Frequently Asked Questions
BEAMSCAN Software 4.5 - AI Functionality

When should I use the new deconvolution function?

The most accurate way to measure profiles is to use the microDiamond detector. Sometimes, however, it can be more pragmatic to use a Semiflex 3D ionization chamber instead. The Semiflex ionization chamber has a larger sensitive volume, and the resulting measurement contains averaging effects.
Deconvolution counters these effects, which brings Semiflex 3D much closer to the true dose. This is almost always desirable. Only in rare cases it should be avoided. For instance, when the scan is additionally processed by another tool, which also tries to combat volume effects. It is important to correct these effects only once.

When should I use Denoise?

The most accurate way to measure dose is a microDiamond scan with high integration times. This is, however, not always practical. In such situations **Denoise** improves the quality of fast diamond scans. It behaves similar to classic filters like the moving average filter, but with much better results in regions of high curvature.
Like other filters, it has tradeoffs and cannot improve on scans that are already perfect. It should therefore not be used on scans that already have extremely low noise levels.

What is the relation between AI deconvolution and the fitting-based deconvolution method in BEAMSCAN software 4.4?

Both methods work well, and both methods are derived from classical convolution theory. Therefore, both methods have similar accuracy, with classical convolution theory being the limiting factor. However, the curve-fitting method does not support FFF scans, while the AI method does.

Should I repeat deconvolutions I did with the BEAMSCAN 4.4 method?

No, the BEAMSCAN 4.4 method has similar accuracy as the AI method. There is no need to repeat deconvolutions.

Does the neural net learn from the scans I process?

No, the neural nets were trained and validated at PTW and their weights are frozen.

For which field sizes can the deconvolve function be used?

The function can be used for all fields for which the Semiflex 3D ionization chamber is specified. This means for field sizes between 2.5 cm and 40 cm.

Which AI technique was used?

Both **Denoise** and **Deconvolution** were implemented using the tensorflow.keras framework from Google. Both are convolutional neural networks based on the UNet architecture. They were trained in a two-step process. First synthetic training data sets were generated. Afterwards mean square error between network output and true dose was minimized on these datasets using the ADAM optimizer.

What does synthetic training data mean?
How was the training data obtained?

To train a neural network, one needs a large dataset of examples. Let us look at the deconvolution case in more detail, the denoise case is analogous. Each example must consist of an input curve, which represents a Semiflex 3D scan, and an output curve, which represents a microDiamond scan.
There are multiple approaches to obtain such a dataset. One is measurement and the other is synthetic data. Synthetic data in this case means that we randomly generate profile data with different penumbra settings to cover a wide range of machine types. We then use classical convolution theory to turn these into Semiflex 3D profiles, convolving the profiles with a Gaussian function.

We use measurements only for the final validation of our network. The advantage of this approach is that it protects us from overfitting. When using measurements for the training, there is the danger that the neural net could work well for the linacs used during training, but not work well on all linacs. Synthetic data allows to expose the network to a much larger variation of examples during training to prevent overfitting.

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