**Background & Introduction**

Inverse Photoemission Spectroscopy (IPS) is a technique for investigating the unoccupied electronic states in solids. An incoming electron couples to a high-lying unoccupied state and makes a radiative transition (decays) into a lower energy unoccupied state emitting a photon of characteristic energy.

Photons generated in this way are directed towards a diffraction grating which deflects photons of different energies by different angles. The photons are then detected by a 2-dimensional multichannel plate where different positions correspond to different photon energies.

**Motivation**

- Interesting physics occurs on the energy scale of 40 meV and lower.
- Our current IPS resolution is approximately 400 meV, so a new experimental design with 10x better resolution is needed.
- Using the Oasys ray-tracing software package, photon trajectories can be simulated for our novel optical design.

*Our simulations suggest it is possible...*

- The new design should provide a ten-fold improvement of the energy resolution with respect to current systems: from 400 meV to 40 meV.

**Experimental Results**

Improved resolution upon increasing $d_{sample}$

- Current setup is limited by the quality and age of the 2D-MCP
- A new 2D-MCP is being installed on the experimental chamber

- Measurement of reflected photons can be used experimentally to optimize the optical path.
- Using Oasys we simulated the $m=0$ diffraction order beam at different detector and sample positions for set angles and incident photon energy.
- The Full Width Half Maximum (FWHM) of the reflected photon beam is very sensitive to the optical path.

**Conclusions and Future Work**

- Small changes in detector and/or sample position have significant effects on the zeroth order beam resolution.
- Once the new detector is installed, further tests will be run to determine geometry for best resolution.
- Finally, the current electron source should be replaced by a high-resolution source.