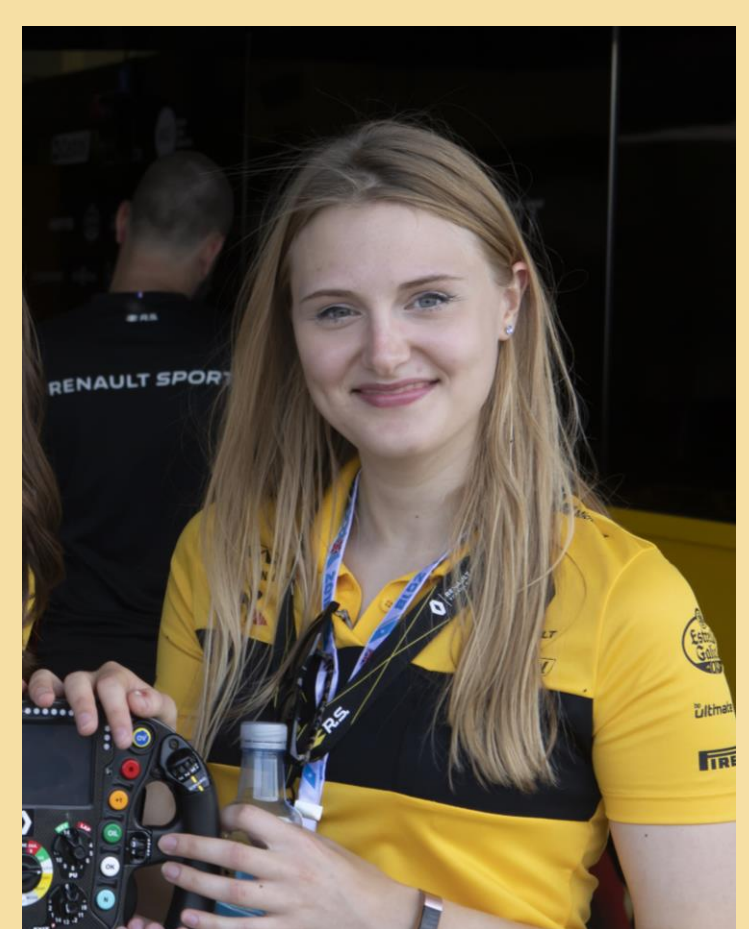


# The Invention of an Alignment Jig for the Manufacture of a Magnification System for a Spectrometer Microscope

**Amelia Böttcher** - Supervisor: Dr Arnaud Marotin

School of Engineering

BEng (Hons) Mechanical & Manufacturing Engineering



Above: Working with the **Renault F1 team** at Silverstone who use the Spotlight 400 Spectroscopy system for diagnostics of the location of vehicle damage detected in particulates found in engine oil. (Photo courtesy of Luca Mazzocco)

## Introduction

Working as an Intern since June 2018, this project allows PerkinElmer to manufacture the optical magnification system inside the companies most advanced Fourier Transform Infra-Red Spectrometer Microscope, the Spotlight 400.

Due to optical design changes, the company made a strategic decision to bring the assembly of the part from overseas to PerkinElmer's plant in Llantrisant, South Wales.

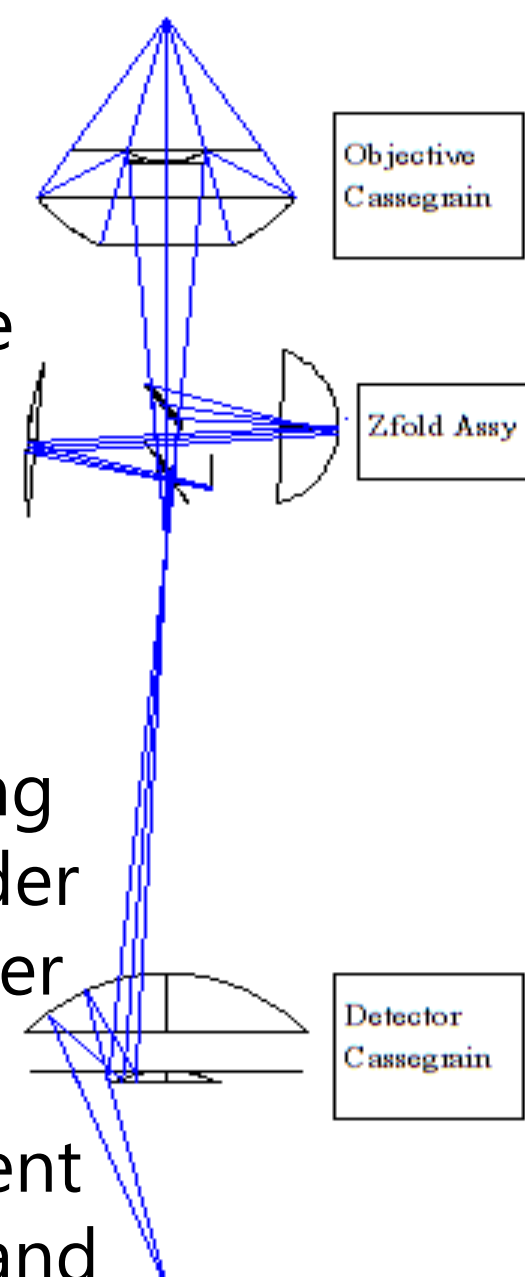
Insourcing will incur a **saving of over £400,000** per year and further enhance the optics manufacturing capabilities on site. This figure was found through reductions in supplier prices and factored with estimated build times.

## Materials and Methods

Using the PerkinElmer's laboratory and manufacturing facilities it was possible to break down the instrument and understand how the optical paths inside the product perform.

The system of lenses and mirrors inside the magnification system are aligned from bonding process during manufacture. A slight error can render the instrument redundant by the user if this is not correct.

By reverse engineering the instrument using **Solidworks Lens Mechanix** and **Zemax Optic Studio optical modeling software** it was made clear what properties of light must be made by the jig to align the optics perfectly.

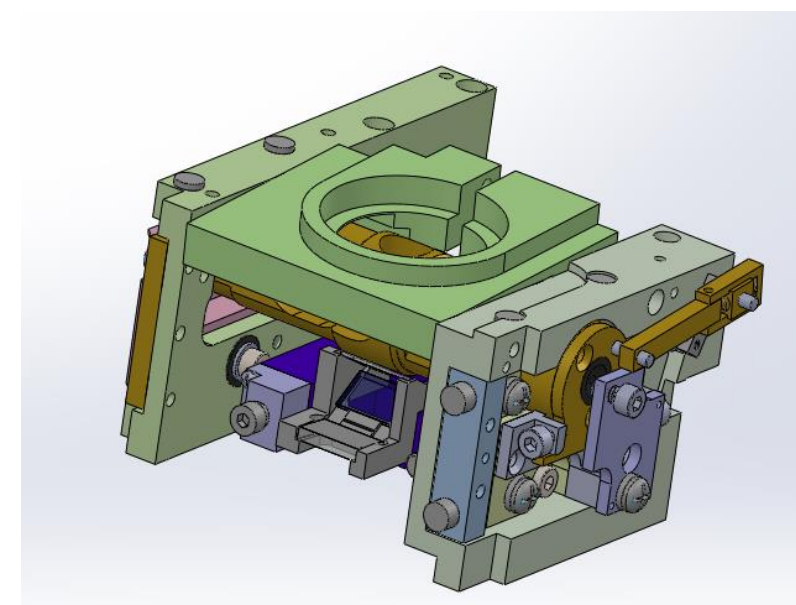


Above: The light ray paths within the instrument as shown in Zemax

### Key Applications of the Product

- ▶ Biomaterial studies such as tissue, bone, teeth, leaves, etc
- ▶ Product defect analysis
- ▶ Impurity identification
- ▶ Forensics
- ▶ Academic research
- ▶ Pharmaceutical table analysis and other component distribution studies

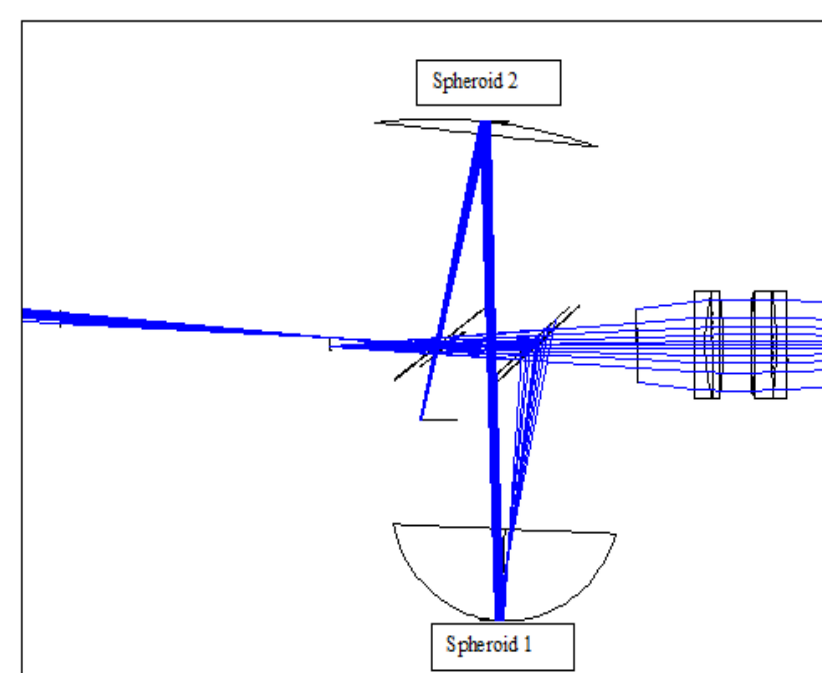
Below Left: A model of the magnification system assembly housing the moving optics



Below Left: A representation of the light rays found within the instrument using Zemax. Above Right: Mapping light in the jig with Zemax software



Below: Spotlight 400 FT-IR System[1].



## Conclusions

During the project, a decision was made to reach out to the current manufacturers of the optical assembly and request their tooling. This meant that merely a proof of concept needed to be generated and understand enough about the assembly to immediately begin production on the suppliers jig after rigorous testing which is ongoing.

## Recommendations

The addition of an internally made production standard jig would retain the knowledge of the product requirements and specifications of the manufactured parts, thus keeping control and retaining operating procedures, securing supply and future part developments within the organisation.

A programme written in MATLAB is recommended to give the technician on the assembly line an easy to use guide on optical alignment thresholds. A heavily restricted jig would ensure there would be no room for human error and external factors during the bonding process and would be detected before the instruments final test prior to shipping.

## Acknowledgements

I owe my gratitude to Andrew Thorn for opening the door to the company. I would like to thank David Bridgeman for the project and the Spotlight line team for their continuous input and support.

## References

- PerkinElmer, 2019. Spotlight 400FTIR System. [Online] [http://www.newprojectsrl.com/docs/Strumentazione%20analitica/Spettroscopia%20Molecolare/CHEIMMSPO/Data%20Sheet/DS\\_Spotlight%20200\\_400.pdf](http://www.newprojectsrl.com/docs/Strumentazione%20analitica/Spettroscopia%20Molecolare/CHEIMMSPO/Data%20Sheet/DS_Spotlight%20200_400.pdf)
- DataRay Inc, 2018. [Online] <https://www.dataray.com/beamr2-xy-scanning-slit-beam-profiler.html>

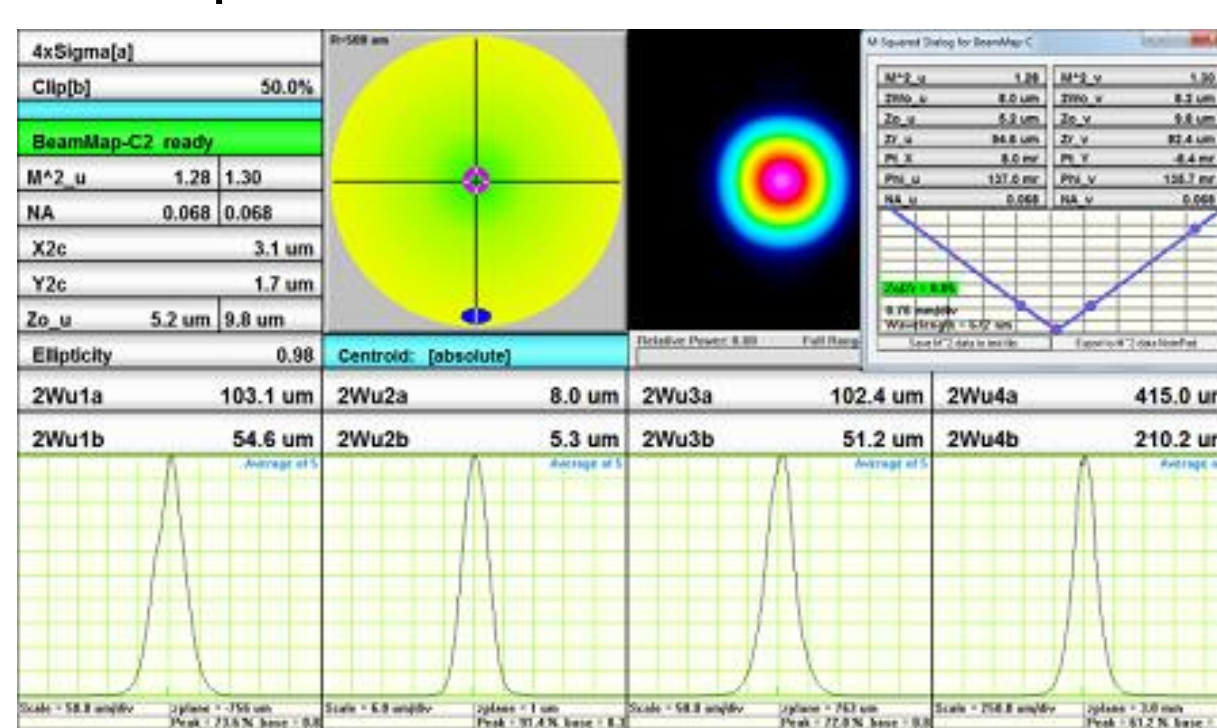
The success of the project relies upon the replication of the point at which the light in the optical system is in focus. The problem was further complicated by the microscope spectrometer switching between levels of magnification in Infrared and Visible light modes.

By investigating the components practically by assembling a jig from laboratory optics consisting of:

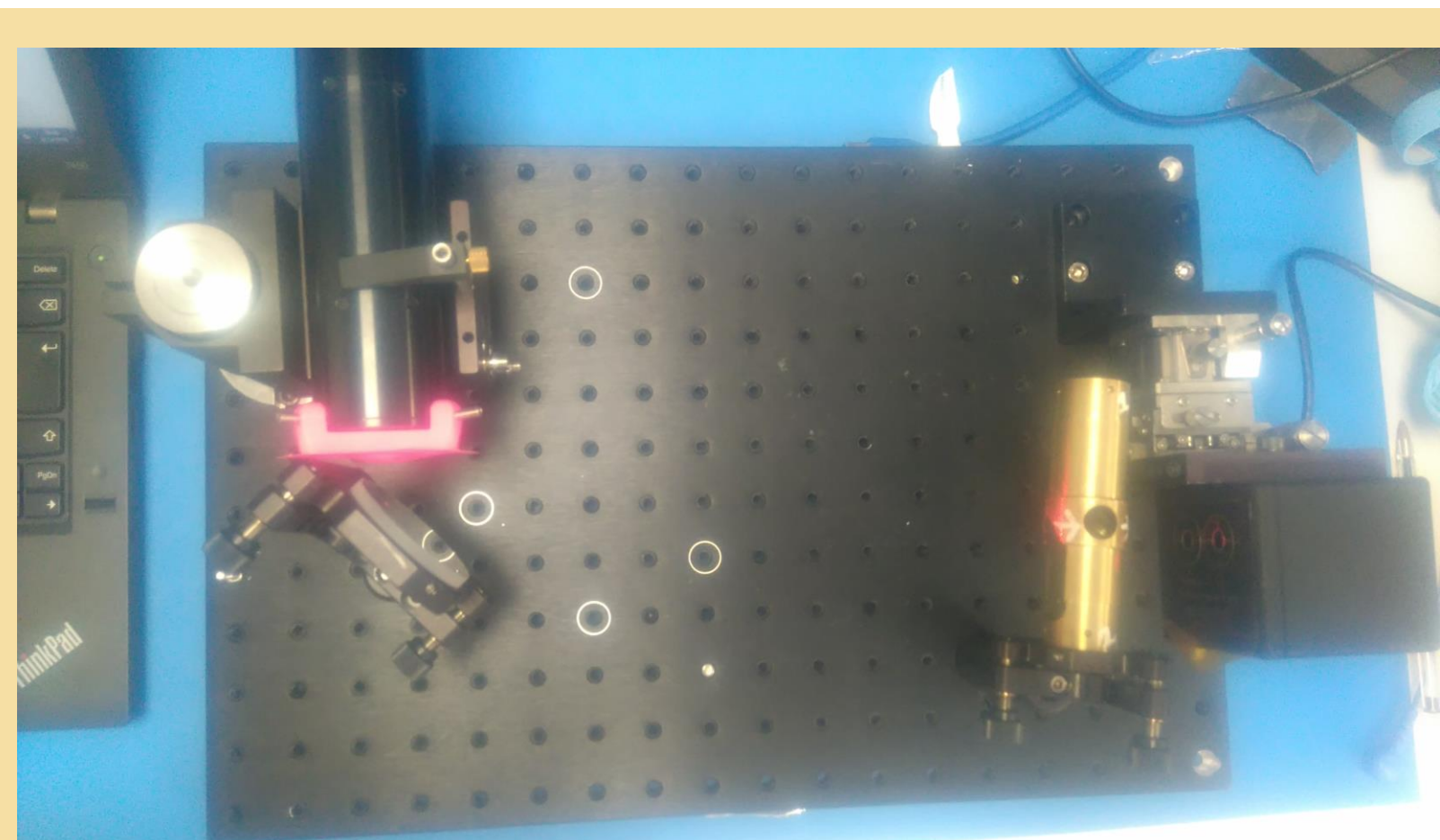
- ▶ Various HeNe Lasers with 633nm beam to show the paths of the visual light
- ▶ Micro Positioners with vacuum pumps to hold and maneuver lenses in four degrees of freedom
- ▶ Optical Breadboard, posts, clamps, kinematic mounts fastenings etc.
- ▶ Scanning Slit Laser Beam Profiler – BeamMap2

## Results

The experiments in the laboratory setup were successful however needed to be validated with theoretical backing with focal point measurements with Zemax.



Above: Using the software from the Beam Map to show the shape of the laser spot in 3D and the rings on the target show the focus point. This provided data on the spot quality which is of great importance in light reproduction. DataRay Inc [2].



Above: Reverse engineering the optical system in the laboratory in the research and development stage, the gold tube being the magnification element, which rotates 90° to change from normal sample view to 5X magnification view of the sample within the Microscope Spectrometer. To comply with laser safety regulations, 3D printed parts (shown in pink) were created to mount filters over the lasers beam to decrease its intensity