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CONF-9706168

Title: THE EFFECT OF JOINTS AND GAPS ON SHOCK PROPAGATION

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Submitted to: **27TH ANNUAL ANOMALOUS ABSORPTION CONF.**
Vancouver, BC
June 1997

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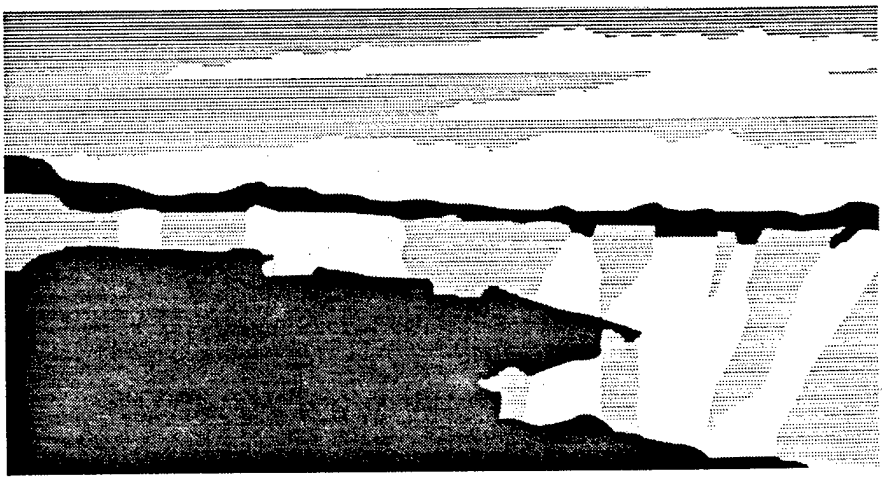

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June 18, 1997

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Dr. A. Velikovich
Berkeley Research Associates
P. O. Box 852
Springfield VA 22150-0852

Dr. Velikovich,

Please find enclosed the requested copy of the poster "The Effect of Joints and Gaps on Shock Propagation" presented at the recent Anomalous Absorption Conference held in Vancouver, B. C. If you have questions concerning this work please contact me at the above address or call (505) 667-2487 or e-mail scaldwell@lanl.gov.

Sincerely,

The Effect of Joints and Gaps on Shock Propagation

S. E. Caldwell, P. L. Gobby S. R. Goldman, D. J. Thoma, M. D. Wilke,
and D. C. Wilson
Los Alamos National Laboratory

National Ignition Facility targets, especially those made with material such as beryllium through which hydrogen doesn't permeate, may be made in sections and pieced together. Tolerances, chamfers, glue joints and fill tubes will form density mismatches which may lead to asymmetries in the capsule implosion. Such defects or perturbations also form nonlinear initial conditions of interest for hydrodynamic evolution. The physics of this process is being studied in planar packages in indirect drive. Ablation driven shock waves, similar to those produced by the foot of the NIF pulse, are generated from Nova hohlraum radiation. Time resolved radiography is used to study the propagation of non-planar shock waves through a uniform material and across material interfaces in order to examine the stability of the interface. We will compare shocks propagating around "gaps" and through "joints" with two-dimensional numerical simulations in planar geometry.

Poster presentation for the 27th Annual Anomalous Absorption Conference, Vancouver, B. C. June 1997

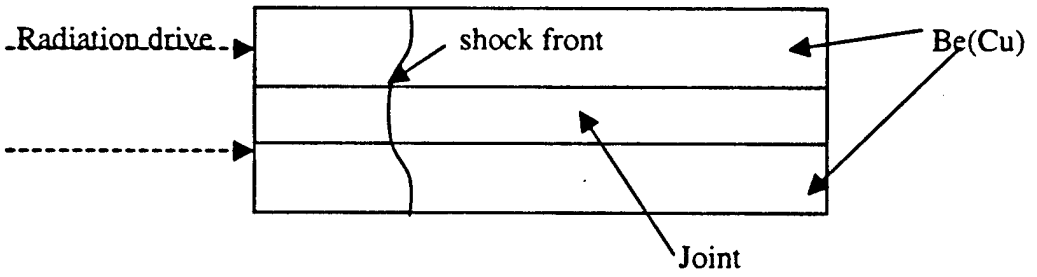
The Effect of Fabrication Defects on Targets with Beryllium Based Ablators

S.R. Goldman, M.D. Wilke, D.C. Wilson, and S.E. Caldwell

Los Alamos National Laboratory

The use of copper-doped beryllium [Be(Cu)] ablators on NIF targets, in place of plastic, can involve the bonding together of hemispheres with joints of differing composition; in addition, fill plugs can be necessary for placing DT within the enclosing ablator shell. Either application defines a large amplitude, short wavelength perturbation with variation perpendicular to the direction of drive through the target.

The radiation drive incident on the target produces an ablation pressure which drives a shock into the target. The shock front within the joint can either lead or lag the front in the copper doped beryllium outside. For example, schematically for a higher density joint, one has:

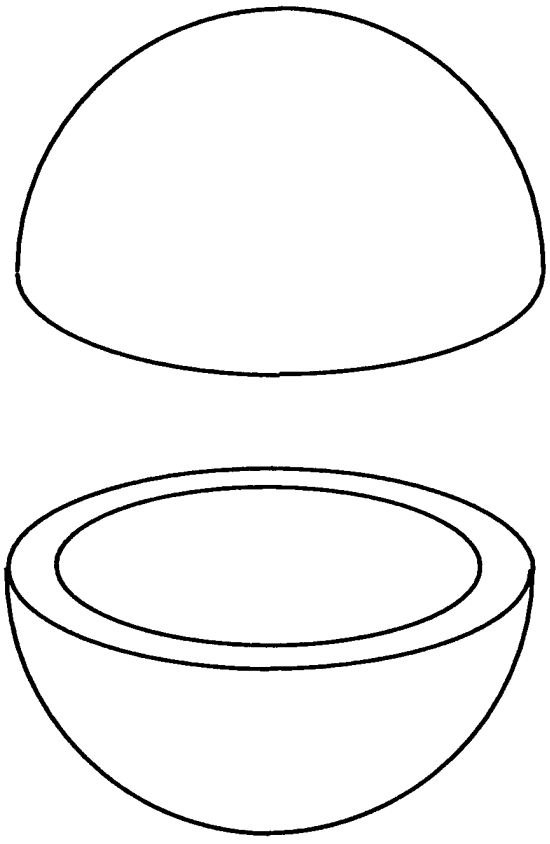


The hydrodynamic contact across the joint-Be(Cu) interface results in an increase in the spatial extent of the shock non-uniformity normal to the joint. Within the theoretical modeling, variation with shock strength, joint thickness and material composition, and radiation pulse width, can be estimated.

We have performed experiments on aluminum, polystyrene, and brominated polystyrene joints with NOVA 1ns flat pulse drive in cartesian (non-converging) geometry, with transverse X-ray radiography as the primary diagnostic. The results have been simulated with Lasnex and the TDG post-processor, as well as with the Rage automatic mesh refinement code. There are marked similarities between both types of code calculation and the experimental data, and we are currently seeking to compare experimental and simulational drive non-uniformity.

We intend to extend this work in two directions for application to NIF targets. First, it appears with beryllium based ablator, that the first shock during the NIF drive can be defined so that the shocked Be(Cu) will not melt, will melt or will melt and then recrystallize prior to the second shock; it would be interesting to investigate these possibilities and their desirability. Second, we need to determine the effect of target convergence on the development of perturbations from joints.

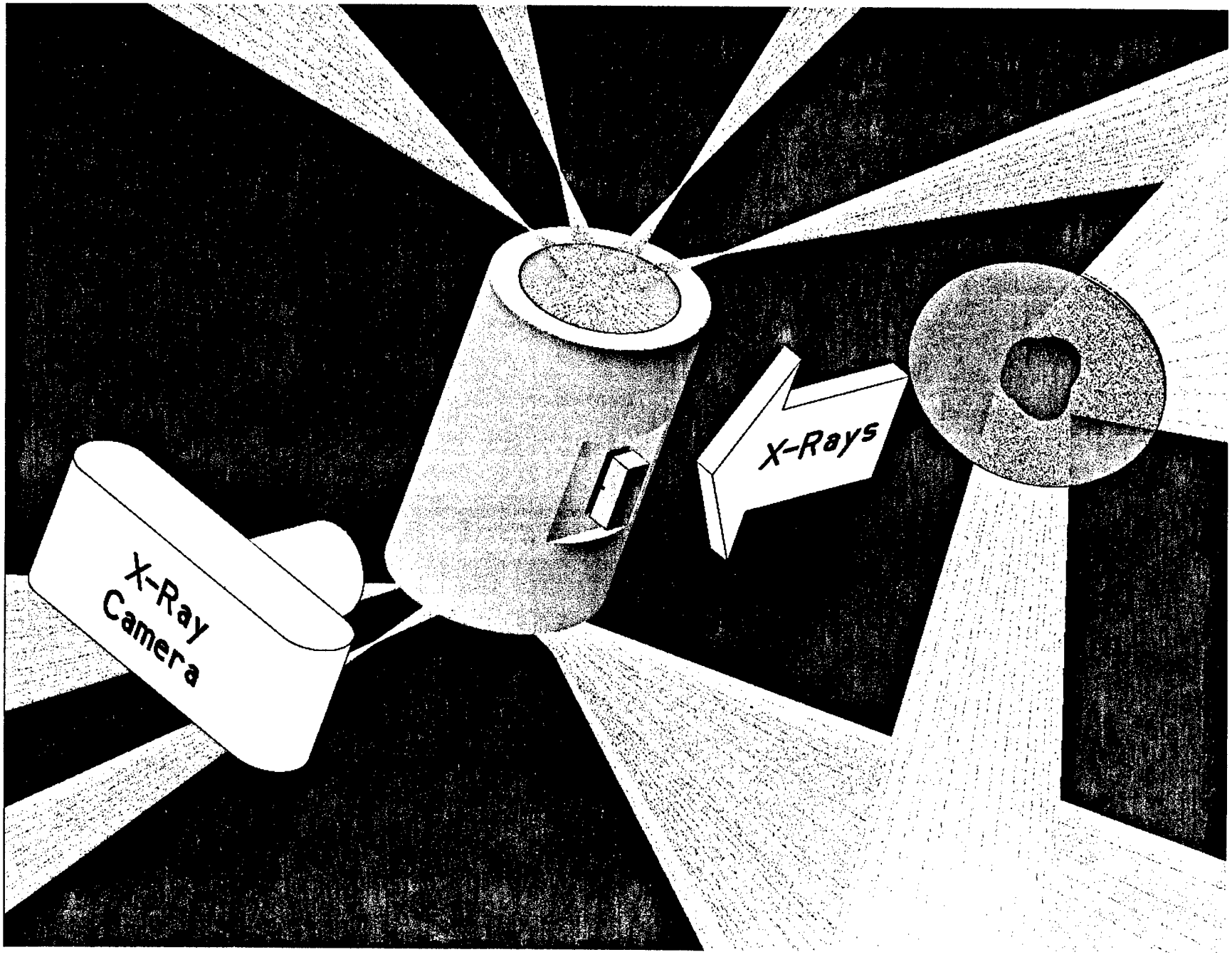
Associated Paper 702
this conference



MOTIVATION: Imperfections in implosion capsules may distort the symmetry of the implosion, resulting in reduced yield.

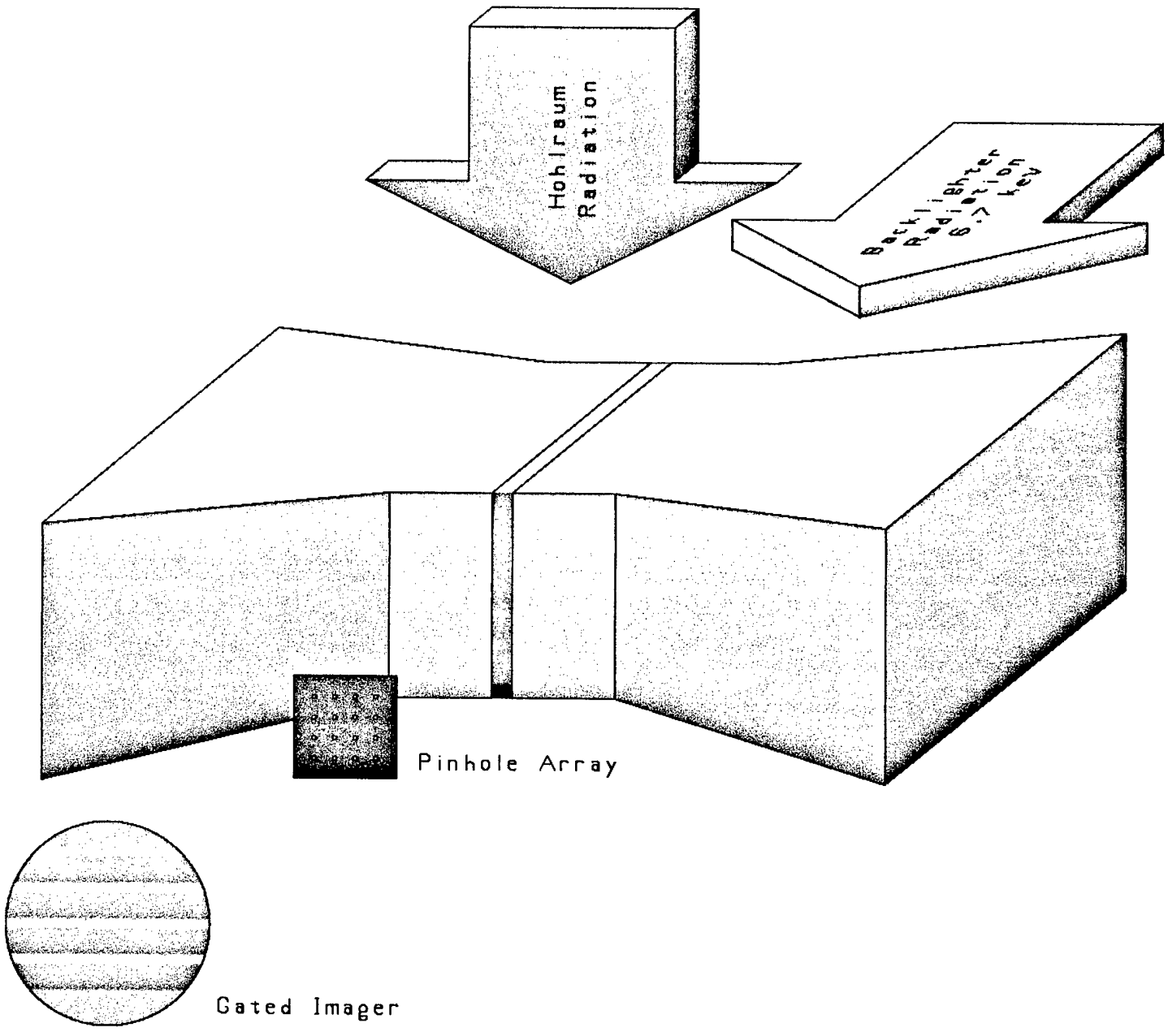
OBJECTIVE: Observe the propagation of a shock wave through a bulk material where the shock is perturbed by a defect in the material.

Targets are mounted on the side of a scale 1 hohlraum


X-Ray
Camera
X-Rays

Target #1: Copper doped Be (10% Cu by weight) with an aluminum joint. The joint region is 200 by 200 microns with an aluminum thickness of 18 microns.

LASNEX predicts that the shock traveling through the denser joint material will lag behind the shock traveling through the Be(Cu). A transition region is set up in the Be(Cu) in which the shock near the joint also lags. As time goes by, this transition region grows.


Hohlraum
Radiation
Pinhole Array
Gated Imager

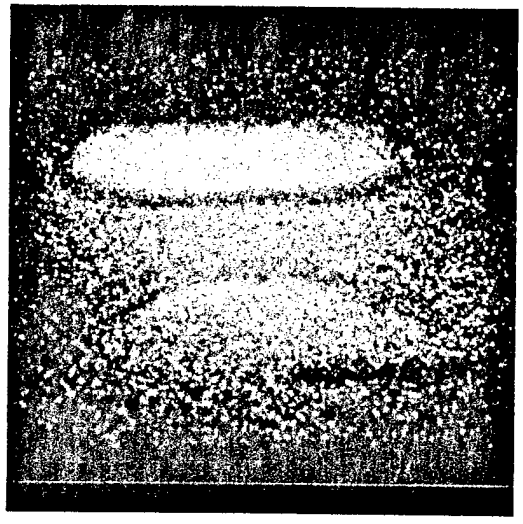
t = 1.1 ns

NOVA data is shown to the immediate right. LASNEX predictions are shown on the far right. A comparison of the shock fronts is given in the center. The NOVA data consists of two 'identical' shots with one target having no joint and the other target having an 18 micron aluminum joint. Since the NOVA data shows a strong bowing due to the target shape, the plotted data is the **difference** between the two NOVA shots.

NOVA Data

taken with Fast X-ray Imager

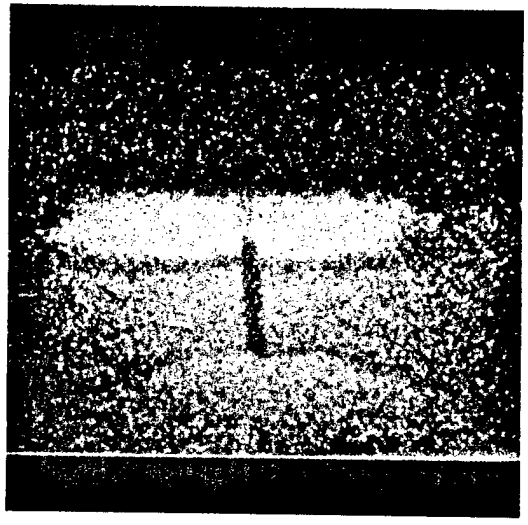
no joint



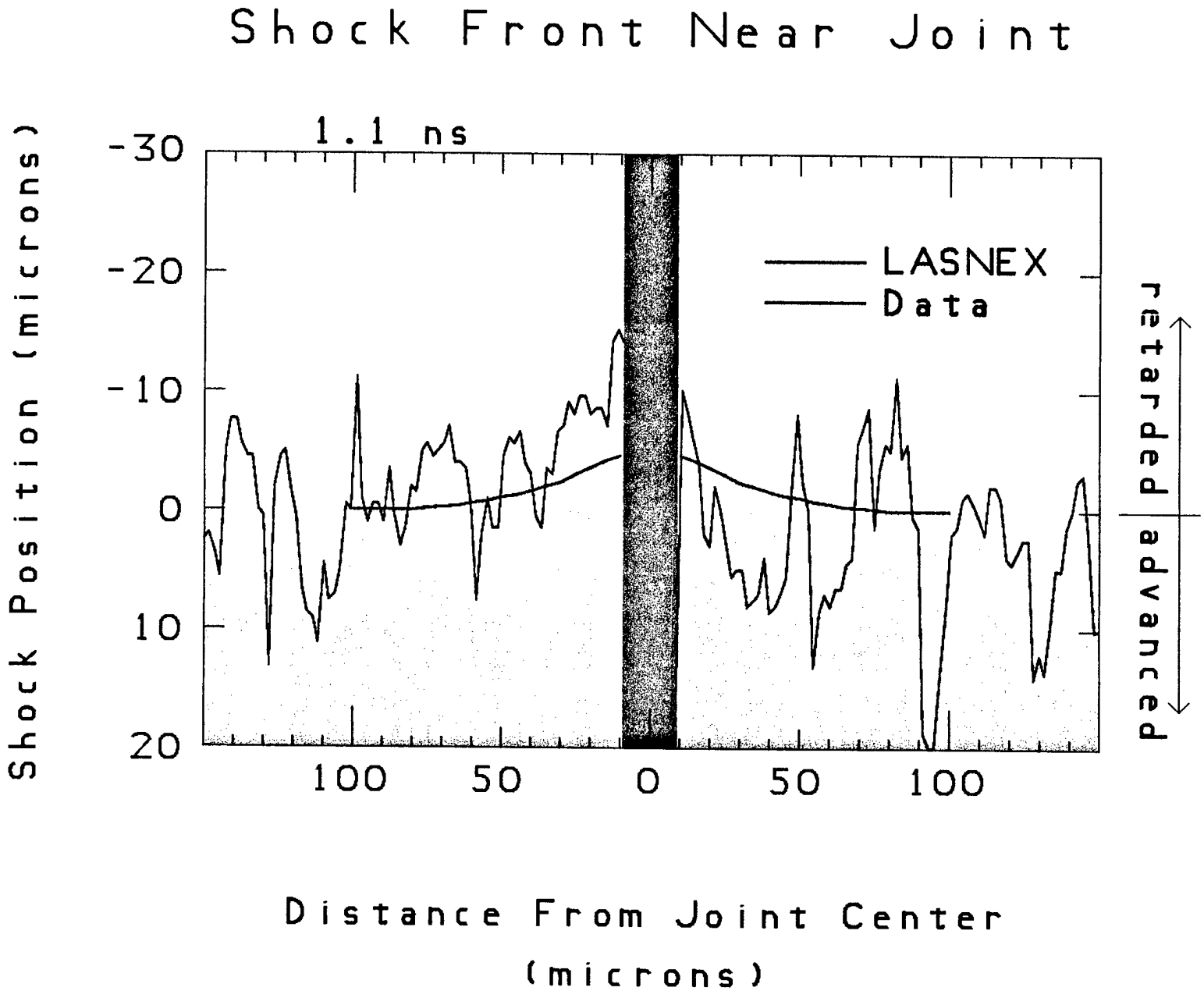
27041705

1.1 ns

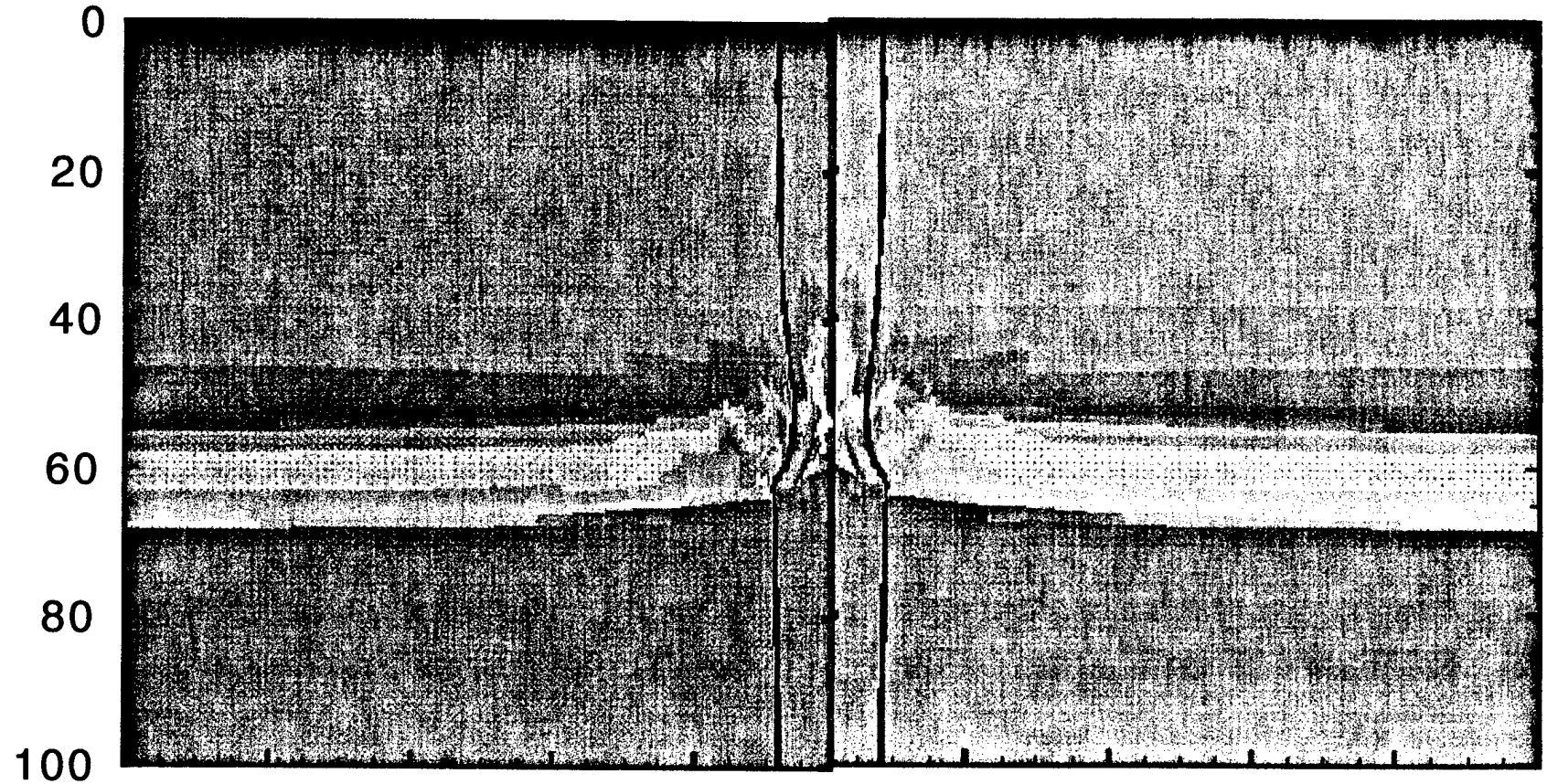
with joint



27041703

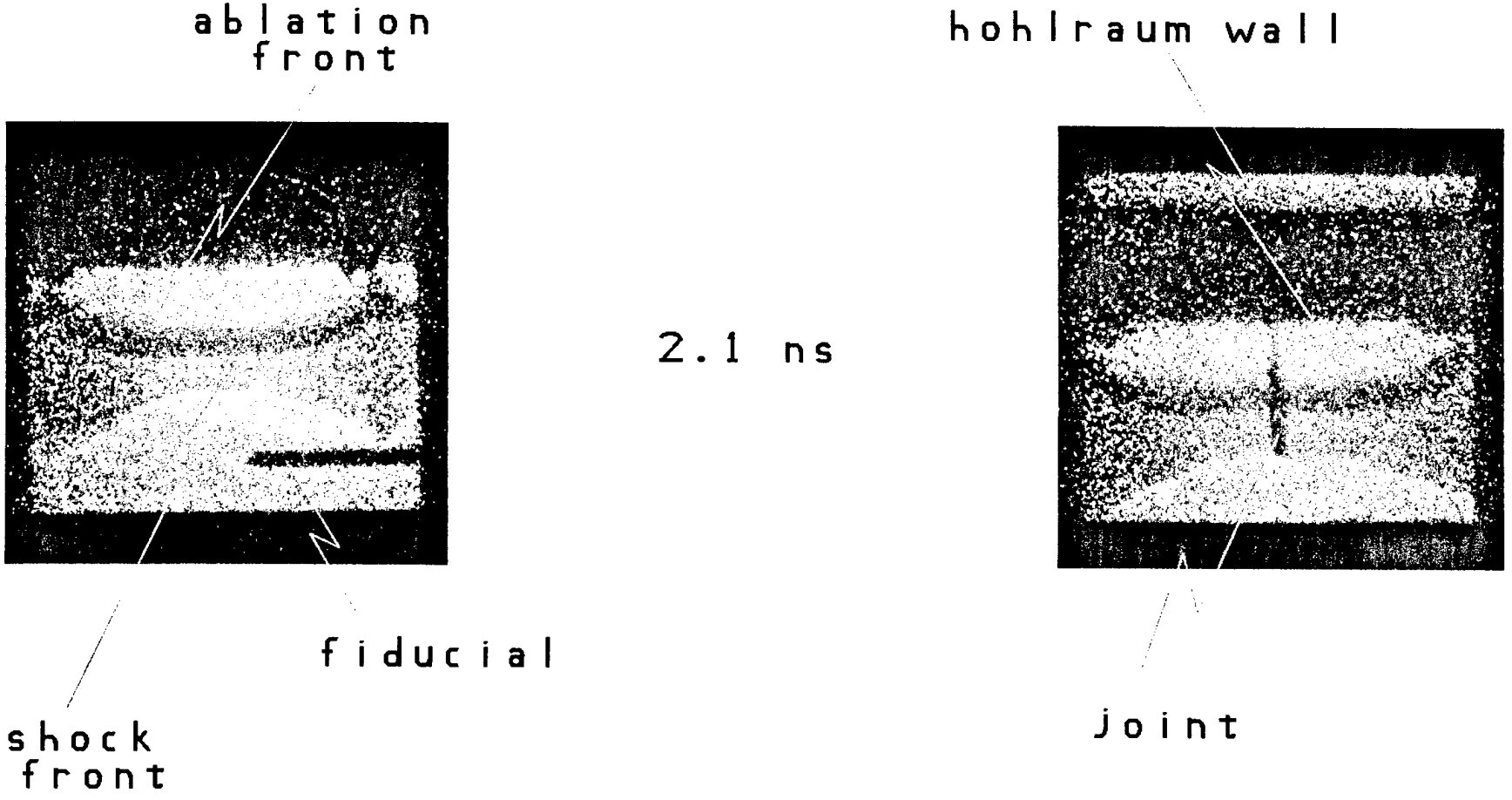

Shock Front Near Joint
1.1 ns
-30
-20
-10
0
10
20
100
50
0
50
100
LASNEX
Data
retarded
advanced
Shock Position (microns)
Distance From Joint Center
(microns)

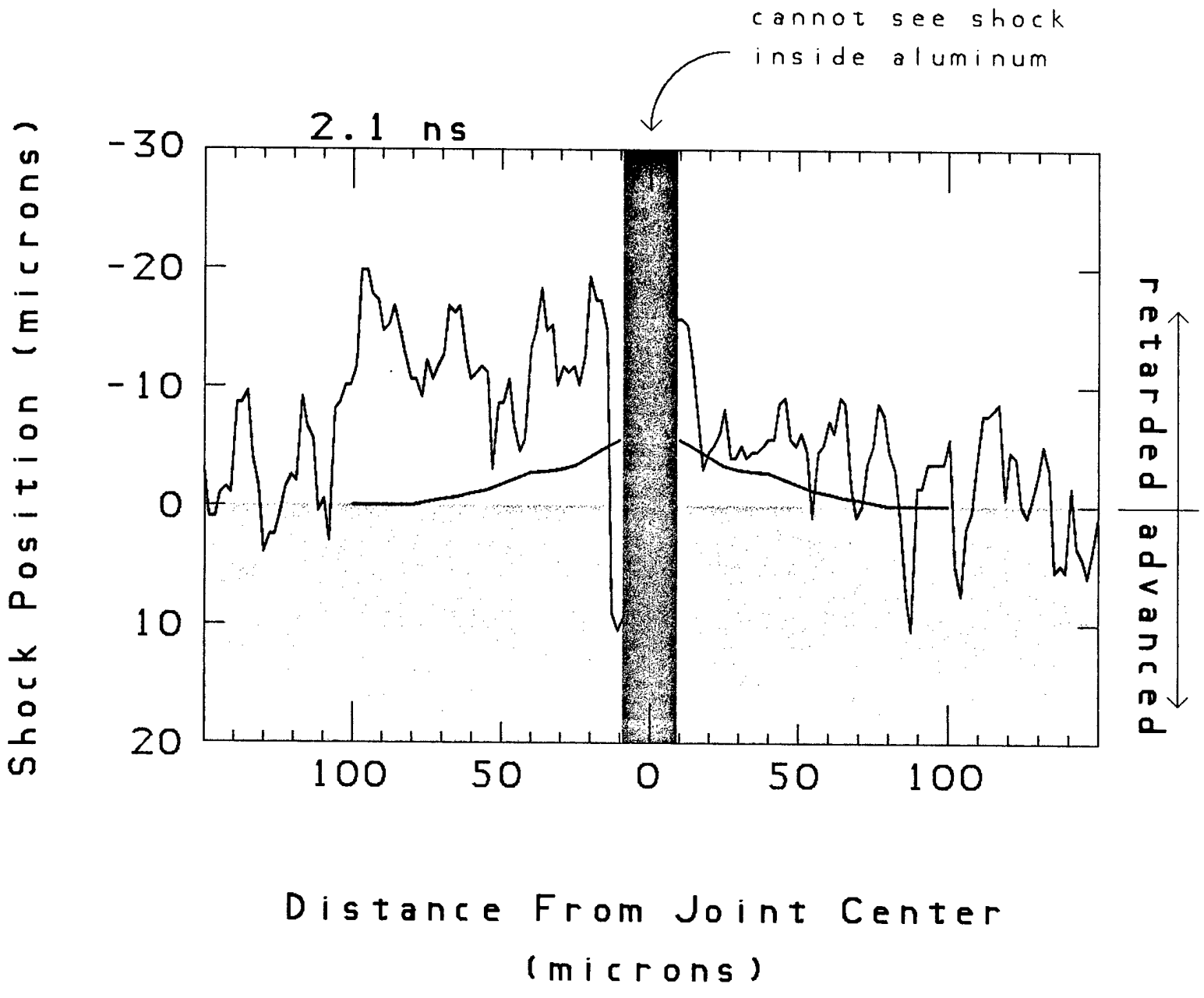
LASNEX Calculation at 1.1 ns



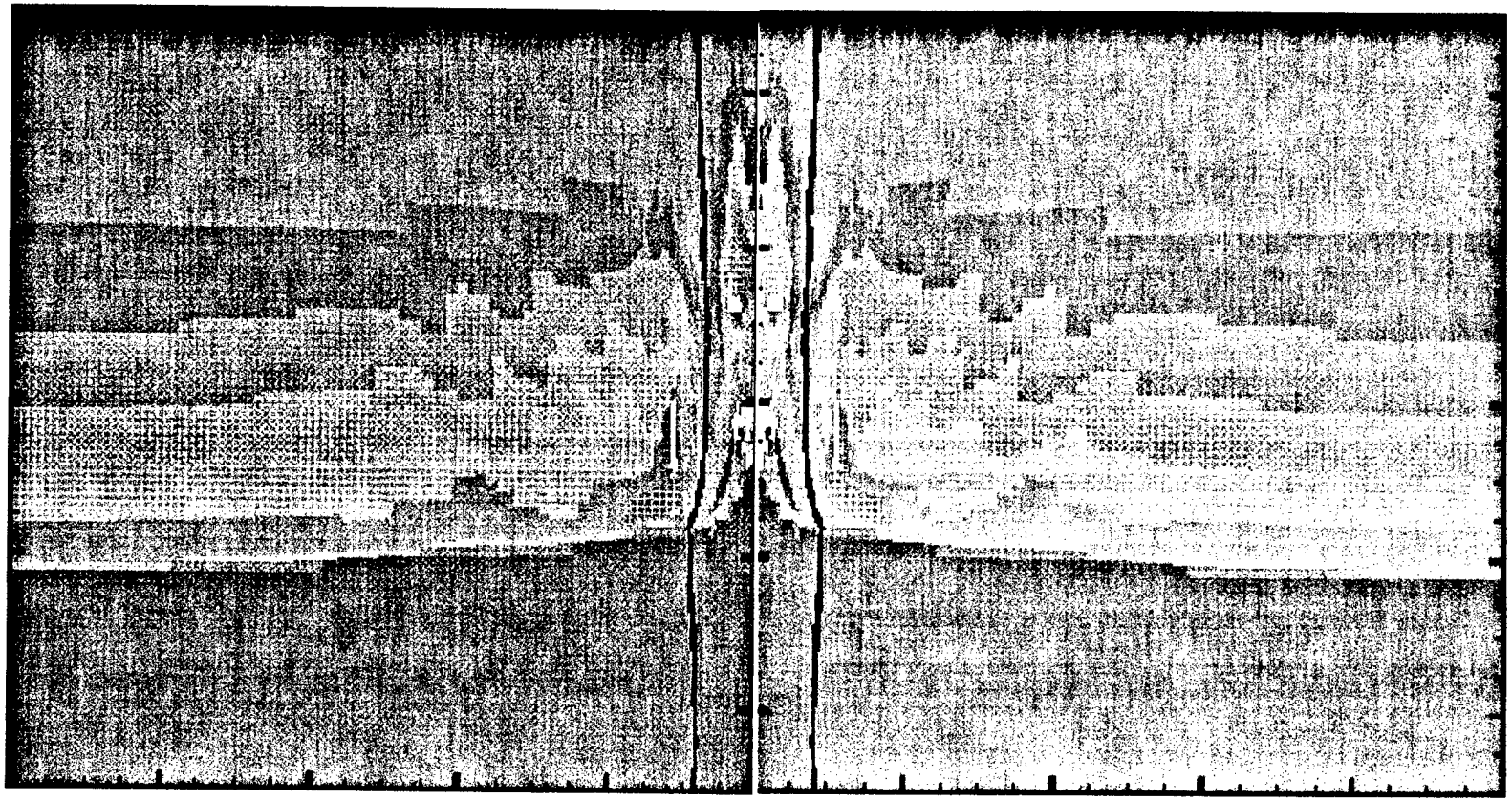
t = 2.1 ns

The left/right asymmetry in the data is probably due to the fact that the joint is not parallel to the hohlraum radiation, resulting in some shadowing of the left side.


ablation front
hohlraum wall
2.1 ns
fiducial
shock front
joint


cannot see shock
inside aluminum
2.1 ns
-30
-20
-10
0
10
20
100
50
0
50
100
Shock Position (microns)
retarded
advanced
Distance From Joint Center
(microns)

LASNEX Calculations at 2.1 ns

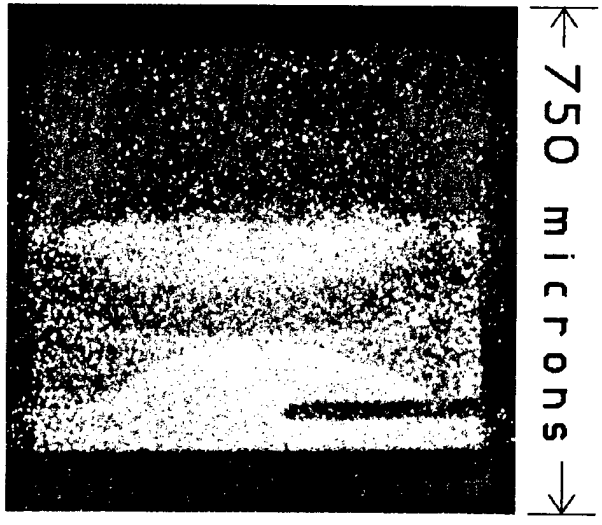


t = 3.1 ns

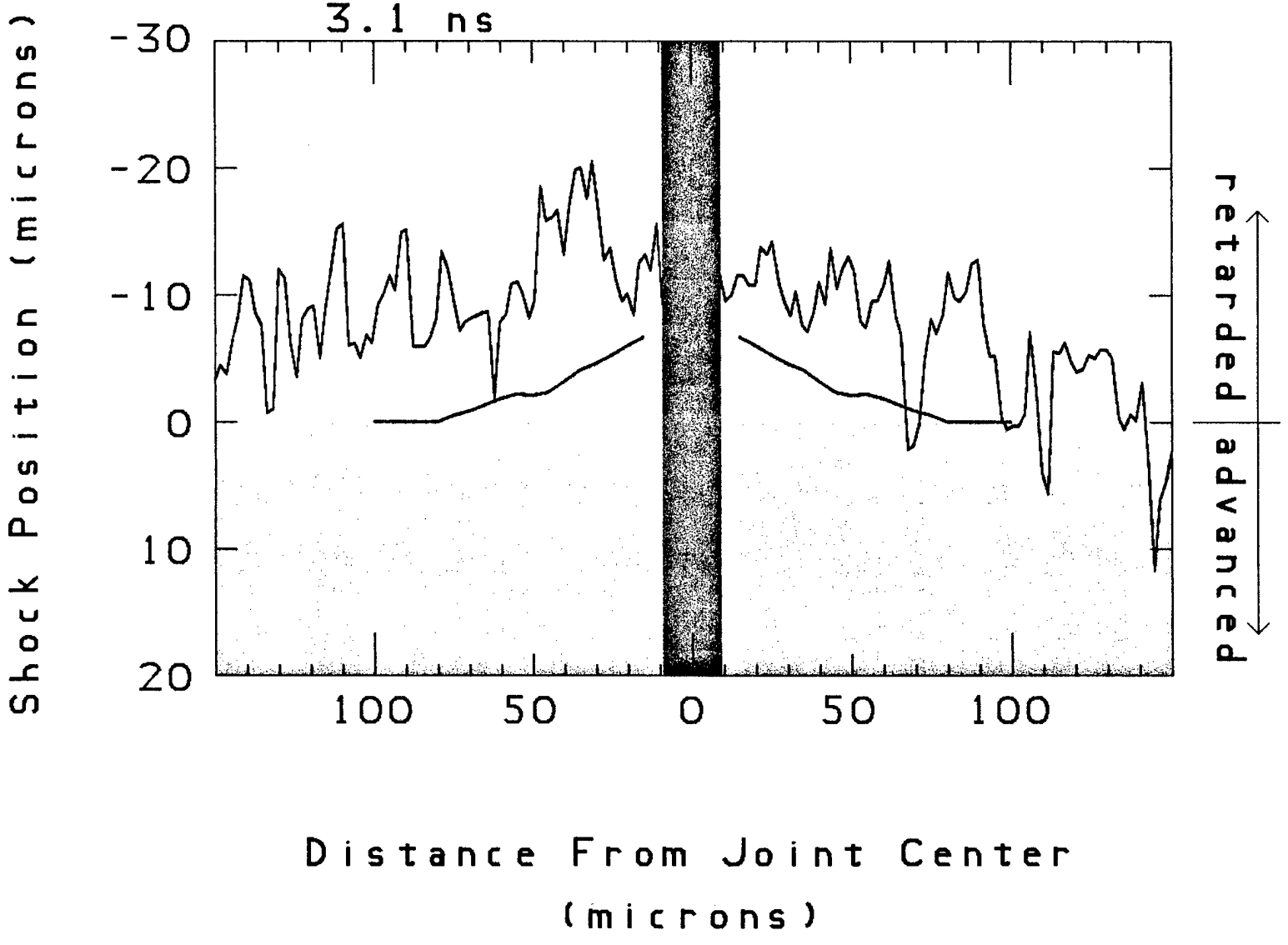
The observed retardation of the shock front near the joint is greater than predicted.

CONCLUSION:

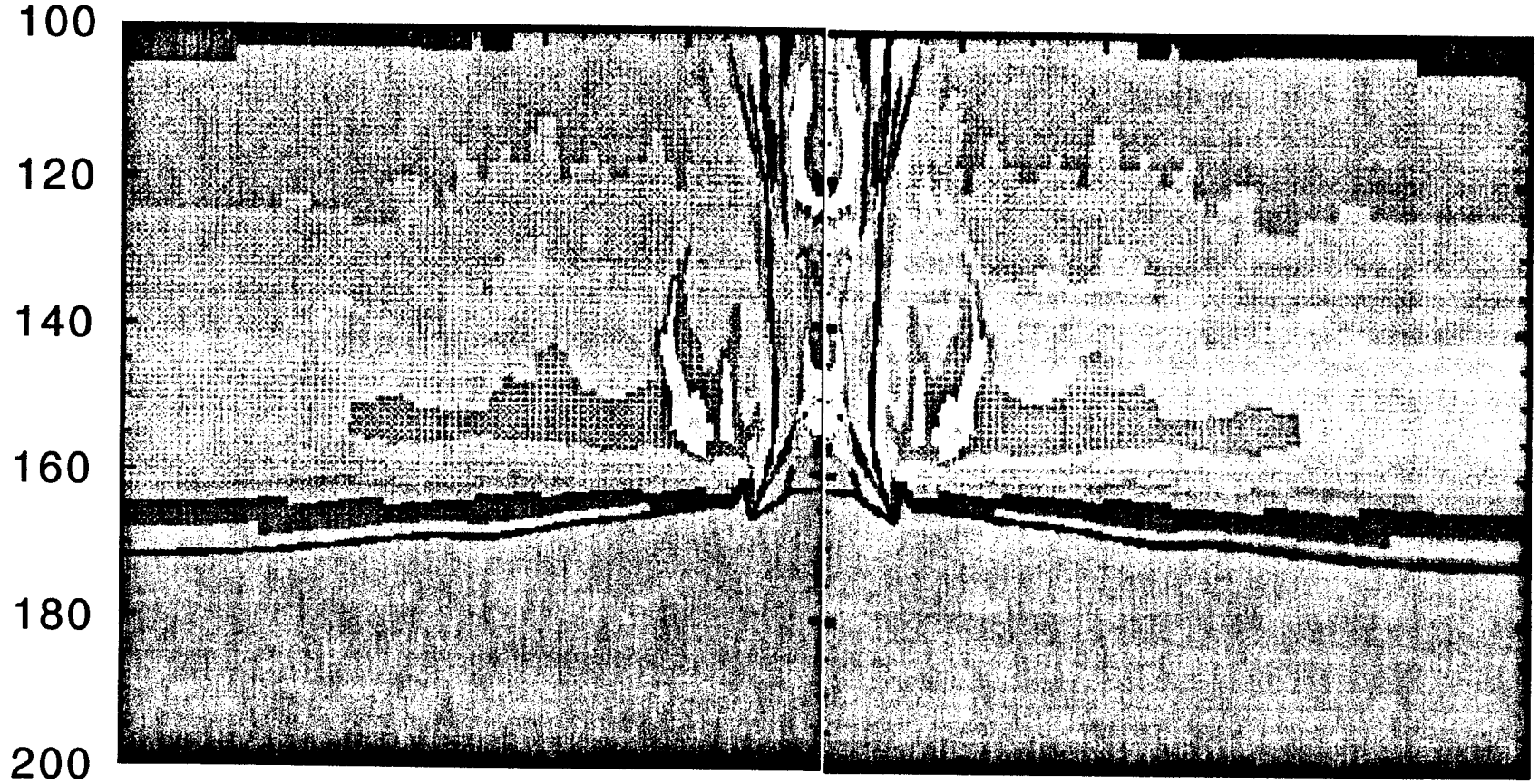
LASNEX predicts the retardation effect, but not the magnitude of the effect.



3.1 ns

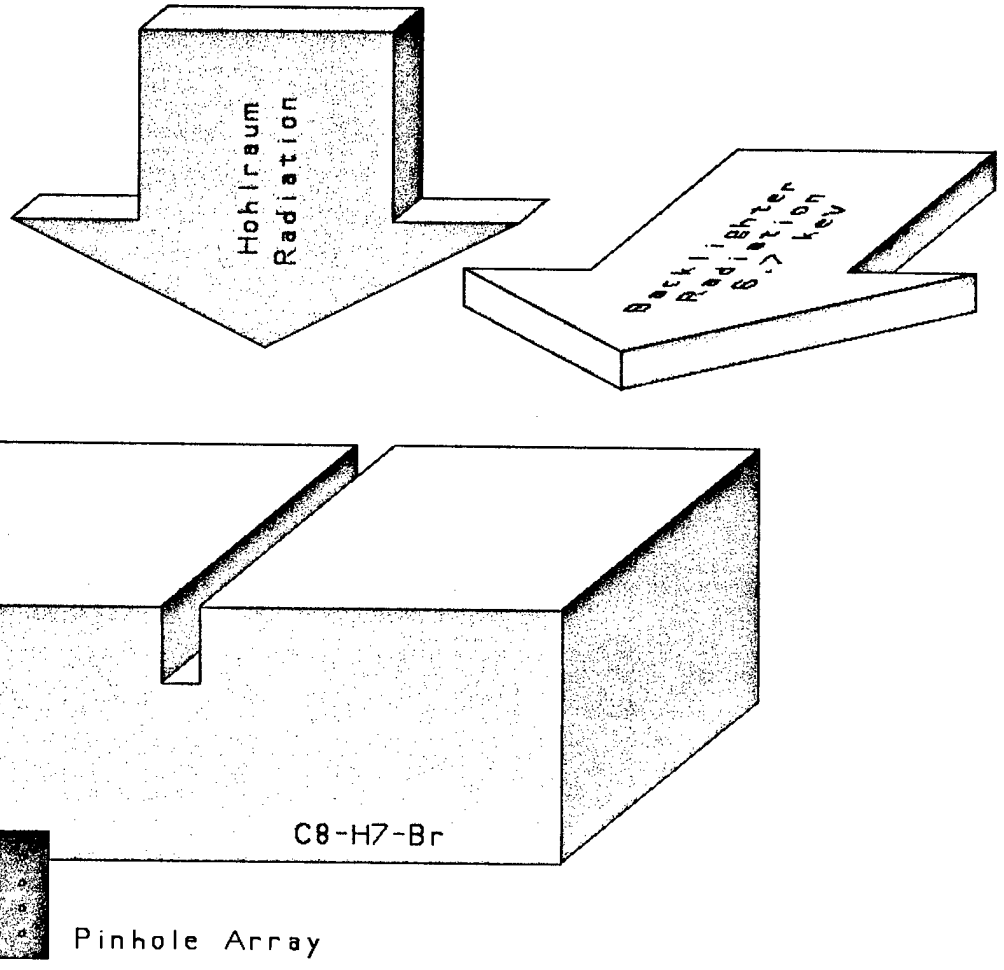

3.1 ns
-30
-20
-10
0
10
20
100
50
0
50
100
Shock Position (microns)
retarded
advanced
Distance From Joint Center
(microns)

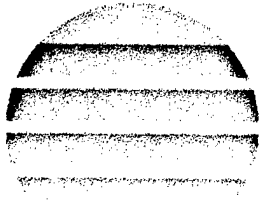
LASNEX Calculation at 3.1 ns



Target #2: 200 micron high by 700 micron wide by 200 micron deep piece of brominated polystyrene with a 15 micron wide by 30 micron deep notch cut in the surface nearest the radiation source.

RAGE predicts that (1) the notch will widen but not deepen as material is ablated and (2) the shock away from the notch will break out the back surface before the shock directly beneath the notch.



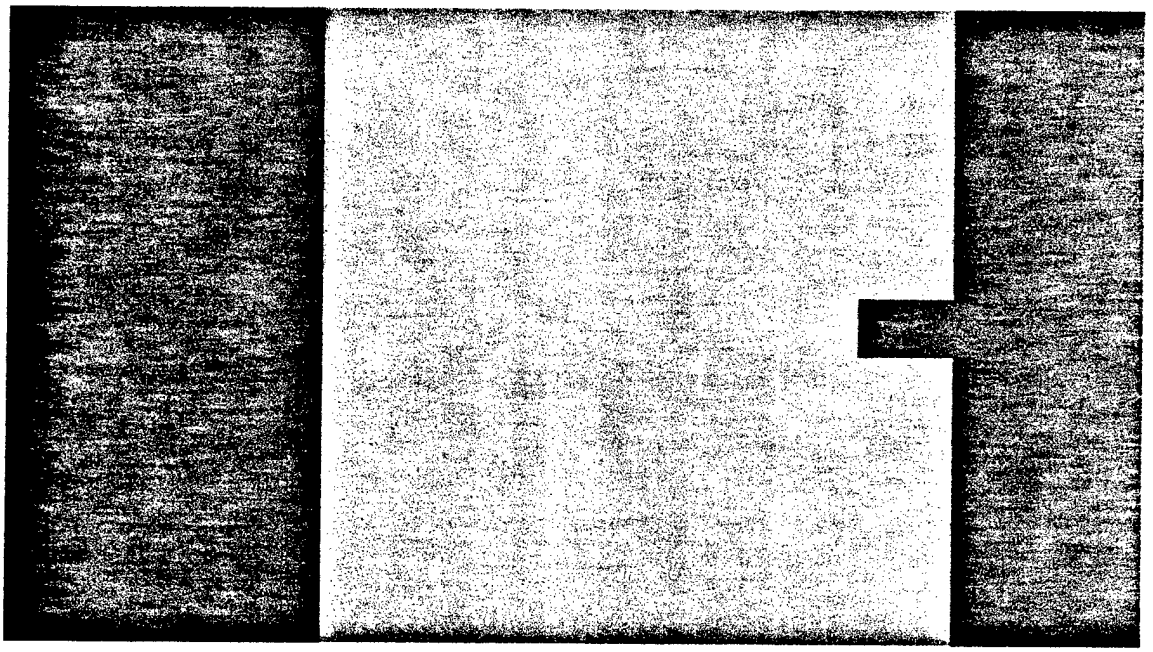


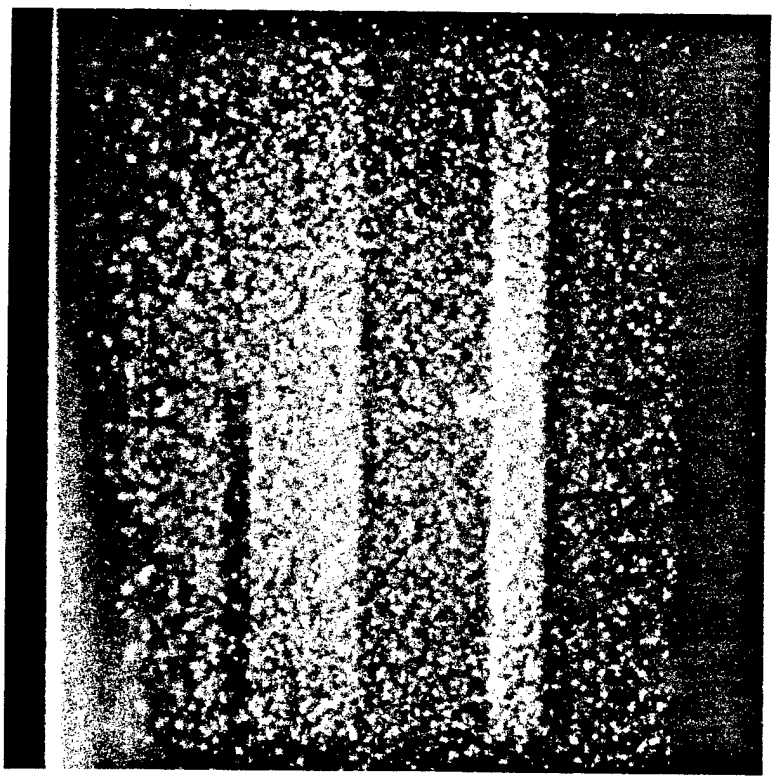
Gated Imager

t = 0 ns

The Gated X-ray Imager can easily resolve the 15 micron wide notch.

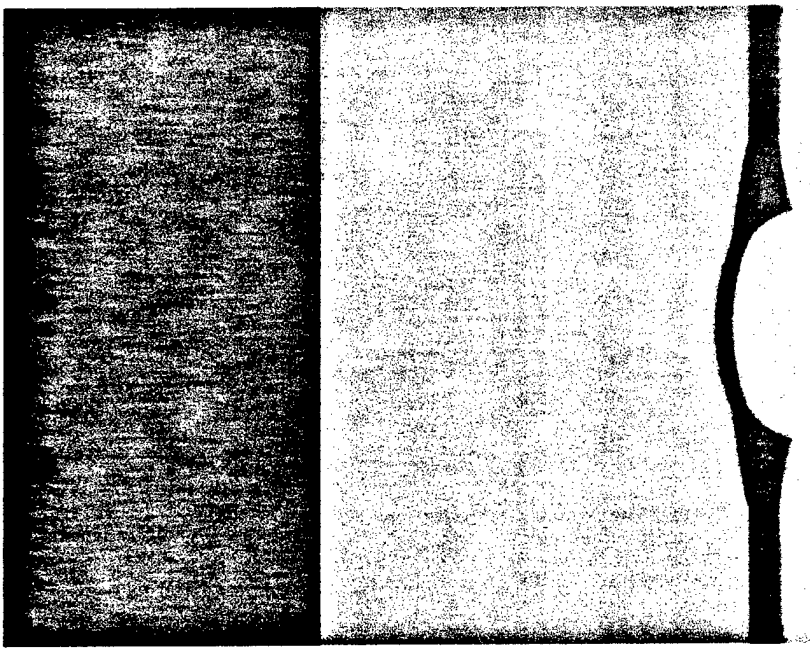
Compare the RAGE density calculations (left) with NOVA data (right)

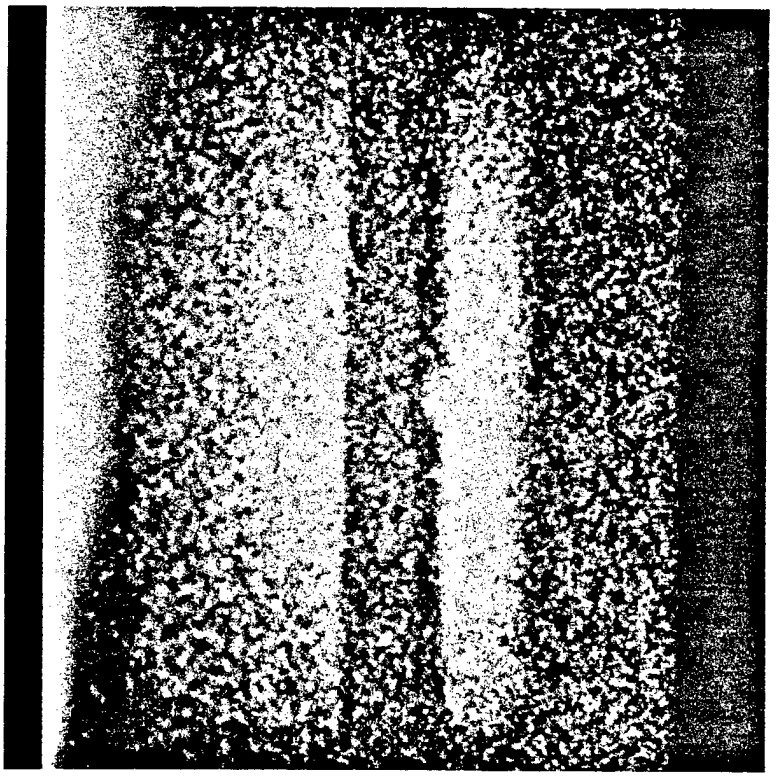




t = 0.99 ns

Qualitative features such as the bow of the shock front and width of the notch agree well with RAGE calculations.

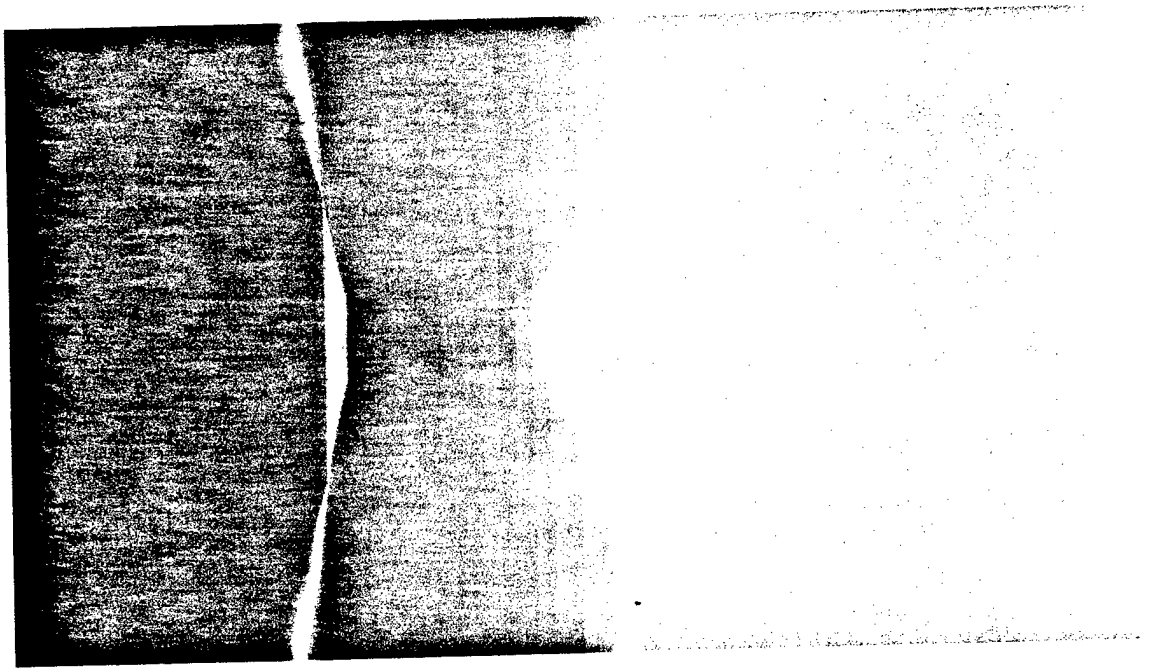


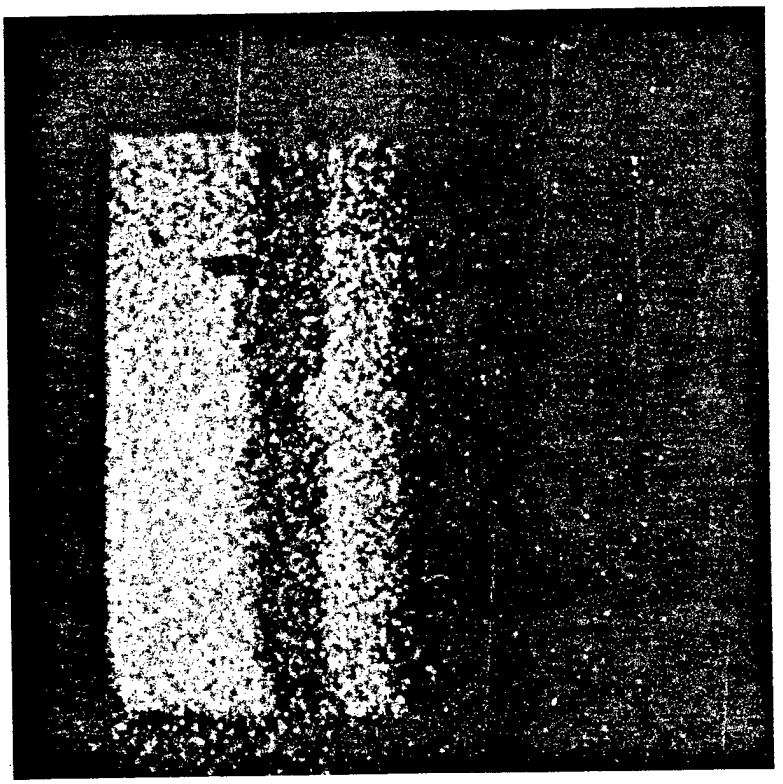


t = 2.93 ns

The shock front away from the gap reaches the back surface before the shock front directly under the original gap.

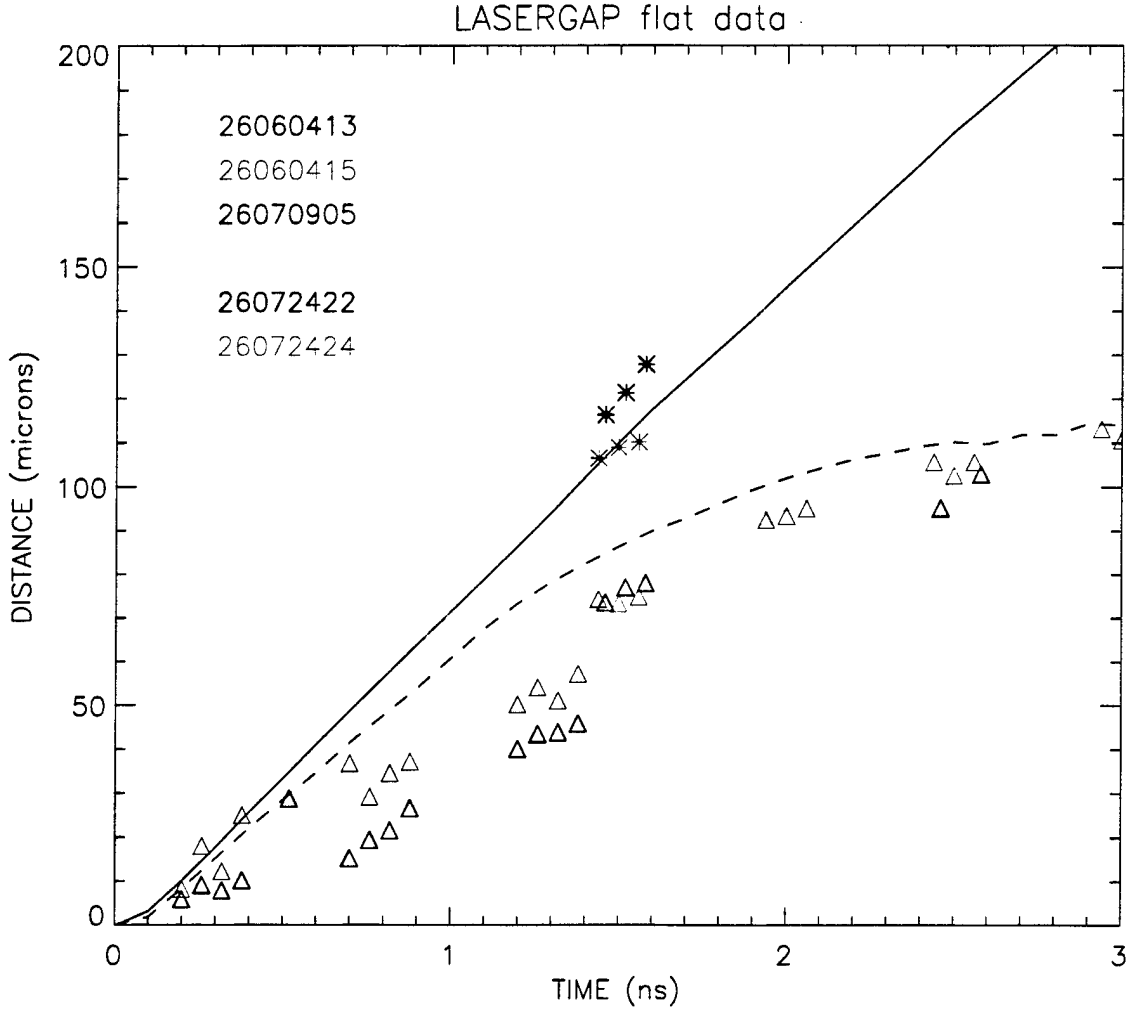
Note that the 'as built' targets ranged from 126 to 194 microns in thickness (vertical) instead of the specified 200 microns. This limited the available observation time for shock front propagation and effected the properties of the shock breakout.





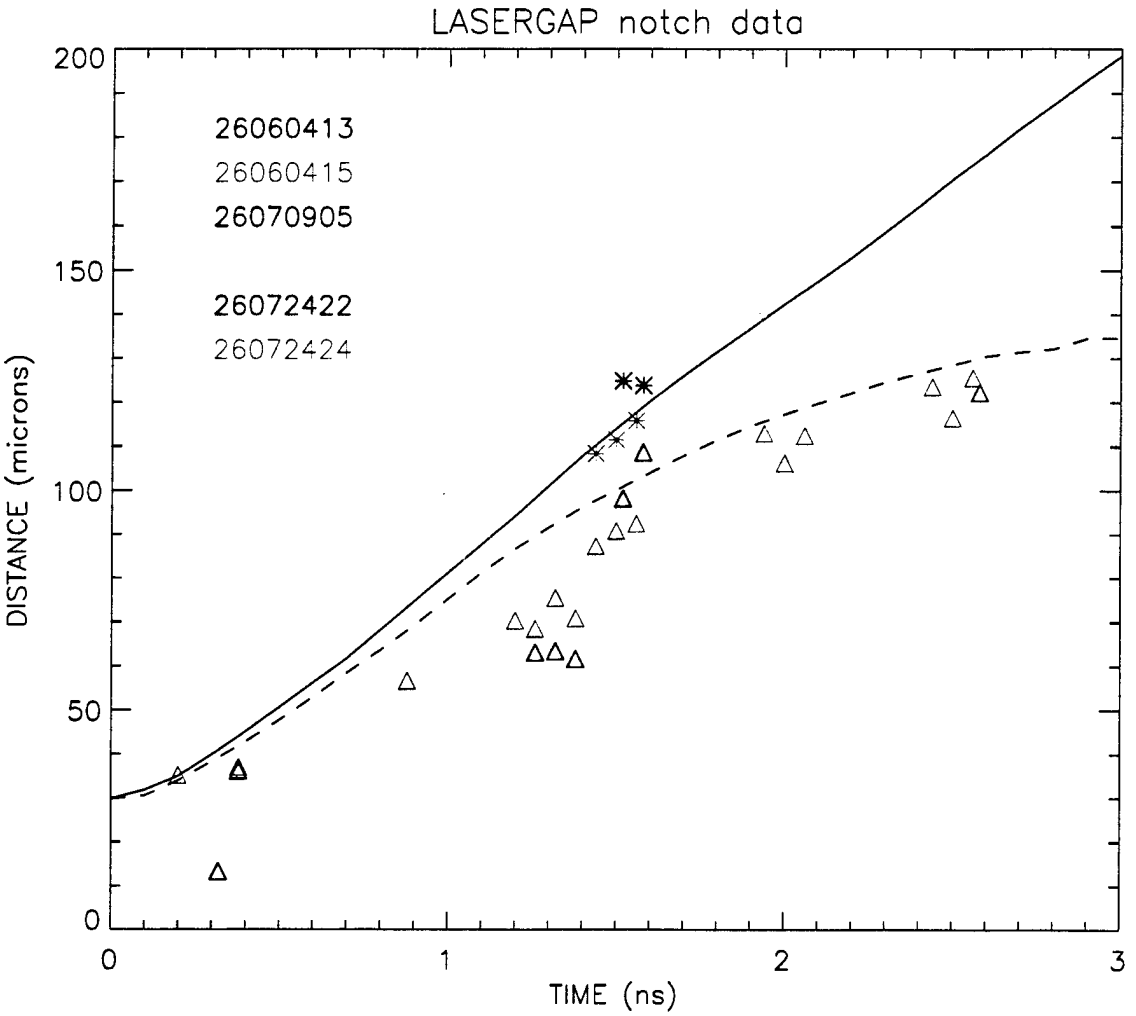
Shock front vs. time (stars) and ablation front vs. time (triangles) are compared to RAGE calculations for the region well away from the gap.

Shock front vs. time (stars) and ablation front vs. time (triangles) are compared to RAGE calculations for the region directly below the gap.


LASERGAP flat data
26060413
26060415
26070905
26072422
26072424
DISTANCE (microns)
TIME (ns)
0
50
100
150
200
0
1
2
3

Shock front vs. time (stars) and ablation front vs. time (triangles) are compared to RAGE calculations for the region well away from the gap.

Shock front vs. time (stars) and ablation front vs. time (triangles) are compared to RAGE calculations for the region directly below the gap.


LASERGAP notch data
26060413
26060415
26070905
26072422
26072424
DISTANCE (microns)
TIME (ns)
0
50
100
150
200
0
1
2
3

CONCLUSION:

RAGE calculations agree well with observations.

M97008836

Report Number (14) LA-UR--97-2444
CONF-9706168--

Publ. Date (11) 199708
Sponsor Code (18) DOE/DP, XF
UC Category (19) UC-712, DOE/ER

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