

Partical Therapy in Shanghai

Zhen Zhang MD

Shanghai Cancer Center, Fudan University

Shanghai Proton and Heavy Ion Center

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- Milestone of project and system introduction
- Registration IONTRIAL
- Particle therapy and preliminary results
- Current practice and future development



- 1998 - SPHIC project initiated
- 2005 - License from the Ministry of health, China
- 2009 - Ground break
- 2012 - System installation, acceptance testing and commissioning
- 2014 - trial registration
- 2015 - Approval from CFDA

Total Project Investment: \$450 million





- Occupy 60,030 sq.m.
- In-patient service: 220-bed
- Proton & heavy ion Therapy
- Conventional Therapy
- Future planning: 40,020 sq.m.

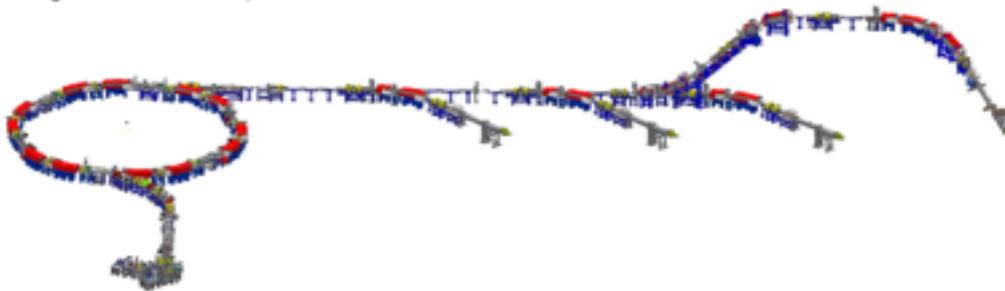
A hospital specialized in radiation oncology

The system (SIEMENS IONTRIS)

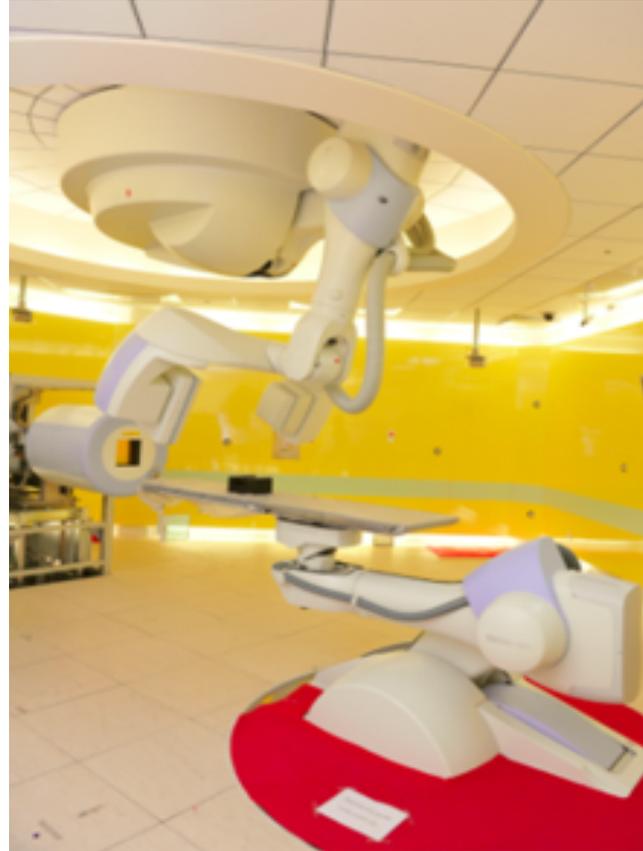


- Synchrotron with two particle sources
- Produce protons of 50-250MeV and carbon ions of 85-430 MeV
- The time of switching between two particles is less than 20 sec
- 4 treatment rooms: with 90° , 90° , 45° and 90° gantry
- Raster beam scanning

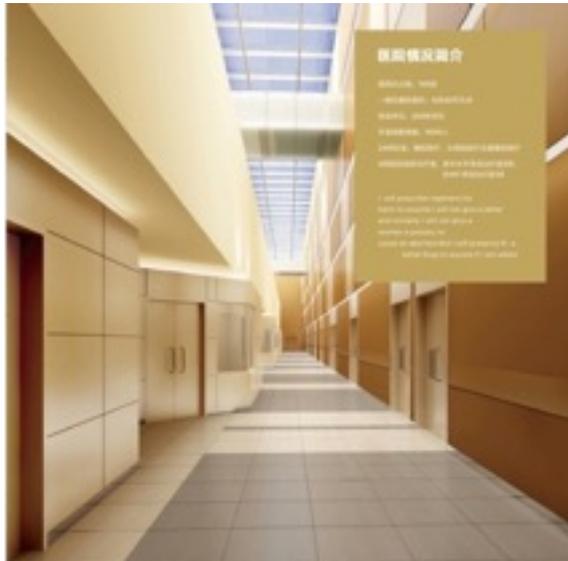
Project specific variations exist.
(e.g. number of on sources, treatment
room configuration – beam outlets)



The facilities



- Particle Therapy
- Conventional RT
- Diagnostic Radiology
- Nuclear Medicine
- Medical Oncology
- Pathology
- Lab Medicine
- Pharmacy



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- Purpose:
 - To verify the safety and efficacy of the proton and carbon ion particle therapy treatment on SPHIC system
- End points:
 - Acute toxicity at 3 months follow up (CTCAE 4.03)
 - Efficacy (RECIST / PERCIST)
- First CFDA required trial for RT
- Required number of patients: 32+4 designed as a phase II trial

Patient characteristics



	Total pts	Tumor type	pts
Head & Neck	10	Chordoma	8
		ACC	1
		Sarcoma	1
Thoracic	4	Primary lung ca	3
		Lung mets	1
Abdominal tumor	2	HCC	1
		Retroperitoneal sarcoma	1
Pelvic tumor	19	Prostate	19

35 patients enrolled in the trial. Age: Mean 69Y, 36-80Y



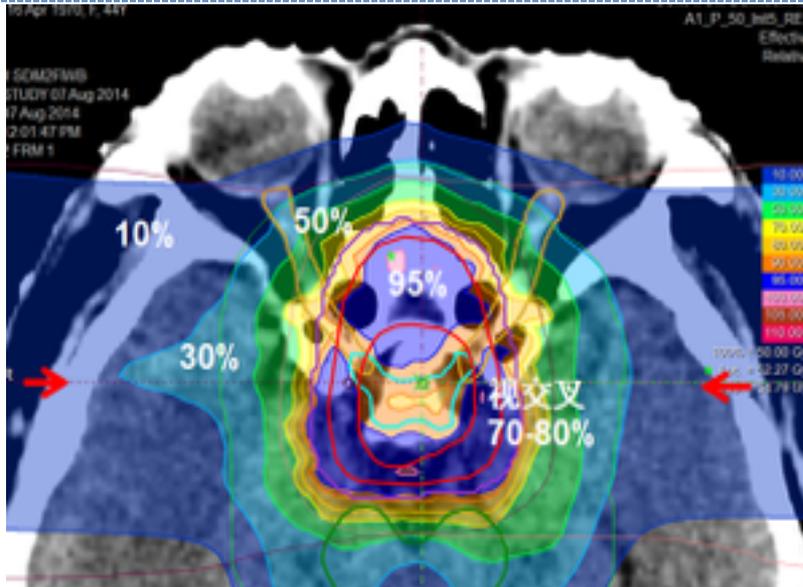
Total dose and fraction size



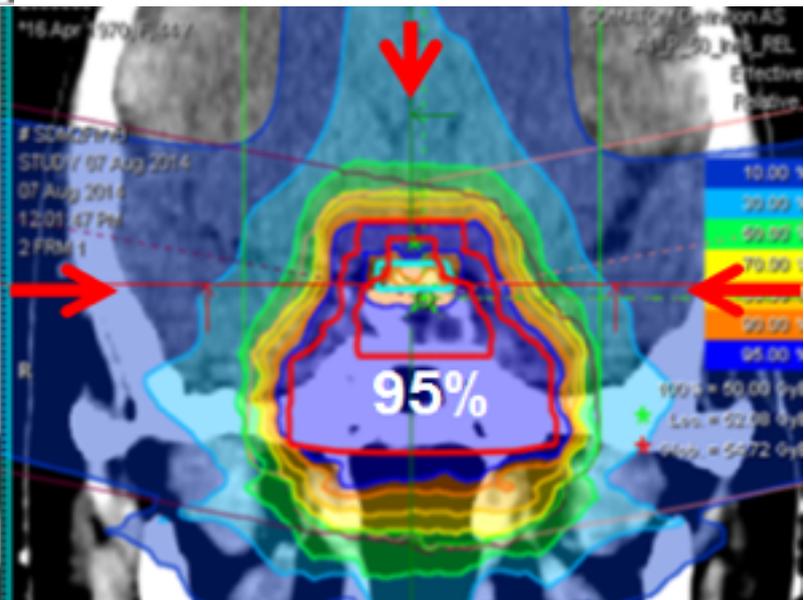
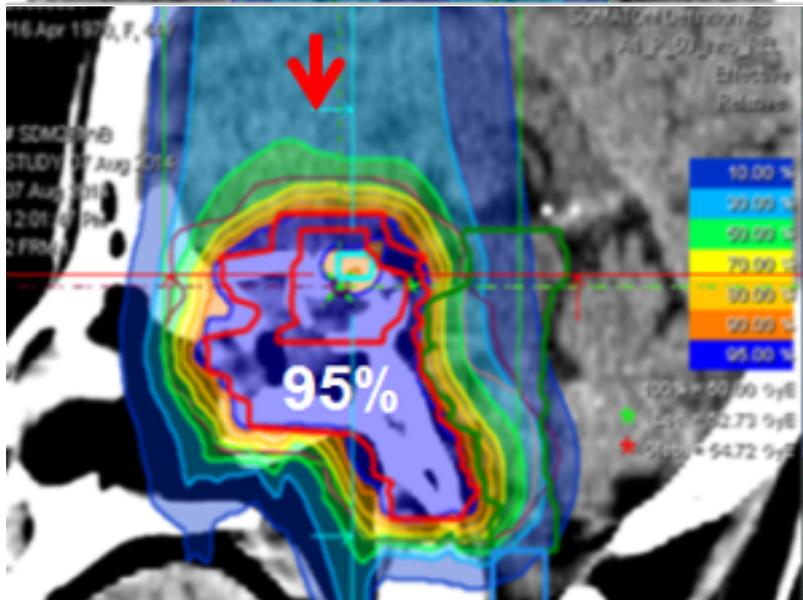
	Ion	Pts	Fractionation
Chordoma	C	1	3GyE/fx, 5fx/wk; 63GyE/21fx, 4.2wks
	P	7	2GyE/fx, 5fx/wk; 70GyE/35fx, 7wks
ACC	P	1	2GyE/fx, 5fx/wk; 60GyE/30fx, 6wks
Sarcoma	P	1	2GyE/fx, 5fx/wk; 70GyE/35fx, 7wks
Lung	P	1	4GyE/fx, 5fx/wk; 60GyE/15fx, 3wks
		2	5GyE/fx, 5fx/wk; 50GyE/10fx, 2wks
Lung mets	P	1	3.1GyE/fx, 5fx/wk; 46.5GyE/15fx, 3wks
HCC	C	1	10GyE/fx, qod; 40GyE/4fx, 8days
Retroperitoneal sarcoma	C	1	3.5GyE/fx, 5fx/wk; 63GyE/18fx, 3.6wks
Prostate	C	17	2.74GyE/fx, 5fx/wk, 63GyE, 23fx, 4.6wks
		2	2.74GyE/fx, 5fx/wk, 66GyE, 24fx, 4.8wks



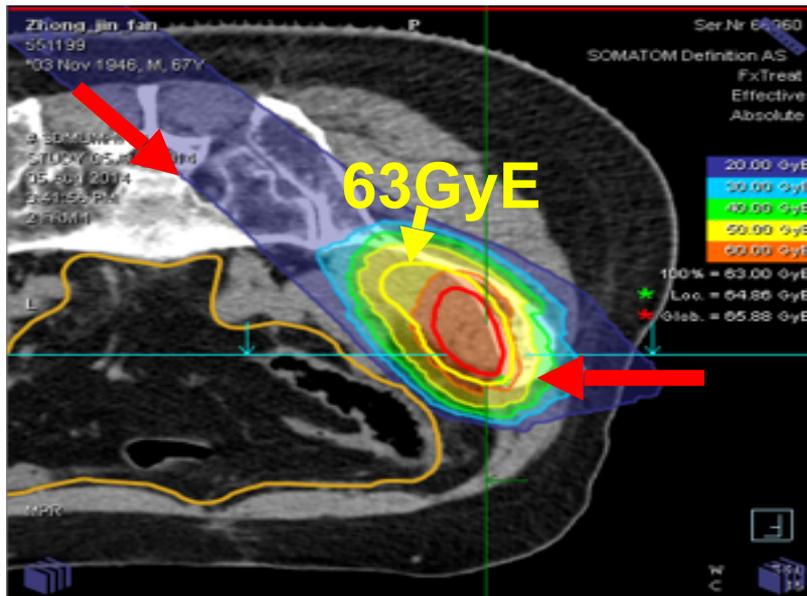
Case - recurrent chordoma



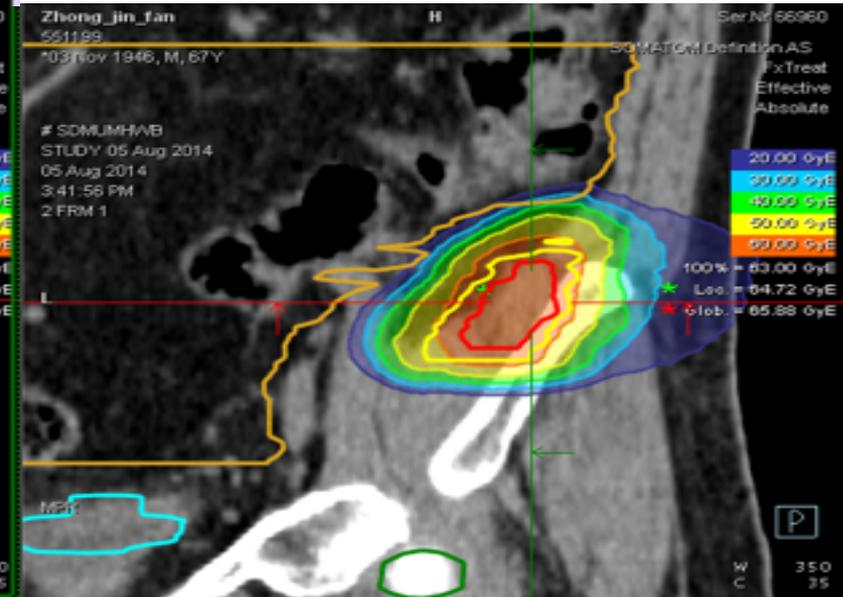
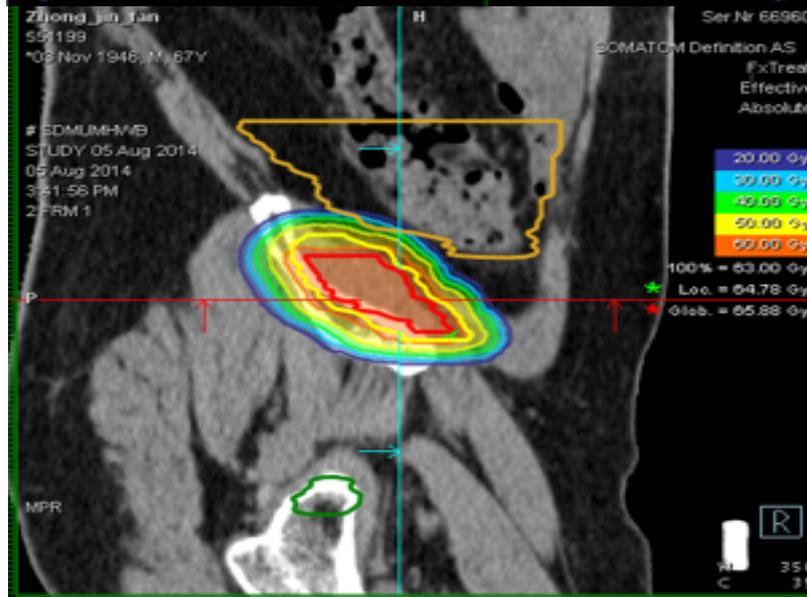
- Proton
- 2GyE/fx, 50GyE
- Cone done to 70GyE



Case - pelvic recurrent sarcoma

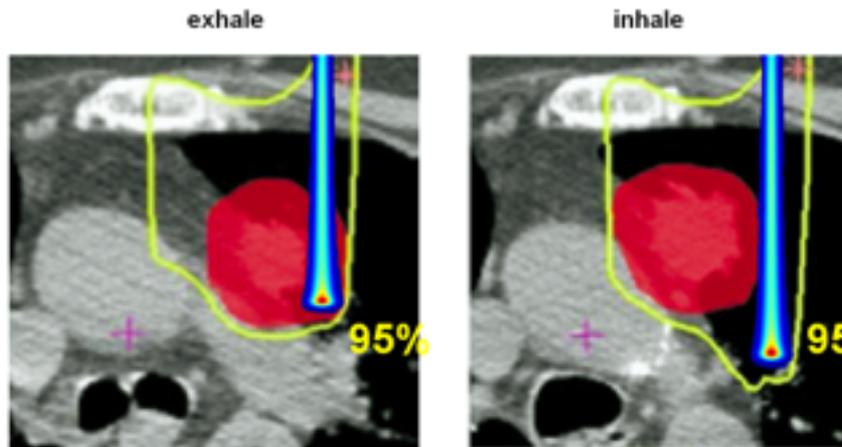


- Carbon
- PTV: 3.0GyE/fx,
- total: 54GyE/18fx, 3.6 wks
- GTV: 3.5GyE/fx
- total: 63GyE/18fx, 3.6 wks

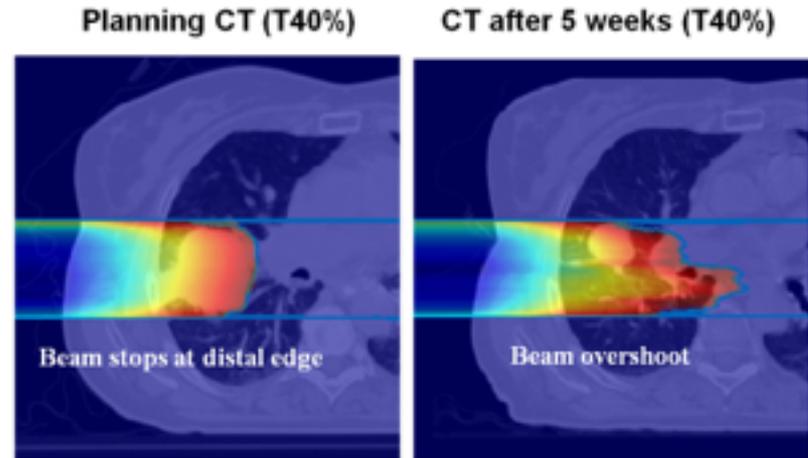


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- Proton/Heavy ion beams are more sensitive to
 - Organ motion
 - Anatomy changes in the beam path
 - Inhomogeneity



Engelsman et al., IJROBP 64(5):1589-1595, 2006



S. Mori, G. Chen

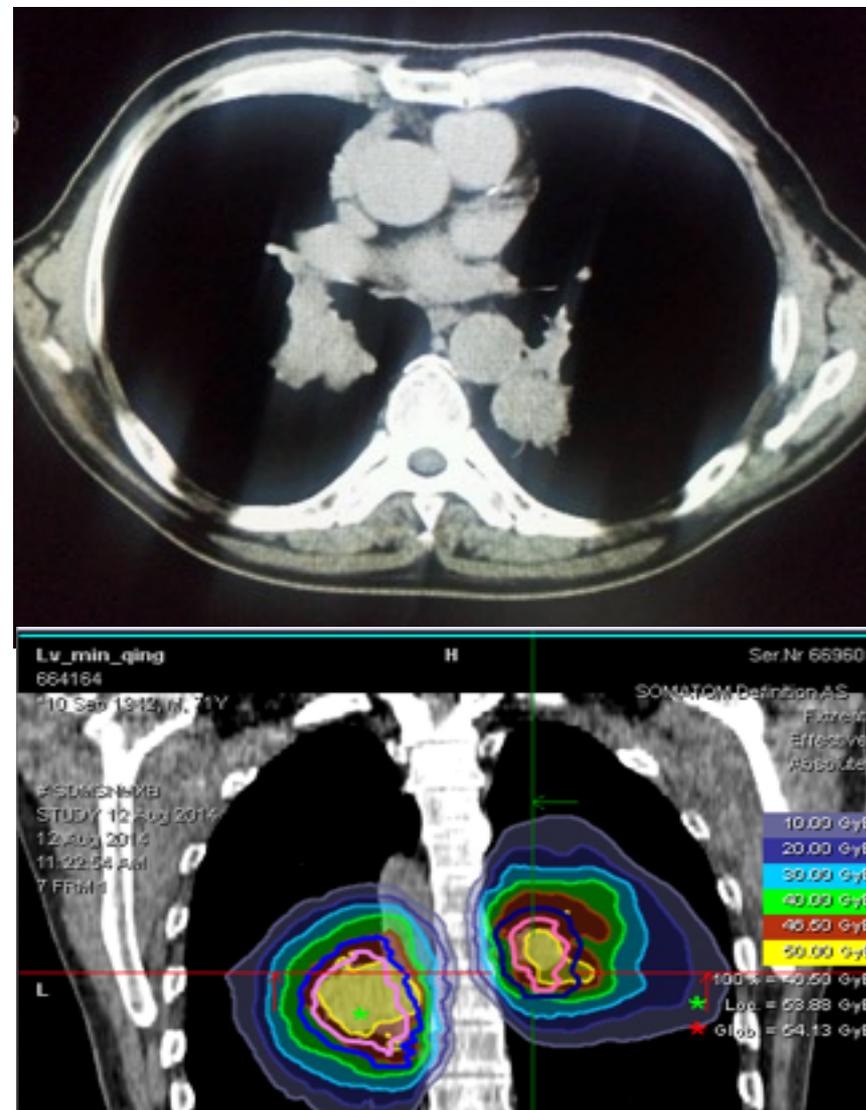


- Motion management
 - Gating with Anzai
 - Abdominal compression
 - ABC
- Beam orientation
- Dose verification



Three pts with lung lesions

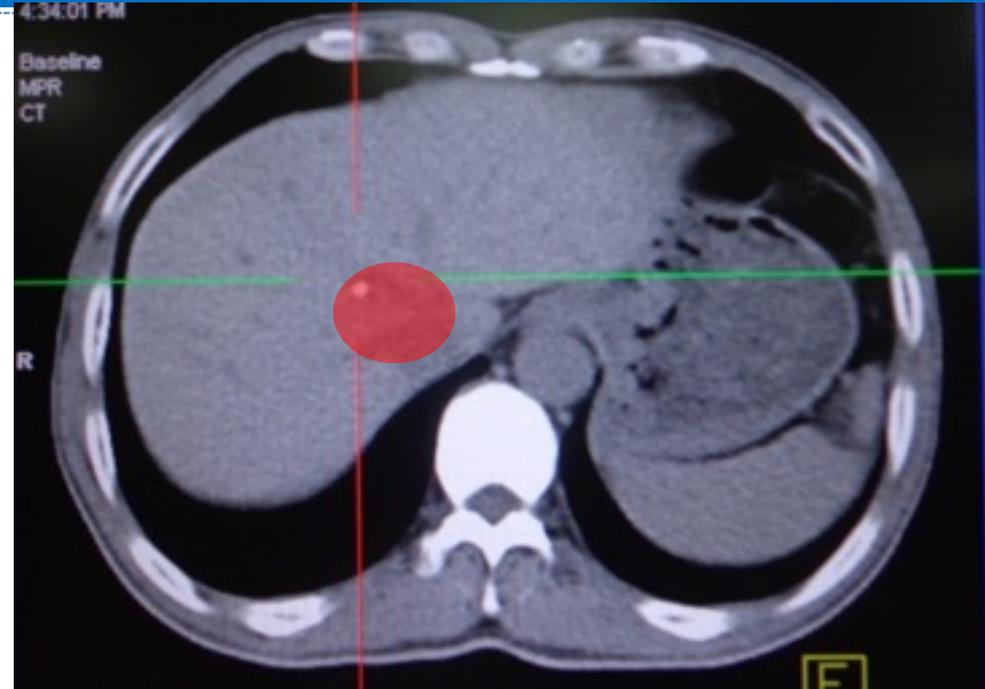
- 1#: Bilateral lung mets from colon cancer (motion 2.5 cm)
- 2#: Right middle lobe NSCLC (motion 2 cm)
- 3#: Right upper lobe NSCLC (motion 1.5 cm)



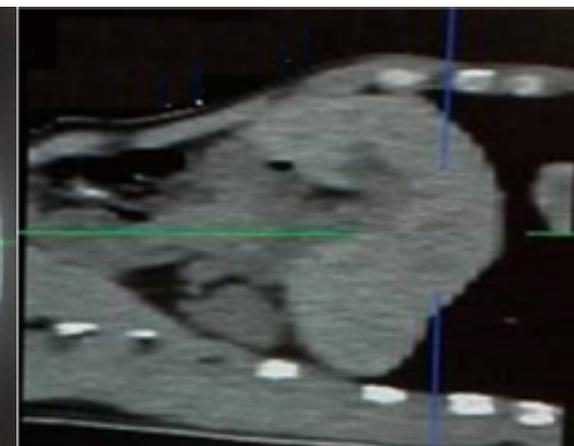
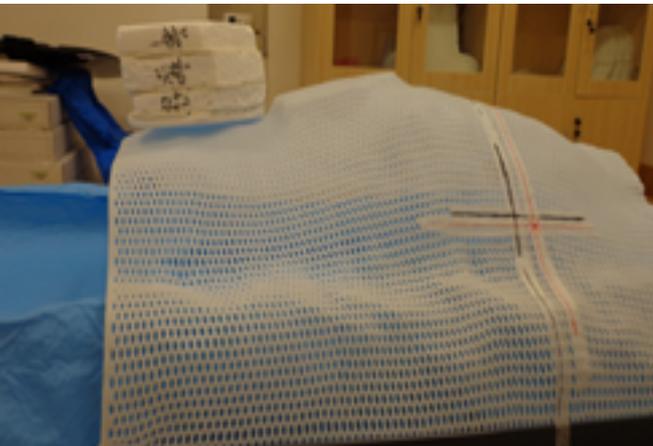
Abdominal compression



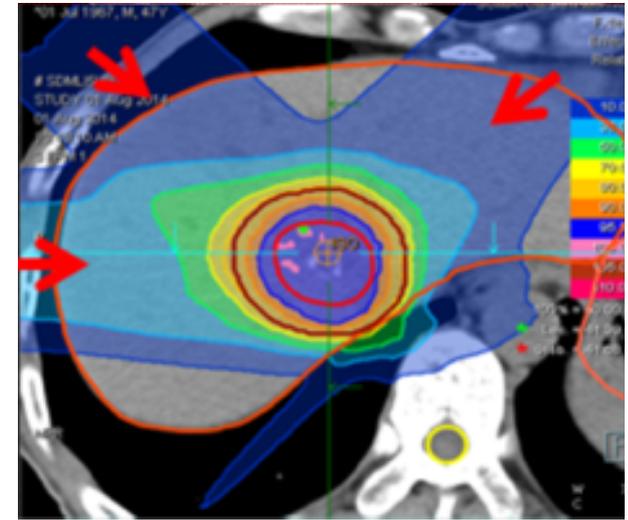
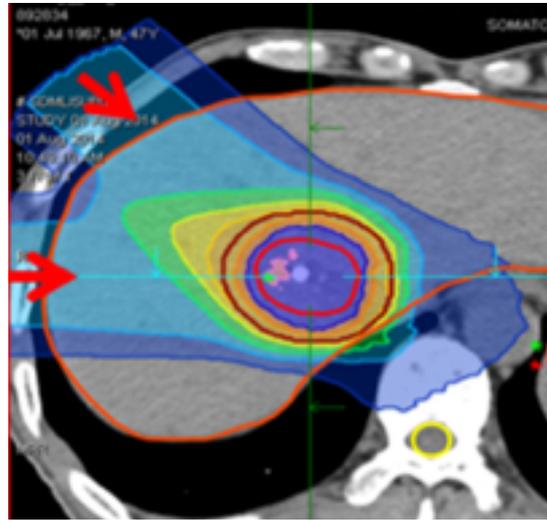
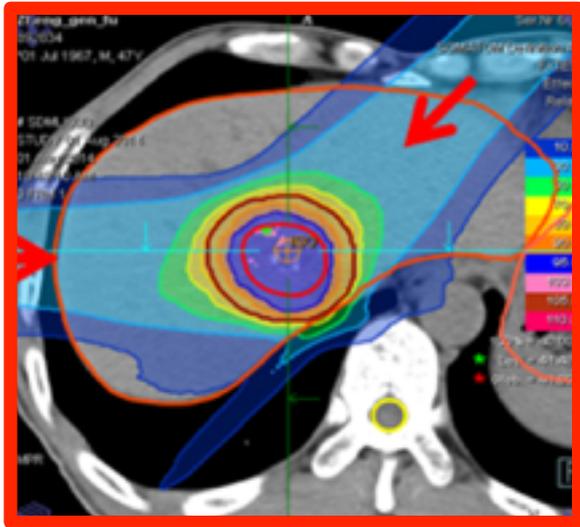
- HCC (T3bN0M0)
- Carbon
- GTV 10GyE/fx
 - total 40GyE/4fx, 8 days
- PTV 8.4GyE/fx
 - total 33.6GyE/4fx, 8 days



Motion: free breathing 1.5-2cm; with compression <0.5 cm

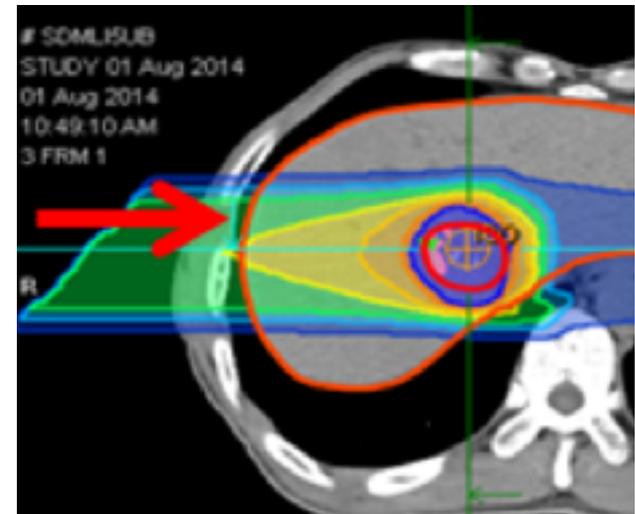


Beam orientation: dose comparison

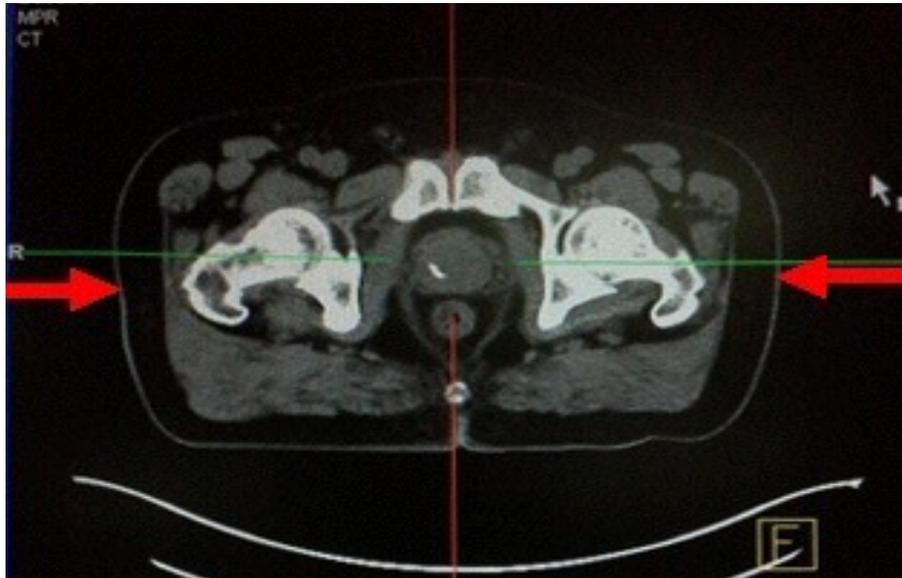


Mean dose to normal liver:

- **2 beam 270+45** **6.55GyE**
- 2 beam 270+315 6.05GyE
- 3 beam 270+315+45 6.59GyE
- 1 beam 270 6.34GyE



Dose verification post treatment

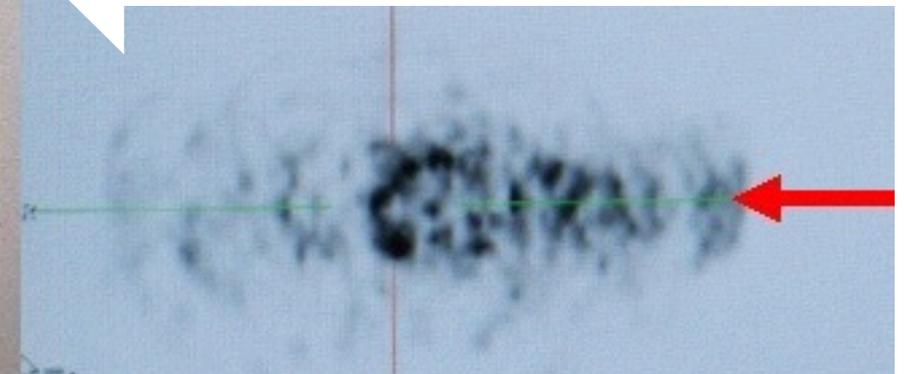
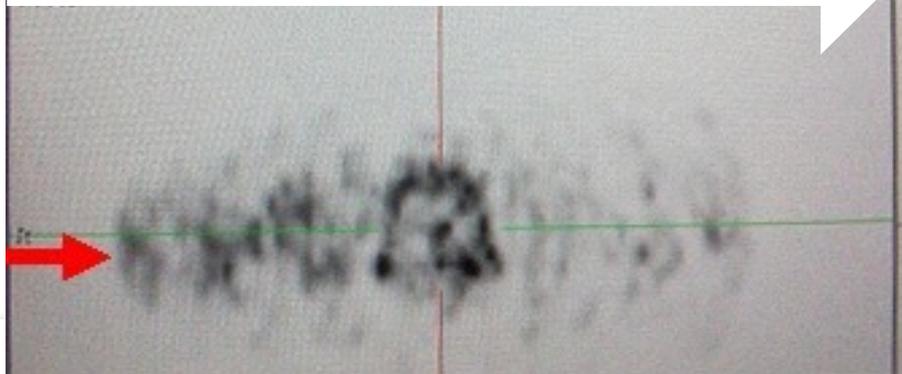


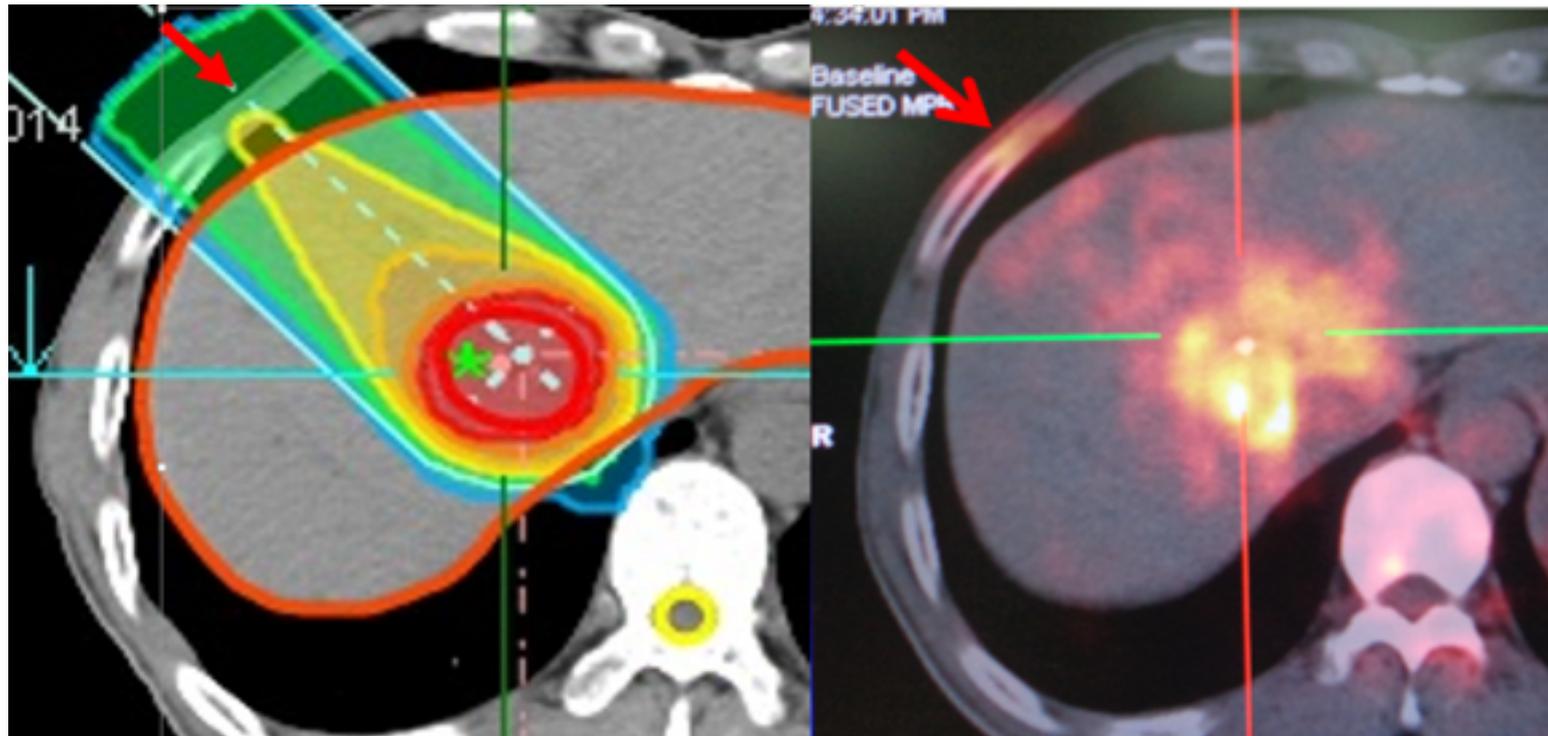
Prostate ca:

- Carbon 2.74GyE/fx
- Bilateral parallel opposed beams
- 10 min after carbon therapy
- PET/CT scan
- More positrons emitted from the fatty layer surrounding the prostate

fx1: 2.74GyE delivered from pt right side

fx2: 2.74GyE delivered from pt left side





PET/CT image:

- Scanned after 10GyE of carbon
- Delivered with a 315 degree beam

Preliminary results - toxicity



	Pts	AE			
		0	G1	G2	G≥ 3
Nasal ACC	1	1	0	0	0
Chordoma skull base	8	2	6	0	0
Chondrosarcoma skull base	1	0	1	0	0
Lung	4	2	2	0	0
HCC	1	0	1	0	0
Retroperitoneal sarcoma	1	0	1	0	0
Prostate	19	5	14	0	0
Total	35	10	25 (71.5%)	0	0

33AE in 25 PTS, 10 AE relieved at months after PT



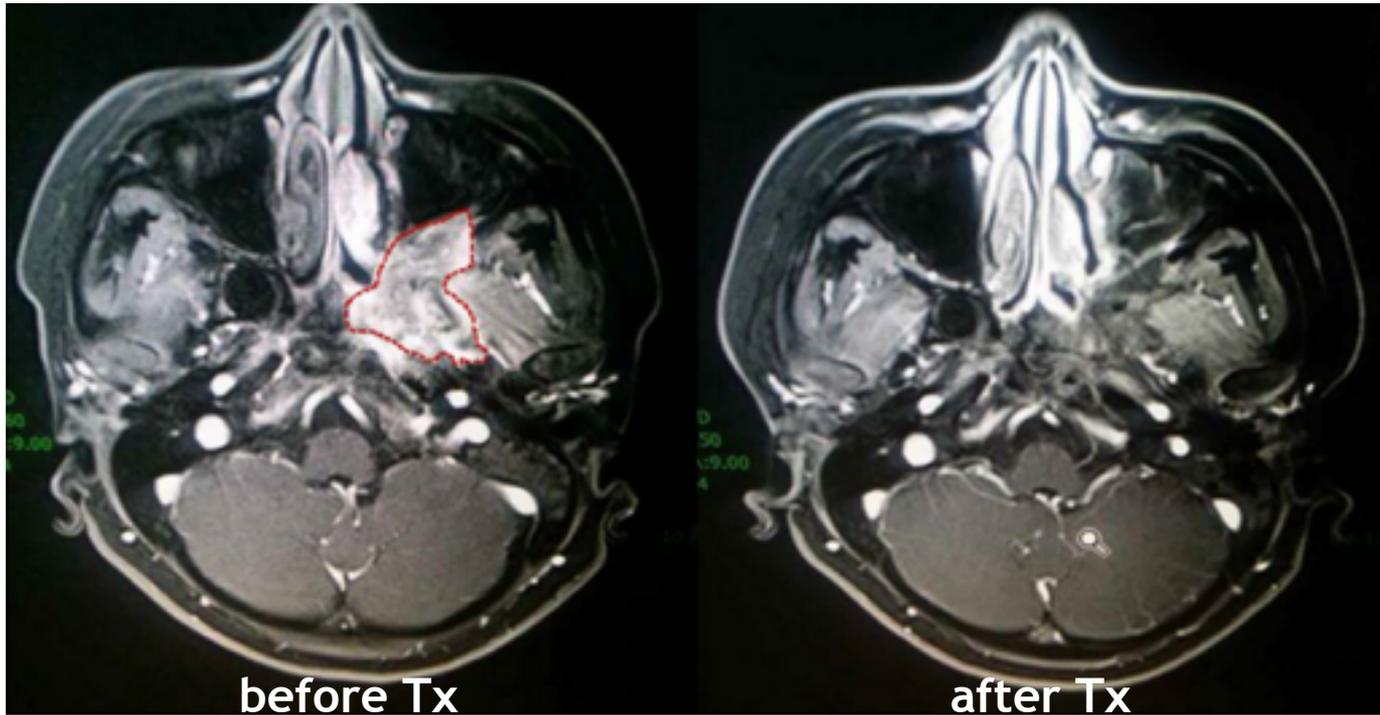
Preliminary results - efficacy



Cancer	No pts	With symptoms	Disappeared	Improved	Stable	Worsened
Head & neck	10	8	1	6	1	0
Thoracic	4	3	2	0	1	0
Prostate	19	4	3	1	0	0
Other	2	0	0	0	0	0
Total	35	15	6 (40.0%)	7 (46.7%)	2 (13.3%)	0



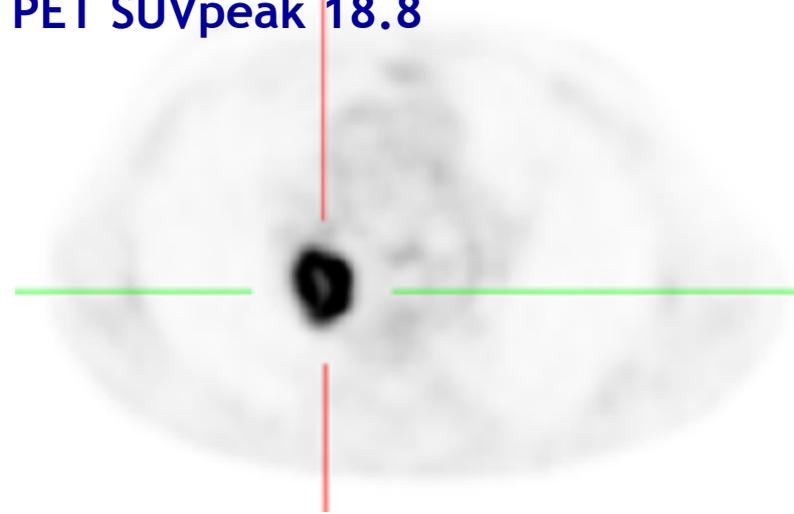
ACC unresectable



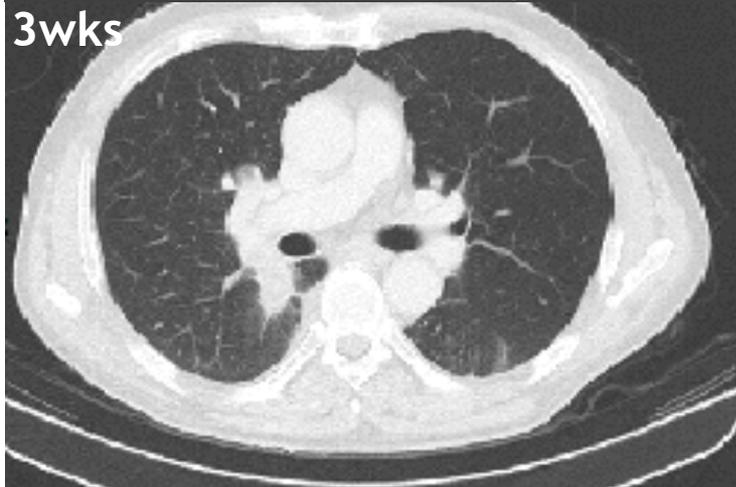
Aug. 2014 before PT



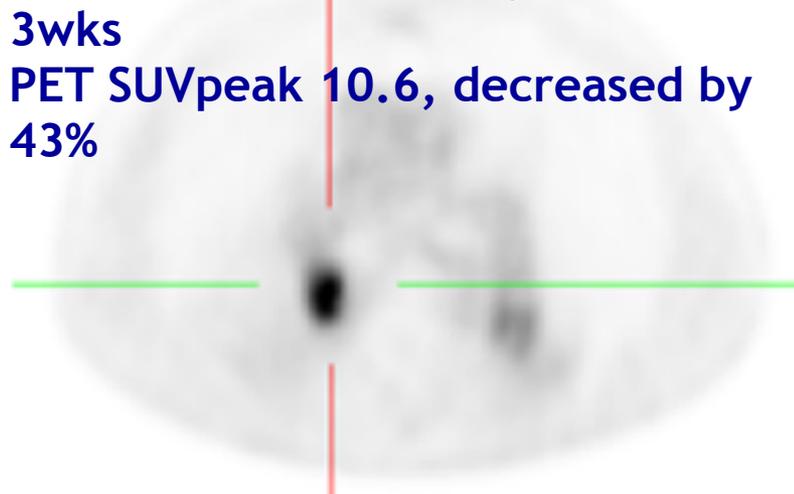
Aug. 2014 before PT
PET SUVpeak 18.8

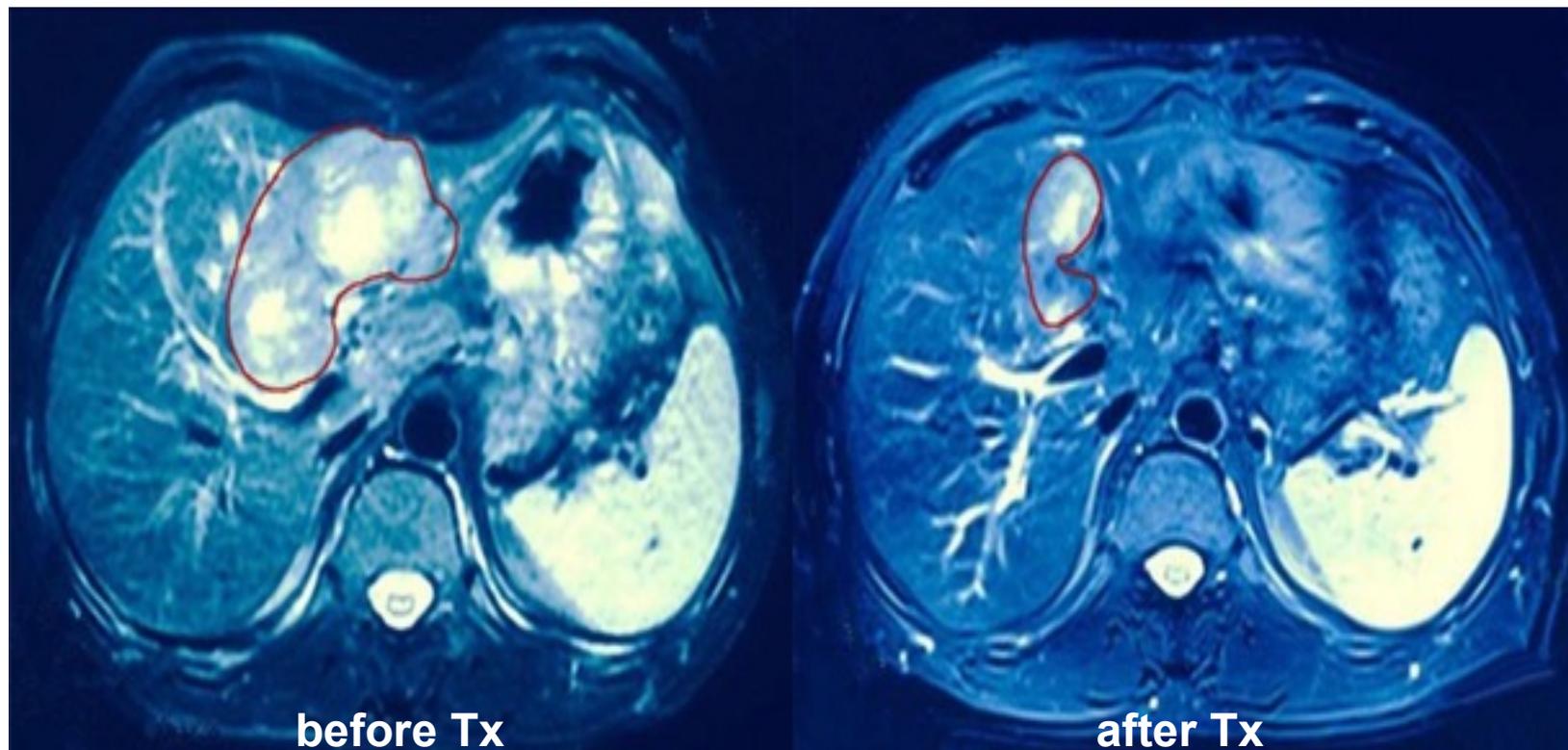


Nov. 2014 after 46.5GyE/15fx,
3wks



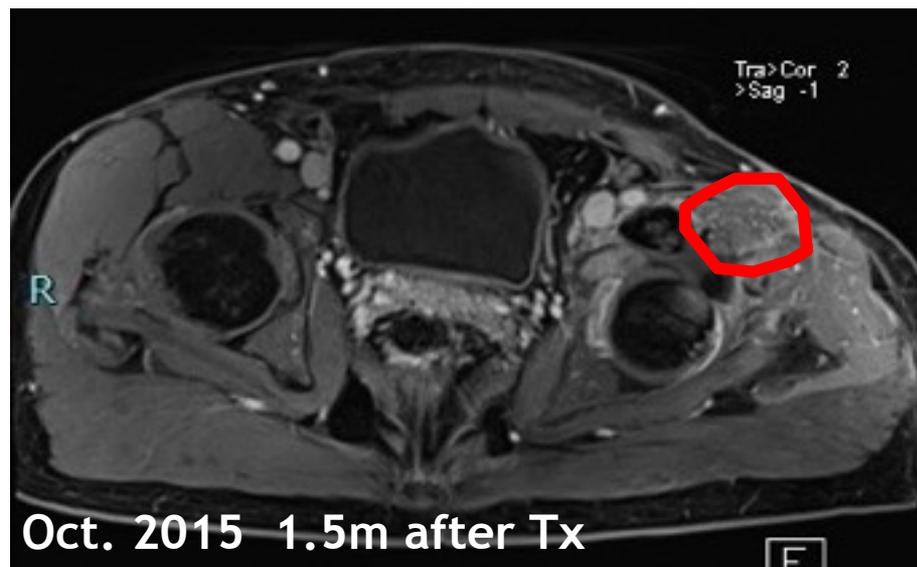
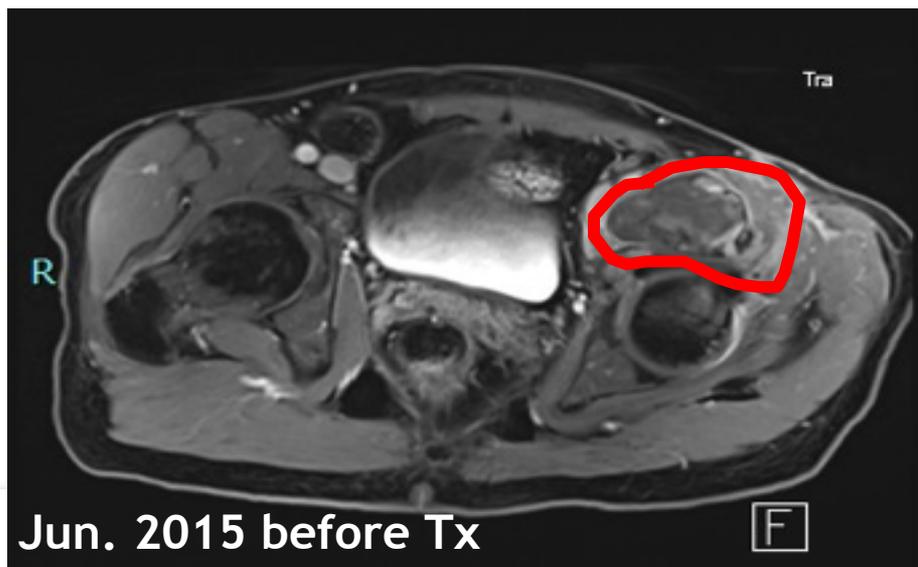
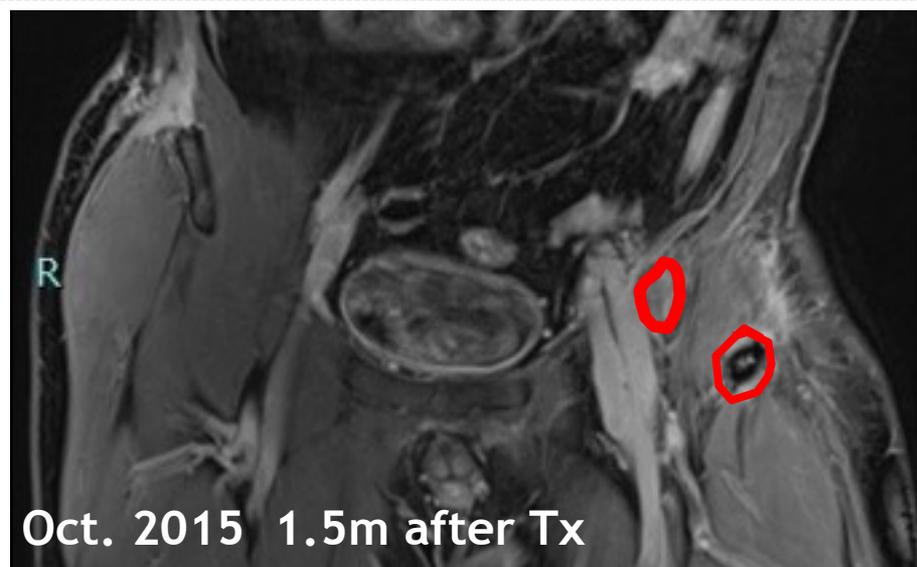
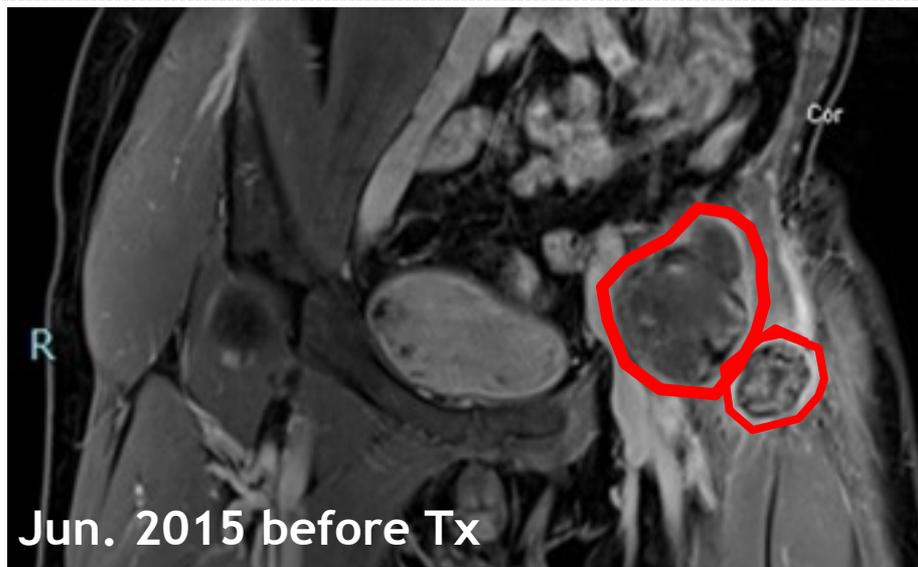
Nov. 2014 after 46.5GyE/15fx,
3wks
PET SUVpeak 10.6, decreased by
43%





Tumor size:	8.1x5.2cm	vs	5.5x3.0cm
AFP:	46,763ng/ml	vs	2,007ng/ml
Toxicity:	G0		

Recurrent angiosarcoma: carbon 66GyE/22fx





- Both proton and carbon ion treatment were well tolerated
- Minimal toxicities were observed in all patients
 - Grade 1 RT-induced AE were observed
 - No Grade 2, 3 or 4 RT-induced AE were observed
- 12 months follow-up
 - OS 100%
 - PFS 97%
- Long term f/u is needed for late toxicities and efficacy of the particle therapy



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May 2015 - Dec.2015

Total **180**

Carbon **82**

Proton **27**

Carbon/proton **71**

Head & neck 86 (recurrent NPC 39; oral cavity 3; Meningiomas 2; ACC 11; GBM 3; other base of skull and brain tumor 28)

Thoracic 37 (lung 32; thymoma 2; other mediastinum tumor 3)

Abdominal and pelvic tumor 57 (prostate 25; bone and soft tissue sarcoma 13; pancreatic ca 9; HCC 6; rectal ca 2; lymphoma 1; neuroglioma 1)



- Clinical trials
- Biological modeling
 - Efficacy
 - Normal tissue toxicity
- Treatment optimization
 - Beam orientation
 - 4D PT treatment planning
 - Adaptive PT: total and fraction dose
- Tumor response evaluation



Thank you for your attention!

