

Energy diagnostics of the TOP-IMPLART linac proton beam using radiophotoluminescent Bragg curves in lithium fluoride detectors

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In the framework of the TOP-IMPLART (Terapia Oncologica con Protoni – Intensity Modulated Proton Linear Accelerator) project [1,2], the energy spectrum of the proton beam delivered by the TOP-IMPLART linac at ENEA Frascati has been extensively characterised in recent years through the visible radiophotoluminescence (RPL) emitted by stable aggregate colour centres (CCs) formed in lithium fluoride (LiF) upon irradiation. Among these, F₂ centres – consisting of two electrons trapped at two neighbouring anion vacancies – emit red light under blue-light excitation.

Assuming point-by-point proportionality between the RPL intensity and the locally deposited dose, justified by the hypothesis of single-track dominance in the formation of the F₂ centres for doses below approximately 10⁵ Gy, accurate analysis of the RPL replica of the underlying Bragg curve, acquired by fluorescence microscopy, enables high-resolution energy diagnostics of the proton beam responsible for generating these defects [3].

Over the past few years, several techniques and tools have been developed for the detection and analysis of these experimental RPL profiles. The analysis typically relies on a theoretical model of the proton Bragg curve in LiF [4], incorporating relevant detector geometric and physical properties, such as crystal dimensions [5] and irradiation angle [6]. This work reviews the methodology and its application to the energy diagnostics of the proton beam produced by the TOP-IMPLART linac.

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