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## Online measurement of deposited energy by ion beams using bremsstrahlung X-rays

Flavien Ralite<sup>[1,\*]</sup>, Charbel Koumeir<sup>[2]</sup>, Ferid Haddad<sup>[1,2]</sup>, Vincent Metivier<sup>[1]</sup>, Noel Servagent<sup>[1]</sup> and Nicolas Varmentot<sup>[2,3]</sup>

[1] Laboratoire SUBATECH, IMT Atlantique, CNRS-IN2P3, Université de Nantes / Nantes / France

[2] GIP ARRONAX / Saint-Herblain / France

[3] Institut de Cancérologie de l'Ouest / Saint-Herblain / France

The detection of bremsstrahlung X-rays emitted directly by low-Z medium is a promising noninvasive technique to obtain all or part of the information of the deposited energy online [1], in hadrontherapy framework. The aim of this study is to understand the relation between the bremsstrahlung and the deposited energy in the medium. The experimental set-up allows the irradiations of targets (PMMA,C,Al) by alpha particles or protons delivered by the cyclotron ARRONAX (energy < 70MeV). The detection of bremsstrahlung X-rays is performed using a silicon detector. A theoretical model that takes into account the different contributions of bremsstrahlung (QFEB, SEB and AB) was used to simulate the emitted bremsstrahlung spectrum [2].

A first experiment, with 68MeV alpha particles, shows a good agreement between measured and simulated spectrums (c.f. figure). The overall number of bremsstrahlung X-rays detected for one gray received by the medium is  $1060 \pm 140$  as compare to 970 X-rays/Gy determined by simulation. Thus, the number of X-rays per gray demonstrates a good sensibility. In order to investigate the evolution of this bremsstrahlung X-rays signal as a function of the deposited energy in the medium, experiments using different beams have been performed. The analyses are in progress and the results will be presented. These experiments are also helpful to study the predominance of bremsstrahlung components and understand the small discrepancies observed between our measured and simulated data.

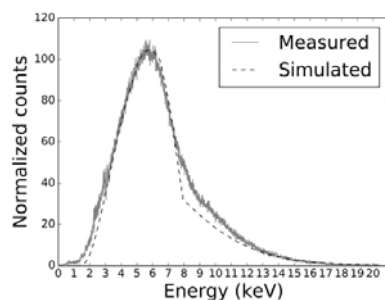


Figure: Bremsstrahlung spectrum measured (full line) and simulated (dashed line) from PMMA target.

[1] L. Schwob et al, New beam monitoring tool for radiobiology experiments at the cyclotron Arronax, Radiation Protection Dosimetry, 166(1-4), 2015, 257-60.

[2] K. Ishii et al, Continuous X-rays produced in light-ion-atom collisions, Radiation Physics and Chemistry, 75, 2006, 1135-1163.

\*corresponding author: flavien.ralite@subatech.in2p3.fr