



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 04:27 AM UTC

PDB ID : 7Z4D / pdb_00007z4d
Title : Crystal structure of SpCas9 bound to a 10 nucleotide complementary DNA substrate
Authors : Pacesa, M.; Jinek, M.
Deposited on : 2022-03-03
Resolution : 3.10 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
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

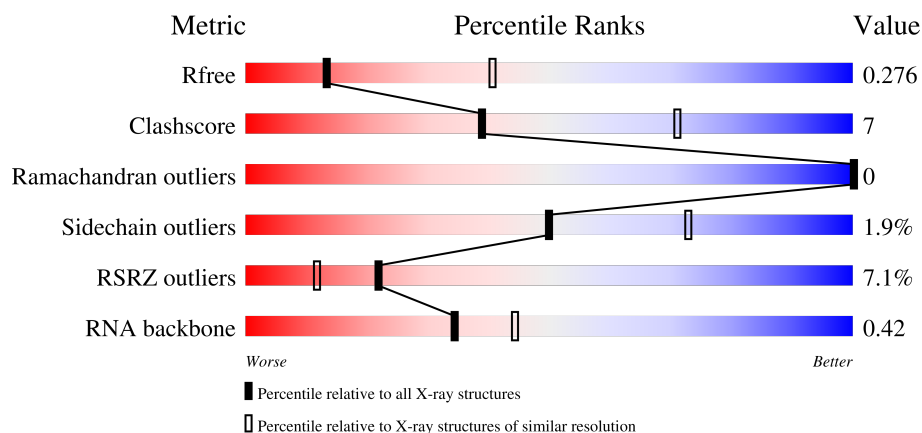
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.10 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	1456 (3.10-3.10)
Clashscore	190562	1539 (3.10-3.10)
Ramachandran outliers	187476	1467 (3.10-3.10)
Sidechain outliers	187428	1467 (3.10-3.10)
RSRZ outliers	180081	1456 (3.10-3.10)
RNA backbone	3983	1022 (3.32-2.88)

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 $\leq 5\%$. 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	84	0.2% 39% 43% 7% 11%
1	F	84	5% 35% 44% 13% 8%
2	B	1368	6% 78% 13% 8%
2	E	1368	7% 70% 15% 15%

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Mol	Chain	Length	Quality of chain
3	C	30	3% 37% 63%
3	G	30	7% 33% 57% 10%
4	D	30	13% 50% 23% 27%
4	H	30	7% 43% 20% 37%

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 25082 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 sgRNA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	75	Total	C	N	O	P	0	0	0
			1610	723	303	510	74			
1	F	77	Total	C	N	O	P	0	0	0
			1652	742	310	524	76			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	1259	Total	C	N	O	S	0	0	0
			10259	6549	1769	1921	20			
2	E	1166	Total	C	N	O	S	0	0	0
			9537	6102	1640	1776	19			

There are 4 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
E	10	ALA	ASP	engineered mutation	UNP Q99ZW2
E	840	ALA	HIS	engineered mutation	UNP Q99ZW2

- Molecule 3 is a DNA chain called Target strand of 10 nucleotide complementary DNA substrate.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	30	Total	C	N	O	P	0	0	0
			606	291	105	181	29			
3	G	27	Total	C	N	O	P	0	0	1
			526	252	90	159	25			

- Molecule 4 is a DNA chain called Non-target strand of 10 nucleotide complementary DNA substrate.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	22	Total	C	N	O	P	0	0	1
			429	207	75	127	20			
4	H	19	Total	C	N	O	P	0	0	1
			359	172	64	106	17			

- Molecule 5 is POTASSIUM ION (CCD ID: K) (formula: K).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	6	Total	K	0	0
			6	6		
5	B	3	Total	K	0	0
			3	3		
5	C	1	Total	K	0	0
			1	1		
5	E	2	Total	K	0	0
			2	2		
5	F	3	Total	K	0	0
			3	3		
5	G	1	Total	K	0	0
			1	1		

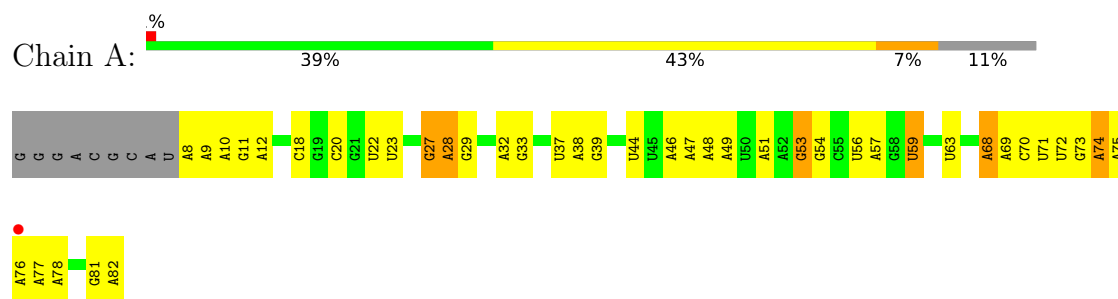
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	15	Total	O	0	0
			15	15		
6	B	22	Total	O	0	0
			22	22		
6	C	1	Total	O	0	0
			1	1		
6	D	2	Total	O	0	0
			2	2		
6	E	29	Total	O	0	0
			29	29		
6	F	14	Total	O	0	0
			14	14		
6	G	1	Total	O	0	0
			1	1		
6	H	4	Total	O	0	0
			4	4		

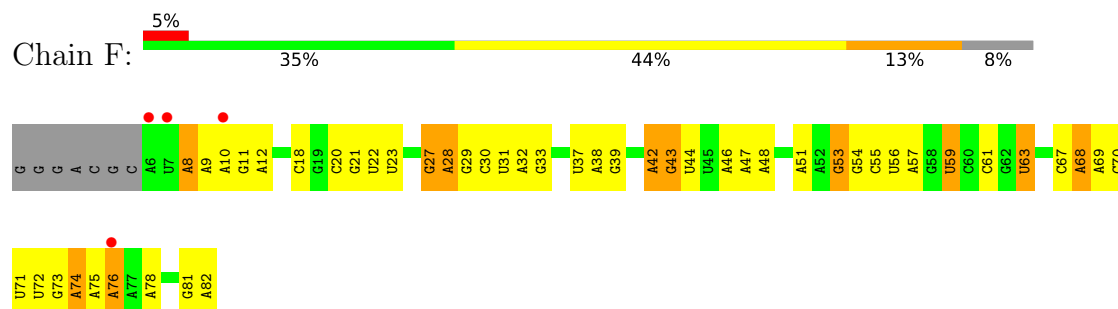
3 Residue-property plots [i](#)

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 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.

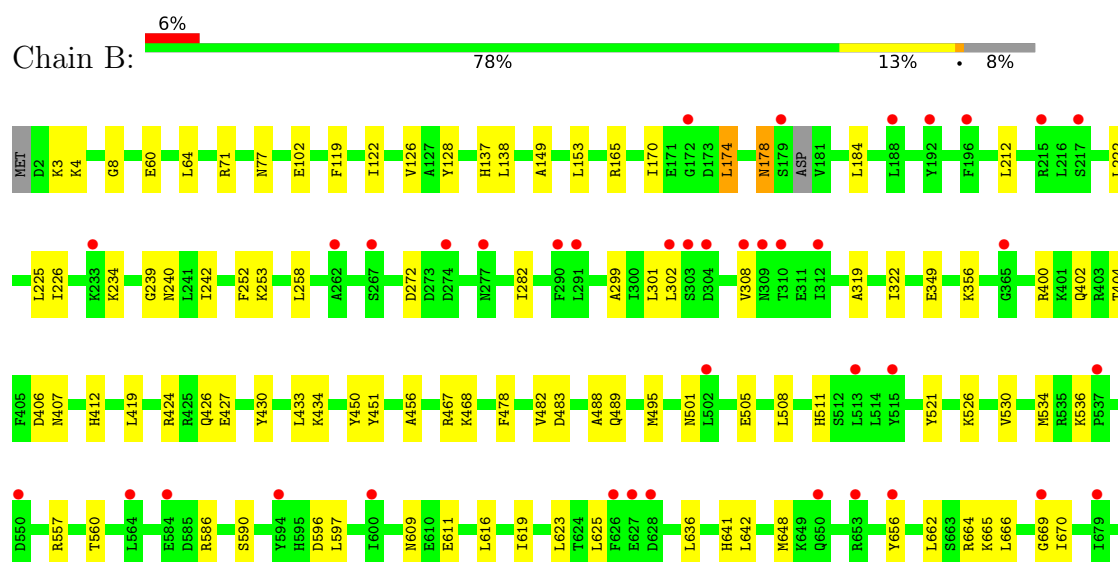
• Molecule 1: sgRNA

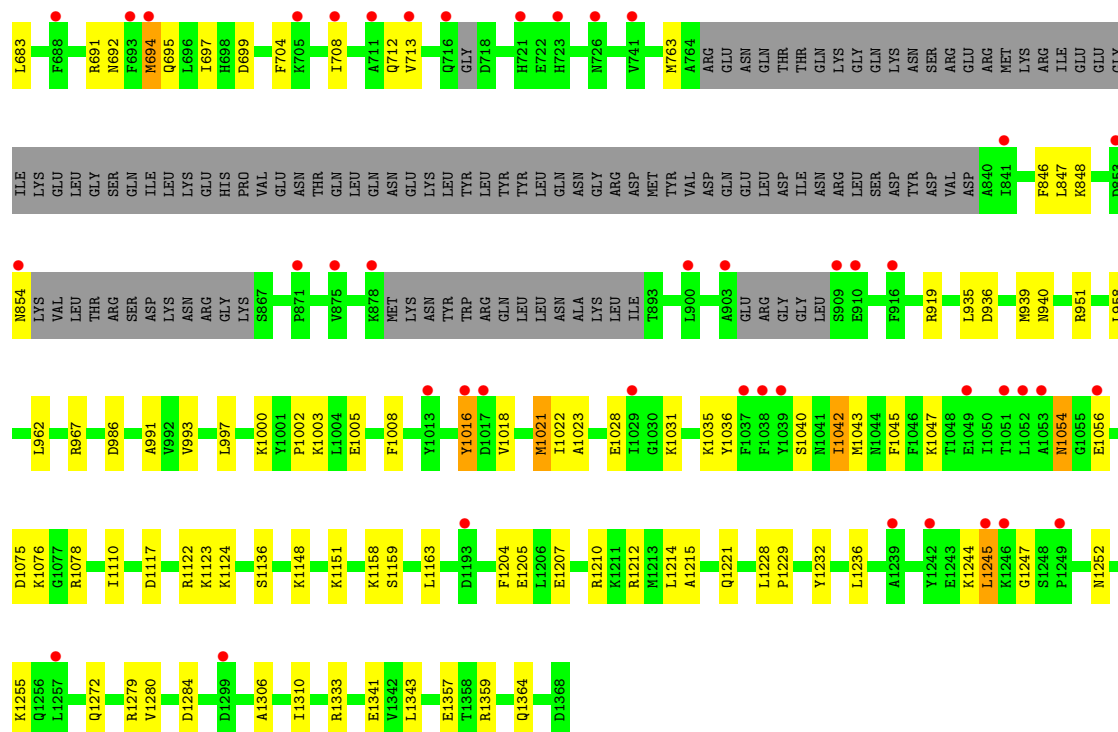


• Molecule 1: sgRNA

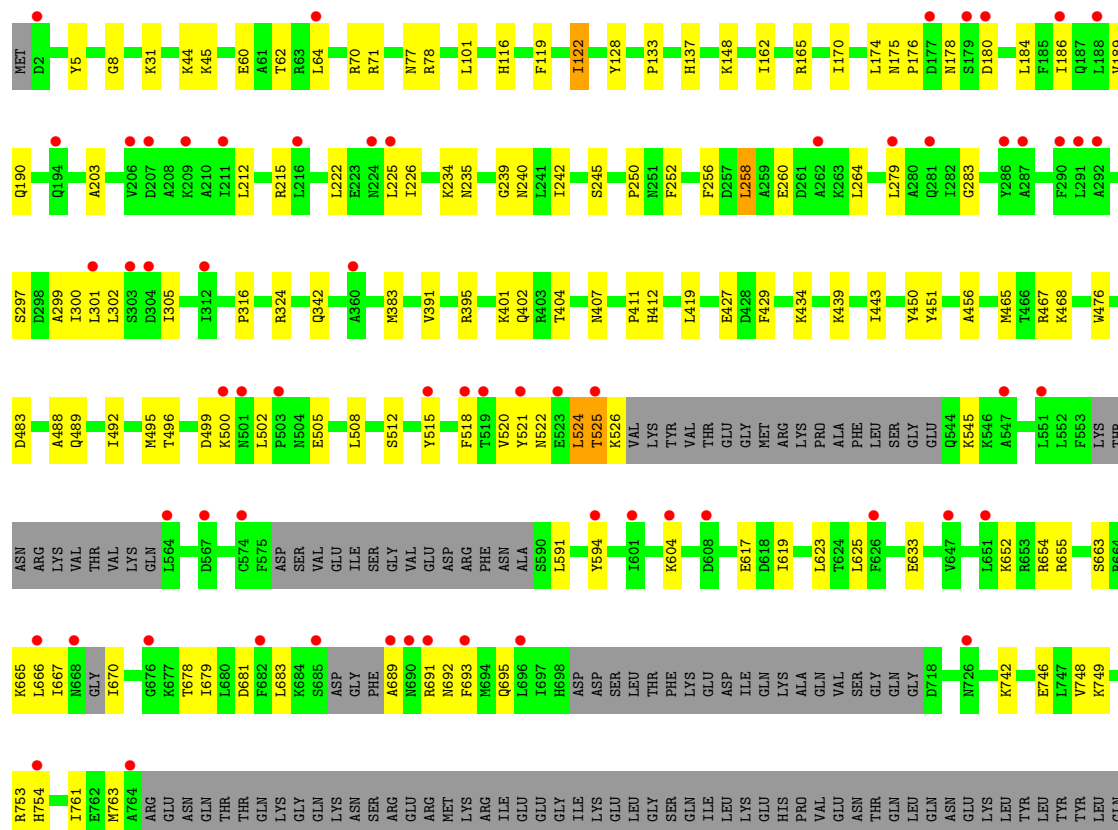


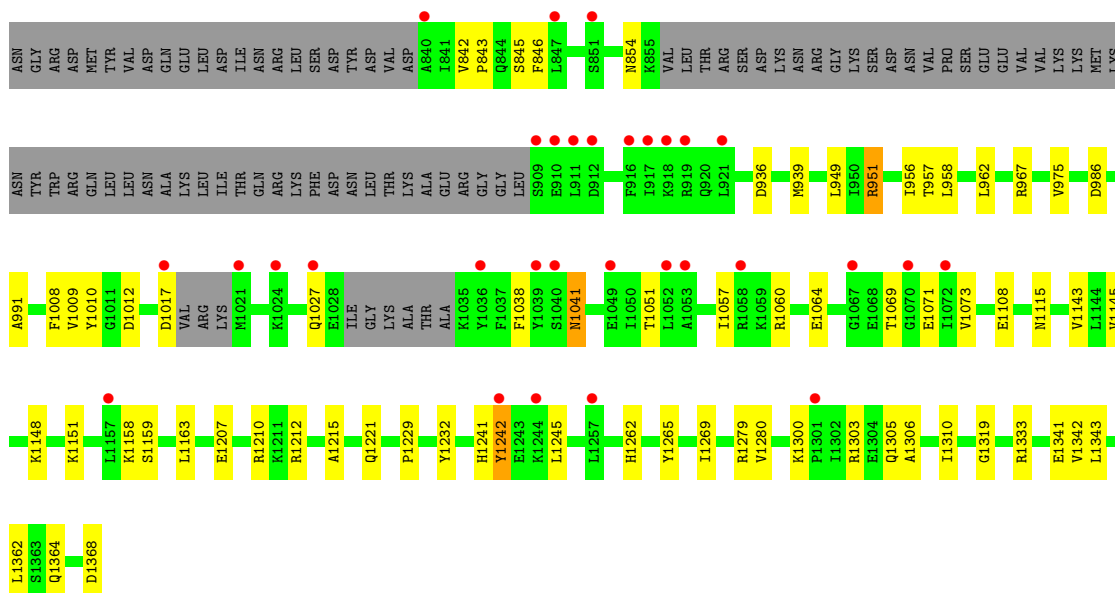
• Molecule 2: CRISPR-associated endonuclease Cas9/Csn1



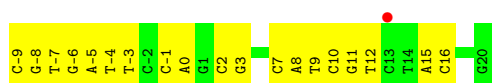


• Molecule 2: CRISPR-associated endonuclease Cas9/Csn1





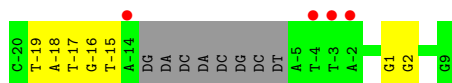
- Molecule 3: Target strand of 10 nucleotide complementary DNA substrate



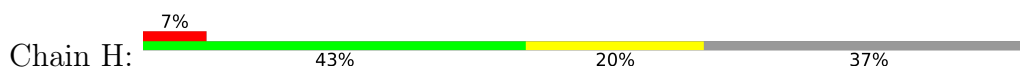
- Molecule 3: Target strand of 10 nucleotide complementary DNA substrate



- Molecule 4: Non-target strand of 10 nucleotide complementary DNA substrate



- Molecule 4: Non-target strand of 10 nucleotide complementary DNA substrate



4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, α , β , γ	88.64Å 95.51Å 169.80Å 80.83° 78.04° 62.34°	Depositor
Resolution (Å)	66.49 – 3.10 66.49 – 3.10	Depositor EDS
% Data completeness (in resolution range)	89.2 (66.49-3.10) 89.2 (66.49-3.10)	Depositor EDS
R_{merge}	0.34	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.86 (at 3.13Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, R_{free}	0.246 , 0.276 0.247 , 0.276	Depositor DCC
R_{free} test set	4132 reflections (4.47%)	wwPDB-VP
Wilson B-factor (Å ²)	52.8	Xtriage
Anisotropy	0.009	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 63.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.87	EDS
Total number of atoms	25082	wwPDB-VP
Average B, all atoms (Å ²)	68.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 17.13% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ 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:
K

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	0.14	0/1807	0.34	0/2816
1	F	0.15	0/1854	0.34	0/2889
2	B	0.14	2/10440 (0.0%)	0.30	0/14026
2	E	0.11	0/9706	0.30	0/13036
3	C	0.23	0/677	0.40	0/1042
3	G	0.21	0/586	0.40	0/901
4	D	0.21	0/479	0.42	0/737
4	H	0.21	0/401	0.42	0/616
All	All	0.14	2/25950 (0.0%)	0.32	0/36063

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	1021	MET	SD-CE	6.31	1.95	1.79
2	B	1021	MET	CG-SD	5.61	1.94	1.80

There are no bond angle outliers.

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	1610	0	809	27	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	F	1652	0	830	37	0
2	B	10259	0	10425	109	0
2	E	9537	0	9689	127	0
3	C	606	0	341	18	0
3	G	526	0	297	18	0
4	D	429	0	242	5	0
4	H	359	0	201	7	0
5	A	6	0	0	0	0
5	B	3	0	0	0	0
5	C	1	0	0	0	0
5	E	2	0	0	0	0
5	F	3	0	0	0	0
5	G	1	0	0	0	0
6	A	15	0	0	0	0
6	B	22	0	0	1	0
6	C	1	0	0	0	0
6	D	2	0	0	0	0
6	E	29	0	0	1	0
6	F	14	0	0	1	0
6	G	1	0	0	0	0
6	H	4	0	0	0	0
All	All	25082	0	22834	323	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 7.

The worst 5 of 323 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:10:A:H62	3:C:11:DG:H1	1.14	0.92
2:E:1051:THR:HG22	2:E:1057:ILE:HG22	1.65	0.78
2:B:847:LEU:HD21	2:B:919:ARG:HH11	1.49	0.76
3:G:-8:DG:H2''	3:G:-7:DT:H5'	1.68	0.75
2:E:1148:LYS:HG2	2:E:1159:SER:HA	1.66	0.75

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	
2	B	1245/1368 (91%)	1189 (96%)	56 (4%)	0	100	100
2	E	1144/1368 (84%)	1102 (96%)	42 (4%)	0	100	100
All	All	2389/2736 (87%)	2291 (96%)	98 (4%)	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	
2	B	1125/1225 (92%)	1103 (98%)	22 (2%)	48	72
2	E	1045/1225 (85%)	1025 (98%)	20 (2%)	50	73
All	All	2170/2450 (89%)	2128 (98%)	42 (2%)	50	73

5 of 42 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	E	419	LEU
2	E	1017	ASP
2	E	524	LEU
2	E	753	ARG
2	E	1115	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 34 such sidechains are listed below:

Mol	Chain	Res	Type
2	E	980	ASN
2	E	1027	GLN
2	E	1101	GLN
2	B	869	ASN
2	B	854	ASN

5.3.3 RNA ⓘ

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	A	74/84 (88%)	18 (24%)	2 (2%)
1	F	76/84 (90%)	18 (23%)	3 (3%)
All	All	150/168 (89%)	36 (24%)	5 (3%)

5 of 36 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	A	20	C
1	A	28	A
1	A	29	G
1	A	37	U
1	A	51	A

All (5) RNA pucker outliers are listed below:

Mol	Chain	Res	Type
1	A	27	G
1	A	28	A
1	F	27	G
1	F	28	A
1	F	42	A

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 16 ligands modelled in this entry, 16 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

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 [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	75/84 (89%)	-0.01	1 (1%) 75 56	22, 43, 142, 151	0
1	F	77/84 (91%)	0.18	4 (5%) 33 17	25, 46, 153, 210	0
2	B	1259/1368 (92%)	0.59	82 (6%) 25 13	18, 67, 118, 149	0
2	E	1166/1368 (85%)	0.68	93 (7%) 18 10	21, 65, 117, 142	0
3	C	30/30 (100%)	0.34	1 (3%) 49 29	36, 61, 129, 140	0
3	G	27/30 (90%)	0.48	2 (7%) 20 11	32, 55, 126, 130	0
4	D	22/30 (73%)	0.59	4 (18%) 3 1	32, 89, 137, 141	0
4	H	19/30 (63%)	0.55	2 (10%) 11 6	33, 83, 122, 141	0
All	All	2675/3024 (88%)	0.59	189 (7%) 22 12	18, 64, 119, 210	0

The worst 5 of 189 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	E	519	THR	5.3
1	F	6	A	4.7
2	E	1049	GLU	4.7
2	B	903	ALA	4.3
2	E	207	ASP	4.1

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

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

6.3 Carbohydrates [i](#)

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, 95th 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($\text{\AA}^2$)	Q<0.9
5	K	A	106	1/1	0.81	0.21	80,80,80,80	0
5	K	F	101	1/1	0.84	0.12	93,93,93,93	0
5	K	B	1402	1/1	0.88	0.14	60,60,60,60	0
5	K	E	1401	1/1	0.89	0.13	61,61,61,61	0
5	K	C	101	1/1	0.89	0.12	43,43,43,43	0
5	K	F	103	1/1	0.89	0.09	86,86,86,86	0
5	K	A	101	1/1	0.90	0.14	98,98,98,98	0
5	K	A	104	1/1	0.90	0.11	68,68,68,68	0
5	K	B	1401	1/1	0.92	0.20	53,53,53,53	0
5	K	A	103	1/1	0.93	0.09	52,52,52,52	0
5	K	G	101	1/1	0.94	0.12	48,48,48,48	0
5	K	A	105	1/1	0.95	0.08	73,73,73,73	0
5	K	F	102	1/1	0.95	0.08	58,58,58,58	0
5	K	B	1403	1/1	0.97	0.05	56,56,56,56	0
5	K	E	1402	1/1	0.97	0.13	47,47,47,47	0
5	K	A	102	1/1	0.97	0.05	69,69,69,69	0

6.5 Other polymers

There are no such residues in this entry.