# Improved proton stopping power ratio estimation for a deformable 3D dosimeter using dual energy CT

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## Background

The highly localized dose distribution is an advantage of proton therapy, but it is also a cause of uncertainty. 3D dose verification can therefore be beneficial.
Proton treatment planning is based on a CT scan of the patient and a conversion of the CT numbers (Hounsfield Units, HU) to a stopping power ratio (SPR).
However, silicone-based 3D dosimeters are not made of tissue-like material, so the conventional conversion method may not be applicable for the dosimeter.

## Conclusions

If the stoichiometric method is applied for the dosimeter its HU must be manually corrected in the treatment planning system to give a correct SPR estimate. However, using dual energy CT the stopping power can be estimated directly.

**The overall aim of this study was to investigate if use of dual energy CT can improve the stopping power determination for a silicone-based deformable 3D dosimeter compared to use of single energy CT.**

## Specific aims

It must be assessed if the SPR of a silicone-based dosimeter is estimated correctly from its HU. Therefore, we investigated:

- If the conventional calibration method – the stoichiometric method – gave the correct SPR estimate.
- If potential errors in the stoichiometric estimate could be mitigated.
- If new dual energy CT calibration methods would improve the SPR estimate.

## Materials and methods

**Material:** The dosimeter material is based on **silicone** and does not have a tissue equivalent composition.
**Methods:** Both single energy and dual energy **CT images** of the dosimeter were acquired with using a **dual source CT** scanner (Siemens SOMATOM Definition Flash).
The **stopping power ratio** of the dosimeter was measured in a 60 MeV proton beam at the Institute of Nuclear Physics Polish Academy of Sciences in Krakow.

## Results

Estimating the SPR from the HU of the dosimeter gave 1.10 for the SE stoichiometric method and 1.01 for the DE calibrations. The measured SPR for the dosimeter was 0.97.
The SE stoichiometric method thereby **overestimated** the SPR by **13%**, while the overestimation with the DE calibrations was **3%**.

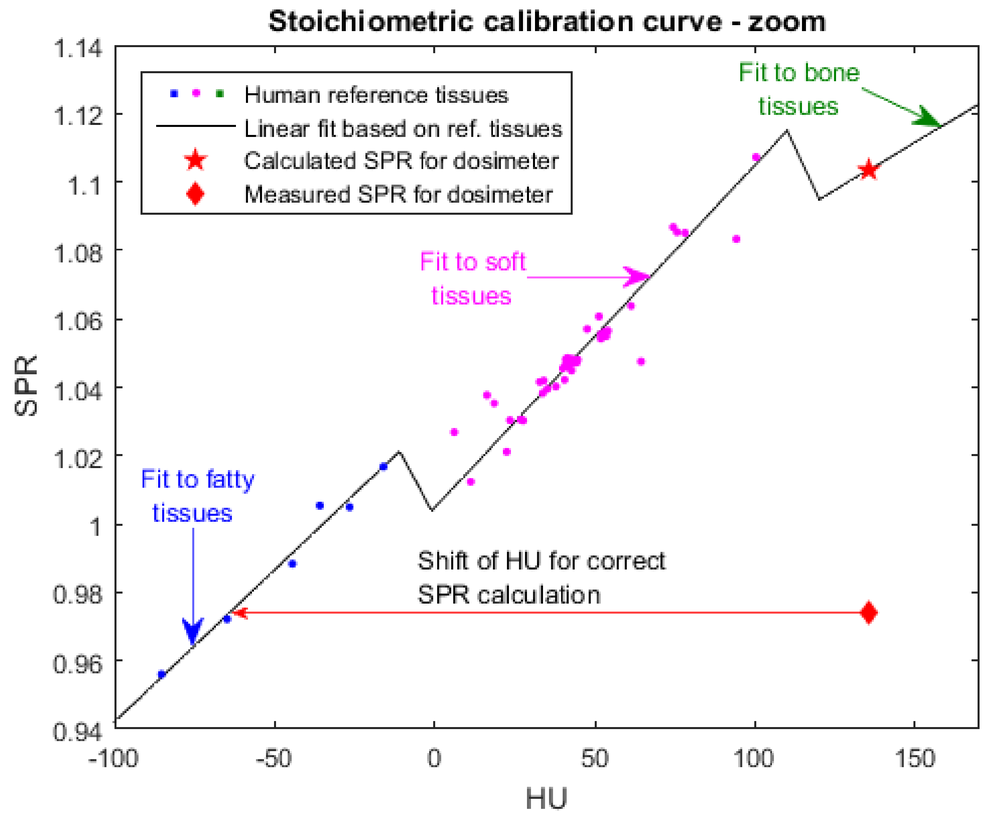


**Fig. 1:** Zoom of **stoichiometric** calibration curve for **single energy CT**. The red arrow shows that the HU must be **manually changed** to give the correct SPR estimate.

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