The MONDO Project
a neutron tracker for particle therapy applications

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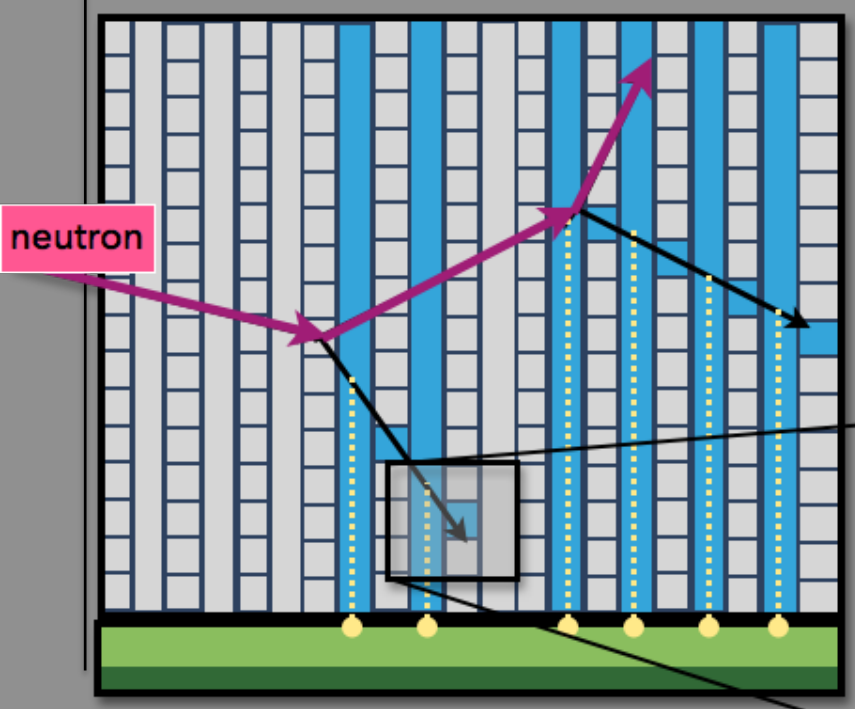
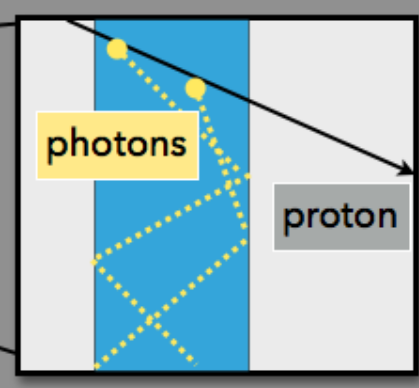
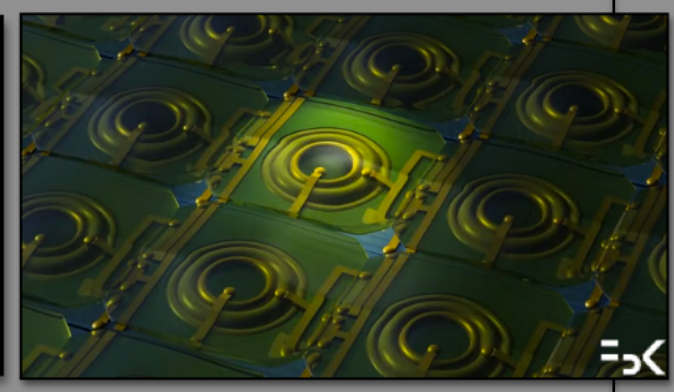
INTRODUCTION. During Particle Therapy treatments the patient irradiation produces, among different types of secondary radiation, an abundant flux of neutrons that can release a significant dose far away from the tumour region. The additional dose due to secondary neutrons can be responsible on the incidence of Secondary Malignant Neoplasie [1]. The technical challenges posed by a neutron detector aiming for high detection efficiency and good backtracking precision will be addressed within the MONDO project, whose main goal is to develop a tracking detector targeting fast and ultrafast secondary neutrons [2],[3].



THE NEUTRON TRACKING PRINCIPLE: plastic scintillators will be used as scattering and detection media. The tracker is being developed as a matrix of **squared scintillating fibres** of 250μm side. The image are acquired using CMOS **Single Photon Avalanche Diode** arrays. The sensor is realized by FBK and is not commercial yet. The first prototype is under test and a new device is in development according to the characteristic of the expected signal.





Full MonteCarlo Simulation of the tracker with FLUKA code has been performed: 10 x 10 x 20 cm^3. The **energy deposit** in the fibres and the number of produced photons per protons has been studied.

A small **prototype** of the tracker has been constructed in order to study the effective scintillation light

Deposit energy in fiber	150 keV in 250 μm
Fiber light yield	8000 γ/MeV
Fiber trapping efficiency	7%
N_{γ}^{prod}	80 γ
Sensor QE	40%
Sensor Fill Factor	40%
N_{SpadOn}	60%
$N_{ph.el}^{pixel}$	4 γ

FBK sensor

Test beam with electrons performed at LNF beam Facility (**BTF**) on single and multiple layers. preliminary results on **single layer** efficiency.

THE POTENTIAL IMPACT. A deep knowledge on secondary neutron production **yields**, as a function of production **angle** and **energy** will immediately be translate in a more detailed TPS models improving the overall treatment quality. Thus, a reduction on safety margins that allows more patients to be treated with Particle Therapy. The estimation of the contribution to the total dose induced by neutrons in region away from the tumour volume is particularly essential for paediatric Treatment Planning System.

[1] W.D.Newhauser, M.Durante, Assessing the risk of second malignancies after modern radiotherapy Nat. Rev. Cancer 11 438 doi: http://dx.doi.org/10.1038/nrc3069
[2] Marafini et al., MONDO: a neutron tracker for particle therapy secondary emission fluxes measurements NIM A 58300 doi:10.1016/j.nima.2015.10.109
[3] M.Valle et al., The MONDO project: A secondary neutron tracker detector for particle therapy. NIM A In Press, Corrected Proof doi:10.1016/j.nima.2016.05.001

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