Research and Development for the Optical Fibre-Based AntiMatter-OTech Detector

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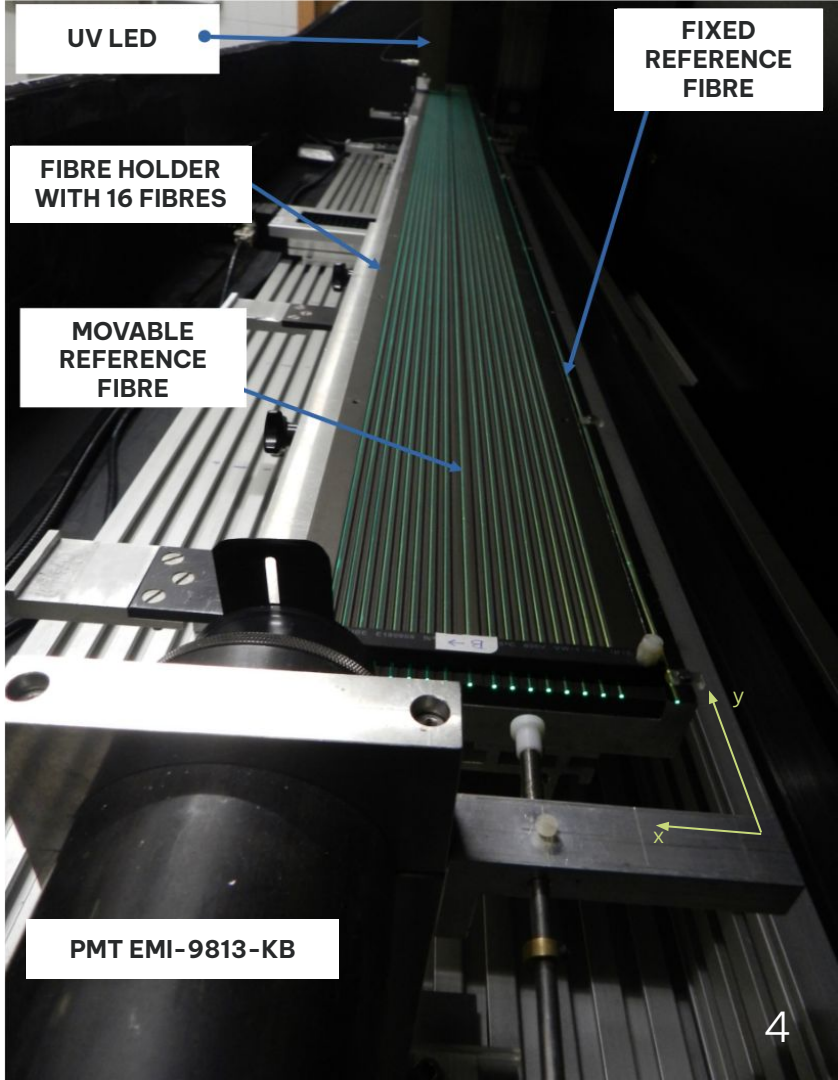
AntiMatter -OTech

Innovative detector with potential applications in nuclear safeguards and reactor safety.

- Comprising **20000 optical fibres** with 4 m of length.
- Will be constructed at Campus Loures (**CTN**) and installed at **EDF Chooz-B** nuclear reactor in France.
- LIP contributes to the optimization of the detector's **optical instrumentation**: identifying the most suitable fibres, fibre-cutting procedures and classifying fibre defects .

Fibrometer

- **Sixteen fibres** in plate B: f9 and a fibre fixed to the supporting table are reference fibres.
- **UV LED** (V_{LED}=2.900V and $\lambda \in [360, 400]$ nm) **excites fibres** at different positions: $y_{i+1}=y_i$ + Step
- PMT signal integrated using picoammeter: 10 measurements with 17 ms integration time.
- Each **signal I(y_i)** has a corresponding **uncertainty RMS (y_i)**
- **Plastic holders** are used to attenuate effects from the fibres curvature.

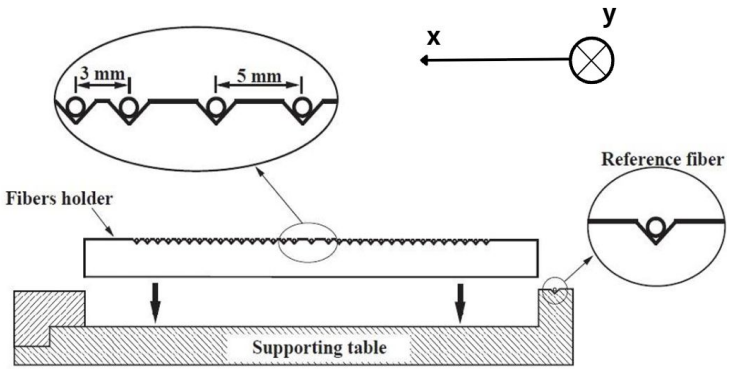


Fibrometer

Overview of Runs

- Each run measures all 16 fibres in the plate
  + The setup reference fibre ← l(y=30cm) used for normalisation

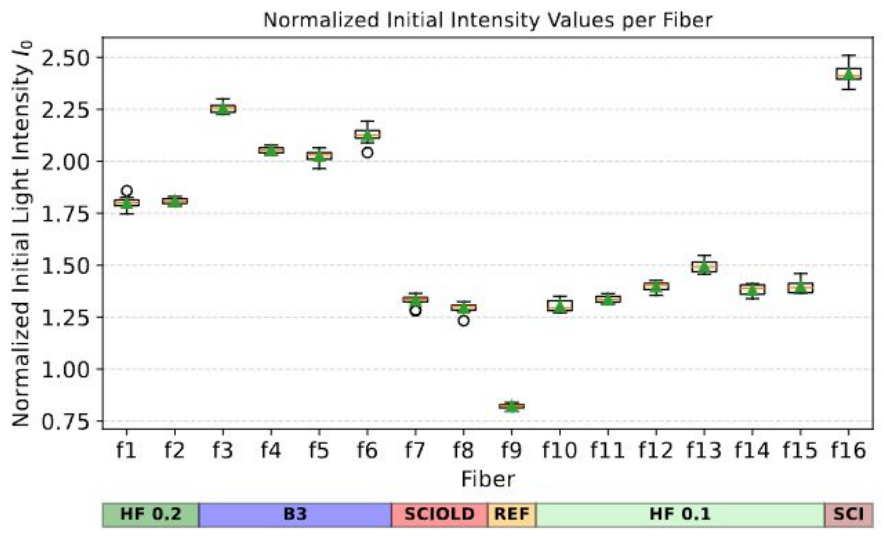
- Two measurements for the reference fibre, one at the beginning and the other at the end



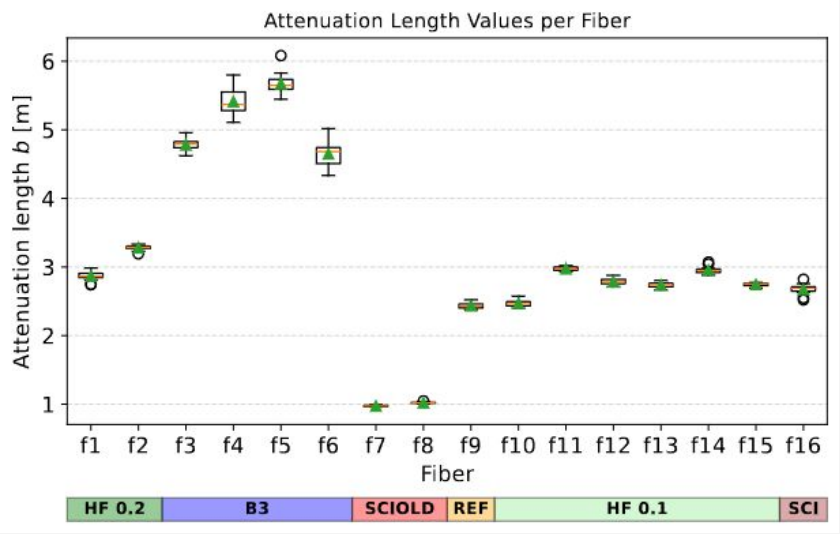
Run	Date	Time	Step (cm)
B3_4	17/03/2026	10:49	5.0
B3_5	17/03/2026	15:33	5.0
B3_6	18/03/2026	13:13	5.0
B3_7	18/03/2026	17:01	5.0
B3_8	19/03/2026	10:33	5.0
B3_9	19/03/2026	15:10	5.0
B3_11	20/03/2026	10:47	5.0
B3_12	20/03/2026	13:59	5.0
B3_13	20/03/2026	16:21	5.0
B3_15	23/03/2026	16:19	1.0
B3_19	31/03/2026	12:54	1.0
B3_20	01/04/2026	11:41	1.0

Results

Normalized Initial Intensities



Attenuation Lengths

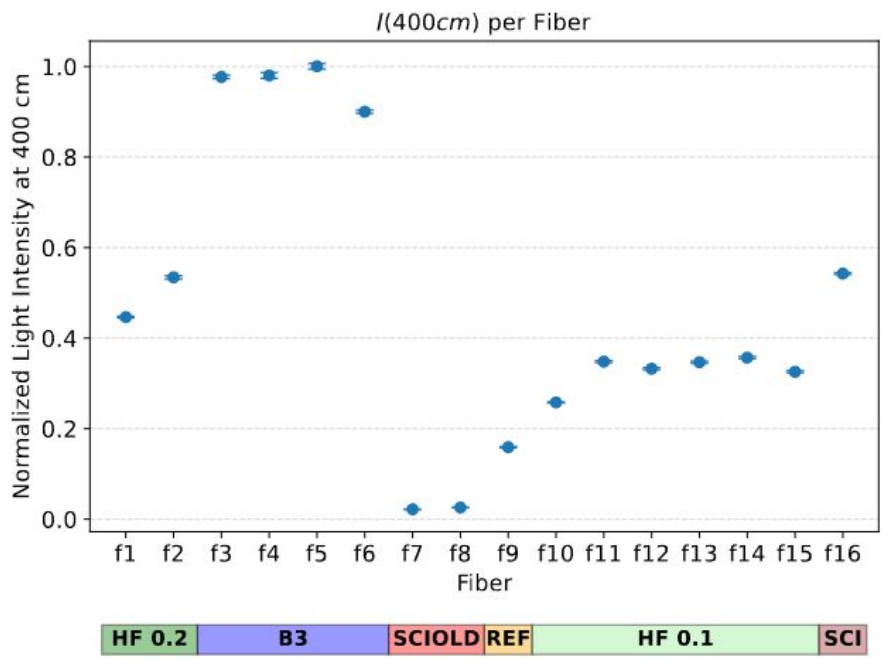


Results

Fibre	$\langle I(400\,\mathrm{cm})\rangle$
HF 0.2	0.49 ± 0.05
B3	0.96 ± 0.03
HF 0.1	0.33 ± 0.02
SCIOLD	0.024 ± 0.002
SCI	0.54 ± 0.01

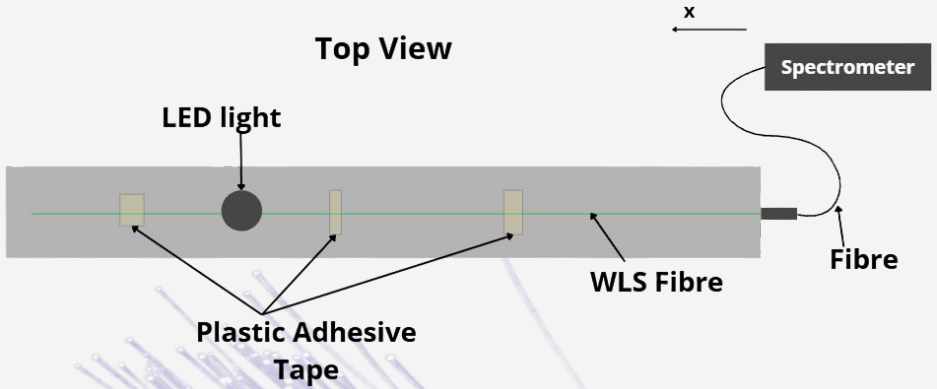
Table 1: Mean fitted predicted normalized light intensity at 400 cm for each fibre type.

Normalized Light Intensities at 4m



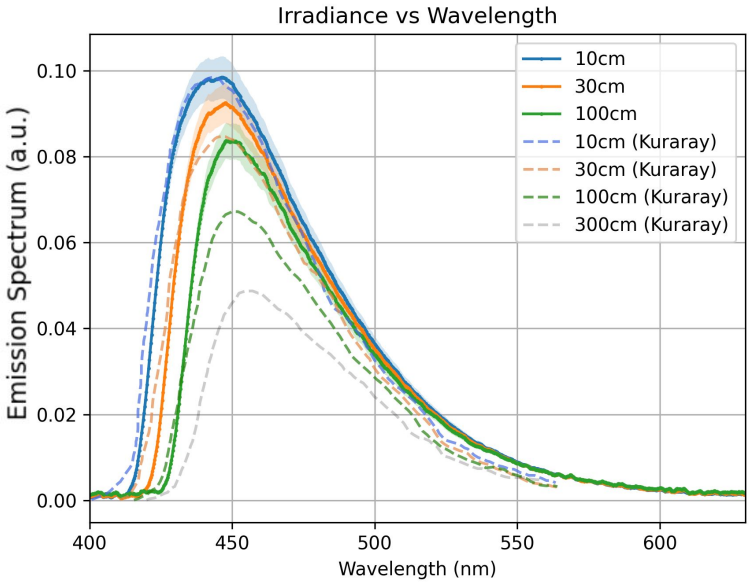
Spectrometry

- **Monofribrometer** with **B3 fibre**, fixed by plastic adhesive tape.
- **UV LED** light, with 365 nm, scans the fibre trough every position.
- Ten averaged measurements and 500ms of integration time. For each position, a **spectrum** with the **irradiance as a function of wavelength** is produced.

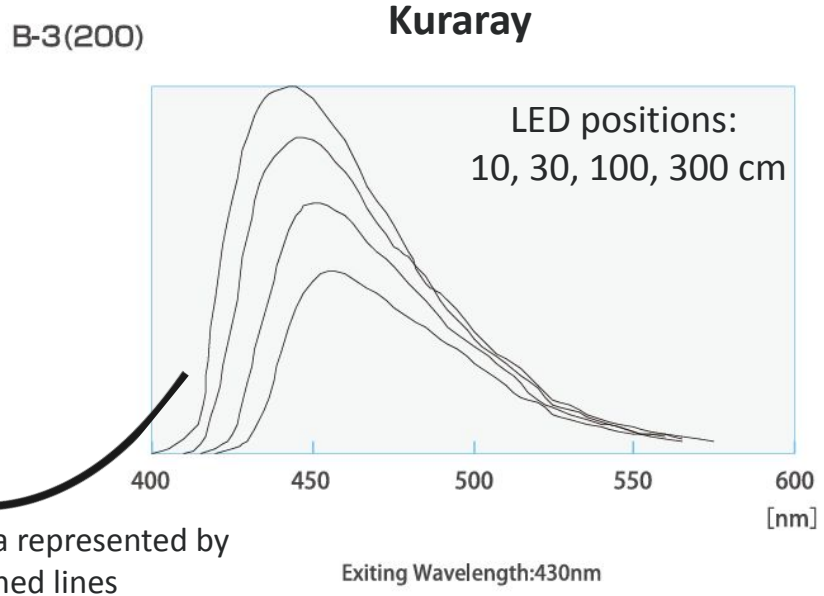


Wavelength Spectrum – B3 Fibre

Six fibres were measured. The **mean** is presented for different positions of the UV LED.
(the shaded region represents the spectrometer uncertainty ~5%)

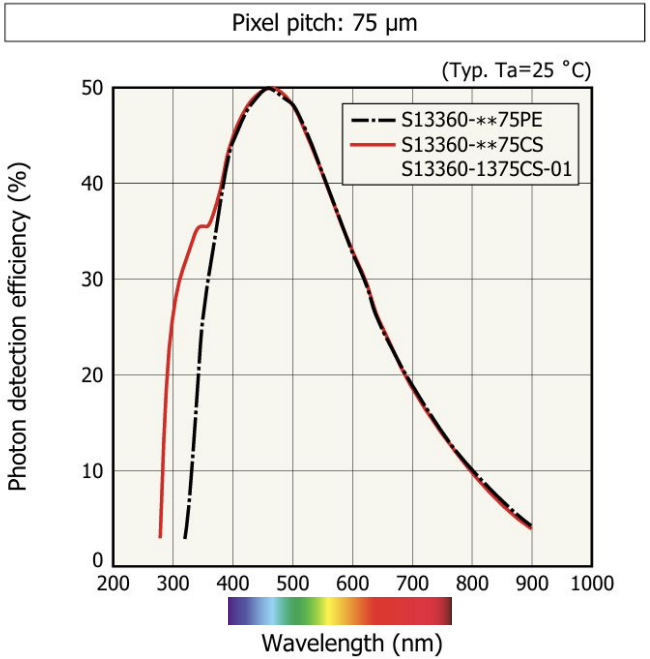


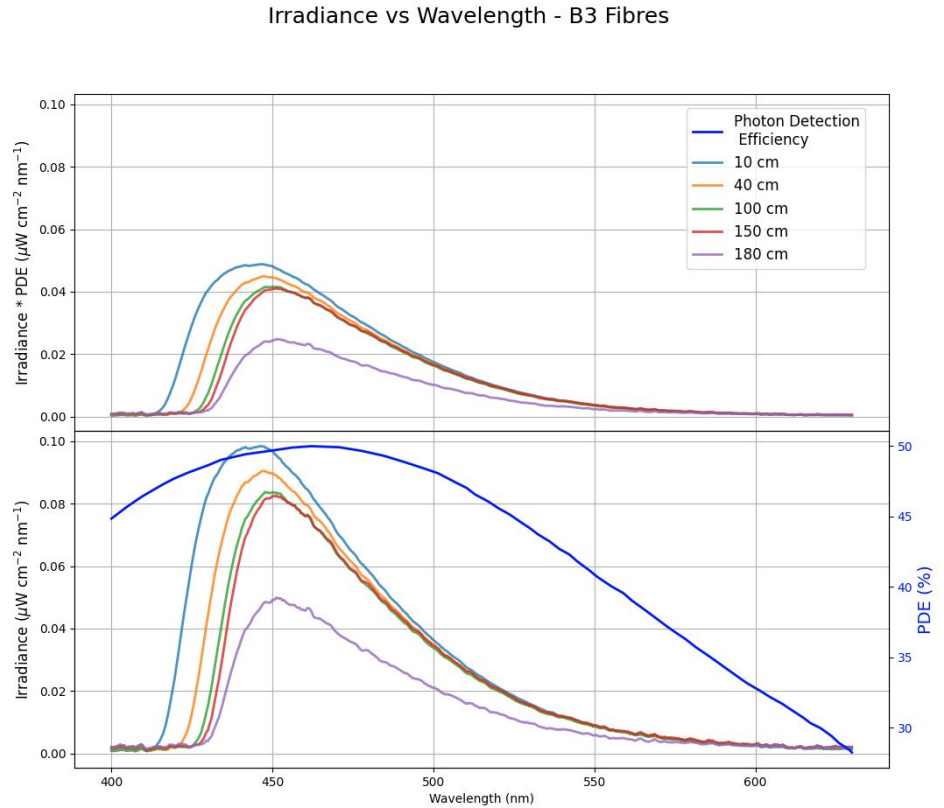
Kuraray data represented by dashed lines



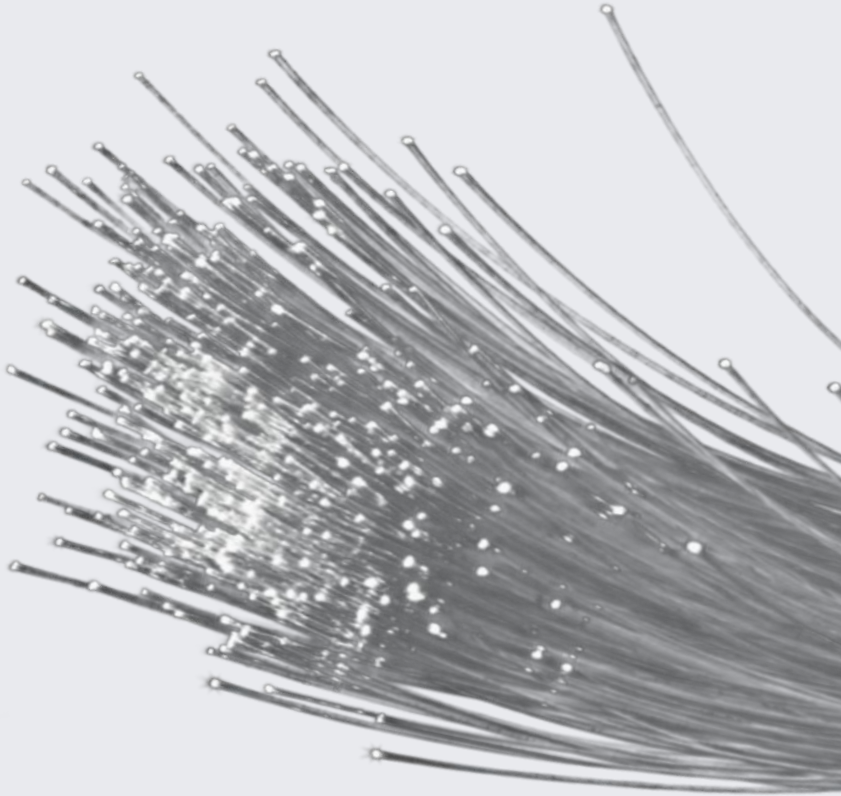
Photon detection efficiency

- S13360-1375PE/CS Silicon Photomultiplier (**SiPM**) chosen, due to its **high gain** (4.0×10^6) and photon detection efficiency (**PDE**).
- In an ideal SiPM, the PDE would be 100% for all wavelengths.





Conclusions



Thank you
for your attention.

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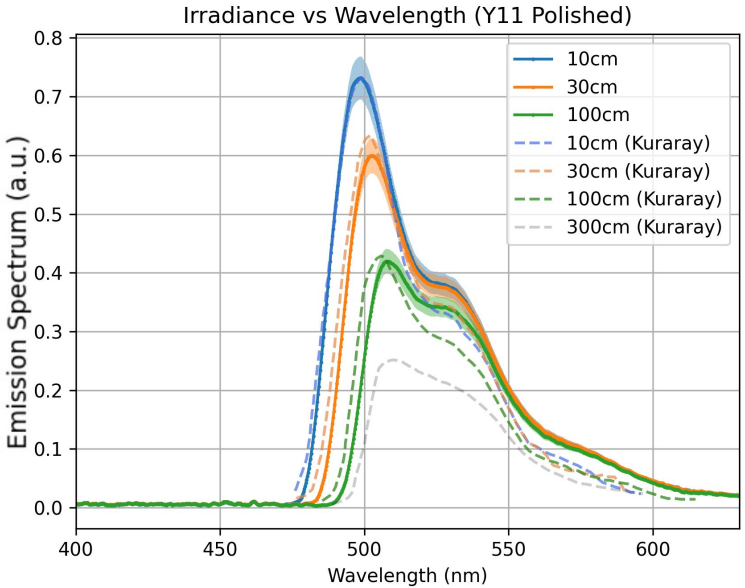
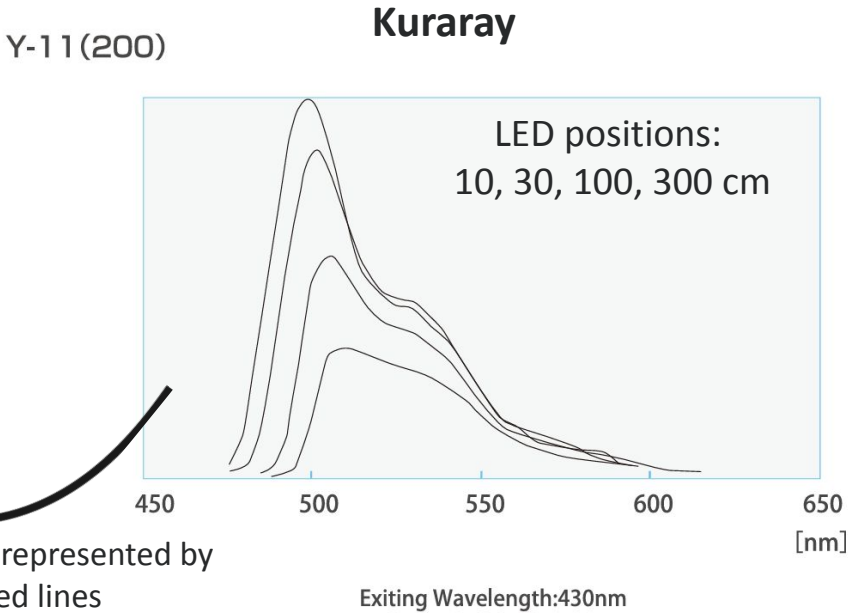
Wavelength Spectrum – Y11 Fibre

Blue LED - 470nm
Y11 Polished is presented for different positions of the UV LED
(the shaded region represents the spectrometer uncertainty ~5%)

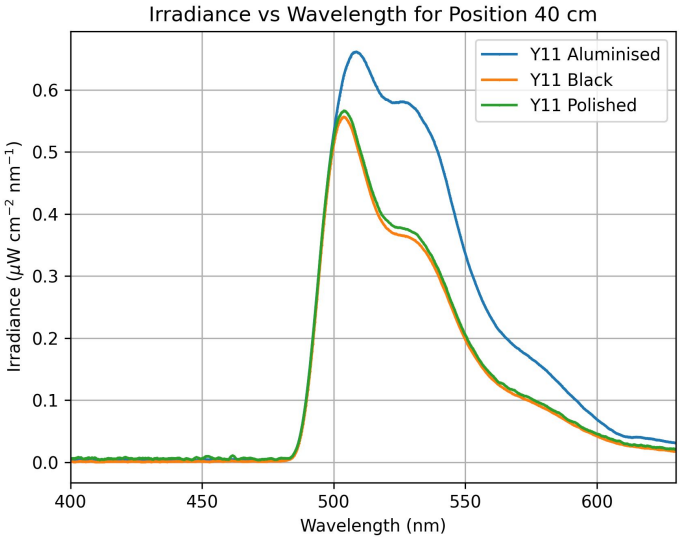


Kuraray data represented by dashed lines

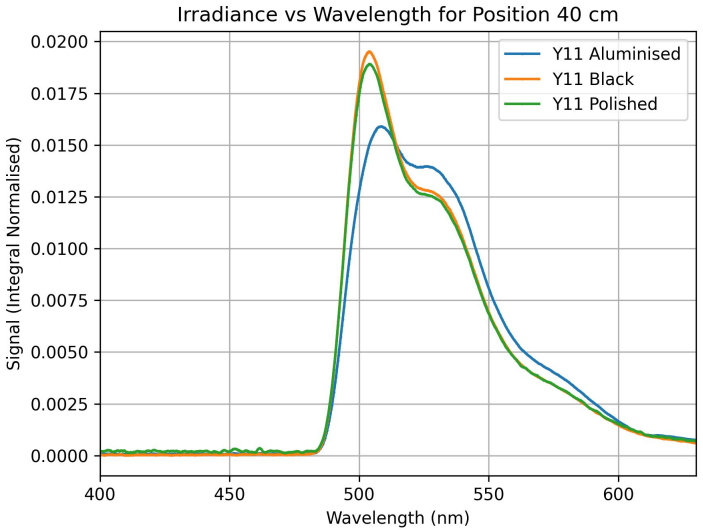


Wavelength Spectrum – Y11 Fibre

For a fixed position of the Blue LED 470nm - 40cm. Each line represents a different Y11 fibre.



Integral Normalised



Photon detection efficiency

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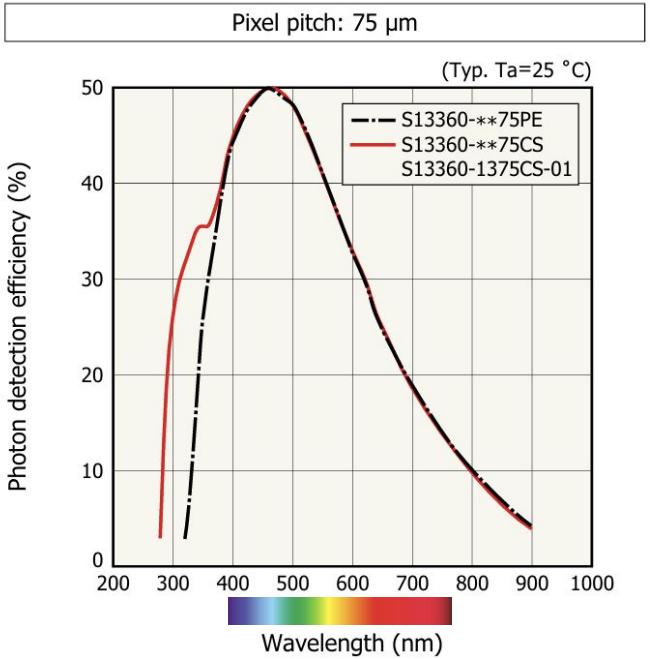
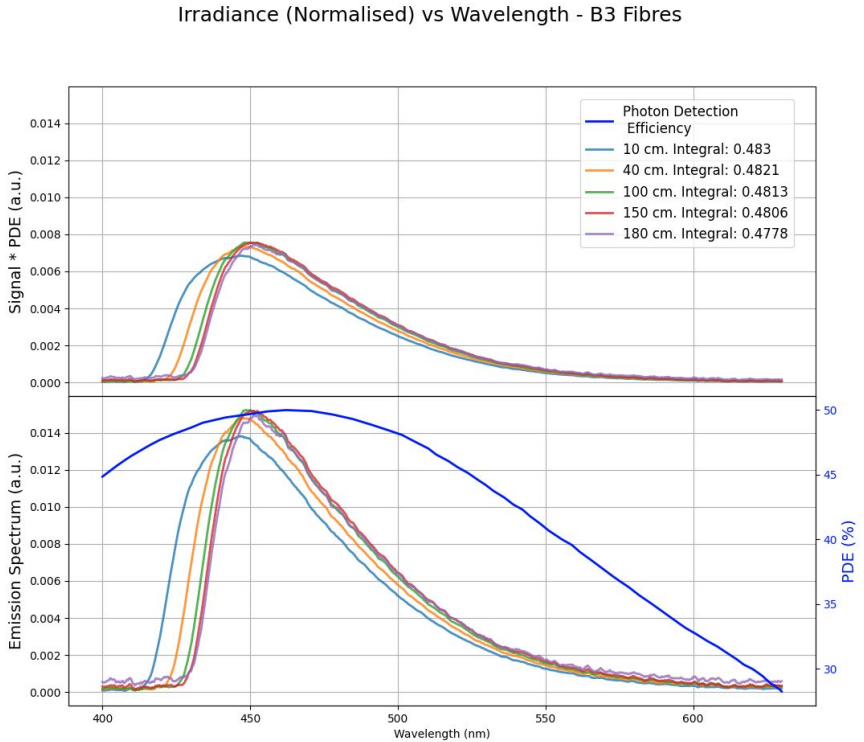


Integral Normalised



Shifting of Spectra

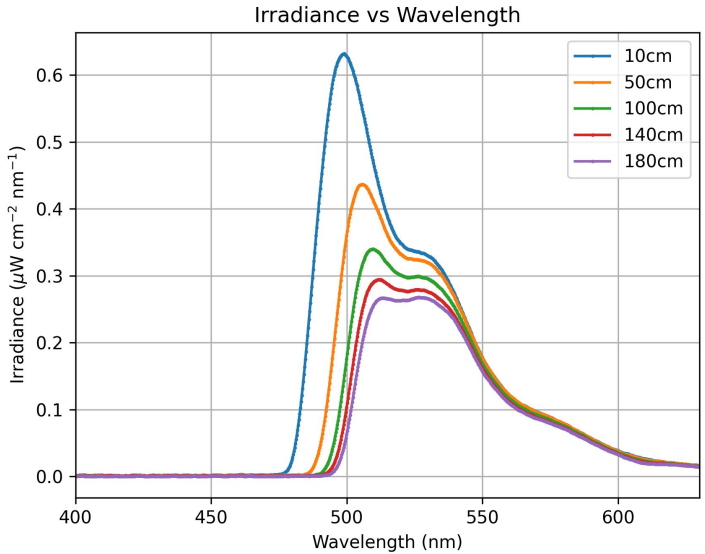
Rayleigh Scattering

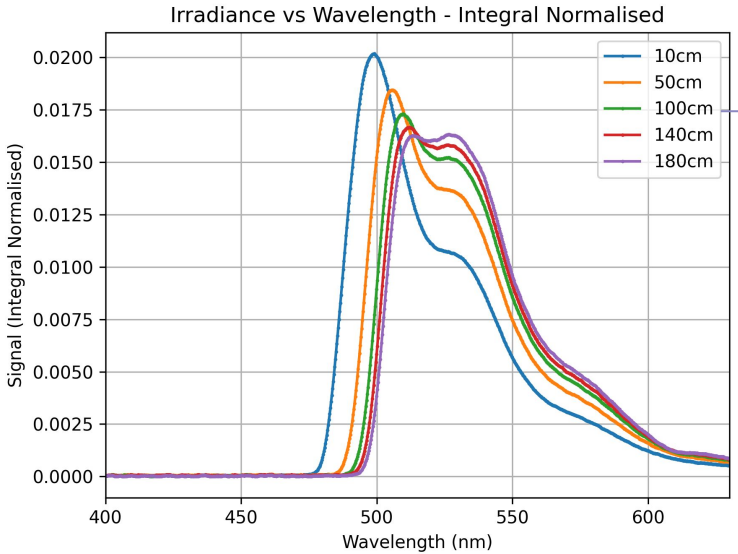
Attenuation constant

$$\alpha = \frac{8\pi^3}{3\lambda^4}(n^2-1)^2 k_B T \beta$$

As the distance between the LED and fibre end increases there is a shift in spectra towards larger wavelengths

Y11 polished





Smaller wavelengths are more attenuated