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Design study of a white muon beamline at RCNP for radioisotope production via muon capture reaction

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The MuSIC beamline at the Research Center for Nuclear Physics (RCNP), Osaka University, provides a high-intensity continuous muon beam using proton beam (392MeV, 1.1 μA). Pions and muons generated in the graphite target are efficiently captured by the large solid angle superconducting solenoid magnet and are transported to the downstream[1] . At the experimental port located at the end of the beamline, monochromatic muon beam can be selected using dipole magnets. In contrast, a broad momentum muon beam, namely "white muon beam"was observed just downstream of the solenoid magnet[2] . Since negative muons are efficiently captured by target nuclei once stopped, the white muon beam is particularly advantageous for radioisotope (RI) production via the muon-induced capture reactions. We therefore explore the feasibility of modifying the existing muon beamline to provide a dedicated white muon beam and to enable efficient RI production via muon capture reaction. This study focuses on two objectives using a radium (226Ra) target.
The first objective is the production of francium isotopes (221Fr-225Fr), which are of particular interest for electron electric dipole moment (EDM), due to their high sensitivity[3] . Since francium isotopes do not occur naturally, a stable and high-intensity production method is required for practical use.
The second objective is the production of Actinium-225 (225Ac) for medical applications, which is utilized for an α-emitting radioisotope for alpha targeted therapy[4] . With the future development of an extremely high-intensity muon source, it could open the possibility of using white muons as a novel production method. In this presentation, we investigate the beam characteristics of the white muon beam at the MuSIC beamline with the aim of optimizing beam parameters through Monte Carlo simulations. Furthermore, we evaluate the production yields of francium isotopes and actinium via muon-induced capture reaction using the same white muon beam.

References

[1] https://www.rcnp.osaka-u.ac.jp/RCNPhome/music/
[2] S. Cook et al. Phys. Rev. Accel. Beams 20, 030101 (2017).
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