Brunel University London WP14 (Task 14.2) Contributions

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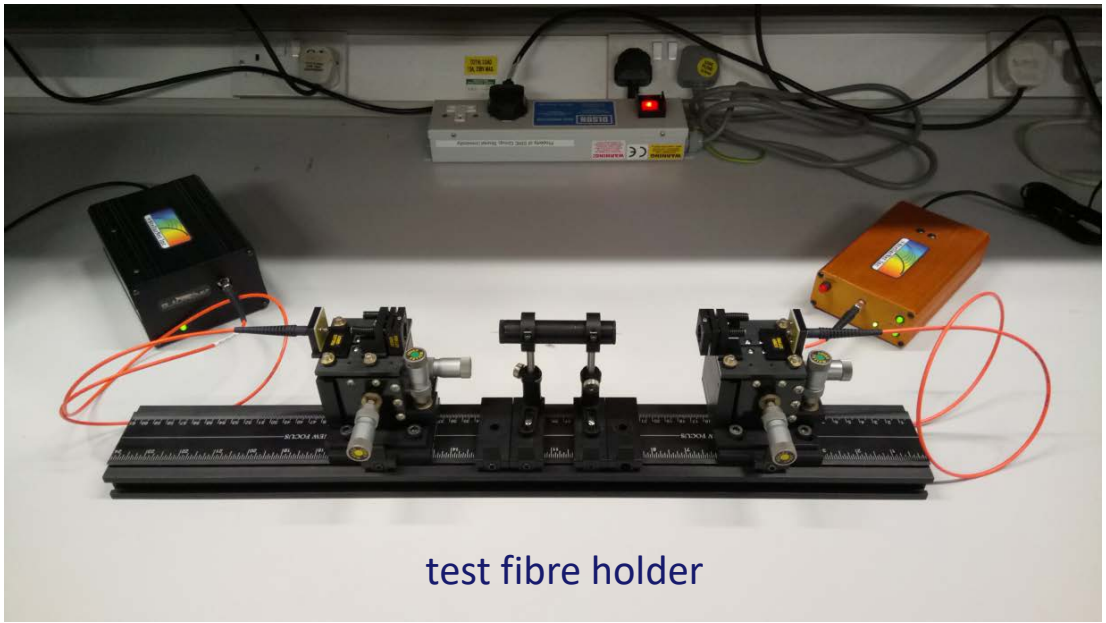
5 April 2017

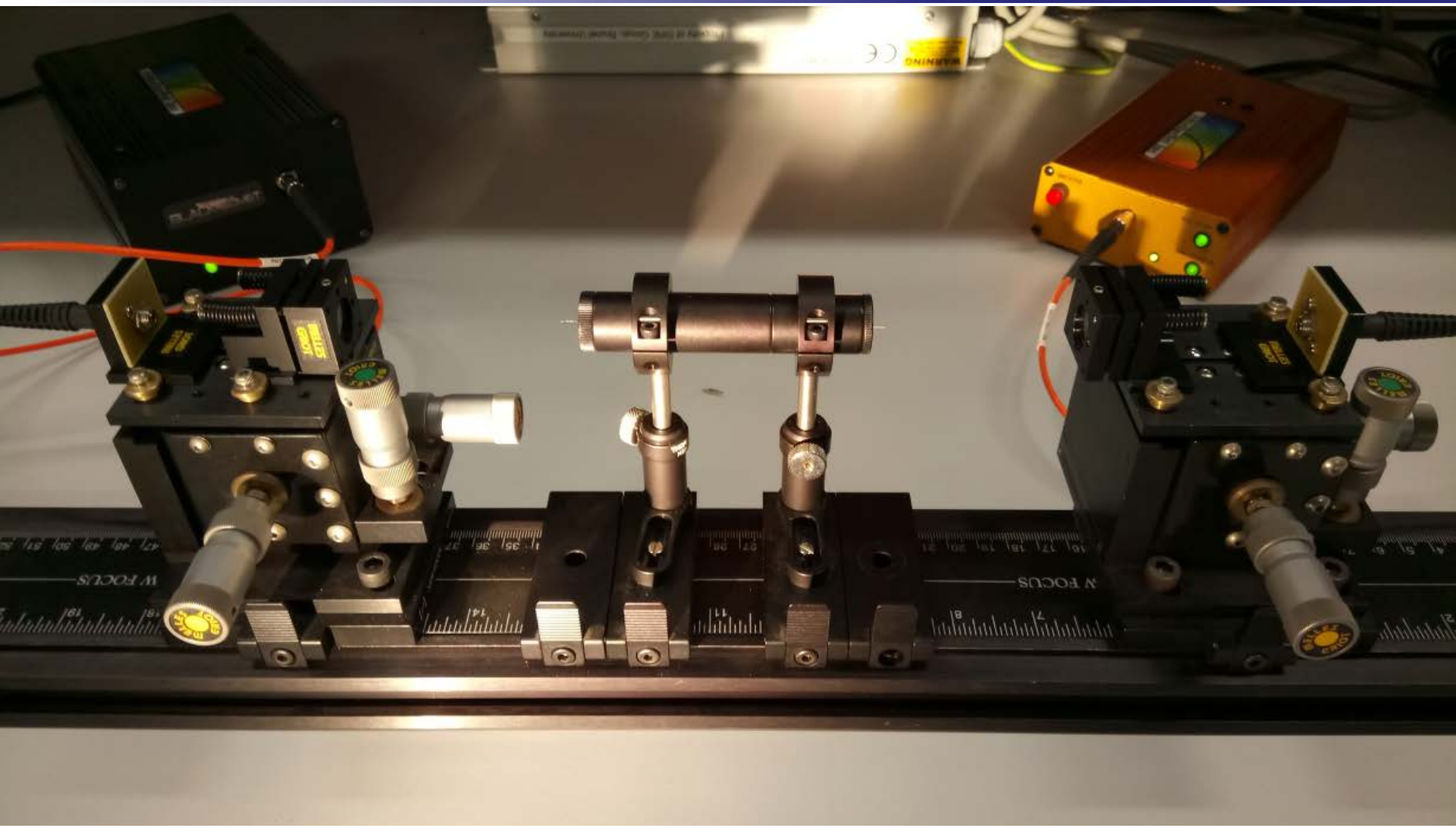
This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168.

Fibre test bench hardware

- Use of StellarNet spectrometer and light source with test fibre:
  - Black Comet Spectrometer (190 nm - 850 nm)
  - Combined deuterium and tungsten halogen light source (190 nm - 1100 nm)
  - Thorlabs silica core, 200 μm diameter, 0.22 NA fibre (fibre type FG200UEA)

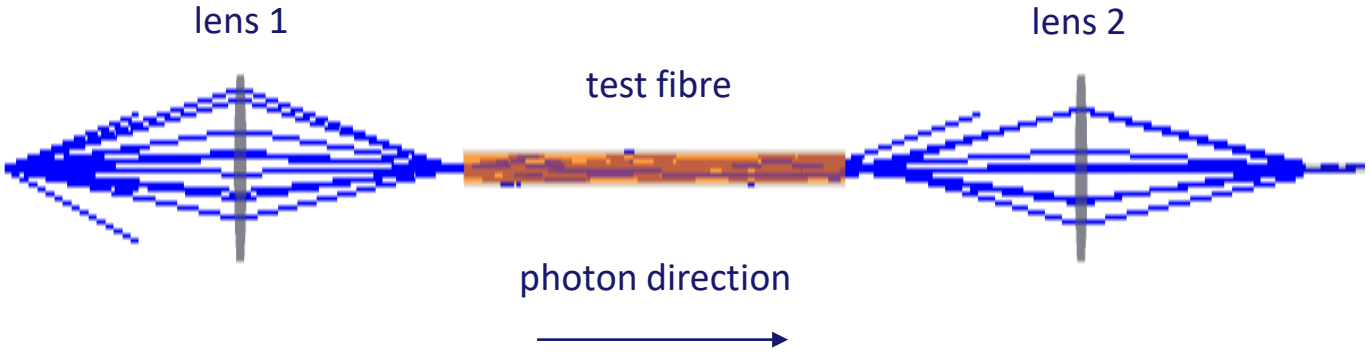


Fibre test bench hardware



Fibre test bench operation

- The test bench set up in ‘focused mode’:
  - ThorLabs LB4003 UV fused silica bi-convex lenses with 12.7 mm diameter and 30.0 mm focal length each lens being positioned at 2× focal length distance (i.e. 60.0 mm) from the end of the test fibre (fused silica chosen for its gamma radiation tolerance)
  - ZEMAX OpticStudio software used to simulate path of photons using non-sequential ray-tracing and circular symmetry about the axis of the test fibre
  - Test fibre shown is a 100 mm long, 2 mm diameter quartz rod matching the reference standard rod provided to Brunel as part of the AIDA-2020 project for testing

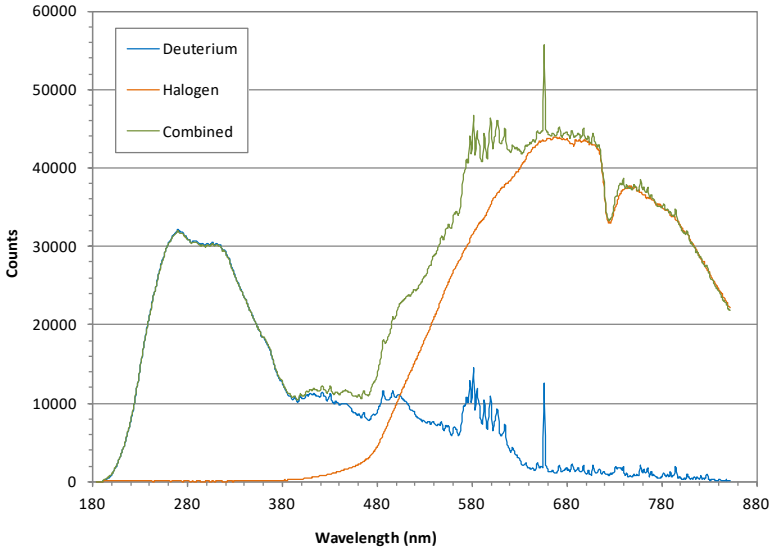


(Note that the y-axis of the figure has been stretched)

Initial fibre characterisation

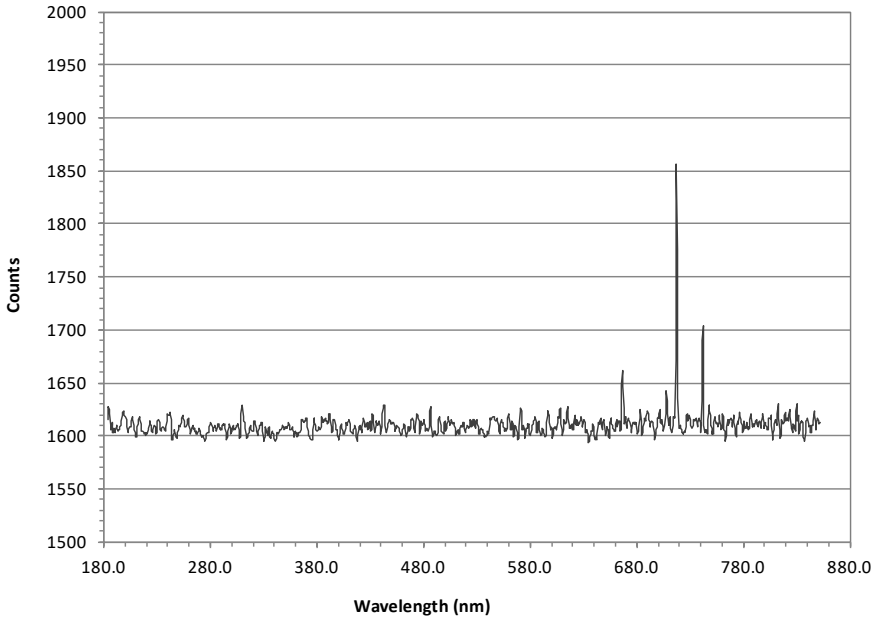
- Three sample fibres tested using the system:
  - 100 mm long, 1 mm diameter **cerium doped quartz** fibre
  - 140 mm long, 1×1 mm square cross-section **cerium doped YAG** fibre
  - 100 mm long, 2 mm diameter **quartz reference** fibre (UQG Optics Ltd, Cambridge)

- Data collection settings:
  - Integration time of 400 ms
  - Average of 16 spectra collected
  - Light source spectra background subtracted

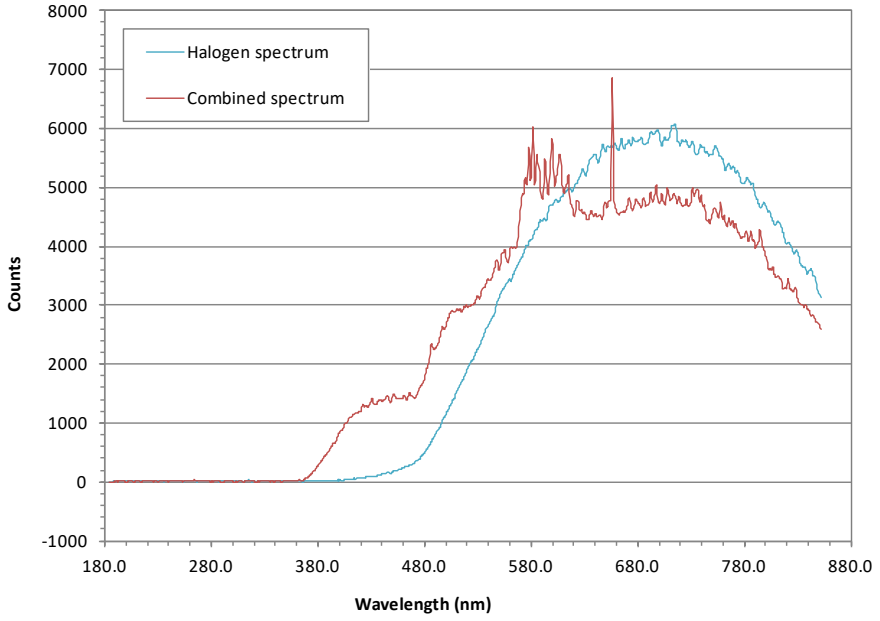


raw spectra obtained from light source

Cerium doped quartz

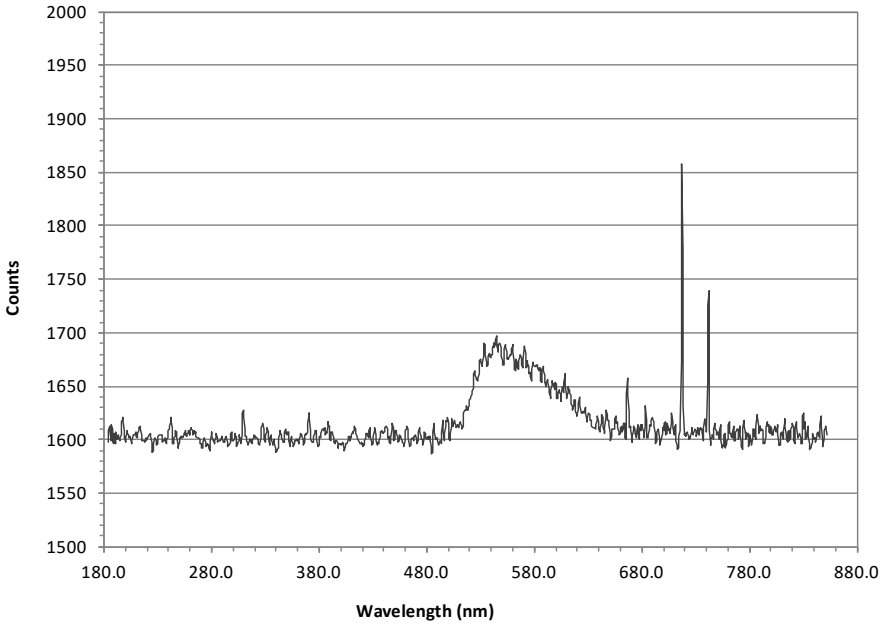


dark frame



(Note that the three ‘spikes’ in the background signal are fixed pattern noise from the spectrometer)

Cerium doped YAG



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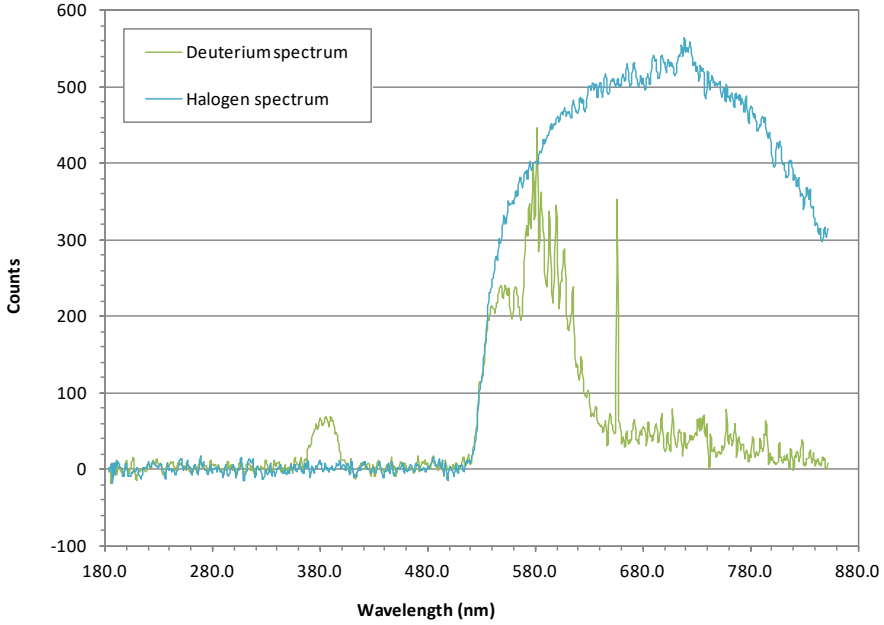
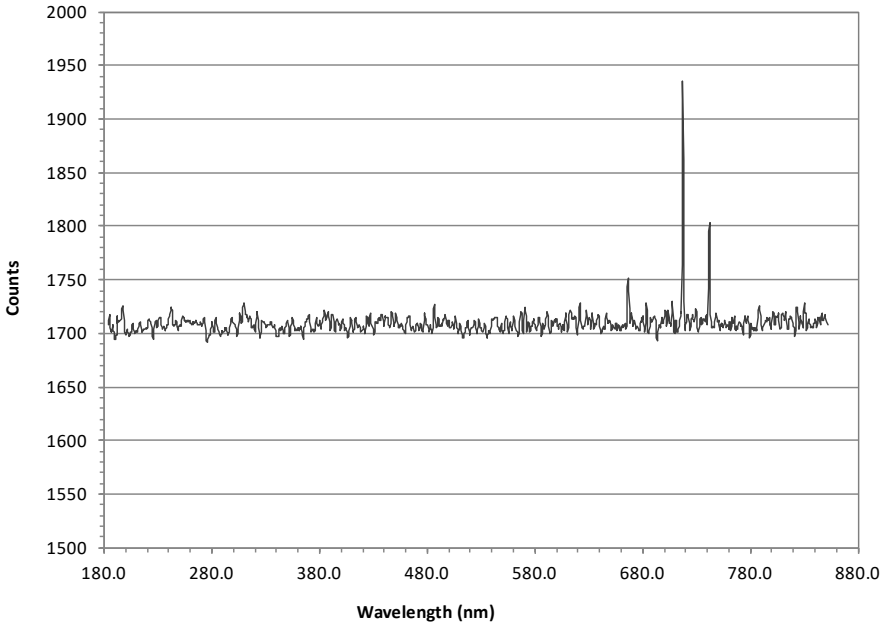


(Note that the 'bump' in the background signal level is due to the longer fibre channelling ambient light)

Quartz reference



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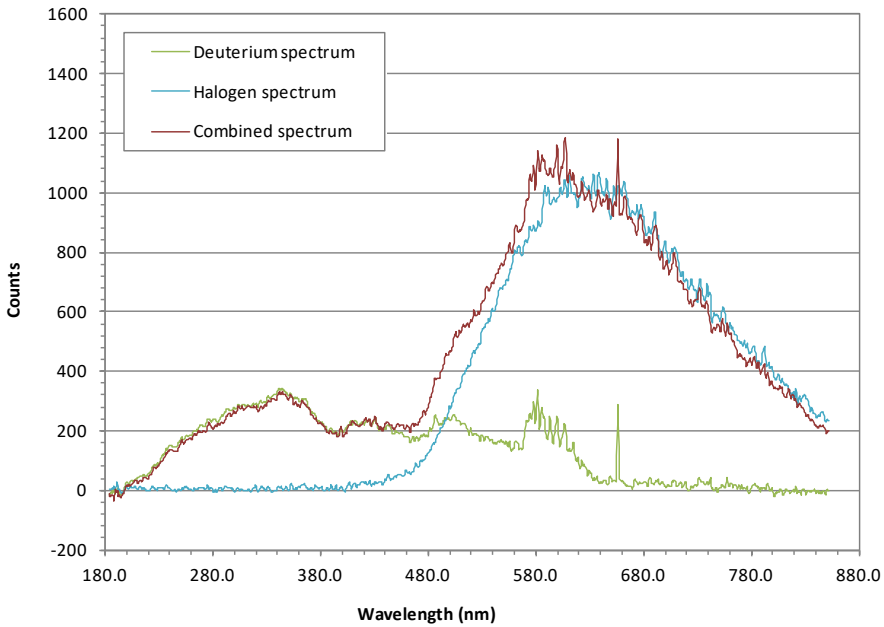

(Note that the background signal level increased due to increased ambient light level)

Summary

- A fibre test bench has been commissioned and demonstrated to successfully allow the focusing of light through a test fibre and resulting spectra to be obtained
- Further optimisation of the test bench with regard to the positioning of the lenses and test fibre holder can be carried out to greatly enhance the signal to noise in the collected spectra
- Ambient light will be absent during data collection under irradiation as the Brunel shielded ^{60}Co irradiation cell is completely dark
- The test bench is portable and can be used in other radiation facilities for real-time monitoring of test fibres during irradiation (a pair of 20 m long FG200UEA fibres can be used to operate the system remotely)
- The system can be adapted to provide specific fluorescence excitation of scintillating or WLS fibres
- Testing in Brunel shielded ^{60}Co irradiation cell planned for late April/May