

SureSelect^{XT HS} Target Enrichment System

**For Illumina Multiplexed
Sequencing Platforms**

Protocol

Version D0, August 2020

**SureSelect platform manufactured with Agilent
SurePrint Technology**

**For Research Use Only. Not for use in diagnostic
procedures.**



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In this Guide...

This guide provides an optimized protocol for preparation of target-enriched Illumina paired-end multiplexed sequencing libraries using SureSelect^{XT HS} Reagent Kits.

The SureSelect^{XT HS} Reagent Kits and protocol are used to prepare indexed library samples with molecular barcodes prior to target enrichment to allow high-sensitivity next-generation sequencing (NGS) on the Illumina platform.

1 Before You Begin

This chapter contains information (such as procedural notes, safety information, required reagents and equipment) that you should read and understand before you start an experiment.

2 Sample Preparation

This chapter describes the steps to prepare indexed, molecular-barcoded gDNA sequencing libraries for target enrichment.

3 Hybridization and Capture

This chapter describes the steps to hybridize and capture the prepared DNA library using a SureSelect or ClearSeq Probe Capture Library.

4 Post-Capture Sample Processing for Multiplexed Sequencing

This chapter describes the steps for post-capture amplification and guidelines for sequencing sample preparation.

5 Appendix: Using FFPE-derived DNA Samples

This chapter describes the protocol modifications for gDNA isolated from FFPE samples.

6 Reference

This chapter contains reference information, including component kit contents and index sequences.

What's New in Version D0

- Support for revised SureSelect custom probe products, produced using an updated manufacturing process beginning August, 2020 (see [Table 3](#) on page 14). Custom probes produced using the legacy manufacturing process are also fully supported by the protocols in this document. Probe nomenclature was updated throughout document.
- Support for separately-purchased SureSelect XT HS Reagent Kits (Agilent p/n G9702A, G9702B or G9702C) and Probes (see [Table 2](#) on page 13 and [Table 3](#) on page 14). Bundled SureSelect XT HS Reagent Kit + Probe products (Agilent p/ns G9704A-S, G9705A-S and G9706A-S) are also supported by the protocols in this document; see [page 90](#) for information on available Reagent Kit + Probe bundles.
- Reorganization of tables in section "[Materials Required](#)" on page 13 to highlight requirements for specific workflow options.
- Updates to thermal cycler recommendations and usage instructions (see *Caution* and [Table 5](#) on page 16, and example usage instructions in [step 2](#) on [page 31](#)).
- Updates to *Materials Required* including updated ordering information for Dynabeads MyOne Streptavidin T1 beads and AMPure XP Kits ([Table 4](#) on page 15) and updated ordering information for Eppendorf ThermoMixer C and Qubit Fluorometer ([Table 5](#) on page 16).
- Updates to "[Optional Materials](#)" on page 19, including removal of ethylene glycol supplier information (see [page 26](#) for related update to DNA shearing set up instructions).
- Updates to Agilent TapeStation 4200/4150 ordering and sample mixing information (see [Table 5](#) on page 16 and see *Caution* on [page 43](#) and [page 65](#)).
- Support for 5200 Fragment Analyzer (see footnote to [Table 5](#) on page 16).

- Support for optional overnight hybridization (see *Note* on [page 49](#)).
- Formulation of 1X Low TE Buffer added to [step 3](#) on [page 22](#).
- Update to instructions in [step 3](#) on [page 53](#) to include brief spin when washes mixed by vortexing.
- Updates to Technical Support contact information (see [page 2](#))
- Updates to *Notice to Purchaser* (see [page 2](#)).

Content

1	Before You Begin	9
	Overview of the Workflow	10
	Procedural Notes	12
	Safety Notes	12
	Materials Required	13
	Optional Materials	19
2	Sample Preparation	21
	Step 1. Prepare and analyze quality of genomic DNA samples	22
	Step 2. Shear the DNA	26
	Step 3. Repair and dA-Tail the DNA ends	29
	Step 4. Ligate the molecular-barcoded adaptor	33
	Step 5. Purify the sample using AMPure XP beads	34
	Step 6. Amplify the adaptor-ligated library	36
	Step 7. Purify the amplified library with AMPure XP beads	39
	Step 8. Assess quality and quantity	41
3	Hybridization and Capture	47
	Step 1. Hybridize DNA samples to the probe	48
	Step 2. Prepare streptavidin-coated magnetic beads	53
	Step 3. Capture the hybridized DNA using streptavidin-coated beads	54

4	Post-Capture Sample Processing for Multiplexed Sequencing	57
	Step 1. Amplify the captured libraries	58
	Step 2. Purify the amplified captured libraries using AMPure XP beads	61
	Step 3. Assess sequencing library DNA quantity and quality	63
	Step 4. Pool samples for multiplexed sequencing	68
	Step 5. Prepare sequencing samples	70
	Step 6. Do the sequencing run and analyze the data	73
	Sequence analysis resources	80
5	Appendix: Using FFPE-derived DNA Samples	83
	Protocol modifications for FFPE Samples	84
	Methods for FFPE Sample Qualification	84
	Sequencing Output Recommendations for FFPE Samples	85
6	Reference	87
	Kit Contents	88
	Nucleotide Sequences of SureSelect XT HS Indexes	91
	Troubleshooting Guide	92
	Quick Reference Protocol	96



1

Before You Begin

Overview of the Workflow	10
Procedural Notes	12
Safety Notes	12
Materials Required	13
Optional Materials	19

Make sure you have the most current protocol. Go to agilent.com and search for G9702-90000.

To prepare libraries for Agilent SureSelect Cancer All-In-One assays, use the protocols detailed in this publication, while implementing the considerations provided in the SureSelect Cancer All-In-One Target Enrichment Product Overview Guide (publication [G9702-90100](#)).

Make sure you read and understand the information in this chapter and have the necessary equipment and reagents listed before you start an experiment.

NOTE

This protocol differs from the Illumina Multiplexed Paired-End sequencing manual and other SureSelect protocols at several steps. Pay close attention to the primers used for each amplification step and the blocking agents used during hybridization.

NOTE

Agilent guarantees performance and provides technical support for the SureSelect reagents required for this workflow only when used as directed in this Protocol.



Overview of the Workflow

The SureSelect^{XT HS} target enrichment workflow is summarized in [Figure 1](#). The estimated time requirements for each step are summarized in [Table 1](#).

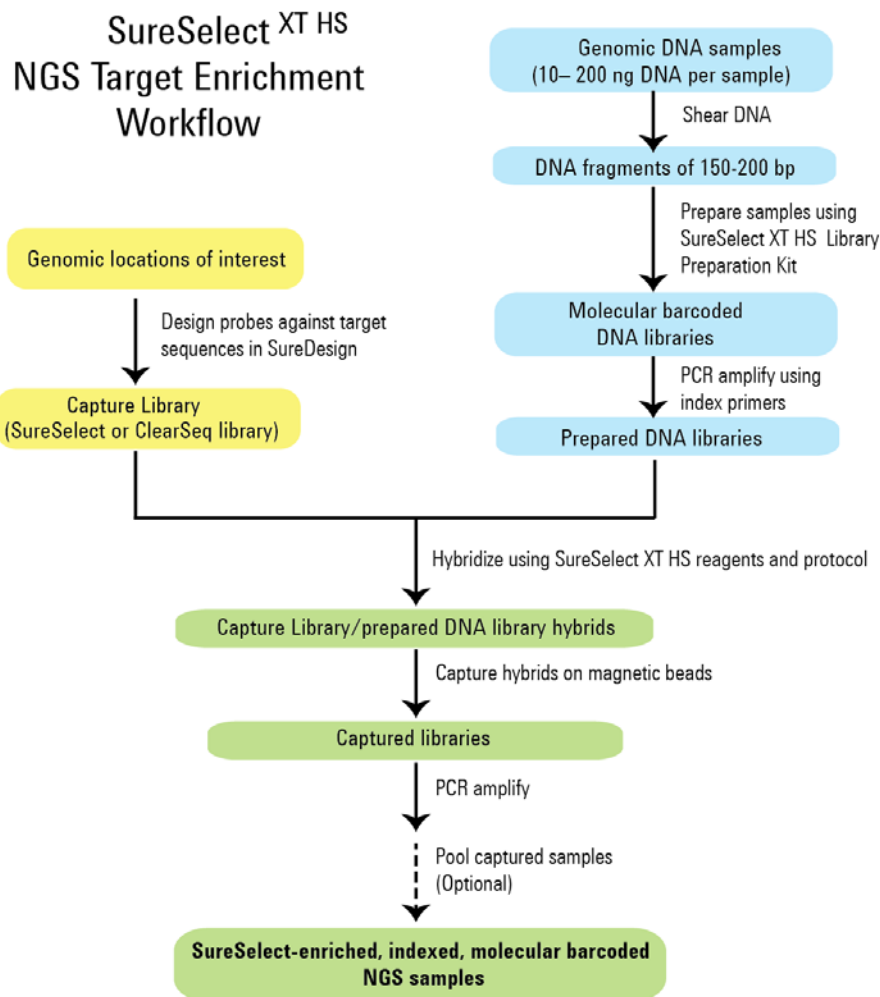


Figure 1 Overall target-enriched sequencing sample preparation workflow.

Table 1 Estimated time requirements (up to 16 sample run size)

Step	Time
Library Preparation	3.5 hours
Hybridization and Capture	3.5 hours
Post-capture amplification	1 hour
QC using Bioanalyzer or TapeStation platform and sample pooling	1.5 hours

Procedural Notes

- To prevent contamination of reagents by nucleases, always wear powder-free laboratory gloves and use dedicated solutions and pipettors with nuclease-free aerosol-resistant tips.
- Use best-practices to prevent PCR product contamination of samples throughout the workflow:
 - 1 Assign separate pre-PCR and post-PCR work areas and use dedicated equipment, supplies, and reagents in each area. In particular, never use materials designated to post-PCR work areas for pre-PCR segments of the workflow.
 - 2 Maintain clean work areas. Clean pre-PCR surfaces that pose the highest risk of contamination daily using a 10% bleach solution, or equivalent.
 - 3 Always use dedicated pre-PCR pipettors with nuclease-free aerosol-resistant tips to pipette dedicated pre-PCR solutions.
 - 4 Wear powder-free gloves. Use good laboratory hygiene, including changing gloves after contact with any potentially-contaminated surfaces.
- For each protocol step that requires removal of tube cap strips, reseal the tubes with a fresh strip of domed caps. Cap deformation may result from exposure of the cap strips to the heated lid of the thermal cycler and from other procedural steps. Reuse of strip caps can cause sample loss, sample contamination, or imprecision in sample temperatures during thermal cycler incubation steps.
- In general, follow Biosafety Level 1 (BL1) safety rules.
- Possible stopping points, where samples may be stored at -20°C , are marked in the protocol. Do not subject the samples to multiple freeze/thaw cycles.

Safety Notes

CAUTION

- Wear appropriate personal protective equipment (PPE) when working in the laboratory.

Materials Required

Materials required to complete the SureSelect XT HS protocol will vary based on the following considerations:

- DNA sample type: high-quality gDNA derived from fresh/fresh-frozen samples vs. FFPE-derived gDNA samples
- DNA fragmentation method used in workflow: mechanical (Covaris-mediated) shearing vs. enzymatic fragmentation

To determine the materials required for your workflow, first select the preferred SureSelect XT HS Reagent Kit format from [Table 2](#) below and a compatible target enrichment Probe from [Table 3](#) on page 14. Then refer to [Table 4](#) through [Table 6](#) for additional materials needed to complete the protocols according to your DNA sample type/fragmentation method.

Table 2 SureSelect XT HS Reagent Kit Varieties

Description	Kit Part Number	
	16 Reaction Kit*	96 Reaction Kit†
SureSelect XT HS Reagent Kit for Illumina (ILM) platform‡	G9702A (with Index Primers 1–16)	G9702C (with Index Primers 1–32)**
	G9702B (with Index Primers 17–32)	

* 16-reaction kits contain enough reagents for 2 runs containing 8 samples per run.

† 96-reaction kits contain enough reagents for 4 runs containing 24 samples per run.

‡ Compatible with HiSeq, MiSeq, NextSeq 500, and NovaSeq 6000 platforms.

** Includes 3 single-reaction vials of each index primer 1–32, for a total of 96 library preparations.

1 Before You Begin

Materials Required

Table 3 Compatible Probes *

Probe Capture Library	16 Reactions	96 Reactions
Pre-designed Probes		
SSel XT HS and XT Low Input Human All Exon V7	5191-4028	5191-4029
SureSelect XT Human All Exon V6	5190-8863	5190-8864
SureSelect XT Human All Exon V6 + UTRs	5190-8881	5190-8882
SureSelect XT Clinical Research Exome V2	5190-9491	5190-9492
ClearSeq Comprehensive Cancer XT	5190-8011	5190-8012
Custom Probes [†]		
SureSelect Custom Tier1 1–499 kb	Please visit the SureDesign website to design Custom SureSelect probes and obtain ordering information. Contact the SureSelect support team (see page 2) or your local representative if you need assistance. Custom probes are also available in 480 Reaction size.	
SureSelect Custom Tier2 0.5 –2.9 Mb		
SureSelect Custom Tier3 3 –5.9 Mb		
SureSelect Custom Tier4 6 –11.9 Mb		
SureSelect Custom Tier5 12–24 Mb		
Pre-designed Probes customized with additional <i>Plus</i> custom content		
SSel XT HS and XT Low Input Human All Exon V7 Plus 1	Please visit the SureDesign website to design the customized <i>Plus</i> content and obtain ordering information. Contact the SureSelect support team (see page 2) or your local representative if you need assistance.	
SSel XT HS and XT Low Input Human All Exon V7 Plus 2		
SureSelect XT Human All Exon V6 Plus 1		
SureSelect XT Human All Exon V6 Plus 2		
SureSelect XT Clinical Research Exome V2 Plus 1		
SureSelect XT Clinical Research Exome V2 Plus 2		

* Protocols in this document are also compatible with bundled SureSelect XT HS Reagent Kits + Target Enrichment Probes, ordered using p/n G9704A-S, G9705A-S, and G9706A-S. See [page 90](#) for more information.

† Custom Probes designed August 2020 or later are produced using an updated manufacturing process; design size Tier is shown on labeling for these products. Custom Probes designed and ordered prior to August 2020 may be reordered, with these probes produced using the legacy manufacturing process; design-size Tier is not shown on labeling for the legacy-process products. Custom Probes of both categories use the same optimized target enrichment protocols detailed in this publication.

Table 4 Required Reagents--All Sample Types/Fragmentation Methods

Description	Vendor and part number
AMPure XP Kit	Beckman Coulter Genomics
5 ml	p/n A63880
60 ml	p/n A63881
450 ml	p/n A63882
Dynabeads MyOne Streptavidin T1	Thermo Fisher Scientific
2 ml	p/n 65601
10 ml	p/n 65602
50 ml	p/n 65604D
1X Low TE Buffer (10 mM Tris-HCl, pH 7.5-8.0, 0.1 mM EDTA)	Thermo Fisher Scientific p/n 12090-015, or equivalent
100% Ethanol (Ethyl Alcohol, 200 proof)	Millipore p/n EX0276
Qubit BR dsDNA Assay Kit	Thermo Fisher Scientific
100 assays	p/n Q32850
500 assays	p/n Q32853
Nuclease-free Water (not DEPC-treated)	Thermo Fisher Scientific p/n AM9930

1 Before You Begin

Materials Required

CAUTION

Sample volumes exceed 0.2 ml in certain steps of this protocol. Make sure that the plasticware used with the selected thermal cycler holds ≥ 0.25 ml per well.

Table 5 Required Equipment--All Sample Types/Fragmentation Methods

Description	Vendor and part number
Thermal Cycler with 96-well, 0.2 ml block	Various suppliers
Plasticware compatible with the selected thermal cycler: 96-well plates or 8-well strip tubes Tube cap strips, domed	Consult the thermal cycler manufacturer's recommendations
Qubit Fluorometer	Thermo Fisher Scientific p/n Q33238
Qubit Assay Tubes	Thermo Fisher Scientific p/n Q32856
DNA LoBind Tubes, 1.5-ml PCR clean, 250 pieces	Eppendorf p/n 022431021 or equivalent
Microcentrifuge	Eppendorf microcentrifuge, model 5417C or equivalent
Plate or strip tube centrifuge	Labnet International MPS1000 Mini Plate Spinner, p/n C1000 (requires adapter, p/n C1000-ADAPT, for use with strip tubes) or equivalent
96-well plate mixer	Eppendorf ThermoMixer C, p/n 5382000023 and Eppendorf SmartBlock 96 PCR, p/n 5306000006, or equivalent
Multichannel pipette	Rainin Pipet-Lite Multi Pipette or equivalent
Single channel pipettes (10-, 20-, 200-, and 1000- μ l capacity)	Rainin Pipet-Lite Pipettes or equivalent
Sterile, nuclease-free aerosol barrier pipette tips	general laboratory supplier
Vortex mixer	general laboratory supplier

Table 5 Required Equipment--All Sample Types/Fragmentation Methods

Description	Vendor and part number
DNA Analysis Platform and Consumables*	
Agilent 2100 Bioanalyzer Instrument	Agilent p/n G2939BA
Agilent 2100 Expert SW Laptop Bundle (optional)	Agilent p/n G2953CA
DNA 1000 Kit	Agilent p/n 5067-1504
High Sensitivity DNA Kit	Agilent p/n 5067-4626
OR	
Agilent 4200/4150 TapeStation	Agilent p/n G2991AA/G2992AA
96-well sample plates	Agilent p/n 5042-8502
96-well plate foil seals	Agilent p/n 5067-5154
8-well tube strips	Agilent p/n 401428
8-well tube strip caps	Agilent p/n 401425
D1000 ScreenTape	Agilent p/n 5067-5582
D1000 Reagents	Agilent p/n 5067-5583
High Sensitivity D1000 ScreenTape	Agilent p/n 5067-5584
High Sensitivity D1000 Reagents	Agilent p/n 5067-5585
Magnetic separator	Thermo Fisher Scientific p/n 12331D or equivalent†
Ice bucket	general laboratory supplier
Powder-free gloves	general laboratory supplier

* DNA samples may also be analyzed using the Agilent 5200 Fragment Analyzer, p/n M5310AA, and associated NGS Fragment Kits (DNF-473-0500 and DNF-474-0500). Implement any sample dilution instructions provided in protocols in this document, and then follow the assay instructions provided for each NGS Fragment Kit.

† Select a magnetic separator configured to collect magnetic particles on one side of each well. Do not use a magnetic separator configured to collect the particles in a ring formation.

1 Before You Begin

Materials Required

Table 6 Additional Required Materials based on DNA Sample Type/Fragmentation Method

Description	Vendor and Part Number
Required for preparation of high-quality DNA samples (not required for FFPE DNA sample preparation)	
High-quality gDNA purification system, for example:	
QIAamp DNA Mini Kit	Qiagen
50 Samples	p/n 51304
250 Samples	p/n 51306
Required for preparation of FFPE DNA samples (not required for high-quality DNA sample preparation)	
QIAamp DNA FFPE Tissue Kit, 50 Samples	Qiagen p/n 56404
Deparaffinization Solution	Qiagen p/n 19093
FFPE DNA integrity assessment system:	
Agilent NGS FFPE QC Kit	Agilent
16 reactions	p/n G9700A
96 reactions	p/n G9700B
OR	
TapeStation Genomic DNA Analysis Consumables:	Agilent
Genomic DNA ScreenTape	p/n 5067-5365
Genomic DNA Reagents	p/n 5067-5366
Required for mechanical shearing of DNA samples (not required for workflows with enzymatic fragmentation)	
Covaris Sample Preparation System	Covaris model E220
Covaris microTUBE sample holders	Covaris p/n 520045
Required for enzymatic fragmentation of DNA samples* (not required for workflows with mechanical shearing)	
SureSelect Enzymatic Fragmentation Kit	Agilent
	p/n 5191-4079 (16 reactions)
	p/n 5191-4080 (96 reactions)

* See Agilent publication [G9702-90050](#) for the enzymatic fragmentation protocol (not provided in this publication).

Optional Materials

Table 7 Supplier Information for Optional Materials

Description	Vendor and Part Number	Purpose
Tween 20	Sigma-Aldrich p/n P9416-50ML	Sequencing library storage (see page 69)
Optical Caps, 8× strip (flat)	Consult the thermal cycler manufacturer's recommendations	Sealing wells for protocol steps performed outside of the thermal cycler*
MicroAmp Clear Adhesive Film	Thermo Fisher Scientific p/n 4311971	Improved sealing for flat strip caps*
PlateLoc Thermal Microplate Sealer with Small Hotplate and Peelable Aluminum Seal for PlateLoc Sealer	Please contact the SureSelect support team (see page 2) or your local representative for ordering information	Sealing wells for protocol steps performed inside or outside of the thermal cycler

* Flat strip caps may be used instead of domed strip caps for protocol steps performed outside of the thermal cycler. Adhesive film may be applied over the flat strip caps for improved sealing properties.

1 Before You Begin

Optional Materials



2 Sample Preparation

- Step 1. Prepare and analyze quality of genomic DNA samples 22
- Step 2. Shear the DNA 26
- Step 3. Repair and dA-Tail the DNA ends 29
- Step 4. Ligate the molecular-barcoded adaptor 33
- Step 5. Purify the sample using AMPure XP beads 34
- Step 6. Amplify the adaptor-ligated library 36
- Step 7. Purify the amplified library with AMPure XP beads 39
- Step 8. Assess quality and quantity 41

The sample preparation protocol is used to prepare DNA libraries for sequencing using the Illumina paired-read platform. For each sample to be sequenced, an individual indexed and molecular-barcoded library is prepared. For an overview of the SureSelect^{XT} HS target enrichment workflow, see [Figure 1](#) on page 10.

The library preparation protocol is compatible with both high-quality gDNA prepared from fresh or fresh frozen samples and lower-quality DNA prepared from FFPE samples. Modifications required for FFPE samples are included throughout the protocol steps. For a summary of modifications for FFPE samples see [Chapter 5](#), “Appendix: Using FFPE-derived DNA Samples” on [page 83](#).

The protocol requires 10 ng to 200 ng of input DNA, with adjustments to DNA input amount or quantification method required for some FFPE samples. For optimal sequencing results, use the maximum amount of input DNA available within the recommended range.

This protocol includes DNA fragmentation by mechanical shearing. As an alternative, Agilent offers reagents and protocols for enzymatic DNA fragmentation prior to SureSelect^{XT} HS library preparation (see Agilent publication [G9702-90050](#) for details). If you have enzymatically-fragmented DNA ready for use, proceed directly to “[Step 3. Repair and dA-Tail the DNA ends](#)” on page 29.



2 Sample Preparation

Step 1. Prepare and analyze quality of genomic DNA samples

Step 1. Prepare and analyze quality of genomic DNA samples

NOTE

Instructions in this section are used to prepare gDNA samples for mechanical shearing. To instead prepare input gDNA for enzymatic fragmentation, follow the sample preparation instructions provided in the [SureSelect Enzymatic Fragmentation Kit Protocol \(publication G9702-90050\)](#).

NOTE

If you are preparing DNA samples for an Agilent SureSelect Cancer All-In-One assay, use the following modifications to the gDNA sample preparation instructions in this section:

- Where required for your experimental design, make sure to prepare reference DNA sample(s) alongside your experimental samples
- Use at least 50 ng input gDNA for best results

See publication [G9702-90100](#) for more information.

Preparation of high-quality gDNA from fresh biological samples

- 1 Prepare high-quality gDNA using a suitable purification system, such as Qiagen's QIAamp DNA Mini Kit, following the manufacturer's protocol.

NOTE

Make sure genomic DNA samples are of high quality with an OD 260/280 ratio ranging from 1.8 to 2.0.

- 2 Use the Qubit BR dsDNA Assay Kit to determine the concentration of each gDNA sample. Follow the manufacturer's instructions for the instrument and assay kit.
- 3 Prepare each DNA sample for the library preparation protocol by diluting 10 ng to 200 ng gDNA with 1X Low TE Buffer (10 mM Tris-HCl, pH 7.5-8.0, 0.1 mM EDTA) to a final volume of 50 µl. Vortex well to mix, then spin briefly to collect the liquid. Keep the samples on ice.

Additional qualification of DNA samples is not required for DNA derived from fresh biological samples. Proceed to “[Step 2. Shear the DNA](#)” on page 26.

Preparation and qualification of gDNA from FFPE samples

- 1 Prepare gDNA from FFPE tissue sections using Qiagen's QIAamp DNA FFPE Tissue Kit and Qiagen's Deparaffinization Solution, following the manufacturer's protocol. Elute the final gDNA samples from the MinElute column in two rounds, using 30 µl Buffer ATE in each round, for a final elution volume of approximately 60 µl.

NOTE

If tissue lysis appears incomplete after one hour of digestion with Proteinase K, add an additional 10 µl of Proteinase K and continue incubating at 56°C, with periodic mixing, for up to three hours.

Store the gDNA samples on ice for same-day library preparation, or at -20°C for later processing.

- 2 Assess the quality (DNA integrity) for each FFPE DNA sample using one of the methods below.

Option 1: Qualification using the Agilent NGS FFPE QC Kit (Recommended Method)

The Agilent NGS FFPE QC Kit provides a qPCR-based assay for DNA sample integrity determination. Results include a $\Delta\Delta C_q$ DNA integrity score and the precise quantity of amplifiable DNA in the sample, allowing direct normalization of DNA input for each sample. DNA input recommendations based on $\Delta\Delta C_q$ scores for individual samples are summarized in Table 8.

- a Use the Qubit BR dsDNA Assay Kit to determine the concentration of each gDNA sample. Follow the manufacturer's instructions for the instrument and assay kit.
- b Remove a 1 µl aliquot of the FFPE gDNA sample for analysis using the Agilent NGS FFPE QC Kit to determine the $\Delta\Delta C_q$ DNA integrity score. See the kit user manual at www.agilent.com for more information.
- c For all samples with $\Delta\Delta C_q$ DNA integrity score ≤ 1 , use the Qubit-based gDNA concentration determined in step a, above, to determine volume of input DNA needed for the protocol.

2 Sample Preparation

Step 1. Prepare and analyze quality of genomic DNA samples

- d For all samples with $\Delta\Delta Cq$ DNA integrity score >1 , use the qPCR-based concentration of amplifiable gDNA, reported by the Agilent NGS FFPE QC Kit results, to determine amounts of input DNA for the protocol.

Table 8 SureSelect XT HS DNA input modifications based on $\Delta\Delta Cq$ DNA integrity score

Protocol Parameter	non-FFPE Samples	FFPE Samples	
		$\Delta\Delta Cq \leq 1^*$	$\Delta\Delta Cq > 1$
DNA input for Library Preparation	10 ng to 200 ng DNA, based on Qubit Assay	10 ng to 200 ng DNA, based on Qubit Assay	10 ng to 200 ng of amplifiable DNA, based on qPCR quantification

* FFPE samples with $\Delta\Delta Cq$ scores ≤ 1 should be treated like non-FFPE samples for DNA input amount determinations. For samples of this type, make sure to use the DNA concentration determined by the Qubit Assay, instead of the concentration determined by qPCR, to calculate the volume required for 10–200 ng DNA.

Option 2: Qualification using Agilent's Genomic DNA ScreenTape assay DIN score

Agilent's Genomic DNA ScreenTape assay, used in conjunction with Agilent's TapeStation instrument, provides a quantitative electrophoretic assay for DNA sample integrity determination. This assay reports a DNA Integrity Number (DIN) score for each sample which is used to estimate the appropriate normalization of DNA input required for low-integrity DNA samples.

- a Use the Qubit BR dsDNA Assay Kit to determine the concentration of each gDNA sample. Follow the manufacturer's instructions for the instrument and assay kit.
- b Remove a 1 μ l aliquot of the FFPE gDNA sample and analyze using the Genomic DNA ScreenTape assay. See the user manual at www.agilent.com for more information.

Step 1. Prepare and analyze quality of genomic DNA samples

- c Using the DIN score reported for each sample in the Genomic DNA ScreenTape assay, consult [Table 9](#) to determine the recommended amount of input DNA for the sample.

Table 9 SureSelect XT HS DNA input modifications based on DNA Integrity Number (DIN) score

Protocol Parameter	non-FFPE Samples	FFPE Samples		
		DIN > 8*	DIN 3–8	DIN < 3
DNA input for Library Preparation	10 ng to 200 ng DNA, quantified by Qubit Assay	10 ng to 200 ng DNA, quantified by Qubit Assay	Use at least 15 ng for more intact samples and at least 40 ng for less intact samples. Use the maximum amount of DNA available, up to 200 ng, for all samples. Quantify by Qubit Assay.	Use at least 50 ng for more intact samples and at least 100 ng for the least intact samples. Use the maximum amount of DNA available, up to 200 ng, for all samples. Quantify by Qubit Assay.

* FFPE samples with DIN > 8 should be treated like non-FFPE samples for DNA input amount determinations.

- 3 Prepare each FFPE DNA sample for the library preparation protocol by diluting the appropriate amount of gDNA with 1X Low TE Buffer to a final volume of 50 µl. See [Table 8](#) or [Table 9](#) above for FFPE DNA input guidelines based on the measured DNA quality in each sample. Vortex each sample dilution to mix, then spin briefly to collect the liquid. Keep the samples on ice.

Step 2. Shear the DNA

NOTE

The DNA shearing steps in this section may be replaced by enzymatic DNA fragmentation, using Agilent's SureSelect Enzymatic Fragmentation Kit (see Protocol publication [G9702-90050](#) for details).

In this step, the 50- μ l gDNA samples are sheared using conditions optimized for either high-quality or FFPE DNA. The target DNA fragment size is 150 to 200 bp.

NOTE

This protocol has been optimized using a Covaris model E220 instrument and the 130- μ l Covaris microTUBE for a target DNA fragment size of 150 to 200 bp. If you wish to use a different Covaris instrument model/sample holder or if your NGS workflow requires a different DNA fragment size (e.g., for translocation detection with the SureSelect Cancer All-In-One assay), consult the manufacturer's recommendations for shearing conditions for the recommended DNA fragment size.

- 1** Set up the Covaris E220 instrument. Refer to the Covaris instrument user guide for details.
 - a** Check that the water in the Covaris tank is filled with fresh deionized water to the appropriate fill line level according to the manufacturer's recommendations for the specific instrument model and sample tube or plate in use.
 - b** Check that the water covers the visible glass part of the tube.
 - c** On the instrument control panel, push the Degas button. Degas the instrument according to the manufacturer's recommendations, typically 30–60 minutes.
 - d** Set the chiller temperature to between 2°C to 5°C to ensure that the temperature reading in the water bath displays 5°C. Consult the manufacturer's recommendations for addition of coolant fluids to prevent freezing.

- 2 Complete the DNA shearing steps below for each of the gDNA samples. Each high-quality DNA sample or FFPE DNA sample should contain 10–200 ng gDNA (adjusted as required for DNA integrity) in 50 µl of 1X Low TE Buffer.

NOTE

Do not dilute samples to be sheared using water. Shearing samples in water reduces the overall library preparation yield and complexity.

- a Transfer the 50-µl DNA sample into a Covaris microTUBE, using a tapered pipette tip to slowly transfer the sample through the pre-split septum of the cap.
- b Spin the microTUBE for 30 seconds to collect the liquid and to remove any bubbles from the bottom of the tube.
- c Secure the microTUBE in the tube holder and shear the DNA with the settings in [Table 10](#).

Table 10 Shear settings for Covaris E-series instrument (SonoLab software v7 or later)

Setting	High-quality DNA	FFPE DNA
Duty Factor	10%	10%
Peak Incident Power (PIP)	175	175
Cycles per Burst	200	200
Treatment Time	2 × 120 seconds	240 seconds
Bath Temperature	2° to 8° C	2° to 8° C

Use the steps below for two-round shearing of **high-quality DNA samples only**:

- Shear for 120 seconds
- Spin the microTUBE for 10 seconds
- Vortex the microTUBE at high speed for 5 seconds
- Spin the microTUBE for 10 seconds
- Shear for additional 120 seconds
- Spin the microTUBE for 10 seconds
- Vortex the microTUBE at high speed for 5 seconds
- Spin the microTUBE for 10 seconds

2 Sample Preparation

Step 2. Shear the DNA

- d** After completing the shearing step(s), put the Covaris microTUBE back into the loading and unloading station.
- e** While keeping the snap-cap on, insert a pipette tip through the pre-split septum, then slowly remove the sheared DNA.
- f** Transfer the sheared DNA sample (approximately 50 µl) to a 96-well plate or strip tube sample well. Keep the samples on ice.
- g** After transferring the DNA sample, spin the microTUBE briefly to collect any residual sample volume. Transfer any additional collected liquid to the sample well used in [step f](#).

NOTE

It is important to avoid loss of input DNA at this step, especially for low-abundance DNA samples. Visually inspect the microTUBE to ensure that all of the sample has been transferred. If droplets remain in the microTUBE, repeat [step g](#).

Step 3. Repair and dA-Tail the DNA ends

The NGS library preparation protocol that begins here can be used for fragmented DNA samples produced by mechanical shearing (as detailed on [page 22](#) to [page 28](#)) or produced by enzymatic fragmentation (as detailed in publication [G9702-90050](#)). Samples produced by either method should contain 10–200 ng of DNA fragments in a volume of 50 µl.

This step uses the components listed in [Table 11](#). Thaw and mix each component as directed in [Table 11](#) before use.

Remove the AMPure XP beads from cold storage and equilibrate to room temperature in preparation for use on [page 34](#).

Table 11 Reagents thawed before use in protocol

Kit Component	Storage Location	Thawing Conditions	Mixing Method	Where Used
End Repair-A Tailing Buffer (yellow cap or bottle)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR),* –20°C	Thaw on ice (may require >20 minutes) then keep on ice	Vortexing	page 31
Ligation Buffer (purple cap or bottle)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR),* –20°C	Thaw on ice (may require >20 minutes) then keep on ice	Vortexing	page 30
End Repair-A Tailing Enzyme Mix (orange cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR),* –20°C	Place on ice just before use	Inversion	page 31
T4 DNA Ligase (blue cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR),* –20°C	Place on ice just before use	Inversion	page 30
Adaptor Oligo Mix (white cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR),* –20°C	Thaw on ice then keep on ice	Vortexing	page 33

* May also be labeled as *SureSelect XT HS and XT Low Input Library Preparation Kit for ILM (Pre PCR)*.

To process multiple samples, prepare reagent mixtures with overage at each step, without the DNA sample. Mixtures for preparation of 8 samples and 24 samples (including excess) are shown in each table as examples.

2 Sample Preparation

Step 3. Repair and dA-Tail the DNA ends

1 Before starting the end-repair protocol, prepare the Ligation master mix to allow equilibration to room temperature before use.

- a Vortex the thawed vial of Ligation Buffer for 15 seconds at high speed to ensure homogeneity.

CAUTION

The Ligation Buffer used in this step is viscous. Mix thoroughly by vortexing at high speed for 15 seconds before removing an aliquot for use. When combining with other reagents, mix well by pipetting up and down 15–20 times using a pipette set to at least 80% of the mixture volume or by vortexing at high speed for 10–20 seconds.

Use a flat-top vortex mixer when vortexing strip tubes or plates throughout the protocol. When reagents are mixed by vortexing, visually verify that adequate mixing is occurring.

- b Prepare the appropriate volume of Ligation master mix by combining the reagents in [Table 12](#).

Slowly pipette the Ligation Buffer into a 1.5-ml Eppendorf tube, ensuring that the full volume is dispensed. Slowly add the T4 DNA Ligase, rinsing the enzyme tip with buffer solution after addition. Mix well by slowly pipetting up and down 15–20 times or seal the tube and vortex at high speed for 10–20 seconds. Spin briefly to collect the liquid.

Keep at room temperature for 30–45 minutes before use on [page 33](#).

Table 12 Preparation of Ligation master mix

Reagent	Volume for 1 reaction	Volume for 8 reactions* (includes excess)	Volume for 24 reactions† (includes excess)
Ligation Buffer (purple cap or bottle)	23 µl	207 µl	575 µl
T4 DNA Ligase (blue cap)	2 µl	18 µl	50 µl
Total	25 µl	225 µl	625 µl

* The minimum supported run size for 16-reaction kits is 8 samples per run, with kits containing enough reagents for 2 runs of 8 samples each.

† The minimum supported run size for 96-reaction kits is 24 samples per run, with kits containing enough reagents for 4 runs of 24 samples each.

- 2 Preprogram a thermal cycler (with the heated lid ON) with the program in [Table 13](#) for the End Repair and dA-Tailing steps. Immediately pause the program, and keep paused until samples are loaded in [step 6](#).

Table 13 Thermal cycler program for End Repair/dA-Tailing *

Step	Temperature	Time
Step 1	20°C	15 minutes
Step 2	72°C	15 minutes
Step 3	4°C	Hold

* Use a reaction volume setting of 70 μ l, if required for thermal cycler set up.

- 3 Vortex the thawed vial of End Repair-A Tailing Buffer for 15 seconds at high speed to ensure homogeneity. Visually inspect the solution; if any solids are observed, continue vortexing until all solids are dissolved.

CAUTION

The End Repair-A Tailing Buffer used in this step must be mixed thoroughly by vortexing at high speed for 15 seconds before removing an aliquot for use. When combining with other reagents, mix well either by pipetting up and down 15–20 times using a pipette set to at least 80% of the mixture volume or by vortexing at high speed for 5–10 seconds.

- 4 Prepare the appropriate volume of End Repair/dA-Tailing master mix, by combining the reagents in [Table 14](#).

Slowly pipette the End Repair-A Tailing Buffer into a 1.5-ml Eppendorf tube, ensuring that the full volume is dispensed. Slowly add the End Repair-A Tailing Enzyme Mix, rinsing the enzyme tip with buffer solution after addition. Mix well by pipetting up and down 15–20 times or seal the tube and vortex at high speed for 5–10 seconds. Spin briefly to collect the liquid and keep on ice.

Table 14 Preparation of End Repair/dA-Tailing master mix

Reagent	Volume for 1 reaction	Volume for 8 reactions (includes excess)	Volume for 24 reactions (includes excess)
End Repair-A Tailing Buffer (yellow cap or bottle)	16 μ l	144 μ l	400 μ l
End Repair-A Tailing Enzyme Mix (orange cap)	4 μ l	36 μ l	100 μ l
Total	20 μl	180 μl	500 μl

2 Sample Preparation

Step 3. Repair and dA-Tail the DNA ends

- 5 Add 20 µl of the End Repair/dA-Tailing master mix to each sample well containing approximately 50 µl of fragmented DNA. Mix by pipetting up and down 15–20 times using a pipette set to 60 µl or cap the wells and vortex at high speed for 5–10 seconds.
- 6 Briefly spin the samples, then immediately place the plate or strip tube in the thermal cycler and resume the thermal cycling program in [Table 13](#).

Step 4. Ligate the molecular-barcoded adaptor

- 1 Once the thermal cycler reaches the 4°C Hold step, transfer the samples to ice while setting up this step.
- 2 Preprogram a thermal cycler (with the heated lid ON) for the Ligation step with the program in [Table 15](#). Immediately pause the program, and keep paused until samples are loaded in [step 5](#).

Table 15 Thermal cycler program for Ligation*

Step	Temperature	Time
Step 1	20°C	30 minutes
Step 2	4°C	Hold

* Use a reaction volume setting of 100 µl, if required for thermal cycler set up.

- 3 To each end-repaired/dA-tailed DNA sample (approximately 70 µl), add 25 µl of the Ligation master mix that was prepared on [page 30](#) and kept at room temperature. Mix by pipetting up and down at least 10 times using a pipette set to 85 µl or cap the wells and vortex at high speed for 5–10 seconds. Briefly spin the samples.
- 4 Add 5 µl of Adaptor Oligo Mix (white capped tube) to each sample. Mix by pipetting up and down 15–20 times using a pipette set to 85 µl or cap the wells and vortex at high speed for 5–10 seconds.

NOTE

Make sure to add the Ligation master mix and the Adaptor Oligo Mix to the samples in separate addition steps as directed in [step 3](#) and [step 4](#) above, mixing after each addition.

- 5 Briefly spin the samples, then immediately place the plate or strip tube in the thermal cycler and resume the thermal cycling program in [Table 15](#).

NOTE

A unique molecular barcode sequence is incorporated into each library DNA fragment at this step.

Stopping Point If you do not continue to the next step, seal the sample wells and store overnight at either 4°C or –20°C.

2 Sample Preparation

Step 5. Purify the sample using AMPure XP beads

Step 5. Purify the sample using AMPure XP beads

- 1 Verify that the AMPure XP beads were held at room temperature for at least 30 minutes before use. *Do not freeze the beads at any time.*
- 2 Prepare 400 µl of 70% ethanol per sample, plus excess, for use in [step 8](#).

NOTE

The freshly-prepared 70% ethanol may be used for subsequent purification steps run on the same day. The complete Library Preparation protocol requires 0.8 ml of fresh 70% ethanol per sample.

- 3 Mix the AMPure XP bead suspension well so that the reagent appears homogeneous and consistent in color.
- 4 Add 80 µl of homogeneous AMPure XP beads to each DNA sample (approximately 100 µl) in the PCR plate or strip tube. Pipette up and down 15–20 times or cap the wells and vortex at high speed for 5–10 seconds to mix.
- 5 Incubate samples for 5 minutes at room temperature.
- 6 Put the plate or strip tube into a magnetic separation device. Wait for the solution to clear (approximately 5 to 10 minutes).
- 7 Keep the plate or strip tube in the magnetic stand. Carefully remove and discard the cleared solution from each well. Do not touch the beads while removing the solution.
- 8 Continue to keep the plate or strip tube in the magnetic stand while you dispense 200 µl of freshly-prepared 70% ethanol in each sample well.
- 9 Wait for 1 minute to allow any disturbed beads to settle, then remove the ethanol.
- 10 Repeat [step 8](#) to [step 9](#) once.
- 11 Seal the wells with strip caps, then briefly spin the samples to collect the residual ethanol. Return the plate or strip tube to the magnetic stand for 30 seconds. Remove the residual ethanol with a P20 pipette.

- 12** Dry the samples by placing the unsealed plate or strip tube on the thermal cycler, set to hold samples at 37°C, until the residual ethanol has just evaporated (typically 1–2 minutes).

NOTE

Do not dry the bead pellet to the point that the pellet appears cracked during any of the bead drying steps in the protocol. Elution efficiency is significantly decreased when the bead pellet is excessively dried.

- 13** Add 35 µl nuclease-free water to each sample well.
- 14** Seal the wells with strip caps, then mix well on a vortex mixer and briefly spin the plate or strip tube to collect the liquid.
- 15** Incubate for 2 minutes at room temperature.
- 16** Put the plate or strip tube in the magnetic stand and leave for approximately 5 minutes, until the solution is clear.
- 17** Remove the cleared supernatant (approximately 34.5 µl) to a fresh PCR plate or strip tube sample well and keep on ice. You can discard the beads at this time.

NOTE

It may not be possible to recover the entire 34.5-µl supernatant volume at this step; transfer the maximum possible amount of supernatant for further processing. To maximize recovery, transfer the cleared supernatant to a fresh well in two rounds of pipetting, using a P20 pipette set at 17.25 µl.

2 Sample Preparation

Step 6. Amplify the adaptor-ligated library

Step 6. Amplify the adaptor-ligated library

This step uses the components listed in [Table 16](#). Before you begin, thaw the reagents listed below and keep on ice.

Table 16 Reagents for pre-capture PCR amplification

Component	Storage Location	Mixing Method	Where Used
Herculase II Fusion DNA Polymerase (red cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR) [*] , –20°C	Pipette up and down 15–20 times	page 38
5× Herculase II Reaction Buffer (clear cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR) [*] , –20°C	Vortexing	page 38
100 mM dNTP Mix (green cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR) [*] , –20°C	Vortexing	page 38
Forward Primer (brown cap)	SureSelect XT HS Library Preparation Kit for ILM (Pre PCR) [*] , –20°C	Vortexing	page 38
SureSelect XT HS Index Primers A01 through H04 (black-capped tubes)	SureSelect XT HS Index Primers for ILM (Pre PCR) [†] , –20°C	Vortexing	page 38

^{*} May also be labeled as *SureSelect XT HS and XT Low Input Library Preparation Kit for ILM (Pre PCR)*.

[†] Indexing primers are provided in kits containing individual tubes in sets of 1–16 (A01–H02), 17–32 (A03–H04), or 1–32 (A01–H04). Thaw only the specific primers assigned to samples in the run.

- 1 Determine the appropriate index assignments for each sample. See [Table 42](#) in the “Reference” chapter for sequences of the 8 bp index portion of the SureSelect XT HS Index Primers A01 through H04 used to amplify the DNA libraries in this step.

Use a different indexing primer for each sample to be sequenced in the same lane.

CAUTION

The SureSelect XT HS Index Primers are provided in single-use aliquots. To avoid cross-contamination of libraries, discard each vial after use in one library preparation reaction. Do not retain and re-use any residual volume for subsequent experiments.

- 2 Preprogram a thermal cycler (with the heated lid ON) with the program in [Table 17](#). Immediately pause the program, and keep paused until samples are loaded in [step 6](#).

Table 17 Pre-Capture PCR Thermal Cycler Program *

Segment	Number of Cycles	Temperature	Time
1	1	98°C	2 minutes
2	8 to 14, based on input DNA quality and quantity (see Table 18)	98°C	30 seconds
		60°C	30 seconds
		72°C	1 minute
3	1	72°C	5 minutes
4	1	4°C	Hold

* Use a reaction volume setting of 50 µl, if required for thermal cycler set up.

Table 18 Pre-capture PCR cycle number recommendations

Quality of Input DNA	Quantity of Input DNA	Cycles
Intact DNA from fresh sample	100 to 200 ng	8 cycles
	50 ng	9 cycles
	10 ng	11 cycles
FFPE sample DNA	100 to 200 ng *	11 cycles
	50 ng	12 cycles
	10 ng	14 cycles

* qPCR-determined quantity of amplifiable DNA or DIN value-adjusted amount of input DNA

2 Sample Preparation

Step 6. Amplify the adaptor-ligated library

CAUTION

To avoid cross-contaminating libraries, set up PCR reactions (all components except the library DNA) in a dedicated clean area or PCR hood with UV sterilization and positive air flow.

- 3 Prepare the appropriate volume of pre-capture PCR reaction mix, as described in [Table 19](#), on ice. Mix well on a vortex mixer.

Table 19 Preparation of Pre-Capture PCR Reaction Mix

Reagent	Volume for 1 reaction	Volume for 8 reactions (includes excess)	Volume for 24 reactions (includes excess)
5× Herculase II Reaction Buffer (clear cap)	10 µl	90 µl	250 µl
100 mM dNTP Mix (green cap)	0.5 µl	4.5 µl	12.5 µl
Forward Primer (brown cap)	2 µl	18 µl	50 µl
Herculase II Fusion DNA Polymerase (red cap)	1 µl	9 µl	25 µl
Total	13.5 µl	121.5 µl	337.5 µl

- 4 Add 13.5 µl of the PCR reaction mixture prepared in [Table 19](#) to each purified DNA library sample (34.5 µl) in the PCR plate wells.
- 5 Add 2 µl of the appropriate SureSelect XT HS Index Primer to each reaction.
Cap the wells then vortex at high speed for 5 seconds. Spin the plate or strip tube briefly to collect the liquid release any bubbles.
- 6 Before adding the samples to the thermal cycler, resume the program in [Table 17](#) to bring the temperature of the thermal block to 98°C. Once the cycler has reached 98°C, immediately place the sample plate or strip tube in the thermal block and close the lid.

CAUTION

The lid of the thermal cycler is hot and can cause burns. Use caution when working near the lid.

Step 7. Purify the amplified library with AMPure XP beads

- 1 Verify that the AMPure XP beads were held at room temperature for at least 30 minutes before use. *Do not freeze the beads at any time.*
- 2 Prepare 400 µl of 70% ethanol per sample, plus excess, for use in [step 8](#).
- 3 Mix the AMPure XP bead suspension well so that the reagent appears homogeneous and consistent in color.
- 4 Add 50 µl of homogeneous AMPure XP beads to each 50-µl amplification reaction in the PCR plate or strip tube. Pipette up and down 15–20 times or cap the wells and vortex at high speed for 5–10 seconds to mix.
- 5 Incubate samples for 5 minutes at room temperature.
- 6 Put the plate or strip tube into a magnetic separation device. Wait for the solution to clear (approximately 5 minutes).
- 7 Keep the plate or strip tube in the magnetic stand. Carefully remove and discard the cleared solution from each well. Do not touch the beads while removing the solution.
- 8 Continue to keep the plate or strip tube in the magnetic stand while you dispense 200 µl of freshly-prepared 70% ethanol into each sample well.
- 9 Wait for 1 minute to allow any disturbed beads to settle, then remove the ethanol.
- 10 Repeat [step 8](#) and [step 9](#) step once.
- 11 Seal the wells with strip caps, then briefly spin the samples to collect the residual ethanol. Return the plate or strip tube to the magnetic stand for 30 seconds. Remove the residual ethanol with a P20 pipette.
- 12 Dry the samples by placing the unsealed plate or strip tube on the thermal cycler, set to hold samples at 37°C, until the residual ethanol has just evaporated (typically 1–2 minutes).
- 13 Add 15 µl nuclease-free water to each sample well.
- 14 Seal the wells with strip caps, then mix well on a vortex mixer and briefly spin the plate or strip tube to collect the liquid.
- 15 Incubate for 2 minutes at room temperature.
- 16 Put the plate or strip tube in the magnetic stand and leave for 2 to 3 minutes, until the solution is clear.

2 Sample Preparation

Step 7. Purify the amplified library with AMPure XP beads

17 Remove the cleared supernatant (approximately 15 µl) to a fresh PCR plate or strip tube sample well and keep on ice. You can discard the beads at this time.

NOTE

It may not be possible to recover the entire 15-µl supernatant volume at this step; transfer the maximum possible amount of supernatant for further processing.

Step 8. Assess quality and quantity

Sample analysis can be done with either the 2100 Bioanalyzer instrument or an Agilent TapeStation instrument.

NOTE

Using either analysis method, observation of a low molecular weight peak, in addition to the expected library fragment peak, indicates the presence of adaptor-dimers in the library. Adaptor-dimer removal is not required for libraries that will be target-enriched in later steps of the workflow. However, for libraries being prepared for whole-genome sequencing (not specifically supported by this user guide), samples with an adaptor-dimer peak must be subjected to an additional round of SPRI-purification. To complete, first dilute the sample to 50 µl with nuclease free water, then follow the SPRI purification procedure on [page 39](#).

Option 1: Analysis using the 2100 Bioanalyzer instrument and DNA 1000 Assay

Use a Bioanalyzer DNA 1000 chip and reagent kit. Perform the assay according to the [Agilent DNA 1000 Kit Guide](#).

- 1 Set up the 2100 Bioanalyzer instrument as instructed in the reagent kit guide.
- 2 Prepare the chip, samples and ladder as instructed in the reagent kit guide, using 1 µl of each sample for the analysis. Load the prepared chip into the instrument and start the run within five minutes after preparation.
- 3 Verify that the electropherogram shows the peak of DNA fragment size positioned between 300 to 400 bp for high-quality DNA and approximately 200 to 400 bp for FFPE DNA. Sample electropherograms are shown in [Figure 2](#) (library prepared from high-quality DNA), [Figure 3](#) (library prepared from medium-quality FFPE DNA), and [Figure 4](#) (library prepared from low-quality FFPE DNA).

The appearance of an additional low molecular weight peak indicates the presence of adaptor-dimers in the library. It is acceptable to proceed to target enrichment with library samples for which adaptor-dimers are observed in the electropherogram at low abundance, similar to that seen in sample electropherograms on [page 42](#). See Troubleshooting information on [page 94](#) for additional considerations.

- 4 Determine the concentration of each library by integrating under the entire peak. For accurate quantification, make sure that the concentration falls within the linear range of the assay.

2 Sample Preparation

Step 8. Assess quality and quantity

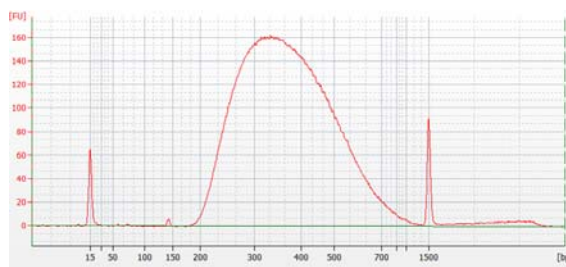


Figure 2 Pre-capture library prepared from a high-quality gDNA sample analyzed using a DNA 1000 Bioanalyzer assay.

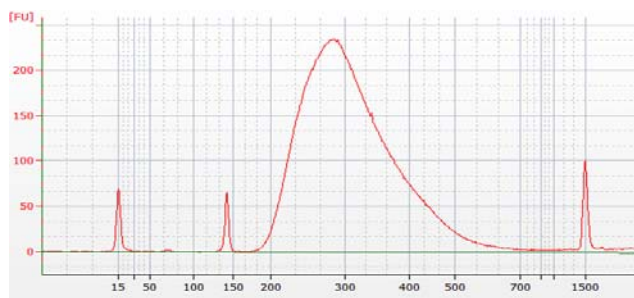


Figure 3 Pre-capture library prepared from a typical FFPE gDNA sample analyzed using a DNA 1000 Bioanalyzer assay.

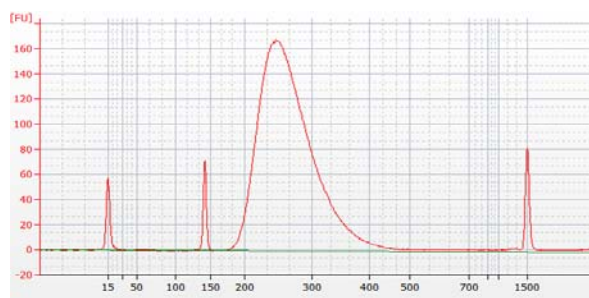


Figure 4 Pre-capture library prepared from a low-quality FFPE gDNA sample analyzed using a DNA 1000 Bioanalyzer assay.

Stopping Point If you do not continue to the next step, seal the sample wells and store at 4°C overnight or at -20°C for prolonged storage.

Option 2: Analysis using an Agilent TapeStation and D1000 ScreenTape

Use a D1000 ScreenTape and associated reagent kit. For more information to do this step, see the [Agilent D1000 Assay Quick Guide](#).

- 1 Prepare the TapeStation samples as instructed in the reagent kit guide. Use 1 µl of each DNA sample diluted with 3 µl of D1000 sample buffer for the analysis.

CAUTION

For accurate quantitation, make sure to thoroughly mix the combined DNA and sample buffer by vortexing the assay plate or tube strip for 1 minute on the IKA MS3 vortex mixer provided with the 4200/4150 TapeStation system before loading the samples.

- 2 Load the sample plate or tube strips from [step 1](#), the D1000 ScreenTape, and loading tips into the TapeStation as instructed in the reagent kit guide. Start the run.
- 3 Verify that the electropherogram shows the peak of DNA fragment size positioned between 300 to 400 bp for high-quality DNA and approximately 200 to 400 bp for FFPE DNA. Sample electropherograms are shown in [Figure 5](#) (library prepared from high-quality DNA), [Figure 6](#) (library prepared from medium-quality FFPE DNA), and [Figure 7](#) (library prepared from low-quality FFPE DNA).

The appearance of an additional low molecular weight peak indicates the presence of adaptor-dimers in the library. It is acceptable to proceed to target enrichment with library samples for which adaptor-dimers are observed in the electropherogram at low abundance, similar to that seen in sample electropherograms on [page 44](#) to [page 45](#). See Troubleshooting information on [page 94](#) for additional considerations.

- 4 Determine the concentration of the library DNA by integrating under the peak.

2 Sample Preparation

Step 8. Assess quality and quantity

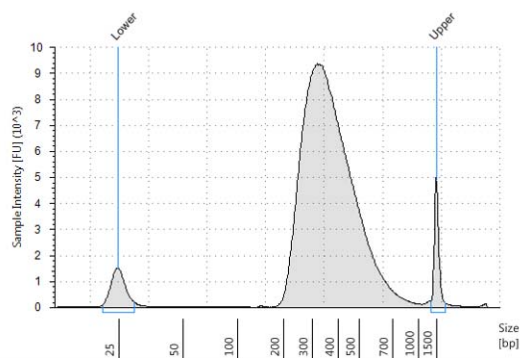


Figure 5 Pre-capture library prepared from a high-quality gDNA sample analyzed using a D1000 ScreenTape assay.

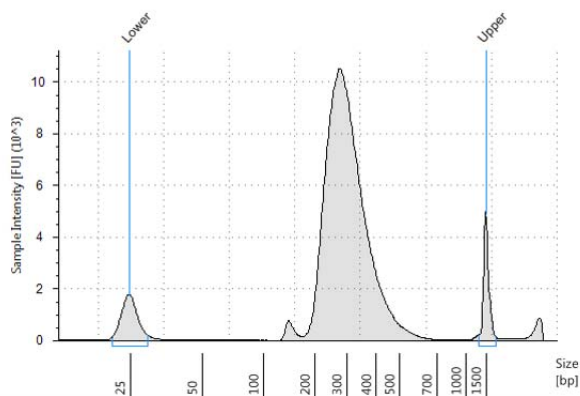


Figure 6 Pre-capture library prepared from a typical FFPE gDNA sample analyzed using a D1000 ScreenTape assay.

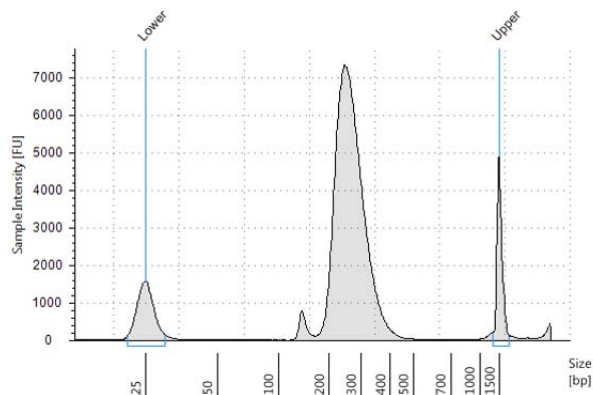


Figure 7 Pre-capture library prepared from a low-quality FFPE gDNA sample analyzed using a D1000 ScreenTape assay.

Stopping Point If you do not continue to the next step, seal the sample wells and store at 4°C overnight or at -20°C for prolonged storage.

2 Sample Preparation

Step 8. Assess quality and quantity



3 Hybridization and Capture

- Step 1. Hybridize DNA samples to the probe 48
- Step 2. Prepare streptavidin-coated magnetic beads 53
- Step 3. Capture the hybridized DNA using streptavidin-coated beads 54

This chapter describes the steps to hybridize the prepared gDNA libraries with a target-specific Probe Capture Library. After hybridization, the targeted molecules are captured on streptavidin beads. Each DNA library sample must be hybridized and captured individually.

The standard single-day protocol includes the hybridization step (approximately 90 minutes) immediately followed by capture and amplification steps. If required, the hybridized samples may be held overnight with capture and amplification steps completed the following day by using the simple protocol modifications noted on [page 49](#).

CAUTION

The ratio of probe to prepared gDNA library is critical for successful capture.



3 Hybridization and Capture

Step 1. Hybridize DNA samples to the probe

Step 1. Hybridize DNA samples to the probe

In this step, the prepared gDNA libraries are hybridized to a target-specific Probe Capture Library. For each sample library prepared, do one hybridization and capture. Do not pool samples at this stage.

The hybridization reaction requires 500–1000 ng of prepared DNA in a volume of 12 µl. Use the maximum amount of prepared DNA available within this range.

This step uses the components listed in [Table 20](#). Thaw each component under the conditions indicated in the table. Vortex each reagent to mix, then spin tubes briefly to collect the liquid.

Table 20 Reagents for Hybridization

Kit Component	Storage Location	Thawing Conditions	Where Used
SureSelect XT HS and XT Low Input Blocker Mix (blue cap)	SureSelect XT HS Target Enrichment Kit ILM Hyb Module, Box 2 (Post PCR), * –20°C	Thaw on ice	page 49
SureSelect RNase Block (purple cap)	SureSelect XT HS Target Enrichment Kit ILM Hyb Module, Box 2 (Post PCR), * –20°C	Thaw on ice	page 50
SureSelect Fast Hybridization Buffer (bottle)	SureSelect XT HS Target Enrichment Kit ILM Hyb Module, Box 2 (Post PCR), * –20°C	Thaw and keep at Room Temperature	page 51
Probe Capture Library	–80°C	Thaw on ice	page 51

* May also be labeled as *SureSelect XT HS and XT Low Input Target Enrichment Kit ILM Hyb Module, Box 2 (Post PCR)*.

- 1** Preprogram a thermal cycler (with the heated lid ON) with the program in [Table 21](#). Immediately pause the program, and keep paused until samples are loaded in [step 4](#).

Table 21 Pre-programmed thermal cycler program for Hybridization *

Segment Number	Number of Cycles	Temperature	Time
1	1	95°C	5 minutes
2	1	65°C	10 minutes
3	1	65°C	1 minute
4	60	65°C [†]	1 minute
		37°C	3 seconds
5	1	65°C [†]	Hold

* When setting up the thermal cycling program, use a reaction volume setting of 30 µl (final volume of hybridization reactions during cycling in Segment 4).

† Reducing the hybridization temperature to 60°C (Segments 4 and 5) may improve coverage for AT-rich regions of some libraries.

NOTE

The Hybridization reaction may be run overnight with the following protocol modifications:

- In segment 5 of the thermal cycler program ([Table 21](#)), replace the 65°C Hold step with a 21°C Hold step.
- Pause the thermal cycler as directed in [step 1](#) and complete the hybridization setup steps as directed on [page 49](#) through [page 52](#) before resuming the paused program.
- The hybridized samples may be held at 21°C for up to 16 hours. Complete the streptavidin bead preparation steps on [page 53](#) just before you are ready to start the capture steps on [page 54](#). Move the hybridized samples to room temperature just before adding the washed streptavidin beads to each sample.

- 2** Place 500–1000 ng of each prepared gDNA library sample into the hybridization plate or strip tube wells and then bring the final volume in each well to 12 µl using nuclease-free water. Use the maximum possible amount of each prepped DNA, within the 500–1000 ng range.
- 3** To each DNA library sample well, add 5 µl of SureSelect XT HS and XT Low Input Blocker Mix. Cap the wells then vortex at high speed for 5 seconds. Spin the plate or strip tube briefly to collect the liquid and release any bubbles.

3 Hybridization and Capture

Step 1. Hybridize DNA samples to the probe

CAUTION

The lid of the thermal cycler is hot and can cause burns. Use caution when working near the lid.

- 4 Transfer the sealed sample plates or strips to the thermal cycler and resume the thermal cycling program set up on [page 49](#) and shown in [Table 22](#) below.

Important: Notice that the thermal cycler must be paused during Segment 3 (see [Table 22](#)) to allow additional reagents to be added to the Hybridization wells, as described in [step 7](#) on [page 52](#).

During Segments 1 and 2 of the thermal cycling program below, begin preparing the additional reagents as described in [step 5](#) and [step 6](#) on [page 51](#). If needed, you can finish these preparation steps after pausing the thermal cycler in Segment 3.

Table 22 Thermal cycler program for Hybridization with required pause

Segment Number	Number of Cycles	Temperature	Time
1	1	95°C	5 minutes
2	1	65°C	10 minutes
3	1	65°C	1 minute (PAUSE cycler here)
4	60	65°C	1 minute
		37°C	3 seconds
5	1	65°C	Hold*

* Begin the capture steps on [page 53](#) when the thermal cycler starts the 65°C Hold segment.

- 5 Prepare a 25% solution of SureSelect RNase Block (containing 1 part RNase Block:3 parts water), according to [Table 23](#). Prepare the amount required for the number of hybridization reactions in the run, plus excess. Mix well and keep on ice.

Table 23 Preparation of RNase Block solution

Reagent	Volume for 1 reaction	Volume for 8 reactions (includes excess)	Volume for 24 reactions (includes excess)
SureSelect RNase Block	0.5 µl	4.5 µl	12.5 µl
Nuclease-free water	1.5 µl	13.5 µl	37.5 µl
Total	2 µl	18 µl	50 µl

NOTE

Prepare the mixture described in [step 6](#), below, just before pausing the thermal cycler in Segment 3 as described on [page 50](#). Keep the mixture at room temperature briefly until the mixture is added to the DNA samples in [step 7](#) on [page 52](#). Do not keep solutions containing the Probe at room temperature for extended periods.

- 6** Prepare the Capture Library Hybridization Mix appropriate for your probe design size. Use [Table 24](#) for probes ≥ 3 Mb or [Table 25](#) for probes < 3 Mb.

Combine the listed reagents at room temperature. Mix well by vortexing at high speed for 5 seconds then spin down briefly. Proceed immediately to [step 7](#).

Table 24 Preparation of Capture Library Hybridization Mix for probes ≥ 3 Mb

Reagent	Volume for 1 reaction	Volume for 8 reactions (includes excess)	Volume for 24 reactions (includes excess)
25% RNase Block solution (from step 5)	2 μ l	18 μ l	50 μ l
Probe (with design ≥ 3 Mb)	5 μ l	45 μ l	125 μ l
SureSelect Fast Hybridization Buffer	6 μ l	54 μ l	150 μ l
Total	13 μl	117 μl	325 μl

Table 25 Preparation of Capture Library Hybridization Mix for probes < 3 Mb

Reagent	Volume for 1 reaction	Volume for 8 reactions (includes excess)	Volume for 24 reactions (includes excess)
25% RNase Block solution (from step 5)	2 μ l	18 μ l	50 μ l
Probe (with design < 3 Mb)	2 μ l	18 μ l	50 μ l
SureSelect Fast Hybridization Buffer	6 μ l	54 μ l	150 μ l
Nuclease-free water	3 μ l	27 μ l	75 μ l
Total	13 μl	117 μl	325 μl

3 Hybridization and Capture

Step 1. Hybridize DNA samples to the probe

- 7 Once the thermal cycler starts Segment 3 of the program in [Table 22](#) (1 minute at 65°C), pause the program. With the cycler paused, and while keeping the DNA + Blocker samples in the cycler, transfer 13 µl of the room-temperature Capture Library Hybridization Mix from [step 6](#) to each sample well.

Mix well by pipetting up and down slowly 8 to 10 times.

The hybridization reaction wells now contain approximately 30 µl.

- 8 Seal the wells with fresh domed strip caps. Make sure that all wells are completely sealed. Vortex briefly, then spin the plate or strip tube briefly to remove any bubbles from the bottom of the wells. Immediately return the plate or strip tube to the thermal cycler.
- 9 Resume the thermal cycling program to allow hybridization of the prepared DNA samples to the Probe Capture Library.

CAUTION

Wells must be adequately sealed to minimize evaporation, or your results can be negatively impacted.

Before you do the first experiment, make sure the plasticware and capping method are appropriate for the thermal cycler. Check that no more than 4 µl is lost to evaporation under the conditions used for hybridization.

Step 2. Prepare streptavidin-coated magnetic beads

The remaining hybridization capture steps use the components listed in [Table 26](#).

Begin the bead preparation steps described below approximately one hour after starting hybridization in [step 9](#) on [page 52](#).

Table 26 Reagents for Capture

Kit Component	Storage Location	Where Used
SureSelect Binding Buffer	SureSelect Target Enrichment Kit ILM Hyb Module, Box 1 (Post PCR), RT	page 53
SureSelect Wash Buffer 1	SureSelect Target Enrichment Kit ILM Hyb Module, Box 1 (Post PCR), RT	page 54
SureSelect Wash Buffer 2	SureSelect Target Enrichment Kit ILM Hyb Module, Box 1 (Post PCR), RT	page 54
Dynabeads MyOne Streptavidin T1	Follow storage recommendations provided by supplier (see Table 4 on page 15)	page 53

- 1** Vigorously resuspend the Dynabeads MyOne Streptavidin T1 magnetic beads on a vortex mixer. The magnetic beads settle during storage.
- 2** For each hybridization sample, add 50 µl of the resuspended beads to wells of a fresh PCR plate or a strip tube.
- 3** Wash the beads:
 - a** Add 200 µl of SureSelect Binding Buffer.
 - b** Mix by pipetting up and down 20 times or cap the wells and vortex at high speed for 5–10 seconds then spin down briefly.
 - c** Put the plate or strip tube into a magnetic separator device.
 - d** Wait at least 5 minutes or until the solution is clear, then remove and discard the supernatant.
 - e** Repeat [step a](#) through [step d](#) two more times for a total of 3 washes.
- 4** Resuspend the beads in 200 µl of SureSelect Binding Buffer.

NOTE

If you are equipped for higher-volume magnetic bead captures, the streptavidin beads may instead be batch-washed in an Eppendorf tube or conical vial.

Step 3. Capture the hybridized DNA using streptavidin-coated beads

- 1** After the hybridization step is complete and the thermal cycler reaches the 65°C hold step (Segment 5; see [Table 22](#) on page 50), transfer the samples to room temperature.
- 2** Immediately transfer the entire volume (approximately 30 µl) of each hybridization mixture to wells containing 200 µl of washed streptavidin beads using a multichannel pipette.

Pipette up and down 5–8 times to mix then seal the wells with fresh caps.
- 3** Incubate the capture plate or strip tube on a 96-well plate mixer, mixing vigorously (at 1400–1800 rpm), for 30 minutes at room temperature.

Make sure the samples are properly mixing in the wells.

- 4** During the 30-minute incubation for capture, prewarm SureSelect Wash Buffer 2 at 70°C as described below.
 - a** Place 200-µl aliquots of Wash Buffer 2 in wells of a fresh 96-well plate or strip tubes. Aliquot 6 wells of buffer for each DNA sample in the run.
 - b** Cap the wells and then incubate in the thermal cycler, with heated lid ON, held at 70°C until used in [step 9](#).
- 5** When the 30-minute incubation period initiated in [step 3](#) is complete, spin the samples briefly to collect the liquid.
- 6** Put the plate or strip tube in a magnetic separator to collect the beads. Wait until the solution is clear, then remove and discard the supernatant.
- 7** Resuspend the beads in 200 µl of SureSelect Wash Buffer 1. Mix by pipetting up and down 15–20 times, until beads are fully resuspended.
- 8** Put the plate or strip tube in the magnetic separator. Wait for the solution to clear (approximately 1 minute), then remove and discard the supernatant.

Step 3. Capture the hybridized DNA using streptavidin-coated beads

CAUTION

It is important to maintain bead suspensions at 70°C during the washing procedure below to ensure specificity of capture.

Make sure that the SureSelect Wash Buffer 2 is pre-warmed to 70°C before use.

Do not use a tissue incubator, or other devices with significant temperature fluctuations, for the incubation steps.

9 Remove the plate or strip tubes from the magnetic separator and transfer to a rack at room temperature. Wash the beads with Wash Buffer 2, using the protocol steps below.

- a** Resuspend the beads in 200 µl of 70°C prewarmed Wash Buffer 2. Pipette up and down 15–20 times, until beads are fully resuspended.
- b** Seal the wells with fresh caps and then vortex at high speed for 8 seconds. Spin the plate or strip tube briefly to collect the liquid without pelleting the beads.

Make sure the beads are in suspension before proceeding.

- c** Incubate the samples for 5 minutes at 70°C in the thermal cycler with the heated lid ON.
- d** Put the plate or strip tube in the magnetic separator at room temperature.
- e** Wait 1 minute for the solution to clear, then remove and discard the supernatant.
- f** Repeat [step a](#) through [step e](#) five more times for a total of 6 washes.

10 After verifying that all wash buffer has been removed, add 25 µl of nuclease-free water to each sample well. Pipette up and down 8 times to resuspend the beads.

Keep the samples on ice until they are used on [page 60](#).

NOTE

Captured DNA is retained on the streptavidin beads during the post-capture amplification step.

3 Hybridization and Capture

Step 3. Capture the hybridized DNA using streptavidin-coated beads



4 Post-Capture Sample Processing for Multiplexed Sequencing

- Step 1. Amplify the captured libraries 58
- Step 2. Purify the amplified captured libraries using AMPure XP beads 61
- Step 3. Assess sequencing library DNA quantity and quality 63
- Step 4. Pool samples for multiplexed sequencing 68
- Step 5. Prepare sequencing samples 70
- Step 6. Do the sequencing run and analyze the data 73

This chapter describes the steps to amplify, purify, and assess quality and quantity of the captured libraries. Sample pooling instructions are provided to prepare the indexed, molecular barcoded samples for multiplexed sequencing.



4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 1. Amplify the captured libraries

Step 1. Amplify the captured libraries

In this step, the SureSelect-enriched DNA libraries are PCR amplified.

This step uses the components listed in [Table 27](#). Before you begin, thaw the reagents listed below and keep on ice.

Table 27 Reagents for post-capture PCR amplification

Component	Storage Location	Mixing Method	Where Used
Herculase II Fusion DNA Polymerase (red cap)	SureSelect XT HS Target Enrichment Kit, ILM Hyb Module Box 2 (Post PCR),* –20°C	Pipette up and down 15–20 times	page 60
5× Herculase II Reaction Buffer (clear cap)	SureSelect XT HS Target Enrichment Kit, ILM Hyb Module Box 2 (Post PCR),* –20°C	Vortexing	page 60
100 mM dNTP Mix (green cap)	SureSelect XT HS Target Enrichment Kit, ILM Hyb Module Box 2 (Post PCR),* –20°C	Vortexing	page 60
SureSelect Post-Capture Primer Mix (clear cap)	SureSelect XT HS Target Enrichment Kit, ILM Hyb Module Box 2 (Post PCR),* –20°C	Vortexing	page 60

* May also be labeled as *SureSelect XT HS and XT Low Input Target Enrichment Kit ILM Hyb Module Box 2 (Post PCR)*.

Prepare one amplification reaction for each DNA library.

CAUTION

To avoid cross-contaminating libraries, set up PCR mixes in a dedicated clean area or PCR hood with UV sterilization and positive air flow.

- 1 Preprogram a thermal cycler (with the heated lid ON) with the program in [Table 28](#). Immediately pause the program, and keep paused until samples are loaded in [step 5](#).

Table 28 Post-capture PCR thermal cycler program

Segment	Number of Cycles	Temperature	Time
1	1	98°C	2 minutes
2	9 to 14 See Table 29 for hybridization probe design size-based cycle number recommendations	98°C	30 seconds
		60°C	30 seconds
		72°C	1 minute
3	1	72°C	5 minutes
4	1	4°C	Hold

Table 29 Post-capture PCR cycle number recommendations

Probe Size/Description	Cycles
Probes <0.2 Mb	14 cycles
Probes 0.2–3 Mb (includes ClearSeq Comp Cancer)	12 cycles
Probes 3–5 Mb	10 cycles
Probes >5 Mb (includes Human All Exon V6, Human All Exon V7 and Clinical Research Exome V2)	9 cycles

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 1. Amplify the captured libraries

- 2 Prepare the appropriate volume of PCR reaction mix, as described in [Table 30](#), on ice. Mix well on a vortex mixer.

Table 30 Preparation of post-capture PCR Reaction mix

Reagent	Volume for 1 reaction	Volume for 8 reactions (includes excess)	Volume for 24 reactions (includes excess)
Nuclease-free water	12.5 µl	112.5 µl	312.5 µl
5× Herculase II Reaction Buffer (clear cap)	10 µl	90 µl	250 µl
Herculase II Fusion DNA Polymerase (red cap)	1 µl	9 µl	25 µl
100 mM dNTP Mix (green cap)	0.5 µl	4.5 µl	12.5 µl
SureSelect Post-Capture Primer Mix (clear cap)	1 µl	9 µl	25 µl
Total	25 µl	225 µl	625 µl

- 3 Add 25 µl of the PCR reaction mix prepared in [Table 30](#) to each sample well containing 25 µl of bead-bound target-enriched DNA (prepared on [page 55](#) and held on ice).
- 4 Mix the PCR reactions well by pipetting up and down until the bead suspension is homogeneous. Avoid splashing samples onto well walls; do not spin the samples at this step.
- 5 Place the plate or strip tube in the thermal cycler and resume the thermal cycling program in [Table 28](#).
- 6 When the PCR amplification program is complete, spin the plate or strip tube briefly. Remove the streptavidin-coated beads by placing the plate or strip tube on the magnetic stand at room temperature. Wait 2 minutes for the solution to clear, then **remove each supernatant (approximately 50 µl) to wells of a fresh plate or strip tube.**
The beads can be discarded at this time.

Step 2. Purify the amplified captured libraries using AMPure XP beads

- 1 Let the AMPure XP beads come to room temperature for at least 30 minutes. *Do not freeze the beads at any time.*
- 2 Prepare 400 µl of fresh 70% ethanol per sample, plus excess, for use in [step 8](#).
- 3 Mix the AMPure XP bead suspension well so that the suspension appears homogeneous and consistent in color.
- 4 Add 50 µl of the homogeneous AMPure XP bead suspension to each amplified DNA sample (approximately 50 µl) in the PCR plate or strip tube. Mix well by pipetting up and down 15–20 times or cap the wells and vortex at high speed for 5–10 seconds.

Check that the beads are in a homogeneous suspension in the sample wells. Each well should have a uniform color with no layers of beads or clear liquid present.
- 5 Incubate samples for 5 minutes at room temperature.
- 6 Put the plate or strip tube on the magnetic stand at room temperature. Wait for the solution to clear (approximately 3 to 5 minutes).
- 7 While keeping the plate or tubes in the magnetic stand, carefully remove and discard the cleared solution from each well. Do not disturb the beads while removing the solution.
- 8 Continue to keep the plate or tubes in the magnetic stand while you dispense 200 µl of freshly-prepared 70% ethanol in each sample well.
- 9 Wait for 1 minute to allow any disturbed beads to settle, then remove the ethanol.
- 10 Repeat [step 8](#) and [step 9](#) once for a total of two washes. Make sure to remove all of the ethanol at each wash step.
- 11 Seal the wells with strip caps, then briefly spin to collect the residual ethanol. Return the plate or strip tube to the magnetic stand for 30 seconds. Remove the residual ethanol with a P20 pipette.
- 12 Dry the samples by placing the unsealed plate or strip tube on the thermal cycler, set to hold samples at 37°C, until the residual ethanol has just evaporated (typically 1–2 minutes).
- 13 Add 25 µl of nuclease-free water to each sample well.

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 2. Purify the amplified captured libraries using AMPure XP beads

- 14** Seal the sample wells, then mix well on a vortex mixer and briefly spin to collect the liquid without pelleting the beads.
- 15** Incubate for 2 minutes at room temperature.
- 16** Put the plate or strip tube in the magnetic stand and leave for 2 minutes or until the solution is clear.
- 17** Remove the cleared supernatant (approximately 25 µl) to a fresh well. You can discard the beads at this time.

Step 3. Assess sequencing library DNA quantity and quality

Option 1: Analysis using the Agilent 2100 Bioanalyzer instrument and High Sensitivity DNA Assay

Use the Bioanalyzer High Sensitivity DNA Assay to analyze the amplified indexed DNA. Perform the assay according to the [High Sensitivity DNA Kit Guide](#).

- 1 Set up the 2100 Bioanalyzer instrument as instructed in the reagent kit guide.
- 2 Prepare the chip, samples and ladder as instructed in the reagent kit guide, using 1 µl of each sample for the analysis.
- 3 Load the prepared chip into the instrument and start the run within five minutes after preparation.
- 4 Verify that the electropherogram shows the peak of DNA fragment size positioned between 200 and 400 bp. Sample electropherograms are shown in [Figure 8](#) (library prepared from high-quality DNA), [Figure 9](#) (library prepared from medium-quality FFPE DNA), and [Figure 10](#) (library prepared from low-quality FFPE DNA).
- 5 Measure the concentration of each library by integrating under the entire peak. For accurate quantification, make sure that the concentration falls within the linear range of the assay.

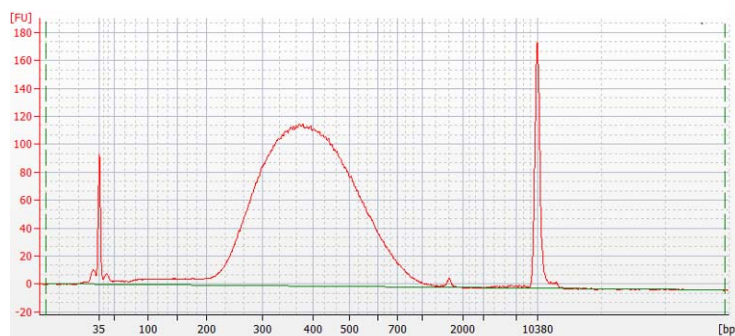


Figure 8 Post-capture library prepared from a high-quality gDNA sample analyzed using a Bioanalyzer system High Sensitivity DNA assay.

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 3. Assess sequencing library DNA quantity and quality

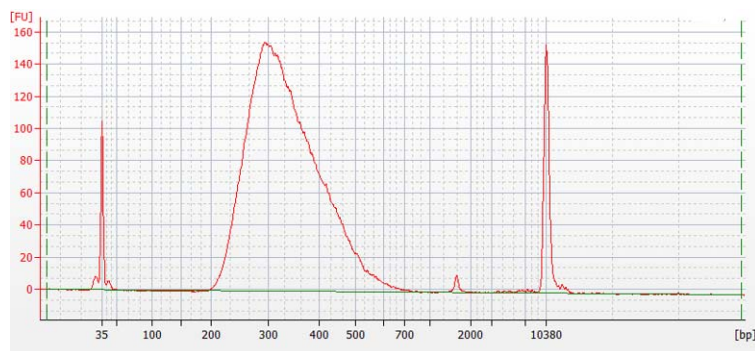


Figure 9 Post-capture library prepared from a typical FFPE gDNA sample analyzed using a Bioanalyzer system High Sensitivity DNA assay.

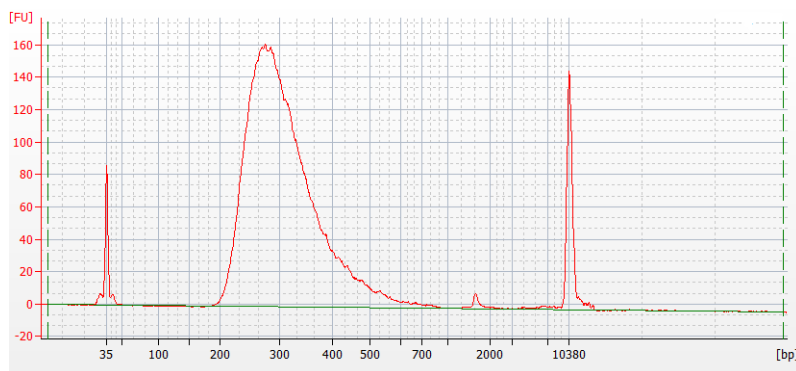


Figure 10 Post-capture library prepared from a low-quality FFPE gDNA sample analyzed using a Bioanalyzer system High Sensitivity DNA assay.

Stopping Point If you do not continue to the next step, seal the plate and store at 4°C overnight or at -20°C for prolonged storage.

Option 2: Analysis using an Agilent TapeStation and High Sensitivity D1000 ScreenTape

Use a High Sensitivity D1000 ScreenTape and associated reagent kit. For more information to do this step, see the [Agilent High Sensitivity D1000 Assay Quick Guide](#).

- 1 Prepare the TapeStation samples as instructed in the reagent kit guide. Use 2 µl of each indexed DNA sample diluted with 2 µl of High Sensitivity D1000 sample buffer for the analysis.

CAUTION

For accurate quantitation, make sure to thoroughly mix the combined DNA and sample buffer by vortexing the assay plate or tube strip for 1 minute on the IKA MS3 vortex mixer provided with the 4200/4150 TapeStation system before loading the samples.

- 2 Load the sample plate or tube strips from [step 1](#), the High Sensitivity D1000 ScreenTape, and loading tips into the TapeStation as instructed in the reagent kit guide. Start the run.
- 3 Verify that the electropherogram shows the peak of DNA fragment size positioned between 200 and 400 bp. Sample electropherograms are shown in [Figure 11](#) (library prepared from high-quality DNA), [Figure 12](#) (library prepared from medium-quality FFPE DNA), and [Figure 13](#) (library prepared from low-quality FFPE DNA).
- 4 Determine the concentration of each library by integrating under the entire peak.

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 3. Assess sequencing library DNA quantity and quality

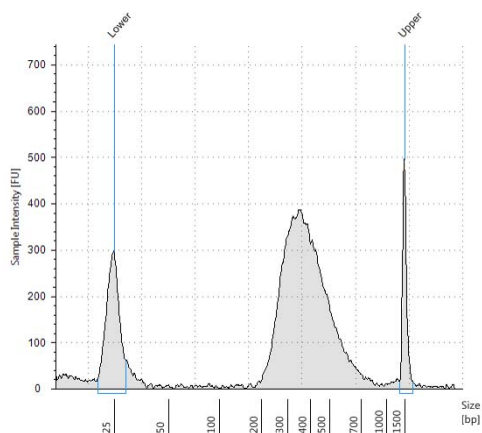


Figure 11 Post-capture library prepared from a high-quality gDNA sample analyzed using a High Sensitivity D1000 ScreenTape assay.

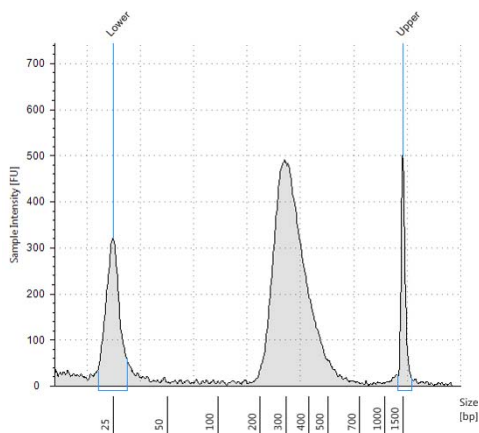


Figure 12 Post-capture library prepared from a typical FFPE gDNA sample analyzed using a High Sensitivity D1000 ScreenTape assay.

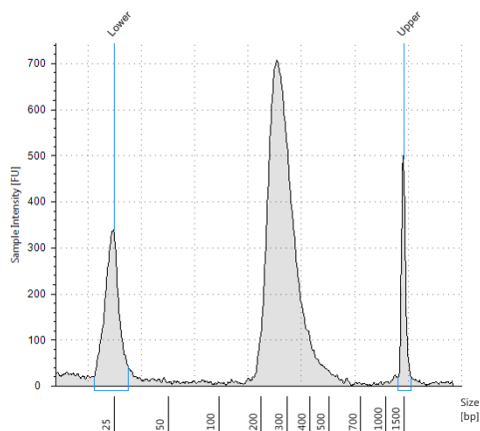


Figure 13 Post-capture library prepared from a low-quality FFPE gDNA sample analyzed using a High Sensitivity D1000 ScreenTape assay.

Stopping Point If you do not continue to the next step, seal the plate and store at 4°C overnight or at -20°C for prolonged storage.

Step 4. Pool samples for multiplexed sequencing

The number of indexed libraries that may be multiplexed in a single sequencing lane is determined by the output specifications of the platform used, together with the amount of sequencing data required for your research design. Calculate the number of indexes that can be combined per lane, according to the capacity of your platform and the amount of sequencing data required per sample.

Combine the libraries such that each index-tagged sample is present in equimolar amounts in the pool using one of the following methods:

Method 1: Dilute each sample to be pooled to the same final concentration (typically 4 nM–15 nM, or the concentration of the most dilute sample) using Low TE, then combine equal volumes of all samples to create the final pool.

Method 2: Starting with samples at different concentrations, add the appropriate volume of each sample to achieve equimolar concentration in the pool, then adjust the pool to the desired final volume using Low TE. The formula below is provided for determination of the amount of each indexed sample to add to the pool.

$$\text{Volume of Index} = \frac{V(f) \times C(f)}{\# \times C(i)}$$

where $V(f)$ is the final desired volume of the pool,

$C(f)$ is the desired final concentration of all the DNA in the pool (typically 4 nM–15 nM or the concentration of the most dilute sample)

$\#$ is the number of indexes, and

$C(i)$ is the initial concentration of each indexed sample

Table 31 shows an example of the amount of 4 index-tagged samples (of different concentrations) and Low TE needed for a final volume of 20 µl at 10 nM DNA.

Table 31 Example of volume calculation for total volume of 20 µl at 10 nM concentration

Component	V(f)	C(i)	C(f)	#	Volume to use (µl)
Sample 1	20 µl	20 nM	10 nM	4	2.5
Sample 2	20 µl	10 nM	10 nM	4	5
Sample 3	20 µl	17 nM	10 nM	4	2.9
Sample 4	20 µl	25 nM	10 nM	4	2
Low TE					7.6

If you store the library before sequencing, add Tween 20 to 0.1% v/v and store at -20°C short term.

Step 5. Prepare sequencing samples

The final SureSelect^{XT HS} library pool is ready for direct sequencing using standard Illumina paired-end primers and chemistry. Each fragment in the prepared library contains one target insert surrounded by sequence motifs required for multiplexed sequencing using the Illumina platform, as shown in Figure 14.

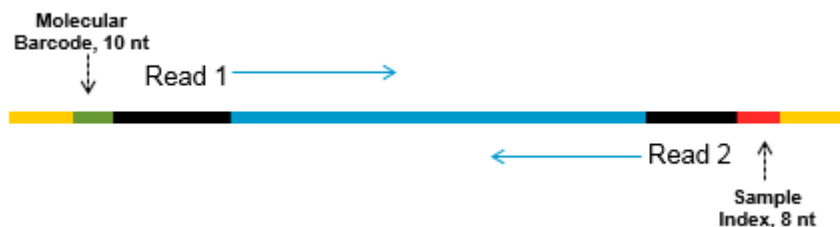


Figure 14 Content of SureSelect XT HS sequencing library. Each fragment contains one target insert (blue) surrounded by the Illumina paired-end sequencing elements (black), the sample index (red), the molecular barcode (green) and the library bridge PCR primers (yellow).

Libraries can be sequenced on the Illumina HiSeq, MiSeq, NextSeq, or NovaSeq platform using the run type and chemistry combinations shown in Table 32.

CAUTION

Do not use the HiSeq2500 instrument in high-output run mode (v4 chemistry) if your analysis pipeline includes molecular barcode (i5) reads. Poor molecular barcode sequence data quality (lower Q scores, with impacts on coverage and sensitivity of variant calls) has been observed when SureSelect^{XT HS} libraries are sequenced on the HiSeq 2500 instrument in this mode. See Table 32 for alternative run mode/chemistry options for the HiSeq2500 platform. Sequencing performance for Read 1, Read 2, and sample-level index (i7) reads is not affected, and this platform/run mode/chemistry may be used for applications that omit molecular barcode analysis.

Proceed to cluster amplification using the appropriate Illumina Paired-End Cluster Generation Kit. See Table 32 for kit configurations compatible with the recommended read length.

The optimal seeding concentration for SureSelect^{XT} HS target-enriched libraries varies according to sequencing platform, run type, and Illumina kit version. See Table 32 for guidelines. Seeding concentration and cluster density may also need to be optimized based on the DNA fragment size range for the library and on the desired output and data quality. Begin optimization using a seeding concentration in the middle of the range listed in Table 32.

Follow Illumina's recommendation for a PhiX control in a low-concentration spike-in for improved sequencing quality control.

Table 32 Illumina Kit Configuration Selection Guidelines

Platform	Run Type	Read Length	SBS Kit Configuration	Chemistry	Seeding Concentration
HiSeq 2500	Rapid Run	2 × 100 bp	200 Cycle Kit	v2	9–10 pM
HiSeq 2500	High Output	2 × 100 bp	4×50 Cycle Kits*	v3	9–10 pM
HiSeq 2500	High Output†	2 × 100 bp	250 Cycle Kit	v4	12–14 pM
HiSeq 2000	All Runs	2 × 100 bp	4×50 Cycle Kits*	v3	6–9 pM
HiSeq 2000	All Runs	2 × 100 bp	250 Cycle Kit	v4	8–12 pM
MiSeq	All Runs	2 × 100 bp	300 Cycle Kit	v2	9–10 pM
MiSeq	All Runs	2 × 75 bp	150 Cycle Kit	v3	12–16 pM
NextSeq 500/550	All Runs	2 × 100 bp‡	300 Cycle Kit	v2.5	1.2–1.5 pM
HiSeq 3000/4000	All Runs	2 × 100 bp	300 Cycle Kit	v1	230–240 pM
NovaSeq 6000	Standard Workflow Runs	2 × 100 bp‡	300 Cycle Kit	v1	300–500 pM
NovaSeq 6000	Xp Workflow Runs	2 × 100 bp‡	300 Cycle Kit	v1	200–400 pM

* A single 200-cycle kit does not include enough reagents to complete Reads 1 and 2 in addition to the 8-bp i7 and 10-bp i5 index reads in this format. If preferred, the additional reads may be supported by using one 200-cycle kit plus one 50-cycle kit.

† Do not use HiSeq 2500 High Output (v4 chemistry) runs if your analysis pipeline includes molecular barcode (i5) reads. Reduced molecular barcode sequence quality and lowered Q scores have been observed in sequences obtained from HiSeq 2500 platform runs under these conditions. Sequencing performance for Read 1, Read 2, and sample-level index (i7) reads is not affected.

‡ Use of 300 Cycle Kits on these platforms also supports 2 × 150 bp read length sequencing, as recommended for translocation detection with the SureSelect Cancer All-In-One assay.

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 5. Prepare sequencing samples

Use the following additional considerations for sequencing set up for SureSelect Cancer All-In-One assays:

- For All-In-One assays that include translocation detection, Agilent strongly recommends using paired-end sequencing read length of at least 2×100 bp and preferably 2×150 bp.
- The *All-In-One Analysis* workflow in Agilent's SureCall application (v4.1) does not currently use molecular barcodes to remove duplicate reads. Collection of the 10-bp i5 index reads is therefore not required specifically for samples analyzed using this workflow.

Step 6. Do the sequencing run and analyze the data

Use the guidelines below for SureSelect^{XT HS} library sequencing run setup and analysis.

- The sample-level index (i7) requires an 8-bp index read. For complete i7 index sequence information, see [Table 42](#) on page 91.

CAUTION

The 8-bp index sequences in SureSelect XT HS Index Primers A01 through H04 differ from the 8-bp index sequences in index primers A01 through H04 in Agilent's SureSelect XT system.

NOTE

- The degenerate molecular barcode (i5) requires a 10-bp index read.

If you are using the SureCall (v4.1) *All-In-One Analysis* workflow for analysis of SureSelect Cancer All-In-One assays, this workflow does not currently include molecular barcode analysis, and you can modify the steps in this section to omit collection and analysis of i5 index reads if desired.

- For the HiSeq, NextSeq, and NovaSeq platforms, set up the run using the instrument's user interface, following the guidelines on [page 74](#).
- For the MiSeq platform, set up the run using Illumina Experiment Manager (IEM) using the steps detailed on [page 77](#) to [page 80](#) to generate a custom sample sheet.
- Retrieval of I2 index files containing the molecular barcode (i5) index reads requires offline conversion of .bcl to fastq files. For information on how to do this step, see [page 74](#) for HiSeq, NextSeq and NovaSeq runs and see [page 80](#) for MiSeq runs.
- Before aligning reads to the reference genome, trim the reads from Illumina adaptor sequences. See [page 80](#) for information on Agilent's SureCall data analysis software, which may be used for this task.

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 6. Do the sequencing run and analyze the data

HiSeq/NextSeq/NovaSeq platform sequencing run setup guidelines

Set up sequencing runs using the instrument control software interface. A sample run setup for the HiSeq platform using 100 + 100 bp paired-end sequencing is shown below.

The screenshot displays the 'RUN CONFIGURATION' window with the 'PRE-RUN SETUP' tab active. The 'Recipe' sub-tab is selected, showing a progress bar with steps: Volume Check, Integration, Storage, Flow Cell Setup, Advanced, Recipe (current), and Sample Sheet. A message box says 'Check remaining parameters and select NEXT to continue.' Below this, the 'Index Type' section has four radio buttons: 'No Index', 'Single Index', 'Dual Index', and 'Custom' (which is selected and circled in red). The 'Flow Cell Format' section has two radio buttons: 'Single Read' and 'Paired End' (which is selected and circled in red). At the bottom, a table-like structure shows the sequencing parameters for four lanes: Read 1, Index 1 (i7), Index 2 (i5), and Read 2. Each lane has a 'Cycles' field and a grid icon. The values are: Read 1 (100), Index 1 (8), Index 2 (10), and Read 2 (100). The entire 'Cycles' row is circled in red.

Read 1	Index 1 (i7)	Index 2 (i5)	Read 2
Cycles: 100	8	10	100

If using the NextSeq or NovaSeq platform, locate the same parameters on the *Run Setup* screen, and populate the **Read Length** fields using the **Cycles** settings shown in HiSeq platform example above. In the **Custom Primers** section of the NextSeq or NovaSeq platform *Run Setup* screen, clear (do **not** select) the checkboxes for all primers (*Read 1*, *Read 2*, *Index 1* and *Index 2*).

BaseSpace currently does not support the sequencing of molecular barcodes as index reads. Set up NextSeq runs using the stand-alone mode.

Retrieve I2 FASTQ files containing molecular barcodes

Retrieval of I2 index files containing the molecular barcode (i5) index reads requires offline conversion of .bcl to fastq files using one of the two methods below.

Option 1: Use bcl2fastq software with base masking

To generate Index 2 fastq files containing the P5 molecular barcodes using the bcl2fastq software, follow Illumina's instructions for use of the software with the following modifications:

- 1 Use of a sample sheet is mandatory and not optional. Modify the sample sheet to include only the sample index and not the molecular barcode index by clearing the contents in the **I5_Index_ID** and **index2** columns.
- 2 Set **mask-short-adaptor-reads** to value of 0.
- 3 Use the following base mask: Y*, I8, Y10, Y* (where * should be replaced with the actual read length, with the value entered matching the read length value in the RunInfo.xml file).

CAUTION

When generating fastq files using Illumina's bcl2fastq software, make sure to clear the contents of the **index2** column in the sample sheet as described above. **Do not enter an N₁₀ sequence to represent the degenerate molecular barcode**; instead, simply leave the column cells cleared.

The bcl2fastq software does not treat the "N" character as a wildcard when found in sample sheet index sequences, and usage in this context will cause a mismatch for any sequence character other than "N".

Option 2: Use Broad Institute Picard tools

To generate Index 2 fastq files containing the P5 molecular barcodes using the Broad Institute Picard tools, complete the following steps:

- 1 Use tool **ExtractIlluminaBarcodes** to find the barcodes. A sample set of commands is shown below (commands used by your facility may vary).

```
nohup java -jar picard.jar ExtractIlluminaBarcodes
BASECALLS_DIR=<sequencing_run_directory>/Data/Intensities/BaseCalls/
OUTPUT_DIR=<barcode_output_dir_name> LANE=1 READ_STRUCTURE=<read_structure>
BARCODE_FILE=<barcode_file> METRICS_FILE=<metric_file_name>
NUM_PROCESSORS=<n>
```

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 6. Do the sequencing run and analyze the data

- 2 Use tool **IlluminaBaseCallsToFastq** to generate the fastq files based on output of step 1. A sample set of commands is shown below (commands used by your facility may vary).

```
nohup java -jar picard.jar IlluminaBasecallsToFastq  
BASECALLS_DIR=<sequencing_run_directory>/Data/Intensities/BaseCalls/ LANE=1  
BARCODES_DIR=<barcode_output_dir_name> READ_STRUCTURE=<read_structure>  
FLOWCELL_BARCODE=<FCID> MACHINE_NAME=<machine_name>  
RUN_BARCODE=<run_number> ADAPTERS_TO_CHECK=PAIRED_END  
NUM_PROCESSORS=<n> READ_NAME_FORMAT=CASAVA_1_8 COMPRESS_OUTPUTS=true  
MULTIPLEX_PARAMS=<multiplex_params_file> IGNORE_UNEXPECTED_BARCODES=true  
TMP_DIR=<temp_directory_location>
```

MiSeq platform sequencing run setup guidelines

Use the Illumina Experiment Manager (IEM) software to generate a custom Sample Sheet according to the guidelines below. Once a Sample Sheet has been generated, index sequences need to be manually changed to the SureSelect XT HS indexes used for each sample. See [Table 42](#) on page 91 for nucleotide sequences of the SureSelect XT HS system indexes.

Set up a custom Sample Sheet:

- 1 In the IEM software, create a Sample Sheet for the MiSeq platform using the following Workflow selections.
 - Under **Category**, select *Other*.
 - Under **Application**, select *FASTQ Only*.
- 2 On the **Workflow Parameters** screen, enter the run information, making sure to specify the key parameters highlighted below. In the *Library Prep Workflow* field, select **TruSeq Nano DNA**. In the *Index Adapters* field, select **TruSeq DNA CD Indexes (96 Indexes)**. If your pipeline uses SureCall for adaptor trimming, then make sure to clear both adaptor-trimming checkboxes under *FASTQ Only Workflow-Specific Settings* (circled below), since these are selected by default.

If **TruSeq Nano DNA** is not available in the *Sample Prep Kit* field, instead select **TruSeq HT**.

FASTQ Only Run Settings

Reagent Cartridge Barcode* MS5871368-300V2

Library Prep Workflow TruSeq Nano DNA

Index Adapters TruSeq DNA CD Indexes (96 Indexes)

Index Reads ☐ 0 (None) ☐ 1 (Single) ☒ 2 (Dual)

Experiment Name

Investigator Name

Description

Date 1/22/2018

Read Type ☒ Paired End ☐ Single Read

Cycles Read 1 100

Cycles Read 2 100

FASTQ Only Workflow-Specific Settings

☐ Custom Primer for Read 1

☐ Custom Primer for Index

☐ Custom Primer for Read 2

☐ Reverse Complement

☐ Use Adapter Trimming

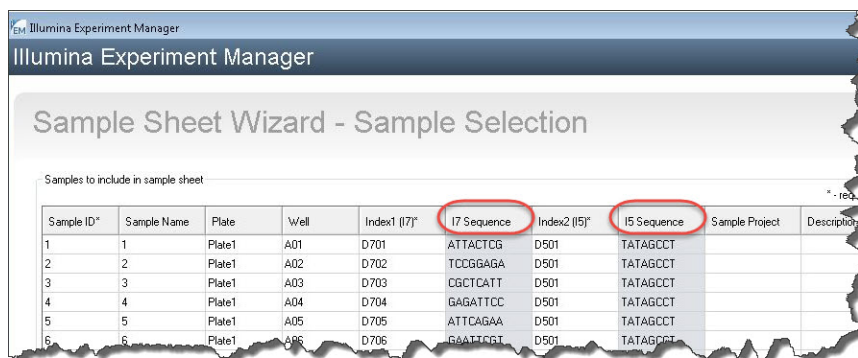
☐ Use Adapter Trimming Read 2

4 Post-Capture Sample Processing for Multiplexed Sequencing

Step 6. Do the sequencing run and analyze the data

- 3 Using the **Sample Sheet Wizard**, set up a New Plate, entering the required information for each sample to be sequenced. In the **I7 Sequence** column, assign each sample to any of the Illumina i7 indexes. The index will be corrected to a SureSelect XT HS index at a later stage.

Likewise, in the **I5 Sequence** column, assign any of the Illumina i5 indexes, to be corrected to the degenerate molecular barcode at a later stage.



Sample ID*	Sample Name	Plate	Well	Index1 (I7)*	I7 Sequence	Index2 (I5)*	I5 Sequence	Sample Project	Description
1	1	Plate1	A01	D701	ATTACTCG	D501	TATAGCCT		
2	2	Plate1	A02	D702	TCCGGAGA	D501	TATAGCCT		
3	3	Plate1	A03	D703	CGCTCATT	D501	TATAGCCT		
4	4	Plate1	A04	D704	GAGATTCC	D501	TATAGCCT		
5	5	Plate1	A05	D705	ATTCAGAA	D501	TATAGCCT		
6	6	Plate1	A06	D706	GAATTGGT	D501	TATAGCCT		

- 4 Finish the sample sheet setup tasks and save the sample sheet file.

Edit the Sample Sheet to include SureSelect XT HS indexes and molecular barcodes

- 1 Open the Sample Sheet file in a text editor and edit the i7 and i5 index information for each sample in columns 5–8 (highlighted in Figure 15).
- In column 5 under **I7_Index_ID**, enter the name of the SureSelect XT HS index assigned to the sample. In column 6 under **index**, enter the corresponding SureSelect XT HS Index sequence. See Table 42 on page 91 for nucleotide sequences of the SureSelect XT HS indexes.
- In column 7 under **I5_Index_ID**, enter *MBC* for all samples. In column 8 under **index2**, enter text *NNNNNNNNNN* for all samples to represent the degenerate 10-nucleotide molecular barcode tagging each fragment.

NOTE

Enter N₁₀ text in the **index2** column only when sample sheets are processed using MiSeq Reporter software adjusted to retrieve I2 fastq files containing molecular barcodes, as detailed on page 80. Sample sheets processed offline using Illumina's bcl2fastq software must not contain N₁₀ wildcard index sequences. See page 75 for more information.

[Header]									
IEMFileVer		5							
Experimen	XTHS								
Date		1/22/2018							
Workflow	GenerateFASTQ								
Application	FASTQ Only								
Instrument	MiSeq								
Assay	TruSeq Nano DNA								
Index Ada	TruSeq DNA CD Indexes (96 Indexes)								
Description									
Chemistry	Amplicon								
[Reads]									
	100								
	100								
[Settings]									
ReverseCc		0							
[Data]									
Sample_ID	Sample_Name	Sample_Plate	Sample_W	Index_Plate_W	I7_Index_ID	index	I5_Index_I	index2	Sample
XTHS-S1	XTHS-S1	1	A01	A01	A01	GTCTGTCA	MBC	NNNNNNNNNN	XTHS
XTHS-S2	XTHS-S2	1	B01	B01	B01	TGAAGAGA	MBC	NNNNNNNNNN	XTHS

Figure 15 Sample sheet for use with MiSeq platform after MiSeq Reporter reconfiguration

- 2 Save the edited Sample Sheet in an appropriate file location for use in the MiSeq platform run.

Reconfigure the MiSeq Reporter Software to retrieve I2 FASTQ files

By default, MiSeq Reporter software does not generate fastq files for index reads. To generate fastq I2 index files containing the molecular barcode reads using MiSeq Reporter, adjust the software settings as described below before the first use of the MiSeq instrument for SureSelect XT HS library sequencing. Once changed, this setting is retained for future runs.

To change this setting, open the file **MiSeq Reporter.exe.config**. Under the **<appSettings>** tag, add **<add key="CreateFastqForIndexReads" value="1"/>**. You must restart the instrument for this setting change to take effect.

NOTE

If you are using the same instrument for assays other than SureSelect XT HS library sequencing, the configuration file should be edited to **<add key="CreateFastqForIndexReads" value="0"/>** and the instrument should be restarted before running the other assay.

If you are using the MiSeqDx platform, run the instrument in research mode to make changes to MiSeq Reporter settings. If research mode is not available on your instrument, you may need to upgrade the system to include the dual boot configuration to allow settings changes in research mode.

The alternative methods for retrieval of I2 fastq files described on [page 74](#) for HiSeq and NextSeq platform runs may also be applied to MiSeq platform runs.

Sequence analysis resources

Agilent SureCall NGS data analysis software is designed to perform adaptor trimming, alignment of reads, and variant calling of sequencing data generated from SureSelect^{XT HS} libraries. To download SureCall free-of-charge and for additional information, including SureCall software tutorials, visit www.agilent.com/surecall.

If using another pipeline for alignment and downstream analysis, Agilent provides the Agilent Genomics NextGen Toolkit (AGeNT), with certain of the Agilent SureCall capabilities in a flexible command-line interface for integration into your bioinformatics pipeline. AGeNT is a Java-based software module that has been designed to provide adaptor and low-quality bases trimming and duplicate read removal for high-sensitivity (HS) and non-HS data. This tool is explicitly designed for users with established in-house bioinformatics experts with the capability to build, integrate, maintain, and troubleshoot internal analysis pipelines. Moreover, the module is designed specifically for users with sufficient computing

infrastructure and IT support to troubleshoot all issues unrelated to the execution of the AGeNT algorithms. Because Agilent provides limited support of AGeNT, users with limited bioinformatics expertise should instead use Agilent SureCall software. Agilent does not guarantee the usability of third party tools (open- or closed-source) in upstream/downstream analysis of data in conjunction with AGeNT. For additional information on this tool, visit the [AGeNT page at www.agilent.com](http://www.agilent.com).

4 Post-Capture Sample Processing for Multiplexed Sequencing

Sequence analysis resources



5 Appendix: Using FFPE-derived DNA Samples

Protocol modifications for FFPE Samples 84

Methods for FFPE Sample Qualification 84

Sequencing Output Recommendations for FFPE Samples 85

This chapter summarizes the protocol modifications to apply to FFPE samples based on the integrity of the FFPE sample DNA.



Protocol modifications for FFPE Samples

Protocol modifications that should be applied to FFPE samples are summarized in [Table 33](#).

Table 33 Summary of protocol modifications for FFPE samples

Workflow Step and page	Parameter	Condition for non-FFPE Samples	Condition for FFPE Samples
gDNA Sample Preparation page 23	Qualification of DNA Integrity	Not required	Required
DNA input for Library Preparation page 23	Input amount and means of quantification	10 ng to 200 ng, quantified by Qubit assay	Based on determined DNA integrity (see Table 8 on page 24 and Table 9 on page 25)
DNA Shearing page 27	Mode of DNA Shearing	2 × 120 seconds	240 seconds (continuous)
Pre-capture PCR page 37	Cycle number	8–11	11–14
Sequencing page 85	Output augmentation	Per project requirements	1× to 10× based on determined DNA integrity (see Table 34 and Table 35 on page 85)

Methods for FFPE Sample Qualification

DNA integrity may be assessed using the Agilent NGS FFPE QC Kit or using the Agilent TapeStation instrument and Genomic DNA ScreenTape.

The Agilent NGS FFPE QC Kit provides a qPCR-based assay for DNA sample integrity determination. Results include the precise quantity of amplifiable DNA in the sample to allow direct normalization of input DNA amount and a $\Delta\Delta Cq$ DNA integrity score used to design other protocol modifications.

The Agilent TapeStation instrument, combined with the Genomic DNA ScreenTape assay, provides an automated electrophoresis method for determination of a DNA Integrity Number (DIN) score used to estimate amount of input DNA required for sample normalization and to design other protocol modifications.

Sequencing Output Recommendations for FFPE Samples

After determining the amount of sequencing output required for intact DNA samples to meet the goals of your project, use the guidelines below to determine the amount of extra sequencing output required for FFPE DNA samples.

Samples qualified using $\Delta\Delta\text{Cq}$: For samples qualified based on the $\Delta\Delta\text{Cq}$ DNA integrity score, use the guidelines in [Table 34](#). For example, if your workflow demands 100 Mb output for intact DNA samples to achieve the required coverage, an FFPE sample with $\Delta\Delta\text{Cq}$ score of 1 requires 200–400 Mb of sequencing output to achieve the same coverage.

Table 34 Recommended sequencing augmentation for FFPE-derived DNA samples

$\Delta\Delta\text{Cq}$ value	Recommended fold increase for FFPE-derived sample
<0.5	No extra sequencing output
between 0.5 and 2	Increase sequencing allocation by 2× to 4×
>2	Increase sequencing allocation by 5× to 10× or more

Samples qualified using DIN: For samples qualified based on the Genomic DNA ScreenTape assay DIN integrity score, use the guidelines in [Table 35](#). For example, if your workflow demands 100 Mb output for intact DNA samples to achieve the required coverage, an FFPE sample with DIN score of 4 requires approximately 200–400 Mb of sequencing output to achieve the same coverage.

Table 35 Recommended sequencing augmentation for FFPE-derived DNA samples

DIN value	Recommended fold increase for FFPE-derived sample
≥8	No extra sequencing output
between 3 and 8	Increase sequencing allocation by 2× to 4×
<3	Increase sequencing allocation by 5× to 10× or more

5 Appendix: Using FFPE-derived DNA Samples

Sequencing Output Recommendations for FFPE Samples



6 Reference

Kit Contents	88
Nucleotide Sequences of SureSelect XT HS Indexes	91
Troubleshooting Guide	92
Quick Reference Protocol	96

This chapter contains reference information, including component kit contents, index sequences, troubleshooting information, and a quick-reference protocol for experienced users.



Kit Contents

SureSelect XT HS Reagent Kits include the component kits listed in [Table 36](#). Detailed contents of each of the multi-part component kits listed in [Table 36](#) are shown in [Table 37](#) through [Table 40](#).

Table 36 Contents of SureSelect XT HS Reagent Kits

Component Kit Name	Storage Condition	Component Kit Part Number	
		16 Reaction Kits (G9702A, G9702B)	96 Reaction Kits (G9702C)
SureSelect XT HS Library Preparation Kit for ILM (Pre PCR)	–20°C	5500-0138	5500-0140
SureSelect XT HS Index Primers for ILM (Pre PCR)	–20°C	5500-0141 (Indexes 1–16), OR 5500-0142 (Indexes 17–32)	5190-9876 (Indexes 1-32)
SureSelect Target Enrichment Kit ILM Hyb Module, Box 1 (Post PCR)	Room Temperature	5190-9685	5190-9687
SureSelect XT HS Target Enrichment Kit ILM Hyb Module, Box 2 (Post PCR)	–20°C	5190-9684	5190-9686

Table 37 SureSelect XT HS Library Preparation Kit (Pre PCR) Content

Kit Component	16 Reactions (p/n 5500-0138)	96 Reactions (5500-0140)
End Repair-A Tailing Enzyme Mix	tube with orange cap	tube with orange cap
End Repair-A Tailing Buffer	tube with yellow cap	bottle
T4 DNA Ligase	tube with blue cap	tube with blue cap
Ligation Buffer	tube with purple cap	bottle
Adaptor Oligo Mix	tube with white cap	tube with white cap
Forward Primer	tube with brown cap	tube with brown cap
100 mM dNTP Mix (25 mM each dNTP)	tube with green cap	tube with green cap
Herculase II Fusion DNA Polymerase	tube with red cap	tube with red cap
5× Herculase II Reaction Buffer	tube with clear cap	tube with clear cap

Table 38 SureSelect XT HS Index Primers Kit (Pre PCR) Content

Kit Component	16 Reaction Kit, Index Primers 1-16 (p/n 5500-0141)	16 Reaction Kit, Index Primers 17-32 (p/n 5500-0142)	96 Reaction Kit, I Index Primers 1-32 (p/n 5190-9876)
SureSelect XT HS Index Primers (reverse primers containing 8-bp index sequence)*	SureSelect XT HS Index Primers A01 through H02, provided in 16 black-capped tubes	SureSelect XT HS Index Primers A03 through H04, provided in 16 black-capped tubes	SureSelect XT HS Index Primers A01 through H04, provided in 96 black-capped tubes (3 vials of each of 32 different primers)

* See [Table 42](#) on page 91 for index sequences.

CAUTION

The SureSelect XT HS Index Primers are provided in single-use aliquots. To avoid cross-contamination of libraries, discard each vial after use in one library preparation reaction. Do not retain and re-use any residual volume for subsequent experiments.

Table 39 SureSelect Target Enrichment Kit ILM Hyb Module, Box 1 (Post PCR) Content

Kit Component	16 Reactions (p/n 5190-9685)	96 Reactions (5190-9687)
SureSelect Binding Buffer	bottle	bottle
SureSelect Wash Buffer 1	bottle	bottle
SureSelect Wash Buffer 2	bottle	bottle

Table 40 SureSelect XT HS Target Enrichment Kit ILM Hyb Module, Box 2 (Post PCR) Content

Kit Component	16 Reactions (p/n 5190-9684)	96 Reactions (5190-9686)
SureSelect Fast Hybridization Buffer	bottle	bottle
SureSelect XT HS and XT Low Input Blocker Mix	tube with blue cap	tube with blue cap
SureSelect RNase Block	tube with purple cap	tube with purple cap
SureSelect Post-Capture Primer Mix	tube with clear cap	tube with clear cap
100 mM dNTP Mix (25 mM each dNTP)	tube with green cap	tube with green cap
Herculase II Fusion DNA Polymerase	tube with red cap	tube with red cap
5× Herculase II Reaction Buffer	tube with clear cap	tube with clear cap

Bundles of SureSelect XT HS Reagent Kits with certain Target Enrichment Probes are available for purchase using the Agilent part numbers listed in [Table 41](#). The SureSelect XT HS Reagent Kits included in these bundles are supplied with the same component kits listed in [Table 36](#) on [page 88](#).

Table 41 Supported SureSelect XT HS Reagent Kit + Probe Bundles

Included SureSelect (SSel) XT HS Probe Capture Library	Included SureSelect XT HS Reagent Kit		
	16 Reactions, with Index Primers 1–16	16 Reactions, with Index Primers 17–32	96 Reactions, with Index Primers 1–32
Custom 1–499 kb*	G9704A	G9705A	G9706A
Custom 0.5 –2.9 Mb*	G9704B	G9705B	G9706B
Custom 3–5.9 Mb*	G9704C	G9705C	G9706C
Custom 6–11.9 Mb*	G9704D	G9705D	G9706D
Custom 12–24 Mb*	G9704E	G9705E	G9706E
ClearSeq Comp Cancer	G9704G	G9705G	G9706G
Clinical Research Exome V2	G9704H	G9705H	G9706H
Clinical Research Exome V2 Plus	G9704J	G9705J	G9706J
Human All Exon V6	G9704K	G9705K	G9706K
Human All Exon V6 Plus	G9704L	G9705L	G9706L
Human All Exon V6+UTRs	G9704M	G9705M	G9706M
Human All Exon V7	G9704N	G9705N	G9706N
Human All Exon V7 Plus 1	G9704P	G9705P	G9706P
Human All Exon V7 Plus 2	G9704Q	G9705Q	G9706Q
Cancer All-In-One Lung	G9704R	G9705R	G9706R
Cancer All-In-One Solid Tumor	G9704S	G9705S	G9706S

* Kits that include Custom SureSelect Cancer All-In-One panels, designed using Agilent’s SureDesign application, are ordered using these bundled custom design Agilent part numbers. The Custom SureSelect Cancer All-In-One panels are designated using design IDs beginning with an ‘A’ character. (Refer to the probe vial label and the associated Certificate of Analysis to view the design ID.)

Nucleotide Sequences of SureSelect XT HS Indexes

The SureSelect XT HS Index Primers are provided in individual tubes containing single-use aliquots. Tubes are labeled using well position references indicating the recommended well position for runs of up to 32 samples (see [Table 42](#)).

Each index is 8 nt in length. See [page 73](#) for sequencing run setup requirements for sequencing libraries using 8-bp indexes.

Table 42 SureSelect XT HS Indexes 1–32 (A01–H04), provided in black-capped tubes

Index #	Well Reference	Sequence	Index #	Well Reference	Sequence
1	A01	GTCTGTCA	17	A03	AGCAGGAA
2	B01	TGAAGAGA	18	B03	AGCCATGC
3	C01	TTCACGCA	19	C03	TGGCTTCA
4	D01	AACGTGAT	20	D03	CATCAAGT
5	E01	ACCACTGT	21	E03	CTAAGGTC
6	F01	ACCTCCAA	22	F03	AGTGGTCA
7	G01	ATTGAGGA	23	G03	AGATCGCA
8	H01	ACACAGAA	24	H03	ATCCTGTA
9	A02	GCGAGTAA	25	A04	CCGTGAGA
10	B02	GTCGTAGA	26	B04	GACTAGTA
11	C02	GTGTTCTA	27	C04	GATAGACA
12	D02	TATCAGCA	28	D04	GCTCGGTA
13	E02	TGGAACAA	29	E04	GGTGCGAA
14	F02	TGGTGGTA	30	F04	AACAACCA
15	G02	ACTATGCA	31	G04	CGGATTGC
16	H02	CCTAATCC	32	H04	AGTCACTA

CAUTION

The 8-bp index sequences in SureSelect XT HS Index Primers A01 through H04 differ from the 8-bp index sequences in index primers A01 through H04 in Agilent's SureSelect XT system.

Troubleshooting Guide

If recovery of gDNA from samples is low

- ✓ Using excess tissue for gDNA isolation can reduce yield. Use only the amount of each specific tissue type recommended by the gDNA isolation protocol.
- ✓ Tissue sample lysis may not have been optimal during gDNA isolation. Monitor the extent of sample lysis during the Proteinase K digestion at 56°C by gently pipetting the digestion reaction every 20–30 minutes, visually inspecting the solution for the presence of tissue clumps. If clumps are still present after the 1-hour incubation at 56°C, add another 10 µl of Proteinase K and continue incubating at 56°C, with periodic mixing and visual inspections, for up to two additional hours. When the sample no longer contains clumps of tissue, move the sample to room temperature until lysis is complete for the remaining samples. Do not over-digest. Individual samples may be kept at room temperature for up to 2 hours before resuming the protocol. Do not exceed 3 hours incubation at 56°C for any sample.

If yield of pre-capture libraries is low

- ✓ The library preparation protocol includes specific thawing, temperature control, pipetting, and mixing instructions which are required for optimal performance of the highly viscous buffer and enzyme solutions used in the protocol. Be sure to adhere to all instructions when setting up the reactions.
- ✓ Ensure that the ligation master mix (see [page 30](#)) is kept at room temperature for 30–45 minutes before use.
- ✓ PCR cycle number may require optimization. Repeat library preparation for the sample, increasing the pre-capture PCR cycle number by 1 to 2 cycles. If a high molecular weight peak (>500 bp) is observed in the electropherogram for a sample with low yield, the DNA may be overamplified. Repeat library preparation for the sample, decreasing the pre-capture PCR cycle number by 1 to 3 cycles.
- ✓ DNA isolated from degraded samples, including FFPE tissue samples, may be over-fragmented or have modifications that adversely affect library preparation processes. Use the Agilent NGS FFPE QC Kit to determine the precise quantity of amplifiable DNA in the sample and allow direct normalization of input DNA amount.

- ✓ Performance of the solid-phase reversible immobilization (SPRI) purification step may be poor. Verify the expiration date for the vial of AMPure XP beads used for purification. Adhere to all bead storage and handling conditions recommended by the manufacturer. Ensure that the beads are kept at room temperature for at least 30 minutes before use. Use freshly-prepared 70% ethanol for each SPRI procedure.
- ✓ DNA elution during SPRI purification steps may be incomplete. Ensure that the AMPure XP beads are not overdried just prior to sample elution.

If solids observed in the End Repair-A Tailing Buffer

- ✓ Vortex the solution at high speed until the solids are dissolved. The observation of solids when first thawed does not impact performance, but it is important to mix the buffer until all solutes are dissolved.

If pre-capture library fragment size is larger than expected in electropherograms

- ✓ Shearing may not be optimal. For intact, high-quality DNA samples, ensure that shearing is completed using the two-round shearing protocol provided, including all spinning and vortexing steps.
- ✓ Any bubbles present on the microTUBE filament may disrupt complete shearing. Spin the microTUBE for 30 seconds before the first round of shearing to ensure that any bubbles are released.

If pre-capture library fragment size is different than expected in electropherograms

- ✓ FFPE DNA pre-capture libraries may have a smaller fragment size distribution due to the presence of DNA fragments in the input DNA that are smaller than the target DNA shear size.
- ✓ DNA fragment size selection during SPRI purification depends upon using the correct ratio of sample to AMPure XP beads. Before removing an aliquot of beads for the purification step, mix the beads until the suspension appears homogeneous and consistent in color and verify that you are using the bead volume recommended for pre-capture purification on [page 39](#).

If low molecular weight adaptor-dimer peak is present in pre-capture library electropherograms

- ✓ The presence of a low molecular weight peak, in addition to the expected peak, indicates the presence of adaptor-dimers in the library. It is acceptable to proceed to target enrichment with library samples for which adaptor-dimers are observed in the electropherogram at low abundance, similar to the samples analyzed on [page 42](#) to [page 45](#). The presence of excessive adaptor-dimers in the samples may be associated with reduced yield of pre-capture libraries. If excessive adaptor-dimers are observed, verify that the adaptor ligation protocol is being performed as directed on [page 33](#). In particular, ensure that the Ligation master mix is mixed with the sample prior to adding the Adaptor Oligo Mix to the mixture. Do not add the Ligation master mix and the Adaptor Oligo Mix to the sample in a single step.
- ✓ For whole-genome sequencing (not specifically supported by this protocol), samples with an adaptor-dimer peak must be subjected to an additional round of SPRI-purification. To complete, first dilute the sample to 50 µl with nuclease free water, then follow the SPRI purification procedure on [page 39](#).

If yield of post-capture libraries is low

- ✓ PCR cycle number may require optimization. Repeat library preparation and target enrichment for the sample, increasing the post-capture PCR cycle number by 1 to 2 cycles.
- ✓ The RNA Probe Capture Library used for hybridization may have been compromised. Verify the expiration date on the Probe vial or Certificate of Analysis. Adhere to the recommended storage and handling conditions. Ensure that the Capture Library Hybridization Mix is prepared immediately before use, as directed on [page 51](#), and that solutions containing the Probe are not held at room temperature for extended periods.

If post-capture library fragment size is different than expected in electropherograms

- ✓ DNA fragment size selection during SPRI purification depends upon using the correct ratio of sample to AMPure XP beads. Before removing an aliquot of beads for the purification step, mix the beads until the suspension appears homogeneous and consistent in color and verify that you are using the bead volume recommended for post-capture purification on [page 61](#).

If low % on-target is observed in library sequencing results

- ✓ Stringency of post-hybridization washes may have been lower than required. Complete the wash steps as directed, paying special attention to the details of SureSelect Wash Buffer 2 washes listed below:
 - SureSelect Wash Buffer 2 is pre-warmed to 70°C (see [page 54](#))
 - Samples are maintained at 70°C during washes (see [page 55](#))
 - Bead suspensions are mixed thoroughly during washes by pipetting up and down **and** vortexing (see [page 55](#))
- ✓ Minimize the amount of time that hybridization reactions are exposed to RT conditions during hybridization setup. Locate a vortex and plate spinner or centrifuge in close proximity to thermal cycler to retain the 65°C sample temperature during mixing and transfer steps ([step 8](#) to [step 9](#) on [page 52](#)).

If low uniformity of coverage with high AT-dropout is observed in library sequencing results

- ✓ High AT-dropout may indicate that hybridization conditions are too stringent to obtain the desired level of coverage for AT-rich targets. Repeat target enrichment at lower stringency using a modified thermal cycler program for hybridization, reducing the hybridization temperature in segments 4 and 5 from 65°C to 62.5°C or 60°C (see [Table 21](#) on [page 49](#)).

Quick Reference Protocol

An abbreviated summary of the protocol steps is provided below for experienced users. Use the complete protocol on [page 22](#) to [page 80](#) until you are familiar with all of the protocol details such as reagent mixing instructions and instrument settings.

Step	Summary of Conditions
Library Prep	
Prepare and qualify DNA samples	Prepare 10–200 ng gDNA in 50 µl Low TE For FFPE DNA, qualify integrity and adjust input amount as directed on page 24 and page 25
Shear DNA	Use shearing conditions on page 27 , with two rounds of duration 120 seconds for high-quality DNA and single round of duration of 240 seconds for FFPE DNA
Prepare Ligation master mix	Per reaction: 23 µl Ligation Buffer + 2 µl T4 DNA Ligase Keep at room temperature 30–45 min before use
Prepare End-Repair/dA-Tailing master mix	Per reaction: 16 µl End Repair-A Tailing Buffer + 4 µl End Repair-A Tailing Enzyme Mix Keep on ice
End-Repair and dA-Tail the sheared DNA	50µl sheared DNA sample + 20 µl End Repair/dA-Tailing master mix Incubate in thermal cycler: 15 min @ 20°C, 15 min @ 72°C, Hold @ 4°C
Ligate adaptor	70 µl DNA sample + 25 µl Ligation master mix +5 µl Adaptor Oligo Mix Incubate in thermal cycler: 30 min @ 20°C, Hold @ 4°C
Purify DNA	100 µl DNA sample + 80 µl AMPure XP bead suspension Elute DNA in 35 µl nuclease-free H ₂ O
Prepare PCR master mix	Per reaction: 10 µl 5× Herculase II Reaction Buffer + 0.5 µl 100 mM dNTP Mix + 2 µl Forward Primer + 1 µl Herculase II Fusion DNA Polymerase Keep on ice
Amplify the purified DNA	34.5 µl purified DNA + 13.5 µl PCR master mix + 2 µl assigned SureSelect XT HS Index Primer Amplify in thermal cycler using program on page 37
Purify amplified DNA	50 µl amplified DNA + 50 µl AMPure XP bead suspension Elute DNA in 15 µl nuclease-free H ₂ O
Quantify and qualify DNA	Analyze 1 µl using Agilent 2100 Bioanalyzer or 4200 TapeStation instrument

Step	Summary of Conditions
Hybridization/Capture	
Program thermal cycler	Input thermal cycler program on page 49 and pause program
Prep DNA in Hyb plate	Adjust 500–1000 ng purified prepared library to 12 µl volume with nuclease-free H ₂ O
Run pre-hybridization blocking protocol	12 µl library DNA + 5 µl SureSelect XT HS and XT Low Input Blocker Mix Run paused thermal cycler program segments 1 through 3; start new pause during segment 3 (1 min @ 65°C)
Prepare Capture Library Hyb Mix	Prepare 25% RNase Block dilution, then prepare appropriate mixture below: Probes ≥3 Mb: 2 µl 25% RNase Block + 5 µl Probe + 6 µl SureSelect Fast Hybridization Buffer Probes <3 Mb: 2 µl 25% RNase Block + 2 µl Probe + 3 µl nuclease-free H ₂ O + 6 µl SureSelect Fast Hybridization Buffer
Run the hybridization	With cycler paused and samples retained in cycler, add 13 µl Capture Library Hyb Mix to wells Resume the thermal cycler program, completing segments 4 (hybridization) and 5 (65°C hold)
Prepare streptavidin beads	Wash 50 µl Dynabeads MyOne Streptavidin T1 beads 3× in 200 µl SureSelect Binding Buffer
Capture hybridized libraries	Add hybridized samples (~30 µl) to washed streptavidin beads (200 µl) Incubate 30 min at RT with vigorous shaking (1400-1800 rpm) During incubation, pre-warm 6 × 200 µl aliquots per sample of SureSelect Wash Buffer 2 to 70°C
Wash captured libraries	Collect streptavidin beads with magnetic stand, discard supernatant Wash beads 1× with 200 µl SureSelect Wash Buffer 1 at RT Wash beads 6× with 200 µl pre-warmed SureSelect Wash Buffer 2 (5 minutes at 70°C per wash) Resuspend washed beads in 25 µl nuclease-free H ₂ O
Post-capture amplification	
Prepare PCR master mix	Per reaction: 12.5 µl nuclease-free H ₂ O + 10 µl 5× Herculase II Reaction Buffer + 0.5 µl 100 mM dNTP Mix + 1 µl SureSelect Post-Capture Primer Mix + 1 µl Herculase II Fusion DNA Polymerase Keep on ice
Amplify the bead-bound captured libraries	25 µl DNA bead suspension + 25 µl PCR master mix Amplify in thermal cycler using conditions on page 59
Purify amplified DNA	Remove streptavidin beads using magnetic stand; retain supernatant 50 µl amplified DNA + 50 µl AMPure XP bead suspension Elute DNA in 25 µl nuclease-free H ₂ O
Quantify and qualify DNA	Analyze 1 µl using Agilent 2100 Bioanalyzer or 4200 TapeStation instrument

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In This Book

This guide contains information to run the SureSelect^{XT} HS target enrichment protocol.

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