

## 2D-IR Photon Echo Spectroscopy with Dual XMS Stages

A team of scientists at the Central Laser Facility at the STFC Rutherford Appleton Laboratory, United Kingdom are dedicated to research and development of Photon Echo Spectroscopy (PES). The PES technique uses very short infrared laser pulses to excite energy transfer between molecules. Fourier transforms are then applied to the data collected in the time domain, allowing researchers to understand more about fundamental characteristics and chemical dynamics of materials.

In the experimental setup of PES, two motorized linear stages with excellent velocity stability and highly repeatable bi-directional motion capability are required for sample positioning and laser pulse control. To fulfil the experimental motion requirements of PES, dual XMS linear stages and an XPS motion controller were used.

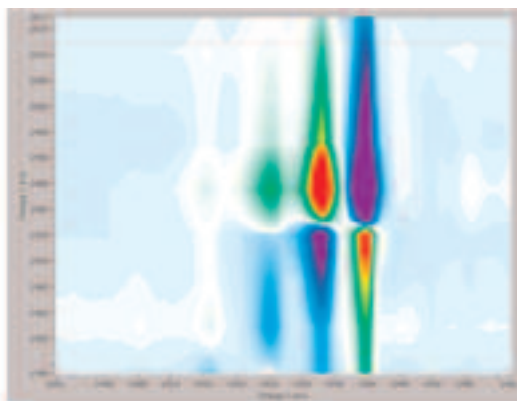


Figure 1: 2D-IR Map

In two-dimensional infrared spectroscopy, multiple IR pulses allow one to observe correlations of a molecule's vibrations, providing information on transient molecular structure. Typical schemes involve "pumping" a sample with an IR laser pulse and probing the sample with a second IR pulse sometime later to measure how the initial vibration energy from the pump pulse flowed through the molecule.

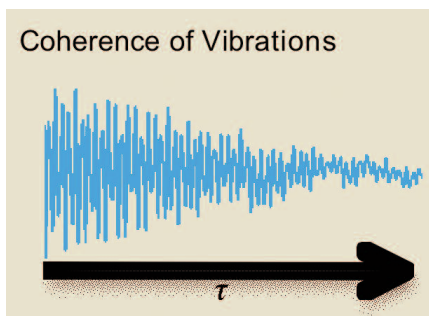


Figure 2: Coherence of Vibrations

The photon-echo 2D-IR method from Rutherford Laboratory uses two IR pump pulses for response measurement in the time domain. A third IR pulse is used to probe the sample and the transmitted light is dispersed in a spectrometer to provide data for a probe axis on a 2D-IR map (see figure 1). The signal gathered from time scanning provides a frequency response spectrum when a Fourier transform is applied.

To control the timing of these pulses with femto-second precision, two XMS50 Ultra-

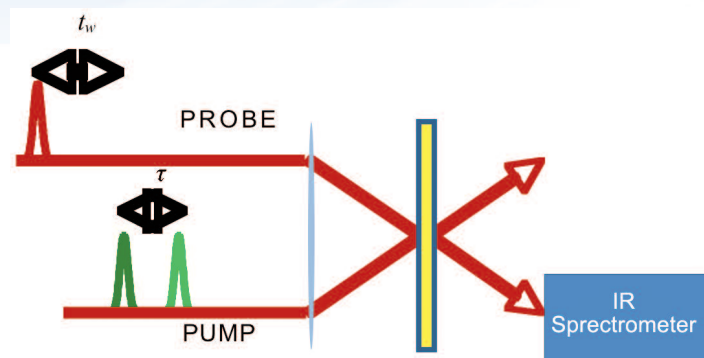


Figure 3: Timing values controlled using Newport XMS50 linear stages

precision linear motor stages are deployed, one controlling pump probe timing (waiting time,  $t_w$ ) and second controlling pump pulse coherence ( $\tau$ ) as shown in figure 3. The XMS stages utilize a linear scale encoder with 1nm sensitivity and superior 80nm bi-directional repeatability to enable highly accurate control of the pump pulse coherence variations. The research scientists in Rutherford commented that Newport XMS50 stages helped reduce the test time and decrease the degradation of chemical samples greatly.

The customized experimental control capability of the XPS provides unmatched benefits compared to alternative control methods using commercial FTIP interferometers. The ironless linear motor of the XMS stage in conjunction with ultra high resolution linear scale encoder enables smooth scanning of "t" as well as rapid data collection. With a laser repetition rate 10 kHz, 100  $\mu$ s position updates are

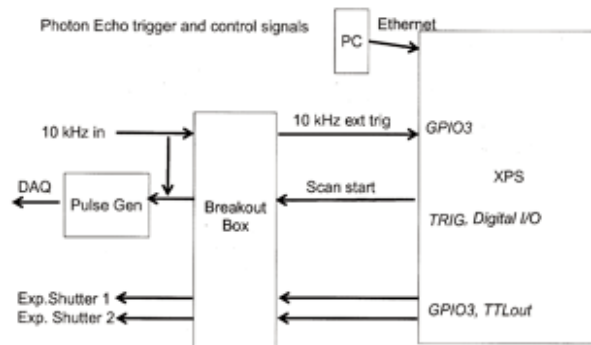


Figure 4: Trigger and control signals using the XPS

required. The event triggering, data gathering and digital I/O features of the XPS (See figure 4) permit data collection to commence upon reaching a stable velocity defining the exact start point of the scan (within one pulse of the laser). These features allow position information for a specific laser pulse to ensure repeatable, rapid scanning and sub- $\mu$ m interferometry synchronized to the 10 kHz laser system.

For further information on Newport XMS stage and XPS controller, please contact Newport application engineers at [tech@newport.com](mailto:tech@newport.com).