Frontier of Materials, Life and Particle Science Explored by Ultra Slow Muon Microscope

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The Ultra Slow Muon Microscope (USMM), under construction at the U-line of the Muon Facility in J-PARC/MLF, will be the first experimental instrumentation in the world possessing two novel muon sources with unique capabilities: **an ultra slow muon beam** for depth profiling from the surface to the interior of a material, across interfaces, with nanometer resolution near surface, and **a muon micro-beam** for probing the interior of a material with a resolution of several micrometers at the stopping position. The new spatial imaging method, USMM, is developed for studies of local functional properties and their dynamical aspects near surface and buried interfaces which play key roles in materials and life sciences, such as electron and spin density of states, charge, spin transportation, defects and vacancies in catalytic reaction and so on. Further cooling and sharpening by acceleration of the ultra slow muons to higher energies will open up a new frontier research field of physics, beyond the standard model, by utilizing muons to test fundamental properties in the lepton sector, e.g., precise measurements of the muon anomalous magnetic moment and electric dipole moment .

Ultra slow muons are generated by resonant ionization of thermal Mu atoms evaporated from the surface of a hot tungsten foil, placed at the intense surface muon beam line. In order to efficiently ionize the Mu near the W surface, we adopted a resonant ionization scheme via the {1S-2P-unbound} transition.

The principle to generate ultra slow muon was verified at the Booster Meson Facility of KEK in 1995 by Nagamne et al. Its ultimate performance in time and spatial resolution was verified in collaboration with KEK and RIKEN. The world-strongest pulsed muon beam at J-PARC together with the cutting-edge pulsed laser technology to generate the world-strongest pulsed VUV laser developed in RIKEN realize the ideal quantum beam with practical intensity of the order of 10^5 event/s. Progress of the development as well as the science explored by the new quantum beam will be reported.
http://slowmuon.jp/engish/