Production performance testing of Pre-Swirl Nozzle (PSN) assembly through Background-Oriented Schlieren (BOS)

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A visit to the Rolls-Royce Heat Transfer Facilities was undertaken to apply Background-Oriented Schlieren (BOS) to quantify jet outlet angles from the Pre-Swirl Nozzle (PSN).

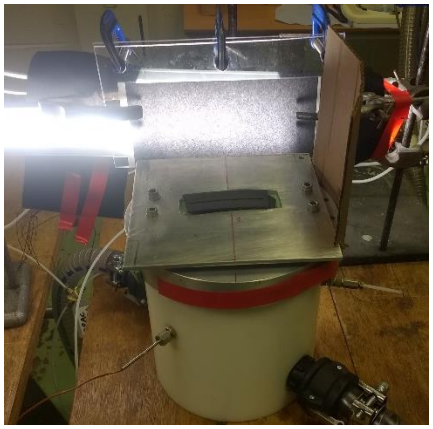
The purpose of this visit was to determine if the BOS technique developed and refined at the University of Manchester (UoM) when applied to hypersonic flow and shockwaves could visualise the weaker density gradients from a PSN assembly for production flow testing.

A series of development tests were conducted to refine the BOS results on a benchtop flow rig. The technique was able to capture discernible flow features over the full-span PSN using a basic Matlab-based processing algorithm.

Tests were then conducted with a series of PSN sets to measure the flow angles from each of the nine outlet jets. These showed a relatively close agreement from the manual measurement technique; improved results are expected with further post-processing back at the University of Manchester.

Collaborative discussions with the defence aerospace production research department were made, with the possibility of applying the technique to examine other flow measurement requirements within the department.

Future collaboration between the HTF and the University of Manchester was proposed, to conduct a further refinement of BOS and automation of the angle measurement. Testing with conventional schlieren will yield a deeper understanding of the flow-field from which BOS can be developed to apply in a production testing facility.



PSN flow testing rig (left) and BOS of flow field (right).

The PSN rig is used for measurement of the flow function through each nozzle assembly for a given pressure ratio. The BOS data shown on the right has been processed as if it were a horizontal schlieren image (the colourbar shown on the right is of vertical displacement magnitude in pixels).