

Lab Description

The Center for Accelerator Mass Spectrometry (cams.llnl.gov), an Institute within the Lawrence Livermore National Laboratory, has a long history of facilitating student-lead projects, and leading the development and application of AMS isotope analyses to Earth system problems and the evolution of Earth's landscape. We have existing capabilities for AMS-based measurements of the following cosmogenic radionuclides: ^{10}Be , ^{14}C , ^{26}Al , ^{36}Cl , ^{129}I , and ^{41}Ca , centered around a $\sim 10,000\text{ ft}^2$ facility which houses three accelerator-based systems. CAMS distinguishes between cosmogenic nuclides (^{10}Be , ^{26}Al , ^{36}Cl , in situ ^{14}C) and the more traditional application of radiocarbon to geochronology and carbon cycle work. The former is referred to as GeoCAMS, and the latter as natural carbon, although the distinction is informal and flexible. Our facilities include a chemistry laboratory for the complete preparation of samples for radiocarbon analysis. Facilities for sample preparation for GeoCAMS nuclides are not available at CAMS, but we encourage students interested in those analyses who do not have access to a sample prep lab to contact us directly to investigate possible alternatives. Methods development proposals can, in general, be easily accommodated due to the presence of multiple ion-sources on the main FN accelerator, which allows for analysis of stable isotope beams without affecting other (simultaneous) AMS activities.

Expected time frame

Duration of visits will be specific to the project objectives and will depend on the number and type of samples, and the isotope to be analyzed. Students bringing fully prepared cosmogenic nuclide targets may visit for a week or less, while visits to the natural carbon sample prep lab are usually one to two weeks in duration. In general, batches of 10-15 carbonaceous macrofossils (e.g., shells, wood) can often be accomplished in 5-10 days, while preparation of bone samples or multiple batches may require two weeks or longer.

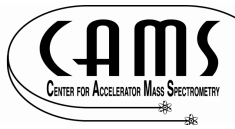
Observation of the analysis of samples on the accelerator is an important part of the visit, whether or not the samples are the student's own. Natural carbon runs occur weekly, while GeoCAMS runs are scheduled monthly (^{10}Be) or quarterly (^{26}Al , ^{36}Cl), depending on sample demand; in this case, the visit will be coordinated with the run schedule.

Analytical costs

CAMS' analytical costs are based on per-sample AMS charges, and range from \$250-\$400 for natural carbon samples, and \$250-\$650 for GeoCAMS samples. Note that the natural carbon charge includes both sample preparation and AMS analysis, while the GeoCAMS charge is for the AMS analysis only. If the student guest takes their samples to graphite, the charge will be for graphite targets and consumables.

Preparation for visit

For natural carbon, sample preparation facilities exist for the chemical pretreatment and conversion of carbonaceous materials to graphite for subsequent AMS analysis. We do not have a dedicated sieving and microscope laboratory, so it is highly preferred that macrofossils or charcoal are isolated or picked at the student's home lab. The choice of



material that will best provide the desired information can vary greatly with geologic setting, available material, and project goals, and sample selection is best discussed ahead of the visit. We strongly discourage “bulk” dates unless the geology and depositional environment preclude macrofossil dating, or the scientific question being posed can be answered with bulk dates.

As for any lab submitting samples for the first time, students preparing samples in a lab space that does not routinely send radiocarbon samples to CAMS will need to check their lab for tracer ^{14}C contamination prior to bringing samples to our sample prep lab. A swipe kit and instructions for effective swiping will be provided, and the cost of initial swipes are borne by CAMS, but 3-4 weeks should be allowed for the swipes to be taken and measured before scheduling the visit.

Students in residence will be afforded office space and wireless internet access while visiting CAMS.

Relevant Laboratory Staff

GeoCAMS point of contact: Dr. Susan Zimmerman (zimmerman17@llnl.gov)

Natural Carbon point of contact: Dr. Thomas Guilderson (tguilderson@llnl.gov)

Data Processing and Interpretation

While observing the AMS analysis of samples, students will also be introduced to the procedures for reducing the raw AMS data to isotope ratios, using CAMS’ in-house software, including any observations made during the run, and assessment of the international standards and/or consensus materials measured alongside the samples. Students will be guided through the parts of the official CAMS report for the nuclide they are working with, so that they understand the calculations involved in the final age or isotope ratio, and how to take advantage of the additional information included (e.g., stable isotope currents, associated blanks and monitor materials, etc.).

Expected Lab Availability

Visits for preparation of natural carbon samples can usually be scheduled with 1-2 months’ notice; visits for GeoCAMS isotopes will be coordinated with the run schedule, but for ^{10}Be or ^{26}Al can usually also be scheduled within 2-3 months.