Full wwPDB EM Validation Report (i)

Dec 7, 2022 – 10:48 AM JST

PDB ID	:	6J54
EMDB ID	:	EMD-0668
Title	:	Cryo-EM structure of the mammalian E-state ATP synthase FO section
Authors	:	Gu, J.; Zhang, L.; Yi, J.; Yang, M.
Deposited on	:	2019-01-10
Resolution	:	3.94 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/EMValidationReportHelp
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:

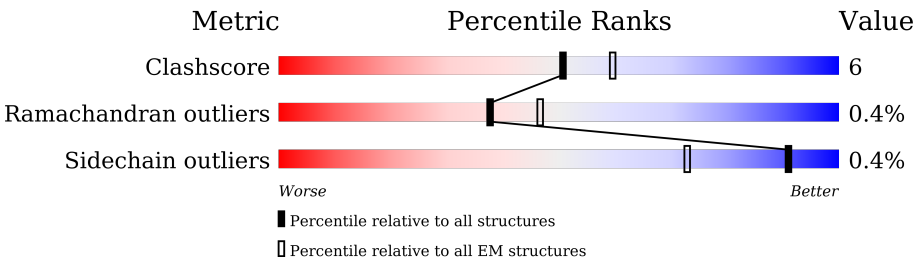
EMDB validation analysis	:	0.0.1.dev43
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
MapQ	:	1.9.9
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.31.3

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 3.94 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 >=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 EM map (all-atom inclusion < 40%). The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	b	82	34% / 100%
2	d	24	12% / 100%
3	e	63	70% / 100%
4	f	87	29% / 95% / 5%
5	g	84	40% / 100%
6	i	42	24% / 100%
7	k	29	55% / 100%
8	8	30	13% / 67% / 20% / 10% / •

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
9	a	226	12% 98%
10	K	72	24% 83% 17%
10	L	72	28% 90% 10%
10	M	72	32% 85% 14%
10	N	72	14% 85% 15%
10	O	72	33% 88% 12%
10	P	72	35% 90% 10%
10	Q	72	18% 90% 10%
10	R	72	21% 92% 8%
11	u	42	100% 100%

2 Entry composition (i)

There are 11 unique types of molecules in this entry. The entry contains 8547 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 ATP synthase peripheral stalk-membrane subunit b.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
1	b	82	440	267	85	88	0	0

- Molecule 2 is a protein called ATP synthase subunit d, mitochondrial.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
2	d	24	120	72	24	24	0	0

- Molecule 3 is a protein called ATP synthase subunit e, mitochondrial.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
3	e	63	315	189	63	63	0	0

- Molecule 4 is a protein called ATP synthase subunit f, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
4	f	87	530	327	103	98	2	0	0

- Molecule 5 is a protein called ATP synthase subunit g, mitochondrial.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
5	g	84	420	252	84	84	0	0

- Molecule 6 is a protein called ATP synthase membrane subunit DAPIT.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
6	i	42	309	204	49	54	2	0	0

- Molecule 7 is a protein called subunit k analog.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
7	k	29	145	87	29	29	0	0

- Molecule 8 is a protein called ATP synthase protein 8.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
8	8	30	251	170	34	45	2	0	0

- Molecule 9 is a protein called ATP synthase subunit a.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
9	a	223	1706	1133	270	291	12	0	0

- Molecule 10 is a protein called Mitochondrial H+ transporting ATP synthase subunit c isoform 1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
10	K	72	513	340	80	89	4	0	0
10	L	72	513	340	80	89	4	0	0
10	M	72	513	340	80	89	4	0	0
10	N	72	510	338	80	89	3	0	0
10	O	72	513	340	80	89	4	0	0
10	P	72	513	340	80	89	4	0	0
10	Q	72	513	340	80	89	4	0	0
10	R	72	513	340	80	89	4	0	0

- Molecule 11 is a protein called ATP synthase membrane subunit 6.8PL.

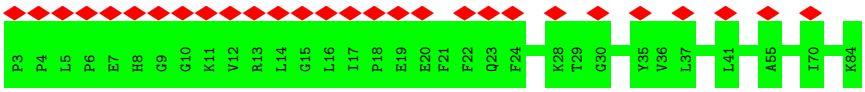
Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
11	u	42	210	126	42	42	0	0

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 atom inclusion in map 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 diamond above a residue indicates a poor fit to the EM map for this residue (all-atom inclusion < 40%). 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.

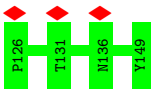
• Molecule 1: ATP synthase peripheral stalk-membrane subunit b

Chain b: 34% 100%



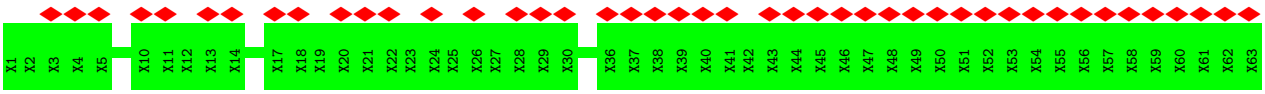
• Molecule 2: ATP synthase subunit d, mitochondrial

Chain d: 12% 100%



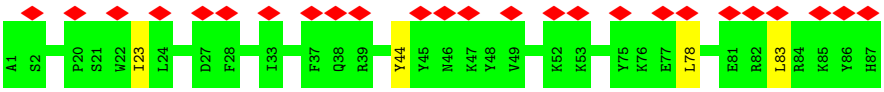
• Molecule 3: ATP synthase subunit e, mitochondrial

Chain e: 70% 100%



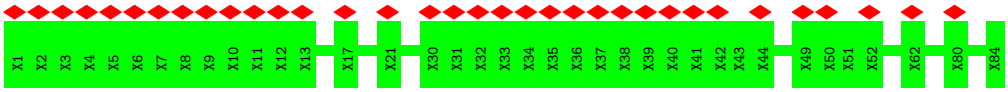
• Molecule 4: ATP synthase subunit f, mitochondrial

Chain f: 29% 95% 5%



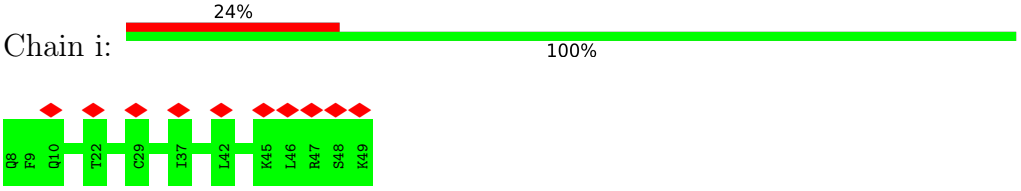
• Molecule 5: ATP synthase subunit g, mitochondrial

Chain g: 40% 100%



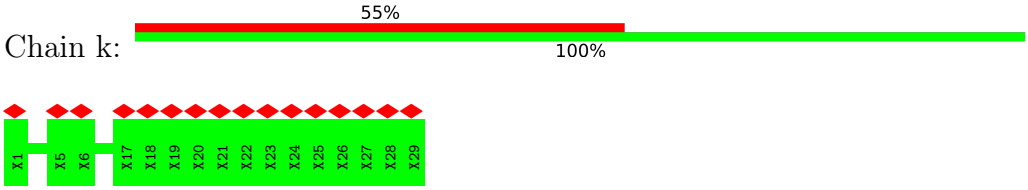
• Molecule 6: ATP synthase membrane subunit DAPIT

Chain i:



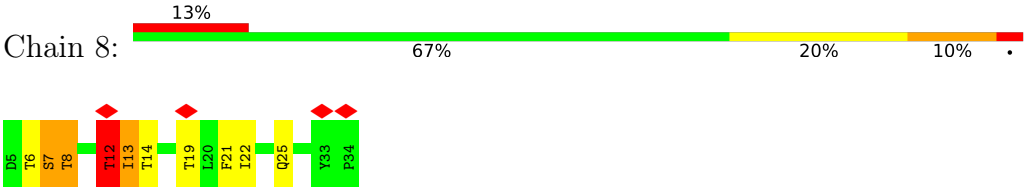
• Molecule 7: subunit k analog

Chain k:



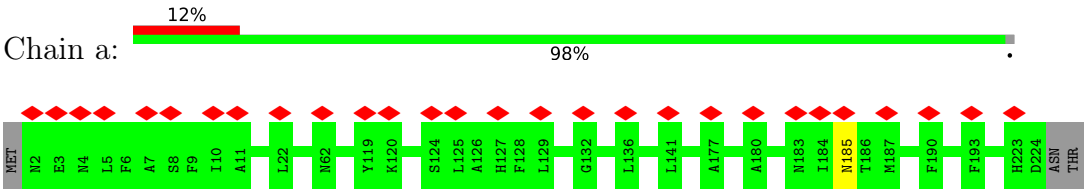
• Molecule 8: ATP synthase protein 8

Chain 8:



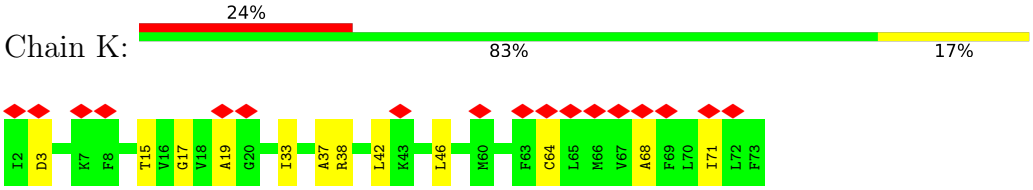
• Molecule 9: ATP synthase subunit a

Chain a:



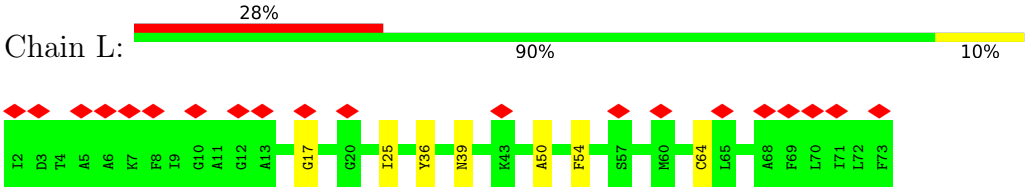
• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

Chain K:



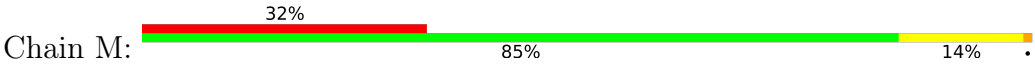
• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

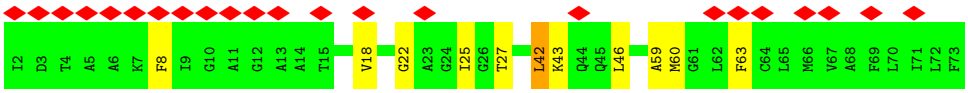
Chain L:



• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

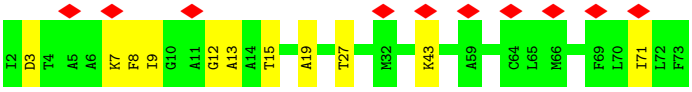
Chain M:





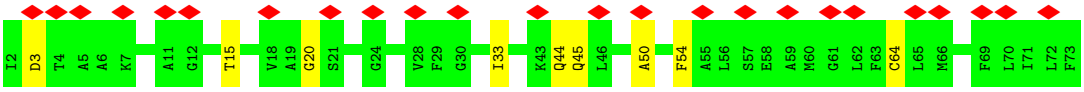
• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

Chain N:



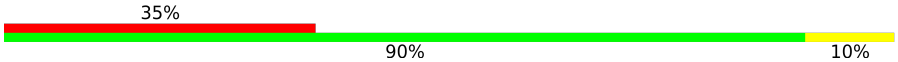
• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

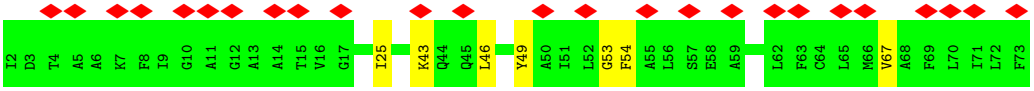
Chain O:



• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

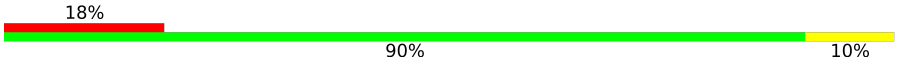
Chain P:

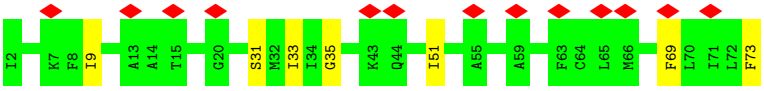




• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

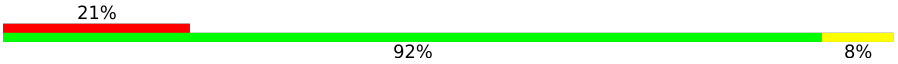
Chain Q:

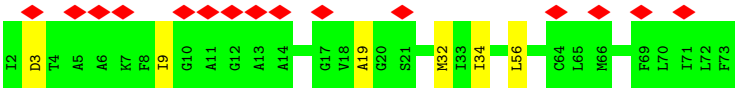




• Molecule 10: Mitochondrial H+ transporting ATP synthase subunit c isoform 1

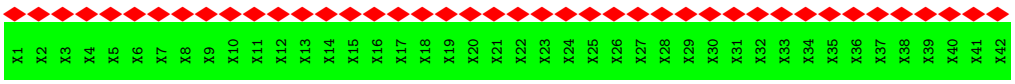
Chain R:





• Molecule 11: ATP synthase membrane subunit 6.8PL

Chain u:



4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	167954	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	1.56	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	0.186	Depositor
Minimum map value	-0.130	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.003	Depositor
Recommended contour level	0.0286	Depositor
Map size (Å)	331.2, 331.2, 331.2	wwPDB
Map dimensions	240, 240, 240	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.38, 1.38, 1.38	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	b	0.28	0/440	0.52	0/602
2	d	0.28	0/119	0.45	0/165
4	f	0.34	0/535	0.66	2/730 (0.3%)
6	i	0.34	0/314	0.50	0/424
8	8	0.52	0/258	0.89	0/351
9	a	0.43	0/1743	0.67	0/2384
10	K	0.41	0/522	0.54	0/703
10	L	0.38	0/522	0.56	0/703
10	M	0.42	0/522	0.59	0/703
10	N	0.44	0/519	0.50	0/700
10	O	0.40	0/522	0.59	0/703
10	P	0.35	0/522	0.53	0/703
10	Q	0.34	0/522	0.47	0/703
10	R	0.40	0/522	0.57	0/703
All	All	0.40	0/7582	0.60	2/10277 (0.0%)

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
4	f	0	2
8	8	0	4
All	All	0	6

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	f	83	LEU	CA-CB-CG	5.12	127.08	115.30
4	f	78	LEU	CA-CB-CG	5.02	126.84	115.30

There are no chirality outliers.

All (6) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
8	8	12	THR	Peptide
8	8	6	THR	Peptide
8	8	7	SER	Peptide
8	8	8	THR	Peptide
4	f	23	ILE	Peptide
4	f	44	TYR	Peptide

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	b	440	0	282	0	0
2	d	120	0	46	0	0
3	e	315	0	65	0	0
4	f	530	0	385	0	0
5	g	420	0	88	0	0
6	i	309	0	298	0	0
7	k	145	0	32	0	0
8	8	251	0	253	4	0
9	a	1706	0	1804	0	0
10	K	513	0	530	10	0
10	L	513	0	530	6	0
10	M	513	0	530	9	0
10	N	510	0	523	8	0
10	O	513	0	530	7	0
10	P	513	0	530	4	0
10	Q	513	0	530	5	0
10	R	513	0	530	6	0
11	u	210	0	45	0	0
All	All	8547	0	7531	45	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 6.

All (45) 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)
10:P:25:ILE:HD11	10:P:54:PHE:HA	1.76	0.67
8:8:21:PHE:O	8:8:25:GLN:NE2	2.29	0.66
10:K:17:GLY:HA2	10:R:19:ALA:HB2	1.86	0.58
10:K:38:ARG:HH21	10:R:34:ILE:HD11	1.69	0.57
10:K:42:LEU:HA	10:K:46:LEU:HD12	1.87	0.56
10:N:8:PHE:O	10:N:12:GLY:N	2.37	0.56
10:M:42:LEU:HA	10:M:46:LEU:HB3	1.89	0.53
10:L:50:ALA:O	10:L:54:PHE:N	2.41	0.53
10:L:25:ILE:HD11	10:L:54:PHE:HD1	1.74	0.52
10:K:37:ALA:O	10:L:39:ASN:ND2	2.38	0.52
10:Q:9:ILE:HG22	10:R:9:ILE:HG21	1.93	0.51
10:K:19:ALA:HB2	10:L:17:GLY:HA2	1.93	0.50
10:Q:31:SER:O	10:Q:35:GLY:N	2.44	0.50
8:8:12:THR:OG1	8:8:13:ILE:N	2.44	0.49
10:M:42:LEU:HD11	10:M:43:LYS:HZ2	1.77	0.49
10:M:18:VAL:O	10:M:22:GLY:N	2.47	0.47
10:O:33:ILE:HG23	10:P:46:LEU:HD11	1.96	0.47
10:K:68:ALA:HA	10:K:71:ILE:HD12	1.96	0.47
10:M:27:THR:HA	10:N:27:THR:HG21	1.96	0.47
10:M:8:PHE:HD1	10:N:71:ILE:HG23	1.80	0.47
10:K:64:CYS:O	10:K:68:ALA:N	2.48	0.46
10:O:50:ALA:O	10:O:54:PHE:N	2.42	0.45
10:N:15:THR:OG1	10:O:64:CYS:SG	2.67	0.45
10:Q:33:ILE:HG21	10:R:32:MET:HA	1.99	0.44
10:O:15:THR:HG21	10:P:67:VAL:HG21	2.00	0.44
10:N:9:ILE:O	10:N:13:ALA:N	2.49	0.44
10:M:60:MET:HE2	10:M:60:MET:HB2	1.90	0.44
10:L:36:TYR:HD2	10:M:46:LEU:HD13	1.82	0.44
10:N:43:LYS:HD2	10:N:43:LYS:HA	1.78	0.44
10:P:49:TYR:O	10:P:53:GLY:N	2.51	0.43
10:Q:69:PHE:O	10:Q:73:PHE:N	2.44	0.43
10:M:25:ILE:HA	10:M:25:ILE:HD12	1.75	0.43
10:O:44:GLN:HG2	10:O:45:GLN:H	1.83	0.43
10:N:3:ASP:O	10:N:7:LYS:N	2.47	0.42
10:R:3:ASP:OD1	10:R:3:ASP:N	2.40	0.42
10:Q:51:ILE:HD13	10:Q:51:ILE:HA	1.92	0.41
8:8:12:THR:O	8:8:14:THR:N	2.53	0.41
10:O:3:ASP:OD1	10:O:3:ASP:N	2.45	0.41
10:K:3:ASP:OD1	10:K:3:ASP:N	2.54	0.41
10:K:33:ILE:HD13	10:K:33:ILE:HA	1.87	0.41
10:M:59:ALA:O	10:M:63:PHE:HB2	2.21	0.41
10:K:15:THR:HG1	10:L:64:CYS:HG	1.66	0.41

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
8:8:19:THR:HA	8:8:22:ILE:HD12	2.03	0.40
10:R:56:LEU:HA	10:R:56:LEU:HD12	1.78	0.40
10:N:19:ALA:HB1	10:O:20:GLY:HA3	2.03	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	b	80/82 (98%)	68 (85%)	12 (15%)	0	100	100
2	d	22/24 (92%)	18 (82%)	4 (18%)	0	100	100
4	f	85/87 (98%)	63 (74%)	22 (26%)	0	100	100
6	i	40/42 (95%)	39 (98%)	1 (2%)	0	100	100
8	8	28/30 (93%)	21 (75%)	3 (11%)	4 (14%)	0	3
9	a	221/226 (98%)	194 (88%)	27 (12%)	0	100	100
10	K	70/72 (97%)	67 (96%)	3 (4%)	0	100	100
10	L	70/72 (97%)	66 (94%)	4 (6%)	0	100	100
10	M	70/72 (97%)	65 (93%)	5 (7%)	0	100	100
10	N	70/72 (97%)	67 (96%)	3 (4%)	0	100	100
10	O	70/72 (97%)	66 (94%)	4 (6%)	0	100	100
10	P	70/72 (97%)	67 (96%)	3 (4%)	0	100	100
10	Q	70/72 (97%)	66 (94%)	4 (6%)	0	100	100
10	R	70/72 (97%)	65 (93%)	5 (7%)	0	100	100
All	All	1036/1067 (97%)	932 (90%)	100 (10%)	4 (0%)	38	70

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
8	8	13	ILE
8	8	7	SER
8	8	8	THR
8	8	12	THR

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	b	14/67 (21%)	14 (100%)	0	100	100
4	f	27/75 (36%)	27 (100%)	0	100	100
6	i	29/36 (81%)	29 (100%)	0	100	100
8	8	30/30 (100%)	30 (100%)	0	100	100
9	a	189/199 (95%)	188 (100%)	1 (0%)	88	93
10	K	49/49 (100%)	49 (100%)	0	100	100
10	L	49/49 (100%)	49 (100%)	0	100	100
10	M	49/49 (100%)	48 (98%)	1 (2%)	55	73
10	N	48/49 (98%)	48 (100%)	0	100	100
10	O	49/49 (100%)	49 (100%)	0	100	100
10	P	49/49 (100%)	48 (98%)	1 (2%)	55	73
10	Q	49/49 (100%)	49 (100%)	0	100	100
10	R	49/49 (100%)	49 (100%)	0	100	100
All	All	680/799 (85%)	677 (100%)	3 (0%)	91	94

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
9	a	185	ASN
10	M	42	LEU
10	P	43	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
8	8	25	GLN
9	a	39	ASN
9	a	47	GLN
9	a	63	GLN
9	a	83	ASN
10	L	44	GLN
10	R	39	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.

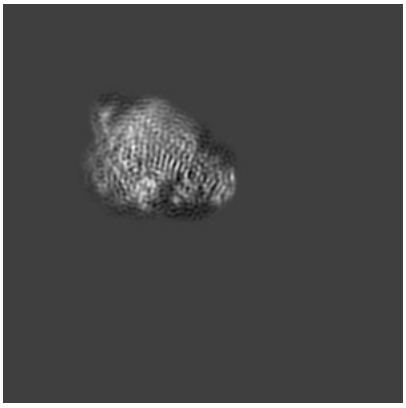
6 Map visualisation (i)

This section contains visualisations of the EMDB entry EMD-0668. These allow visual inspection of the internal detail of the map and identification of artifacts.

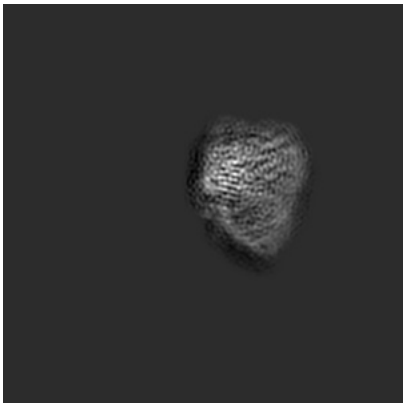
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections (i)

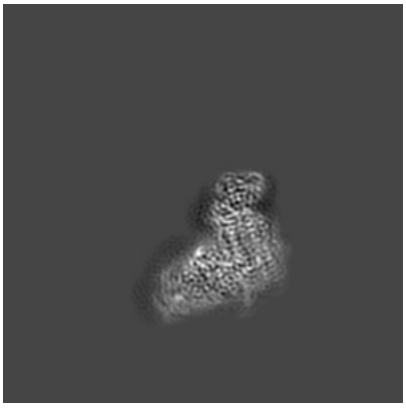
6.1.1 Primary map



X



Y

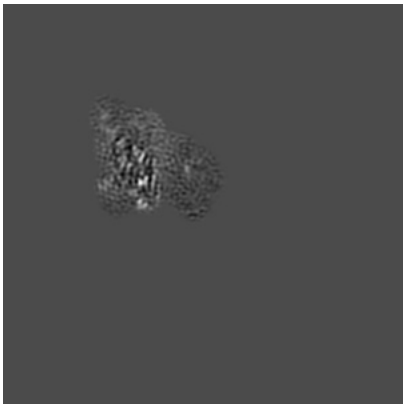


Z

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

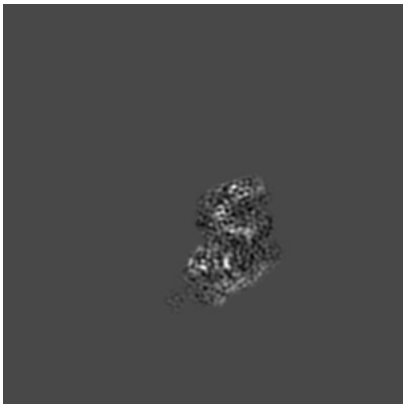
6.2 Central slices (i)

6.2.1 Primary map



X Index: 120

Y Index: 120

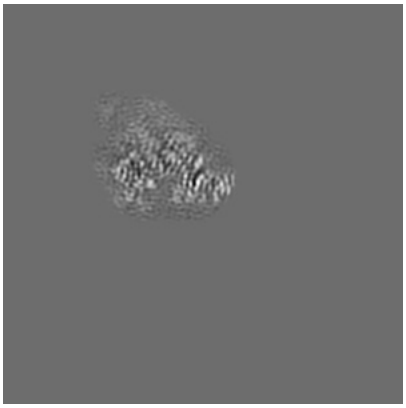


Z Index: 120

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: 135

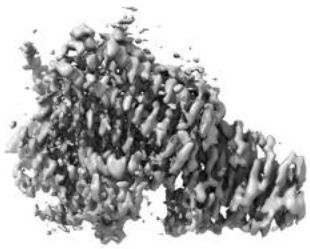
Y Index: 78

Z Index: 134

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 0.0286. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

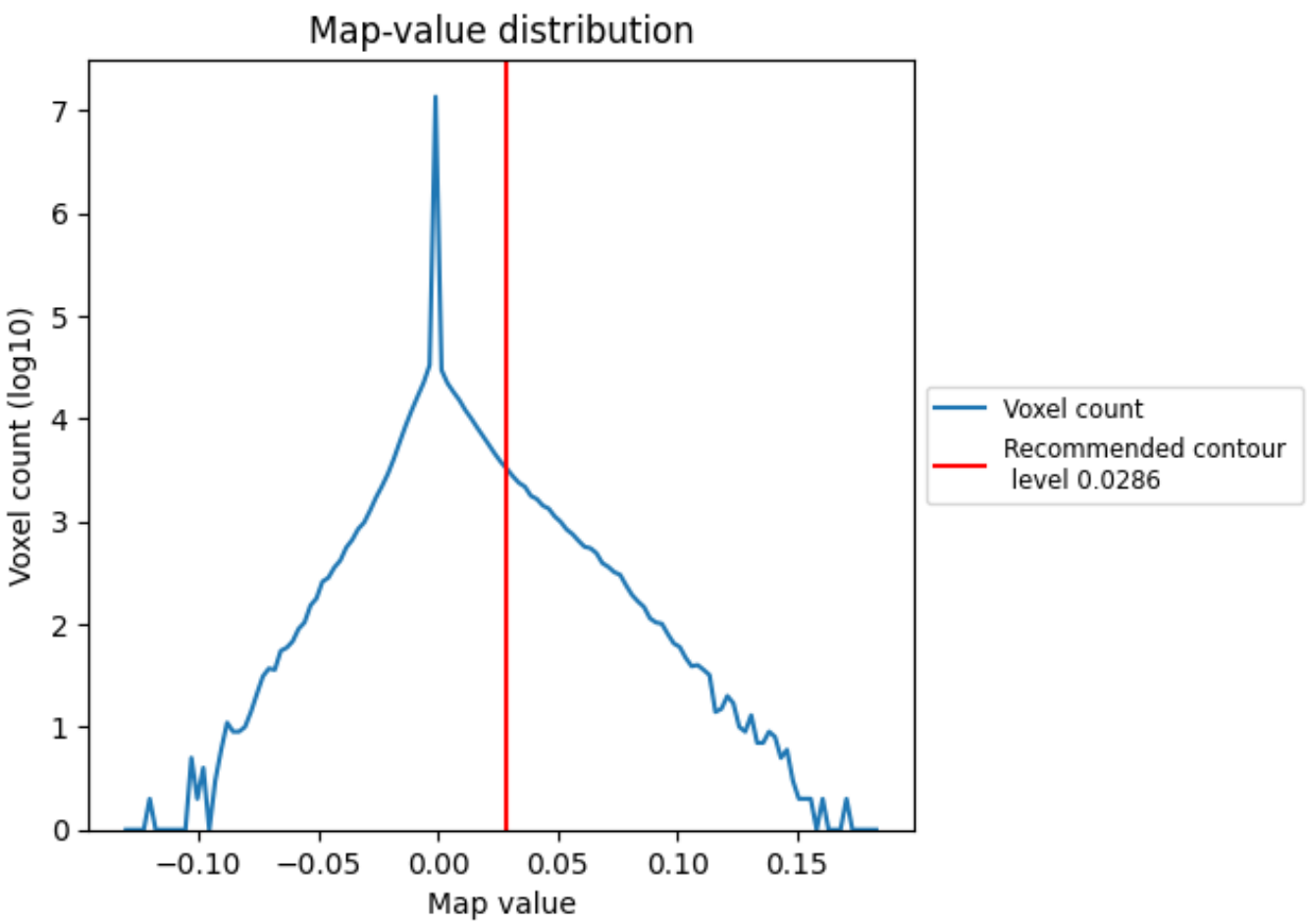
6.5 Mask visualisation (i)

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

7 Map analysis (i)

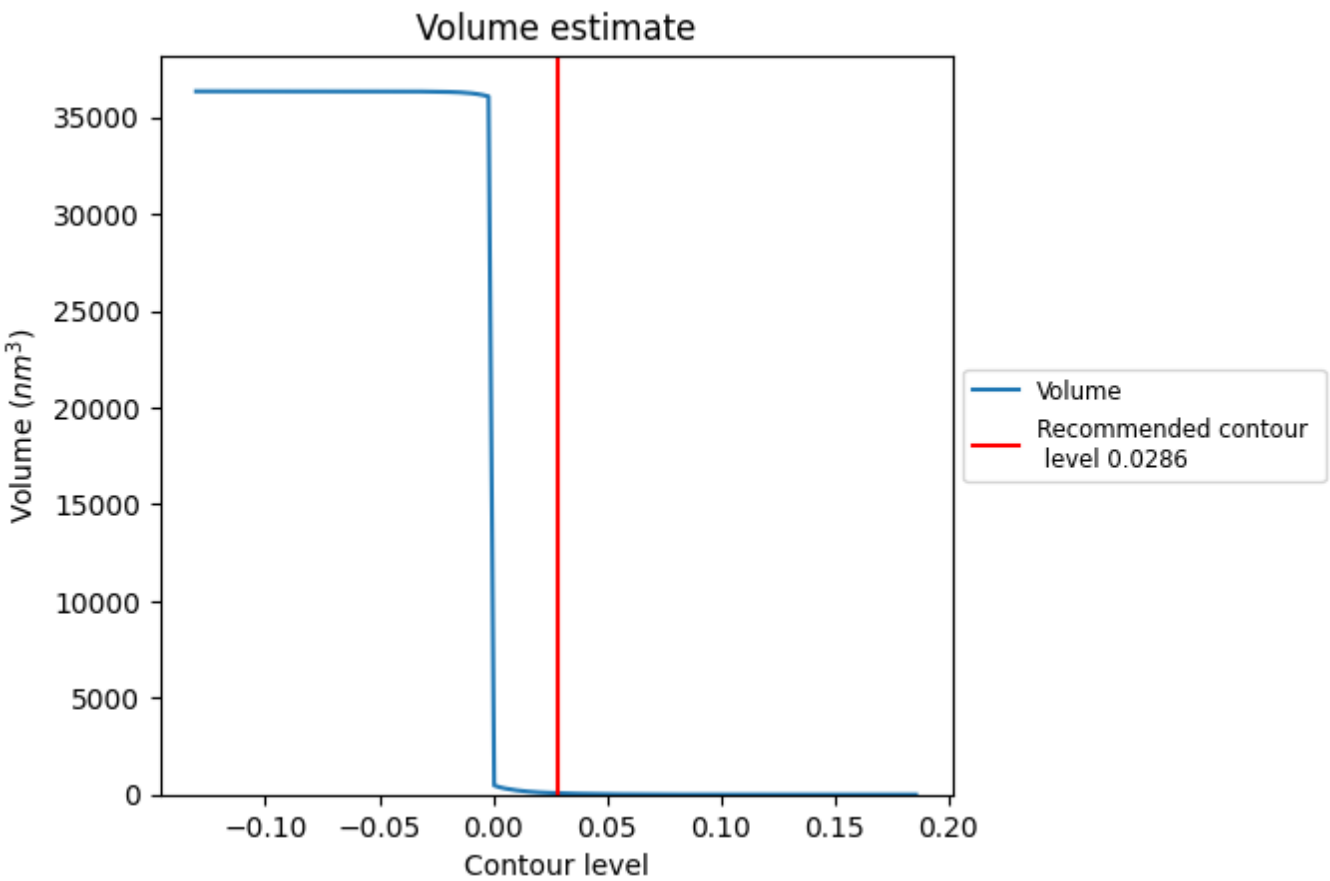
This section contains the results of statistical analysis of the map.

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.

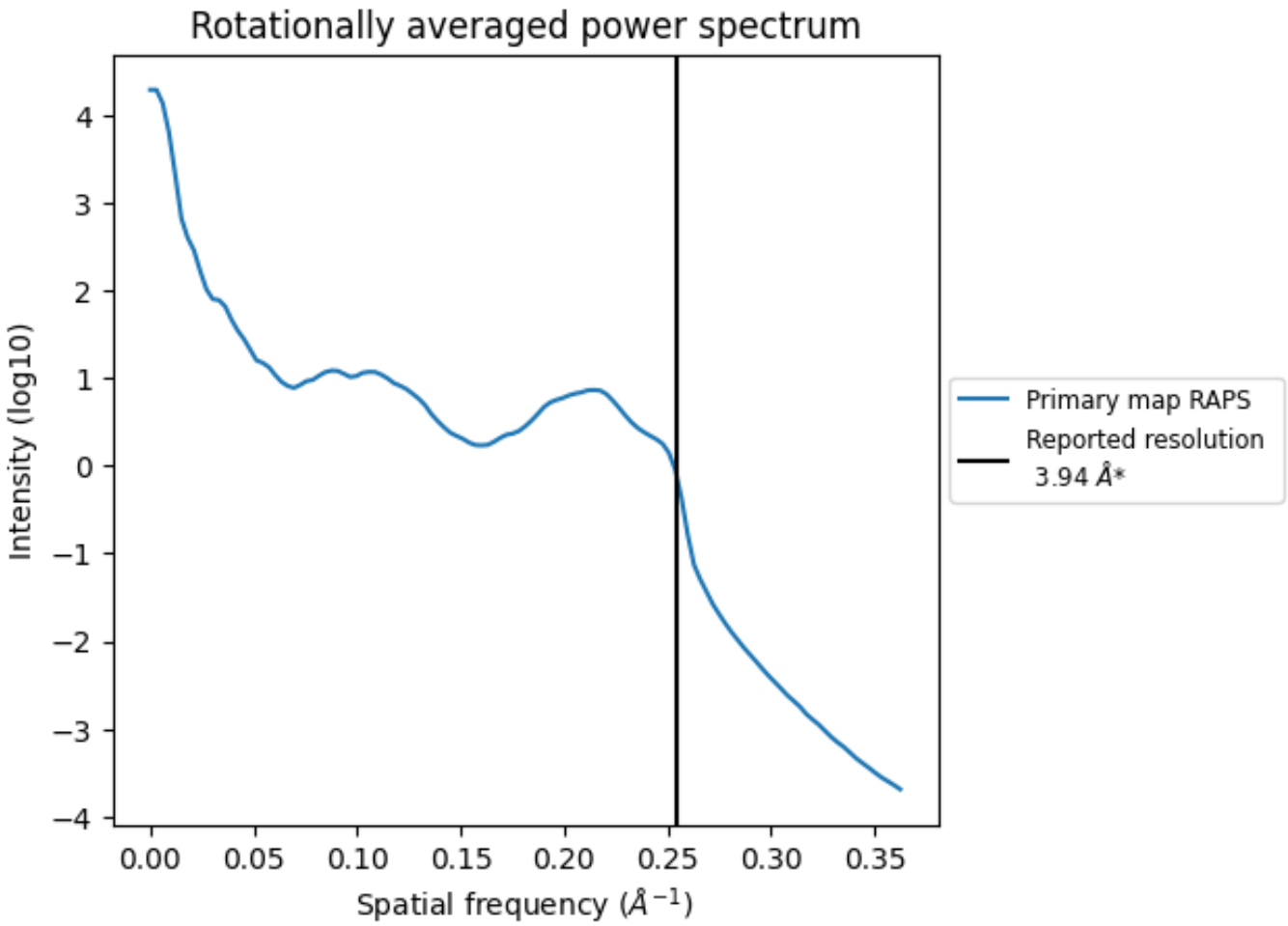
7.2 Volume estimate (i)



The volume at the recommended contour level is 69 nm^3; this corresponds to an approximate mass of 62 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 0.254 Å^{-1}

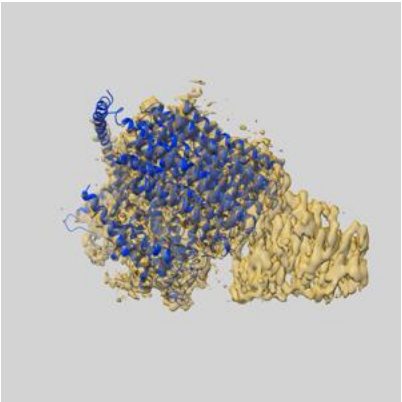
8 Fourier-Shell correlation (i)

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

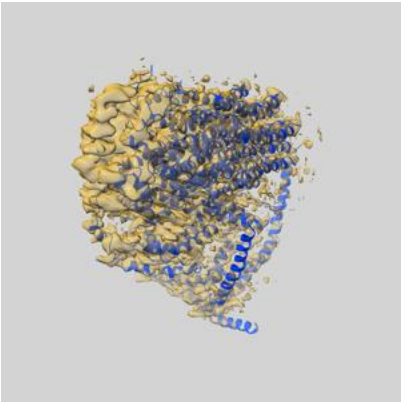
9 Map-model fit (i)

This section contains information regarding the fit between EMDB map EMD-0668 and PDB model 6J54. Per-residue inclusion information can be found in section 3 on page 6.

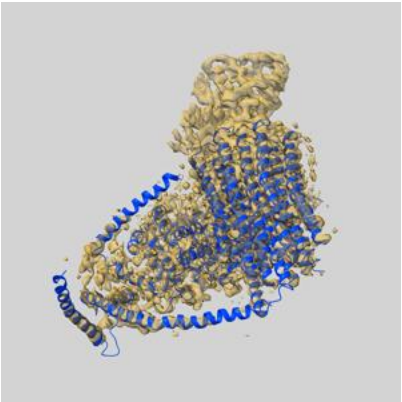
9.1 Map-model overlay (i)



X



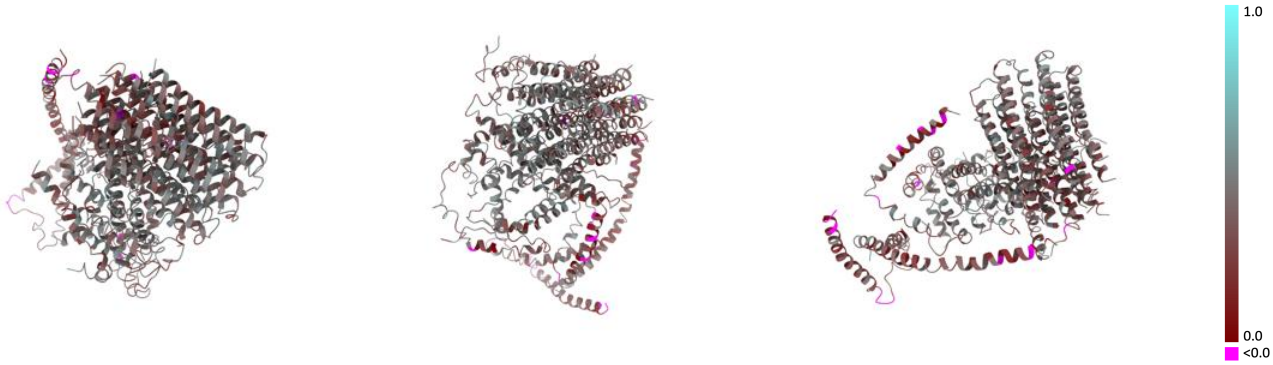
Y



Z

The images above show the 3D surface view of the map at the recommended contour level 0.0286 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.

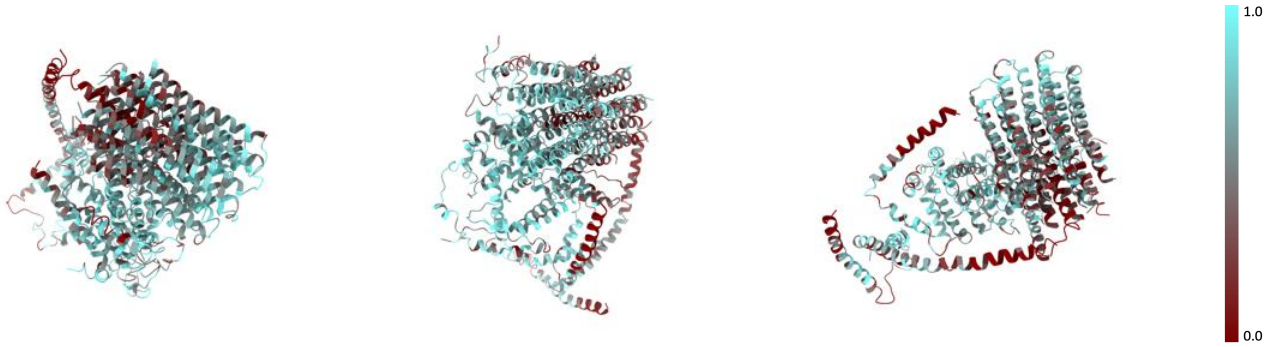
9.2 Q-score mapped to coordinate model (i)



X Y Z

The images above show the model with each residue coloured according its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions at which atoms can be resolved. Low Q-score values may therefore be expected for many entries.

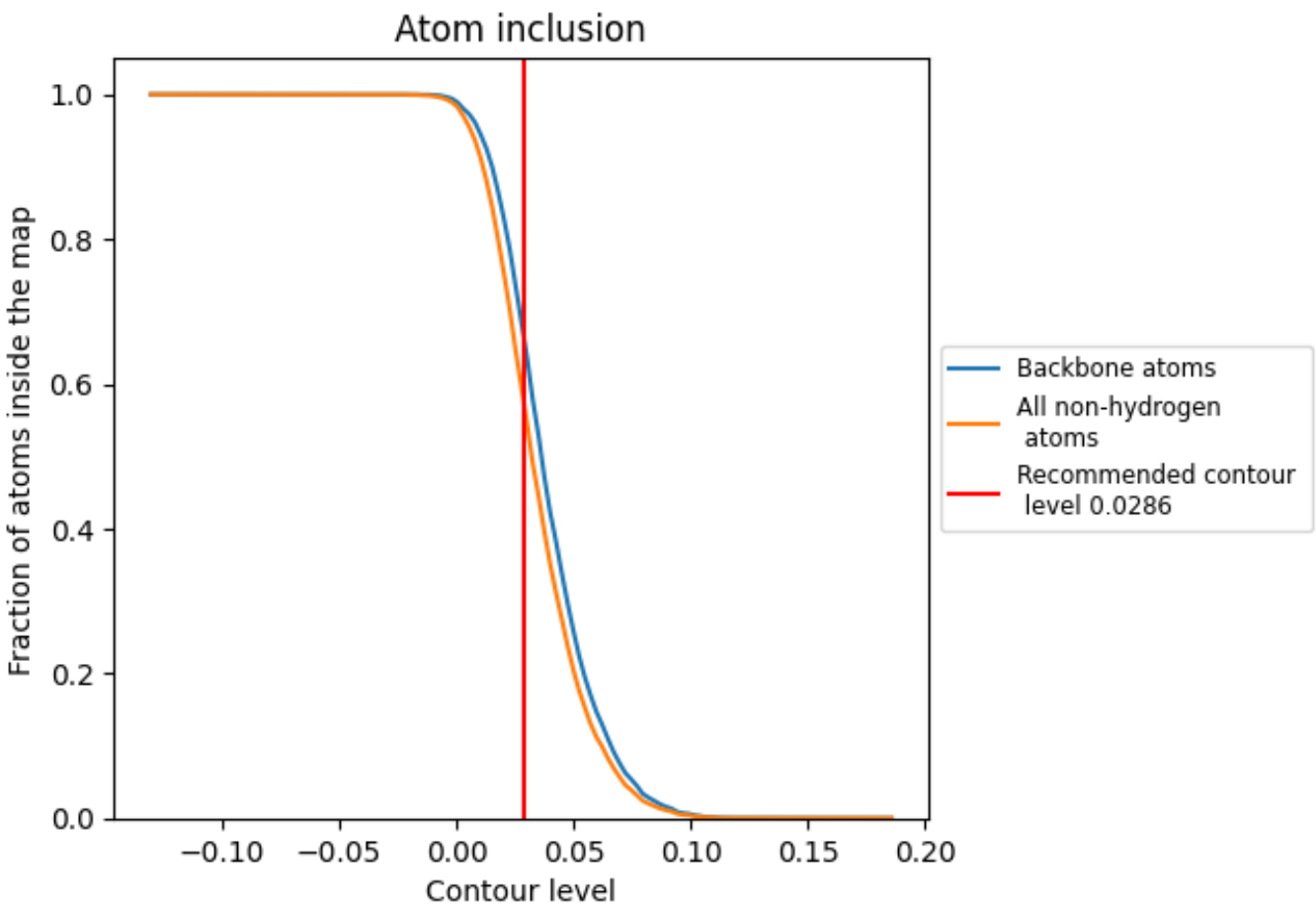
9.3 Atom inclusion mapped to coordinate model (i)



X Y Z

The images above show the model with each residue coloured according to its atom inclusion. This shows to what extent they are inside the map at the recommended contour level (0.0286).

9.4 Atom inclusion (i)



At the recommended contour level, 67% of all backbone atoms, 58% of all non-hydrogen atoms, are inside the map.

9.5 Map-model fit summary (i)

The table lists the average atom inclusion at the recommended contour level (0.0286) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.5784	0.3920
8	0.6653	0.3980
K	0.5619	0.4050
L	0.5403	0.4230
M	0.5403	0.4190
N	0.6779	0.4260
O	0.5383	0.3840
P	0.5344	0.3820
Q	0.6365	0.4130
R	0.5796	0.4050
a	0.6871	0.4380
b	0.5809	0.3440
d	0.7500	0.3870
e	0.3238	0.2820
f	0.5950	0.3790
g	0.5333	0.2630
i	0.6197	0.4120
k	0.3724	0.3740
u	0.0524	0.2590