Experiments at the planned RIKEN Cooler Ring

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Present status of the RIKEN New Project --
RIKEN RI Beam Factory
Next Stage - Accumulation/Cooling Ring (ACR)
and Collider
Atomic Physics at ACR?

RIKEN Accelerator Research Facility (working)

Heavy ion accelerator complex with three accelerators.

Main accelerator

Ring cyclotron (RRC) (1986–)

Injectors

Heavy Ion Linac (1980–) for slower heavy ions (He–Bi)
up to 3 MeV/u

AVF cyclotron K70 (1989–) for light ions (H–Kr)
3.8–14.5 MeV/u

Maximum Beam Energy

proton 210 MeV
Ar 135 MeV/u
Bi 15 MeV/u

Research Fields (multi-purpose)

Nuclear physics
Atomic physics, Material Irradiarion
Chemistry (tracer, Moessbauer..)
Biology (animals, plants, cells..)

Radio Isotope (RI) Beams

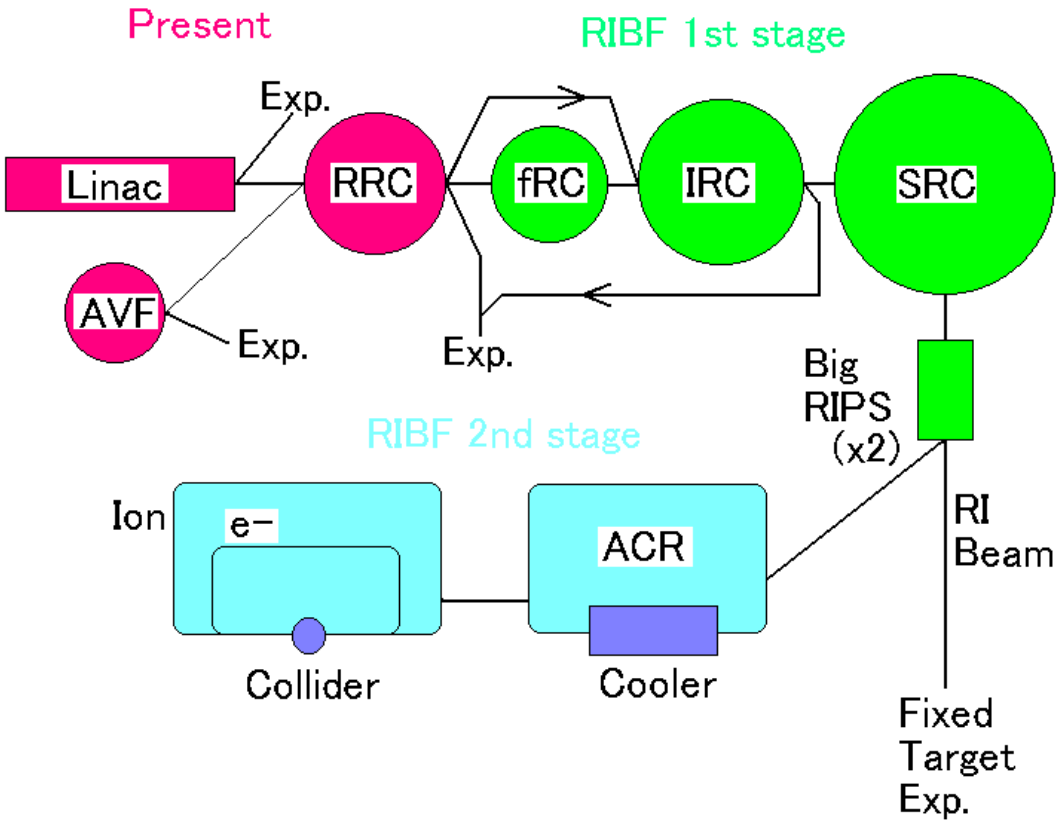
RIKEN Projectile fragment Separator (RIPS)
Light and medium heavy nuclei (Mass<60)
like ^{8}He, ^{9,11}Li, ^{12,14}Be, ^{14,15}B, ^{16}C, ^{32}Mg, ^{57}Mn
Intensity 10^{2}–10^{7}p/s
Widely used for nuclear physics and chemistry

Radio Isotope Beam Factory (RIBF)

(Under construction since 1997)

Overview

Extension of the present accelerator facility
for more variety of RI beams
(over whole range of atomic number)
at higher energy intensity and quality
(above 100MeV/u, 10^7pps, continuous)



Present status (red) and future plan (green for 1st stage, blue for 2nd stage of RIBF) of the RIKEN accelerator facility.
RRC denotes the present ring cyclotron, fRC and IRC new conventional ring cyclotrons, SRC superconducting ring cyclotron, Big RIPS two fragment separators and ACR accumulator cooler ring.
Linac will be used for the beam injection to RIBF.

Production of RI beams (1st stage; 1997-2005)

1) New post accelerators

(Conventional and superconducting ring cyclotrons)
accelerate ions from the present ring cyclotron to

100 MeV/u for heavy ions,
400 MeV/u for light ions
with intensity of 10^{13}p/s.

2) Fragment separators (Big RIPS)

RI ions are produced from the accelerated ion beams by projectile fragmentation or fission.
The RI ions are momentum and charge-state selected for a high-quality RI beam.
Two separators:

- Super-conducting, high acceptance -> In flight fission
- Normal-conducting, low acceptance ->
  Fragmentation

Typical quality (depends on species and mass)

- Momentum spread; 0.5%
- Transverse emittance; 4.5 π mm mrad
- Intensity; 10^7 (10^9) pps continuous,

Storage and Collider Rings (2nd stage; 2002-2009?)

1) Accumulator Cooler Ring (ACR) for improvement of the RI beam quality

2) Collider for electron-RI ion scattering experiments

Accumulation Cooler Ring (ACR, 2007)

Accumulation/cooling of RI beam and injection to Collider ring

Multi-turn injection and RF stacking

+ Stochastic cooling (small number of ions)

+ Electron cooling (large number of ions)

Circumference: 146m

Magnetic rigidity: 8Tm

Energy: Light ions, 400 MeV/u

Heavy ions, 100 MeV/u

Electron-Ion Collider Ring (2009?)

Intersecting ion and electron storage rings:

for e-nucleus collision experiments

to study structure of RI nuclei.

Accelerator developments needed.

Possibilities of AP Research at ACR

Characteristics of ACR

Similar to ESR in size

Optimized for RI beam

High acceptance (H125π/V40π mm･mrad)

Short accumulation and cooling time

No RF accel./Decel. (except for RF Stacking)

Atomic Physics Experiments

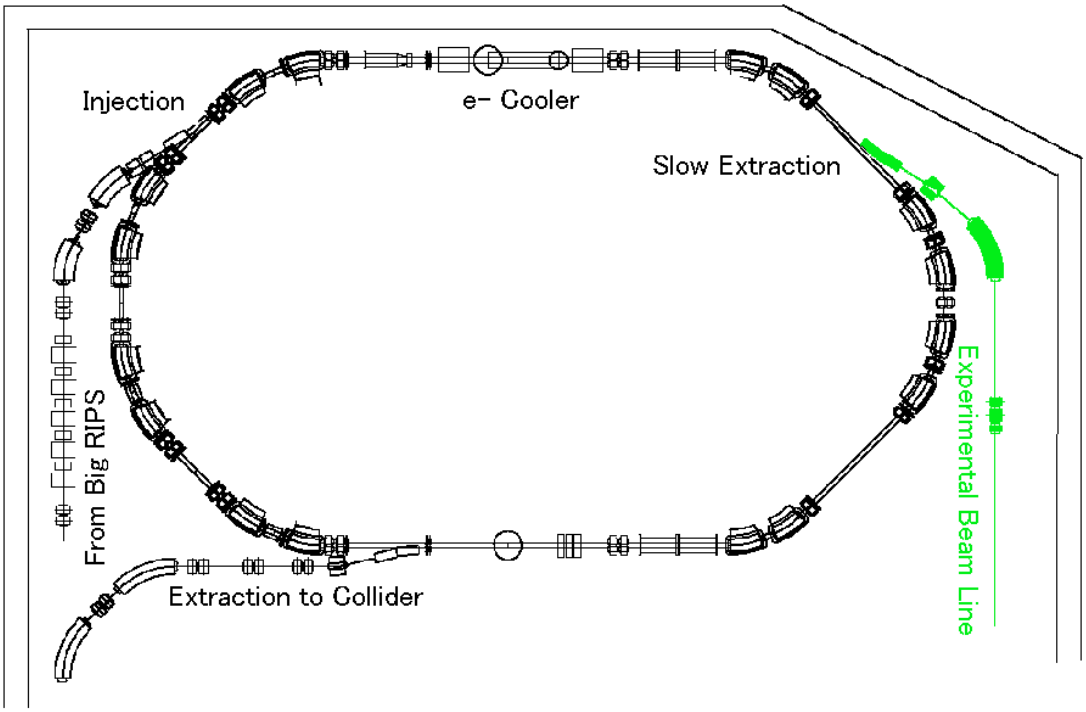
Extracted beam by recombination

Beam extraction by electron recombination at cooler

High quality and DC beam

Low intensity (10^3–10^4/s)

Parasitic experiments



Hspectroscopy of highly-charged ion by Crystal-assisted resonant excitation

Highly charged ion spectroscopy
Planar channeling condition in single crystal
High resolution (FWHM 100ppm)
Absolute value for transition energy
(Precision within 10ppm)
Low intensity but high quality beam

Being studied by KOMAKI K, YAMAZAKI Y. et al
at HIMAC, Japan

For detail,

K. Komaki et al, "Resonant coherent exctation of 390 MeV/u Ar ions planar channeled in Si crystals", Nucl. Instrum. and Methods in Phys. Res. B 146 (1998) 19.

T. Azuma et al., "Impact Parameter Dependent Resonant Coherent Excitation of Relativistic Heavy Ions Planar Channeled in Crystals", Phys. Rev. Lett. 83 (1999) 528.