In-beam LET Measurements of 1.3 GeV Carbon Ions for the Calibration of a PADC Neutron Track Dosimeter

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1) Introduction

Carbon ions are extensively used for high precision hadron-therapy for its ballistic properties and high relative biological effect (RBE). Due to the sharp Bragg peak, the dose can be deposited specifically to the targeted tumor cells[1], avoiding unwanted side-effects in the surrounding healthy tissue. In this study, the LET spectrum of the heavy ions along a beam of 1.3 GeV Carbon ions has been measured in stacks of 1.5 mm Intercast PADC detectors at the CNAO[2] facility. Using the LET_{nc} spectrometry technique described in M. Caresana et al. [3], the track parameters have been used to measure the LET distributions of high-energy hadrons impinging on a stack of track detectors.

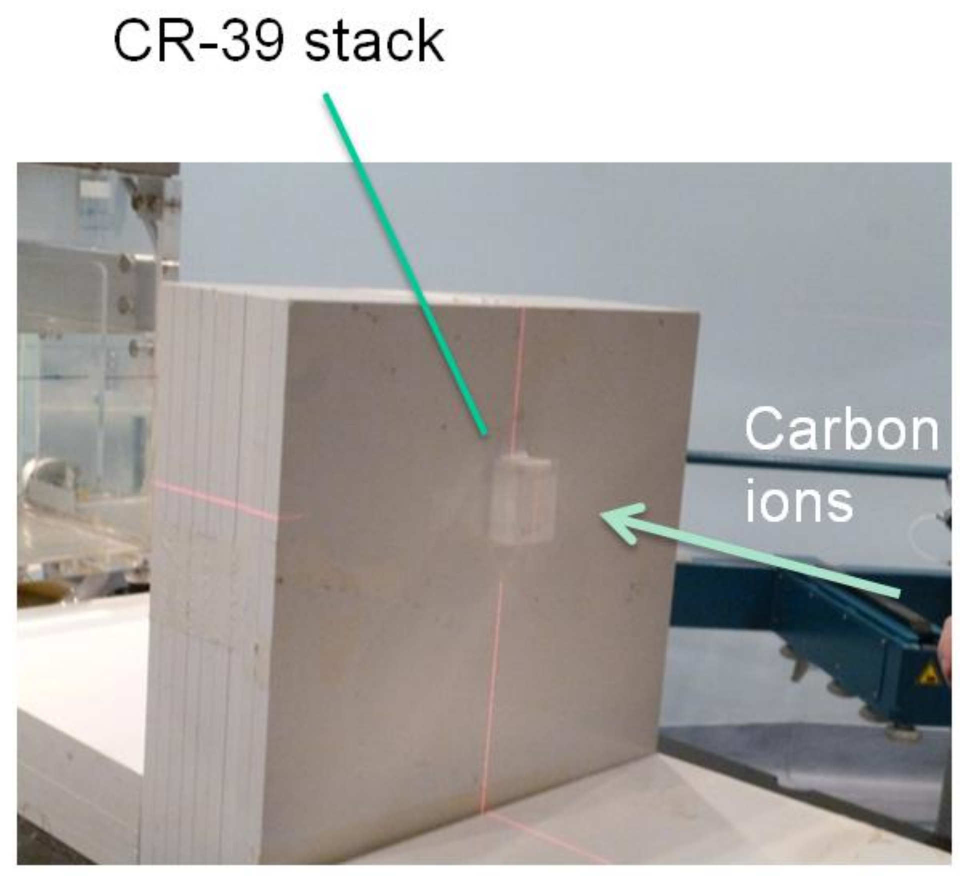

Figure 1. Stack of PADC detectors aligned in the 115.2 MeV/u Carbon ions' beam

2) LET spectrometry using PADC detectors

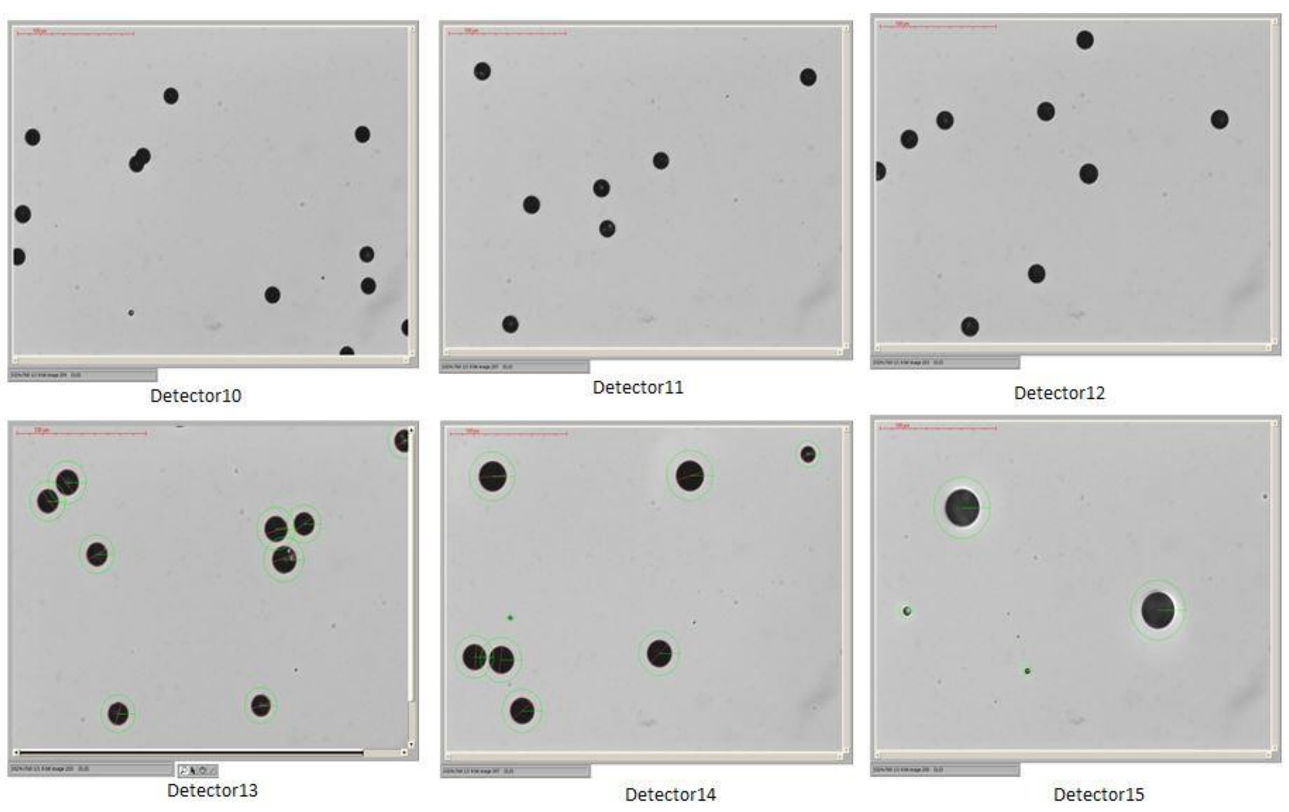

Figure 2. *Tracks parameters and density variation along the beam until the Bragg peak in the tissue-equivalent PADC stack*

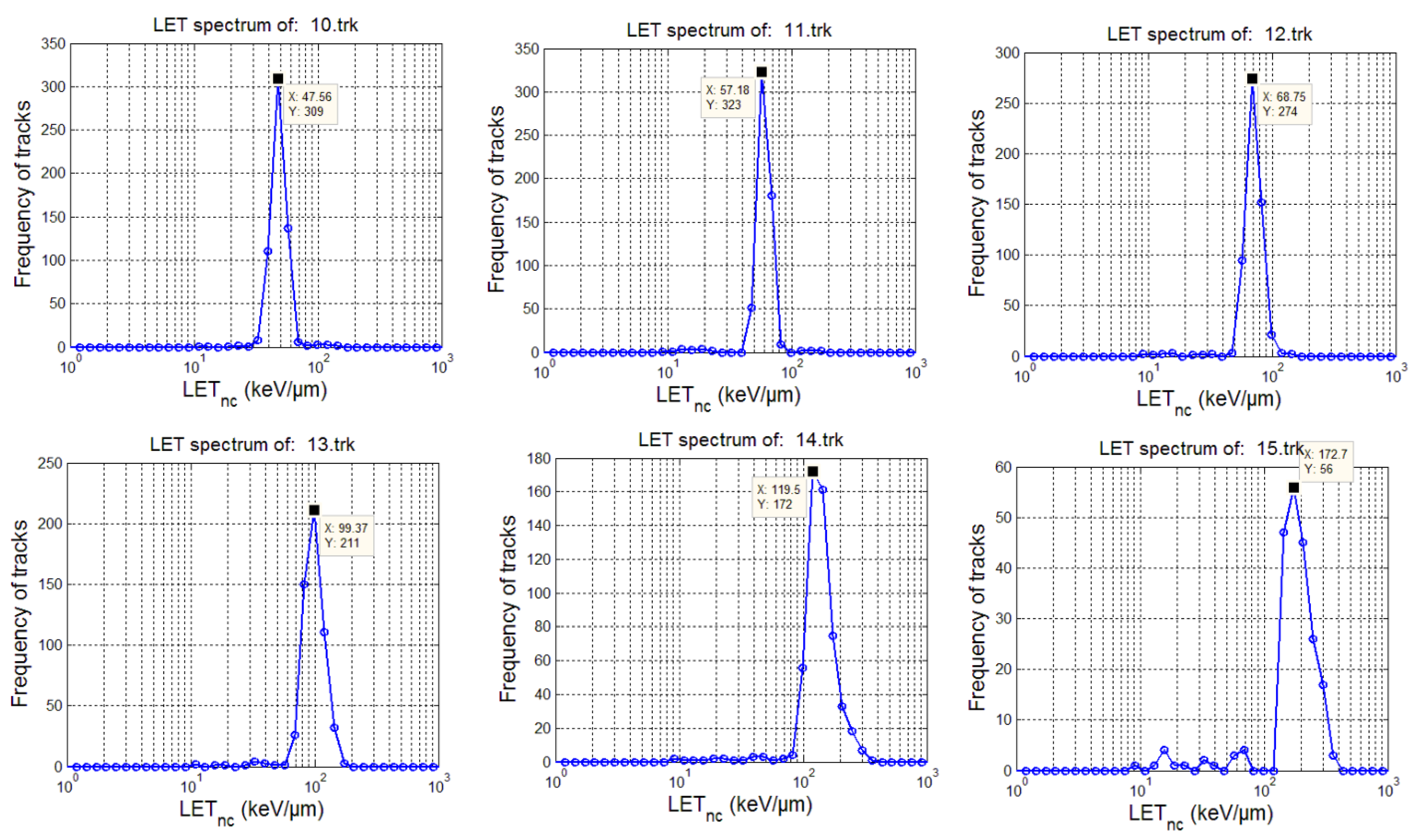

Figure 3. *Illustration of the LET_{nc} distributions calculated from the track parameters measured using the Politrack PADC reader [3]*

3) Measurements compared to FLUKA

A stack of 16 detectors was placed in the 1.3 GeV Carbon beam. The LET_{nc} [3] of the Carbon ions was measured until the Bragg peak and compared to the FLUKA code simulations. The comparison between the measured LET_{nc} and the calculated LET is shown in figure 4.

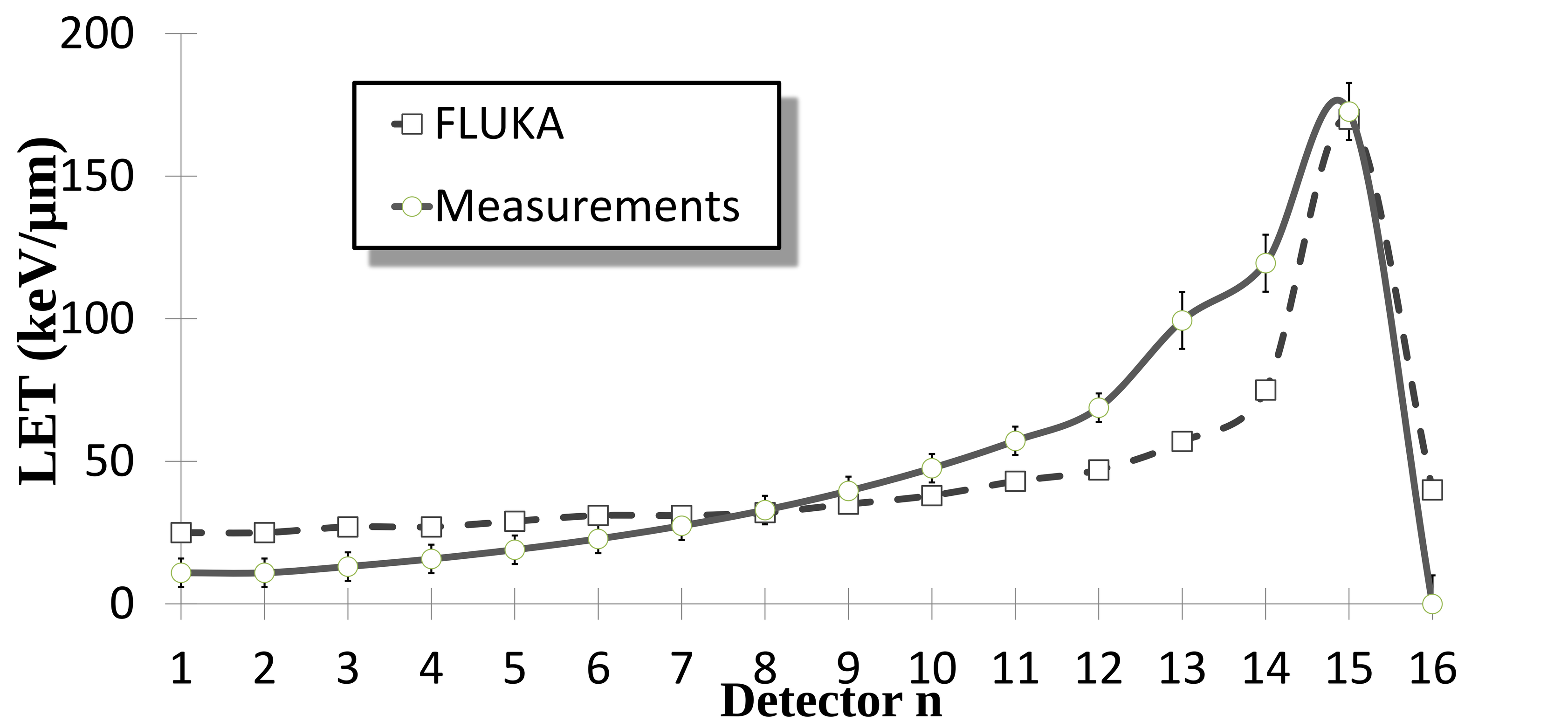

Figure 4. *LET_{nc} of Carbon ions measured in the experiments compared to the Carbon ions' LET calculated using the FLUKA code [5]*

4) Conclusion

The results show that, for a carbon ion beam, the LET spectrometry along the beam using the LET_{nc} method from M. Caresana et al. [3] show an overall accptable agreement between measured and calculated LET. However, at some depths the agreement is not sufficiently good to evaluate a reliable dose response. Former research [4] shows that the response in terms of LET in the range 10 – 200 keV/µm gives good results with light particles (proton and alpha) but further investigations are needed as far as carbon ions are concerned.

5) References

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[5] A. Ferrari, P.R. Sala, A. Fasso`, and J. Ranft, "FLUKA: a multi-particle transport code", CERN-2005-10 (2005), INFN/TC_05/11, SLAC-R-773