# Assessing productivity of public research institutions: findings from national evaluation exercise

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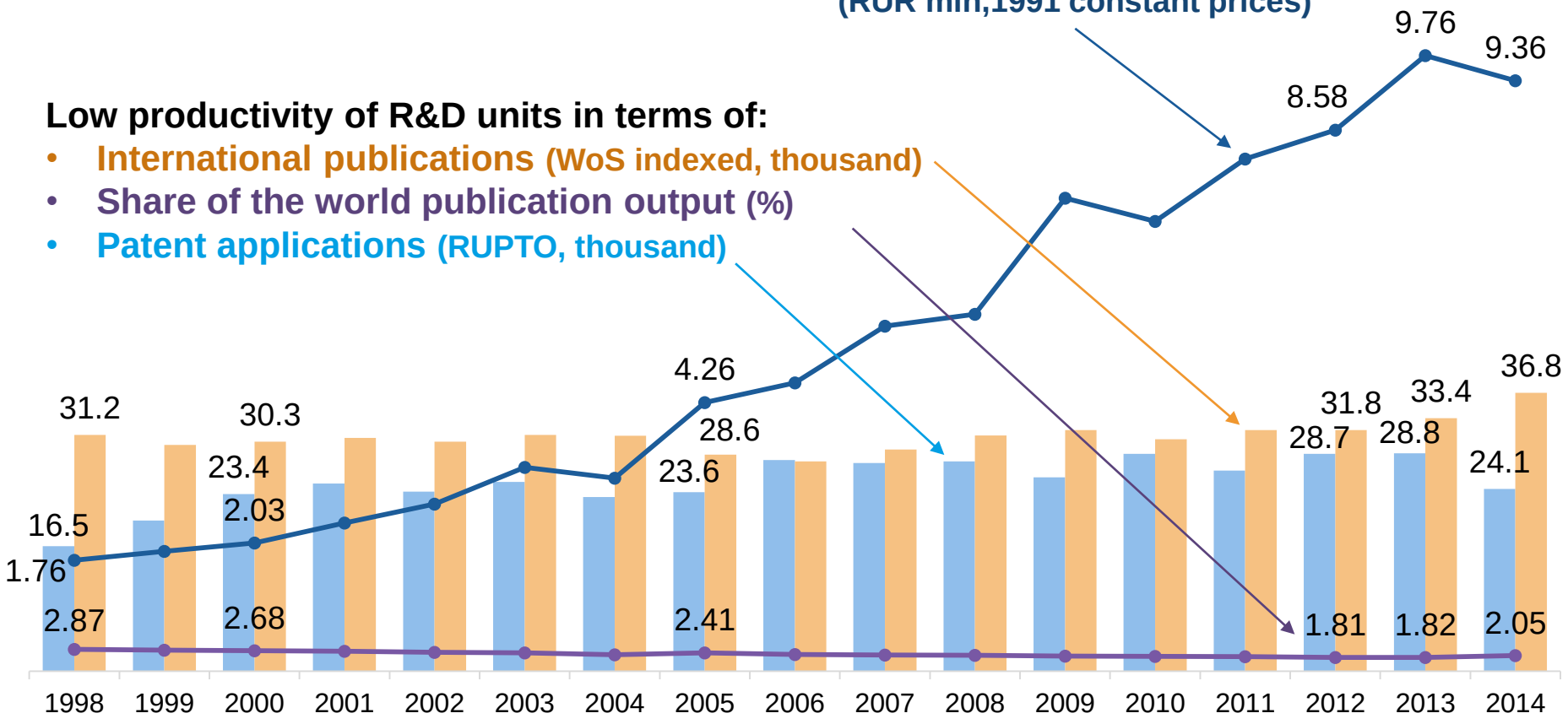
# Background

**Growth of R&D budget appropriations for R&D**
**(RUR mln,1991 constant prices)**

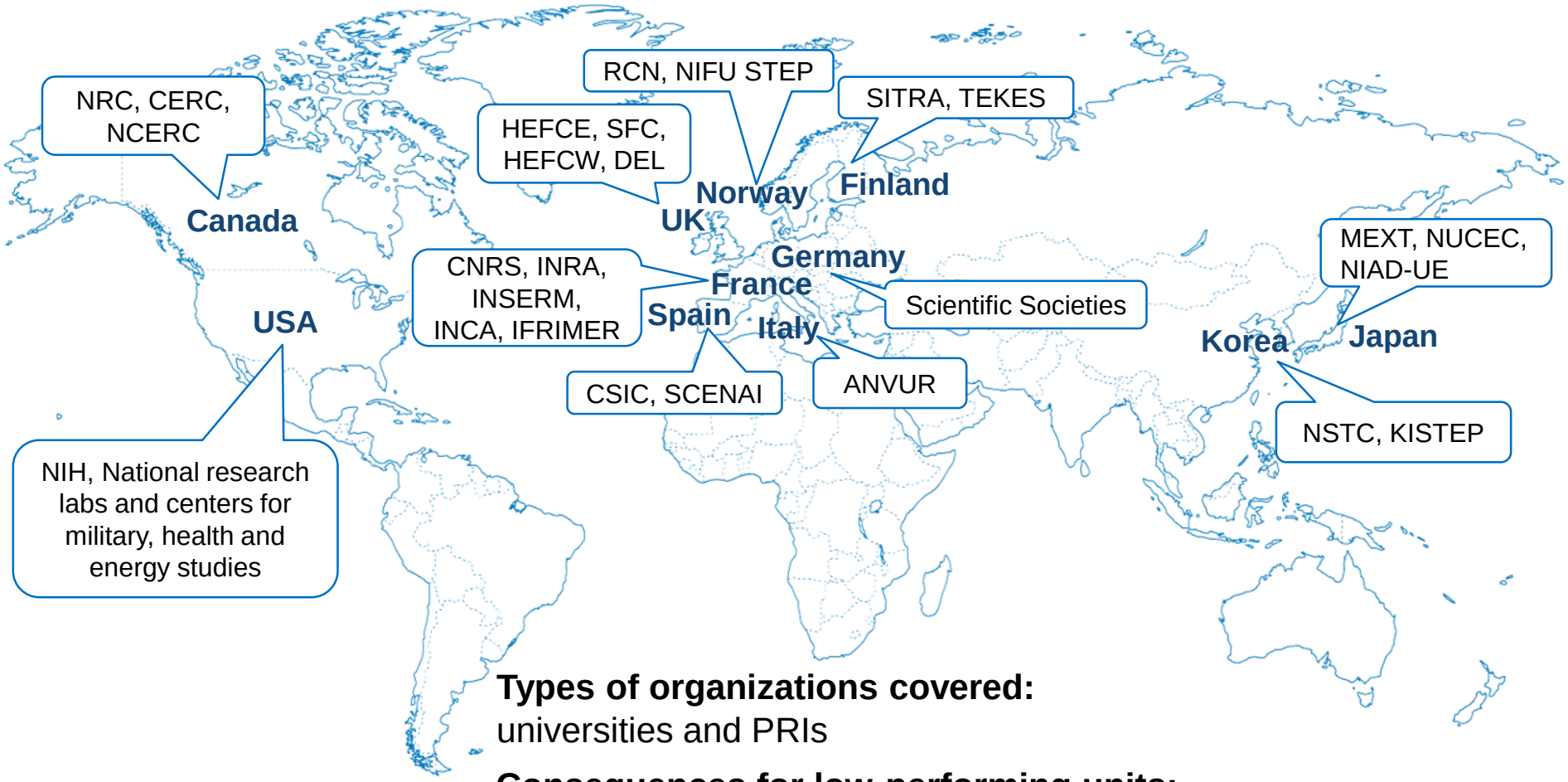
**Low productivity of R&D units in terms of:**

- **International publications (WoS indexed, thousand)**
- **Share of the world publication output (%)**
- **Patent applications (RUPTO, thousand)**




**Need for new policy instruments to increase research productivity**

# International practice




**Types of organizations covered:**
universities and PRIs

**Consequences for low-performing units:**
- reputational and financial risks (Germany, France)
- retraction of accreditation/license (Japan)
- reorganization or elimination (USA)

# Elements of performance evaluation in Russia

- **Mid 2000s: initial discussions on the need for developing national system for research evaluation**
- **2007: Pilot performance evaluation of PRIs**
  - **Coverage:** 119 state research centers and institutes
  - **Measurement issues:**
    - inputs (personnel, fixed assets, finance)
    - outputs (publications, patents, other IPRs)
    - organizational capabilities (innovation infrastructure, experimental base, spin-offs, etc.)
  - **Findings:** four clusters of institutions of which 16% - leaders and 38% - outsiders
- **2009 – 2011: First round of the national evaluation exercise**
  - **Coverage:** around 400 research institutions within the jurisdiction of national academies of sciences and federal ministries
  - **Shortcomings:**
    - Formal quantitative approach
    - Evaluation was carried by public agencies (no expert participation)
    - No peer-review or individual approach to particular cases
    - Minor effect on strategic planning of research institutions and public funding reallocation
- **2011 – 2013: Small-scale studies and public debates on the use of S&T indicators for research evaluation**

# New evaluation framework

**A new round of national evaluation exercise started in November 2013 to:**

- provide evidence for S&T policymaking
- increase effectiveness of PRIs
- allow benchmarking of R&D performing institutions

**Specific issues:**

- open interagency approach
- use of one data source
- yearly based data collection with evaluation once in 5 years
- comparison of organizations only within their reference groups
  (by the same research area and orientation towards similar types of outputs)
- combination of quantitative and peer-based based assessment
  - indicator based analysis for performance categories identification (leaders, stable, outsiders)
  - peer-review for outsiders

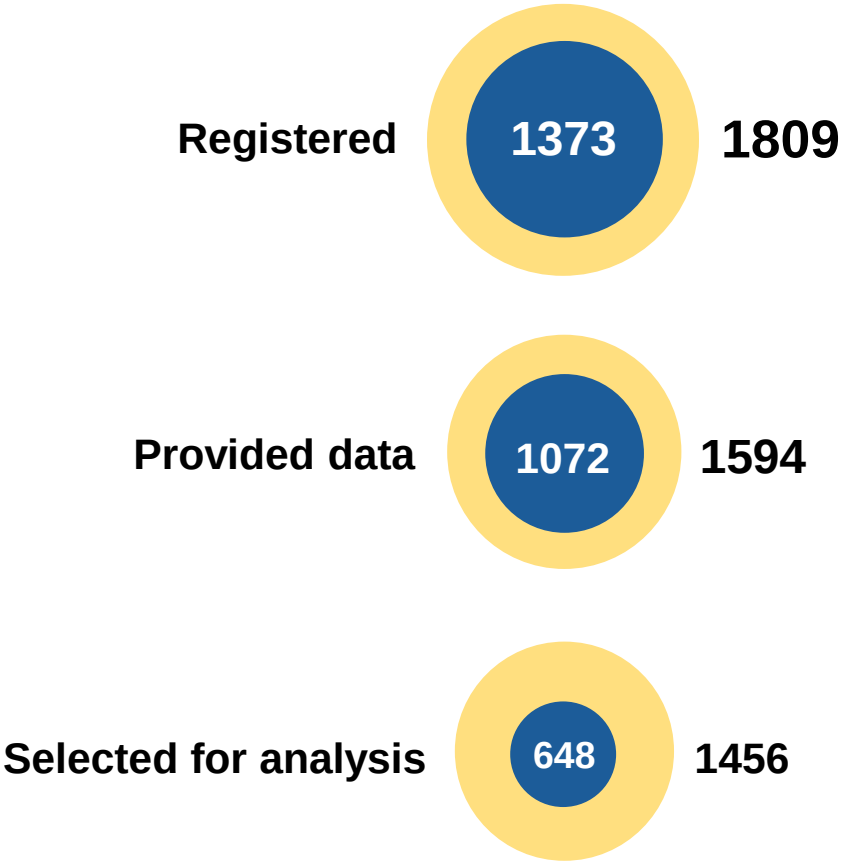
**Expected outcomes:**

- for Leaders (1st category) – additional support
- for Stable (2nd category) – correction of their development strategies
- for Outsiders (3rd category) – reorganization or elimination

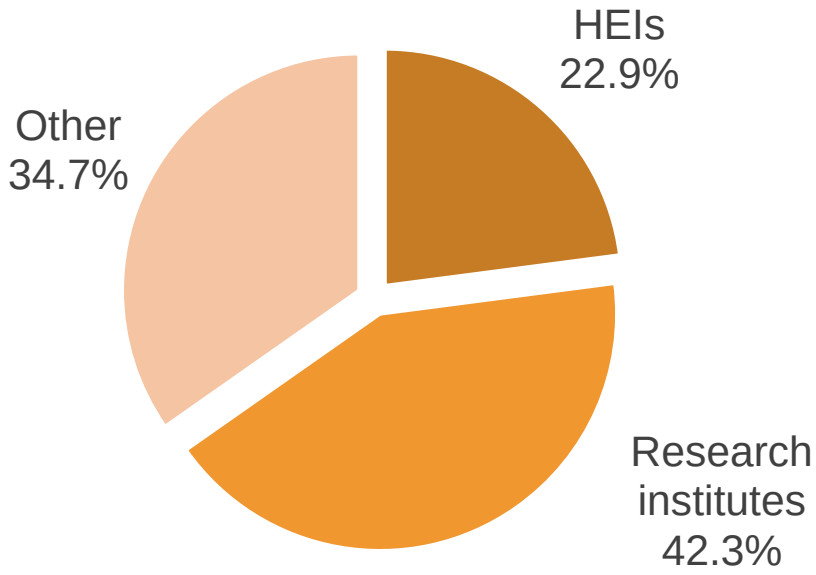
# Information sources

## Federal system for monitoring of civil PRIs

**Number of organizations:** 2014 2015




**Types of organizations**




*Source:* http://www.sciencemon.ru/analytic/

# Available indicators

**Inputs**
- Financial
- Human
- Tangible/ intangible assets

**Outputs**
- Publications
- IPR objects
- S&T services

**Education**
- Education and training of R&D personnel
- International internship

**Communication**
- Popularization of science
- International cooperation

# Preliminary data analysis

## Regression analysis (part)

| | | Response variable | | | |
|---|---|---|---|---|---|
| | | Int_publications | Total_publications | Total IPRs | S&T services |
| Explanatory variables | (Intercept) | -2.686516e+00 | 5.713606e+01 | 2.571198e+00 | 1.545863e+05*** |
| | area_1 | 3.648218e+01* | -1.059553e+02 | 1.362283e+00 | -2.181827e+04 |
| | area_1a | -4.906644e+01** | 4.767007e+01 | -2.602123e-01 | -1.637292e+05** |
| | area_1b | -5.177187e+01*** | -2.904623e+01 | -1.429751e+00 | -7.978305e+04 |
| | area_1c | 1.780714e+01 | 1.740110e+02** | 1.355497e+00 | 4.155804e+04 |
| | area_2 | -3.661866e+01* | -8.981482e+01 | 1.701620e+00 | -2.150564e+04 |
| | area_2a | 1.178070e+01 | 1.393652e+02 | 7.444990e+00 | -7.176769e+04 |
| | area_2b | -2.514783e+01 | -2.529060e+01 | 9.101042e+00 | -1.860885e+04 |
| | area_2c | 9.881977e+00 | 7.611685e+01 | 8.813838e+00* | -3.337046e+04* |
| | area_2d | 2.691478e+00 | 4.245259e+01 | -9.277988e-01 | -9.014010e+04 |
| | | | ... | | |
| | basic research | 4.043102e+01*** | 1.789390e+01 | -3.856855e+00 | -4.239129e+04 |
| | budget | -1.098293e-05*** | -3.436766e-05*** | -1.551656e-06** | 2.116107e-01*** |
| | nobudget | 5.236118e-05*** | 2.089028e-04*** | 7.939489e-06** | 8.285664e-01*** |
| | size | 3.005055e-02*** | 8.694736e-02*** | 5.151982e-03*** | 1.109734e+01 |
| ADJ.R.SQUARED | | 0.3144 | 0.4507 | 0.2301 | 0.711 |

* sig. = 5%; ** sig. = 1%; *** sig. = 0.1%

## Observations:

- Strong significant cohesion between expenditure on basic research and publication output
- Different effects of specialization
- Size matters
- Type of institution and legal status are weak characteristics to differentiate R&D outputs

# Algorithm

**Division by fields of science**

**Construction of reference groups (FOS ∩ profile)**

1 → 2 → 3 → 4

**Identification of research profile**

**Nomination of a performance category**

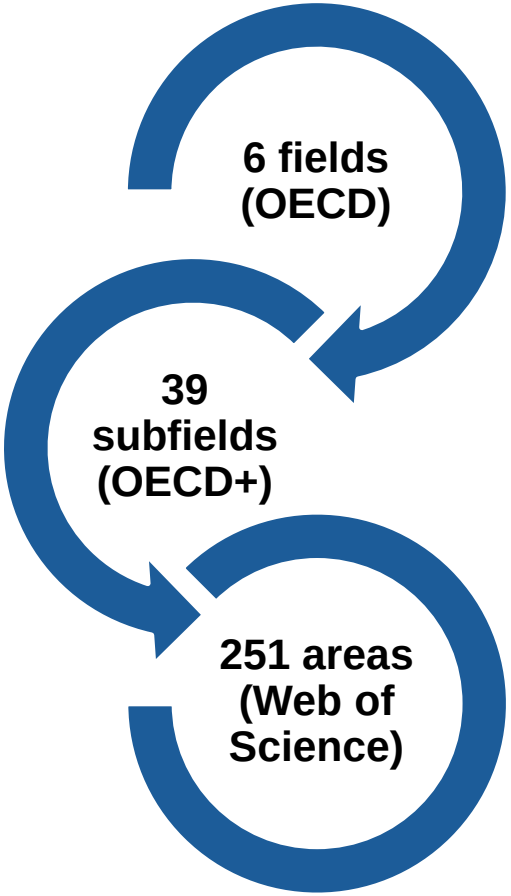
- 1.1 Mechanical redistribution in accordance with the Unified Classification of Scientific Fields (OECD harmonized)
- 1.2 Expert validation and correction at micro level

- 2.1 I “Knowledge generation”
- 2.2 II “Technology development”
- 2.3 III “S&T services”
- 2.4 IV “Specific”

- 4.1 **1st category:** Leaders
- 4.2 **2rd category:** Stable
- 4.3 **3rd category:** Outsiders

# 1 Division by field of science

## Initial classification




Expertise

**Shortcomings:**

- Low homogenity of groups
- Not representing current structure of knowledge
- Inadequate to research specialization of national PRIs

With participation of leading universities, RAS, FASO, Ministry of Education and Science

## Unified Classification of Scientific Fields

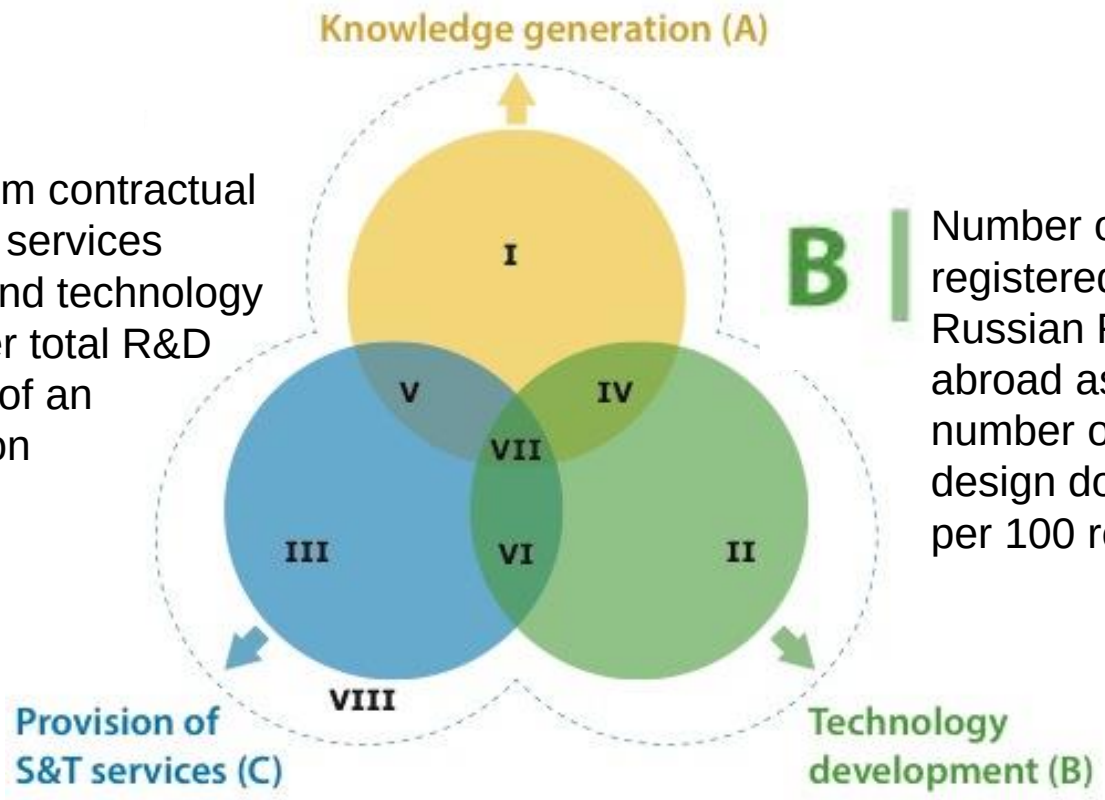
Information basis

Harmonization

**40 research areas**

# 2 Identification of research profile

**A** The number of books or scientific periodicals and papers indexed in Web of Science, Scopus or other specialized database (maximum value from one of the databases representative for an organization) per 100 researchers




**C** Income from contractual R&D, S&T services provided and technology transfer per total R&D personnel of an organization

**B** Number of IPRs registered in the Russian Federation or abroad as well as the number of issued design documentation per 100 researchers

An organization refers to a particular research profile reflecting its bent for certain research function and corresponding output, if one or more of the indicators (A – C) is not zero and equal or exceeds the median value for the field of science

# 3 Construction of reference groups

## An example of distribution of research institutes in Natural Sciences

| Natural Sciences – subfields | Total | Research profile | | | |
|---|---|---|---|---|---|
| | | I (A) Knowledge generation | II (B) Technology development | III (C) Service provision | IV Specific |
| Mathematics | 21 | 11 | 11 | 11 | 3 |
| Hydro- and aerodynamics, micromechanics | 46 | 23 | 23 | 23 | 8 |
| Condensed matter physics | 51 | 26 | 26 | 26 | 10 |
| Plasma physics, molecular physics, wave activity | 50 | 25 | 25 | 25 | 9 |
| High energy and nuclear physics | 20 | 10 | 10 | 10 | 1 |
| Astrophysics and astronomy | 17 | 9 | 9 | 9 | 2 |
| Organic and coordination chemistry | 48 | 24 | 24 | 24 | 5 |
| Inorganic chemistry, chemistry of solids, materials science | 47 | 24 | 24 | 24 | 5 |
| Physical chemistry and chemical physics, polymers | 56 | 28 | 28 | 28 | 8 |
| Physiology and general biology | 165 | 83 | 83 | 83 | 18 |
| Physico-chemical and molecular biology, biotechnology | 69 | 36 | 35 | 35 | 5 |
| Ecology and geography | 180 | 90 | 90 | 90 | 26 |
| Geology, minerals and mining sciences | 70 | 35 | 35 | 35 | 8 |
| Physics of ocean, atmosphere and geophysics | 96 | 48 | 48 | 48 | 9 |

# 4 Performance category identification

## Indicators

| Research profile | Key indicator | Additional indicators |
|---|---|---|
| I Knowledge generation | A = publications | B or C* |
| II Technology development | B = IPRs | A or C** |
| III Service provision | C = S&T services provided | A or B |
| IV Specific | – | |

C* = S&T services financed from non-budgetary sources

C** = income from technology transfer

## Nomination principle

**1st category:** key indicator ≥ M +25% one of the additional indicators ≥ M

**3rd category:** key indicator < M +25% all additional indicators < M

**2nd category:** other (neither 1st nor 3rd)

# Distribution by performance categories

## An example of distribution of research institutes in Natural Sciences

| Natural Sciences – Subfields | Total | Research profile | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | I Knowledge generation | | | II Technology development | | | III Service provision | | |
| | | by performance categories (% of total) | | | | | | | | |
| | | 1st | 2nd | 3rd | 1st | 2nd | 3rd | 1st | 2nd | 3rd |
| Mathematics | 21 | 18 | 82 | 0 | 45 | 18 | 36 | 0 | 100 | 0 |
| Hydro- and aerodynamics, micromechanics | 46 | 17 | 74 | 9 | 30 | 61 | 9 | 26 | 74 | 0 |
| Condensed matter physics | 51 | 19 | 81 | 0 | 27 | 62 | 12 | 8 | 88 | 4 |
| Plasma physics, molecular physics, wave activity | 50 | 20 | 80 | 0 | 20 | 72 | 8 | 24 | 76 | 0 |
| High energy and nuclear physics | 20 | 20 | 70 | 10 | 20 | 80 | 0 | 20 | 80 | 0 |
| Astrophysics and astronomy | 17 | 22 | 67 | 11 | 44 | 44 | 11 | 44 | 56 | 0 |
| Organic and coordination chemistry | 48 | 17 | 83 | 0 | 21 | 75 | 4 | 17 | 83 | 0 |
| Inorganic chemistry, chemistry of solids, materials science | 47 | 21 | 75 | 4 | 29 | 63 | 8 | 21 | 71 | 8 |
| Physical chemistry and chemical physics, polymers | 56 | 14 | 86 | 0 | 29 | 54 | 18 | 21 | 79 | 0 |
| Physiology and general biology | 165 | 28 | 70 | 2 | 25 | 61 | 13 | 20 | 77 | 2 |
| Physico-chemical and molecular biology, biotechnology | 69 | 25 | 67 | 8 | 29 | 60 | 11 | 31 | 66 | 3 |
| Ecology and geography | 180 | 28 | 66 | 7 | 27 | 60 | 13 | 21 | 78 | 1 |
| Geology, minerals and mining sciences | 70 | 29 | 69 | 3 | 31 | 57 | 11 | 23 | 77 | 0 |
| Physics of ocean, atmosphere and geophysics | 96 | 21 | 75 | 4 | 27 | 54 | 19 | 23 | 75 | 2 |

# Limitations

**Proposed approach can be easily replicated, but…**

- Results of final distribution are very sensitive to the quality of data that requires detailed guidance for reporting units and system of arithmetic and logical controls at the step of initial data collection
- Further verification using different samples and statistical modeling is needed
- Current approach uses performance measurement by total outputs that is more or less accepted for research institutes due to their mono-disciplinary specialization, though inclusion to the sample of multidisciplinary organizations or HEIs will require introduction of fractional counting
- One institution may have different categories in different reference groups – which one to choose for decision making?
- Final decisions cannot be taken without further peer-review process not only of organizations from the 3rd performance category, but all categories

# (M)any questions?

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