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### *Saturation phenomena for ultra short Free Electron Laser pulses*

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Saturable absorption was recently observed in transmission measurements above the LII,III edge of pure Al thin films using ultra short x-ray pulses at a free-electron-laser (FEL) facility . [1] The high fluence reachable by FEL pulses, the shortness of the pulse duration, and the typical lifetime of the excited state, are all important factors enabling observation of the phenomenon. We devised a simplified theoretical model describing the saturation phenomenon using a three- channel model containing ground, excited and relaxed states. This phenomenological model explicitly includes the interaction between the solid and photon field in semi classical way, and the resulting non-linear coupled equation is solved numerically. We successfully applied this model to recent experimental results obtained using FEL radiation. [2,3]

[1] B. Nagler et. al., *Nature Physics* 5, 693 - 696 (2009), [2] A. Di Cicco et al, "Probing matter under extreme conditions at the free-electron-laser facilities: the TIMEX beamline", *Notiziario - Neutroni e Luce di Sincrotrone*, 18 19-25 (2013), [3] K. Hatada and A. Di Cicco, "Modeling saturable absorption for ultra short X-ray pulses", *J. Electron. Spectrosc. Relat. Phenom.* , Submitted

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