

HUGONIOT OF FUSED SILICA

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Arione made three measurements of the wave profile in fused silica using the VISAR and a fused silica window⁽¹⁾. Density and sound velocity in the target material were not measured, nor is its source known for certain. It was probably part of the lot obtained by Bjorkman, namely Dynasil 1000, which differs slightly from GE 151, for which Barker gives a Rankine-Hugoniot curve⁽²⁾. Barker made the measurement on Dynasil 1000 and concluded that the Hugoniot for GE 151 would reproduce the performance of Dynasil 1000 with an error of less than 1%.

Measured profiles are compared with calculated profiles in Figs. 1,2, and 3 and in Table 1. The average error in measured rise time is -0.8%. The largest error is -8%. It's unfortunate that the sources of material used in these shots were not known. The best we can say with certainty is that differences between rise time calculated from the Barker Hugoniot will not exceed 10%. It is probably true that all three samples were Dynasil 1000, in which case the average error is less than 1%, in agreement with Barker's measurement.

The equations used for computations were:

$$p(\text{kilobars}) = 131.7U - 73.61U^2 + 99.47U^3 - 41.63U^4 \quad (1)$$

$$c(\text{mm/microsec.}) = 5.9836 - 6.6888U + 13.5579U^2 - 7.5657 U^3 \quad (2)$$

$$\rho_0 = 2.201 \text{ g/cm}^3$$

where U = particle velocity in mm/microsec.

There are two different analyses of the measurement of Shot 84-03 each made with the VISAR program at different times. These are shown in Fig. 4. The solid curve (file h84-03plot) was used in Fig. 3. The two curves probably represent, in some fashion, the errors in reduction of fringe data from the VISAR.

Table I

Shot Parameters for Fused Silica Experiments

<u>Shot No.</u>	<u>Impactor</u>	<u>Projectile Velocity mm/microsec</u>	<u>Sample Thickness mm</u>	<u>Ramping time, nsec</u>		<u>% Error</u>
				<u>Measured</u>	<u>Calculated</u>	
83043	A16061-76	.457	12.84	422	406	3.9
83046	Fused Silica	.454	12.86	353	385	-8.3
84003	Fused Silica	.431	12.89	382	375	1.9

References

1. Salvo E. Arione; Temperature Dependence of the Precursor Amplitude in <111> Lithium Fluoride; A disseration submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Washington State University, Department of Physics, May 1985.
2. L. M. Barker and R. E. Hollenbach; System for Measuring the Dynamic Properties of Materials; Rev. Sci. Instrum. 35, No. 6, 742-46 (June 1964).

Captions for Figures

- Fig. 1 Measured and calculated particle velocity profiles for fused quartz. Shot No. 83-43. ————— measurements from Ref. 1. ----- Calculated from Eqs. (1) and (2). Measurements and calculations are filed in /user/ged/QTZFUSED as 83-43meas and 83-43calc, respectively. This figure can be reproduced by entering the above directory and typing "graphit -m -r -0 83-43meas 83q" (First remove the comments at the ends of the two files.)
- Fig. 2 Measured and calculated particle velocity profiles for fused quartz. Shot No. 83-46. ————— measurements from Ref. 1. ----- Calculated from Eqs. (1) and (2). Measurements and calculations are filed in /user/ged/QTZFUSED as s83-46plot and 83-46calc, respectively. This figure can be reproduced by entering the above directory and typing "graphit -m -r -0 s83-46plot 83q2" (First remove the comments at the ends of the two files.)
- Fig. 3 Measured and calculated particle velocity profiles for fused quartz. Shot No. 84-03. ————— measurements from Ref. 1. ----- Calculated from Eqs. (1) and (2). Measurements and calculations are filed in /user/ged/QTZFUSED as h84-03plot and 84-043calc, repectively. This figure can be reproduced by entering the above directory and typing "graphit -m -r -0 h84-03plot q3" (First remove the comments at the ends of the two files.)
- Fig. 4 Two different analyses of VISAR measurements from Shot. No. 84-03. Both can be found in /user/ged/QTZFUSED. The solid curve is h84-03plot; the dashed curve is s84-03plot.

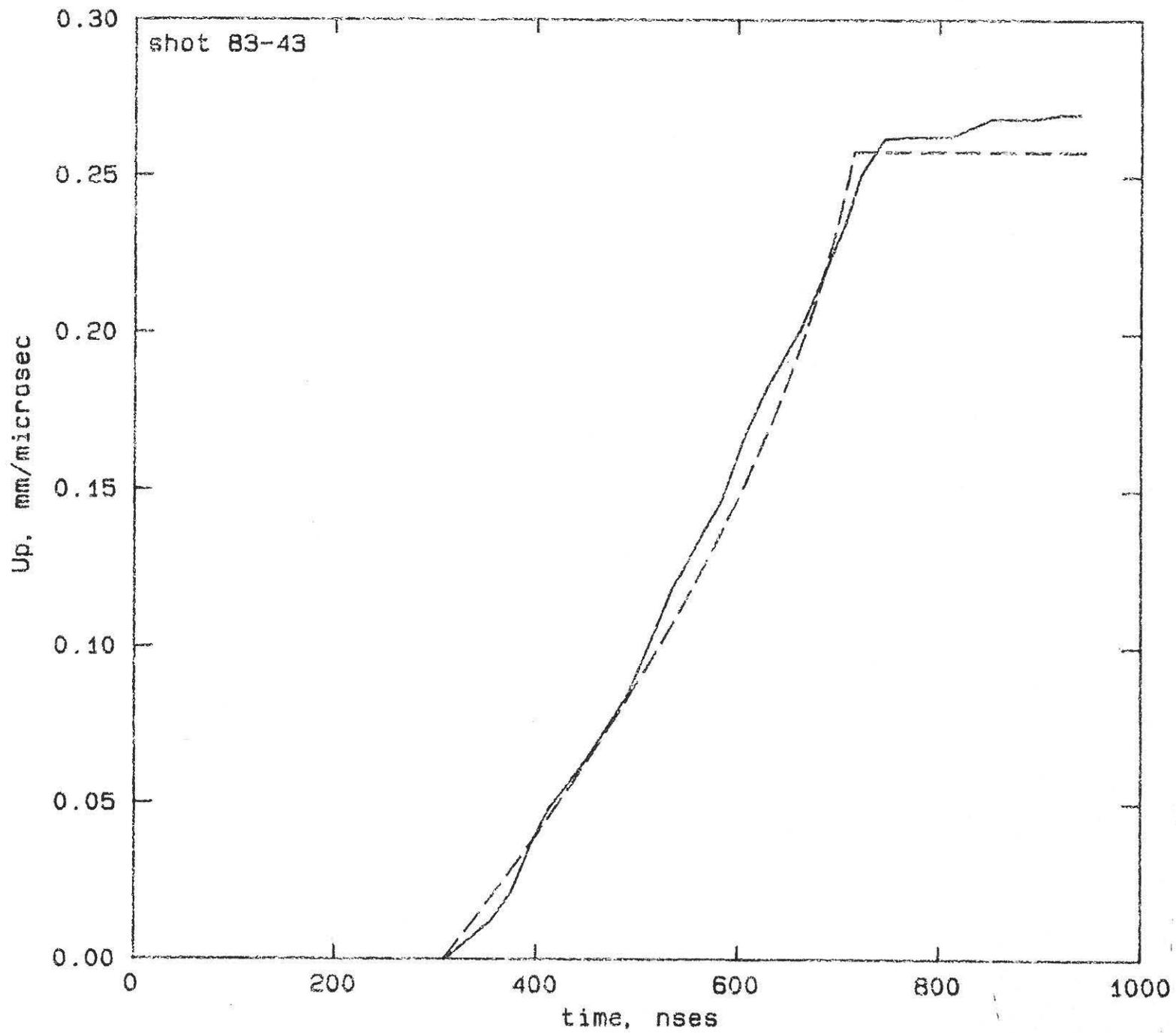


Figure 1.

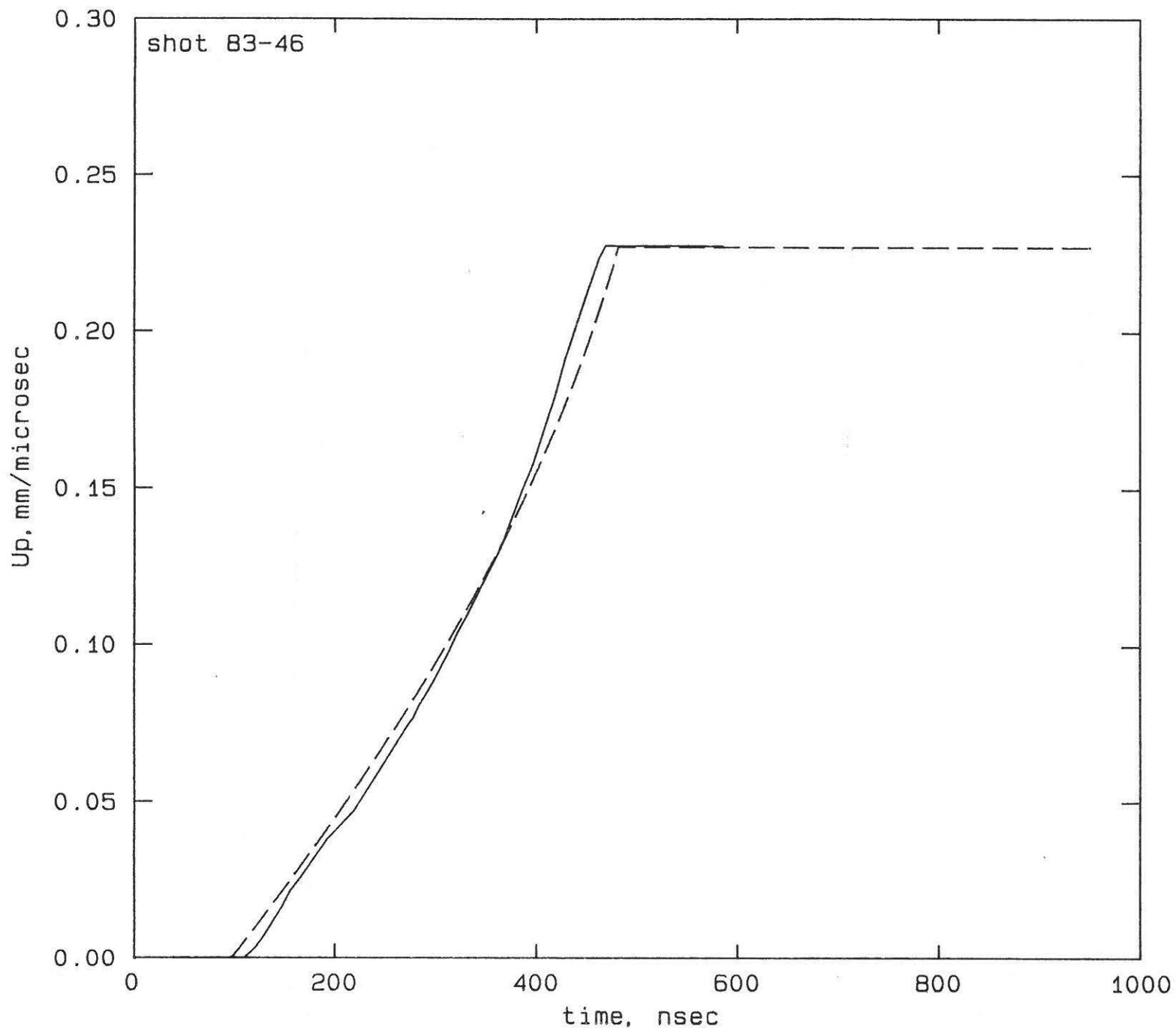


Figure 2.

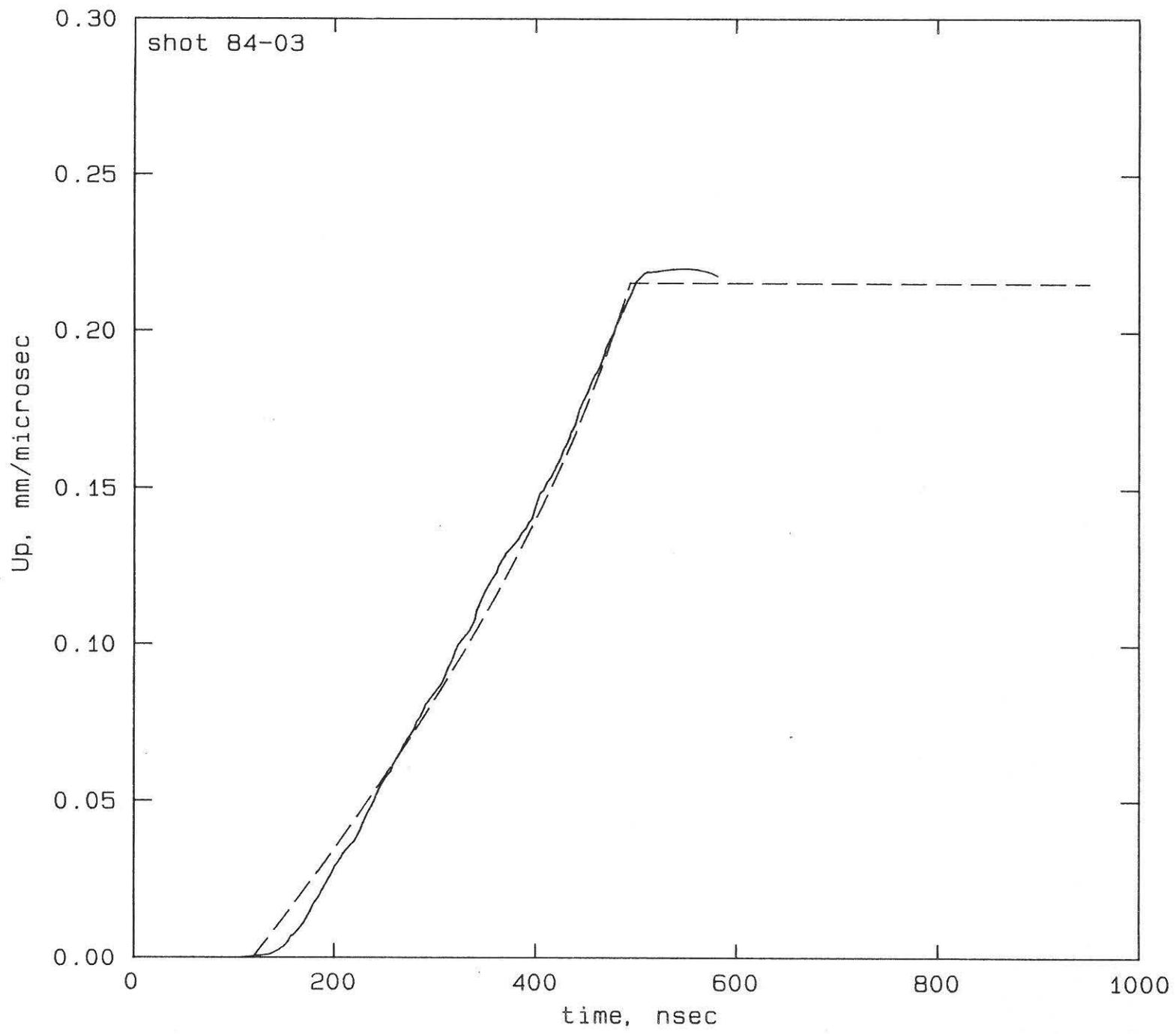


Figure 3.

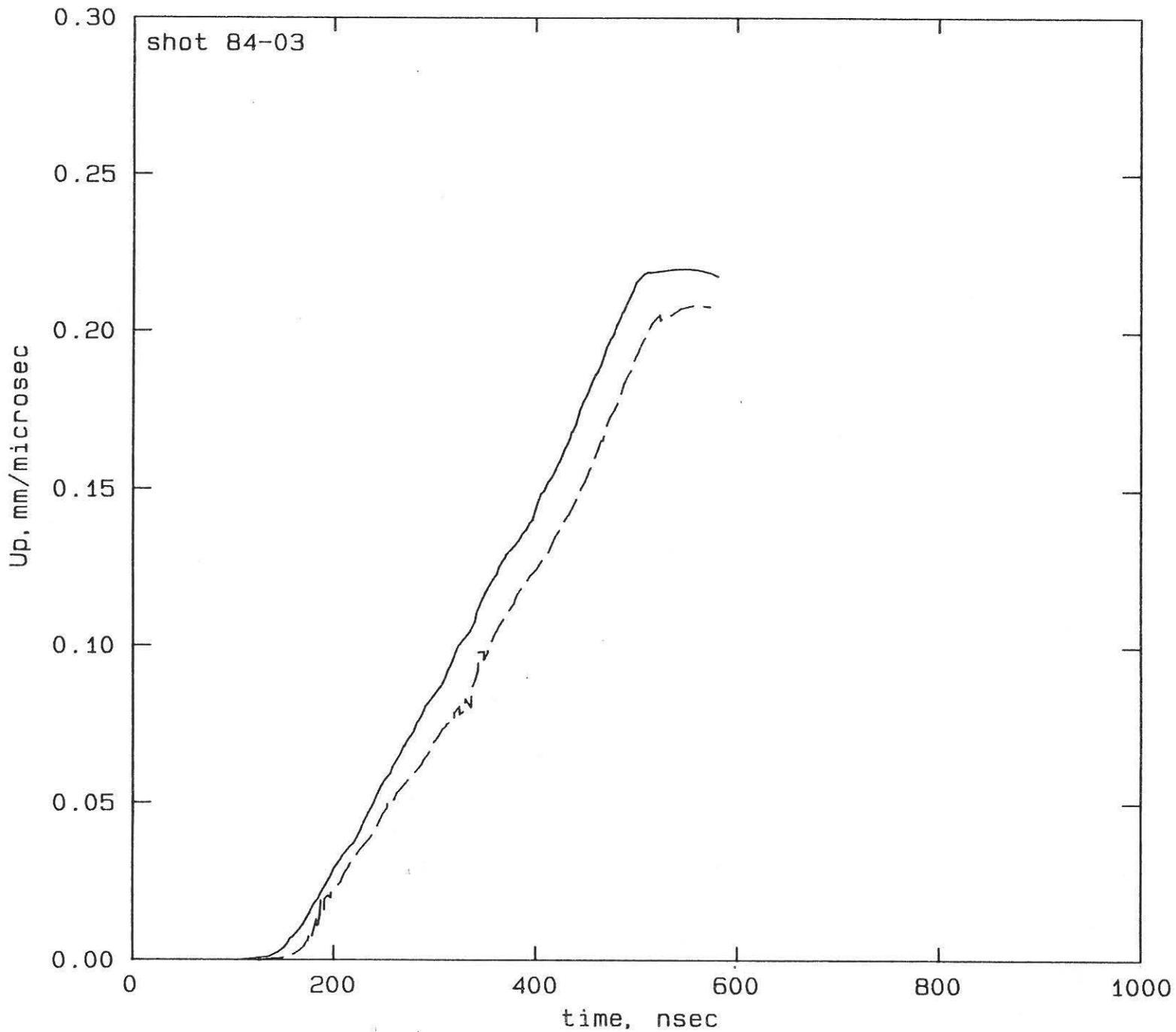


Figure 4.