Abstract: At the Paul Scherrer Institute we are developing a novel positive muon beam at low energy by compressing the 6-dimensional phase space of an existing 4.1 MeV muon beam. Muons are stopped in a helium gas target with a cryogenic stop temperature and the phase space compression is done by making use of complex-shaped B- and E-fields.

Introduction

• Device to compress phase space of standard beam by O(10^6) [1]
• For future precision experiments (muon g-2/EDM, Mu 1S-2S spectroscopy, high quality Mu beam from SF/He for gravity experiment [2], µSR)
• Cryogenic He gas stopping target + complex fields
• Fast compression (~6 µs) with efficiency of O(10^-3)

Setup

• Kapton foil with equipotential lines to define E-field
• Sapphire plates to define temperature on top/ bottom

Observed muon compressions

Transverse compression

Longitudinal compression

Working principle

Complex fields

Gas density gradient

Muon drift velocity vector in He gas

\[
\vec{\mu}_D = \frac{\mu_E}{1 + \omega T^2} \left[ \vec{E} \times \vec{B} + \frac{1}{2} \vec{E} \cdot \vec{B} \right]
\]

\(\mu\): muon mobility, \(\omega\): cyclotron frequency, \(T\): mean time between collisions

5T solenoid

Cryocooler

He IN

OUT

\(\vec{\mu}\)

\(\mu = 4.1\) MeV
\(\Delta x = 10\) mm
100% spin polarised

Status

• Transverse and longitudinal compressions were separately demonstrated with different setups [3,4]
• Currently developing a new single-stage setup with both compressions. Muon drifts along both directions were successfully observed

Prospects

• Improving compression by improving |E| (beam test at end of this year)
• Extracting muons into vacuum with differential pumping
• Reaccelerating muons (~keV) and extracting from B-field region