The Brookhaven LINAC Isotope Production Facility (BLIP) Raster Scanning System First Year Operation with Beam*

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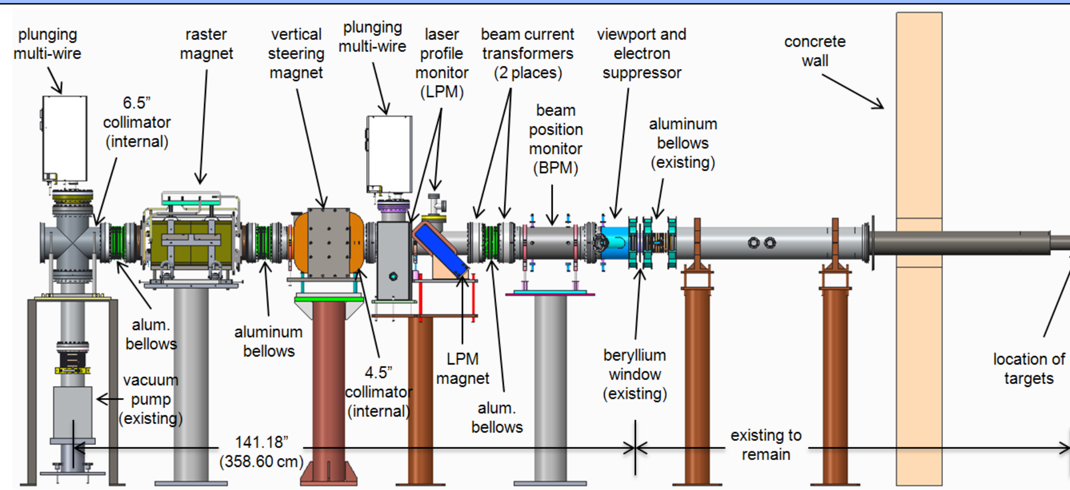
Abstract

Brookhaven National Laboratory's BLIP facility produces radioisotopes for the nuclear medicine community and industry, and performs research to develop new radioisotopes desired by nuclear medicine investigators. A raster scanning system was recently completed in December 2015 and fully commissioned in January 2016 to provide improved beam distribution on the targets, allow higher beam intensities, and ultimately increase production yield of the isotopes. The project included the installation of horizontal and vertical dipole magnets driven at 5 kHz with 90 deg phase separation to produce a circular beam raster pattern, a beam interlock system, and several instrumentation devices including multi-wire profile monitors, a laser profile monitor, beam current transformers and a beam position monitor. The first year operational experiences will be presented.

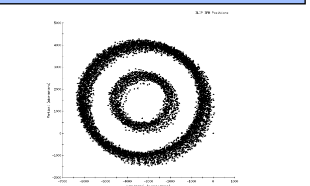
Introduction

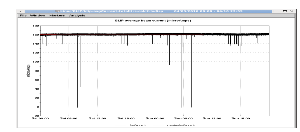
The purpose of the recently completed raster system at BNL's BLIP facility is to "paint" the proton beam on the target in a circular pattern in order to provide a more even distribution of beam on the target material. At IBIC 2014 we reported on the overall system architecture and presented specific details for each system component. This report will focus on results with beam during the first year of operation with the new system.

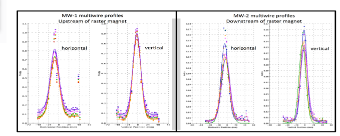
The beam instrumentation devices were installed in the fall of 2014 and commissioned with beam during the 2015 beam run from January to July 2015. The raster magnet and associated power supplies were installed during the fall of 2015, and full system commissioning was quickly completed in January 2016, four months ahead of the schedule that was already shortened by one year. The system was reliably operated with beam for the entire 2016 beam run from January to July 2016.



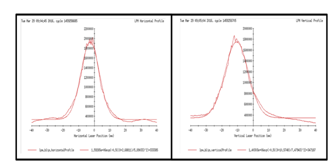
New BLIP beam-line layout.


Beam position monitor data, horizontal vs. vertical (~100 points per beam pulse), March 30, 2016, 117 MeV beam and repeating raster pattern radii of 12.5 mm and 5.5 mm at the target.


A 48-hour period (April 9-10, 2016) of the average beam current for 117 MeV ^{82}Sr production with the raster system on. Note that the average beam current is nearly steady at 160 µA for the entire period.



BLIP horizontal and vertical multi-wire profile measurements for MW-1 (left) and MW-2 (right). Profiles for six beam pulses are overlaid in each plot. The y-scale is the integrated signal strength for each wire. The wire spacing is 3.175 mm and each plane has 32 wires. These profiles were taken with 117 MeV and with the raster on. Note that all overlaid profiles for MW-1 (which is located upstream of the raster magnet) are well aligned, while the overlaid profiles for MW-2 (which is located downstream of the raster magnet) are shifted with respect to each other. This is the expected beam raster behavior.


Horizontal (left) and vertical (right) BLIP laser profile monitor data with curve fits, with raster on. The y-scale is arbitrary units and is proportional to the number of electrons collected at each laser position. In these scans, the distance between each data point is 0.5 mm. A total number of 161 laser positions are provided. Each position value is the average of 24 points, where each point is a narrow slice of one beam pulse.

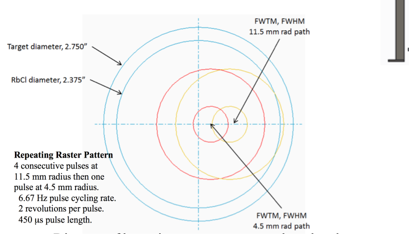
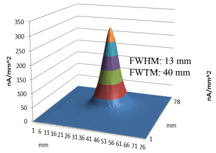
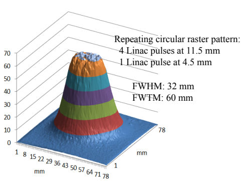


Diagram of beam images on on target plotted at the right most positions for 2 circular raster patterns.

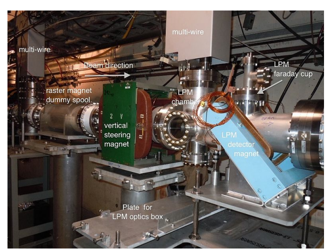


Beam distribution without raster

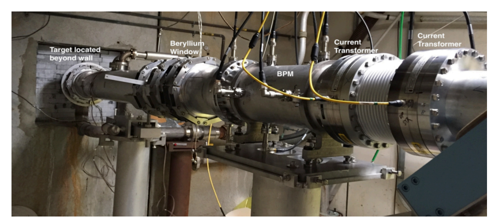


Beam distribution with raster

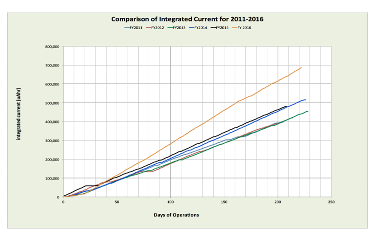
Comparison of beam profiles on target with and without rastering.
117 MeV, 100 µA, Dec. 24, 2015
The integral of the beam distribution is equivalent for both profiles.
Note that the y-scale for the non-rastered profile is about 5 times the y-scale for the rastered profile.



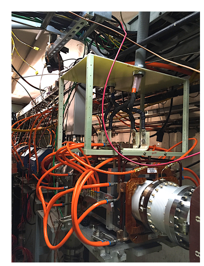
Equipment in BLIP tunnel prior to installation of raster magnet



Downstream section of BLIP beam-line



Plot of annual BLIP integrated currents from 2011 to 2016.
The total integrated current increased 48% from 2015 to 2016.


Raster magnet installed in beam-line


Equipment racks in the BLIP control room