

ICARST 2017

1st International Conference on Applications
of Radiation Science and Technology

Status and Prospect of Application of Radiation Science and Technology in China: a national report

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Preamble

- Radiation Science and Technology (RST) Application is an emerging strategic industry in China. It has seen rapid development in recent years. The annual output of the industry in China has exceeded 300 billion RMB *yuan* (approximately 43.2 billion USD) in 2016, which is expected to maintain an annual growth of around 20% in next decade.
- Entrusted by China Atomic Energy Authority (CAEA), China Association of Science and Technology and other related ministries, Chinese Nuclear Society (CNS), China Isotope and Radiation Association (CIRA) and China Institute of Atomic Energy (CIAE) carried out a two-year-long nation-wide survey on radiation science and technology application since late 2015 in order to have an overall idea of the major achievements in the past ten years, its important role in improving people's living and health and the opportunities and challenges facing the industry in order to predict its development trend in future. This presentation reflects the key outcome of this survey.



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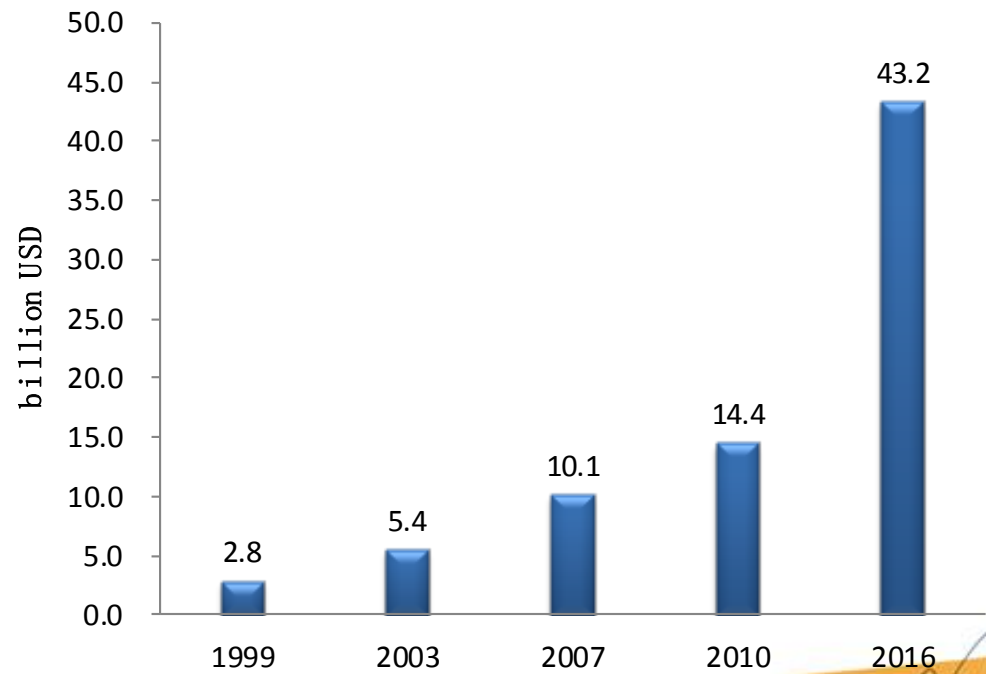
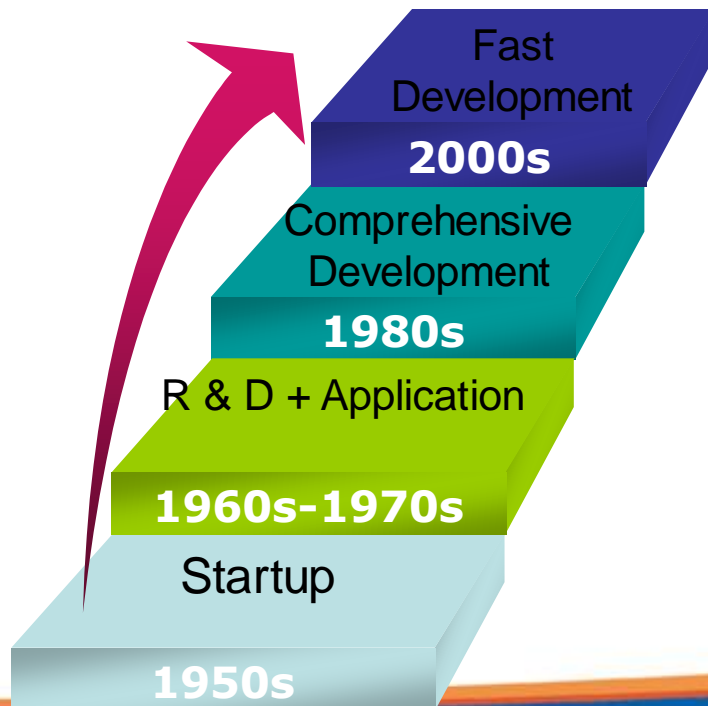
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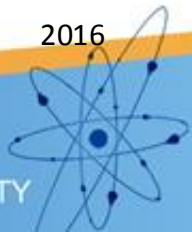


Overview :

- ✓ **More than 400** institutions/companies engaged in R&Ds in RST, and **several thousand** in applications of RST by the end of 2016.
- ✓ Annual output exceeding **300 billion yuan RMB (43.2 billion US dollars)**, 3 times that of 2010, and maintaining an annual increase of about **20%**.
- ✓ Creating nearly **100,000 jobs**.

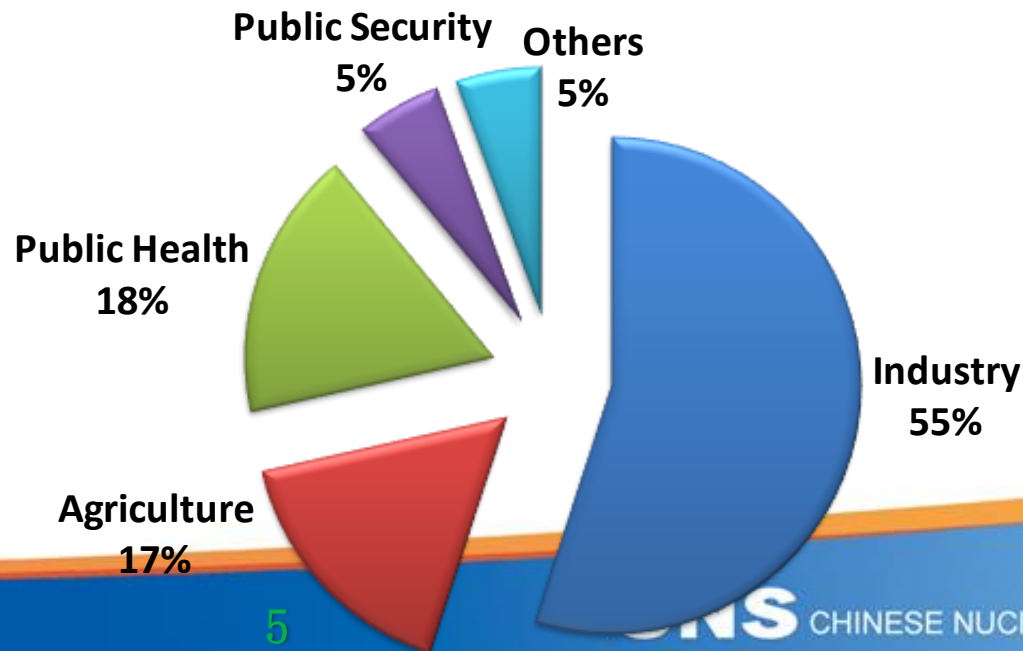


Annual Output Value of RST in China in 1999~2016



Overview

- ✓ Widespread applications in industry, agriculture, medicine, environment, etc.
- ✓ developing into industry scale in a variety of areas including material performance improvement by irradiation, radiation processing, radiation based equipment, public health, public security and environment protection.



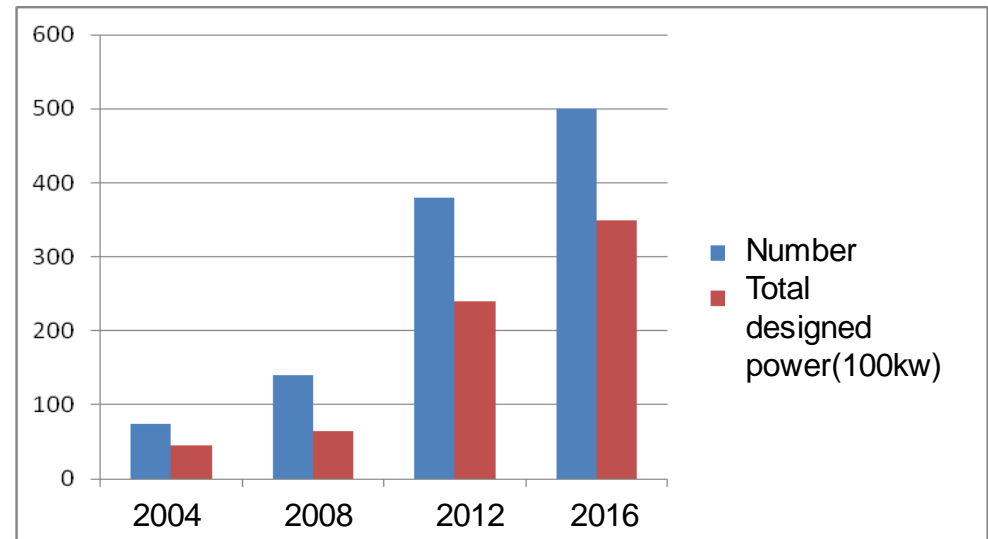
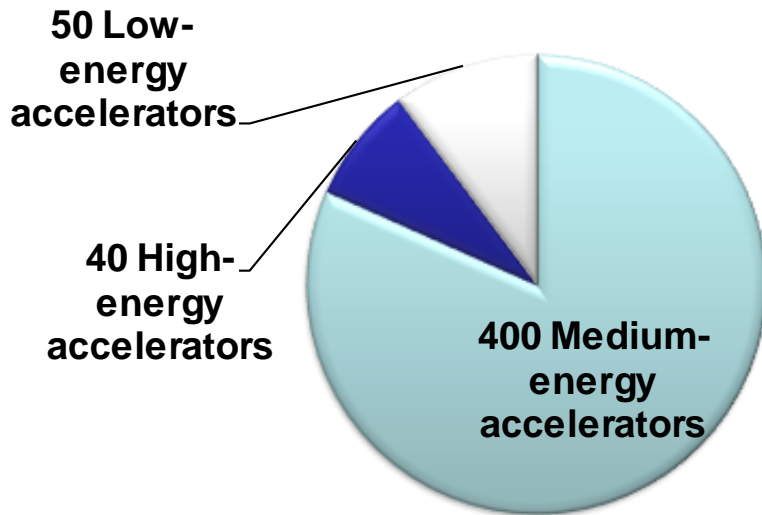
Radiation science

- ✓ **More than 80** research institutions and universities engaged in RST
- ✓ Radiation sciences (including radiation chemistry and physics) in vigorous development with the support of large-scale facilities, achieving fruitful results which have established the basis for industrialization of RST.

Type	Name of large-scale facility	Status
Accelerator	HIRFL (Heavy-Ion Research Facility in Lanzhou), 100MeV high Intensity proton cyclotron, 4MeV electrostatic accelerator, dielectric wall proton accelerator used for oncotherapy, proton cyclotron for PET	in operation
	High Intensity Heavy-ion Accelerator Facility (HIAF)	under construction
Reactor	High Flux Engineering Test Reactor (HFETR, 125MW), China Pulse Reactor (CPR, 1MW), Minjiang Test Reactor (MJTR, 5MW), China Experimental Fast Reactor (CEFR, 20MW), China Advanced Research Reactor (CARR, 60 MW), China Mianyang Research Reactor (CMRR, 20MW)	in operation
Light Source	Beijing Electron-Positron Collider (BEPC), Beijing Synchrotron Radiation Facility (BSRF), Hefei Light Source (HLS), Shanghai Synchrotron Radiation Facility (SSRF)	in operation
	Shanghai X-ray Free Electron Laser (SXFEL), China Spallation Neutron Source (CSNS)	under construction
	Beijing Light Source (Gen-IV Light Source)	under planning

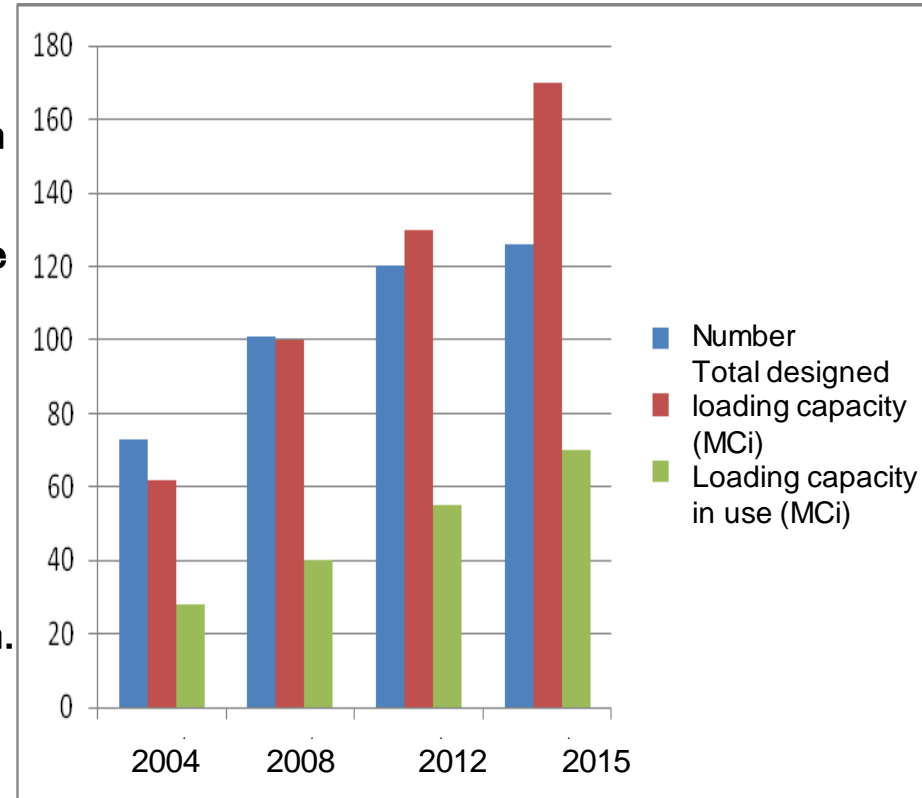
✓ Status of radiation technology and equipment

- R&D in electronic accelerator for irradiation has seen significant progress, and the number of radiation equipment grows remarkably with an annual increase of **more than 40 sets**.
- Capable of supply internationally: **more than 30** radiation equipment have been exported to overseas market including the US, southern-eastern Asia.



✓ Status of radiation technology and equipment

- Cobalt-60 is able to be produced in China, with an annual output of 6 million curies which meets **about 75%** of the demand of the Chinese market.
- Production of Cobalt-60 for medical use was approved in March 2017 and first product expected in 2019.
- China's capacity has been significantly improved for designing and building γ radiation. By 2015, γ radiation facilities (designed loading capacity $>0.3\text{MCi}$) reached 130 sets, taking up 40% of the world's total. The single biggest design capacity is 6MCi. The total design capacity $>170\text{MCi}$, actual loading is 70MCi, taking up 23% of world's total.

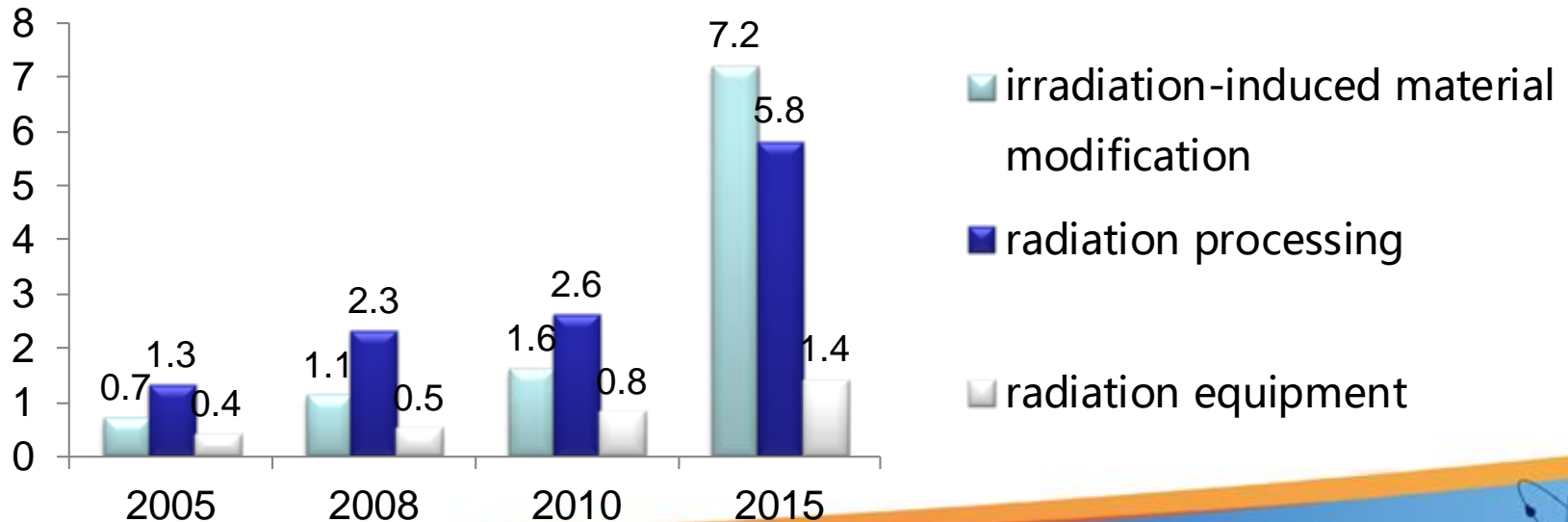


Development of γ radiation devices



Industrial applications

- ✓ Annual output of radiation processing industry has reached **14.4 billion** US dollars in 2015 with annual growth rate of **15%**.
- ✓ Industrialization has been realized in irradiation-induced material modification, radiation processing and radiation equipment. The outputs of the three sectors have reached **\$7.2 billion, \$5.8 billion and \$1.4 billion** respectively in 2015.



Agricultural applications

- ✓ Significant progress in radiation-induced mutation breeding of plants
 - China has developed more than **800** mutations in **45** kinds of plants, accounting for **26%** of the world's total.
 - The radiation-induced mutations have been planted on **20%** of China's crop area, with an annual planting area of **>130 million mu** (20 million acres) contributing **3.5 – 4 billion kilograms** to China's grain production every year.
- ✓ Radiation-processed agricultural products take up a half of world total
 - Irradiated products in 2015 exceeded **400,000 tones**, generating an annual output value of over **US\$ 2.6 billion**.

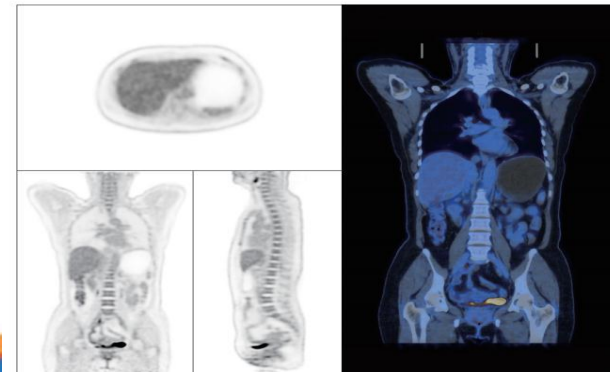


Medical applications

- ✓ **New breakthroughs are achieved in medical equipment**
 - Big growth in the number of medical-use Linac from **71** in 1986 to **1,931** in 2015 ;
 - Achieved major progress in proton and heavy-ion therapy techniques ;
 - Domestic diagnostic imaging equipment wins recognition of international peers. UIH is cooperating with the Explorer, to develop world's first PET-CT capable of panoramic scanning, 40 times in precision of traditional PET and real-time dynamic whole-body scanning.
- ✓ **Applications in medical areas expand in all-round way**
 - Nuclear imaging and therapy in China is in rapid development. As of the end of 2015, China owns **600** SPECTs and coincidence circuit SPECTs, **258** PETs and PET-CTs, and **2.1 million** person times accept nuclear imaging diagnosis.



112-ring digital PET-CT produced by UIH



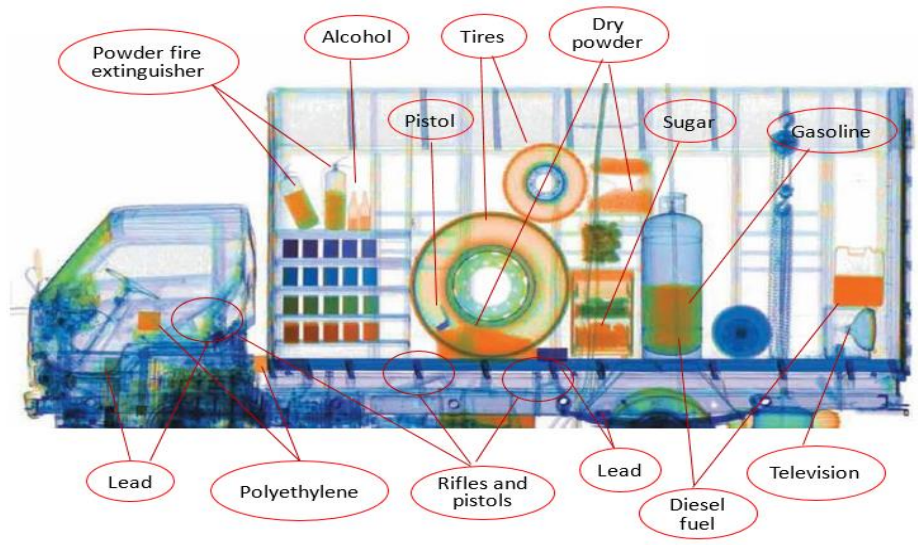
18F-FDG, 3xCI, BMI 21.7, 35y/M, REC, 3R/0

Exquisite images using low radiation doses and thin-slice reconstruction



Application in public security

- ✓ Detection technologies based on X-ray, γ -ray and neutron see widespread applications;
- ✓ Fingerprint-level high precision detection technologies such as Nuclear magnetic resonance, nuclear quadrupole resonance and cosmic muons scattering see bright prospect in applications;
- ✓ Large container/vehicle inspection system wins high international reputation.
 - Top 1 in international market share for 4 consecutive years and the share in 2015 reached **31.6%**.
 - Deployed in customs, ports and border stations in more than 140 countries.
 - Providing security services to many key world-class activities, including state head summits, Olympic Games, World Expo, and the annual BoAo Forum for Asia.



A high-definition image produced by a system of Nuctech

Applications in environmental protection

- ✓ Widely used in environment monitoring and waste treatment;
- ✓ Electron accelerator used for industrial waste water treatment
 - The technology has come to initial stage of industrialization. The newly developed 5000 m³/d demonstration facility used for deep treatment of waste water from printing or dyeing industry has been put into pilot operation. It can reduce COD of waste water from 200 mg/L to 60 mg/L with chroma 10 times less than the original water, and treatment fee of 35 US cents/m³.



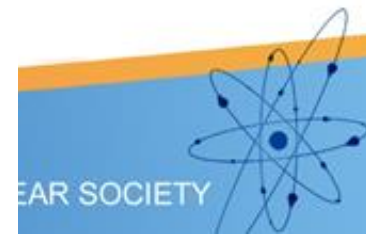
✓ **Government support creates a favorable development environment**

Departments of the Central government, provincial and municipal governments have introduced a number of policies for promoting the development of RST in China, and provided support by listing RST in prioritized advanced manufacturing areas or as an emerging high-tech industry.

✓ **Leading enterprises drive rapid development of RST in China.**



深圳市沃尔核材股份有限公司
SHENZHEN WOER HEAT-SHRINKABLE MATERIAL CO.,LTD.



✓ Inexhaustible force from independent innovation

China has been sticking to independent innovation in developing RST, and has achieved significant progress in electron beam accelerators, γ irradiation devices, Co60 source, ray imaging inspection equipment, medical diagnostic and therapeutic equipment, owning almost **10,000** patents (Nuotech has more than **2000** and UIH more than **1600**).

✓ Fast development fueled by mixed-ownership reform

- CGN took the lead in this reform and her daughter company already publicly listed with a turnover of 3.023 billion RMB yuan, an increase of 41.48%.
- CNNC is taking measures to publicly list her daughter company China Isotope and Radiation Corporation.

✓ Standardized dosimetry ensures high quality

- The Chinese government has issued 20 national standards and technological codes relating to dosimetry measurement for radiation processing;
- National benchmarks such as absorption dose of ferrous sulfate dosimeter have participated in international comparisons, and have received recognition as international equivalence.
- 70% of China's radiation processing institutions participated in National Dosimetry Assurance Service (NDAS).

- ✓ **Strong demand, promising prospects**
 - The high degree of its universality, closely related to other industries and its own advantages ensure its broad room of development.
 - In the US, RST application industries contribute 3%-4% of the country's GDP, compared with 2%-3% in Japan and Europe and only 0.4% in China, indicating that China has a greater potential for development, and a more promising future.
- ✓ **Continuous government support ensures sound industry development**
 - The 13th National Five-year Plan listed RST as an emerging industry of strategic importance
 - China Atomic Energy Authority laid out comprehensive and systematic arrangements in the 13th Five-year Plan on Nuclear Industry Development.
- ✓ **Momentum for China's RST development remains strong**
 - Vigorous development of global RST application and IAEA's assistance;
 - substantial government support, efficient financing channels , gradual increase of level of RST industrialization;
 - Industry insiders predict the industry will maintain an annual growth rate of at least 20% and will grow to \$140 billion in a decade, while expanding its application areas, scale, and regions.

- **RST will embrace a leap development**

With increasing public recognition of nuclear science and technology, RST applications will gradually expand its scope in more fields and will meet with a leap development.

- **The Chinese government vows to build another “name card” for the country**

Thanks to the promotion by the Government and the concerted efforts of the industry, China's RST application sector is hopeful to be built into another “name card” for the country. We would be happy to share our experience.

Acknowledgements

IAEA has provided China with great support for its development of RST application, an access to international cooperation and a platform for international exchanges. China will continue to strengthen its cooperation with IAEA and take joint efforts to make RST application more beneficial to humankind.



Thank you for your attention!

**For more information please come
to the booths and to**

**Chinese Mission Side Event
At 18:30-20:00, Tuesday 25th April!**

