The aim of the AMIT cyclotron is to deliver an 8.5 MeV, 10 μA CW proton beam to a target to produce radioisotopes for PET diagnostics. Such a small cyclotron poses some challenges to the diagnostics design for commissioning and normal operation due to its small size, so miniaturized devices should be built in order to fit in the available space. Two sets of diagnostics have been designed, each one aiming at a different phase of the machine lifecycle. During normal operation the stripping foil and the target will be used to measure the current, a dual transverse profile monitor based on a scintillating screen will be used for interceptive measurements and a Fluorescence Profile Monitor will measure the beam position and the horizontal profile without intercepting the beam. During first stages of commissioning the dual transverse profile monitor and the target will be substituted by an emittance monitor based on a pepperpot to characterize the beam at the cyclotron exit. Also a movable interceptive Beam Probe will be located inside the cyclotron to give information about the beam during acceleration. Additionally, a test bench for the characterization of the beam right after the exit of the ion source has been built with different instruments to measure the beam current and the transverse profile. The main challenge of this cyclotron with respect to the beam diagnostics is its compactness. At 4 T and 8.5 MeV the proton bending radius is about 10 cm, limiting enormously the beam diagnostics which can fit inside the cyclotron. During Phase 2 the only possible diagnostic to employ is the moveable beam probe inside the cyclotron. The mechanical is similar to the one tested in Phase 1, but with a few changes to improve accuracy, mechanical stability and smoothing the overall response to the force applied by the piezoelectric motor. Graphite has been chosen for the probe in order to withstand the 85 W continuous beam power in an area of few square millimeters and keep its activation as low as possible for easy maintenance. Simulations of the same order of magnitude over time performed with ANSYS show that the probe should withstand CW operation mode although the RF system is capable of pulsed mode. Results are shown in Fig. 2.

The current and energy measurements in the CDL will come from a dedicated energy monitor. With this information we will be able to evaluate the beam losses in the transport from the stripping foil to the target and the position. A peperpot based emittance measurement device has been chosen to characterize the beam during commissioning. In its design the same considerations of the Beam Probe were taken into account, albeit it is expected to activate less the the BP due to its use only during commissioning.

The transverse profile is given by two independent methods, an Al2O3 fluorescent screen and a Fluorescent Profile Monitor. The optical system is shared between both of them. The screen is dedicated to the commissioning phase and initial tuning during normal operation and the FPM intended to monitor the beam during the irradiation. Due to the small available space for diagnostics the compactness of the diagnostics was chosen an approach based on image fiber bundles and micro video lenses. Because of the small light output of the residual gas fluorescence [2] a detector based on an image intensifier and a CID camera was chosen (Fig. 3), with the possibility to install a gas leak valve to use different gases to enhance both the light output and profile accuracy. It has been also foreseen the possibility to install an optical filter wheel to select different transitions.

**Conclusions**

A set of diagnostics has been designed and constructed to be installed in the AMIT cyclotron. It includes interceptive devices which are very reliable and are well established in the field with non-interceptive ones which can provide information without affecting the beam. Although the size requirements are very strict the designed instruments fit into the specifications and provide measurements of the beam parameters during commissioning and normal operation.

**References**


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**Diagnostic layout**

The diagnostic layout of Phase 1 consists of an intercepting beam probe to measure the total beam current and a wire scanner to measure both the vertical and horizontal profiles of the beam. The current readings are performed simultaneously by a Keithley 6485 Picoammeter and with the measure of the voltage drop in a shunt resistor. Due to the low beam power (less than 1 W) no special thermomechanical requirements are needed, hence a simple stainless steel probe and copper wires are used. During this phase we have been steadily increasing the voltage extraction and the beam current.

**Conclusions**

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**References**