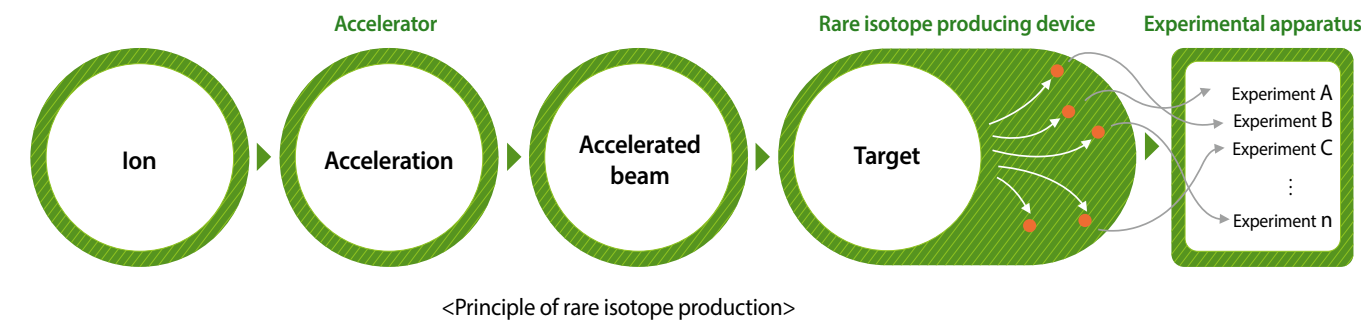


Heavy-ion accelerator, a science facility for rare isotopes

Heavy-ion accelerators are used to produce rare isotopes that have not been observed in nature. Heavy-ion accelerators ionize atoms heavier than hydrogen and helium, and cause them to collide with target atoms. Such collisions unlock physics on a scale smaller than atoms, leading to the discovery of new, rare isotopes.

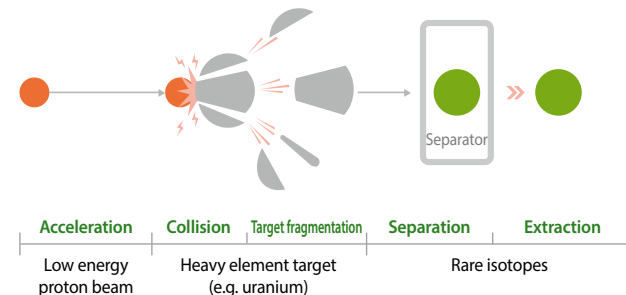


Methods of rare isotope production

The two methods of producing rare isotopes with existing accelerators are Isotope Separation On-Line (ISOL) and In-flight Fragmentation (IF).

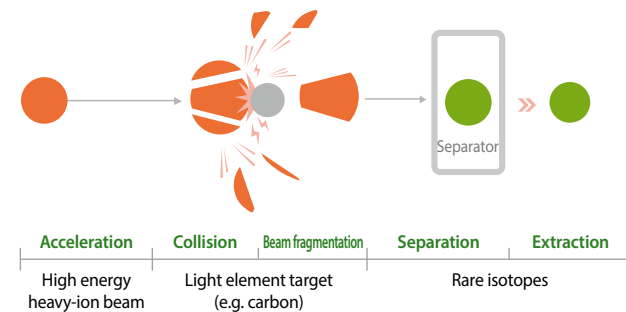
ISOL (Isotope Separation On-Line)

- Acceleration of light atomic ions for collisions with heavy atomic targets
- Production of large amounts of rare isotopes



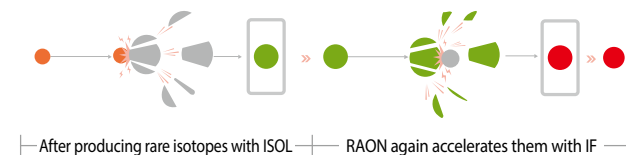
IF (In-flight Fragmentation)

- Acceleration of heavy atomic ions for collisions with light atomic targets
- Production of various rare isotopes



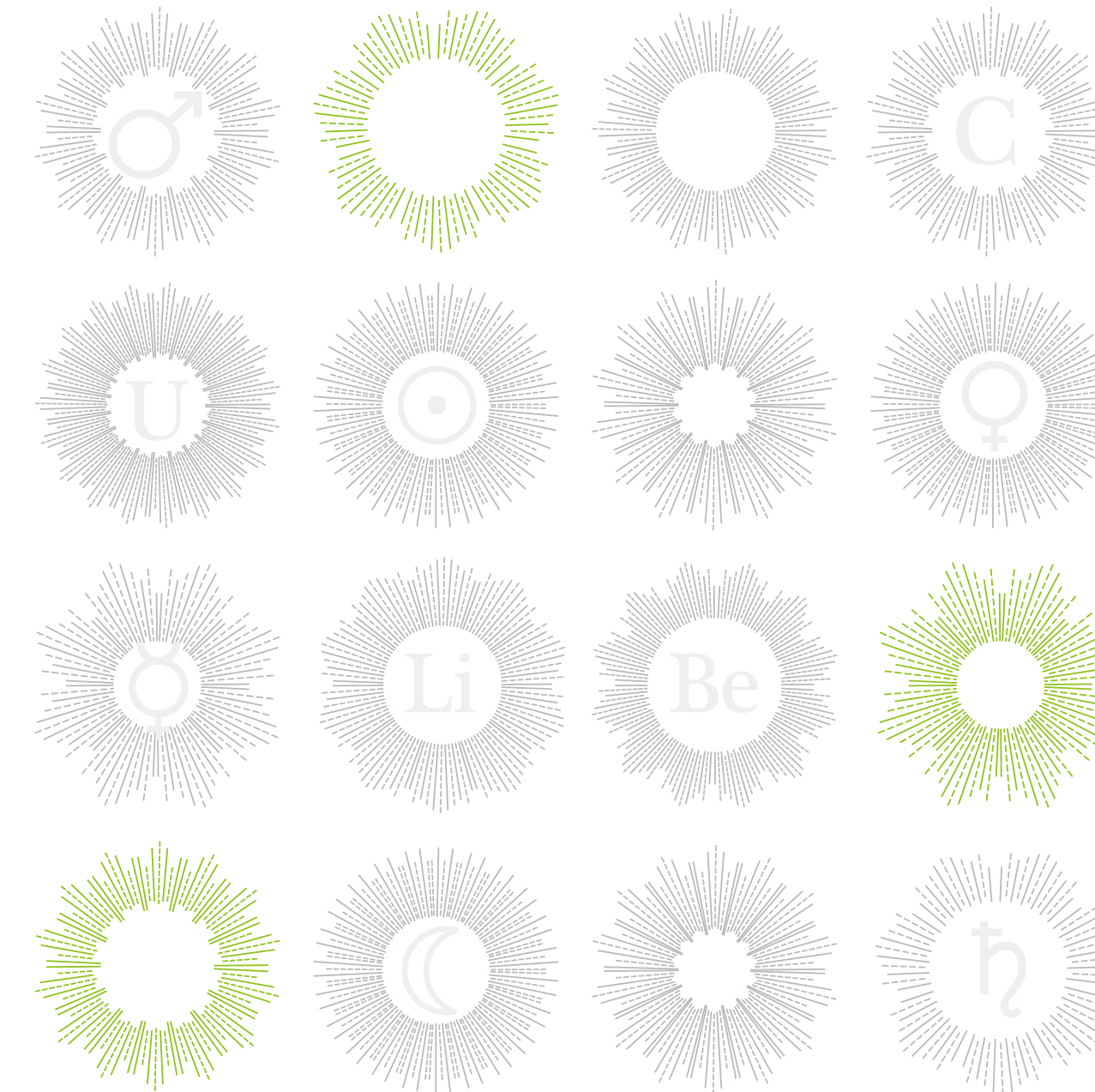
ISOL+IF

- Applying an IF (In-Flight Fragmentation) method to rare isotopes which are re-accelerated after being produced by using an ISOL method
- Production of newer and more rare isotopes than isotopes produced by an existing method



Beyond Basic Science

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Beyond Basic Science

Korean heavy-ion accelerator, RAON
 A major big-science facility
 of the International Science and Business Belt

Beyond Basic Science

Isotopes or twin atoms

Atoms are basic units of nature. Atoms are made of protons, neutrons and electrons. Atomic properties are determined by the number of such constituents. The number of protons determines the atomic number and chemical properties, while the atomic mass is equal to the sum of protons and neutrons.

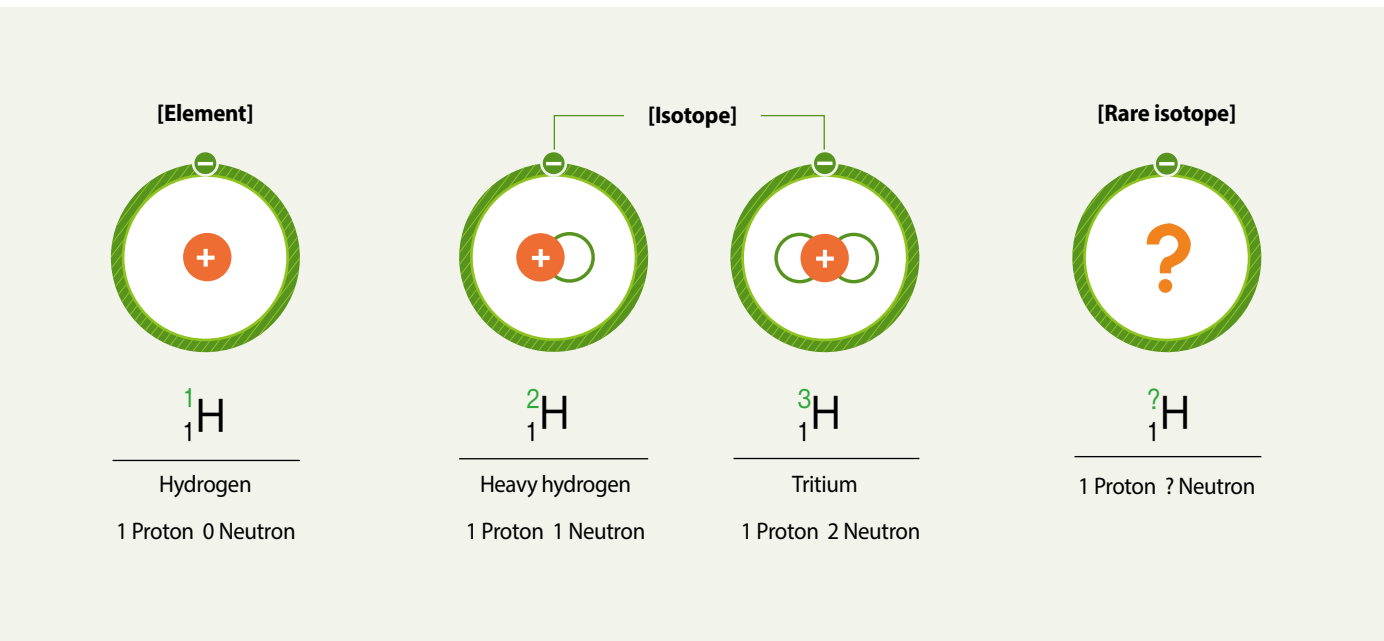
Isotopes are twin atoms with the same number of protons and thus the same atomic number but different numbers of neutrons. Each element has several different isotopes. Scientists have discovered 118 elements and about 3,000 isotopes to date.

Hidden, undiscovered rare isotopes

Rare isotopes are isotopes that have not yet been discovered because they are rare and decay rapidly. They must be produced or discovered by artificial means because they no longer exist or only remain in very small traces on the earth.

Rare isotopes can be utilized to obtain new knowledge that was not accessible with existing techniques. In particular, rare isotopes enable better understanding of the creation and evolution of the natural world and the universe, and the characteristics of substances. This implies that rare isotopes have the potential to break free of the limits of current basic science and create new research fields.

● Proton ● Neutron ● Electron

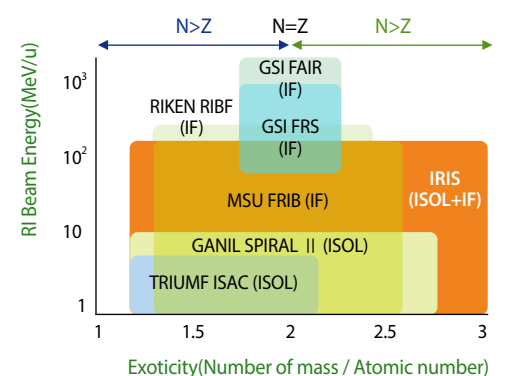
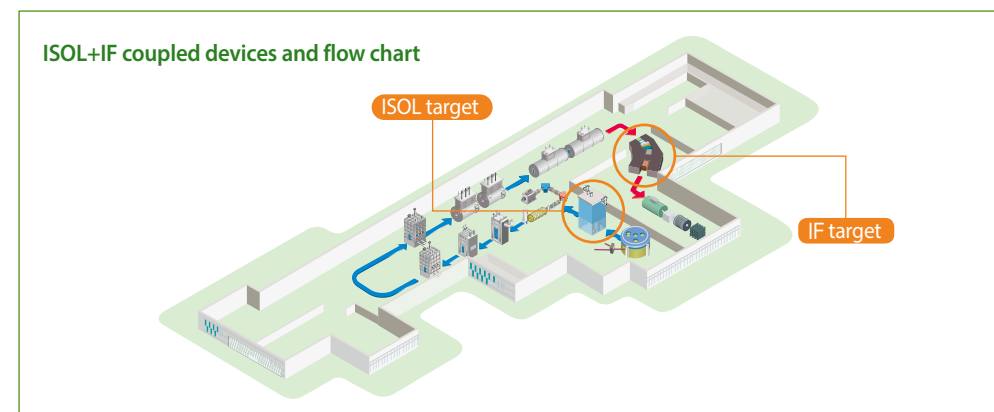


Korean heavy-ion accelerator, RAON

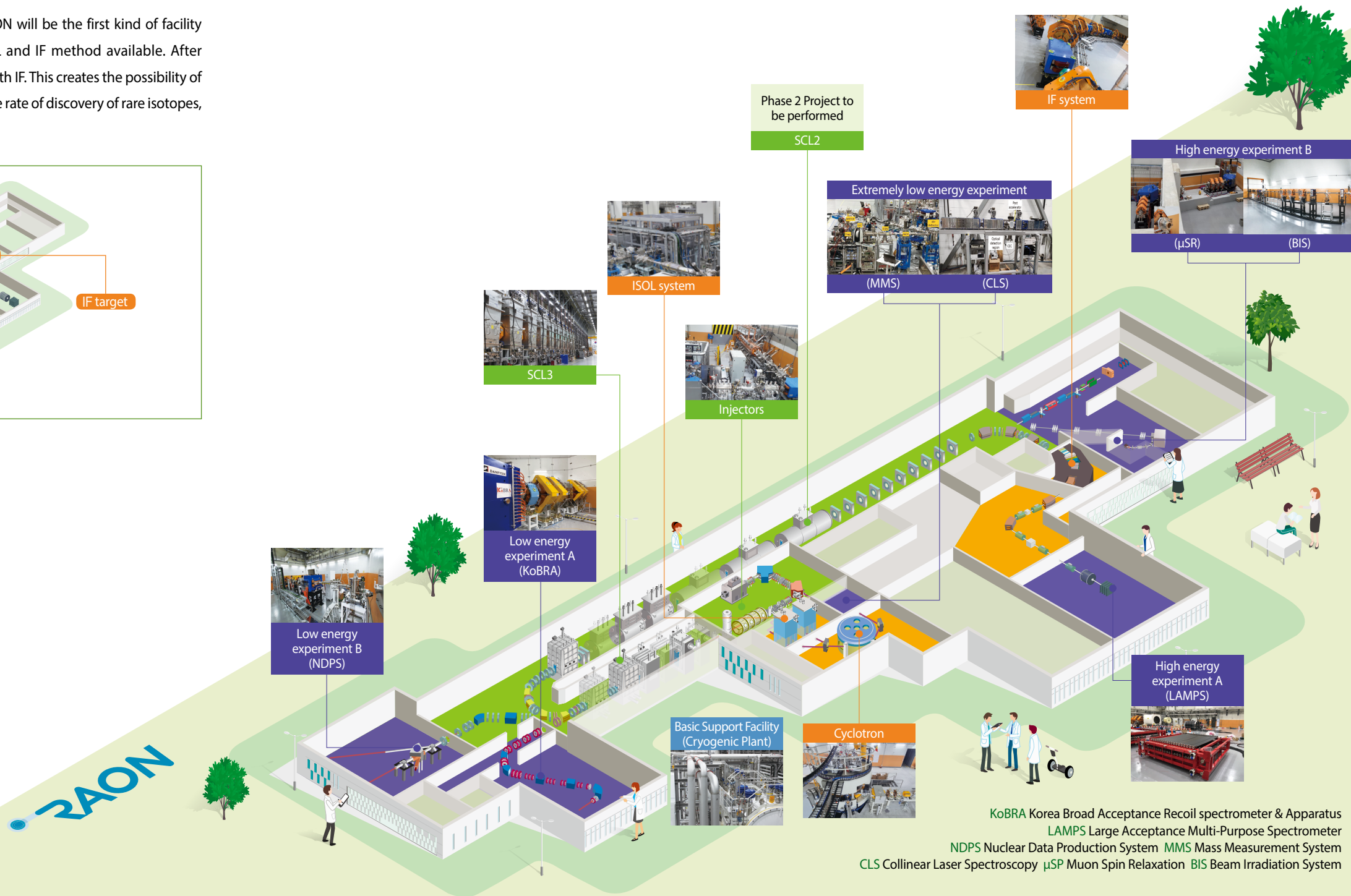
RAON is a world-class heavy-ion accelerator that will produce highly rare isotopes. It will consist of ion generators, accelerators, rare isotopes producing devices and various experimental apparatuses.

Unique generation of highly rare isotopes by RAON (ISOL+IF)

While accelerators around the world rely on either ISOL or IF, RAON will be the first kind of facility having ISOL and IF method combined in addition to each ISOL and IF method available. After producing rare isotopes with ISOL, RAON again accelerates them with IF. This creates the possibility of discovering new and rare isotopes. RAON is expected to increase the rate of discovery of rare isotopes, whilst producing them in larger quantities and in greater variety.



Tip
Expansion into new areas of Rare Isotope Science comparing to similar facilities overseas



Applied science research field of RAON experimental systems

Nuclear science

The discovery of new atoms and the identification of the principles behind atomic production will open new horizons for atomic science.

- Research areas**
 - Origin of elements and the evolution of stars
 - Nuclear structure and nuclear force
 - Nuclear reactions and nuclear structure experiments
 - Nuclear science theory
- Experiments**
 - Korea Broad acceptance Recoil spectrometer and Apparatus (KoBRA): Examination of the production of rare isotopes and nuclear structures based on processes resulting from collisions between nuclei of rare isotopes and stable atoms
 - Large Acceptance Multi-Purpose Spectrometer (LAMPS): Examination of high density states of substances through collisions of neutron-rich rare isotopes
 - Nuclear Data Production System (NDPS): Production of precise atomic nuclear reaction data on high-speed neutrons and rare isotope nuclear materials

Atomic and molecular science

The various types of atomic structures can be categorized based on precise measurements of mass, size and shape of rare isotopes.

- Research areas**
 - Precise measurement of rare isotope mass and development of atomic manipulation technology
 - Development of micro-measurement technology for atomic structures
 - Precise measurement of basic physical constants
- Experiments**
 - Mass Measurement System (MMS): Device that categorizes rare isotopes and discovers new atoms based on precise mass measurements
 - Collinear Laser Spectroscopy (CLS): Categorization of rare isotopes and determination of their nuclear characteristics based on changes in atomic energy levels and shapes of rare isotopes

Physical science

Electromagnetic microstructures are studied in a non-destructive manner using muons.

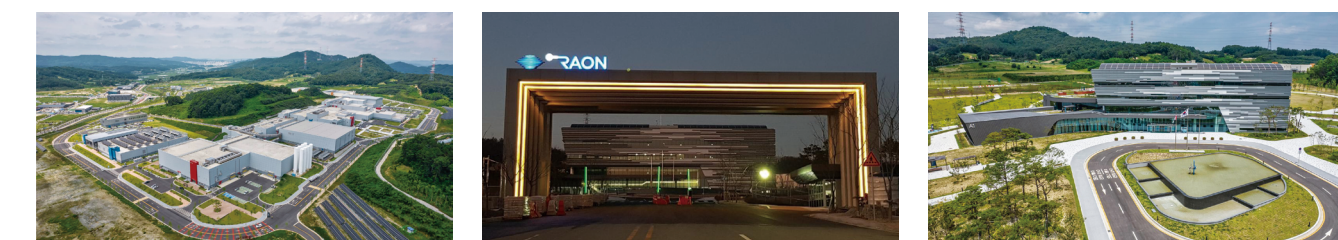
- Research areas**
 - Development of ultra-sensitive device for measurement of physical properties
 - Study of physical properties of new materials including high-temperature superconductors, semiconductors, nano-magnetic materials and topological insulators
- Experiments**
 - Muon Spin Relaxation (μSR): Examination of new and unique phenomena such as superconductivity, nano-magnetism and topological insulation based on the measurements of local electromagnetic properties of new materials using muons

Biomedical science

Safer and more effective biomedical methods can be developed using the different properties of rare isotopes.

- Research areas**
 - Development of cancer treatment methods using rare isotopes
 - Development of breeding methods
- Experiments**
 - Beam Irradiation System (BIS): Development of new biomedical techniques for cancer treatment, breeding, etc., by exposing biological tissue to rare isotope beams or heavy-ion beams to perform cell destruction and DNA modification

Status of Rare Isotope Science Project



Project summary

- Goal** - Establishment of a domestic heavy-ion accelerator(RAON) for advanced basic science research on rare isotopes
- Resource** - 200MeV/u beam energy, 400kW heavy-ion accelerator
- Performance** - World's first facility to produce rare isotopes by combining ISOL and IF
- Period** - 2011 ~ (Phase 1 : '11~'22/ Pre-production R&D : '22~'27/ Phase 2 : '28~)
- Location** - The International Science and Business Belt Sindong-area(Daejeon Yusoeng-gu)
- Scale** - Total expenses : KRW 1,518,300 million (522.8 billion for device establishment, 638.4 billion for facility construction, 357.1 billion for land purchase)
- Site 952,066㎡ (approx. 290,000 pyeong), total floor area 130,144㎡ (approx. 40,000 pyeong)
- Expected** - Delivery of world-class research results based on global competitiveness in basic science outcomes
- Stimulation of local industries and enhanced technical capacities through acquisition of novel technology

Details

Classification	Details
Rare Isotope Science Project	• Development and installation of accelerators, Basic Support Facility, Rare Isotope Production System, Experimental Systems, etc
Facility construction project	• Construction of research/supporting facilities to operate accelerators and create an effective research environment
Site purchase	• Purchase of site to install accelerators and facilities



Phase	Category	Details
Phase 1	Accelerators	• Establishment of low energy accelerators (injector, SCL3)
	Basic Support Facility	• Establishment of Basic Support Facility for accelerator operation (Cryogenic Plant, control system)
	Rare Isotope Production System	• Establishment of Rare Isotope Production System (ISOL & IF system, cyclotron)
	Experimental Systems	• Establishment of Extremely-low energy, low energy, and high energy experimental devices (7)
Phase 2	Facility construction	• Establishment of 10 buildings and utilities (electricity, water, gas, communications, etc.)
	Accelerators	• Establishment of high-energy accelerators (SCL2)