Queen Mary
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Science and Engineering

Optical Simulations for LhARA test stand (6)

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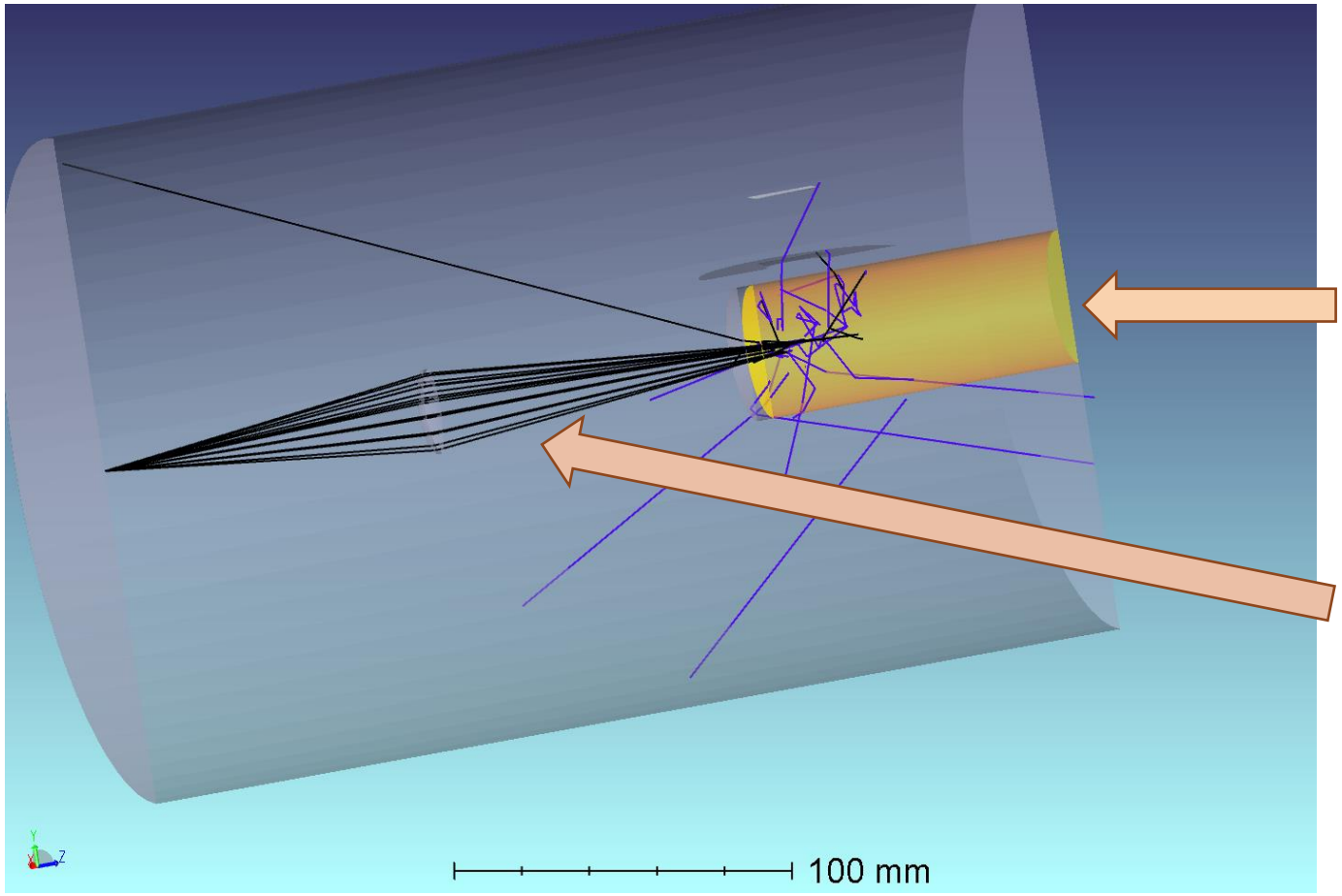
Modelling of UV LED test system

1. Using non-sequential ray tracing;
2. Simulating the UV test-tank with a fluorescent material in water, 5 mm thick BK7 glass entrance window. Imaging assumed to be through the water-air interface.
3. 10 million primary rays traced, rays split according to Fresnel equations, scatter with wavelength change simulating fluorescence is also modelled;
4. Primary rays from the LED have a single wavelength of 363 nm, Fluorescence is modelled as a single wavelength at 450 nm;
5. No absorbing surfaces, other than the lens aperture, are included yet;
6. Simulations were carried out using ZEMAX OpticStudio Professional V22.2 on my home PC (Gen 11 i5 6/12 core @4.3 GHz sustained average, 32 Gbytes of 3200 MHz DDR4 memory).

Overall view of simulated system

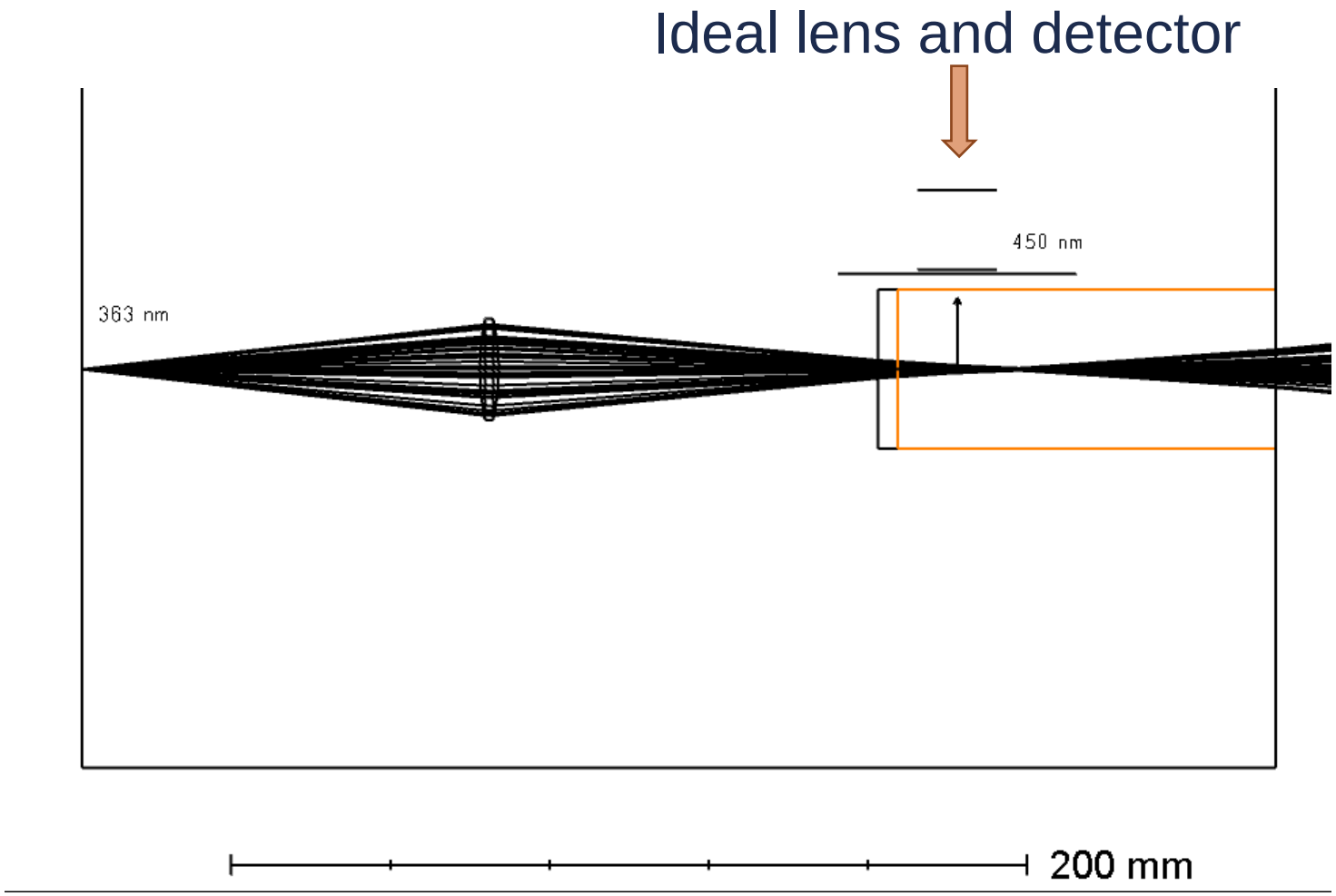


Black primary UV rays
Blue fluorescence

Water volume with 35% quantum efficiency to produce 450 nm fluorescence

Biconvex lens f= 60 mm

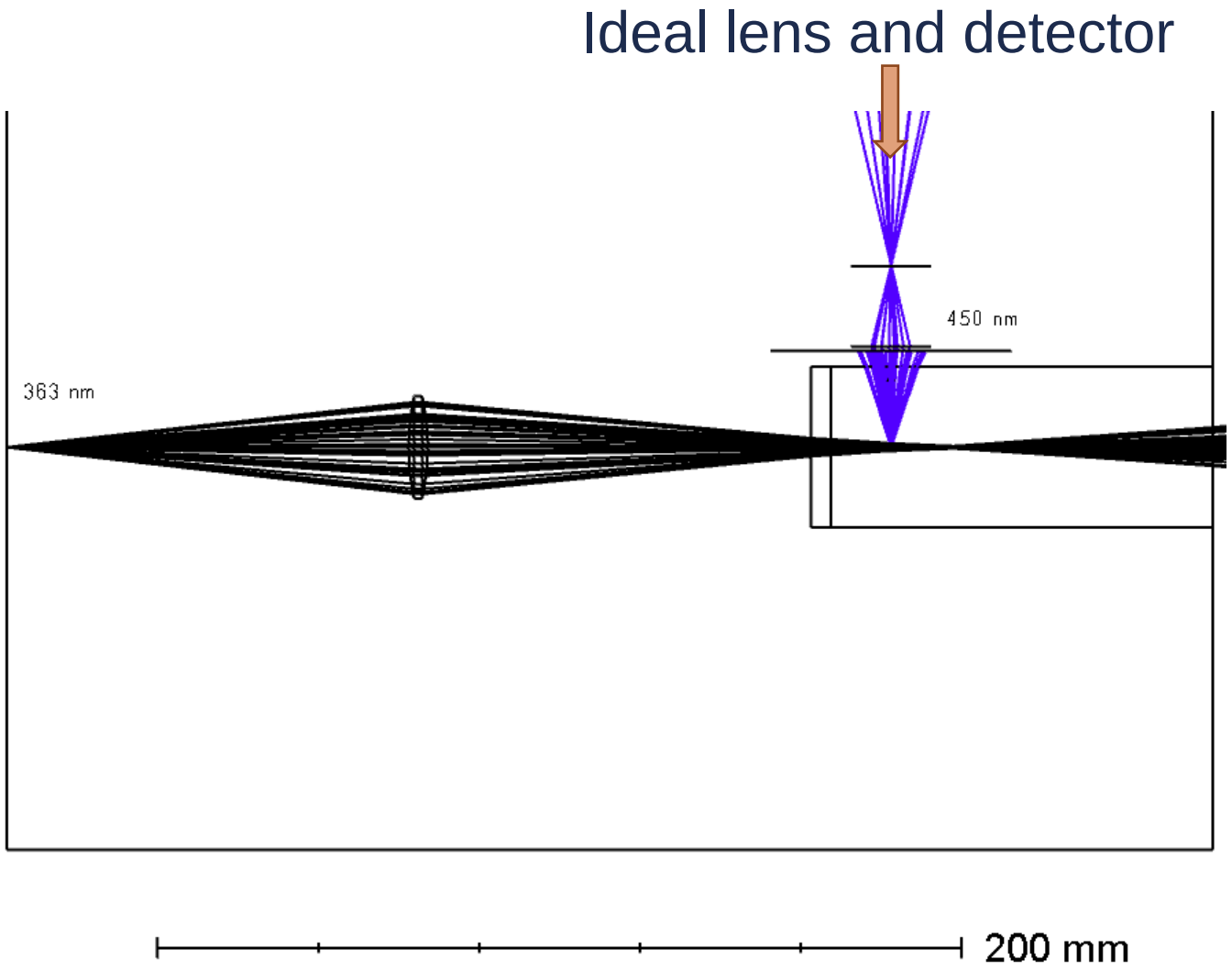
Overall view of simulated system



Black primary UV rays
Blue fluorescence

Scatter and ray splitting OFF

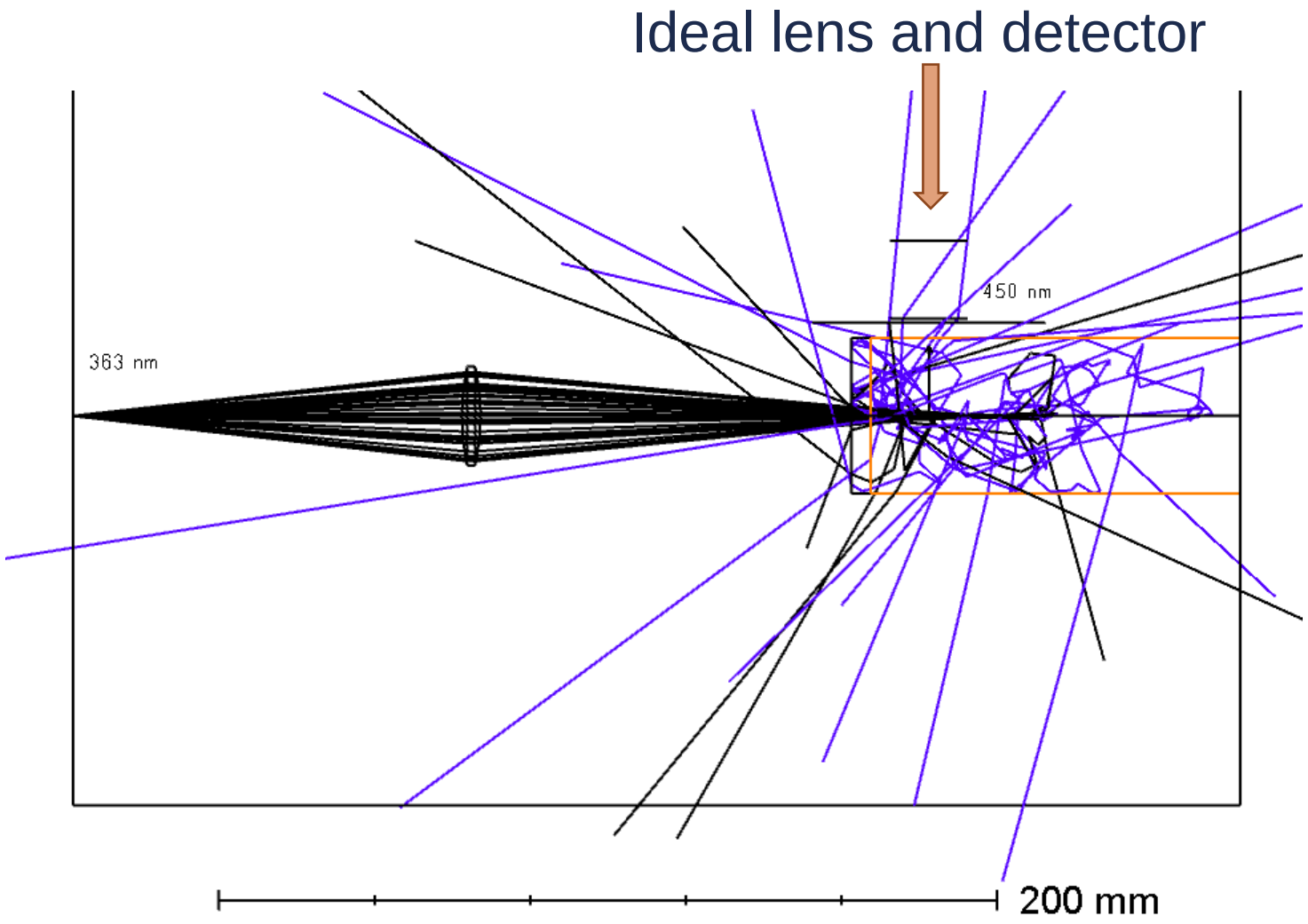
Overall view of simulated system



Black primary UV rays
Blue fluorescence

Scatter and ray splitting OFF, a point source simulating fluorescence is shown to demonstrate imaging.

Overall view of simulated system



Black primary UV rays
Blue fluorescence

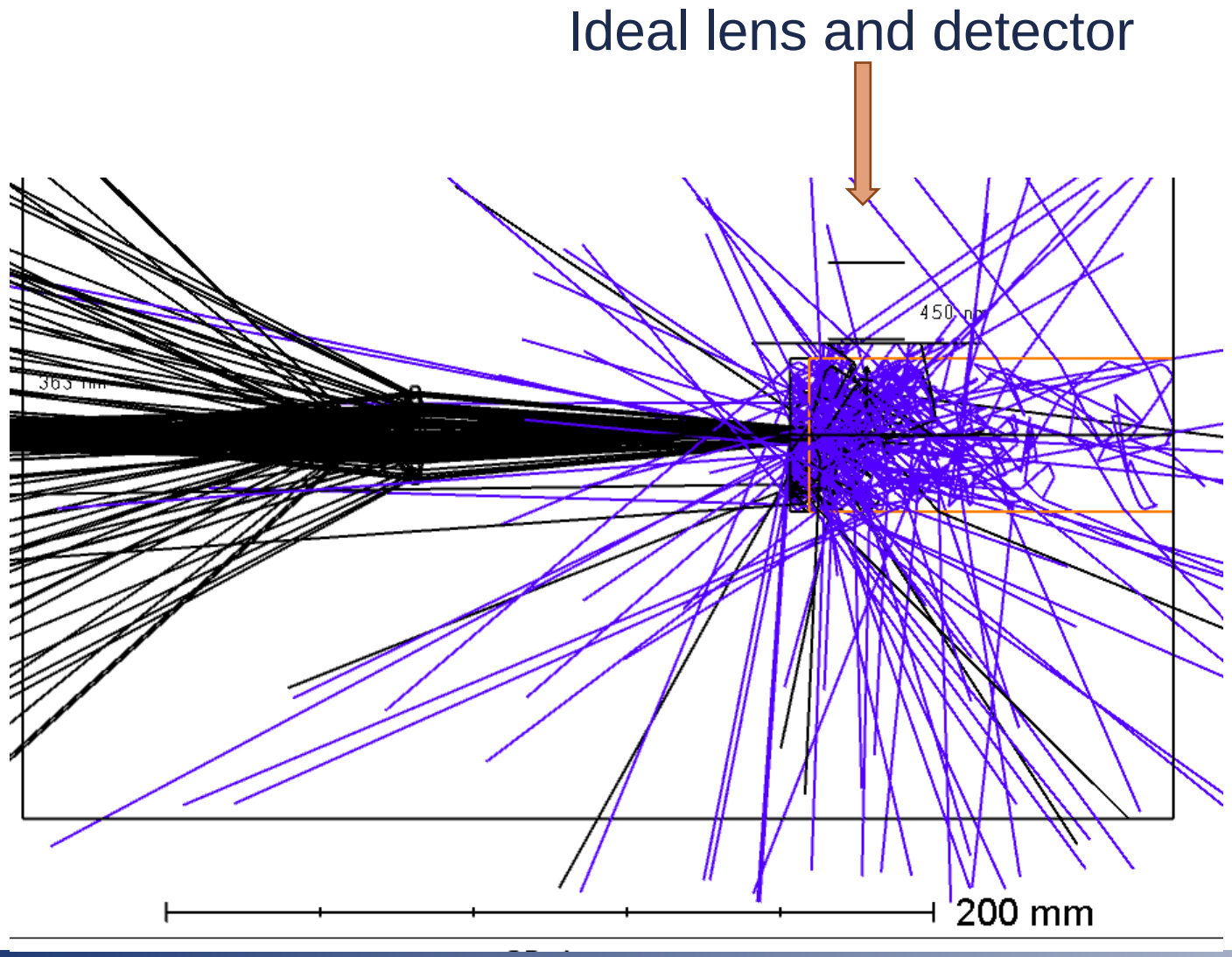
Scatter (fluorescence) is ON and ray splitting is OFF

Scattering model is “angle” with 180° cone semi-angle.

Rays traveling a distance *x* within the media have an integrated probability of having been scattered given by p(*x*) and μ is the reciprocal of the m.f.p.

$$\mathbf{p(x) = 1.0 - e^{-\mu x}}$$

Overall view of simulated system

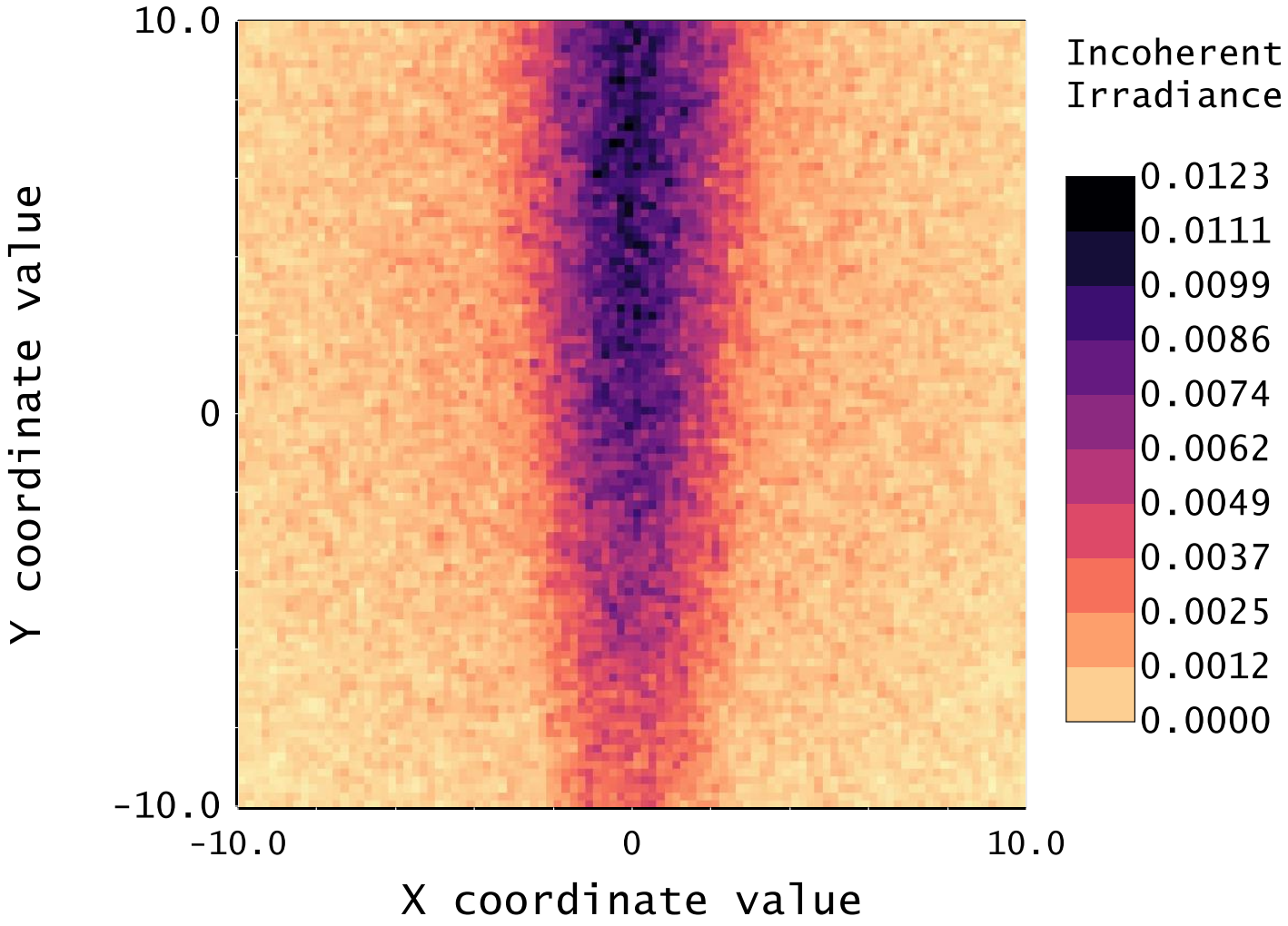


Black primary UV rays
Blue fluorescence

Scatter (fluorescence) is ON and ray splitting is ON

Mean path in water for UV light set to15 mm

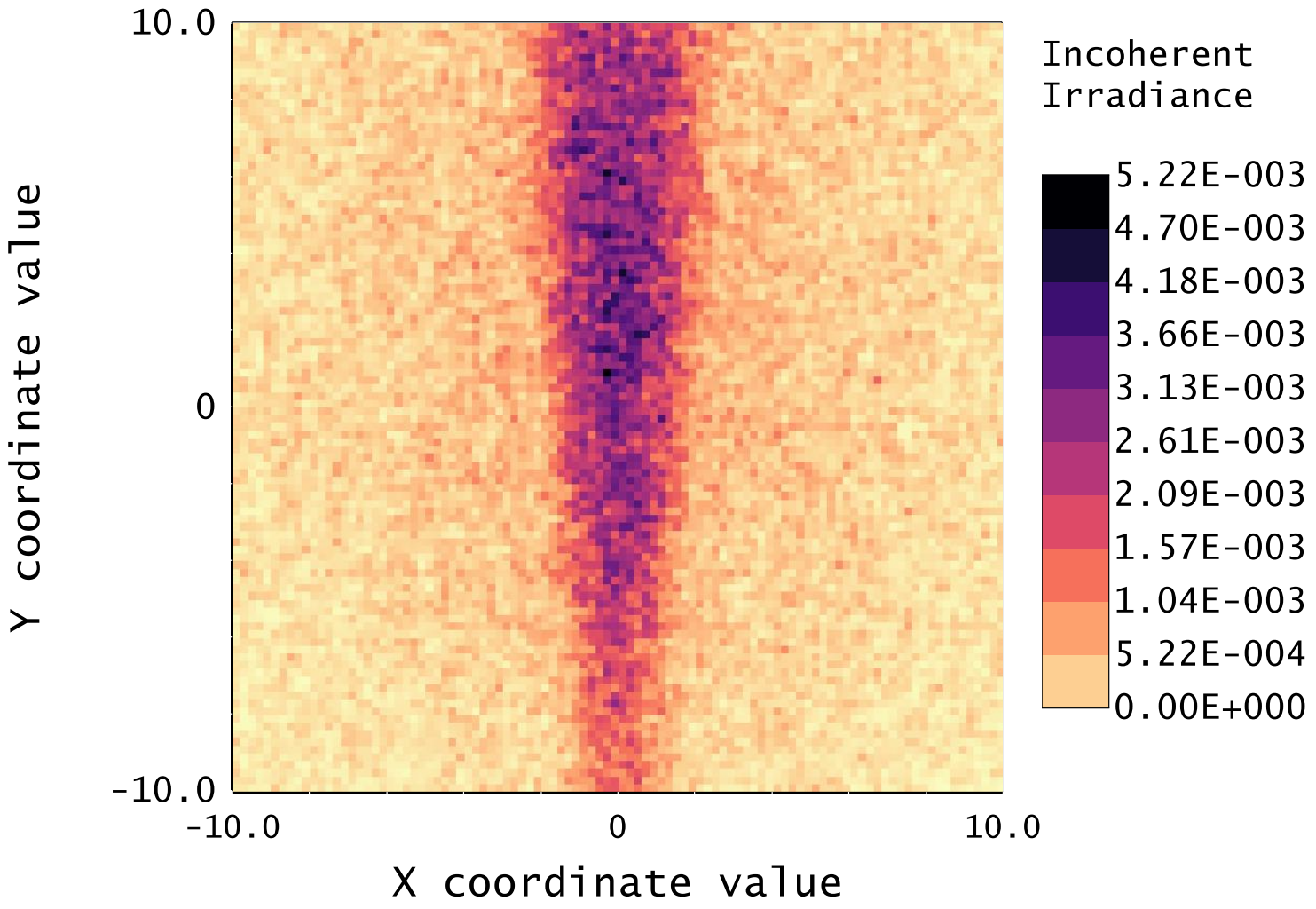
Image at detector



1 W LED produced 350 mW fluorescence of which 10 mW collected by ideal F#1, 10 mm focal length lens.

This is an unrealistically fast lens!

Image at detector



1 W LED produced 350 mW fluorescence of which 3 mW collected by ideal F#2, 10 mm focal length lens.

To do list!

1. Use a realistic lens and object/image distance for the imaging system
2. Add the PMMA sides to the water volume
3. You need to add to this list (in priority order)!