AbstractID: 7586 Title: Design of a vacuum chamber for a universal proton therapy nozzle

Introduction:
In Intensity Modulated Proton Therapy (IMPT), the position and quantity of the dose deposited by monoenergetic pencil beams are simultaneously controlled, which can offer a more tumor-conformal dose compared to IMRT and 3D conformal proton therapies. We are developing the ability to treat patients with IMPT and double scattering in a single nozzle mounted on a gantry, which is called a universal proton therapy nozzle. A vacuum chamber is one useful method to reduce the beam width in IMPT, however, interactions of the protons with the chamber walls could reduce the energy of the protons and change the lateral profile of the beam in double scattering.

Methods:
A GEANT Monte Carlo simulation was used to compare large-diameter double-scattering fields. Simulated depth-dose distributions and profiles of the dose deposited in the lateral directions in a water phantom were produced to compare configurations with the vacuum chamber to one without a vacuum chamber. Regions of the vacuum chamber that affected the properties of the beam were identified and optimized. Experimental data were obtained using a proton beam with a prototype vacuum chamber installed in the nozzle.

Results:
Without special care, a vacuum chamber designed only to fit the geometry constraints limited the lateral beam profile and adversely affected the longitudinal dose distribution. A properly designed fiberglass-walled vacuum chamber can be constructed that will have negligible impact on the longitudinal dose distribution in double scattering. The flatness of the dose deposited in the lateral direction will be reduced slightly in the direction of the axis of rotation of the gantry.

Conclusions:
It is possible to design an optimized fiberglass-walled vacuum chamber that will be suitable for installation in a universal nozzle. Ongoing studies include simulating a helium-filled chamber as an alternative to a vacuum chamber.