An Update of the Depth-Dose Curve of Antiprotons

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The CERN AD-4/ACE project purports to measure the relative biological effectiveness (RBE) of antiprotons.

Compared to protons, antiprotons feature:

- a doubling of the physical dose in the Bragg-peak
- a localized increase of RBE in the Bragg-peak

We have revisited previously published data (2008) for the antiproton depth-dose curve \cite{1}.

In that paper \cite{1}:

- Monte Carlo calculations were done with SHIELD-HIT, and compared to the experimental data.
- experimental data were measured with plane parallel ionization chambers in a water tank.

In this revision, we:

- \textbf{refine} the experimental data to absolute dose per primary particle
- \textbf{simulate} the exact ionization chamber geometry
- \textbf{translate} dose-to-air to dose-to-water

We observe that

- \textbf{better agreement} between measured data and simulations is obtained using full simulation of ionization chamber compared to scoring directly in water, especially in the plateau region and beginning of Bragg peak
- dose in the Bragg peak is still underestimated.

\begin{figure}[h]
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\includegraphics[width=\textwidth]{depth-dose_curve.png}
\caption{Depth-dose curve for antiprotons compared to protons.}
\end{figure}

\begin{figure}[h]
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\includegraphics[width=\textwidth]{ionization_chamber.png}
\caption{Experimental setup for ionization chamber measurements.}
\end{figure}

\begin{figure}[h]
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\includegraphics[width=\textwidth]{simulation.png}
\caption{Monte Carlo simulation setup.}
\end{figure}

\begin{figure}[h]
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\includegraphics[width=\textwidth]{comparison.png}
\caption{Comparison of measured and simulated depth-dose curves.}
\end{figure}

\begin{figure}[h]
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\includegraphics[width=\textwidth]{histogram.png}
\caption{Histogram of dose distribution.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{scatterplot.png}
\caption{Scatterplot of measured vs. simulated data.}
\end{figure}

\textbf{References}