

Status of RAON

Young Kwan KWON

Rare Isotope Science Project (RISP)
Institute for Basic Science (IBS)

Asian Forum for Accelerators and Detectors (AFAD) 2018

29th Jan 2018, DCC @ Daejeon, Korea



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Project RISP Overview

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Facility RAON Overview

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Project Status

- Accelerator system
- RI Production & Experimental system
- Demonstration system @ off-site test facility
- Construction

A horizontal bar with a green segment on the left and a dark blue segment on the right.

RISP Overview

A horizontal bar with a dark blue segment on the left and a green segment on the right.

Rare Isotope Science Project (RISP)

🍅 **Goal:** To build a heavy ion accelerator complex RAON, for rare isotope science research in Korea.

* RAON - **R**are isotope **A**ccelerator complex for **ON**-line experiments

🍅 **Budget:** US\$ 1.44 B (1 B\$~1T Won)

- accelerators and experimental apparatus : 0.46 B\$
- civil engineering & conventional facilities : 0.98 B\$ (incl. construction site purchase) (recently approved in June 2014)

🍅 **Period:** 2011.12 ~ 2021.12 (10.1 years)

Future Extension

- Charged Lepton Flavor Violation

RAON

Accelerator complex

ISOL + In-Flight Fragmentation

Origin of Matter

- Nuclear Astrophysics
- Nuclear Matter
- Super Heavy Element Search
- High-precision Mass Measurement

Properties of Exotic Nuclei

- Nuclear Structure
- Electric Dipole Moment and Symmetry
- Nuclear Theory
- Hyperfine Structure Study

Applied Science

- Bio-Medical Science
- Material Science
- Neutron Science

$$\begin{aligned} Z=8, N=28 \\ Z=28, N=28 \\ Z=28, N=20 \\ Z=28, N=8 \\ Z=28, N=2 \end{aligned}$$

: Accelerator complex for producing rare isotope beams

- High intensity **RI** beams by **ISOL** & **IF**

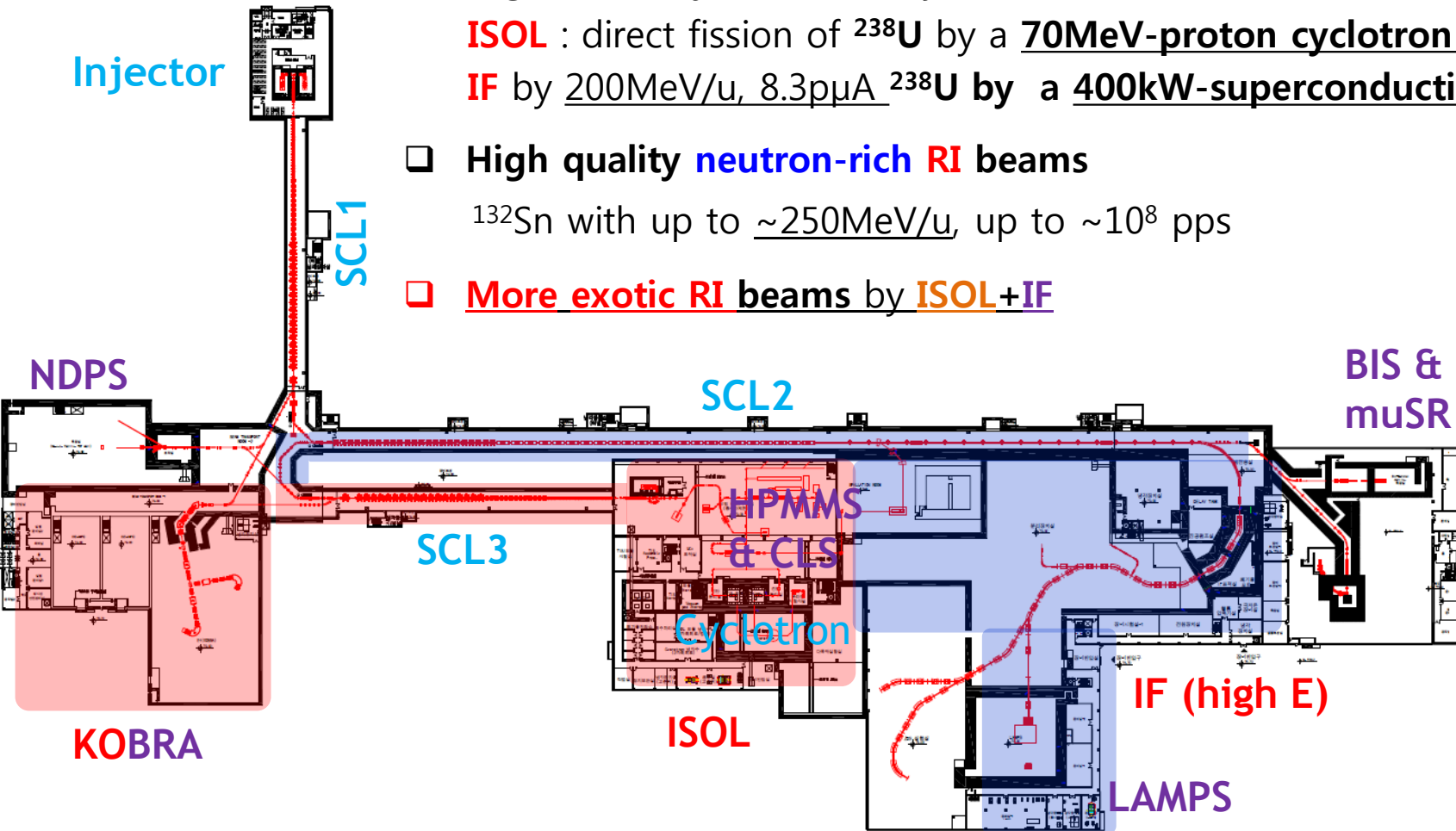
ISOL : direct fission of ^{238}U by a **70MeV-proton cyclotron** $\sim 10^{14}$ f/s

IF by 200MeV/u, 8.3pμA ^{238}U by a 400kW-superconducting LINAC

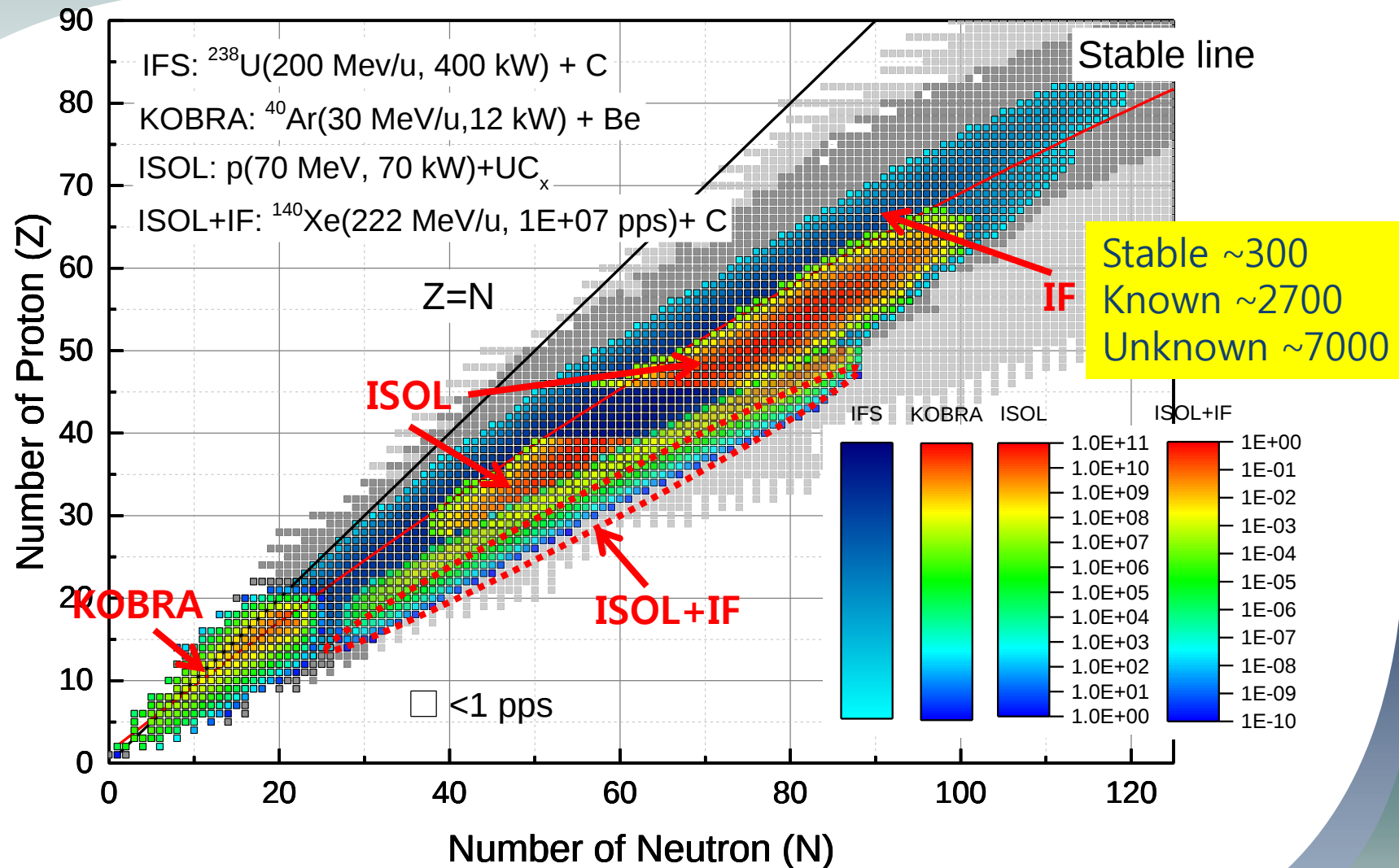
- High quality **neutron-rich RI** beams

^{132}Sn with up to ~250MeV/u, up to $\sim 10^8$ pps

- More exotic RI beams by **ISOL+IF**



Expected RIBs at RAON in nuclear landscape



- RAON will provide access to unexplored regions of the nuclear chart !
- RAON will be a powerful RIBs' supplier to users globally
→ More exotic, More intense, and More various RIBs

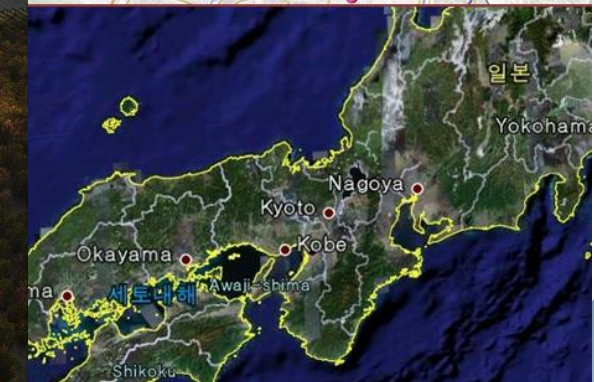
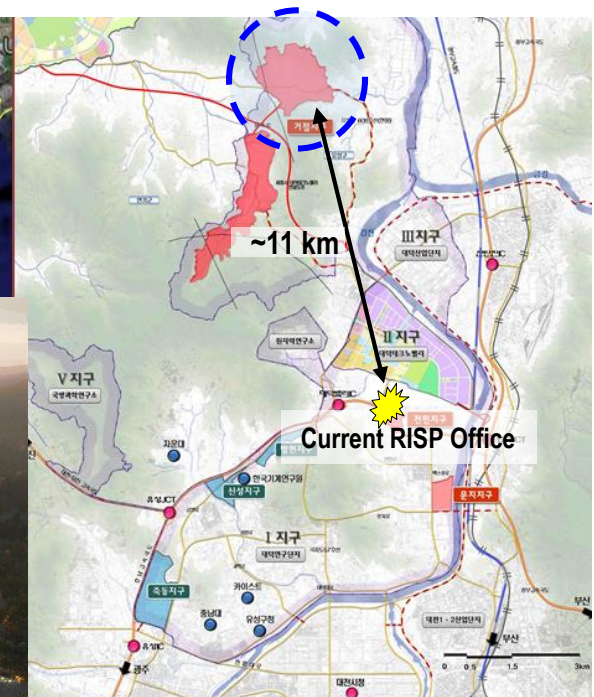
RAON Site : Sindong in Daejeong



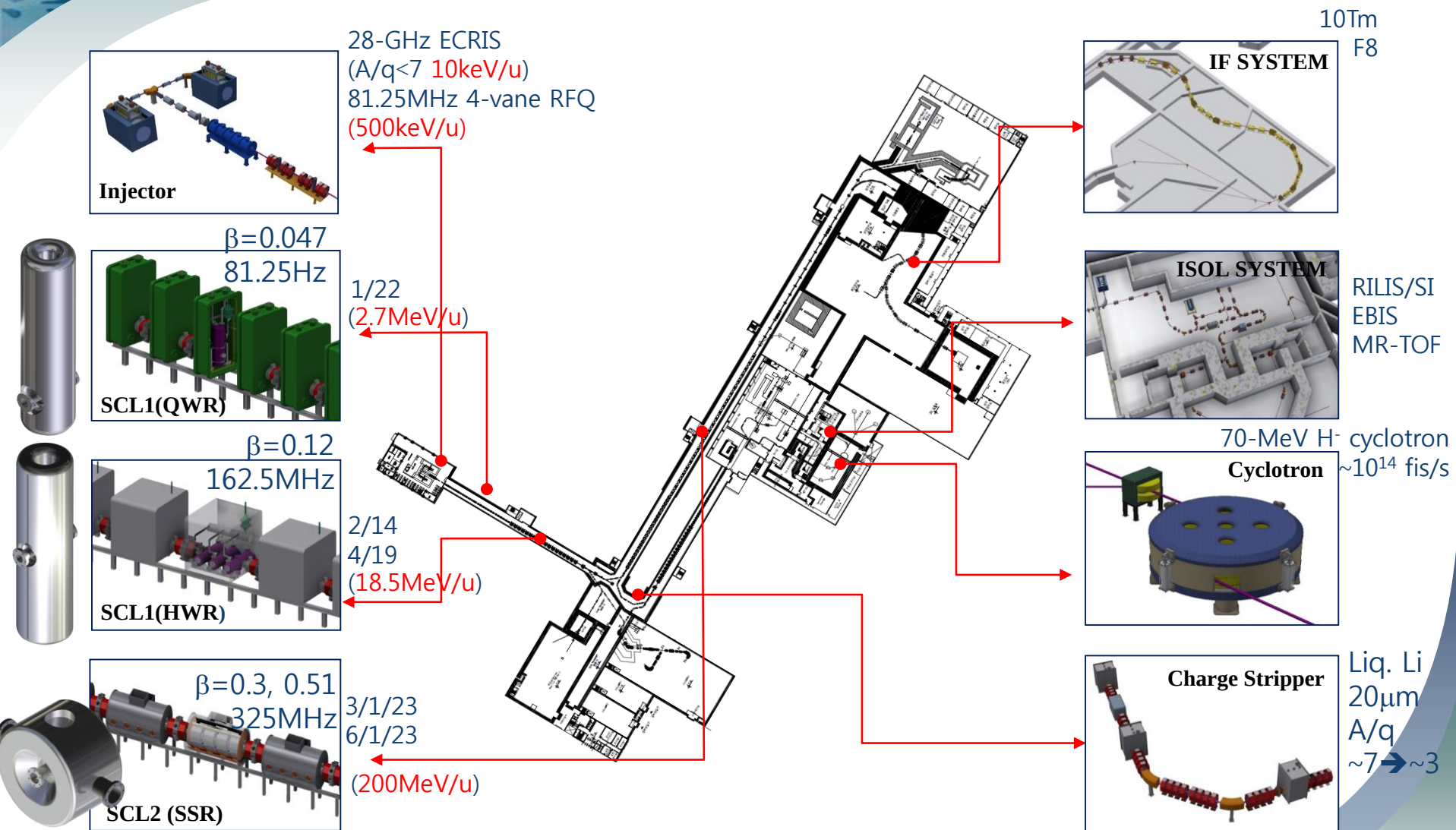
Bird's-eye view



Final design under inspection
Fast-Track Construction underway from Feb. 2017
Main Construction has started in Aug. 2017.

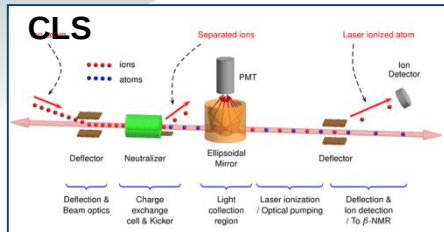


Accelerator systems (Layout & Specs.)



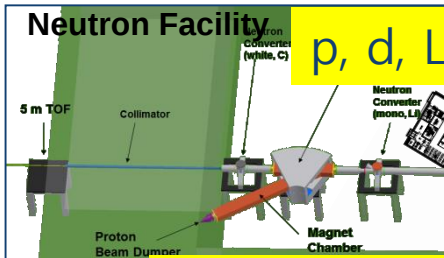
Warm sections for focusing components betw. CMs

Experimental Systems

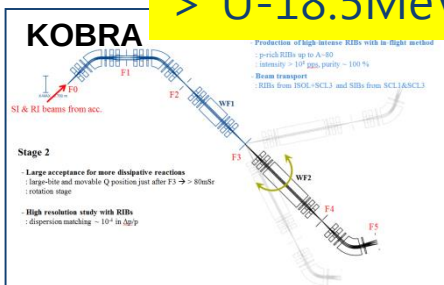


Collaborated with
WNSC/KEK & RIKEN

$\sim \text{keV/u}$



$p, d, Li < P-88 \text{ MeV/u}$



$> U-18.5 \text{ MeV/u}$

Low Energy Exp.

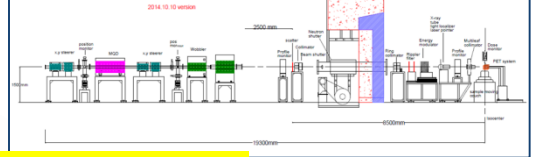
High Energy Exp. II

High Energy Exp. I

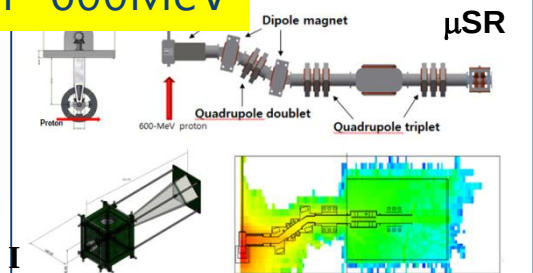
$HI > 200 \text{ MeV/u}$

$P-600 \text{ MeV}$

Bio-medical facility

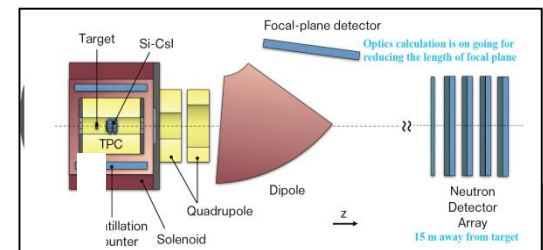


μSR

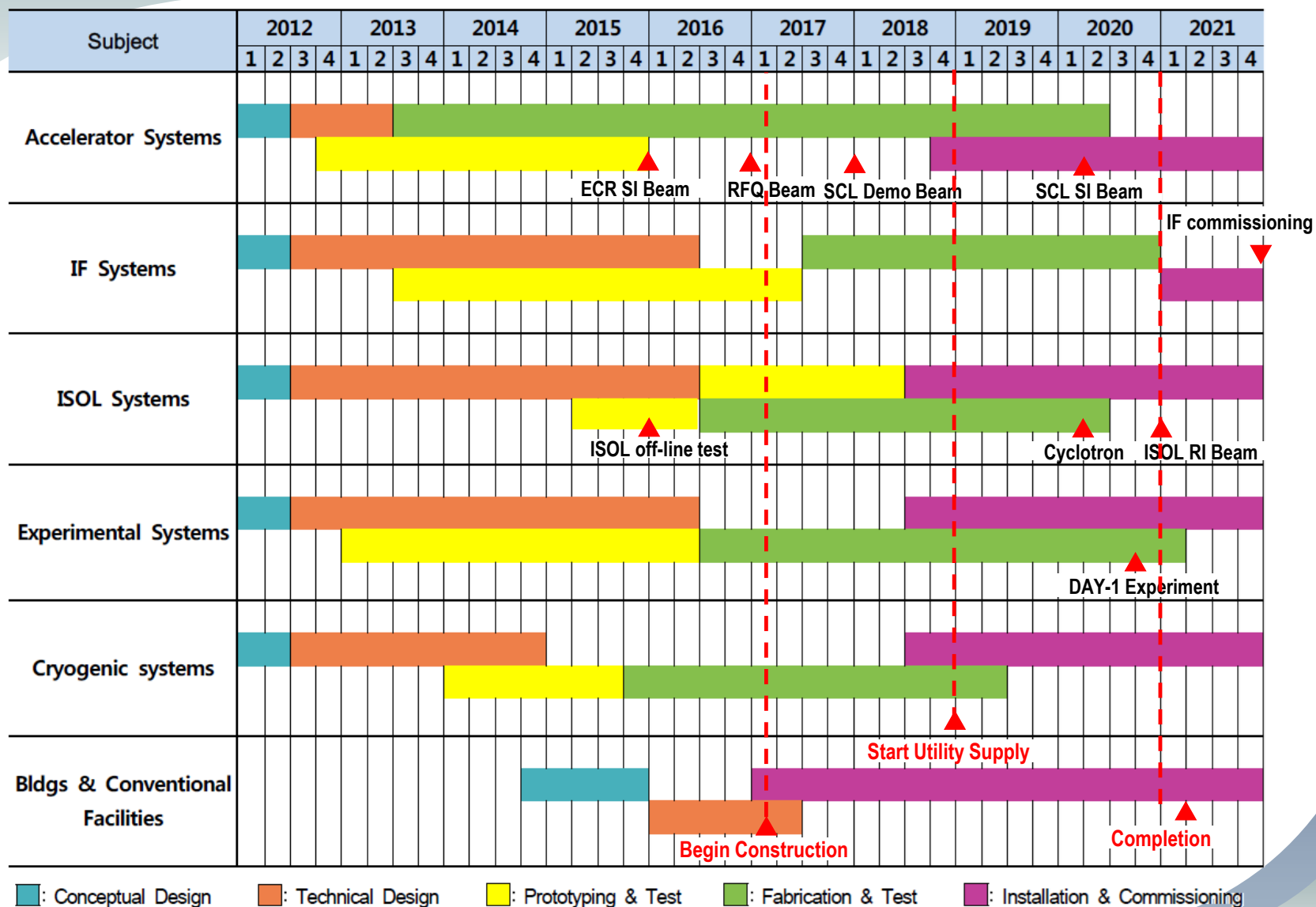


$> U-200 \text{ MeV/u}$

LAMPS



RISP Milestone Schedule

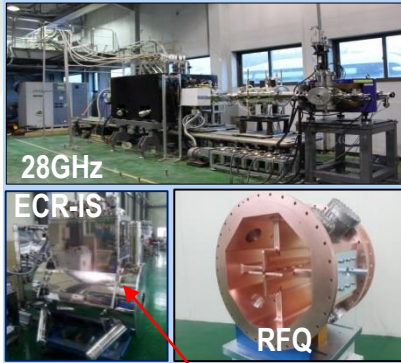


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Project Status

Prototyping & test... under progress

Injector System

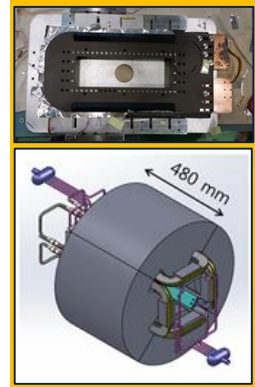


Supervised
by Dr. Nakagawa
at RIKEN

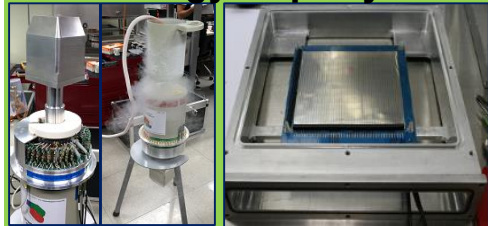
SC LINAC System



IF System



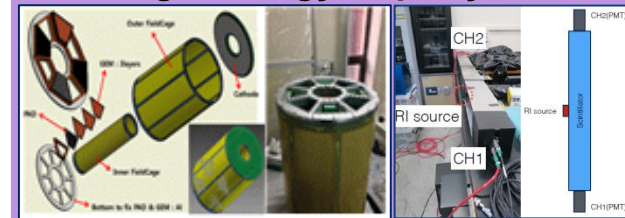
Low-energy Exp. System



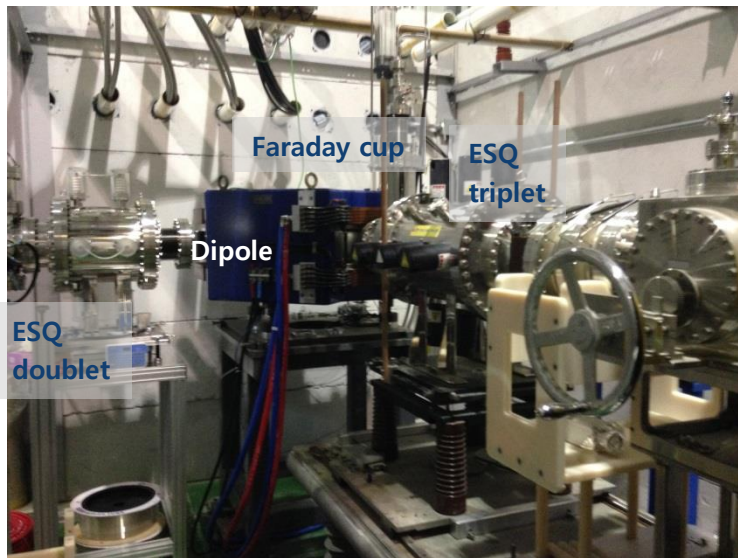
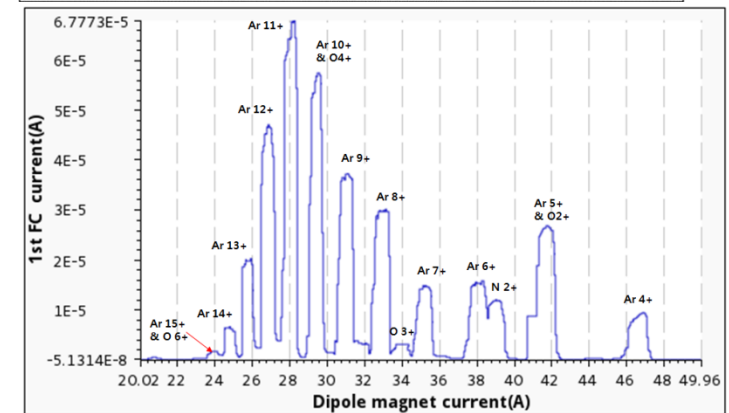
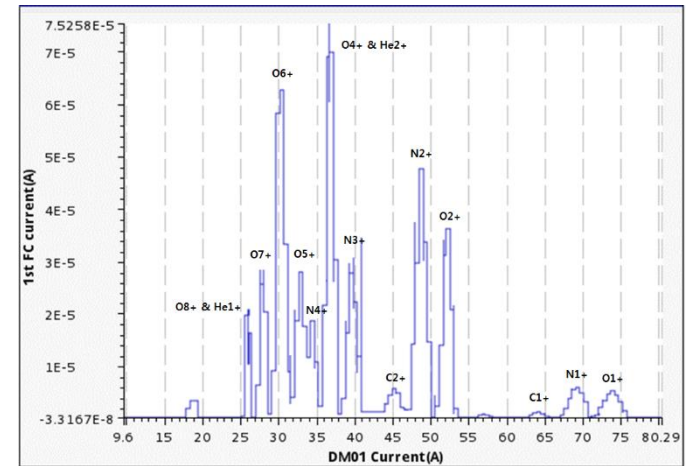
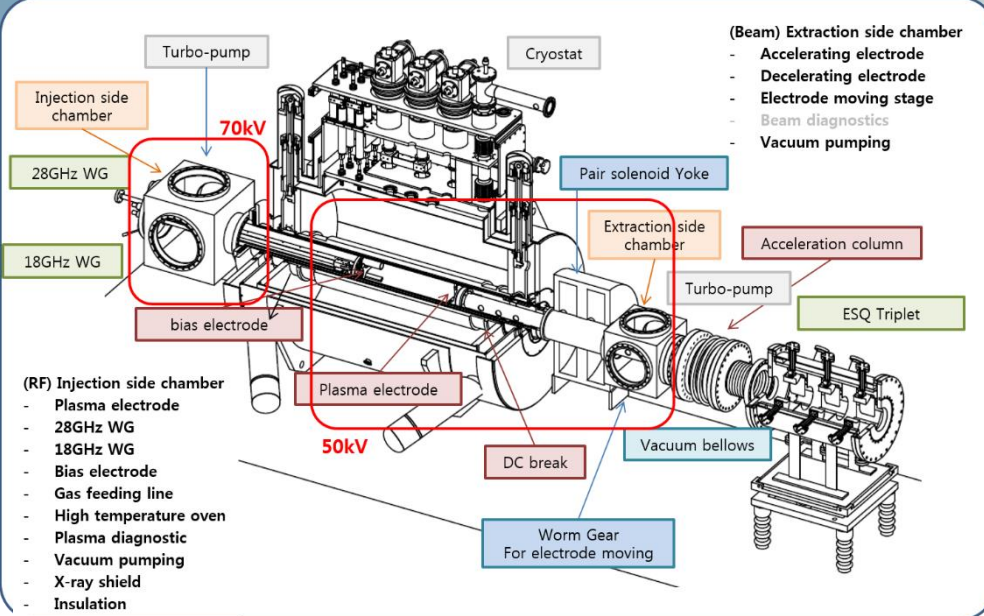
ISOL System



High-energy Exp. System

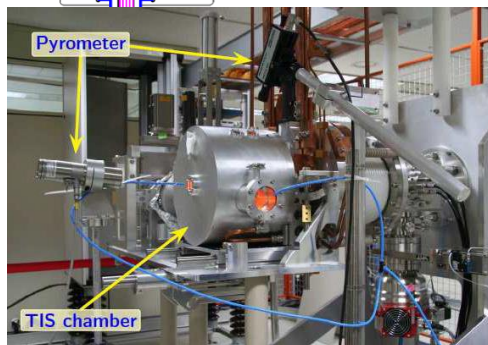
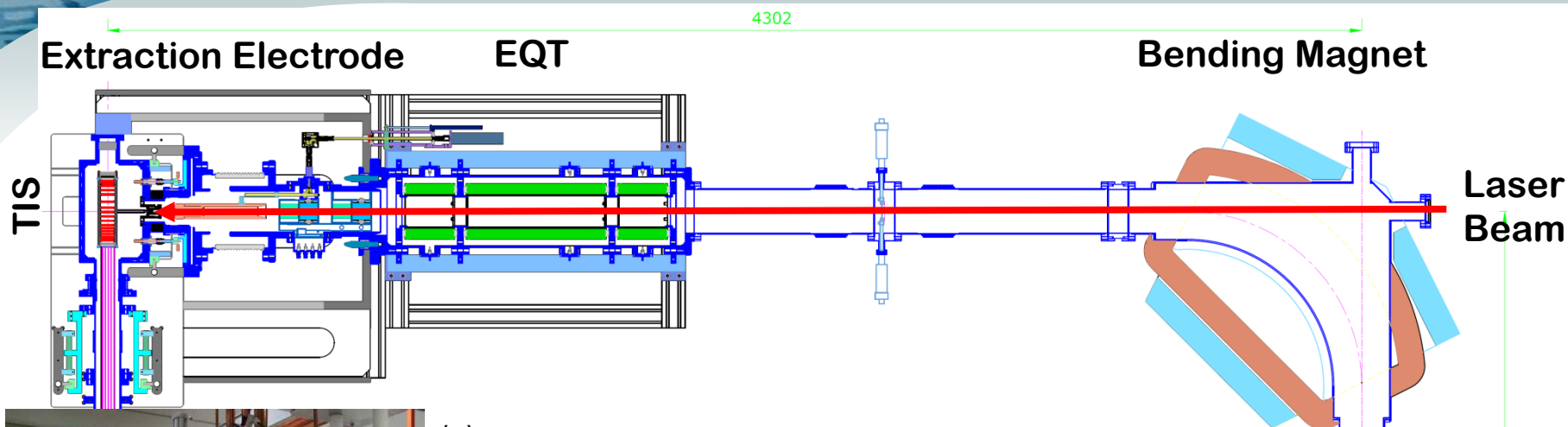


Ion beam extraction from 28 GHz ECRIS



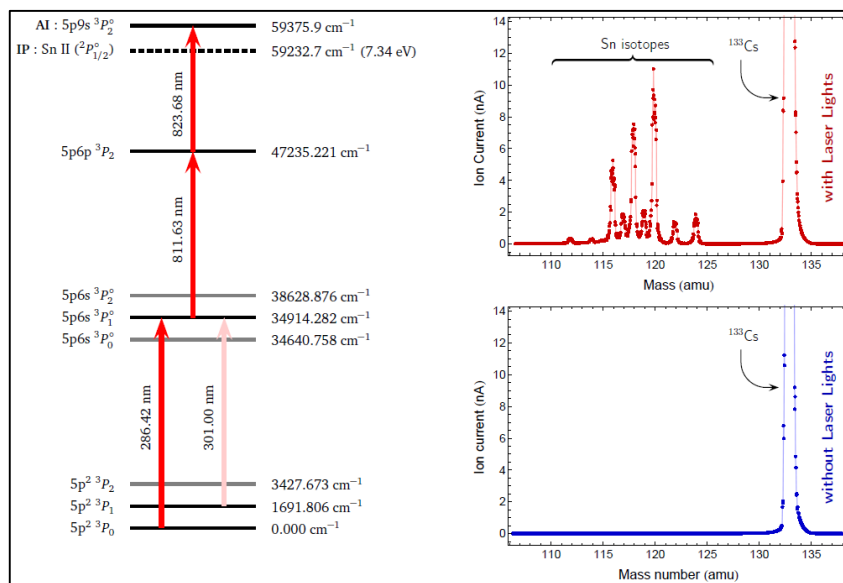
- O7+ of 30euA was extracted
- Ar11+ of about 70euA was extracted
- there are some issues and on going beam improvement

Ion beam extraction from ISOL test bench



TIS @~2000°C

Laser System



Sn mass spectrum w/ RILIS

Beam diagnostics

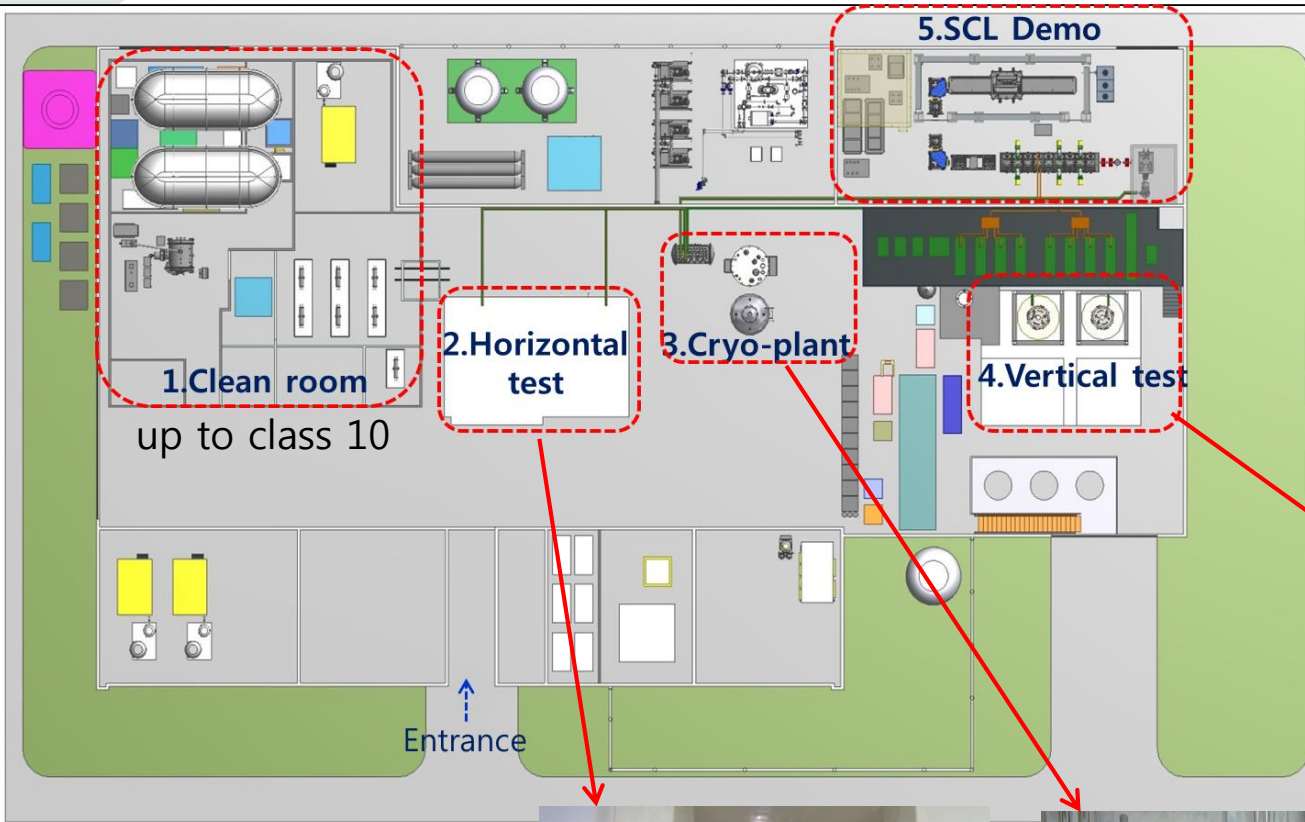
2415

SRF Test Infrastructure (off-site test facility)

Performance test of SC cavities and cryomodules

Quality control of SC cavities and CMs delivered by vendors in mass production

Start operating
from June, 2016.



Cryomodule test



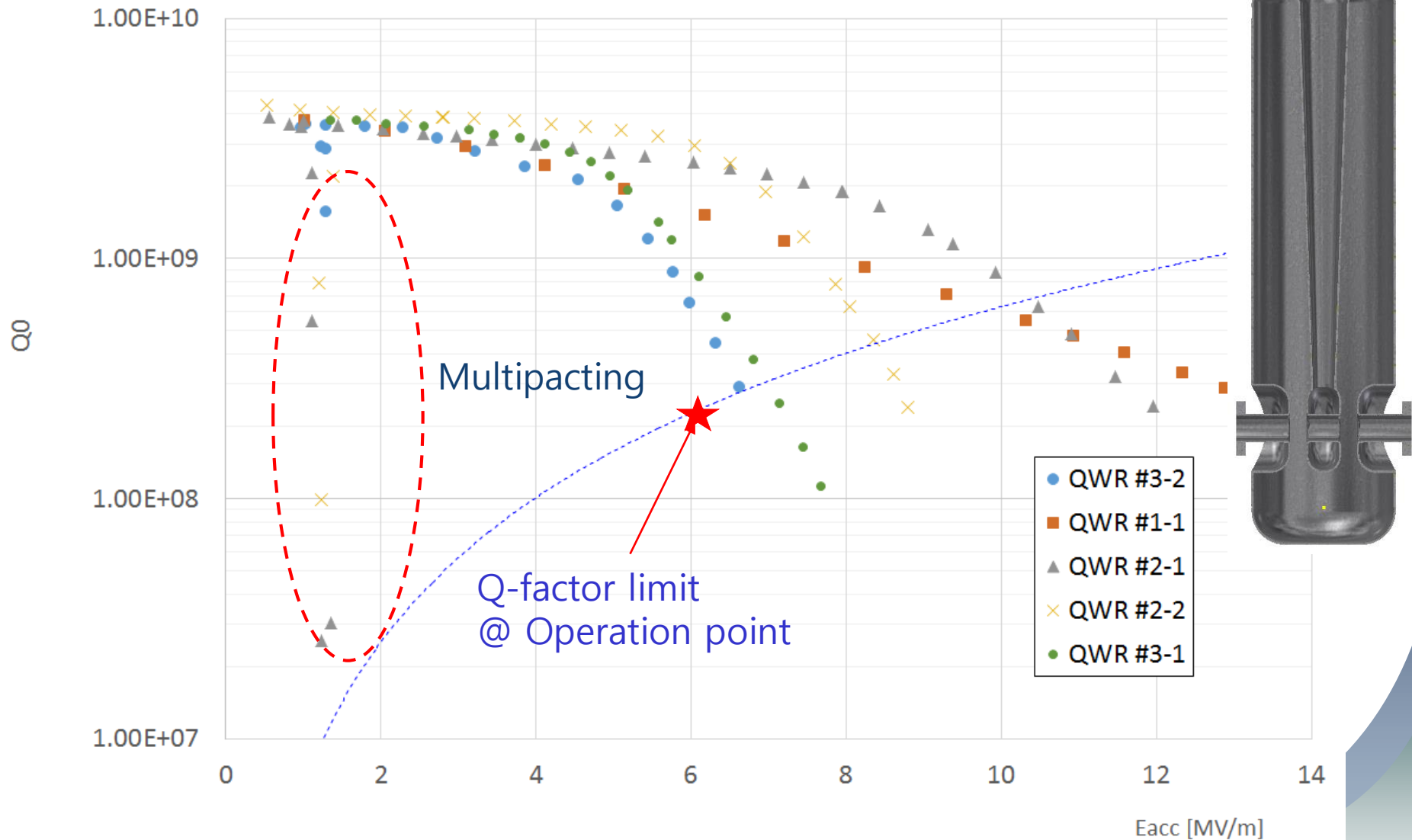
LHe system (330 W at 4.5 K)



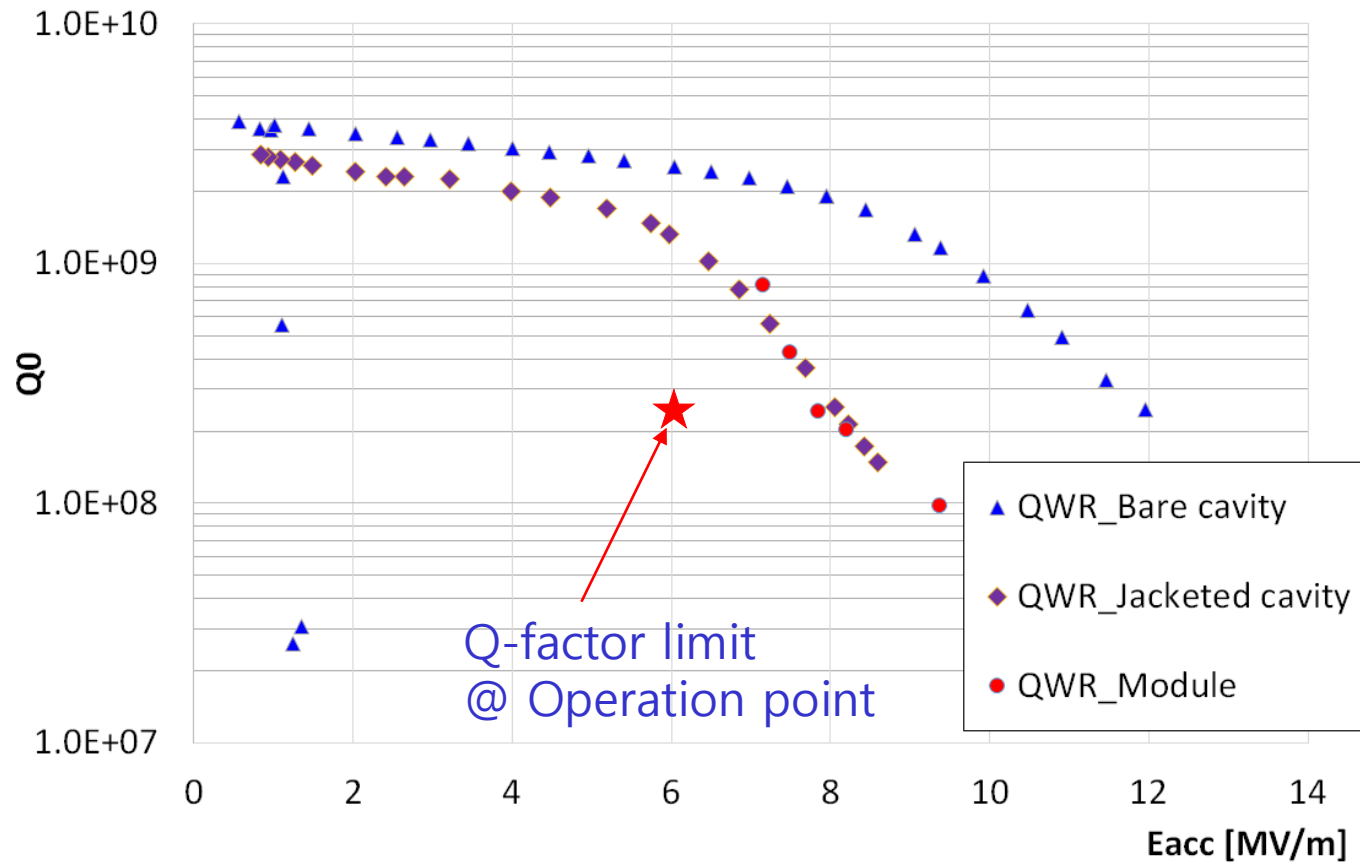
Vertical cavity test

Performance Test of Superconducting Cavities

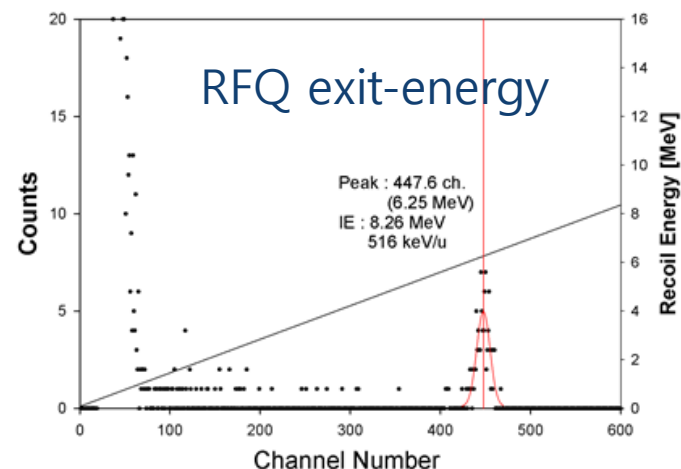
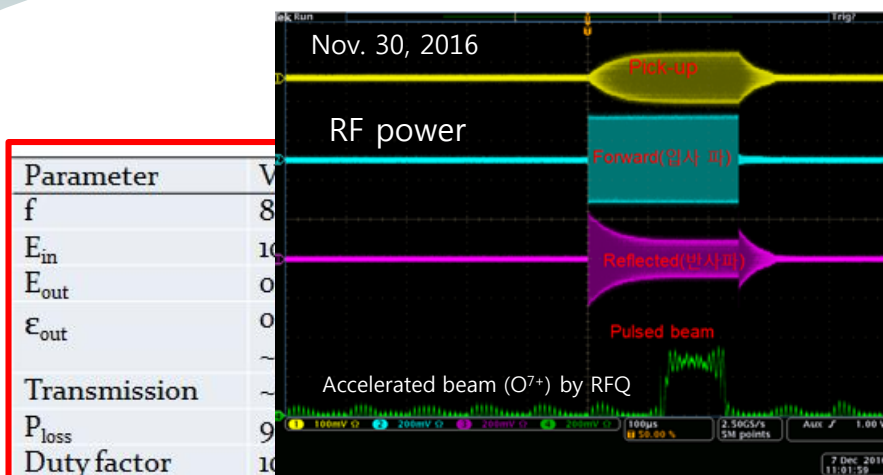
5 Quarter Wave Resonators(QWRs) are fabricated and tested



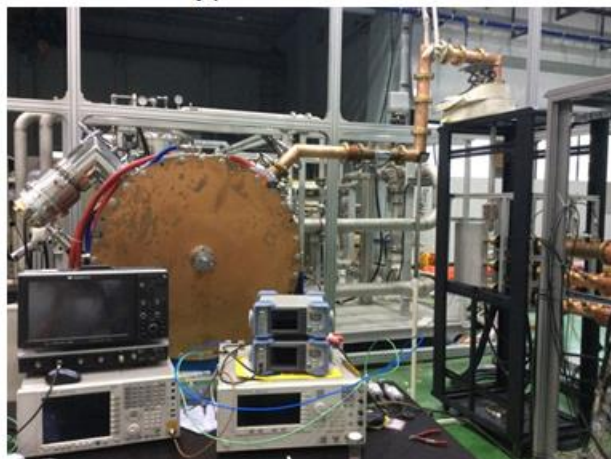
QWR(#2-1) performance test



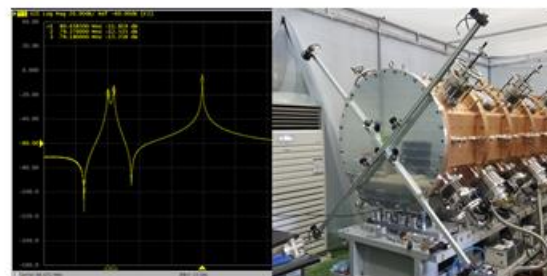
Beam acceleration by RFQ in 2016



Prototype test: ~15 kW CW



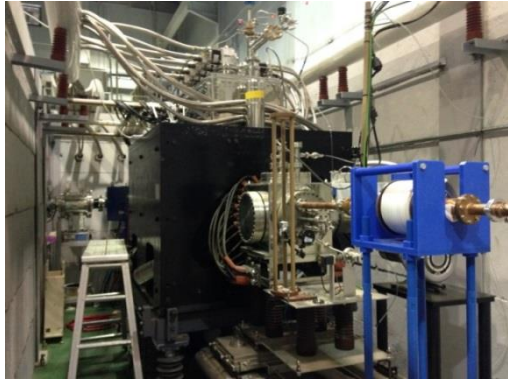
Nine segments of the RFQ aligned



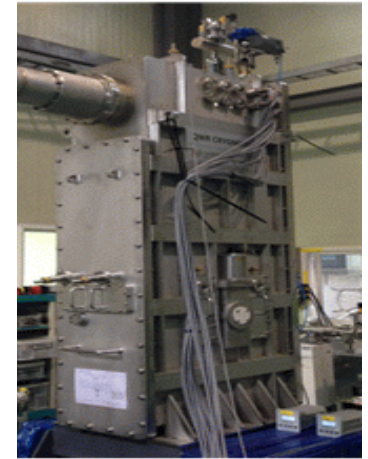
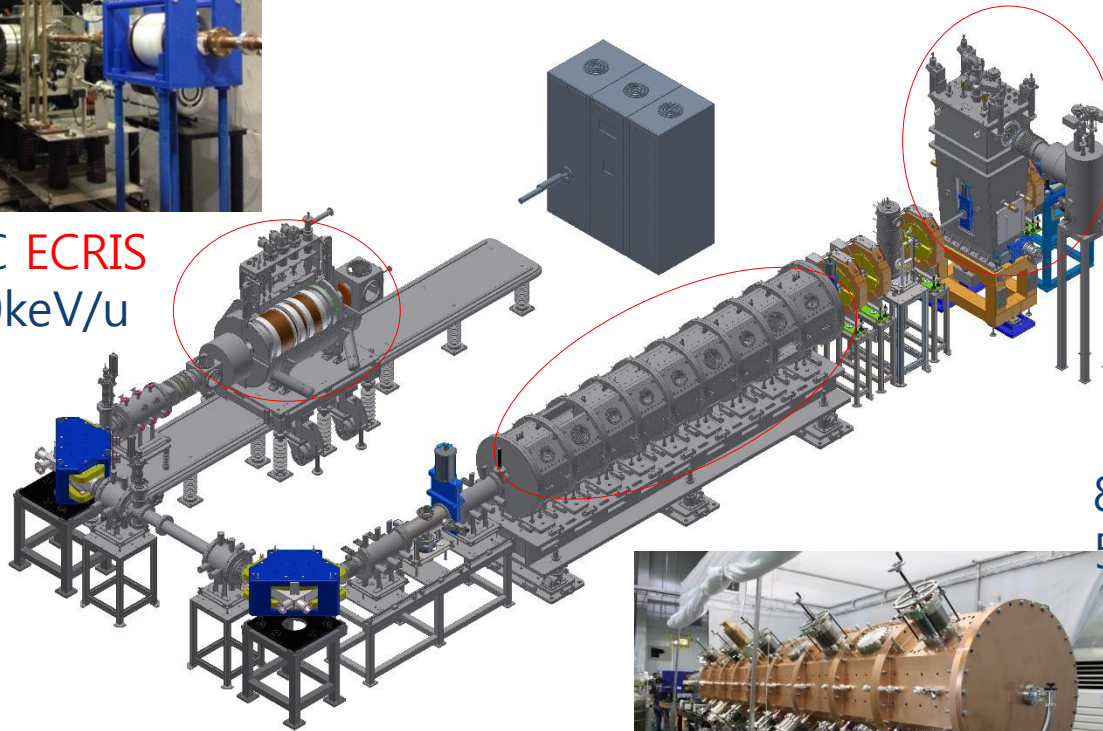
Field tuning underway with a bead-pull method (Aug. 2016)

Demonstration System

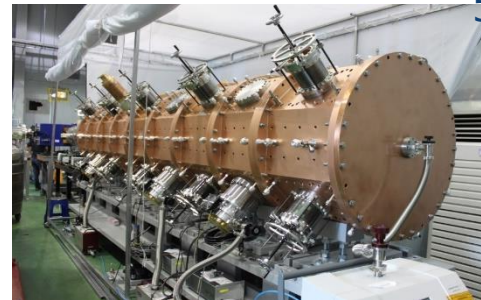
- For integral test of key accelerator systems
- Sub-systems is installed
 - **ECR-IS**, LEBT, **RFQ**, MEBT, **QWR**
 - Aux systems: Cryogenic system, RF system, Beam diagnostics, Beam dump, etc.



28GHz SC **ECRIS**
 $A/q \sim 7$, 10keV/u



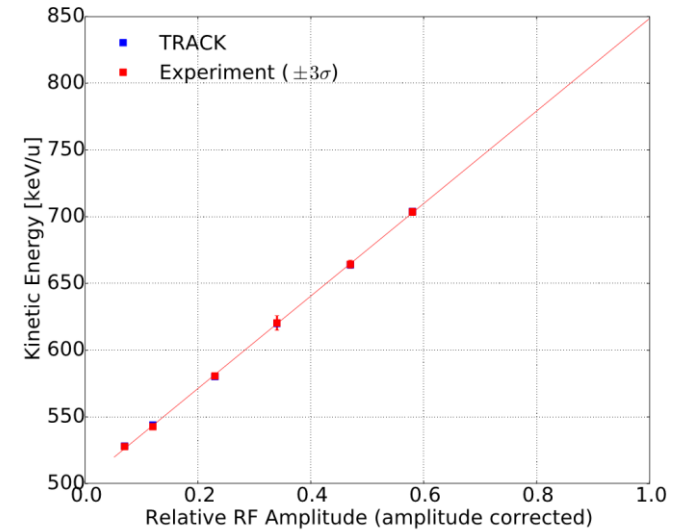
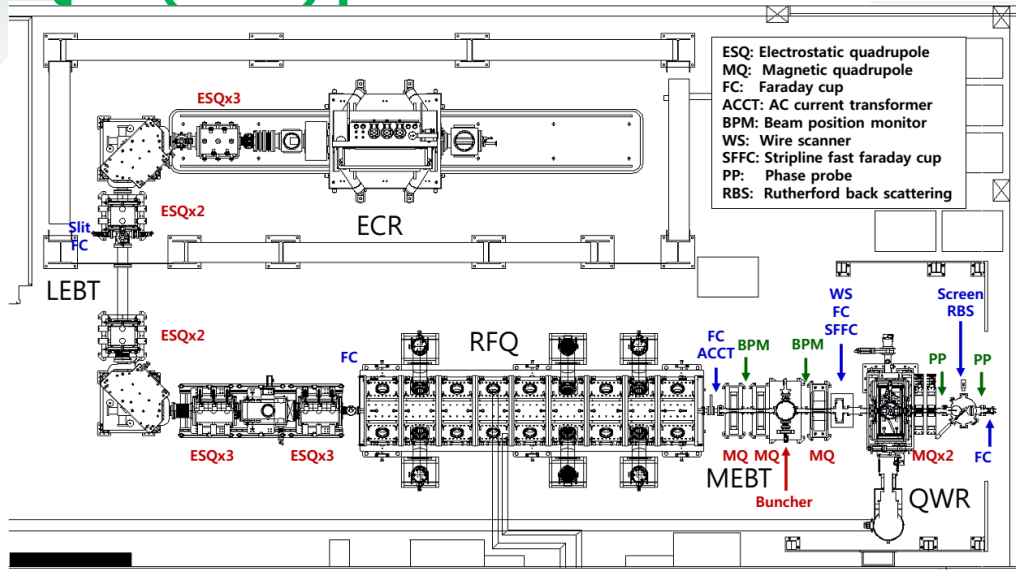
81.25MHz **QWR**
500keV/u $\rightarrow$ > 530KeV/u



81.25MHz **RFQ**
10keV/u $\rightarrow$ 500keV/u

Test Results of Demonstration System

QWR(#2-1) performance test



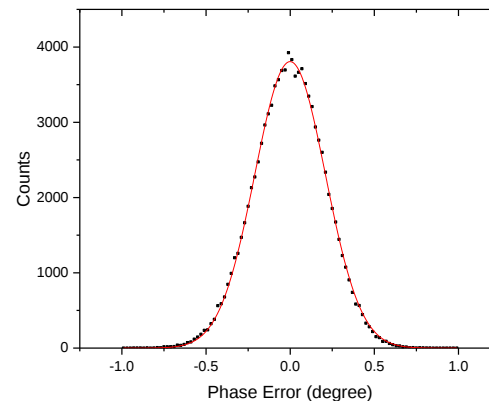
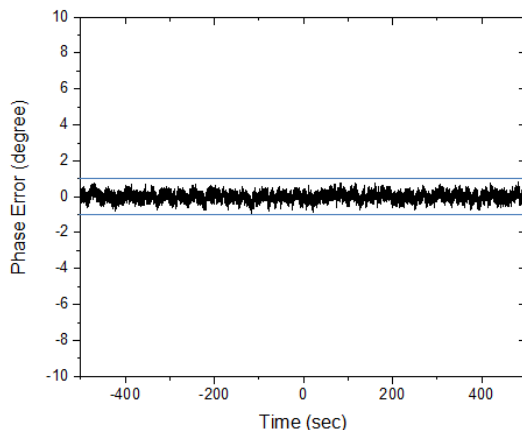
Beam: O^{+7} , 7uA

Accelerating:

507keV/u $\rightarrow$ 530keV/u $\sim$ 700keV/u

RF control

- Phase: ± 0.8 (PtoP), ± 0.2 (RMS)



Two horizontal bars, one above and one below the word 'Construction'. Each bar is composed of a dark blue segment and a light green segment. The top bar has the green segment on the left, and the bottom bar has the green segment on the right.

Construction

Bird-eye view on construction site (~'17.12.)



❖ Status of Construction('18.1)

- Bird-eye View : Accelerator Bldg., SRF Facility, Assembly Bldg.



- Accelerator Bldg. : Concrete work of B2F~B1F



❖ Status of Construction('18.1)

- Acc. Supporting Bldg.: Under Concrete work of B1F~1F

Utility bld. - B1F Wall & Slab Iron frame



Electricity Bldg. - PIT - MAT complete



Control bldg. - Foundation work complete



- Research Bldg. : Foundation work complete, Under iron frame work

SRF Facility & Assembly bldg. - Iron frame

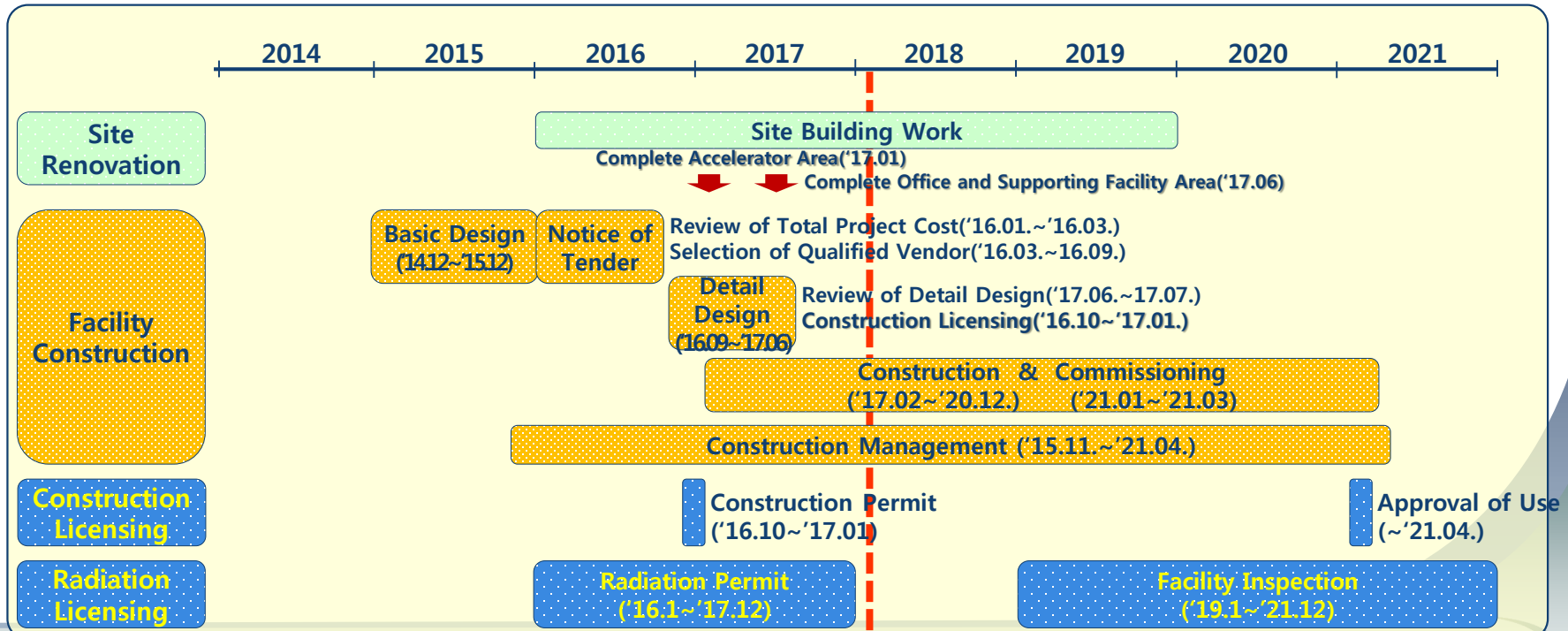


SRF Facility

Assembly Bldg.

Schedule of Construction Project

- ❖ ('18.10.) SRS Facility, Assembly Building complete
- ❖ ('18.12.) Accelerator Building(SCL3, Low Energy A, ISOL) Structure complete
- ❖ ('18.12.) Utility, Electricity, Control Bldgs complete & commissioning(~'19.3.)
- ❖ ('19.12.) 154kV power supply
- ❖ ('20.08.) Construction complete & commissioning(~'21.4.)



Development of accelerator and experimental systems of the RISP is on track with civil constructions

- Prototyping of major accelerator parts has been in progress since 2013 (after TDR)
- Some prototypes are in testing stage.
- **SRF test facility** is operating from June 2016.
- Under progress for the procurement of cavities, cryomodules etc...
 - QWR of SCL3 in 2017 was contracted (for **mass- production**)

- ❖ RAON- Rare isotope Accelerator complex for ON-line experiments
- ❖ Stable and Rare Isotope HI beams (accelerated properly) can open a new era in Korea for the research of basic science.
- ❖ Strong connections to applications and training
- ❖ Early operation of Low-Energy Facility from the mid of 2020

감사합니다.

