wwPDB X-ray Structure Validation Summary Report (i)

Feb 6, 2024 – 10:22 PM EST

PDB ID	:	2FJ7
Title	:	Crystal structure of Nucleosome Core Particle Containing a Poly (dA.dT) Sequence Element
Authors	:	Bao, Y.; White, C.L.; Luger, K.
Deposited on	:	2005-12-31
Resolution	:	3.20 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:

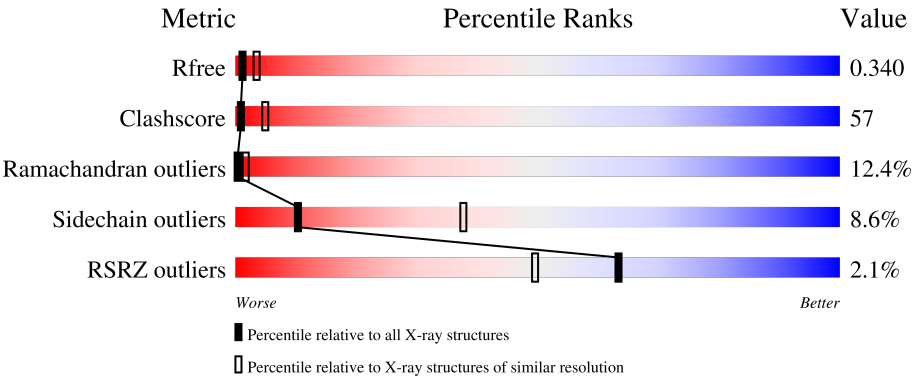
MolProbity	:	4.02b-467
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

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

The reported resolution of this entry is 3.20 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.



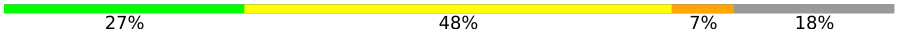
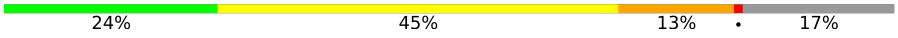
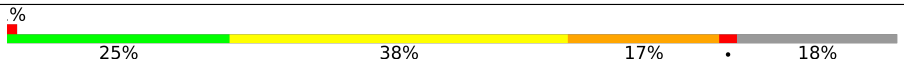
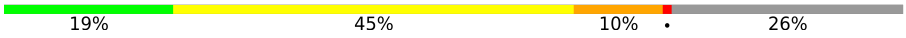
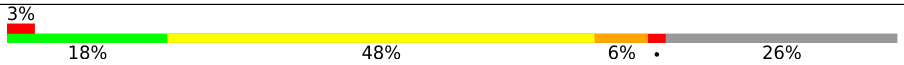
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	1133 (3.20-3.20)
Clashscore	141614	1253 (3.20-3.20)
Ramachandran outliers	138981	1234 (3.20-3.20)
Sidechain outliers	138945	1233 (3.20-3.20)
RSRZ outliers	127900	1095 (3.20-3.20)

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 >=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	I	147	5% 9% 91%
2	J	147	3% 11% 85%
3	A	135	2% 10% 47% 16% 27%
3	E	135	% 13% 47% 12% 27%
4	B	102	21% 47% 10% 23%

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
4	F	102	
5	C	129	
5	G	129	
6	D	125	
6	H	125	

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 12038 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 DNA chain called 147 bp DNA containing 16 bp poly dA element.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	I	147	Total	C	N	O	P	0	0	0
			3013	1443	555	869	146			

- Molecule 2 is a DNA chain called 147 bp DNA containing 16 bp poly dT element.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	J	147	Total	C	N	O	P	0	0	0
			3008	1445	526	891	146			

- Molecule 3 is a protein called histone H3.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	A	98	Total	C	N	O	S	0	0	0
			808	509	156	140	3			
3	E	98	Total	C	N	O	S	0	0	0
			808	509	156	140	3			

- Molecule 4 is a protein called Histone H4.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	B	79	Total	C	N	O	S	0	0	0
			627	395	121	110	1			
4	F	84	Total	C	N	O	S	0	0	0
			673	424	133	115	1			

- Molecule 5 is a protein called histone H2A.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
5	C	107	Total	C	N	O	0	0	0
			825	520	161	144			
5	G	106	Total	C	N	O	0	0	0
			818	516	160	142			

- Molecule 6 is a protein called Histone H2B.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
6	D	93	Total	C	N	O	S	0	0	0
			729	459	131	137	2			
6	H	93	Total	C	N	O	S	0	0	0
			729	459	131	137	2			

There are 2 discrepancies between the modelled and reference sequences:

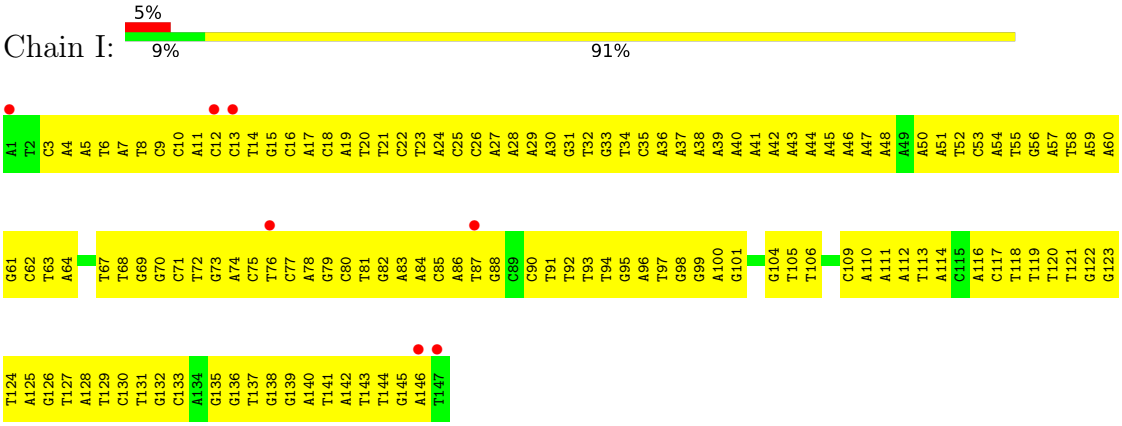
Chain	Residue	Modelled	Actual	Comment	Reference
D	29	THR	SER	conflict	UNP P02281
H	29	THR	SER	conflict	UNP P02281

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.

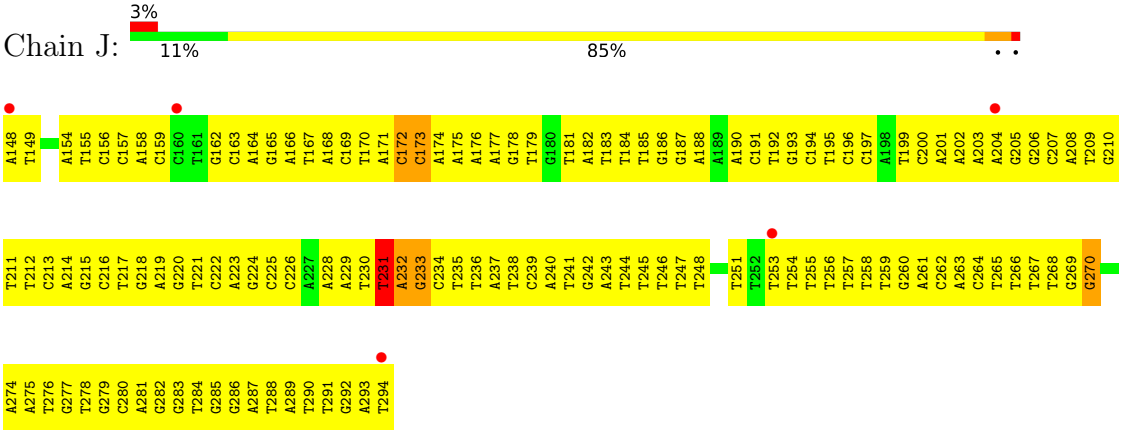
• Molecule 1: 147 bp DNA containing 16 bp poly dA element

Chain I:



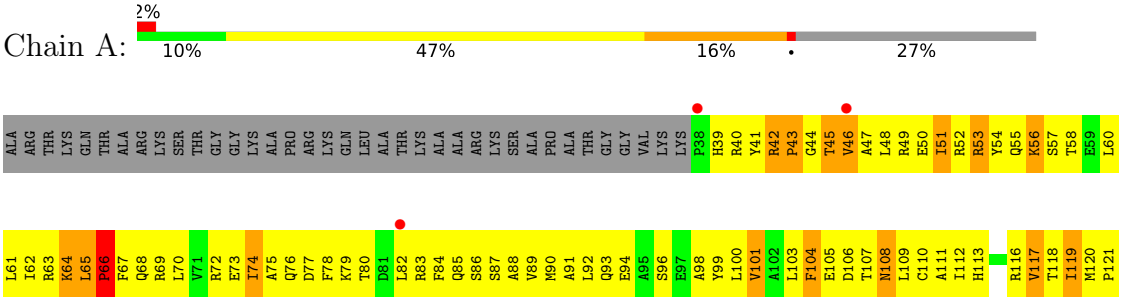
• Molecule 2: 147 bp DNA containing 16 bp poly dT element

Chain J:



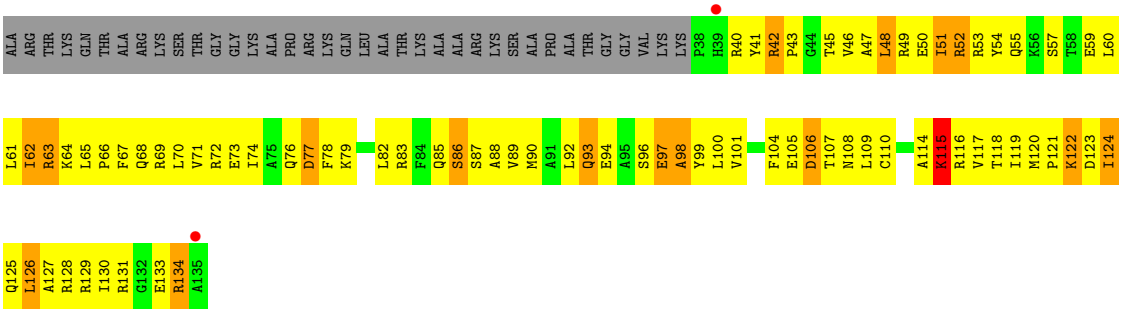
• Molecule 3: histone H3

Chain A:



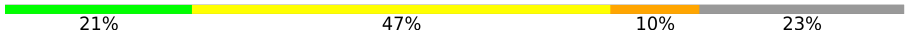
• Molecule 3: histone H3

Chain E:



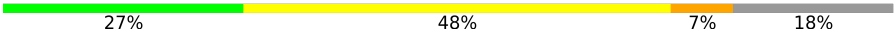
• Molecule 4: Histone H4

Chain B:



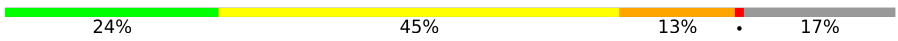
• Molecule 4: Histone H4

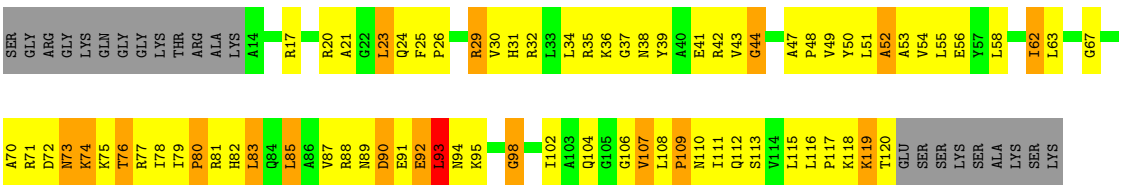
Chain F:



• Molecule 5: histone H2A

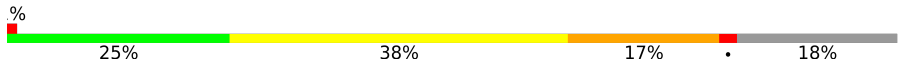
Chain C:

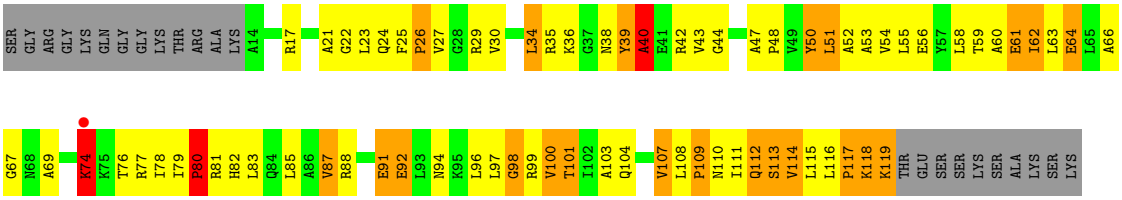




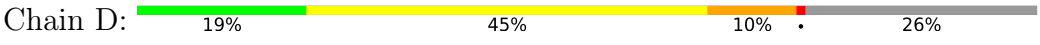
• Molecule 5: histone H2A

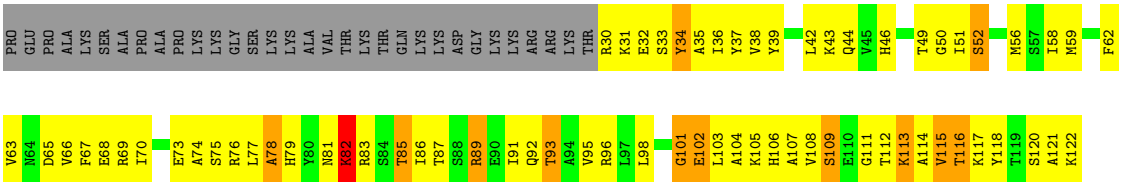
Chain G:



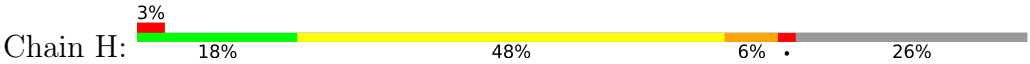


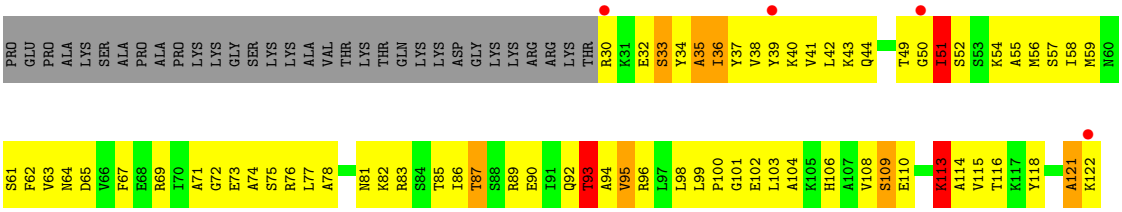
• Molecule 6: Histone H2B





• Molecule 6: Histone H2B





4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	104.92Å 109.60Å 177.97Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	50.00 – 3.20 37.89 – 2.69	Depositor EDS
% Data completeness (in resolution range)	95.2 (50.00-3.20) 78.9 (37.89-2.69)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	4.38 (at 2.69Å)	Xtriage
Refinement program	CNS	Depositor
R, R_{free}	0.280 , 0.350 0.278 , 0.340	Depositor DCC
R_{free} test set	2252 reflections (4.37%)	wwPDB-VP
Wilson B-factor (Å^2)	71.7	Xtriage
Anisotropy	0.698	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.26 , 81.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.45$, $< L^2 > = 0.27$	Xtriage
Estimated twinning fraction	0.035 for k,h,-l	Xtriage
F_o,F_c correlation	0.92	EDS
Total number of atoms	12038	wwPDB-VP
Average B, all atoms (Å^2)	126.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.55% 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

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	I	0.35	0/3384	0.73	0/5220
2	J	0.40	0/3370	0.93	10/5201 (0.2%)
3	A	0.44	0/820	0.81	1/1099 (0.1%)
3	E	0.57	0/820	0.84	1/1099 (0.1%)
4	B	0.49	0/634	0.76	0/848
4	F	0.58	0/680	0.87	0/908
5	C	0.53	0/835	0.83	2/1127 (0.2%)
5	G	0.39	0/828	1.02	5/1117 (0.4%)
6	D	0.56	0/740	0.78	0/994
6	H	0.44	0/740	0.66	0/994
All	All	0.44	0/12851	0.83	19/18607 (0.1%)

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
2	J	0	2
5	G	0	2
All	All	0	4

There are no bond length outliers.

The worst 5 of 19 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	G	40	ALA	O-C-N	-20.12	90.50	122.70
2	J	173	DC	O5'-P-OP2	-19.42	87.39	110.70
2	J	172	DC	OP2-P-O3'	-17.76	66.12	105.20
2	J	172	DC	OP1-P-O3'	-17.68	66.30	105.20
2	J	173	DC	O5'-P-OP1	-15.76	91.51	105.70

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
5	G	40	ALA	Mainchain,Peptide
2	J	231	DT	Sidechain
2	J	270	DG	Sidechain

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	I	3013	0	1661	243	0
2	J	3008	0	1672	248	0
3	A	808	0	846	179	0
3	E	808	0	846	139	0
4	B	627	0	663	109	0
4	F	673	0	722	113	0
5	C	825	0	884	134	0
5	G	818	0	877	132	0
6	D	729	0	753	119	0
6	H	729	0	753	96	0
All	All	12038	0	9677	1230	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 57.

The worst 5 of 1230 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)
4:B:45:ARG:O	4:B:46:ILE:HG13	1.25	1.28
2:J:281:DA:H2"	2:J:282:DG:H5'	1.25	1.15
3:E:61:LEU:HD12	4:F:37:LEU:HD23	1.28	1.15
3:A:117:VAL:HB	4:B:44:LYS:HG2	1.23	1.14
5:G:26:PRO:HB2	5:G:29:ARG:HD2	1.32	1.12

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
3	A	96/135 (71%)	55 (57%)	25 (26%)	16 (17%)	0 0
3	E	96/135 (71%)	61 (64%)	21 (22%)	14 (15%)	0 1
4	B	77/102 (76%)	45 (58%)	25 (32%)	7 (9%)	1 3
4	F	82/102 (80%)	57 (70%)	19 (23%)	6 (7%)	1 7
5	C	105/129 (81%)	73 (70%)	20 (19%)	12 (11%)	0 2
5	G	104/129 (81%)	64 (62%)	21 (20%)	19 (18%)	0 0
6	D	91/125 (73%)	59 (65%)	23 (25%)	9 (10%)	0 3
6	H	91/125 (73%)	56 (62%)	26 (29%)	9 (10%)	0 3
All	All	742/982 (76%)	470 (63%)	180 (24%)	92 (12%)	0 2

5 of 92 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	A	45	THR
3	A	65	LEU
3	A	117	VAL
3	A	124	ILE
3	A	126	LEU

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
3	A	85/110 (77%)	78 (92%)	7 (8%)	11 41

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
3	E	85/110 (77%)	77 (91%)	8 (9%)	8 33
4	B	64/78 (82%)	60 (94%)	4 (6%)	18 52
4	F	69/78 (88%)	66 (96%)	3 (4%)	29 64
5	C	85/101 (84%)	76 (89%)	9 (11%)	6 27
5	G	84/101 (83%)	76 (90%)	8 (10%)	8 32
6	D	79/105 (75%)	72 (91%)	7 (9%)	9 35
6	H	79/105 (75%)	71 (90%)	8 (10%)	7 29
All	All	630/788 (80%)	576 (91%)	54 (9%)	10 38

5 of 54 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	E	63	ARG
4	F	35	ARG
6	H	87	THR
3	E	93	GLN
3	E	122	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 15 such sidechains are listed below:

Mol	Chain	Res	Type
6	D	44	GLN
6	H	81	ASN
6	D	79	HIS
6	H	92	GLN
5	G	38	ASN

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)

There are no ligands in this entry.

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	I	147/147 (100%)	-0.06	7 (4%) 30 18	77, 171, 203, 203	0
2	J	147/147 (100%)	-0.11	5 (3%) 45 29	82, 169, 203, 203	0
3	A	98/135 (72%)	-0.12	3 (3%) 49 32	41, 96, 171, 181	0
3	E	98/135 (72%)	-0.22	2 (2%) 65 51	21, 69, 145, 196	0
4	B	79/102 (77%)	-0.19	0 100 100	34, 87, 158, 192	0
4	F	84/102 (82%)	-0.36	0 100 100	24, 55, 103, 131	0
5	C	107/129 (82%)	-0.35	0 100 100	17, 62, 145, 184	0
5	G	106/129 (82%)	-0.21	1 (0%) 84 75	40, 95, 163, 201	0
6	D	93/125 (74%)	-0.28	0 100 100	25, 62, 118, 170	0
6	H	93/125 (74%)	-0.16	4 (4%) 35 22	25, 85, 164, 203	0
All	All	1052/1276 (82%)	-0.19	22 (2%) 63 49	17, 94, 200, 203	0

The worst 5 of 22 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	E	135	ALA	5.4
1	I	147	DT	4.9
3	E	39	HIS	4.4
6	H	39	TYR	3.9
2	J	148	DA	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 (i)

There are no monosaccharides in this entry.

6.4 Ligands (i)

There are no ligands in this entry.

6.5 Other polymers (i)

There are no such residues in this entry.