dicated, but it may be different for air. Furthermore, the influence of other parameters on transition must also be assessed: classical freestream—wall temperature ratio and pressure gradient induced by the presence of the boundary layer, this last parameter being possibly non-negligible in tubes of moderate and small cross sections working at low initial pressures. Furthermore, for large values of Re^*, the transition occurs very close to the shock front; thus, from an experimental point of view, the mounting of gages must be carefully done, trying to avoid any discontinuity in the tube wall. Thus, taking into account these final remarks, new systematic experiments on transition in shock-tube boundary-layer flows are needed.

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Reply by Authors to R. Brun

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REMARKS in the Comment suggest that a common feature of shock tube wall boundary-layer transition behavior is that at low unit Reynolds number Re_u the velocity U_T of the front corresponding to departure from laminar flow is less than the laboratory fluid particle velocity U_2, and that with increasing Re_u, U_T progresses toward the shock velocity U_s. Our experimental data do not fully support this hypothesis. In Fig. 2 of Ref. 1 only the largest value of the transition Reynolds number Re_T observed at each T_w/T_e was shown. Examination of the complete data given in Ref. 2 allows some features of the transition path to be identified. These data are presented in Fig. 1, in which experimental Re_T values are shown for the various x stations for each T_w/T_e considered. Estimated uncertainties in Re_T are shown. At a given T_w/T_e (a given shock Mach number) Re_T is proportional to the transition time t_T, the time between the arrival of the shock and the transition front at a given x. Thus, if the transition front travels at a speed less than U_s, Re_T will increase with increasing x, and if $U_T = U_s$ the same value of Re_T would be obtained at all x stations.

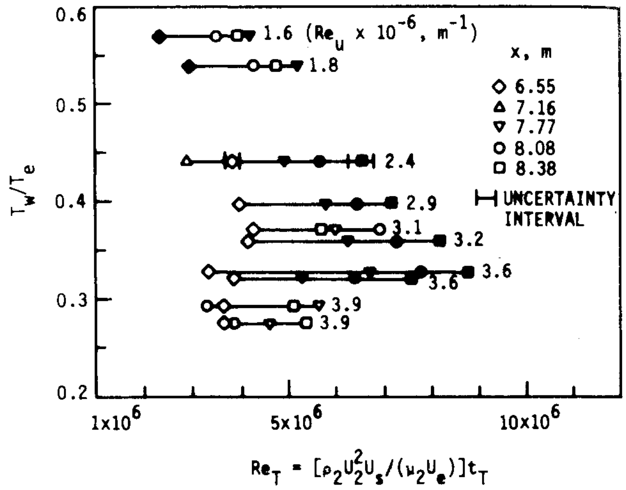

Fig. 1 Transition Reynolds number range for various wall-to-post-shock temperature ratios.

Consider first the data in Fig. 1 in the range $2.4/\text{m} \le Re_u \times 10^{-6} \le 3.6/\text{m}$. These data exhibit Re_T values that vary with x. However, a clearly defined transition front velocity exists only for the data represented by the solid symbols; these data closely follow the transition path $U_T = U_2$. Data for five of the six runs in this range exhibit this characteristic, and only data from stations at the three largest values of x behave in this manner. Consider next the data in Fig. 1 at the two lowest values of Re_u. These data are in the range of unit Reynolds number which, according to Brun, should exhibit a transition front velocity less than U_2 and thus should exhibit a pattern of increasing Re_T with x similar to that for $U_T = U_2$ but with even larger increments of Re_T between the measurement stations. The results do not follow this pattern. The data at x stations 6.55 m and 7.77 m (solid symbols) lie very close to the transition path $U_T = U_2$, while the data for the remaining two x stations indicate that U_T is near U_s downstream of $x = 7.77$ m.

The results in Fig. 1 for $Re_u = 3.9 \times 10^6$/m do not exhibit a trend in Re_T that allows clear identification of a transition front velocity. However, both the mean values for Re_T and the Re_T range observed for these runs are smaller than those for the data in the range $2.4/\text{m} \le Re_u \times 10^{-6} \le 3.6/\text{m}$. The smaller spread in Re_T suggests a trend toward $U_T = U_s$, as observed by Brun at $Re_u = 4.1 \times 10^6$/m.

Brun associates transition front velocities less than U_2 at low Re_u with the presence of turbulent spots in an otherwise laminar flow. The existence of turbulent spots in the flow would possibly explain results in which measured values of Re_T first decrease and then increase with x. The results in Fig. 1 at $Re_u = 2.4 \times 10^6$/m exhibit this variation with x. These data are from the study conducted to assess the influence of driver-created disturbances on transition (Fig. 1, Ref. 1). Data at this unit Reynolds number were obtained at five x stations for several runs. Mean values of Re_T at each x station are shown in Fig. 1. Turbulent spots are identified on heat flux gage response curves by an increase from the step-like laminar signal and a subsequent signal decrease indicating a return to laminar flow.[3] Records of heat flux gage response for all of the data obtained in this study do not in-

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dicate the presence of turbulent spots. Instead, they show an abrupt and complete transition from laminar to turbulent flow. Thus the transition pattern in Fig. 1 at $Re_u = 2.4 \times 10^6$/m is not explained by the presence of turbulent spots.

Although our experimental results do not in all respects behave in the manner proposed by Brun, it is evident from the results in Fig. 1 that, as suggested by Brun, a multiplicity of measurement stations is necessary to obtain a complete description of shock tube wall boundary layer transition.

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