

Illumina Proactive Technical Note

The benefits of Illumina Proactive, and instructions on how to implement performance monitoring with Illumina sequencing instruments.

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Maximizing operational efficiency through Illumina Proactive

Illumina provides a wide range of next-generation sequencing (NGS) instruments that have become the core production technology for many laboratories. Whether a user is operating a large sequencing center or a small research lab with a single instrument, reliable instrument operation and management are critical for optimal usage with maximum throughput.

To achieve this goal, Illumina provides Illumina Proactive, a monitoring service in which instrument performance data from each run are sent to Illumina to enable proactive maintenance. All Illumina sequencing instruments are designed to capture performance data, while the type of metrics used to monitor performance depends on the software version. By enabling Illumina Proactive, users facilitate troubleshooting with more accurate diagnosis of failures and detection of failure risks. Furthermore, Illumina Proactive can increase instrument uptime, improve operational efficiency, and reduce the risk of lost resources.

This technical note explains the benefits of instrument performance monitoring, instructs on how to enable Illumina Proactive, and answers frequently asked questions about data security.

Benefits of Illumina Proactive

Maximize instrument uptime

Preemptive detection and notification of elevated instrument failure risk can reduce unplanned downtime and allow users to schedule required component replacements at their convenience. This capability has been enabled for several Illumina instrument components and will continue to be expanded to others.

Troubleshoot runs more efficiently

Requiring users to locate, download, and send required information can cause unnecessary delays. On the other hand, direct access to instrument performance parameters allows the Illumina Service and Support team to diagnose and troubleshoot instrument issues quickly. In addition, historical performance monitoring supports efficient troubleshooting, and sometimes, preemptive instrument repair.

Prevent loss of time, labor, and precious samples

Through instrument performance monitoring, proactive notification and preemptive repair can improve operational efficiency and risk management. Preventing incidences of in-run failures reduces the associated loss of time, labor, sequencing reagents, and precious samples (Figure 1).



Figure 1: Example of how Illumina Proactive can benefit laboratories through detection of risk failure and facilitated troubleshooting—Routine monitoring of system performance data results in detection of failure risk for optical hardware, resulting in planned maintenance around a high priority project. A potentially expensive loss of time, effort, and sample is avoided.

What is instrument performance data and why is it important?

Instrument performance data refers to any metric that can characterize the operational performance of the sequencing instrument, including software logs, instrument configurations, and other file types. Sequencing data are not included in this category, and are not accessible or reported through the same data stream. Instrument performance data can support failure risk prediction, failure detection, and performance issue troubleshooting in various ways (Table 1).

Table 1: Different types of instrument performance data

| | Run performance data | Instrument configuration data | Run configuration data |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Data collected | Q-scores, error rates, instrument operational logs | Instrument serial number, software version | Run parameters, reagent and flow cell lot numbers, primary analysis set-up and configuration. |
| Data used by Illumina | Failure risk prediction, failure detection | Run troubleshooting | Run troubleshooting |
| Value to user | Enables analysis of error and warning notifications regarding optical, mechanical, thermal, and fluidic system performance | Enables assessment of whether software version, instrument type, or other hardware variables may be contributing to performance issues | Informs on roles of lot numbers, experiment type, and other experimental variables that contribute to performance issues |

How to enable Illumina Proactive

For each system, instrument performance monitoring is configured in the control software by the user. User manuals provide details on how to enable or disable the delivery of instrument performance data. For greater detail on universal and instrument-specific network configurations, refer to the Universal Settings and Instrument-Specific Settings sections in this document.

Requirements for enabling Illumina Proactive:

- Port 443, 80, and 8080
- BaseSpace Domains for each region
- Connection to a 1 GB network switch to accommodate delivery. Additional details regarding networking and bandwidth are provided in site prep guides for specific instruments.
- Software must be configured to enable performance monitoring

Instructions for enabling Illumina Proactive:

1. Ensure that any concerns regarding information security are addressed by appropriate IT representatives, and that all institutional requirements are met.
2. Confirm current system instrument performance monitoring settings. Some instruments may already be enabled by default. See instrument performance monitoring settings (Table 5).
3. Enable "Send Instrument Performance Data to Illumina" checkbox prior to starting a run. All Illumina instruments should provide this option in the user interface, although the exact wording may vary.

Data security considerations

Data security is a top priority for Illumina customers. As a result of consistent effort, security profiles for Illumina operating systems improve over time as new systems are designed and new threats to information are identified.

No inbound ports

Illumina sequencing systems do not require inbound ports from the Internet. Illumina recommends blocking these ports, which reduces the possibility of reaching the login screen via the internet. This security measure reduces access to the operating system from remote locations.

Software restriction policy

NovaSeq™ and iSeq™ Systems have a feature called software restriction policy (SRP), which limits the applications run on Illumina computers to those that Illumina has approved (whitelisted). This restriction prevents any malware from being executed, even if it infiltrates the system, because SRP protection will not allow execution, regardless of how files appear to the user (ie, malware may appear as an image file, or excel spreadsheet).

Enhanced machine experience toolkit

NovaSeq Systems include a feature called enhanced machine experience toolkit (EMET). Designed by Microsoft, EMET provides an additional layer of security for Microsoft Windows. With an interface that can be used to adjust Windows security features, EMET is an additional, complementary defense tool placed between the firewall and user-selected antivirus software.

Windows security updates

Illumina recommends that all Windows security updates be applied regularly. However, this feature is not enabled by default. Instructions for enabling security updates are provided in the Microsoft Security Update Guide.¹

Security in transit

Instruments communicate with BaseSpace™ Sequence Hub through a web-based application program interface (API). All traffic between the sequencing instrument and BaseSpace Sequence Hub uses Transport Layer Security (TLS), an internet standard that encrypts sensitive communications as they pass over the internet. All service methods require API key signatures, and service is refused to all others.

Encryption at rest

Data that are stored in persistent storage systems are referred to as being “at rest.” BaseSpace Sequence Hub uses Advanced Encryption System (AES)-256 to protect data at rest. AES-256 is a specification for the encryption of electronic data, established by the US National Institutes of Standards and Technology (NIST).²

Data center security

BaseSpace Sequence Hub is built on preexisting cloud infrastructure provided by Amazon Web Services (AWS), and inherits controls that have allowed BaseSpace Sequence Hub to achieve ISO 27001³ and Health Insurance Portability and Accountability Act (HIPAA) compliance. Illumina software as a service (SaaS) products are designed and operated in keeping with best practices and laws around data protection and data handling, including General Data Protection Regulation (GDPR).⁴ Customers should determine GDPR responsibilities for use of their own personal data. More details on cloud security, privacy, HIPAA, and GDPR are provided in separate white papers.^{5,6}

Frequently asked questions about data security

Will my sequence data also be sent to Illumina if I enable Illumina Proactive?

No. Only instrument performance data, which includes software logs and instrument configurations as described above, are sent by the instrument to Illumina. Sequencing run data are not sent and are not accessible through this service. Various features distinguish the connectivity between instrument performance monitoring and sequence data analysis (Table 2).

Table 2: BaseSpace Sequence Hub connectivity options

| Attribute | Illumina Proactive mode | Run monitoring mode | BaseSpace Sequence Hub Analysis mode |
|---------------------------------------------------------------------|-----------------------------------|-------------------------|--------------------------------------|
| Connection type | One-time instrument configuration | Per-run user connection | Per-run user connection |
| Requires internet connection | X | X | X |
| Includes instrument configuration and operational logs ^a | X | X | X |
| Requires BaseSpace Sequence Hub login | | X | X |
| Includes sequence data [BCL] files | | | X |

a. For details around specific instrument configuration and operational logs, please refer to the Instrument-specific settings section in the appendix.

Will sending my instrument performance data to Illumina enable all types of failure risk to be proactively detected?

No. Instrument performance monitoring has successfully enabled proactive maintenance on a number of cases to date. As more data become available, the capabilities of this service will continue to be expanded and improved across the Illumina portfolio of sequencing products.

Will I need to log in to my BaseSpace Sequence Hub to enable this service?

No. For instrument performance data mode, only a network connection to Illumina is needed. Because instrument performance data and sequencing data are sent independently of each other, a BaseSpace Sequence Hub login is not required.

My Information Security team requires additional technical information prior to enabling this service. Are there additional resources available?

Yes. Additional details and an overview of data security considerations are provided in this document. Links to Site Prep Guides for each system are also available in the appendix. More information on SaaS security is provided in the BaseSpace Sequence Hub security whitepaper.⁵

Is Illumina Proactive compliant with GDPR?

Yes. Illumina SaaS products are designed and operated to comply with global laws, including GDPR.

Are there other best practices that Illumina recommends concerning data security?

Illumina strongly recommends that sample-specific information be omitted from the name of the experiment or sample ID.

Appendix

The remaining sections contain information on requirements that your IT department needs to know to implement Illumina Proactive.

Universal settings

Several integration settings are common to all Illumina systems for implementing Illumina Proactive or integrating with BaseSpace Sequence Hub.

Table 3: Universal settings for Illumina sequencing systems

| BaseSpace instances | Whitelist domains |
|-------------------------------|--------------------------------------------------------------------|
| US nonenterprise instance: | basespace.illumina.com |
| | api.basespace.illumina.com |
| | instruments.sh.basespace.illumina.com |
| | basespace-data-east.s3-external-1.amazonaws.com |
| EU nonenterprise instance: | basespace-data-east.s3.amazonaws.com |
| | euc1.sh.basespace.illumina.com |
| | api.euc1.sh.basespace.illumina.com |
| | instruments.sh.basespace.illumina.com |
| China nonenterprise instance: | euc1-prd-seq-hub-data-bucket.s3-eu-central-1.amazonaws.com |
| | cn-sh-cnn1.sh.basespace.illumina.com.cn |
| | api.cn-sh-cnn1.sh.basespace.illumina.com.cn |
| | instruments.sh.basespace.illumina.com.cn |
| US enterprise instance: | cn-sh-cnn1-prod-seq-hub-data-bucket.s3.cn-north-1.amazonaws.com.cn |
| | {domain}.basespace.illumina.com |
| | {domain}.api.basespace.illumina.com |
| | instruments.sh.basespace.illumina.com |
| EU enterprise instance: | basespace-data-east.s3-external-1.amazonaws.com |
| | basespace-data-east.s3.amazonaws.com |
| | {domain}.euc1.sh.basespace.illumina.com |
| | {domain}.api.euc1.sh.basespace.illumina.com |
| | instruments.sh.basespace.illumina.com |
| | euc1-prd-seq-hub-data-bucket.s3-eu-central-1.amazonaws.com |

| Port requirements | |
|-------------------|--------------------------------------|
| Port (outbound) | Purpose |
| 443 | BaseSpace Sequence Hub configuration |
| 80 | BaseSpace Sequence Hub data upload |
| 8080 | Software updates |

Inbound ports are not required or recommended, except for Local Run Manager (LRM). Remote Desktop Protocol (RDP) may be enabled on some systems, by default, and the recommendation is to close all inbound ports, including RDP, unless LRM is noted as a requirement for local whitelisting. LRM does not require internet access, only access to local storage and management resources.

The Illumina Security Best Practices Guide provides more information on firewalls and RDP.⁷

Antivirus configuration

User-selected antivirus software is highly recommended to protect the instrument control computer against viruses. To avoid data loss or interruptions, configure the antivirus software as follows:

- Set for manual scans. Do not allow automatic scans.
- Perform manual scans only when the instrument is not in use.
- Set updates to download without user authorization, but not install.
- Do not update during instrument operation. Update only when the instrument is not running and when it is safe to reboot the instrument control computer.
- Do not reboot the computer automatically upon update.
- Exclude the application directory and data drives from any real-time file system protection. Apply this setting to the C:\Illumina and Z:\ilmn directories.
- Disable Windows Defender. This Windows product can affect the operating system resources used by Illumina software.

Operating system configurations

Illumina instruments are tested and verified to operate within specifications before shipping. After installation, changes to settings can create performance or security risks. The following configuration recommendations mitigate performance and security risks for the operating system:

- Configure a password that is at least 10 characters, and use local ID policies for additional guidance. Keep a record of the password.
- Illumina does not keep customer login credentials, and unknown passwords cannot be reset.
- An unknown password requires that an Illumina representative restore the factory default, which removes all data from the system and extends the necessary support time.
- Configure Automatic Updates in Windows to prevent updates.
- When connecting to a domain with Group Policy Objects (GPOs), some settings might affect the operating system or instrument software. If the instrument software operates incorrectly, consult your facility IT administrator about possible GPO interference.
- Use the Windows firewall or a network firewall (hardware or software) and disable the Remote Desktop Protocol (RDP). For more information on firewalls and RDP, see the Illumina Security Best Practices Guide.⁵
- Maintain administrative privileges for users. Illumina instrument software is configured to allow user permissions when the instrument is shipped.
- The system has fixed internal IP addresses, which can cause system failure when conflicts occur.
- The control computer is designed to operate Illumina sequencing systems. Web browsing, checking email, reviewing documents, and other nonsequencing activity creates quality and security problems.

Windows updates

Illumina recommends the application of Critical Security Updates only. To control configuration and operation of the instrument control computer and deliver a more robust operating environment, the default Windows OS has Windows Update turned off. Feature or General Updates on the system can put the system operating environment at risk and is not supported.

The Illumina Security Best Practices Guide provides more information on Windows Update alternatives.⁵

Third-party software

Illumina does not support software beyond what is provided at installation. Do not install Chrome, Java, Box, or any other third-party software that was not provided with the system. Third-party software is untested and can interfere with performance and security. For example, RoboCopy or other synchronization and streaming programs can cause corrupt or missing sequencing data because it interferes with streaming performed by the control software suite.

User behavior

The instrument control computer is designed to operate Illumina sequencing systems. It should not be used as a general-purpose computer. For quality and security reasons, using the control computer for web browsing, checking email, reviewing documents, or other unnecessary activity is discouraged, as it can result in degraded performance or loss of data.

Group policy application

When connecting to a domain with Group Policy Objects (GPOs), some settings might affect the operating system or instrument software. If the instrument software operates incorrectly, consult your facility IT administrator about possible GPO interference.

Password management

Configure a password that is at least 10 characters, and use local ID policies for additional guidance. Keep a record of the password. For customer security, Illumina does not keep customer login credentials, and unknown passwords cannot be reset. An unknown password requires that an Illumina representative restore the factory default, which removes all data from the system and extends the necessary support time.

Administrative rights and privileges

Maintain administrative privileges for users. Illumina instrument software is configured to allow user permissions when the instrument is shipped.

Table 4: Universal approval requirements for internal system operation

| Connection | Value | Purpose |
|------------|-------------|------------------------------------------------------------------------------------------------------|
| Domain | localhost:* | All ports for localhost-to-localhost communication, which are needed for interprocess communication. |
| Port | 8081 | Real-Time Analysis |
| Port | 8080 | Control Software |
| Port | 8090 | Remote Copy Service |

Instrument-specific settings

In addition to settings previously mentioned, there are the settings that need to be considered for each platform, representing internal settings that need to be whitelisted.

Table 5: Information security specifications for Illumina sequencing systems

| System | SRP | EMET | Default IPD setting | Opt-in or Opt-out | IPD setting at software upgrade |
|---------------|-----|------|---------------------|-------------------|---------------------------------|
| NovaSeq | Yes | Yes | On | Opt-out | Retain previous setting |
| HiSeq™ | No | No | On | Opt-out | Reset to On |
| NextSeq™ | No | No | On | Opt-out | Retain previous setting |
| NextSeq 550Dx | Yes | Yes | Off | Opt-in | Retain previous setting |
| MiSeq™ | No | No | On | Opt-out | Retain previous setting |
| MiSeqDx | No | No | Off | Opt-in | Retain previous setting |
| MiniSeq™ | No | No | On | Opt-out | Retain previous setting |
| iSeq 100 | Yes | No | On | Opt-out | Retain previous setting |
| HiScan™SQ | No | No | On | Opt-out | Reset to On |

Systems with the LRM module require Port 80 to be inbound for the local network only.

Table 6: Internal communication requirements by system

| System | Ports and IP addresses | Purpose | Bandwidth requirement |
|---------------|--------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----------------------|
| NovaSeq | 5555 | Hardware controller interface | 200MB/system |
| NovaSeq | 22, 80, 111, 443, 623, 2049, 5900, 8889, 9980, 169.254.x.x, fddc:65e5:66fa::1/48, fddc:65e5:66fa::2/48 | Internal data transfer | 200MB/system |
| HiSeq | | The HiSeq System has no internal IP communication processes. | 100MB/system |
| NextSeq | 192.168.113.*:* | Allow All Ports. This is the communication link with firmware on the internal network card. | 50MB/system |
| NextSeq 550Dx | 192.168.113.*:* | Allow All Ports. This is the communication link with firmware on the internal network card. | 50MB/system |
| NextSeq 550Dx | Port 80 | Local Run Manager. Required local inbound (no internet access) | 50MB/system |
| MiSeq | Port 80 | Local Run Manager. Required local inbound (no internet access) | 10MB/system |
| MiSeqDx | Port 80 | Local Run Manager. Required local inbound (no internet access) | 10MB/system |
| MiniSeq | 192.168.113.*:* | Allow All Ports. This is the communication link with firmware on the internal network card. | 10MB/system |
| MiniSeq | Port 80 | Local Run Manager. Required local inbound (no internet access) | 10MB/system |
| iSeq 100 | Port 80 | Local Run Manager. Required local inbound (no internet access) | 10MB/system |
| HiScanSQ | | The HiSeq System has no internal IP communication processes. | 50MB/system |

The IP listed is critical. It is the interface for the hardware controller.

For more information and details on communication requirements, see the Site Prep Guide for the specific system (Table 7). User manuals for each specific system contain information on steps to enable IPD through instrument software (Table 7).

Table 7: User guides and site prep guides for Illumina systems

| System | User guide | Site prep guide |
|---------------|-------------------------------|-------------------------------|
| NovaSeq | 1000000019358 | 1000000019360 |
| HiSeq 1000 | 15023355 | 15006407 |
| HiSeq 1500 | 15035788 | 15006407 |
| HiSeq 2000 | 15011190 | 15006407 |
| HiSeq 2500 | 15035786 | 15006407 |
| HiSeq 3000 | 15066493 | 15066492 |
| HiSeq 4000 | 15066496 | 15066492 |
| HiSeq X | 15050091 | 15050093 |
| NextSeq 500 | 15046563 | 15045113 |
| NextSeq 550 | 15069765 | 15045113 |
| NextSeq 550Dx | 1000000009513 | 1000000009869 |
| MiSeq | 15027617 | 15027615 |
| MiSeq Dx | 15070067 | 15038351 |
| MiniSeq | 1000000002695 | 1000000002696 |
| iSeq | 1000000036024 | 1000000035337 |
| HiScan SQ | 15015392 | 15015393 |

If a hyperlink becomes inactive due to updates, the provided document number can be used to search the Illumina website for a newer version of the guide.

Instrument performance data types

Table 8: Instrument performance data types (instrument configuration files)

| File name | File description | HiScanSQ | HiSeq 1000/1500/2000/2500 | HiSeq 3000/4000 | HiSeq X | iSeq 100 | MiniSeq | MiSeq | MiSeq Dx | NextSeq | NextSeq 550Dx | NovaSeq 6000 |
|-----------------------------|---------------------------------------------------|----------|---------------------------|-----------------|---------|----------|---------|-------|----------|---------|---------------|--------------|
| Effective.cfg | Software system configuration total parameters | X | X | X | X | | X | X | X | X | X | X |
| FirmwareVersions.txt | Firmware version on instrument hardware | | | | | | X | | | X | X | X |
| *Calibration.cfg | Software system calibration parameters | | | | | | X | X | | X | X | X |
| *Override.cfg | Software system configuration override parameters | X | X | X | X | | X | | | X | X | X |
| RTAStart.bat | Primary analysis start file. | | | | | X | X | | | X | X | |
| Options.cfg | Software system configuration override parameters | | | | | | | | | | | X |
| *HardwareHistory.csv | Instrument hardware configuration history. | | | | | | X | | | X | X | |
| *CurrentHardware.csv | Instrument hardware current configuration. | | | | | | X | | | X | X | |
| SequencingConfiguration.xml | Instrument system configuration parameters | | | | | X | | | | | | |

Table 9: Instrument performance data types (instrument operational logs)

| File name | File type | File description | HiScanSQ | HiSeq 1000/1500/2000/2500 | HiSeq 3000/4000 | HiSeq X | iSeq 100 | MiniSeq | MiSeq | MiSeq Dx | NextSeq | NextSeq 550Dx | NovaSeq 6000 |
|-------------------|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|-----------------|---------|----------|---------|-------|----------|---------|---------------|--------------|
| *.jpg | Run Specific Operational Images | Thumbnail image for each tile and color channel if option has been turned on in software (off by default), usually turned on by FAS/FSE. | | | | | | X | X | X | X | X | |
| Samplesheet.csv | Run Specific Sample Configuration File | | | | | | | | | | | | X |
| Recipe file (XML) | Run Specific configuration file | Sequencing recipe used in run | | | | | X | | | | | X | X |
| Logs.zip | | Zipped folder of human readable files. All files readily accessible by customer on instrument | | | | | | X | X | X | X | X | X |

Table 10: Instrument performance data types (instrument analytics configuration files)

| File name | File description | HiScanSQ | HiSeq 1000/1500/2000/2500 | HiSeq 3000/4000 | HiSeq X | iSeq 100 | MiniSeq | MiSeq | MiSeq Dx | NextSeq | NextSeq 550Dx | NovaSeq 6000 |
|----------------------|---------------------------------|----------|---------------------------|-----------------|---------|----------|---------|-------|----------|---------|---------------|--------------|
| RTAConfiguration.xml | RTA configuration | X | X | X | X | X | X | X | X | | X | |
| RTA3.cfg | RTA configuration | | | | | | | | | | | X |
| RTAerror.txt | Primary analysis error log file | | | | | | X | X | | | | |

Table 11: Instrument performance data types (miscellaneous file types)

| File name | File description | HiScanSQ | HiSeq 1000/1500/2000/2500 | HiSeq 3000/4000 | HiSeq X | iSeq 100 | MiniSeq | MiSeq | MiSeq Dx | NextSeq | NextSeq 550Dx | NovaSeq 6000 |
|--------------|--------------------------------------------------------------------------------------------------------------------|----------|---------------------------|-----------------|---------|----------|---------|-------|----------|---------|---------------|--------------|
| *.IMF logs | Software operational log files | | | X | X | | X | | | | X | X |
| *Results.zip | Service software test results. This is sent only if triggered by a Service & Support personnel in service software | | | | | | X | | | X | X | |

Table 12: Instrument performance data types (run-specific operational logs)

| File name | File description | HiScanSQ | HiSeq1000/1500/2000/2500 | HiSeq 3000/4000 | HiSeq X | iSeq 100 | MiniSeq | MiSeq | MiSeq Dx | NextSeq | NextSeq 550Dx | NovaSeq 6000 |
|-----------------------|-----------------------------------------------------------------------------------|----------|--------------------------|-----------------|---------|----------|---------|-------|----------|---------|---------------|--------------|
| *Firmware_Logs | Firmware operation log files (CSV) | | | | | | X | | | X | X | |
| PreRunDiagnosticFiles | Pre-sequencing run check results and log files (csv an xml) | | | | | X | X | | | X | X | X |
| Cycle Logs | Troubleshooting logs for operational data generated per cycle. (TXT and XML form) | | | | | | X | X | X | X | X | X |
| *Error*.log | Troubleshooting logs for operational data. | X | X | X | X | | | | | | | X |
| CycleTimes.txt | cycle duration time during a sequencing run | X | X | X | X | | | | | | | |
| UCS Logs | Copy Service log file (.json and .csv) | | | | | | | | | | | X |

Table 13: Instrument performance data types (run-specific analytics files)

| File name | File description | HiScanSQ | HiSeq 1000/1500/2000/2500 | HiSeq 3000/4000 | HiSeq X | iSeq 100 | MiniSeq | MiSeq | MiSeq Dx | NextSeq | NextSeq 550Dx | NovaSeq 6000 |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------------------|-----------------|---------|----------|---------|-------|----------|---------|---------------|--------------|
| RTAComplete.txt | Indicator file that all primary processing has completed | X | X | X | X | X | X | X | X | X | X | X |
| RTARead*Complete.txt | Indicator file that primary processing has completed key step | | | | | X | | | | | | |
| RunParameters.xml | Run set up configuration parameters outputted in XML form at the beginning of the run. | X | X | X | X | X | X | X | X | X | X | X |
| RunInfo.xml | Run set up configuration parameters output in XML form at the beginning of the run used for sequencing analysis viewer. | X | X | X | X | X | X | X | X | X | X | X |
| RunCompletionStatus.xml | Indicator file indicates sequencing is complete. | X | X | X | X | | X | X | X | X | X | X |
| SequenceComplete.txt | Indicator file indicates sequencing is complete. | | | | | | | | | | | X |
| *MetricsOut.bin | Binary reporting files for Sequencing Analysis Viewer. Not readable by customer without additional software. | X | X | X | X | X | X | X | X | X | X | X |
| AlignmentMetricsOut.bin | | | | | | X | | | | | | X |
| BasecallingMetricsOut.bin | | | | | | X | | | | | | X |
| CorrectedIntMetricsOut.bin | Average Intensity, Corrected Channel Intensity, Corrected Called Intensity, Called counts | X | X | X | X | X | X | X | X | X | X | X |
| EmpiricalPhasingMetricsOut.bin | Phasing, Prephasing per cycle | X | X | X | X | X | X | X | X | X | X | X |
| ErrorMetricsOut.bin | Error Rate, Read Errors | X | X | X | X | X | X | X | X | X | | X |
| EventMetricsOut.bin | Timing data for RTA Started, Cycle Started, Template Generation Started/Completed, PostTemplate Max Clusters Init, System Memory Available Gigabyte, Registration And Extraction, Neighbor Correction, Color Matrix Correction, Template Generation, BasecallingAnd Quality Scoring, Sequence Alignment, BdWriting, Read Started/Completed, Filter Align Started/Completed, Cycle Completed, RTA Completed | X | X | X | X | X | X | X | X | X | X | X |
| ExtendedTileMetricsOut.bin | | | | | | X | | | | | | X |
| ExtractionMetricsOut.bin | Focus Scores, Intensities, Time | X | X | X | X | X | | X | X | X | X | X |
| FWHMGridMetricsOut.bin | | | | | | X | | | | | | X |
| ImageMetricsOut.bin | | | | | | X | | | | | | X |
| IndexMetricsOut.bin | Name, Sample Name, Project Name | | | | | X | | X | | | | X |
| OpticalModelMetricOut.bin | | | | | | | | | | | | X |
| PFGridMetricsOut.bin | Cluster Count, PF Cluster Count, Locs area in mm^2 | X | X | X | X | X | | X | X | X | X | X |
| QMetrics2030Out.bin | | | | | | X | | X | | | | X |
| QMetricsByLaneOut.bin | | | | | | X | | X | | | | X |
| QMetricsOut.bin | QScore histogram | X | X | X | X | X | | X | X | X | | X |
| RegistrationMetricsOut.bin | Subtile Offsets, Affine Transform | X | X | X | X | | | X | X | X | | X |
| TileMetricsOut.bin | Cluster Density, Cluster Density PF, Cluster Count, Cluster Count PF, Percent Aligned, Percent Phasing, Percent Prephasing, Latest Extracted Cycle, Latest Called Cycle, Latest QScored Cycle, Latest Error Cycle | X | X | X | X | X | | X | X | X | X | X |
| *.tsv or *.txt | TSV or TXT log files generated for RTA file copy logs, global logs, and warnings logs. Accessible by customer in human readable form. | | | | | X | | X | X | X | X | |
| QGridMetricsOut.bin | | | | | | X | | | | | | |

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