Development of the collinear laser spectroscopy system for the study of unstable nuclei at BRIF facility

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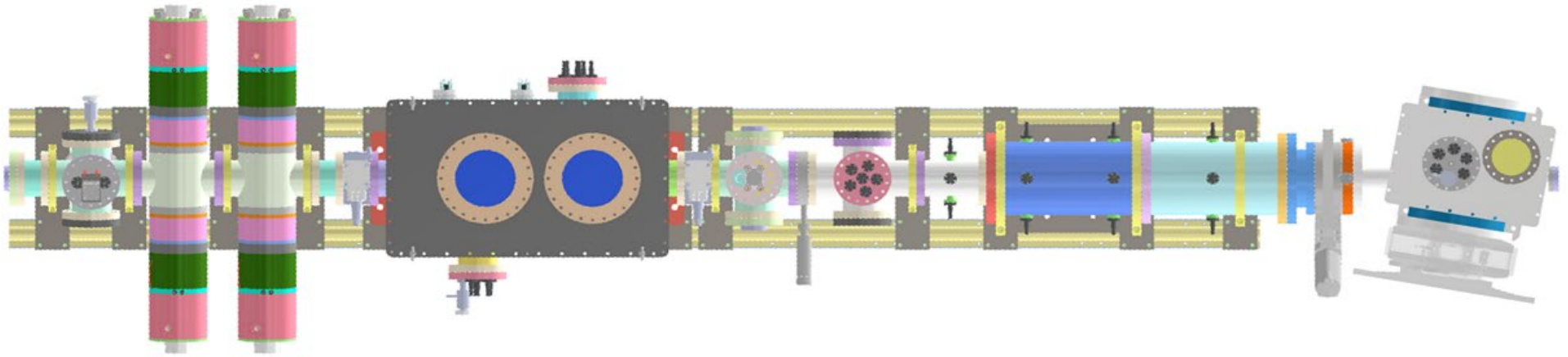

Outline

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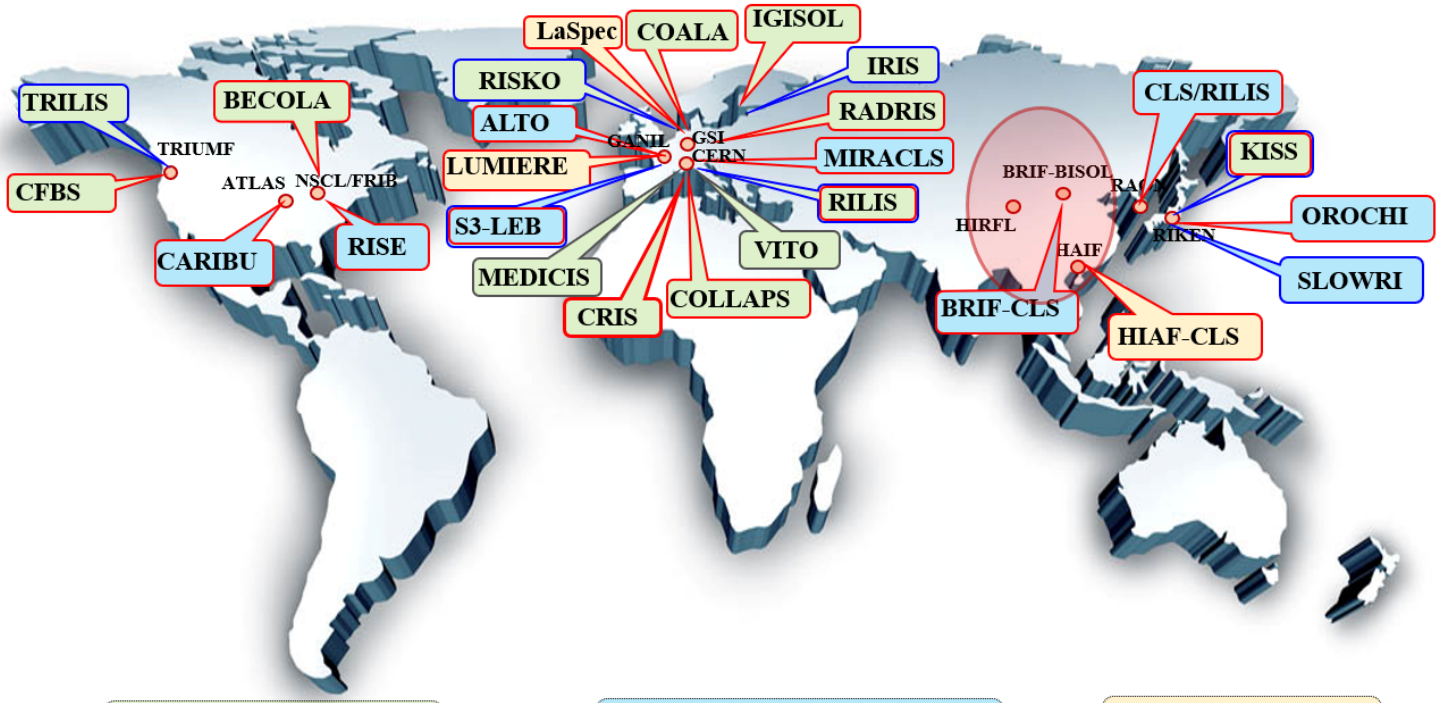
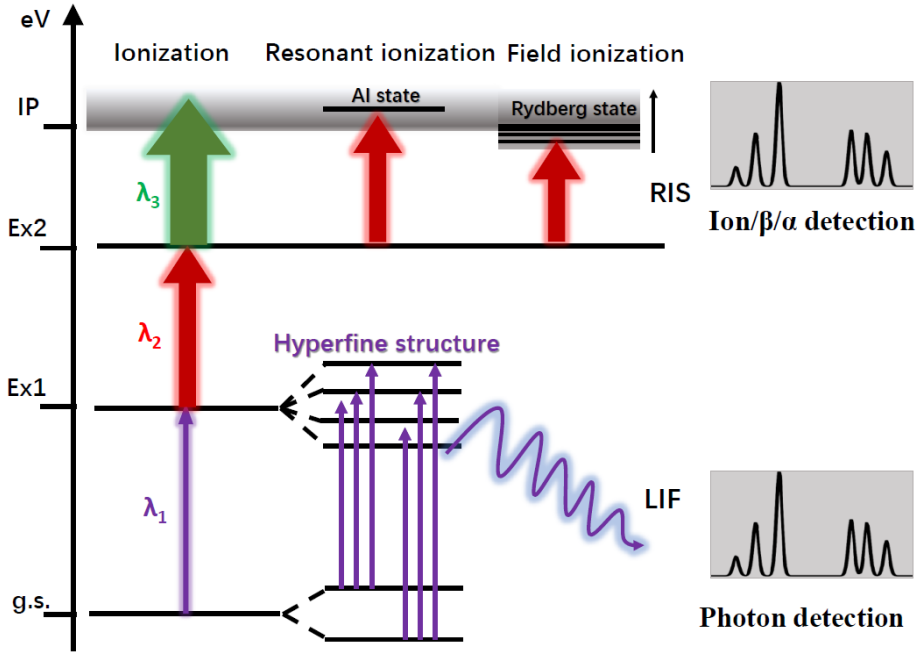
- Motivation
- BRIF RIB facility
- Collinear laser spectroscopy (CLS) setup
- First commissioning of CLS at BRIF
- Future plan

Motivation: Laser spectroscopy setups worldwide

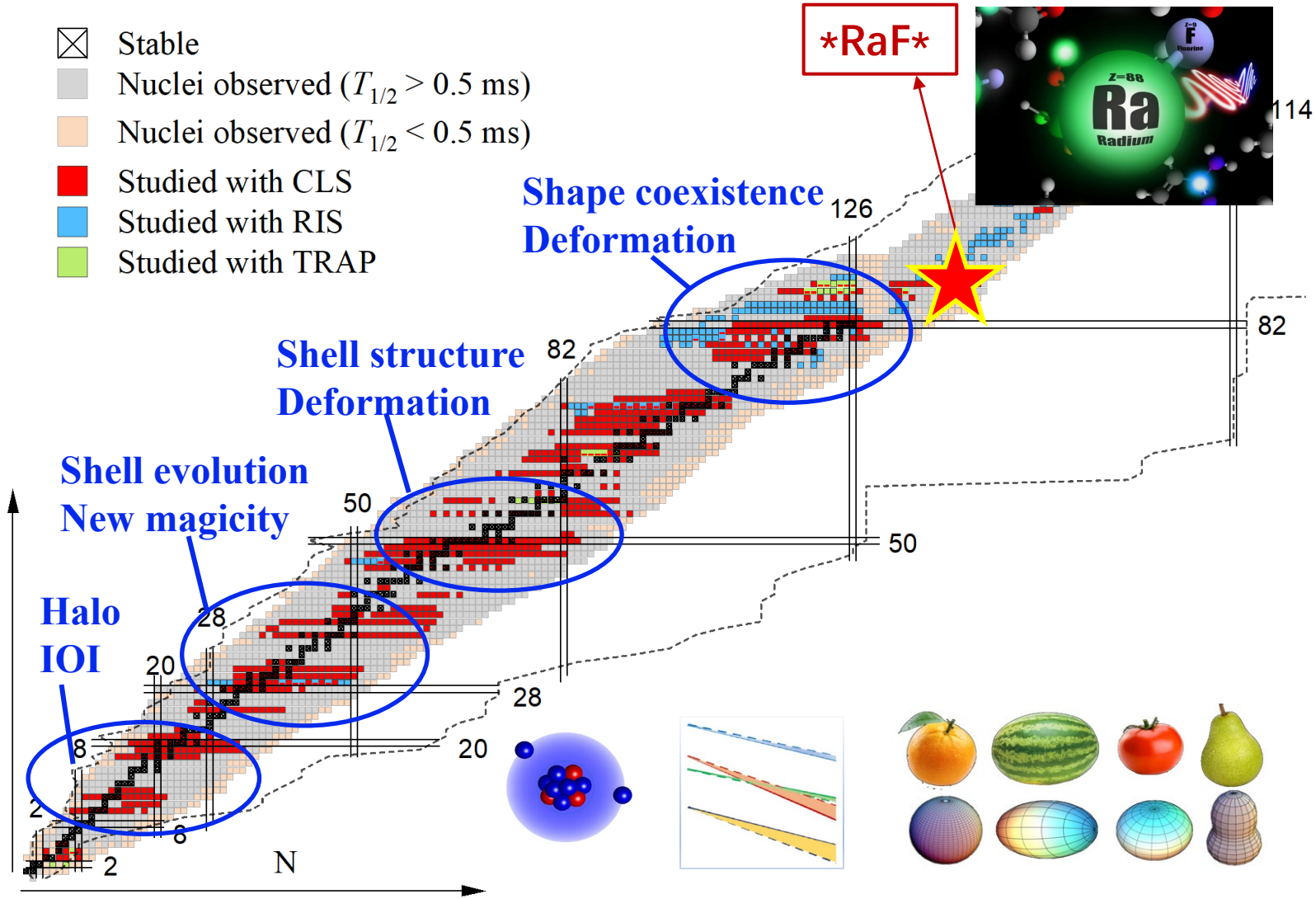




LIF: Laser induced florescence

RIS: Resonance ionization spectroscopy

Motivation: Unstable nuclei probed by laser spectroscopy

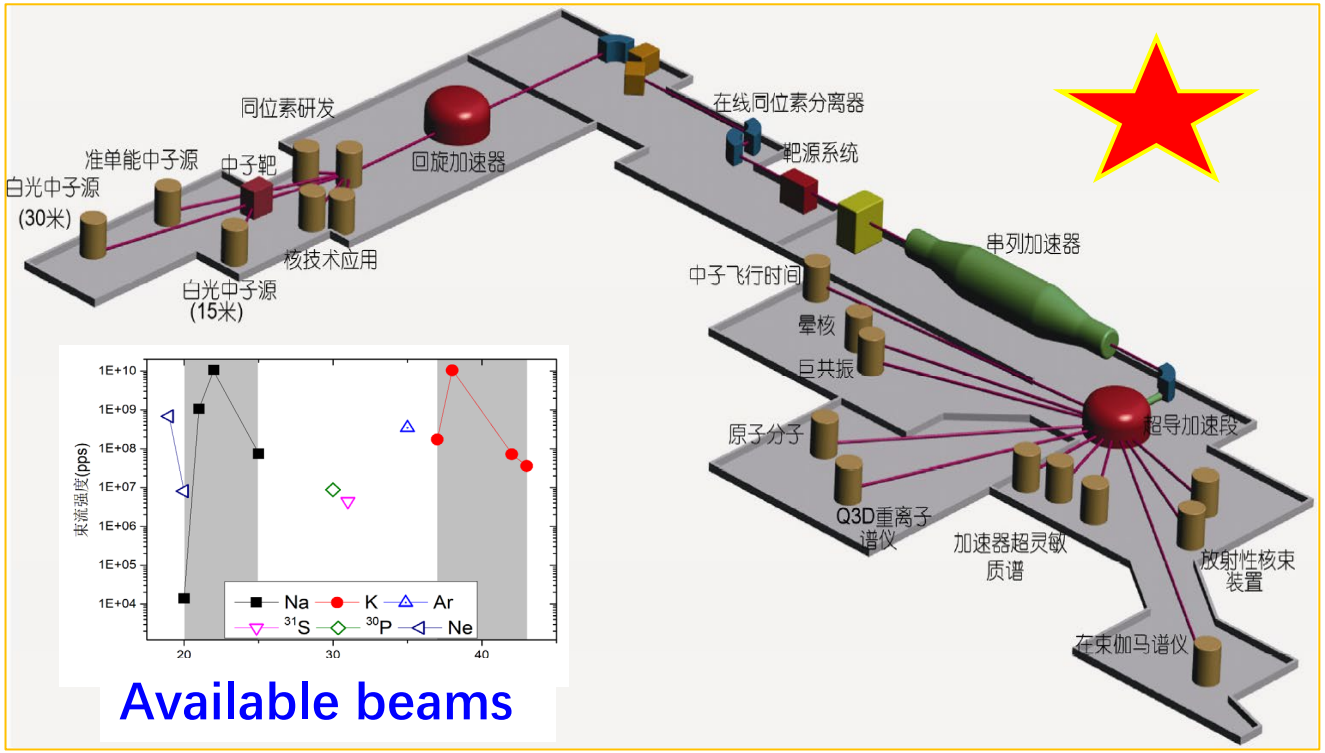


- **Probed more than 1000 nuclei**
  - -contribute significantly to the study of nuclear structure and NN interactions
- **First laser spectroscopy of RaF (radioactive molecule)**
  - -offer new opportunity for the study of fundamental symmetry and astrophysics

"Laser Spectroscopy for the Study of Exotic Nuclei", Prog. Part. Nucl. Phys. (2022) submitted; arXiv:2209.15228

Motivation: Current and future RIB facilities in China

BRIF@CIAE, Beijing

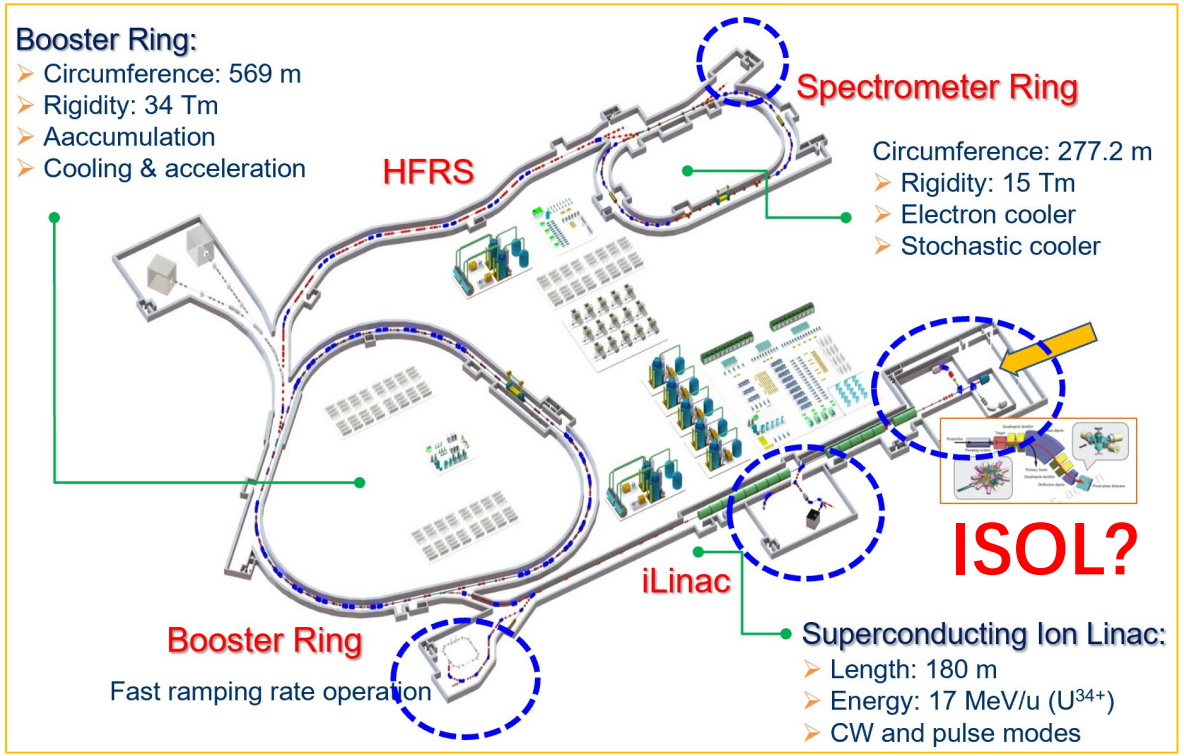


Available beams

- 100 MeV proton beam (200uA) +Target
- kW ISOL Target +online separator

Beijing Radioactive Ion Beam Facility (BRIF)

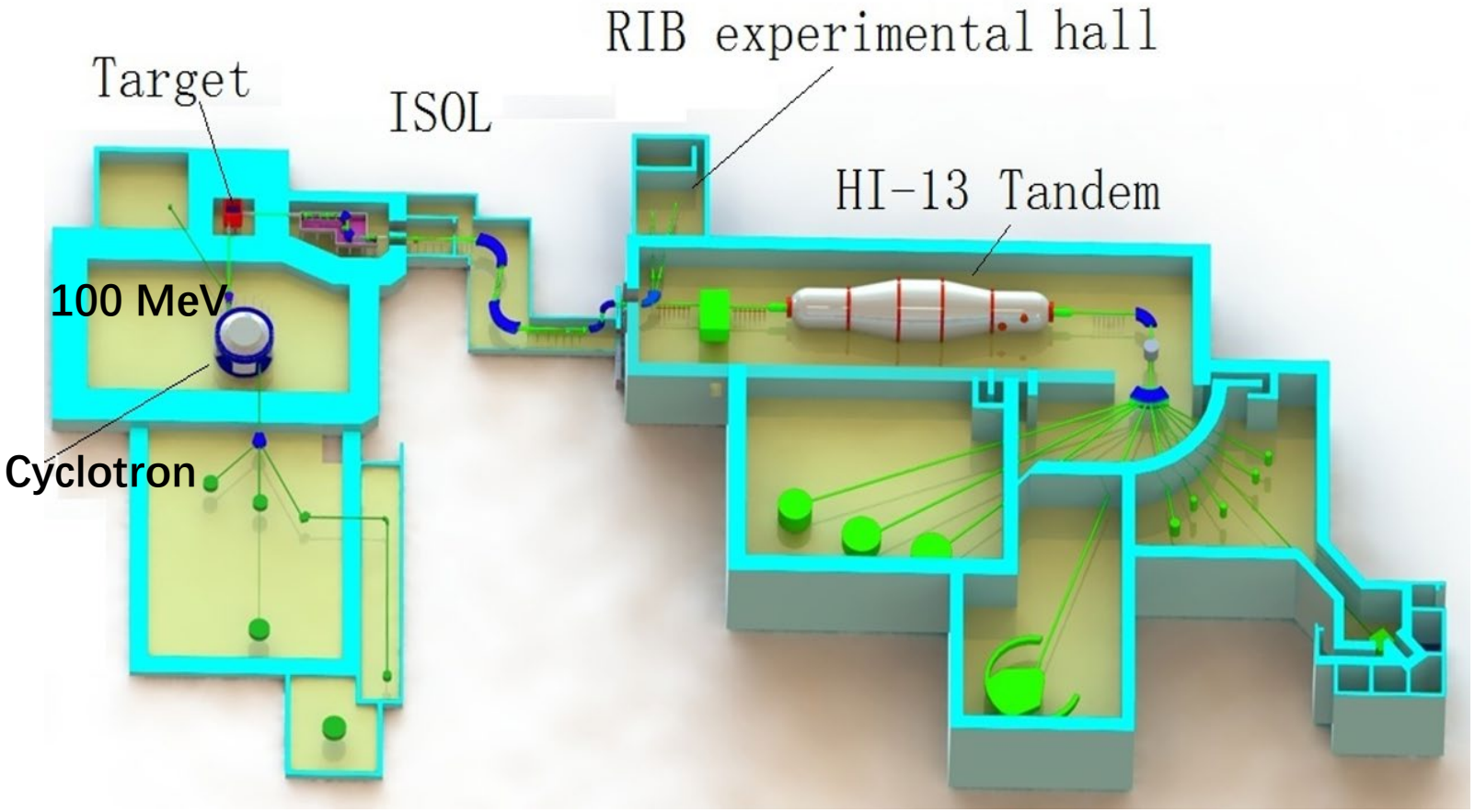
HIAF@IMP, Huizhou, Guangdong

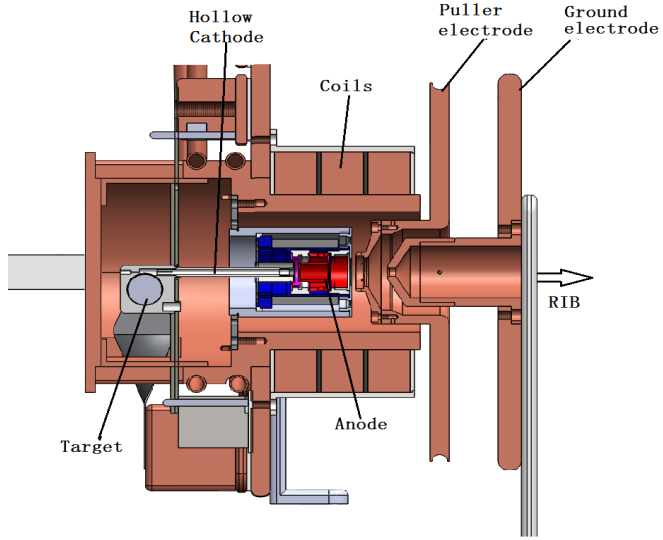


- **Under construction**

High-Intensity Heavy Ion Accelerator Facility (HIAF)

BRIF facility





Tested Target:

SiC, MgO, CaO

^{20}Na: ~2.0E+05 pps

^{23}Al: ~220 pps

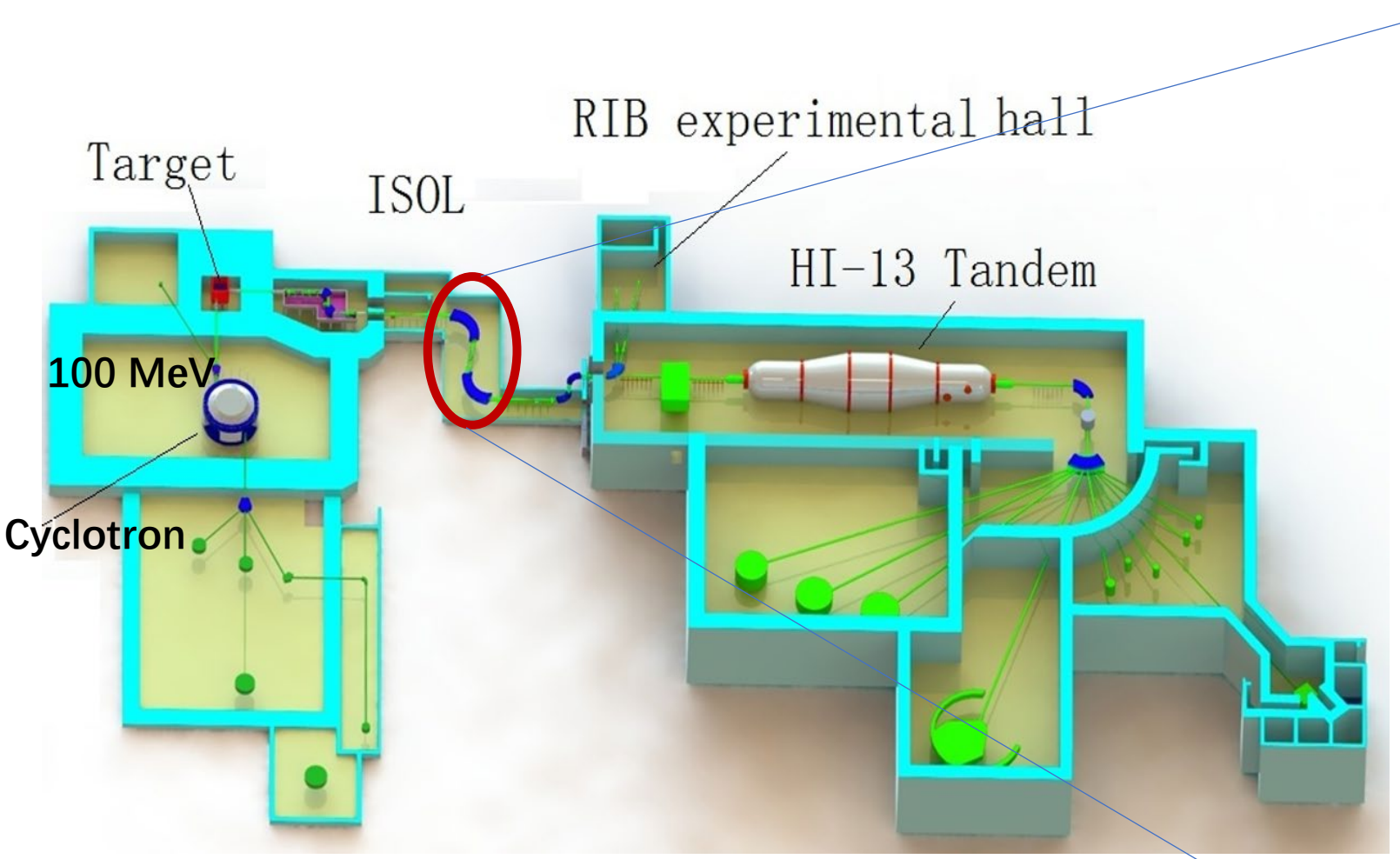
^{36}K: ~3.0E+04 pps

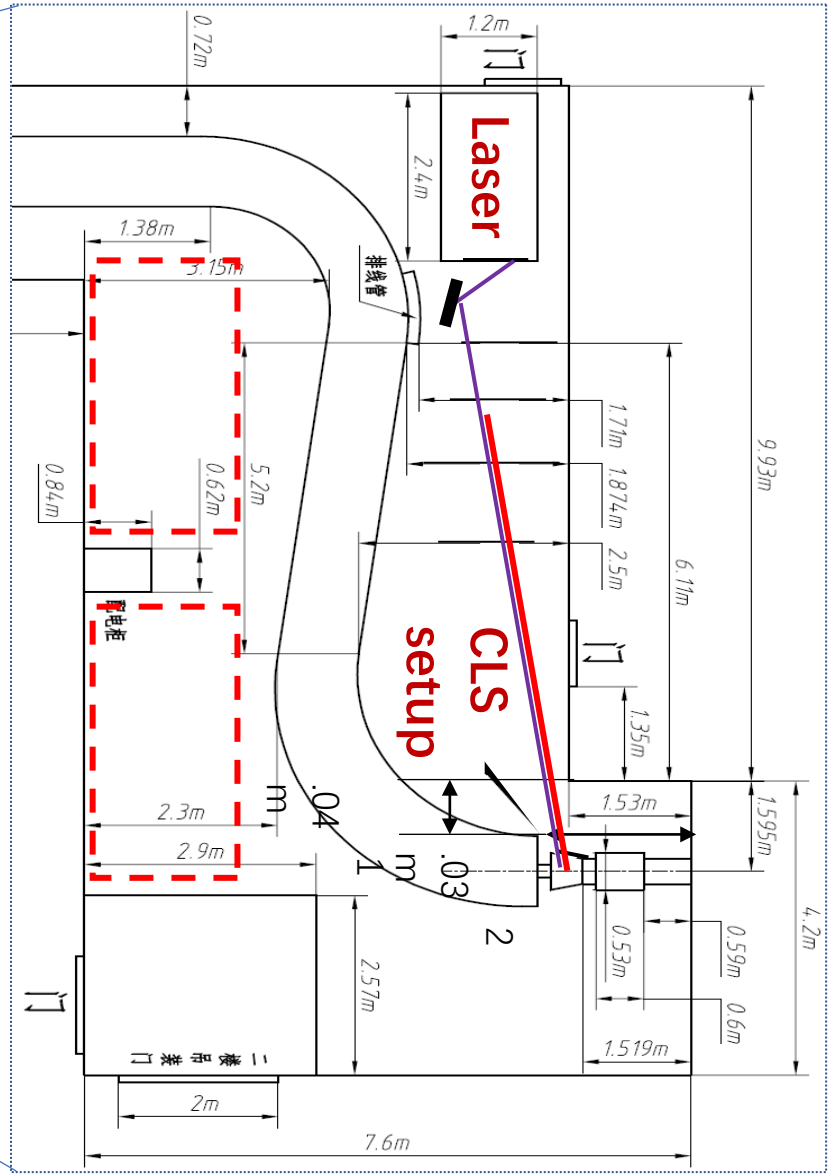
To be tested:

UCx

B. Tang et al., NIMB https://doi.org/10.1016/j.nimb.2019.06.003

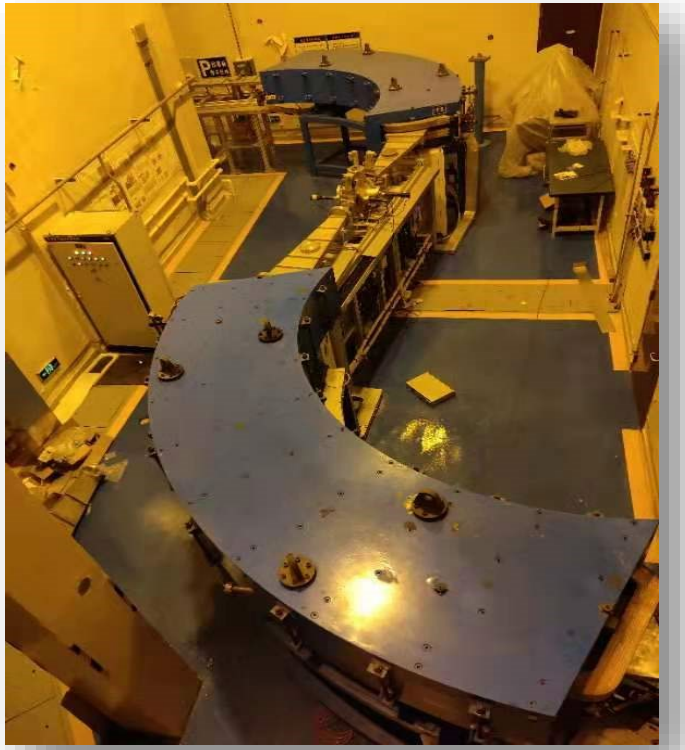
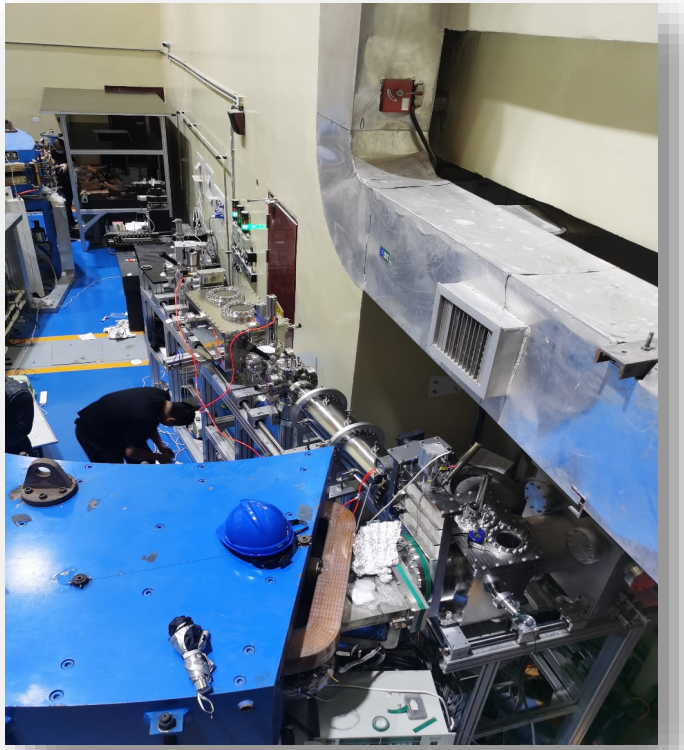
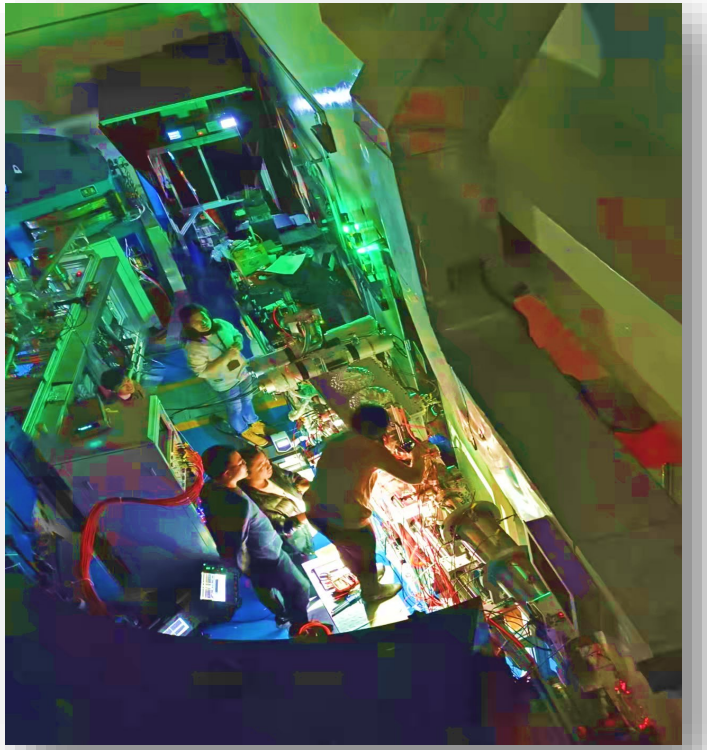
BRIF facility

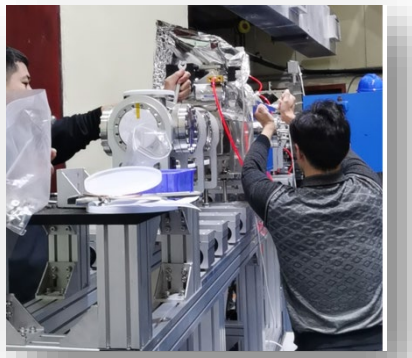
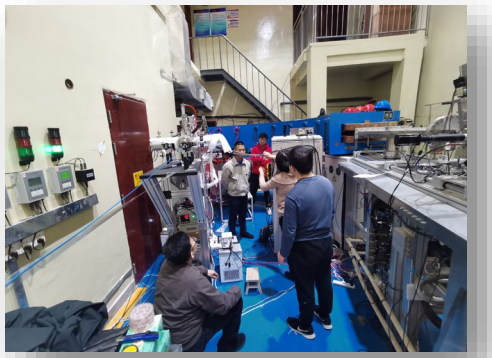
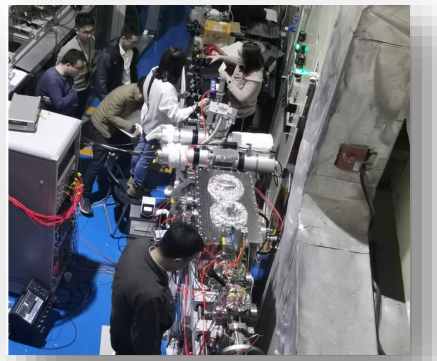
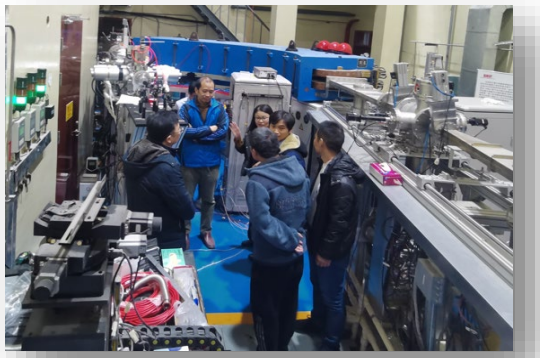




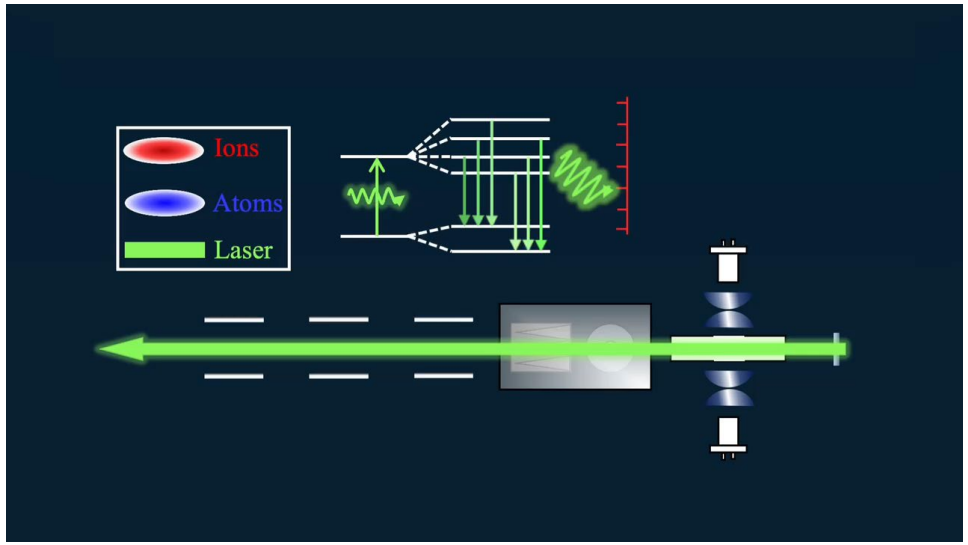
B. Tang et al., NIMB https://doi.org/10.1016/j.nimb.2019.06.003

CLS setup @BRIF facility

CLS setup @BRIF facility



QT: Quadrupole Triplet

CEC: Charge Exchange Cell

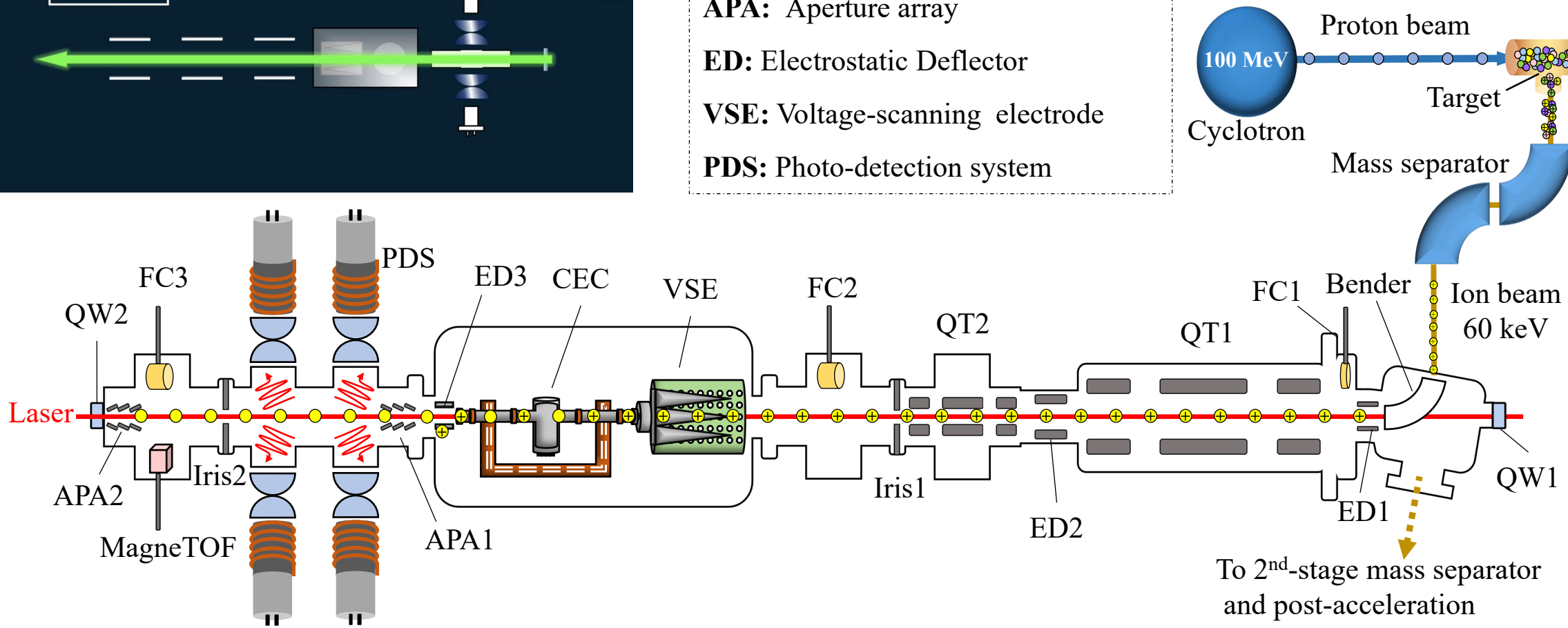
FC: Faraday Cup

APA: Aperture array

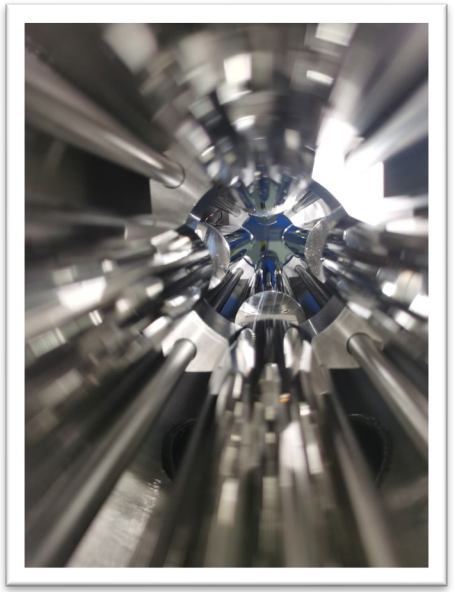
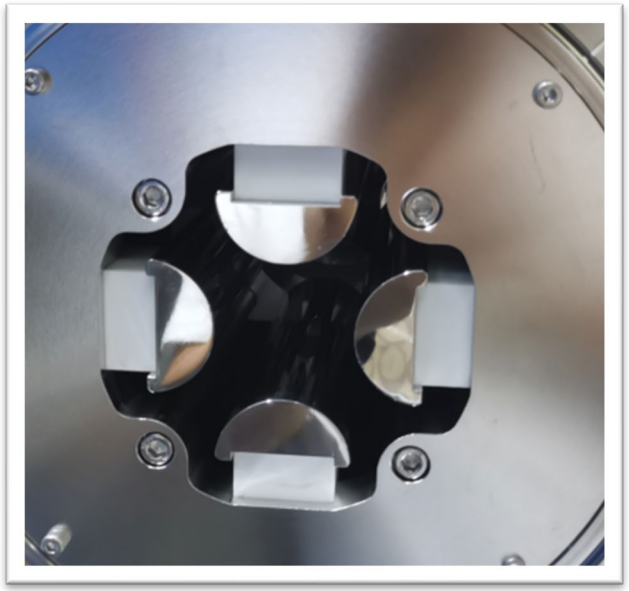
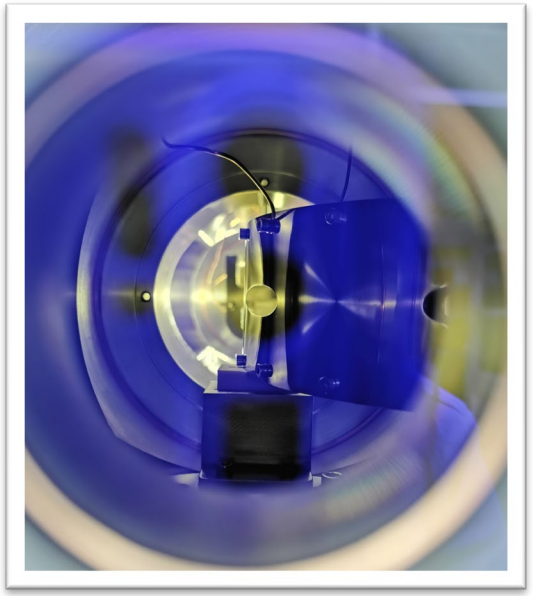
ED: Electrostatic Deflector

VSE: Voltage-scanning electrode

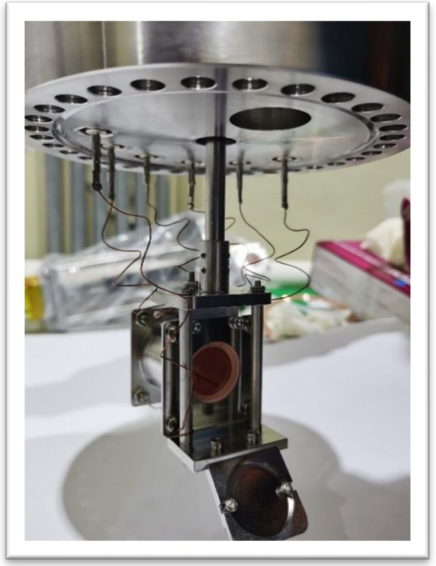
PDS: Photo-detection system

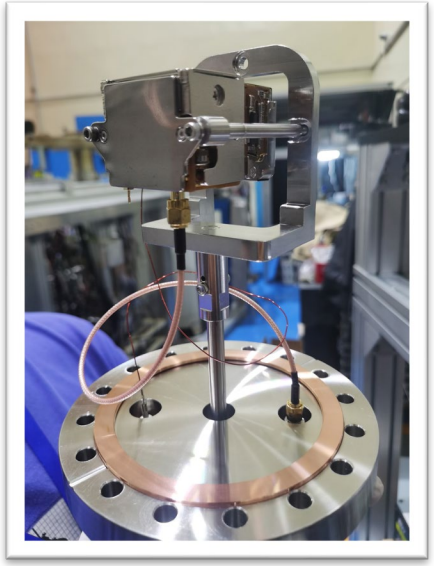


CLS setup @BRIF facility: Ion optics, diagnostics


Ion optics

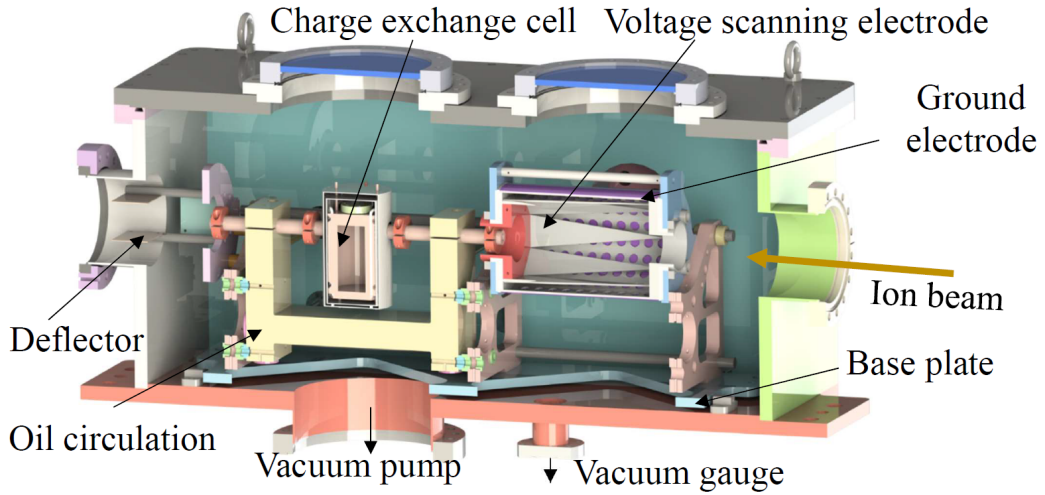


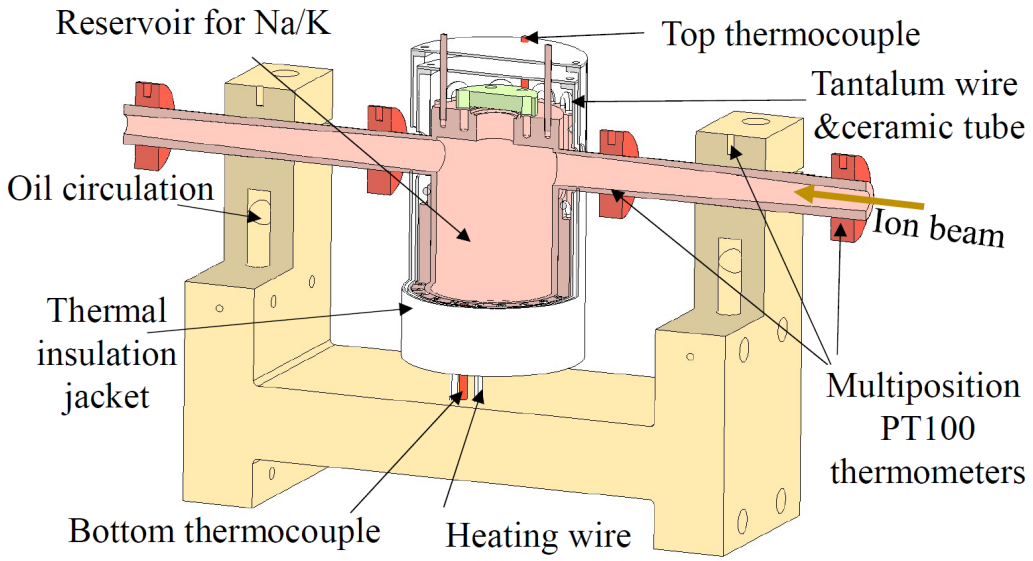


Beam Diagnostics

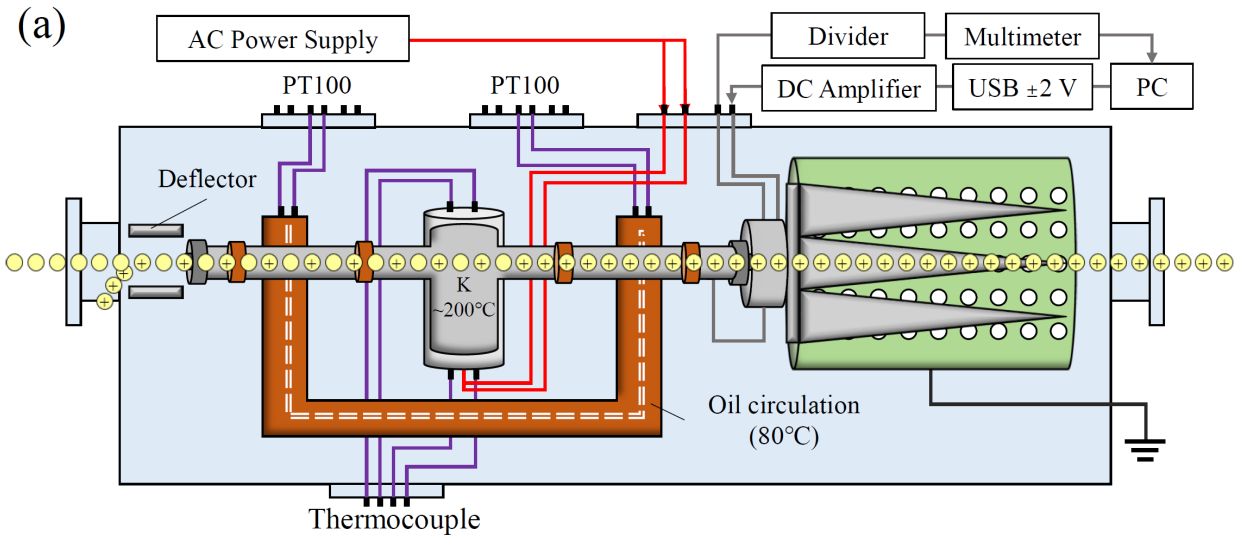
- Faraday Cup
- IRIS
- Ion detector
- Phosphor Screen

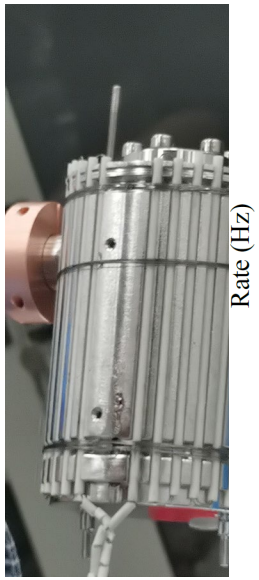
CLS setup @BRIF facility: CEC and voltage scanning

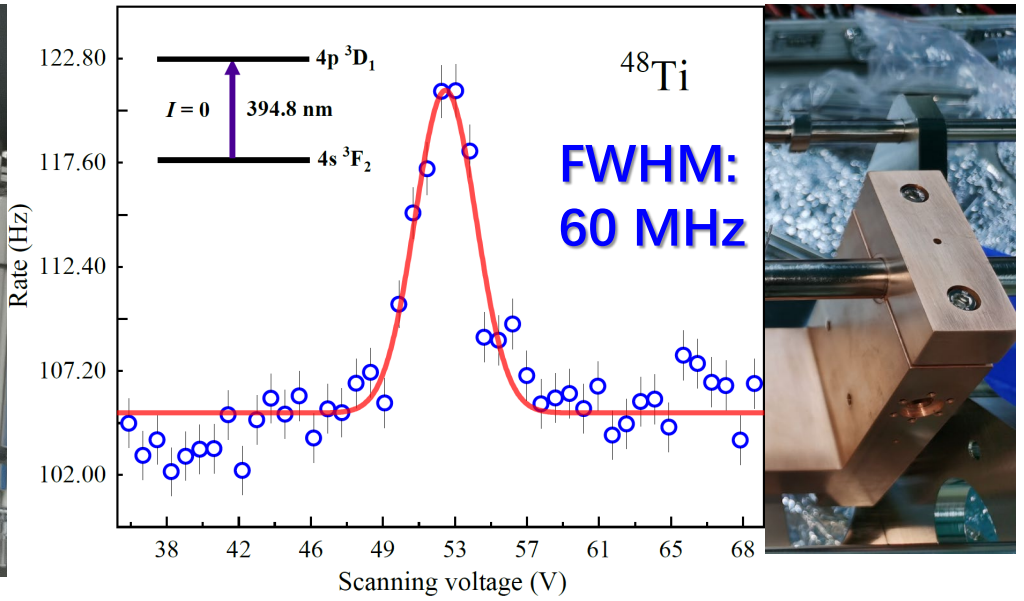




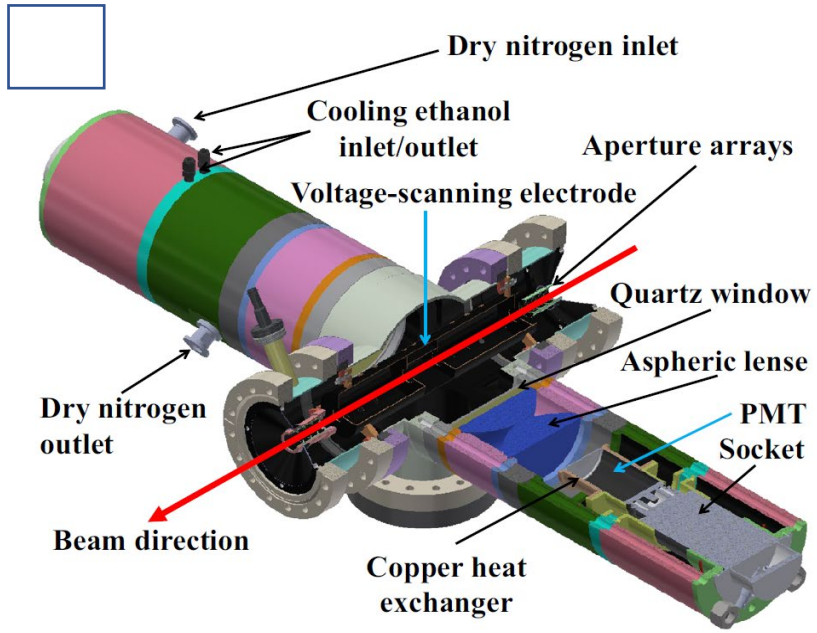
S.J. Wang, X.F. Yang et al., NIMA 1032,166622 (2022)

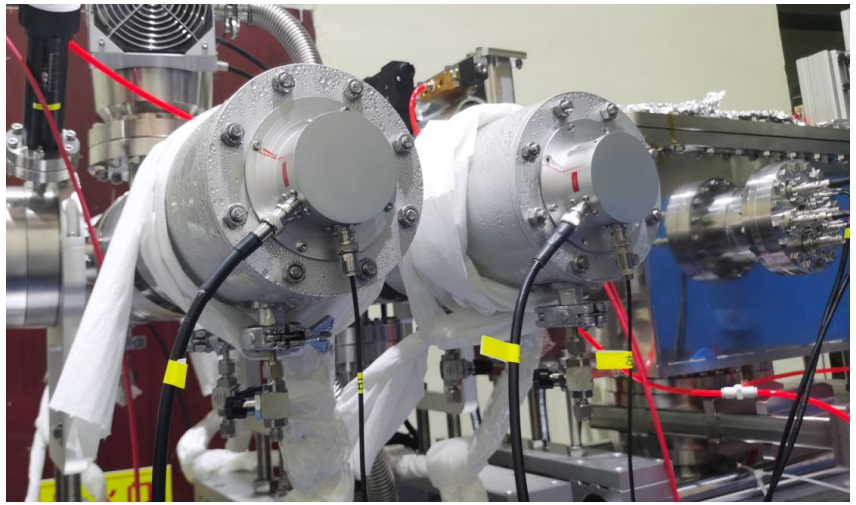




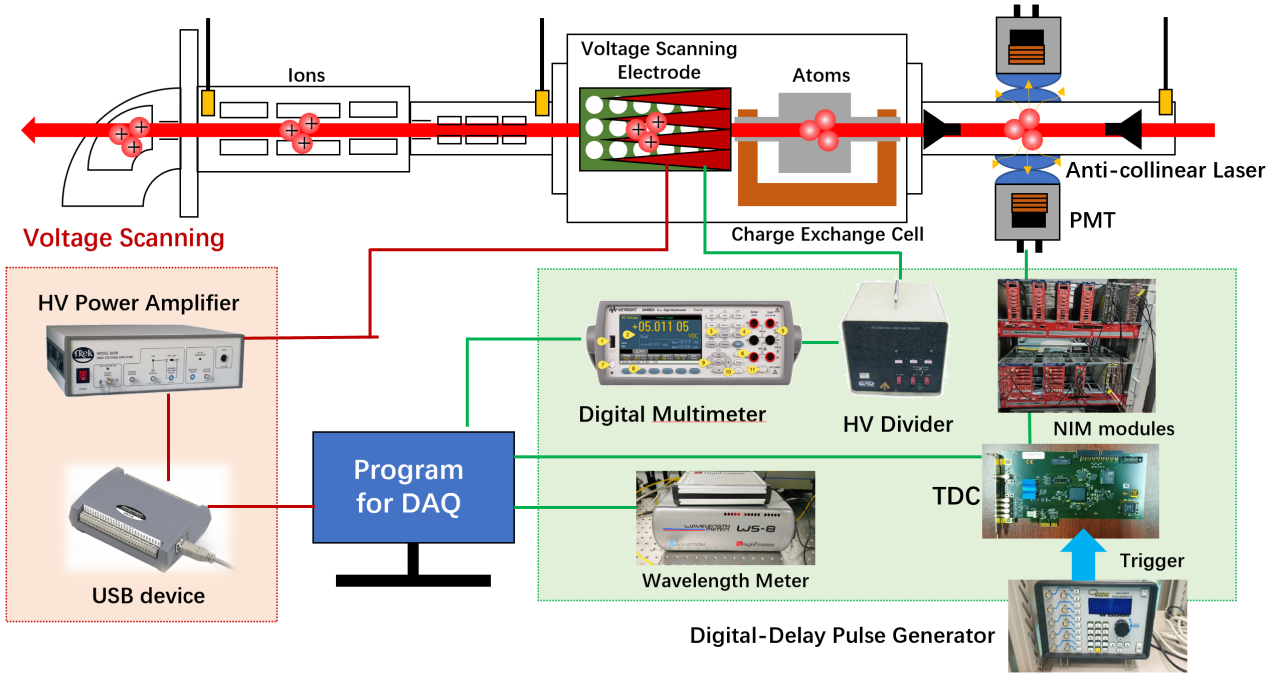


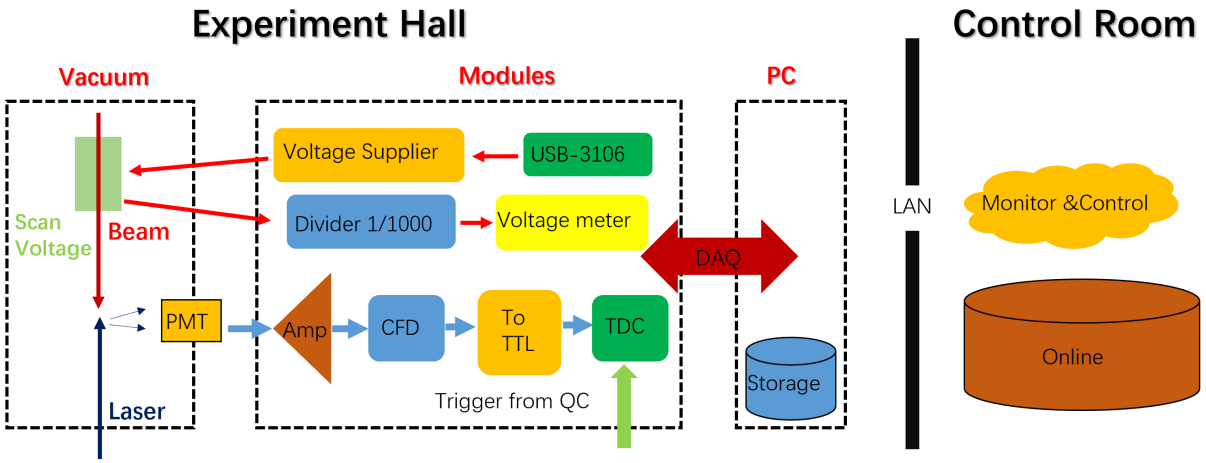
CLS setup @BRIF facility: Photon detection and DAQ



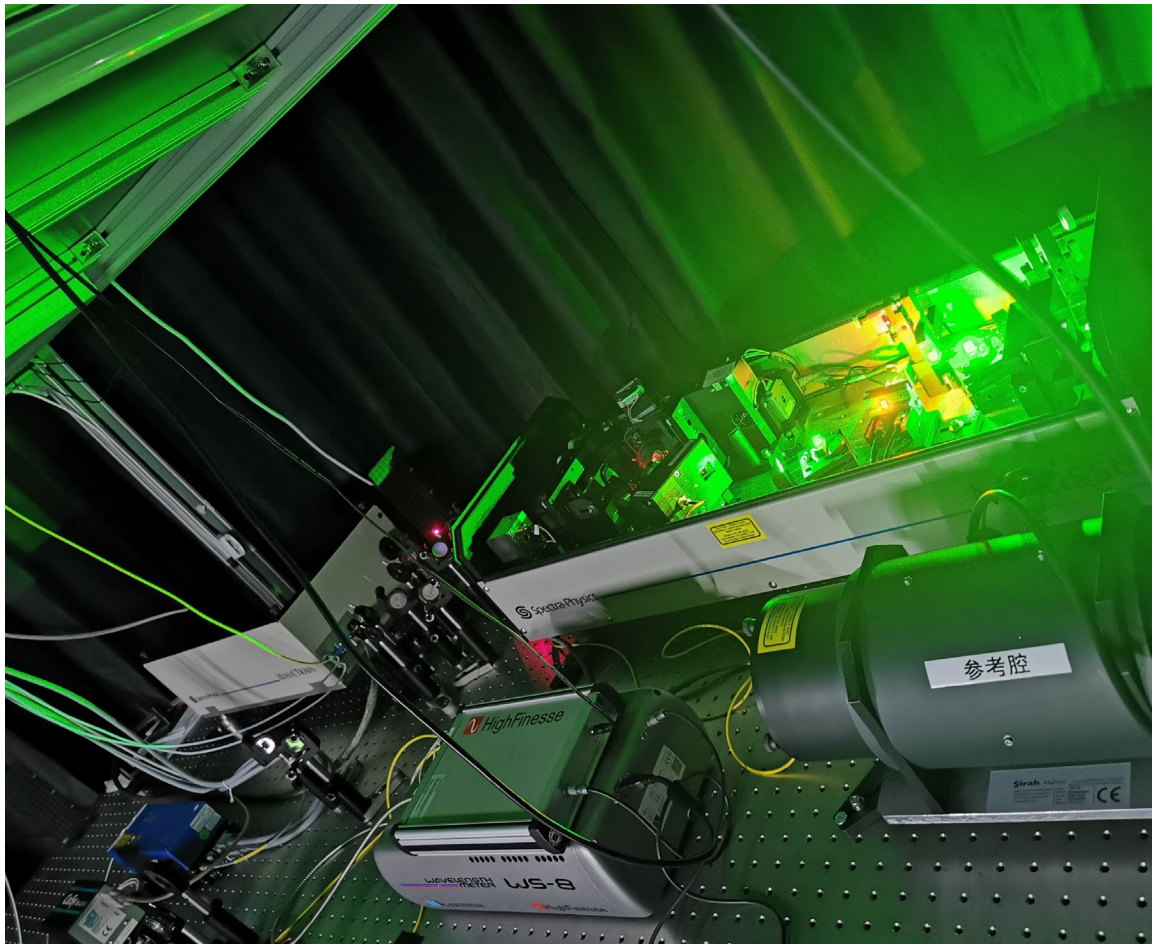


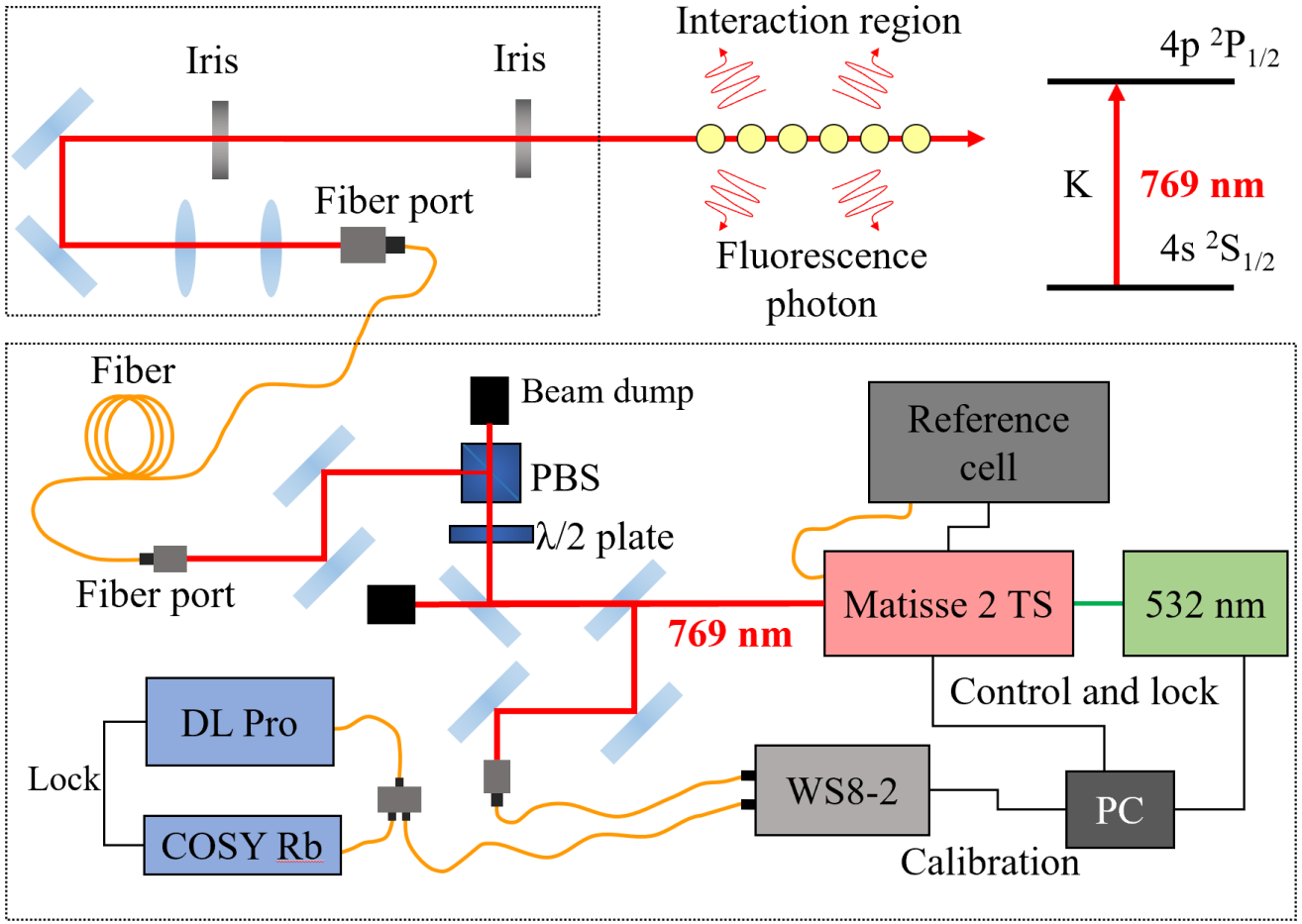
S.W. Bai, X.F. Yang et al., NST. 33, 9 (2022)





CLS setup @BRIF facility: Laser system

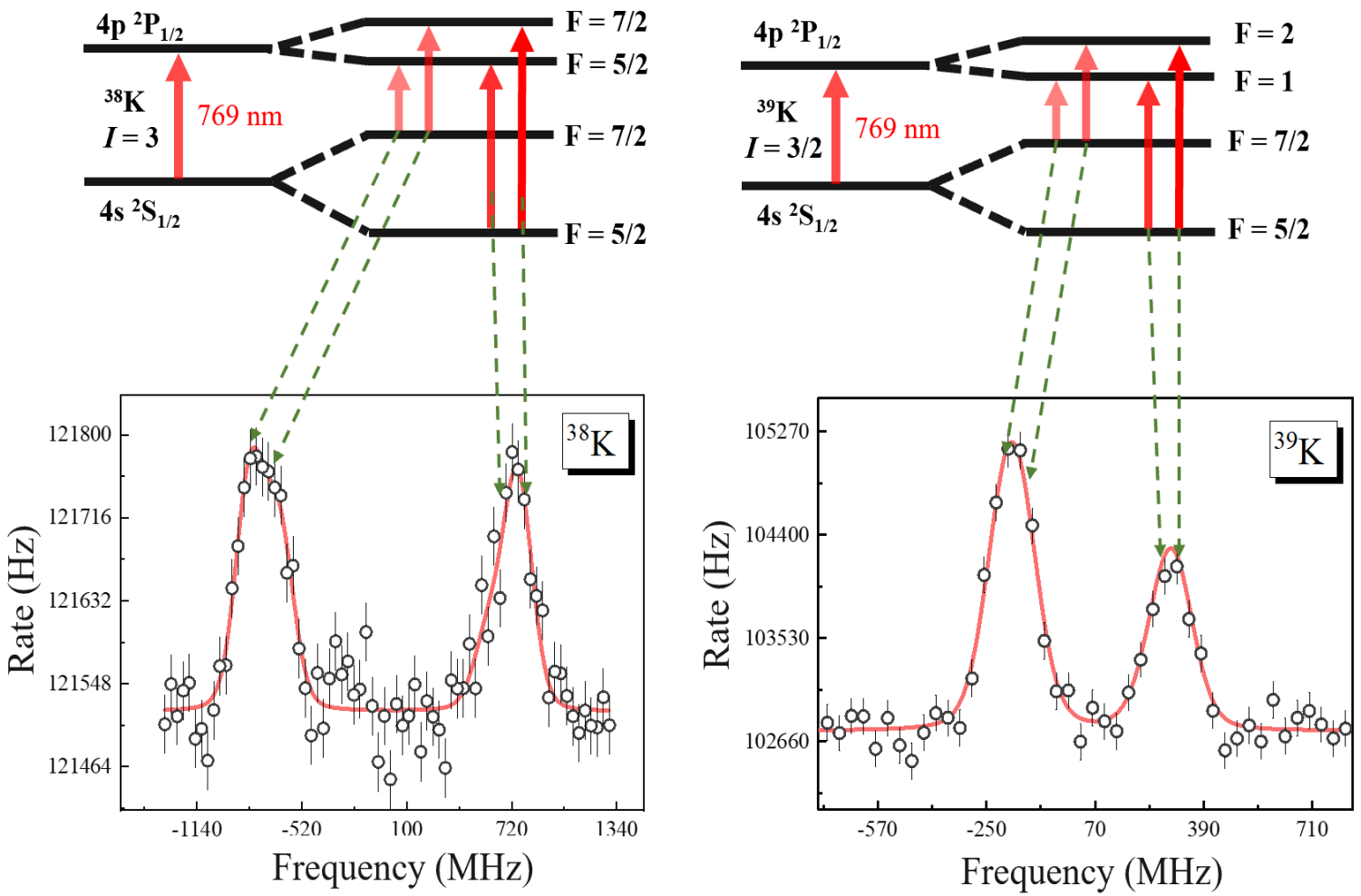




S.J. Wang, X.F. Yang et al., NIMA 1032,166622 (2022)

First online commissioning

Hyperfine structure spectra of ^{38,39}K



- Target: CaO
- Ion Beam: ^{38,39}K
- Energy: 60 keV
- Continuous beam
- CEC: K vapor 50%

A	Al (MHz)	Al [1] (MHz)	$\delta\upsilon^{39,A}$ (MHz)	$\delta\upsilon^{39,A}$ [2] (MHz)
38	404(6)	404.2(5)	-124(7)	-126.1(19)
39	230()	231.1(3)		

[1] Á. Koszorús, X.F. Yang et al., Phys. Rev. C 100(2019)034304
[2] Á. Koszorús, X.F. Yang et al., Nature Physics 17 (2021) 439

S.J. Wang, X.F. Yang et al., NIMA 1032,166622 (2022)

Future Plan: RFQ at BRIF

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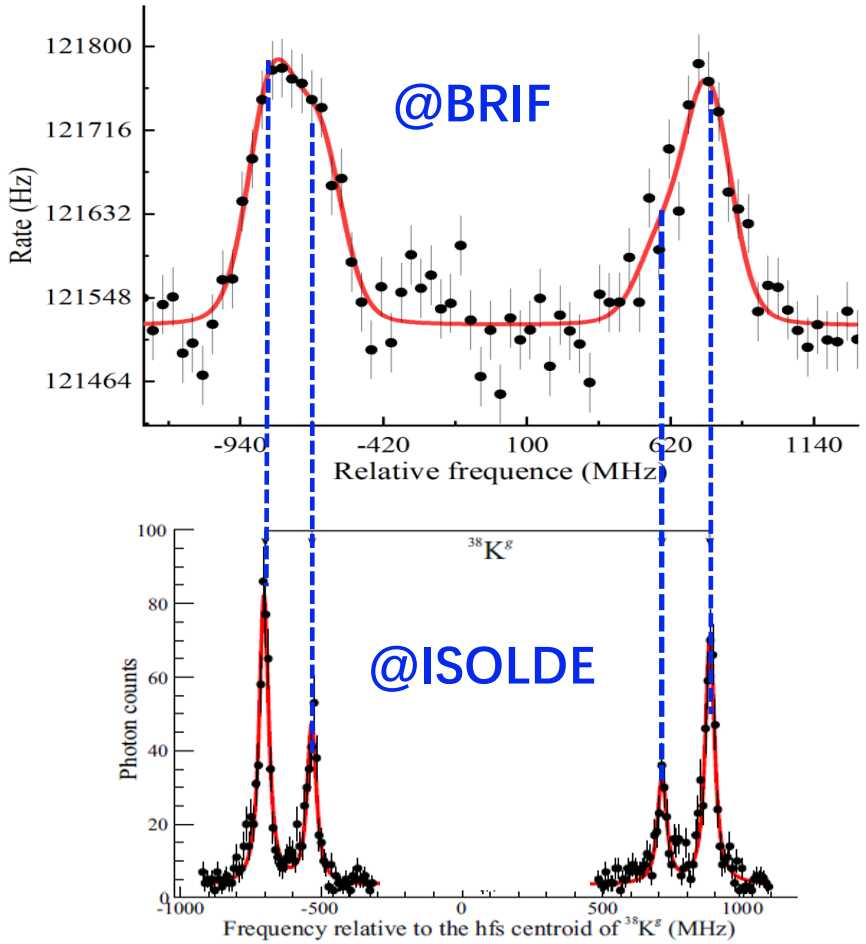
Main problems from this run:

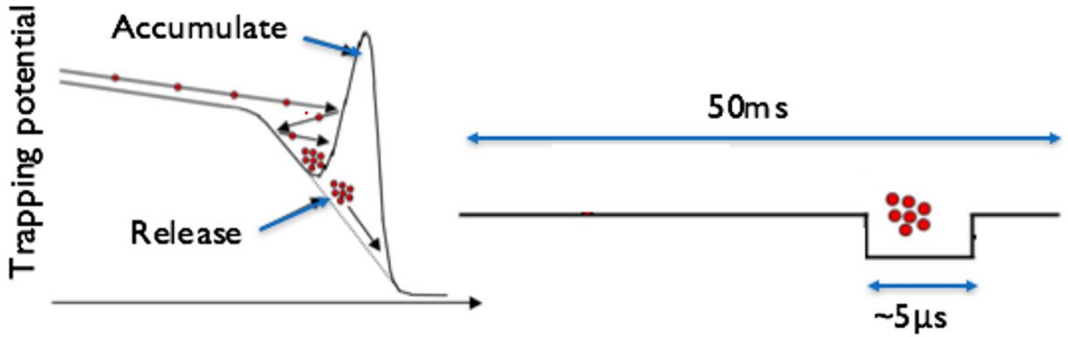


PRL113 052502 (2014)

Sensitivity: continuous beam, 10^{6-8} ion/s

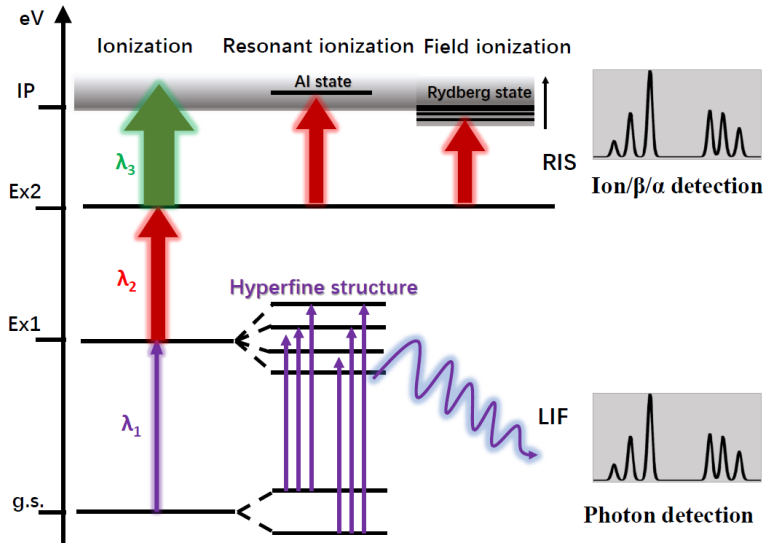
Resolution: large energy spread: ~20 eV

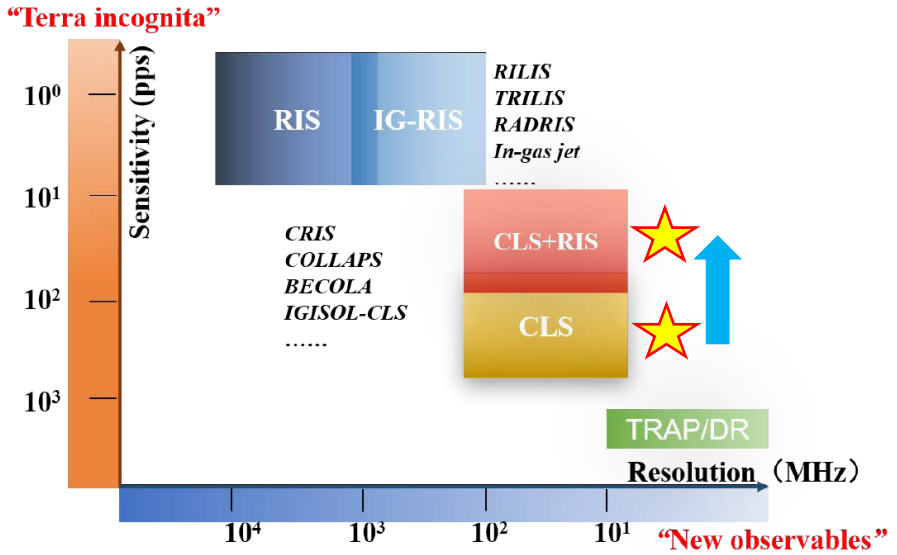
RFQ is urgently needed

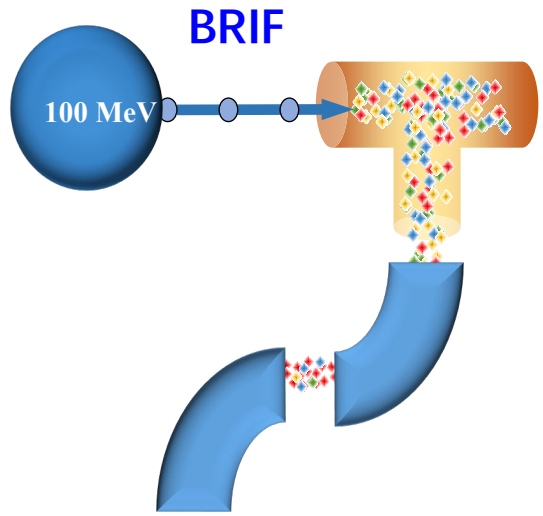


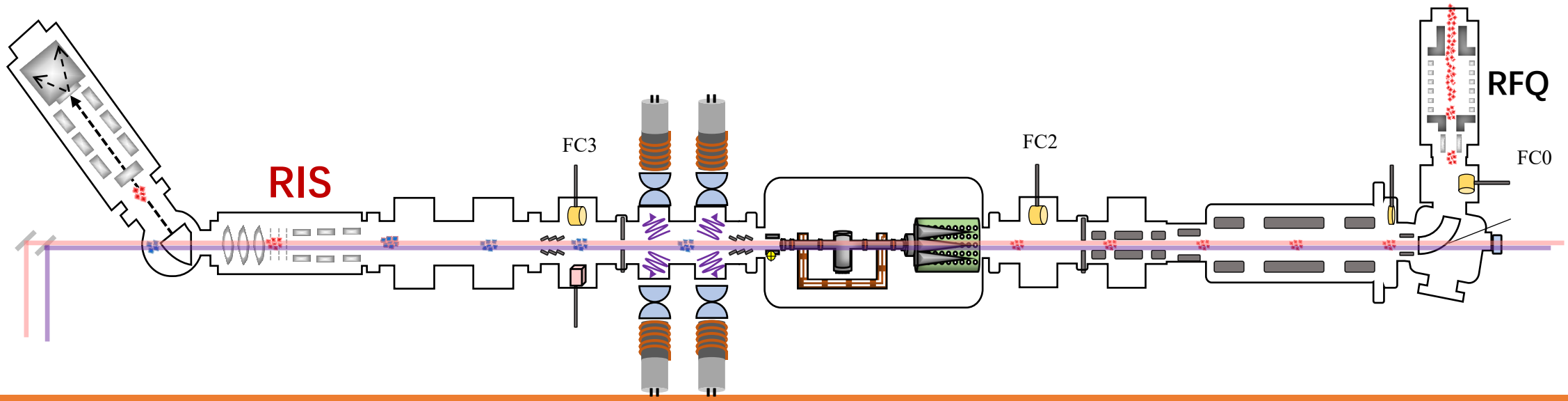
Under development @CIAE/PKU

Future Plan: towards collinear resonance ionization spectroscopy









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Thanks for your attention!