



Proven direct model transferability across instruments using through-vial Raman measurements

Thermo Scientific DXR3 SmartRaman+ Spectrometer

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Accelerating biopharmaceutical QC with reliable Raman model transfer

Robust, transferable analytical methods are essential for biopharmaceutical QC environments that are increasingly distributed across multiple instruments, sites, and operators. The Thermo Scientific™ DXR3 SmartRaman+ Spectrometer delivers consistent optical alignment, stable sampling geometry, and reproducible Raman performance, enabling calibration models developed on one instrument to be applied directly to others with minimal adjustment.



Figure 1 illustrates this capability, showing a quantitative acetaminophen model acquired through glass vials with a 532 nm laser excitation and predictions for results across five different instruments. The DXR3 SmartRaman+ platform achieves high uniformity across instruments, supporting direct model transferability with prediction errors well below the predefined 10% target of the training concentration range. Further improvements in model transferability can be achieved through additional strategies when required.

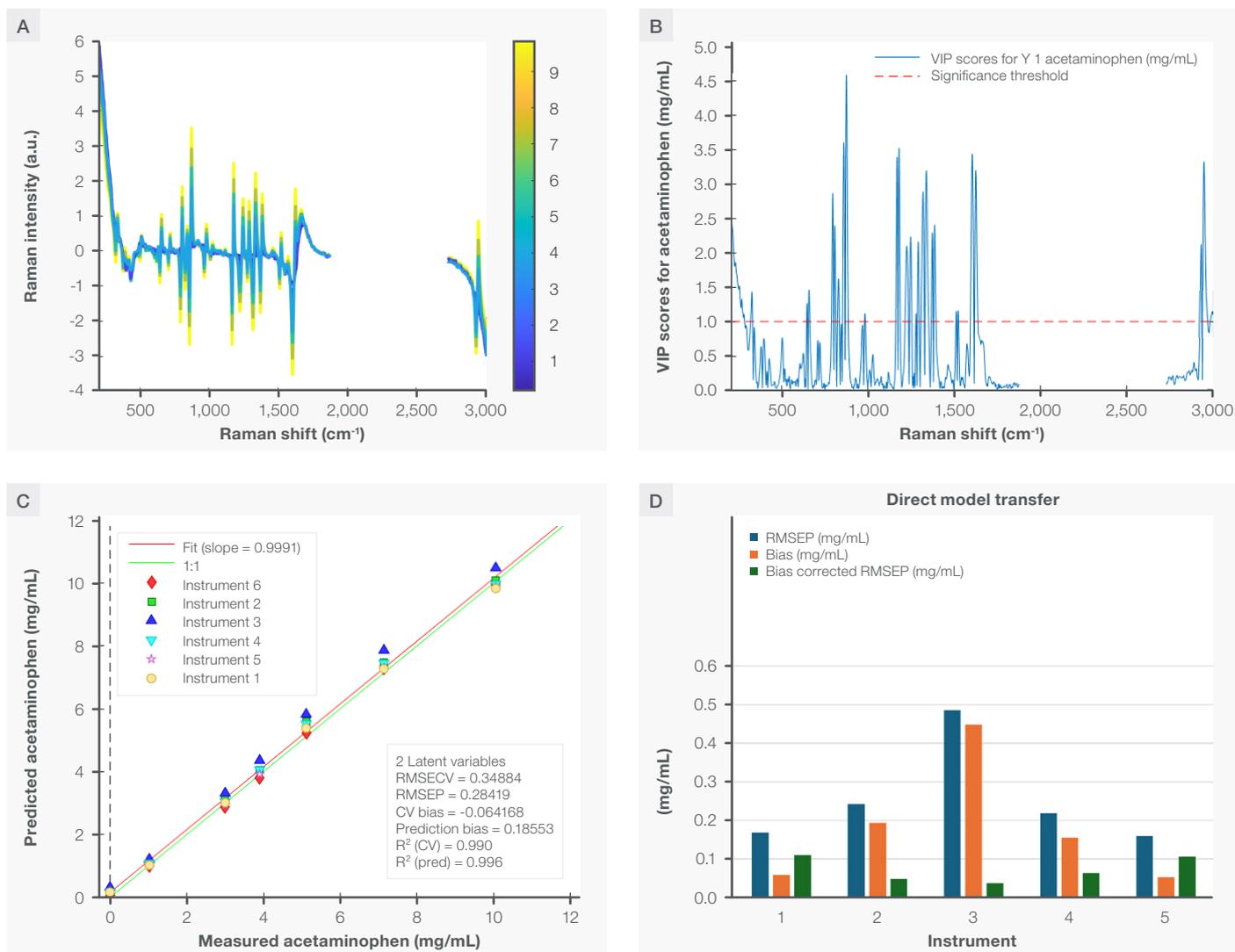


Figure 1. Direct model transfer across DXR3 SmartRaman+ using a 532 nm laser with through-vial measurements. (A) Spectral region used for modeling after preprocessing; spectra are color-coded by acetaminophen concentration. (B) VIP score plot; Raman shifts with VIP > 1 correspond to acetaminophen Raman signatures. (C) Correlation plot of predictions across five test instruments and the instrument used to develop the model. Prediction statistics shown in the inset. (D) Instrument-specific error analysis.

Key technical highlights

- Excellent prediction consistency:** All instruments produced highly comparable results with strong linearity ($R^2 > 0.98$) and low prediction error, achieving an average root mean square error of prediction (RMSEP) of 0.28 mg/mL across the 0–10 mg/mL concentration range.
- Bias-driven minor differences:** Instrument-to-instrument variability was minimal and primarily systematic. These small differences were easily addressed through simple bias correction without altering the underlying calibration model (see reference for details).
- Uniform optical response:** Identical optical settings and acquisition parameters were used across all DXR3 SmartRaman+ instruments, confirming stable mechanical and optical alignment and supporting robust model transferability.
- Through-vial performance:** All measurements were performed through standard glass vials, demonstrating the suitability of the DXR3 SmartRaman+ spectrometer for non-destructive, automation-friendly fill-finish QC workflows.



A custom 8-vial holder plate loaded with finished-product vials is inserted into the DXR3 SmartRaman+ for at-line testing during the fill-finish stage of manufacturing.

Advantages for biopharmaceutical QC and method deployment

- **Accelerate method transfer** across development, pilot, and manufacturing sites.
- **Reduce calibration overhead** by reusing existing models without rebuilding.
- **Increase QC reliability** through reproducible hardware and automated alignment.
- **Enable scalable automation** for high-throughput fill-finish analytics.
- **Support regulatory expectations** with consistent, traceable multivariate performance.

Summary

DXR3 SmartRaman+ platform provides for direct model transferability, even when measuring through glass vials—an essential requirement for modern biopharmaceutical QC. With strong predictive accuracy and minimal instrument-to-instrument variability, the DXR3 SmartRaman+ spectrometer enables seamless model deployment across laboratories, enhancing efficiency and supporting robust product quality assurance. Similar results for biological samples packaged in glass containers using 785 nm laser excitation are discussed in detail in the corresponding application note referenced below.

Reference

[Thermo Scientific™ DXR3 SmartRaman+: Providing Automation Platform for Fill and Finish Quantification and Qualitative Assessment with Model Transferability](#)

Key attributes of the DXR3 SmartRaman+ spectrometer for fill-finish

- Industry 4.0-ready with seamless OPC UA connectivity
- Flexible sampling options: design and integrate your own vial or sample holder
- Adjustable z-focus with autofocus to enable accurate measurements through glass containers of varying thickness
- Selectable excitation lasers: 532 nm or 785 nm to fit your application needs
- Pharmacopeia-aligned performance, with validation in accordance with USP and Ph. Eur. standards

Learn more at thermofisher.com/smartramanplus

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