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Development of an Optical Diagnostics System for Arc Discharge Ion Sources

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The UK Science and Technology Facilities Council (STFC) and iThemba Laboratory for Accelerator Based Sciences (LABS) are currently collaborating on the development of an optical diagnostic system for monitoring ion sources. The proposed work builds on the pioneering development of optical diagnostics at ISIS. A particular interest with this work is for monitoring the Penning ion sources at both facilities under operational conditions. At iThemba LABS the Penning source is used to produce a proton beam whereas it produces negative hydrogen ions at ISIS. At iThemba LABS the protons are produced by electron impact ionization of hydrogen atoms producing a 500 - 700 ⊠A beam at the centre of the 8 MeV cyclotron. At ISIS the H– ions forming a 55-60 mA beam are produced on the caesiated molybdenum cathode surfaces of the ion source and injected into an RFQ and linac. A common mode of failure of both ion sources seems to be intricately linked to erosion and subsequent poisoning of the plasma surfaces. By monitoring the optical emission spectrum emitted from the plasma, the results can be analysed and used to guide operational decisions e.g. caesium feed rate at ISIS or filament heating current at iThemba LABS. With this contribution we will report on prototyping results of various optical detectors (CCD spectrometer, Avalanche PhotoDetectors, Single-Photon Avalanche Detectors and PhotoMultiplier Tubes) viewing the slit and extraction electrode of the ISIS source and using bandpass filters for wavelength selection. Detection techniques, first results of time-resolved hydrogen and caesium optical emissions and their dependencies on the ion source operational parameters, and prototyping status in general will be reported on. Additionally, we will discuss the challenges foreseen when deploying the optical emission monitoring technique developed for the ISIS ion source to monitoring the internal ion source at iThemba LABS.

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