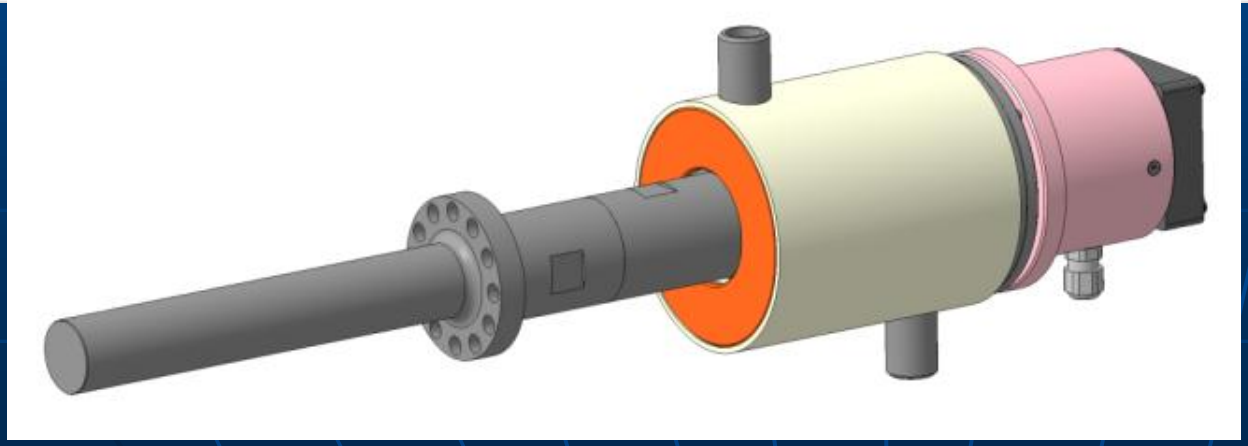
Thermal protection of the piezoelectric transducer





Thermal protection at high pressures

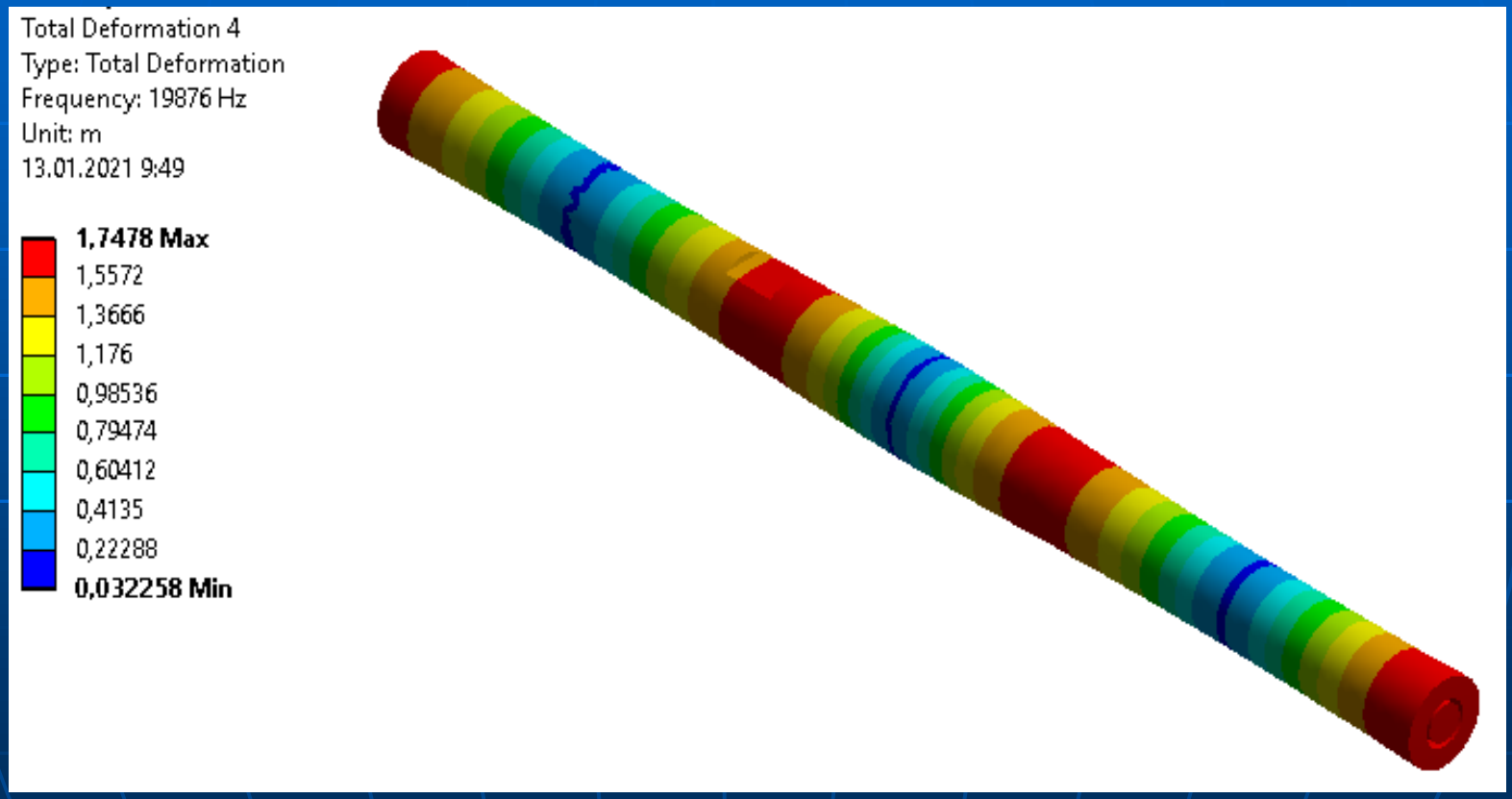




Features:
Liquid cooling;
Operation at high pressure on the radiating surface

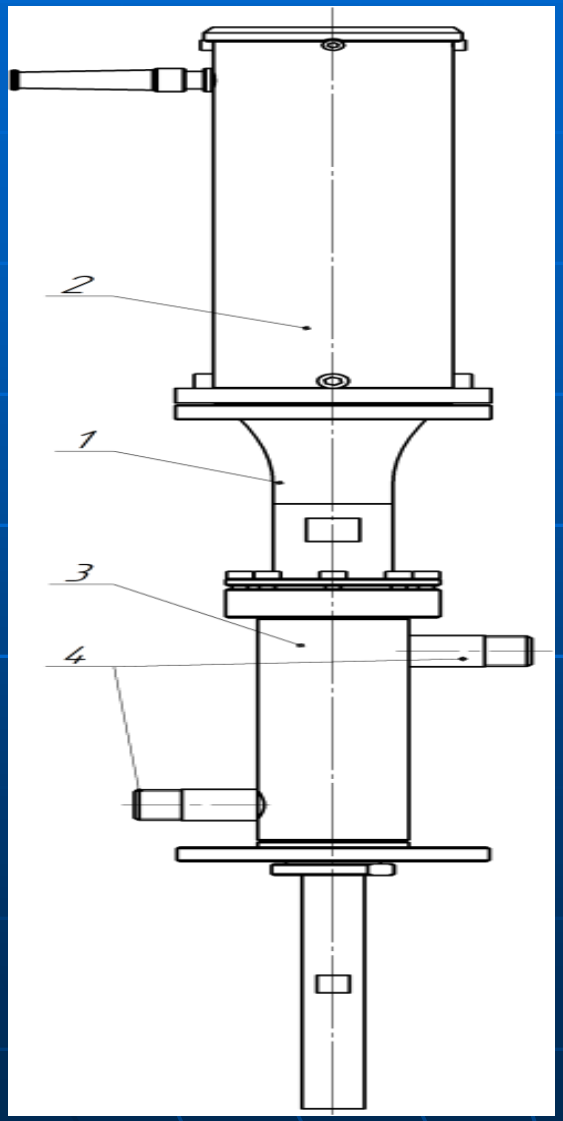
Exposure of melted metals

Application of tools made of high-temperature materials (niobium, molybdenum)

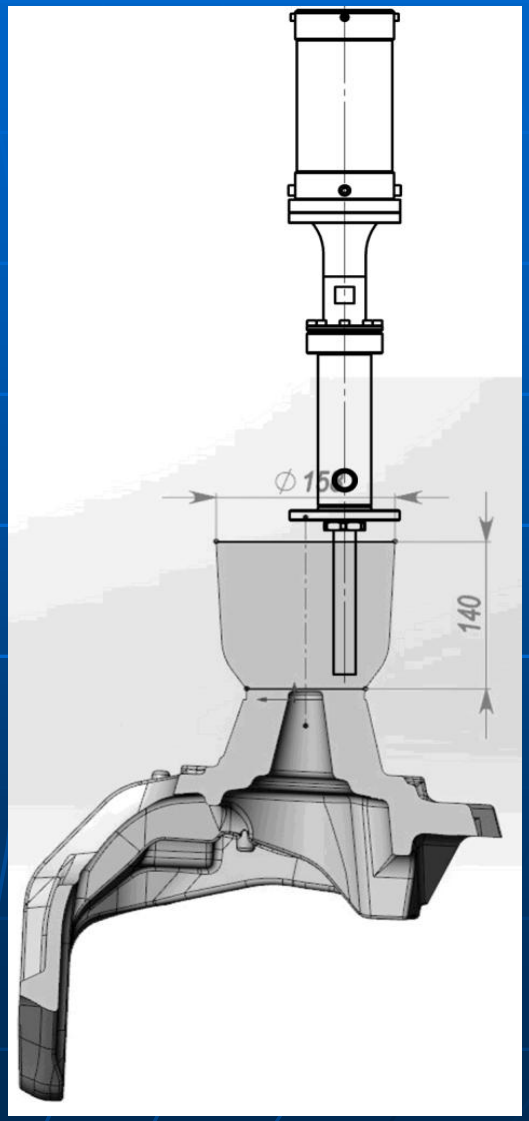


Distribution of vibrations of a niobium instrument at 1000 K

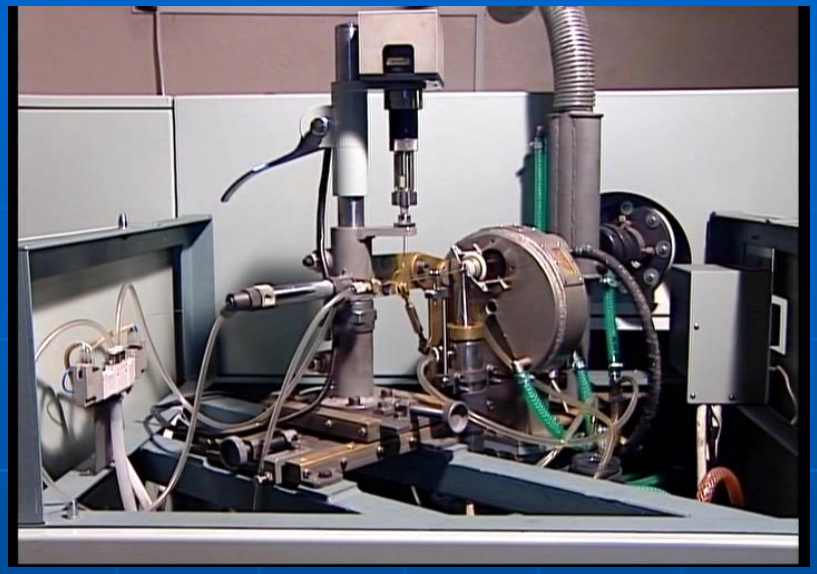
Ultrasonic processing of melts



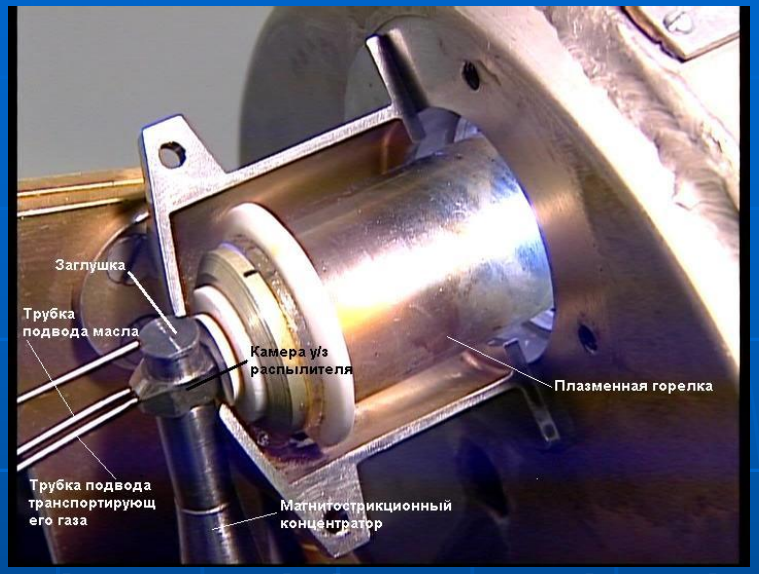
1 - Ultrasonic vibratory system;
2 - piezoelectric transducer body;
3 - heat exchanger;
4 - pipes;



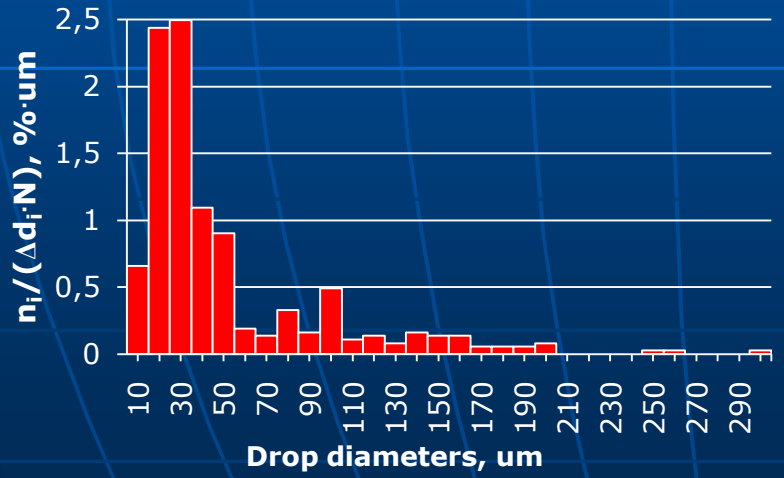
Nebulizing for analysis of aviation oil composition



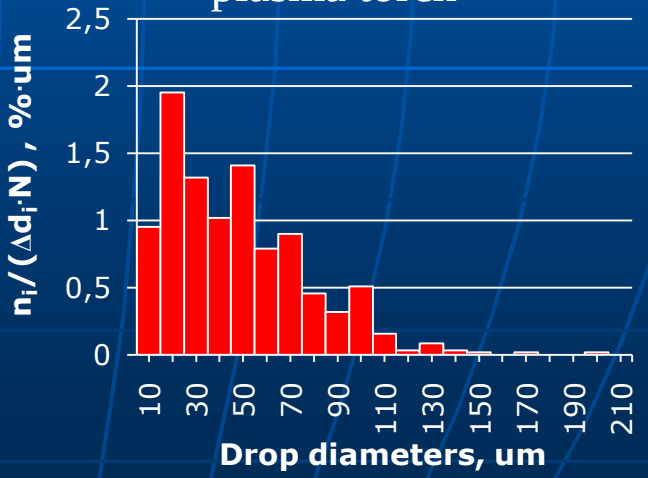
Spectral particle analyzer



Ultrasonic nebulizer mounted into the plasma torch

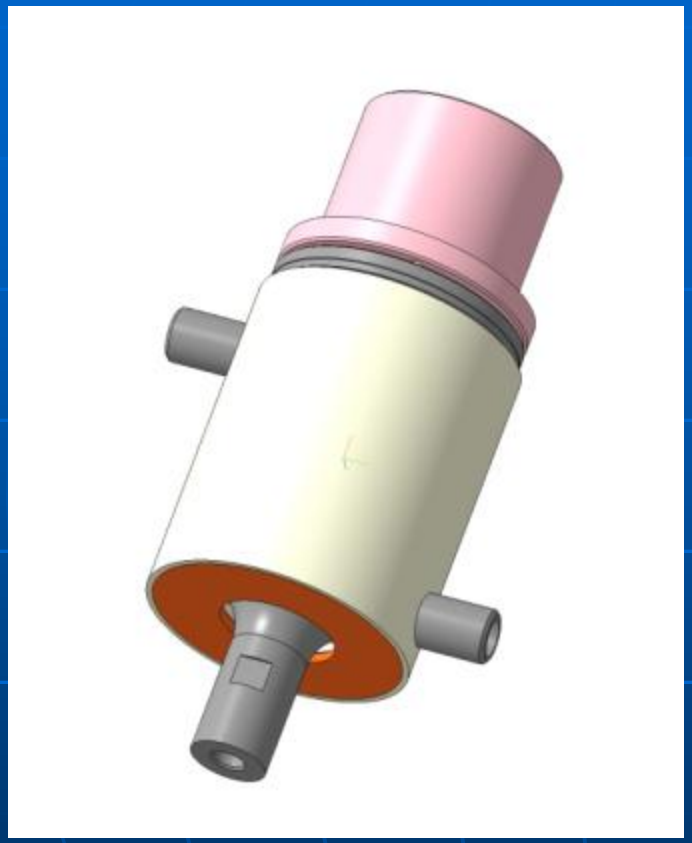


Nebulizer work frequency 60 kHz



Nebulizer work frequency 22 kHz

Nebulizing of aluminum



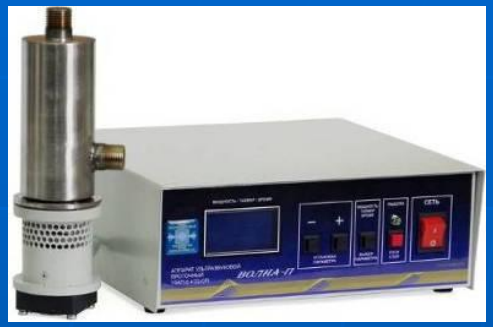
Ultrasonic vibratory system for forming vibration on nebulizing nozzle

Mounted vibratory system

Ultrasonic devices for operation in abnormal conditions of pressure, temperature and chemical aggressiveness

1- Thermal protection of the transducer; 2- operation at high pressures; 3 - chemical resistance; 4- immersion in an abnormal medium

Ultrasonic devices for flow-through processing



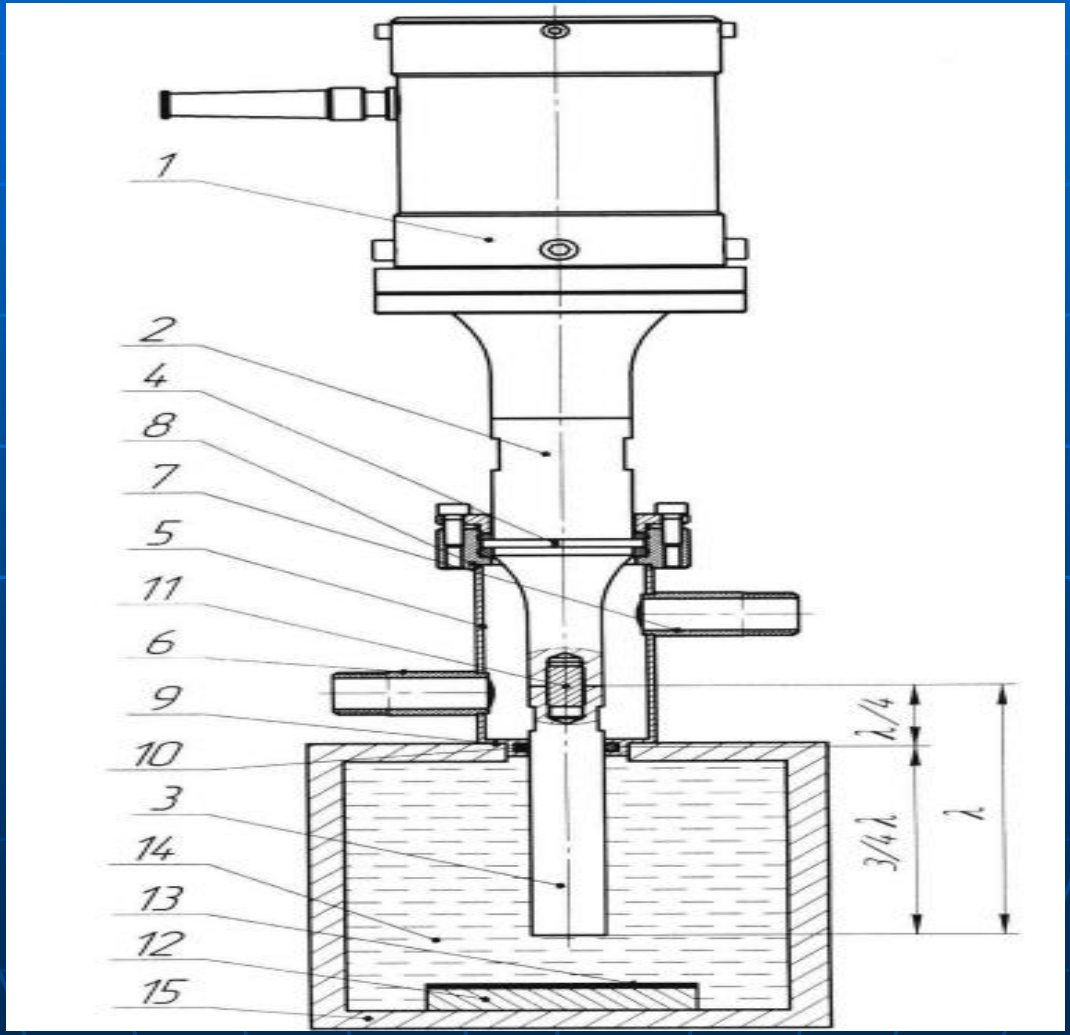
the flow volume

Volume for mounting multiple vibrating systems

flow volumes with cooling

Industrial ultrasonic equipment

Investigation of the durability of coatings under abnormal conditions

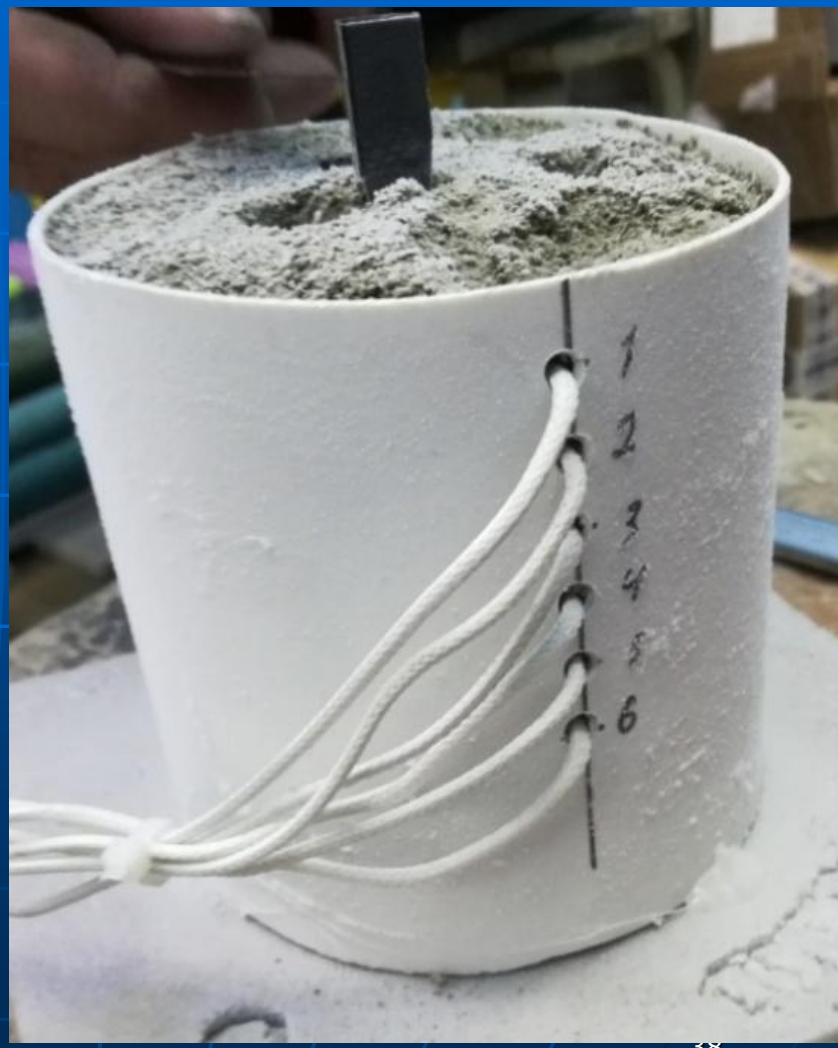


Drilling device in abnormal conditions

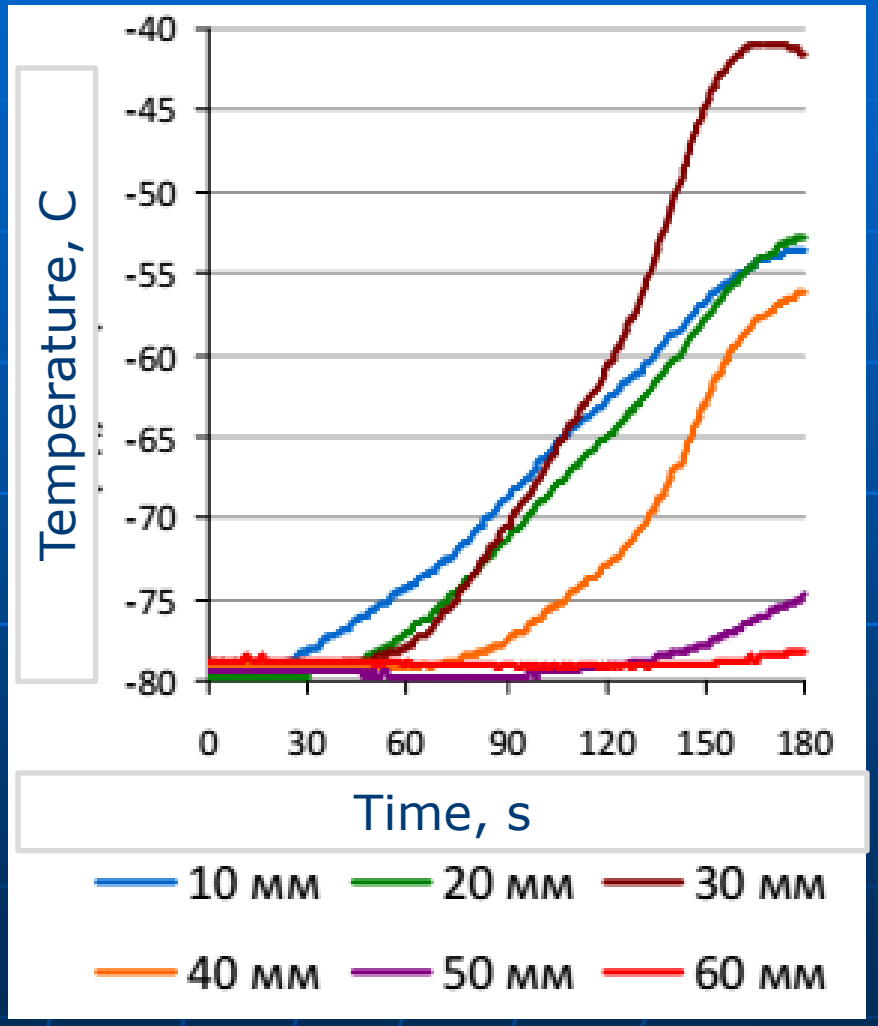
Drilling stand

Working tool for ultrasonic drilling with soil destruction

Drilling studies at low temperatures



Results of studies of ultrasonic drilling at low temperatures



Хмелев Владимир Николаевич

Доктор технических наук, профессор, заслуженный изобретатель РФ, почетный работник высшего профессионального образования РФ, лауреат премии Правительства РФ в области науки и техники, лауреат премии Алтайского края в области науки и техники. Специалист в области создания и применения ультразвуковых колебаний высокой интенсивности. Автор более 1000 печатных работ, 65 патентов.

Барсуков Роман Владиславович

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Специалист по настройке ультразвуковых аппаратов, автоматизации и измерительному обеспечению процесса настройки. Лауреат премии Алтайского края в области науки и техники. Автор более 170 печатных работ, 19 патентов.

Абраменко Денис Сергеевич

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Барсуков Александр Романович

Специалист в области информационных технологий, программного обеспечения измерительного оборудования. Автор 6 печатных работ.

УЛЬТРАЗВУК. ПРИНЦИПЫ ПОСТРОЕНИЯ, АЛГОРИТМЫ И СИСТЕМЫ УПРАВЛЕНИЯ УЛЬТРАЗВУКОВЫМИ АППАРАТАМИ

В.Н. Хмелев
Р.В. Барсуков
Д.В. Генне
Д.С. Абраменко
А.Р. Барсуков

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