

USER GUIDE

Chromium Next GEM Single Cell ATAC Reagent Kits v2



FOR USE WITH

Chromium Next GEM Single Cell ATAC Kit v2, 16 rxns PN-1000390

Chromium Next GEM Single Cell ATAC Kit v2, 4 rxns PN-1000406

Chromium Next GEM Chip H Single Cell Kit, 48 rxns PN-1000161

Chromium Next GEM Chip H Single Cell Kit, 16 rxns PN-1000162

Single Index Kit N, Set A, 96 rxns PN-1000212

Notices

Document Number

CG000496 • Rev B

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Document
Revision
Summary

Document Number	CG000496
Title	Chromium Next GEM Single Cell ATAC Reagent Kits v2 User Guide
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Revision Date	August 2022

Specific Changes:

- Updated Chromium Next GEM Chip and Gasket assembly/loading instructions.

General Changes:

- Updated for general minor consistency of language and terms throughout.

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Introduction

Chromium Next GEM Single Cell ATAC Reagent Kits v2

Chromium Accessories

Recommended Thermal Cyclers

Additional Kits, Reagents & Equipment

Recommended Pipette Tips

Protocol Steps & Timing


Stepwise Objectives

Chromium Next GEM Single Cell ATAC Reagent Kits v2

Chromium Next GEM Single Cell ATAC Kit v2, 16 rxns PN-1000390


Chromium Next GEM Single Cell ATAC Library Kit v2, 16 rxns PN-1000392 (store at -20°C)

Chromium Next GEM Single Cell ATAC Library Kit v2		
	#	PN
● 20X Nuclei Buffer	2	2000207
● ATAC Buffer B	1	2000193
● ATAC Enzyme B	1	2000265
● Barcoding Reagent B	1	2000194
● Barcoding Enzyme	1	2000125
○ Reducing Agent B	1	2000087
● Cleanup Buffer	2	2000088
○ Amp Mix	1	2000047
● SI-PCR Primer B	1	2000128

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Chromium Next GEM Single Cell ATAC Gel Bead Kit v2, 16 rxns PN-1000391 (store at -80°C)

Chromium Next GEM Single Cell ATAC Gel Beads v2		
	#	PN
Single Cell ATAC Gel Beads v2	2	2000210

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Dynabeads™ MyOne™ SILANE, PN-2000048 (store at 4°C)


	#	PN
Dynabeads MyOne SILANE	1	2000048

Chromium Next GEM Single Cell ATAC Reagent Kits v2

Chromium Next GEM Single Cell ATAC Kit v2, 4 rxns PN-1000406


Chromium Next GEM Single Cell ATAC Library Kit v2, 4 rxns PN-1000408 (store at -20°C)

Chromium Next GEM Single Cell ATAC Library Kit v2		
	#	PN
● 20X Nuclei Buffer	2	2000207
● ATAC Buffer B	1	2000193
● ATAC Enzyme B	1	2000272
● Barcoding Reagent B	1	2000194
● Barcoding Enzyme	1	2000139
○ Reducing Agent B	1	2000087
● Cleanup Buffer	1	2000088
○ Amp Mix	1	2000103
● SI-PCR Primer B	1	2000128

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Chromium Next GEM Single Cell ATAC Gel Bead Kit v2, 4 rxns PN-1000407 (store at -80°C)

Chromium Next GEM Single Cell ATAC Gel Beads v2		
	#	PN
Single Cell ATAC Gel Beads v2 (4 rxns)	1	2000210

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Dynabeads™ MyOne™ SILANE, PN-2000048 (store at 4°C)

	#	PN
Dynabeads MyOne SILANE	1	2000048

Chromium Next GEM Chip H Single Cell Kit, 48 rxns PN-1000161 (store at ambient temperature)

Chromium Partitioning Oil			
	#	PN	
<input checked="" type="radio"/> Partitioning Oil	6	2000190	

Chromium Recovery Agent			
	#	PN	
<input type="radio"/> Recovery Agent	6	220016	

Chromium Next GEM Chip H & Gaskets			
	#	PN	
Chromium Next GEM Chip H	6	2000180	
Gasket, 6-pack	1	370017	

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Chromium Next GEM Chip H Single Cell Kit, 16 rxns PN-1000162 (store at ambient temperature)

Chromium Partitioning Oil			
	#	PN	
<input checked="" type="radio"/> Partitioning Oil	2	2000190	

Chromium Recovery Agent			
	#	PN	
<input type="radio"/> Recovery Agent	2	220016	

Chromium Next GEM Chip H & Gaskets			
	#	PN	
Chromium Next GEM Chip H	2	2000180	
Gasket, 2-pack	1	3000072	

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Single Index Kit N Set A, 96 rxns PN-1000212 (store at -20°C)

Single Index Kit N Set A			
	#	PN	
Single Index Plate N Set A	1	3000427	

Chromium Accessories

Product	PN (Orderable)	PN (Item)
10x Vortex Adapter	120251	330002
Chromium Next GEM Secondary Holder	1000195	3000332
10x Magnetic Separator	120250	230003

Recommended Thermal Cyclers

Thermal cyclers used must support uniform heating of 100 µl emulsion volumes.

Supplier	Description	Part Number (US)
Bio-Rad	C1000 Touch Thermal Cycler with 96-Deep Well Reaction Module	1851197
Analytik Jena [†]	Biometra TAdvanced 96 SG	846-x-070-241 (x = 2 for 230 V; 4 for 115 V; 5 for 100 V, 50-60 Hz)
Eppendorf [‡]	Mastercycler X50s*	6311000010
	Mastercycler Pro (discontinued)	North America 950030010 International 6321 000.019
Thermo Fisher Scientific	Veriti 96-Well Thermal Cycler (discontinued)	4375786

For select instruments, ramp rates should be adjusted for all steps as described below:

[†]Analytik Jena Biometra TAdvanced 96 SG: 2°C/sec for both heating and cooling

[‡]Eppendorf Mastercycler X50s: 3°C/sec heating and 2°C/sec cooling

Additional Kits, Reagents & Equipment

The items in the table below have been validated by 10x Genomics and are highly recommended for the Single Cell ATAC protocols. Substituting materials may adversely affect system performance. This list does not include standard laboratory equipment such as water baths, centrifuges, vortex mixers, pH meters, freezers etc.

Supplier	Description	Part Number (US)
Plastics		
Eppendorf	PCR Tubes 0.2 ml 8-tube strips DNA LoBind Tubes, 1.5 ml DNA LoBind Tubes, 2.0 ml	951010022 022431021 022431048
USA Scientific	TempAssure PCR 8-tube strip	1402-4700
Thermo Fisher Scientific	MicroAmp 8-Tube Strip, 0.2 ml MicroAmp 8-Cap Strip, clear	N8010580 N8010535
Kits & Reagents		
Thermo Fisher Scientific	Nuclease-free Water	AM9937
Millipore Sigma	Ethanol, Pure (200 Proof, anhydrous)	E7023-500ML
Beckman Coulter	SPRIselect Reagent Kit	B23318
Bio-Rad	10% Tween 20	1662404
Ricca Chemical Company	Glycerin (glycerol), 50% (v/v) Aqueous Solution	3290-32
Qiagen	Qiagen Buffer EB	19086
Equipment		
VWR	Vortex Mixer Divided Polystyrene Reservoirs	10153-838 41428-958
Thermo Fisher Scientific	MYFUGE 12 Mini Centrifuge (alternatively, use any equivalent mini centrifuge)	C1012
Eppendorf	Eppendorf ThermoMixer C Eppendorf ThermoMixer C Bundle, includes SmartBlock 1.5 ml, Thermoblock for 24 reaction vessel (alternatively, use a temperature-controlled Heat Block)	5382000023 2231000574
Quantification & Quality Control		
Agilent	2100 Bioanalyzer Laptop Bundle High Sensitivity DNA Kit 4200 TapeStation High Sensitivity D1000 ScreenTape High Sensitivity D1000 Reagents	Choose Bioanalyzer, or TapeStation based on availability & preference. G2943CA 5067-4626 G2991AA 5067-5584 5067-5585
KAPA Biosystems	KAPA Library Quantification Kit for Illumina Platforms	KK4824




Recommended Pipette Tips

10x Genomics recommends using only validated emulsion-safe pipette tips for all Single Cell protocols. Rainin pipette tips have been extensively validated by 10x Genomics and are highly recommended for all single cell assays. If Rainin tips are unavailable, any of the listed alternate pipette tips validated by 10x Genomics may be used.

Supplier	Description	Part Number (US)
Recommended Pipettes & Pipette tips		
Rainin	Pipettes	
	Pipet-Lite Multi Pipette L8-50XLS+	17013804
	Pipet-Lite Multi Pipette L8-200XLS+	17013805
	Pipet-Lite Multi Pipette L8-10XLS+	17013802
	Pipet-Lite Multi Pipette L8-20XLS+	17013803
	Pipet-Lite LTS Pipette L-2XLS+	17014393
	Pipet-Lite LTS Pipette L-10XLS+	17014388
	Pipet-Lite LTS Pipette L-20XLS+	17014392
	Pipet-Lite LTS Pipette L-100XLS+	17014384
	Pipet-Lite LTS Pipette L-200XLS+	17014391
	Pipet-Lite LTS Pipette L-1000XLS+	17014382
	Pipette Tips	
	Tips LTS 200UL Filter RT-L200FLR	30389240
	Tips LTS 1ML Filter RT-L1000FLR	30389213
Tips LTS 20UL Filter RT-L10FLR	30389226	
Alternate Recommendations <i>(If Rainin pipette tips are unavailable, any of the listed pipette tips may be used)</i>		
Eppendorf	Pipettes	
	Eppendorf Research plus, 8-channel, epT.I.P.S. Box, 0.5 – 10 µL	3125000010
	Eppendorf Research plus, 8-channel, epT.I.P.S. Box, 10 – 100 µL	3125000036
	Eppendorf Research plus, 8-channel, epT.I.P.S. Box, 100 – 300 µL	3125000052
	Eppendorf Research plus, 1-channel, epT.I.P.S.® Box, 0.1 – 2.5 µL	3123000012
	Eppendorf Research plus, 1-channel, epT.I.P.S.® Box, 0.5 – 10 µL	3123000020
	Eppendorf Research plus, 1-channel, epT.I.P.S.® Box, 2 – 20 µL	3123000039
	Eppendorf Research plus, 1-channel, epT.I.P.S.® Box, 2 – 200 µL	3123000055
	Eppendorf Research plus, 1-channel, epT.I.P.S.® Box, 100 – 1000 µL	3123000063
	Pipette Tips (compatible with Eppendorf pipettes only)	
	ep Dualfilter T.I.P.S., 2-20 µL	0030078535
ep Dualfilter T.I.P.S., 2-200 µL	0030078551	
ep Dualfilter T.I.P.S., 2-1,000 µL	0030078578	
Labcon*	ZAP SLIK 20 µL Low Retention Aerosol Filter Pipet Tips for Rainin LTS	4-1143-965-008
	ZAP SLIK 200 µL Low Retention Aerosol Filter Pipet Tips for Rainin LTS	4-1144-965-008
	ZAP SLIK 1000 µL Low Retention Aerosol Filter Pipet Tips for Rainin LTS	4-1145-965-008
Biotix*	xTIP4 Racked Pipette Tips, Rainin LTS Pipette Compatible, 0.1-20uL	63300931
	xTIP4 Racked Pipette Tips, Rainin LTS Pipette Compatible, 200uL	63300001
	xTIP4 Racked Pipette Tips, Rainin LTS Pipette Compatible, 1000uL	63300003

*Compatible with Rainin pipettes

Protocol Steps & Timing

	Steps	Timing	Stop & Store
2 h	Nuclei Isolation		
	Dependent on Cell Type	~1-2 h	
	Step 1 – Transposition		
	1.1 Prepare Transposition Mix	10 min	
	1.2 Isothermal Incubation	30 min	
4 h	Step 2 – GEM Generation & Barcoding		
	2.1 Prepare Master Mix	10 min	
	2.2 Load Chromium Next GEM Chip H	10 min	
	2.3 Run the Chromium Controller or X/iX	18 min	
	2.4 Transfer GEMs	3 min	
	2.5 GEM Incubation	45 min	 15°C ≤ 18 h or -20°C ≤ 1 week
	Step 3 – Post GEM Incubation Cleanup		
	3.1 Post GEM Incubation Cleanup – Dynabeads	35 min	
	3.2 Post GEM Incubation Cleanup – SPRIselect	15 min	 4°C ≤ 72 h or -20°C ≤ 2 weeks
6 h	Step 4 – Library Construction		
	4.1 Sample Index PCR	40 min	
	4.2 Post Sample Index Double Sided Size Selection – SPRIselect	20 min	 4°C ≤ 72 h or -20°C long-term
	4.3 Post Library Construction QC	60 min	

Stepwise Objectives

The Chromium Single Cell ATAC Solution provides a comprehensive, scalable approach to determine the regulatory landscape of chromatin in hundreds to thousands of cells in a single sample. This is achieved by transposing nuclei in a bulk solution; then using a microfluidic chip, the nuclei are partitioned into nanoliter-scale Gel Beads-in-emulsion (GEMs). A pool of ~750,000 10x Barcodes is sampled to separately and uniquely index the transposed DNA of each individual nucleus. Libraries are generated and sequenced, and 10x Barcodes are used to associate individual reads back to the individual partitions, and thereby, to each individual nucleus.

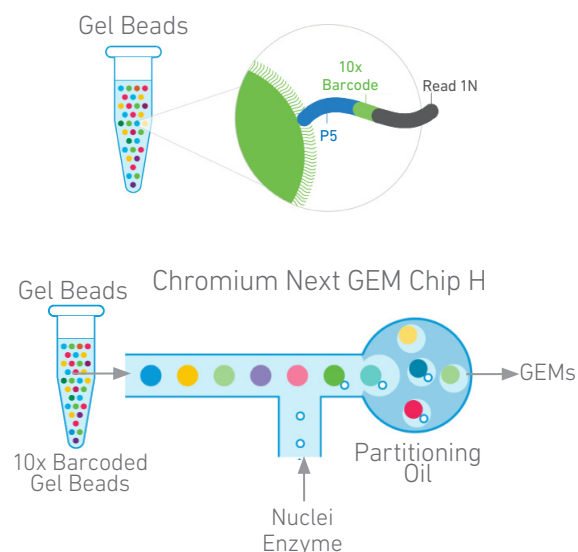
Step 1 Transposition

Nuclei suspensions are incubated in a Transposition Mix that includes a Transposase. The Transposase enters the nuclei and preferentially fragments the DNA in open regions of the chromatin. Simultaneously, adapter sequences are added to the ends of the DNA fragments.

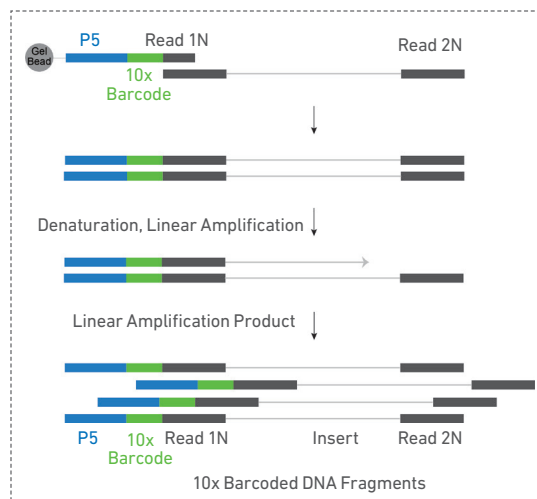
Step 2 GEM Generation & Barcoding

GEMs are generated by combining barcoded Gel Beads, transposed nuclei, a Master Mix, and Partitioning Oil on a Chromium Next GEM Chip H. To achieve single nuclei resolution, the nuclei are delivered at a limiting dilution, such that the majority (~90-99%) of generated GEMs contains no nuclei, while the remainder largely contain a single nucleus.

Upon GEM generation, the Gel Bead is dissolved. Oligonucleotides containing (i) an Illumina® P5 sequence, (ii) a 16 nt 10x Barcode and (iii) a Read 1 (Read 1N) sequence are released and mixed with DNA fragments and Master Mix. Thermal cycling of the GEMs produces 10x barcoded single-stranded DNA. After incubation, the GEMs are broken and pooled fractions are recovered.



Inside Individual GEMs



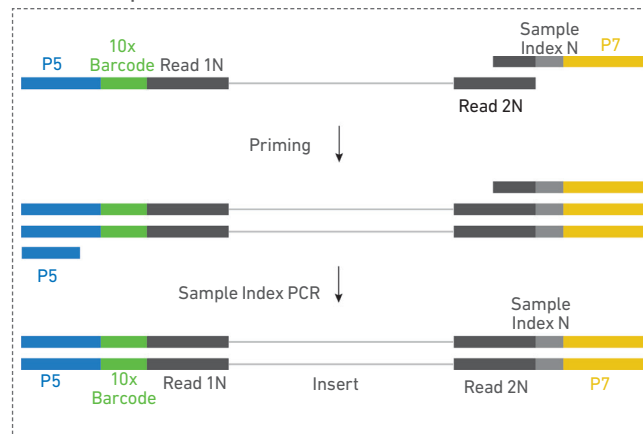
Step 3 Post GEM Incubation Cleanup

Silane magnetic beads are used to remove leftover biochemical reagents from the post GEM reaction mixture. Solid Phase Reversible Immobilization (SPRI) beads are used to eliminate unused barcodes from the sample.

Step 4 Library Construction

P7 and a sample index are added during library construction via PCR. The final libraries contain the P5 and P7 sequences used in Illumina® bridge amplification.

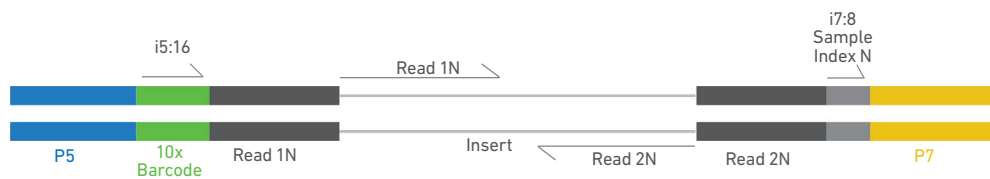
Pooled Amplified DNA Processed in Bulk



Step 5 Sequencing

The Chromium Next GEM Single Cell ATAC Reagent Kits v2 protocol produces Illumina®-ready sequencing libraries. Illumina® sequencer compatibility, sample indices, sequencing depth & run parameters, library loading and pooling are summarized.

Chromium Single Cell ATAC Library



[See Appendix for Oligonucleotide Sequences](#)

Tips & Best Practices

TIPS

Icons



Tips & Best Practices section includes additional guidance



Signifies critical step requiring accurate execution



Troubleshooting section includes additional guidance



Version specific protocol step updates

Emulsion-safe Plastics

- Use 10x Genomics validated emulsion-safe plastic consumables when handling GEMs as some plastics can destabilize GEMs.

Multiplet Rate

Multiplet Rate (%)	# of Nuclei Loaded	# of Nuclei Recovered
0.4%	~775	~500
0.8%	~1,550	~1,000
1.6%	~3,075	~2,000
2.3%	~4,625	~3,000
3.1%	~6,150	~4,000
3.9%	~7,700	~5,000
4.6%	~9,250	~6,000
5.4%	~10,750	~7,000
6.2%	~12,300	~8,000
6.9%	~13,850	~9,000
7.7%	~15,400	~10,000

General Reagent Handling

- Fully thaw and thoroughly mix reagents before use.
- Keep all enzymes and Master Mixes on ice during setup and use. Promptly move reagents back to the recommended storage.
- Calculate reagent volumes with 10% excess of 1 reaction values.
- Cover Partitioning Oil tubes and reservoirs to minimize evaporation.
- Thoroughly mix samples with the beads during bead-based cleanup steps.

50% Glycerol Solution

- Purchase 50% glycerol solution from Ricca Chemical Company, Glycerin (glycerol), 50% (v/v) Aqueous Solution, PN-3290-32.
- Prepare 50% glycerol solution:
 - Mix an equal volume of water and 99% Glycerol, Molecular Biology Grade.
 - Filter through a 0.2- μ m filter.
 - Store at -20°C in 1-ml LoBind tubes. 50% glycerol solution should be equilibrated to room temperature before use.

Pipette Calibration

- Follow manufacturer's calibration and maintenance schedules.
- Pipette accuracy is particularly important when using SPRIselect reagents.

Chromium Next GEM Chip Handling

- Minimize exposure of reagents, chips, and gaskets to sources of particles and fibers, laboratory wipes, frequently opened flip-cap tubes, clothing that sheds fibers, and dusty surfaces.
- After removing the chip from the sealed bag, use within 24 h.
- Execute steps without pause or delay, unless indicated. When multiple chips are to be used, load, run, and collect the content from one chip before loading the next.
- Fill all unused input wells in rows labeled 1, 2, and 3 on a chip with an appropriate volume of 50% glycerol solution before loading the used wells. **DO NOT** add glycerol to the wells in the bottom NO FILL row.
- Avoid contacting the bottom surface of the chip with gloved hands and other surfaces. Frictional charging can lead to inadequate priming of the channels, potentially leading to either clogs or wetting failures.
- Minimize the distance that a loaded chip is moved to reach the Chromium Controller.
- Keep the chip horizontal to prevent wetting the gasket with oil, which depletes the input volume and may adversely affect the quality of the assay.

Chromium Next GEM Secondary Holders

- Chromium Next GEM Secondary Holders encase Chromium Next GEM Chips.
- The holder lid flips over to become a stand, holding the chip at 45 degrees for optimal Recovery Well content removal.
- Squeeze the black sliders on the back side of the holder together to unlock the lid and return the holder to a flat position.



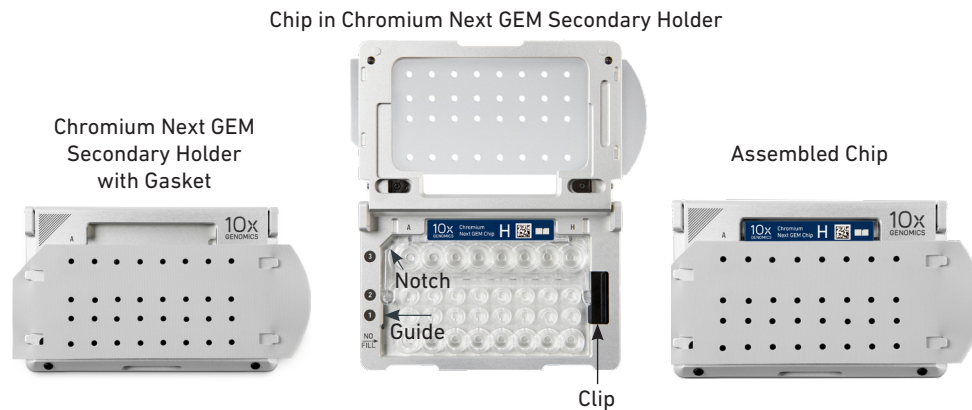
Chromium Next GEM Chip & Holder Assembly

- Align notch on the chip (upper left corner) and the holder.
- Insert the left-hand side of the chip under the guide. Depress the right-hand side of the chip until the spring-loaded clip engages.
- Close the lid before dispensing reagents into the wells.



Chromium
Next GEM
Chip & Holder
Assembly with
Gasket

- Close the holder lid. Attach the gasket by holding the tongue (curved end, to the right) and hook the gasket on the left-hand tabs of the holder. Gently pull the gasket toward the right and hook it on the two right-hand tabs.
- DO NOT touch the smooth side of the gasket.
- Open the chip holder.
- Align notch on the chip (upper left corner) and the open holder with the gasket attached.
- Slide the chip to the left until the chip is inserted under the guide on the holder. Depress the right hand side of the chip until the spring-loaded clip engages.
- Keep the assembled unit with the attached gasket until ready for dispensing reagents into the wells.



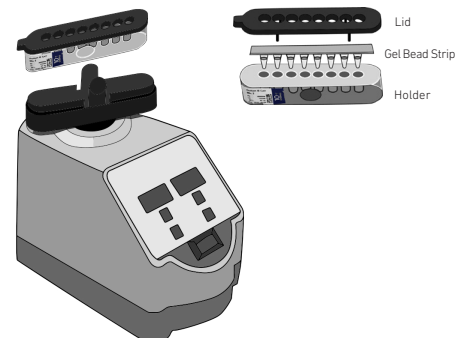
Chromium
Next GEM
Chip Loading

- Place the assembled chip and holder flat (gasket attached) on the bench with the lid closed.
- Dispense at the bottom of the wells without introducing bubbles.
- When dispensing Gel Beads into the chip, wait for the remainder to drain into the bottom of the pipette tips and dispense again to ensure complete transfer.
- Refer to [Load Chromium Next GEM Chip H](#) for specific instructions.



Gel Bead
Handling

- Use one tube of Gel Beads per sample. DO NOT puncture the foil seals of tubes not used at the time.
- Equilibrate the Gel Beads strip to room temperature before use.
- Store unused Gel Beads at -80°C and avoid more than 12 freeze-thaw cycles. DO NOT store Gel Beads at -20°C .

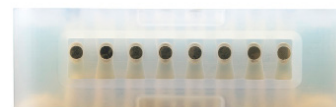


Gel Bead Handling Contd.

- Snap the tube strip holder with the Gel Bead strip into a 10x Vortex Adapter. Vortex **30 sec.**
- Centrifuge the Gel Bead strip for **~5 sec.** Confirm there are no bubbles at the bottom of the tubes and the liquid levels look even. Place the Gel Bead strip back in the holder and secure the holder lid.
- If the required volume of beads cannot be recovered, place the pipette tips against the sidewalls and slowly dispense the Gel Beads back into the tubes. **DO NOT** introduce bubbles into the tubes and verify that the pipette tips contain no leftover Gel Beads. Withdraw the full volume of beads again by pipetting slowly.

10x Magnetic Separator

- Offers two positions of the magnets (high and low) relative to a tube, depending on its orientation. Flip the magnetic separator over to switch between high (magnet•**High**) or low (magnet•**Low**) positions.
- If using MicroAmp 8-Tube Strips, use the high position (magnet•**High**) only throughout the protocol.



SPRIselect Cleanup & Size Selection

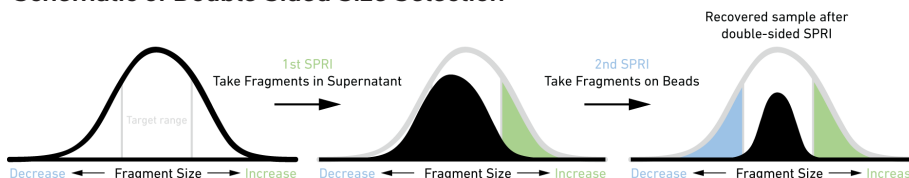
- After aspirating the desired volume of SPRIselect reagent, examine the pipette tips before dispensing to ensure the correct volume is transferred.
- Pipette mix thoroughly as insufficient mixing of sample and SPRIselect reagent will lead to inconsistent results.
- Use fresh preparations of 80% Ethanol.

Tutorial — SPRIselect Reagent:DNA Sample Ratios

SPRI beads selectively bind DNA according to the ratio of SPRIselect reagent (beads).

$$\text{Example: Ratio} = \frac{\text{Volume of SPRIselect reagent added to the sample}}{\text{Volume of DNA sample}} = \frac{50 \mu\text{l}}{100 \mu\text{l}} = 0.5\text{X}$$

Schematic of Double Sided Size Selection



After the first SPRI, supernatant is transferred for a second SPRI while larger fragments are discarded (green). After the second SPRI, fragments on beads are eluted and kept while smaller fragments are discarded (blue). Final sample has a tight fragment size distribution with reduced overall amount (black).

Tutorial — Double Sided Size Selection

Step a – First SPRIselect: Add 50 μl SPRIselect reagent to 100 μl sample (0.5X).

$$\text{Ratio} = \frac{\text{Volume of SPRIselect reagent added to the sample}}{\text{Volume of DNA sample}} = \frac{50 \mu\text{l}}{100 \mu\text{l}} = 0.5\text{X}$$

Step b – Second SPRIselect: Add 30 μl SPRIselect reagent to supernatant from step a (0.8X).

$$\text{Ratio} = \frac{\text{Total Volume of SPRIselect reagent added to the sample (step a + b)}}{\text{Original Volume of DNA sample}} = \frac{50 \mu\text{l} + 30 \mu\text{l}}{100 \mu\text{l}} = 0.8\text{X}$$

Sample Indices in Sample Index PCR

- Choose the appropriate sample index sets to ensure that no sample indices overlap in a multiplexed sequencing run.
- Each well in the i7 Single Index plate N, Set A contains a unique mix of 4 oligos.
- The sample indexes can therefore be used in any combination.
- Each sample index set is base-balanced to avoid monochromatic signal issues when it is the sole sample loaded on an Illumina® sequencer.









Step 1

Transposition

- 1.1 Prepare Transposition Mix
- 1.2 Isothermal Incubation

1

1.0 Transposition

GET STARTED!																					
Action		Item	10x PN	Preparation & Handling	Storage																
Equilibrate to Room Temperature		ATAC Buffer B	2000193	Vortex, centrifuge briefly.	-20°C																
		20X Nuclei Buffer* *Concentrated 20X stock; dilute 1:20 in nuclease-free water before use. (See below to Prepare Diluted Nuclei Buffer)	2000207	Thaw. Vortex, centrifuge briefly.	-20°C																
Place on Ice		ATAC Enzyme B	2000265/ 2000272	Centrifuge briefly.	-20°C																
<p>Nuclei** in Diluted Nuclei Buffer (See below to Prepare Diluted Nuclei Buffer)</p> <p> **Refer to Demonstrated Protocols for isolating nuclei for ATAC Sequencing (Documents CG000169; CG000212). Adhering to this protocol is critical for optimal assay performance. If following a different nuclei isolation protocol, use the Diluted Nuclei Buffer for final nuclei pellet suspension.</p> <p> The use of the Tris-based Diluted Nuclei Buffer for nuclei suspension is critical for optimal assay performance. The composition of the Diluted Nuclei Buffer, including Magnesium concentration, has been optimized for the Transposition and Barcoding steps. Suspension of nuclei in a different buffer may not be compatible with the downstream protocol steps.</p>																					
Prepare	Diluted Nuclei Buffer	<table border="1"> <thead> <tr> <th>Diluted Nuclei Buffer</th> <th>Stock</th> <th>Final</th> <th>1 ml</th> </tr> </thead> <tbody> <tr> <td colspan="4">Maintain at 4°C</td> </tr> <tr> <td> 20X Nuclei Buffer (PN-2000207)</td> <td>20X</td> <td>1X</td> <td>50 µl</td> </tr> <tr> <td>Nuclease-free Water</td> <td>-</td> <td>-</td> <td>950 µl</td> </tr> </tbody> </table>				Diluted Nuclei Buffer	Stock	Final	1 ml	Maintain at 4°C				 20X Nuclei Buffer (PN-2000207)	20X	1X	50 µl	Nuclease-free Water	-	-	950 µl
Diluted Nuclei Buffer	Stock	Final	1 ml																		
Maintain at 4°C																					
 20X Nuclei Buffer (PN-2000207)	20X	1X	50 µl																		
Nuclease-free Water	-	-	950 µl																		

Nuclei Concentration Guidelines

Based on the Targeted Nuclei Recovery, resuspend the nuclei in Diluted Nuclei Buffer to get corresponding Nuclei Stock Concentrations (see Table). This enables pipetting volumes of the Nuclei Stock for Transposition (step 1.1) to be 2-5 μl . Higher Nuclei Stock Concentrations will result in lower pipetting volumes that may increase nuclei input variability.

Targeted Nuclei Recovery	Nuclei Stock Concentration (nuclei/ μl)
500	155-390
1,000	310-780
2,000	610-1,540
3,000	925-2,300
4,000	1,230-3,075
5,000	1,540-3,850
6,000	1,850-4,600
7,000	2,150-5,400
8,000	2,460-6,150
9,000	2,770-6,900
10,000	3,080-7,700



Calculate volumes necessary first and proceed to making the Transposition Mix. DO NOT mix Nuclei Stock and Diluted Nuclei Buffer together until indicated in the User Guide (Step 1.1).

Calculate volume of Nuclei Stock and Diluted Nuclei Buffer for a total volume of 5 μl

$$\text{Volume of Nuclei Stock } (\mu\text{l}) = \frac{\text{Targeted Nuclei Recovery} \times 1.53 \text{ (Recovery efficiency factor)}}{\text{Nuclei Stock Concentration (nuclei/ } \mu\text{l)}}$$

$$\text{Volume of Diluted Nuclei Buffer* } (\mu\text{l}) = 5 \mu\text{l} - \text{volume of Nuclei Stock } (\mu\text{l})$$

*Use ONLY Diluted Nuclei Buffer (Dilute 20X Nuclei Buffer (PN-2000207) 1:20 in nuclease-free water)

Example Calculation

Targeted Nuclei Recovery = 4000 nuclei

Nuclei Stock Concentration = 2500 nuclei/ μl

Recovery efficiency factor 1.53

Volume of Nuclei Stock (μl) =

$$\frac{\text{Targeted Nuclei Recovery} \times 1.53 \text{ (Recovery efficiency factor)}}{\text{Nuclei Stock Concentration (nuclei/} \mu\text{l)}} = \frac{4000 \times 1.53}{2500} = 2.45 \mu\text{l}$$

$$\text{Volume of Diluted Nuclei Buffer} = 5 \mu\text{l} - 2.45 \mu\text{l} = 2.55 \mu\text{l}$$


Add calculated volumes of Diluted Nuclei Buffer and Nuclei Stock to the Transposition Mix in [Step 1.1](#)

1.1 Prepare Transposition Mix



- a. Prepare Transposition Mix on ice. Pipette mix 10x and centrifuge briefly.

Transposition Mix <i>Add reagents in the order listed</i>	PN	1X (µl)	4X + 10% (µl)	8X + 10% (µl)
● ATAC Buffer B	2000193	7.0	30.8	61.6
● ATAC Enzyme B	2000265/ 2000272	3.0	13.2	26.4
Total	-	10.0	44.0	88.0

- b. Add 10 µl Transposition Mix to a tube of a PCR 8-tube strip for each sample. Centrifuge briefly and maintain on ice.
- c. Refer to [Nuclei Concentration Guidelines](#) to calculate the volume of Nuclei Stock and Diluted Nuclei Buffer for a total volume of 5 µl.
- d. Add the calculated volume of Diluted Nuclei Buffer to the Transposition Mix. Pipette mix. Centrifuge briefly.
- e.  Gently pipette mix the Nuclei Stock. Add the calculated volume of the Nuclei Stock to the tube containing the Transposition Mix. Gently pipette mix 6x (pipette set to 10 µl). DO NOT centrifuge.

1.2 Isothermal Incubation



- a. Incubate in a thermal cycler using the following protocol. Ensure lid temperature is set to 50°C. DO NOT use heated lid option if temperature defaults to 100°C.

Lid Temperature	Reaction Volume	Run Time
50°C	15 µl	30 min
Step	Temperature	Time (hh:mm:ss)
Incubate	37°C	00:30:00
Hold	4°C	Hold

- b. Immediately proceed to the next step.

Step 2

GEM Generation & Barcoding

- 2.1 Prepare Reaction Mix
- 2.2 Load Chromium Next GEM Chip H
- 2.3 Run the Chromium Controller or X/iX
- 2.4 Transfer GEMs
- 2.5 GEM Incubation

2.0 GEM Generation & Barcoding

GET STARTED!				
Action	Item	10x PN	Preparation & Handling	Storage
Equilibrate to Room Temperature	Single Cell ATAC Gel Beads v2	2000210	Equilibrate to room temperature 30 min before loading the chip.	-80°C
	○ Reducing Agent B	2000087	Thaw, vortex, verify no precipitate, centrifuge briefly.	-20°C
	● Barcoding Reagent B	2000194	Thaw, vortex, verify no precipitate, centrifuge briefly.	-20°C
Place on Ice	● Barcoding Enzyme	2000125/ 2000139	Maintain on ice. Store at -20°C immediately after use.	-20°C
Obtain	● Partitioning Oil	2000190	-	Ambient
	Chromium Next GEM Chip H	2000180	See Tips & Best Practices.	Ambient
	10x Gasket	370017/ 3000072	See Tips & Best Practices.	Ambient
	10x Vortex Adapter	330002	See Tips & Best Practices.	Ambient
	Chromium Next GEM Secondary Holder	3000332	See Tips & Best Practices.	Ambient
	50% glycerol solution If using <8 reactions	-	See Tips & Best Practices.	-



Firmware Version 4.00 or higher is required in the Chromium Controller or the Chromium Single Cell Controller used for the Single Cell ATAC v2 protocol.

2.1 Prepare Master Mix

a. Prepare Master Mix on ice. Pipette mix 10x and centrifuge briefly.

Master Mix <i>Add reagents in the order listed</i>	PN	1X (μl)	4X + 10% (μl)	8X + 10% (μl)
● Barcoding Reagent B	2000194	56.5	248.6	497.2
○ Reducing Agent B	2000087	1.5	6.6	13.2
● Barcoding Enzyme	2000125/ 2000139	2.0	8.8	17.6
Total	-	60.0	264.0	528.0

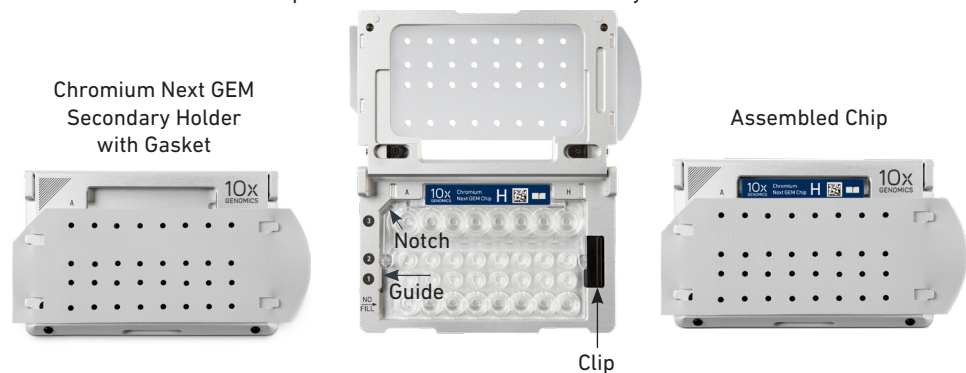
Assemble Chromium Next GEM Chip



See Tips & Best Practices for chip handling instructions.

- Close the holder lid. Attach the gasket by holding the tongue (curved end, to the right) and hook the gasket on the left-hand tabs of the holder. Gently pull the gasket toward the right and hook it on the two right-hand tabs.
- DO NOT touch the smooth side of the gasket.
- Open the chip holder.
- Remove the chip from the sealed bag. Use the chip within ≤ 24 h.
- Align notch on the chip (upper left corner) and the open holder with the gasket attached.
- Slide the chip to the left until the chip is inserted under the guide on the holder. Depress the right hand side of the chip until the spring-loaded clip engages.
- Keep the assembled unit with the attached gasket open until ready for and while dispensing reagents into the wells. DO NOT touch the smooth side of the gasket. After loading reagents, close the chip holder. DO NOT press down on the top of the gasket.

Chip in Chromium Next GEM Secondary Holder



For GEM generation, load the indicated reagents only in the specified rows, starting from row labeled 1, followed by rows labeled 2 and 3. DO NOT load reagents in the bottom row labeled NO FILL. See step 2.2 for details.

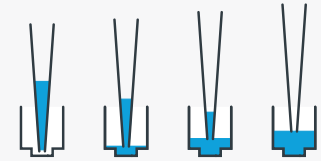
2.2 Load Chromium Next GEM Chip H



After removing chip from the sealed bag, use in ≤ 24 h.
Open the lid (gasket attached) of the assembled chip and lay flat for loading.

When loading the chip, raising and depressing the pipette plunger should each take ~ 5 sec.

When dispensing, raise the pipette tips at the same rate as the liquid is rising, keeping the tips slightly submerged.



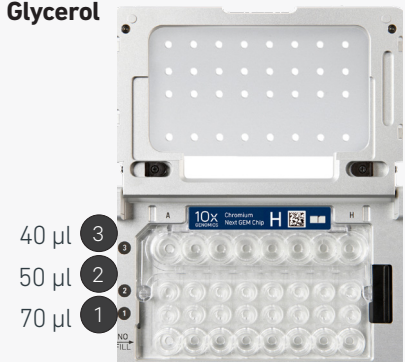
a. Add 50% glycerol solution to each unused well

(if processing < 8 samples/chip)

- 70 μ l in each unused well in row labeled 1
- 50 μ l in each unused well in row labeled 2
- 40 μ l in each unused well in row labeled 3

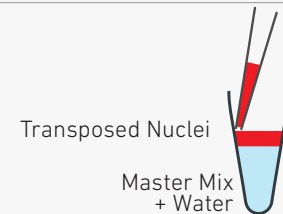
DO NOT add 50% glycerol solution to the bottom row of NO FILL wells.
DO NOT use any substitute for 50% glycerol solution.

Glycerol



b. Prepare Master Mix + Transposed Nuclei

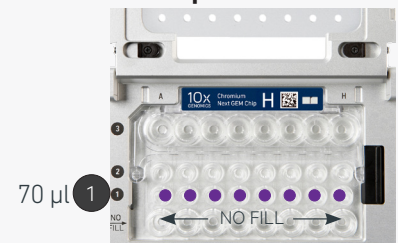
- Add 60 μ l Master Mix to each tube containing Transposed Nuclei for a total of 75 μ l in each tube.



c. Load Row Labeled 1

- Gently pipette mix the Master Mix + Transposed Nuclei 5x.
- Using the same pipette tip, dispense 70 μ l Master Mix + Transposed Nuclei into the bottom center of each well in **row labeled 1** without introducing bubbles.

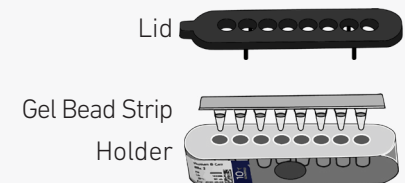
Master Mix + Sample



d. Prepare Gel Beads

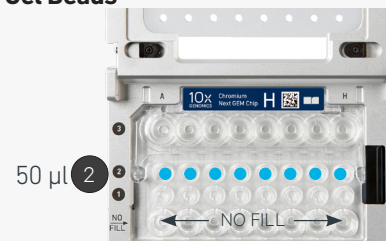
- Snap the tube strip holder with the Gel Bead strip into a 10x Vortex Adapter. Vortex **30 sec.**
- Centrifuge the Gel Bead strip for **~ 5 sec.**
- Confirm there are no bubbles at the bottom of the tubes and the liquid levels are even.
- Place the Gel Bead strip back in the holder. Secure the holder lid.

Prep Gel Beads



e. Load Row Labeled 2

- Puncture the foil seal of the Gel Bead tubes.
- Slowly aspirate **50 μ l** Gel Beads.
- Dispense into the wells in **row labeled 2** without introducing bubbles.
- Wait **30 sec.**

Gel Beads**f. Load Row Labeled 3**

- Dispense **40 μ l** Partitioning Oil into the wells in **row labeled 3** from a reagent reservoir.

! Failure to add Partitioning Oil to the top row labeled 3 will prevent GEM generation and can damage the Chromium Controller.

Partitioning Oil**g. Prepare for Run**

- Close the lid (gasket already attached). **DO NOT** touch the smooth side of the gasket. **DO NOT** press down on the top of the gasket.

Run the chip in the Chromium Controller or X/iX immediately after loading the Partitioning Oil.



2.3 Run the Chromium Controller or X/iX

If using Chromium Controller:

- Press the eject button on the Controller to eject the tray.
- Place the assembled chip with the gasket in the tray, ensuring that the chip stays horizontal. Press the button to retract the tray.
- Press the play button.
- At completion of the run (~18 min), the Controller will chime. **Immediately** proceed to the next step.



Firmware Version 4.00 or higher is required in the Chromium Controller or the Chromium Single Cell Controller used for the Single Cell ATAC v2 protocol.

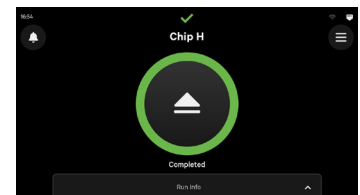
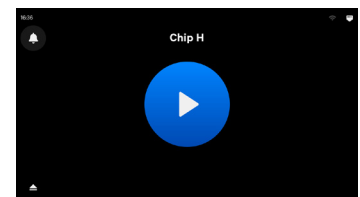


If using Chromium X/iX:





Consult the Chromium X Series (X/iX) User Guide (CG000396) for detailed instrument operation instructions and follow the instrument touchscreen prompts for execution.

- Press the eject button on Chromium X/iX to eject the tray.
If the eject button is not touched within 1 min, tray will close automatically. System requires a few seconds before the tray can be ejected again.
- Place the assembled chip with the gasket in the tray, ensuring that the chip stays horizontal. Press the button to retract the tray.
- Press the play button.
- At completion of the run (~18 min), Chromium X/iX will chime. **Immediately** proceed to the next step.



2.4 Transfer GEMs

- a. Place a PCR 8-tube strip on ice.
- b. Press the eject button of the Controller to remove the chip.
- c. Discard the gasket. Open the chip holder. Fold the lid back until it clicks to expose the wells at 45 degrees.
-  d. Visually compare the remaining volume in rows labeled 1-2 across all samples. Abnormally high volume in one sample with respect to the others may indicate a clog.
- e. Slowly aspirate **100 µl** GEMs from the lowest points of the recovery wells in the top row labeled 3 without creating a seal between the pipette tips and the wells.
-  f. Withdraw pipette tips from the wells. GEMs should appear opaque and uniform across all channels. Excess Partitioning Oil (clear) in the pipette tips indicates a potential clog.
- g. Over the course of **~20 sec**, dispense GEMs into the tube strip on ice with the pipette tips against the sidewalls of the wells.
- h. If multiple chips are run back-to-back, cap/cover the GEM-containing tube strip or plate and place on ice for no more than **1 h**.

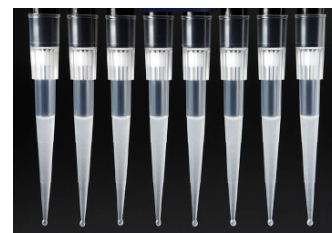
Expose Wells at 45 Degrees



Transfer GEMs



GEMs



2.5 GEM Incubation

Use a thermal cycler that can accommodate at least 100 μl volume. A volume of 125 μl is the preferred setting on Bio-Rad C1000 Touch. In alternate thermal cyclers, use highest reaction volume setting.

- a. Incubate in a thermal cycler with the following protocol.

Lid Temperature	Reaction Volume	Run Time
105°C	100 μl	30 min

Step	Temperature	Time (hh:mm:ss)
1	72°C	00:05:00
2	98°C	00:00:30
3	98°C	00:00:10
4	59°C	00:00:30
5	72°C	00:01:00 Go to step 3, repeat 11X (Total 12 cycles)
6	15°C	Hold



- b. Store at 15°C for up to 18 h or at -20°C for up to 1 week, or proceed to the next step.

Step 3

Post GEM Incubation Cleanup

- 3.1 Post GEM Incubation Cleanup – Dynabeads
- 3.2 Post GEM Incubation Cleanup – SPRIselect



3.0 Post GEM Incubation Cleanup

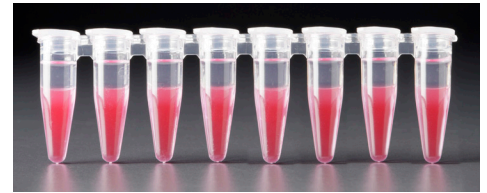
GET STARTED!				
Action	Item	10x PN	Preparation & Handling	Storage
Equilibrate to Room Temperature	<input type="radio"/> Reducing Agent B	2000087	Thaw, vortex, verify no precipitate, centrifuge briefly.	-20°C
	Nuclease-free Water	-	-	-
	Dynabeads MyOne SILANE	2000048	Vortex thoroughly (≥ 30 sec) to resuspend beads immediately before use.	4°C
	Beckman Coulter SPRIselect Reagent	-	Manufacturer's recommendations.	-
Thaw at 65°C	<input checked="" type="radio"/> Cleanup Buffer	2000088	Thaw for 10 min at 65°C at max speed on a thermomixer, or in a water bath or bead bath, mixing every 5 min. Verify there are no visible crystals. Cool to room temperature.	-20°C
Obtain	Recovery Agent	220016	-	Ambient
	Qiagen Buffer EB	-	Manufacturer's recommendations.	-
	Bio-Rad 10% Tween 20	-	Manufacturer's recommendations.	-
	10x Magnetic Separator	230003	-	Ambient
	Prepare 80% Ethanol Prepare 10 ml for 8 reactions	-	Prepare fresh.	-

3.1 Post GEM Incubation Cleanup – Dynabeads

- a. Add **125 μ l** Recovery Agent to each sample at room temperature. **DO NOT** pipette mix or vortex the biphasic mixture. Gently invert tube 10x to mix. Centrifuge briefly.

The resulting biphasic mixture contains Recovery Agent/Partitioning Oil (pink) and aqueous phase (clear), with no persisting emulsion (opaque).

Biphasic Mixture

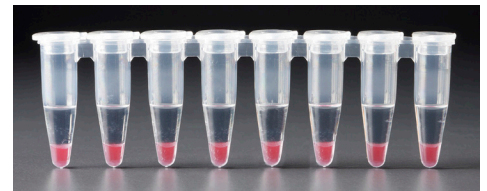


A smaller aqueous phase volume indicates a clog during GEM generation.



- b. Slowly remove and discard **125 μ l** Recovery Agent/Partitioning Oil (pink) from the bottom of the tube. **DO NOT** aspirate any aqueous sample.

Remove Recovery Agent



- c. Prepare Dynabeads Cleanup Mix.

Dynabeads Cleanup Mix

Add reagents in the order listed

	PN	1X (μ l)	4X + 10% (μ l)	8X + 10% (μ l)
● Cleanup Buffer	2000088	182	800.8	1601.6
○ Dynabeads MyOne SILANE Vortex thoroughly (≥ 30 sec) immediately before adding to the mix.	2000048	8	35.2	70.4
○ Reducing Agent B	2000087	5	22	44
Nuclease-free Water	-	5	22	44
Total	-	200	880	1760

Dynabeads MyOne SILANE

Vortex thoroughly (≥ 30 sec)
immediately before adding to the mix.

Aspirate the full liquid volume with a pipette tip to verify that the beads have not settled in the bottom of the tube. If clumps are present, pipette mix to resuspend completely. **DO NOT** centrifuge before use.



- d. Vortex and add **200 μ l** to each sample. Pipette mix 5x (pipette set to 200 μ l).
- e. Incubate **10 min** at room temperature. Pipette mix again at ~ 5 min after start of incubation to resuspend settled beads. Keep caps open during incubation.

Add Dynabeads Cleanup Mix



f. Prepare Elution Solution I. Vortex and centrifuge briefly.

Elution Solution I* <i>Add reagents in the order listed</i>	PN	1X (μl)	4X + 10% (μl)	8X + 10% (μl)
Buffer EB	-	98.0	431.2	862.4
10% Tween 20	-	1.0	4.4	8.8
<input type="radio"/> Reducing Agent B	200087	1.0	4.4	8.8
Total	-	100.0	440.0	880.0

*Elution Solution I will be used in steps 3.1o and 3.2j



- g. At the end of **10 min** incubation, place on the 10x Magnetic Separator, high position (magnet•**High**) until the solution clears. A white interface between the aqueous phase and Recovery Agent is normal.
- h. Remove the supernatant.
- i. Add **300 μl** freshly prepared 80% ethanol to the pellet while on the magnet•**High**. Wait **30 sec**.
- j. Remove the ethanol.
- k. Add **200 μl** 80% ethanol to pellet. Wait **30 sec**.
- l. Remove the ethanol.
- m. Centrifuge briefly. Place on the magnet•**Low**.
- n. Remove remaining ethanol.
- o. Remove from the magnet. **Immediately** add **40.5 μl** Elution Solution I to avoid clumping.
- p. Pipette mix (pipette set to 40 μl) without introducing bubbles.
- q. Incubate **1 min** at **room temperature**.
- r. Centrifuge briefly. Place on the magnet•**Low** until the solution clears.
- s. Transfer **40 μl** sample to a new tube strip.

3.2 Post GEM Incubation Cleanup – SPRIselect

- a. Vortex the SPRIselect reagent until fully resuspended. Add **48 μ l** SPRIselect reagent to each sample. Pipette mix thoroughly using a pipette set to 80 μ l.
- b. Incubate **5 min** at **room temperature**.
- c. Centrifuge briefly. Place on the magnet•**High** until the solution clears.
- d. Remove the supernatant.
- e. Add **200 μ l** 80% ethanol to the pellet. Wait **30 sec**.
- f. Remove the ethanol.
- g. **Repeat** steps e and f for a total of 2 washes.
- h. Centrifuge briefly. Place on the magnet•**Low**.
- i. Remove any remaining ethanol.
- j. Remove the tube strip from the magnet. **Immediately** add **40.5 μ l** Elution Solution I.
- k. Pipette mix (pipette set to 30 μ l) without introducing bubbles.
- l. Incubate **2 min** at **room temperature**.
- m. Centrifuge briefly. Place on the magnet•**Low** until the solution clears.
- n. Transfer **40 μ l** sample to a new tube strip.
- o. Store at **4°C** for up to **72 h** or at **-20°C** for up to **2 weeks**, or proceed to the next step.



Step 4

Library Construction

- 4.1 Sample Index PCR
- 4.2 Post Sample Index Double Sided Size Selection – SPRIselect
- 4.3 Post Library Construction QC
- 4.4 Post Library Construction Quantification

4.0 Library Construction

GET STARTED!				
Action	Item	10x PN	Preparation & Handling	Storage
Equilibrate to Room Temperature	Single Index Plate N Set A	3000427	-	-20°C
	Beckman Coulter SPRIselect Reagent	-	Manufacturer's recommendations.	-
	Agilent Bioanalyzer DNA kit (if used for QC)	-	Manufacturer's recommendations.	-
Place on Ice	<input checked="" type="radio"/> SI-PCR Primer B	2000128	Vortex, centrifuge briefly.	-20°C
	<input type="radio"/> Amp Mix	2000047/ 2000103	Gently pipette mix, centrifuge briefly.	-20°C
	KAPA Library Quantification Kit for Illumina® Platforms	-	Manufacturer's recommendations.	-
Obtain	Qiagen Buffer EB	-	-	Ambient
	10x Magnetic Separator	230003	See Tips & Best Practices.	Ambient
	Prepare 80% Ethanol Prepare 10 ml for 8 reactions	-	Prepare fresh.	Ambient

4.1 Sample Index PCR



Choose the appropriate sample index sets to ensure that no sample indices overlap in a multiplexed sequencing run. Record the 10x Sample Index name used.

a. Prepare Sample Index PCR Mix.

Sample Index PCR Mix <i>Add reagents in the order listed</i>	PN	1X (μl)	4X + 10% (μl)	8X + 10% (μl)
<input type="radio"/> Amp Mix	2000047/ 2000103	50	220	440
<input checked="" type="radio"/> SI-PCR Primer B	2000128	7.5	33	66
Total	-	57.5	253	506

b. Add 57.5 μl Sample Index PCR Mix to 40 μl sample. Pipette mix and centrifuge briefly.

c. Add 2.5 μl of an individual Single Index N Set A to each sample and record the well ID used. Pipette mix and centrifuge briefly.

d. Incubate in a thermal cycler with the following protocol.

Lid Temperature	Reaction Volume	Run Time
105°C	100 μl	~30 min

Step	Temperature	Time (hh:mm:ss)
1	98°C	00:00:45
2	98°C	00:00:20
3	67°C	00:00:30
4	72°C	00:00:20 Go to step 2, see table below for # cycles
5	72°C	00:01:00
6	4°C	Hold

The table recommends a starting point for cycle number optimization based on Targeted Nuclei Recovery.

Cycle Number Optimization Table

Targeted Nuclei Recovery	Total Cycles
500-2,000	9
2,001-6,000	8
6,001-10,000	7



e. Store at 4°C for up to 72 h or proceed to the next step.

4.2
Post Sample Index
Double Sided Size
Selection – SPRIselect



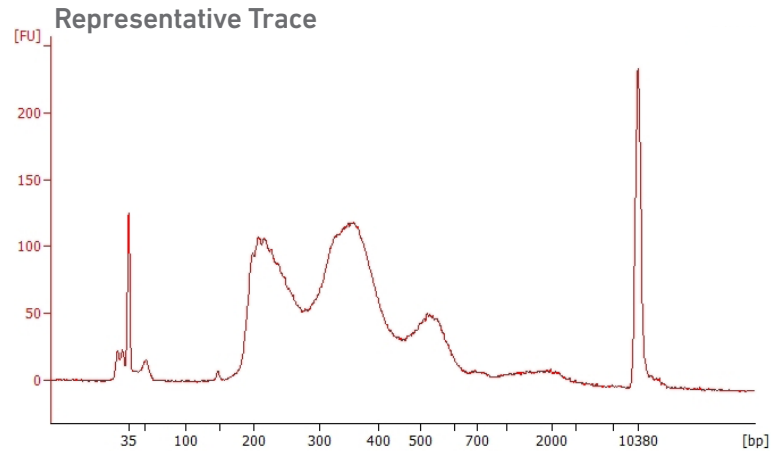
- a. Vortex to resuspend SPRIselect reagent. Add **40 µl** SPRIselect reagent to each sample. Pipette mix thoroughly using a pipette set to 130 µl.
- b. Incubate **5 min** at **room temperature**.
- c. Place on the magnet•**High** until the solution clears. **DO NOT** discard the supernatant.
- d. Transfer **130 µl** supernatant to a new strip tube.
- e. Vortex to resuspend SPRIselect reagent. Add **74 µl** SPRIselect reagent to each sample. Pipette mix thoroughly using a pipette set to 190 µl.
- f. Incubate **5 min** at **room temperature**.
- g. Place on the magnet•**High** until the solution clears.
- h. Remove the supernatant. **DO NOT** discard any beads.
- i. With the tube still on the magnet, add **200 µl** 80% ethanol to the pellet. Wait **30 sec**.
- j. Remove the ethanol.
- k. **Repeat** steps i and j for a total of 2 washes.
- l. Centrifuge briefly. Place on the magnet•**Low**.
- m. Remove remaining ethanol.
- n. Remove from the magnet. **Immediately** add **20.5 µl** Buffer EB. Pipette mix thoroughly using a pipette set to 15 µl.
- o. Incubate **2 min** at **room temperature**.
- p. Centrifuge briefly. Place on the magnet•**Low** until the solution clears.
- q. Transfer **20 µl** sample to a new tube strip.
- r. Store at **4°C** for up to **72 h** or at **-20°C** for **long-term** storage.



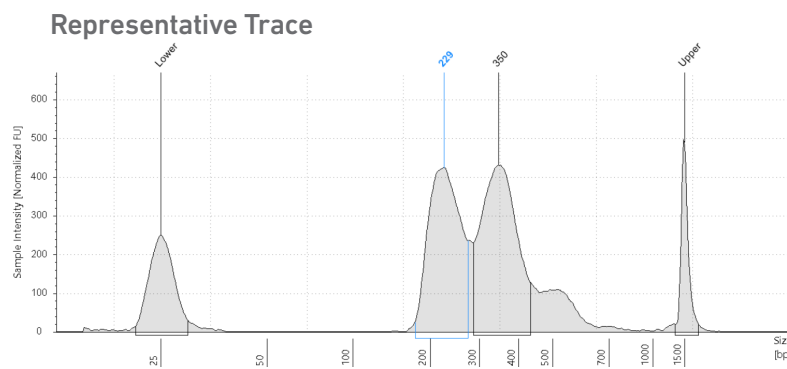
4.3

Post Library Construction
QC

- a. **EITHER** Run 1 μl sample at 1:5 dilution on the Agilent Bioanalyzer High Sensitivity DNA chip to determine fragment size. Lower molecular weight product (≤ 150 bp) and/or a high molecular weight product ($\sim 2,000$ bp) may be present and is normal. This does not affect sequencing.



- b. **OR** Run 2 μl sample on the Agilent TapeStation High Sensitivity D1000 or D5000 ScreenTape to determine fragment size.



4.4

Post Library Construction
Quantification

- a. Thaw KAPA Library Quantification Kit for Illumina® Platforms.
- b. Dilute **1 µl** sample with deionized water to appropriate dilutions that fall within the linear detection range of the KAPA Library Quantification Kit for Illumina® Platforms. (For more accurate quantification, make the dilution(s) in duplicate).
- c. Make enough Quantification Master Mix for the DNA dilutions per sample and the DNA Standards (plus 10% excess) using the guidance for 1 reaction volume below.

Quantification Master Mix	1X (µl)
SYBR Fast Master Mix + Primer	12
Water	4
Total	16

- d. Dispense **16 µl** Quantification Master Mix for sample dilutions and DNA Standards into a 96 well PCR plate.
- e. Add **4 µl** sample dilutions and **4 µl** DNA Standards to appropriate wells. Centrifuge briefly.
- f. Incubate in a thermal cycler with the following protocol.

Step	Temperature	Run Time
1	95°C	00:03:00
2	95°C	00:00:05
3	67°C	00:00:30
4	Go to Step 2, 29X (Total 30 cycles)	

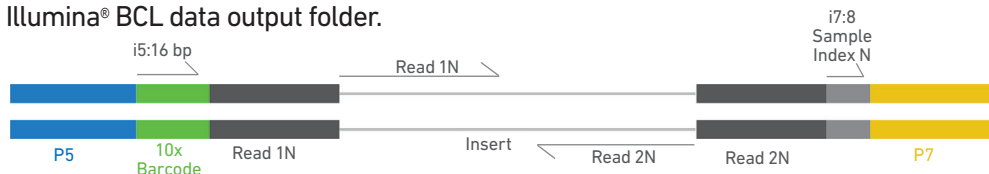
- g. Follow the manufacturer's recommendations for qPCR-based quantification. For library quantification for sequencer clustering, determine the concentration using the average size in the region of 175-1,000 bp.

Sequencing

5

Sequencing Libraries

Chromium Single Cell ATAC libraries comprise double stranded DNA fragments which begin with P5 and end with P7. Sequencing these libraries produces a standard Illumina® BCL data output folder.



The BCL data for Single Cell ATAC libraries include:

- Paired-end Read 1N containing insert sequence only
- Read 2N containing insert sequence, starting from the opposite end of fragment
- 8 bp sample index in the i7 read
- 16 bp 10X barcode sequence in the i5 read

The Cell Ranger scATAC pipeline performs demultiplexing and leverages the 10x Barcodes to group read-pairs and associate them to individual cells for secondary analysis and visualization. In addition to performing standard analysis steps such as alignment, Cell Ranger scATAC leverages the 10x Barcodes to generate chromatin accessibility data with single cell resolution. This enables applications including cell clustering, cell type classification, and differential accessibility at a scale of hundreds to thousands of cells.

Illumina® Sequencer Compatibility

The compatibility of the listed sequencers has been verified by 10x Genomics. Some variation in assay performance is expected based on sequencer choice. For more information about performance variation, visit the 10x Genomics Support website.

- MiSeq™
- NextSeq™ 500/550 (High Output)
- NextSeq™ 1000/2000
- HiSeq 2500™ (Rapid Run)
- HiSeq™ 3000/4000
- NovaSeq™

Sample Indices

Each i7 sample index in the Single Index Plate Kit N Set A (PN-3000427) is a mix of 4 different sequences to balance across all 4 nucleotides. If multiple samples are pooled in a sequence lane, the sample index name (i.e. Single Index Plate N Set A well ID) is needed in the sample sheet used for generating FASTQs with “cellranger-scATAC mkfastq”.

Sequencing Depth & Run Parameters

Sequencing Depth	25,000 read pairs per nucleus (25,000 reads for Read 1N; 25,000 reads for Read 2N)
Sequencing Type	Paired-end, dual indexing
Sequencing Read	Recommended Number of Cycles
Read 1N	50 cycles
i7 Index	8 cycles
i5 Index	16 cycles
Read 2N	50 cycles

Library Loading

Once quantified and normalized, Single Cell ATAC libraries should be denatured and diluted according to the table below. Consult the Technical Note on Sequencing Metrics and Base Composition of Chromium Single Cell ATAC Libraries (Document CG000181), available at the 10x Genomics Support website, for more information.

Instrument	Loading Concentration (pM)	PhiX (%)
MiSeq™	11	1
NextSeq™ 500/550	1.7	1
NextSeq™ 1000/2000	650	1
HiSeq™ 2500 (RR)	11	1
HiSeq™ 4000	180	1
NovaSeq™ 6000	300	1

Library Pooling

Pooling dissimilar libraries may compromise the ability to pool effectively due to differences in insert sizes. **DO NOT** pool Single Cell ATAC libraries with other 10x Genomics libraries.

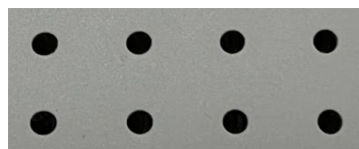
Troubleshooting



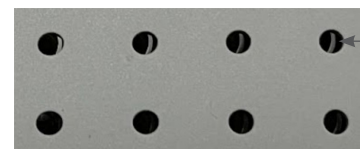
GEM Generation & Barcoding

STEP	NORMAL	IMPACTED
------	--------	----------

2.2
Load Chromium
Next GEM Chip H



Gasket holes are aligned with the sample and gel bead wells.



Misaligned gasket holes & chip wells

Gasket holes are misaligned with the gel bead wells. Open and close the chip holder slowly once.

2.4 d
After Chip H is
removed from the
Controller and the
wells are exposed

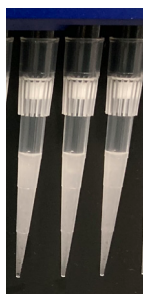


All 8 recovery wells are similar in volume and opacity.

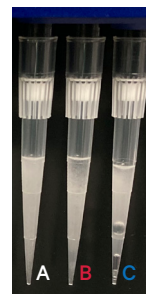


Recovery well G indicates a reagent clog. Recovery well C and E indicate a wetting failure. Recovery wells B, D, and F are normal. Wells A and H contain 50% Glycerol Solution.

2.4 e
Transfer GEMs from
Chip H Recovery
Wells



All liquid levels are similar in volume and opacity without air trapped in the pipette tips.



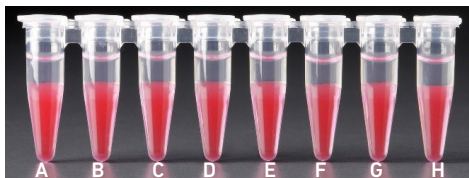
- Adequate emulsion volume (no clog or wetting failure)
- Wetting failure
- Low emulsion volume (clog)

Pipette tip A shows normal GEM generation, pipette tip B indicates a wetting failure, and pipette tip C shows a clog and wetting failure.

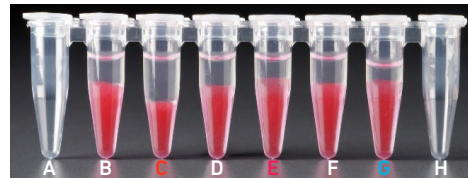
Consult the *Best Practices to Minimize Chromium Next GEM Chip Clogs and Wetting Failures (Technical Note CG000479)* for more information.

STEP	NORMAL	IMPACTED
------	--------	----------

3.1 a
After transfer of the
GEMs +
Recovery Agent



All liquid levels are similar in the aqueous sample volume (clear) and Recovery Agent/Partitioning Oil (pink).



Tube **G** indicates a reagent clog has occurred. There is a decreased volume of aqueous layer (clear).
Tube **C** and **E** indicate a wetting failure has occurred. There is an abnormal volume of Recovery Agent/Partitioning Oil (pink).

3.1 b
After aspiration of
Recovery Agent/
Partitioning Oil



All liquid volumes are similar in the aqueous sample volume (clear) and residual Recovery Agent/Partitioning Oil (pink).



Tube **G** indicates a reagent clog has occurred. There is a decreased volume of aqueous layer (clear). There is also a greater residual volume of Recovery Agent/Partitioning Oil (pink).
Tube **C** and **E** indicate a wetting failure has occurred. There is an abnormal residual volume of Recovery Agent/Partitioning Oil (pink).

3.1 d
After addition of
Dynabeads
Cleanup Mix



All liquid volumes are similar after addition of the Dynabeads Cleanup Mix.



Tube **G** indicates a reagent clog has occurred. There is an abnormal ratio of Dynabeads Cleanup Mix (brown) to Recovery Agent/Partitioning Oil (appears white).
Tube **C** and **E** indicate a wetting failure has occurred. There is an abnormal ratio of Dynabeads Cleanup Mix (brown) to Recovery Agent/Partitioning Oil (appears white).

If a channel clogs or wetting failure occurs during GEM generation, it is recommended that the sample be remade. If any of the listed issues occur, take a picture and send it to support@10xgenomics.com for further assistance.

Chromium Controller Errors

If the Chromium Controller or the Chromium Single Cell Controller fails to start, an error tone will sound and one of the following error messages will be displayed:

- a. **Chip not read – Try again:** Eject the tray, remove and/or reposition the Chromium Next GEM Secondary Holder assembly and try again. If the error message is still received after trying this more than twice, contact support@10xgenomics.com for further assistance.
- b. **Check gasket:** Eject the tray by pressing the eject button to check that the 10x Gasket is correctly installed on the Chromium Next GEM Chip. If the error message persists, try a new gasket. Contact support@10xgenomics.com for further assistance.
- c. **Error Detected: Row _ Pressure:**
 - i. If this message is received within a few seconds of starting a run, eject the tray by pressing the eject button and check for dirt or deposits on the 10x Gasket. If dirt is observed, replace with a new 10x Gasket, open and close the lid to ensure the gasket is properly aligned and try again. If the error message is still received after trying this more than twice, contact support@10xgenomics.com for further assistance.
 - ii. If this message is received after a few minutes into the run, the Chromium Next GEM Chip must be discarded. **Do not try running this Chromium Next GEM Chip again as this may damage the Chromium Controller.**
- d. **Invalid Chip CRC Value:** This indicates that a Chromium Next GEM Chip has been used with an older firmware version. The chip must be discarded. Contact support@10xgenomics.com for further assistance.
- e. **Chip Holder Not Present:** Open the controller drawer and check if chip holder is present. Insert chip properly into chip holder and retry.
- f. **Unauthorized Chip:** This indicates that an incompatible non-Next GEM chip has been used with an instrument that only can run Next GEM assays. Use only Chromium Controller (PN-120223;120246) or Chromium Single Cell Controller (PN-120263;120212) to run that chip or chip must be discarded. Contact support@10xgenomics.com for further assistance.
- g. **Endpoint Reached Early:** If this message is received, contact support@10xgenomics.com for further assistance.

Chromium X Series Errors

The Chromium X touchscreen will guide the user through recoverable errors. If the error continues, or if the instrument has seen critical or intermediate errors, email support@10xgenomics.com with the displayed error code. Support will request a troubleshooting package. Upload pertinent logs to 10x Genomics by navigating to the Logs menu option on screen.

There are two types of errors:

Critical Errors — When the instrument has seen a critical error, the run will immediately abort. Do not proceed with any further runs. Contact support@10xgenomics.com with the error code.

- a. System Error
- b. Pressure Error
- c. Chip Error
- d. Run Error
- e. Temperature Error
- f. Software Error

User Recoverable Errors — Follow error handling instructions through the touchscreen and continue the run.

- a. Gasket Error
- b. Tray Error
- c. Chip Error
- d. Unsupported Chip Error
- e. Update Error



Consult the Chromium X Series (X/iX) User Guide (CG000396) for additional information and follow the Chromium X touchscreen prompts for execution.

Appendix

Oligonucleotide Sequences

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