

**55th AAPM annual meeting
Particle Beam Therapy Symposium**

SUMITOMO
Particle Therapy Technologies

August 3, 2013

Yukio Kumata

 **Sumitomo Heavy Industries, Ltd.**

Sumitomo Heavy Industries, Ltd.

- **Experience**
accelerators for science
- **Current Status**
proton and carbon
- **Future Technologies**
particle therapy

Experience

accelerators for science

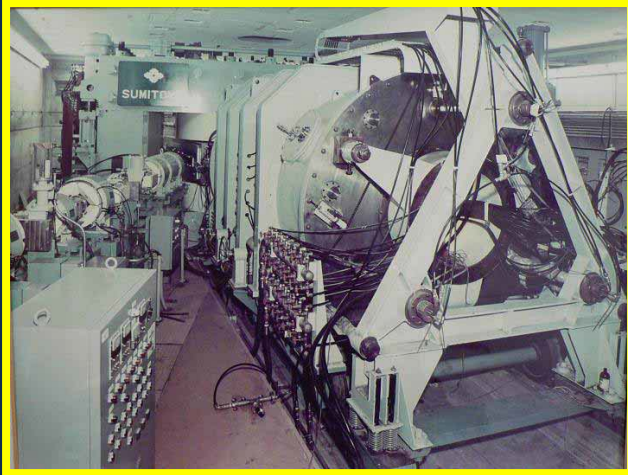
Sumitomo Heavy Industries, Ltd.

- Accelerator business since 1971
- Medical accelerators since 1980
- Particle therapy system since 1998
(R&D started in 1989)

over 14 years

R&D Accelerators since 1970s

CYCLOTRON



Osaka Univ.
1973
K=150MeV



Tohoku Univ.
1977
K=50MeV



RIKEN
1986
Heavy Ions
K=540MeV

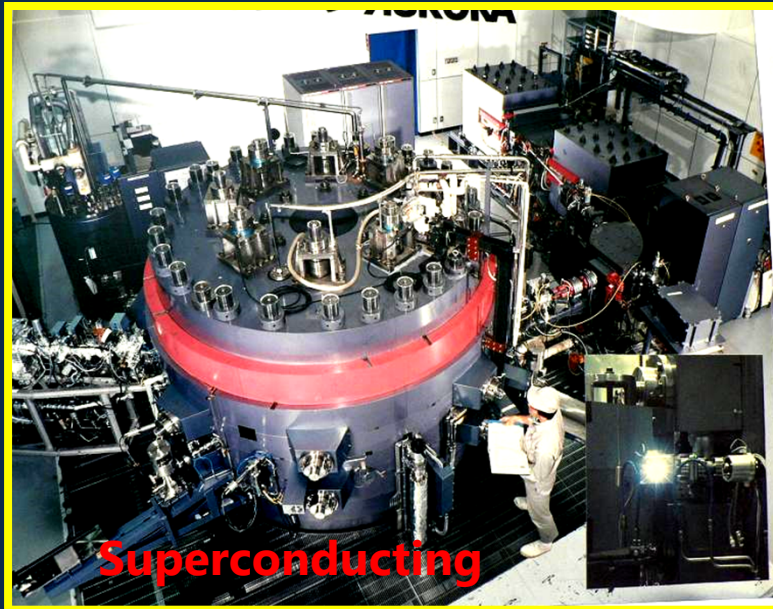


Japan Atomic
Energy Agency
1989
K=110MeV

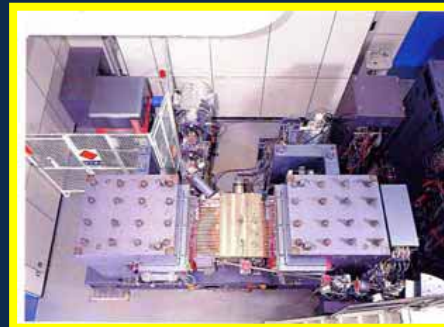
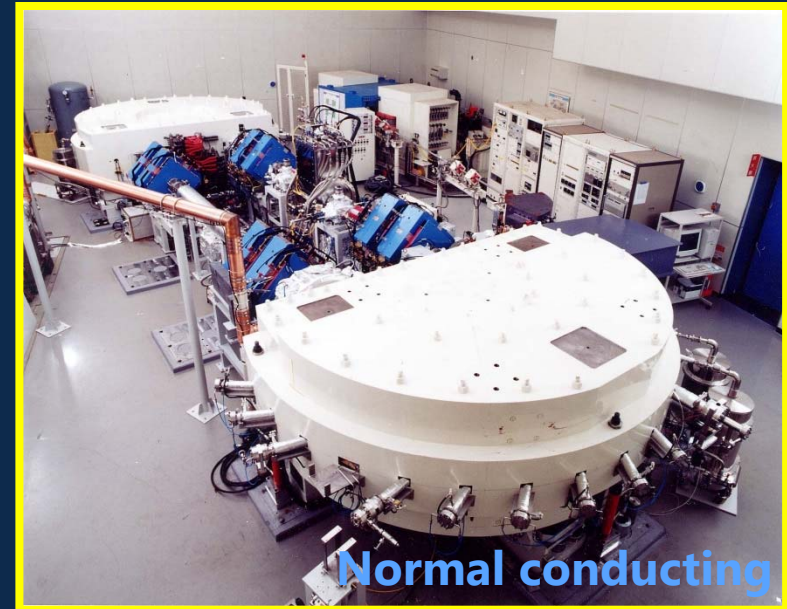
R&D Accelerators since 1970s

SYNCHROTRON

Ritsumeikan Univ.
1990
Electron 700MeV



Hiroshima Univ.
2000
Electron 700MeV



Injector
(Racetrack Microtron)
Electron 150MeV

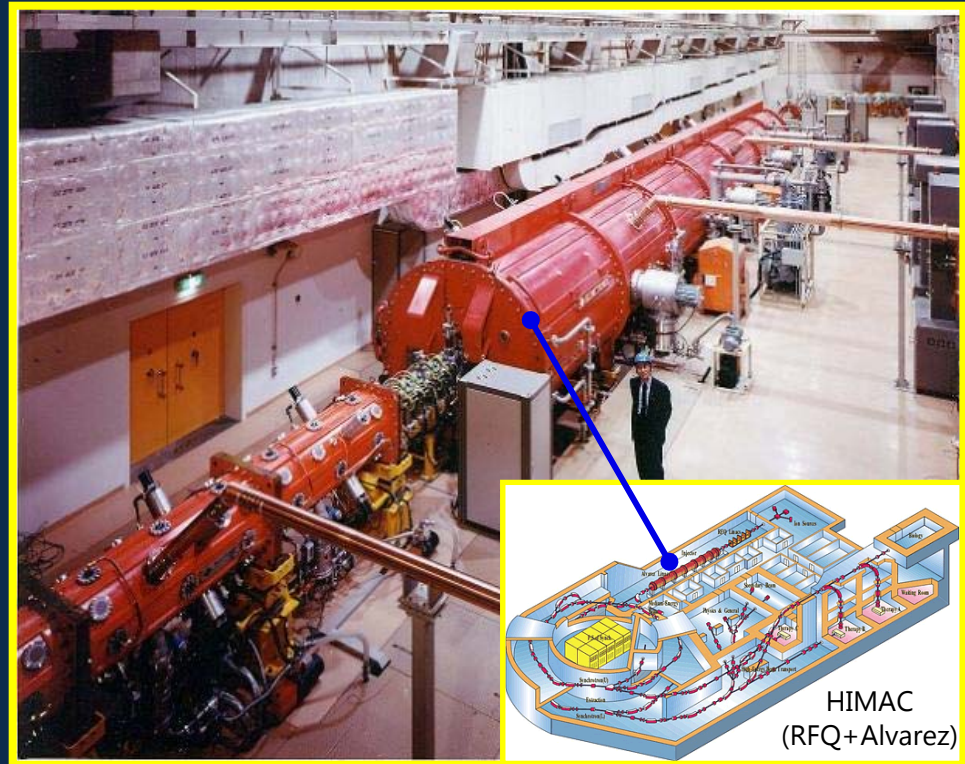
R&D Accelerators since 1970s

Heavy Ion Linac

RIKEN
1978
 C^{4+} 8.3MeV/n



NIRS
1989
 C^{4+} 7MeV/n



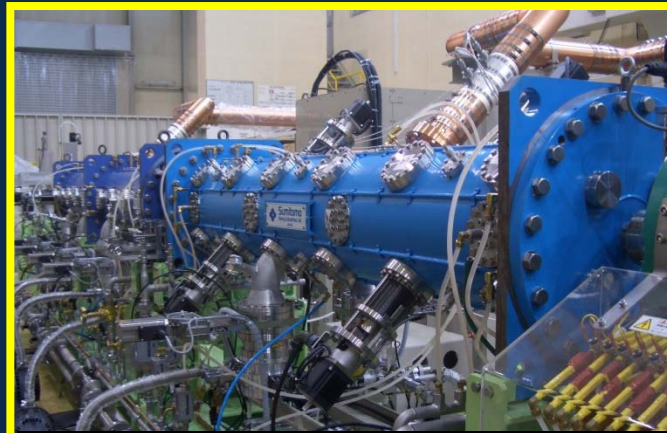
Medical Accelerators



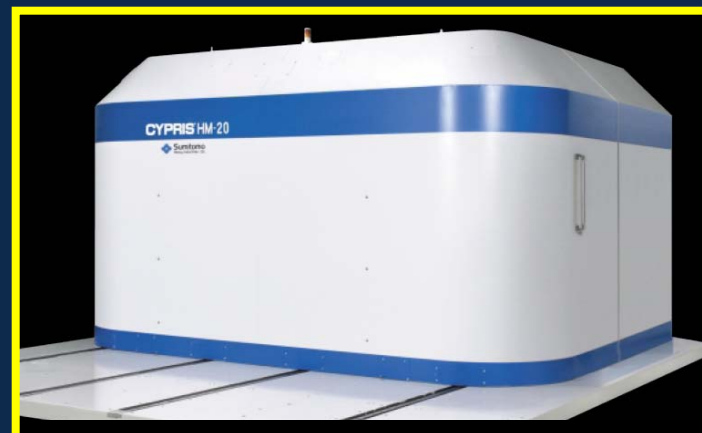
Proton Therapy System



Boron Neutron Capture Therapy System



Injector for Carbon Therapy



PET cyclotron

Components for Particle Therapy

- Proton therapy cyclotron (IBA)
- Carbon therapy injector (Mitsubishi etc.)
- Cryocooler for superconducting cyclotron (Varian, MEVION)



for MRI SC magnet, too
(GE, Siemens, Philips)

Current Status

Proton and carbon

Proton Reference Sites

Starting 2015



**Samsung
Medical Center
Korea**

In operation
since 1998



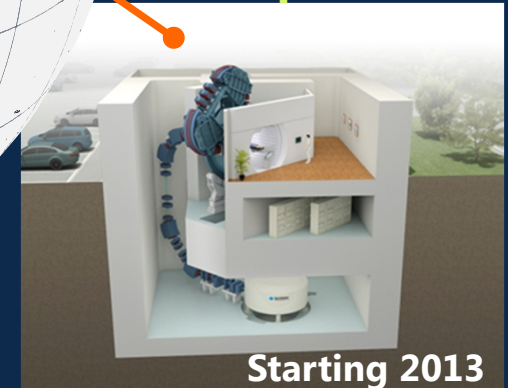
**National
Cancer Center
Japan**

**Chang Gung
Memorial Hospital
Taiwan**



Starting 2014

**Aizawa
Hospital
Japan**



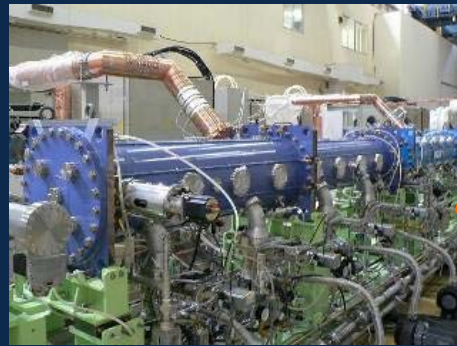
Starting 2013



Carbon Injector Reference Sites



Gunma University
Heavy-Ion Medical Center
[GHMC]
operational:2010



National Institute of
Radiological Sciences
[NIRS HIMAT]
operational:1994



Hyogo Ion Beam
Medical Center
operational: 2001

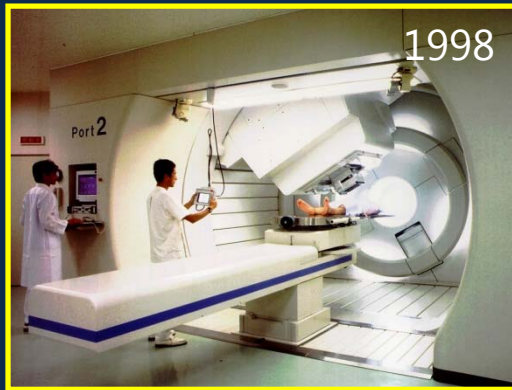


Ion-beam Radiation Oncology Center
In Kanagawa [i-ROCK]
start: 2015



SAGA Heavy Ion Medical Accelerator in Tosu
[SAGA HIMAT]
start: 2013

14-Years Operation at NCC



- Upgraded in 2008
 - Gantry #1:
 - MLC,
 - Pencil beam scanning
 - Gantry #2:
 - Robotic couch,
 - Orthogonal DR,
 - CT on rail



Double Decker Compact Solution: Aizawa

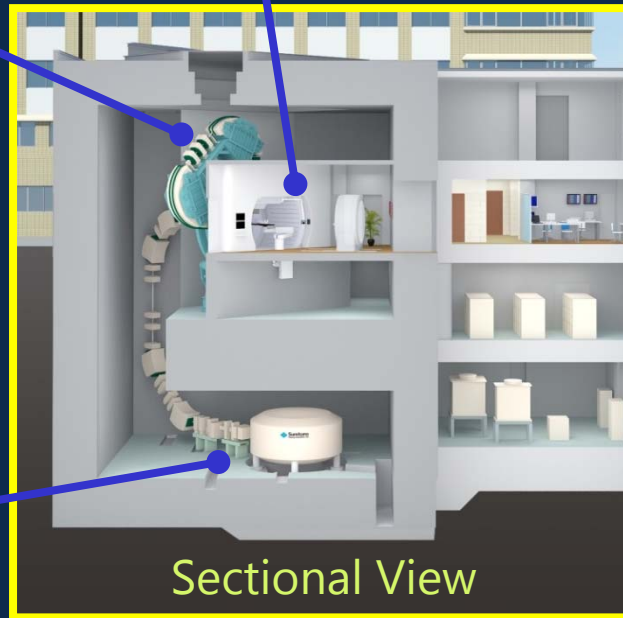


Gantry

Treatment room with CT on rail



Cyclotron



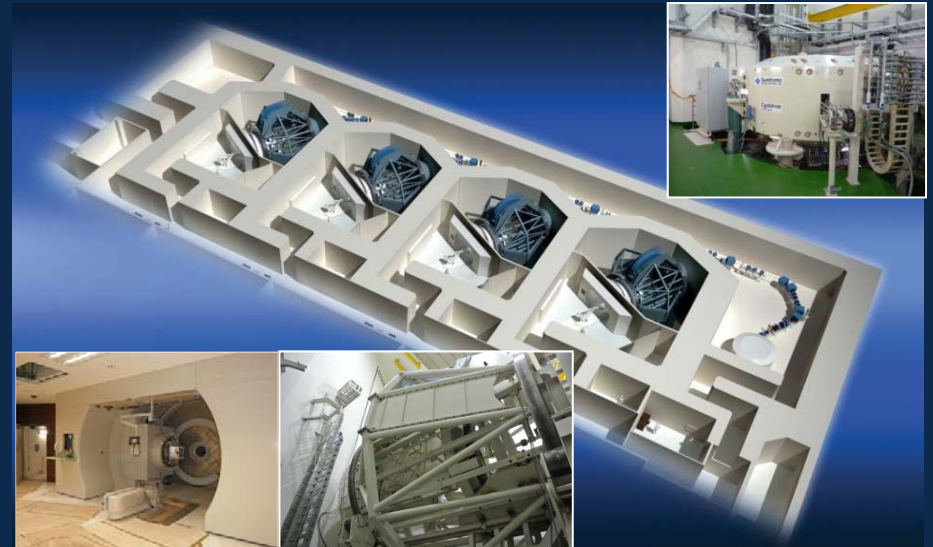
Sectional View

- Single Gantry
- Double Decker
- Small vault footprint:
53' x 66' (16m x 20m)
- **Performance achieved!!**
- Treatment starts in 2013.



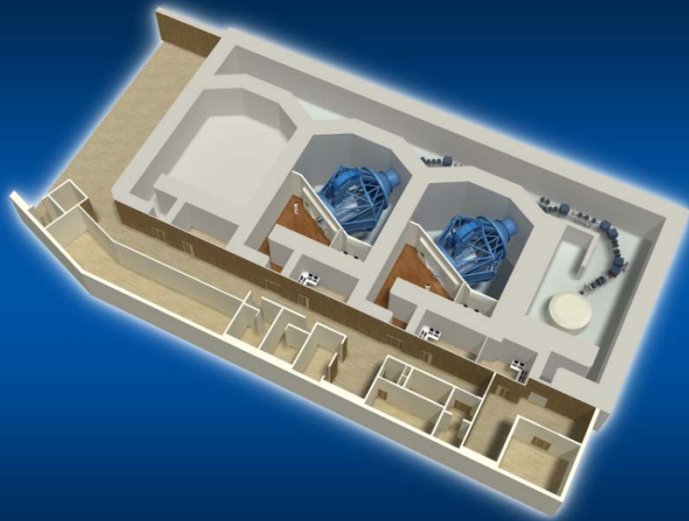
Matsumoto city

Taiwan First Proton: CGMH



- 4 Gantries + 1 Fixed beam port
- **First beam delivered to the treatment room!!**
- Treatment will start in 2014

Korean Second Proton: Samsung



Samsung Medical Center, Korea

- One of the top hospitals in Korea
- 2 Gantries, 3 vaults for future expansion
- Major components have been installed!!
- Treatment will start in 2015



Hospital Building



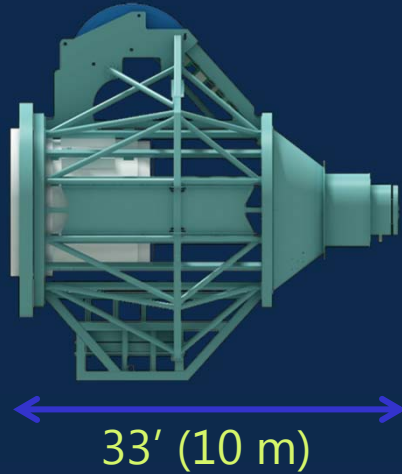
Cyclotron



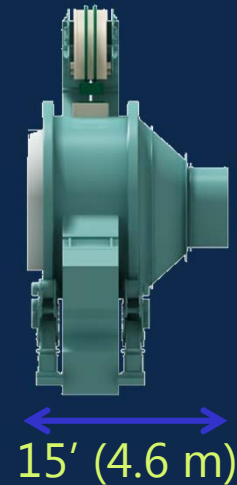
Beamline

Small vault footprint

Conventional Gantry

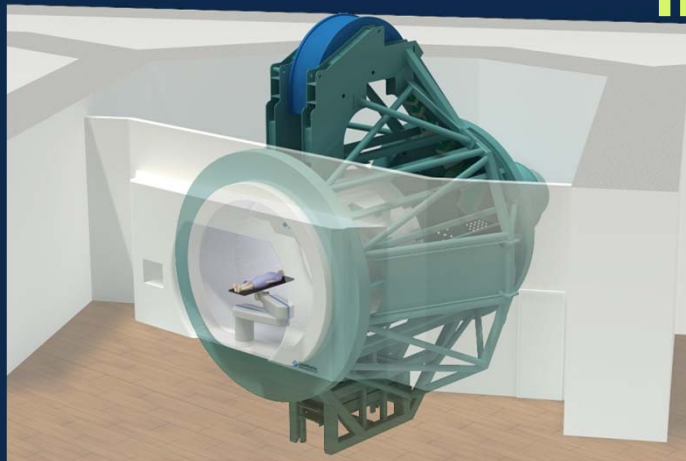


Short-length Gantry

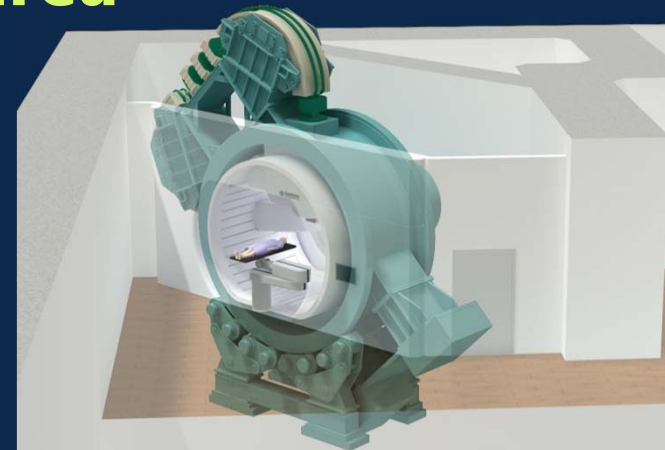
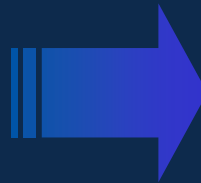


50% DOWN
in length

30% DOWN
in vault area

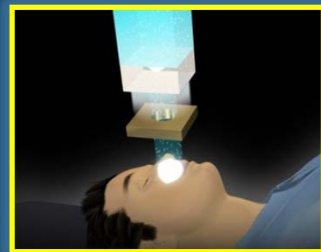


360 deg. rotation



360 deg. rotation

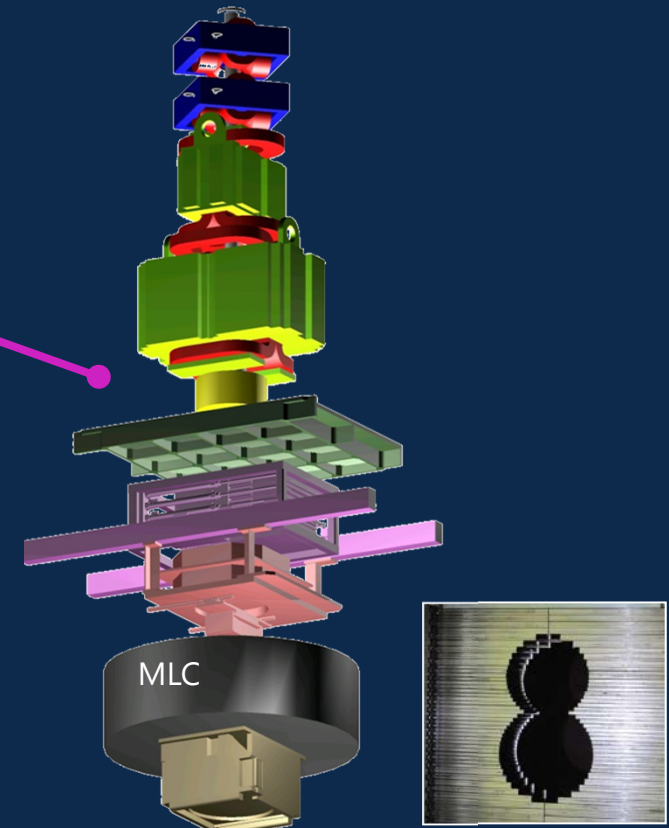
Broad Beam & Pencil Beam



Broad beam



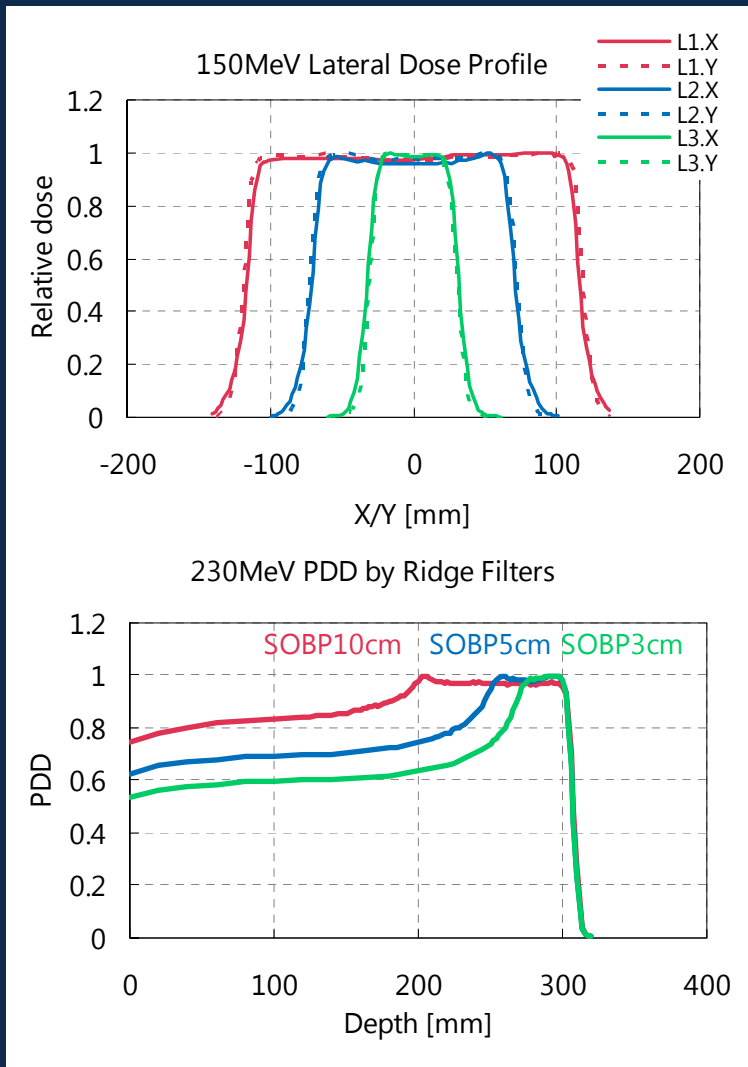
Pencil beam



- Broad beam with an MLC & Pencil beam scanning capabilities in a single nozzle (multi-purpose nozzle)

Performance of Multi-Purpose Nozzle

Broad beam (wobbling)



Scanning beam

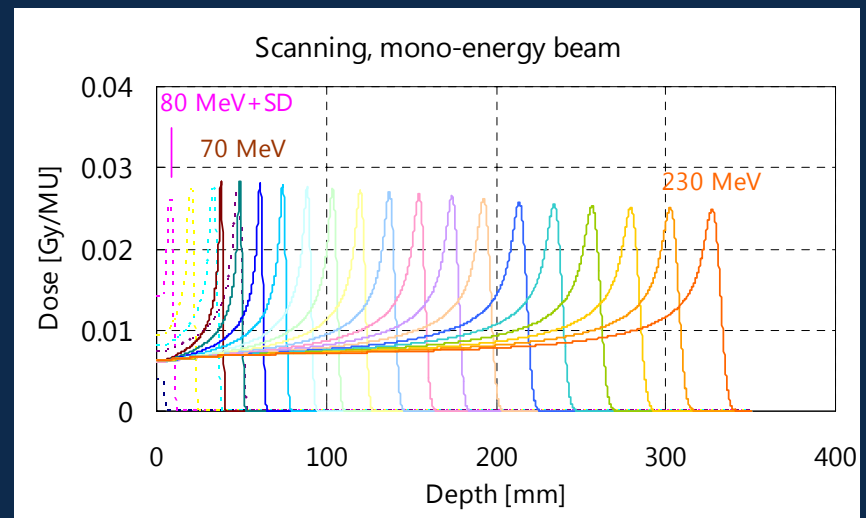
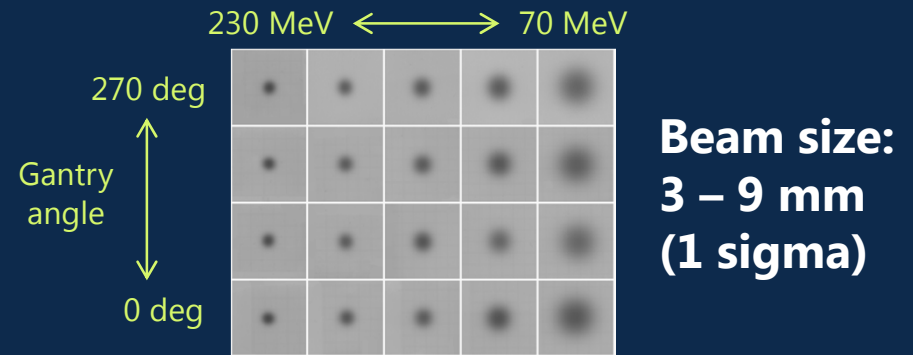
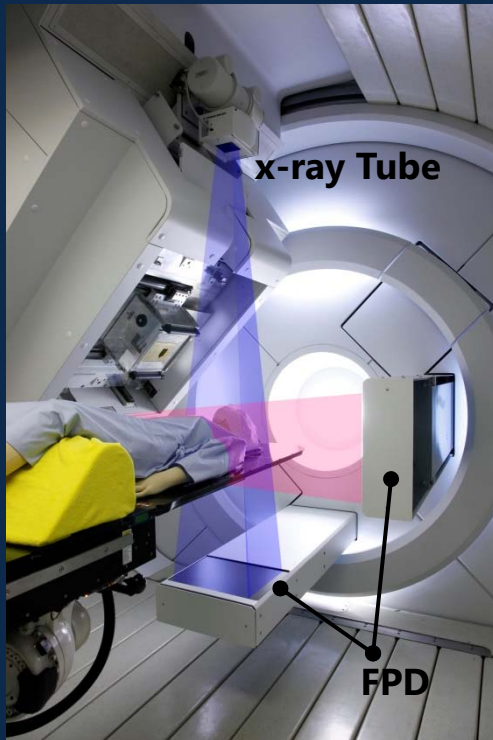
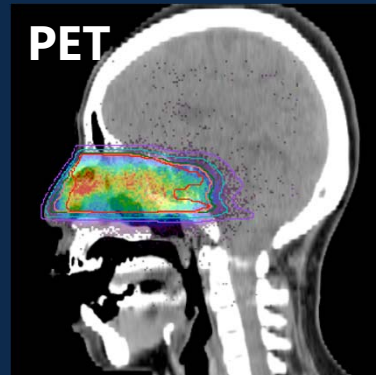
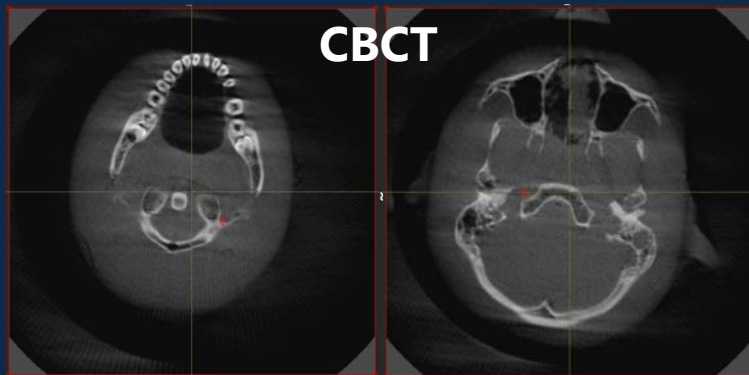


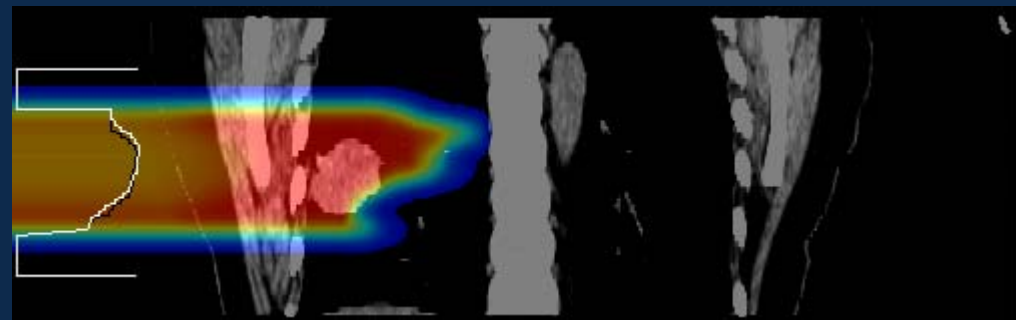
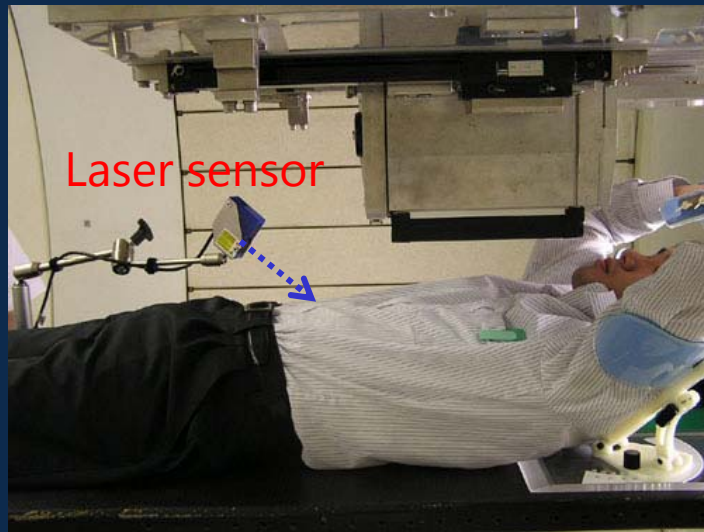
Image-Guided Proton Therapy



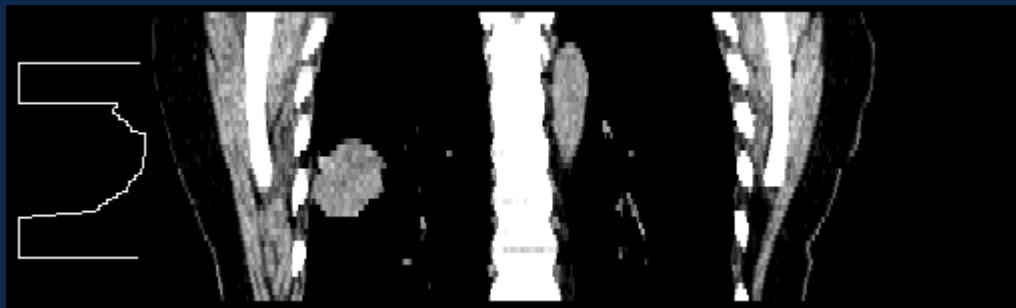
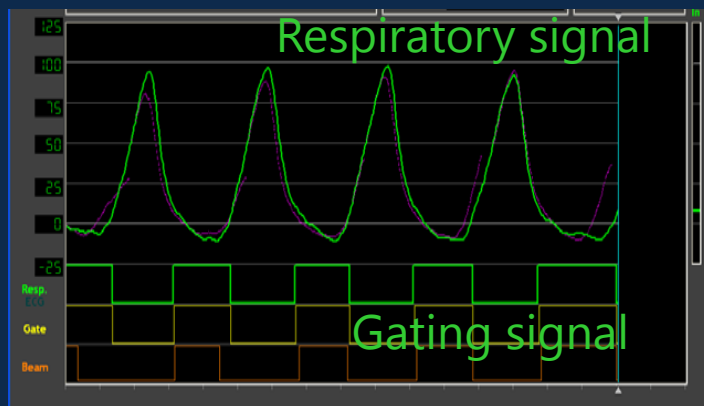
- Orthogonal Digital Radiograph
Fluoroscopy
- CBCT
- CT on rail
- Positron Emission Detection



Respiratory Gating for Moving Target



Without Gating

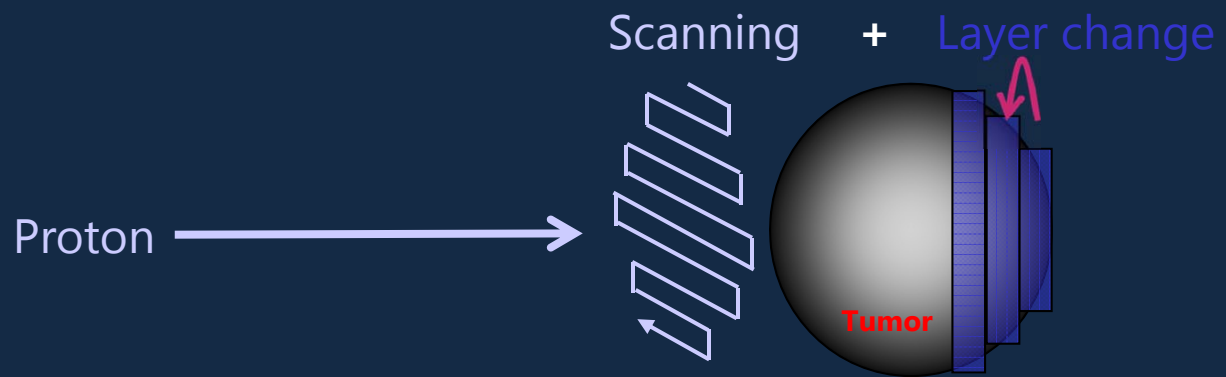


With Gating

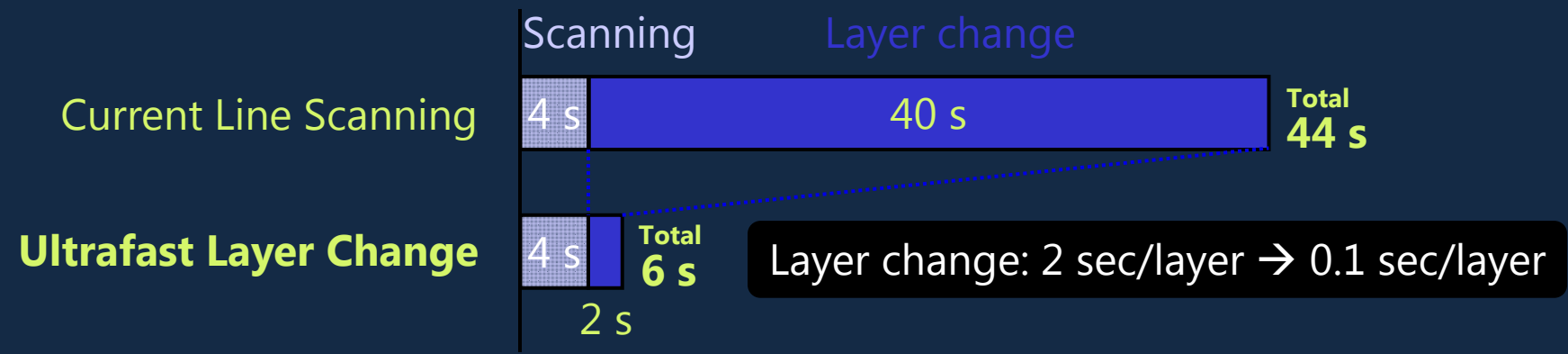
Future Technologies

Particle Therapy

Ultrafast Layer Change for Moving Target



Time structure of 20-layers scanning for 1 liter volume



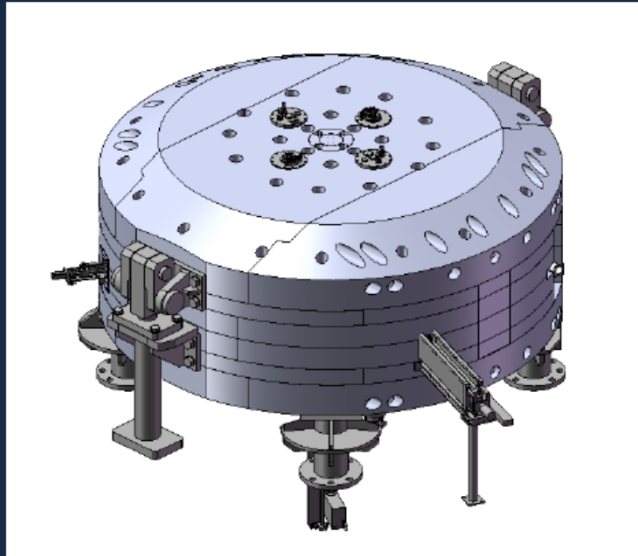
6 sec for 1 liter volume



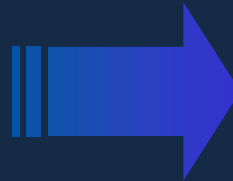
**Breath-hold
No interplay effect**

Superconducting AVF cyclotron

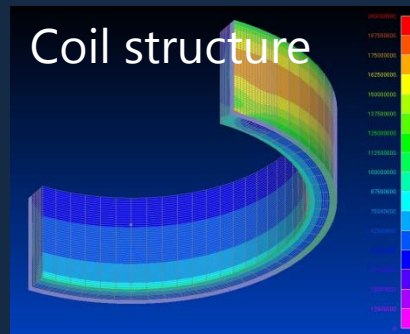
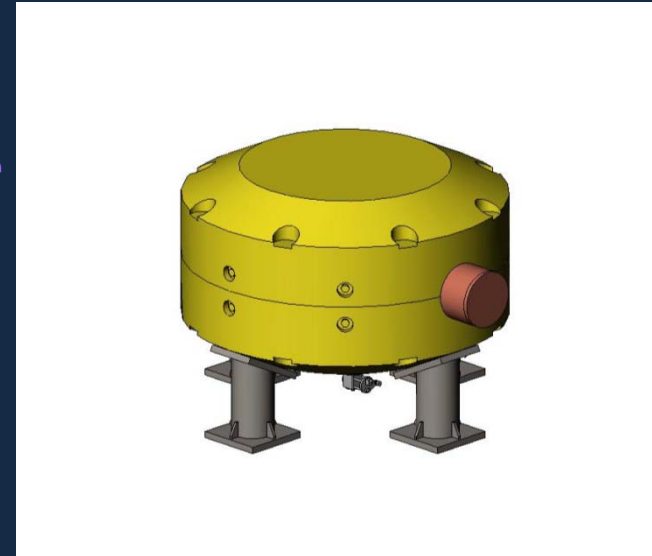
Normal Conducting AVF cyclotron



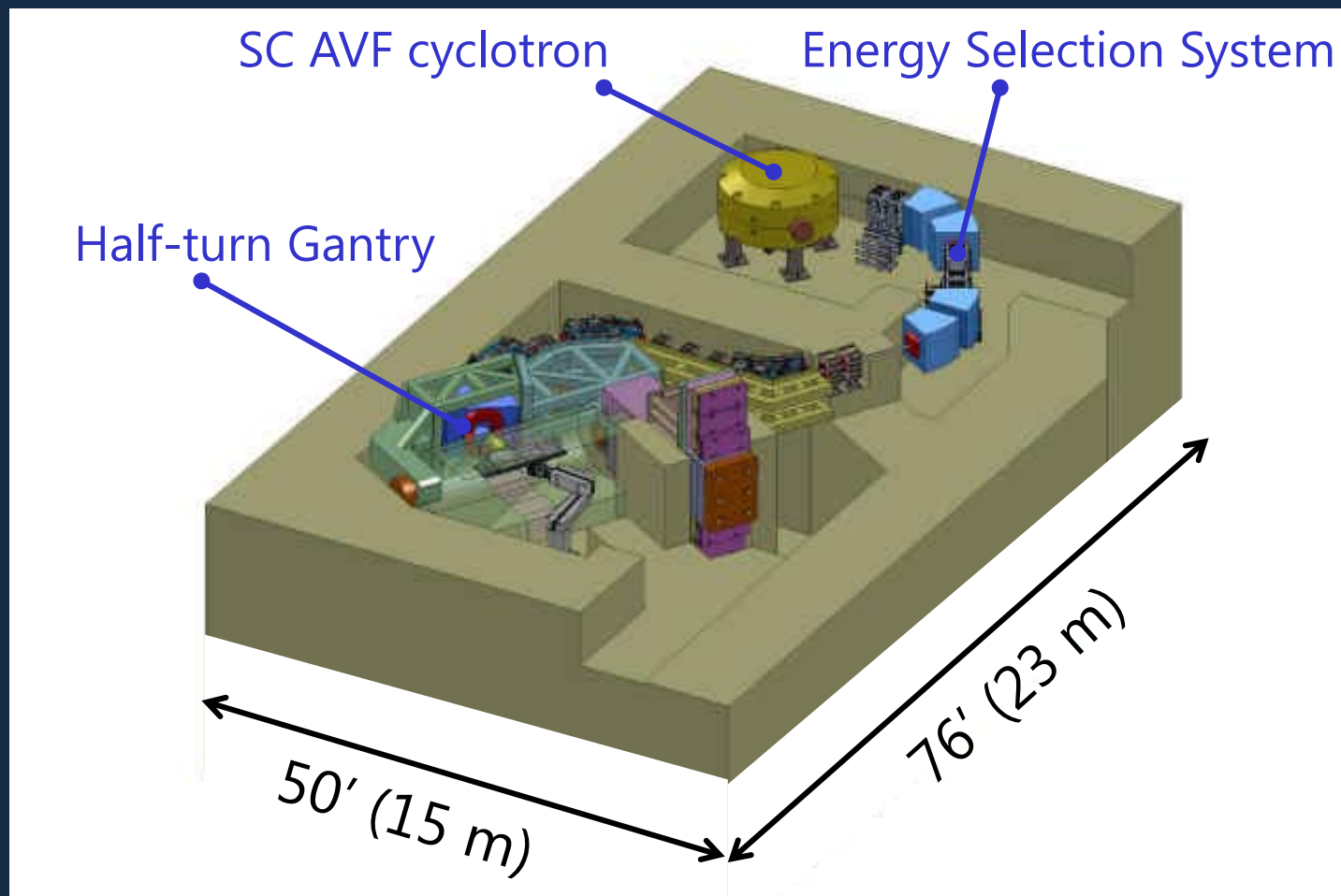
Downsizing
Light weight
Less expensive
Quick delivery
No trade off!



Superconducting AVF cyclotron



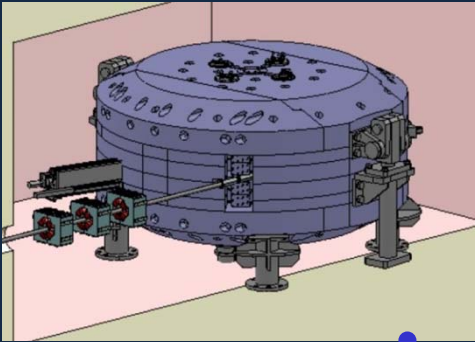
SC AVF cyclotron + Half-turn gantry



Light Ion Therapy System

H_2^+ , α , Li^{3+} , B^{5+} , C^{6+}

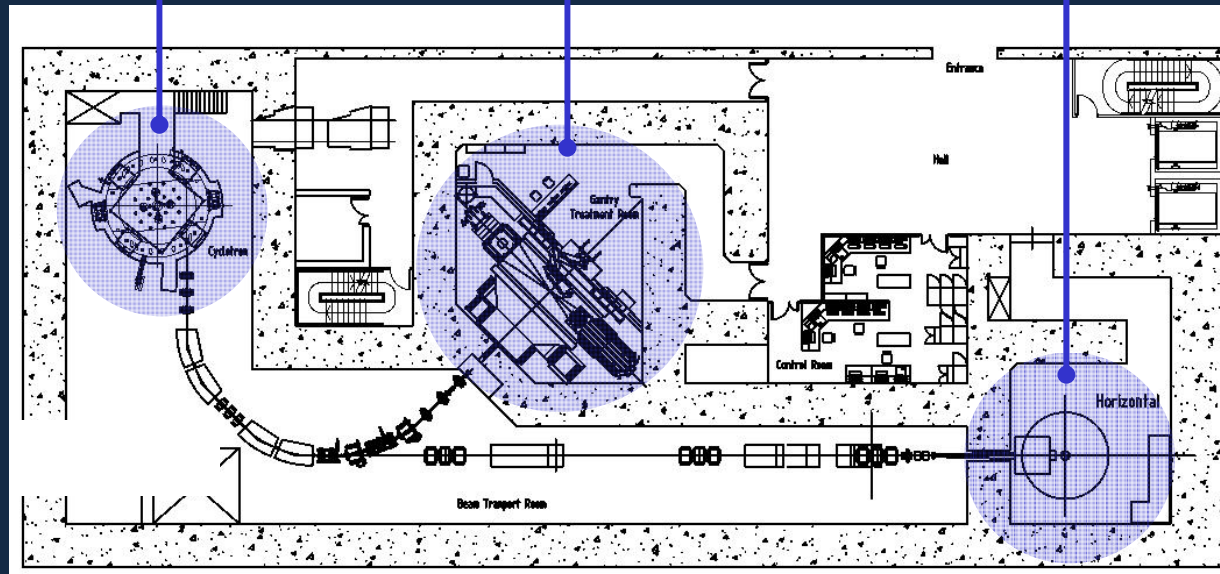
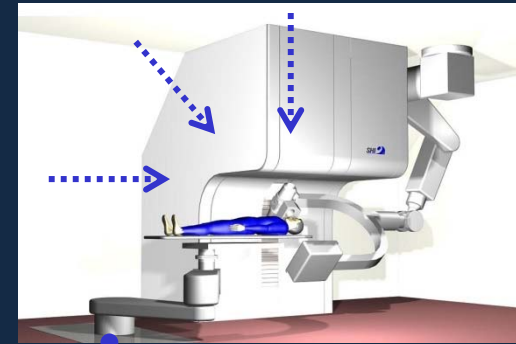
300 MeV/u AVF
superconducting cyclotron



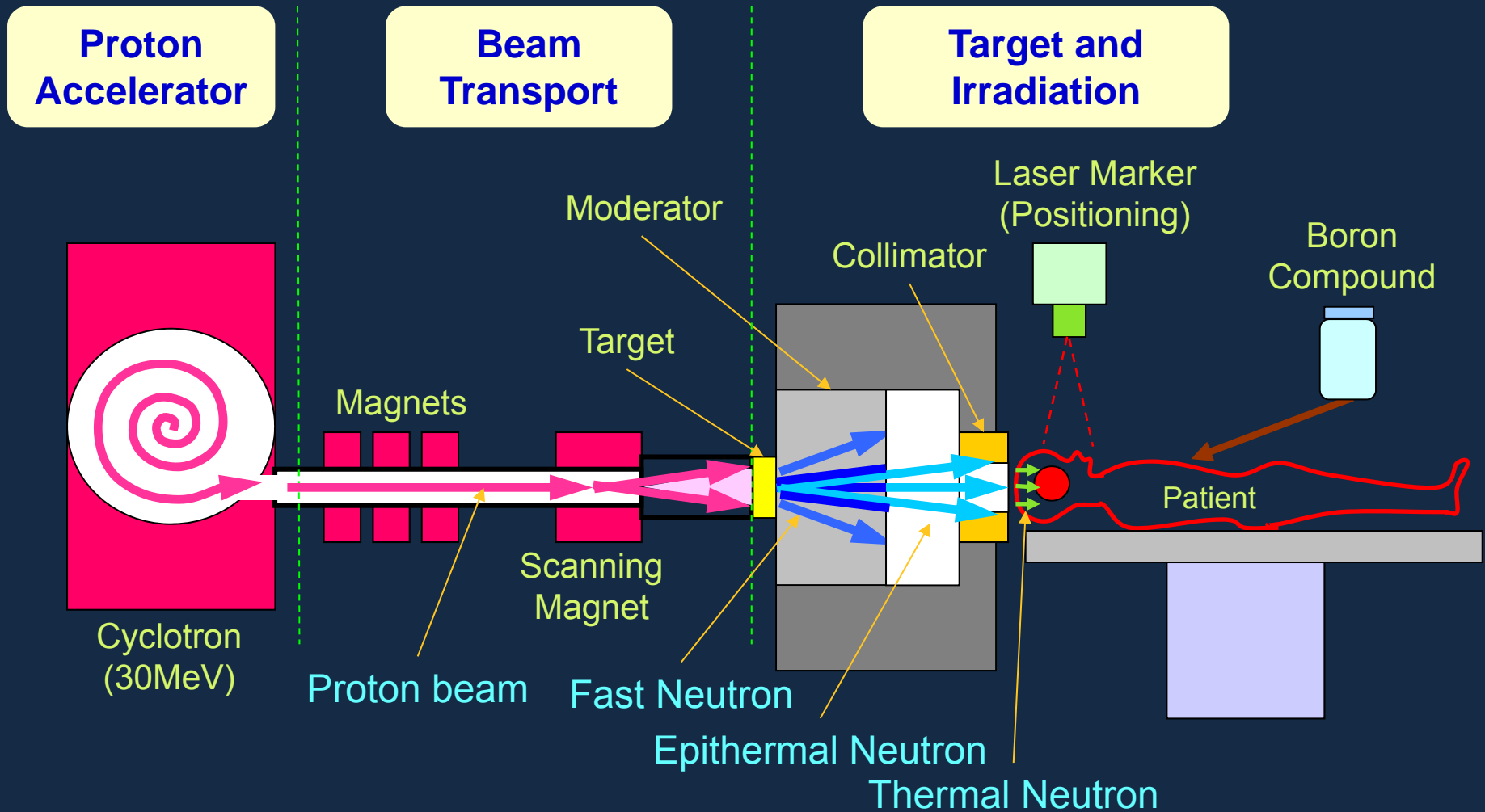
360 deg.
Proton gantry



0/45/90 deg.
Light-ion nozzle



Boron Neutron Capture Therapy (BNCT) System



- Clinical Trial is under way at Kyoto University in Japan.

A scenic landscape featuring Mount Fuji in the background, partially covered in snow. In the foreground, there are several cherry blossom trees in full bloom, with pink and white flowers. Below the trees, a blue lake is visible. The sky is a clear, bright blue with some light clouds. The overall scene is peaceful and beautiful.

Thank you!