Facility upgrades for Artemis in new laboratory

C. E. Sanders, A. S. Wyatt, R. T. Chapman, G. Karras, Y. Zhang, G. G. Greetham, A. Cox, P. Rice, D. Rose, S. Spurdle, P. Brummitt, L. Benson, J. Suarez, R. Sarasola, I. Shaw, M. Dominey, R. Bickerton, N. Crook, P. Amos, M. Towrie, and E. Springate
(*Central Laser Facility, Research Complex at Harwell, STFC Rutherford Appleton Laboratory, Harwell Campus, Didcot, UK)*

Contact: emma.springate@stfc.ac.uk

Introduction

The Artemis lab has been relocated to the Research Complex at Harwell since 2018, when it was moved across campus (from its old location in building R7) and reassembled with new beamlines and a new vacuum system[1]. In 2019-20, the lab made numerous planned upgrades to its experimental capabilities, including the installation of a new 100 kHz laser system.

New 100-kHz laser

In autumn 2019, Artemis received its new 100 kHz laser system – a customised system from the FastLite company in France. This new laser, based on optical parametric chirped pulse amplification of output from a Yb:YAG thin-disc pump, represents a major improvement in repetition rate over Artemis's older, 1 kHz laser system. The laser was installed (Figure 1) on a new beamline that is being built for the material science programme. This will ultimately support beamtimes for pump-probe photoemission spectroscopy with improved signal-to-noise characteristics, and will also be the basis for new capabilities in pump-probe transient absorption spectroscopy. The beamline will generate short pulses in the tens-of-fs regime, with photon energies of tens of eV via high harmonic generation (HHG). It remains under construction, with plans for commissioning in the upcoming year.

Figure 1: Artemis's new 100 kHz laser system on the table in the new lab.

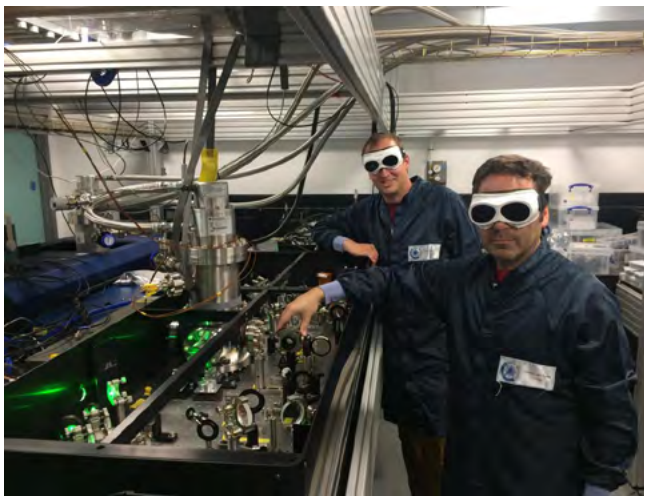

Figure 2: Laser engineer Ben Langdon of Crunch Technologies and Artemis staff member Richard Chapman, aligning the upgraded 1 kHz Ti:sapp laser system in the new laboratory

Upgrades to 1-kHz laser

The 1 kHz KLM Labs 'Red Dragon' titanium-sapphire (Ti:sapp) laser system that has served Artemis since 2008 has received upgrades from Crunch Technologies, USA. These include new Pockels cells, stretcher and compressor upgrades, and a third amplifier. The laser and beamline are now installed in the new lab (Figure 2). With these upgrades, along with upgrades to the beamline, users will be able to see intensity improvements in HHG. The Artemis access panel met to evaluate the first round of proposals on this system in November 2019.

New lab layout improves user experience

The layout of the new lab will allow improvements to the user experience. Four independent beamlines will now support user experiments in imaging, infrared spectroscopy, and photoemission from the gas and solid states on the basis of short pulses by HHG (Figures 3 and 4). The two laser systems are sequestered in a temperature- and humidity-controlled laser room, while the experimental stations are housed in the neighbouring room. Furthermore, a plant room (Figure 5) now segregates compressors and mechanical pumps from the lab, so as to reduce noise and vibrations in the measurement area.

Engineering upgrades

A new laser interlock system has been designed and installed, offering better trouble-shooting capability and upgraded logic. This will minimise disruption to the lasers when the interlock system is tripped. The engineering and mechanical sections, working in close collaboration with each other, also designed and installed a new vacuum control system for the HHG beamlines. With this, Artemis

Figure 3: User area in the new laboratory. The beamline closest to the camera is the flat-field imaging beamline; the beamline behind it is for photoemission spectroscopy from the gas phase (see the chamber on a blue table-frame, docked at the beamline's end). At the back of the lab, behind the partition, are beamlines for solid-state photoemission (the material science chamber is just visible at left) and – not visible here – a beamline for infrared spectroscopy.

Figure 4: Another view of the lab. A partition, at centre, allows the lab to be divided into two separate rooms. The beamline at left is the solid-state photoemission beamline, under construction. Just to the right of the partition is the beamline for photoemission from the gas phase. At far right is the flat-field imaging beamline.

can reduce the number of vacuum pumps it needs to use, along with energy usage and noise levels.

Current status

User operations have now been restarted on the 1 kHz beamline, which has been recommissioned with ten times higher HHG flux than in the old lab. The 100 kHz beamline is undergoing further assembly, and laser commissioning is in progress. More details of the current status are posted on the Artemis section of the CLF website[2].

Conclusions

The Artemis programme is installed in its new lab in the Research Complex at Harwell, and has executed major upgrades to its laser capabilities. With a new laser, upgrades to the existing laser, new beamlines, and a new lab layout, users can expect major improvements in measurement capabilities and in the user experience.

References

1. www.clf.stfc.ac.uk/Pages/Annual-Report-2018-19.aspx
2. www.clf.stfc.ac.uk/Pages/Artemis.aspx

Figure 5: Pumps and compressors are now housed in a separate plant room that opens out onto the back of the building. By segregating these from the experimental stations, we achieve major improvements in noise, and we free up space in the lab.