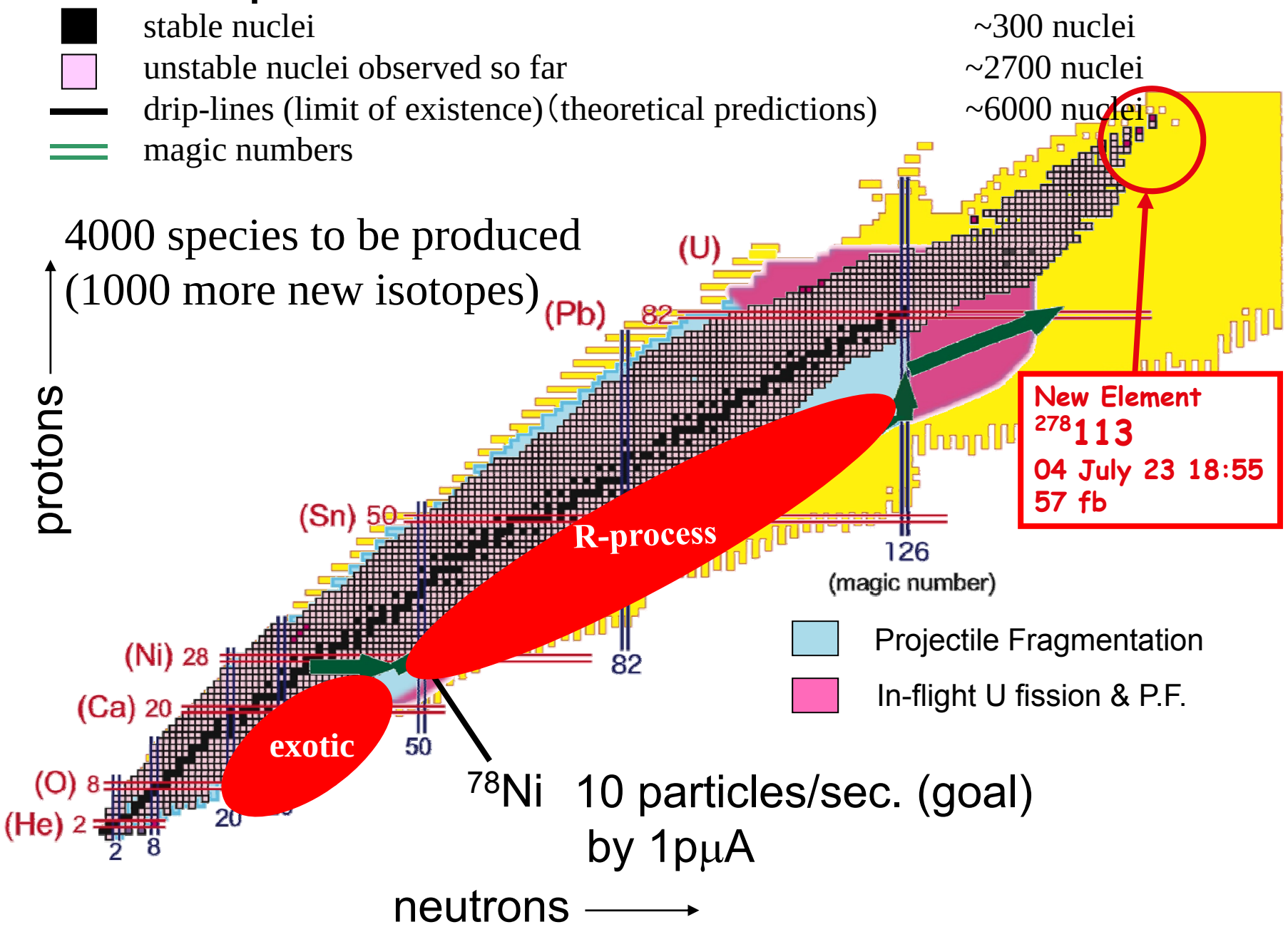
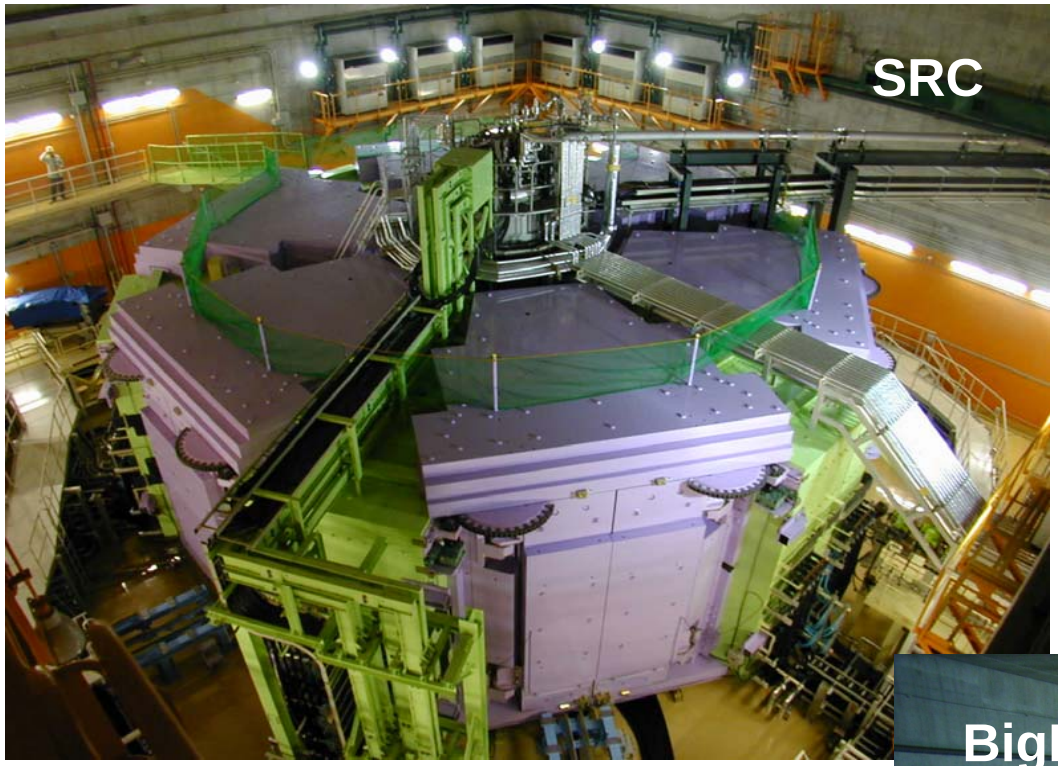
Overview of R I B F

H. Sakai
User Liaison and Industrial Cooperation (ULIC) Division in RIBF

1. Operation/management of RIBF
2. Status of accelerators
3. EURICA project

Exploration of the Limit of Existence





World's First and Strongest
K2600MeV
Superconducting Ring Cyclotron

400 MeV/u Light-ion beam
345 MeV/u Uranium beam

World's Largest Acceptance
9 Tm
Superconducting RI beam Separator

~250-300 MeV/nucleon RIB

RIBF Layout as of 2011

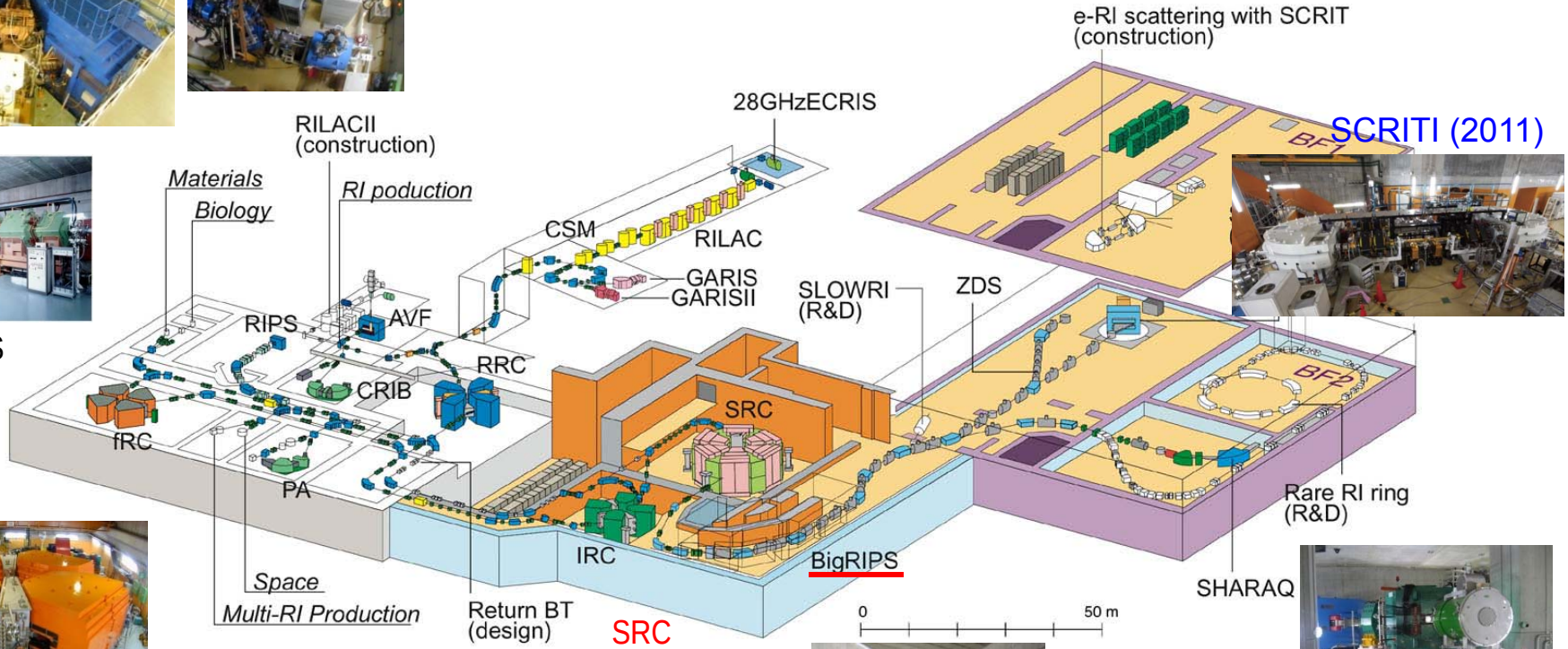
RILAC

RRC

ZeroDegree (ZDS) (2008)

SAMURAI (2011)

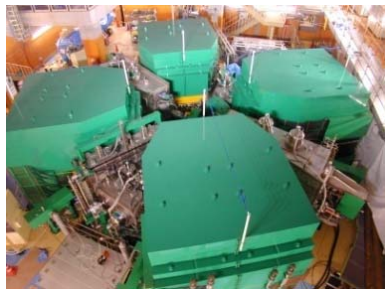
RIPS



SCRITI (2011)

fRC

IRC



SRC

BigRIPS (2007)

SHARAQ (2009)

Courtesy of Ueno-san

Operation/management of RIBF

Beam time at RIBF

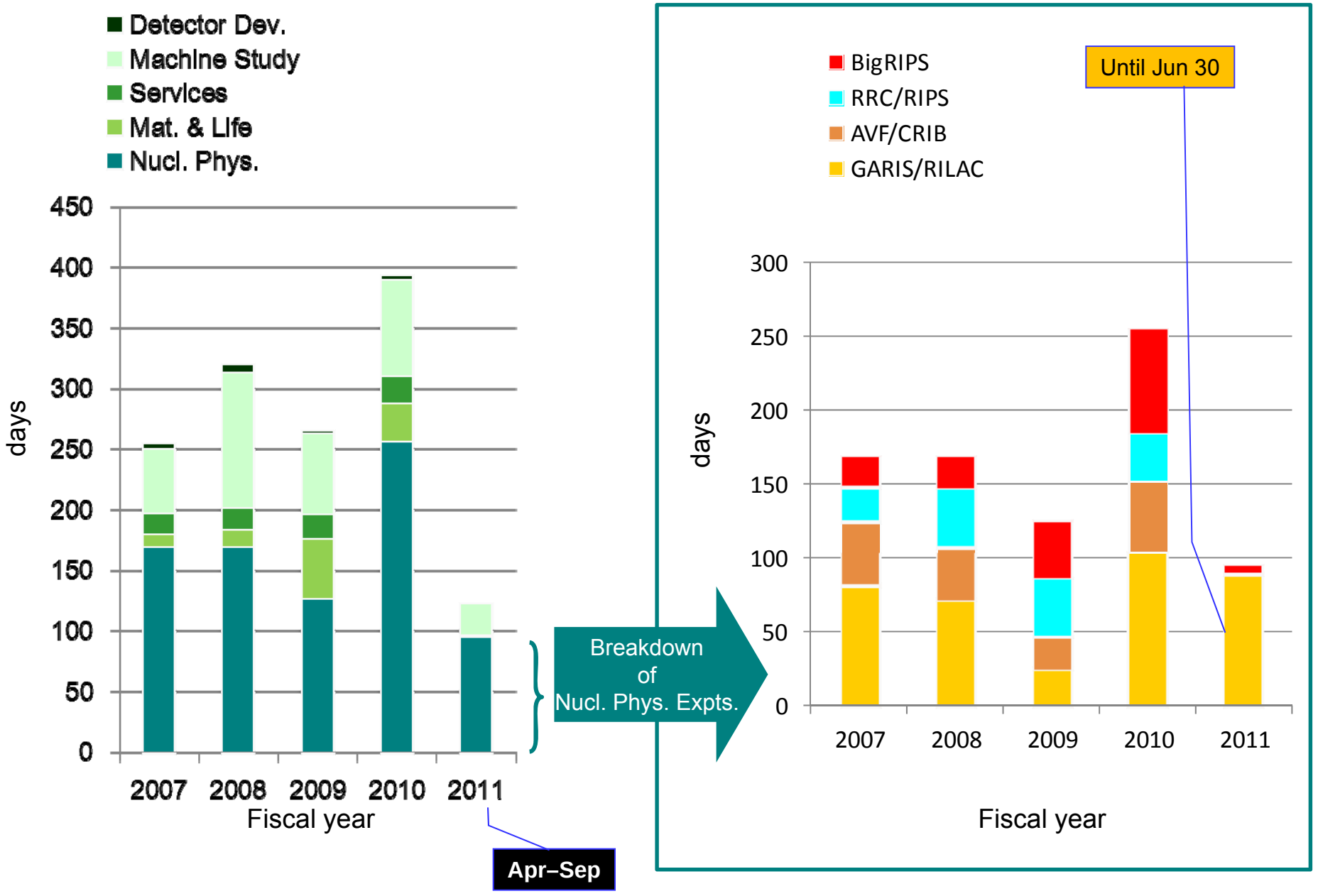
- **Driven by PACs**
  - ➢ Experiments
  - ➢ Development
  - ➢ Construction of equipment
- **RNC initiative**
  - ➢ "service" (plant breeding, isotope production, …)
  - ➢ Accelerator development
  - ➢ Commissioning of basic equipment
  - ➢ Educational experiments for undergraduate students
- **Large backlogs (243(311) days only for RIBF exp.)**
  - ➢ due to insufficient operation-budget (5.1 months)
  - ➢ accelerator conditions (SRC down)

FY2011 planned to have 8 months operation.

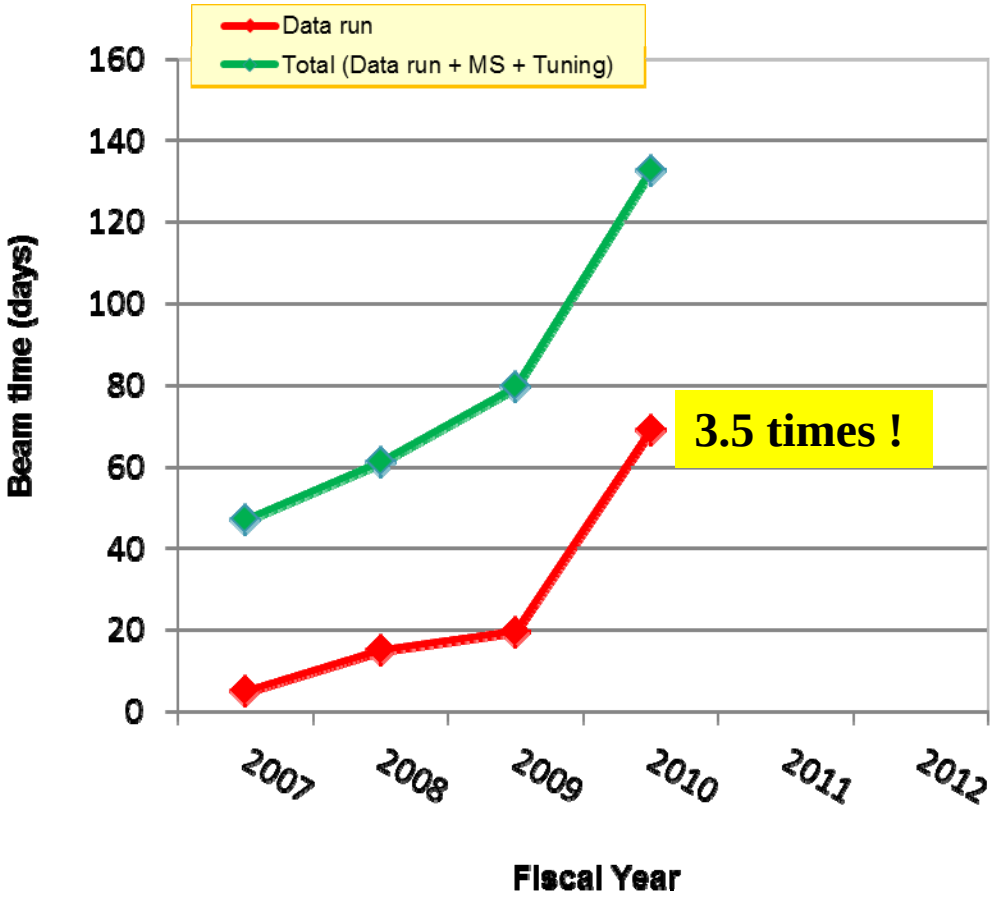
- In FY2012, backlog will be reduced to 180 days (1.5 years.)
- Two-year beam plans.

- **Maximize the available BT for SRC-BigRIPS based experiments.**

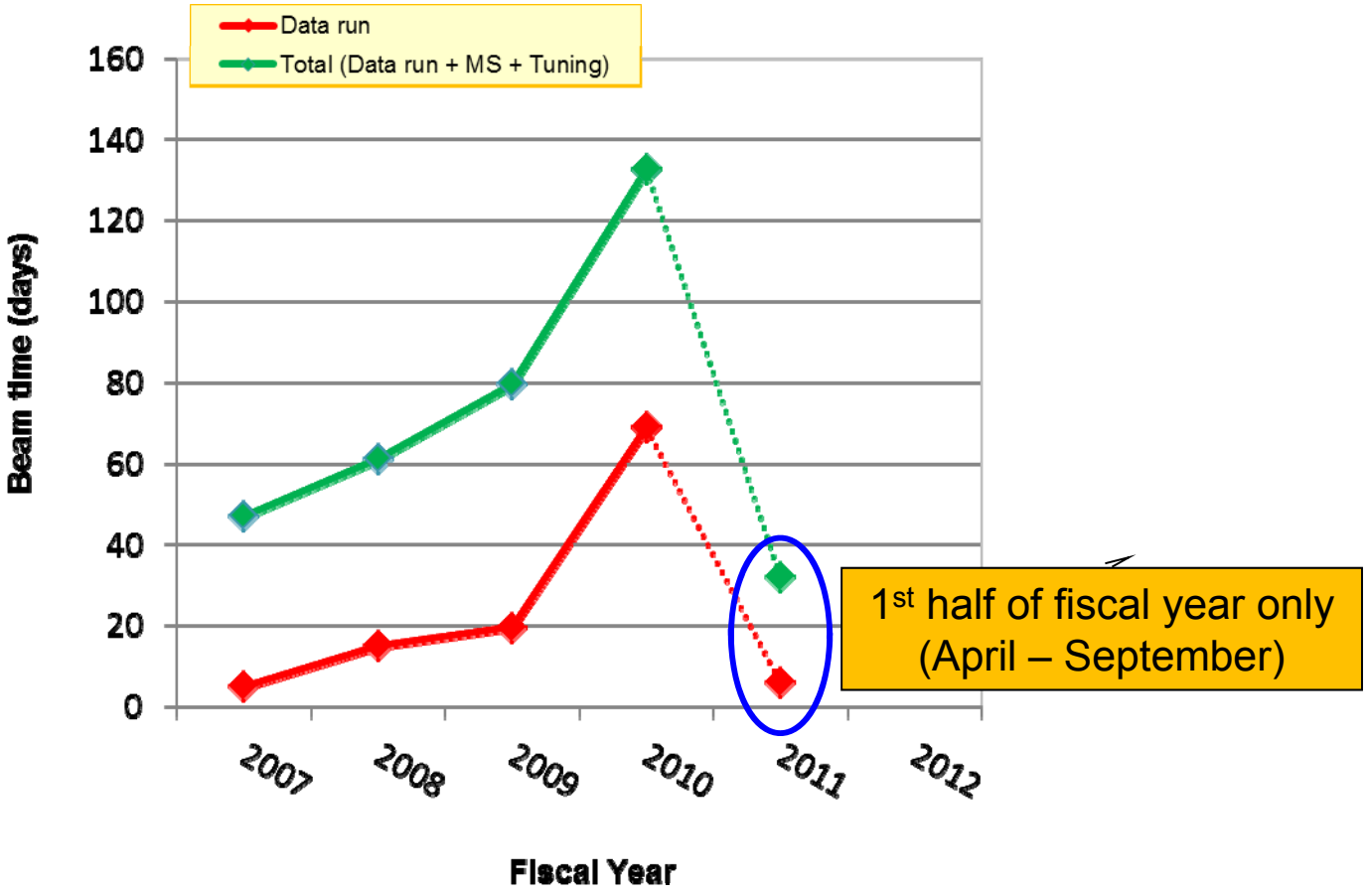
Total beam time for experiments



Total beam time for BigRIPS experiments

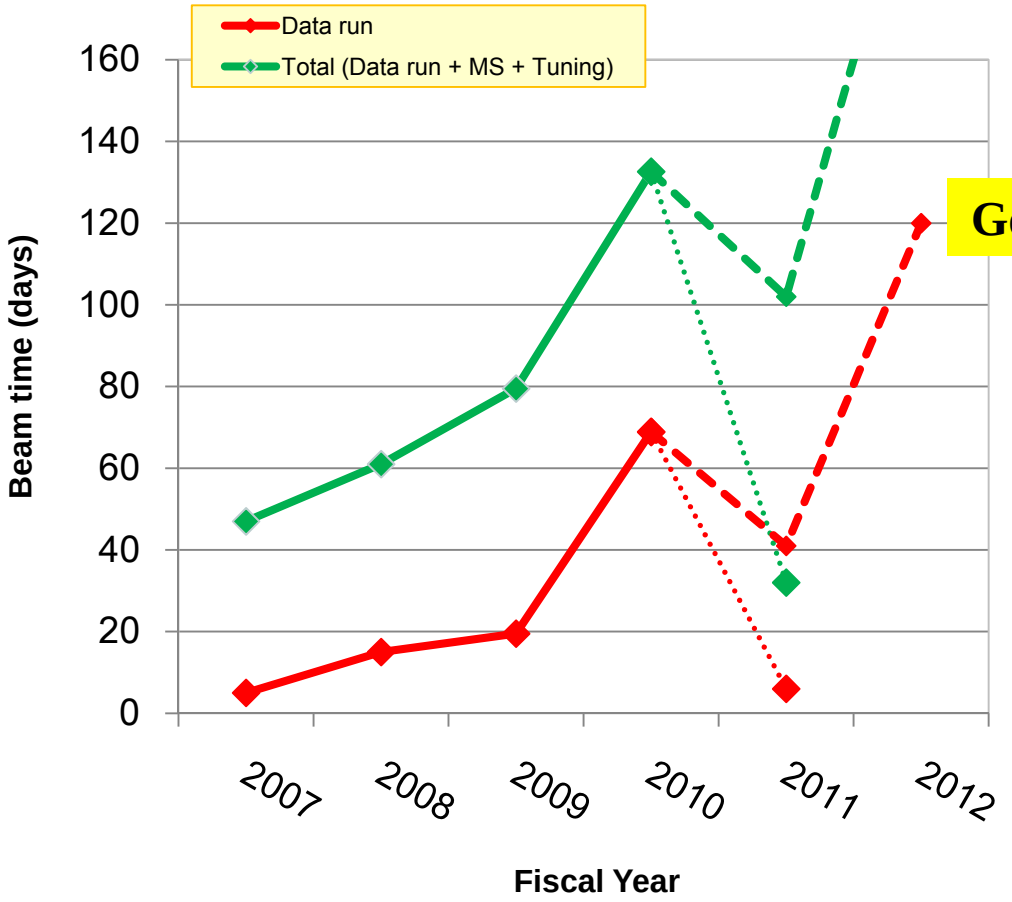


Total beam time for BigRIPS experiments



Total beam time for BigRIPS experiments

8 months operation in FY2012



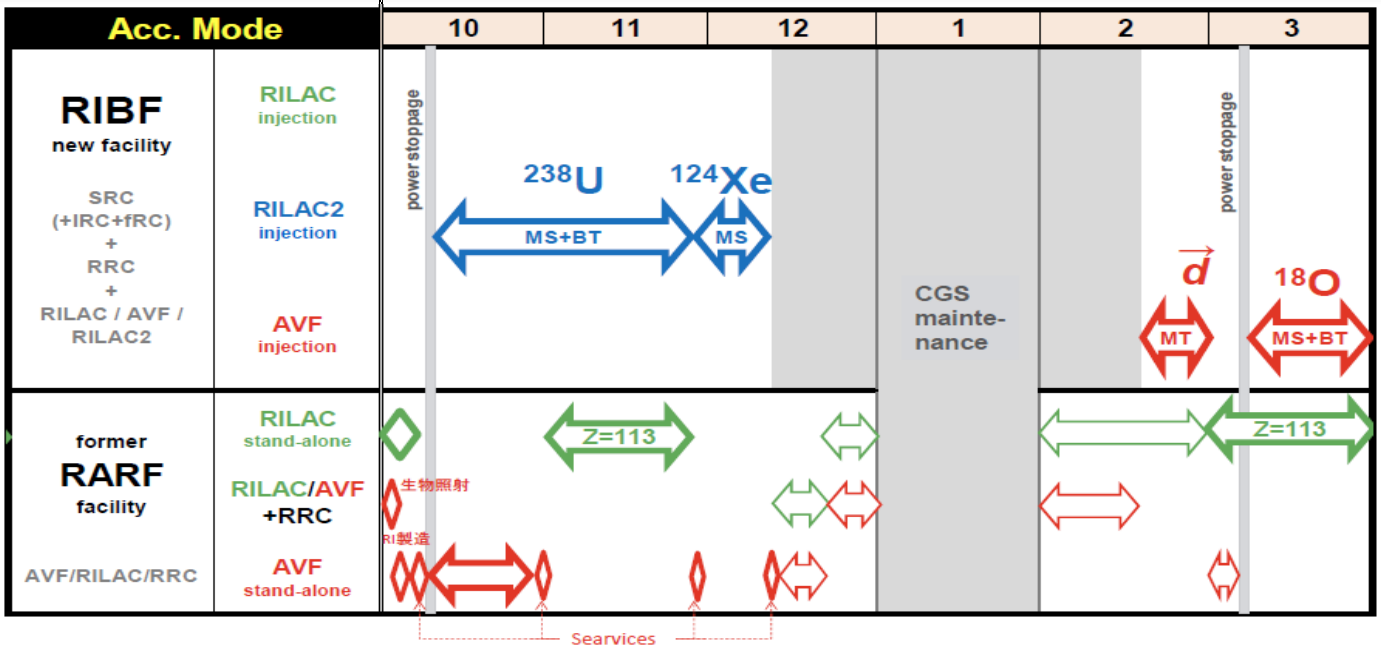
Goal 120 days.

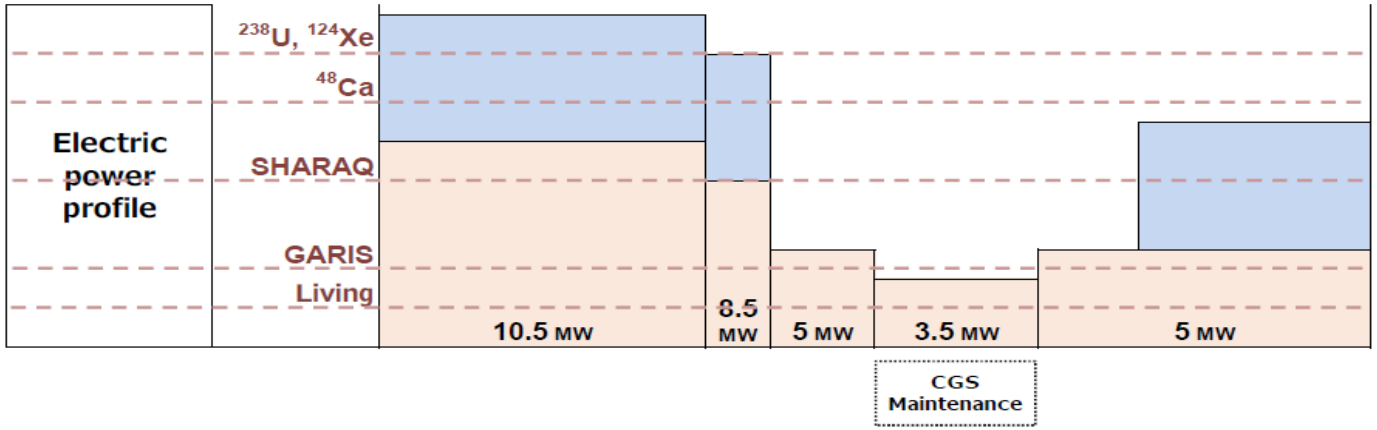
8 months operation = 216 days
(1 month = 27 days at RIBF)

BT schedule of 2nd half of FY2011

Priority
1. RIBF exp. (emphasis on ^{124}Xe, ^{238}U beams)
2. SHE exp.

Power saving





Tentative two-year plan for RigRIPS-based experiments

- **Maximize the available BT for SRC-BigRIPS based experiments.**

2011	Spring	Machine study & U commissioning
	Autumn	^{238}U & (^{124}Xe)
2012	Winter	^{18}O (Samurai commissioning) & AVF inj.
	Spring	^{238}U & ^{124}Xe or (^{48}Ca) & AVF Inj.
	Autumn	^{238}U & ^{86}Kr & ^{48}Ca & AVF Inj.
2013	Winter	(open)

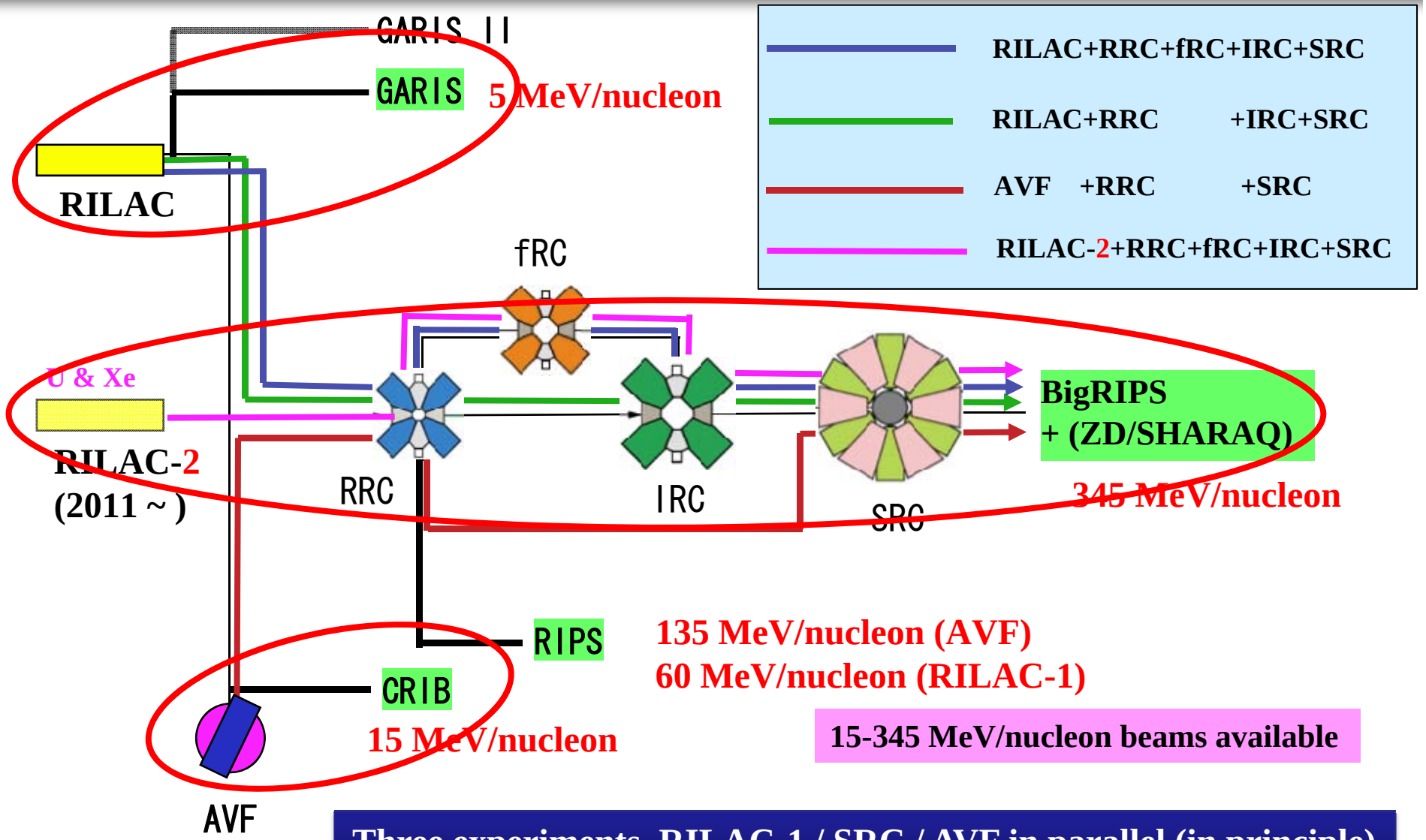
Now

8 months

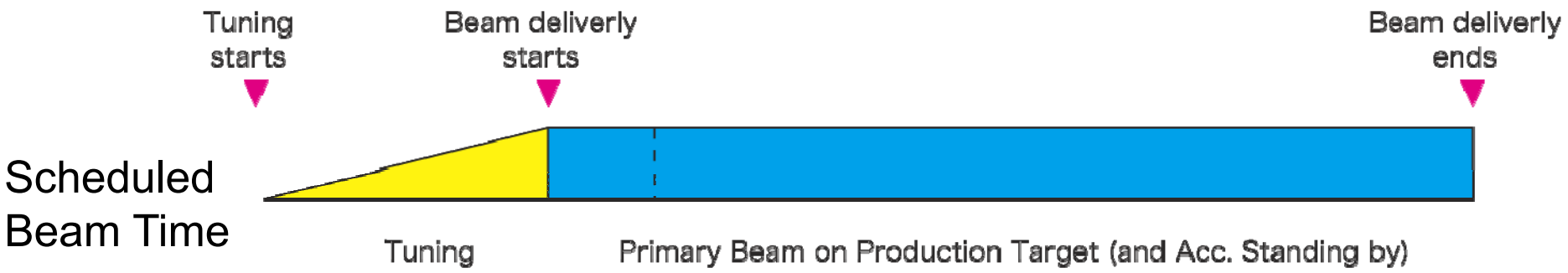
Courtesy of Kamigaito-san

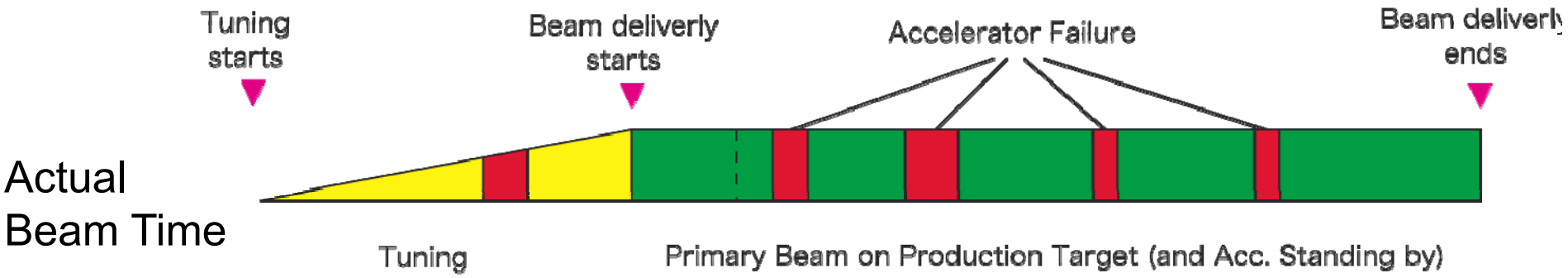
Status of Accelerators

RIBF accelerator operation scheme



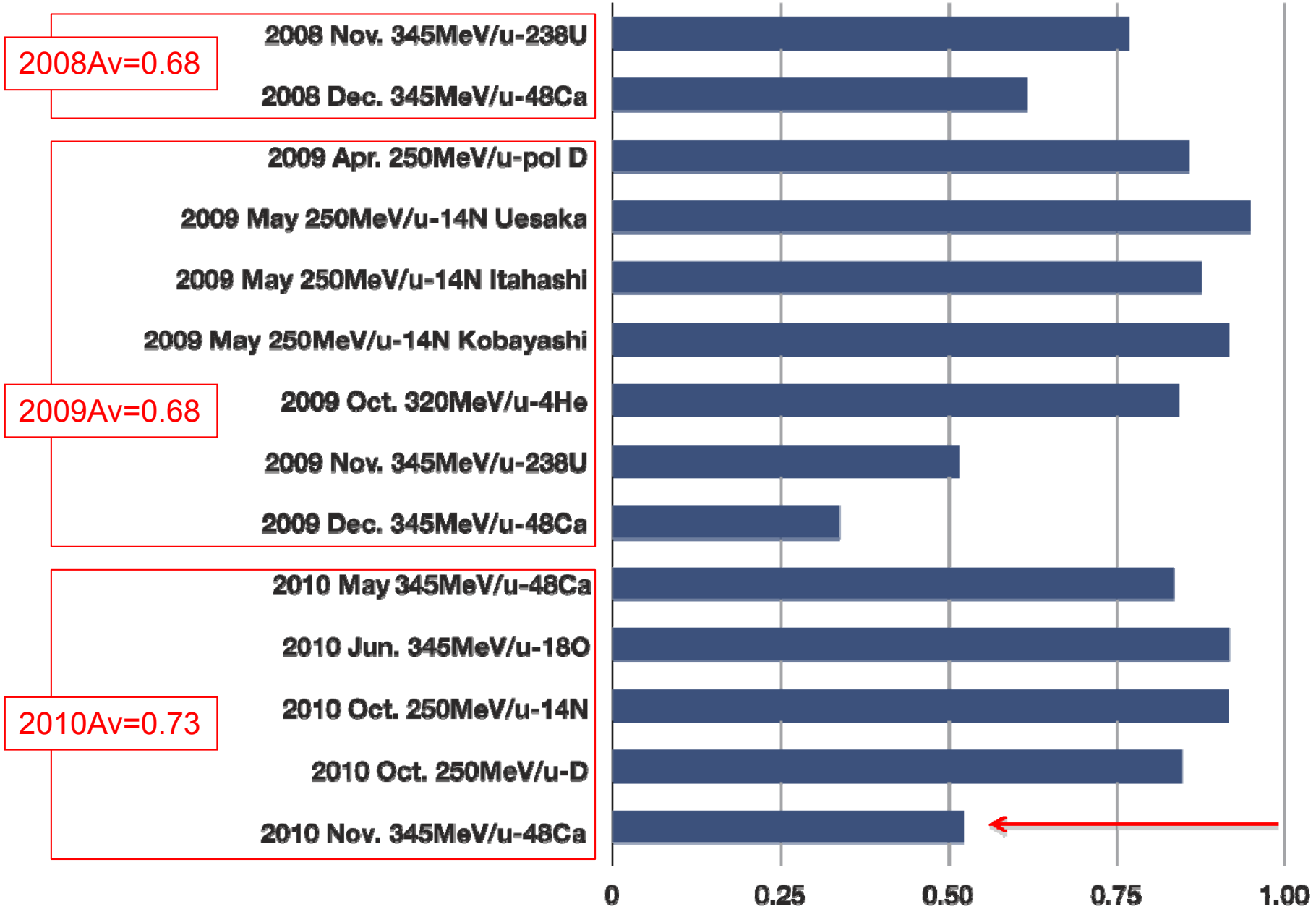
Efficiency (“Machine Efficiency for Beam-on-(Production)Target”)





“Machine Efficiency for Primary Beam-on-(Production)Target” $\equiv \dfrac{\sum}{}$

Evolution of efficiency for RIBF exp.



Available beams at RIBF accelerator complex

Heavy-ion primary beam intensities at RIBF

	Ca	Kr	Xe	U
announced intensities for FY2010	200 pnA	30 pnA	10 pnA	5 pnA
achieved (maximum)	230 pnA (Jun. 2010)	30 pnA (07/11/04)	12 pnA (May 2011)	0.8 pnA (Dec. 2009)

Under development

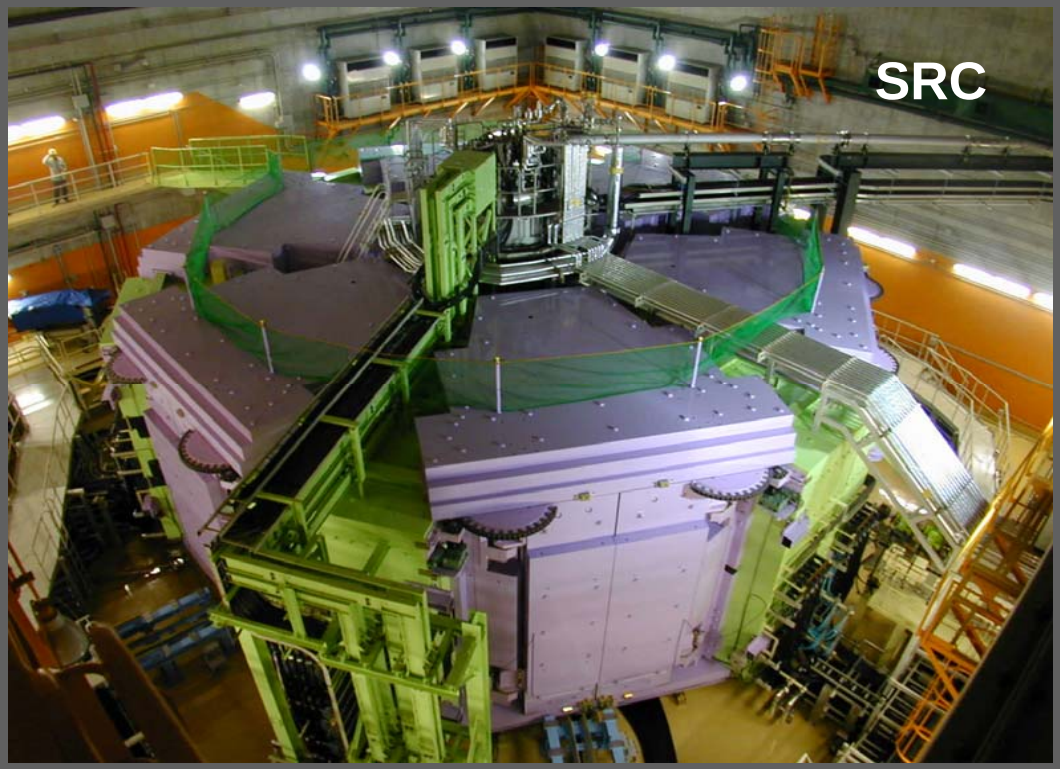
Light-ion beams(achieved)

Pol. d (250 MeV/nucleon) : pol. ~ 80 % (April 2009)
d (250 MeV/nucleon) : 1000 pnA (Oct. 2010)
^{4}He (320 MeV/nucleon) : 1000 pnA (Oct. 2009)
^{14}N (250 MeV/nucleon) : 400 pnA (Oct. 2010)
^{18}O (345 MeV/nucleon) : 1000 pnA (Jun. 2010)

Priority of beam development

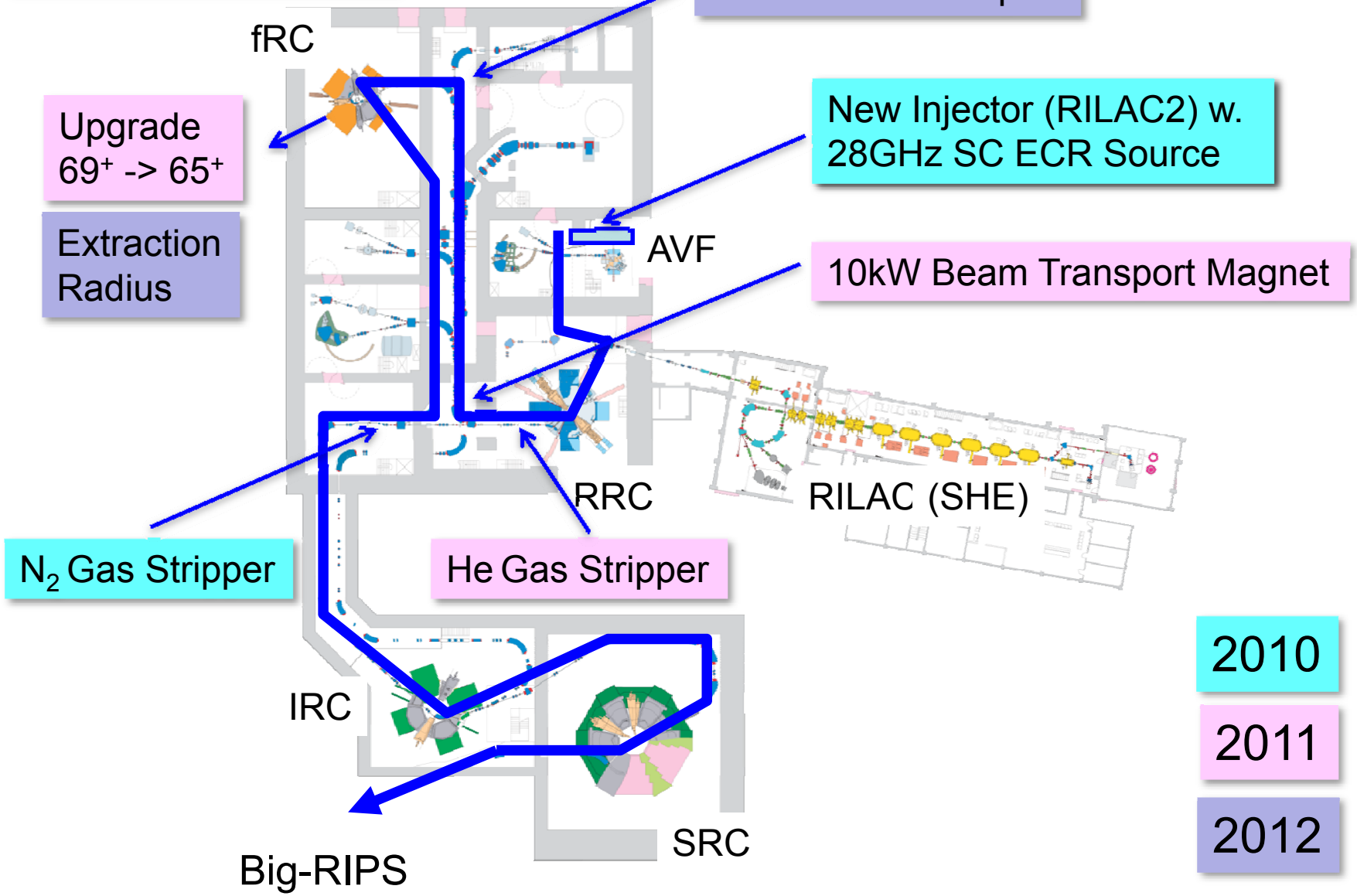
1 ^{238}U RILAC-2 inj. >5 pnA in Fall, 2012(….)
2 ^{70}Zn RILAC-1 inj. (stripper foil test needed)
3 ^{86}Kr (*) RILAC-1 inj. (stripper foil test needed)
4 ^{76}Ge RILAC-1 inj. (wait for new oven system)

How to achieve >10 pnA ^{238}U(345 MeV/u) beam and beyond ?

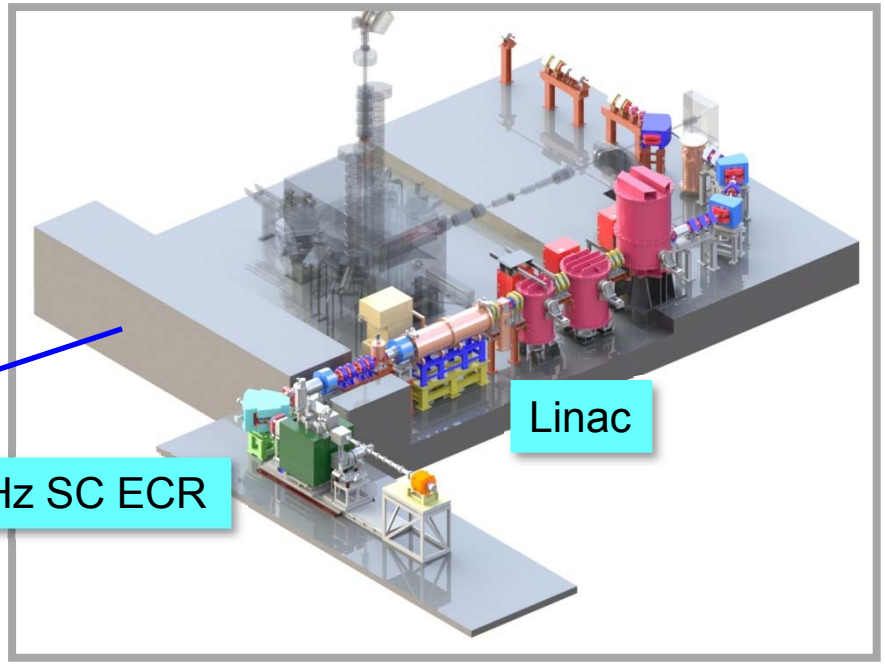


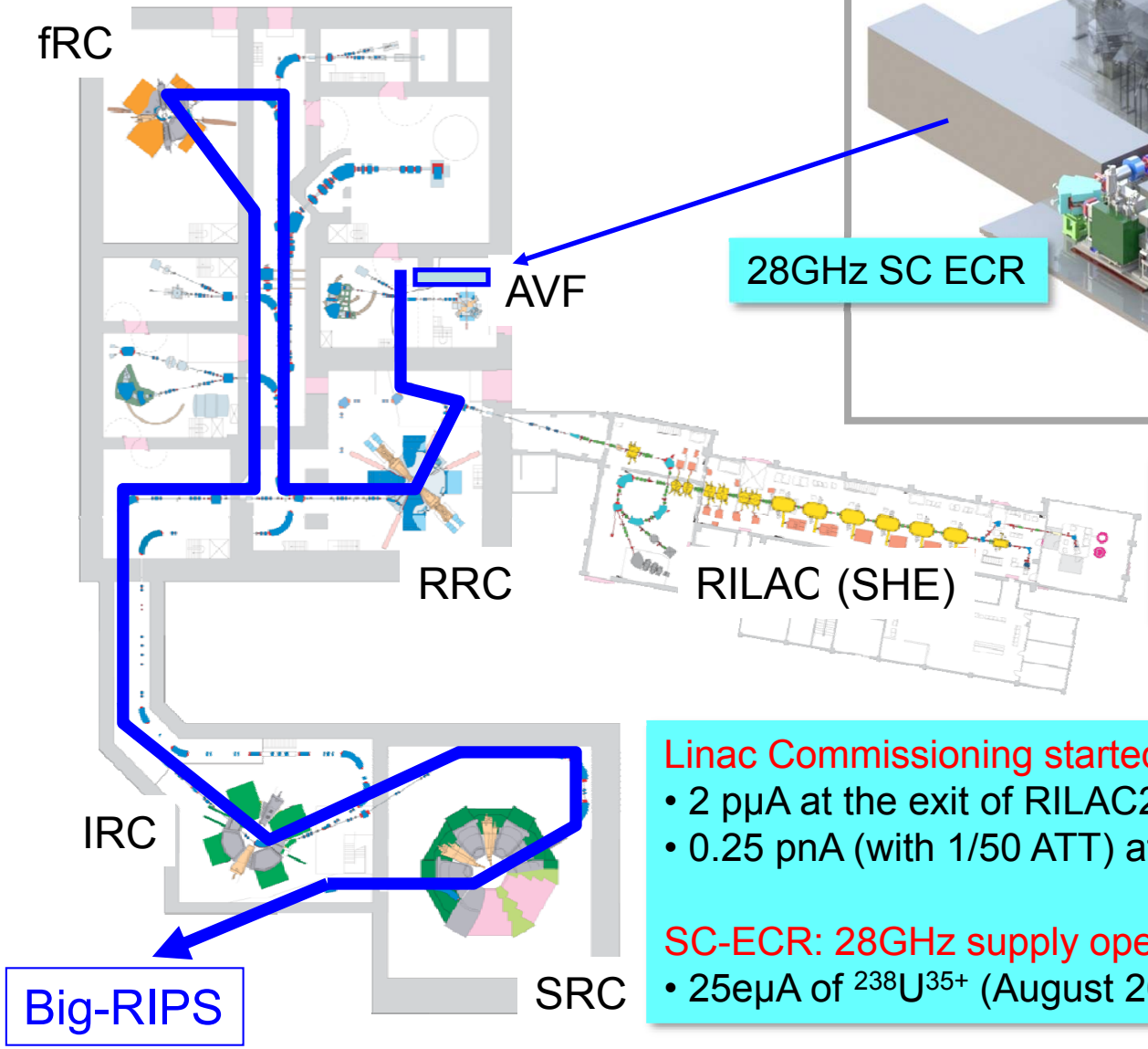
1. RILAC2 injector linac construction
2. 28 GHz ECR ion souce
3. Gas charge stripper
4. Modification of fRC cyclotron

RIBF Upgrades



New Injector (RILAC2)



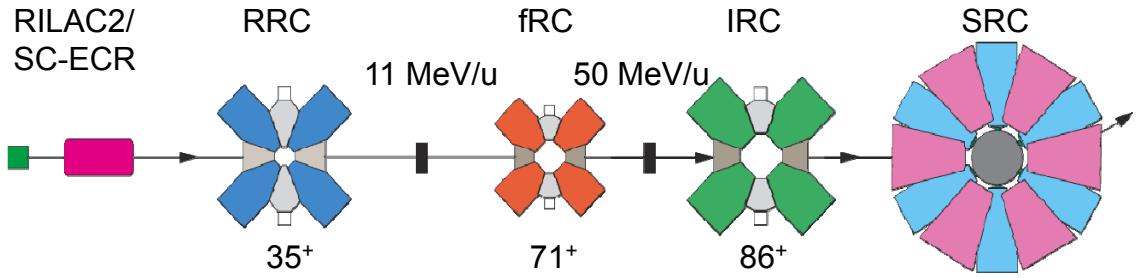


Independent operation of
- SRC (with Xe & U)
- RILAC1/GARIS (SHE)

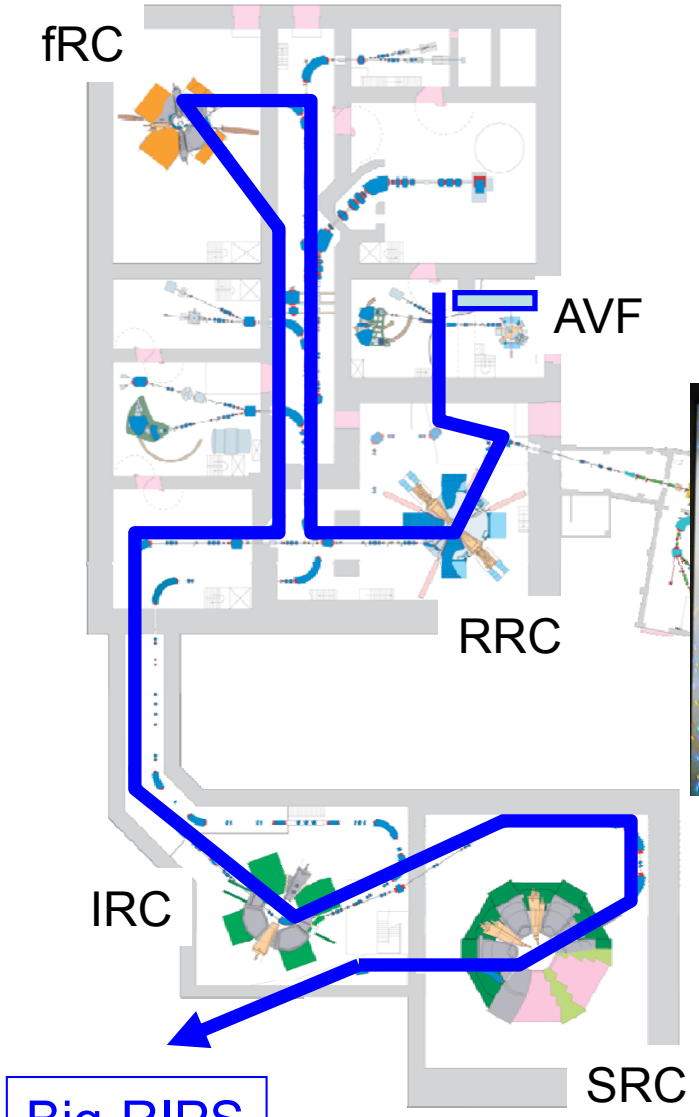
Linac Commissioning started in Dec. 2010 with ^{124}Xe
- 2 pμA at the exit of RILAC2 (May 12)
- 0.25 pnA (with 1/50 ATT) at the exit of SRC (May 18)

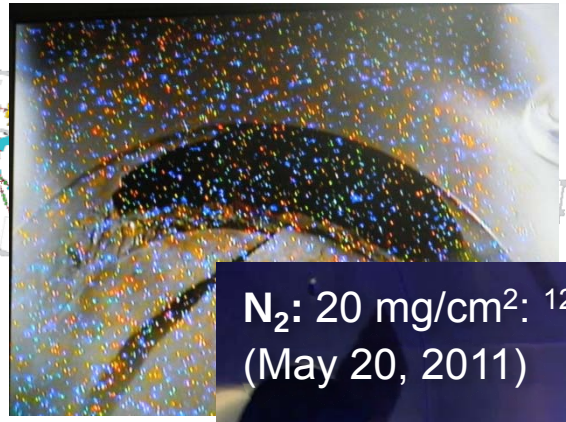
SC-ECR: 28GHz supply operational
- 25eμA of $^{238}U^{35+}$ (August 2011)

Charge Strippers

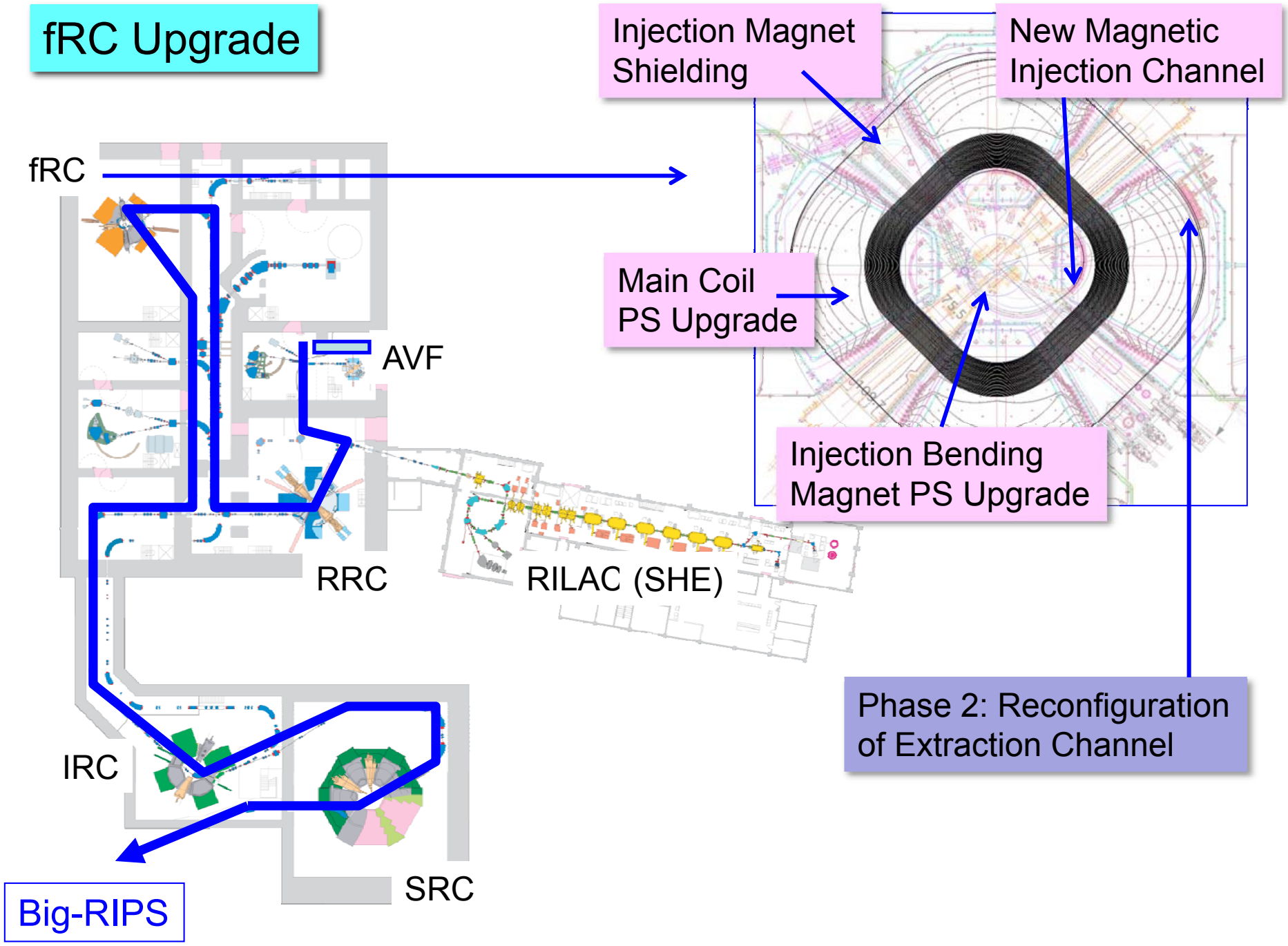


Foil Stripping	Carbon		Carbon		
	17%	x	27%	→	5%
Stripper Lifetime	~ 12h		few hours		
Gas Stripping	**He**		**N_2**		
	∞		∞		

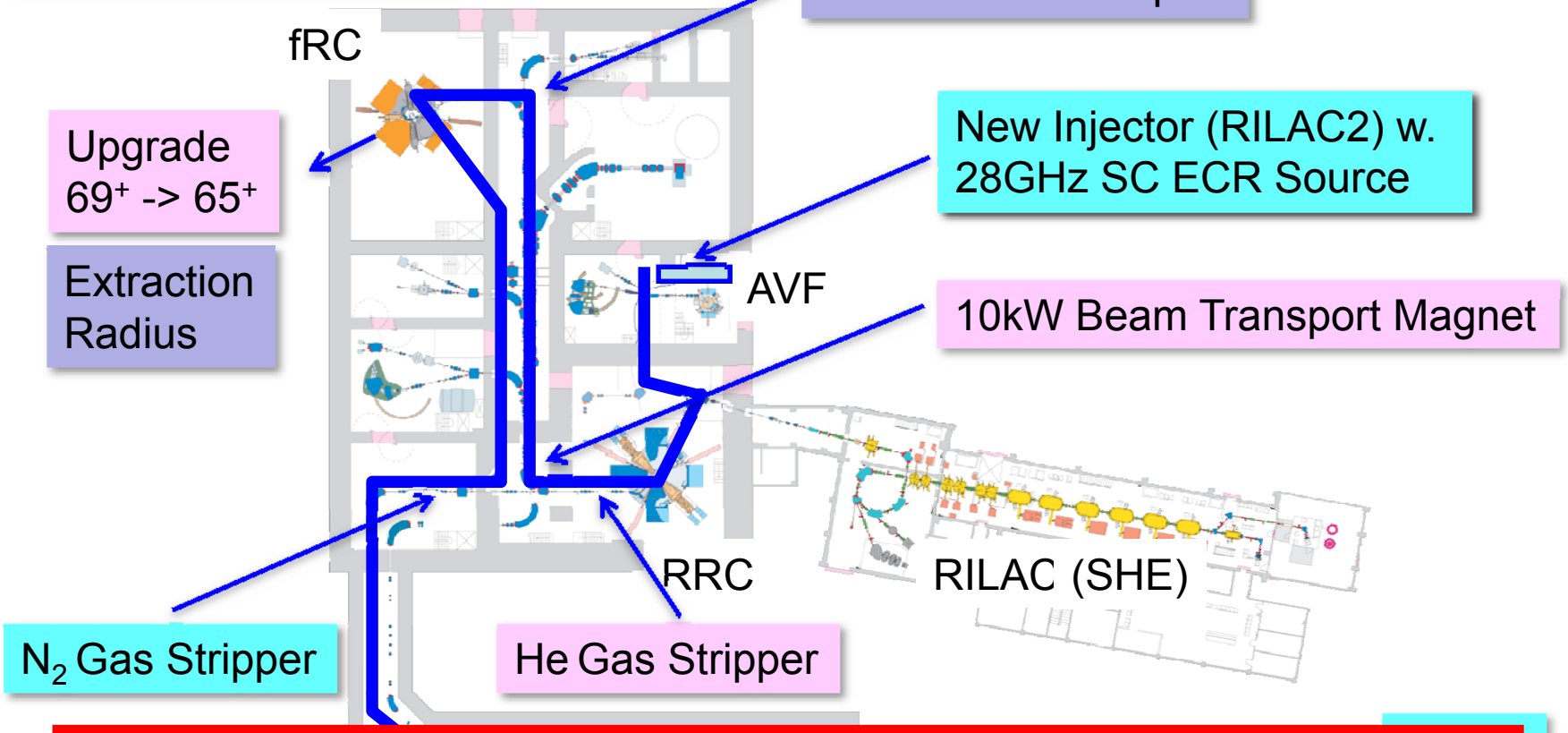




fRC Upgrade

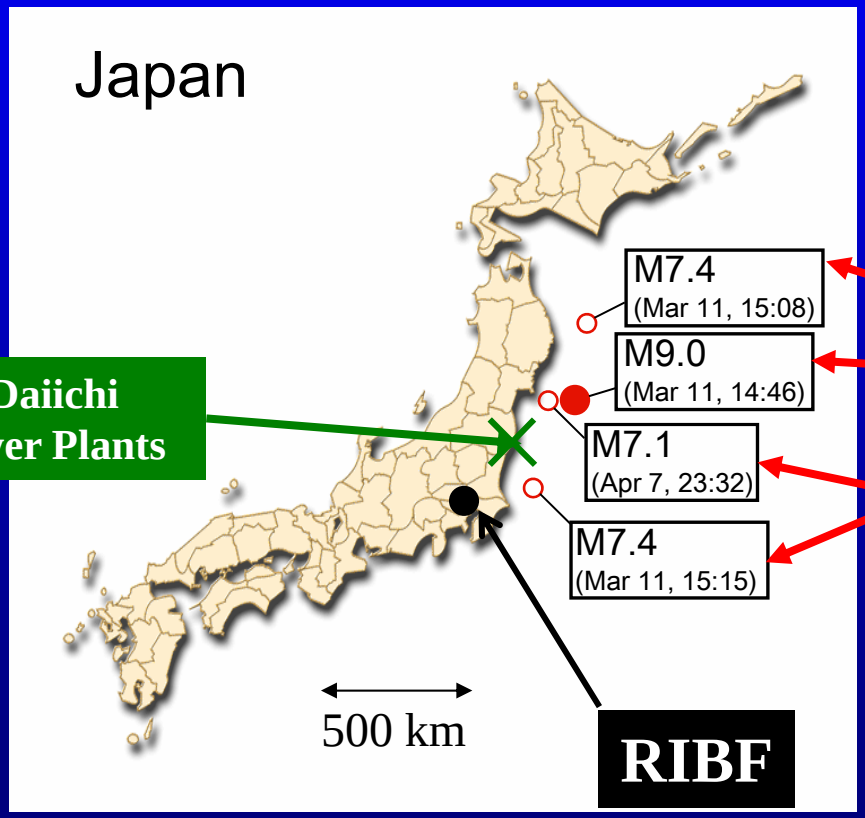

Injection Magnet Shielding
New Magnetic Injection Channel
fRC
Main Coil PS Upgrade
AVF
Injection Bending Magnet PS Upgrade
RRC
RILAC (SHE)
Phase 2: Reconfiguration of Extraction Channel
IRC
SRC
Big-RIPS

RIBF Upgrades



RILAC2 + 28GHz-Ion source + gas stripper
+ fRC → > 10 pnA U-beam

Damages of RIBF by the Massive Earthquake of March 11

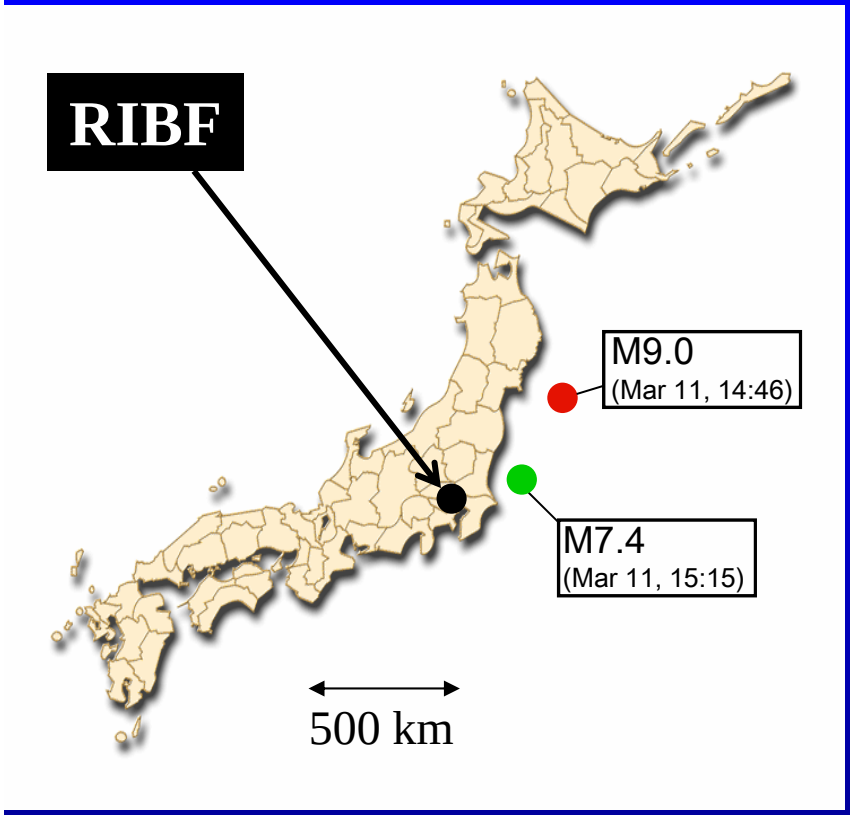


Fukushima Daiichi Nuclear Power Plants

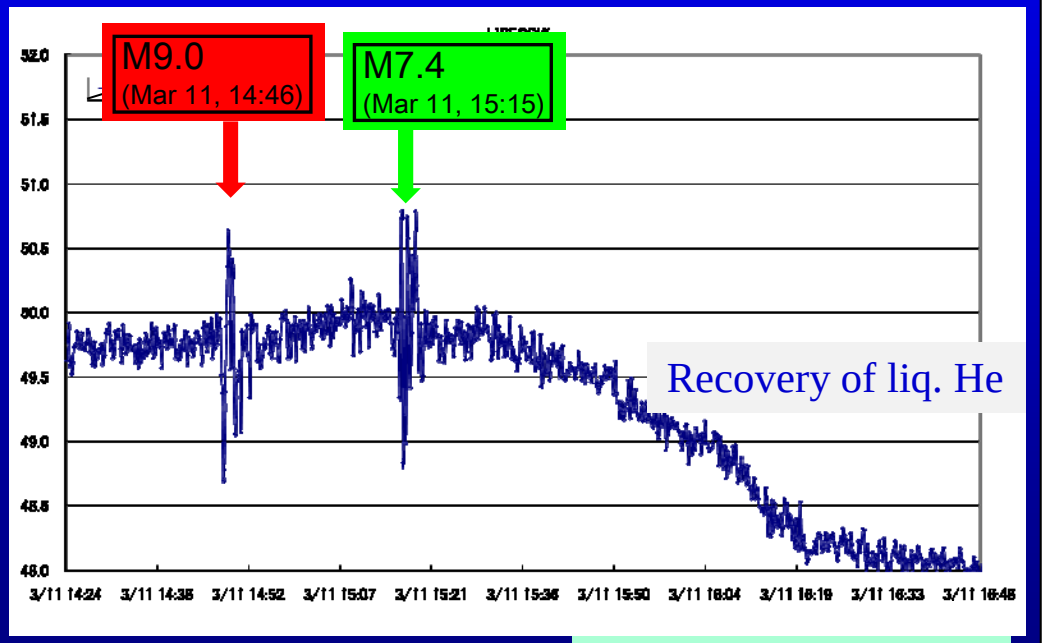
3/11 Epicenters

4/7 Aftershock

Observation of Earthquake via liq. He



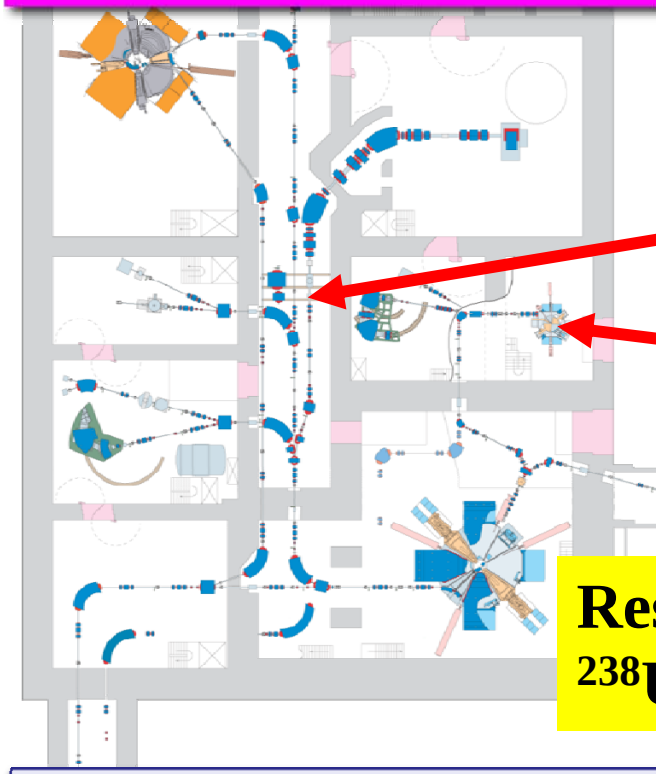
Level gauge of liq. He storage tank (2,000 litters)

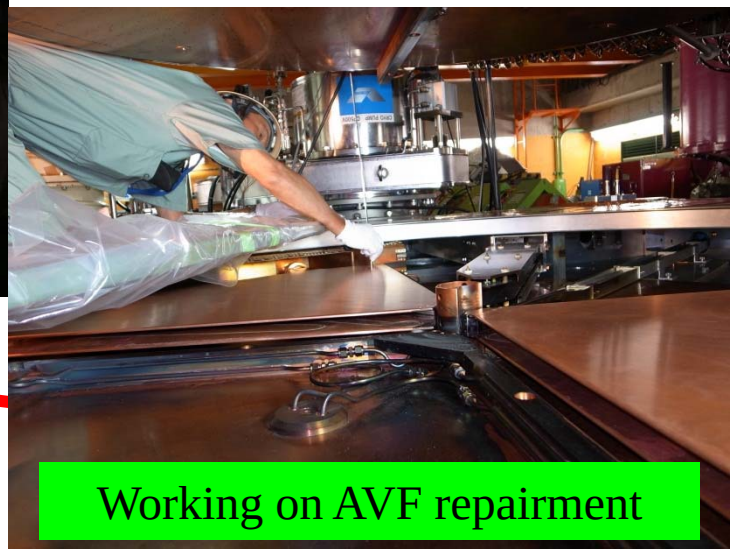


Recovery of liq. He

Courtesy of Okuno-san

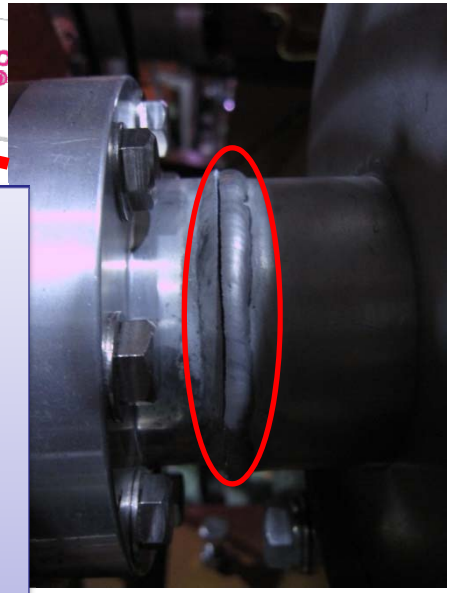
Recovery process





Working on AVF repairment

Resumed an operation with ^{238}U beam since October.



(Already repaired)

Apr. 2 : GARIS exp. restarted (RILAC1 tested)
Apr. 5 : AVF tested
Apr.16: RRC tested
Apr. 30: AVF failure (vacuum leak & water leak of D-electrode)
May 6 - 21: RILAC2-RRC-fRC-IRC-SRC tested (^{124}Xe)
May 23 - Jun. 12: BigRIPS and SHARAQ tested
RILAC-RRC-IRC-SRC (^{18}O)
Jun. 15 - : RILAC2-RRC-fRC (^{238}U)

Instruments of RIBF

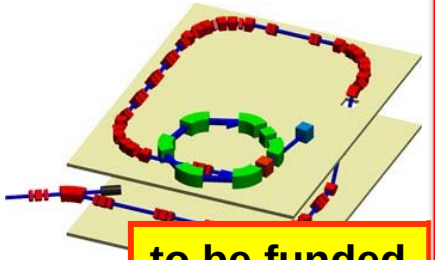
Courtesy of Sakurai-san

To maximize the potentials of intense RI beams available at RIBF

for several 100s species

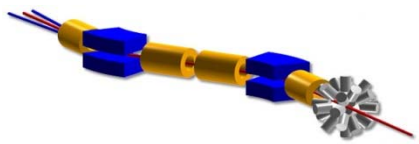
- mass
- half-life
- excited states
- deformation
- charge radii
- matter radii
- charge distribution
- matter distribution
- EM moments
- single particle states
- astrophysical reactions
- giant resonances
- exotic modes
- HI collisions (EOS)

Rare RI ring



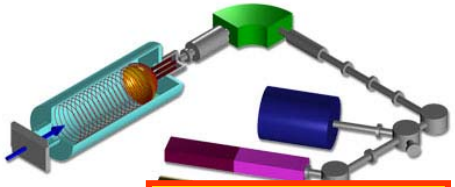
to be funded

ZeroDegree



2008-

SLOWRI

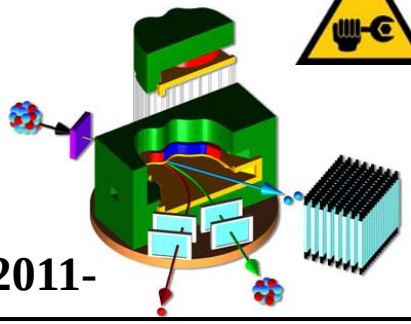


to be funded

IRC-to-RIPS BT

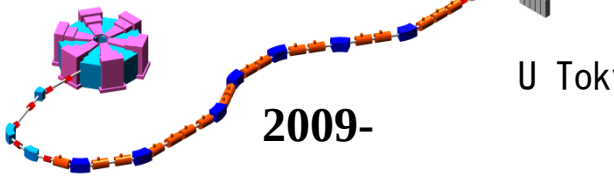
to be funded

SAMURAI



2011-

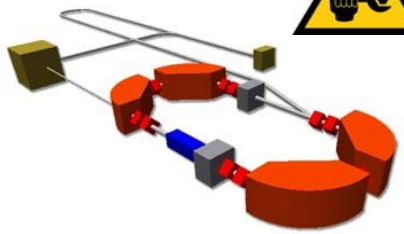
SHARAQ spectrometer



U Tokyo

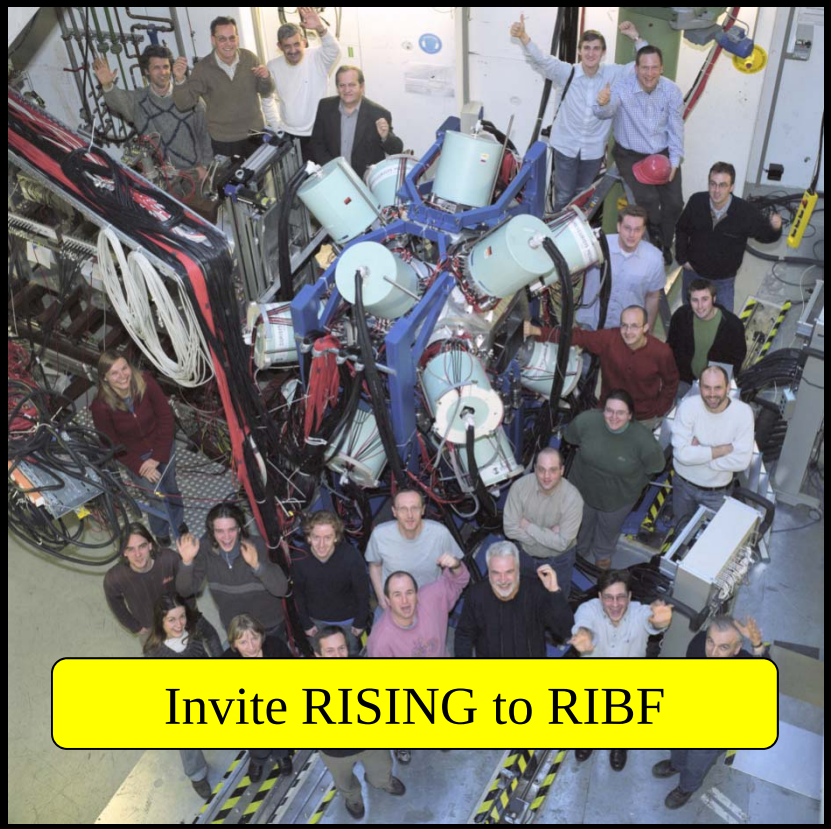
2009-

SCRIT



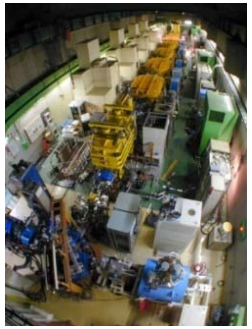
2010-

New international collaboration:
EURICA



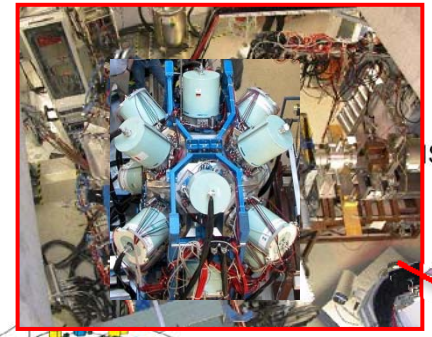
RIBF Layout

RILAC



RRC

EURICA



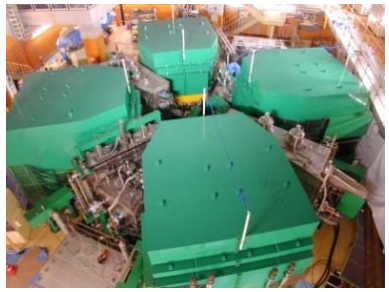
ZeroDegree (ZDS) (2008)

SAMURAI

RIPS

fRC

IRC

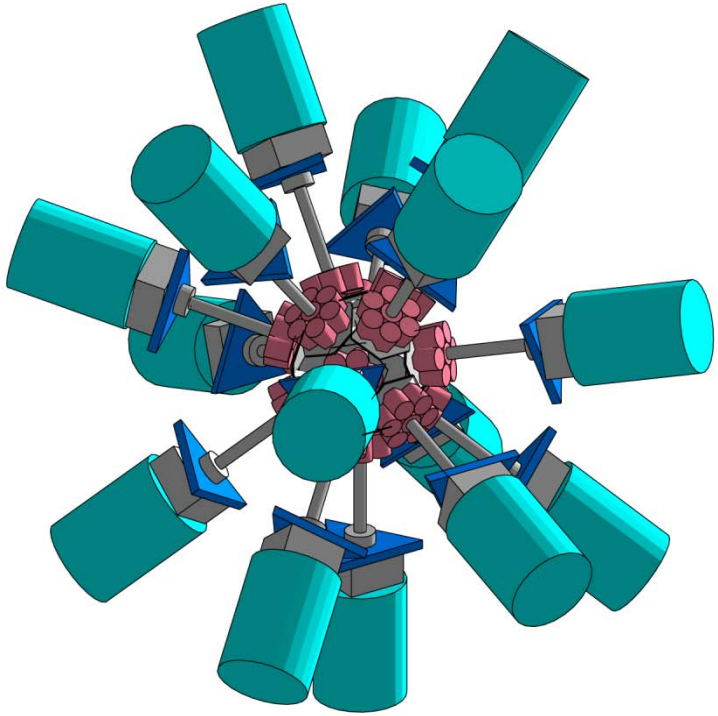


SRC

BigRIPS
(2007)

SHARAQ
(2009)

EU ROBALL
RI KEN
C luster
A rray



- Collaboration of about 200 scientists that uses high-efficiency Ge-spectrometer for isomeric and β-delayed γ-ray spectroscopy at RIKEN
- 12 Cluster detectors placed at the final focus of the ZDS
  - 84(88) crystals
    - High granularity
    - 15 % photopeak efficiency at 662 keV
- Ancillary β detectors, e.g. the SIMBA array from the TU München

Summary

- Operation/management of RIBF
  - Large backlogs, 243days(S & A priorities)
  - 8 months operation in FY2012
- Status of accelerators
  - ^{235}U beam intensity up(2010-2012)
  - 2.4 pnA achieved yesterday!
- New collaboration: EURICA
  - 40% of available MT of a year

Carbon stripper

1st stripper after RILAC1 (@~2.7 MeV/u)

Carbon, 40 μg/cm^2

	MeV/u	pnA	Loss(W)	W/cm^2	Made by	Lifetime
^{48}Ca 345 MeV/u	2.7	1700	1.7	~13	RIKEN	>21h
^{86}Kr	2.3	1100	2.4	~24	RIKEN	4h
^{86}Kr	2.3	1100	2.4	~24	Arizona	0.16h
^{136}Xe 200 MeV/u	1.9	100	0.3	~10	RIKEN	4h
^{136}Xe 200 MeV/u	1.9	100	0.3	~10	Arizona	1.2h