APPLICATION NOTE

# Circularly Polarised Luminescence Accessory for the FLS980 Spectrometer

AN_P15; 11 September 2014, Mark McCallum

## Circularly Polarised Luminescence Accessory for FLS980

Circularly polarised luminescence (CPL) measurements can be made on an FLS980 spectrometer which has been modified to include a photo-elastic modulator (PEM) and lock-in amplifier CB1 box. The firmware inside the photon counting box (CB1) is modified for the application and the usual F980 software has custom calculation wizard and PEM control functionality.

## CPL Spectroscopy

CPL spectroscopy is used to measure samples which preferentially emit circularly polarised light of a specific chirality. It is used for characterising chiral emissive chromophores and is an offset of a branch of spectroscopy known as circular dichroism spectroscopy, which measures the chirality of the absorption spectrum. Applications include the assessment of structural properties of biological macromolecules (e.g. proteins).

## CPL with FLS980 Spectrometer

The PEM is positioned in the emission path of the system, between the sample and emission linear polariser. The PEM is the active component in CPL and acts as a switchable quarter-wave plate, with the fast axis rotating by 90 degrees, between horizontal and vertical axes, at the PEM switching frequency of 50 kHz. The linear polariser is positioned at 45 degrees to the PEM axis (in F980 this is 135 degree location) in order to allow the transmission of circularly polarised emission light.

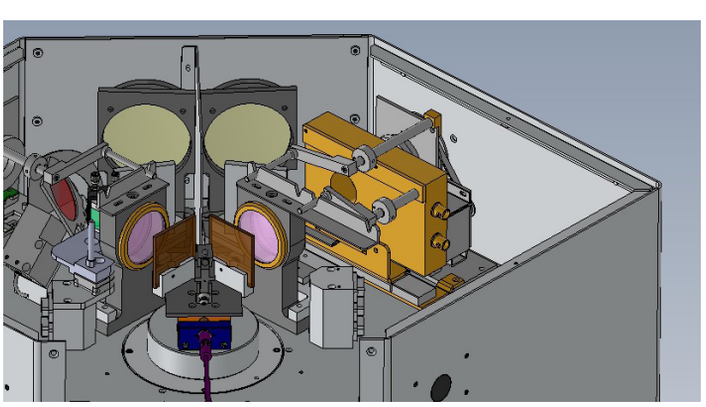

Figure 1: CPL System Sample Chamber (PEM in yellow).

The CB1 acts as a lock-in amplifier and collects emission signal when the PEM is in a horizontal or vertical location, accepting an exposure time of 1 µs at each position.

It collects the photon counts during 1µs windows at temporal location A and B during every 20 µs period of the PEM oscillation. This measurement is on-going for whichever dwell time/repeat options the user wishes to make the measurement for.

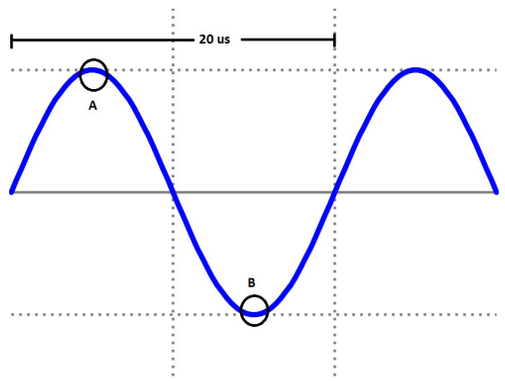


Figure 2: CPL Timing Schematic

The As and Bs represent $I_L$ and $I_R$ (intensity of right-hand/ left-hand circularly polarised light) respectively and are collected and substituted into the standard CPL formula (1) to generate $\Delta I$, $I$ and $g_{lum}$ values.[1]

$$g_{lum} = \frac{2\Delta I}{I} = \frac{2(I_L - I_R)}{(I_L + I_R)} \qquad (1)$$

In terms of Edinburgh Instruments F980 software $I_L$ and $I_R$ are obtained using the table and method below.

| Detector | Mux Channel | Value | Scan Name |
|---|---|---|---|
| Det 1 | 20 | $I_L$ | EmScan X |
| Ref Det | 22 | $I_R$ | Ref EmScan X |

Both channels are obtained simultaneously by selecting 'Display Ref. Data' on the emission scan menu, as shown below in Figure 3. Note all correction is turned OFF in order to obtain the raw data.

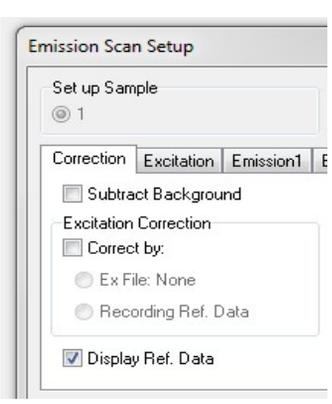


Figure 3: CPL Emission Scan Setup.

The two spectral measurements for $I_L(\lambda)$ and $I_R(\lambda)$ are made in two separate scans windows, called "EmScanX" and "Ref EmScan X". The user selects the "EmScan X" then from the F980 drop-down menu **Analysis / CPL Analysis** and three new spectral windows are generated for $\Delta I(\lambda)$, $I(\lambda)$ and $g_{lum}(\lambda)$.

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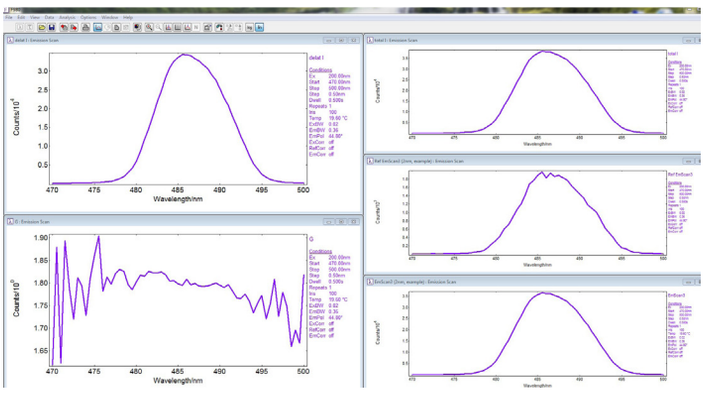

Figure 4: F980 Software Wizard.

## References


[1] James P. Riehl, Circularly Polarized Luminescence Spectroscopy. Chemical Reviews, 86, 0786-0001, 1986.


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