Status of the HIAF accelerator complex in China

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Outline

I. General information

II. Challenges on the accelerator design

III. Status of the construction

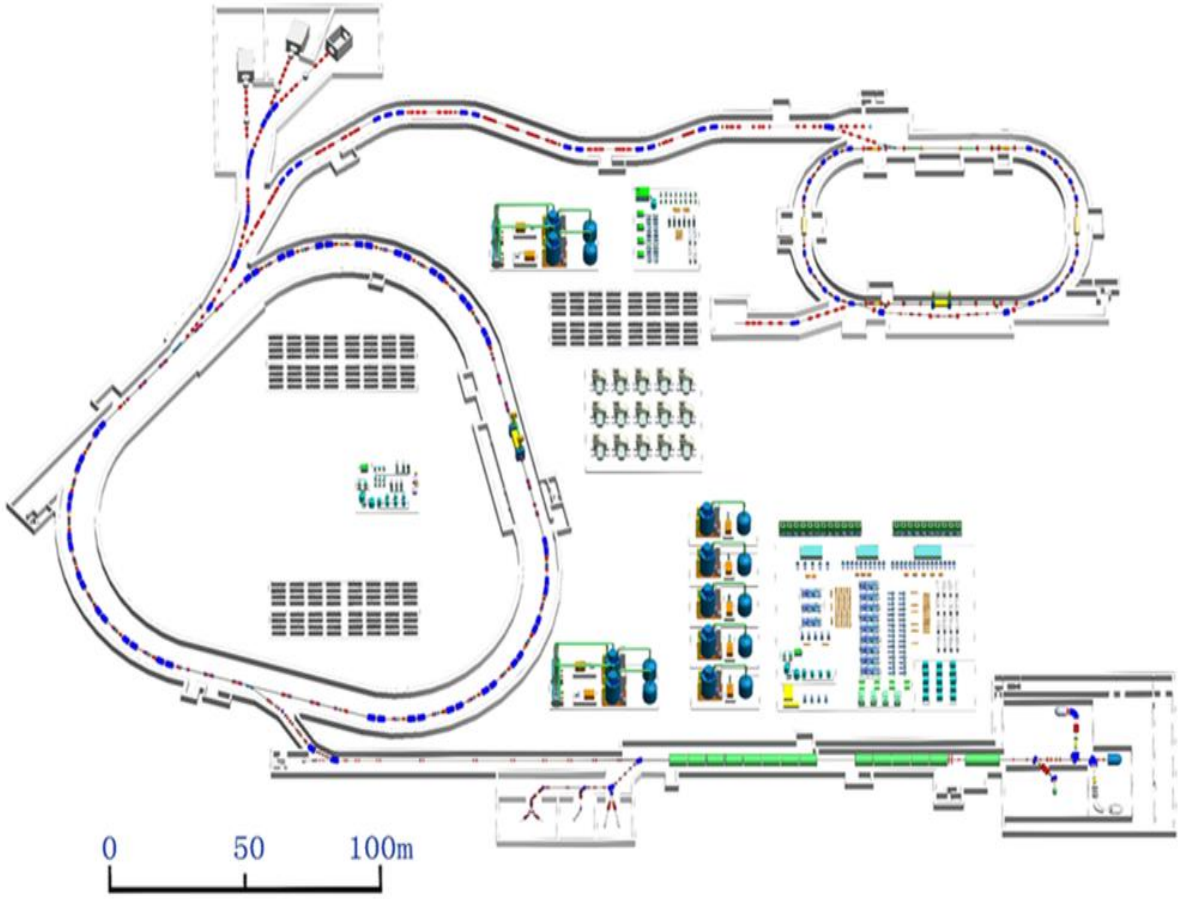
IV. Outlook

General information

- HIAF (High Intensity heavy-ion Accelerator Facility) is one of the mega-scientific projects under constructed in China

- Mainly designed to provide high energy (~800MeV/u) and high intensity (10^{11}ppp) heavy ion beams (up to U^{35+})
- Civil construction was started in the end of 2018
- Beam commissioning date is December 2025

- Superconducting ECR ions source provides highly charge heavy ions
- CW linac is used as the injector of synchrotron
- The booster is used to accumulated and accelerated ions
- 6 experimental terminals will be constructed for nuclear physics, atomic physics and application studies



General information

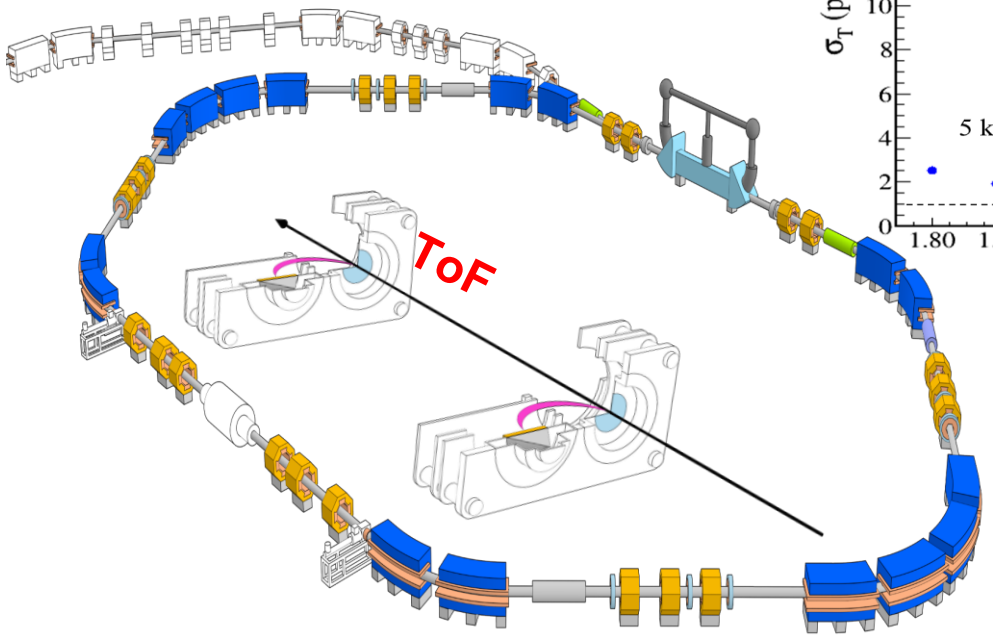
- Beam parameters, here we selected the uranium as the reference particle

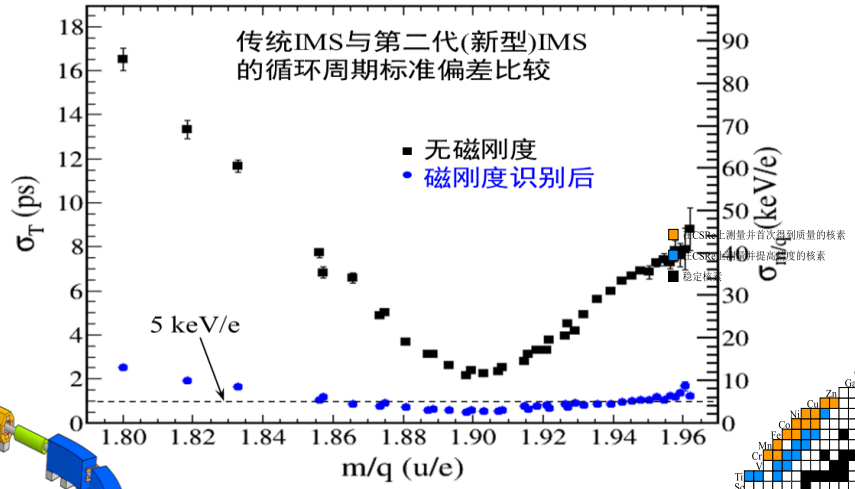
	SECR	iLinac	BRing	HFRS	SRing
Length / circumference (m)	---	114	569	192	277
Final energy of U (MeV/u)	0.014 (U^{35+})	17 (U^{35+})	835 (U^{35+})	800 (U^{92+})	800 (U^{92+})
Max. magnetic rigidity (Tm)	---	---	**34**	25	15
Max. beam intensity of U	50 pμA (U^{35+})	28 pμA (U^{35+})	**1×10^{11}ppp (U^{35+})**	-------	**$(2\sim4)\times10^{11}$ppp (U^{92+})**
Operation mode	DC	CW or pulse	**fast ramping (12T/s, 3Hz)**	Momentum-resolution 1100	**DC,** deceleration
Emittance or Acceptance (H/V, π·mm·mrad, dp/p)		5 / 5	200/100, 0.5%	±30mrad(H)/±15 mrad(V), ±2%	40/40, 1.5% (normal mode)

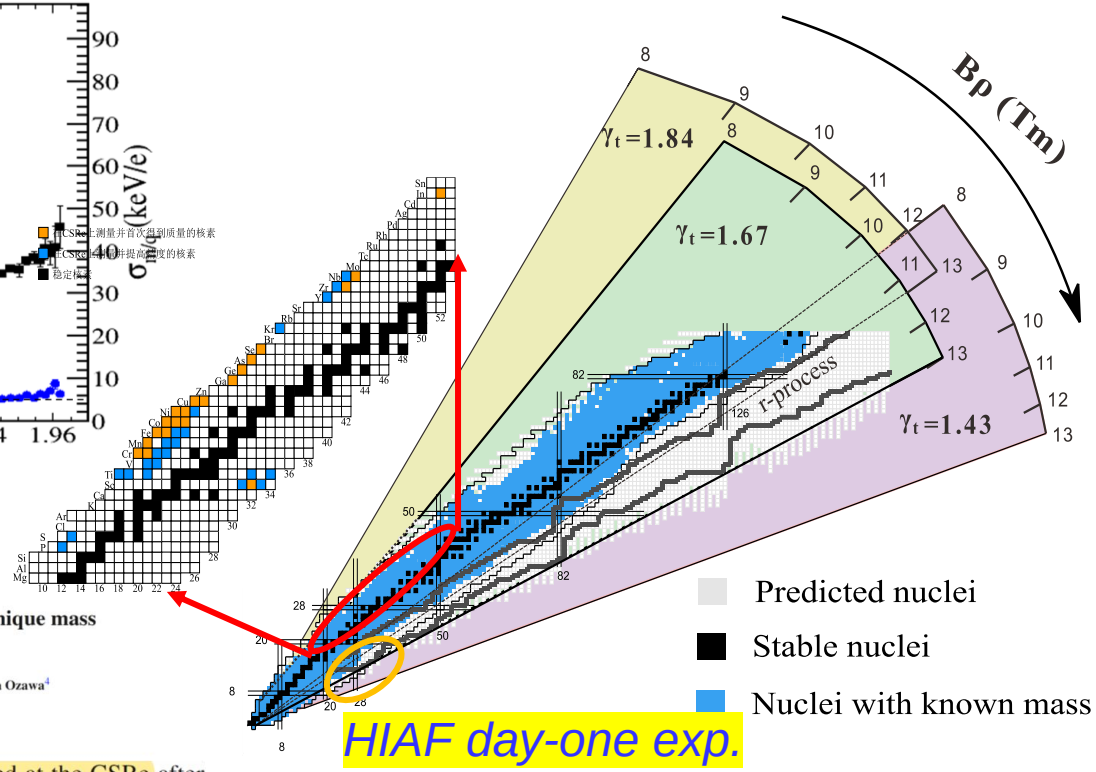
General information

- As an example, the facility can be used for the predicted nuclei study (mass measurement)

- $B\rho$-defined Isochronous Mass Spectrometry (**with a couple of dedicated ToF detectors**)
- Three modes with γ=**1.43, 1.67 and 1.84**, cover the aera of unknow nuclei







HIAF day-one exp.

---Courtesy of Ruijiu Chen

Recent achievements at the Rare-RI Ring, a unique mass spectrometer at the RIBF/RIKEN

Sarah Naimi[1,2], Yoshitaka Yamaguchi[2], Takayuki Yamaguchi[3,4], Akira Ozawa[4]

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[2] RIKEN Nishina Center for Accelerator Based Science, Wako, Saitama 351-0198, Japan
[3] Department of Physics, Saitama University, Saitama, Saitama 338-8570, Japan
[4] Institute of Physics, University of Tsukuba, Tsubuka, Ibaraki 305-8571, Japan

[10]. Recently, a milestone was achieved at the CSRe after establishing a new measurement method, namely Bρ-defined isochronous mass spectrometry. With this new method record mass precision and accuracy was reached for short-lived nuclei in storage ring operated as IMS [11,12].

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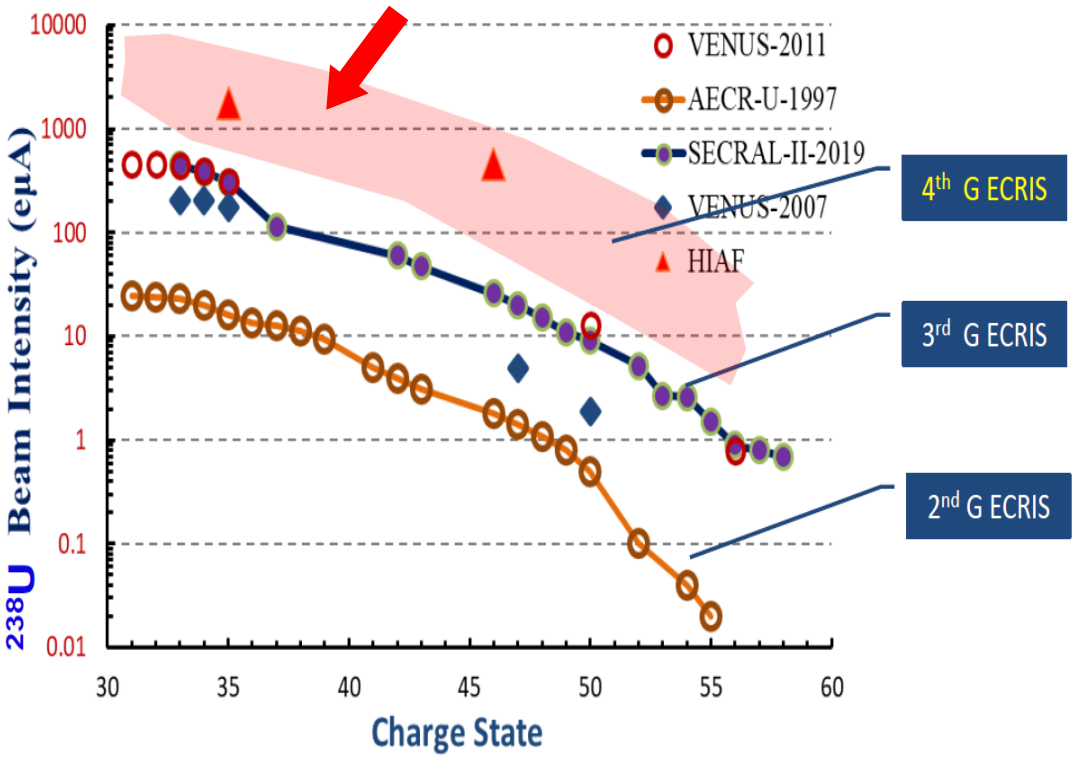
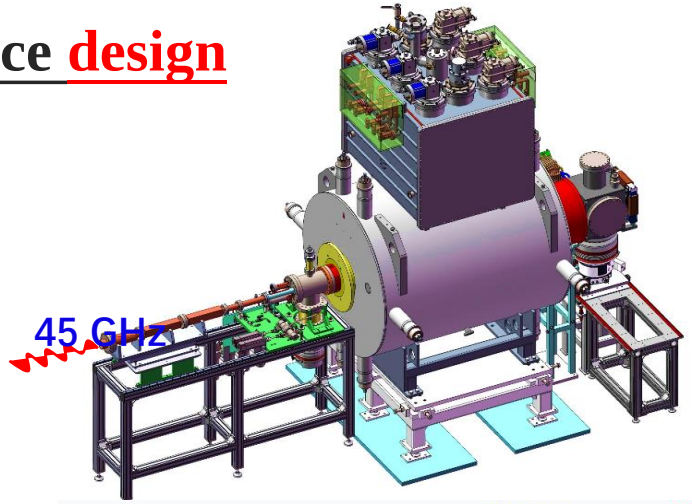
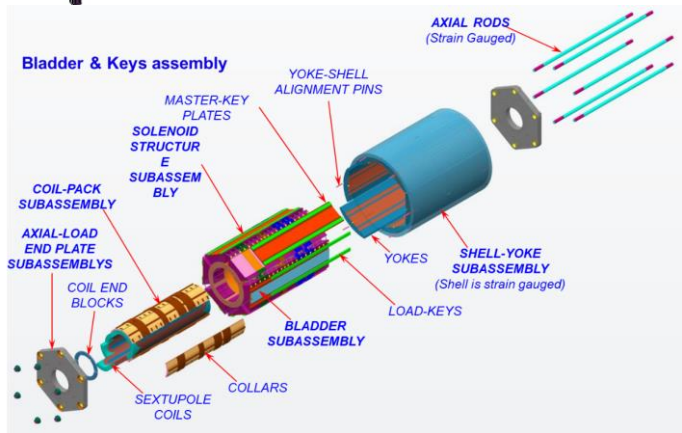
Challenges on the accelerator design

- The 4th generation of ECR ion source, provide highly charge U ions with the current about mA
- A CW superconducting linac is designed as the injector of synchrotron
- Two phase painting injection and fast ramping in the booster ring (BRing)

45 GHz superconducting ECR ion source design







Full-sized cold mass

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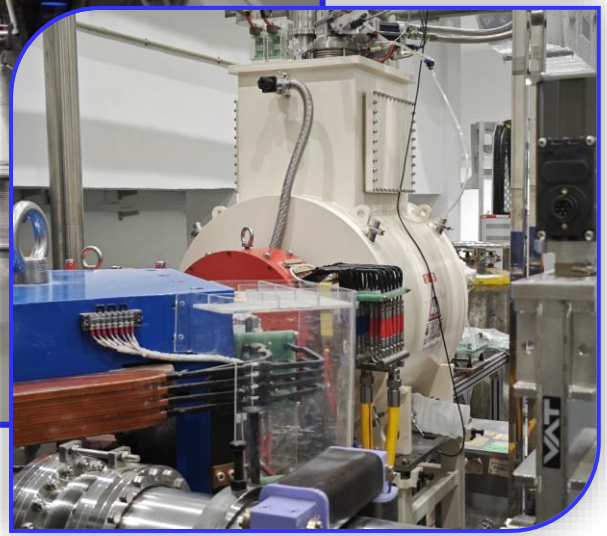
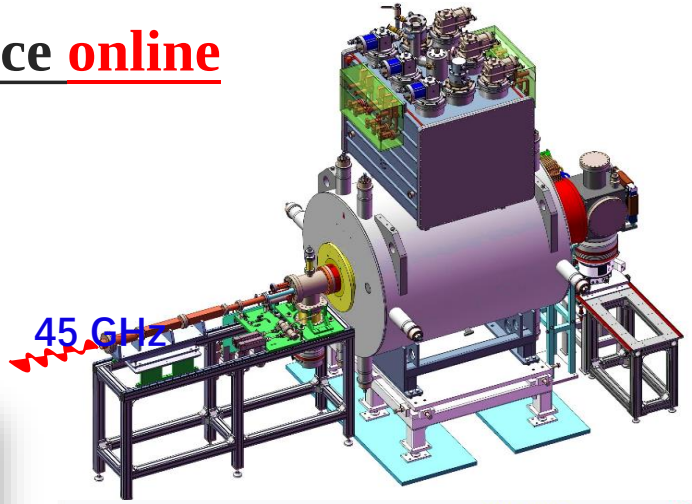
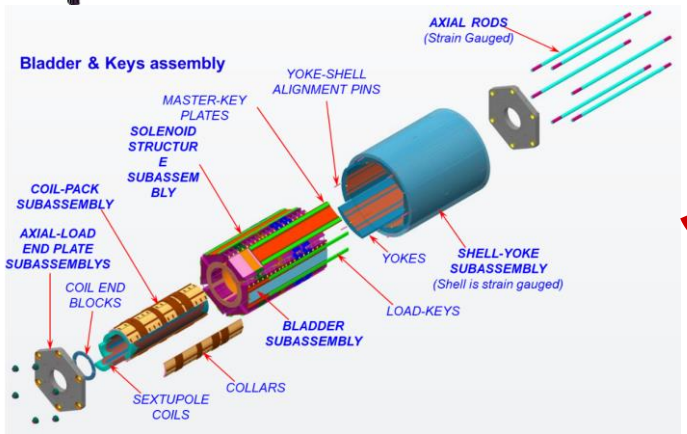
28 GHz superconducting ECR ion source online







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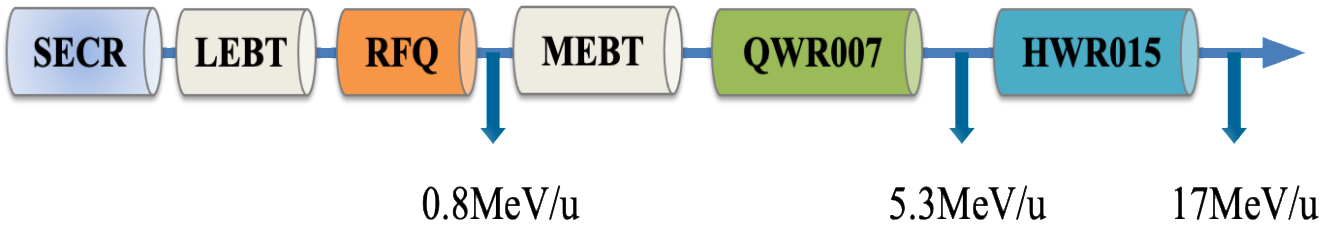
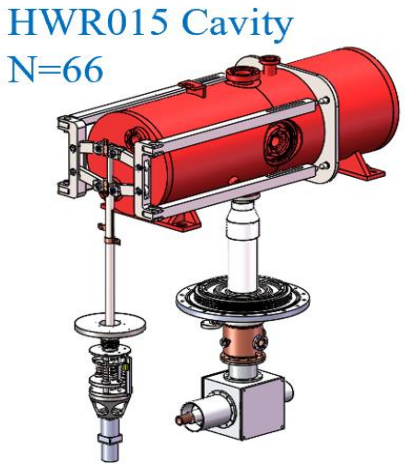
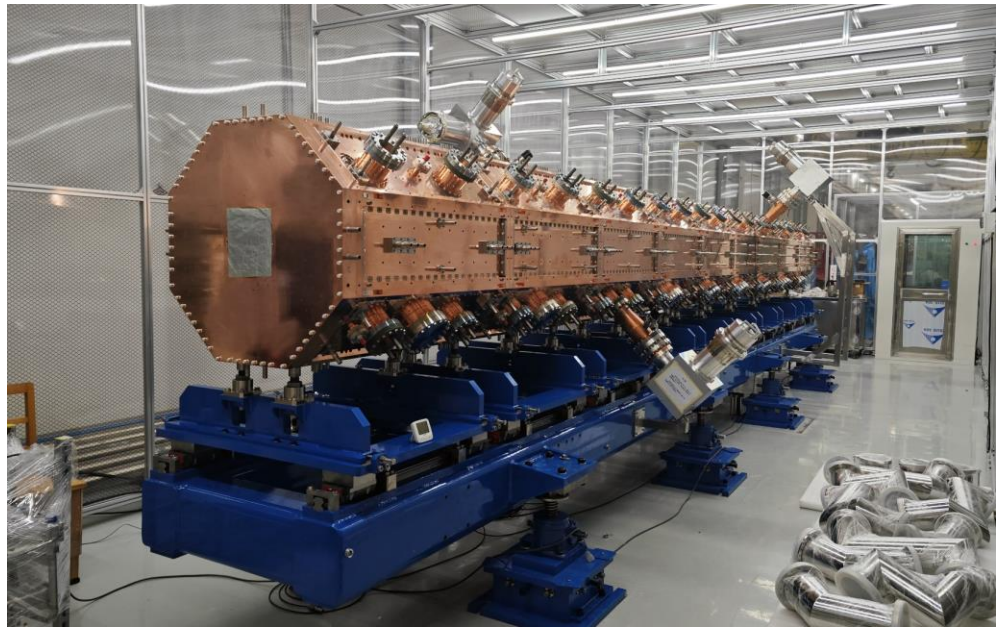
Superconducting Linac, 2 types of cavities





Cavities in the cleaning room



RFQ is assembling and commissioning in June

Challenges on the accelerator design

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- A CW superconducting linac is designed as the injector of synchrotron
- Two phase painting injection and fast ramping in the booster ring (BRing)

gain factor ~60 is needed for BRing accumulation

iLinac beam parameters

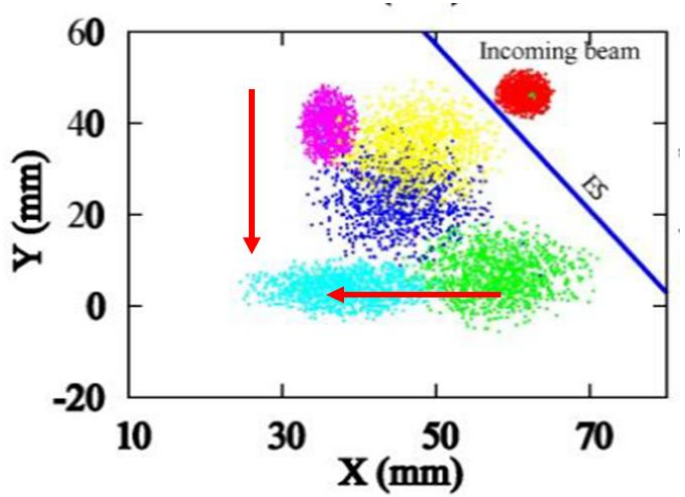
Ion	Ek	$\varepsilon_{x,y}$(RMS)	Δp/p	I_{avg}
$^{238}U^{35+}$	17MeV/u	1.0 π.mm.mrad	0.2%	1.0 mA

Only horizontal painting:

$$N \leq \frac{\varepsilon_A}{1.5\varepsilon_{inj}} = 25$$

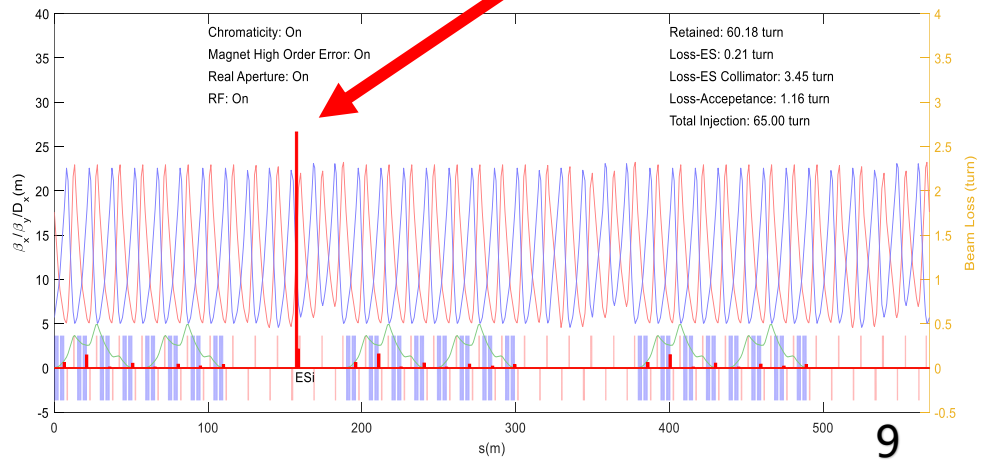
Both horizontal and vertical painting:

gain factor ~100



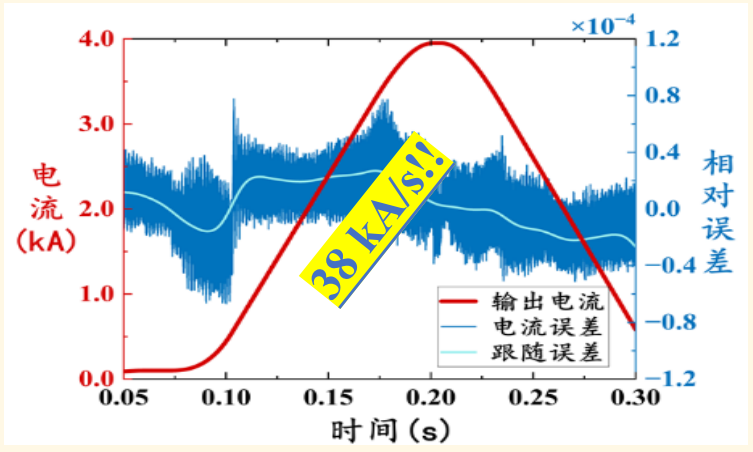
Tilted injection septum

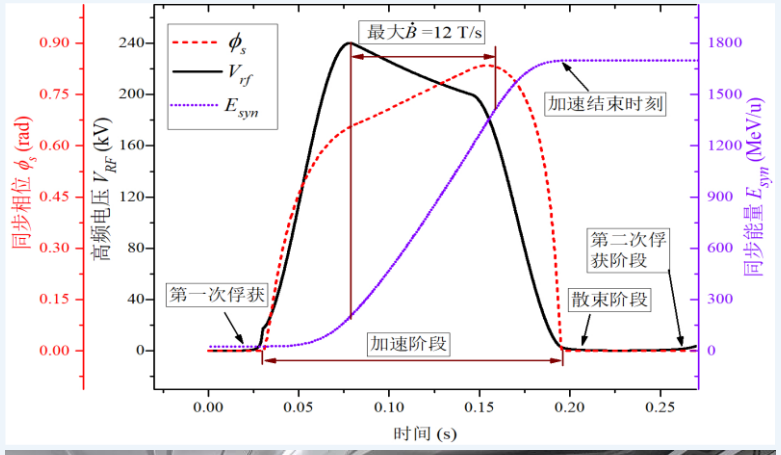
Control the beam loss within 5%



Challenges on the accelerator design

- Power supply for dipole (Full energy storage fast cycling power supply)
- Nanocrystalline soft magnetic alloy loaded cavity
- thin-walled vacuum chamber (Titanium ring supported thin wall vacuum chamber)





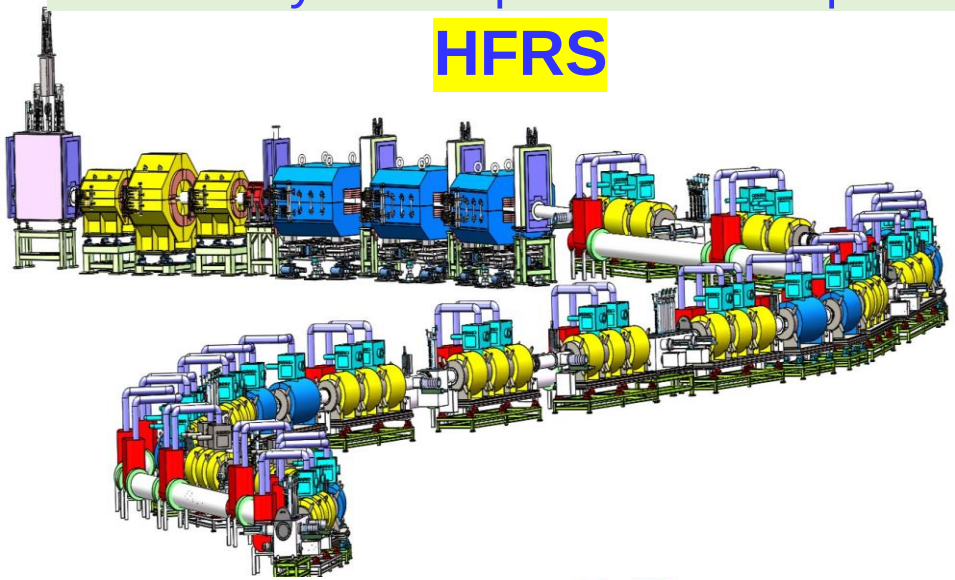
Status of the HIAF construction

- The civil construction was started in Dec. 2018
- The first dipole of BRing moved to the tunnel in Mar. 2024
- We plan to finish the installation of BRing in the end 2024

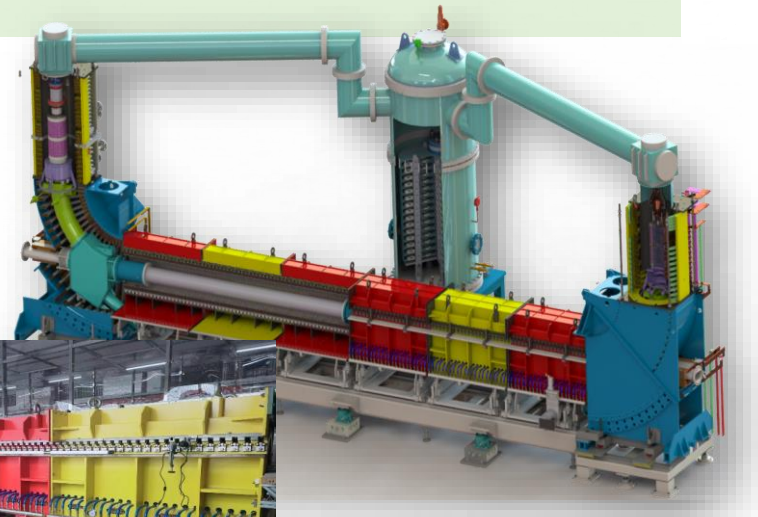
Status of the terminals

- High energy fragment separator (HFRS) and Spectrometer Ring (SRing)
- The day-one experiment is expected in the end of 2025

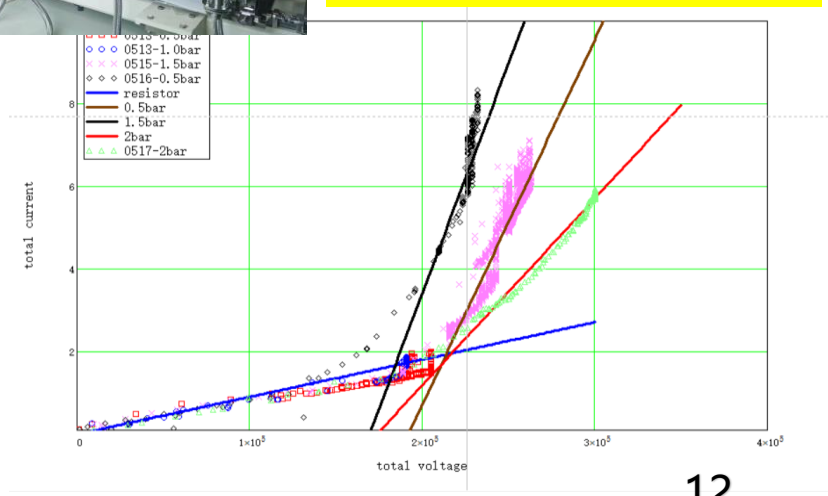
HFRS

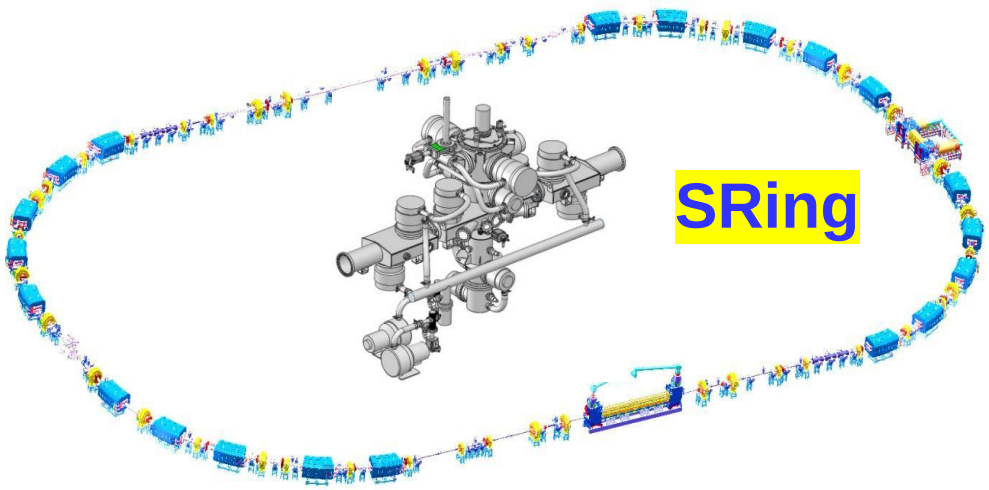


HFRS dipoles in tunnel



450kV electron cooler





SRing

Conclusion

- The ion source, Linac and BRing installation should be finished in Sep. of 2024
- The test of BRing injection beam is planed to be done before the end of 2024
- The day-one experiment (nuclear exp. with isotopes) will be done in 2025

Thanks for your attention!

Welcome to HIAF!

With cooling