Full wwPDB X-ray Structure Validation Report ⓘ

Oct 18, 2022 – 10:33 am BST

PDB ID	:	7ZO1
Title	:	SpCas9 bound to CD34 off-target9 DNA substrate
Authors	:	Pacesa, M.; Jinek, M.
Deposited on	:	2022-04-23
Resolution	:	2.40 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at *validation@mail.wwpdb.org*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

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

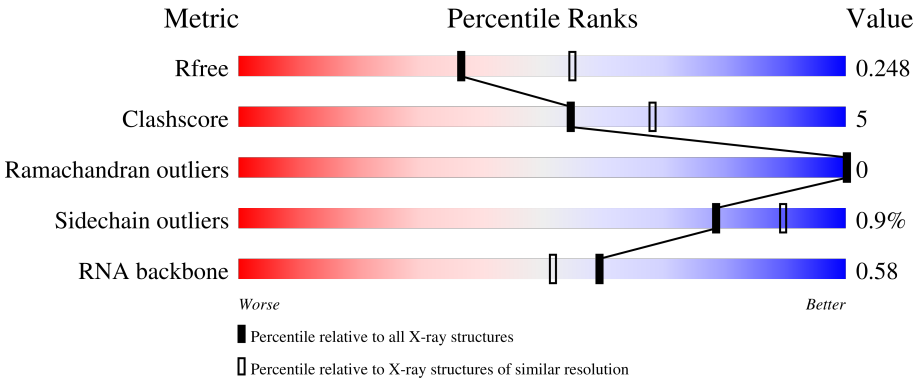
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.31.2
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0267
CCP4	:	7.1.010 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.31.2

1 Overall quality at a glance (i)

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

The reported resolution of this entry is 2.40 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}	130704	3907 (2.40-2.40)
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)
RNA backbone	3102	1174 (2.80-2.00)

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%

Mol	Chain	Length	Quality of chain
1	A	85	48% 46% 6%
2	B	1368	76% 10% 15%
3	C	28	57% 43%
4	D	12	25% 58% 17%

2 Entry composition (i)

There are 7 unique types of molecules in this entry. The entry contains 12407 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 RNA chain called CD34 sgRNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	85	Total	C	N	O	P	0	0	1
			1794	801	335	574	84			

- Molecule 2 is a protein called CRISPR-associated endonuclease Cas9/Csn1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	1169	Total	C	N	O	S	0	1	0
			9559	6107	1650	1783	19			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	10	ALA	ASP	engineered mutation	UNP Q99ZW2
B	840	ALA	HIS	engineered mutation	UNP Q99ZW2

- Molecule 3 is a DNA chain called CD34 off-target9 DNA target strand.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	28	Total	C	N	O	P	0	0	0
			555	270	90	168	27			

- Molecule 4 is a DNA chain called CD34 off-target9 DNA non-target strand.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	10	Total	C	N	O	P	0	0	0
			205	100	35	61	9			

- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	2	Total	Mg	0	0
			2	2		

- Molecule 6 is POTASSIUM ION (three-letter code: K) (formula: K).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	3	Total K 3 3	0	0
6	B	5	Total K 5 5	0	0

- Molecule 7 is water.

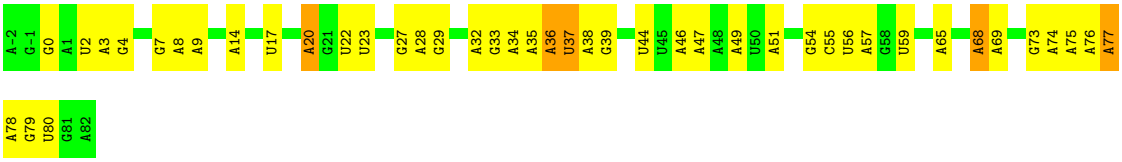
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	110	Total O 110 110	0	0
7	B	166	Total O 166 166	0	0
7	C	5	Total O 5 5	0	0
7	D	3	Total O 3 3	0	0

3 Residue-property plots (i)

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. 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. 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.

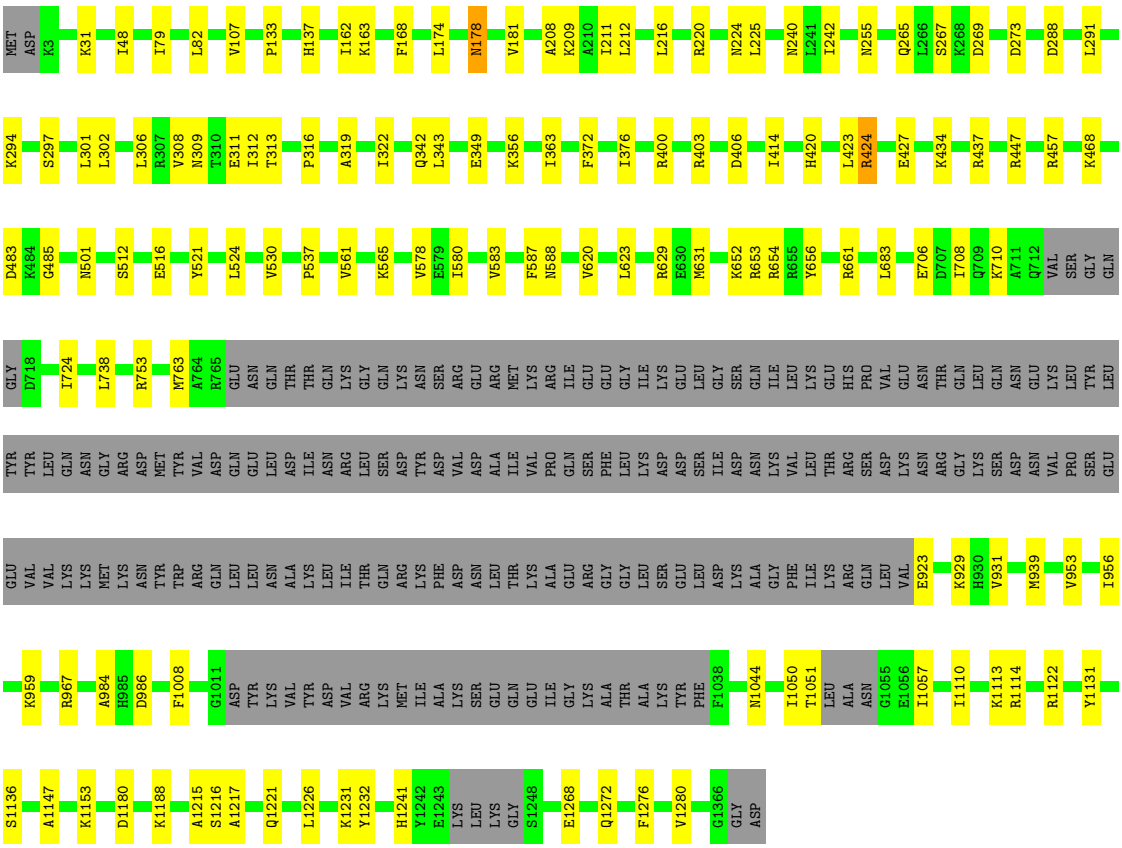
- Molecule 1: CD34 sgRNA

Chain A:



- Molecule 2: CRISPR-associated endonuclease Cas9/Csn1

Chain B:



- Molecule 3: CD34 off-target9 DNA target strand

Chain C:

• Molecule 4: CD34 off-target9 DNA non-target strand

Chain D:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	177.41Å 69.20Å 188.46Å 90.00° 111.77° 90.00°	Depositor
Resolution (Å)	46.51 – 2.40 46.51 – 2.30	Depositor EDS
% Data completeness (in resolution range)	99.8 (46.51-2.40) 86.0 (46.51-2.30)	Depositor EDS
R_{merge}	0.13	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	0.68 (at 2.29Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.212 , 0.250 0.210 , 0.248	Depositor DCC
R_{free} test set	4739 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å^2)	45.6	Xtriage
Anisotropy	0.408	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	(Not available) , (Not available)	EDS
L-test for twinning[2]	$< \|L\| > = 0.48$, $< L^2 > = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	12407	wwPDB-VP
Average B, all atoms (Å^2)	90.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.54% of the height of the origin peak. No significant pseudotranslation is detected.*

[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

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: K, MG

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	0.24	0/2013	0.79	1/3140 (0.0%)
2	B	0.25	0/9735	0.47	0/13083
3	C	0.56	0/618	1.00	0/948
4	D	0.55	0/229	1.04	0/353
All	All	0.28	0/12595	0.59	1/17524 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	17	U	C2-N1-C1'	5.16	123.89	117.70

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts

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	1794	0	891	30	0
2	B	9559	0	9709	85	0
3	C	555	0	320	8	0
4	D	205	0	117	6	0
5	A	2	0	0	0	0
6	A	3	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	B	5	0	0	0	0
7	A	110	0	0	2	0
7	B	166	0	0	3	0
7	C	5	0	0	0	0
7	D	3	0	0	0	0
All	All	12407	0	11037	119	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 5.

All (119) 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)
3:C:-7:DC:H2'	3:C:-6:DA:C8	2.28	0.69
2:B:501:ASN:HB3	2:B:708:ILE:HD12	1.74	0.68
2:B:309:ASN:HD21	2:B:311:GLU:HB2	1.60	0.66
1:A:2:U:H2'	1:A:3:A:C8	2.32	0.65
2:B:1215:ALA:HB2	2:B:1221:GLN:HG3	1.81	0.62
1:A:2:U:H2'	1:A:3:A:H8	1.63	0.62
2:B:1051:THR:HG22	2:B:1057:ILE:HG12	1.81	0.62
1:A:46:A:H2'	1:A:47:A:C8	2.35	0.61
1:A:49:A:N3	2:B:1122:ARG:NH2	2.50	0.60
4:D:6:DT:H2"	4:D:7:DG:H5"	1.83	0.60
2:B:1114:ARG:NH1	4:D:4:DA:OP1	2.35	0.59
2:B:181:VAL:HB	2:B:209:LYS:HG3	1.83	0.59
2:B:623:LEU:HD13	2:B:654:ARG:HG3	1.84	0.58
1:A:22:U:H2'	1:A:23:U:C6	2.38	0.58
1:A:34:A:H2'	1:A:35:A:O4'	2.03	0.57
2:B:561:VAL:HG12	2:B:565:LYS:HD2	1.87	0.56
4:D:-2:DT:H1'	4:D:-1:DA:H5'	1.87	0.56
2:B:306:LEU:HD22	2:B:316:PRO:HB2	1.89	0.55
2:B:1113:LYS:NZ	7:B:1507:HOH:O	2.37	0.55
2:B:956:ILE:HG23	2:B:1008:PHE:HB3	1.88	0.54
2:B:565:LYS:NZ	2:B:578:VAL:O	2.34	0.54
3:C:-6:DA:H2"	3:C:-5:DA:C8	2.42	0.54
1:A:35:A:H2'	1:A:36:A:C8	2.42	0.54
1:A:46:A:H2'	1:A:47:A:H8	1.72	0.54
2:B:349:GLU:HG3	2:B:356:LYS:HG3	1.89	0.54
2:B:181:VAL:H	2:B:209:LYS:HE3	1.72	0.54
2:B:1044:ASN:HB3	2:B:1050:ILE:HD13	1.90	0.54
2:B:212:LEU:HD21	2:B:225:LEU:HD22	1.90	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:54:G:H2'	1:A:55:C:C6	2.44	0.53
2:B:240:ASN:ND2	2:B:255:ASN:OD1	2.38	0.53
2:B:1110:ILE:HG23	2:B:1122:ARG:HD2	1.92	0.52
2:B:485:GLY:HA2	2:B:631:MET:HE1	1.92	0.52
1:A:65:A:N6	7:A:203:HOH:O	2.32	0.52
2:B:273:ASP:HB2	2:B:653:ARG:HH21	1.75	0.52
2:B:216:LEU:HD13	2:B:220:ARG:HG2	1.93	0.51
2:B:1216:SER:OG	2:B:1217:ALA:N	2.43	0.51
2:B:923:GLU:HA	2:B:959:LYS:HE3	1.93	0.51
2:B:168:PHE:CG	2:B:447:ARG:HD2	2.46	0.50
1:A:3:A:OP1	2:B:661:ARG:NH1	2.44	0.50
2:B:1051:THR:HA	2:B:1057:ILE:H	1.77	0.50
2:B:82:LEU:HD22	2:B:162:ILE:HD12	1.93	0.50
1:A:77:A:H2'	1:A:78:A:H8	1.77	0.50
1:A:20:A:OP2	2:B:403:ARG:NH1	2.45	0.49
2:B:583:VAL:HG21	2:B:587:PHE:CE1	2.47	0.49
2:B:565:LYS:HZ2	2:B:580:ILE:HG12	1.78	0.49
2:B:133:PRO:HG2	2:B:137:HIS:CE1	2.47	0.49
4:D:-2:DT:H2"	4:D:-1:DA:C8	2.47	0.49
2:B:512:SER:HA	2:B:620:VAL:HG11	1.94	0.49
2:B:516:GLU:OE1	7:B:1501:HOH:O	2.20	0.49
1:A:77:A:H2'	1:A:78:A:C8	2.47	0.49
2:B:427:GLU:HB2	2:B:434:LYS:HB2	1.94	0.48
1:A:68:A:C4	1:A:69:A:C8	3.01	0.48
2:B:468:LYS:HE3	2:B:483:ASP:HA	1.95	0.48
1:A:22:U:H2'	1:A:23:U:H6	1.78	0.47
1:A:74:A:H2'	1:A:75:A:O4'	2.14	0.47
3:C:-5:DA:H1'	3:C:-4:DT:H5'	1.95	0.47
2:B:137:HIS:HA	2:B:322:ILE:HD11	1.97	0.47
2:B:265:GLN:HG2	2:B:267:SER:H	1.78	0.47
1:A:27:G:N2	1:A:44:U:OP2	2.47	0.47
2:B:423:LEU:HB3	2:B:437:ARG:HG3	1.97	0.47
2:B:654:ARG:HD2	2:B:656:TYR:CZ	2.50	0.47
1:A:78:A:H2'	1:A:79:G:H8	1.80	0.46
3:C:-6:DA:H2"	3:C:-5:DA:H8	1.81	0.46
2:B:178:ASN:HD21	2:B:309:ASN:HA	1.81	0.46
1:A:75:A:H2'	1:A:76:A:C8	2.50	0.46
2:B:967:ARG:NH1	2:B:986:ASP:OD1	2.48	0.46
2:B:468:LYS:HG3	2:B:483:ASP:HB2	1.98	0.45
1:A:37:U:H2'	1:A:38:A:C8	2.51	0.45
2:B:269:ASP:HB2	2:B:629:ARG:NH2	2.30	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:312:ILE:HG13	2:B:313:THR:HG22	1.97	0.45
1:A:37:U:H2'	1:A:38:A:H8	1.82	0.45
2:B:308:VAL:HG11	2:B:319:ALA:HB3	1.98	0.45
2:B:939:MET:HE2	2:B:953:VAL:HG21	1.99	0.44
1:A:0:G:H5"	2:B:929:LYS:HE2	1.99	0.44
2:B:521:TYR:HB3	2:B:683:LEU:HB3	1.99	0.44
1:A:78:A:H2'	1:A:79:G:C8	2.53	0.44
1:A:80:U:OP2	2:B:753:ARG:NH2	2.50	0.44
2:B:420:HIS:CE1	2:B:424:ARG:HD3	2.52	0.44
2:B:1232:TYR:OH	2:B:1268:GLU:OE1	2.32	0.44
4:D:3:DT:H2"	4:D:4:DA:C8	2.52	0.44
2:B:225:LEU:HD23	2:B:242:ILE:HG21	1.99	0.44
2:B:211:ILE:HD11	2:B:224:ASN:HB3	2.00	0.43
2:B:48:ILE:HG12	2:B:984:ALA:HB1	2.00	0.43
2:B:763:MET:HE1	2:B:931:VAL:HG21	1.98	0.43
2:B:406:ASP:OD1	2:B:406:ASP:N	2.51	0.43
2:B:706:GLU:HG2	2:B:710:LYS:NZ	2.34	0.43
1:A:14:A:N3	7:A:208:HOH:O	2.37	0.43
2:B:724:ILE:HD12	2:B:738:LEU:HD13	2.01	0.43
1:A:57:A:H5"	2:B:457:ARG:HH21	1.84	0.42
2:B:306:LEU:HD21	2:B:414:ILE:HD13	2.00	0.42
1:A:38:A:H2'	1:A:39:G:C8	2.54	0.42
2:B:706:GLU:HG2	2:B:710:LYS:HZ3	1.84	0.42
2:B:1147:ALA:HB1	2:B:1188:LYS:O	2.19	0.42
3:C:5:DC:H2'	3:C:6:DA:H8	1.84	0.42
2:B:79:ILE:HD11	2:B:163:LYS:HB2	2.01	0.42
2:B:288:ASP:HA	2:B:291:LEU:HB3	2.02	0.42
2:B:208:ALA:HA	2:B:211:ILE:HG22	2.02	0.42
2:B:403:ARG:NH1	7:B:1524:HOH:O	2.52	0.41
2:B:372:PHE:O	2:B:376:ILE:HG12	2.19	0.41
2:B:1276:PHE:O	2:B:1280:VAL:HG22	2.20	0.41
3:C:-1:DC:H2"	3:C:0:DA:C8	2.55	0.41
2:B:652:LYS:HB3	2:B:652:LYS:HE2	1.77	0.41
3:C:7:DT:H2'	3:C:8:DC:O4'	2.21	0.41
2:B:211:ILE:HD12	2:B:211:ILE:HA	1.88	0.41
2:B:400:ARG:NH2	2:B:406:ASP:OD2	2.52	0.41
2:B:763:MET:HE3	2:B:763:MET:HB2	1.99	0.41
2:B:1136:SER:HA	4:D:2:DG:O3'	2.20	0.41
2:B:297:SER:O	2:B:301:LEU:N	2.53	0.41
2:B:631:MET:HE2	2:B:631:MET:HB3	1.96	0.41
2:B:530:VAL:HG22	2:B:537:PRO:HB3	2.03	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:174:LEU:HD13	2:B:302:LEU:HD11	2.02	0.40
2:B:294:LYS:O	2:B:297:SER:HB3	2.20	0.40
3:C:12:DT:H2'	3:C:13:DT:C6	2.56	0.40
2:B:524:LEU:HD12	2:B:587:PHE:CE1	2.57	0.40
2:B:1226:LEU:HD13	2:B:1276:PHE:CG	2.56	0.40
2:B:31:LYS:HD3	2:B:31:LYS:HA	1.90	0.40
2:B:107:VAL:HG23	2:B:1131:TYR:CE1	2.56	0.40
1:A:44:U:H5'	2:B:363:ILE:HD12	2.03	0.40
1:A:4:G:H21	2:B:588:ASN:ND2	2.19	0.40

There are no symmetry-related clashes.

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

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	
2	B	1158/1368 (85%)	1110 (96%)	48 (4%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains (i)

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	
2	B	1048/1225 (86%)	1039 (99%)	9 (1%)	78	90

All (9) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	178	ASN
2	B	342	GLN
2	B	343	LEU
2	B	424	ARG
2	B	1153	LYS
2	B	1180	ASP
2	B	1231	LYS
2	B	1241	HIS
2	B	1272	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	175	ASN
2	B	178	ASN
2	B	309	ASN
2	B	556	ASN
2	B	980	ASN

5.3.3 RNA (i)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	A	82/85 (96%)	16 (19%)	0

All (16) RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	A	7	G
1	A	8	A
1	A	9	A
1	A	20	A
1	A	28	A
1	A	29	G
1	A	32	A
1	A	33	G
1	A	36	A
1	A	37	U
1	A	51	A
1	A	56	U

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Mol	Chain	Res	Type
1	A	59	U
1	A	68	A
1	A	73	G
1	A	77	A

There are no RNA pucker outliers to report.

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

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

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 10 ligands modelled in this entry, 10 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data

6.1 Protein, DNA and RNA chains

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.

6.3 Carbohydrates

Unable to reproduce the depositors R factor - this section is therefore empty.

6.4 Ligands

Unable to reproduce the depositors R factor - this section is therefore empty.

6.5 Other polymers

Unable to reproduce the depositors R factor - this section is therefore empty.