Queen Mary
University of London
Science and Engineering

Optical Simulations for LhARA test stand (2)

Peter Hobson

School of Physical and Chemical Sciences

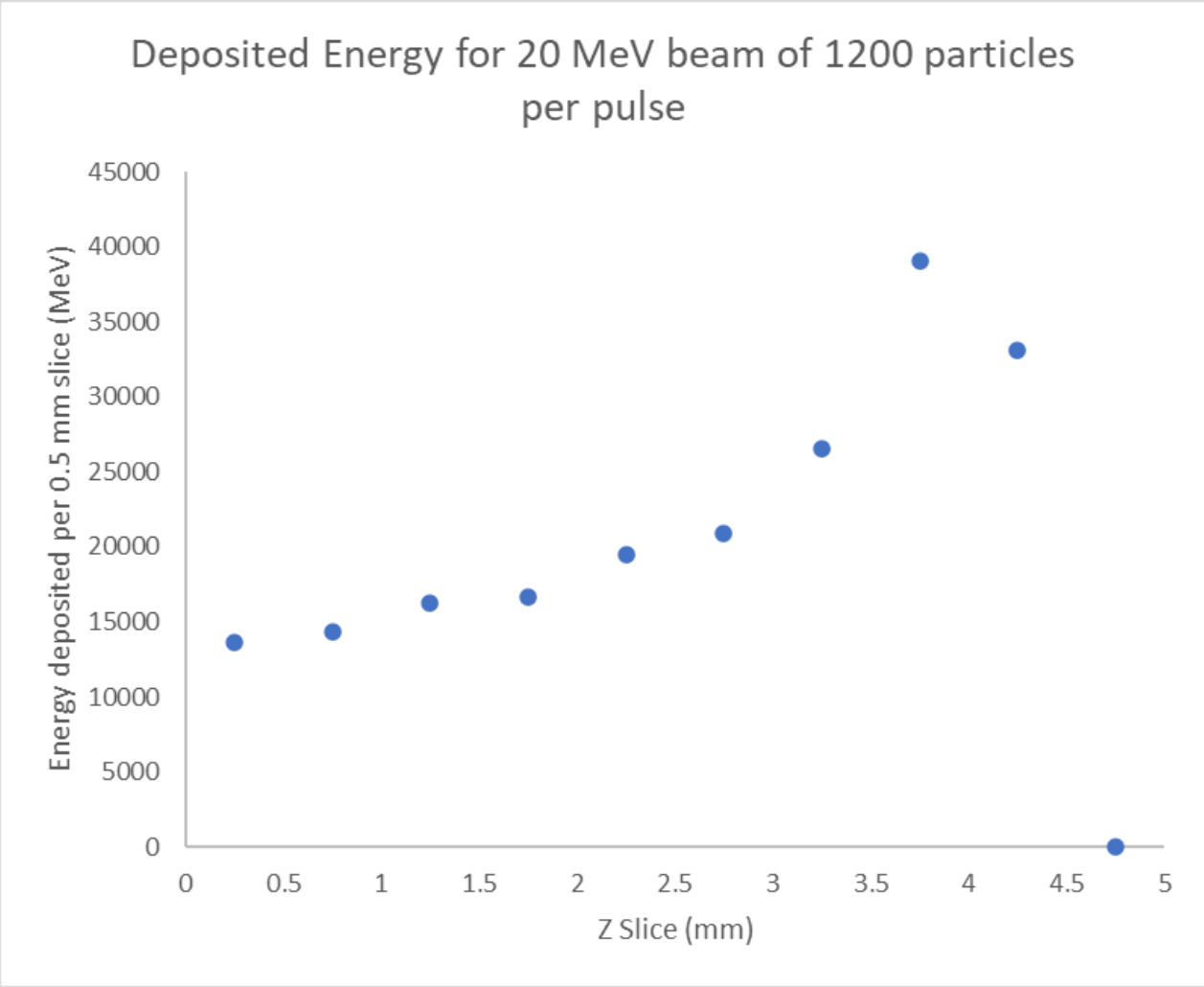
23 February 2023

Last revised 23 February 2023

Modelling

1. Volume is assumed to be **water** contained within a cylinder in air;
2. Non-sequential rays are traced with “ray-splitting” enabled (i.e. Fresnel reflection and polarization is accounted for);
3. F#2 imaging optics are a plausible combination of two identical 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 into 0.5 mm thick slices. Each slice can have 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).

Beam Data (from Maria)



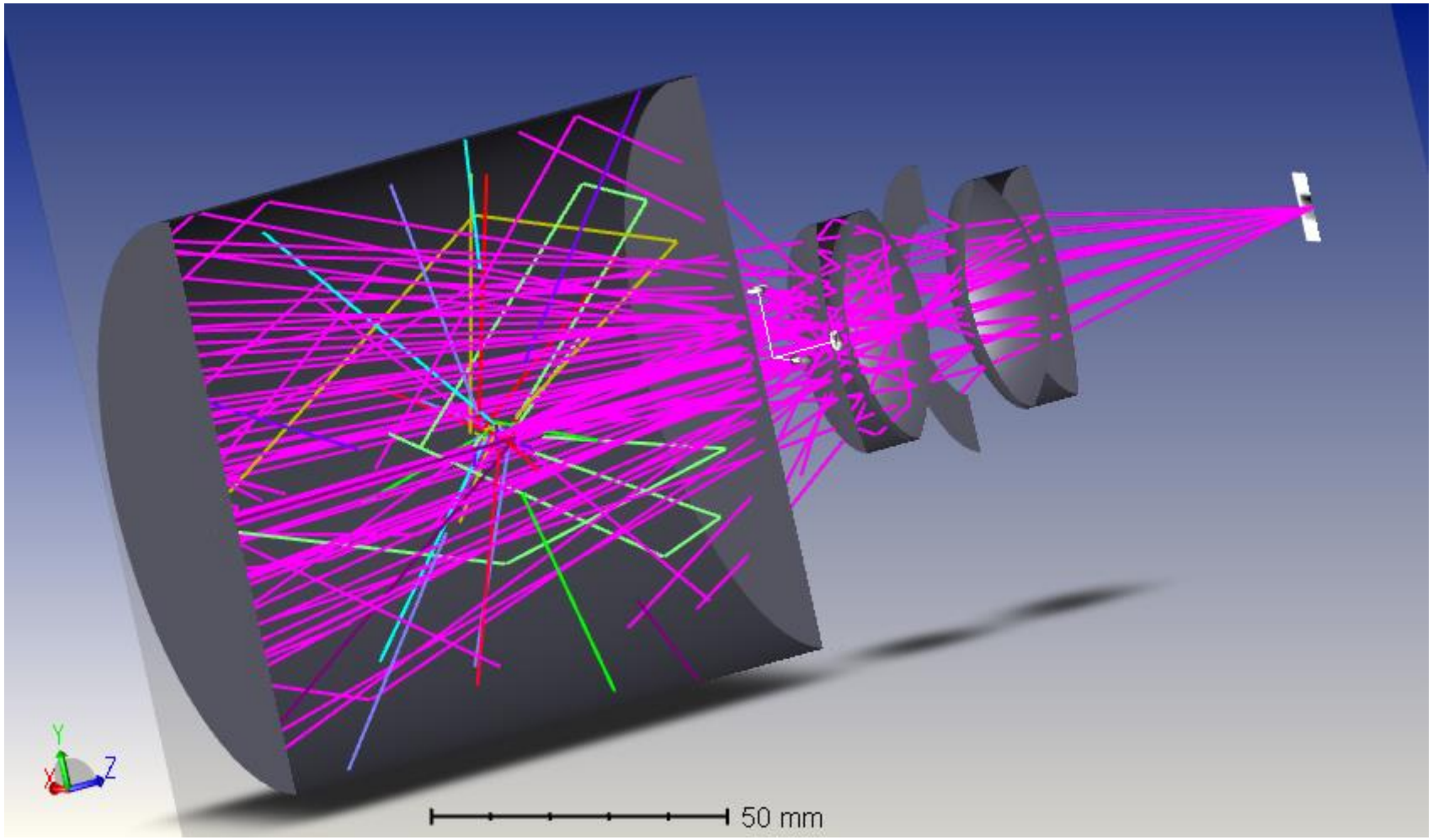
Parameters:

Beam Energy = 20 MeV (+/- 0.3 MeV)

Number of particles per pulse: = 1200

Nominal width of energy deposit in transverse plane = 10 mm

Geometry View 3D cut section render

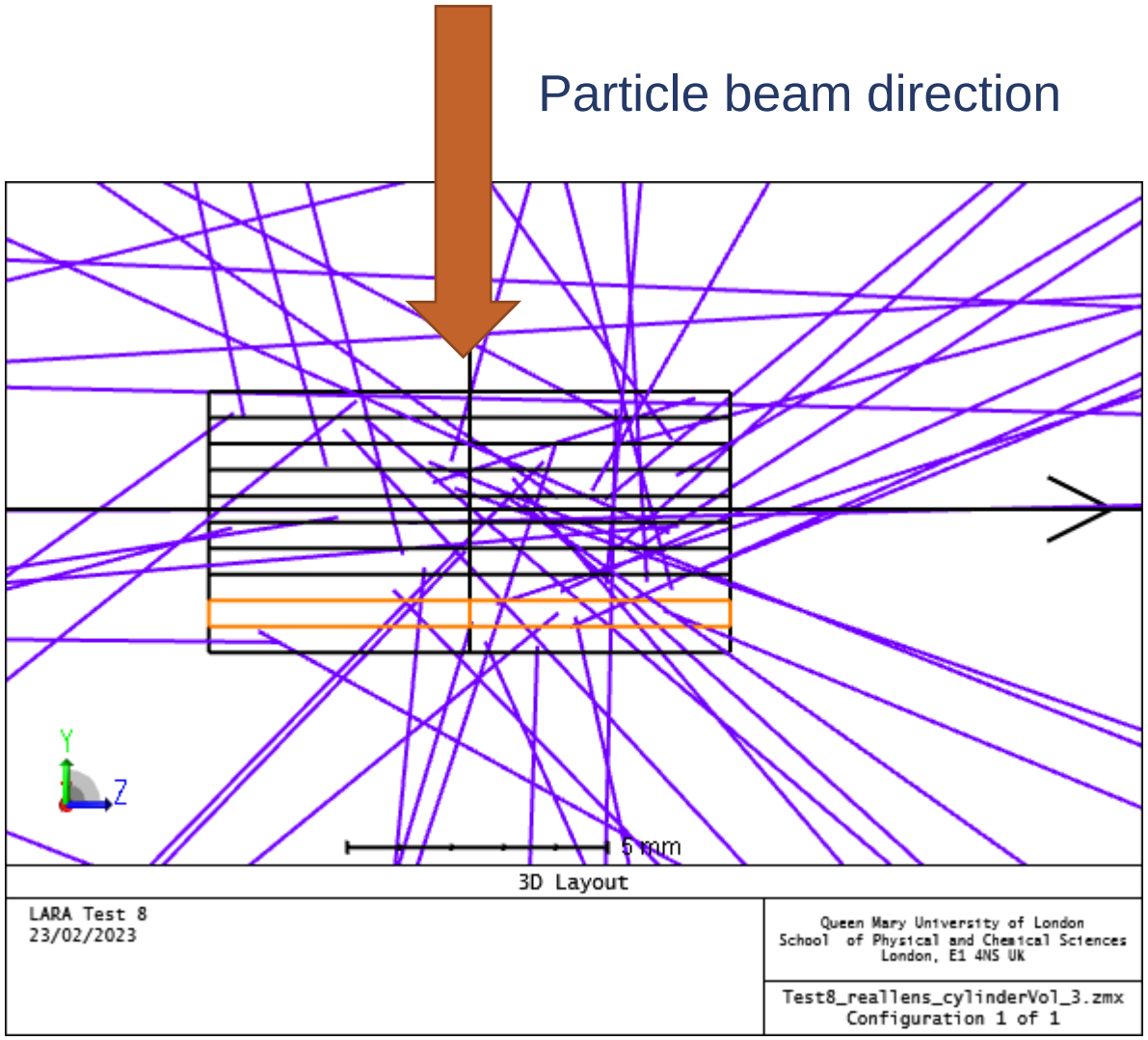


Ray splitting ON, purple rays are from a point source, at the centre of the water volume, and are only used for lens position optimisation.

Note the reflections from the lens surfaces, no AR coating in model yet.

Cylindrical and back face of water volume now modelled as 100% absorbing

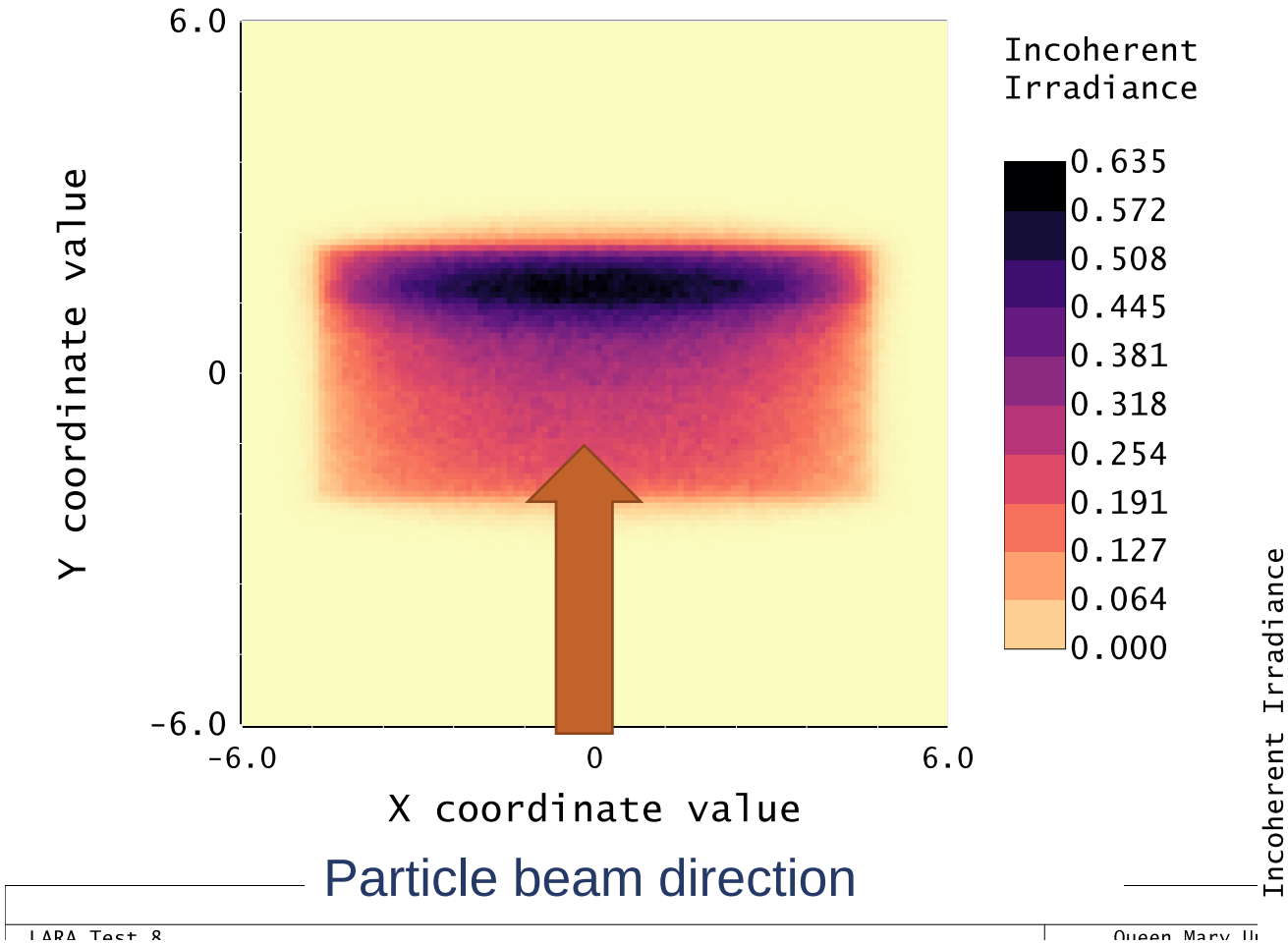
Geometry View 2D wire at centre of water



Particle beam is now assumed to come down from the +Y direction, 10 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 0.5 mm thick.

Ray splitting is off for clarity.

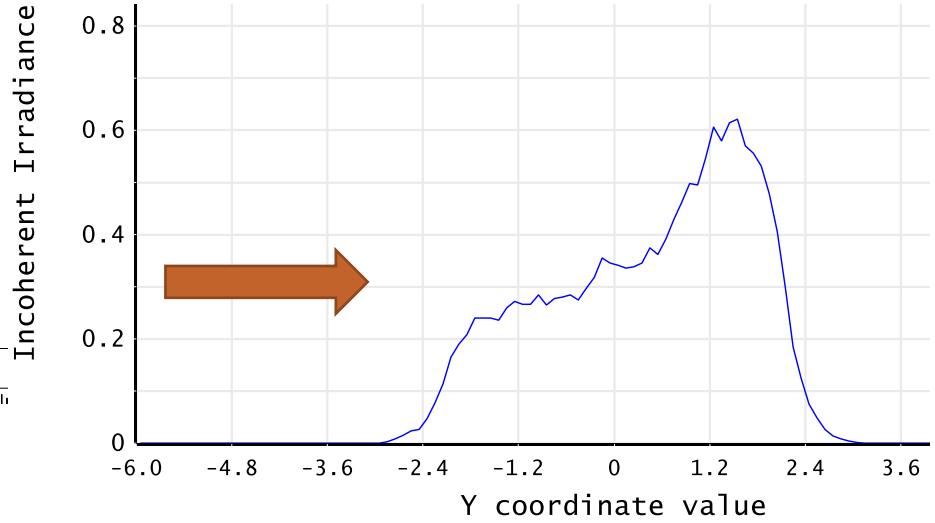
Preliminary Result



200 **million** primary rays traced (equivalent to a beam with 120 particles per pulse). Each slice has an intensity in the proportional to the energy deposition data provided by Maria. **Remember that the lens system inverts the image**!

No ray is traced after it has dropped below 1% of its original intensity

Detector has 120x120 100x100 μm² pixels, below is the column at X=0.



To do list!

1. Add correct AR coating to the lenses;
2. Use a less perfect absorber for the water volume, i.e. determine what the specification of the container should be in that respect;
3. Determine if it matters if the water volume is a cuboid;
4. Determine the appropriate window for the optical system, a glass flat or the first element of the lens;
5. Add noise from a real camera to the images;
6. Add absorption in the water.
7. You need to add to this list (in priority order)!