Purpose:
This study reports on the basic physics acceptance testing results of a pre-clinical proton discrete pencil beam scanning (PBS) system (sometimes also known as modulated scanning).

Methods:
The PBS system tested consists of a 230 MeV cyclotron, a continuous range selector and a dedicated scanning nozzle mounted on two instances of a rotational gantry. The following basic field/beam qualities of the system were determined: maximum field size, lateral and longitudinal field uniformity of a one liter cubic uniform field, output stability over time, gantry angle invariance, monitoring system linearity and reproducibility. Ionization chambers, film and scintillation dosimetry were used. A test scan pattern was irradiated to determine beam in air transverse properties.

Results:
A 10 x 10 x 10 cm test field was shown to be homogeneous within 3% laterally and longitudinally at high and low energy taking about 2-3 minutes to deliver an approximate physical dose of 2 Gy. The machine output showed variation of 1% over one month and 1% dependency over 5 tested gantry angles. Pencil beam alignment to gantry iso-center was better than 1 mm. The irradiated test pattern analysis indicated that the delivered fluence map when Gaussian blurred for the measured spot profile agreed within 1.5%/1.5mm gamma factor to the physical measurement. The delivery system resolution exceeded the highest test pattern resolution bars that had been spaced at two line pairs per cm.

Conclusions:
The results suggest that the pre-clinical PBS system delivers homogeneous fluence under nominal test conditions and gives high performance with respect to accuracy, precision and resolution. A higher resolution test pattern is called for in order to determine the intrinsic PBS resolution.