Element
Biosciences

Specification Sheet

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 sequencing kits
- Exceptional accuracy with early insight into data quality
- Seamless compatibility with > 95% of libraries

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, AVITI saves time and resources without the need to batch or accept lesser quality. Avidity base chemistry (ABC) 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.

Ultimate efficiency

Cloudbreak™ sequencing kits advanced the core ABC technology, increasing 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. Building on these gains, Cloudbreak Freestyle™ kits fully integrate onboard circularization into runs for Elevate or third-party linear libraries. This advance eliminates library conversion steps on the bench, saving time and minimizing touchpoints that can introduce errors.

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

Scalable experimental design

Sequencing systems are broadly based on read length and output specifications. Therefore, expanding application interests often means obtaining and maintaining a different system and establishing new workflows. Whether an experiment requires 2 billion reads per run or 100 million, AVITI enables cost-effective, high-quality sequencing at scale.

Multiple sequencing kit configurations with 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 cost benefits are similar to a production-scale system without waiting to fill a flow cell or acquire a sufficiently large project. The kits support a range of insert sizes while accommodating unique dual indexes (UDIs) and unique molecular identifiers (UMIs).

Industry-leading performance

AVITI and ABC reset expectations on quality scores (Q-scores), delivering exceptional Q30 accuracy for standard 2 x 150 kits at > 90% and > 85% for 2 x 300 sequencing.[1]

Kit Configuration	Read Length	Output (Gb)	Read Count[a]	Run Time (hours)[b]	Q30
High output	2 x 300	180	300 million	60	> 85%
	2 x 150	300	1 billion	38	> 90%
	2 x 75	150	1 billion	24	> 90%
Medium output	2 x 300	60	100 million	51	> 85%
	2 x 150	150	500 million	31	> 90%
	2 x 75	75	500 million	20	> 90%
Low output	2 x 150	75	250 million	27	> 90%

[a] 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.

[b] Individually addressable lanes and other custom recipes can extend run times.

Table 1. AVITI performance metrics

An assessment of data quality concluded that across all 20–50x coverages, AVITI demonstrated higher accuracy compared to legacy sequencing technology. AVITI data had fewer soft-clipped reads in difficult homopolymer and repeat regions, among other clear advantages.[2]

Novel ABC sequencing

The fundamentals of ABC translate into real-world benefits for data quality and value. The technology leverages the unique properties of avidites to execute an efficient sequencing reaction that yields highly accurate data.[3] A strong signal-to-noise ratio that persists through high polony densities drives this accuracy.

When a run starts, 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.

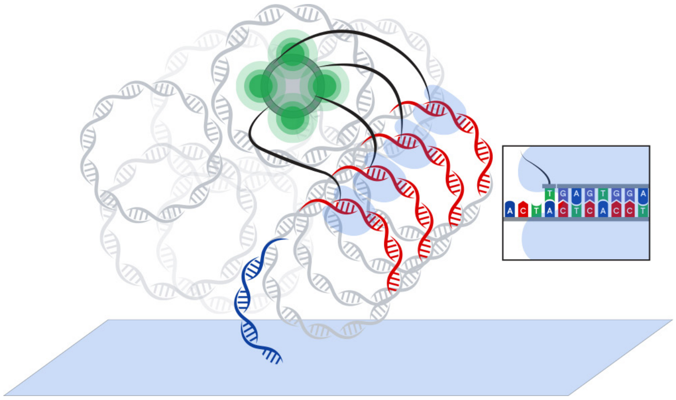

Figure 2. Polymerase binds avidites, trapping them at the interrogation site of template DNA. The avidite arms connect to a core that provides a fluorescent signal for detection. Low-binding surface chemistry makes signals appear more prominent against a dark backdrop.

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 (SBS), which drives 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 method 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 PCR 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 AVITI rate is < 1%—delivers more usable reads.

Complete NGS solution

AVITI provides end-to-end NGS workflows that integrate library prep, sequencing, and analysis (Figure 3). Partnerships with a growing range of library prep and analysis partners validate these end-to-end solutions and facilitate the transition to AVITI.

Multiple library prep options serve as an AVITI entry point, unlocking an open ecosystem that meets the needs of any lab:

- **Element Adept™ Library Compatibility Workflow**—Adapt a completed linear third-party library.

Figure 3. AVITI takes you from sample to answer in three simple steps. The seamless integration of genomics resources balances ease of use with the freedom to refine experiments for specific research needs.

- Element Elevate™ Library Prep Workflow—Prepare a native Element library from input DNA or RNA.
- LoopSeq™ for AVITI—Prepare a long-read library for short-read sequencing.
- Third party—Using Cloudbreak Freestyle, load a third-party library directly onto AVITI, which is compatible with the vast majority of library preps.

Simple software

AVITI Operating Software (AVITI OS) delivers step-by-step, guided run setup with helpful reminders, menu-style selection of run parameters, and consumable validation. 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, freeing labs to choose or configure the ideal analysis environment.

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 advance insight into index assignment metrics, providing confirmation of a high-quality run or sparing the time of a low-quality run. Further downstream, Bases2Fastq Software detects and applies the correct index sequence orientation for virtually error-proof FASTQ file generation without guesswork. A related adapter detection feature automatically identifies and trims adapter sequences.

Efficient instrument layout

AVITI is a compact benchtop instrument that suits a variety of spaces (Figure 4). 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.

Figure 4. 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.

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.[4]

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 to AVITI, the Element AVITI System LT runs both low- and medium-output sequencing kits to offer low-throughput and budget-friendly access to ABC. If future growth and expanded applications require a broader range of throughputs, labs can easily update the AVITI LT to a full-throughput AVITI, 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 touchsceen 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

AVITI reinvents surface chemistry, base detection, and data analysis to offer a flexible and cost-effective sequencing platform. From AVITI LT to the $200 genome, AVITI supports a spectrum of genomic needs. Overarching compatibility with standard NGS libraries provides a path to in-house sequencing while integrated software tools streamline operations. Multiple kits and abundant software features promote adaptive run setup and analysis to satisfy 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 FS Medium Output	860-00014
AVITI 2x75 Sequencing Kit Cloudbreak FS High Output	860-00015
AVITI 2x150 Sequencing Kit Cloudbreak FS Low Output	860-00011
AVITI 2x150 Sequencing Kit Cloudbreak FS Medium Output	860-00012
AVITI 2x150 Sequencing Kit Cloudbreak FS High Output	860-00013
AVITI 2x300 Sequencing Kit Cloudbreak FS Medium Output	860-00016
AVITI 2x300 Sequencing Kit Cloudbreak FS High Output	860-00017
Cloudbreak FS PhiX Control, 3rd Party	830-00023
Custom Primer Set Cloudbreak FS	820-00025

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

References

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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. Element Biosciences, *Element AVITI System Site Prep Guide*, November 2023, doc. no. MA-00007.

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