Queen Mary University of London
Science and Engineering

LhARA
Laser-hybrid Accelerator for Radiobiological Applications

SmartPhantom: Effect of “Shiny” Black Aluminium

Peter Hobson

Queen Mary University of London, Department of Physics and Astronomy

Last revised 18 September 2025

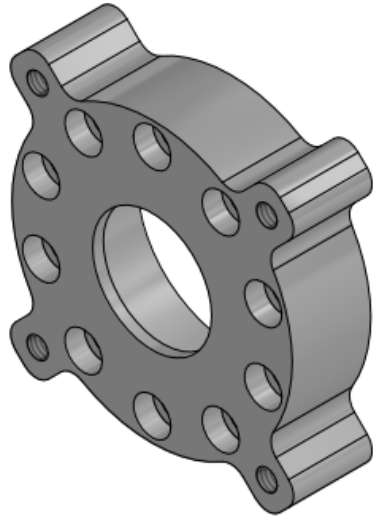
Simulation parameters

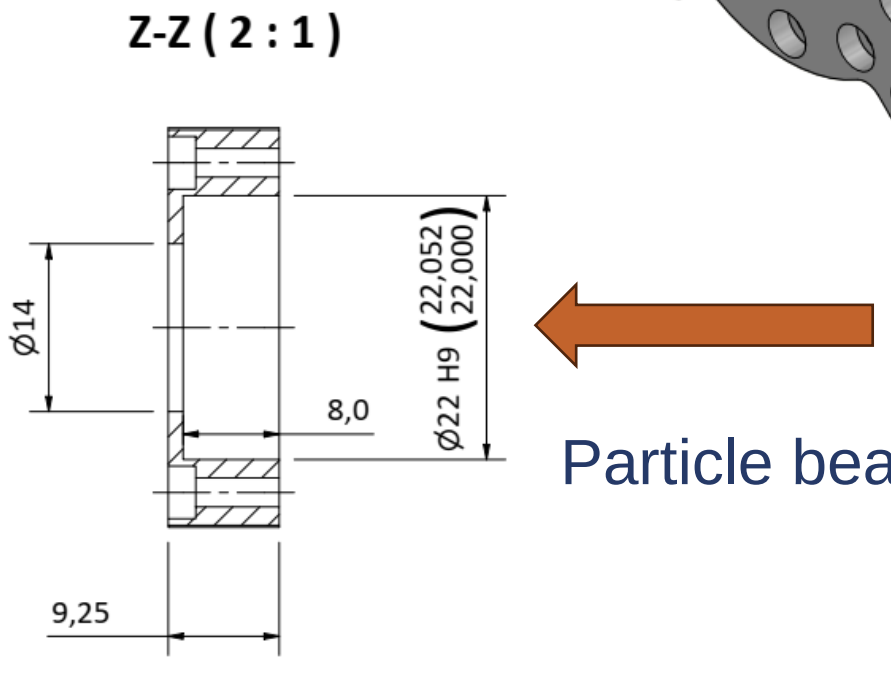
1. SmartPhantom is assumed to contain Ultima Gold XR;
2. Sequential ray tracing is used, 15 million primary rays traced;
3. Imaging optics are pairs of achromatic doublet lenses (as used at LION);
4. The emitting cylinder is 1.0 mm in diameter divided into 15 longitudinal segments each 0.5 mm long;
5. Simulations use **Ansys ZEMAX OpticStudio Pro 2025R1** (PC is an i5 6/12 core @4.6 GHz peak with 32 Gbytes of 3200 MHz DDR4 memory);
6. Data shown for a weighted set of wavelengths from 406 nm to 525 nm.
7. The data are shown in camera coordinates not object coordinates.

Occluding effect of “Beam Window Seal Mk II”

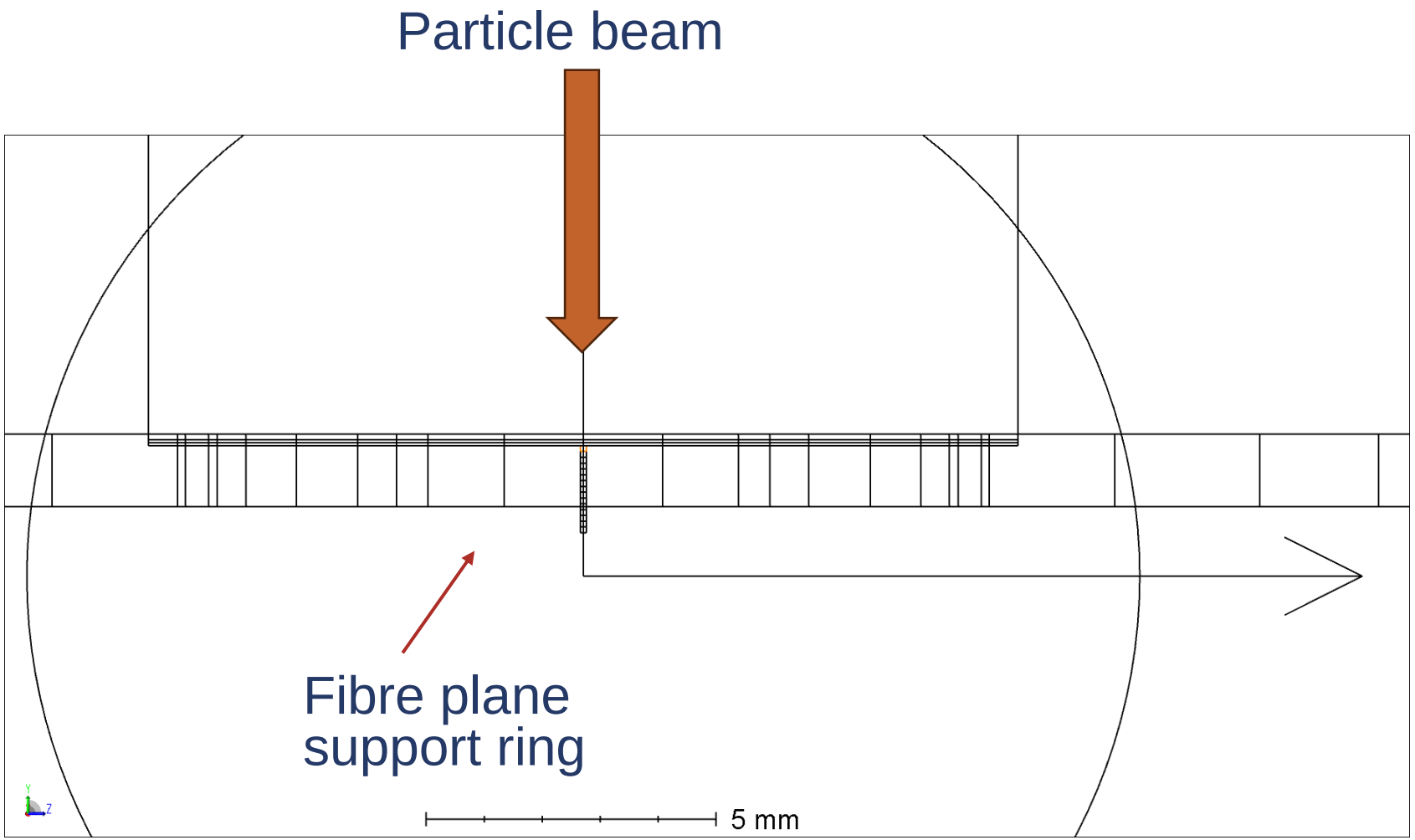
This item (drawing #M1024-025) provides a seal for the Kapton™ beam entrance window & is the support for the fibre planes.

It is black anodised aluminium, which is not shot blasted.



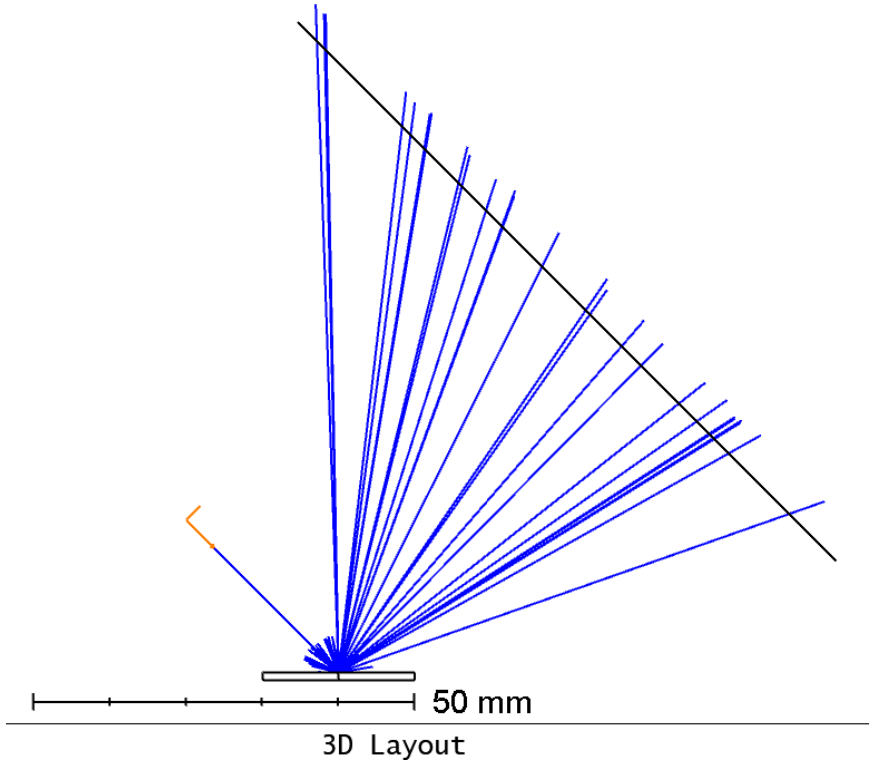


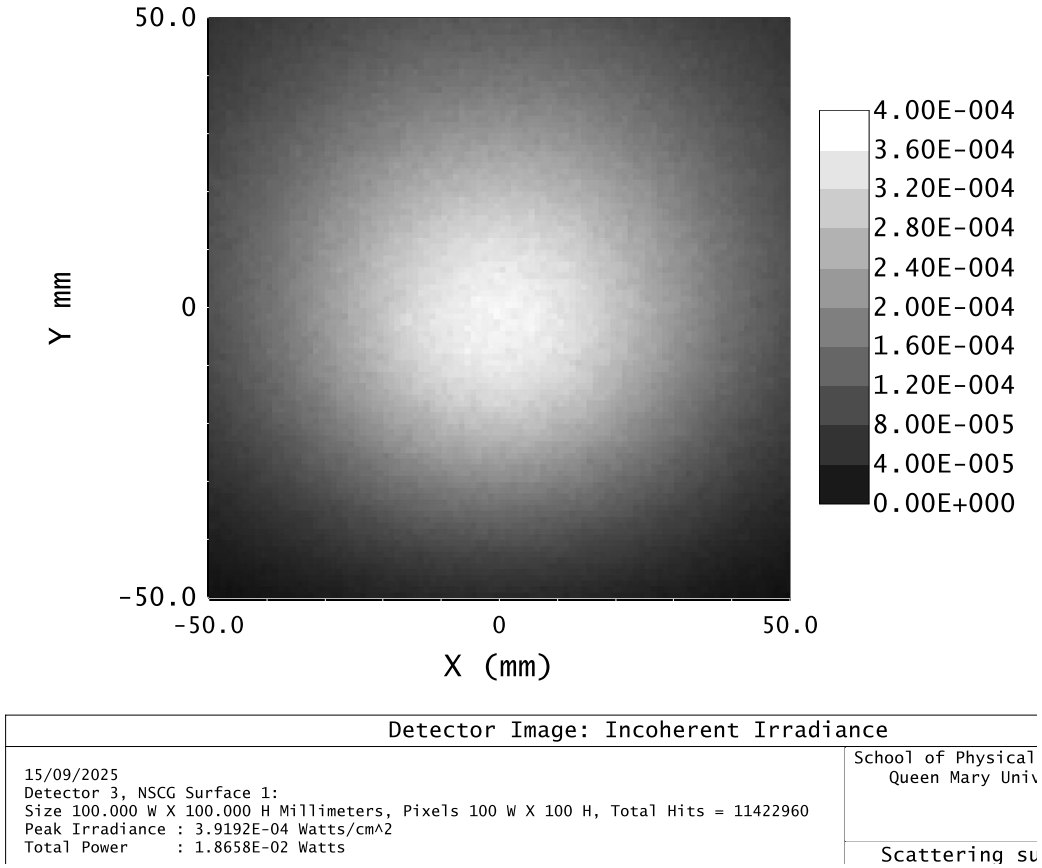
Occluding effect of “Beam Window Seal Mk II”



Scattering from a Lambertian Surface

Scattering surface is “black aluminium”, 95.1 % absorbing. Total power from point source is 1.0 W. All light reflected is via Lambertian scattering



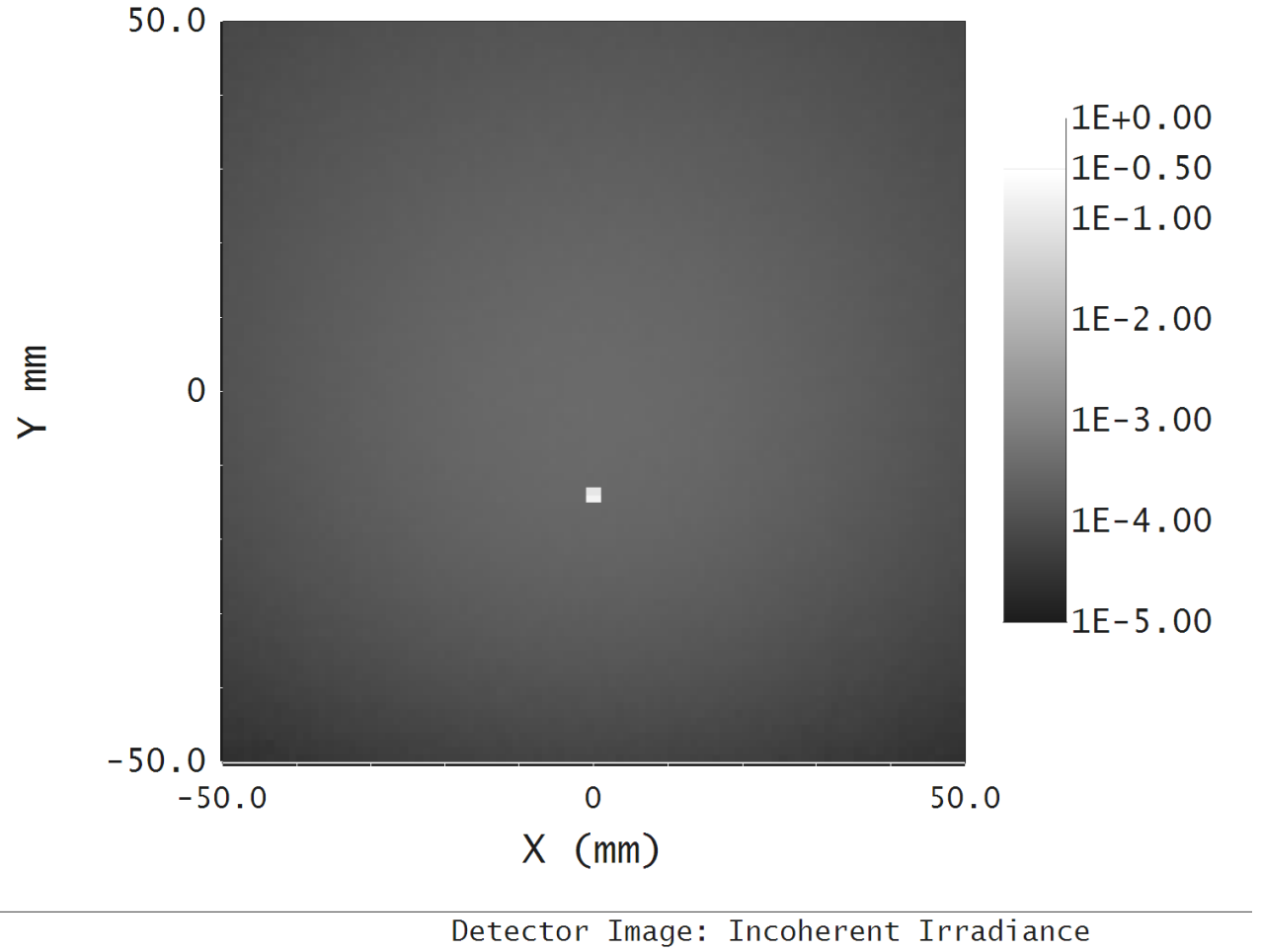


Scattering from a Lambertian Surface

Scattering surface is “black aluminium”, Total power from point source is 1.0 W

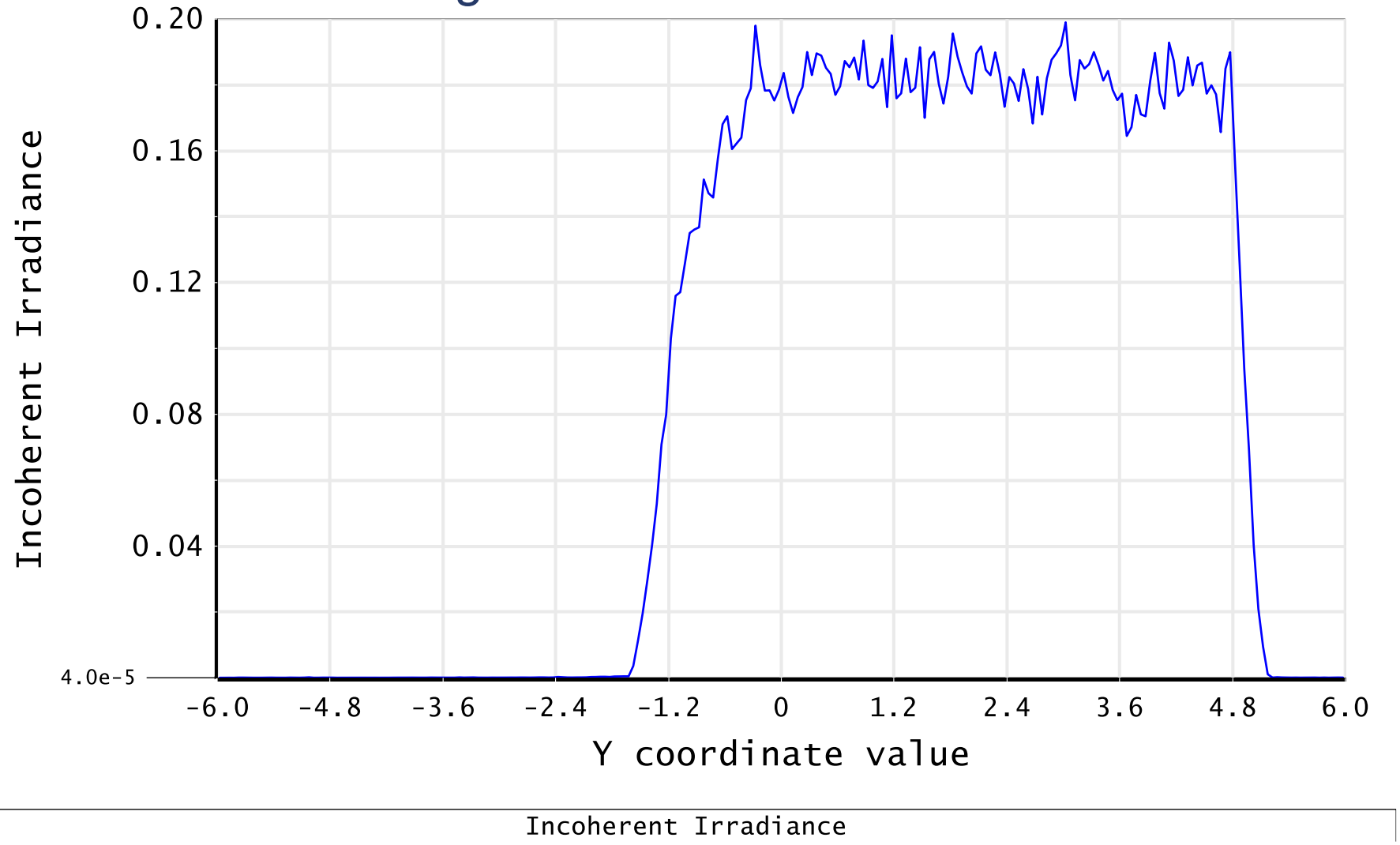
Here 5% of the light that is **not absorbed** is specular reflected and 95 % of non-absorbed light is Lambertian scattered.

Note the logarithmic irradiance ($W.cm^{-2}$) scale



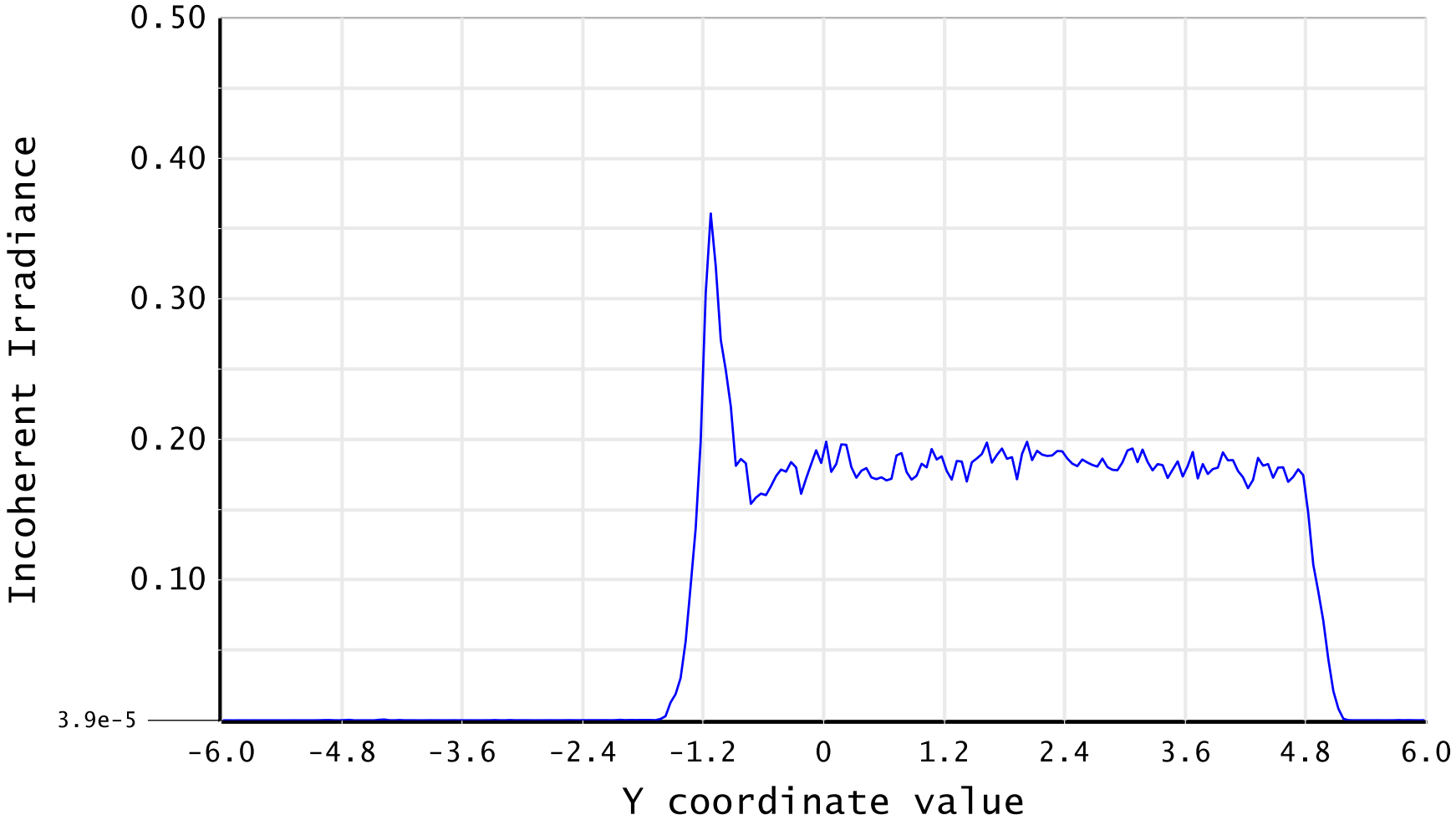
Support Ring – Diffuse Black Aluminium

All ring surfaces “black aluminium”



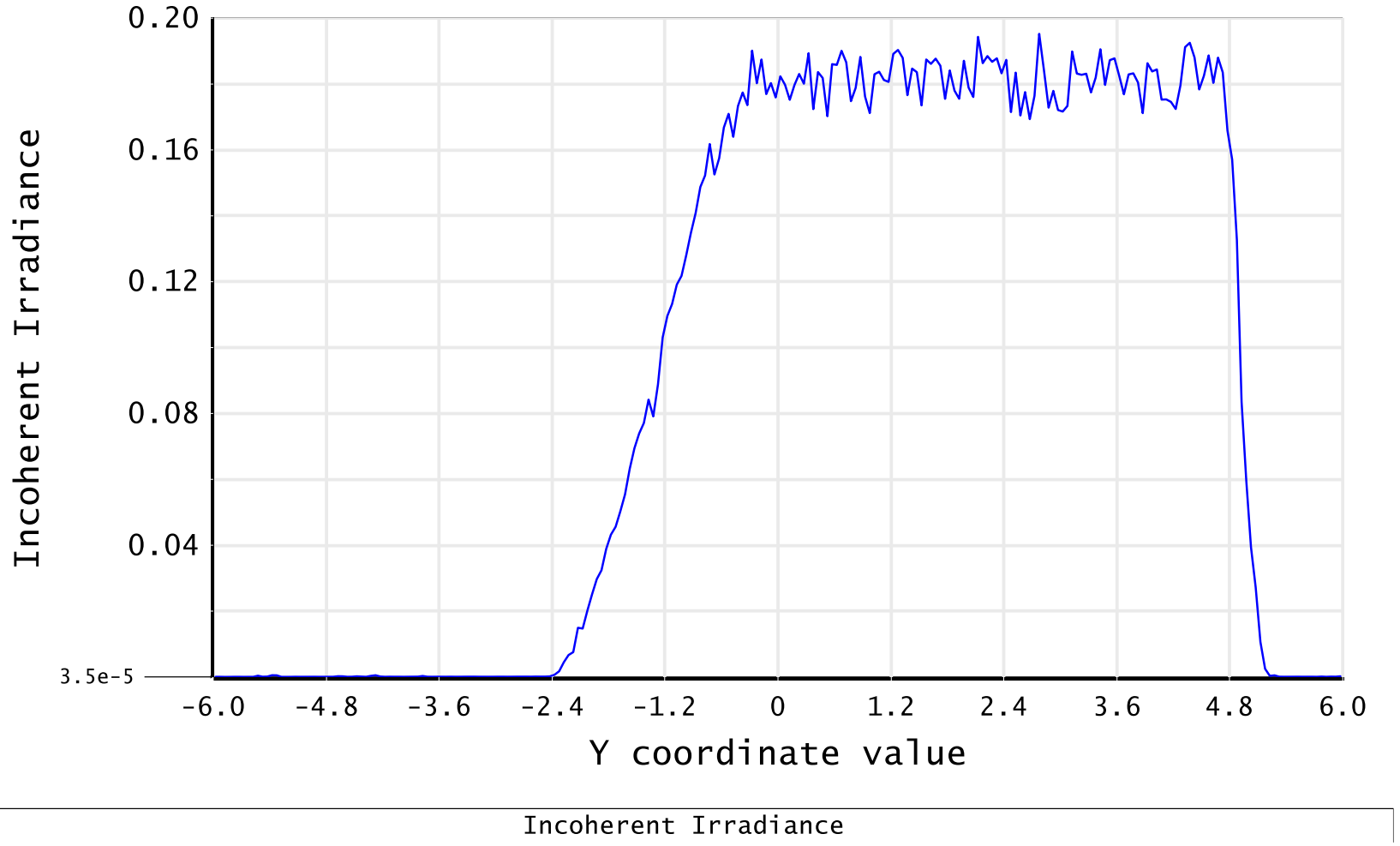
Support Ring – Inner ring 100% R

All other surfaces “black aluminium”

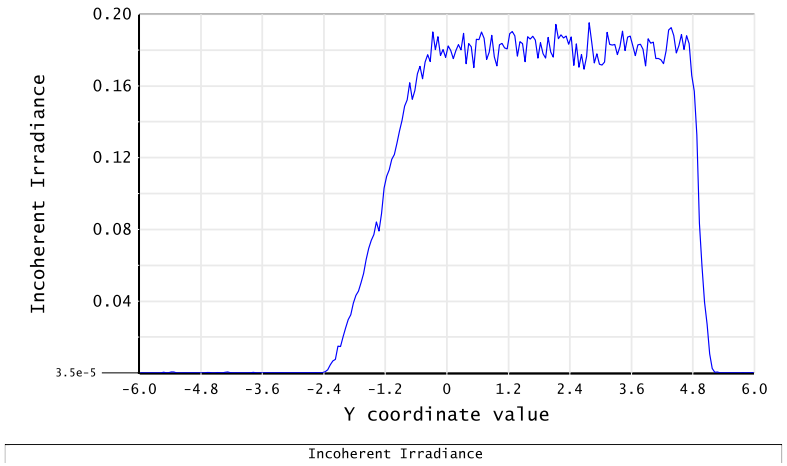


Support Ring – Outer faces 100% R

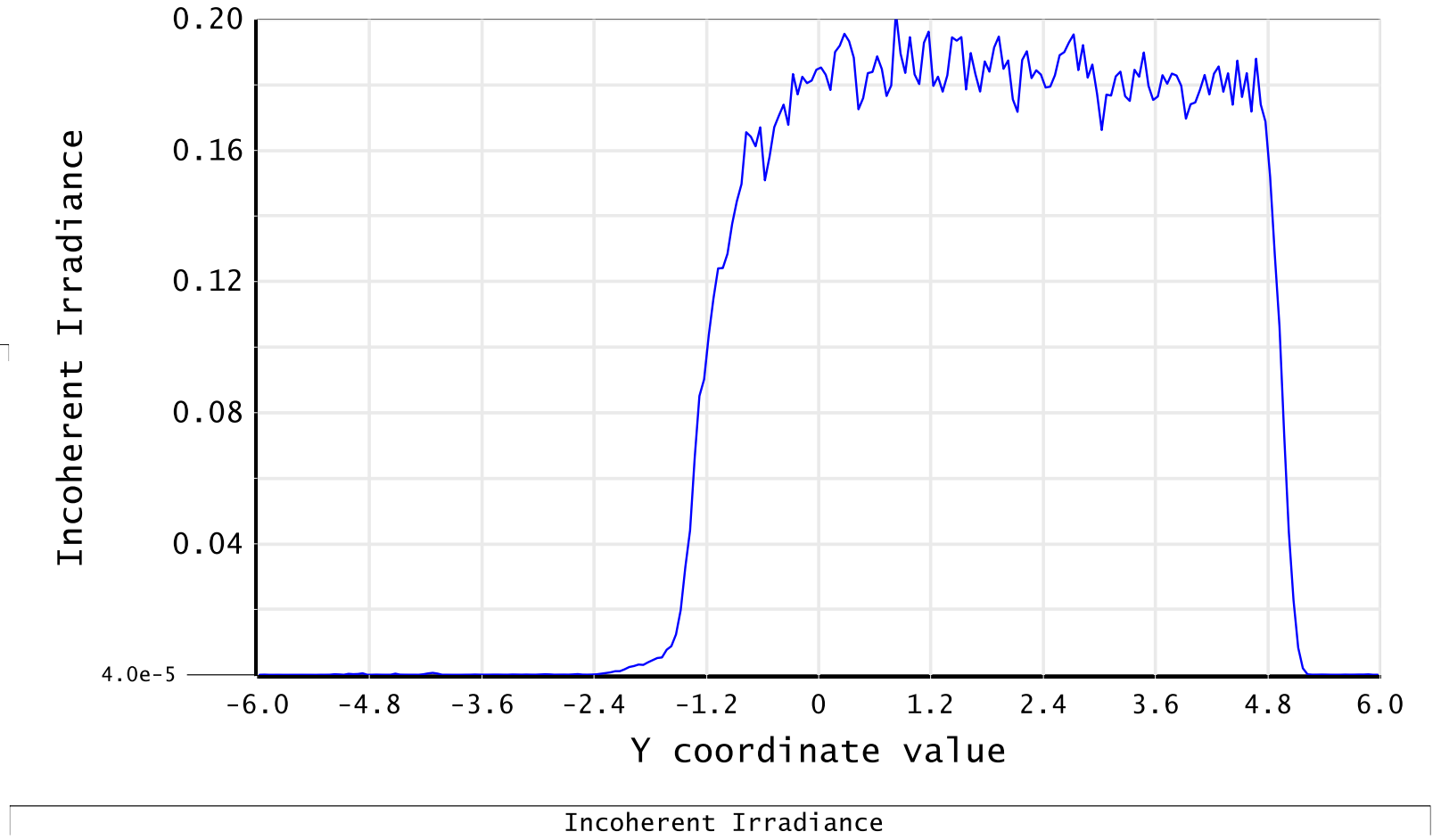
Inner surface “black aluminium”



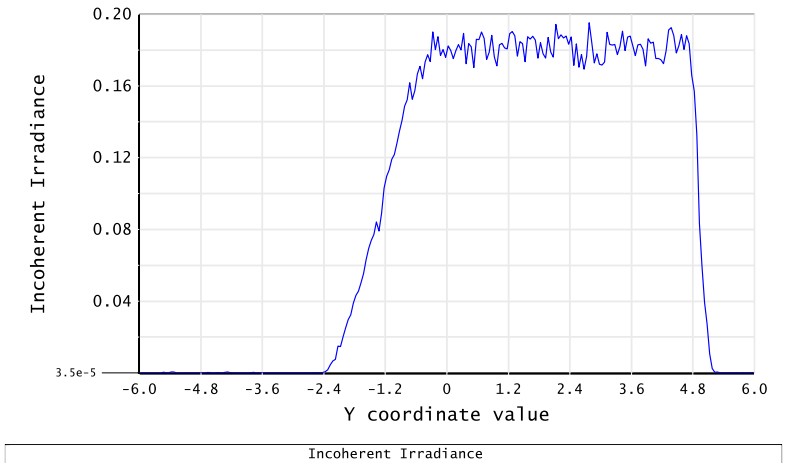
Support Ring – Outer faces “black”, with 90% scatter, 10% specular



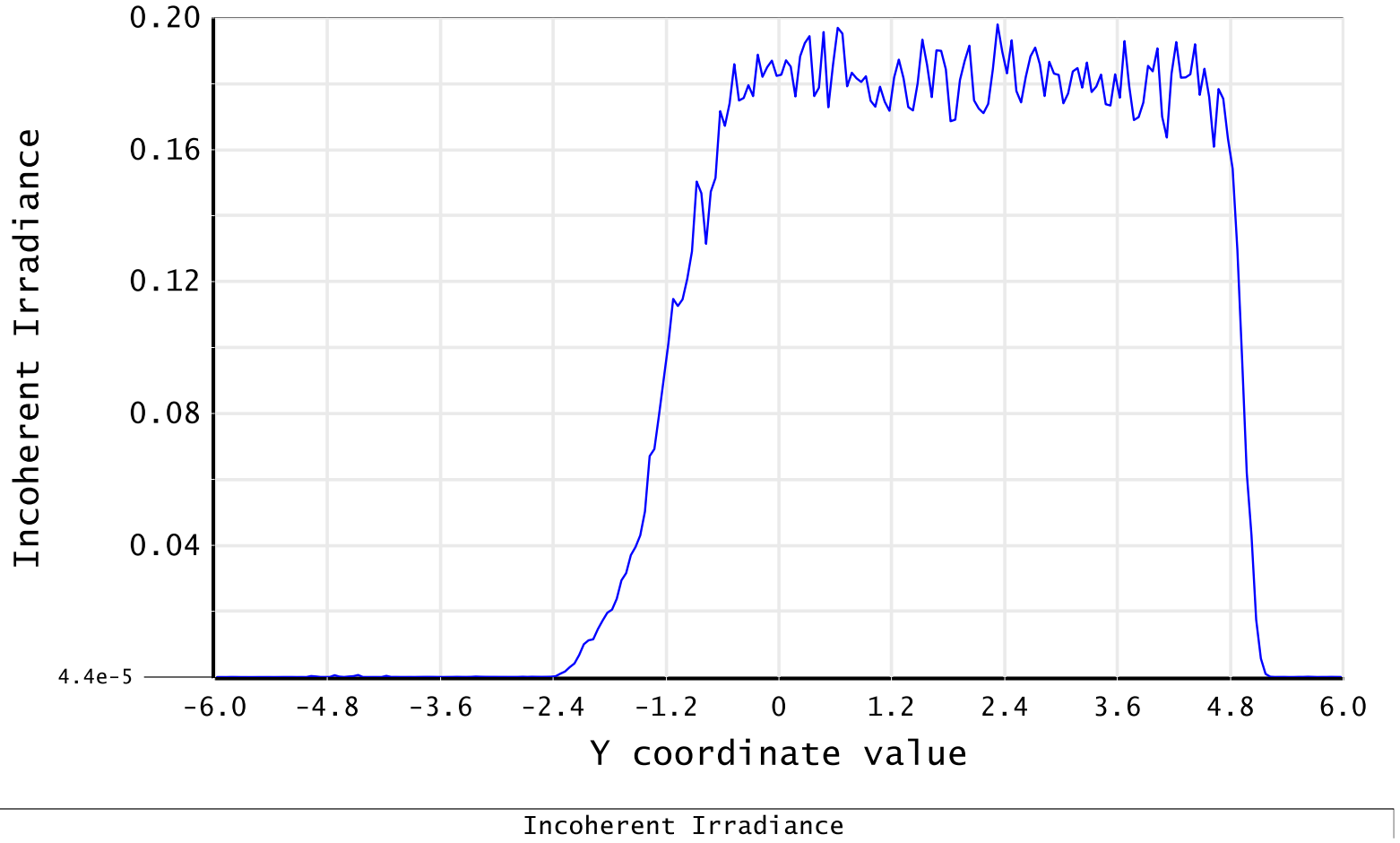
Inner surface “black aluminium”, Outer 100% reflecting



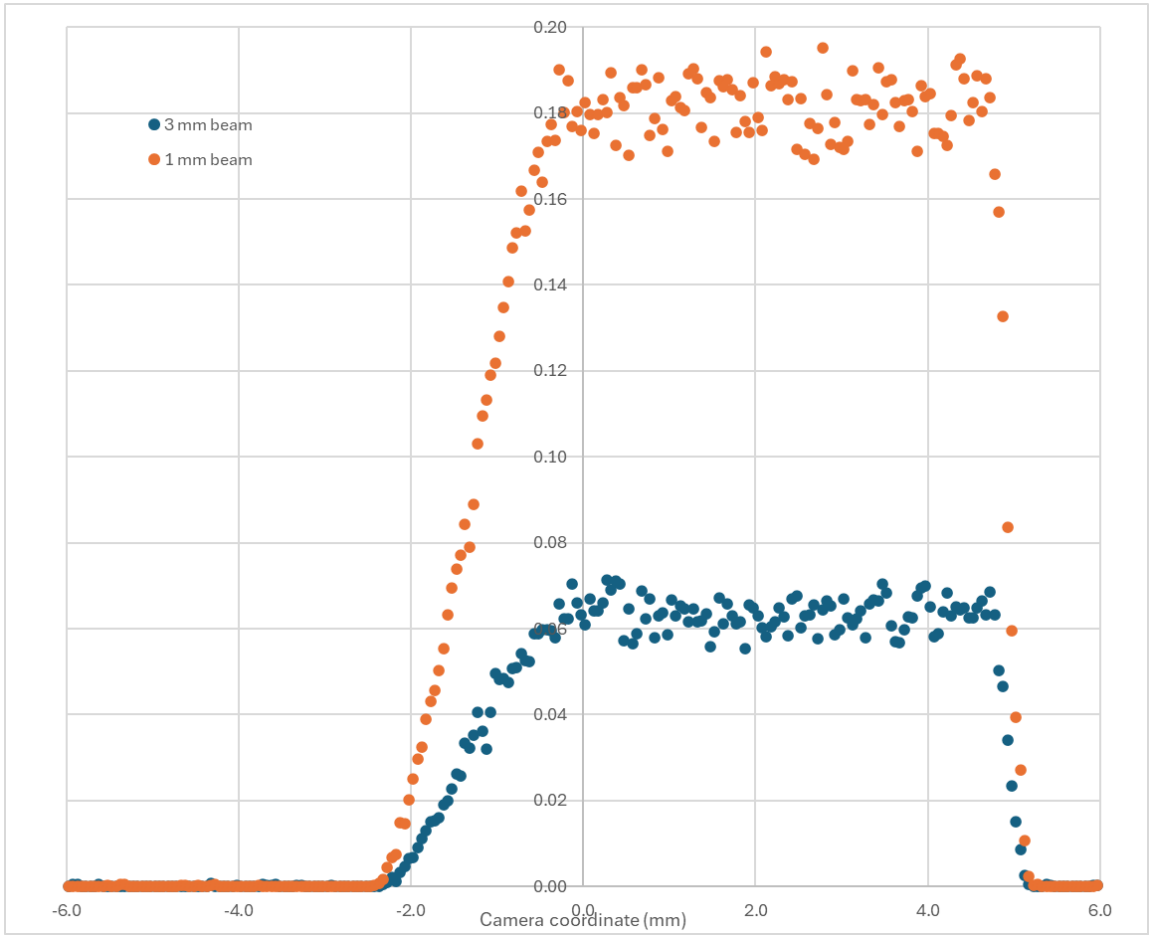
Support Ring – Outer faces “black”, with 50% scatter, 50% specular

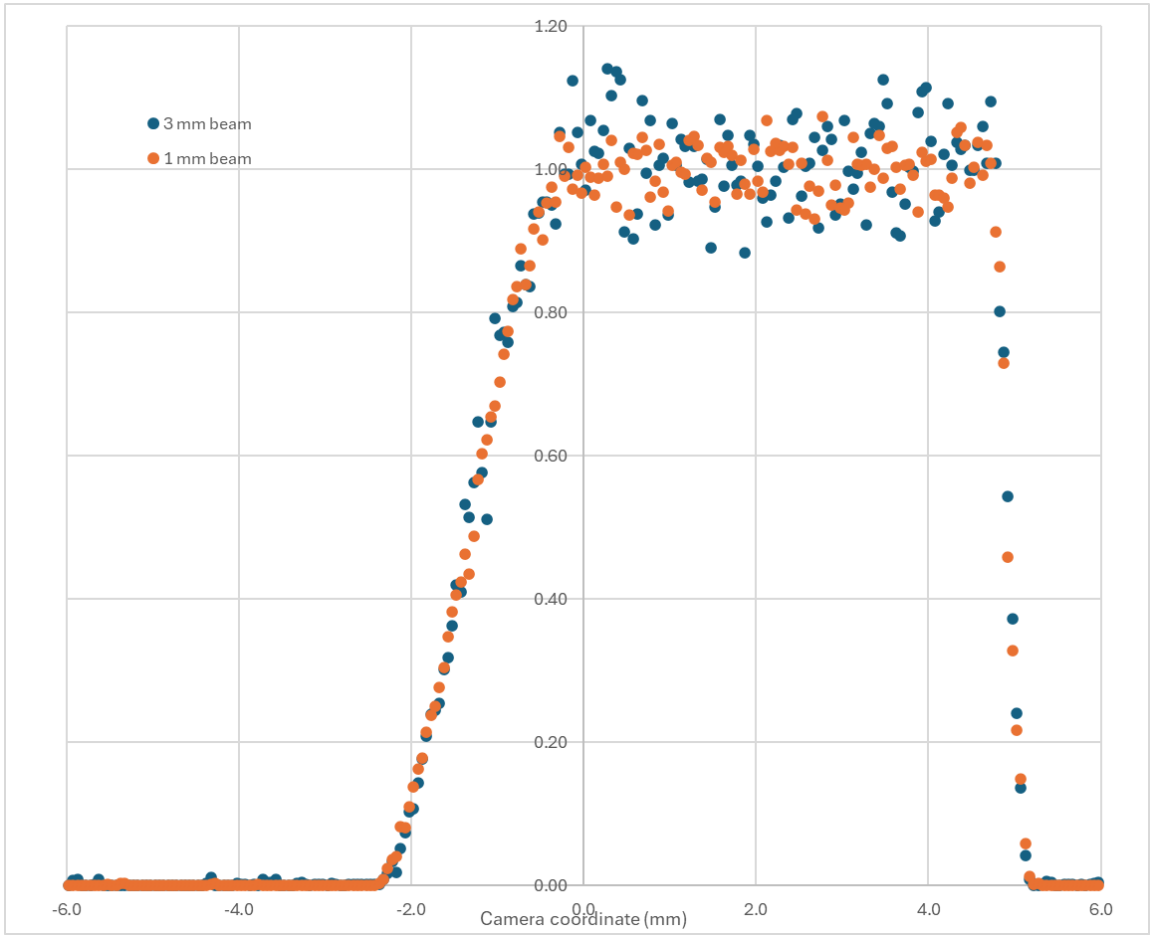


Inner surface “black aluminium”, Outer 100% reflecting



Support Ring – Effect of Beam diameter





Outer faces of ring are 100% R, inner face of ring is “black aluminium”

LH plot shows the “raw” data, RH plot shows data normalized to the mean in [1,3]

What next?

Measure the actual reflectance (specular and diffuse) of the support ring.

Continue lab work to measure the effect in the real SmartPhantom.