NOBLE GAS LABORATORY AT WASHINGTON UNIVERSITY: HISTORY AND ANALYTICAL CAPABILITIES. A. Meshik and O. Pravdivtseva. McDonnell Center for Space Sciences and Physics Department, Washington University, CB1105, 1 Brookings Drive, Saint Louis, MO 63130 (am@physics.wustl.edu).

Noble gas isotopes have unique diagnostic properties. They are rare in rocks but not in space. Stable isotopes of heavy noble gases have very high fission yields: for example, more than 10% of all fission fragments are xenon isotopes. All these properties combined allow for accurate resolution of isotopic differences between noble gas components which originated from various fissile materials, planetary atmospheres, solar wind, as well as nucleosynthetic products of s-, r- and p-processes in stars, while corresponding differences in other elements are barely visible. Xe isotopic signatures of various processes are presently well established and routinely used as genetic markers of terrestrial and extraterrestrial materials. Systematic noble gas analyses of chemically treated meteorites led to separation and identification of presolar nanodiamonds, SiC and graphite in primitive chondrites, which are presently extensively studied in the Laboratory for Space Sciences [1] which includes the Noble Gas Lab as an integrated part.

The noble gas laboratory at Washington University in St. Louis (WUNGL) was founded by Charles Hohenberg who built his first instrument in 1975 during his sabbatical in Zurich [2]. This magnetic sector mass spectrometer called Supergnome was brought to St. Louis and in 1976 it produced the first ion beam. Therefore this year the WUNGL has its 40th anniversary.

Today the Noble Gas Lab has four running mass spectrometers. In addition to the original Supergnome-N, which is now controlled by the 4th generation of electronics and pumped by modern oil- and mercury free vacuum pumps, a Supergnome-S has been built in house. It is a clone of Supergnome-N, but is optimized for Ne measurements, while Supergnome-N is mostly used for Xe analyses. Both Supergnomes employ high transmission Baur-Singer ion sources [3]. They have at least 90% ion transmission and virtually no instrumental mass-discrimination because they do not employ an electron focusing magnet; hence all isotopes have essentially the same trajectories before entering the flight tube. Both Supergnomes have a Xe sensitivity of 4 mA/torr at 200 µA of electron emission. At the same emission current traditional instruments equipped with Nier-type ion sources have typical sensitivities of < 1 mA/torr.

The third noble gas mass spectrometer is a multi-collector Noblesse equipped with the unique 8-multiplier ion detector. This instrument was developed by Nu Instruments in UK and is optimized for analyses of Solar Wind noble gases delivered by the Genesis NASA mission [4, 5].

The fourth instrument is our recently acquired 5-mulplier Helix-MC$^+$ built by Thermo Scientific. This is the first Helix-MC$^+$ delivered to the US. During the installation we discovered several serious defects which could be fixed only in the Bremen factory. But after Thermo kindly sent us free replacements for both the Ion Source and detector blocks, and two electronic boards, this instrument is now up and running. The Fusions.970 Laser Stepped Heating System from Photon Machines (now Teledyne), a new gas separation and purification line, and gas calibration systems have recently been added to the Helix MC$^+$. The original pumps were replaced with truly oil free magnetically suspended turbopumps backed by the Edwards latest scroll pump nXDS-10i. This setup is optimized for light noble gas analyses. Helix MC$^+$ is our only instrument capable of resolving $^{20}Ne^+$ from $^{40}Ar^{++}$ and $^3He^+$ from HD^++$3H^+$.

Over the last 40 years WUNGL established the ages of several prominent lunar craters to precisions of a few percent, deciphered the irradiation histories of both meteorites and lunar soils, refined iodine-xenon cosmochronology and revealed the first hard evidence for an early active Sun (T-Tauri). WUNGL successfully analyzed noble gases from samples delivered by the Apollo, Genesis and Stardust NASA missions, and we are looking forward to sample analyses of future return missions.

Although Cosmochemistry is the major priority of our facility, WUNGL analytical capabilities have allowed us to study extremely slow nuclear processes which are hardly detectable in direct counting experiments. For the first time we reliably observed the excess of ^{130}Xe generated by weak decay of ^{130}Ba in barite shielded from cosmic rays [6]. Only one atom of ^{130}Xe /year is generated in 2 kg of this mineral! Strong nuclear interactions were also studied in WUNGL. Using surgical mineral specific laser extraction of Xe, the operational conditions of the natural nuclear reactor in Oklo were revealed in unprecedented details [7]. Using WUNGL instruments we discovered and investigated fundamental physico-chemical processes which control the behavior of heavy noble gases in natural environments: Active capture, Anomalous adsorption [8] and Chemically Fractionation Fission [9].

We continuously improve vacuum and laser extraction systems, update electronics, software and laser extraction techniques to make noble gas instruments more reliable and analyses as accurate as possible. WUNGL is now completely oil-free facility.

WUNGL is open for scientific collaboration and welcomes researchers from another noble labs which may not have the capabilities we have here. In recent years collaborators from HIGP/Hawaii, from noble gas labs in Nancy/France and Heidelberg/Germany have visited St. Louis to analyze their samples in WUNGL.

Over its 40 years of existence, WUNGL trained two generations of mass spectrometrists. Several of them built and successfully run new noble gas labs both in the US and abroad.

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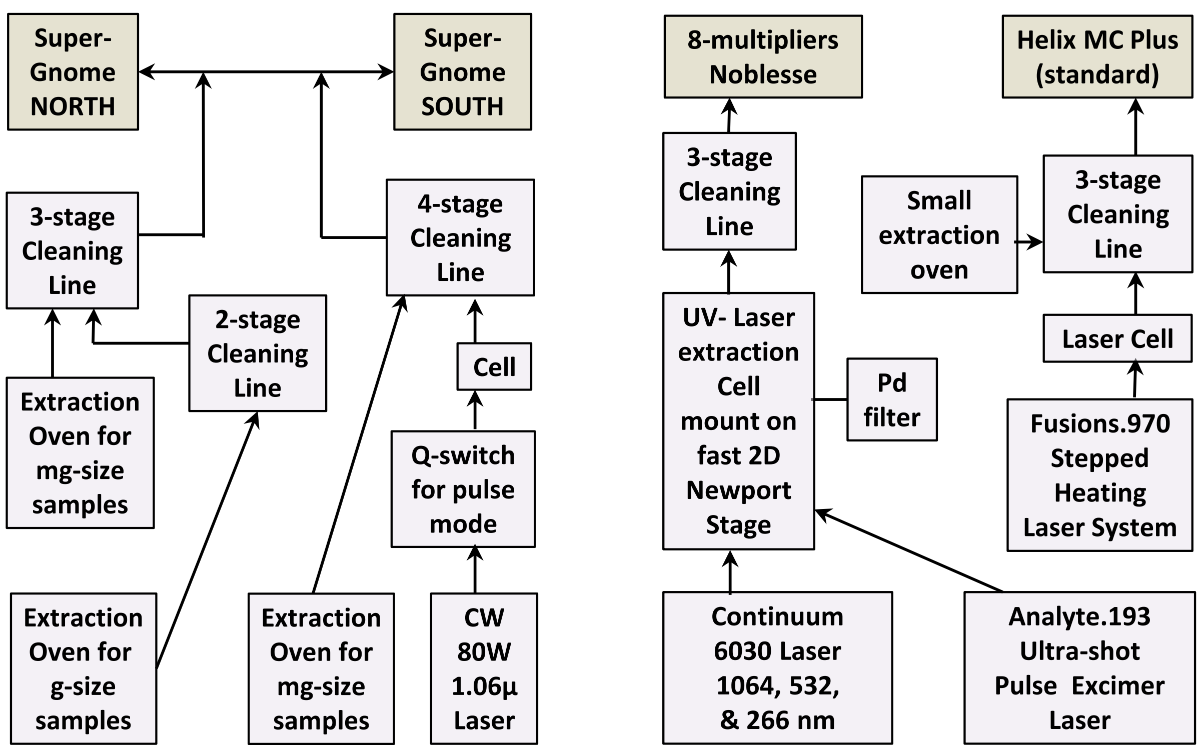

Fig. 1 Current setup of Noble Gas Laboratory at Washington University (WUNGL). Each of four mass-spectrometers has gas calibration systems and quadrupole mass spectrometer SRS-200, which are not shown here. Laser systems are movable and can be used in conjunction with any of the four instruments.