WS101-8: Requirements of New Tools for Challenges in Ultrafast Radiation Chemistry

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Developing the study of radiation- condensed matter interactions to different scales of time and space, with advanced detection techniques, to understand real-time defect formation and oxidation processes occurring under irradiation in biological system are very challenging. In fact, the two past decades have been an encouraging period in the development of pulse radiolysis capabilities that has reversed an earlier trend of decline in number and accessibility. The new technology based on photocathode electron guns accelerators, has emerged and spawned a large new generation of fast accelerator facilities. These installations in Brookhaven (US), at Orsay (France) in Tokyo and Osaka (Japan) are developing advanced experimental techniques and making sophisticated experiments available to a larger community of researchers. New inaccessible research area such as, direct effect, solvation dynamics of electron in alcohol and high temperature spur reactions were well studied. Nevertheless, important domains remains unreachable for example the observation of the redox reactions before solvation in water or the charge localization in biosystems occurring in subpicosecond range. Moreover, the processes induced by ionizing radiation concern several applications. Nuclear energy, from upstream to downstream of the cycle and radiobiology and radiotherapy are concerned by the chemical effect of the ionizing radiation. For these applications, a thorough knowledge of physical and chemical processes of radiation effects in the objective to master and to control the operation of equipment's, ensuring the safety and performance is needed.

Up to now the time resolution of the energetic electron pulse available is not, enough short and it can be improved. The best time resolution of electron pulses with enough charge (more than 0.2 nC) is limited to picosecond. Femtosecond time resolution of energetic electron beam coupled with specific laser spectroscopy can be very helpful to study subpicosecond reactions occurring during the direct effect and also during the scavenging of electron and hole in water before the hydration process. The energy of the electron ranging from a few MeV and 20 MeV, must be mono-energetic.

In addition, the fast and ultrafast ion beams are not available for pulse radiolysis. The earliest physiochemical processes induced by high LET (Linear energy transfer) are studied only with microsecond time resolution by using mainly the heavy ion beam produced by cyclotrons. A high number of studies need ion beam (mainly Proton and Alfa beam) with high energy (from 20 MeV to 100 MeV) with a time resolution of less than 1 ns. These new tools of pulsed electron and heavy ion beams are indeed to face the new challenges in radiation chemistry and radiation damage.