

KURRI and FFAG

Overview

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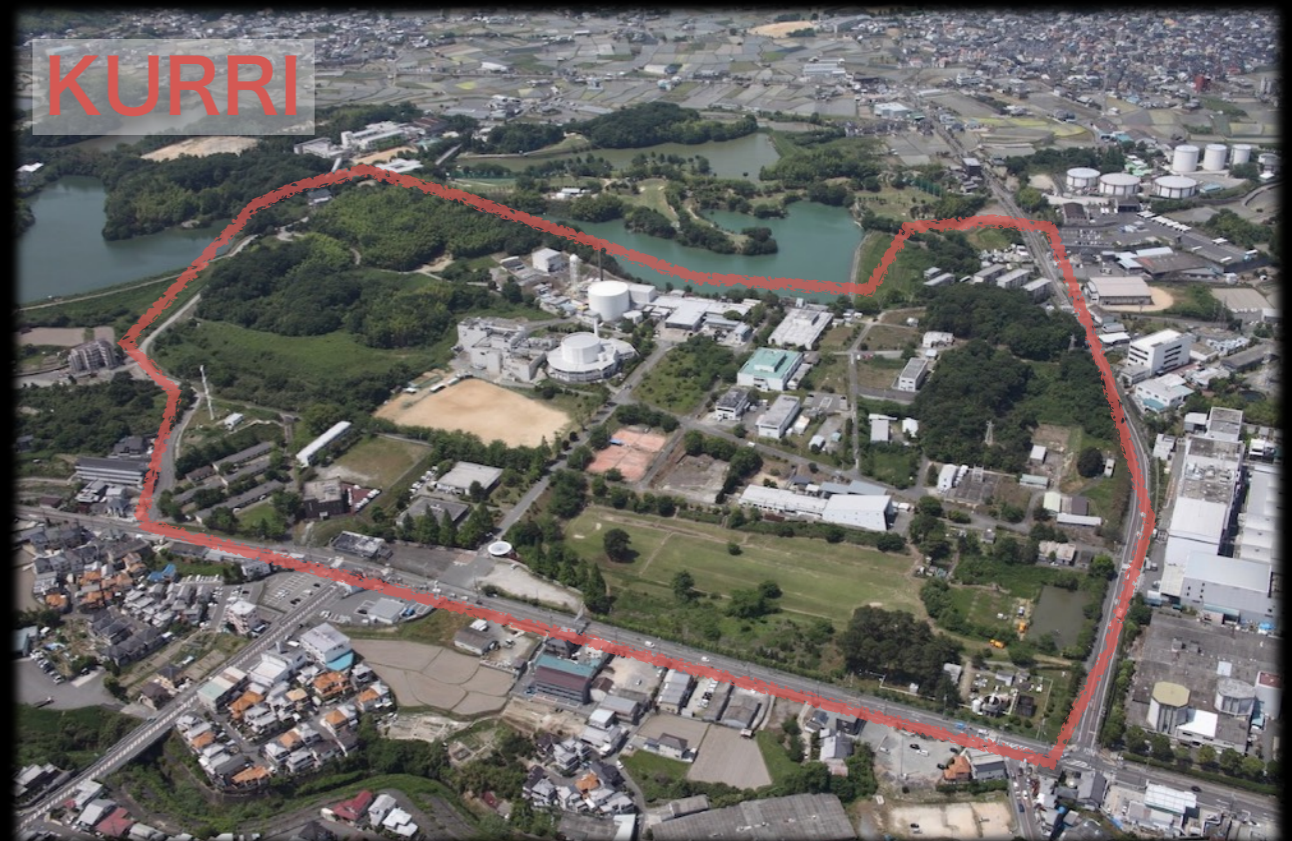
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- KART
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- Future Plan

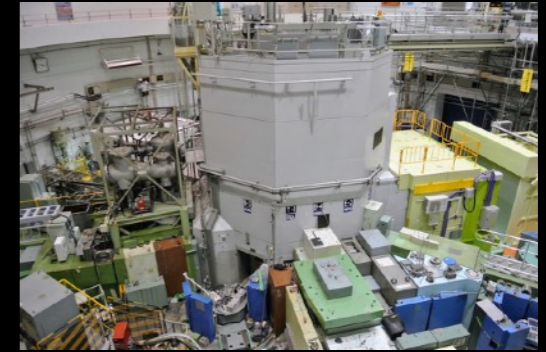


Kyoto University Research Reactor Institute

- In 1963, RRI was established
- Two Reactors :
 - **KUR**
 - In 1964, Reached the critical stage
 - The nominal maximum power 5000 KW
 - As a Neutron Generator
 - **KUCA**
 - In 1974, Reached the critical stage
 - The nominal maximum power 100 W
 - For reactor physics & educational purpose
- Two Main Projects :
 - ADS “Accelerator Driven System”
 - BNCT “Boron Neutron Capture Therapy”

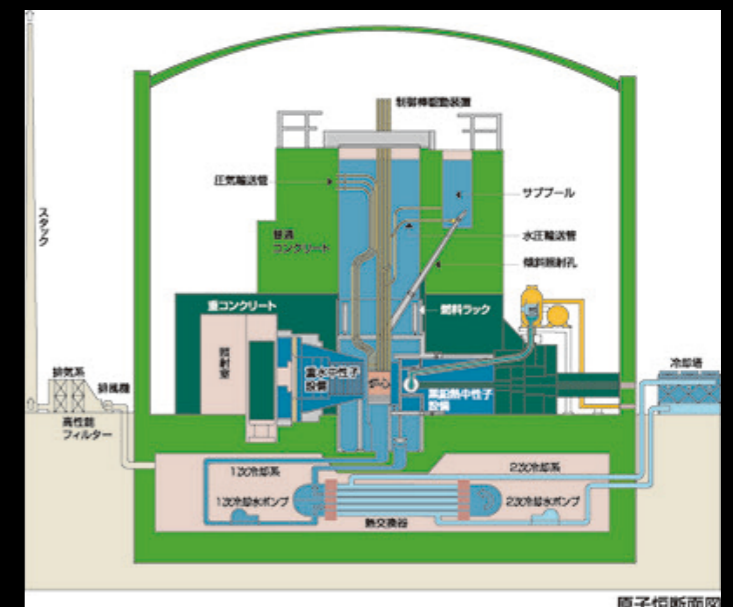
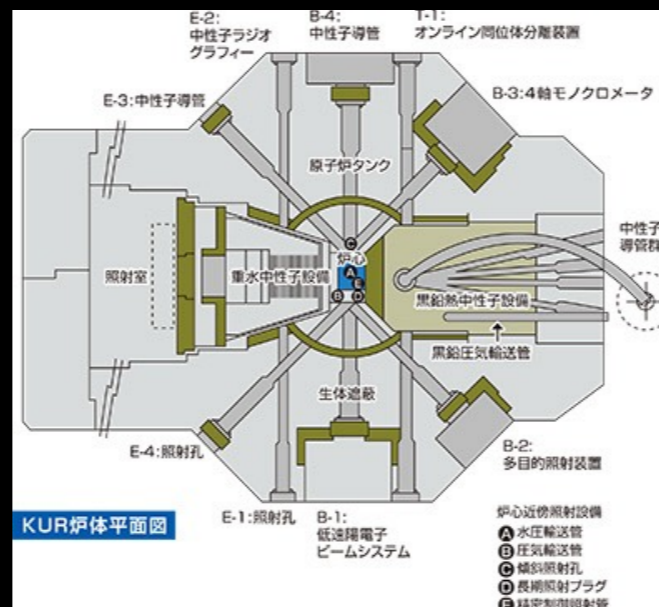


KUR



Kyoto University Research Reactor

- As a neutron source for research
- 5 MW (max.), 3×10^{13} neutrons / $\text{cm}^2 \text{s}$



KURRI Tour!!

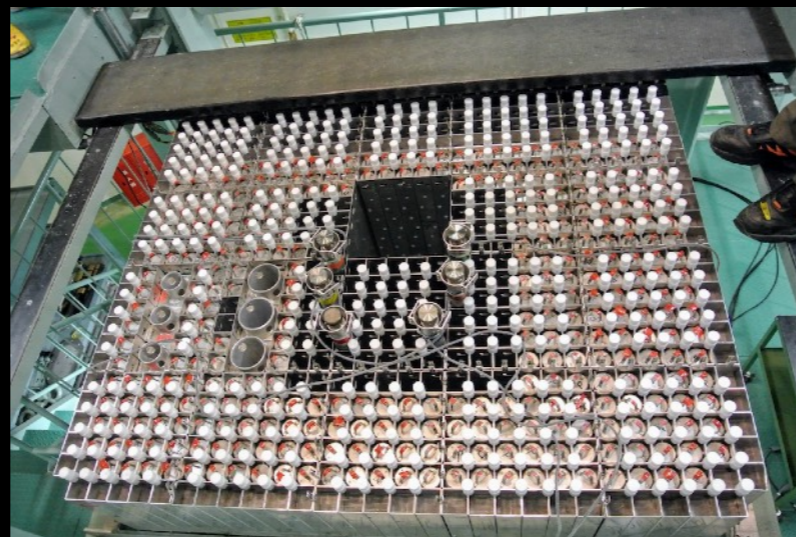


KUCA



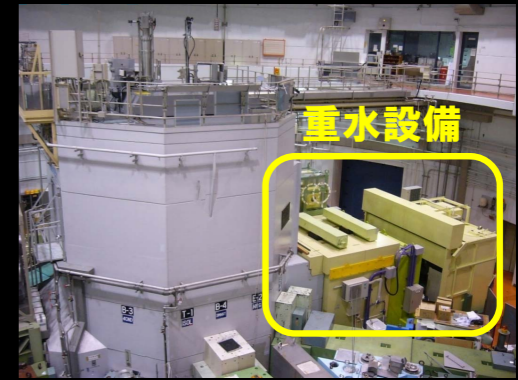
Kyoto University Critical Assembly

- Number of reactor core is 3
 - One has liquid (water) moderator, other have solid moderator
- D-T accelerator in the reactor room
 - 14 MeV Neutron Source for ADS study



From
Masako IWASAKI

BNCT

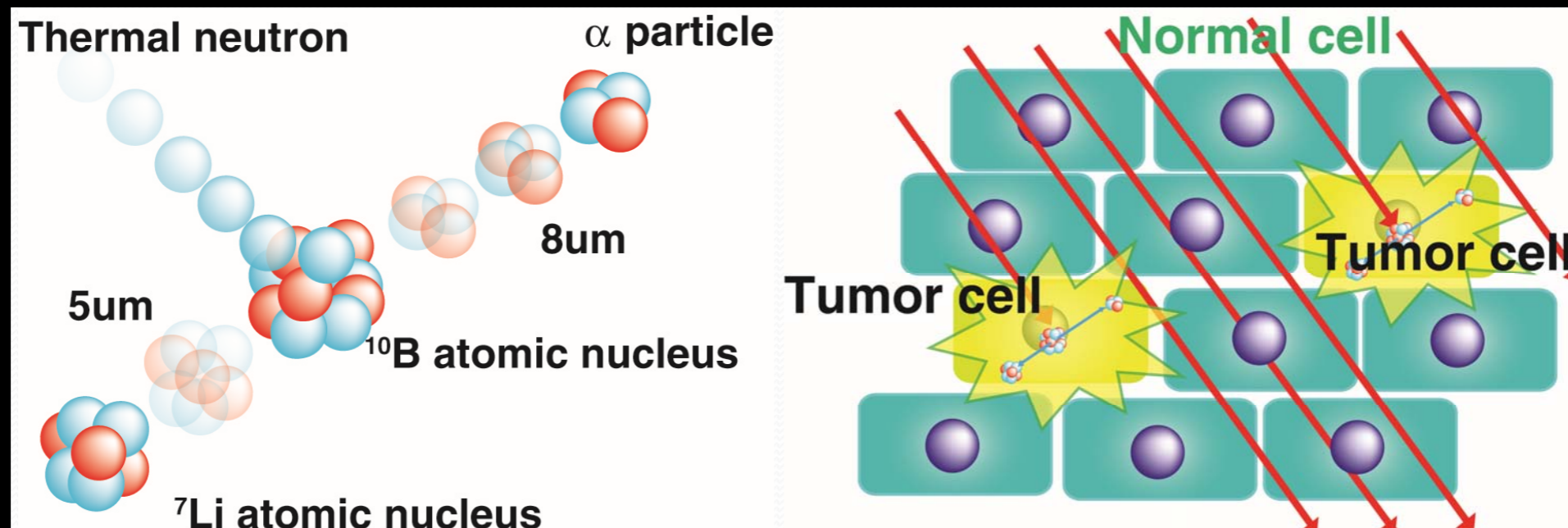


From Hiroki TANAKA

Boron Neutron Capture Therapy

- Cancer Therapy using Neutron
- Since 1974
- Neutron Source : KUR (or **30 MeV Cyclotron**)

< Under Clinical Trial >

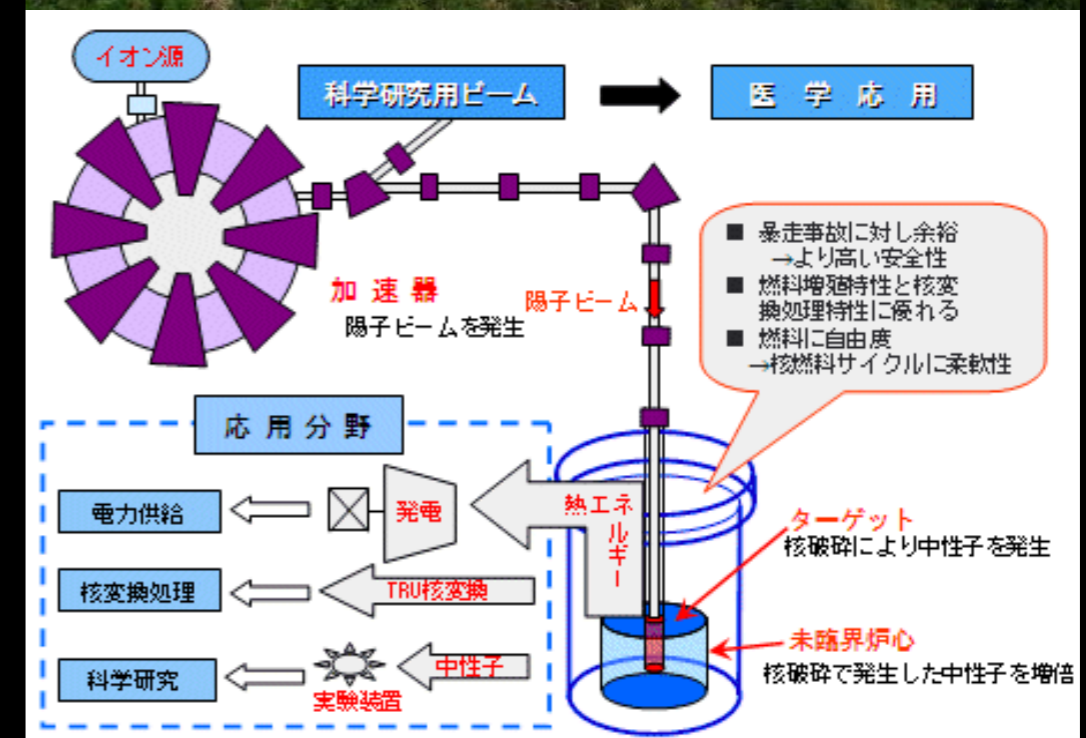


From Hiroki TANAKA

KART

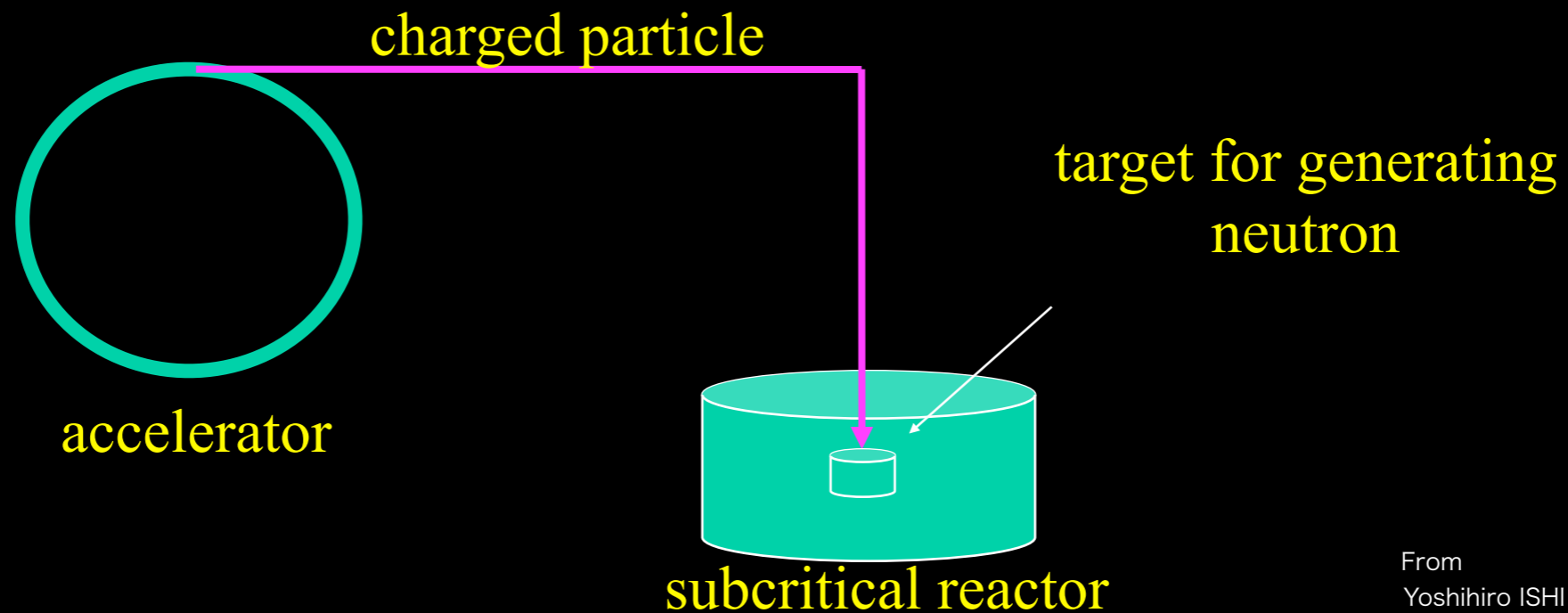
Kumatori Accelerator-driven Reactor Test facility

- For ADS experiment, started in 2002
- FFAG Complex had been build for the KART project
- KUCA has been used as a subcritical reactor



ADS

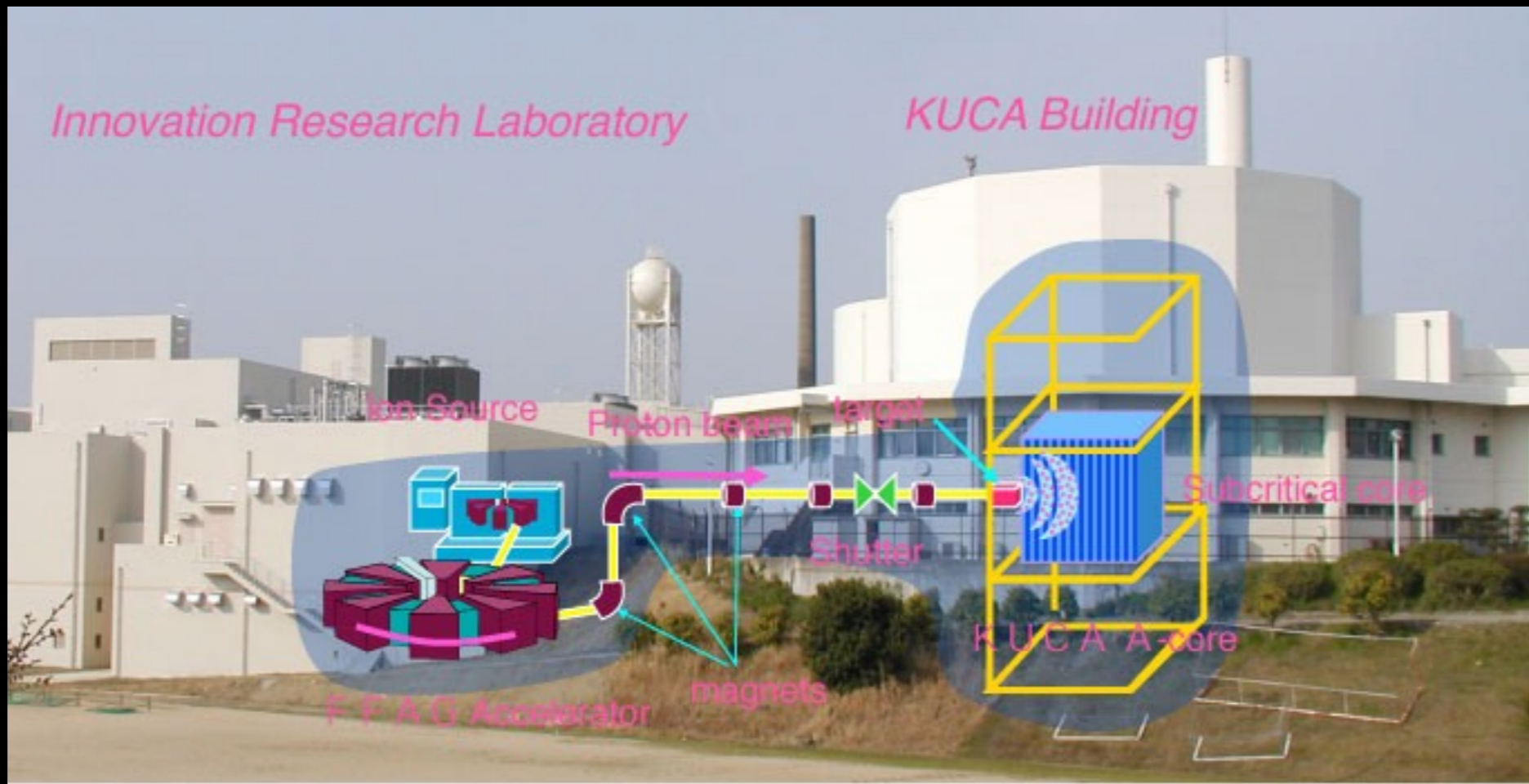
Accelerator Driven System



From
Yoshihiro ISHI

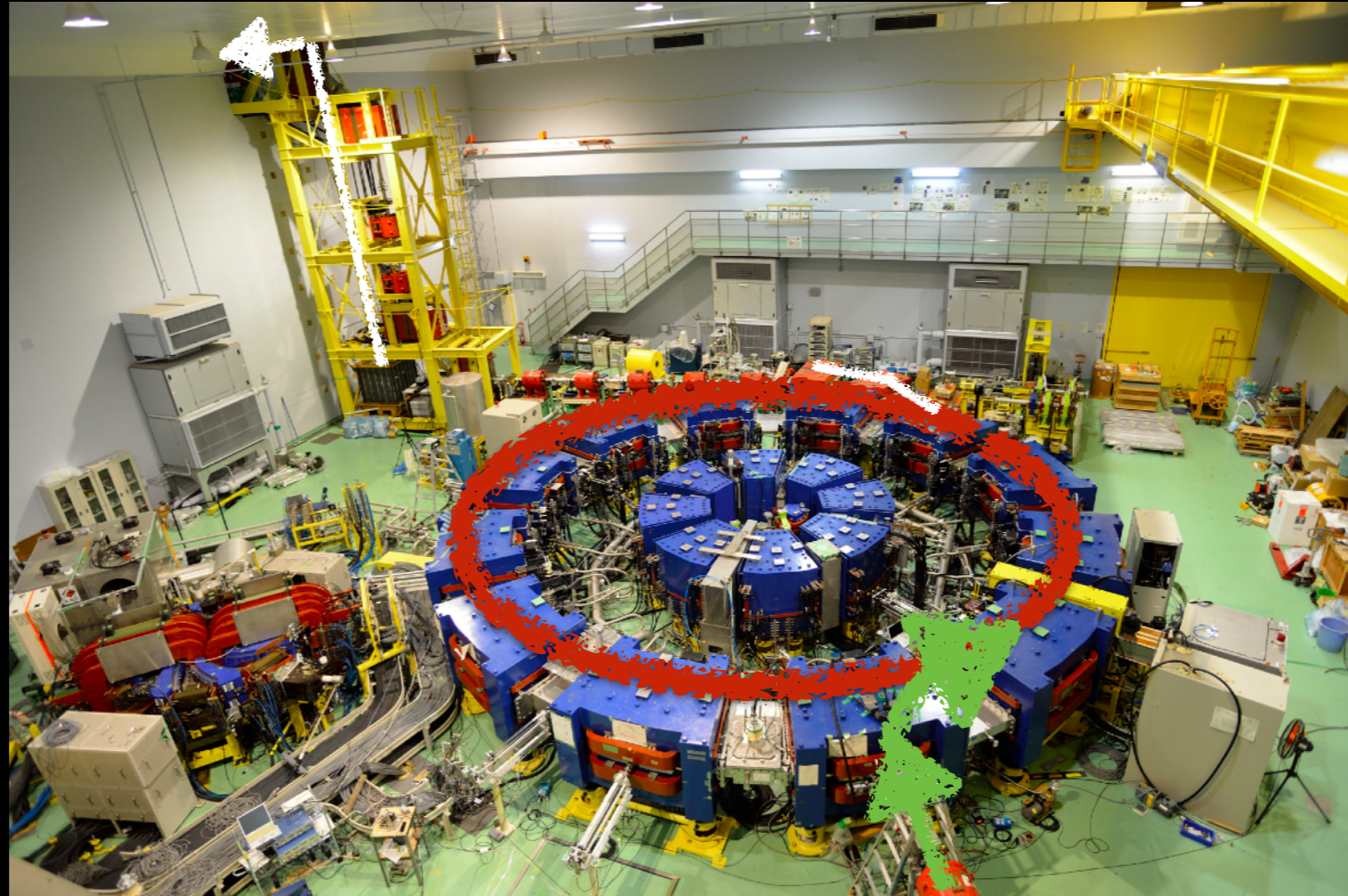
- Subcritical Reactor + Neutron Source (Proton Driver)
- Reduce Nuclear Waste by nuclear transmutation

ADS at KURRI



- Sub-critical Reactor : KUCA (~ 1 W)
- Proton Driver : FFAG Complex (100 MeV, 1 nA)

ADS at KURRI



From
Yoshihiro ISHI

- Sub-critical Reactor : KUCA (~ 1 W)
- Proton Driver : FFAG Complex (100 MeV, 1 nA)

KURRI Tour!!

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京都大学 原子炉実験所
Kyoto University Research Reactor Institute

First ADS Experiment



- World First ADS Experiment with Spallation Neutrons
- The First FFAG used for Application

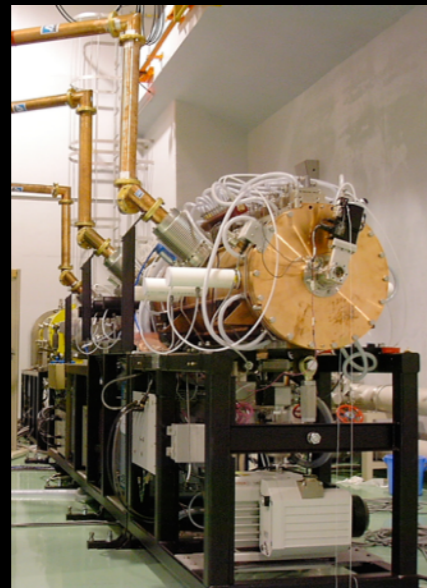
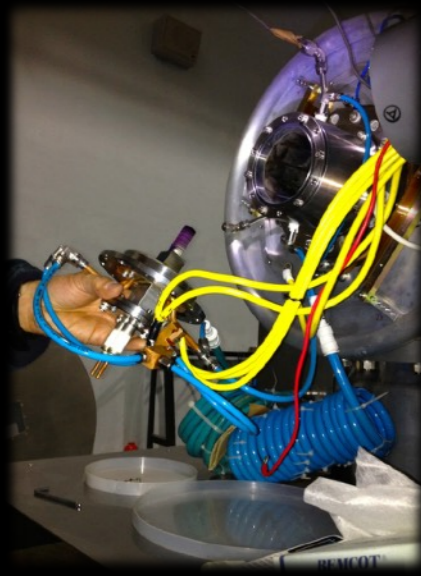
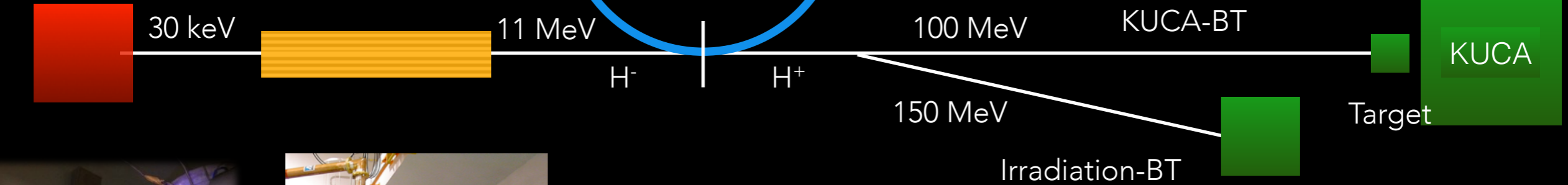
KURRI-FFAG Complex

150 MEV FFAG MAIN RING

H- IONSOURCE

11MEV LINAC

Charge Exchange Foil



- Injector : 11 MeV H⁻ Linac
- 1 μA ave., ~ 200 Hz Repetition
- MR : 150 MeV FFAG
- 10 nA, ~ 60 Hz Repetition

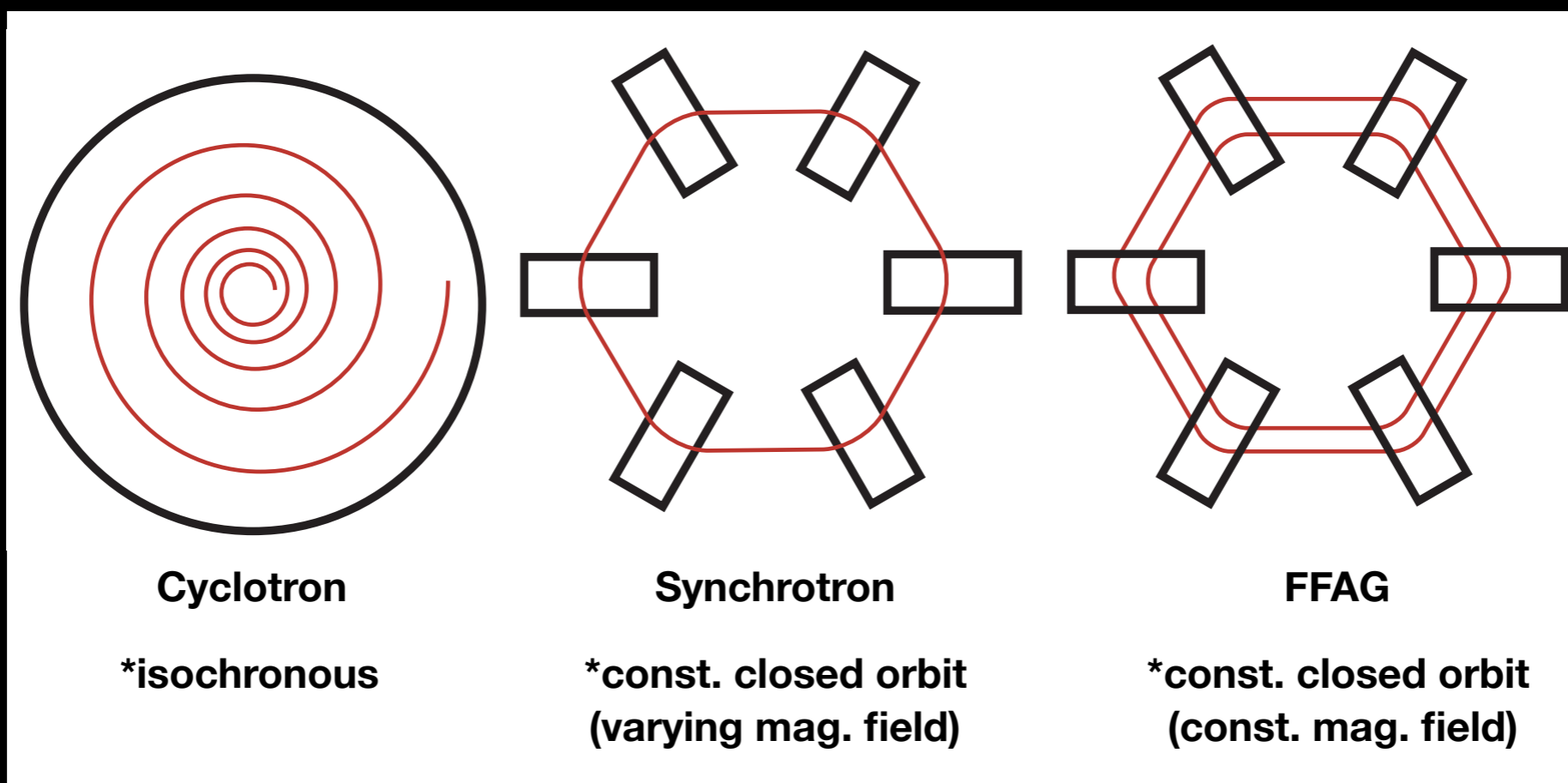
FFAG



From
Yoshiharu MORI

Fixed Field Alternating Gradient accelerator

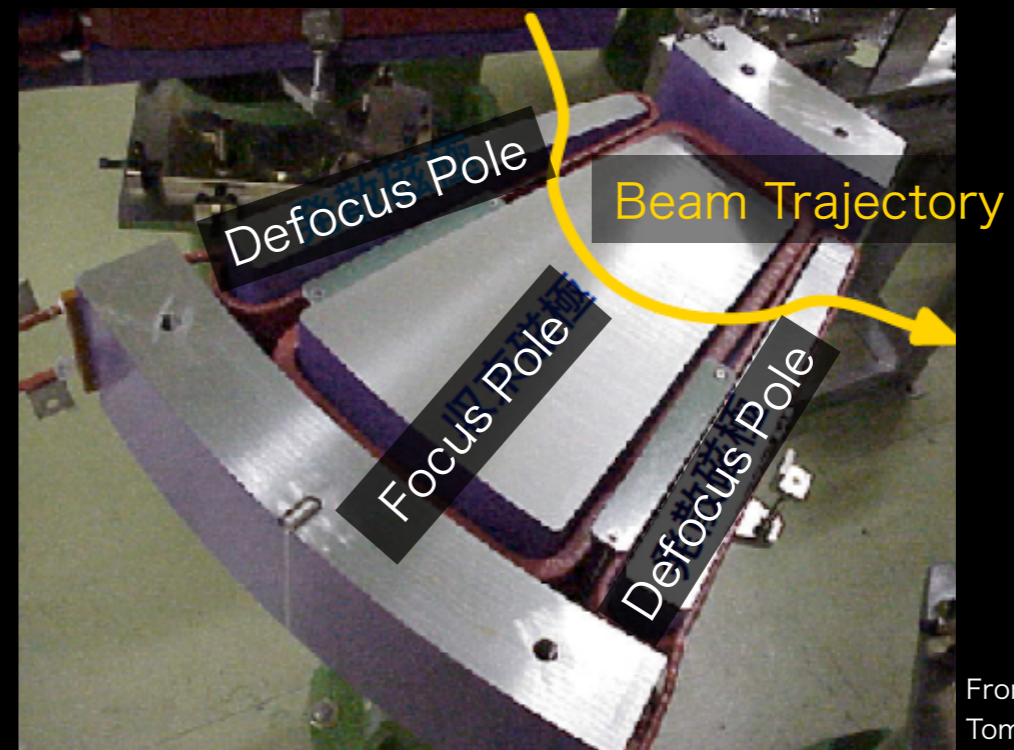
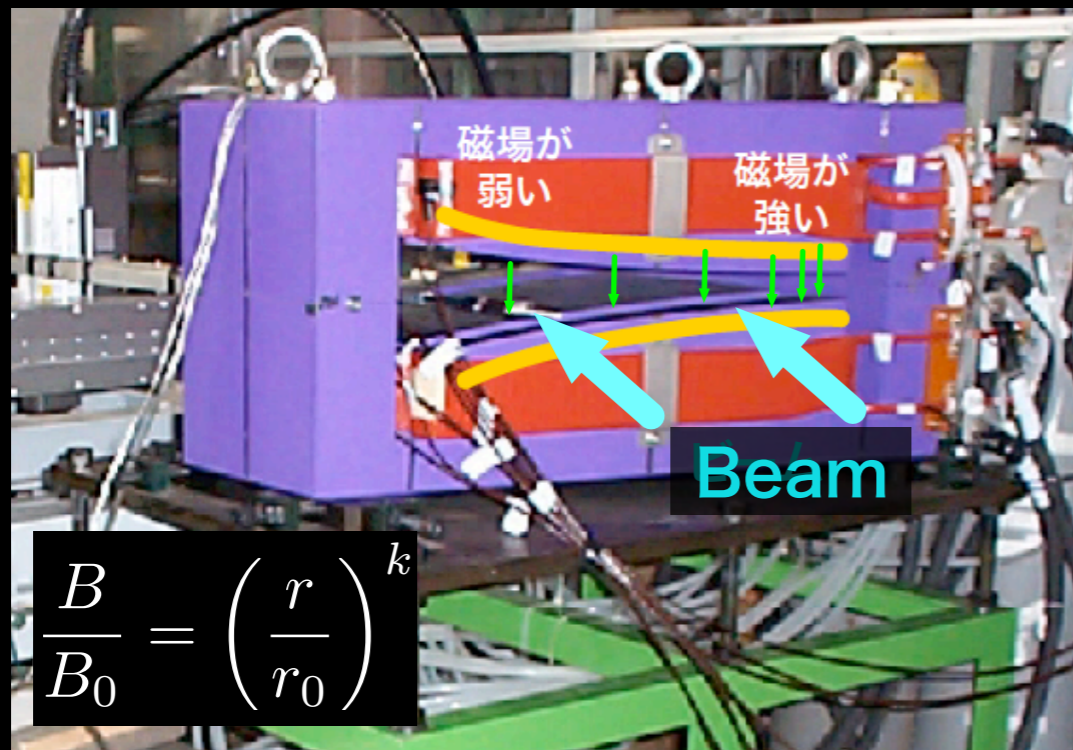
Strong Focus, Zero Chromaticity (Const. Tune), Fixed Field,
Frequency Modulation (not isochronous, synchrotron oscillation)



$$\frac{B}{B_0} = \left(\frac{r}{r_0} \right)^k$$

FFAG

- In 1950, Electron FFAG Constructed
- In 2000, Proton FFAG Constructed at KEK
 - Development of Broadband Magnetic Core for RF Cavity (MA Core)
 - Improvement of Computing Power
 - Precise Calculation of 3D magnetic field map (Opera-3D)



From
Tomonori UESUGI

Another FFAG Activities

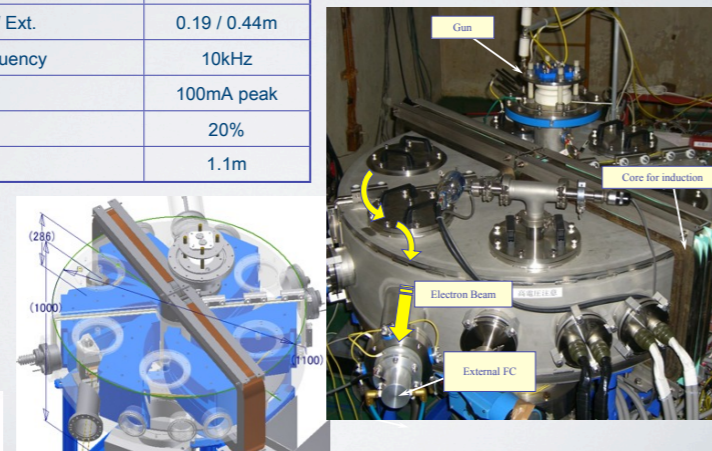
CYCLOTRON'10, Sept. 6-10, 2010, Lanzhou

NHV CO.

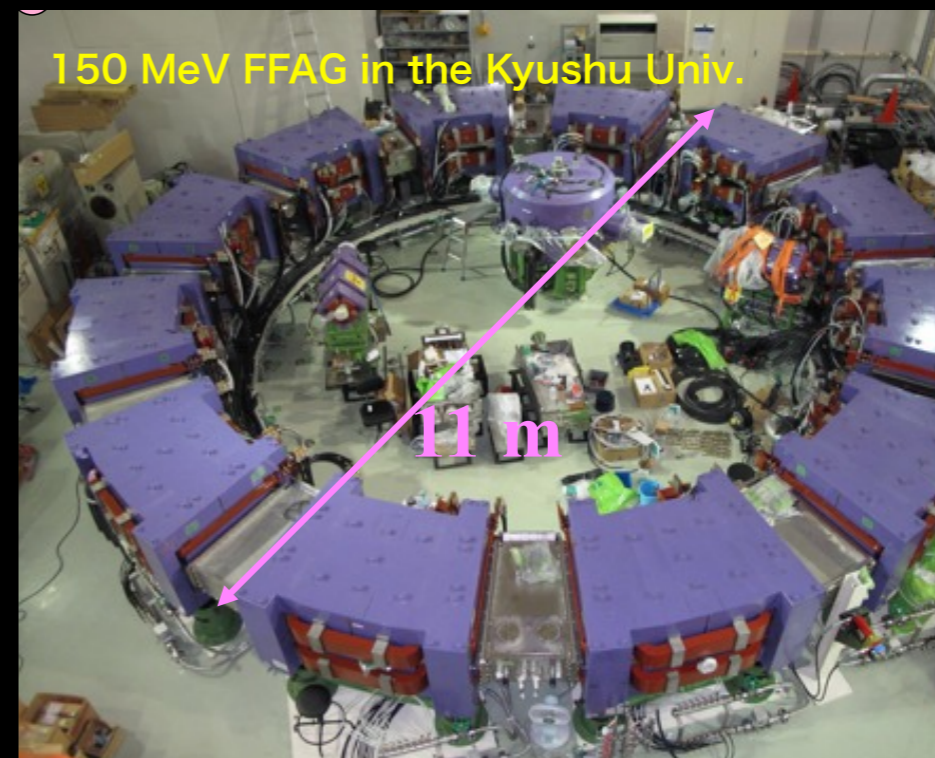
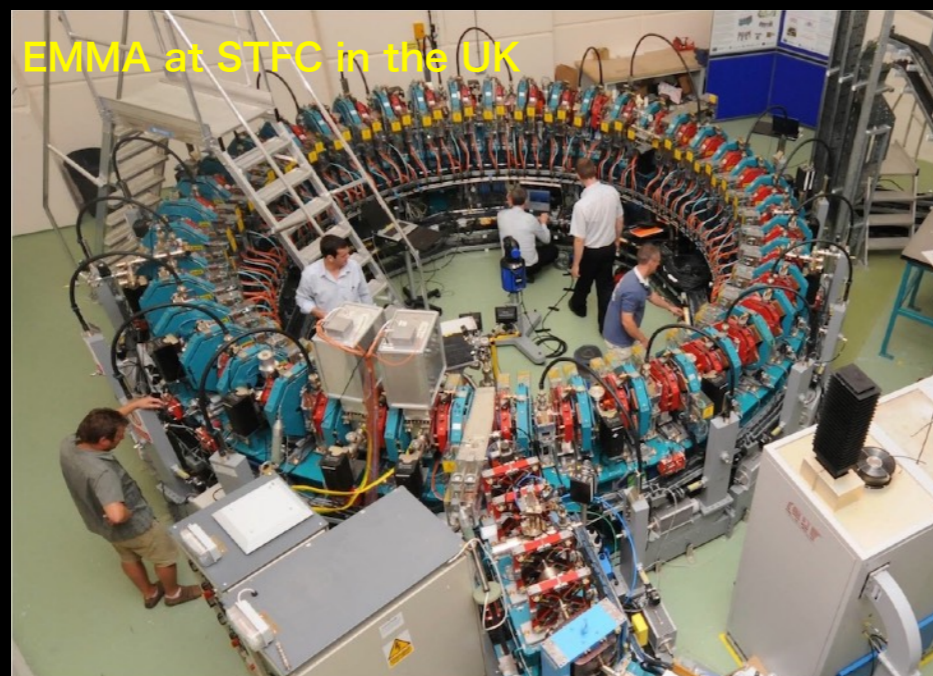
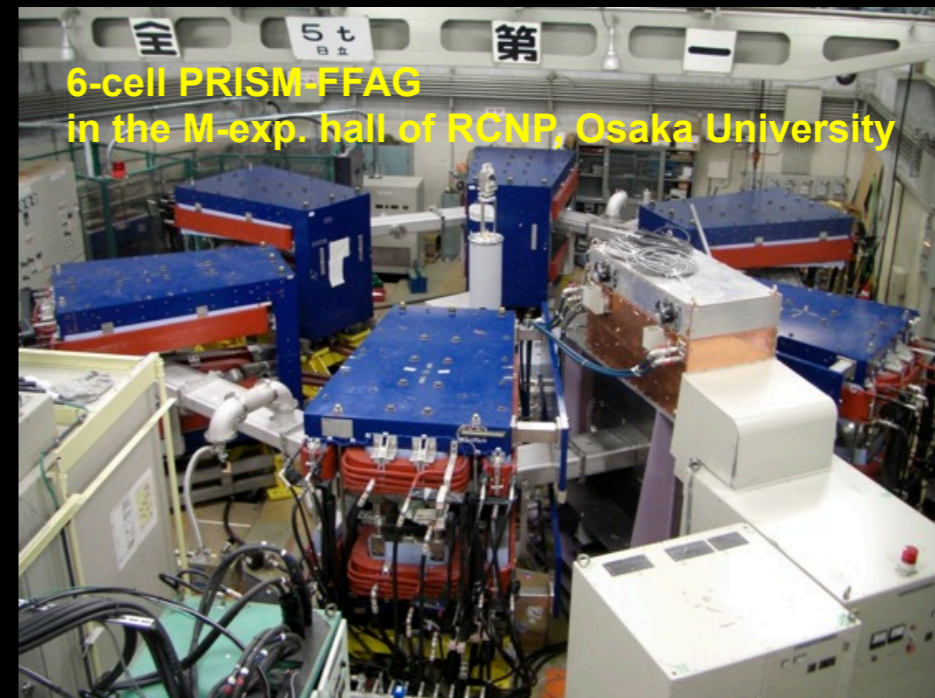
T.Baba, M.Yuasa

Prototype of FFAG Electron Accelerator: sterilization etc.

Energy	Inj. / Ext.	50 / 500keV
Orbit radius	Inj. / Ext.	0.19 / 0.44m
Acceleration frequency		10kHz
Beam Current		100mA peak
Duty		20%
Outer diameter		1.1m

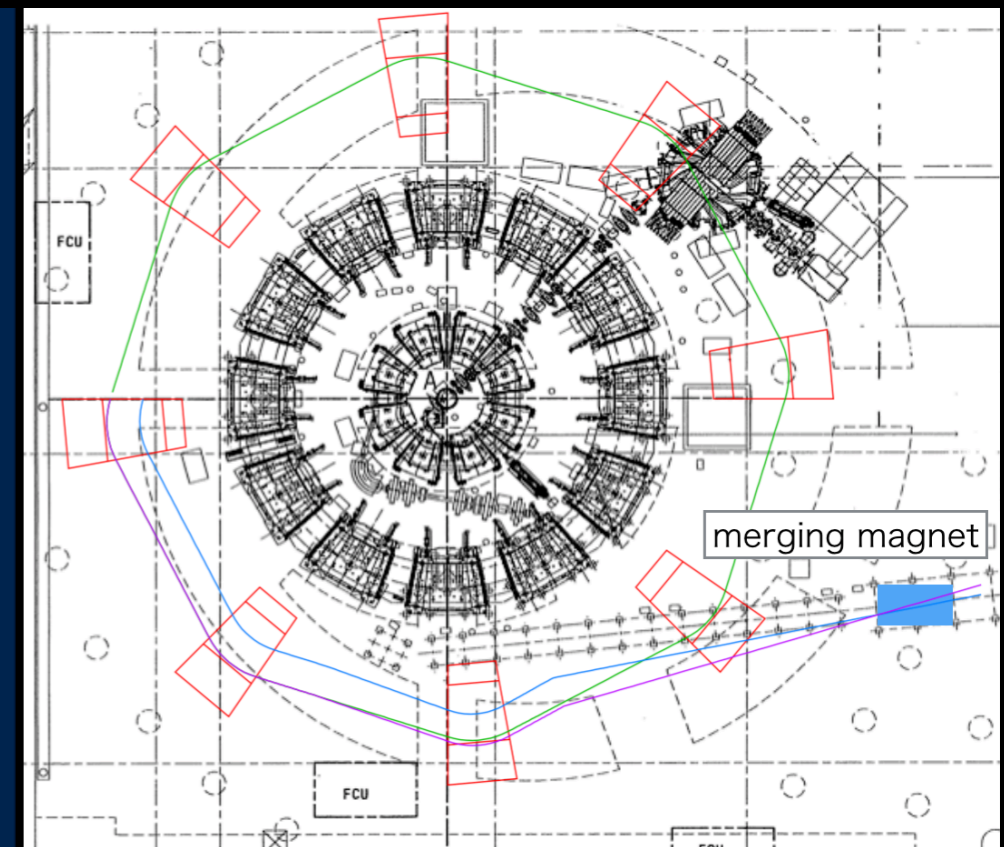
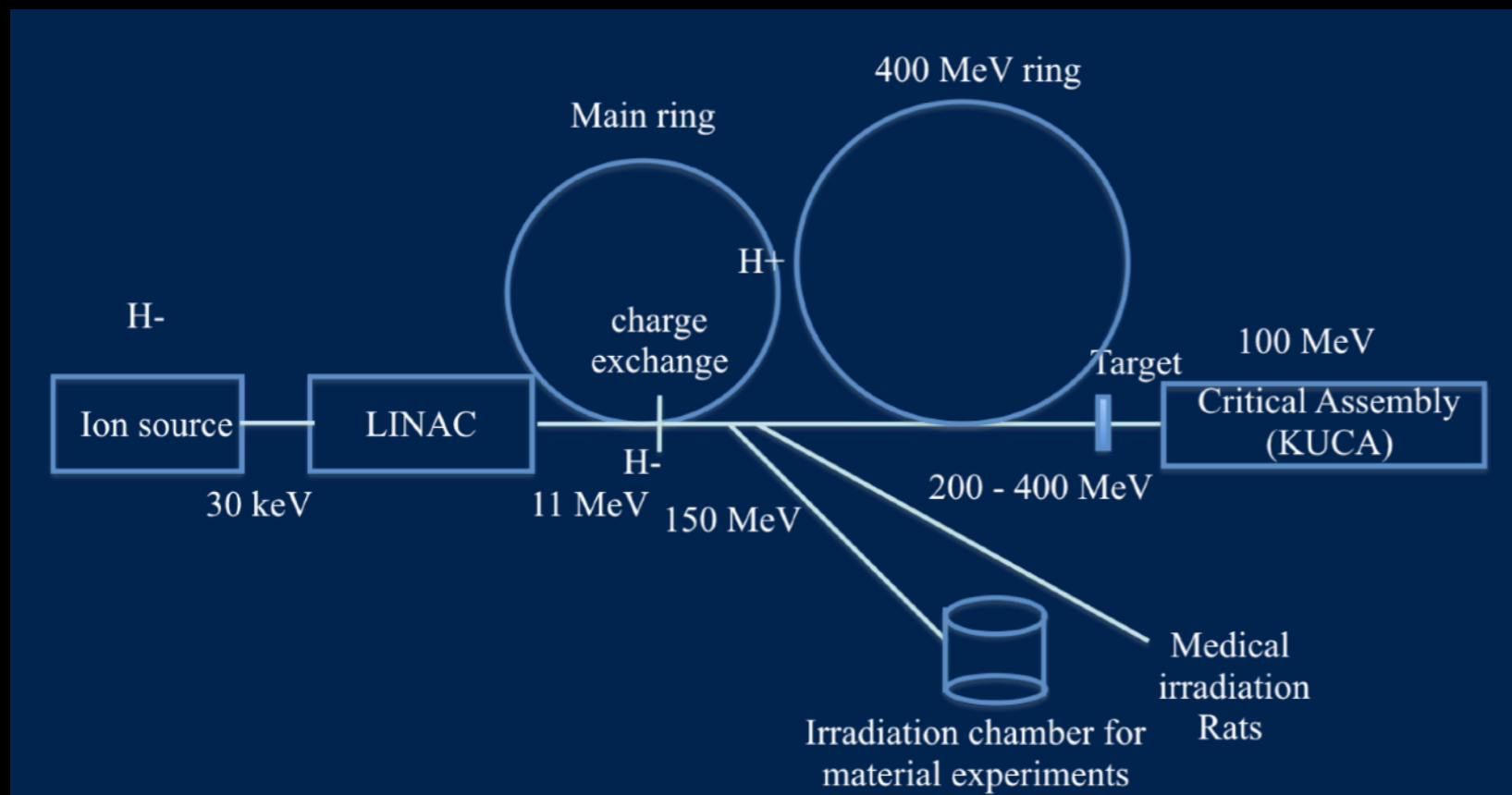


NHV Corporation
2010年10月27日水曜日



Future Plan of KURRI- FFAG Complex

- After 150 MeV FFAG MR, build new 400 MeV FFAG ring
- Stage of design study



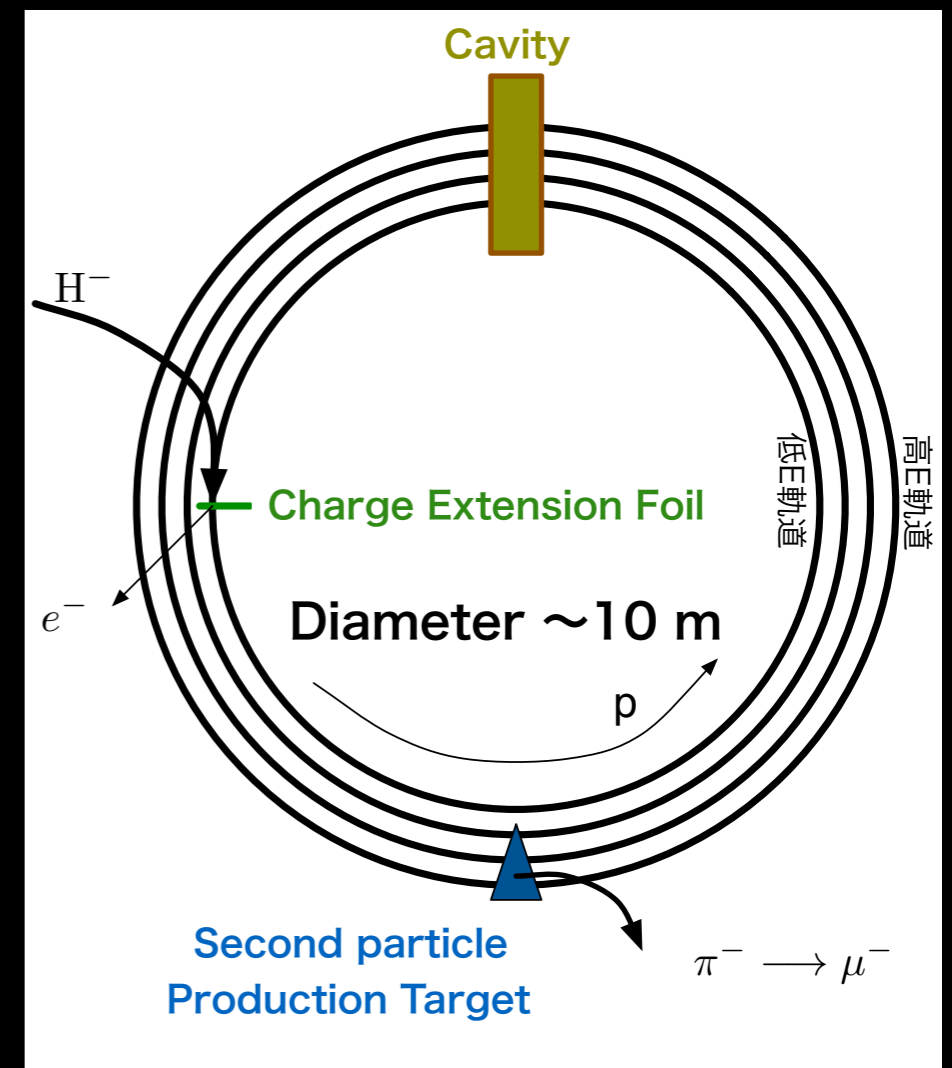
From
Yoshihiro ISHI

MERIT



Meson Production Energy Recovery Internal Target

- FFAG ring with Internal Target
 - Goal : Produce Negative Muon
 - Purpose : Reduce nuclear waste through nuclear transmutation
- In FY2016 to FY2019, Demonstrate serpentine acceleration
- Now modifications of FFAG ring (ERIT) is undergoing



From
Tomonori UESUGI

Future

- Two Reactors KUR&KUCA will be resumed in this summer.
- Next ADS experiment is planned this winter.
 - Last ADS experiment had been done in Jan. 2014.
- Accelerator Group is trying to design a new 400 MeV FFAG and demonstrate serpentine acceleration in the FFAG with internal target.