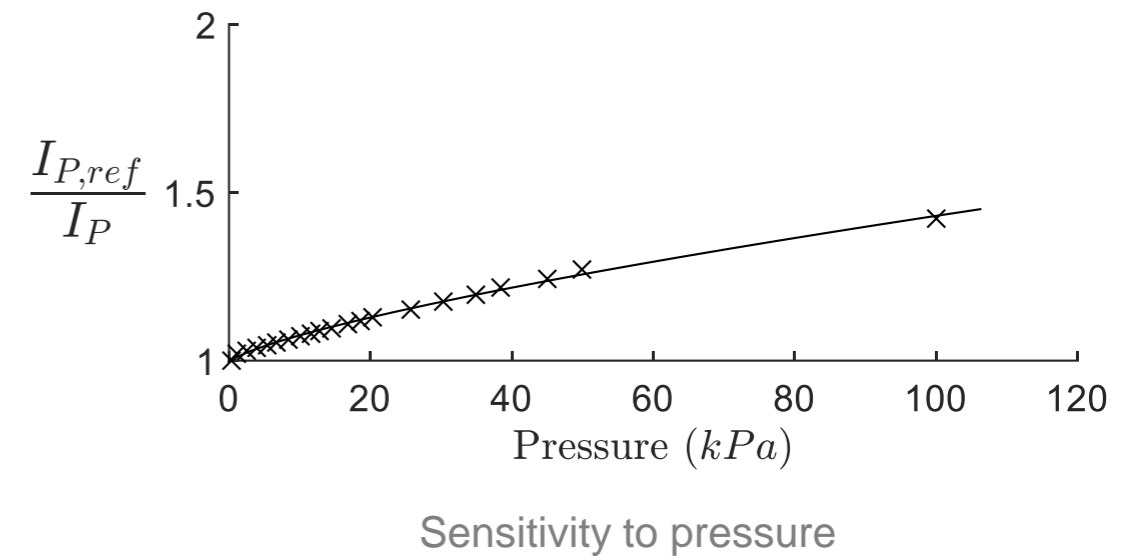
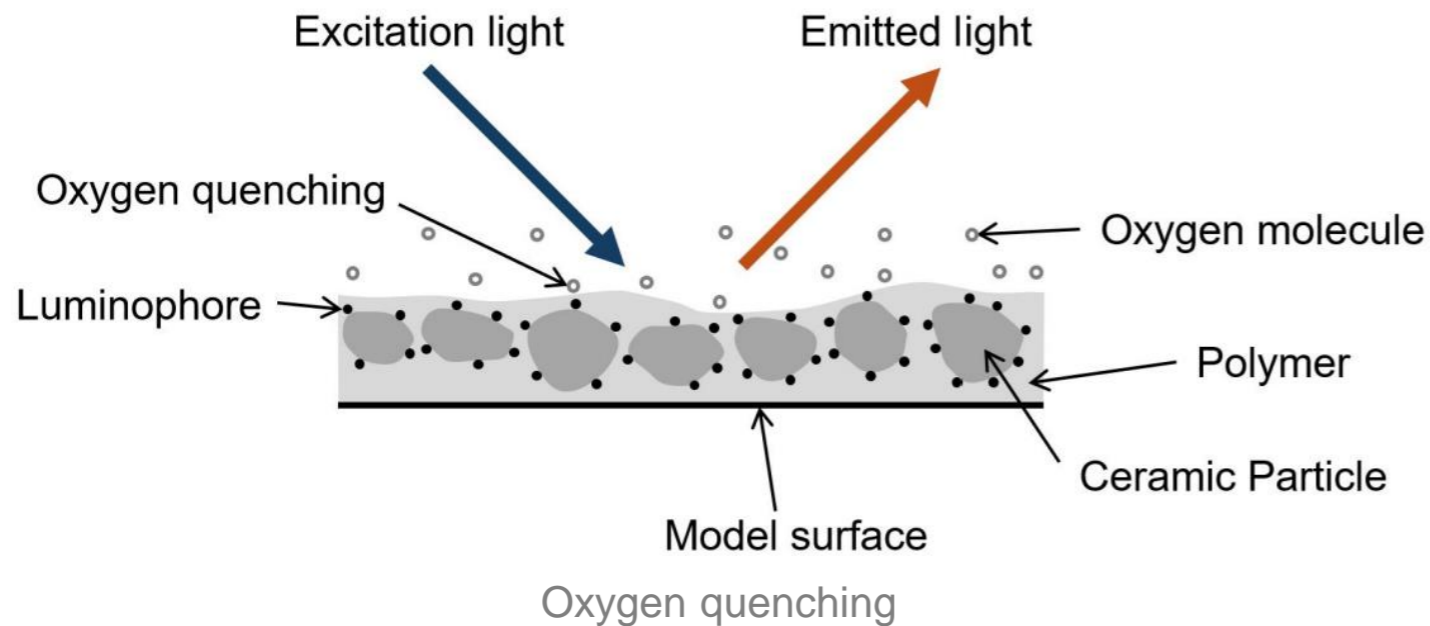


Development of Binary Pressure-Sensitive Paint for Short Duration Hypersonic Wind Tunnels

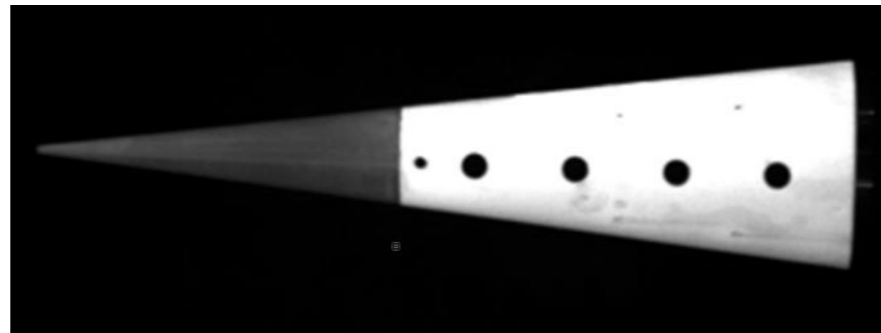
Mr Oscar Jones, Dr Luke J. Doherty, Dr Laurent M. Le Page, Mr Liam P. McQuellin, Mr Tom Tyler

- **Surface pressure distribution is one of the most important properties measured in wind tunnel experiments**
- **Pressure-sensitive paint (PSP) allows for**
 - **Non-intrusive measurement**
 - **Quantitative measurement**
 - **Measurement the continuous surface pressure distribution**
- **Validating computational and numerical models**

- **Oxygen-quenching of fluorescent signal**
- **Binary PSP – pressure-insensitive component**



- **Developing on previous binary PSP experiments at Oxford**
- **Investigate variables affecting binary PSP response**
- **Test developed mixtures on canonical geometries at Mach 5**

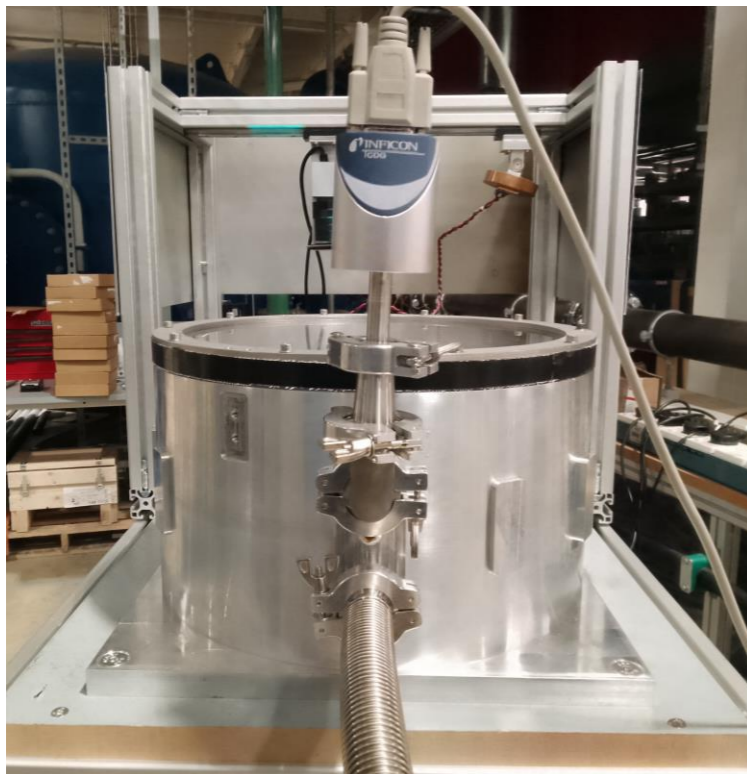


Pressure signal

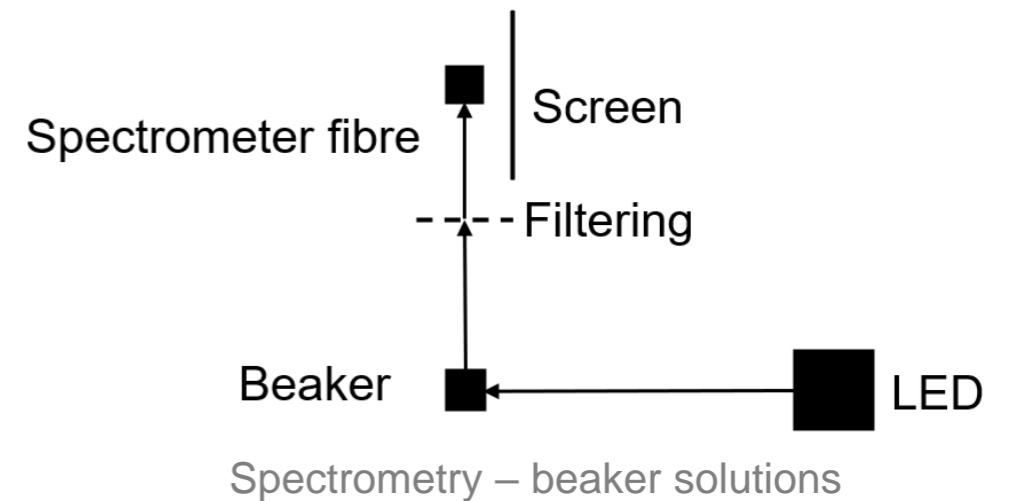
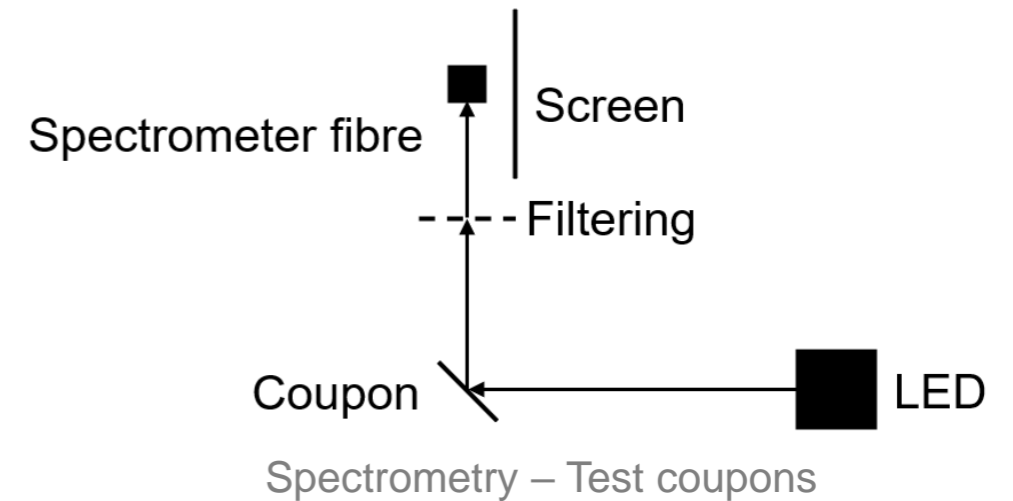


Reference signal

- **Diameter: 340mm. Height: 200mm**
- **Absolute pressure range: 0 bar to 3 bar**
- **Test coupons (60mm × 60mm × 2mm)**
- **Wind tunnel models**

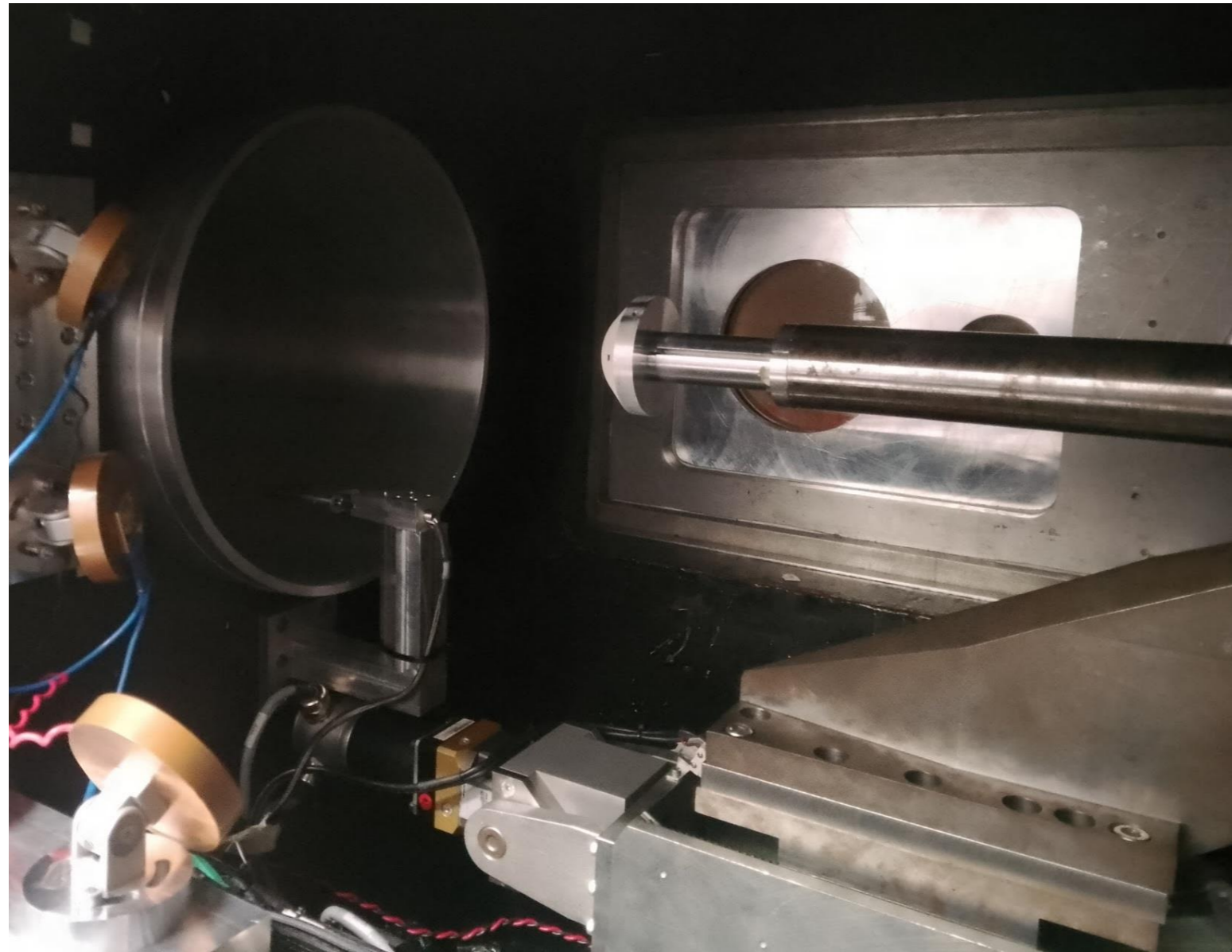


PSP Rig

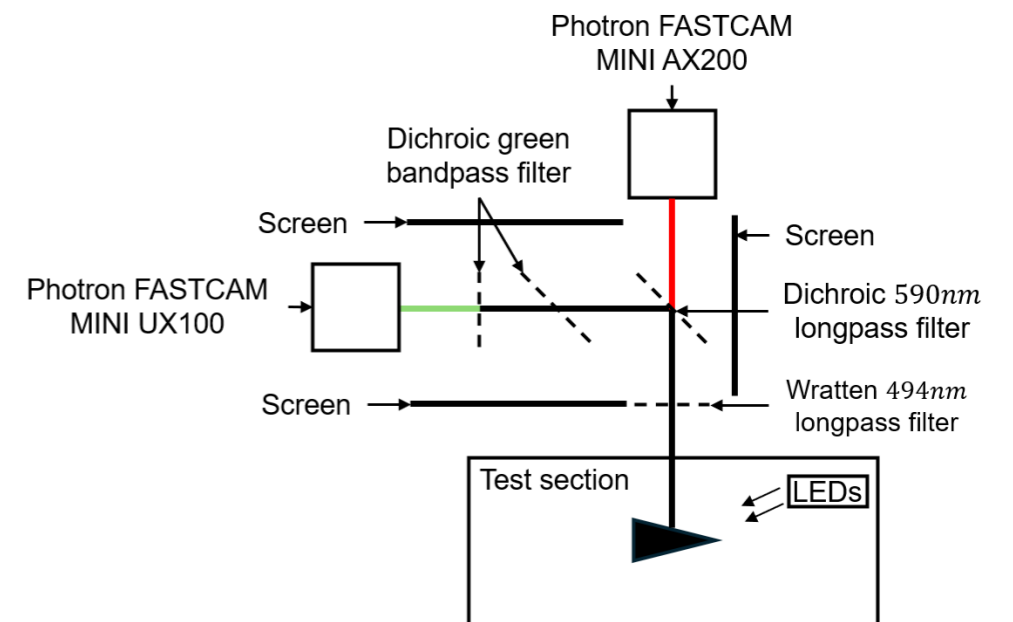
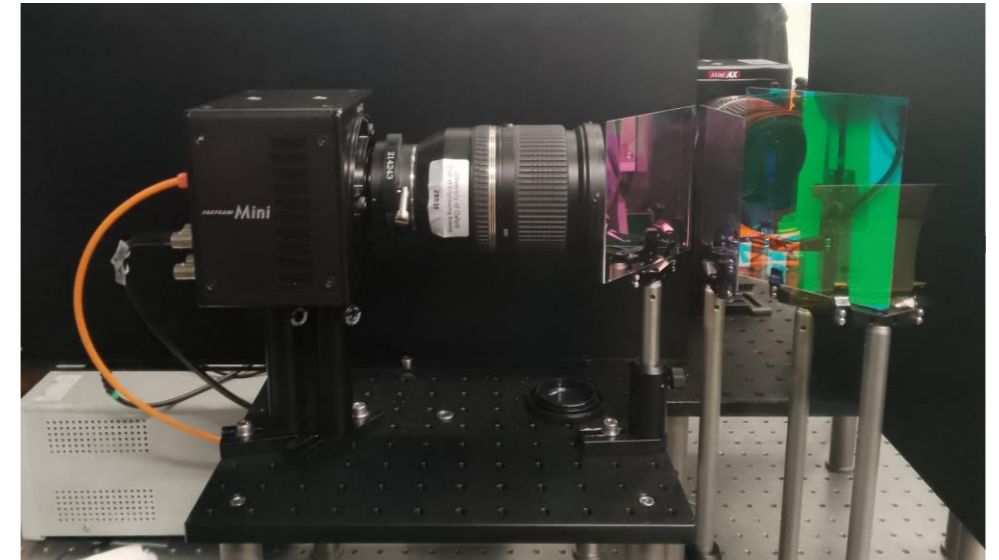


- **Right-angle measurement of fluorescent intensity**
- **Beaker solutions and test coupons**

Experimental Setup – High-Density Tunnel

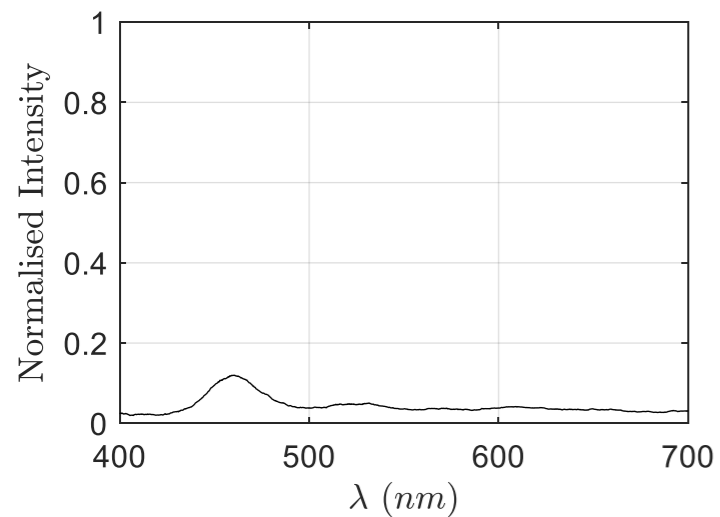


High-Density Tunnel test section

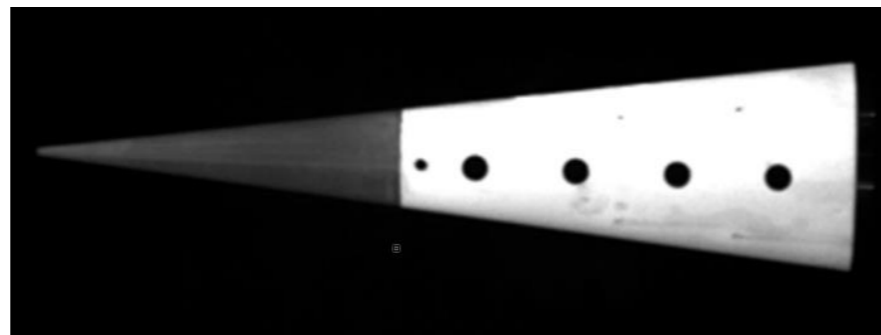


Optical filtering arrangement

- **Pressure-insensitive component: Fluorescein**
- **Pressure-sensitive component: Ru(dpp)₃**
- **Solvent: Dichloromethane**



Fluorescein in Dichloromethane

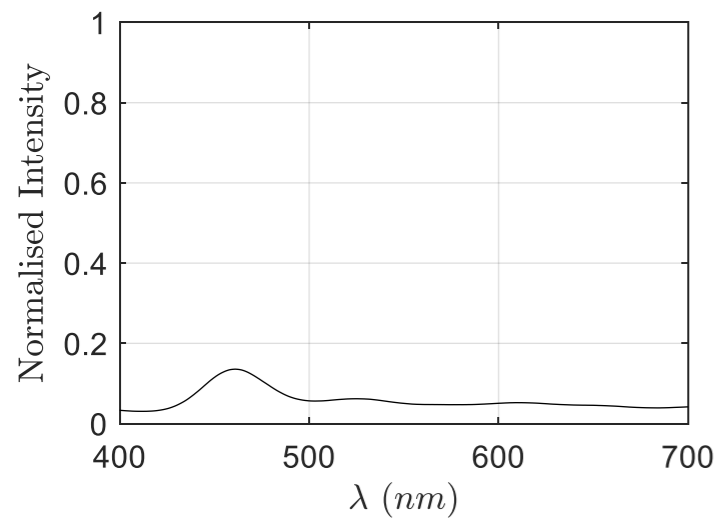
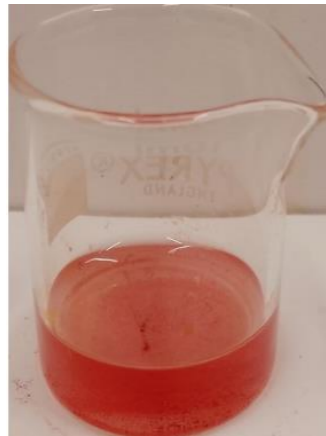


Pressure signal

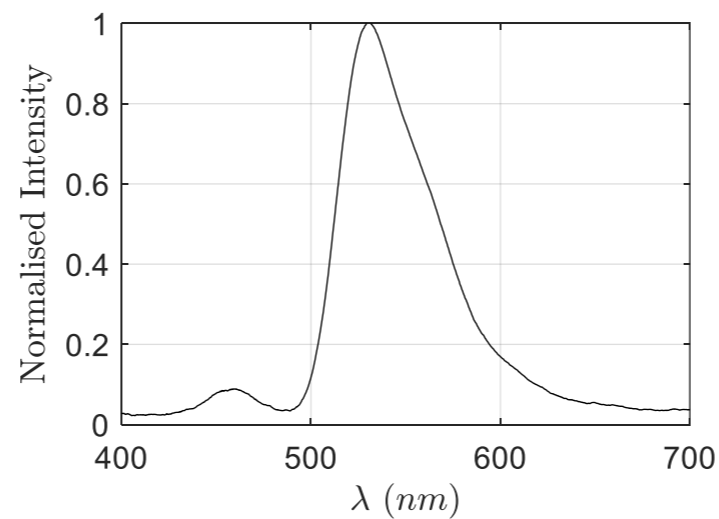


Reference signal

- **Pressure-insensitive component: Fluorescein Sodium Salt**
- **Solvent: Isopropyl Alcohol**

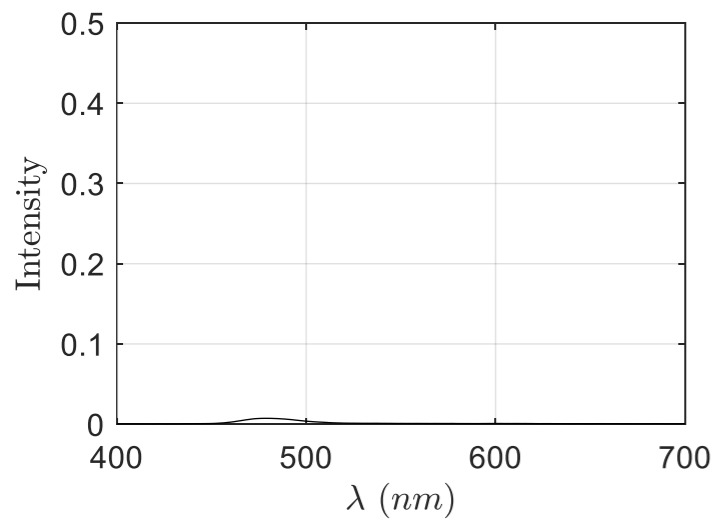
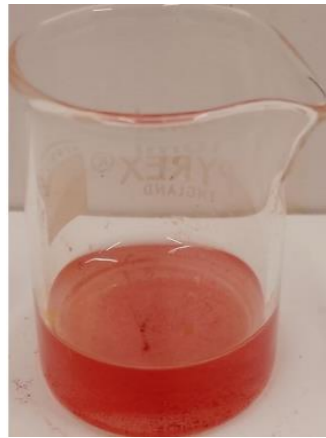


Fluorescein Sodium Salt in
Dichloromethane

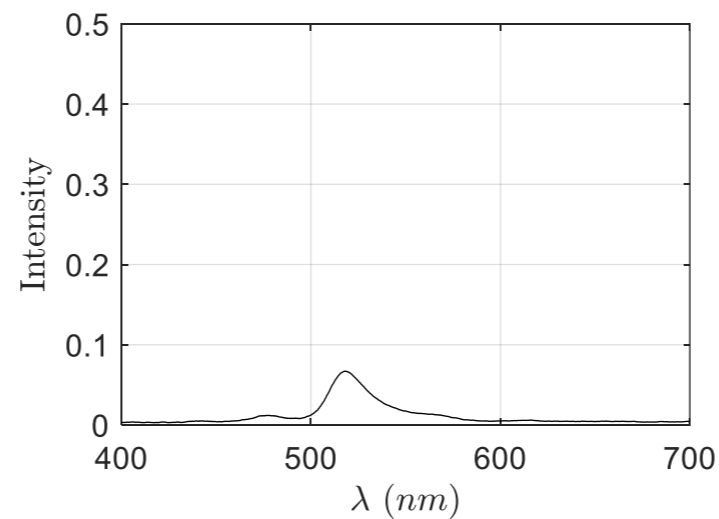


0.27mM Fluorescein Sodium
Salt in Isopropyl Alcohol

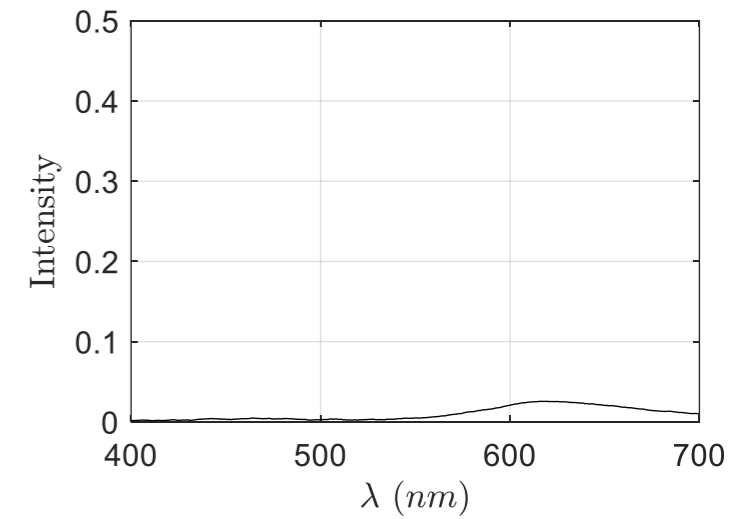
- **Pressure-insensitive component: Fluorescein Sodium Salt**
- **Pressure-sensitive component: Ru(dpp)₃**
- **Solvent: Isopropyl Alcohol**



Fluorescein Sodium Salt in
Dichloromethane – coupon

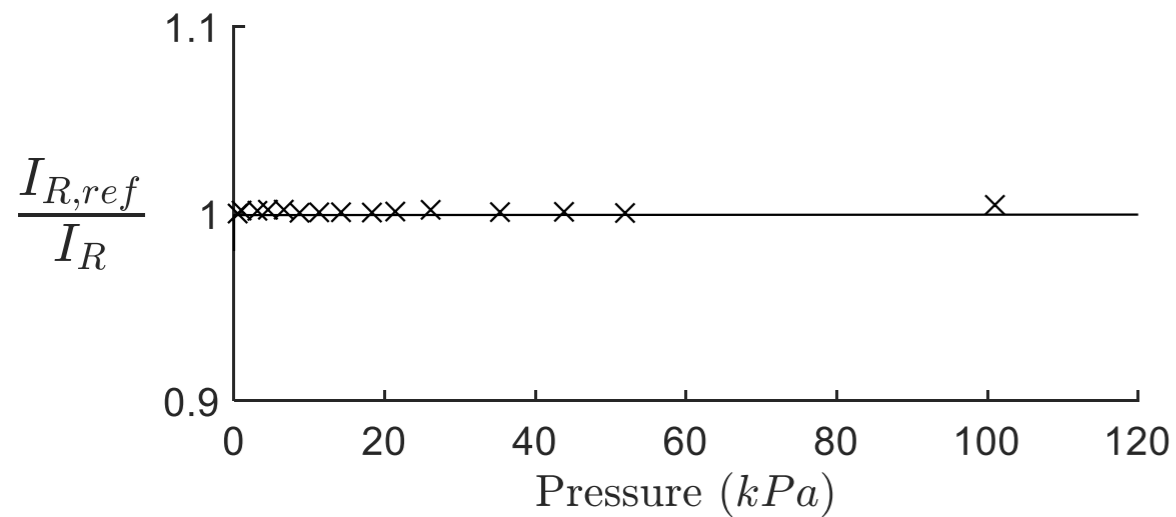
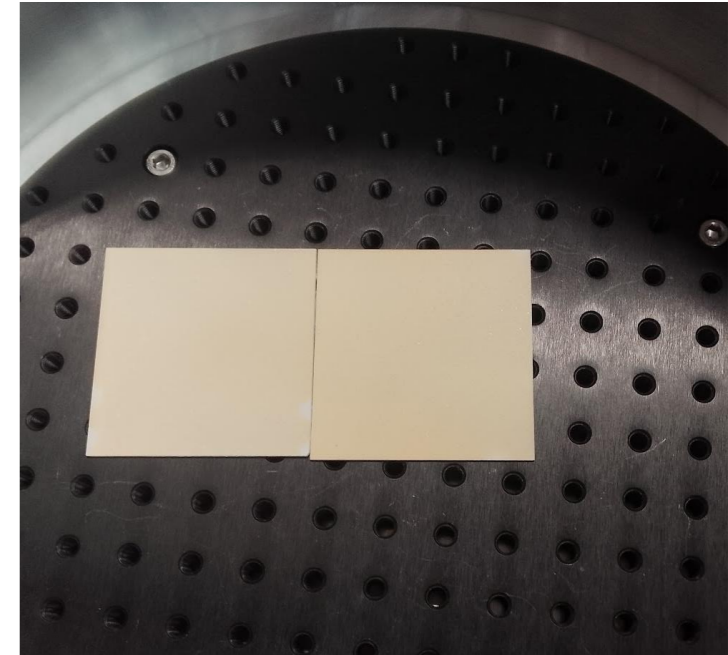


Fluorescein Sodium Salt in
Isopropyl Alcohol – coupon

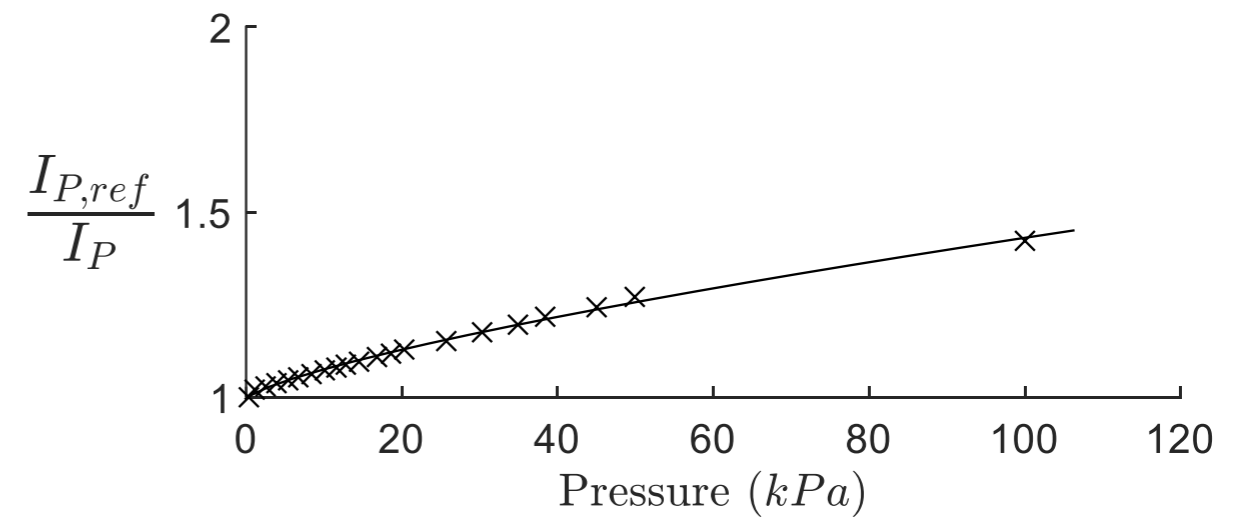


Ru(dpp)₃ in Isopropyl
Alcohol – coupon

- Pressure-insensitive component: Fluorescein Sodium Salt
- Pressure-sensitive component: Ru(dpp)_3
- Solvent: Isopropyl Alcohol

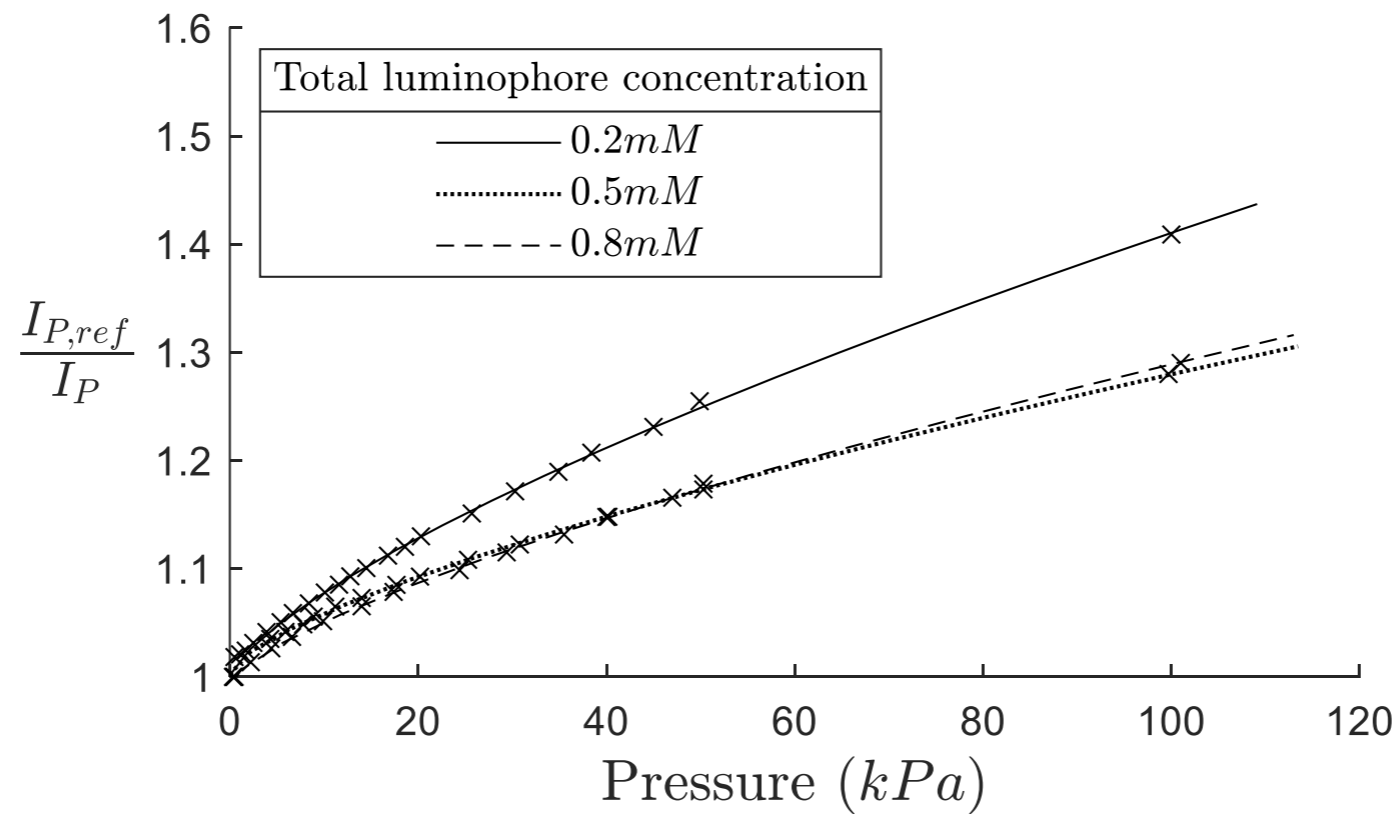


Fluorescein Sodium Salt in Isopropyl Alcohol – coupon



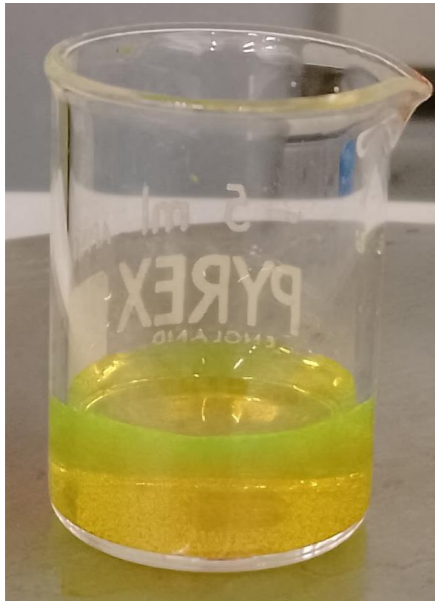
Ru(dpp)_3 in Isopropyl Alcohol – coupon

- **Fluorescein Sodium Salt: $M_r = 376.27$**
- **Ru(dpp)_3 : $M_r = 1196.17$**

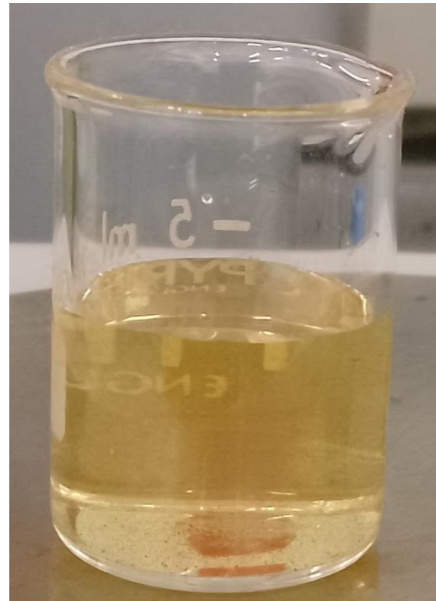


Influence of luminophore concentration on pressure sensitivity

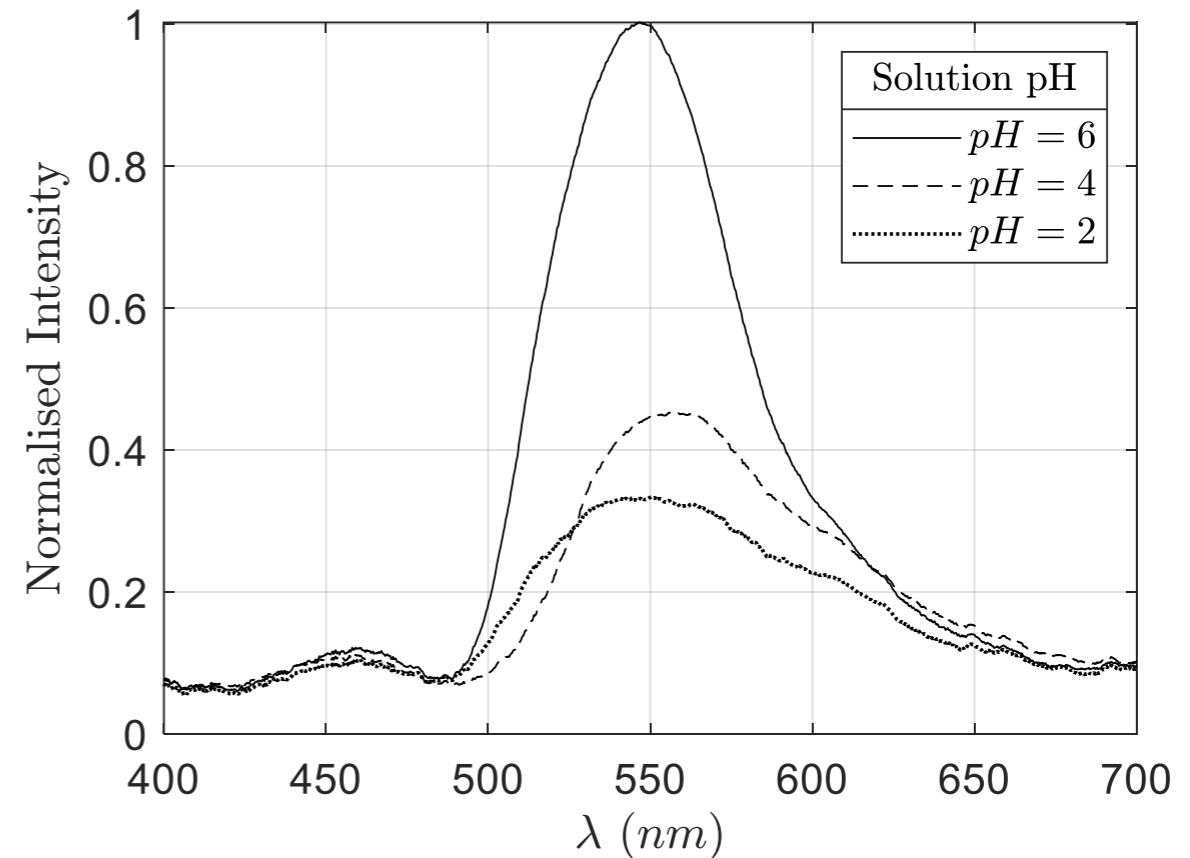
- **Binary PSP solution: $pH \approx 3$**
- **Fluorescein exists in the neutral molecule state**



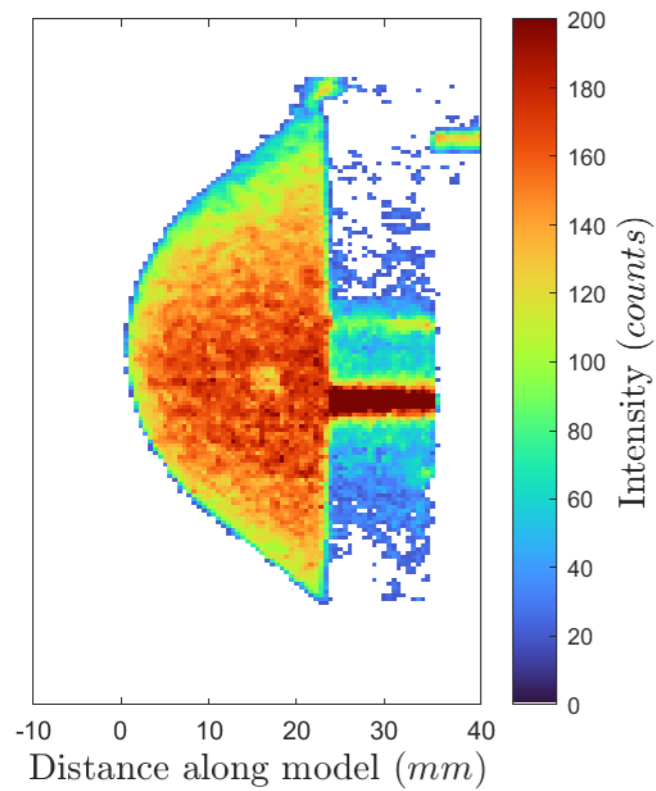
$pH = 6$
Fluorescein Sodium
Salt in Isopropyl
Alcohol



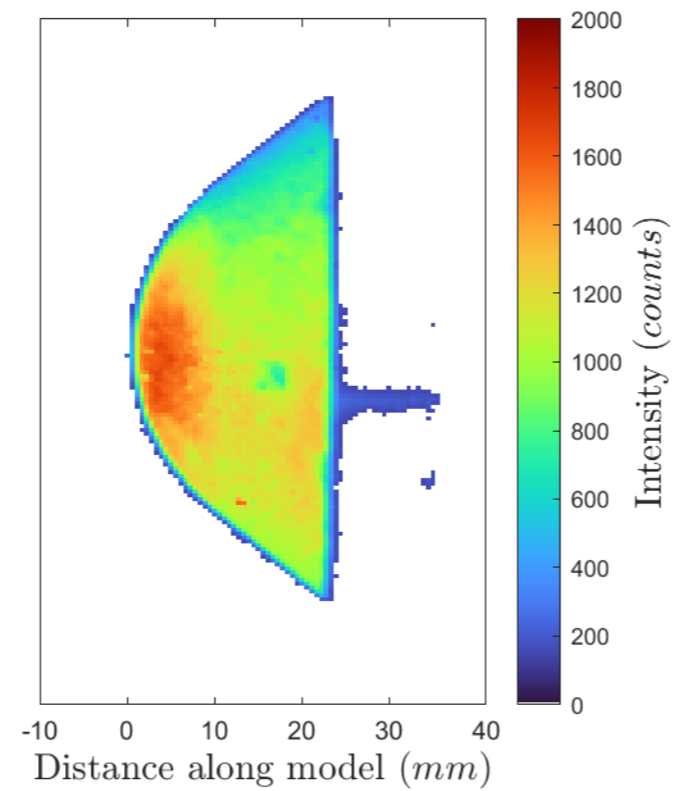
$pH = 2$
Fluorescein Sodium
Salt in Isopropyl
Alcohol



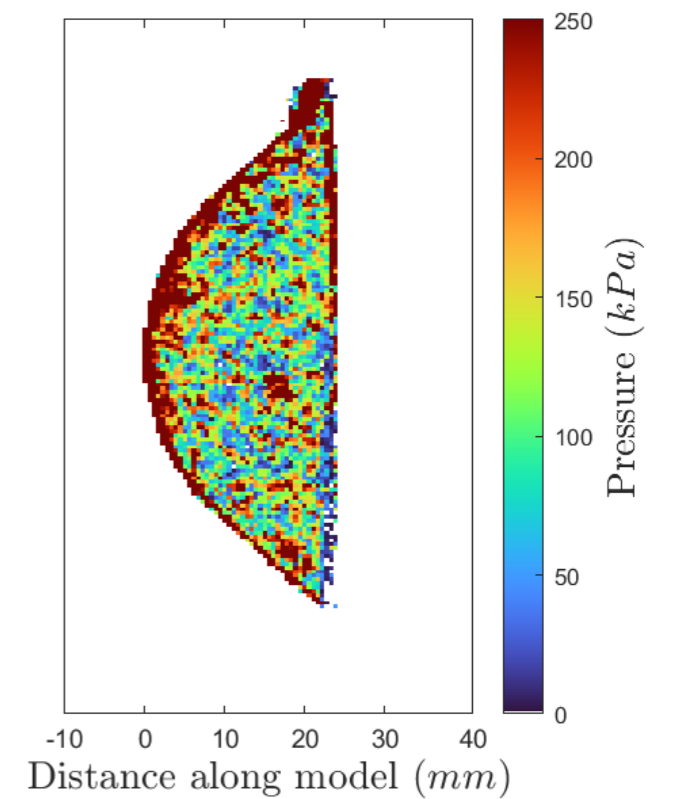
Influence of pH on Fluorescein Sodium
fluorescent intensity



Reference signal intensity

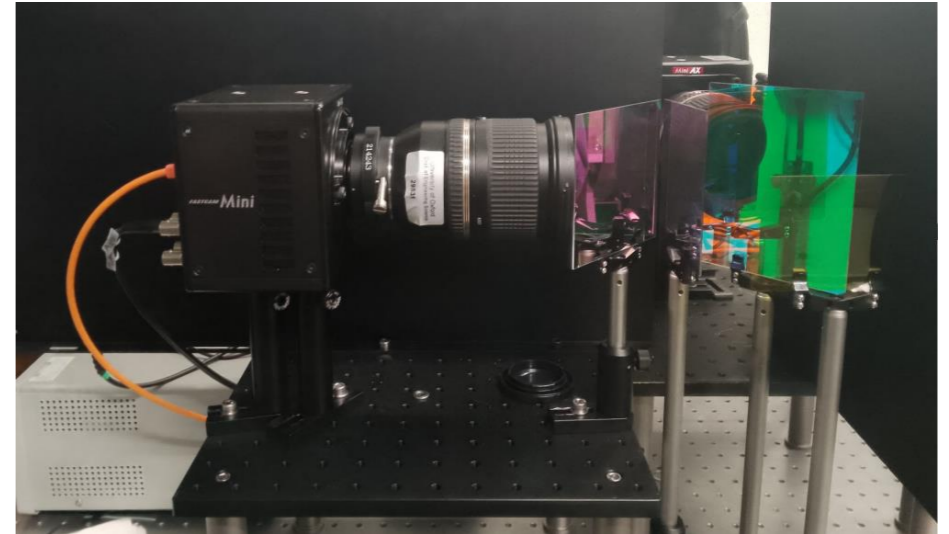


Pressure signal intensity

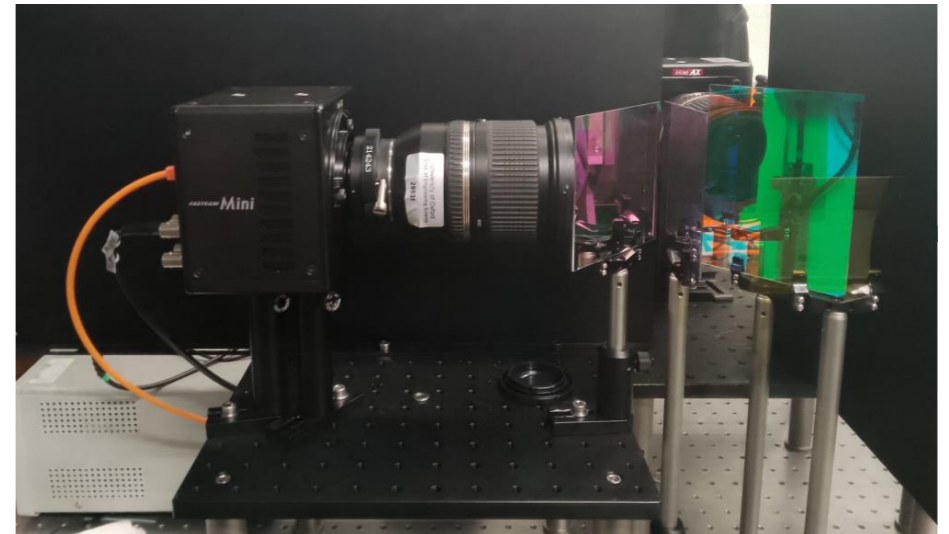


Surface pressure distribution

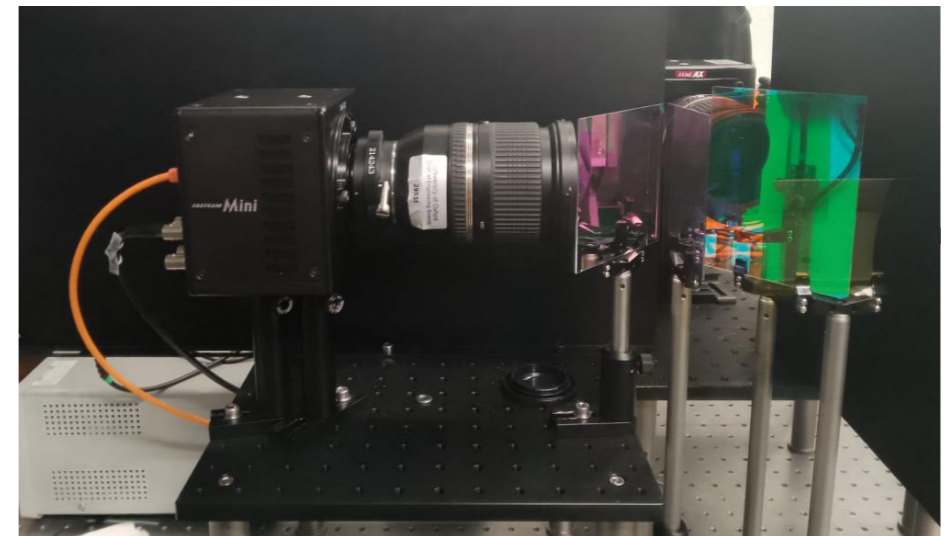
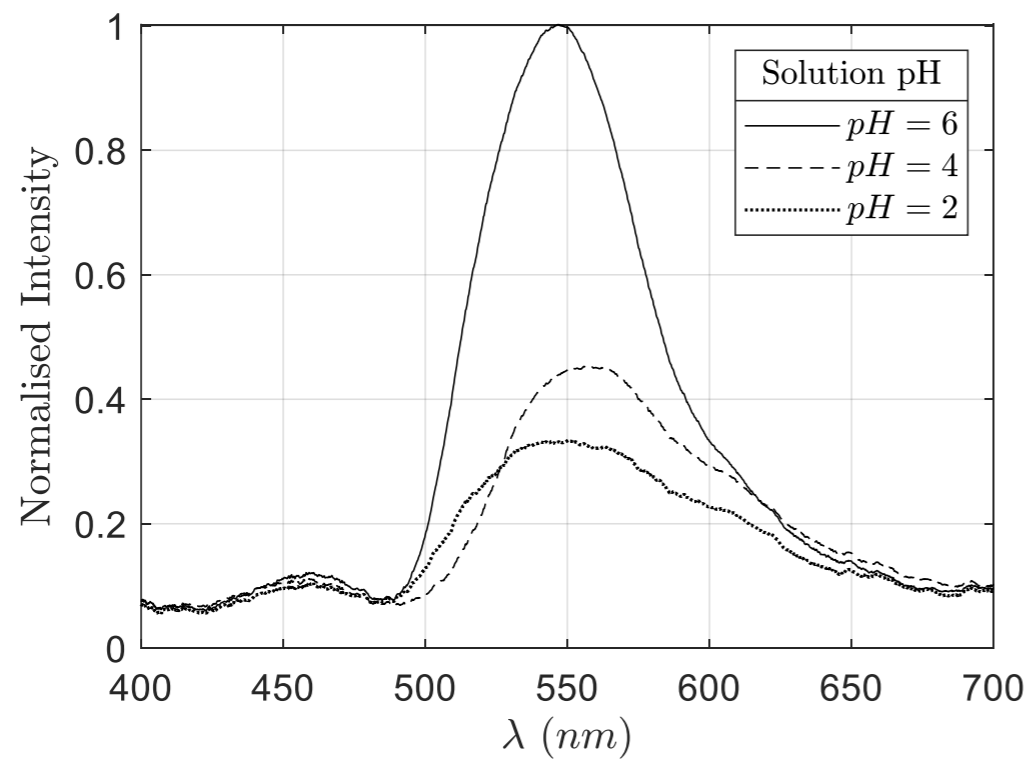
- **Narrower band-pass filters**



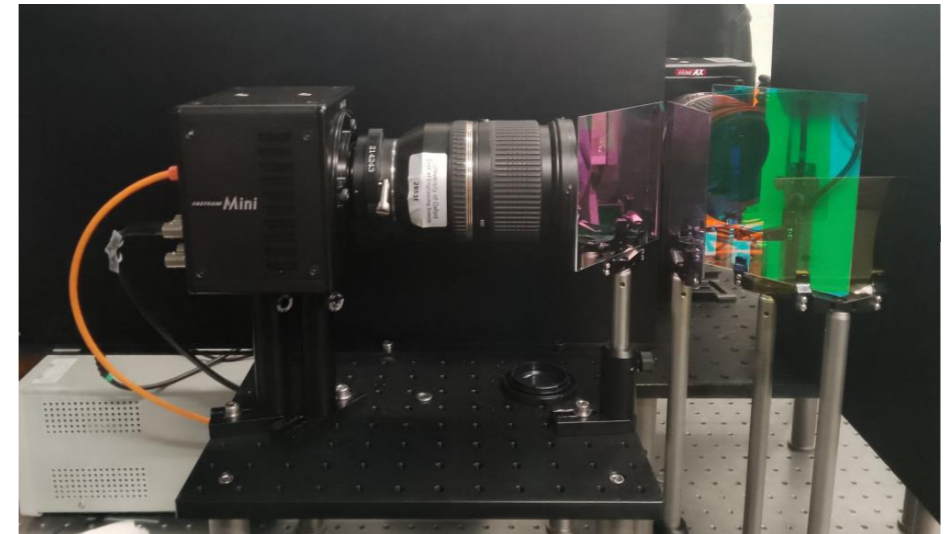
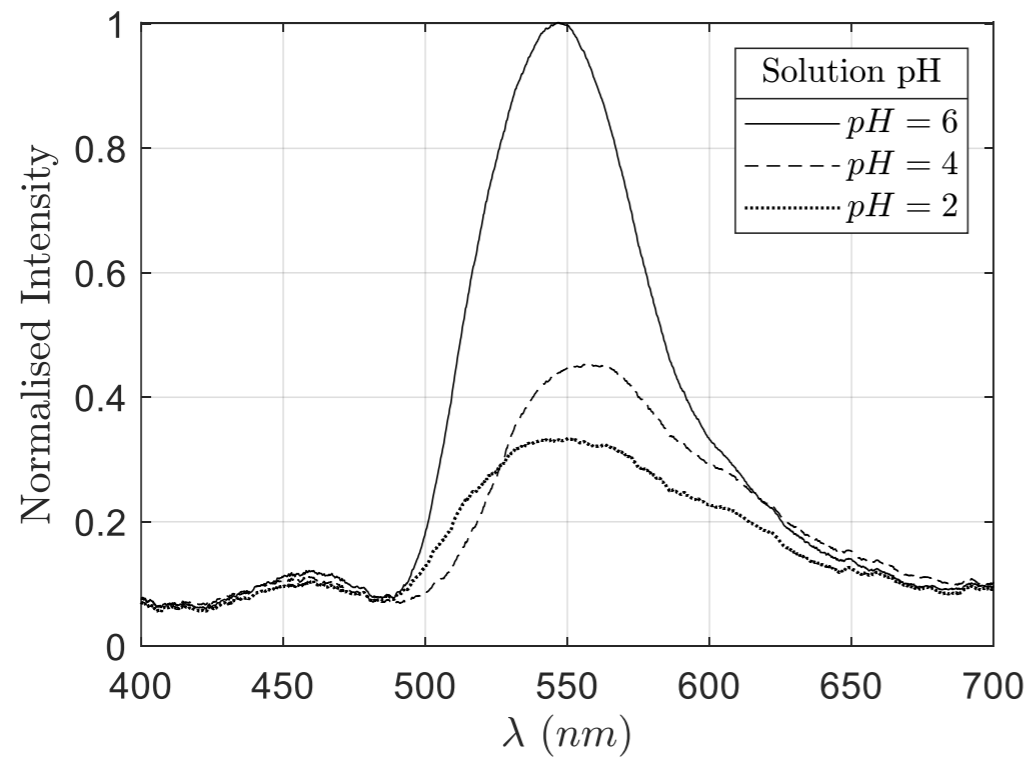
- **Narrower band-pass filters**
- **Precision mass balance**



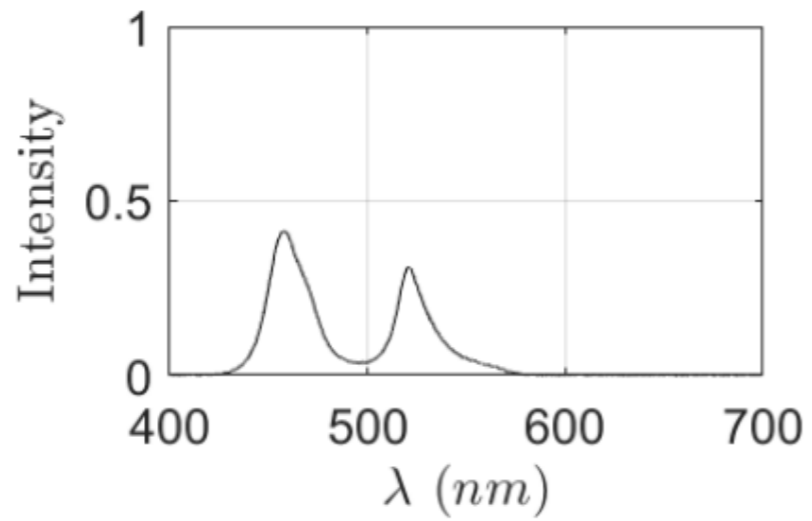
- **Narrower band-pass filters**
- **Precision mass balance**
- **Alkaline solvent**



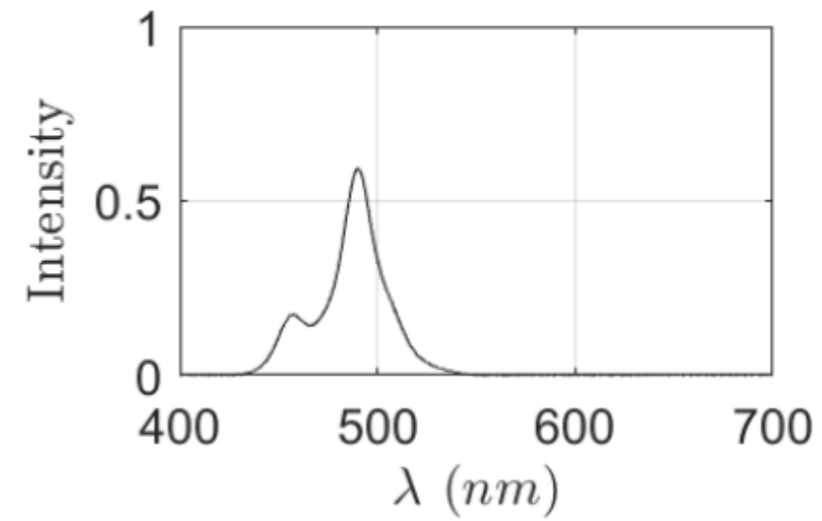
- **Narrower band-pass filters**
- **Precision mass balance**
- **Alkaline solvent**
- **Flat plate geometry**



Questions



0° angle of incidence



45° angle of incidence