



Queen Mary

University of London

Science and Engineering



Sparse Fibre Plane – Further thoughts

Peter Hobson

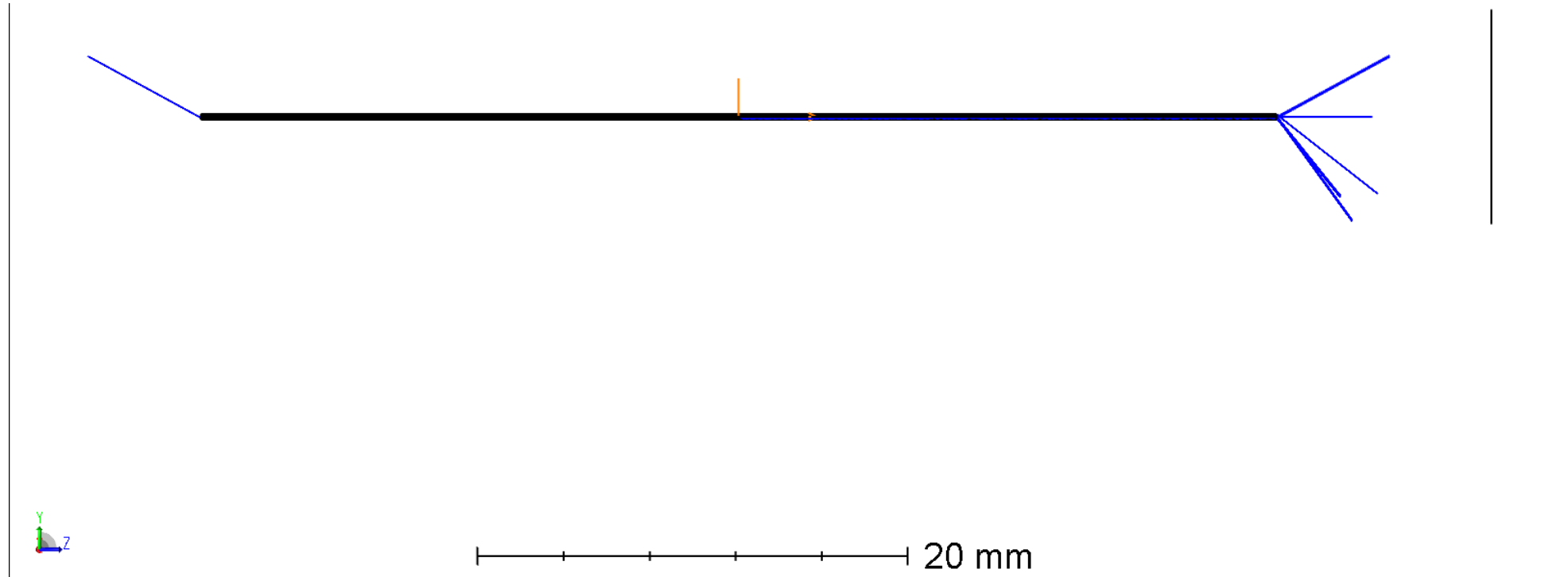
Queen Mary University of London, School of Physical and Chemical Sciences

Simulation parameters

1. Starting to look at Ken's new sparse fibre plane for PoPLaR beam monitoring;
2. Non-sequential ray tracing is used;
3. Simulations use **Ansys ZEMAX OpticStudio Premium 2025R1.01** (PC is an i5 6/12 core @4.6 GHz peak with 32 Gbytes of 3200 MHz DDR4 memory);
4. Data shown for a wavelength of 491 nm (emission peak of scintillator);

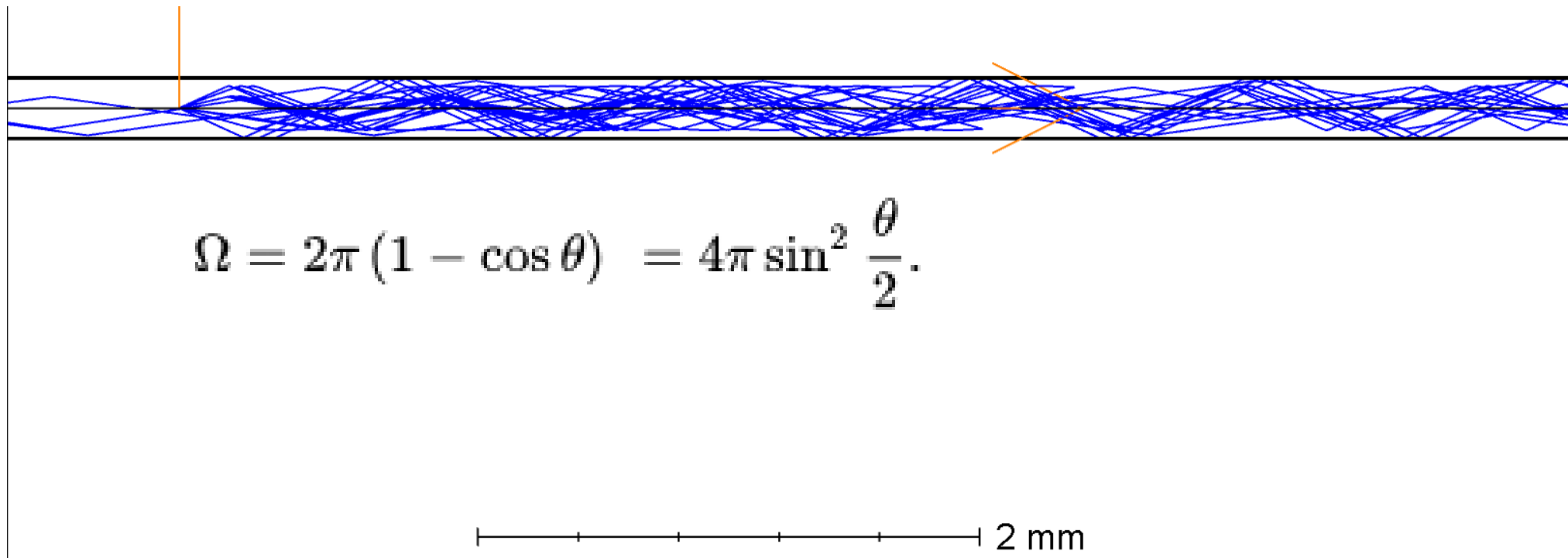
Realistic Fibre

Simulated at Polystyrene (Core) and PMMA (cladding) as per BCF20. NA = 0.58
50 mm long fibre



Realistic Fibre

Here you can see core and cladding modes from a point source with a 70 degree cone apex angle 2θ emitting to the right. Remember we get Fresnel reflection at the ends of the fibre. The actual scintillation light is produced in 4π sr, here we generate rays into only 1.1 sr.



NS parameter settings used currently

System Explorer ?

Update: All Windows ▾

- Wavelengths
- Environment
- Polarization
- Advanced
- Material Catalogs
- ▾ Non-Sequential

Maximum Intersections Per Ray:

4000

Maximum Segments Per Ray:

100000

Maximum Nested/Touching Objects:

10

Maximum Source File Rays In Memory:

1000000

Minimum Relative Ray Intensity:

1.0000E-003

Minimum Absolute Ray Intensity:

1.0000E-009

Glue Distance In Lens Unit:

1.0000E-006

Missed Ray Draw Distance In Lens Unit:

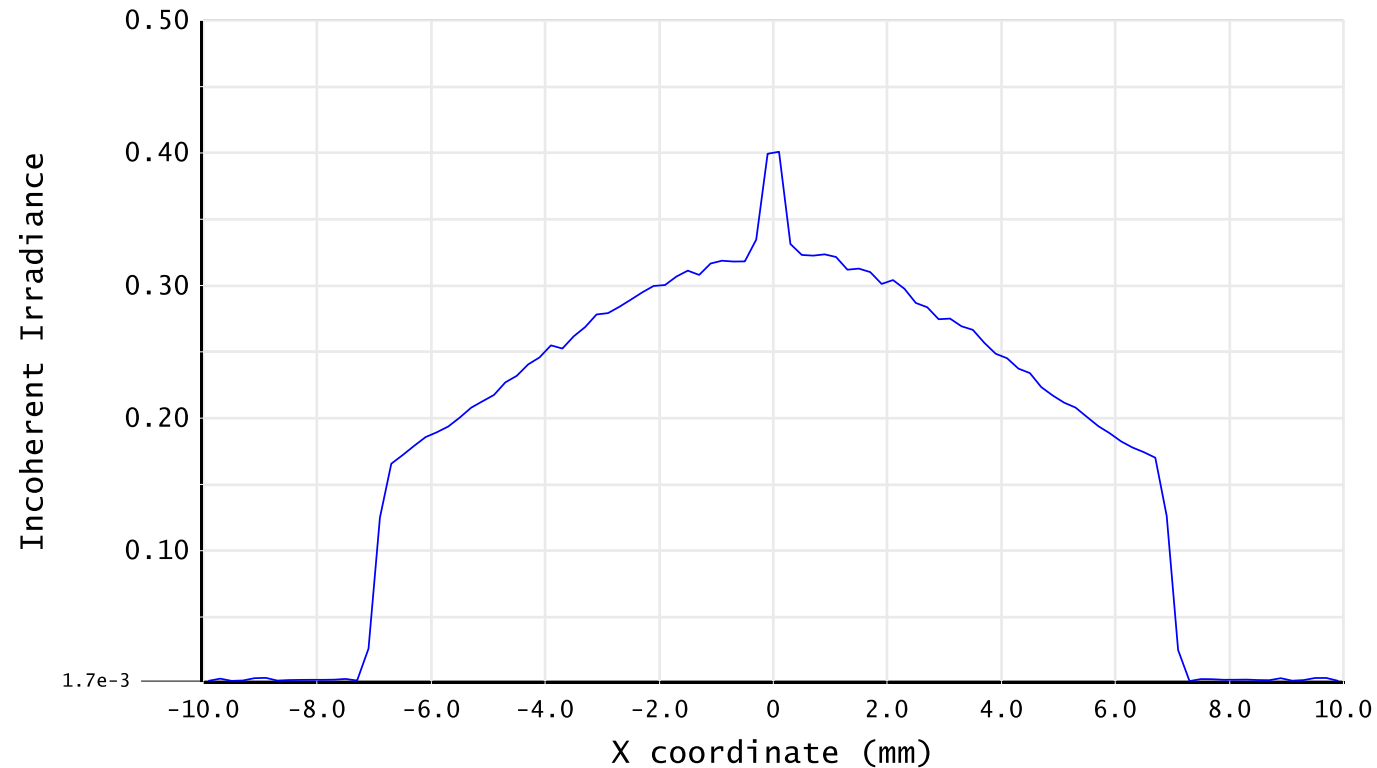
0.0000E+000

☒ Simple Ray Splitting

☐ Retrace Source Rays Upon File Open



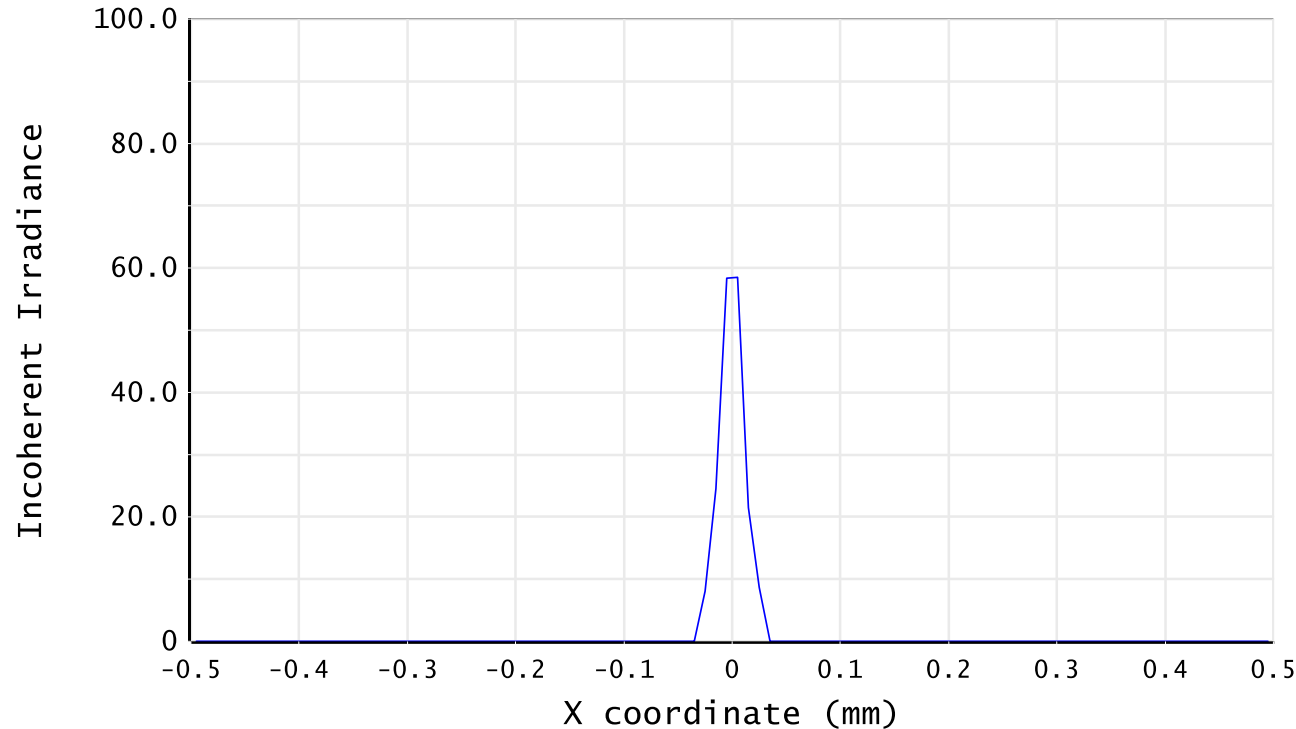
Light Distribution 10 mm after Fibre (no lens)



Incoherent Irradiance	
Fibre Test for PoPLaR 12/12/2025 Detector 4, NSCG Surface 1: Row Center, Y = 0.0000E+00 Size 20.000 W X 20.000 H Millimeters, Pixels 100 W X 100 H, Total Hits = 465598 Peak Irradiance : 4.0100E-01 Watts/cm² Total Power : 3.5433E-01 Watts	School of Physical & Chemical Sciences Queen Mary University of London
Fibre_TestBCF20.zmx Configuration 1 of 1	

Nominal source of power 1W, 1 million primary rays traced.

Light Distribution Imaged to Camera



$F = 25$ mm, 6 mm aperture
paraxial lens located at 150 mm
from fibre end. Paraxial image
plane shown.

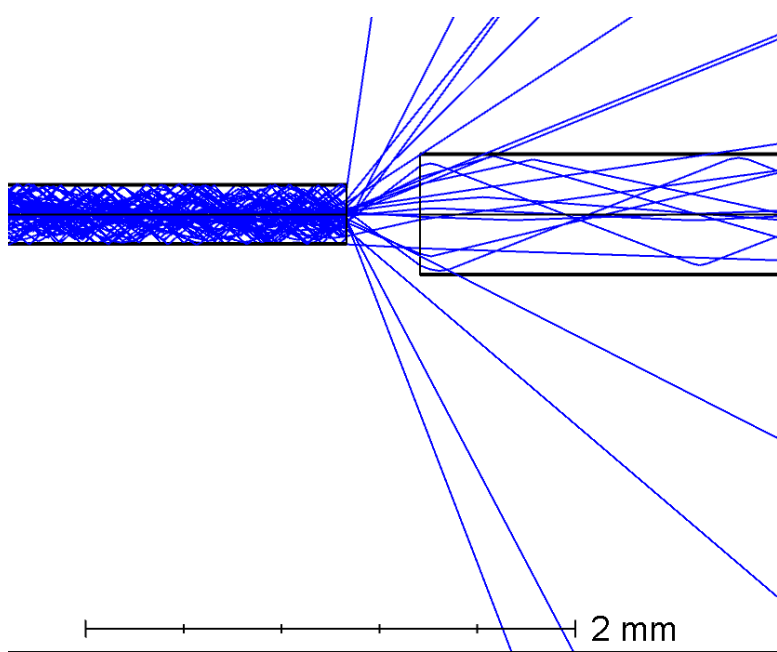
Total power imaged $< 0.1\%$ of
what was produced into
restricted cone.

Incoherent Irradiance	
Fibre Test for PoPLaR 12/12/2025 Detector 5, NSCG Surface 1: Row Center, Y = 0.0000E+00 Size 1.000 W X 1.000 H Millimeters, Pixels 100 W X 100 H, Total Hits = 6324 Peak Irradiance : 5.8817E+01 Watts/cm ² Total Power : 6.2057E-04 Watts	School of Physical & Chemical Sciences Queen Mary University of London Fibre_TestBCF20.zmx Configuration 1 of 1

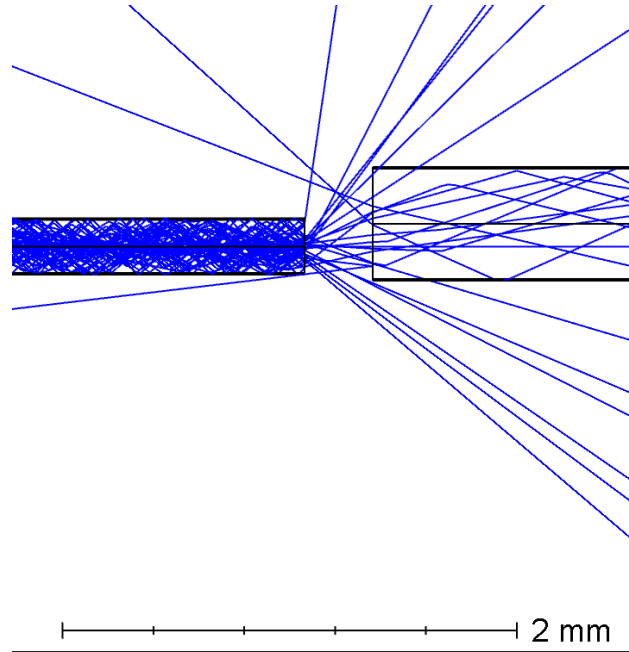
Nominal source of power 1W, 1 million primary rays traced.

Light Coupling to transparent fibre (0.5 mm Ø)

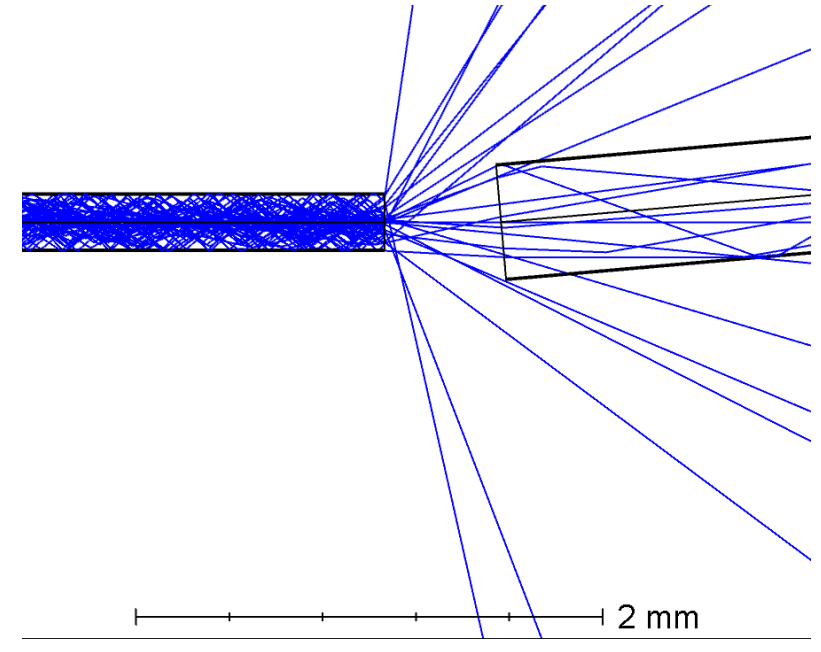
Effect of tolerances on fibre-to-fibre alignment, cone angle in BCF-20 scintillator was 55°. Source power 1W, 1 million primary rays traced per simulation.



Longitudinal only



Lateral only



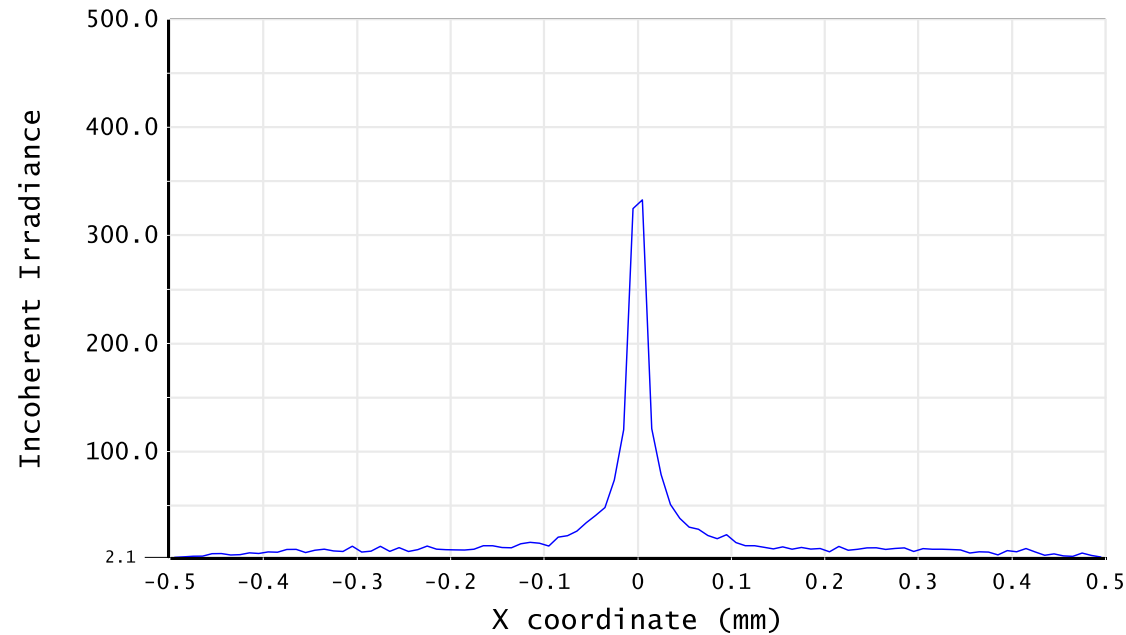
Angular only

Light Coupling to transparent fibre

Effect of tolerances on fibre-to-fibre alignment, cone angle in BCF-20 scintillator was 55 °. Source power 1W, 1 million primary rays traced per simulation.

Longitudinal Offset (mm)	Lateral Offset (mm)	Power inside BCF98-XL fibre (W)	Compared to 1W launched in BCF-20 fibre	
	0.1	0.0	3.733E-01	37.3%
	0.3	0.0		
	0.5	0.0	9.730E-02	9.7%
	0.7	0.0		
	1.0	0.0	3.133E-02	3.1%
	0.1	0.05	3.678E-01	36.8%
	0.3	0.05		
	0.5	0.05	9.692E-02	9.7%
	0.1	0.10	3.500E-01	35.0%
	0.3	0.10	1.714E-01	17.1%
	0.5	0.10	9.268E-02	9.3%
	Angular Offset (degrees)			
0.5 mm for all		0.0	9.730E-02	9.7%
		1.0	9.723E-02	9.7%
		3.0	9.737E-02	9.7%
		5.0	9.725E-02	9.7%

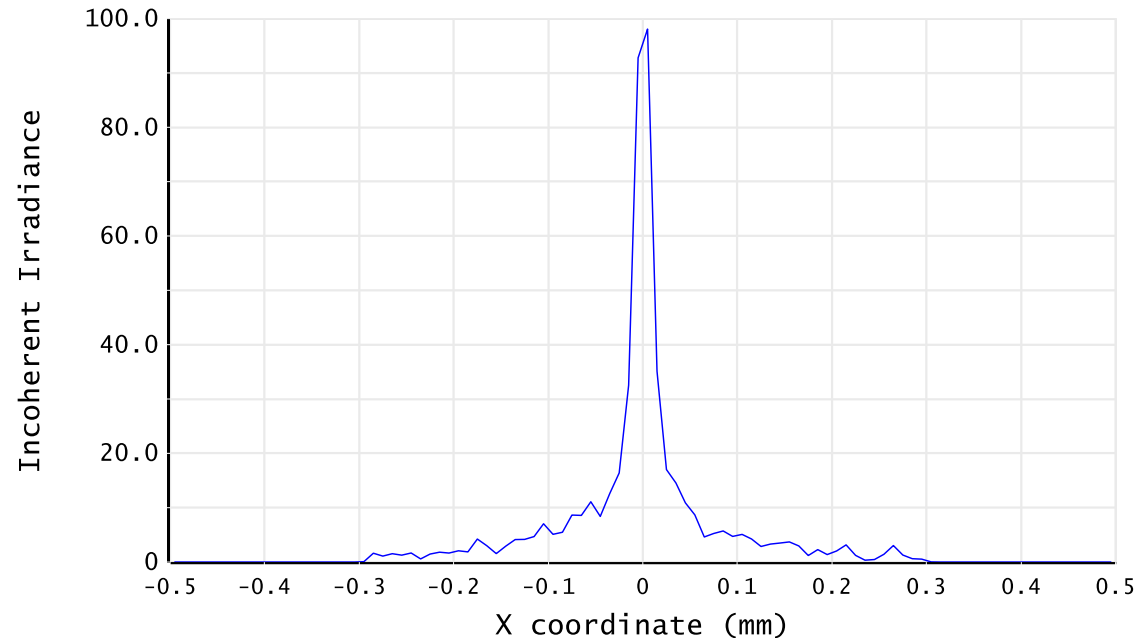
Light Distribution 1 mm after 100 mm of BCF98XL Fibre (no lens), 0.5 mm gap



Incoherent Irradiance	
Fibre Test for PoPLaR 21/01/2026 Detector 8, NSCG Surface 1: Row Center, Y = 0.0000E+00 Size 1.000 W X 1.000 H Millimeters, Pixels 100 W X 100 H, Total Hits = 72782 Peak Irradiance : 3.3284E+02 Watts/cm^2 Total Power : 7.2782E-02 Watts	School of Physical & Chemical Sciences Queen Mary University of London Fibre_TestBCF20_BCF98XL.zmx Configuration 1 of 1

Nominal source of power 1W, 1 million primary rays traced. 7% of power reaches the detector plane.

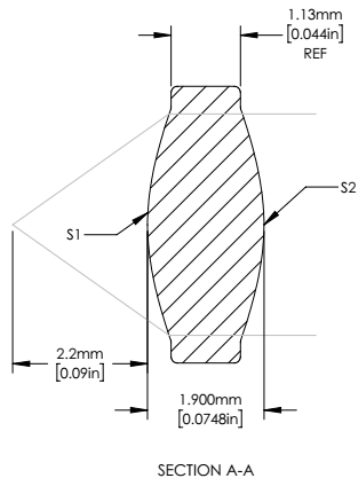
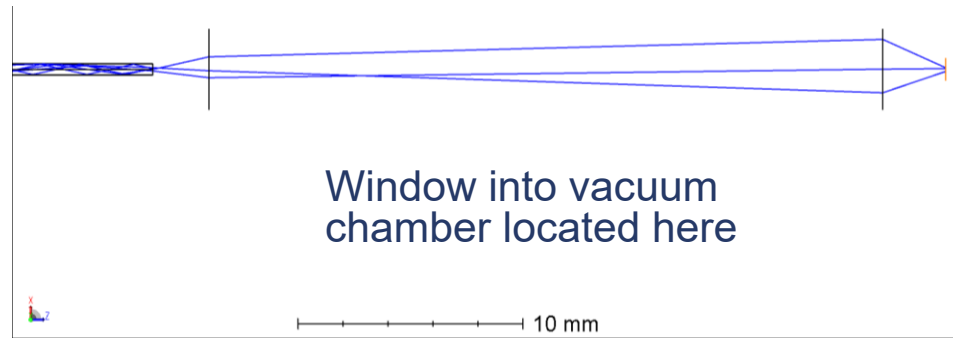
Light Distribution after 100 mm of BCF98XL Fibre imaged with $f = 12.5$ mm paraxial lens.



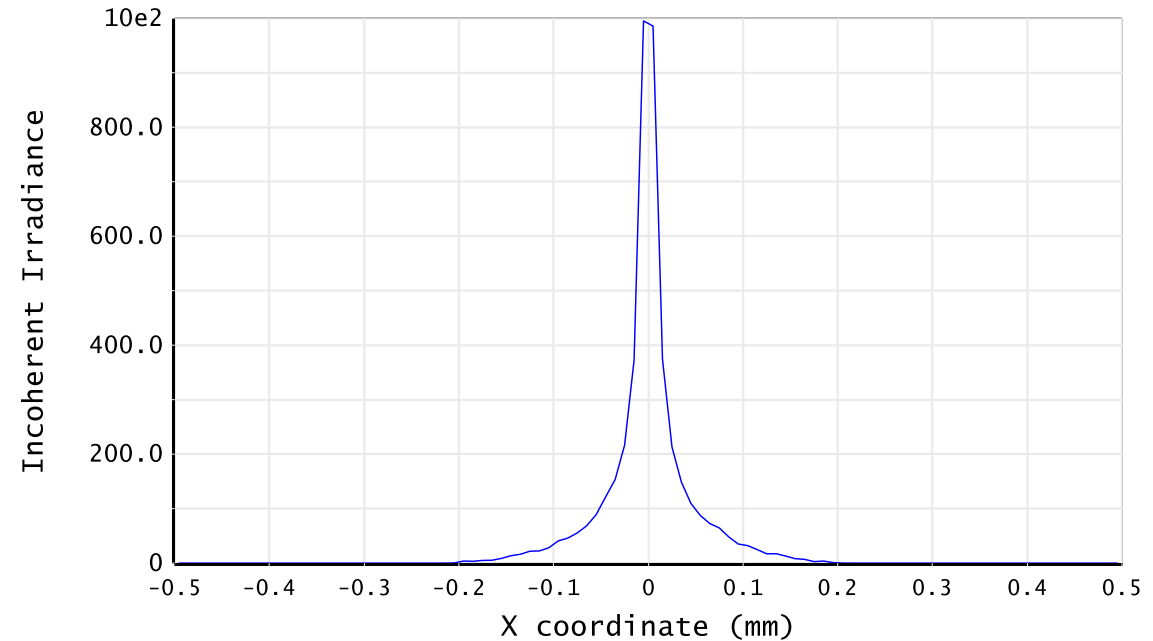
Incoherent Irradiance	
Fibre Test for PoPLaR 21/01/2026 Detector 8, NSCG Surface 1: Row Center, Y = 0.0000E+00 Size 1.000 W X 1.000 H Millimeters, Pixels 100 W X 100 H, Total Hits = 9937 Peak Irradiance : 1.0660E+02 Watts/cm^2 Total Power : 9.9370E-03 Watts	School of Physical & Chemical Sciences Queen Mary University of London Fibre_TestBCF20_BCF98XL.zmx Configuration 1 of 1

Nominal source of power 1W, 1 million primary rays traced. 1% of power reaches the detector plane.

Light Distribution after 100 mm of BCF98XL fibre imaged with two $f = 2.8$ mm paraxial lenses.



THORLABS www.thorlabs.com		
0.55 NA ASPHERIC LENS, $f=2.8$ mm, DW=830 nm, A COATED		
MATERIAL	SEE NOTES	REV E
ITEM #	355390-A	APPROX WEIGHT 0.1 g



Incoherent Irradiance	
Fibre Test for PoPLaR 21/01/2026 Detector 10, NSCG Surface 1: Row Center, $Y = 0.0000E+00$ Size 1.000 W X 1.000 H Millimeters, Pixels 100 W X 100 H, Total Hits = 45761 Peak Irradiance : 9.9634E+02 Watts/cm ² Total Power : 4.5761E-02 Watts	School of Physical & Chemical Sciences Queen Mary University of London Fibre_TestBCF20_BCF98XL_Lenses.zmx Configuration 1 of 1

Nominal source of power 1W, 1 million primary rays traced.
4.5% of power reaches the detector plane.

What next?

Include the frame, minus the production “tabs”, as CAD object with some coating derived from measurements on the actual frame;

Estimate the typical light produced in a sparse fibre per laser pulse;

Look at how we can get the scintillation light efficiently out of the vacuum chamber so that active components (camera) are not outgassing nor subject to so much EMP risk;

Determine how to image efficiently onto standard “C” mount CMOS camera with collimated beam via vacuum feedthrough (simple version shown on previous won’t work);

Are any cameras/lenses I bought with STFC LhARA funds now useful ?

