

# **Current Status and Future Direction of Proton Beam Therapy**

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# Comparison of status of particle therapy

## - USA vs. Japan -

	<b>Number of Particle Therapy Facilities (2008→2011)</b>	<b>Number of New Patients (2008-2011)</b>
<b>Japan</b>	<b>6 → 8</b>	<b>9,057</b>
<b>USA</b>	<b>6 → 9</b>	<b>16,358</b>

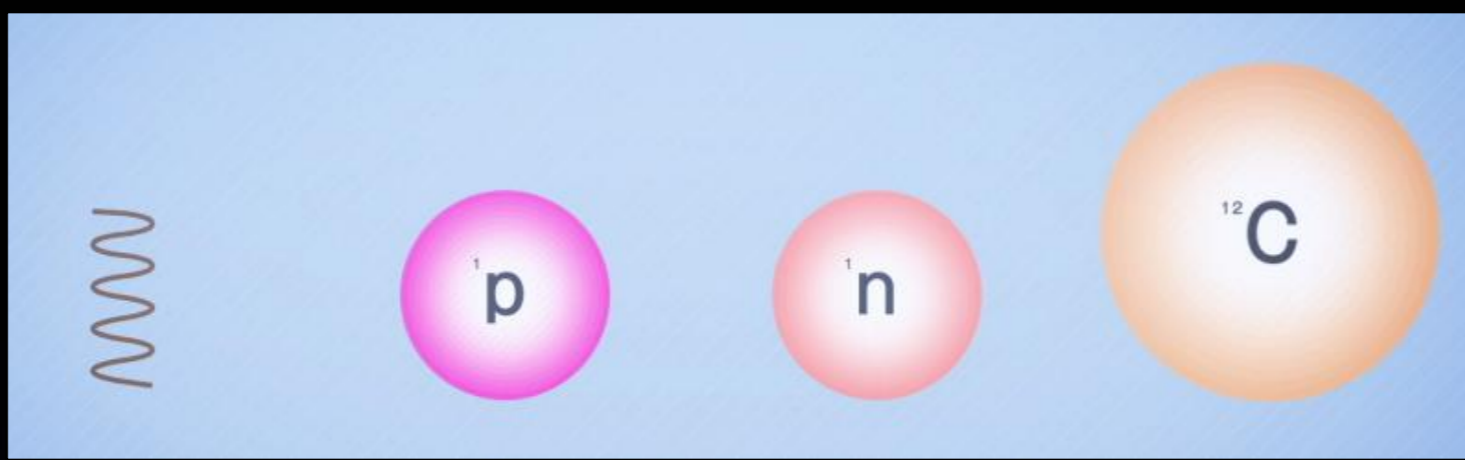
	<b>Number of Radiation Therapy Facilities</b>	<b>Number of New Patients</b>
<b>Japan (2005) ※1</b>	<b>735</b>	<b>162,000 (estimate)</b>
<b>USAA (2004) ※2</b>	<b>2,010</b>	<b>700,000 (estimate)</b>

※1: Data from JASTRO, ※2: Data from ASTRO

# Particle therapy in Japan

Years	No of Institution (Radiation Therapy)	Number of New Patients	No of Institution (Particle Therapy)	Number of New Patients	% of New patients (Particle therapy/All patients)
2003	700	149,793	6	657	0.44
2005	712	156,318	6	1,240	0.79
2007	721	170,229	6	1,643	0.97
2009	726	182,390	7	2,038	1.12

- Radiation therapy is an important treatment modality for curable localized cancer.
- Applicable even to elderly patients who are not suited for surgery and any type of cancer.
  - # Developed countries : 60% of all cancer patient
  - # Japan: 25%→40% (Rapidly increasing)
- Particle therapy is more sophisticated and advanced form of radiation therapy.

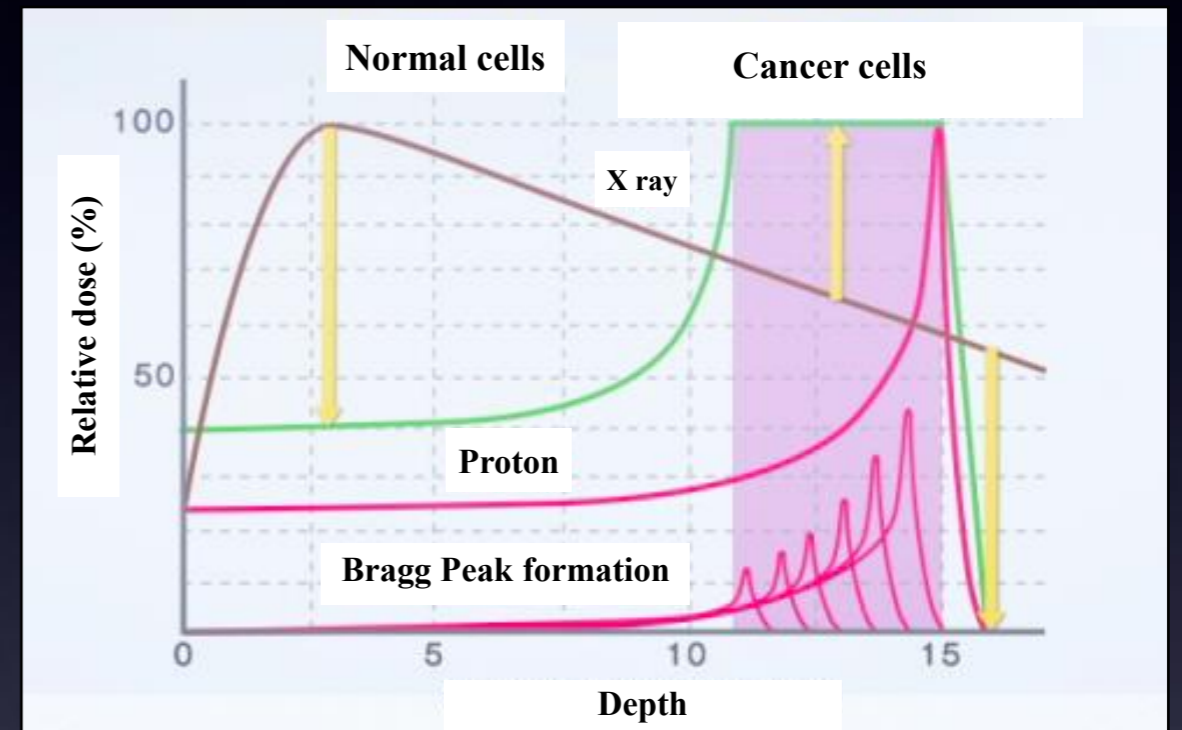
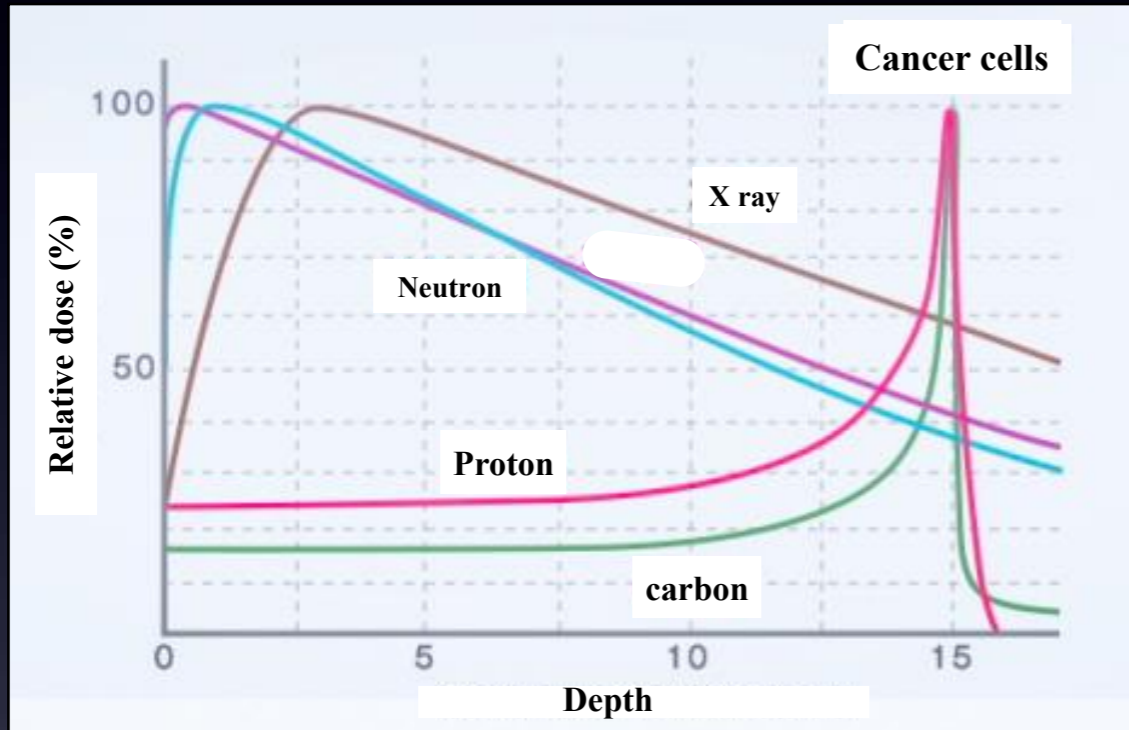


**X-ray**

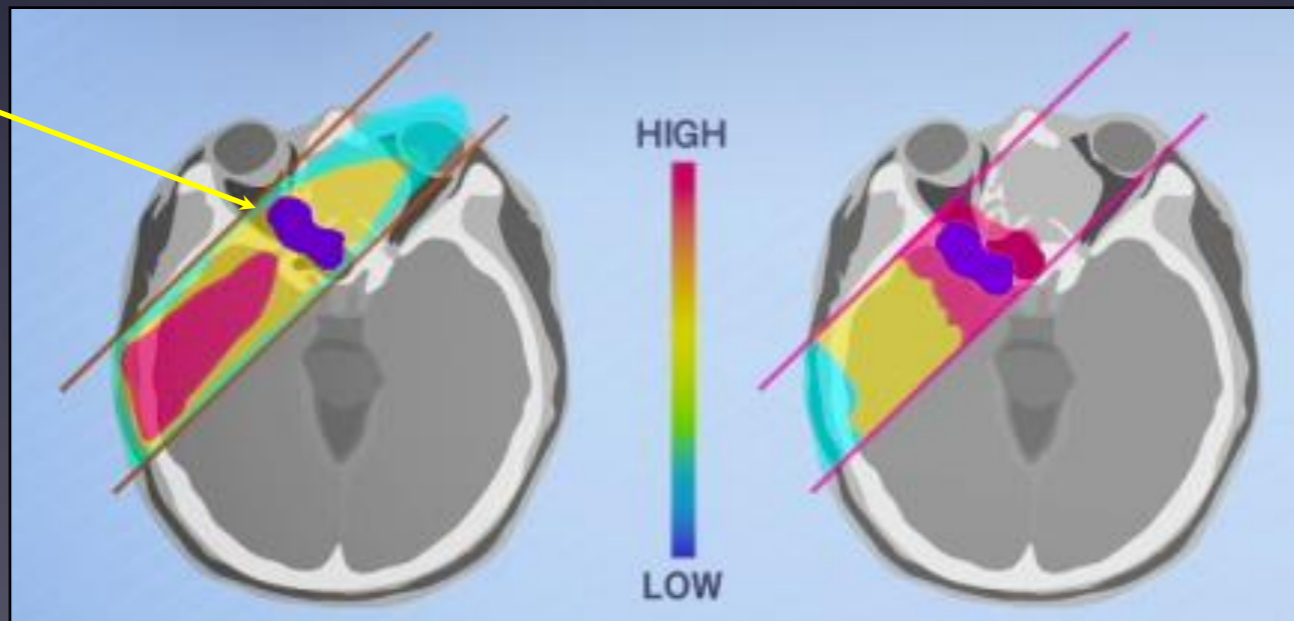
**Proton**

**Neutron**

**Carbon**

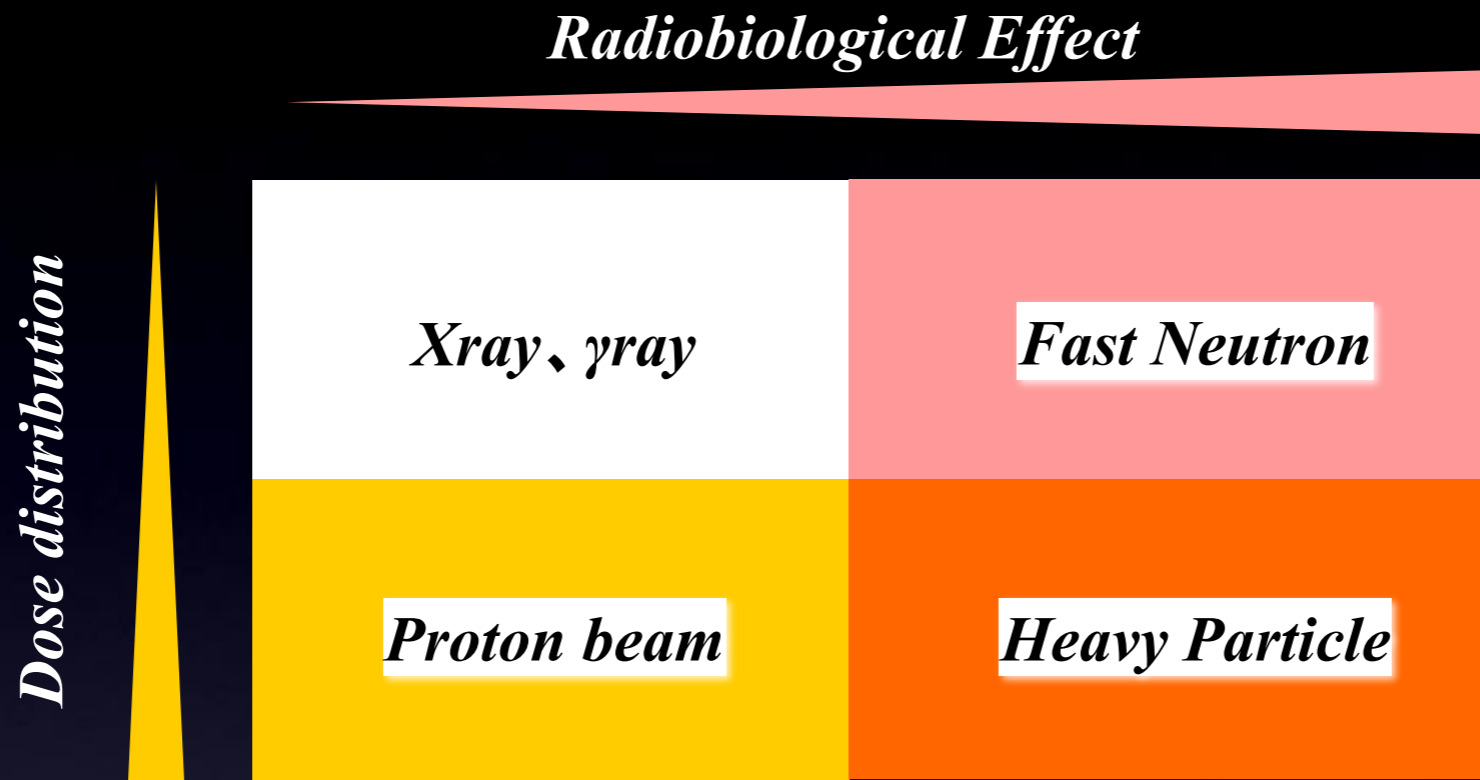


**Tumor**  
**Dose Distribution (Xray)**



**Dose Distribution (Protons)**

# Advantage of proton beam therapy



- Non-invasive and highly confined irradiation tool.
- 📖 Improvement of local control and curability
- 📖 Preserve organ function of treated area, leading to high QOL after treatment
- 📖 Reduction of treatment-related toxicities
- Proton beam therapy can be used as combination form with chemotherapy as well as single modality.
- 📖 It can be applicable for locally advanced cancer
- 📖 Wide indication

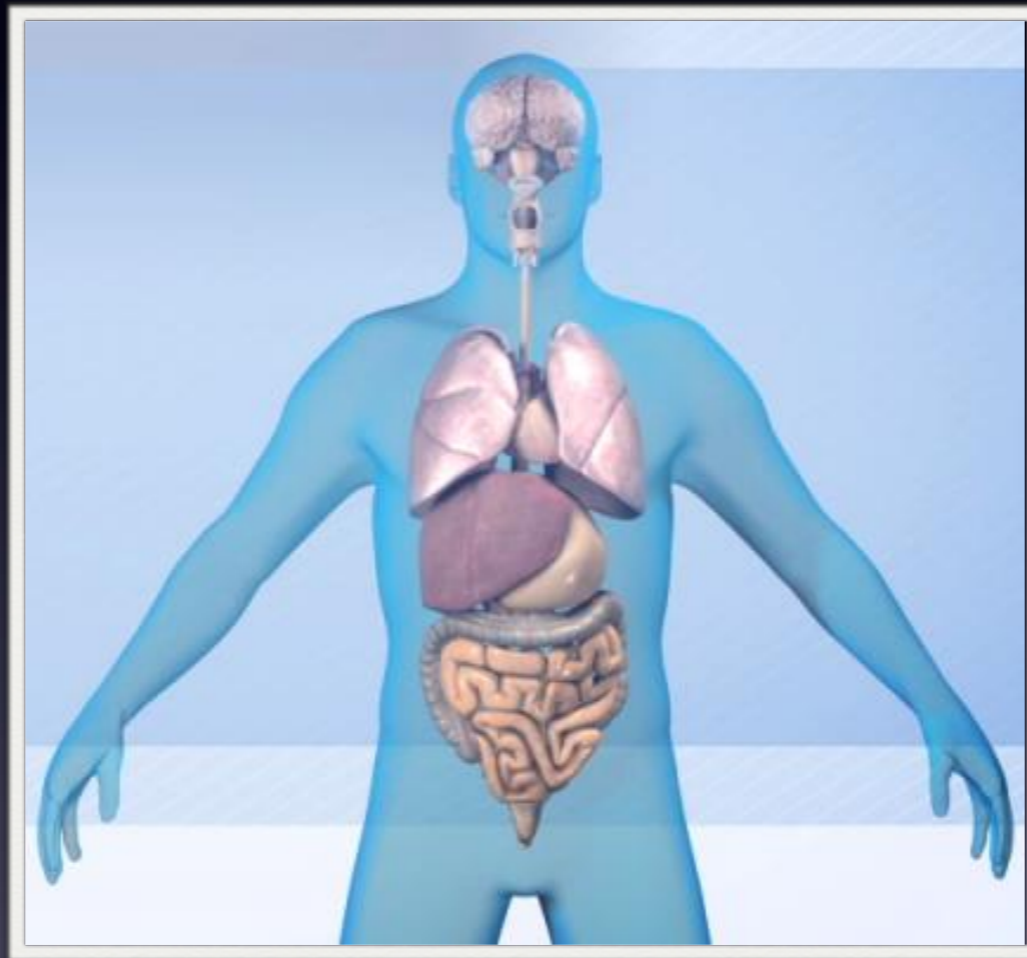
# Indications

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**Brain tumor**  
**Skull base**  
**Head and Neck cancer**

**Lung cancer**  
**Esophageal cancer**  
**Metastatic lung cancer**  
**Mediastinal tumors**

**Bone and Soft tissues**  
**Pediatric tumors**  
**Malignant lymphoma**

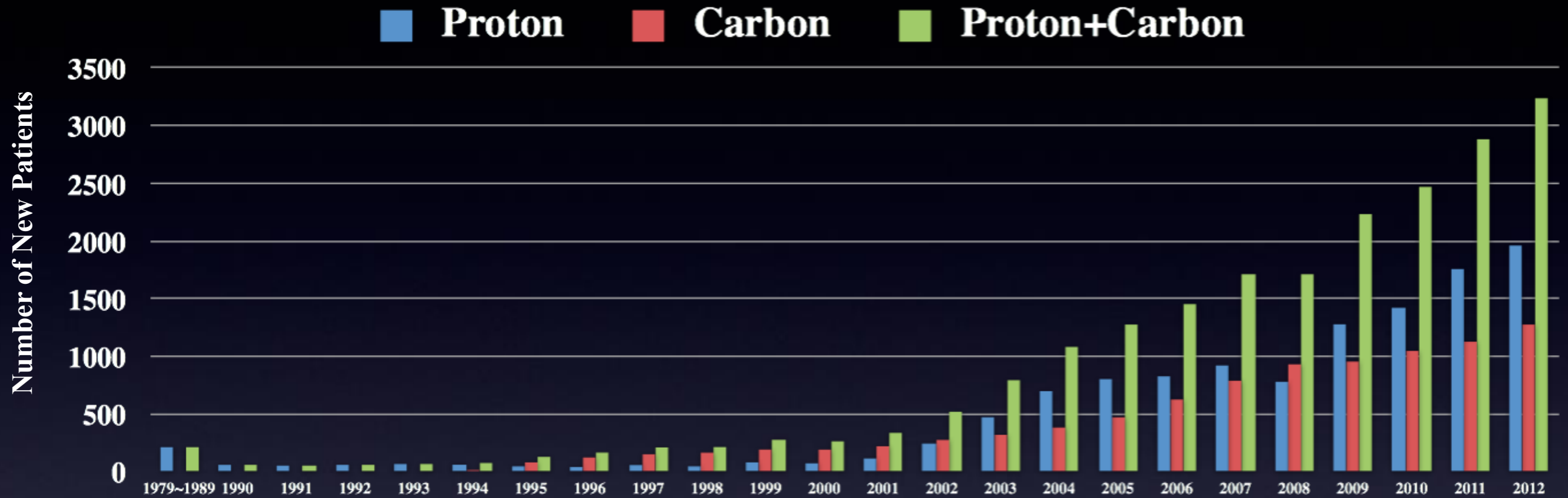


**Hepatocellular cancer**  
**Pancreatic cancer**  
**Metastatic liver cancer**

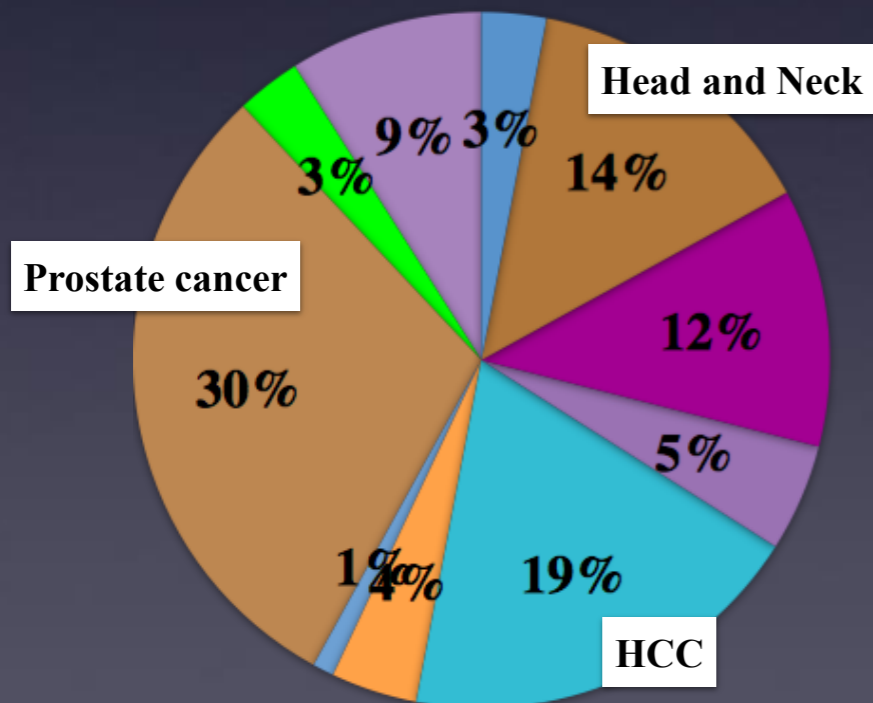
**Prostate cancer**  
**Rectal cancer**  
**Bladder cancer**

# Changes in the Number of Patients teated with particle therapy

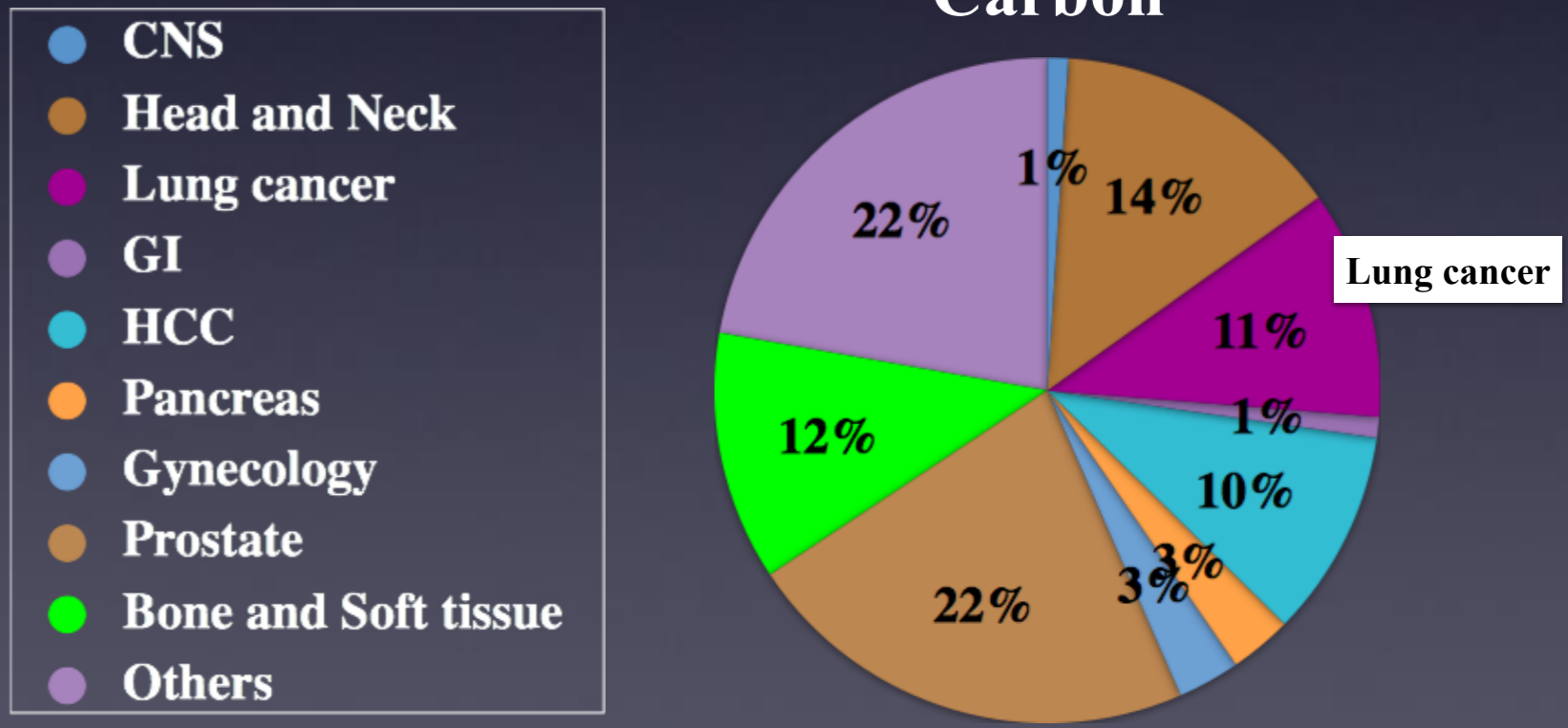
## - 1979 ~ 2012 -



### Proton

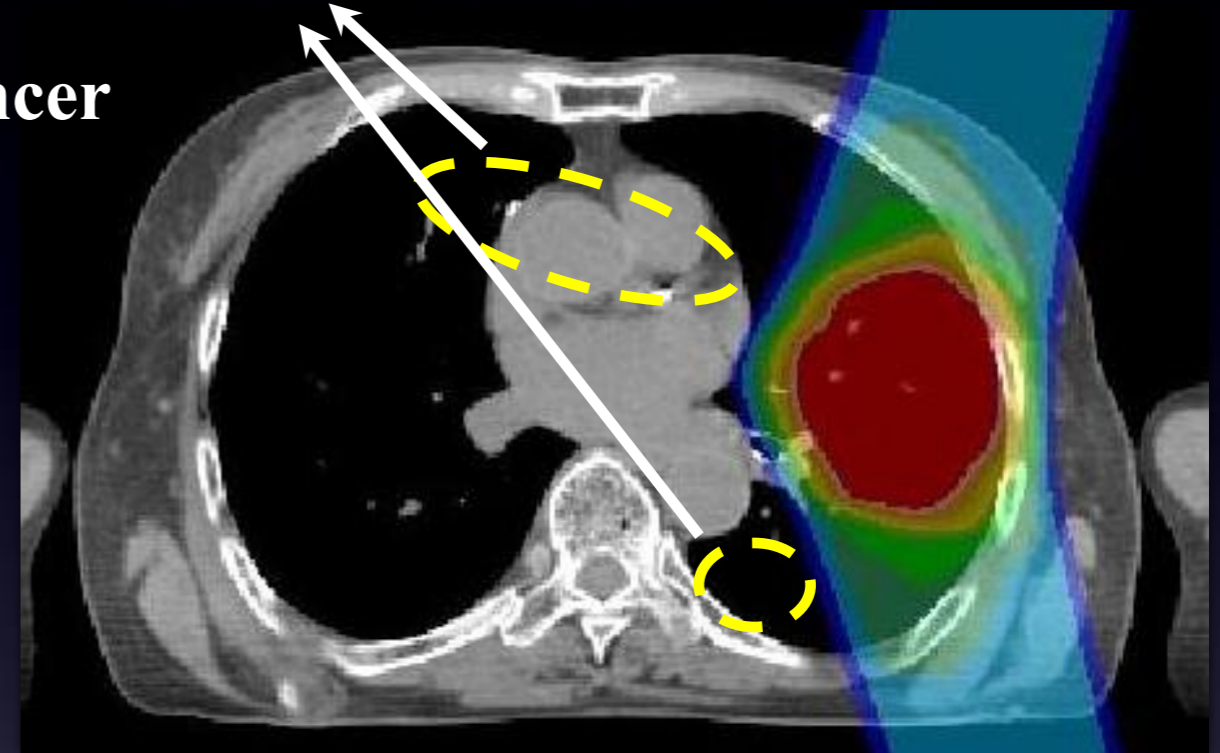
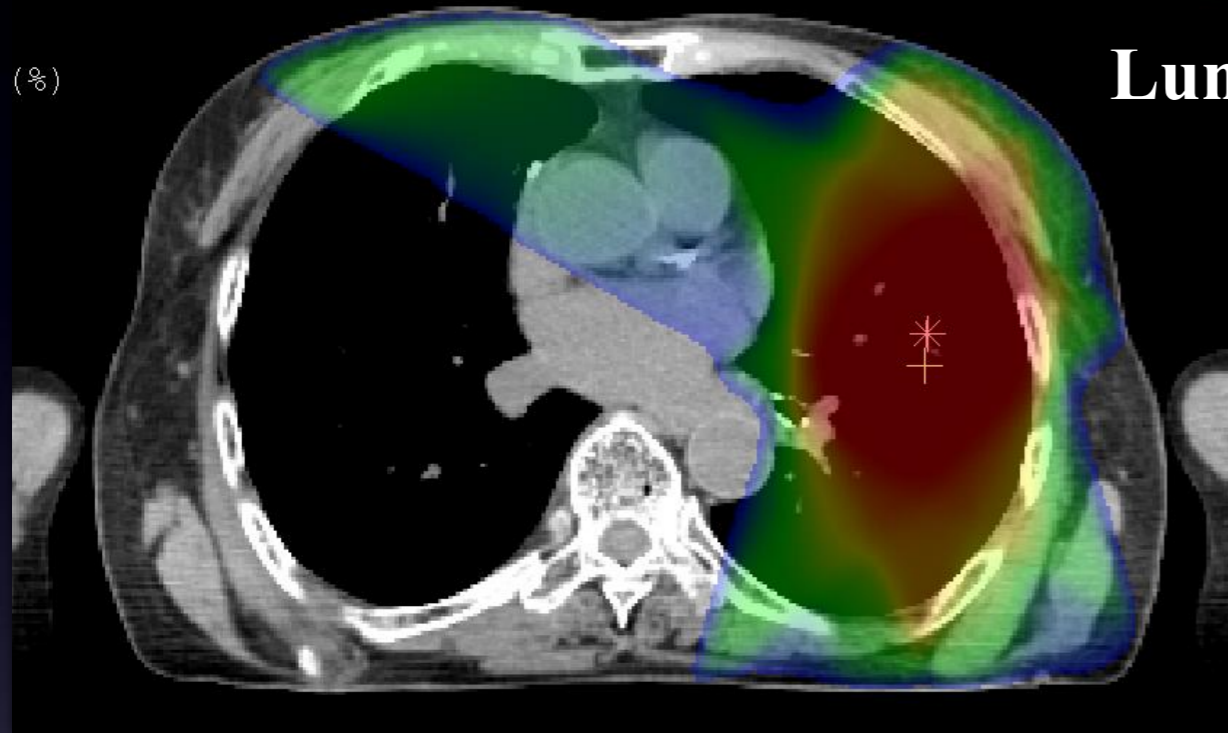


### Carbon



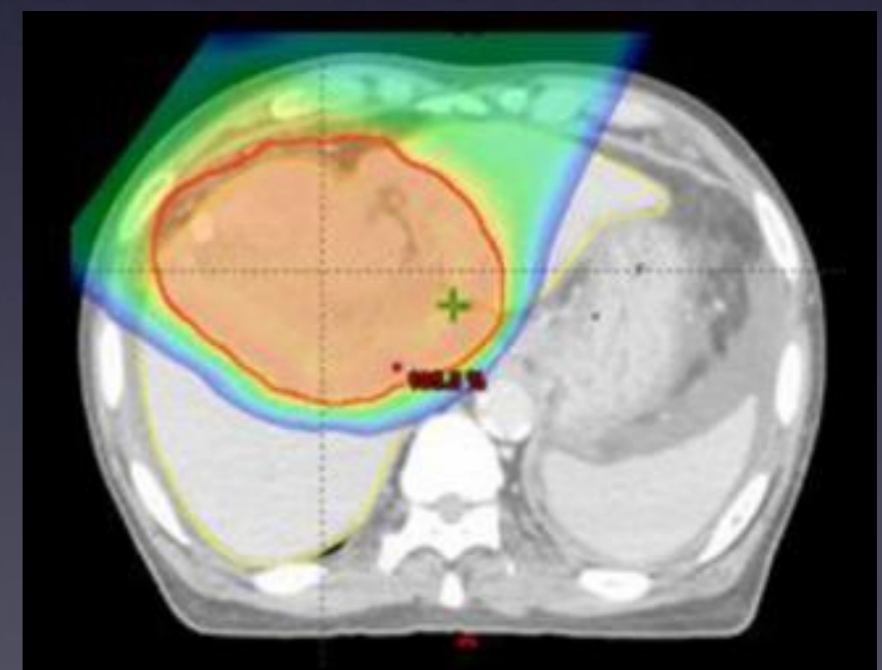
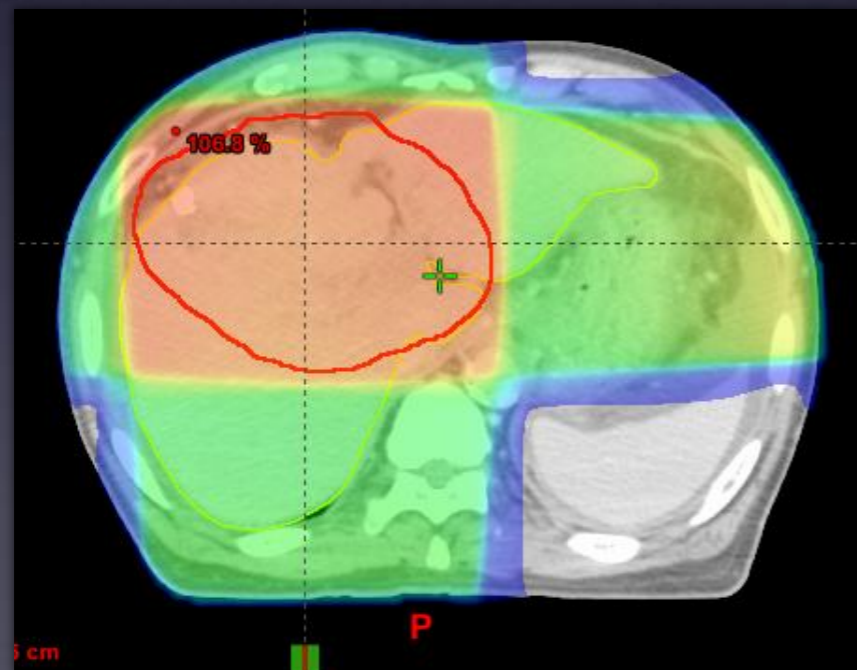
# Comparison of Dose distribution of Proton beam therapy and photon beam

Reduction of excessive dose to normal lungs



Photon

Proton





# Proton beam therapy for Pediatric cancer

## Late treatment-related morbidities

- Bone growth retardation
- Cataract
- Neuro-cognitive dysfunction
- Impairment of endocrine, gonadal function
- Pulmonary fibrosis
- Second malignant neoplasms

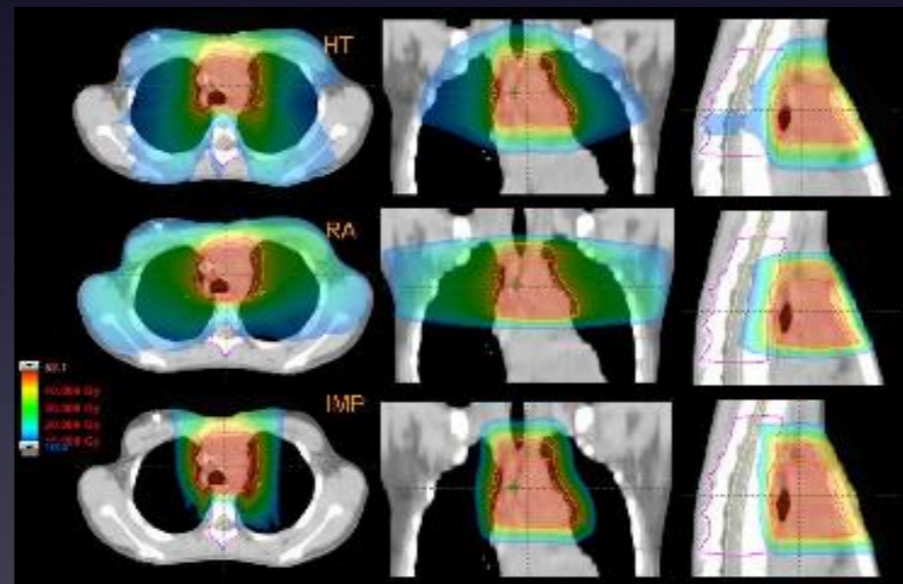
Excessive dose to normal tissues or healthy organs



*Conformal RT*

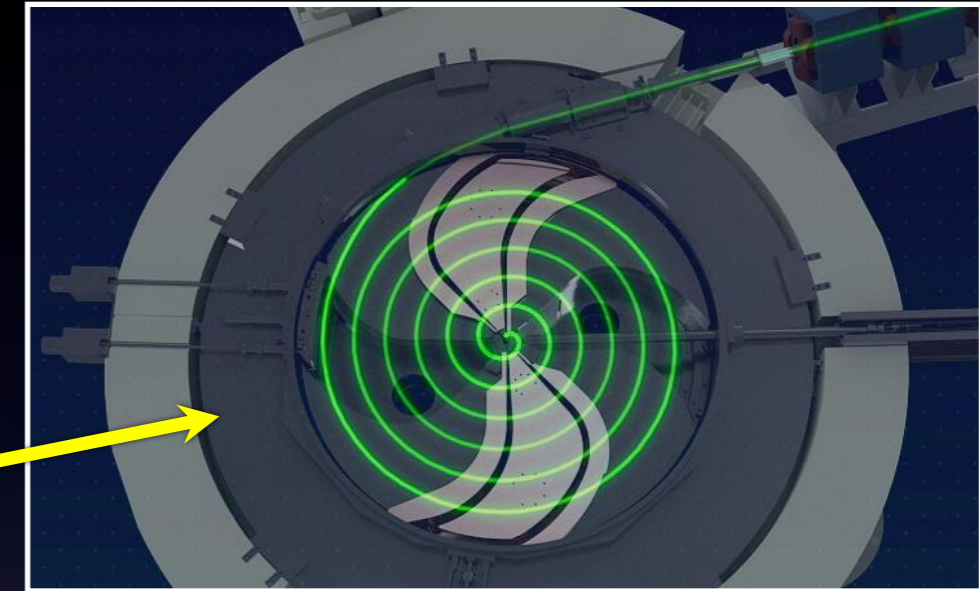
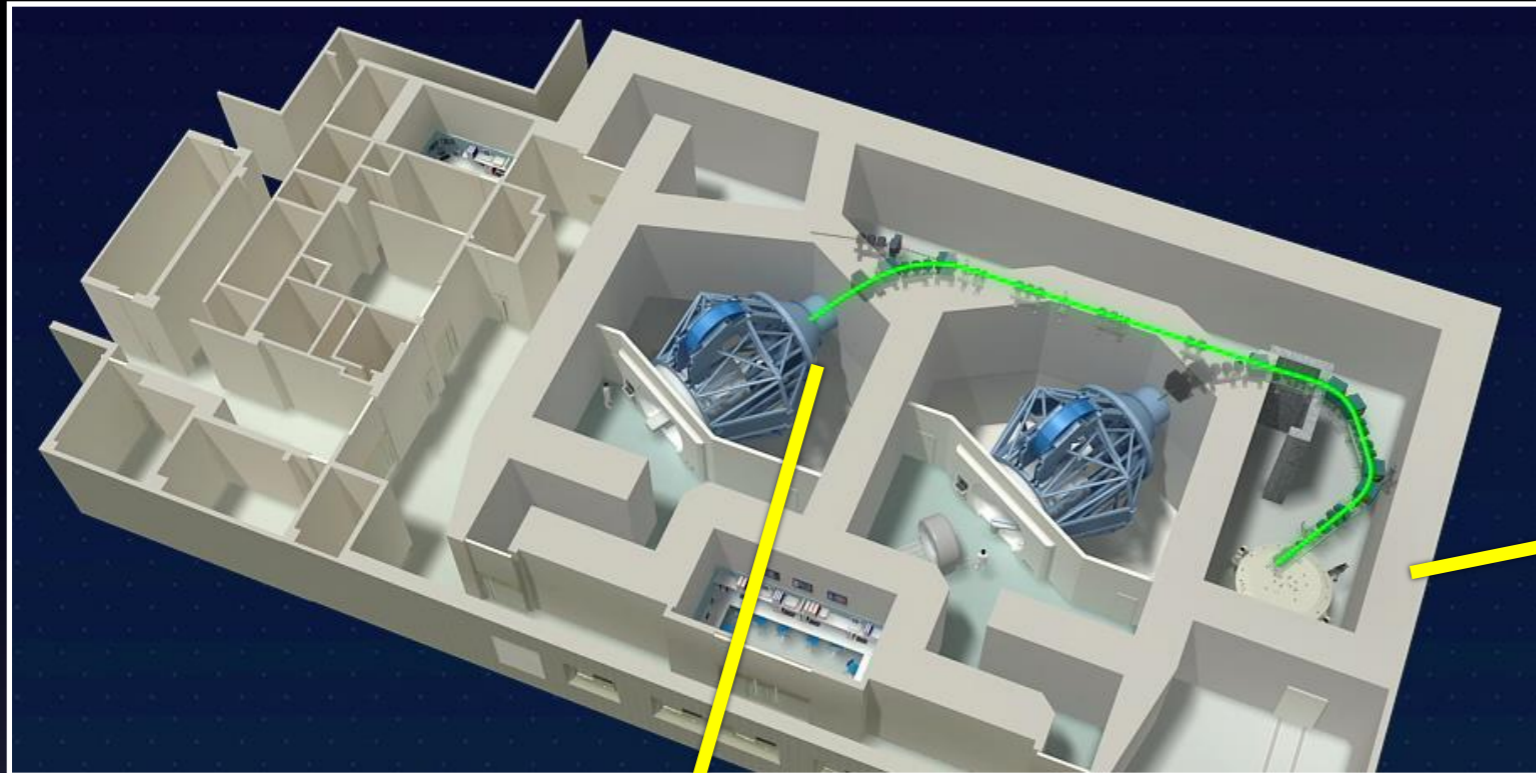
*IMRT*

*Proton*

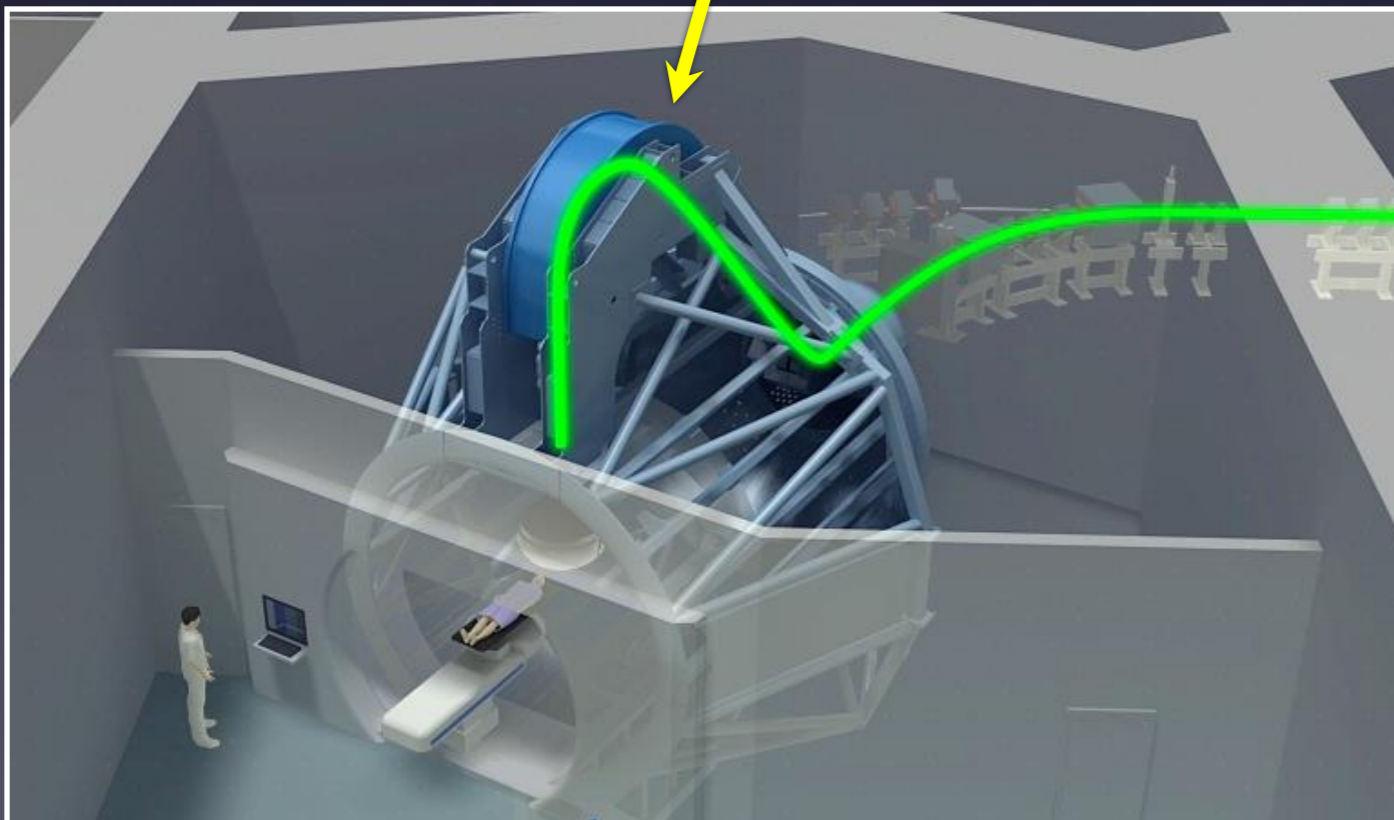


Proton beam therapy has a positive impact on reduction of occurrence of long-term treatment-related morbidities compared with photon RT through reduction of dose to normal tissues.

# Proton therapy facility in National Cancer Center Hospital East

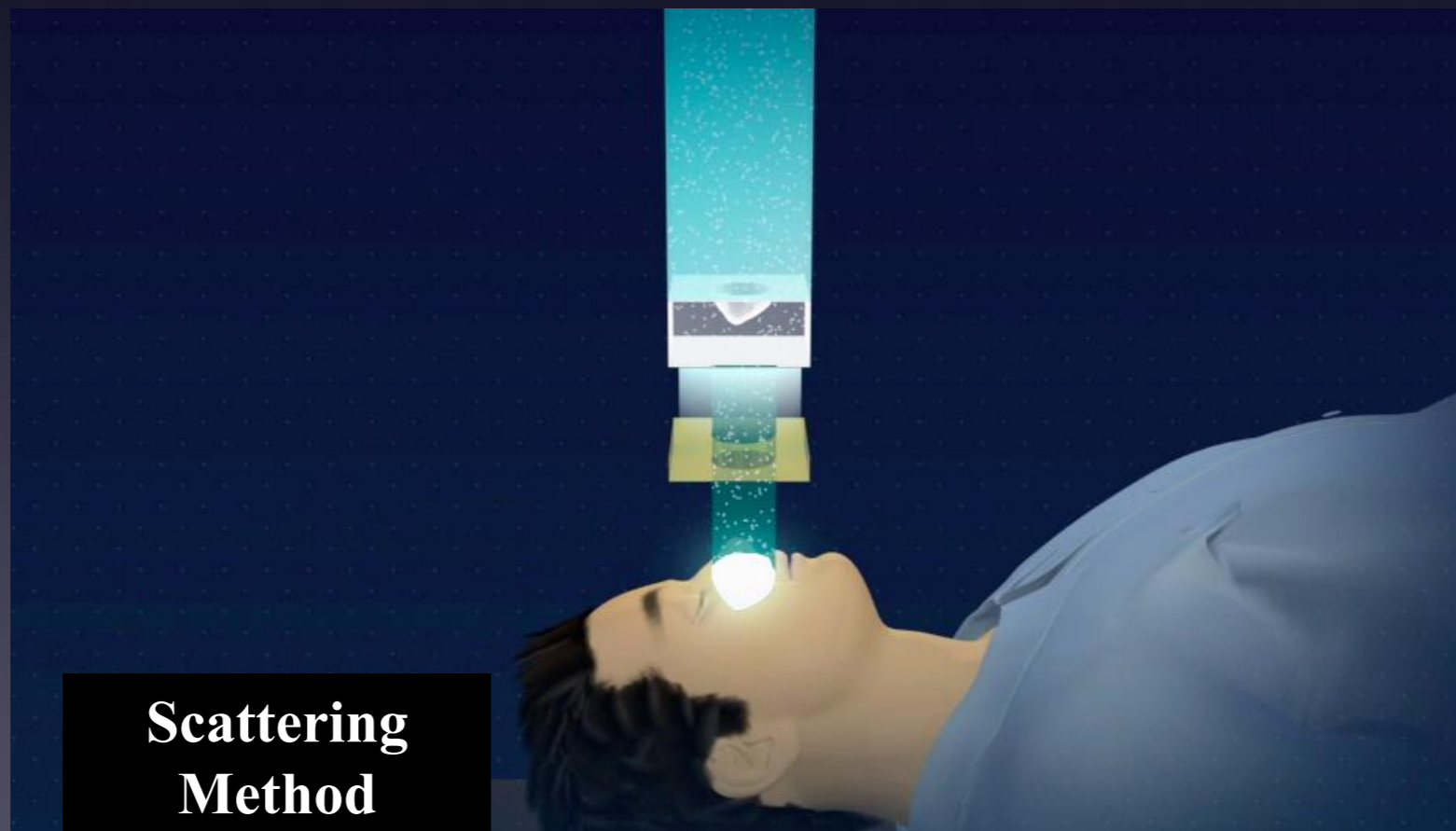
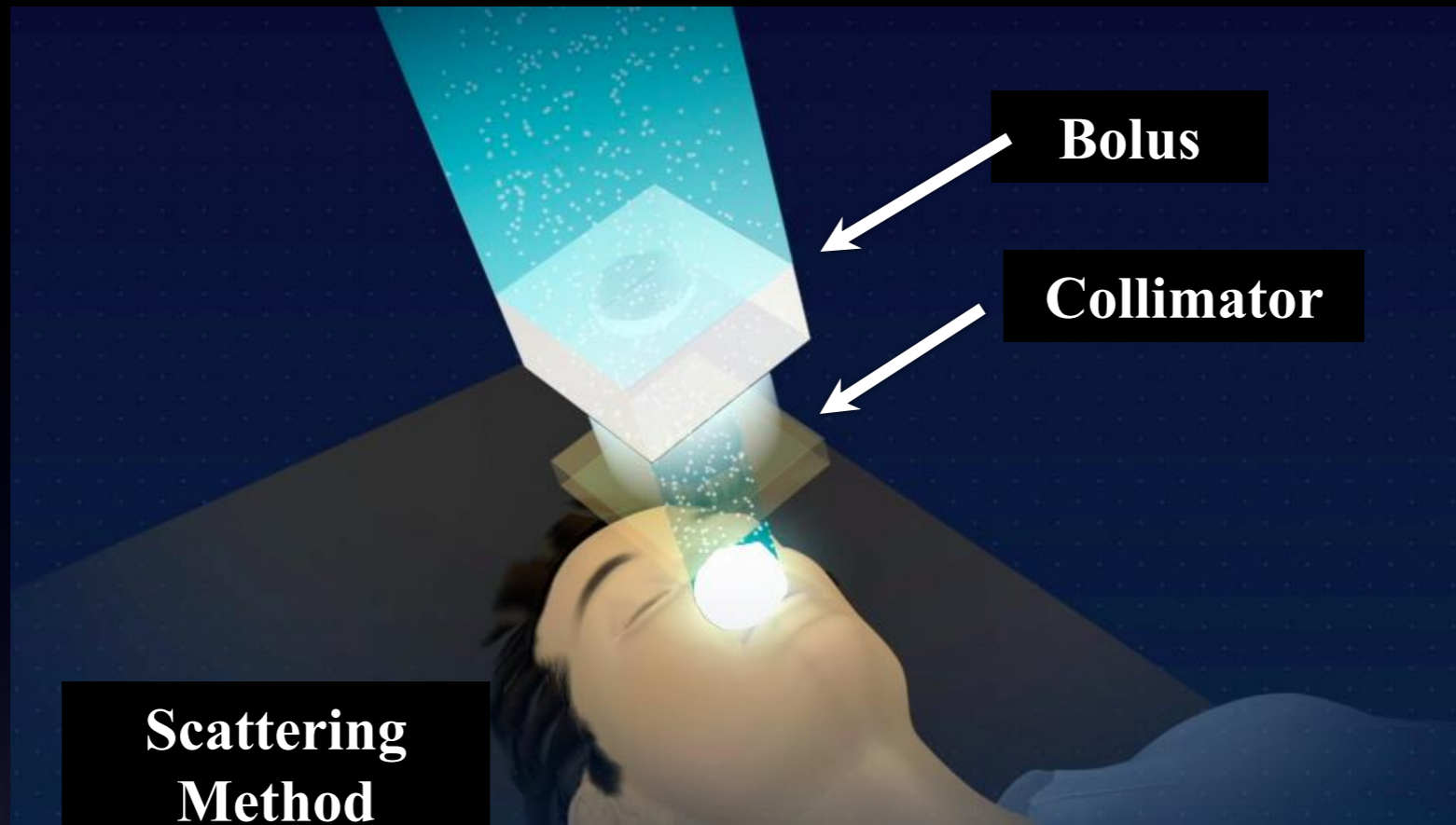


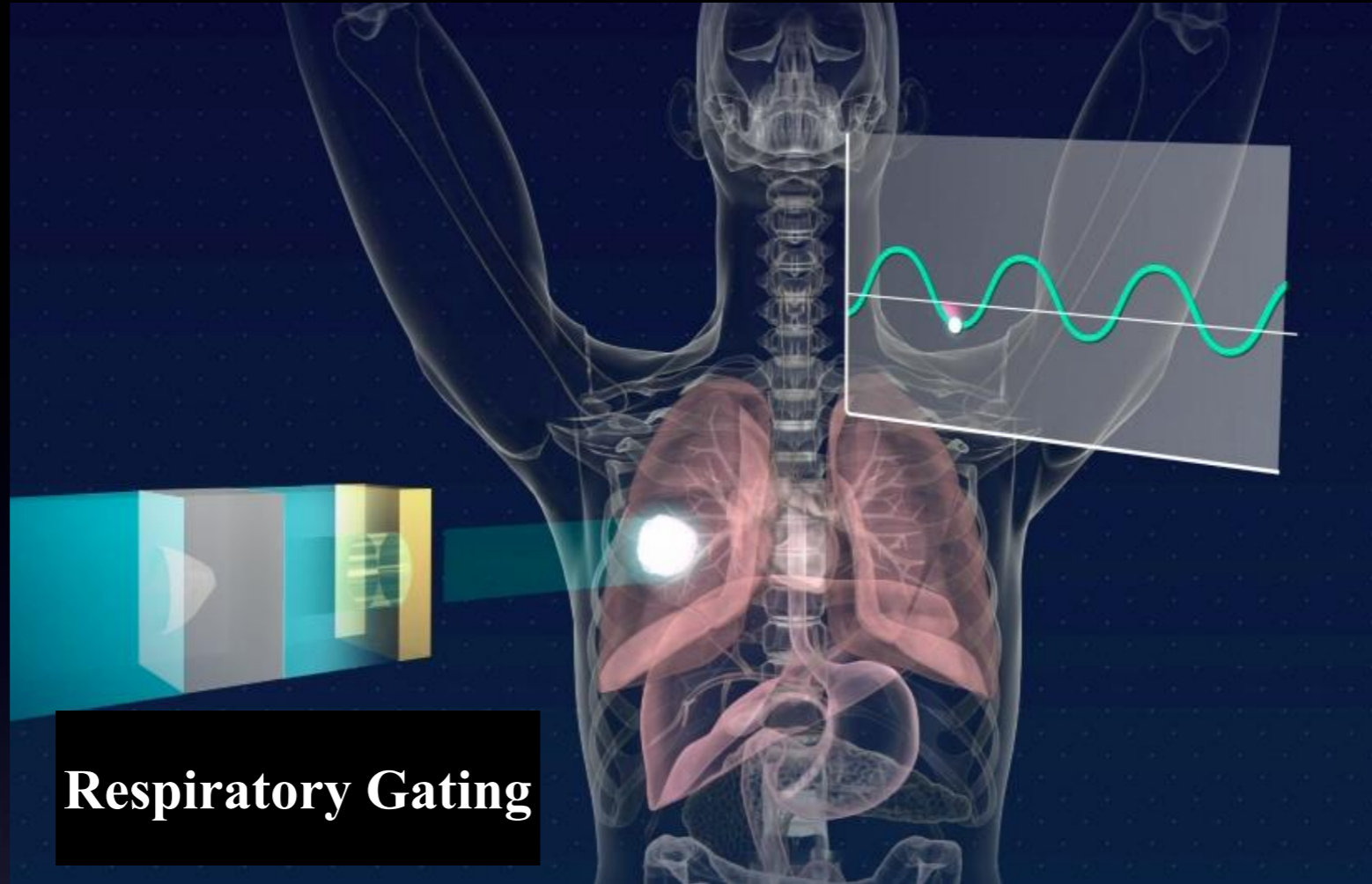
**Cyclotron**



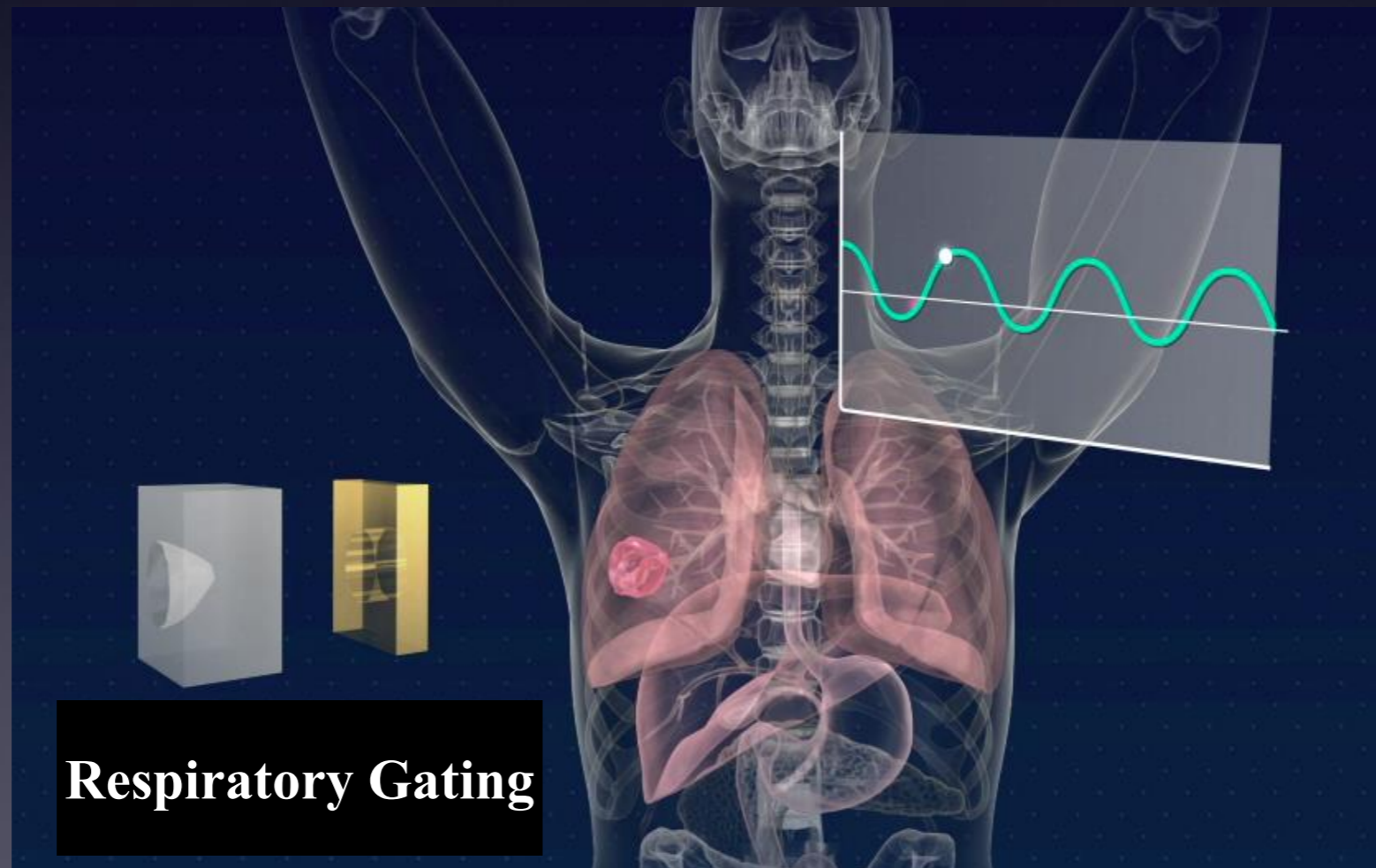
- **Contracted with the Sumitomo heavy Industry in 1996**
- **Clinical treatment was started in 1998**
- **2nd hospital-based proton therapy facility in the world**

**# the 1st hospital-based proton therapy facility was opened at Loma Linda Medical Center in 1990**



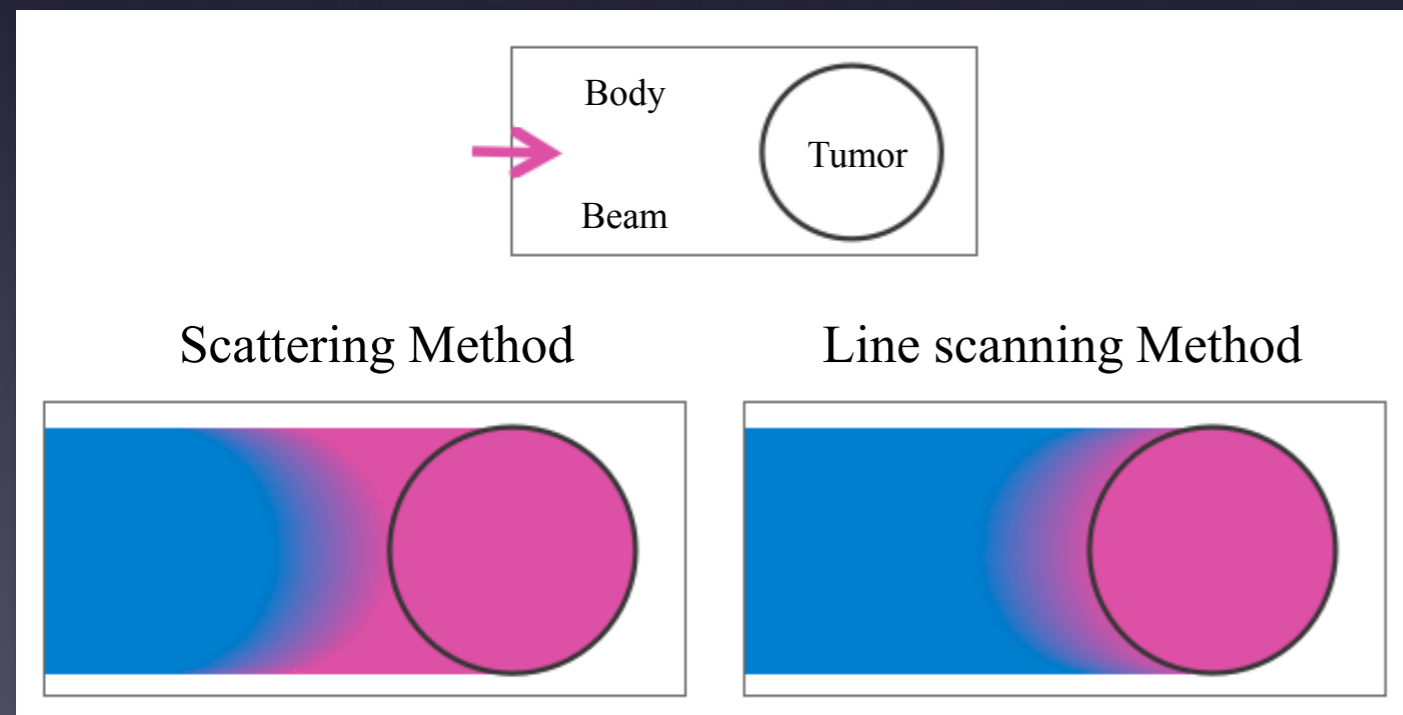
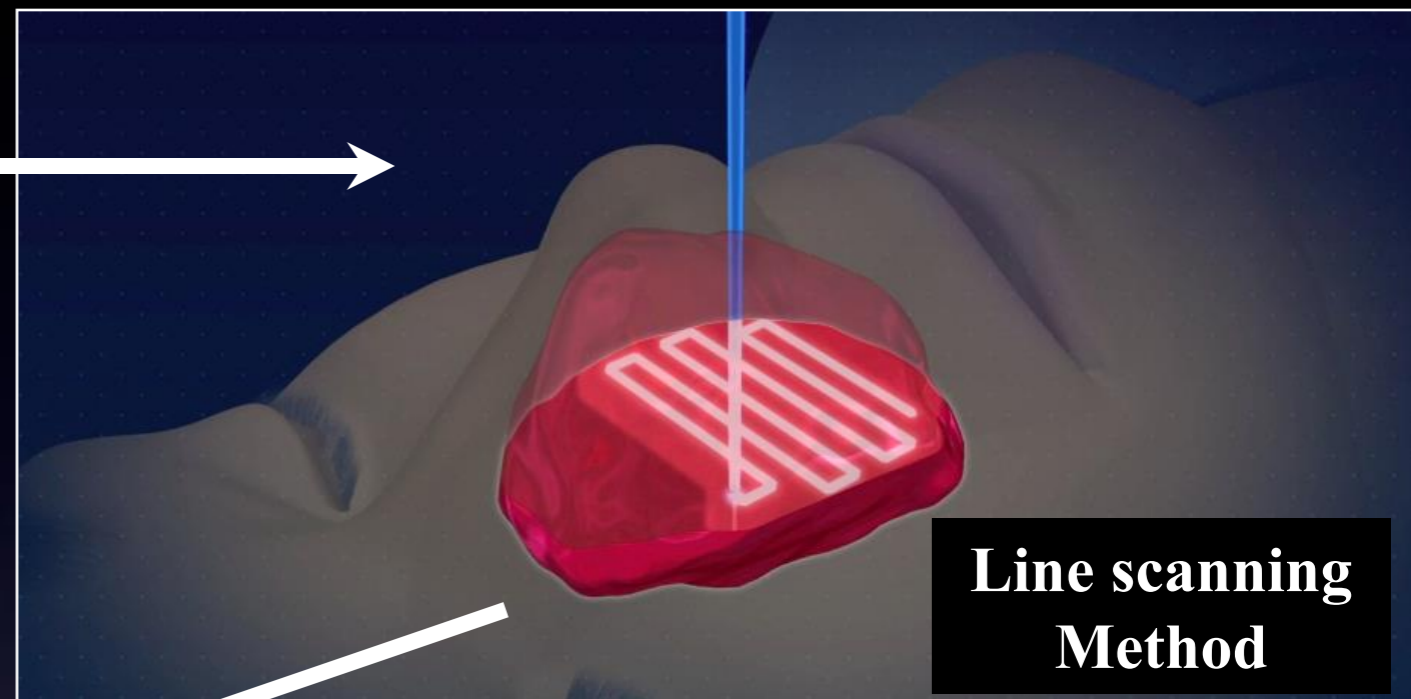


**Respiratory Gating**

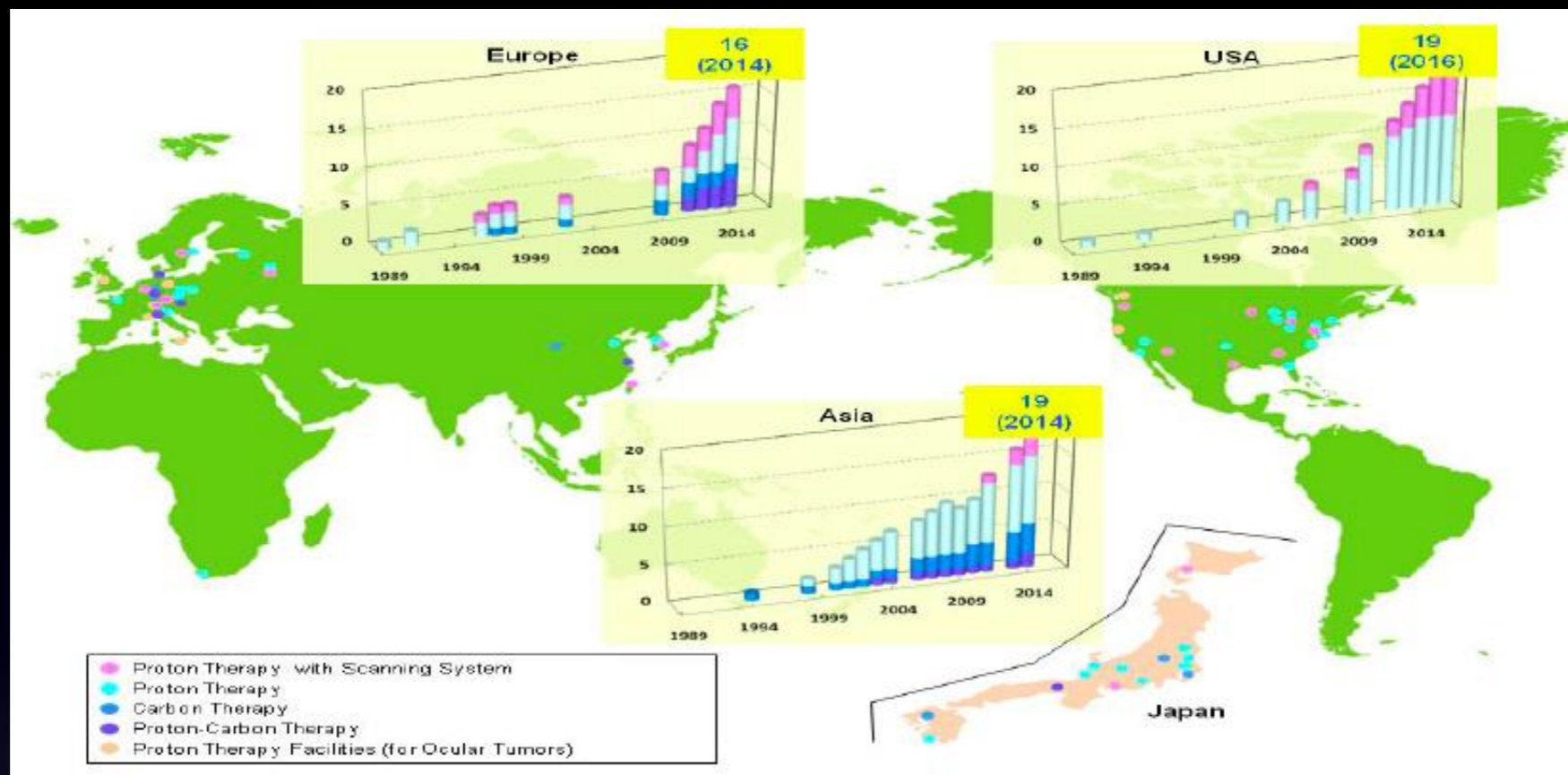


**Respiratory Gating**

# Line Scanning



- Pencil beam scanning offers the best flexibility for shaping the dose distribution
- Improvement of dose conformality compared with scattering method
- Intensity modulation are possible



- **High precision technology overcoming current drawbacks of radiation therapy.**
- 📖 **World-leading innovative technologies and clinical experience in Japan**
- 📖 **Compact treatment system → Improve cost effectiveness**
- **Establishment of effectiveness of proton beam therapy enables us to realized effective solution for cancer treatment in aging society.**
- **Continuous development of cutting edge technology of particle therapy would result in improve the role of Japan in the international particle radiotherapy community and encouraging Japanese radiotherapy equipment industries.**