

Nov 12, 2025

Enzolution™ WRN Helicase ATPase Assay System Technical Manual

DOI

<https://dx.doi.org/10.17504/protocols.io.3byl468ergo5/v1>

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Protocol Citation: info 2025. Enzolution™ WRN Helicase ATPase Assay System Technical Manual. **protocols.io**
<https://dx.doi.org/10.17504/protocols.io.3byl468ergo5/v1>

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Protocol status: Working

We use this protocol and it's working

Created: October 28, 2025

Last Modified: November 12, 2025

Protocol Integer ID: 230989

Keywords: enzymatic activity for wrn helicase, wrn helicase inhibitor, purified human wrn helicase, human wrn helicase, wrn helicase, helicase activity, dna substrate, enzymatic activity, formation by the wrn helicase, atp, assay, multifunctional enzyme, stranded dna, exonuclease activity, inhibitor dose response measurement, dependent dna, magnesium

Abstract

The Enzolution™ WRN Helicase ATPase Assay System is intended for use with the Transcreener® ADP² Assay Kits to measure enzymatic activity for WRN Helicase (Also known as Werner Syndrome ATP-dependent Helicase). WRN is a multifunctional enzyme that has both magnesium and ATP-dependent DNA-helicase activity and 3'→5' exonuclease activity towards double-stranded DNA with a 5'-overhang. ADP formation by the WRN helicase can be detected using the Transcreener® ADP² assay, a far-red, competitive fluorescence assay that enables single addition, mix-and-read detection in a continuous or endpoint format. The assay has been optimized and extensively validated for high throughput screening (HTS) and inhibitor dose response measurements using most multimode plate readers.

The Enzolution™ WRN Helicase ATPase Assay System provides all reagents required to screen and profile WRN Helicase inhibitors, including the purified human WRN Helicase (amino acids 500-946, N-terminal 6xHis) and DNA Substrate, when used with the Transcreener® ADP² Assay Kits, which are available with FP, FI and TR-FRET readouts. The protocol is configured for 384-well plates; use of different multi-well plate formats will require adjustment of reagent concentrations utilized in the assay.

Introduction

- 1 The Enzolution™ WRN Helicase ATPase Assay System is intended for use with the Transcreener® ADP² Assay Kits to measure enzymatic activity for WRN Helicase (Also known as Werner Syndrome ATP-dependent Helicase). WRN is a multifunctional enzyme that has both magnesium and ATP-dependent DNA-helicase activity and 3'→5' exonuclease activity towards double-stranded DNA with a 5'-overhang. ADP formation by the WRN helicase can be detected using the Transcreener® ADP² assay, a far-red, competitive fluorescence assay that enables single addition, mix-and-read detection in a continuous or endpoint format. The assay has been optimized and extensively validated for high throughput screening (HTS) and inhibitor dose response measurements using most multimode plate readers.

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Key Applications:

- Screening for WRN Helicase inhibitors (or activators)
- Generating dose response curves and IC₅₀ values for WRN Helicase inhibitors
- Kinetic and mechanistic analyses

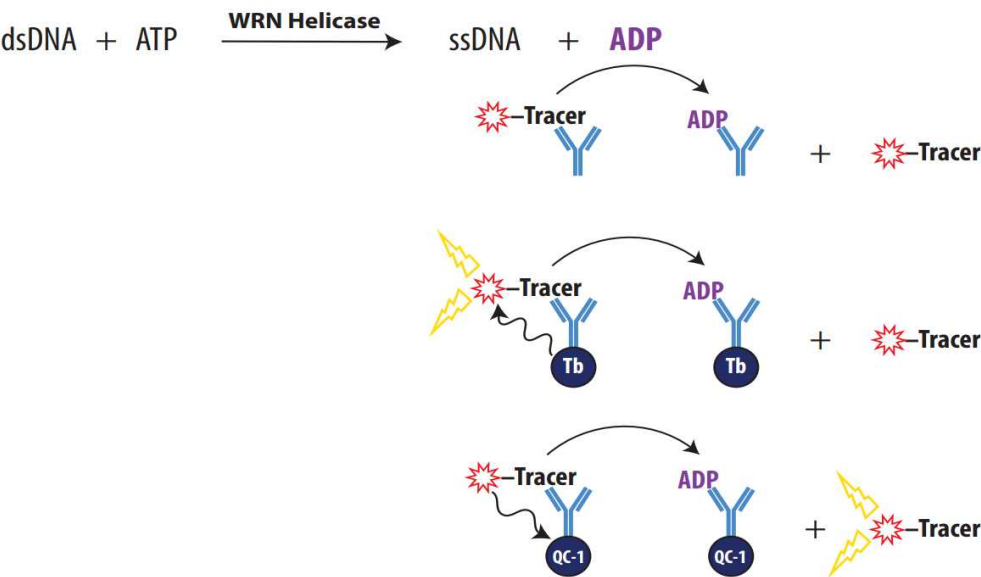


Figure 1. Schematic Overview of the Enzolution™ WRN Helicase ATPase Assay System with the Transcreener® ADP² Assays.

For FP Readout (A): ADP produced by WRN Helicase displaces an Alexa Fluor® 633 Tracer from the ADP² antibody, resulting in decreased fluorescence polarization.

For TR-FRET Readout (B): ADP produced by WRN Helicase displaces a HiLyte647 Tracer from the ADP² antibody conjugated to terbium (Tb), resulting in a decrease in TR-FRET.

For FI Readout (C): ADP produced by WRN Helicase displaces an Alexa Fluor® 594 Tracer from the ADP² antibody conjugated to an IRDye® QC-1 quencher, resulting in an increase in fluorescence intensity.

Product Specifications

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	Product	Quantity	Part #	Part #
	Enzolution™ WRN Helicase ATPase Assay System	1,000 assays*	FP	3032-1K-FP
			FI	3032-1K-FI
			TR-FRET	3032-1K-TR
		10,000 assays*	FP	3032-10K-FP
			FI	3032-10K-FI
			TR-FRET	3032-10K-TR

*The exact number of assays depends on the enzyme reaction conditions. The kits are designed for use with 384-well plates, using a 10 μ L Enzyme Reaction and a 20 μ L Complete Assay volume.

Storage

Enzymes should be stored at -80°C ; other reagents can be stored at -20°C . Though we have confirmed that the WRN helicase is stable up to 5 freeze-thaw cycles, we recommend aliquoting the enzyme and snap-freezing for multiple uses to minimize loss of activity.

Use the reagents provided in this kit within 6 months from date of receipt.

Materials Provided

2.1

Component	Composition	Notes
WRN Helicase Enzyme	0.1 mg/mL (1.93 μ M)* in 50 mM Tris-HCl, 500 mM NaCl, 20% Glycerol, 0.5 mM TCEP, pH 8.0	Amino acids 500-946, N-terminal 6xHis, 51.8 kDa. Sufficient enzyme is included in the kit to complete at least 1,000 assays (Part # 3032-1K) or 10,000 assays (Part # 3032-10K).
WRN-H DNA Substrate, 40 μ M	40 μ M in H ₂ O	Supplied as a 37-bp annealed 3'-Flap duplex DNA oligomer.
Enzyme Assay Buffer A, 10X	500 mM TRIS (pH 7.5), 10 mM MgCl ₂ , 0.1% Triton	Use Enzyme Assay Buffer A in the Enzyme Reaction and for preincubation with inhibitors. Changes to the assay buffer could affect enzyme activity and/or detection of ADP.
384-Well Low Volume Assay Plates	Corning #4514 - FP and FI Only Corning #4513 - TR-FRET Only	Polystyrene non-binding surface assay plates in either a 3-pack (1,000+ Assays) or a 30-pack (10,000+ Assays). We strongly recommend the use of these plates as inconsistent results have been observed with other plates.

*The exact concentration may vary from batch to batch. Please refer to the Certificate of Analysis for an accurate concentration.

Materials Required But Not Provided

2.2

Component	Notes
Ultrapure Nuclease Free Water	Some deionized water systems are contaminated with nucleases that can degrade both nucleotide substrates and products, reducing assay performance. Use nuclease free water such as: Invitrogen Part # AM9930
Plate Reader	A multimode microplate reader configured to measure FP, FI, or TR-FRET is required. Transcreener® Assays have been validated on the following instruments: BioTek Synergy™2 and Synergy™4; BMG Labtech PHERAstar® Plus and CLARIOstar® Plus; Molecular Devices SpectraMax™ Paradigm; Perkin Elmer EnVision® and ViewLux; and Tecan Infinite® F500, Safire2™, and M1000. Full list of compatible plate readers and settings.
Liquid Handling Devices	Use liquid handling devices that can accurately dispense a submicroliter volumes into 384-well plates.
Laboratory Incubator	An incubator model that is capable of maintaining temperature stability at 30°C is required.

Transcreener® ADP² FP Assay - SOLD SEPARATELY

Component	Composition	Notes
ADP ² Antibody	3.4 mg/mL solution in PBS with 10% glycerol*	1,000 assays (Part # 3010-1K) or 10,000 assays (Part # 3010-10K).
ADP ² Alexa Fluor® 633 Tracer	400 nM solution in 2 mM HEPES (pH 7.5) containing 0.01% Brij-35	1,000 assays (Part # 3010-1K) or 10,000 assays (Part # 3010-10K).
Stop & Detect Buffer B, 10X	200 mM HEPES (pH 7.5), 400 mM EDTA, and 0.2% Brij-35	The EDTA in the Stop & Detect Buffer B quenches the WRN Enzyme Reaction by chelating Mg ²⁺ . The final concentrations of Mg ²⁺ and EDTA in the Complete Assay are 1 mM and 20 mM, respectively.
ATP	5 mM	The ATP supplied in this kit can be used for WRN Enzyme Reaction and the ATP/ADP standard curve.



Component	Composition	Notes
ADP	5 mM	The ADP is used for the ATP/ADP standard curve.

Transcreener® ADP² FI Assay - SOLD SEPARATELY

Component	Composition	Notes
ADP ² Antibody-IRDye® QC-1	1.4 mg/mL solution in 100 mM KH ₂ PO ₄ (pH 8.5)*	1,000 assays (Part # 3013-1K) or 10,000 assays (Part # 3013-10K).
ADP ² Alexa Fluor® 594 Tracer	800 nM solution in 2 mM HEPES (pH 7.5) containing 0.01% Brij-35	1,000 assays (Part # 3013-1K) or 10,000 assays (Part # 3013-10K).
Stop & Detect Buffer B, 10X	200 mM HEPES (pH 7.5), 400 mM EDTA, and 0.2% Brij-35	The EDTA in the Stop & Detect Buffer B quenches the WRN Enzyme Reaction by chelating Mg ²⁺ . The final concentrations of Mg ²⁺ and EDTA in the Complete Assay are 1 mM and 20 mM, respectively.
ATP	5 mM	The ATP supplied in this kit can be used for WRN Enzyme Reaction and the ATP/ADP standard curve.
ADP	5 mM	The ADP is used for the ATP/ADP standard curve.

Transcreener® ADP² TR-FRET Assay - SOLD SEPARATELY

Component	Composition	Notes
ADP ² Antibody - Terbium Conjugate	800 nM solution in HEPES-buffered saline	1,000 assays (Part # 3011-1K) or 10,000 assays (Part # 3011-10K).
ADP HiLyte647 Tracer	10 µM solution in 2 mM HEPES (pH 7.5) containing 0.01% Brij-35	1,000 assays (Part # 3011-1K) or 10,000 assays (Part # 3011-10K).
Stop & Detect Buffer C, 10X	500 mM HEPES (pH 7.5), 200 mM EDTA, and 0.2% Brij-35	The EDTA in the Stop & Detect Buffer B quenches the WRN Enzyme Reaction by chelating Mg ²⁺ . The final concentrations of Mg ²⁺ and EDTA in the Complete Assay are 1 mM and 20 mM, respectively.
ATP	5 mM	The ATP supplied in this kit can be used for WRN Enzyme Reaction and the ATP/ADP standard curve.

Component	Composition	Notes
ADP	5 mM	The ADP is used for the ATP/ADP standard curve.

*The exact concentration may vary from batch to batch. Please refer to the Certificate of Analysis for an accurate concentration.

Before You Begin

- 3
 1. Read the entire protocol and note any reagents or equipment needed (see **Section 2.2**).
 2. Check the plate reader and verify that it is compatible with the Transcreener® ADP² Assay for the respective readout: **Full list of compatible plate readers and settings.**
 3. Please read and understand Transcreener® ADP² Assay Technical Manuals prior to use with this kit.

Protocol

- 4 The methods described below are for single-addition, endpoint detection: the WRN Helicase Enzyme Reaction is quenched by the addition of EDTA along with the detection reagents (see **Figure 2**). The methods were designed for 384-well plates using a 10 µL WRN Helicase Enzyme Reaction and 10 µL of detection/quench reagents (final volume 20 µL when the plates are read). The use of different plate densities or reaction volumes will require changes in reagent quantities (see **Section 5.1** for example reaction volumes).

The methods were optimized for initial velocity detection of ADP formation ($\leq 20\%$ conversion of ATP to ADP) by WRN Helicase with ATP at the approximate K_m concentration (50 µM) and WRN-H DNA Substrate at a saturating concentration (0.1 µM). These conditions will ensure sensitive detection of inhibitors that compete with ATP while minimizing the effects of compounds that inhibit WRN via non-specific interactions with DNA. Significant changes in the ATP concentration may require optimization of the ADP² Antibody concentration (in the case of FP and FI readout modes) or the ADP Tracer (in the case of the TR-FRET readout mode) to adjust the dynamic range as described in the Transcreener® ADP² Assay Manual.

Note: Antibody (TR-FRET) and Tracer (FP and FI) concentrations remain constant in the 20 µL Complete Assay regardless of changes to other reaction conditions.

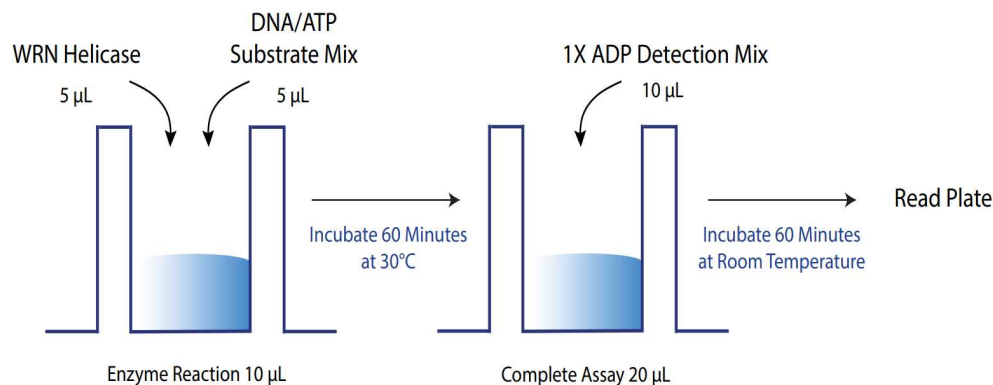


Figure 2. An Outline of the Procedure. The WRN Helicase Enzyme Reaction is initiated by the addition of WRN-H DNA Substrate and ATP. After the Enzyme Reaction incubation is completed, ADP detection reagents are added (Transcreener® ADP² Antibody and Tracer) along with EDTA to quench the WRN reaction.

10 µL Enzyme Reaction Components

Component	Working Stock	Final Concentration in 10 µL
Enzyme Assay Buffer A, 10X	1X in Nuclease Free Water	1X (50 mM TRIS pH 7.5, 1 mM MgCl ₂ , and 0.01% Triton)
WRN Helicase Enzyme, 0.1 mg/mL (1.93 µM)	2X in 1X Enzyme Assay Buffer A	250 pM – 500 pM*
ATP, 5 mM	100 µM in 1X Enzyme Assay Buffer A (with 0.2 µM WRN-H DNA Substrate)	50 µM
WRN-H DNA Substrate, 40 µM	0.2 µM in 1X Enzyme Assay Buffer A	0.1 µM

*See Section 4.1 for Determining the Optimal Enzyme Concentration.

Table 1. WRN Helicase Enzyme Reaction Components. Concentrations are provided for the standard protocol using 5 µL of WRN Enzyme Mix and 5 µL of DNA/ATP Substrate Mix for the Enzyme Reaction.

Component	1X ADP Detection Mix - Add 10 μ L Per Well					
	FP		FI		TR-FRET	
	Detection Mix Concentration	Complete Assay	Detection Mix Concentration	Complete Assay	Detection Mix Concentration	Complete Assay
Stop & Detect Buffer	1X	0.5X	1X	0.5X	1X	0.5X
ADP Tracer	4 nM	2 nM	4 nM	2 nM	500 nM	250 nM
ADP Antibody	55 μ g/mL	27.5 μ g/mL	50 μ g/mL	25 μ g/mL	4 nM	2 nM

Table 2. 1X ADP Detection Mix Components. The optimal concentrations for each of the detection reagents based on the preferred readout are shown. Changes to the concentrations may require re-optimization of the assay.

Determining the Optimal Enzyme Concentration

- 4.1 Using the enzyme concentration suggested in the WRN Helicase Enzyme Certificate of Analysis should provide a robust signal that is within the linear range for ADP formation. However, for best results, we suggest performing an enzyme titration to identify the optimal enzyme concentration (EC_{50} to EC_{80}), especially when running the assay in a different buffer system, or with a different ATP or WRN-H DNA Substrate concentration. This example uses a 2X serial dilution; it should be performed at least in duplicate. If a compound screen is planned, you should include the solvent (e.g., DMSO) at its final assay concentration.

4.1.1 Enzyme Titration Steps

1. Prepare 1500 μ L 1X Enzyme Assay Buffer A: dilute 150 μ L of 10X Enzyme Assay Buffer A in 1350 μ L ultrapure nuclease free water.
2. Prepare 121 μ L of 32 nM WRN Helicase Enzyme: dilute 2 μ L of 1.93 μ M WRN Helicase Enzyme in 119 μ L 1X Enzyme Assay Buffer A.
3. Add 10 μ L of the WRN Helicase Enzyme to well 1 (including replicates).
4. Add 5 μ L of 1X Enzyme Assay Buffer A to wells 2-12, DO NOT add the Assay Buffer to well 1.
5. Transfer 5 μ L from well 1 to well 2 and mix by pipetting, then transfer 5 μ L from well 2 to well 3 and mix by pipetting; repeat this serial dilution process until well 11 has received WRN Helicase Enzyme. Well 12 is to be used as a blank and should not include enzyme.

IMPORTANT: After mixing the last well (11) in the dilution series, remove 5 μ L from that well only and discard, so that all the wells contain 5 μ L final volume.

6. Prepare 500 μ L of DNA/ATP Substrate Mix: dilute 2.5 μ L 40 μ M WRN-H DNA Substrate and 10 μ L 5 mM ATP in 487.5 μ L 1X Enzyme Assay Buffer A.
7. Start the Enzyme Reaction by adding 5 μ L of the DNA/ATP Substrate Mix to every

well (1-12). Gently mix for 40 to 60 seconds on a plate shaker. Incubate at 30°C for 60 minutes.

8. Prepare 500 µL 1X ADP Detection Mix based on the concentrations provided in Table 2: 50 µL 10X Stop & Detect Buffer B, 5 µL ADP² Alexa Fluor® 633 Tracer and 55 µg/mL ADP² Antibody in Ultrapure Nuclease Free Water.

Note: The concentration of the ADP² Antibody may vary from batch to batch. Additionally, the 1X ADP Detection Mix varies for the readout mode used. Table 2 lists the 1X ADP Detection Mix for each readout.

9. Add 10 µL of 1X ADP Detection mix to every well (1-12), in replicate.

10. Gently mix on a plate shaker for 40 to 60 seconds and then allow it to incubate at room temperature for 60 minutes before reading.

Note: The reagent volumes indicated above are sufficient for running the enzyme titration in duplicate plus excess for pipetting dead volume. Scaling of volumes can be performed if necessary.

For detection of inhibitors at single concentration or in dose response mode, we recommend selecting an enzyme concentration that produces a 50–80% change in signal (EC₅₀ to EC₈₀) (see **Figure 3**). This will result in initial velocity conditions, which correspond to the linear phase of the reaction after conversion of values to ADP formation (see **Figure 6**). The EC₅₀ is provided by common graphing programs; the EC₈₀ enzyme concentration can be calculated from the EC₅₀, as follows:

$$EC_X = (X \div (100 - X))^{(1 \div |\text{hillslope}|)} \times EC_{50}$$

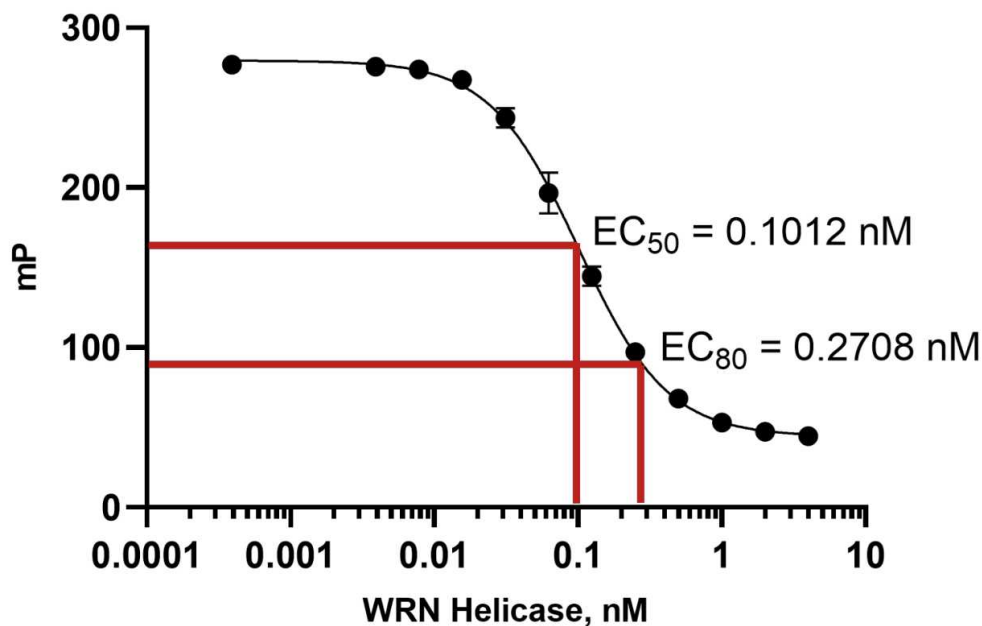


Figure 3. Enzyme Titration Curve. Example WRN Helicase enzyme titration. The ideal range of enzyme concentrations is between EC₅₀ and EC₈₀; the specific concentration may vary depending on the enzyme lot.

Performing Single Compound Screening and Dose-Response Assays

4.2 4.2.1 Experimental Samples

1. Perform a serial dilution of test compounds with your method of choice. Add the enzyme to the test compounds at the desired concentration so that the total volume of this mixture is 5 μ L. Mix gently on a plate shaker for 40 to 60 seconds. Preincubate the Enzyme Inhibitor Mix for the desired time (typically at least 30 minutes) at room temperature to allow equilibration of the E-I complex.

Note: Final concentration of test compounds should be based on the volume of the Enzyme Reaction.

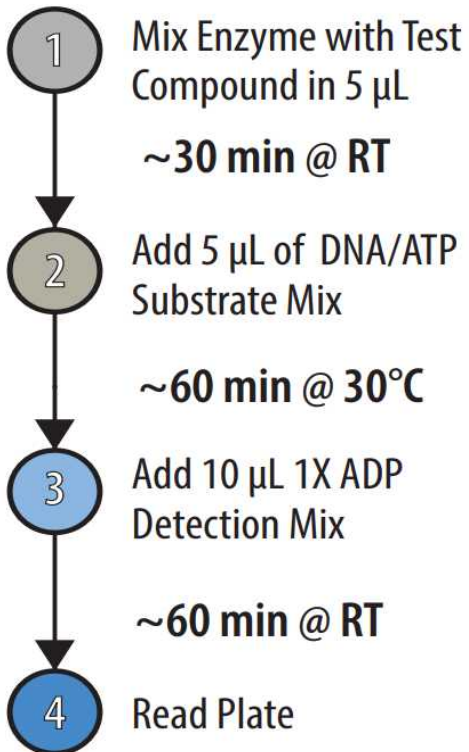
2. Start the Enzyme Reaction by adding 5 μ L of the DNA/ATP Substrate Mix. It is recommended to incubate the Enzyme Reaction at 30°C for 60 minutes.

Note: The final volume of the Enzyme Reaction mixture should be 10 μ L for 384 well plates. See Section 5.1 for a list of other plate formats.

3. After the incubation, add 10 μ L of 1X ADP Detection Mix to the 10 μ L Enzyme Reaction and mix the 20 μ L Complete Assay using a plate shaker.

Note: The 1X ADP Detection Mix varies for the readout mode used. Table 2 lists the 1X ADP Detection Mix for each readout.

4. Incubate at room temperature (20–25°C) for 60 minutes and measure FP.



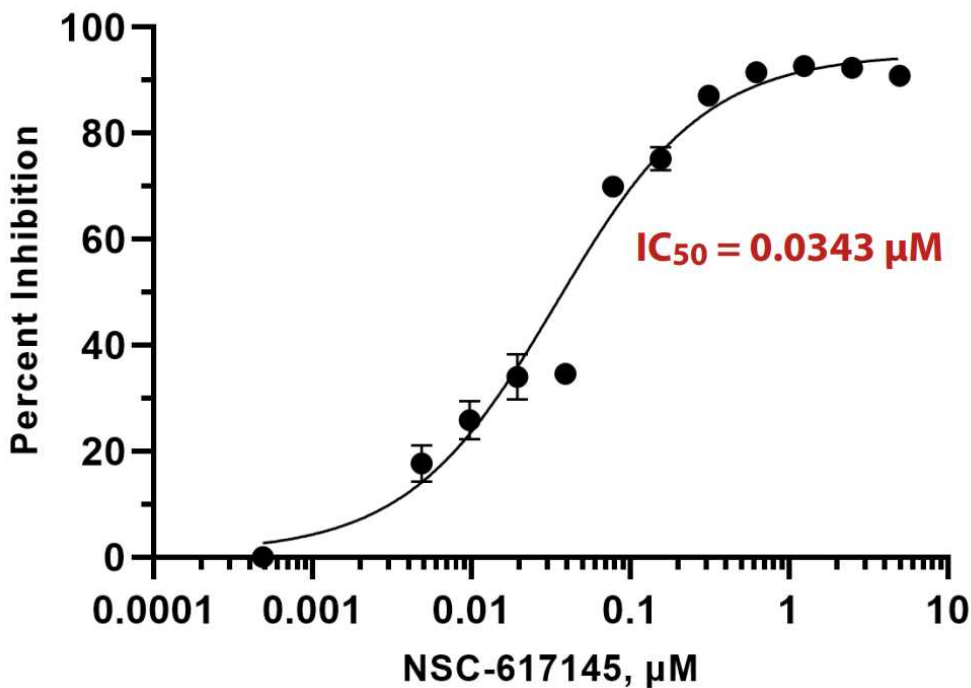


Figure 4. Dose-Response Curve. Example probe inhibitor NSC-617145 titration with WRN Helicase.

Setting Up a Standard Curve

- 4.3 Use of a standard curve for conversion of values to amount of ADP formed allows quantitative measurement of the enzyme activity and accurate IC_{50} determinations; it is not typically done for screening at single concentrations. The standard curve mimics the Enzyme Reaction (as ATP concentration decreases, ADP concentration increases); the adenine nucleotide concentration remains constant. The ADP/ATP standard curve allows calculation of the concentration of ADP produced in the Enzyme Reaction and, therefore, the percent ADP conversion.

In this example, a 12-point standard curve was prepared using the concentrations of ADP and ATP shown in the following Table. Commonly, 8- to 12-point standard curves are used. Here we describe preparation of a standard curve from 50 μM to 0.25 μM ADP, which encompasses the appropriate range for this assay.

	% Conversion	ATP (μM)	ADP (μM)
	100	0	50
	50	25	25

	% Conversion	ATP (μM)	ADP (μM)
	25	37.5	12.5
	15	42.5	7.5
	10	45	5
	7.5	46.25	3.75
	5	47.5	2.5
	3	48.5	1.5
	2	49	1
	1	49.5	0.5
	0.5	49.75	0.25
	0	50	0

Table 3. Concentration of ATP and ADP to prepare a 12-point standard curve

4.3.1 Standard Curve Steps

1. Prepare 1X Enzyme Assay Buffer A.
2. Dilute 5 mM ATP and ADP to 50 μM in 1X Enzyme Assay Buffer A. The volume for both dilutions should be based on the total amount of volume to be utilized during preparation of the ATP/ADP percent conversion solutions.
3. Starting from 50 μM of ADP, add proportional values of ATP and ADP with the method of choice (i.e., Automatic Dispenser). For manual preparations, add reagents in separate microcentrifuge tubes to generate the desired percent conversions utilized in the standard curve. An example of the dilution scheme can be found in **Table 3**. Once all dilutions are completed, add 10 μL of each solution to the respective wells.
4. Afterwards, add 10 μL of 1X ADP Detection Mix. The 1X ADP Detection Mix varies for the readout mode used. **Table 2** lists the 1X ADP Detection Mix for each readout.
5. Finally, mix for 40 to 60 seconds, before measuring in the instrument of choice.

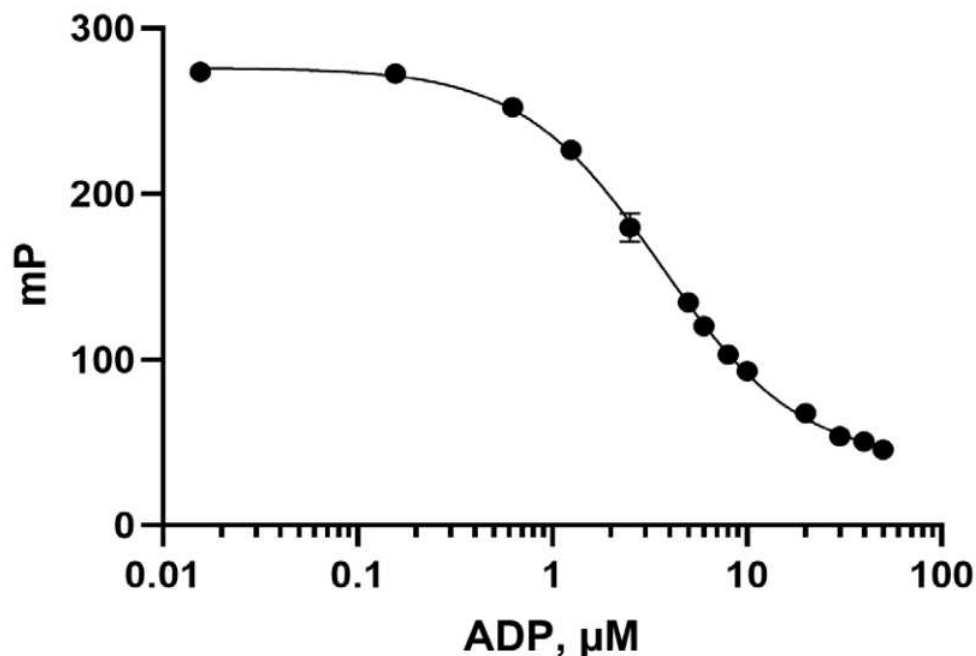


Figure 5. ADP Standard Curve. Standard curve using 1X ADP Detection Mix (FP Readout) as shown in **Table 2**. (55 $\mu\text{g}/\text{mL}$ ADP² antibody, 4 nM ADP² Tracer)

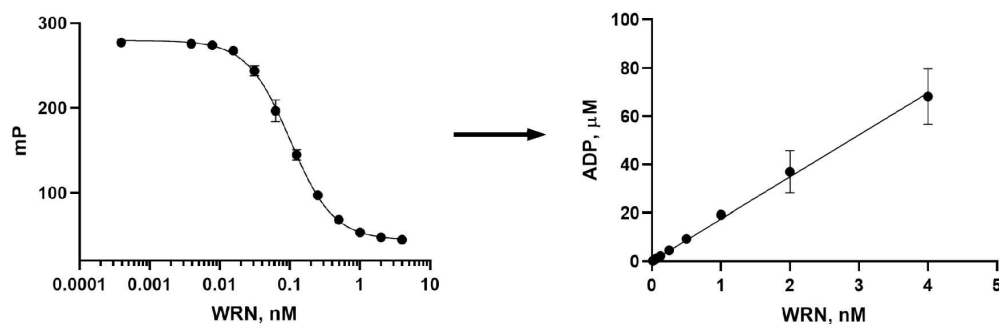


Figure 6. Enzyme Titration Curve Converted to ADP Formed. Raw polarization signal (mP) is converted to ADP formed using a standard curve as described in **Section 4.3**. Only the linear portion of the graph is shown; interpolation was performed using GraphPad Prism.

Measuring Assay Robustness with Z'

- 4.4 By taking into account both dynamic range and data variability at the high and low ranges of the assay, the Z' statistic provides a measure of what is of most interest when considering the suitability of an assay for HTS: the usable screening or "assay window." It is a dimensionless coefficient for the quality of the screening window that is relevant for any assay, regardless of detection method or readout, without the intervention of test

compounds. As a guideline, a Z' value of 0.5 or greater is generally considered to be indicative of a very good screening window for a biochemical assay, thus the assay is an excellent assay. When running the WRN Helicase ATPase Assay, run the controls with and without enzyme (no test compound) to achieve final results. Use the following formula to determine Z' :

$$Z' = 1 - \frac{[(3 \times SD_{\text{No Enzyme}}) + (3 \times SD_{\text{Complete Reaction}})]}{|(\text{Mean}_{\text{No Enzyme}}) - (\text{Mean}_{\text{Complete Reaction}})|}$$

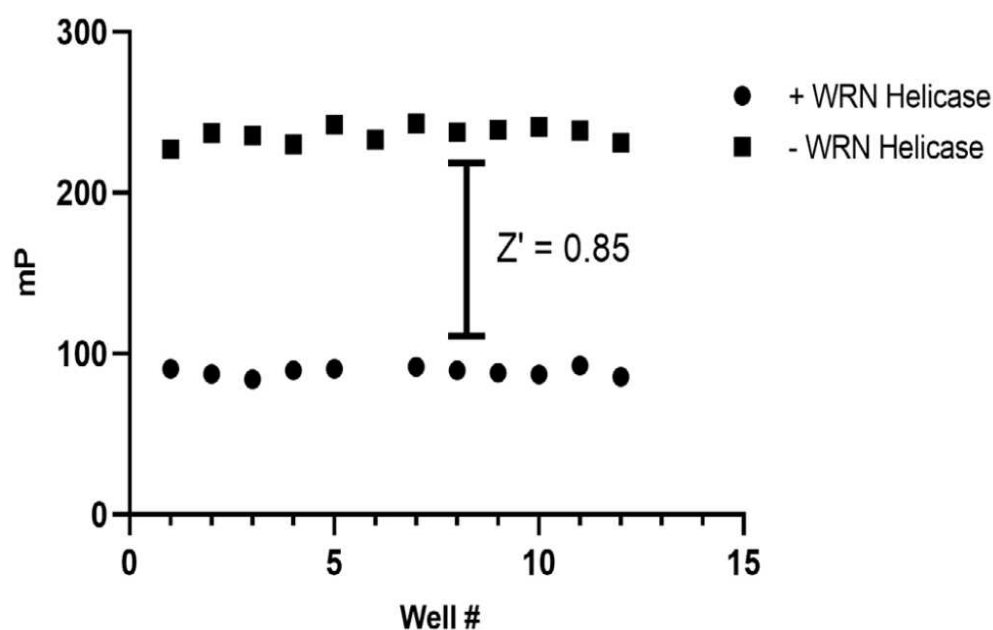


Figure 7. Z' Measurement. Complete Assay is performed with and without WRN Helicase enzyme (n=12). Z' is then calculated based on the formula shown in **Section 4.4**.

Appendix



Using the Assay with Different Volumes and Plate Formats

5.1

	Component	Total Volume	Enzyme Reaction Volume	1X ADP Detection Mixture Volume
	96 Well Low Volume Plate	50 μ L	25 μ L	25 μ L
	384 Well Low Volume Plate	20 μ L	10 μ L	10 μ L
	1536 Well Low Volume Plate	8 μ L	4 μ L	4 μ L

Please check the working plate volumes from the manufacturer to ensure they are within the suggest volumes ranges of your plate.

Links to Applicable Application Notes

- 5.2
- [A Guide to Navigating Hit Prioritization After Screening Using Biochemical Assays](#)
 - [A Guide to Measuring Drug-Target Residence Times with Biochemical Assays](#)
 - [Using GraphPad Prism to Interpolate Data from a Standard Curve to Generate a Dose-Response](#)
 - [List of Commonly Used Plate Readers and Settings](#)

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