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Title: PINHOLE APERTURE POINT BACKLIGHTER DEVELOPMENT EXPERIMENTS ON TRIDENT, 9-13, 2001

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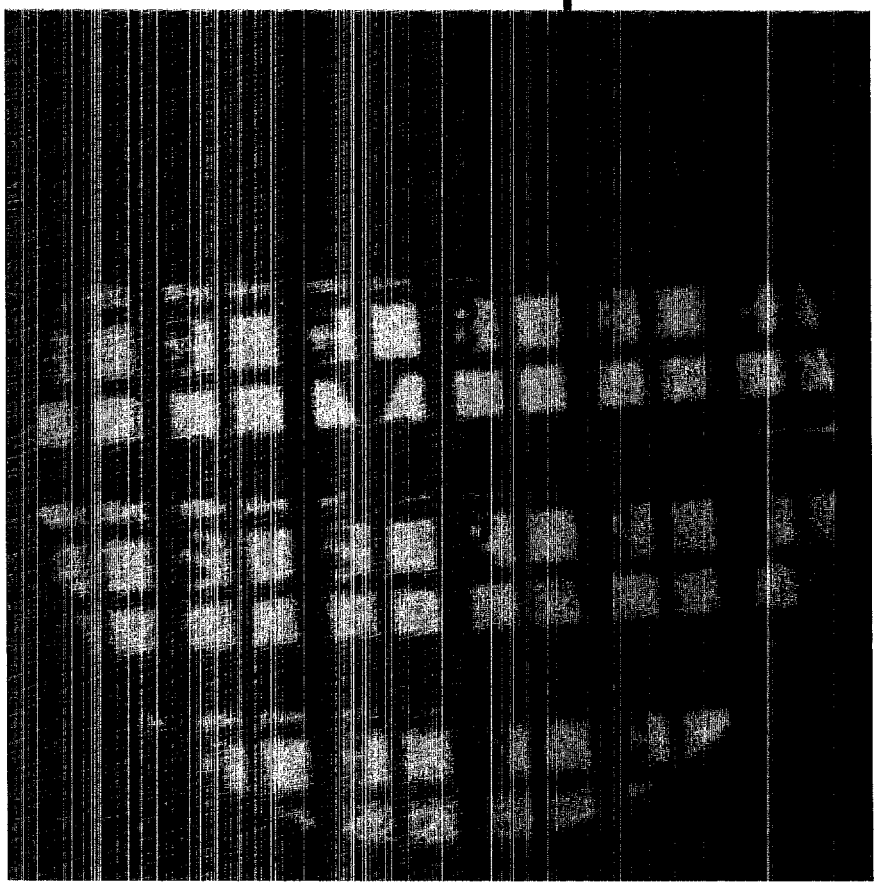
Pinhole Aperture Point Backlighter Development Experiments on Trident 9-13 July 2001 Post Shot Report



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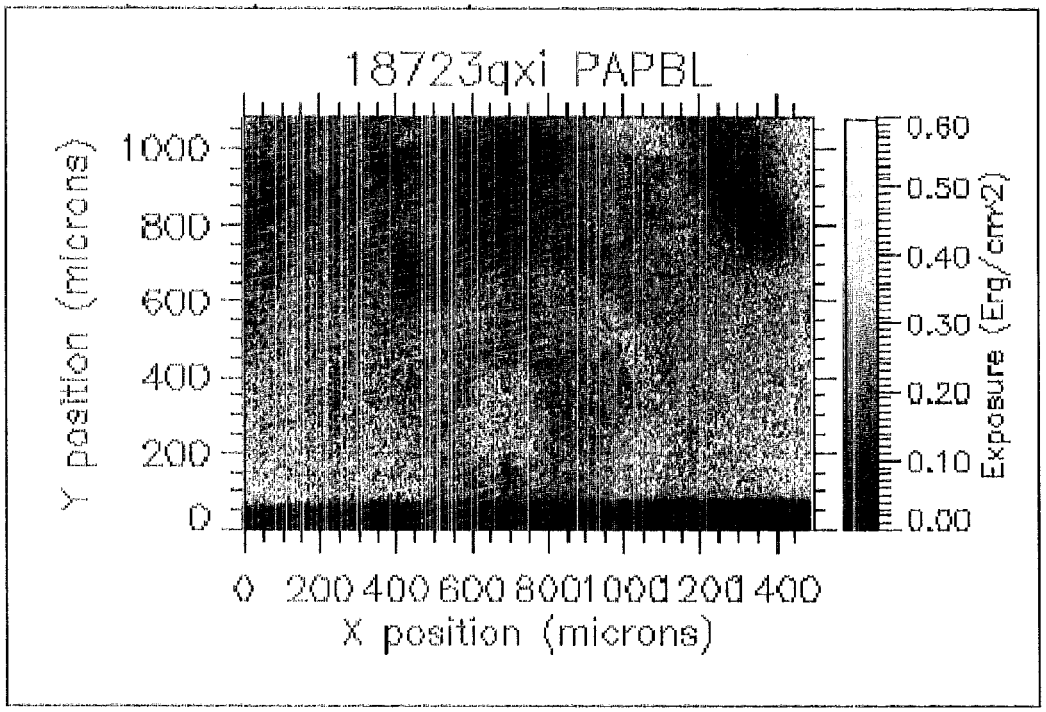
Background:

Pinhole aperture point backlighter (PAPBL) imaging has been used on experiments on Omega, but results have been compromised by large backgrounds. This technique has advantages over traditional area backlighting/pinhole imaging, and our Omega experiments could benefit from this capability, but Omega time is expensive and not the



place for developing diagnostic techniques if they can be developed on Trident instead.

PAPBL shot from Direct Drive Cylinder Mix experiments on Omega (DDCYLMIX 00-1, January 18 & 19, 2000). [See LA-UR-00-4187, Post-Shot Report,Direct Drive Cylinder Mix]

In this campaign, we used Trident to obtain clean PAPBL images. Having accomplished that, we attempted to replicate the noise environment of Omega by producing hot electrons and having them impinge on material to produce high-energy x-rays similar to those that might be produced by hot electrons impinging on diagnostics or target positioner components on Omega.

Backlighter target design was based, to some degree, on that shown by Bullock et al. at the42nd Annual APS-DPP Meeting in Québec City, Québec, Canada, October 23-27, 2000. [A. B. Bullock *et al., Bull. Am. Phys. Soc.* **45**,(7) 359 (2000); A. B. Bullock *et al., Rev. Sci. Instrum.* 72, 690 (2001).]

We accomplished this to some degree and then attempted, with some success, to obtain a good PAPBL image in the presence of this noise. Results of this work suggest methods that might reduce the background noise in Omega PAPBL images.

Goals:

A. Obtain a pinhole aperture point backlighter (PAPBL) image on Trident.

B. Develop a method to simulate the high-energy background contribution to PAPBL images seen on Omega experiments in order to allow future experiments to optimize signal-to-noise in PAPBL imaging.

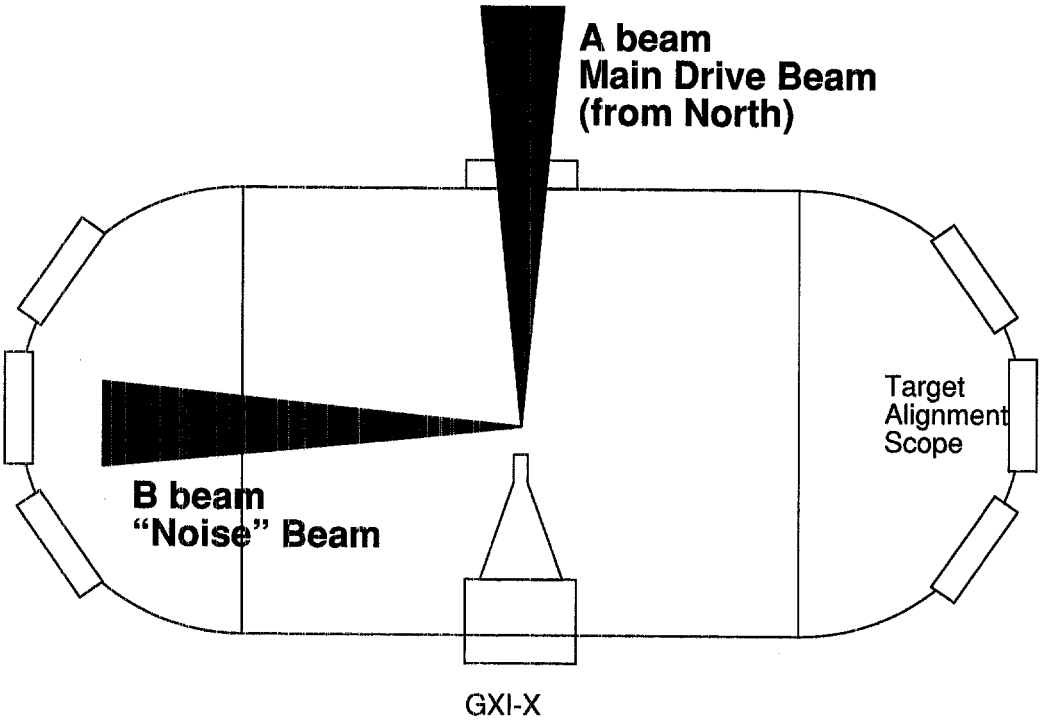
Laser conditions:

A beam:
North Port
0.8 ns
180 J
200 μm spot
Start of beam defines T_0

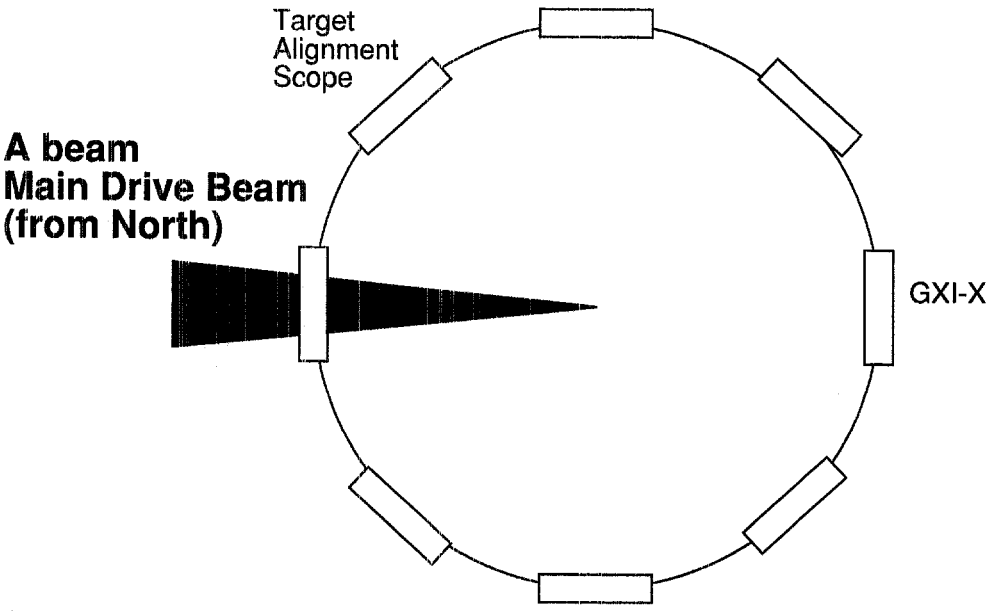
B beam:
West Port
0.8 ns
180 J
minimum spot size
0.5 ns earlier than A beam

Trident setup:

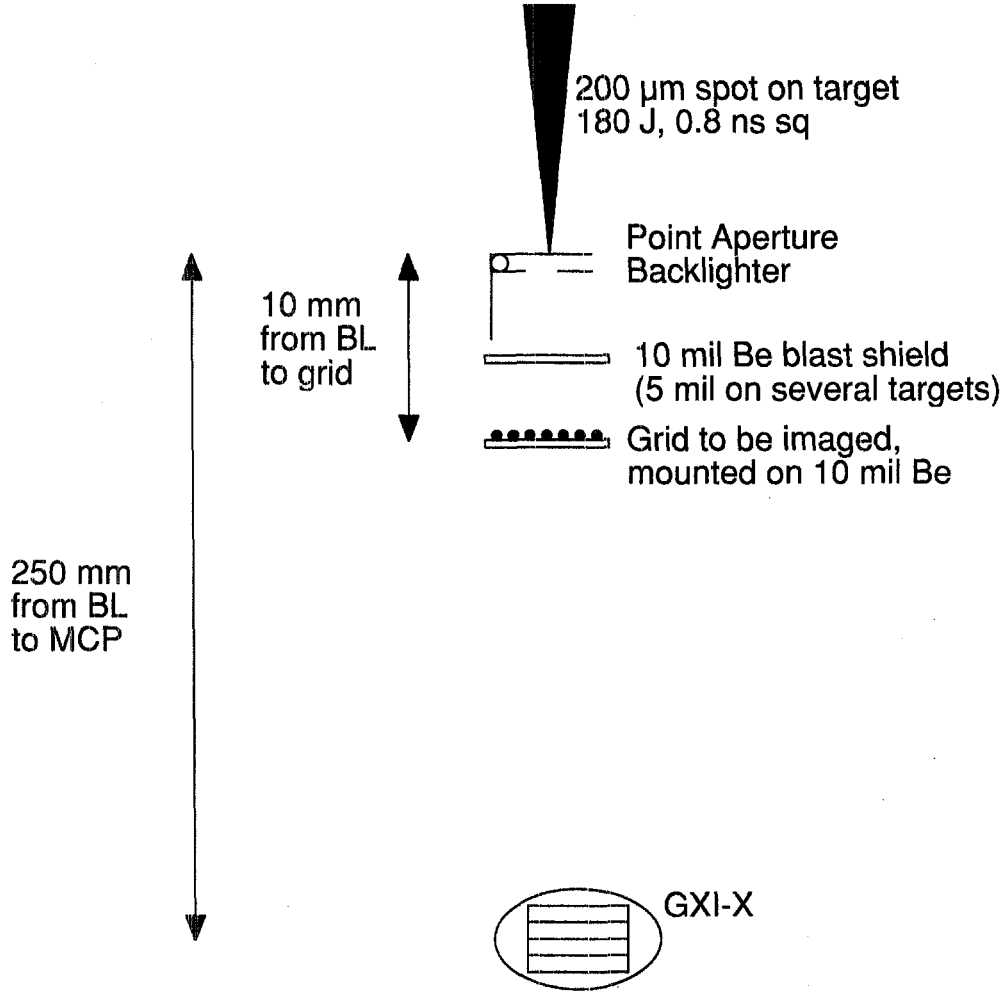
Top View:

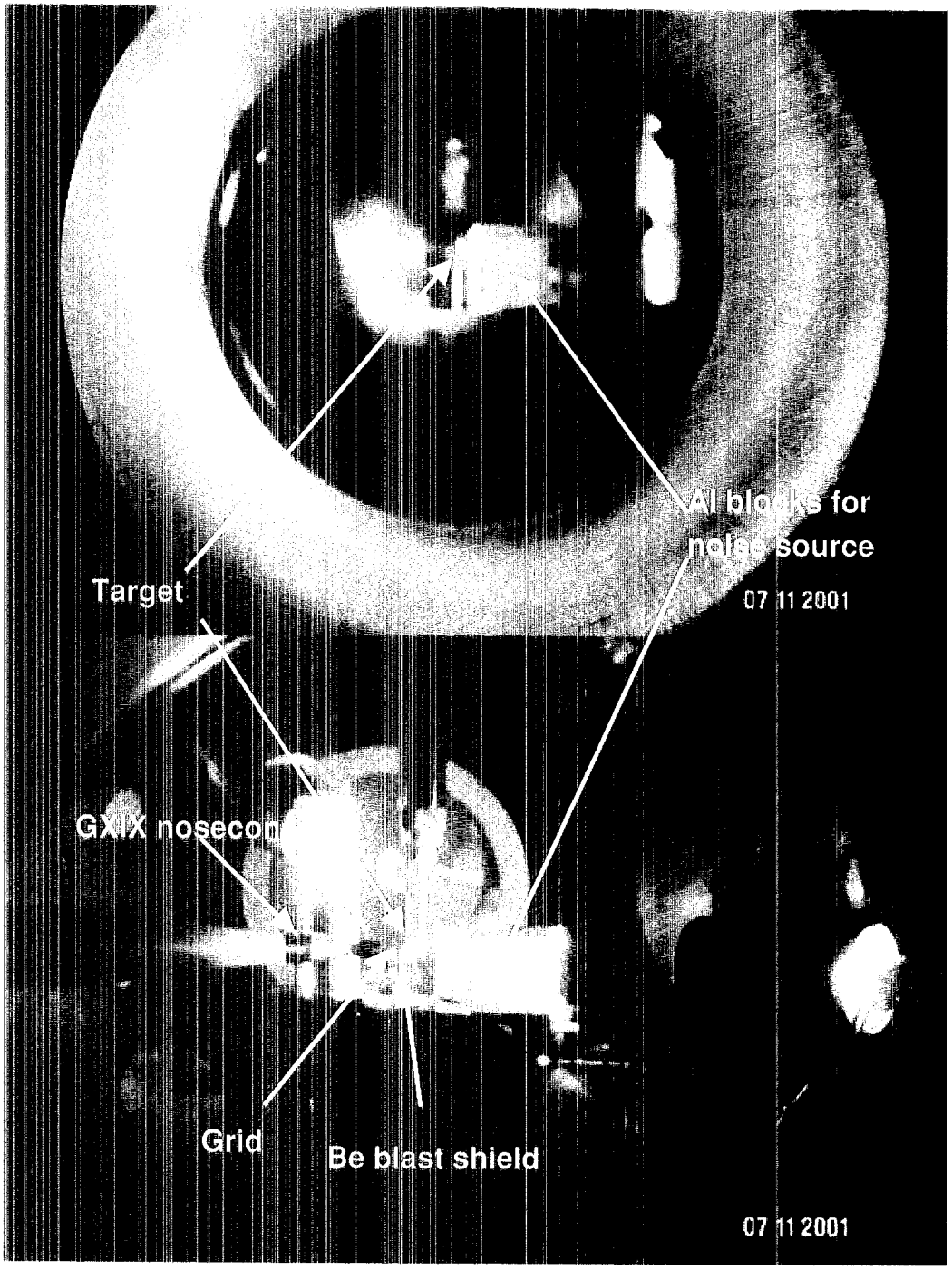


View from West:

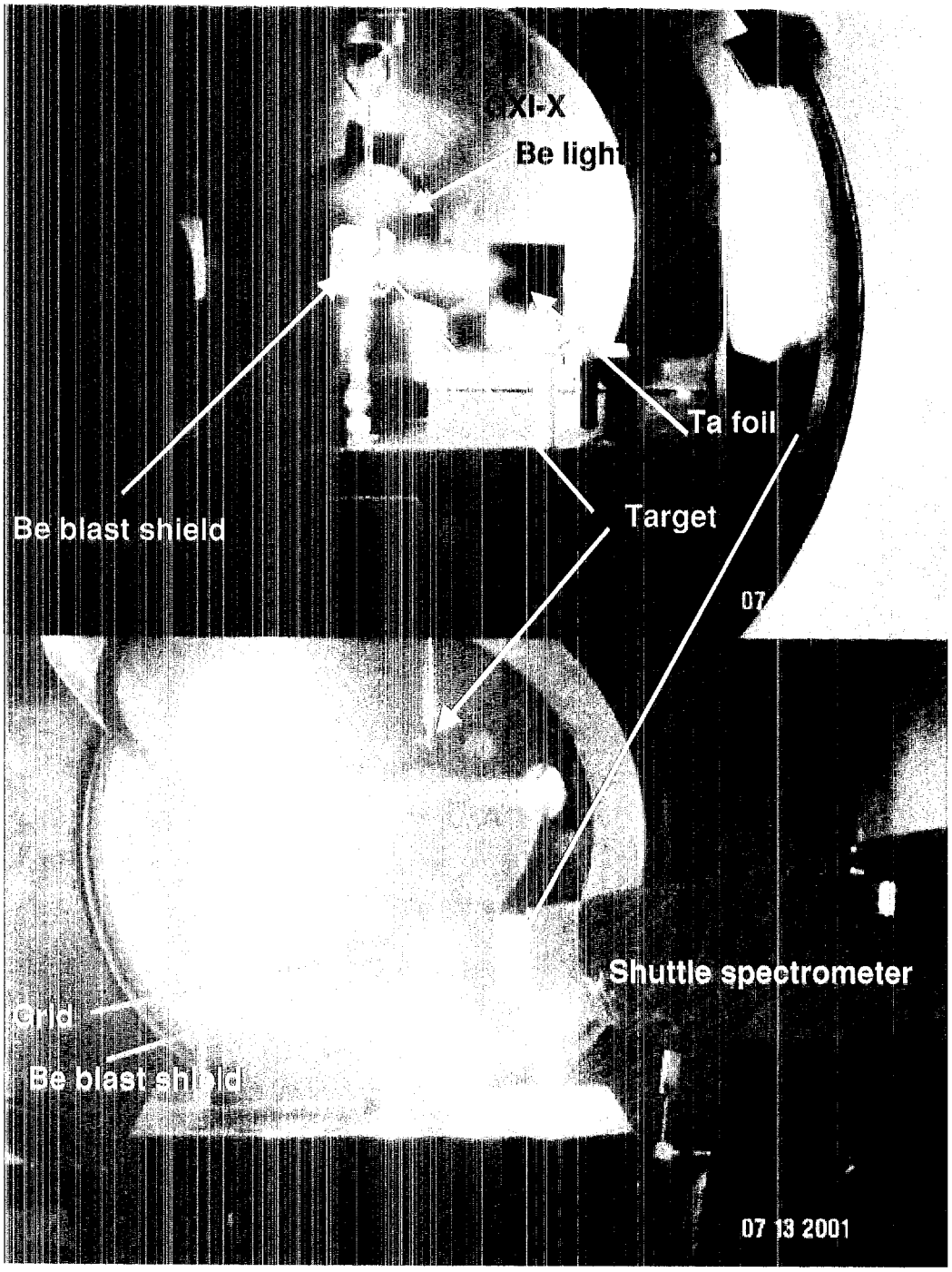


Layout near target chamber center:





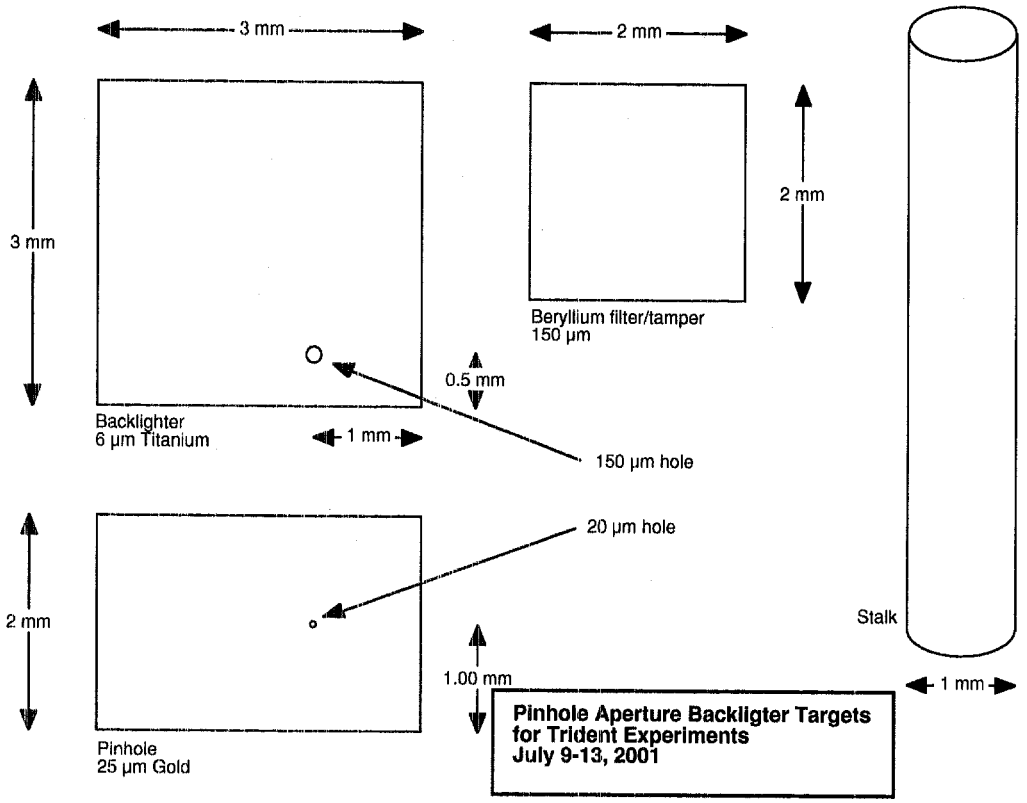
Setup for shot 13439. The aluminum blocks were added as a noise source. (Note that the date is off by one day, and the actual date was 7/10/2001.)

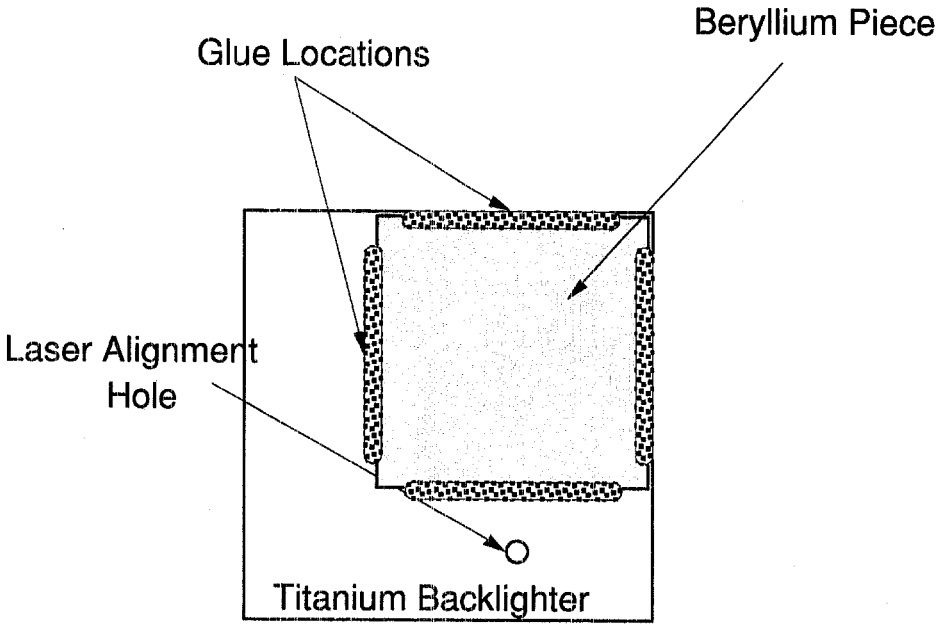


Setup for shot 13455. The tantalum foil was added as a noise source.In the lower picture, the target has not yet been placed in its shot position. (Note that the date is off by one day, and the actual date was 7/12/2001.)

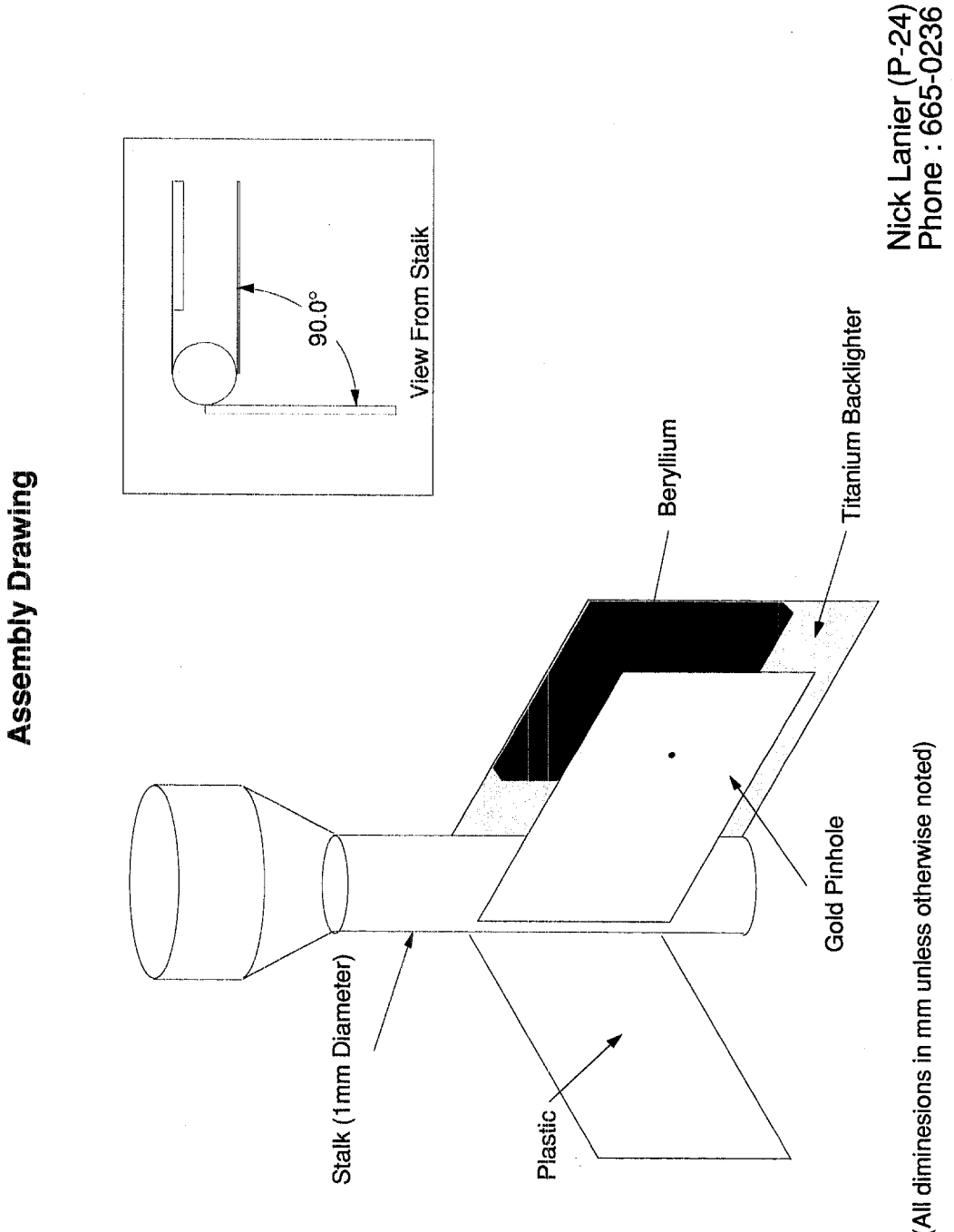
Target design:

Parts:





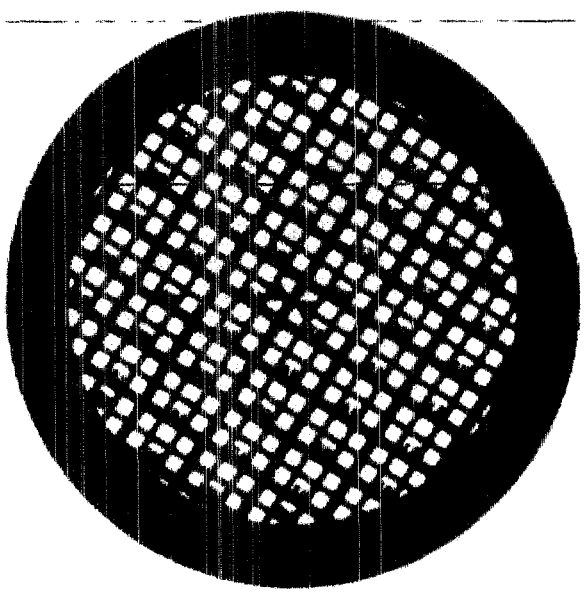
Assembly drawing:



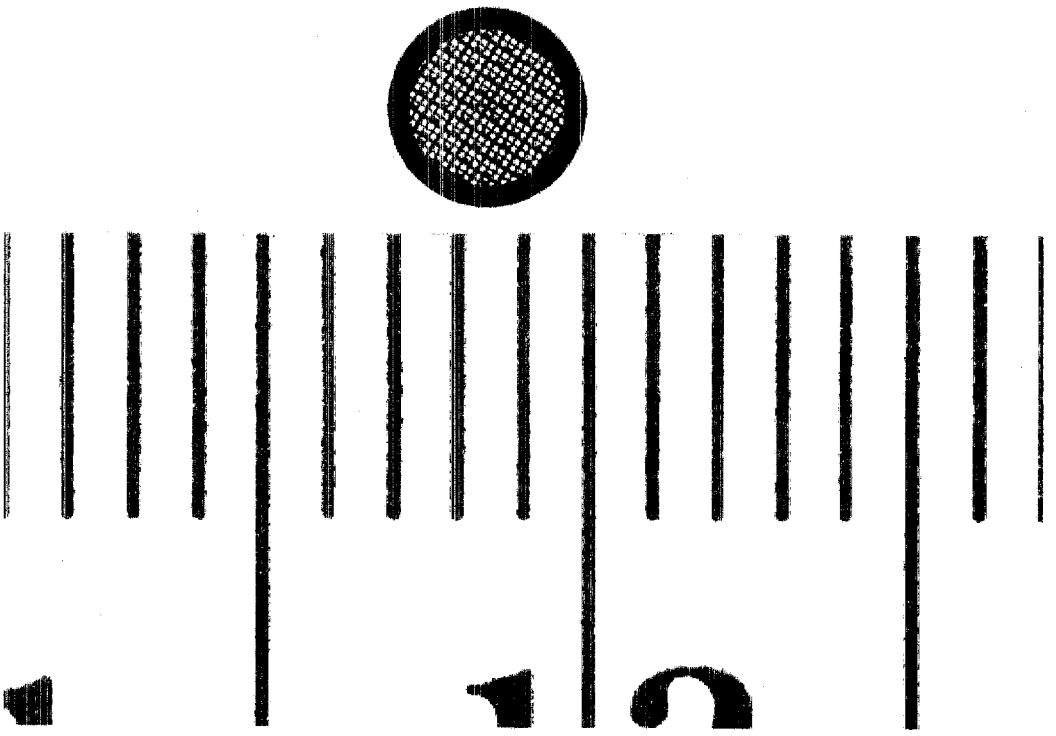
Grid:

The grid being imaged was a model G-200F1-G electron microscope finder grid obtained from Energy Beam Sciences, Inc. It consisted of a gold grid with 28 and 40 μm bars surrounding 90 μm square open areas. The center of the grid was marked with two arrows, and rectangles of the grid were identified with a number and letter combination, allowing identification of locations on the grid.

The grid was supported by gluing it at three perimeter points to a 20 mil piece of beryllium. For alignment purposes, the grid was placed in the target chamber facing the backlighter. A 10 mil beryllium blast shield (5 mil on shots 13450 and 13451) was placed between the grid and backlighter to prevent damage to the grid. After the first few shots, the blast shield was replaced on each shot.

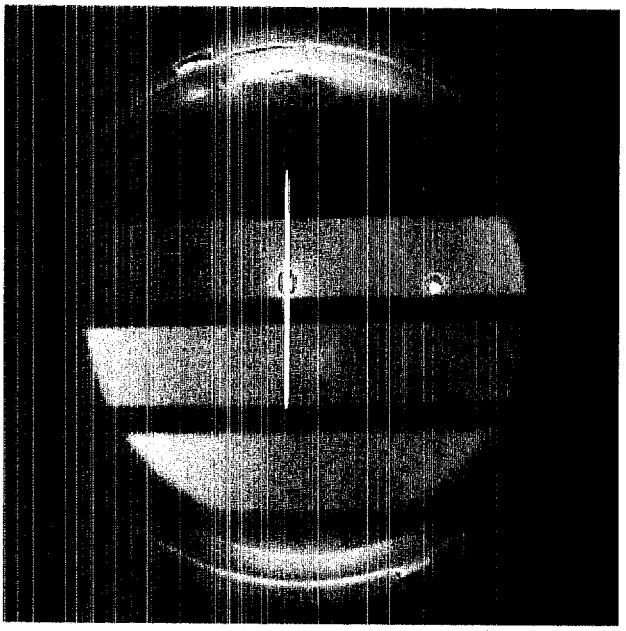


Grid used in these PAPBL imaging experiments. The thicker bars are 40 μm wide, and the thinner bars are 28 μm wide. (Photos courtesy of B. Carpenter.)

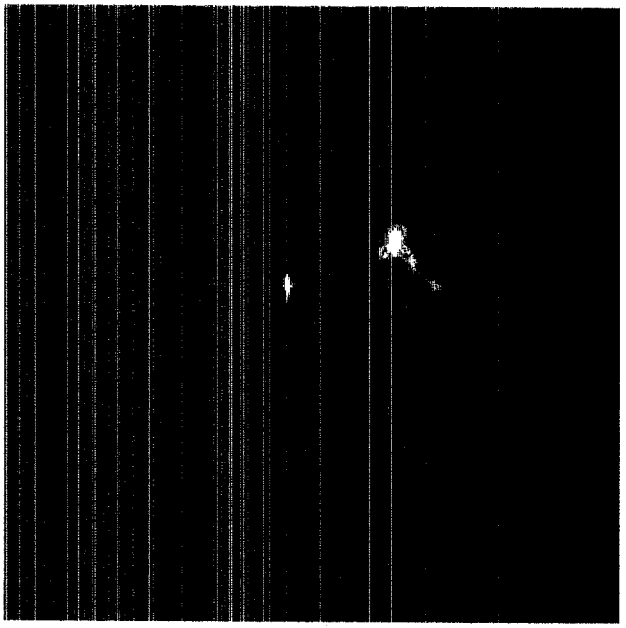


Grid used in these PAPBL imaging experiments. The overall diameter of the grid is about 3 mm. (Photos courtesy of B. Carpenter.)

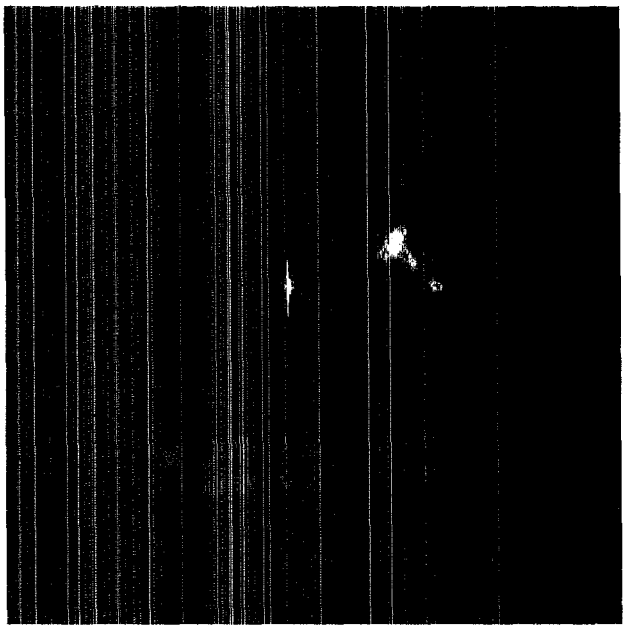
GXI-X images



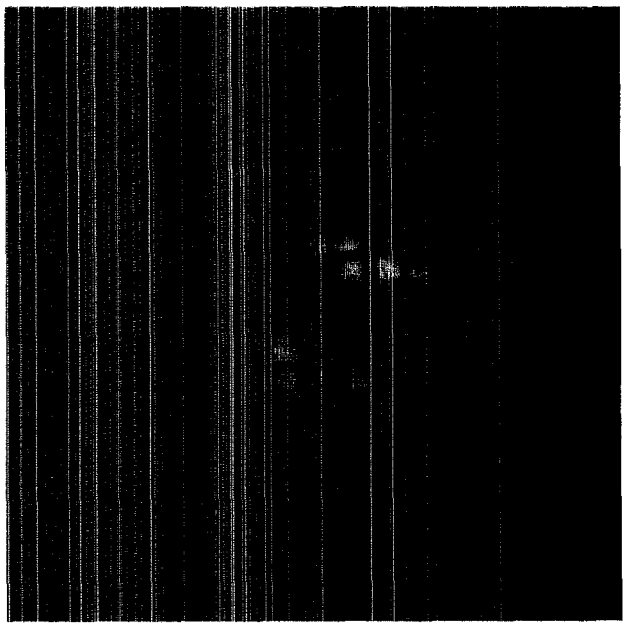
Shot 13430: Ti disk for timing.



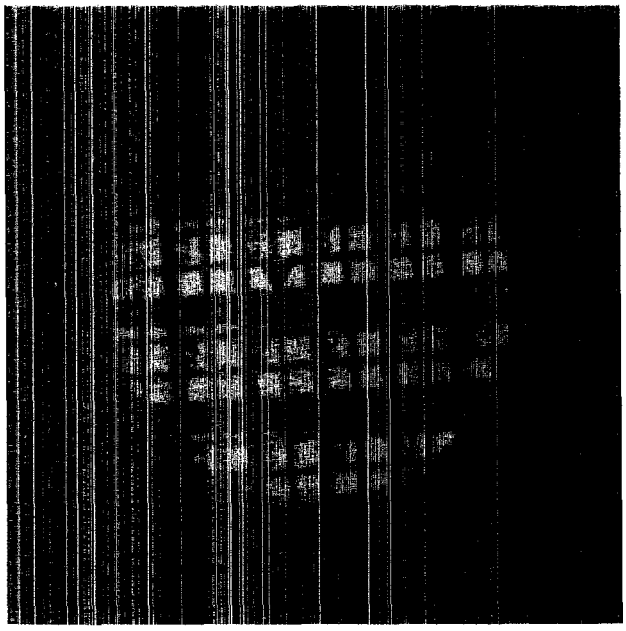
Shot 13432: PAPBL target, grid was misaligned.



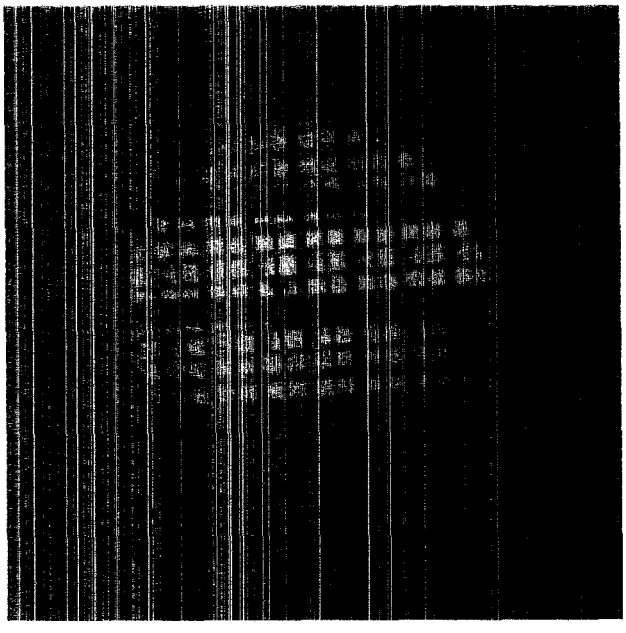
Shot 13433: PAPBL image of a grid on the lower two strips.



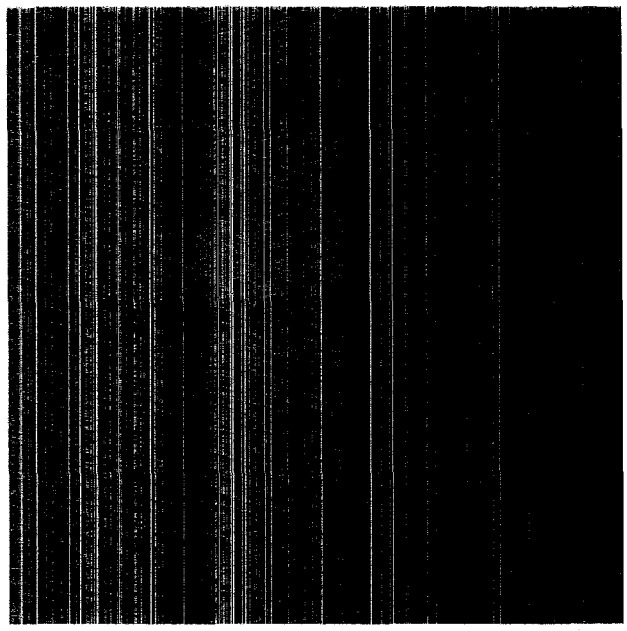
Shot 13434: Better timing gets the full grid image on the imager, but the blast shield has enough debris to prevent good transmission. A 1 mil Be blast shield was added to the nose of the GXI-X to eliminate the light leak seen in previous shots, probably due to pinholes in the Be light shield on the GXI-X microchannel plate.



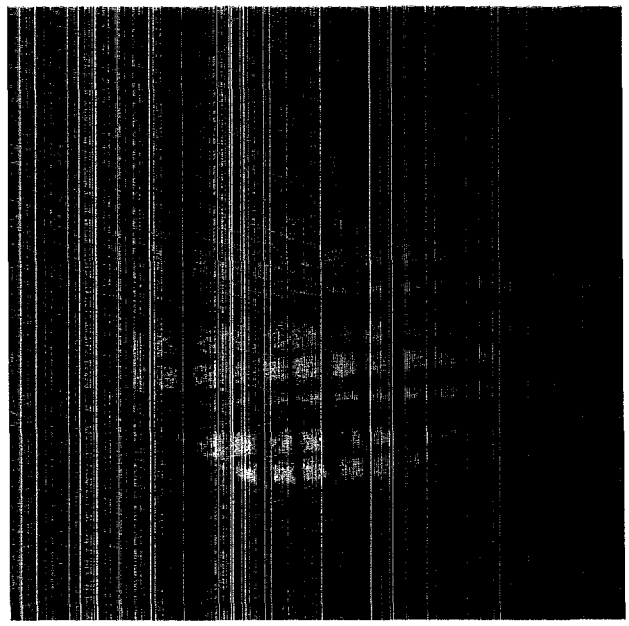
Shot 13435: Good alignment and timing and a new blast shield yield a good image.



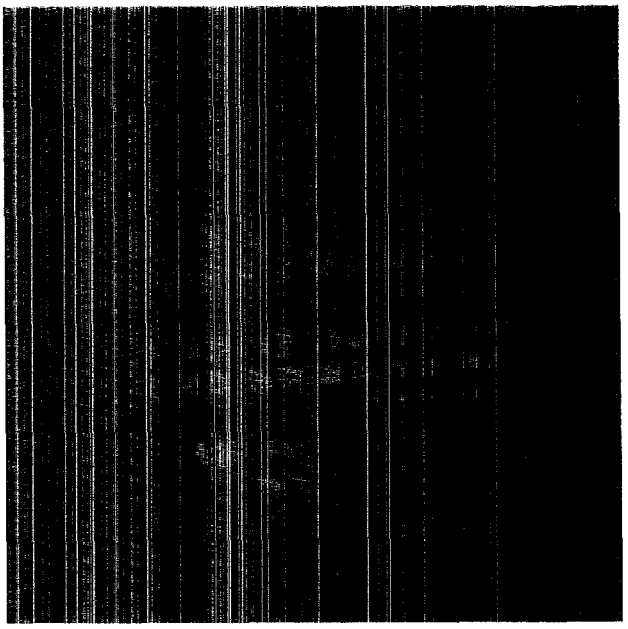
Shot 13436: PAPBL is moved 5 mm north to reduce the magnification to approximately 16X.



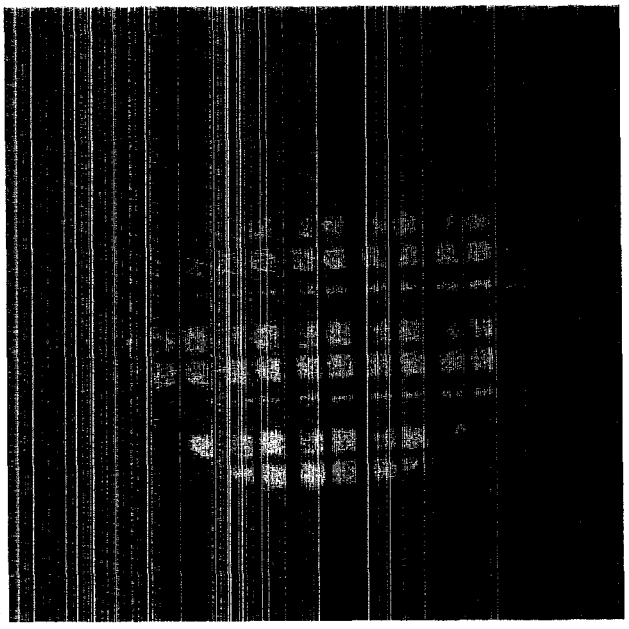
Shot: 13437: RPP is removed and the backlighter is placed at best focus, but the target appears to be misaligned.



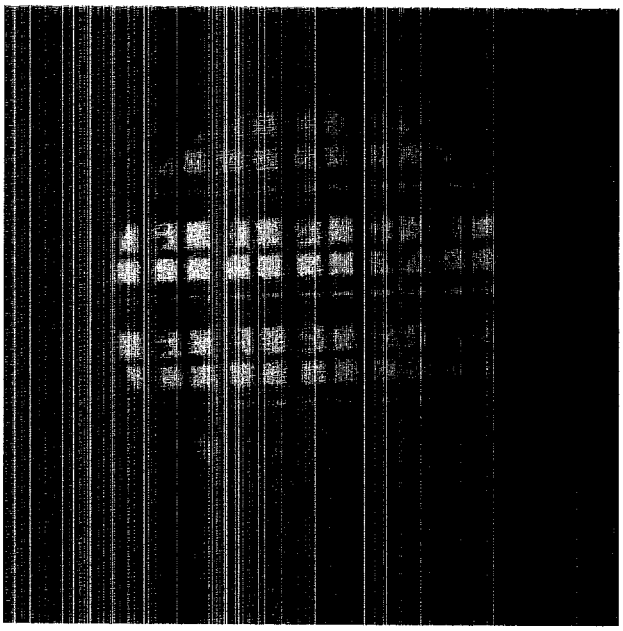
Shot 13438: RPP is still out, but this time a good image is obtained, though apparently not as good as with RPPs.



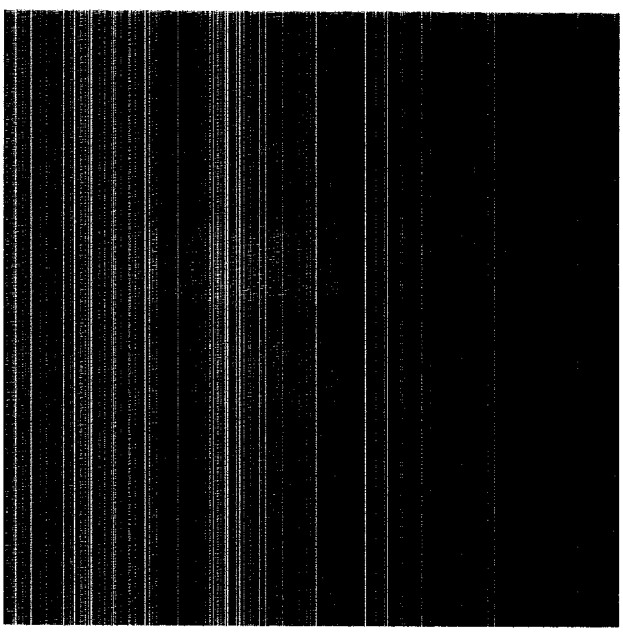
Shot 13439: Again, backlighter beam is at best focus with no RPP, but with aluminum blocks near the field of view.



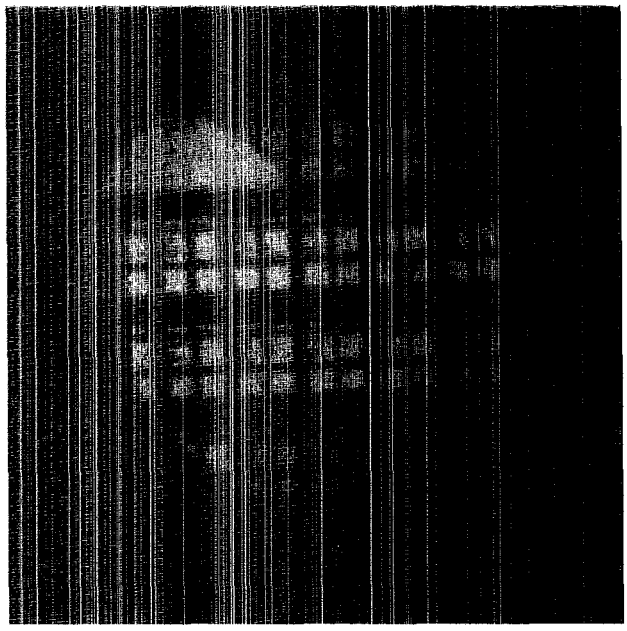
Shot 13446: RPP back in, but with material still in close proximity.



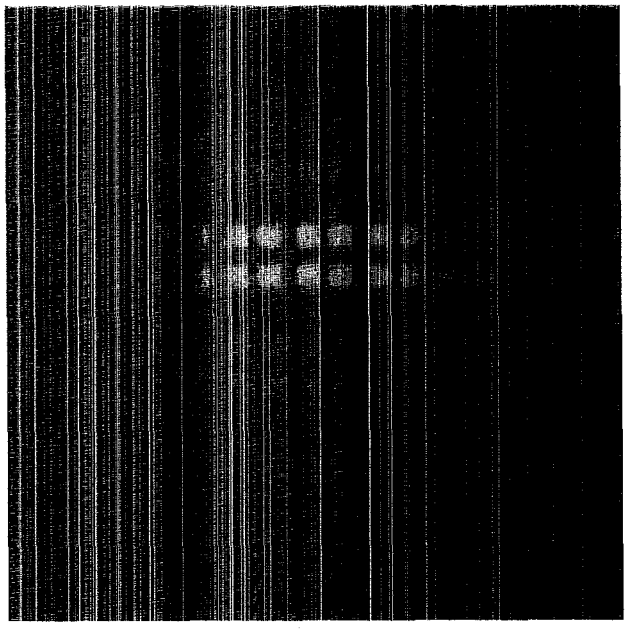
Shot 13447: PAPBL image with no beryllium between the backlighter and pinhole substrate.



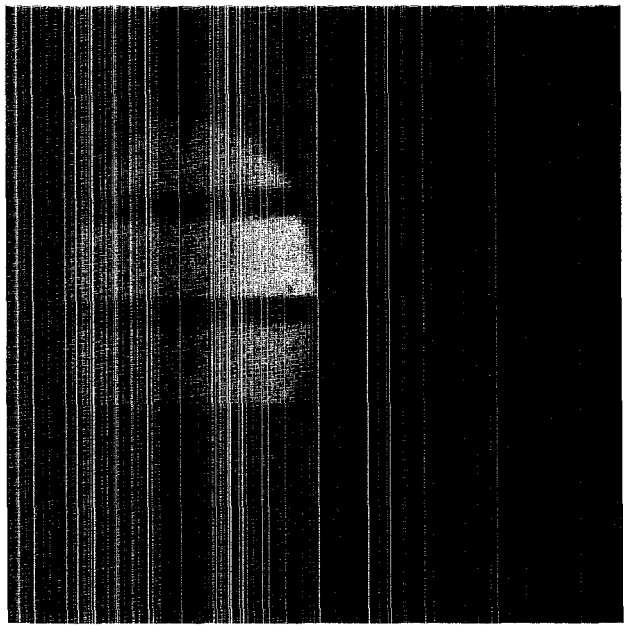
Shot 13448: PAPBL image with no beryllium between the backlighter and pinhole substrate, and beams at best focus with no RPP



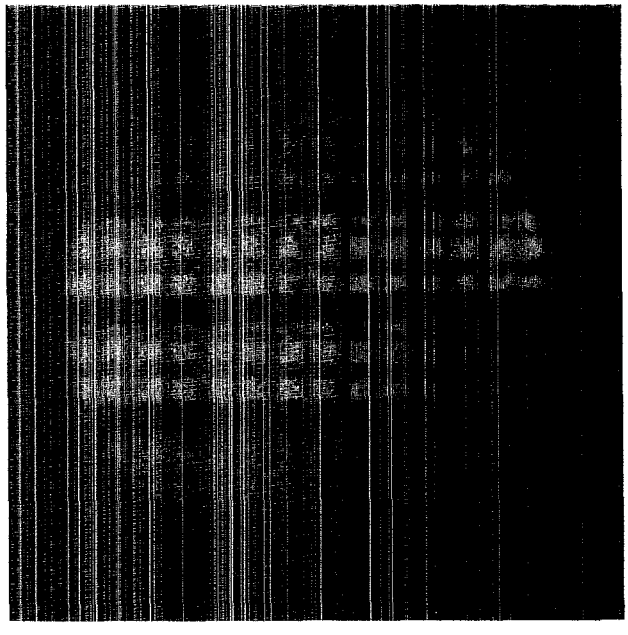
Shot 13449: PAPBL target with CH flag driven starting 480 ps before start of backlighter beam to determine the effect of drive beams on imaging.



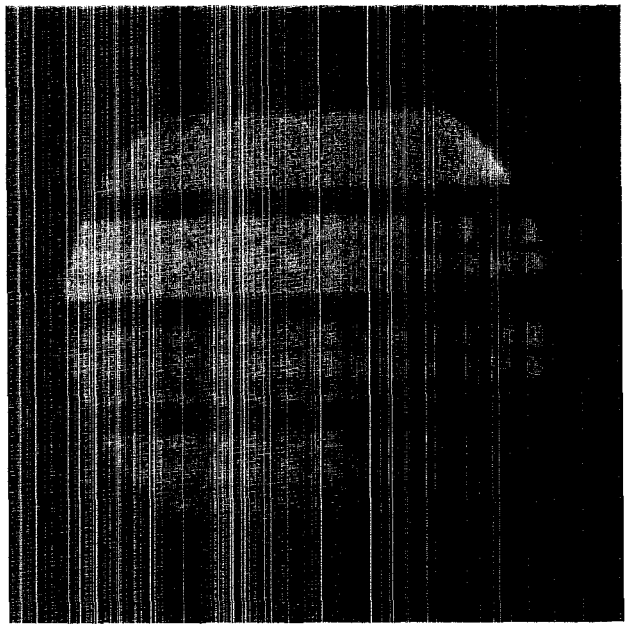
Shot 13450: Same as previous shot, but with the GXIX timed 500 ps earlier to see the full contribution of the plastic.



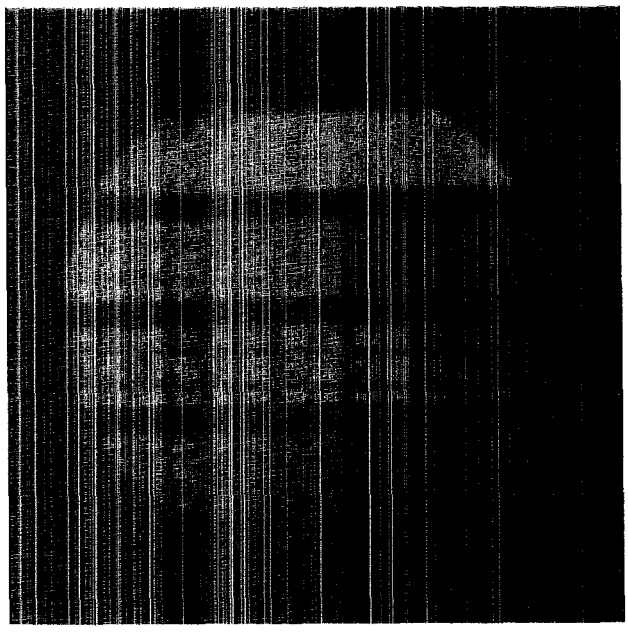
Shot 13451: Shot with B-beam on the plastic flag only (no PAPBL imaging) to see the contribution of the plastic flag directly.



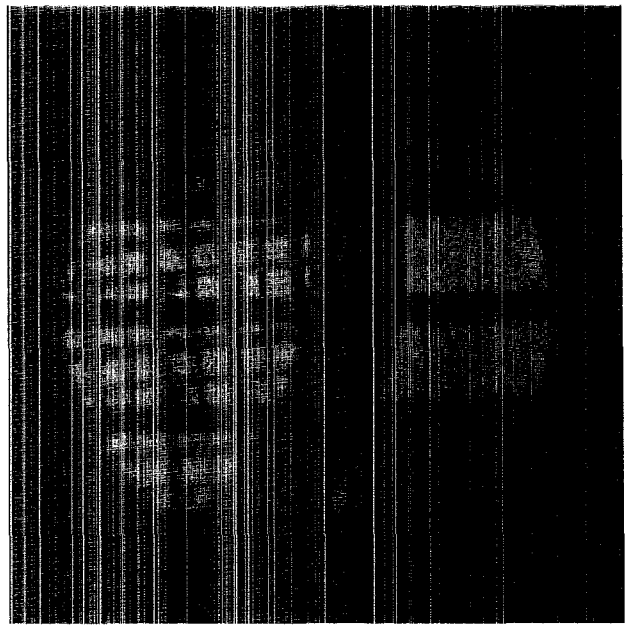
Shot 13453: PAPBL image with the nosecone removed from the GXIX to allow background noise from a wider range of angles.



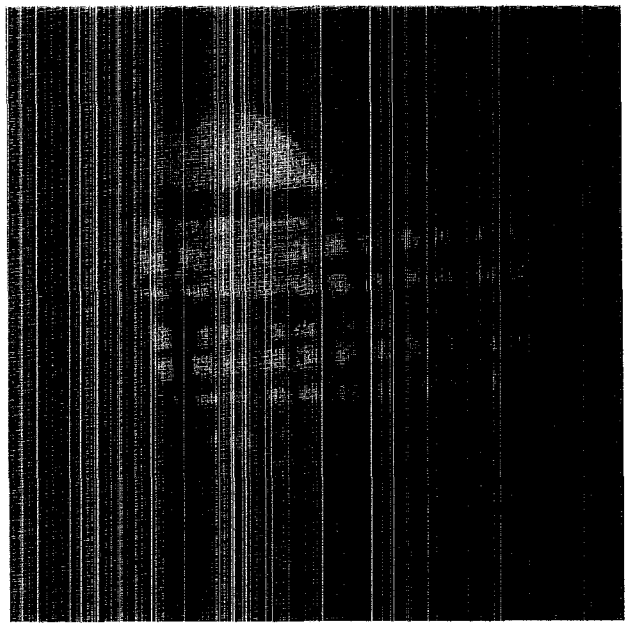
Shot 13454: PAPBL image with the nosecone removed from the GXIX and the plastic flag illuminated at best focus.



Shot 13455: PAPBL image with the nosecone removed from the GXIX and the plastic flag illuminated at best focus and a piece of tantalum (approximately 28 mm x 28 mm) placed in the field of view and exposed to any radiation or hot electrons from the target.



Shot 13456: PAPBL image with the nosecone removed from the GXIX and no plastic flag, but a piece of tantalum (approximately 6 cm x 6 cm) placed in the field of view and exposed to any radiation or hot electrons from the target. (Note that the grid was accidentally displaced prior to the shot.)

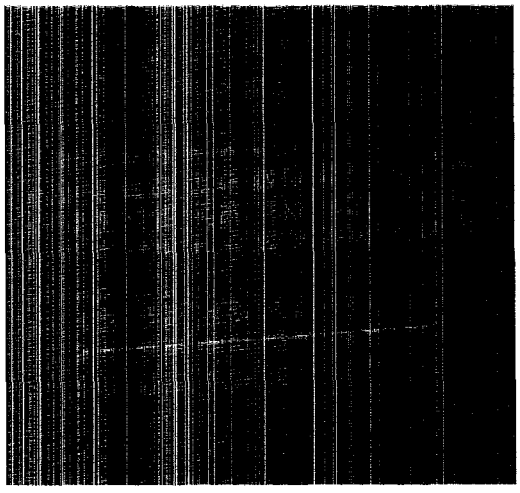


Shot 13458: PAPBL image with the nosecone put back on the GXIX and the plastic flag illuminated at best focus and a piece of tantalum (approximately 6 cm x 6 cm) placed in

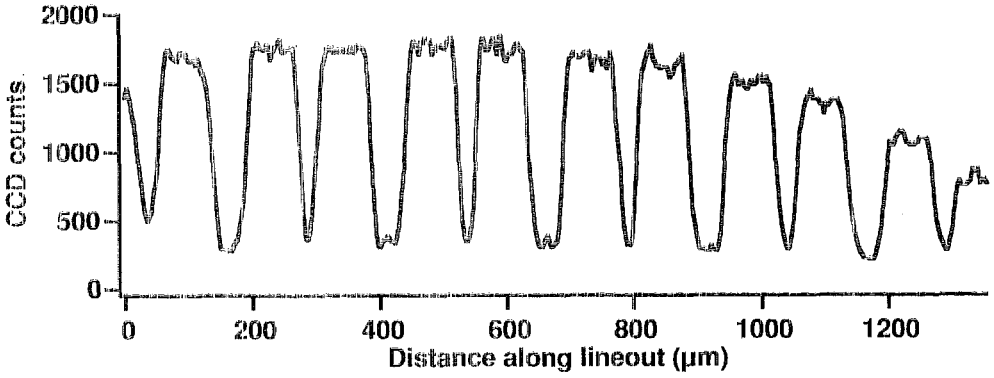
the field of view and exposed to any radiation or hot electrons from the target to see if the nosecone could restrict the field of view so that a good image could be obtained.

Edge response

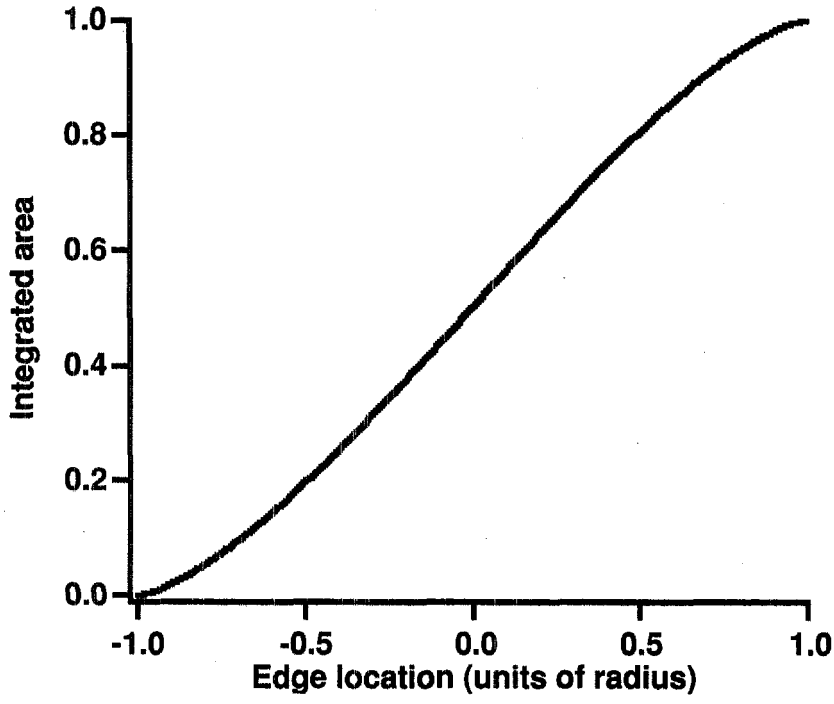
The edge response of the imaging was measured by looking at a lineout across a number of bars in the image. With no smoothing, a lineout one pixel wide gives the results shown below. The 10% to 90% edge response is between 12 and 15 μm. If the resolution is limited only by the size of the pinhole, then the resolution (10-90%) should be 68.7% of the pinhole radius, or 13.7 μm for these experiments. This demonstrates that we are achieving close to the limit of what can be achieved with 20 μm pinholes.



Shot 13436 with the location of the lineout used to analyze the edge response of the PAPBL imaging described in this report.



Single-pixel lineout across a portion of the image shown above. No smoothing, averaging, or flat-fielding was performed.



Integrated area across a circle showing the predicted edge reponse of PAPBL imaging assuming that the resolution is limited only by the size of the pinhole. The 10 and 90% points lie at ±0.687 radii.

Recommendations

Based on this data, we believe that a large background can be obtained in PAPBL images from objects in the field of view of the detector radiating due to hot electrons from the target or similar excitation mechanisms. In order to get a high background on Trident, we had to:

1) Remove the nosecone and snout from the GXIX allowing the imager to see a large portion of the volume around target chamber center.
2) Illuminate a plastic flag near the backlighter with a full energy Trident beam at best focus.
3) Place a piece of tantalum, approximately 28 mm by 28 mm, in a position such that it would be exposed to any hot electrons produced by the target and would illuminate the microchannelplate of the GXIX.

To apply this knowledge to Omega experiments, it is recommended that:

1) The imaging instrument use a nosecone to restrict the field of view as much as possible.
2) To the extent possible, extraneous objects be kept out of the field of view. For example, gated imagers looking at the back side of the backlighter might constitute a major source of noise.
3) Excellent images were obtained with less than 200 J of laser light on the backlighter. Backlighters on Omega should utilize the minimum amount of light necessary to obtain an image.
4) If hot electrons are the major source of noise, higher-Z objects near the target and near the line of site should be shielded or coated by lower-Z materials to reduce the x-ray flux created.
5) Filtering should be provided to eliminate x-ray background at lower energy than the backlighter. For the experiments preformed here, up to a total of 36 mils of beryllium were used in the light shield, nose cone, blast shield, grid mounting, and backlighter.

PAPBL Shot Log

Date	Time	Shot Number	Target	Purpose	Notes	RPP in A	Beam Energy	
							A	B
09-Jul-01	1730	13430	Ti disk	Timing shot	No x rays on strip 1, x rays on strips 2, 3, 4	6 mm Hex	162	
10-Jul-01	904	13432	PAPBL	Obtain PAPBL image	Background, but no grid image	6 mm Hex	159	
10-Jul-01		13433	PAPBL	Obtain PAPBL image	Image on bottom two strips	6 mm Hex	163	
10-Jul-01	1109	13434	PAPBL	Obtain PAPBL image	Image with obscuration, presumably due to blast shield contamination	6 mm Hex	156	
10-Jul-01	1312	13435	PAPBL	Obtain PAPBL image	Beautiful image	6 mm Hex	162	
10-Jul-01	1405	13436	PAPBL	Obtain image at lower magnification	Reduced magnification	6 mm Hex	155	
10-Jul-01		13437	PAPBL	Obtain image with backlighter at best focus, no RPP	Misaligned, no image	none	180	
10-Jul-01	1600	13438	PAPBL	Obtain image with backlighter at best focus, no RPP	Good image with high energy component	none	167	
10-Jul-01	1705	13439	PAPBL	Obtain image with backlighter at best focus, no RPP, material in close proximity to create hard x rays	Good image with high energy component	none	176	
11-Jul-01	1043	13446	PAPBL	Obtain image with backlighter and RPP, material in close proximity to create hard x rays	Good images on strips 2, 3, 4. Not much on strip 1	6 mm Hex	178	
11-Jul-01	1144	13447	PAPBL/No Be (built by Nick)	Obtain image with no Be between BL and Pinhole to see effect of Be	Good image, data on strips 1, 2, 3, and going off on 4 (flags were on opposite sides of stalk as for other targets)	6 mm Hex	172	
11-Jul-01	1313	13448	PAPBL/No Be (built by Nick)	Obtain image with no Be between BL and Pinhole and beam at best focus to see effect of Be	Very noisy image, low contrast	none	176	
11-Jul-01	1419	13449	PAPBL with plastic noise source	Obtain image with drive on plastic flag using B beam timed to start 480 ps before beam A starts	Good image, but with exposure from plastic on the first strip	6 mm Hex	180	150
11-Jul-01	1608	13450	PAPBL with plastic noise source	Obtain image with drive on plastic flag using B beam timed to start 480 ps before beam A starts	Good image, but with exposure from plastic on the first strip. Shuttle spectrometer on this shot	6 mm Hex	185	171
11-Jul-01	1710	13451	PAPBL with plastic noise source	Obtain noise background with B beam on plastic flag at best focus only.	Good image of noise on all strips, off center since plastic is not centered.	—		182

PAPBL Shot Log

Date	Time	Shot Number	Target	Purpose	Notes	RPP in A	Beam Energy	
							A	B
12-Jul-01	952	13453	PAPBL	Obtain image with noise cone off the GXI-X so that the MCP sees the world	Good image. Lower contrast	6 mm Hex	196	
12-Jul-01	1107	13454	PAPBL with plastic noise source	Obtain image with noise cone off the GXI-X so that the MCP sees the world and the plastic noise generator	Good image, but with noise early.	6 mm Hex	182	166
12-Jul-01	1215	13455	PAPBL with plastic noise source	Obtain image with noise cone off the GXI-X so that the MCP sees the world and the plastic noise generator and Ta foil	Good image, and wiped out at early time due to Ta?	6 mm Hex	191	163
12-Jul-01	1330	13456	PAPBL	Obtain image in the presence of the Ta foil with no CH drive to see if there is any contribution from Ti fluorescing the Ta	Good image, little evidence of noise	6 mm Hex?	176	
12-Jul-01	1420	13457	Foam shot (for Nick)	not a PABPL shot		6 mm Hex?	166	
12-Jul-01	1527	13458		Obtain image with noise cone on the GXI-X so that the MCP can't see the Ta foil	Good image, some image from CH?	6 mm Hex?	?	?
12-Jul-01			Foam shot (for Nick)	not a PABPL shot		6 mm Hex?	173	

PAPBL Shot Log

Date	Time	Shot Number	GXiX Timing	PCD	Strip 1	Strip 2	Strip 3	Strip 4	Timing Notes
			ps	ns	ns	ns	ns	ns	
09-Jul-01	1730	13430			9.72	11.04	12.28	13.48	PCD on too low a scale
10-Jul-01	904	13432	3018550						Data lost (scope triggered before data was recorded on disk)
10-Jul-01		13433	3018050	5.52	9.08	10.40	11.64	12.80	
10-Jul-01	1109	13434	3018550	5.23	9.64	11.00	12.20	13.36	
10-Jul-01	1312	13435	3018550	5.31	9.52	10.84	12.04	13.20	
10-Jul-01	1405	13436	3018700	5.16	9.76	11.08	12.28	13.48	
10-Jul-01		13437	3018600	5.59	10.04	11.40	12.60	13.76	
10-Jul-01	1600	13438	3018600	5.30	9.60	10.92	12.12	13.28	
10-Jul-01	1705	13439	3018600		9.72	11.04	12.24	13.40	Noisy PCD data
11-Jul-01	1043	13446	3018600	5.51					Ch 2 data lost due to defect on disk
11-Jul-01	1144	13447	3018850	5.43	10.00	11.28	12.52	13.68	
11-Jul-01	1313	13448	3018850	5.59	10.00	11.36	12.56	13.72	
11-Jul-01	1419	13449	3018850	5.66	10.12	11.48	12.68	13.84	
11-Jul-01	1608	13450	3018850		10.32	11.72	12.88	14.04	Noisy PCD data
11-Jul-01	1710	13451	3018350		9.54	10.88	12.08	13.24	Noisy PCD data

PAPBL Shot Log

Date	Time	Shot Number	GXIX Timing ps	PCD ns	Strip 1 ns	Strip 2 ns	Strip 3 ns	Strip 4 ns	Timing Notes
12-Jul-01	952	13453	3018850	5.04	9.80	11.12	12.32	13.48	
12-Jul-01	1107	13454	3018850	5.54	9.96	11.28	12.52	13.68	
12-Jul-01	1215	13455	3018850	5.48	10.00	11.36	12.56	13.72	
12-Jul-01	1330	13456	3018850	5.20	9.80	11.12	12.32	13.48	
12-Jul-01	1420	13457	Not run	5.20					No GXI on this shot
12-Jul-01	1527	13458	3018850	5.80	10.04	11.36	12.56	13.76	
12-Jul-01			Not run						No data since trigger cable had already been removed