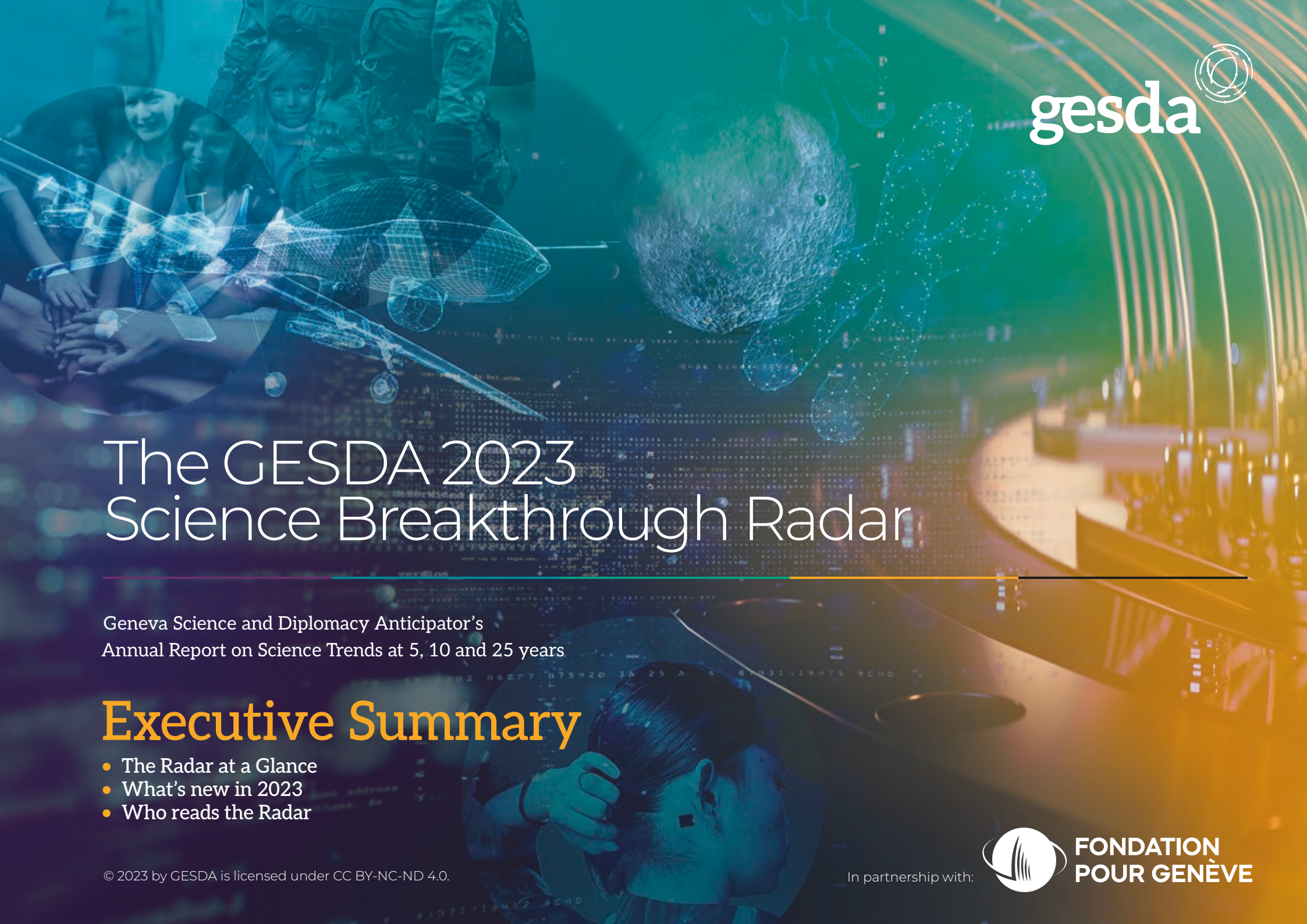

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The GESDA 2023 Science Breakthrough Radar

Geneva Science and Diplomacy Anticipator's
Annual Report on Science Trends at 5, 10 and 25 years

Executive Summary

- The Radar at a Glance
- What's new in 2023
- Who reads the Radar

In partnership with: FONDATION POUR GENÈVE

Use the Future to build the Present

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www.gesda.global
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2023

Visit: radar.gesda.global

The Radar at a Glance

As a Swiss foundation with global reach and a private-public partnership working from Geneva, GESDA was started in September 2019 to develop and promote anticipatory science and diplomacy for greater impact and multilateral effectiveness.

WHAT

The GESDA Science Breakthrough Radar® is:

1. A new tool for multilateralism, informed discussions, and concerted action.
2. A single point of entry to catch up with the unprecedented pace of science and technology.
3. A factual basis for eye-opening reflections on the impacts of future scientific discoveries for people, society and the planet(s).
4. An interactive, evolving instrument updated once every year.

FOR WHOM

The GESDA Science Breakthrough Radar® provides a single entry point for all communities of practice interested in becoming early adopters of scientific advances, regardless of whether they are fellow scientists, political authorities, diplomats working in embassies or in international organizations, economic actors, NGOs or citizens from all over the world.

HOW

The GESDA Science Breakthrough Radar® gives an overview on the emerging trends in five major fields of science and technology:

1. Advanced AI and Quantum Revolution
2. Human Augmentation
3. Eco-Regeneration and Geoengineering
4. Science & Diplomacy
5. Knowledge Foundations

It offers three complementary points of view on these five fields, each point of view comprising a chapter of the Radar:

1. Trends – Scientific emerging topics and possible breakthroughs at 5, 10, 25 years as they are currently already "cooking" in the laboratories.

   The 2023 GESDA Science Breakthrough Radar® presents 42 scientific emerging topics and 324 breakthroughs at 5, 10 and 25 years in the five considered fields. Its Knowledge Foundations' portion comprises 3 lenses on philosophy, geopolitics, and science, dealing with 3 fundamental questions about the future of humanity, which are debated by 84 scholars in philosophy, social sciences, humanities, and geopolitics.

2. Actions and Debates – What people all over the world already do with and think about these possible scientific breakthroughs.

   *Every edition of the GESDA Science Breakthrough Radar® includes an analysis of more than **10 million social media posts** and **1.3 million articles** in mainstream media to take the pulse of society on what people do and say about emerging scientific topics presented in the trends chapter of the Radar.*

3. Opportunities – Emerging Initiatives worth following and joining.

   *The 2023 GESDA Science Breakthrough Radar® presents the **Open Quantum Institute 2023 Incubation Report**, GESDA's first Solution Idea ready for pilot implementation as well as a summary of the Proceedings of the 2022 Geneva Science and Diplomacy Anticipation Summit organized once a year by the GESDA Foundation.*

WHO

The GESDA Science Breakthrough Radar® is a collective work resulting from the collaboration of 1,542 different scientists around the world who are building the radar community within the GESDA Academic Forum chaired by Professor Michael Hengartner, a member of the GESDA Board of Directors. The briefs presented in the 2023 edition are signed off by 58 top scientists.

The total number of contributors to the Radar looks as follows:

- **543** scientists from **53** countries contributed to the 2021 edition.
- **774** scientists from **70** countries contributed to the 2022 edition.
- **848** scientists from **73** countries contributed to the 2023 edition.

For three days every year in October, the GESDA Foundation gathers representatives of the communities of practice interested in discussing and using the emerging scientific trends depicted in the Radar. Called the Geneva Science and Diplomacy Anticipation Summit, the summit is the event where the new annual edition of the Radar is officially presented and released.

- **937** people attended the 2021 Summit featuring **108** speakers from **33** countries.
- **1,267** people attended the 2022 Summit featuring **152** speakers from **46** countries.

WHY

The activity of scouting each year for future breakthroughs and emerging trends across scientific domains, from natural and social sciences to engineering and the humanities, is more critical than ever due to the pace at which science and technology are evolving. It's the only way to be ready for the time when some of these breakthroughs become a reality. By projecting ourselves into the future, we aim to detect in advance the major scientific and technological advances that will change the ways we live, think, and behave.

Consequently, we give people time to prepare for these changes with the best possible transitions and empower them to develop uses of their own that can benefit everyone. As we are learning from the current debates raging over this year's rapid adoption of artificial intelligence - which is changing almost every industry and starting to impact society - it becomes more difficult to construct long-term solutions once the debates have begun and are creating a rushed atmosphere.

Navigating Emerging Science at 5, 10, 25 Years

Scientific Platform	6 Deep Dives for 2023	27 Breakthrough Briefs 3 new topics added for 2023 in **bold**	11 Invited Contributions 9 new topics added for 2023 in **bold**
1 Quantum Revolution & Advanced AI	**The Opportunities of Quantum & Advanced AI:** GESDA Pulse of Diplomacy	1.1 Advanced AI 1.2 Quantum Revolution **1.3 Unconventional Computing** 1.4 Augmented Reality 1.5 Collective Intelligence	• The Technology Opportunity for Digital Humanities and Art • AI for Science • **Robotics & Embodied AI** • **Digital History**
2 Human Augmentation	**Neuro-augmentation**	2.1 Cognitive Enhancement 2.2 Human Applications of Genetic Engineering 2.3 Healthspan Extension 2.4 Consciousness Augmentation 2.5 Organoids 2.6 Future Therapeutics	• **Future of Psychedelics Medicine**
3 Eco-Regeneration & Geoengineering		3.1 Decarbonisation **3.2 Earth Systems Modelling** 3.3 Future Food Systems 3.4 Space Resources 3.5 Ocean Stewardship 3.5 Solar Radiation Modification 3.7 Infectious Diseases	• **Deep-sea Mining** • **Fungal Pandemics**
4 Science & Diplomacy		4.1 Science-based Diplomacy 4.2 Advances in Science Diplomacy **4.3 Prediction, Foresight and Futures Literacy** 4.4 Democracy-Affirming Technologies	• **Misperceptions, Meta-perception and Conflict** • **Understanding the Reality of Multilateral Relations with Computational Diplomacy**
5 Knowledge Foundations	**The Future of People, Society and the Planet(s)**– GESDA Philosophical Lens **The Future of Peace and War**– GESDA Geopolitical Lens **The Human Right to Science**– GESDA Science Lens **GESDA Digital Pulse of Society:** People's expectations about science throughout the world	5.1 Complex Systems Science 5.2 Future of Education 5.3 Future Economics, Trade and Globalisation 5.4 The Science of the Origins of Life 5.5 Synthetic Biology	• **Future of Archaeology** • **Responsible Anticipation and Self-Regulation**

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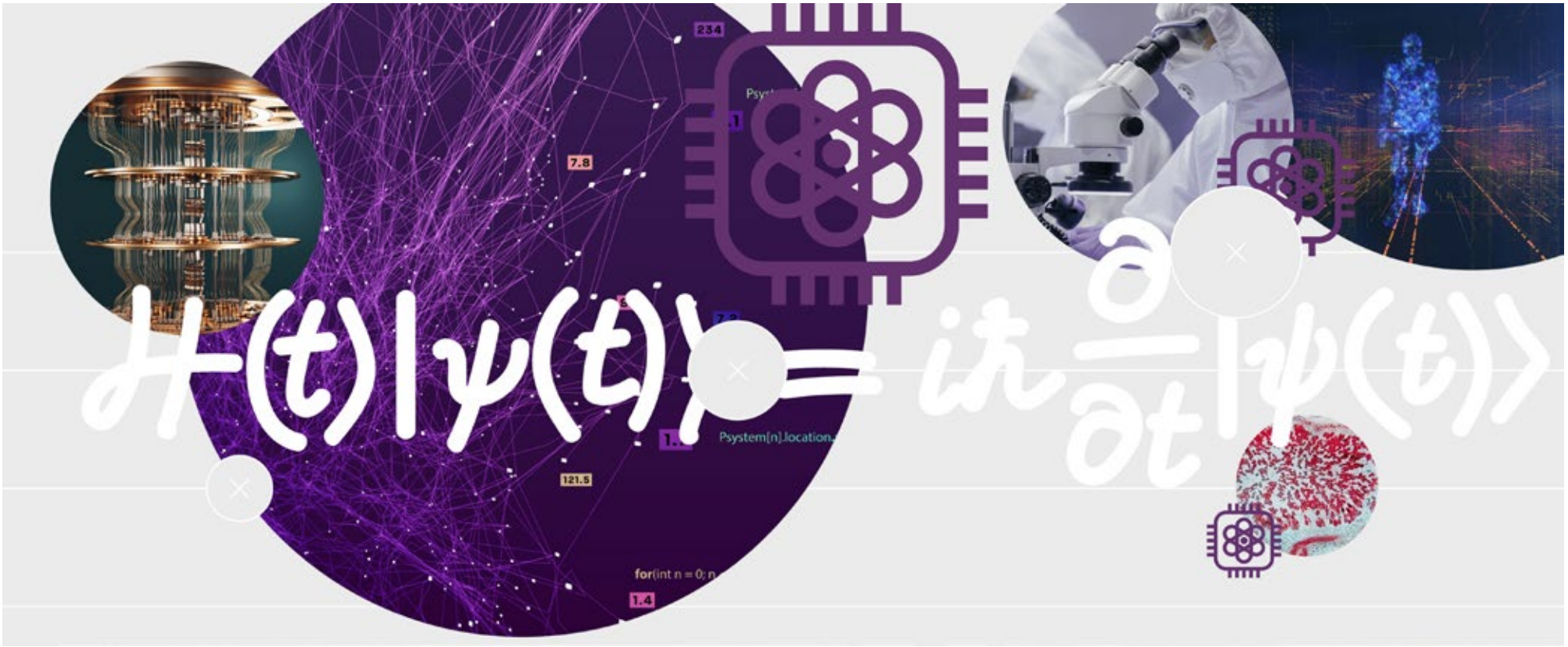
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What's new in 2023

Zoom in on the 2023 Edition

Compared to the previous editions released in 2021 and 2022, the 2023 GESDA Science Breakthrough Radar 2023® innovates with:

- **Six Deep Dives on current and future hot topics**
- **27 Breakthroughs Briefs**
- **7 Updates of existing Briefs**
- **3 Briefs on new emerging topics**
- **9 new invited contributions that will nurture the next editions of the Radar**

Deep Dives 2023

Neuro-Augmentation

Neuro-augmentation, one of the fastest developing fields of science, involves enhancing our brains and nervous systems by using advanced technologies, including Advanced AI and Quantum Computing.

Recent breakthroughs in neuroscience, neurotechnology, and brain-inspired computing are paving the way for new treatments for neurodegenerative diseases and the enhancement of our cognitive abilities. For many people, this field is the next big thing.

To delve into these complex topics, experts from various fields gathered at the GESDA Spring Anticipation Workshop in Villars. They discussed the current state of neuro-augmentation science and identified its short-term, mid-term, and long-term implications and ethical concerns. These discussions notably aim to guide diplomatic interventions in this rapidly advancing field, ensuring responsible and beneficial progress for everybody.

The discussion in Villars focused on three hot topics:
1. Brain Hacking
2. Hybrid Brain
3. Artificial Cognition (brain-inspired AI and robotics)

Some examples of these advancements include brain-monitoring devices and brain-machine interfaces, which allow us to both read and write signals from our nervous system.

These innovations could have wide-ranging impacts, from changes in workplace dynamics to new definitions of what it means to be human. Additionally, scientists are exploring the creation of brain organoids, interspecies chimeras, and genetically modified primates, all of which are pushing the boundaries of our understanding of life and the human brain. Moreover, researchers are investigating the potential for applying our understanding of the human brain to the development of computing devices and robots that could someday possess a form of consciousness.

The Future of Peace and War

After presenting an introductory essay on the topic last year, the GESDA Geopolitical Lens of the Radar takes a deep dive into the challenges of peace and war.

Often resulting in violence or conflict, today's increasing tensions between countries and power blocs are aggravated by climate change and competition in the field of digital technologies.

Anticipation informed by an understanding of science and technology is, therefore, also essential in the field of peace and war. It makes possible the creation and implementation of appropriate programs and strategies to prevent or contain conflict and to advance more promising approaches to peace.

Applying GESDA's anticipatory methodology to mapping the future of peace and war involves plotting social and political scientists' anticipations of the future.

Unlike the anticipation of breakthroughs or new applications in the field of technology, foresight in the fields of social and political sciences entails more fragile projections accompanied by greater uncertainty, unanticipated tipping points and black swan events.

In a series of high-level workshops held in Geneva and New York in 2023, the three convening organizations — GESDA Foundation, the Geneva Centre for Security Policy (GCSP) and the School of International and Public Affairs (SIPA) at Columbia University — brought together experts in the field of peace and war to develop and apply a methodology to anticipate how advances in science and technology will influence the distribution of power in the next 10 to 25 years.

Breakthroughs & Opportunities of Advanced AI & Quantum

As we witness a remarkable integration of Artificial Intelligence (AI) and advanced computing technologies into our daily lives, the 2023 edition of GESDA Science Breakthrough Radar explores these developments, first by featuring an updated briefing on Advanced AI science and introducing a new brief on Unconventional Computing, which highlights alternative computing technologies that are poised to outperform current state-of-the-art AI in the future.

Additionally, the Radar 2023 includes two invited contributions that discuss how AI is reshaping our understanding of the past on the one hand, and, on the other hand, how it is increasing the potential for neuromorphic computing to create robots with genuine 'embodied' intelligence.

GESDA's world, however, extends beyond being just a think-tank; it actively seeks to transform knowledge into action. Building on the scientifically validated insights gathered in its first Radar released in 2021, GESDA invested the last two years in conceiving and designing solution ideas for effective multilateralism in partnership with its broad science and diplomacy community.

The Open Quantum Institute (OQI) has emerged as the first initiative to be incubated by GESDA. An exclusive report of the incubation phase in 2023 outlines OQI's development journey, starting from the anticipation of quantum technologies in the scientific realm to its establishment as a validated solution concept for science diplomacy.

The report elaborates on how the OQI aims to become the premier hub for applying quantum computing to achieve the **UN Sustainable Development Goals (SDGs)**.

It details collaborations with partners to broaden access to quantum computers; underscores the significance of educational and training programs associated with the institute; and presents a proposal for shaping a multilateral governance structure that empowers the use of quantum computing for the SDGs.

Furthermore, the report emphasizes the engagement of a supportive community of stakeholders in co-creating OQI's unique value proposition, ensuring that quantum technologies benefit society as a whole rather than a select few.

The Human Right to Science

To mark the celebration in 2023 of the 75th Anniversary of the Universal Declaration of Human Rights, the GESDA Science Lens highlights the importance of the right to science, as mentioned in international declarations and covenants.

Article 27 of the Universal Declaration of Human Rights specifies the right for everyone to benefit from the advances of science. Other related documents emphasize that this right includes the responsibility to use scientific progress and its applications in a manner that takes into consideration both their benefits and potential harm.

In late 2022, GESDA convened a scientific workshop with the Brocher Foundation in Geneva to get an overview on the current status of the Human Right to Science, both generally and more specifically within the health sector.

The resulting report presented in the 2023 Radar involves 29 experts in international and humanitarian law discussing how integrating human rights into the scientific process can lead to collaborative, holistic, and inclusive approaches. This approach goes beyond merely mitigating risks; it encourages responsible exploration of the opportunities offered by scientific and technological progress.

The Future of People, Society & the Planet(s)

In the GESDA Philosophy Lens, a group of leading philosophers assembled by GESDA has been exploring since 2021 how the advancements outlined in the Radar might reshape humanity, society, and our relationship with the planet(s).

Each edition of the Radar proposes new points of view on three fundamental questions that the GESDA Foundation is addressing:

1. WHO ARE WE? What does it mean to be human in an age of robots, gene editing and augmented reality?
2. HOW ARE WE GOING TO LIVE TOGETHER? Which deployment of technologies can help reduce inequality and foster inclusive development and well-being?
3. HOW CAN WE ASSURE HUMANKIND'S WELL-BEING WITH THE SUSTAINAIBLE HEALTH OF OUR PLANET? How can we supply the world's population with the necessary food and energy while regenerating our planet?

For example, the possible development of ‘conscious’ machines requires us to reflect on our purported uniqueness as humans, and which properties we may wish to actively preserve as the sole remit of human beings. Additionally, the group of philosophers considers how emerging digital technologies can impact fundamental aspects of society, from trust and privacy to democracy and justice. It also addresses the challenges posed by climate engineering technologies and how we perceive our control over nature in the face of environmental disruptions.

People’s Uses and Expectations Regarding Science

Through a detailed examination of global public sentiment as well as people’s stances toward science, the Pulse of Society of the Radar delves into the influence of science and technology on humanity’s self-perception, social interactions, and relationship with the environment. It also aims at detecting the early uses of advanced technology. It underscores the importance of comprehending public approaches regarding present and future scientific developments.

To achieve this, the GESDA Foundation uses artificial intelligence to analyze both mainstream media and online social platforms.

As it has every year since its inception in 2021, GESDA’s analysis provides new insights into the extent of discussions surrounding topics mentioned in the Radar, how these topics connect with other themes both inside and outside the Radar, and the evolving sentiment around these subjects.

It also identifies the actions taken by citizens in response to their interests related to each topic, spotlighting noteworthy initiatives and influential figures that have emerged over the past year. Importantly, this year’s analysis also includes a comparison of how public opinions, sentiment, and actions have evolved since the initial release of the Radar in 2021.

Who reads the Radar

Figures before the 2023 edition is released

Audience of the Radar

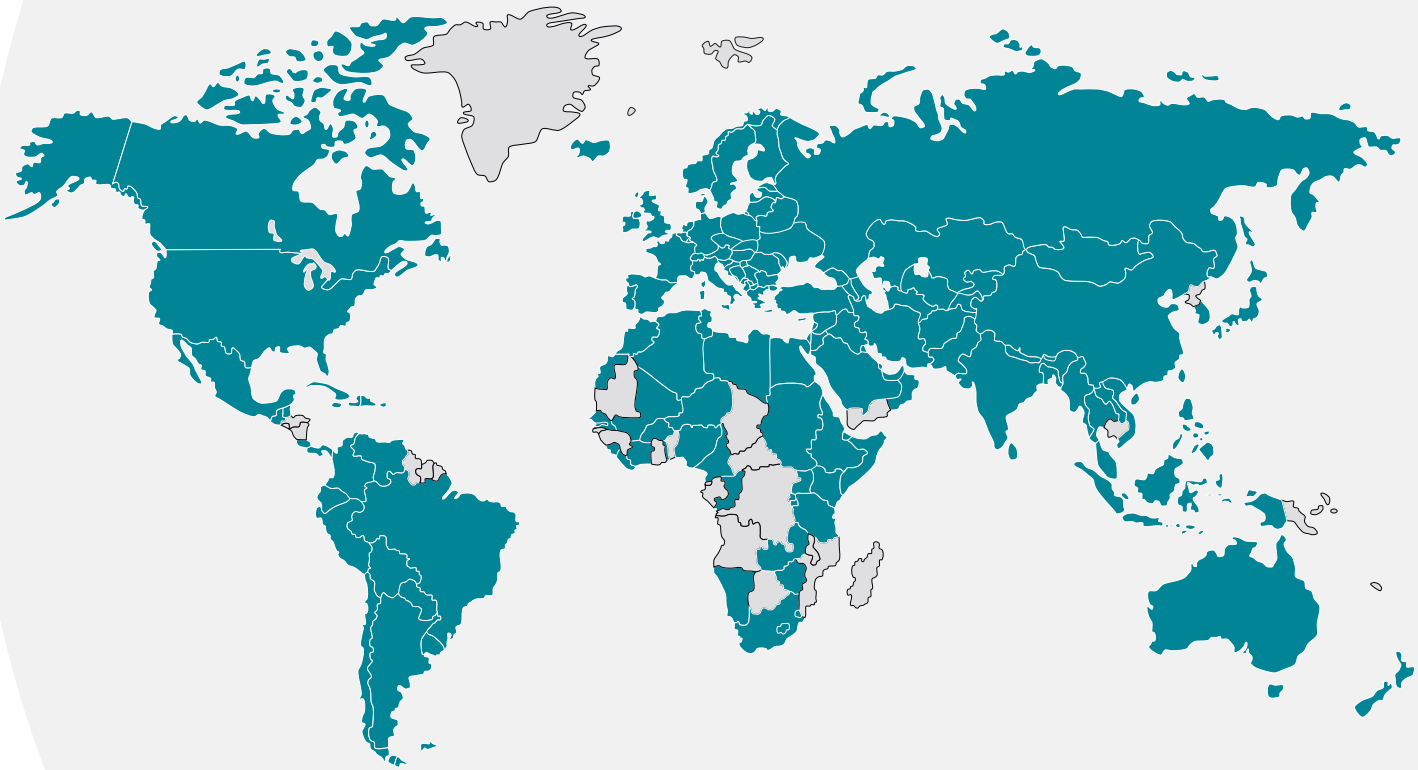
From October 7, 2021
to September 6, 2023

- **33’950 Online Readers**
- From **170 countries**, with most in
  1. Switzerland
  2. United States
  3. United Kingdom
  4. France
  5. Germany
  6. South Africa
  7. India
  8. The Netherlands
  9. Australia
  10. Canada

- **Most watched emerging topics**
  1. Advanced AI
  2. Quantum Technologies
  3. Cognitive Enhancement
  4. Decarbonization
  5. Human Applications of Genetic Engineering
  6. Biological Computing

- **112’163** page views in total
- **1000** new readers per month

33’950 Readers from 170 Countries



GESDA Online Community
Countries of unique visitors to the Science Breakthrough Radar digital platform

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