New laboratories for Artemis in the RCaH

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Introduction

The Artemis / ULTRA upgrade continued this year with the relocation of the Artemis laboratory to the RCaH. Two adjacent laboratories totaling 120 m^2 have been fully refurbished for Artemis, doubling the floor space of the facility.

Design of the new laboratories

The layout of the new laboratories is shown in Figure 1. The lasers and experiments are housed in adjacent rooms. The laser room will house the upgraded 1 kHz Ti:sapph laser system and new 100 kHz OPCPA laser. The experiment room is divided in two by a folding wall. This enables experiments to be carried out with the 1 kHz and 100 kHz lasers simultaneously in separate areas. The wall folds back to allow ease of access for engineering, and to make provision for more complex experiments.

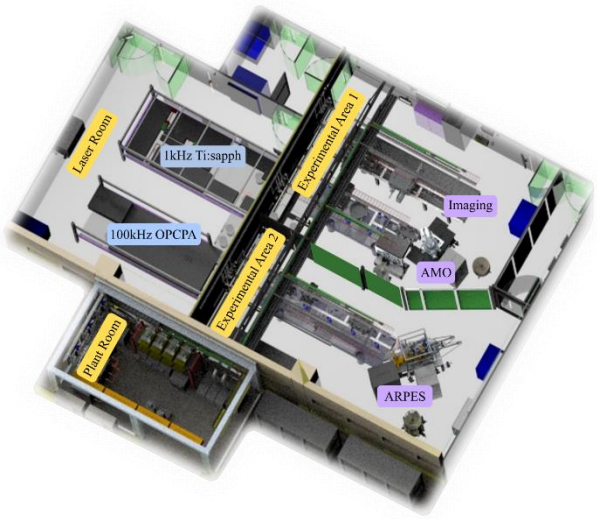

Figure 1. Schematic of the new Artemis facility in the Research Complex.

Experimental area 1 is primarily used with the 1 kHz laser system. It will house the two existing Artemis beamlines, which have been upgraded as part of the move. The monochromatised beamline is designed for time-resolved photoemission and photoelectron spectroscopy experiments that require a single harmonic to be isolated from the high harmonic spectrum. It consists of a high harmonic generation (HHG) chamber, monochromator and focusing chamber with grazing incidence toroidal mirror. This beamline can be connected to the Artemis experimental chambers for angle-resolved photoemission (ARPES) [1,2] or for gas-phase photoelectron spectroscopy [3,4]. The non-monochromatised beamline is designed for high harmonic spectroscopy and coherent imaging applications. It contains an HHG chamber, flat-field spectrometer and a large breadboard chamber for imaging experiments.

Experimental area 2 will be mainly used for experiments with the new 100 kHz laser system. It contains a new XUV beamline, and also an experiment area dedicated to IR spectroscopy. The new XUV beamline will enable both time-resolved photoemission and also time-resolved x-ray absorption spectroscopy and will include both a monochromator and a flat-field spectrometer.

A new external plant room has been built for the laboratories. This will house the backing pumps for the XUV beamlines and end-stations, and the cryogenic compressors and chillers for the Ti:sapph laser system. This will minimize noise, vibration and heat-load in the laboratories, making the environment better for both experiments and scientists. It also better enables off-line servicing of plant.

A vacuum control system has been designed to enable backing pumps to be controlled remotely from the labs, to turn pumps on and off, open valves between chambers and backing lines, and to monitor pressures.

Laboratory construction

Building work to upgrade the laboratories started in November 2018 and is now complete.

Figure 2. New plant room. The Artemis and Ultra teams are pictured, with the CLF buggy used to move equipment.

Figure 1 shows the external plant room. This is insulated and air-conditioned to house equipment putting out a heat-load in excess of 15 kW. It also contains a crane.

Figure 3. The experimental area, with newly installed optical tables in Feb 2019.

Coupled optical tables have been installed in both laser and experimental areas. The optical tables for the beamlines (figure 3) are 10 cm lower than the main tables for lasers and optics, and have a series of holes through them for the beamline support rails. This allows the chambers and vacuum pumps to be decoupled from the breadboards inside the chambers. The breadboards are mounted from the optical table on rigid posts, and sealed to the vacuum chamber with flexible vacuum bellows.

Figure 4. Laser area in Feb 2019.

The laser area (fig 4) will house both the 1 kHz Ti:sapph laser (on near table) and the new 100 kHz OPCPA system. The Ti:sapph laser table is 1.8 m x 4.5 m, and formed of three tables coupled together along their long edges. A laser safety interlock system has been designed to enable safe operation of the two lasers simultaneously.

Conclusions

In conclusion, we report here on the new Artemis laboratories in the Research Complex at Harwell. The next steps for commissioning are the installation of vacuum pumping systems, plant, vacuum control systems and laser interlock systems, which will take place through 2019-20.

References

[1] F. Cilento, G. Manzoni, A. Sterzi, S. Peli, A. Ronchi, A. Crepaldi, F. Boschini, C. Cacho, R. Chapman, et al., "Dynamics of correlation-frozen antinodal quasiparticles in superconducting cuprates," *Sci. Adv.* **4**, eaar1998 (American Association for the Advancement of Science, 2018).

[2] K. Volckaert, H. Rostami, D. Biswas, I. Marković, F. Andreatta, C. E. Sanders, P. Majchrzak, C. Cacho, R. T. Chapman, et al., "Momentum-resolved linear dichroism in bilayer MoS_2," *Phys. Rev. B* **100**, 241406 (2019).

[3] A. D. Smith, E. M. Warne, D. Bellshaw, D. A. Horke, M. Tudorovskya, E. Springate, A. J. H. Jones, C. Cacho, R. T. Chapman, et al., "Mapping the Complete Reaction Path of a Complex Photochemical Reaction," *Phys. Rev. Lett.* **120**, 183003 (2018).

[4] E. M. Warne, B. Downes-Ward, J. Woodhouse, M. A. Parkes, D. Bellshaw, E. Springate, P. Majchrzak, Y. Zhang, G. Karras, et al., "Photodissociation dynamics of CH 3 I probed via multiphoton ionisation photoelectron spectroscopy," *Phys. Chem. Chem. Phys.* **21**, 11142–11149 (2019).