Application Note AN-RS-044

Optimize raw material identification and verification (RMID) with MIRA P

Validation model transfer increases productivity

Using a verification model on multiple instruments expands a manufacturer's raw material identification/verification (RMID) capabilities by speeding up incoming inspection, imparting flexibility to an operation, or avoiding downtime.

In a scenario where several operators use multiple MIRA P systems at different locations, the ability of any operator to use any MIRA P to validate a new shipment streamlines operations and allows that shipment to be quickly released to production.

In most cases, a well-designed model with inherent sample variability can be built on one MIRA P and transferred to another. In some cases, variance must be added to a training set with a few additional samples. This Application Note describes how a model transfers from one MIRA P to another in order to scale MIRA P usage across an entire operation.

INTRODUCTION

Model building (including training and validation set samples, operating procedure (OP) settings, and necessary variance) has already been well-established for RMID with a unique MIRA P [1,2].

In summary, MIRA Cal P generates PCA-based (principal component analysis) models using Training Set data and Operating Set parameters to verify target substances. Ideally, a model can be created on one instrument («MIRA P 1»), downloaded onto a second instrument («MIRA P 2»), then validated on the second unit and used directly.

The model must be expanded if the initial transfer does not produce satisfactory p-values or does not pass validation. This involves introducing variance in the model and/or optimizing model parameters and/or ensuring consistent usage by each operator of the instrument.

MODEL TRANSFER

This Application Note details the:

1. transfer of a material verification model from one MIRA P to another MIRA P
2. validation of the success of the model transfer
3. expansion of the model using a transfer matrix, if necessary

Contact your local Metrohm Sales and/or Service Representative for the full MIRA P to MIRA P Transfer Protocol.

Parameter optimization and/or inclusio n of additional data that includes instrument variance and variance based on historical and current samples are both simple ways to expand a model.

Using an established model, new validation data is collected from both MIRA P units and added to the Training Set. Parameter optimization is recommended at this step. After this updated model is uploaded to the new MIRA P unit, it must be validated on the new unit.

VALIDATION

Validation of a model demonstrates that the model adequately assesses a material on a new instrument. In other words, validation data serves as a «diagnosis» of how the model performs on the new unit.

Validation is an assessment of a method using test samples:

- that are expected to PASS (positive samples). These are samples of the target material but are different than the samples used to build the Training Set.
- that are expected to FAIL (negative samples). These can either be dissimilar materials or similar yet different materials. This ensures the specificity of a model.

It is a simple task, requiring just a few minutes, to run a validation set. This will inform successive steps.

HOW MANY OPTIMIZATIONS ARE NEEDED?

A good way to assess the success of a transferred model is to look at p-value distributions of positive and negative Validation Set samples. This is a good measure of a model's **robustness**—its ability to correctly assess new data, not just the data it was trained on. For example, Figure 1 contains Validation Set results for sodium bicarbonate on the receiving MIRA P device (MIRA P 2).

Initial Validation results for sodium bicarbonate show all the characteristics of good validation results (Figure 1a).
Red bars indicate that negative validation samples are failing appropriately, and positive samples are also passing with high p-values.

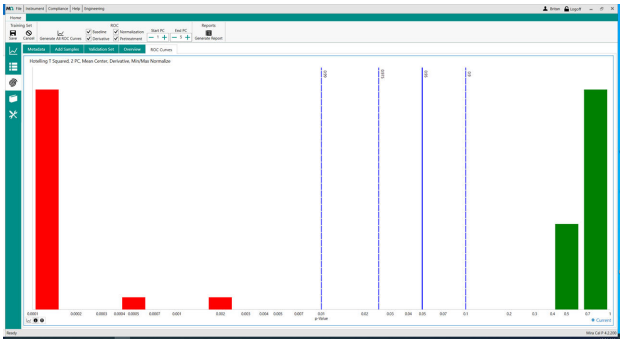


Figure 1a. Validation results for sodium bicarbonate on MIRA P: the original model.

After transfer to MIRA P 2 (Figure 1b), p-values for negative and positive samples show greater variance, but all are passing/failing appropriately.
Ultimately, this is a good example of a model that was transferred and used immediately.

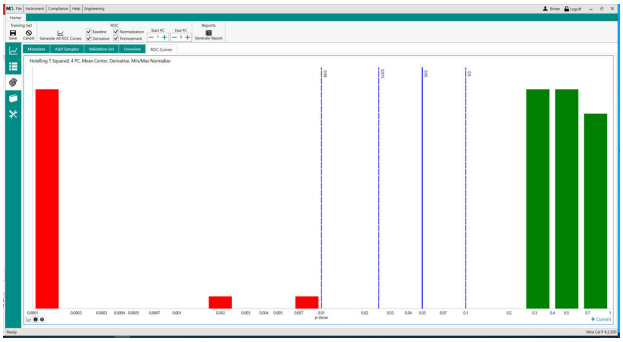


Figure 1b. Validation results for sodium bicarbonate on MIRA P: the model after transfer to another unit.

Lactose fluoresces with 785 nm Raman, but a well-built model can accommodate such fluorescence. This is a good test of the model transfer capability.
The lactose model transfers easily, requiring only parameter optimization in MIRA Cal P and addition of a small number of scans from the new instrument to the training set (Figure 2).

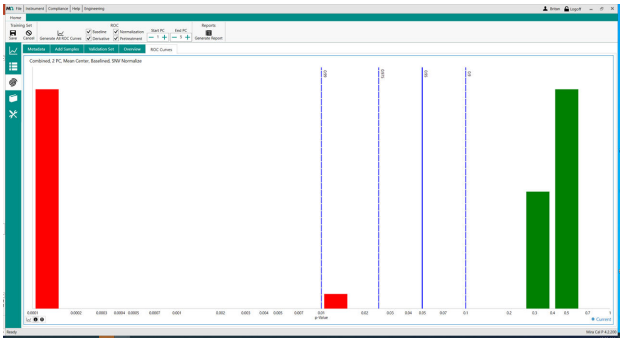


Figure 2a. Validation results for lactose on MIRA P: the original model

P-values exhibited slightly more variance on the new instrument (Figure 2b), but the model was robust.

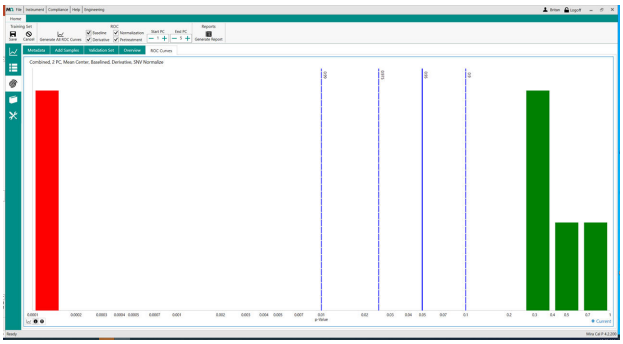


Figure 2b. Validation results for lactose on MIRA P: the model after transfer and parameter optimization.

Microcrystalline cellulose (MCC) is a challenging sample for 785 nm Raman, as it is very fluorescent. This can be seen in the wider distribution of validation set p-values in the original model (Figure 3a).
Thus, it was not expected for the original model to transfer without the Transfer Matrix.

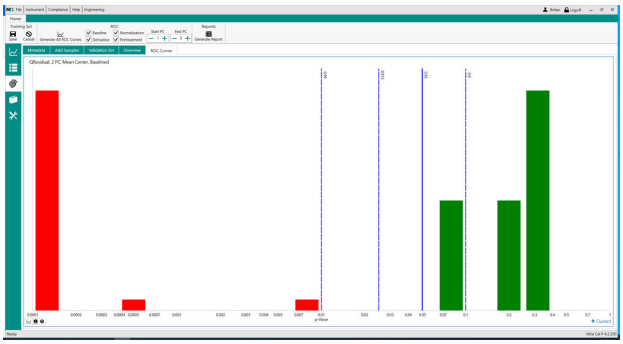


Figure 3a. Validation results for microcrystalline cellulose (MCC) on MIRA P: the original model

Ultimately, the optimization of parameters and utilization of the Transfer Matrix provided a robust model that could be used on a second MIRA P instrument and with a smaller spread of p-values.

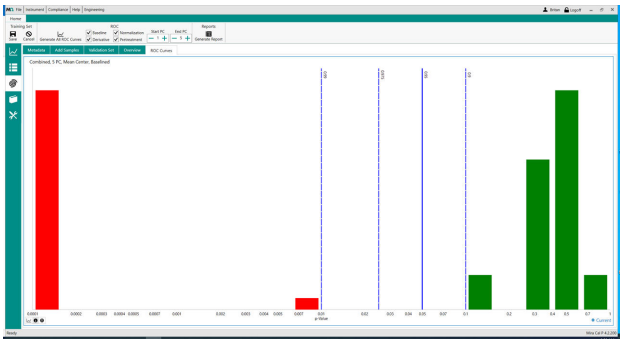


Figure 3b. Validation results for microcrystalline cellulose (MCC) on MIRA P: the model after parameter optimization and Transfer Matrix.

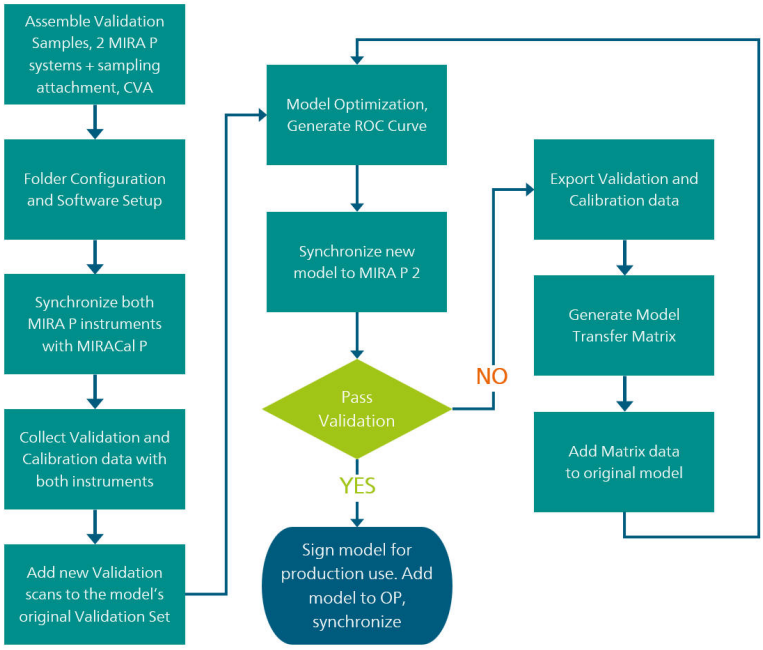
COMPLIANCE

Compliance with 21 CFR Part 11 requires document control at the highest level. Specifically, all model metadata is preserved, ensuring traceability after model transfer. The manufacturer-supported means for this are simple: MIRA P Model Transfer Protocol includes a sign-off sheet to record and track data from MIRA Cal P export, through the transfer matrix, and import back into MIRA Cal P.

CONCLUSION

The benefits of using multiple MIRA P devices for raw material verification include smoother operations and faster turnaround of products. This Application Note is intended to guide users through model transfer and enable the deployment of multiple MIRA P instruments.

From tips for the simplest transfer to tools for more challenging tasks, we want you to be confident in taking your inspection with MIRA P to the next level. This flowchart is a quick reference for the basic flow of operations during MIRA P to MIRA P transfer.



REFERENCES

1. Metrohm AG. Simplified RMID Model Building – Mira Cal P and ModelExpert; AN-RS-031; Metrohm AG: Herisau, Switzerland, 2021.
2. Gelwicks, M. J. Real World Raman: Simplifying Incoming Raw Material Inspection. *Analyze This – The Metrohm Blog*.

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CONFIGURATION

MIRA P Basic

The Metrohm Instant Raman Analyzer (MIRA) P is a high-performance, portable Raman spectrometer used for rapid, nondestructive determination and verification of different material types, such as pharmaceutical APIs and auxiliary materials. Despite the small size of the instrument, the MIRA P is highly ruggedized and features a high-efficiency spectrograph equipped with our unique Orbital-Raster-Scan (ORS) technology. The MIRA P complies with the directives of FDA 21 CFR Part 11 in their entirety.

MIRA P Basic package allows the user to customize the MIRA P to meet their needs. The MIRA P Basic package is a starter package that contains the basic components required for operating the MIRA P.

The Basic package contains the MIRA calibration/verification accessories, the USP library, and the LWD attachment for analyses in bottles or bags. Laser Safety Class 3B operation.

MIRA P Advanced

The Metrohm Instant Raman Analyzer (MIRA) P is a high-performance, handheld Raman spectrometer used for rapid, nondestructive determination and verification of different material types, such as Pharmaceutical APIs and excipients. Despite the small size of the instrument, the MIRA P has a ruggedized design and features a high-efficiency spectrograph design equipped with our unique Orbital-Raster-Scan (ORS) technology. The MIRA P is fully compliant with FDA 21 CFR Part 11 regulations.

The Advanced Package includes an attachment lens for analyzing materials directly or through containers (laser class 3b), as well as a vial holder attachment for analyzing samples contained in glass vials (laser class 1).

MIRA P Flex

The MIRA P Flex package allows users to customize MIRA P to meet their needs. The Flex package includes the basic components needed to operate the MIRA P without sampling attachments. At least one sampling attachment is required for operation. The MIRA P Flex package includes the USP library, calibration/verification accessories, and a USB cable. Class 3B operation.