

Sample Movement Automation For Integration With Analytical Instruments



From left to right: Anne Martin S., Mark Amundson I., Peter Asamoah K., and Owen Mcchane A.

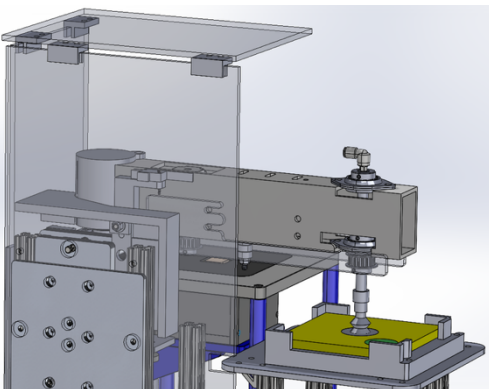
PROJECT SUMMARY:

3M Corporate Research Analytical Laboratory (CRAL) supports product developers across 3M with advanced measurements and method development. One key tool is the NMR-Mouse, a single-sided magnetic-resonance sensor with a 1 in × 1 in opening that briefly energizes hydrogen atoms in the first few millimeters of a sample using a radio pulse and then detects how that signal fades. The way the signal relaxes reflects how mobile the molecules are near the surface, which lets analysts determine moisture and how fully a material has cured (how completely a polymer or adhesive has set and hardened). The instrument is used on polymers (bulk plastic or rubber parts and adhesives), films (thin polymer sheets and coatings), and composites (layered materials such as fiber-reinforced laminates), and it does this without cutting the sample.

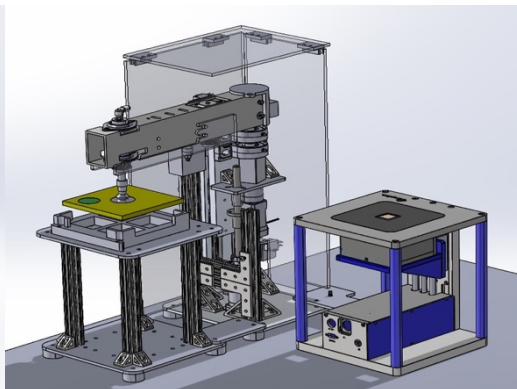
Operators currently place each sample by hand, keep it flat, trigger the scan, wait 30 minutes to 4 hours, and remove it. Our project delivers a compact, benchtop automation system that performs this handling: a non-magnetic arm picks from a queue of ≥ 10 samples, places each piece over the opening flat at ≤ 0.5 mm clearance, triggers the scan via 5 V TTL, holds steady during measurement, and returns the sample to storage. A labeled interface provides clear status, progress, and error indications for a standing user.

DESIGN GOAL:

Design and demonstrate a compact, non-magnetic automation system that safely places and holds flat samples over the NMR-Mouse opening, maintains the required working distance during a scan, accepts the sponsor's range of sizes and thicknesses, interfaces with the instrument using 5 V TTL signals, and manages at least 10 queued samples with a simple, labeled interface.



Automated System attaching to sample



Automated System retrieving sample



TEAM D

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DESIGN CONSTRAINTS:

- Footprint and access: The system shall fit within 1 m × 1 m × 1.370 m and shall allow a trained user to remove the NMR-Mouse in ≤ 5 minutes.
- Non-magnetic keep-out and safety: Any solution components within 152 mm (6 in) of the stand during testing shall be non-magnetic, and the system shall be physically safe for users in normal lab operation.
- Sample envelope and standoff: The system shall handle samples from 1 in × 1 in to 6 in × 6 in, thickness 0–10 mm; samples shall remain flat with an NMR-to-sample clearance ≤ 0.5 mm during measurement.
- Positioning and coverage: The system shall move samples to and from the 1 in × 1 in opening and shall provide repeatable positioning to probe user-specified points on larger samples.
- Integration and HMI: The system shall send and receive 5 V TTL pulses and shall present labeled, accessible controls with status/progress/error indicators.
- Capacity and autonomy: The system shall store ≥ 10 samples and shall operate through a batch of 10 samples without operator intervention.
- Load time: The user interface shall allow a trained user to load 10 samples within 30 minutes.
- Label accommodation: The sample holder shall reserve space for a 1 in × 2 in QR label.