Coordinates of the manufactured and tested blade

Suction surface			Pressure surface
XS/C	YS/C	XP/C	YP/C
0.003340	0.007015	0.002942	0.002671
0.006305	0.006805	0.006332	0.002332
0.012863	0.006425	0.010336	0.002006
0.037199	0.005176	0.036806	-0.000244
0.072572	0.003724	0.072046	-0.003149
0.107956	0.002772	0.107250	-0.005660
0.143372	0.002416	0.142464	-0.007514
0.178825	0.003246	0.177684	-0.008735
0.214218	0.005099	0.212900	-0.009408
0.249591	0.007495	0.248146	-0.009675
0.284948	0.010173	0.283368	-0.009510
0.320298	0.012964	0.318624	-0.009112
0.355636	0.015781	0.353882	-0.008562
0.390966	0.018616	0.389134	-0.007900
0.426311	0.021376	0.424396	-0.007149
0.461655	0.024133	0.459664	-0.006316
0.496983	0.026848	0.494935	-0.005489
0.532274	0.029115	0.530221	-0.004672
0.567538	0.030781	0.565492	-0.004102
0.602771	0.031658	0.609595	-0.003539
0.633646	0.031709	0.644869	-0.003193
0.668843	0.030636	0.680150	-0.002892
0.704111	0.028336	0.715424	-0.002694
0.739401	0.025599	0.750687	-0.002595
0.774711	0.022500	0.785963	-0.002605
0.810045	0.019415	0.821224	-0.002577
0.845370	0.016439	0.856495	-0.002632
0.880703	0.013429	0.891765	-0.002704
0.916019	0.010541	0.927045	-0.002812
0.951345	0.007626	0.962310	-0.002936
0.973404	0.005762	0.988245	-0.003076
0.996600	0.003798	0.994591	-0.003065

DISCUSSION

Yu Shen[1]

1 In this paper, it was written: "The rear leg of the lambda shock seems to be a slightly curved, strong oblique shock, . . .". These words are rather ambiguous and might lead to misunderstanding. I would like to mention that, in fact, the total pressure ratio across the rear leg was about 0.998, but *the total pressure ratio across the front leg was about 0.98.* That means that the total pressure loss across the rear leg was only one tenth of the loss across the front leg. The shock strength of the front leg was much greater than that of the rear leg. The front leg was the stronger, which must be kept in mind.

2 I would like to mention here that in 1984 and 1985, when I was a guest scientist in DLR initiating this investigation with Mr. Schreiber, I made a lot of oil streak pictures in DLR on the same blades, in addition to the two pictures shown in Fig. 13 in this paper. From all these pictures (including Fig. 13 in this paper), it is obvious that there were strong vortices in the left and right corner regions on suction surface; one of the causes was the sidewall suction through large trapezoidal openings. On the pressure surface, there were disturbances emanating from the leading edge corners, where the trapezoidal openings were also located. Obviously, these openings have a great influence on the flow, and this influence must not be ignored. However, it was difficult to estimate the magnitude of this influence in data reduction; consequently, the estimated uncertainties in this paper (Table 2) are questionable.

3 Concerning surface flow visualization, I would say, oil streak techniques are more appropriate than the ink injection *method for studying flow separation and reattachment.* The ink injection method is not good for indicating reattachment, because ink spreads in the spanwise direction where there is separation, but, in any case, it is difficult to reduce the spread ink to streak lines, even if reattachment exists. However, if the thickness of the oil layer is properly selected, the oil streak method can indicate separation and reattachment very clearly. If reattachment exists after slight separation, parallel oil streak lines reappear.

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Authors' Closure

The authors would like to take this opportunity to clear up certain misinterpretations.

1 The total pressure drop across the lambda shock system has not been measured, but if one applies the theoretical shock relations to the flow vectors obtained from the laser measurements, for example at about 7 mm distance from the blade surface, one recognizes that the total pressure loss of the leading oblique shock ($M_o = 1.5$, $\delta = 9$ deg, $\hat{P}_t/P_{to} = 0.990$) is slightly higher than that of the rear leg of the lambda shock ($M_o = 1.2$, $\delta = 4$ deg, $\hat{P}_t/P_{to} = 0.997$), which is not surprising. But as the Mach number behind the rear leg is subsonic, this shock can be interpreted still as a strong oblique shock. The discontinuities across the oblique front leg and the rear leg are clearly demonstrated in Fig. 7 of the paper.

2 The disturbances visible in the oil streak pattern of the suction surface sidewall corner region near the blade leading edge (Fig. 13, top) are on no account induced by the sidewall suction system. These disturbances originate in the leading edge corner region, where the detached bow shock wave ahead of the leading edge interacts with the incoming sidewall boundary layer. These disturbances have been localized in an additional test series using also a laser anemometer. The disturbances (three-dimensional expansion and oblique shock wave) fade away toward the blade center and have only little effect on the suction surface velocity distribution. The pressure surface disturbances are even of minor influence (see Fig. 13 bottom).

A sidewall suction system is absolutely necessary in such compressor cascade tests. Without suction it would not be possible to establish such highly loaded flow configurations with strong shock waves being relevant for real compressor blade element flows. The flow field within the cascade blade channel would be seriously influenced by a strong interaction of the main passage shock with the sidewall boundary layer. Certainly the sidewall suction introduces a further complex flow structure in the endwall region; however, those endwall effects are of minor influence on the midspan flow region where the investigations have been performed.

The uncertainties given in Table 2 of the paper refer to the midspan data and are based on experimental experience of several previous transonic cascade tests.

3 Concerning a flow visualization technique suited to show boundary layer separation and reattachment, both the oil streak technique and the ink injection technique are useful. Our experience, however, is that the line of separation is more clearly indicated by using the ink injection technique and boundary layer reattachment can be confirmed easily by injecting ink immediately behind the reattachment line.