wwPDB X-ray Structure Validation Summary Report (i)

Jun 3, 2024 – 02:55 PM JST

PDB ID	:	8KAL
Title	:	Crystal structure of SpyCas9 in complex with sgRNA and 17nt target DNA
Authors	:	Chen, Y.; Chen, J.; Liu, L.
Deposited on	:	2023-08-03
Resolution	:	3.16 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 (i) 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 (1)) were used in the production of this report:

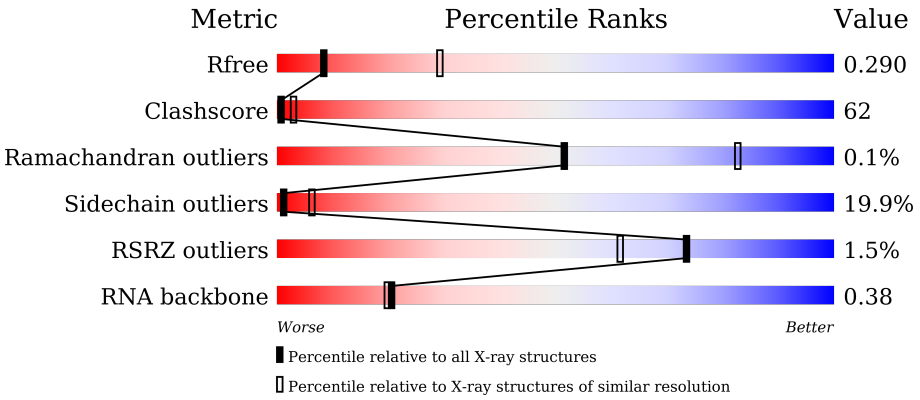
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36.2
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36.2

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 3.16 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	1665 (3.20-3.12)
Clashscore	141614	1804 (3.20-3.12)
Ramachandran outliers	138981	1770 (3.20-3.12)
Sidechain outliers	138945	1769 (3.20-3.12)
RSRZ outliers	127900	1616 (3.20-3.12)
RNA backbone	3102	1073 (3.50-2.82)

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	98	11% 48% 32% 5%
1	E	98	16% 49% 28%
2	B	1368	30% 52% 14%
2	G	1368	32% 52% 13%

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Mol	Chain	Length	Quality of chain
3	C	25	12% 72% 16%
3	H	25	28% 64% 8%
4	D	11	9% 18% 73% 9%
4	J	11	9% 36% 64%

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 27214 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 RNA (98-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	94	Total	C	N	O	P	0	0	0
			2009	899	362	654	94			
1	E	95	Total	C	N	O	P	0	0	0
			2029	908	365	661	95			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	1326	Total	C	N	O	S	0	0	0
			10821	6892	1877	2030	22			
2	G	1326	Total	C	N	O	S	0	0	0
			10822	6892	1879	2029	22			

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
G	10	ALA	ASP	engineered mutation	UNP Q99ZW2
G	840	ALA	HIS	engineered mutation	UNP Q99ZW2

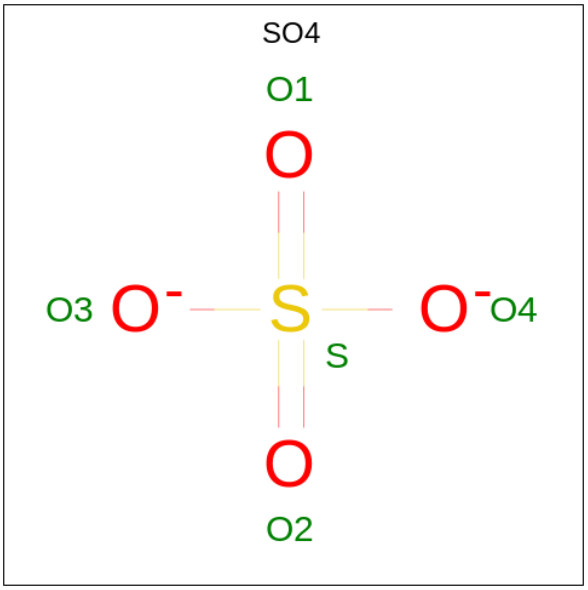
- Molecule 3 is a DNA chain called DNA (25-MER).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	25	Total	C	N	O	P	0	0	0
			505	243	93	145	24			
3	H	25	Total	C	N	O	P	0	0	0
			505	243	93	145	24			

- Molecule 4 is a DNA chain called DNA (5'-D(*TP*TP*TP*AP*GP*GP*TP*AP*TP*TP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	D	11	Total	C	N	O	P	0	0	0
			225	110	37	68	10			
4	J	11	Total	C	N	O	P	0	0	0
			225	110	37	68	10			

- Molecule 5 is SULFATE ION (three-letter code: SO4) (formula: O_4S).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	B	1	Total	O	S		0	0
			5	4	1			
5	G	1	Total	O	S		0	0
			5	4	1			

- Molecule 6 is water.

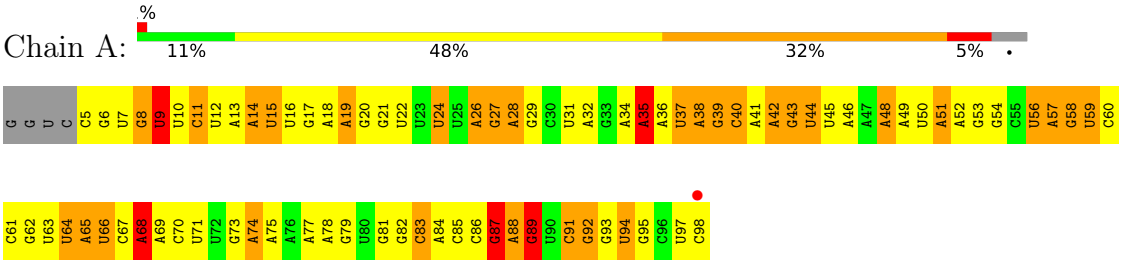
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	3	Total	O	0	0
			3	3		
6	B	26	Total	O	0	0
			26	26		
6	C	1	Total	O	0	0
			1	1		
6	E	3	Total	O	0	0
			3	3		
6	G	29	Total	O	0	0
			29	29		
6	H	1	Total	O	0	0
			1	1		

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.

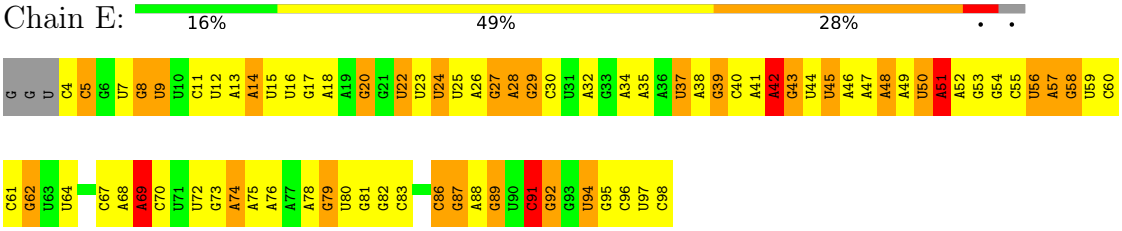
• Molecule 1: RNA (98-MER)

Chain A:



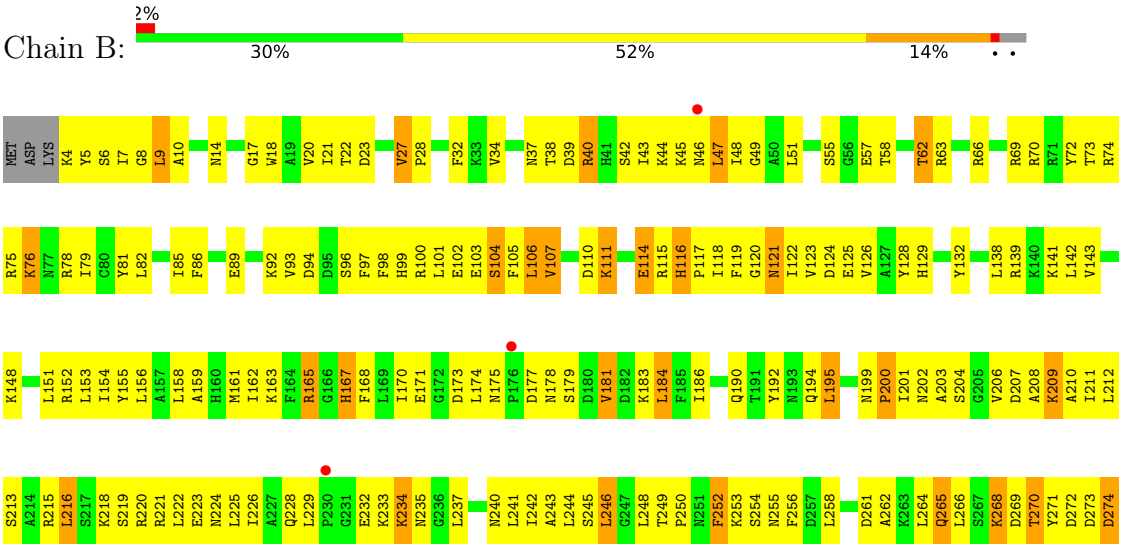
• Molecule 1: RNA (98-MER)

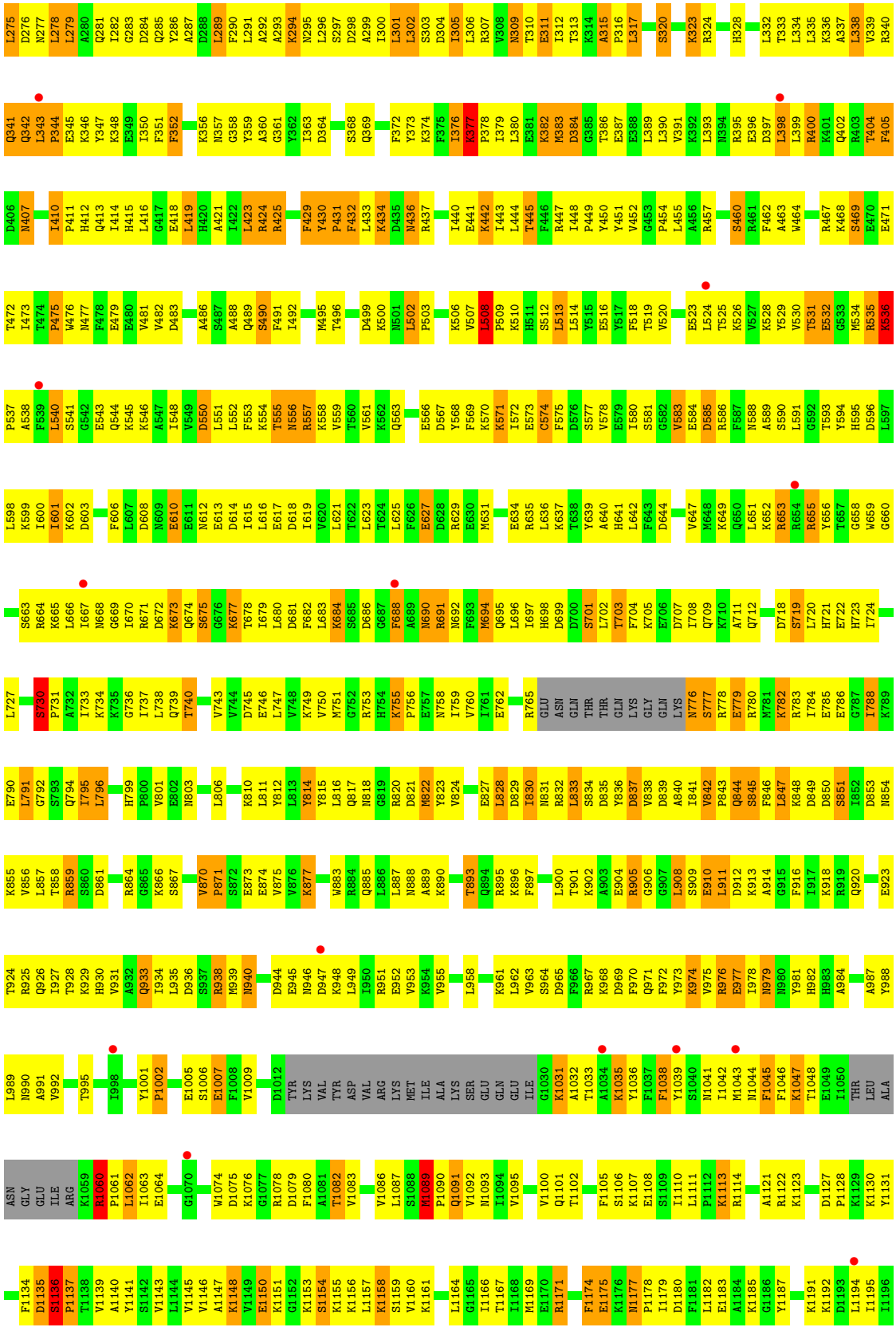
Chain E:

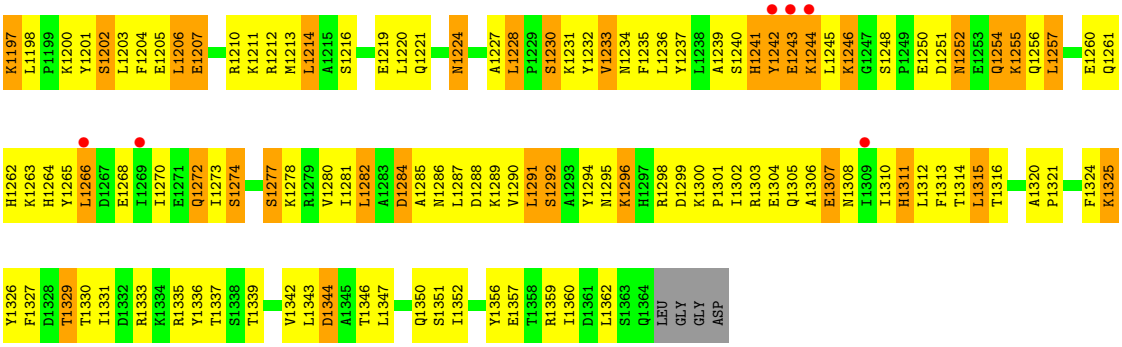


• Molecule 2: CRISPR-associated endonuclease Cas9/Csn1

Chain B:

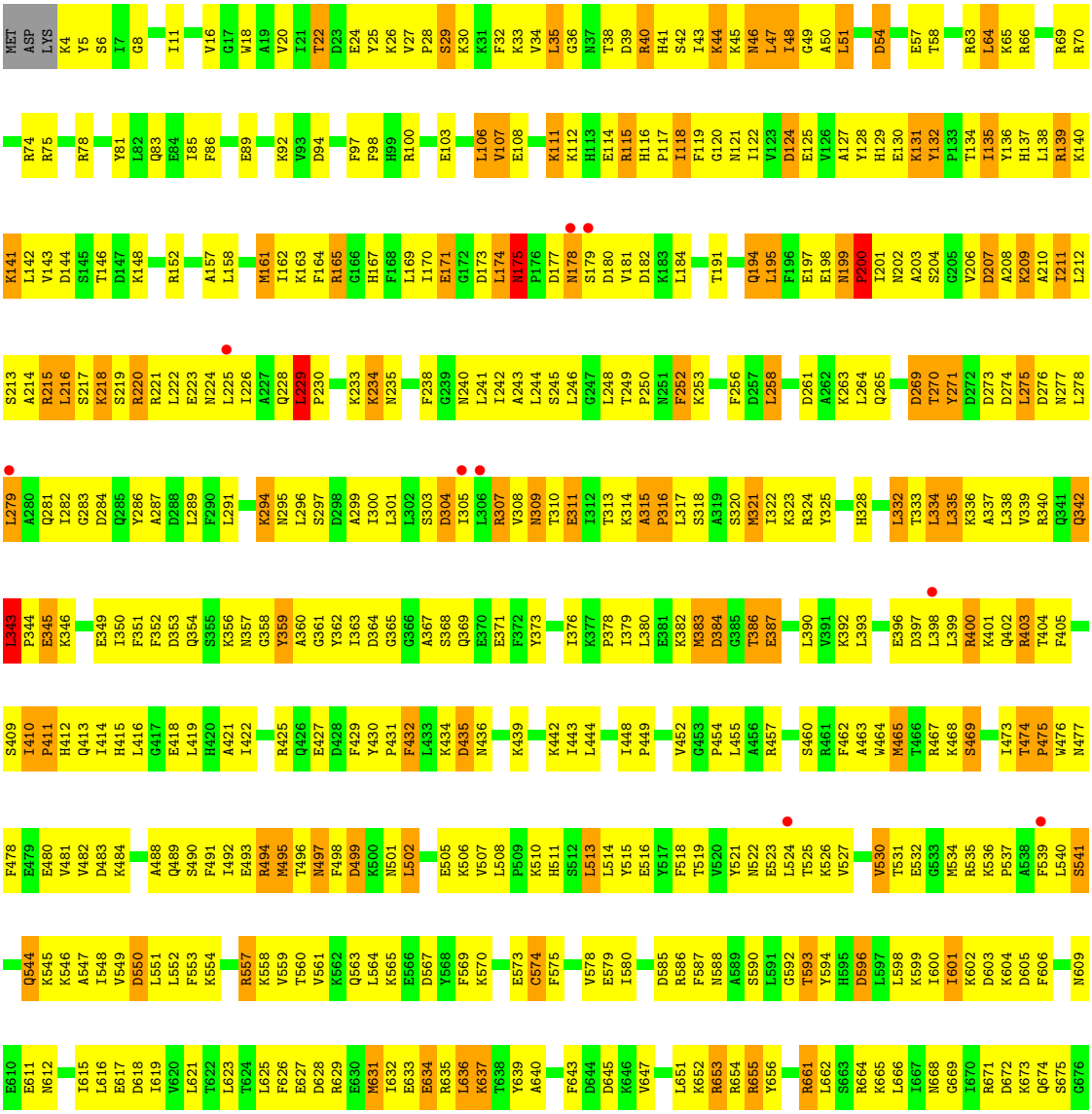


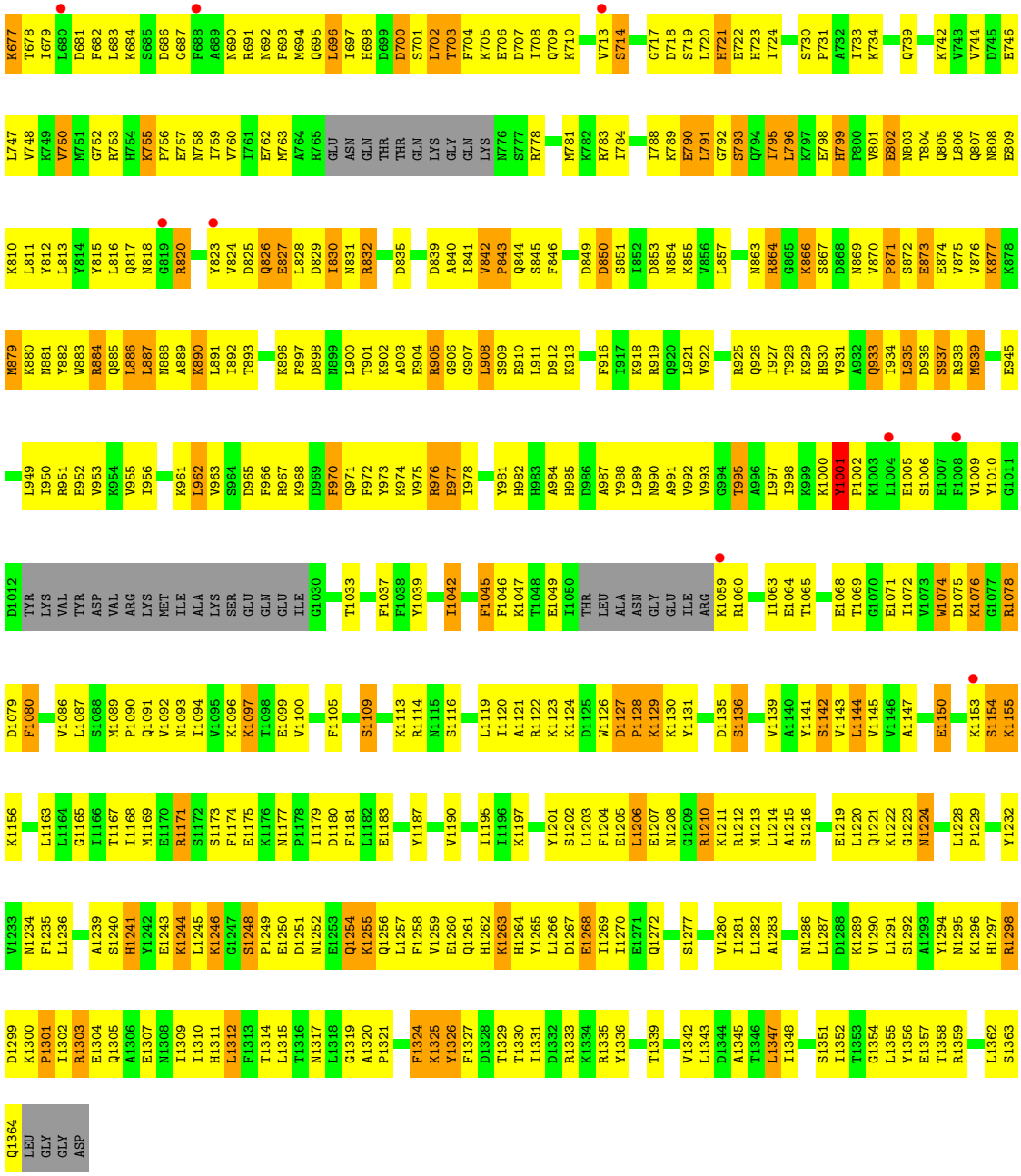




• Molecule 2: CRISPR-associated endonuclease Cas9/Csn1

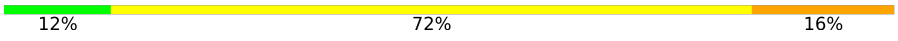
Chain G:

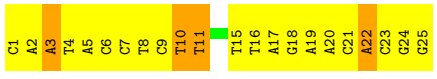




• Molecule 3: DNA (25-MER)

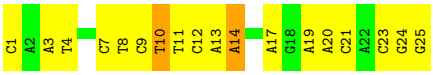
Chain C:



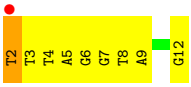


• Molecule 3: DNA (25-MER)

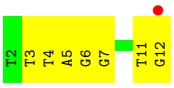
Chain H:



• Molecule 4: DNA (5'-D(*TP*TP*TP*AP*GP*GP*TP*AP*TP*TP*G)-3')



• Molecule 4: DNA (5'-D(*TP*TP*TP*AP*GP*GP*TP*AP*TP*TP*G)-3')



4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	362.05Å 70.96Å 200.10Å 90.00° 101.52° 90.00°	Depositor
Resolution (Å)	50.17 – 3.16 50.17 – 3.16	Depositor EDS
% Data completeness (in resolution range)	65.6 (50.17-3.16) 65.6 (50.17-3.16)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.79 (at 3.19Å)	Xtriage
Refinement program	PHENIX 1.17.1_3660	Depositor
R, R_{free}	0.251 , 0.288 0.251 , 0.290	Depositor DCC
R_{free} test set	2797 reflections (4.94%)	wwPDB-VP
Wilson B-factor (Å^2)	58.3	Xtriage
Anisotropy	0.329	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.23 , 35.6	EDS
L-test for twinning[2]	$< \|L\| > = 0.39$, $< L^2 > = 0.22$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.85	EDS
Total number of atoms	27214	wwPDB-VP
Average B, all atoms (Å^2)	59.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 43.87 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 1.6562e-04. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[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: SO4

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	0.87	1/2249 (0.0%)	1.58	39/3503 (1.1%)
1	E	0.84	0/2271	1.55	31/3537 (0.9%)
2	B	0.62	11/11013 (0.1%)	0.73	29/14802 (0.2%)
2	G	0.60	9/11013 (0.1%)	0.71	22/14799 (0.1%)
3	C	1.25	2/566 (0.4%)	1.24	6/870 (0.7%)
3	H	1.38	2/566 (0.4%)	1.21	1/870 (0.1%)
4	D	1.40	2/251 (0.8%)	1.27	0/387
4	J	1.29	2/251 (0.8%)	1.20	0/387
All	All	0.71	29/28180 (0.1%)	0.97	128/39155 (0.3%)

The worst 5 of 29 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	H	10	DT	C3'-O3'	-7.60	1.34	1.44
4	J	3	DT	C1'-N1	6.21	1.57	1.49
4	D	3	DT	N1-C2	5.78	1.42	1.38
4	J	4	DT	C3'-O3'	-5.67	1.36	1.44
3	H	14	DA	N9-C4	-5.66	1.34	1.37

The worst 5 of 128 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	E	14	A	O5'-P-OP2	-9.27	97.36	105.70
2	B	684	LYS	N-CA-C	-9.20	86.15	111.00
1	E	51	A	C8-N9-C4	-9.21	102.12	105.80
2	G	506	LYS	N-CA-C	-9.19	86.20	111.00
2	G	507	VAL	N-CA-CB	-9.01	91.67	111.50

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	2009	0	1009	110	0
1	E	2029	0	1020	127	0
2	B	10821	0	10948	1507	0
2	G	10822	0	10967	1594	0
3	C	505	0	283	31	0
3	H	505	0	283	23	0
4	D	225	0	129	18	0
4	J	225	0	129	6	0
5	B	5	0	0	0	0
5	G	5	0	0	1	0
6	A	3	0	0	0	0
6	B	26	0	0	7	0
6	C	1	0	0	0	0
6	E	3	0	0	1	0
6	G	29	0	0	10	0
6	H	1	0	0	0	0
All	All	27214	0	24768	3234	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 62.

The worst 5 of 3234 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)
2:G:530:VAL:CG1	2:G:537:PRO:HB3	1.21	1.65
2:B:181:VAL:HG11	2:B:300:ILE:CD1	1.14	1.59
2:G:279:LEU:CD1	2:G:287:ALA:HB2	1.28	1.59
2:G:279:LEU:HD11	2:G:287:ALA:CB	1.21	1.59
2:G:870:VAL:CG2	2:G:908:LEU:CD2	1.77	1.59

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	1318/1368 (96%)	1279 (97%)	38 (3%)	1 (0%)	51 83
2	G	1318/1368 (96%)	1273 (97%)	43 (3%)	2 (0%)	47 78
All	All	2636/2736 (96%)	2552 (97%)	81 (3%)	3 (0%)	51 83

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	200	PRO
2	G	200	PRO
2	G	230	PRO

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	1185/1225 (97%)	943 (80%)	242 (20%)	1 5
2	G	1186/1225 (97%)	957 (81%)	229 (19%)	1 7
All	All	2371/2450 (97%)	1900 (80%)	471 (20%)	1 6

5 of 471 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	1291	LEU
2	G	1205	GLU
2	G	220	ARG

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Mol	Chain	Res	Type
2	G	1155	LYS
2	G	886	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 48 such sidechains are listed below:

Mol	Chain	Res	Type
2	G	235	ASN
2	G	497	ASN
2	G	281	GLN
2	G	342	GLN
2	G	690	ASN

5.3.3 RNA (i)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	A	93/98 (94%)	31 (33%)	4 (4%)
1	E	94/98 (95%)	24 (25%)	3 (3%)
All	All	187/196 (95%)	55 (29%)	7 (3%)

5 of 55 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	A	9	U
1	A	11	C
1	A	20	G
1	A	24	U
1	A	27	G

5 of 7 RNA pucker outliers are listed below:

Mol	Chain	Res	Type
1	A	68	A
1	E	8	G
1	E	42	A
1	E	27	G
1	A	42	A

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)

2 ligands are modelled in this entry.

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	$\#\|Z\| > 2$
5	SO4	G	1401	-	4,4,4	0.98	0	6,6,6	1.66	1 (16%)
5	SO4	B	1401	-	4,4,4	0.98	0	6,6,6	1.66	1 (16%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	B	1401	SO4	O4-S-O3	3.83	125.39	109.06
5	G	1401	SO4	O4-S-O3	3.83	125.39	109.06

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	G	1401	SO4	1	0

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

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, 95^{th} 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	94/98 (95%)	-0.27	1 (1%) 80 70	27, 56, 107, 151	0
1	E	95/98 (96%)	-0.29	0 100 100	31, 56, 109, 125	0
2	B	1326/1368 (96%)	-0.21	23 (1%) 70 57	24, 57, 90, 137	0
2	G	1326/1368 (96%)	-0.21	18 (1%) 75 63	25, 57, 89, 123	0
3	C	25/25 (100%)	-0.32	0 100 100	32, 47, 96, 107	0
3	H	25/25 (100%)	-0.31	0 100 100	34, 47, 99, 112	0
4	D	11/11 (100%)	0.23	1 (9%) 9 5	48, 65, 121, 133	0
4	J	11/11 (100%)	0.13	1 (9%) 9 5	35, 60, 114, 132	0
All	All	2913/3004 (96%)	-0.21	44 (1%) 73 61	24, 57, 93, 151	0

The worst 5 of 44 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	947	ASP	3.9
2	B	1243	GLU	3.7
2	G	305	ILE	3.6
2	B	1043	MET	3.3
4	D	2	DT	3.3

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 monosaccharides 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
5	SO4	B	1401	5/5	0.95	0.26	30,30,30,30	0
5	SO4	G	1401	5/5	0.95	0.13	78,81,95,107	0

6.5 Other polymers

There are no such residues in this entry.