Progress of ANPhA (Asian Nuclear Physics Association)

Weiping Liu, ANPhA chair

IUPAP WG9 Annual General Meeting, SURA center, Washington

June 16, 2022

Many thanks for the contribution of ANPhA members!

China Institute of Atomic Energy (CIAE)

Beijing, China

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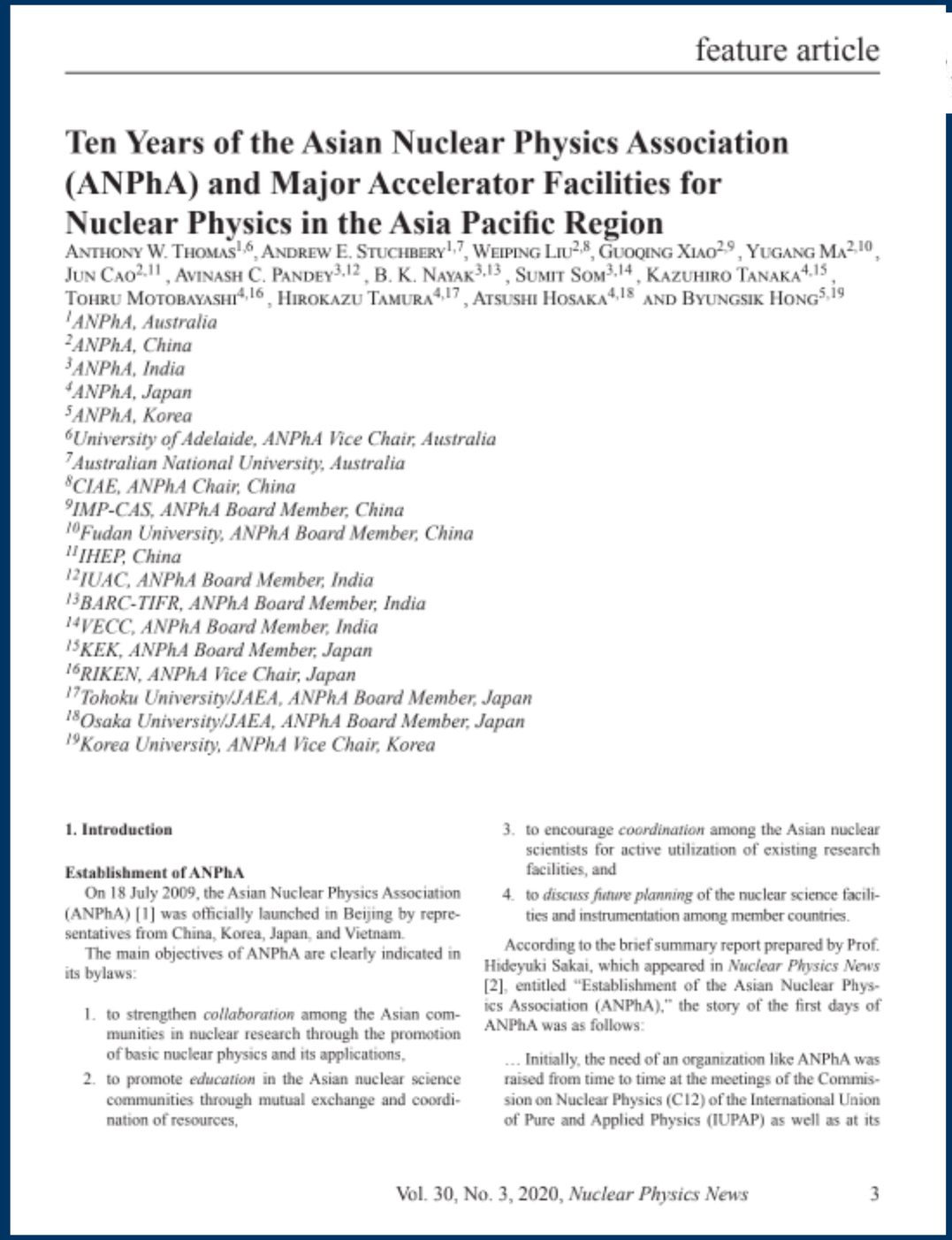
- About ANPhA
- Asia overview
- Recent ANPhA activities



feature article

Ten Years of the Asian Nuclear Physics Association (ANPhA) and Major Accelerator Facilities for Nuclear Physics in the Asia Pacific Region

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[1]*ANPhA, Australia*
[2]*ANPhA, China*
[3]*ANPhA, India*
[4]*ANPhA, Japan*
[5]*ANPhA, Korea*
[6]*University of Adelaide, ANPhA Vice Chair, Australia*
[7]*Australian National University, Australia*
[8]*CIAE, ANPhA Chair, China*
[9]*IMP-CAS, ANPhA Board Member, China*
[10]*Fudan University, ANPhA Board Member, China*
[11]*IHEP, China*
[12]*IUAC, ANPhA Board Member, India*
[13]*BARC-TIFR, ANPhA Board Member, India*
[14]*VECC, ANPhA Board Member, India*
[15]*KEK, ANPhA Board Member, Japan*
[16]*RIKEN, ANPhA Vice Chair, Japan*
[17]*Tohoku University/JAEA, ANPhA Board Member, Japan*
[18]*Osaka University/JAEA, ANPhA Board Member, Japan*
[19]*Korea University, ANPhA Vice Chair, Korea*

1. Introduction

Establishment of ANPhA

On 18 July 2009, the Asian Nuclear Physics Association (ANPhA) [1] was officially launched in Beijing by representatives from China, Korea, Japan, and Vietnam.

The main objectives of ANPhA are clearly indicated in its bylaws:

1. to strengthen *collaboration* among the Asian communities in nuclear research through the promotion of basic nuclear physics and its applications,
2. to promote *education* in the Asian nuclear science communities through mutual exchange and coordination of resources,
3. to encourage *coordination* among the Asian nuclear scientists for active utilization of existing research facilities, and
4. to *discuss future planning* of the nuclear science facilities and instrumentation among member countries.

According to the brief summary report prepared by Prof. Hideyuki Sakai, which appeared in *Nuclear Physics News* [2], entitled "Establishment of the Asian Nuclear Physics Association (ANPhA)," the story of the first days of ANPhA was as follows:

… Initially, the need of an organization like ANPhA was raised from time to time at the meetings of the Commission on Nuclear Physics (C12) of the International Union of Pure and Applied Physics (IUPAP) as well as at its

ANPhA meetings

- 2009, July 18, established in Beijing
- 2010, Jan 17, in Tokai; Oct. in Seoul
- 2011, April 29, in Lanzhou
- 2012-2019, meetings
- 2020, online, Dec. 10 in Hong Kong
- 2021, online, Dec. 3 in Beijing
- 2022, online, Jan. 15, NuPPEC meeting
- 2022, online, June 14, IUPAP/WG9 meeting
- 2022, online, Aug., during APPC15 conference, planned

W. P. Liu, WG9 meeting 2022, June

13th Asian Nuclear Physics Association (ANPhA) Board meeting

September 14, 2018, Beijing

ANPhA
Asian Nuclear Physics Association

Figure 2. *Current officers of ANPhA (= AAPPS–DNP). From left to right: Weiping Liu (chair, CIAE, China); Tohru Motobayashi (vice chair, RIKEN, Japan); Anthony Thomas (vice chair, University of Adelaide, Australia); Byungsik Hong (vice chair, Korea University, Korea); Bing Guo (scientific cecretary, CIAE, China).*

W. P. Liu, WG9 meeting 2022, June

Member evolution

ANPhA Asian Nuclear Physics Association

2009-2011, country and region

Australia : Anthony Thomas

China : Weiping Liu
Guoqing Xiao
Yugang Ma
Yanlin Ye (Vice-Chair)

India : Bikash Sinha,
Swaminathan Kalias

Japan : Shoji Nagamiya
Tohru Motobayashi (Secretary)
Takaharu Otsuka
Hideyuki Sakai (Chair)

Korea : Dong-Phil Min (Vice-Chair)
Seung-Woo Hong
Wooyoung Kim

Mongolia : to be decided

Taiwan : Jiunn-Wei Chen

Vietnam : Dao Tien Khoa

ANPhA Board 2019-2022, institution

last update: February 10, 2020

Chairs:

Chair:	Weiping Liu (China) (E-mail: wpliu@ciae.ac.cn)
Vice Chair:	Anthony Thomas (Australia)
	Tohru Motobayashi(Japan)
	Byungsik Hong (Korea)

Members:

Wen-Chen Chang (Institute of Physics, Academia Sinica)
Myeong Ki Cheoun (Soongsil University)
Phan Viet Cuong(Deputy director of VINAGAMMA, Danang Unit)
Byungsik Hong (Korea University)
Atsushi Hosaka (RCNP, Osaka University)
Kairat Kuterbekov (Eurasian National University)
Jenny Hiu Ching Lee (The University of Hong Kong)
Weiping Liu (China Institute of Atomic Energy)
Yugang Ma (Shanghai Institute of Applied Physics)
Tohru Motobayashi (RIKEN)
Khin Swe Myint (University of Mandalay)
B. K. Nayak (BARC, Mumbai)
Avinash C. Pandey (IUAC, Delhi)
Sumit Som (VECC, Kolkata)
Kazuhiro Tanaka (KEK)
Hirokazu Tamura (Tohoku University)
Anthony Thomas (The University of Adelaide)
Furong Xu (Peking University)
Guoqing Xiao (Institute of Modern Physics)
Jin-Hee Yoon(Inha University)

Observers:

Marek Lewitowicz(NuPECC Chair, GANIL, France)
Chair of European Physical Society– *Division of Nuclear Physics*
Hideyuki Sakai (Past Chair, RIKEN, Japan)
Shoji Nagamiya (RIKEN and KEK, Japan)
Yanlin Ye (Past Chair, Peking University, China)
Dong-Pil Min (Past Chair, Seoul National University, Korea)

Secretary:

Secretary:	Bing Guo (China) (E-mail: guobing@ciae.ac.cn)

ANPhA chair

2009-2011， Hideyuki Sakai

2012-2015, Yanlin Ye

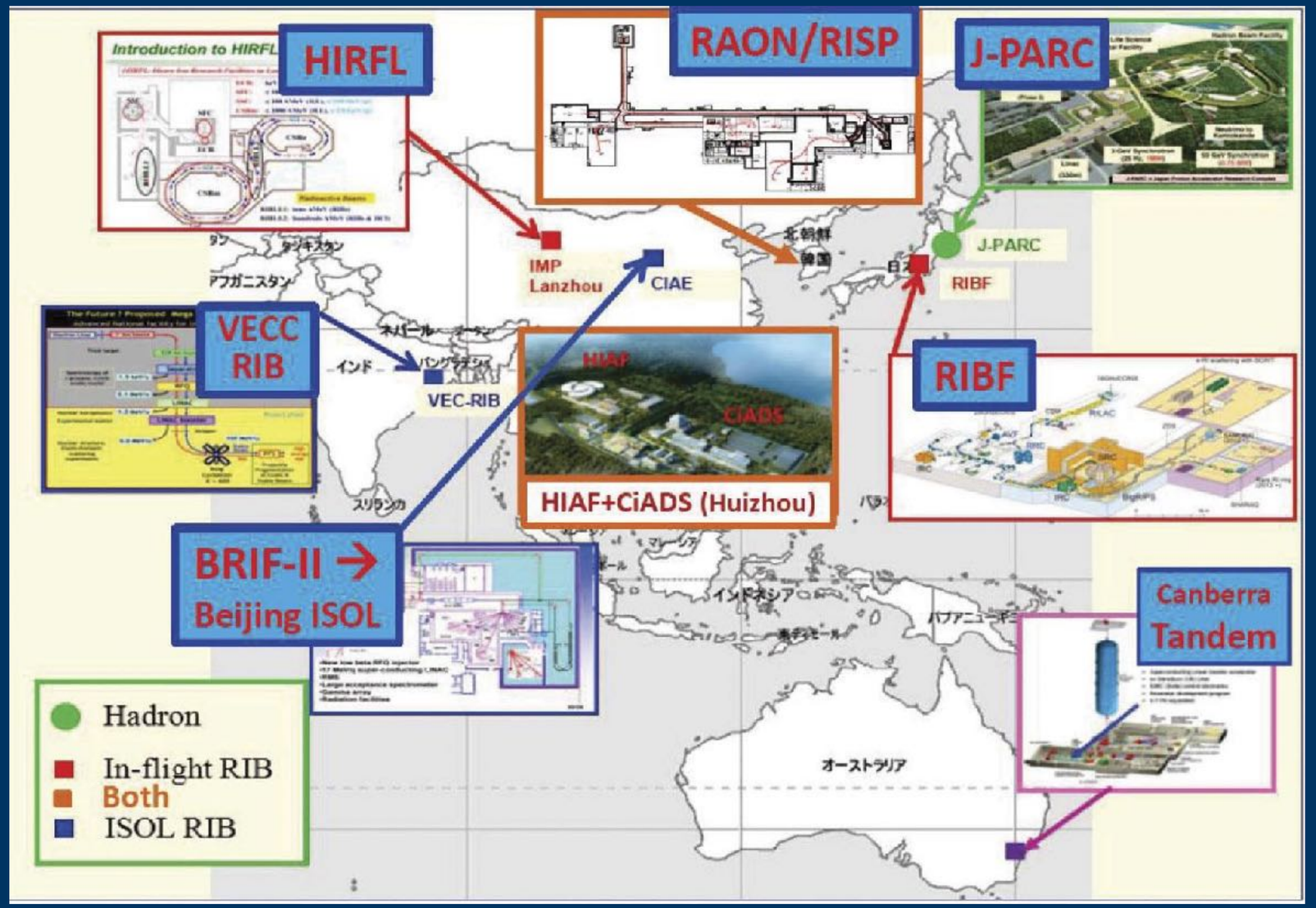
2016-2019, Kazuhiro Tanaka

2019-2022, Weiping Liu

Overview of Operational and Planned Facilities

- Japan: PF facilities+KEK+neutrino
- Korea: PF+ISOL facilities
- India: ISOL facilities+nuclear structure
- Australia: construction of the underground lab in Stawell proceeding well
- China
  - ISOL: BRIF, and BISOL planned
  - PF: Lanzhou CSR, HIAFunder construction Guangdong
  - Other: JUNA in CJPL, SLEGS, JUNO, and Daya Bay.

W. P. Liu, WG9 meeting 2022, June



A. W. Thomas et al., Nuclear Physics News, 30(2020)3

Town	Institute	Facility	Characteristics
Canberra, Australia	Australian National University (ANU), Heavy Ion Accelerator Facility		15MV Tandem accelerator + superconducting Linear Accelerator
Beijing, China	Beijing Tandem Accelerator Nuclear Physics National Laboratory	BTANL	15 MV tandem accelerator, 100 MeV 20 μA proton cyclotron, ISOL
Shanghai, China	Shanghai Laser Electron Gamma Source	SLEGS	0.4-20 MeV BCS γ-ray source based on Synchrotron Radiation Facility
Jinping, China	China Jinping underground Laboratory (CJPL), JINPING UNDERGROUND NUCLEAR ASTROPHYSICS EXPERIMENT (JUNA)	CJPL / JUNA	400 kV accelerator (Ion species of Stable nuclei: H to He), Max. Energy: 400 kV*q, Beam Intensity: up to 2.5 emA
Lanzhou, China	Heavy Ion Research Facility in Lanzhou	HIRFL	SSC cyclotron: K=450 and full ion acceleration CSRm booster synchrotron 12.2 Tm
Huizhou, China	Heavy Ion Accelerator Facility, Institute of modern Physics	HIAF	Heavy-Ion Linac, Booster-ring ~1GeV/u and Ring spectrometer (Phase 1). Compressor ring ~5GeV/u and Enrgy Recovery Linac.
Huizhou, China	China Initiative ADS	CIADS	The 250 MeV and 10mA (maximum beam current) CW mode superconducting proton LINAC
Munbai, India	Bhabha Atomic Research Centre - Tata Institute of Fundamental Research (BARC-TIFR)	BARC-TIFR	14MV heavy ion tandem + superconducting linac (PLF: Pelletron LINAC Facility)
New Delhi, India	Inter-University Accelerator Centre	IUAC	15MV heavy ion tandem + superconducting linac
Kolkata, India	Variable Energy Cyclotron Centre	VECC	VECC K130 cyclotron (p,α), K500 Superconducting Cycrotron
Chiba, Japan	Heavy Ion Medical Accelerator, National Institute of Radiological Sciences	HIMAC	High energy heavy ion beams, up to 800 MeV/u, supplied by linear accelerators and two synchrotron rings.
Tokai, Ibaraki, Japan	J-PARC (Nuclear and Particle Physics Facility)	J-PARC	High Intensity Accelarators, 400MeV LINAC, 3GeV RCS, 50GeV MR
Osaka, Japan	Research Center for Nuclear Physics, Osaka University	RCNP/LEPS	Cyclotron complex (K140 AVF + K400 Ring) Laser-electron back-scattered photon facility at SPring-8 site, 2.4 and 2.9 GeV.
SPring-8 site, Hyogo, Japan	Laboratory of Advanced Science and Technology for Industry	NewSUBARU	Laser Compton Scattering Gamma-ray Beam Source (1 - 76 MeV)
Wako, Saitama, Japan	RIKEN Nishina Center for Accelerator-Based Science, RI Beam Factory	RIBF	Heavy Ion Linac and several big Ring Cycrotrons (Max K=2500MeV), Big Rips Projectile Isotope Separator
Fukuoka, Japan	Kyushu University, Center for Accelerator and Beam Applied Science		FFAG synchrotron and tandem acceleror
Tokai, Ibaraki, Japan	Japan Atomic Energy Agency (JAEA), Tandem Accelerator Facility		20MV tandem accelerator and superconducting linac booster.
Tsukuba, Ibaraki, Japan	University of Tsukuba, Tandem Accelerator Complex	UTTAC	6 MV tandem accelerator / 1 MV Tandetron accelerator
Sendai, Japan	Tohoku University, Cyclotron and Radioisotope Center	CYRIC	K110 and K12 cycrotrons
Sendai, Japan	Research Center for Electron-Photon Science, Tohoku Univerisity	ELPH	60 MeV High intensity ELECTRON Linac, 1.3 GeV Booster Electron Synchrotron for GeV tagged photon beams
Gyeongsangbuk-do, Korea	Korea Multi-purpose Accelerator Complex	KOMAC	100 MeV and 20 MeV Proton linac
Seoul, Korea	Korea Institute of Science and Technology (KIST), The Accelerator Laboratory		2MeV and 6 MV tandetron accelerators
Seoul, Korea	Korea Heavy Ion Medical Accelerator at Korea Institute of Radiological and Medical Sciences (KIRMAS)	KIRAMS	AVF cyclotron for 50MeV protons
Jeollabuk-do, Korea	Advanced Radiation Technology Institute		15-30 MeV 500mA Proton Cycrotron
Daejeon, Korea	Rare isotope Accelerator complex for ON-line experiments (RAON), Institute for Basic Science (IBS)	RAON	Superconducting Driver Linac (proton: 600MeV, 660 microA, HI: 200MeV/u), Superconducting Post Linac (HI: 18.5 Mev/u), Cyclotron: (proton 70 MeV, 1mA)
Hsinchu, Taiwan	Graduate Institute of Nuclear Science (INS) National Tsing Hua University (NTHU)	INS / NTHU	3MV Van de Graaff (KN) Accelerator, 3MV Tandem accelerator (NEC 9SDH-2), open air 500kV accelerator
Hanoi, Vietnam	Tandem machine at Hanoi University of Natural Science		1.7MV Tandem Pelletron,
Hanoi, Vietnam	Military Central Hospital 108		30 MeV 300 microA proton cyclotron

Mainly basic research

Mainly application

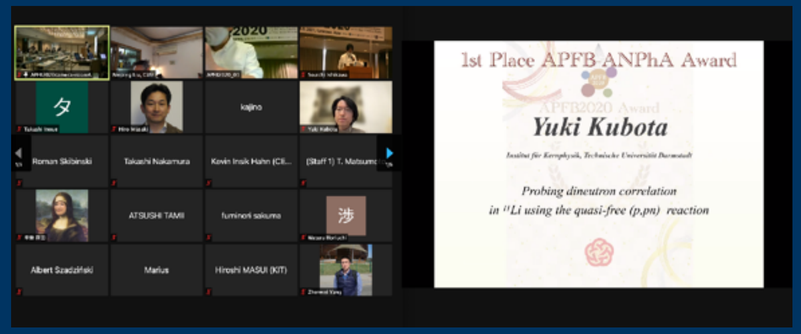
Under construction

Contents

- Asia overview
- Recent activities

Summary of ANPhA symposium and activities 2020-2021

- **Nearly all ANPhA board member participation**
- **Organized by university of Hong Kong**
- **With NuPPEC presentation**
- **Progress of AP progress presented**
- **With encouraging discussions**
- **Enhance the future collaborations**
- **Support many conference and workshops, award to young researchers**



Summary of ANPhA symposium and activities 2020-2021

- All facilities basically open for domestic users
- Conference given by online+offline mode, e. g. APFB
- CJK exchange very often, get support by NSF A3 grants
- Other very active in theory
- Young researchers still have high interest, with large numbers
  - new center like Beihang, BNU etc.

Progress nuclear physics Japan 2022

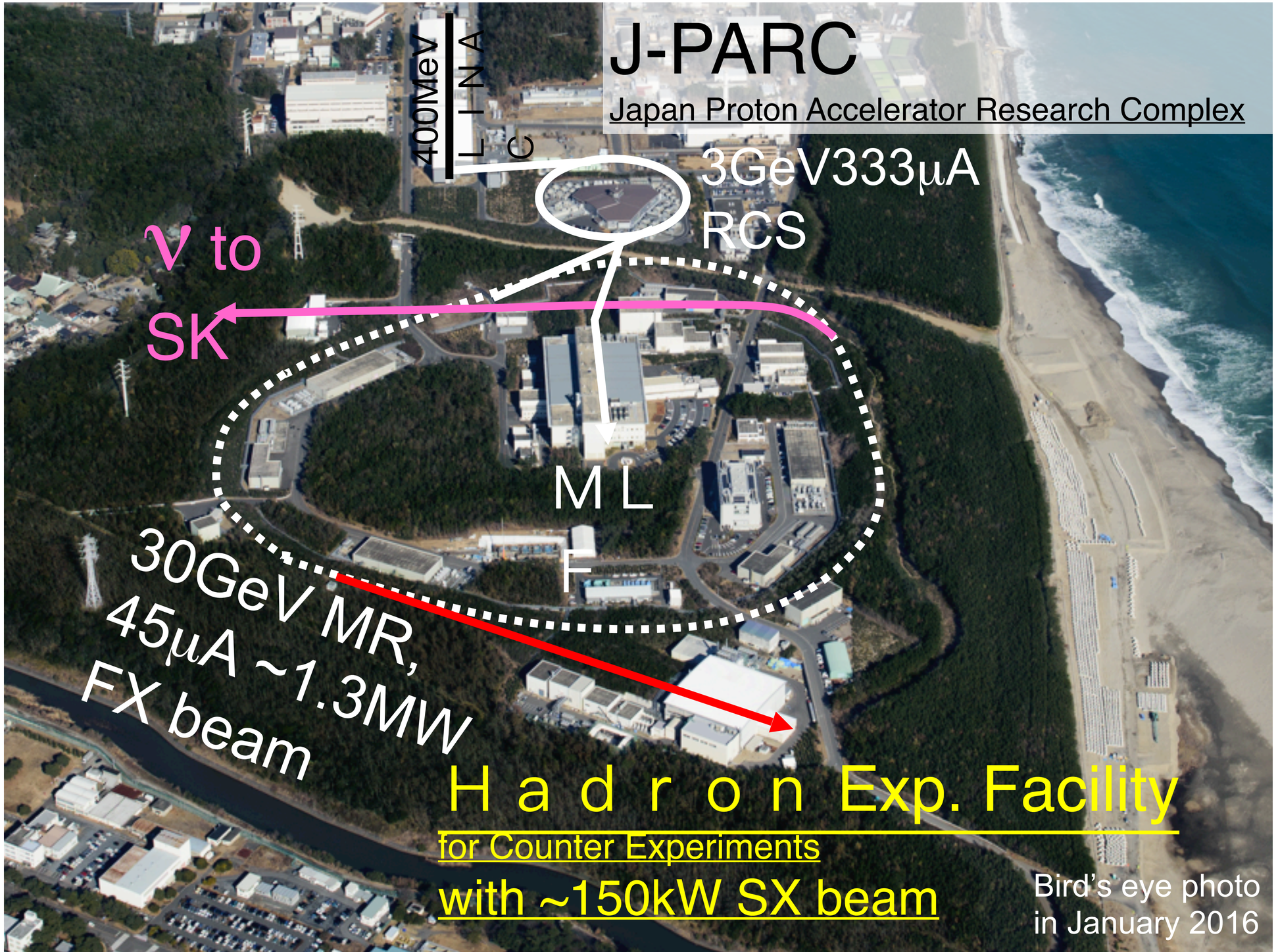
Kazuhiro Tanaka

Tohru Motobayashi

Takashi Nakano

Toshifumi Suda

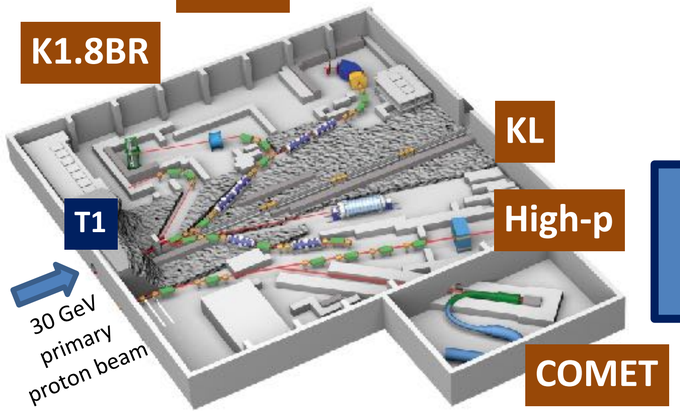
Atsushi Hosaka



Hadron Experimental Facility eXtension (HEF-ex) Project

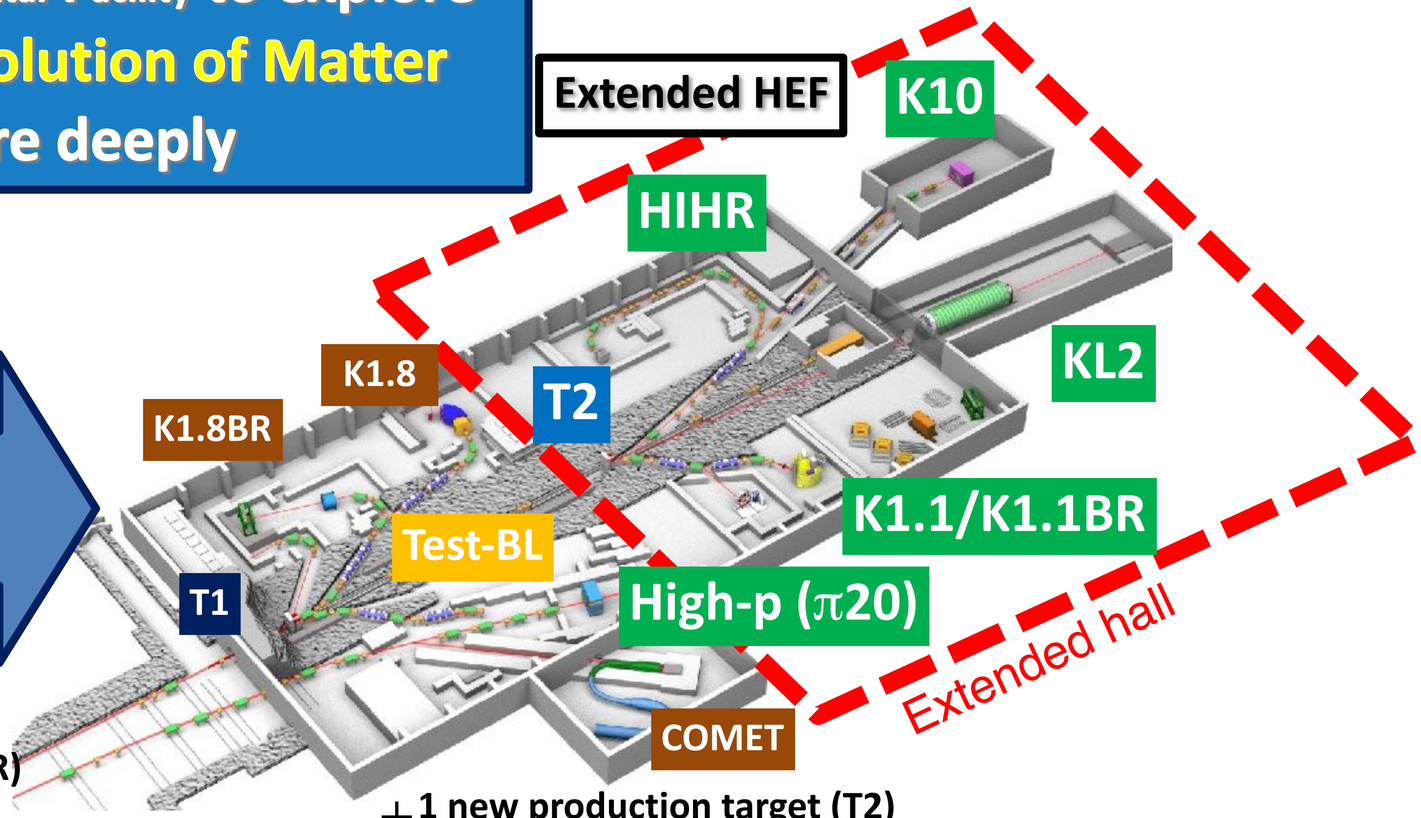
Expand research programs at the Hadron Experimental Facility to explore Origin & Evolution of Matter more deeply

Present HEF (2009～)



1 production target (T1)
1 secondary-charged beamline (K1.8/K1.8BR)
1 neutral beamline (KL)
1 primary beamline (High-p)
1 muon beamline (COMET)

Extended HEF



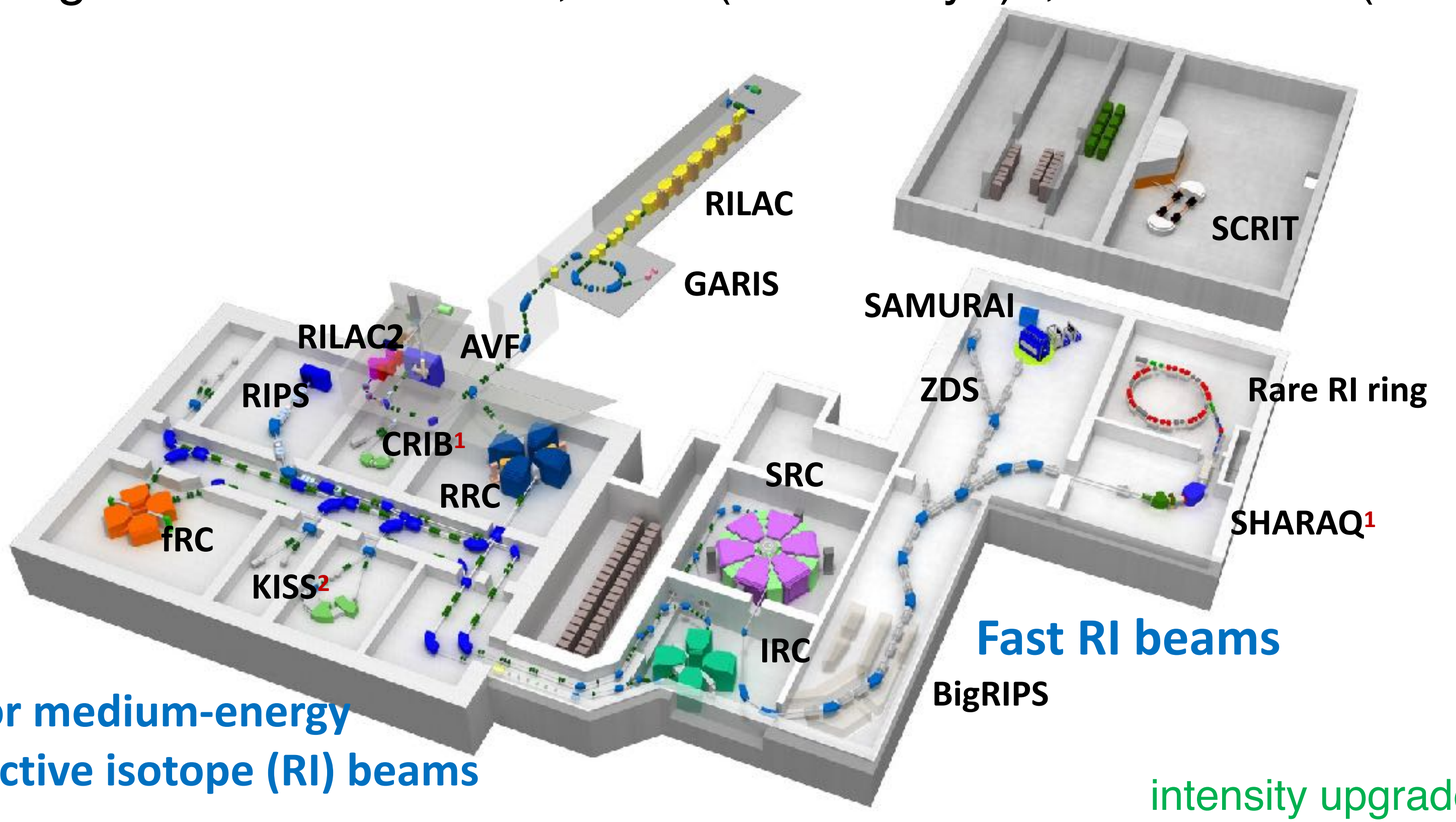
＋1 new production target (T2)
＋4 new beamlines (HIHR, K1.1/K1.1BR, KL2, K10)
＋ 2 updated beamlines (High-p (π20), Test-BL)

This HEF-ex Project has been selected the KEK's TOP Priority Project by KEK Science Advisory Committee (SAC) for coming 5 Years (June 2022)!

RI Beam Factory at RIKEN Nishina Center

H to U up to 345 MeV /u; polarized deuterons) - in stable operation

3 organizations - RIKEN , CNS (U. of Tokyo) [1], and WNSC (KEK) [2]



COVID-19 issue

Essentially no access control to the RIKEN campus,
but national border is still highly controlled.

intensity upgrade (2022)

^{48}Ca: 738 pnA (12.3 kW)

^{70}Zn: 788 pnA (19.0 kW)

^{78}Kr: 486 pnA (13.1 kW)

^{124}Xe: 173 pnA (7.4 kW)

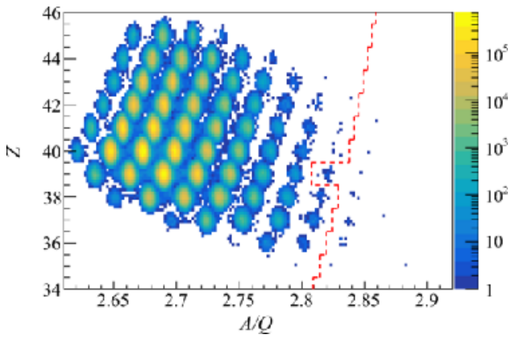
^{238}U: 117 pnA (9.6 kW)

Recent Highlights (1)

New Isotopes:

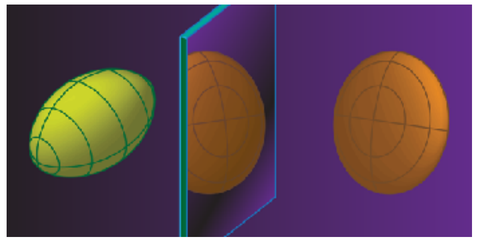
Observation of new neutron-rich isotopes

^{101}Br, ^{102}Kr, ^{105,106}Rb, ^{108}Sr, ^{110,111}Y, ^{114}Zr, ^{117}Nb(PRC)



Shell Evolution :

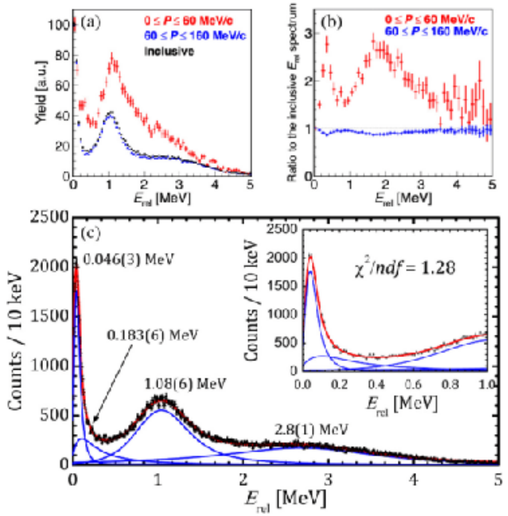
Shape Changes in the Mirror Nuclei: ^{70}Kr and ^{70}Se (PRL)



Pairing Forces Govern Population of Doubly Magic ^{54}Ca from Direct Reactions (PRL)

β decay of the very neutron deficient ^{60}Ge and ^{62}Ge nuclei (PRC)

Three-quasiparticle isomers in odd-even ^{159,161}Pm (PRC/L)



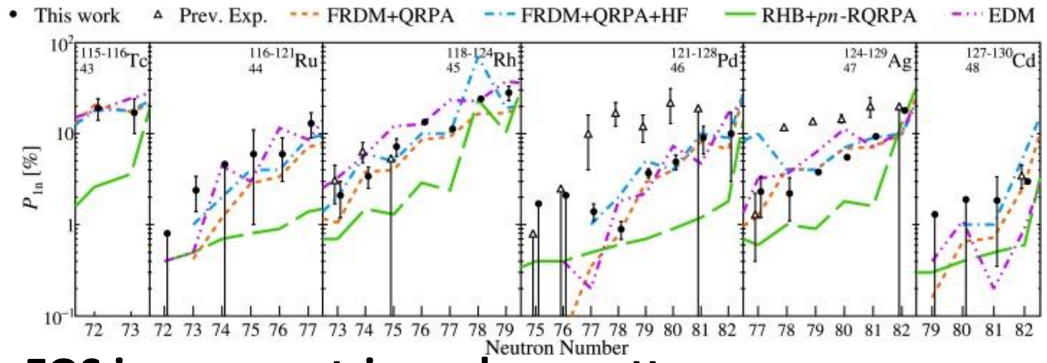
Neutron correlation:

Quasi-free Neutron Knockout Reaction
for invariant-mass spectroscopy of ^{16}B (PRL)

Recent Highlights (2)

r-process nucleosynthesis:

beta-delayed neutron emission of r-process nuclei at the N=82 shell closure (PLB)

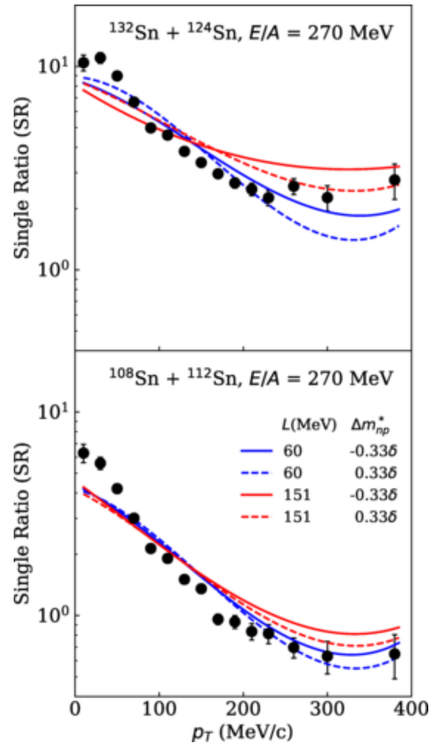


EOS in asymmetric nuclear matter:

Probing the Symmetry Energy with the Spectral Pion Ratio (PRL)

Symmetry energy investigation with pion production
(PLB, highly cited paper)

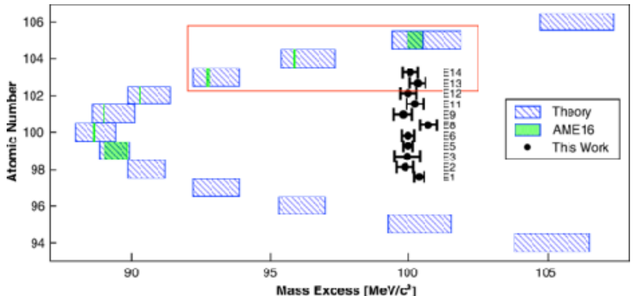
Rapidity distributions of Z=1 isotopes (PLB)



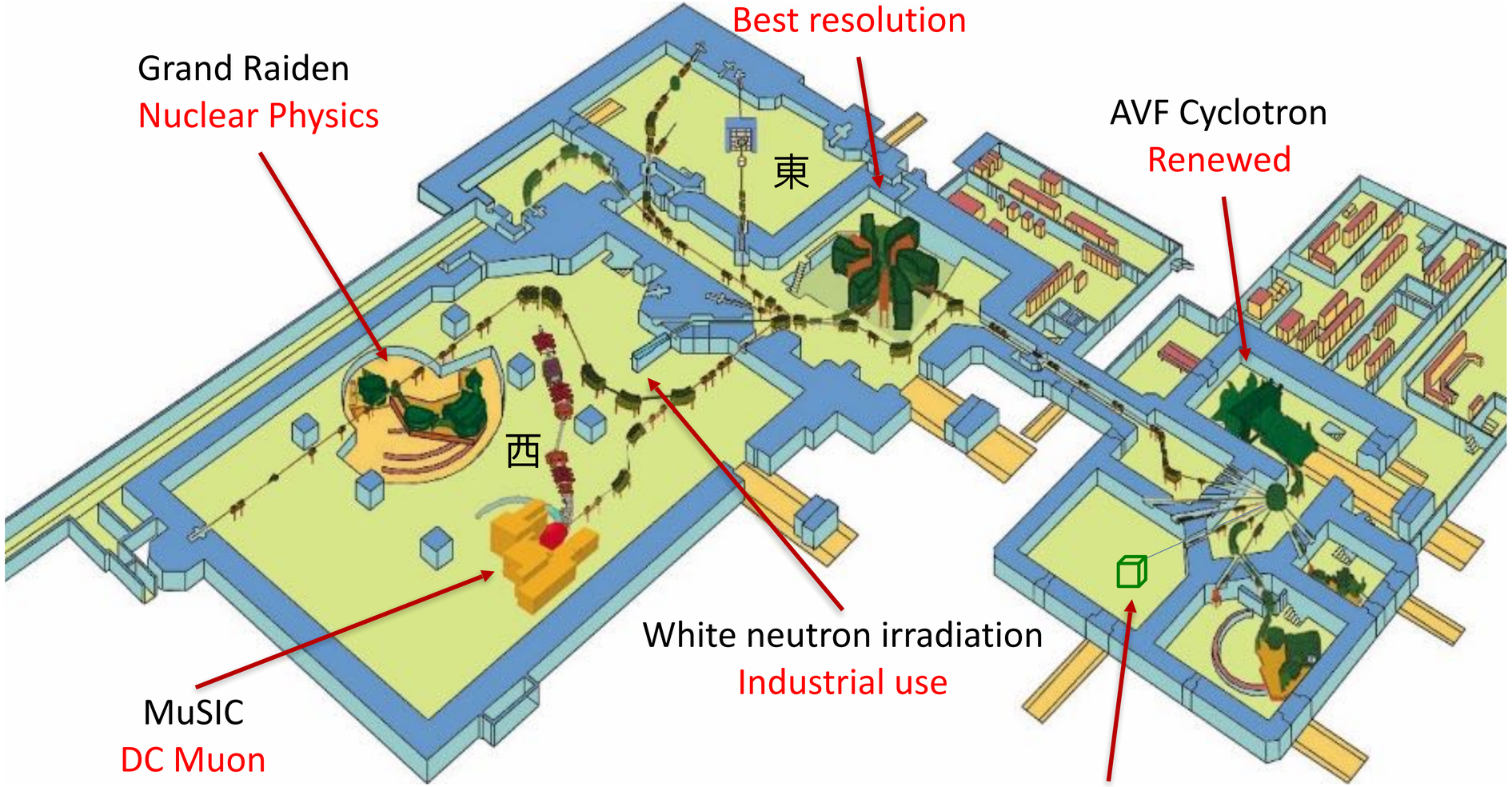
Mass measurement in the HE and SHE region:

First high-precision direct determination of the atomic mass of a superheavy nuclide(PRC/L)

$^{206, 207g, m}$Ra using an alpha-TOF detector (PRC)



Cyclotron Facility at RCNP



Renewal of AVF Cyclotron

AVF Cyclotron

single use

High Intensity
High resolution

Ring Cyclotron

tundem use

- Short-lived RI supply

10～100μA

・Proton & Deuteron beam
→ Short-lifeved RI supply platform

・He beam
→^{211}At for Targeted Alpha Therapy

- interdisciplinary&industrial use

Proton
400MeV
～10μA

・Proton beam
→DC Muon（MuSIC）
→White neutron irradiation

- High resolution experiment

ΔE/E～10^{-4}

・High quality beam

- Hyper Deformed Nucleus Study

・HI beam
→C A G R A＋Grand-RAIDEN

ELPH, Tohoku University

(Research Center for ELectron-PHoton Science)

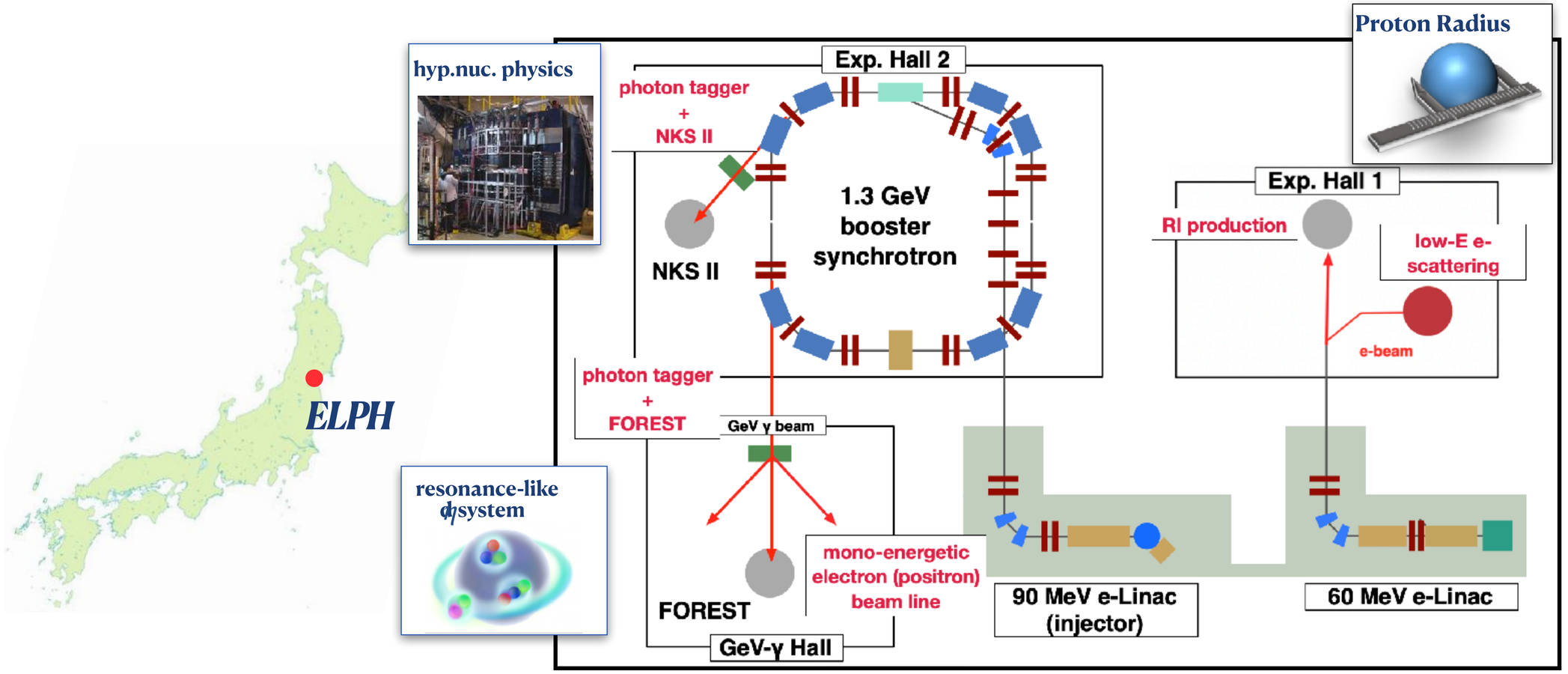
university-based accelerator user facility

electron accelerators

- 60 MeV high-power e-linac (10 kW)
- 1.3 GeV Synchrotron (GeV tagged photon)

researches with electron beam

- hadron physics, nuclear physics
- radiochemistry
- related fields with radioactive isotopes



Theory by Supercomputer Fugaku

Fugaku (富岳) : 440 PFlops

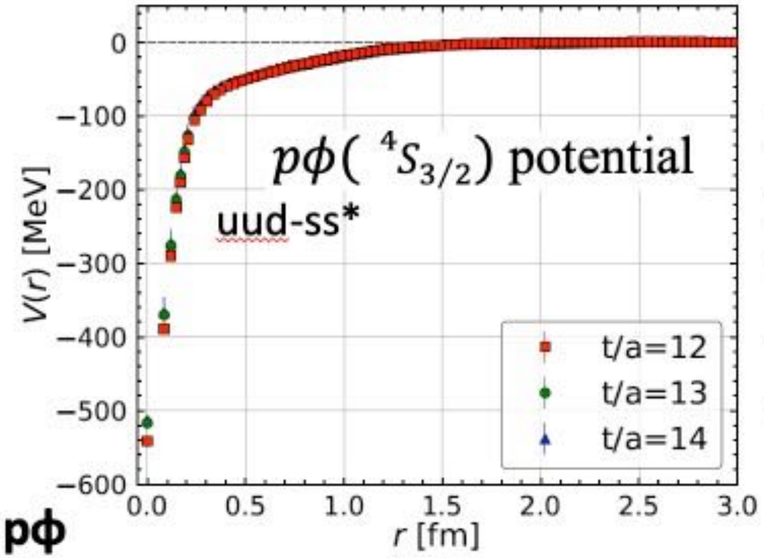
Successor of K-computer
Developed since 2014-,
Full operation since 2021-

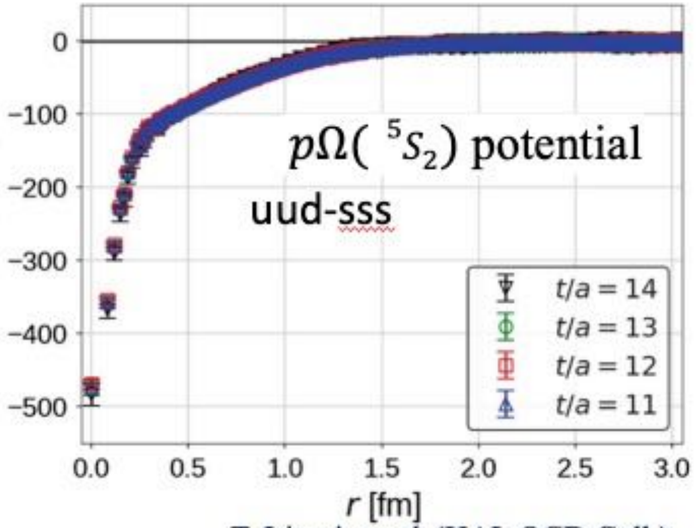
Codesign of hardware/software
(LQCD was one of 9 targets)

Now 2nd…

Fastest in the world! (2020-)

1. Lattice study for hadron interactions: HALQCD





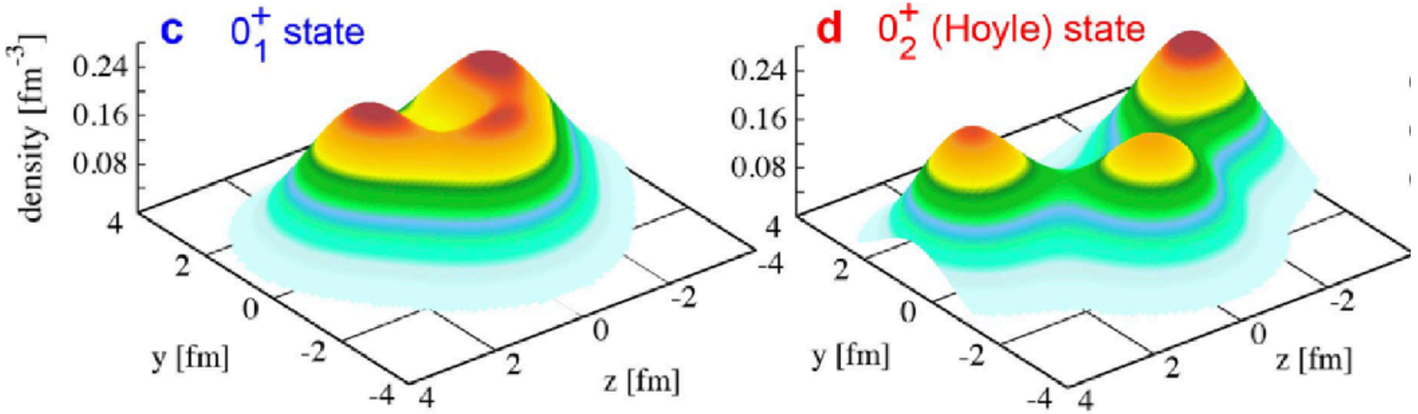
T. Iritani, *et al.* (HAL QCD Coll.),
Phys. Lett. B **792,** 284 (2019)

For pϕ

- Two pion exchange is important
- Scattering length should be examined carefully:
  HAL: a(3/2) ~ -1.43 (e-Print: 2205.10544) vs EXP: |a| ~ 0.063 (PRC101,045201,2020)

2. *Ab initio* nuclear-structure calculations for the Hoyle state

- α clusters
  - believed to exist in light nuclei, but difficult to “see” due to nuclear rotation
- Hoyle state
  - 0^+_2 state in ^{12}C: crucial role in the synthesis of heavier elements than carbon
- First-principles Monte Carlo shell model calculations
  - with a realistic nuclear force (Daejeon16 interaction based on N3LO chiral EFT)
  - in a very large model space using the FUGAKU supercomputer
- Extracted density distribution in the body-fixed frame
  - Clear three α structure for the Hoyle state

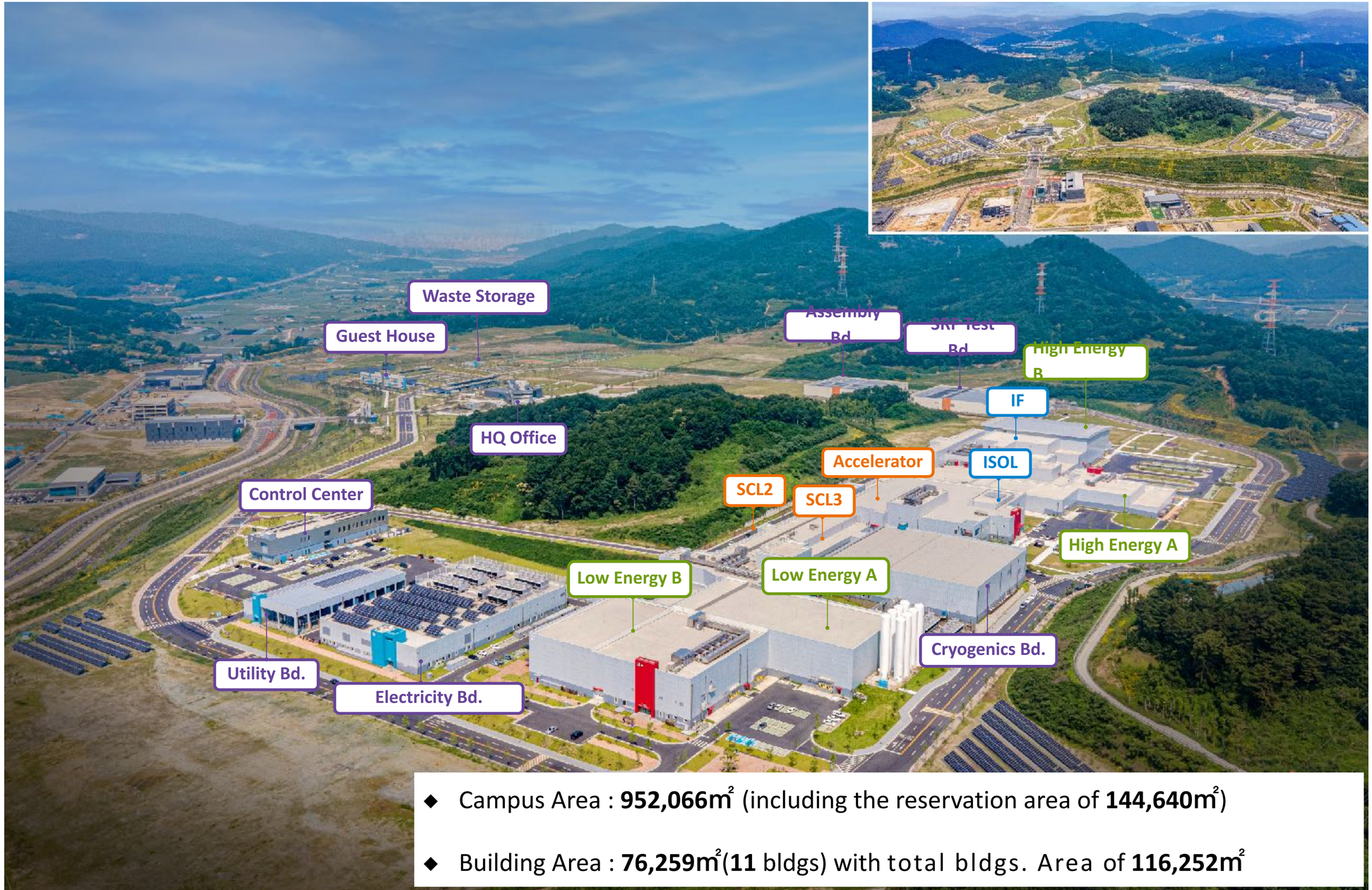


T. Otsuka, T. Abe, T. Yoshida, Y. Tsunoda, N. Shimizu, N. Itagaki, Y. Utsuno, J. Vary, P. Maris, and H. Ueno, Nature Communications 13, 2234 (2022).

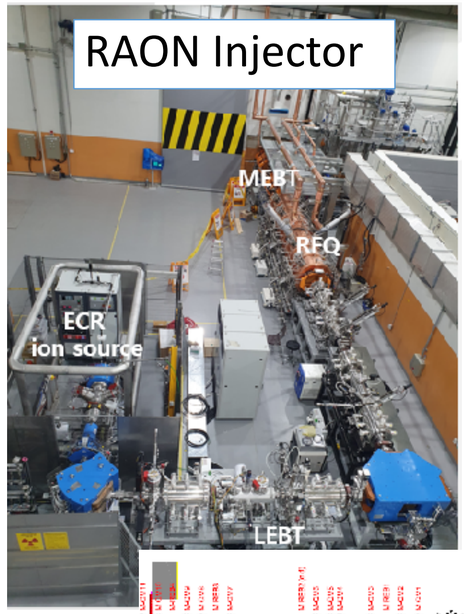
Korea: RAON Layout

Rare Isotope Science Project

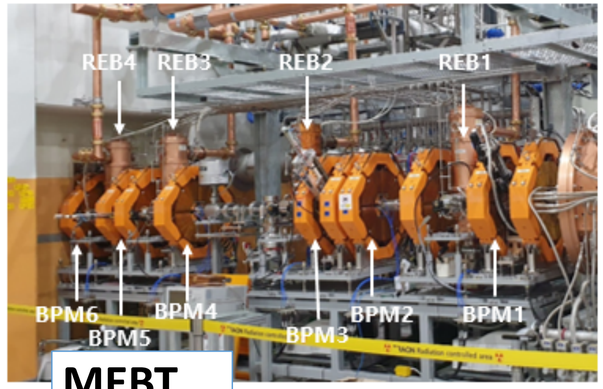
- Accelerator System
- Conventional Utilities
- RI producing System
- Experimental System



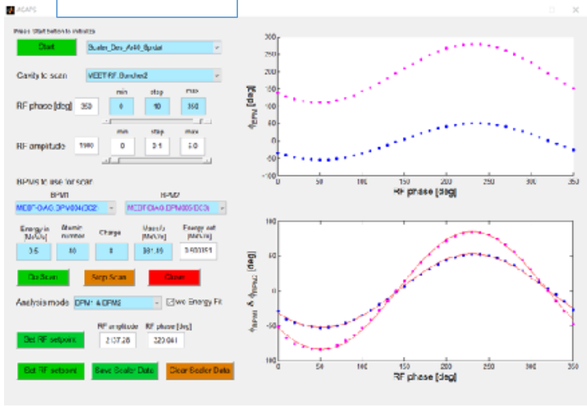
- Campus Area : **952,066m²** (including the reservation area of **144,640m²**)
- Building Area : **76,259m²**(**11** bldgs) with total bldgs. Area of **116,252m²**

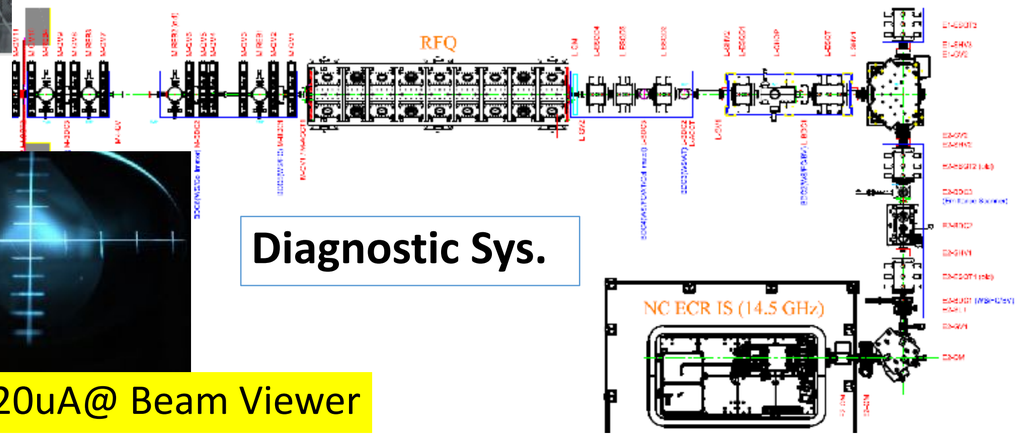


- **RAON Injector: ECR-IS, LEBT, RFQ, MEBT**
  - * ECR IS: 14.5GHz ECR
  - * LEBT: 10keV/u
  - * RFQ: 507 keV/u, 98% transmission
  - * MEBT: 507 keV/u, 4 bunchers
- **Injector beam commissioned('21~'22)**
- **Ready for post-accelerator SCL3**
  - * Ion used: Ar9+ (A/q=4.4), Ar8+(5.0)
  - * 1Hz, 100μsec



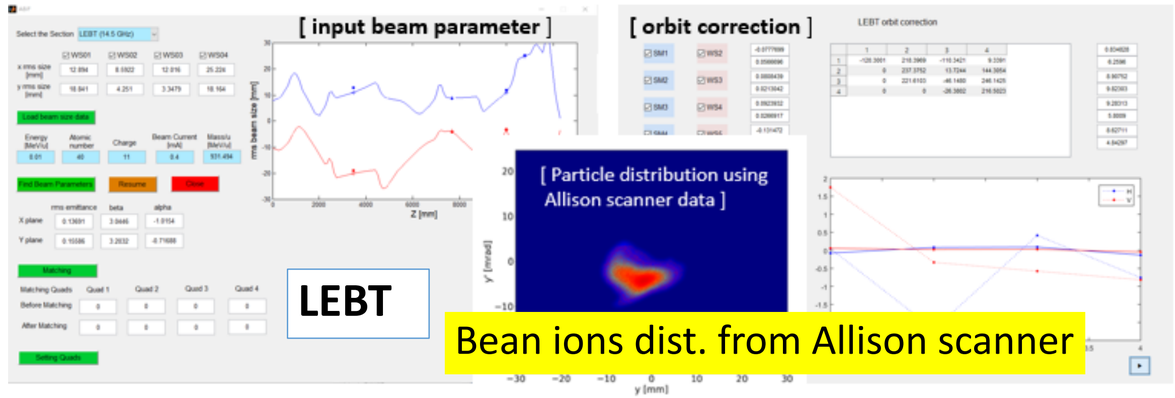
MEBT





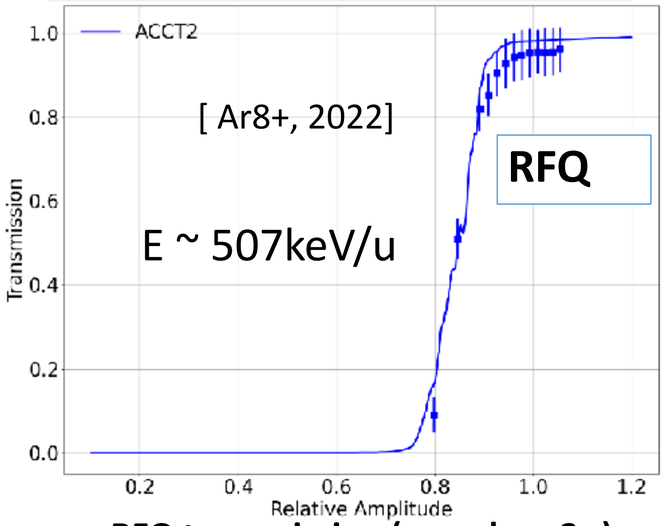
Diagnostic Sys.

Ar^{8+} ~20uA@ Beam Viewer



LEBT

Bean ions dist. from Allison scanner



RFQ transmission (error bar: 3σ)

SCL3 and Cryo-plant Installation completed 2021
& Beam commissioning starts from Oct, 2022

-Cryomodule(CM) & Warm section is clean assembled in the clean booth@tunnel
-Total Particle counts(size=0.5um above/10 mins) were less than 30 counts

- SCL3 cryoplant (4.2 kW @ 4.5 K)



Compressors and Oil Removal System (WCS)

Cold Box(CB)

- SCL2 cryoplant (13.5 kW @ 4.5 K)


Compressors and Oil Removal System (WCS)

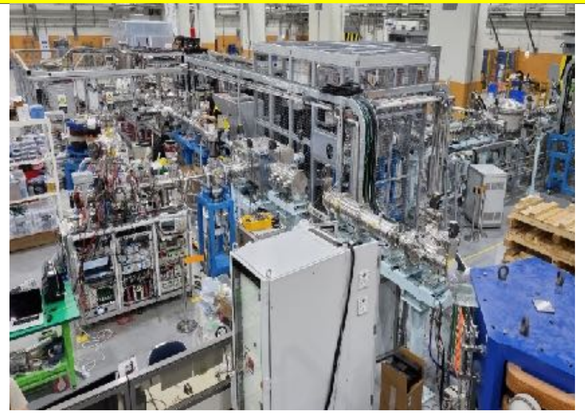

Cold Box (CB)
(left warm side, right – cold side)

Warm section

SCL3 LINAC installed on 2021

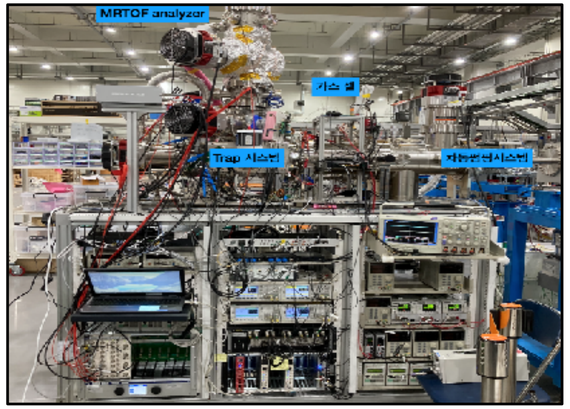
ISOL system installed in 2021 and RI beam test on 2022 & All Exp. Systems are to be installed by 2022 and machine commissioned

(Cyclotron)



(ISOL Beam Line)

(IF Separator)



(MMS)

(LAMPS)

(BIS)

Research Project of Theoretical Nuclear Physics Group Myanmar

Carrying out the following research recently. The outcome of these projects are submitted to APPC15 for oral contributions.

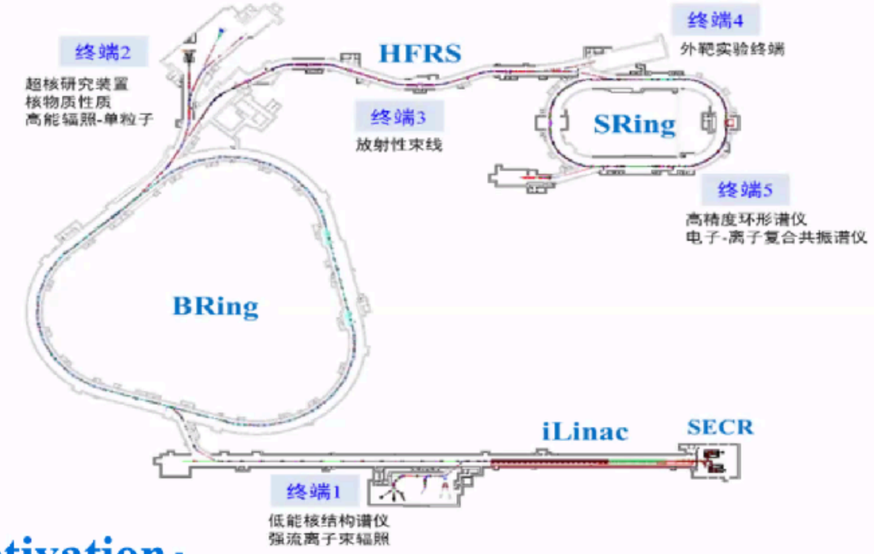
- **Energy and level width of Feshbach resonance $_{\Sigma}{}^{6}$H**
- **Structure of kaonic nuclei and possible existence of Λ^* strangelets**
- **Application of linearized AMY T-Matrix method to CLAS-Data analysis**
- **Comparison of $K^{-}(pp)$ and $\Lambda^{*}p$ models for reaction**
- **Weak decay spectroscopy of s-Shell Λ and double Λ hypernuclei**

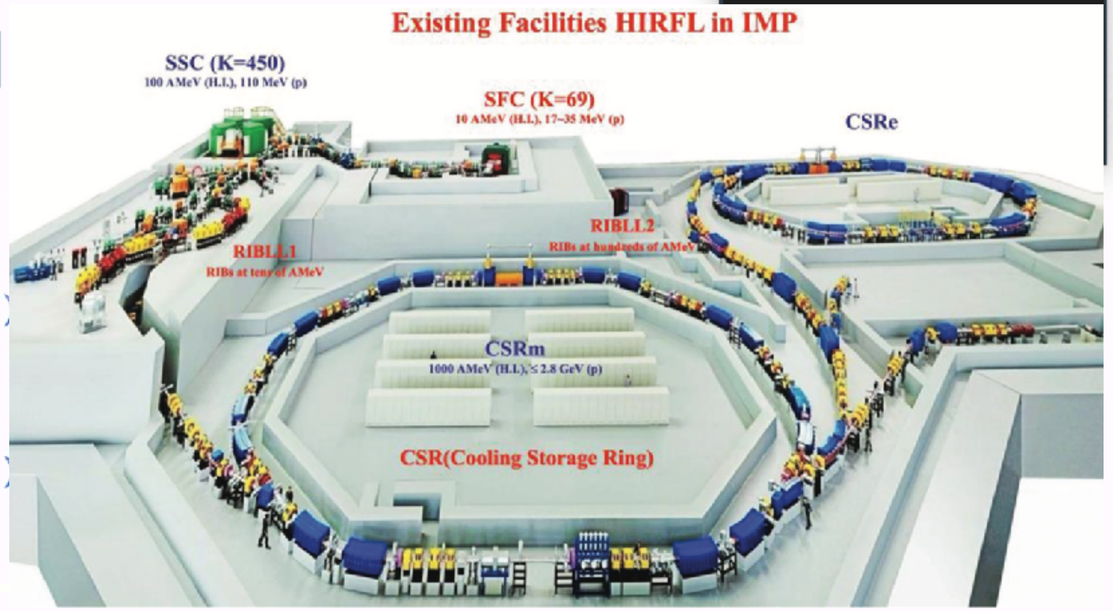
Contents

- Asia overview
- Recent activities

National major science and

High Intensity Heavy-ion Accelerator Facility





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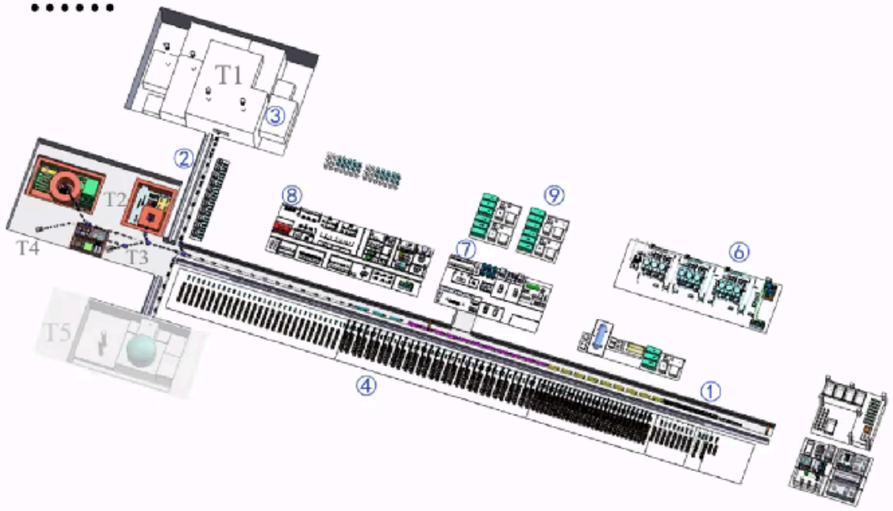


Motivation:

- to understand the effective interactions in nuclei
- to understand the origin of chemical elements, especially from Fe to U, in the universe
- to depict the QCD phase diagram of nuclear matter
- to study the property of high energy density physics
- to simulate the radiation environment in space
- .....

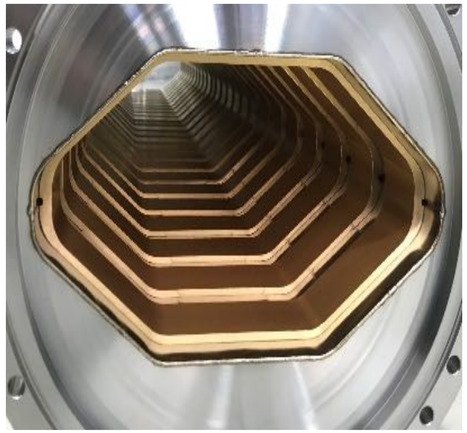
Chinese initial Accelerator Driven System (CiADS)

- HIAF underground tunnel completed construction and capping of main structure, comprehensive station building, test hall, and refrigeration center. All civil works will be completed in June 2023;
- CiADS completed civil engineering design of the accelerator and supporting facilities, and is in process of bidding for construction.

HIAF key technology progress

Handel key technology of HIAF fast-cycle synchrotron, the prototype indicators are finished, and start batch processing



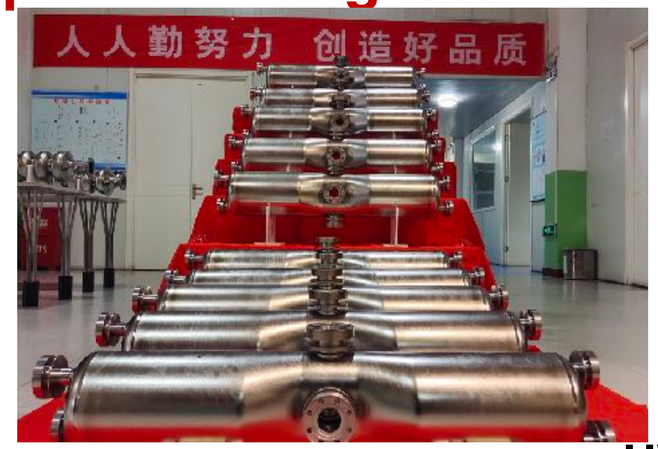





- Develop "ceramic ring lining" ultra-thin ultra-high vacuum chamber
- Full energy storage non-resonant fast rate high power supply
- High Gradient Broadband Fast Response Large Magnetic Alloy High Frequency
- Debugging of full energy storage non-resonant high-power magnet power supply

CiADS progress

Accelerator has entered the mass production and processing, test prototype of spallation target reach experimental conditions

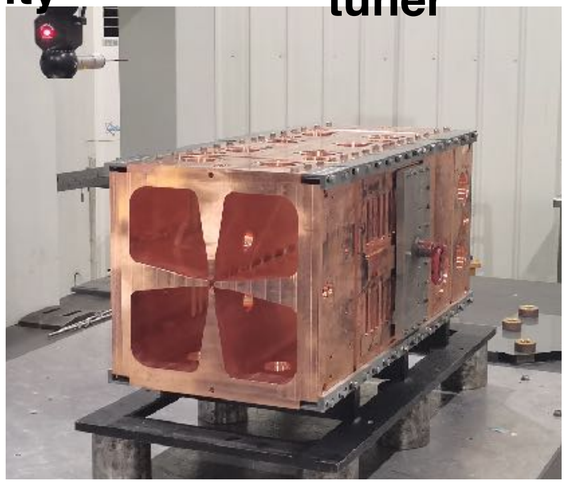


HWR010 Niobium cavity

HWR010 Cu Nb Cavity

Helium pressure tuner

Coupler (room temperature & Superconducting)



Radio Frequency Quadrupole (RFQ) Cavity

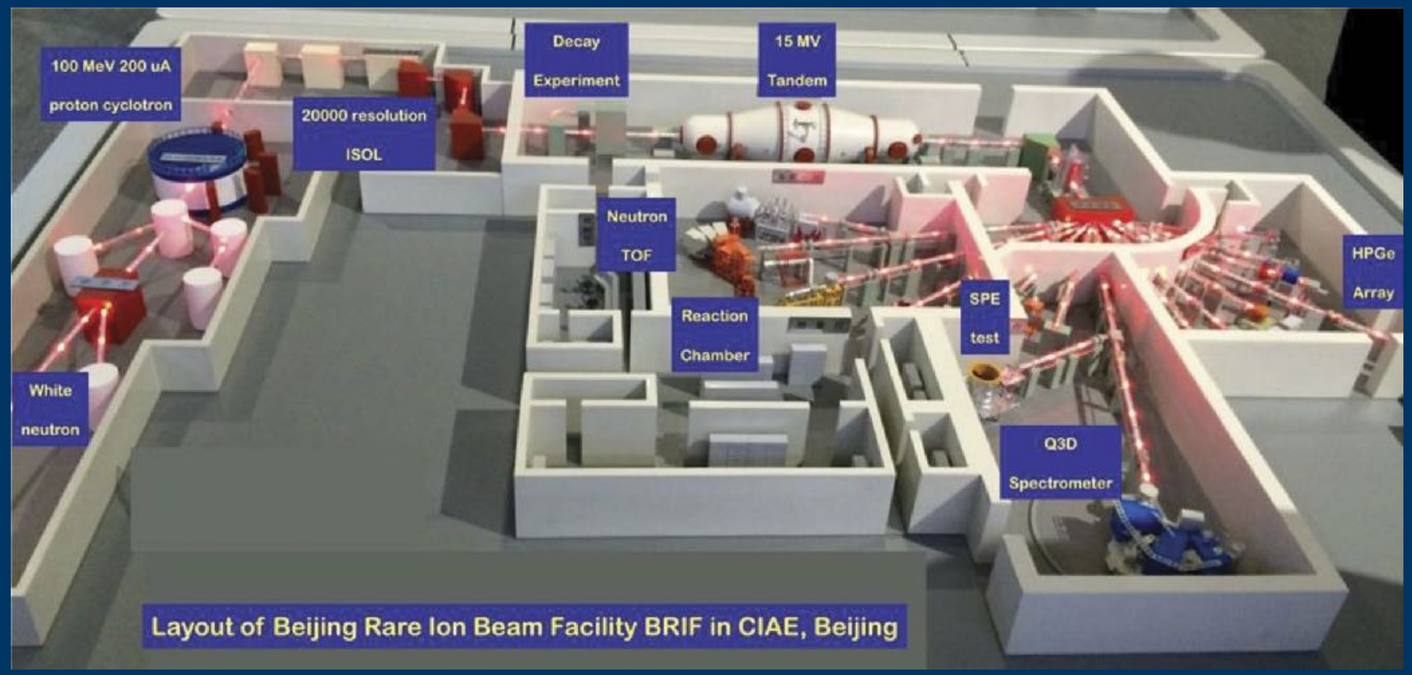
Bundle assembly

Solenoid Pump Assembly

duct assembly

BRIF Beijing

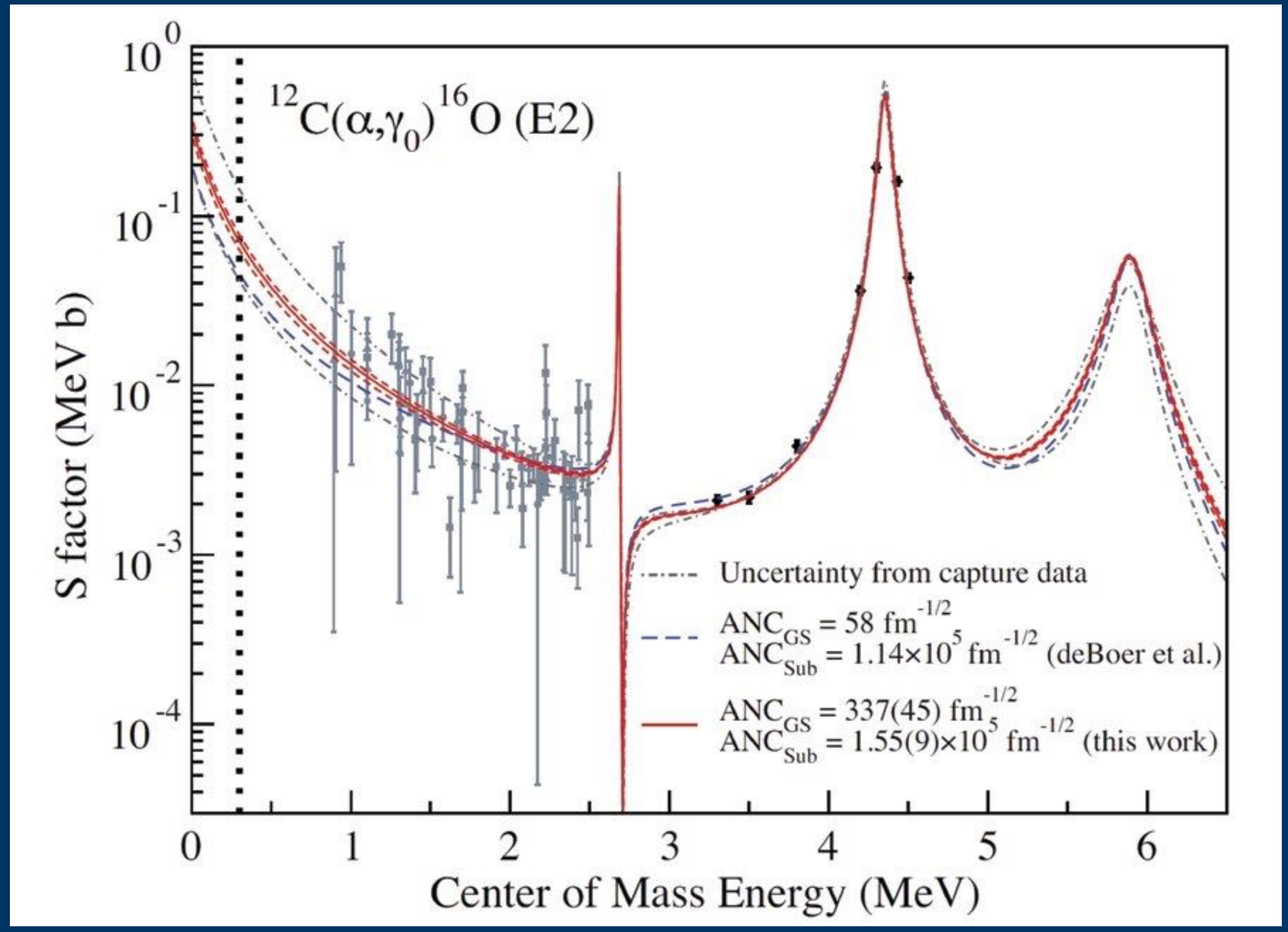
- HI-13 tandem generate beams from H to U. Operating voltage 13 MV.
- Stable operation 4,000 hours user time per year. Ladder and the divider resistor system, laboratory made, saving large amounts of operation costs.
- BRIF composed of 100 MeV, 200 μA proton cyclotron and ISOL with resolution of 20,000 as a RI beam or driver tandem as an ISOL facility.
- Fills the gap as a RI ISOL facility China.



W. P. Liu et al., Sci. China A 54 (2011) s14.

$^{12}C(\alpha,\gamma)^{16}O$

- $^{12}C(\alpha,\gamma)^{16}O$ most crucial in nuclear astrophysics. E2 external capture to 16O GS h make a significant contribution to cross-section, depending on the value of the GS ANC.
- Determine ANC to be 337 ± 45 $fm^{-1/2}$ through $^{12}C(^{11}B,^{7}Li)^{16}O$ using Q3D in HI-13 tandem. Solve discrepancy of more than two orders of previous ANC.
- Based new ANC, constrain the GS external capture through interference with the high-energy tail of the 2^+ sub threshold state, a enhancement in the GS SE2(300) obtained (70 ± 7 keV b) compared recent review (45 keV b), an increase of total S-factor from 140 keV b to 162 keV b
- Good agreement with the value obtained by supernova nucleosynthesis calculations .



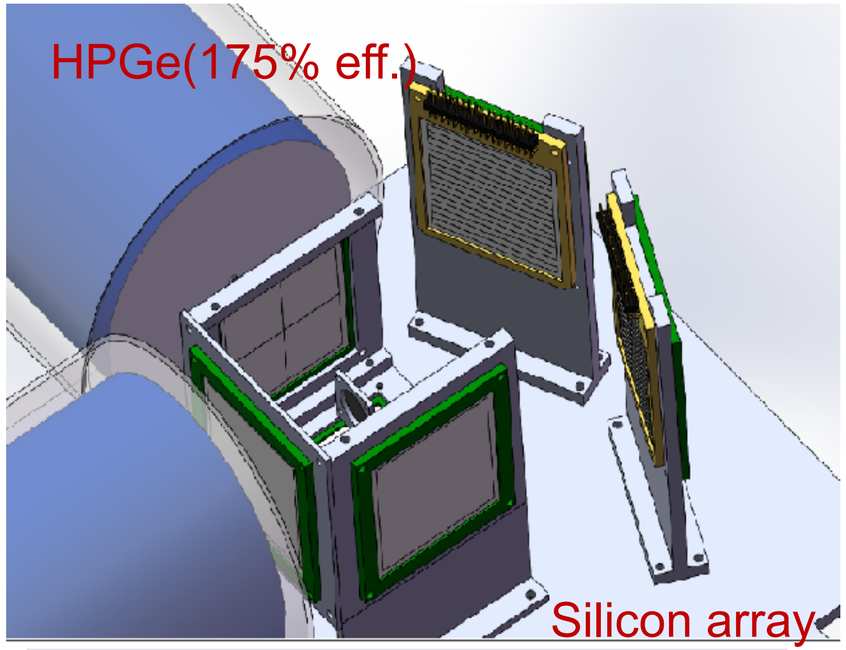
Y. P. Shen et al., Phys. Rev. Lett. 124 (2020) 162701.

W. P. Liu, WG9 meeting 2022, June

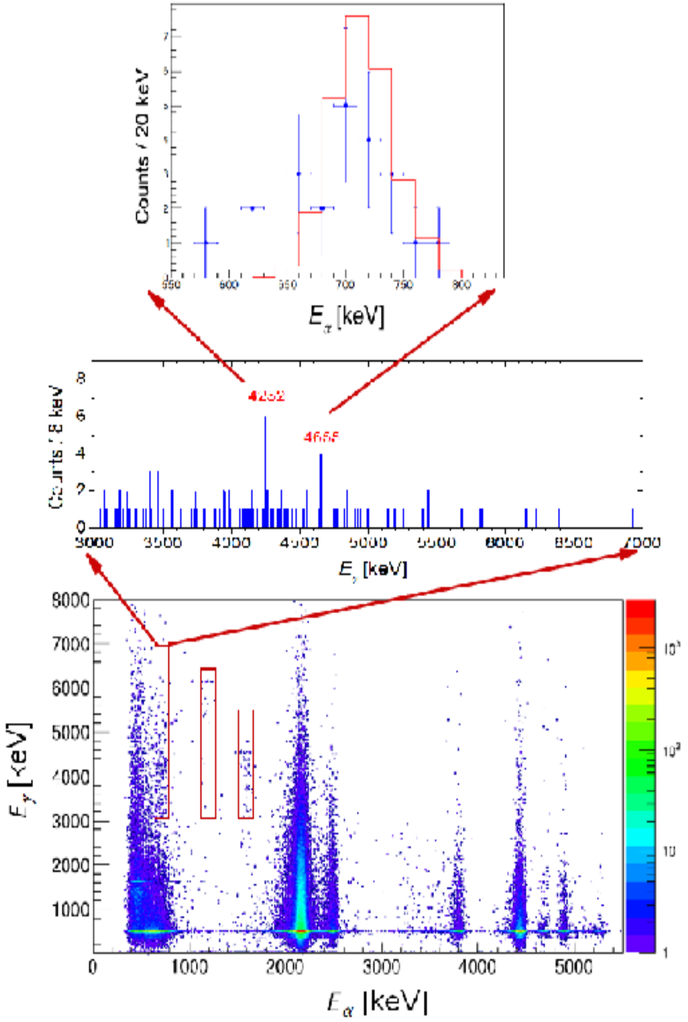
BRIF day one RI via ISOL

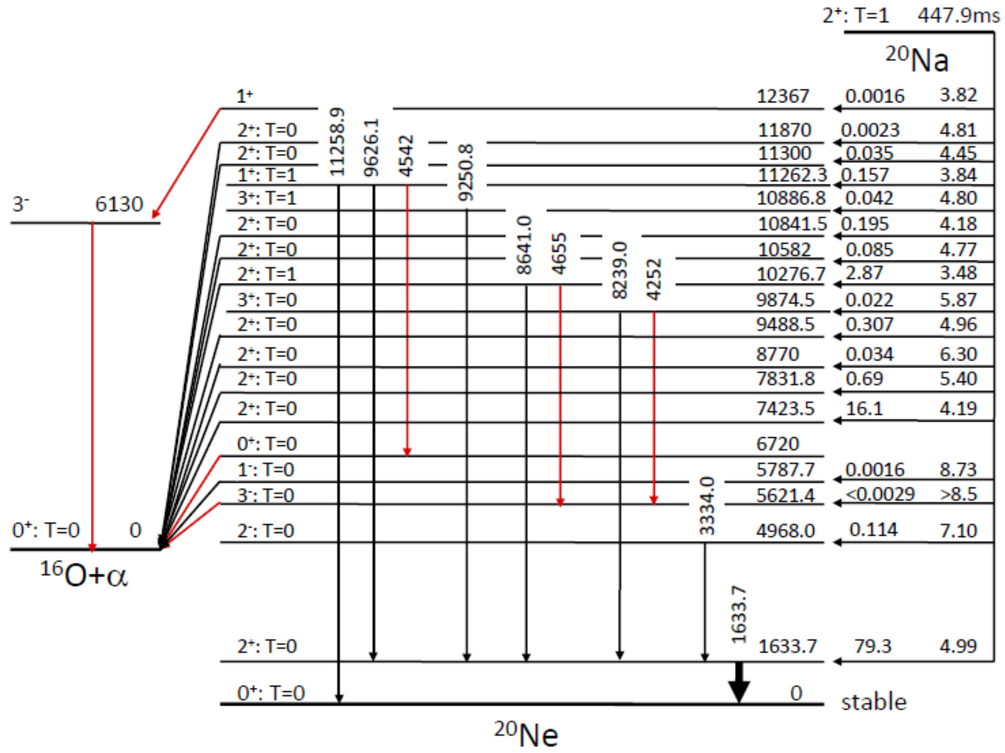
- Jan. 2018, 445ms)$^{20}Na^{+}$, 18,600pps, 100%
- ISOL, max 24460； proton beam max 200μA

- β-γ-α BR<10^{-4}
- iso sping mixing probe
- calibration for B(F) and B(GT)



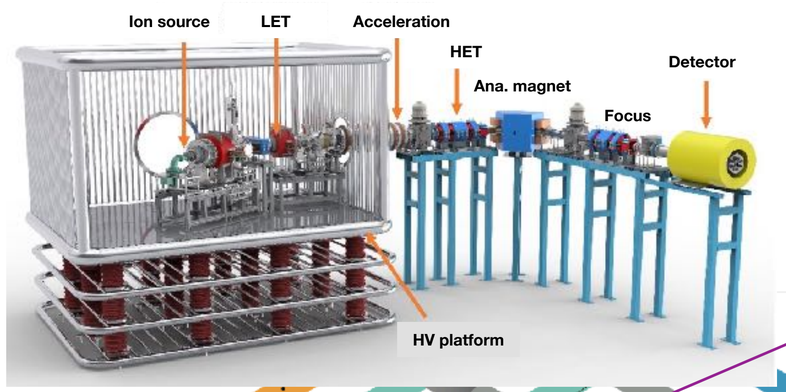
β-γ-α setup

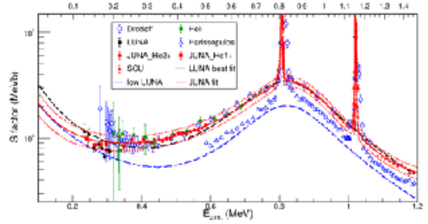




Y. Wang*, J. Su*, Z. Han et al. et al.,
Phys. Rev. C Lett. 103, 011301 (2021).

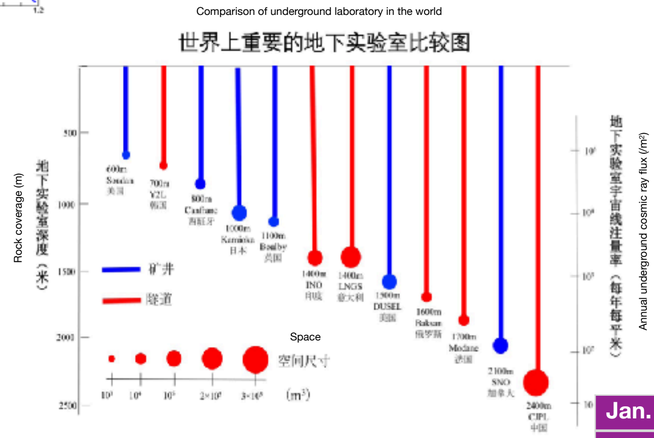
W. P. Liu et al., Sci. China 59(2016)5785.



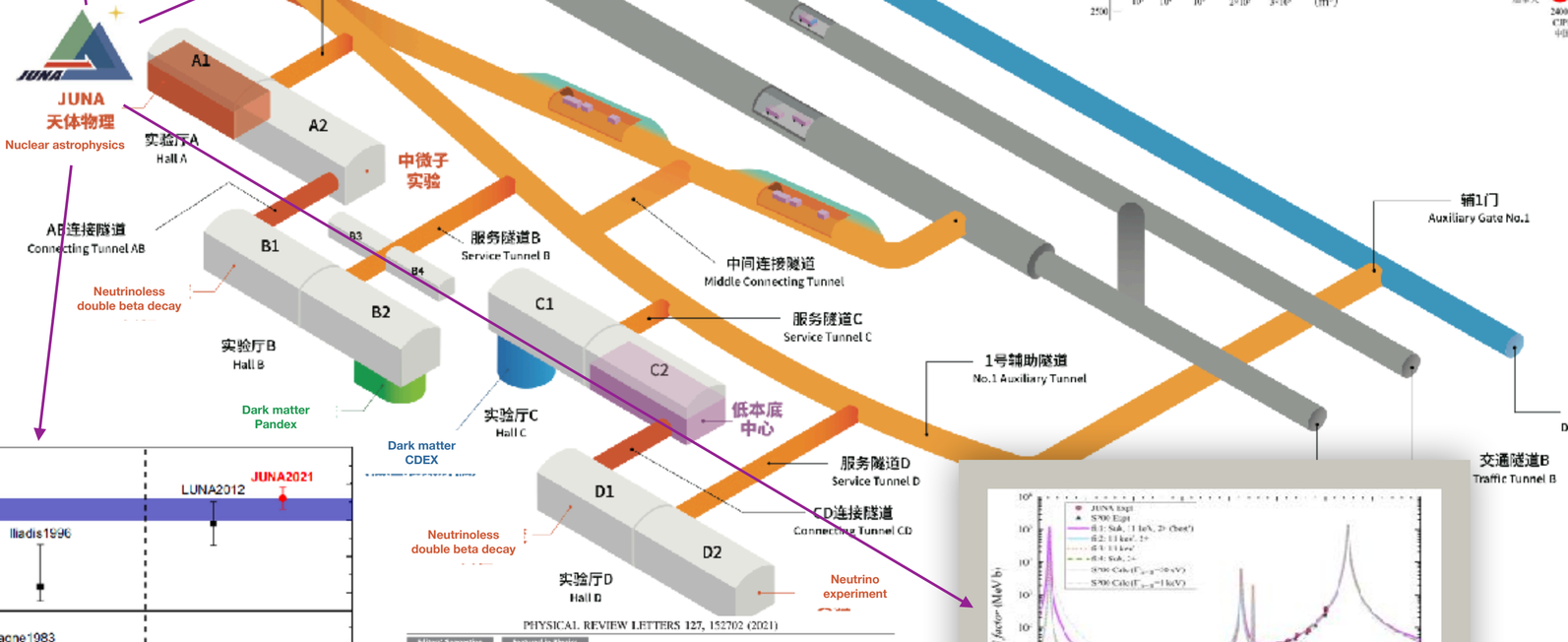


$^{13}C(\alpha,n)^{16}O$, B.S. Gao, et al., PRL 2022, accepted.

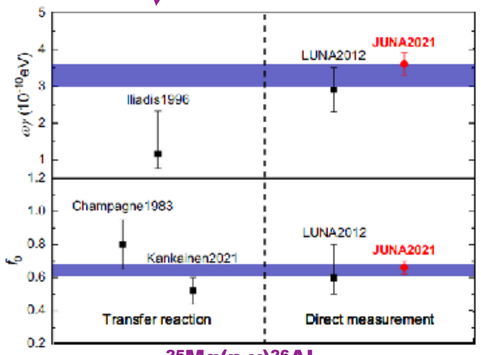
中国锦屏地下实验室
China Jinping Underground Laboratory
CJPL
清华大学 · 雅砻江流域水电开发有限公司



Beam	Intensity mA	Energy keV
H^+	12	350
He^+	2.5	350
He^{++}	1	800



Jan. 2015	NSFC support
May 2017	beam in ground
Dec. 2017	test experiment in ground
Dec. 2018	beam reach 10 mA
Apr. 2019	target and detector ready
Dec. 2020	eam underground in CJPL-II A
May 2021	4 experiment finished
Dec. 2021	news releaseresults



$^{25}Mg(p,\gamma)^{26}Al$,
Su J et al. Sci. Bull., 67(2022)125 .

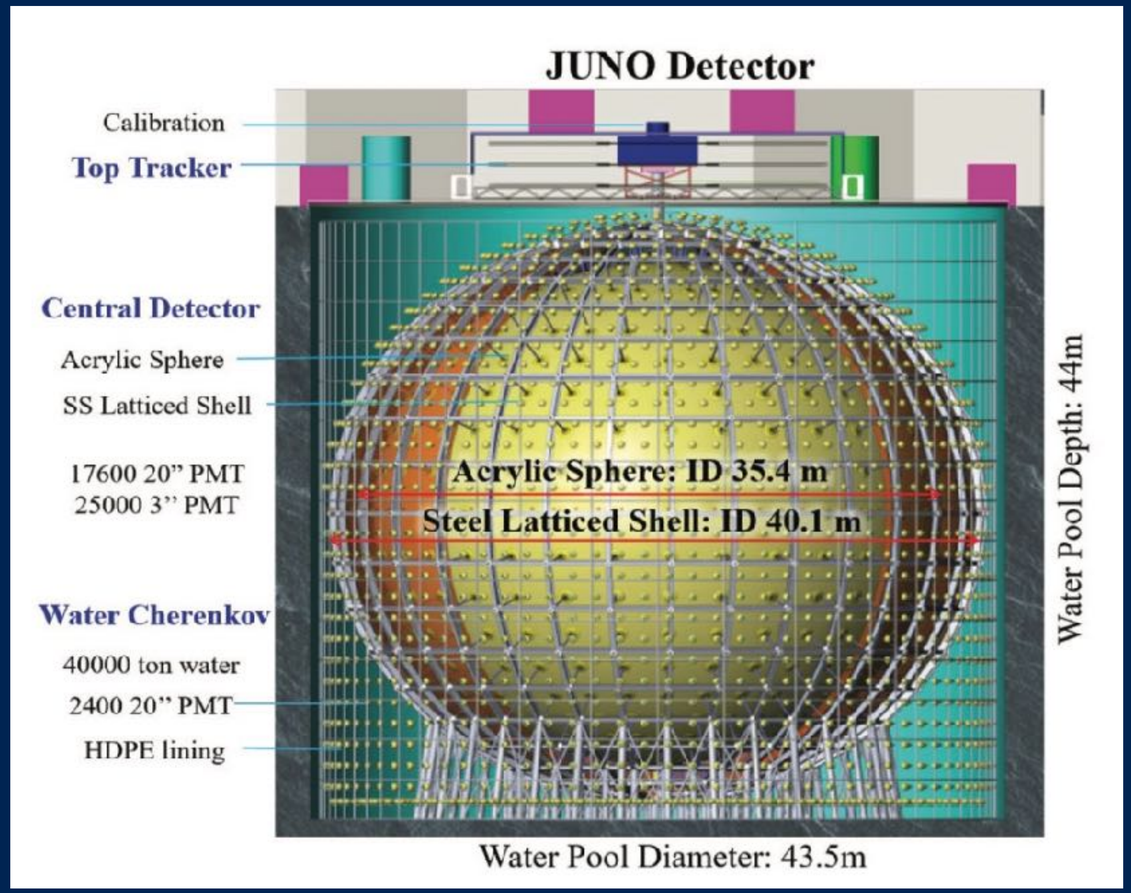
PHYSICAL REVIEW LETTERS 127, 152702 (2021)

Direct Measurement of the Astrophysical $^{19}F(p,\alpha\gamma)^{16}O$ Reaction in the Deepest Operational Underground Laboratory

L. Y. Zhang, J. Su, J. J. He, M. Wiescher, R. J. deBoer, D. Kahl, Y. J. Chen, X. Y. Li, J. G. Wang, L. Zhang, F. Q. Cao, H. Zhang, Z. C. Zhang, T. Y. Fan, Y. D. Sheng, L. H. Wang, L. Y. Song, X. Z. Bing, Z. M. Li, B. T. Li, S. Wang, G. Lian, Z. H. Li, X. D. Tang, H. W. Zhao, L. T. Sun, Q. Wu, J. Q. Li, B. Q. Cui, H. Chen, R. G. Ma, B. Guo, S. W. Xu, J. Y. Li, N. C. Qi, W. L. Sun, X. Y. Guo, P. Zhang, Y. H. Chen, Y. Zhou, J. F. Zhou, J. R. He, C. S. Shang, M. C. Li, X. H. Zhou, Y. H. Zhang, F. S. Zhang, Z. G. Hu, H. S. Xu, J. P. Chen, and W. P. Liu

$^{19}F(p,\alpha g)^{16}O$,
L.Y. Zhang, et al., PRL 127(2021)152702.

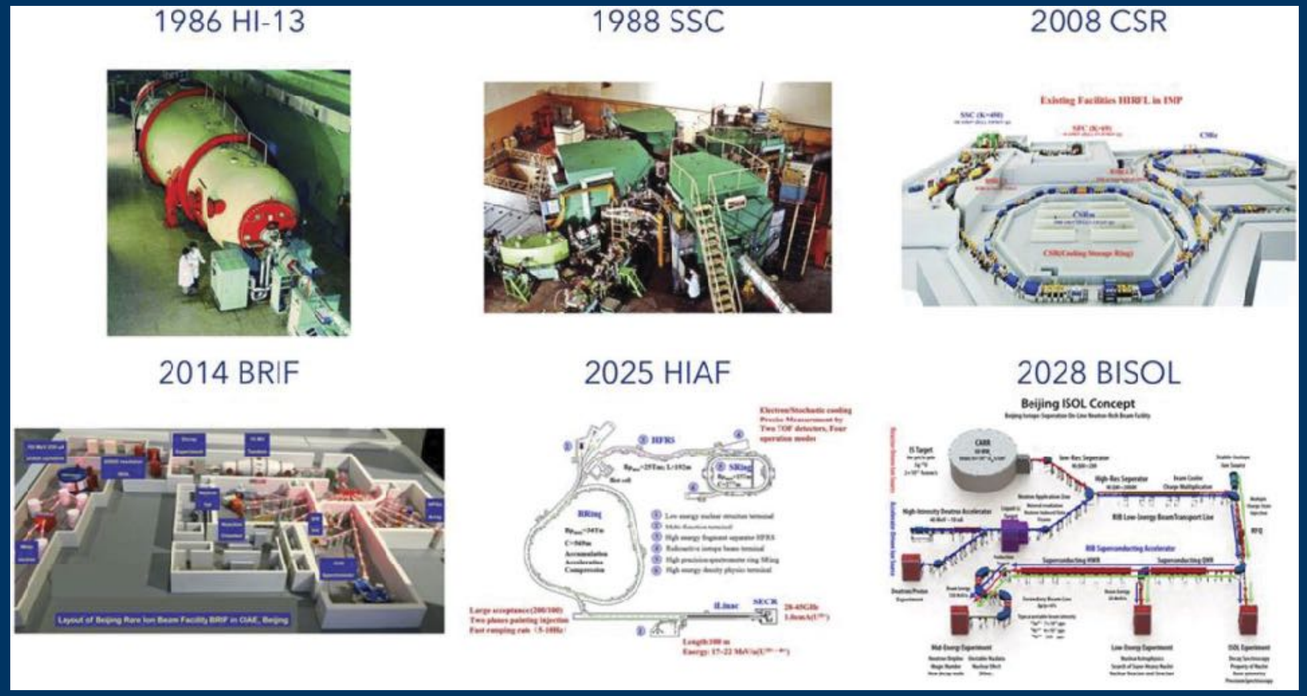
JUNO layout.



- Z. Djurcic et al., arXiv:1508.07166 (2015).

Summary for Chinese Facilities and researches

- Research in nuclear physics and construction of big facilities are growing very well in China.
- Unstable nuclear physics and nuclear astrophysics are both focused on long range plans by NSFC.
- Roadmap for large-scale facilities discussed in Xiangshan forum , HIAF and BISOL to be future focus.
- Level of facilities and support for young impressive. But achieve full performance of many facilities and government understanding of research culture, openness, operational, and long-term support is challenge .
- Need to continuous input to government by top-level research achievements.
- International collaboration is good way to achieve above. Need to add the China plan to the Asia and world roadmap to have collaborative and complementary solution to profound questions.

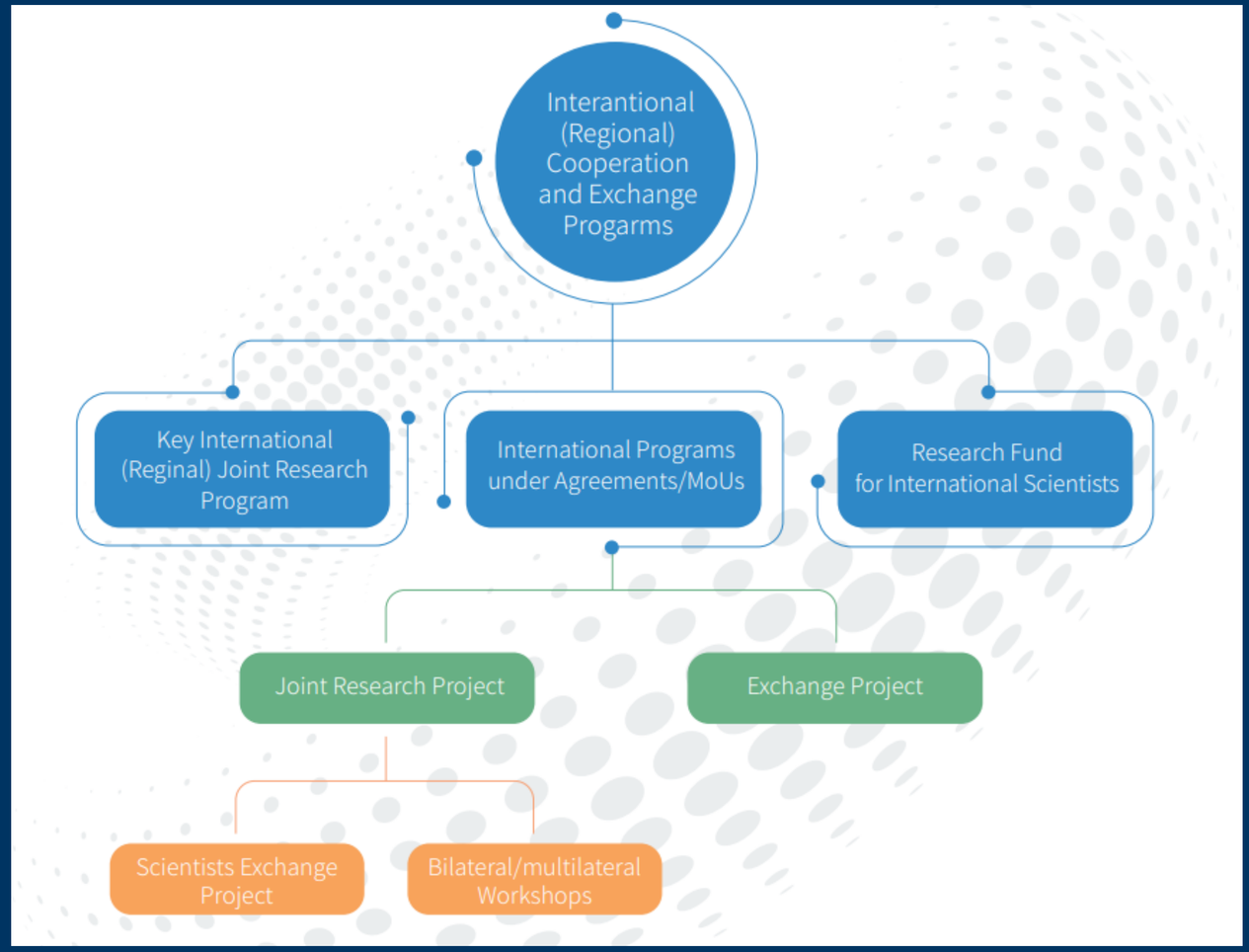


Xiangshan roadmap report 2014, internal, in Chinese.

NSFC: National Natural Science Foundation of China

- **NSFC is China's leading funding agency for basic science. In 2021, NSFC funded 48,,788 awards with a total direct funding of 30.5 billion RMB (~ $4.55 billion) to support high-quality researches from universities and research institutes**

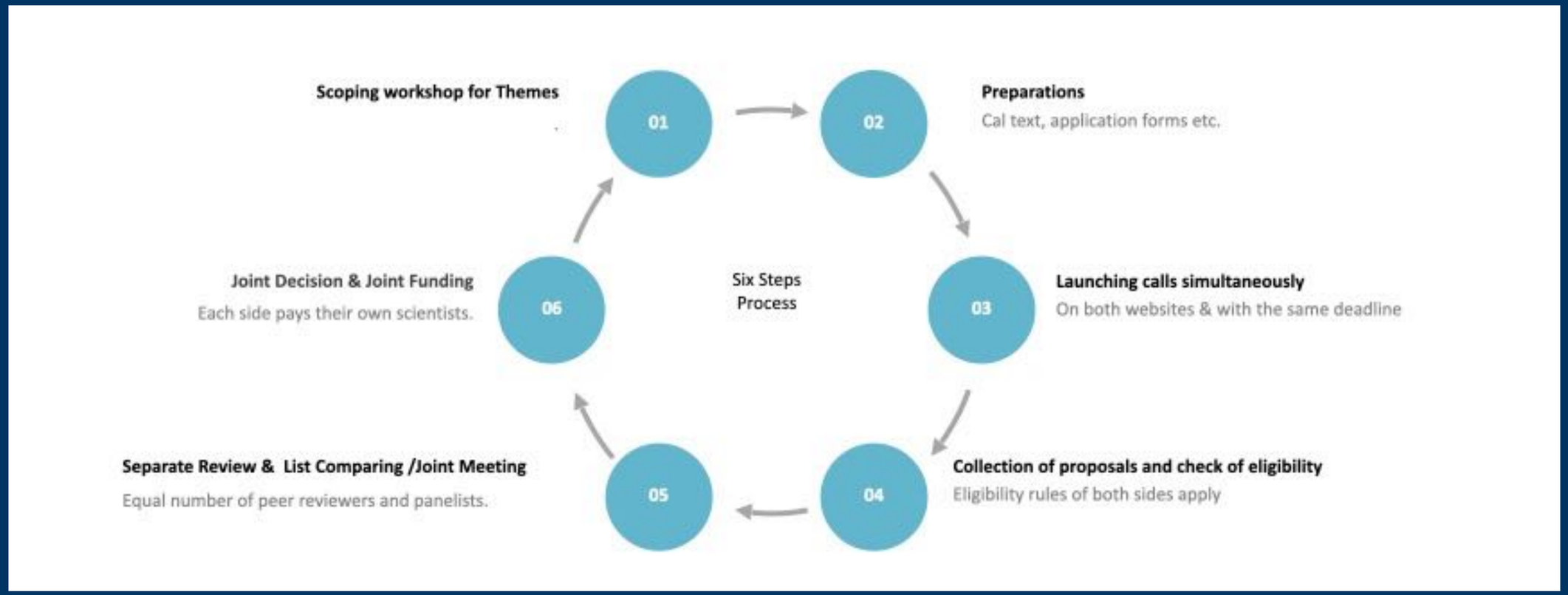
- **NSFC has signed agreements or MoUs with 100 funding agencies or research institutions in 53 countries (regions). NSFC provides three programs to support international collaboration between Chinese and international researchers**



W. P. Liu, WG9 meeting 2022, June

NSFC

- **NSFC works with international funding partners to fund joint research on nuclear science. For example, in 2019, NSFC, NRF of Korea and JSPS of Japan launched a call on “nuclear physics in the 21st century” and funded 2 project.**



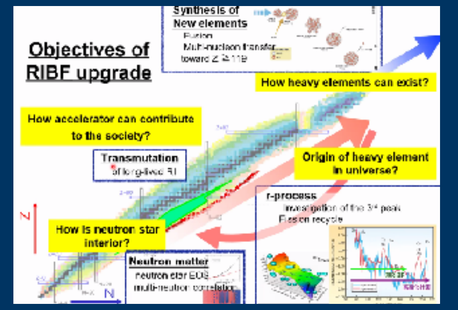
CJK joint fund: A3 foresight program—Nuclear Physics in the 21st century

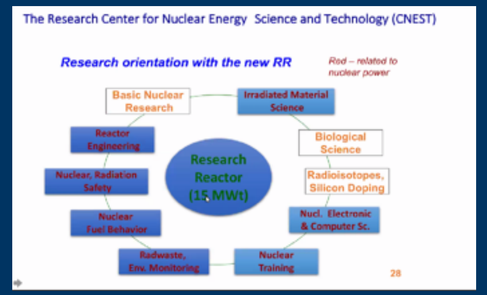
Scientific field of nuclear physics in the A3 countries, Japan, China, and Korea, RIBF and RCNP in Japan and HIRFL and BRIF in China are operational while the next generation facilities HIAF in China and RAON in Korea will start operation in a few years.

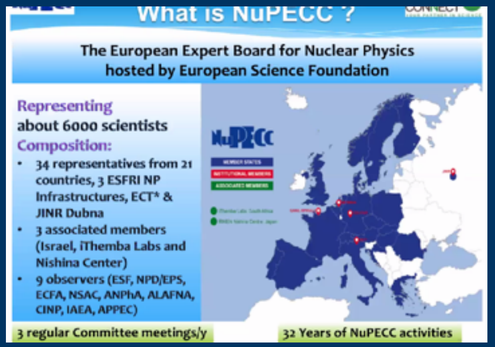
- **Various Manifestations of Nuclear Structure--- From Nucleons to Nuclear Matter at Extreme Conditions**
  - ➢ Exotic properties of atomic nuclei at extreme conditions from nucleons to nuclear matter.
- **Reaction dynamics towards the limits of nuclear and elemental existence**
  - ➢ Dynamics of synthesizing new atomic nuclei and challenging the limits of nuclear and elemental existences by combing the research scientists from China, Japan and Korea.

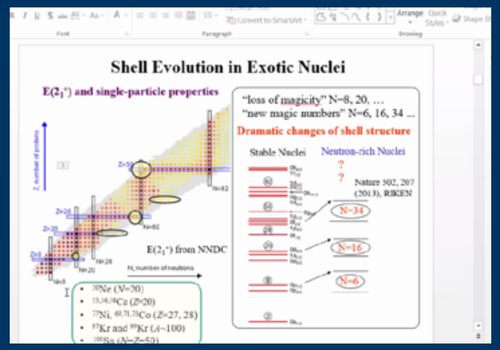
Summary of discussion and recommendation

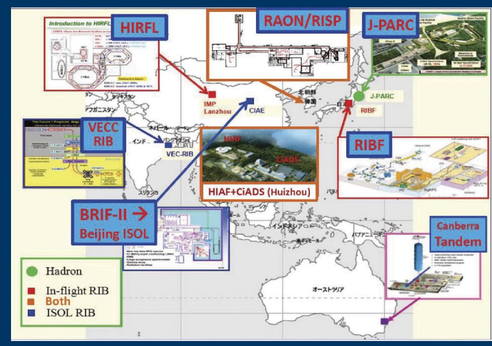
- New facility fully progress will enhance user communities and experimental setup in Asia
- Great progress, facility, experiment, theory; Nice combination, collaboration; Good prospective, future developments
- More collaboration, with other continents to make a global effort
- Operation facility release top results to allow more operational and man power support
- Coordinate efforts between exp/the, facilities and acc/exp, man/women, collaboration, needed further
- ANPhA push future white paper and road map for Asia facilities, with good coordination with IUPAP, NuPPECC and other organizations
- Will share more high lights in August 2022 in ANPhA symposium Korea
- Wish to have more collaboration with C12/WG9











W. P. Liu, WG9 meeting 2022, June

AP NP facilities, A. W. Thomas et al., Nuclear Physics News, 30(2020)3

AP NA progress, A. A. Aziz et al. AAPPS Bulletin 31(2021)18