CHILI: Is it ready yet?

ANDREW M. DAVIS[1,2,3], THOMAS STEPHAN[1,3], MICHAEL J. PELLIN[1,2,3,4], DETLEF ROST[1,3], MICHAEL R. SAVINA[3,4], RETO TRAPPITSCH[1,3,4] AND NAN LIU[1,3,4]

[1]Department of the Geophysical Sciences,
[2]Enrico Fermi Institute, The University of Chicago, Chicago, IL
[3]Chicago Center for Cosmochemistry
[4]Materials Science Division, Argonne National Laboratory, Argonne, IL

Almost. CHILI (the CHicago Instrument for Laser Ionization), a resonance ionization mass spectrometry (RIMS) nanobeam instrument nearing completion, is designed for isotopic and chemical analysis at the ~10-nm scale with a useful yield of ~40%, capabilities well beyond those of currently available secondary ion mass spectrometers. CHILI uses a liquid metal ion gun for sputtering or a 351 nm Nd:YLF laser for ablating atoms from the sample, six tunable Ti:sapphire lasers of our own design pumped with three 527 nm Nd:YLF lasers to resonantly ionize up to three elements simultaneously from the atom cloud, and a time-of-flight mass spectrometer to mass-analyze and detect photoions. We summarized progress a year ago [1] and we provide an update here. All tunable lasers are now operational and outperform earlier generation lasers. The ablation laser has achieved a spot size of ~1 μm. The final electronic components, for switching high voltages at nanosecond timescales, are now nearing completion after a delay of two years because of a massive backlog at the switch manufacturer. All major subsystems of CHILI are controlled by our own software and we are developing 3D imaging of isotopic and chemical composition as samples are sputtered or ablated away. The CHILI laboratory is temperature-controlled to stabilize lasers and other sensitive components. Adjacent to the laboratory is a class ~100 clean room containing optical microscopes and a micromanipulator for sample preparation. We anticipate initial operation of CHILI within a month of this writing.

CHILI's strengths will be in isotopic and chemical analysis at lateral resolutions from ~10 nm to a few μm and unprecedented analytical sensitivity. Among the samples planned for isotopic analyses are those from sample-return missions: Stardust–cometary and contemporary interstellar dust; Genesis–solar wind; Hayabusa and OSIRIS-REx–samples from asteroids with ordinary and carbonaceous chondrite affinities. We are particularly interested in presolar grains, which inform us about stellar nucleosynthesis, and refractory inclusions and chondrules, useful for early solar system chronology, but we are open to collaboration to anyone with an exciting problem and some samples.

[1] Davis A. M. *et al* (2013) *Mineral. Mag.* **77**, 951