Development of a beam pulse monitor for the heavy ion accelerator facility

D. Tsifakis, N. R. Lobanov, P. Linardakis

Department of Nuclear Physics, Research School of Physics & Engineering, The Australian National University, Canberra, Australia.

INTRODUCTION

The Australian National University (ANU) Heavy Ion Accelerator Facility (HIAF) comprises of a 15 million volt electrostatic accelerator (NEC 14UD) followed by a superconducting LINAC booster. The LINAC consists of four cryostats, each with three split loop resonators (SLR), operating at a frequency of 150 MHz. The pulsing of the DC beam provided by the tandem accelerator is performed by a low energy buncher, two high energy choppers and a superconducting, quarter-wave resonator superbuncher (SB). The LE buncher compresses the beam to pulses with typically 1.5 ns FWHM while the superbuncher typically produces pulses of approximately 100 ps FWHM. There are a number of techniques required to tune the LINAC, amongst them is the beam pulse monitor presented in this poster. The monitor provides the operator with a time profile of the beam which is necessary for the adjustment of amplitude and phase of the pulsing system. It has been developed by the department of Nuclear Physics academic staff and it has proven to be simple to operate and highly reliable.

METHOD DESCRIPTION

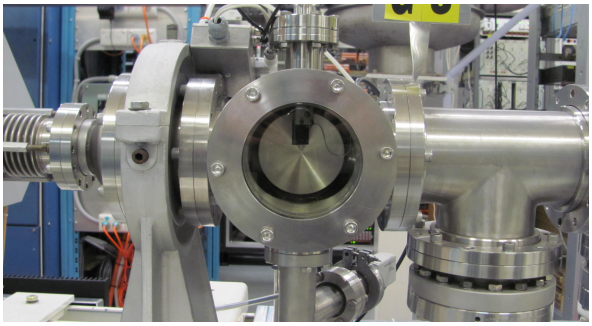


Photo of the beam pulse monitor. The tantalum target, mounted at 45 degrees to the beam, can be seen through the viewing port. The target is moved out of the path of the beam when not using the beam pulse system.

The beam pulse monitor consists of the following:

- Barium fluoride (BaF_2) scintillation detector to detect prompt γ-rays from beam striking a tantalum target
- Detector output is connected to a constant fraction discriminator (CFD) which produces a fast logic signal used for timing
- The CFD output is connected to the "start" input of a time-to-analog (TAC) converter
- The 150 MHz master accelerator RF clock is used to produce the "stop" TAC signal, which is 9.375 MHz (1/16th of the master RF) and is the frequency of the low energy buncher
- At most one γ-ray per beam pulse
- A multi-channel analyser (MCA) is connected to the TAC output and produces a histogram representing the beam pulse time profile

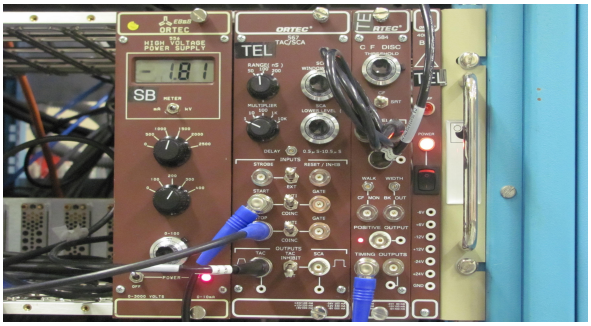
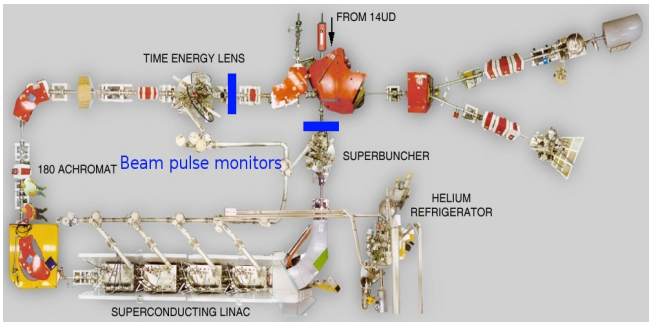


Photo of the electronics of the beam pulsing system.

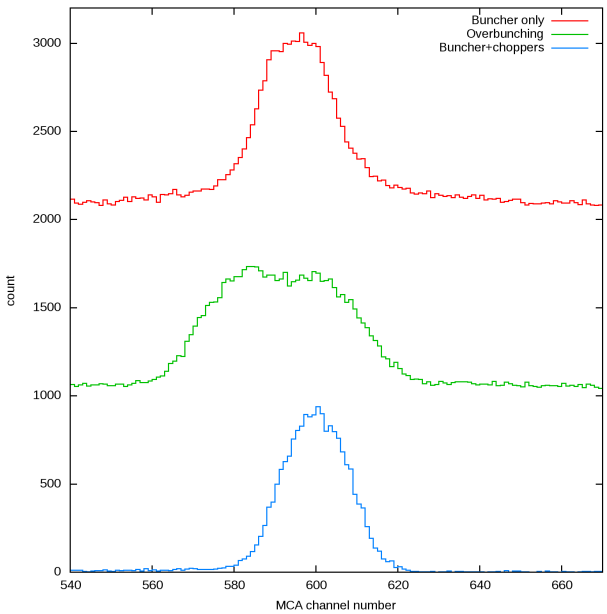


Composite photo of the ANU LINAC: the location of the two beam pulse monitors is highlighted in blue.

RESULTS AND DISCUSSION

The following plot shows the beam pulses as seen by the first beam pulse monitor, located before the superbuncher. The beam details are:

- $^{16}O^{+6}$ beam, 72 MeV energy, from 14UD accelerator set to 10.3 MV terminal voltage, using single electron stripper at terminal
- Beam current approximately 50 nA
- MCA set to 1024 conversion range and has a calibration factor of 8.47 channels per nanosecond
- Collection time is 60 seconds



- Top histogram (shifted up by 2000 counts) shows typical pulse produced by the low energy buncher only
- Middle histogram (shifted up by 1000 counts) shows double peaking which is an effect of overbunching
- Bottom histogram shows the typical pulse shape with LE buncher and HE choppers. The reduced background in the time between pulses is an effect of the high energy chopper operation