



wwPDB EM Validation Summary Report ⓘ

May 26, 2025 – 12:54 AM EDT

PDB ID : 7TFH / pdb_00007tfh
EMDB ID : EMD-25872
Title : Atomic model of the *S. cerevisiae* clamp-clamp loader complex PCNA-RFC bound to two DNA molecules, one at the 5'-recessed end and the other at the 3'-recessed end
Authors : Zheng, F.; Georgescu, R.; Yao, Y.N.; O'Donnell, M.E.; Li, H.
Deposited on : 2022-01-06
Resolution : 3.09 Å(reported)

This is a wwPDB EM 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/EMValidationReportHelp>
with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

EMDB validation analysis : 0.0.1.dev118
Mogul : 2022.3.0, CSD as543be (2022)
MolProbity : 4-5-2 with Phenix2.0rc1
buster-report : 1.1.7 (2018)
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)
MapQ : 1.9.13
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.43.1

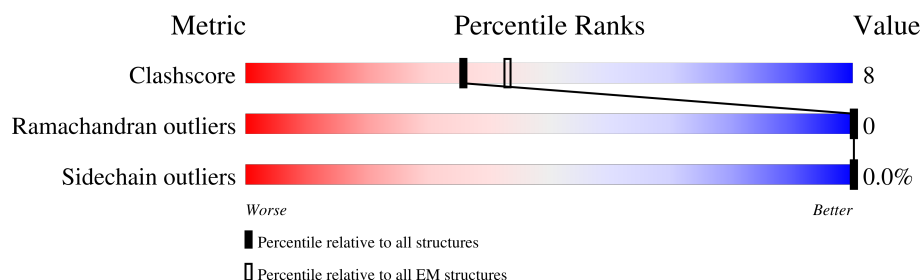
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY

The reported resolution of this entry is 3.09 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	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

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 $\leq 5\%$. 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	861	
2	B	323	
3	C	340	
4	D	353	
5	E	354	
6	F	260	
6	G	260	
6	H	260	

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
7	I	40	<div><div><div></div><div></div><div></div></div><div>45%10%45%</div></div>
7	K	40	<div><div><div></div><div></div><div></div></div><div>22%5%72%</div></div>
8	J	20	<div><div><div></div><div></div><div></div></div><div>85%15%</div></div>
8	L	20	<div><div><div></div><div></div><div></div></div><div>45%5%50%</div></div>

2 Entry composition [i](#)

There are 11 unique types of molecules in this entry. The entry contains 22831 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 Replication factor C subunit 1.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	628	Total	C	N	O	S	0	0
			4925	3120	864	921	20		

- Molecule 2 is a protein called Replication factor C subunit 4.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	B	320	Total	C	N	O	S	0	0
			2510	1583	447	467	13		

- Molecule 3 is a protein called Replication factor C subunit 3.

Mol	Chain	Residues	Atoms					AltConf	Trace
3	C	330	Total	C	N	O	S	0	0
			2615	1645	458	504	8		

- Molecule 4 is a protein called Replication factor C subunit 2.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	D	331	Total	C	N	O	S	0	0
			2622	1656	453	503	10		

- Molecule 5 is a protein called Replication factor C subunit 5.

Mol	Chain	Residues	Atoms					AltConf	Trace
5	E	341	Total	C	N	O	S	0	0
			2694	1706	469	500	19		

- Molecule 6 is a protein called Proliferating cell nuclear antigen.

Mol	Chain	Residues	Atoms						AltConf	Trace
6	F	256	Total	C	N	O	S	Se	0	0
			2011	1285	317	399	4	6		

Continued on next page...

Continued from previous page...

Mol	Chain	Residues	Atoms						AltConf	Trace
6	G	257	Total	C	N	O	S	Se	0	0
			2014	1287	318	399	4	6		
6	H	254	Total	C	N	O	S	Se	0	0
			1995	1277	314	394	4	6		

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	-1	ALA	-	expression tag	UNP P15873
F	0	SER	-	expression tag	UNP P15873
G	-1	ALA	-	expression tag	UNP P15873
G	0	SER	-	expression tag	UNP P15873
H	-1	ALA	-	expression tag	UNP P15873
H	0	SER	-	expression tag	UNP P15873

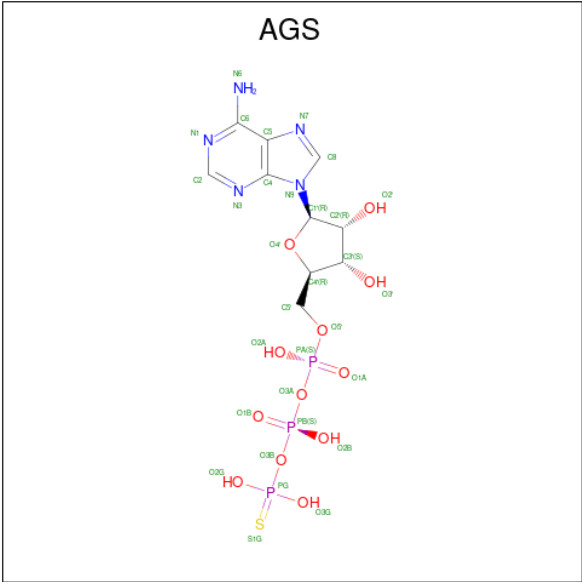
- Molecule 7 is a DNA chain called Template strand.

Mol	Chain	Residues	Atoms					AltConf	Trace
7	I	22	Total	C	N	O	P	0	0
			449	216	72	139	22		
7	K	11	Total	C	N	O	P	0	0
			225	108	36	70	11		

- Molecule 8 is a DNA chain called Primer strand.

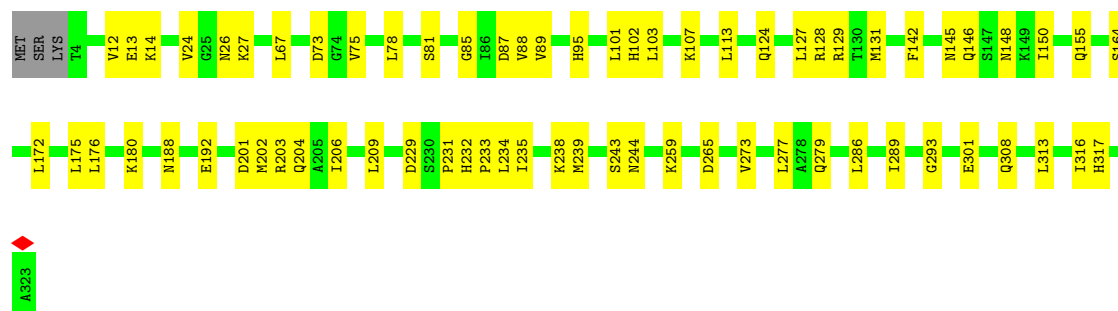
Mol	Chain	Residues	Atoms					AltConf	Trace
8	J	20	Total	C	N	O	P	0	0
			411	195	81	115	20		
8	L	10	Total	C	N	O	P	0	0
			205	97	41	57	10		

- Molecule 9 is PHOSPHOTHIOPHOSPHORIC ACID-ADENYLATE ESTER (CCD ID: AGS) (formula: C₁₀H₁₆N₅O₁₂P₃S).



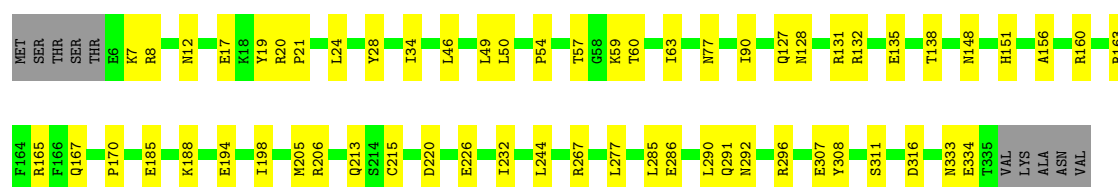


Mol	Chain	Residues	Atoms					AltConf
11	E	1	Total	C	N	O	P	0
			27	10	5	10	2	



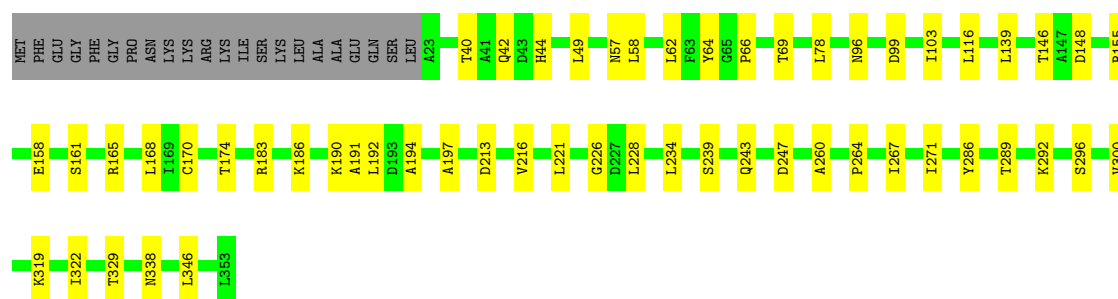
• Molecule 3: Replication factor C subunit 3

Chain C: 79% 18%



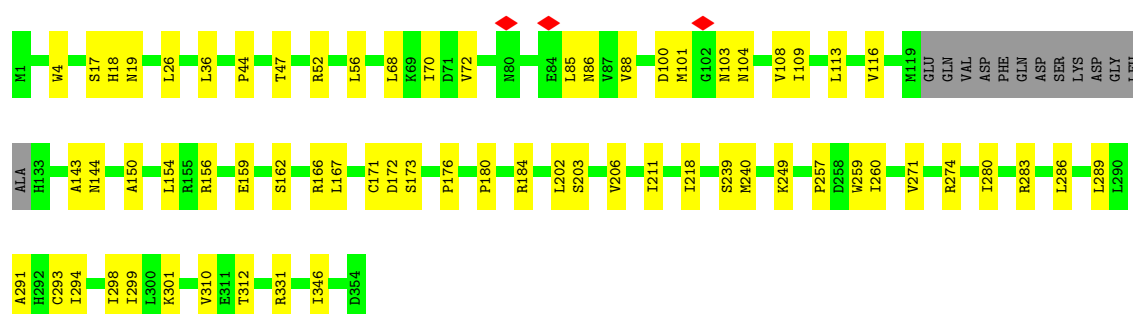
• Molecule 4: Replication factor C subunit 2

Chain D: 78% 16% 6%



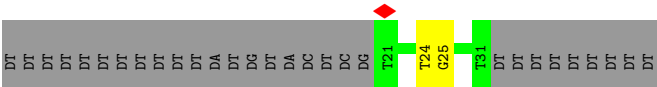
• Molecule 5: Replication factor C subunit 5

Chain E: 78% 19%

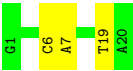
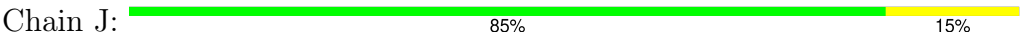


• Molecule 6: Proliferating cell nuclear antigen

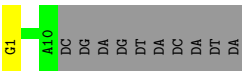
Chain F: 40% 78% 21%



• Molecule 8: Primer strand



• Molecule 8: Primer strand



4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	432904	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 ($e^-/\text{\AA}^2$)	65	Depositor
Minimum defocus (nm)	1300	Depositor
Maximum defocus (nm)	1900	Depositor
Magnification	Not provided	
Image detector	GATAN K3 (6k x 4k)	Depositor
Maximum map value	3.318	Depositor
Minimum map value	-0.417	Depositor
Average map value	0.007	Depositor
Map value standard deviation	0.041	Depositor
Recommended contour level	0.17	Depositor
Map size (\AA)	331.2, 331.2, 331.2	wwPDB
Map dimensions	400, 400, 400	wwPDB
Map angles ($^\circ$)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (\AA)	0.828, 0.828, 0.828	Depositor

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: ADP, MG, AGS

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	0.11	0/5009	0.29	0/6749
2	B	0.13	0/2545	0.31	0/3432
3	C	0.11	0/2655	0.27	0/3589
4	D	0.12	0/2667	0.29	0/3607
5	E	0.12	0/2732	0.29	0/3689
6	F	0.09	0/2036	0.28	0/2738
6	G	0.12	0/2038	0.32	0/2739
6	H	0.13	0/2020	0.33	0/2716
7	I	0.21	0/500	0.41	0/770
7	K	0.16	0/250	0.36	0/384
8	J	0.21	0/462	0.35	0/710
8	L	0.17	0/230	0.30	0/352
All	All	0.12	0/23144	0.30	0/31475

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	4925	0	5037	79	0

Continued on next page...

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	2510	0	2606	50	0
3	C	2615	0	2647	43	0
4	D	2622	0	2652	35	0
5	E	2694	0	2823	49	0
6	F	2011	0	2029	36	0
6	G	2014	0	2035	30	0
6	H	1995	0	2019	39	0
7	I	449	0	253	4	0
7	K	225	0	127	3	0
8	J	411	0	224	2	0
8	L	205	0	112	1	0
9	A	31	0	12	2	0
9	B	31	0	12	4	0
9	C	31	0	12	5	0
9	D	31	0	12	2	0
10	A	1	0	0	0	0
10	B	1	0	0	0	0
10	C	1	0	0	0	0
10	D	1	0	0	0	0
11	E	27	0	12	1	0
All	All	22831	0	22624	336	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 8.

The worst 5 of 336 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)
5:E:103:ASN:ND2	7:I:12:DA:OP2	2.23	0.71
3:C:77:ASN:HA	6:G:44:ARG:HH21	1.56	0.71
1:A:445:ARG:HH12	1:A:469:VAL:HG12	1.55	0.70
4:D:161:SER:O	4:D:165:ARG:NH1	2.24	0.69
5:E:143:ALA:HB3	5:E:171:CYS:HB3	1.75	0.69

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 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	620/861 (72%)	606 (98%)	14 (2%)	0	100	100
2	B	318/323 (98%)	310 (98%)	8 (2%)	0	100	100
3	C	328/340 (96%)	320 (98%)	8 (2%)	0	100	100
4	D	329/353 (93%)	318 (97%)	11 (3%)	0	100	100
5	E	337/354 (95%)	321 (95%)	16 (5%)	0	100	100
6	F	254/260 (98%)	249 (98%)	5 (2%)	0	100	100
6	G	255/260 (98%)	253 (99%)	2 (1%)	0	100	100
6	H	252/260 (97%)	239 (95%)	13 (5%)	0	100	100
All	All	2693/3011 (89%)	2616 (97%)	77 (3%)	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 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	537/742 (72%)	537 (100%)	0	100	100
2	B	280/283 (99%)	280 (100%)	0	100	100
3	C	287/296 (97%)	287 (100%)	0	100	100
4	D	294/312 (94%)	294 (100%)	0	100	100
5	E	313/324 (97%)	313 (100%)	0	100	100
6	F	231/228 (101%)	231 (100%)	0	100	100

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
6	G	231/228 (101%)	230 (100%)	1 (0%)	89	94
6	H	229/228 (100%)	229 (100%)	0	100	100
All	All	2402/2641 (91%)	2401 (100%)	1 (0%)	100	100

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
6	G	94	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
5	E	229	ASN
6	H	153	GLN
3	C	180	ASN
3	C	260	HIS
4	D	96	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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 9 ligands modelled in this entry, 4 are monoatomic - leaving 5 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. 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 $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
9	AGS	B	401	10	28,33,33	0.78	1 (3%)	31,52,52	0.95	2 (6%)
9	AGS	A	901	10	28,33,33	0.76	1 (3%)	31,52,52	0.97	2 (6%)
9	AGS	D	401	10	28,33,33	0.79	1 (3%)	31,52,52	0.91	2 (6%)
9	AGS	C	401	10	28,33,33	0.78	1 (3%)	31,52,52	0.94	2 (6%)
11	ADP	E	500	-	24,29,29	0.87	0	29,45,45	1.24	2 (6%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
9	AGS	B	401	10	-	7/17/38/38	0/3/3/3
9	AGS	A	901	10	-	3/17/38/38	0/3/3/3
9	AGS	D	401	10	-	5/17/38/38	0/3/3/3
9	AGS	C	401	10	-	6/17/38/38	0/3/3/3
11	ADP	E	500	-	-	0/12/32/32	0/3/3/3

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
9	D	401	AGS	PG-S1G	2.10	1.95	1.90
9	C	401	AGS	PG-S1G	2.08	1.95	1.90
9	A	901	AGS	PG-S1G	2.07	1.95	1.90
9	B	401	AGS	PG-S1G	2.06	1.95	1.90

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
11	E	500	ADP	N3-C2-N1	-3.80	123.51	128.67
9	C	401	AGS	PB-O3B-PG	-3.69	119.65	133.17
9	A	901	AGS	PB-O3B-PG	-3.68	119.70	133.17
9	B	401	AGS	PB-O3B-PG	-3.62	119.92	133.17
9	D	401	AGS	PB-O3B-PG	-3.22	121.38	133.17

There are no chirality outliers.

5 of 21 torsion outliers are listed below:

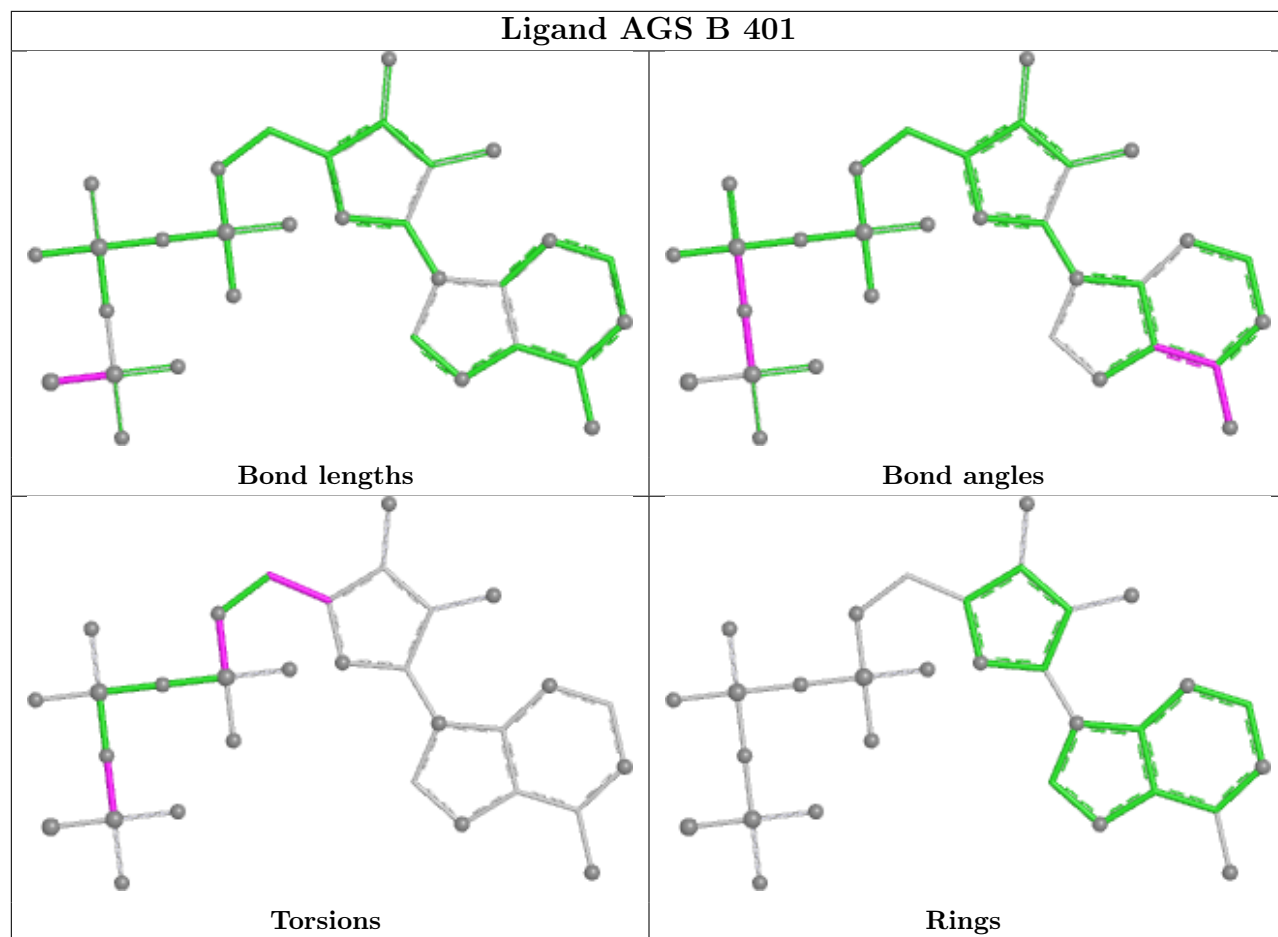
Mol	Chain	Res	Type	Atoms
9	A	901	AGS	C5'-O5'-PA-O1A
9	A	901	AGS	C5'-O5'-PA-O3A
9	B	401	AGS	PB-O3B-PG-O2G
9	B	401	AGS	PB-O3B-PG-O3G
9	B	401	AGS	C5'-O5'-PA-O1A

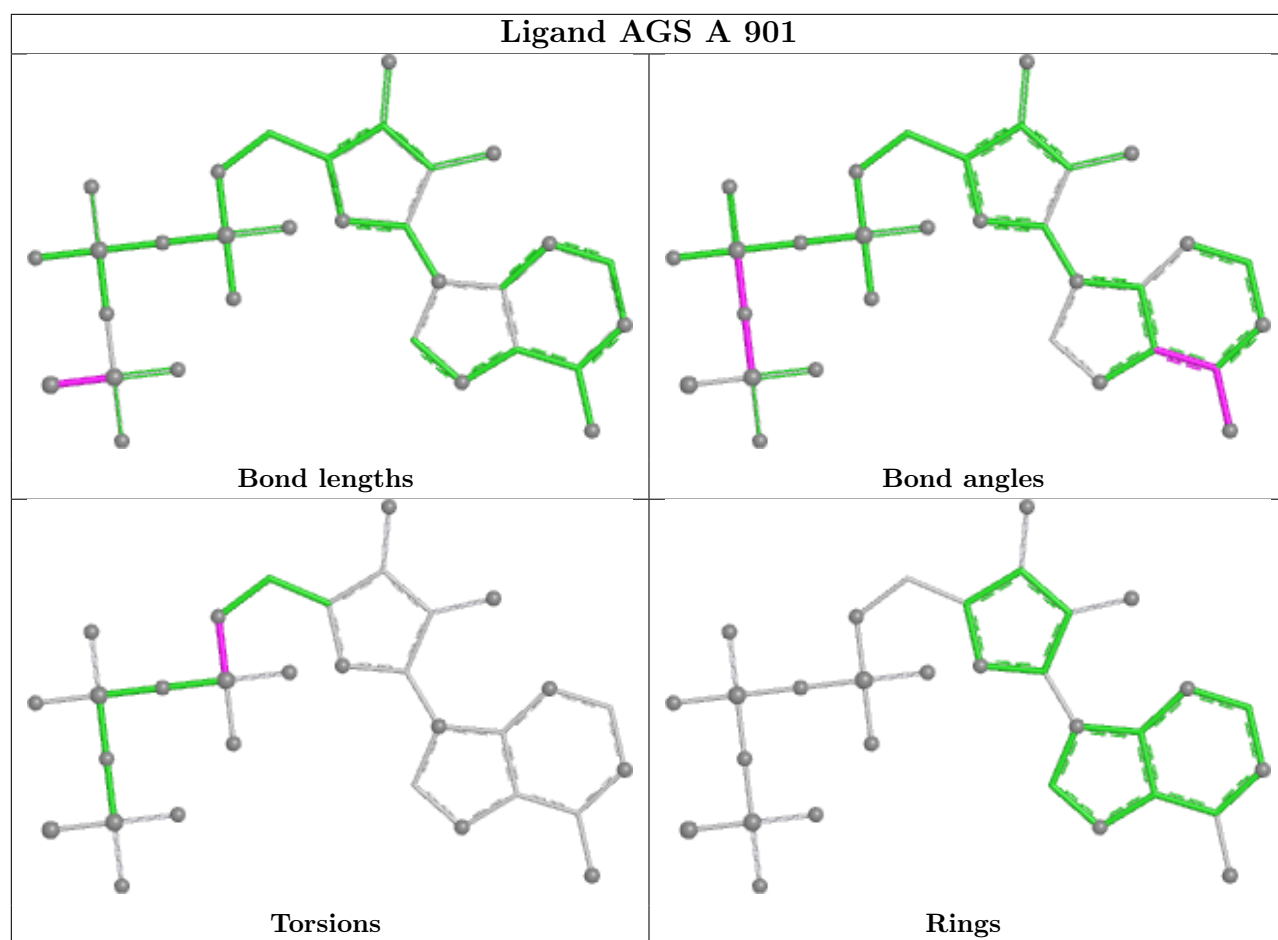
There are no ring outliers.

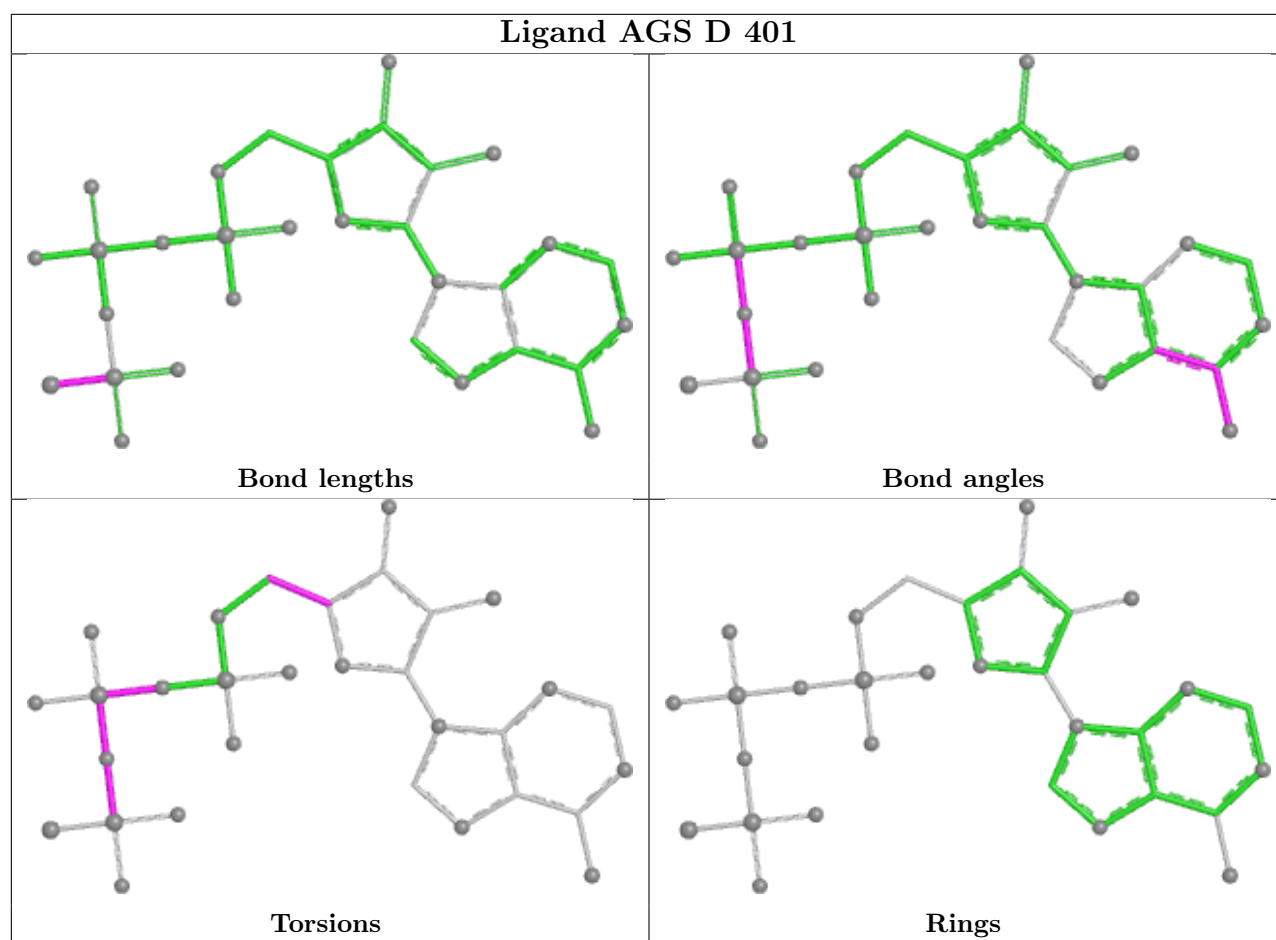
5 monomers are involved in 14 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
9	B	401	AGS	4	0
9	A	901	AGS	2	0
9	D	401	AGS	2	0
9	C	401	AGS	5	0
11	E	500	ADP	1	0

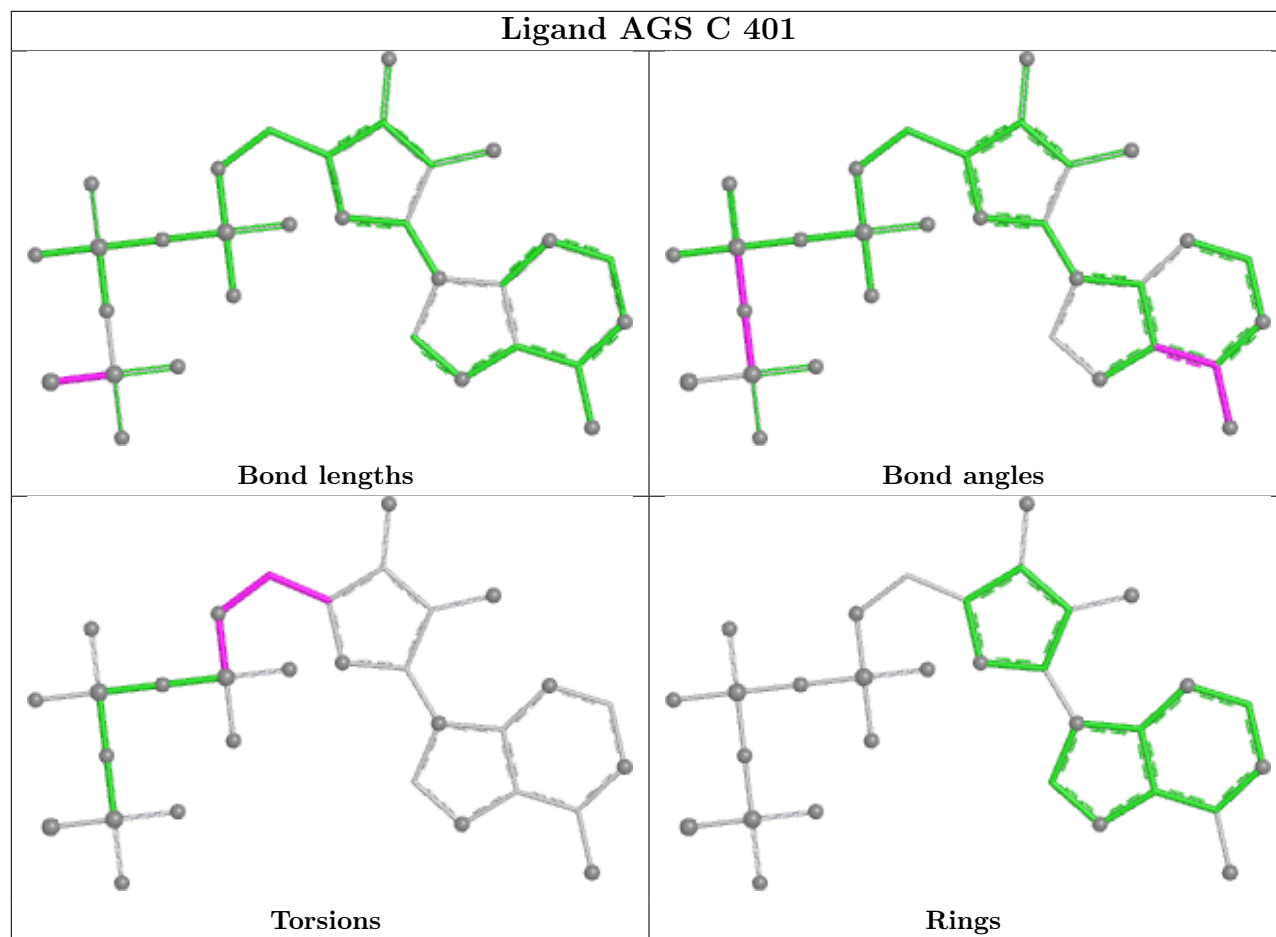
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.



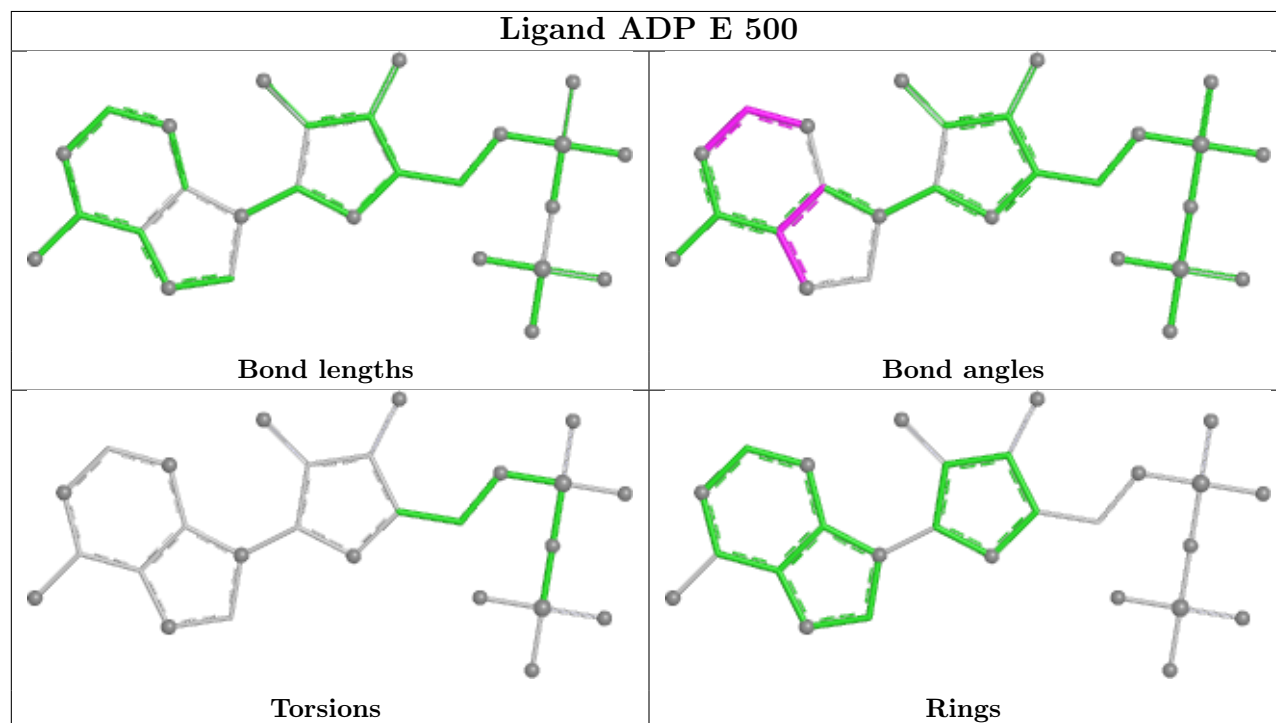




Ligand AGS C 401



Ligand ADP E 500



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.

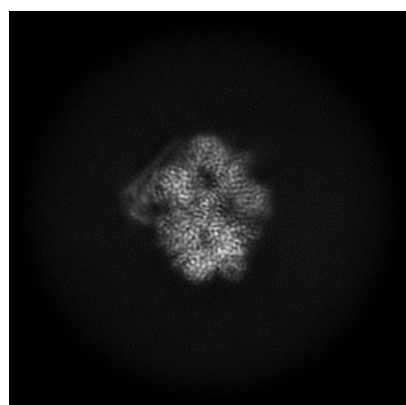
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-25872. These allow visual inspection of the internal detail of the map and identification of artifacts.

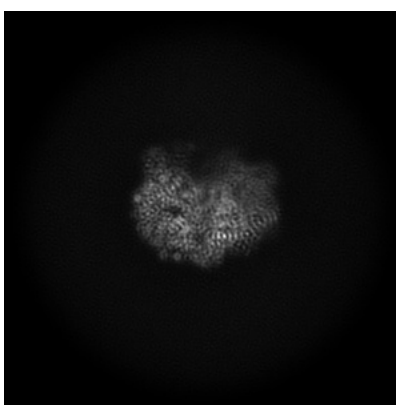
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections [i](#)

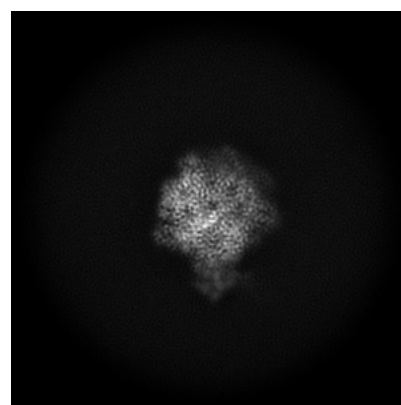
6.1.1 Primary map



X



Y

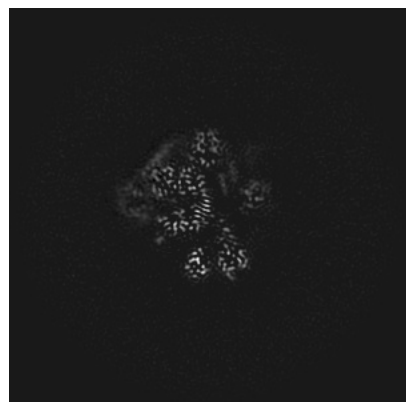


Z

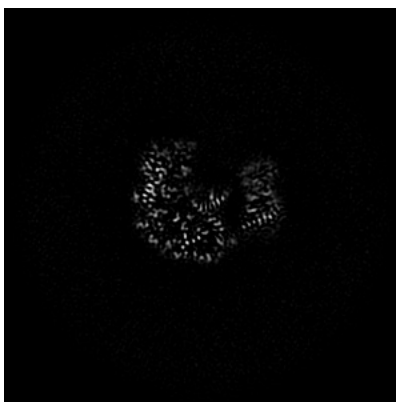
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

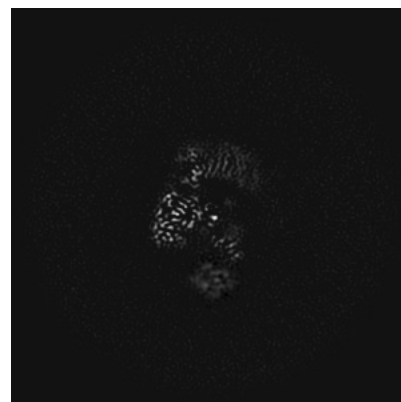
6.2.1 Primary map



X Index: 200



Y Index: 200

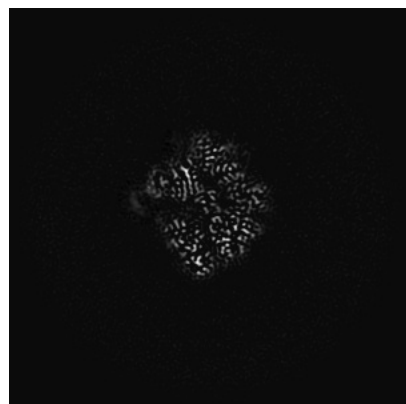


Z Index: 200

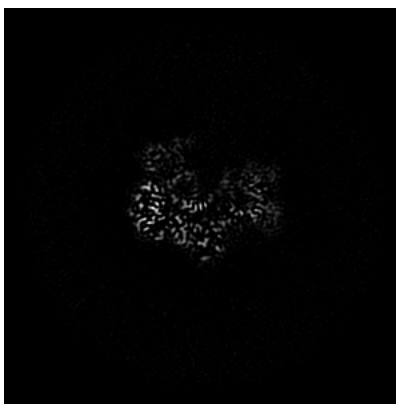
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

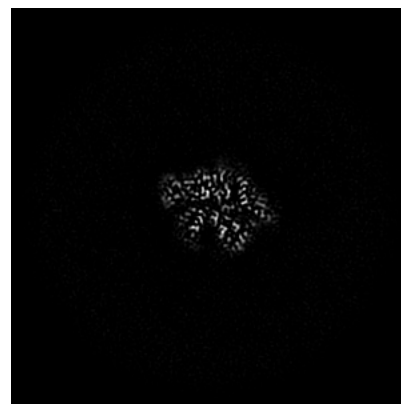
6.3.1 Primary map



X Index: 185



Y Index: 188

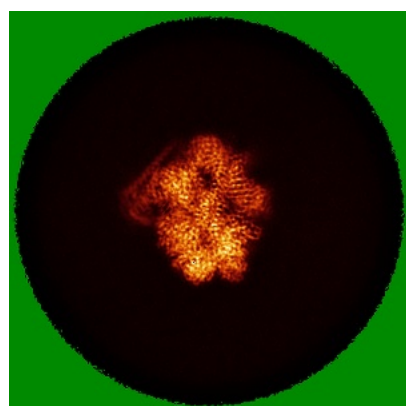


Z Index: 159

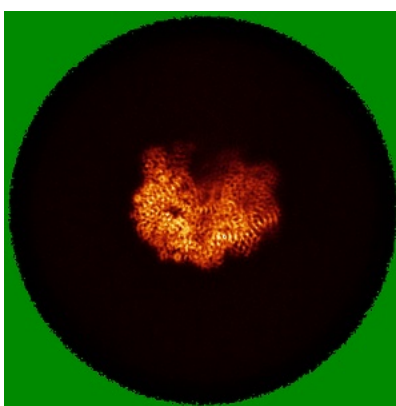
The images above show the largest variance slices of the map in three orthogonal directions.

6.4 Orthogonal standard-deviation projections (False-color) [i](#)

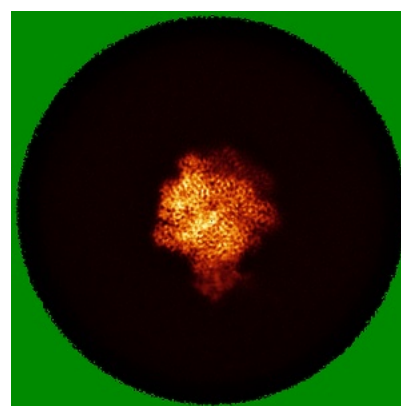
6.4.1 Primary map



X



Y

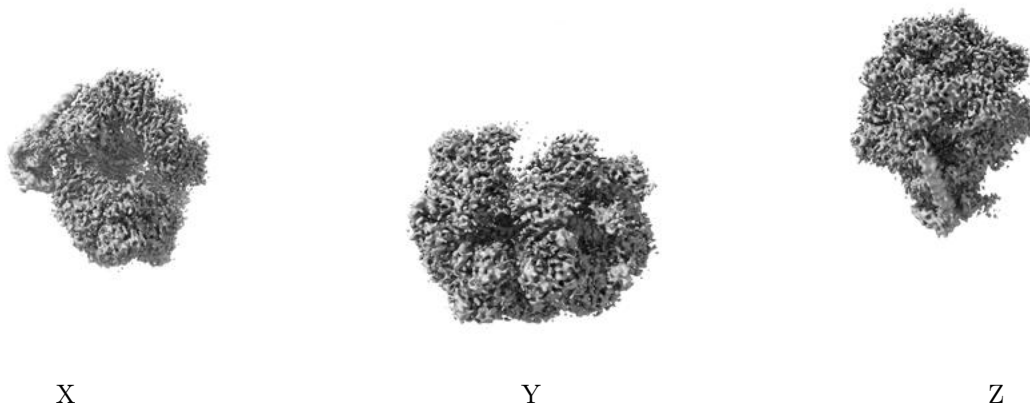


Z

The images above show the map standard deviation projections with false color in three orthogonal directions. Minimum values are shown in green, max in blue, and dark to light orange shades represent small to large values respectively.

6.5 Orthogonal surface views [i](#)

6.5.1 Primary map



The images above show the 3D surface view of the map at the recommended contour level 0.17. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

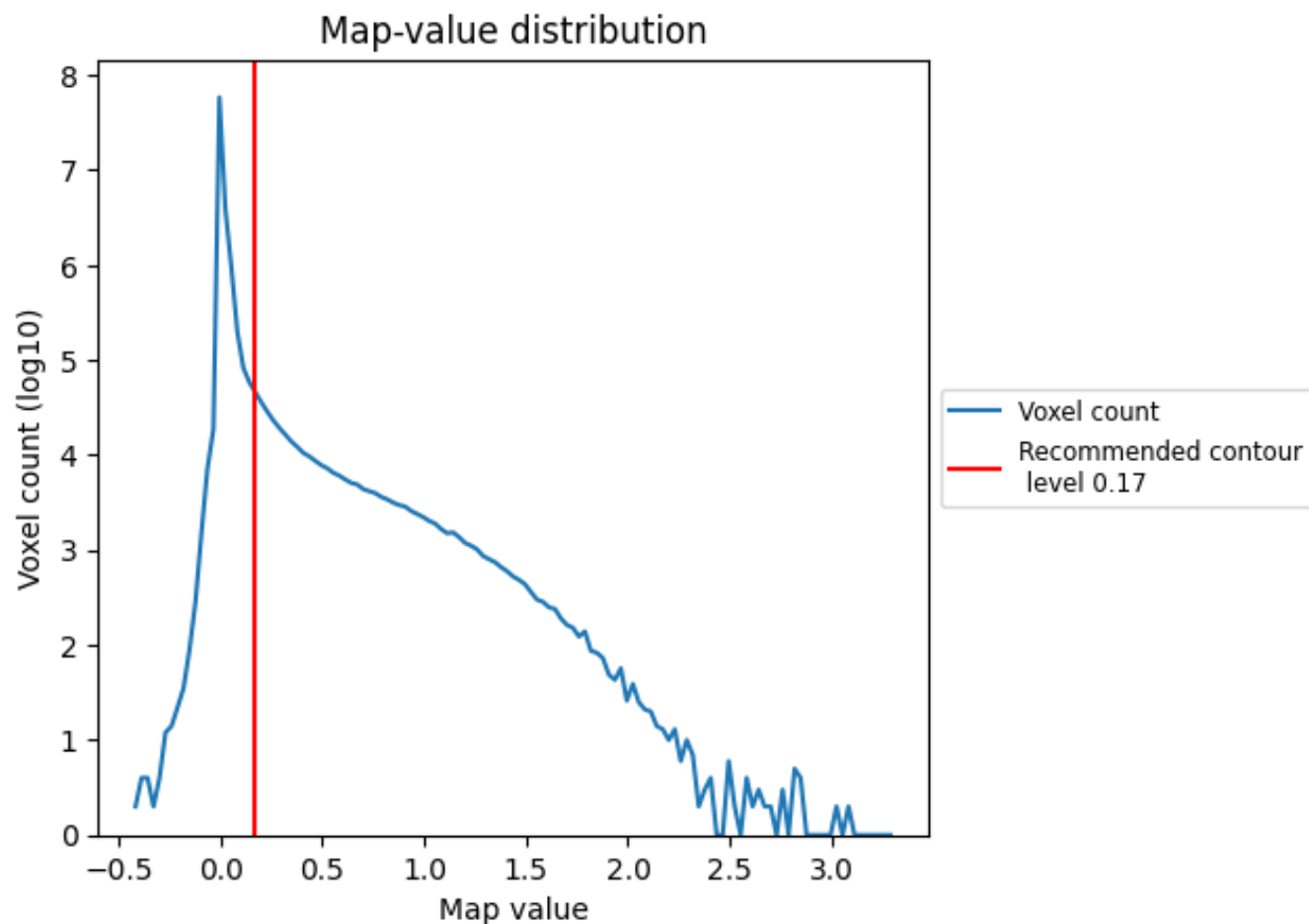
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

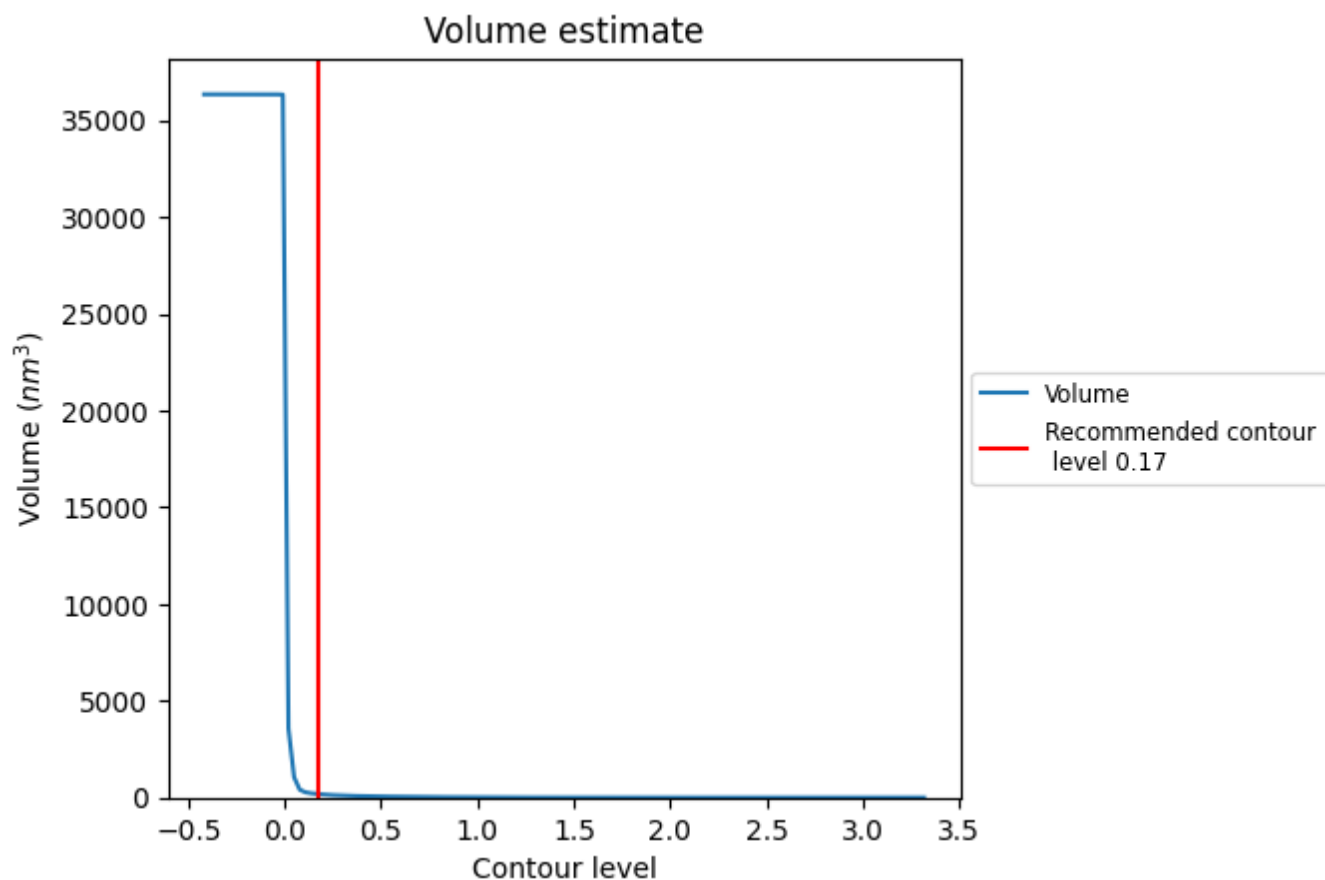
This section contains the results of statistical analysis of the map.

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.

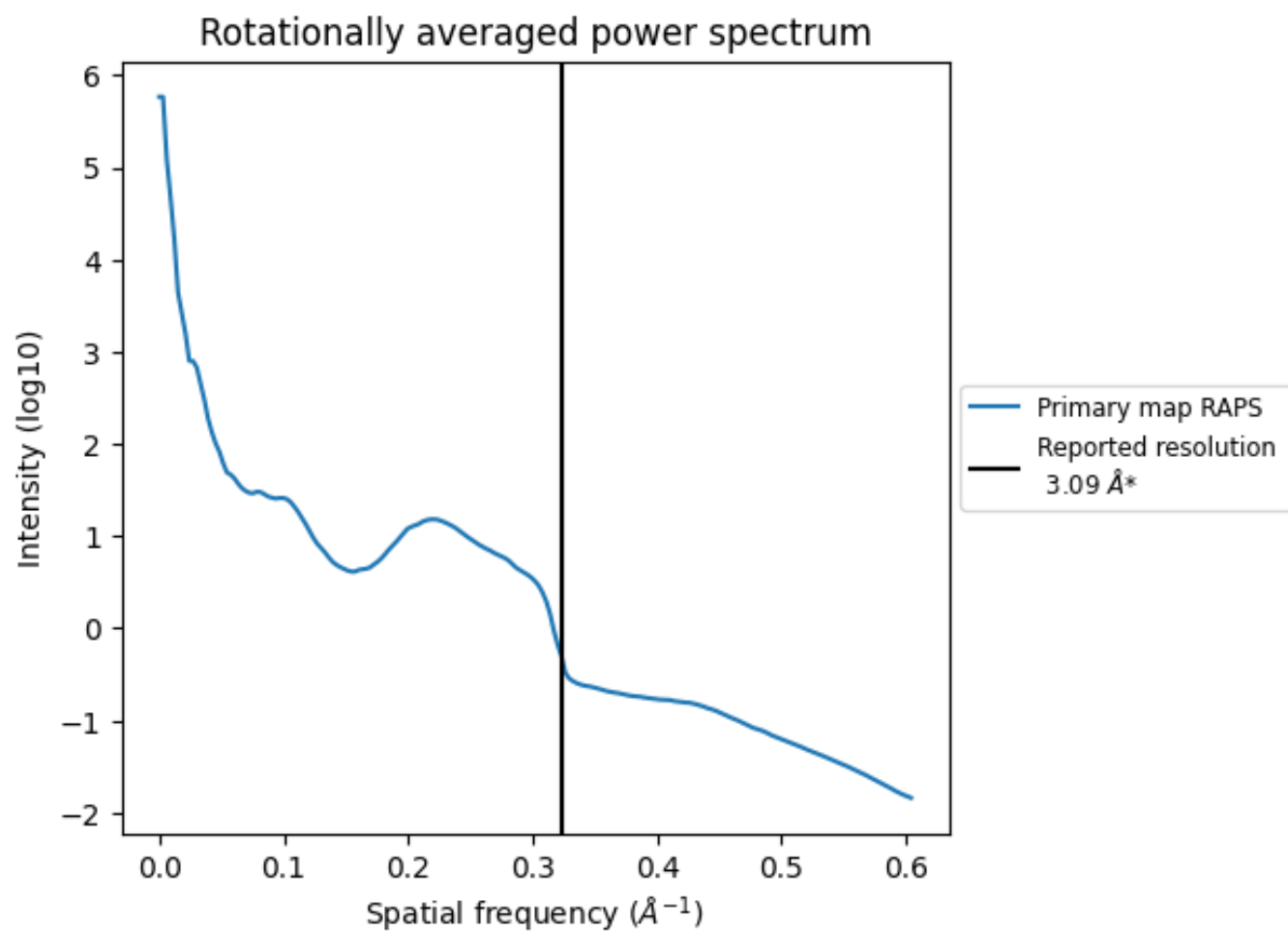
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 185 nm³; this corresponds to an approximate mass of 168 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 ⓘ



*Reported resolution corresponds to spatial frequency of 0.324 Å⁻¹

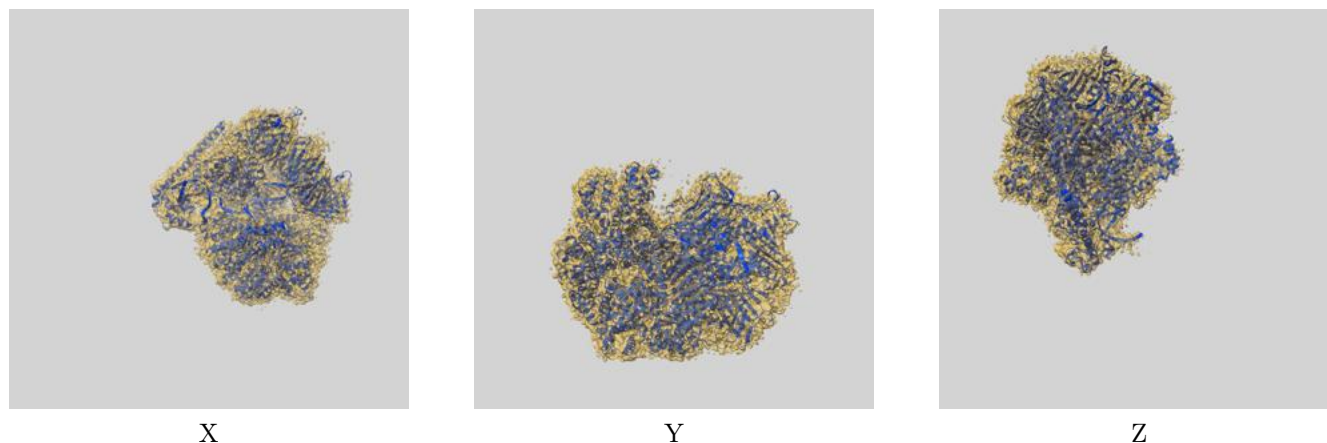
8 Fourier-Shell correlation

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

9 Map-model fit [i](#)

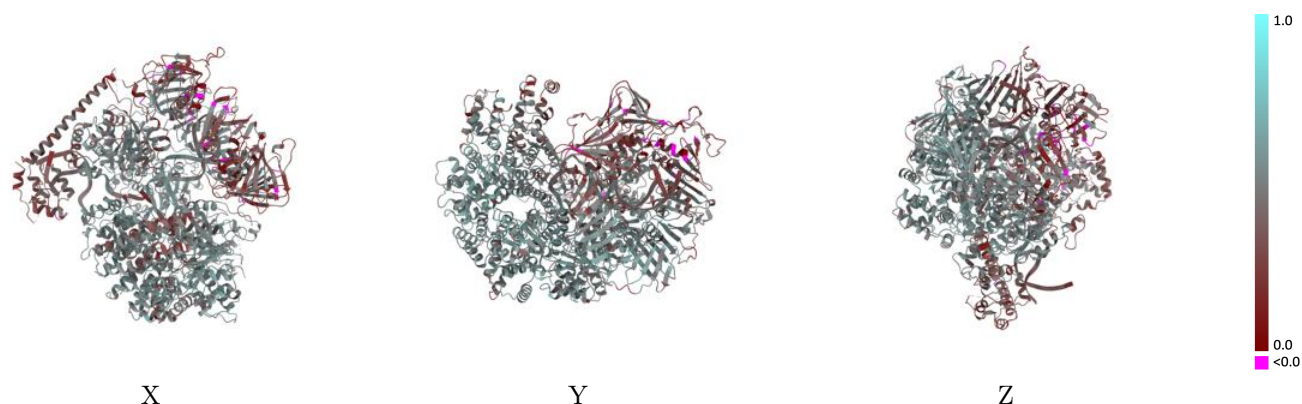
This section contains information regarding the fit between EMDB map EMD-25872 and PDB model 7TFH. Per-residue inclusion information can be found in [section 3](#) on [page 8](#).

9.1 Map-model overlay [i](#)



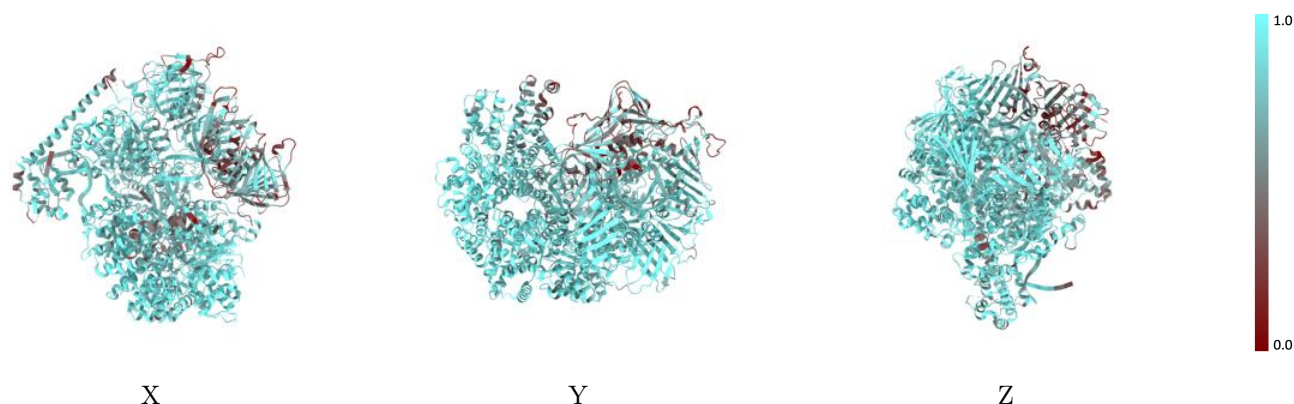
The images above show the 3D surface view of the map at the recommended contour level 0.17 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

9.2 Q-score mapped to coordinate model [i](#)



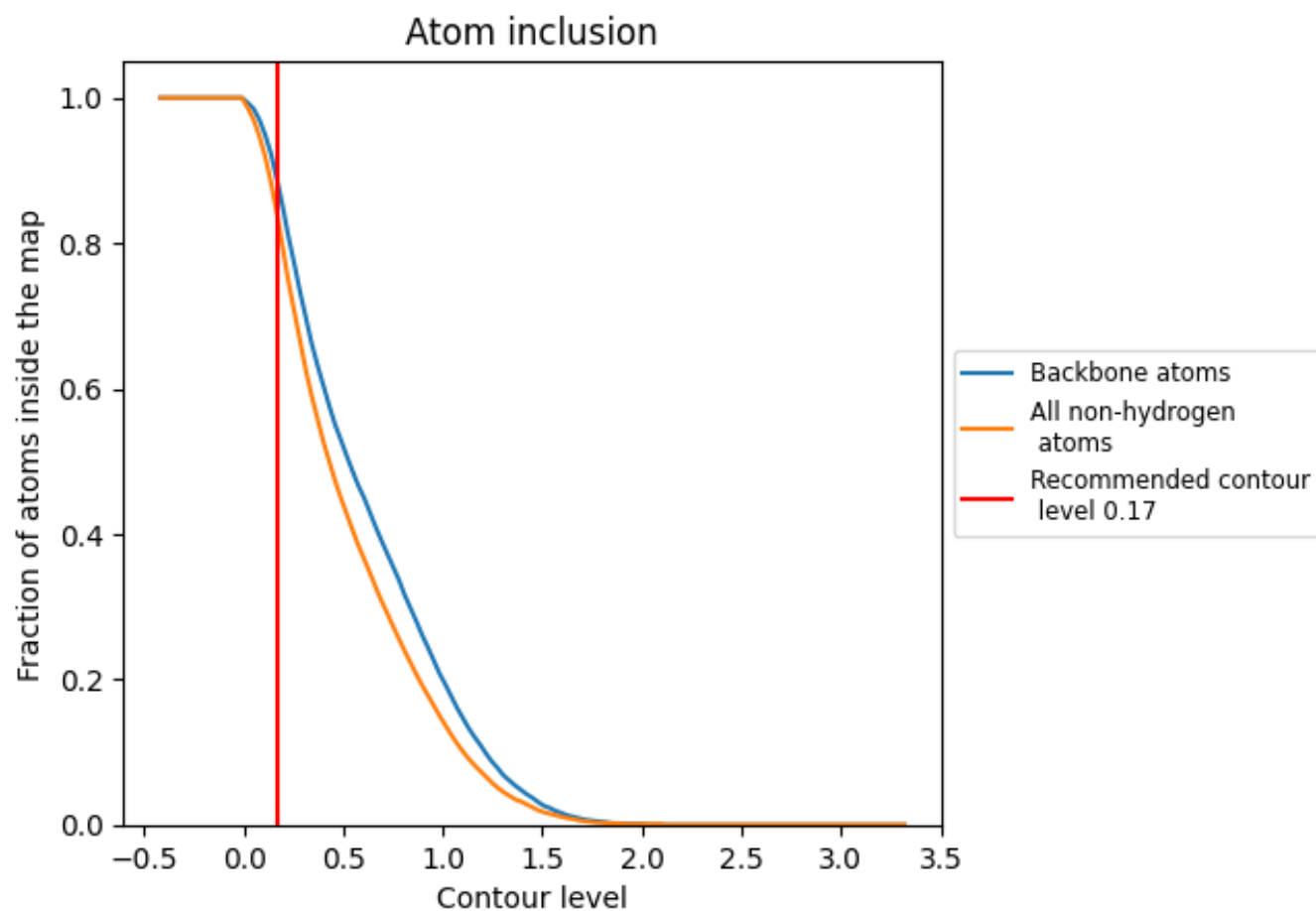
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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](#)



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 (0.17).



























9.4 Atom inclusion [i](#)



At the recommended contour level, 88% of all backbone atoms, 84% of all non-hydrogen atoms, are inside the map.

9.5 Map-model fit summary

The table lists the average atom inclusion at the recommended contour level (0.17) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	 0.8360	 0.4690
A	 0.8200	 0.4370
B	 0.9220	 0.5300
C	 0.9260	 0.5440
D	 0.9420	 0.5560
E	 0.8990	 0.5080
F	 0.4590	 0.2940
G	 0.8810	 0.4990
H	 0.7630	 0.3650
I	 0.8530	 0.4760
J	 0.8470	 0.4410
K	 0.7780	 0.4190
L	 0.7710	 0.4410

