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CAST Newsletter

CAST unveils 2025 Top 10 Scientific, Engineering, and Industrial Challenges

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Headlines

CAST unveils 2025 Top 10 Scientific, Engineering, and Industrial Challenges

Main Forum of the 27th CAST Annual Meeting

On July 6, 2025, the Main Forum of the 27th CAST Annual Meeting was held at the China Science and Technology Hall.

In his opening remarks, CAST President Wan Gang emphasized that this year's gathering is designed to keep pace with the latest global advances in science and technology, support China's goal to become a world-leading innovation powerhouse, and serve as a platform to share new theories, perspectives, and paradigms. The forum also aimed to spotlight emerging disciplines, uncover new growth opportunities, and inspire cross-sector exploration. Wan highlighted CAST's continued commitment to tracking cutting-edge scientific developments, improving the supply of high-quality research and innovation, and strengthening interdisciplinary collaboration. He stressed the importance of providing high-level scientific consultation and fostering an open, pragmatic academic atmosphere that encourages effective dialogue. He urged participants to take full advantage of the forum for meaningful exchange.

During the Main Forum, CAST unveiled the Top 10 Scientific, Engineering, and Industrial Challenges for 2025.

Top 10 Scientific Challenges

- Topological and Geometric Classification of Manifolds
- Properties of the Higgs Boson and the Origin of Its Mass
- Evaluating the Potential of Semimetals as Substitutes for Transition Metals in Precision Synthesis and Catalysis
- Abnormal Typhoon Tracks and Sudden Changes in Intensity
- Mechanisms Underlying Spatial Patterns in Macro-Ecosystems and Inter-System Interactions

◆New Theories and Cryptographic Protection Mechanisms for AI Security

◆Multidimensional, Reconfigurable Supramolecular Machine Assembly

◆Dark Energy and the Tension in the Hubble Constant

◆Breeding Potential of Wild Crop Relatives to Enhance Stress Resistance in Cultivated Varieties

◆Regulatory Mechanisms of Human Microbiota-Host Interactions

Top 10 Engineering Challenges

◆Integrated Design-Simulation-Manufacturing Algorithms for Complex Systems

◆Scalable Deep-Sea Mining Technologies with Reduced Environmental Impact

◆Coordinated Water Resource Management across Surface Water, Groundwater, Reclaimed Water, Diverted Water, and Seawater

◆Smart and Simplified Network Architecture for Integrated AI Communication

◆Biomanufacturing of Complex Organs

◆Integrated Development of Coal and Associated Energy Resources

◆Next-Generation Low-Cost, Low-Energy Carbon Capture and Storage Technologies

◆Advanced Aircraft Energy and Thermal Management Systems

◆Biomanufacturing of Bulk and High-Value Food Ingredients

◆Data-Driven Drug Discovery Powered by Clinical and Multi-omics Data

Top 10 Industrial Challenges

◆Reducing Import Dependence on High-End Equipment for Large-Scale Seawater Desalination

◆Enhancing Oxidation Resistance of Ultra-Supercritical Steam Turbine Blades

◆Autonomous Mining Technologies for Deep-Space Resource Development

◆Developing Autonomy Evaluation Systems for Smart Industrial Unmanned Systems

◆Industrializing High-Speed Optical Interconnect (Optical I/O) Technology for Chips

◆Developing Regenerative Biomaterials to Address Aging-Related Conditions

◆Achieving a Balanced Energy System: Security, Low-Carbon Transition, and Affordability

◆Smart Processing and Industrial Application of Satellite Remote Sensing Data

◆AI-Designed Synthetic Biovaccines for Crop Pests

◆Brain Function Assessment and Closed-Loop Brain-Machine Interface Interventions

(Source: Official WeChat account of VOC)

WCCE12 & APCChE 2025 highlight paradigm shifts in chemical engineering

Opening ceremony of WCCE12 & APCChE 2025
Photo credit: gmw.cn

From July 14 to 18, 2025, the 12th World Congress of Chemical Engineering (WCCE12) and the 21st Asian Pacific Confederation of Chemical Engineering Congress 2025 (APCChE 2025) were held jointly at the China National Convention Center in Beijing. Under the theme "Paradigm Shifting in Chemical Engineering for Global Challenges," the event spotlighted four major focus areas: Foundational Chemical Reengineering, Strategic and Emerging Industries, Future Chemical Engineering and Smart Innovation, and Education and Training. CAST President Wan Gang attended the opening ceremony and delivered remarks. Also in attendance were Luo Hui, Director-General of the CAST Department of International Affairs, as well as leaders of international organizations, experts, scholars, and industry representatives from around the world.

In his address, Wan Gang emphasized that the chemical industry forms the backbone of modern industrial systems. To enable transformative breakthroughs and drive advanced industrial upgrades, he stressed that innovation must serve as the primary engine, with open, global collaboration as a vital pathway. He called on the global chemical engineering community to deepen knowledge sharing and joint problem-solving to catalyze disruptive innovation, strengthen productivity, and support sustainable, high-quality development. He expressed hope that the congress would foster openness, mutual trust, and mutually bene-

ficial cooperation across the field, fully leveraging the discipline's role in building a community with a shared future for humanity.

The event also featured more than 50 side activities, including the International Chemical Engineering Innovation Expo 2025 (IChEIE 2025), youth-led initiatives focused on the UN Sustainable Development Goals (SDGs), and site visits. During the congress, the *Beijing Initiative: Embracing Paradigm Shifts, Forging Smart Innovation for a Green Future* was officially released, aiming to build global consensus and share Chinese perspectives on the future transformation of chemical engineering worldwide.

(Source: Official website of CAST)

CAST-UN Consultation Platform advances UN Sustainable Development Agenda

On July 9, 2025, Luo Hui, Director-General of the CAST Department of International Affairs, met in Beijing with Bjørg Sandkjær, Assistant Secretary-General for Policy Coordination in the United Nations Department of Economic and Social Affairs (UN DESA), and her delegation.

The two sides held in-depth discussions on strengthening cooperation through the CAST-UN consultation platform, focusing on policy research, capacity building, and knowledge sharing to advance the implementation of the *UN 2030 Agenda for Sustainable Development* and the *Pact for the Future*. Both parties emphasized the value of using the UN's multilateral framework to boost international cooperation in science and technology, highlight successful Chinese approaches, and harness innovation to accelerate progress on the Sustainable Development Goals (SDGs).

Since gaining special consultative status with the UN Economic and Social Council (ECOSOC) in 2004, CAST has played an active role in science diplomacy. It has introduced a wide range of interdisciplinary topics to the UN system, responded proactively to UN initiatives and action plans, and promoted the engagement of Chinese scientists in advancing the 2030 Agenda, with increasingly impactful results.

(Source: Official website of CAST)

CAST and FAO collaborate to empower youth and advance agricultural innovation

On July 10, 2025, Luo Hui, Director-General of the Department of International Affairs, met in Beijing with Thanawat Tiensin, Assistant Director-General of the UN Food and Agriculture Organization (FAO), during his visit to China.

The two sides held in-depth discussions on a range of topics, including scientific and technological innovation in food and agriculture, academic exchange, science communication, and the training of young scientists. Both parties underscored that innovation is essential to sustainable development in agriculture and food systems. They agreed on the need to strengthen global trust and cooperation among scientists and highlighted the critical role of young researchers in proposing solutions to shared global challenges. They also discussed potential collaboration to support international initiatives led by the International Society of Zoological Sciences, particularly efforts to promote the "One Health" approach, which addresses animal diseases and pest outbreaks through coordinated global scientific action.

(Source: Official website of CAST)

Academic Exchange

CIES and CIE explore avenues for international cooperation

Group photo of CIES and CIE representatives

On the afternoon of July 4, 2025, the China Illuminating Engineering Society (CIES) visited the International Commission on Illumination (CIE) in Vienna, Austria, for in-depth discussions on strengthening collaboration.

The two sides explored a range of joint initiatives, including the contract and memorandum of understanding for the 31st CIE Session, scheduled to be held in 2027 in Nanjing. They also discussed plans for a CIE site visit to Nanjing in 2026, as well as CIES's proposal to establish a CIE International Standards Promotion Center. CIE representatives offered recommendations to support the planning of the 2027 session and suggested co-hosting an academic event with CIES in Beijing during the International Science Council's 2026 Midterm Meeting. In addition, CIES will host the Third China Lighting Science and Technology Conference later this year in Huzhou, Zhejiang Province, where CIE President Jennifer Veitch is expected to deliver a video address.

The two organizations also discussed future areas of cooperation, including CIE's potential participation in the 2nd Shanghai International Light Festival in 2025, joint involvement in the Light + Building trade fair in Frankfurt, and the collaborative promotion of CIE publications.

(Source: Official website of CIES)

International Deep Space Exploration Association launched in China

Founding ceremony of IDSEA
Photo credit: Xinhua News Agency

On July 7, 2025, the International Deep Space Exploration Association (IDSEA) was officially launched in Hefei, Anhui Province.

Jointly established by China's Deep Space Exploration Laboratory (DSEL), the Lunar Exploration and Space Engineering Center (CLEP), the Chinese Society of Astronautics, the Chinese Society of Space Research, and France's Planetary Exploration Horizon 2061, IDSEA brings together a global community of leading experts. Its founding members include 50 prominent scientists and academy members from 19 countries, including China, France, Italy, South Africa, Canada, and Spain. Wu Weiren, chief designer of China's Lunar Exploration Program and a member of the Chinese Academy of Engineering, was elected IDSEA's first president.

IDSEA is dedicated to exploring the unknowns of the universe, advancing new frontiers, and promoting international cooperation in space science. Its key focus areas include lunar exploration, interplanetary missions, and planetary defense against asteroid threats. The association will monitor global developments in deep space exploration, host high-level international conferences, and establish platforms to foster interdisciplinary exchange. It also aims to translate scientific breakthroughs into real-world applications, support socioeconomic development, and cultivate the next gener-

ation of talent through science exhibitions and international training programs. In addition, IDSEA plans to publish international journals, sponsor major global research projects, and recognize outstanding contributions to space science through international awards.

(Source: Official website of CAST)

International Carbon Capture Utilization and Storage Technology Innovation & Cooperation Organization inaugurated in China

Inaugural general assembly and founding ceremony of ICTO
Photo credit: CAST Department of International Affairs

On July 11, 2025, the inaugural general assembly and founding ceremony of the International Carbon Capture Utilization and Storage Technology Innovation & Cooperation Organization (ICTO) was held in Beijing. Jointly initiated by Sinopec and 50 prominent institutions and individuals, ICTO brings together founding members from 12 countries, including China, the United States, the United Kingdom, Canada, Australia, Germany, and Kazakhstan. The organization's diverse membership includes enterprises, professional associations, research institutes, and expert teams from national academies. Ma Yongsheng, a member of the Chinese Academy of Engineering, was elected ICTO's first president.

ICTO is committed to advancing international standards, regulatory frameworks, and policy research in carbon capture, utilization, and storage (CCUS). It serves as a global platform for academic exchange and technological cooperation, launching joint research initiatives and supporting youth development. Positioned as a think tank for scientific breakthroughs, a transfer hub for applied innovation, and a talent incubator for developing expertise, ICTO aims to integrate technology, industry, and human capital into a unified innovation ecosystem. By bridging academia, research, industry, and real-world application, the organization seeks to accelerate the industrialization of CCUS technologies and contribute to

building a community with a shared future for humanity in the fight against climate change.

(Source: CAST Department of International Affairs)

International Awards

Christopher Chao honored with Louise and Bill Holladay Distinguished Fellow Award

Christopher Chao receives the Louise and Bill Holladay Distinguished Fellow Award 2025

On June 21, 2025, Professor Christopher Chao, Vice President (Research and Innovation) at The Hong Kong Polytechnic University (PolyU) and Chair Professor of Thermal and Environmental Engineering, was presented with the Louise and Bill Holladay Distinguished Fellow Award at the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Annual Conference.

ASHRAE is a global professional society dedicated to advancing the technologies and sciences of heating, ventilation, air conditioning, refrigeration, and related fields. Established in 1979, the Louise and Bill Holladay Distinguished Fellow Award is one of ASHRAE's highest honors, recognizing individuals for their sustained excellence and contributions to engineering and research.

Professor Chao's research integrates intelligent building systems with infectious disease prevention. By leveraging AI-driven energy optimization, he creates infection-resilient and energy-efficient environments, positioning smart buildings as vital for both health and sustainability.

(Source: Official website of PolyU)

Gao Caixia elected EMBO associate member

Photo of Gao Caixia

On July 1, 2025, the European Molecular Biology Organization (EMBO) announced its newly elected members, with Dr. Gao Caixia, a research fellow at the Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, named an associate member.

Dr. Gao is widely recognized for her groundbreaking work in plant genome editing. Her research has driven major innovations in precision genome editing, crop breeding techniques, and germplasm development. Both *Science* and *Nature* have featured in-depth profiles on her pioneering contributions to genome-editing technology and its transformative impact on agricultural science. A Clarivate highly cited researcher for six consecutive years, Gao was named a New Cornerstone Investigator in 2023. Her numerous honors include the National Award for Excellence in Innovation, the Tan Jiazhen Life Sciences Award, and a spot on *Nature*'s list of "Top 10 Science Stars of China" in 2016.

Founded in 1964, EMBO is committed to advancing molecular biology and related fields by supporting scientists, fostering international collaboration, and promoting scientific excellence.

(Source: *Science and Technology Daily*)

Scientist Profile

Scientists spotlight quantum computing breakthroughs and industrialization hurdles

From July 1 to 31, 2025, the 27th CAST Annual Meeting took place in Beijing, where quantum computing emerged as a key topic of discussion. Chinese Academy of Sciences members Xue Qikun and Pan Jianwei shared insights into both the opportunities and challenges facing this rapidly evolving field, from cutting-edge research to the barriers of commercialization.

From classical to quantum chips: Engineering the future of computing

Photo of Xue Qikun

In the editorial titled "From Classical to Quantum Chips" for the CAST Annual Meeting special issue of *Science & Technology Review*, experimental physicist Xue Qikun offered a candid yet forward-looking perspective, describing the development of quantum computers as "a challenge even more

daunting than a moon landing."

Although full of promise, quantum computing remains in its early stages. The dominant technical pathway—superconducting qubits—faces major hurdles, including ultra-low temperature requirements and high error rates. These systems must operate near absolute zero, relying on massive cryogenic setups that can occupy up to a quarter of a football field. Alternative approaches, such as trapped ions and cold atom arrays, are also under active development, yet all share the same bottleneck: the need to achieve high-fidelity logical qubits. Currently, superconducting qubits have error rates around 10^{-3} to 10^{-4}, far from the 10^{-10} threshold needed for universal quantum computing, and still significantly higher than the 10^{-12} error rate typical of classical semiconductor transistors.

Xue emphasized that progress in quantum computing follows a long cycle, moving from basic science to industrial transformation. A fully functional quantum computer may still be 10 to 20 years away, with substantial technical obstacles to overcome. While foundational research often leads to disruptive breakthroughs, the path to commercialization in the quantum field is particularly long and complex. He called for a strategic balance between basic research, applied development, and commercial deployment, as well as between long-term ambition and short-term progress. Ultimately, Xue expressed hope that quantum computing will evolve into a powerful driver of computational innovation in the age of artificial intelligence.

Quantum technology requires patience and informed support for industrialization

Interview with Pan Jianwei

On the sidelines of the Annual Meeting, CAST Vice President and renowned physicist Pan Jianwei shared his insights on the current state and future trajectory of quantum technology industrialization.

Pan noted that quantum information science is driv-

ing a second quantum revolution, encompassing three key areas: quantum computing, quantum communication, and quantum precision measurement. While quantum computing remains largely confined to the laboratory, progress is accelerating. Notably, China's Zuchongzhi-3 has demonstrated quantum computational advantage using a superconducting quantum system. However, Pan emphasized that widespread commercial application is still years away. He estimated it could take another 10 to 15 years for quantum computing to reach industrial maturity, with the lack of practical algorithms posing one of the most significant challenges.

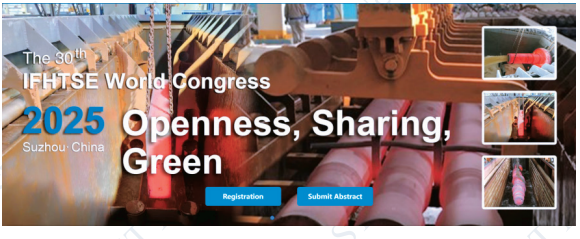
Pan also identified two major obstacles in this process: resistance from entrenched interests in traditional industries and overhype surrounding the technology's maturity. He called on the scientific community to adopt a realistic view of current progress and to help cultivate a rational environment for continued development.

"According to the natural rhythm of technological progress," Pan said, "we expect quantum information technologies to reach a new level within the next decade. Now is the time to seize this opportunity and guide quantum technologies toward steady development."

(Sources: Official WeChat account of VOC and *Science and Technology Daily*)

Upcoming Conferences

30th IFHTSE World Congress to convene in Suzhou



The 30th IFHTSE World Congress, hosted by the International Federation for Heat Treatment and Surface Engineering (IFHTSE) and organized by the Chinese Heat Treatment Society (CHTS), will take place from August 19 to 22, 2025, in Suzhou, Jiangsu Province. This marks the fifth time the congress will be held in China, following earlier editions in 1983, 2004, 2012, and 2018. As IFHTSE's flagship academic event, the World Congress is recognized

globally as the leading platform for cutting-edge research and innovation in the field.

The 2025 congress will feature the latest advancements in materials processing, bringing together top scholars and industry professionals from around the world. With a strong focus on exchange and collaboration, the event aims to foster a dynamic environment for sharing insights. Researchers and business leaders from China and abroad are warmly invited to participate for in-depth discussions on emerging technologies and industrial applications in this fast-evolving discipline.

For program details, visit www.ifhtse2025.com.

(Source: Official website of the 30th IFHTSE World Congress)

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