

Raman RunTime - what's new?

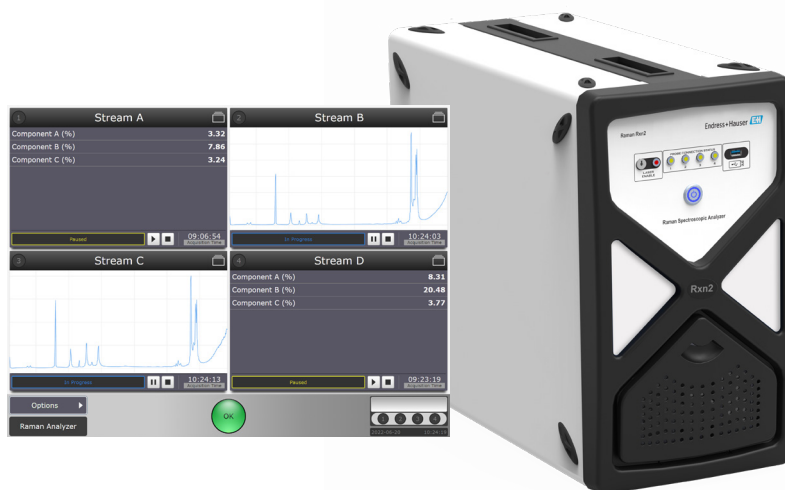


Figure 1: Raman RunTime user interface alongside a Raman Rxn2 analyzer with embedded technology

New feature highlights

- Support for Raman Rxn5 analyzer
- Harmonized calibration/verification experience across gas- and condensed-phase applications
- Streamlined remote access with enhanced certificate management for secure communications
- Support for new Calibration Reference Standard (CRS) based Raman calibration and verification kits
- Diagnostic fault codes published via OPC and Modbus
- Alerts for low storage space
- Automation enhancements
- Support for LNG application
- Additional multivariate software predictors

Overview

Since its introduction into the bioprocess market in 2017, Raman RunTime (powered by Kaiser Raman technology) has been successfully expanded to support all Endress+Hauser Raman analyzers and a wide range of industry applications. It seamlessly integrates spectrometer functions into analyzer electronics without the need for an external controller or a PC running proprietary software.

Raman RunTime features embedded connectivity, a user-friendly interface, is inherently secure, and offers many Industry 4.0 capabilities, including:

- Simple, accurate analyzer and probe calibration and verification
- Integrated OPC server and Modbus capabilities for full communication to OPC and Modbus-enabled devices
- Embedded chemometric predictors for real-time multivariate results
- On-screen data visualization
- Multilevel user interaction

- Export of raw data (via OPC) and diagnostics using standard communication protocols to support data integrity
- Remote access through a desktop web browser

These features were created to meet the market needs of the bioprocess and energy industries, and solve problems related to analyzer workflow and automation.

Our Raman Rxn embedded analyzers are controlled by multiple means of accessing Raman RunTime:

- Via an optional touchscreen or external HMI (touchscreen and probe analyzers only)
- Remote access via a local network connection
- Commands through OPC or Modbus

This document provides insight into the features of Raman RunTime, while also addressing common questions regarding the software's functionalities.

Compatibility and usability enhancements

New version compatibility

Raman RunTime v6 and above accommodates the next generation of Endress+Hauser Raman products featuring embedded analyzer technology. Versions prior to v6 used a custom external HMI.

v6.1 – Version 6.1 of Raman RunTime introduced compatibility with Raman Rxn2/Rxn4 analyzer systems configured with 785 nm and 1000 nm laser wavelengths, as well as external HMI controllers for non-embedded Raman Rxn analyzers.

v6.2 – Version 6.2 of Raman RunTime focused on supporting additional Endress+Hauser Raman embedded analyzer models, including hybrid configurations (compatible with the Rxn-20 probe) and 532 nm systems, as well as support for our new Calibration Reference Standard (CRS) technology. Note: The ability to use CRS requires v6.2.2+.

v6.3 – Version 6.3 expanded predictor support with features for Aspen Unscrambler, PLS_Toolbox/Solo, and PEAXACT models. The release featured enhanced automation commands for calibration and exports, and support for LNG applications on the Rxn 785 models.

v6.4 – Version 6.4 improved remote access* for Raman Rxn2 and Raman Rxn4 analyzers, and allowed web browsers on network-connected workstations to connect to the analyzer through a standard or secure connection. This release also added support for the latest iterations of multivariate predictors.

v6.5 – Version 6.5 brought support for the Raman Rxn5 embedded controller, thereby consolidating support for all Endress+Hauser Raman Rxn analyzers (Raman Rxn2, Rxn4, and Rxn5) under a single Raman RunTime version. This version also improved remote access* for the Raman Rxn5. The introduction of receiving diagnostic fault codes via automation protocols was implemented, along with improved certificate management to simplify the establishment of secure communications.

Endress+Hauser Raman RunTime continues to add features and enhance support for industries and key integrators, especially for cGMP regulated industries.

* by removing dependency on Microsoft Silverlight

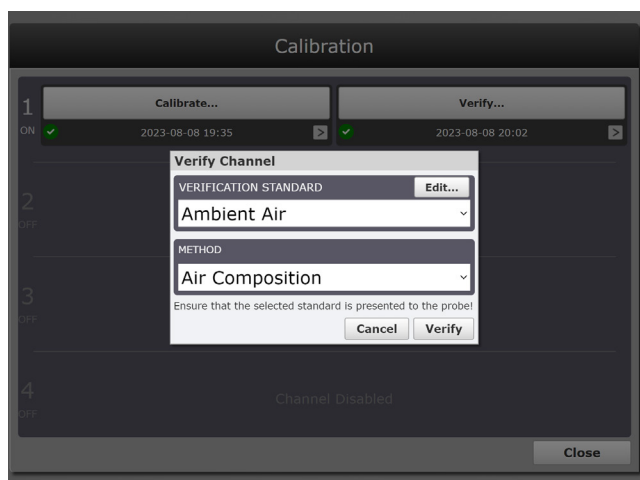


Figure 2: New Raman RunTime v6.5 calibration and verification interface for Raman Rxn5 gas analyzers

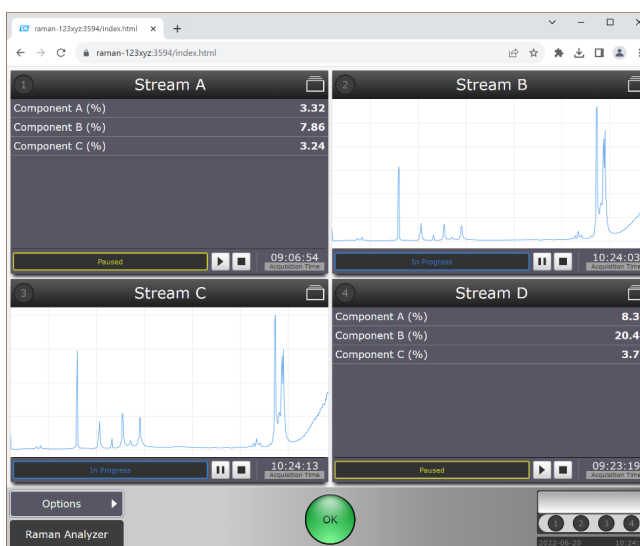


Figure 3: Raman RunTime's secure remote access (v6.4+)

Usability enhancements

Usability features have continuously been added to Raman RunTime to improve the user experience across different applications and industries. The most notable recent enhancements include support for standard web browsers for remote access, improved certificate management for swift deployment of secure connections, and alerts for low storage space (with version 6.5).

At Endress+Hauser, we have expanded our calibration and verification portfolio to better serve the needs of the Life Science industry and other markets in the future. Raman RunTime, as of v6.2.2, has added support for our new Raman calibration and verification kit product line that utilizes the new Calibration Reference Standard (CRS) technology. The new kits currently only support a limited selection of probe types. Please refer to *Comparing the Raman calibration and verification kits with the Raman calibration accessory (HCA) - Q&A* (doc code: PU01519C) for details.

Support for the condensed-phase LNG application was added to Raman RunTime in v6.3 when it brought Raman RunTime's unique self-monitoring, diagnostics, and self-calibration capabilities to the LNG custody transfer, truck loading, and bunkering industries. To facilitate this addition, support for acetone and cyclohexane-based surrogate verification standards were added. Details on the application can be sought by referring to *Raman technology for LNG* (doc code: IN01222C).

Raman RunTime features full system diagnostics, including historical trend monitoring of system component voltage, temperature, and power. In addition, Raman RunTime provides error messages and diagnostic fault codes through OPC and Modbus that provide insight to remote system monitoring and performance.

Raman RunTime v6.5 added support for enhanced certificate management that is utilized for encrypting HTTPS communication, which will facilitate local IT services teams when deploying trusted certificates to managed workstations. This helped further streamline the implementation of secure remote access that was introduced earlier in v6.4

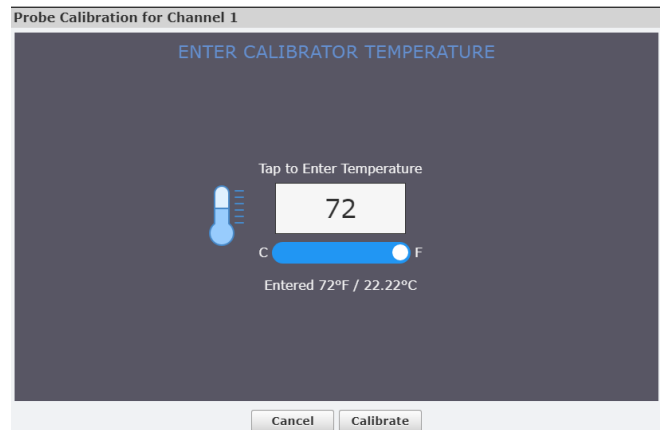


Figure 4: Raman RunTime's calibration screen when utilized with a Calibration Reference Standard (CRS) based calibration and verification kit

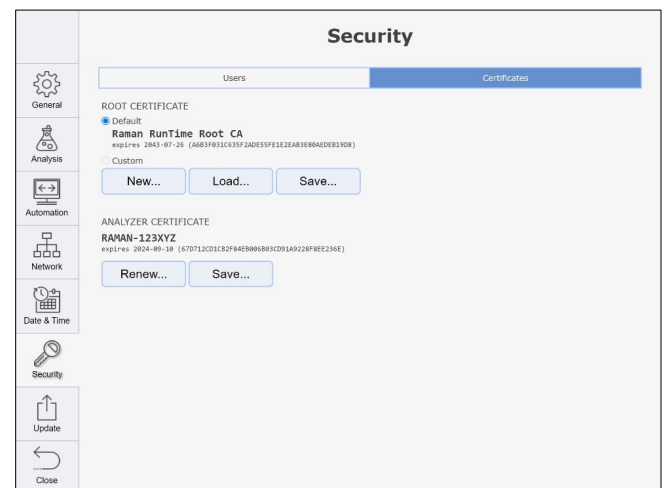


Figure 5: Raman RunTime's secure access management (v6.5+)

Communication protocols

OPC, Modbus, and HTTPS automation

Communication enhancements

Raman RunTime has the benefit of easy integration via OPC UA (preferred) or OPC Classic to many different OPC clients and through Modbus to distributed control systems (DCS). This includes PAT platforms such as synTQ™ (Optimal), SIPAT™ (Siemens), DeltaVTM Spectral PAT (Emerson), and Aspen Process Pulse™ (AspenTech), as well as basic process/reactor controllers, advanced process control systems (DCS, SCADA etc.), data historians, and more.

OPC clients can receive Raman RunTime data, including full spectra and diagnostics, and control Raman Rxn analyzers through OPC controls. Building on successful collaboration with multiple platforms, OPC tags have consistently improved system communication and integration abilities.

The value added by these improvements include:

- Custom names for spectra
- Flexible collection mode settings
- Collection option for no local storage of spectral data when used in conjunction with a PAT platform
- Proactive model output population for simple OPC client start up
- Detailed error messages
- Loading and usage of channel specific HCA intensity reference spectrum
- System-wide and channel-specific diagnostic fault codes
- Intensity reference spectrum name and calibration date

While Modbus remains a reliable communication protocol of choice, Raman RunTime enhances streamlined connection with on-site DCS with a standard Modbus map and simplified register mapping for predicted component values, accessible from the user interface. Raman RunTime supports both Modbus TCP/IP and Modbus RTU. Despite the limitations of Modbus when compared to OPC, Endress+Hauser has maximized its potential by integrating robust analyzer data, comprehensive control functionality, and detailed diagnostic fault codes through specific registers.

Model results can be viewed on-screen within Raman RunTime and sent via OPC or Modbus for process control. Raman RunTime's automation screen in Figure 6 shows options for Modbus communication for a model file. Additional model calculated properties can be selected for each model and channel, and then communicated along with the predicted values.

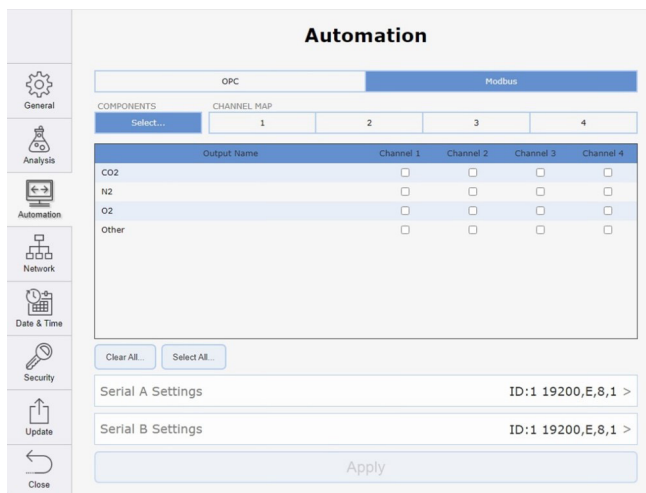


Figure 6: Raman RunTime's Modbus automation window

Prediction improvements

Multivariate model predictors

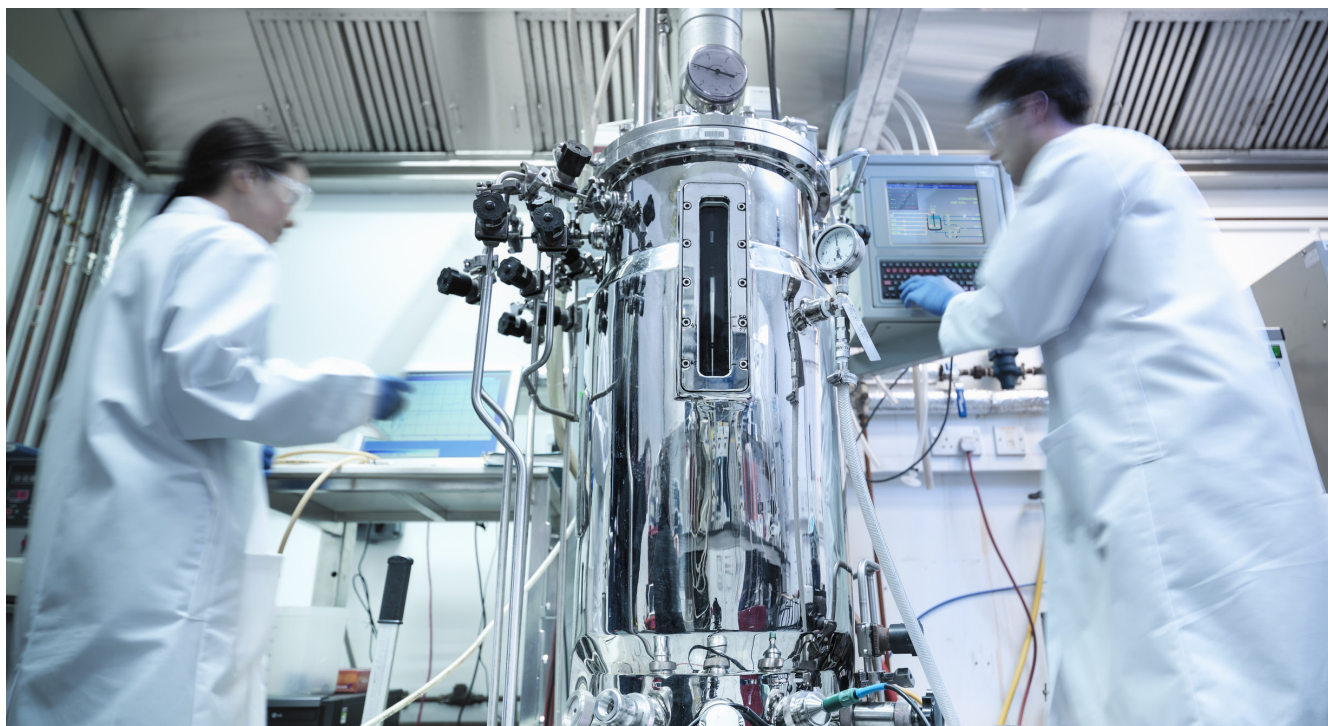
Predictors

With predictors in Raman RunTime, you can apply multivariate models to Raman spectra in real time. Model results may be viewed on-screen within Raman RunTime and sent via OPC or Modbus for process control. Please note that the various modeling packages will have different outputs that are defined by the modeling software, not Raman RunTime. Raman RunTime simply provides them as an option for viewing and output.

Raman RunTime supports the following predictors:

Raman RunTime version:		5.1	6.1	6.2	6.3	6.4/6.5
Predictor version:	SIMCA®-Q (Sartorius) *.usp, .rusp No hierarchical model support	14 Compatible with models built in SIMCA® 14, 13	15 Compatible with models built in SIMCA® 15, 14, 13	16 Compatible with models built in SIMCA® 16, 15, 14, 13 Excludes Python script support	16 Compatible with models built in SIMCA® 16, 15, 14, 13 Excludes Python script support	17 Compatible with models built in SIMCA® 17, 16, 15, 14, 13 Excludes Python script support
	GRAMS IQ™ (Thermo Fisher Scientific) *.cal	9.3 and previous	9.3 and previous	9.3 and previous	9.3 and previous	9.3 and previous
	PEAXACT (S-Pact) *.pxm, .pxs	N/A	4	4 and 5	4 and 5	4 and 5
	Aspen Unscrambler™ (Camo Analytics, An Aspen Technology Company) *.unsb	N/A	N/A	N/A	11.0 No support for Classification or Batch models. MLR models are not fully supported.	11.0 No support for Classification or Batch models. MLR models are not fully supported.
	Solo/PLS-Toolbox (Eigenvector) *.mat	N/A	N/A	N/A	8.9 Does not support Hierarchical Model Builder (HMB) models.	9.0 Does not support Hierarchical Model Builder (HMB) models.

Figure 7: Raman RunTime predictor compatibility matrix



Security

Raman RunTime is built upon robust protection measures for maintaining system integrity and prohibiting unauthorized modification. Endress+Hauser devices use proprietary, custom embedded controllers that have no facility for running non-Endress+Hauser software, and only accept updates authenticated and guaranteed by means of encrypted digital signatures.

Raman RunTime strictly enforces operation as a fixed-purpose device to eliminate any opportunity to compromise the system through either inadvertent or malicious user action. Network accessibility is narrow, and any protocols that could comprise Raman RunTime's defined functionality are restricted.

Constant vigilance

Raman RunTime is designed to eliminate the potential points of entry for malware. A redundant layer of real-time protection is provided in all versions of Raman RunTime v6.0+ in the form of built-in antivirus technology, tailored to the unique design of our embedded platform. Updates of Raman RunTime deliver updated threat definitions as needed.

Trust assurance

The security and reliability of Endress+Hauser Raman devices are enhanced by special trust-assurance features. Raman RunTime always starts up in a known, trusted state. Only changes which are expressly permitted by Raman RunTime can ever be permanently retained. Any other changes are automatically reset to the Raman RunTime defaults when the system initiates a restart, shuts down, or loses power.

Security

All user actions are carried out through the Raman RunTime's user Interface; there is no direct interaction with the low-level operating system (OS). Raman RunTime's customized embedded operating system ensures:

- Network accessibility limited to the protocols that comprise Raman RunTime's defined functionality (OPC and Modbus)
- Built-in antivirus protection
- System only accepts Endress+Hauser-supplied software that is verified as authentic and unadulterated through encrypted digital signatures
- Unauthorized modifications to the system are automatically purged upon reboot

Additionally, Raman RunTime includes User Management to password protect certain actions of analyzer functionality. Administrators, Operators, and Users can be created and managed. Figure 9 shows a Raman RunTime channel (probe) view with security enabled.

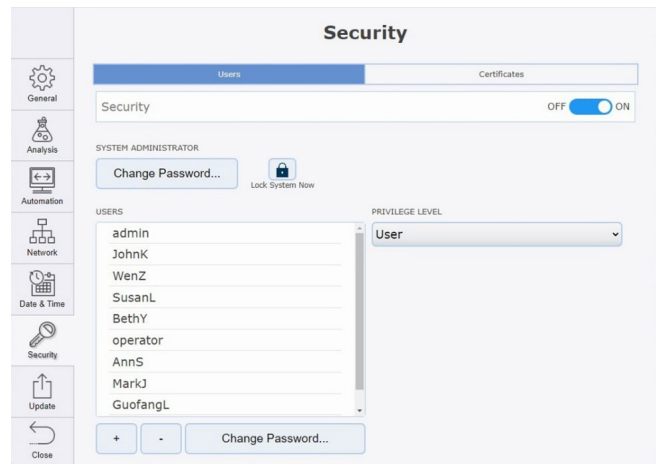


Figure 8: Raman RunTime's security page showing users with different security levels

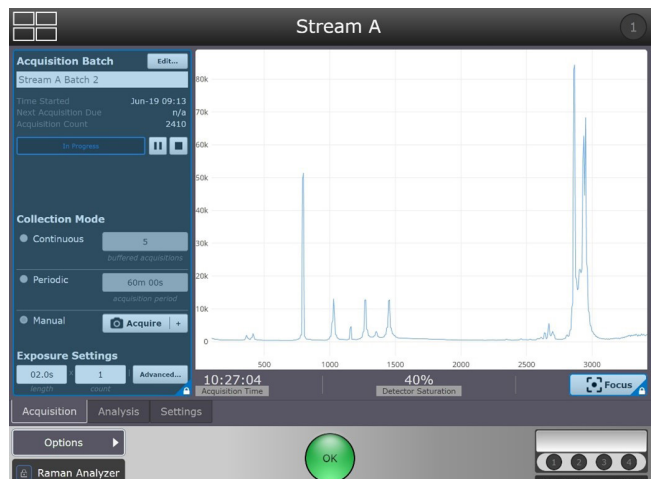


Figure 9: Example of user actions that are password protected when security is enabled

Annual software subscription

Predictable software maintenance to ensure easy budgeting and industry compliance

With the launch of our fully embedded Raman Rxn analyzer portfolio, we introduced an annual subscription plan for our Raman RunTime embedded software. The embedded analyzer portfolio offers you longevity of supply, lower cost of ownership, frequent improvements for IIoT connectivity, and new features for Raman-enabled process automation. The software subscription model builds

on these benefits by ensuring that analyzers are always current and in compliance with industry standards, making it easier for companies to budget for updates and support on an annualized basis. For more information, see *Raman RunTime annual software subscription plan* (doc code PU01436C).



Frequently asked questions

How is the Raman RunTime controller different than a standard PC?

Raman RunTime is an embedded platform that allows exclusive control of Endress+Hauser Raman Rxn analyzers. Endress+Hauser chose this direction to support the transition to IIoT / Industry 4.0.

Historically, running Endress+Hauser Raman software on a general-purpose PC exposed conflicts in data collection while running in conjunction with external programs such as antivirus software and automatic updates. Utilizing a dedicated controller allows the embedded software to operate in a more controlled environment and radically reduces the potential for field issues. Raman RunTime includes a variety of protection measures that maintain system integrity and protect it from unauthorized modification (see the security section on page 6).

What is Raman RunTime's operating system?

Raman RunTime uses an Endress+Hauser proprietary, custom-embedded controller. There is no interaction with the low-level operating system, so all functions of Raman Rxn analyzer control are carried out through the Raman RunTime user interface.

Can I install antivirus software or other programs?

To ensure full system integrity, Raman RunTime does not support installation of any other programs. Its secure design purges all attempted system changes upon reboot.

Can I use an encrypted or password-protected USB flash drive with Raman RunTime?

Raman RunTime does not support these types of USB flash drives. When standard USB drives cannot be used to upload or download to Raman RunTime due to company policy, we have provided the capability to execute common USB drive actions using the remote access feature across a local network.

Once Raman RunTime is network connected, you can use the remote access feature to upload and save items to or from the remote workstation instead of a local USB flash drive. This feature enables loading models, software updates, and intensity calibration files, as well as saving data, calibration reports, and diagnostic exports.

Is Raman RunTime compatible with Windows Active Directory?

Raman RunTime is compatible with Active Directory (AD) in that it can be deployed on a network that uses Active Directory with no loss of functionality. However, Raman RunTime does not integrate with the authentication services of AD, so access to the Raman RunTime system cannot be managed at the AD level.



Figure 10: Raman Rxn4 analyzers shown in NEMA-4X enclosure and rack-mounted versions ideal for process or manufacturing environments

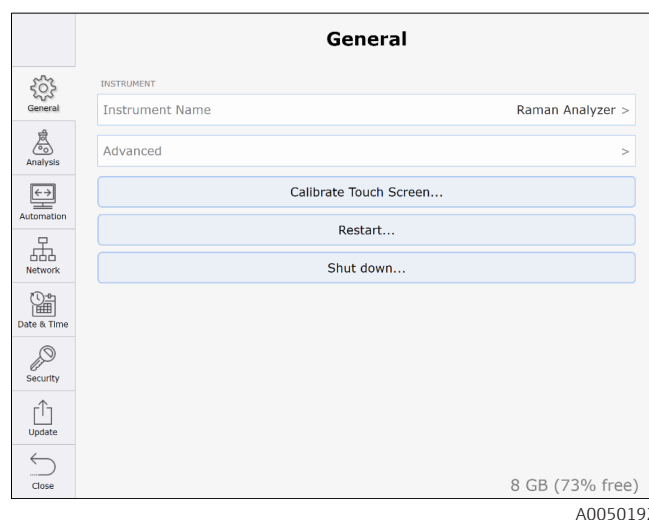
What are some of the data management features available to users within Raman RunTime?

The General tab in System Settings displays the amount of system memory (RAM) available on the analyzer, as shown in Figure 12. This can be helpful in monitoring the overall resources and to help troubleshoot potential performance issues.

Raman RunTime stores spectral files locally on the analyzer where it allows for it to be exported onto a USB flash drive. Locally stored data can be exported off the analyzer via Raman RunTime's remote access feature from any workstation on the same local network. SPC files are also available over a network shared folder that is updated in real time as data is acquired. Lastly, real time spectral data is made available in an encrypted manner via OPC for integration and data management with a PAT platform.

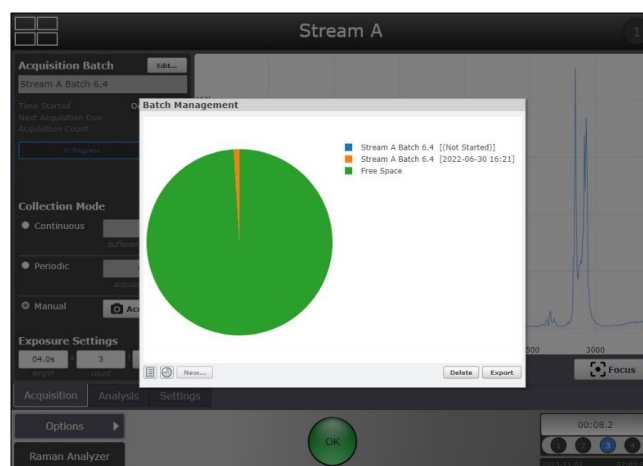
How much data can Raman RunTime store?

Raman RunTime's core definition is to continually collect Raman spectra 24/7/365 if needed. Therefore, it is not intended to be the primary source of spectra data storage. We recommended that data be regularly backed up externally, and removed from the Raman RunTime controller as soon as it is backed up. The data maintenance interval will depend on the individual Raman application since the data within each spectrum can vary, based on the sample being analyzed. To help give insight into the available storage, a pie chart representation is provided on the batch management screen of Raman RunTime. As seen in Figure 13, the batch management screen shows the amount of storage available on the analyzer and the amount of space each batch is utilizing, as a percentage value. Additionally, unused models or scrap data should be regularly purged from the system. Data management and storage is handled by the PAT platform of choice when Raman RunTime is used in conjunction with a PAT platform.



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Figure 12. Raman RunTime showing system memory (RAM)



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Figure 13. Raman Runtime's batch management screen showing the percentage of free storage



Figure 11: Raman Rxn2 for embedded analyzers shown in cart and bench-top versions ideal for the laboratory environment

Can Raman RunTime be used for cGMP manufacturing?

Yes, Raman RunTime may be used for cGMP manufacturing applications. It is already employed by several biopharmaceutical companies for cGMP bioprocess control. However, Raman RunTime's compliance depends on its intended use case. Stand alone, Raman RunTime does not meet all 21 CFR part 11 requirements. When used in combination with other cGMP-ready platforms such as process analytical technology (PAT) management software (synTQ, SIPAT, DeltaV Spectral PAT, Process Pulse) or direct DCS and data historian integrations, Raman RunTime meets 21 CFR part 11 requirements. We collaborate with these platform owners to develop and improve pre-configured adapters. With Raman RunTime's availability of controls and diagnostics through industry-standard automation protocols, additional integrations are possible. Raman RunTime has been successfully implemented and continues to perform within cGMP environments.

For example, current cGMP installations of Raman RunTime trigger all analyzer/probe calibrations and data collection from software that has full audit trail and data archival capabilities. In this case, all user actions and resulting data are fully traceable and unmodifiable per 21 CFR part 11 requirements.

The diagram below shows where these requirements lie for a Raman RunTime plus PAT platform integration.

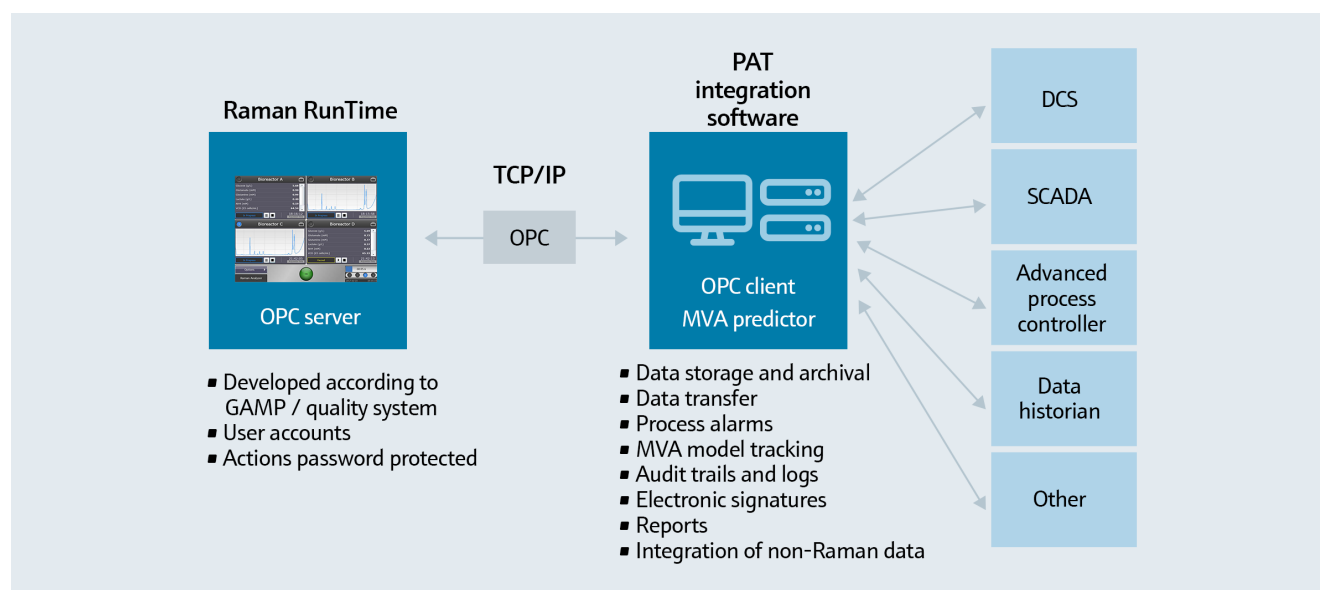


Figure 14: Raman RunTime installation example for cGMP showing where 21 CFR part 11 requirements are covered.

Conclusions

Raman RunTime is recognized as the control software solution for Endress+Hauser Raman analyzers and has been effectively implemented by many clients across major industries. New versions incorporate expanded predictors, upgraded functionality, and user requested improvements. Endress+Hauser will continue development of Raman RunTime to provide optimized Raman lab and process systems for many industries and applications.