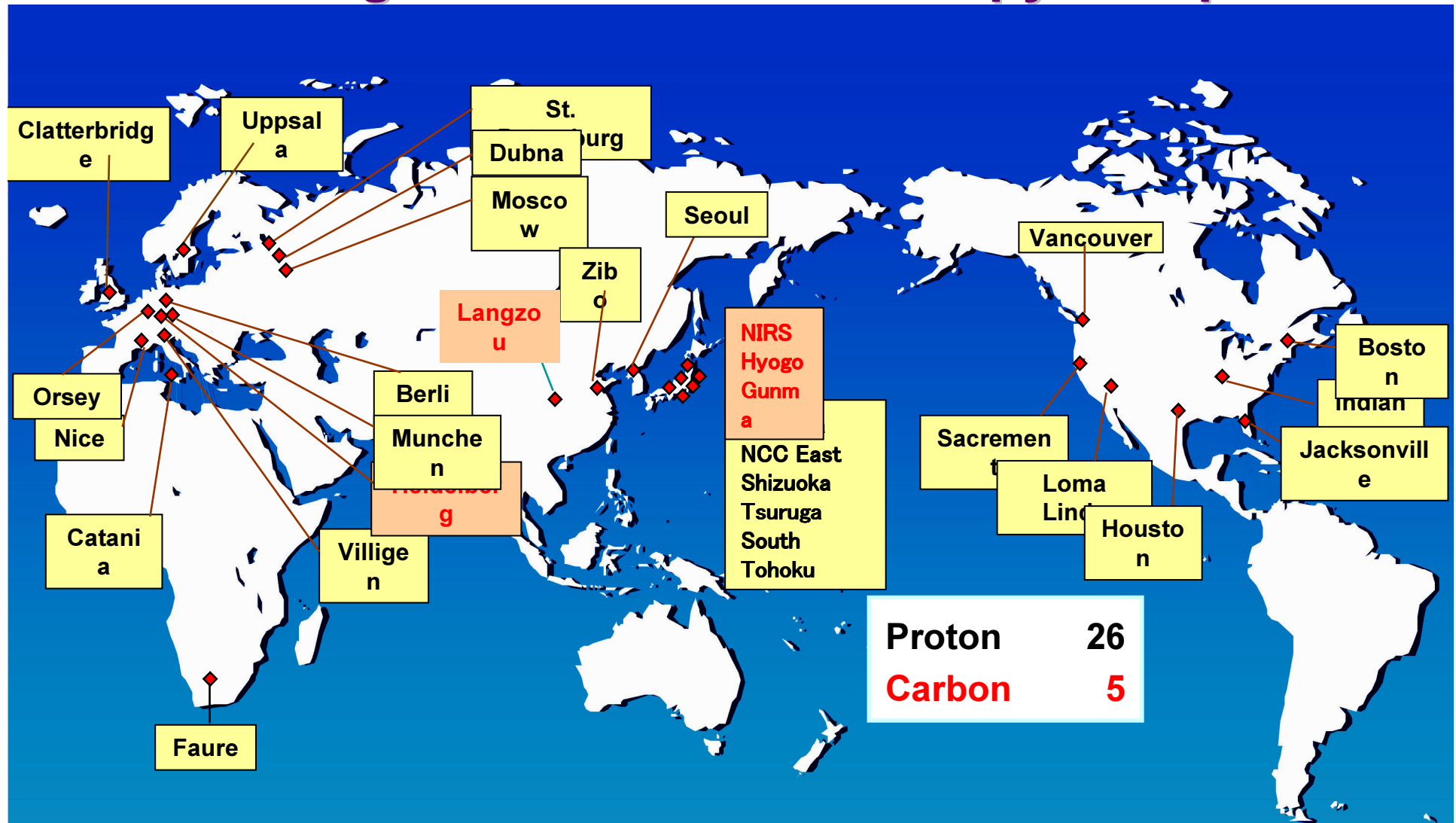


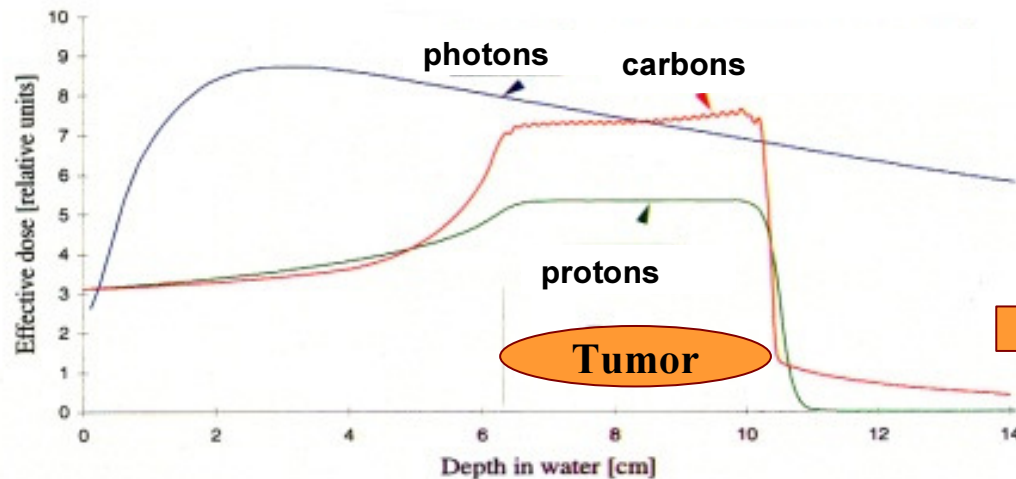
# Current Status and Perspective of Charged Particle Radiotherapy in Japan



- 3 out of 5 operating carbon therapy facilities are in Japan.
- 2 more facilities will be constructed in the near future.

# Characteristics of Charged Particles in Radiotherapy

Depth dose profiles of photon, proton and carbon beams



Dose concentration;

Photon  $\ll$  Proton  $<$  Carbon

Biological effect;

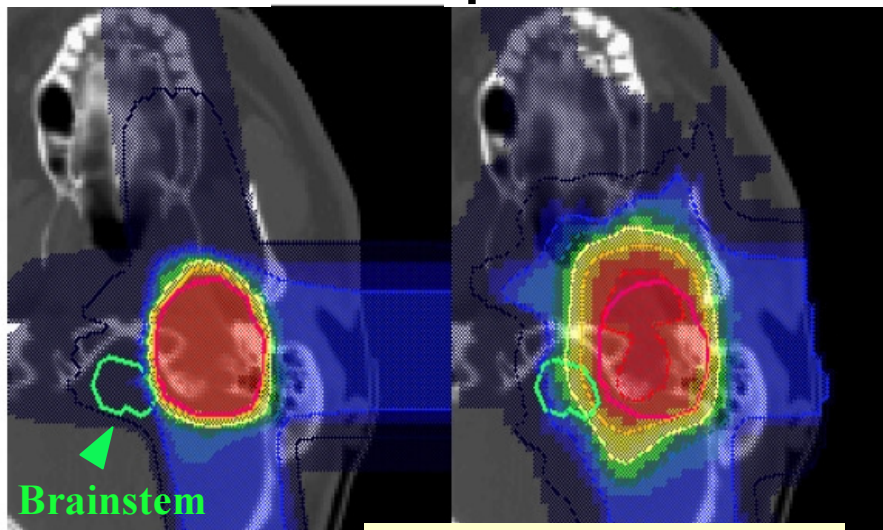
Photon = Proton  $<$  Carbon

◆ Bragg Peak of charged particle beam can offer excellent concentration of dose.

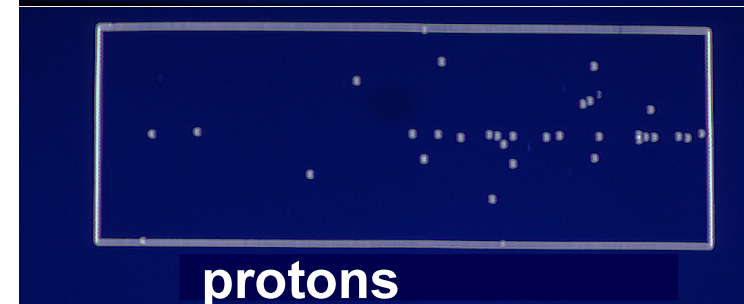
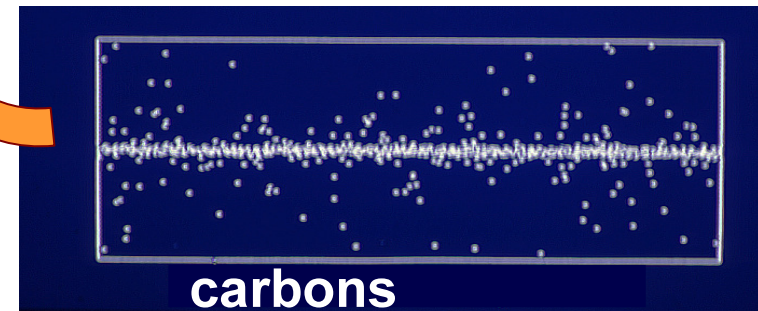
◆ Dense ionization of carbon beam can provide higher efficacy against cancer.

carbons

protons



Case with skullbase tumor



# Indications (Carbon-ion RT)

Definite indications (difficult to cure by other means)

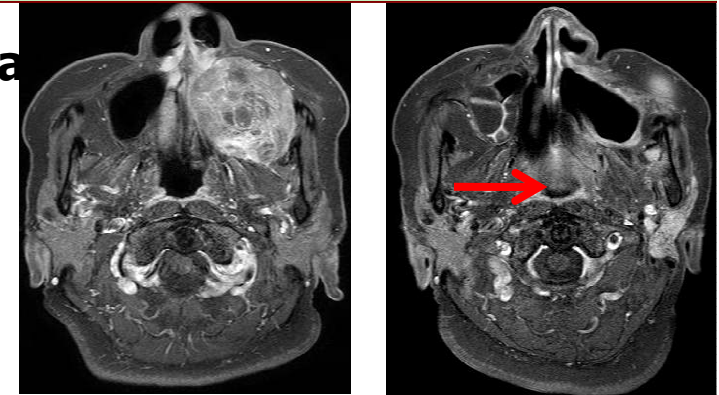
Advanced non-SCC head and neck cancer

Inoperable bone/soft tissue sarcoma

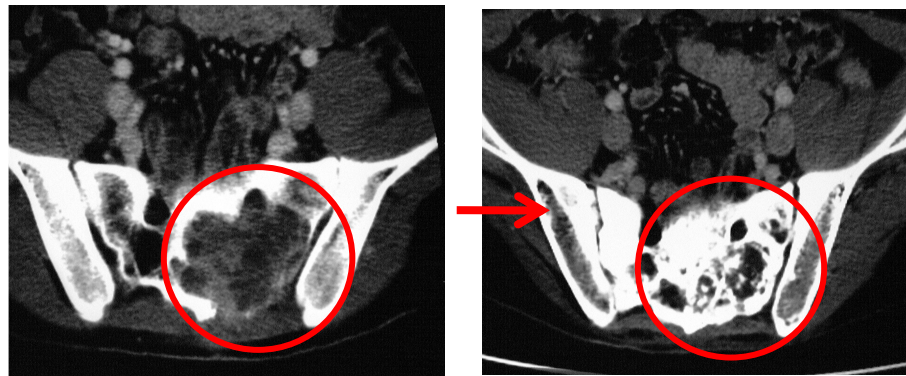
Postoperative recurrence of rectal cancer

Slow growing tumor

## Malignant Melanoma of Maxillary sinus



## Osteosarcoma of Sacrum



## 5-year Survival in Osteosarcoma

Institute	No. pts	Overall	Operable	Inoperable
MSKCC (USA)	40	34 %	41%	10 %
NCBT (Netherland)	40	21 %	26%	-
ROH (England)	36	18 %	41%	0%
COSS (Germany etc)	89	27-30 %	34-40%	0%
<b>NIRS (Carbon-ion)</b>	<b>33</b>	<b>42 %</b>	<b>-</b>	<b>42 %</b>

## Outcomes in Sacral Chordoma

Institute	Treatment	No. pts	Local Control	5-year Survival	10-year Survival
SUH (Sweden)	Surgery	39	44 %	84 %	64 %
MGH (USA)	Surgery + Proton	27	72 %	82 %	62 %
LBLN (USA)	Surgery + Helium	14	55 %	85 %	22 %
Mayo (USA)	Surgery	52	56 %	74 %	52 %
<b>NIRS</b>	<b>Carbon RT alone</b>	<b>123</b>	<b>89 %</b>	<b>87 %</b>	<b>74 % (8 year)</b>

**Highly effective,  
without severe  
toxicity**



# Indications (Carbon-ion RT)

## Elective indications (better or promising outcomes in common cancer)

Lung cancer

Prostate cancer

Hepatoma

Choroidal melanoma

Skull base tumors

Promising results could obtain also in cancer of uterus, pancreas, kidney, and many others.

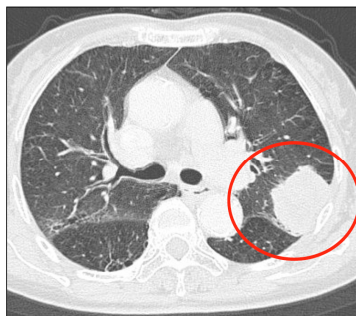
Better survival and less toxicity by short course treatment was achieved!

### Outcomes in Prostate Cancer

Treatment	Risk Group (Group 2; Intermediate, 3; High, 4; Very high)					
	Group 2		Group 3		Group 4	
	No.pts	5-y survival	No.pts	5-y survival	No.pts	5-y survival
Radiotherapy (X-ray) alone	443	82%	338	68%	324	52%
Radiotherapy + HT	114	76%	138	79%	103	63%
<b>Carbon-ion therapy + HT</b>	<b>345</b>	<b>99%</b>	<b>295</b>	<b>93%</b>	<b>136</b>	<b>86%</b>

Treatment, Institute	Toxicity (≥ Grade 2)			
	Fractions	No. pts	Rectum	GU
Conventional X-ray, MD Anderson	33-43	189	14.8%	8.5%
3DCRT, Fox Chase	38	232	11.0%	7.0%
IMRT, Cleveland	28	770	4.4%	5.2%
Proton, Loma Linda	39	901	3.5%	5.4%
<b>Carbon, NIRS</b>	<b>16</b>	<b>272</b>	<b>0.7%</b>	<b>2.6%</b>

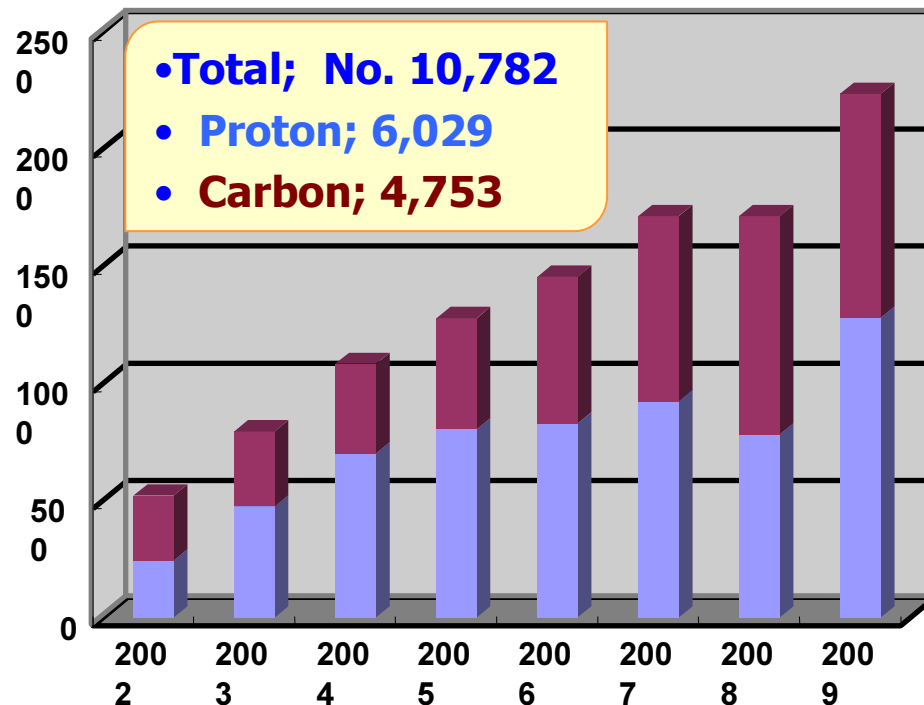
### Single fraction Treatment in Lung Cancer



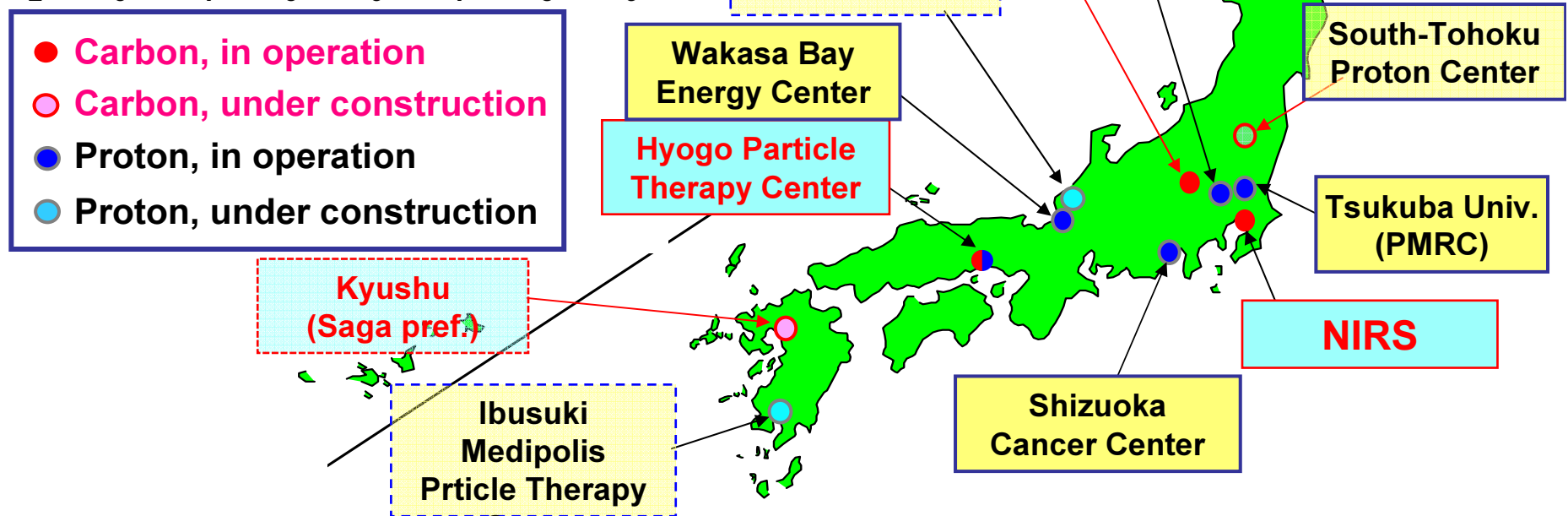
### Outcomes in Lung Cancer

Treatment, Institute		No. pts	Local Control	5-year Survival
Conventional X-ray		149	56 %	22 %
Stereotactic RT		245	86 %	47 %
Proton	Tsukuba	28	57 %	30 %
<b>Carbon</b>	<b>NIRS</b>	<b>129</b>	<b>92 %</b>	<b>42 %</b>
Surgery	Japan	4,264	-	60 %

# Increase in Numbers of Patients and Facilities in Japan



- Numbers of facilities and patients have increased year by year because of excellent outcomes at operating institutes.
- More than 10,000 patients underwent charged particle radiotherapy in Japan, for 8 years.

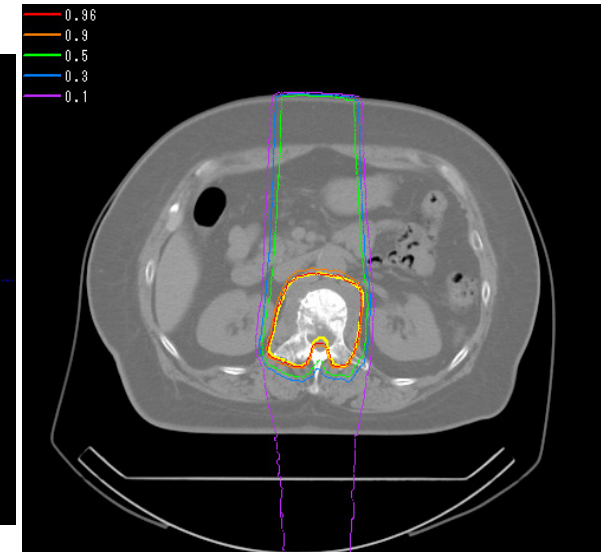
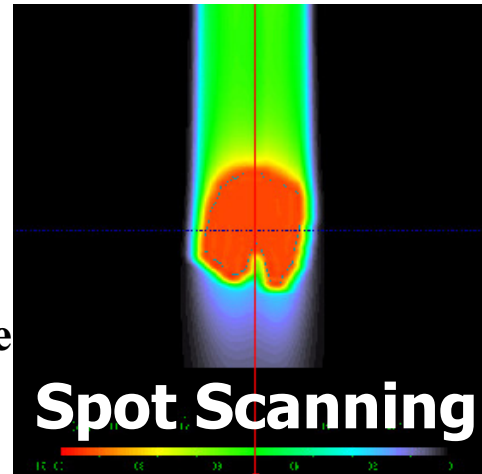


# Further Development

Even better results in the future can be expected!!

- A new facility for **fast 3D hybrid-raster scanning** will be available.
- Very high concentration of dose by scanning irradiation will be realized even for mobile target.
- A compact rotating gantry will be installed in the near future.

## •Example of dose distribution with spot scanning



## A new facility



## •Designed Compact Rotating Gantry

