Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA21126

Grantee name: Jozef Rakovsky

Details of the STSM

Title: Optimization and Repair of Experimental Setup for Ion Detection and Pump-Probe Experiments

Start and end date: 07/10/2024 to 14/10/2024

Description of the work carried out during the STSM

1. Alignment of Femtosecond Laser

The femtosecond 1030 nm laser was successfully aligned to the SGH crystal to generate second harmonic light at 515 nm. This second harmonic output was further aligned to focus precisely at the center of the Time-of-Flight (TOF) electrodes within the vacuum chamber. The SGH crystal was optimized, achieving a conversion efficiency of approximately 20%. However, the third harmonic generation (THG) could not be implemented as the required THG crystal was not available.

2. Inspection and Testing of Detector and Power Supplies

The high-voltage (HV) supply for powering the Microchannel Plate (MCP) detector required calibration for knob position vs output voltage. Additionally, the ±12V power supply for the amplifier (1 GHz, gain 10) was found to produce regular pattern spikes at a frequency of around 80 kHz, with an amplitude of ~5 mV. Switching to a laboratory-grade power supply resolved this issue, reducing noise to below 1 mV.

Upon applying a voltage of ~2 kV to the MCP, ion detection from the ion pressure gauge was confirmed.

3. TOF Testing with the laser

Acetone vapors were introduced into the vacuum chamber at a pressure of ~5 x 10^{-6} mbar to test the TOF system with the laser. High voltages were applied to both the repeller and extractor electrodes with suggested voltages 5 and 3.8 kV, respectively, but no ions induced by the laser pulses were detected. It is likely that the power density of laser pulse (16 µJ per pulse @515 nm, ~300 fs pulse

[1] This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

duration, 10 cm focus, M^2 = 1.5) was too low for ionization. This deviation from the initial plan limited our ability to proceed with the intended testing of other samples. Consequently, no additional molecules were tested.

4. Diagnostics of Another Laser System (Seeder)

As part of the STSM plan, diagnostics were carried out on an additional laser system, specifically the seeder. The temporal behavior of the seeder was analyzed under three modes: seeded, unseeded, and open servo-loop. The diagnostics revealed a minor irregularity, where approximately once every three seconds, a noise pulse propagated through the Q-switch line, which the seeder misinterpreted as a signal, leading to incorrect calculations of the build-up time. Despite this, the issue is not expected to have a significant impact on the seeder's overall performance.

5. Implementation of Remote System Monitoring

In addition to the proposed STSM objectives, remote system monitoring from guest's laboratory was successfully implemented in the host laboratory. This system allows the monitoring of various laboratory parameters, including pressure and voltage readings. To integrate the Edwards AGC pressure controller into the monitoring system, a new driver was developed and installed. Additionally, a custom RS-232 cable was constructed, as the controller required a non-standard connection (0V connected to pin 7 instead of pin 5).

6. Additional Maintenance and Repairs

Several additional tasks were completed, including addressing issues with laser cooling and repairing or replacing the leak valve to ensure proper operation of the sample inlet line.

Description of the STSM main achievements and planned follow-up activities

The key components of the TOF mass spectrometry system, including the high-voltage (HV) power supplies, MCP detector, amplifier, acquisition card, and software, are now fully operational and ready for use in mass spectra acquisition. The ion detection quality has significantly improved with the resulting in a five-fold enhancement in S/N, ensuring reliable ion detection.

The alternative nanosecond laser system, seeded by the tested seeder, has been verified as operational and is ready for use in ns time scale experiments. This system offers a viable alternative to the femtosecond laser for future ionization experiments, particularly in schemes such as Resonance Enhanced Multi-Photon Ionization (REMPI).

Additionally, a central pressure monitoring and logging system, similar to the one used in the visitor's home laboratory, was successfully implemented in the host laboratory. The system is currently monitoring the Edwards AGC pressure controller and can be further expanded. It can be extended to integrate additional controllers or up to eight general voltage inputs for monitoring various measured parameters. A planned extension includes the implementation of HV monitoring, as the current HV power supply lacks precise voltage indicators.

To complete the TOF testing process, one of two strategies will be pursued: either the power of the femtosecond laser will be increased, or the seeded nanosecond laser system will be utilized. If the latter is chosen, the TOFapparatus will need to be relocated to another room to facilitate its use in the further experiments.