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3D HEAT FLUX COMPARATIVE MAPPING STUDY

C²I²

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600W White and Black SFEH elements

The other two SFEH elements were both Ceramicx 600W but in this case the differences between white and black glazes are compared. From Figure 5 and Figure 6, both samples have similar shaped hemispheric profiles vertically and horizontally. However the heat flux intensity profiles are not of similar magnitudes, the white heater showing less IR emission. In the case of the white element, the 0.7-0.8W/cm2 band (brown) measures around 35mm horizontally and vertically and projects to around 115mm into the Y axis (from the heater surface).

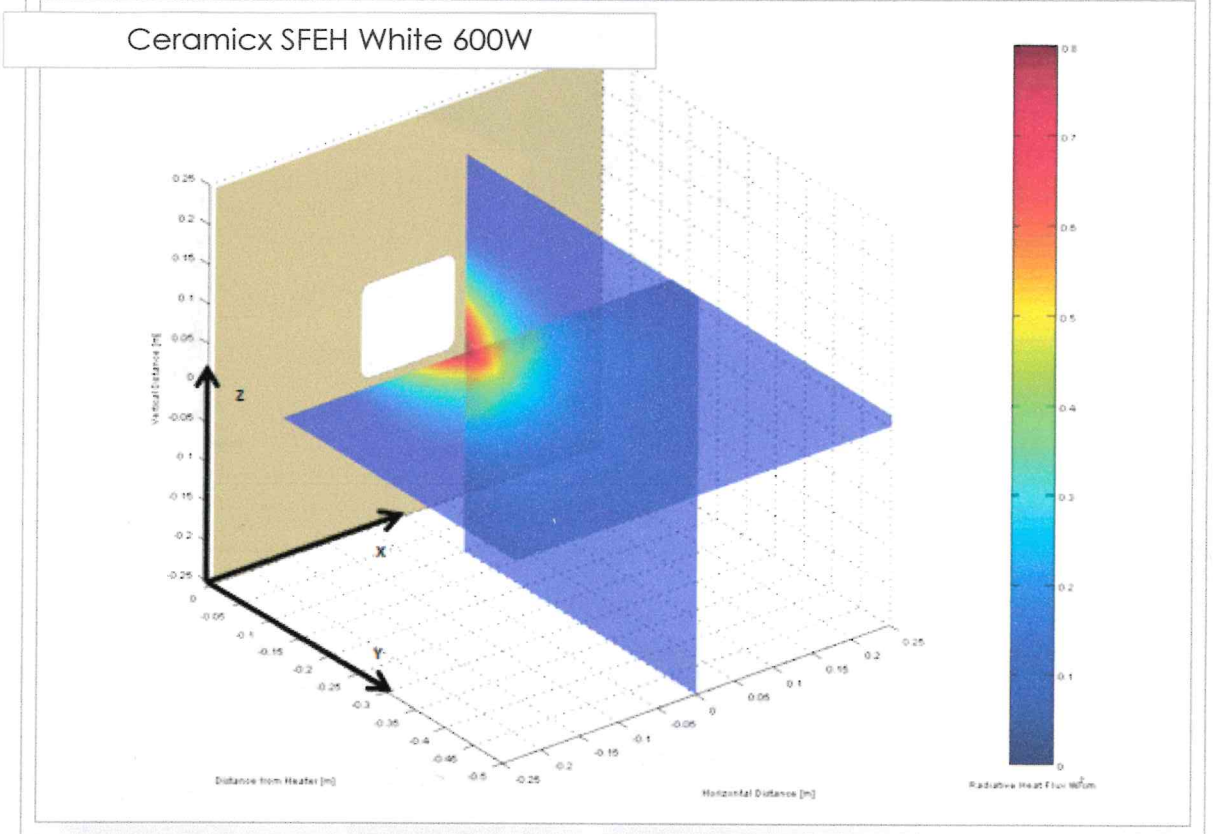

Figure 5: Ceramicx White SFEH 3D heat flux profile, 600W

Contrastingly, the black heater element IR projection in the 0.7-0.8W/cm2 band is almost double in extent, measuring approximately 70mm vertically and horizontally at the same distance of 100mm, and this band also extends up to 125mm into the Y axis from the heater surface. The close ups in Figure 7 show the superior performance of the black surface over the white surface.

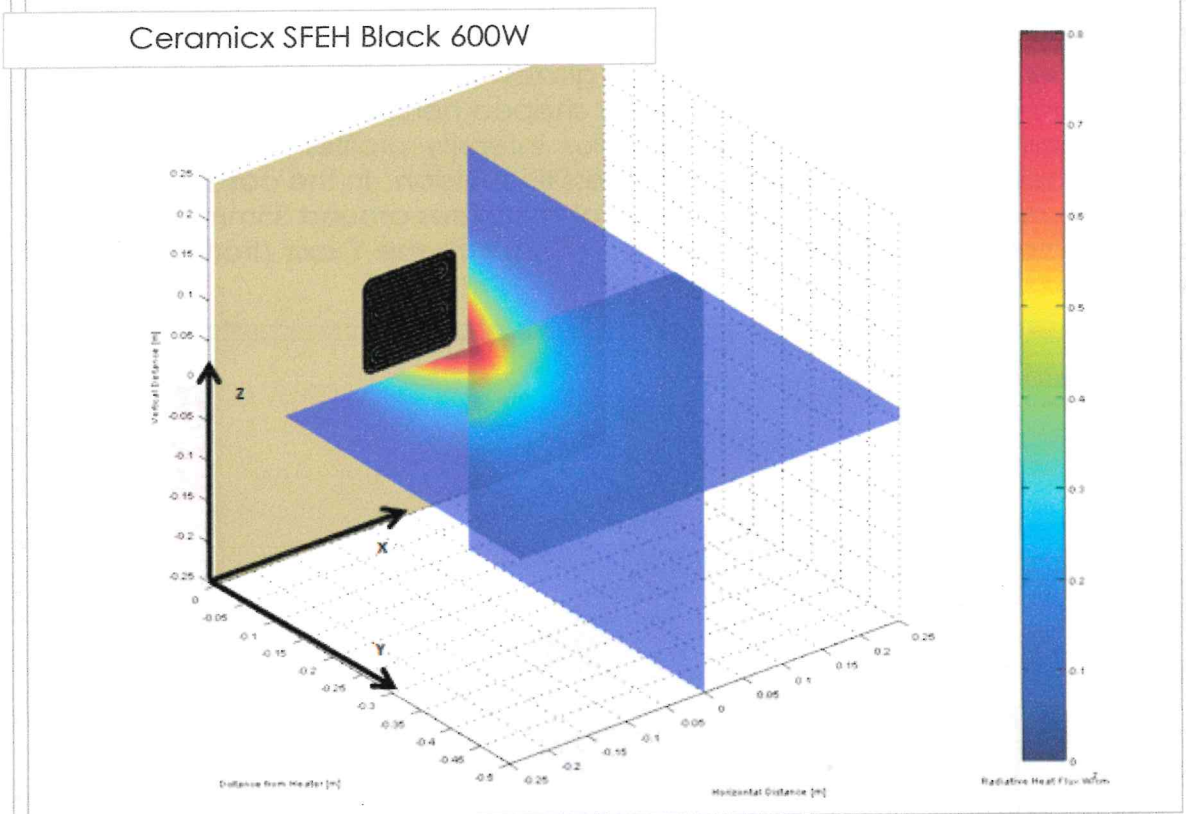

Figure 6: Ceramicx Black SFEH 3D heat flux profile, 600W

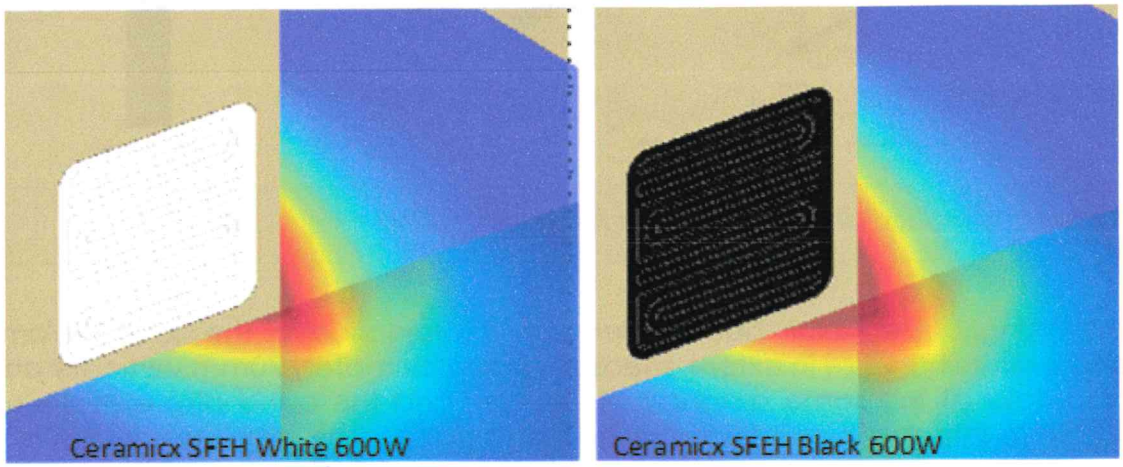

Figure 7: Close ups of Ceramicx White and Black SFEH 3D heat flux profiles, 600W

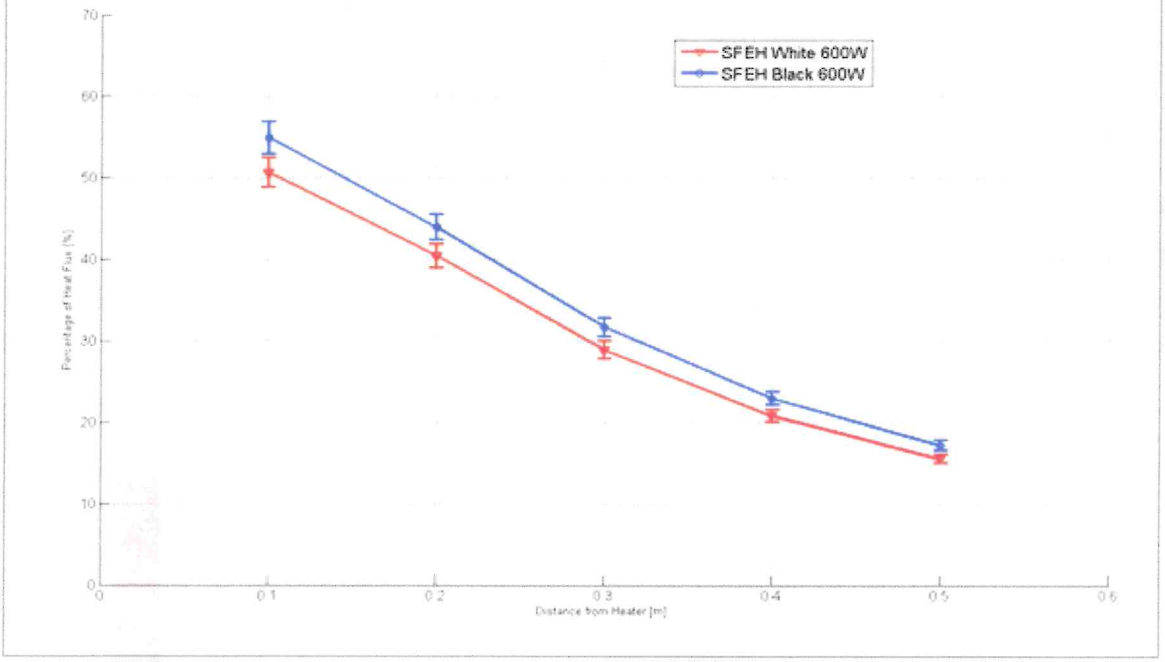

Figure 8: Measured IR heat flux as a percentage of input power for Ceramicx Black and White SFEH elements

When one looks at the percentage of IR radiated over the electrical power input in Figure 8, again at Y=100mm, the black element radiates almost 55% of the input power of 600W compared to 50.7% of the white element. The black element performs better than the white also with increased distance up to 500mm. In general terms the black element can be thought to perform around 8% better than the white element. The precise reasons for this difference in the performance of black and white elements are currently under investigation.

FFEH Full Flat Element Hollow

In this test, four hollow full flat elements were compared. Two elements are Ceramicx, one white, the other black. The other two elements are equivalent competitor's models, again one white and one black. All are 800W/230V and the grid is 500mm x 500mm x 500mm. The X and Z axes are in 21 increments of 25mm, while the Y-axis is in 5 steps of 100 to 500mm from the element surface. Again, a minimum of 100mm is maintained from the element surface to protect the IR sensor.

FFEH White

Both samples tested at 800W are broadly similar in performance. The vertical and horizontal heat flux intensity profiles are of similar magnitudes.

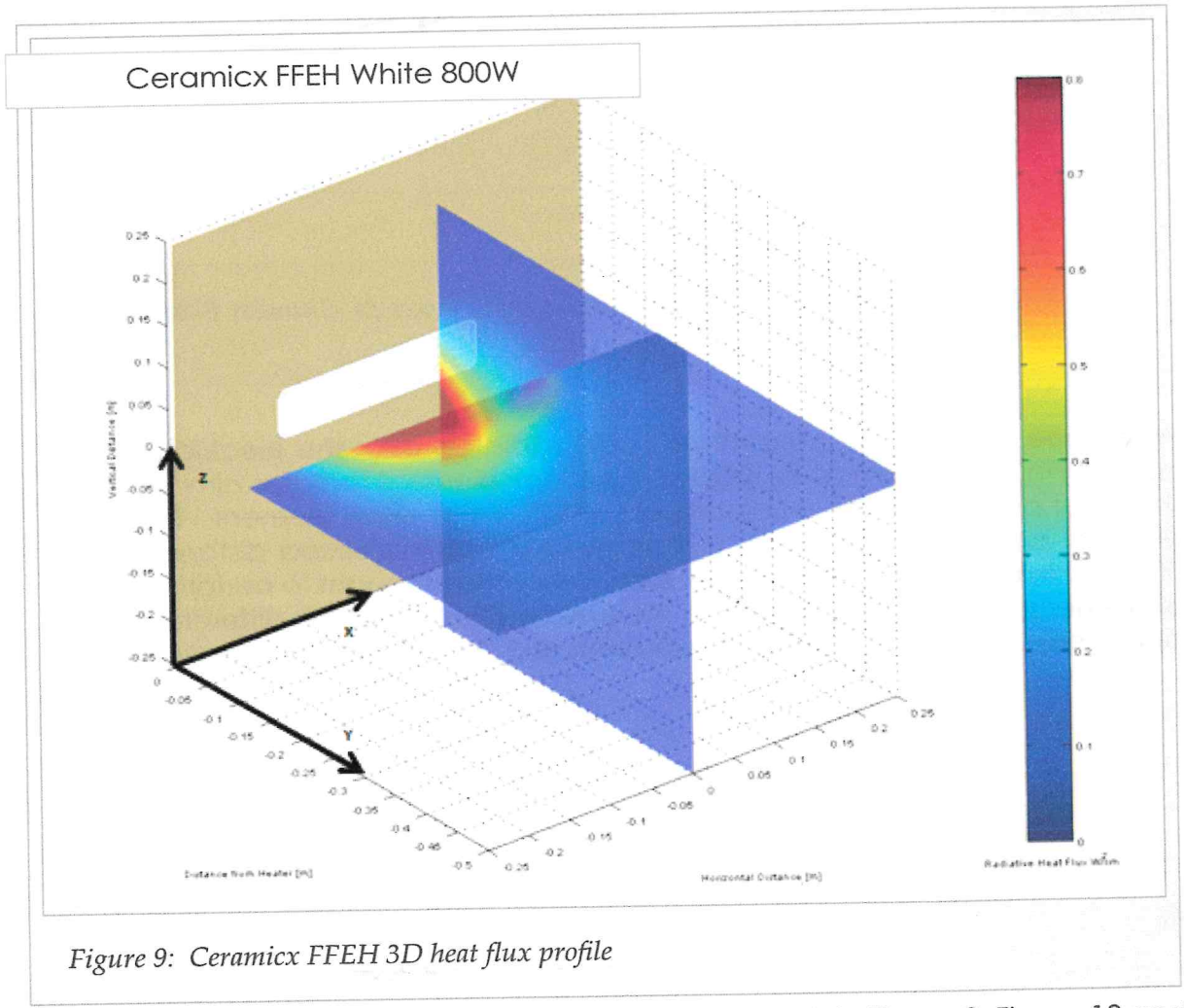

Figure 9: Ceramicx FFEH 3D heat flux profile

Comparing the radiant profiles of both white elements in Figure 9, Figure 10 and the close ups in Figure 11, their IR outputs are almost identical. The extent of the 0.5W/cm2 zone (yellow band) measures the same in both cases, extending to approximately 250mm horizontally at a distance of 100mm from the heater element.

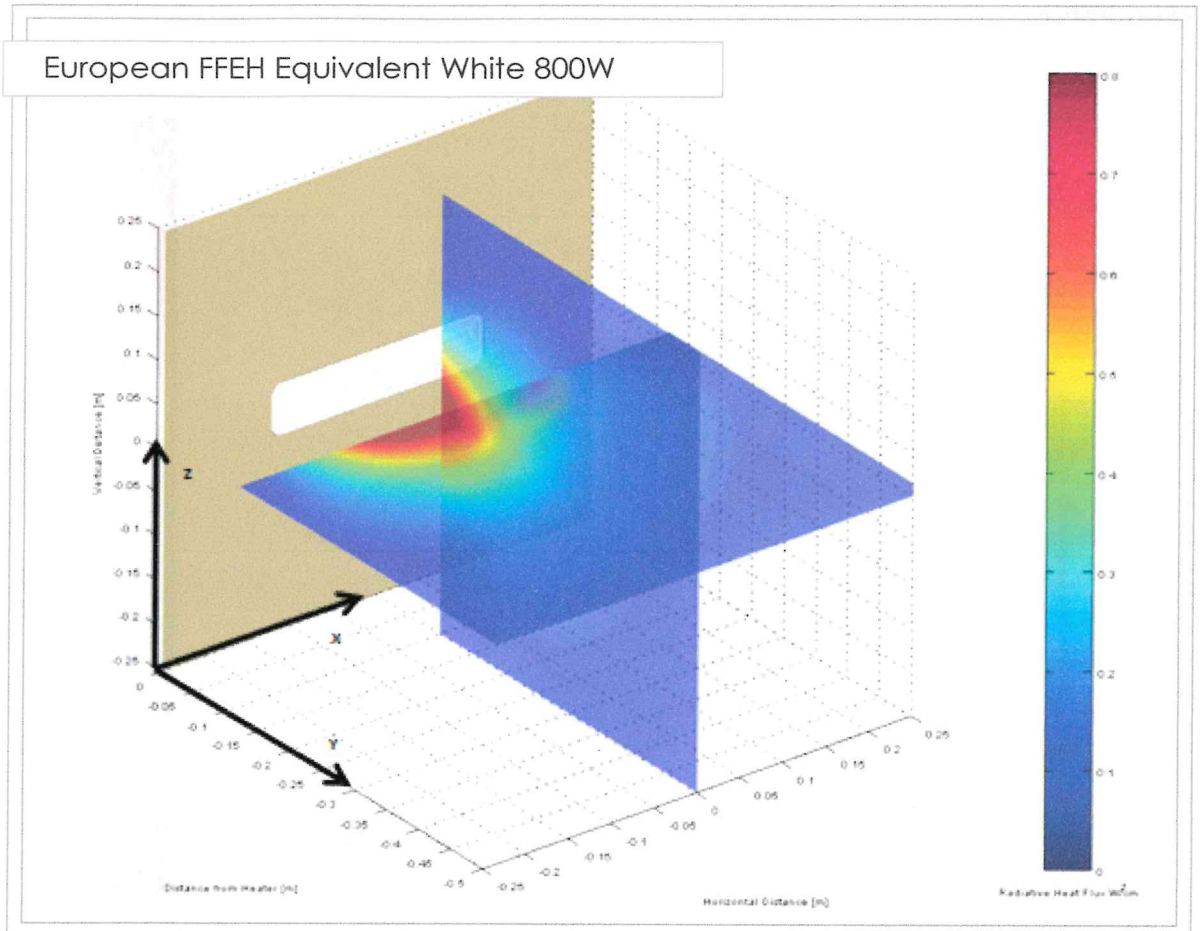

Figure 10: European Equivalent FFEH 3D heat flux profile

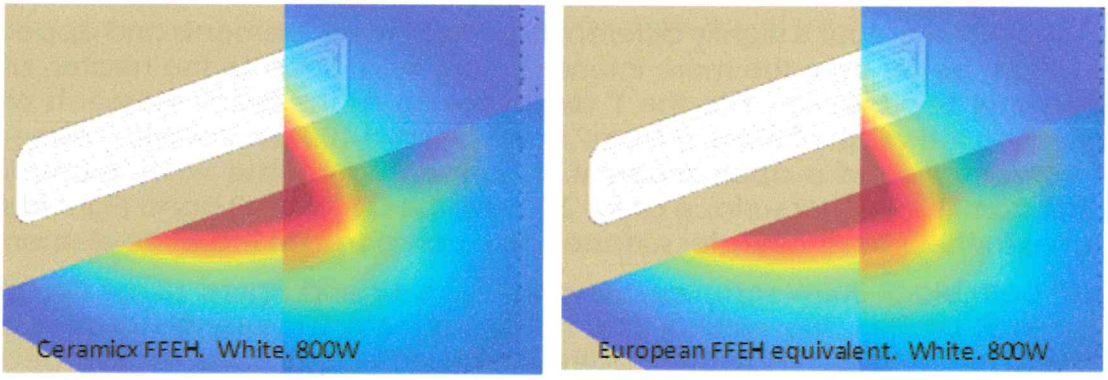

Figure 11: Close up of Ceramicx FFEH and European Equivalent 3D heat flux profile, White

FFEH Black

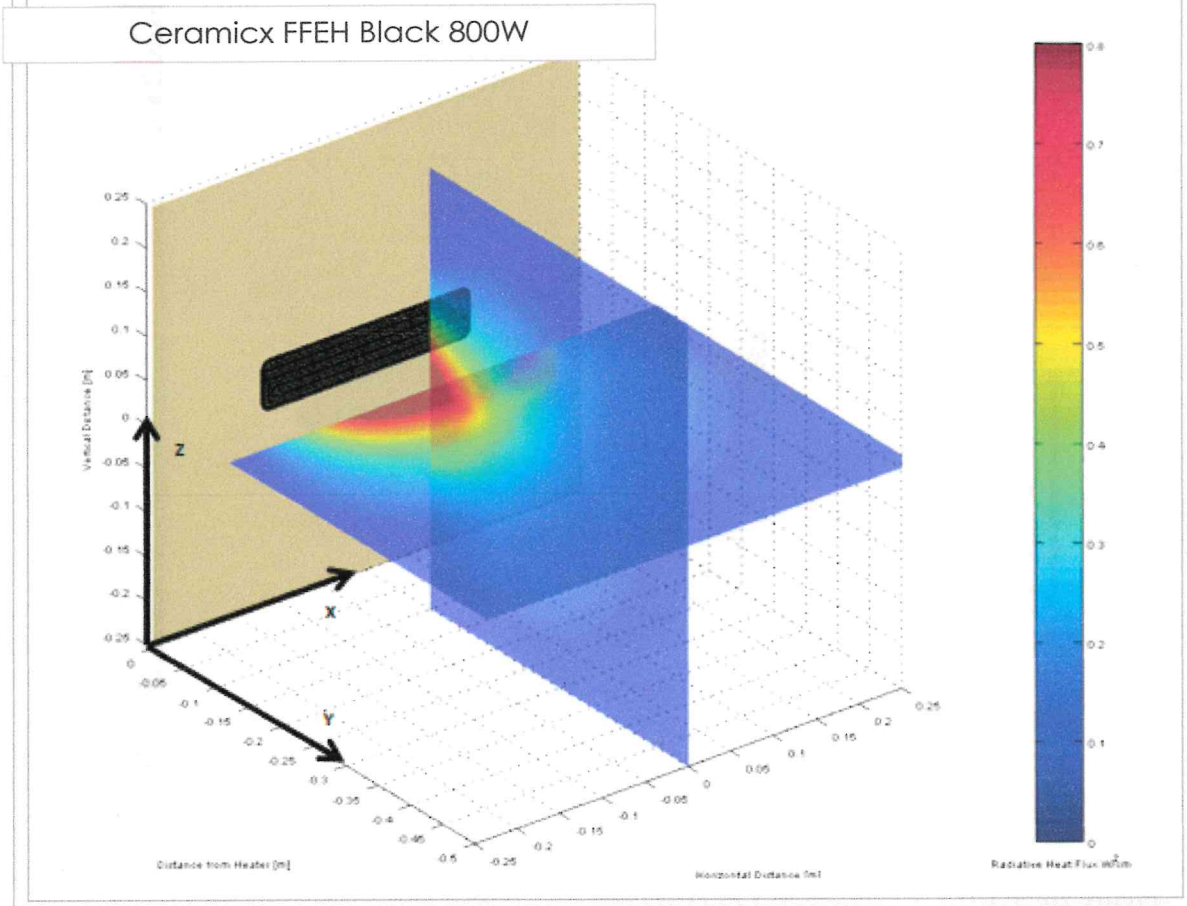

Figure 12: Ceramicx FFEH 3D heat flux profile, Black

The black FFEH output is slightly different from both white elements and appears to perform better from the more intense colour field closer to the heater, and the greater IR projection into the Y axis. Looking at the black elements and comparing the width of the 0.5W/cm2 band (yellow) 100mm from the element, the horizontal band is approximately 4% longer than in the white elements. Further from the emitter surface at X = 300mm, the 0.3 W/cm2 band (light blue) reaches further from the heater surface when compared to the white elements.

Again both black 800W samples shown in Figure 12 and Figure 13 are broadly similar in IR profile. The vertical and horizontal heat flux intensity profiles are of similar magnitudes. However, both black elements appear to give better performance compared to the white FFEH units. This is easier to see in the close up views in Figure 11 and Figure 14. This is also shown in the percentage graphs in Figure 15 where the black surface outperforms the white surface.

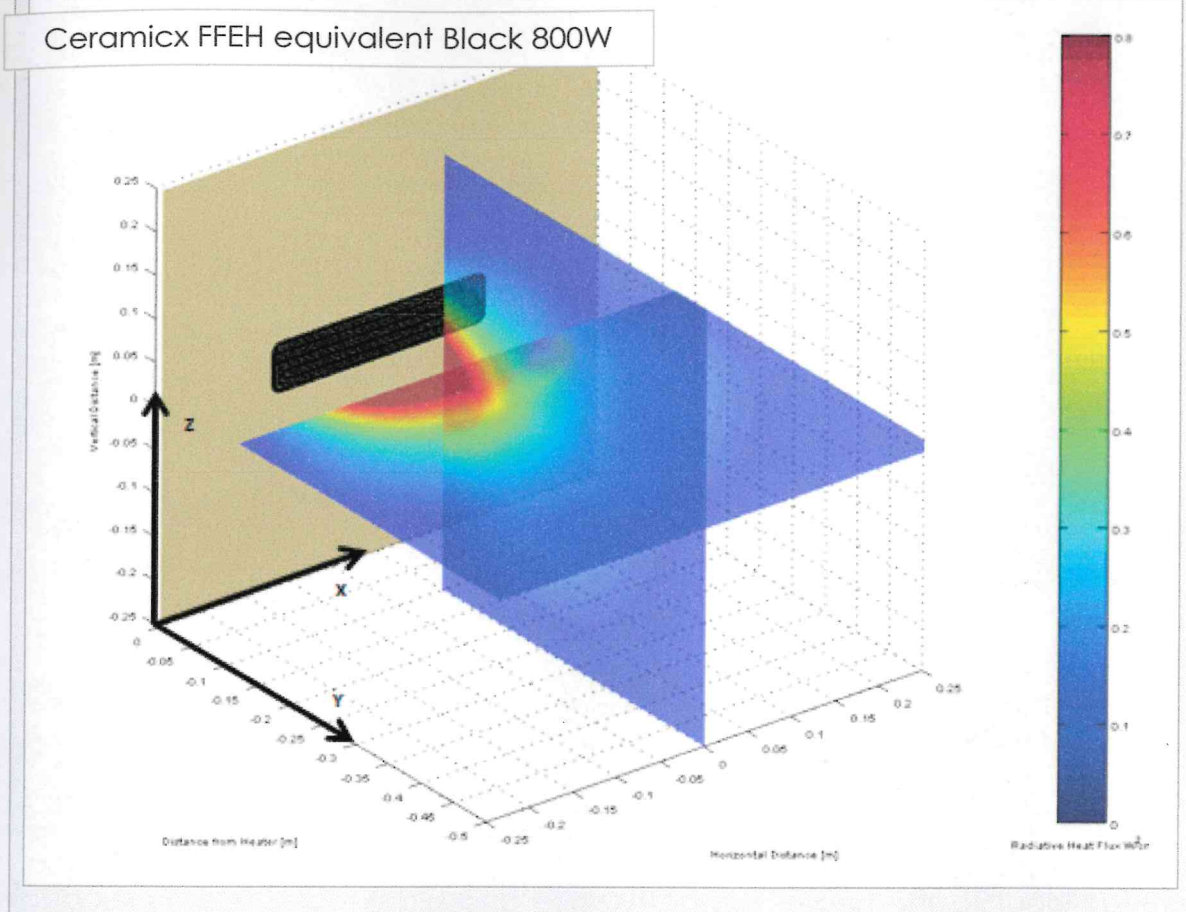

Figure 13: European Equivalent FFEH 3D heat flux profile, Black

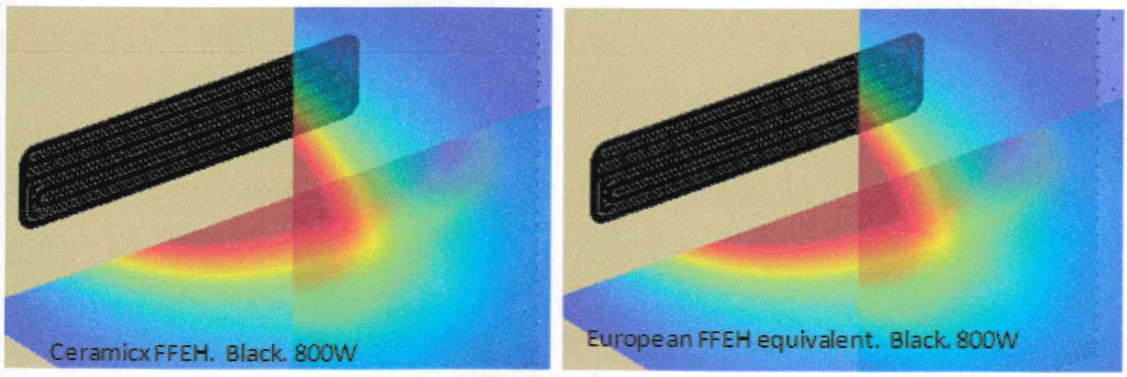

Figure 14: Close up of Ceramicx and European FFEH equivalent 3D heat flux profile, Black

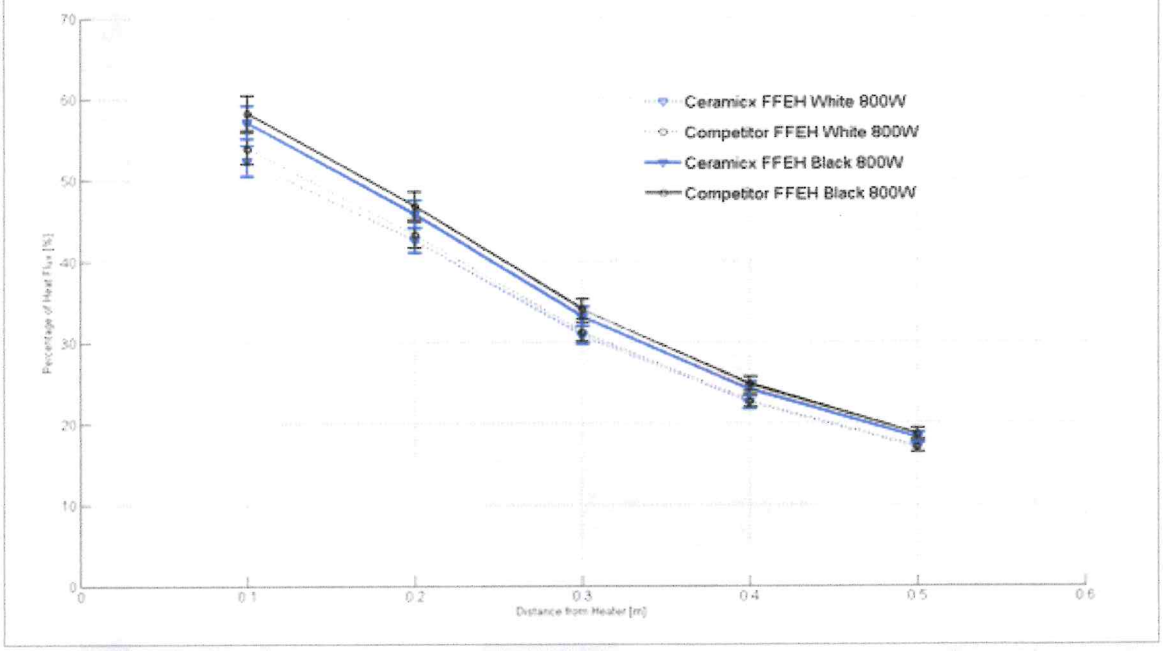

Figure 15: Measured IR heat flux as a percentage of input power for Ceramicx and Competitor Black and White FFEH elements

Figure 15 shows the emitted IR measured when compared to the electrical energy input to the heater. In both white and black cases, Ceramicx and competitors modules are almost identical in performance, by 1.2-1.5% at 100mm. This is within the levels of measurement uncertainty of 3.6%. However, it is clear that the black surface transmits more of the input power into radiative emission than the white surfaced elements.

By way of a comparison, some test results performed by Trinity College Dublin are also shown in Figure 16 and Figure 17. These tests were carried out at 600W input power.

Figure 16 shows a comparison between three Ceramicx elements and one competitor element. All four perform similarly returning around 52%-54% at a distance of 100mm.

A similar degree of uniformity between Ceramicx and competitor elements is seen for the black elements shown in Figure 17; however, the general performance is 54%-56% for the black element as opposed to 52%-54% for the white elements.

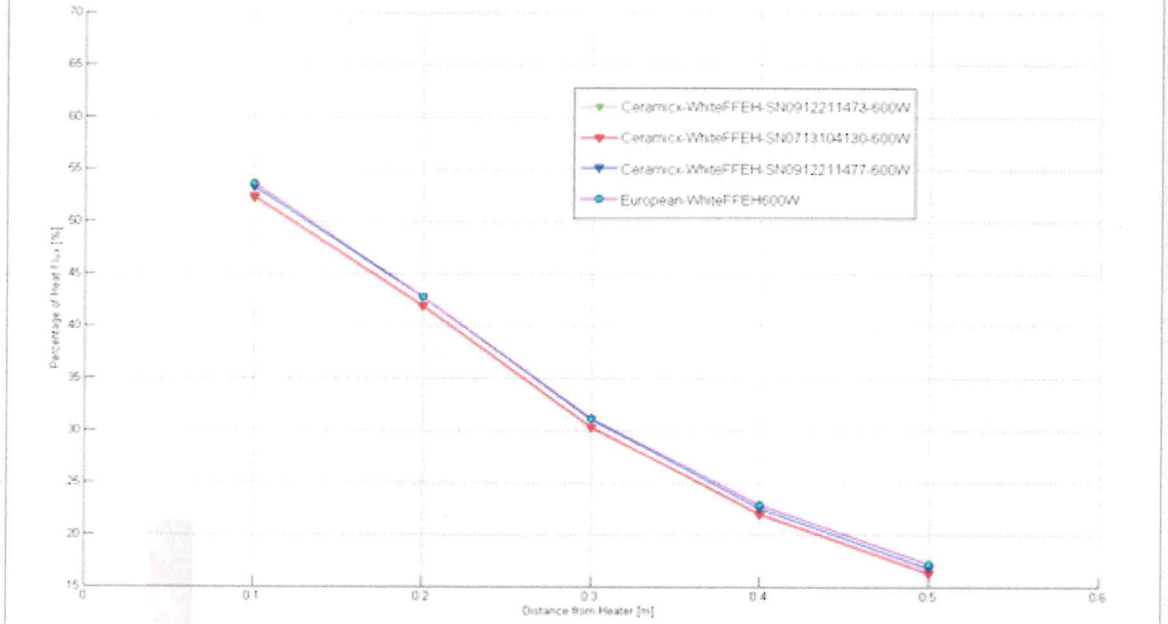

Figure 16: A series of White FFEH Measured IR heat flux tests performed by Trinity College Dublin

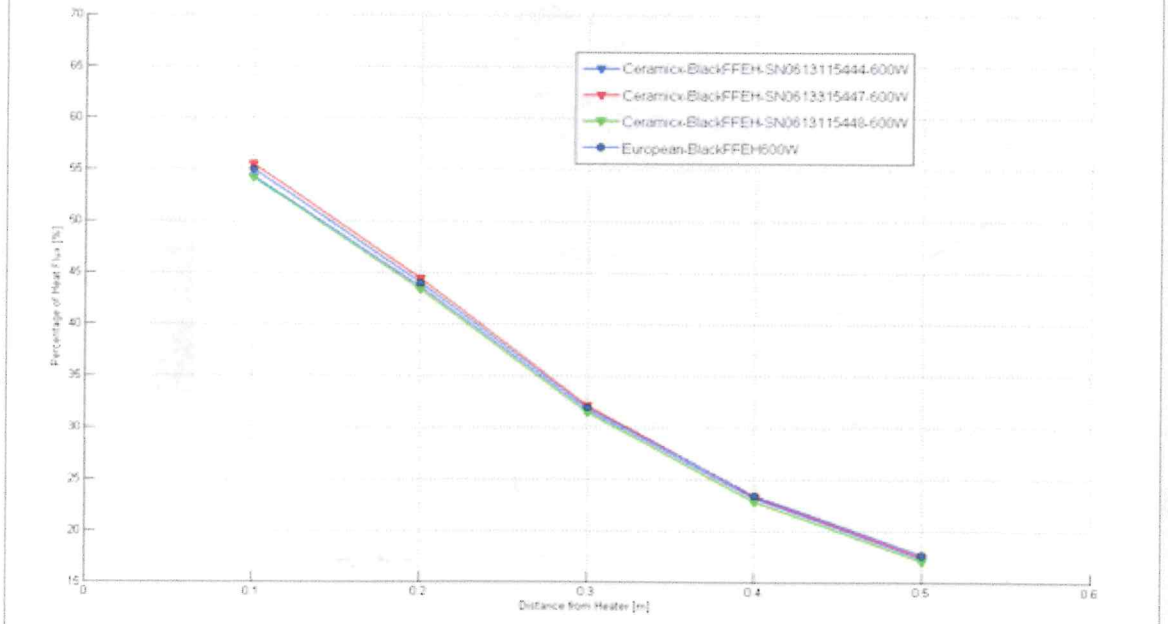

Figure 17: A series of Black FFEH Measured IR heat flux tests performed by Trinity College Dublin