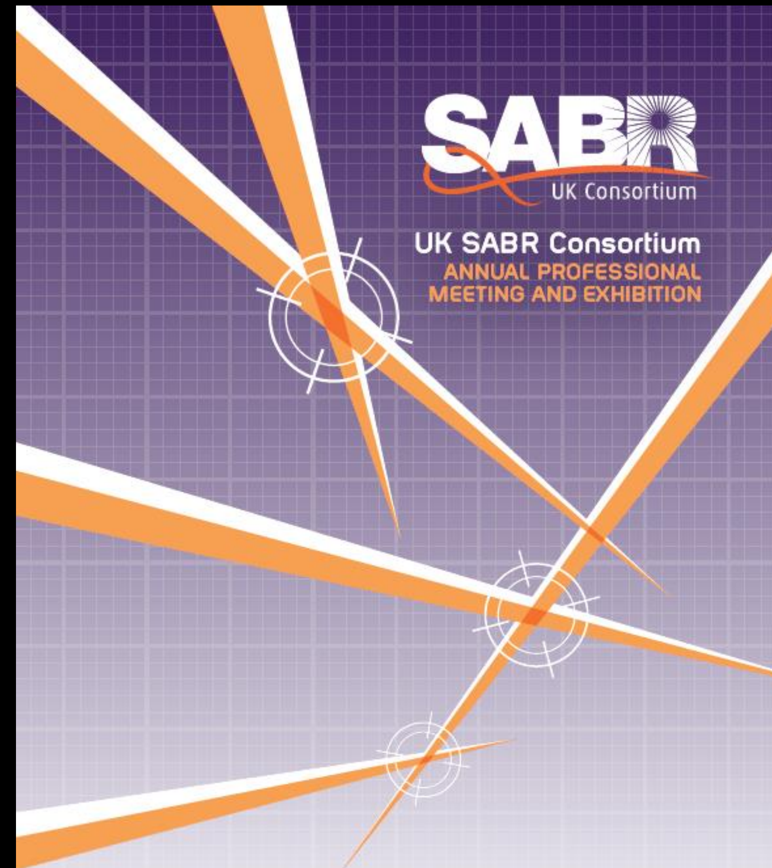
Solihull, Birmingham, UK
November 25, 2016

This house believes that in times of austerity, the UK Government should only fund and commission SABR with photons, not protons

For: Brian Kavanagh
Dr Clive Peedell



University of Colorado
Anschutz Medical Campus

School of Medicine

Proton Therapy

What we desperately want it to be

What it actually is

On the clinical spatial resolution achievable with proton and heavier charged particle radiotherapy beams

Pedro Andreo
Karolinska University Hospital

IOP PUBLISHING PHYSICS IN MEDICINE AND BIOLOGY

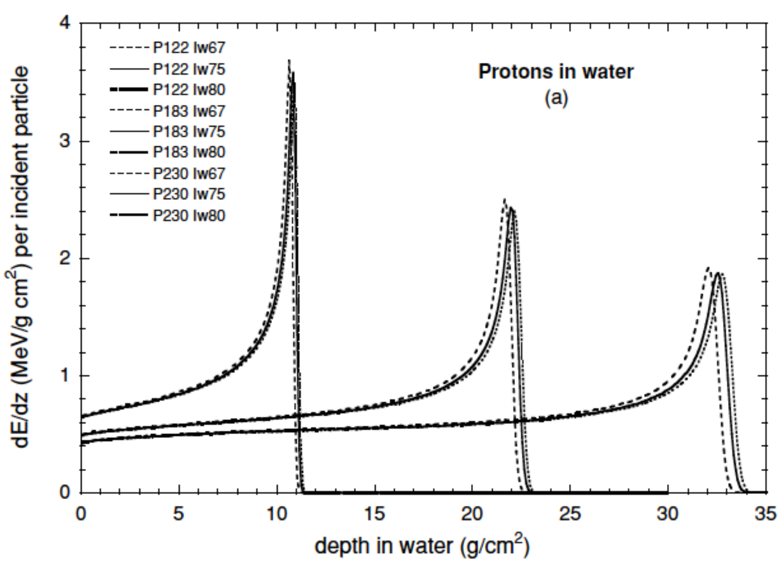
Phys. Med. Biol. **54** (2009) N205–N215 doi:10.1088/0031-9155/54/11/N01

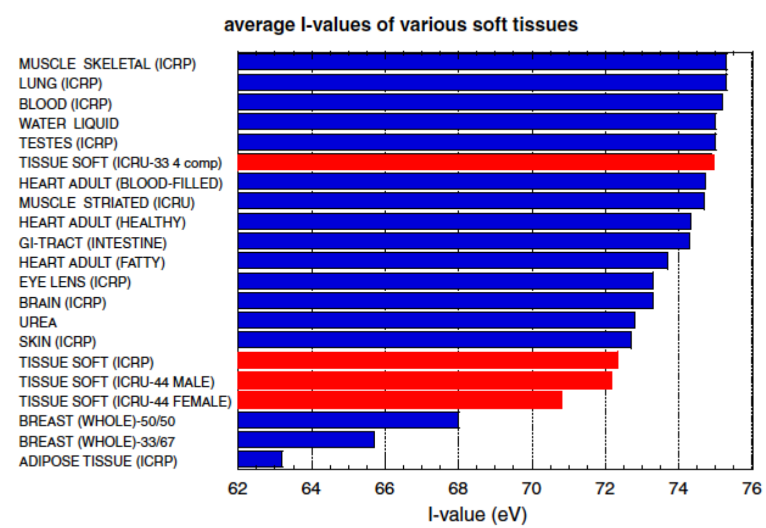
$$\ln I = \frac{\sum_j w_j (Z_j/A_j) \ln I_j}{\sum_j w_j (Z_j/A_j)}$$

$$(1/\rho) S_{\mathrm{col}} = 0.307 \frac{1}{\beta^2} \frac{Z}{A} z^2 [L_0(\beta) + z L_1(\beta) + z^2 L_2(\beta)]$$

where

$$L_0(\beta) = \frac{1}{2} \ln \frac{2mc^2\beta^2 W_{\mathrm{max}}}{1-\beta^2} - \beta^2 - \ln I - \frac{C}{Z} - \frac{\delta}{2},$$





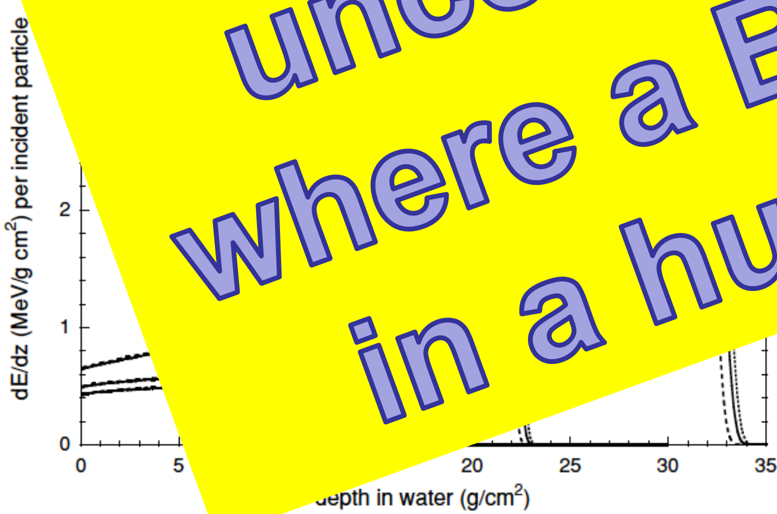
On the clinical spatial resolution achievable with proton and heavier charged parti[...] radiotherapy beams

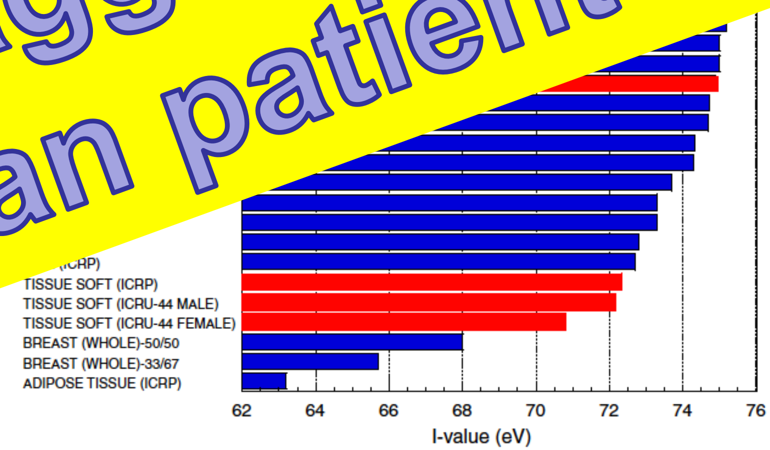
[...]rsity Hospital

IOP PUBLISHING [...]ND BIOLOGY

Phys. Med. Biol. [...]/11/N01

bottom line:
there is substantial uncertainty around where a Bragg Peak is in a human patient

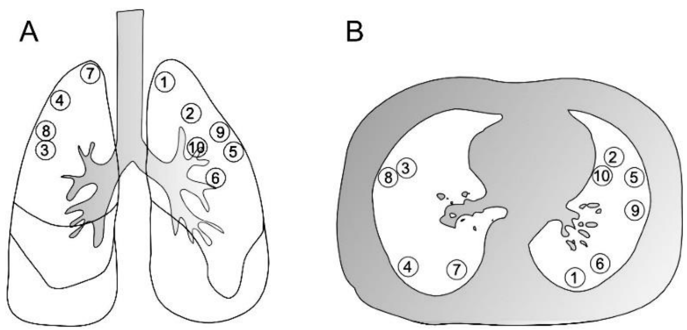




Treatment of Non-Small Cell Lung Cancer Patients With Proton Beam-Based Stereotactic Body Radiotherapy: Dosimetric Comparison With Photon Plans Highlights Importance of Range Uncertainty

Joao Seco, Ph.D., Hamid Reza Panahandeh, M.Sc., Kenneth Westover, M.D., Ph.D., Judith Adams, M.Sc., Henning Willers, M.D.

International Journal of Radiation Oncology • Biology • Physics
Volume 83, Issue 1, Pages 354-361 (May 2012)



For proton treatments, the passive scattering method was used, where approximately 3.5% ± 2 mm of the proximal and distal ranges were added (27, 31). In protons, the final PTV included

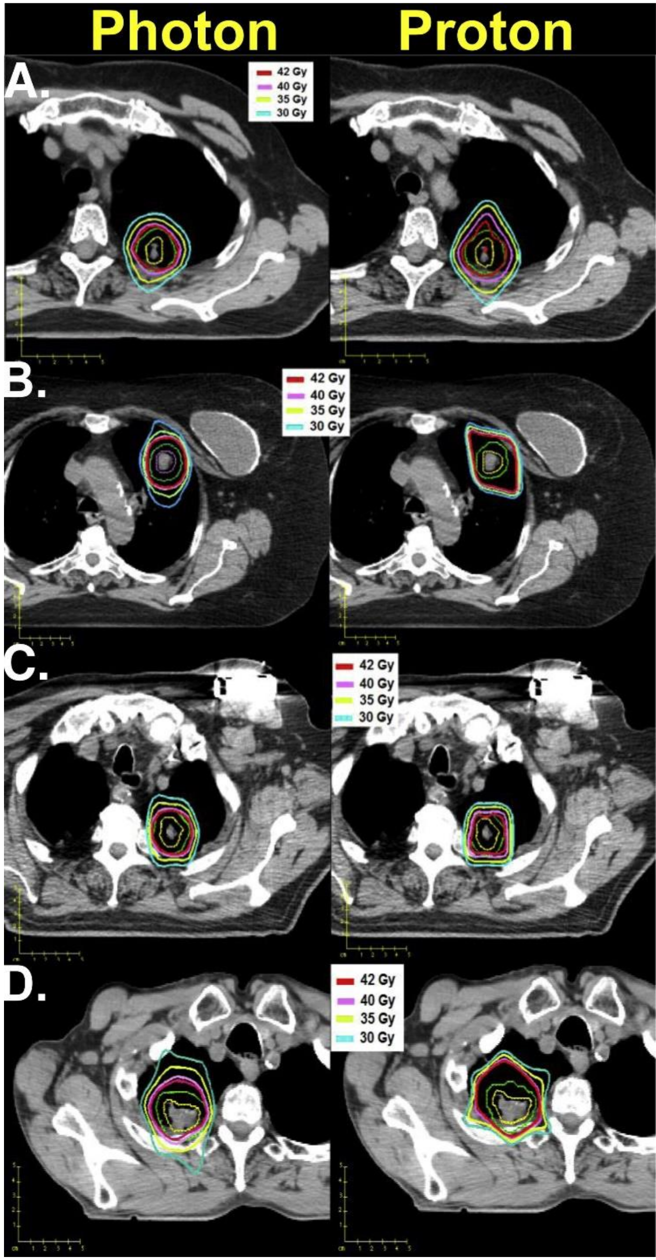


Table 1 Mean gross tumor volume dose and chest wall volume receiving ≥30 Gy for photon and photon plans (n = 10)

	Photon		Proton		
Parameter	Mean	Range	Mean	Range	p
GTV (Gy)	52.6	47.9−58.2	47.5	42.4−59.5	.015
Chest wall V_{30} (cm^3)	14	1.2−32.7	18.2	2.0−32.7	.08

Abbreviations: GTV = gross tumor vol[illegible] receiving ≥30 Gy.

higher mean tumor dose with photons
lower chest wall dose with photons

Table 2 Intercomparison of photon and proton estimates for mean ipsilateral lung dose, mean lung dose, ipsilateral V_5, and V_5 in lung and maximum esophageal dose

	Photon		Proton		
Parameter	Mean	Range	Mean	Range	p
Ipsilateral lung					
Mean lung dose (Gy)	5	1.4−12.0	4.9	1.2−11.5	.965
V_5 (%)	25.5	6.0−54.0	20.3	4.8−39.0	.072
Bilateral lung					
Mean lung dose (Gy)	2.7	0.9−7.4	2.3	0.7−6.0	.102
V_5 (%)	14.8	3.8−38.8	9.2	2.5−20.7	.019
Esophagus					
Maximum (Gy)	10	0.3−16.1	3.2	0.0−13.6	[illegible]
Spinal cord					
Maximum (Gy)	4.2	0.3−11.0	5.8	[illegible]	[illegible]

Abbreviation: V_5 = volume receiving ≥5 Gy.

trivial other differences

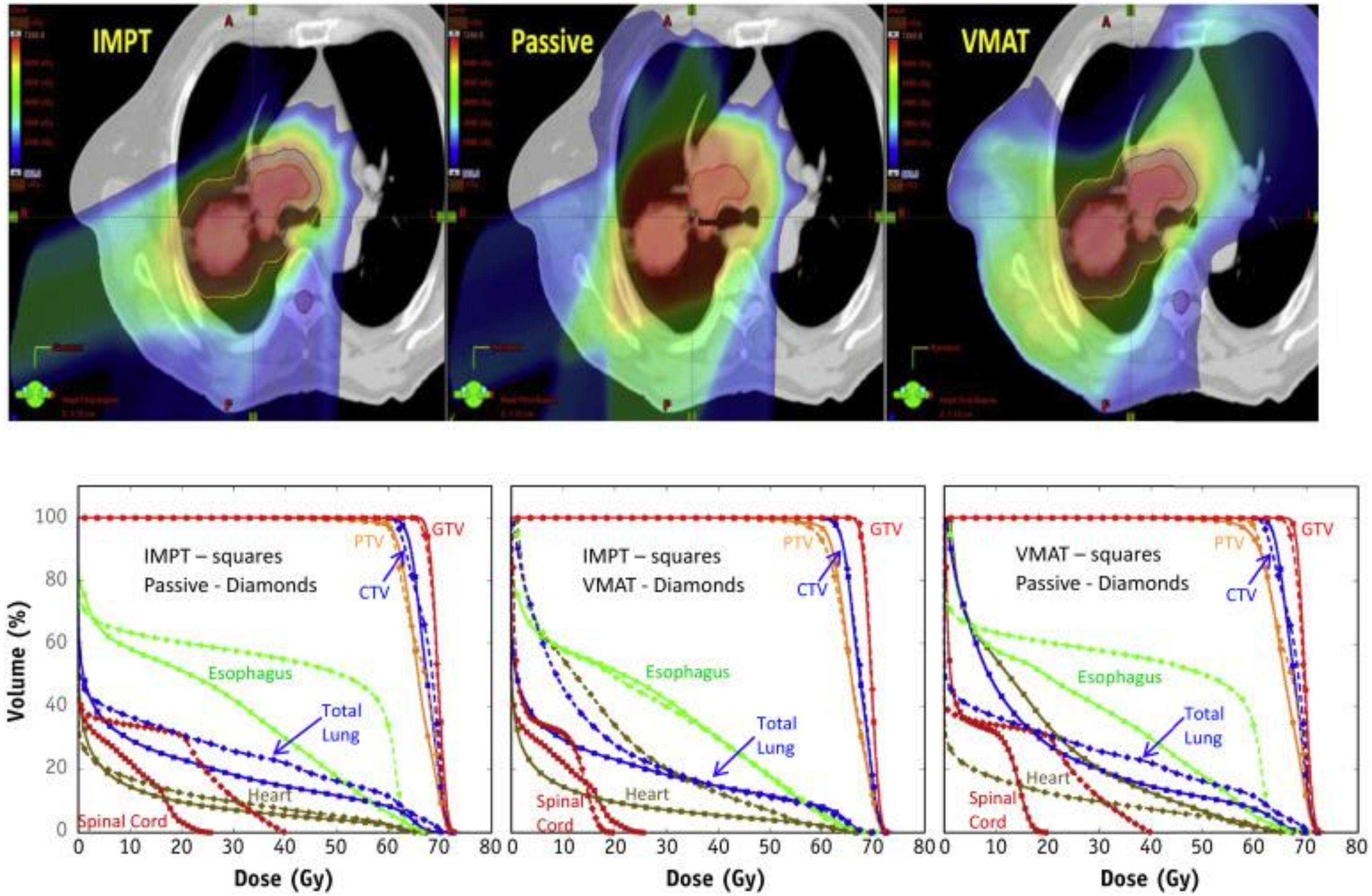


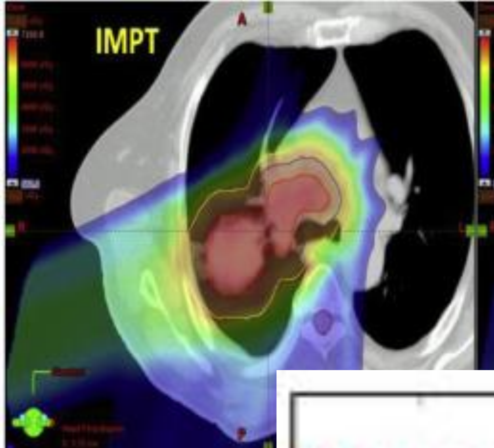
Fig. 1. Comparison of intensity modulated proton therapy (IMPT) versus passive scattering proton therapy (PSPT) and volumetric intensity modulated arc therapy (VMAT) in stage III non–small cell lung cancer. The IMPT plan achieves the best sparing of all critic...

Joe Y. Chang, Salma K. Jabbour, Dirk De Ruysscher, Steven E. Schild, Charles B. Simone II, Ramesh Rengan, Steven Feigenberg, Atif J. Khan, Noah C. Choi, Jeffrey D. Bradley, Xiaorong R. Zhu, Antony J. Lomax, Bradford S. Hoppe

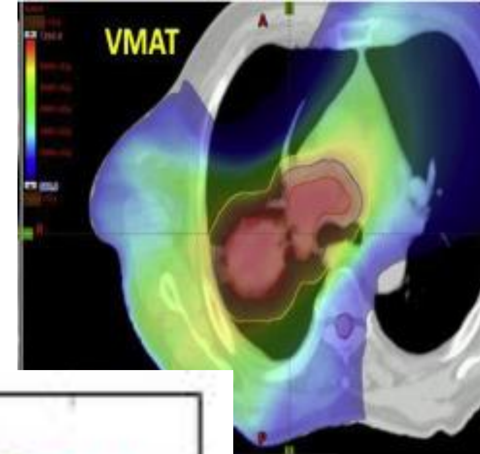
Consensus Statement on Proton Therapy in Early-Stage and Locally Advanced Non–Small Cell Lung Cancer

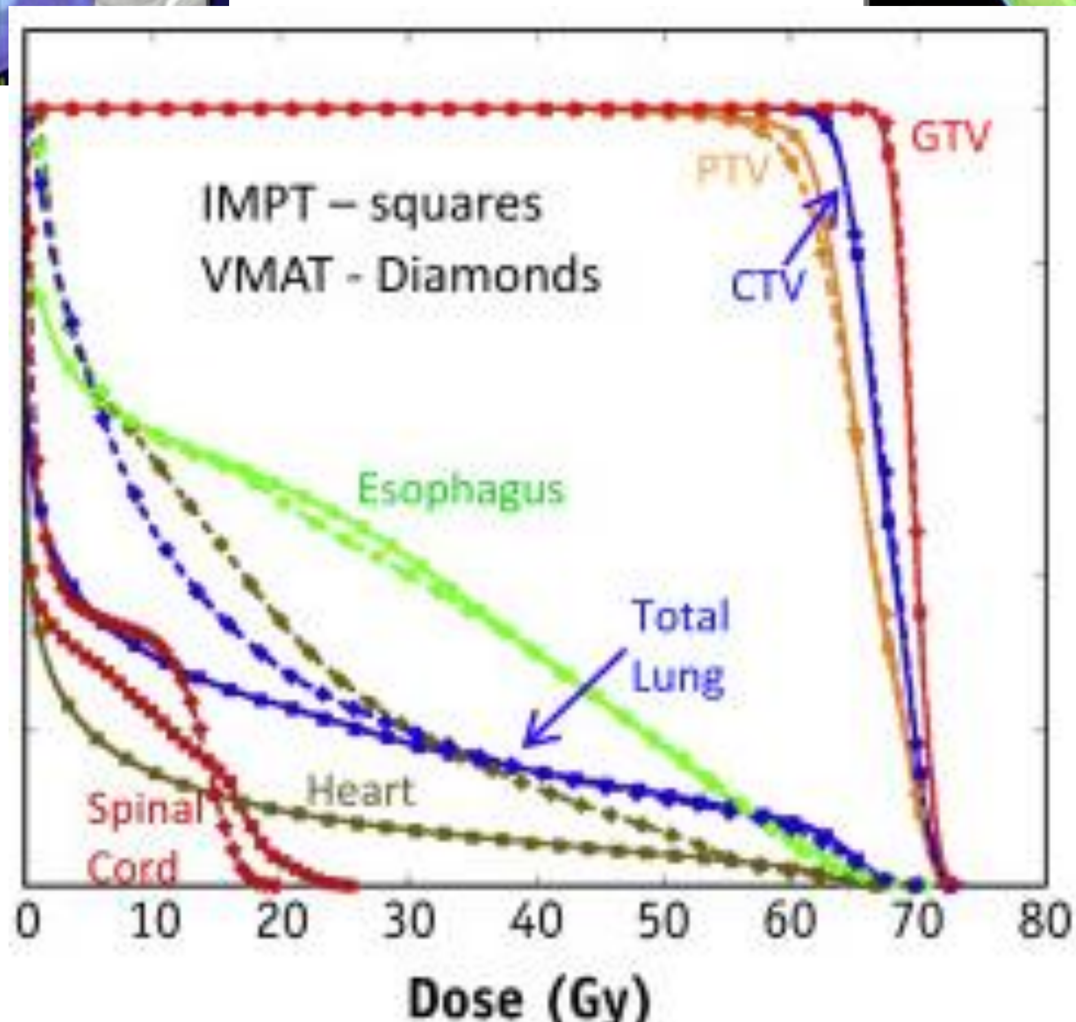
International Journal of Radiation Oncology*Biology*Physics, Volume 95, Issue 1, 2016, 505–516

http://dx.doi.org/10.1016/j.ijrobp.2016.01.036

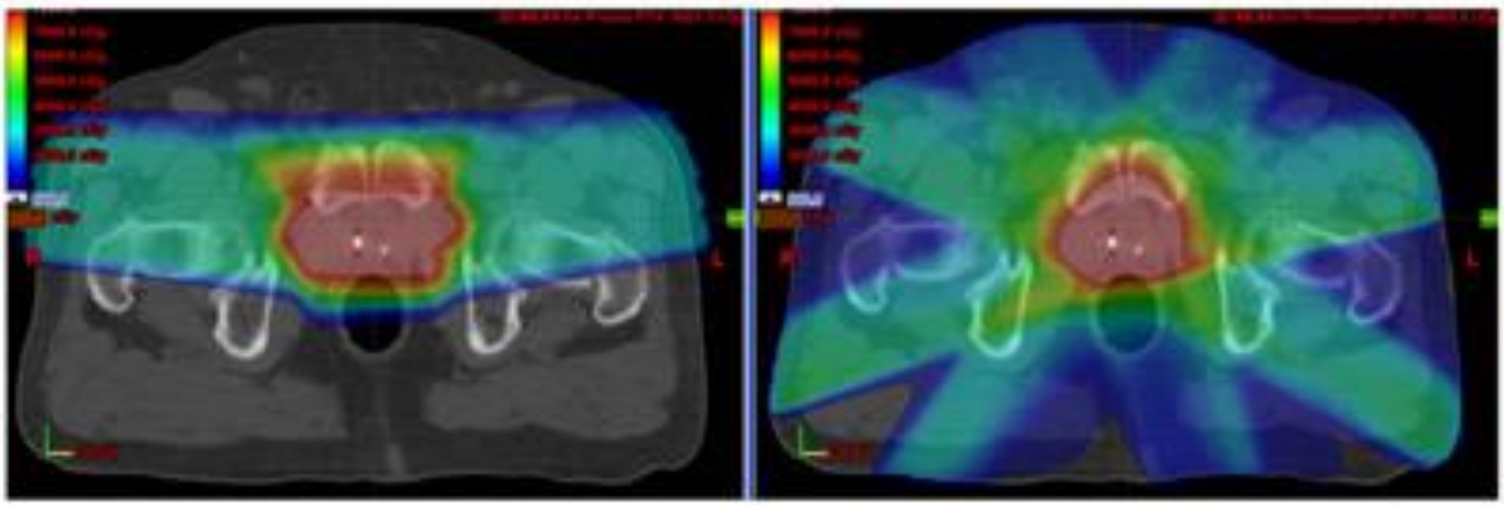


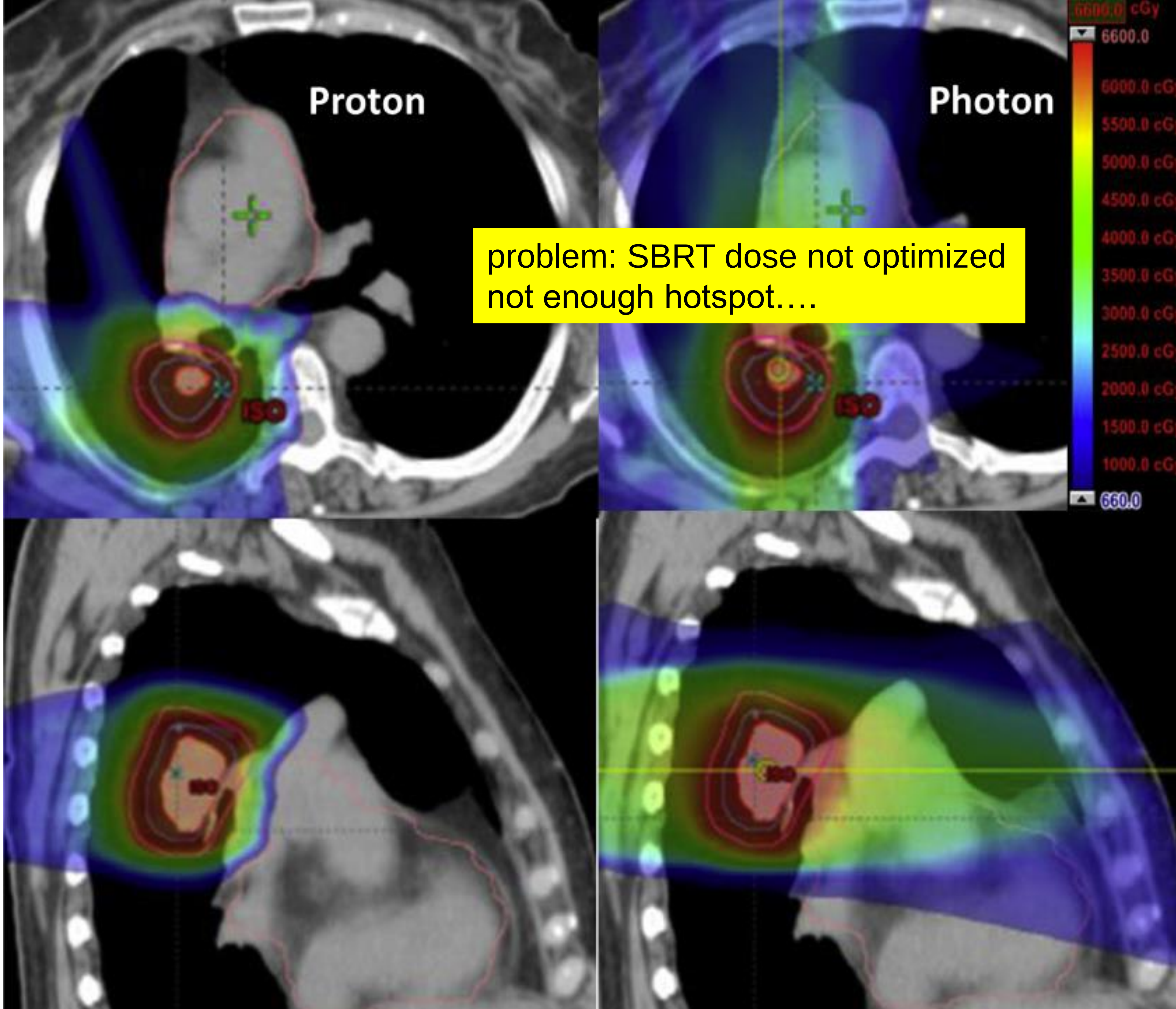
stage III example case





proton therapy for prostate cancer

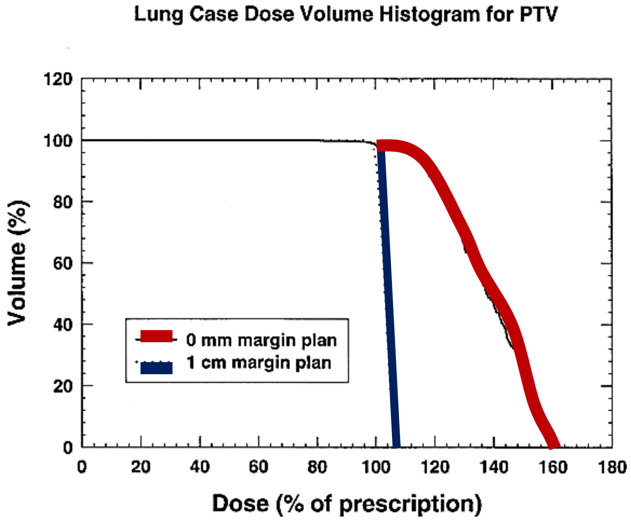


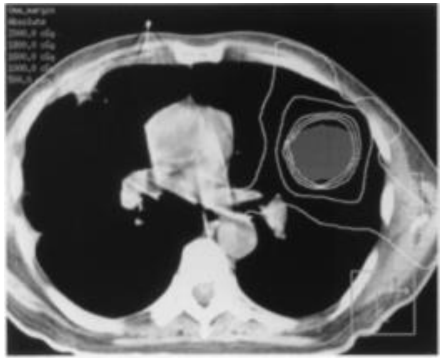


problem: SBRT dose not optimized
not enough hotspot….

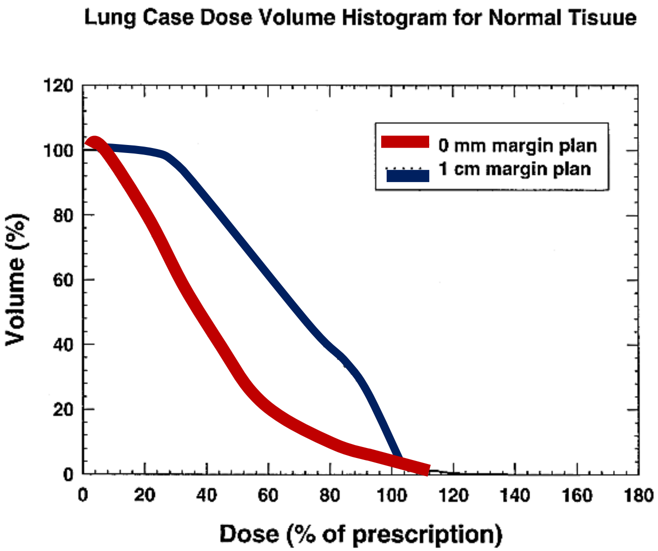
Hotspots steepen the dose gradient outside the PTV primarily because the lateral penumbra is typically steepest around the 50% isodose line

- 7 non-coplanar beams
- PTV DVH, 0mm v 1cm margin





Cardinale et al
IJROBP 1999



Hotter hotspot in tumor
Eg, 0mm v larger block margin

→

Steeper dose falloff in lung

Notable exception: Prostate SBRT

conclusions

- dosimetric uncertainty is higher for protons than photons
- the Bragg peak doesn’t really help
  - note: lateral penumbra used for sharp dose gradients in proton therapy for prostate cancer
- beware unfair comparisons of protons v photons for SBRT