



## Full wwPDB EM Validation Report ⓘ

Dec 5, 2020 – 10:43 pm GMT

PDB ID : 6SEF  
EMDB ID : EMD-10154  
Title : Class2C : CENP-A nucleosome in complex with CENP-C central region  
Authors : Ali-Ahmad, A.; Bilokapic, S.; Schafer, I.B.; Halic, M.; Sekulic, N.  
Deposited on : 2019-07-29  
Resolution : 3.70 Å(reported)

This is a Full wwPDB EM 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/EMValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

EMDB validation analysis : 0.0.0.dev61  
MolProbity : 4.02b-467  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.15.1

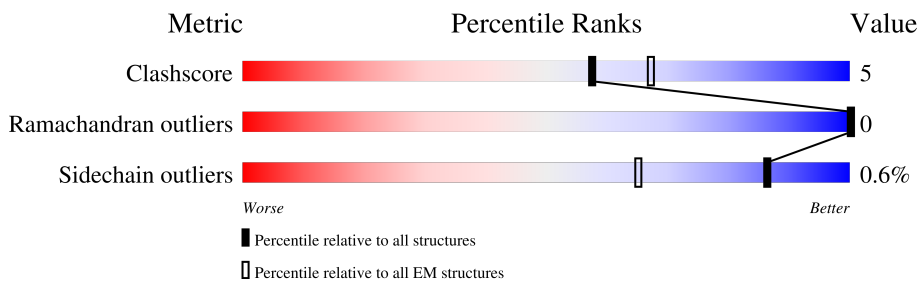
# 1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 3.70 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.



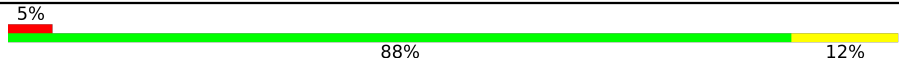
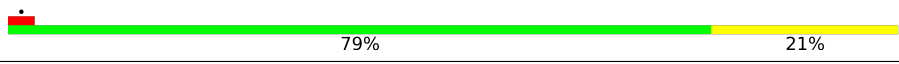

Metric	Whole archive (#Entries)	EM structures (#Entries)
Clashscore	158937	4297
Ramachandran outliers	154571	4023
Sidechain outliers	154315	3826

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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 EM map (all-atom inclusion  $< 40\%$ ). The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	140	
1	E	140	
2	B	103	
2	F	103	
3	C	130	
3	G	130	
4	D	126	
4	H	126	

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Mol	Chain	Length	Quality of chain
5	I	145	 5% 88% 12%
6	J	145	 1% 79% 21%
7	V	124	 15% 12% 85%

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 11919 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 Histone H3-like centromeric protein A.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	98	Total	C	N	O	S	0	0
			812	524	155	132	1		
1	E	98	Total	C	N	O	S	0	0
			812	524	155	132	1		

- Molecule 2 is a protein called Histone H4.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	B	78	Total	C	N	O	S	0	0
			629	397	123	108	1		
2	F	78	Total	C	N	O	S	0	0
			618	391	120	106	1		

- Molecule 3 is a protein called Histone H2A type 2-A.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	C	96	Total	C	N	O	S	0	0
			739	464	144	130	1		
3	G	103	Total	C	N	O	S	0	0
			792	496	157	138	1		

- Molecule 4 is a protein called Histone H2B type 1-C/E/F/G/I.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
4	D	92	Total	C	N	O	S	0	0
			719	452	129	136	2		
4	H	90	Total	C	N	O	S	0	0
			699	440	123	134	2		

- Molecule 5 is a DNA chain called DNA (145-MER).

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	P		
5	I	145	2952	1404	537	867	144	0	0

- Molecule 6 is a DNA chain called DNA (145-MER).

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	P		
6	J	145	2987	1416	558	869	144	0	0

- Molecule 7 is a protein called Centromere protein C.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
7	V	18	160	100	34	26	0	0

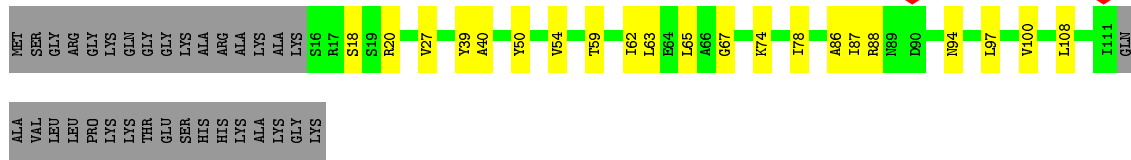
There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
V	414	GLY	-	expression tag	UNP Q03188
V	415	PRO	-	expression tag	UNP Q03188
V	416	LEU	-	expression tag	UNP Q03188
V	417	GLY	-	expression tag	UNP Q03188
V	418	SER	-	expression tag	UNP Q03188
V	419	PRO	-	expression tag	UNP Q03188
V	420	GLU	-	expression tag	UNP Q03188
V	421	PHE	-	expression tag	UNP Q03188
V	422	GLY	-	expression tag	UNP Q03188
V	423	ARG	-	expression tag	UNP Q03188
V	424	ALA	-	expression tag	UNP Q03188
V	425	THR	-	expression tag	UNP Q03188

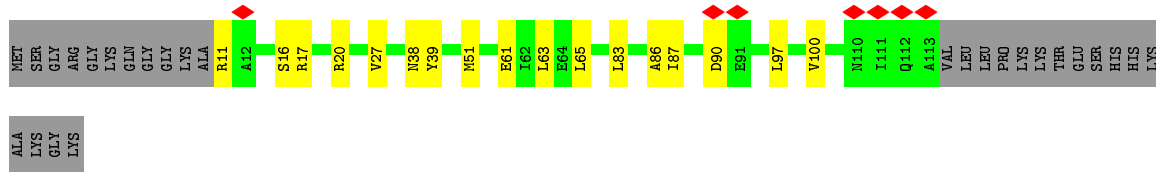




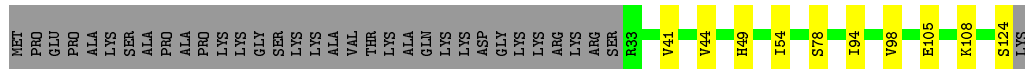
• Molecule 3: Histone H2A type 2-A



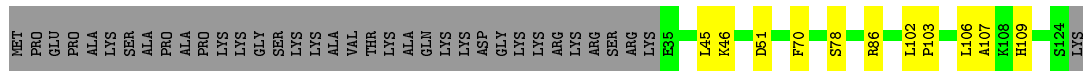
• Molecule 3: Histone H2A type 2-A



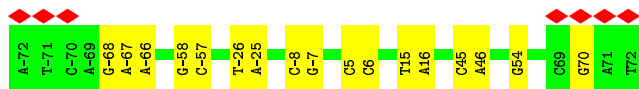
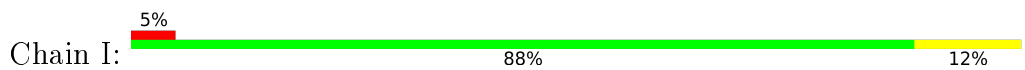
• Molecule 4: Histone H2B type 1-C/E/F/G/I



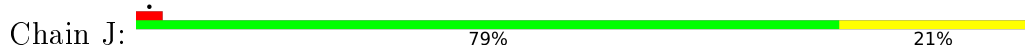
• Molecule 4: Histone H2B type 1-C/E/F/G/I

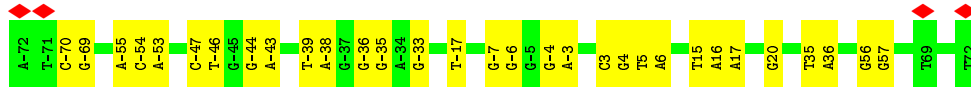


• Molecule 5: DNA (145-MER)



• Molecule 6: DNA (145-MER)





• Molecule 7: Centromere protein C





## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	40000	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	100	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	Not provided	
Image detector	GATAN K2 SUMMIT (4k x 4k)	Depositor
Maximum map value	0.047	Depositor
Minimum map value	-0.019	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.003	Depositor
Recommended contour level	0.012	Depositor
Map size (Å)	218.4, 218.4, 218.4	wwPDB
Map dimensions	168, 168, 168	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.3, 1.3, 1.3	Depositor

## 5 Model quality [i](#)

### 5.1 Standard geometry [i](#)

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	0.34	0/827	0.52	0/1111
1	E	0.34	0/827	0.55	0/1111
2	B	0.34	0/636	0.53	0/852
2	F	0.36	0/625	0.54	0/837
3	C	0.32	0/748	0.48	0/1008
3	G	0.35	0/801	0.55	0/1077
4	D	0.33	0/730	0.45	0/982
4	H	0.35	0/710	0.54	0/957
5	I	0.83	0/3308	0.94	0/5099
6	J	0.80	1/3354 (0.0%)	0.93	1/5180 (0.0%)
7	V	0.35	0/164	0.76	0/219
All	All	0.63	1/12730 (0.0%)	0.78	1/18433 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	J	20	DG	C3'-O3'	5.28	1.50	1.44

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	J	-17	DT	OP1-P-O3'	5.32	116.91	105.20

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	812	0	854	7	0
1	E	812	0	854	15	0
2	B	629	0	670	4	0
2	F	618	0	659	18	0
3	C	739	0	780	17	0
3	G	792	0	842	17	0
4	D	719	0	738	8	0
4	H	699	0	712	9	0
5	I	2952	0	1629	12	0
6	J	2987	0	1630	19	0
7	V	160	0	163	4	0
All	All	11919	0	9531	94	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 5.

All (94) 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:F:46:ILE:HG23	2:F:50:ILE:HD12	1.78	0.64
3:C:78:ILE:HG22	4:D:54:ILE:HA	1.79	0.63
1:E:102:LEU:HD11	2:F:58:LEU:HD12	1.83	0.61
2:F:34:ILE:HG21	2:F:54:THR:HG21	1.82	0.60
3:C:20:ARG:HE	4:D:124:SER:HB3	1.67	0.60
3:G:16:SER:HA	6:J:-43:DA:H5''	1.83	0.59
3:G:90:ASP:OD2	7:V:522:ARG:NH1	2.36	0.58
3:G:65:LEU:HB3	3:G:86:ALA:HB1	1.87	0.57
1:E:113:THR:HG21	1:E:121:LEU:HA	1.86	0.56
1:A:128:LEU:HD11	1:E:111:LEU:HD13	1.89	0.55
1:E:50:GLU:OE1	2:F:39:ARG:NH2	2.40	0.54
1:E:139:LEU:HD11	7:V:533:VAL:HG21	1.90	0.54
2:B:96:THR:HG23	3:G:100:VAL:HG23	1.88	0.53
3:C:54:VAL:HG21	4:D:98:VAL:HG21	1.91	0.52
3:G:17:ARG:NH1	6:J:-43:DA:OP2	2.43	0.51
2:F:73:THR:HG21	2:F:81:VAL:HA	1.92	0.51
4:H:102:LEU:HD12	4:H:103:PRO:HD2	1.92	0.51
3:C:50:TYR:HB3	4:D:94:ILE:HD11	1.93	0.51
3:C:18:SER:HA	3:C:27:VAL:HG22	1.93	0.50
3:G:61:GLU:OE1	7:V:521:ARG:NH1	2.43	0.50
3:C:39:TYR:HB3	4:D:78:SER:HB2	1.94	0.50
3:C:20:ARG:NH1	3:C:20:ARG:O	2.45	0.49
6:J:5:DT:H2''	6:J:6:DA:C8	2.47	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:C:88:ARG:HB3	3:C:108:LEU:HD11	1.94	0.49
3:C:65:LEU:HB3	3:C:86:ALA:HB1	1.93	0.49
3:G:87:ILE:HG12	3:G:97:LEU:HD22	1.95	0.49
3:G:63:LEU:HD22	4:H:45:LEU:HD13	1.93	0.49
3:C:100:VAL:HG23	2:F:96:THR:HG23	1.93	0.48
3:C:88:ARG:NH1	3:C:94:ASN:OD1	2.46	0.48
4:H:106:LEU:O	4:H:109:HIS:HB2	2.13	0.48
4:H:86:ARG:NH2	6:J:-33:DG:OP2	2.41	0.48
6:J:15:DT:H2''	6:J:16:DA:C8	2.48	0.48
4:H:102:LEU:HD23	4:H:107:ALA:HA	1.94	0.48
3:G:51:MET:HE3	4:H:70:PHE:HA	1.96	0.48
5:I:5:DC:H2''	5:I:6:DC:C5	2.50	0.47
6:J:3:DC:H2''	6:J:4:DG:C8	2.49	0.47
1:E:99:GLU:HG2	2:F:37:LEU:HD21	1.97	0.47
5:I:-26:DT:H2''	5:I:-25:DA:C8	2.50	0.47
3:C:87:ILE:HD11	3:C:97:LEU:HD13	1.96	0.46
2:F:60:VAL:HG21	7:V:533:VAL:HB	1.97	0.46
6:J:-39:DT:H2''	6:J:-38:DA:C8	2.51	0.46
6:J:-36:DG:H2''	6:J:-35:DG:N7	2.31	0.46
3:C:74:LYS:HE3	3:C:74:LYS:HB2	1.79	0.46
2:F:30:THR:OG1	2:F:31:LYS:N	2.49	0.45
4:H:51:ASP:OD1	4:H:51:ASP:N	2.43	0.45
5:I:15:DT:H2''	5:I:16:DA:C8	2.51	0.45
2:F:57:VAL:HA	2:F:60:VAL:HG12	1.98	0.45
1:E:136:GLU:O	2:F:95:ARG:NH1	2.50	0.45
6:J:-4:DG:H2''	6:J:-3:DA:C8	2.52	0.45
6:J:-47:DC:H2''	6:J:-46:DT:C5	2.52	0.45
1:A:118:ARG:NH1	1:A:125:ASP:OD2	2.48	0.44
5:I:-68:DG:H2''	5:I:-67:DA:C8	2.53	0.44
1:A:66:PRO:HD3	6:J:17:DA:H5''	1.99	0.44
3:G:11:ARG:HH11	5:I:45:DC:H5'	1.83	0.44
1:A:103:VAL:HG21	2:B:40:ARG:HG2	2.00	0.44
1:A:115:HIS:NE2	1:E:125:ASP:OD1	2.50	0.44
4:D:105:GLU:O	4:D:108:LYS:HB2	2.18	0.43
2:B:24:ASP:N	2:B:24:ASP:OD1	2.50	0.43
1:E:85:ASN:HB2	2:F:80:THR:HG22	2.00	0.43
3:G:17:ARG:HA	3:G:20:ARG:HG2	2.00	0.43
5:I:-26:DT:H2''	5:I:-25:DA:N7	2.34	0.43
1:E:62:ILE:HD11	2:F:37:LEU:HD11	2.01	0.43
1:A:44:ARG:HG3	5:I:70:DG:H5''	2.00	0.43
3:G:83:LEU:HA	3:G:83:LEU:HD23	1.87	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:G:87:ILE:HD11	3:G:97:LEU:HD13	2.01	0.43
5:I:-8:DC:H2"	5:I:-7:DG:C8	2.54	0.42
2:B:68:ASP:OD1	2:B:92:ARG:NH2	2.53	0.42
3:C:40:ALA:HA	3:G:38:ASN:HD22	1.84	0.42
3:G:17:ARG:HG3	3:G:27:VAL:HB	2.01	0.42
6:J:-54:DC:H2"	6:J:-53:DA:C8	2.54	0.42
4:D:41:VAL:HA	4:D:44:VAL:HG12	2.02	0.42
4:H:46:LYS:HD3	4:H:46:LYS:HA	1.70	0.42
1:E:110:TYR:HB2	2:F:43:VAL:HG22	2.02	0.42
1:E:43:ARG:NH1	5:I:-66:DA:OP1	2.51	0.42
1:A:69:ARG:NH1	6:J:17:DA:OP1	2.43	0.42
5:I:-58:DG:H2"	5:I:-57:DC:C6	2.54	0.42
5:I:54:DG:O6	6:J:-55:DA:N6	2.53	0.42
3:C:63:LEU:HD23	3:C:63:LEU:HA	1.86	0.41
3:C:67:GLY:HA3	4:D:49:HIS:CE1	2.56	0.41
1:E:129:ALA:O	1:E:133:ARG:HB2	2.19	0.41
2:F:46:ILE:HD13	2:F:46:ILE:HA	1.91	0.41
6:J:-70:DC:H2"	6:J:-69:DG:C8	2.55	0.41
1:E:50:GLU:HA	1:E:53:LYS:HE2	2.02	0.41
6:J:35:DT:H2"	6:J:36:DA:C8	2.56	0.41
6:J:-7:DG:H2"	6:J:-6:DG:C8	2.55	0.41
2:F:54:THR:HA	2:F:57:VAL:HG22	2.02	0.41
1:E:74:ILE:HG23	2:F:63:GLU:HG2	2.03	0.41
3:G:39:TYR:HB3	4:H:78:SER:HB3	2.03	0.41
6:J:-44:DG:H2"	6:J:-43:DA:H8	1.86	0.41
3:G:63:LEU:HD23	3:G:63:LEU:HA	1.94	0.40
3:C:59:THR:HA	3:C:62:ILE:HG22	2.02	0.40
2:F:62:LEU:HA	2:F:62:LEU:HD23	1.93	0.40
5:I:45:DC:H2"	5:I:46:DA:N7	2.37	0.40
6:J:56:DG:H2"	6:J:57:DG:N7	2.36	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 PDB entries followed by that with respect to all EM entries.

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	96/140 (69%)	93 (97%)	3 (3%)	0	100	100
1	E	96/140 (69%)	94 (98%)	2 (2%)	0	100	100
2	B	76/103 (74%)	74 (97%)	2 (3%)	0	100	100
2	F	76/103 (74%)	72 (95%)	4 (5%)	0	100	100
3	C	94/130 (72%)	91 (97%)	3 (3%)	0	100	100
3	G	101/130 (78%)	100 (99%)	1 (1%)	0	100	100
4	D	90/126 (71%)	88 (98%)	2 (2%)	0	100	100
4	H	88/126 (70%)	86 (98%)	2 (2%)	0	100	100
7	V	16/124 (13%)	15 (94%)	1 (6%)	0	100	100
All	All	733/1122 (65%)	713 (97%)	20 (3%)	0	100	100

There are no Ramachandran outliers to report.

### 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 PDB entries followed by that with respect to all EM entries.

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	83/118 (70%)	82 (99%)	1 (1%)	71	84
1	E	83/118 (70%)	81 (98%)	2 (2%)	49	71
2	B	65/79 (82%)	65 (100%)	0	100	100
2	F	63/79 (80%)	63 (100%)	0	100	100
3	C	75/99 (76%)	75 (100%)	0	100	100
3	G	79/99 (80%)	79 (100%)	0	100	100
4	D	79/106 (74%)	79 (100%)	0	100	100
4	H	77/106 (73%)	77 (100%)	0	100	100
7	V	18/115 (16%)	17 (94%)	1 (6%)	21	53
All	All	622/919 (68%)	618 (99%)	4 (1%)	86	93

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	75	CYS
1	E	63	ARG
1	E	75	CYS
7	V	522	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
3	C	68	ASN
3	C	73	ASN
4	D	49	HIS
1	E	59	HIS
3	G	94	ASN
3	G	104	GLN
4	H	63	ASN
4	H	109	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](#)

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

There are no chain breaks in this entry.



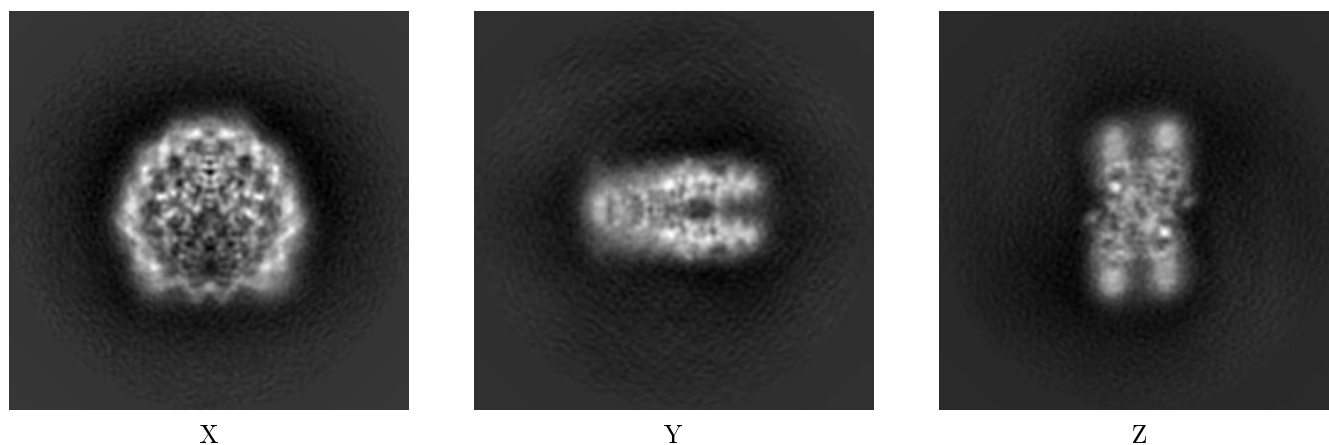
## 6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-10154. These allow visual inspection of the internal detail of the map and identification of artifacts.

No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

### 6.1 Orthogonal projections [i](#)

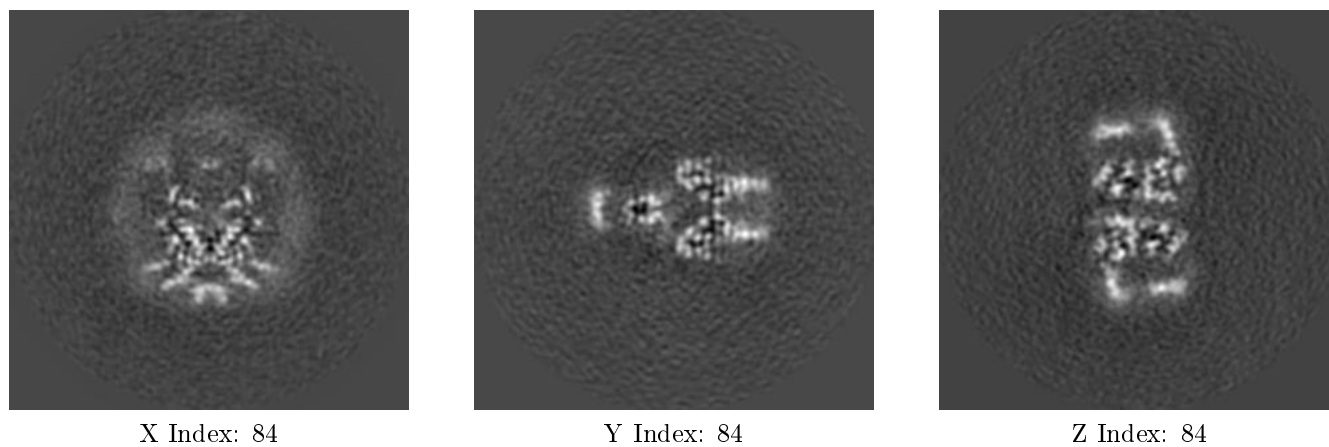
#### 6.1.1 Primary map



The images above show the map projected in three orthogonal directions.

### 6.2 Central slices [i](#)

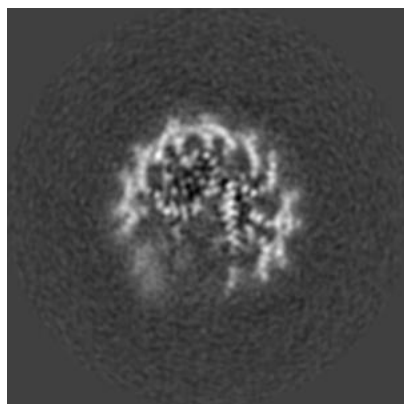
#### 6.2.1 Primary map



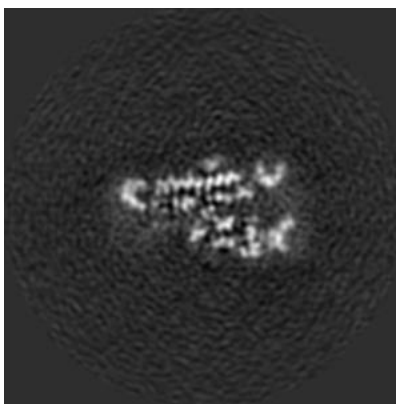
The images above show central slices of the map in three orthogonal directions.

## 6.3 Largest variance slices [i](#)

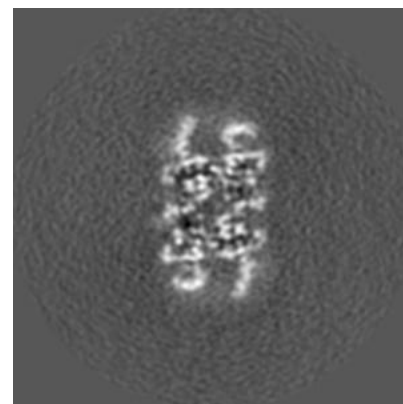
### 6.3.1 Primary map



X Index: 74



Y Index: 74

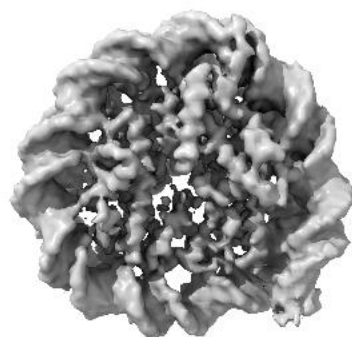


Z Index: 89

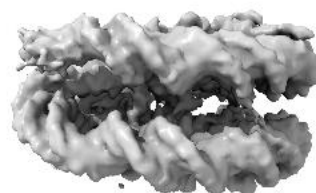
The images above show the largest variance slices of the map in three orthogonal directions.

## 6.4 Orthogonal surface views [i](#)

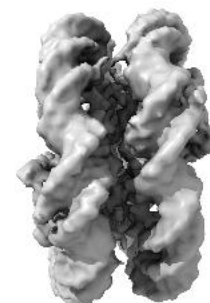
### 6.4.1 Primary map



X



Y



Z

The images above show the 3D surface view of the map at the recommended contour level 0.012. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

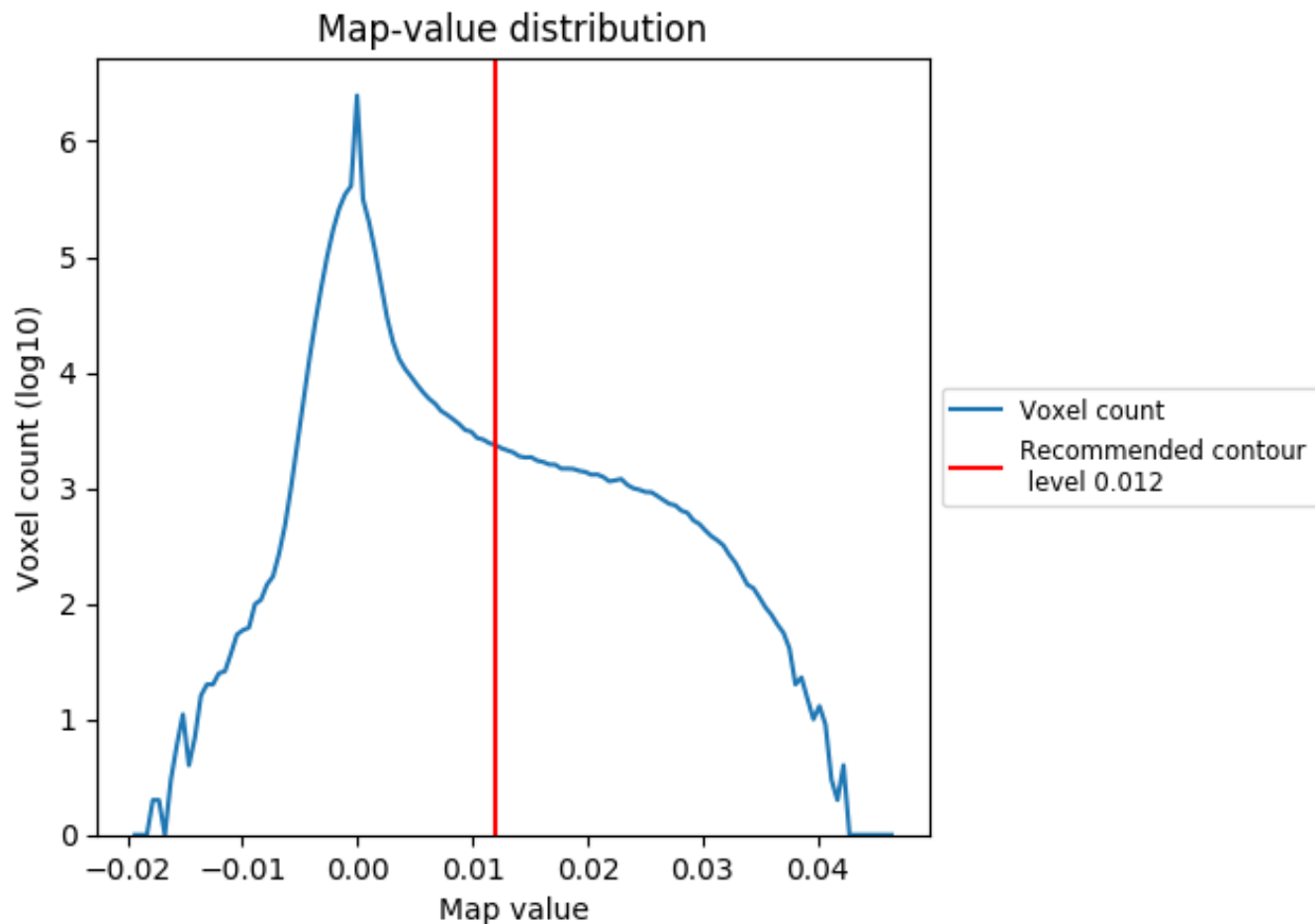
## 6.5 Mask visualisation

This section was not generated. No masks/segmentation were deposited.

## 7 Map analysis [i](#)

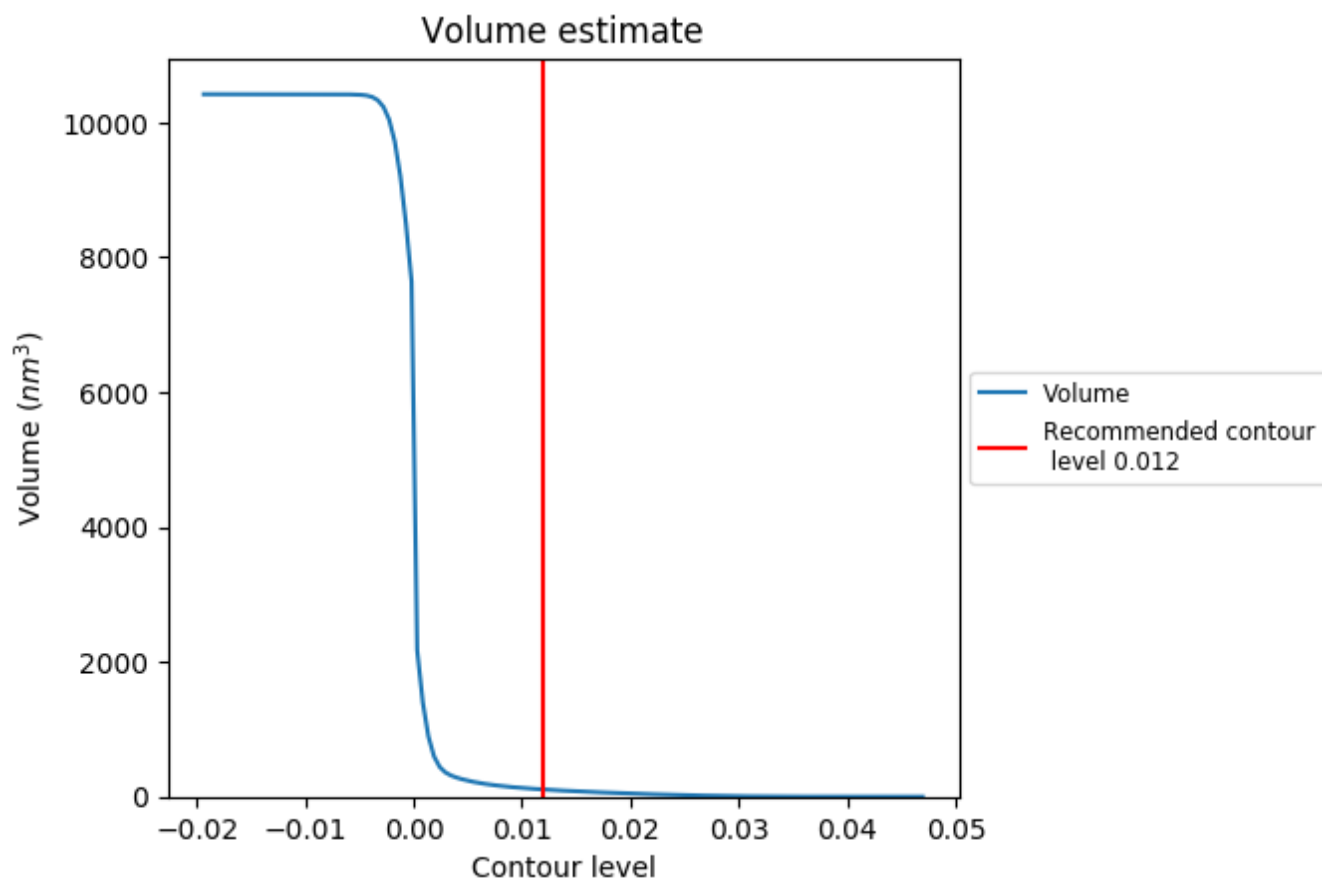
This section contains the results of statistical analysis of the map.

### 7.1 Map-value distribution [i](#)



The map-value distribution is plotted in 128 intervals along the x-axis. The y-axis is logarithmic. A spike in this graph at zero usually indicates that the volume has been masked.

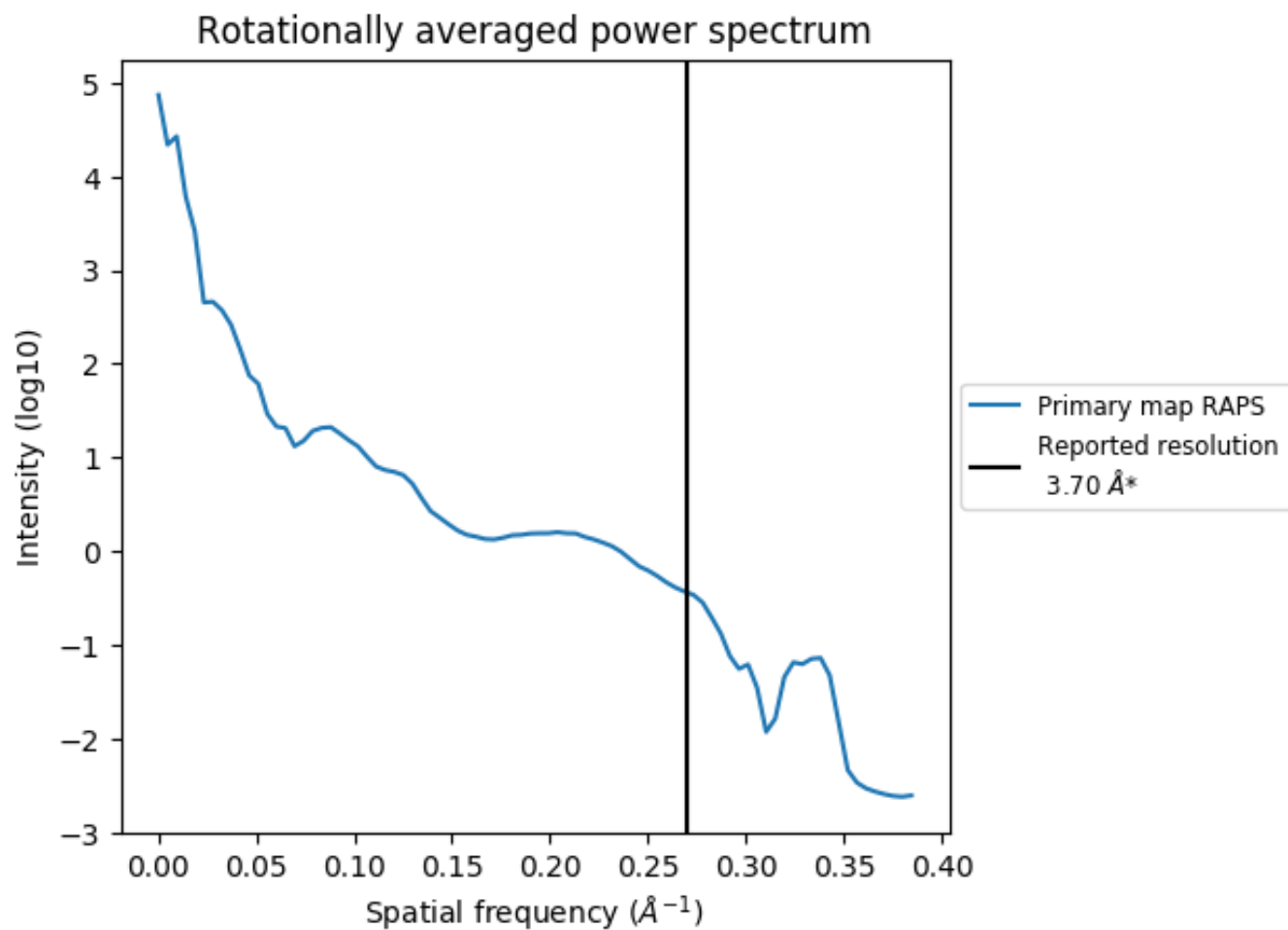
## 7.2 Volume estimate [i](#)



The volume at the recommended contour level is 107 nm<sup>3</sup>; this corresponds to an approximate mass of 96 kDa.

The volume estimate graph shows how the enclosed volume varies with the contour level. The recommended contour level is shown as a vertical line and the intersection between the line and the curve gives the volume of the enclosed surface at the given level.

### 7.3 Rotationally averaged power spectrum [\(i\)](#)



\*Reported resolution corresponds to spatial frequency of 0.270 Å<sup>-1</sup>

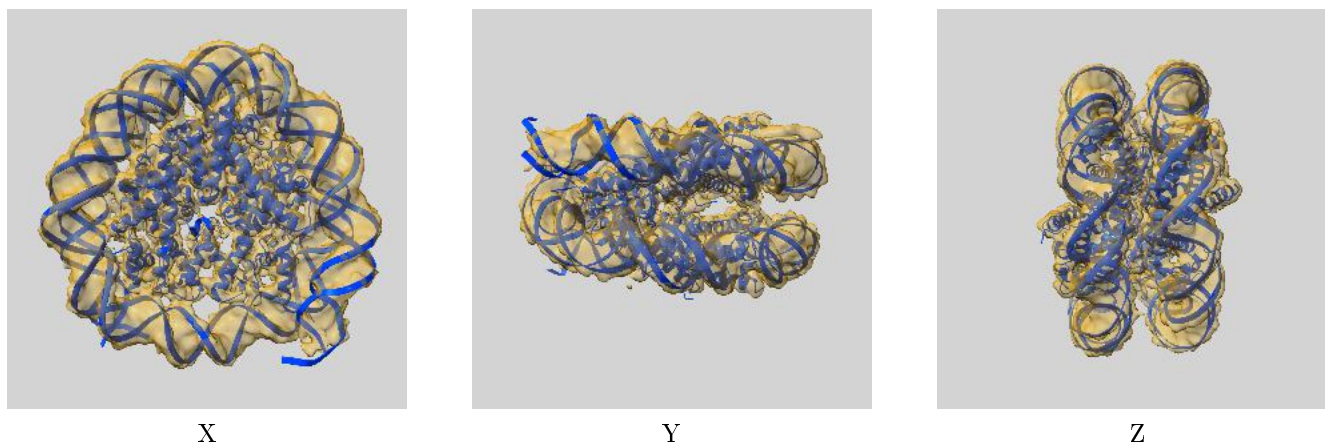
## 8 Fourier-Shell correlation

This section was not generated. No FSC curve or half-maps provided.

## 9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-10154 and PDB model 6SEF. Per-residue inclusion information can be found in section 3 on page 6.

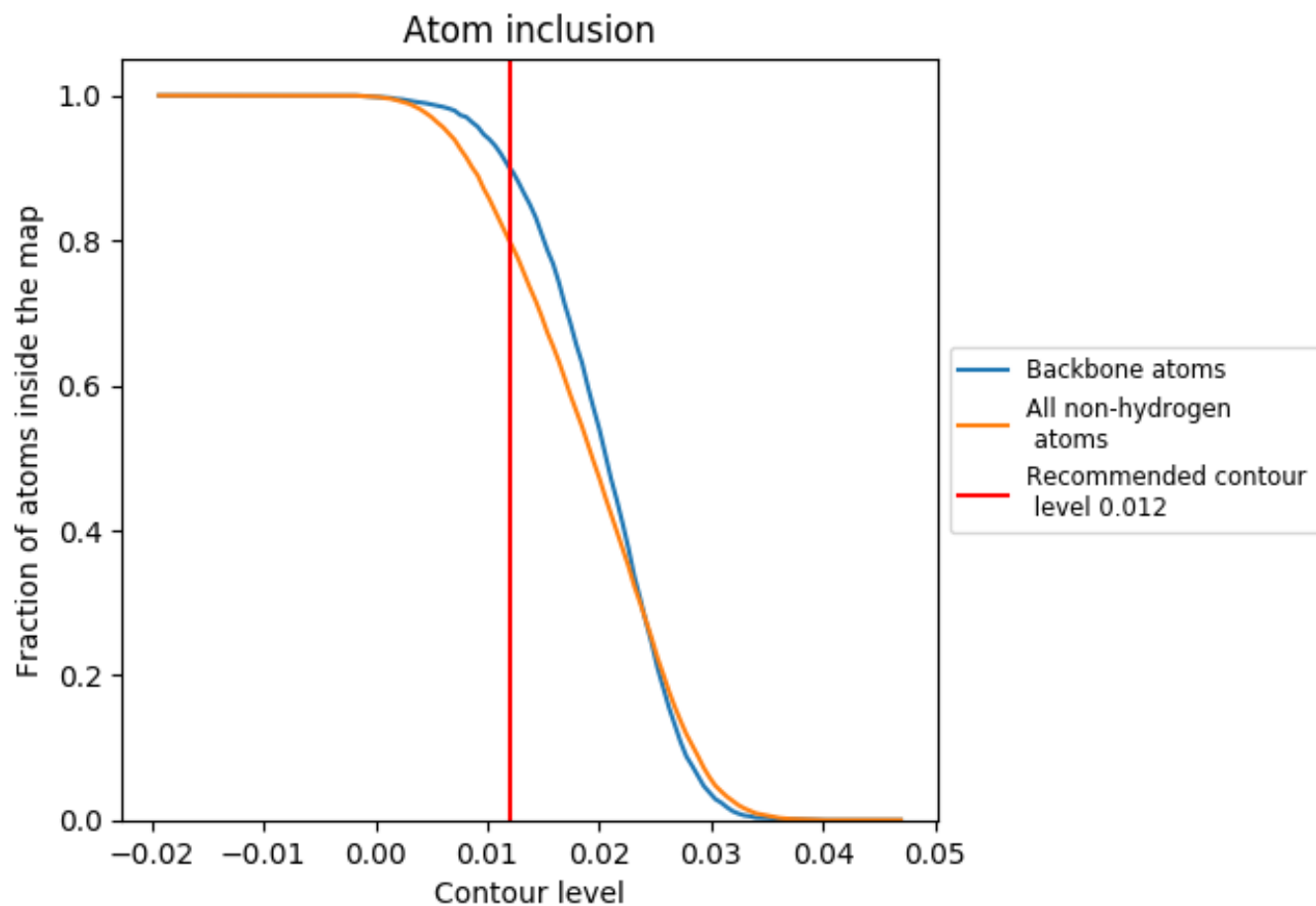
### 9.1 Map-model overlay [i](#)



The images above show the 3D surface view of the map at the recommended contour level 0.012 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.



## 9.2 Atom inclusion [i](#)



At the recommended contour level, 90% of all backbone atoms, 80% of all non-hydrogen atoms, are inside the map.