



# Full wwPDB X-ray Structure Validation Report ⓘ

Sep 2, 2023 – 02:45 PM EDT

PDB ID : 3Q8K  
Title : Crystal Structure of Human Flap Endonuclease FEN1 (WT) in complex with product 5'-flap DNA, SM3+, and K+  
Authors : Tsutakawa, S.E.; Classen, S.; Chapados, B.R.; Arvai, A.; Finger, D.L.; Guenther, G.; Tomlinson, C.G.; Thompson, P.; Sarker, A.H.; Shen, B.; Cooper, P.K.; Grasby, J.A.; Tainer, J.A.  
Deposited on : 2011-01-06  
Resolution : 2.20 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](mailto: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>.

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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 : 2.35  
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) : 2.35

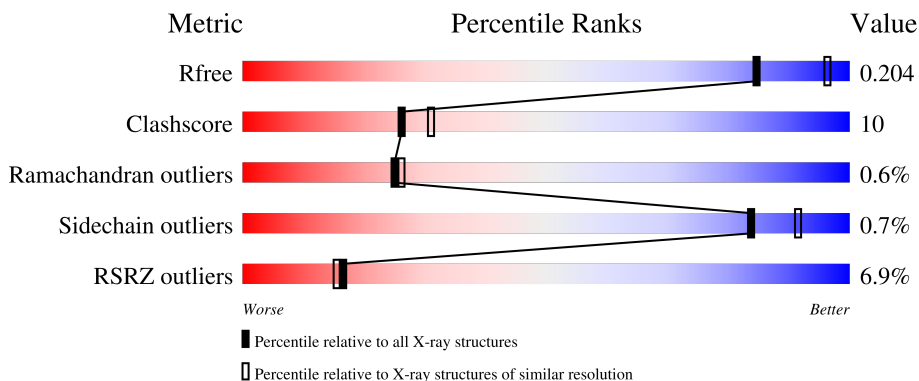
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

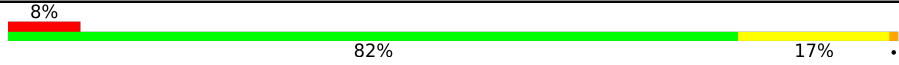


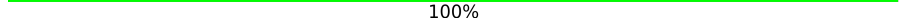
The reported resolution of this entry is 2.20 Å.

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	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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  $\geq 3$ , 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	341	
2	D	18	
3	E	11	
4	F	7	

## 2 Entry composition i

There are 8 unique types of molecules in this entry. The entry contains 4178 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 Flap endonuclease 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	341	2872	1804	510	542	16	11	20	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	337	LEU	-	expression tag	UNP P39748
A	338	GLU	-	expression tag	UNP P39748
A	339	VAL	-	expression tag	UNP P39748
A	340	LEU	-	expression tag	UNP P39748
A	341	PHE	-	expression tag	UNP P39748
A	342	GLN	-	expression tag	UNP P39748

- Molecule 2 is a DNA chain called DNA (5'-D(\*AP\*CP\*TP\*CP\*TP\*GP\*CP\*CP\*TP\*CP\*AP\*AP\*GP\*AP\*CP\*GP\*GP\*T)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
2	D	18	363	174	66	106	17	0	0	0

- Molecule 3 is a DNA chain called DNA (5'-D(P\*TP\*GP\*AP\*GP\*GP\*CP\*AP\*GP\*AP\*GP\*T)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
3	E	11	233	109	47	66	11	0	0	0

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
4	F	7	136	66	24	40	6	0	0	0

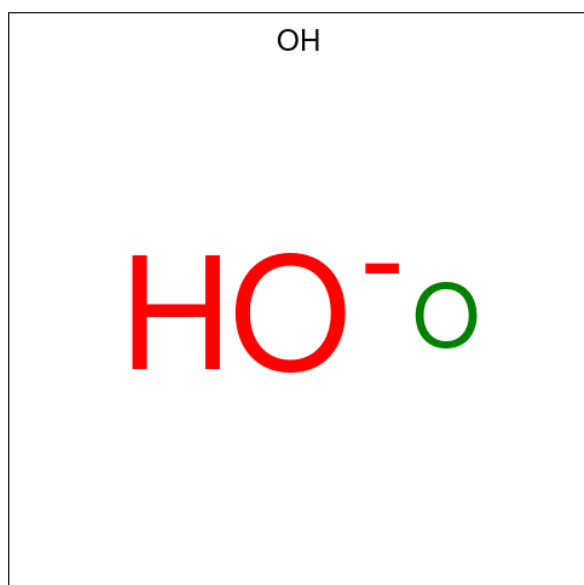
- Molecule 5 is SAMARIUM (III) ION (three-letter code: SM) (formula: Sm).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	4	Total 4	Sm 4	0	0

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

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	1	Total 1	K 1	0	0

- Molecule 7 is HYDROXIDE ION (three-letter code: OH) (formula: HO).



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

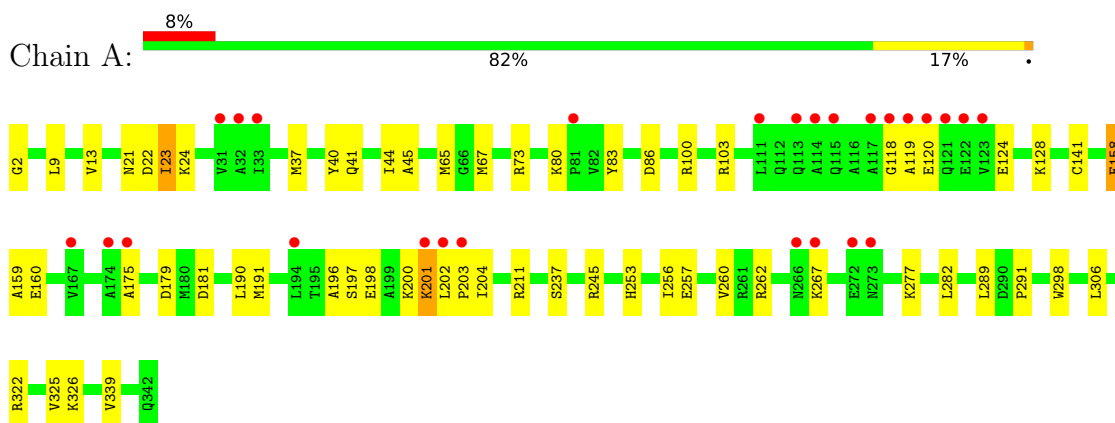
- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	449	Total 449	O 449	0	0
8	D	61	Total 61	O 61	0	0
8	E	42	Total 42	O 42	0	0
8	F	16	Total 16	O 16	0	0

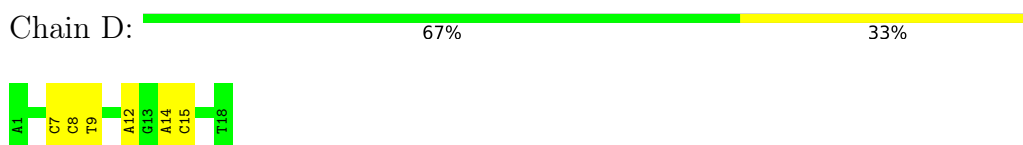
### 3 Residue-property plots [i](#)

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 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.

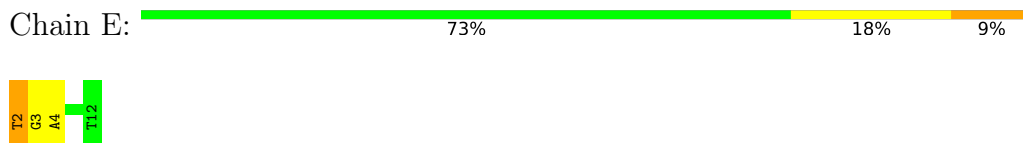
- Molecule 1: Flap endonuclease 1



- Molecule 2: DNA (5'-D(\*AP\*CP\*TP\*CP\*TP\*GP\*CP\*CP\*TP\*CP\*AP\*AP\*GP\*AP\*CP\*GP\*GP\*T)-3')



- Molecule 3: DNA (5'-D(P\*TP\*GP\*AP\*GP\*GP\*CP\*AP\*GP\*AP\*GP\*T)-3')



- Molecule 4: DNA (5'-D(\*AP\*CP\*CP\*GP\*TP\*CP\*C)-3')



There are no outlier residues recorded for this chain.

## 4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	105.44Å 105.44Å 105.06Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	34.46 – 2.20 34.46 – 2.20	Depositor EDS
% Data completeness (in resolution range)	95.5 (34.46-2.20) 98.8 (34.46-2.20)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	0.08	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.13 (at 2.20Å)	Xtrriage
Refinement program	PHENIX 1.7_629	Depositor
R, $R_{free}$	0.168 , 0.213 0.158 , 0.204	Depositor DCC
$R_{free}$ test set	1739 reflections (5.07%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	45.1	Xtrriage
Anisotropy	0.309	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 71.7	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.022 for -h,-k,l	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	4178	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	59.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.37% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: OH, K, SM

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	0.31	0/2919	0.45	0/3922
2	D	0.50	0/406	1.08	0/624
3	E	0.81	1/262 (0.4%)	1.08	0/402
4	F	0.53	0/151	1.10	0/230
All	All	0.40	1/3738 (0.0%)	0.66	0/5178

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	E	2	DT	OP3-P	-10.62	1.48	1.61

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	2872	0	2884	62	0
2	D	363	0	204	8	0
3	E	233	0	124	6	0
4	F	136	0	80	0	0
5	A	4	0	0	0	0
6	A	1	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
7	A	1	0	0	1	0
8	A	449	0	0	10	0
8	D	61	0	0	1	0
8	E	42	0	0	2	0
8	F	16	0	0	0	0
All	All	4178	0	3292	72	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 10.

All (72) 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:65:MET:HG3	8:D:294:HOH:O	1.63	0.98
1:A:2:GLY:N	7:A:347:OH:O	2.02	0.93
1:A:24:LYS:HB2	8:A:479:HOH:O	1.91	0.71
1:A:267[A]:LYS:HE3	1:A:267[A]:LYS:HA	1.76	0.67
1:A:22:ASP:OD2	1:A:24:LYS:HG2	1.95	0.66
1:A:306[B]:LEU:HD23	1:A:325:VAL:HG22	1.76	0.66
1:A:204[A]:ILE:HG12	8:A:660:HOH:O	1.97	0.65
1:A:73[A]:ARG:NH1	1:A:197:SER:HA	2.15	0.62
1:A:201[A]:LYS:CB	1:A:202[A]:LEU:HA	2.30	0.61
1:A:100:ARG:HG2	1:A:103:ARG:HH21	1.65	0.61
1:A:202[A]:LEU:HB3	8:A:686:HOH:O	2.01	0.60
3:E:2:DT:P	8:E:455:HOH:O	2.59	0.60
1:A:160[A]:GLU:HG3	1:A:181:ASP:OD1	2.01	0.60
1:A:158:GLU:CG	1:A:160[A]:GLU:OE2	2.50	0.59
1:A:158:GLU:HG3	1:A:160[A]:GLU:OE2	2.03	0.59
1:A:200[A]:LYS:C	1:A:202[A]:LEU:HB2	2.22	0.58
1:A:37:MET:O	1:A:41:GLN:HG2	2.03	0.58
1:A:73[C]:ARG:CZ	1:A:197:SER:HA	2.33	0.58
3:E:3:DG:H2''	3:E:4:DA:O5'	2.02	0.57
1:A:73[A]:ARG:NH2	2:D:14:DA:OP1	2.38	0.57
1:A:204[B]:ILE:HD12	8:A:660:HOH:O	2.03	0.56
1:A:100:ARG:HG2	1:A:103:ARG:NH2	2.21	0.56
1:A:245[A]:ARG:HD3	8:A:584:HOH:O	2.06	0.56
1:A:201[A]:LYS:N	1:A:202[A]:LEU:HB2	2.22	0.54
3:E:3:DG:H2'	3:E:4:DA:C8	2.43	0.54
1:A:40:TYR:CZ	1:A:44:ILE:HD11	2.42	0.53
3:E:2:DT:H72	8:E:608:HOH:O	2.08	0.53
1:A:21:ASN:O	1:A:203[A]:PRO:HA	2.08	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:282:LEU:O	1:A:282:LEU:HD23	2.08	0.53
1:A:202[A]:LEU:HD22	1:A:203[A]:PRO:CD	2.40	0.51
2:D:8:DC:H2'	2:D:9:DT:C6	2.45	0.51
1:A:257:GLU:OE2	1:A:277[B]:LYS:HE3	2.11	0.50
1:A:2:GLY:HA2	1:A:179:ASP:OD1	2.11	0.49
1:A:175:ALA:O	1:A:190:LEU:HD12	2.12	0.49
1:A:158:GLU:HG2	1:A:160[A]:GLU:OE2	2.12	0.49
1:A:73[A]:ARG:NH1	1:A:196:ALA:O	2.45	0.49
1:A:67[B]:MET:HG3	1:A:141:CYS:SG	2.53	0.48
1:A:202[A]:LEU:HD13	1:A:203[A]:PRO:N	2.28	0.48
1:A:306[B]:LEU:HD23	1:A:325:VAL:CG2	2.44	0.48
1:A:73[B]:ARG:HD2	1:A:198[B]:GLU:OE2	2.14	0.48
2:D:7:DC:H2''	2:D:8:DC:H6	1.79	0.47
1:A:23:ILE:N	8:A:660:HOH:O	2.47	0.47
1:A:9:LEU:C	1:A:9:LEU:HD23	2.35	0.47
1:A:73[C]:ARG:NH1	2:D:14:DA:H3'	2.30	0.47
2:D:8:DC:H2''	2:D:9:DT:H5'	1.97	0.47
1:A:73[A]:ARG:HD3	2:D:15:DC:P	2.55	0.46
1:A:253:HIS:CE1	1:A:262[A]:ARG:HG3	2.50	0.46
2:D:7:DC:H2''	2:D:8:DC:C6	2.50	0.46
1:A:200[A]:LYS:CB	1:A:202[A]:LEU:HB2	2.46	0.46
1:A:80:LYS:HB3	1:A:298:TRP:CE2	2.50	0.46
1:A:191:MET:HE1	1:A:204[A]:ILE:HG21	1.99	0.45
1:A:67[B]:MET:HE1	1:A:83:TYR:CE1	2.51	0.45
1:A:256:ILE:O	1:A:260:VAL:HG23	2.17	0.45
1:A:45:ALA:HB2	2:D:12:DA:H2'	1.99	0.45
3:E:3:DG:H2'	3:E:4:DA:H8	1.82	0.44
1:A:289:LEU:O	1:A:291:PRO:HD3	2.18	0.43
1:A:73[A]:ARG:HH12	1:A:196:ALA:C	2.21	0.43
1:A:13:VAL:HG12	1:A:13:VAL:O	2.17	0.43
1:A:322[A]:ARG:O	1:A:326:LYS:HG2	2.19	0.43
1:A:202[A]:LEU:HD22	1:A:203[A]:PRO:HD2	2.00	0.43
1:A:291:PRO:HG2	8:A:528:HOH:O	2.18	0.42
1:A:201[B]:LYS:O	1:A:202[B]:LEU:C	2.57	0.42
1:A:86:ASP:OD1	1:A:159:ALA:N	2.40	0.42
1:A:118:GLY:O	1:A:120:GLU:N	2.53	0.42
3:E:3:DG:H2''	3:E:4:DA:C5'	2.50	0.41
1:A:191:MET:CE	1:A:204[A]:ILE:HG21	2.51	0.41
1:A:339:VAL:HG23	8:A:559:HOH:O	2.20	0.41
1:A:202[A]:LEU:HD13	1:A:203[A]:PRO:O	2.20	0.41
1:A:73[C]:ARG:NH1	1:A:197:SER:HA	2.36	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:211:ARG:NH2	8:A:592:HOH:O	2.53	0.40
1:A:124:GLU:O	1:A:128:LYS:HG3	2.21	0.40
1:A:237:SER:HB2	8:A:402:HOH:O	2.21	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
1	A	360/341 (106%)	342 (95%)	15 (4%)	3 (1%)	19 19

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	119	ALA
1	A	201[A]	LYS
1	A	201[B]	LYS

### 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
1	A	309/293 (106%)	307 (99%)	2 (1%)	86 93

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	23	ILE
1	A	158	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	253	HIS

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

## 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 6 ligands modelled in this entry, 5 are monoatomic and 1 is modelled with single atom - 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

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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	341/341 (100%)	0.30	26 (7%) 13 12	28, 49, 95, 151	0
2	D	18/18 (100%)	-0.20	0 100 100	49, 72, 93, 101	0
3	E	11/11 (100%)	0.46	0 100 100	73, 82, 92, 110	0
4	F	7/7 (100%)	-0.82	0 100 100	46, 57, 66, 70	0
All	All	377/377 (100%)	0.26	26 (6%) 16 15	28, 50, 96, 151	0

All (26) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	201[A]	LYS	8.3
1	A	202[A]	LEU	6.7
1	A	117	ALA	5.2
1	A	118	GLY	5.1
1	A	122	GLU	5.0
1	A	114	ALA	4.7
1	A	119	ALA	4.3
1	A	121	GLN	4.3
1	A	272	GLU	3.6
1	A	120	GLU	3.6
1	A	267[A]	LYS	3.5
1	A	111	LEU	3.2
1	A	273	ASN	3.1
1	A	113	GLN	3.0
1	A	174	ALA	2.9
1	A	33	ILE	2.8
1	A	123	VAL	2.8
1	A	175	ALA	2.4
1	A	203[A]	PRO	2.3
1	A	266	ASN	2.3
1	A	115	GLN	2.3

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Mol	Chain	Res	Type	RSRZ
1	A	81	PRO	2.1
1	A	32	ALA	2.0
1	A	31	VAL	2.0
1	A	167	VAL	2.0
1	A	194	LEU	2.0

## 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 monosaccharides in this entry.

## 6.4 Ligands [i](#)

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<sup>th</sup> 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
6	K	A	1101	1/1	0.90	0.16	82,82,82,82	0
5	SM	A	1003	1/1	0.99	0.12	40,40,40,40	0
5	SM	A	1002	1/1	0.99	0.11	49,49,49,49	1
7	OH	A	347	1/1	0.99	0.12	60,60,60,60	0
5	SM	A	1001	1/1	1.00	0.10	48,48,48,48	1
5	SM	A	1004	1/1	1.00	0.11	41,41,41,41	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.