**ION IRRADIATION AND SAMPLE ANALYSIS AT UVA’S KEVION FACILITY.** C. A. Dukes,1 A. K. Woodson1, R. E. Johnson1, J. Terwisscha van Scheltinga2, John Ihlefeld3, P. Reinke1, Robin Garrod1, & L. Isidore Cleeves1 1University of Virginia, Charlottesville, VA 22904, USA (cdukes@virginia.edu), 2Leiden University, 2333 CA Leiden, NL.

**Introduction:** KEVION, a KiloElectron Volt ION irradiation facility for space science is under development as a NASA Planetary Science Enabling Facility (PSEF) within the Laboratory for Astrophysics and Surface Physics at the University of Virginia (LASP-UVa). This resource facility, available at no cost to NASA’s planetary science community, is comprised of four components: (1) a 25-300 keV Pelletron ion accelerator to provide positive ions over a wide range of species, charges, and energies; (2) a novel, new multi-technique ultrahigh vacuum (UHV) chamber built around an X-ray photoelectron spectrometer for studies of geologic samples and other materials (GRAINS); (3) an established, time-tested cryogenic UHV chamber for ice studies (ICE); and (4) a minimally-equipped, user-configurable UHV chamber for instrument calibration and testing (TEST). The KEVION facility is expected to go online in entirety at the end of 2025, although some instruments and analytical chambers are expected be available in December 2024.

**Background:** Given the deployment of multiple NASA Missions to Solar System bodies with radiation-exposed surfaces and new galactic and interstellar science anticipated from the James Webb Telescope, the KEVION facility addresses an identified gap in available community tools for high-impact Planetary Science Division research. The KEVION linear accelerator will provide positive ions over a range of species, charges, and energies which, in combination with the two multi-technique analysis chambers, will be extremely valuable for transformative research in studies of space weathering, radiolysis, radiosynthesis, sputtering, and surface charging. The TEST chamber, meanwhile, can be utilized to facilitate planetary science instrument development and calibration.

Investigators submitting proposals to virtually any of the NASA Planetary Science Division programs — including Laboratory Analysis of Returned Samples, Emerging Worlds, Exobiology, Interdisciplinary Consortia for Astrobiology Research, Planetary Data Archiving and Restoration with laboratory components, Solar System Workings, Planetary Instrument Concepts for the Advancement of Solar System Observations, Maturation of Instruments for Solar System Exploration, and the Data Analysis Programs — are encouraged to integrate the KEVION facility into their research plans.

A full-time facility instrument scientist is available to assist with experiment planning, accelerator operation, instrument training, and analytical procedure. Specific details of the Pelletron accelerator and available analytical techniques associated with each end-chamber are outlined below and summarized on NASA’s science link: [https://smd-cms.nasa.gov/wp-content/uploads/2023/06/KEVION.pdf](https://smd-cms.nasa.gov/wp-content/uploads/2023/06/KEVION.pdf)

**Ion Accelerator:** The National Electrostatics Corp. Pelletron ion implanter will generate isotopically pure ion beams with energies between 25 and 300 keV for simulated space weathering, materials characterization, measurement of fundamental parameters, and instrument prototyping applications. This range is sufficient to simulate a substantial cross section of energetic particles originating from the Sun, which vary in energy from ~300 eV/amu in the slow Solar Wind, to ~50 keV in transient Interplanetary Coronal Mass Ejection events (CMEs), to > 1 MeV in the suprathermal tail. Similarly, magnetospheric ion energies generally range from a few keV to a few tens of keV measured for Mercury and Titan’s interaction regions, to MeV particle fluxes at the Moons of Jupiter [1-5]. A schematic of the proposed 300 kV system is shown in Fig. 1. The NEC instrument is designed to provide beam currents of 300 μA into the beamline Faraday Cup.

**Fig. 1:** Modern 25–300 kV NEC Pelletron dual-beamline ion implanter optimized for acceleration of singly- and doubly-charged positive ions [e.g., H, H₂, He, C, N, O, OH, O₂, Ne, Ar, C].

**GRAINS Chamber:** The GRAINS chamber [Fig. 2] is designed to enable comprehensive analytical measurement and monitoring of surface (1–3 mono-layers, ML), near-surface (to ~10 nm depth) and bulk (to ~10 μm depth) material characteristics. In situ sample characterization can be done by: quadrupole secondary-ion mass spectroscopy (SIMS), X-ray photoelectron spectroscopy (XPS), medium energy Rutherford-
ford scattering (forward and backward), and UV-Vis-NIR optical reflectance or transmission. The chamber will be equipped with an electron flood gun for neutralization of positive surface charge, and a low-energy ion gun (0.2–4 keV) with mass-per-charge filter for dual charge neutralization, depth profiling, and low-energy irradiation including solar wind simulation. In combination with the KEVION accelerator, this will allow for “effects” comparisons over decades of energies. Multiple, integrated analytical techniques on the same chamber eliminates the need to transfer samples between systems, thereby reducing the logistical complexity of such experiments as well as the risk of contamination due to atmospheric exposure.

**ICE Chamber:** Investigations in solid-phase radiocchemistry are of high importance to understand molecular formation / destruction pathways, rates, and species stability on icy interstellar grains and planetary bodies, which act as substrates for gas-grain chemistry and photolytic/radiolytic reactions. The ICE cryogenic end chamber [Fig. 3] is equipped with an in situ gas-dosing system, FT-IR spectrometer for Vis-IR reflectance and transmission, an in situ quartz crystal microbalance system (QCM), a UV-Vis interferometer for coupled mass and density/porosity/thickness measurement, and a ion-neutral mass spectrometer.

**TEST Chamber:** The TEST chamber (not shown) is a large-diameter, mu-metal-lined UHV vessel with numerous ConFlat ports intended for characterization of charged-particle instrument response functions. It is minimally instrumented with a goniometer and pressure gauges, but can be outfitted with additional research tools supplied by the user for experiments beyond the capabilities of GRAINS and ICE.

![Fig. 3: Schematic of ICE multi-technique end chamber for ion processing and analysis (temperature controlled cryogenic stage [10 –300K], optical, interferometry, mass spectroscopy, QCM, gas doser and sample transfer).](https://engineering.virginia.edu/kevion)

**Usage Information:** The KEVION facility is available ~6 months per year at no cost for NASA DPS awarded projects. We also welcome non-DPS academic, governmental, and industrial clients to make use of the facility at a nominal, tiered hourly rate. Access to the facility is available both in person and remotely. For in person access, users will be trained on-site and guided as necessary by the instrument scientist and/or PI. Remote analyses will be carried out by the instrument scientist as agreed upon in collaboration with the client.

**Contact Information:** For more information on how to utilize the KEVION or to solicit information for proposals, please contact PI Dukes (cedukes@virginia.edu) or Instrument Scientist Woodson (akw88r@virginia.edu). Else, a “Request for Service” form can be submitted directly on the KEVION Website: https://engineering.virginia.edu/kevion.

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