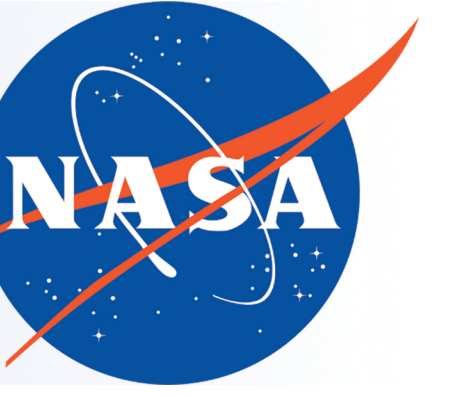


# Rediscovering Apollo Biomedical Data to Support Artemis: The Apollo Records Synthesis Project

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## Introduction

With the dawn of the Artemis era, the space medicine and research communities seek to buy down human system risks for crewed landings on the surface of the moon. These efforts include the reuse of historic Apollo datasets, the only data available for understanding human life on the Moon. Archivists with NASA's Life Sciences Data Archive (LSDA) and epidemiologists with the Lifetime Surveillance of Astronaut Health (LSAH) are collaborating on the Apollo Records Synthesis Project (ARSP), a project designed to improve access to historic datasets from the Apollo Program. ARSP is assessing the physical media collections held by LSDA and LSAH to identify records that contain Apollo biomedical data. The team is also establishing a digitization workspace to produce digital surrogates of the records that can be transformed into usable datasets. This poster discusses the progress of the project, gives context to the dual research-clinical care nature of the records, and highlights the challenges and opportunities in using data from historical records.

## HRP's Human Data Repositories

The ARSP team is made up of representatives from two of NASA's human spaceflight data repositories: the Life Sciences Data Archive (LSDA) and the Lifetime Surveillance of Astronaut Health (LSAH). These two repositories house both astronaut data from research studies and medical data. Investigators wishing to utilize privacy-protected datasets from both repositories can make a data request via the NASA Life Sciences Portal (NLSP).



### Life Sciences Data Archive

Based at NASA's Johnson Space Center, LSDA is the primary data repository for human subject science data resulting from Human Research Program (HRP) funded experiments. With datasets spanning the breadth of human spaceflight from Project Mercury to the International Space Station (ISS) along with spaceflight analogs, the archive is one of the most complete collections of human spaceflight data. In addition to LSDA's digital data repository collections, LSDA holds physical media collections that include historic research data. LSDA contains both publicly available and privacy-protected datasets. LSDA's experiment catalog can be found on the NLSP website via the QR code to the left.



### Lifetime Surveillance of Astronaut Health (LSAH)

LSAH is a proactive occupational surveillance program for the NASA astronaut corps which screens and monitors astronauts for occupationally-related injury or disease. Descriptions of the data are available on the NLSP website via the QR code to the left.



## Apollo Data Sources

Apollo-era record collections containing biomedical data and related documentation are housed in a wide range of organizations and institutions.

- Johnson Space Center holds two key collections of Apollo biomedical records within the LSDA and LSAH repositories:
  - LSDA: Collections of research materials from former NASA researchers and the historic Space Life Sciences Archival Library (SLSAL) Collection, an early predecessor to LSDA that operated from 1975 to 1981.
  - LSAH: Collections of clinical and operational records, such as flight surgeon and biomedical engineer logs.
- Collections of materials from former NASA researchers that have been donated to university repositories, for example:
  - The Charles A. Berry Papers were donated by the family of the former NASA flight surgeon and include many of his materials from the Apollo program. These papers are available at the University of Texas Medical Branch (UTMB) Moody Medical Library. Some materials have been digitized and are available online.
  - The Human Space Flight Collection in the University of Houston Clear Lake (UHCL) Archives and Special Collections holds a wide range of human space flight-related materials, including collections from the Apollo era.



## Dual Medical-Research

### Purpose for Experiments

One challenge presented by Apollo-era data is the dual medical-research purpose for which it was collected. Apollo-era datasets do not adhere to the clear categories of research data and medical data that today's researchers and data management policies expect. In the 1960s and early 1970s NASA thought in terms of biomedical (human-focused) versus bioengineering (uncrewed/animal experiments) research. The dual medical-research focus of human studies reflects the nature of the questions that Apollo-era researchers needed to address: how space flight affected humans and how to maintain the health of humans in space. The most urgent research questions were also medical questions. With limited resources, the Apollo program focused on preparedness, emphasizing medical readiness and observational data collection over experimental studies. While a limited number of experimental radiation studies, studies of plant growth in regolith, and studies tracking the impact of lunar materials on animals and fungi are included, most material falls into the medical-research data category.



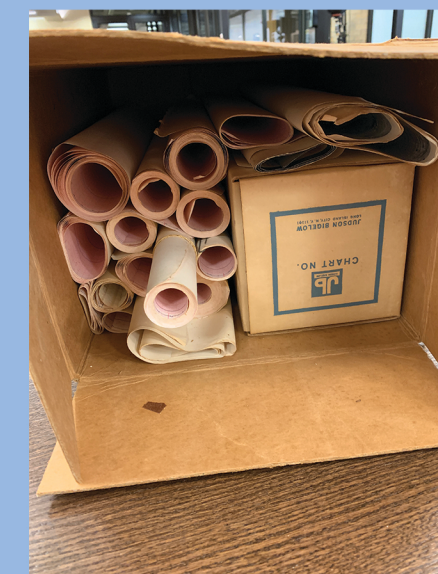
## Apollo Archival Records Formats Challenges

One of the challenges with working with Apollo-era records is that data are not in a readily reusable format. For example, flight surgeons and biomedical engineers handwrote flight logs on a nearly minute-by-minute basis during a mission to track mission events and the health of the crew. Handwriting coupled with inconsistent shorthand remains difficult to understand, much less from which to extract data. LSAH interns conducted a manual review of these logs to document data relating to dust exposures on the Moon and health outcomes, a time consuming and labor-intensive process. The range of physical formats used during the Apollo era presents another challenge. In addition to standard-sized paper documents, these Apollo records come in a wide variety of physical media formats representing unique access and care considerations.

### Examples of Some Media Formats Encountered



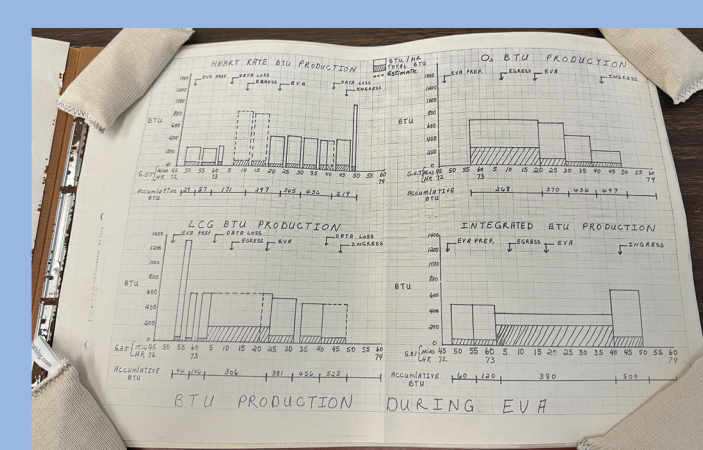
35mm Slides



Strip Charts



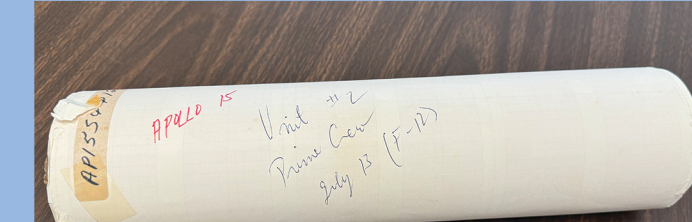
16mm Acetate Motion Picture Film



Oversized Paper Documents



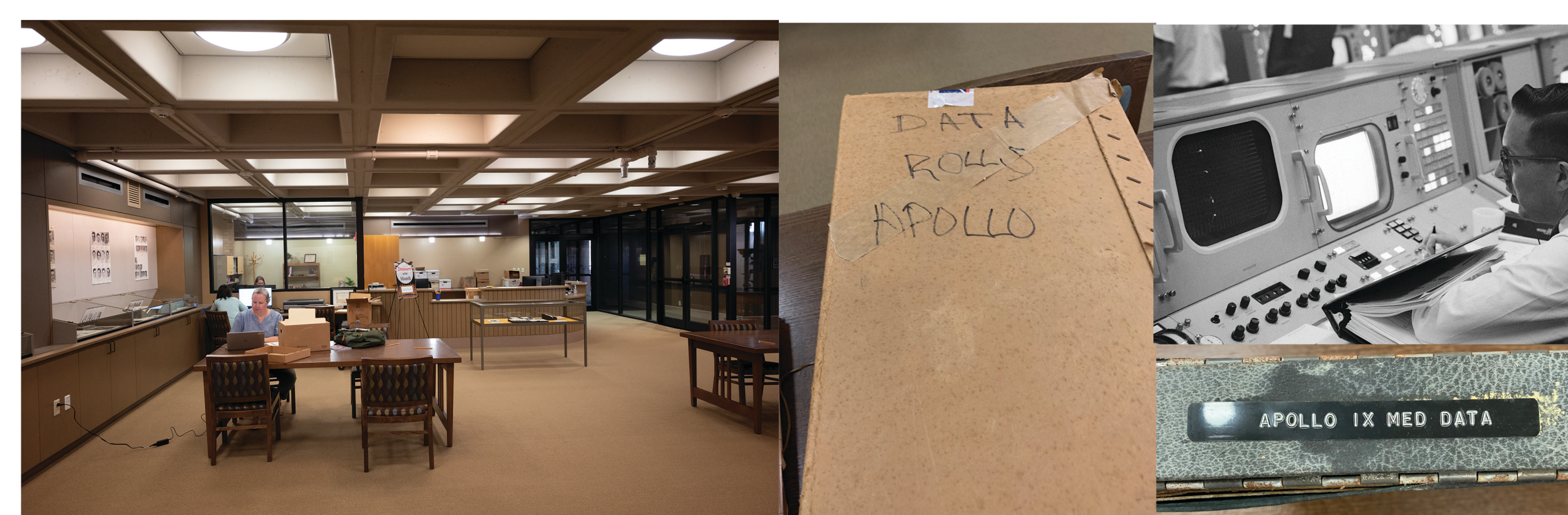
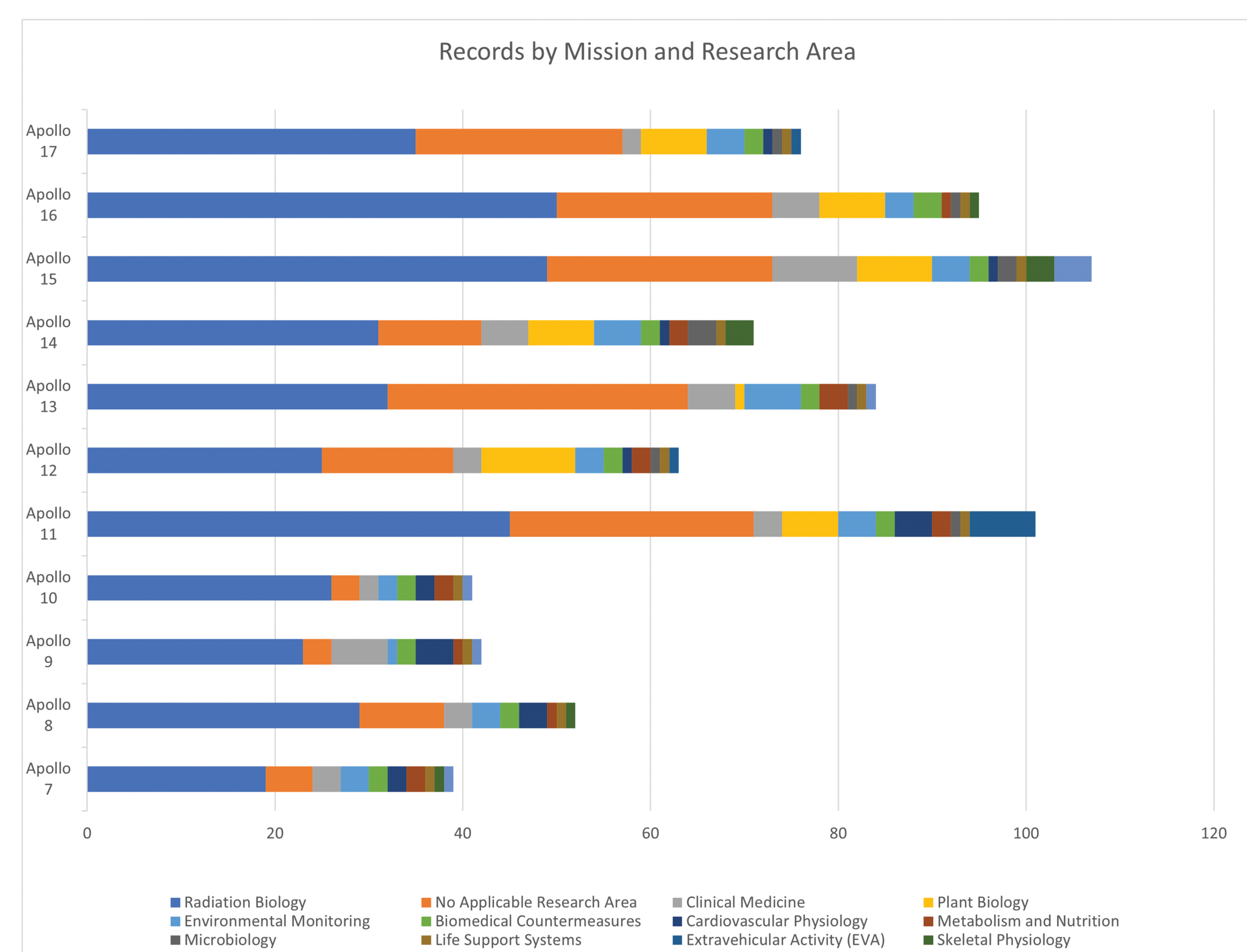
Analog Magnetic Tape



Continuous Feed EKG Strip Charts (some over 220 feet in length)

## Progress on Inventory and Assessment

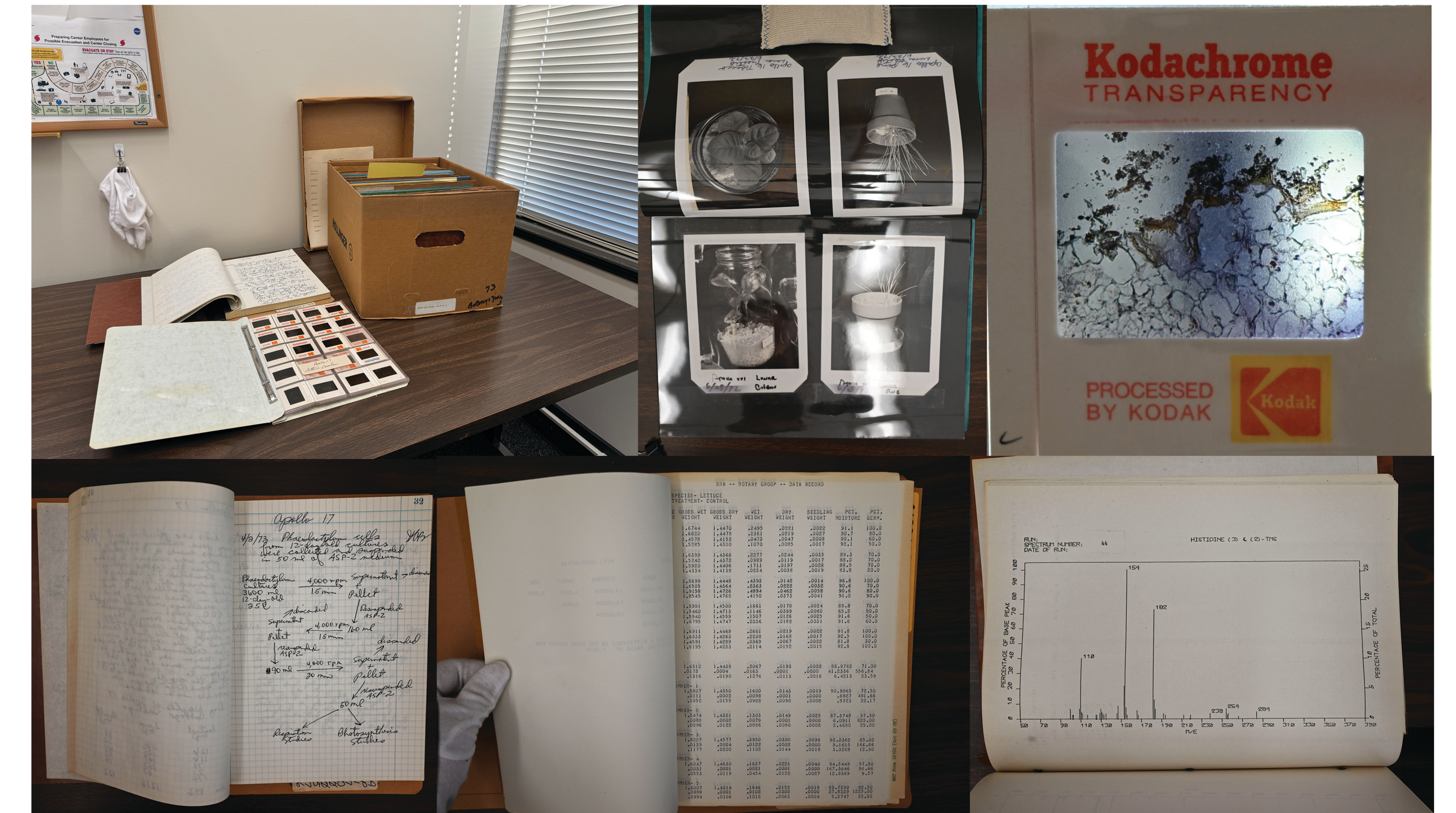
To date, work on the project has focused on inventorying and assessing the Apollo records collections held by LSDA and LSAH. LSDA has primarily focused on inventorying Apollo-related materials from the SLSAL collection. The charts below show the current composition of LSDA's Apollo collections broken down by research area. LSAH has assessed the Apollo clinical records collection with assistance from medical students and epidemiology interns.



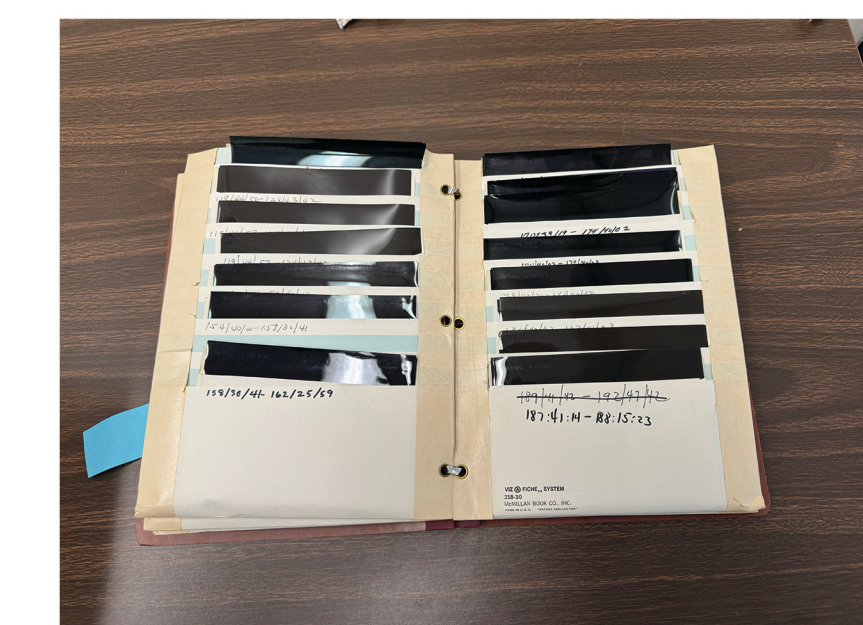
The team also visited the UTMB Moody Medical Library to assess unprocessed portions of Charles A. Berry's papers for materials related to life sciences research.

## Discoveries and Outreach

When ARSP's inventory work uncovers data with reuse potential, the team reaches out to researchers and curators in the appropriate subject areas.



A box of Botany and Zoology records with research data from Apollo plant studies was found. These studies grew different types of plants in lunar regolith that had been collected during the Apollo missions to the lunar surface. The aim was to understand how lunar regolith impacted a plant's health and growth. The team has shared an inventory of these records with the archivists and data curators who support the Space Biology Program at Ames Research Center and Kennedy Space Center.



Another example of biomedical data in these collections are printouts and microfiche from the Apollo Telemetry History Report in Formatted Tabulations (THRIFT) System, a system that printed out tables of telemetry data every 4 hours during a mission. THRIFT data products found so far include: a dosimeter dataset and a cardiovascular dataset (heart rate, respirations, accompanied by some vehicle cabin environmental data). Most of these datasets appear to be from late Apollo missions (15,16,17). These datasets represent less processed versions of the data associated with previously published Apollo datasets such as those included in *Biomedical Results of Apollo* (1975).

## Future Work

The Apollo Records Synthesis Project team is currently working to improve access to this unique documentation of human life on the moon by making these datasets accessible for research use. The process will involve two phases for each record:

### Phase 1: Digitization

Digital copies will be created from each item. Digitization work will start with the paper materials in the collections and then expand to other media formats as resources are available. Paper records will be scanned according to the Federal Agency Digital Guidelines Initiative (FADGI) imaging standard, which will ensure that the resultant scans capture all the aspects of the original document. Creating high quality scans will enable the use of the images in future use cases as new technologies, such as improved handwriting optical character recognition software, becomes available.



FADGI 19264 image target used as a reference during scanning

### Phase 2: Data Extraction and Transformation

There are several different methods for extracting data from the digital surrogate files. For pages with typed text, Optical Character Recognition (OCR) software will convert images to text for search and extraction. Handwritten Text Recognition (HTR) will be needed for handwritten records and notes. The recognized text can then be used with Natural Language Processing to gain additional data insights.

## So How to Access these Data?

Data from these records are not currently available in a usable digital form for researchers. Furthermore, human data archived with LSDA and LSAH are often not publicly available due to privacy concerns. Datasets from this project will become available for researchers to access by filing a data request with the help of an LSDA Archivist or LSAH Epidemiologist. Digitization priorities will be based on the needs of the broader research community. Researchers wishing to express interest and/or inquire about undigitized Apollo records from this project can submit a data request via the data request portal on NLSP. Inquiries and expressions of interest are highly encouraged as they will help to prioritize datasets within the digitization queue. When submitting a request please include the phrase "Apollo Records Synthesis Project" in the data request description field.

