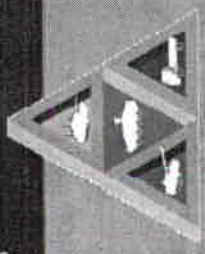


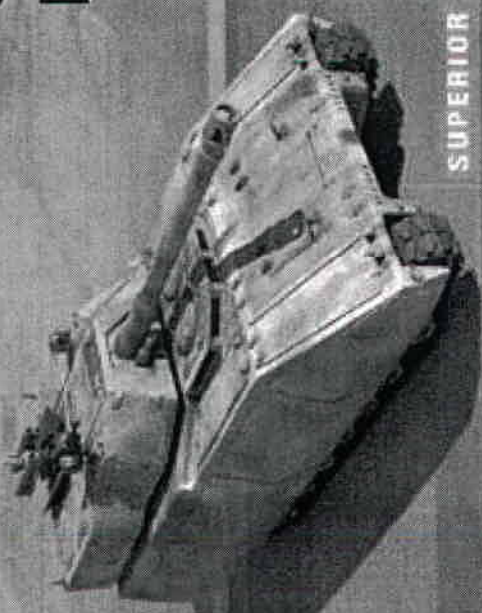
1577a

APPROVED FOR PUBLIC RELEASE



# JOEL SCHMITTIGAL

## Near-Infrared Fuel Analysis

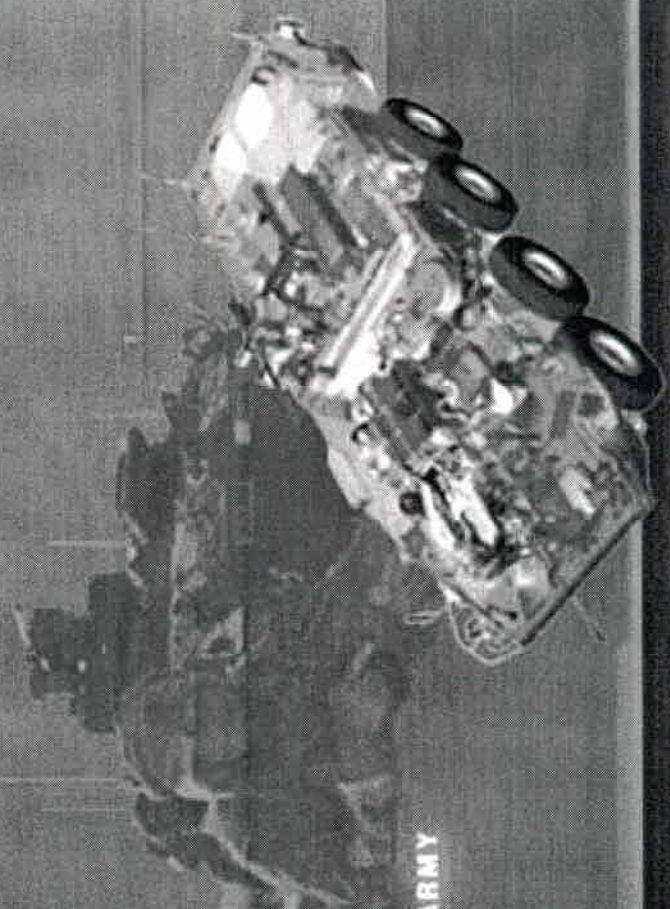


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The Society of Automotive Engineers

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U.S. ARMY TRAC AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

# Report Documentation Page

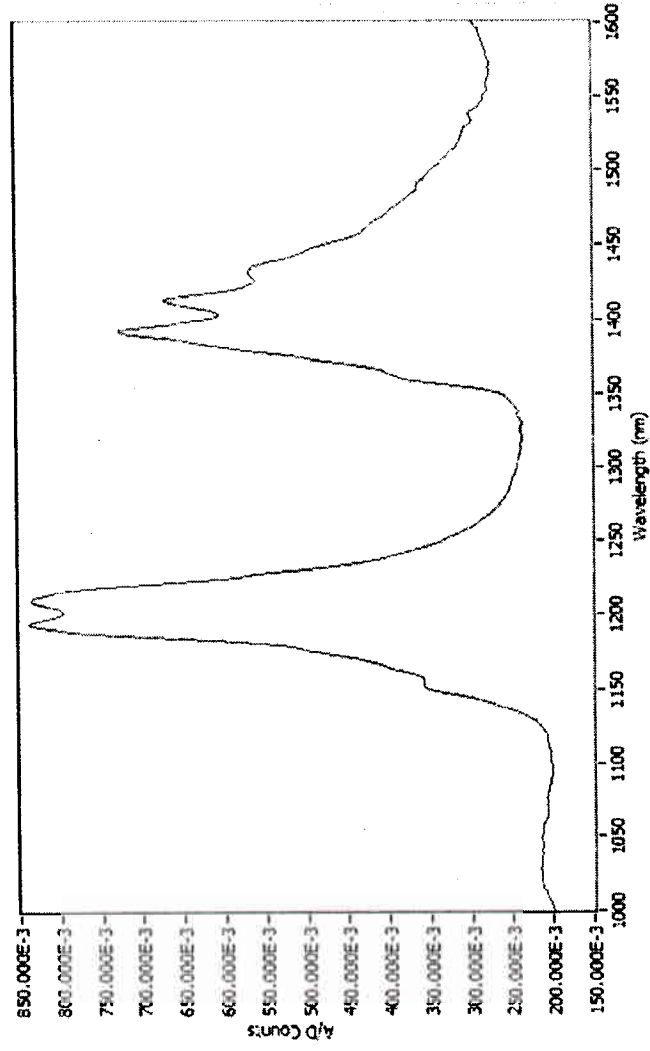
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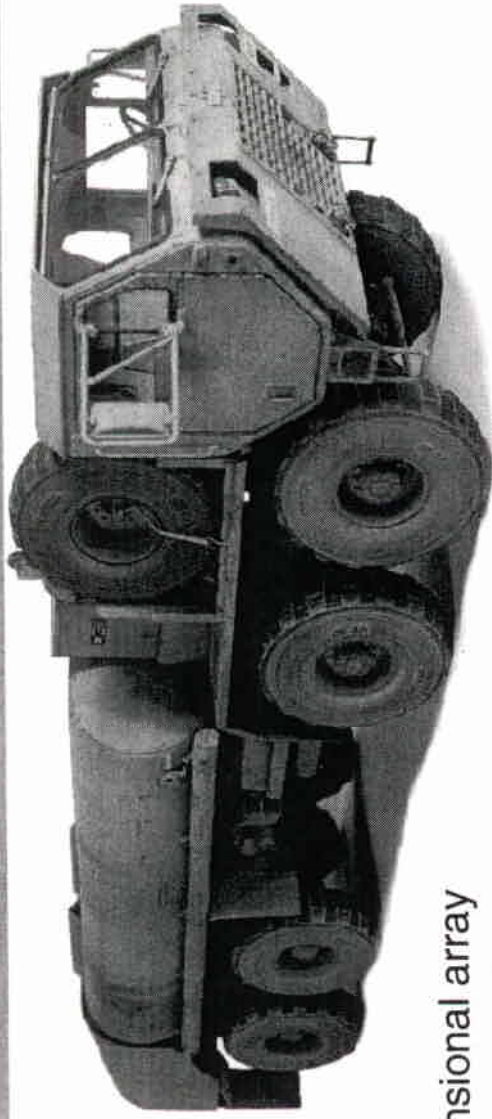
|  |                                    |  |  |                                  |                                 |
|--|------------------------------------|--|--|----------------------------------|---------------------------------|
| 1. REPORT DATE<br><b>03 MAY 2006</b>   | 2. REPORT TYPE<br><b>N/A</b>       | 3. DATES COVERED   |  |                                  |                                 |
| 4. TITLE AND SUBTITLE<br><b>Near-Infrared Fuel Analysis</b>  |                                    | 5a. CONTRACT NUMBER                                      |  |                                  |                                 |
|  |                                    | 5b. GRANT NUMBER   |  |                                  |                                 |
|  |                                    | 5c. PROGRAM ELEMENT NUMBER                               |  |                                  |                                 |
| 6. AUTHOR(S)<br><b>Schmitigal /Joel</b>  |                                    | 5d. PROJECT NUMBER                                       |  |                                  |                                 |
|  |                                    | 5e. TASK NUMBER  |  |                                  |                                 |
|  |                                    | 5f. WORK UNIT NUMBER                                     |  |                                  |                                 |
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| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br><b>Approved for public release, distribution unlimited.</b>         |                                    |  |  |                                  |                                 |
| 13. SUPPLEMENTARY NOTES  |                                    |  |  |                                  |                                 |
| 14. ABSTRACT   |                                    |  |  |                                  |                                 |
| 15. SUBJECT TERMS  |                                    |  |  |                                  |                                 |
| 16. SECURITY CLASSIFICATION OF:  |                                    |  | 17. LIMITATION OF ABSTRACT<br><b>SAR</b> | 18. NUMBER OF PAGES<br><b>22</b> | 19a. NAME OF RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>   | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b>                      |  |                                  |                                 |

# METHODOLOGY

- Portable, Ruggedized, Near Infrared Spectrometer
- Chemometrics using Principal Component Analysis and Partial Least Squares or Soft Independent Modeling of Class Analogies Method (SIMCA)
- Manufactured by Micron Optical Systems Inc.
  - Suffolk, VA
- Army Small Business Innovative Research (SBIR)
  - Phase II awarded 1/11/2001



# SPECTROMETER CONFIGURATION



## Size

- 4.25" x 5.25" x 11.75"

## Detector

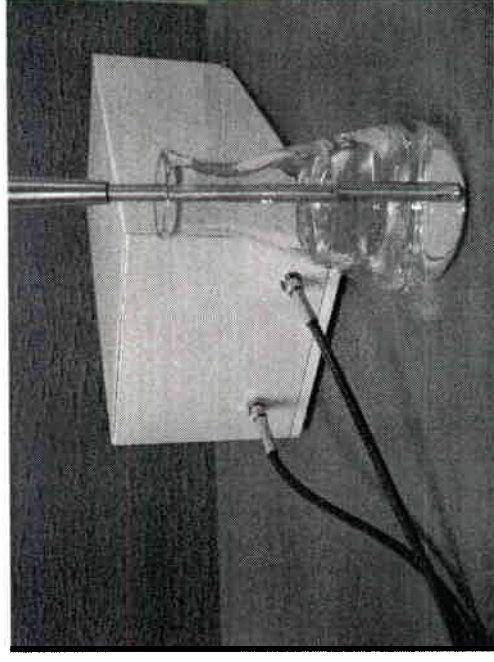
- Substrate: InGaAs one dimensional array
- Pixels: 512 pixels
- Electronic Shutter: Integration from 1 ms to minutes
- Readout and Display Update: 50 spectra / second

## Spectrograph

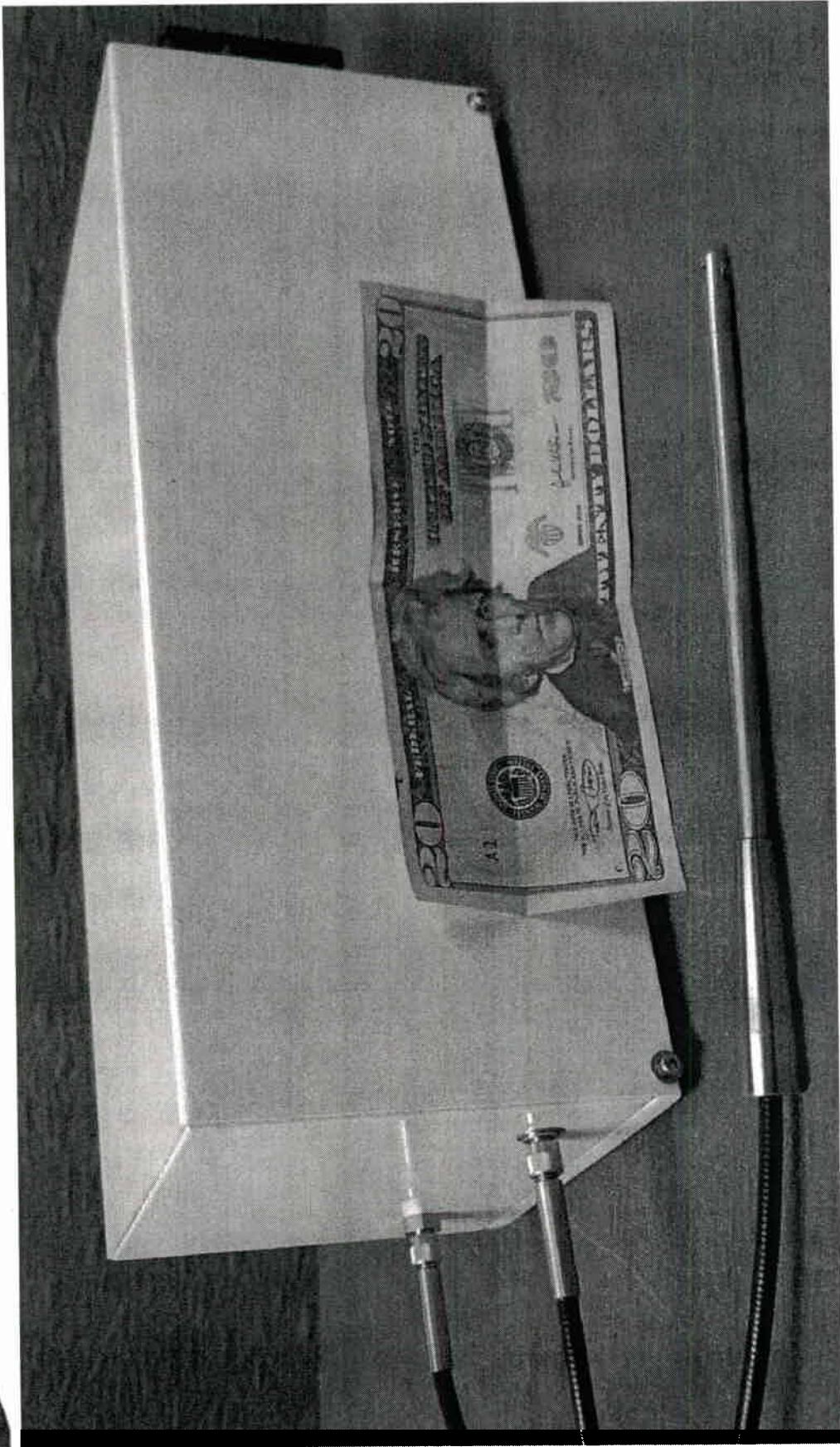
- Grating: Volume Holographic transmission grating
- Spectral Range: 1000-1600 nm
- Spectral Dispersion: 1.56 or 0.98 nm/pixel

## Source

- Feedback-Stabilized High-Intensity tungsten halide lamp with peak intensity at 1100nm.



# SPECTROMETER CONFIGURATION



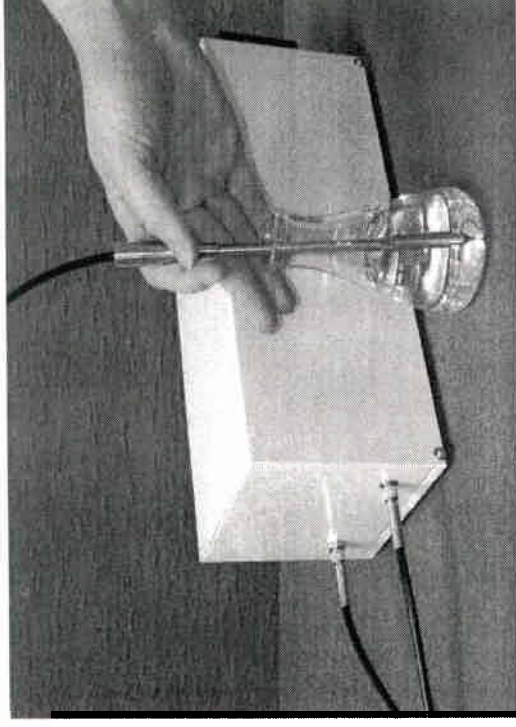
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# ADVANTAGES AND LIMITATIONS

## ADVANTAGES

- Small Size : 4.25" x 5.25" x 11.75"
- Light Weight
- Adaptable fiber optic probe
- Easy to use
- Fast Analysis: Results in less than 1s
- No hazardous waste generated



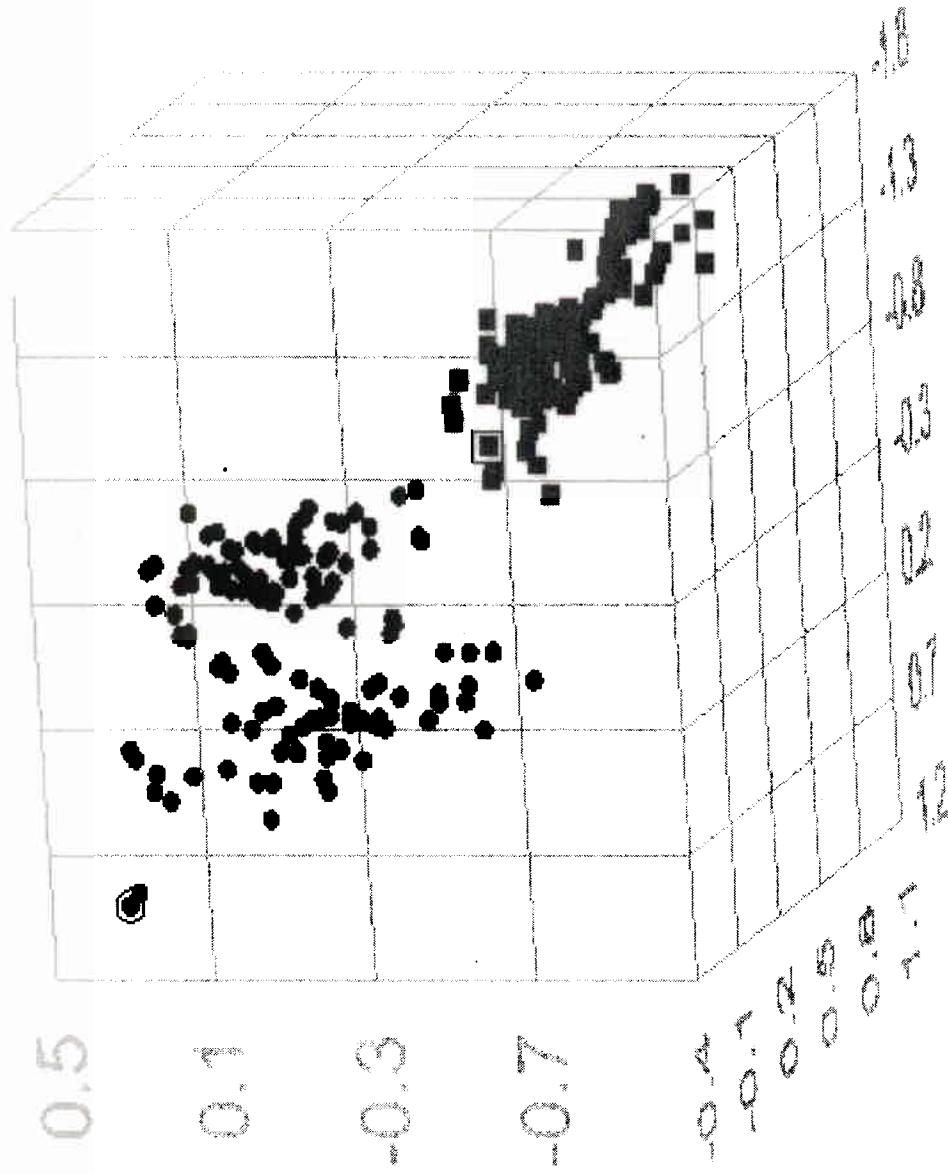
## LIMITATIONS

- Correlative measurement: the accuracy of your results are dependant on the accuracy of the ASTM data used to build the models
- Correlation to properties dependent on molecular structure
- Range/Quantity of fuel samples
- Sensitivity directly related to composition of fuel

# FUEL PROPERTIES MODELED

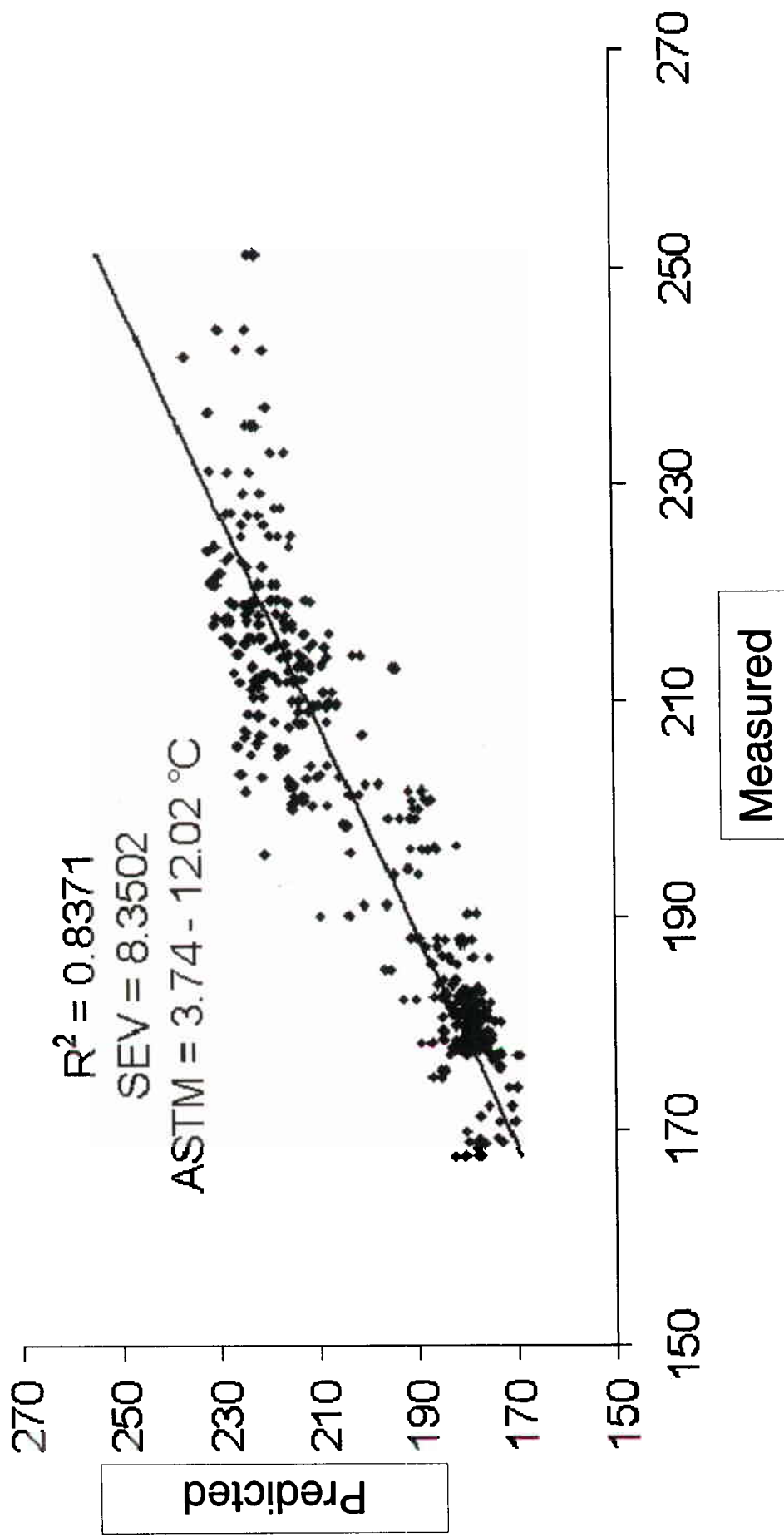
| <u>Property</u>           | <u>ASTM Method</u> | <u>ASTM Reproducibility</u> | <u>SEV</u>  |
|---------------------------|--------------------|-----------------------------|-------------|
| Boiling point at 10% dist | D 86               | 3.74 - 12.02 °C             | 8.35 °C     |
| Boiling point at 90% dist | D 86               | 3.74-10.52 °C               | 9.40 °C     |
| Dist End Point            | D 86               | 10.5 °C                     | 12.87 °C    |
| Density                   | D 1298             | 0.0012 g/mL                 | 0.0041 g/mL |
| API Gravity               | D 1298             | 0.3                         | 0.9384      |
| Flashpoint                | D 93               | 6 °C                        | 5.141 °C    |
| Viscosity at 40 °C        | D 445              | 0.013 - 0.046 cSt           | 0.156 cSt   |
| Cetane Index              | D 976              | 2                           | 1.183       |
| Aromatics %               | D 1319             | 1.5-3.3%                    | 1.9%        |
| Cloud Point               | D 2500             | 4 °C                        | 5.8 °C      |
| Freeze Point              | D 5972             | .80 °C                      | 0.75 °C     |
| Net Heat of Combustion    | D 4809             | 0.046 MJ/kg                 | 0.098 MJ/kg |
| Hydrogen Content          | D 3343             | 0.012-0.015%                | 0.22 %      |

# SIMCA

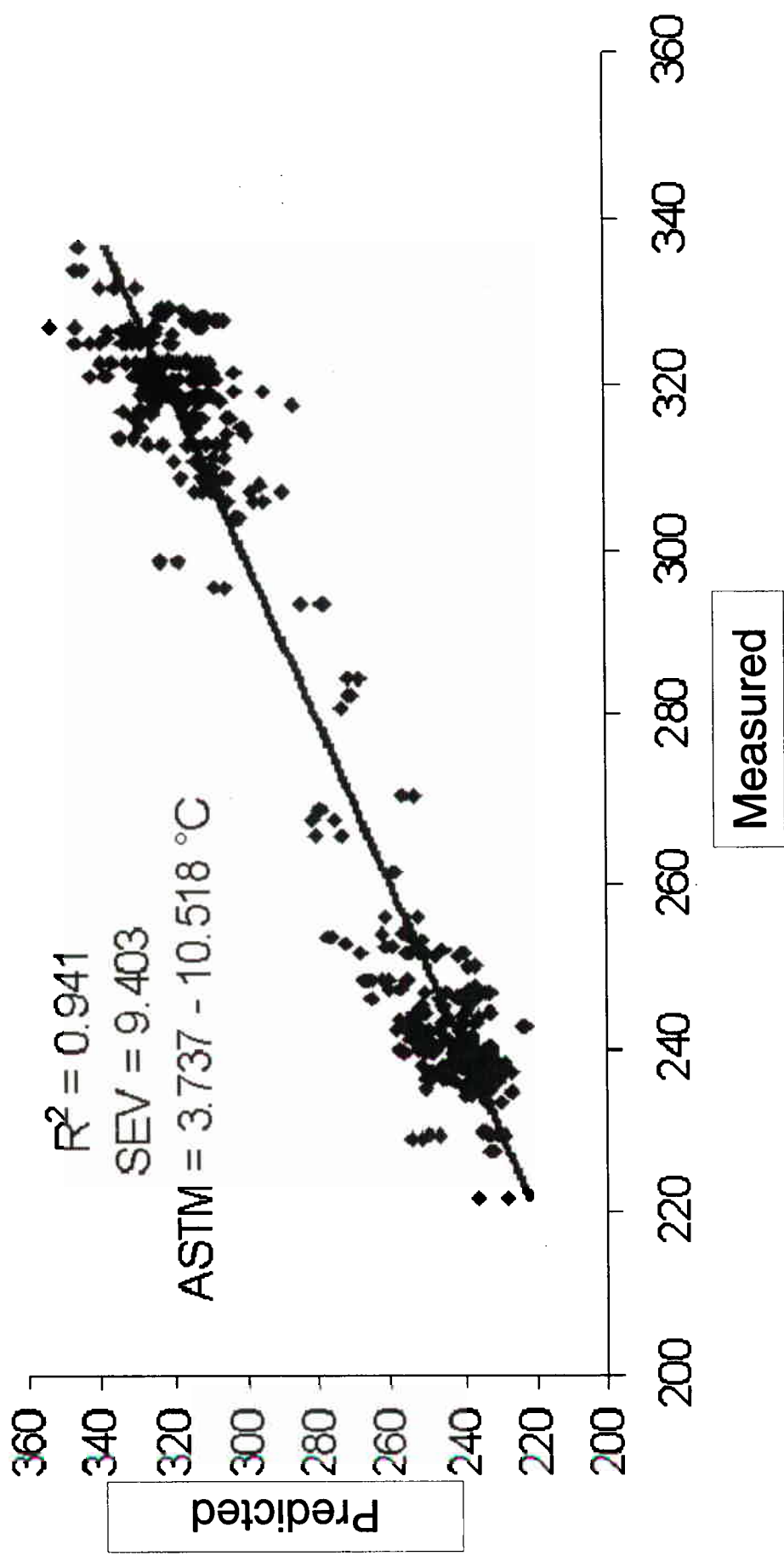
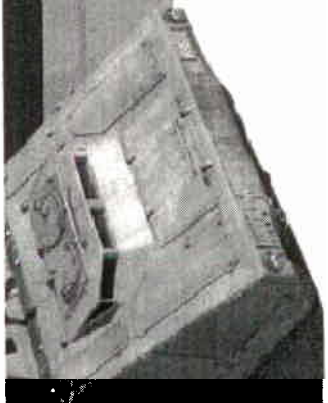


- DIESEL 2
- JP-8

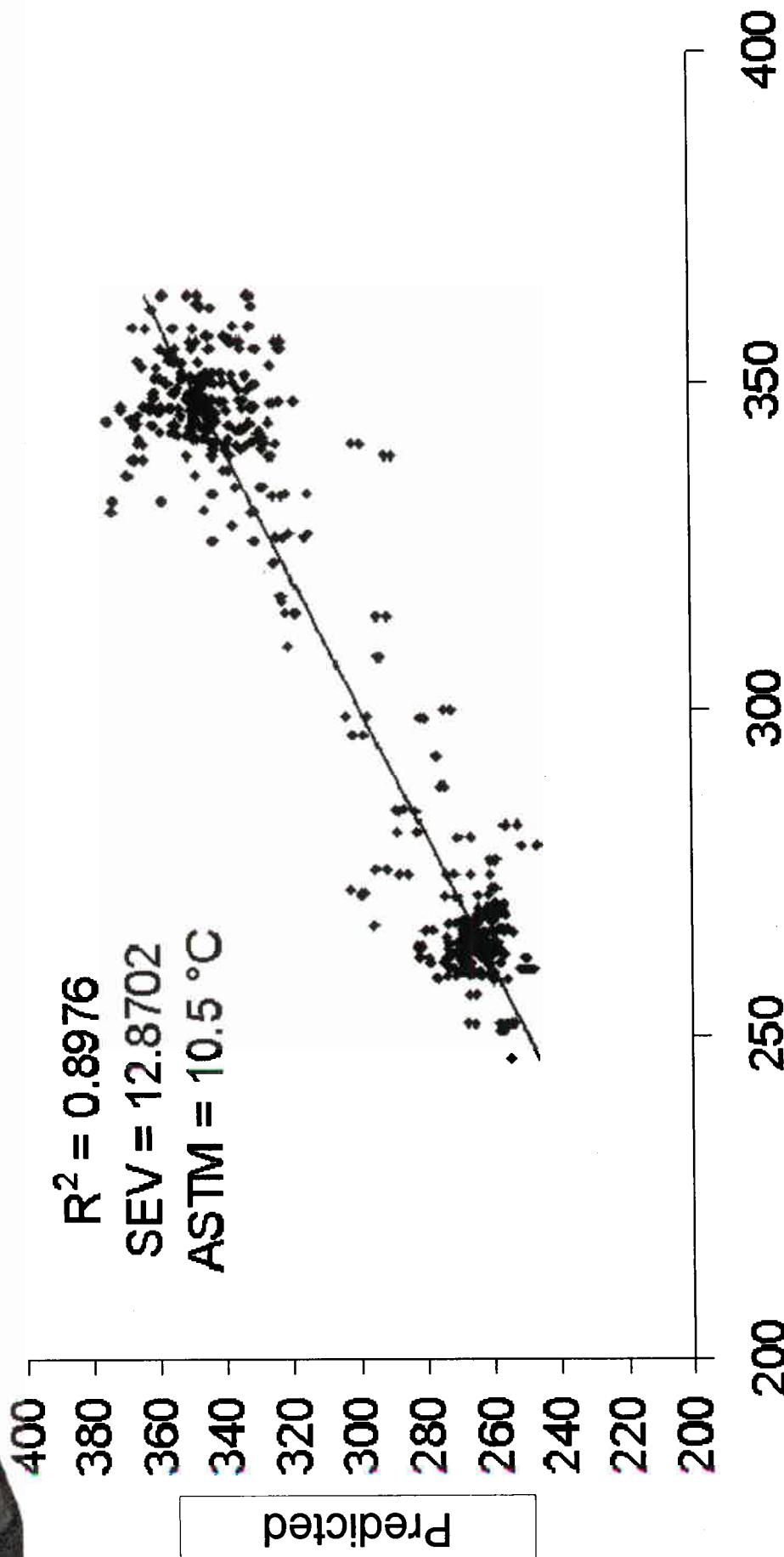
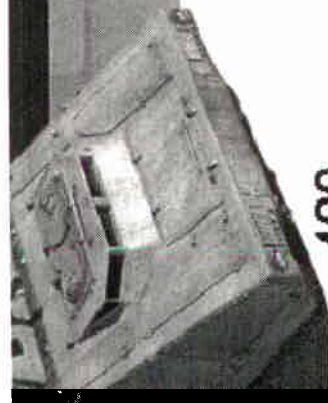
# BOILING POINT AT 10% DISTILLED



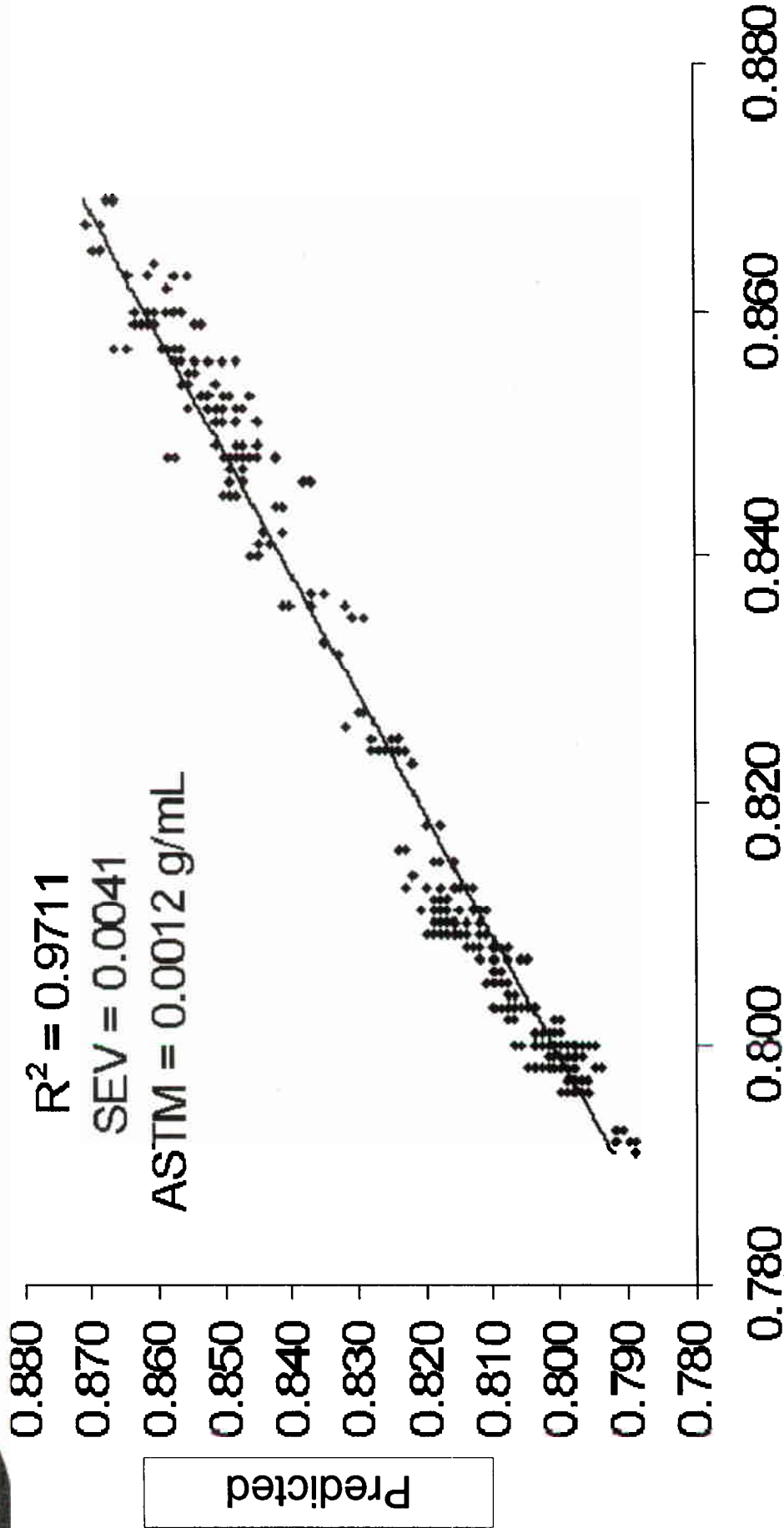
# BOILING POINT AT 90% DISTILLED



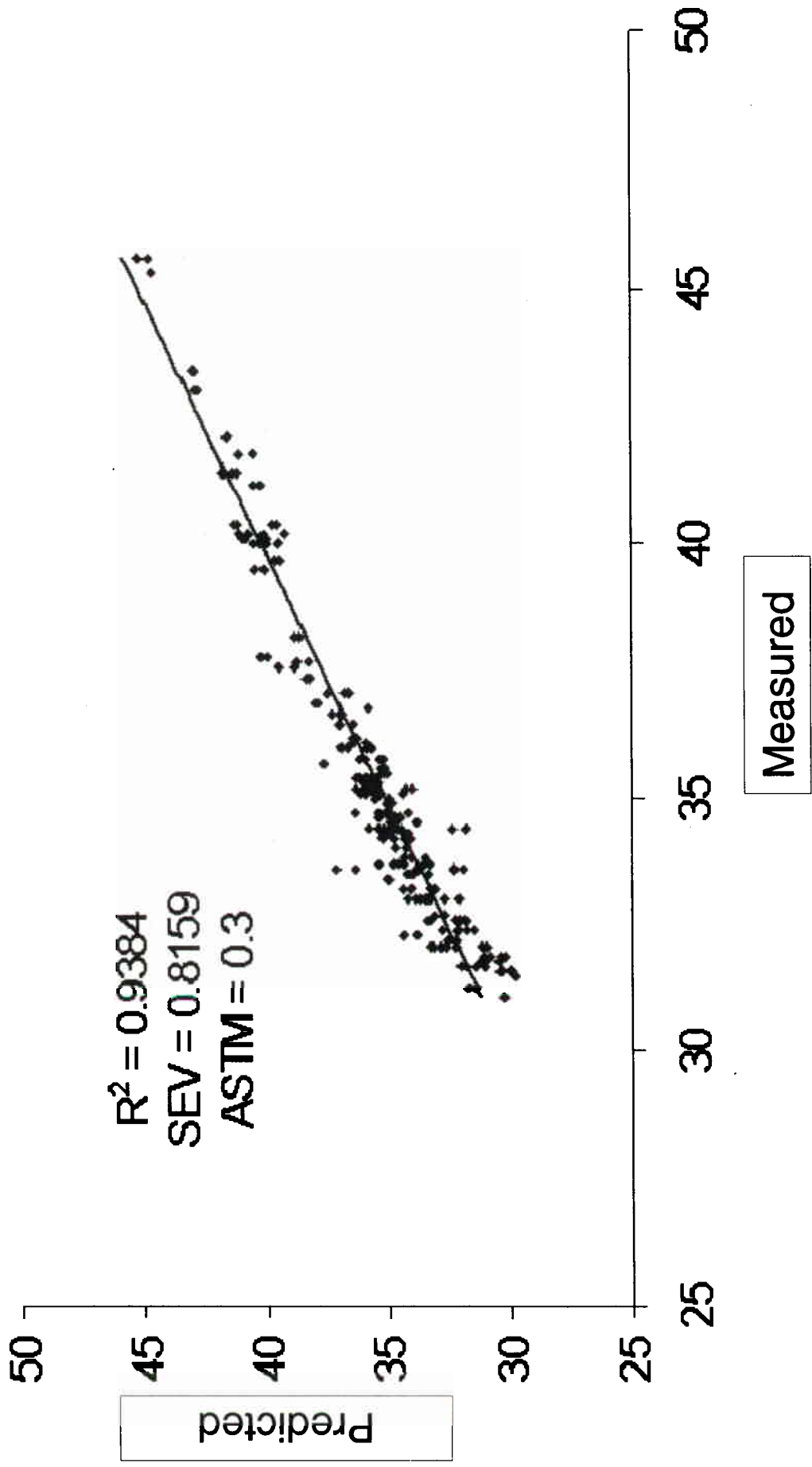
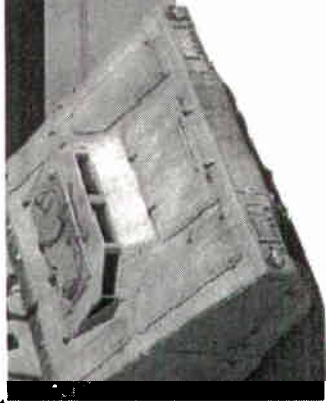
# DISTILLATION END POINT



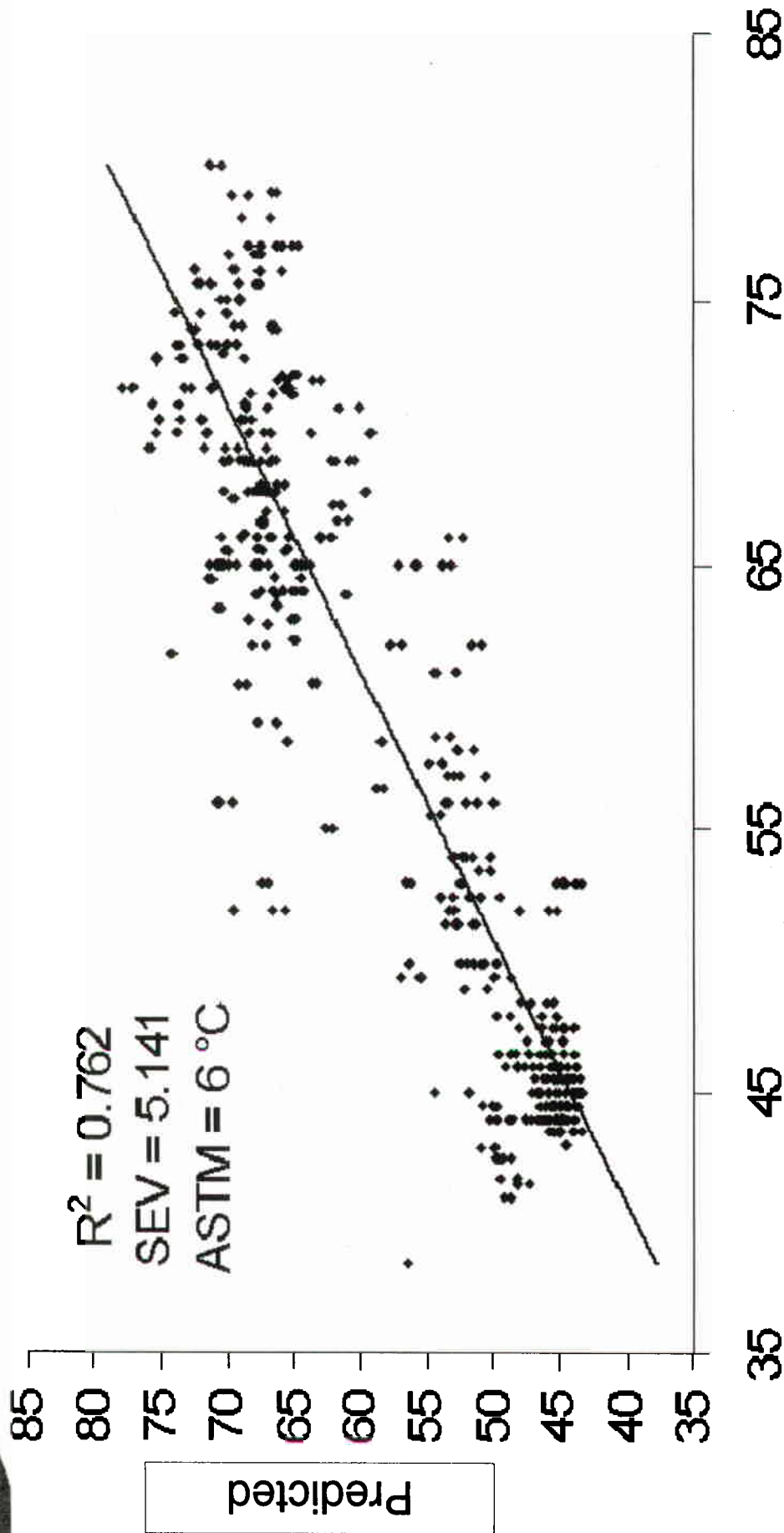
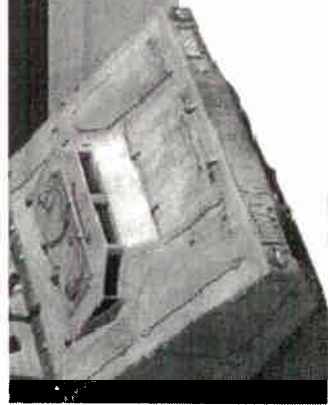
# DENSITY



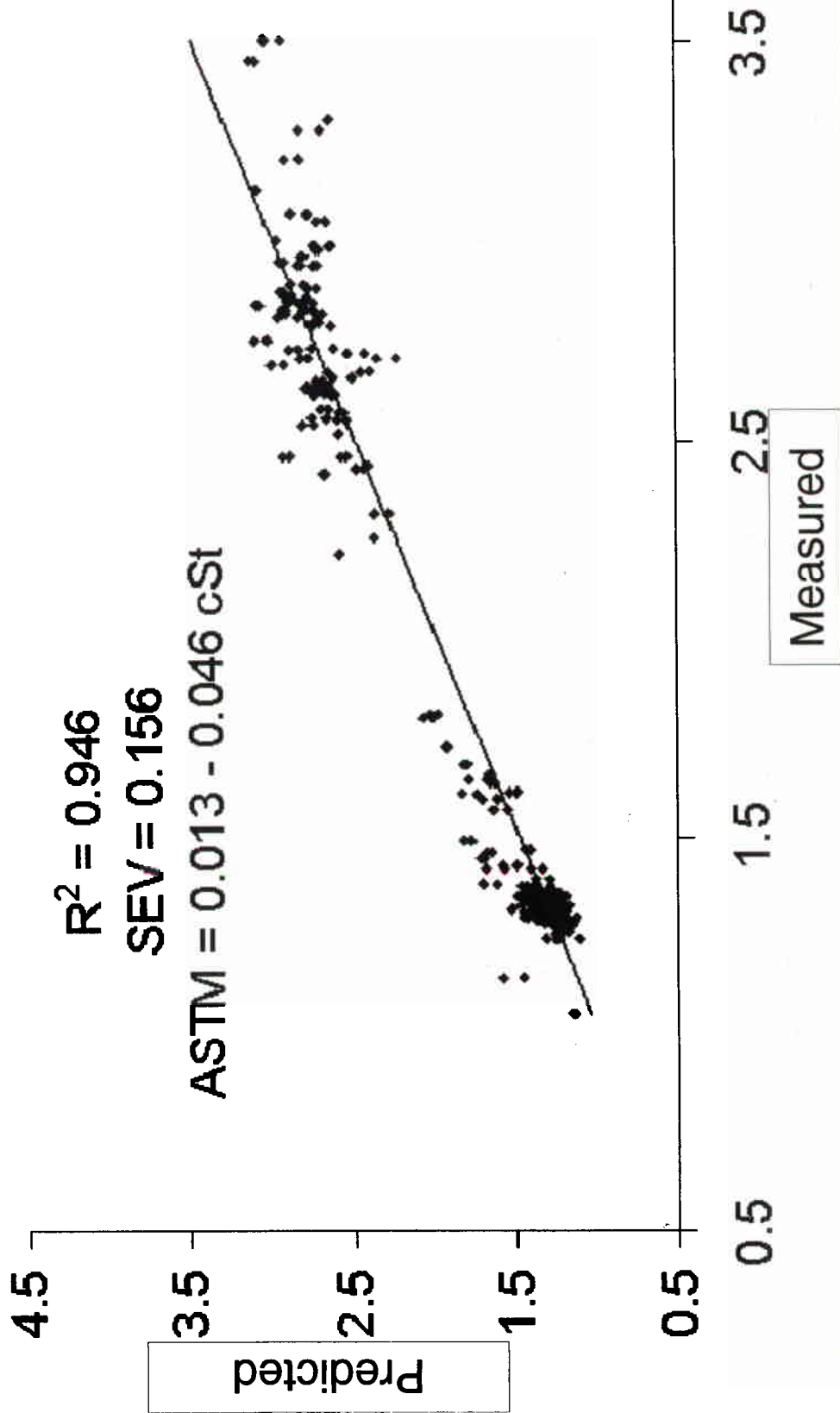
# API GRAVITY



# FLASHPOINT °C



# VISCOSITY AT 40 °C



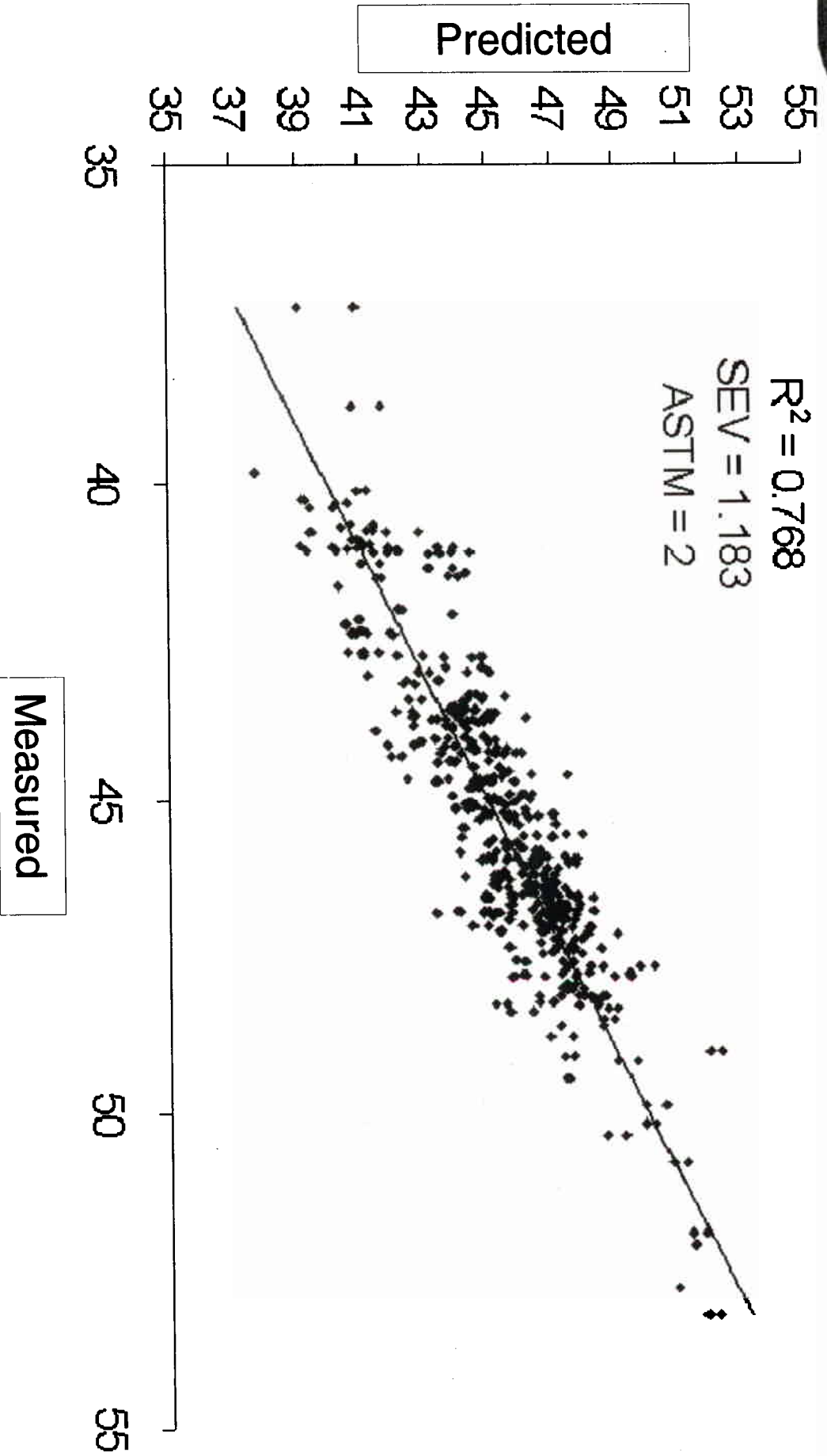
# CETANE INDEX



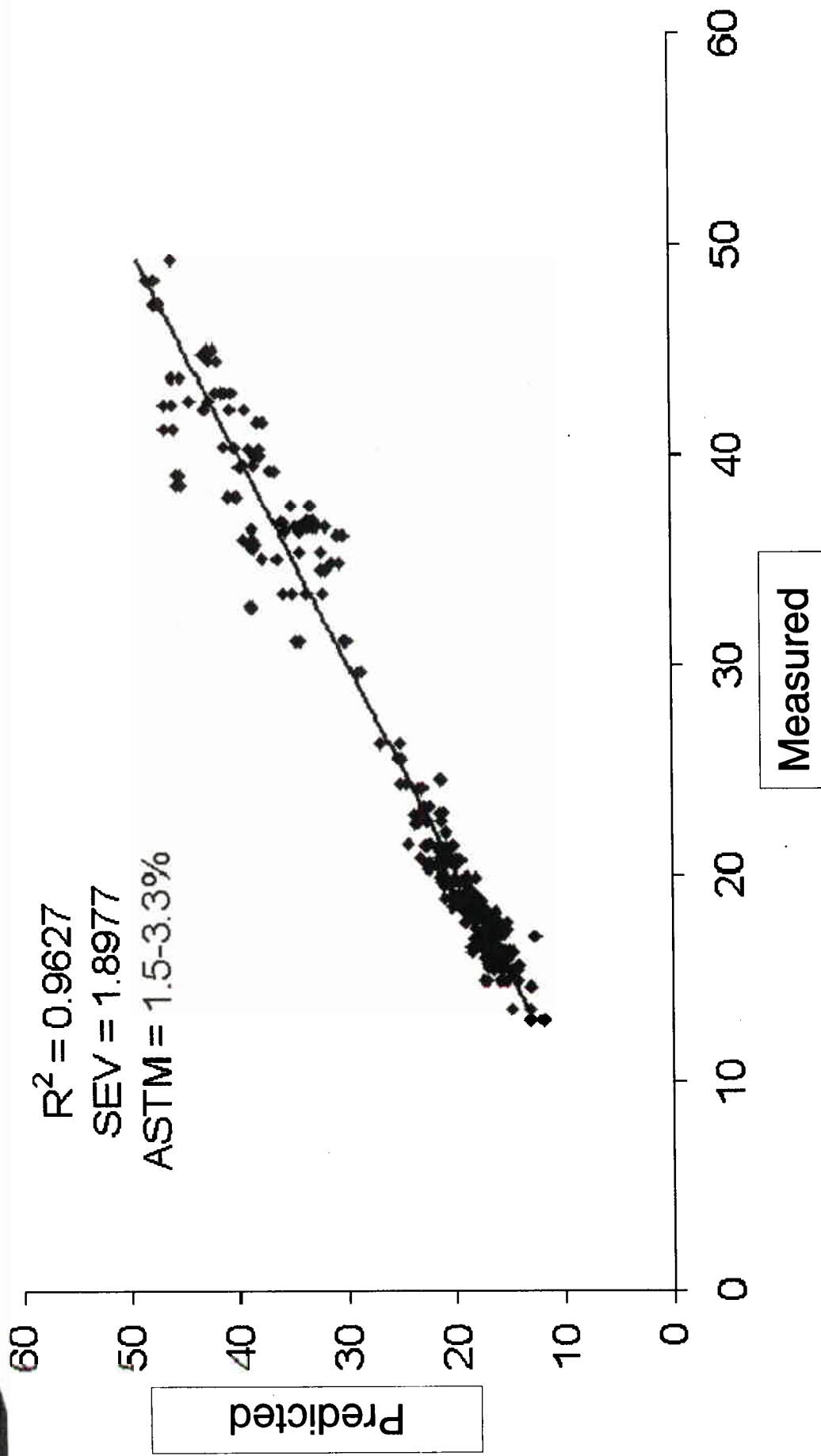
$R^2 = 0.768$

SEV = 1.183

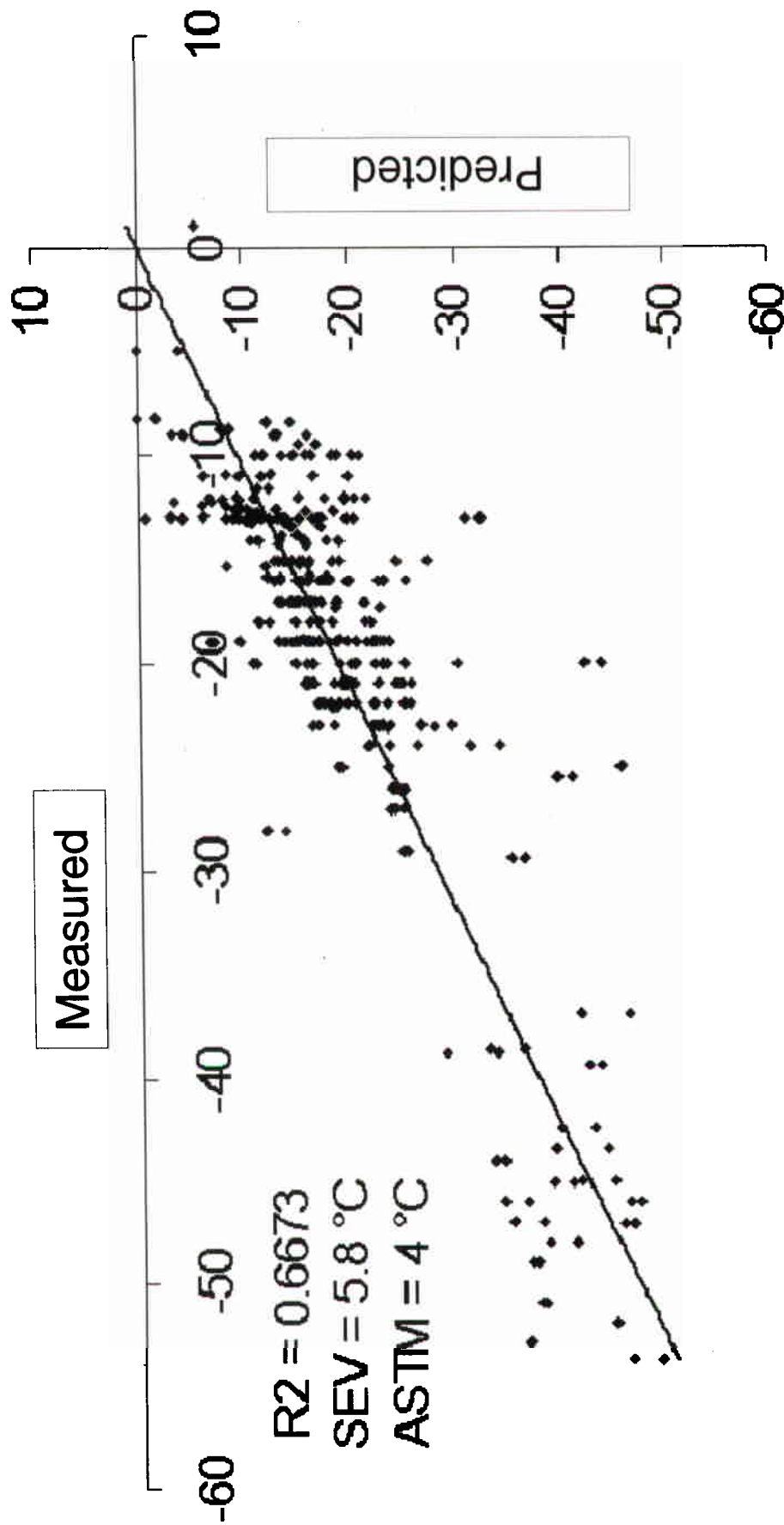
ASTM = 2



# PERCENT AROMATICS

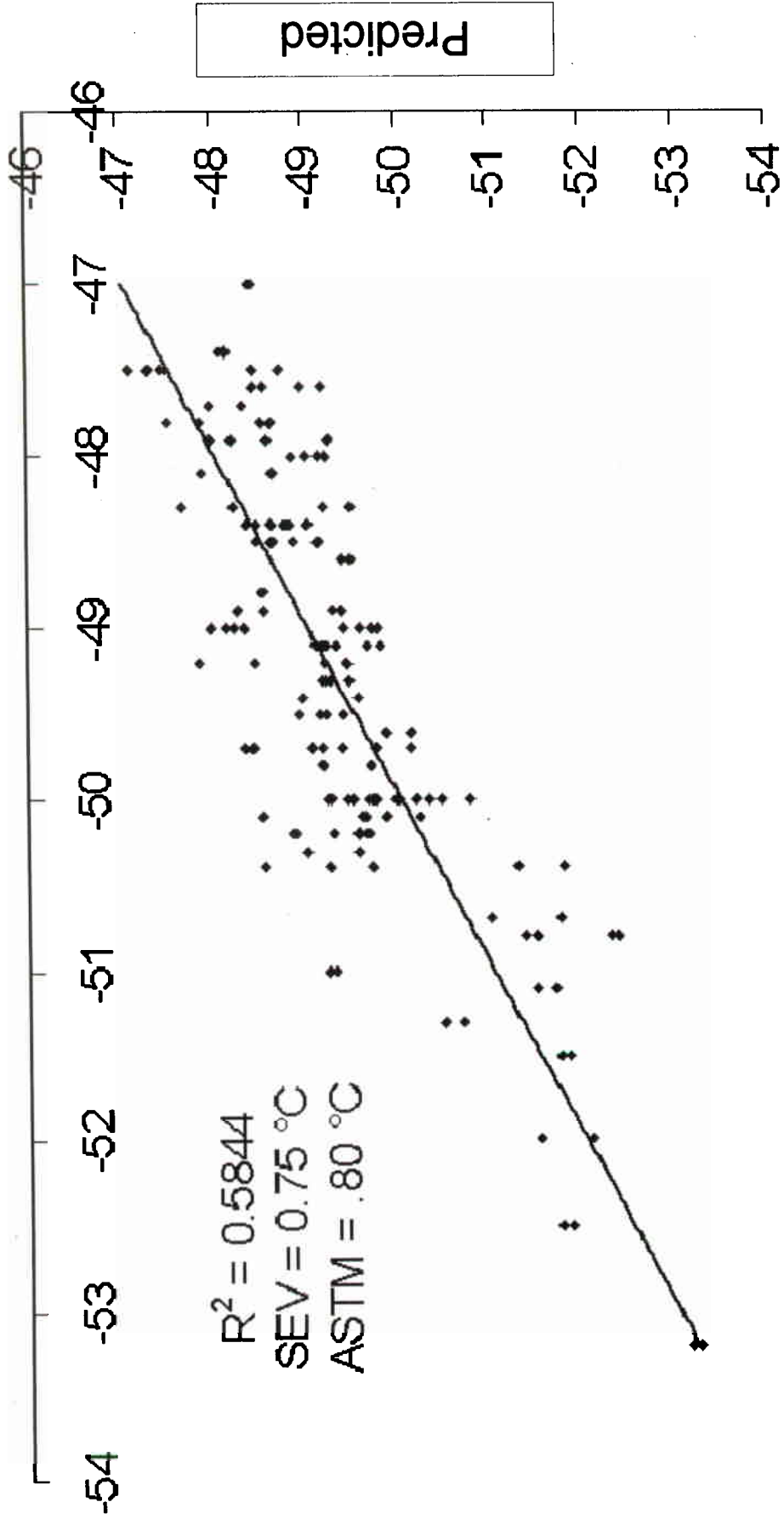


# CLOUD POINT

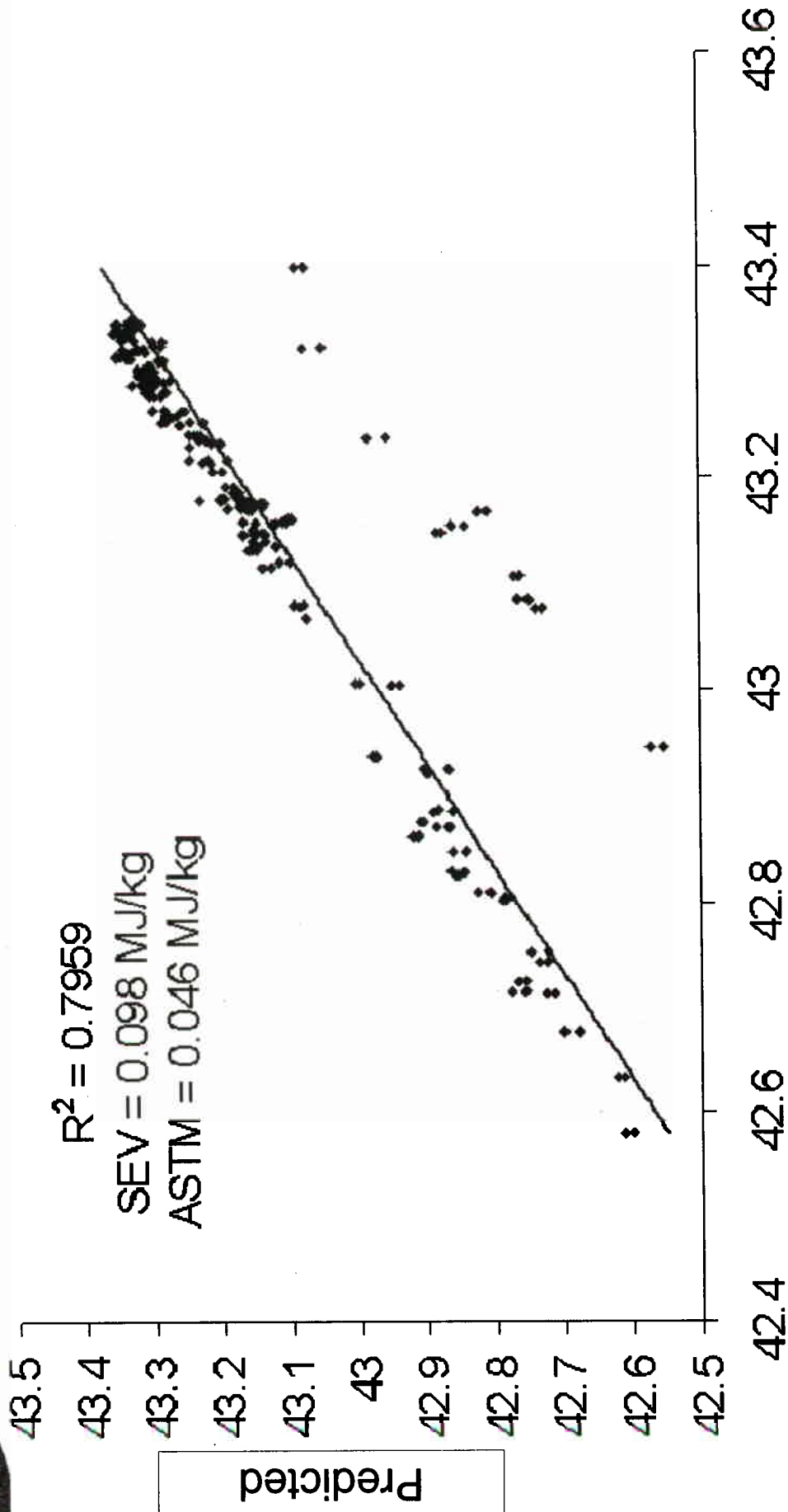


# FREEZE POINT

Measured



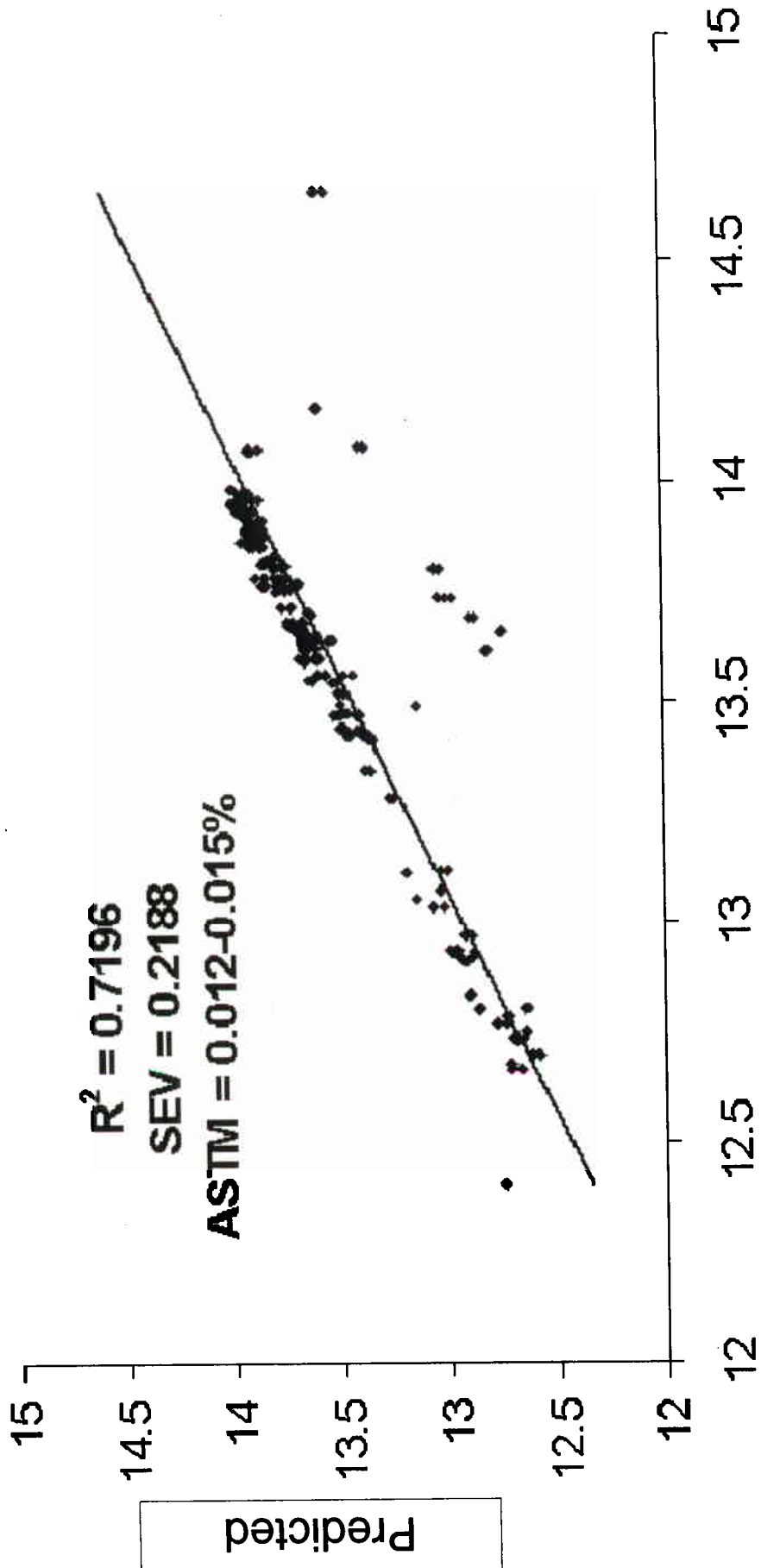
# NET HEAT OF COMBUSTION



Measured

Predicted

# HYDROGEN CONTENT



Measured

Predicted

# TECHNICAL CHALLENGES

Obtaining fuels needed for modeling effort:

- Jet A
- Diesel 1
- JP-5
- Off Specification fuels (procuring or manufacturing)

Improve laboratory results for modeling

- Pour Point
- FSII detection

**Harris, Marsha G CONT TARDEC/PraxisCom**

---

**From:** Harris, Marsha G CONT TARDEC/PraxisCom  
**Sent:** Monday, April 24, 2006 10:03 AM  
**To:** Schmitigal, Joel A MR TARDEC  
**Subject:** #15772 TIC REGISTRATION CONFIRMATION - OPSEC STARTED

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**TIC Registration Confirmation**

| REG#  | Monitoring Name | TITLE                       |
|-------|-----------------|-----------------------------|
| 15772 | SCHMITIGAL      | NEAR-INFRARED FUEL ANALYSIS |

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If you have any questions please contact the TIC @ 45377.

Marsha

Marsha Harris, Contracted Coordinator TARDEC Technical Information Center

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