PROSCIA®

SOLUTION BRIEF

Automating Quality Control in Digital Pathology Workflows

Automatically identify common slide and image artifacts to improve workflow efficiency and data quality in your life sciences environment.

Digital pathology is unlocking new insights that accelerate discovery, improve patient outcomes, and fulfill the promise of precision care.

But artifacts and image quality issues – imperfections in slides or images – can still be introduced during the manual slide preparation and digitization process. If these artifacts go undetected, they can adversely skew research findings, as well as create significant downstream complications and costly rework. For example, rescan rates and reprep rates of 3-5% are common, with some labs seeing upwards of 10%.

Without a technology-assisted way of detecting artifacts early in the process, you will need significant resources available to review images and ensure they are of sufficient quality before they are sent for analysis. Often, labs dedicate between 0.5-1 FTE per scanner to manually spot check each image. Variations in what constitutes "poor quality" for reviewers can result in inconsistencies in what gets flagged and what passes through for analysis by scientists.

Even if you have legacy tools for artifact detection, most of them have limited capabilities, support limited scanners, and can't be fully embedded into your digital pathology workflow. What's needed is an automated-quality control solution that can detect the full range of artifacts with speed and accuracy and works seamlessly within your current workflow.

Boost Slide Quality with Automated Quality Control (QC)

Automated QC is an AI-enabled module that can be added to the Concentriq® LS platform to automatically identify commonly occurring slide and image quality artifacts. Unlike manual and other QC tools, Automated QC offers more comprehensive QC detection capabilities, is scanner agnostic, and integrates seamlessly into your routine research workflow. The software detects artifacts and flags affected images to both optimize the quality-control process and improve the quality of data driving that research. As a result, Automated QC improves clinical and research workflow efficiency and the quality of data analyzed by pathologists.

6X faster

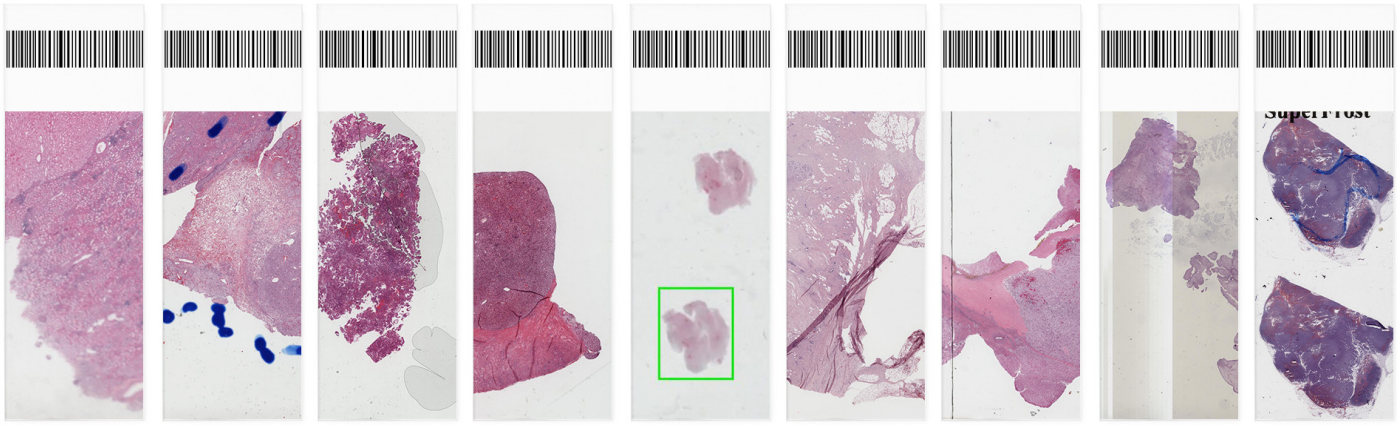
Using Automated QC in a simulated manual review process resulted in a 6X faster review of artifacts at the highest sensitivity setting, which catches 99% of artifacts.*

How It Works

Automated QC analyzes whole slide images generated from formalin-fixed paraffin-embedded (FFPE) tissue stained with hematoxylin and eosin (H&E), immunohistochemistry (IHC) or special stains and identifies the image or slide quality artifacts present. Catch artifacts early so they can be addressed before they reach pathologists, undergo image analysis, or get shipped to customers. Save your entire team a great deal of time, cost and frustration – and keep workflows moving efficiently. Figure 1 shows what artifacts are detected by Automated QC.

* Versus manual review of artifacts at high power. Measured in a timed trial by Proscia scientists.

Figure 1: Automated QC provides comprehensive detection of slide artifacts.



Types of Artifacts Detected by Automated QC

Out of Focus
The scanner produces an image with blurry, out of focus (OOF) areas.

Pen Mark
Pen marks cover any area of the glass slide.

Air Bubble
Air bubbles form under the coverslip when air is trapped in the mounting medium.

Cut Off Tissue
Tissue is cut off at the edge of the viewable area due to poor scanner detection, tissue placement, or a sharp ending to the image.

Unscanned Tissue
One or more pieces of tissue from the slide are missing in the scanned image.

Tissue Fold
Folding or overlapping of tissue occurs when it is placed on the slide or during a water bath.

Coverslip Line
A line is seen on the top or side edge of the image from a coverslip that is misaligned, too small, or angled.

Striping
A checkerboard pattern or banding appears on an image. Often grayscale.

Printed Slide Mark
Printed marks such as text or symbols on the physical slide that are visible in the scanned region and can occasionally obscure tissue.

No Macro
There is no macro image present, either due to a scanner setting, limitation, or a technical error.

Streamline Your Pathology Workflow

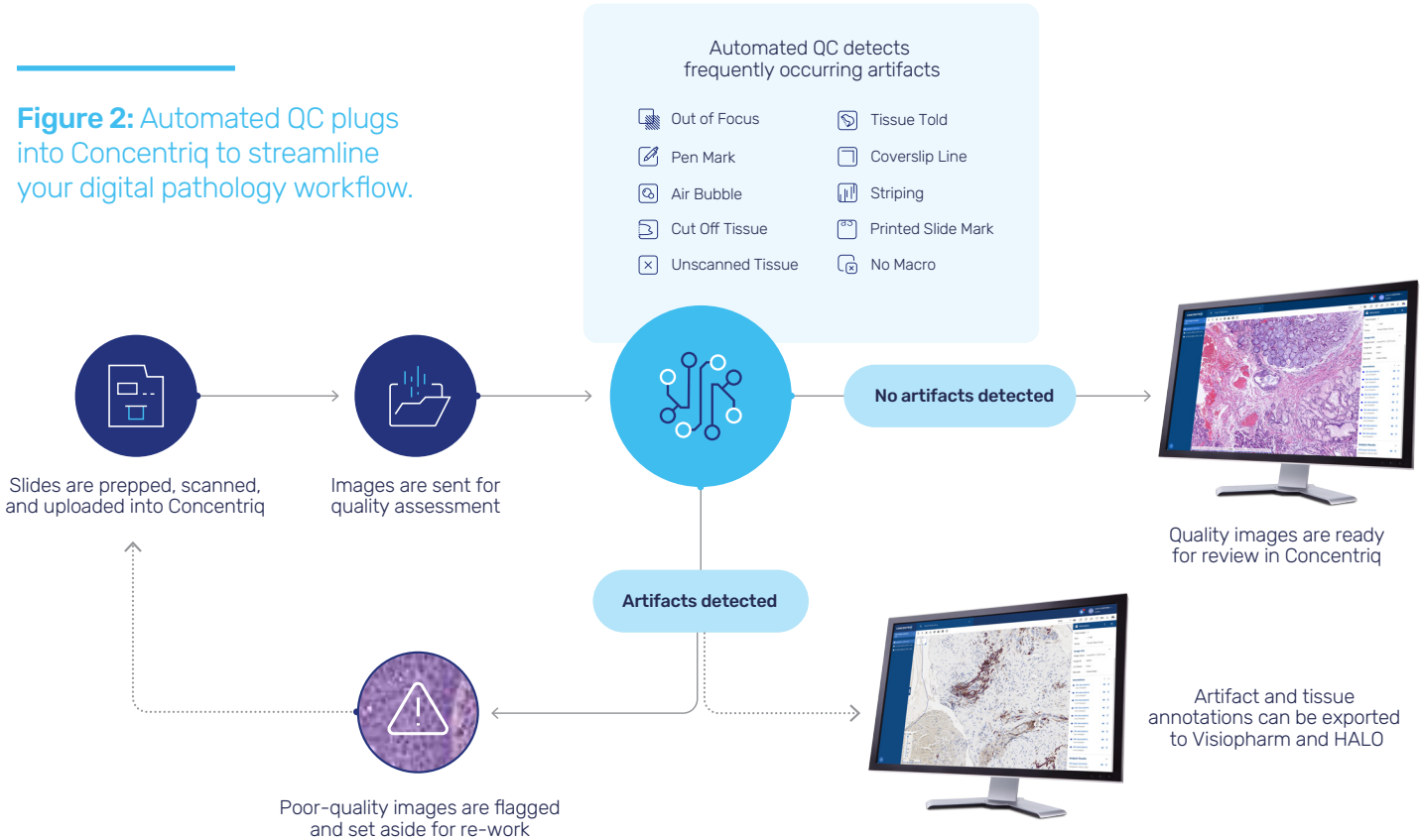
Automated QC is ideal for both high-volume contract research organizations (CROs) and biopharma companies. As illustrated in Figure 2, your team manually preps, scans and uploads slide images into the Concentriq LS platform. Images flow to Concentriq LS, where Automated QC detects and flags frequently occurring artifacts – including artifacts that occur as the result of slide preparation or scan issues. The software even identifies the tissue or slide area affected by each artifact type, allowing easy confirmation of the artifact regions, which can be shared with downstream analysis applications. Automated QC also measures the percentage of tissue covered by artifacts and the area of the usable tissue which is not affected by artifacts. The Automated QC artifact detection and tissue information allows poor-quality images to be quickly identified and set aside for rework. Automated QC will also show when no issues are found on a slide, so it's clear when slides are ready for review.

Automated QC can process hundreds or thousands of whole slide images in the time it takes to grab coffee, with a lightweight model and autoscaling available on Proscia's cloud-based solution.

Every laboratory has different quality-control standards. Automated QC supports configuration to closely mirror the unique quality-control needs of your laboratory. Automated QC can be configured during deployment to enable or disable specific artifacts and to set the relative sensitivity of enabled artifacts.

You have the option to select one of three sensitivity configurations for each artifact type prior to deployment, which determines the threshold at which the artifact is automatically flagged. For example, your laboratory may want to disable out-of-focus detection if it is not an artifact that is actionable for your workflow. You may only want to flag out-of-focus regions that obscure a large portion of tissue. Or, you may want high sensitivity to detect the smallest out-of-focus regions whenever they occur - maximizing the available information about artifacts on your slides. Every laboratory is different, and now you can set automated standards to match your own.

Figure 2: Automated QC plugs into Concentriq to streamline your digital pathology workflow.



Customize Your Configuration

You may choose one of four configuration options (Off, Low, Medium, High) for each artifact. The setting will be applied by Proscia on deployment.

Artifact Off	Low Sensitivity	Medium Sensitivity	High Sensitivity
Artifact won't be detected.	Detects only large, major artifacts affecting tissue.	Detects only moderate or large artifacts.	Detects any size artifact - major to very minor.
Beneficial if you would not take any action if you encounter this artifact, and therefore prefer not to have it detected.	Beneficial if you only want actionable artifact information. Often requested by organizations using Automated QC to aid the pathologist quality-control review.	Beneficial if you want to balance actionable artifact information with higher sensitivity.	Beneficial if you prefer to detect all artifact information. Often requested by organizations using Automated QC to aid existing robust histotechnician quality-control reviews.

Save Time and Gain Confidence with Automated QC

With Automated QC for Concentriq, everyone benefits because slides with defects are automatically identified and sent for remediation as early as possible in your pathology workflow – when it is easiest and most cost-effective for the research process. Additionally, slide images and artifact regions are quickly identified for exclusion before they have a chance to corrupt downstream image analysis.

- **Research Directors** – Automated QC reduces image review time and rescan requests later in the research process that slow turnaround times, freeing up lab techs and researchers to focus on higher-value work. Research directors can be confident that the data their lab creates is high quality and defensible.
- **Lab Techs** – Automated QC detects issues right away, and even highlights the specific areas of slides with suspected issues. As a result, lab techs spend less time reviewing slides and looking for detected issues and more time on higher-value work.
- **Pathologists** – Automated QC reduces the likelihood that pathologists will encounter a poor-quality image. It flags these images prior to lab techs even beginning their review, giving pathologists greater confidence that they can work on high-quality slides with minimal disruption and rework.
- **Data Scientists** – Automated QC helps ensure that the data they are using to do everything from performing complex analysis of imaging data to development of their own algorithms is based on a solid data foundation.
- **Research Scientists** - Automated QC helps research scientists using image analysis tools by ensuring that the algorithms are running on highest-quality slides and data.

How was Automated QC validated?

Automated QC was developed with expertise from pathology professionals, including pathologists, histotechnicians, and laboratory administrators.

To support good performance, product development with a large amount of image data that is as varied as your organization's is required. Automated QC has been trained and tested on over 77,000 images, with four scanner vendors, eight organ types and growing. Proscia grew the Automated QC dataset by 20% in the past year.

In a test set of over 100,000 quality-control tasks on over 10,000 slide images, at its default operating point, Automated QC achieved an average accuracy of 96% compared to ground truth determined by a single rater per slide. Automated QC agreed with the human rater on a pass/fail decision 75% of the time. This performance is higher than the 73% reported agreement between human expert raters noted by Chen et al [1] and thus is consistent with state-of-the-art performance. Automated QC performance can be further tailored to the requirements of your lab using Automated QC's configuration settings.

1 Chen et al. (2021). Assessment of a computerized quantitative quality control tool for whole slide images of kidney biopsies. Journal of Pathology, 253(3), 268-278. doi: 10.1002/path.5590

Realize the Benefits

With Automated QC for Concentriq LS, you can:

Start studies faster by increasing efficiency. Now you can catch slides that need a rescan earlier in the workflow and present them to reviewers in a way that reduces overall review time. This drives efficiency, reduces turnaround time, and lowers costs.

Drive better results by improving data quality. Automated QC significantly reduces the possibility of compromised images being introduced into the research process, helping to ensure that the data driving research efforts – and the data used to train and validate machine learning algorithms – is reliable. Automated QC also reduces the variability of manual review to increase data consistency and study repeatability.

Improve operational efficiency and reduce turnaround times. By improving quality-control workflows, identifying artifacts sooner, and reducing the need for pathologists to request repreps and rescans later in the workflow, Automated QC vastly improves operational efficiency.

Reduce the cost of review. By reducing the time pathologists and technicians spend on image reviews and rework due to missed quality issues, you can substantially reduce costs.

Optimize resource reallocation and cost savings. Automated QC not only detects image artifacts with high precision, but it reduces the amount of time required for the quality-control process, allowing your labs to reallocate time to higher-value efforts.

> "We are excited to see Proscia's Automated Quality Control product deployed into day-to-day research practice for non-clinical laboratories. These types of AI products will help us to get these new drugs to market faster by overcoming a critical, yet tedious, step in our process."
>
> **Dr. Daniel Rudmann**
> Scientific Director, Digital Pathology at Charles River Laboratories

Move Faster on a Cloud-based Digital Pathology Platform

Spend less time managing high volumes of pathology data and more time on your GLP and non-regulated studies. Scalable and flexible deployment options are available for research teams of any size. Proscia-hosted cloud can be deployed in days, and at a fraction of the cost and effort of customer-hosted on-premise or cloud. Highlights of the Proscia-hosted cloud include:

Deployment	Standard deployment in days upon completion of contracting and professional services.
Infrastructure Costs to Customer	None for Automated QC. For the platform, pay only for the storage you use.
Surging Workloads	Pay only for what you use. Proscia is responsive to your ingestion and will automatically scale up or down in response to your workload.
Reliability	• High • Hardware failures non-issue • Fast, streamlined support through Proscia
Security	Proscia responsibility. • Managed by Proscia Information Security team and monitored 24/7 SOC. • Near-real-time alerting and response. • Compliant with all regional regulations. • Independently audited and reviewed.

Evaluate Automated Quality Control Solutions

Start by asking these questions:

Is the solution fully embedded in my routine workflow?

- Can the module be triggered automatically or do I need to manually initiate it each time?

How is the system deployed?

- Can it be deployed in the cloud and on-prem and what are the consequences of each?
- Can it be run on CPU-only or does it require GPUs?

How was the solution validated?

- Were pathology quality-control experts involved in the solution development?
- How many whole slide images, scanners, stain types and organs were in the training and validation dataset?

How does the organization manage product updates?

- Does the system have everything I anticipate needing today?
- How does the company consider my product requests and performance improvement needs?
- How are updates managed?
- How does the system perform?
- How was performance estimated?
- Are there enough images in the performance test dataset that I have confidence in performance estimates?
- Is the runtime and throughput of the system sufficient for my laboratory?

What artifacts are detected?

- What format are outputs delivered in?
- Is it easy to export results?
- Is it easy to identify images that do or do not have quality issues?
- Are there limits to the size of artifacts that can be detected?
- What options do I have if the system is too sensitive or not sensitive enough?
- Can I disable artifacts that are not valuable to me?

How will I use the outputs of a quality-control module in my lab? For example:

- To speed up an existing manual review workflow?
- To exclude images from my downstream workflow?
- To mark images for rescan or reprep?
- To exclude images from image analysis?

Learn More

Visit **proscia.com/qc** for more information, or to sign up for a demo of Automated QC and our Concentriq digital pathology platform.

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