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## INDUSTRY OVERVIEW

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## INDUSTRY BACKGROUND

### Isotopes and Radiation

Isotopes refer to a group of nuclides with the same number of protons but different number of neutrons. Radiation refers to the emission or transmission of energy in the form of waves and particles. Radioisotopes are unstable isotopes that are radioactive. Radiation used most frequently in the radioisotope and irradiation industry are alpha-rays, beta-rays, gamma rays, X-rays and electron beam.

Radioisotope and irradiation technology utilizes physical, chemical, biological and nuclear properties of the isotope or irradiation from electron accelerator and decay of radioactive atom in various civil fields such as medicine, biology, testing, research, agriculture, chemistry and industry. Isotope and irradiation technology is an important subset of nuclear technology in addition to nuclear weapons and nuclear power technology. Scientific research on applications of isotope and irradiation technology in China started in late 1950s. After decades of development, PRC isotope and irradiation industry has become an important part of economy and radioisotope and irradiation technology has been broadly applied for medical and industrial uses in China.

### Radiopharmaceuticals

Radiopharmaceuticals are a group of radioactive pharmaceuticals used for imaging diagnostic and therapeutic purposes. A radiopharmaceutical is composed of a radioisotope paired with a molecular agent designed to localize to specific organs and tissues. The agent then conveys a radioisotope to specific organs, tissues or cells. Radiopharmaceuticals are delivered to patients by oral administration or injection. The nuclear medicine physicians use gamma camera such as PET or SPECT to detect the radiation emitted by the radioisotopes contained in the relevant radiopharmaceuticals for diagnosis and treatment of the particular diseases.

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### Radioactive Sources

Radioactive sources are radioactive materials which emit ionizing radiation including alpha-rays, beta-rays, gamma rays, X-rays. Radioactive sources are usually sealed in a specific case or bonded to a surface. Radioactive source products could primarily be categorized into radioactive sources for medical applications and radioactive sources for industrial applications.

Medical radioactive source products are mainly for radiotherapy. Radiotherapy is a common cancer treatment aiming to kill, or shrink the size of, tumor cells. There are two types of radiotherapy, namely external radiation therapy and brachytherapy. The external radiation therapy involves delivering radiation to the patients from an external source. Advanced techniques like stereotactic radiosurgery focuses the beam continuously on the target abnormality, allowing only small amounts of radiation to the surrounding healthy tissue. In brachytherapy, a radioactive source is placed inside or next to the area requiring treatment. Brachytherapy involves the precise placement of short-range radioactive source directly at the site of the tumor.

Industrial radioactive sources are mainly used for irradiation service, non-destructive testing, and well-logging. Cobalt-60 sealed source is one of the most common industrial radioactive sources, and is widely used for gamma ray irradiation service. Other common industrial radioactive sources are iridium-192, selenium-75 and cesium-137.

### Irradiation Service

Irradiation service is used to modify properties of materials and sterilize various products including food, medical products, cosmetics and traditional Chinese medicine. Irradiation sterilization enjoys various benefits such as high penetration, low energy consumption, no residual, no damage to original packaging and room temperature sterilization. There are two types of irradiation facilities in China, namely: gamma ray irradiator and electron accelerator. Gamma ray irradiators need to be filled with, cobalt-60 sealed source, which needs to be renewed periodically. Irradiation facilities are placed in specialized irradiation centers (辐照中心) that provide irradiation service, or directly housed in the production or research bases of customers for irradiation use.

## THE PRC ISOTOPES MEDICAL APPLICATION MARKET

The medical application of isotopes in China primarily includes the imaging diagnostic and therapeutic radiopharmaceuticals, UBT kits and analyzers, RIA kits and medical radioactive source products. PRC isotopes medical application market reached RMB4,382.0 million in 2017, growing at a CAGR of 12.1% during 2013 to 2017, and is expected to grow to RMB10,634.1 million in 2022, with a CAGR of 19.4%.

Imaging diagnostic and therapeutic radiopharmaceuticals, UBT kits and analyzers, RIA kits, and medical radioactive source products accounted for 60.4%, 26.5%, 6.9% and 2.9% of the total isotope medical application market in China in 2013, respectively. Such four segments accounted for 57.2%, 32.9%, 5.7% and 1.6% of the total isotope medical application market in China in 2017, respectively, and were expected to account for 61.2%, 33.6%, 2.7% and 1.0% of the total isotope medical application market in China in 2022, respectively.

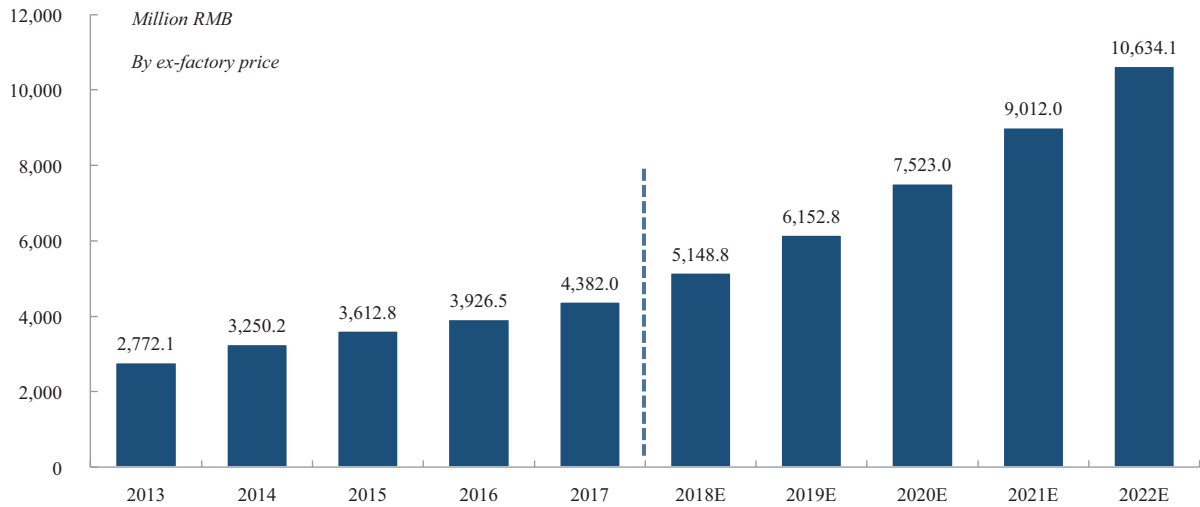
In the US, per capita expenditure grew at a CAGR of 9.7% from RMB39.1 in 2013 to RMB56.5 in 2017. During the same period, per capita expenditure on medical application of isotopes

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in China grew from RMB2.0 in 2013 to RMB3.2 in 2017, indicating a low penetration of the PRC medical application of isotopes market with significant growth potential compared with US market.

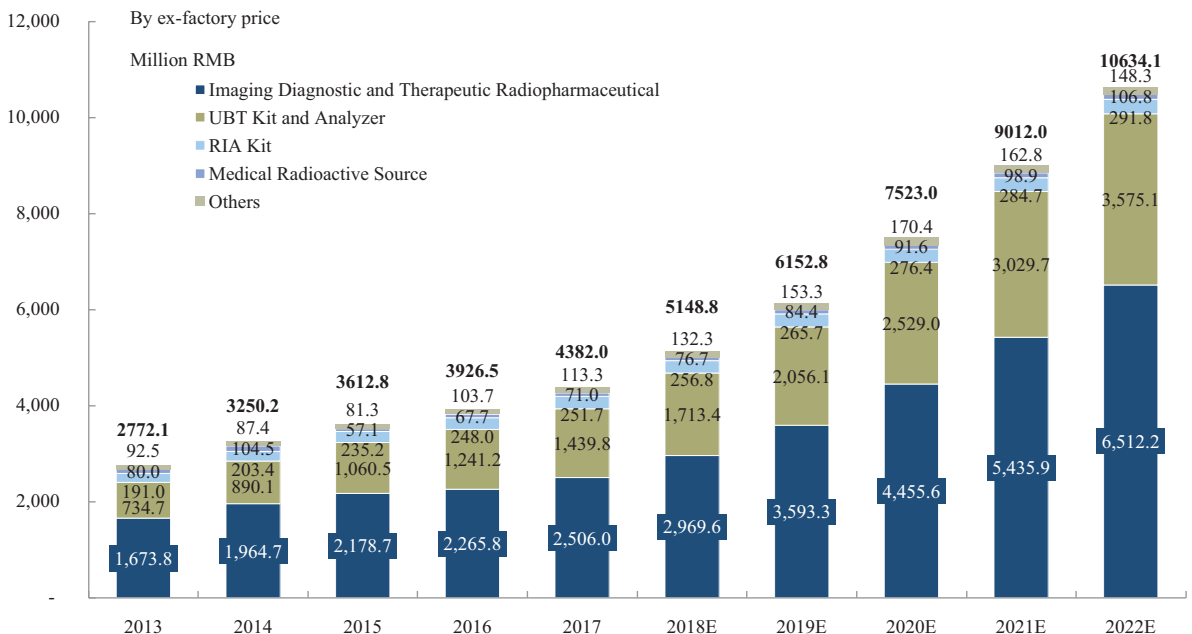
The following charts illustrates the historical and forecast market size of the isotopes medical application market in China, the historical and forecast market share of each market segment to the total isotopes medical application market in China, and the historical per capita expenditure on medical application of isotopes in the US and China:

### Historical and Forecast Market Size of Isotopes Medical Application Market, China, 2013-2022E



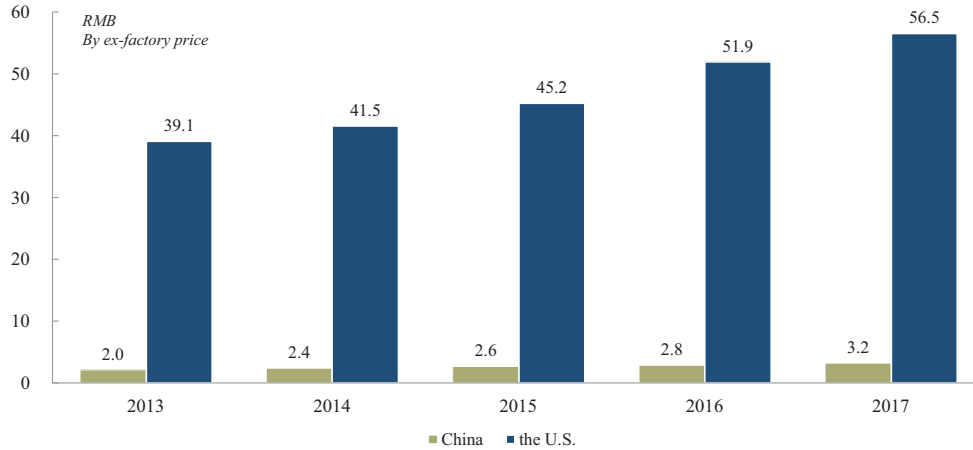
Source: Frost & Sullivan

### Historical and Forecast Market Share of Market Segment to Total Isotopes Medical Application Market, China, 2013-2022E



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### Per Capita Expenditure, China and the US, 2013-2017



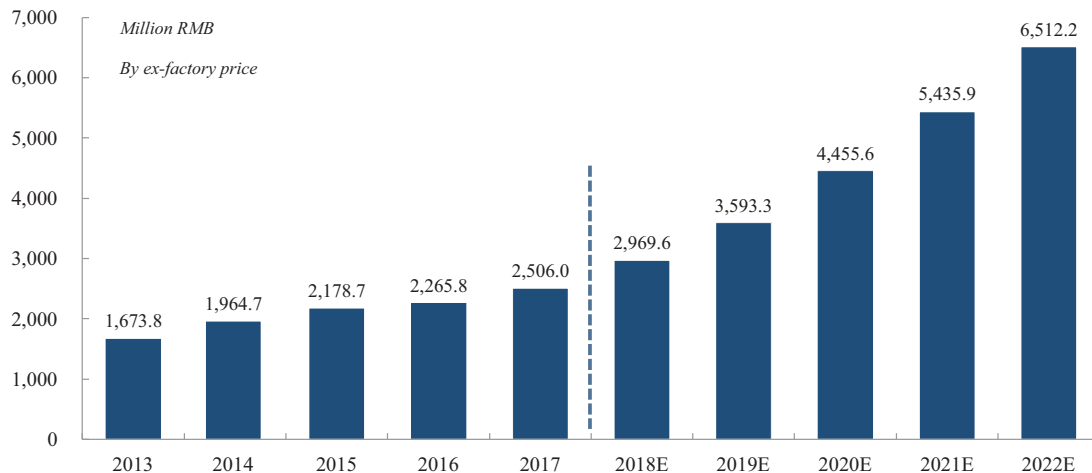
Source: Frost & Sullivan

## THE PRC IMAGING DIAGNOSTIC AND THERAPEUTIC RADIOPHARMACEUTICALS MARKET

### Market Size and Market Share

According to Frost & Sullivan, the PRC market of imaging diagnostic and therapeutic radiopharmaceuticals reached RMB2,506.0 million in 2017, growing at a CAGR of 10.6% from 2013 to 2017. The market is expected to continue to grow with a CAGR of 21.0% from 2017 to 2022 and reach RMB6,512.2 million in 2022. According to Frost & Sullivan, we were the largest manufacturer of imaging diagnostic and therapeutic radiopharmaceuticals in China, accounting for 40.4% of the market share in 2017. The following charts illustrate the historical and forecast market size and the market share of major players in the imaging diagnostic and therapeutic radiopharmaceuticals market in the PRC:

### Historical and Forecast Market Size of Imaging Diagnostic and Therapeutic Radiopharmaceuticals Market, China, 2013-2022E



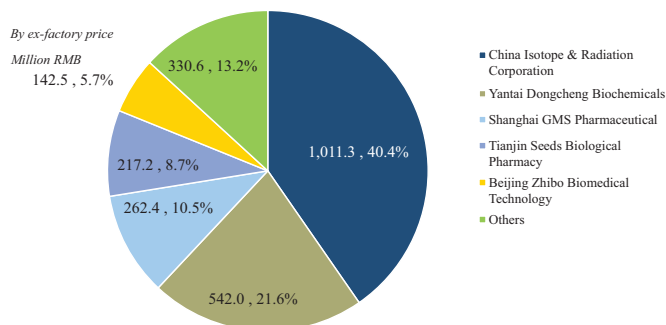
Source: Frost & Sullivan

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### Market Share of Leading Manufacturers in PRC Imaging Diagnostic and Therapeutic Radiopharmaceutical Market in 2017



Source: Frost & Sullivan

We manufacture and sell certain major imaging diagnostic and therapeutic radiopharmaceuticals in China, including iodine-125 sealed source, molybdenum-99/technetium-99m generator, technetium-99m labeled injections, fluorine-18-FDG injection, sodium iodine-131 solution and strontium-89 chloride injection. The following is a discussion of market size and our market share of such products in China.

#### ***Iodine-125 sealed source***

Iodine-125 sealed source is primarily for treatment of prostate cancer and other tumors not suitable for surgeries, as well as for implantation treatment of residual lesions following tumor resection. According to Frost & Sullivan, the iodine-125 sealed source market increased from RMB689.6 million in 2013 to RMB939.8 million in 2017, growing at a CAGR of 8.0% from 2013 to 2017, and the market is expected to grow with a CAGR of 21.1% during the period of 2017 to 2022 and reach RMB2,447.0 million in 2022. We were the third largest manufacturer in iodine-125 sealed source market in 2017, with a market share of 21.4%.

#### ***Sodium iodine-131 oral solution***

Sodium Iodine-131 oral solution is primarily for diagnosis and treatment of hyperthyroidism, thyroid cancer and metastatic cancer and other thyroid-related diseases. According to Frost & Sullivan, the market size of sodium iodine-131 oral solution reached RMB284.3 million in 2017, growing at a CAGR of 11.6% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 22.2% during the period of 2017 to 2022 and reach RMB773.9 million in 2022. We were the largest manufacturer of sodium iodine-131 oral solution in China in 2017, with a market share of 96.9%.

#### ***Strontium-89 chloride injection***

Strontium-89 chloride Injection is primarily used for relief of pain from late malignant tumor bone metastases caused by prostate cancer and breast cancer. According to Frost & Sullivan, the strontium-89 chloride injection market reached RMB87.2 million in 2017, growing at a CAGR of 2.1% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 21.3% during the period of 2017 to 2022 and reach RMB229.4 million in 2022. We were the dominant player in the strontium-89 chloride injection market in 2017, with a market share of 97.7%.

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### ***Fluorine-18-FDG injection***

Fluorine-18-FDG injection is primarily used for detecting and staging of tumors and the analysis of curative effectiveness, as well as diagnosis of myocardial viability (心肌活度) and brain imaging. According to Frost & Sullivan, the market size of fluorine-18-FDG injection reached RMB 203.9 million in 2017, growing at a CAGR of 12.9% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 24.3% during the period of 2017 to 2022 and reach RMB604.4 million in 2022. We dominated fluorine-18-FDG injection market with the largest market share of 83.6% in 2017.

### ***Technetium-99m labeled injections***

Technetium-99m labeled injections is primarily used for diagnosis of diseases related to brain, vascular, myocardial, bone, liver, kidney, lymph node and lungs. According to Frost & Sullivan, the market size of technetium-99m labeled injections reached RMB146.5 million in 2017, growing at a CAGR of 31.6% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 23.0% during the period of 2017 to 2022 and reach RMB412.2 million in 2022. We were the largest manufacturer of technetium-99m labeled injections in 2017, with a market share of 72.2%.

### ***Molybdenum-99/Technetium-99m generator***

Molybdenum-99/Technetium-99m generator is a device used to extract technetium-99m from decaying molybdenum-99. According to Frost & Sullivan, as of the Latest Practicable Date, we were the only approved manufacturer of molybdenum-99/technetium-99m generator in China. The market size of molybdenum-99/technetium-99m generator reached RMB157.8 million in 2017, growing at a CAGR of 11.2% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 22.7% during the period of 2017 to 2022 and reach RMB438.6 million in 2022.

### **Analysis of Major Raw Materials**

As of the Latest Practicable Date, PRC manufacturers of imaging diagnostic and therapeutic radiopharmaceuticals imported all major radioisotopes raw materials (except fluorine-18) from overseas suppliers. The following is a discussion of the historical price of major radioisotopes of our imaging diagnostic and therapeutic radiopharmaceuticals.

### ***Molybdenum-99***

Molybdenum-99 is the radioisotope used to produce molybdenum-99/technetium-99m generator and technetium-99m labeled injections. The major overseas suppliers of molybdenum-99 are NTP Radioisotopes SCO Ltd and Belgian National Institute for Radioelements in South Africa and Belgium, respectively. Molybdenum-99's price has experienced a substantial growth in the past five years. From 2013 to 2014, the price of molybdenum-99 remained relatively stable. However, in 2015, the price grew to over RMB6,000.0 per Ci and reached RMB7,078.8 per Ci in 2017 with a CAGR of 12.0% from 2013 to 2017. Such price increase was primarily due to (i) the change in target material used to produce molybdenum-99 from high enriched uranium-235 to low enriched uranium-235 by nuclear reactors around the world, which resulted in higher production costs, (ii) the fact that the nuclear reactor which manufactures molybdenum-99 in Canada ceased production in 2016, resulting in the decrease in the supply of molybdenum-99 and (iii) the molybdenum-99 manufacturers took in account of the costs related to the overall nuclear reactor operations and maintenance as well as

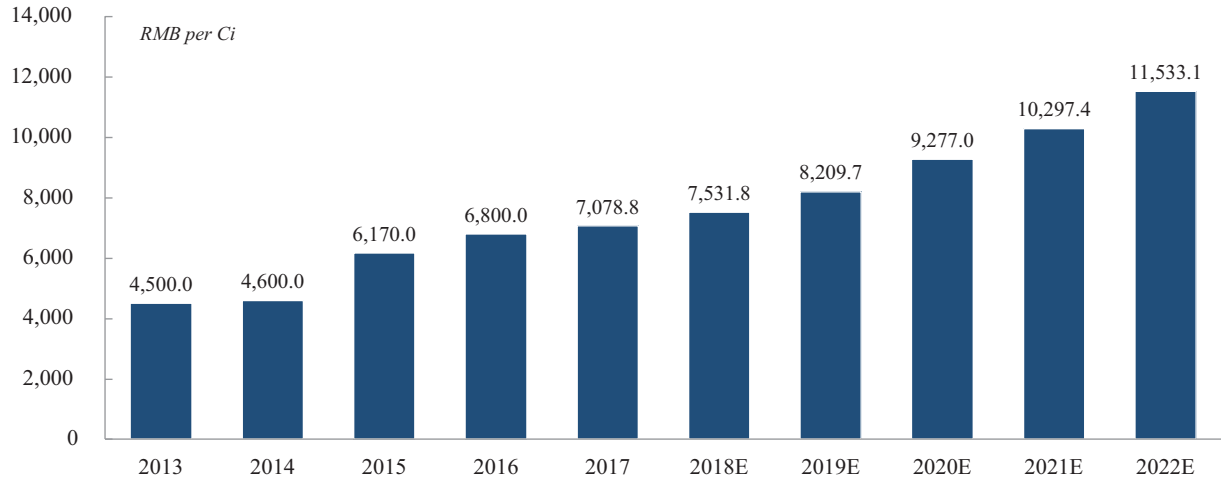
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replacement or refurbishment costs of the reactor production facilities in addition to the daily operational costs, which drove up the raw materials costs of manufacturing of molybdenum-99. The following chart illustrates the historical and forecasted price of molybdenum-99 in China:

**Price of Molybdenum-99, China, 2013-2022E**



Source: Frost & Sullivan

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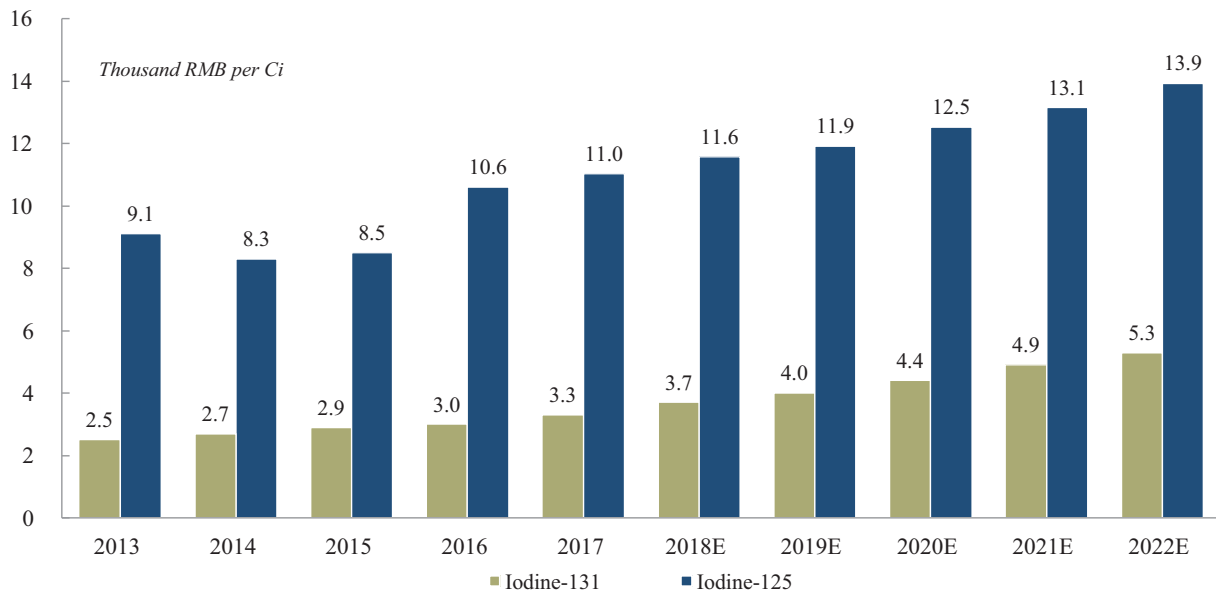
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### *Iodine-131 and iodine-125*

The price of iodine-131 and iodine-125, the radioisotopes used in the manufacturing of iodine-125 sealed source and sodium iodine-131 oral solution, is the major cost driver of the pricing of the final products. The major overseas suppliers of iodine-131 and iodine-125 are National Centre for Nuclear Research Radioisotope Centre POLATOM, NTP Radioisotopes SCO Ltd, Belgian National Institute for Radioelements and Nordion (Canada) Inc. in Poland, South Africa, Belgium and Canada, respectively. The price of iodine-131 gradually increased from RMB2,500 per Ci in 2013 to RMB3,300 per Ci in 2017. In the same period, iodine-125's price was in the range of approximately RMB8,300 and RMB9,100 per Ci from 2013 to 2015, surged to RMB11,000 per Ci in 2017. Such price increase was primarily due to the limited supply of the relevant radioisotopes and an increased demand for the final products. The supply of such radioisotope is limited primarily due to the limited number of nuclear reactors to manufacture quality radioisotopes in the world. The following chart illustrates the historical and forecasted price of iodine-131 and iodine-125 in China:

**Price of Iodine-131 and Iodine-125, China, 2013-2022E**



Source: Frost & Sullivan



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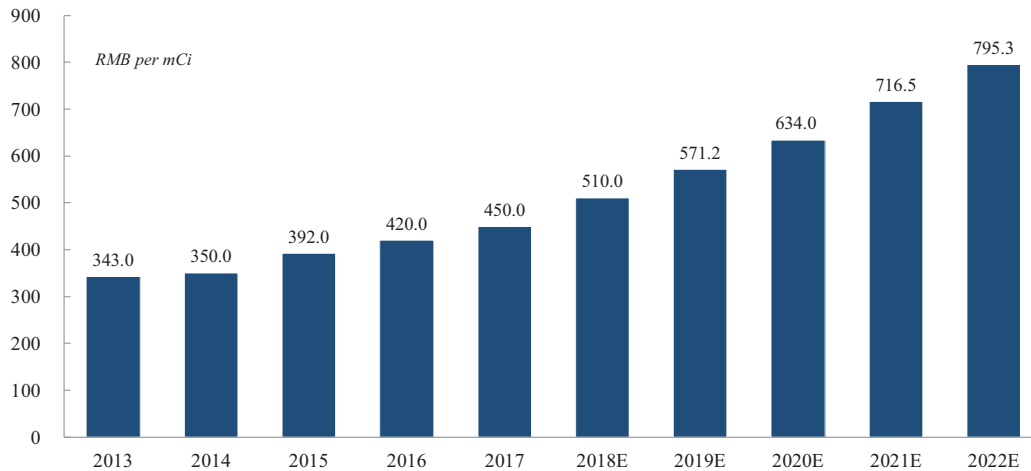
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### *Strontium-89*

Strontium-89's price has seen a stable growth trend in the past five years. The major overseas supplier of strontium-89 is Nuclear Research and Consultancy Group in Netherlands. Its price increased from RMB343.0 per mCi in 2013 to RMB450.0 per mCi in 2017 with a CAGR of 7.0%. Such price increase was primarily due to the limited supply of the relevant radioisotopes and an increased demand for the final products. The supply of such radioisotope is limited primarily due to the limited number of nuclear reactors to manufacture quality radioisotopes in the world. The following chart illustrates the historical and forecasted price of strontium-89 in China:

**Price of Strontium-89, China, 2013-2022E**



Source: Frost & Sullivan

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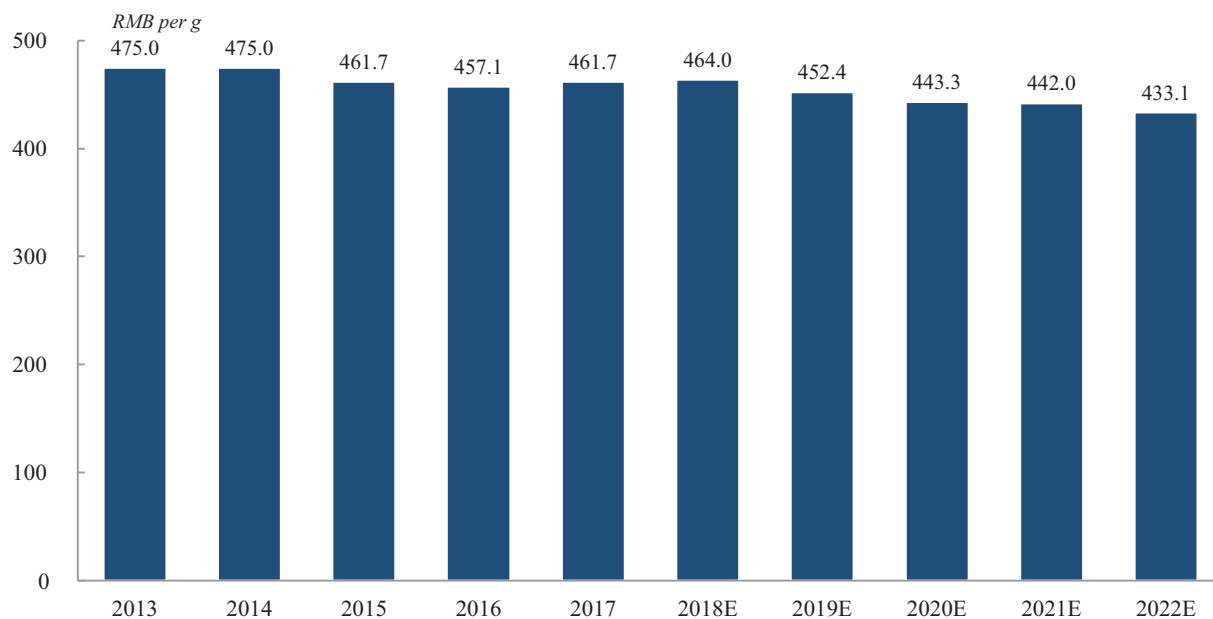
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### **Oxygen-18**

Oxygen-18 is the isotope to produce fluorine-18 which, in turn, is the major isotope of fluorine-18-FDG injection. Oxygen-18's price slightly decreased from RMB475.0 per gram in 2013 to RMB461.7 per gram in 2017. The major overseas supplier of oxygen-18 is Cambridge Isotope Laboratories, Inc. in the US. The following chart illustrates the historical and forecasted price of oxygen-18 in China:

**Price of Oxygen-18, China, 2013-2022E**



### **Market Drivers**

**Increasing Incidence and Mortality of Severe Diseases:** According to NHFPC's 2016 Yearbook, cancers caused 25.0% of the total deaths in urban and rural residents in 2015. In addition, the population aged 65 and above who have higher prevalence of neurodegenerative diseases has achieved 150.0 million in 2016, accounting for 10.9% of the total population in China. It is expected that such population with higher prevalence of neurodegenerative diseases will continue to grow. Compared with other medical imaging equipment, PET/SPECT scan can generate more precise imaging result and thus help provide earlier diagnosis of cancer as well as neurodegenerative disease. The large patient base indicates the huge potential for further growth of imaging diagnostic radiopharmaceuticals.

**Improved Affordability:** PET/SPECT scan used to be a heavy economic burden for patients and has not been widely used in China. The improved coverage of medical insurance and increased disposable income in China will increase patients' willingness to engage these services. The imaging diagnostic and therapeutic radiopharmaceuticals market is expected to develop faster in the future given its improved affordability.

**Technology Advancement:** Technology used in disease diagnosis and therapy is constantly improving. PET/SPECT imaging is able to produce a three-dimensional image of functional processes in the human body to generate more precise imaging for diagnosis purpose. The increasing use of PET/

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SPECT in hospitals and other medical imaging centers could drive up the demand of diagnostic radiopharmaceuticals. Radioimmunotherapy is a type of targeted therapy which can combine a monoclonal antibody with a radioisotope that recognizes, binds and thereafter directly delivers radiation to certain parts of cancer cells, such novel medical use of radiopharmaceuticals offers patients more effective options for disease diagnosis and treatment.

***Improving Access to Nuclear Medicine:*** Although large-scale public hospitals have separate nuclear medicine department, county-level hospitals seldom own nuclear medicine department. In 2015, Chinese Society of Nuclear Medicine actively advocated the plan of establishing a nuclear medicine department for each county. Consequently, the utilization of radiopharmaceuticals is expected to further boom with the improving access to nuclear medicine.

### Entry Barriers

***Demanding Industrial Qualifications:*** The radiopharmaceuticals industry is highly regulated in China. Compared to normal chemical drugs manufacturing, radiopharmaceuticals manufacturer is imposed more stringent requirements because of the radioactive materials used in the manufacturing process. Manufacturers of imaging diagnostic and therapeutic radiopharmaceuticals must obtain necessary permits and certificates in the PRC to produce, sell and use imaging diagnostic and therapeutic radiopharmaceuticals, including but not limited to radiation safety permit, radiopharmaceuticals production permit, radiopharmaceuticals sales permit and GMP certificates. In addition, the storage and waste treatment in connection with the manufacturing radiopharmaceuticals requires specific regulatory monitoring and processing approval.

***Shortage of Raw Materials Supply:*** PRC manufacturers of imaging diagnostic and therapeutic radiopharmaceuticals rely on overseas suppliers of radioisotopes as their source of raw materials, which exposes them to supply risks such as shortages, unstable production etc. Overseas suppliers of radioisotopes also tend to co-operate with existing customers rather than engage with new customers which creates another supply chain risk. To ensure the stable supply of radioisotopes at a reasonable price presents a significant challenge for new entrants to the market.

***High Technical Barrier:*** Radioisotope production relies on large nuclear reactors or cyclotrons. The construction and operation of nuclear reactors or cyclotrons involve complex techniques and are subject to rigorous regulations. In addition, imaging diagnostic and therapeutic radiopharmaceuticals manufacturing involves sophisticated nuclear technology including radioactive tracer technology, radioactive detection technology, etc. In addition, manufacturers must maintain qualified radiation proof production equipment and machinery and qualified nuclear technology professionals to operate and oversee the production process. These technology barriers also act as a significant deterrent against new entrants.

***Branding Effect:*** Due to the aforementioned entry barriers, the radiopharmaceuticals market has the characteristic of a monopoly. Hospitals and other medical institutions are the major users of imaging diagnostic and therapeutic radiopharmaceuticals. To ensure product quality and safety, hospitals and other medical institutions usually commit to long-term suppliers of imaging diagnostic and therapeutic radiopharmaceuticals. First movers are able to establish strong brand recognition and typically become the preferred suppliers for hospitals and other medical institutions, which creates another obstacle for new entrants.

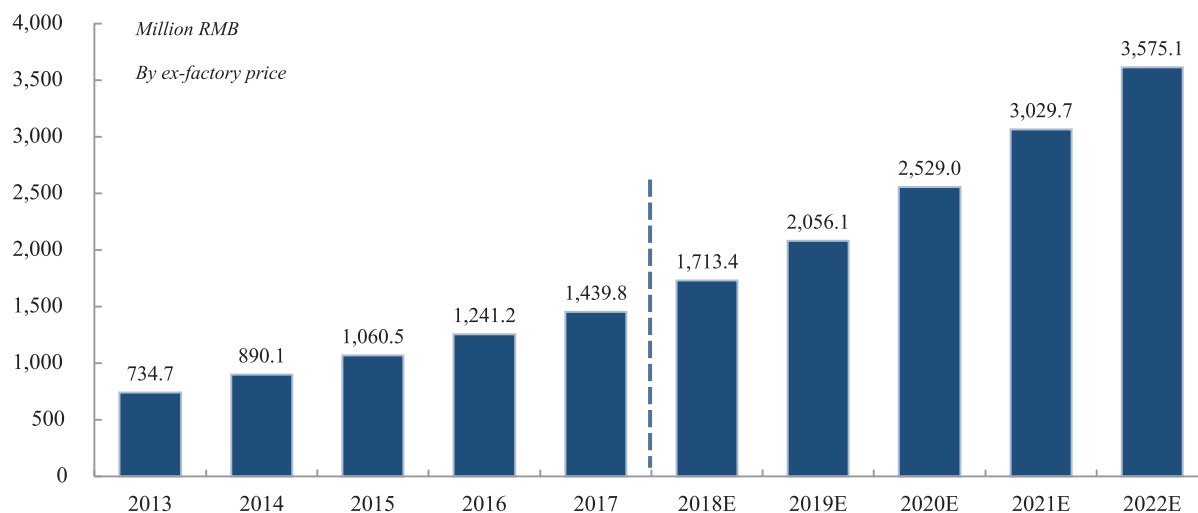
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### THE PRC UBT KITS AND ANALYZERS MARKET

#### Market Size and Market Share

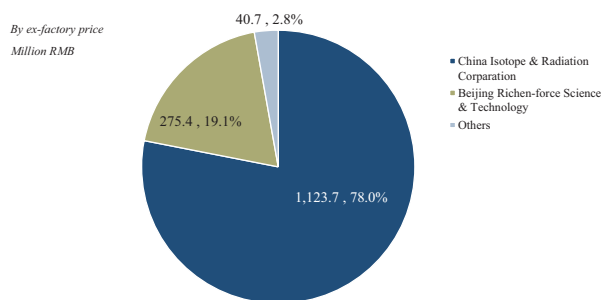
According to Frost & Sullivan, the market size of PRC UBT kits and analyzers reached RMB1,439.8 million in 2017, growing at a CAGR of 18.3% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 19.9% during the period of 2017 to 2022 and reach RMB3,575.1 million in 2022. We were the largest manufacturer of UBT kits and analyzers by revenue in 2017 in China, with a market share of 78.0%. The following charts illustrate the historical and forecast market size and the market share of major players of UBT kits and analyzers in the PRC:

**Historical and Forecast Market Size of UBT Kits and Analyzers Market, China, 2013-2022E**



Source: Frost & Sullivan

**Market Share of Leading Manufacturers in UBT Kits and Analyzers Market in 2017**



Source: Frost & Sullivan

According to Frost & Sullivan, we are one of the first companies in China to engage in the research, development, manufacturing and sale of UBT kits and analyzers for the diagnosis of *H. pylori* infection in China and the only company that is capable of manufacturing both UBT kits and UBT analyzers in China as of the Latest Practicable Date, having ranked first for five consecutive years and grew at the highest rate in China UBT kits and analyzers market during the period of 2013 to 2017, at a CAGR of 20.9%.

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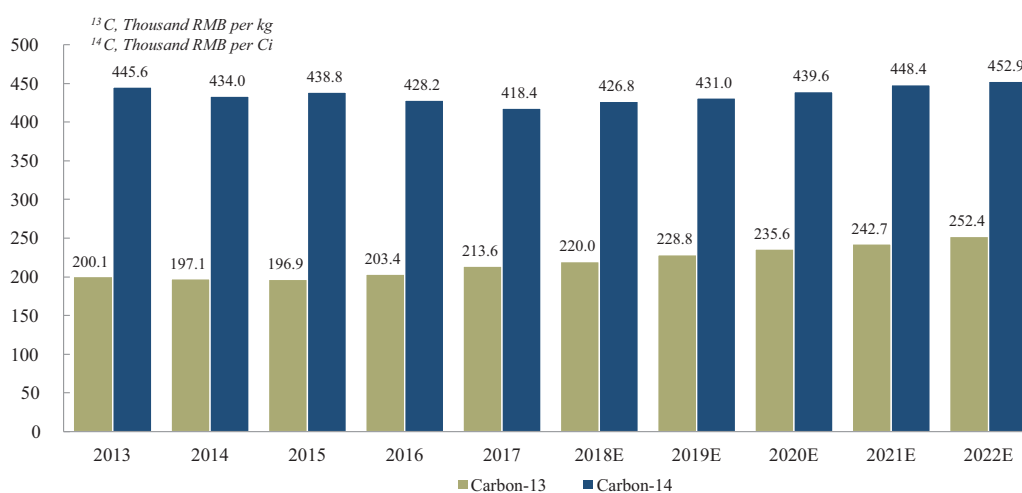
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### Analysis of Raw Materials

As of the Latest Practicable Date, PRC manufacturers of UBT kits purchased carbon-13 and carbon-14 raw materials from overseas suppliers. The major overseas suppliers of carbon-13 and carbon-14 are Sigma-Aldrich Co. LLC., PerkinElmer Inc. and Moravek, Inc. in the US. The prices of carbon-13 and carbon-14, as the key isotopes for manufacturing UBT kits, are key cost drivers of the pricing of the final products. The price of carbon-14 gradually decreased from RMB445.6 thousand per Ci in 2013 to RMB418.4 thousand per Ci in 2017. In the meantime, carbon-13's price increased to RMB213.6 thousand per kg in 2017 from RMB200.1 thousand per kg in 2013. The prices of both isotopes were relatively stable from 2013 to 2017. The following chart illustrates the historical and forecasted prices of carbon-13 and carbon-14 in China:

**Price of Carbon-13 and Carbon-14, China, 2013-2022E**



Source: Frost & Sullivan

### Market Drivers

**Rising Health Awareness:** China's steady economic growth raises patients' health consciousness and health expenditures and improves access to healthcare services, which encourages patients to attend physical examinations. As indicated by NHFPC's statistics, the number of physical examinations has grown from 344 million in 2011 to 385 million in 2015 with a CAGR of 2.8% during that period.

**High Efficiency Test Method:** "Fifth National Consensus on Helicobacter pylori Infection" (第五次全國幽門螺桿菌感染處理共識) specifically defined that UBT method is suitable for large-scale promotion in Helicobacter pylori screening because UBT method features non-invasive and ease of operation in practice. In comparison, invasive method has disadvantages such as poor compliance and complicated operations resulting in the limited usage among patients. As a result, UBT kit and analyzer market is believed to experience a fast development in the future.

**Increased Prevalence of Chronic Diseases:** According to Gastric Disease Investigation 2016 (中國胃病調查), the prevalence of peptic ulcer and chronic gastritis has reached 10% and 30%, respectively, in which *H. pylori* is the major pathogenic bacteria. Such prevalence will lead to an increased demand for examinations using UBT products.

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### Entry Barriers

**High Industry Concentration:** UBT kits and analyzers are products of advanced technology. As of the Latest Practicable Date, bundle sales of UBT kits and test analyzers by the same manufacturer was the main sales model in China, which further contributes to a high level of market concentration. Therefore, homogeneous products without distinct benefits or price advantages may face fierce competition.

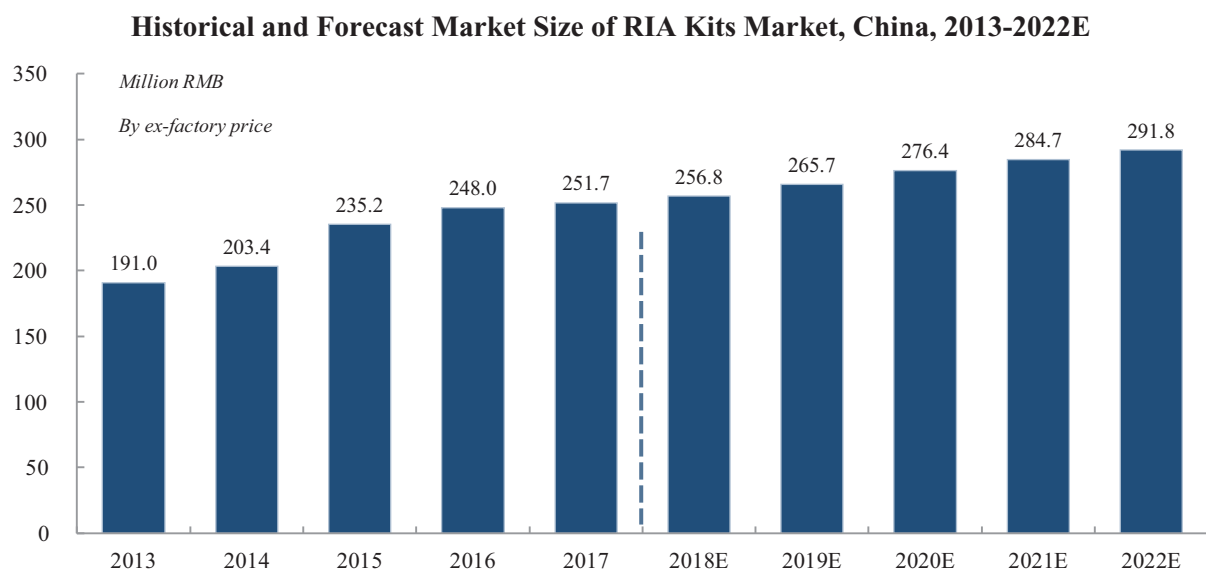
**Shortage of Raw Materials Supply:** For UBT kits, supply of carbon-13 and carbon-14 raw materials mainly depends on importation from overseas suppliers. However, supply of raw materials from overseas suppliers is unstable and leads to price fluctuations due to foreign exchange risks. New players will find it difficult to secure the supply of carbon-13 and carbon-14.

**High Technical and Regulatory Barrier:** UBT products require special techniques for research and development and manufacturing. The relevant technology is highly confidential and has relatively low transparency, which may lead to the high technical barrier for new entrants. Furthermore, carbon-14 UBT kit, regulated as radiopharmaceutical in China, is facing stringent regulations like other radiopharmaceuticals. The manufacturer of carbon-14 UBT kit must obtain radiopharmaceuticals production permit, radiopharmaceuticals sales permit and radiation safety permit. Moreover, the storage and waste treatment require specialized monitoring and processing approval from regulatory bodies.

## THE PRC IN VITRO IMMUNOASSAY DIAGNOSTIC REAGENTS AND KITS MARKET

### The Market Size of RIA Kits

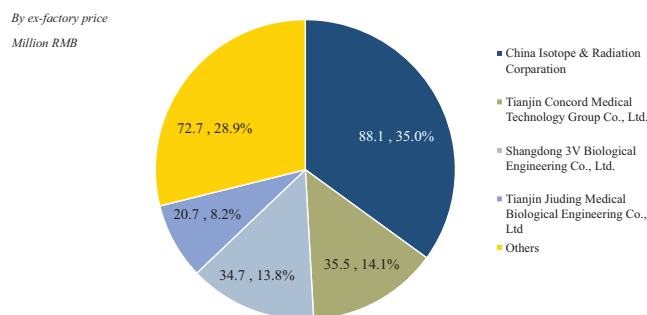
According to Frost & Sullivan, the market size of the PRC RIA kits reached RMB251.7 million in 2017, growing at a CAGR of 7.1% during the period of 2013 to 2017. The market is expected to grow with a CAGR of 3.0% during the period of 2017 to 2022 and reach RMB291.8 million in 2022. We were the largest manufacturer of RIA kits by revenue in 2017, with a market share of 35.0%. According to Frost & Sullivan, we were the earliest manufacturers specialized in the research, development, manufacturing and sales of RIA kits in China. The following charts illustrate the historical and forecast market size and the market share of major players of RIA kits in the PRC:



Source: Frost & Sullivan

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### Market Share of Leading Manufacturers in RIA Kits Market in 2017

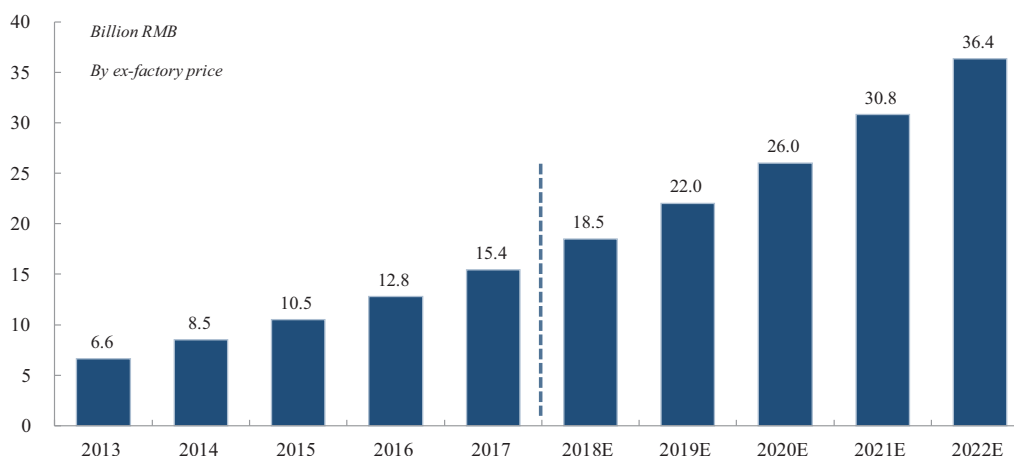


Source: Frost & Sullivan

### The Market Size of In Vitro Immunoassay Diagnostic Reagents (Other than RIA Kits)

In vitro immunoassay diagnostic reagents in China include mainly RIA kits, EIA reagents, CLIA reagents, TRFIA reagents and colloidal gold reagents. The sales of in vitro immunoassay diagnostic reagents (other than RIA kits) reached RMB15.4 billion in 2017, with a CAGR of 23.5% during 2013 to 2017. The market is expected to reach RMB36.4 billion in 2022, representing a CAGR of 18.7% during 2017 to 2022. The following chart illustrates the historical and forecast market size of the in vitro immunoassay diagnostic reagents (other than RIA kits) in the PRC:

#### Historical and Forecast Market Size of In Vitro Immunoassay Reagents (other than RIA kits), China, 2013-2022E



Source: Frost & Sullivan

### Market Drivers

**Rapid Growth of Independent Clinical Labs:** In the past, almost 90% of in vitro diagnostic tests were performed in in-house clinical laboratories at hospitals in China. Alongside the development of in vitro diagnosis technologies, small- and mid-size hospitals which lacked sufficient resources failed to upgrade their clinical laboratories with cutting-edge facilities such as immunoassay and molecular diagnostics facilities in recent years. As a result, the independent clinical labs market has recently emerged and continues to expand, further boosting the development of the immunoassay reagents market.

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***Increased Health Expenditure and Awareness of Early Treatment of Diseases:*** Total health expenditures in China has grown from RMB2,434.6 billion in 2011 to RMB4,097.5 billion in 2015, which indicates a growing demand for in vitro diagnosis. Meanwhile, rising awareness of early treatment of various diseases further increases the consumption of healthcare products and services. Thus, the in vitro diagnosis market including immunoassay reagents and kits will expand accordingly.

***Aging Population and Growing Prevalence of Chronic Diseases:*** The population aged over 65 years old in China reached 143.9 million in 2015, accounting for more than 10% of the whole population. Due to age-related diseases, the number of Chinese residents who need in vitro diagnosis tests and related products is also growing as the population ages. In addition, unhealthy life-styles, intense work pressure and environmental pollutions led to growing prevalence of chronic diseases in China, such as cardiac disease and malignancy, which stimulates consumer demand for the in vitro diagnosis market including immunoassay reagents and kits.

### Entry Barriers

***High Technical Requirement:*** The production of immunoassay reagents and kits involves multidisciplinary expertise, including clinical medicine, biochemistry, electronics, optics, computer software, etc. Currently, few enterprises have equipped themselves with all the relevant technologies and research and development capabilities to operate in the immunoassay reagents and kits industry, without which new entrants may find it impossible to enter the industry. Immunoassay reagents usually require a high level of stability to ensure the reliability of test results, which in turn creates a high technology requirement for research and development, and production capability.

***Lack of Talents:*** The immunoassay reagents and kits industry involves multiple technologies, and therefore only talents with adequate expertise and a multitude of experiences can achieve long-term success. Talent recruitment and cultivation is a long and expensive process. New entrants may find it difficult to recruit or maintain a capable research, production and marketing team.

***Capital-intensive Nature of the Industry:*** In recent years, the development of clinical medicine has accelerated the progress of immunoassay technique advancement and diagnostic performance. For immunoassay enterprises, in order to satisfy individual needs with respect to products or services from healthcare institutions, lots of capital and time will be injected into product innovation and the establishment of extensive sales networks. Consequently, without strong and ongoing capital investment, new entrants may not be able to compete with leading enterprises in the market.



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## INDUSTRY OVERVIEW

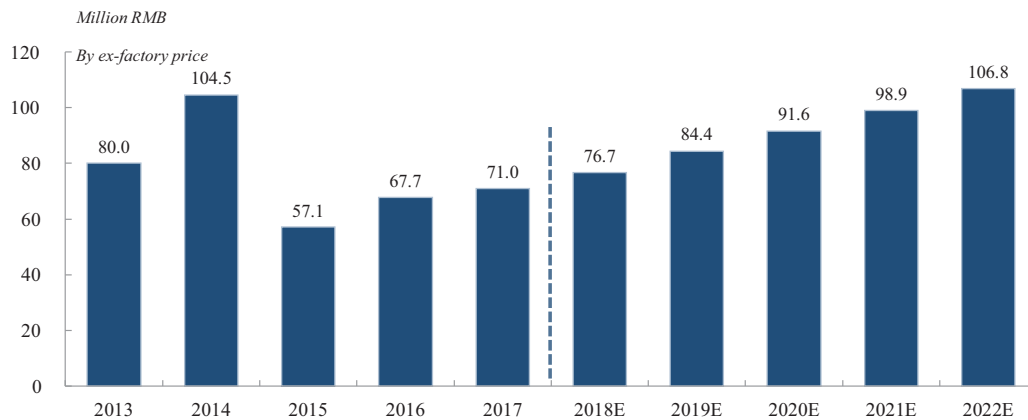
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### THE PRC RADIOACTIVE SOURCES MARKET

#### Market Size of Medical Radioactive Sources

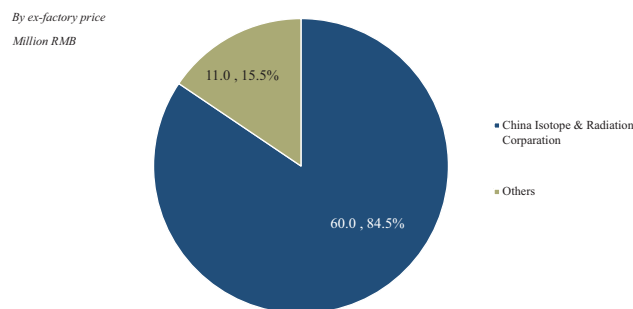
The market size of medical radioactive source was RMB71.0 million in 2017. The market is expected to reach RMB106.8 million in 2022, representing a CAGR of 8.5% during 2017 to 2022. We were the largest manufacturer of medical radioactive source in China by revenue in 2017, with a market share of 84.5%. The following charts illustrate the historical and forecast market size and the market share of major players of medical radioactive source in the PRC:

#### Historical and Forecast Market Size of Medical Radioactive Source Market, China, 2013-2022E



Source: Frost & Sullivan

#### Market Share of Leading Manufacturers in Medical Radioactive Source Market in 2017



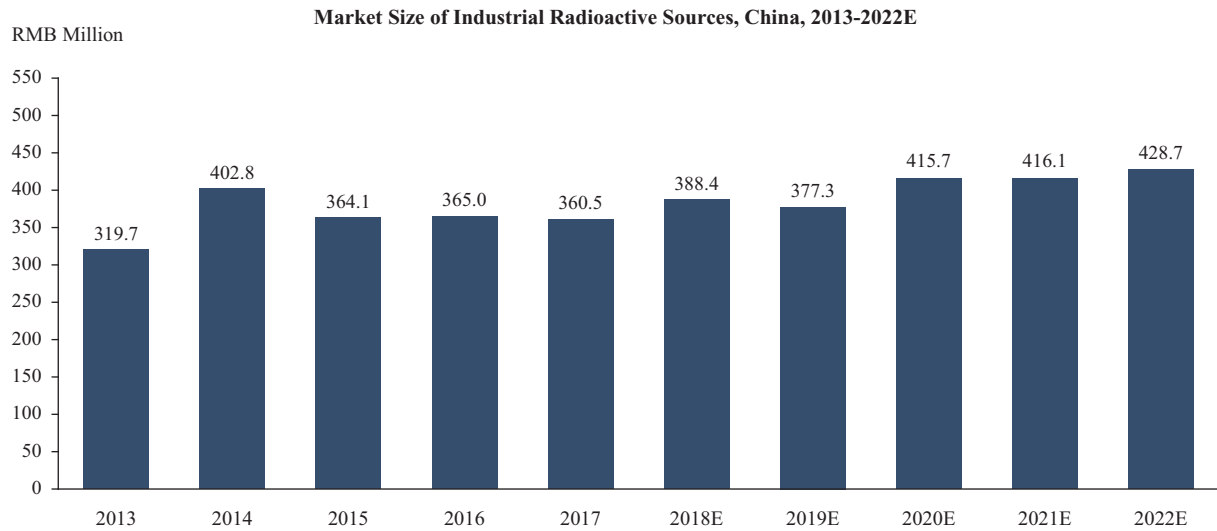
Source: Frost & Sullivan

#### Market Size of Industrial Radioactive Sources

With a growing number of gamma ray irradiation facilities in operation, and expanding use of radioactive sources in various areas, the market size for industrial radioactive sources reached RMB360.5 million in 2017, representing a CAGR of 3.0% from 2013 to 2017. The market size of industrial radioactive sources is expected to reach RMB428.7 million in 2022, representing a CAGR of 3.5% from 2017 to 2022. Cobalt-60 sealed source for irradiation service is the key component of gamma ray irradiation facilities and needs to be refilled periodically. We were the largest industrial radioactive source supplier in China, with a market share of 53.4% by revenue in 2017. The following

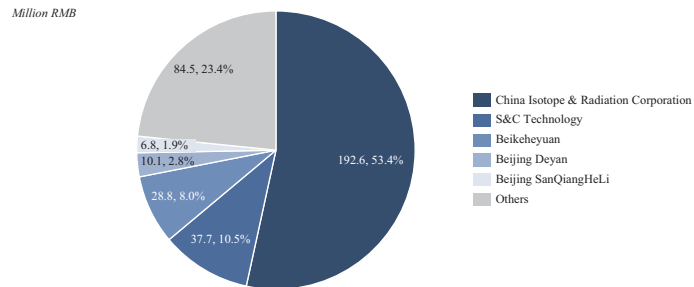
## INDUSTRY OVERVIEW

charts illustrate the historical and forecast market size and the market share of major players in the industrial radioactive source market in the PRC:



Source: Frost & Sullivan

**Market Share of China's Industrial Radioactive Source Suppliers in 2017**



Source: Frost & Sullivan

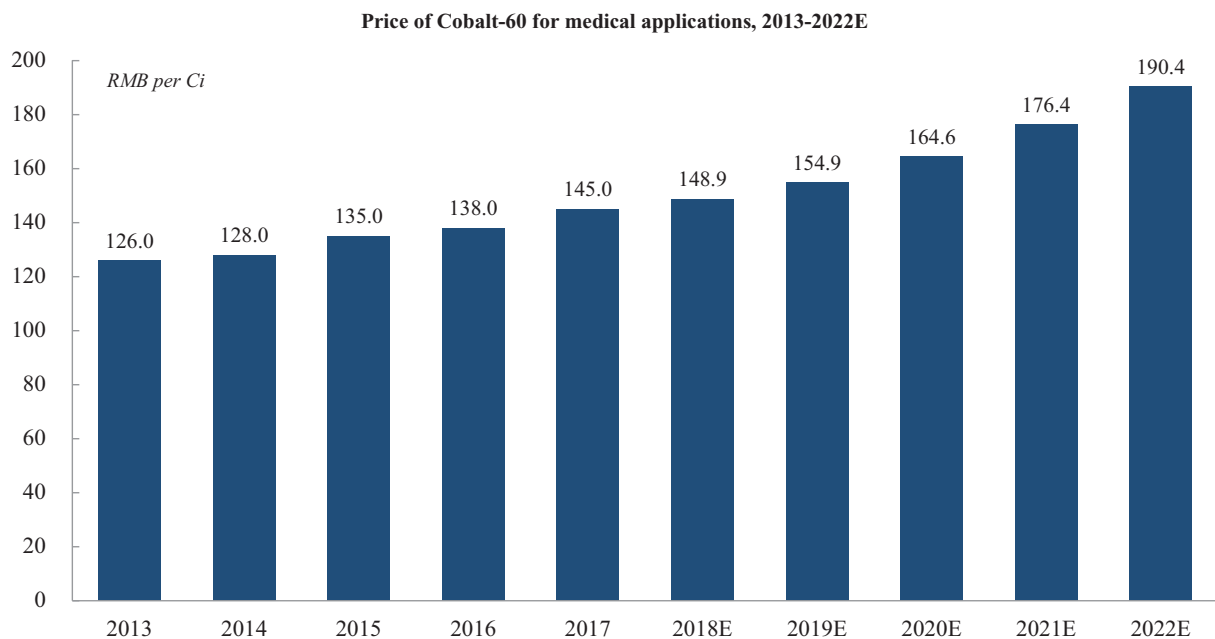
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## INDUSTRY OVERVIEW

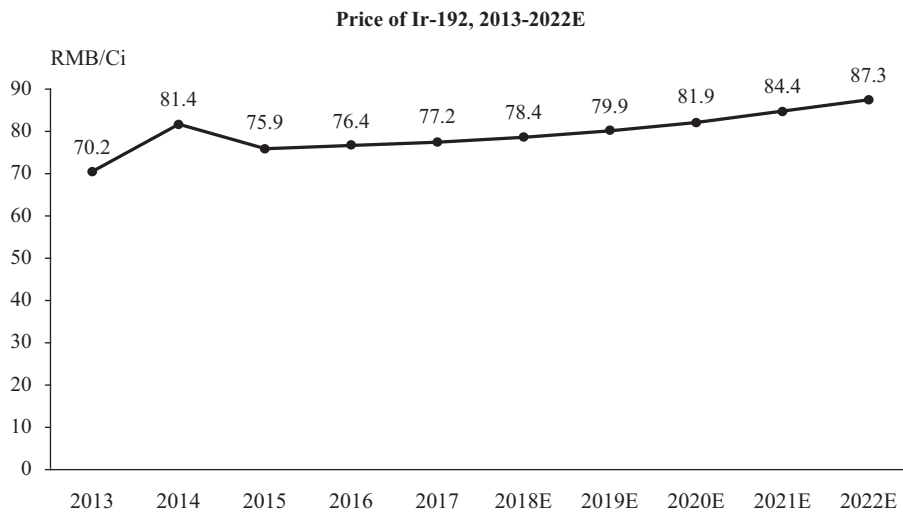
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### Analysis of Raw Materials

Raw radioisotopes are the major raw materials of industrial and medical radioactive source products. We purchase raw radioisotopes from overseas suppliers. Our major raw radioisotopes of medical and industrial radioactive source products include cobalt-60 for medical applications and iridium-192, respectively. The major overseas suppliers of cobalt-60 for medical applications are Joint Stock Company Isotope in Russia and Nordion (Canada) Inc., and Best Therapeutics Ltd in Canada. The major overseas suppliers of iridium-192 are National Centre for Nuclear Research Radioisotope Centre POLATOM and NTP Radioisotopes SCO Ltd in Poland and South Africa, respectively. Prices of cobalt-60 for medical application fluctuated from RMB126.0 to RMB145.0 per Ci during 2013 to 2017. Prices of iridium-192 were relatively stable from 2013 to 2017, ranging between RMB70.2 and RMB81.4 per Ci. The following chart illustrates the historical and forecasted price of cobalt-60 for medical applications and iridium-192 in China:



Source: Frost & Sullivan



Source: Frost & Sullivan

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## INDUSTRY OVERVIEW

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According to Frost & Sullivan, the production capacity of cobalt-60 for both medical and industrial applications is mainly limited by the availability of the production facilities. Most of the cobalt-60 produced around the world is manufactured by pressurized heavy water reactors. In China, the production volume of cobalt-60 is limited as there are only two pressurized heavy water reactors in Qinshan No.3 Nuclear Power. Since no other pressurized heavy water reactor is under construction in China as at the Latest Practicable Date, the production capacity of cobalt-60 in China will remain stable in the foreseeable future.

There are 49 pressurized heavy water reactors in operation and four under construction around the world. The number of global production facilities of cobalt-60 will remain limited in the foreseeable future and the production capacity of cobalt-60 will not experience any significant increase based on the current development technological capacity and capability.

### Market Drivers

***Increased Incidence and Mortality of Cancer:*** Radiotherapy has shown significant efficacy and plays an increasingly important role in the treatment of cancers. According to NHFPC 2017 Yearbook, cancers accounted for 26.1% and 23.2% of the total death in urban and rural residents. The increase in the number of cancer patients drives the development of medical applications of radioactive sources.

***Improved Affordability:*** Although radiotherapy using radioactive sources has shown significant improvement for cancer treatment, it is a heavy economic burden for patients and has not been widely used. The improved coverage of medical insurance and increase in disposable income in China will boost patients' willingness to accept radiotherapy. The medical radioactive sources market is expected to develop faster in the future with improved affordability.

***Technological Advances:*** Technology in cancer therapy is constantly evolving. Innovative stereotactic radiosurgery uses precisely focused radiation beams to treat tumors in the brain, neck and other parts of the human body. It directs high doses of radiation at affected areas with minimal impact on surrounding tissue and thus is able to preserve more healthy tissue than traditional therapy. This provides a more effective option for disease treatment and is attracting increased attention in the market.

***Potential Application in Extensive Fields:*** Applications of industrial radioactive sources are expanding. Industrial radioactive sources can be used in irradiation service, non-destructive testing and oil well-logging, etc. Extensive applications of industrial radioactive sources stimulate the upstream manufacturing market in China.

### Entry Barriers

***Shortage of Raw Material Supply:*** There are a limited number of suppliers of raw cobalt-60 for medical applications and industrial applications around the world. We partner with Qinshan No.3 Nuclear Power to secure the only domestic supply of raw cobalt-60 in China for the production of cobalt-60 sealed source for industrial applications. Manufacturers of cobalt-60 sealed source for medical applications in China have to import raw cobalt-60 from overseas suppliers. The ability to ensure a stable supply of raw materials at a reasonable price is a significant challenge for new participants in the market.

## INDUSTRY OVERVIEW

**High Technological Requirements:** Technological requirements for the design, manufacturing and safety control of medical and industrial radioactive sources are high. The relevant technology is usually a trade secret to a few institutions and companies around the world. Professionals with the relevant experience in the field are also limited. New entrants must be equipped with sufficient capital, assisted by a team of professionals and possess the necessary licenses and the ability to innovate in order to participate and success in the market.

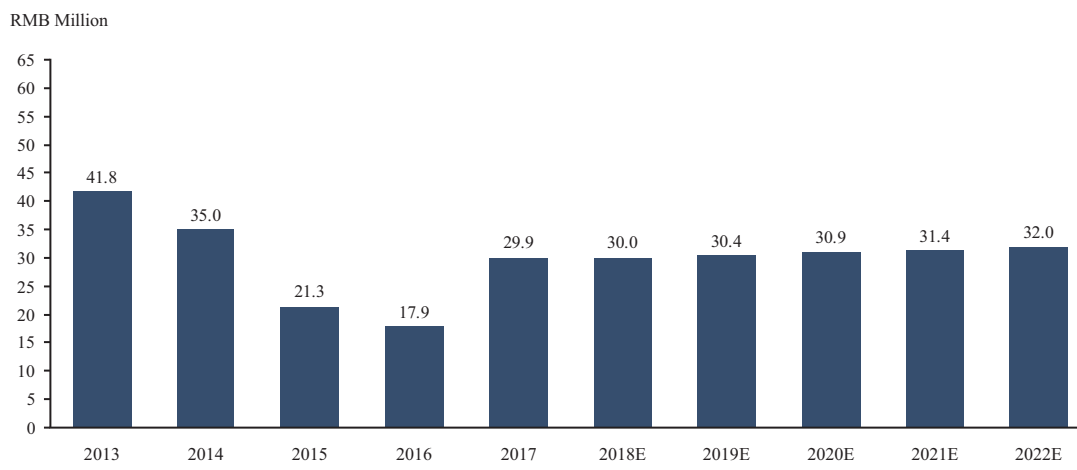
**First Mover Advantage:** At present, radioactive sources applications in hospitals are comparatively expensive. The user group is relatively small and stable, which is easy for the first mover to cultivate customer loyalty. Therefore, it is difficult for new players to enter such market.

### THE PRC IRRADIATION MARKET

#### Market Size of EPC Service of Gamma Ray Irradiation Facilities in China

The market size of the design and installation of gamma ray irradiation facilities in China was RMB29.9 million in 2017. With the growing demand for irradiation service, the number of newly-built irradiation facilities will remain stable in the foreseeable future. In addition, as a large portion of the existing facilities are established in 1990s and 2000s require retrofitting in order to regain economies of scale and competitiveness. As a result, the market size of gamma ray irradiation facilities will grow from 2017 to 2022 with a CAGR of 1.3%. We were the largest EPC service provider for the design, manufacturing and installation of gamma ray irradiation facilities in China in terms of revenue combined from 2014 to 2017. The following charts illustrate the historical and forecast market size and the market share of major players of EPC service of gamma ray irradiation facilities in the PRC:

**Market Size of EPC Service of Gamma Ray Irradiation Facilities, China, 2013-2022E**



Source: Frost & Sullivan

**Market Share of (by Revenue), China, 2015-2017**

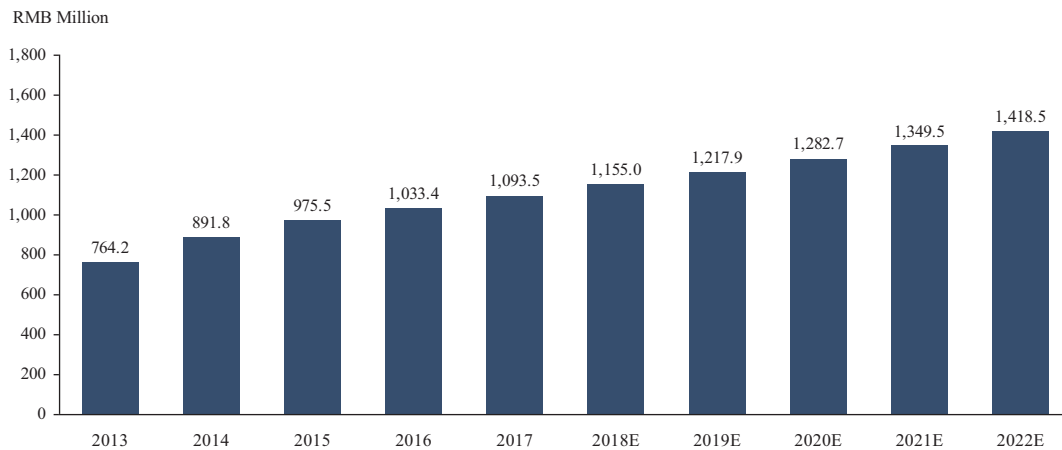
Rank	Company	Revenue 2014-2017 (RMB in Million)	Market Share
1	Our Group	53.6	51.4%
2	Company A	50.5	48.6%
<b>Total Market Size</b>		<b>104.1</b>	<b>100.0%</b>

## INDUSTRY OVERVIEW

### Market Size of Irradiation Service in China

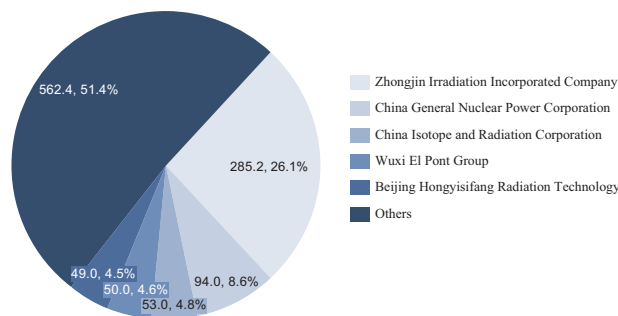
The market size of irradiation service reached RMB1,093.5 million in 2017, representing a CAGR of 9.4% from 2013 to 2017. As the benefits of irradiation for sterilization gain more recognition and the expanding category of materials applicable to be modified, the irradiation service market will continue to grow from 2017 to 2022 with a CAGR of 5.3%. We were the third largest irradiation service provider by revenue in China in 2017. The following charts illustrate the historical and forecast market size and the market share of major players of irradiation service in the PRC:

**Market Size of Irradiation Service, China, 2013-2022E**



Source: Frost & Sullivan

**Top Five Irradiation Service Providers (by Revenue), China, 2017**



Source: Frost & Sullivan

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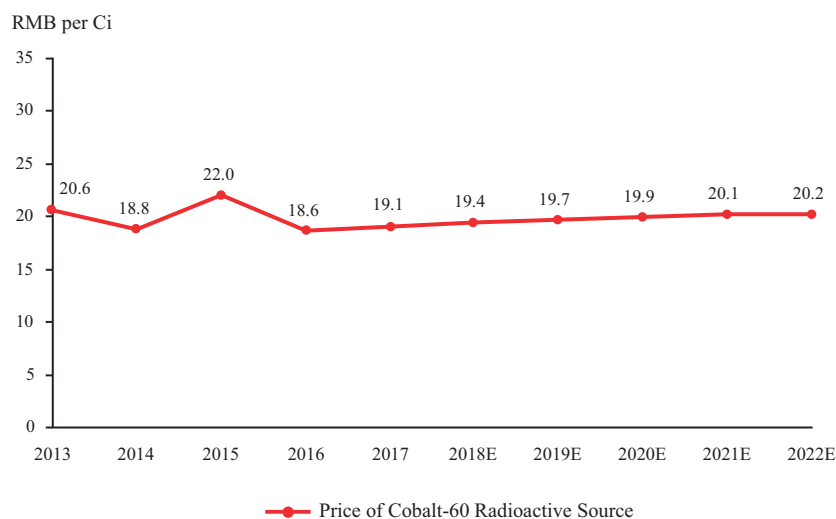
## INDUSTRY OVERVIEW

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### Analysis of Raw Materials for Gamma Ray Irradiation Service

According to Frost & Sullivan, the average price of cobalt-60 sealed source for irradiation service remained relatively stable ranging from RMB18.6 per Ci to RMB22.0 per Ci from 2013 to 2017. The following chart illustrates the historical and forecasted price of cobalt-60 sealed source for irradiation service in China:

**Average Price of Cobalt-60 Sealed Source for Irradiation Service, China, 2013-2022E**



Source: Frost & Sullivan

### Market Drivers

**Favorable Policy Environment:** Irradiation is regarded as an advanced technology in China, as such, development of the irradiation industry has been included in multiple PRC government initiatives in recent years and an increasing number of regulations for the irradiation service market have been issued to promote and accelerate the development process.

**Increasing Market Recognition:** As the irradiation technology has become increasingly mature and sophisticated in China, the safety and efficiency of irradiation have been significantly improved. As a result, irradiation service is gaining more recognition from end-users.

**High Market Potentials:** Most of the irradiation facilities in China are located in Eastern China and Southern China. The market potential of irradiation service is high in China as it is yet to be developed in the rest of China.

### Entry Barriers

**Qualification and Technological Barrier:** The design and installation of irradiation facilities and supply of irradiation service are highly regulated in China by the MEP and other competent authorities. It requires integrated technologies and expertise with regard to irradiation technology, material technology and radiation protection. As of the Latest Practicable Date, we are two out of three companies approved by the MEP to engage in the EPC service of gamma ray irradiation facilities in China. Companies must possess the relevant and extensive industry experience as well as advanced technology to obtain the necessary qualifications from authorities. It is difficult for new entrants with little experience in the irradiation industry to obtain such qualifications.

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## INDUSTRY OVERVIEW

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***Talent Barrier:*** The design, manufacturing, installation and operation of irradiation facilities should be managed by professionals with adequate experience in the relevant fields. It is difficult for new entrants to form a team of capable professionals within a short timeframe or at low cost.

### REPORT COMMISSIONED FROM FROST & SULLIVAN

Frost & Sullivan, an experienced consultant in a variety of industries including the healthcare industry in the PRC, has been engaged as an independent consultant to provide the Frost & Sullivan Report for use in whole or in part in this prospectus. Frost & Sullivan prepared its report based on data released by government institutions and non-government organizations such as the CFDA, National Bureau of Statistics of China as well as data gathered by Frost & Sullivan and analysis performed by Frost & Sullivan based on the available data. Where necessary, Frost & Sullivan visits companies operating in the industry to gather and synthesize information about the market and other relevant information. The information derived from the Frost & Sullivan Report and contained herein has been obtained from sources believed by Frost & Sullivan to be reliable, but there can be no assurance as to the accuracy or completeness of the information included in this prospectus. Forecasts and assumptions included in the Frost & Sullivan Report are inherently uncertain because of events or combinations of events that cannot reasonably be foreseen, including, without limitation, the actions of government, individuals, third parties and competitors. Specific factors that could cause actual results to differ materially include, among others, risks inherent in the PRC isotope and irradiation technology industry, financing risks, labor risks, supply risks, regulatory risks and environmental concerns.

This prospectus contains information extracted from the Frost & Sullivan Report in sections such as “Industry Overview” and “Business.” We paid Frost & Sullivan a fee of RMB800,000 for the preparation and update of the Frost & Sullivan Report.