WHITE PAPER

How High-Volume Pathology Labs Are Solving the Throughput Problem: Without Adding Headcount

At 500 or more slides per day, a manual glass slide workflow is not just inefficient it is a structural capacity ceiling. The high-volume labs that are breaking through that ceiling without expanding their workforce are not managing their way out of the problem. They are engineering their way out of it.

There is a volume threshold above which the manual glass slide workflow stops being a manageable inefficiency and becomes a structural operational constraint. For most high-volume pathology laboratories, that threshold is somewhere in the range of 400 to 600 slides per day. Below it, experienced staff absorb the friction of retrieval, assembly, transport, and case preparation through a combination of institutional knowledge and informal workarounds. Above it, those workarounds begin to fail: turnaround times extend, overtime escalates, QC incidents become more frequent, and the backlog that accumulates during peak periods takes days rather than hours to clear.

The laboratory managers responsible for these environments are not unaware of the problem. They have been managing it for years. What many have not yet fully reckoned come to terms with is that the problem is not a staffing problem. It is a workflow architecture problem. Adding headcount to a glass slide workflow does not address the structural constraints that make high- volume labs inherently inefficient in that model. It adds cost without resolving throughput. The laboratories that have broken through the capacity ceiling have done so by changing the architecture — not the headcount.

This article describes what that architectural change looks like in high-volume lab environments, what the published evidence shows about where throughput gains come from, and what the specific scanner and workflow design choices are that determine whether a digital pathology deployment actually delivers the capacity improvement it promises. For laboratory leaders, this is increasingly a question of strategic lab workflow management and proactive laboratory capacity planning rather than simply increasing staffing levels.

Understanding Where Lab Throughput Constraint Actually Lives

Lab managers approaching a throughput problem often diagnose it as a scanning bottleneck: the scanner is too slow, or there aren't enough scanners. This is often a secondary rather than primary constraint. The Schwen et al. (2023) review of digitization lessons learned identified that scanner throughput in routine practice routinely differs from advertised throughput not because the scanner is slower than specified, but because of the non-scanning elements of the digital workflow: slide loading, handling time, and the QC intervention events that interrupt continuous operation. Published data shows that a median scan time of 98 seconds per slide in a test phase was reduced to 74 seconds after optimizing fragment placement and scanner parameters. That represents a 24% throughput improvement achieved through workflow design alone, without any hardware changes.

The second constraint is the QC rescan rate. A scanner that requires 5–10% of slides to be rescanned because automated focus failed or because an operator identified a quality issue during review creates a throughput leak that compounds over volume. At 500 slides per day, a 5% rescan rate means 25

slides per day requiring manual identification, retrieval, and reprocessing. Over a 250-working-day year, that is 6,250 rescan events. Each one requires staff time, interrupts continuous scanning, and adds latency to the case completion cycle. A scanner with a materially lower rescan rate does not just save QC effort; it removes a compounding throughput constraint that worsens with volume.

The Throughput Challenge Facing High-Volume Labs

800
slides/day peak requirement documented

One published implementation reported a peak scanning requirement of 800 slides per day, with 120 slides per hour during peak periods, demonstrating the scale of infrastructure that high-volume labs must support. For these operations, rescan rate and automation quality are primary throughput determinants. (Schwen et al., 2023)

Lab Workflow Management: The Five Throughput Gains That Published Evidence Actually Supports

Published operational data from high-volume implementations is specific enough to allow lab managers to estimate the throughput impact of each design choice. The following five gains are consistently documented:

Throughput Driver	Gain	Source	Note
Scan-parameter and fragment-placement optimization	98s → 74s	median scan time/slide (~24% faster)	Reduction achieved by optimizing fragment placement and scanner parameters, with no hardware change (Schwen et al., 2023)
Continuous loading (direct from cover slipper)	24-h operation	undisrupted, minimal supervision	Continuous-load scanners enabled undisrupted 24-h operation and lowered cost per slide; scanners exceeded marketed capacity (Ardon et al., 2023)
Automated QC rescan (no manual identification)	1 FTE / 3-4 scanner	Scanners per QC FTE	Slides not manually inspected/prepped showed ~50% higher rescan likelihood; image QC estimated at 1 FTE per 3–4 scanners (Ardon et al., 2023)
LIS-integrated case assembly	5 min/case	time saved	Corresponds to 2.3 FTE of laboratory staff saved in logistics (Schwen et al., 2023)
Workload prioritization and safety container	Reduced disruption	per shift	Problematic slides isolated without stopping scanner; urgent cases can be prioritized (E1000 Dx design feature, US FDA, 2025)

Sources cited per row above: Schwen et al. (2023); Ardon et al. (2023); Hanna et al. (2019); US FDA (2025). Figures derive from published peer-reviewed operational data and FDA regulatory documents.

The critical insight from the data is that the largest throughput gains do not come from scanning speed. They come from eliminating the non-scanning overhead that fragments a continuous digital workflow. Every time a scanner stops because of a batch boundary, a manual QC intervention, or a slide handling event that could have been automated, it consumes capacity that cannot be recovered without additional shifts or headcount. The lab that eliminates these interruptions runs more output through the same scanner in the same shift, with the same staff.

The Capacity Ceiling vs. The Capacity Plateau

There is an important distinction between two different throughput states that high-volume labs experience with glass slide workflows. The capacity ceiling is the absolute limit imposed by the workflow architecture: the number of slides that can physically be assembled, transported, and made available for sign-out per shift. This

ceiling cannot be raised without adding either people or hours. In today's constrained labor market, both are increasingly difficult to obtain.

The capacity plateau is different. It is the point at which a laboratory operating at the ceiling begins to experience degrading quality and increasing error rates, because the workflow is at maximum human load. A published analysis examining pathologist workload and departure rates found that high individual workload and work maldistribution were associated with significantly higher rates of absences and departures. In other words, operating continuously at the capacity ceiling can erode the very workforce needed to sustain it (Bonert et al., 2022). The capacity ceiling is self-undermining at high volume.

The Benefits of Digital Pathology for Workflow Scalability and Staff Efficiency

Digital pathology disrupts both constraints. By automating non-diagnostic workflow elements such as case assembly, slide retrieval, QC triggering, and prior case comparison, digital pathology raises capacity while reducing the cognitive and physical burden on staff. The same staff can process more cases. The pathologists spend a larger fraction of their working time on diagnostic decisions rather than logistics. And the workflow sustains quality at volumes that manual processes cannot without burnout-driven attrition.

‘I need to constantly do more with less while maintaining the highest possible quality.’ The answer to that constraint is not finding more with which to do it. It is designing the workflow so that less is required to achieve more. That is what digital pathology at scale actually delivers.

What 500+ Slides Per Day Requires From a Scanner

For lab managers planning digital pathology for high-volume environments, scanner specification comparisons often focus on slide capacity (how many slides can be loaded at once) and advertised scanning speed. Published operational data suggests that neither of these is the primary throughput determinant in practice. What matters at sustained volume are four operational characteristics:

- Continuous loading capability: A scanner that requires slides to be batch-loaded in fixed rack sizes introduces periodic downtime at each batch boundary. In a 500-slide-per-day operation running two shifts, this means multiple loading interruptions per shift, each requiring staff presence and attention. Continuous loading from a coverslipper feeds slides directly into the scanner queue without batching dependency, a fundamentally different capacity architecture.
- Automated QC rescan with no manual trigger: At high volume, the QC inspection overhead of a scanner that requires manual identification of out-of-focus slides becomes a significant fraction of total staff time. The E1000 Dx Digital Pathology Solution is the first FDA-cleared WSI system with an automated focal map rescan that triggers automatically on out-of-focus detection without requiring staff identification or manual intervention (US FDA, 2025). The published comparative analysis of all six FDA-cleared WSI platforms confirmed the E1000 Dx Digital Pathology Solution has the lowest rescan rate of any cleared system (Kuhlman et al., 2025). At 500 slides per day, the difference between the highest and lowest rescan rates across cleared platforms translates to dozens of staff interventions per day avoided or required.
- Safety container architecture: In a conventional scanning workflow, when the scanner detects a problematic slide that could compromise either the slide or the instrument, the run is halted. This not only interrupts workflow but can also cause the slide to drop and break, potentially resulting in damage to the machine and the sample. Staff must identify the issue, manage the slide manually, and restart the case sequence before continuous operation resumes. The E1000 Dx Digital Pathology Solution handles this differently. When the scanner detects that continued processing would risk damage to the slide or the instrument, the slide is automatically moved to a dedicated safety container and the scanning run continues uninterrupted (US FDA, 2025). The operational consequence is significant at volume: a single problematic slide no longer cascades into a shift-wide workflow interruption, and staff are not required to monitor the scanner continuously to catch and resolve these events. The capacity

that would otherwise be lost to interruption-driven downtime, and the staff hours that would be consumed monitoring for it, return to value-added work elsewhere in the lab.

- Workload prioritization at load: High-volume labs routinely receive urgent cases, including intraoperative consultations and expedited oncology biopsies, alongside their standard daily volume. A scanner that supports on-demand slide loading and case prioritization directly from the coverslipper allows urgent cases to bypass the queue without staff intervention to reorganize batch loads.

Planning a High-Volume Digital Pathology Lab Operation

Published operational experience from high-volume implementations converges on a consistent set of planning principles for lab managers:

- Scanner capacity must be planned against peak rather than average volume. Published implementations report peak requirements substantially above daily averages. One study documented 120 slides per hour during peak periods against a 800-slide daily volume (Schwen et al., 2023). Planning scanner capacity against average demand creates a throughput deficit every time peak demand occurs. Planning against a well-understood peak profile, with appropriate redundancy, is the correct framework for high-volume laboratory capacity planning.
- The scan team structure scales differently from glass slide staff requirements. A comprehensive operational cost analysis found that a scan team of 21 individuals managed 26 scanners at a major cancer center, while a separate operational analysis estimated 1 FTE per 3–4 WSI scanners for image QC (Schwen et al., 2023; Ardon et al., 2023). These are substantially more favorable staff-to-output ratios than glass slide workflows support and the per-person output improves with automation quality. A scanner with lower rescan rates requires fewer QC staff hours per thousand slides.
- Network and storage infrastructure must be sized for peak data transfer, not average throughput. A 500-slide-per-day operation scanning at 40x generates roughly 1 TB of data per day. Designing the network for average rather than peak capacity creates data transfer bottlenecks during high-volume periods that can delay digital availability and extend sign-out turnaround times for reasons that are invisible in scanner performance metrics.

How The Right High-Throughput Scanner Can Support Large-Volume Labs

The volume math	40,000 to 148,000 slides per scanner per year is the reported range across published high-volume implementations (Schwen et al., 2023). At 500 slides per day across 250 working days, that equates to 125,000 slides annually. That volume falls within the documented range supported by a single high-throughput scanner with continuous loading and a low-rescan workflow. The right scanner, correctly implemented, serves the full volume of a large-volume lab.

Conclusion: Lab Throughput Is an Architecture Decision

The labs that are solving the throughput problem without adding headcount have not discovered a better way to manage a glass slide workflow. They have replaced it. The throughput gains that digital pathology delivers at high volume are not marginal improvements to an existing process. They are the result of removing the structural constraints that make high-volume glass slide pathology inherently headcount-dependent.

For lab managers operating at or approaching 500 slides per day, the question is no longer whether digital pathology can match the volume requirements of their operation. It is which scanner architecture best supports continuous operation at that volume, which design choices maximize uptime and minimize staff intervention, and what the transition timeline looks like to capture the efficiency gains the evidence documents.

Laboratory Capacity Planning: Key Takeaways for High-Volume Lab Managers

1. The throughput constraint in high-volume labs is a workflow architecture problem, not a staffing problem. Adding headcount to a glass slide workflow adds cost without raising the structural capacity ceiling. Digital workflows raise the ceiling by removing non-scanning overhead from the throughput equation.

2. Rescan rate is the most consequential scanner selection variable at high volume. At 500 slides/day, a 5% rescan rate means 6,250 staff interventions per year. The E1000 Dx Digital Pathology Solution demonstrated the lowest rescan rate of all six FDA-cleared WSI platforms (Kuhlman et al., 2025) and the only automated focal map rescan that triggers without manual identification (US FDA, 2025).

3. Continuous loading is a structural throughput advantage at sustained volume. Removing batch-boundary downtime changes operations from a batch-limited model to a flow-based model that is inherently more efficient for high-volume laboratories.

4. Plan scanner capacity against peak demand, not average daily volume. One published implementation documented 120 slides/hour during peak periods against an 800-slide daily volume. Capacity planned against average demand creates a throughput deficit during peak periods that cascades across the shift schedule. (Schwen et al., 2023)

5. The scan team FTE ratio is substantially more favorable than glass slide logistics. Published data shows 21 individuals managing 26 scanners, with 1 FTE per 3–4 scanners estimated for QC. This is the correct benchmark for comparing digital pathology staffing costs against the 2.3 FTE logistics overhead documented for equivalent glass slide volume. (Ardon et al., 2023; Schwen et al., 2023)

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