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The review “Russian Economy. Trends and Outlooks” has been published by the Gaidar Institute since 1991. This is the 44th issue. This publication provides a detailed analysis of main trends in Russian economy, global trends in social and economic development. The paper contains 5 big sections that highlight different aspects of Russia’s economic development, which allow to monitor all angles of ongoing events over a prolonged period: the monetary and budget spheres; financial markets and institutions; the real sector; social sphere; institutional changes. The paper employs a huge mass of statistical data that forms the basis of original computation and numerous charts confirming the conclusions.

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The state of science and innovation in Russia in 2022²

Sanctions were the main factor influencing the sphere of science and innovation in 2022. Quick measures to solve the issues that arose were developed only to a certain extent. The first priority steps were made in such areas of science policy as changing the composition of reporting and accounting indicators and revising the partners and directions of international cooperation. In technological field the agenda was reoriented toward ensuring technological sovereignty. For this purpose, first of all, the following were planned: strengthening support of applied research; growth of financing of innovations from regional budgets; identification of “niches” where there is a potential for the development of necessary technologies and products.

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5.3.1. Sanctions and their consequences

Main factor that brought changes in the field of science and technology was economic sanctions (which made it more difficult to buy high-tech equipment and materials and stopping of equipment servicing) and those aimed at isolating Russian science (breaking institutional ties and stopping joint projects, restrictions on participation in scientific conferences, publishing articles and sanctions against individual universities). Russian science has found itself under the pressure of an unprecedented number of sanctions if we compare, for example, with the situation in Iran where American sanctions are predominantly in effect.

Immediately after the start of special military operation institutional cooperation with Russian universities was terminated by Germany, France, the United States, Canada, Denmark, the Baltic States, the Netherlands, and Finland, as well as the European Union. Cooperation at a number of mega-science facilities including CERN¹ was curtailed. It suspended the observer status of Russian Federation and cooperation with Russian institutions despite the fact that Russian side provided part of funding and equipment for the Large Hadron Collider. Partnerships at Europe's ExoMars 2022 and joint projects at the largest X-ray laser XFEL in Germany were terminated although Russia made a significant financial contribution to its construction and made unique magnets for the facility. Work was also frozen on German Space Agency's eRosita X-ray telescope aboard Russian Spektr-RG observatory.²

In March, the U.S. suspended its participation in the Arctic Council chaired by Russia. In June, the U.S. and other Arctic Council countries announced resumption of some projects including scientific research on the condition that they do not involve Russian government.³

Countries that terminated cooperation with Russian scientific organizations and universities noted viability of maintaining individual ties. Possibility of maintaining such contacts is quite illusory as each scientist is associated with an organization. In addition, team science prevails today in almost all research fields and the average number of participants in scientific groups is growing. Therefore, it is possible to maintain individual connections in a fairly narrow range of disciplines where researchers work mostly independently rather than in groups.

A number of publishers have stopped accepting articles from Russian authors⁴ including those from universities on U.S. Treasury Department's sanctions lists.⁵ Moreover, Russian scientific organizations and universities have been

1 Solidarity with Ukraine. URL: <https://home.cern/solidarity-ukraine>

2 *Leibin V.* Disconnecting from the scientific network // Expert. 9 may 2022. URL: <https://expert.ru/expert/2022/19/otklyucheniye-ot-nauchnoy-seti/>

3 *Ambrose M.* US Restricts Science Collaborations with Russia // FYI Bulletin, No. 47. 17 June 2022. URL: <https://www.aip.org/fyi/2022/us-restricts-science-collaborations-russia>

4 *Brainard J.* Few journals heed calls to boycott Russian papers // Science. 10 March 2022. doi: 10.1126/science.adb1981. URL: <https://www.science.org/content/article/few-journals-heed-calls-boycott-russian-papers>

5 In particular, MIT issued a circular according to which even informal communication with employees of Skoltech and Phystech, including the preparation of joint publications, should be stopped immediately. Zuber N. New U.S. Sanctions Prohibit Collaborations with Certain Russian Entities // MIT. 5 August 2022. URL: https://orgchart.mit.edu/node/27/letters_to_community/new-us-sanctions-prohibit-collaborations-certain-russian-entities

disconnected from the Web of Science database which has not been done, for example, in relation to Iran. Major scientific publishers (Elsevier, Springer/Nature, IOP Publishers, etc.) have officially announced¹ that Russian organizations have been cut off from access to their journals. Russian authors were deprived of the opportunity to publish articles in Open Access journals. Indexing of Russian publications in Crossref² was suspended. Since Russian journals account for about 3% of the world's scientific output cut off from most sources of information has drastically limited the ability of Russian researchers to keep up to date of current scientific achievements.

Opportunities to hold international conferences in Russia and to participate in foreign events have also declined. Moving an International Mathematical Congress which was to be held in July in St. Petersburg to an online format was a landmark move after growing pressure from national mathematical societies and invited speakers. In terms of participation of Russian scientists in international conferences in addition to the political aspect there is also a financial one due to difficulty of transferring abroad payment for the organizational fee. One cannot also ignore the ban on flights by Russian airlines which has complicated and significantly increased the cost of personal attendance at conferences abroad.

A survey of 577 heads of scientific institutions and universities confirmed that sanctions mostly affected various types of international cooperation including commercialization of R&D results abroad and opportunities to obtain foreign funding or publication in international papers.⁴ Furthermore, managers expect a drop in participation in international conferences, a decrease in the number of articles in foreign publications and a decline in access to foreign databases of scientific information in the future.

It is worth noting that in the field of international cooperation, sanctions have had a negative impact not only on Russian science. For example, termination of participation of Russian scientists in projects of the European Union in a number of cases led to inability of partners from other countries to continue research.⁵ In turn, because of the withdrawal from JINR (Joint Institute for Nuclear Research in Dubna) projects, foreign partners cannot conduct joint experiments which predetermine retardation in development of a number of topics.⁶

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- 1 Publishers condemn invasion of Ukraine by Russia. URL: <https://mailchi.mp/4851e2a74119/joint-publisher-statement>
 - 2 *Rara-Avis A.* Academic boycott and political persecution: Russian science in the time of war. April 11, 2022. URL: <https://www.opendemocracy.net/ru/rossiyskaya-nauka-vo-vremya-voyny/>
 - 3 *Gaind N., Else H.* Global research community condemns Russian invasion of Ukraine // *Nature*. 2022. No. 603. P. 209–210. doi: <https://doi.org/10.1038/d41586-022-00601-w>
 - 4 The survey was conducted in November 2022. See.: *Vlasova V., Gershman M.* Making the science in Russia: moods and expectations // *Science. Technology. Innovation. Express-information*. 14 December 2022. URL: <https://issek.hse.ru/news/802297927.html>
 - 5 *Lem P.* War forces post-Soviet scholars to choose between Russia and West // *Times Higher Education*. 19 March 2022. URL: <https://www.timeshighereducation.com/news/war-forces-post-soviet-scholars-choose-between-russia-and-west>
 - 6 *Loshak V., Grigory Trubnikov.* General Director of the Joint Institute for Nuclear Research in Dubna, on who loses first to sanctions and the search for trust between scientists and the state // *Kommersant*. 29 October 2022. URL: <https://www.kommersant.ru/doc/5608815>

Impact of economic sanctions has been traumatic no less. Problems with updating scientific equipment and access to software and updating technical aids used in modern science have a direct impact on quality of findings. Sanctions limited the import of high-tech equipment and its maintenance while, according to estimates, 80% of tenders for supply of equipment to scientific organizations were won by foreign companies from unfriendly countries.¹ However, situation with software turned out to be even more complicated. If scientific equipment can be operated without replacement for 5—7 years and components and laboratory materials can last for a year, ban on the use of computer programs for scientific calculations had an immediate effect since any analogues of the programs are of poorer quality.²

Evaluation of medium-term effects of sanctions have shown that the greatest damage is done to the human resource potential of science mainly owing to the increased “brain drain”. New wave of departures included both strong scientists who received contracts and grants abroad and those who did not have invitations to work. In addition, not only guest foreign scientists began to leave the country³ which became especially noticeable in universities⁴ but also leading scientists who are fellow countrymen.⁵ Number of researchers who left Russia is unknown. Moreover, there are not even tentative figures for “researchers” (or “scientists”). Moreover, it is not known how many of them have gone abroad temporarily — to wait it out, working on a grant or short-term contract or the number of those who have the opportunity to work remotely and decided to temporarily do so abroad.

In addition to the push factors, there were external “pull” factors of a selective nature. These include various foreign assistance programs for Ukrainian, Russian and Belarusian scientists who left the country⁶ as well as initiatives to make it easier to obtain work visas. The U.S. is interested in selected specialists, primarily those with experience in semiconductors, cybersecurity, artificial intelligence, nuclear and space technologies and a number of other specialized scientific fields.⁷ In general, the pool of potential beneficiaries is very limited and does not stimulate a serious exodus. However, information that further escalated things has begun to spread, such as that the U.S. intends to issue 100,000 visas to Russian scientists⁸.

1 Voronin N. The isolation of Russia would hit Russian science hard and affect world science. 10 March 2022. URL: <https://www.bbcussian.com/russian/features-60682102>

2 Give science freedom. Scientists talk about how to resist sanctions // RIA Novosti. 4 April 2022. URL: <https://ria.ru/20220316/nauka-1778138471.html>

3 Balashova A. «Skolkovo» и Skoltech: «We keep forgetting that we are not in the USSR» // RBK. 15 August 2022. URL: https://www.rbc.ru/interview/technology_and_media/15/08/2022/62f2a5ca9a7947785cd167d1

4 Foreign professors quit the Tyumen School of Advanced Studies – what will happen next? // 72.ru. 1 June 2022. <https://72.ru/text/education/2022/06/01/71369477/>

5 Tuyeva E. We do not observe a total flight of foreigners, although there are some sad losses // Kommersant. 22 May 2022. URL: <https://www.kommersant.ru/doc/5357614>

6 Funding Opportunities and Help for Scholars from Ukraine, Russia and Belarus. URL: <https://eapil.org/funding-opportunities-and-help-for-scholars-from-ukraine-russia-and-belarus/>

7 Popova T. Brain Drain as a New Global Weapon of the U.S. // Nezavisimaya Gazeta – Science. 5 May 2022. URL: https://www.ng.ru/world/2022-05-05/100_usa050522.html

8 Chumakov K. Monkeypox. Coronavirus is not defeated. War will kill Russian science. 24 May 2022. URL: <https://www.youtube.com/watch?v=THrHUEMjHrQ>

This is obviously impossible since there are fewer than 100,000 researchers with PhD and doctoral degrees working in the country.¹

First sample surveys of emigrants demonstrated that the new wave of “brain drain” was prevailed by researchers who did not have invitation to work. Thus, from online interviews conducted in April 2022 with 60 highly educated emigrants² who left Russia after February 24,³ it became known that the majority left for Armenia, Georgia, Israel, and Turkey. These countries were chosen for temporary residence while the search for work is mainly conducted in the U.S. and EU countries. The easiest way to find a job was for postgraduates and postdocs especially for those who already had partnership experience (internships) in foreign universities. It should be noted that this survey was conducted before the beginning of partial mobilization during which the flow of emigrants surged. There are estimates, the grounds for which are not given, that the total outflow of researchers in 2022 stood at around 10% of their total number, i.e. we are talking about 35,000 people and probably a high gender imbalance.

At about the same time in April-May 2022, a survey of 4,100 Russian researchers in the country was conducted which included an assessment of changes in emigration attitudes. They increased for 31.6% of respondents and did not change for 57%.⁴ Those under 39 years of age (51%) were most willing to go abroad and it is this group that has the best chance of finding work abroad.

Experts also consider the growth of isolationist sentiments and corresponding rhetoric to be the effects of sanctions.⁵ Meanwhile, history of the anti-German and anti-Soviet boycotts shows that if a country has a significant scientific complex, then the removal from world science has no serious consequences in the short term.⁶ In historical record one can find different estimates of the average effectiveness of sanctions: on average, they are between 20%⁷ and 40%.⁸

Characteristically, many scientists abroad supported sanctions against Russian science. Thus, an anonymous online survey of 240 scientists working in the EU (not of Russian or Ukrainian origin constituted about one-third of the sample) showed that 62% support sanctions and only 25% oppose them. Furthermore, 75% believe it is correct to terminate institutional relations and programs involving Russian state universities and scientific institutions and 37% believe it is necessary to

1 Science Indicators: 2022. Statistical Compendium. M.: NRU HSE, 2022. P. 54.

2 The respondents' ages ranged from 20-60 years old with the majority being 30-45 years old; the majority of respondents were residents of Moscow all with higher education and some with advanced degrees. However, this was not a professional cross-section of researchers.

3 *Borusyak L.* A New Wave of Highly Educated Emigrants: Why Are They Leaving Russia?// *Palladium*. 2022. No. 3 (2). P. 98–115. DOI: 10.55167/29b32cb46280

4 *Gusev A.B., Yerevich M.A.* Science policy of Russia – 2022: a profession is not dearer than the motherland. M.: OOO «Buki Vеди», 2022. P. 10.

5 *Baker S.* Do academic boycotts work? // *Times Higher Education*. 9 March 2022. URL: <https://www.timeshighereducation.com/depth/do-academic-boycotts-work>

6 *Gordin M.* A century of science boycotts // *Nature*. 2022. No. 606. P. 27–29. doi: <https://doi.org/10.1038/d41586-022-01475-8>

7 *Mulder N.* How America Learned to Love (Ineffective) Sanctions // *Foreign Policy*. 30 January 2022. URL: <https://foreignpolicy.com/2022/01/30/us-sanctions-reliance-results/>

8 *Morgan T.C., Bapat N., Kobayashi Y.* Threat and imposition of economic sanctions 1945–2005: Updating the TIES dataset // *Conflict Management and Peace Science*. 2014. No. 31 (5). P. 541–558. URL: <https://doi.org/10.1177/0738894213520379>

terminate individual cooperation as well. Finally, about a third of the respondents support the idea of not accepting articles by Russian authors for publication in international scientific journals.¹

In response to sanctions government began to introduce response and countermeasures. They boiled down to the following main areas:

- abandonment of accounting principles for publications in journals indexed in the Web of Science and Scopus databases and developing a national system for assessing performance of science; strengthening the focus on development of Russian scientific journals;
- reorienting international scientific cooperation toward countries that have not imposed sanctions. Among other things, it is planned to modernize the megagrant program by expanding cooperation with representatives of the scientific diaspora from countries that have not imposed sanctions;²
- increased support for applied research that is important for regional development and for formation of technological sovereignty. Including increased attention to creation of the material base of science (and for this purpose initiation of the Federal project “Development of domestic instrumentation for civil purposes”³).

Let us elaborate on these areas.

5.3.2. Changing the system of assessment of science effectiveness

The system for assessing effectiveness of scientific research, which has been widely used in recent years was based on accounting publications indexed in the international scientific citation databases Web of Science and Scopus. In March⁴ a discussion began of a new idea that is based on rejecting this principle and reorientating to inhouse system of ranked scientific journals while removing the requirement to publish in papers indexed in foreign databases. Intention to start actively developing open access⁵ journals was also expressed, possibly in cooperation with the BRICS countries.

Second idea for forming a new evaluation system was to introduce indicators that would account works that didn't conclude with reports on R&D but instead concluded with practical results (for example, finished products).⁶ If we look at Russian science in terms of types of research, then publications from only 20—25% of

1 Science Business survey: Most European researchers support science sanctions on Russia. 27 October 2022. URL: <https://sciencebusiness.net/news/sciencebusiness-survey-most-european-researchers-support-science-sanctions-russia>

2 *Volchkova N.* When the thunder roared. Measures to support science under sanctions are outlined // *Poisk*. 15 April 2022 No. 16. P. 3. URL: <https://poisknews.ru/magazine/kogda-gryanul-grom/>

3 Developed in accordance with Executive Order of the President of the Russian Federation of February 10, 2022 No. Pr-290.

4 Experts discussed creation of the National System of Research and Development Performance Evaluation. 11 March 2022. URL: https://www.minobrnauki.gov.ru/press-center/news/?ELEMENT_ID=48219

5 Ministry of Education and Science and the Russian Academy of Sciences are working on joint solutions for the development of Russian scientific journals. 29 July 2022. URL: <https://minobrnauki.gov.ru/press-center/news/novosti-ministerstva/55782/>

6 *Mikhailchenko N.* The Broken Mirror of Bibliometrics // *Stimul online*. 17 March 2022. URL: <https://stimul.online/articles/science-and-technology/razbitoe-zerkalo-bibliometrii/>

scientists can be considered relevant, as the rest are engaged in applied research and development in one way or another.

As early as March 19 an RF Government Decree was published that prohibited the use of publication activity indicators in papers indexed in the international databases Web of Science and Scopus² until December 31, 2022 as well as abandonment of the following evaluations: effectiveness of scientific, scientific and technical and innovation programs and projects, provision of grants in form of subsidies as well as activity effectiveness of budget and autonomous institutions and other organizations and work of their managers. Requirement for participation in foreign scientific conferences was also cancelled along with publications on results of such conferences. Work of expert councils of Russian Science Foundation (RSPF) was restructured accordingly, increased attention being paid to quality of published articles rather than the place of their publication.³ At the same time, requirements for preparation of articles in co-authorship with foreign colleagues⁴ were alleviated. In addition, Russian Science Foundation expressed its intention to strengthen the evaluation of practical results of projects.

By August, it became clear that decisions made indicated the beginning of a long-term restructuring of the system in which science functions. Ministry of Science and Higher Education issued an order according to which, starting from 2025, points for articles written by scientific and pedagogical university staff will be awarded only for publications in scientific journals included in the list of the Higher Attestation Commission (HAC).⁵ In the meantime, a transition period of two years is established. Scientific publications in WoS and Scopus in 2019—2020 will be taken into account in 2023, while those published in 2021 will be accounted for in 2024. In late September, the following requirements were extended until December 31, 2023:⁶ requirement to publish in scientific journals indexed in the international databases Web of Science, Scopus, requirement to participate in foreign scientific conferences, as well as a requirement to consider these indicators in performance evaluation.

As National System of R&D Performance Assessment was being developed, a list of scientific publications was created, being published in which will now be taken into account when evaluating results. By November, two lists of publications

1 Science Indicators: 2022. Statistical Compendium. M.: NRU HSE, 2022. P. 131.

2 RF Government Decree of 19.03.2022 No. 414 «On some issues of the application of requirements and target values of indicators related to publication activity». URL: <http://actual.pravo.gov.ru/text.html#pnum=0001202203210040>

3 Position of Expert Councils of Russian Science Foundation on the issue of accounting for publications // RSF Press-Service. 6 May 2022. URL: <https://rscf.ru/news/found/pozitsiya-ekspertnykh-sovetov-rnf-po-voprosu-ucheta-publikatsiy/>

4 *Mishenko E.* It is not worth pouring young wine into old bottles. Publications and Science Metrics in the Context of Sanctions // Indicator.ru. 23 May 2022. URL: <https://indicator.ru/humanitarian-science/ne-stoit-vlivat-molodoe-vino-v-starye-mekhi-publikacii-i-naukometriya-v-usloviyakh-sankcii.htm>

5 *Mishina V., Kurilova A.* Evaluation of university development will be revised to take into account the “new realities” // Vedomosti. 19 August 2022. URL: <https://www.vedomosti.ru/society/articles/2022/08/18/936683-razvitiya-vuzov>

6 RF Government Decree of 19.09.2022 No. 1655 «On amending the first paragraph of article 1 of Resolution of Government of the Russian Federation from 19.03.2022 No. 414». URL: <http://publication.pravo.gov.ru/Document/View/0001202209210014>

appeared — the White List and the VAK list. The VAK list included 2,593 Russian scientific publications, including the ones indexed in Web of Science and Scopus, as well as 944 journals of the RSCI (Russian Science Citation Index — “Russian shelf of Web of Science”),¹ which were divided into three categories by quartiles. The quality of some of the journals on the list was considered by a number of authoritative experts to be insufficiently high and VAK plans to consider all the comments.

In turn, the White List which was compiled by Interdepartmental Working Group of the Ministry of Science and Higher Education of the Russian Federation includes more than 30,000 titles. These are all publications indexed in Web of Science Core Collection and Scopus, as well as Russian journals included in RSCI (“RSCI Core”).² White List has not yet been sorted and some duplicates occur (for example, this applies to translated Russian-language journals). There is a plan to verify the list by a large number of experts and to make the selection system more transparent. The list has not yet been ranked and proportions of the VAK list will probably be used: 25% of journals will be placed in the first category and 25% in the third category and the rest will receive the second category. At the same time, there were no restrictions on publications of results in foreign journals. This will be a test of how effective the past experience has been and whether researchers will still seek to get into journals indexed in Web of Science and Scopus or will lower their bar of requirements.

According to optimistic expectations it is on the White List that scientometric part of the National System of Evaluation of Effectiveness of Scientific Research and Development will be based. However, if lobbyists of “full autonomy” from foreign bases win then the system of evaluation will be based on the VAK list. A way to mitigate negative consequences of such scenario could be a more active transition to the system of open access since it imposes higher requirements for the quality of initial scientific data³ and, therefore, promotes scientific integrity which has declined⁴ in recent years as a result of the publication race.

It should be noted that tendency to use bibliometric indicators to evaluate individuals and organizations is contrary to the changes taking place in countries with advanced science. Thus, in 2022 more than 300 European organizations signed an agreement to reform the evaluation of scientific research. Transition to using mainly qualitative indicators is announced as well as inclusion in the evaluation system activities such as teaching, expert and administrative work.⁵ European Research Council is also changing the procedure of how grant applications are

1 *Vasyliya A.* Scientists will respond to articles // *Kommersant*. 3 November 2022. P. 4. URL: <https://www.kommersant.ru/doc/5650549>

2 «White list» of scientific journals. URL: <https://journalrank.rcsi.science/ru/>

3 *Dezhina I.G.* International scientific cooperation of Russian universities under new conditions: Constraints and opportunities // *EKO*. 2022. No. 11. P. 125–143. DOI: 10.30680/ECO0131-7652-2022-11-125-143.

4 *Trubnikova E.I.* The Exchange of gifts in the academic sphere: Predatory practices, false signal, and conflicts of interest in excellence programs // *Mir Rossii*. 2022. No 31 (1). P. 25–48. <https://doi.org/10.17323/1811-038X-2022-31-1-25-48>

5 *Upton B.* Centralised hiring a barrier to research assessment reform // *Times Higher Education*. 21 December 2022. URL: <https://www.timeshighereducation.com/news/centralised-hiring-barrier-research-assessment-reform>

evaluated in favor of paying more attention to applicants themselves rather than to their past achievements (the Hirsch index and other scientometric parameters).¹ In the context of sanctions restrictions in Russia, a similar revision of evaluation principles could help to increase the accuracy when measuring the results, which itself has become the task of prime importance.

Meanwhile, National Performance Assessment System being developed includes not only a journal policy but also a new approach to monitoring, which is based on a scale called “percentage of completion of a scientific result”. This approach is rightly criticized because not only the concept of “completion of scientific result” opposed to “technology completion” is an unclear measure, but it is also planned to be verified by involving business (apparently, in the area of applied research). However, business actors cannot always give an objective assessment of the result’s prospects. Finally, with regard to the social and humanitarian sciences this approach may be completely unworkable.

5.3.3. New focus of international cooperation

International scientific cooperation has been forced to restructure because of sanctions and completion of the unfriendly countries list. Unfriendly countries are the main scientific powers that account for about 65% of the world’s expenditure on research and development.² For many years main partners of Russian scientists were organizations and researchers from such countries (primarily the United States, Germany, Great Britain and France), although in the last decade cooperation with them has somewhat declined.

China with which scientific cooperation has been strengthening in recent years has turned out to be a promising partner among friendly countries.³ In China international cooperation is expanding (not only with Russia) and the government has increased funding for the National Natural Science Foundation by about 7% per year over the past three years.⁴ It is planned to work on global issues which creates preconditions for cooperation with Russia. Moreover, potential for developing relations is limited by the fact that in 2022 according to Clarivate, Russia was ranked 20th by the scale (and therefore significance) of cooperation with China.⁵ In addition to China, there are plans to expand cooperation with other “world majority” countries including India and Iran. So far, friendly countries,

1 *Upton B.* ERC evaluation overhaul focuses on proposals over track record // Times Higher Education. 21 December 2022. URL: <https://www.timeshighereducation.com/news/erc-evaluation-overhaul-focuses-proposals-over-track-record>

2 Head of Russian Academy of Sciences Sergeyev against the rupture of scientific cooperation with unfriendly countries // Interfax. 1 June 2022. URL: <https://academia.interfax.ru/ru/news/articles/8538>

3 *Gaind N., Abbott A., Witze A., Gibney E., Tollefson J., Irwin A., Van Noorden R.* Seven ways the war in Ukraine is changing global science // Nature. 2022. No. 607. P. 440–443. DOI: 10.1038/d41586-022-01960-0

4 *Williams T.* China’s dip in research collaboration ‘temporary’, funder insists // Times Higher Education. 12 October 2022. URL: <https://www.timeshighereducation.com/news/chinas-dip-research-collaboration-temporary-funder-insists>

5 *Johnson J., Adams J., Grant J., Murphy D.* Stumbling bear, soaring dragon. Russia, China and the geopolitics of global science. Harvard Kennedy School for Business and Government, Clarivate, The Policy Institute, King’s College London. July2022.

primarily China and India account in total for less than 20% of the total number of international publications by Russian scientists.¹

The pivot to the East was accompanied by identifying mutually beneficial areas and forms of cooperation. Thus, RAS has identified areas of mutual interest with Iran which include nanotechnology, biotechnology and information technology.² These areas are the most developed in Iran and they have long been supported by the government. In terms of potential forms of cooperation, creation of branches in universities and research institutes is considered in friendly countries, including CIS.

Meanwhile heads of Russian Academy of Sciences spoke in favor of finding ways to continue cooperation with unfriendly countries³ including the fact that main breakthroughs are currently being made in international teams.⁴ Such position is also supported by many representatives of the scientific community: according to the survey carried out in April-May 2022 among 4100 Russian scientists 76,3% of them consider cooperation with foreign scientists and their teams from unfriendly countries acceptable, at least on a personal level.⁵

Also, measures were taken to decrease cooperation primarily with the United States. Government Edict No. 1350-r of May 28, 2022 terminated the Memorandum of Understanding between the Government of the Russian Federation and the Government of the United States on principles of cooperation in culture, humanities and social sciences, education, and mass media, that was signed in Moscow on September 2, 1998.

In response the White House announced that in accordance with U.S. domestic and international law, institutional, administrative, financial, personnel, and S&T cooperation with Russian government research institutions and individuals who continue to work at or under the direction of those institutions will be terminated. Projects and programs initiated and/or funded prior to February 2022 may be completed but new ones will not be initiated.⁶

There remain areas of international cooperation where Russia, the United States, and a number of EU countries have continued to cooperate. This refers

1 *Pertsova V., Kirilochkina V.* Isolation from the global community and the brain drain: what the future holds for Russian science // Forbes. 21 march 2022. URL: <https://www.forbes.ru/forbeslife/459339-izolacia-ot-mirovogo-soobsestva-i-utecka-mozgov-kakoe-budusee-zdet-rossijskuu-nauku>.

2 *Burmistrov A.* Russian scientists develop cooperation with Iran // Scientific Russia. 20 april 2022. URL: <https://scientificrussia.ru/articles/rossijskie-ucenye-razvivaut-sotrudnicestvo-s-iranom>

3 Academician Alexei Khokhlov: "Science in the new Russia is my peak Communism."// Scientific Russia. 2022. No. 5–6. URL: <https://scientificrussia.ru/articles/akademik-aleksej-hohlov-nauka-v-novoj-rossii-eto-moj-pik-kommunizma-v-mire-nauki-no5-6>.

4 *Alexander Sergeev:* Russia has always found a way out of hopeless situations // RG – federal edition. 15 марта 2022. No. 55 (8703). URL: <https://rg.ru/2022/03/15/aleksandr-sergeev-rossiia-vsegda-nahodila-vygod-iz-bezvyhodnyh-situacij.html>

5 *Gusev A.B., Yurevich M.A.* Science policy of Russia – 2022: a profession is not dearer than the motherland. M.: OOO «Buki Vedi», 2022. P. 26.

6 Guidance On Scientific and Technological Cooperation with the Russian Federation for U.S. Government and U.S. Government Affiliated Organizations // Press release. White House. 11 June 2022. URL: <https://www.whitehouse.gov/ostp/news-updates/2022/06/11/guidance-on-scientific-and-technological-cooperation-with-the-russian-federation-for-u-s-government-and-u-s-government-affiliated-organizations/>

exclusively to megascience facilities, i.e., joint scientific work in unique facilities. Cooperation at the ITER thermonuclear complex in France where Russia is one of the founding members has not been terminated. Partners' main contributions are manufacturing and supplying high-tech equipment for ITER. Europe provides about 45% to the cost of building the facility. Other countries including Russia provide 9.09% each. However, what is more important is that Russian specialists are involved in the production of 25 unique systems that involve more than 30 leading Russian scientific and technical organizations. Russia continues to manufacture and send appropriate technological elements and complexes to ITER.¹ Second area where U.S.—Russian cooperation continues is the joint operation of the International Space Station due to it being a legally binding partnership.² Third, Russia continues to participate in the European Synchrotron Radiation Facility (ESRF), an accelerator complex located in Grenoble.³

Finally, while developing an ideology in the field of international scientific cooperation, the Ministry of Education and Science together with the Ministry of Justice created a working team to protect national interests in science and higher education from external influence.⁴ Special attention is supposed to be paid to the activity of NPOs as providers of “hidden influence”. The list of NPOs — undesirable organizations, is constantly being expanded including the Woodrow Wilson International Center for Scholars⁵ located in the United States which after the collapse of the USSR implemented internship programs for Russian scholars in the social sciences.

5.3.4. Turn to applied sciences

Reorientation to research that is important for the country's economy, along with changes in the management system became a separate direction of scientific policy. First Deputy Prime Minister Andrey Belousov suggested introducing the position of head of scientific and technological transformation in ministries with the rank of deputy minister.⁶

A loud resonance was caused by a statement of Ministry of Science and Higher Education of the Russian Federation that the subjects of works of fundamental research starting from 2023, should be coordinated with the governors⁷. Almost immediately it was explained that it concerns not all organizations engaged in

1 *Polkanov V.* Scientists tame fusion // *Nezavisimaya Gazeta – science*. 25 October 2022. URL: https://www.ng.ru/nauka/2022-10-25/12_8574_synthesis.html

2 *Ambrose M.* US Restricts Science Collaborations with Russia // *FYI Bulletin*, No. 47. 17 June 2022. URL: <https://www.aip.org/fyi/2022/us-restricts-science-collaborations-russia>

3 *Polkanov V.* Scientists tame fusion // *Nezavisimaya Gazeta – science*. 25 October 2022. URL: https://www.ng.ru/nauka/2022-10-25/12_8574_synthesis.html

4 The Ministry of Education and Science and the Ministry of Justice will protect Russia's scientific interests from external influence. 1 September 2022. URL: <https://minjust.gov.ru/ru/events/49057/>

5 The General Prosecutor's Office recognized the Wilson Center as an undesirable organization // *RIA Novosti*. 11 November 2022. URL: <https://ria.ru/20221111/genprokuratura-1830805842.html>

6 *Belousov A.* Positions of head of science and technology transformation should be introduced in ministries // *TASS*, 18 July 2022. URL: <https://tass.ru/ekonomika/15244967>

7 *Zykina T.* Ministry of Education and Science has bound scientists to approve research topics from regional heads // *RBK*. 11 April 2022. URL: <https://www.rbc.ru/society/11/04/2022/6253544f9a794784b517f0db>

fundamental research but only world-class research and educational centers (RECs) of which there are only 15 in the country. The governors will not decide whether or not to finance the declared works but will only evaluate their usefulness for the region¹.

Since the development of regional economies under sanctions will have to be taken into account when choosing the topics of fundamental research, an increase in financing of such research from regional budgets is also possible. In April, a law was adopted expanding the powers of regions to support federal scientific and educational organizations.² Now subjects of the Russian Federation can finance R&D in federal state educational institutions of higher education, federal state scientific organizations and participate in formation of such organizations. Thus, there are more opportunities for RECs to receive funds from regional budgets. Strengthening of the role of governors is really important from the point of view of assessing the significance of the results but at the same time we are talking about fundamental research where the practical output is, in principle, not obvious.

Following the REC in May, there were plans to adjust the topics of projects within the framework of the state assignments implementation of which should contribute to technological development. In this case the priority will be given to complex scientific and technical programs of the full innovation cycle where the results should be in the form of pilot batches.

Reorientation of topics to meet the changed needs of the economy in the context of sanctions can be useful since the data of a large-scale survey of researchers conducted in April-May 2022³ shows that only 18.4% of researchers believe that their work is relevant and will become even more important under the new conditions, and 34.8% recognized the decreasing importance of their research.

Increased focus on support of applied research has also affected research foundations. Last year the reform of the system of scientific foundations was completed leading to only one foundation that allocates grants for scientific research remaining — the Russian Science Foundation (RSF), its functionality adjusted as well. The Russian Foundation for Fundamental Research (RFFR) was renamed into the Russian Center of Scientific Information (RCSI)⁴ with a corresponding change in functionality. Main purpose of RCSI is information and analytical activity in the sphere of science, international scientific and technical cooperation including scientific diplomacy and provision of access of Russian scientists to scientific information. Meanwhile initial version of the RCSI charter contained a number of tasks that are performed by the RAS, which raised worries

1 *Vasilyeva A.* Science will not be given away to governors // *Kommersant*. 13 April 2022. URL: <https://www.kommersant.ru/doc/5305620>

2 Federal Law “On Amendments to Article 12 of the Federal Law “On Science and State Scientific and Technical Policy” and Article 8 of the Federal Law “On Education in the Russian Federation” from 16.04.2022 No. 108-FZ. URL: <https://docs.cntd.ru/document/350237363>

3 *Gusev A.B., Yurevich M.A.* Science policy of Russia – 2022: a profession is not dearer than the motherland. M.: OOO «Buki Vedi», 2022. P. 34.

4 The Ministry of Education and Science of Russian Federation intends to rename Russian Foundation for Basic Research into Russian Center for Scientific Information // *Science*. TASS. 15 April 2022. URL: <https://nauka.tass.ru/nauka/14389501>

in the Academy. In the final version of the RCSI charter duplication with the RAS was eliminated including in the part of the centres' expert activity. Organizational changes caused a sharp budget reduction of the RCSI and led to moving a share of funds to the Russian Science Foundation (*Table 8*).

Table 8

Public allocations for Russian Science Foundation and RCSI

| Type of expense | 2023 | 2024 | 2025 |
|--|------|------|------|
| Russian Center of Scientific Information (former Russian Foundation for Basic Research), Rb bn | 5.4 | 4.4 | 1.9 |
| Russian Science Foundation, Rb bn | 29.5 | 38.7 | 38.8 |

Sources: Appendix 10 to the explanatory note to Federal Law “On the Federal Budget for 2023 and for the Planning Period of 2024 and 2025”; annex 15 of the law.

A law was passed¹ in December under which RSF besides supporting fundamental research will also support experimental design and technological works (EDTW) “in order to facilitate the implementation of strategic initiatives of the President of the Russian Federation in the scientific and technological sphere”. According to that law RSF creates an expert Scientific and Technical Council which will evaluate experimental and development projects. This change in RSF’s functions means that closer interaction with development institutions that support the development and implementation of new technologies is more likely.

In general, an idea that there can be a subdivision within a foundation of basic scientific research that supports handling of applied issues is now being realized in several developed countries. For example, U.S. National Science Foundation (NSF) has established a separate directorate with the function of supporting transformational research. Similar processes are under way in Great Britain and Canada where it is being decided whether such a structure should be independent or be a part of existing foundations. In Russian version planned changes are dangerous because they increase monopolization of the RSF against the background of lack of alternatives in the form of private and non-profit research foundations, and regardless of where it is always means a decrease in quality. In USA besides the large public NSF there are many private philanthropic foundations that support science with total research funding of more than \$30 bn per year² which is 3 times more than the budget of the NSF itself. All in all, research in the USA is financed by more than 70 thousand organizations of various sizes.

1 Federal law from 19.12.2022 No. 531-FZ “On Amendments to the Federal Law “On the Russian Science Foundation and Amendments to Certain Legislative Acts of the Russian Federation”. URL: http://www.consultant.ru/document/cons_doc_LAW_434568/

2 *Allen M.* US philanthropic organizations spend over \$30bn a year on science // *Physics World*. 3 July 2022. URL: <https://physicsworld.com/a/us-philanthropic-organisations-spend-over-30bn-a-year-on-science/>

New RSF functions caused few more specific questions. First one, is the choice of areas of support for experimental design and technological work. Priority areas are known¹ but it is difficult to cover them all at once. At the end of the year, a palliative decision was made to form a Scientific and Technical Council in the field of microelectronics.² Second one, is to identify a qualified customer³ (which can be both state authorities and companies), who needs results of OCTD. In contrast to classical scientific projects which so far have been financed by the Russian Science Foundation new projects should give a clear economic result.

5.3.5. Academic and university science

New RAS Policy

In 2022, there were regular elections of members of RAS as well as an election of new president of RAS after which a new course of development of the Academy was outlined.

In June, more than 300 new members of RAS were elected.⁴ Data on formal scientific successes of the candidates (including their bibliometric indicators) was made public in advance which was a sign of a rather bold openness of the Academy. Bold, because many applicants' bibliometrically measured successes were more than modest. Most objective assessment was found to be the RSCI core percentile. This is a ranking of researchers from a particular field of science in order of decreasing number of citations of their papers from the RSCI core. The percentile can range from 1 to 100 where 1 is the group of researchers with the highest number of citations. To be considered for an academic applicant one must be in percentile 1 or 2. However, the median percentile among all RAS candidates was 5 and for colleagues elected to RAS it turned out to be 3⁵ which in general raises questions about choice of the initial pool of candidates. Moreover, in the Department of Global Problems and International Relations of RAS the median percentile of candidates for membership was higher than that of the elected (4 vs. 6). For election of RAS academicians a similar phenomenon was observed in the Departments of Mathematical Sciences, Nanotechnology, as well as Historical and Philological Sciences.

Then President of the Russian Academy of Sciences Alexander Sergeyev outlined several priorities for the Academy:

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- 1 These include microelectronics, medicine, agro-technology, genetic technology, ecology, and scientific instrumentation.
 - 2 *Vedeneyeva N.* An official and academics discovered 135 billion of extra grant money // MKRU. 27 December 2022. URL: <https://www.mk.ru/science/2022/12/27/chinovnik-i-akademiki-obnaruzhili-lishnie-135-miliardov-grantovykh-deneg.html>
 - 3 It's a challenge. The head of the Russian Science Foundation spoke about the Foundation's new tasks // Poisk. 23 December 2022. No 52. P. 2.
 - 4 Live broadcast of the general meeting of members of Russian Academy of Sciences // Scientific Russia. 1 June 2022. URL: <https://scientificrussia.ru/articles/1062022-pramaa-translacia-obsego-sobrania-clenov-rossijskoj-akademii-nauk-2>
 - 5 *Hohlov A.* Scientometrical analysis confirms that the expert selection for the election was carried out qualitatively --// RAS. 5 July 2022. URL: <https://new.ras.ru/activities/news/naukometricheskiy-analiz-podtverzhaet-chto-ekspertnyy-otbor-na-vyborakh-proveden-kachestvenno-aleks/>

1) changing status of RAS from FSBI to “state academy of sciences”, which will allow it to become a co-founder of scientific institutes and partake in scientific research;

2) initiating a program for research institutes similar to “Priority 2030” for universities;

3) strengthening ties with real economy and regions;

4) in international activities – to maintain contacts with foreign colleagues at the level of individual researchers and laboratories.

Thus, half of the agenda corresponded to the country’s national science policy and the other half reflected position of the president of Russian Academy of Sciences related to strengthening influence of the Academy and increasing funding of the former academic institutions.

Big intrigue in the academic community followed after the election of a new president of RAS in September. Alexander Sergeev who had nominated himself for the next term and had received considerable support from the academic community withdrew the candidacy on the first day of the General Meeting of RAS.¹ Two candidates remained - Gennady Krasnikov, an academician-entrepreneur and General Director of the JSC Scientific Research Institute of Molecular Electronics and Dmitry Markovich, Director of the S. S. Kutateladsky Institute of Thermophysics SB RAS. The choice was predetermined in favor of Gennady Krasnikov whose nomination was supported by most departments of RAS.

Withdrawal of Alexander Sergeev’s candidacy was followed by criticism of his activities. Main reproach to the former president was that RAS did not become the leading organization in goal-setting and implementation of the country’s S&T policy. A number of decisions, even those related to the competence of RAS were made without taking into account opinions of its members (for example, decision regarding the tools for evaluating the results of scientific activity). Latent goal of strengthening the Academy by restoring management of scientific institutes was not achieved either. Institutes remained under jurisdiction of Ministry of Science and Higher Education. Academy could still only approve appointments of directors and charters of RAS institutes and approve decisions on reorganization and liquidation of scientific organizations.

Before the election Alexander Sergeev and Gennady Krasnikov presented largely similar agendas. Among the tasks was highlighting the importance of conducting research in the interests of real sector with G. Krasnikov identifying areas that required special attention. The task was to overcome paternalistic attitude to the university science and a broader cooperation with universities because it can accelerate the solution of applied scientific issues. However, Sergeev did not set such a task and Krasnikov wrote in his program that “*RAS should provide real scientific and methodological leadership of academic institutions that have been transferred to the Ministry of Science and Higher Education of the Russian Federation and universities in order to form a unified approach to scientific research,*” thus putting RAS above the university science.

¹ RAS President Sergeev withdrew his candidacy from the election of academy’s head due to pressure // Kommersant. 19 September 2022. URL: <https://www.kommersant.ru/doc/5570400>

After his election Gennady Krasnikov significantly changed the formation of vice presidents and reduced their total number from 11 to 10.¹ In November during the meeting with President Putin² Gennady Krasnikov more clearly defined the priority areas of the Academy's work. First is the inclusion of RAS in the state system of decision-making, i.e. a new attempt to do what the two previous presidents of RAS who were elected after the reform of the Academy in 2013 failed to do. Gennady Krasnikov hopes to achieve this through the scientific and methodological management of scientific institutes with the help of commissions which until recently were created to analyze the work and evaluate institutes. These commissions are supposed to be used as a tool for coordinating new approaches in the work and evaluation of problems the institutes face. Gennady Krasnikov considers the second important task of the Presidium of RAS to be initiation of large-scale projects and then ensuring scientific and methodological management of such projects. The third direction assumes larger involvement in applied developments based on consortiums without company formation which would include representatives of fundamental, applied, university science and high-tech companies. According to the idea of new president of RAS such consortia can receive support at different stages from the Ministry of Science and Higher Education, the Ministry of Industry and Trade and a number of industry ministries as well as from production sector. Gennady Krasnikov called the areas that are related to solving problems of technological independence (microelectronics, electronic engineering, additive technologies, new materials)³ the priority ones. Such projects should accelerate translation of fundamental knowledge into practically useful results. On one hand in current conditions such approach is relevant. On the other hand, it is based on a linear model of innovation suggesting that it begins with fundamental research which has long been recognized as an outdated concept.

Thus, in comparison with Alexander Sergeyev, the new president of RAS expands the area of the Academy's activity, strengthens the focus on applied results and at the same time concentrates mainly on internal tasks, paying much less attention to involvement in the international scientific agenda and not expressing a position on issues of cooperation with foreign partners.

“Priority-2030”

There were no significant changes in the sphere of university science. Main “Priority-2030” program in which 106 universities participate continued but due to new geopolitical circumstances the dynamics of its development somewhat slowed down and discussions began on changes to be made in the program.

First of all, the need for changes is connected with the fact that the creation of consortiums with international participation has become a popular form of

1 Bykova N. RAS President of the Mobilization Era // Ekspert. 26 September 2022. No. 39. URL: <https://expert.ru/expert/2022/39/prezident-ran-epokhi-mobilizatsii/>

2 Meeting with Gennady Krasnikov, President of the Russian Academy of Sciences. 11 November 2022. URL: <http://kremlin.ru/events/president/news/69824>

3 Mikhail Mishustin meets with Gennady Krasnikov, President of the Russian Academy of Sciences. 29 December 2022. URL: <http://government.ru/news/47462/>

science development in the universities participating in the program. A number of such consortiums began to disintegrate due to sanctions. Secondly, the program was focused on considering publications indexed in Web of Science and Scopus databases but due to changes in the system of accounting of scientific results it was necessary to revise the approaches to evaluation in the program. A separate problem emerged for the universities of the research leadership track as their participation in world rankings (such as The Times Education and QS) became problematic. In the Shanghai ARWU ranking Russian universities are the weakest because it relies on the indicators of scientific achievements to a much greater extent than THE/QS including the number of Nobel laureates working at universities. That is why in 2022 ranking the best position is 501—600 among the universities participating in “Priority-2030” which is occupied by Moscow Institute of Physics and Technology¹.

In addition, analysis of the interim achievements of the programs’ participants showed that a significant number of universities with high results in various fields were not included. A comparison between universities — participants of “Priority — 2030” and the ones that did not enter the programme showed that among top 20 Russian universities-leaders by integral indicators in the field of science and development of human resource only 13 participate in the program (65%). And this is the best result. Among the leaders in terms of educational activity the program participants account for 15% and in terms of financial activity — only 5%.²

In July, the Ministry of Science and Higher Education announced adjustments to the program³ including an increased focus on bringing R&D to commercialization and scale as well as research important to the country’s technological sovereignty.

The most remarkable was the results of the implementation of the program for year 2021 by Russian Ministry of Science and Higher Education at the end of November. Universities which have not reached the target indicators were established (in all, 42 out of 106 participants of the program or about 40%) as well as universities which showed signs of presenting false reported data have been revealed (there were 73 universities or almost 70% of the total number).⁴ Tough measures were supposed to be taken against the institutions of higher education which failed to achieve indicators of achievement by more than 5%: they were to return funds to the federal budget. Institutions of higher education that might have provided inaccurate information would be subject to a ‘documentary check’. It was not been made public exactly which characteristic had not been achieved and under what parameters inaccurate information had been uncovered.⁵

1 URL: <https://www.shanghairanking.com/rankings/arwu/2022>

2 New Leading Universities: An Analysis of the Contribution to the Development of Russian Higher Education. Analytical brochure / E.G. Grishakina, V.L. Parkacheva et al.; Moscow Financial-Industrial University “Synergy”. M.: Synergy University Publishing House, 2022. P. 89.

3 The “Priority-2030” program may be adjusted in the context of new reality. 26 July 2022. URL: <https://minobrnauki.gov.ru/press-center/news/novosti-ministerstva/55376/>

4 Minutes of meeting of the Commission of Ministry of Science and Higher Education of the Russian Federation on the selection of Russian educational institutions of higher education for participation in the program of strategic academic leadership “Priority-2030”. November 24, 2022.

5 Vasileva A. Universities have mislabelled priority // Kommersant. 1 December 2022. URL: <https://www.kommersant.ru/doc/5695686>

As universities of the “Project 5-100” were the most experienced and also were receiving the special part of the grant, results of the inspection of those 21 universities are worth looking at. Of these only 12 reached target parameters while at the same time among these 12 universities there were 8 with signs of unreliable data. Thus, only four universities — the former participants of the “Project 5-100” — actually reached target parameters: Tomsk State University and Tomsk Polytechnic University, Baltic Federal University and PFUR. The number of universities that fulfilled their obligations but provided unreliable data included Fiztech, National Research University Higher School of Economics, Novosibirsk State University, and St. Petersburg Polytechnic University, i.e. the leading research universities of the country.

Despite the obtained assessments Expert Council of the program actually left the entry list of the participants unchanged.¹ Rotation of HEIs participating in the program which had been planned a year earlier resulted in no changes² in the research leadership track while in the territorial or sectoral leadership track three more HEIs joined making it equal to 31. Rotation which implies withdrawal of some HEIs from the program and the influx of other HEIs into it did not take place.

5.3.6. Science budgetary policy

Response to sanctions and acceleration of technological development require a significant increase in budget expenditures on R&D. Financing of the state program “Scientific and technological development of the Russian Federation” is planned to be increased but on a short-term basis. The maximum increase is planned for 2023 followed by a sharp decrease in allocations in 2025 (*Table 9*).

Table 9

Public allocations for civilian fundamental research 2023—2025

| Indicator | 2023 | 2024 | 2025 |
|--|--------------|--------------|--------------|
| Federal budget expenditures on civilian R&D, overall, billion rubles | 562.3 | 552.9 | 438.6 |
| Change to previous year, % | +21.7 | -1.7 | -20.7 |
| Change compared to the bill in 2022–2024., every year, % | +18.0 | +15.8 | — |
| State program “Scientific and Technological Development of the Russian Federation” | 553.5 | 543.9 | 427.9 |

Sources: Appendix 10 to the explanatory note of Federal Law “On the Federal Budget for 2023 and for the Planning Period of 2024 and 2025”; own calculations.

Moreover, Rb125.3 bn have been allocated to National Project “Science and Universities” in 2022 and in 2023 it is planned to slightly reduce appropriations in

1 Ministry of Science and Higher Education of the Russian Federation. Minutes of the meeting of Presidium of the Council for support of development programs of educational institutions of higher education within the framework of implementation of the Strategic Academic Leadership Program “Priority-2030” dated December 21, 2022.

2 Not counting the voluntary relinquishment of funds from the special part of the Mining University grant.

comparison with the Law No. 390-FZ¹. In the National Project the most “expensive” are infrastructure projects (*Table 10*).

Table 10

**Amounts of funding for individual activities of the National Project
“Science and Universities”, Rb bn**

| Topic | 2023 | 2024 |
|--|------|------|
| Completion of a unique megascience-class scientific installation of the Siberian Ring Photon Source Collaborative Center with experimental stations | 17.5 | 13.8 |
| Updating the instrumentation base of the leading organizations performing research and development | 16.4 | 12.4 |
| Construction of new modern research vessels of unlimited area of navigation | 9.5 | 4.0 |
| Developing cooperation of Russian educational organizations of higher education, state scientific institutions and organizations of the real sector of the economy in order to implement complex projects to create high-tech industries | 4.5 | 4.5 |
| Creation of world-class science centers | 4.2 | 4.2 |
| Creation of new laboratories including those led by promising young researchers | 4.0 | 3.6 |

Sources: Appendix 10 to the explanatory note of Federal Law “On the Federal Budget for 2023 and for the Planning Period of 2024 and 2025”; own calculations.

Sanctions restrictions put science in conditions when problems must be solved related to the development of necessary technologies against the background of sharply reduced access to modern devices, equipment and materials. Thus, following important areas of budgetary support are:

- 1) scientific instrumentation and infrastructure;
- 2) cooperation of science and business;
- 3) R&D in small innovative companies, including startups;
- 4) R&D in selected critical industries.

In the context of targeted areas budget support is inadequate at best, and in some cases, it is lacking.

Scientific instrumentation and infrastructure (improvement of material base of science) will be supported under two federal projects — “Development of Domestic Civil Instrumentation” (a new Federal project) and “Development of Infrastructure for Scientific Research and Personnel Training” of the “Science and Universities” National Project. Annual allocation for the Federal Project “Development of the National Civilian Instrument-Making Industry” amounts to about 4 billion rubles while annual requirement is estimated at Rb10—15 bn.² Under the Federal Project “Development of infrastructure for scientific research and personnel training” expenditures will fluctuate with a slight upward trend. It has become impossible to

- 1 Federal Law «On federal budget for 2022 and for the planning period of 2023 and 2024» from 06.12.2021 No. 390-FZ. URL: http://www.consultant.ru/document/cons_doc_LAW_402647/
- 2 As of 2022, 93% of scientific equipment in Russia is imported. See.: *Bykova N.* Russia will build scientific instruments // *Expert*. 28 November 2022. No 48. URL: <https://expert.ru/expert/2022/48/v-rossii-budut-delat-nauchnyye-pribory/>

directly buy imported scientific equipment which is mainly produced in unfriendly countries, and buying it through third countries will be much more expensive which has not been taken into account in the budget projections.

Cooperation between science and business is supported via the framework of the federal project “Development of Integration Processes in Science, Higher Education, and Industry” which is a part of a National Project “Science and Universities”. Allocations for this project are planned to decrease in 2023—2024 in comparison with the level of financing in 2022. It would be necessary to at least keep the former level of financing because now it is necessary to strengthen and develop connections as complex projects on developing new technologies that are in progress are based on consortiums.

R&D that is supported by small innovative companies is important because they can promptly develop elements of technologies for medium and large businesses. Funds for R&D for small innovative companies and startups are allocated within the framework of the federal project “Takeoff — from Startup to IPO” and through the Fund for Assistance to Small Innovative Enterprises in Science and Technology. Reductions in allocations of both the project and the fund are planned. Federal Project is to be reduced by almost 10% annually as compared with the Law No. 390-FZ. In turn, budgetary allocations for R&D to Fund for Assistance to Small Innovative Enterprises in Science and Technology will be lower than previously planned and by 2025 they will be cut in half.

R&D in certain critically important industries can include research and development in civilian industries, electronics, IT and materials for the energy sector. The situation here is uneven: an increase in allocations is planned in a number of areas but even there the expenditures will be lower than the level of 2022.

As to the Federal project “Promotion of research and development in civilian industries” allocations will be reduced in comparison with the level of 2022 and in 2023 will amount to 70.6% of the last year’s level, in 2023 — 78.2% and in 2025 — 96.2%. Thus, only by 2025 can the level of 2022 be achieved (excluding inflation).

Support of the IT-industry will be carried out in the framework of the Federal project “Development of human resources in the IT-industry” which provides for a 10% reduction in funding annually in 2023—2024 and the termination of support in 2025. Maybe, it is predicted that in two years the staffing problem in the IT industry will be solved.

With total influx of allocations to the State program “Development of electronic and radio electronic industry” by Rb13 bn in 2023 and almost Rb95 bn in 2024 expenses on means of production and R&D will be reduced. For the “Artificial Intelligence» project, there is no financing allocated in the year 2025. Furthermore, for federal project “Scientific support of the development of electronic and radio electronic industry” 23 billion rubles was allocated in 2022 and only Rb17.5 bn is planned for 2023 with a subsequent reduction in funding.

By comparison, “Chips and Science Act” recently signed by the U.S. President provides \$52 bn over 5 years of which \$11 bn is allocated to the Department of Commerce for a number of new R&D programs. While the Department of Defense

gets \$2 bn for the National Microelectronics R&D Network.¹ If translated at the average exchange rate of 2022 (68.5 rubles per \$1) the costs are incomparable: \$13 bn for R&D (or \$2.6 bn per year) is Rb890 bn for 5 years or Rb178.1 bn annually. Moreover, in case of the U.S. — new program provides additional funds for the development of electronics.

Finally, federal project “Development of New Materials and Technologies for Advanced Energy Systems” is about to see a reduction in appropriations relative to 2022. In 2023 funding is assumed to be 51.6% of 2022, in 2024 — 42.2% and in 2025 — 39.4%. Thus, a number of critical industries will not have sufficient funds for the development of domestic technologies.

Room for redistribution of funds within the budget for civilian R&D is small. It can be mainly done by reducing financing of budget classification “fundamental scientific research” under which subsidies for fundamental research (state assignments) and grants from the Russian Science Foundation (*Table 11*) are allocated. Annually more funds are allocated to them in total than to the National Project “Science and Universities”. These funds can be partially redirected to applied research, all the more so because topics of state assignments and grants are self-motivated and often do not correspond to the real needs of the country.²

Table 11

R&D funding under subsidies to public institutions and grants from the Russian Science Foundation, Rb bn

| | 2023 | 2024 | 2025 |
|---|-------|-------|-------|
| Subsidies to federal state institutions for completing scientific research, information on which is placed in unified state information system of registration of research, experimental design and technological works of civil purposes | 120.3 | 127.3 | 134.5 |
| Property contribution of the Russian Federation to the Russian Science Foundation | 29.5 | 38.7 | 38.8 |

Sources: Appendix 10 to the explanatory note of Federal Law “On the Federal Budget for 2023 and for the Planning Period of 2024 and 2025”; own calculations.

The Committee on Science and Higher Education of the Lower House of Parliament in its conclusion of the draft federal budget considered planned growth in civilian R&D insufficient and not big enough to complete tasks of technological breakthrough.³ Indeed, at the macro level R&D expenditure continues to fall: according to the data for 2021 for the first time in the past ten years it has fallen

1 CHIPS Act Funding Sets Semiconductor Initiatives Into Motion. 24 August 2022. URL: <https://www.aip.org/fyi/2022/chips-act-funding-sets-semiconductor-initiatives-motion>

2 Moreover, according to estimates by RAS President Gennady Krasnikov by the time topics of work for state assignments are formed they are often already 70—80% completed. See.: Meeting of Science and Education Council. 8 February 2023. URL: <http://kremlin.ru/events/president/news/70473>

3 *Volchkova N.* Hardly enough. The science budget will continue to shrink // *Poisk*. 21 October 2022. No 43. P. 3. URL: <https://poisknews.ru/science-politic/vryad-li-dostatochno-nauchnyj-byudzheth-prodolzhit-sezhivatsya/>

to 0.99% of GDP.¹ Therefore, it would be correct not to redistribute funds within the budget for R&D but to look for reserves in other budget items. Example of China is illustrative in this respect: after USA strengthened restrictions, funds are increasing annually and are allocated from the country's budget to R&D, and now the total investment in research and development has exceeded 2% of GDP.²

5.3.7. Development of technological innovation

The main task in the field of innovative development was the development of technologies necessary to ensure technological sovereignty. It was formulated by the president and the government.³ First Deputy Prime Minister Andrey Belousov defined technological sovereignty as “*maintenance of technological parity with leading countries of the world, possession of key technologies that determine the ability to solve strategic, socioeconomic and defense tasks*”.⁴ Concept of technological sovereignty has been operationalized differently at the ministerial level. Ministry of Industry and Trade defined it through the resource base as a set of measures aimed at ensuring, developing and retaining human, financial, technological and material potential within Russia aimed at the development of Russian industry.⁵ Ministry of Education and Science has not given a clear definition of technological sovereignty but it can be concluded from various speeches of the Minister of Science and news sources that it refers to “cooperation between authorities, scientific and educational sector and the real sector of the economy to quickly put the results of scientific research into practice”.⁶ Some business representatives interpret technological sovereignty more narrowly — as “ability to overcome dominance of the largest and strongest players”.⁷ That is, they view it in terms of competition between companies. Thus, despite frequent repetition the concept of technological sovereignty is interpreted broadly and diversely.

If we consider technological sovereignty as “possession of key technologies” then it means development along two parallel tracks: borrowing necessary technologies including reverse-engineering and developing domestic ones

1 Ratai T. Russian Science in 2021. // Science. Technologies. Innovation. Express information. 8 September 2022. URL: <https://issek.hse.ru/news/759541996.html>

2 China's spending on R&D expected to reach new high in 2023. URL: <https://www.ecns.cn/cns-wire/2022-09-01/detail-ihccsiks1357125.shtml>

3 Plenary session of St. Petersburg International Economic Forum // President of Russia. 17 June 2022. URL: <http://kremlin.ru/events/president/news/68669>; Meeting of the Council for Strategic Development and National Projects.. 15 December 2022. URL: <http://kremlin.ru/events/president/news/70086>

4 Speech by Andrey Belousov at a meeting of the Council for Strategic Development and National Projects. 18 July 2022. URL: <http://www.kremlin.ru/events/councils/by-council/1029/69019>

5 Grinkevich D., Kinyakin E., Boiko A., Sidorkova I. Ministry of Industry and Trade offered a way to achieve technological sovereignty // Vedomosti. 6 November 2022. URL: <https://www.vedomosti.ru/business/articles/2022/11/03/948680-minpromtorg-predlozhit-sposob-dostich-tehnologicheskogo-suvereniteta>

6 Ministry of Science and Higher Education of the Russian Federation. Breakthrough developments of Russian scientists will ensure the technological sovereignty of the country. 28 October 2022. URL: <https://minobrnauki.gov.ru/press-center/news/nauka/60896/>

7 Mechanick A. Lack of ideas means subordination// Stimul.online. 2 September 2022. URL: <https://stimul.online/articles/innovatsii/bezydeynost-oznachaet-podchinennost/>

based on the development of technological leap. Notion of technological leap implies that in a certain technology market the country is able to follow leaders at an accelerated pace and not only “catch up” with them,¹ but also find its own trajectory of technological development.² This gives the laggards an opportunity to avoid significant investments in preceding technological systems.

Complexity of the set task is not only in the need to overcome unprecedented number of sanctions but is also in the existing reliance on imports, including means of production. According to the 2021 data, dependence on imports for machinery and equipment was 58%, for drugs and medical products — 60%, for chips — more than 70%,³ for computers and electronics — 87%, for auto parts — 95%.⁴ In addition, country has virtually no clean materials⁵ which creates additional obstacles to development of new technologies. A poll held in 2022 among companies-members of Russian Union of Industrialists and Entrepreneurs (RUIE)⁶ has confirmed that domestic products are lacking most of all in the following categories: “equipment” (the share of domestic products there is only 8%) and “components” (the share of domestic products — 11%).

In this context, two lines of action become important: 1) increase of state investments, 2) minimization of bureaucratic procedures that slow down the process of development and approbation of new technologies. President of the Russian Academy of Sciences also mentioned the importance of overcoming bureaucratic barriers expressing the broad opinion of the scientific community that it is necessary to abolish the Federal Law No. 44 regulating state purchases⁷ for scientific organizations. The move will speed up the process of purchasing necessary equipment, reagents, components for prototypes and small batches which will accelerate R&D results built into production.

In addition to direct financing, indirect measures such as lower loan rates are also important for companies (*Table 12*).

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- 1 Intellectual Property Rights, Development, and Catch up: An International Comparative Study / Ed. by H. Odagiri, A. Goto, A. Sunami. R.R. Nelson. London: Oxford University Press, 2010.
 - 2 *Malerba F., Lee K.* An evolutionary perspective on economic catch-up by latecomers // *Industrial and Corporate Change*. 2021. Vol. 30. No. 4. P. 986–1010. DOI: 10.1093/icc/dtab008.
 - 3 Domestic microcircuits are used mainly in the military-industrial complex and space.
 - 4 *Sokolov A.* Russia’s import dependence reached its highest level since 2014 amid rising prices // *Vedomosti*. 1 February 2022. URL: <https://www.vedomosti.ru/economics/articles/2022/02/01/907191-importozavisimost-rossii>
 - 5 *Mechanik A.* From science to the business on science and back again: The scientist’s way // *Expert*. 14 November 2022. No. 46. URL: <https://expert.ru/expert/2022/46/ot-nauki-k-biznesu-na-nauke-i-obratno-put-uchenogo/>
 - 6 *Shokhin A.N.* Speech at the Plenary Session of the National Industrial Congress: Development Priorities. 5 October 2022.
 - 7 Federal Law “ On the contract system for procurement of goods, works and services for state and municipal needs ” from 05.04.2013 No. 44-FZ. URL: http://www.consultant.ru/document/cons_doc_LAW_144624/
 - 8 *Sergeyev A.* Russia has always found a way out of hopeless situations // *RG – federal edition*. 15 March 2022. No. 55 (8703). URL: <https://rg.ru/2022/03/15/aleksandr-sergeev-rossiia-vsegdannahodila-vyhod-iz-bezvyhodnyh-situacij.html>

**Demand for economic policy measures from RSPP member companies
to achieve technological sovereignty**

| Measure | Percentage of respondents who consider the measure relevant, % |
|--|--|
| Loans at a lower rate | 65 |
| Simplification of government procurement | 42 |
| Income tax reduction | 40 |
| Reducing the rate of insurance premiums | 36 |
| Reimbursement of part of the costs for the purchase of pilot batches of products | 29 |
| Creation of industrial clusters | 29 |
| Reducing the number of inspections | 28 |
| Granting the status of a single supplier | 28 |
| Support under industrial mortgages | 12 |

Source: Shokhin A.N. Speech at the plenary session of the National Industrial Congress: Development Priorities (5 October 2022).

In July, at a meeting of the Council for Strategic Development and National Projects the President of Russia outlined the main areas of technological development (end-to-end technologies) under sanctions pressure as well as state companies that are responsible for their development: Sberbank (artificial intelligence), Russian Railways (quantum communications), Rosatom (new materials and quantum computing), Rostelecom (ICT), Rosneft (genetic technologies). Thus, main reliance is on big business which is also apparent from the list of main instruments that are planned to be used to ensure technological sovereignty:

- the most important innovation projects of national importance;
- technological programs of industry ministries and state corporations;
- beacon projects¹ in the implementation of which optimal conditions for business, including regulatory and financial models, are worked out;
- National Technology Initiative (dealing with regulatory aspects and cultivation of startups);
- for staffing technological sovereignty - support for advanced engineering schools.

Listed areas of support include direct financing and regulatory measures. First step was reverse-engineering and parallel import of components. With RF Government Decree No. 506 of 29.03.2022 the government legalized parallel imports to meet the demand for foreign devices and technologies.²

1 Currently, five beacon projects have been launched, three of which focus on the use of unmanned vehicles in different environments, one on the development of electric vehicles and another on the development of personal digital medical devices (medical assistants).

2 RF Government Decree from 29.03.2022 No. 506 «About goods (groups of goods) in relation to which certain provisions of the Civil Code of the Russian Federation on protection of exclusive rights to results of intellectual activity expressed in such goods and means of individualization with which such goods are marked cannot be applied». URL: http://www.consultant.ru/document/cons_doc_LAW_413173/

Development institutions have not yet become serious players in ensuring technological sovereignty and in general last year they actually returned to their previous organizational forms of activity. RF Government Decree No. 459 dated March 24, 2022 canceled the transfer of development institutions to VEB.RF¹ as well as relevant road map and the VEB.RF functioning as the founder and owner of properties of the Agency for Technological Development, the SME Corporation, Rusnano, Skolkovo Foundation, FRE, the Foundation for Assistance to Innovations, RFRIT and the Foundation of Infrastructure and Educational Programs. Documents on development of these structures received the stamp of For Official Use Only. Among all the listed institutes of development special attention was attracted to Rusnano.

After former head of Rusnano A. Chubais left the country, the search for causes of inefficiency of this organization intensified. Among them was the low quality of project management, errors in estimating the volume of required investments for implementation of projects, too high costs of maintaining the very staff of Rusnano. In mid-April the new head of Rusnano Sergey Kulikov appealed to the Prosecutor General's Office with a request to check activities of this organization in the period when it was headed by Anatoly Chubais². Later, in June, at a meeting with the President the head of Rusnano said that from the moment of establishment of the company and up to 2020 only Rb65 bn of extrabudgetary funding had been attracted and for the last year almost the same amount — Rb64 bn.³ Nevertheless, in October there was information about possible liquidation of Rusnano⁴. Despite the efforts taken by new management of the company it remains unprofitable partly due to inability to service the debt because to sanctions. Meanwhile an alternative scenario of transferring Rusnano to one of the corporations while reducing its functionality and reorientating it to a specific technology stack (for example, related to hydrogen transport) was also considered. Rusnano itself suggested changing the model of financing projects by increasing the share of private investments⁵. Furthermore, over the past two years Rusnano sold 70% of its assets most of which were “problematic,”⁶ at the expense of which it partially repaid its debts. Final decision on the fate of Rusnano will be made by the President of Russia.

1 RF Government Decree from 02.03.2022 No. 459 «On the Annulment of Certain Acts of the Government of the Russian Federation and on Amendments to the Order of the Government of the Russian Federation from 31.12.2020 No. 3710-p». URL: http://www.consultant.ru/document/cons_doc_LAW_413819/92d969e26a4326c5d02fa79b8f9cf4994ee5633b/

2 *Tutina V.* Kovalchuk said that Chubais did not create anything at Rusnano // RBK. 17 June 2022. URL: <https://www.rbc.ru/politics/17/06/2022/62acb34b9a7947d9e6ff3035>

3 Meeting with Sergey Kulikov, head of Rusnano. 15 June 2022. URL: <http://kremlin.ru/events/president/news/68656>

4 *Chernyshova E., Kanaev P.* Authorities have begun discussing possible liquidation of Rusnano // RBK. 19 October 2022. URL: <https://www.rbc.ru/business/19/10/2022/634f559d9a79475b384c7d51>

5 *Dobrunov M.* Rusnano named an alternative to liquidation of the company // RBK. 20 October 2022. URL: <https://www.rbc.ru/business/20/10/2022/6350f2c59a79475ba2ab963f>

6 Rusnano sold out 70% of its historical assets in two years // TASS. 25 October 2022. URL: <https://tass.ru/ekonomika/16153479>

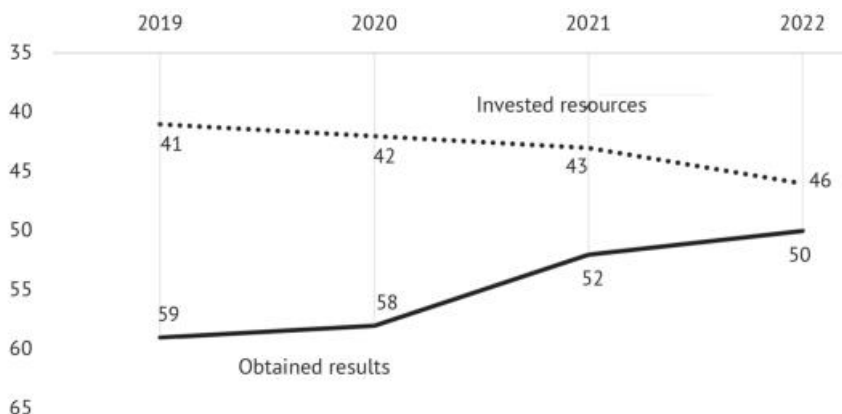


Fig. 1. Russia: indicators of invested resources and obtained results, the Global Innovation Index

Sources: Global Innovation Index, 2019; 2020; 2021; 2022.

At present, proprietary technologies on which production is based are created mostly by medium-sized technological companies-gasels,¹ often based on consortiums with organizations-developers (including universities and scientific institutes). According to the latest data about 2000 organizations² belong to the fast-growing innovation-active companies in the high-tech sphere. This is about half of the fast-growing high-tech companies and 7% of all fast-growing companies in the country with more than 10 employees. Examples of successfully implemented projects include creation of equipment for mobile communication networks, mobile energy sources based on metal-ion storage devices and hydrogen fuel cells; proprietary design systems; development of some groups of modern pharmaceuticals. Since beginning of the pandemic state support measures for such companies has been discussed and a number of resolutions have been passed but not all of them have come into force³. Special conditions were created only for companies in the ICT sector. They are exempt from profit tax for three years, inspections are cancelled for the same period and they can get loans at a rate of no more than 3%. For them procedures for employing foreigners and obtaining a residence permit are simplified⁴.

1 These are fast-growing companies with annual revenue growth of at least 20% for three years.

2 Rozmirovich S. Gazelles of Good Hope // Expert. 16 May 2022. URL: <https://expert.ru/2022/05/16/gazeli-dobroy-nadezhdy/>

3 Thus, RF Government Decree of 17.03.2022 № 392 «On approval of rules for granting subsidies from the federal budget to an autonomous non-profit organization» Engineering and Innovation Support Center «in order to create tools for finalizing products of technological companies to requirements of major corporations,» which determines allocation of funds to medium technology companies to finalize their products for guaranteed demand from major corporations, has not yet entered into force. URL: <https://www.garant.ru/products/ipo/prime/doc/403617556/>

4 Support measures for IT companies // ConsultantPlus. URL: http://www.consultant.ru/document/cons_doc_LAW_411198/d47d63c1bd09b4f09b07d6278860e9673ca0f14f/

It should be noted that medium-sized companies developing their own technologies often contradicts the experience and interests of large and state businesses and in some cases even relevant agencies which focus on the critical problems of import substitution. In such a situation acceleration of own promising developments requires introduction of a management scheme which should operate in parallel with existing system of civil industry regulation¹.

Some optimism about the possibility of a technological leap is inspired by dynamics of Russia's position in the Global Innovation Index in terms of growing indicators of innovation performance, even with deteriorating indicators of invested resources (*Fig. 1*).

5.3.8. Conclusions

Sanctions have had a significant negative impact on sphere of science. They aimed to isolate Russian organizations while by 2022 Russian science was already deeply embedded in international cooperation. Russian organizations and researchers were actively working on mega-science installations; a number of programs were aimed at attracting leading foreign scientists to the country; system of evaluation and promotion of researchers and organizations was based on the use of international databases of scientific publications Web of Science and Scopus. Outflow of personnel from science created additional problems despite the fact that the flow of those who left was diverse and included not only demanded specialists. Nevertheless, it is hardly possible to quickly replace them with young scientists without losing time and quality of work. Therefore, all previous guidelines and models had to be reconsidered.

A new ideology was developed in the area of a national system for assessing the performance of scientific activities and with regard to international relations with refocusing on countries that have not imposed sanctions. Where possible participation in research at megascience sites was continued.

An important policy direction has become reorientation on supporting applied research in the interests of economic development and technological sovereignty but there are a number of complex problems here. First: for the sake of technological leap, it is important to radically increase investment which is not included in the budget for R&D over the next three years. Second: the country has few domestic production facilities needed to create new technologies and in science the lack of domestic instruments to carry out modern research is a separate problem. Federal project to develop scientific instrumentation, although it was initiated, was on the scale of a pilot project. Creation of domestic instrumentation requires not only more significant funds but also a long period of time.

Global experience including that of countries under sanctions shows that rapid development of technology is only possible with involvement of international expertise access to which is obtained indirectly through personal connections as well as interaction with scientific diaspora. Russia has yet to establish such links,

¹ *Dezhina I.G., Ponomarev A.K.* Approaches to ensuring technological independence of Russia // *Science Management: Theory and Practice*. 2022. V. 4. No. 3. P. 53–68. DOI: 10.19181/sntp.2022.4.3.5. EDN: DGCVVI

which is not easy in the atmosphere of sanctions imposed on the Russian science and technology sector.
