Queen Mary
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Optical Simulations for LhARA test stand

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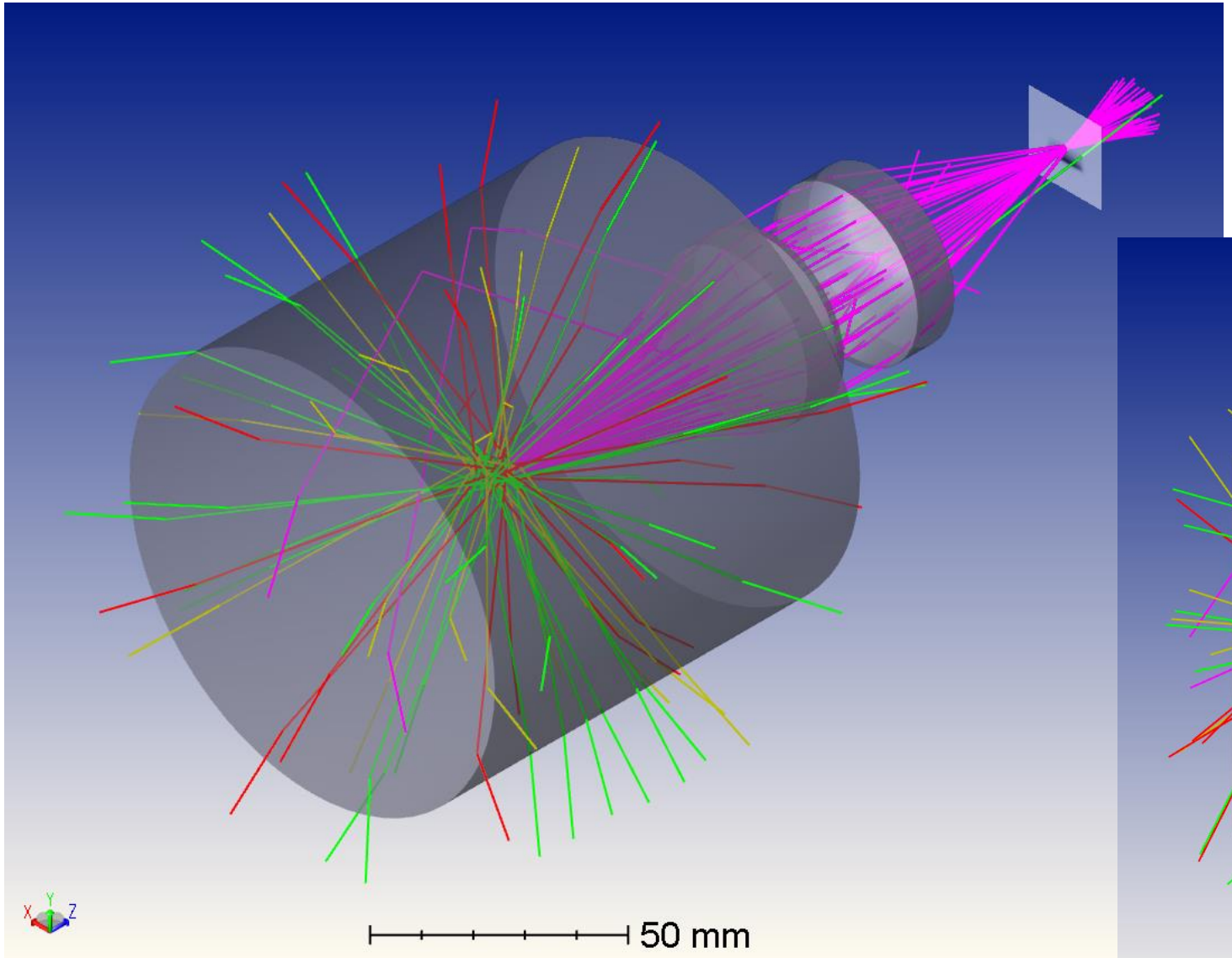
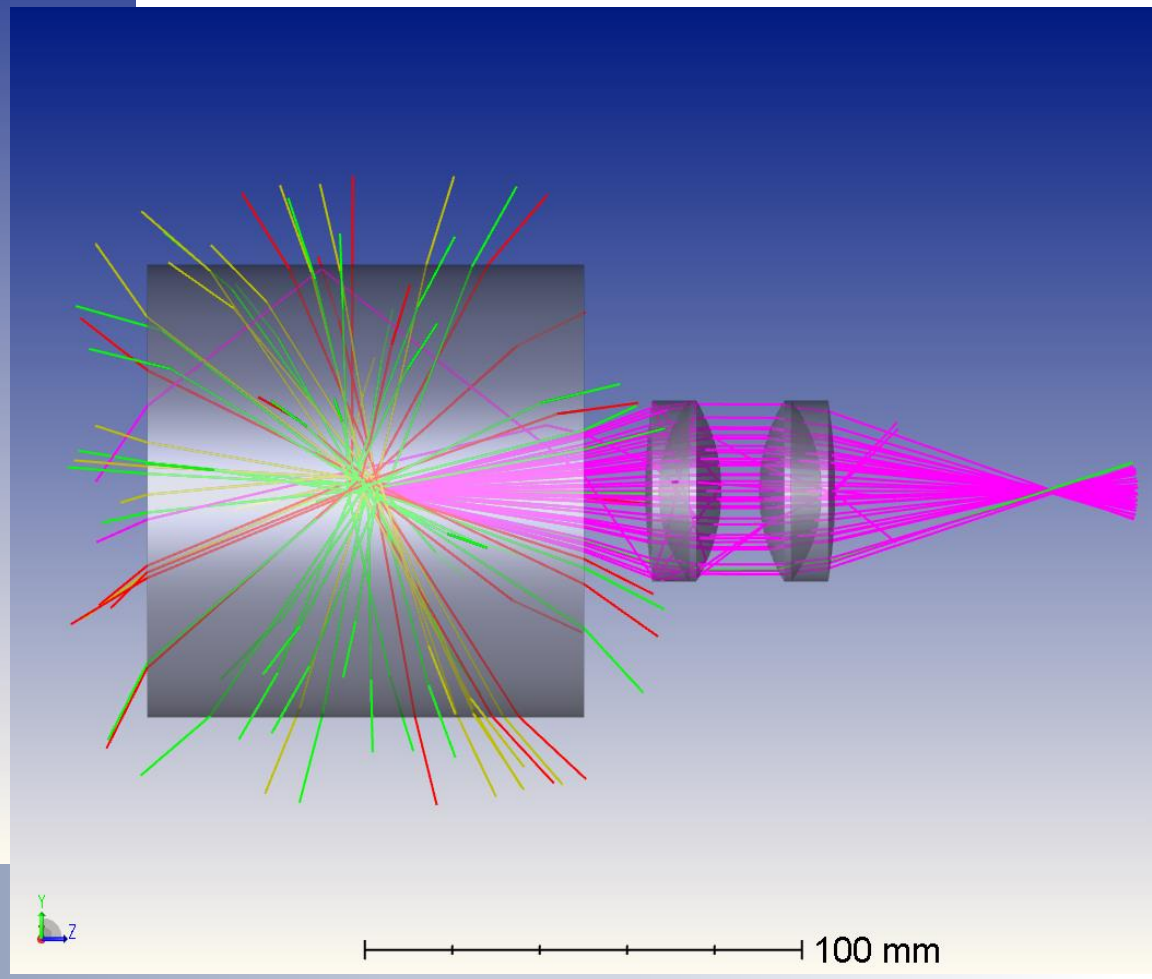
Modelling

1. Volume is assumed to be **ideal water** (100% transmitting) contained within a cylinder surrounded by air;
2. Non-sequential rays are traced with “ray-splitting” enabled (i.e. Fresnel reflection and polarization is accounted for);
3. Imaging optics are a plausible combination of two commercial achromatic lenses but have not been in any way optimised;
4. The detector is perfect (no noise, no pixel gaps);
5. The scintillation yield is assumed to be 10000 photons per MeV (typical of Eljen liquid organic scintillators);
6. The beam is modelled as a cylinder of 10 mm diameter sub-divided in z into a number of slices. Each slice has a different intensity and rays are emitted isotropically in each slice;
7. All rays have a single wavelength of 400 nm;
8. Simulations were carried out using ZEMAX OpticStudio Professional V22.2 on my home PC (i5 6/12 core @4.6 GHz peak, 32 Gbytes of 3200 MHz DDR4 memory).

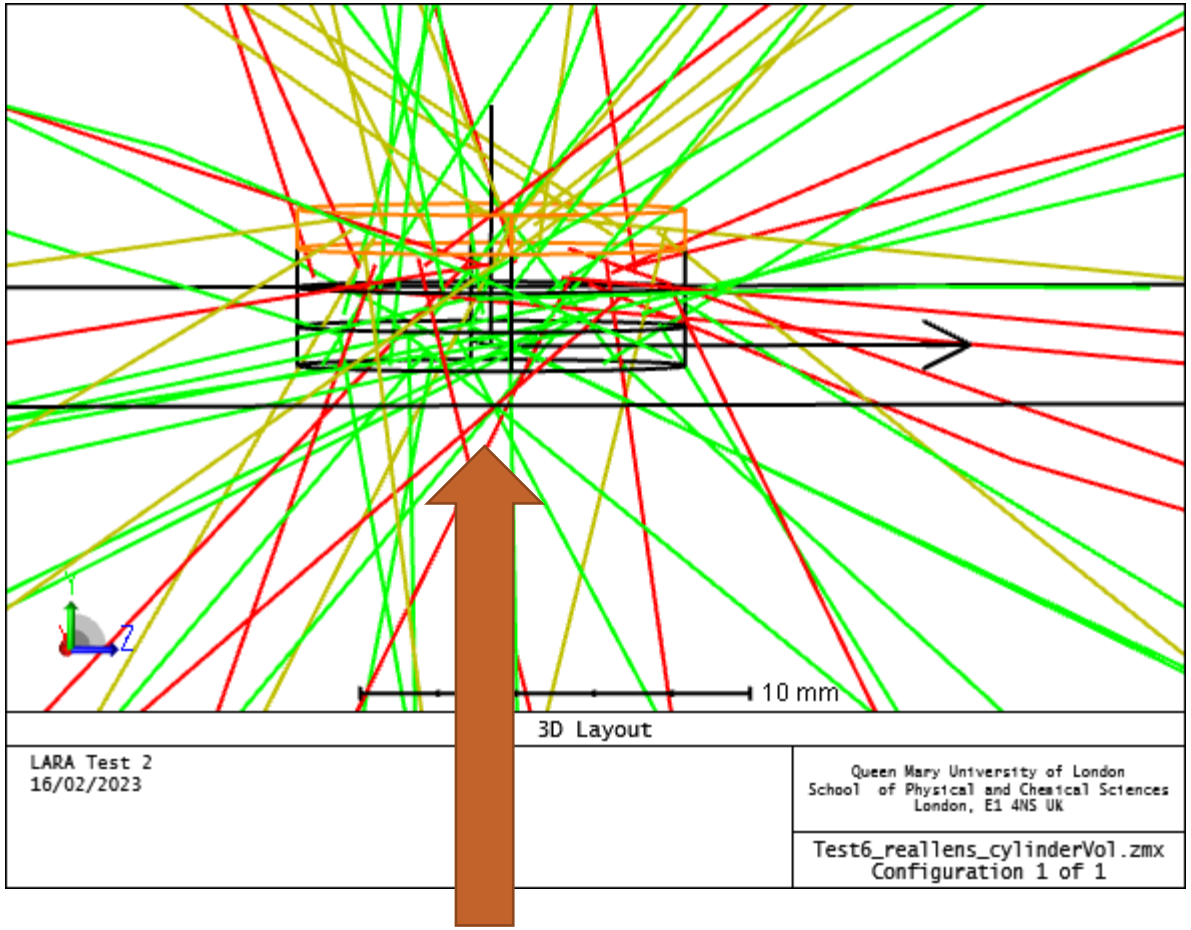
Geometry View 3D render



Ray splitting OFF for clarity, purple rays are from a point source and are only used for lens position optimisation.



Geometry View 2D wire

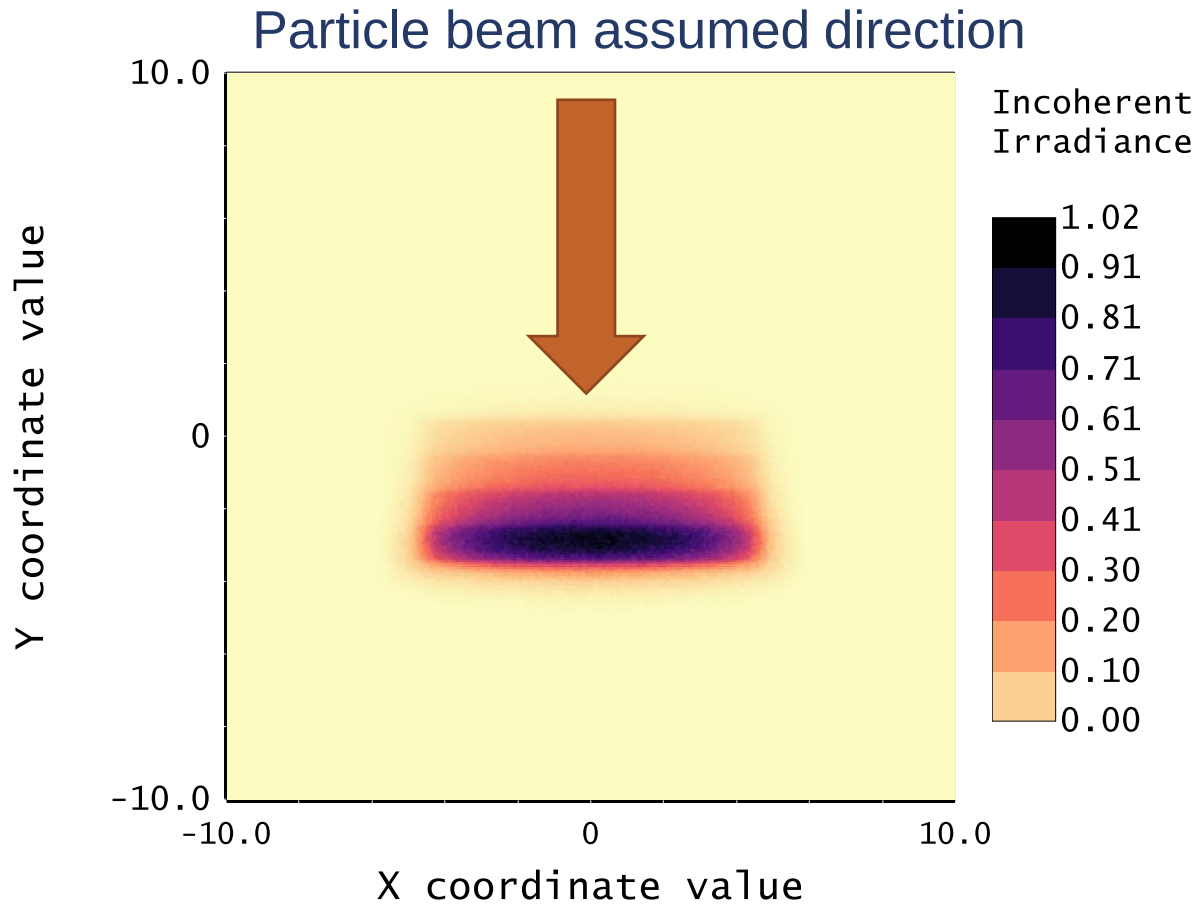


Particle beam assumed direction

Particle beam is assumed to come up from the –Y direction, four beam cylinder slices of 10 mm diameter are modelled here, the one coloured orange is in the position of the “Bragg” peak. Each slice is 1.0 mm thick.

Ray splitting is off for clarity.

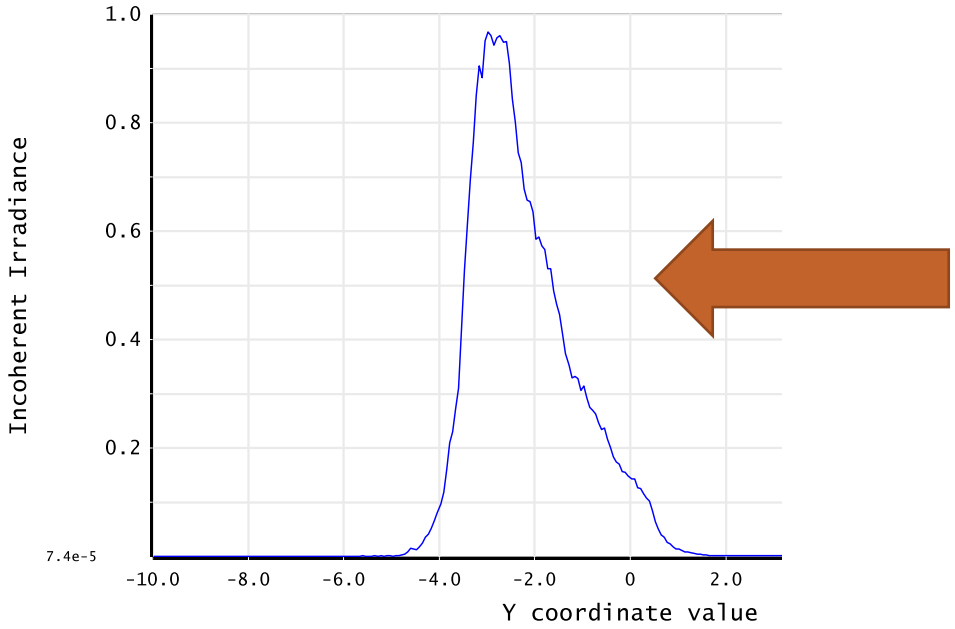
Results



400 **million** primary rays traced, slices have intensities in the ratio 1:2:4:8. Remember the lens system inverts the image!

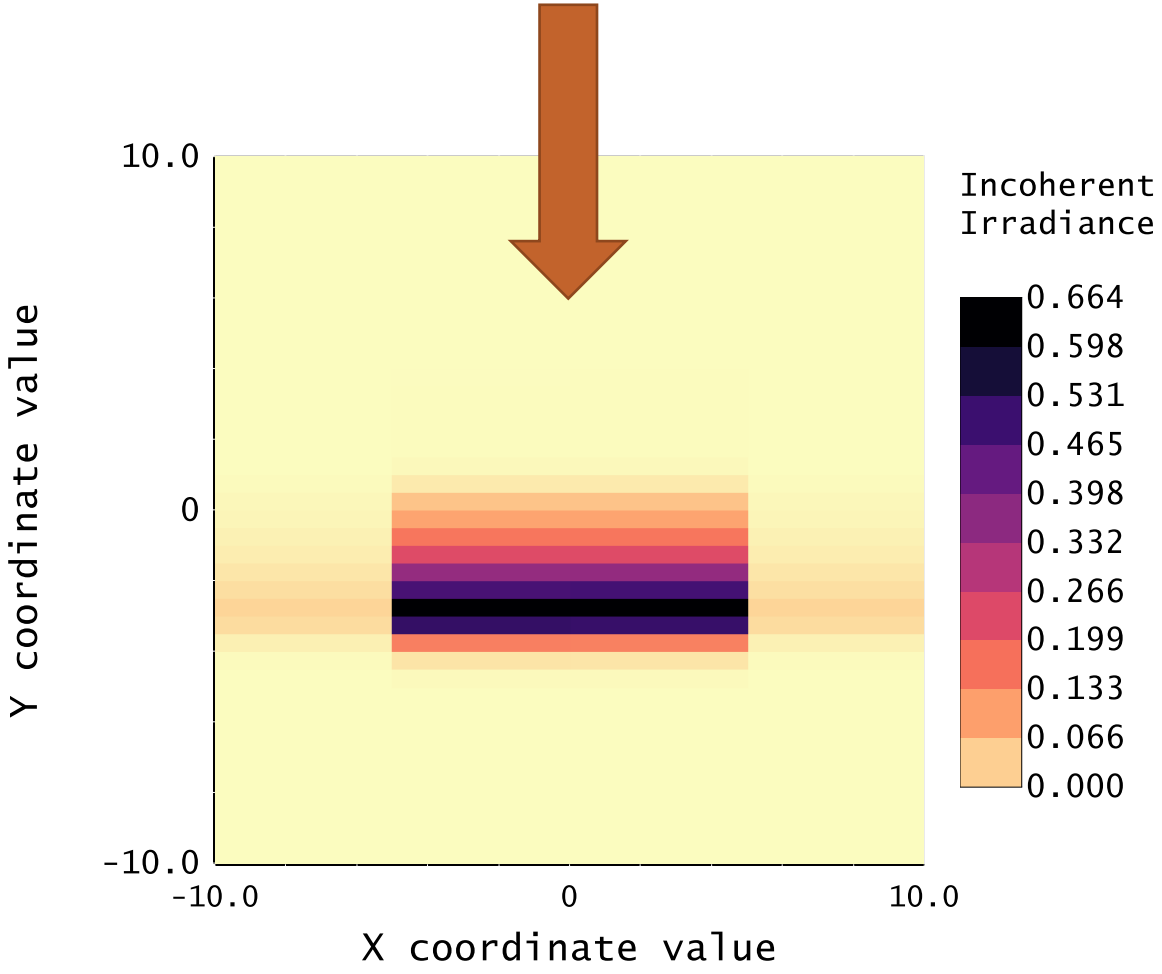
About 1% of the primary rays make it to the detector.

Detector has 320x320 pixels, below is shown the column at X=0.



Results 2

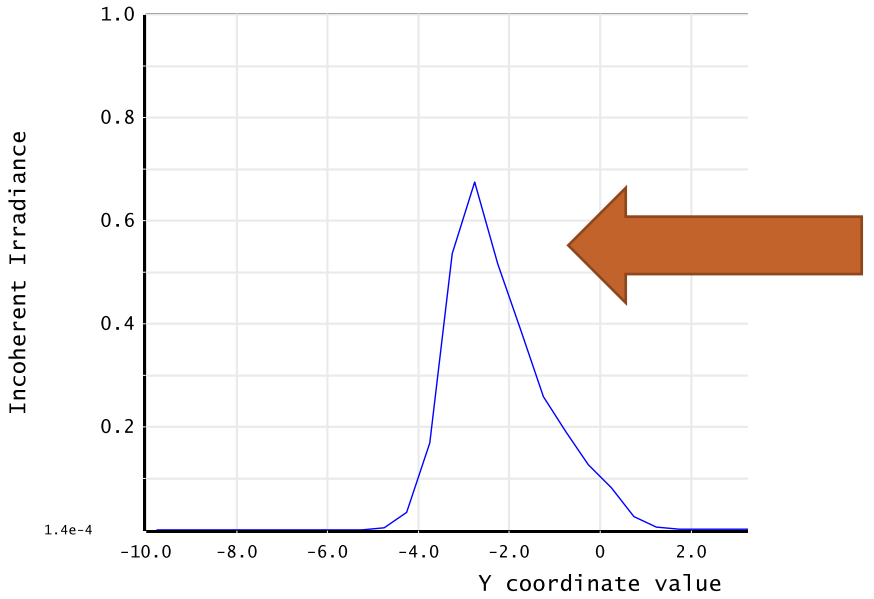
Particle beam assumed direction



40 **million** primary rays traced, slices have intensities in the ratio 1:2:4:8. Remember the lens system inverts the image!

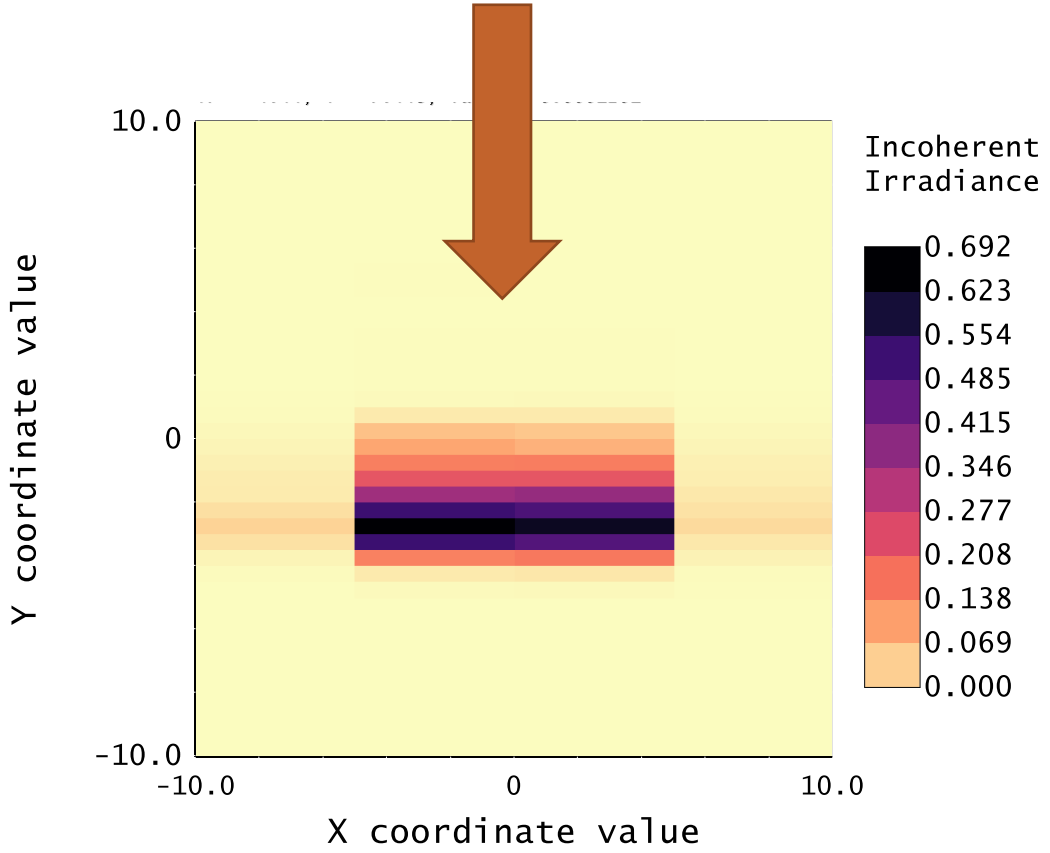
About 1% of the primary rays make it to the detector.

Detector has 4x40 pixels, below is shown the column at X=0.



Results 3

Particle beam assumed direction



200 **thousand** primary rays traced (~ one 20 MeV particle), slices have intensities in the ratio 1:2:4:8.

Detector to left has 4x40 pixels
Detector below has 320x320 pixels.