

Deployment Validation of the Quantum Three-Dimensional Microscope System for use in Casework at the Virginia Department of Forensic Science

Purpose:

The purpose of this validation is to determine if the Quantum Three-Dimensional Microscope System can be utilized to perform virtual comparison microscopy (VCM) of cartridge cases and demonstrate the reproducibility and reliability of results for source determination.

Terms:

- 3D Toolmark Data: A digital representation of toolmark topography consisting of coordinates of points on the toolmark surface [1].
- Check Standard: A measurement standard that is used to periodically verify the performance of measuring instruments or measuring systems [2].
- Common (shared) check standard: A check standard that is shared and measured by all instruments within a network for the development and verification of the common control limit [2].
- False Negative: Source of a sample was determined to be an “Elimination” when the ground truth is Identification [3].
- False Positive: Source of a sample was determined to be an “Identification” when the ground truth is Elimination [3].
- Gauge Reproducibility (GR): The variation in measurements obtained when different operators measure the same sample using the same instrument [2].
- Ground Truth: The source of the sample is known [3].
- Individual (local) check standard: A check standard used for a specific instrument to track its performance [2].
- Known Different Source Toolmarks (KDS): Toolmarks known to have been made by different tools or different working surfaces of the same tool.
- Known Same Source Toolmarks (KSS): Toolmarks known to have been made by the same tool.
- Light Comparison Microscopy (LCM): The use of a comparison microscope with reflected light illumination for the visual side-by-side comparison of microscopic features between two toolmarks [1].
- Network: A collection of instruments or laboratories that share 3D topography measurement data for VCM applications. At DFS, the Central, Eastern, and Northern laboratories make up the Quantum network [2].
- Photometric Stereo: Surface topography measurement method in computer vision for measuring the surface normals of a surface by observing that surface under different lighting conditions. Given

sufficient independent light sources, the surface normals, and thus surface geometry, can be determined for every position on the surface [4].

- Quality Control Checks (QCC): Periodic measurement instrument performance tests conducted and documented to detect changes in the performance of the measurement instrument relative to its calibrated state [5].
- Reference Material (RM): Manufactured and certified to have repeatable surface topographies across the manufactured lot [2] (e.g. NIST SRM 2461 cartridge case).
- Sensitivity: A ratio of the number of same source comparisons with a result of identification to the number of same source comparisons [3].
- Specificity: A ratio of the number of different source comparisons with a result of elimination to the number of different source comparisons [3].
- Toolmark: Impressed and/or striated mark created when a harder object comes into contact with a softer object [3].
- Virtual Comparison Microscopy (VCM): The visual comparison of toolmarks using software that enables side-by-side viewing and manipulation of toolmark images without physical access to the samples [1].

References:

1. Technical Working Group for 3D Toolmark Technologies (TWG3D2T). Best Practices 03 (2026). *Best practice guide for quality control when using multiple 3D surface topography instruments*. <https://www.twg3d2t.org/documents/>
2. TWG3D2T. Best Practices 02. (2026) *Best practice guideline for conducting a virtual comparison microscopy (VCM) deployment validation for source conclusions in the firearms and toolmarks discipline*. <https://www.twg3d2t.org/documents/>
3. Dallas Police Department. (2025). *Deployment Validation of the Quantum Three-Dimensional Microscope System for use in Casework at the Dallas Police Department*.
4. Academy Standards Board. (2021). *ANSI/ASB Standard 061-21: Firearms and toolmarks 3D measurement systems and measurement quality control* (1st ed.). American Academy of Forensic Sciences. <https://www.aafs.org/asb-standard/firearms-and-toolmarks-3d-measurement-systems-and-measurement-quality-control>
5. TWG3D2T Best Practices 01. (2024). *Best practice guide for the calibration and quality control of 3D surface topography measurement instruments used for virtual comparison microscopy (VCM) of toolmarks, 1st Edition*.
6. Hanley, J. A., & Lippman-Hand, A. (1983). If nothing goes wrong, is everything all right? Interpreting zero numerators. *Journal of the American Medical Association*, 249(13), 1743–1745.

7. Academy Standards Board. (2021). *ANSI/ASB Standard 062-21: Standard for Topography Comparison Software for Toolmark Analysis* (1st ed.). American Academy of Forensic Sciences. <https://www.aafs.org/asb-standard/standard-topography-comparison-software-toolmark-analysis>
8. Academy Standards Board. (2021). *ANSI/ASB Standard 063-21: Implementation of 3D technologies in forensic firearm and toolmark comparison laboratories* (1st ed.). American Academy of Forensic Sciences. <https://www.aafs.org/asb-standard/implementation-3d-technologies-forensic-firearm-and-toolmark-comparison-laboratories>

Equipment:

- Quantum F1 3D Microscopes
- Current Q3M Software
- Traceable Reference Standards
 - Bull's eye/concentric rings pattern
 - Sine Wave 135µm wavelength, 10 µm amplitude
 - Check Standards:
 - Common check standard: RM - NIST SRM 2461 (Standard cartridge case)
 - Individual (local) check standards: Lab-generated test fires, one primary and one backup for each instrument
 - Firearm used: Ruger P85, 9mm Luger pistol, serial number 302-27886 (C-DFS reference firearm #24671)
 - Ammunition used: Federal 9mm Luger with Nickel cartridge case and Nickel primer material

Introduction:

The Quantum F1 system utilizes photometric stereo to create 3D renderings of the surface topography of cartridge cases. These 3D images can be compared directly on the Quantum System using the Q3M software. Virtual Comparison Microscopy addresses some of the limitations and challenges found in light comparison microscopy, such as variations in lighting conditions, issues mounting samples, sample orientation variation, limited depth of field, and excessive reflectivity. VCM provides users tools for annotating images and highlighting similarities and differences between samples. Additionally, the Quantum 3D microscope software allows users at different regional laboratories to easily share and access these images.

Limitations:

The main limitation of the use of Quantum Virtual Comparison Microscopy is the limited areas for comparison. Using the F1 system for cartridge cases, only the head of the cartridge case is captured. While the ability to capture other areas exists by using the Model S1 Quantum 3D Microscope, this will not be utilized in this validation.

Validation Manager: Forensic Scientist Senior Bronwyn McMaster will serve as Validation Manager (VM). The VM will serve as the proctor and oversee the validation process including test set creation, test distribution, training, and evaluating the results.

Lead Laboratory:

The Northern Laboratory will be responsible for creating a master reference measurement, establishing control limits in conjunction with the Program Manager, and maintaining the common control charts.

User Training:

Training is required prior to beginning the Validation Program. Training for individuals involved in image acquisition will include the following topics: calibration, sample preparation, mounting, acquisition, and image validation. For individuals who are involved in image comparisons, additional training will also cover comparisons and quantitative analysis using the RBL method and False Match Rate (FMR).

User training was provided to staff by LeadsOnline (combination of in-person and online training) or will be provided by a designated internal trainer. In-person training covered the above-listed topics (Appendix A).

Supplemental online training was provided on the LeadsOnline Training Portal and included an Introduction to the Quantum 3D Microscope and the following prerecorded webinars: “Introducing a game changer for firearm and toolmark examiners”, “Multi Caliber Quantitative Analysis Webinar”, “Working a case using a Quantum 3D Microscope vs. Conventional Microscope Webinar”, and “Examining Damaged Bullets with Quantum 3D Microscope”.

All participants must have received NIBIN Image Acquisition Training for cartridge cases and be authorized to perform NIBIN Image Acquisition.

Following successful completion of the in-person Training, all participants must successfully complete a competency test. For comparison examiners (Forensic Scientists), competency will be assessed through the acquisition of several cartridge cases, completion of a calibration check for the F1 System, and the completion of a cartridge case test set generated using previous CTS Tests. For individuals assisting with acquisition only (Forensic Scientist-NIBINs, Forensic Laboratory Specialists, and individuals cross-trained in the Firearms Section to assist with NIBIN entries), competency will be assessed through the acquisition of several cartridge cases and completion of a calibration check for the F1 System. Competency will be evaluated by the VM and will be Pass/Fail.

Image acquisition competency will be considered successful if all the following criteria are met:

- The object is free of any dirt or debris
- The object is in focus, and no stitching errors are observed
- The Regions of Interest are correctly marked and properly labeled

Calibration check competency will be considered successful if the following criteria are met:

- Successful navigation and completion of the calibration check
- Traceable Reference Standards fall within manufacturer's tolerances.

Virtual comparison microscopy competency will be considered successful if the correct source determination is made by the examiner (Appendix A).

Phase One: Validation of the Quantum F1 3D Microscopes – Gauge Reproducibility Study

Purpose:

The purpose of this study is to demonstrate the accuracy and consistency of surface topography measurement results across all Quantum F1 Systems in the VA DFS network (Central, Eastern, and Northern Laboratories).

Participants:

All Quantum F1 instruments within the VA DFS network will participate in this Gauge Reproducibility study. Individual participants in this phase of the validation will include: Comparison Examiners (Forensic Scientists), Forensic Scientist-NIBINs, Forensic Laboratory Specialists, and Forensic Scientists cross-trained to work in the Firearms Section, currently totaling approximately 21 individuals. All participants have received NIBIN Image Acquisition Training and are authorized to perform NIBIN Image Acquisition. In addition, they have either attended training provided by LeadsOnline or received internal training on the acquisition of cartridge cases using the Quantum F1 3D microscope. Following the training, participants will be required to pass a competency test (see Appendix A).

Procedure:

This phase will allow for the evaluation of the respective instrument's performance in a calibrated state and to establish threshold values to ensure significant changes in the systems do not go unnoticed. The following metrics will be monitored in this study and moving forward for ongoing quality control checks: Ra value of the sinusoid (sine) wave, Pixel Size from the bull's eye/concentric rings pattern, and the Breech Face (BF) and Firing Pin (FP) score for the Check Standard cartridge case (NIST 2461).

Selecting a Master Reference Measurement

Prior to the start of the Gauge Reproducibility Test, the VM will conduct a limited gauge reproducibility study to establish a master reference measurement. This 3D topography measurement will serve as the reference in all Quality Control Check (QCC) measurements across the network of instruments [1]. The VM will run a calibration check of the instrument and acquire the NIST 2461 standard cartridge case to establish the Common reference scan. This will be accomplished by scanning the common check standard ten times, removing and remounting between scans, and then running quantitative analysis on the scans. The average score will be taken for each scan and the scan with the highest average score will

become the master reference. These scans will be saved in the Reference Scan Workspace in the Firearms Network folder and labeled *Common Check Standard – REFERENCE #*. The scan that becomes the master reference will be renamed: *Common Check Standard – MASTER REFERENCE*.

This common check standard will be sent periodically in a round-robin style rotation to all laboratories within the network to develop and verify a common control limit.

In addition, each laboratory will maintain a primary individual (local) check standard and a backup check standard. A designee at each laboratory will run a calibration check of the instrument and acquire their assigned primary check standard and backup standard to establish local reference scans. This will be accomplished by scanning each check standard ten times, removing and remounting between scans, and then running quantitative analysis on the scans. The average score will be taken for each scan and the scan with the highest average score will become the master references for the primary and backup check standards. These scans will be saved in the Reference Scan Workspace in the Firearms Network folder and labeled *[Lab] Local Check Standard – REFERENCE #*. The scan that becomes the master reference will be renamed: *[Lab] Local Check Standard – MASTER REFERENCE*.

Part 1: Quantum F1 System

Each participant will run a calibration check and acquire their lab's assigned primary check standard once a day over ten days (days do not have to be consecutive). The scan acquisitions will be labeled as follows: *[Lab] Primary Check Standard – DATE – INITIALS*. Once each item has been acquired, a Quantitative Analysis must be performed between the Master Reference Scan and the newly acquired scan. Both scans will be "Unknowns" on the sample selection window. The Date and Time of the calibration check, the Ra value of the sinusoid wave, the pixel size from the bull's eye, and the check standard BF and FP Scores will be recorded on the *Gauge Reproducibility Data Sheet*.

Reporting of Results:

Participants will record their calibration check results and the acquisition names of the Check Standards on the *Gauge Reproducibility Data Sheet* (Appendix C) and provide them to the designee at the Lead Laboratory for data analysis.

Data Analysis will include the creation of Control Charts. For the F1 System, the following control charts will be created:

- Sinusoid Wave - Ra value
- Bullseye – Pixel Size
- Check Standard – BF Score
- Check Standard – FP Score

The Control Charts used are templates provided by the Technical Working Group of 3-Dimensional Toolmark Technology (TWG3D2T). The two-sided Control Chart Template will be used to track Traceable Reference Standard Measurements. “For a two-sided control chart (e.g., monitoring a step height measurement), there are upper and lower warning and control limits. The upper and lower warning limits are calculated and drawn at ordinate values equal to the mean plus and minus 2.0 times the standard deviation (95% confidence level). Similarly, the upper and lower control limits are calculated and drawn at ordinate values equal to the mean plus and minus 3.0 times the standard deviation (99.73% confidence level)” [5]. The one-sided Control Chart will be used to track the Comparison Algorithm Scores for each score listed above. “For a one-sided control chart (e.g., monitoring a similarity score), a single lower warning limit and a single lower control limit are established. The warning and control limits are calculated and drawn at ordinate values equal to the mean minus 1.645 times (95% confidence level) and 2.782 times (99.73% confidence level) the standard deviation respectively” [5].

Validation Requirements:

This system will be successfully validated for image acquisition of VCM images for use in the continuation of the validation and pending successful completion of phase 2 (use in casework) following the creation of control charts and continued successful Quality Control Checks (QCC).

Phase Two: Validation of Virtual Comparison Microscopy utilizing the Q3M Software

Participants:

Participants in this phase of the validation will include Comparison Examiners from the Virginia Department of Forensic Science, totaling approximately fifteen individuals. All participants are authorized to perform microscopic analysis of firearms evidence and underwent training provided by LeadsOnline or a designated internal trainer. Following both virtual and hands-on training, participants will be required to pass a competency test (See Appendix A). Ten practice sets (consisting of two known and one unknown/question cartridge cases) were assigned to each comparison examiner to be completed following the completion of their training and before beginning their competency test.

Test Set Creation:

For this validation a total of 130 cartridge case test sets will be created. Each test set will include two knowns and one unknown/question sample. Calibers and brands selected for this study are based on DFS Firearm Database entries from July 1, 2025, through July 1, 2026, with an inclusion threshold of 0.5%. The test sets will include the following calibers, grouped by size:

- Small caliber: 22LR, 223 Remington / 5.56x45mm, 5.7x28mm, 7.62x39mm, 300 Blackout
- Medium caliber: 357 SIG, 380 Auto, 9mm Luger, 38 Special, 40 S&W, 10mm Auto
- Large caliber: 45 Auto and 12 Gauge

Across all sets, approximately 15% will consist of small calibers, 75% medium calibers, and 10% large calibers. Within each caliber category, firearm brands most frequently observed in casework will be proportionally represented. Reference firearms used to create test sets will include a range of manufacturers and models.

Ammunition used in test set creation will be similar within test sets but overall will include a variety of cartridge case and primer metal compositions. The VM will oversee the test firing of firearms and will assemble and assign the test sets. Cartridge case test sets will be equally distributed between the three laboratories to be acquired by users on all three instruments. All DFS test sets will be scanned on the Quantum F1 System following successful completion of Phase 1. A day-of-use quality control check will be performed prior to test set acquisition. This will include the performance of a calibration check, the acquisition of the check standard, and entry into and evaluation of the control chart. The VM will inspect DFS test set scans for suitability during test compilation.

An additional 110 test sets provided by the Dallas Police Department will be used in this study. These test sets have been acquired on the Quantum System and the set design is identical, containing two known samples and one unknown/question sample.

A total of 240 independent test sets will be included in the validation, with 120 test sets being ground truth same source and 120 test sets being ground truth different source. The answer key will be retained by the VM.

Test Set Distribution:

Each participant will be randomly assigned 20 cartridge case test sets for primary examination and 5 cartridge case test sets for verification. Verification test sets will not be marked as such and will be treated no differently than the primary examination test sets. The verification test sets will be selected and will not include previously assigned test sets for that participant. Each test set will be examined at least once, with at least 60 test sets being examined more than once. Each participant will receive a link to a folder containing the randomly assigned test sets. Test set ground truth will not be considered for test set distribution to prevent conclusion bias.

Procedure:

Participants will treat the comparisons on the Quantum System no differently than casework samples. Participants will follow VADFS Firearm/Toolmark Section Procedures Manual for microscopic comparison of firearms evidence. The following conclusions will be available for participants (Identification, Inconclusive, and Elimination). Each participant will examine the test sets to reach a source determination conclusion. The *VCM Datasheet* (Appendix C) will be used to document the conclusions, the reason for any inconclusive conclusion, and the mechanism mark(s) used. A minimum of one photograph will be required to support each conclusion.

NOTE: Use of analysis tools, to include “Quantitative Analysis” and “Best Match Position” will not be permitted during this phase of the validation study.

Reporting of Results:

All results will be submitted to the VM for evaluation and data analysis. The False Positive and False Negative Error Rate will be calculated based on the submitted results. Inconclusive results are considered a correct response, as it is neither a false positive response nor a false negative response; however, these results will be reported separately to show the percentage of inconclusive results. Sensitivity and Specificity will also be calculated.

The formula for False Negative Error Rate (FNER), False Positive Error Rate (FPER), Sensitivity, and Specificity will be as follows:

		Experimental Results		
		Same Source	Inconclusive	Different Source
Ground Truth	Same Source	True Positive (TP)	Inconclusive Same Source (Iss)	False Negative (FN)
	Different Source	False Positive (FP)	Inconclusive Different Source (Ids)	True Negative (TN)

$$\text{False Positive Error Rate} = \frac{FP}{(TN + Ids + FP)}$$

$$\text{False Negative Error Rate} = \frac{FN}{(TP + Iss + FN)}$$

$$\text{Sensitivity} = \frac{TP}{(TP + Iss + FN)}$$

$$\text{Specificity} = \frac{TN}{(TN + Ids + FP)}$$

[1]

If no errors are observed, an approximate error rate will be calculated using the “rule of three” approximation [6]. This will show the true error rate for the method will be between 0 and p_u (upper limit of the estimated error rate). The laboratory will utilize 95% confidence level for the calculation of p_u . The formula for the upper limit of the estimated error rate is as follows:

$$p_u = 1 - \left(1 - \frac{C}{100\%}\right)^{1/n}$$

Where C is the confidence level, and n is the number of independent comparison sets.

Verification Test Sets will not be used in the calculation of Error Rates, Sensitivity, and Specificity. Verification results will be compared directly to the primary examination results to determine if the conclusions agree. A conclusion is not in agreement when the primary examination conclusion is different than the verification examination conclusion. Should disagreement be observed it will be documented in the Validation Summary and the potential source of disagreement will be investigated by the VM.

Validation Requirements:

Virtual Comparison Microscopy will be successfully validated and deployed for use in casework if the False Positive and False Negative Error Rate are determined to be less than or equal to 5%, at 95% confidence. If errors are observed, a Root Cause Analysis will be performed and additional test sets will be completed until the approximate error rate is below 5%.

Next Steps:

Following the successful completion of this validation plan, the laboratory will develop standard operating procedures for VCM Image Acquisition and VCM for Source Determination for cartridge case evidence. Following implementation, an ongoing evaluation will take place through routine proficiency tests.

A follow up validation plan may be conducted for the purpose of reducing the error rate approximation of the method. This will include additional test sets and proficiency tests being completed utilizing VCM. Error rates will be recalculated following any error and/or after every ten test sets.

Appendix A: Training Policy

Virginia Department of Forensic Science Internal Quantum Training for Cartridge Cases Acquisition Only

1.1 Objectives

1.1.1 To become familiar with the software and hardware of the Quantum systems

- Understanding software functionality (e.g., loading items for comparison)
- Understanding instrument settings (e.g., magnification, focus, lighting intensity/direction, and sample manipulation)
- Toolmark image quality (e.g., Region of interest (ROI) acquisition and identifying missing ROIs)
- Scan acquisitions and retention

1.1.2 To become familiar with the Quality Control Checks, what they are and why they are needed

1.1.3 To become familiar with sample preparation/cleaning

1.2 Prerequisites

1.2.1 NIBIN Image Acquisition Training for cartridge cases

1.2.2 Authorization to perform NIBIN Image Acquisition

1.3 Required Reading/viewing

1.3.1 Quantum Acquisition PowerPoint

1.3.2 Webinar (located on Leads Online website) “Introducing a game changer for firearm and toolmark examiners”

1.4 Study Questions

1.4.1 What is photometric stereo and how is it used to generate a 3D rendering of the cartridge case head?

1.4.2 What is a workspace?

1.4.3 What is a calibration check, why is it completed, and how frequently it should be completed on the Quantum system?

1.4.4 What is the proper sample preparation for entry into the Quantum system?

1.4.5 How is Quantum different than IBIS?

1.4.6 Define the following terms:

1.4.6.1 Toolmark

1.4.6.2 Light Comparison Microscopy (LCM)

1.4.6.3 Virtual Comparison Microscopy (VCM)

1.4.6.4 Reference material

1.5 Practical Exercises

1.5.1 Discuss with the TC what the Quantum system is used for and how it is different from IBIS.

1.5.2 Discuss with the TC acquisition procedures for cartridge cases, both rimfire and centerfire.

1.5.3 Discuss with the TC the Quantum software, including acquisition tools.

1.5.4 Discuss with the TC how to properly handle the reference materials.

1.5.5 Obtain 10 cartridge cases from your TC and image them in the Quantum system.

1.6 Evaluation

1.6.1 Complete a competency test for entry.

Virginia Department of Forensic Science Internal Quantum Training for Cartridge Cases Acquisition and VCM

1.1 Objectives

1.1.1 To become familiar with the software and hardware of the Quantum systems

- Understanding software functionality (e.g., loading items for comparison)
- Understanding instrument settings (e.g., magnification, focus, lighting intensity/direction, and sample manipulation)
- Toolmark image quality (e.g., Region of interest (ROI) acquisition and identifying missing ROIs)
- Understanding scan acquisitions and retention
- Understanding Virtual Comparison Microscopy

1.1.2 To become familiar with the Quality Control Checks, what they are and why they are needed

1.1.3 To become familiar with sample preparation/cleaning

1.2 Prerequisites

1.2.1 NIBIN Image Acquisition Training for cartridge cases

1.2.2 Authorization to perform NIBIN Image Acquisition

1.3 Required Reading/viewing

1.3.1 Quantum Acquisition and Analysis PowerPoint

1.3.2 Webinar (located on Leads Online website) “Introducing a game changer for firearm and toolmark examiners”

1.3.3 Webinar (located on Leads Online website) “Multi Caliber Quantitative Analysis Webinar”

1.3.4 Webinar (located on Leads Online website) “Working a case using a Quantum 3D Microscope vs. Conventional Microscope Webinar”

1.4 Study Questions

1.4.1 What is photometric stereo and how is it used to generate a 3D rendering of the cartridge case head?

1.4.2 What is a workspace?

- 1.4.3 What is a calibration check, why is it completed, and how frequently it should be completed on the Quantum system?
- 1.4.4 What is the proper sample preparation for entry into the Quantum system?
- 1.4.5 How is Quantum different than IBIS?
- 1.4.6 What is the RBL graph and how can it be used to interpret results?
- 1.4.7 What is False Match Rate?
- 1.4.8 What is the subclass warning coefficient?
- 1.4.9 Define the following terms:
 - 1.4.9.1 Virtual Comparison Microscopy (VCM)
 - 1.4.9.2 Reference material
 - 1.4.9.3 Ground Truth
 - 1.4.9.4 False Positive
 - 1.4.9.5 False Negative
 - 1.4.9.6 Specificity
 - 1.4.9.7 Sensitivity
 - 1.4.9.8 Check Standard
 - 1.4.9.9 Gauge Reproducibility
 - 1.4.9.10 Quality Control Chart (QCC)
 - 1.4.9.11 Virtual toolmark image

1.5 Practical Exercises

- 1.5.1 Discuss with the TC what the Quantum system is used for and how it is different from IBIS.
- 1.5.2 Discuss with the TC acquisition procedures for cartridge cases, both rimfire and centerfire.
- 1.5.3 Discuss with the TC the Quantum software, including acquisition tools.
- 1.5.4 Discuss with the TC how to properly handle the reference materials.
- 1.5.5 Obtain 10 cartridge case sets from your TC, image them in the Quantum system, and render VCM results, to include annotated images that support the results.

1.6 Evaluation

- 1.6.1 Complete a competency test for entry and review.

VA DFS Firearm/Toolmark Section – Quantum Acquisition Training

MODULE 1

Quantum F1 System Familiarization and Cartridge Case Acquisition

PURPOSE Become proficient in navigating the Quantum Application, mounting and acquiring cartridge cases, and validating cartridge case images.

ELEMENTS Fired cartridge cases
 Quantum F1 System

The trainee must complete the on-site training provided by LeadsOnline or Authorized Quantum User. The training will cover the following:

- Running a Calibration Check
- Mounting the cartridge case in the cartridge case holder
- Navigating the Quantum Application
- Acquiring centerfire and rimfire cartridge cases with various firing pin shapes
- Validating images and masking regions of interest

Upon completion of this training, the trainee must successfully complete a Competency Test to satisfy the training requirements for this module.

Trainee:

Trainer:

Date completed:

COMPETENCY EXAMINATION- Cartridge Case Acquisition

Trainee: _____

Instructions:

Run a Calibration Check on the Quantum System. **Record Date and Time below.**

Create a new Workspace titled **Competency – NAME**.

Perform acquisitions of the provided samples. For the centerfire cartridge cases, acquisition should include the Breechface (BF), Firing Pin (FP) and Ejector mark (EJT). For the rimfire cartridge case, acquisition should include the FP.

Sample	CC Type:	FP Shape:	Image Free of Dirt/Debris:	BF Ring Placement	FP Ring Placement	EJT properly identified:
1	Centerfire	Hemispherical				
2	Centerfire	Elliptical				

Sample	CC Type:	FP Shape:	Image Free of Dirt/Debris:	FP placement
3	Rimfire	Rectangular		

CALIBRATION CHECK DATE AND TIME: _____

The trainee should demonstrate an understanding of how to:

- | | |
|---|----------|
| 1. Run a calibration check and verify status | Yes / No |
| 2. Acquire cartridge cases with Quantum System | Yes / No |
| 3. Create a new case/workspace in Quantum | Yes / No |
| 4. Correctly mount cartridge cases in the sample holder | Yes / No |

PASS / FAIL

Comments:

Trainer:

Date:

VA DFS Firearm/Toolmark Section – Virtual Comparison Microscopy Training

MODULE 1

Quantum System Familiarization and Virtual Comparison Microscopy

PURPOSE	Become proficient in navigating the Quantum Comparison Viewer, and to render source conclusions from acquired images
ELEMENTS	Fired cartridge cases Quantum Application

The trainee must complete the on-site training provided by LeadsOnline or Authorized Quantum User. The training will cover the following:

- Navigating the Comparison Viewer
- Understanding image display adjustments and manipulating both the items and the lighting
- Managing Images in the Comparison Viewer

Prior to completing this Module, the trainee must be authorized to perform Microscopic Comparisons of Firearms Evidence. Upon completion of this training, the trainee must successfully complete a Competency Test to satisfy the training requirements for this module.

Trainee:

Trainer:

Date completed:

COMPETENCY EXAMINATION - Virtual Comparison Microscopy

Trainee _____

Instructions:

Each test set contains two known samples (TF1 and TF2) and one unknown sample (Q1). Perform a microscopic comparison to determine if the unknown item was fired in the firearm.

For each set, report one of the following conclusions: Identification (ID), Elimination, (ELIM), or Inconclusive (INC). Provide the reason for any inconclusive conclusion in your examination notes. Provide a minimum of one image to support each conclusion. Do not use analysis tools, including Quantitative Analysis and Best Match Position.

Test Set #:	Comparison Matrix			
	Item #	Item # (Standard)	Conclusion:	Examination Notes:
1				
2				

The trainee should demonstrate an understanding of how to:

- | | |
|--|----------|
| 1. Load samples in the Comparison Viewer | Yes / No |
| 2. Utilize the Comparison Viewer to render a source conclusion | Yes / No |

PASS / FAIL

Comments:

Trainer:

Date:

Appendix B:**Gauge Reproducibility Data Sheet – F1****Name:** _____

Date:	Pixel Size (nm)	Ra Value (nm)	Primary Check Standard – CC		Back-Up Check Standard – CC	
			BF Score	FP Score	BF Score	FP Score

Appendix C:

VCM Data Sheet

Name: _____

Instructions: Each test set contains two known samples (TF1 and TF2) and one unknown sample (Q1). Perform a microscopic comparison to determine if the unknown item was fired in the firearm.

For each set, report one of the following conclusions: Identification (ID), Elimination, (ELIM), or Inconclusive (INC). Provide the reason for any inconclusive conclusion in your examination notes. Document the mechanism mark(s) used and provide a minimum of one image to support each conclusion.

Do not use analysis tools, including Quantitative Analysis and Best Match Position.

Test Set #:	Conclusion:	Examination Notes: