W O R L D W I D E
wwPDB
P R O T E I N   D A T A   B A N K

wwPDB X-ray Structure Validation Summary Report (i)

Dec 17, 2023 – 08:13 am GMT

PDB ID	:	4AEZ
Title	:	Crystal Structure of Mitotic Checkpoint Complex
Authors	:	Kulkarni, K.A.; Chao, W.C.H.; Zhang, Z.; Barford, D.
Deposited on	:	2012-01-13
Resolution	:	2.30 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 (i)) were used in the production of this report:

|		
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
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

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 2.30 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.
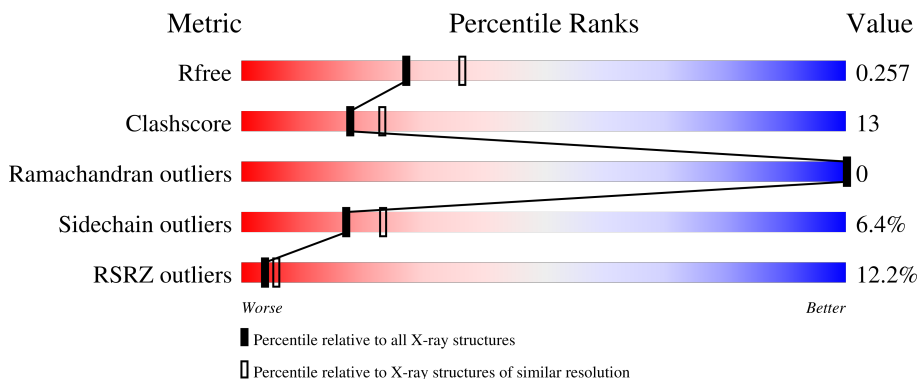
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	5042 (2.30-2.30)
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)
RSRZ outliers	127900	4938 (2.30-2.30)

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	401	71% 9% · 19%
1	D	401	3% 61% 16% · 22%
1	G	401	12% 54% 23% · 21%
2	B	203	71% 16% · 11%
2	E	203	25% 53% 30% · 14%

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Mol	Chain	Length	Quality of chain
2	H	203	23% 60% 28% 9%
3	C	223	2% 77% 19%
3	F	223	7% 66% 19% 12%
3	I	223	35% 44% 34% 9% 13%

2 Entry composition ⓘ

There are 4 unique types of molecules in this entry. The entry contains 16896 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 WD REPEAT-CONTAINING PROTEIN SLP1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	326	Total	C	N	O	S	0	0	0
			2499	1565	445	483	6			
1	D	314	Total	C	N	O	S	0	0	0
			2406	1507	426	467	6			
1	G	317	Total	C	N	O	S	0	0	0
			2400	1502	425	467	6			

- Molecule 2 is a protein called MITOTIC SPINDLE CHECKPOINT COMPONENT MAD2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	180	Total	C	N	O	S	0	0	0
			1469	941	243	278	7			
2	E	175	Total	C	N	O	S	0	0	0
			1369	880	224	260	5			
2	H	185	Total	C	N	O	S	0	0	0
			1477	951	246	274	6			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	12	ALA	LEU	engineered mutation	UNP O14417
B	133	ALA	ARG	engineered mutation	UNP O14417
E	12	ALA	LEU	engineered mutation	UNP O14417
E	133	ALA	ARG	engineered mutation	UNP O14417
H	12	ALA	LEU	engineered mutation	UNP O14417
H	133	ALA	ARG	engineered mutation	UNP O14417

- Molecule 3 is a protein called MITOTIC SPINDLE CHECKPOINT COMPONENT MAD3.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	215	Total	C	N	O	S	0	0	0
			1799	1142	313	339	5			

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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	196	Total 1585	C 1013	N 265	O 302	S 5	0	0	0
3	I	193	Total 1574	C 997	N 273	O 300	S 4	0	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	114	Total 114	O 114	0	0
4	B	33	Total 33	O 33	0	0
4	C	33	Total 33	O 33	0	0
4	D	61	Total 61	O 61	0	0
4	E	1	Total 1	O 1	0	0
4	F	48	Total 48	O 48	0	0
4	G	21	Total 21	O 21	0	0
4	H	6	Total 6	O 6	0	0
4	I	1	Total 1	O 1	0	0

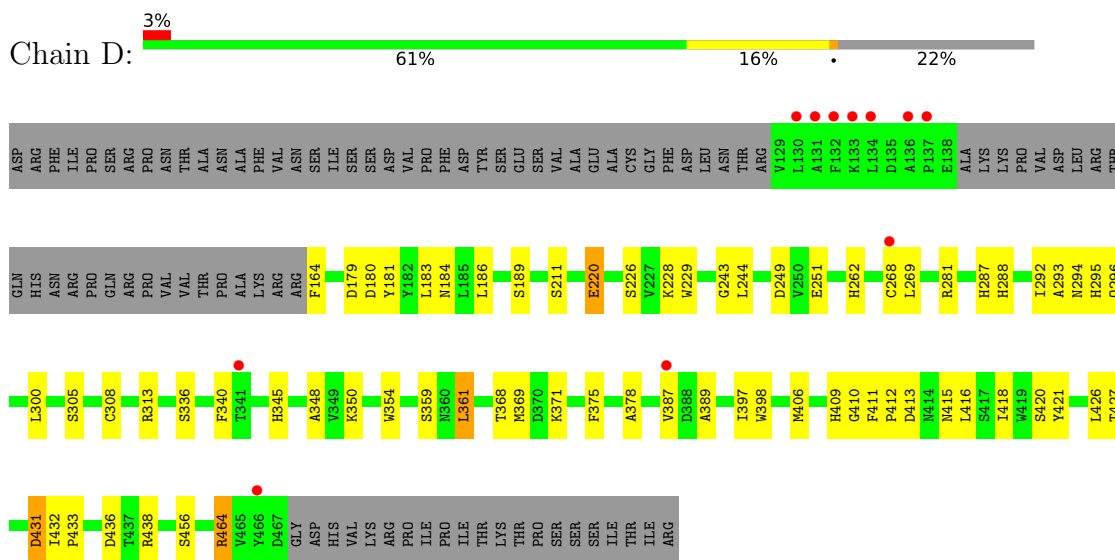# 3 Residue-property plots ⓘ

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.
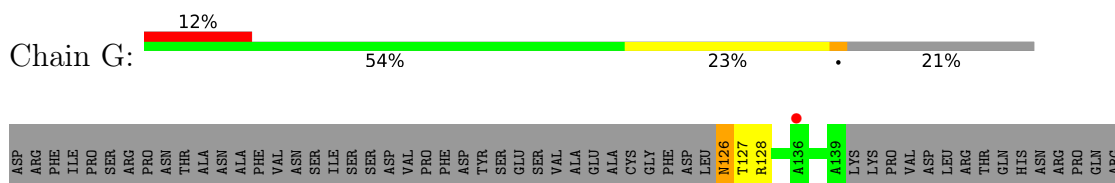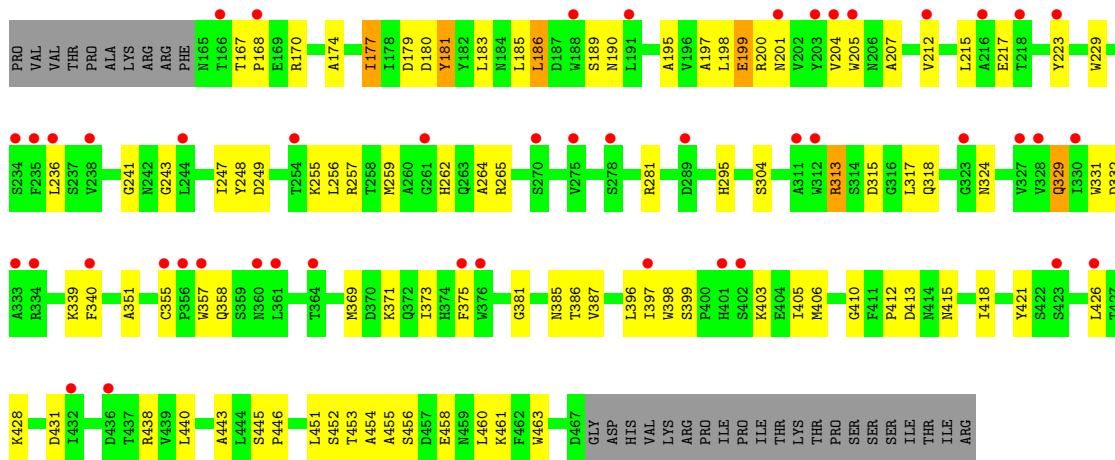
• Molecule 1: WD REPEAT-CONTAINING PROTEIN SLP1

Chain A:

• Molecule 1: WD REPEAT-CONTAINING PROTEIN SLP1
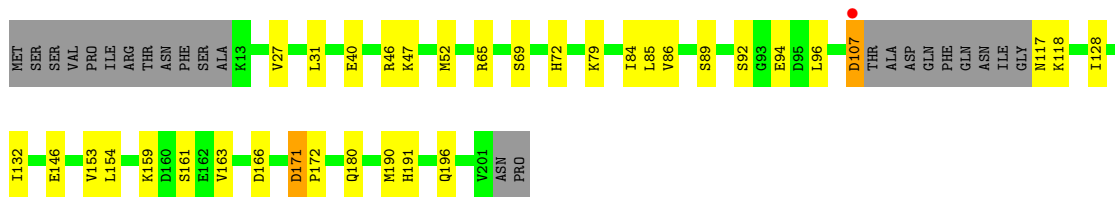
Chain D:

• Molecule 1: WD REPEAT-CONTAINING PROTEIN SLP1

Chain G:

• Molecule 2: MITOTIC SPINDLE CHECKPOINT COMPONENT MAD2

Chain B:

71%　　　　　16%　•　11%

• Molecule 2: MITOTIC SPINDLE CHECKPOINT COMPONENT MAD2

Chain E:

25%

53%　　　　　30%　•　14%

• Molecule 2: MITOTIC SPINDLE CHECKPOINT COMPONENT MAD2

Chain H:

23%

60%　　　　　28%　•　9%

N152 V153 L154 V155 Y156 A157 E162 V163 P164 T165 D166 W167 V168 D169 S170 D171 I174 L175 R176 D177 A178 E179 Q180 V181 Q182 L183 R184 S185 F186 K192 I193 D194 C195 Q196 V197 A198 Y199 R200 V201 ASN PRO

• Molecule 3: MITOTIC SPINDLE CHECKPOINT COMPONENT MAD3

Chain C:

2%
77%　　　　　　19%

MET GLU PRO LEU ASP ALA GLY LYS N9 W10 S19 K20 A49 K53 S67 L68 Q73 D77 Y78 K92 T93 S94 R109 N110 P111 V117 R121 I122 W123 M124 Q125 Y126 V127 I130 E135 L140 S150 Y153 E154 E155 Y156 F160 L165

K168 Q174 K175 G176 K177 R178 M179 K182 P183 F184 L185 R186 Q189 K190 Y191 L199 E200 P203 N209 S222 T223

• Molecule 3: MITOTIC SPINDLE CHECKPOINT COMPONENT MAD3

Chain F:

7%
66%　　　　　　19%　　　12%

MET GLU PRO LEU ASP ALA GLY LYS ASN W10 V11 H12 M13 D14 S19 K20 E21 K27 A36 K37 S38 R41 V97 T98 L99 L100 E101 T104 R105 V108 P111 K114 V117 L120 R121 M124 Q125 Y126 V127 I130 L136 E148 S149 S150 I151

E154 E155 Y156 A157 N158 R163 G164 L165 F166 Q167 K168 A169 D170 E171 V172 Y173 Q174 K175 G176 K177 K180 A181 K182 P183 F184 L185 R186 Y191 F194 T195 H196 R197 TRP LEU GLU PHE ALA PRO GLN SER PHE SER ASN THR ASN SER VAL ASN P215 L216 F220 E221 S222

THR
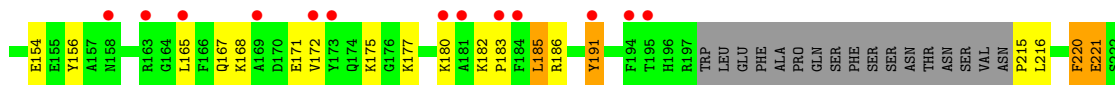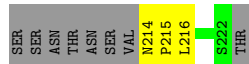
• Molecule 3: MITOTIC SPINDLE CHECKPOINT COMPONENT MAD3

Chain I:

35%
44%　　　　　34%　　　9%　　13%

MET GLU PRO LEU ASP ALA GLY LYS ASN W10 V11 H12 M13 D14 V15 I16 E17 Q18 S19 K20 I23 E24 A28 G29 H30 A34 S38 S39 N42 H43 T44 E45 K46 E47 Q52 R55 M56 G57 H58 E59 R60 K61 I62 E63 T64 S65 E66 S67 L68 D69 D70 P71 L72

Q73 V74 W75 I76 D77 Y78 I79 T82 E90 T91 L96 V97 T98 L99 L100 E101 R102 C103 T104 R105 E106 F107 V108 R109 N110 P111 L112 Y113 K114 D115 D116 V117 R118 Y119 L120 R121 I122 W123 M124 Q125 Y126 V127 N128 Y129 I130 D131 E132 P133 V134 E135 L136 F137 S138 F139 L140 A141 H142

H143 H144 I145 G146 Q147 E148 S149 S150 I151 F152 Y153 E154 E155 Y156 A157 N158 Y159 F160 S162 R163 G164 L165 F166 Q167 K168 A169 D170 K175 G176 K177 R178 M179 LYS ALA LYS PRO PHE L185 R186 Q189 K190 Y191 Q192 Q193 F194 T195 H196 R197 W198 LEU GLU PHE ALA PRO GLN SER PHE

SER SER ASN THR ASN SER VAL N214 P215 L216 S222 THR

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	70.81Å 286.90Å 72.01Å 90.00° 119.04° 90.00°	Depositor
Resolution (Å)	62.96 – 2.30 62.96 – 2.30	Depositor EDS
% Data completeness (in resolution range)	99.8 (62.96-2.30) 99.8 (62.96-2.30)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.84 (at 2.29Å)	Xtriage
Refinement program	PHENIX (PHENIX.REFINE)	Depositor
R, R_{free}	0.221 , 0.267 0.211 , 0.257	Depositor DCC
R_{free} test set	1973 reflections (1.78%)	wwPDB-VP
Wilson B-factor (Å^2)	41.8	Xtriage
Anisotropy	0.217	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 54.6	EDS
L-test for twinning[2]	$< |L| > = 0.49$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	0.002 for -h-l,k,h 0.002 for l,k,-h-l 0.024 for h,-k,-h-l 0.022 for -h-l,-k,l 0.024 for l,-k,h	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	16896	wwPDB-VP
Average B, all atoms (Å^2)	60.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.14% 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 ⓘ

5.1 Standard geometry ⓘ

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	0.36	0/2559	0.54	0/3492
1	D	0.34	0/2465	0.56	0/3366
1	G	0.28	0/2458	0.49	0/3361
2	B	0.36	0/1494	0.50	0/2016
2	E	0.27	0/1394	0.43	0/1895
2	H	0.29	0/1502	0.46	0/2032
3	C	0.35	0/1847	0.46	0/2495
3	F	0.34	0/1625	0.48	0/2198
3	I	0.27	0/1614	0.44	0/2187
All	All	0.32	0/16958	0.50	0/23042

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
3	I	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
3	I	107	PHE	Peptide

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	2499	0	2393	33	0
1	D	2406	0	2290	46	0
1	G	2400	0	2269	76	0
2	B	1469	0	1476	23	0
2	E	1369	0	1312	83	0
2	H	1477	0	1462	48	0
3	C	1799	0	1718	27	0
3	F	1585	0	1472	41	0
3	I	1574	0	1434	88	0
4	A	114	0	0	3	0
4	B	33	0	0	0	0
4	C	33	0	0	0	0
4	D	61	0	0	3	0
4	E	1	0	0	0	0
4	F	48	0	0	0	0
4	G	21	0	0	0	0
4	H	6	0	0	0	0
4	I	1	0	0	0	0
All	All	16896	0	15826	436	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 13.

The worst 5 of 436 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:466:TYR:O	1:A:467:ASP:HB3	1.49	1.08
3:C:222:SER:O	3:C:223:THR:HB	1.54	1.05
1:G:177:ILE:HD11	1:G:458:GLU:HA	1.42	0.99
1:D:164:PHE:HE1	1:D:432:ILE:HD11	1.25	0.97
3:I:122:ILE:HG22	3:I:126:TYR:CE1	2.01	0.95

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	322/401 (80%)	318 (99%)	4 (1%)	0	100	100
1	D	310/401 (77%)	303 (98%)	7 (2%)	0	100	100
1	G	313/401 (78%)	306 (98%)	7 (2%)	0	100	100
2	B	176/203 (87%)	176 (100%)	0	0	100	100
2	E	171/203 (84%)	169 (99%)	2 (1%)	0	100	100
2	H	179/203 (88%)	178 (99%)	1 (1%)	0	100	100
3	C	213/223 (96%)	213 (100%)	0	0	100	100
3	F	192/223 (86%)	191 (100%)	1 (0%)	0	100	100
3	I	187/223 (84%)	185 (99%)	2 (1%)	0	100	100
All	All	2063/2481 (83%)	2039 (99%)	24 (1%)	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	269/340 (79%)	260 (97%)	9 (3%)	38	53
1	D	259/340 (76%)	248 (96%)	11 (4%)	30	42
1	G	255/340 (75%)	244 (96%)	11 (4%)	29	40
2	B	166/187 (89%)	157 (95%)	9 (5%)	22	30
2	E	145/187 (78%)	134 (92%)	11 (8%)	13	16

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PROTEIN DATA BANK

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	H	160/187 (86%)	147 (92%)	13 (8%)	11	15
3	C	196/203 (97%)	184 (94%)	12 (6%)	18	25
3	F	163/203 (80%)	154 (94%)	9 (6%)	21	30
3	I	162/203 (80%)	134 (83%)	28 (17%)	2	2
All	All	1775/2190 (81%)	1662 (94%)	113 (6%)	17	23

5 of 113 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	F	185	LEU
3	I	186	ARG
1	G	371	LYS
3	I	175	LYS
3	I	128	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 6 such sidechains are listed below:

Mol	Chain	Res	Type
2	H	70	GLN
2	H	117	ASN
3	I	128	ASN
1	A	429	GLN
1	A	126	ASN

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 monosaccharides in this entry.

5.6 Ligand geometry ⓘ

There are no ligands in this entry.

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(Å²)	Q<0.9
1	A	326/401 (81%)	0.38	2 (0%) 89	92	17, 33, 64, 116	0
1	D	314/401 (78%)	0.51	11 (3%) 44	51	19, 42, 84, 116	0
1	G	317/401 (79%)	1.06	48 (15%) 2	3	43, 72, 103, 124	0
2	B	180/203 (88%)	0.33	1 (0%) 89	92	25, 44, 69, 109	0
2	E	175/203 (86%)	1.53	50 (28%) 0	0	40, 85, 127, 150	0
2	H	185/203 (91%)	1.36	47 (25%) 0	0	47, 70, 117, 139	0
3	C	215/223 (96%)	0.41	4 (1%) 66	73	19, 46, 80, 118	0
3	F	196/223 (87%)	0.62	15 (7%) 13	17	21, 53, 115, 149	0
3	I	193/223 (86%)	1.92	78 (40%) 0	0	40, 97, 133, 147	0
All	All	2101/2481 (84%)	0.85	256 (12%) 4	6	17, 56, 111, 150	0

The worst 5 of 256 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	H	151	PHE	9.3
2	E	153	VAL	8.4
3	I	117	VAL	7.9
3	I	158	ASN	7.8
3	I	141	ALA	7.8

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 ⓘ

There are no ligands in this entry.

6.5 Other polymers ⓘ

There are no such residues in this entry.