Dawn of Big Science in China

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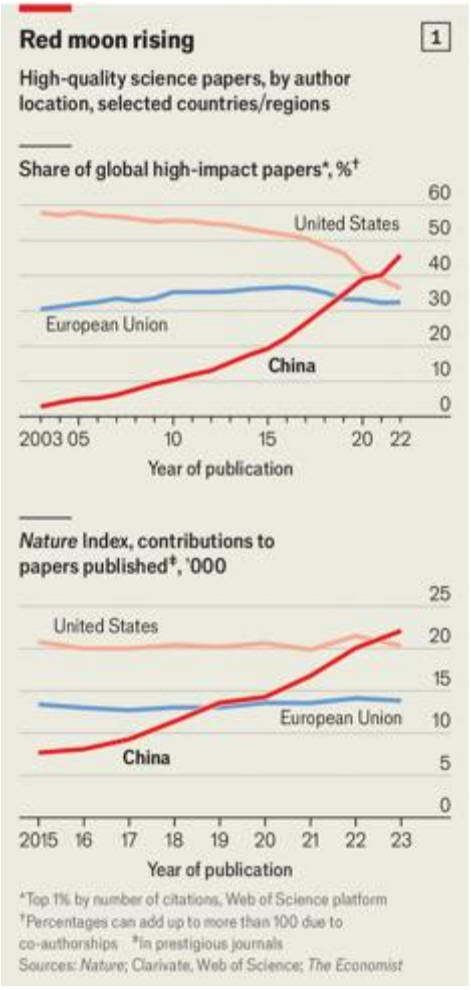
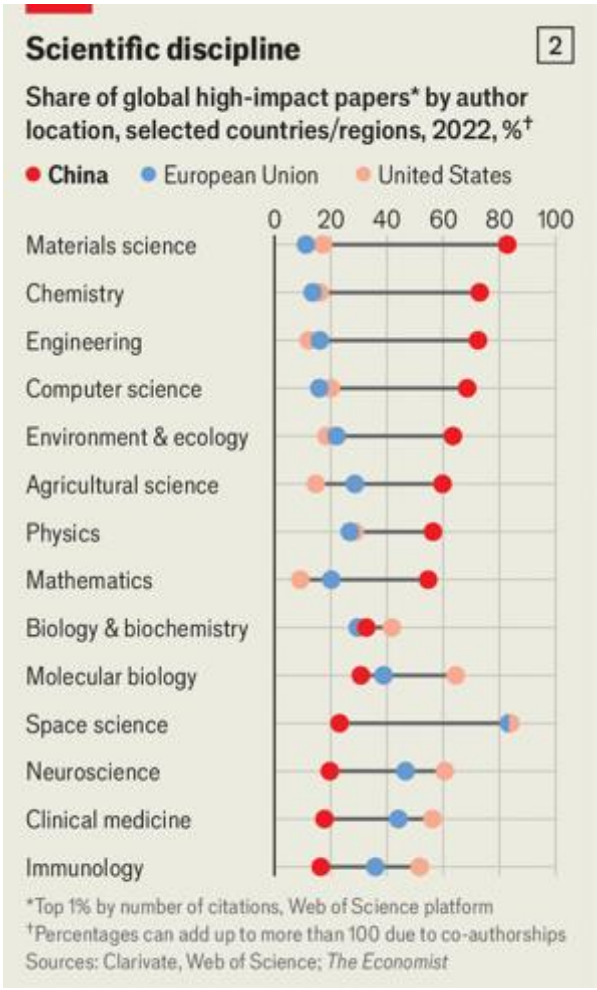
Chinese S&T Rise: Macro Perspective

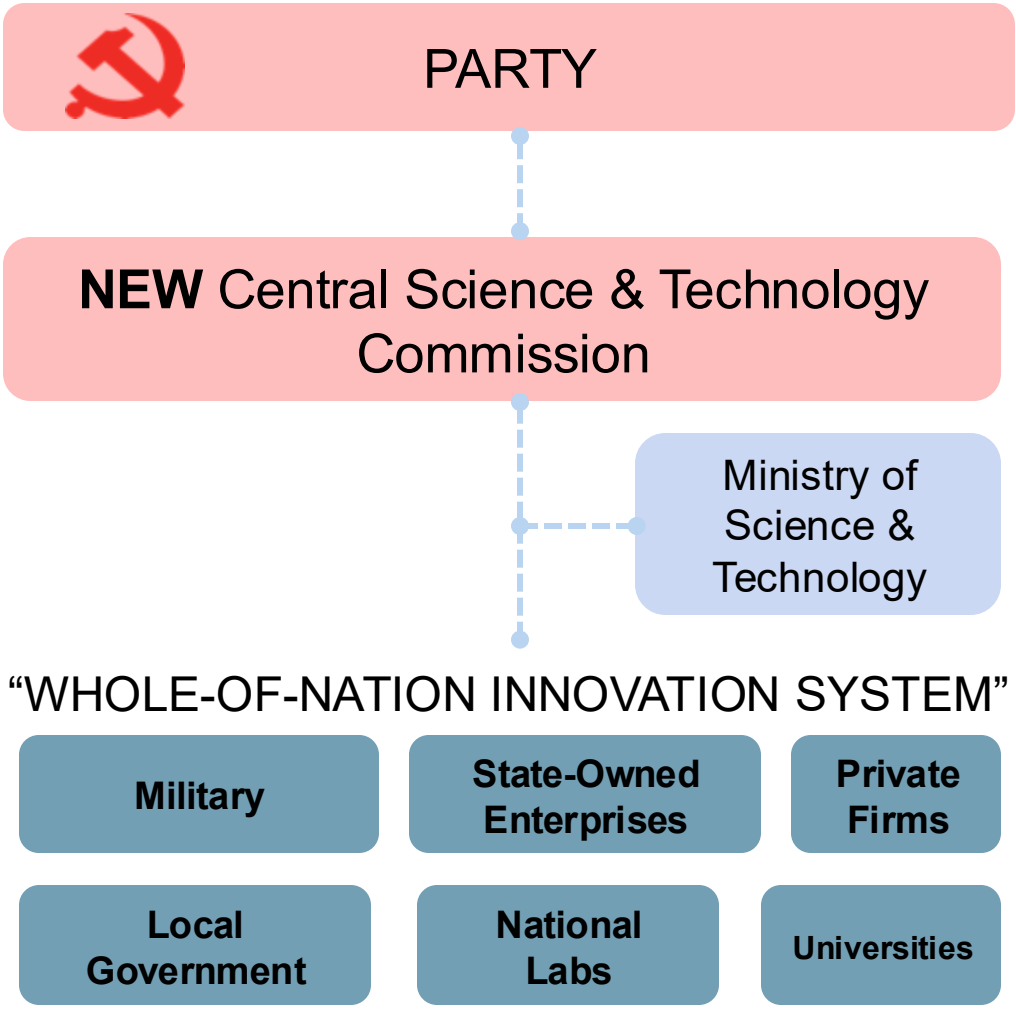




The Economist

New Major Focus on S&T Policy in China

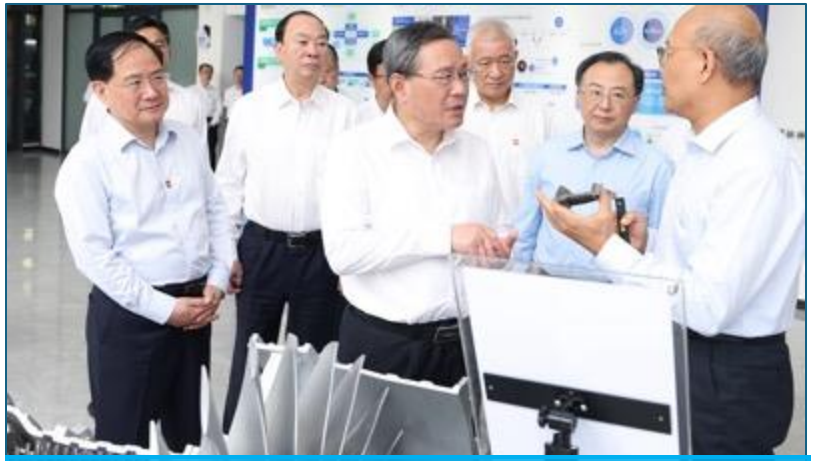
- New National Central Science & Technology Commission announced
- Goal of “strengthening party unified control” over science & technology in China
- China believes it can utilize the party to conduct “command & control” mobilization of innovation to overcome U.S. export controls
- Modeled after China’s successful space and military technology programs
- Likely going to be more secretive, Manhattan-project style efforts



S&T Focus of Top CCP Political Leaders

Xi Visits Robotics Firm, 2023

Li Qiang Visits Space Lab, 2024



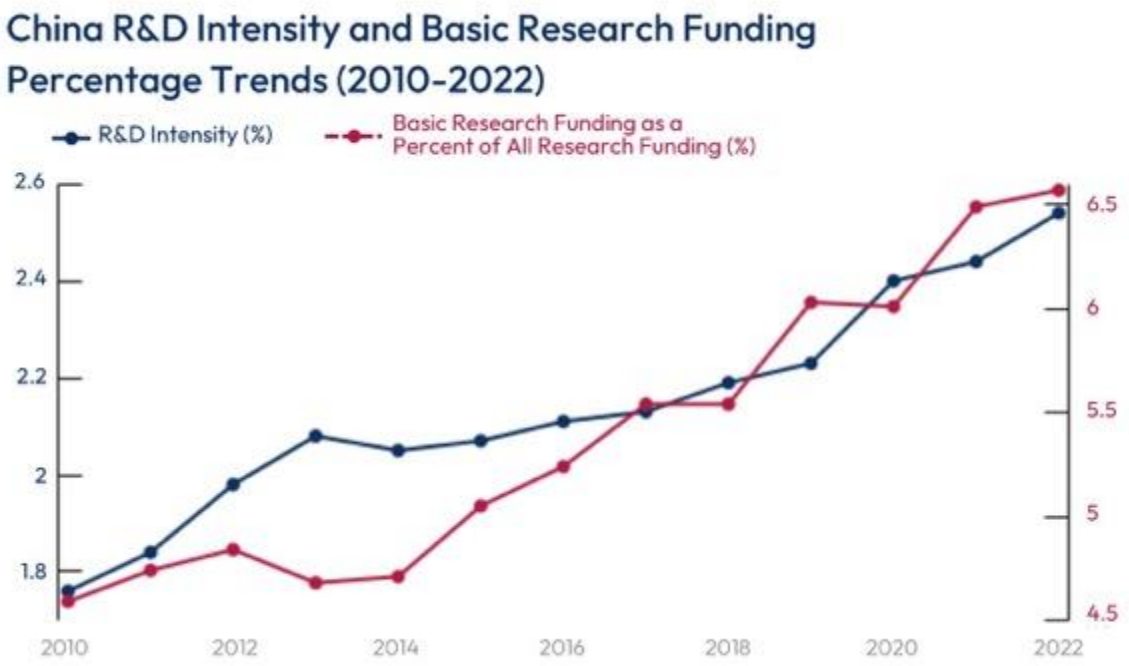
Li Qiang Visits Materials Lab, 2024

Xi Visits Chip Factory, 2024

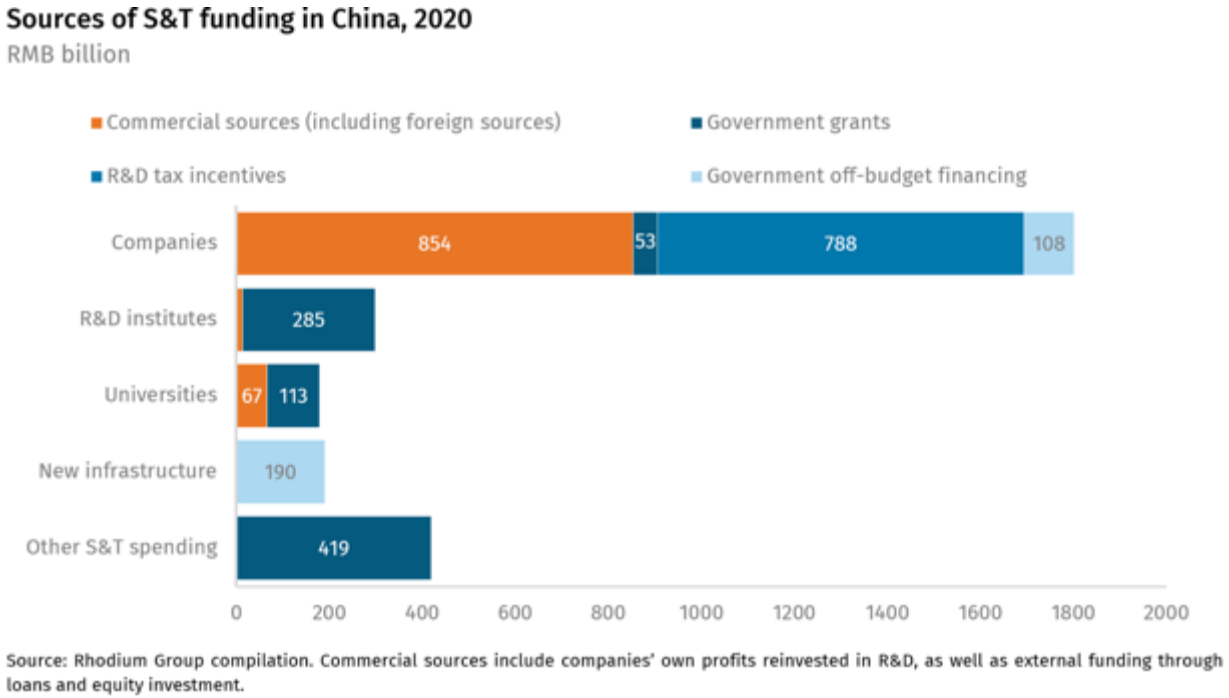
Li Qiang Visits Lithography Lab, 2024

Xi Visits Agricultural Lab, 2023

S&T is Top Funding Priority



Source: SCSP



Source: Rhodium

- Current estimates potentially vastly underestimate actual spending
- 2024 (国家重大战略实施和重点领域安全能力建设) program allocates up to $150 billion USD in extra-long term bonds for "major national projects" including S&T infrastructure. Many new projects and labs receiving funding
- In 2024, China Development Bank loaned billions under its infrastructure program for "major national S&T infrastructure (part of a larger $200 billion USD loan program (国开行积极服务深圳、合肥等综合性国家科学中心建设，助力大科学装置布局)

Sources: https://www.gov.cn/zhengce/202405/content_6953691.htm and https://www.cdb.com.cn/xwzx/mtjj/202502/t20250210_12338.html


“National laboratories have become an important platform for major developed countries to seize the high ground in scientific and technological innovation. **For instance, U.S. national laboratories such as Argonne, Los Alamos, and Lawrence Berkeley**…are research bases that revolve around national missions….
Xi Jinping, 2015

China is Making Big Strides in Big Science

JANUARY 25, 2024 | 4 MIN READ

China's New Dark Matter Lab Is Biggest and Deepest Yet

The world's deepest and largest underground laboratory is scaling up its search for dark matter

BY GEMMA CONROY & NATURE MAGAZINE

The entrance to the sprawling China Jinping Underground Laboratory, the world's biggest and deepest subterranean science lab. Image/Alamy Stock Photo

China's giant underground neutrino lab prepares to probe cosmic mysteries

Due to come online this year, the JUNO facility will help to determine which type of neutrino has the highest mass – one of the biggest mysteries in physics.

By Gemma Conroy

Hard at work building China's Jiangmen Underground Neutrino Observatory (JUNO). JUNO hopes

South China Morning Post

Science China / Science

China's FAST radio telescope set for major upgrade to keep its place as world leader

An array of 24 radio telescopes will be built around China's FAST to help boost the massive telescope's resolution

Reading Time: **2 minutes**

20 New Big Science Facilities Planned

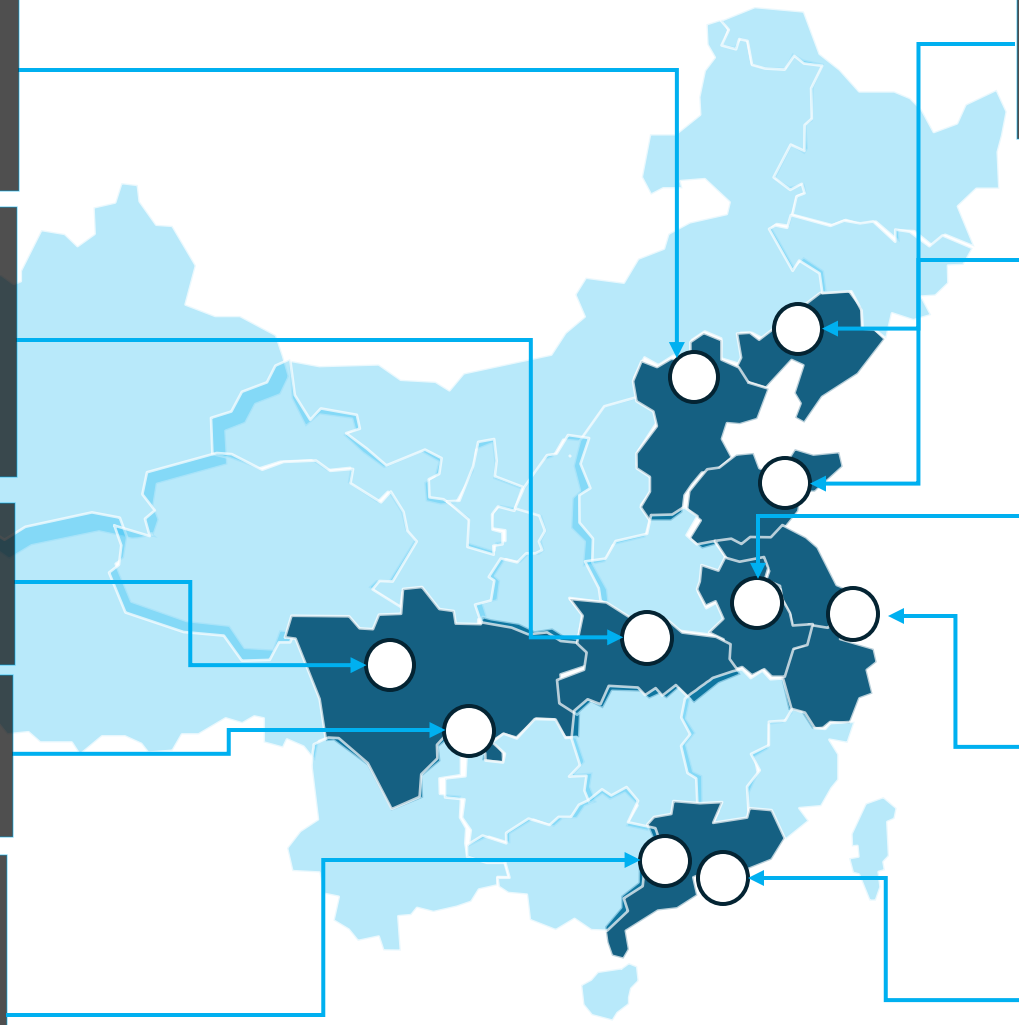
BEIJING
(1) High-efficiency solar energy conversion and utilization facility
(2) Human organ simulation lab

WUHAN
(3) Pulsed magnetic field lab
(4) Crop phenotypic research lab
(5) Deep geotechnical disturbance simulation facility

CHENGDU
(6) National z-pinch facility

CHONGQING
(7) Super transient experimental device

GUANGZHOU
(8) Cold spring ecosystem lab
(9) Human cell lineage science research lab



SHENYANG
(10) Ultra-large deep engineering disaster physical simulation facility

SHANDONG
(11) Air-breathing engines test facility
(12) Marine system simulation

ANHUI
(13) Advanced Light Source
(14) Air-Ground Quantum Precision
(15) optical/magnetic facility
(16) Atmospheric 3D detection facility

SHANGHAI
(17) Thorium-based molten salt reactor

SHENZHEN AREA
(18) Cloud Brain III HPC System
(19) Spallation Neutron Source Phase
(20) Advanced Attosecond Laser Facility
(21) Spallation Neutron Source Phase II

Goodrich: Dawn of Big Science in China

S&T Device Approval Process in China

Key Policies & Stakeholders

National Medium-Long Range Plan for Scientific Infrastructure
(2012 – 2030, Managed by NDRC)

14th Five-Year Plan for National S&T Devices
(2020-2025, Classified)

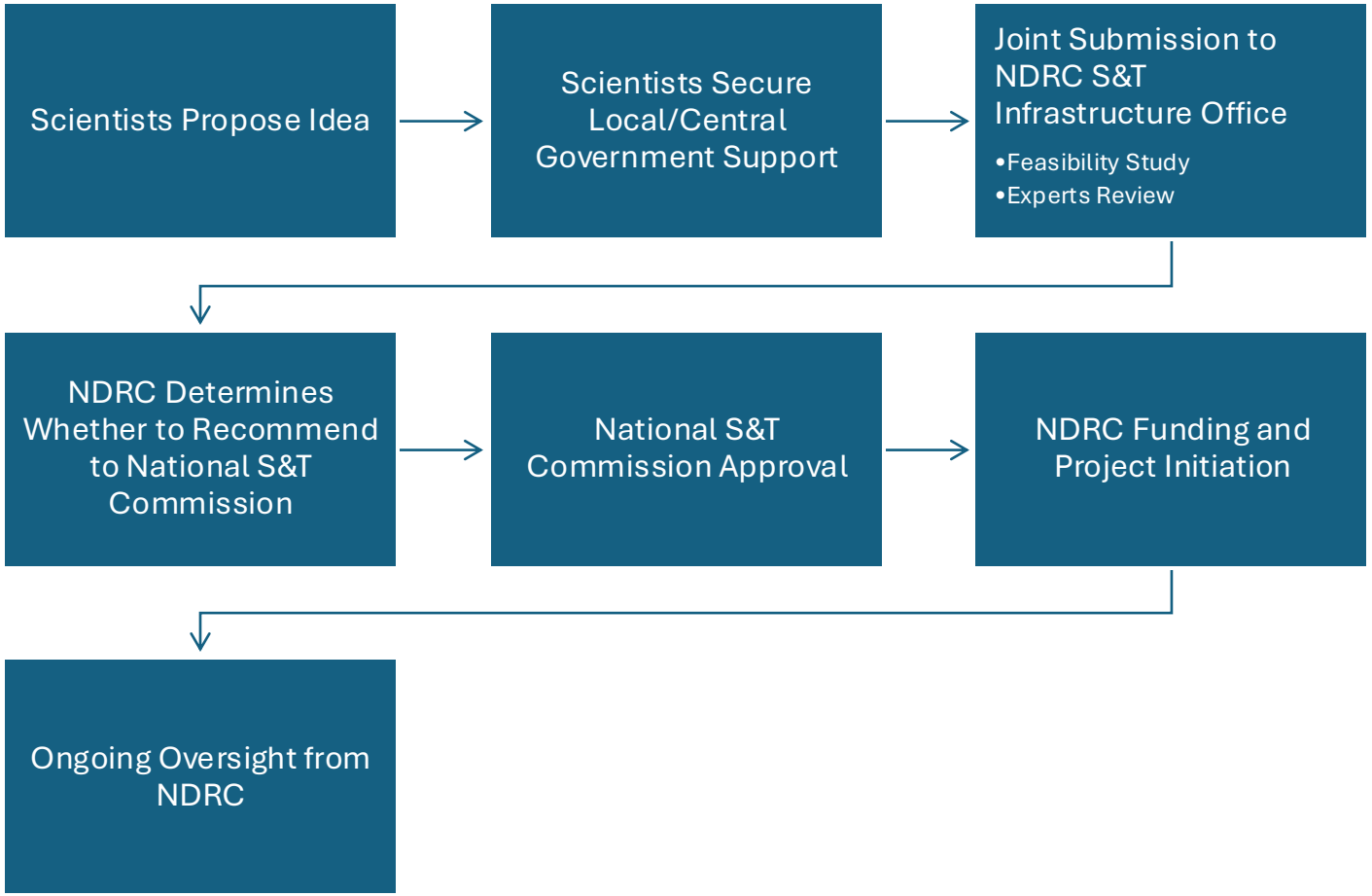
National Medium-Long-Range Plan for S&T Development 2021-2035
(Classified)

National Development & Reform Commission

National S&T Commission

Scientific Community

Approval Process



Examples: Nuclear Physics & Fusion

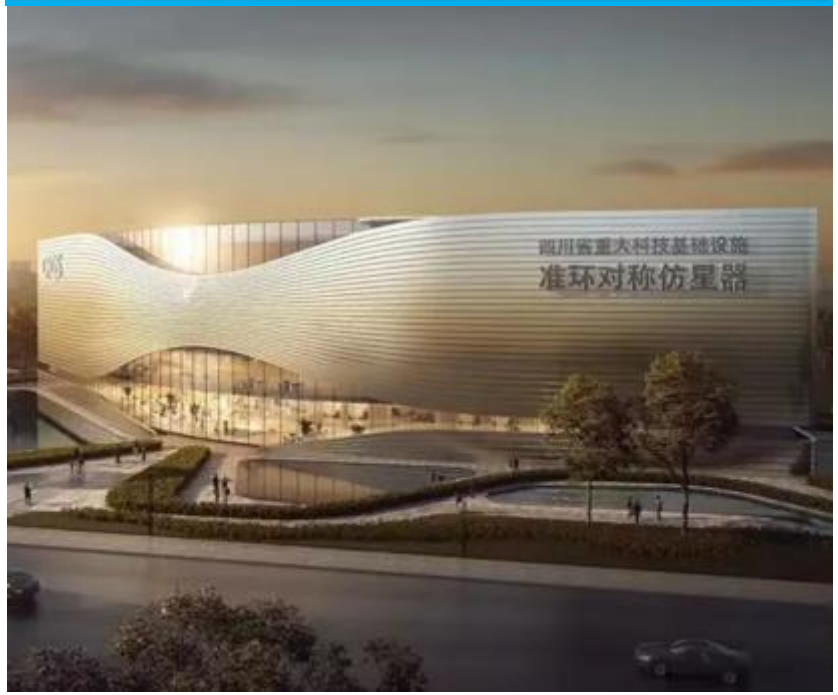
Hefei Burning Plasma Fusion Reactor (BEST)

Accelerating superconducting tokamak fusion energy research and prototyping and test reactor to be built on site

High Intensity Heavy-ion Accelerator Facility (HiAF)

Studying exotic nuclei and astrophysical element formation, quark-gluon plasma and heavy-ion collisions), and radiation effects on spacecraft materials

Fusion Stellarator Lab



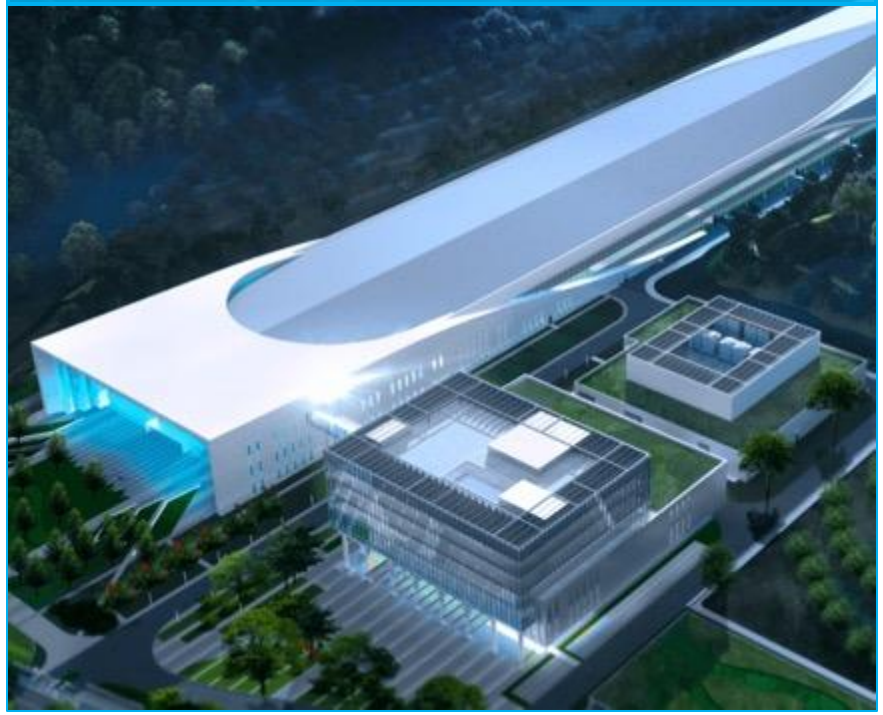
Advancing state of the art research for stellarator based nuclear fusion with large-scale prototype and lab to be built

Source: Reuters

Examples: Frontier High-Energy Physics

Hefei Advanced Synchrotron Light Source

Shenzhen Superconducting Soft-X-ray Free Electron Laser (S^3FEL)



Beijing Synchrotron Light Source

High-energy synchrotron colliders probe the fundamental structure of matter by accelerating and smashing particles together at near-light speeds, revealing new particles and forces. Synchrotron light sources generate intense X-rays and other electromagnetic radiation to study the atomic and molecular structures of materials, advancing fields like biology, chemistry, and materials science.

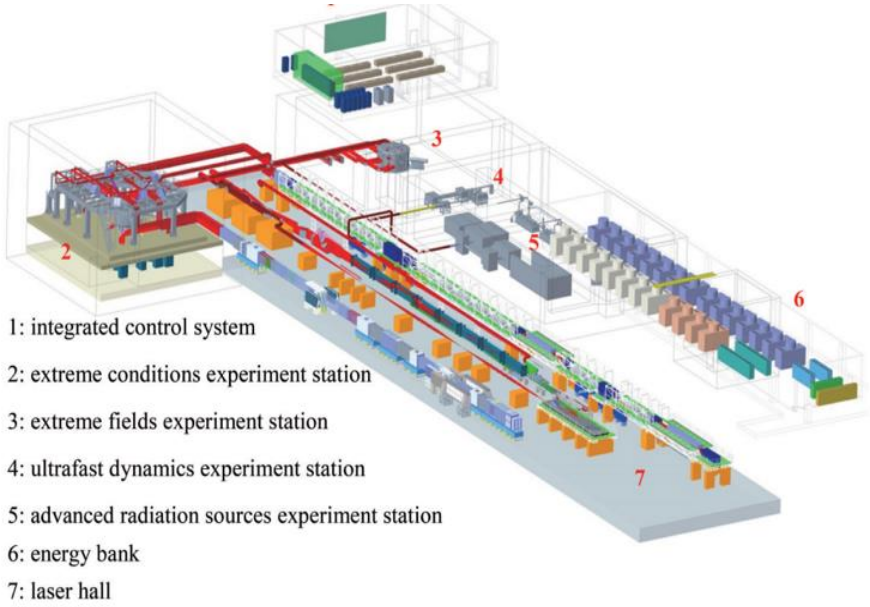
Shenzhen Superconducting Soft-X-ray Free Electron Laser (S^3FEL)

Examples: More Lasers, Light Sources, & Accelerators

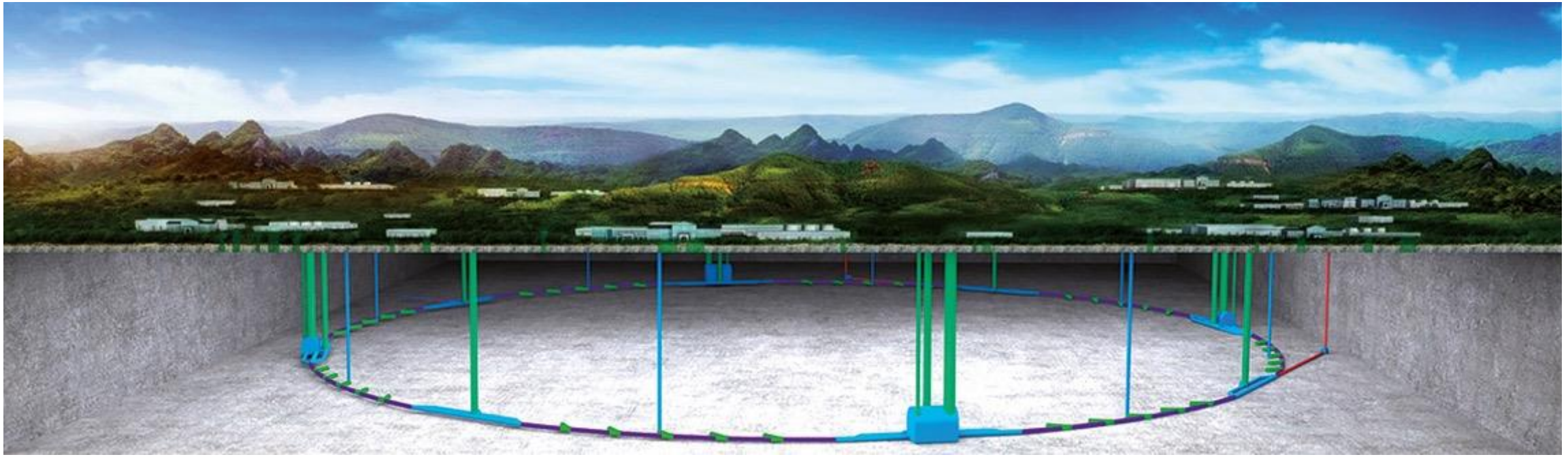
Dongguan Advanced Attosecond Laser

Shanghai High Repetition Rate Hard XFEL and Extreme Light Facility (SHINE)

Ultra Intense Pulsed Laser (Femto/Picosecond Lasers)



China Circular Electron–Positron Collider (CEPC)



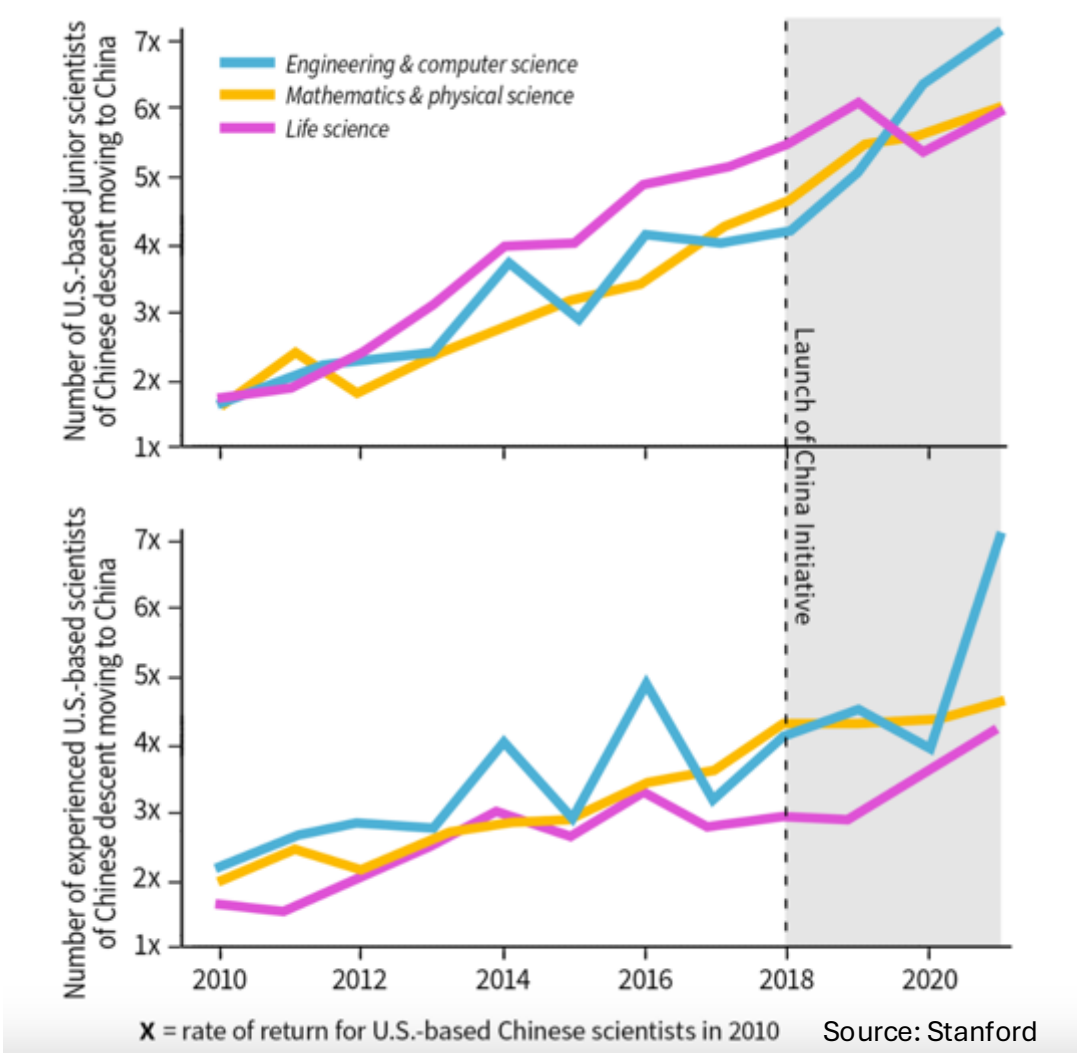
- The Circular Electron–Positron Collider (CEPC) is a proposed 100 km circumference particle accelerator in China, designed primarily as a Higgs boson factory. It aims to operate at center-of-mass energies of 240 GeV for Higgs boson studies, with potential operation at 91.2 GeV for Z boson and 160 GeV for W boson studies.
- The CEPC accelerator Technical Design Report (TDR) was completed and released in December 2023, marking a significant milestone in the project's development. Following this, the project has entered the Engineering Design Report (EDR) phase, scheduled from 2024 to 2027, focusing on detailed engineering designs and site selection.
- The team plans to submit a formal proposal to the Chinese government in 2025, aiming for construction to commence around 2027 and completion by 2035.

Examples: Hypergravity Research Center

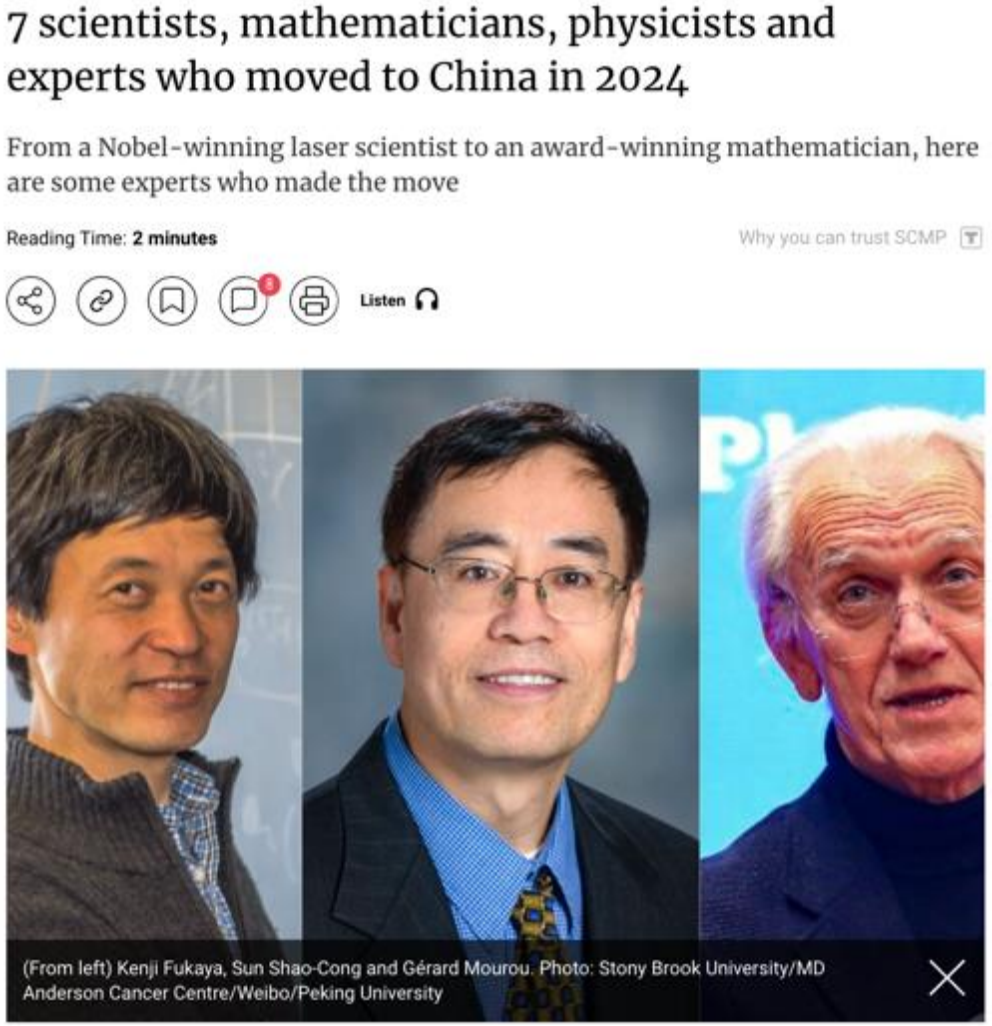
Centrifugal Hypergravity and Interdisciplinary Experiment Facility

World's largest hypergravity centrifuge, capable of generating forces up to 1,900 times Earth's gravity, allowing scientists to study extreme physical conditions and test materials under intense gravitational stress across various fields like engineering, geology, and material science; essentially simulating natural events like earthquakes or deep-sea pressures in a controlled environment

Cutting-Edge Facilities Attract Talent



Source: Stanford



7 scientists, mathematicians, physicists and experts who moved to China in 2024

From a Nobel-winning laser scientist to an award-winning mathematician, here are some experts who made the move

Reading Time: **2 minutes**

Why you can trust SCMP

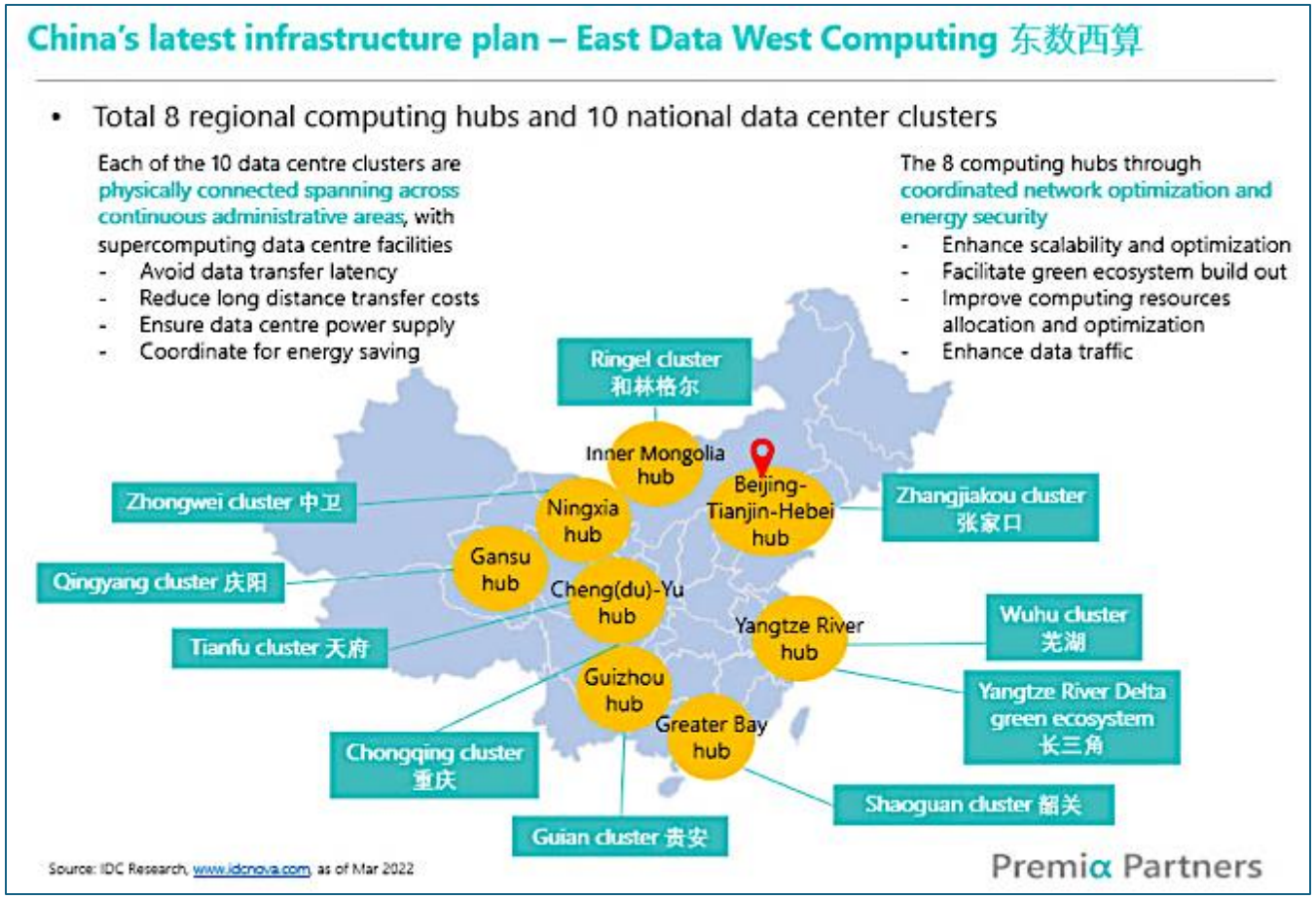
Listen

(From left) Kenji Fukaya, Sun Shao-Cong and Gérard Mourou. Photo: Stony Brook University/MD Anderson Cancer Centre/Weibo/Peking University

Source: SCMP

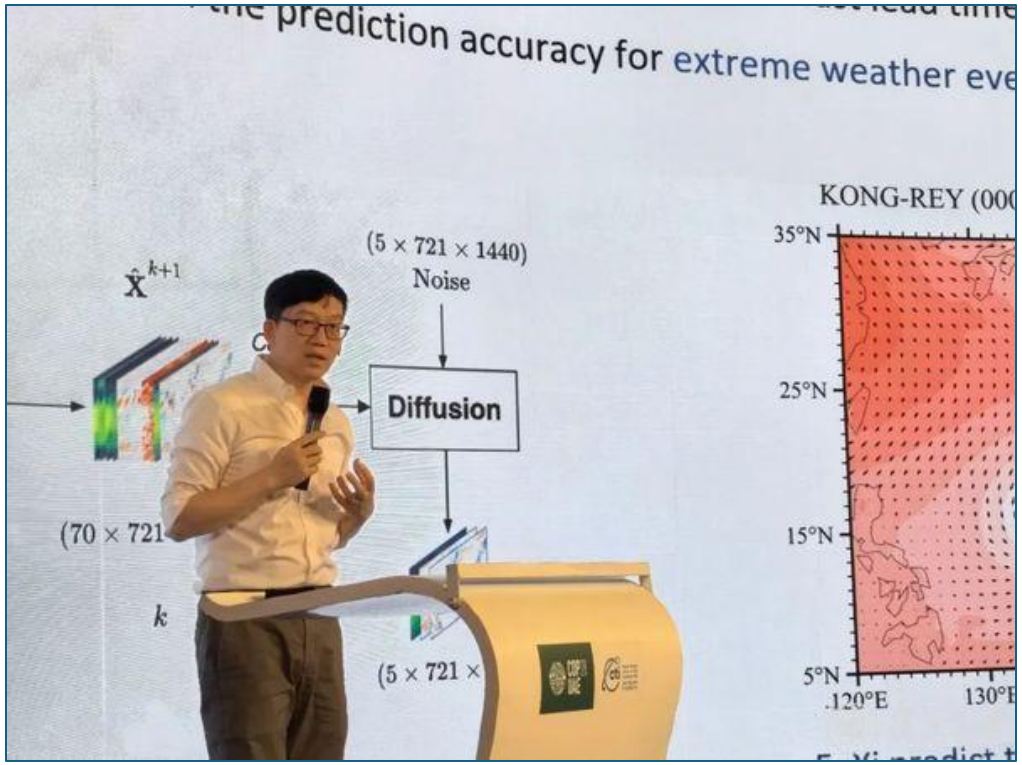
Can AI and Compute Boost China's Scientific Research?

Computing as National S&T Infrastructure



AI for Science Taking off in China

Significant work underway, competition between institutes



- Multiple government institutes and labs are putting a new focus on AI for science in China
- Less controversial than traditional foundational models focused on natural language processing – less regulatory oversight
- Dozens of scientific LLMs developed for CFD, earthquake prediction, aerospace design, biological science, climate science, some exceeding hundreds of billions parameters
- Multiple dedicated compute clusters for AI4S training

AI4S Example: Peng Cheng AI Labs

盘古大模型

- Established in 2019. 3,200 researchers, including 600 active PhD students
- Funded by Guangdong Provincial Government, runs S&T several projects for the Chinese Central Government
- Focused on AI, computing, robotics, and advanced networking

- Peng Cheng Labs has been training foundational models on scientific and government data since 2019
- Co-developed with Huawei the Pangu 3 Foundational LLM, 500 billion plus parameters, proprietary model
- Developed its own Pengcheng Cloud Mind 200B + parameter foundational MoE model
- Nebula System – StarSquare System – astrophysics and geospatial data set used for LLM training

AI4S Example: Zhejiang Lab

- Affiliated with PCL. 2,100 full-time staff. $300 million campus. ~$200 million annual budget
- 500 petaflops, FP64 cluster based on heterogenous system of mixed AI accelerators. 10 EFLOPS FP16 performance
- AI Astronomy LLM, MOU with CAS, other institutes to train with astronomical data for their LLM
- LLM for advanced reactor cores
- Spaceborne LLM

Macro Challenges: Political Ideology & Funding

Conclusions

- China is pushing towards the scientific frontier
- It has attempting to replicate the era of U.S. big science (1940-1970) in developing national labs and S&T infrastructure
- China will no longer be imitating, but rather be pioneering new scientific discoveries

Questions & Discussion

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