# Tube entrance lens focus control

D.C. Weisser,[1] L.K. Fifield,[1] T.F.G. Kitchen,[1]
T.B. Tunningley,[1] N.R. Lobanov,[1] and A.G. Muirhead[1]

[1]*Department of Nuclear Physics, The Australian National University, ACT 0200, Australia*

The entrance of the accelerator tube in a large electrostatic accelerator imposes a strong lens that dominates the beam optics. The magnification of the lens is large because of the low injection energy, the high voltage gradient of the acceleration tube and the long distance to the terminal. In the absence of the acceleration, the magnification would produce an unacceptably large beam spot at the terminal. The tyranny of the lens is especially irksome when the accelerator is required to operate at a lower terminal voltage than the one corresponding to the nominal gradient at high voltage. One way around the difficulty, used in NEC Pelletron accelerators, is to insert a series of nylon and steel rods that short together units of the acceleration structure at the terminal leaving the ones near the entrance close to the nominal gradient for optimum transmission. This operation takes time and risks the loss of insulating gas. Another alternative used in the 25URC at Oak Ridge National Laboratory, is to focus the beam at the tube entrance, substantially diluting the effect of the entrance lens. The beam then diverges and so requires an additional lens part way to the terminal. This solution is only partially effective and still necessitates use of shorting rods for low voltage operation. The fact that these elaborate strategies are used is evidence that the alternative of lowering the injection energy as the terminal voltage is lowered imposes enough problems that it is not used in practice. We have modeled a solution that controls the voltage gradient at the tube entrance using an external power supply. This not only maintains the focusing effect of the lens but provides the opportunity to tune the beam by adjusting the entrance lens. A 150 kV power supply outside the pressure vessel feeds a controllable voltage through a high voltage feed-through to the fifth electrode of the accelerator tube. Thus 150 kV on this electrode creates the nominal gradient of 30 kV per gap. The beam optics simulations demonstrating the effectiveness of this will be presented along with the design of the tested high voltage feed through. Beam transmission test have confirmed the efficacy of the lens in providing somewhat superior transmission to that achieved with shorting rods. The typical optimal lens voltage is about 80% of the injection energy and displays a broad range of acceptable values when combined with compensating settings for the electrostatic quadrupole lens that precedes the accelerator entrance.