Recent developments in the fast tape-transport system

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The fast tape-transport system has been used for 20 years as part of the precision on-line β-decay facility mounted at the end of the Momentum Achromat Recoil Spectrometer (MARS). It is used to rapidly move high-purity sources collected from MARS to a well-shielded counting location. It consists of two reels, a reservoir reel and a take-up reel, which are mounted independently on two separate decks. Each tape deck has its own vacuum buffer and controls, and the height of the deck is adjustable by motor drive. The distinctive features of our tape-transport system are that it operates entirely in air and it moves collected sources very rapidly, covering the 90 cm to the counting location in less than 200 ms.

In recent years we have maintained and optimized the tape-transport system to study short-lived nuclides. Most recently, we have pushed its limits by using it to measure ^{42}Ti, which has a half-life as short as ~200 ms. The measurements of such decay studies require more than 150,000 repeat cycles defined as *collect-move-count* to obtain high statistics, and each cycle period of the tape transport can be as short as ~6.5 s. There is no doubt that under these conditions, the tape system is operating at the limit of its mechanical capabilities.

Our first task in preparing the unit for such a demanding measurement was to check the quality of new aluminized Mylar tapes, produced by our new suppliers, by cycling them through the tape-transport system. High-quality metallization and the precise width of the tapes permitted the tape reels to be completely filled. We then repaired a failure of the tape-transport system to place the collected source consistently into the center of the detector, a new problem we recently encountered [1]. Critical to this repair was a very fine alignment of the pinch roller with the capstan, both being located on the take-up reel deck. The effect of every alignment change we made was evaluated by repeatedly measuring the distance that the tape moves during the pre-set time between the engagement of the pinch roller and the closing of the brakes. That distance is now reproducible from cycle to cycle within ±5 mm, but there is still room for improvement. We also cleaned two brakes located on both sides of the counting location to stop the tape promptly and to stretch it tightly in front of the detectors.

The tape-transport system also showed its age by developing very low-level noise signals from the installed motors. We first noticed this issue at the beginning of our latest online half-life experiment on ^{42}Ti [2]. The symptom was that unphysical structure appeared in the middle of the cumulative time-decay spectrum recorded from the 4π proportional gas counter at the lowest discriminator level. We observed this effect as the tape reel on the take-up deck became heavier as more tape wound onto it. This relationship made us suspect that the observed structure was due to noise pickup arising from the servo-motors that control the tape reels.

For the experiment, we resolved the problem by restricting ourselves to using approximately two-thirds of the tape roll before imposing a tape rewind. Diagnostic tests following the online experiment confirmed that the gas counter picked up the noise generated by the servo-motor at the take-up deck. We also identified another source of noise: the motor that regulates the capstan which drives the tape at a precise and constant speed. The elimination of these unwanted noise signals, which interfered with valid detector signals, was successfully accomplished by our screening the area where the servomotors and capstan motors are installed with 0.25-inch thick Al plates, and by improving the grounding of the gas detector.

We are currently putting our efforts into getting spare parts for the tape-transport system to maintain its prime operating condition in future.

[1] H.I. Park *et al*., *Progress in Research*, Cyclotron Institute, Texas A&M University (2016-2017), p. I-15.

[1] H.I. Park *et al*., *Progress in Research*, Cyclotron Institute, Texas A&M University (2017-2018), p. I-24.