Full wwPDB X-ray Structure Validation Report ⓘ

May 19, 2026 – 10:12 pm BST

PDB ID	:	9S18 / pdb_00009s18
Title	:	WRN helicase in complex with HRO761
Authors	:	Fletcher, C.T.; Rucktooa, P.
Deposited on	:	2025-07-18
Resolution	:	2.00 Å(reported)

The following versions of software and data (see references ⓘ) were used in the production of this report:

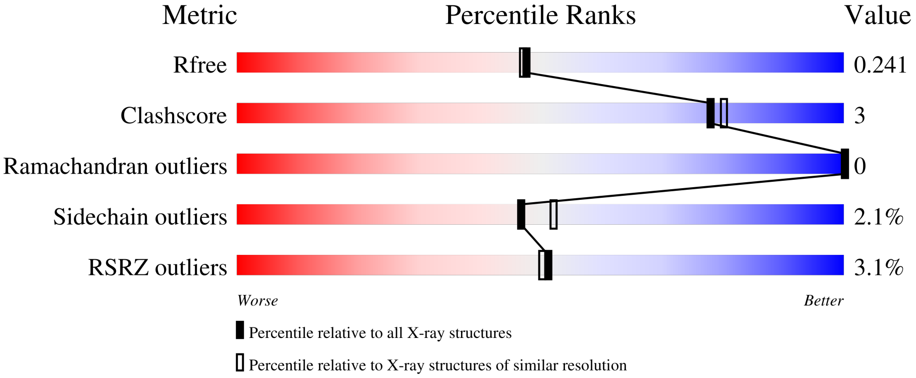
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

1 Overall quality at a glance

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

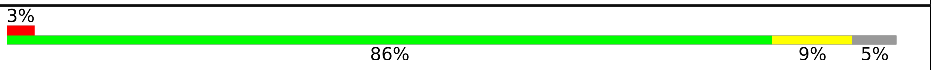
The reported resolution of this entry is 2.00 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	180053	10052 (2.00-2.00)
Clashscore	190562	11152 (2.00-2.00)
Ramachandran outliers	187476	11031 (2.00-2.00)
Sidechain outliers	187428	11029 (2.00-2.00)
RSRZ outliers	180081	10067 (2.00-2.00)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	443	

2 Entry composition (i)

There are 8 unique types of molecules in this entry. The entry contains 3754 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

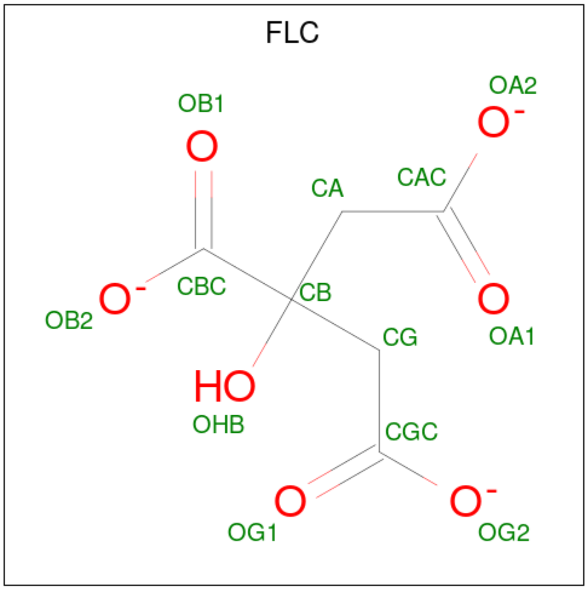
- Molecule 1 is a protein called Bifunctional 3'-5' exonuclease/ATP-dependent helicase WRN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	422	3463	2182	612	636	33	0	14	0

There are 16 discrepancies between the modelled and reference sequences:

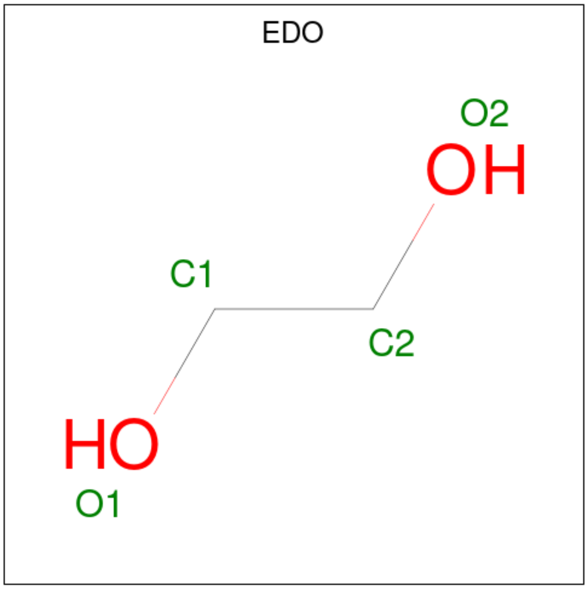
Chain	Residue	Modelled	Actual	Comment	Reference
A	501	MET	-	initiating methionine	UNP Q14191
A	502	GLY	-	expression tag	UNP Q14191
A	503	HIS	-	expression tag	UNP Q14191
A	504	HIS	-	expression tag	UNP Q14191
A	505	HIS	-	expression tag	UNP Q14191
A	506	HIS	-	expression tag	UNP Q14191
A	507	HIS	-	expression tag	UNP Q14191
A	508	HIS	-	expression tag	UNP Q14191
A	509	GLU	-	expression tag	UNP Q14191
A	510	ASN	-	expression tag	UNP Q14191
A	511	LEU	-	expression tag	UNP Q14191
A	512	TYR	-	expression tag	UNP Q14191
A	513	PHE	-	expression tag	UNP Q14191
A	514	GLN	-	expression tag	UNP Q14191
A	515	GLY	-	expression tag	UNP Q14191
A	516	SER	-	expression tag	UNP Q14191

- Molecule 2 is CITRATE ANION (CCD ID: FLC) (formula: $C_6H_5O_7$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C O 13 6 7	0	0
2	A	1	Total C O 13 6 7	0	0
2	A	1	Total C O 13 6 7	0	0

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: $C_2H_6O_2$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C O 4 2 2	0	0

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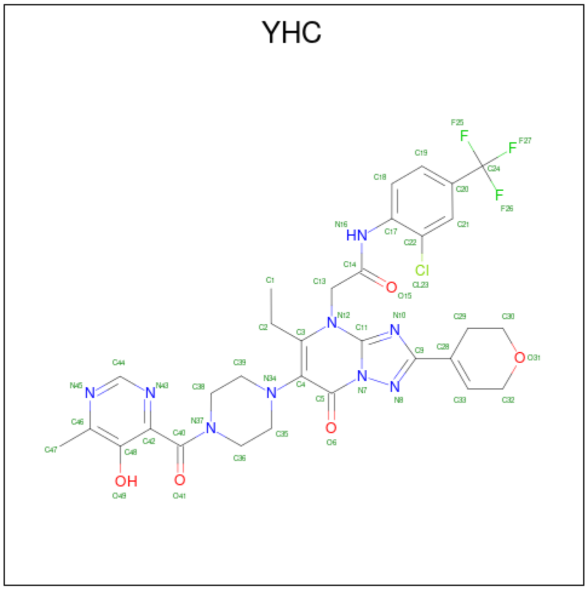
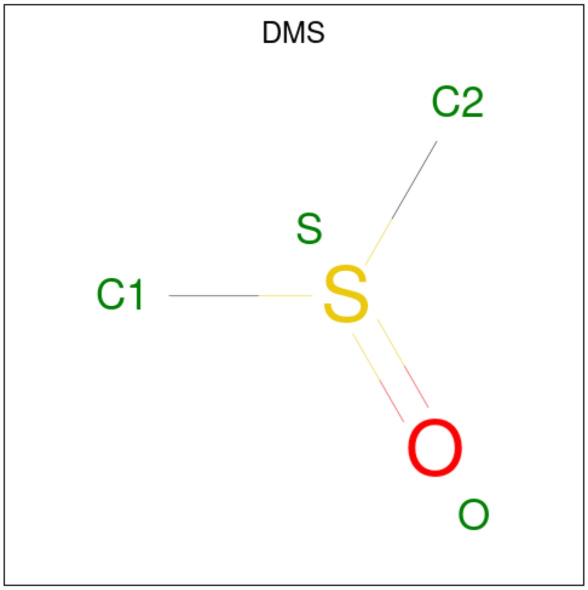
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	A	1	4	2	2	0	0
3	A	1	4	2	2	0	0
3	A	1	4	2	2	0	0

- Molecule 4 is {N}-[2-chloranyl-4-(trifluoromethyl)phenyl]-2-[2-(3,6-dihydro-2 {H}-pyran-4-yl)-5-ethyl-6-[4-(6-methyl-5-oxidanyl-pyrimidin-4-yl)carbonylpiperazin-1-yl]-7-oxidanylidene-[1,2,4]triazolo[1,5-a]pyrimidin-4-yl]ethanamide (CCD ID: YHC) (formula: $C_{31}H_{31}ClF_3N_9O_5$) (labeled as "Ligand of Interest" by depositor).



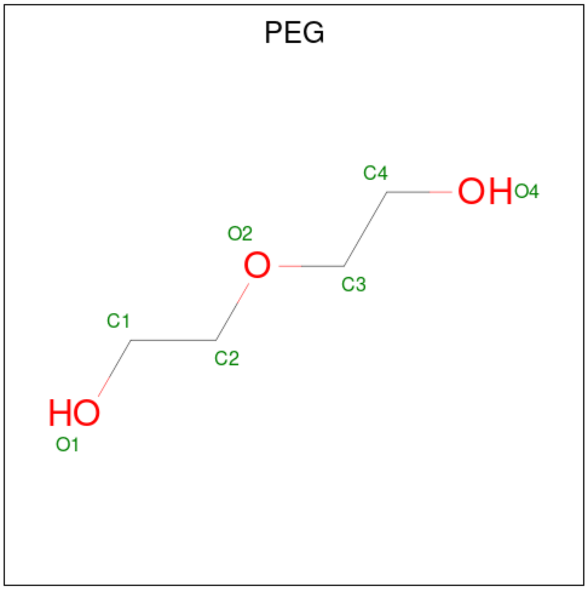
Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
			Total	C	Cl	F	N	O		
4	A	1	49	31	1	3	9	5	0	0

- Molecule 5 is DIMETHYL SULFOXIDE (CCD ID: DMS) (formula: C_2H_6OS).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	O	S		
5	A	1	4	2	1	1	0	0

- Molecule 6 is DI(HYDROXYETHYL)ETHER (CCD ID: PEG) (formula: $C_4H_{10}O_3$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
6	A	1	7	4	3	0	0

- Molecule 7 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Zn		
7	A	1	1	1	0	0

- Molecule 8 is water.

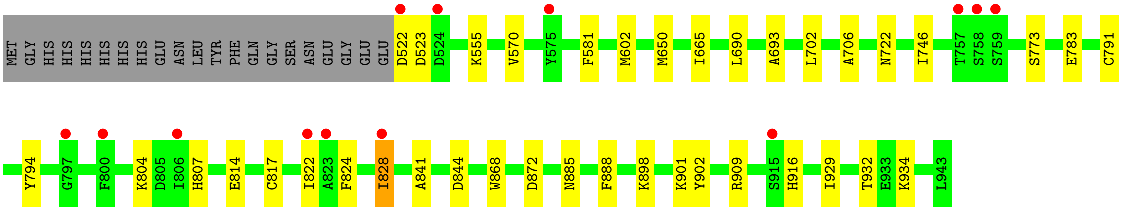
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
8	A	175	175	175	0	2

3 Residue-property plots ⓘ

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density (RSRZ > 2). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: Bifunctional 3'-5' exonuclease/ATP-dependent helicase WRN

Chain A:



4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	67.18Å 68.16Å 119.01Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	24.13 – 2.00 24.13 – 2.00	Depositor EDS
% Data completeness (in resolution range)	77.0 (24.13-2.00) 76.9 (24.13-2.00)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.48 (at 1.99Å)	Xtriage
Refinement program	BUSTER 2.11.8	Depositor
R, R_{free}	0.210 , 0.251 0.201 , 0.241	Depositor DCC
R_{free} test set	1434 reflections (4.91%)	wwPDB-VP
Wilson B-factor ($Å^2$)	46.6	Xtriage
Anisotropy	0.040	Xtriage
Bulk solvent $k_{sol}(e/Å^3)$, $B_{sol}(Å^2)$	0.32 , 36.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.34$	Xtriage
Estimated twinning fraction	0.012 for k,h,-l	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	3754	wwPDB-VP
Average B, all atoms ($Å^2$)	53.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.05% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: PEG, EDO, ZN, YHC, FLC, DMS

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\#\|Z\| > 5$	RMSZ	$\#\|Z\| > 5$
1	A	0.75	0/3538	1.06	7/4771 (0.1%)

There are no bond length outliers.

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	844	ASP	CA-CB-CG	7.04	119.64	112.60
1	A	872	ASP	CA-CB-CG	6.28	118.88	112.60
1	A	932	THR	CA-C-N	5.60	128.35	120.28
1	A	932	THR	C-N-CA	5.60	128.35	120.28
1	A	722	ASN	CA-CB-CG	5.42	118.02	112.60
1	A	523	ASP	CA-C-N	5.38	127.75	120.38
1	A	523	ASP	C-N-CA	5.38	127.75	120.38

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3463	0	3465	20	0
2	A	39	0	15	2	0
3	A	16	0	24	2	0
4	A	49	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	A	4	0	6	0	0
6	A	7	0	10	0	0
7	A	1	0	0	0	0
8	A	175	0	0	0	0
All	All	3754	0	3520	20	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 3.

All (20) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:522:ASP:HA	1:A:916:HIS:CD2	1.99	0.97
1:A:522:ASP:HA	1:A:916:HIS:HD2	1.33	0.89
1:A:807:HIS:CD2	1:A:828:ILE:HD12	2.29	0.68
1:A:522:ASP:N	1:A:898:LYS:HZ2	2.00	0.59
1:A:650[A]:MET:HE1	1:A:690:LEU:HD12	1.86	0.57
1:A:804:LYS:HA	2:A:1008:FLC:HA2	1.88	0.55
1:A:665:ILE:HG21	1:A:690:LEU:HD21	1.91	0.53
1:A:807:HIS:CD2	1:A:828:ILE:CD1	2.96	0.48
1:A:773:SER:HA	2:A:1003:FLC:HA1	1.97	0.47
1:A:794:TYR:CD1	1:A:824:PHE:HB2	2.51	0.46
1:A:885:ASN:HD22	1:A:888:PHE:H	1.63	0.46
1:A:902:TYR:O	1:A:909:ARG:NH1	2.49	0.45
1:A:570:VAL:HG11	1:A:706:ALA:HA	2.00	0.43
1:A:650[A]:MET:HE2	1:A:693:ALA:HB3	2.00	0.43
1:A:828:ILE:HD13	1:A:828:ILE:HA	1.86	0.42
1:A:581:PHE:HE2	3:A:1010:EDO:H21	1.86	0.41
1:A:602:MET:HG2	3:A:1004:EDO:H12	2.02	0.41
1:A:841:ALA:HB2	1:A:868:TRP:HB2	2.03	0.41
1:A:791:CYS:HB3	1:A:817:CYS:HB3	2.03	0.40
1:A:746:ILE:HB	1:A:783:GLU:HG3	2.02	0.40

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	A	434/443 (98%)	424 (98%)	10 (2%)	0	100 100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains ⓘ

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	A	388/392 (99%)	380 (98%)	8 (2%)	47 52

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	555	LYS
1	A	702	LEU
1	A	814	GLU
1	A	822	ILE
1	A	828	ILE
1	A	901	LYS
1	A	929	ILE
1	A	934	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	558	HIS
1	A	605	GLN
1	A	678	HIS
1	A	808	HIS
1	A	835	GLN
1	A	878	HIS
1	A	885	ASN
1	A	916	HIS
1	A	921	GLN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 11 ligands modelled in this entry, 1 is monoatomic - leaving 10 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
2	FLC	A	1003	-	12,12,12	0.95	0	17,17,17	1.27	1 (5%)
3	EDO	A	1007	-	3,3,3	0.23	0	2,2,2	0.32	0
5	DMS	A	1006	-	3,3,3	0.63	0	3,3,3	0.28	0
2	FLC	A	1001	-	12,12,12	0.96	0	17,17,17	1.20	2 (11%)
2	FLC	A	1008	-	12,12,12	0.96	0	17,17,17	1.38	3 (17%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
3	EDO	A	1002	-	3,3,3	0.18	0	2,2,2	0.41	0
6	PEG	A	1009	-	6,6,6	0.29	0	5,5,5	0.24	0
4	YHC	A	1005	-	51,54,54	0.47	0	58,80,80	0.79	2 (3%)
3	EDO	A	1010	-	3,3,3	0.06	0	2,2,2	0.32	0
3	EDO	A	1004	-	3,3,3	0.22	0	2,2,2	0.30	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	FLC	A	1003	-	-	0/16/16/16	-
3	EDO	A	1007	-	-	1/1/1/1	-
2	FLC	A	1001	-	-	0/16/16/16	-
2	FLC	A	1008	-	-	8/16/16/16	-
3	EDO	A	1002	-	-	0/1/1/1	-
6	PEG	A	1009	-	-	2/4/4/4	-
4	YHC	A	1005	-	-	1/28/50/50	0/6/6/6
3	EDO	A	1010	-	-	1/1/1/1	-
3	EDO	A	1004	-	-	0/1/1/1	-

There are no bond length outliers.

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	1005	YHC	C13-N12-C3	3.56	125.71	121.03
2	A	1008	FLC	OB1-CBC-CB	-3.40	117.44	122.25
2	A	1003	FLC	OB1-CBC-CB	-3.09	117.87	122.25
2	A	1001	FLC	OB1-CBC-CB	-3.00	118.00	122.25
4	A	1005	YHC	C39-N34-C35	2.55	117.53	112.62
2	A	1001	FLC	OA1-CAC-CA	-2.23	116.43	122.94
2	A	1008	FLC	OG1-CGC-CG	-2.08	116.87	122.94
2	A	1008	FLC	OA1-CAC-CA	-2.06	116.92	122.94

There are no chirality outliers.

All (13) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	1009	PEG	O1-C1-C2-O2

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Mol	Chain	Res	Type	Atoms
2	A	1008	FLC	CG-CB-CBC-OB2
3	A	1007	EDO	O1-C1-C2-O2
6	A	1009	PEG	O2-C3-C4-O4
3	A	1010	EDO	O1-C1-C2-O2
2	A	1008	FLC	CAC-CA-CB-CBC
2	A	1008	FLC	CAC-CA-CB-CG
2	A	1008	FLC	CA-CB-CBC-OB2
2	A	1008	FLC	CB-CG-CGC-OG2
2	A	1008	FLC	CB-CG-CGC-OG1
2	A	1008	FLC	CG-CB-CBC-OB1
2	A	1008	FLC	CA-CB-CBC-OB1
4	A	1005	YHC	C5-C4-N34-C39

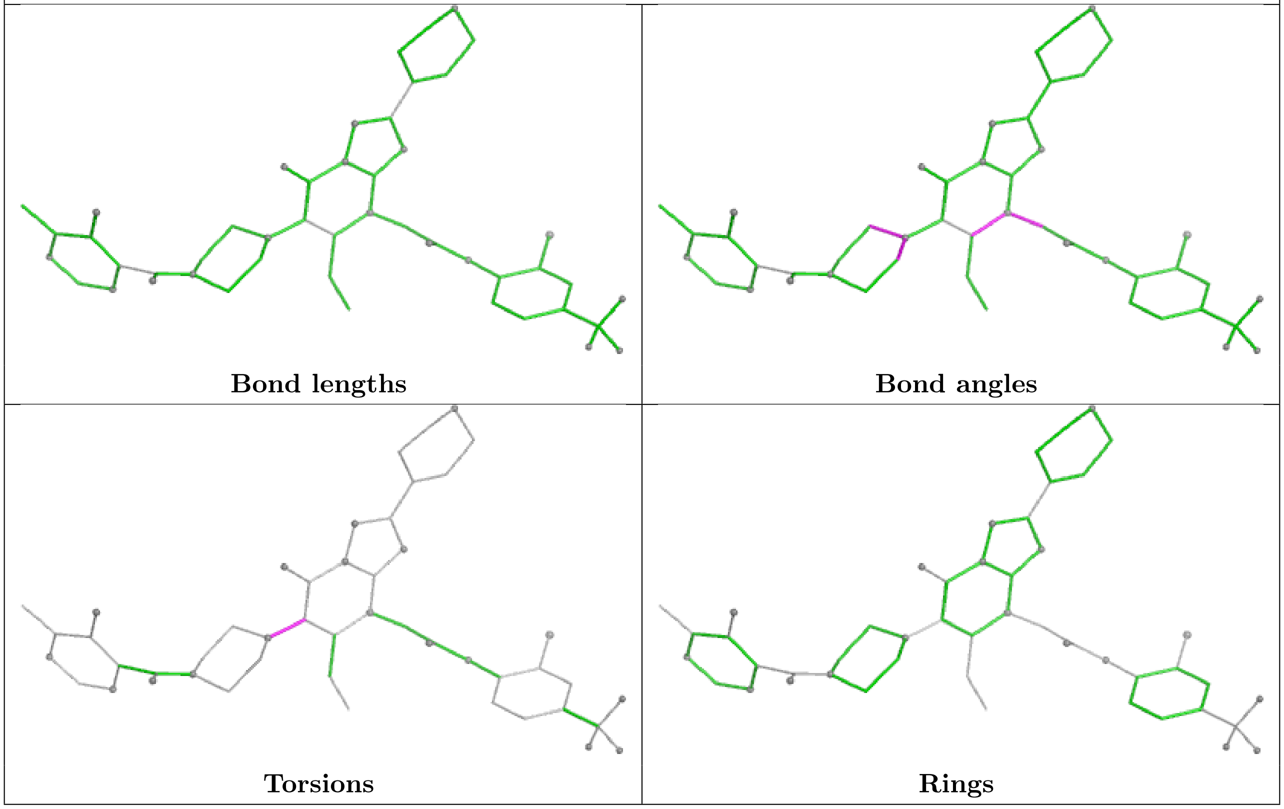
There are no ring outliers.

4 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	1003	FLC	1	0
2	A	1008	FLC	1	0
3	A	1010	EDO	1	0
3	A	1004	EDO	1	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand YHC A 1005



Bond lengths

Bond angles

Torsions

Rings

5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2			OWAB(Å^2)	Q<0.9
1	A	422/443 (95%)	0.38	13 (3%)	51	50	18, 51, 72, 92	18 (4%)

All (13) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	757	THR	7.0
1	A	758	SER	5.1
1	A	575	TYR	3.4
1	A	522	ASP	3.1
1	A	822	ILE	3.0
1	A	524	ASP	2.9
1	A	759	SER	2.9
1	A	806	ILE	2.8
1	A	800	PHE	2.7
1	A	823	ALA	2.4
1	A	828	ILE	2.1
1	A	797	GLY	2.1
1	A	915	SER	2.0

6.2 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

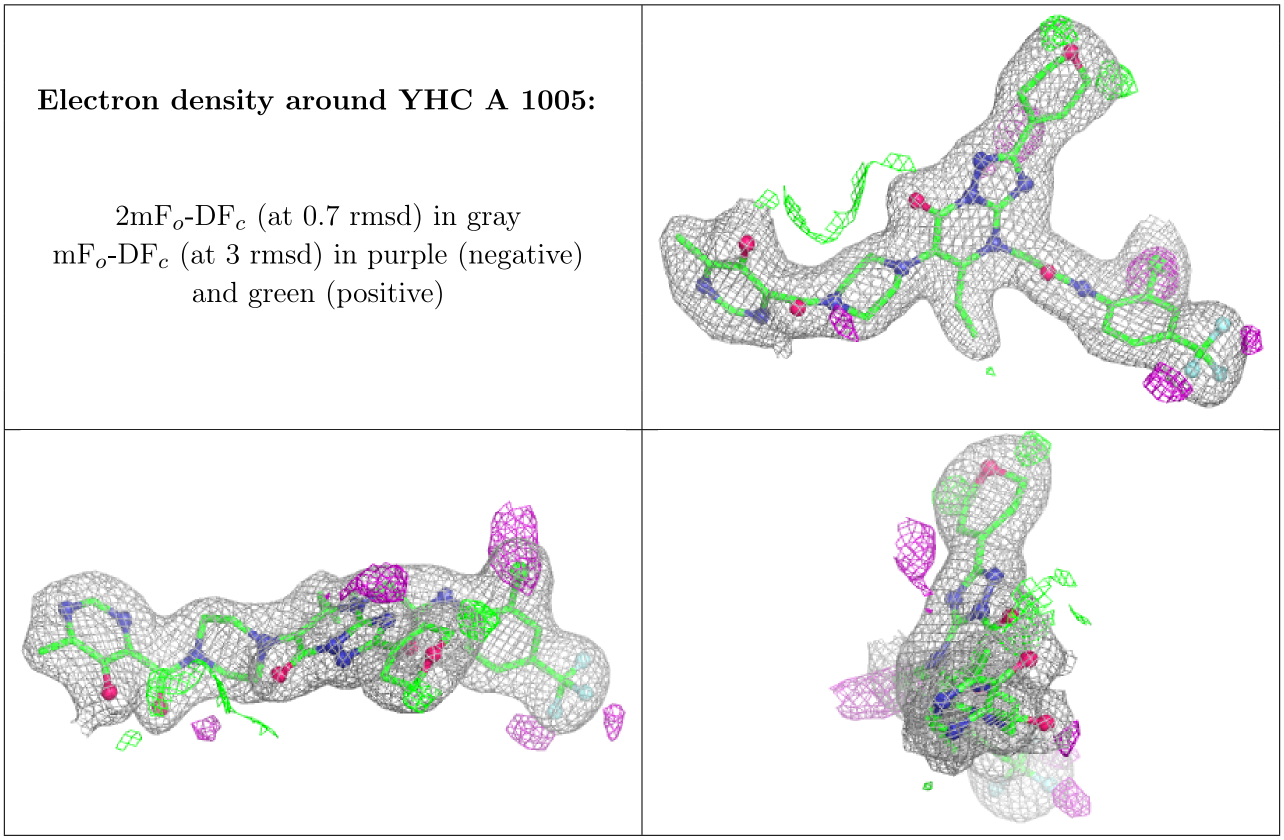
There are no oligosaccharides in this entry.

6.4 Ligands

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	FLC	A	1003	13/13	0.60	0.16	107,108,108,108	0
2	FLC	A	1008	13/13	0.71	0.17	126,127,127,127	0
6	PEG	A	1009	7/7	0.78	0.19	60,61,63,63	0
3	EDO	A	1010	4/4	0.81	0.17	80,80,80,80	0
3	EDO	A	1007	4/4	0.81	0.21	74,74,74,74	0
2	FLC	A	1001	13/13	0.84	0.10	84,86,86,87	0
5	DMS	A	1006	4/4	0.86	0.22	99,99,99,99	0
3	EDO	A	1004	4/4	0.88	0.16	76,76,76,76	0
3	EDO	A	1002	4/4	0.93	0.12	66,66,66,66	0
4	YHC	A	1005	49/49	0.93	0.07	36,40,49,50	0
7	ZN	A	1011	1/1	1.00	0.02	50,50,50,50	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.



Electron density around YHC A 1005:

2mF$_o$-DF$_c$ (at 0.7 rmsd) in gray
mF$_o$-DF$_c$ (at 3 rmsd) in purple (negative)
and green (positive)

6.5 Other polymers ⓘ

There are no such residues in this entry.