Queen Mary
University of London
Science and Engineering

Optical Simulations for LhARA test stand (5)

Peter Hobson

School of Physical and Chemical Sciences

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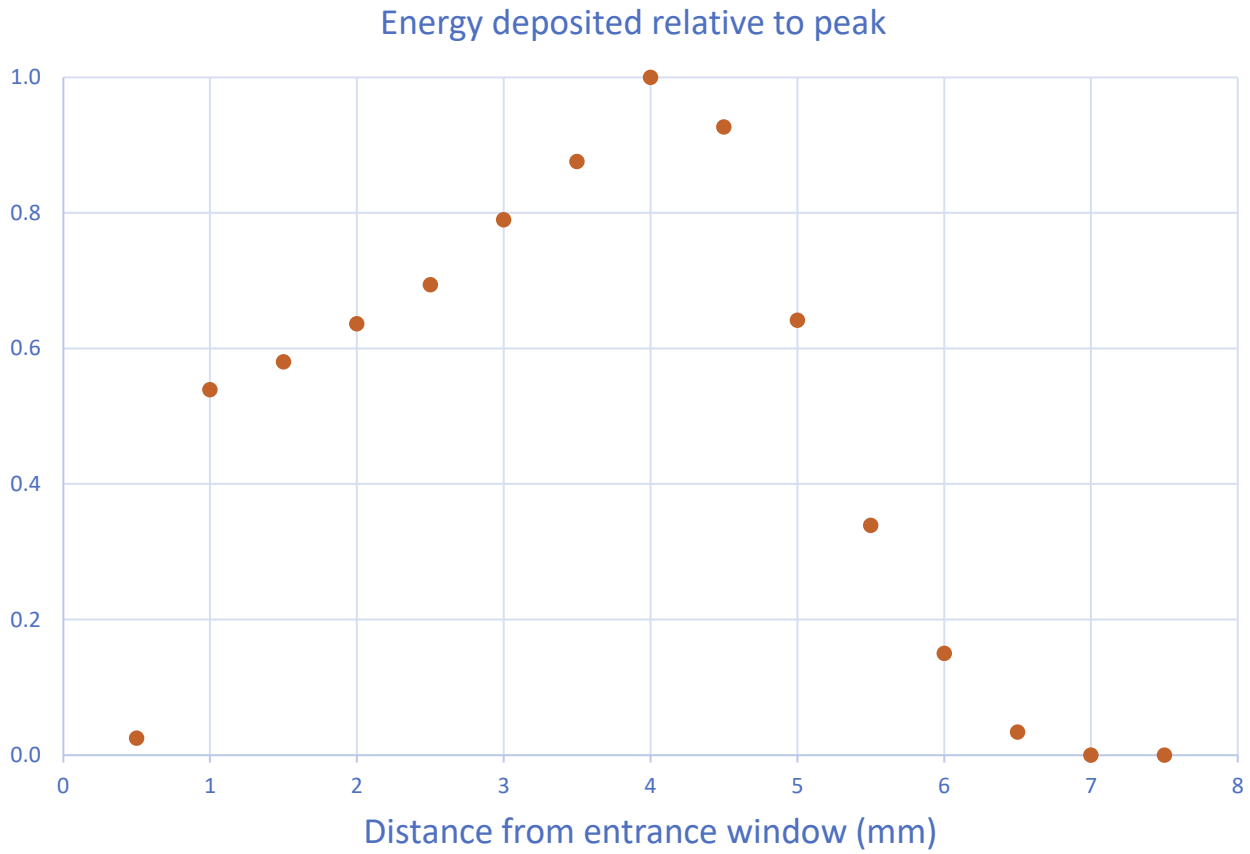
Modelling of whole system

1. Using non-sequential ray tracing;
2. Updated energy profile and much narrower beam (1.05 mm FWHM) in water.
3. All rays have a single wavelength of 400 nm, **1000 photons per MeV** assumed;
4. Detector has 100 µm square pixels (no gaps);
5. “Black” surfaces are 5% reflective split 80% Lambertian scatter and 20% specular;
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).

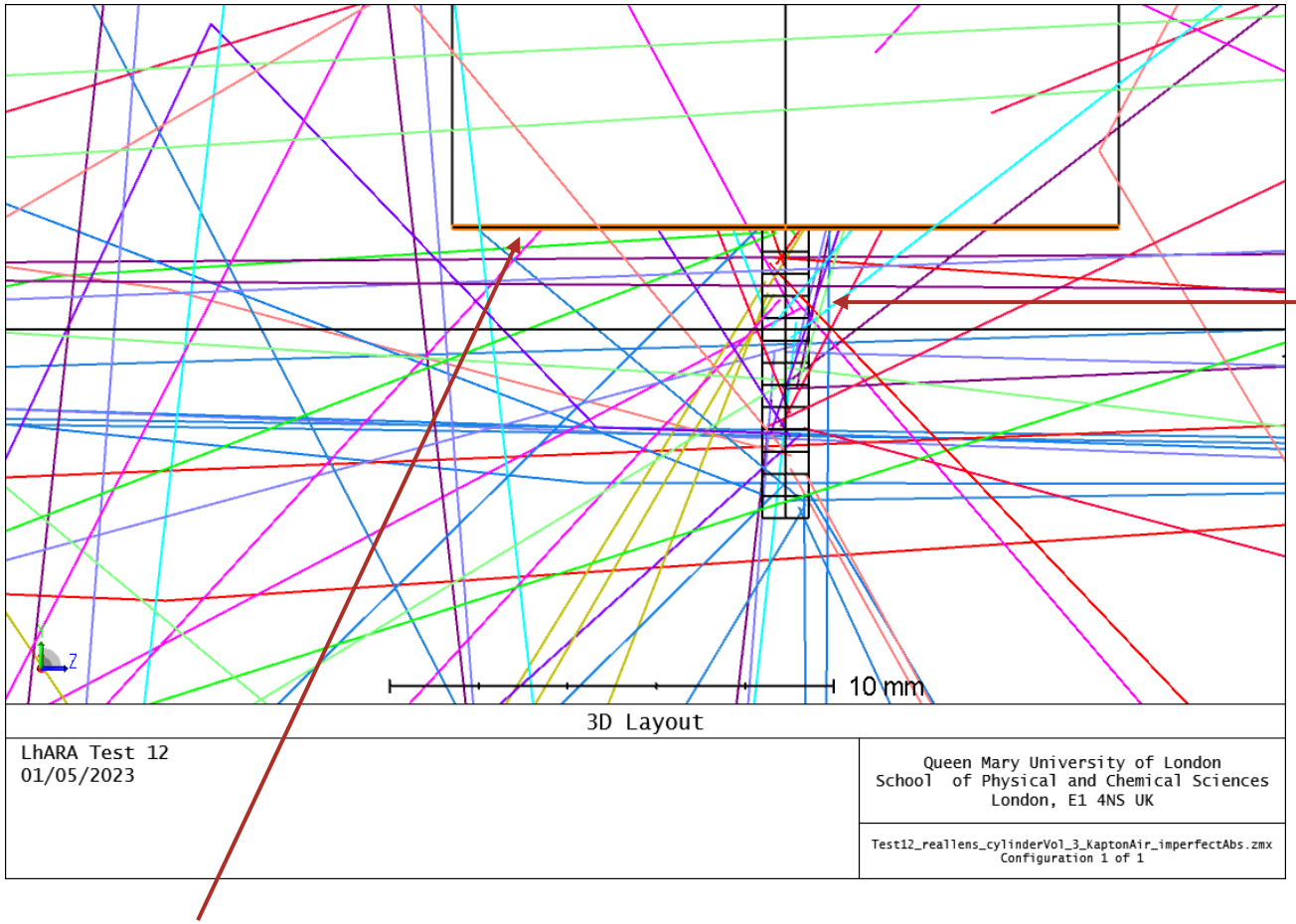
Deposited energy spectrum



Beam FWHM = 1.05 mm

Data from Maria on 25/04/2023

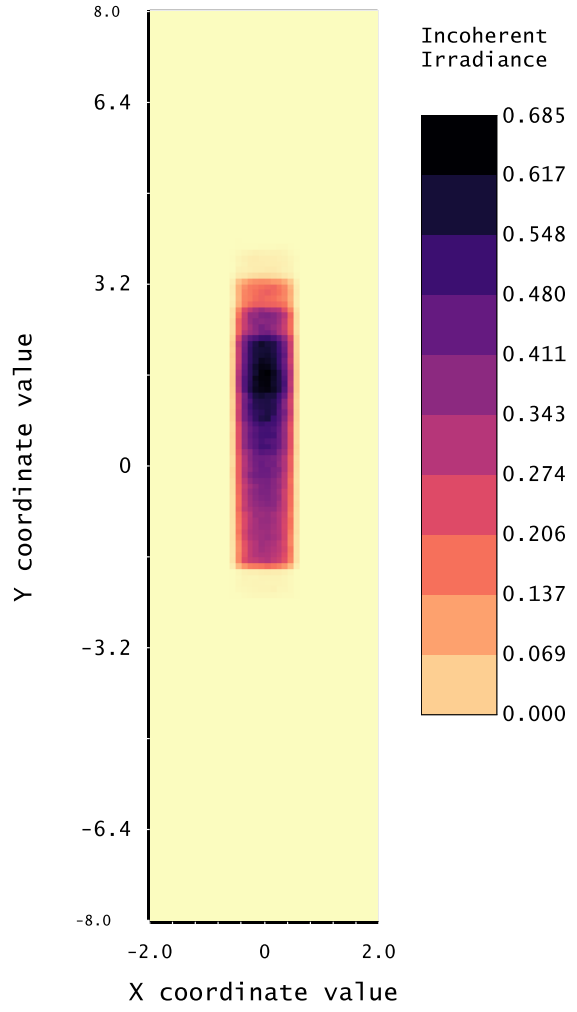
Overall view of simulated system (1)

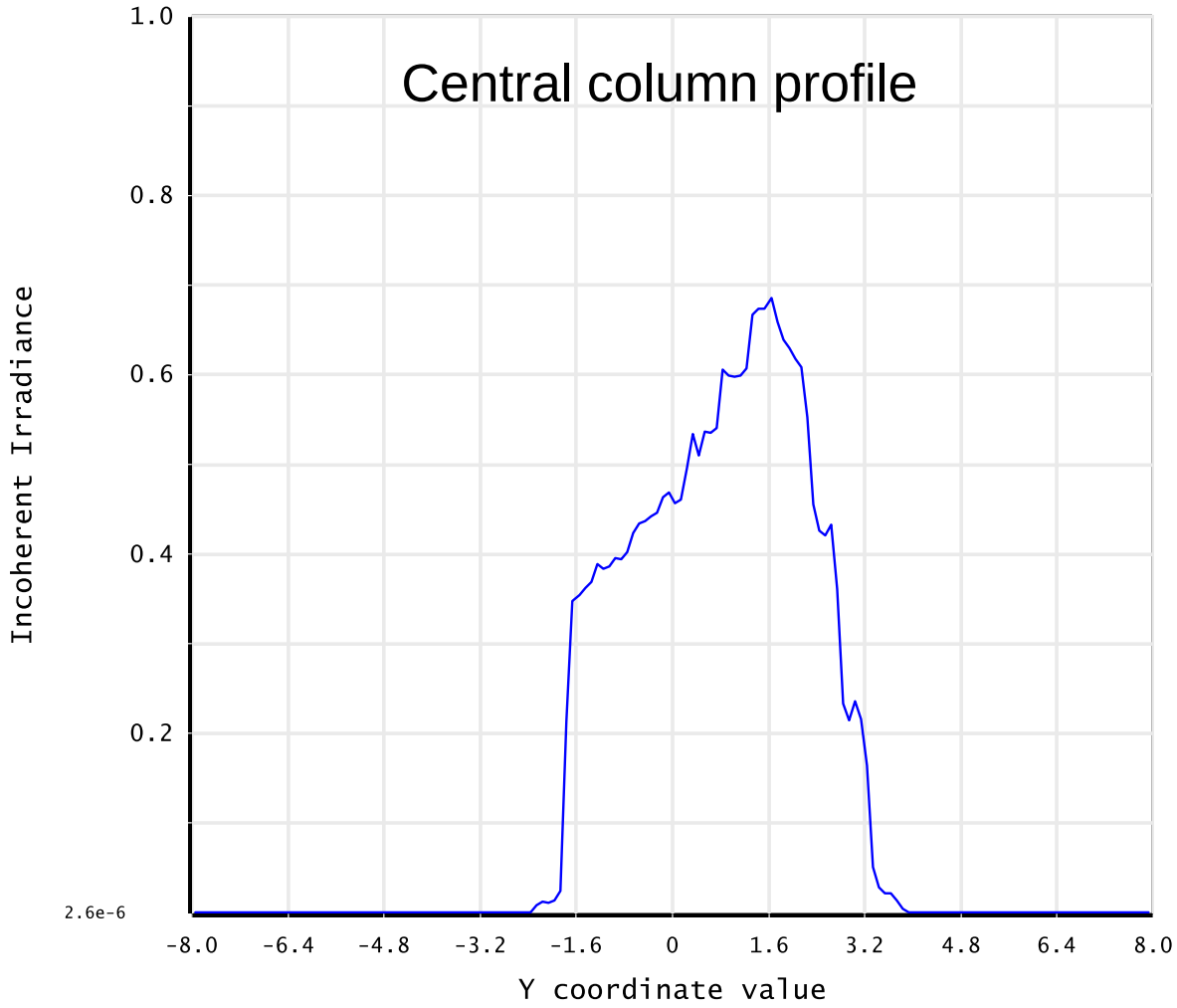


0.5 mm cylindrical slices simulate the energy deposited by the beam.

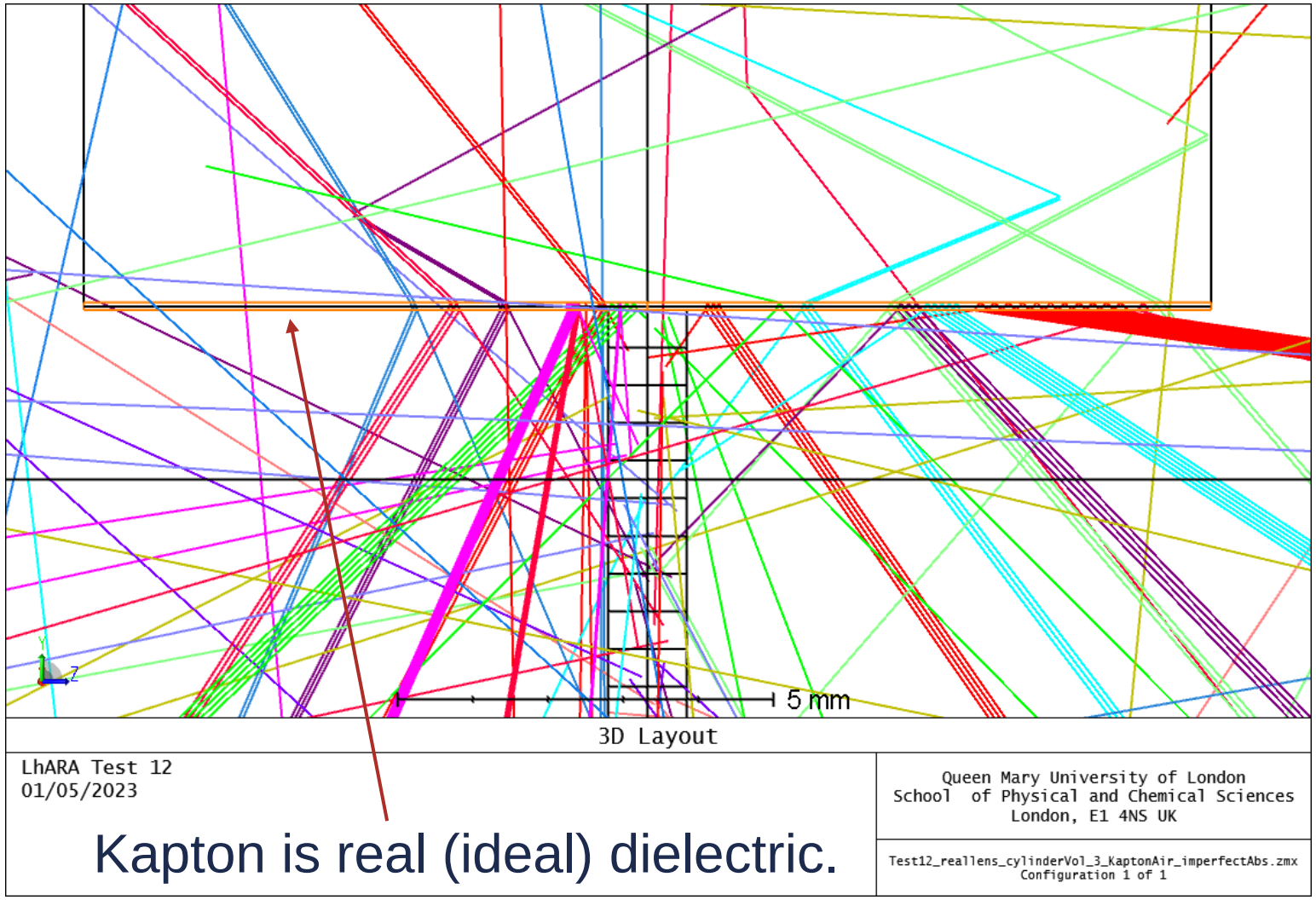
Kapton is made to be 100% absorbing or real or replaced with lower r.i. materials.

“Invisible” Kapton entrance window



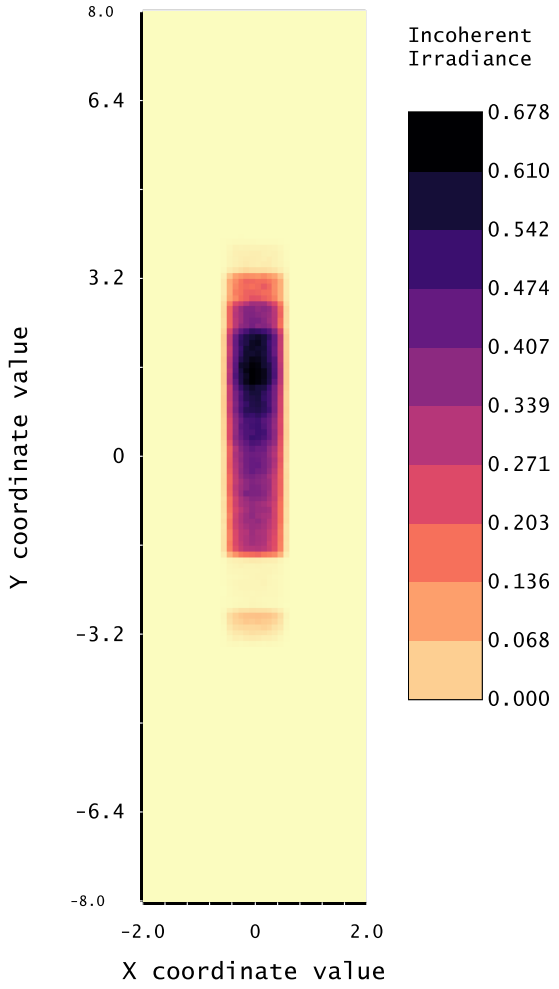


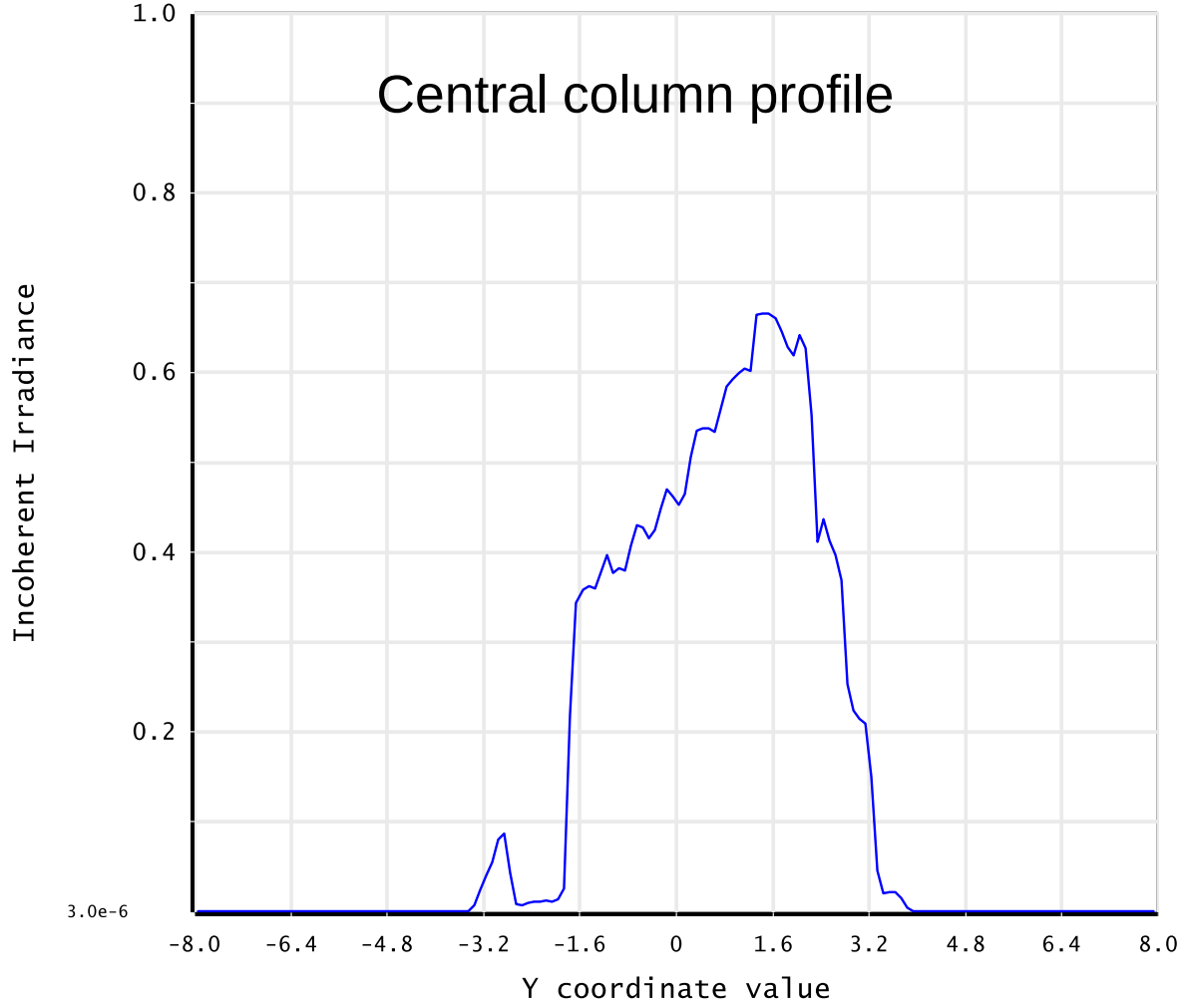
Overall view of simulated system (2)



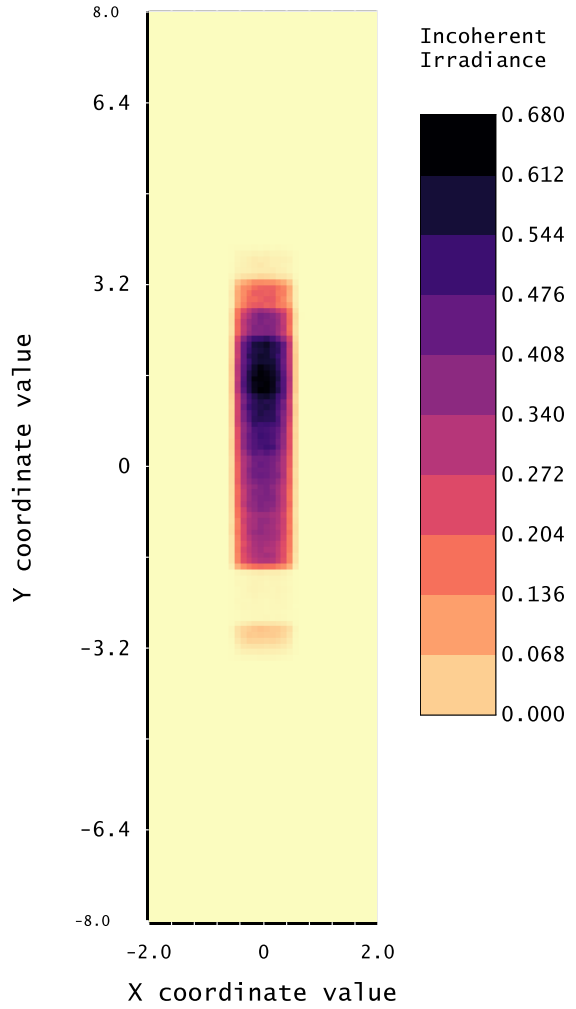
Kapton is real (ideal) dielectric.

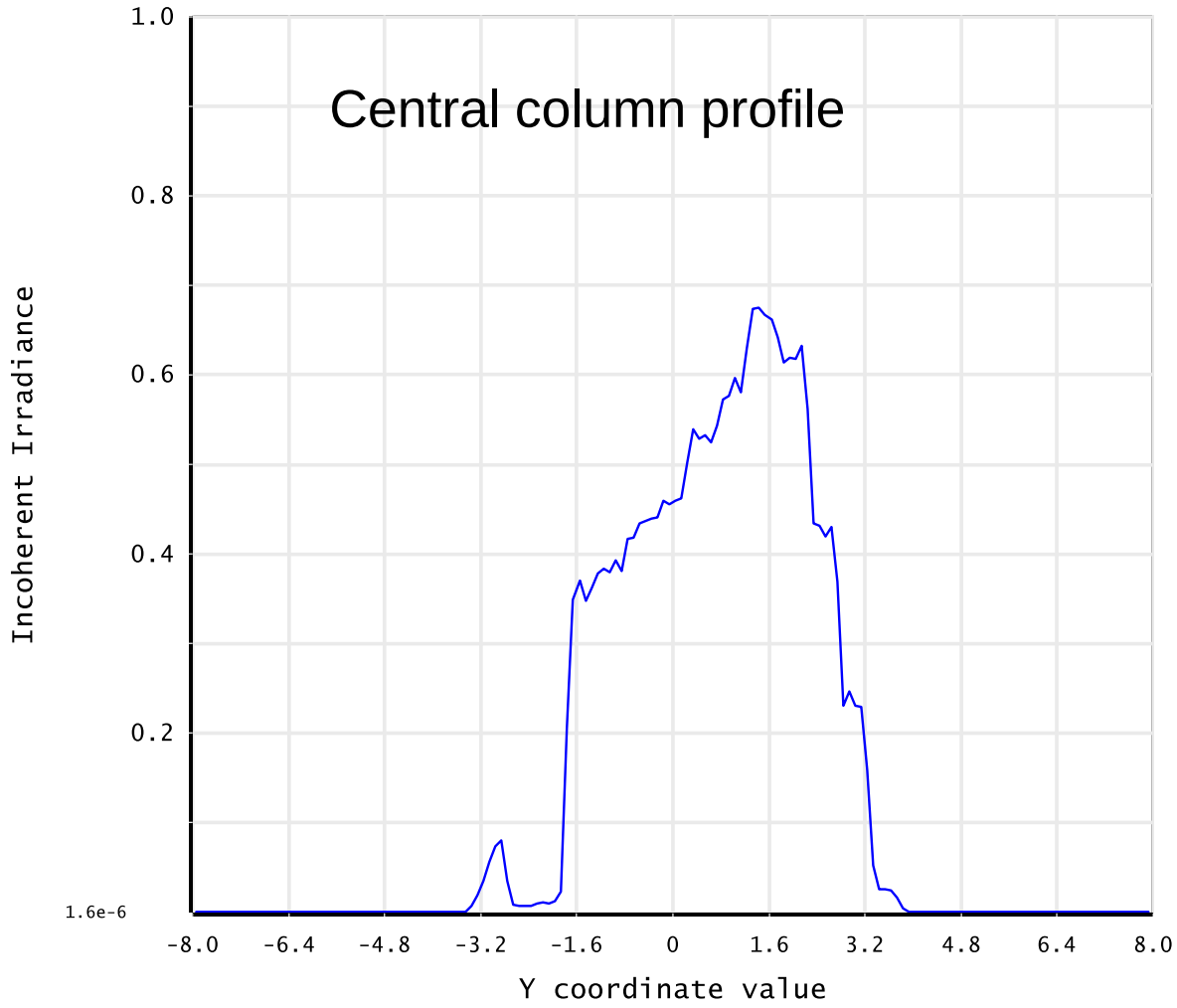
Dielectric Kapton entrance window (n = 1.95)



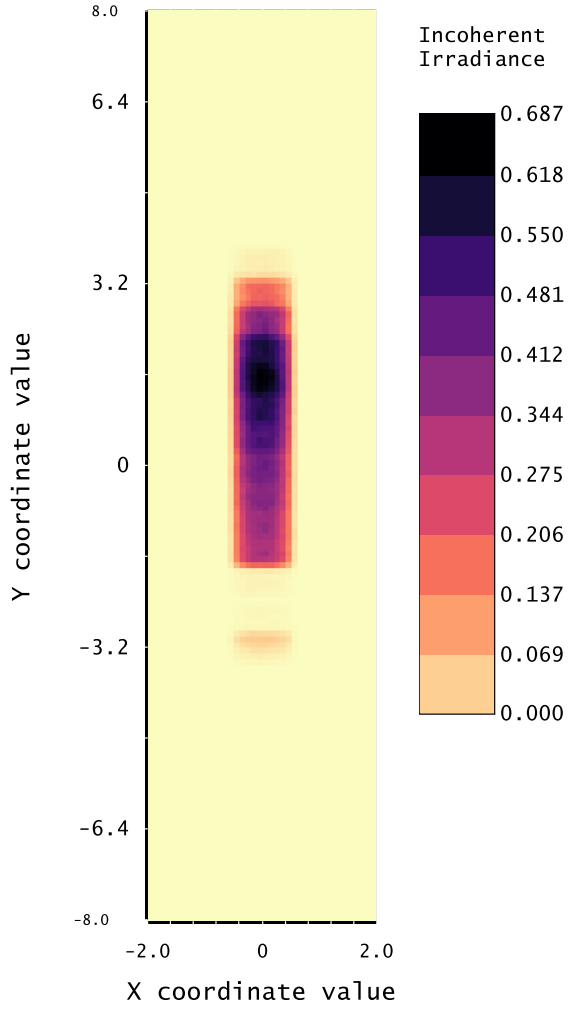


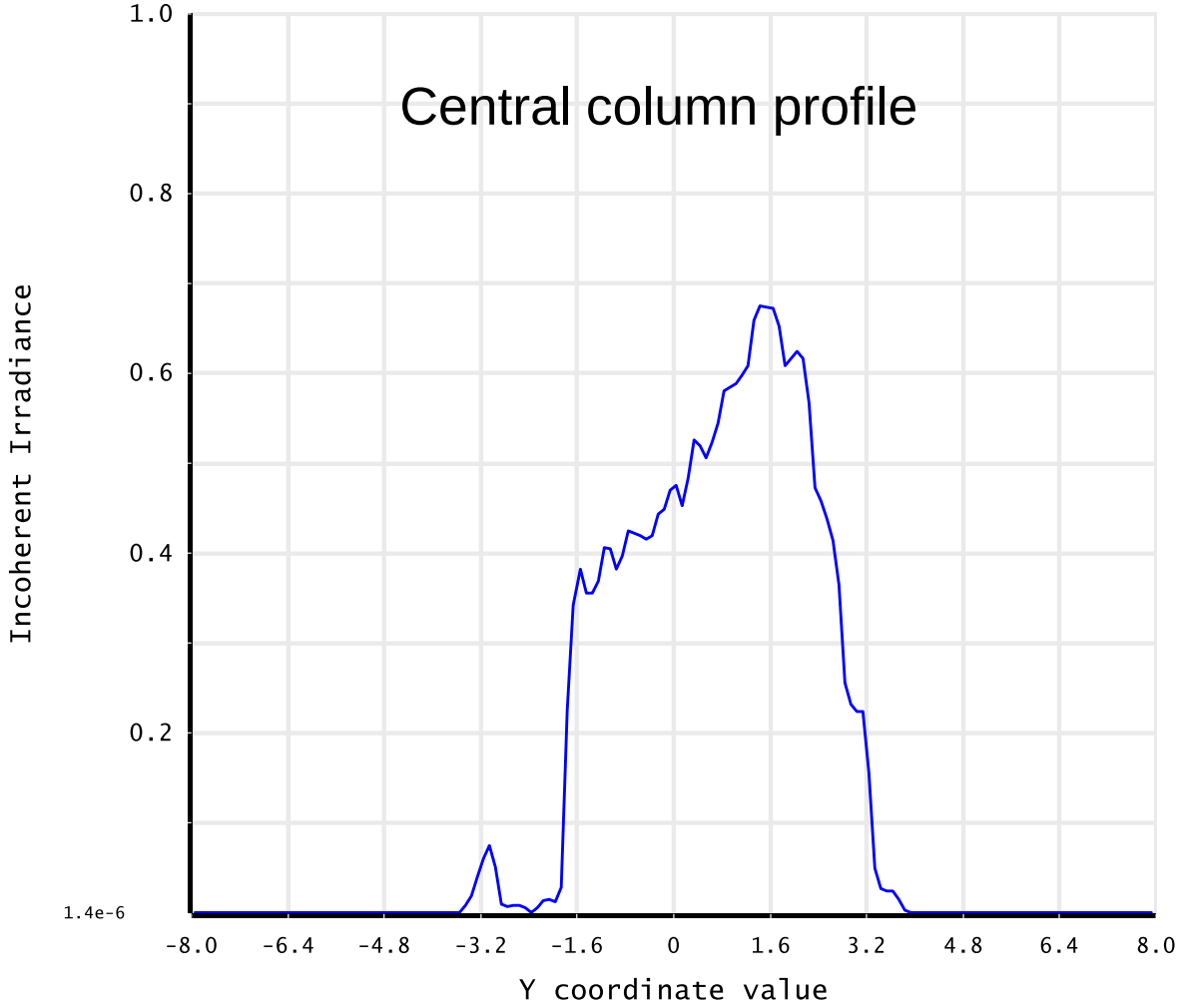
Dielectric BK7 glass entrance window (n = 1.53)



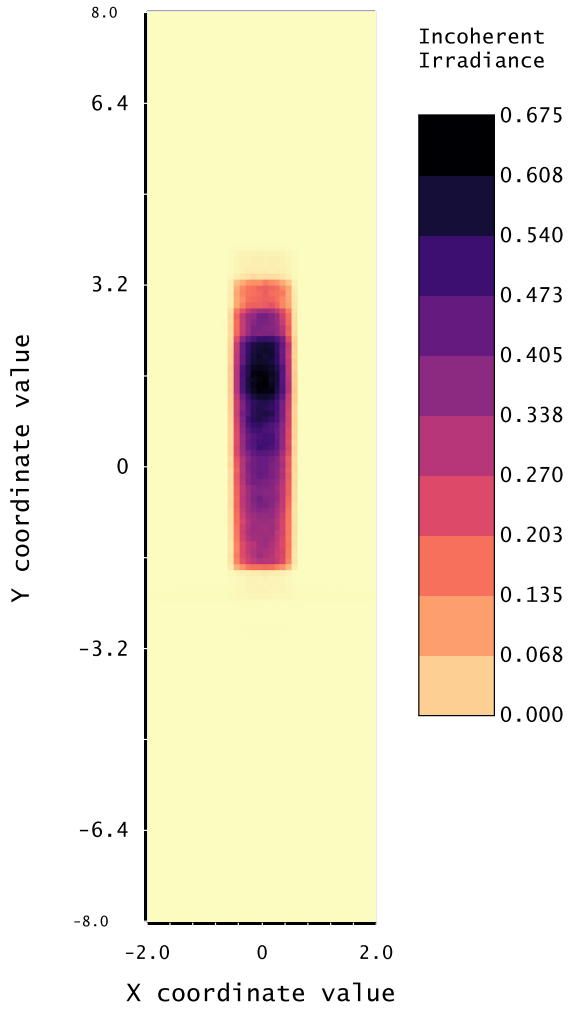


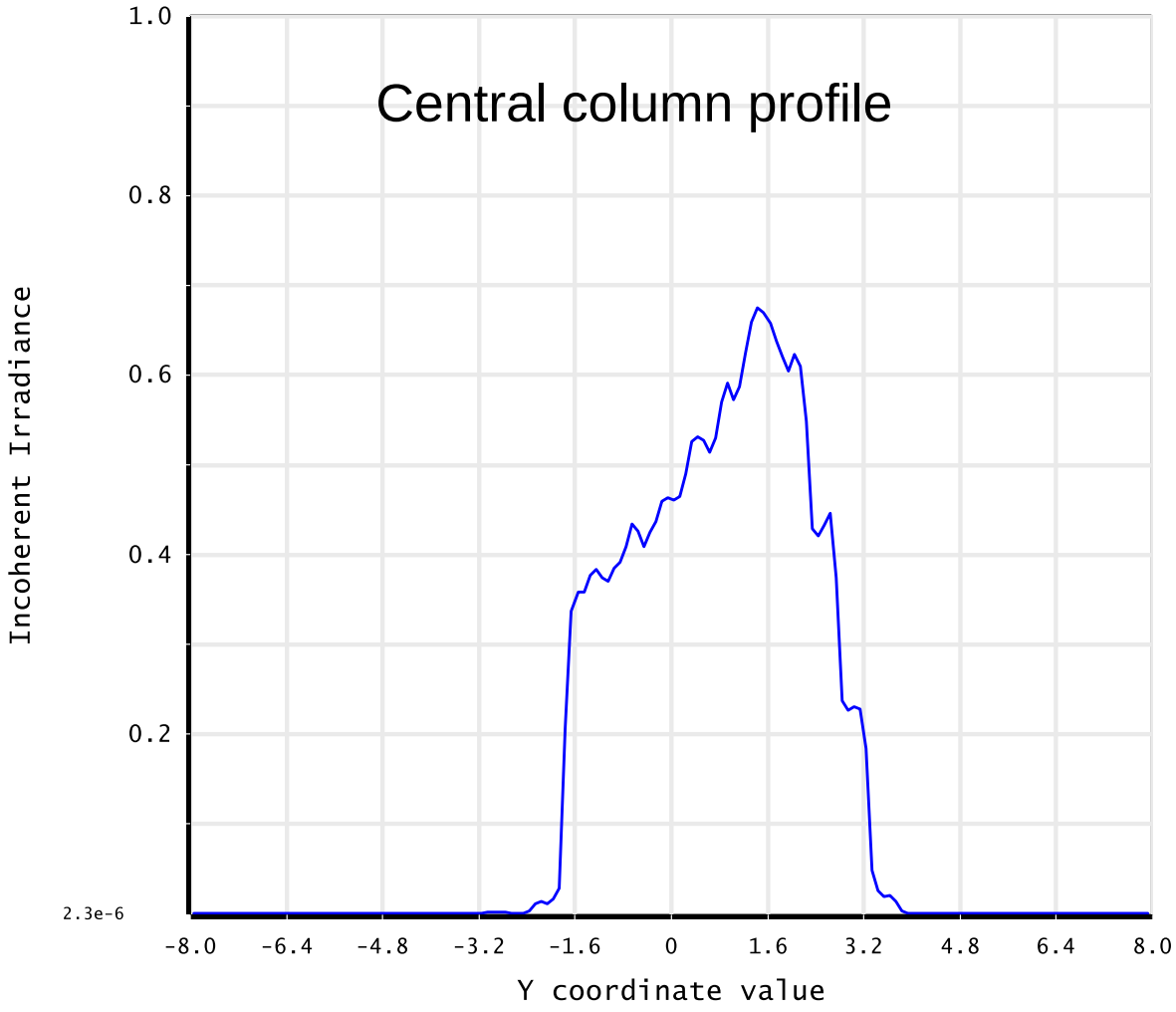
Dielectric water entrance window (n = 1.34)





“Black window” (5% reflecting of which 80% is diffuse)





To do list!

1. Add dark/readout noise from a real camera to the images;
2. Use actual wavelength(s) of WbLS (~ 1000 photons per MeV)*
3. Determine if it matters if the water volume is a cuboid;
4. Add the self-absorption of the scintillation light in the water*.
5. You need to add to this list (in priority order)!

*See for example:

NIMA **660** (2011) 51–56; *NIMA* **967** (2020) 163860; *NIMA* **969** (2020) 163931