Proton treatment for shallow brain targets: the influence of the range shifter in terms of in-field and out-of-field doses.

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Abstract 272

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Background

- ✓ Superficial targets may require the use of a range shifter (RS) at nozzle exit in pencil-beam scanning technique.
- ✓ However, it becomes an additional source of neutrons that could irradiate organs situated far from the target.

Purpose To **compare** treatment plans made **with (RS) and without (NRS)** a RS, for a shallow brain target, considering not only the **in-field doses** but also the **out-of-field doses** not routinely assessed in the clinical evaluation of the plans.

Material and Methods

BRAIN CASE

One lateral proton field

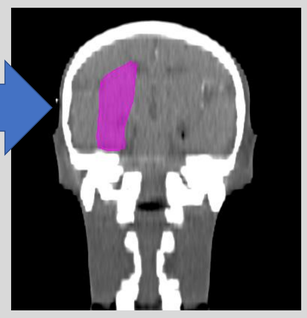

Fig. 1. Shallow target in brain.

- Planned by Eclipse™.
- Prescription: **60 Gy (RBE)**.
- Energy layers:
  - **21** between 60 and 97 MeV (NRS).
  - **14** between 93 and 124 MeV (RS).

PLAN EVALUATION

- In-field doses: DVHs from TPS.
- Out-of-field doses: Equivalent dose in organ from full Monte Carlo simulation (using MCNP 6.2 code).
  - Actual spot distribution.
  - Secondary neutrons and photons.

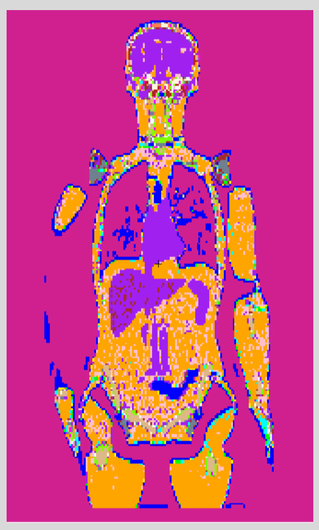

Fig. 2. MC voxel phantom created from CT images using the method described by Schneider *et al* (PMB 2000 45 459–478).

Conclusions

- ✓ NRS plan led to slightly better results in terms of target coverage and lower in-field OAR and out-of-field doses.
- ✓ However, **RS** plan was **clinically acceptable** while **reducing** the number of **energy layers** by one third, and therefore, reducing the delivery time.
- ✓ Neutron exposure with the RS increased 10 mSv in the left eye but less than 2 mSv in the rest of peripheral organs.

Results

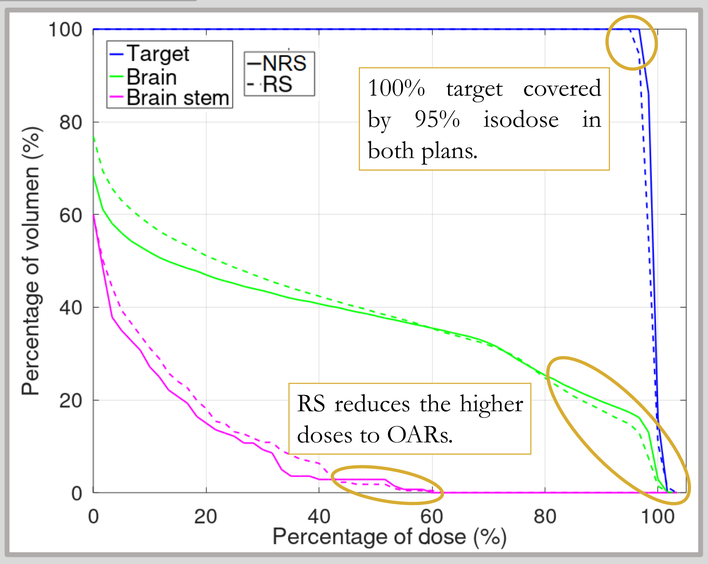

Table 1. Plans metrics.

	Dmax (RBE Gy)			Homogeneity index in target
	Brain	Brain stem	Chiasm	
NRS	63	36	28	0.04199
RS	63	37	39	0.04984
Recommended*	72	54	55	

* QUANTEC, IJROBP 2010 76(3) S1-S160

Fig. 3. Dose-volume histograms in the NRS and RS cases.

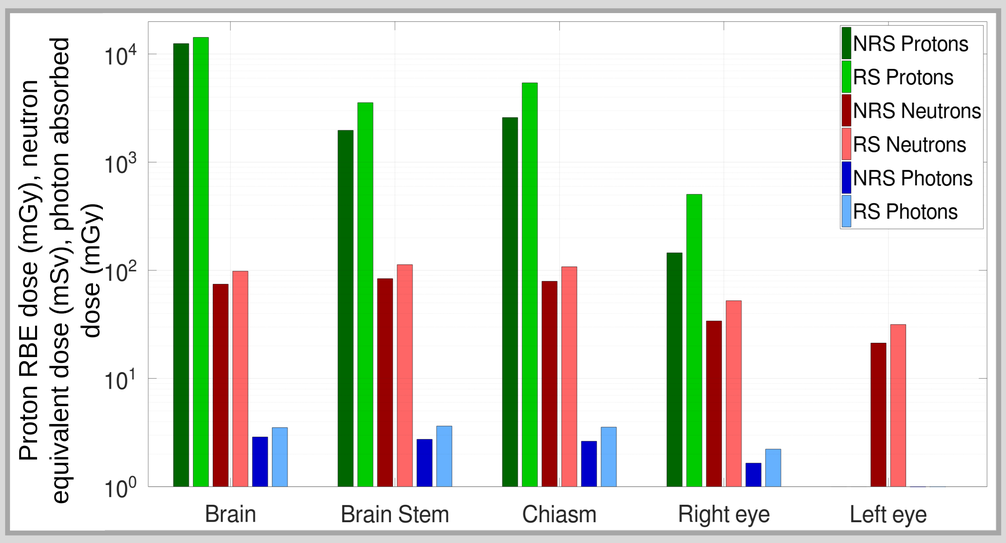

Fig. 4. Equivalent doses in organs around the target in the NRS and RS cases.

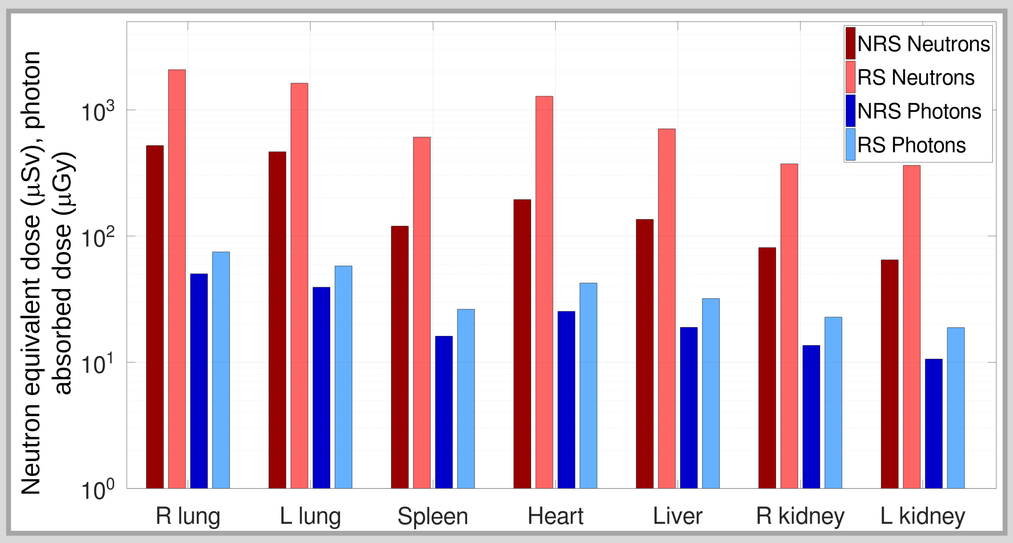

Fig. 5. Equivalent doses in organs in the out-of-field area in the NRS and RS cases.

Neutrons

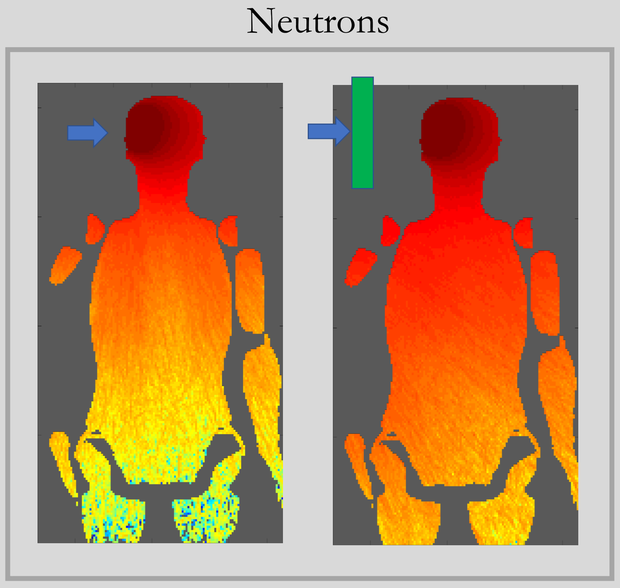

Fig. 7. Distribution of neutron equivalent dose in the NRS (left) and RS (right).

Photons

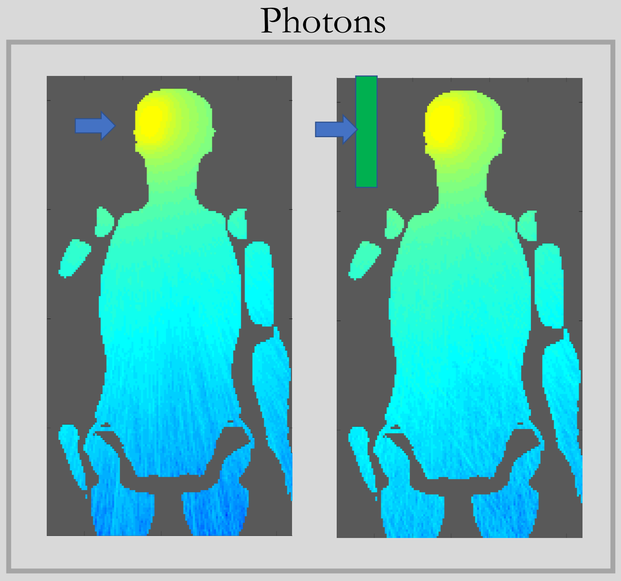

Fig. 6. Distribution of photon absorbed dose in the NRS (left) and RS (right).

Neutron equivalent doses are between 5 up to 37 times higher than photon doses.

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