

From Tradition to Innovation

Food Irradiation

in China

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Sep, 2023



Photo: China General Nuclear Power Group

World & China Irradiated Food Volume

In 2020, China processed an astonishing **950,000 tonnes** of food, accounting for **over half (~80%)** of the global irradiated food volume.

China

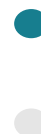


950,000 tonnes



Photo: by Gillian Hu. Yunnan, China.

Historical, Regulatory, & Societal Context



Drive: The Distinctiveness of China

China's Vast Population

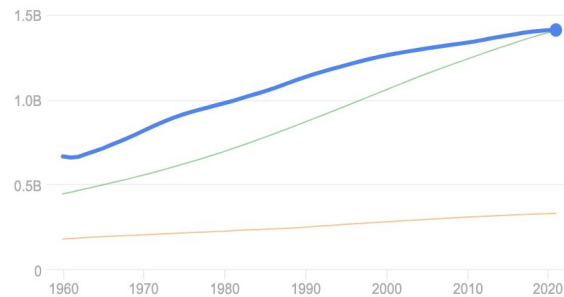
most populous country in the world



Rich Food Diversity

56 ethnic groups, a broader spectrum of ingredients to monitor, preserve, and transport

1.412 billion (2021)



Intricate Supply Chains

Diverse range of climates, terrains, and regional specialties.
Decentralized agricultural system



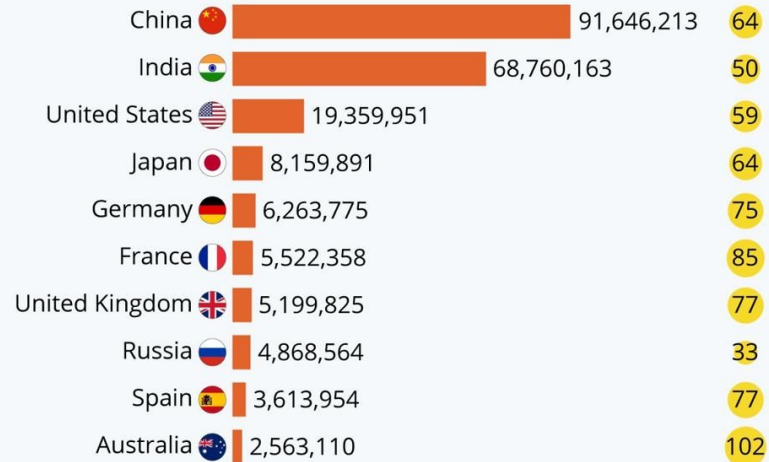
Drive: The Distinctiveness of China

The Enormous Scale of Global Food Waste

Total annual household food waste produced in selected countries*



- Total food waste per year (tonnes)
- Estimated food waste per capita (kg)



* UNEP estimates with high or medium confidence
Source: UNEP Food Waste Index Report 2021



Forbes statista

Food Safety Concerns

- Contamination to adulteration and misleading labeling.
- Made substantial reforms.
- Public Perception
- Global Implications

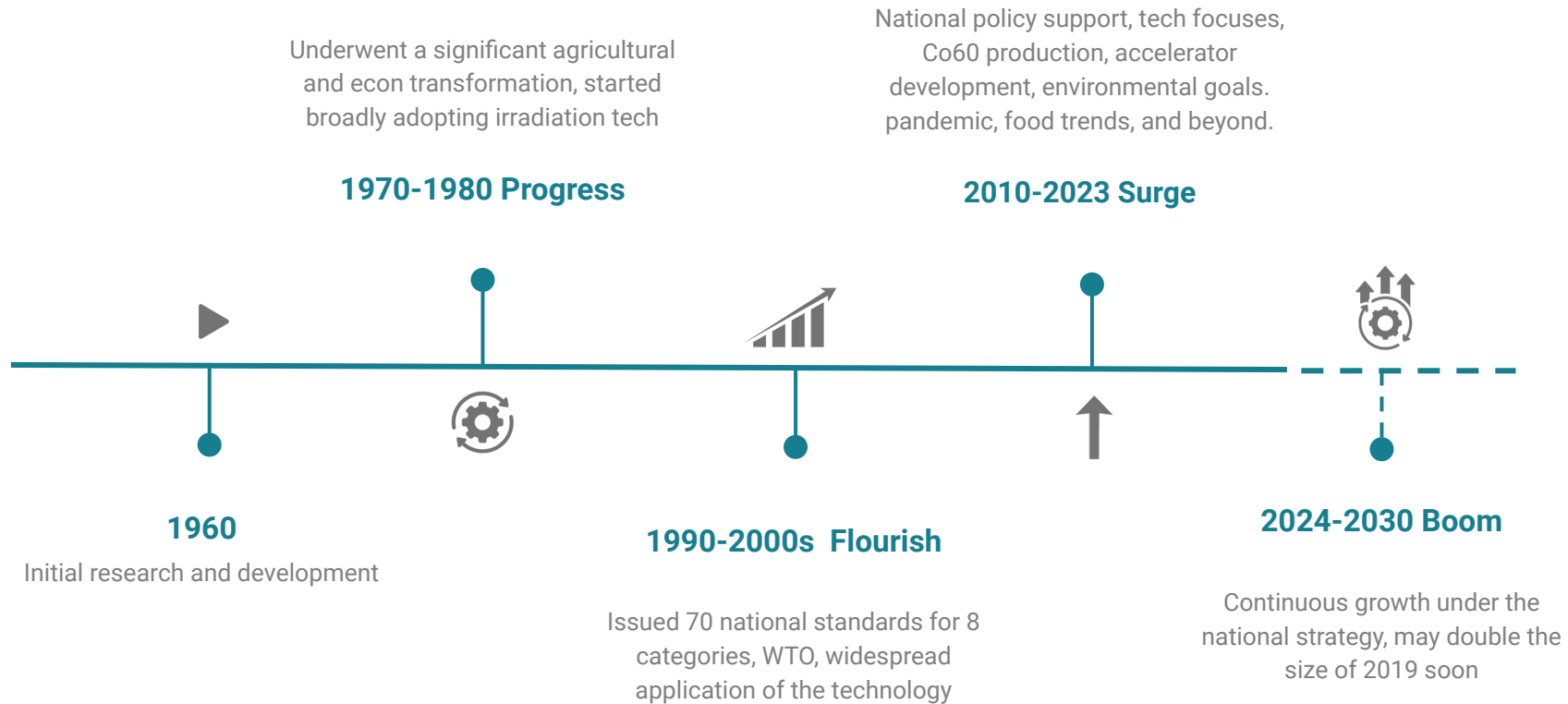


Pesticide Residue Export Restrictions

Pesticide residue exceeding limits has become a bottleneck restricting the export of Chinese agricultural products. (~1 billion USD/year)



China Historical Background



2020 powered by irradiation During the Pandemic

PPE market share rapid growth



Given the urgent need for sterilized PPE and the advantages of irradiation, it rapidly became the preferred method. This resulted in a meteoric rise in its adoption, capturing ~95% of the PPE sterilization market in a short span (around 2 months).



**15 Days
millions of Gowns**

~0%

Before Covid

~95%

During Covid

Data source: CIRA



Over 15 days, numerous national irradiation centers sterilized millions of medical protective sets and related supplies.

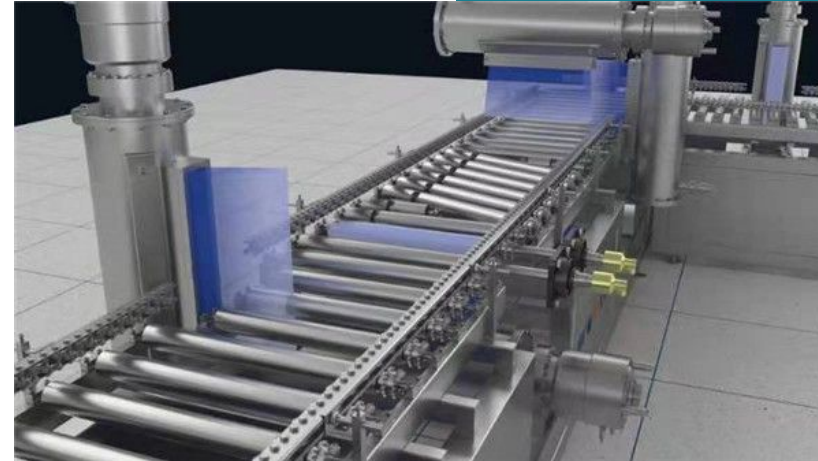
2020 Cold-Chain Challenges & More

Coronavirus

In response to the pandemic and previous issues of cold chain and imported foods carrying viruses and pests, leaders like CGN rapidly deployed e-beam accelerator at ports.

Salmonella & others

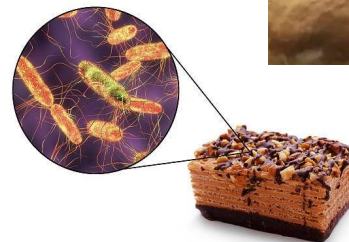
We started building irradiation facility at borders, such as the Pingxiang port in Guangxi, specifically for irradiating and inspecting imported fruits from ASEAN.



CGN compact ebeam accelerator 120keV



Pingxiang port in Guangxi



Market Dynamics, Industry Evolution, & Consumer Behaviors

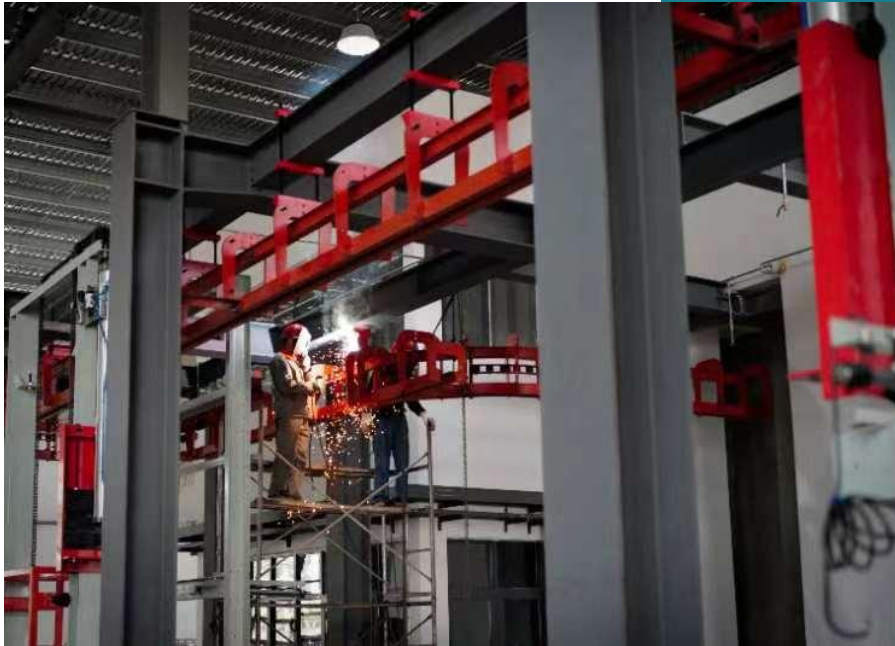
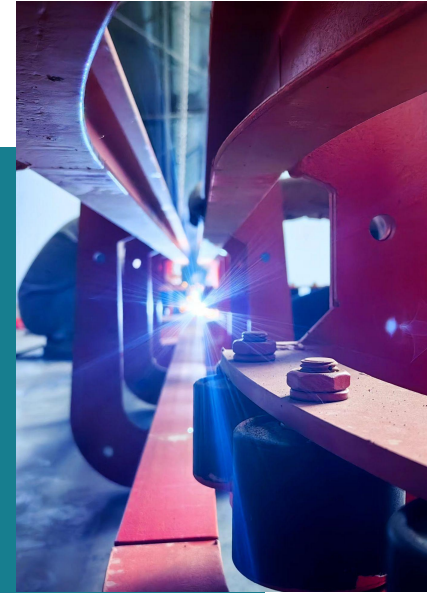
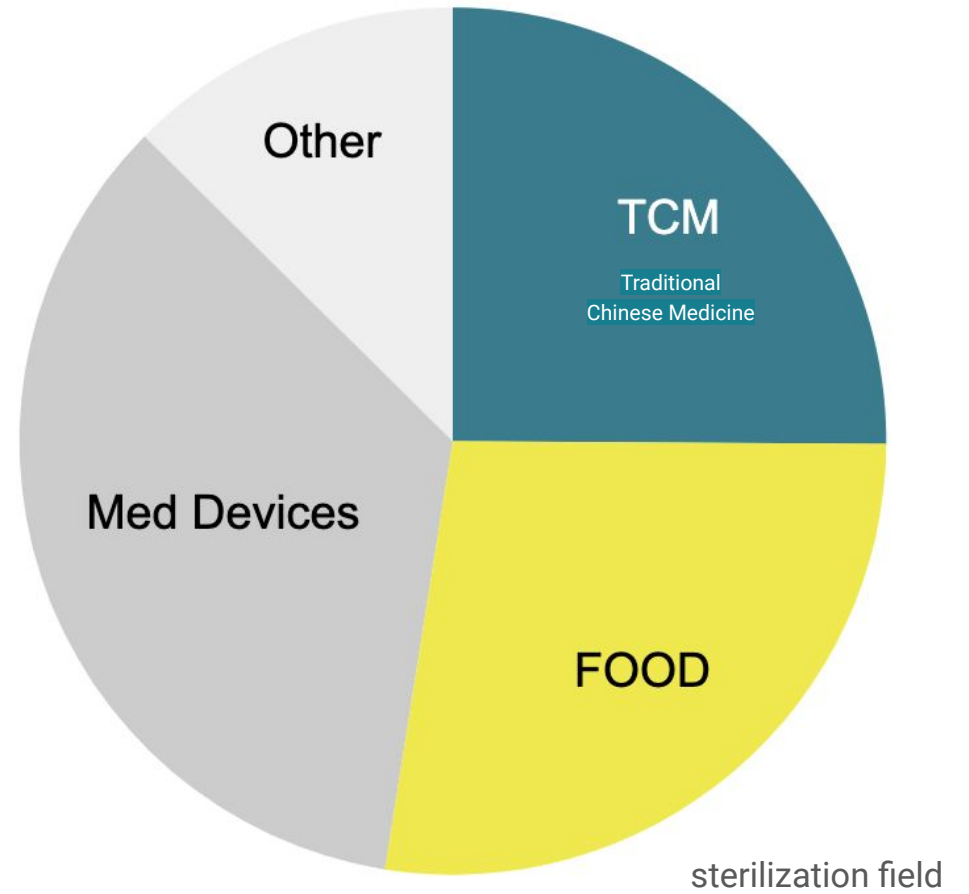


Photo: by Gillian Hu. Yunnan, China.



Revenue Composition of Irradiation Facilities in some Major Regions



Challenges in Food Safety

- Supply Chain Complexity
- higher risks of foodborne
- Complexity of specialized foods
- Food Allergen Management
- Sustainability Concerns
- Quality Control

Benefits of New Solutions

- Supply Chain Flexibility
- Consistency in Quality
- Reduced Food Waste
- Cost-Efficiency
- Market Expansion
- Consumer Convenience



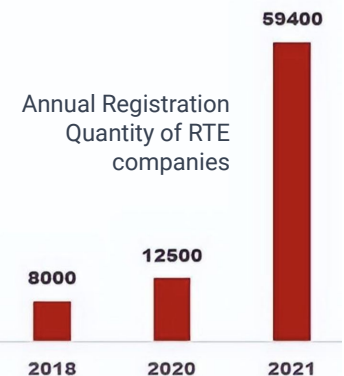
Booming Food Trend Ready to Eats

Surge in China, Steady growth in US

- China **CAGR > 20%** from 2019 to 2022, 150 bn in 2025
- Global market value **180 bn** USD in 2021. CAGR 7.7%, reaching 300 bn in 2032.*

Key Reasons

- Changing Lifestyles & Urbanization
- E-commerce and Convenience
- COVID-19 Impact and Safety
- Consumer Preferences & Innovation
- Health Focus and Diverse Options
- Packaging and Portability
- Rising Disposable Income
- Food Safety and Quality
- Global Influence on Food Trends



Case Study

Packaged / Ready to Eat

Category	Irradiation Dose	Type of Item for Irradiation	Type of Sterilization	Purpose of Irradiation
Meat	1-8 kGy	Raw and cooked poultry and livestock meat	E. coli, Salmonella	Parasite control, shelf life extension

Pickled chicken feet

3 days to 200 days

High microbial levels and temperature sensitivity challenge traditional preservation, affecting quality.



The “snack meat” icon

crayfish

2022, 26m tons, \$70 bn

Microbes, parasites, allergenic proteins, heavy metals and chemical toxins...



The top-selling item in dining

Successful Cases in China



Crystal Pork

3-5 days to 90 days

dishes that involve gelatin or collagen from animal parts



Crab Meatballs

3-5 days to 60 days

non-reactive and preventing allergic reactions



Salted duck

3 days to 60 days

36 million sold per year. Irradiation alone not enough.

Western Similar Food



Aspic



Pork Pie



Raw Seafood



Shrimp



egg & milk



peanut & tree nuts



cured meats



soft Cheese

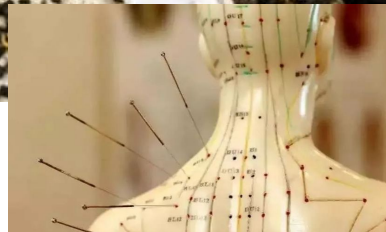


Smoked Fish

Temp Sensitive:
collagen, raw,
texture needs etc.

Allergens:
protein,
gluten, nuts
etc.

Irradiation Sensitive:
Fat, sugar, protein



From Ancient Roots to Modern Growth Traditional Chinese Medicine

3.3 bn People

TCM is used by about 3.3 billion people worldwide.

\$200+ bn Market Size

valued in 2022 and is expected to expand at a CAGR of 7.43% reaching USD 300+bn by 2028. (1/4 in China)

Trend Worldwide

The demand for TCM products has surged, Southeast Asia, Europe, and North America

32% of Pharma in China

2019 accounted for a market share of 32.1% in China's pharmaceutical market.

data: [industry research](#), [ibis world](#)

TCM Intersection with Irradiation

- Plant Materials: herbs, trees, bark, roots, leaves, flowers, fruits...
- Animal Materials: deer antlers, bear bile, eels, seahorses, pearls...
- Mineral Materials: gypsum, sulfur, cinnabar...

Category	Irradiation Dose	Type of Item for Irradiation	Type of Sterilization	Purpose of Irradiation
TCM	5-10 kGy	Powdered, tablet, pill, raw TCM ingredients	Insects, bacteria, fungi	preserve the potency



● **The Role of Irradiation in TCM:** For TCMs containing volatile components, heat-sensitive ingredients, and those with a high sugar content prone to mold. experiments began in the 1970s

● **TCM Contamination:** TCMs have varied types with intricate compositions. They can get contaminated by microorganisms from their growth environment and other channels. Sterilization has always been a pivotal process in TCM production.

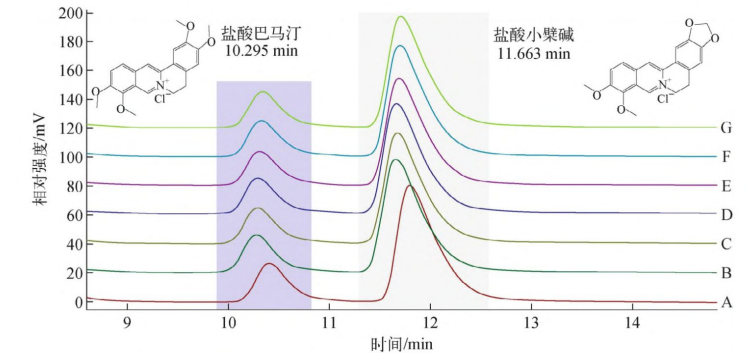
● **Dosage Considerations:** A balance is essential. Insufficient dosage might not effectively kill bacteria, leading to shorter preservation times. Excessive dosage might alter the constituents and activity of the TCMs.

TCM Intersection with Irradiation



- **Chemical Composition:** Post-irradiation, the active ingredients of TCMs remain largely unchanged for many ingredients.
- **Biological Activity Impact:** The medicinal efficacy of TCMs is dependent on their ingredients. These components must form biologically active substances for therapeutic effect. Doses usually 5kGy - 10kGy.
- **Post-Irradiation Stability:** Focus on how TCMs are stored and their stability after irradiation. (in terms of both Chemical and Biological impact).

Other Potentials: Refinement and Extraction, Breeding Optimization, R&D...



A—未辐照(A); B—⁶⁰Co-γ 辐照 5 kGy; C—15 kGy; D—30 kGy(D); E—电子加速器辐照 5 kGy; F—15 kGy; G—30 kGy

图7 黄连活性成分的 HPLC 图及分子结构

Fig. 7 HPLC spectrum and molecular structure of active components in *Coptis chinensis*

Table 5 Effects of irradiation on active components of Chinese medicinal materials

辐照条件	隐丹参酮/ (mg · L ⁻¹)	丹参酮 II A/ (mg · L ⁻¹)	丹参酮 I / (mg · L ⁻¹)	盐酸巴马汀/ (mg · L ⁻¹)	盐酸小檗碱/ (mg · L ⁻¹)	天麻素/ (mg · L ⁻¹)	黄芪多糖/ (mg · L ⁻¹)
未辐照	2.71	5.19	1.75	14.89	18.81	105.23	45.65
⁶⁰ Co-γ 辐照 5 kGy	2.55	5.04	1.71	14.51	18.68	103.6	53.68
⁶⁰ Co-γ 辐照 15 kGy	2.38	4.79	1.62	13.92	18.05	100.5	55.97
⁶⁰ Co-γ 辐照 30 kGy	2.47	4.99	1.66	14.02	18.11	95.03	50.56

*Effect of Irradiation on Extraction of Active Components from LZgMsffcMm WaZzfc鹿ZZ and other Chinese Medicinal Materials 1000 7512(2021)02 0111 09

Key Drivers for the next explosive growth?

Policy and Regulatory Influences:

1. Major Food Safety Incidents
2. Policy and Regulatory Support
3. Approval for a Wider Range of Food Categories

Technological, Economic, and Trade Factors:

1. Technological Advancements and Cost Reduction
2. Combination with Other Technologies
3. Emergence of New Markets
4. Globalization of the Food Supply Chain
5. Agricultural Export Competitive Advantage

Consumer and Market Dynamics:

1. Improved Consumer Awareness
2. Rise of Healthy Eating Trends
3. Food Safety Concerns in Emerging Economies
4. Participation and Support from Large Food Corporations

Environmental and Global Challenges:

1. Global Climate Changes and Disease Outbreaks
2. Environmental Movement Against Excessive Packaging
3. Focus on Food Waste Issues



Photo: by Gillian Hu. Yunnan, China.



辐照食品 搜索

全部 视频号 文章 公众号 小

食品安全问题一直是热点话题在众多的食品加工工艺中... 云南医改 11个月前

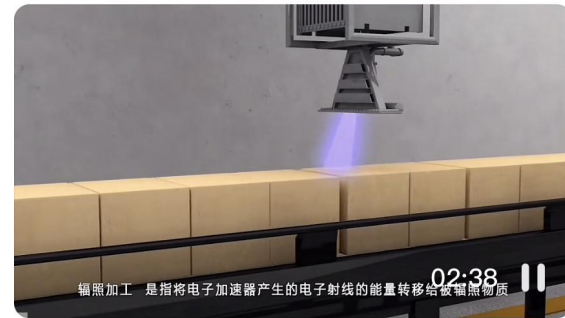
你吃过“辐照食品”吗? 关于辐照食品的安全性试验是整个辐照保藏食品研究最... 特医食品虫 8个月前

本身就是非常好的细菌培养基 宠物食品加工技术——辐照#宠物食品 维尔福 6个月前

食品中的核技术 辐照技术在食品保鲜上我们不反... 孔姐有... 10天前



#电子加速器 #辐照食品 #蓝孚高能 #核工业 #辐照改性 #辐照灭菌



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#抗击疫情央企行动#中广核电子束辐照为什么这么快? 来看看辐照加工站吧





Thanks.

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Photo: by Gillian Hu. Yunnan, China.