09-06091

LA-UR-

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Title:	PRAD0374: Equation of State Iron Shot Report
Author(s):	Alexander Saunders
Intended for:	Archiving, public release

Los Alamos
NATIONAL LABORATORY
EST. 1943

Form 836 (7/06)

Bainbridge, Joseph	188457	DE-3
Bitteker, Leo	111476	LANSCE-NS
Brooks, Bethany	188462	P-25
Campos, Eduardo	188791	P-25
Dominguez, Jose	169395	P-25
Espinoza, Camilo	092843	P-25
Fait, Jeremy	225839	P-25
Furlanetto, Michael	203247	P-23
Gray, George	098613	MST-8
Grim, Gary	188779	P-23
Hogan, Gary	089987	P-25
Hollander, Brian	172536	P-25
King, Nicholas	023852	P-23
Lewis, Douglas	152683	NSTEC
Lopez, Julian	176436	P-25
Lopez, Robert	086557	DE-3
Lovro, Luke	235719	P-25
Mariam, Fesseha	094970	P-25
Marr-Lyon, Mark	113973	DE-3
McNeil, Wendy	196665	HX-4
Meidinger, Alfred	182754	NSTEC
Merrill, Frank	105671	P-25
Morley, Deborah	085596	P-25
Morris, Christopher	081720	P-25
Murray, Matthew	083303	P-25
Nedrow, Paul	089364	P-23
Park, Nigel	200417	HX-DO
Rigg, Paulo	170311	DE-9
Rightley, Paul	118629	DE-3
Saunders, Alexander	133578	P-25
Schwartz, Cynthia	197376	P-25
Tainter, Amy	230139	P-25
Thompson, Neil	101120	P-25
Tupa, Dale	104583	P-25
Tybo, Joshua	182458	NSTEC
Vidisheva, Aleksandra	235952	P-25
Zellner, Michael	216107	DE-9

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PRAD0374-Equation of State-Iron

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- [X] LANSCE APP. Form
- [X] DE Shot Plan
- [X] VAA App.
- [X] Contained Shot Request
- [X] Safety and Security Review
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Cast of Characters

Shot number: 374
Equation of State - Iron

Experimenter in Charge: Cynthia Schwartz
Principle Investigator: Cynthia Schwartz
High Explosives Person in Charge: Mark Marr-Lyon
Firing Site Leader: Robert Lopez
Secondary FSL: Joe Bainbridge
Laser Person in Charge: N/A
Camera Point of Contact: Paul Nedrow
Analysis Lead: Cynthia Schwartz
Safety Watch: Eduardo Campos
Data Acquisition System Point of Contact: Neil Thompson
Experimental Area Manager: Leo Bitteker

PRAD Core Team

Joe Bainbridge, Bethany Brooks, Eduardo Campos, Jose Domingez, Camilo Espinoza, Jeremy Fait, Gary Grim, Gary Hogan, Brian Hollander, Nicholas King, Kris Kwiatkowski, Douglas Lewis, Julian Lopez, Robert Lopez, Luke Lovro, Fesseha Mariam, Mark Marr-Lyon, Wendy McNeil, Alfred Meidinger, Frank Merrill, Deborah Morley, Christopher Morris, Matthew Murray, Paul Nedrow, Paul Rightley, Alexander Saunders, Cynthia Schwartz, Amy Tainter, Terry N. Thompson, Dale Tupa, Joshua Tybo, Aleksandra Vidisheva

Experiment Team

Cynthia Schwartz, Michael Furlanetto, George Gray, Nicholas King, Kris Kwiatkowski, Mark Marr-Lyon, Wendy McNeil, Frank Merrill, Christopher Morris, Nigel Park, Paulo Rigg, Alexander Saunders, Michael Zellner

Crystal Orientation-Dependence of Shock-Induced Phase Transitions

Cynthia L. Schwartz (PI)	LANL, P-25	USA	cschwartz@lanl.gov
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George T.Gray III	LANL, MST-8	USA	rusty@lanl.gov
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Alexander Saunders	LANL, P-25	USA	asaunders@lanl.gov
Michael Zellner	LANL, DE-9	USA	mzellner@lanl.gov

When a compressed material changes phase it doesn't do so instantly. Instead it transitions through a mixed phase as it transforms to the end state phase for a given pressure, volume and temperature. Common phase diagrams show the phase boundaries as sharp lines when compression has been slowly applied and held for an infinite amount of time. When the compression is applied with high strain rate, however, the phase boundaries are no longer crisp as the kinetic effects of the crystal reorientation delay the transitions, resulting in regions of mixed phase. Molecular dynamics (MD) simulations recently have been used to examine the shock-induced transition in single crystal materials illustrating an orientation dependence of the transition stress, mechanisms, kinetics, and Hugoniot response.[1] For example, the [100] orientation of iron had a simulated transition stress higher than the experimentally determined polycrystalline value of 13 GPa by 2 Gpa.

In December, the proton radiography team performed an HE-driven experiment with tin, shocking the sample to a peak pressure with an unsupported Taylor shock wave. Below is an 18-frame time sequence of the shock moving through the tin target: decaying pressure is indicated by contrast reduction.

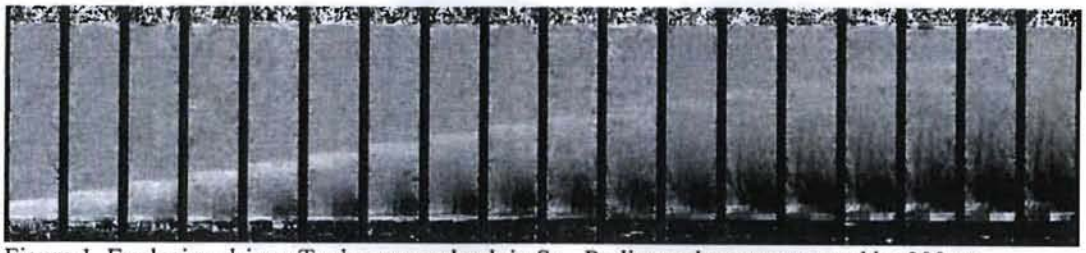


Figure 1. Explosive-driven Taylor wave shock in Sn. Radiographs are separated by 300 ns.

As the pressure decayed, we measured shock positions (velocities) and relative densities directly off the radiographs. For each radiograph, a point on the Hugoniot was measured, resulting in 18 data points on the Hugoniot from one experiment. Unfortunately, we did not drive the tin sample hard enough to successfully force a phase transition.

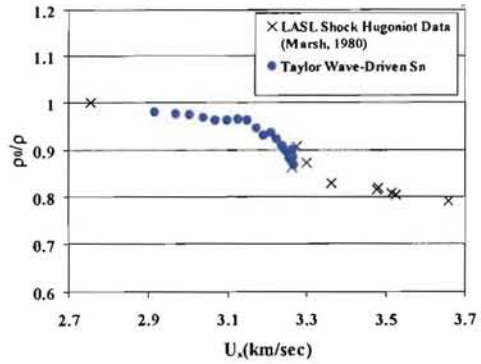
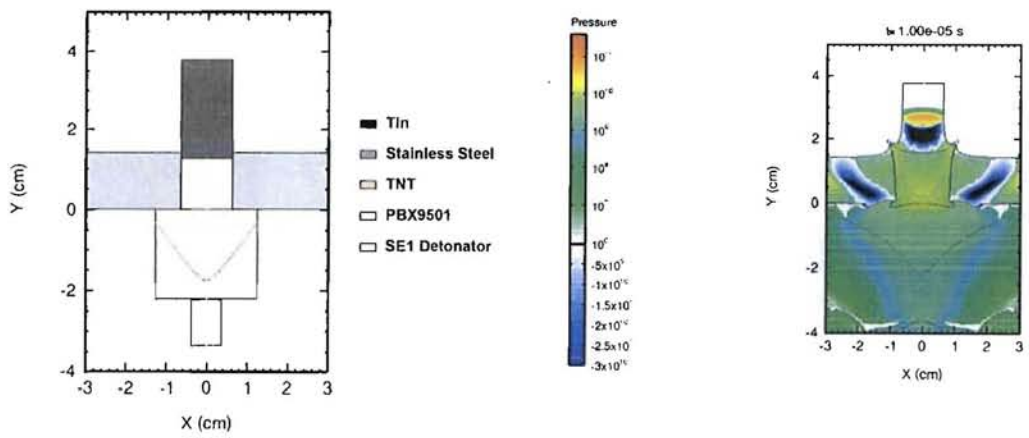


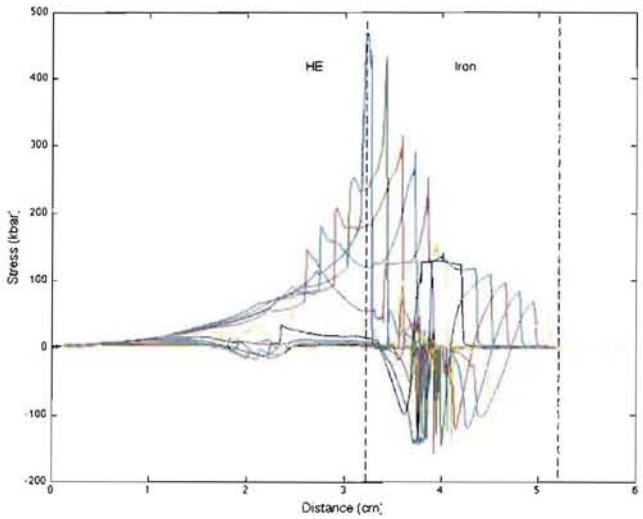
Figure 2. Each radiograph yields a shock position (velocity) and relative density measurement, plotting out points on the Hugoniot as the pressure decays

We propose a series of measurements using this newly developed technique on shock-loaded samples of different material composition and crystal orientations. Materials will include tin, iron, gallium, and zirconium. Through shock loading, we will dynamically compress polycrystalline samples as well as single crystals along different crystal planes. Since we are able to measure many points along the Hugoniot in one experiment, we will be able to determine Hugoniot response as a function of crystal structure and orientation by simply overlaying measured curves. Predicted transition stress differences are greater than 1%, which is greater than our achieved accuracy. We also intend to measure the length scale of the nucleating centers and volume fraction of mixed phase as a function of time for the targeted materials. We will use high accuracy bulk density measurements directly off the radiographs to determine the volume fraction of the two phases. Additionally, with quantitative relative density measurements, we will look for features in the region of the mixed phase, such as any ramping density change over time.

A preliminary shot design is pictured below. It consists of a 25mm plane-wave lens with a nearly 1.0 mm thick Stainless Steel ring and ¼ inch of PBX9501 booster. With this P-25 lens, the target sample is driven to high enough peak pressure (~400kbar) for all the target materials, Fe, Ga, Zr and Sn to completely transition phase. To optimize the radiography, the target samples will be 12.7mm (1/2inch) diameter and 25mm thick.



We have run CTH simulations with a tin target sample and looked at the pressure profile down the center of sample. The pressures are relatively constant around the center plane. This is important to measure the most accurate shock velocities and densities. For the iron sample, a CTH run with a P25 lens in direct contact with a 12mm diameter x 20mm thick iron cylinder and is profiled below. The α->ε phase transition is noticeable at approximately 3/4 cm into the iron target.

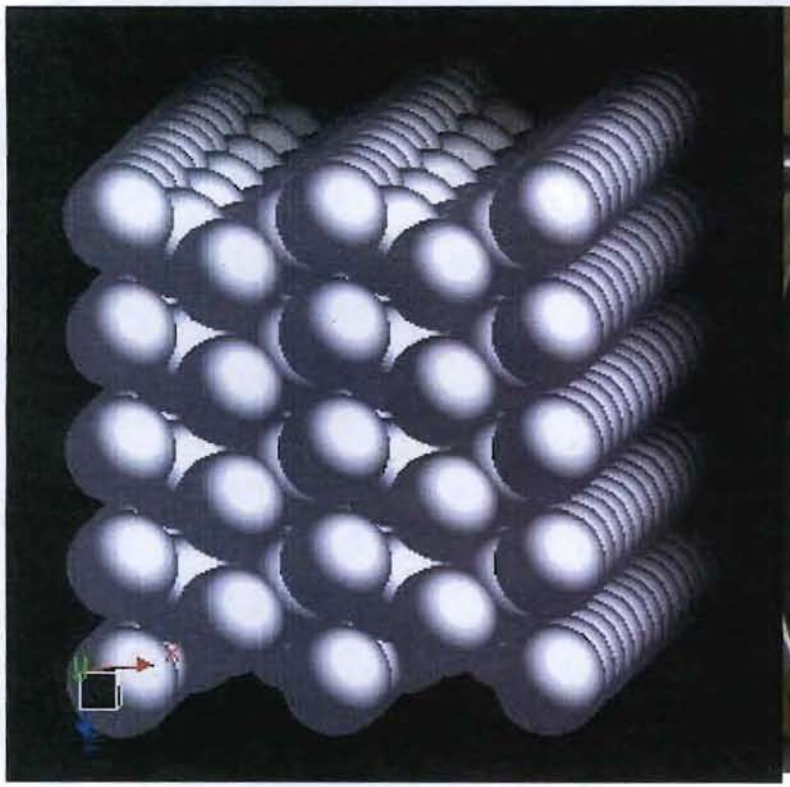


We are presently running more CTH simulations with various shot configurations with and without 9501 booster, with stacked boosters, and with the suite of target materials.

1. K. Kadau, T. C. Germann, P. S. Lomdahl, and B. L. Holian, "Atomistic simulations of shock-induced transformations and their orientation dependence in bcc Fe single crystals", Phys. Rev. B, **72**, 064120 (2005).

Crystal Orientation-Dependence of Shock-Induced Phase Transitions

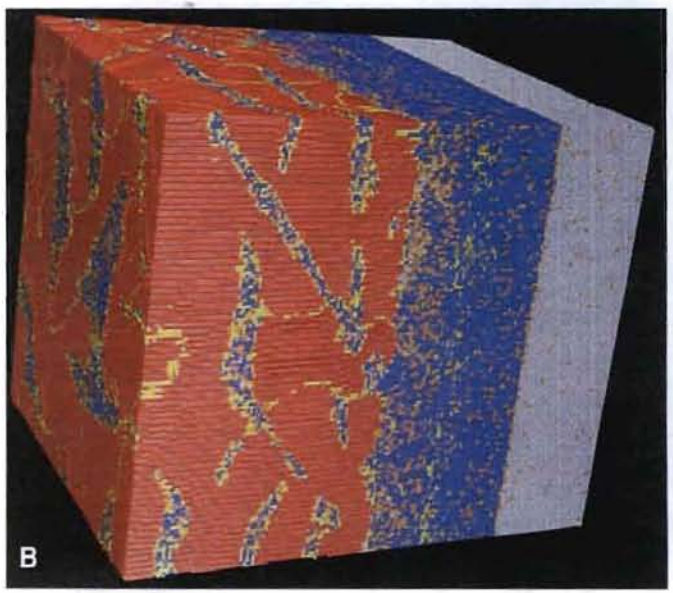
Cynthia L. Schwartz,
Los Alamos National Laboratory



Transition Stress, Mechanisms, Kinetics and Hugoniot response depend on crystal orientation

Polycrystalline Material

- Distribution of grain orientations
- Grain boundaries serve as heterogeneous nucleation sites
- Decreased transformation threshold
- Fast mechanism

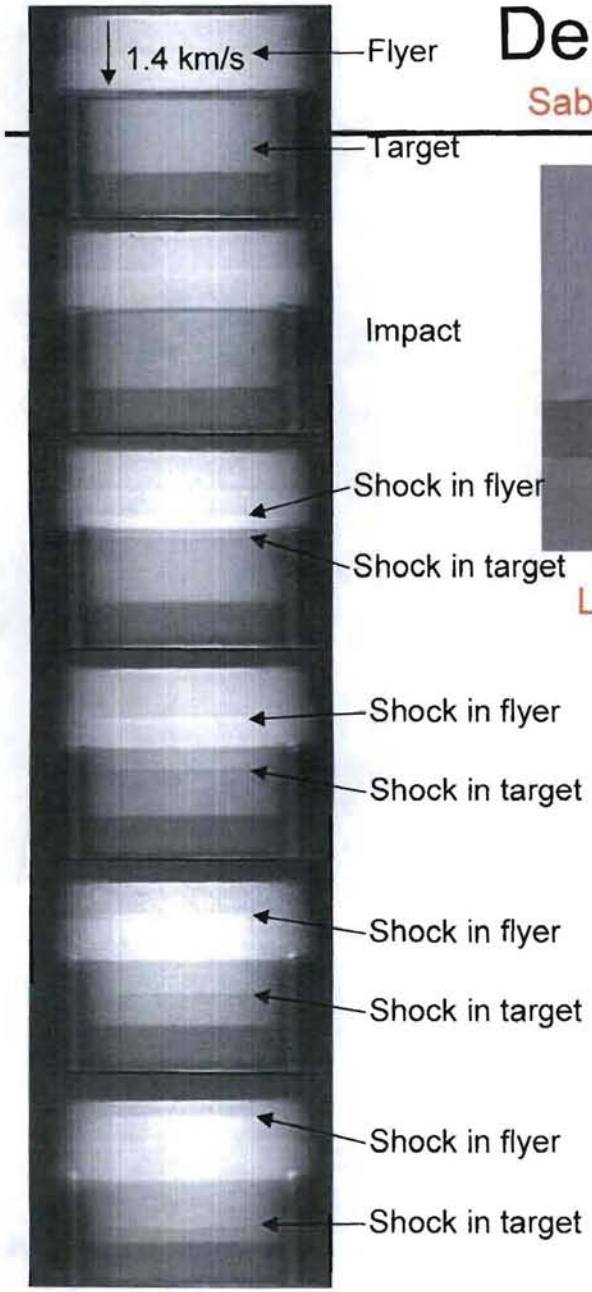


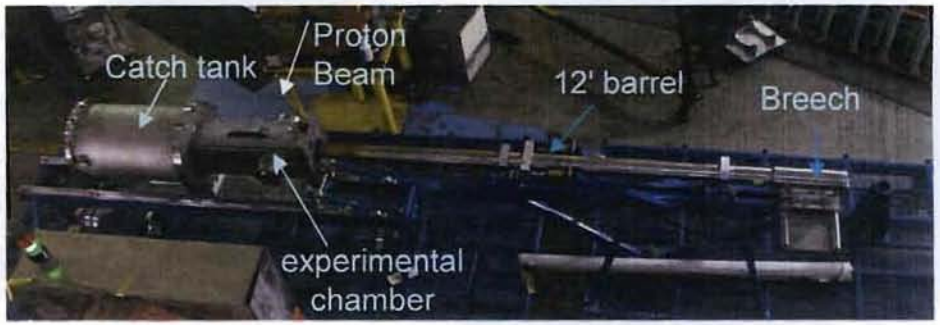
Single Crystal Material

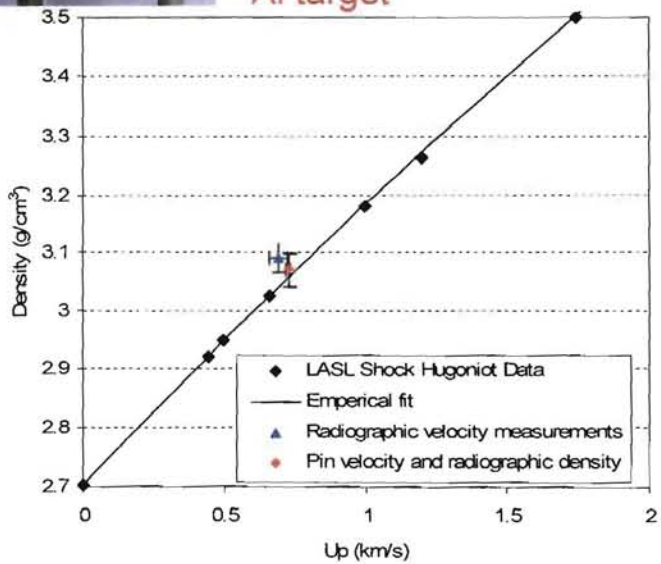
- Mulitmillion atom MD simulations for single crystal iron
- Homgeneous nucleation
- Slower mechanism
- Increased transformation threshold

K. Kadau, T. C. Germann, P. S. Lomdahl, and B. L. Holian, *Science* **296**, 1681 2002.

Demonstration Powder Gun Experiment







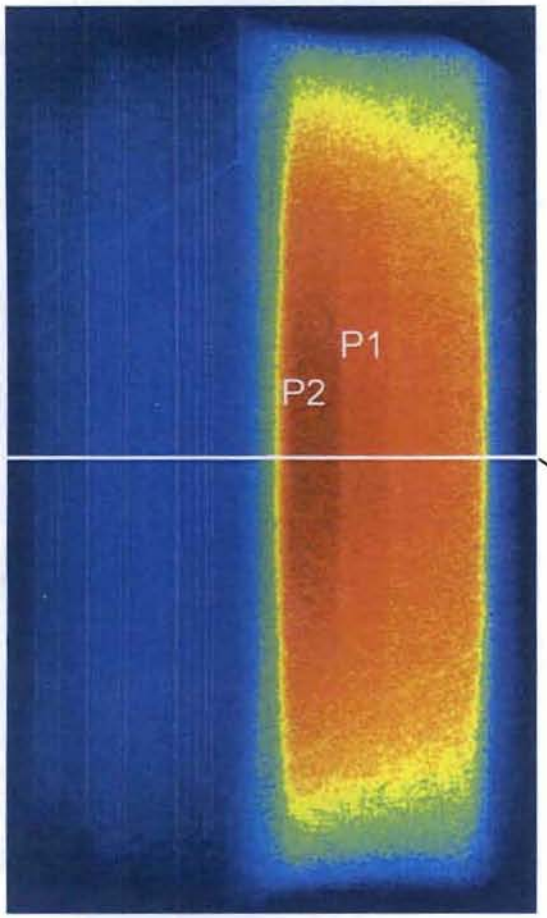
Two methods of measuring a point on shock Hugoniot per dynamic event:

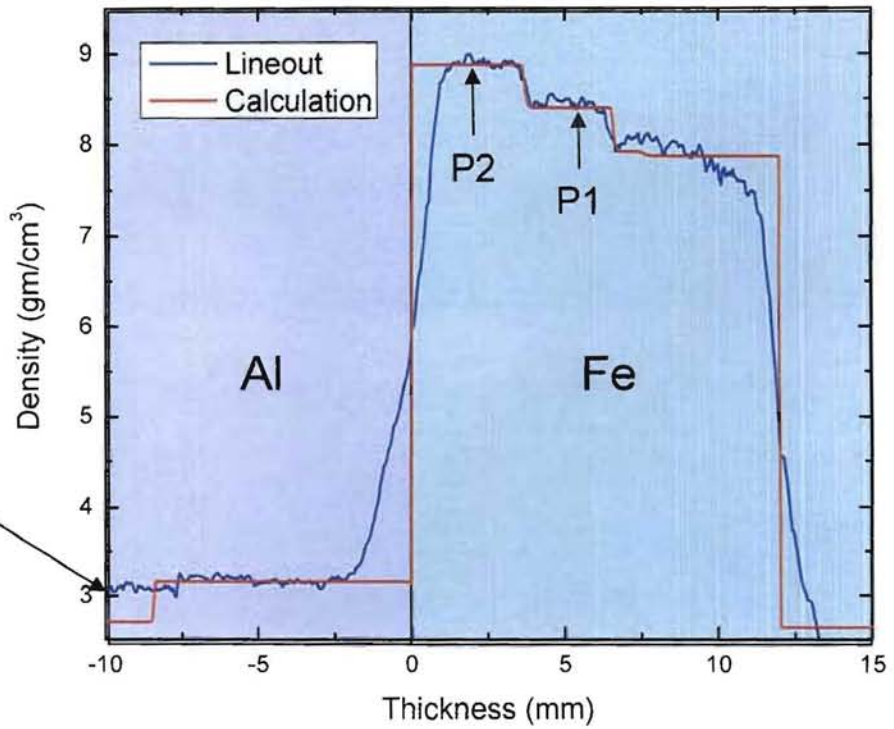
- Radiographic measurement of density behind shock front.
- Simultaneous measurement of particle and shock velocity

Invited Talk : Paulo Rigg, *Shock Compression of Condensed Matter*, 2007

Rigg, Schwartz, et al., *Phys. Rev. B*, Jun 08, vol. 77, iss. 22 220101

Powder Gun-Driven
Measured and Calculated Densities - Iron





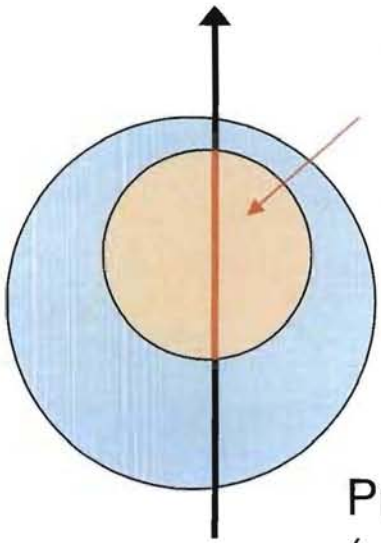
Schwartz, Rigg, et. al, IP Conference Proceedings (12 Dec. 2007) vol.955, no.1, p.1135-8

Fe Densities

State	Measured	Calculated*	Agreement
P1	8.346	8.342	<0.1%
P2	8.854	8.846	0.1%

*calculated values from 1-D Multi-Phase EOS for Fe model

Tomographic reconstruction and subtraction of overburden



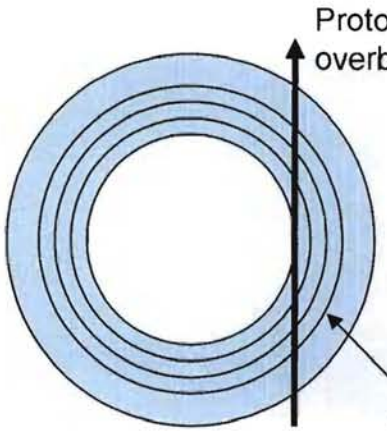
Experiment

Overburden

Proton path
(red is the good part;
We'd like to subtract the black)

Tomographic Reconstruction (Abel Inversion)

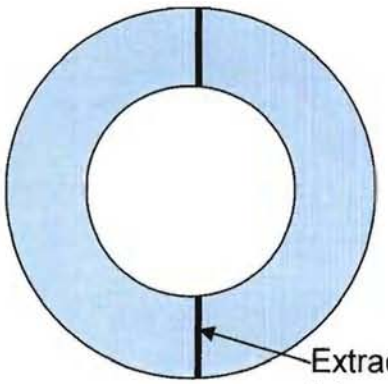
Converts line integrals to volume density map



Proton path thru overburden

Reconstructed density map

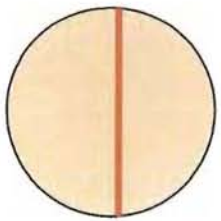
Projection: converts density map back to line integrals



Extracted and projected line integral thru overburden

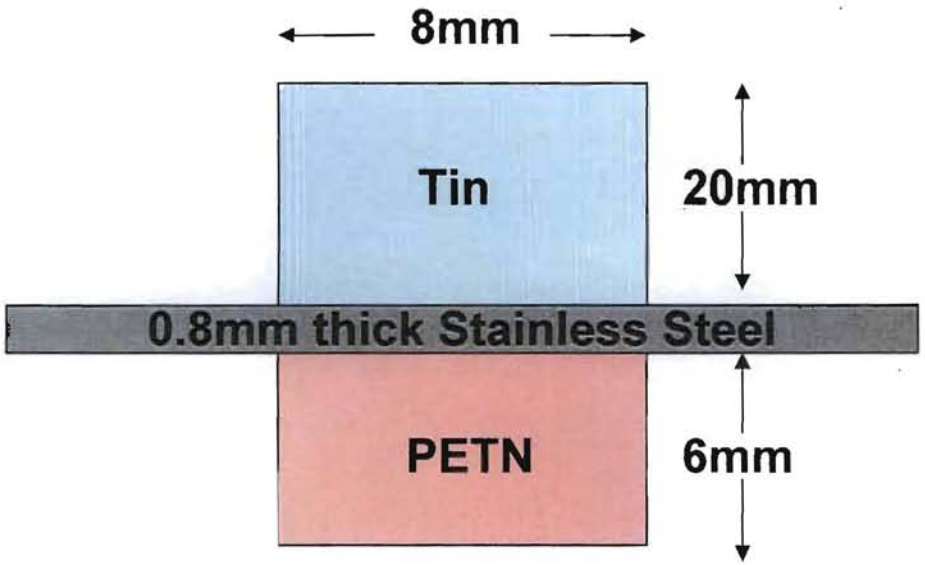
Subtraction

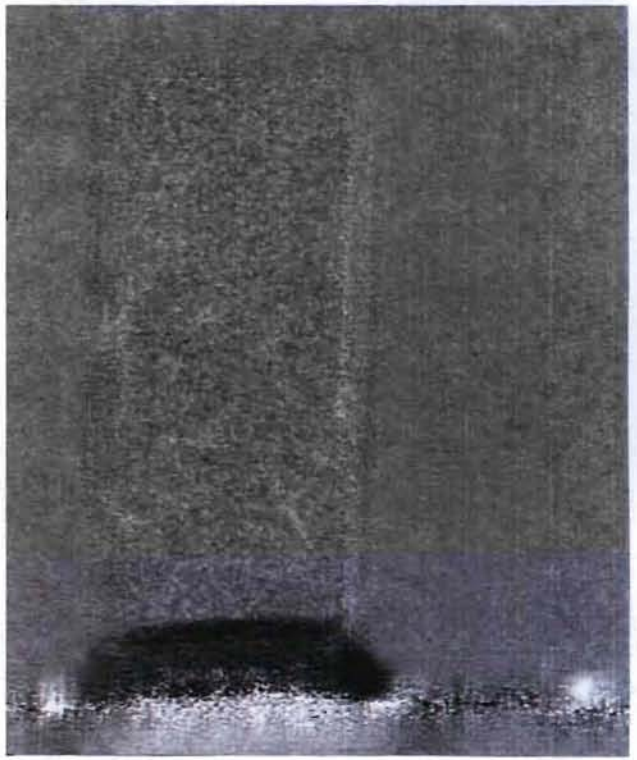
Leaves only the data we want



Taylor Wave-Driven Tin

- Explosive-driven "Taylor Wave" shock
- Multiple pressures, decaying over time
- Stainless steel membrane for future Pu shots

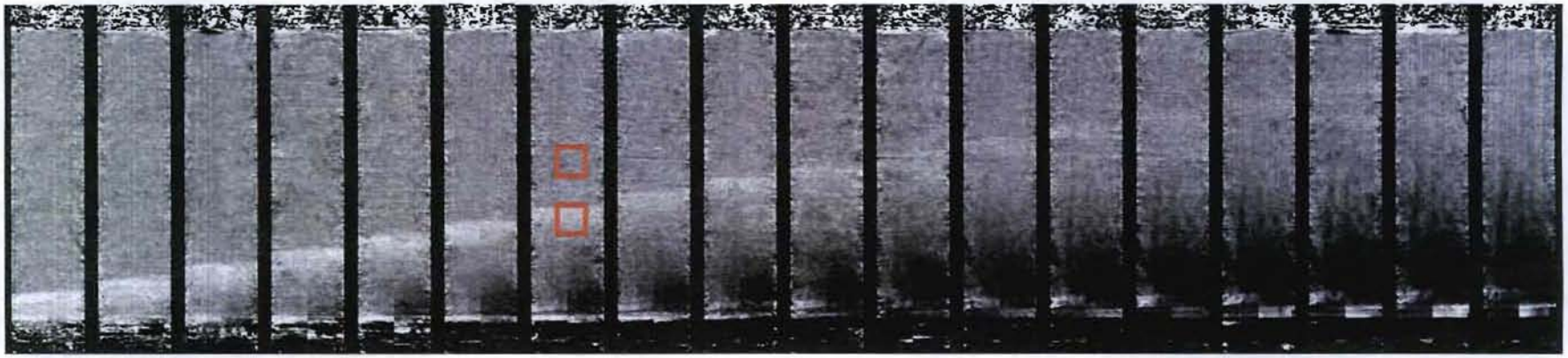




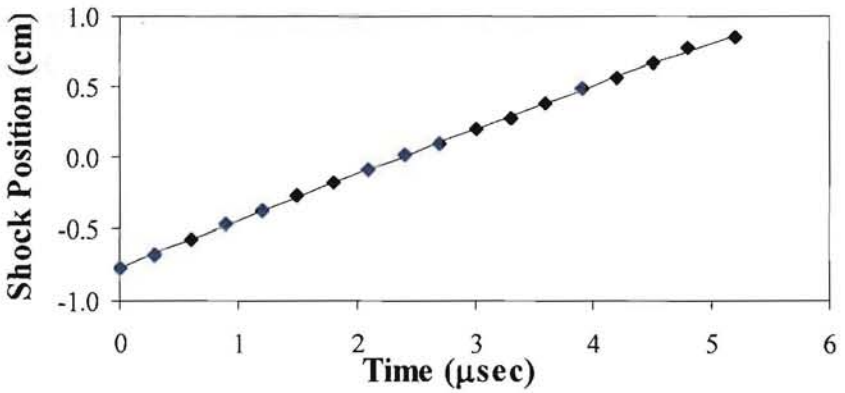
Dynamic / Static transmission radiographs

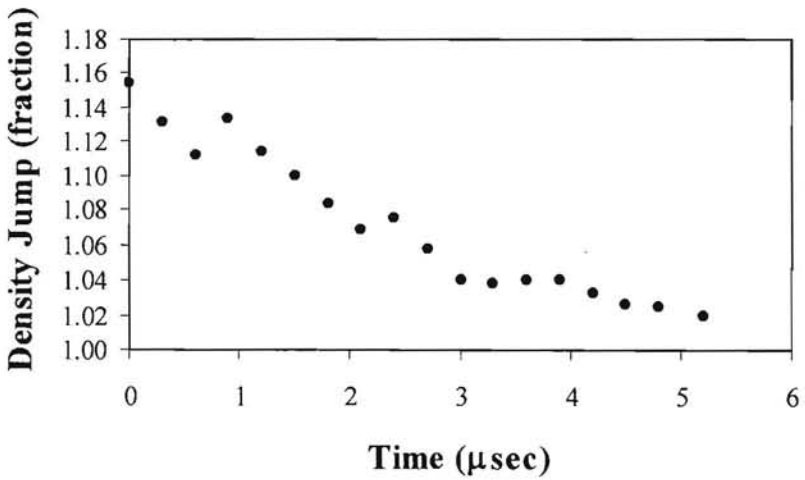
Rusty Gray provided "pristine" tin sample

Position and Density



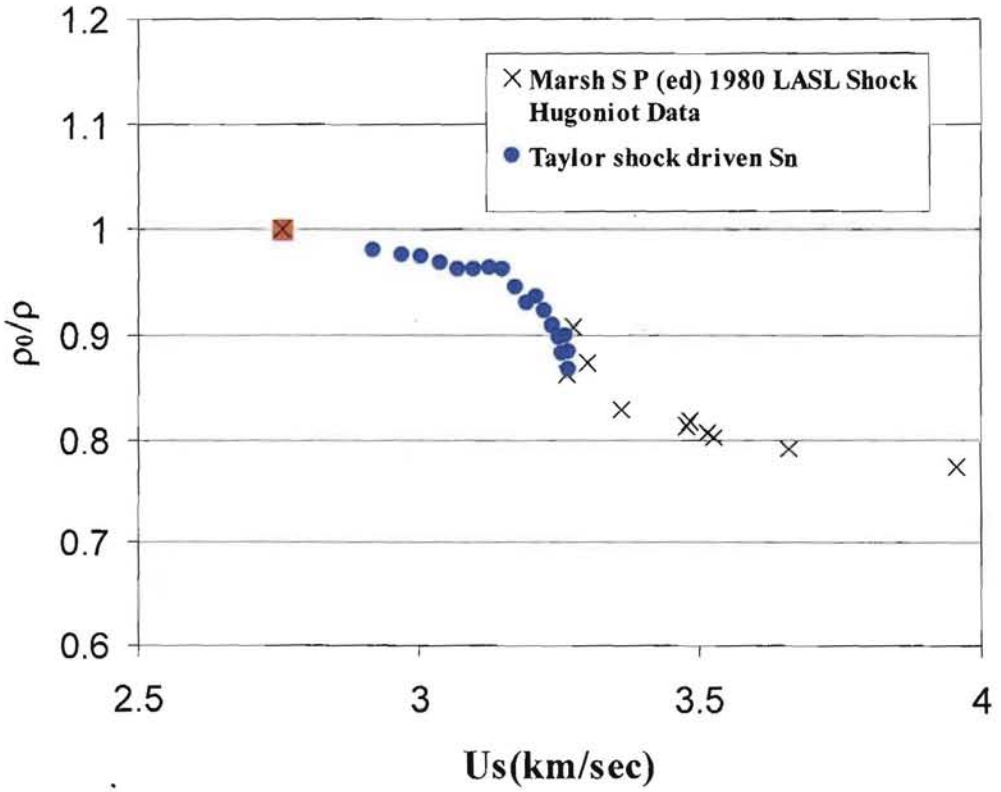
1.8μsec Time 6.9μsec





Single experiment, Multiple Measurements

- Single experiment measures many Hugoniot points
- Agreement with LASL Hugoniot data
- Hugoniot points measured from peak shock velocity down to nearly sound velocity



Technique Summary

- Measured points on the Hugoniot from peak shock velocity down to nearly sound wave velocities
- 19 images in single experiment equates to 19 points on the Hugoniot (we measured 18 points)
- Agreement between present measurement and known Hugoniot with less than 1% density and 0.3mm/μsec (1%) shock velocity statistical uncertainty

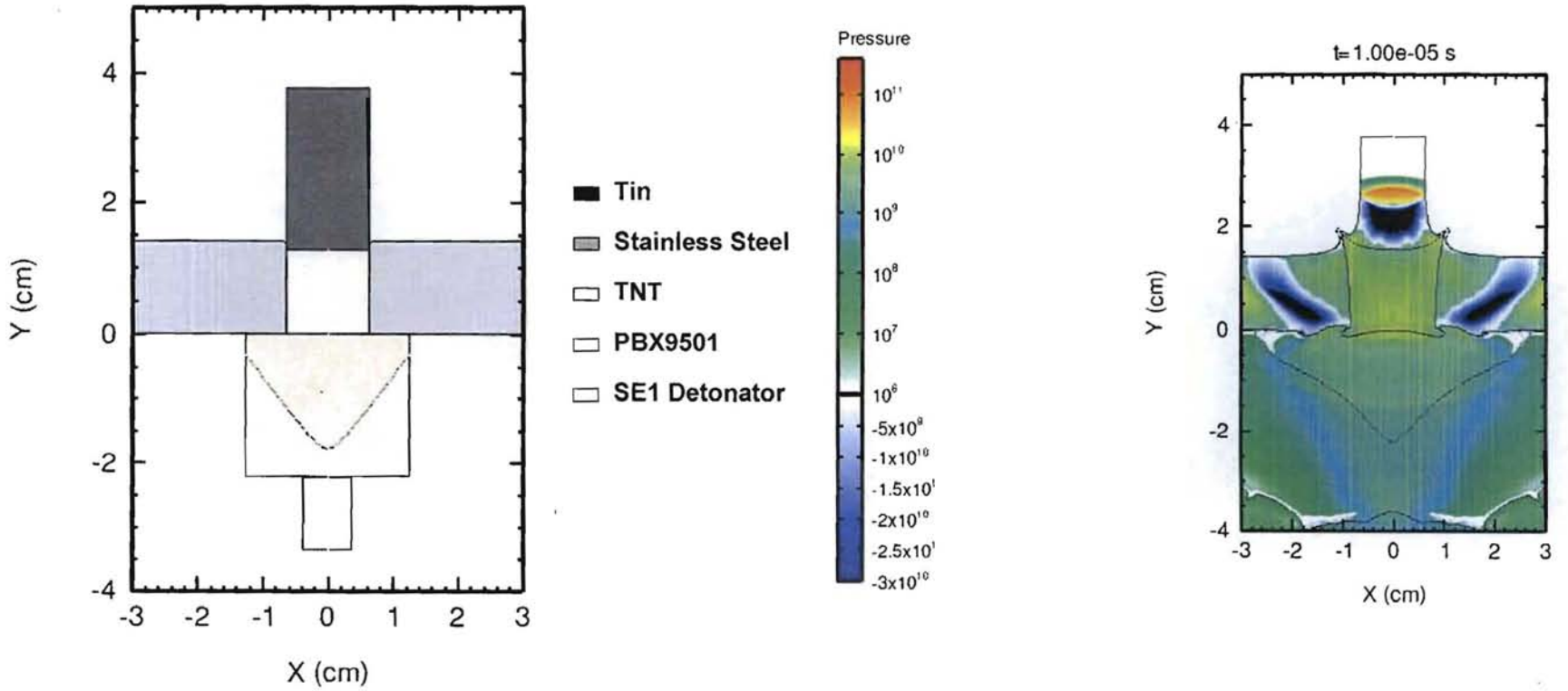
Technique Questions

- Are we in equilibrium?
- How well does our tomographic reconstruction work?
- How flat is the pressure wave we are using to measure position?
- Is a polynomial approximation of position with time during a phase transition valid?

In 2 weeks….

- Determined we need proof of principle experiments with known materials such as Al, Cu
- To optimize radiography, samples are 12.7mm in diameter
- To optimize number of measured position, samples are 40mm in thickness (length)
- Redo Sn with different drive and no membrane to complete the β->γ phase transition

In 2 weeks….



Marr Marr-Lyon simulation using CTH of new drive on Tin target sample

Our Proposal

- Static experiment to verify our tomographic reconstruction analysis technique
- Use a Taylor Wave drive to acquire many points on the Hugoniot in single experiment
- Perform experiments with multiple crystal orientations in individual materials to understand the affect of crystal orientation on Hugoniot response
- Perform experiments on a range of materials
  - Fe : well studied; atomistic MD simulations to compare to; will use for benchmarking
  - Ga : used in nuclear weapons; EOS not known
  - Zr : used in shaped charges; multiple phase transitions and triple point
  - Sn : low strength; well studied

Shot Type	Number
Fe Poly	1
Fe [100]	1
Sn [100]	1
Sn [TBD]	1
Zr Poly	1
Zr [111]	1
Zr [100]	1
Ga Poly	1
Ga [111]	1
Ga [100]	1

Proposal Team

Cynthia Schwartz, PI (P-25),
Mike Furlanetto (P-23),
George (Rusty) Gray III (MST-8),
Nicholas King (P-23),
Kris Kwiatkowski (P-23),
Mark Marr-Lyon (DE-3),
Wendy McNeil (HX-4),
Frank Merrill (P-25)
Christopher Morris (P-25),
Nigel Park (AWE) (UK),
Paulo Rigg (DE-9),
Alexander Saunders (P-25),
Michael Zellner (DE-9)

LANSCE Approval Form
Explosives Operations in Area C

Starting Date of Activity: 21 July 2009
PRAD Proposal Number: 20081901
PRAD Shot Number: 374
HE Shot Plan Number: H3861 / LNSC-10628-DE3
Description: Phase Transition – Iron

Vessel Experiment:
VAA approved vessel: Yes
HE ≤ 10-lbs TNT-equivalent: Yes

Powder Gun Experiment:
Propellant ≤ 350-g Class 1.3: NA

Dynamic MAR Experiment:
Requirements of ASE 3.5.2 met: NA

Experiment Technical and Safety Review complete: Yes

PRAD EIC Authorization:

Signature Cynthia Schwartz Date: 21 July 2009

Print Cynthia Schwartz

DE-3 HE PIC Authorization:

Signature _____ Date: 21 July 2009

Print Mark Marshall

LANSCE Area B/C AM Authorization:

Signature _____ Date: 21 July 2009

Print Leo Bitteker

Shot Plan

K

WFO Shot Number:	LNSC-10625-10630 – DE3	**Release Date:**	7/10/09			
Shot/Series Title:	PHASE TRANSITION	Originator's shot # (optional):	43858, 3859, 3860, 3861, 3862, 3863			
Estimated Number of shots:	UP TO SIX	Past shot reference (optional):				
Lead Experimenter(s):	WENDY VOGAN McNEIL	**Group:**	HX-4	**Phone:**	7-9038	
Experiment Program Code/Cost Account:	3R050A / J1DP / 0000 /0000					
Firing Lead (s):	Robert Lopez Joe Bainbridge	**Group:**	DE-3	**Phone:**	7-0393 7-5495	
Firing Site:	pRad	**Owning Group:**	DE-3	**Phone:**	5-4425	

Max. Quantity HE per test:	< 50 g
Clearance Plan:	pRad
Desired Test Date(s):	Weeks of 13 and 20 Jul 09
IWD# and WPF# : Specify applicable document # (s) & expiration date(s) or note as NEW and in progress:	IWD: IWD-DE3-53-003-PJ00-0004 WPF: P DIVISION IS RESPONSIBLE FOR WASTE MANAGEMENT AT PRAD
Classified Shot: ☐ **YES** ☒ **NO**	If YES create classified shot addendum per classified document requirements
☐ After Hours Contingency Plan	Required for shots executed after normal working hours. (defined as 4:30 PM)

WFO Services Requested:

☐ RCT ☐ IH
☐ WMC ☐ Fire Department
☐ Heavy Equipment ☑ Fire Mitigation Review ☐ Other (Specify): _____
☐ Access Control ☐ Environmental

Brief Shot Description/Objectives: Attach sketches and drawings as necessary.
Shoot in the 6-foot 5-port vessel: SE-1 + P25 + ½" x ½" 9501 booster + metal target (metal = Al, Cu, Sn, Fe, or alloy).
The x3 magnifier will be used.
Up to 1/8" Al + 1/8" glass will be used.

High Explosive Operations Safety Officer (HE OSO): Shot Plan fire mitigation review. Provide comments as appropriate:
Shot screened out

C. M. Anderson
HE OSO approval for shot setup to proceed

7/10/09
Date

Firing Site Leader (FSL): The FSL is the final authority on all operations of safety and procedure during firing site operatio
FSL ensures safety and technical aspects for executing the shots are complete.

FSL approval

Date

Classification Review: (**IF REQUIRED BY TSM LEAD EXPERIMENTER,** refer to K. Jones e-mail of 5/2/05)

☒ Unclassified	☐ Restricted Data	**Authorized Derivative Classifier:**
☐ Confidential	☐ Formerly Restricted Data	Signature T. P. Turner
☐ Secret	☐ National Security Information	Name: T. TURNER Date: 7/10/09
☐ Unclassified Controlled Nuclear Information (UCNI)		Title: GL
		Derived From:

Line Management (or Designee) Signature T. P. Turner **Date** 7/10/09

Firing Site Leader is responsible for keeping original record with Site records

From: "Paul Rightley" <pright@lanl.gov>
Subject: **VAA approval for H3861**
Date: July 20, 2009 9:34:42 PM MDT
To: vogan@lanl.gov
Cc: lbj@lanl.gov, mmarr@lanl.gov, dallman@lanl.gov, turner@lanl.gov
Reply-To: pright@lanl.gov

I approve firing shot H3861 in vessel 6-2-5-1 this week.

I have heard back that the steel ring involved in this shot remains intact and that the armor plate is not substantially damaged by the shot. Otherwise, there is no vessel damage. This approval is contingent upon a visual inspection of the interior of the vessel since I have not received information about an inspection since the last shot.

Please call me at (505)500-4047 and describe the results of the vessel inspection (leave a message if I do not answer).

Paul

Hi Paul,

We would like to fire up to six "phase transition" shots at pRad during the weeks of 13 and 20 July 2009: H3858 - H3863. These are the ones that Cynthia and Mark and I have been working to design.

They consist of a P-25 plane wave lens [17 g PBX-9501 + 8 g TNT], initiated with an SE-1 detonator, driving a 1/2" diameter by 1/2" thick cylinder of PBX-9501 [3 g] (also see description of Shot 5 below), which drives a metal target. The first four shots have targets of either Al (Al-6061-T651), Sn (Rusty's Sn), Cu (OFHC) or Fe (Armco), and the targets are 0.492" diameter by 40mm thick. Shots 5 and 6 have targets of gold-silver alloy; the first target is 1" diameter and 0.25" thick, and the second target is 1cm diameter and 0.75" thick.

Shots 1 - 4 and 6: coupling the lens to the 9501 cylinder and the target is a steel ring of 3.5" diameter by 0.75" thick (~ 920 g). The ring is supported by nylon rods from a plastic holder plate which also seats the lens, and the plastic holder plate is screwed down to the lexan main 16" dia. mounting plate.
Shot 5 is a twin shot to H3837 to be fired at DARHT this fall, and has a slightly different drive: SE-1 + P-25 pwl [17 g PBX-9501 + 8 g TNT] + 1" dia. x 0.25" PBX-9501 [6 g] + 1" dia. x 0.25" alloy target. (There is no steel ring on Shot 5.)

The targets will be fired upward, and the usual amount of armor will be placed at the bottom of the vessel and in the top hat assembly. Shots 5 and 6 will be fired into a foam-filled tank (last used in Recovery/Capture shots) so that the targets will not be introduced to the vessel waste stream. (The post-shot targets will be returned to MST-6 for analysis.)

Proposed windows: 1/8" Al + 1/8" glass.

Thanks,
WVM

>X-Sieve: CMU Sieve 2.2
>Date: Tue, 7 Jul 2009 15:05:03 -0600 (MDT)
>Subject: Contained shot request
>From: "Mark Marr-Lyon" <mmarr@lanl.gov>
>To: pright@lanl.gov
>Cc: vogan@lanl.gov
>User-Agent: SquirrelMail/1.5.1
>X-NIE-2-MailScanner-Information: Please see
>http://network.lanl.gov/email/virus-scan.php
>X-NIE-2-MailScanner: Found to be clean
>X-NIE-2-MailScanner-From: mmarr@lanl.gov
>X-Spam-Status: No
>
>We would like to fire up to three RMI shots next week at pRad. They consist of a P-25 plane wave lens, initiated with an SE-1 detonator, driving a 1 3/4 inch diameter by 1 inch long cylinder of PBX-9501. Surrounding the explosives is a 1 3/4 inch ID delrin cylinder with
>approximately 1/2 inch thick walls. A smaller delrin cylinder fills the
>space between the P-25 and the outer delrin cylinder and holds the

Proton Radiography Experiment Safety and Security Review Checklist

PRAD shot number 369 Title ~~AAA~~ Equation of state series

Review Date 7/13/09 Shot Date 7/13 ff

Review must be performed within two weeks of shot date.

Table 1: Requirements of the Accelerator Safety Envelope (ASE): Require USI to violate or modify

Table 2: Requirements of the Safety Analysis Document: Require USI to violate or modify

Table 3: Requirements of LANL Safety Documents: Require Hazard Analysis and Management Approval to violate or modify

Table 4: Requirements of LANL Security documents: Require Management Approval to violate or modify

Brief Unclassified Description of experiment, including sample material, form, and quantity:

He Taylor wave drive into metal samples: Al, Cu, Fe, Sn

Measure V_s and ρ/ρ_0 within metal.

Required Facility Configuration (e.g. magnifier vs. –I lens; powder gun vs. 6-foot vessel):

x3 Mag. 6' vessel

No other diagnostics

Required Beam parameters (e.g. standard PRAD; video mode):

Standard PRAD

All SMEs participating in review:

Table 1a: Requirements of Accelerator Safety Envelope (ASE):

Number	Question	Yes	No	Requirements if YES	SME Inits.
1	ASE section 3.1.1.5 "Line X/B/C Beam Delivery Mode" will NOT be satisfied?		X	Outside of Safety Envelope: USI to proceed	
2	Outer vessel NOT qualified to greater than 150% of HE load in this shot?		X	Outside of Safety Envelope: USI to proceed	
3	Outer vessel NOT qualified for this shot by Vessel Approving Authority?		X	Outside of Safety Envelope: USI to proceed	
4	Total HE load greater than 10.0 lbs TNT equivalent?		X	Outside of Safety Envelope: USI to proceed	
5	Total propellant load in powder gun greater than 350 g Class 1.3 propellant?		X	Outside of Safety Envelope: USI to proceed	
6	Total Material at Risk (MAR) of greater than 12.0 Plutonium-Equivalent Grams (PEG)?		X	Outside of Safety Envelope: USI to proceed	

Table 1b: Additional requirements of ASE if MAR >= 0.1 PEG

Number	Question	Yes	No	Requirements if YES	SME Inits.
1	Total MAR in target assembly greater than 11.0 PEG?		X	Outside of Safety Envelope: USI to proceed	
2	Any MAR in non-metallic form, including powders?		X	Outside of Safety Envelope: USI to proceed	
3	Total HE in target assembly greater than 30 g?		X	Outside of Safety Envelope: USI to proceed	

Table 2: Requirements of Safety Analysis Document (SAD):

Number	Question	Yes	No	Requirements if YES	SME Inits.
1	New experiment configuration not covered by SAD?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
2	Change to building design not consistent with SAD?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
3	Explosives or detonators NOT approved by Laboratory Explosives Review Committee?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
4	Firing circuits or firing circuit test equipment NOT approved by Explosives Instrument Review Committee?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
5	Flammable gases would result in greater than 50% of flammability limit if released into vessel and backfilled with air?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
6	Low voltage detonators on this shot?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
7	No containment for this shot?		X	Outside of Safety Analysis: Hazard Analysis and USI to proceed	
8	New hazards due to materials or equipment inside containment vessel?		X	Review for new hazards	

Table 3: Requirements of LANL Safety Documents

Number	Question	Yes	No	Requirements if YES	SME Inits.
1	Shot contains more than 100 lbs of DU?		X	Hazard analysis and management approval required	
2	Shot contains hazardous materials other than lead, silver, DU, or transuranics?		X	Hazard analysis, management approval, and waste profile required	
3	This shot contains lead, silver, or DU materials?		X	Hazard analysis, management approval, and waste profile required	
4	Lasers not covered by VISAR IWD required for this shot?		X	LSO Review required	
5	Pins NOT approved by EIRC required?		X	EIRC approval required	
6	Flammable gasses required in vessel?		X	Hazard analysis and management approval required	
7	Will some HE NOT be burned after dynamic event?		X	Hazard analysis and management approval required	
8	New chemicals required for this shot?		X	Hazard analysis required	
9	Internal pressure vessel?		X	Test pressure vessel to 110% for remote fill or 150% for manual fill	
10	Will hazardous waste be generated without an identified disposal path?		X	Submit waste profile to Waste Coordinator before experiment	
11	Unlisted or uninspected electrical equipment?		X	ESO review	
12	Will radioactive materials be produced that cannot be stored in radioactive materials cabinet in Area C?		X	RP-1 review required	
13	Any work not covered by P25-IWD-07-42 (PRAD IWD) and IWD-DE3-53-003-P100-0001 (HE IWD)?		X	Assess uncovered work and implement controls	

Table 4: Security Review

Number	Question	Yes	No	Requirements if YES	SME Inits.
1	Any special handling due to security concerns?		X	DC Review; Activity Security Plan	
2	Has experiment NOT been DC or SAFE-7 reviewed?	X	X	DC review	AS
3	Does experiment involve cleared or uncleared foreign nationals?		X	Escort and computer use requirements	
4	Does this shot require overnight classified supervision?		X	Arrange for overnight supervision	

Any new hazards or vulnerabilities not listed above?

No

Summarize requirements from tables above, including new training requirements:

DC Review by A. Saunders:
Not classified

Approval by Experiment Safety Review Committee

EIC _____ Date 7/13/09
Experimenter in Charge

HE PIC _____ Date 07.13.09
High Explosives Person in Charge

EAM _____ Date 13 July 2009
Experimental Area Manager

New review required if initial review is more than two weeks before activity:

Proton Radiography

Science Based Stockpile Stewardship

43794 | 7/21/2009 7:48:18 AM | **EIC** | Edit

PRAD0374 - Equation of State - Iron

Beam Line Configuration

```
Beam Line Title: EOS-370 & 373 & 374 - 07/14/2009 - 6 Foot [116]
Comment: EOS-370 & 373 & 374
Mode: Perm Mag X3
Vessel: 6 Foot
Collimator IL0: None
Collimator IL1: 10 mr Straight
Collimator IL2: None
Window IL0: 125 mil Al [125 mil G]
Window Object Up: N/A
Window Object Down: N/A
Window Up IL1: 125 mil Al [125 mil G]
Window Down IL1: 20 mil Kapton
Window IL2: 62.5 mil Al
Converter IL0: None
Converter IL1: 1.9 mm LSO, 2x3
Converter IL2: 2.2 mm Mosaic, LSO, black
Location: LANSCE, Line C, Cave
Key: 116
Date Created: 7/14/2009
```

Basic Filters	Content Filters
○ By Date ○ Last 10 ○ Today ○ This Week ○ This Month ◉ This Year ○ All	Date Range Start 8/31/2009 / 9/1/2009 End ☐ Name EIC ☑ Text Entry Beam Line * ☑ Activity No PRAD0374 - Equation of State - Iron ☐ Expt Family Miscellaneous ☐ Pic Type Other ☐ Run No ☐ Pic No

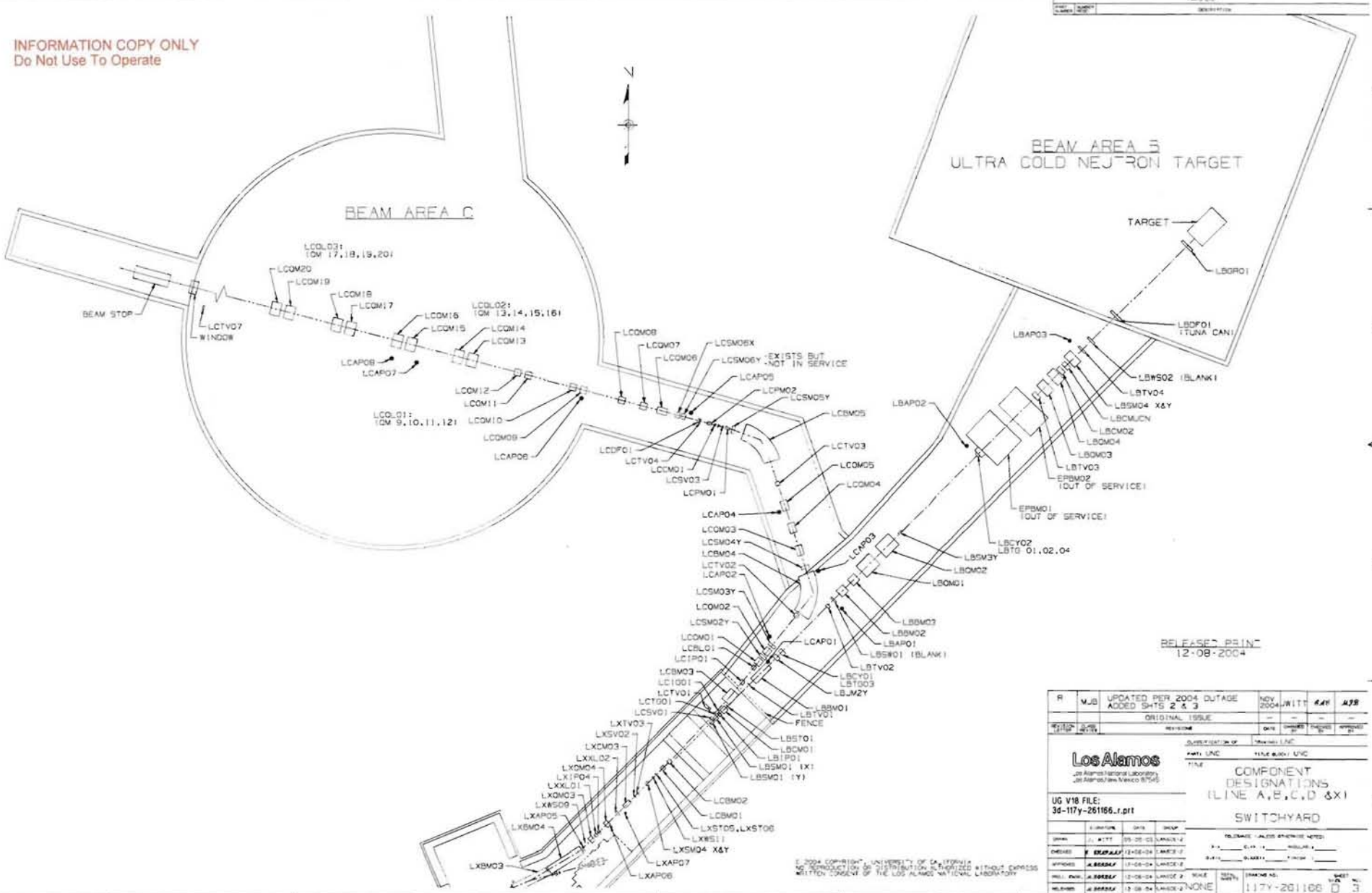
Check checkboxes to select content filters ("" , * , ? chars allowed).

Refresh | Hide Filters | New Entry

PRAD Home > Logbook Home

PRAD On-Line | Logbook | PRAD Off-Line | Run Status | Beam Status | Phone

Operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy


INFORMATION COPY ONLY
Do Not Use To Operate
BEAM AREA C
BEAM AREA 5
ULTRA COLD NEUTRON TARGET
TARGET
LBGR01
LBDF01 (TUNA CAN)
BEAM STOP
LCTV07 WINDOW
LCQL03: (QM 17,18,19,20)
LCQM20
LCQM19
LCQM18
LCQM17
LCQM16
LCQM15
LCQL02: (QM 13,14,15,16)
LCQM14
LCQM13
LCAP08
LCAP07
LCQM12
LCQM11
LCQL01: (QM 9,10,11,12)
LCQM10
LCQM09
LCAP06
LCDF01
LCTV04
LCQM01
LCSV03
LCPM01
LCQM08
LCQM07
LCQM06
LCSM06X
LCSM06Y (EXISTS BUT NOT IN SERVICE)
LCAP05
LCPM02
LCSM05Y
LCBM05
LCTV03
LCQM05
LCQM04
LCAP04
LCQM03
LCSM04Y
LCBM04
LCTV02
LCAP02
LCSM03Y
LCQM02
LCSM02Y
LCQM01
LCBL01
LCIP01
LCBM03
LC1001
LCTV01
LCT001
LCSV01
LXTV03
LXSV02
LXCM03
LXXL02
LXQM04
LXIP04
LXXL01
LXQM03
LXMS09
LXAP05
LXBM04
LXBM03
LXAP07
LXAP06
LXSM04 X&Y
LXMS11
LXST05,LXST06
LCBM02
LCBM01
LBAP03
LBWS02 (BLANK)
LBTV04
LBSM04 X&Y
LBCMUCN
LBCM02
LBQM04
LBQM03
LBTV03
EPBM02 (OUT OF SERVICE)
EPBM01 (OUT OF SERVICE)
LBAP02
LBCY02
LBTG 01,02,04
LBSM3Y
LBQM02
LBQM01
LCAP03
LBBM03
LBBM02
LBAP01
LBSW01 (BLANK)
LBTV02
LCAP01
LBCY01
LBT003
LBJM2Y
LBBM01
LBTV01
FENCE
LBST01
LBCM01
LBIP01
LBSM01 (X)
LBSM01 (Y)
RELEASED PRINT
12-08-2004
R MJB UPDATED PER 2004 OUTAGE ADDED SHTS 2 & 3 NOV 2004 JWITT RAY MJB
ORIGINAL ISSUE
Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545
UG V18 FILE:
3d-117y-261156_r.prt
COMPONENT DESIGNATIONS (LINE A,B,C,D &X)
SWITCHYARD
DRAWN JWITT 05-05-03 LAHDE-2
CHECKED RAY 12-06-04 LAHDE-2
APPROVED MJB 12-06-04 LAHDE-2
WELD ENGR. MJB 12-06-04 LAHDE-2
RELEASED MJB 12-06-04 LAHDE-2
SCALE NONE
DRAWING NO. 117Y-261156
SHEET 3 OF 3
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prad374			cvr to db	db to foi	FOI Camera	DB to 1st camera (us)	CVR TO 1ST CAM	FC TIME REL TO	CVR to FOI
Fe EOS					H		8.1	300	9.30
	Camera	Daq Timing	seperation between pulses (ns)	CCPG pattern start	CCPG pattern stop	width	X=gone	Rel To CVR	REL to FOI
1	E	0	0	300000	300060	60		8.1	-1.20
2	H	300	300	300300	300360	60		8.4	-0.90
3	G1	300	0	300300	300360	60		8.4	-0.90
4	K	600	300	300600	300660	60		8.7	-0.60
5	F1	600	0	300600	300660	60		8.7	-0.60
6	N	900	300	300900	300960	60		9	-0.30
7	G2	900	0	300900	300960	60		9	-0.30
8	Q	1200	300	301200	301260	60		9.3	0.00
9	F2	1200	0	301200	301260	60		9.3	0.00
10	T	1500	300	301500	301560	60		9.6	0.30
11	G3	1500	0	301500	301560	60		9.6	0.30
12	X	1800	300	301800	301860	60		9.9	0.60
13	F3	1800	0	301800	301860	60		9.9	0.60
14	I	2100	300	302100	302160	60		10.2	0.90
15	G4	2100	0	302100	302160	60		10.2	0.90
16	L	2400	300	302400	302460	60		10.5	1.20
17	F4	2400	0	302400	302460	60		10.5	1.20
18	O	2700	300	302700	302760	60		10.8	1.50
19	G5	2700	0	302700	302760	60		10.8	1.50
20	R	3000	300	303000	303060	60	X=gone	11.1	1.80
21	F5	3000	0	303000	303060	60	X=gone	11.1	1.80
22	U	3300	300	303300	303360	60	X=gone	11.4	2.10
23	G6	3300	0	303300	303360	60	X=gone	11.4	2.10
24	Y	3600	300	303600	303660	60	X=gone	11.7	2.40
25	F6	3600	0	303600	303660	60	X=gone	11.7	2.40
26	J	3900	300	303900	303960	60	X=gone	12	2.70
27	G7	3900	0	303900	303960	60	X=gone	12	2.70
28	M	4200	300	304200	304260	60	X=gone	12.3	3.00
29	F7	4200	0	304200	304260	60	X=gone	12.3	3.00
30	P	4500	300	304500	304560	60	X=gone	12.6	3.30
31	G8	4500	0	304500	304560	60	X=gone	12.6	3.30
32	S	4800	300	304800	304860	60	X=gone	12.9	3.60
33	F8	4800	0	304800	304860	60	X=gone	12.9	3.60
34	V	5100	300	305100	305160	60	X=gone	13.2	3.90
35	G9	5100	0	305100	305160	60	X=gone	13.2	3.90
36	Z	5400	300	305400	305460	60	X=gone	13.5	4.20
37	A	5700	300	305700	305760	60	X=gone	13.8	4.50
38	B	6000	300	306000	306060	60	X=gone	14.1	4.80
39	C	6300	300	306300	306360	60	X=gone	14.4	5.10
40	D	6600	300	306600	306660	60	X=gone	14.7	5.40
41	F9	6900	300	306900	306960	60	X=gone	15	5.70

Count Down	
LR to First	8.1

Camera	Pulse No.
1	#N/A
2	#N/A
E	0
H	300
I	2100
J	3900
K	600
L	2400
M	4200
N	900
O	2700
P	4500
Q	1200
R	3000
S	4800
T	1500
U	3300
V	5100
X	1800
Y	3600
Z	5400
A	5700
B	6000
C	6300
D	6600
F1	600
F2	1200
F3	1800
F4	2400
F5	3000
F6	3600
F7	4200
F8	4800
F9	6900
G1	300
G2	900
G3	1500
G4	2100
G5	2700
G6	3300
G7	3900
G8	4500
G9	5100

K	0
H	0
N	0
E	0
F1	0
F2	0
F3	0
F4	0
G1	0
G2	0
G3	0
G4	0
G5	0
Q	0
T	0
X	0
I	0
L	0
O	0
D	X=gone
F9	X=gone
F5	X=gone
F6	X=gone
F7	X=gone
F8	X=gone
G6	X=gone
G7	X=gone
G8	X=gone
G9	X=gone
R	X=gone
S	X=gone
U	X=gone
V	X=gone
Y	X=gone
Z	X=gone
J	X=gone
A	X=gone
M	X=gone
B	X=gone
P	X=gone
C	X=gone

Proton Radiography
Science Based Stockpile Stewardship

43792 | 7/21/2009 7:39:26 AM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Activity Change

Activity Changed to PRAD0374 [486]

43793 | 7/21/2009 7:39:26 AM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: HV Off

Picture Type Change

Picture Type changed to HV Off [13]

43794 | 7/21/2009 7:48:18 AM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Beam Line Configuration

Beam Line Title: EOS-370 & 373 & 374 - 07/14/2009 - 6 Foot [116]

Comment: EOS-370 & 373 & 374

Mode: Perm Mag X3

Vessel: 6 Foot

Collimator IL0: None

Collimator IL1: 10 mr Straight

Collimator IL2: None

Window IL0: 125 mil Al [125 mil G]

Window Object Up: N/A

Window Object Down: N/A

Window Up IL1: 125 mil Al [125 mil G]

Window Down IL1: 20 mil Kapton

Window IL2: 62.5 mil Al

Converter IL0: None

Converter IL1: 1.9 mm LSO, 2x3

Converter IL2: 2.2 mm Mosaic, LSO, black

Location: LANSCE, Line C, Cave

Key: 116

Date Created: 7/14/2009

43795 | 7/21/2009 7:52:59 AM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: 31619 Type: HV Off

Independent Picture

07/21 07:52 *Picture* **31619**, HV Off, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C

43796 | 7/21/2009 7:53:53 AM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: 31620 Type: HV Off

Independent Picture

07/21 07:53 *Picture* **31620**, HV Off, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C

43797 | 7/21/2009 7:54:17 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36810 Picture: 31621 Type: HV Off

Start Run

07/21 07:54	*Start Run* **36810**	PRAD 374, Iron EoS
07/21 07:54	*Arm*	
07/21 07:54	*Info*	**Manual Trigger** from PCPRAD307
07/21 07:54	*Trigger*	
07/21 07:54	*Picture* **31621**	HV Off, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D
07/21 07:55	*End Run*	

43798 | 7/21/2009 7:56:12 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36811 Picture: 31622 Type: HV Off

Start Run

07/21 07:56	*Start Run* **36811**	PRAD 374, Iron EoS
07/21 07:56	*Arm*	
07/21 07:56	*Info*	**Manual Trigger** from PCPRAD307
07/21 07:56	*Trigger*	
07/21 07:57	*Picture* **31622**	HV Off, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D
07/21 07:57	*End Run*	

43799 | 7/21/2009 10:28:09 AM | **EIC** | Edit PRAD0374 - Equation of State - Iron

Run: Picture: Type: Dark Field

Picture Type Change

Picture Type changed to Dark Field [1]

43800 | 7/21/2009 10:28:15 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36812 Picture: 31623 Type: Dark Field

Start Run

07/21 10:28	*Start Run* **36812**	PRAD 374, Iron EoS
07/21 10:28	*Arm*	
07/21 10:28	*Info*	**Manual Trigger** from PCPRAD307
07/21 10:28	*Trigger*	
07/21 10:29	*Picture* **31623**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D
07/21 10:29	*End Run*	

43801 | 7/21/2009 10:29:21 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36813 Picture: 31624 Type: Dark Field

Start Run

07/21 10:29	*Start Run* **36813**	PRAD 374, Iron EoS

07/21 10:29 *Arm*

07/21 10:29 *Info* **Manual Trigger** from PCPRAD307

07/21 10:29 *Trigger*

07/21 10:29 *Picture* **31624** Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D

07/21 10:30 *End Run*

43802 | 7/21/2009 10:30:26 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36814 Picture: 31625 Type: Dark Field

Start Run

07/21 10:30 *Start Run* **36814** PRAD 374, Iron EoS

07/21 10:30 *Arm*

07/21 10:30 *Info* **Manual Trigger** from PCPRAD307

07/21 10:30 *Trigger*

07/21 10:31 *Picture* **31625** Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D

07/21 10:31 *End Run*

43803 | 7/21/2009 10:31:32 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36815 Picture: 31626 Type: Dark Field

Start Run

07/21 10:31 *Start Run* **36815** PRAD 374, Iron EoS

07/21 10:31 *Arm*

07/21 10:31 *Info* **Manual Trigger** from PCPRAD307

07/21 10:31 *Trigger*

07/21 10:32 *Picture* **31626** Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D

07/21 10:32 *End Run*

43804 | 7/21/2009 10:32:51 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36816 Picture: 31627 Type: Dark Field

Start Run

07/21 10:32 *Start Run* **36816** PRAD 374, Iron EoS

07/21 10:32 *Arm*

07/21 10:33 *Info* **Manual Trigger** from PCPRAD307

07/21 10:33 *Trigger*

07/21 10:33 *Picture* **31627** Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D

07/21 10:33 *End Run*

43805 | 7/21/2009 11:04:41 AM | **EIC** | Edit PRAD0374 - Equation of State - Iron

Camera Delays

PRAD Trigger Settings - PRAD 374, EoS for Iron

Walk Offset: 0

Camera	Delay	Total Delay	Width
E	0	248.43	0.3
A	5.7	254.18	0.3
B	6	254.46	0.3
C	6.3	254.76	0.3
D	6.6	255.06	0.3
F1	0.6	249.32	0.2
F2	1.2	249.92	0.21
F3	1.8	250.52	0.21
F4	2.4	251.12	0.21
F5	3	251.72	0.21
F6	3.6	252.32	0.21
F7	4.2	252.92	0.21
F8	4.8	253.52	0.21
F9	6.9	255.62	0.21
G1	0.3	249.02	0.2
G2	0.9	249.62	0.21
G3	1.5	250.22	0.21
G4	2.1	250.82	0.21
G5	2.7	251.42	0.21
G6	3.3	252.02	0.21
G7	3.9	252.62	0.21
G8	4.5	253.22	0.21
G9	5.1	253.82	0.21
H	0.3	248.99	0.2
I	2.1	250.79	0.2
J	3.9	252.59	0.2
K	0.6	249.3	0.2
L	2.4	251.1	0.2
M	4.2	252.9	0.2
N	0.9	249.61	0.2
O	2.7	251.41	0.2
P	4.5	253.21	0.2
Q	1.2	249.89	0.2
R	3	251.69	0.2
S	4.8	253.49	0.2
T	1.5	250.19	0.2
U	3.3	251.99	0.2
V	5.1	253.79	0.2
X	1.8	250.49	0.2
Y	3.6	252.29	0.2
Z	5.4	254.09	0.2

43806 | 7/21/2009 11:09:29 AM | **EIC** | Edit PRAD0374 - Equation of State - Iron

Run: Picture: Type: Focus

Picture Type Change

Picture Type changed to Focus [3]

43807 | 7/21/2009 11:12:01 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36817 Picture: 0 Type: Focus

Start Run

```
07/21 11:12 Start Run 36817 PRAD 374, Iron EoS
07/21 11:12 Arm
07/21 11:12 Trigger
07/21 11:12 Lens 1          1760
07/21 11:12 Lens 1          126.219
07/21 11:12 Lens 2          -2.58
07/21 11:12 Lens 2          0
07/21 11:12 Lens 2          -4.919
07/21 11:12 Lens 3          1535
07/21 11:12 Lens 3          1559.734
07/21 11:12 Diffuser        1218
07/21 11:12 Perm Mg 2       79.867
07/21 11:12 Perm Mg 3       112.639
07/21 11:12 Perm Mg 4       135.483
07/21 11:12 Energy Loss     17
07/21 11:12 Energy Cal      0.0268
07/21 11:13 End Run
```

43808 | 7/21/2009 11:13:39 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: Picture: 31628 Type: Focus

Independent Picture

```
07/21 11:13 Picture 31628, Focus, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C,
```

43809 | 7/21/2009 11:18:01 AM | **EIC** | Edit PRAD0374 - Equation of State - Iron

Run: Picture: Type: Dark Field

Picture Type Change

```
Picture Type changed to Dark Field [1]
```

43810 | 7/21/2009 11:20:09 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: Picture: 31629 Type: Dark Field

Independent Picture

```
07/21 11:20 Picture 31629, Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B,
```

43811 | 7/21/2009 11:20:25 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36818 Picture: 31630 Type: Dark Field

Start Run

07/21 11:20	Start Run 36818	PRAD 374, Iron EoS
07/21 11:20	Arm	
07/21 11:20	Info	**Manual Trigger** from PCPRAD307
07/21 11:20	Trigger	
07/21 11:21	Picture 31630	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 11:21	End Run	

43812 | 7/21/2009 11:21:55 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36819 Picture: 31631 Type: Focus

Start Run

07/21 11:21	Start Run 36819	PRAD 374, Iron EoS

07/21 11:22	*Arm*	
07/21 11:22	*Trigger*	
07/21 11:22	*Picture* **31631**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 11:23	*End Run*	

43813 | 7/21/2009 11:24:25 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36820 Picture: 31632 Type: Focus

Start Run

07/21 11:24	*Start Run* **36820**	PRAD 374, Iron EoS
07/21 11:24	*Arm*	
07/21 11:24	*Trigger*	
07/21 11:24	*Picture* **31632**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 11:25	*End Run*	

43814 | 7/21/2009 11:27:09 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36821 Picture: 31633 Type: Focus

Start Run

07/21 11:27	*Start Run* **36821**	PRAD 374, Iron EoS
07/21 11:27	*Arm*	
07/21 11:27	*Trigger*	
07/21 11:28	*Picture* **31633**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 11:28	*End Run*	

43815 | 7/21/2009 11:29:34 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36822 Picture: 31634 Type: Focus

Start Run

07/21 11:29	*Start Run* **36822**	PRAD 374, Iron EoS
07/21 11:29	*Arm*	
07/21 11:29	*Trigger*	
07/21 11:29	*Picture* **31634**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 11:30	*End Run*	

43816 | 7/21/2009 11:31:14 AM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36823 Picture: 31635 Type: Focus

Start Run

07/21 11:31	*Start Run* **36823**	PRAD 374, Iron EoS
07/21 11:31	*Arm*	

07/21 11:31	*Trigger*	
07/21 11:31	*Picture* **31635**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 11:32	*End Run*	

43817 | 7/21/2009 11:32:48 AM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36824 Picture: 0 Type: No picture

Start Run

07/21 11:32 *Start Run* **36824** PRAD 374, Iron EoS
07/21 11:33 *End Run*

43818 | 7/21/2009 12:00:01 PM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: PreShot

Picture Type Change

Picture Type changed to PreShot [6]

43819 | 7/21/2009 12:03:29 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36825 Picture: 31636 Type: PreShot

Start Run

07/21 12:03	*Start Run* **36825**	PRAD 374, Iron EoS
07/21 12:03	*Arm*	
07/21 12:03	*Trigger*	
07/21 12:03	MP Width	100
07/21 12:03	MP Countdown	9999
07/21 12:04	*Picture* **31636**	PreShot, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:04	*End Run*	

43820 | 7/21/2009 12:06:57 PM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: Timing Check

Picture Type Change

Picture Type changed to Timing Check [24]

43821 | 7/21/2009 12:07:16 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36826 Picture: 31637 Type: Timing Check

Start Run

07/21 12:07	*Start Run* **36826**	PRAD 374, Iron EoS
07/21 12:07	*Arm*	
07/21 12:07	*Trigger*	
07/21 12:07	*Picture* **31637**	Timing Check, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:08	*End Run*	

43822 | 7/21/2009 12:09:40 PM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: PreShot

Picture Type Change

```
Picture Type changed to PreShot [6]
```

43823 | 7/21/2009 12:10:35 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36827 Picture: 31638 Type: PreShot

Start Run

07/21 12:10	*Start Run* **36827**	PRAD 374, Iron EoS
07/21 12:10	*Arm*	
07/21 12:10	*Trigger*	
07/21 12:10	MP Width	100
07/21 12:10	MP Countdown	9999
07/21 12:10	*Picture* **31638**	PreShot, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:11	*End Run*	

43824 | 7/21/2009 12:12:43 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36828 Picture: 31639 Type: PreShot

Start Run

07/21 12:12	*Start Run* **36828**	PRAD 374, Iron EoS
07/21 12:12	*Arm*	
07/21 12:13	*Trigger*	
07/21 12:13	MP Width	100
07/21 12:13	MP Countdown	9999
07/21 12:13	*Picture* **31639**	PreShot, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:13	*End Run*	

43825 | 7/21/2009 12:14:05 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36829 Picture: 31640 Type: PreShot

Start Run

07/21 12:14	*Start Run* **36829**	PRAD 374, Iron EoS
07/21 12:14	*Arm*	
07/21 12:14	*Trigger*	
07/21 12:14	MP Width	100
07/21 12:14	MP Countdown	9999
07/21 12:15	*Picture* **31640**	PreShot, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:15	*End Run*	

43826 | 7/21/2009 12:26:23 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36830 Picture: 31641 Type: PreShot

Start Run

07/21 12:26	*Start Run* **36830**	PRAD 374, Iron EoS
07/21 12:26	*Arm*	
07/21 12:26	*Trigger*	
07/21 12:26	MP Width	100
07/21 12:26	MP Countdown	9999
07/21 12:26	*Picture* **31641**	PreShot, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:27	*End Run*	

43827 | 7/21/2009 12:27:39 PM | **EIC** | Edit PRAD0374 - Equation of State - Iron

Run: Picture: Type: Dynamic

Picture Type Change

Picture Type changed to Dynamic [7]

43828 | 7/21/2009 12:28:42 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36831 Picture: 31642 Type: Dynamic

Start Run

07/21 12:28	*Start Run* **36831**	PRAD 374, Iron EoS
07/21 12:29	*Arm*	
07/21 12:29	*Trigger*	
07/21 12:29	Lens 1	1760
07/21 12:29	Lens 1	126.299
07/21 12:29	Lens 2	-2.594
07/21 12:29	Lens 2	0
07/21 12:29	Lens 2	-4.624
07/21 12:29	Lens 3	1515
07/21 12:29	Lens 3	1539.411
07/21 12:29	Diffuser	1218
07/21 12:29	H-GX Gate Delay	200
07/21 12:29	H-GX Gate Length	625
07/21 12:29	MP Width	100
07/21 12:29	MP Countdown	9999
07/21 12:29	Perm Mg 2	79.921
07/21 12:29	Perm Mg 3	112.746
07/21 12:29	Perm Mg 4	135.644
07/21 12:29	Energy Loss	-12345
07/21 12:29	Energy Cal	0.0268

07/21 12:29	Beam Line Title	EOS-370 & 373 & 373 - 07/14/2009 - 6 Foot [116]
07/21 12:29	Comment	EOS-370 & 373 & 373
07/21 12:29	Mode	Perm Mag X3
07/21 12:29	Vessel	6 Foot
07/21 12:29	Collimator IL0	None
07/21 12:29	Collimator IL1	10 mr Straight
07/21 12:29	Collimator IL2	None
07/21 12:29	Window IL0	125 mil Al [125 mil G]
07/21 12:29	Window Object Up	N/A
07/21 12:29	Window Object Down	N/A
07/21 12:29	Window Up IL1	125 mil Al [125 mil G]
07/21 12:29	Window Down IL1	20 mil Kapton
07/21 12:29	Window IL2	62.5 mil Al
07/21 12:29	Converter IL0	None
07/21 12:29	Converter IL1	1.9 mm LSO, 2x3
07/21 12:29	Converter IL2	2.2 mm Mosaic, LSO, black
07/21 12:29	Location	LANSCE, Line C, Cave
07/21 12:29	Key	116
07/21 12:29	Date Created	7/14/2009
07/21 12:29	*Picture* **31642**	Dynamic, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:30	*End Run*	

43829 | 7/21/2009 12:32:14 PM | **TNThompson** | Edit PRAD0374 - Equation of State - Iron

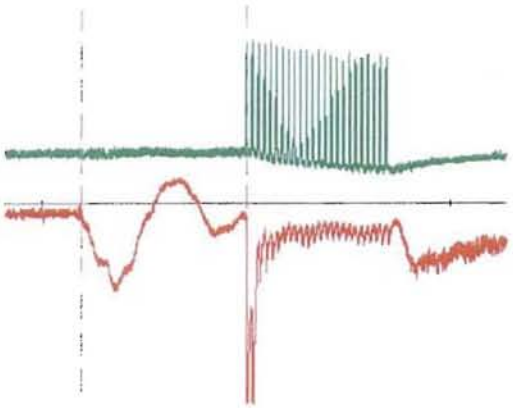
CVR to 1st Camera Timing:

Target: 8.100 uS
Actual: 8.105 uS

Markers: Scope 9, LeCroy LT584M

Time Markers

	1	2
1	0.0000E+00	-8.1047E-06
2	8.1047E-06	0.0000E+00
Value	2.4188E-04	2.4999E-04



File uploaded: ***P374.bmp*** of type ***image/bmp***

Click to open uploaded file

43830 | 7/21/2009 12:33:05 PM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: Small Fiducial

Picture Type Change

```
Picture Type changed to Small Fiducial (11)
```

43831 | 7/21/2009 12:34:34 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36832 Picture: 31643 Type: Small Fiducial

Start Run

07/21 12:34	*Start Run* **36832**	PRAD 374, Iron EoS
07/21 12:34	*Arm*	
07/21 12:34	*Trigger*	
07/21 12:34	Lens 1	1760
07/21 12:34	Lens 1	126.357
07/21 12:34	Lens 2	-2.591
07/21 12:34	Lens 2	0
07/21 12:34	Lens 2	-4.671
07/21 12:34	Lens 3	1515
07/21 12:34	Lens 3	1539.804
07/21 12:34	Diffuser	1219
07/21 12:34	Perm Mg 2	80.054
07/21 12:34	Perm Mg 3	113.014
07/21 12:34	Perm Mg 4	136.046
07/21 12:34	Energy Loss	10
07/21 12:34	Energy Cal	0.0268
07/21 12:34	*Picture* **31643**	Small Fiducial, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:35	*End Run*	

43832 | 7/21/2009 12:36:27 PM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: Beam

Picture Type Change

```
Picture Type changed to Beam [2]
```

43833 | 7/21/2009 12:46:13 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36833 Picture: 31644 Type: Beam

Start Run

07/21 12:46	*Start Run* **36833**	PRAD 374, Iron EoS
07/21 12:46	*Arm*	
07/21 12:46	*Trigger*	
07/21 12:46	Diffuser	1218
07/21 12:46	MP Width	100
07/21 12:46	*Picture* **31644**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:47	*End Run*	

43834 | 7/21/2009 12:47:35 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36834 Picture: 31645 Type: Beam

Start Run

07/21 12:47	*Start Run* **36834**	PRAD 374, Iron EoS
07/21 12:47	*Arm*	
07/21 12:47	*Trigger*	
07/21 12:47	Diffuser	1219
07/21 12:47	MP Width	100
07/21 12:47	*Picture* **31645**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:48	*End Run*	

43835 | 7/21/2009 12:48:51 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36835 Picture: 31646 Type: Beam

Start Run

07/21 12:48	*Start Run* **36835**	PRAD 374, Iron EoS
07/21 12:48	*Arm*	
07/21 12:49	*Trigger*	
07/21 12:49	Diffuser	1218
07/21 12:49	MP Width	100
07/21 12:49	*Picture* **31646**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:49	*End Run*	

43836 | 7/21/2009 12:50:16 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36836 Picture: 31647 Type: Beam

Start Run

07/21 12:50	*Start Run* **36836**	PRAD 374, Iron EoS
07/21 12:50	*Arm*	
07/21 12:50	*Trigger*	
07/21 12:50	Diffuser	1218
07/21 12:50	MP Width	100
07/21 12:50	*Picture* **31647**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:51	*End Run*	

43837 | 7/21/2009 12:51:36 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36837 Picture: 31648 Type: Beam

Start Run

07/21 12:51	*Start Run* **36837**	PRAD 374, Iron EoS
07/21 12:51	*Arm*	
07/21 12:51	*Trigger*	
07/21 12:51	Diffuser	1219
07/21 12:51	MP Width	100
07/21 12:51	*Picture* **31648**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:52	*End Run*	

43838 | 7/21/2009 12:55:12 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36838 Picture: 31649 Type: Beam

Start Run

07/21 12:55	*Start Run* **36838**	PRAD 374, Iron EoS
07/21 12:55	*Arm*	
07/21 12:55	*Trigger*	
07/21 12:55	Diffuser	1218
07/21 12:55	MP Width	100
07/21 12:55	*Picture* **31649**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:56	*End Run*	

43839 | 7/21/2009 12:56:34 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36839 Picture: 31650 Type: Beam

Start Run

07/21 12:56	*Start Run* **36839**	PRAD 374, Iron EoS
07/21 12:56	*Arm*	

07/21 12:56	*Trigger*	
07/21 12:56	Diffuser	1218
07/21 12:56	MP Width	100
07/21 12:56	*Picture* **31650**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:57	*End Run*	

43840 | 7/21/2009 12:57:52 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36840 Picture: 31651 Type: Beam

Start Run

07/21 12:57	*Start Run* **36840**	PRAD 374, Iron EoS
07/21 12:57	*Arm*	
07/21 12:58	*Trigger*	
07/21 12:58	Diffuser	1218
07/21 12:58	MP Width	100
07/21 12:58	*Picture* **31651**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 12:58	*End Run*	

43841 | 7/21/2009 12:59:08 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36841 Picture: 31652 Type: Beam

Start Run

07/21 12:59	*Start Run* **36841**	PRAD 374, Iron EoS
07/21 12:59	*Arm*	
07/21 12:59	*Trigger*	
07/21 12:59	Diffuser	1218
07/21 12:59	MP Width	100
07/21 12:59	*Picture* **31652**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E
07/21 13:00	*End Run*	

43842 | 7/21/2009 1:00:23 PM | **DAQ On-line** | Edit PRAD0374 - Equation of State - Iron

Run: 36842 Picture: 31653 Type: Beam

Start Run

07/21 13:00	*Start Run* **36842**	PRAD 374, Iron EoS
07/21 13:00	*Arm*	
07/21 13:00	*Trigger*	
07/21 13:00	Diffuser	1219
07/21 13:00	MP Width	100
07/21 13:01	*Picture* **31653**	Beam, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E

07/21 13:01	*End Run*	

43844 | 7/21/2009 1:01:44 PM | **EIC** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: Type: Dark Field

Picture Type Change

Picture Type changed to Dark Field [1]

43845 | 7/21/2009 1:01:54 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36843 Picture: 31654 Type: Dark Field

Start Run

07/21 13:01	*Start Run* **36843**	PRAD 374, Iron EoS
07/21 13:01	*Arm*	
07/21 13:02	*Info*	**Manual Trigger** from PCPRAD307
07/21 13:02	*Trigger*	
07/21 13:02	*Picture* **31654**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, A, B, C, D, E, Errors B
07/21 13:02	***Error***	Error in AllCameras, Skip file transfer
07/21 13:03	*End Run*	

43848 | 7/21/2009 1:15:50 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: 31655 Type: Dark Field

Independent Picture

07/21 13:15 *Picture* **31655**, Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A,

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43849 | 7/21/2009 1:16:43 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: 31656 Type: Dark Field

Independent Picture

07/21 13:16 *Picture* **31656**, Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A,

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43850 | 7/21/2009 1:17:38 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: 31657 Type: Dark Field

Independent Picture

07/21 13:17 *Picture* **31657**, Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A,

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43851 | 7/21/2009 1:18:28 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: Picture: 31658 Type: Dark Field

Independent Picture

07/21 13:18 *Picture* **31658**, Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A,

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43852 | 7/21/2009 1:18:44 PM | **DAQ On-line** | Edit — PRAD0374 - Equation of State - Iron

Run: 36844 Picture: 31659 Type: Dark Field

Start Run

07/21 13:18	*Start Run* **36844**	PRAD 374, Iron EoS

07/21 13:18	*Arm*	
07/21 13:18	*Info*	**Manual Trigger** from PCPRAD307
07/21 13:18	*Trigger*	
07/21 13:18	*Picture* **31659**	Dark Field, Cameras X, Y, Z, T, U, V, Q, R, S, N, O, P, K, L, M, H, I, J, G, F, E, A, B, C, D
07/21 13:19	*End Run*	

44135 | 7/27/2009 12:44:41 PM | **ASaunders** | Edit

PRAD0374 - Equation of State - Iron

timing sheet for 374

prad374 Fe EOS		cvr to db		db to foi H		FOI Camera 8.1		DB to 1st camera (us) 300	9.30	CVR TO 1ST CAM F
	Camera	Daq Timing		seperation between pulses (ns)				CCPG pattern start	CCPG pattern stop	w
1	E	0	0	300000	300060	60		8.1	-1.20	
2	H	300	300	300300	300360	60		8.4	-0.90	
3	G1	300	0	300300	300360	60		8.4	-0.90	
4	K	600	300	300600	300660	60		8.7	-0.60	
5	F1	600	0	300600	300660	60		8.7	-0.60	
6	N	900	300	300900	300960	60		9	-0.30	
7	G2	900	0	300900	300960	60		9	-0.30	
8	Q	1200	300	301200	301260	60		9.3	0.00	
9	F2	1200	0	301200	301260	60		9.3	0.00	
10	T	1500	300	301500	301560	60		9.6	0.30	
11	G3	1500	0	301500	301560	60		9.6	0.30	
12	X	1800	300	301800	301860	60		9.9	0.60	
13	F3	1800	0	301800	301860	60		9.9	0.60	
14	I	2100	300	302100	302160	60		10.2	0.90	
15	G4	2100	0	302100	302160	60		10.2	0.90	
16	L	2400	300	302400	302460	60		10.5	1.20	
17	F4	2400	0	302400	302460	60		10.5	1.20	
18	O	2700	300	302700	302760	60		10.8	1.50	
19	G5	2700	0	302700	302760	60		10.8	1.50	
20	R	3000	300	303000	303060	60	X=gone	11.1	1.80	
21	F5	3000	0	303000	303060	60	X=gone	11.1	1.80	
22	U	3300	300	303300	303360	60	X=gone	11.4	2.10	
23	G6	3300	0	303300	303360	60	X=gone	11.4	2.10	
24	Y	3600	300	303600	303660	60	X=gone	11.7	2.40	
25	F6	3600	0	303600	303660	60	X=gone	11.7	2.40	
26	J	3900	300	303900	303960	60	X=gone	12	2.70	
27	G7	3900	0	303900	303960	60	X=gone	12	2.70	
28	M	4200	300	304200	304260	60	X=gone	12.3	3.00	
29	F7	4200	0	304200	304260	60	X=gone	12.3	3.00	
30	P	4500	300	304500	304560	60	X=gone	12.6	3.30	
31	G8	4500	0	304500	304560	60	X=gone	12.6	3.30	
32	S	4800	300	304800	304860	60	X=gone	12.9	3.60	
33	F8	4800	0	304800	304860	60	X=gone	12.9	3.60	
34	V	5100	300	305100	305160	60	X=gone	13.2	3.90	
35	G9	5100	0	305100	305160	60	X=gone	13.2	3.90	
36	Z	5400	300	305400	305460	60	X=gone	13.5	4.20	
37	A	5700	300	305700	305760	60	X=gone	13.8	4.50	
38	B	6000	300	306000	306060	60	X=gone	14.1	4.80	
39	C	6300	300	306300	306360	60	X=gone	14.4	5.10	
40	D	6600	300	306600	306660	60	X=gone	14.7	5.40	
41	F9	6900	300	306900	306960	60	X=gone	15	5.70	

File uploaded: ***Prad374.xls*** of type ***application/vnd.ms-excel***

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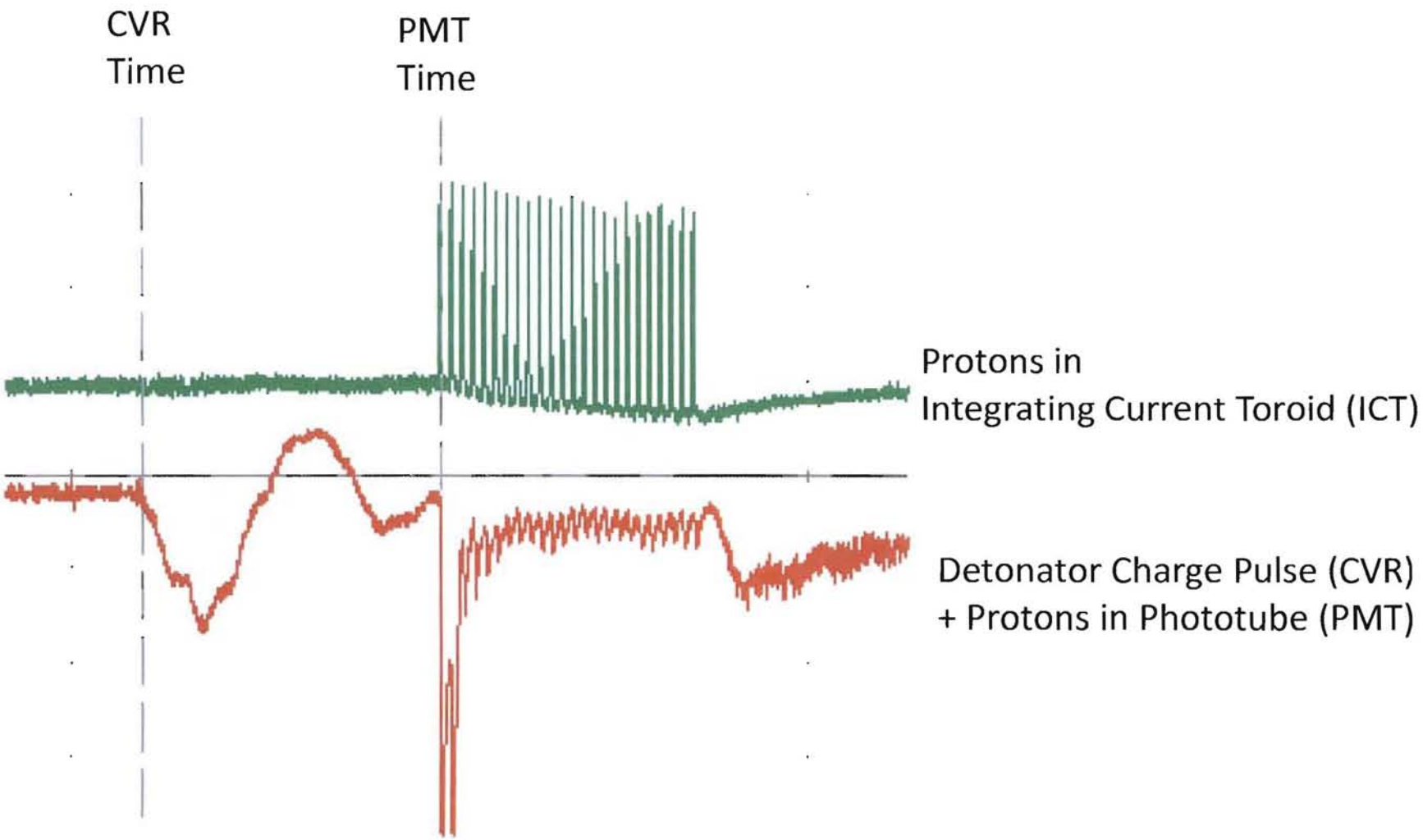
PRAD0374 Proton Timing Measurement



Summary of Run 36831, 12:30:10 PM, Tuesday, July 21, 2009

Batch Protons

	Group 1	
	N	Integral
Trigger 1	25	6.79853E+10
Run 36831	25	6.79853E+10
Batch started at 36831	25	6.79853E+10

Total Protons

RUN	Time	N	Group 1
36831	12:30 07/21/09	25	6.79853E+10

Protons per Peak

Run	Scope	Channel	# Peaks	Sum V-S	Sum P	Peak	Time	Peak V-S	Peak P	Rel Error
36831	9	2	25	2.66714E-06	6.79853E+10					
						1	1.31594E-08	2.22413E-07	5.66930E+09	9.86128E-03
						2	2.49992E-04	1.02355E-07	2.60902E+09	1.74286E-02
						3	2.50289E-04	1.05475E-07	2.68855E+09	1.64815E-02
						4	2.50587E-04	1.06010E-07	2.70218E+09	1.63983E-02
						5	2.50884E-04	1.05051E-07	2.67775E+09	1.69813E-02

6	2.51181 E-04	1.04968 E-07	2.67563E+ 09	1.69947 E-02
7	2.51480 E-04	1.00272 E-07	2.55593E+ 09	1.73366 E-02
8	2.51778 E-04	1.03421 E-07	2.63621E+ 09	1.63684 E-02
9	2.52075 E-04	1.02221 E-07	2.60561E+ 09	1.70061 E-02
10	2.52373 E-04	9.97789 E-08	2.54336E+ 09	1.69659 E-02
11	2.52672 E-04	1.03204 E-07	2.63067E+ 09	1.68441 E-02
12	2.52970 E-04	1.01176 E-07	2.57899E+ 09	1.71816 E-02
13	2.53268 E-04	9.83720 E-08	2.50750E+ 09	1.72086 E-02
14	2.53567 E-04	1.05921 E-07	2.69994E+ 09	1.64119 E-02
15	2.53865 E-04	1.01864 E-07	2.59652E+ 09	1.70656 E-02
16	2.54163 E-04	1.01949 E-07	2.59867E+ 09	1.70515 E-02
17	2.54460 E-04	9.88906 E-08	2.52072E+ 09	1.71183 E-02
18	2.54759 E-04	9.66532 E-08	2.46369E+ 09	1.79857 E-02
19	2.55057 E-04	1.02210 E-07	2.60534E+ 09	1.65624 E-02
20	2.55355 E-04	9.94398 E-08	2.53472E+ 09	1.74817 E-02
21	2.55653 E-04	9.75426 E-08	2.48636E+ 09	1.73549 E-02
22	2.55952 E-04	1.04286 E-07	2.65824E+ 09	1.66694 E-02
23	2.56250 E-04	9.94306 E-08	2.53449E+ 09	1.70254 E-02
24	2.56548 E-04	1.03098 E-07	2.62796E+ 09	1.68614 E-02
25	2.56845 E-04	1.01136 E-07	2.57796E+ 09	1.67383 E-02

DG535 Timing

Run	DG Tag	A Delay	B Delay	C Delay	D Delay
36831	8	2.571200000000E-02	3.000000000000E-04	5.000000000000E-03	0.500000000000
36831	9	5.100000000000E-03	1.000000000000E-04	5.150000000000E-03	5.000000000000E-08
36831	10	4.000000000000E-05	4.500000000000E-05	5.000000000000E-05	6.000000000000E-08
36831	11	1.995120000000E-04	5.000000000000E-05	0.00000000000	0.00000000000
36831	13	2.500000000000E-02	5.000000000000E-07	0.00000000000	1.010000000000E-04
36831	14	5.000000000000E-12	1.300000000000E-05	5.000000000000E-12	5.000000000000E-12
36831	16	2.397950000000E-04	2.000000000000E-07	1.521500000000E-05	5.000000000000E-06
36831	23	9.100000000000E-06	3.000000000000E-04	6.750000000000E-07	1.000000000000E-06

Camera Walk/Timing File

RUN	Time 1	Camera 1
36831	0.000	7.86204E-02,

Beam Line Status

Run	36831		
Time	7/21/2009 12:29:14 PM		
LCQM006V01	134579417	-364.037994384766	OK
LCQM006L06	1	OFF	OK
LCQM007V01	134579417	285.035003662109	OK
LCQM007L03	1	REV	OK

LCQM008V01	134579417	-952.293029785156	OK
LCQM008L03	1	OFF	OK
LCQL001P01	134579417	1760	OK
LCQL001V01	134579417	126.299003601074	OK
LCQL002I01	134579417	-2.59400010108948	OK
LCQL002P01	134579417	0	OK
LCQL002V01	134579417	-4.62400007247925	OK
LCQL003P01	134579417	1515	OK
LCQL003V01	134579417	1539.41101074219	OK
LCDF001E01	1	1218	OK
CCTM006D02	1	200	OK
CCTM006D03	1	625	OK
TBBC002D07	134579417	100	OK
TBBC002D06	134579417	9999	OK
TBMX001L01	134579417	NORM	OK
TBBC022D01	134579417	1500000	OK
TBBC022D02	134579417	1500000	OK
TBBC022D03	134579417	1500000	OK
TBBC022D04	134579417	1500000	OK
TBBC023D01	134579417	1500000	OK
TBBC023D02	134579417	1500000	OK
TBBC024D03	134579417	1500000	OK
TBBC023D04	134579417	1500000	OK
TBBC024D01	134579417	1500000	OK
TBBC024D02	134579417	1500000	OK
TBBC024D03	134579417	1500000	OK
TBBC024D04	134579417	1500000	OK
LCQM017I01	1	5	OK
LCQM020I01	1	79.5	OK
Perm Mg 2	0	79.921	OK
Perm Mg 3	0	112.746	OK
Perm Mg 4	0	135.644	OK
Energy Loss	0	-12345	OK
Energy Cal	0	0.0268	OK

Operational Guide and Safety Control Check List

The following is to be used as an operational guide and as a safety checklist to allow for recording of implementation of controls.
This document is to be completed by the Experimenter In Charge or his designee. This document will be retained for 2 years after completed.

Shot Name: Fe EOS ; PRAD # 374 ; HX # LNSC- 10629 ; Originator's # H386
Dates of Shot: 7/21/2009 ; Experimenter in Charge (PRAD PIC): Cynthia Schwartz
HE PIC: Marr-Lyon ; Firing Leader: R. Lopez ; Secondary Operator: Bainbridge
Checklist & Safety Watch Campos ; Laser Diagnostics PIC N/A

Operational Guide	Safety Control Checklist	Initials	Date	Checked
Mark list for all N/A (Non/Applicable) items before EIC review. Classified shots; Call Richard Harford 5-0060 and Tim Olinger 5-6363 http://ptla.lanl.gov/cgi-bin/mailform/staff_form.htm	◦ EIC reviews & signs check list (Cynthia Schwartz) ◦ PRAD safety/security review for this series within 2 weeks • Guards scheduled for night watching of classified shots	CLS AS NA	* 7/13	✓ ✓ NA
Rope stays up until after shot has been completed.	◦ Rope off truck access entrance, at north end of counting house - Label rope with "No Parking Fire Lane" sign	AS		✓
RWP = Radiation Work Permit – NOT expired Uranium, Pu, and other unusual materials/conditions	• RWP for dynamics – date is current & posted on shield door • RWP for extras (U/Pu) - date is current & posted on shield dr	NA NA		NA NA
1) HE Category (Orange Octagon) 2) Experimenter In Charge permission required for entry	◦ Signs - Line C tunnel entrance station (PACS) ◦ Signs - Line C shield door – small door	AS		✓
Lightning Detector – Display NM. Full Zoom out - verify speaker volume	• Lightning computer speaker volume turned up & verified • LANSCE electric field mill displayed and indicating • Lightning Strike program displayed and updating	Broken Use AS	access	Broken control ✓
	◦ CCR notified EIC for the HE shot.	AS		✓
Gun shots do not normally have a "confined space". NOT for DU/Pu!	• Confined Space Permit 09-5037 ; effective 7/20-24/09	AS		✓
Respirators are required by the IWD.	• HE workers available with current confined space training • Respirators with canisters available – expiration date verified • Level II Anti-C clothing available (U/Pu) • (U/Pu) RCT available with respirator and canisters in date	AS AS NA NA		✓ ✓ NA NA
Experiment Design - HE = High Explosive (Less than or equal to 10 pounds of HE or 300 grams of black powder)	◦ Depleted Uranium less than 100 pounds ◦ HE load within Authorization Basis <10 lb HE <300gr powder	NA AS		NA ✓
	◦ HE on LANSCE Approved List	AS		✓
Some experiments do not use detonators, like electrically heated Cook-Off	◦ Detonators on approved list, if required.	AS		✓
Some Powder gun shots require conductive surfaces for handling powder	◦ Conductive surfaces available if required by shot sheet or PIC	NA		NA
EIRC = Explosives Instrumentation Review Committee Power Supply, CDU, DCU, fiber optics trigger, etc.	• Firing Circuit & firing circuit test equipment, if used, have been reviewed by the EIRC for this specific use.	AS		✓
	◦ Corresponding Proof/Overpressure Tests Completed	AS		✓
Shot sheet specifies the approved HE load for this shot in this vessel/gun	◦ Vessel Approving Authority - Approval Received	AS		✓
LANSCE = Los Alamos Neutron Science Facility	◦ Notification to LANSCE Experimental Area C Manager	AS		✓
Tested within past 30 days.	◦ Emergency Lighting in Line C dome	AS	7/17	✓
Portable gantry - Each structural member is attached by a removable pin. Not usually required for gun shots.	• Ask HX-3 if a Critical Lift Form will be needed later • A-frame crane – Official Daily Check – qualified operator	NA AS		NA ✓

Operational Guide	Safety Control Checklist	Initials	Date	Checked
Braided grounding strap connects ground block on dome wall south side east.	▫ Electrical bonding connection to dome wall ground plate ▪ Vessel or gun target box ▫ Crane ▪ 6` vessel top door (sitting a top assembly stand) or gun barrel	AS AS AS AS	*	✓ ✓ ✓ ✓
Module 9 – select "Normal" & push reset. Place "S1 test" switch in "test" and run unit for 10 minutes. Place "test" switch back into "normal". Check automatic transfer valve is not pointing to empty bottle. If the stand-by tank is not open, the generator will fail when #1 empties.	• Backup generator enabled – Module 9 "Normal" and "Reset" ▫ Backup generator tested (not usually required for gun shots) ▫ Propane automatic selection valve – NOT RED ▫ Both propane tank valves OPEN ▫ Work-Stand light in dome hooked to generator and tested	AS AS AS AS AS	*	✓ ✓ ✓ ✓ ✓
CO = Carbon Monoxide – Zero ITX model after 15 minute warm-up. NOTE: Some CO monitors should not be ON when in their charger. NOTE: TV picture must be readable when dome lights are turned off. NOTE: The ITX models can be left on all day if no blower is installed.	• CO monitors – Two available and tested (includes zero reset) ▫ Calibration memo current • One installed in dome with a TV picture in the counting house • Turn units off, including blowers, to preserve batteries	AS		✓ ✓ ✓ ✓
Turn amplifier power on and select "phono" Amplifier can be turned off after test.	• Microphone is placed on vessel or gun catch tank and audio can be heard in counting house.	AS		✓
GFCI – Ground Fault Circuit Interrupter – Use circuit tester w/trip button Not usually required for gun shots. Power cords on floor can be electrical hazards during flooding caused by a cooling hose rupture. Check 208 V crane and laser cords also.	• GFCI receptacles for vessel tested within 30 days ▪ Vessel drop light(s) hooked to GFCI ▪ Vessel extension cord for impact wrench hooked to GFCI • No 120V or 208V power cord connections on floor	AS NA AS AS	7/17	✓ NA ✓ ✓
House air line drives a venturi pump in the vertical run of the PVC exhaust pipe to the LANSCE radioactive exhaust stack system	• Vacuum pump exhaust booster pump hooked up and working • Radiation Portal Monitor – Green status & bottles have gas	AS AS		✓ ✓
	• Laser setup check list started – if lasers will be used	**NA**		**NA**
Uranium and Plutonium – Vacuum system Pressure after the shot is supposed to be less than atmospheric. First filter layer is 2.0 microns. Second layer is 0.2 microns. Check valve prevents U dust going out into dome during venting. Venting must be done slowly so as to not ignite U dust. TV picture in counting house for vacuum gage.	▪ U/Pu – Calculated post shot pressure is below atmospheric • Filter pack between containment & vacuum sys – 0.2 micron ▪ 2 psig check valve installed on vent valve • Flow restrictor installed in vent line ▪ Remote reading of post shot pressure in counting house ▫ Valves operate OK – containment isolation, vent, purge ▫ Remote reading of primary container pressure in CCH	NA NA NA NA NA NA NA		NA NA NA NA NA NA NA
Uranium and Plutonium - Continuous Air Monitor	▫ CAM or Giraffe near vessel – Checked today by a RCT ▫ Remote indication in counting house	NA NA		NA NA
Uranium and Plutonium – Contamination Control Areas	• Contamination area around vessel ▪ Contamination area around HE assembly area • Contamination buffer area near portal monitor ▪ Radioactive Materials Balance area (safe) posted correctly	NA NA NA NA		NA NA NA NA
Gas cooling/heating system could overpressure vacuum pumping system; so, a "conflat" blank is placed on a tee by the pressure gage. The LN2 dewar connections are easily confused – check the correctness.	• Gas filled, cooled, or heated shots • Zero pressure relief installed for upstream vacuum valve • LN2 dewar inlet & outlet connections double checked	**NA** **NA**	* *	**NA** **NA**
Vacuum pump exhaust system to radioactive exhaust system – white PVC piping system – Big gray valves (usually without their red handles)	• Vacuum fore pump exhaust valve open – Upstream of vessel • Downstream of vessel • Second Lens system	AS		✓ ✓ ✓
Both gage controllers in blue racks	• Vacuum gauge TV picture in CCH with separate illumination	AS		✓

Operational Guide	Safety Control Checklist	Initials	Date	Checked
Remove dust/gases falling out of front door	• Portable HEPA system rigged/tested under vessel front door	JL		✓
The type and thickness required is specified in the "Contained Shot Request Form" under "Shrapnel Protection". Windows must be checked for damage from previous shot every time, including checking the glass for cracks.	• Containment system beam windows • Glass thickness required = 1/8" inch; downStream 1/8" • Metal type = Al, thickness = 1/8"; dwnStr = 1/8" • Upstream checked for damage after previous shot and installed • Downstream checked for damage and installed	 JL JL	 * *	 ✓ ✓
Key & reset at IL0; Power ON = green LEDs on controllers in blue racks	• Dalek - Key IN, Reset, and power ON	JL	*	✓
Beam Line vacuum pump-out valve – The containment system isolation valves to the pumping stations. Tested from CCH. CCH = Line C Counting House TV picture requires separate illumination to be seen when the dome lights are out.	• Containment isolation vacuum valve actuator operation • Upstream of vessel • Downstream of vessel • TV pictures can be viewed in CCH • Illuminators available (flashlight or equivalent) • Vacuum valves OPEN.	JL JL JL JL JL JL	 * * *	 ✓ ✓ ✓ ✓ ✓
No bolts can be left out. Broken bolts must be reported to the HE PIC and EIC. Not required after the first shot in a series.	• Vessel/gun and containment pipes installed and checked for loose and missing bolts – every bolt installed and tight.	JL		✓
Door check for is for the doors installed at this time, like beam line doors.	• Vessel/gun installed doors checked for loose/missing bolts	EC		✓
	• Beam Line Setup entered into DAQ program	EC		✓
Exclusion Threshold Temperature is the temperature above which the HE might be unstable; so, people are excluded. LANSCE requires all Lock Out Tag Outs to be entered into their log. Thermocouple Meter or DVM with temperature scale	• Cook-Offs: • Shutter illumination available • TV picture of laser blocking shutter in counting house • Four lock boxes & padlocks available • Laser shutter tested – Fails safe (closed) upon loss of power • Heater cables locked by FL in CCH and FL has the key(s) • Heated shot - Portable thermocouple meter available and tested	 NA NA NA NA NA NA	 * 	 NA NA NA NA NA NA
	• Exclusion Threshold Temperature = _____ • Temperature readout working in counting house	NA NA	* *	NA NA
CDU = Capacitive Discharge Unit	• Firing Leader in direct charge of HV connection box key and charging key for CDU Power Supply • Cook-Off laser shutter power locked off and FL has the key • Secondary operator has trigger key	JL NA JL	* * *	✓ NA ✓
For ribbon cables, to support "slappers", this test is performed off site.	• High Pot testing of vessel feed-throughs completed	JL	*	✓
DCO – Detonator Checking Ohmmeter	• DCO available, if needed – Charged up or charging	JL	*	✓
Signature in CCR (Central Control Room) for today's shot	• LANSCE Experimental Area C Manager Approval Received	EC	7/21	✓
Firing Site Access Control 7-6742	• Weather status – start a Weather Watch	EL		✓
	• HE starting transport to TA-53 at time = 0758	EL	*	✓
HE staff and P-25 have agreed that asking CCR to not open the line B tunnel door is sufficient control to prevent violation of the HE exclusion area. The EIC knows that the authorization basis requires firing leader approval before permitting line B entries. CCR line-by-line for Line B PACS = LBSS1L1 and/or 1L2 NTOF door – Exclusion Area – Red light ON and door Locked (pull on it)	• Notify CCR – "CCR, high explosives are being shipped to TA-53. Please do not allow entries into the line B and C tunnels without the permission of the Experimenter-In-Charge until after HE operations are completed." • Line B tunnel PACS secured • NTOF cave 202 key exclusion area secured	EL EL	*	✓ ✓
Orange Octagon with a "1" on it.	• Post large sign outside truck roll-up door – HE Category	EL	*	✓

Operational Guide	Safety Control Checklist	Initials	Date	Checked
Post 2 signs - HE Orange Octagon & EIC – **after** HE is on its way. HE octagon clips onto exclusion area box over top of keyed lock.	• EIC Sign for Line B tunnel - NTOF maze outside door • HE octagon – NTOF Exclusion area box	EC EC		✓ ✓
The experimenter in charge will notify CCR when the HE arrives on site.	• HE arrival time: 0821 • CCR Notified that the HE has arrived	 EC	 *	 ✓

******* **Move HE into Line C Dome** **********	**Move HE to Dome** * recheck all items for multiple shots		*	✓
Laminated Badge "I am guarding classified (SRD) High Explosives"	• Bomb Badge issued	**NA**		**NA**
LANL Meteorologist substitutes for broken lightning/field indications Moving the HE out of the delivery truck begins HE operations at TA-53	• Lightning/weather status - Access Control or Meteorologist • Notify Access Control that HE is being removed from truck	NA NA	* *	NA NA
A custom terminator is placed on the end of the cable.	• CDU output detonator cable is terminated – not open ended	EC	*	✓
	• Pathway for HE movement cleared of obstructions and HE area is free of combustibles	EC	*	✓
	• HE moved into Line C dome inside D.O.T. container	EC	*	✓
Door cannot be re-opened until after shot fired or returned to DOT container – AC20 page 83 Explosives Operations at LANSCE	• Area C shield door closed and air pads deflated before opening HE shipping container	EC	*	✓
	• Firing Leader holds keys: • Dome access keys (PACS) • VISAR control box • PDV Laser key • Cook OFF laser control key OR laser ignition fiber lock box	 **NA** **NA** **NA**	 * * * *	 **NA** **NA** **NA**

HCP = Hazard Control Plan IWD = Integrated Work Document EIC = Experimenter In Charge VISAR – Laser system Velocity Interferometer System for Any Reflective surface **Uranium**, Beryllium, Lead, etc. all require additional training and may require a special IWD PIC = Person in Charge -- must be consulted about work which comes under their responsibility before the work starts, as per the IWD. Only one briefing per day is required if all the days shots are discussed at the first briefing and if there are no significant changes from shot to shot. HE heated above its Exclusion Threshold Temperature may go off without warning.	• Pre-Job Briefing by EIC • Has anyone NOT read and signed the PRAD security plan? • ---- Dynamic RWP? • ---- Area C hazard overview? • ---- Dynamic IWD? ----------→ • ---- Special IWD and/or training (U, Be, Ca, Pb, etc.) • Does anyone NOT have current TA-53 site specific training? • Experimenter In Charge is ----------→ • No dome PACS entries after HE load, without EIC approval • HE PIC is ... • Firing-Leader is ... • Secondary firing leader is ----------→ • Ignition sources prohibited in dome – no lighters, no matches • Absolutely no entries after HE exceeds exclusion temperature • Safety Watch is ----------→ • Forklift operations are halted in the dome and truck entrance • Laser Diagnostics PIC is ----------→ • VISAR/LASER system status is ... • Laser Keys – Clarify the times when FL needs to hold keys • MSDS sheets available via counting house computers -------→ • Flammable gases in detectors, cameras, and vessel? • Are there any other issues? • _____ • _____ • _____ • _____ • _____	------→ ------→ ------→ ------→	------→ ------→ ------→ ------→	NA NA ✓ ✓ NA ✓ ✓ ✓ ✓ ✓ ✓ NA ✓ ✓ N/A NA NA _____ _____ _____ _____

******* Load HE into Vessel **********	**Loading HE** * recheck all items for multiple shots		*	✓
	• Crane - Critical Lift form completed	NA	*	NA
	• Laser setup check list completed	NA		NA
U/Pu containment system not opened until after venturi pump disconnect. No air flow through containment system for U/Pu.	• U/Pu - Vacuum system venturi disconnected before opening	NA	*	NA
	• CAM & CAM exhaust pump turned on and verified by a RCT	NA	*	NA
Cook-off laser ignition fiber locked after fiber is through the vessel door.	• Cook-off laser ignition fiber locked in box and FL has key	NA	*	NA
HE procedures limit the number of persons in the area to 5. Access Control or Meteorologist if local indications broken.	• Assign a door watch for HE exclusion area and to watch the lightning detector – reports to firing leader	EC	*	✓
No one is in the dome without the firing leader's approval.	• HE Exclusion Area established	EC	*	✓
Door watch asks each new person if they have ignition sources.	• HE team has NO ignition sources – no matches, no lighters	EC	*	✓
Team going in is in radio contact with a person outside.	• Radio Check – entry team - door watch from inside shield door	EC	* *	✓
epending on the meter, the DCU check is done before or after the vessel is secured. The detonator cable is protected from sparks.	• Detonator Checking Ohmmeter – check completed	EC	*	✓
	• Shorting cap on detonator cable connector	EC	*	✓
U/Pu - venturi pump air line was previously disconnected.	• U/Pu – Vacuum system venturi pump ReConnected	NA	*	NA
Blast containment system All bolts must be installed. No broken or missing bolts. All bolts must be re-checked for tightness after the system is under vacuum.	• Vacuum less than 25 torr and Vessel is secured (fully bolted steel doors) (25 torr = 25mm-Hg; = 25,000 microns)	EC	*	✓
	• Beam line bolts are all installed and tight (after vacuum)	EC	*	✓
	• Vessel door bolts are all installed and tight (after vacuum)	EC	*	✓
	• Gun breech – all holes plugged (pressure transducer)	NA	*	NA
Vessel and/or containment system leak too much for good pictures? 5 min **DO NOT Exceed 25 Torr! HE exclusion area required for >25 torr!**	• Leak check - Vessel pressure start ____ Finish ____ **DO NOT Exceed 25 Torr!** Time start ____ Finish ____	NA	*	NA
Gas cooled/heated shots only – "zero pressure relief valve"	• Pop-off disk clamp ring OFF prior to gas cooling/heating shot	NA	*	NA
U/Pu - The inner chamber is the "Thermos" or other containment vessel holding Pu, U, Be, etc. The "Vessel" is the containment vessel attached to the beam line (6' or 4' vessel).	• 15 minute vacuum check < 1 Torr change – close blast valves	NA	*	NA
	• Inner chamber pressure start ____ finish ____	NA	*	NA
	• Vessel chamber pressure start ____ finish ____	NA	*	NA
Minimize radiation damage to CAM electronics during beam tuning.	• CAM **OFF**	NA	*	NA
Cook-offs - First testing of thermocouples and electric heaters.	• Two thermocouples reading OK in counting house	NA	*	NA
	• Heater Cables still locked up in counting house	NA	*	NA
	• Laser blocking shutter CLOSED and laser ignition fiber locked	NA	*	NA
	• Cook Off heater test – Permission to hookup – HE PIC, EIC	NA	*	NA
	• HE exclusion area is established	NA	*	NA
PACS must be secured for heater test. HX takes credit for PACS.	• Heater cables hooked up by FL in dome	NA	*	NA
	• Line C dome PACS secured	NA	*	NA
	• Permission to unlock & perform heater test – EIC, FL, HE PIC	NA	*	NA
	• Thermocouples tested by raising temperature 5 degrees	NA	*	NA
	• Heater cables locked by FL in CCH and FL has the key(s)	NA		NA
IL = Image location Thin vacuum windows have protective covers to guard against blowouts when the beam line is under vacuum.	• Remove vacuum window covers			✓
	• IL0 upstream		*	✓
	• IL1 downstream		*	✓
	• IL2 upstream and downstream	EC	*	✓

Go back inside vessel/target box with HE inside	**Vessel Re-entry** * recheck all items for multiple entries		*	_____
CDU may have been fired into a short to test timing signal synchronization	• Detonator high Voltage cables are **AGAIN** connected to grounding block on CDU power supply rack	_____	*	_____
	• Cook-off heaters locked off in CCH and the FL has the key(s)	NA	*	NA
	• EIC permission	_____	*	_____
	• Firing Leader & HE PIC permissions	_____	*	_____
	• Weather check with access control	_____	*	_____
	• HX-3 Radio checks with access control and entry team	_____	*	_____
	• FL has key(s) – CDU, laser(s), cook off keys (shutter&heaters)	_____	*	_____
	• Door & weather watch assigned	_____	*	_____
	• HE team has NO ignition sources – no matches, no lighters	_____	*	_____
	• HE Exclusion Area established	_____	*	_____
Inside dome	• U/Pu – Vacuum system venturi disconnected before opening	NA	*	NA
	• CAM & CAM exhaust pump turned on and verified by a RCT	NA	*	NA
	• Cooling/heating system shut off – if required by firing leader	**NA**	*	**NA**
	• Laser blocking shutter CLOSED and laser ignition fiber locked	NA	*	NA
	• Detonator cables disconnected from CDU & shorted	_____	*	_____
Exiting dome	• U/Pu – Vacuum system venturi Re-connected	NA	*	NA
	• Vacuum less than 25 torr and Vessel is secured (fully bolted steel doors) (25 torr = 25mm-Hg; = 25,000 microns)	_____	*	_____
	• Vessel door bolts are all installed and tight (after vacuum)	_____		_____
	• Gun breech – all holes plugged (pressure transducer)	NA	*	NA
	• Detonator Checking Ohmmeter – check completed	_____	*	_____
	• Shorting cap on detonator cable connector	_____	*	_____
	• Leak check - Vessel pressure start _____ finish _____	**NA**	*	**NA**
	• U/Pu - CAM OFF	NA	*	NA
	• 15min double vessel check < 1 Torr change – close valves	NA	*	NA
	• Inner chamber pressure start _____ finish _____	NA	*	NA
	• Vessel chamber pressure start _____ finish _____	**NA**	*	**NA**
	• Cooling/heating system turn ON if required		*	

FINAL ENTRY before FINAL SWEEP	**Final Entry** * recheck all items for multiple shots		*	
Verify Pins signal path has been checked	• Pins operation verified	NA	*	NA
CDU may have been fired into a short to test timing signal synchronization	• Detonator high Voltage cables are **AGAIN** connected to grounding block on CDU power supply rack	EL	*	✓
	• Cook-off laser shutter power locked off by FL and FL has key	NA	*	NA
Radio operator stays outside the shield door	• Weather check with access control	NA	*	NA ✓
Needed for initial re-entry	• CO monitor located outside the dome (second unit)	EL	*	✓
	• Vacuum gage unit 1 on channel 6	EL	*	✓
	• Vacuum gage unit 2 on channel 2	EL	*	✓
Carbon Monoxide detector – Call the line C counting house to verify picture of Co monitor before exiting dome.	• CO monitor in Line C dome turned ON with picture in CCH		*	✓
	• Illumination turned on for CO monitor		*	✓
	• Illumination turned on for vacuum Gauge		*	✓
	• Illumination turned on for vacuum Valve	EL	*	✓
Uranium and Plutonium U/Pu - Venturi pump air line was previously disconnected. CAM - Continuous Air Monitor	• U/Pu – Vacuum system venturi pump connected and working	NA	*	NA
	• CAM turned ON and working verified by a RCT	NA	*	NA
	• CAM exhaust pump turned ON	NA	*	NA
Usually for gun shots	• Turn on PIN power supply in Dome if required	N/A	*	NA
Post shot classified traces not visible to L-cleared RCT or operator	• Classified O-scopes are covered or displays disconnected	NA	*	NA
Amplifier power ON; select "phono".	• Microphone audio ON and in PHONO	EL	*	✓
Tap on vessel with metallic object.	• Microphone audio tested again	EL	*	✓
Note that the sign at the line B tunnel door is a long way away; so, this step is done in parallel with the final sweep with detonator hook-up. With UCN exclusion area, this is now the NTOF maze entrance door.	• Post sign "Special Re-Entry Procedure In Effect"			
	• Line C key bank	EL	*	✓
	• Line B tunnel entrance door (NTOF maze door)	EL	*	✓
FINAL SWEEP before Firing	**Final Sweep**		*	✓
	• EIC **AND** HE PIC give permission to hook-up shot for firing	EL	*	✓
	• Cook-off laser shutter power locked off by FL and FL has key	NA	*	NA
	• Heater cables locked by FL in CCH and FL has the key(s)	NA	*	NA
	• TV picture in counting house or control wires disconnected	NA	*	NA
HE operation - Team going in is in radio contact with a person outside. Lightning/ field level – local indication, Access Control, or Meteorologist	• Door/weather watch assigned	EL	*	✓
	• Weather/Lightning status OK	EL	*	✓
The detonator conductivity is usually checked again before hookup	• DCO meter	EL	*	✓
Team going in is in radio contact with a person outside	• Radio Check – door watch to access control	EL	*	✓
	• Radio Check – entry team - door watch from inside shield door	EL	*	✓
Health Physics Technician, Central Control Room Operator, Firing Leader, and Firing Team Members as needed by the Firing Leader.	• Detonator(s) connected to firing circuit or fiber to laser	EL	*	✓
	• DCO check completed	EL	*	✓
	• Gas cavity fill valve OPEN	NA	*	NA
The gun catch tank and target chamber may have vacuum valves. Gas cavity fill is different from gas target fill valve – different shot types.	• Target/shot gas fill, cooling, or heating valves CLOSED	NA	*	NA
	• Gun catch tank/target vac. valves – Both closed, if applicable	NA	*	NA
Lights are turned out for beam pictures. A containment system breach can release large quantities of CO.	• Lights OUT – dome	EL	*	✓
	• Notify CCR, " Line C Cave is ready for Firing. Special re-entry procedure is in effect due to possible carbon monoxide".	EL	*	

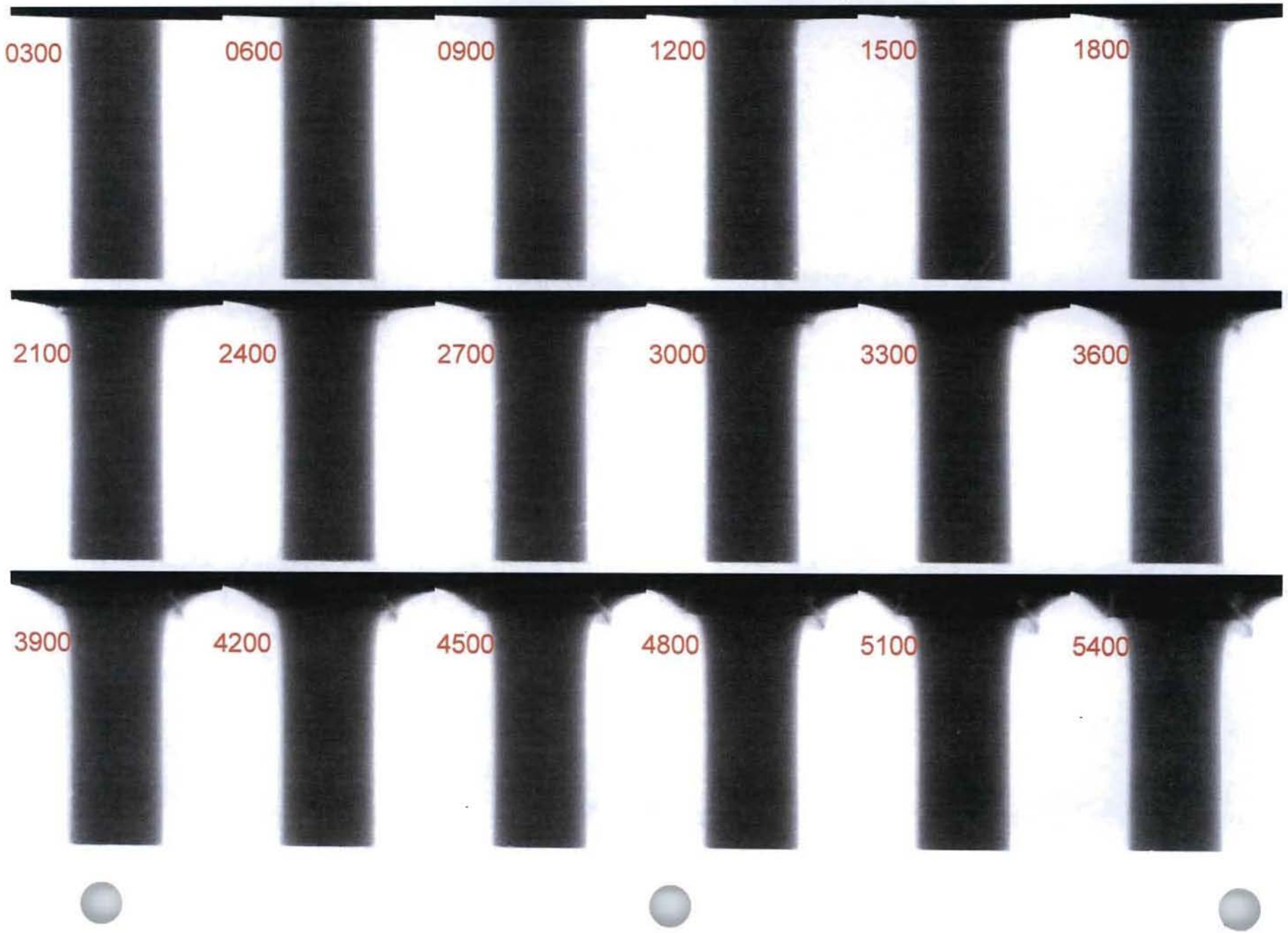
HE heated above its exclusion temperature may go off without warning.	• Cook offs - EIC and HE PIC and FL agree to start heating HE	NA	*	NA
	• Laser trigger OK	NA	*	NA
	• Laser blocking shutter enabled inside dome	NA	*	NA
	• Permission by EIC and FL to exceed exclusion temperature	NA	*	NA
U/Pu - Room 53-3-S207, Motor Control Center T14G – HVA-1 and FE-1	• U/Pu - Lock fans OFF - Line C dome supply and exhaust fans	NA	*	NA
FIRING	**FIRING**		*	✓
Gun and vessel shots are fundamentally different when requesting beam	• LXP timing check – verify gate relationship to shot need	EC	*	✓
DG-535 on top of firing rack. Same one used for firing detonators.	• Cook-off laser - gate generator in external trigger mode	NA	*	NA
Powder gun projectile detection pin(s) are jumpered for pre-shot testing.	• Gun shots – Disconnect short from Beam Request Pin	NA	*	NA
Lights may have been turned on to watch something.	• Lights OUT – dome – again check	EC	*	✓
Some vessel shot have a gas cavity with two valves. The manual isolation valve is opened during final entry and the remotely operated valve is opened for the gas fill and then closed again before firing. Some vessel shots use timing pins powered from the counting house.	• Gas Fill valve OPEN	NA	*	NA
	• Gas fill pressure equalized	NA	*	NA
	• Gas fill valve CLOSED	NA	*	NA
	• PINS power supply ON, in counting house, if applicable	NA	*	NA
	• VISAR ready, if applicable	NA	*	NA
	• PDV ready, if applicable	NA	*	NA
Shift data taking mode from statics to dynamics. If in classified mode, camera computers are mode switched separately. If line X is lined up to the 1X or 2X beam stops, beam will not go to LC.	• DAQ in "Dynamic Mode"	EC	*	✓
	• Classified Camera computers in "Dynamic Mode"	NA	*	NA
	• CCR – "Is the line X beam lined up to send beam to line C?"	EC	*	✓
"Status" display from CCR is checked by EIC – right hand dash is green	• H- injector is ready and enabled to send beam – rt. green dash	EC	*	✓
Usually for cook offs.	• Movie Mode – Cameras in Movie Mode	NA	*	NA
	• Stand alone mode	NA	*	NA
	• 999 Frames	NA	*	NA
	• Acquire mode	NA	*	NA
The radiation safety system **MUST** be secured for HX to fire. Absolutely no talking by anyone, except as required by the EIC	• PACS secured	EC	*	✓
	• Announcement – "Attention! Final firing sequence. Absolutely NO unnecessary TALKING!"	EC	*	✓
Beam Line vacuum pump-out valves – Valves from pumping station to beam pipe.	• Close beam line vacuum pump-out valve remotely – upstream	EC	*	✓
	• Close beam line vacuum pump-out valve remotely downstream	EC	*	✓
CDU – Capacitive Discharge Unit – This energy storage box, located next to the HE, fires the detonator. DG-535 MUST be in external trigger mode before shutter is opened.	• EIC gives permission to charge CDU OR open laser blocking shutter AFTER gate trigger = external	EC	*	✓
	• CDU charged or laser shutter open	EC	*	✓
	• CCR – "Is beam available?" If yes, "CCR, standby for firing!"	EC	*	✓
	• Cook offs – Start DAQ run WITHOUT arming cameras	NA	*	NA
	• Beam ON in continuous mode (like 2 or 3 Hz)	NA	*	NA
	• EIC gives permission to Arm systems	EC	*	✓
	• Cameras ready		*	✓
	• CDU trigger key enabled		*	✓
	• PDV ready			NA
	• EIC called for beam or triggered laser at 1229 hours	EC	7/21	✓

Post Shot	After Firing		*	✓
	• CDU discharged - high Voltage meter indicates zero	EC	*	✓
Detonator high Voltage cables are **AGAIN** connected to grounding block on CDU power supply rack	• Detonator High Voltage cables connected to grounding block • Pin Power Supply OFF (in counting house)	EC NA	* *	✓ NA
	• CDU keys removed or cook-off laser blocking shutter closed	EC	*	✓
Beam line upstream of containment system. Unit 1 channel 6.	• Post shot beam line pressure = 1E-3 torr	EC	*	✓
TV picture of CO monitor	• Line C - CO before initial re-entry = 0 ppm CO	EC	*	✓
Firing Leader determines the apparent shot status after evaluating the microphone audio, vacuum, and camera pictures.	• Apparent status • Successful • Partial (detonator fired) • Misfire (detonator did not fire)	EC	*	✓
Write "N/A" if there is no misfire.	• Misfire/partial-fire procedures started if shot not successful	NA	*	NA
24/7 numbers = PTLA scheduling 7-4438, shift commander 5-1279	• Notify PTLA of need /no need for overnight guards	NA		NA
Photon Doppler Velocimeter – Laser system in counting house	• PDV laser, if used – shutdown and key REMOVED	NA	*	NA
Shut down = Laser Power supply turned OFF and key removed.	• VISAR shut down, if applicable, and key(s) removed	NA	*	NA
Firing Site Access Control 7-6742	• Access Control notified – Shot status • Cook off locks removed	EC NA	* *	✓ NA
Line C dome radioactive exhaust must be ON before pumping. EIC console, Apps, right click, LXL, XAEF1L3 FLOW and 1L97 ON	• Area A radioactive exhaust stack fan is ON Do not rely upon Run Permit Ready - check line-by-line display	EC	*	✓
Uranium and Plutonium	• Inner container pressure _____ Torr • Vessel pressure _____ Torr	NA NA	* *	NA NA
Read post shot pressure remotely. **NOTE: Three pump downs and two vents are a MUST for industrial health safety no matter how small the shot. After the first pump down to remove the HE products, two more air fills must be pumped out to ensure industrial safety.** **Uranium, Vanadium, etc.** need to cool before venting to reduce fire (**Uranium**) and/or slower oxidation (toxic **Vanadium** oxide).	• Upstream pressure 2.9 torr Close Upstream Pump Valve • Open Upstream blast valve - post shot pressure = 5.45 torr • Open Upstream pump valve to begin pumping • Open Downstream blast & pump valves to help pumping • Pump down (1) to less than 5,000 microns (**5 torr**) • Fiducial plate beam picture to verify collimators are clear • Flammable materials (like U) - 30 minutes before venting	EC EC EC EC EC EC NA	* * * * * * *	✓ ✓ ✓ ✓ ✓ ✓ NA
Normally, the first two vents are fast to blow out the collimators. For shots with potentially flammable post shot debris, like U, all venting is slow. **Venting is not required before an entry.**	• Vent 1 – Close Pump Valves & Open Atmosphere Vent valves • Pump down (2) to less than <5,000 microns (**5 torr**) -------> • Vent 2 – Close Pump Valves & Open Atmosphere Vent valves • Pump down (3) to less than <5,000 microns (**5 torr**) • Vent 3 – Slow – Close both pump valves • Open slow vent valve	EC EC EC EC EC EC	* * * * * *	✓ ✓ ✓ ✓ ✓ ✓
The initial entry team should always be minimized.	• EIC and firing leader both agree that Line C can be entered	EC	*	✓
	• Notify CCR that the Line C dome CO is <25 ppm, before entry	EC	*	✓
	• Portable CO monitor in the hands of the entry team	EC	*	✓
Uranium and Plutonium	• Level II Anti-C on both the firing leader and RCT • Respirators for both • CAM reading OK	NA NA NA	* * *	NA NA NA

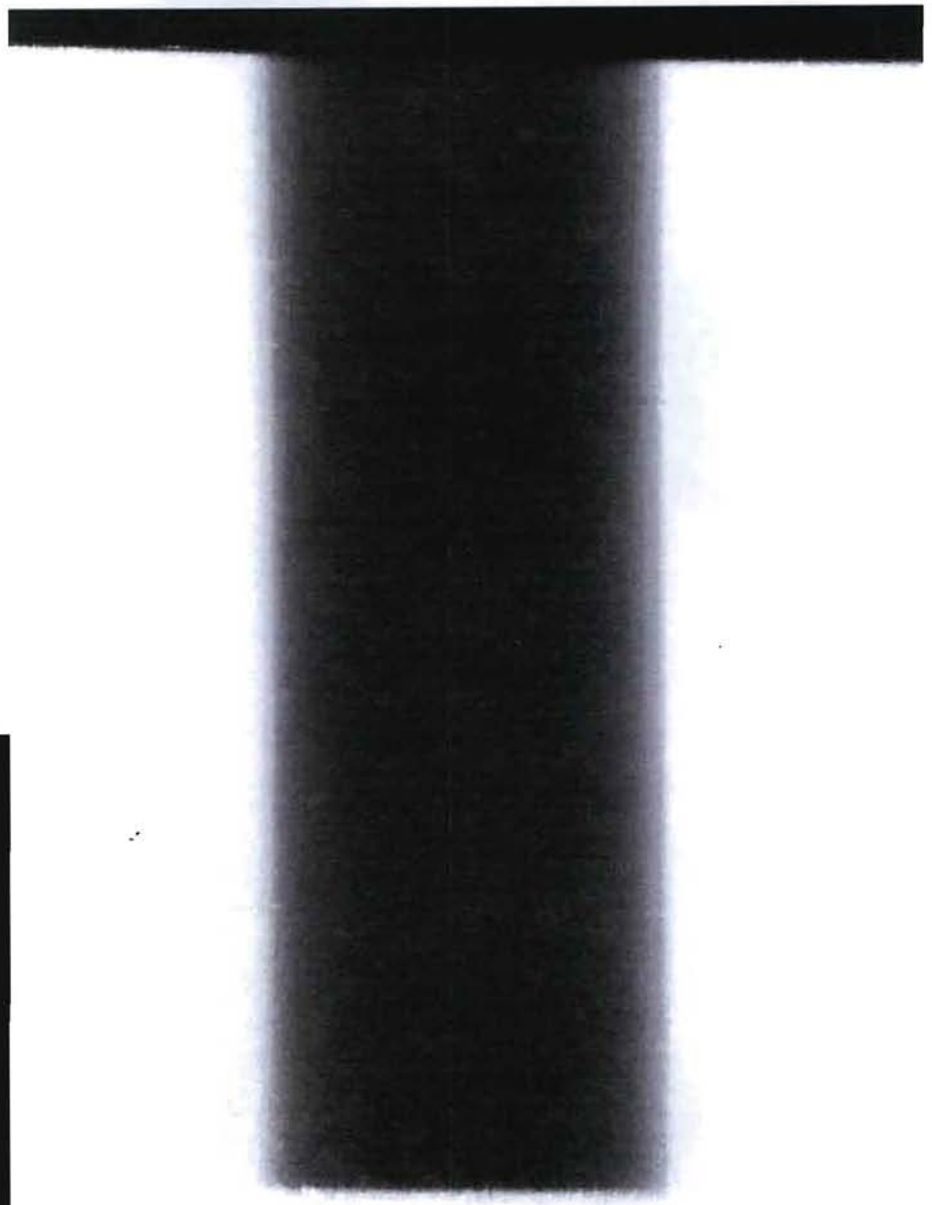
Until after the firing leader has checked for a breach, dome entries after a shot are a high explosives operation. Lightning/ field level – local indication, Access Control, or Meteorologist PPE includes tyvek suits, respirators, gloves, etc.	• Door/weather watch assigned for HE operations • Weather/Lightning status OK • Workers briefed on PPE requirements and waste segregation • Firing leader is controlling dome PACS keys • U/Pu – Reminder - disconnect venture pump before opening	EC EC EC EC NA	* * * * 	✓ ✓ ✓ ✓ NA
HE operation - Team going in is in radio contact with a person outside.	• Radio Check – door watch to access control • Radio Check – entry team - door watch from inside shield door	NA EC	* *	NA ✓
Uranium and Plutonium	• Giraffe air monitor checked for contamination	NA	*	NA
	• Cook off laser key removed	NA	*	NA
	• Breach procedures implemented if a breach has occurred	NA	*	NA
The dome area is a HE exclusion area.	• Firing Leader releases Line C for additional access	EC	*	✓
The EIC makes this decision after the firing leader agrees	• Notify CCR that special re-entry procedures NOT in effect • If HE is still present - Notify CCR "Line C continues to be an HE exclusion area due to unburned HE. Please do not permit entries into the line B tunnel without EIC approval."	EC NA		✓ NA
Classified shots only	• Bomb Badge returned	NA	*	NA
	• Sign removed – Special Re-Entry Procedure - Line C key bank	EC		✓
The dome area has been a HE exclusion area.	• Microphone – Turn OFF amplifier	EC	*	✓
	• Gas cooling/heating system disconnected from vessel	NA	*	NA
Upstream vacuum station bypass ensures vessel fresh air via venture. **Uranium and Plutonium** – No air flow through vessel! Hazardous materials exclusion areas are normally 10' in front of the vessel and bags on the windows. Samples must be sent out for analysis.	• Remind vessel clean up crew to open vacuum bypass valve • Venturi pump air line disconnected • Establish exclusion areas prior to opening vessel and pipes • Samples taken from vessel for analysis of contamination	EC NA NA NA	* * * *	✓ NA NA NA
	• CO Monitor in dome – Turn OFF	EC		✓
Prior to removing vacuum windows	• Beam Window covers installed at • IL0 upstream • IL1 downstream (after camera station removed)	— — —		— — —
Plutonium – Put it back in the safe	• Container stored inside Radioactive Materials Balance Area	NA		NA

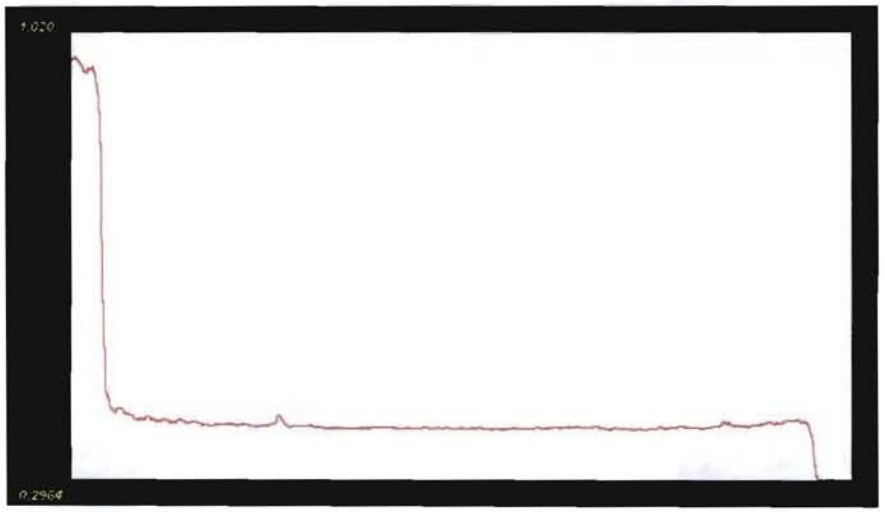
???? LAST SHOT of the day ????	• LAST SHOT of the day?			✓
	• TV Cameras and lights OFF • CO monitor & vacuum gauges at blue racks • Upstream valves • Downstream valves			
	• VISAR status signs = Green	NA		NA
The one in the dome usually stays in the dome with its charger in the blue rack. The other one charges on the bench west of the VISAR room.	• CO monitors in chargers	EC		✓
The EIC and Firing Leader must both agree.	• Notify CCR that HE operations are completed for this day	EC		✓
Locking out is preferable to log off.	• Lightning Detector Computers – Lock out	EC		✓
	• After HE operations are completed, remove signs • Large orange HE octagon – truck door • Small signs for HE and EIC • Line C Shield door • Line C access station (PACS) • Line B tunnel access (NTOF maze door) • Special Re-Entry - Line B tunnel access (NTOF maze door)	EC		✓
Run out of propane - starter cranks until battery dies or starter fails	• Disable generator – Module 9 in "STOP"	EC		✓
Uranium and Plutonium	• CAM turned OFF • Dome Fans unlocked	NA NA		NA NA
	• Remove parking lot rope to truck access for "Fire Lane"			
	• RWP – General RWP is current and posted	NA		NA
http://pwcnv02.lanl.gov/arakfram.htm?7:0 – Username/PW = APC/apc http://praddalek02/arakfram.htm?7:0 Dalek can also be turned off by cycling key switch in dome without Reset.	• HV to beam line data taking cameras – Turned Off • Dalek OFF – Look in the back of HS-R02 • No 120V or 208V power cord connections on floor	EC EC EC		✓
	• CCH doors locked			
Install vacuum window covers IL = Image location Thin vacuum windows have protective covers to guard against blowouts. CanNOT be required if additional beam operations are scheduled.	• IL0 (upstream side) • IL1 (downstream side) • IL2 (both sides)			
Master transfer key removed from transfer block and locked in PACS box	• Dome PACS keys locked in key bank	EC		✓

PRAD0374: Iron EOS Shot Composite



0300 PRAD0374: Iron EOS Shot H





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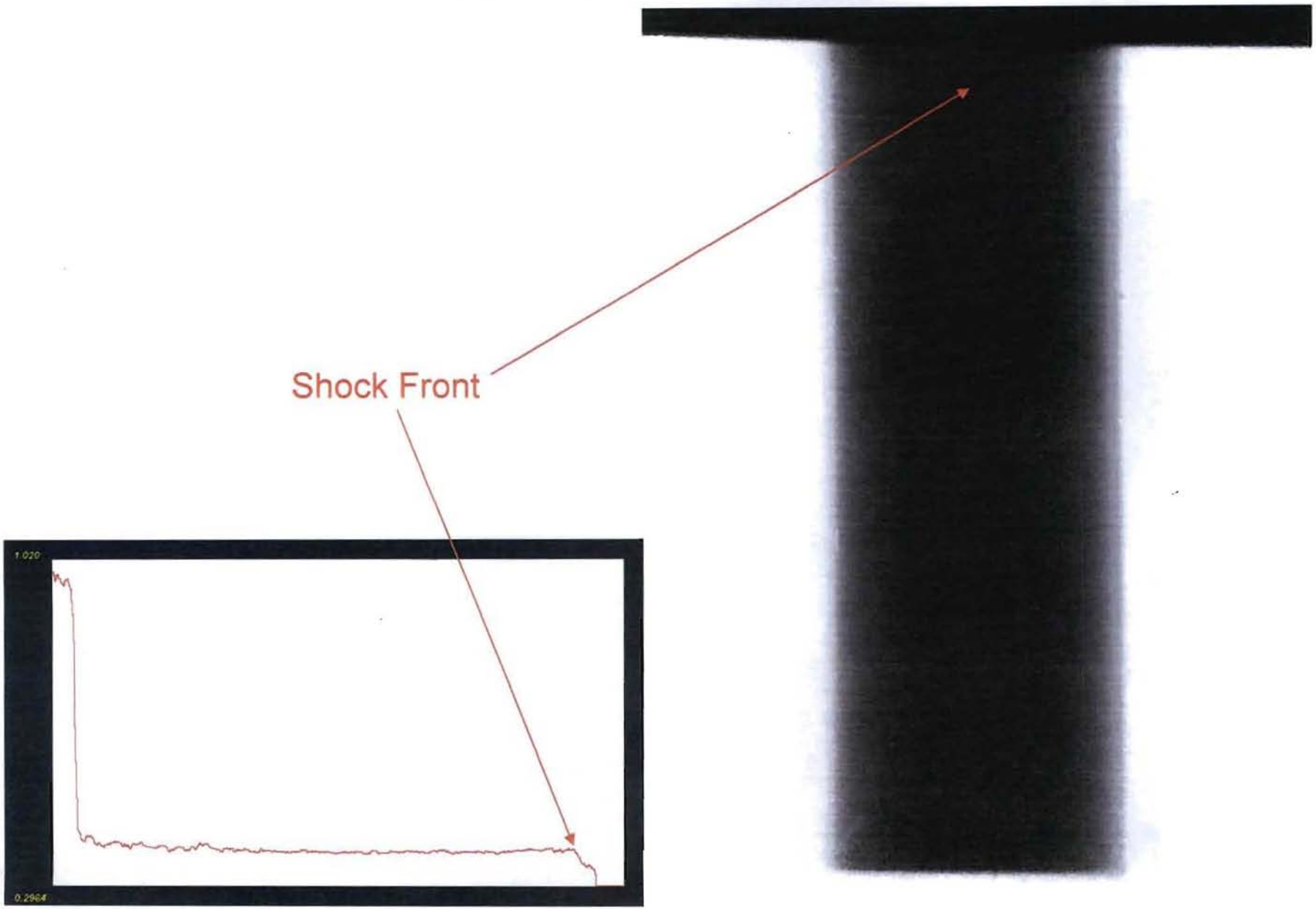
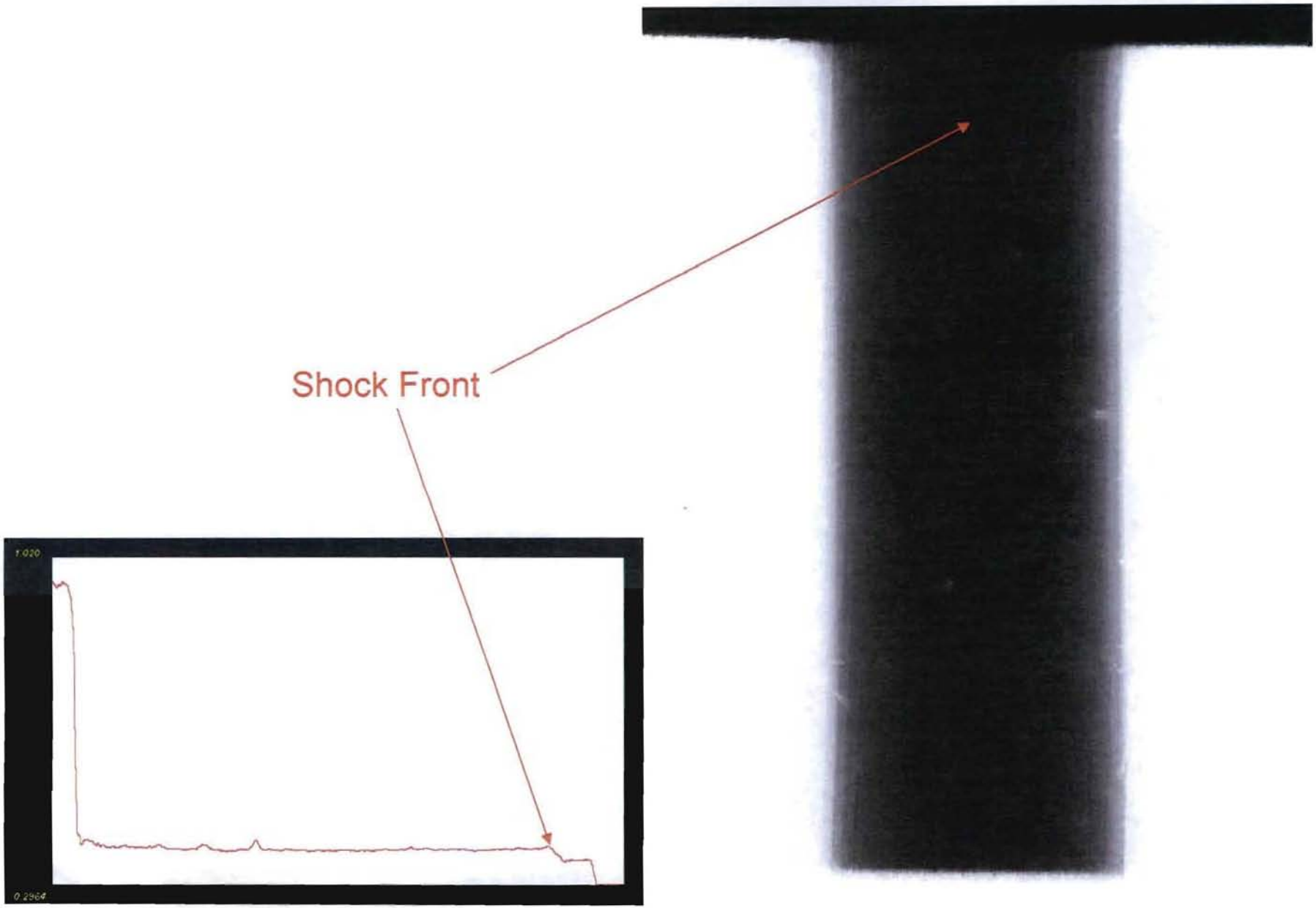
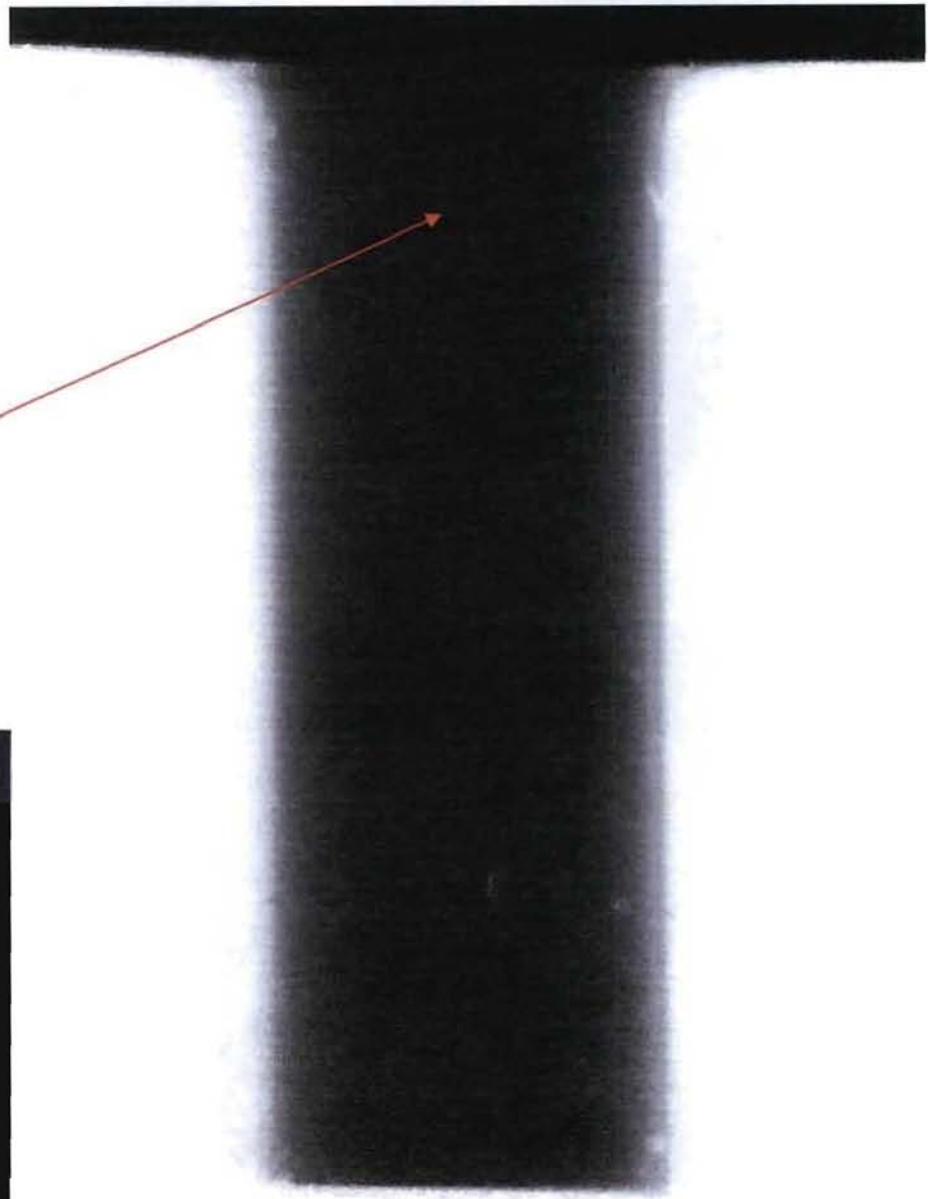


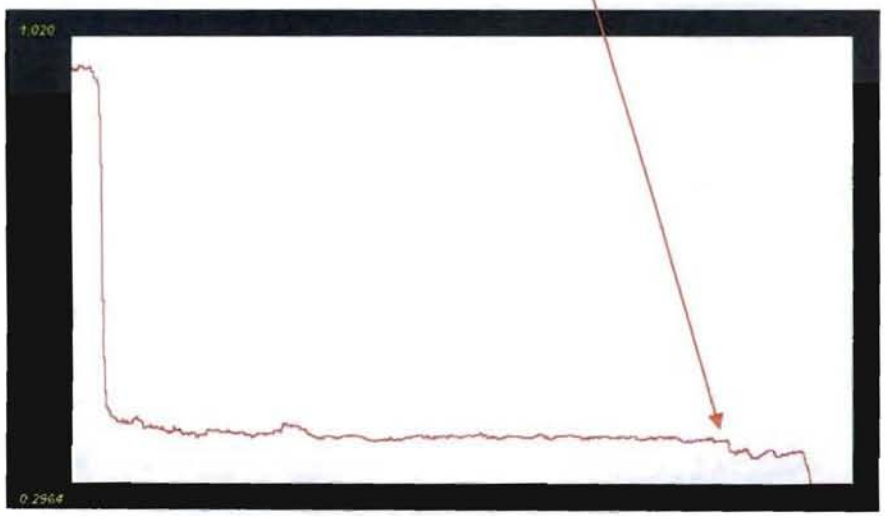
0900 PRAD0374: Iron EOS Shot N



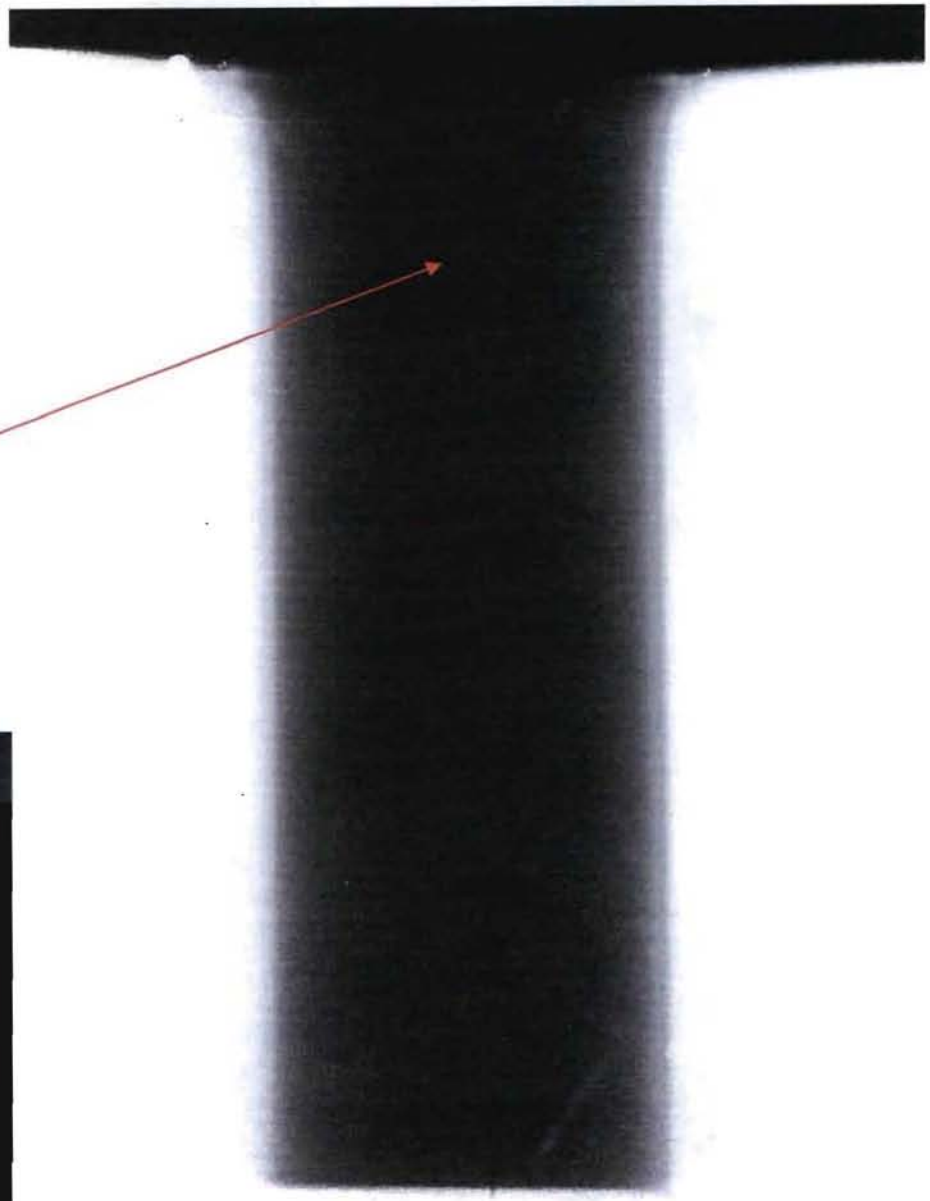
1200 PRAD0374: Iron EOS Shot Q



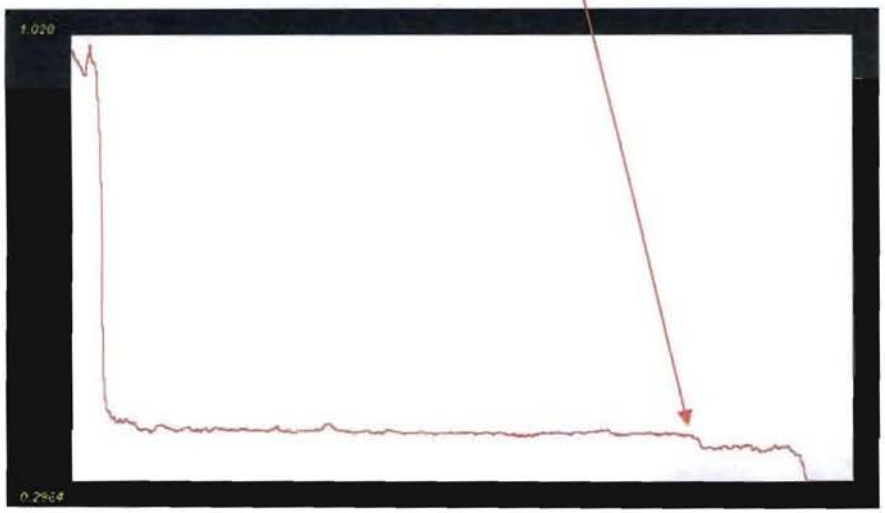
Shock Front



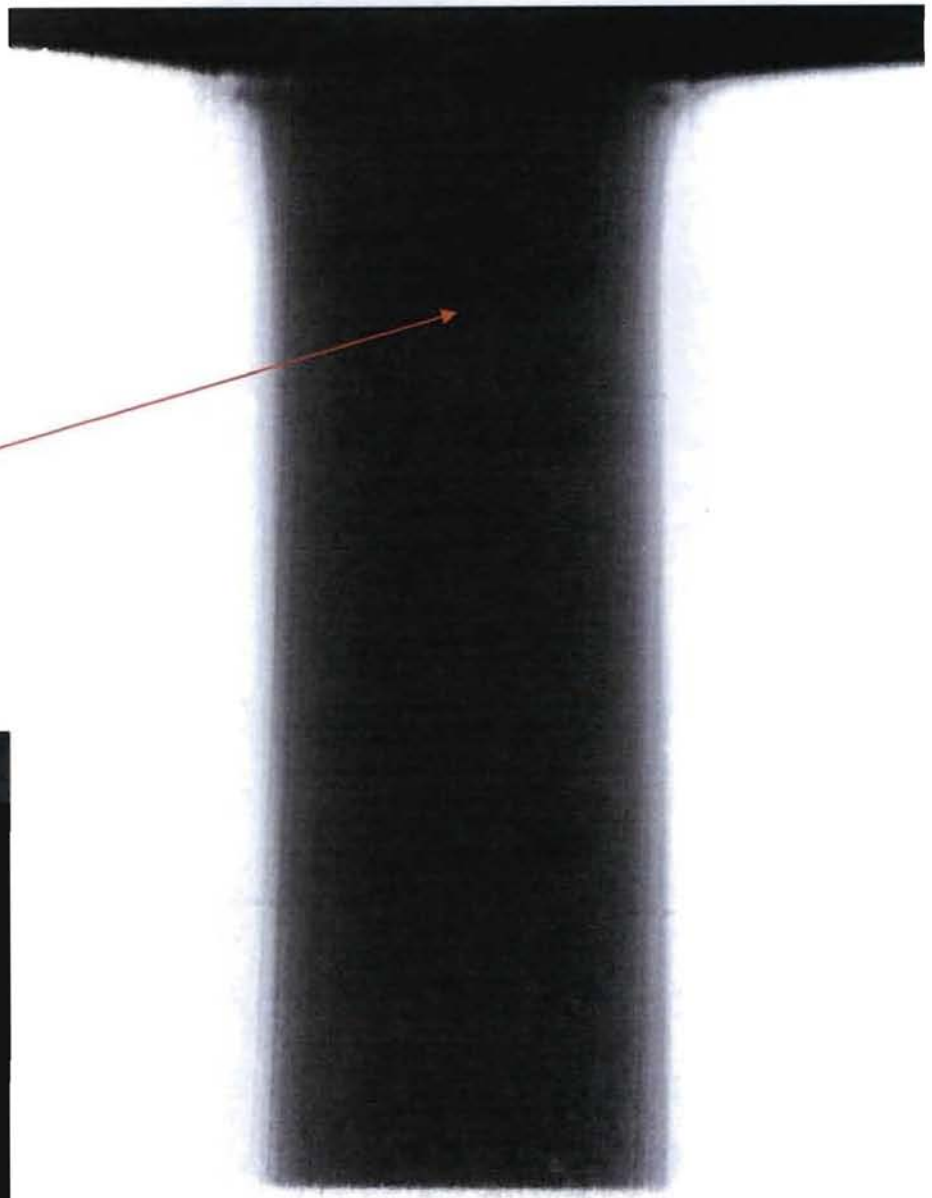
1500 PRAD0374: Iron EOS Shot T



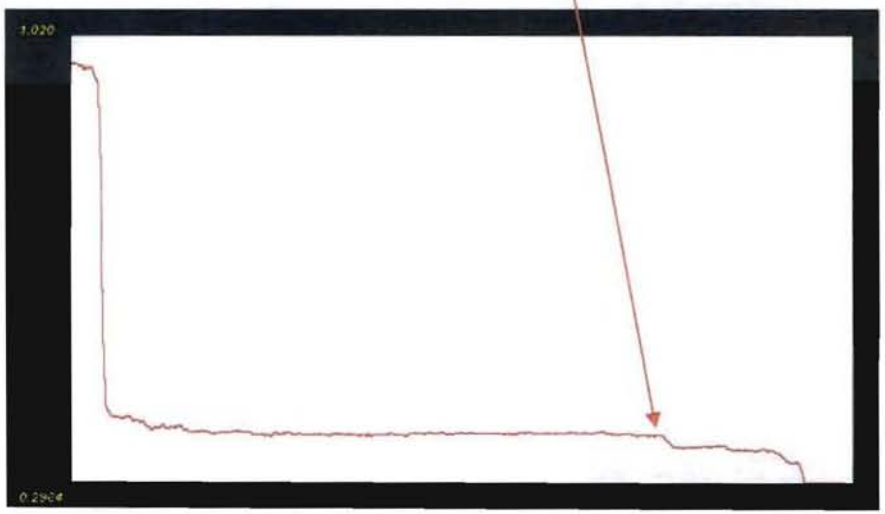
Shock Front



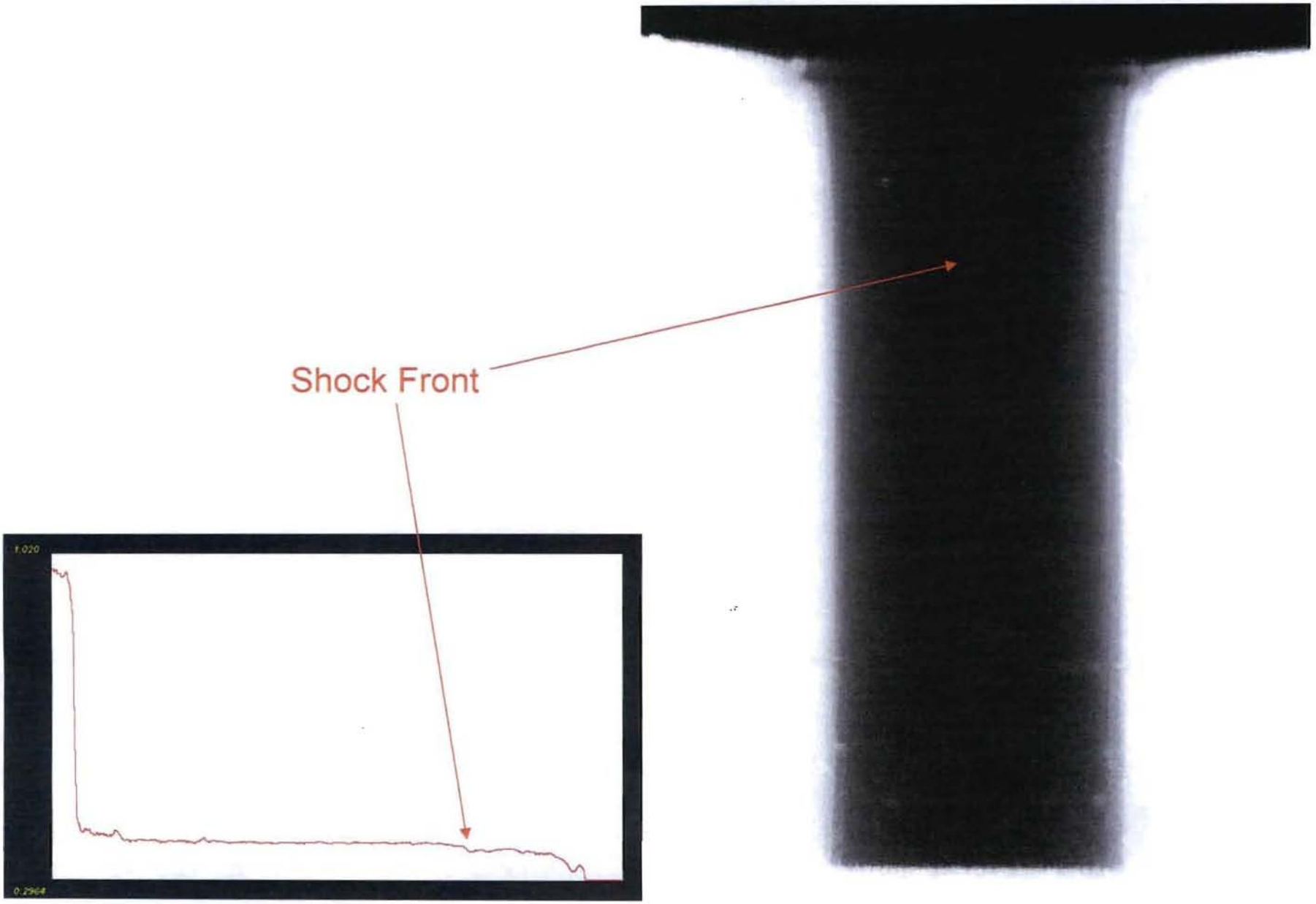
1800 PRAD0374: Iron EOS Shot X



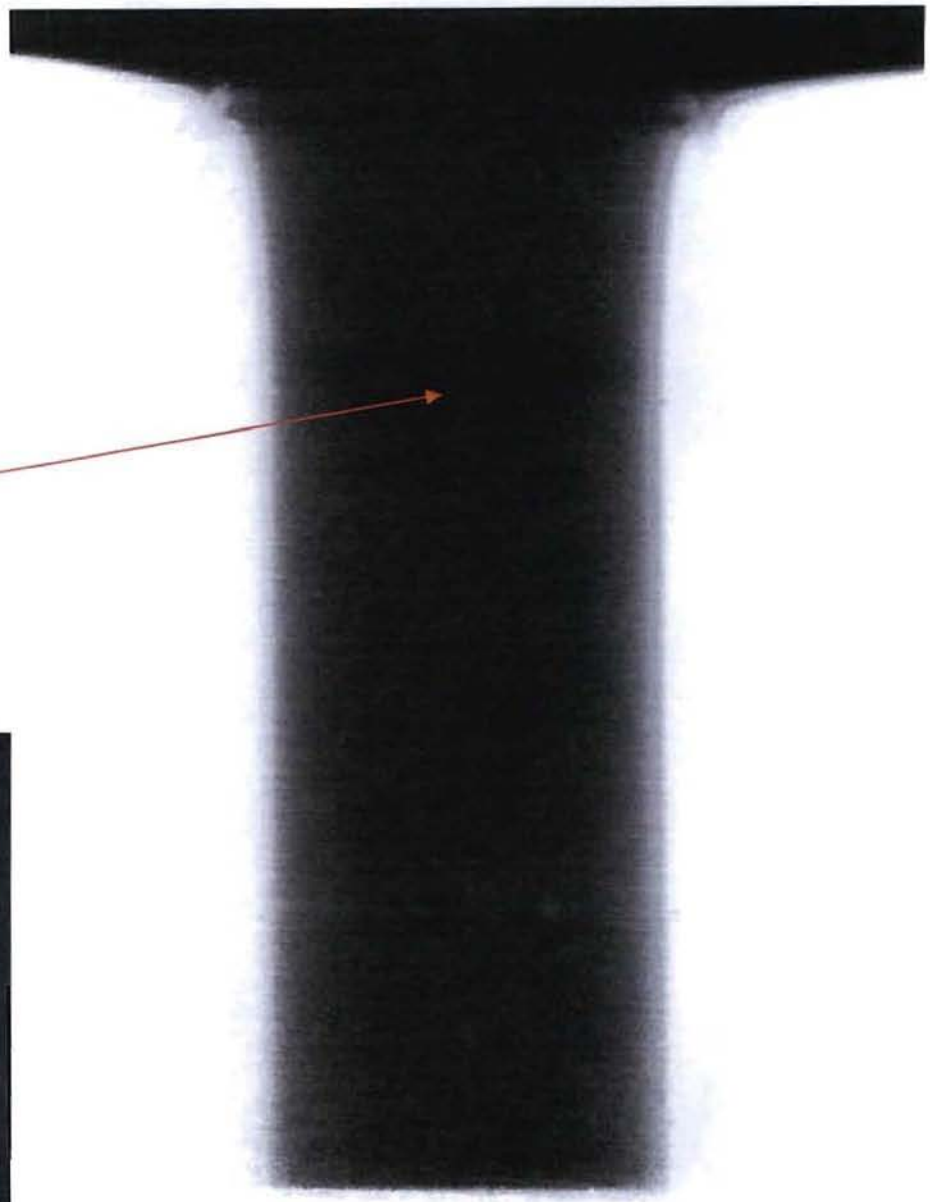
Shock Front



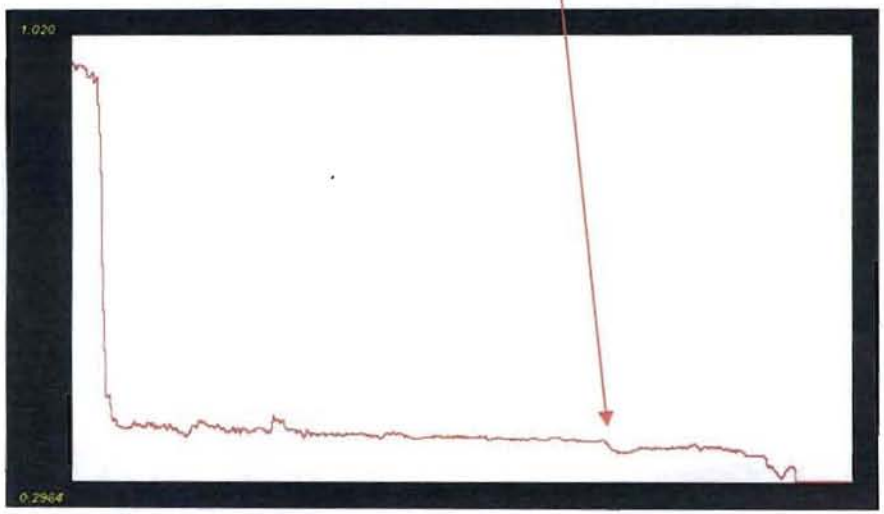
2100 PRAD0374: Iron EOS Shot I



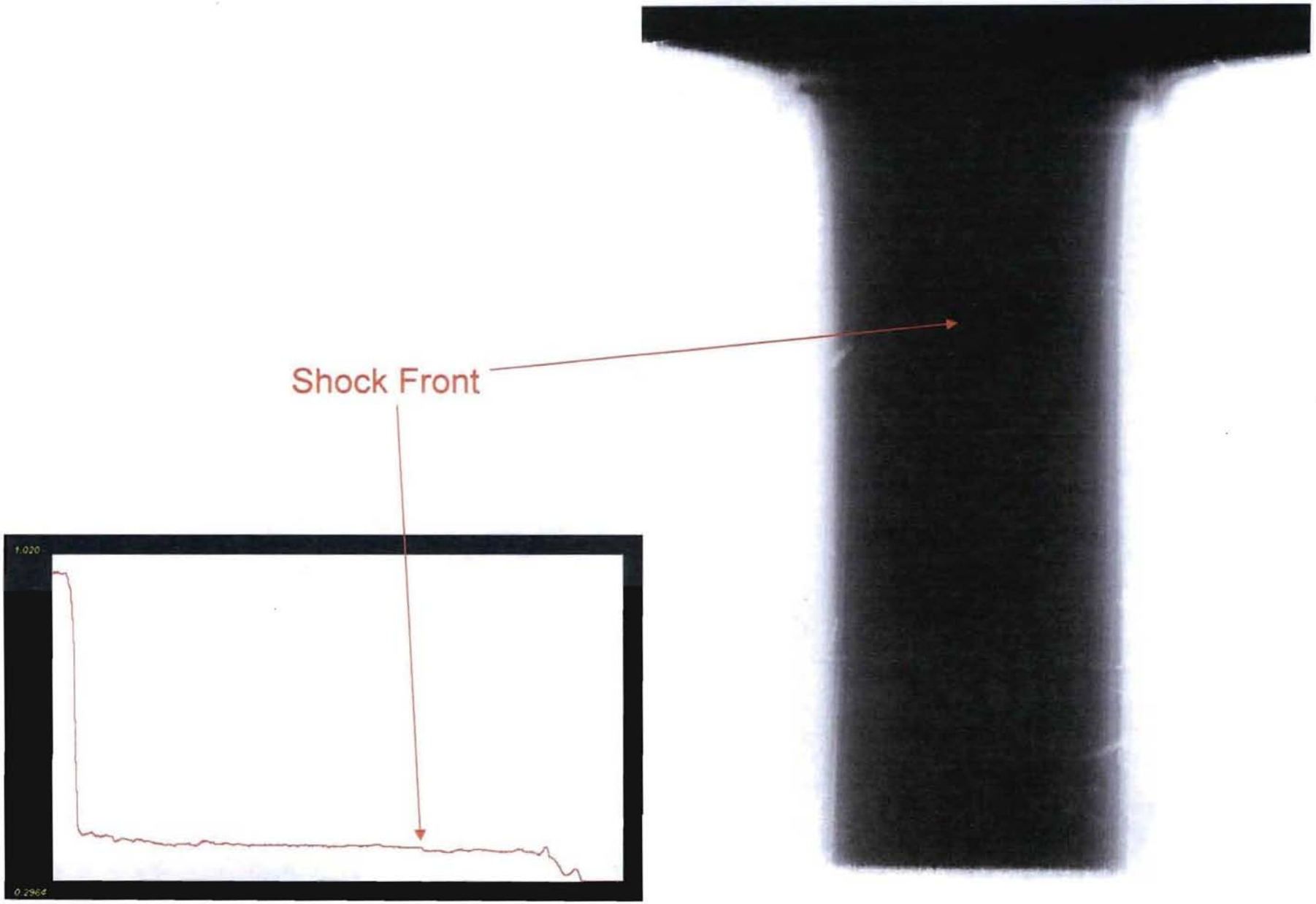
2400 PRAD0374: Iron EOS Shot L



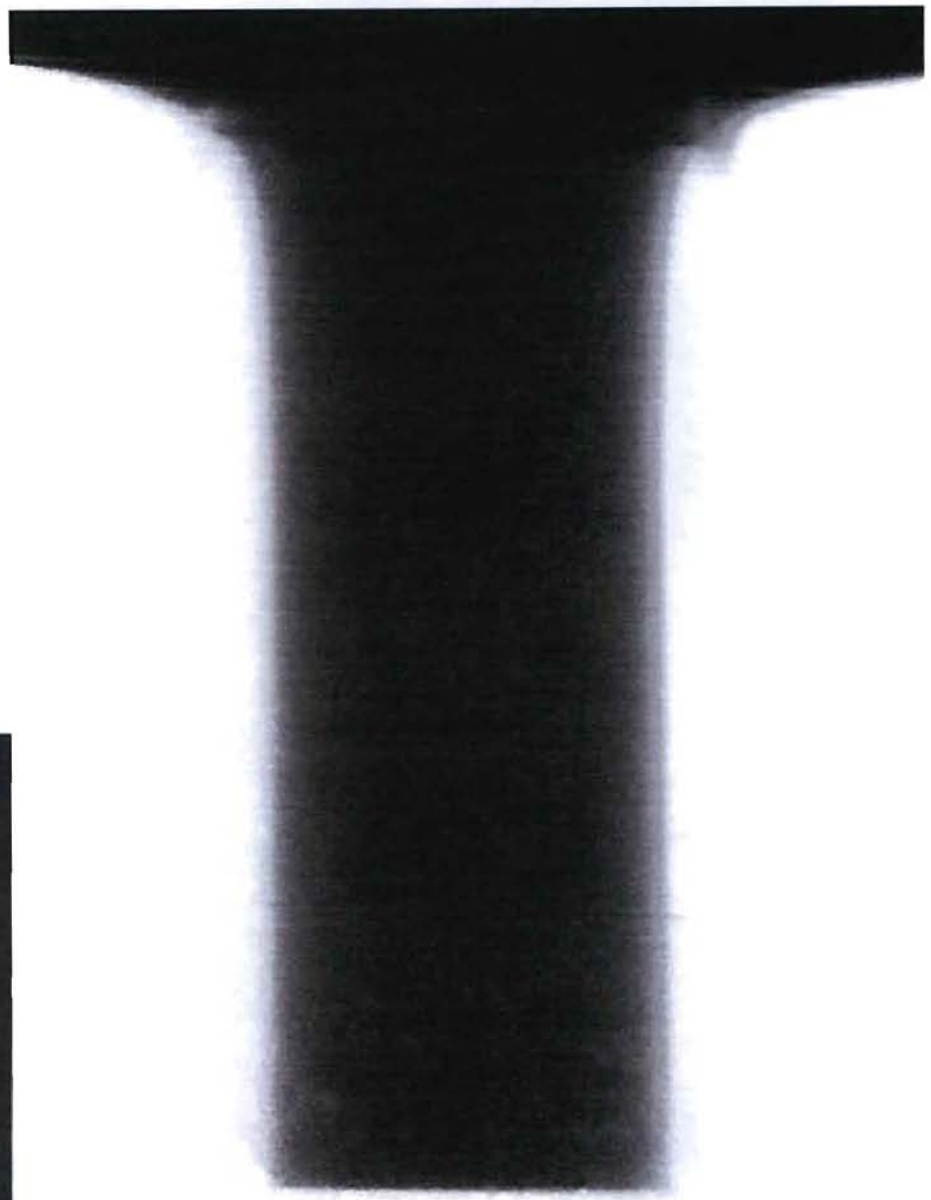
Shock Front

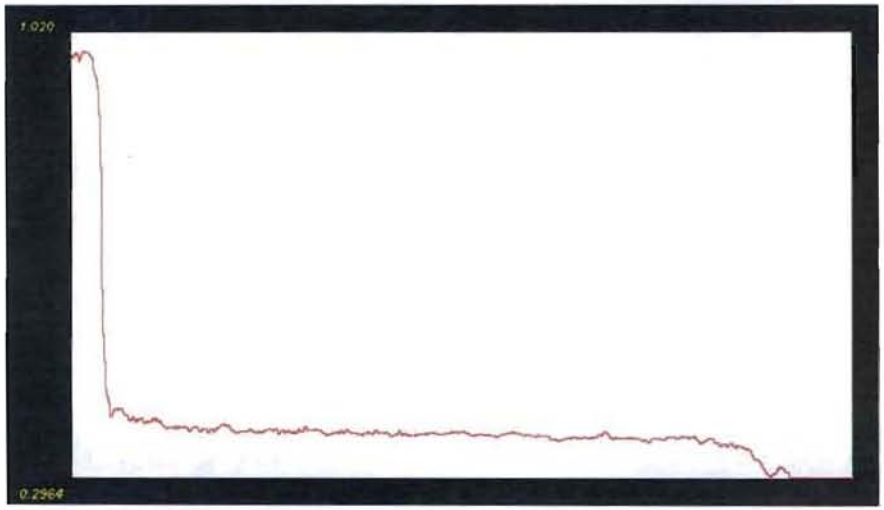


2700 PRAD0374: Iron EOS Shot O

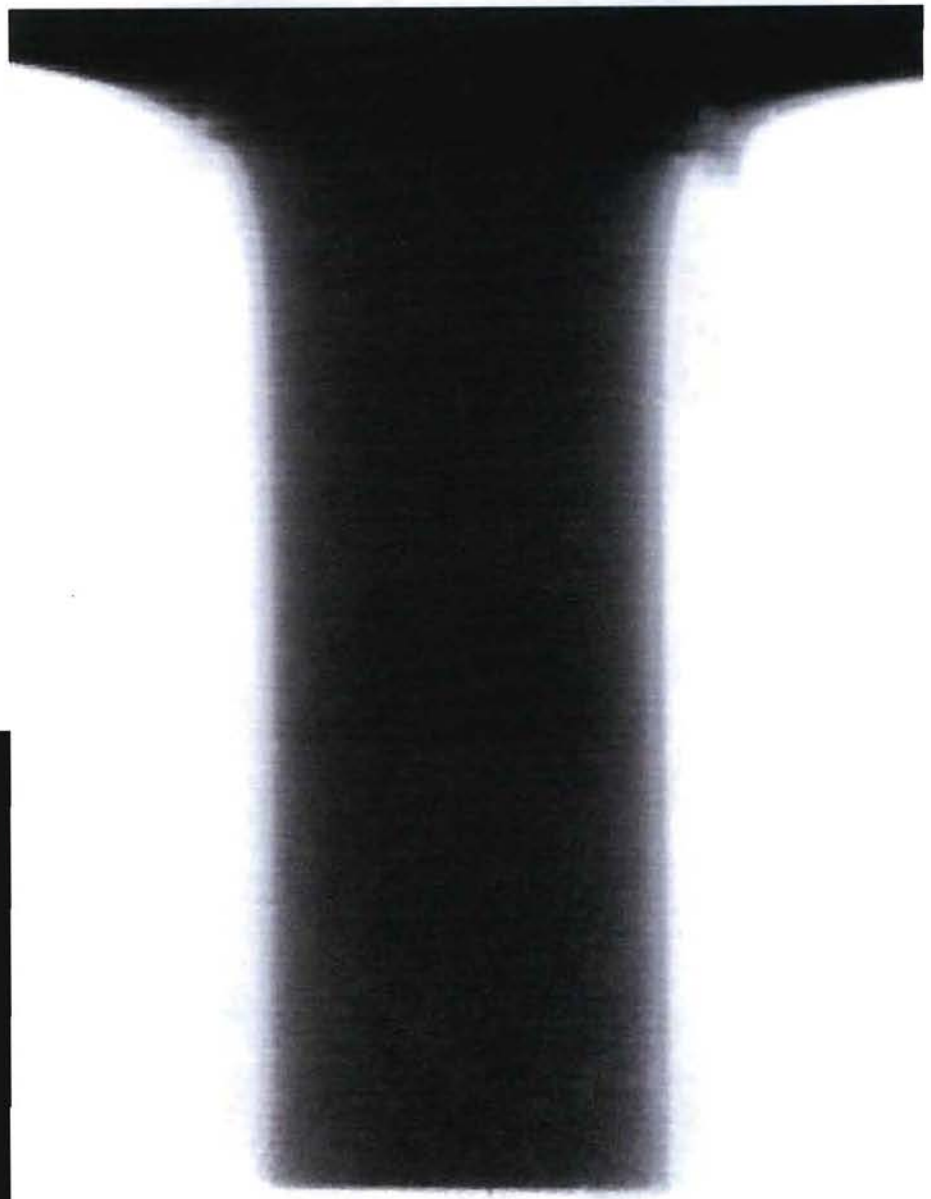


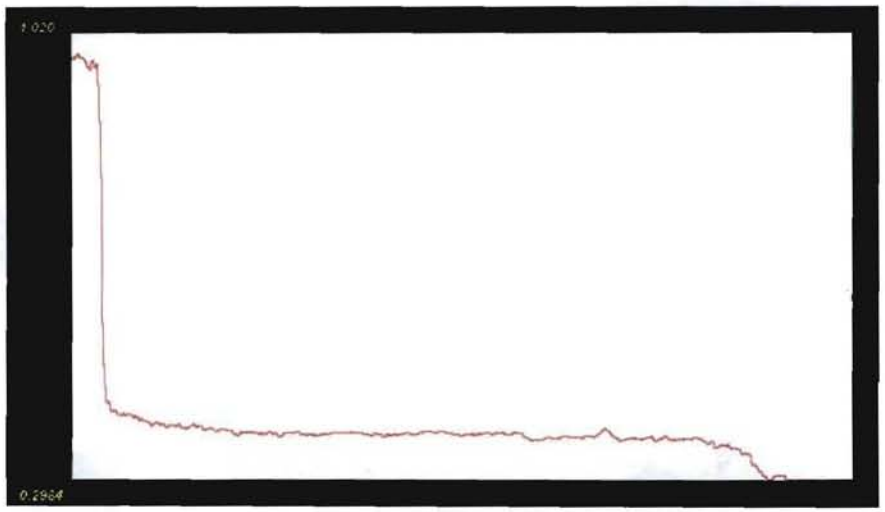
3000 PRAD0374: Iron EOS Shot R



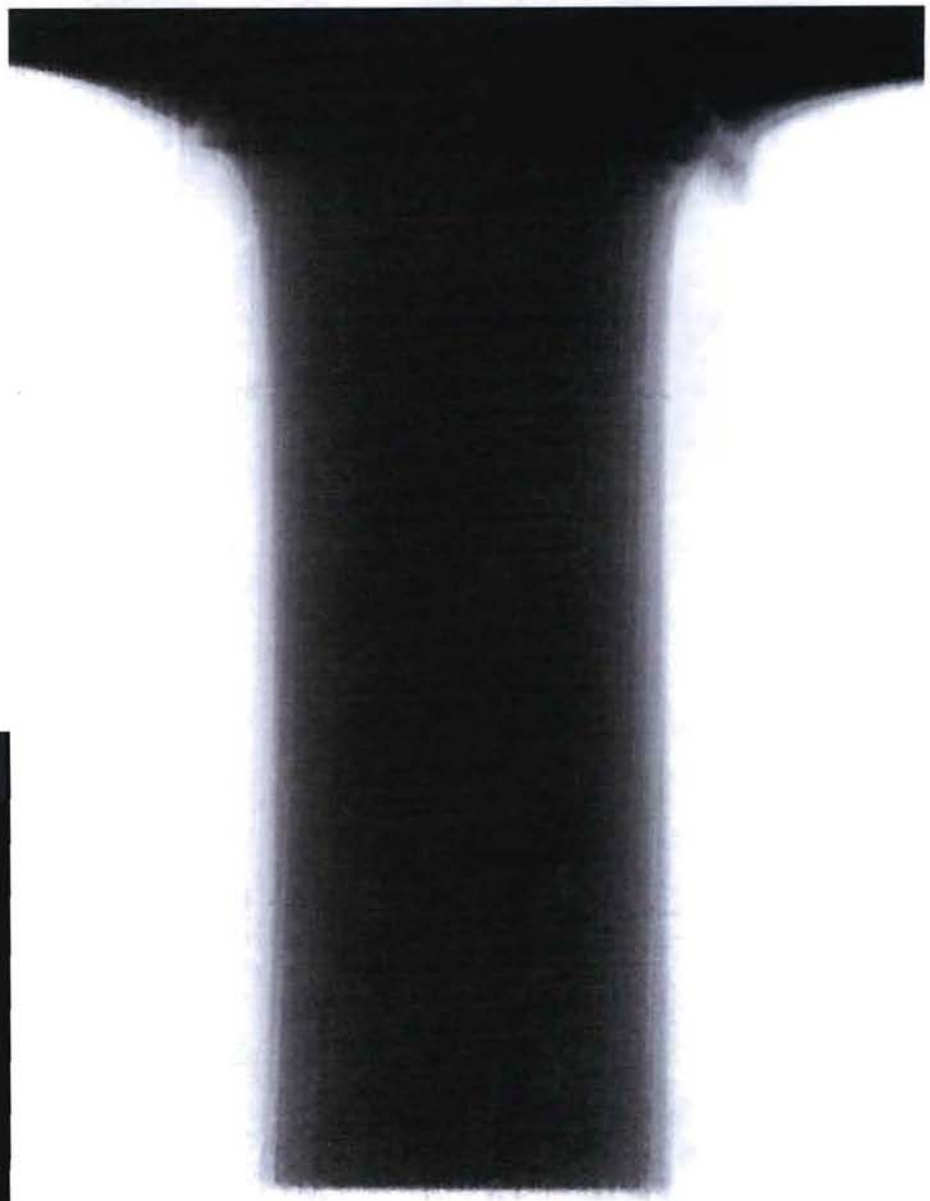


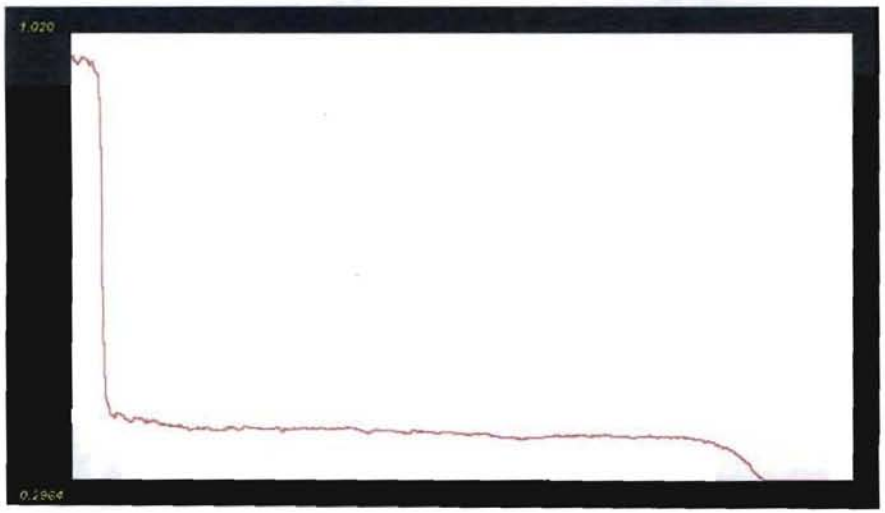
3300 PRAD0374: Iron EOS Shot U



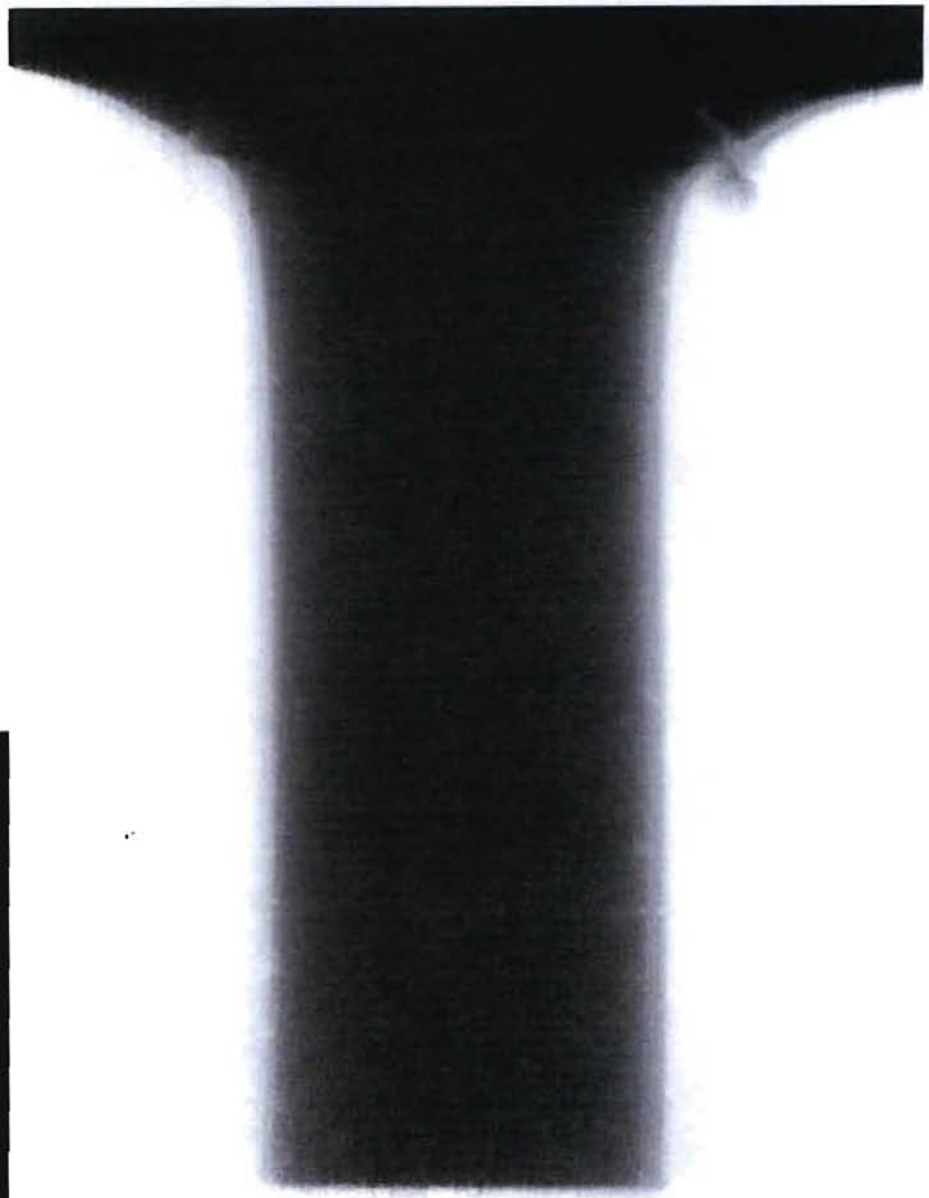


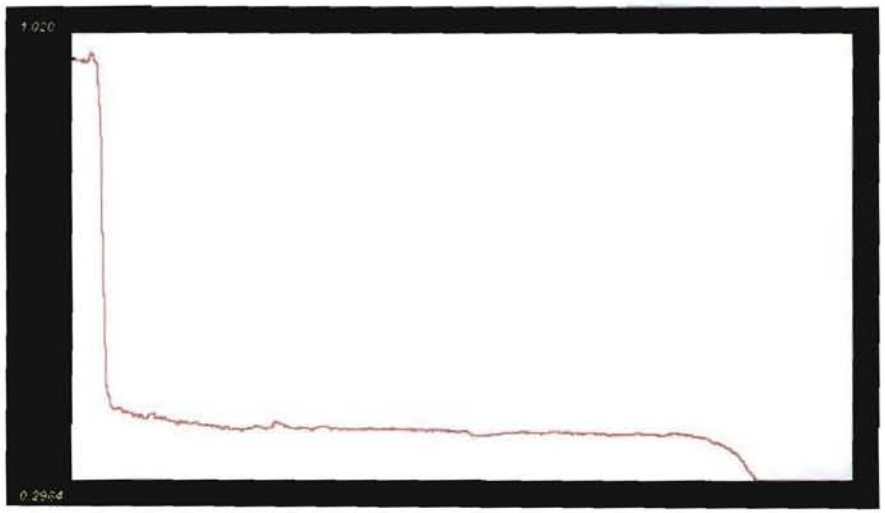
3600 PRAD0374: Iron EOS Shot Y



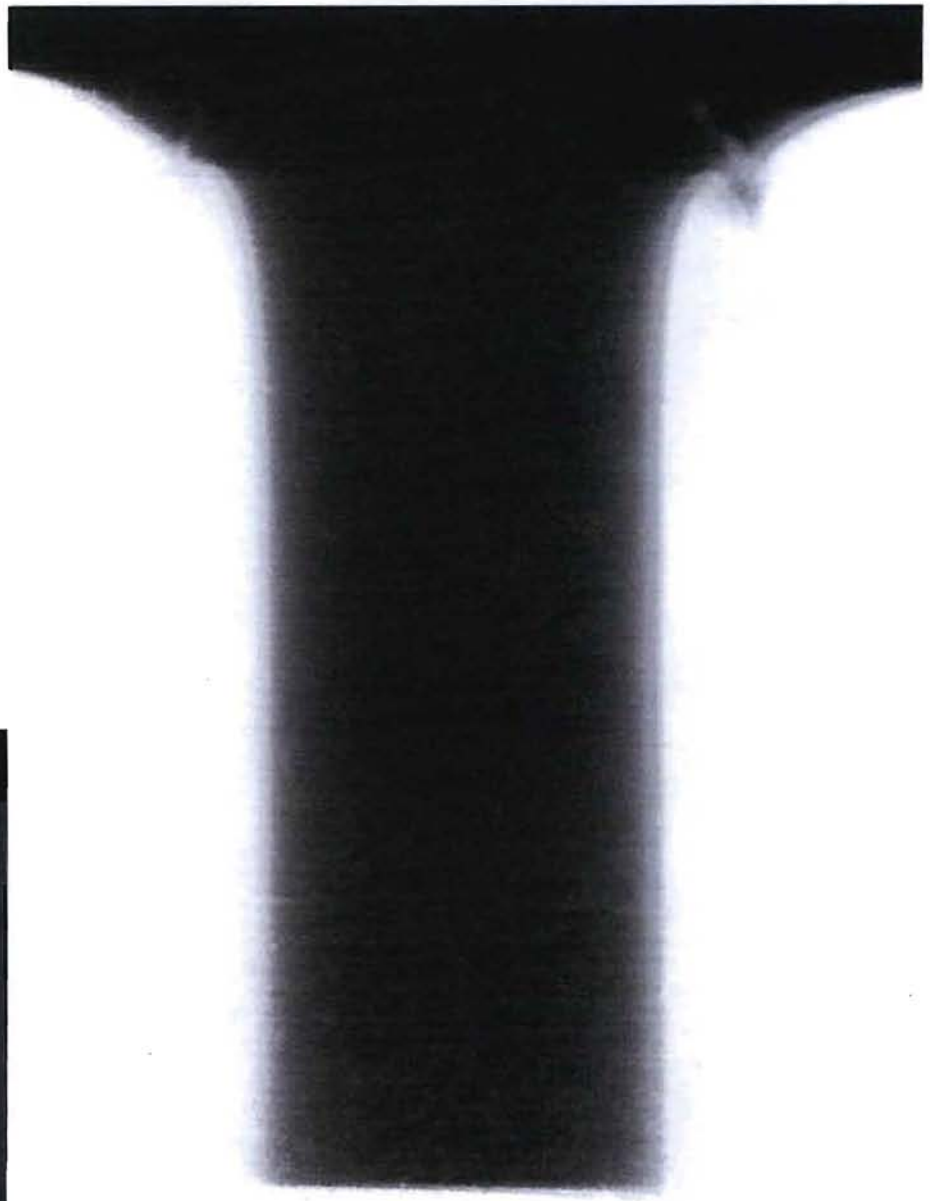


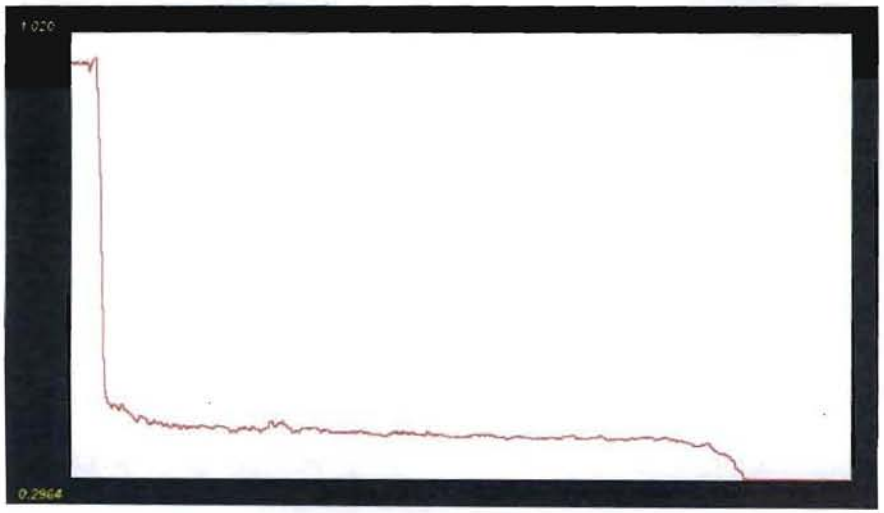
3900 PRAD0374: Iron EOS Shot J



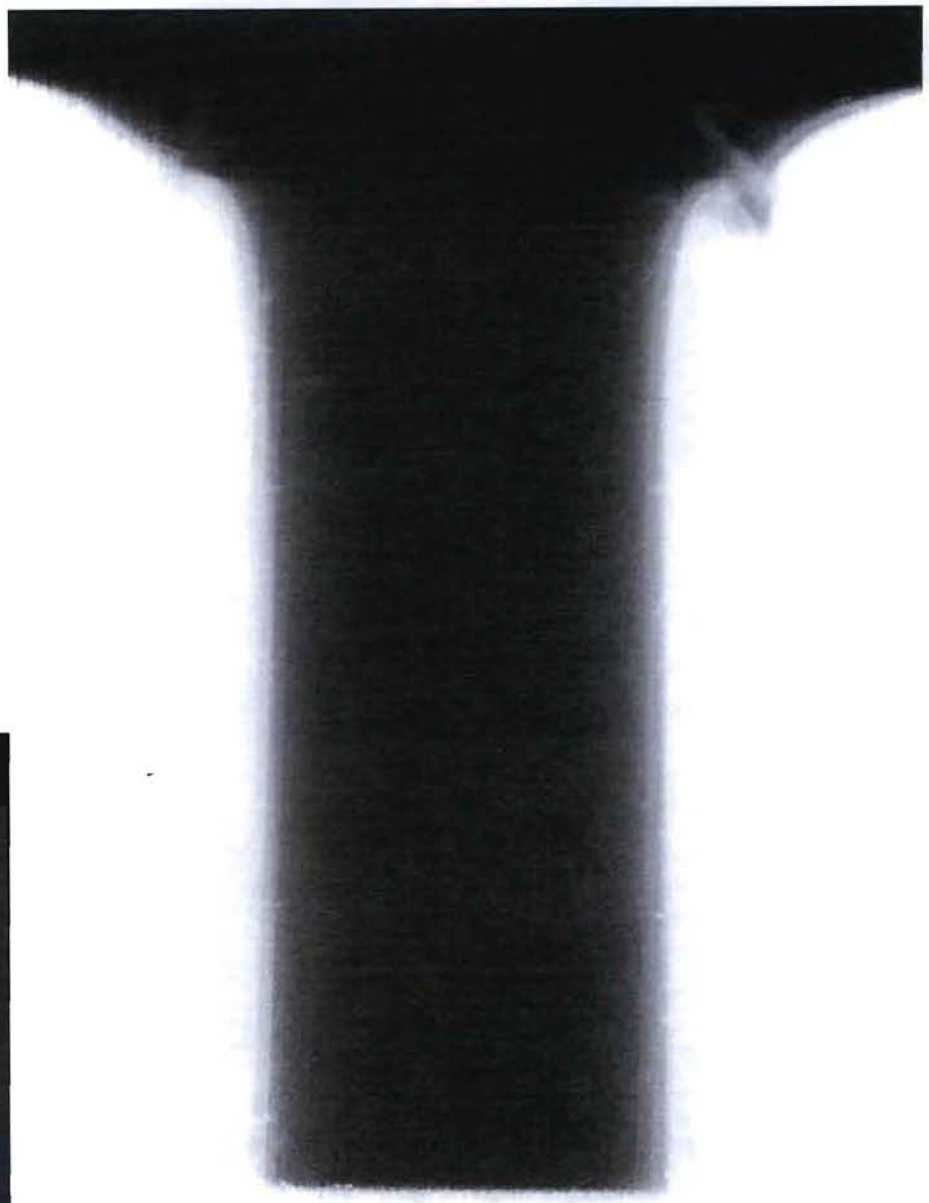


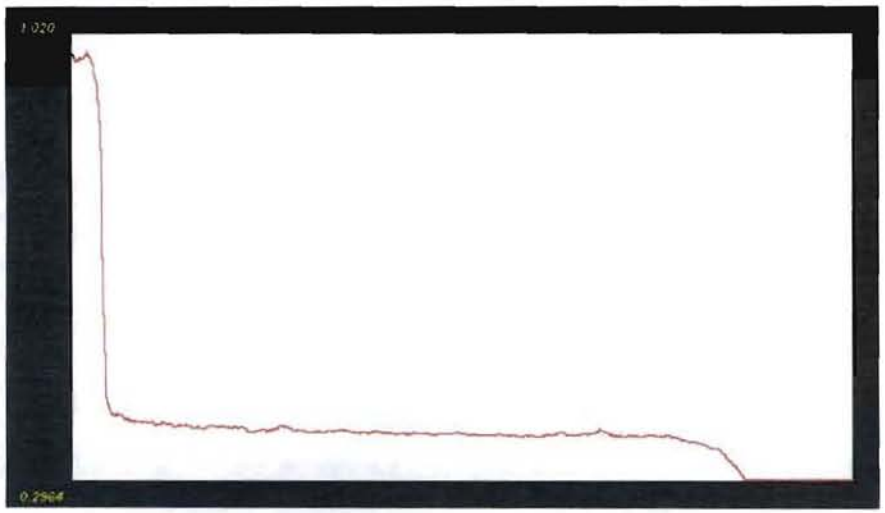
4200 PRAD0374: Iron EOS Shot M



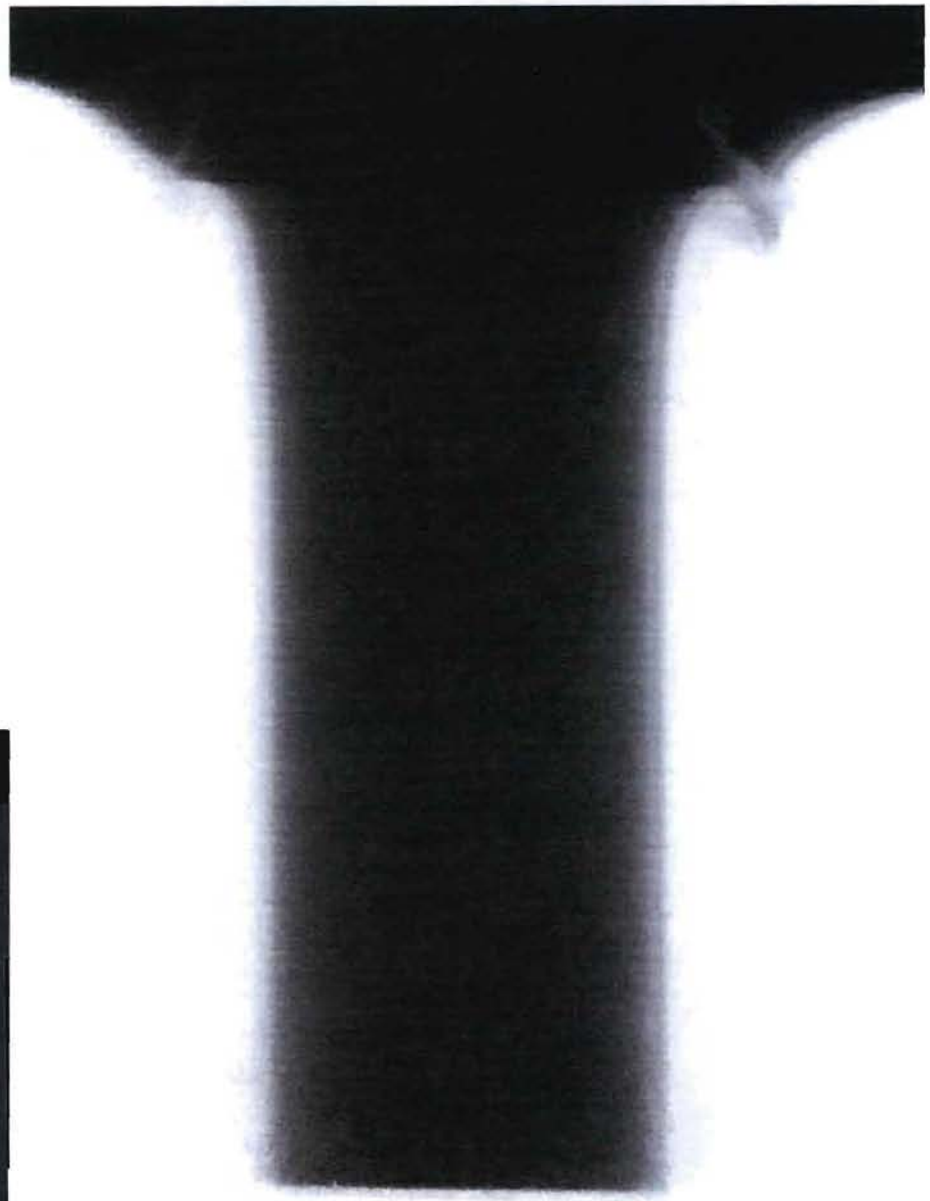


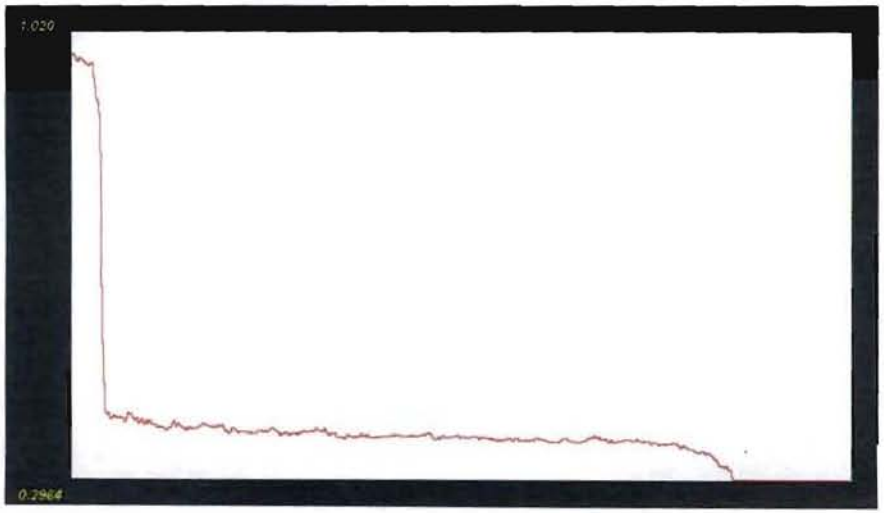
4500 PRAD0374: Iron EOS Shot P



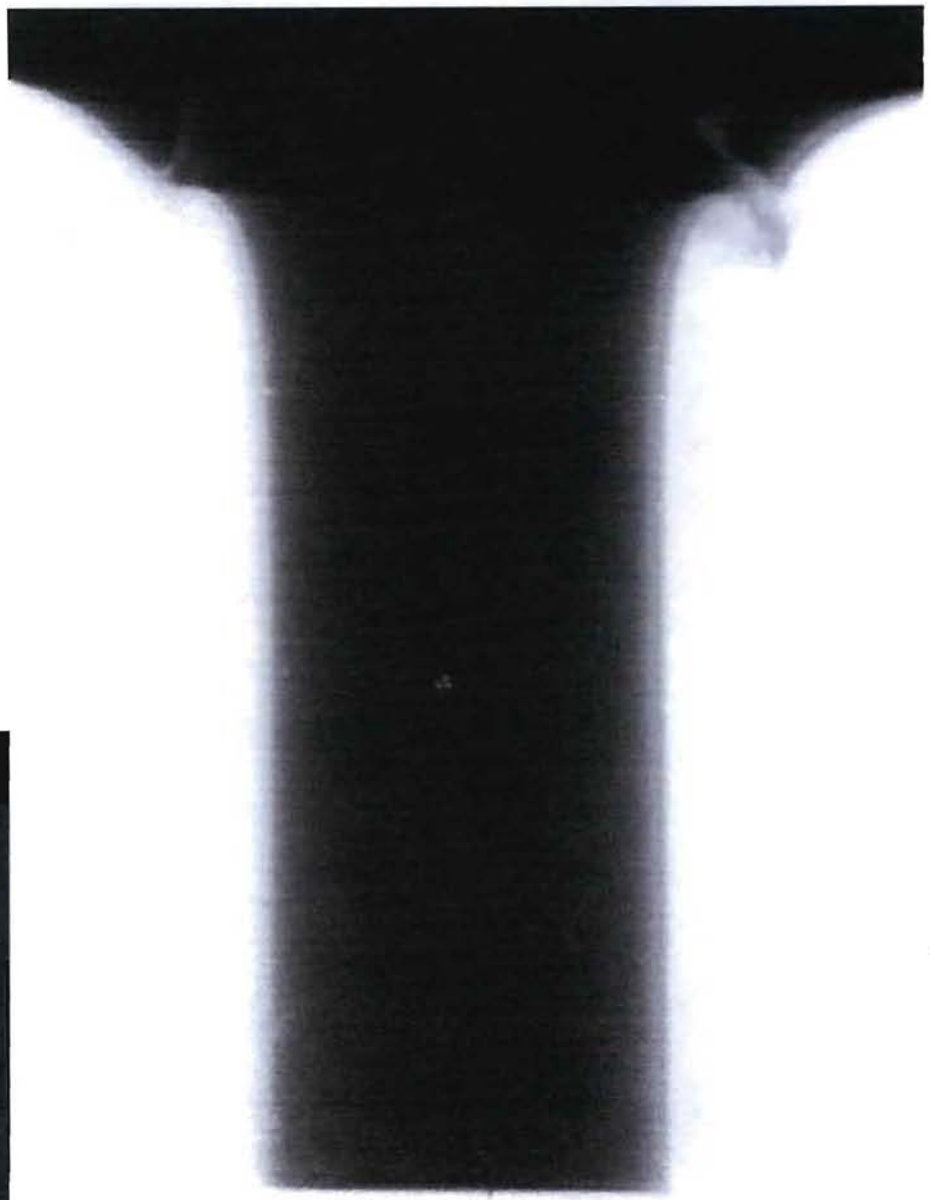


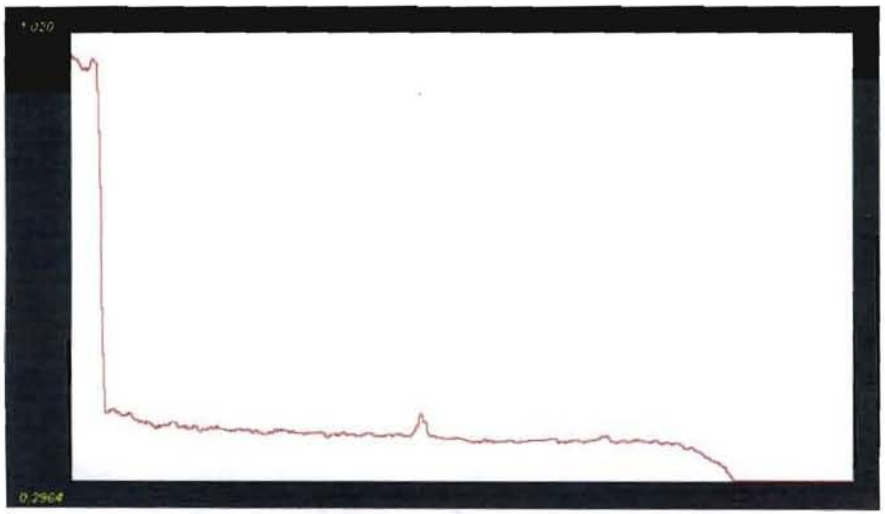
4800 PRAD0374: Iron EOS Shot S



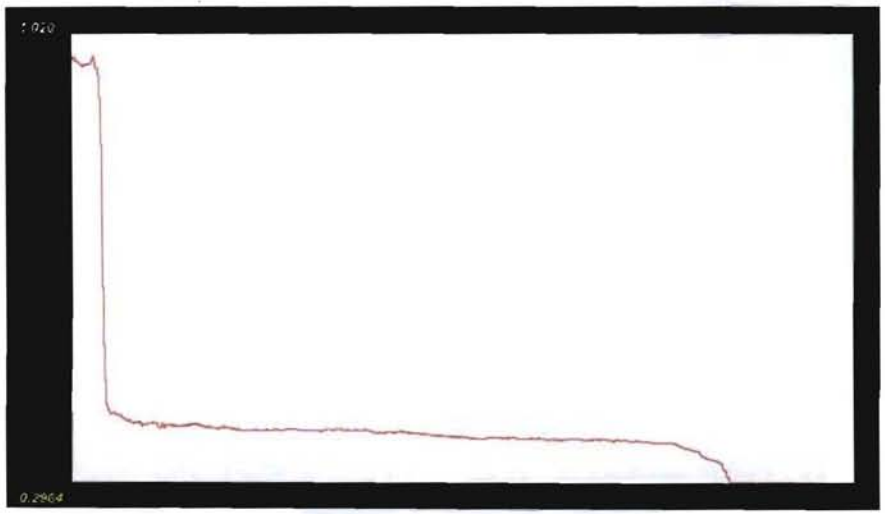


5100 PRAD0374: Iron EOS Shot V

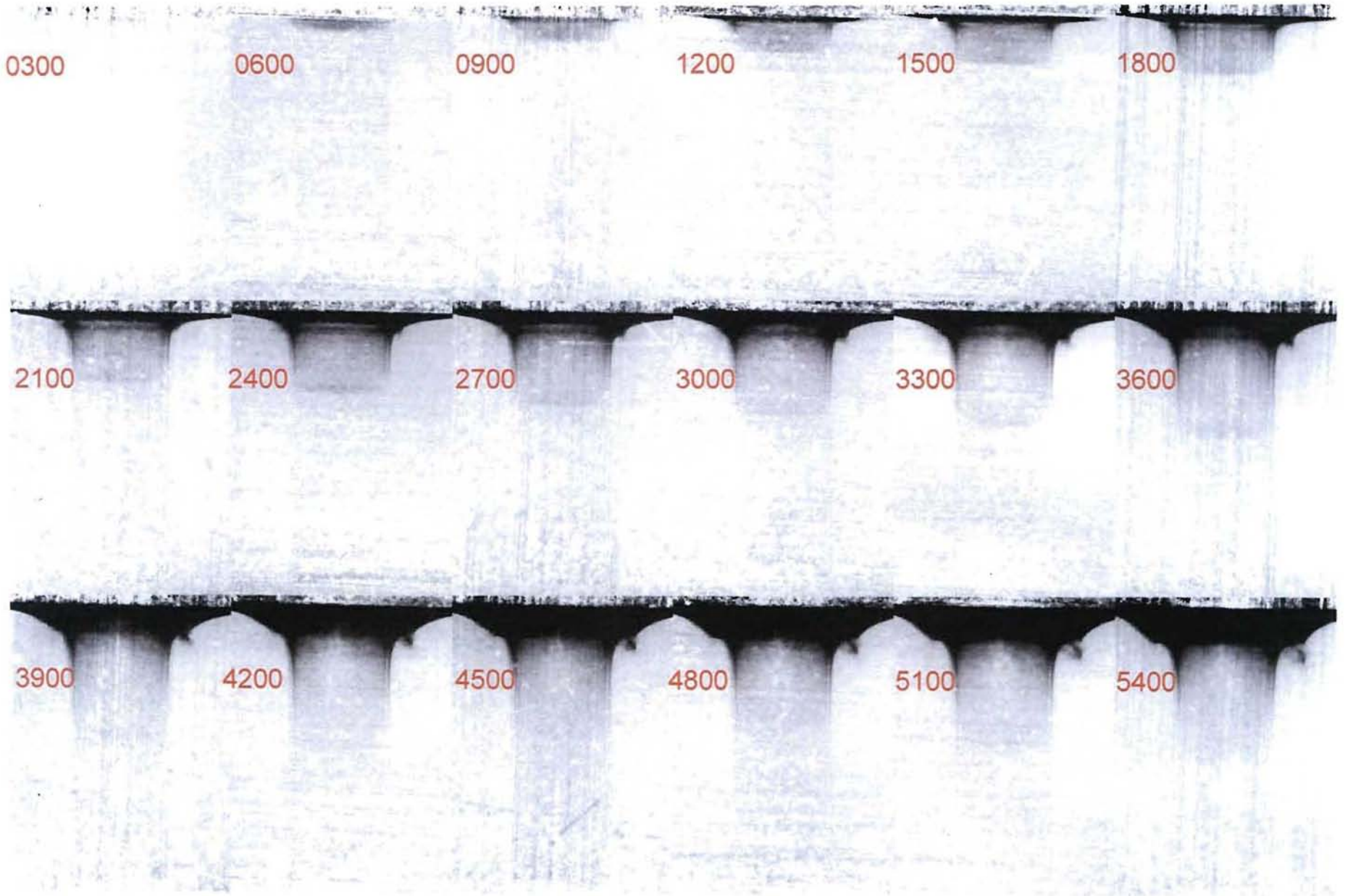




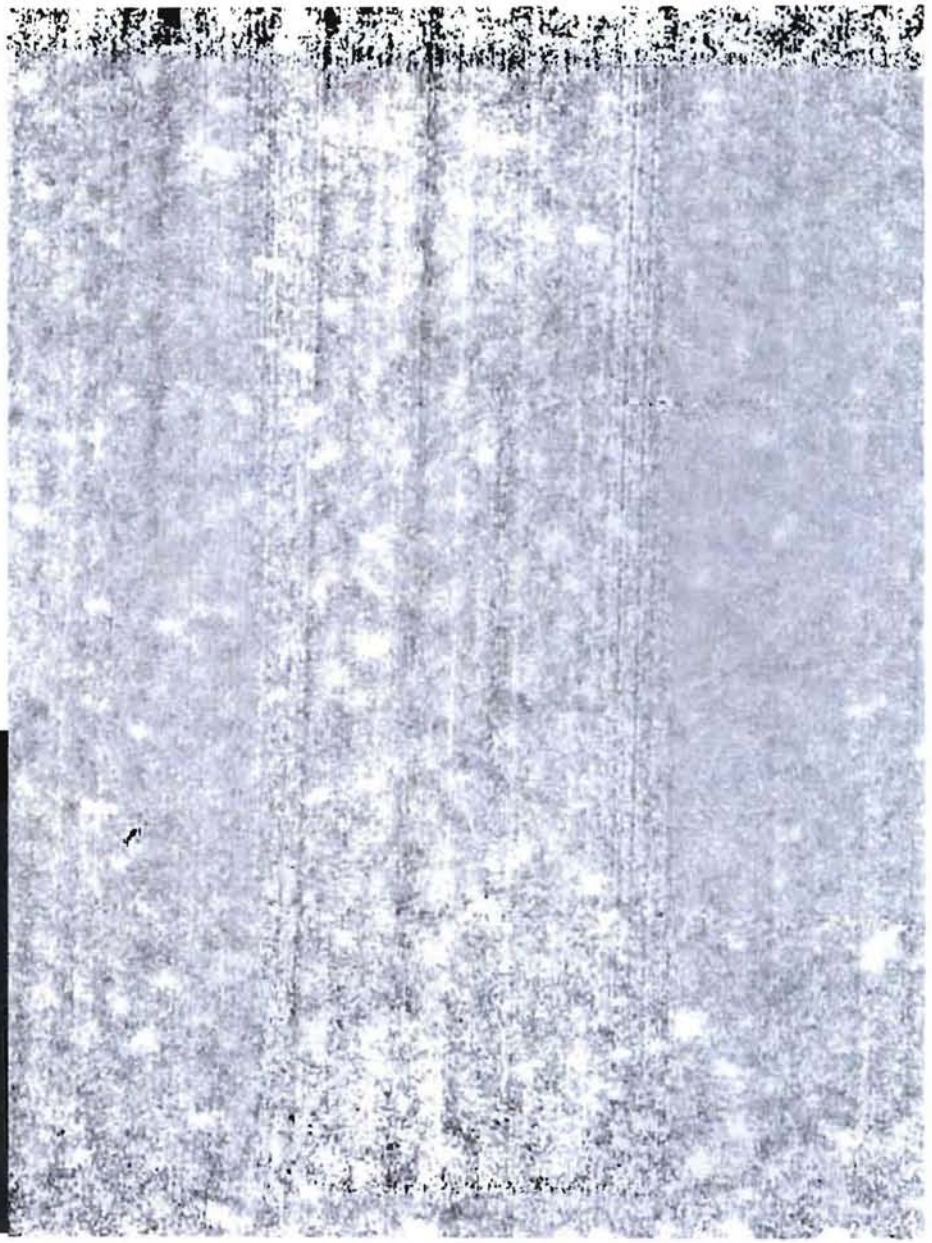
5400 PRAD0374: Iron EOS Shot Z



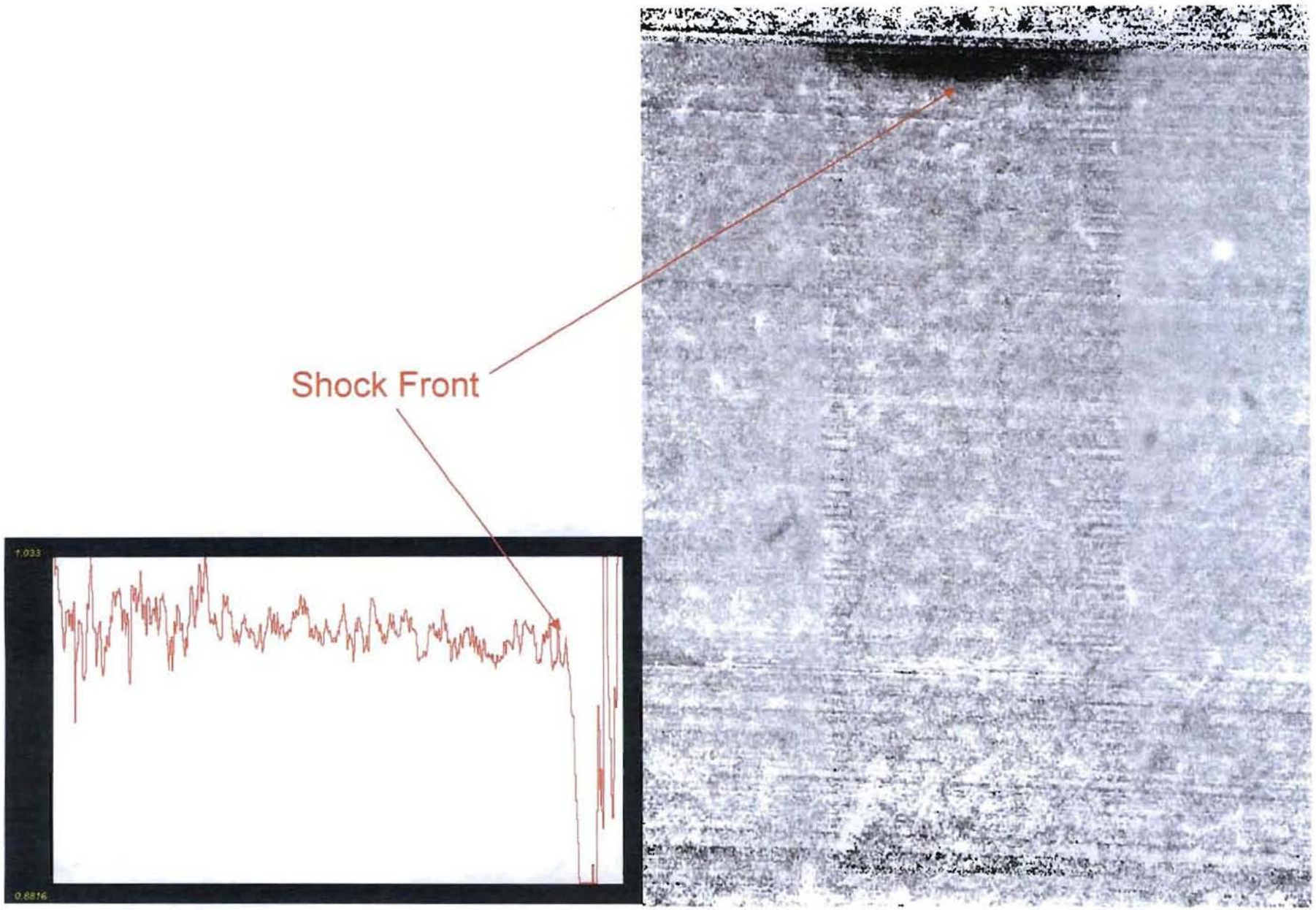
PRAD0374: Iron EOS Ratio Composite



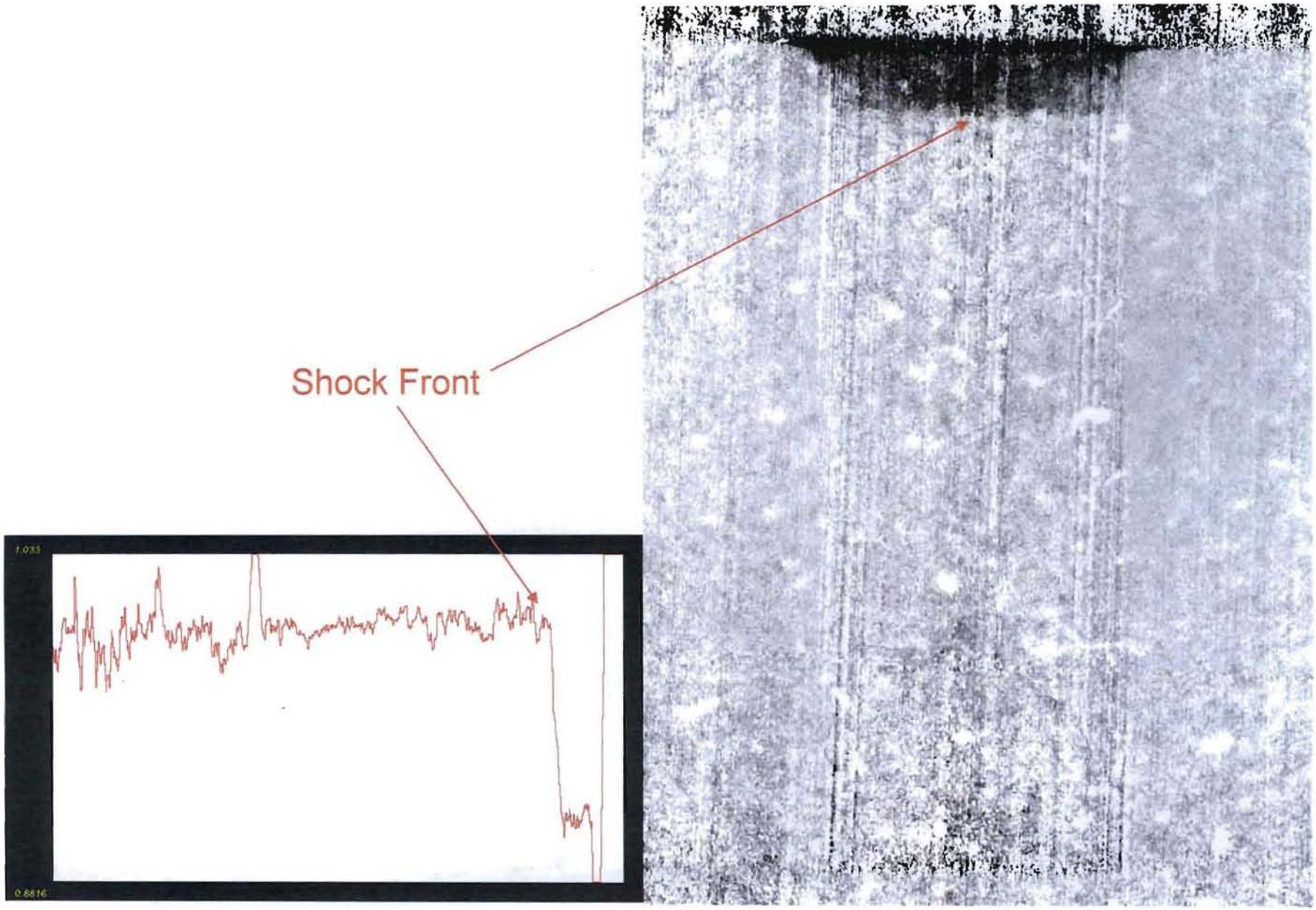
0300 PRAD0374: Iron EOS Ratio H



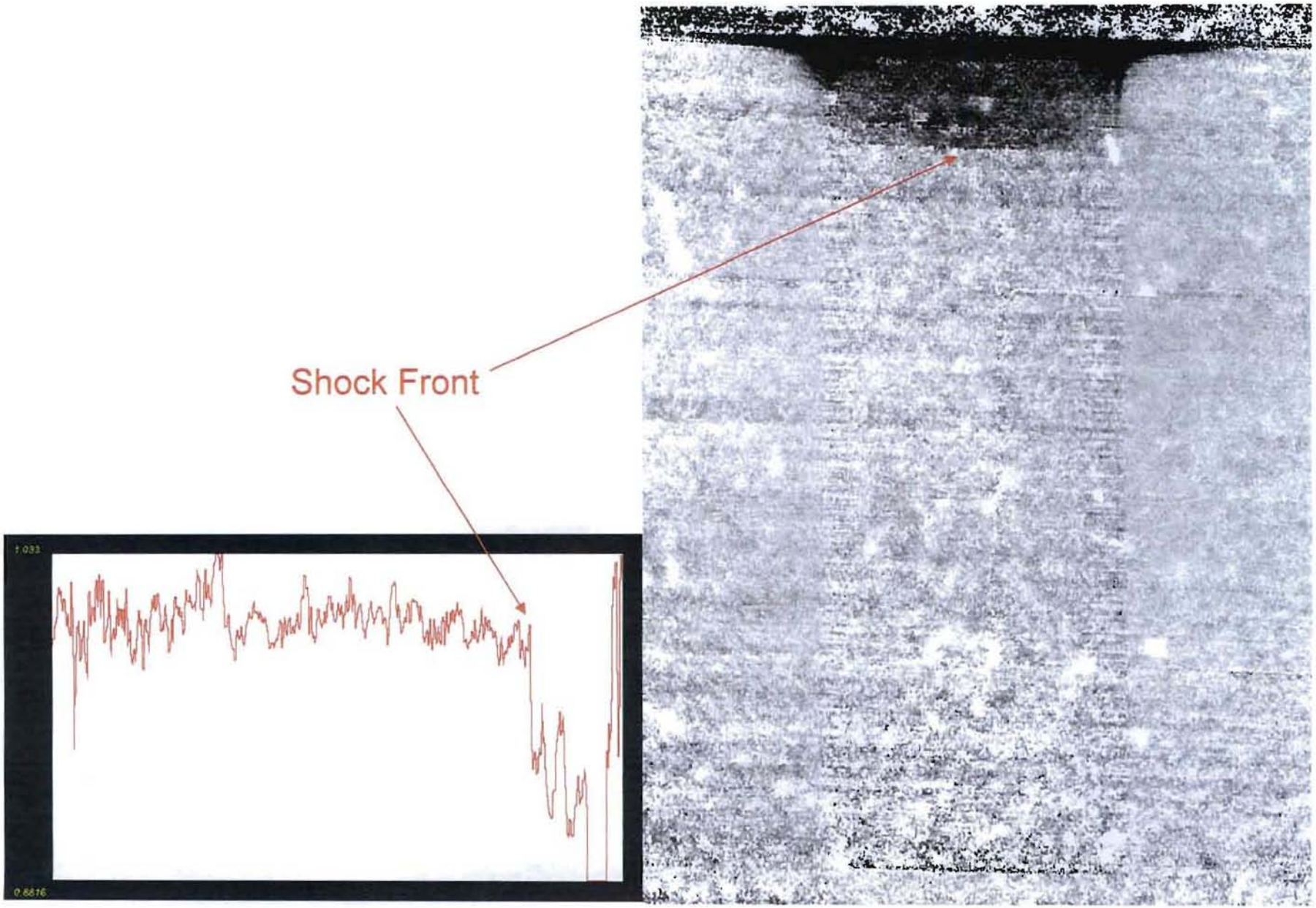
0600 PRAD0374: Iron EOS Ratio K



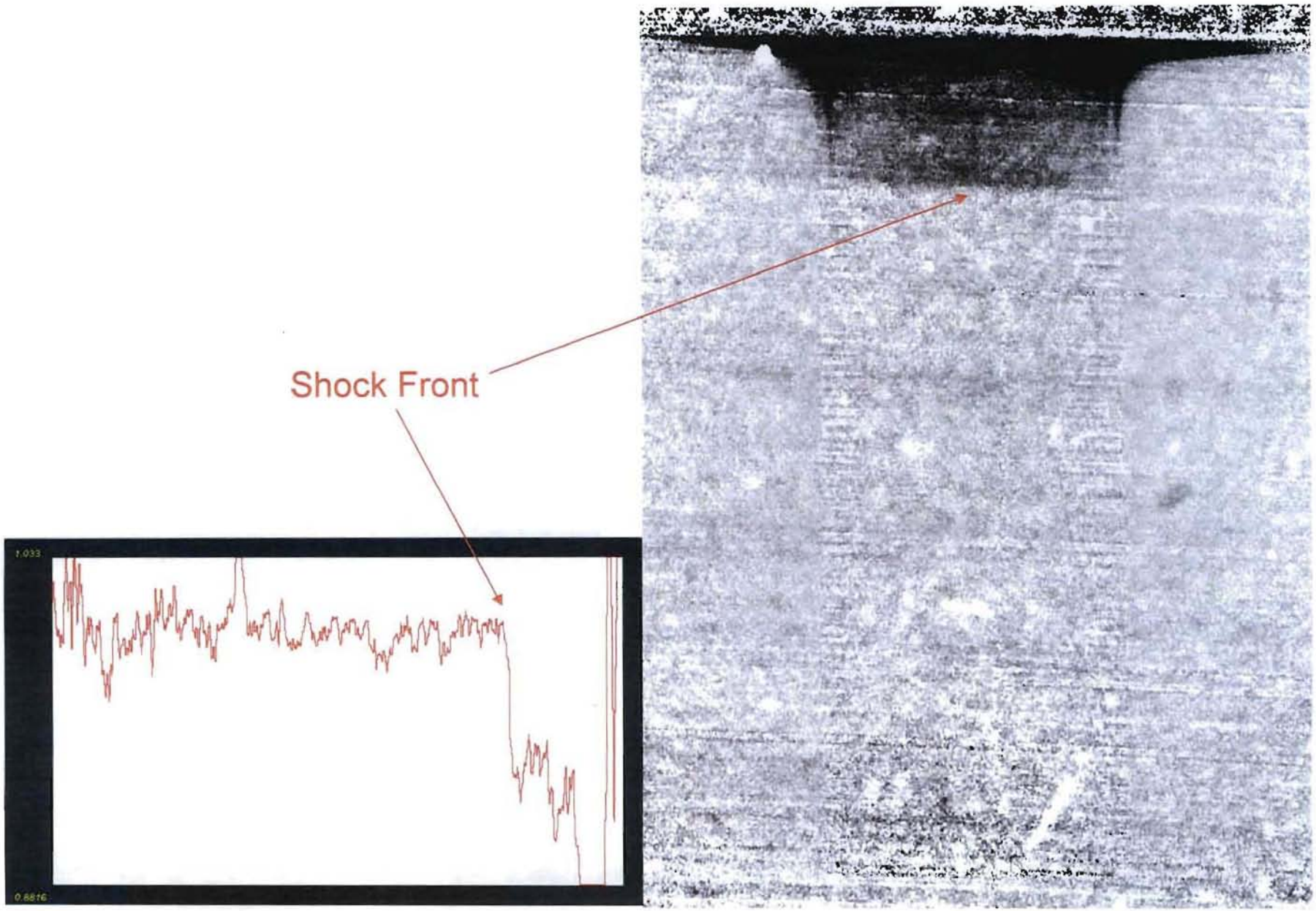
0900 PRAD0374: Iron EOS Ratio N



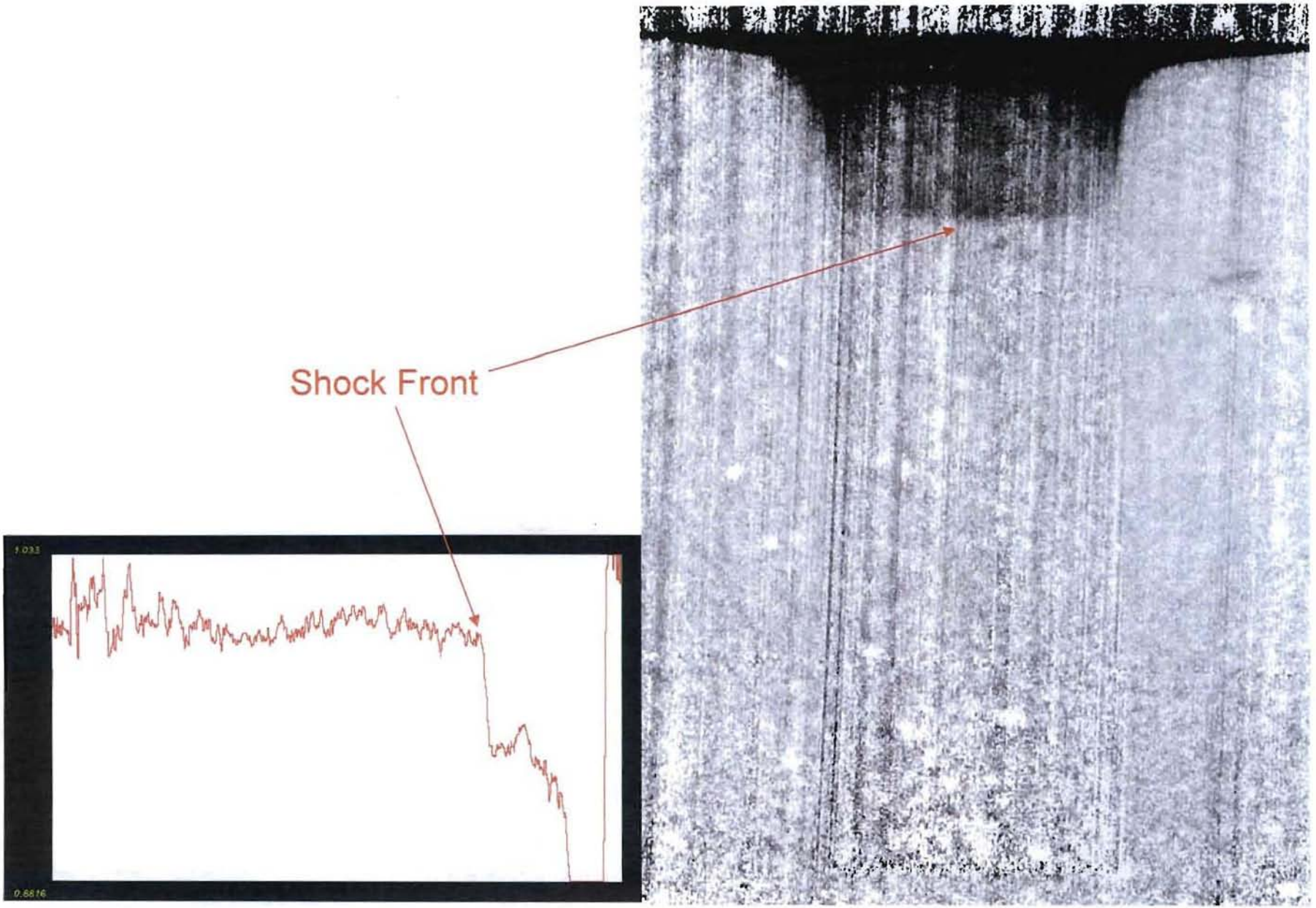
1200 PRAD0374: Iron EOS Ratio Q



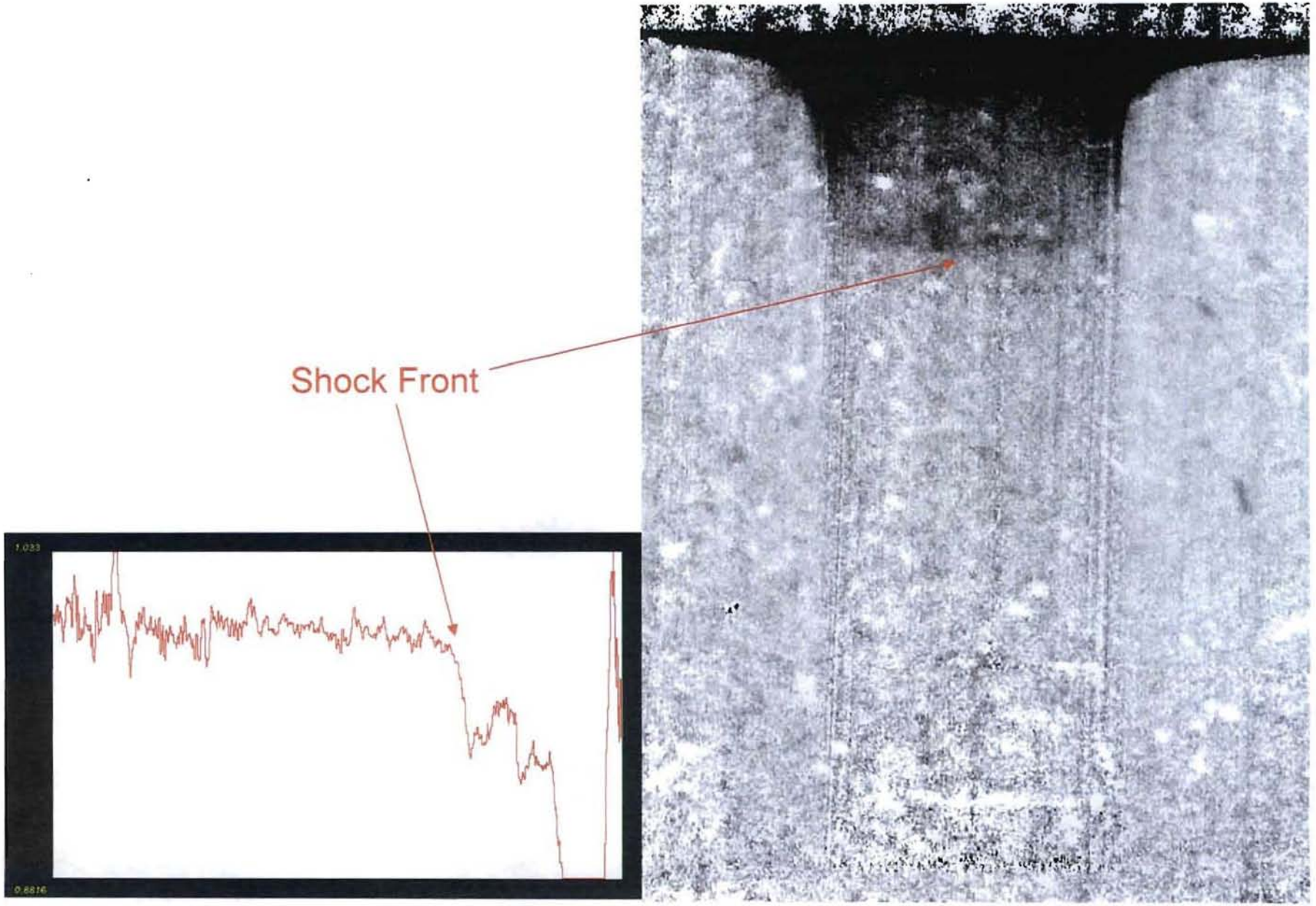
1500 PRAD0374: Iron EOS Ratio T



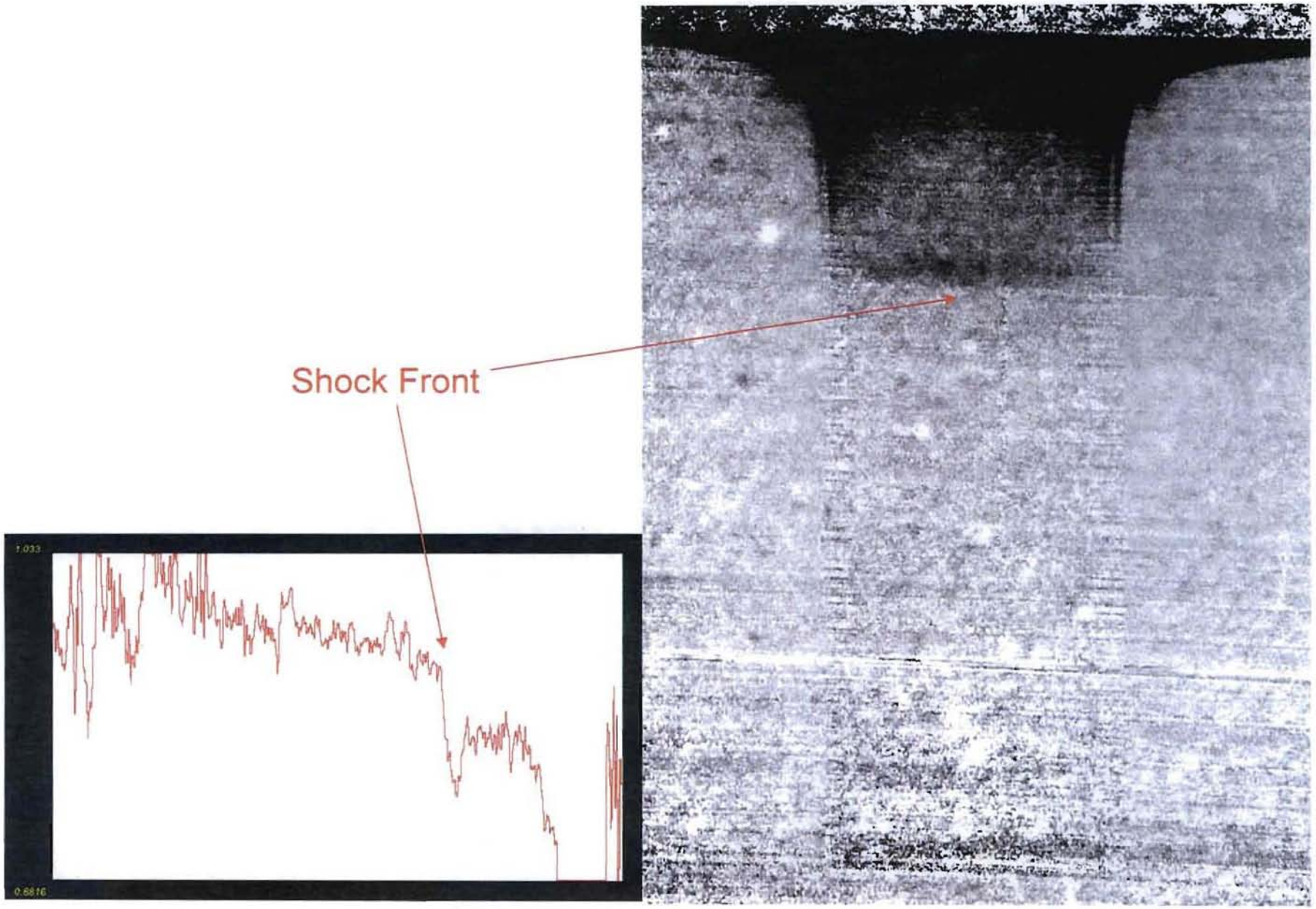
1800 PRAD0374: Iron EOS Ratio X



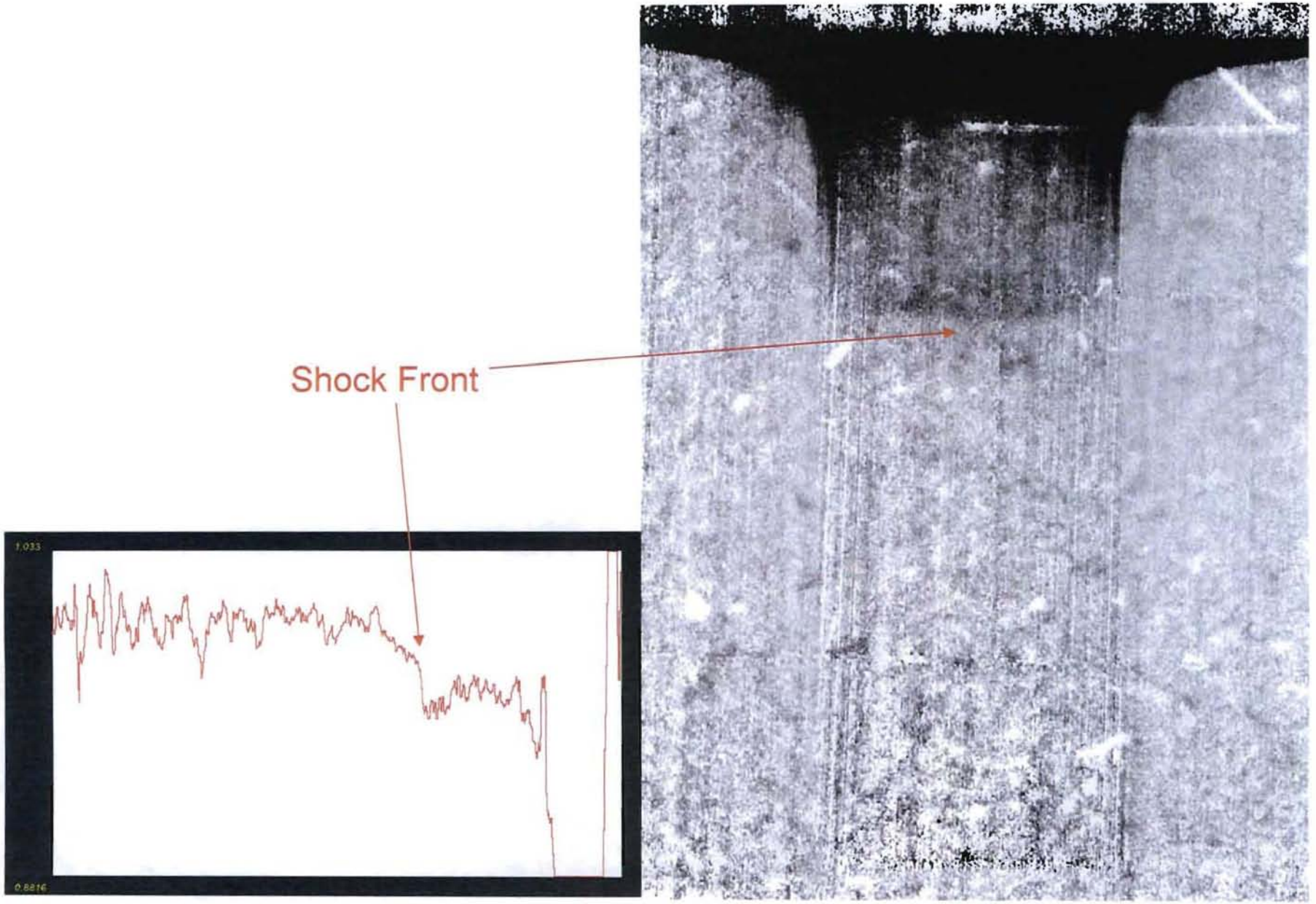
2100 PRAD0374: Iron EOS Ratiol



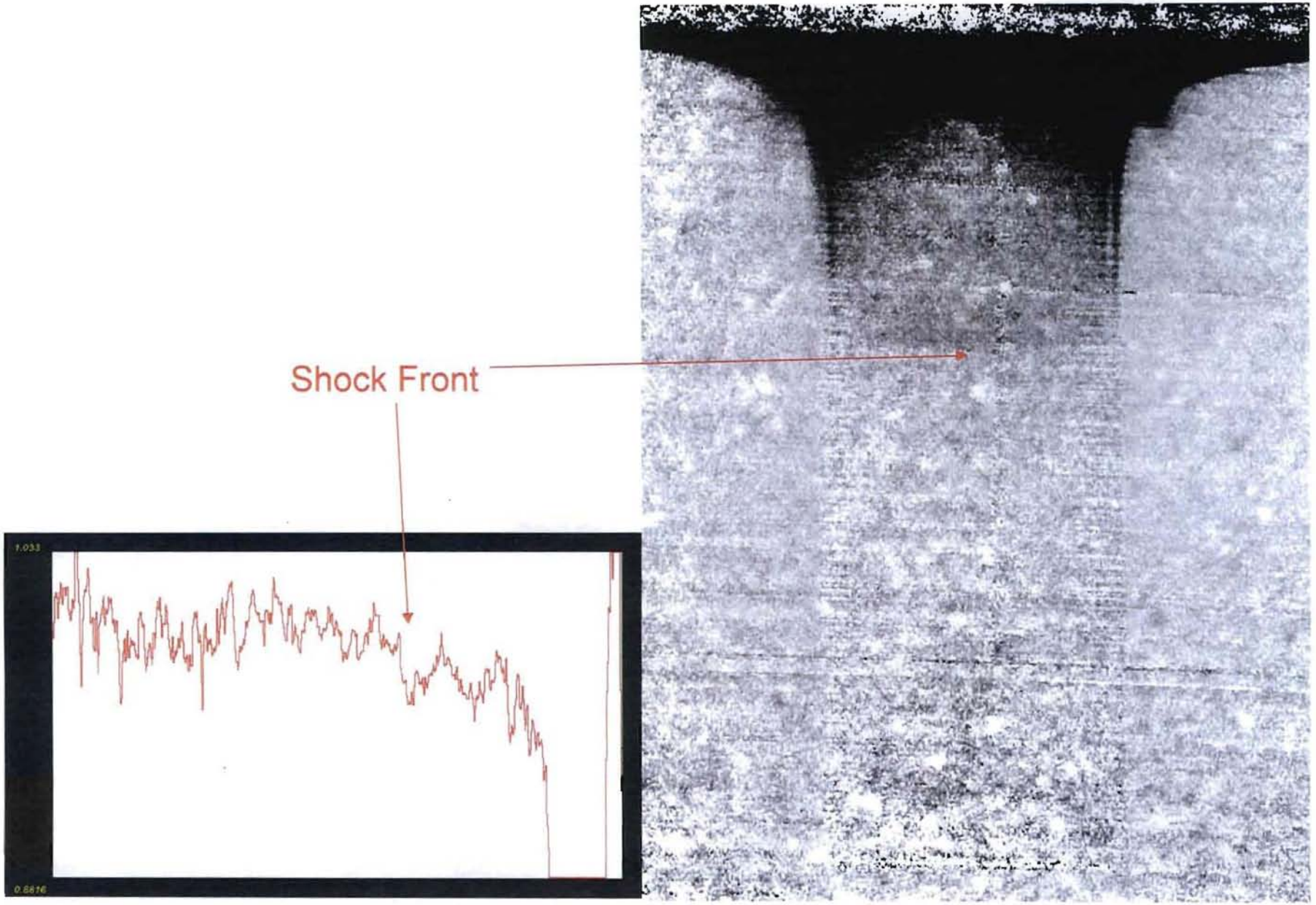
2400 PRAD0374: Iron EOS Ratio L



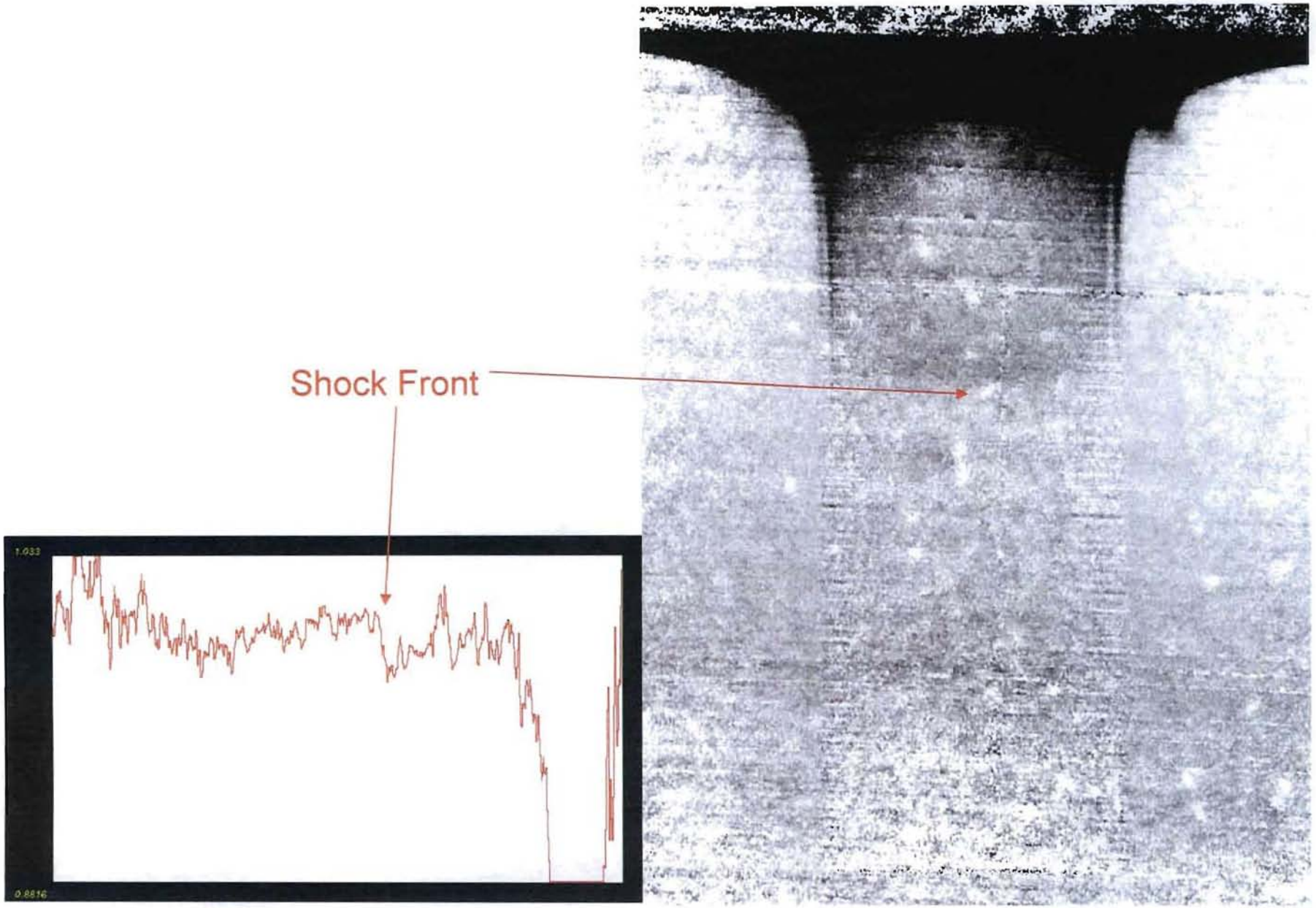
2700 PRAD0374: Iron EOS Ratio O



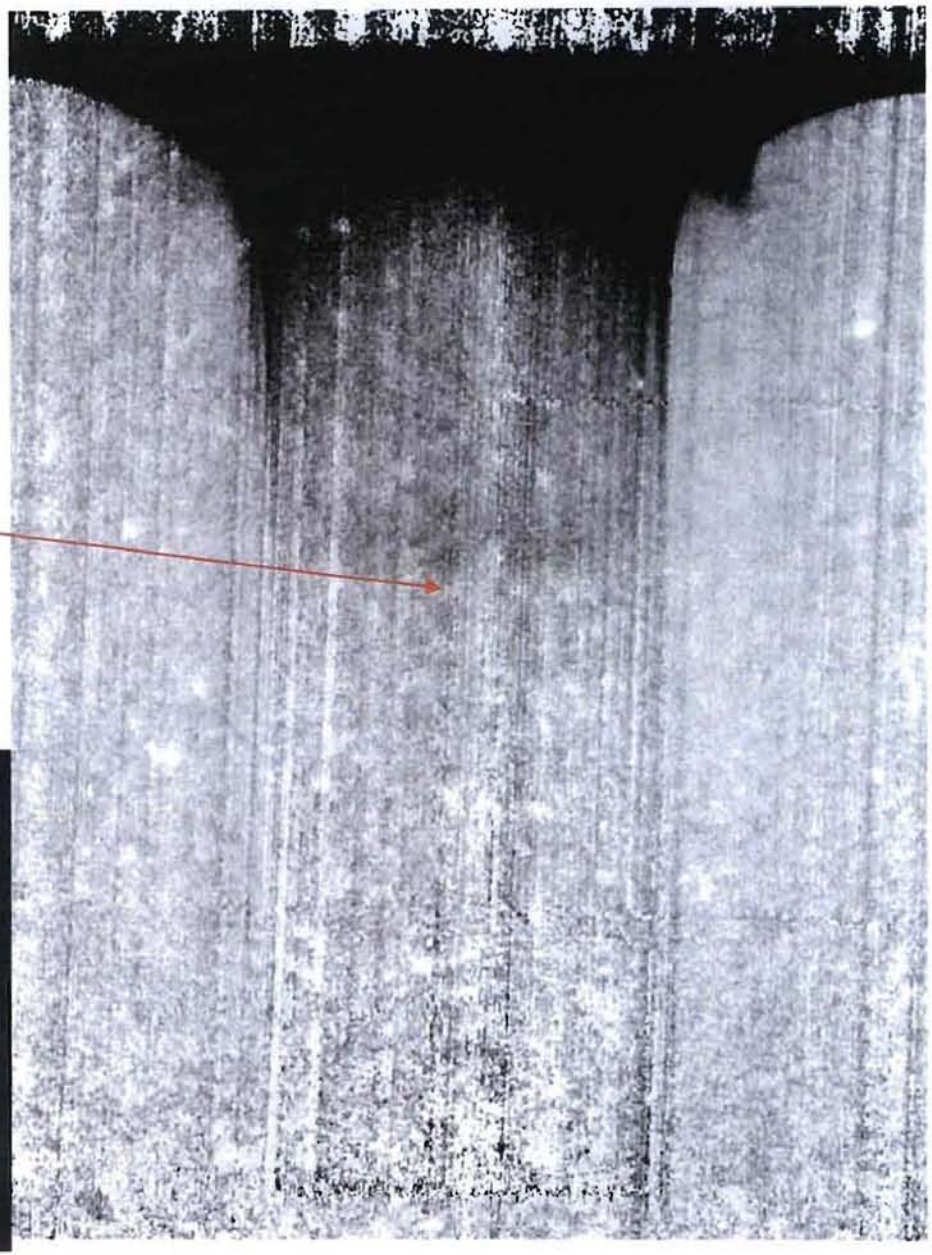
3000 PRAD0374: Iron EOS Ratio R



3300 PRAD0374: Iron EOS Ratio U

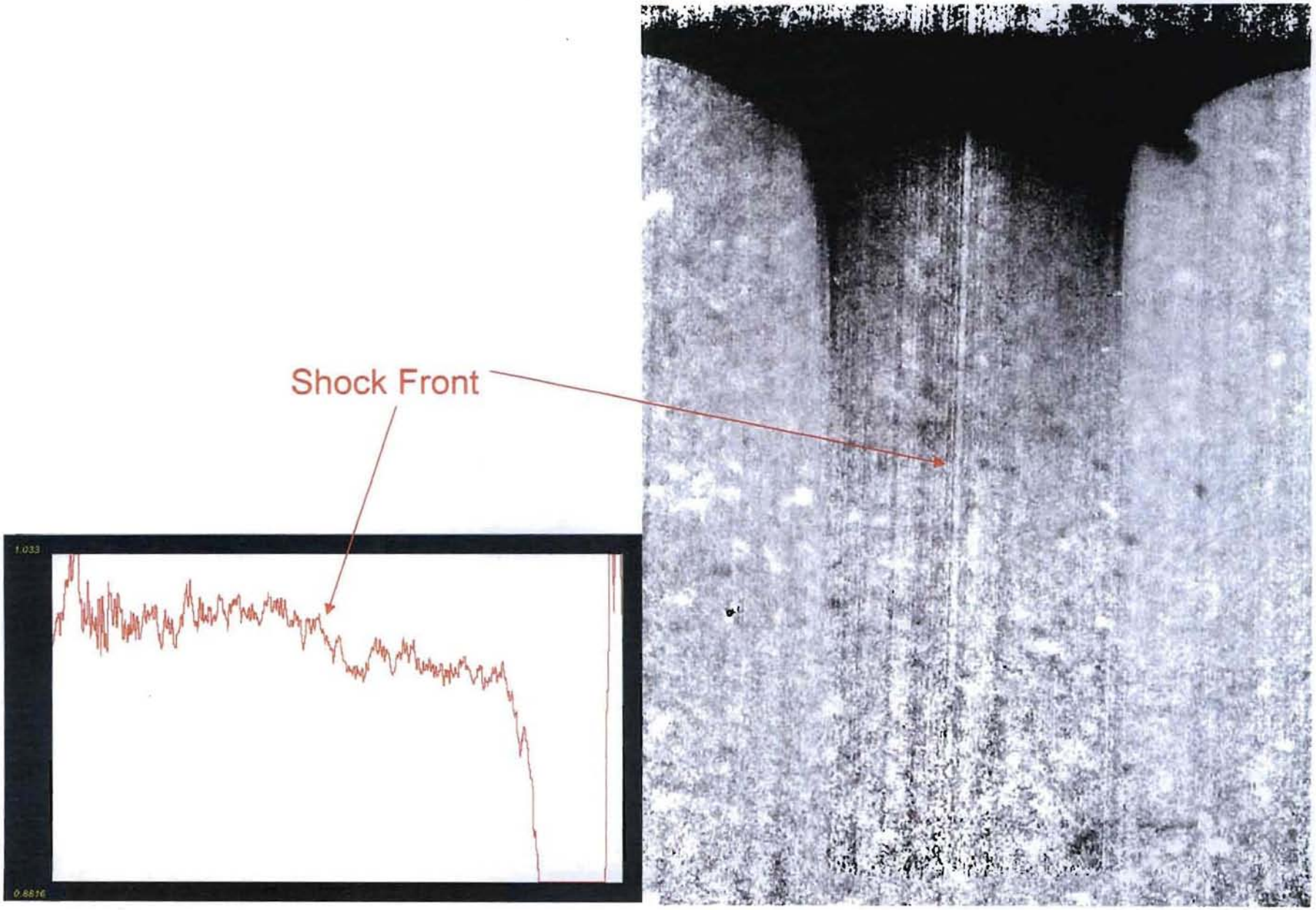


3600 PRAD0374: Iron EOS Ratio Y

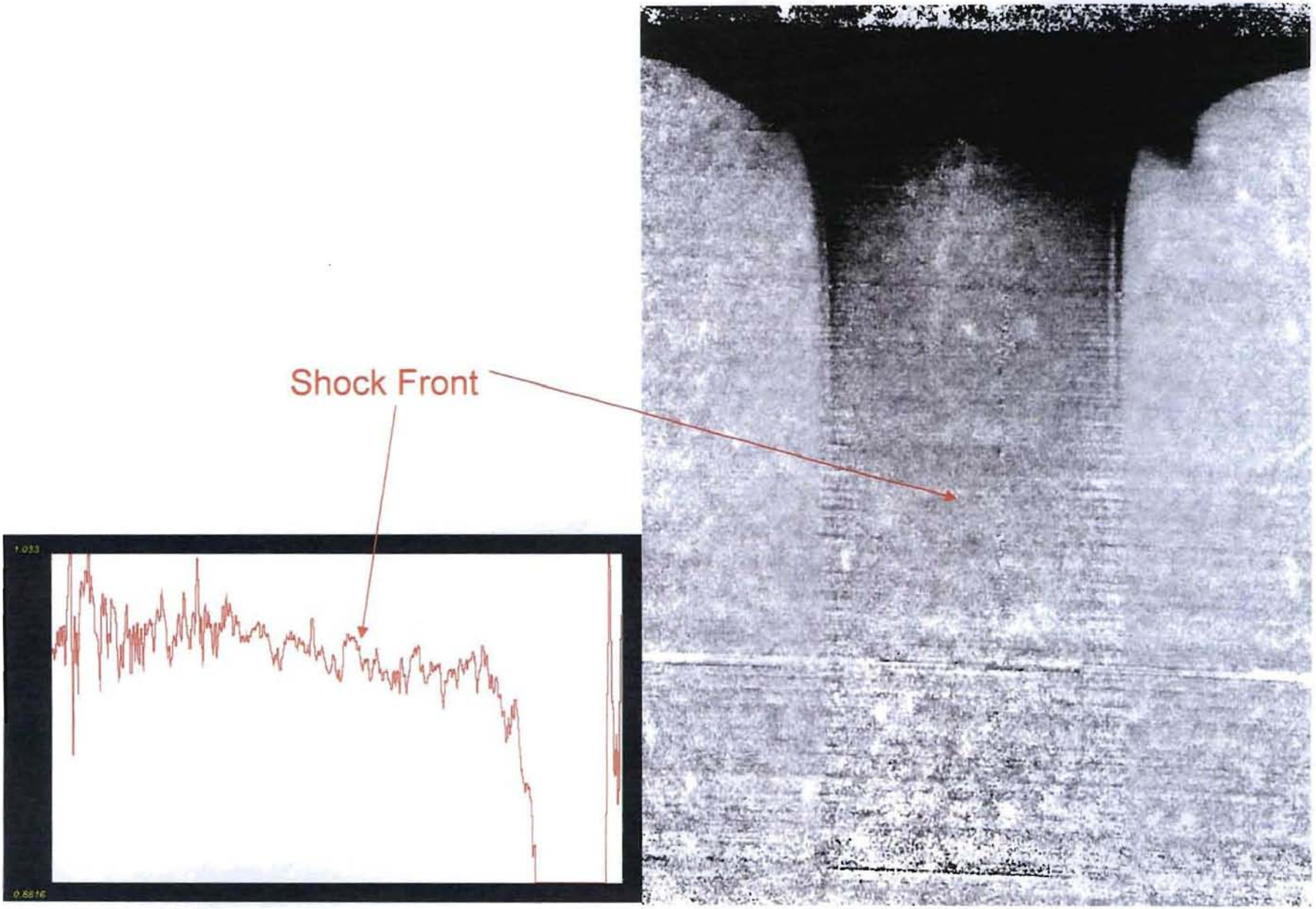


Shock Front

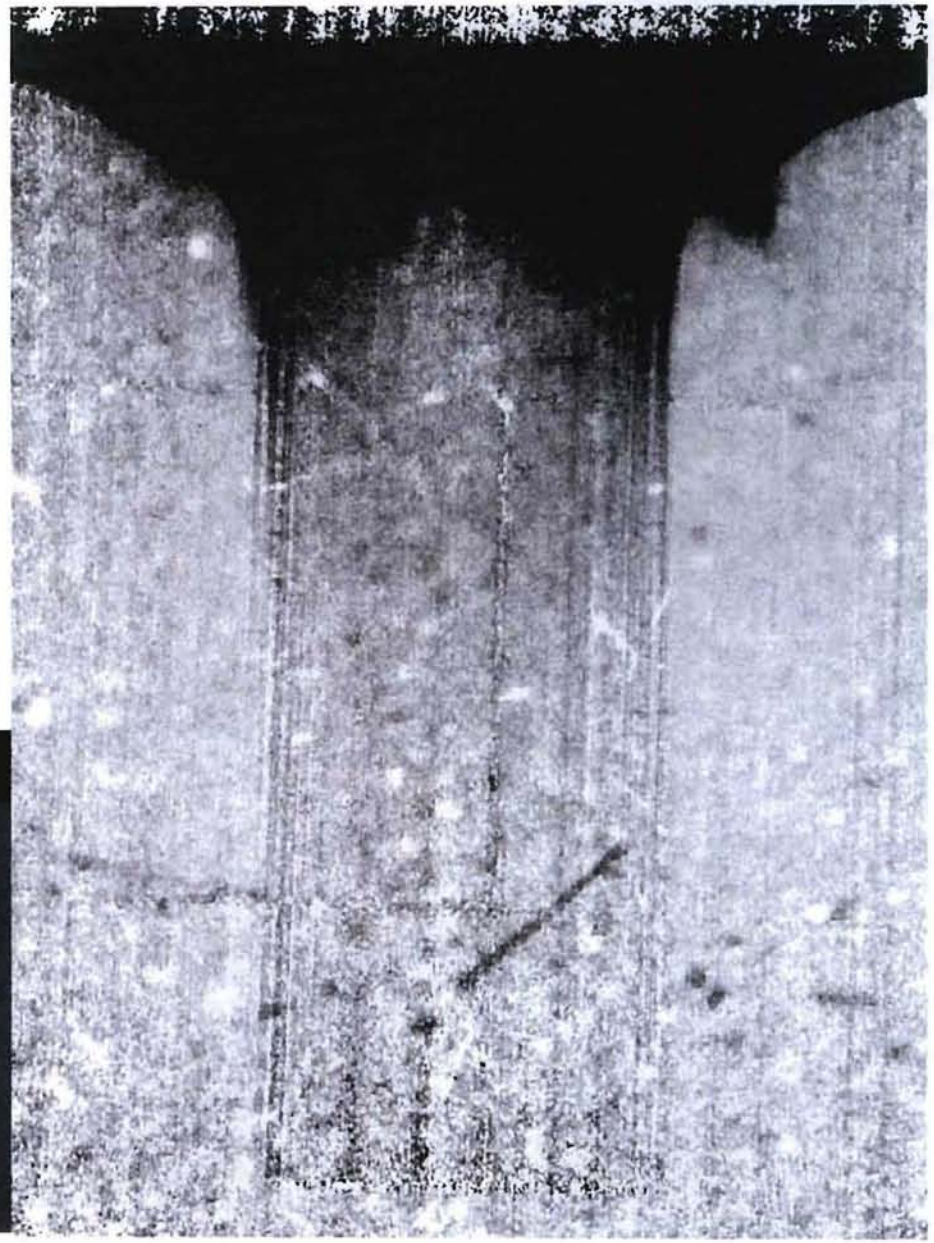
3900 PRAD0374: Iron EOS Ratio J



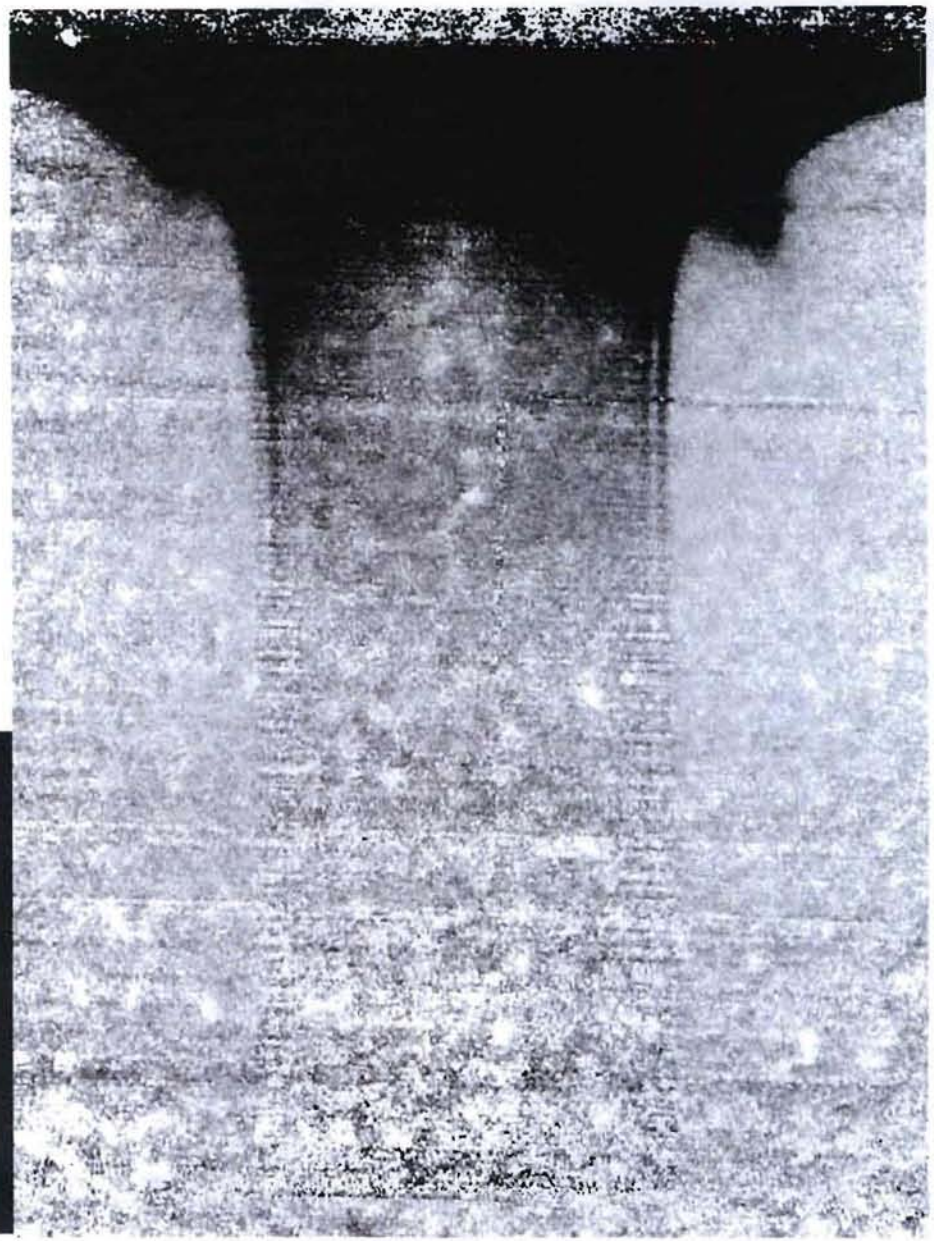
4200 PRAD0374: Iron EOS Ratio M



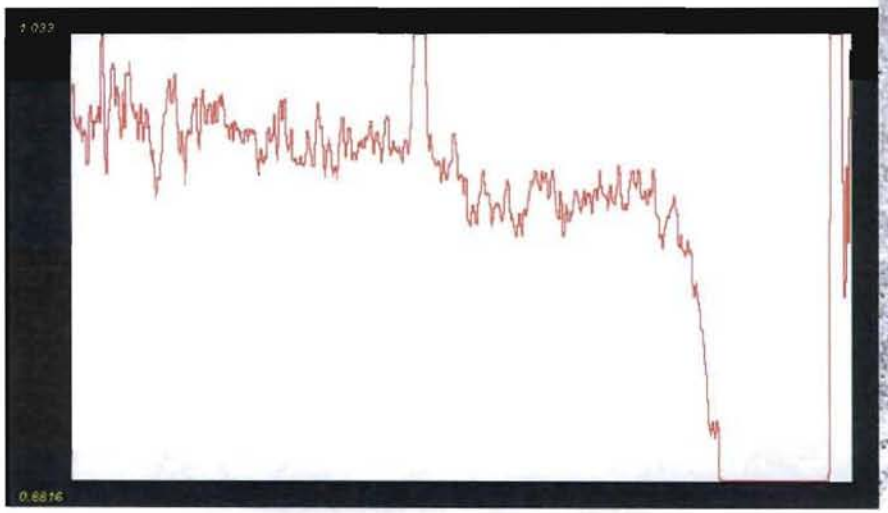
4500 PRAD0374: Iron EOS Ratio P

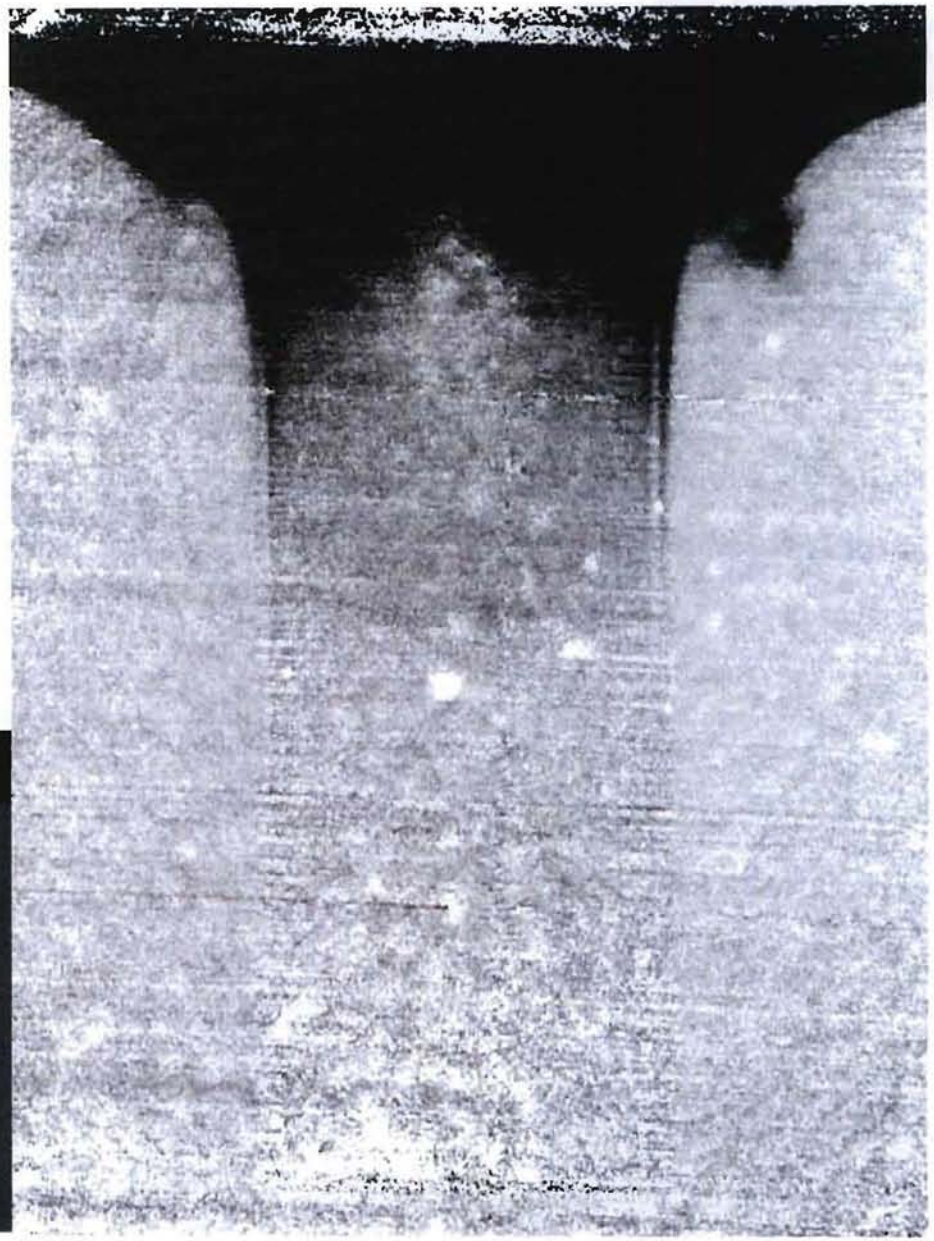


4800 PRAD0374: Iron EOS Ratio S

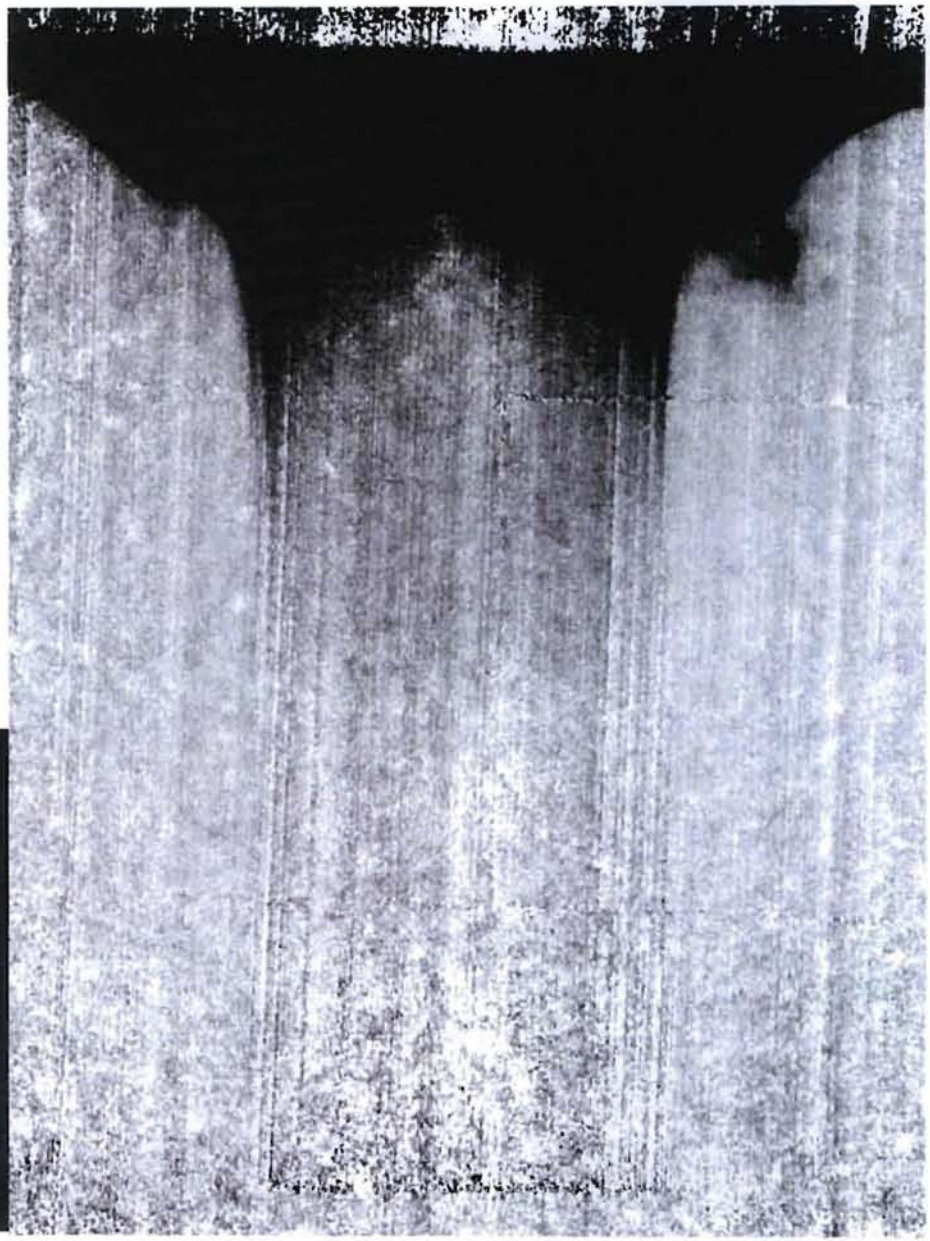


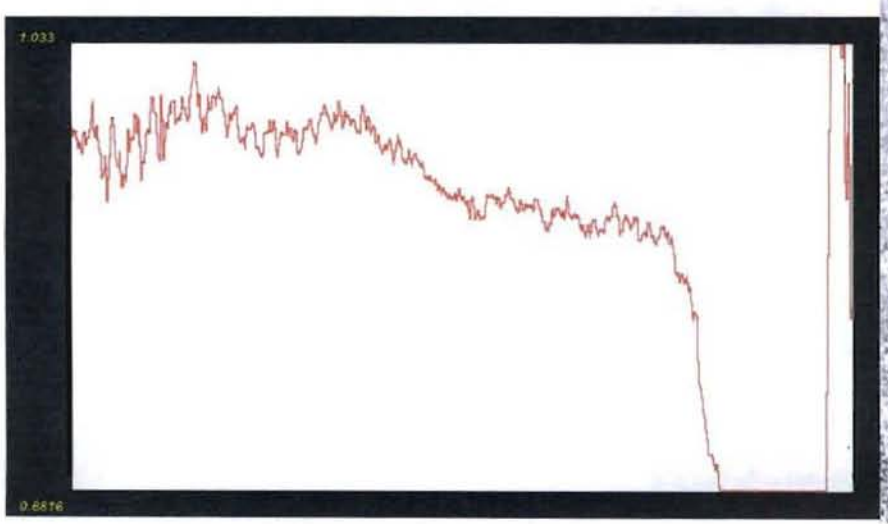
5100 PRAD0374: Iron EOS Ratio V



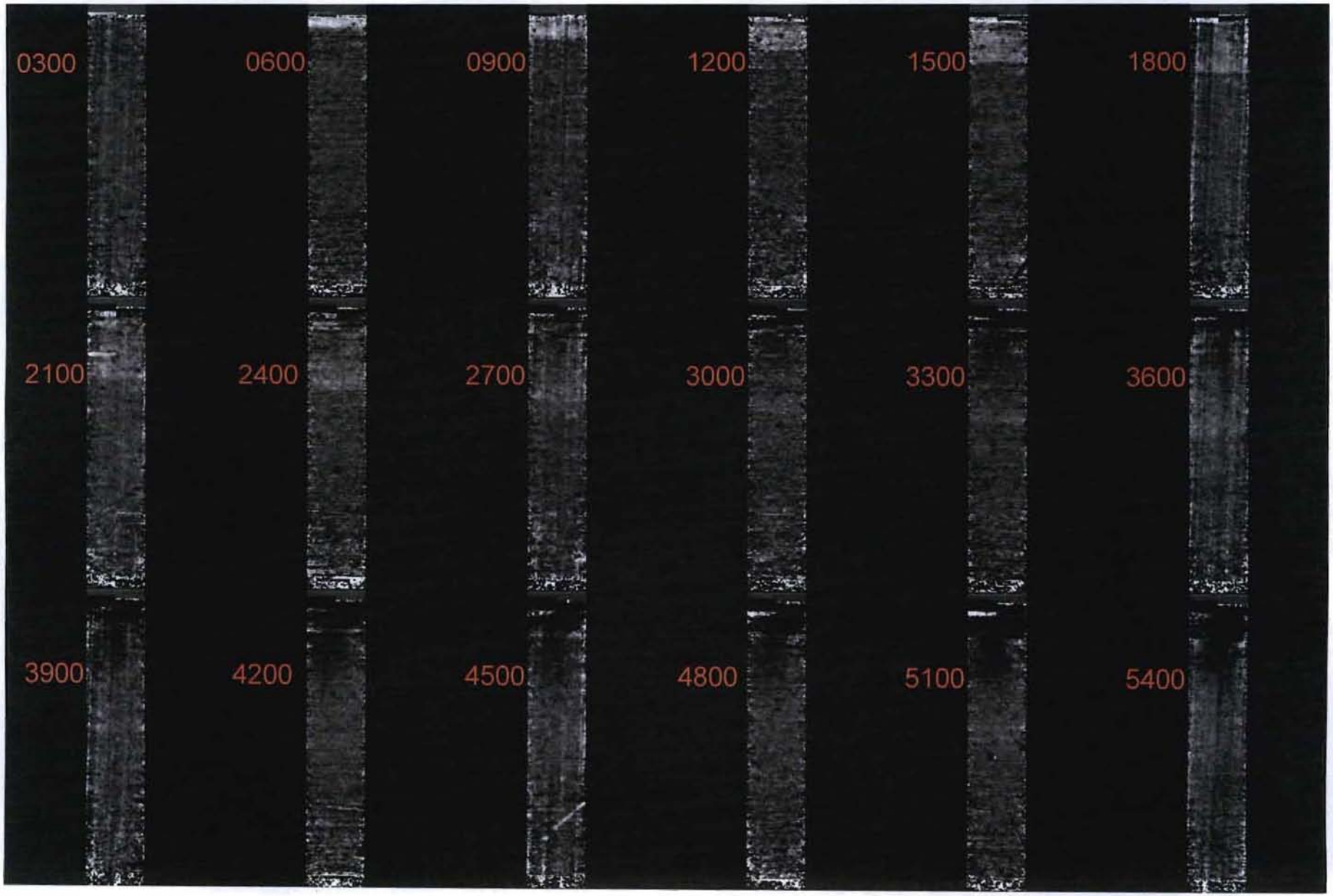


5400 PRAD0374: Iron EOS Ratio Z

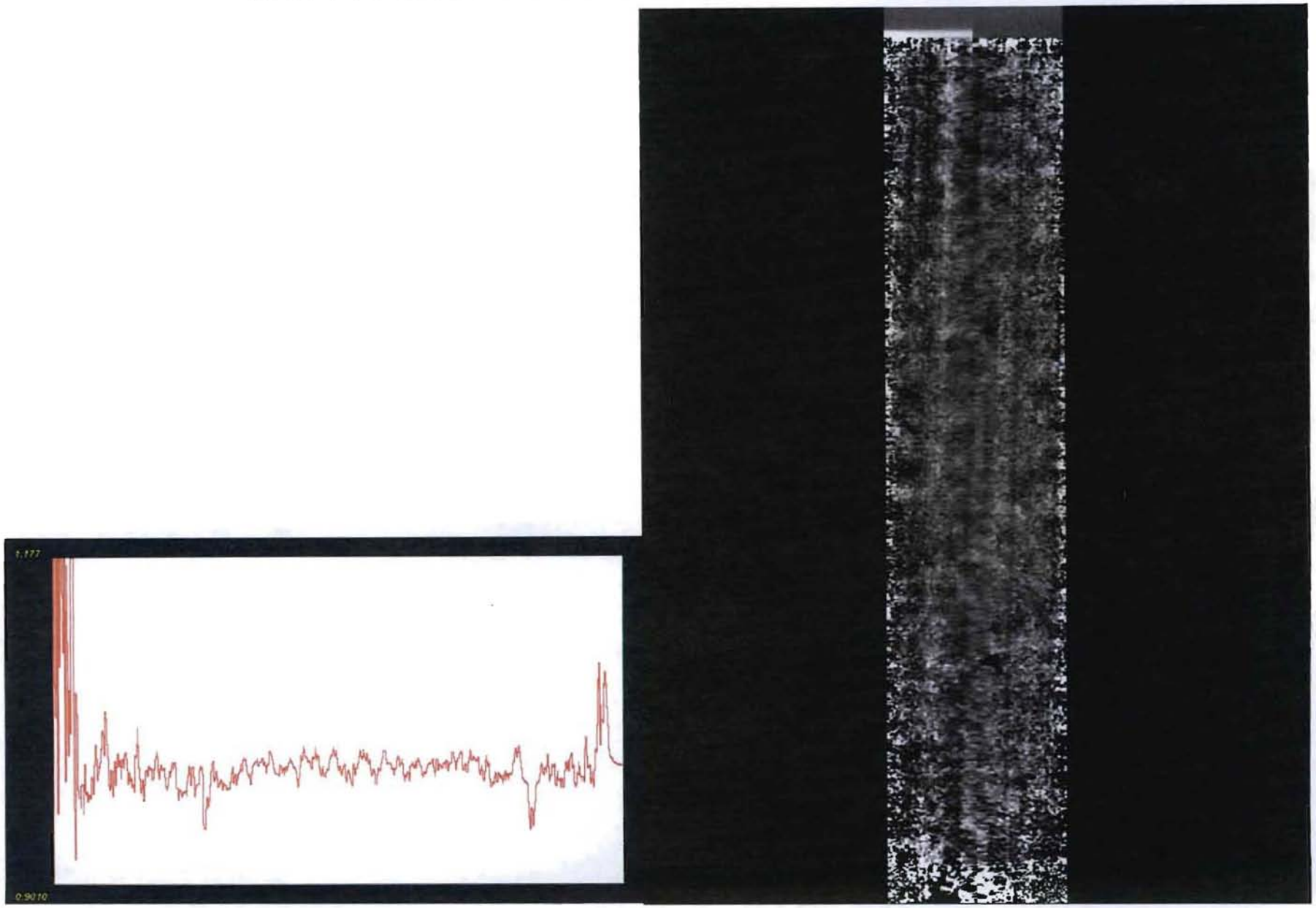




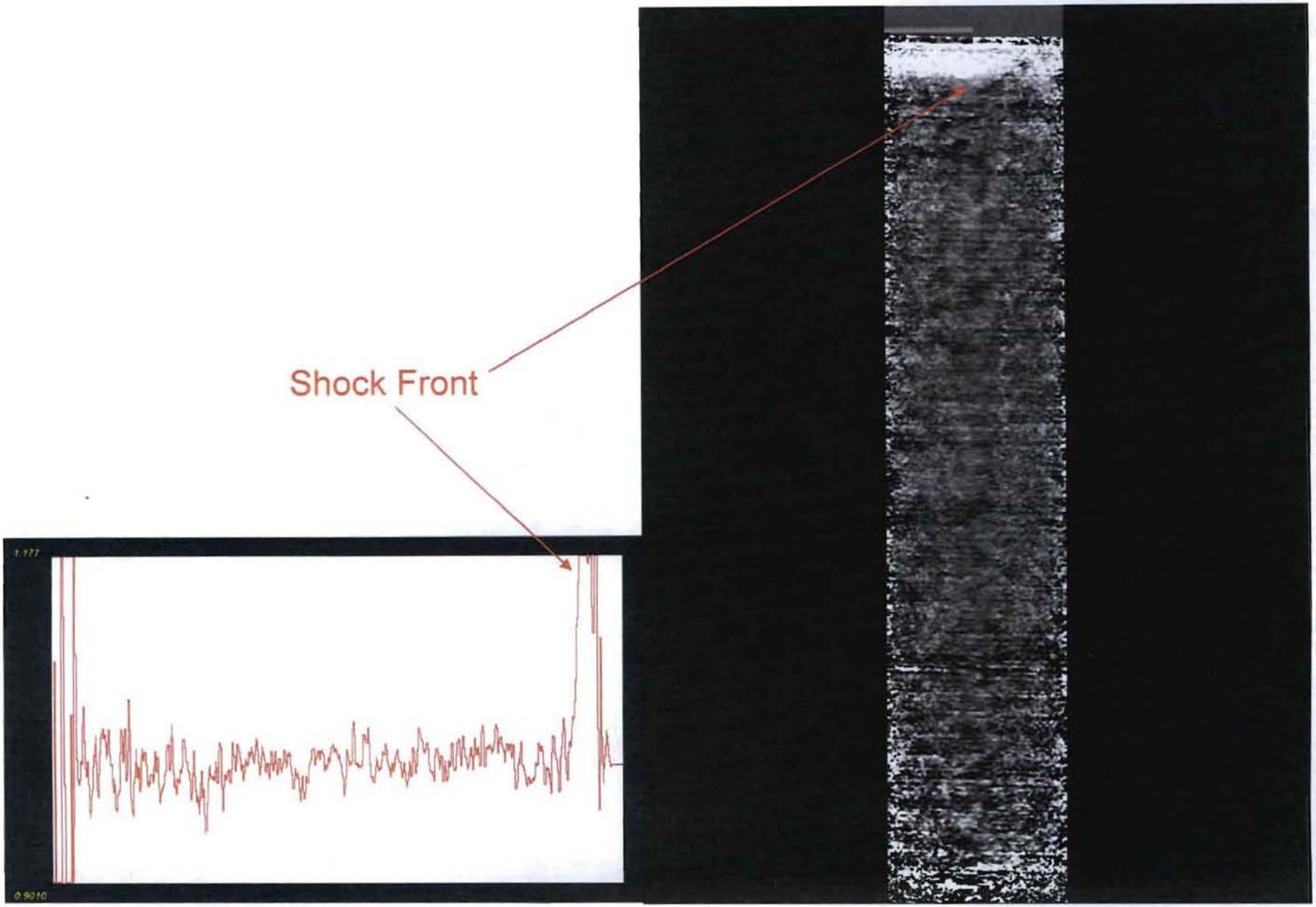
PRAD0374: Iron EOS Trimmed Areal Ratio Composite



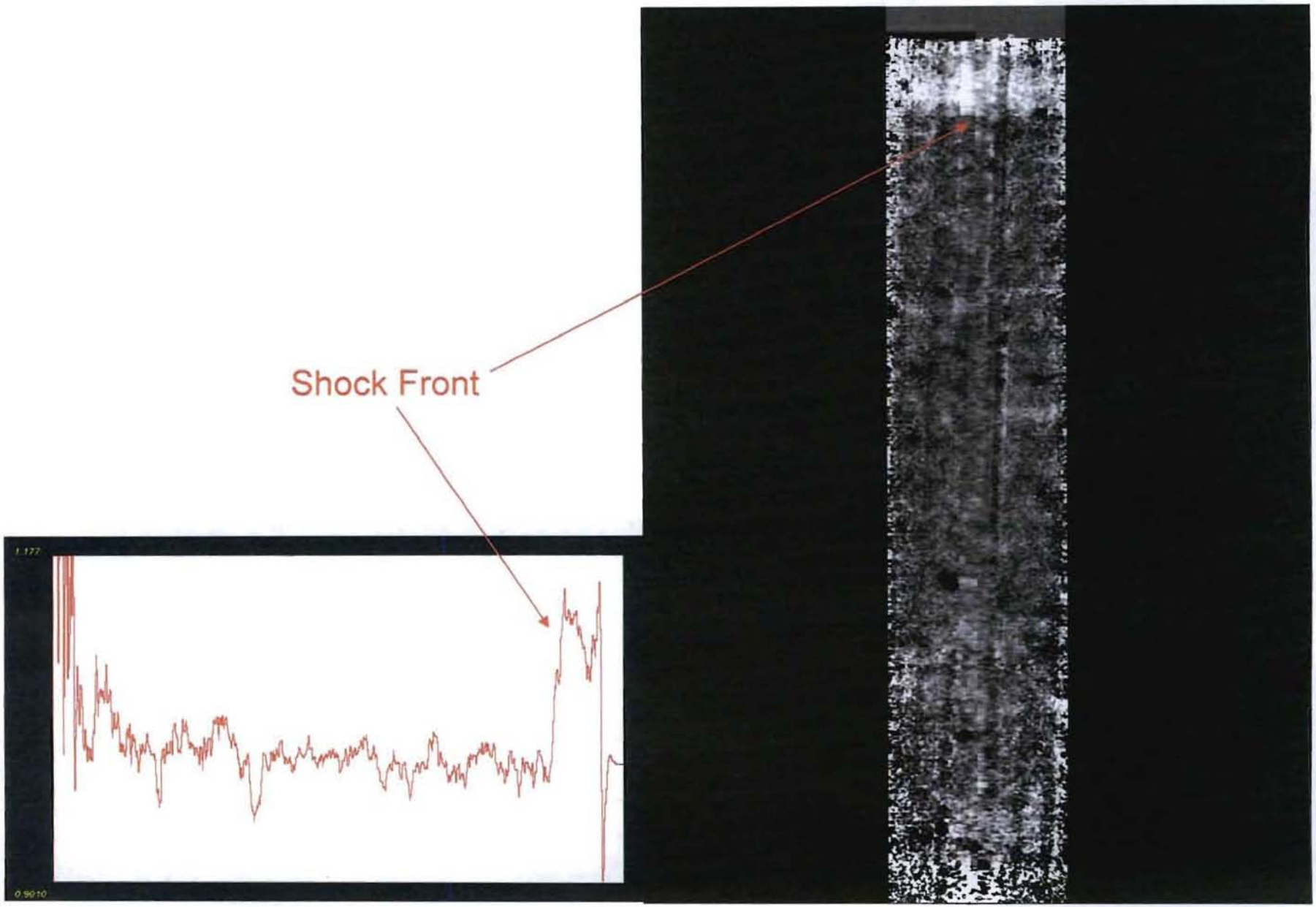
0300 PRAD0374: Iron EOS Trimmed Areal Ratio H



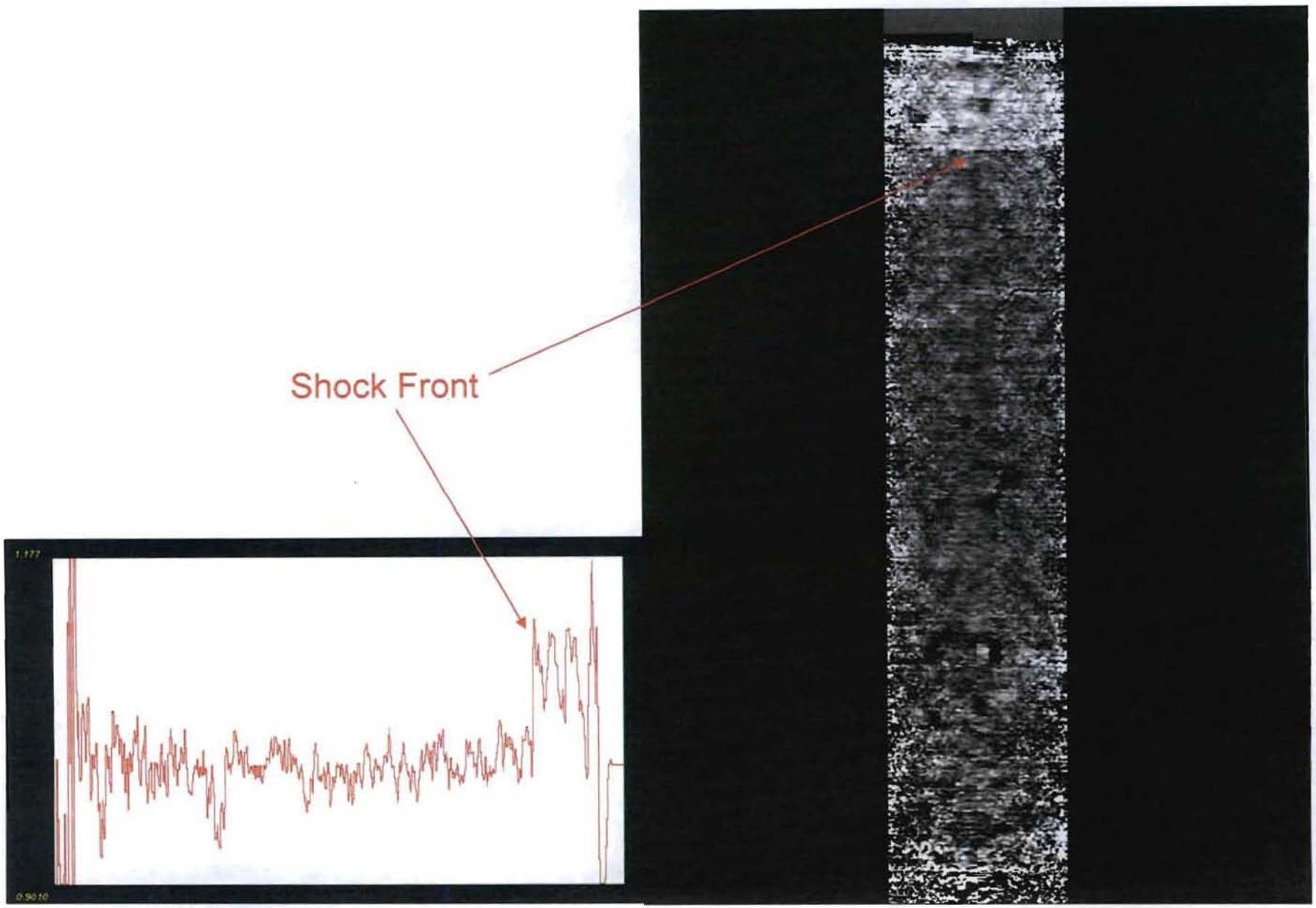
0600 PRAD0374: Iron EOS Trimmed Areal Ratio K



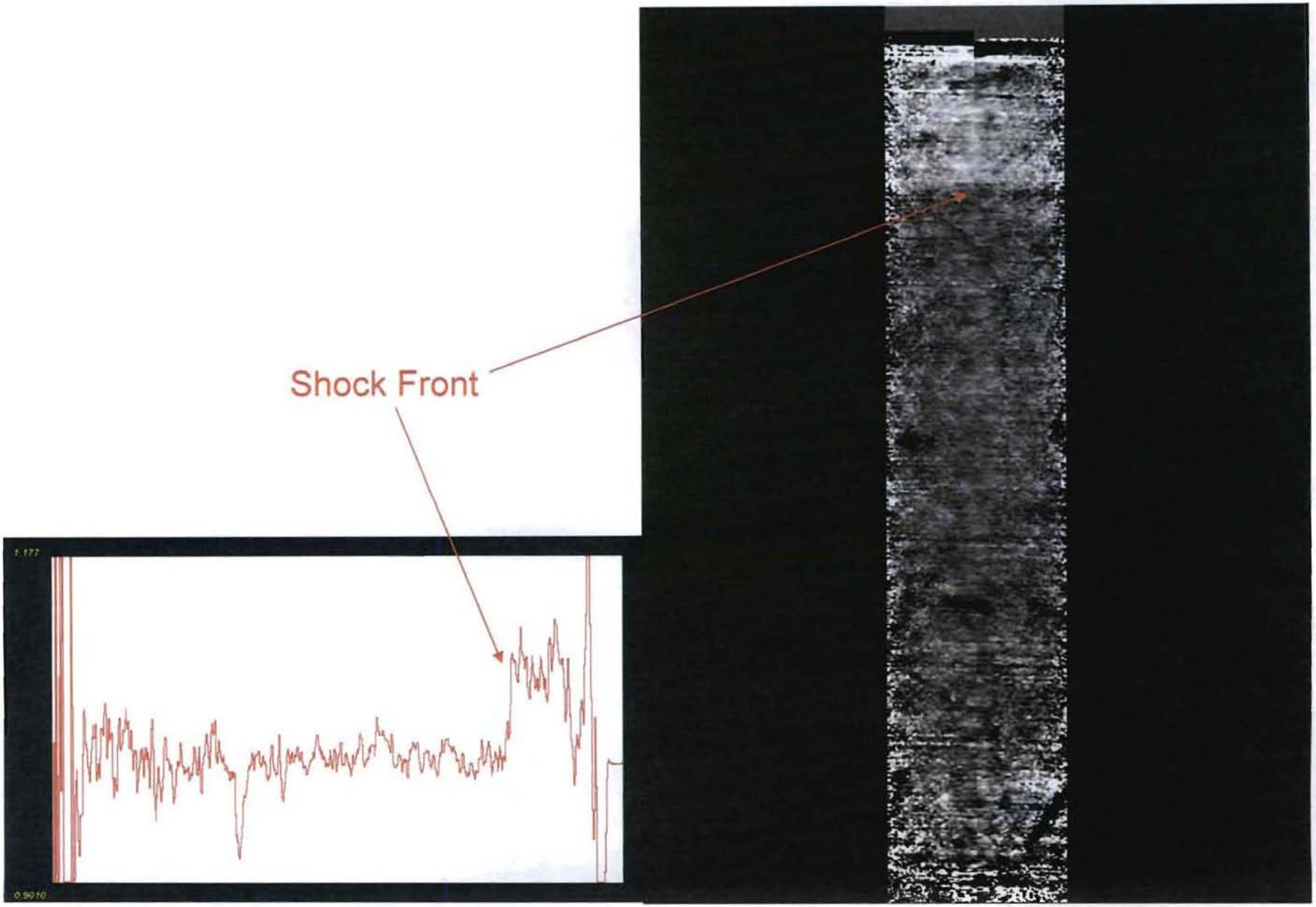
0900 PRAD0374: Iron EOS Trimmed Areal Ratio N



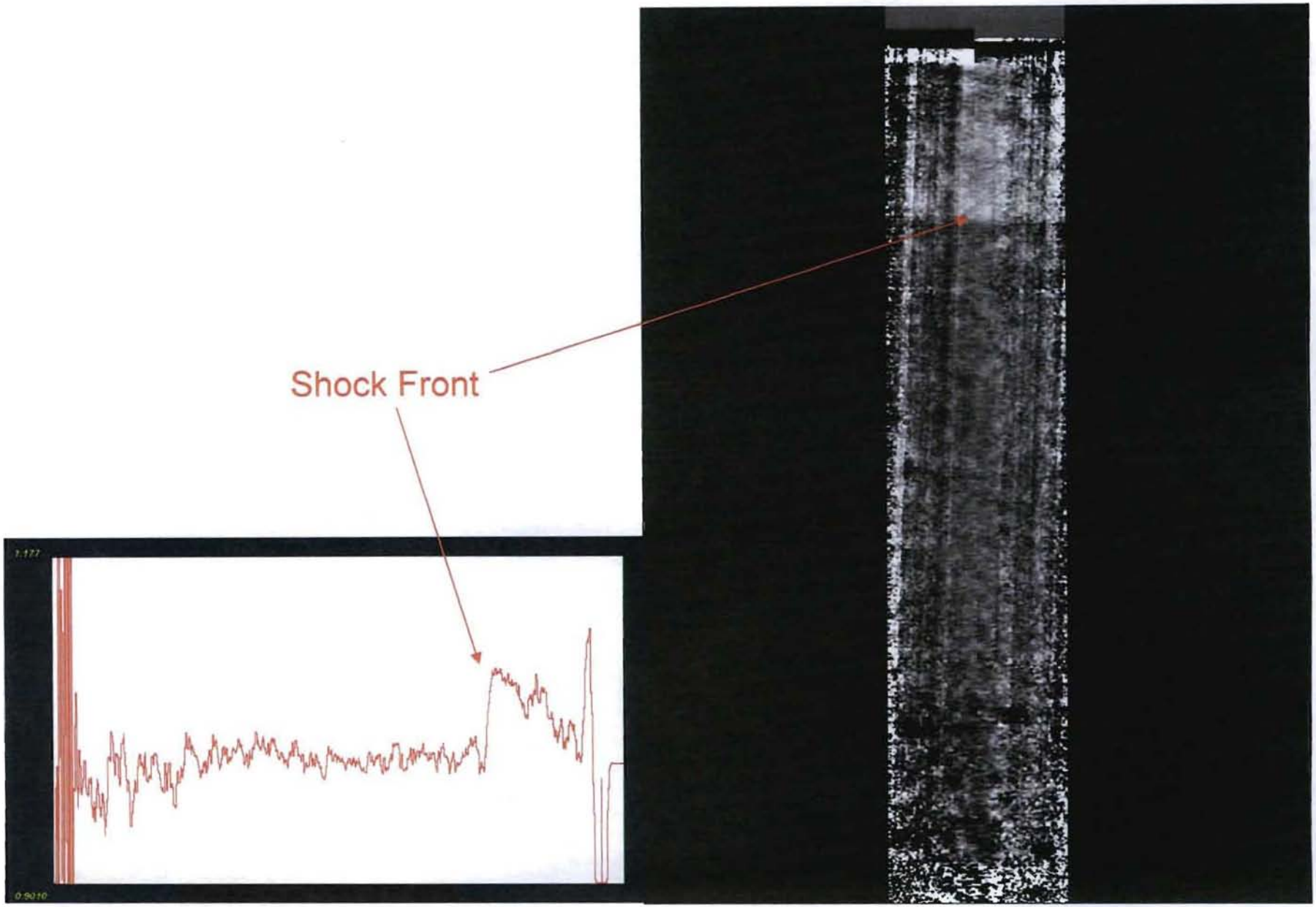
1200 PRAD0374: Iron EOS Trimmed Areal Ratio Q



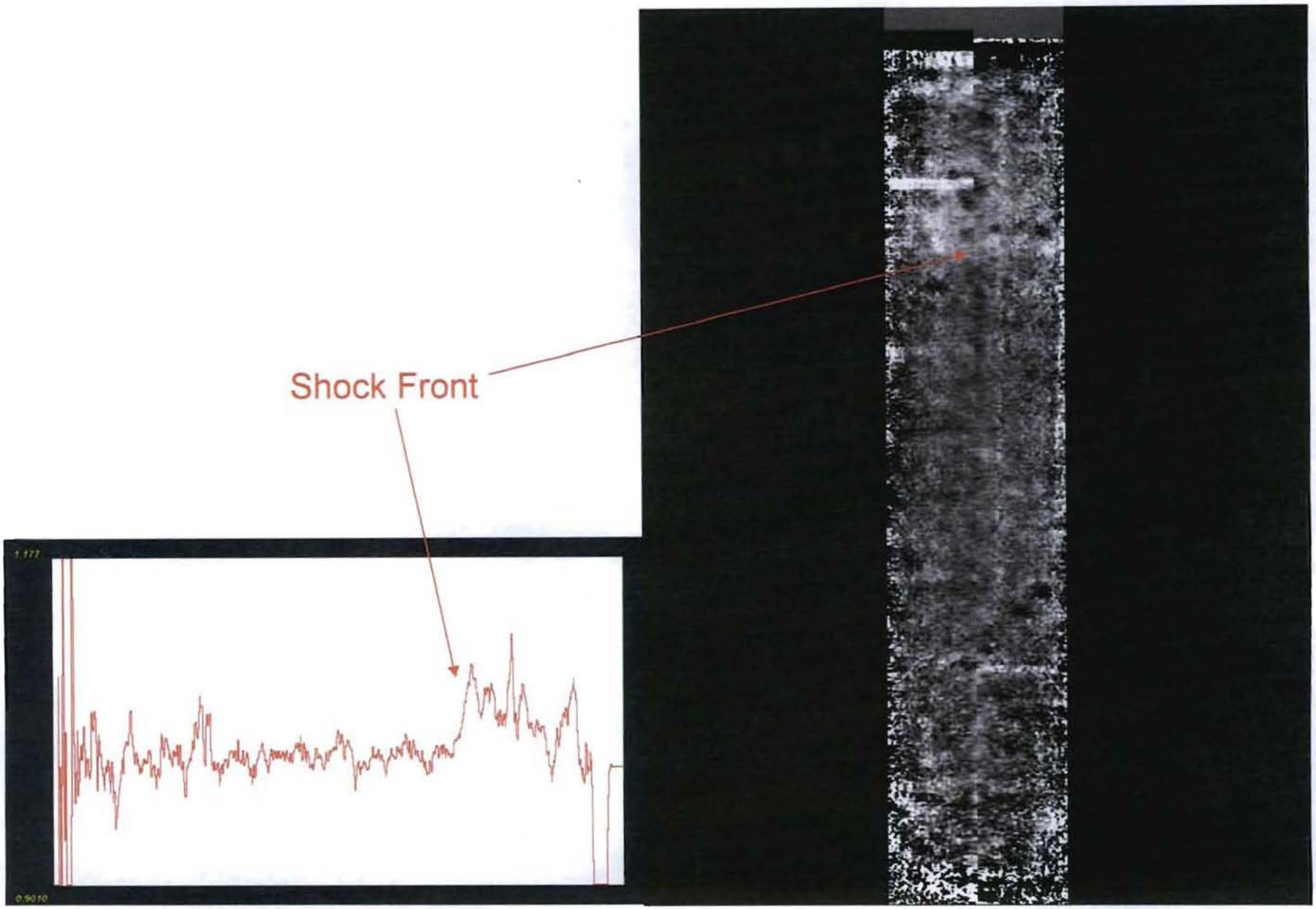
1500 PRAD0374: Iron EOS Trimmed Areal Ratio T



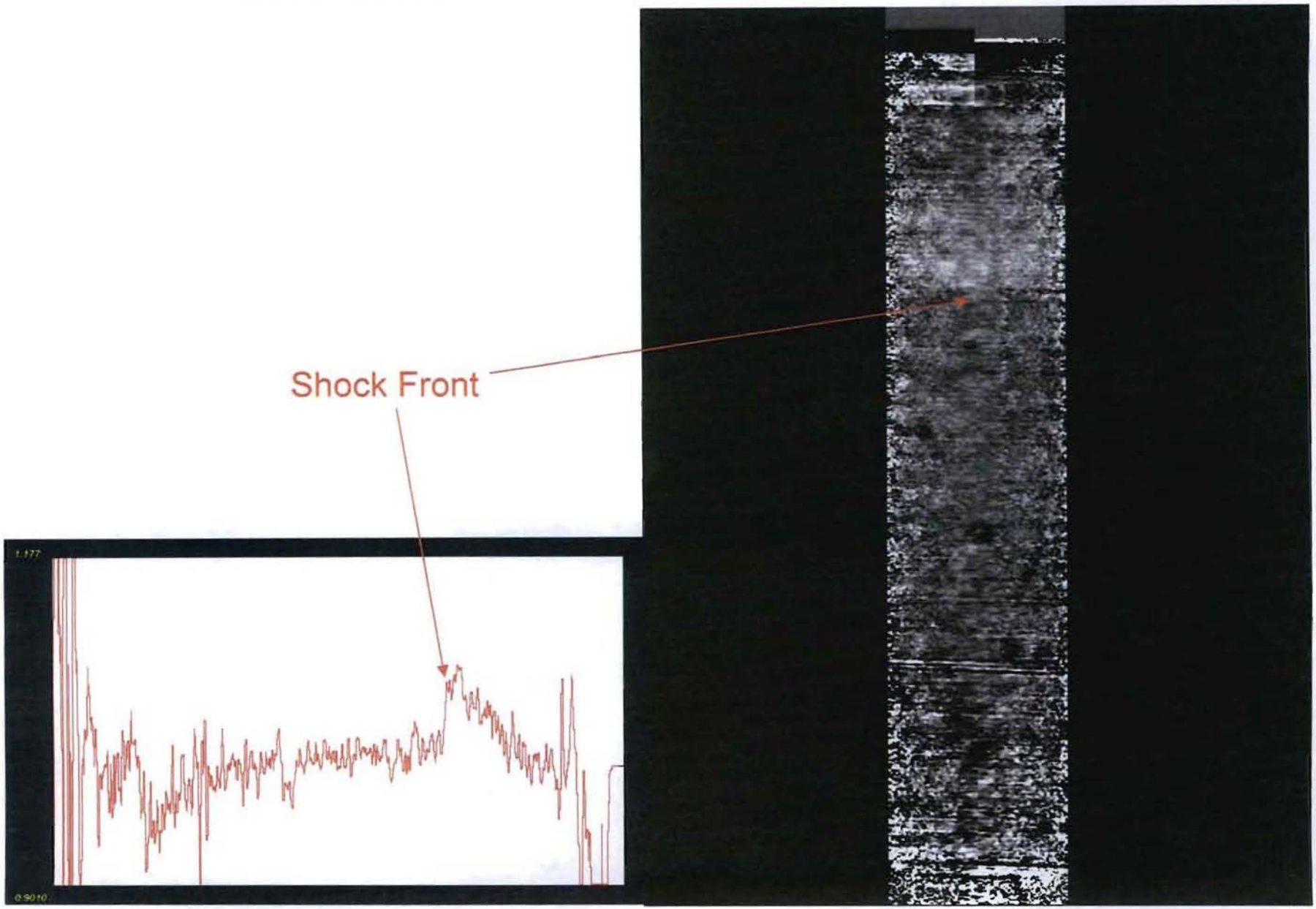
1800 PRAD0374: Iron EOS Trimmed Areal Ratio X



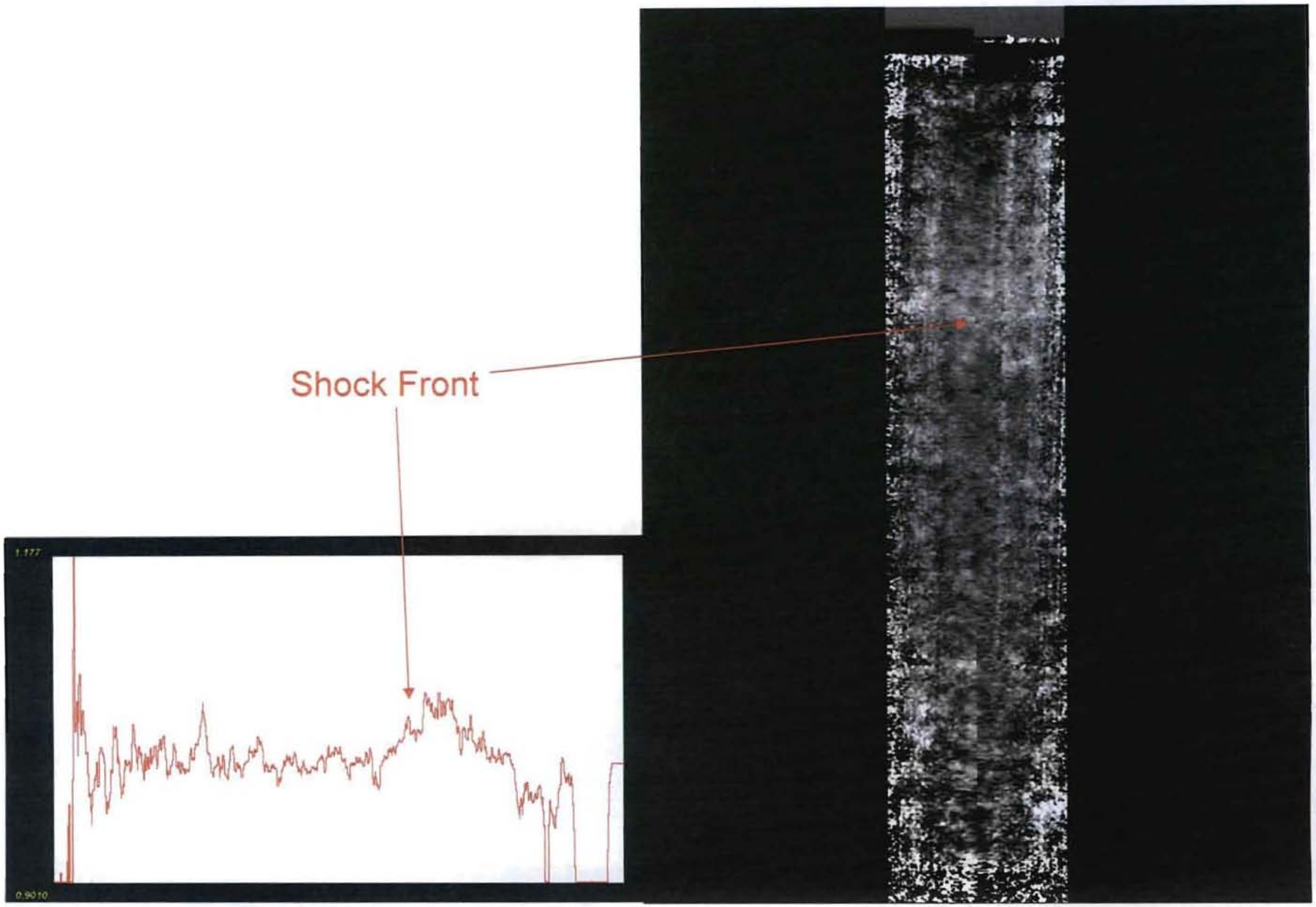
2100 PRAD0374: Iron EOS Trimmed Areal Ratio I



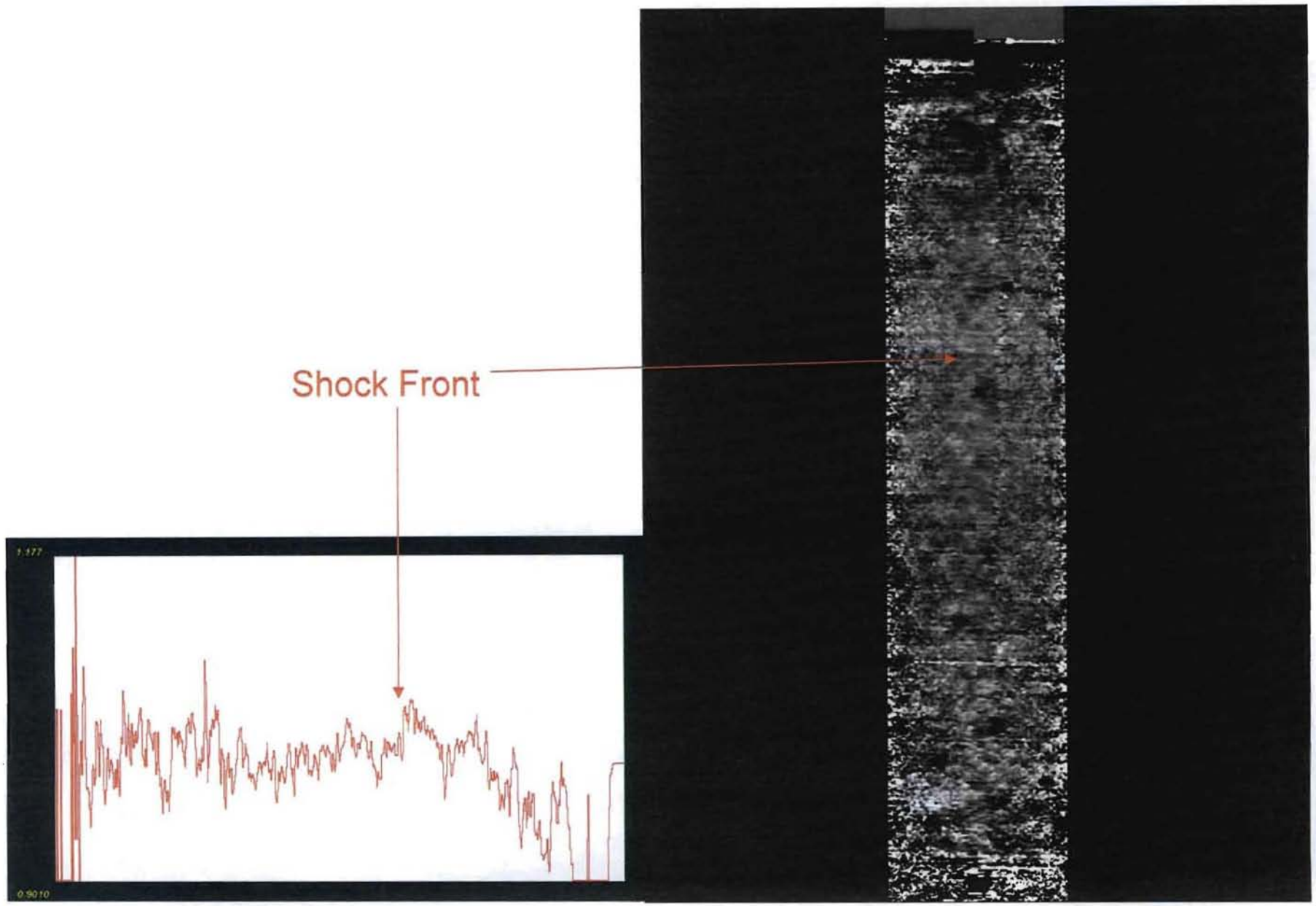
2400 PRAD0374: Iron EOS Trimmed Areal Ratio L



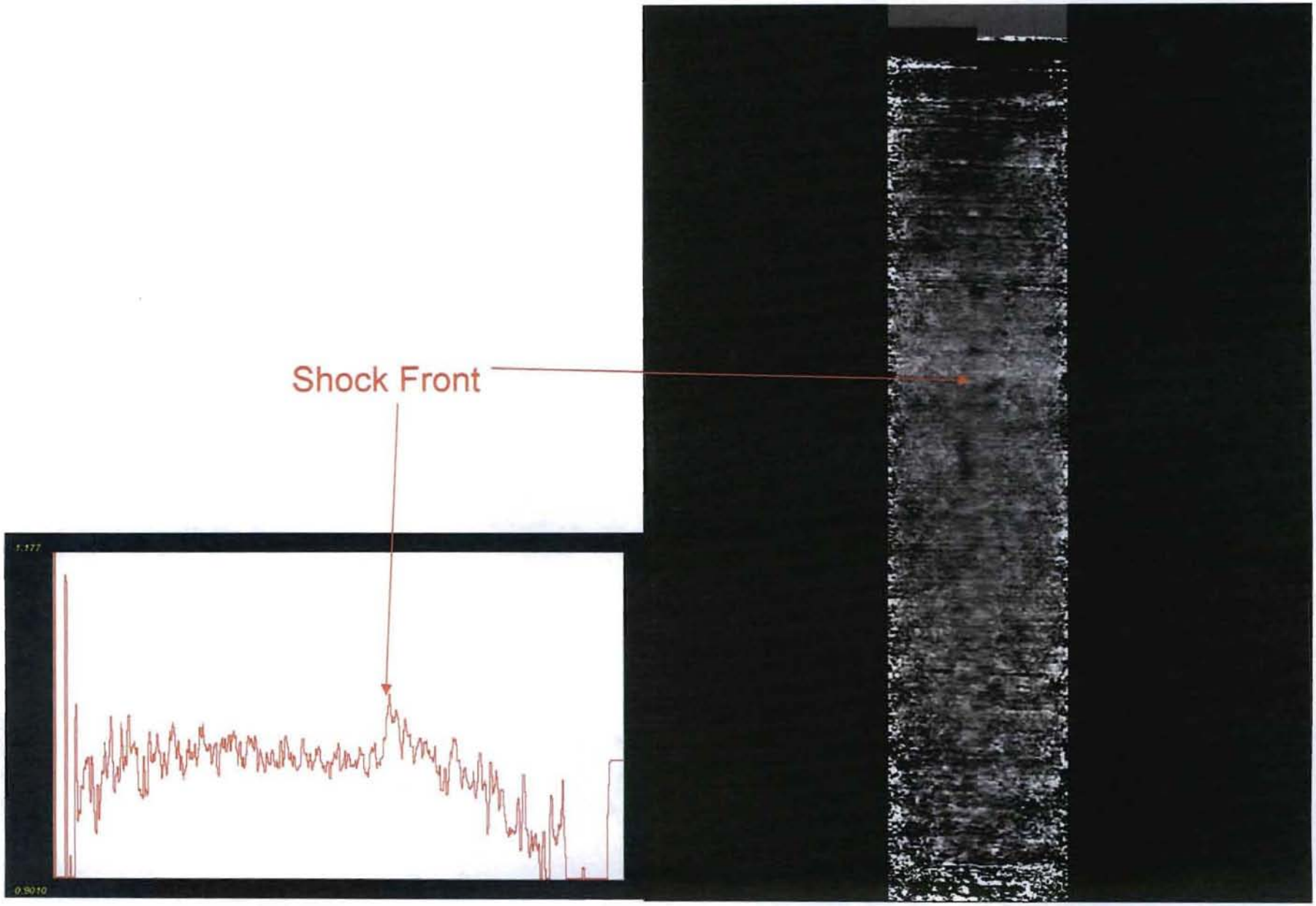
2700 PRAD0374: Iron EOS Trimmed Areal Ratio O



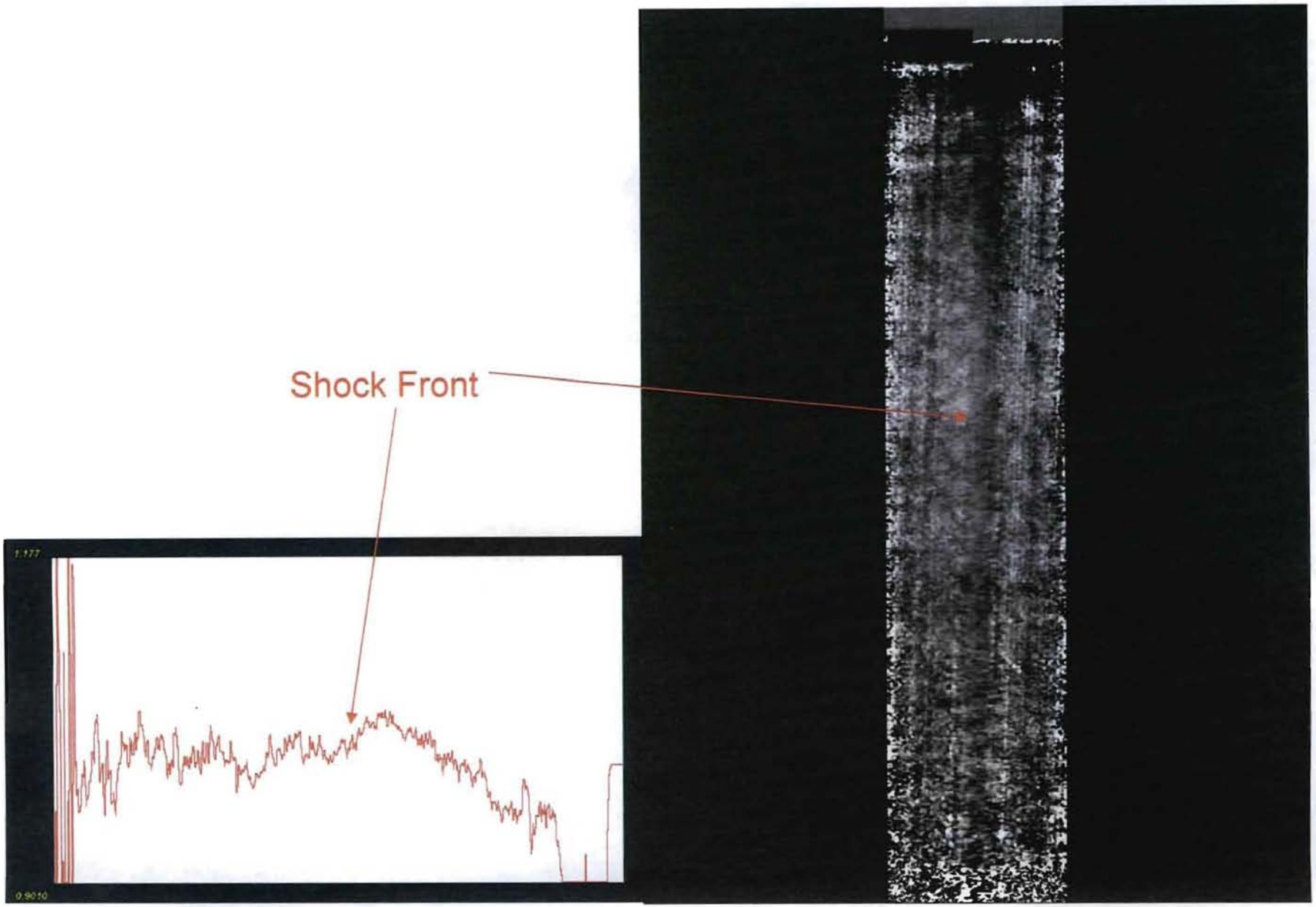
3000 PRAD0374: Iron EOS Trimmed Areal Ratio R



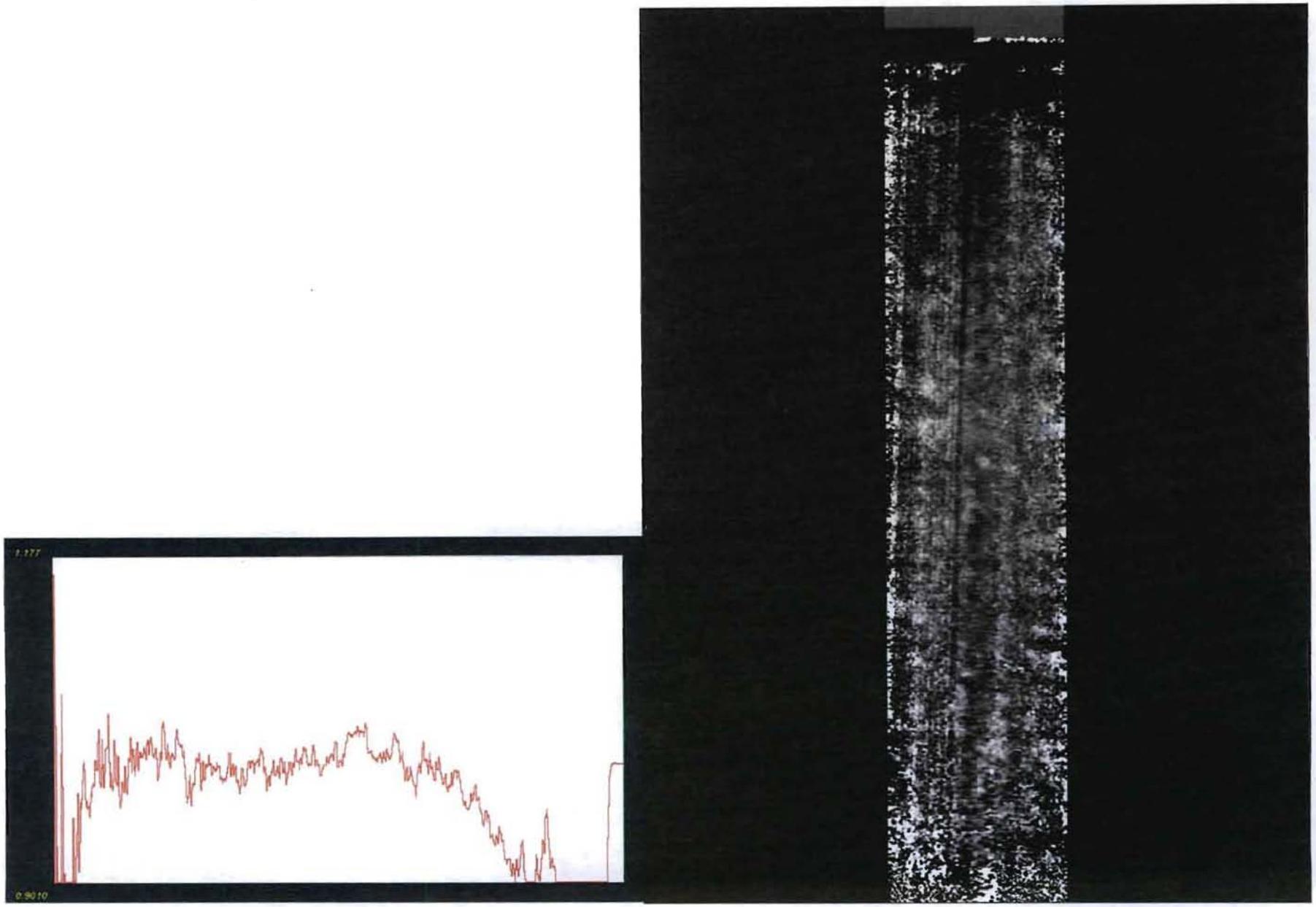
3300 PRAD0374: Iron EOS Trimmed Areal Ratio U



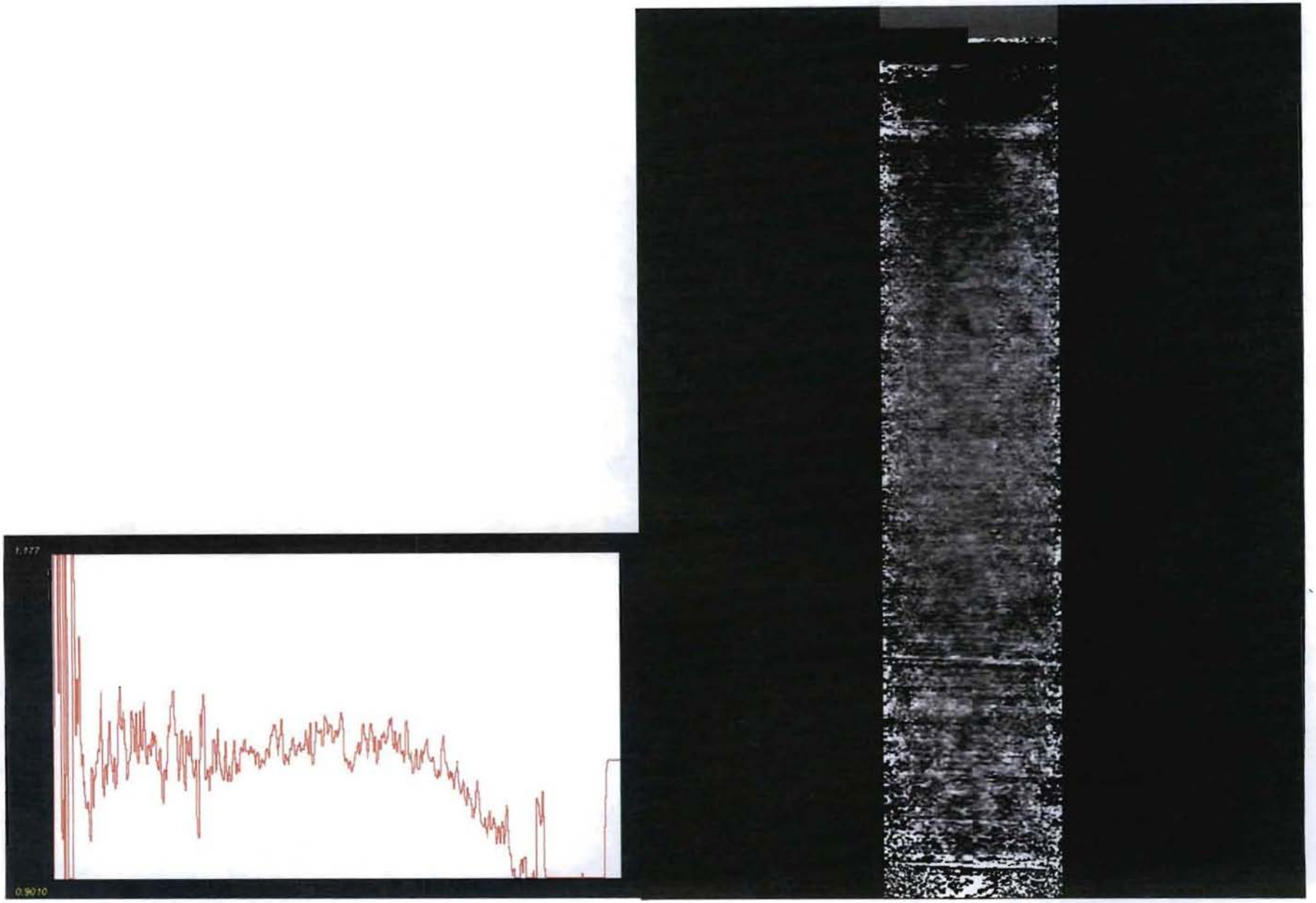
3600 PRAD0374: Iron EOS Trimmed Areal Ratio Y



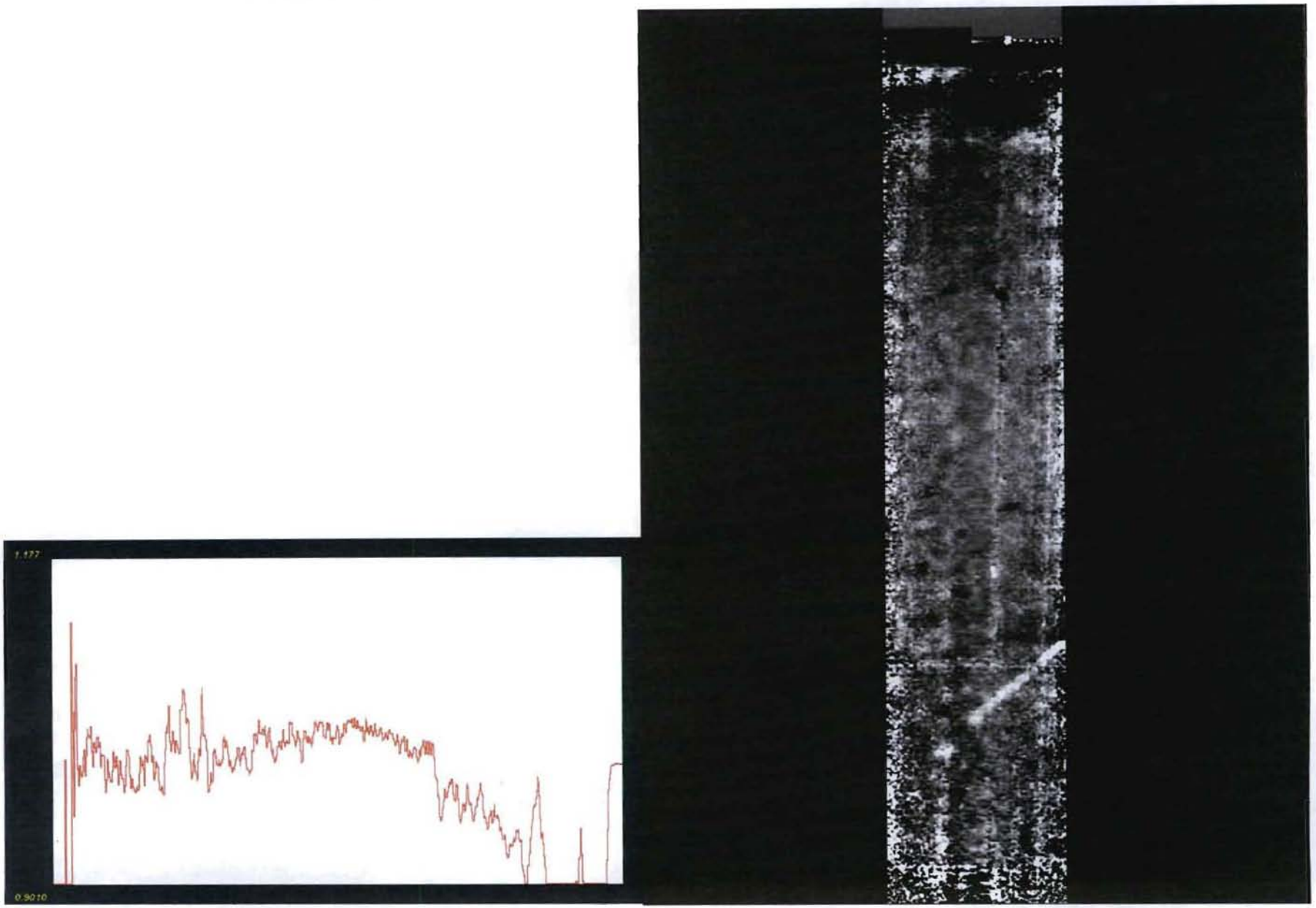
3900 PRAD0374: Iron EOS Trimmed Areal Ratio J



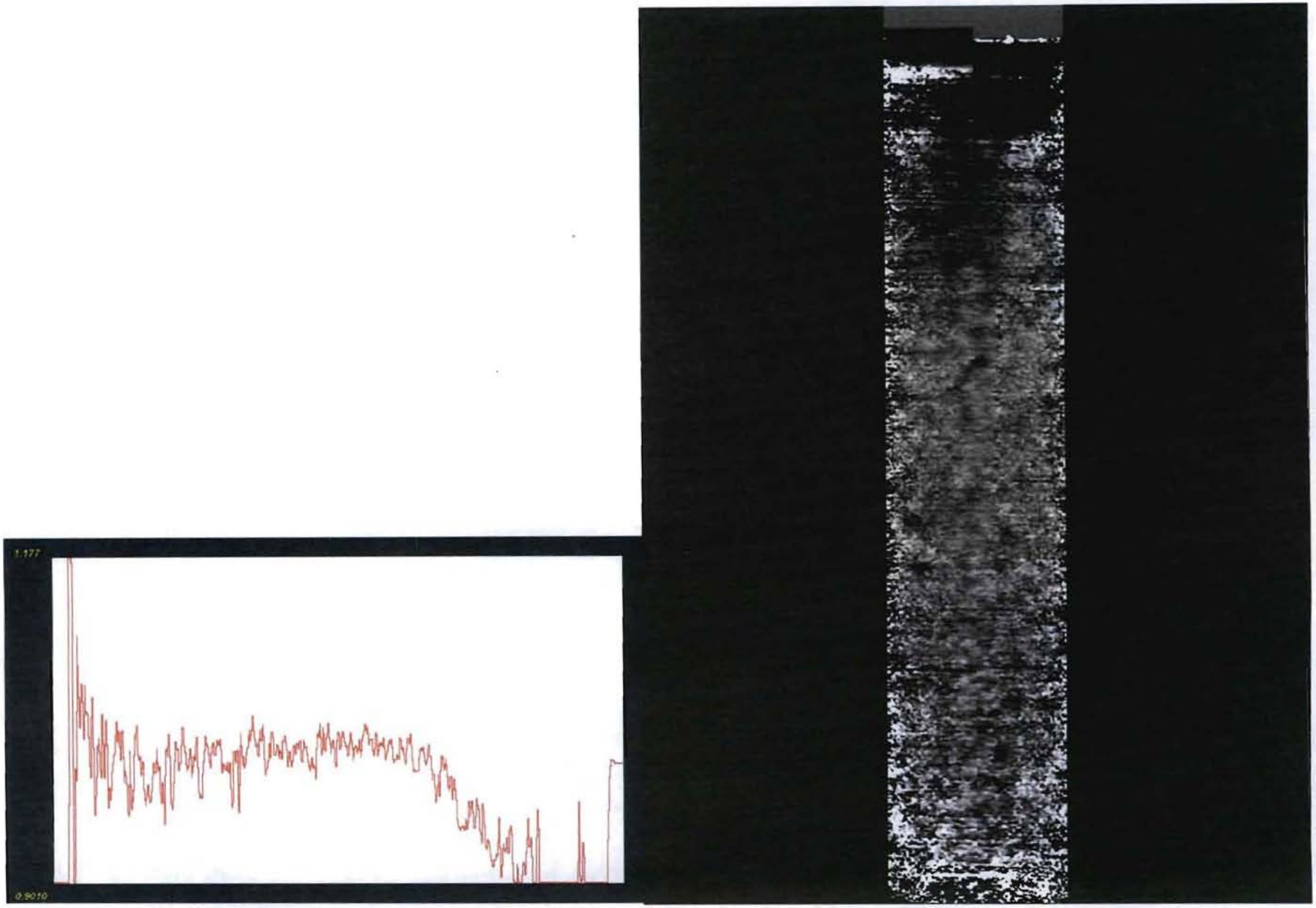
4200 PRAD0374: Iron EOS Trimmed Areal Ratio M



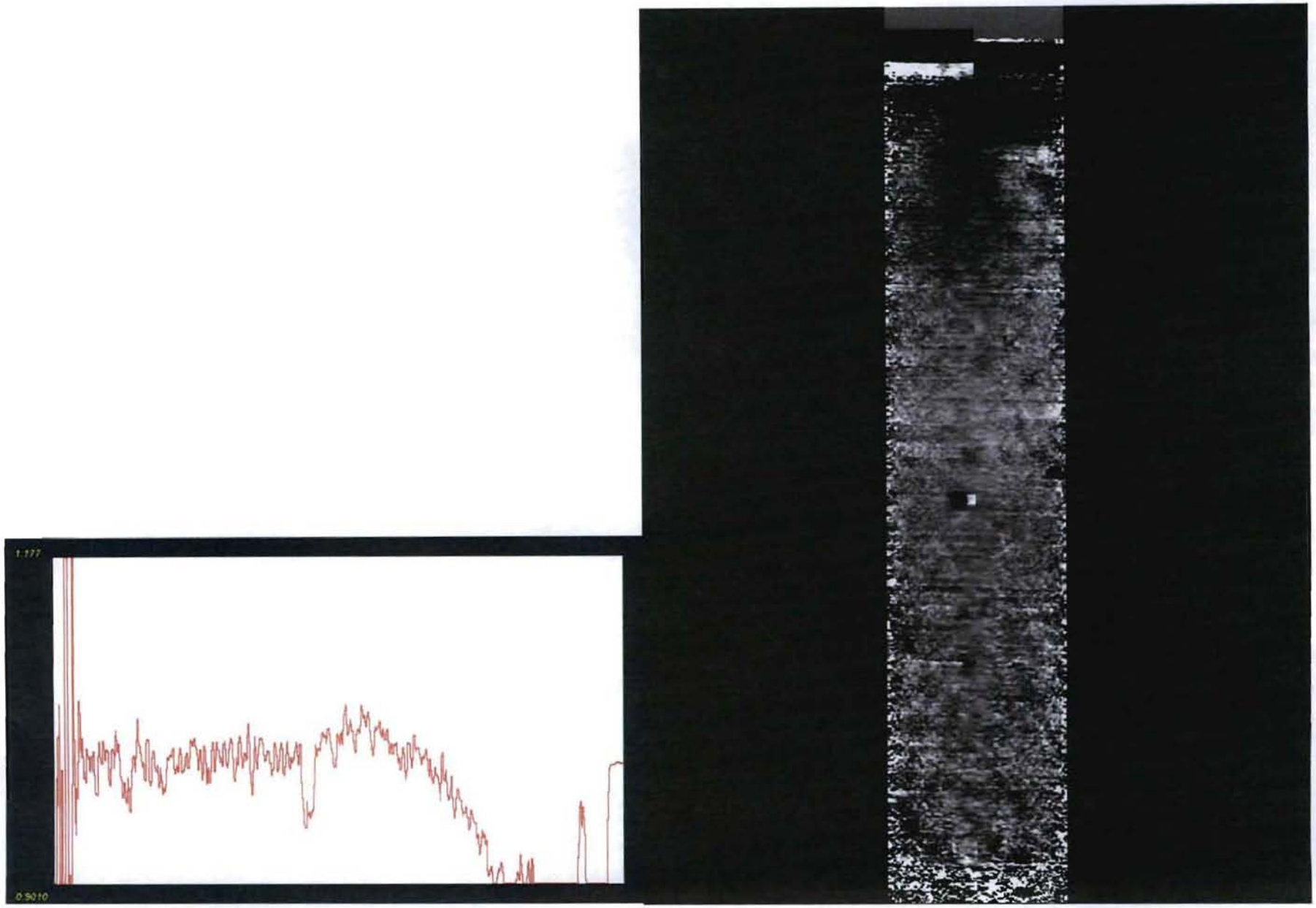
4500 PRAD0374: Iron EOS Trimmed Areal Ratio P



4800 PRAD0374: Iron EOS Trimmed Areal Ratio S



5100 PRAD0374: Iron EOS Trimmed Areal Ratio V



5400 PRAD0374: Iron EOS Trimmed Areal Ratio Z