MARS status report for 2024-2025

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This year, we continued the program of providing rare isotope beams (RIBs) for the physics program at the Cyclotron Institute at Texas A&M University with the Momentum Achromat Recoil Separator (MARS) [1]. The MARS beam line was utilized in five separate runs for various experiments. Three of which involved rare isotope beams (RIBs), one experiment involved cross-section measurements, and one experiment was for a detector test.

A summary of the RIBs produced this year is given in Table I. The production of ^{59}Fe was tested, but not optimized, for a future run with the DAPPER array. The ^{59}Fe test run was conducted as part of a Research Experience for Undergraduates (REU) project. A ^{13}N beam was produced for Professor Rogachev's group to measure ^{13}N+σ scattering. Also, ^{10}C beam was produced for Professor Melconian's group for a new, more precise measurement of the ^{10}C β^+-decay branching ratio. Details of these experiments are provided in separate reports.

Table I. Summary of MARS RIBs for 2024-2025.

RIB beam	Reaction	Production Rate (eV/nC)	Purity	Intensity on Target (est.)
^{59}Fe	d(^{58}Fe,^{59}Fe)p at 12 MeV/u	57 eV/nC*	~70%	Not tested
^{13}N	p(^{13}C,^{13}N)n at 8.1 MeV/u and 7.8 MeV/u	3575 eV/nC, 4200 eV/nC	~100% ~100%	~2.7 x 10^5 p/s ~1.4 x 10^6 p/s
^{10}C	p(^{10}B,^{10}C)n at 17.2 MeV/u and 16.8 MeV/u	1000 eV/nC, 777 eV/nC#	~100% ~100%	~5 x 10^4 p/s ~1 x 10^5 p/s

*Production rate was not fully optimized due to limited time.
#In the lower energy tune, a different optics was used which resulted in 2 times more primary beam on target

There were a series of measurements with a ^{40}Ca beam led by Dr. A. Bonasera in collaboration with Professor G. Souliotis, in continuation of a similar experiment from last year. In this measurement, a ^{40}Ca beam impinged on targets of ^{40}Ar (gas), ^{124}Sn (solid) and ^{27}Al (solid). Beam-like fragments from multi-nucleon transfer reactions were measured at many different rigidity settings. The analysis of these data is ongoing, and further, similar experiments are planned in the coming year, perhaps with a ^{48}Ca beam.

This year, the camera for the coffin slits was replaced with a new, lower light camera and associated lens. In addition, the coffin slits were repainted with a coating of ZnS:Ag phosphor (EJ-600-P11 from Eljen Technology) mixed with clear glue. The combination of the new camera and phosphor material allowed the visualization of beam spots in the coffin down to about 100 pA of current, a large improvement over the previous situation. The new setup allows the observation and tuning of even low intensity beams in the first stage of MARS, and also helps with the reduction of primary beam charge states that may otherwise contaminate the secondary beams.

In March 2025, the magnet chamber of the Indiana magnet, upstream of MARS, was found to have a large air leak that prevented it from being pumped to high vacuum. As a result, further experiments with MARS are delayed until the magnet chamber can be repaired. These repairs are planned during the summer of 2025.

[1] R.E. Tribble, R.H. Burch and C.A. Gagliardi, Nucl. Instrum. Methods Phys. Res. **A285**, 441 (1989).