BOREAL GENOMICS

Aurora

User Manual v2.30

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1. Safety information

The SCODA concentration technology applied by the Aurora instrument is driven by high-voltage electric fields. Improper use of the instrument may expose the user to electrical hazards. The Aurora has safeguards designed to protect the user from these hazards. Please read the information below on these safety features before using the instrument.

Danger

Never attempt to service an Aurora system or to remove any part of the enclosure unless instructed by the user manual or Boreal Genomics' staff. Do not insert any tools or objects into the machine other than those required for regular instrument operation.

Certification and standards information

The Aurora instrument has been certified for safety compliance with the harmonized CSA, UL and EU standard IEC 61010-1 - Safety requirements for electrical equipment for measurement, control and laboratory use.

Electrical safety

The Aurora system is designed with safety features to prevent the user from accessing hazardous parts of the system, particularly the high voltage electronics.

- All hazardous electrical elements of the system are encased within a metal and plastic enclosure that is bonded to earth ground. Do not attempt to remove any of the external panels. Do not operate the instrument if panels have been removed or damaged, or if fluid is ever observed leaking from the instrument.

- The contact plate drawer and cartridge drawer are both designed with electrical safety interlocks that disable the high voltage elements of the system if either of the drawers is opened. Do not attempt to bypass or disable the interlock systems.

To ensure that these systems operate as expected:

- All exterior panels must be in place and free of damage when operating the machine.
- The system must be plugged into a properly grounded outlet that supplies the correct voltage and current (see the **Electrical requirements** section on page 16).

To minimize the risk of electrical damage to the instrument and cartridge, always pause the instrument before opening a drawer during operation.

Lifting, moving and installing the instrument

The Aurora instrument weighs 21 kg (46 lbs). Use proper care and lifting techniques to avoid back strain and injury. Install the system on a sturdy, level surface capable of holding the instrument.

When lifting the Aurora, support the instrument from the underside of the lower rounded white metal panels. Do not attempt to lift the Aurora by the plastic front panel. Ensure that the drawers are securely closed and all cables and tubing have been disconnected.

Hot surfaces

The Aurora instrument is equipped with temperature control hardware that is capable of heating the cartridge to 60 °C. Use caution when opening the cartridge drawer and moving the cartridge to avoid burns from handling a hot cartridge, touching a hot spreader plate or surrounding elements, or splashing hot liquids. Let the system cool down before handling any hot elements or use the temperature control system to cool the cartridge to a safe temperature after a run.

Pinch hazards

The cartridge drawer and contact plate drawer present pinching hazards as the drawers are closing. Always close the instrument drawers in a slow and steady motion, taking care not to trap fingers or gloves in the instrument.

Chemical and biological waste safety

The user is responsible for the safe use, transport, storage, and disposal of any and all materials that may be considered a chemical or biological hazard. Refer to accompanying material safety data sheets (MSDS) for safety information and handling instructions and comply with all federal, state/provincial, municipal/local, and institutional requirements and guidelines for disposal.

Improper usage

Usage of the Aurora instrument in a manner not specified by Boreal Genomics can prevent the proper operation of the protection provided by the instrument against shock and other hazards.

2. Introduction

The Boreal Genomics Aurora instrument uses Synchronous Coefficient of Drag Alteration (SCODA) electrophoretic DNA manipulation technology to concentrate and purify DNA from challenging samples. Instead of separating DNA based on its chemical properties or by affinity, SCODA technology purifies DNA based on its physical properties, selecting for long, charged polymers. As a result, the Aurora instrument provides exceptional contaminant rejection over a broad range of contaminants. In addition, the Aurora delivers up to 100-fold concentration of DNA from a single sample, from several hundred molecules up to 100 µg of DNA.

The Aurora accepts up to 5 ml of low conductivity lysate and purifies the DNA into a final buffer volume of up to 60 µl. To ensure efficient DNA injection and recovery, samples must have a conductivity not exceeding 200 µS/cm in 5 ml. More details regarding specific sample processing upstream of the Aurora are provided as separate protocols by Boreal Genomics.

3. Instrument diagrams

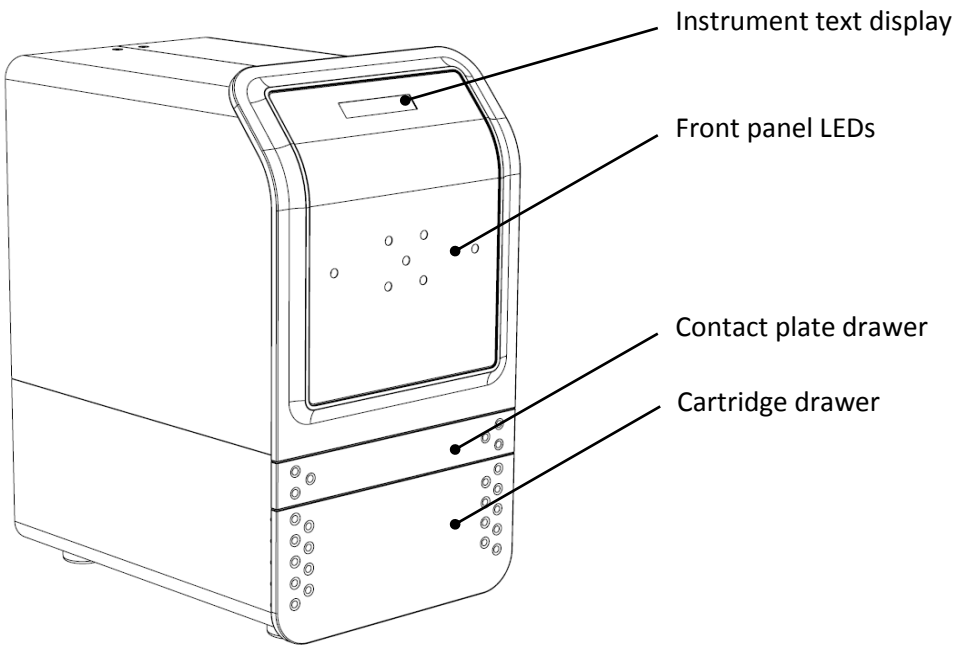

Figure 1. Front view of the Aurora

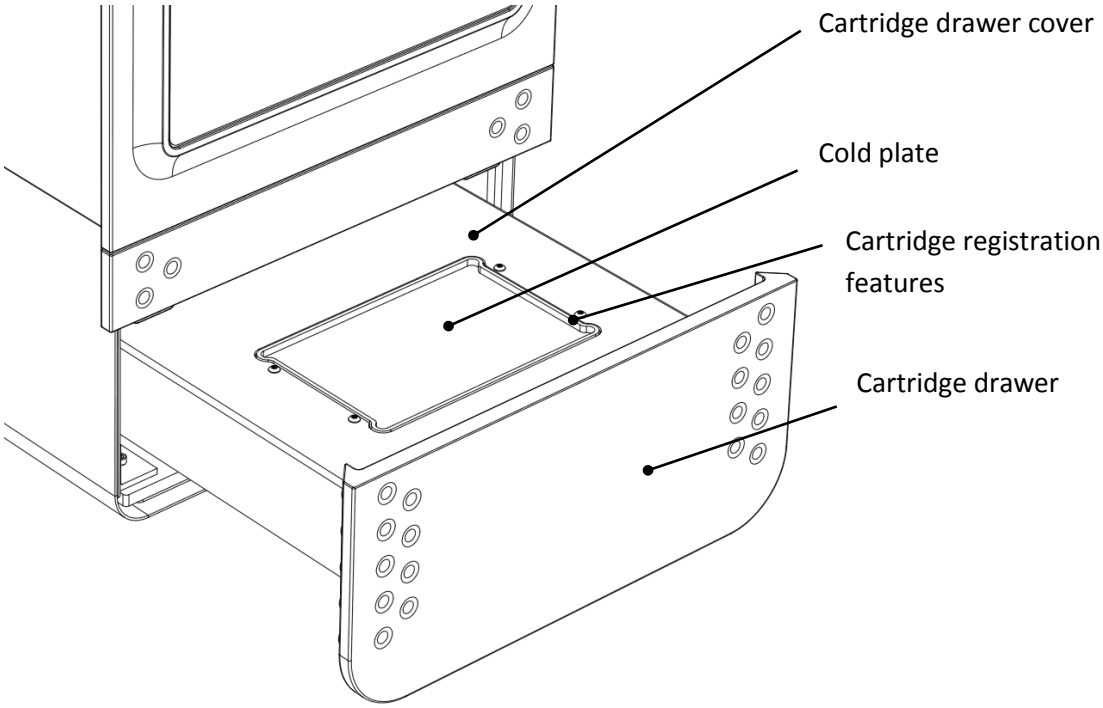

Figure 2. Cartridge drawer and features

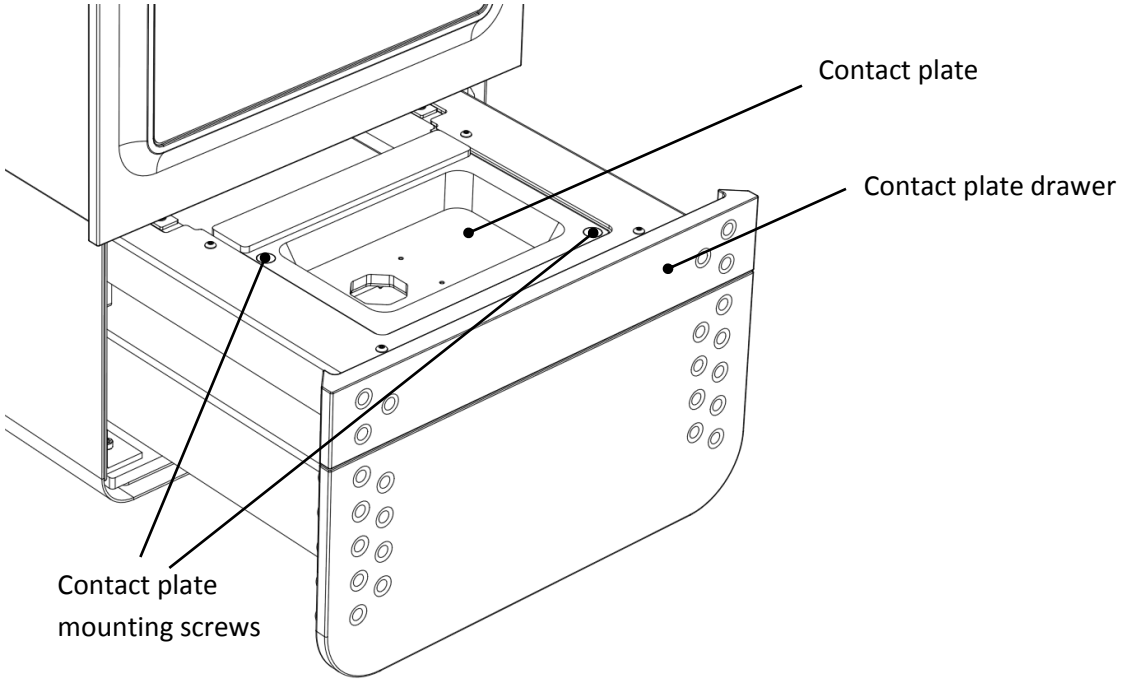

Figure 3. Contact plate drawer and features

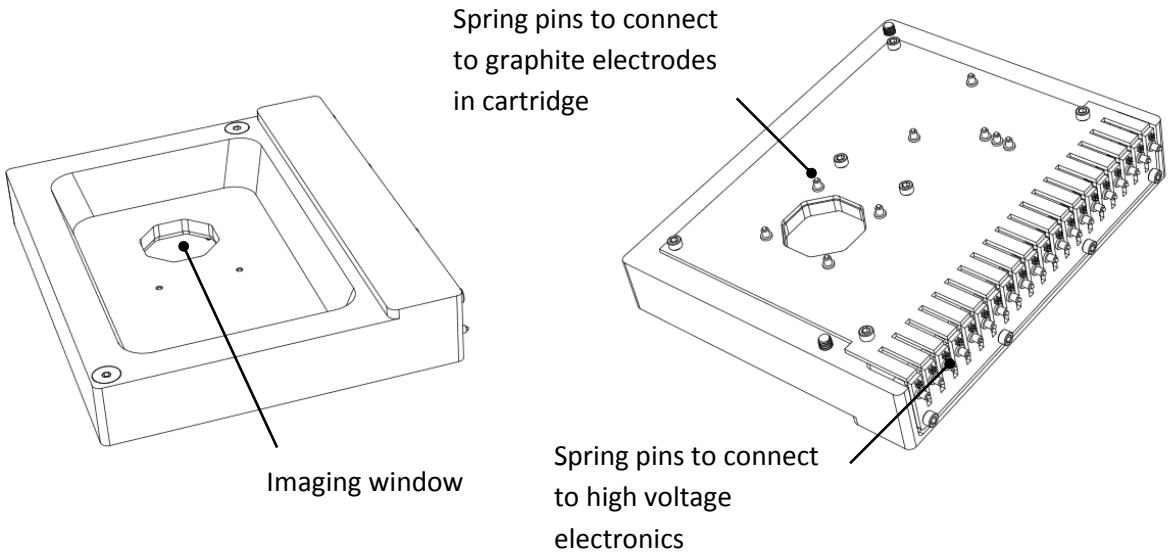

Figure 4. Contact plate

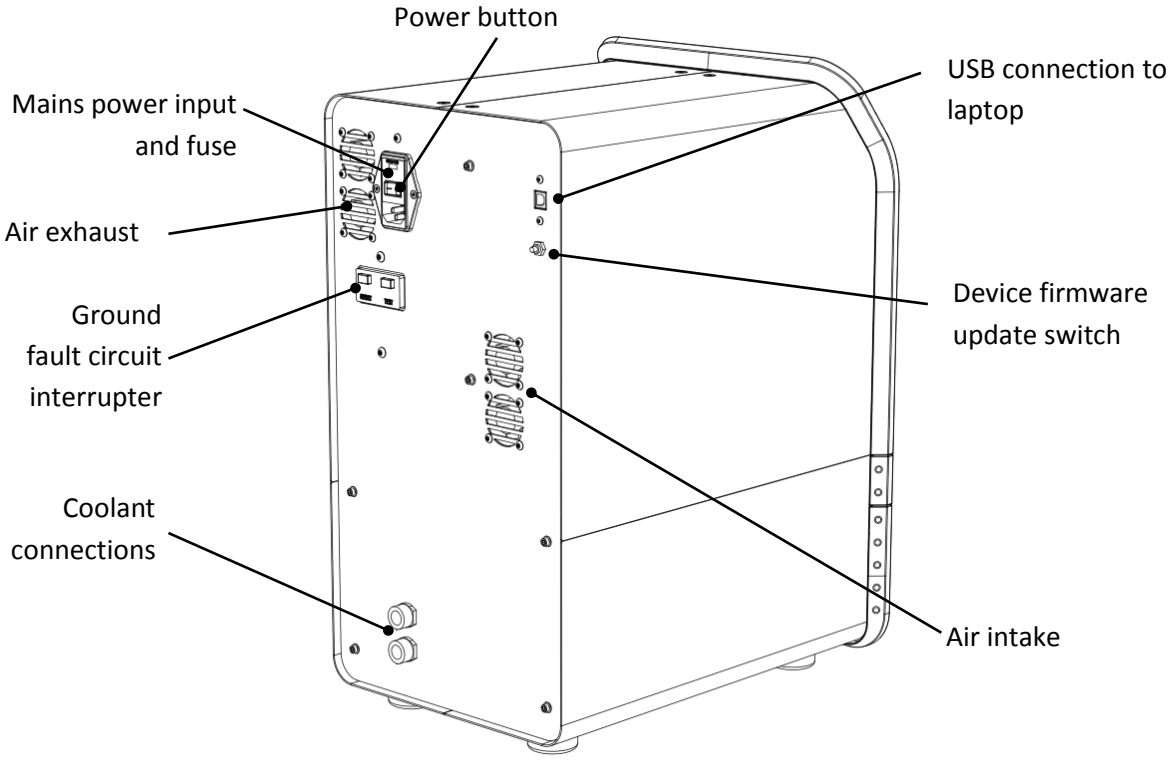

Figure 5. Aurora rear panel

Front panel LEDs

The Aurora front panel contains six LEDs, arranged in the shape of a 1-sample cartridge, that represent the electrical states of the six SCODA electrodes. An additional center LED provides information about the status of the machine.

The electrode LEDs are white to indicate the electrode is at high voltage, blue to indicate the electrode is grounded, or off to indicate that the electrode is electrically disconnected. The status LED in the center blinks white when the instrument is idle or paused, is steady white when a run has been completed, and is steady red when an error occurs during a run.

Each step of the SCODA process has a characteristic field pattern. **Figure 6** illustrates patterns associated with injection (a), focus (b), and a typical wash (c). Different protocols may use wash patterns that are different from pattern (c), which may appear to flicker rapidly. Unless the SCODA software explicitly indicates an error condition, this is normal behaviour and does not indicate a problem.

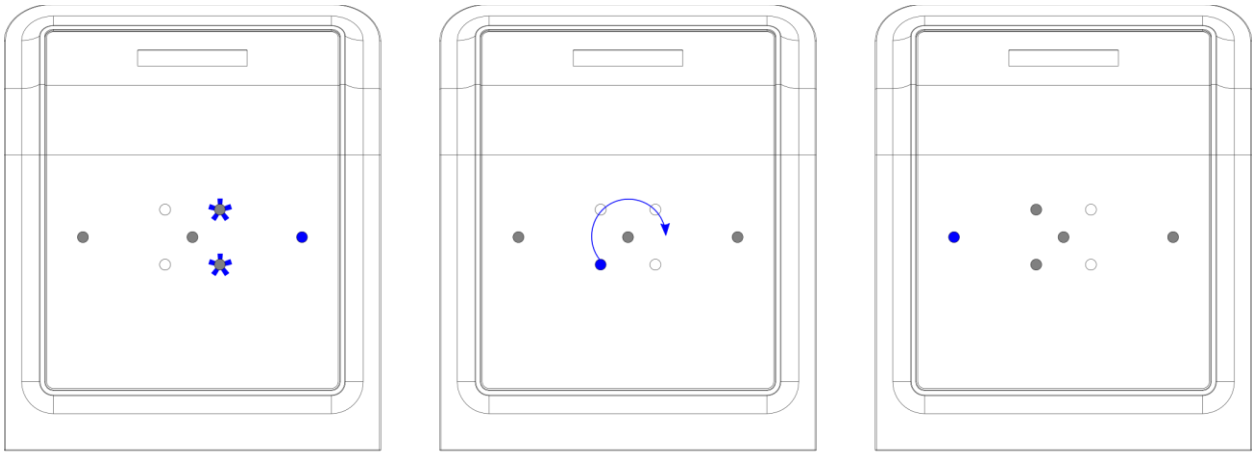

Figure 6. Typical LED patterns

4. Installation and setup

Read this section before unpacking and installing the Aurora. After completing installation, open the enclosed validation kit and follow the validation protocol to perform the validation run to ensure that the Aurora is functioning correctly.

Packing list

- 1x Aurora instrument
    - 1x power cord
    - 1x USB cable
- 1x laptop
    - 1x power cord
    - 1x mouse
- 2x coolant tubes (1.5 m length) with fittings
- 1x validation kit
    - Please see the validation protocol manual for a list of kit contents
- 1x MSDS document package

External chiller

An external chiller is required to operate the Aurora. As described in the Terms and Conditions of Sale for the Aurora instrument, the warranty is only valid if the instrument is used with the following chiller:

- Vendor: Solid State Cooling Systems
- Part Number (North America 120 VAC): 10-400-2D-1-EF-90
- Part Number (Europe 230 VAC): 10-400-2D-2-EF-90

Installation requirements

Determining a location for the instrument

The Aurora instrument requires a flat and level working surface capable of supporting the combined 35 kg (78 lb) weight of the instrument, laptop, and chiller.

The Aurora instrument itself weighs 21 kg (46 lb), the laptop weighs 1.5 kg (3.3 lb), and the chiller weighs 12.7 kg (28 lb). **Figure 7** illustrates the dimensions of the laptop, instrument and chiller.

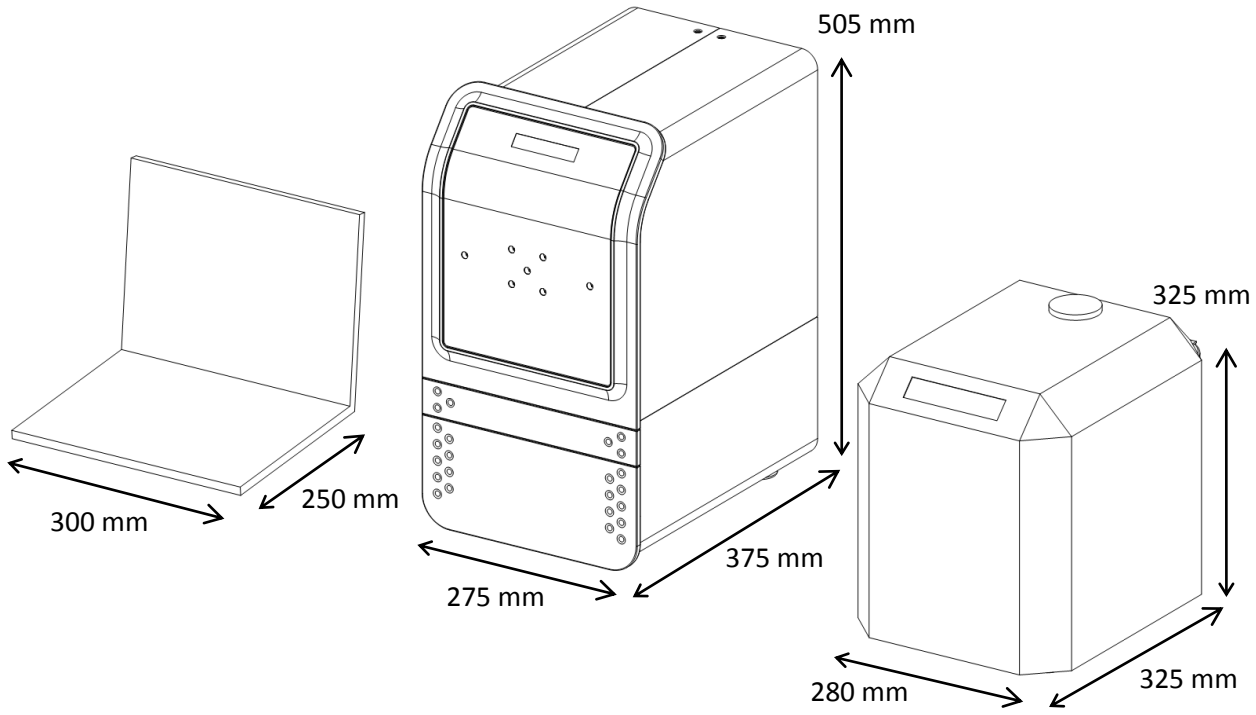

Figure 7. Dimensions of the Aurora and accessories

Both the chiller and the Aurora instrument require extra clearance to allow for the free flow of air to their respective cooling systems, as shown in **Figure 8**. The Aurora requires extra clearance behind the case to allow for the free flow of air into and out of the back panel, while the chiller requires airflow into its left-hand side, and exhaust out of its right-hand side. Restricting this airflow can reduce performance and damage the instrument and chiller.

Warning

Restricting airflow to the Aurora instrument or the chiller, or allowing the ambient air temperature to rise above 25 °C, may cause damage to the Aurora instrument and chiller.

The chiller must be mounted at the same height as the instrument, and care should be taken to ensure that the exhaust on the right-hand side of the chiller does not mix with the air intake on the back panel

of the Aurora instrument. If the chiller and Aurora are placed on the same surface, the chiller must sit to the right of the Aurora, as shown in **Figure 9**. The chiller is connected to the instrument by two tubes of length 1.5 m (5 ft).The laptop must be connected to the instrument in order to control it. The laptop can be placed anywhere within the 1 m (3 ft) reach of the provided USB cable, typically on the working surface next to the instrument or on top of the instrument.

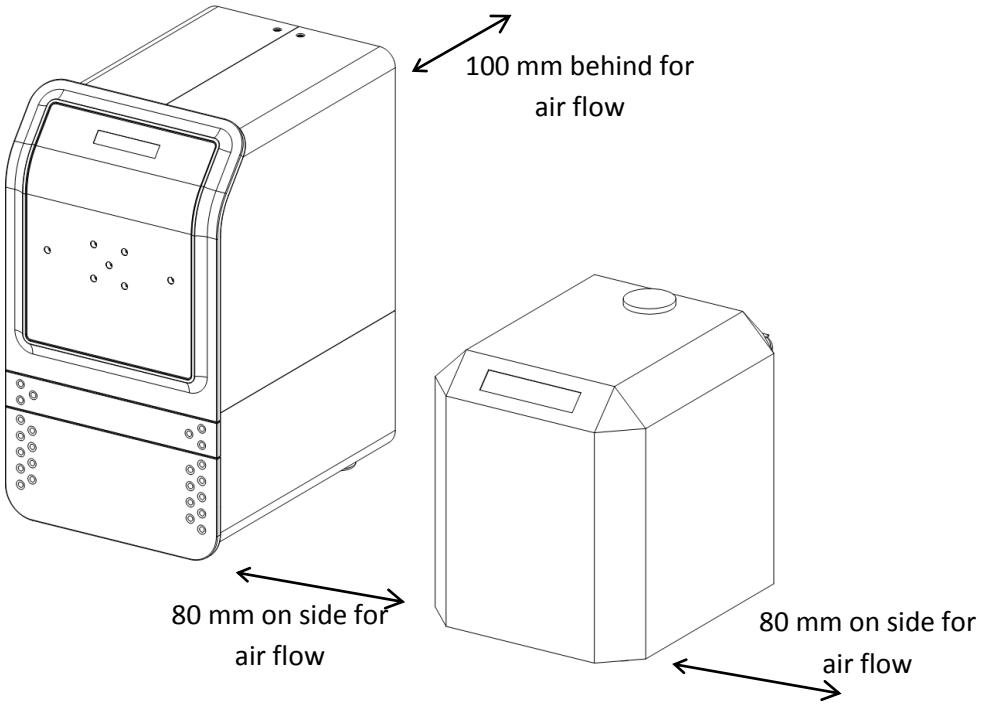

Figure 8. Clearances required for the Aurora and chiller

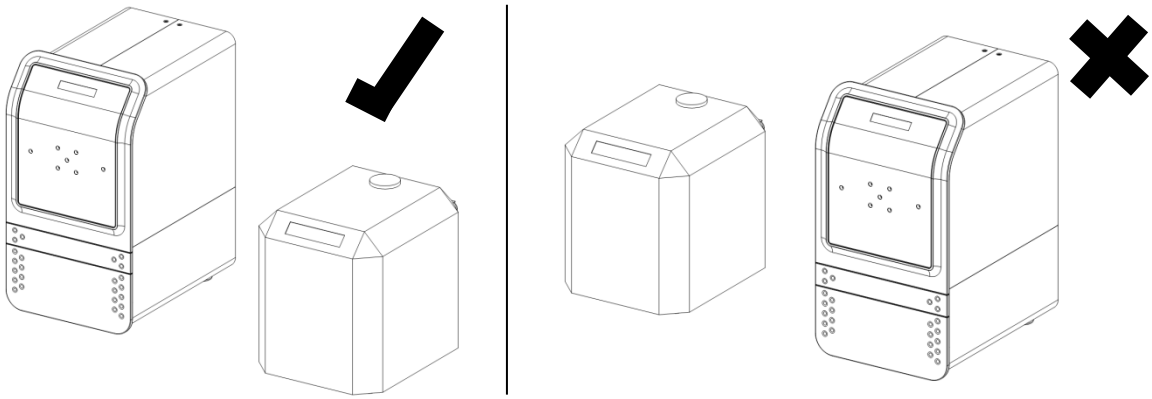

Figure 9. Illustration of the correct relative placement of the Aurora and chiller

Electrical requirements

Table 1. Aurora electrical supply requirements and model compatibility

Region	Voltage	Compatible Aurora model number(s) – listed on back panel
North America	120 VAC, 60 Hz	AUR01A-NA, AUR02A-NA, AUR03A-NA, AUR03B-NA, AUR03C-NA, AUR03D-NA, AUR03E-NA
European Union	230 VAC, 50 Hz	AUR02A-EU, AUR03B-EU, AUR03C-EU, AUR03D-EU, AUR03E-EU

For North American locations, three standard North American AC power receptacles (120 VAC, 60 Hz, three-prong grounded NEMA 5-15) are required. For European locations, three standard European AC power receptacles (230 VAC, 50 Hz, two-pronged grounded CEE-7/4) are required. Voltage fluctuations must be limited to 10% of the of the nominal voltage and transient overvoltages must be limited to typically present on the mains supply. Power strips are acceptable provided they meet all listed electrical requirements. Because the Aurora instrument, laptop, and chiller may together draw up to 12.5 A of current from a 120 V supply, Boreal Genomics recommends that the Aurora instrument and supporting devices do not share an electrical circuit with other equipment to avoid triggering circuit breakers. **Table 2** contains more information about expected current draws.

Warning

In order to ensure that the electrical safety features of the Aurora system operate correctly, it is imperative that the grounding line of the power connection be intact and bonded to earth ground.

Danger

NEVER plug an Aurora instrument that is labeled (on the back panel) 120 VAC into a 230 VAC outlet or vice versa. If you are unsure which voltage your Aurora has been configured for, contact Boreal Genomics for support assistance before proceeding.

Table 2. Electrical requirements

Item	Power draw (W)	Current draw – North America (A)	Current draw – Europe (A)
Aurora instrument	450	4	2
Laptop	180	1.5	0.75
Chiller	700	7	3.5

Environmental considerations

- The instrument is designed for operation in a laboratory environment (temperature 15 to 30 °C, relative humidity below 60%) and must not be operated in an environment where water may condense, pool, drip or splash onto or into the instrument.
- The Aurora is rated for operation at elevations up to 2 000 m.
- The Aurora and chiller have cooling fans that produce 45 dBA (@ 1 m) of noise during operation.
- The chiller must be operated in an area with sufficient air circulation to allow the removal of 1100 W of waste heat while maintaining room temperature.

Unpacking and installing the Aurora

Unpacking the Aurora

Warning

- At least two people are required to remove the Aurora instrument from its packaging materials. Practice proper lifting techniques to avoid strain or injury.
- When moving the Aurora, ensure the drawers are latched closed and support the Aurora only by the metal frame. Do not grip the plastic panels.
- Once the Aurora instrument has been removed from its packaging, it must sit upright on its feet. Do not invert the Aurora.

Open the cardboard box for the main shipment. Remove all items, checking against the packing list (on page 13) to ensure that all items were received and nothing was left in the packing material. Lift the Aurora out of the box by its metal body. Do not lift the Aurora by the plastic front panel. Retain all packing materials until after the validation runs have been completed.

Place the instrument on an appropriate working surface as described in the **Installation requirements** section, ensuring that there is 100 mm (4 in) of space behind the instrument for airflow. The instrument must be level and must not wobble. To correct a tilt or wobble, shim the instrument underneath one or more feet as needed.

Remove all packing tape and material from the Aurora instrument, including the foam from inside the cartridge drawer.

Placing and connecting the chiller

Place the chiller on a sturdy, stable working surface to the right of the instrument. Ensure that there is at least 80 mm (3 in) of clearance on both the left and right side of the chiller for air flow.

Locate the push-to-connect fitting on the chiller labelled PROCESS IN (see **Figure 10**). If there is a solid plug in the fitting, remove it by pushing the outside collar of the fitting down with one hand and simultaneously pulling straight backwards on the plug with the other hand. The plug should come out

with minimal force if the collar is fully depressed. Once the plug has been removed (or if there is no plug provided), insert the bare end of one of the provided fluid tubes into the fitting. Push the tube in until it stops and then pull back to ensure it is secure

The chiller will come with a pre-installed tube running from the port labelled PROCESS OUT to the port on the blue external filter on the back of the chiller (shown in **Figure 11**) labelled IN. Insert the other provided fluid tube into the port on the external filter labelled OUT, again pressing until it stops and then pulling back to check that it is secure. Follow the same procedure to remove a plug for this port, if a plug is present.

Figure 10. Coolant connections on the chiller

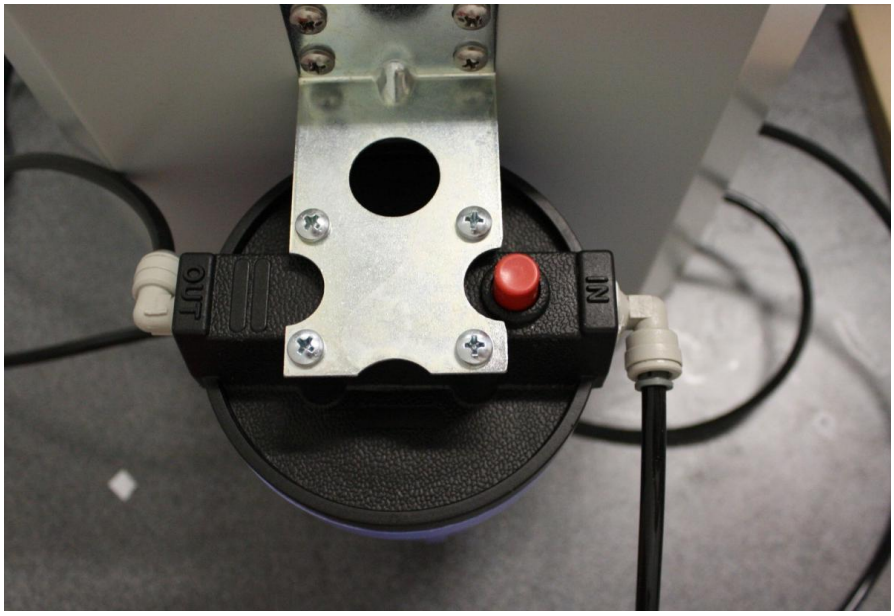

Figure 11. External filter on the back of the chiller

Insert the other ends of the fluid tubes (with the white plastic fittings) into either of the COOLANT WATER ports on the back panel of the Aurora instrument. Press each in until the retaining ring snaps and then pull back to ensure it is secure. It does not matter which tube is plugged into which coolant port on the Aurora.

Make sure the tubes are not strained or kinked at any point – if necessary, use zip ties or other fasteners to relieve strain on the tubes. Take care not to pinch or restrict flow through the tubes.

Plug the chiller into an AC power outlet using the power cord included with the chiller, following the directions in the **Electrical requirements** section above.

Filling the chiller

The chiller's water reservoir cap is located at the top rear of the unit. Fill the reservoir with tap water (do not use deionized, distilled, reverse osmosis, or other high-purity water) to just below the bottom of its neck. Replace and tighten the water cap.

Flip the switch on the left side of the chiller to ON. The chiller's internal pump will start and, after a few seconds, the display on the front of the chiller should display TANK LEVEL LOW, as some of the fluid in the reservoir has now been pumped into the Aurora instrument.

Leave the chiller running for 1 minute to allow air bubbles to escape, then turn the chiller off and top up the reservoir with tap water, again to just below the bottom of its neck. Replace and tighten the water cap.

Note that it is important to only fill the tank while the chiller is off; filling the tank while the chiller (and pump) is running will overfill the tank and result in tank overflow when the chiller is switched off.

Before proceeding, allow the chiller to run for at least **4 hours**, to allow all air bubbles to escape. Repeat the filling steps described above until the reservoir remains full and the chiller does not display the TANK LEVEL LOW error – instead, it should display the word TEMP and the temperature of the coolant (in degrees Celsius). The chiller has now been successfully filled.

Programming the chiller

After turning the chiller on, the chiller should display a star, the word TEMP, and a constantly updating measurement of the temperature of the circulating coolant.

The chiller has four input keys: UP, DOWN, ENTER and START/STOP. The front panel and display are shown in **Figure 12**. Note that the star icon on the far left indicates that temperature control is **not** active.

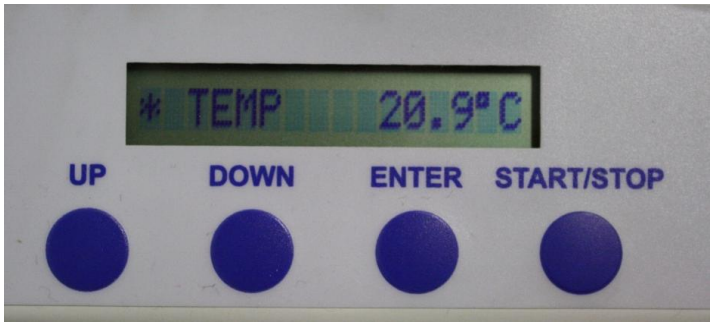

Figure 12. Front panel and display of the chiller. Temperature control is not active

To set the chiller temperature:

1. Press the UP or DOWN keys to change the set temperature to read 20.0 °C. Press Enter to set the temperature. The display will switch back to the current temperature, as in **Figure 12** – note that the star symbol on the far left hand side indicates that the temperature control is *not* yet enabled.
2. Press the START/STOP key to activate temperature control. The icon at the far left of the display will change from a star to a plus or minus symbol to indicate that the chiller is active. The coolant temperature should eventually stabilize at 20 ± 0.2 °C, as shown in **Figure 13**.

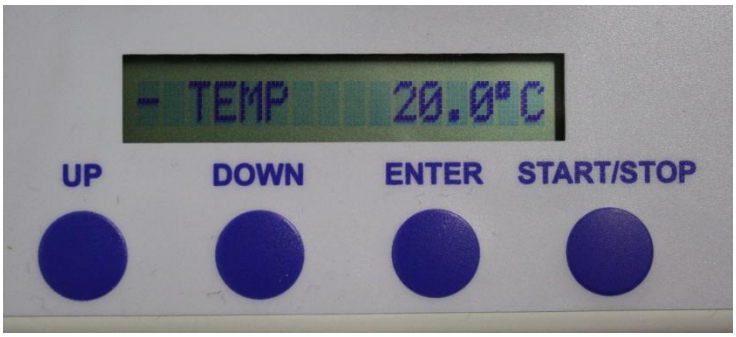

Figure 13. Front panel and display of the chiller, with temperature control active

The set temperature will persist in memory if the chiller is turned off. Once it has been set once to 20 °C, it should never need to be reset. Every time the chiller is powered on with the main switch, however, the START/STOP key will have to be pressed to turn temperature control on.

Setting up the laptop

Place the laptop on the working surface next to or on top of the instrument. Plug the laptop into an AC power outlet, using the AC adapter provided with the laptop, following the directions in the **Electrical requirements** section above.

Plug the mouse into any **uncovered** USB port on the laptop (note that for certain laptop models, Boreal Genomics will install plastic covers on certain USB ports to prevent using them with the Aurora due to driver incompatibility – use only **uncovered** ports). Use the provided cable to connect the port on the back of the Aurora instrument labelled USB to the USB port on the laptop.

Powering the Aurora

Plug the Aurora instrument into an AC power outlet using the provided power cord.

Warning

Ensure that the electrical circuit meets the requirements described in the **Electrical requirements** section on page 16.

The receptacle for AC power is on the back panel of the Aurora instrument and is labelled either 120 VAC or 230 VAC.

Danger

NEVER plug an Aurora instrument that is labeled (on the back panel) 120 VAC into a 230 VAC outlet or vice versa. If you are unsure which voltage your Aurora has been configured for, contact Boreal Genomics for support assistance before proceeding.

Next steps

After installing the Aurora, read the **Operating the Aurora** section to become familiar with the operation of the instrument. Then, use the enclosed validation kit and validation protocol to perform the validation run. The validation protocol file and document can be found pre-installed on the laptop in the folder C:\Boreal Genomics\Protocols\.

5. Operating the Aurora

This chapter will familiarize the user with the basic operation of the Aurora. Read this section after completing the installation of the Aurora system and accessories (described in the **Installation and setup** section beginning on page 13) and before beginning the validation run (described in the enclosed validation run protocol manual).

Warning

Read the safety instructions in the **Safety information** section beginning on page 6 before running the Aurora.

Preparing the Aurora

- Turn on the chiller by toggling the rocker switch on its left side. The LCD display should read TEMP and a constantly updating temperature. Press the “START/STOP” button on the chiller’s front panel to enable the temperature controller. The icon on the left side of the chiller’s LCD should change from a star to a plus or minus symbol to indicate that the temperature control is operating. The temperature readout should update until it stabilizes at 20 ± 0.2 °C. You do not need to wait for the temperature to stabilize before beginning a run.
- Turn on the computer. Log into the SCODA account using the password ‘scoda’ (all lowercase) and start the Aurora control software by double-clicking the shortcut labelled “Aurora” found on the Windows desktop.
- Once the program home screen appears (**Figure 14**), turn on the Aurora instrument by switching on the power switch on the back panel of the device.

Aurora Operation Overview

1	Turn on the Aurora and the chiller. Start the chiller. Make sure that a + or – appears on the chiller display to indicate that it is operating.	page 22
2	Prepare the cartridge and load the sample according to the directions for its accompanying protocol.	See protocol manual
3	Open the cartridge drawer of the Aurora, clean the cold plate, place 1 ml of water on the center of the cold plate to improve thermal contact, and place the cartridge firmly on the cold plate.	pages 25-6
4	Start the Aurora Control software and select the protocol you wish to run. Press Run. 	page 27
5	Define an experiment folder and press Run. 	page 28
6	Once the run has ended, extract the sample according to the protocol directions.	See protocol manual

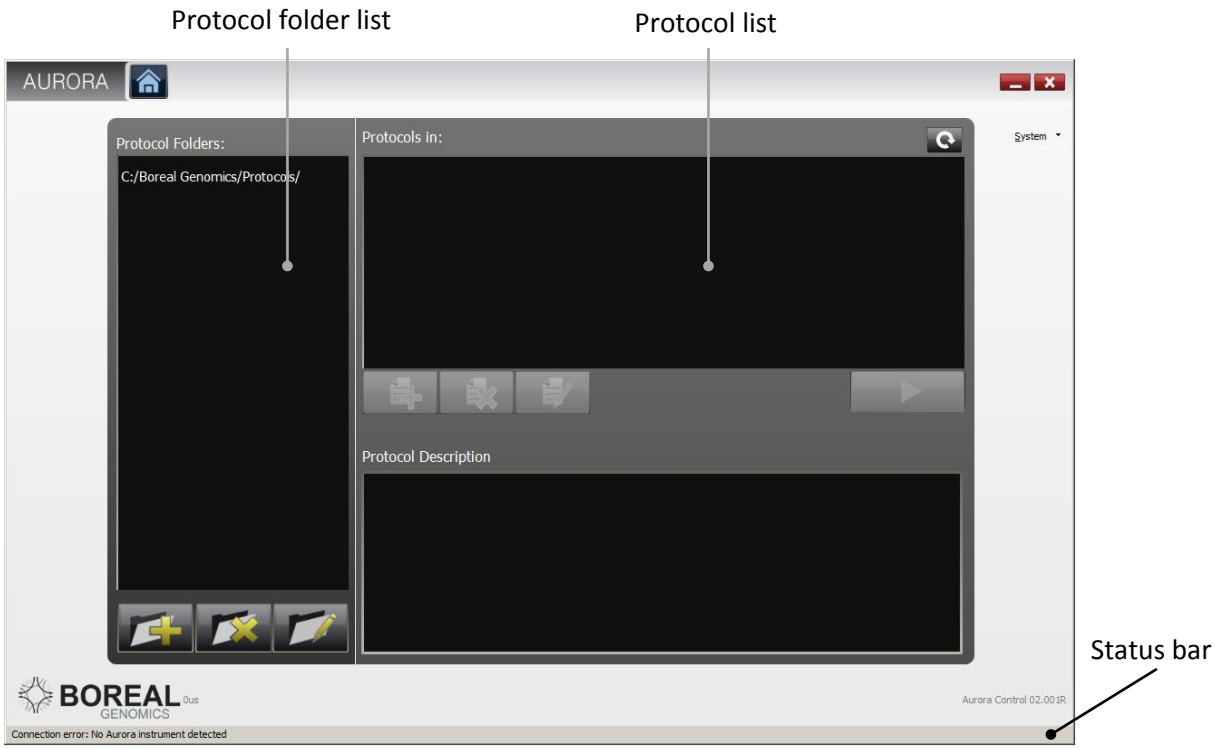

Figure 14. Aurora control software home screen

The control software will automatically connect to the instrument. Check that:

- the status bar message indicates that an instrument is connected and displays the name of the instrument,
- the status bar message indicates that a camera is connected, and
- the front display of the Aurora instrument displays the message “Idle”.

If the camera or Aurora does not connect successfully, unplug the laptop end of the USB cable connecting the Aurora to the laptop, wait five seconds, and reinsert the cable. Repeat as necessary.

A note about temperature control

The SCODA process can generate a significant amount of heat in the small volume of the agarose SCODA gel. Control of the gel temperature is critical to maintain optimal performance. The Aurora cartridge rests on an actively cooled cold plate to draw heat away from the gel. In order to transfer heat from the cartridge to the cold plate, it is critical that the cold plate and bottom of the cartridge are entirely clear of any debris that might create gaps between the two surfaces.

Loading the Aurora cartridge

Important
Take care not to spill buffer, samples, or other materials inside the Aurora. Clean any spills before closing the cartridge drawer.

Consult the protocol documentation for specific advice on loading the cartridge you plan to use into the Aurora. In general, to load a cartridge into the Aurora instrument:

- Prepare the cartridge according to the documentation accompanying the protocol you are following.
- Inspect the cartridge for any signs of leaking buffer, bubbles in the gel, or damage to the graphite electrodes. If you notice damage, contact Boreal Genomics.
- Gently pull the cartridge drawer out of the instrument until it latches in the fully opened position.
- Check the cold plate for debris that may prevent the cartridge from sitting flat.
- Pipette 1 ml of water onto the center of the cold plate to improve transfer of heat from the cartridge to the cold plate.

Important
Ensure that the cold plate and the bottom of the cartridge are clean before loading the cartridge into the Aurora.

- Check the bottom surface of the cartridge for any debris that may prevent it from sitting flat on the surface of the cold plate.
- Place the cartridge onto the surface of the cold plate. Consult the protocol documentation to ensure that the cartridge is oriented correctly. Ensure that the cartridge is sitting flat on the surface of the cold plate and sits within the registration features

Loading the sample

After preparing the cartridge, transfer the sample into the center of the cartridge's sample well (**Figure 16**). Different cartridges have different sample capacities and layouts. Please consult the information that came with the protocol you are running for the recommended sample volume. If the sample is smaller than recommended, dilute it to the recommended volume in nuclease-free deionized water or a very low-conductivity buffer such as 0.01x TBE.

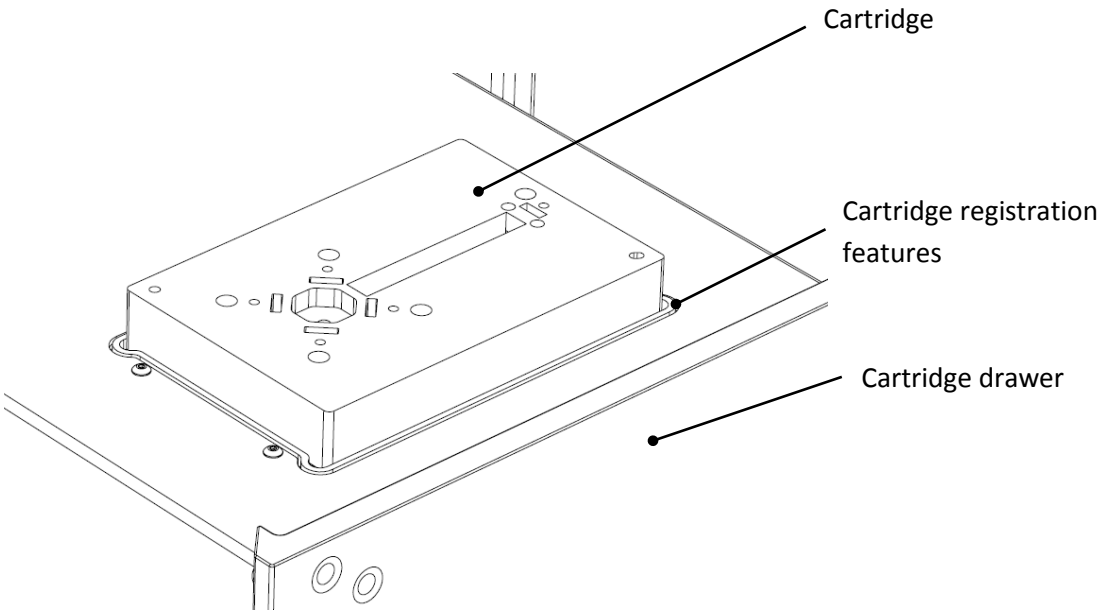

Figure 15. Cartridge loaded into the cartridge drawer. Appearance of cartridge may differ; please refer to protocol documentation.

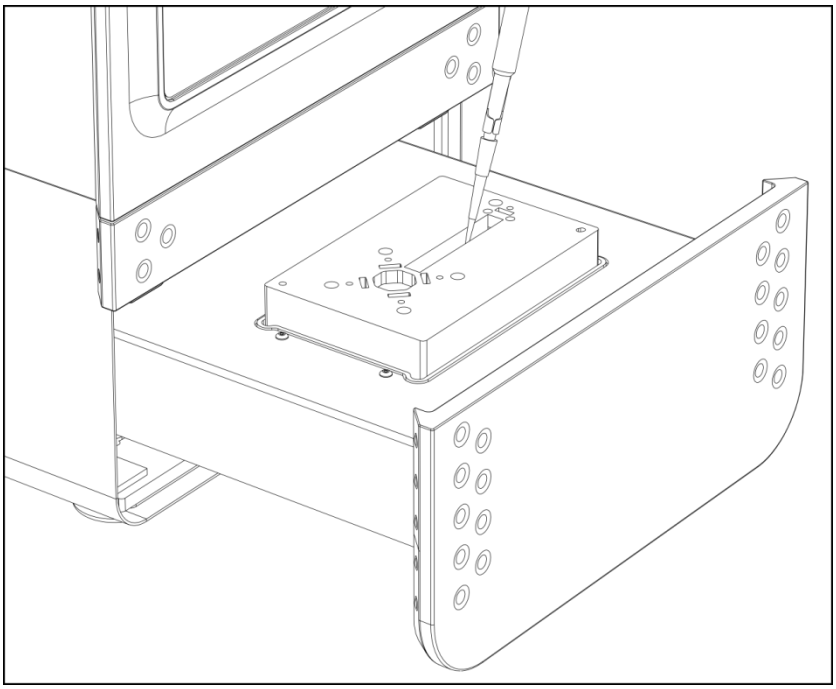

Figure 16. Pipetting a sample into the sample chamber. Appearance of cartridge may differ; please refer to protocol documentation.

Close the cartridge drawer. Resistance will be felt as the drawer closes; apply gentle, even pressure to both left and right sides of the drawer until it is secure. Avoid quick movements that will cause the liquid in the cartridge to splash.

Understanding SCODA protocols

SCODA protocols are composed as sequences of blocks. There are four types of blocks, each of which performs a unique function:

- **Injection block**: Draws DNA into the SCODA gel from the sample chamber.
- **Focus block**: Concentrates DNA in the SCODA gel into the extraction well. Focus blocks can also have an electrophoretic wash superimposed for added contaminant rejection.
- **Wait block**: Pauses for a set time or waits for user intervention.
- **Advanced block**: Runs custom field patterns and operating conditions.

Refer to **Appendix D: Managing, creating, and editing protocols** for more detailed information on blocks and their parameters.

Loading pre-programmed protocols

From the home screen, previously saved protocols can be loaded or new protocols can be created. To run a pre-programmed protocol (such as the validation run or other protocols supplied by Boreal Genomics):

- Select the folder where the protocol resides in the left hand side of the screen.
- Select the protocol to be run in the right side of the screen, and click [].

The control software will advance to the pre-run screen.

The pre-run screen (**Figure 17**) allows the user to:

- review the protocol to be run,
- set the path for the experiment folder where experiment log files (event log and data log) and images acquired during an experiment are saved, and
- add any experiment-specific comments which will appear in the experiment log files and in the captions of any acquired images.

Before starting a run, review and correct any error conditions by following software prompts.

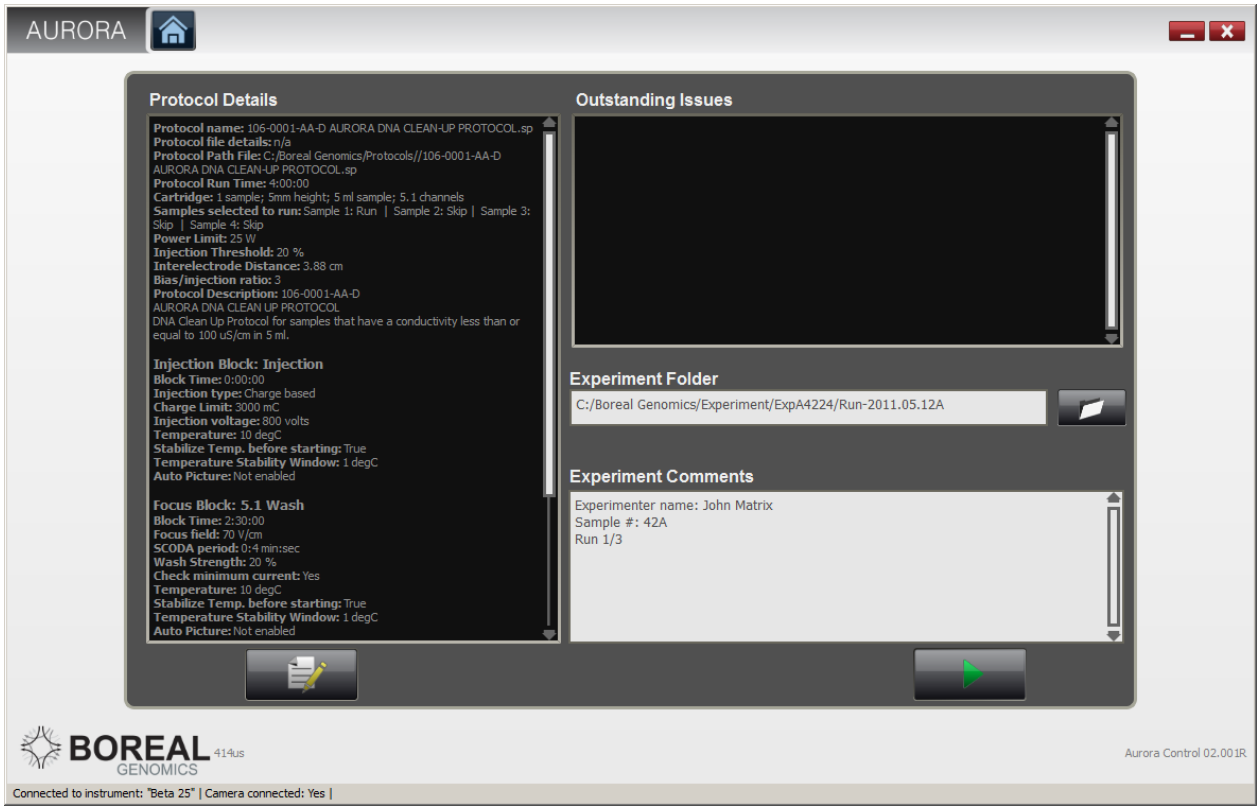

Figure 17. Pre-run screen

Understanding experiment folders

Before starting a protocol, the Aurora control software will prompt for an experiment folder at the Pre-Run screen. During a run, the Aurora logs information about the progress of the run to files in the experiment folder. These include EventLog.html, which contains a summary of events during the run and the time they occurred, and DataLog.csv, which contains debugging and diagnostic information. The experiment folder is also where any automatically captured images are saved. Though the Aurora software is designed to avoid overwriting data, Boreal Genomics recommends creating a new experiment folder for each sample. To select an experiment folder click the "Browse…" button [ ] and, in the window that pops up, choose or create an experiment folder for the run. If no experiment folder is set the software will assign one by default in the system temporary folder and display a warning. Using a separate folder for each experiment will help to keep images and data logs organized.

Figure 18. Run screen

Once all errors have been resolved the “Run” button will become enabled. Click the Run button [ ] to start the run. The screen changes to the run screen (**Figure 18**).

To learn more about outstanding errors refer to **Appendix E: Troubleshooting** on page 47.

During a run

The run screen allows the progress of the run to be monitored and controlled. The run screen always displays information for both the 1 sample and 4 sample functionality. When running 1 sample cartridges, the fields related to samples 2-4 should be ignored.

To increase or decrease the amount of information displayed on this screen, click on the add more details button [ ] at the bottom of the screen.

Before the run starts, the instrument checks that there is good electrical contact between the instrument and the cartridge and that the conductivities of the gel and sample are appropriate for an efficient injection. The front panel LEDs will flash during the check. If the instrument detects a problem, the Aurora software issues an error. See **Appendix E: Troubleshooting** for more information about error conditions and advice for resolving them.

The Aurora waits until the cold plate reaches its set temperature before beginning the run, which typically takes 1-2 minutes. The Aurora LCD will display “Starting Block” and the software will display the message “Setting Temperature”.

During the run, the control software proceeds through each block in the block list in sequence. While the run is proceeding the instrument LCD panel displays the message “Running” and the time remaining in the run. Because the progress of injection is measured by the total amount of charge that has passed through the sample and not by time, the displayed total time will not include the injection block, and the timer will not count down while the sample is injecting. The countdown will begin after injection finishes. If the instrument requires user input the central LED on the front panel blinks white. If the instrument encounters an error during a run, the central LED turns steady red and the Aurora control software displays a pop-up window with information pertaining to the error.

If imaging is enabled, photographs of the cartridge will appear as they are captured. Whether imaging is enabled or not, you can manually capture an image by pressing the camera button []. Manually-acquired images will not be saved unless you press the save button [].

When all blocks in the protocol finish running, the control software displays the post-run screen, the instrument’s LCD screen displays the message “Run Done”, and the center LED glows steady white.

The run can be paused at any point by clicking the “Pause” button []. Always pause the run before opening the sample drawer. Pausing the run will enable the “Stop” and “Edit” buttons. Clicking the “Stop” button [] will cancel the remainder of the protocol and the software will transition to the post-run screen. Clicking the “Edit” button [] will transition the application to the protocol editing screen and will automatically de-select all of the blocks that ran to completion before the “Edit” button was pressed. This allows the parameters of a run to be edited before the run finishes. When the “Run” button is clicked from the Edit screen, the run will resume from the beginning of the block that was in progress when the run was paused.

The event log records events that occur during a run. To add a note to the event log, use the “Add comment” button [] below the Event Log.

After the run

The post-run screen (**Figure 19**) displays the most recently completed run’s event log and any images that were acquired.

The “Home” button [] at the top of the screen will return the software to the home screen. The most recently run protocol can be edited by clicking on the “Edit Protocol” button. The current protocol can be saved by clicking on the “Save” button [] or re-run by clicking on the “Re-Run” button. Additionally the user can add a post run comment to the event log indicating any special events that occurred during or after ther run.

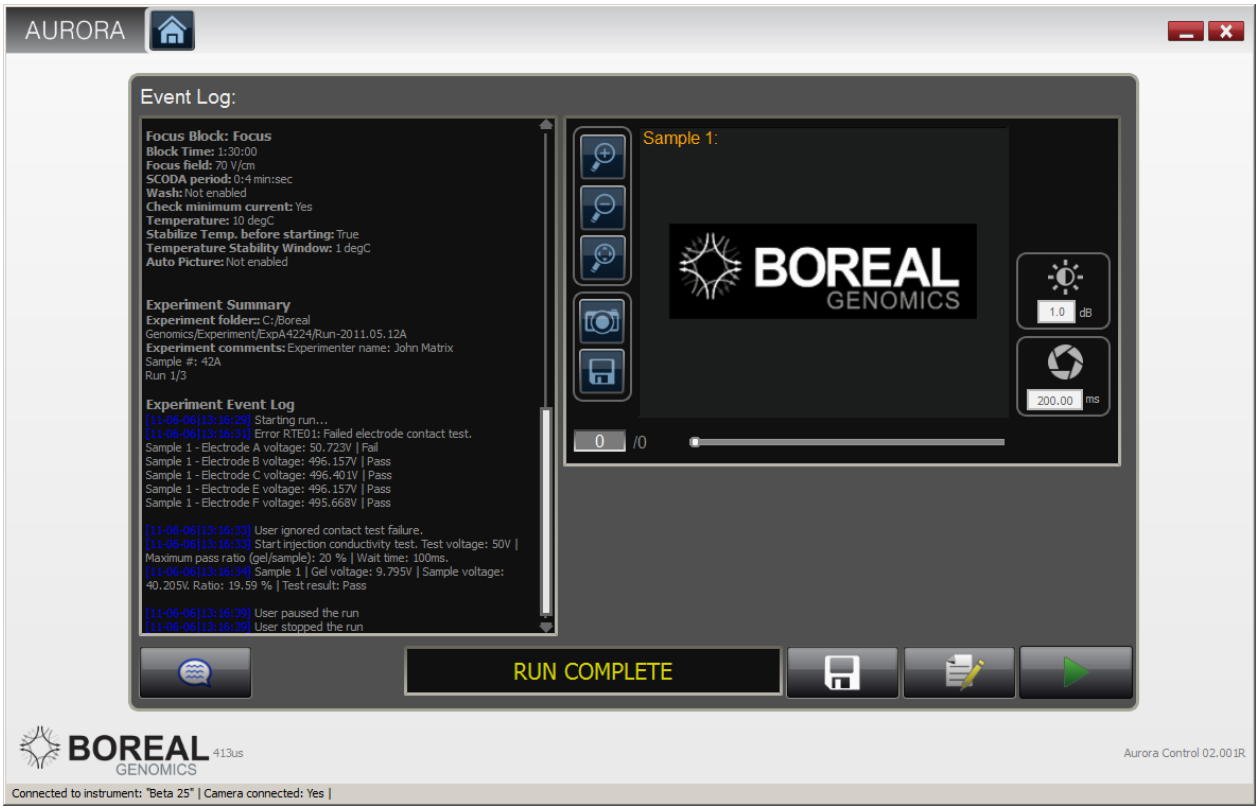

Figure 19. Post-run screen

Extracting the sample

Warning

Use caution when opening the cartridge drawer and removing the cartridge. Test the temperature of the cartridge before picking it up to avoid burns.

Follow the directions in the protocol manual to extract concentrated DNA from the Aurora cartridge. The expected output volume will depend on the type of cartridge being used and may vary slightly. This variability should not affect the performance of the Aurora.

Concentrated nucleic acids produced by the Aurora are suitable for quantification by quantitative PCR and other standard methods. Nucleic acids may be visualized after concentration by DC gel electrophoresis in the presence of a suitable dye.

Dispose of the cartridge and contents following all applicable policies, laws, and regulations. Aurora cartridges, buffers, and gels are non-hazardous as shipped though cartridges that have contained hazardous samples (including many nucleic acid stains) may be considered hazardous in your jurisdiction.

Shutting down the instrument

To shut down the Aurora instrument, first use the software to stop or pause any run that may be in progress. Flip the power switch on the rear panel to the off position and then flip the rocker switch on the left side of the chiller to the off position. The laptop may also be shut down.

Appendices

A. Understanding SCODA

SCODA (Synchronous Coefficient of Drag Alternation) is a nucleic acid separation, concentration and purification method based on electrophoretic motion of molecules in a gel. It is fundamentally different from both DC and AC electrophoretic methods such as pulsed field gel electrophoresis in that all conventional electrophoretic separations tend to be dispersive, with bands increasing in breadth through the duration of a run. SCODA, on the other hand, employs a novel physical parameter, ***k***, associated with molecular motion of long charged molecules in a gel to specifically concentrate all nucleic acids from a sample to a single location. This concentration makes SCODA inherently non-dispersive, in the sense that running SCODA longer, within reason, does not degrade its focusing properties, and DNA from multiple samples may be overlapped onto a single SCODA focus.

The SCODA concept is to generate periodic motion of DNA using electric fields while synchronously altering the mobility or drag coefficient of the molecule with a second electric field to cause a net drift and subsequent concentration. Because concentration results from the non-linear velocity response of the molecule to increasing electric fields (*k*) and appears to be unique to long polymers such as DNA, this allows SCODA to efficiently select only nucleic acids for concentration. In practice, this drives nucleic acids toward a buffer well in the centre of the SCODA gel, to a location free of electrodes. More of the physics behind SCODA concentration can be found in the Proceedings of the National Academy of Sciences, 2009 Sep 1; 106(35):14796-801.

The main advantages of SCODA arise because concentration (based on *k*) is unique to nucleic acids. This enables efficient recovery of DNA from up to 5 ml samples while partitioning contaminants, resulting in excellent contaminant rejection. It also allows for high recovery efficiency, even down to small numbers of DNA molecules. In addition, it provides a 100:1 volume reduction from a single sample, as the output DNA is delivered in 50 µl of buffer.

The main elements of SCODA purification are injection, contaminant rejection (or wash), and concentration. During injection, an electric field is applied across the sample and SCODA gel to drive DNA and all negatively charged molecules into the gel, including any contaminants. Then, SCODA concentration fields are applied, driving only the nucleic acids towards the centre of the gel. Optionally,

adding a wash field provides increased contaminant rejection compared to concentration alone. Finally, a concentration step is applied after the wash to ensure the DNA is collected in the centre of the gel.

The following are practical considerations when running the Aurora:

Injection

- For efficient injection, the sample (when diluted to 5 ml) must be less than one quarter of the conductivity of the SCODA gel, to a maximum gel salinity of ~1200 µS/cm. Samples of higher than one quarter the gel salinity will not inject efficiently and will result in poor recovery efficiency.
- Injection is based on total electric charge run through the sample and gel. Each gel type has a fixed charge it can accept for the highest injection efficiency (specified with the protocol), assuming the one quarter salinity rule is followed. This number will remain fixed for all samples that meet the gel salinity rule.
- Injecting greater than the recommended charge will result in short fragments over-injecting and being lost off the edge of the gel. Injecting less than the recommended charge may fail to admit all DNA in the sample chamber to the gel.
- Because charge-based injection regulates the total electric field seen by the gel, it is more reproducible than specifying a fixed injection time. As a result, charged-based injection is used by default on all Aurora systems.

Concentration

- SCODA concentration on its own provides up to ~100-fold contaminant rejection due to DNA concentration, which increases the ratio of DNA to unbound contaminants.
- The lower the gel conductivity, the faster the SCODA wash and concentration will be. High conductivity gels (i.e. 1x TBE) result in very long run times (overnight with wash), and should only be used for high conductivity samples that cannot be diluted.
- The SCODA concentration duration scales with the inverse of the square of the electric field. If the SCODA fields are reduced by half, run time will increase by a factor of four.
- Heat dissipation from the gel is the limiting factor in the speed of the SCODA concentration. The heat produced in the gel is proportional to the conductivity of the gel and to the square of the applied electric field. If the conductivity is doubled, heat will double. If the fields are doubled, heat production will go up by a factor of four.
- Each protocol has a maximum power dissipation it can sustain during concentration (specified with the protocol) before the gel will fail (bubble or melt) and sample will be lost.
- Excessive focused DNA mass can perturb the electric field geometry and lead to unusual focus locations or shapes and poor recovery. Typically this occurs with >100 µg of DNA for 5 ml cartridges.
- Molecules focus based on their value of *k*. Shorter DNA molecules may not focus efficiently as *k* decreases for small DNA molecules.
- Contaminants with large *k*, or those that bind DNA, may focus along with the DNA.

Contaminant Rejection

- Additional contaminant rejection can be obtained by applying a wash – that is, a DC field time-multiplexed with the SCODA fields during focusing. The SCODA fields constrain the DNA within the gel while contaminants are washed off the edge of the gel by the DC field.

- In general, the stronger the wash, the more quickly contaminants will be removed from the concentrated sample. If the wash fields are too strong compared to the SCODA fields, short fragments may be washed off the gel along with the contaminants, because SCODA fields have larger effects on larger DNA molecules.
- During a wash, SCODA focus fields counterbalance the wash fields to retain DNA in the gel. The focus fields are less effective at the lower field potentials required by more conductive gels, so wash strength must be reduced and run times must be extended for samples too conductive for a 0.25x TBE gel. Wash strength must be reduced to 15% or lower in 1x TBE. Please see the documentation accompanying the cartridges and protocols for more information about wash times.
- The Aurora will only remove contaminants that are not bound to the DNA. Contaminants bound to DNA are likely to focus and remain in the sample unless disassociated by heat or other denaturation prior to concentration.

High Molecular Weight DNA

- Due to the non-mechanical nature of the SCODA process, it is possible to concentrate high molecular weight DNA without shearing using a custom protocol. Run times for HMW DNA can be 48 hours or more.
- High molecular weight DNA (>50 kb) can become trapped in the gel at high SCODA fields and short periods. SCODA fields and periods should be selected to minimize trapping.
- In general, the larger the DNA, the longer the period and lower the fields that should be used. A 4s period will concentrate up to 50 kb DNA at any field. Increasing periods up to a maximum of 120 s may concentrate fragments up to 1.6 Mb at low fields.
- High conductivity gels help reduce trapping of large fragments.
- Lowering fields down to 8 V/cm may assist in concentrating fragments up to 1.6 Mb.
- For long periods, DNA may move significant distances in the course of one period, increasing the chance of losing DNA off the edge of the gel.
- Final focus diameter will not be smaller than the path traced out by a single molecule during a full SCODA cycle. Excessively long periods can increase the size of the SCODA focus, creating losses outside the extraction well.

Run Speed

- The most important constraint on run speed on the Aurora platform is sample conductivity. The conductivity of the sample determines which cartridge can be used, since SCODA gels must be about 4 times as conductive as the sample for complete injection.
- It is advantageous to use the least conductive gel type possible as more conductive gels must be run at lower fields to prevent overheating and take longer to run. Always choose the lowest gel conductivity that the sample will permit.
- **Figure 20** illustrates example run times for focusing without wash as a function of sample conductivity.

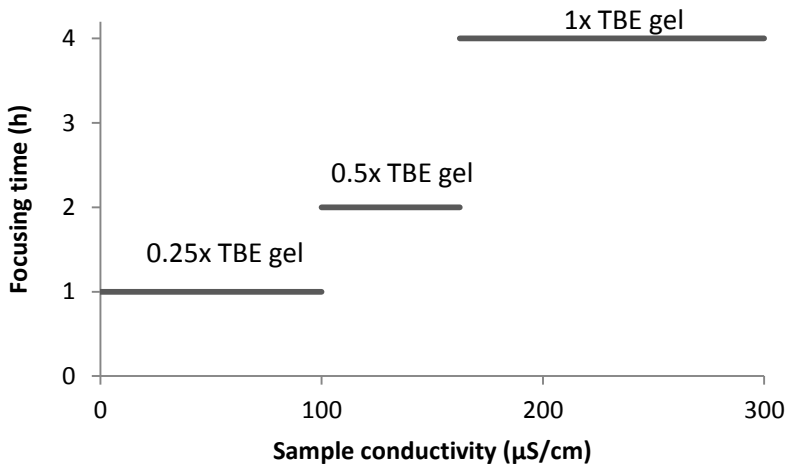

Figure 20. Effect of sample conductivity on focusing time without additional contaminant rejection. Contaminant rejection also increases run length in proportion to sample conductivity

B. Aurora concentration specification

This appendix describes the Aurora system's capabilities. In some cases, these values represent conservative estimates. If you have questions about these values, please contact our technical support team at support@borealgenomics.com.

Input

The table below is intended to describe the types of samples that the Aurora is capable of handling. Please see documentation for individual protocols for more information.

Volume	<5ml
Conductivity	< 200µS/cm
pH	6-8
DNA fragment size	< 50 kb (dsDNA longer than 50 kb but up to 1 Mb will require longer run times)
DNA load	< 40 µg
Particulate content	< 200 mg non-conducting particulates
Solvent content	Solvents are well-tolerated if they do not disrupt the agarose gel or PMMA cartridge.

Samples that exceed these values are likely to produce outputs with low yield. In addition, DNA in the sample must be free to rapidly migrate in solution under electric fields and not bound to contaminants that will inhibit injection of DNA into the SCODA gel.

Output

The output of the Aurora system will have the following characteristics.

Volume	40 – 60 µl (depending on protocol)
Output buffer	Same as gel buffer
DNA yield	>60%, 500 bp-50 kb (300 bp-50 kb in 0.25x TBE gels)

The Aurora will recover DNA fragments from the sample longer than 500 bp (300 bp in 0.25x TBE gels). The presence of shorter fragments will not interfere with concentration but the shorter fragments may not be recovered. **Figure 21** illustrates the effect of fragment size on recovery schematically.

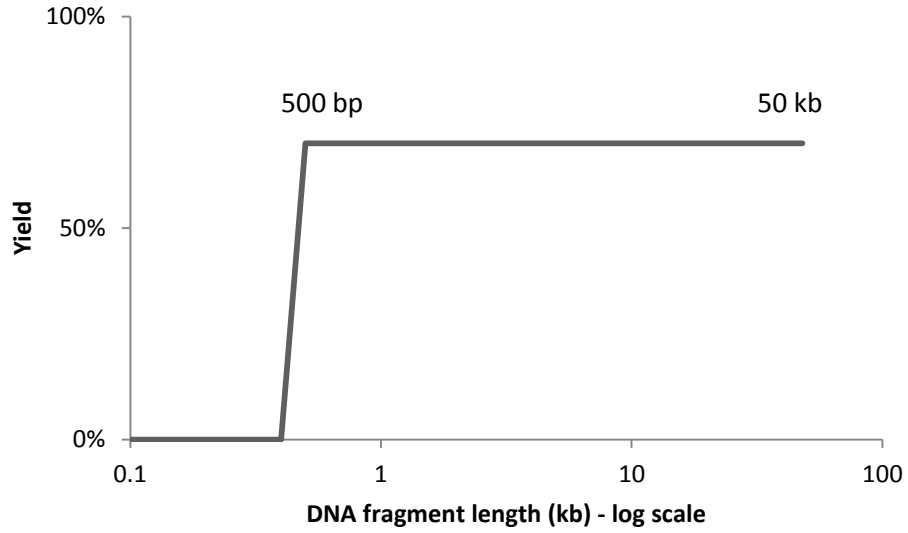

Figure 21. SCODA DNA recovery by fragment length

Contaminant rejection

The Aurora platform has exceptional contaminant rejection capabilities. Contaminant rejection was demonstrated using humic acids, a complex mixture of organic molecules occurring naturally in soil. Humic acids have a deep brown color and strongly inhibit PCR reactions. Because they carry a negative charge, many DNA purification methods fail to partition them from DNA. With electrophoretic washing and SCODA concentration, it is possible to reduce unbound humic level concentrations to a level permitting PCR amplification without dilution in a 25 µl PCR reaction containing 1 µl of sample.

The sample used to demonstrate contaminant rejection contained 100 ng of pNEB206A 2.7 kb dsDNA and 500 µg humic acids (Sigma H16752) in 5 ml 0.05x TBE. A 25 µl qPCR reaction using ABI SYBR Green master mix containing 5 µl of the sample input was inhibited at dilutions lower than 1:1000. Concentration was performed using the DNA Clean Up protocol (BG 106-0002). PCR sensitivity is expressed as the product of fold improvement in the lowest dilution that successfully amplifies (because the Aurora's output is more concentrated than the input, it could be successfully diluted further and still

amplify) and fold improvement in the highest dilution that successfully amplifies (because the Aurora's output is cleaner, it amplified with less dilution).

Wash time (20% wash strength)	**Increase in PCR sensitivity**
0 h (concentration only)	> 10x (concentration is DNA-specific and improves DNA-humic acid ratio)
2 h	10x-50,000x

PCR sensitivity reached a maximum at 2 h, at which point the concentrated sample amplified normally without dilution.

C. Suggestions for upstream processes

In general, any lysis or preparative method that produces mobile DNA in solution with conductivity lower than 100 µS/cm when diluted to 5 ml can be run directly in SCODA in a 0.25x TBE gel. Some examples include standard phenol/chloroform preparations, silica-based methods, and commercially available DNA preparation kits. Larger volumes or higher salinity samples can be run in SCODA by dilution and running multiple injection and focusing blocks, as long as the conductivity of each 5 ml sample is below 100 µS/cm. Higher conductivity samples may be run as a single sample,but will yield less DNA. Higher-salinity gel cartridges can increase the conductivity limit to 300 µS/cm in exchange for longer run times.

Because the Aurora can handle sample volumes up to 5 ml, it may be possible to improve yields of upstream processes by eluting in larger-than-usual volumes since DNA will be re-concentrated by SCODA. It may also be possible to eliminate potentially lossy washes or other contaminant rejection steps from upstream processes, as SCODA concentration will provide contaminant rejection. Finally, the application of heat or other denaturants immediately prior to SCODA may help remove contaminants that are initially bound to the DNA.

D. Managing, creating, and editing protocols

The maintenance of protocol files and folders is done from the home screen, seen in **Figure 22**. A list of folders that contain protocols is displayed on the left-hand side. To add a new folder click on the "Add protocol folder" [ ] button. This will display the "Add protocol folder" pop up window, seen in **Figure 23.** The "Folder Alias" field value is the value displayed in the "Protocol Folder" list. It is available so the user can replace the folder path name (which may be long) with a shorter name.

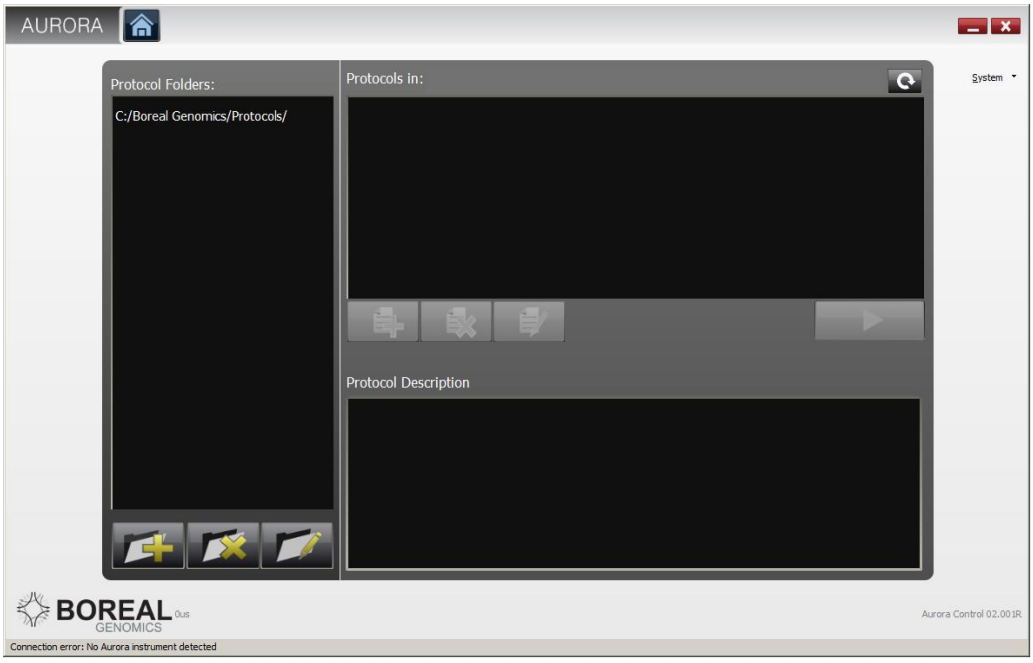

Figure 22. Aurora home screen (protocol management)

For “Folder Path” field either type in a value or click on the “Browse” button to select a folder using the folder explorer. When the correct values have been entered click “Save”.

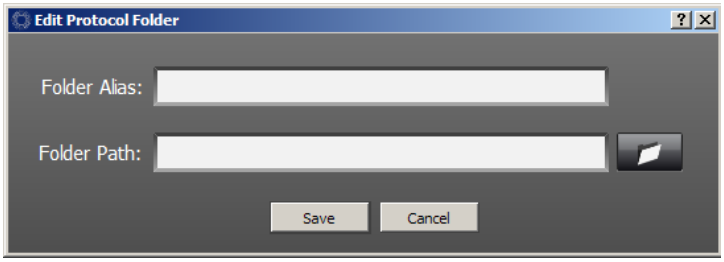

Figure 23. Add protocol folder pop up

To remove an existing folder from the “Protocol Folder” list select the folder and click the “Remove Folder” button [ ]. To edit a current entry in the “Protocol Folder” list, select the folder and click on the “Edit Folder” button [ ]. A prepopulated “Add protocol folder” window will be displayed and can be modified as necessary.

To create a new protocol, go to the home screen of the control software. Select a folder where the new protocol will be created and click on the “New Protocol” button [ ]. If a pre-existing protocol is to be modified, select the protocol of interest and click the “Edit Protocol” button [ ]. In either case, the edit screen will be displayed as in **Figure 24**. You can edit protocol-wide parameters and add, remove and edit blocks in the edit protocol screen.

SCODA protocols are composed as sequences of blocks. Each type of block performs a unique function. There are four types of blocks:

- **Injection block**: Draws DNA into the SCODA gel from the sample chamber.
- **Focus block**: Concentrates DNA in the SCODA gel into the extraction well. Focus blocks can also have an electrophoretic wash superimposed for added contaminant rejection.
- **Wait block**: Pauses for a set time or waits for user intervention.
- **Advanced block**: Runs custom field patterns and operating conditions.

Newly created protocols do not yet contain any blocks. To add a block click on the “Add block” button [ ] under the Protocol Blocks list field. A drop down menu listing the types of blocks that may be added will pop up. Select one of the block types to add it. To change the default name of a newly created block, double-click on the block name in the protocol list and rename the block.

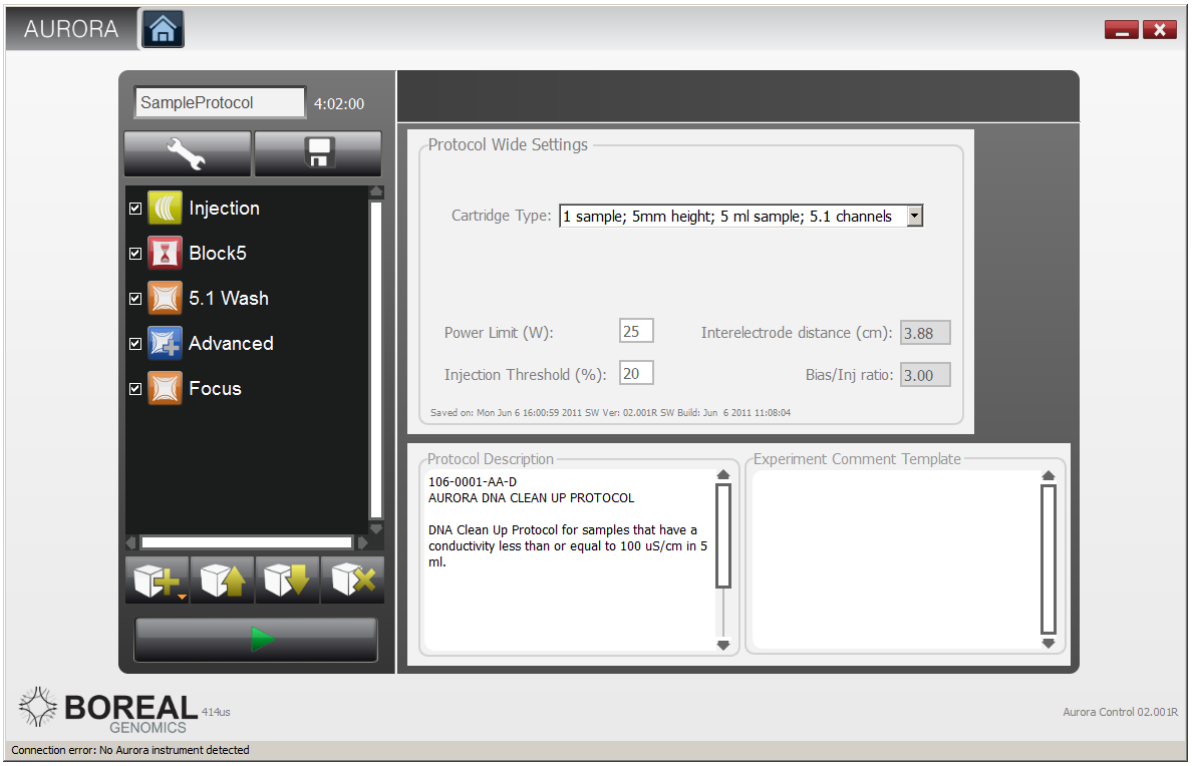

Figure 24. Aurora control software protocol edit screen

To remove a block, select the block to be removed and click on the “Remove block” button []. The application will prompt for confirmation. To change the execution order of blocks, select the block that should be moved and click on either the “Move block up” button [] or “Move block down” button [] to move the block up or down in the list.

To save a protocol, click on the “Save to disk” button []. The application will prompt for the path where the protocol is to be saved.

Each block type has its own set of parameters. At the top of each type of block the block duration is displayed in hours, minutes and seconds. Under the block duration field, the other block parameters appear. The following sections describe the parameter sets for each type of block.

Protocol wide settings

Immediately after creating a new protocol, the protocol-wide parameters will be displayed. You can return to the protocol-wide parameters later by clicking on the “Parameter wide settings” button [] at the top of the block list. **Table 3** provides a brief description of the protocol-wide parameters available.

Table 3. Protocol wide settings

Parameter Name	Description
Cartridge Type	The cartridge type used for this protocol. Depending on cartridge selection the imaging FOV will automatically be resized and rotated to display the gel area with the sample chamber on the right. The 4 sample cartridge choice is currently not supported.
Injection Threshold (%)	If the voltage drop across the gel during injection exceeds this value, a warning will be displayed. Appropriate values for this parameter will ensure that the DNA is transferred efficiently from the sample chamber into the gel.
Power Limit (W)	If the power dissipated in the gel during a run exceeds this value, a warning will be displayed. Appropriate values for this parameter will ensure that the gel will not melt during the SCODA run.
Protocol Description	This text is displayed when the protocol is selected on the home screen.
Experiment Comment Template	This text will be displayed automatically in the Experiment Comments text field in the Pre-Run screen (see **Figure 17**).

Injection block settings

Table 4. Injection block parameters

Parameter Name	Description
Injection Voltage	Specifies the voltage to be applied across the sample chamber and SCODA gel during injection.
Injection Type	Determines whether injection will run for a set time (“time-limited”) or until the integrated amount of current through the sample reaches a threshold (“charge-limited”). If the “Charge Limited” injection type is specified the block duration field is replaced by an injection charge field.
Injection Warning	Enabling this check causes the Aurora to perform an injection conductivity test before the block runs. The conductivity test is used to assess if the gel versus sample voltage drop ratio is appropriate for an efficient injection. The software will issue a warning if this ratio is above the predefined threshold value specified in Protocol Wide Settings.

Focus block settings

Table 5. Focus block parameters

Parameter Name	Description
SCODA Field	Specifies the electrical field strength to be used in the focus block.
SCODA Period	Specifies the rotational period of the SCODA field in minutes and seconds. 4 s periods are standard for most SCODA runs.
Wash Enabled	If the wash checkbox is enabled a wash field is added to the SCODA field pattern.

Parameter Name	Description
Wash Strength	Sets the duty cycle of the wash field with respect to the SCODA field. Using high wash strength values can result in the DNA sample being washed off the gel.
Minimum current warning	Monitor the magnitude of the SCODA current and warn the user if the value drops below a minimum threshold of 3mA. This is used to detect possible failures of the electrical contact between the cartridge and the contact plate.

To obtain a description for the advanced block parameters please contact Boreal Genomics.

Auto imaging settings

The Auto Imaging settings are common to all blocks but the Wait block.

Table 6. Auto imaging settings

Parameter Name	Description
Auto Imaging	If the auto imaging checkbox is checked the instrument will automatically acquire images while the block is running. If the checkbox is not checked, no images will be acquired.
Auto Picture Period	The interval (in minutes and seconds) at which images will be automatically acquired.
Shutter (ms)	Sets the camera "shutter speed." Larger values will make images brighter.
Gain (dB)	Sets the analog gain. Larger values will make images brighter.

Images can be taken or saved directly from the auto imaging tab, using the buttons surrounding the image preview window.

Button	Action
Snap	Acquires an image. The image can be used to decide if the shutter and gain values are appropriate. The acquired image will not be saved (see Save).
Save	Saves the image in the preview window. A pop up window will be displayed that allows the user to select the path of the saved file.
Zoom (in and out)	The user can zoom into/out of the image using these buttons.

Temperature settings

All blocks also have a temperature setting. This sets the temperature of the cold plate during the run.

E. Troubleshooting

This section provides basic information on errors that the user may encounter while operating the Aurora. In many cases you will be able to resolve the error by determining its cause and following the recommended solution as described below. If these steps fail to resolve your error, please contact Boreal Genomics support team: support@borealgenomics.com. Troubleshooting of protocol-specific errors may be found in the documentation for each protocol.

Danger

Under no circumstances should you attempt to resolve an error by servicing the instrument, removing any of the exterior panels, inserting foreign tools or objects into the machine, or overriding the interlock systems.

Software error messages

The error messages listed in this section are generated by the Aurora's fault handling software systems and are grouped into tables according to the screen at which they might occur.

Table 7. Pre-run screen error messages

Code	Error message	Cause	Recommended solution
PRE01	Aurora instrument not found	Aurora instrument is not properly connected to the computer via the USB communication cable.	Ensure that the USB cable from the Aurora instrument is properly connected to the laptop.
		Aurora instrument is not powered on.	Power on the Aurora instrument.
		Other	• Unplug/re-plug the Aurora USB connector into the laptop. • Turn off the instrument for 5

Code	Error message	Cause	Recommended solution
			seconds before turning it back on.
PRE02	Current protocol is not valid.	Current protocol contains invalid values.	Examine the protocol for any values that may be out of range. Alternatively, editing the faulty protocol in the Aurora software and then attempting to run or save the protocol will produce an error message indicating which values are invalid.
PRE03	Current protocol uses 4 samples. No samples are selected to run.	User selected a cartridge that has more than one sample and did not select any samples to run.	Select at least one sample to run or change the cartridge to a one sample cartridge (in this case the one sample is selected by default).
PRE04	Current protocol has no blocks selected to run	Current protocol does not contain any blocks or has none of the existing blocks selected to run.	Edit the protocol and select at least one block to run.
PRE05	Gel boat drawer is open.	The gel boat drawer (and possibly the contact plate drawer) is open, activating the safety interlock.	Close the gel boat drawer.
PRE06	Instrument is not calibrated. Contact Boreal Genomics to have your instrument calibrated.	The instrument has not been calibrated properly prior to running.	Contact Boreal Genomics to have your instrument calibrated. This procedure should only be performed by Boreal Genomics technicians.
PRE07	Instrument Hardware Failure Detected. Contact Boreal Genomics for servicing.	The instrument hardware failure detection system was triggered and the instrument cannot be run in this mode. This may indicate a serious hardware failure or it may possibly be a spurious error due to invalid run conditions not caught by the software. Check RTE08 for additional details.	The hardware failure detection system can be reset by power cycling the instrument. If the hardware failure error persists contact Boreal Genomics for further troubleshooting steps.
PRE08	Protocol uses imaging. A camera is not connected. Connect camera or disable imaging.	No camera was detected although the selected protocol contains blocks that require imaging.	Ensure that a camera is connected to the instrument. Power cycling the instrument can restore camera connectivity.

Table 8 Pre run screen warning messages

Code	Error message	Cause	Recommended solution
PRW01	Experiment folder not set. Experiment will be saved to temporary folder.	The experiment folder has not been selected by the user.	Select an experiment folder.

Table 9. Run screen error messages

Code	Error message	Cause	Recommended solution
RTE010	Failed electrode contact test on X (reading YV instead of ZV). Check electrode contact and fill all buffer chambers. [Additional details]	The electrical contact test between the instrument and the gel-boat has failed. This can result because one or more of the following occurred:	
		Gel boat improperly seated.	Ensure the gel boat is properly seated on the top of the cold plate.
		A gel boat type other than the one specified in the protocol details is used.	Replace the gel boat with a gel boat that is compatible with the protocol and contact plate that are being used.
		The graphite electrodes in the gel boat have been damaged, and do not make contact with the spring-loaded pins on the contact plate.	Carefully examine the gel boat for signs of wear to the graphite electrodes. If damage is observed, replace the gel boat.
		Contact plate electrode pins are damaged.	Remove the contact plate (refer to Appendix F: Maintenance) and ensure that no spring pins are damaged, missing, or stuck in a compressed position. If a spring pin is stuck in the compressed position, examine it closely for any sign of debris, especially salt crystals that may be interfering with its motion. Remove any salt from the spring pins by rinsing with deionized water. If there is no salt or debris, try compressing the spring pin by hand and releasing it. If it does not compress, or does not return to its fully extended position after it is released, contact Boreal Genomics for further troubleshooting and support guidance.
		The buffer in one of the buffer reservoirs is depleted.	Check gel boat buffer reservoirs. Refill with appropriate buffer as needed.
RTE011	Electrode contact test malfunction. [Additional details]	A hardware failure occurred during the electrode contact test.	Contact Boreal Genomics.
RTE020	Failed injection conductivity test. Sample conductivity is too high. Injection might fail. [Additional details]	The conductivity of the sample is too high.	Decrease the sample conductivity.
RTE021	Injection conductivity test malfunction. [Additional details]	A hardware failure occurred during the injection conductivity test.	Contact Boreal Genomics.
RTE030	A high voltage current short was detected. This may be caused by:	The gel boat is leaking and currents from the gel boat are leaking into the cold plate.	Replace the gel boat with a new gel boat.

Code	Error message	Cause	Recommended solution
	1) a leaking gel boat 2) a sample that is too conductive 3) a major hardware fault Please check the gel boat for leaks and that the sample conductivity is within range and retry. If this error reoccurs, please contact Boreal Genomics for assistance.	The conductivity of the sample exceeds specifications causing the power supply to exceed its current ratings.	Dilute the sample to an appropriate conductivity level or drop the voltage of the PS.
		A major hardware fault has occurred.	Contact Boreal Genomics for further troubleshooting steps if unable to resolve this issue.
RTE031	HV current-return path mismatch detected.	Caused by a ground fault interrupt.	See error RTE030.
RTE040	The cooling system temperature is out of range (heat-sink temperature X°C). Please check the cooling water supply. If this error reoccurs please contact Boreal Genomics for assistance. **[pop-up dialog message]**	The chiller is turned off and the internal cooling system in the Aurora is overheating.	Turn on the chiller. Wait until the heat sink temperature drops below 35 °C and continue the run.
		An element of the cooling system (Peltier element, chiller, heat sink) is not performing properly.	Ensure that all tubes are free of kinks and blockages. If this fails to resolve the problem, contact Boreal Genomics for further troubleshooting steps.
RTE041	Temperature out of range (heat sink at X°C | spreader plate at Y°C). **[event log]**	Caused by either the heat sink or the spreader plate temperature being outside their range.	See RTE040.
RTE050	Power limit for sample X exceeded. Average power: Y W. Power limit: Z W. Run Paused.	Average power has exceeded the maximum threshold and the instrument has paused the run in order to avoid boiling the gel.	Decrease the electric fields and continue the run.
RTE061	Current limit exceeded. Current: X mA. Current limit: Y mA. Run Paused.	Average current has exceeded the maximum threshold.	Decrease the electric fields and continue the run.
RTE062	Sample X current is below minimum current limit. Sample X current: Y mA. Current limit: Z mA. Run Paused.	The current measured for one of the samples is below the minimum threshold current.	Check results of electrode contact test. Contact Boreal Genomics.
RTE070	Cannot resume run. Cartridge drawer is open. **[pop-up dialog message]**	The gel boat drawer (and possibly the contact plate drawer) is open, activating the safety interlock.	Close the gel boat drawer.
RTE071	Cartridge drawer open. WARNING: Opening the cartridge drawer without pausing the run can result in permanent damage to the instrument. Please pause the run before opening the cartridge drawer. **[pop-up dialog**	The cartridge drawer has been opened without the run being paused.	Pause the run before opening the cartridge drawer. If this message appears despite the drawer being closed, ensure that the drawer is firmly closed and continue the run.

Code	Error message	Cause	Recommended solution
	message]		
RTE080	A serious hardware fault has been detected. Please contact Boreal Genomics.	Check the LCD panel for more details. LCD can display the following messages:	For any of the messages below Boreal Genomics should be contacted as the instrument is either malfunctioning or has been used improperly. To clear the error the instrument has to be power-cycled. However if no other measures are taken the error will likely re-occur, potentially resulting in a failed experiment.
		RTE081 TC Integral error	The temperature controller cannot be controlled. Contact Boreal Genomics for further troubleshooting steps.
		RTE082 Hardware heat-sink over-temp error	The temperature controller cannot be controlled. Contact Boreal Genomics for further troubleshooting steps.
		RTE083 TC current error	The temperature controller cannot be controlled. Contact Boreal Genomics for further troubleshooting steps.
		RTE084 HV PS voltage error	The PS rail voltage cannot be set – that is the set-point PS voltage and the measured PS voltage differ by more than 50%. Contact Boreal Genomics for further troubleshooting steps.
		RTE085 Incompatible hardware ID	Device hardware is not compatible with the firmware. Upload firmware compatible with existing hardware. Contact Boreal Genomics for more details.
		RTE086 Interlock switch error	The states of the 5V and 24V interlock are not the same. This indicates a serious hardware failure. Please contact Boreal Genomics for assistance.
		RTE08FF Unknown error: XX	The instrument malfunctioned. Contact Boreal Genomics for further troubleshooting steps.
RTE090	The power supply over-current sensor was triggered. This may be caused by: 1) a salty sample 2) a current return path mismatch error Please check the sample saltiness is within range and retry. If this error reoccurs please contact Boreal Genomics for assistance.	Caused by a sample that is too conductive (salty). Major GFI. Internal short of electrode switches.	Try diluting the conductivity of the sample to reduce the current. If this fails to resolve the problem contact Boreal Genomics for further troubleshooting assistance.

Code	Error message	Cause	Recommended solution
RTE091	Power supply over-current detected.	See causes for RTE090.	See RTE090.
RTE0A0	Instrument not found	The instrument has been disconnected.	Reconnect the instrument.

Mechanical issues

The errors described in this section are mechanical in nature and may not generate software error messages.

Table 10. Troubleshooting mechanical issues

Indication	Cause	Recommended solution
Bubbling or gel deformation is observed in the gel during Aurora runs.	The power dissipated in the gel exceeds the limits of the cartridge and protocol and excessive heating has caused the gel to melt or deform.	Refer to protocol documentation for power and sample conductivity limits. Ensure that samples are not more conductive than you expect and that you are using an appropriate cartridge for your sample. Reduce injection and concentration fields until maximum power dissipation is within limits, extending run time as necessary.
	The bottom of the cartridge is not making effective thermal contact with the cold plate and the gel boils despite the fact that the power is within limits.	Carefully examine the bottom of the cartridge and the spreader plate for any debris that may produce gaps between the bottom of the cartridge and the surface of the cold plate. Thoroughly clean the cold plate before repeating the run. Ensure that 1 ml of water is placed on the cold plate to improve contact between the cartridge and cold plate.

Chiller

Table 11. Troubleshooting chiller issues

Indication	Cause	Recommended solution
Front display reads TANK LEVEL LOW.	The water level in the chiller has dropped below the minimum level.	Turn off the chiller. Unscrew the water reservoir cap that is located on the top rear of the instrument. Top up the reservoir to just below the neck of the reservoir, using tap water (do not use deionized, distilled, reverse osmosis, or other high-purity water). Replace the cap and screw down tightly.
Temperature on the front display does not reach the set point (20.0 °C)	The chiller is not operating.	Ensure that the START button has been pressed and the temperature controller is operating, indicated by a plus or minus on the indicator LCD. If the LCD displays a star, this means that the temperature controller is in standby and should be started by pressing START/STOP.
	The set point is incorrect.	Press the UP or DOWN keys to change the setpoint to 20.0 °C.
	The chiller has malfunctioned.	Inform Boreal Genomics of the problem and contact Solid State Cooling Systems for troubleshooting information.
Front display reads RTD OPEN.	The temperature sensor in the chiller has failed or its connector has come loose.	Inform Boreal Genomics of the problem and contact Solid State Cooling systems for repair instructions
Front display reads FAN FAIL.	Fan is supplying insufficient air to cool the chiller.	Power the chiller off to reset the alarm. Check that the side air inlet and outlet gratings are not blocked – at least 3 inches of clearance on either side are required. If airflow is not blocked, inform Boreal Genomics of the problem and contact Solid State Cooling systems for repair instructions.
Front display reads PUMP FAIL or CHECK LINES.	The liquid heat exchanger plate temperature is either too hot or too cold, indicating pump failure	Power the chiller off to reset the alarm. Check that the coolant connectors are firmly seated and

	or a blockage in external plumbing lines.	that there are no kinks in the tubing running from the chiller to the Aurora instrument, or from the chiller to the external filter on the back of the chiller. If there are no kinks, contact Boreal Genomics for further troubleshooting instructions.
Front display is blank (no display)	The chiller is not powered.	Check the electrical connection to the chiller and the electrical outlet it is plugged in to. Ensure that the rocker switch on the left side of the chiller is set to ON.
	The chiller has malfunctioned.	Inform Boreal Genomics of the problem and contact Solid State Cooling systems for repair instructions.
The chiller is leaking coolant.	Tube fittings are loose.	Turn the chiller and instrument off immediately and contact Boreal Genomics for instructions.

F. Maintenance

Preventative maintenance

The Aurora system requires very little maintenance if it is used within its specifications. The following preventative maintenance tasks can be performed periodically in order to ensure consistent and reliable operation of the system and to reduce the likelihood of errors.

Check the contact plate for salt buildup and signs of wear

Each contact plate contains a number of spring-loaded contacts that provide electrical connection between the contact plate and the cartridge, and between the contact plate and the high voltage driving electronics inside the instrument. These spring pins are cycled every time the cartridge drawer or contact plate drawer is opened and closed and may be subjected to considerable wear. Furthermore, there is a possibility that buffer from the cartridge may splash up onto the underside of the contact plate. Over time the accumulation of buffer on the spring pins may leave salt deposits that interfere with the motion of the spring pins.

Periodically remove the contact plate from the contact plate drawer (refer to the **Removing and installing contact plates** section below) and closely examine the surface of the printed circuit boards and the spring pins for signs of wear or debris. If salt deposits are observed on a spring pin, rinse it several times with a small amount of water while actuating the pins by hand. Allow the contact plate to dry before reinstalling it in the instrument. If any spring pins are observed to be missing, bent or corroded, contact Boreal Genomics for assistance.

Check the tubing and fittings for leaks, kinks and signs of wear

Periodically examine all fittings and the entire length of tubing running between the Aurora instrument and the chiller. Ensure that all tubes are free of wear, damage, and kinks and that there is no sign of leaking coolant or condensation.

Check the instrument for sufficient airflow

Sufficient airflow to both the chiller and the Aurora instrument is critical to ensure proper operation and the highest reliability of both systems. Maintain a clear area around both systems, free of clutter or any obstructions that would block free flow of air.

Removing and installing contact plates

The Aurora instrument is designed to accommodate a wide range of cartridges. New cartridges with different geometries can be used with the instrument simply by installing the corresponding contact plate. Refer to **Figure 25** while following the instructions below for removing and installing contact plates.

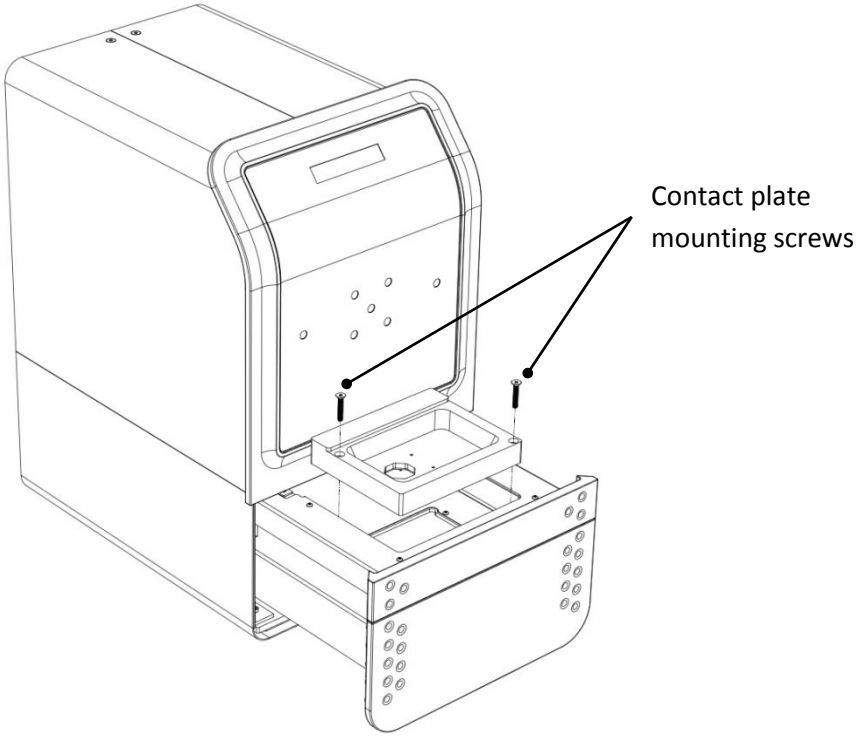

Figure 25. Contact plate mount

Removing a contact plate

- Open the cartridge drawer until it latches in its fully extended position.
- Open the contact plate drawer.
- Using a 3/32” hex key or driver, remove and set aside the two flathead #8-32 screws that hold the contact plate in the contact plate drawer.
- Remove the contact plate from the contact plate drawer.

Installing a contact plate

- Open the cartridge drawer until it latches in its fully extended position.
- Open the contact plate drawer.
- Place the contact plate into the contact plate drawer frame so that the spring-loaded contacts and circuit boards face down and to the back.
- Using a 3/32” hex key or driver, insert the two flathead #8-32 screws that hold the contact plate in the contact plate drawer and tighten until secure. Do not over-tighten the screws to avoid cracking the plastic contact plate housing.
    - **Caution:** The screws should go in smoothly with minimal force. Do not force the screws if they feel tight, as they may not be inserted straight into their mating threads.
- Close the contact plate drawer and cartridge drawer.

Replacing the mains fuse

To replace the mains fuse on the power entry module, use a screwdriver to open the fuse door and remove the red fuse holder from the power entry module. The rated fuse is a medium blow, 5x20mm, 10A fuse (LittleFuse part number: 0234010.MXP). If replacing the mains fuse does not resolve the problem, contact Boreal Genomics for support.

Cleaning the Aurora

Danger

Disconnect the power supply before cleaning any of the electrical contacts. Do not attempt to reach into the cartridge drawer to clean inside the Aurora instrument.

Clean the cold plate regularly with water to prevent the accumulation of debris or salt precipitates that could interfere with the thermal contact between the cold plate and cartridge.

The casing of the Aurora can be cleaned as necessary with a mild soap solution. Avoid organic solvents that may damage the plastic housing of the Aurora instrument.

Chiller

Perform the following preventative maintenance steps every 2 months.

- Perform a pull test on the fluid tubing running between the chiller and the Aurora Instrument. Ensure that the tubing is securely plugged into the chiller and instrument. To perform a pull test, firmly grasp each fluid line and pull straight outwards with moderate force. No tubing should come loose.

- Check for leaks from the chiller, particularly from connection points for tubing. No coolant should leak out at any time. If any coolant is observed to leak, turn the chiller and instrument off immediately and contact Boreal Genomics for troubleshooting information.

Instrument airflow

The airflow into and out of the Aurora and the chiller must be maintained in order to ensure that the systems do not exceed their operating temperature and are able to dissipate the required heat to the environment. Periodically check the layout of the Aurora and chiller to ensure that there is adequate spacing on all sides, that the area has not been cluttered, and that fan and vent holes have not been obstructed. Refer to the section on **Determining a location for the instrument** starting on page 14 for detailed information on adequate airflow.

G. Upgrading the Aurora software

This section provides instructions for upgrading the Aurora control software. The upgrade process has two steps. Step 1 upgrades the software on the laptop. Step 2 upgrades the software (also known as firmware) on the actual instrument. Please finish step 1 before starting step 2.

Step 1: Upgrading Aurora PC software

This section provides information on how to upgrade the Aurora control software on the laptop computer accompanying the Aurora instrument.

Prerequisites

Archive file containing two folders (Bin and Slave) received from Boreal Genomics.

Upgrade procedure

1. Copy the .ZIP update archive to the laptop of the Aurora system that needs to be upgraded.
2. Unzip the archive file on the desktop. You should now have a folder with a name of the form yyyy.mm.dd rXXX (indicating the update build release date and build release number) on the Windows desktop.
3. Move the folder that was just unzipped from the desktop to C:\Boreal Genomics\AuroraControl\. In the same C:\Boreal Genomics\AuroraControl folder the previous build folder is stored.
4. In the C:\Boreal Genomics\AuroraControl folder the previous software build is also located. Navigate to the SW_bin folder of this older build and copy the AuroraProtoFolderLib.pf file from there into the new build SW_bin folder (overwrite any existing files).
5. Return to the desktop and delete the archive file.

6. On the desktop right click on the Aurora software shortcut and select Properties. Update the “Target” text field so that it points to the Aurora executable in the new build folder. Also update the “Start in” text field so that it points to the same new build folder.

7. The first step is complete. To check if it was performed successfully double click on the SCODA Control shortcut on the desktop. The SCODA control application should start. The title bar should report that you are running build [yyyy.mm.dd]:[hh.mm] MSVC and firmware VXX. If the instrument is connected and turned on the software should report in the status bar that it is connected to an instrument. If the status bar message indicates that the connected instrument runs the wrong firmware version you should proceed to step 2. If that is not the case you have finished the upgrade process.

Step 2: Device Firmware Update (DFU)

This section provides information on how to upgrade the device firmware on the Aurora instrument.

Warning

Applying a DFU incorrectly may permanently damage the instrument. Follow these instructions carefully to ensure a successful upgrade.

Prerequisites

To perform a DFU, obtain the firmware image to be deployed on the instrument. If you have just upgraded the Aurora control software, it is typically found at C:\Boreal Genomics\AuroraControl\SlaveImage\Aurora Slave.dfu.

You will also need the ST Microelectronics DfuSe software, which is installed on all laptops delivered with Aurora instruments.

DFU procedure

Power on the Aurora instrument and start the Aurora control software. The control software should detect the instrument connected – check that the status bar in main window displays the message “Aurora detected but is running the wrong software version” as in **Figure 26**. If the software shows that an Aurora is connected normally, do not proceed; the upgrade process is complete.

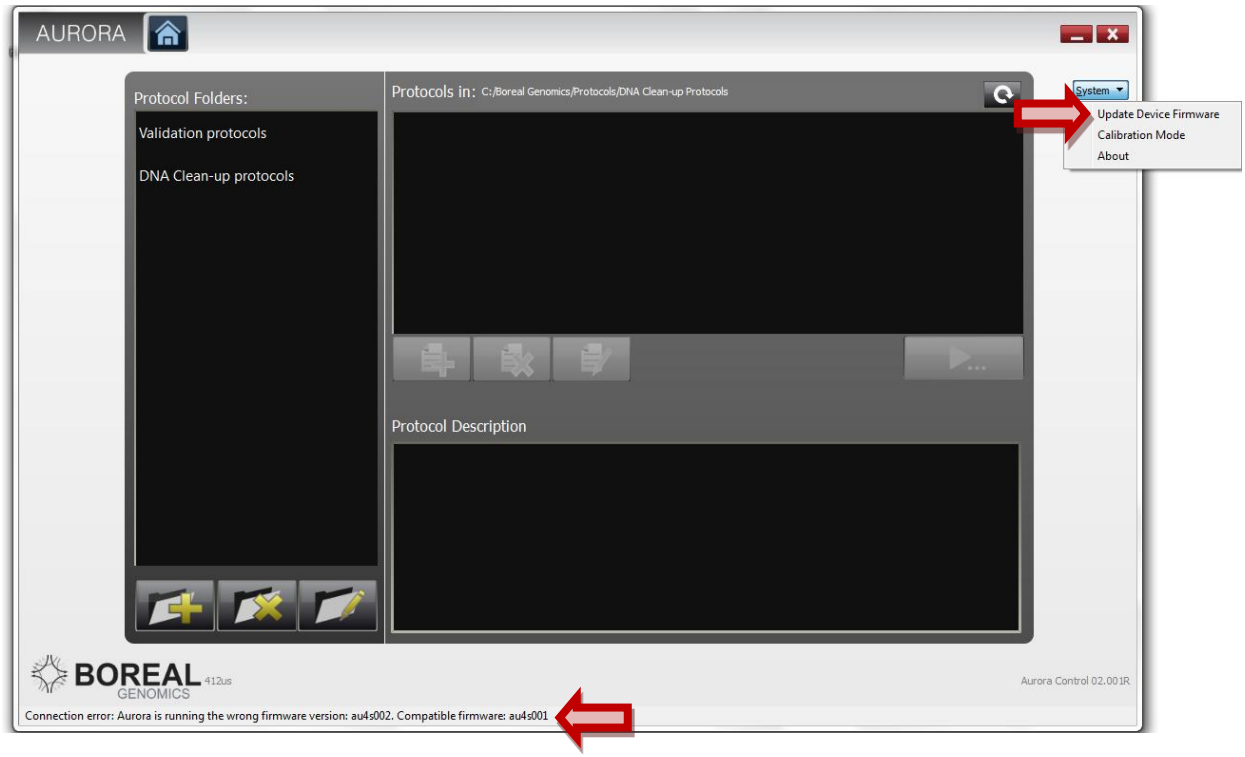

Figure 26. Aurora control - DFU mode selection

1. From the home screen, select System and Update Device Firmware (highlighted in **Figure 26**). Enter scoda123 as password. A pop-up window will announce that the device has entered DFU mode and the status bar will indicate the instrument has been disconnected. At the same time Windows 7 will detect a new device connected to USB.
2. Start ST DfuSe Demonstration software by going to Start->All programs->ST Microelectronics->DfuSe->DfuSe Demonstration. You should now see the window shown in **Figure 27**.
3. Check that in the top left “Available DFU and compatible HID Devices” section the drop down menu has the STM Device in DFU Mode selected.
4. Select the DFU image to be uploaded by clicking the “Choose…” button in the bottom right “Upgrade or Verify Action” section (indicated). Be sure to use the “Choose” button in the “Upgrade or Verify Action” panel and *not* the “Upload Action” panel. Browse to the image received from Boreal Genomics representative – the image should be formatted as a .dfu file (it is usually stored in C:\Boreal Genomics\AuroraControl\SlaveImage\Aurora Slave.dfu.).

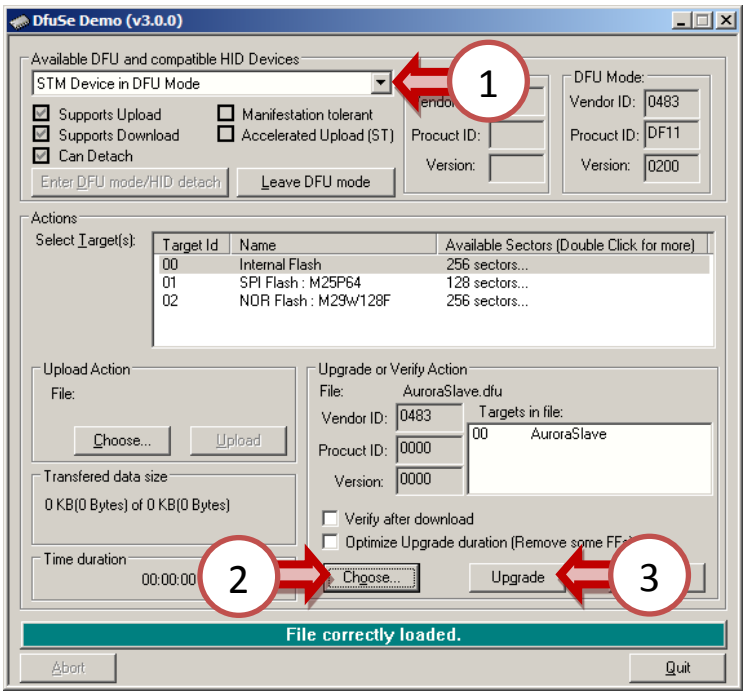

Figure 27. ST DfuSe main window

5. Click Upgrade and then Yes when you are prompted to continue. At the end of a successful upgrade the progress bar at the bottom of the window will display: “Target 00: Upgrade successful!”. If at any point during the upgrade process the instrument disconnects from the computer please see Note 1 at the end of this section on how to proceed.
6. Close the DfuSe Demonstration software and power cycle the Aurora instrument.
7. Return to the Aurora Control software and the Aurora instrument should be detected automatically. The status bar should display a message similar to “Connected to: [instrument name]”.

Congratulations! The upgrade is complete.

Note 1: If the device disconnected from the laptop while the firmware was updating the device firmware has been compromised and the device will not be able to connect to the laptop. To resolve this issue turn off the instrument. On the back panel of the instrument find the DFU switch. While holding down the DFU switch turn on the instrument – the instrument will be detected as a DFU device. Continue the DFU procedure from step 2.