



Researcher Links UK-Russia Workshop

Scientific and Technical Grounds of Future Low-Carbon Propulsion

19th - 22nd November 2018, Northumbria University at Newcastle, UK

Design and experimental studies of spark-ignition automobile engine when working on poor fuel-air mixtures

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**South Ural
State University**

**National Research
University**

South Ural state University was founded in 1943.

Implemented in SUSU 172 bachelor's, 126 master's degree programs, 25 programs specialist degrees, and 24 areas of training graduate students. More than 30,000 students are currently enrolled.

More than 20 world-class research centers operate on the basis of SUSU. They allow you to conduct effective research in areas of knowledge such as engineering, natural Sciences, supercomputers and human Sciences.



In 2018, the University for the first time entered the ranking of the best universities in the world according to the British consulting company Quacquarelli Symonds (QS). South Ural state University took the position between 800 and 1,000 places.



South Ural
State University

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University



Automotive and Tractor Faculty Department «Internal combustion Engines»

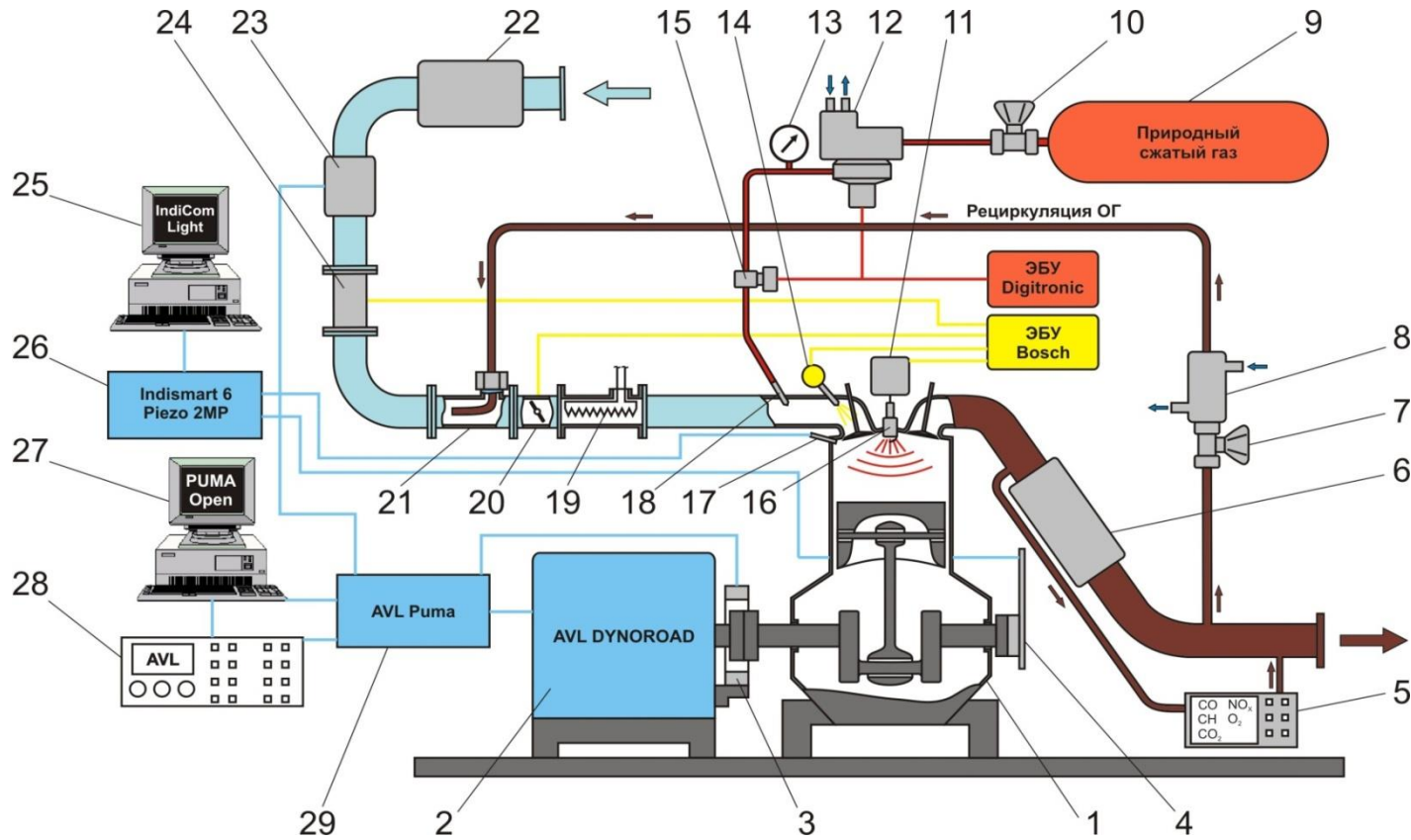
Conducts training of bachelors and masters in the direction of "Power engineering" (piston internal combustion engines).



The main scientific directions of the Department:

1. Organization of an effective combustion process of mixed fuels for advanced low-toxic piston engines (head – Professor Kamaltdinov V.G.).
2. Improving the design of precision interfaces of fuel injector nozzles in order to improve the reliability and resource, reduce the toxicity of exhaust gases of diesel engines (head – Professor Lazarev V.E.).

Motor stand of the company AVL GMBH

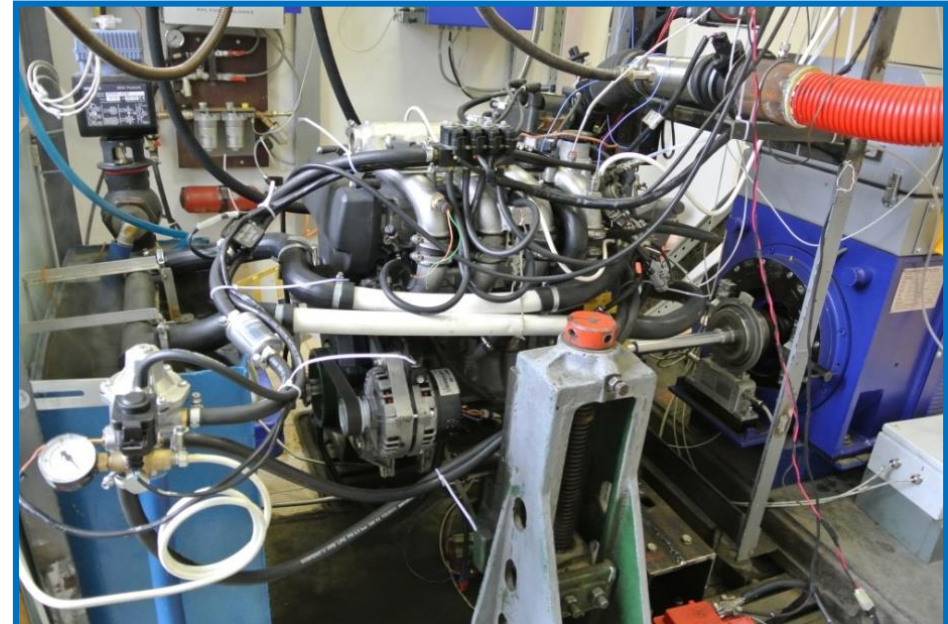
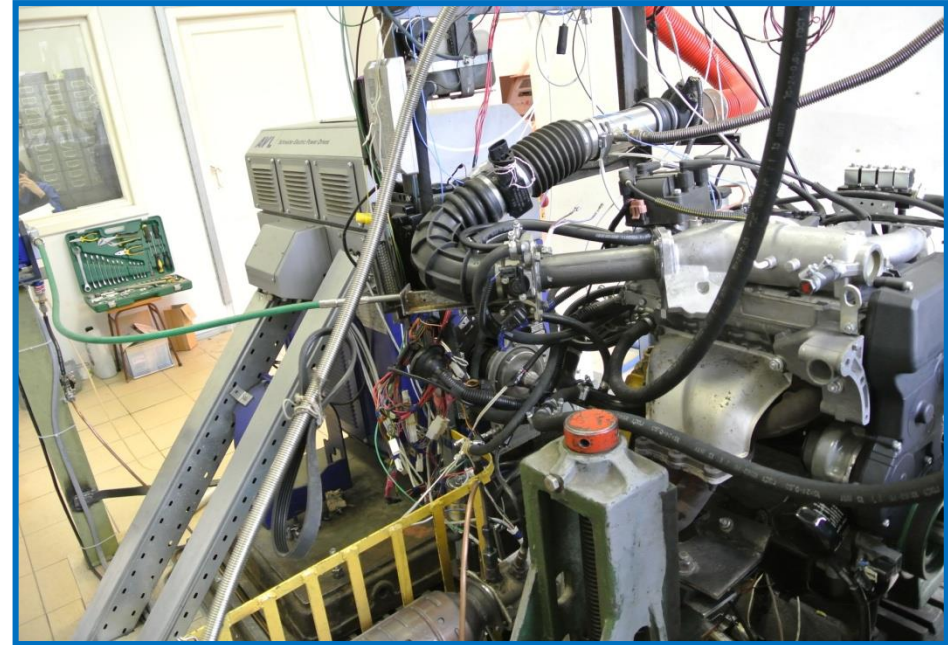


1 – gasoline engine; 2 – asynchronous electric brake; 3 – torque meter; 4 – sensor of angular position of the crankshaft; 5 – detector; 6 – catalytic Converter exhaust gas; 7, 10 – valves; 8 – exhaust gas recirculation cooler; 9 – gas cylinder; 11 – module (coil) ignition; 12 – gas mixer; 13 – gauge; 14 – fuel injector; 15 – gas injector; 16 – spark plug; 17 – the gauge of pressure of gases in the cylinder of the engine; 18 – gas nozzle; 19 – heater air inlet; 20 – throttle; 21 – mixer recirculated exhaust gas with the intake air; 22 – the air filter; 23 – air flow meter AVL; 24 – sensor mass air flow Bosch; 25 – monitor (computer) system of indexing IndiCom Light; 26 – unit indexing system; 27 – monitor (computer) control system PUMA; 28 – unit (panel) control test stand; 29 – external module FEMs management system PUMA

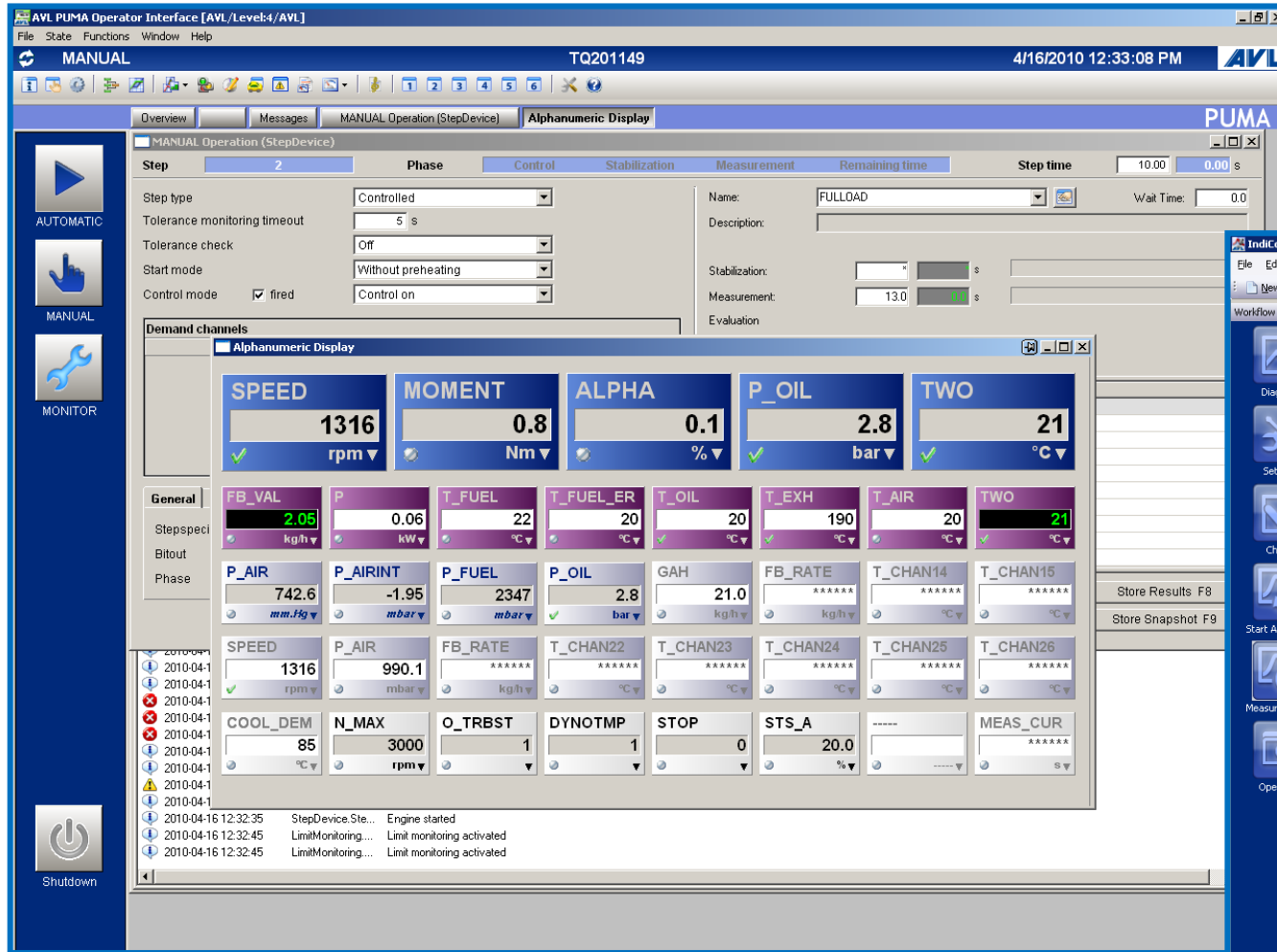


General view of the motor stand AVL GMBH

Motor stand of the company AVL GMBH

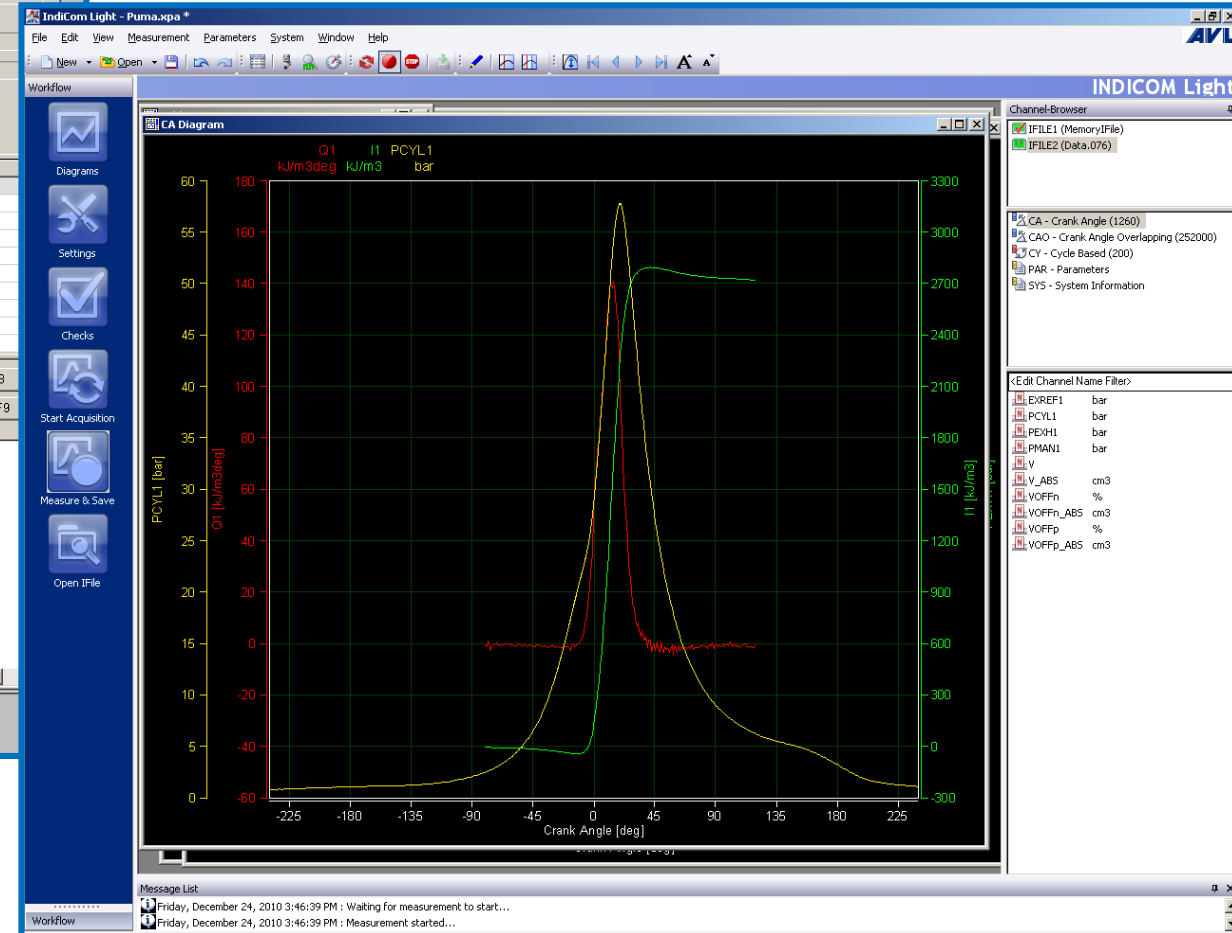


Motor stand of the company AVL GMBH

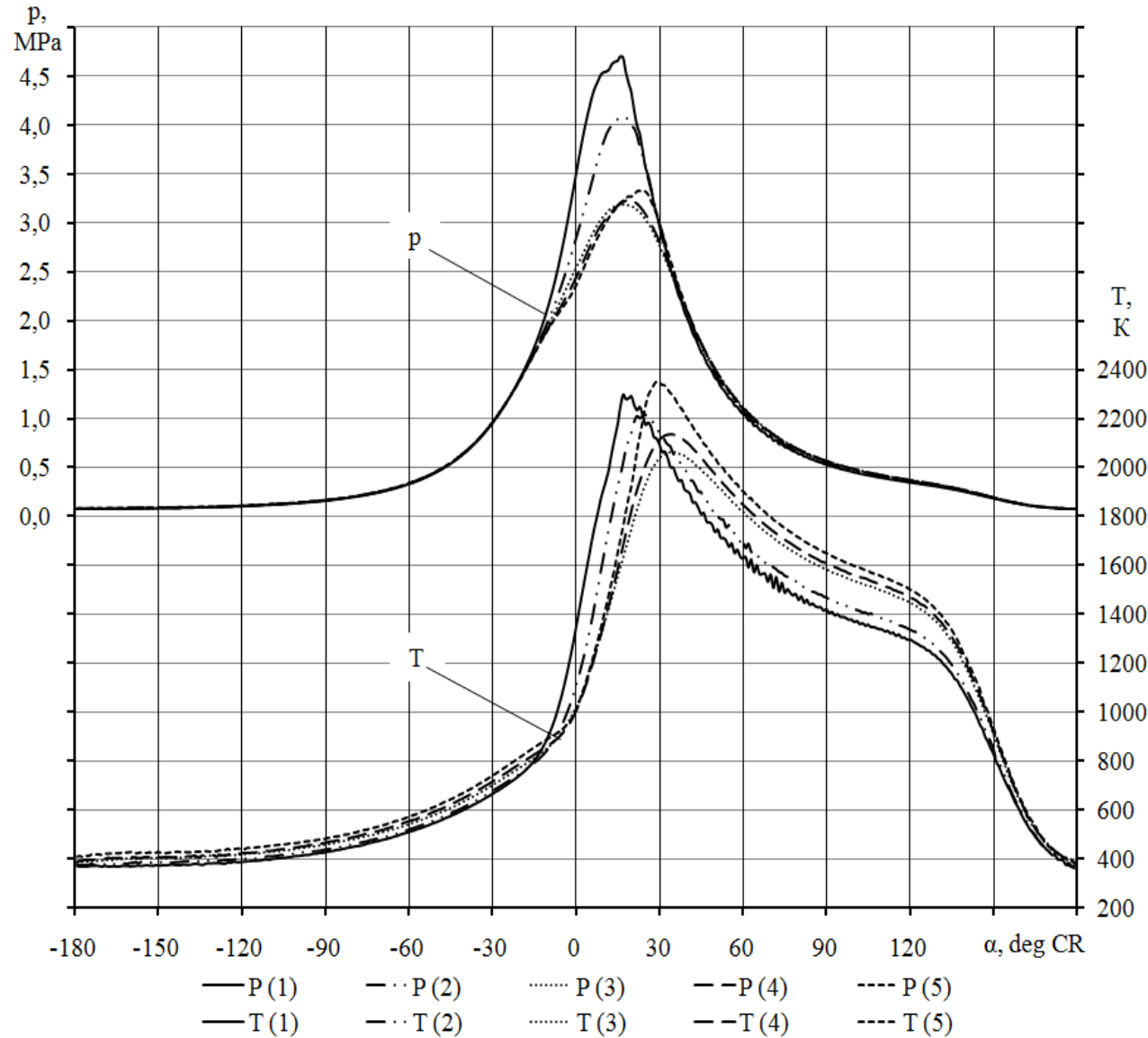


An example of the output in the system PUMA Open

The screen output of the system IndiSmart



Motor stand of the company AVL GMBH



Mode	t_k (°C, meas.)	T_k (K, meas.)	T_a (K, proc.)	T_{max} (K, proc.)
1	29	302	367	2297
2	45	318	373	2218
3	71	344	384	2062
4	84	357	392	2134
5	112	385	410	2351

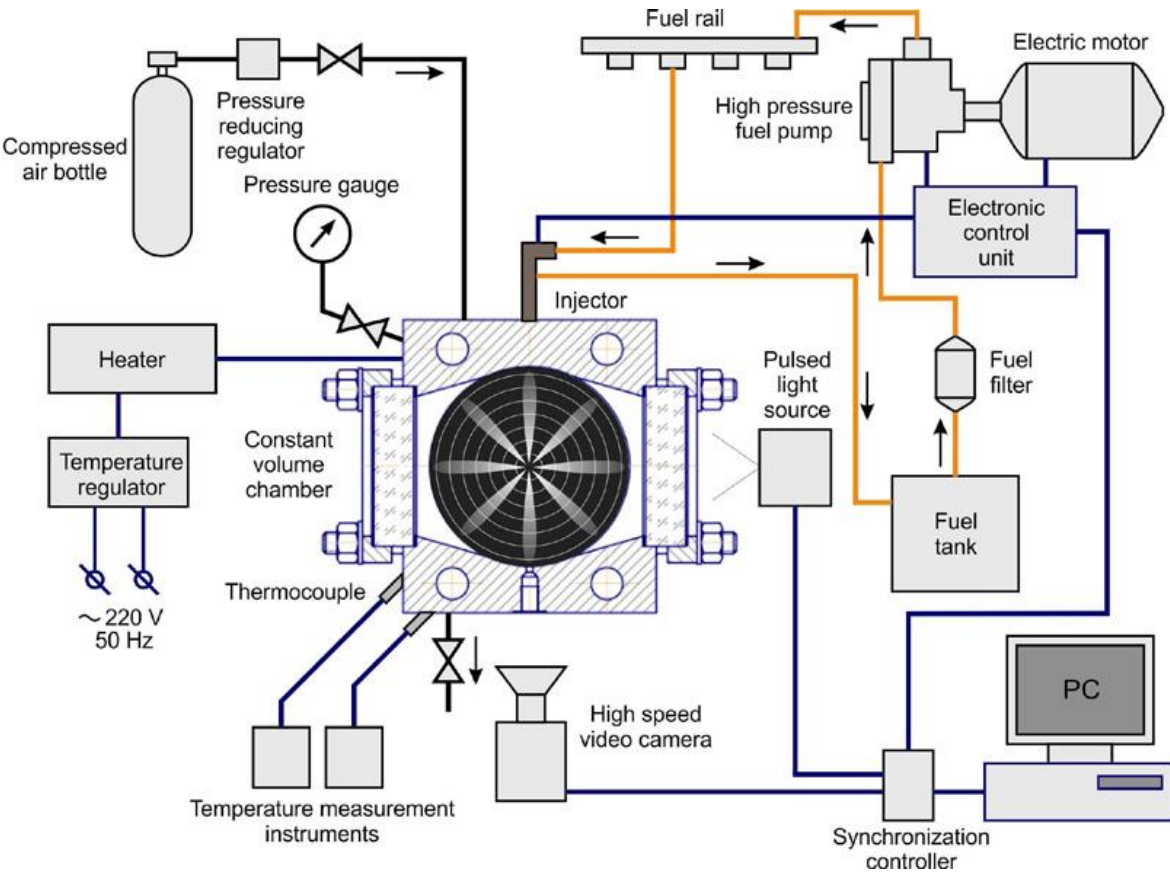
Mode	α (proc.)	IAA (deg CR, meas.)	T (N*m, meas.)	Ne (kW, meas.)	gi (g/(kW*h), proc.)
1	1,55	35,5	75,5	11,86	202,8
2	1,53	30,5	74,8	11,74	203,55
3	1,49	23	72,7	11,43	212,18
4	1,47	18,5	70,5	11,08	211,29
5	1,41	15	69,5	10,91	210,62

Indicator diagrams of gas pressure in the cylinder and graphs of temperatures at different temperatures of the mixture at the inlet

Non-motorized stand

Non-motorized stand has two versions:

1. Stand for research of processes of injection and mixing of diesel fuel;
2. Stand for studies of ignition and combustion of gas fuel

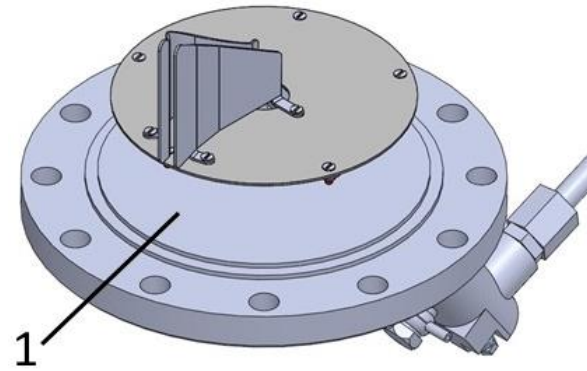
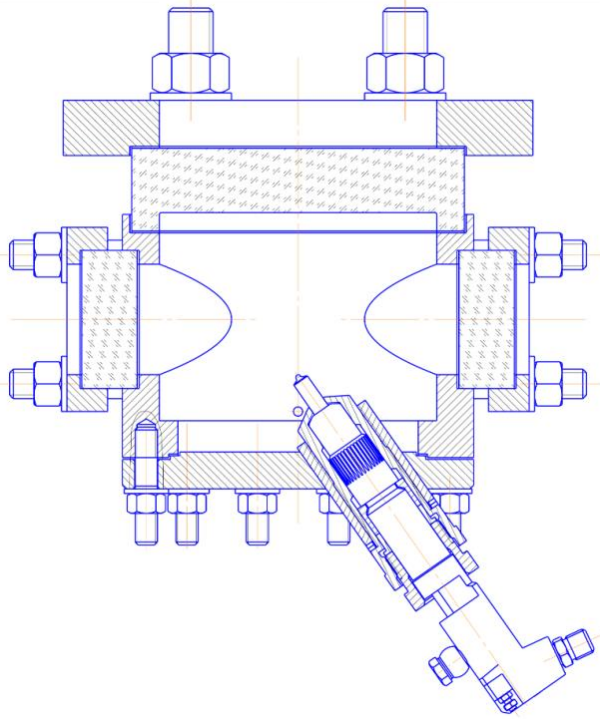


Block diagram and General view of the non-motor stand for the study of injection and mixing of diesel fuel

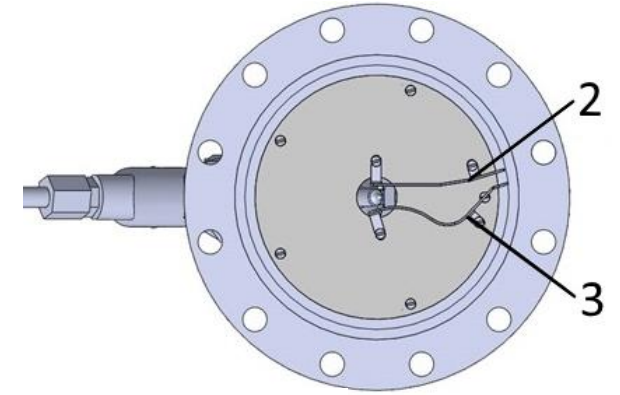


Non-motorized stand

Investigation of the interaction of a sprayed fuel jet with the combustion chamber wall



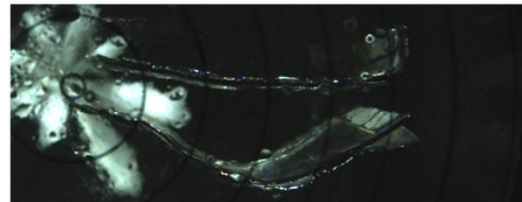
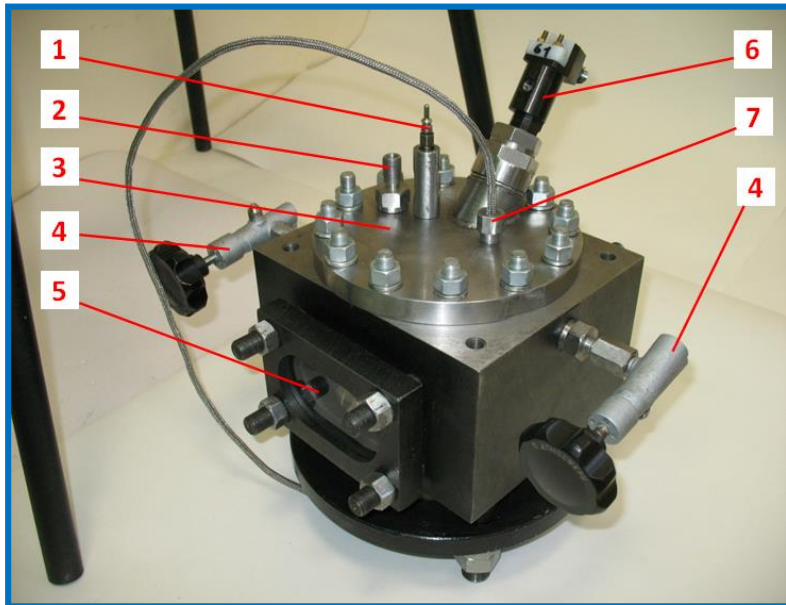
a



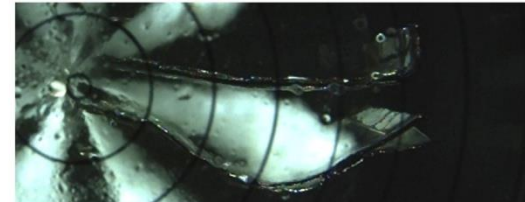
b

Setting the bounding blind flange with nozzle:

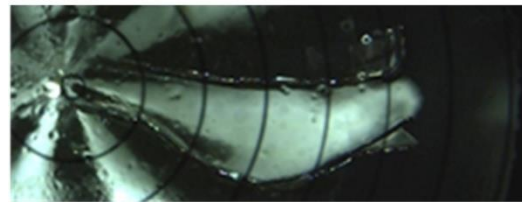
a – General view, b – top view; 1 – flange with installed nozzle, 2 – shutter-simulation of cylinder head, 3 – shutter-simulation of the combustion chamber profile in the piston



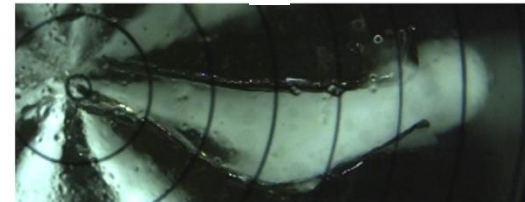
a



b



c



d

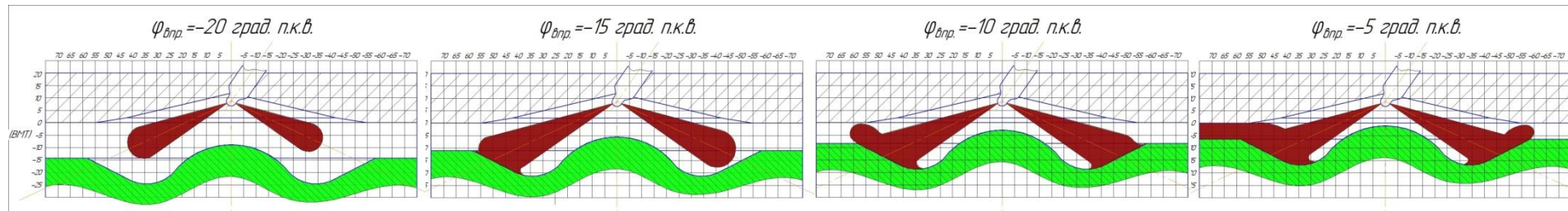
Image sprayed fuel jet bounded by the plates, the cell constant volume when the fuel pressure in the accumulator 165 MPa and back pressure of the gaseous medium 3 MPa:

a – 0.6 ms from start of injection, b – 1.2 ms from start of injection, c – 1.8 MS from start of injection, d – 2.4 MS from start of injection

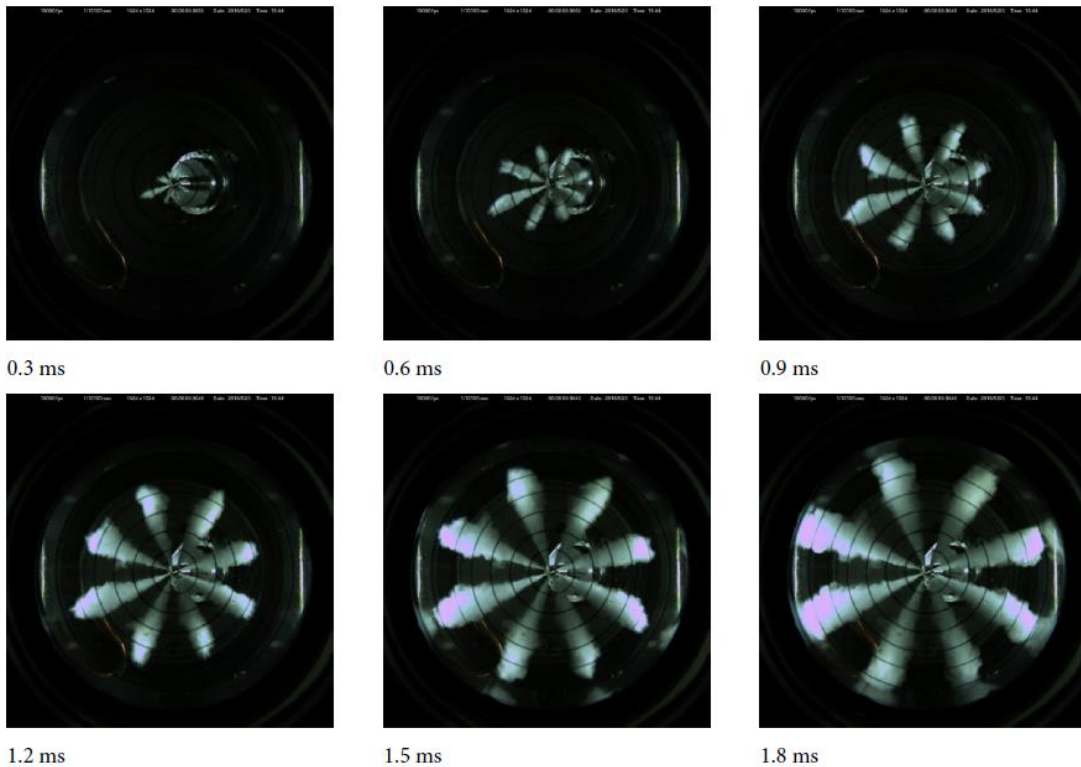
Sketch and General view of the constant volume chamber from the bottom flange side

1 – glow plug; 2 – a nozzle for the removal of air and atomized fuel; 3 – the lower flange of the chamber of constant volume; 4 – valves (valves) for the supply and removal of air; 5 – side window; 6 – fuel electromagnetic nozzle; 7 – thermocouple

Non-motorized stand



The schematic chart of injection of fuel in the conditions of the combustion chamber of the diesel and the nature of reflection of the sprayed fuel streams from the piston bottom



Images of the development of diesel fuel jets observed through the front optical window

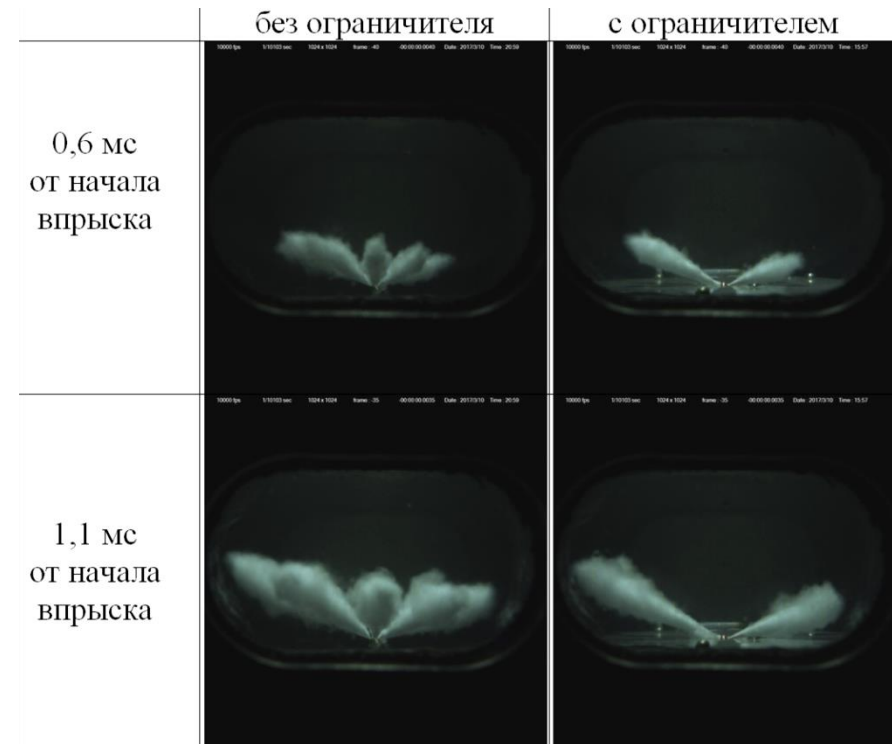
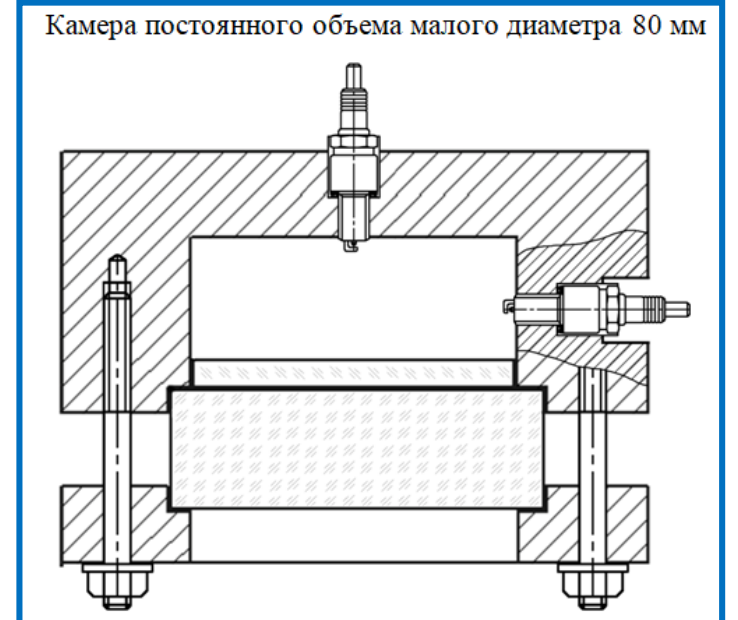


Image of development of fuel jets for diesel fuel, seen through a lateral optical window

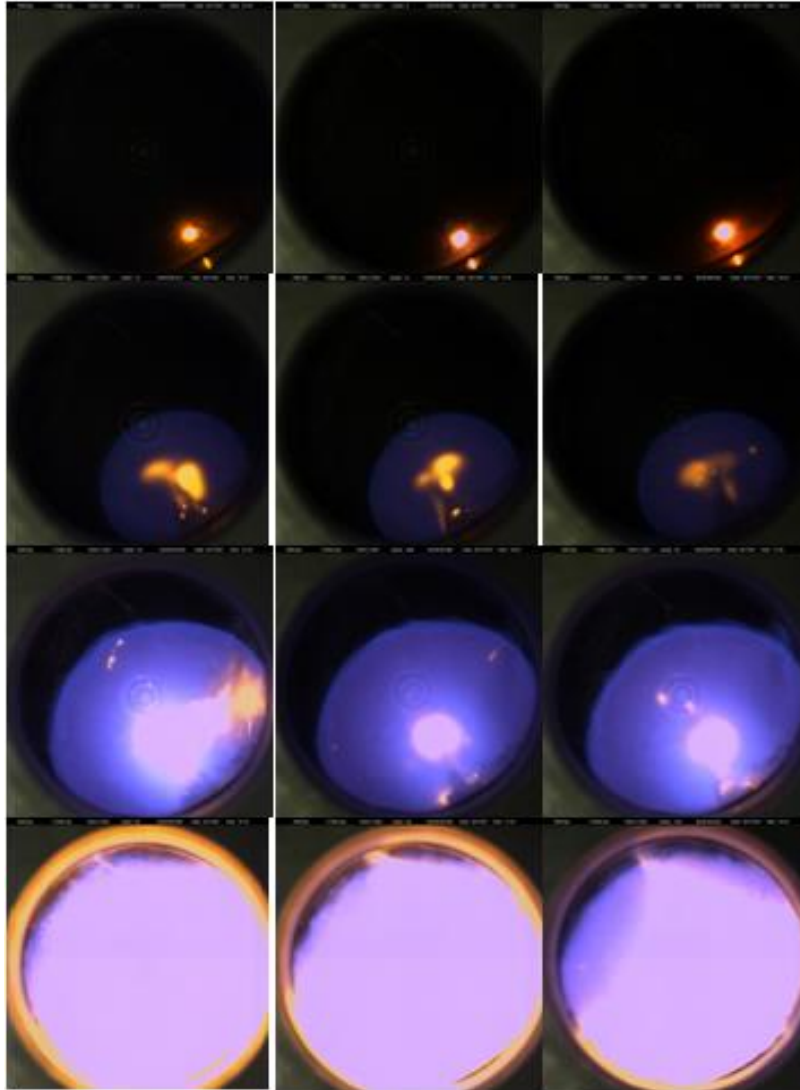
Non-motorized stand

Non-motor stand for studies of ignition and combustion of gas fuel

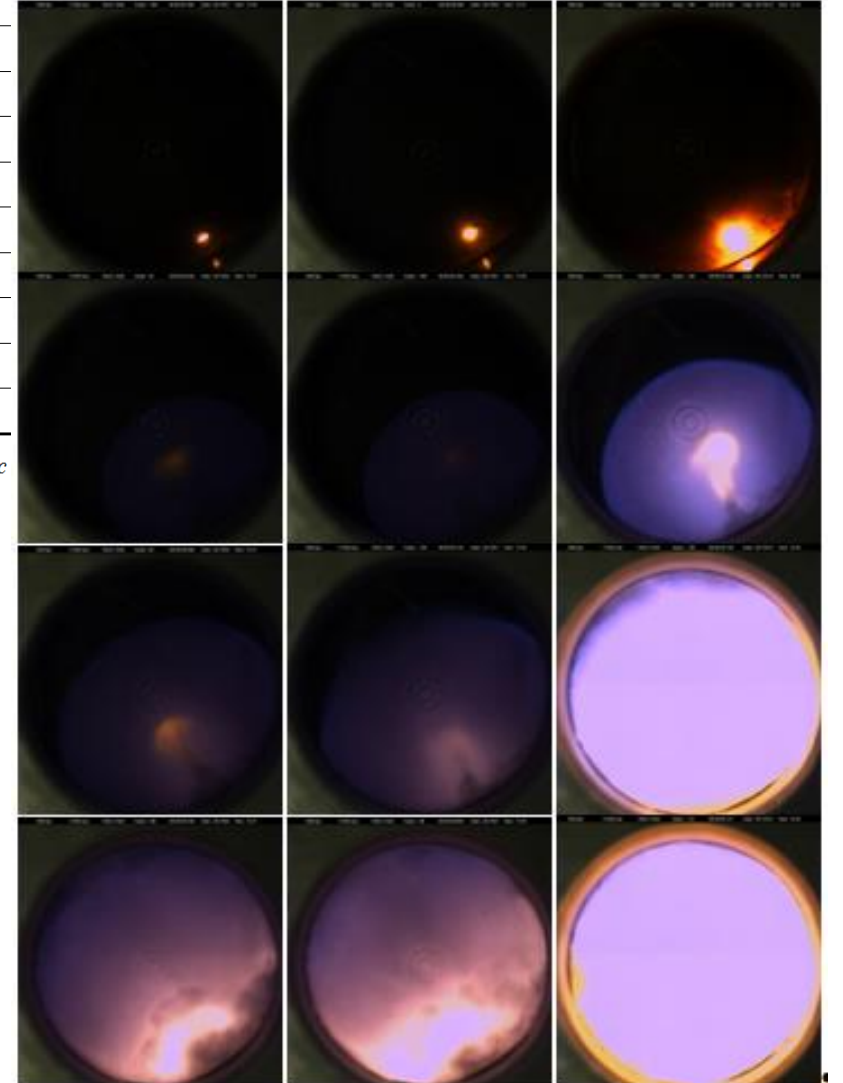
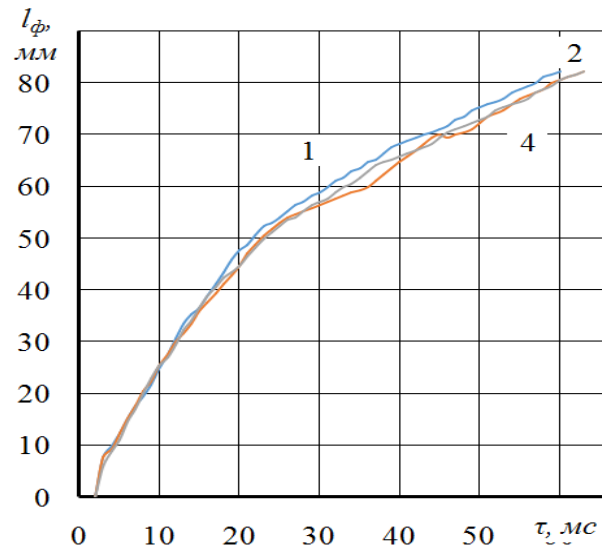
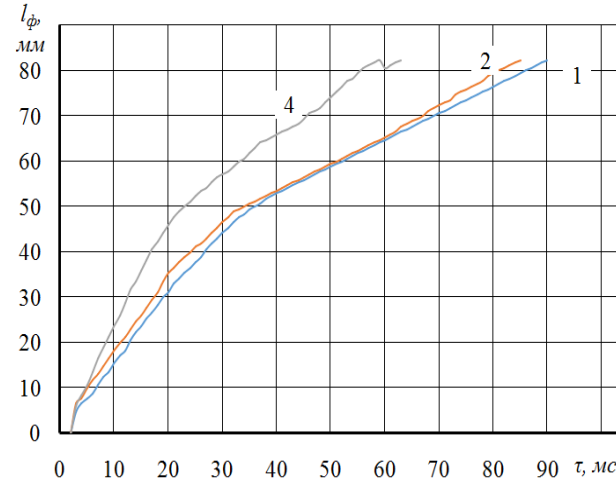


Non-motorized stand

Propagation of flame front at ignition of methane-air mixture of different composition with different number of ignition coils (1, 2 and 4)



$\alpha = 0,96$

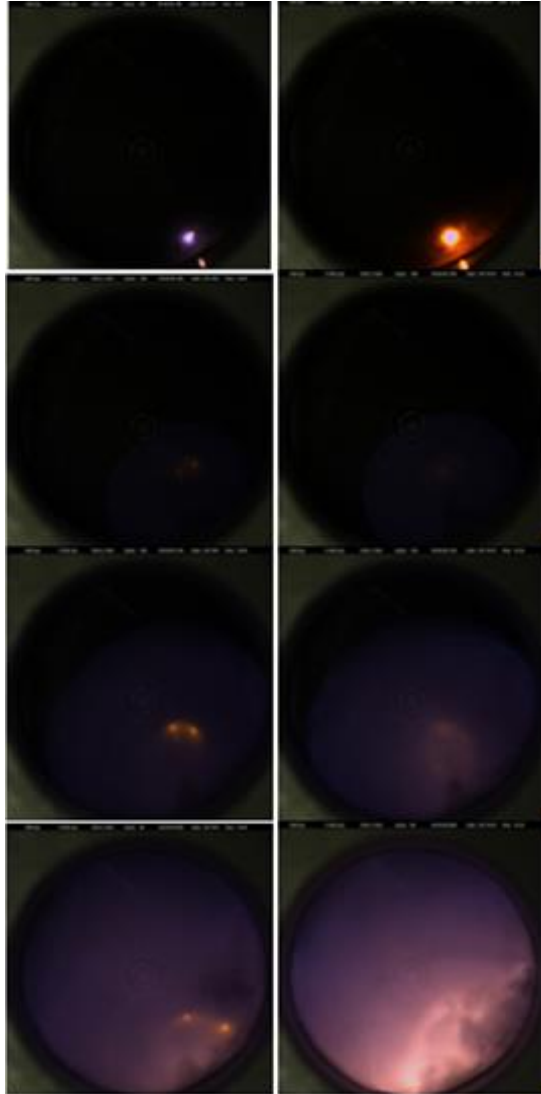


$\alpha = 1,04$

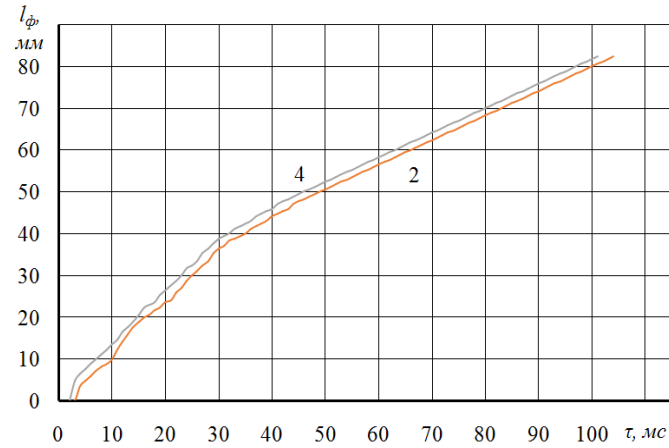
12

Non-motorized stand

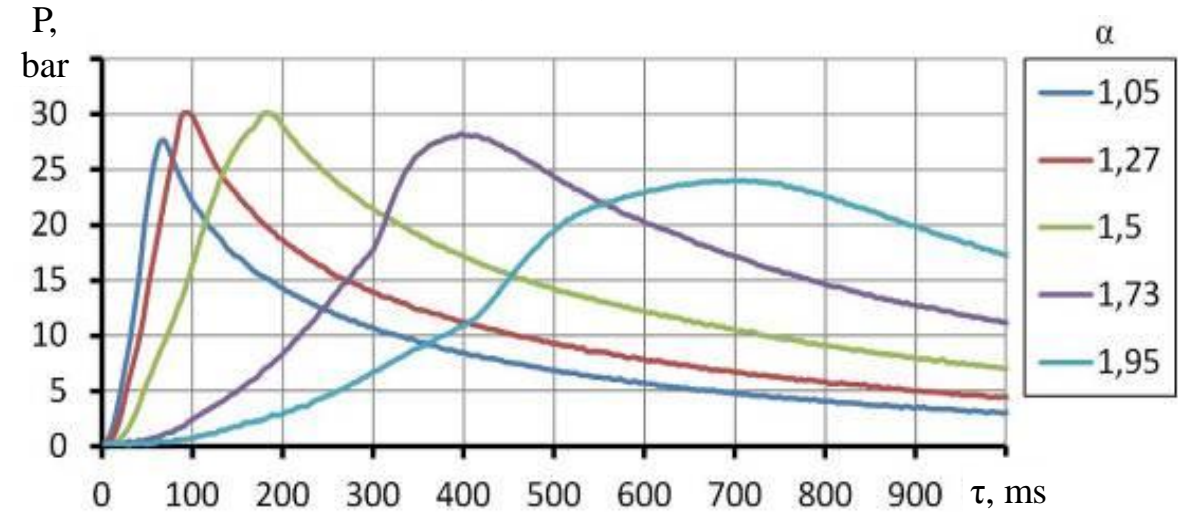
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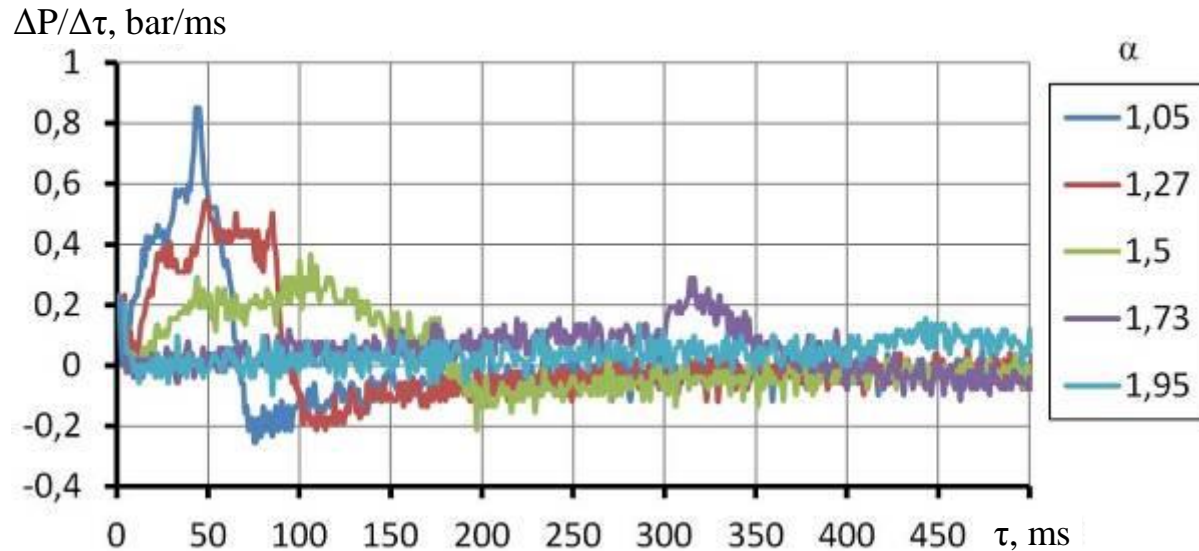
$\alpha = 1,2$



Pressure change in a constant volume chamber with different composition of methane-air mixture



The rate of pressure change in a constant volume chamber with different composition of methane-air mixture





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Thank you for your attention Ready to answer your questions

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