wwPDB EM Validation Summary Report

May 31, 2022 – 01:40 pm BST

PDB ID	:	7Q1U
EMDB ID	:	EMD-13764
Title	:	Structure of Hedgehog acyltransferase (HHAT) in complex with megabody 177 bound to non-hydrolysable palmitoyl-CoA (Composite Map)
Authors	:	Coupland, C.; Carrique, L.; Siebold, C.
Deposited on	:	2021-10-21
Resolution	:	2.70 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 following versions of software and data (see references ⓘ) were used in the production of this report:

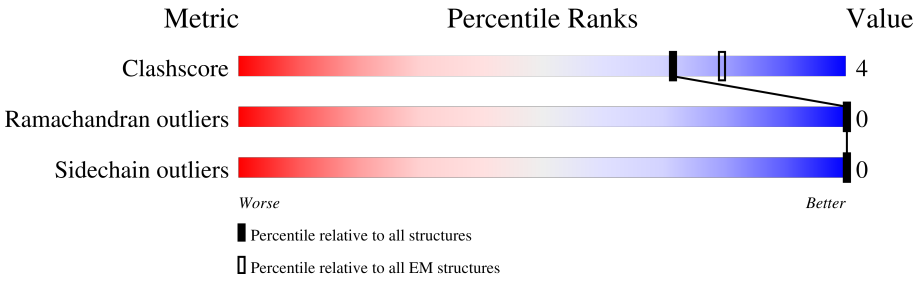
EMDB validation analysis	:	0.0.1.dev8
Mogul	:	1.8.4, CSD as541be (2020)
MolProbity	:	4.02b-467
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.28.1

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 2.70 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 >=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	A	503	23% 88% 8% .
2	B	919	22% 86% 9% 5%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
5	HD6	A	603	X	-	-	-

2 Entry composition (i)

There are 7 unique types of molecules in this entry. The entry contains 21944 atoms, of which 10829 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 Protein-cysteine N-palmitoyltransferase HHAT.

Mol	Chain	Residues	Atoms						AltConf	Trace
1	A	485	Total	C	H	N	O	S	0	0
			7979	2670	3972	638	668	31		

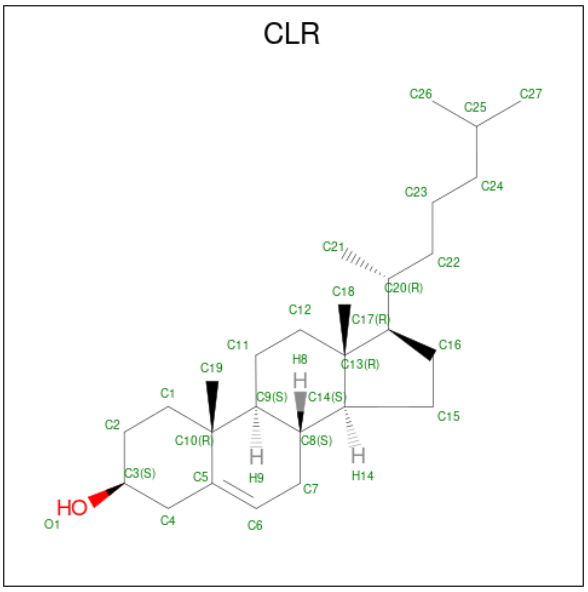
There are 11 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	182	ASN	SER	variant	UNP Q5VTY9
A	494	GLY	-	expression tag	UNP Q5VTY9
A	495	THR	-	expression tag	UNP Q5VTY9
A	496	GLU	-	expression tag	UNP Q5VTY9
A	497	THR	-	expression tag	UNP Q5VTY9
A	498	SER	-	expression tag	UNP Q5VTY9
A	499	GLN	-	expression tag	UNP Q5VTY9
A	500	VAL	-	expression tag	UNP Q5VTY9
A	501	ALA	-	expression tag	UNP Q5VTY9
A	502	PRO	-	expression tag	UNP Q5VTY9
A	503	ALA	-	expression tag	UNP Q5VTY9

- Molecule 2 is a protein called Megabody 177.

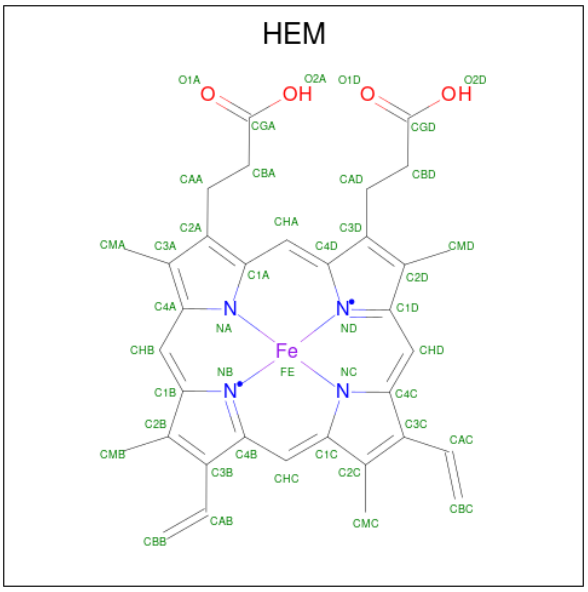
Mol	Chain	Residues	Atoms						AltConf	Trace
2	B	872	Total	C	H	N	O	S	0	0
			13621	4398	6685	1200	1317	21		

- Molecule 3 is CHOLESTEROL (three-letter code: CLR) (formula: $C_{27}H_{46}O$).



Mol	Chain	Residues	Atoms				AltConf
			Total	C	H	O	
3	A	1	74	27	46	1	0

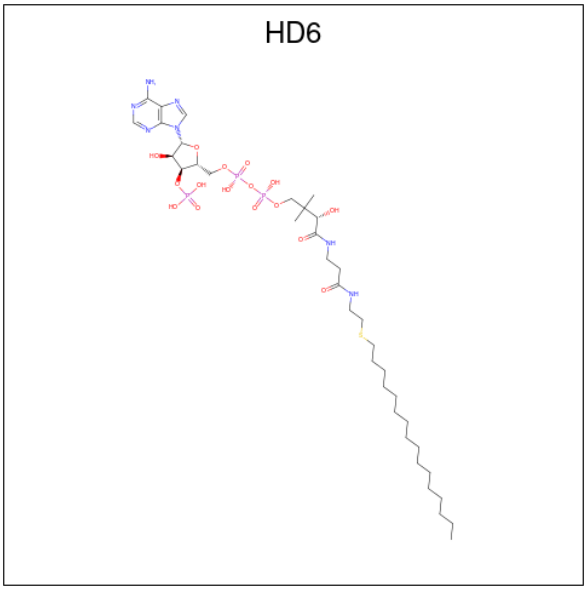
- Molecule 4 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: $C_{34}H_{32}FeN_4O_4$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					AltConf
			Total	C	Fe	N	O	
4	A	1	43	34	1	4	4	0

- Molecule 5 is [[(2 {R},3 {S},4 {R},5 {R})-5-(6-aminopurin-9-yl)-4-oxidanyl-3-phosphonooxy-oxolan-2-yl]methoxy-oxidanyl-phosphoryl] [(3 {S})-4-[[3-(2-hexadecylsulfanyle

thylamino)-3-oxidanylidene-propyl]amino]-2,2-dimethyl-3-oxidanyl-4-oxidanylidene-butyl] hydrogen phosphate (three-letter code: HD6) (formula: $C_{37}H_{68}N_7O_{16}P_3S$) (labeled as "Ligand of Interest" by depositor).

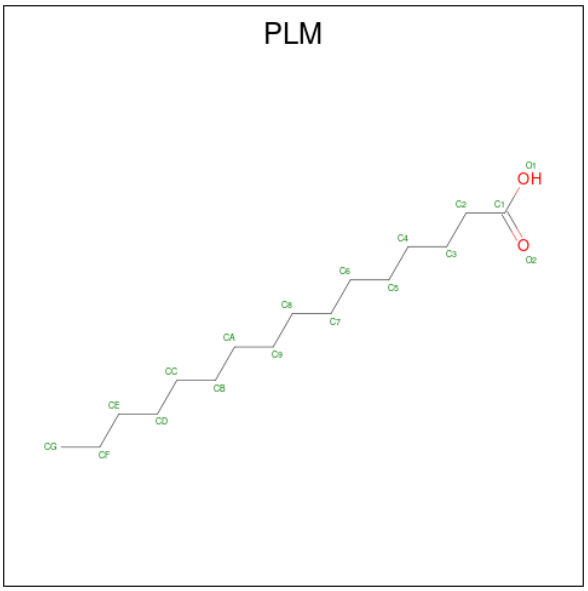


Mol	Chain	Residues	Atoms							AltConf
5	A	1	Total	C	H	N	O	P	S	0
			128	37	64	7	16	3	1	

- Molecule 6 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		AltConf
6	A	1	Total	Mg	0
			1	1	

- Molecule 7 is PALMITIC ACID (three-letter code: PLM) (formula: $C_{16}H_{32}O_2$).



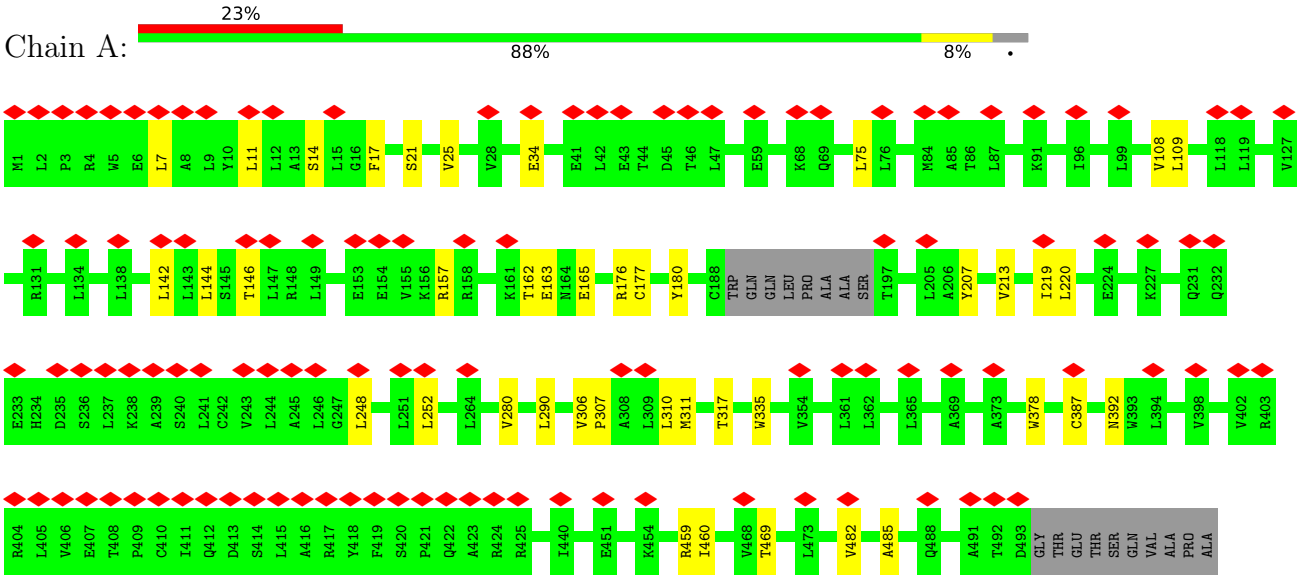
Mol	Chain	Residues	Atoms				AltConf
7	A	1	Total	C	H	O	0
			98	32	62	4	
7	A	1	Total	C	H	O	0
			98	32	62	4	

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.

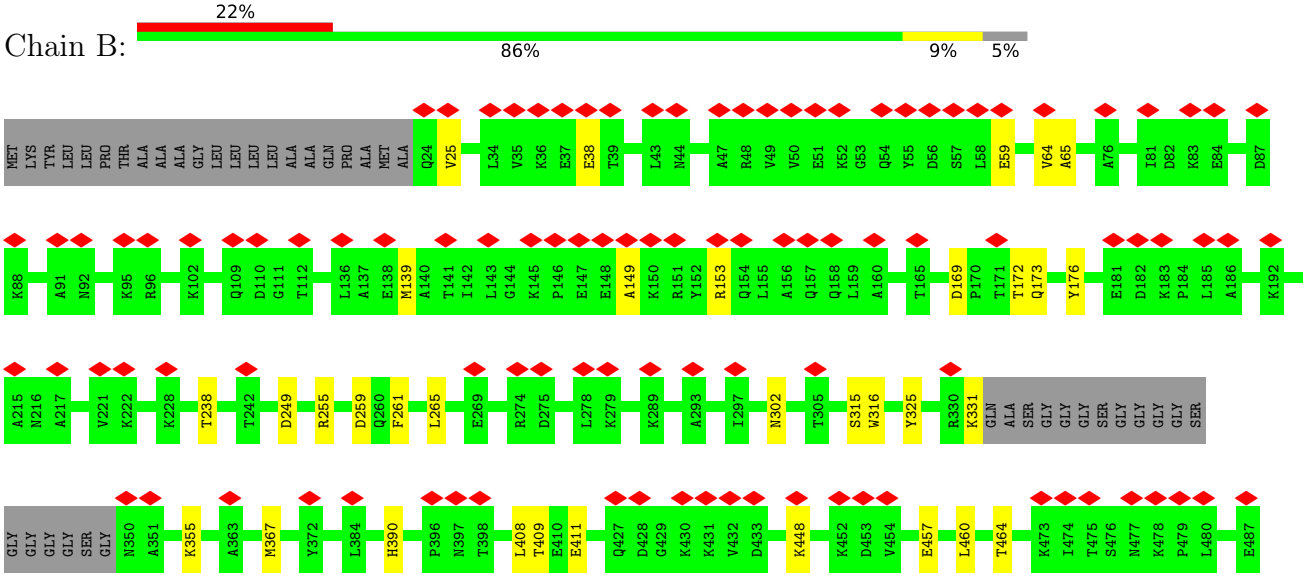
• Molecule 1: Protein-cysteine N-palmitoyltransferase HHAT

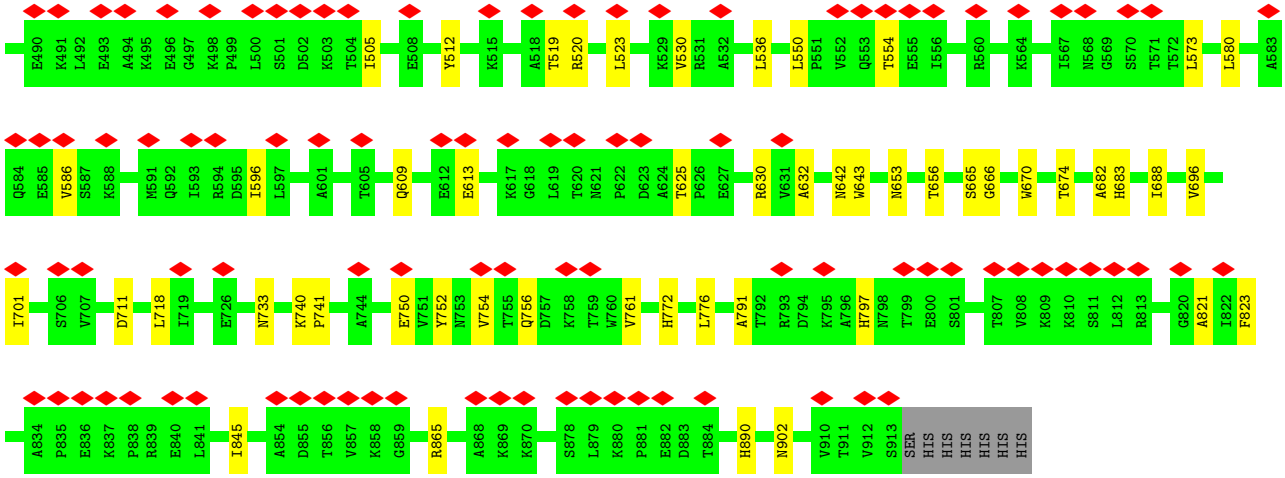
Chain A:



• Molecule 2: Megabody 177

Chain B:




E490 K491 L492 E493 A494 K495 E496 G497 K498 P499 L500 S501 D502 K503 T504 I505 E508 Y512 K515 A518 T519 R520 L523 K529 V530 R531 A532 L536 L550 P551 V552 Q553 T554 E555 I556 R560 K564 I567 N568 G569 S570 T571 T572 L573 L580 A583
Q584 E585 V586 S587 K588 M591 Q592 I593 R594 D595 I596 L597 A601 T605 Q609 E612 E613 K617 G618 L619 T620 N621 P622 D623 A624 T625 P626 E627 R630 V631 A632 N642 W643 N653 T656 S665 G666 W670 T674 A682 H683 I688 V696
I701 S706 V707 D711 L718 I719 E726 N733 K740 P741 A744 E750 V751 Y752 N753 V754 T755 Q756 D757 K758 T759 W760 V761 H772 L776 A791 T792 R793 D794 K795 A796 H797 N798 T799 E800 S801 T807 V808 K809 K810 S811 L812 R813 G820 A821 I822 F823
A834 P835 E836 K837 P838 R839 E840 L841 I845 A854 D855 T856 V857 K858 G859 R865 A868 K869 K870 S878 L879 K880 P881 E882 D883 T884 H890 N902 V910 T911 V912 S913 SER HIS HIS HIS HIS HIS HIS

4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	238000	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 ($e^-/Å^2$)	54.8	Depositor
Minimum defocus (nm)	1000	Depositor
Maximum defocus (nm)	2500	Depositor
Magnification	Not provided	
Image detector	GATAN K3 BIOQUANTUM (6k x 4k)	Depositor
Maximum map value	61.287	Depositor
Minimum map value	-31.064	Depositor
Average map value	0.000	Depositor
Map value standard deviation	1.000	Depositor
Recommended contour level	10.8	Depositor
Map size (Å)	331.59, 331.59, 331.59	wwPDB
Map dimensions	300, 300, 300	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.1053, 1.1053, 1.1053	Depositor

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: HEM, HD6, MG, P1L, PLM, CLR

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	0.28	0/4119	0.44	0/5615
2	B	0.28	0/7119	0.48	0/9674
All	All	0.28	0/11238	0.47	0/15289

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

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	4007	3972	3959	25	0
2	B	6936	6685	6670	49	0
3	A	28	46	46	1	0
4	A	43	0	30	2	0
5	A	64	64	0	0	0
6	A	1	0	0	0	0
7	A	36	62	62	0	0
All	All	11115	10829	10767	77	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 4.

The worst 5 of 77 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:B:409:THR:HG21	2:B:536:LEU:HD12	1.64	0.79
1:A:176:ARG:NH2	1:A:213:VAL:O	2.24	0.71
2:B:580:LEU:HD13	2:B:586:VAL:HA	1.76	0.65
2:B:355:LYS:O	2:B:630:ARG:NH2	2.30	0.64
1:A:317:THR:O	1:A:317:THR:HG23	1.99	0.63

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	480/503 (95%)	466 (97%)	14 (3%)	0	100	100
2	B	868/919 (94%)	846 (98%)	22 (2%)	0	100	100
All	All	1348/1422 (95%)	1312 (97%)	36 (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	422/435 (97%)	422 (100%)	0	100	100

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	B	726/752 (96%)	726 (100%)	0	100	100
All	All	1148/1187 (97%)	1148 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	781	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)

1 non-standard protein/DNA/RNA residue is modelled in this entry.

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	$\#\|Z\| > 2$
1	P1L	A	387	1	21,22,23	0.70	0	18,23,25	1.45	3 (16%)

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
1	P1L	A	387	1	-	4/20/22/24	-

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	387	P1L	C8-C7-SG	-4.14	108.64	113.46
1	A	387	P1L	CB-SG-C7	2.97	104.99	100.84
1	A	387	P1L	O7-C7-SG	2.63	126.03	122.61

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	A	387	P1L	C9-C10-C11-C12
1	A	387	P1L	CA-CB-SG-C7
1	A	387	P1L	C13-C14-C15-C16
1	A	387	P1L	O7-C7-SG-CB

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 6 ligands modelled in this entry, 1 is 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	$\#\|Z\| > 2$
3	CLR	A	601	-	31,31,31	0.11	0	48,48,48	0.20	0
4	HEM	A	602	1	27,50,50	1.22	3 (11%)	17,82,82	1.14	2 (11%)
7	PLM	A	606	-	14,17,17	0.41	0	13,17,17	0.10	0
7	PLM	A	605	-	14,17,17	0.32	0	13,17,17	0.14	0
5	HD6	A	603	6	58,66,66	2.30	14 (24%)	69,91,91	1.52	10 (14%)

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
3	CLR	A	601	-	-	2/10/68/68	0/4/4/4
4	HEM	A	602	1	-	0/6/54/54	-
7	PLM	A	606	-	-	1/13/15/15	-
7	PLM	A	605	-	-	6/13/15/15	-
5	HD6	A	603	6	1/1/13/13	19/60/80/80	0/3/3/3

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	A	603	HD6	CBV-NBU	7.29	1.50	1.33
5	A	603	HD6	CBZ-NBY	7.20	1.49	1.33
5	A	603	HD6	OCK-CCL	6.67	1.50	1.41
5	A	603	HD6	C4-N3	-3.80	1.30	1.35
5	A	603	HD6	CAP-CCL	-3.73	1.48	1.53

The worst 5 of 12 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	A	603	HD6	C4-C5-N7	-5.05	104.14	109.40
5	A	603	HD6	CCL-N9-C4	-4.10	119.44	126.64
5	A	603	HD6	N3-C2-N1	-3.58	123.08	128.68
5	A	603	HD6	PCG-OCF-PCE	-2.60	123.92	132.83
5	A	603	HD6	CAQ-CAP-CCL	2.47	105.36	99.89

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
5	A	603	HD6	CCA

5 of 28 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	603	HD6	CCI-OCH-PCG-OAR
7	A	605	PLM	C1-C2-C3-C4
5	A	603	HD6	OCH-CCI-CCJ-OCK
3	A	601	CLR	C17-C20-C22-C23
3	A	601	CLR	C21-C20-C22-C23

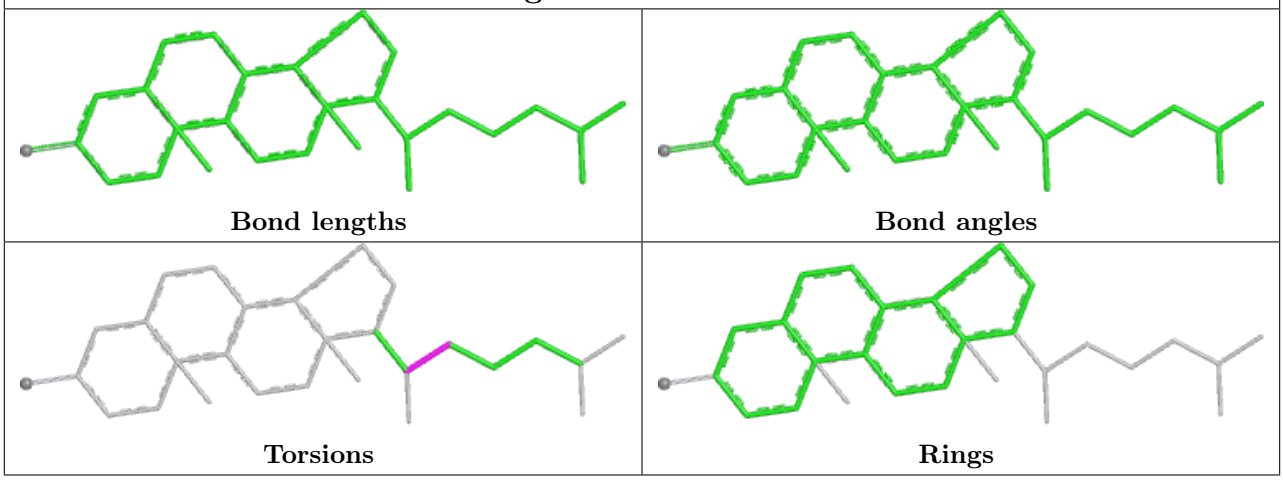
There are no ring outliers.

2 monomers are involved in 3 short contacts:

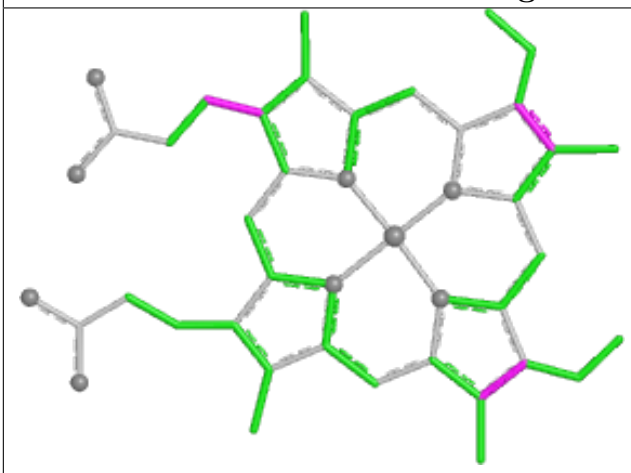
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	601	CLR	1	0
4	A	602	HEM	2	0

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 then 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.

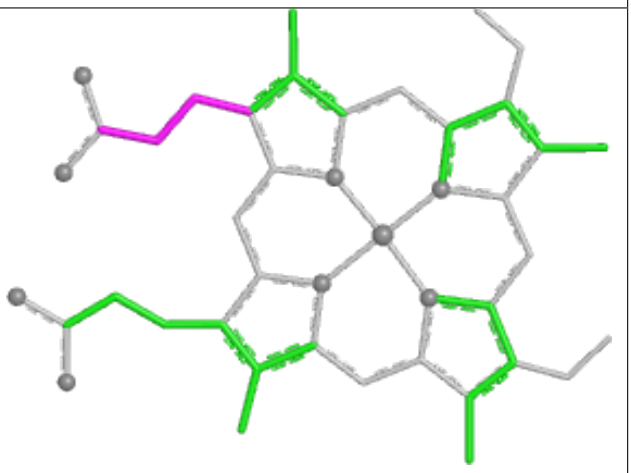
Ligand CLR A 601



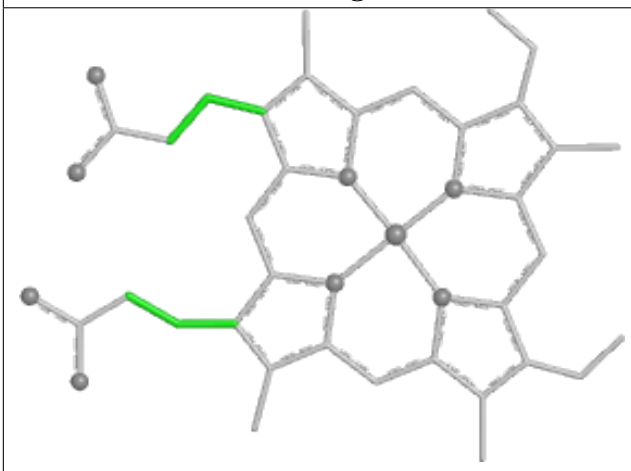
Ligand HEM A 602



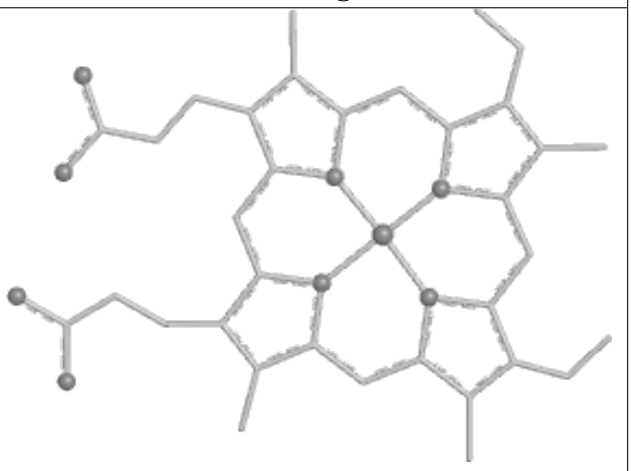
Bond lengths



Bond angles

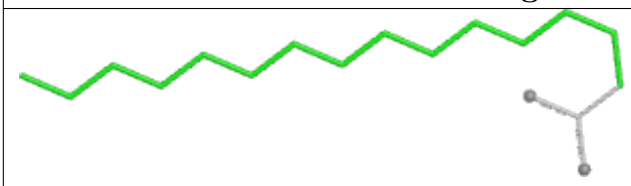


Torsions

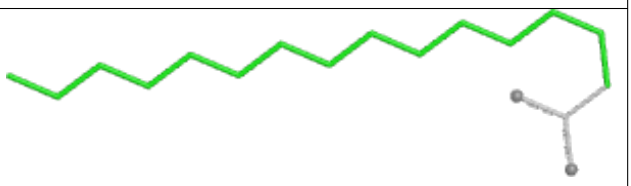


Rings

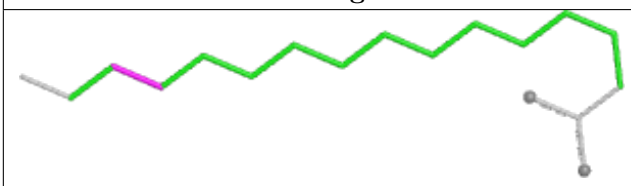
Ligand PLM A 606



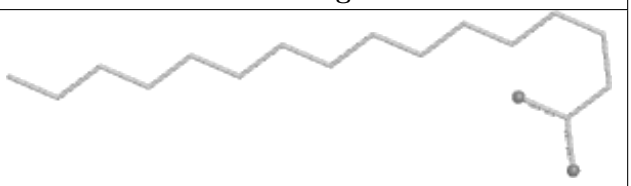
Bond lengths



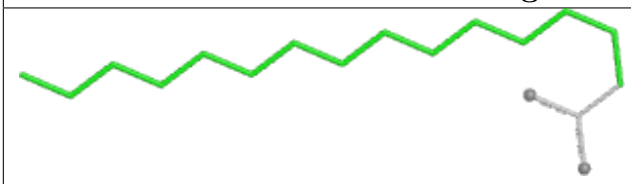
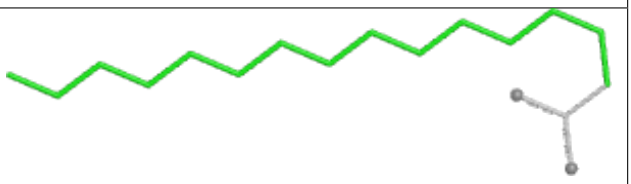
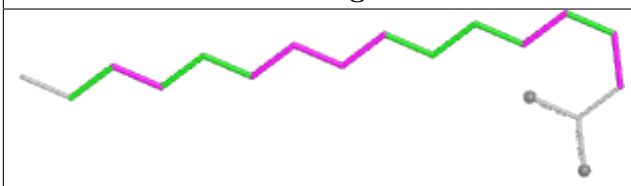
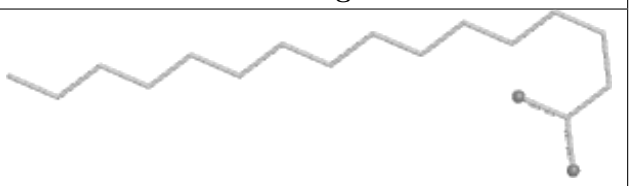
Bond angles

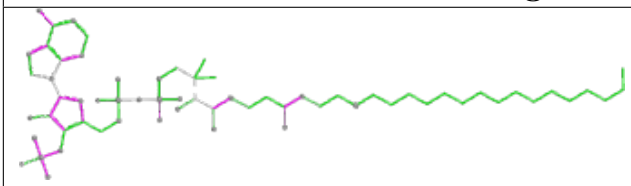
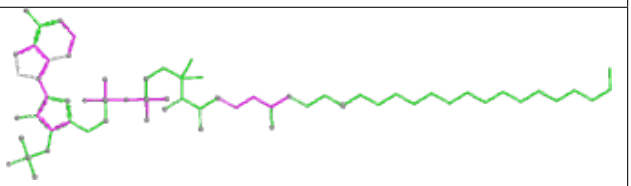
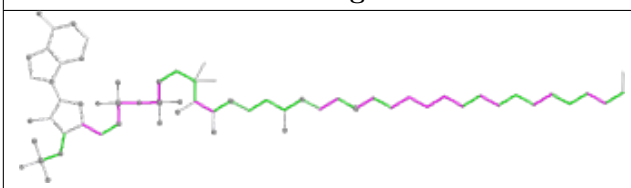
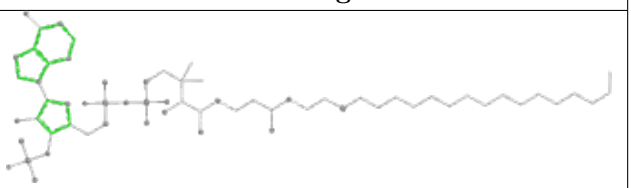


Torsions



Rings

Ligand PLM A 605	
 Bond lengths	 Bond angles
 Torsions	 Rings

Ligand HD6 A 603	
 Bond lengths	 Bond angles
 Torsions	 Rings

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.

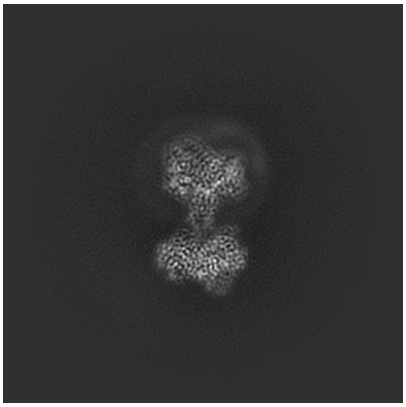
6 Map visualisation

This section contains visualisations of the EMDB entry EMD-13764. These allow visual inspection of the internal detail of the map and identification of artifacts.

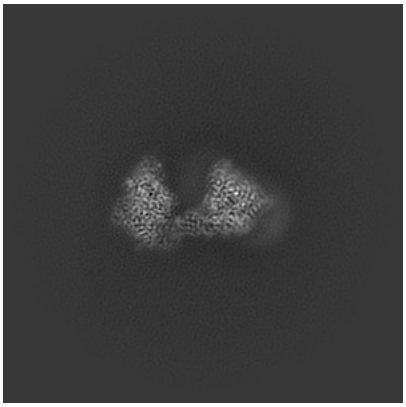
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections

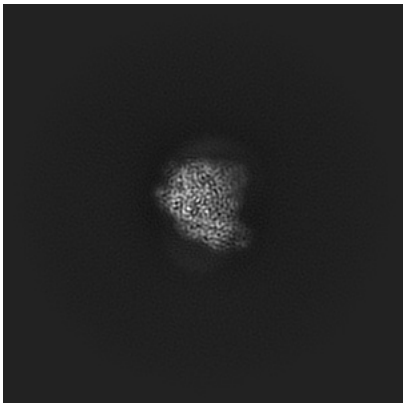
6.1.1 Primary map



X



Y

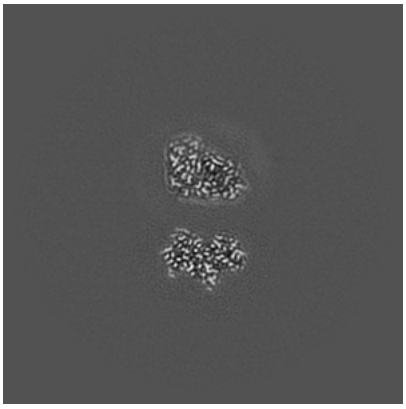


Z

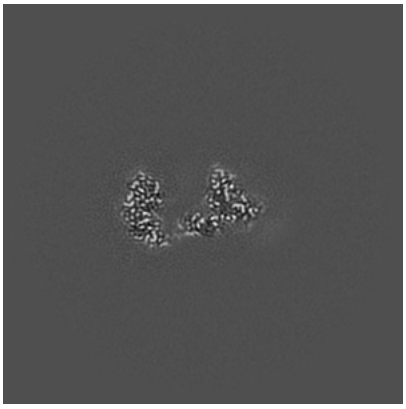
The images above show the map projected in three orthogonal directions.

6.2 Central slices

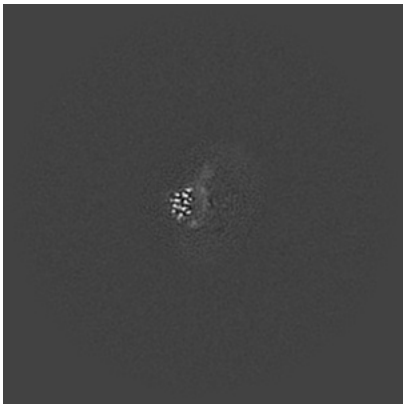
6.2.1 Primary map



X Index: 150



Y Index: 150

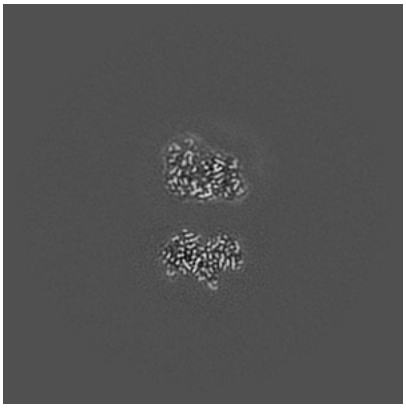


Z Index: 150

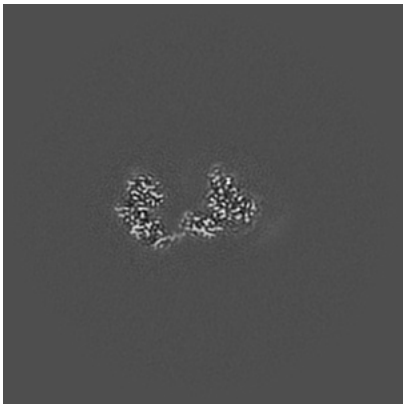
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices (i)

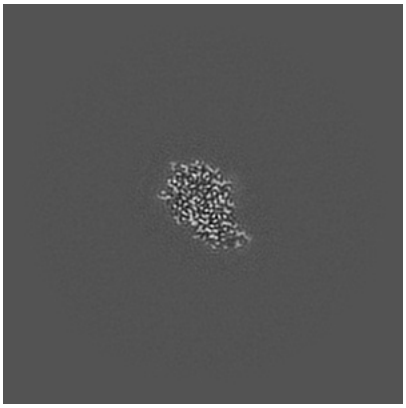
6.3.1 Primary map



X Index: 153



Y Index: 152



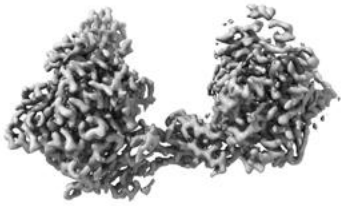
Z Index: 105

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

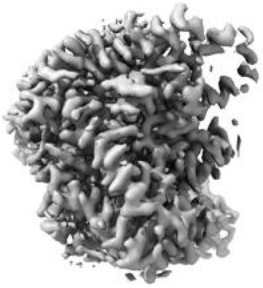
6.4 Orthogonal surface views (i)

6.4.1 Primary map

X



Y



Z

The images above show the 3D surface view of the map at the recommended contour level 10.8. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

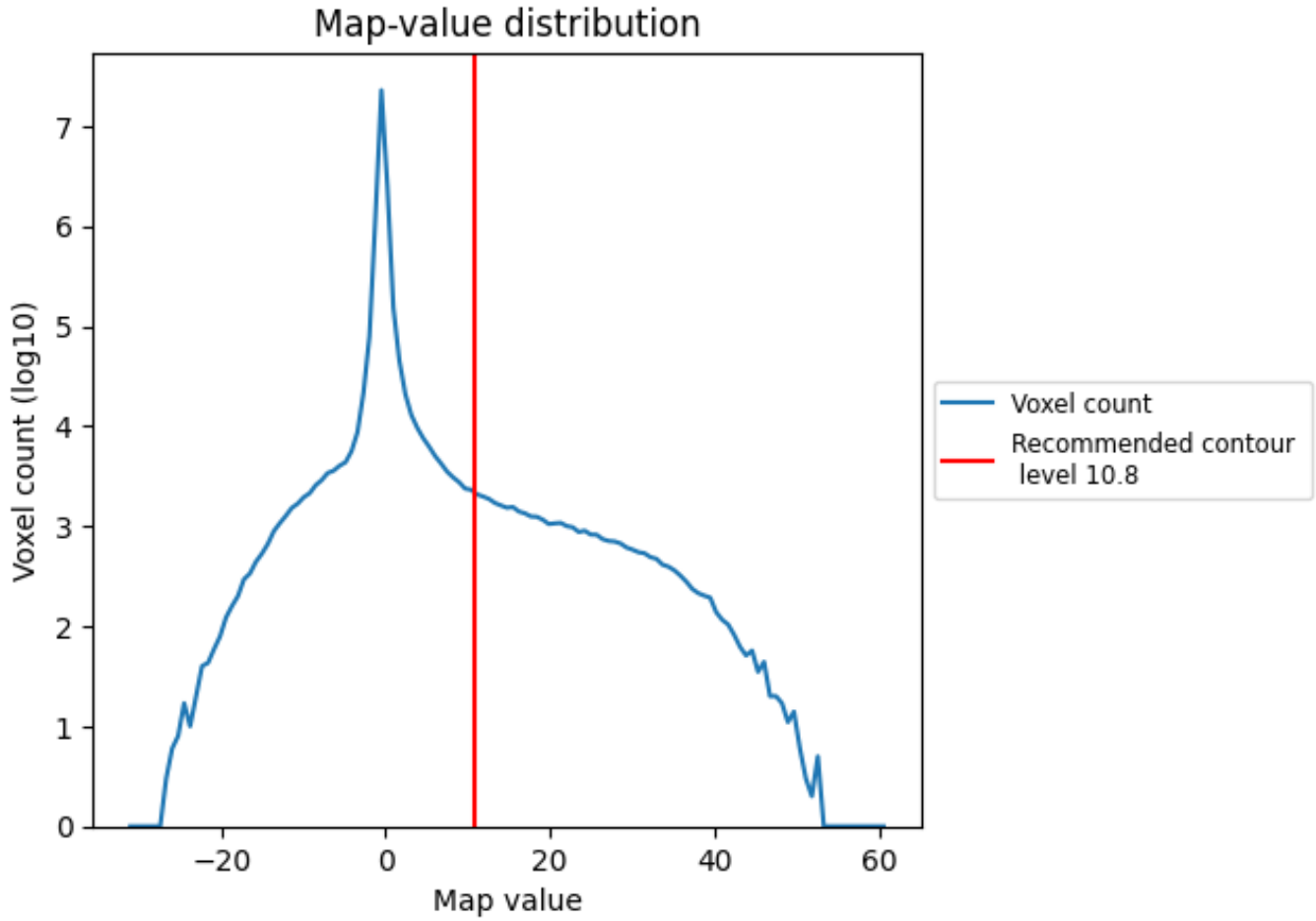
6.5 Mask visualisation (i)

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

7 Map analysis

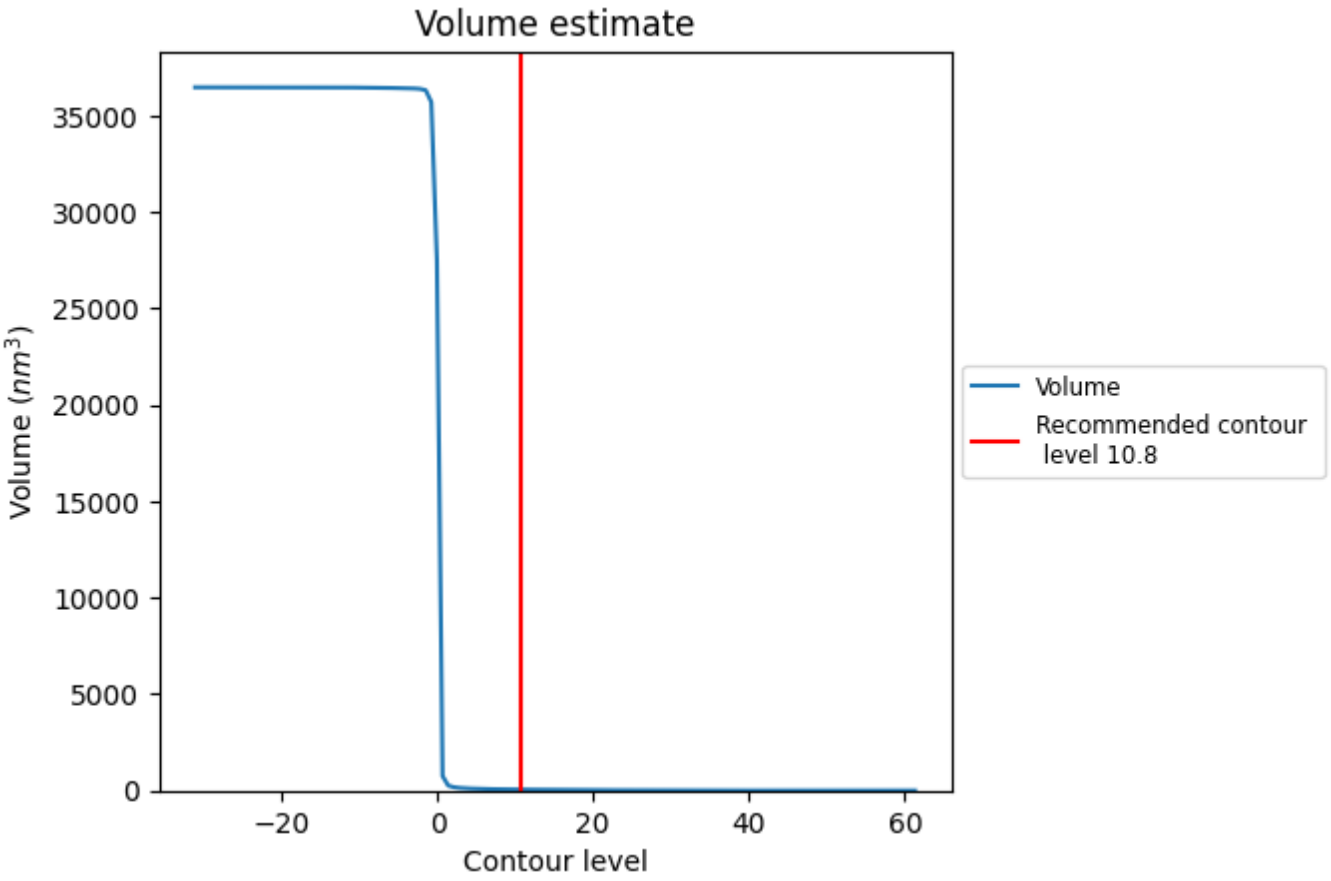
This section contains the results of statistical analysis of the map.

7.1 Map-value distribution



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.

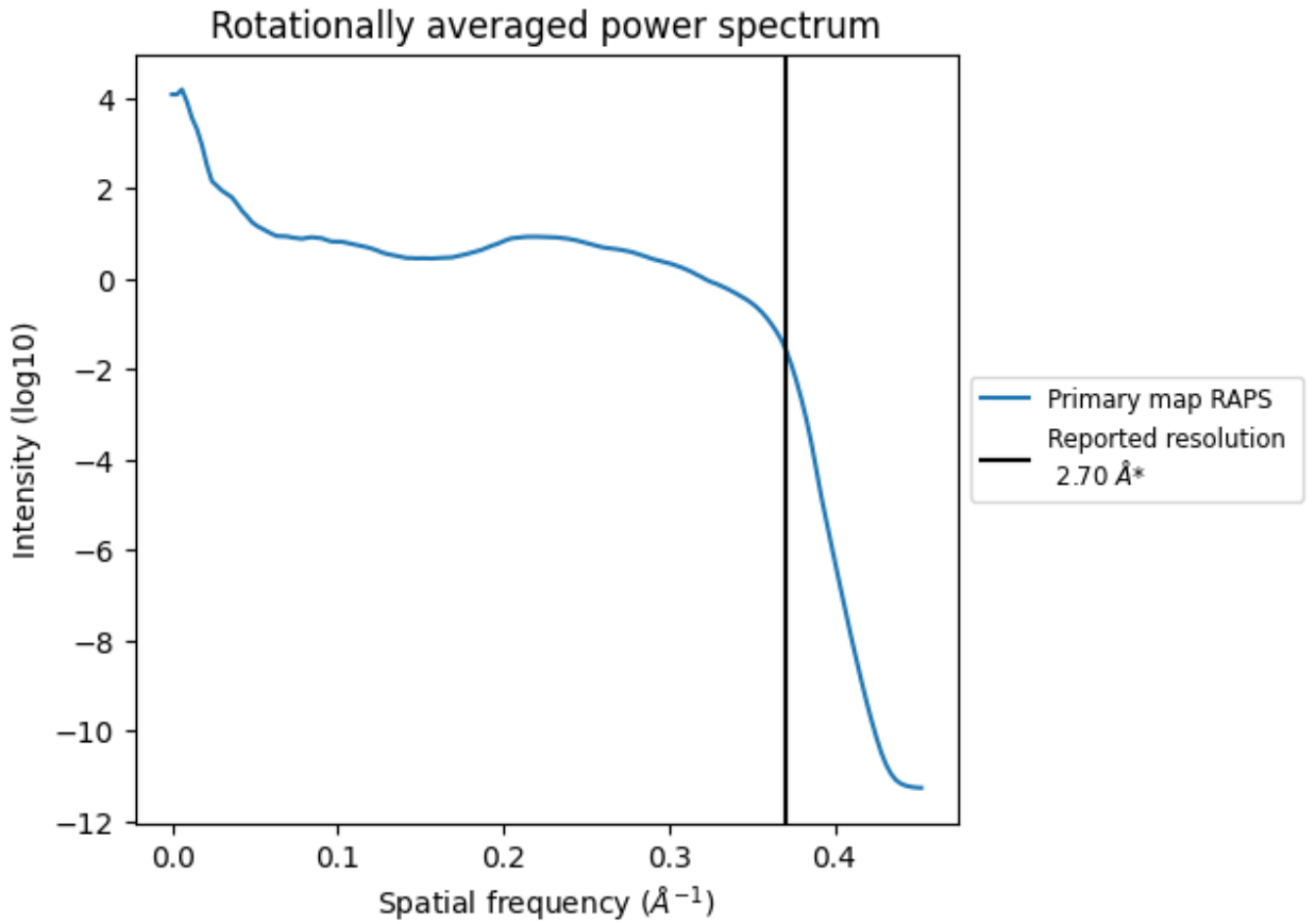
7.2 Volume estimate (i)



The volume at the recommended contour level is 51 nm^3; this corresponds to an approximate mass of 46 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 0.370 $Å^{-1}$

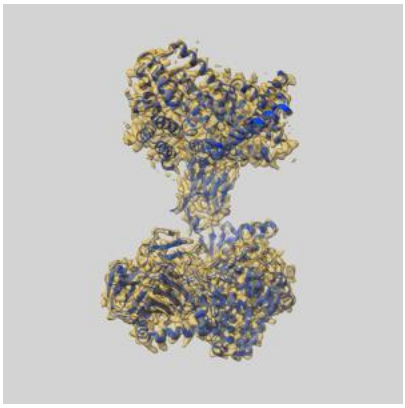
8 Fourier-Shell correlation

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

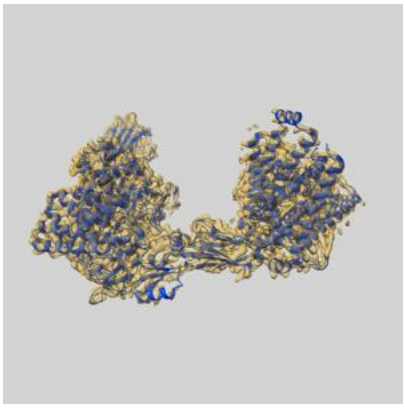
9 Map-model fit

This section contains information regarding the fit between EMDB map EMD-13764 and PDB model 7Q1U. Per-residue inclusion information can be found in section 3 on page 7.

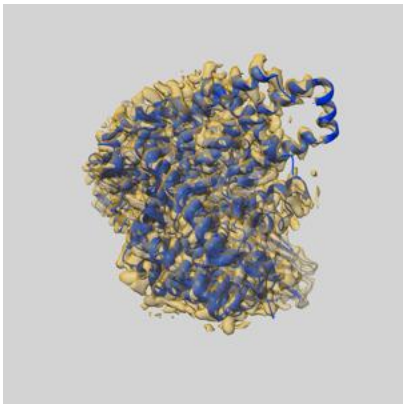
9.1 Map-model overlay



X



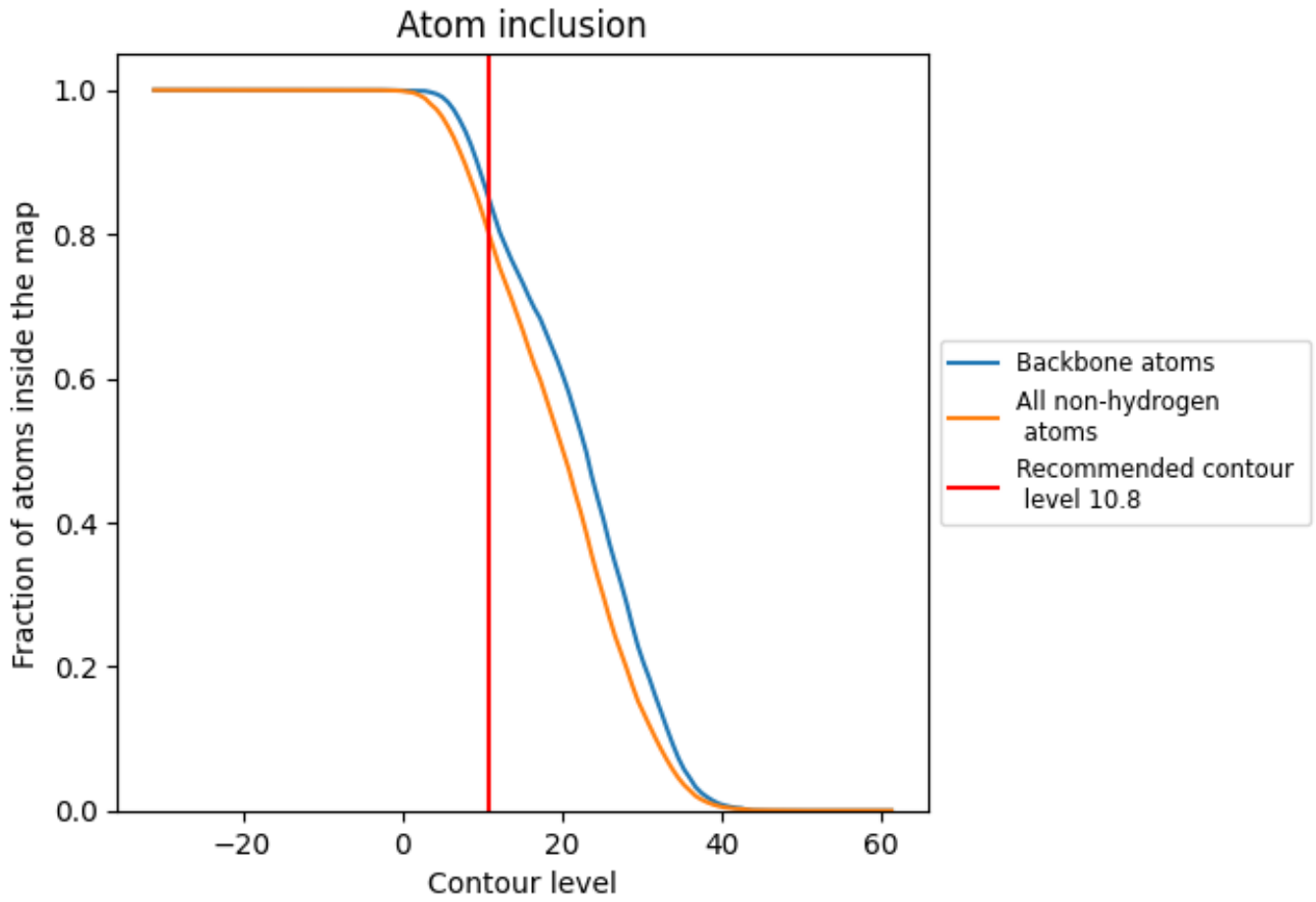
Y



Z

The images above show the 3D surface view of the map at the recommended contour level 10.8 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, 85% of all backbone atoms, 80% of all non-hydrogen atoms, are inside the map.