Investigation of the pellet ELM triggering by fast visible imaging on JET

G. Kocsis[1], J.A. Alonso[2], B. Alper[6], G. Arnoux[6], J. Figueiredo[3], D. Frigione[4], L.Garzotti[6], J. Hobirk[5], M. Maraschek[5], M. Lampert[1], P.T. Lang[5], G. Petravich[1], R. Wenninger[5] and JET-EFDA contributors*

JET-EFDA, Culham Science Centre, OX14 3DB, Abingdon, OXON, UK
[1]*KFKI RMKI, EURATOM Association, P.O.Box 49, H-1525 Budapest-114, Hungary,*
[2]*Laboratorio Nacional de Fusion, Euratom-CIEMAT, 28040 Madrid, Spain,*
[3]*Association EURATOM–IST, Av. Rovisco Pais, 1049-001 Lisbon, Portugal,*
[4]*Associazione EURATOM-ENEA sulla Fusione, CP 65, Frascati, Rome, Italy,*
[5]*MPI für Plasmaphysik, EURATOM Assoc., Boltzmannstr. 2, 85748 Garching, Germany,*
[6]*Euratom/UKAEA Fusion Association, Culham Science Centre, Abingdon, OX14 3DB, UK*
*See the Appendix of F.Romanelli et al., Fusion Energy (Proc. 22nd Int. Conf. Chengdu) IAEA, 2008

Pellet ELM pacemaking is one of the recently proposed method to mitigate the ELM caused heat load on plasma facing components of an ITER class tokamak. The increase of the ELM frequency by frequent injection of shallow penetrating cryogenic pellets seems to be a working technics which was demonstrated on ASDEX Upgrade and JET. To optimize this tool the understanding of the underlying physical processes of the pellet ELM triggering is inevitable. The basic question to be answered is the nature and the location of the seed perturbation - introduced by the ablating pellet - which is indispensable for triggering a type-I ELM. This was already investigated on ASDEX Upgrade revealing that the ablating pellet has to reach the middle of the edge pedestal to be able to trigger an ELM which was detected about $50\mu s$ after the pellet reached the location of the seed perturbation. Studying the pellet caused MHD perturbation and plasma cooling on ASDEX Upgrade it was concluded that the most probable seed perturbation is the modification of the plasma electron pressure. Either the non axisymmetric, field line elongated, high pressure cloud which is probably localized around the pellet or the steeper axisymmetric pressure gradient created in front of the pellet by cooling the according magnetic surface can be formed during a few tens of μs and can be responsible for the ELM trigger.

On JET the pellet ELM triggering was investigated by comparing the onset of natural and pellet triggered ELMs and this will presented in this contribution. The pellets were injected on the midplane from the LFS of the torus. To detect the visible radiation during pellet ablation a Photron APX camera has been recently installed on the 'visible branch' of the infrared endoscope. Its view involves the full poloidal cross section of the vacuum vessel covering a toroidal extent of 90 degrees together with the outboard plasma facing components. The cross section of the pellet injection falls into the middle of the view which makes this observation competent on the $10\mu s$ timescale.

Pellet injected into type-I ELMy H-mode plasmas triggers an ELM shortly after the onset of the ablation. On fast framing images (70kframe/s) formation of a field line elongated filament is observed which probably triggers an ELM seen as high amplitude activity on Mirnov coil signals. At the same time bright spots on limiter elements appear - showing the interaction of this filament with the plasma facing components. Their movement shows the toroidal/poloidal rotation of this filament (after detachment from the pellet) which is slowed down after about $100\mu s$. For natural type-I ELMs such helical structures can also be observed but the onset of this high activity plasma-wall interaction does not necessarily coincide with the MHD onset of the ELMs but varied between 0 and $100\mu s$. From these observations it may be concluded that for LFS pellet injection the triggered ELM grows directly out of the cold, high pressure pellet cloud but the natural ELMs born at arbitrary toroidal location and it takes some time until the perturbation become detectable in the observation volume of the visible imaging.