

Element AVITI™ System

Unrivaled combination of cost, quality, and performance that fits any sequencing application at any scale

Highlights

- Multiple run starts daily
- Complete range of flow cells
- Exceptional accuracy with early insight into data quality
- Seamless compatibility with leading assays

Introduction

Next-generation sequencing (NGS) has revolutionized the field of genomics, empowering researchers to confront complex scientific questions with an evolving portfolio of technology and tools. Offering an unprecedented view of DNA, NGS fuels scientific discovery around the globe. Despite these innovations, the cost of benchtop sequencing has remained high, requiring factory-scale throughput to achieve any savings. A compromise on cost is often at the expense of quality and flexibility. Many labs turn to outsourcing, conceding delays in pursuit of lower costs.

To overcome these tradeoffs and drive more science, the Element AVITI System reimagines the core components of NGS to offer a benchtop platform that grants access to the genomics ecosystem (Figure 1). Delivering flexible throughput at exceptionally low cost, the AVITI System saves time and resources without the need to batch or accept lesser quality. Avidity Sequencing™ forms the core of a disruptive design that readily adapts to any application, offering methods that scale from amplicon to whole genome, and from short-read to long.

Scalable experimental design

Whether an experiment needs 2 billion reads per run or only 100 million, the AVITI System enables cost-effective, high-quality sequencing across a broad scale. Multiple sequencing kit configurations from read lengths of 2 x 75 to 2 x 300 and a full range of high-, medium-, and low-outputs calibrate genomic output without sacrificing cost-effectiveness, even at small scales (Table 1). The kits support a range of insert sizes while accommodating unique dual indexes (UDIs) and unique molecular identifiers (UMIs).



Figure 1. An AVITI System dramatically reduces sequencing costs and turnaround times while elevating the benchmark for sequencing data, all in a compact benchtop format that fits into a variety of spaces.

Individually addressable lanes exert more control over samples and timelines, providing the ability to isolate a library pool in a single lane or sequence two library pools on one flow cell without additional sequencing kits.

Rapid Cloudbreak™ chemistry

Cloudbreak chemistry advances the core Avidity Sequencing technology with increased accuracy, efficiency, and speed. In only 38 hours, two 2 x 150 runs with indexing generate ≤ 600 Gb of data and 2 billion reads. These accelerated turnaround times maximize potential sequencing output during a regular workday, allowing daily completion of up to two 2 x 75 runs.

Industry-leading performance

The AVITI System resets expectations on quality scores (Q-scores), at ≤ 300 cycles delivering the most accurate specification available today with $> 90\%$ of bases scoring Q30.¹ A 2 x 300 kit achieves $> 80\%$. Q-scores exceeding Q40 are routine. An assessment of data quality concluded that across all 20–50x coverages, the AVITI System demonstrated higher accuracy compared to legacy sequencing technology. AVITI System data had fewer soft-clipped reads in difficult homopolymer and repeat regions, among other clear advantages.²

Read Length	High Output Kit (Gb/hours) ^a	Medium Output Kit (Gb/hours)	Low Output Kit (Gb/hours)
<i>Read Count</i>	<i>1 billion^b</i>	<i>500 million</i>	<i>250 million</i>
2 x 75	150/24	75/20	Not applicable
2 x 150	300/38	150/31	75/27
<i>Read Count</i>	<i>300 million</i>	<i>100 million</i>	<i>Not applicable</i>
2 x 300	180/60	60/51	Not applicable

^a Individually addressable lanes slightly extend run times and produce the same output. Each lane contributes half the output.

^b Performance metrics, including read counts, are based on sequencing Element-prepared libraries. Actual results might differ based on factors such as library type and preparation.

Table 2. Output specifications for the AVITI System

Innovative sequencing chemistry

The fundamentals of Avidity Sequencing translate into real-world benefits for data quality and value. The chemistry leverages the unique properties of avidites to execute an efficient sequencing reaction that yields highly accurate data.³ A primary driver of this accuracy is a strong signal-to-noise ratio that persists through high polony densities.

At the start of a run, the library hybridizes to surface primers coating the flow cell. Amplification polymerase then binds to the library and primer duplexes, catalyzing rolling circle amplification (RCA) and generating long DNA strands that include copies of the original library. Each strand forms a polony that contains hundreds of copies of the original library. The polonies hybridize to read-specific sequencing primers.

A cycle begins with a sequencing polymerase binding an avidite to a polony and primer duplex, trapping a base-specific avidite to the polony for imaging and forming an extremely tight complex that enables a 100-fold reduction in reagent concentration compared to sequencing-by-synthesis, by extension driving down the cost per sample (Figure 2). After imaging, the avidites are removed and unlabeled nucleotides are incorporated into the sequencing primer to extend the primer by one nucleotide. Another cycle begins.

Amplification advantages

RCA uses only the original strand as a template to avoid magnifying amplification errors. This amplification method also limits the effects of index hopping and optical duplicates:

- Index hopping assigns reads to the wrong sample and is most pronounced on high-throughput systems using non-RCA amplification. RCA avoids incorporating free index primers into polonies and minimizes index hopping on the flow cell.
- Optical duplicates occur when the software attributes sequences from one large polony to two smaller polonies and separately computes the calls. A low rate of optical duplicates—the rate for the AVITI System is < 1%—results in a greater number of usable reads.

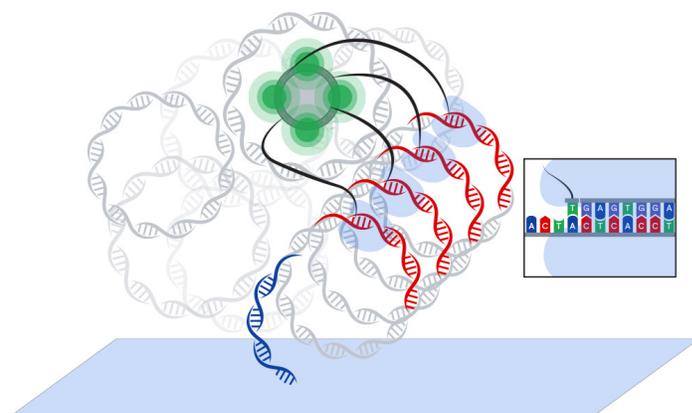


Figure 2. Polymerase binds avidites, trapping them at the incorporation site of template DNA. The avidite arms connect to a core that provides a fluorescent signal for detection. Low-binding surface chemistry makes the signals appear more prominent against a dark backdrop.

Complete NGS solution

The AVITI System grounds an end-to-end NGS workflow that integrates library prep, sequencing, and analysis (Figure 3). Partnerships with a growing range of library prep and analysis companies validate Element solutions and facilitate the transition to the AVITI System. Fixed reagent pricing for the lifetime of the instrument provides assurance for future operational costs and neutralizes batching requirements to expedite results.⁴

Any library prepared with the Element Adept™ Library Compatibility Workflow or Element Elevate™ Library Prep Workflow is compatible with the AVITI System. Both workflows offer robust library prep with broad input requirements and serve as the main entry point for sequencing on the AVITI System. The key difference is methodology: the Adept Workflow adapts existing libraries and the Elevate Workflow prepares libraries from input DNA. 16S LoopSeq™ for AVITI and Amplicon LoopSeq for AVITI provide specialized library prep solutions that are also compatible with the AVITI System.

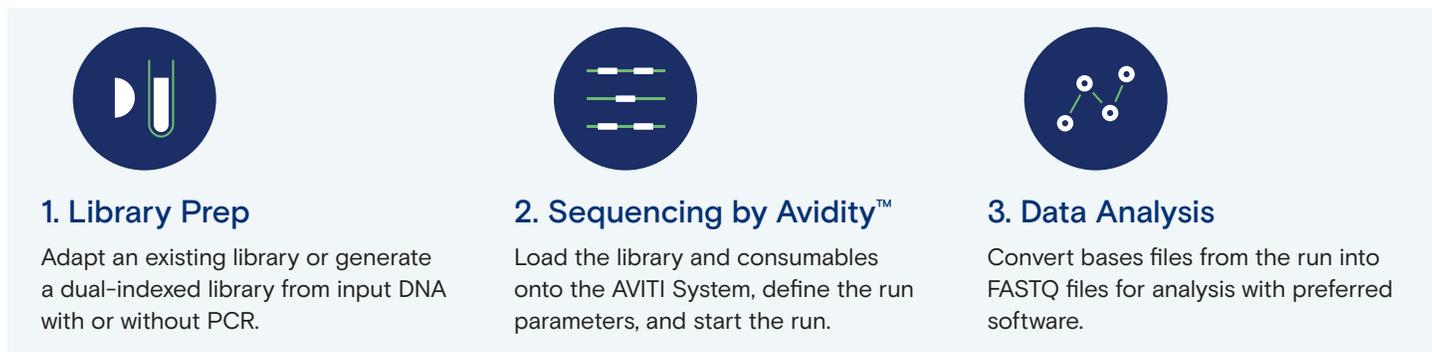


Figure 3. The AVITI System seamlessly integrates genomics resources to offer a sequencing workflow that balances ease of use with the freedom to refine experiments for specific research needs. The AVITI System is compatible with the Adept Workflow, Elevate Workflow, and LoopSeq for AVITI. Bases2Fastq generates FASTQ files.

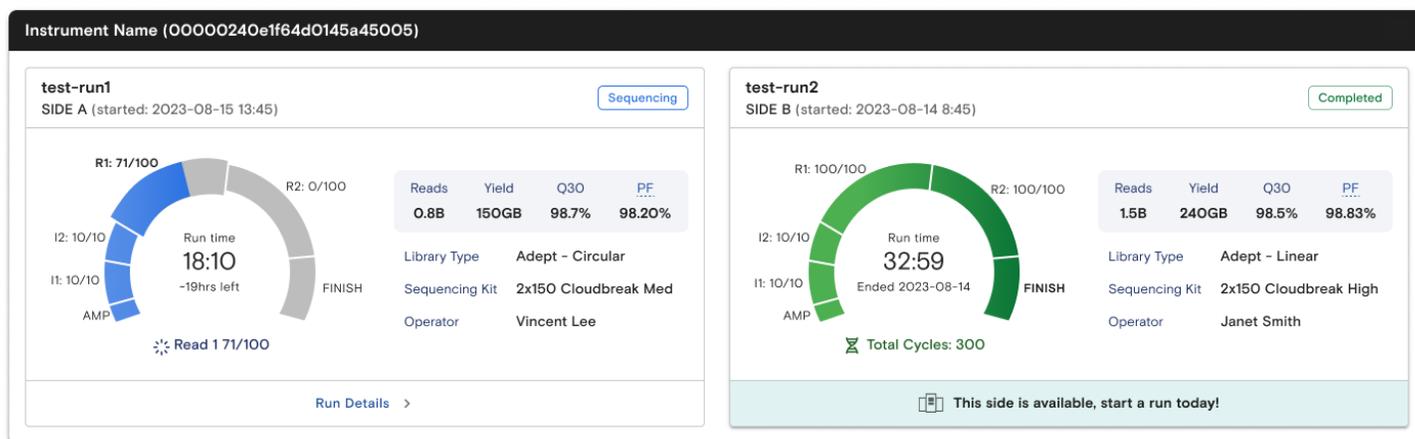


Figure 4. Elembio™ Cloud is an online platform for managing instruments, monitoring runs in real time, and visualizing run metrics to gauge performance.

Adept Workflow for adapted libraries

The Adept Workflow adds Element sequences to linear libraries prepared with a compatible third-party library prep kit. This automation-friendly workflow supports custom primers and allows labs to continue using the same library prep and analysis tools with the AVITI System. Highly accurate quantification optimizes polony density, in turn improving data quality and output.

Optional amplification makes the ends of any incompatible or potentially incompatible library compatible. For an up-to-date list of supported kits, visit go.elembio.link/compatible.

Elevate Workflow for native prep

The Elevate Workflow prepares linear libraries for whole-genome sequencing (WGS). This straightforward workflow integrates with Cloudbreak chemistry to automatically circularize libraries onboard the instrument as part of the run, minimizing hands-on time. A modular kit design enables end-to-end library prep with mechanical or enzymatic fragmentation and the option to integrate Elevate indexes and adapters with a preferred third-party library prep. PCR-free and PCR-plus protocol options round out this flexible WGS solution.

LoopSeq for AVITI bundles Elevate and LoopSeq to generate AVITI-ready libraries with Elevate indexes and adapters. This pairing brings long-read capability to the AVITI System.

Simple and secure data analysis

AVITI Operating Software (AVITI OS) allows you to specify the ideal storage location, keeping genomic data exclusively in your hands.⁵ Guided workflows step through run setup with helpful reminders, menu-style selection of run parameters, and consumable validation. An intuitive user interface guides run setup, run monitoring, and system configuration from the instrument. Elembio Cloud extends AVITI OS capabilities, offering a similarly intuitive view with a rich set of real-time run metrics explorable through a computer or mobile device (Figure 4).

Throughout a run, the software analyzes images and uses the data to call bases and assign Q-scores. These data are packaged into bases files that serve as input for Bases2Fastq Software, which generates FASTQ files for analysis in a preferred application. Features that detect and apply the correct index sequence orientation and automatically identify and trim adapter sequences eliminate guesswork.



Figure 5. A centralized touchscreen monitor (A) simplifies operations. Nests hold two flow cells (B), one for each side, and an LED display (C) communicates the status of a side. The reagents (D) and waste bottles (E) smoothly load and unload from the instrument.

Real-time run QC

An index-first run format sequences the Index 1 and Index 2 reads before the DNA insert, allowing early demultiplexing onboard the instrument for early insight into index assignment metrics, providing confirmation of a high-quality run or sparing the time of a low-quality run. Further downstream, Bases2Fastq detects and applies the correct index sequence orientation for virtually error-proof FASTQ file generation without the guesswork. A related adapter detection feature automatically identifies and trims adapter sequences.

Efficient instrument layout

The AVITI System is a compact benchtop instrument that suits a variety of spaces (Figure 5). Each side of the instrument—side A on the left and side B on the right—is dedicated to one flow cell and operates independently. This dual-sided layout essentially places two systems on the benchtop for the price of one. Moreover, the system ships with accessories designed to minimize waste and facilitate disposal of hazardous reagents.

Dedicated service and support

A dedicated and experienced Element team simplifies service and support and help keep the system operating at peak performance with minimal interruptions. The fully staffed team includes field service engineers to support site prep and installation and verify the system, field application scientists to remove technical barriers and host scientist-to-scientist conversations, and additional engineers and scientists to provide rapid phone and email support.⁶

System sensors measure the performance of key components and send instrument health data to Element. This onboard telemetry rewards labs who partner with Element for proactive system maintenance. Enabling telemetry automatically shares a curated set of metrics that identify potential problems early. The reports are carefully configured to protect sensitive information and do not include any sequencing data. The Element service team cooperates with labs to address any problems quickly and with minimal disruption.

Sequencing at your scale

An alternative model of the full-throughput AVITI System, the AVITI LT runs low- and medium-output sequencing kits to offer low-throughput and budget-friendly access to Avidity Sequencing. If future growth and expanded applications require a broader range of throughputs, labs can easily update the AVITI LT to an AVITI System, which runs all kits. Multi-system labs with high volume can leverage the \$200 Genome Program to sequence at as little as \$200 per genome or \$2 per Gb.

System specifications

Instrument Configuration

Dual flow cells
AVITI Operating Software with a touchscreen display
Ubuntu Core 20.04 LTS operating system

Operating Environment

Temperature: 18–26°C
Elevation: < 2000 m
Sound level: ≤ 62 db at 3.3 ft

Instrument Dimensions

(H x W x D) 29.5 in x 37.6 in x 28.5 in
Weight: 155.1 kg/342 lb

Crate Dimensions

(H x W x D) 48.6 in x 51 in x 35 in
Weight with instrument: 245.9 kg/527 lb

Power Requirements

100–240 VAC at 50/60 Hz, 15 A. 550 W (average)

Summary

The AVITI System reinvents surface chemistry, base detection, and data analysis to offer a flexible and cost-effective sequencing platform that readily supports a variety of NGS applications. From the AVITI LT to the \$200 Genome Program, the AVITI System grows with your needs. Overarching compatibility with standard NGS libraries provides a path to in-house sequencing while integrated and user-friendly software tools streamline operations. Multiple kits at locked prices and abundant software features promote adaptive run setup and analysis to satisfy a spectrum of experiment needs without the demands of batching.

Ordering information

Product	Catalog #
Element AVITI System	880-00001
Element AVITI System LT	880-00003
AVITI 2x75 Sequencing Kit Cloudbreak Medium Output	860-00007
AVITI 2x75 Sequencing Kit Cloudbreak High Output	860-00004
AVITI 2x150 Sequencing Kit Cloudbreak Low Output	860-00005
AVITI 2x150 Sequencing Kit Cloudbreak Medium Output	860-00006
AVITI 2x150 Sequencing Kit Cloudbreak High Output	860-00003
AVITI 2x300 Sequencing Kit Cloudbreak Medium Output	860-00009
AVITI 2x300 Sequencing Kit Cloudbreak High Output	860-00008
Adept Cloudbreak Custom Primer Set	820-00009

To learn more, visit elementbiosciences.com/products/aviti

References

1. Semyon Kruglyak, "Measuring the Accuracy of Element AVITI Sequencing Data," Element Biosciences (blog), July 13, 2022, <https://www.elementbiosciences.com/blog/measuring-accuracy-element-aviti-sequencing-data>.
2. Carroll, Andrew, Alexy Kolesnikov, Daniel E. Cook, et al., "Accurate human genome analysis with Element Avidity sequencing," *bioRxiv* (August 2023): <https://doi.org/10.1101/2023.08.11.553043>.
3. Arslan, Sinan, Francisco J. Garcia, Minghao Guo, et al., "Sequencing by avidity enables high accuracy with low reagent consumption," *Nature Biotechnology* (May 2023): <https://doi.org/10.1038/s41587-023-01750-7>.
4. "Reagent Price Guarantee - Announcement Video," Element Biosciences, accessed February 27, 2023, <https://www.elementbiosciences.com/resources/our-story/our-mission/reagent-price-guarantee-announcement-video>.
5. Element Biosciences, *ElemBio Cloud and Element AVITI System Data Protections White Paper*, July 2023, doc. no. MA-00012.
6. Element Biosciences, *Element AVITI System Site Prep Guide*, October 2022, doc. no. MA-00007.

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