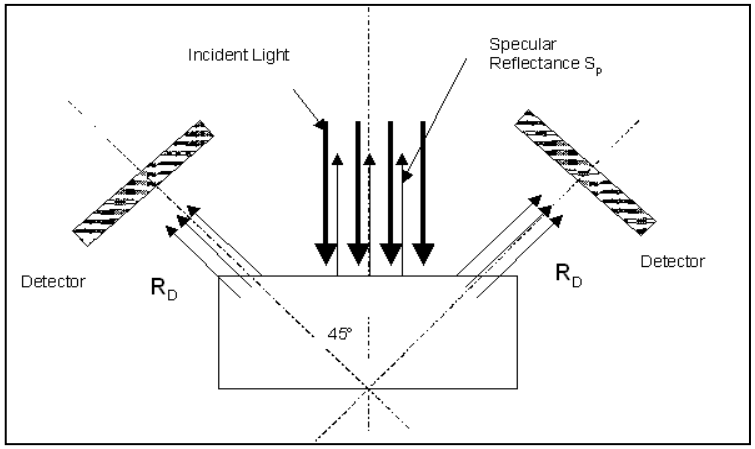
Application Note 172. Flour Analysis using the MultiScan Series 4000 FTNIR Spectrometer

Introduction:

Near Infrared Reflectance spectroscopy is best performed in the 1900 to 2500nm region of the electromagnetic spectrum. Within this spectral region, Protein (N-H 2120nm), Moisture (O-H, 1940nm) and Fat (C-H, 2350nm) absorb NIR energy. Using 0 – 45 degree illumination and detection optics, as shown in figure 1, provides a means of collecting NIR spectra from samples such as flour. Using a Fourier Transform (FTNIR) spectrometer to collect diffuse reflectance spectra from flour provides a very accurate and precise means of developing NIR calibrations for a number of parameter, including: Protein, Moisture, Water Absorption, Starch Damage and Ash as well as rheological parameters, Dough Extensibility and Dough Stability.



This study reports the results of developing calibrations for flour for the above parameters using the MultiScan Series 4000 FTNIR Spectrometer.

Figure 1. Diffuse Reflectance

Procedure:

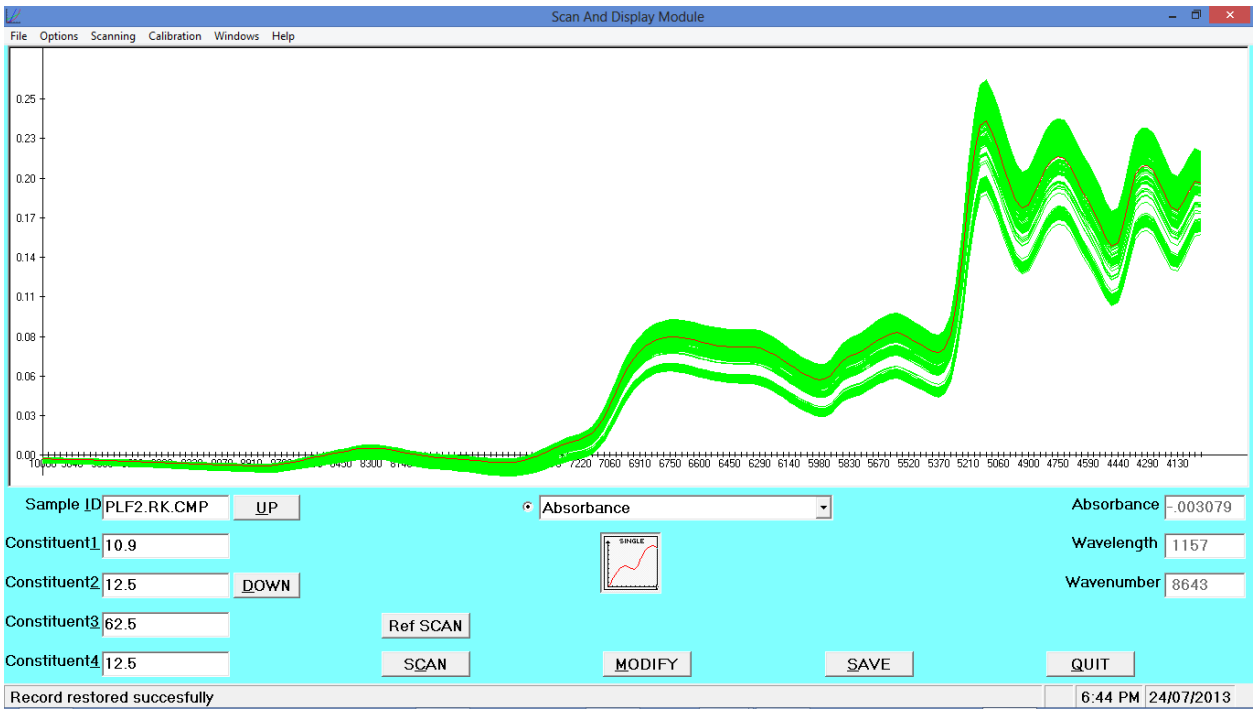
15 samples of flour from several different millers were scanned using the MultiScan Series 4000 FTNIR Spectrometer in Diffuse Reflectance mode from 1000 to 2500nm. Each sample was poured into a 5mm sample dish and levelled out using an aluminium scrapper. The sample dish was placed into the Rotating Sample Holder and the scan initiated. A Teflon Powder Reference disk is fitted into the Rotating Sample Holder so that a 100% reference scan is collected before each set of sample scans. The dish is then rotated into 10 separate locations and 10 spectra are collected and averaged for each portion of the sample dish. The lab values for each parameter are entered and the 10 averaged spectra are stored in memory. Each sample was analysed in duplicate with repacking.

The spectra and lab data were imported into NTAS (NIR Technology Analysis Software) where a Partial Least Squares regression was used to develop calibrations for Protein, Moisture, Water Absorption, Starch Damage, Ash, Dough Extensibility and Dough Stability.

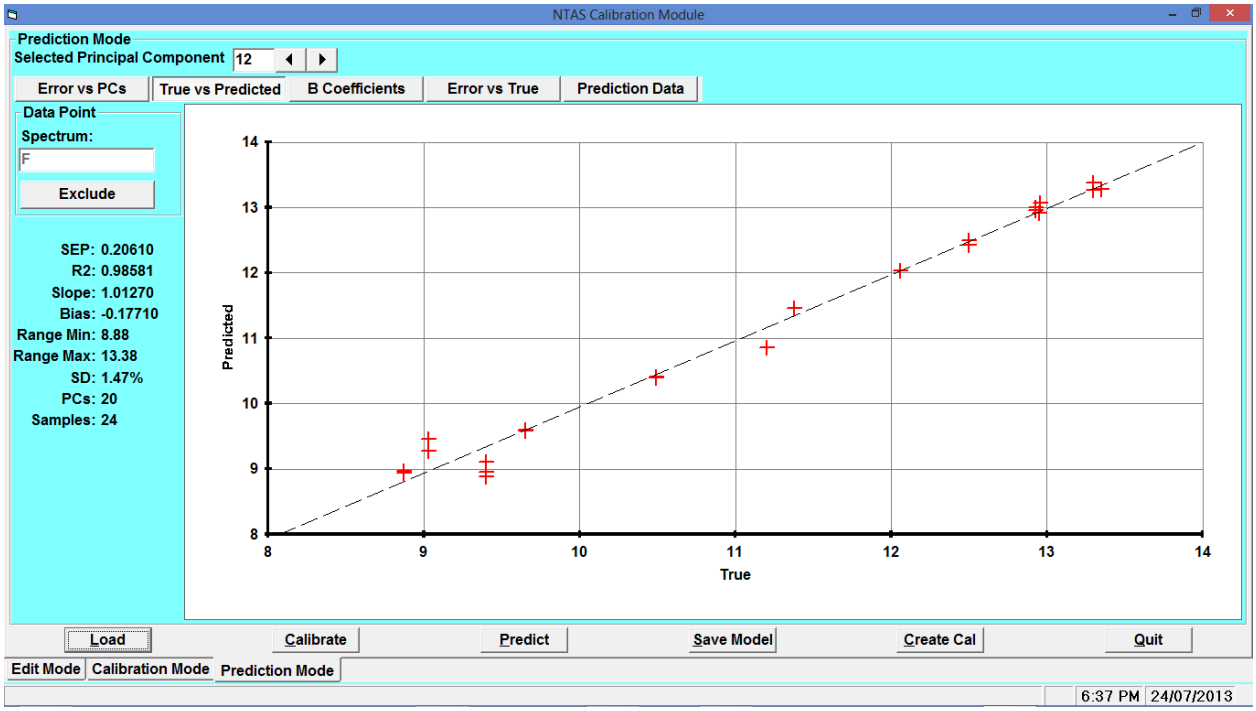
Results:

Figure 2, shows the NIR spectra of the 300 scans of flour.

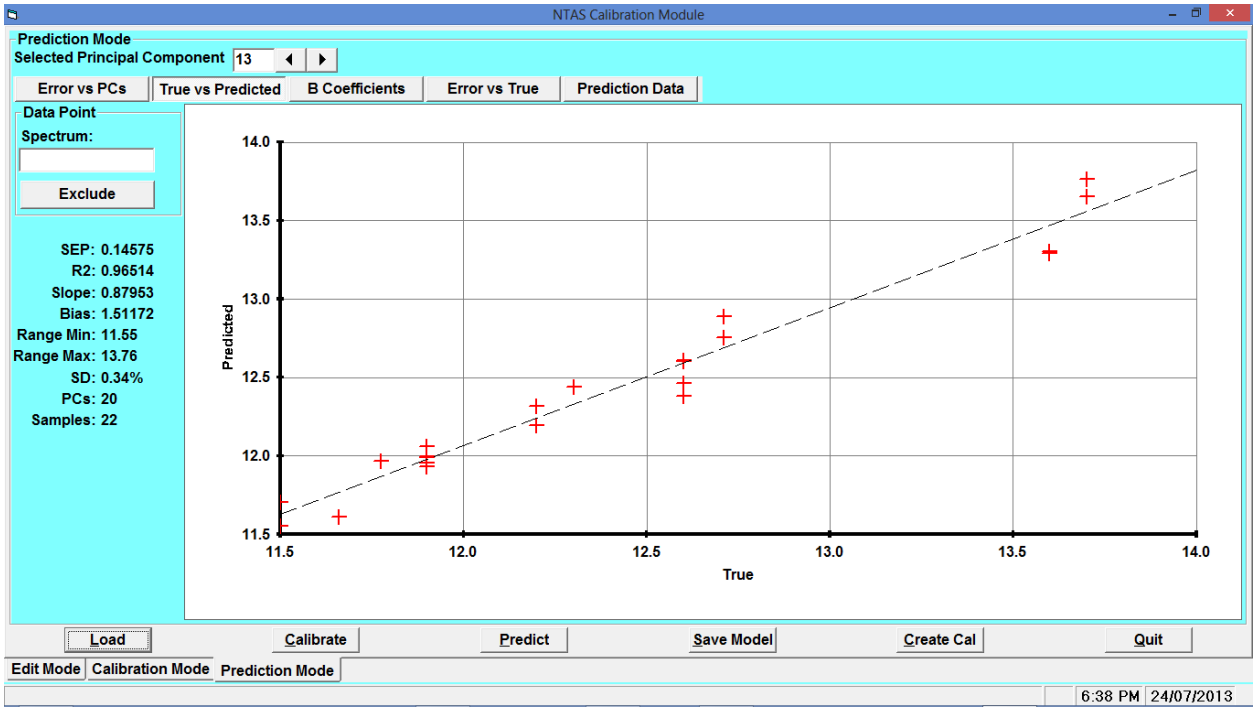
Figures 3 thru 9 show the plots for prediction of 12 samples of flour in duplicate using the calibrations developed for Protein, Moisture, Water Absorption, Starch Damage, Ash, Dough Extensibility and Dough Stability.



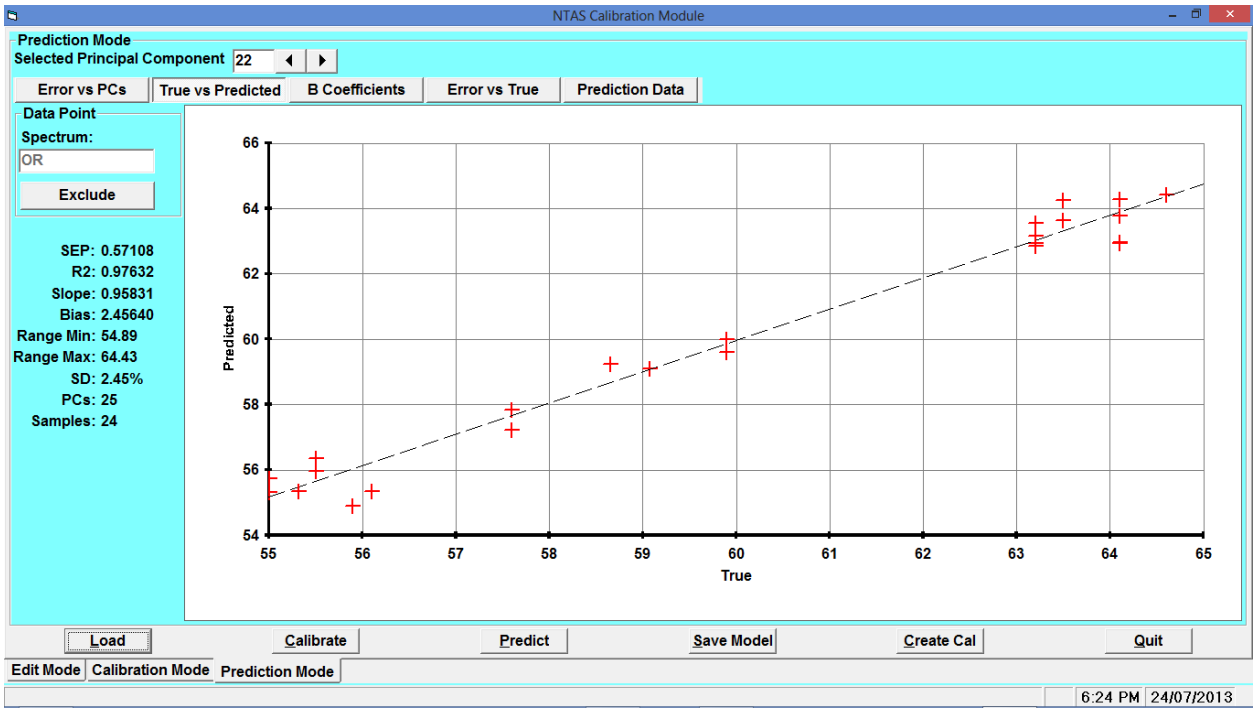
FTNIR Spectra of Flour



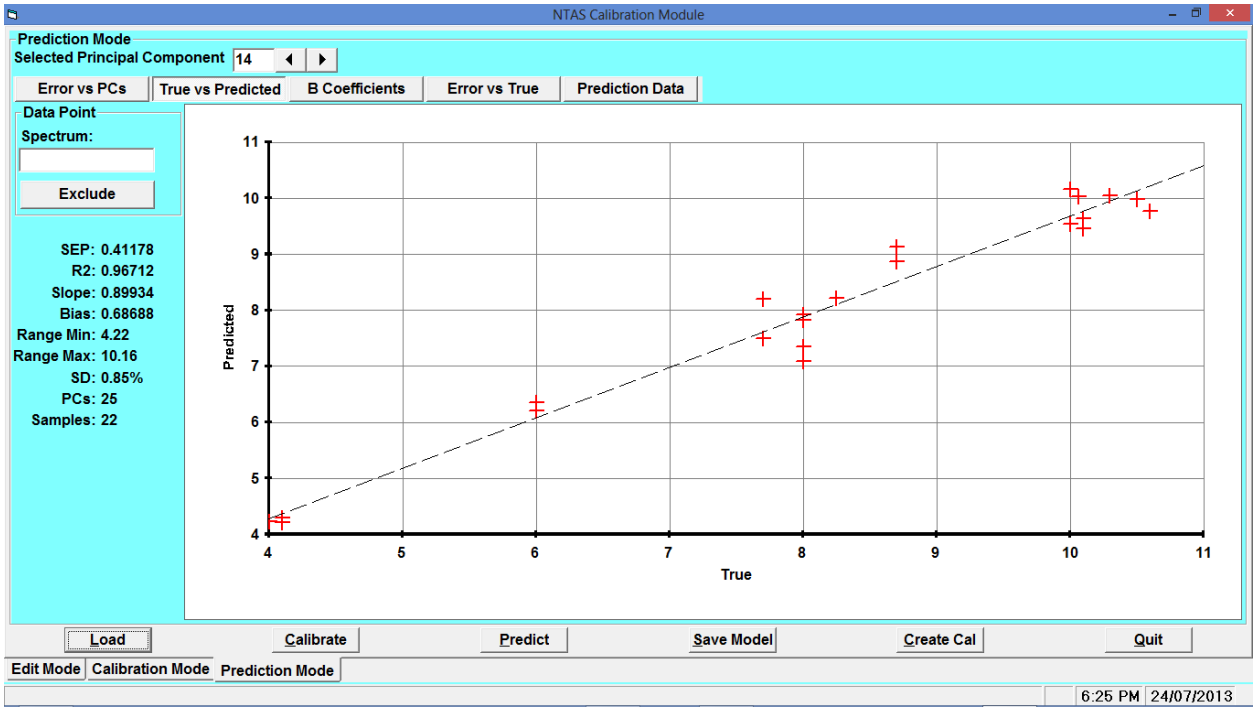
Protein Prediction Plot



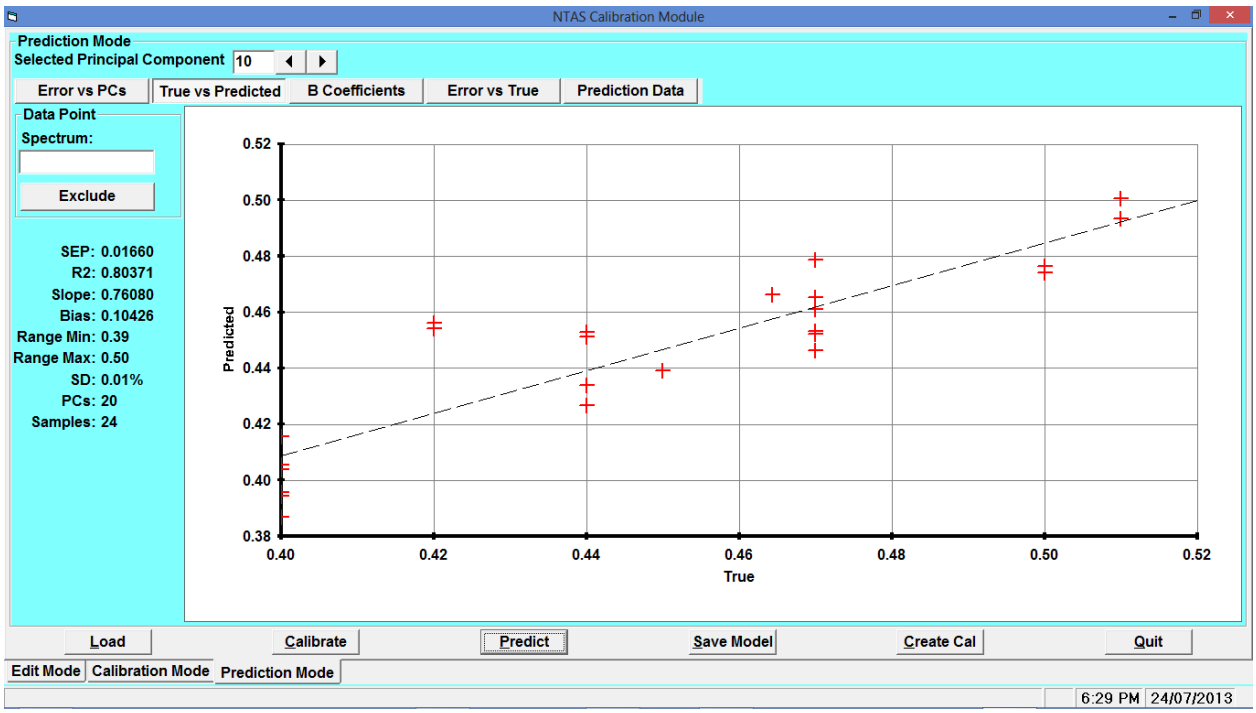
Moisture Prediction Plot



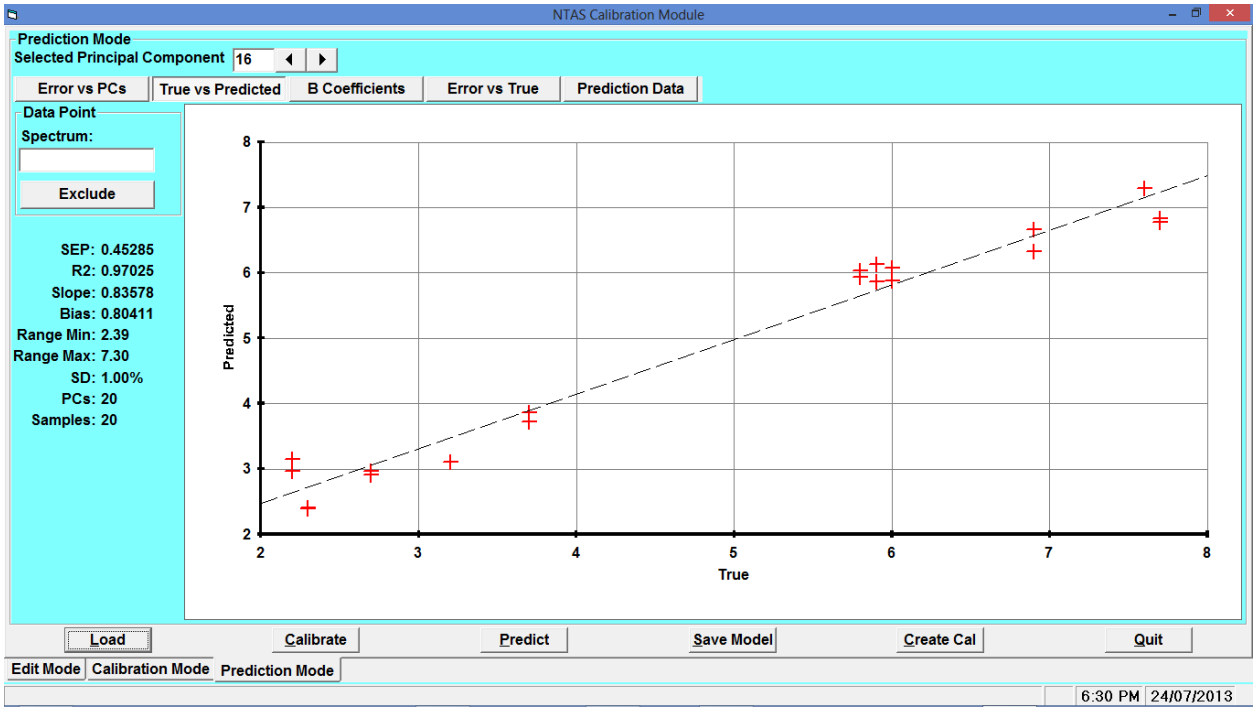
Water Absorption Prediction Plot



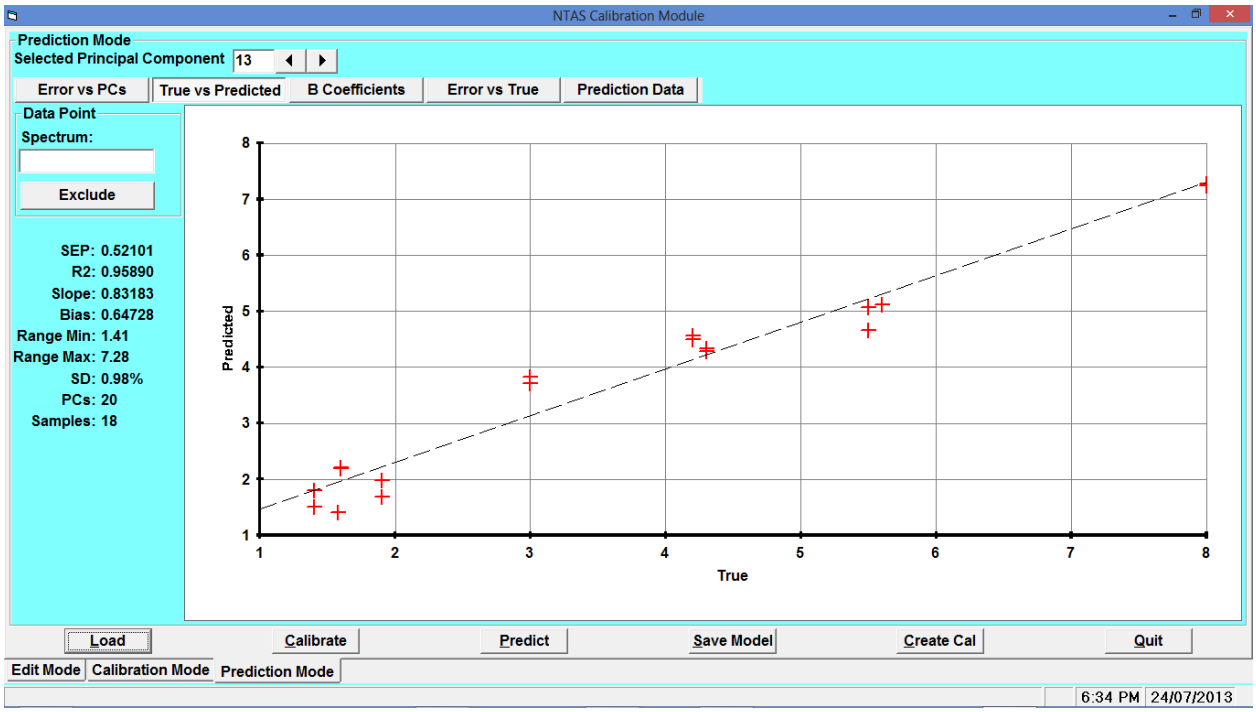
Starch Damage Prediction Plot



Ash Prediction Plot



Dough Extensibility Prediction Plot



Dough Stability Prediction Plot

Discussion:

The analysis of Protein and Moisture in flour is a well proven method. Also Water Absorption and Starch Damage analysis using NIR are well established. The measurement of Ash is a difficult application for NIR since minerals do not have any absorption bands in the NIR region. Nonetheless, Ash analysis is commonly performed and it is explained as calculating the difference between 100% and the protein, moisture and carbohydrates, all of which absorb in the NIR region.

Dough Extensibility and Dough Stability are rheological properties of flour and are measured in a laboratory using a Buehler Farinograph. The ability to develop NIR calibrations that show high correlation to these two parameters can be explained based on the relationships that must exist

between Dough Extensibility and Stability and the chemical properties of protein, starch and moisture.

The objective of this report is to demonstrate that the MultiScan Series 4000 FTNIR Spectrometer is capable of measuring a wide range of chemical and rheological parameters required by the flour milling industry.

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