



## wwPDB EM Validation Summary Report ⓘ

Jul 14, 2025 – 04:13 pm BST

PDB ID : 9QAY / pdb\_00009qay  
EMDB ID : EMD-52979  
Title : Catalytic core 1 of dimeric human telomerase  
Authors : Balch, S.; Sekne, Z.; Franco-Echevarria, E.; Ludzia, P.; Kretsch, R.C.; Sun, W.; Yu, H.; Ghanim, G.E.; Sigurdur, T.R.; Ding, Y.; Das, R.; Nguyen, T.H.D.  
Deposited on : 2025-02-28  
Resolution : 3.80 Å(reported)  
Based on initial model : 7QXA

This is a wwPDB EM Validation Summary 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.

The types of validation reports are described at

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

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

EMDB validation analysis : 0.0.1.dev118  
MolProbity : 4-5-2 with Phenix2.0rc1  
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) : 2.44

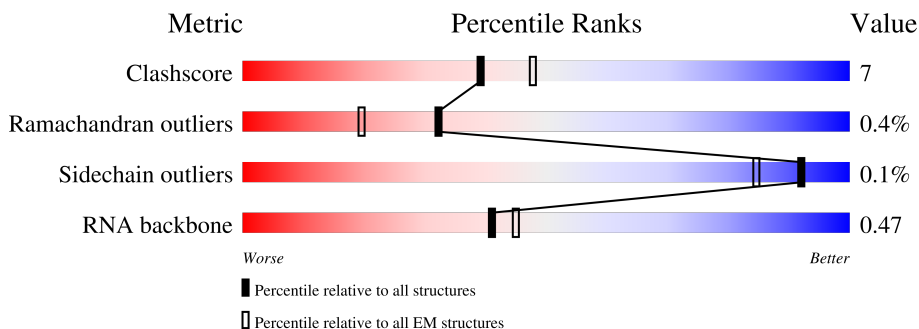
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 3.80 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
RNA backbone	6643	2191

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	1132	
2	B	451	
3	L	130	
4	M	166	
5	N	7	
6	O	458	

## 2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 15471 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 Telomerase reverse transcriptase.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	954	Total	C	N	O	S	0	0
			7649	4906	1424	1283	36		

- Molecule 2 is a RNA chain called hTR, human telomerase RNA (253-mer).

Mol	Chain	Residues	Atoms					AltConf	Trace
2	B	253	Total	C	N	O	P	0	0
			5371	2393	939	1786	253		

- Molecule 3 is a protein called Histone H2A.

Mol	Chain	Residues	Atoms				AltConf	Trace
3	L	81	Total	C	N	O	0	0
			632	397	124	111		

- Molecule 4 is a protein called Histone H2B.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	M	90	Total	C	N	O	S	0	0
			699	440	123	134	2		

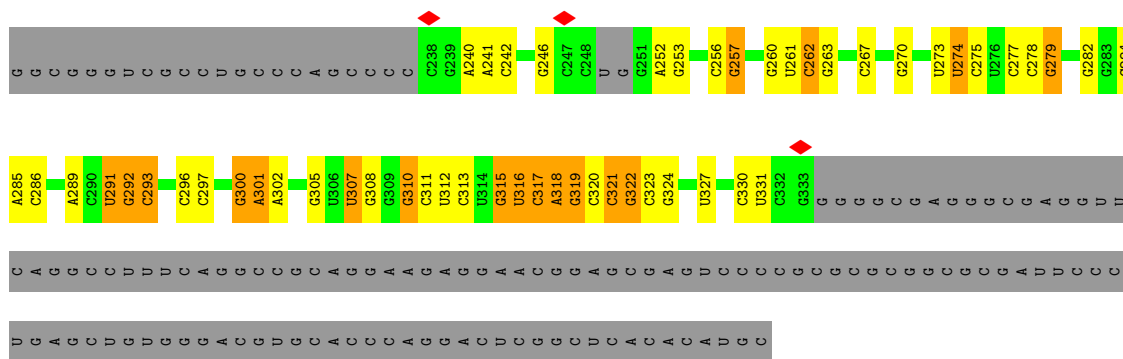
- Molecule 5 is a DNA chain called DNA (5'-D(P\*GP\*TP\*TP\*AP\*GP\*GP\*G)-3').

Mol	Chain	Residues	Atoms					AltConf	Trace
5	N	7	Total	C	N	O	P	0	0
			149	70	29	43	7		

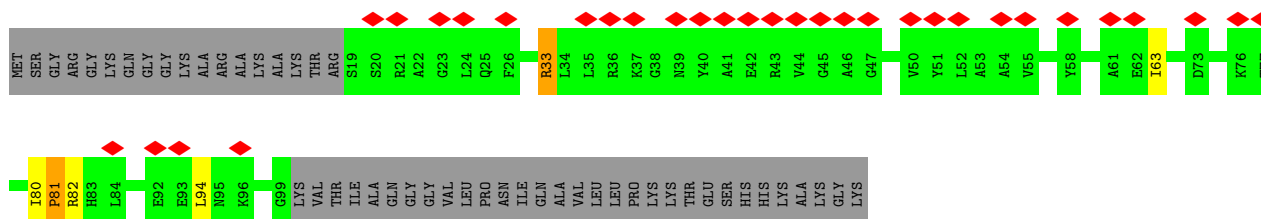
- Molecule 6 is a protein called Adrenocortical dysplasia protein homolog.

Mol	Chain	Residues	Atoms					AltConf	Trace
6	O	122	Total	C	N	O	S	0	0
			971	613	173	181	4		

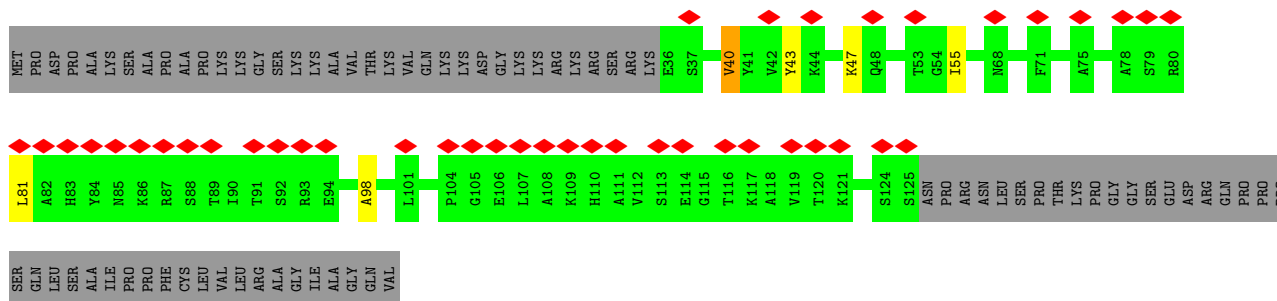




- Molecule 3: Histone H2A



- Molecule 4: Histone H2B

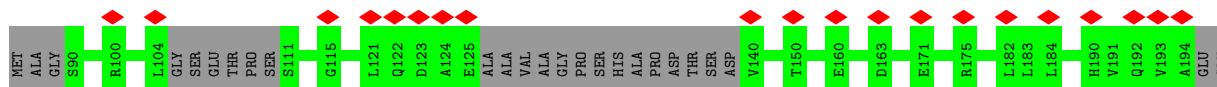


- Molecule 5: DNA (5'-D(P\*GP\*TP\*TP\*AP\*GP\*GP\*G)-3')



There are no outlier residues recorded for this chain.

- Molecule 6: Adrenocortical dysplasia protein homolog



GLY	ALA	PRO	ALA	GLU	F202	Q205	R218	L219	R220	V221	P222	N225	Q226	D227	L228	Q231	K232	Y235	D236	C237	L238	GLU	GLU	HIS	HIS	LEU	LEU	SER	GLU	SER	THR	SER	SER	ASN	ALA	GLY	LEU	SER	LEU	SER	GLN	LEU	LEU	ASP	GLU	MET	ARG	GLU	ASP	GLN	GLN	HIS	GLN	GLY	ALA	LEU
VAL	CYS	LEU	ALA	GLU	SER	CYS	LEU	THR	GLU	GLY	THR	ALA	PRO	PRO	VAL	THR	HIS	TRP	CYS	LYS	ALA	THR	GLY	GLU	ALA	VAL	TYR	THR	VAL	PRO	SER	SER	MET	LEU	CYS	ILE	SER	GLU	GLY	THR	ASN	ASP	GLN	LEU	ILE	LEU	SER	GLY	PRO	CYS	GLM	ARG				
THR	GLN	PRO	GLY	GLU	LEU	PRO	ASP	PRO	ALA	LEU	GLN	ASP	LEU	ALA	THR	LEU	ILE	ALA	PRO	SER	SER	SER	GLY	THR	PRO	ALA	LEU	PRO	GLY	HIS	MET	SER	SER	LEU	GLU	GLY	SER	THR	SER	ILE	SER	LEU	PRO	ALA	LEU	SER	LEU	ALA	PRO							
ASP	PRO	GLY	GLN	ARG	SER	SER	GLN	PRO	VAL	GLY	ILE	CYS	SER	ALA	THR	THR	ALA	HIS	ALA	SER	ARG	THR	PRO	PRO	SER	PRO	LEU	GLN	SER	CYS	THR	PRO	SER	SER	LEU	LEU	ARG	PRO	SER	PRO	THR	VAL	GLN	PRO	GLN	HIS	PRO	ASP	GLY	ARG	THR	PRO				
GLN	LYS	PRO	SER	VAL	GLN	PHE	GLU	PHE	VAL	GLY	PRO	LYS	ASN	ARG	PRO	PRO	THR	THR	ALA	ARG	PRO	THR	THR	THR	THR	VAL	VAL	TRP	GLN	SER	GLY	PRO	LYS	ARG	HIS	ASP	GLY	ASP	GLY	SER	ALA	PHE	GLN	TYR	GLU	TYR	GLU	PRO	PRO	CYS	THR	SER	LEU			
CYS	ALA	ARG	GLN	ALA	VAL	ARG	LEU	PRO	PRO	LEU	MET	ALA	TRP	ALA	LEU	HIS	PHE	MET	ASP	GLY	GLY	PRO	PRO	THR	GLU	ALA	VAL	TRP	GLN	ALA	GLY	THR	LYS	ARG	HIS	ASP	GLY	ASP	GLY	SER	ALA	PHE	GLN	TYR	GLU	TYR	GLU	PRO	PRO	CYS	THR	SER	LEU			

## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	138966	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 ( $e^-/\text{\AA}^2$ )	48	Depositor
Minimum defocus (nm)	1000	Depositor
Maximum defocus (nm)	2400	Depositor
Magnification	45872	Depositor
Image detector	GATAN K3 (6k x 4k)	Depositor
Maximum map value	0.095	Depositor
Minimum map value	-0.026	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.002	Depositor
Recommended contour level	0.00859	Depositor
Map size (Å)	296.52002, 296.52002, 296.52002	wwPDB
Map dimensions	280, 280, 280	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.059, 1.059, 1.059	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	0.60	0/7834	1.01	3/10617 (0.0%)
2	B	0.48	0/5989	0.64	1/9324 (0.0%)
3	L	0.50	0/639	1.05	1/860 (0.1%)
4	M	0.50	0/710	1.00	0/957
5	N	0.49	0/167	0.95	0/257
6	O	0.53	0/984	0.78	0/1329
All	All	0.55	0/16323	0.87	5/23344 (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
1	A	0	3
2	B	0	1
All	All	0	4

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	119	C	O3'-P-O5'	-8.57	91.14	104.00
3	L	33	ARG	NE-CZ-NH2	6.56	125.10	119.20
1	A	338	LYS	CB-CA-C	-5.48	101.62	109.84
1	A	1022	HIS	CB-CA-C	5.36	121.08	110.42
1	A	535	ARG	NE-CZ-NH2	5.03	123.73	119.20

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	470	ARG	Sidechain
1	A	6	ARG	Sidechain
1	A	979	ARG	Sidechain
2	B	142	C	Sidechain

## 5.2 Too-close contacts [i](#)

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

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	7649	0	7896	80	0
2	B	5371	0	2734	188	0
3	L	632	0	667	13	0
4	M	699	0	712	7	0
5	N	149	0	80	0	0
6	O	971	0	977	0	0
All	All	15471	0	13066	197	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 7.

The worst 5 of 197 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)
1:A:752:HIS:CA	2:B:58:G:O6	1.83	1.25
1:A:752:HIS:HA	2:B:58:G:O6	1.17	1.23
1:A:338:LYS:HG2	2:B:41:U:H1'	1.22	1.20
1:A:530:PRO:HB3	2:B:318:A:H61	1.07	1.09
1:A:52:ALA:HB3	2:B:142:C:N4	1.69	1.07

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	946/1132 (84%)	881 (93%)	61 (6%)	4 (0%)	30	63
3	L	79/130 (61%)	72 (91%)	6 (8%)	1 (1%)	10	39
4	M	88/166 (53%)	84 (96%)	4 (4%)	0	100	100
6	O	114/458 (25%)	109 (96%)	5 (4%)	0	100	100
All	All	1227/1886 (65%)	1146 (93%)	76 (6%)	5 (0%)	32	63

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	652	GLU
1	A	7	CYS
1	A	164	PRO
3	L	81	PRO
1	A	367	GLY

### 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	826/958 (86%)	826 (100%)	0	100	100
3	L	63/99 (64%)	63 (100%)	0	100	100
4	M	77/140 (55%)	76 (99%)	1 (1%)	65	76
6	O	108/390 (28%)	108 (100%)	0	100	100
All	All	1074/1587 (68%)	1073 (100%)	1 (0%)	92	95

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

Mol	Chain	Res	Type
4	M	40	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 12 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	1008	GLN
1	A	1051	ASN
6	O	226	GLN
1	A	1100	GLN
1	A	775	GLN

### 5.3.3 RNA ⓘ

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
2	B	249/451 (55%)	80 (32%)	13 (5%)

5 of 80 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
2	B	27	G
2	B	28	G
2	B	29	U
2	B	30	G
2	B	37	A

5 of 13 RNA pucker outliers are listed below:

Mol	Chain	Res	Type
2	B	187	U
2	B	292	G
2	B	321	C
2	B	307	U
2	B	315	G

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

There are no non-standard protein/DNA/RNA residues in this entry.

## 5.5 Carbohydrates ⓘ

There are no oligosaccharides 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.

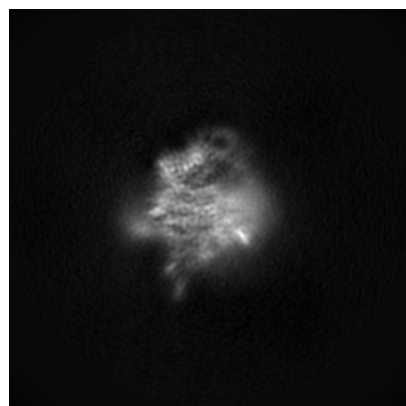
## 6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-52979. These allow visual inspection of the internal detail of the map and identification of artifacts.

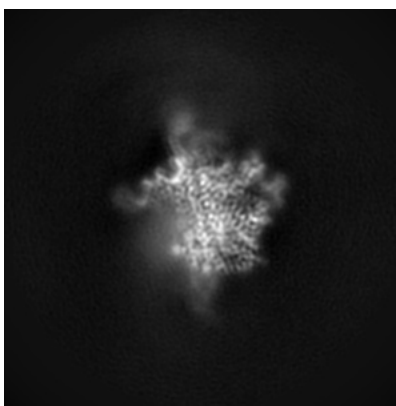
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

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

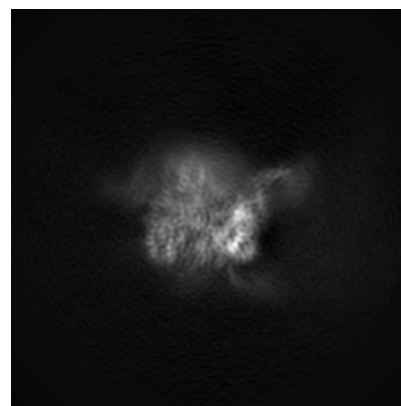
#### 6.1.1 Primary map



X

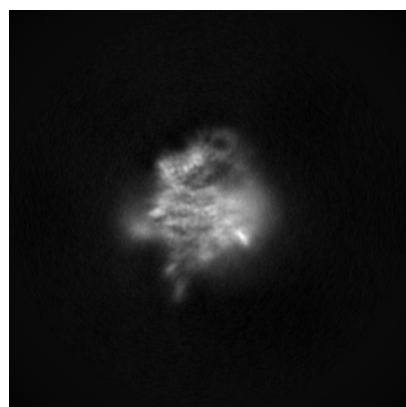


Y

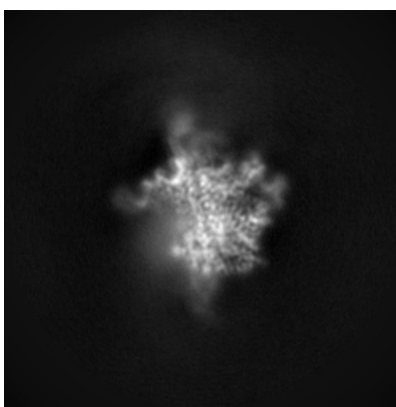


Z

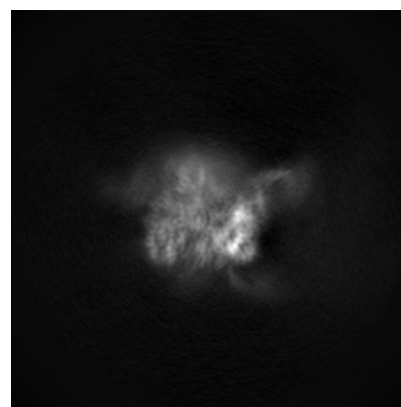
#### 6.1.2 Raw map



X



Y

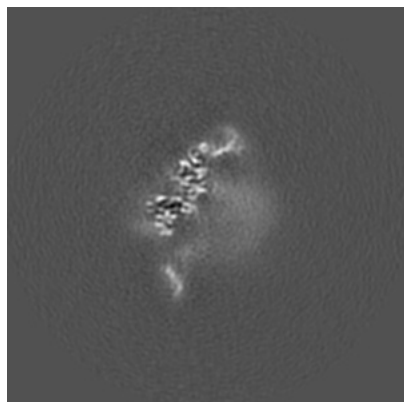


Z

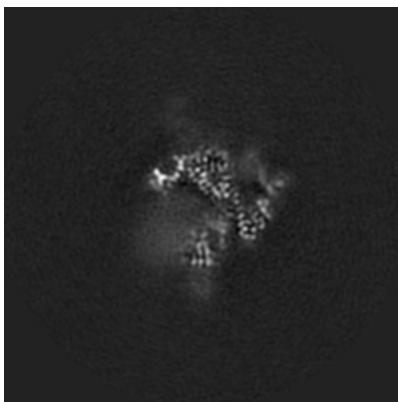
The images above show the map projected in three orthogonal directions.

## 6.2 Central slices [i](#)

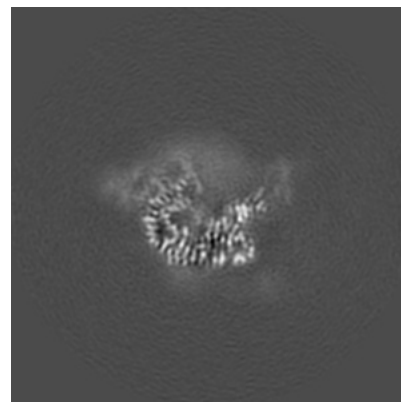
### 6.2.1 Primary map



X Index: 140

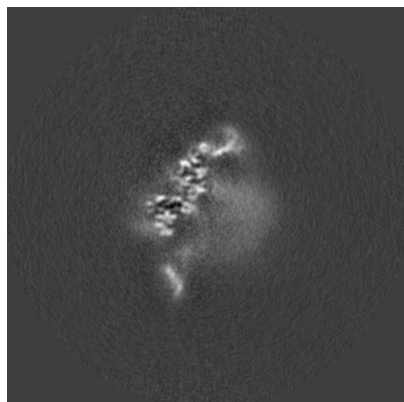


Y Index: 140

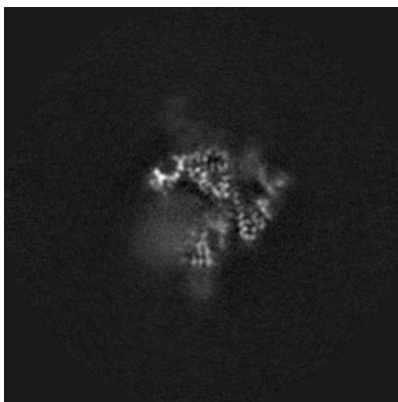


Z Index: 140

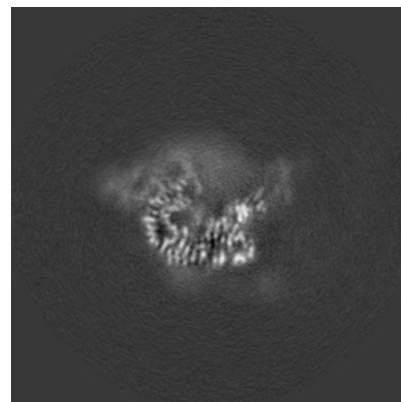
### 6.2.2 Raw map



X Index: 140



Y Index: 140

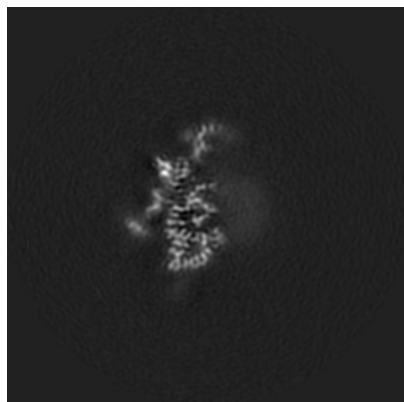


Z Index: 140

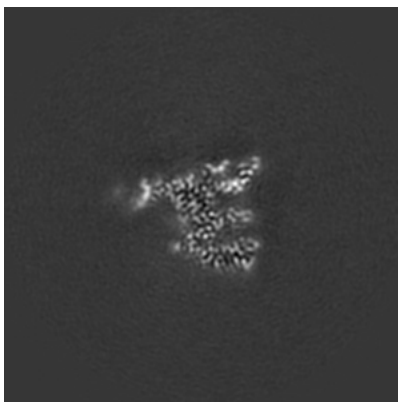
The images above show central slices of the map in three orthogonal directions.

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

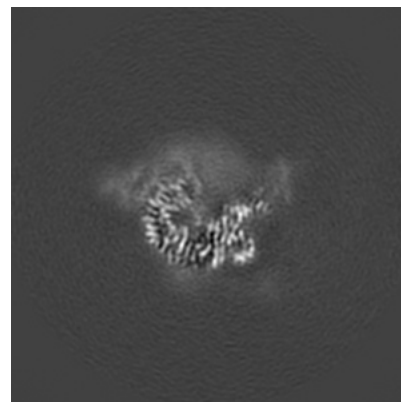
### 6.3.1 Primary map



X Index: 158

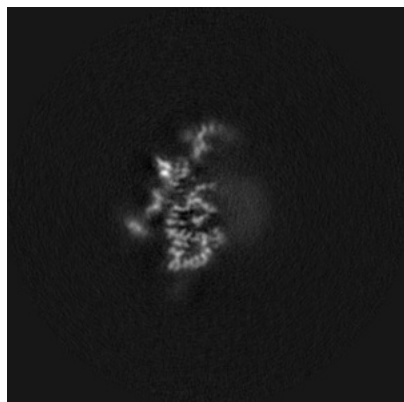


Y Index: 113

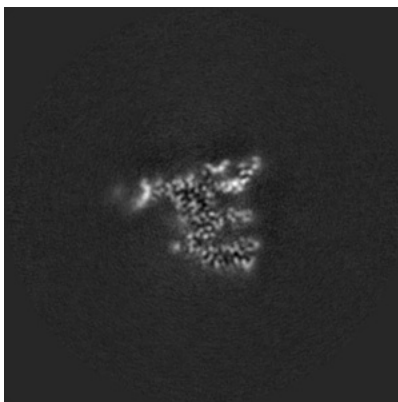


Z Index: 141

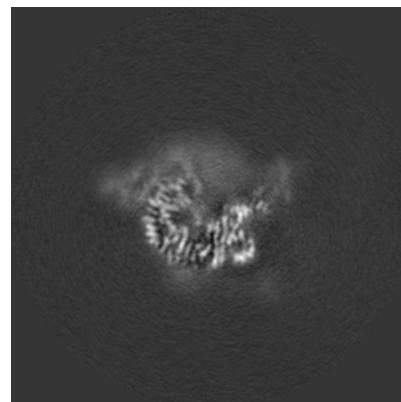
### 6.3.2 Raw map



X Index: 158



Y Index: 113



Z Index: 141

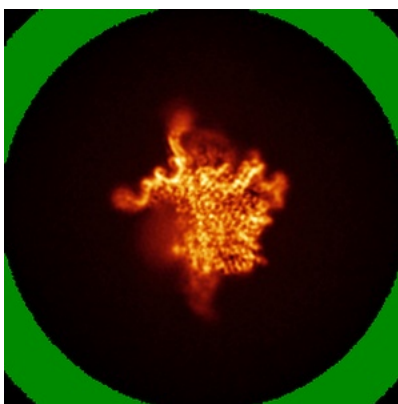
The images above show the largest variance slices of the map in three orthogonal directions.

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

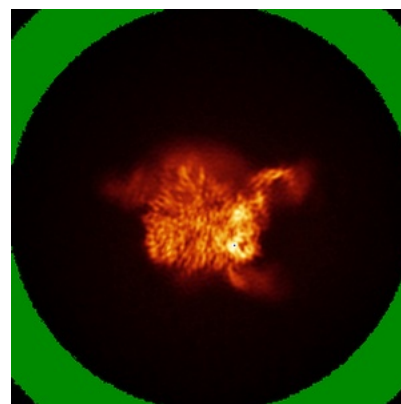
### 6.4.1 Primary map



X



Y



Z

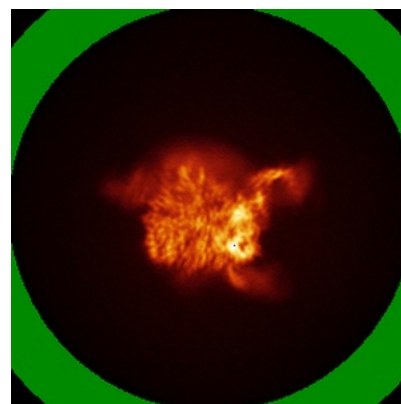
### 6.4.2 Raw map



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.

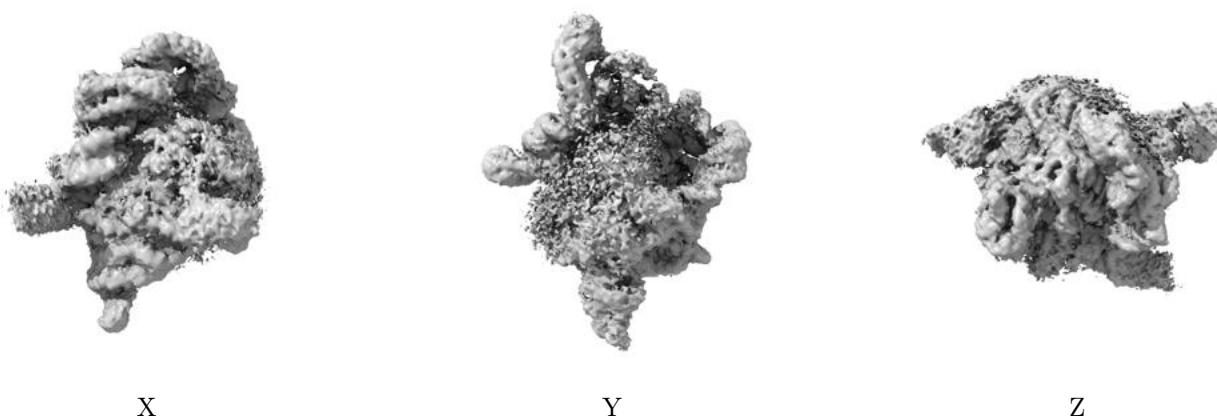
## 6.5 Orthogonal surface views [i](#)

### 6.5.1 Primary map



The images above show the 3D surface view of the map at the recommended contour level 0.00859. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

### 6.5.2 Raw map



These images show the 3D surface of the raw map. The raw map's contour level was selected so that its surface encloses the same volume as the primary map does at its recommended contour level.

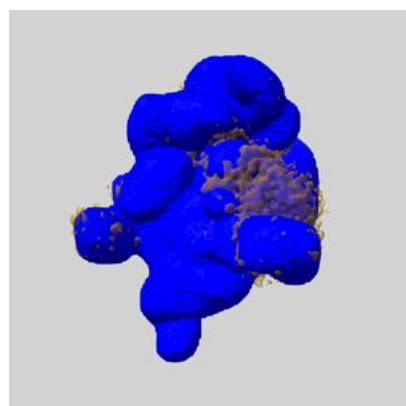
## 6.6 Mask visualisation [i](#)

This section shows the 3D surface view of the primary map at 50% transparency overlaid with the specified mask at 0% transparency

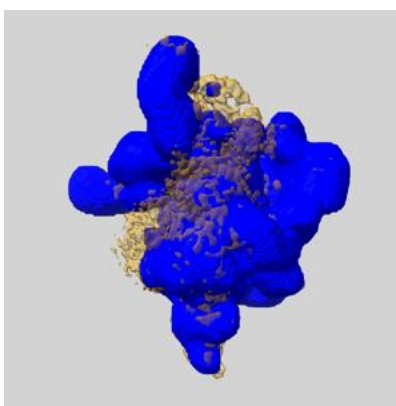
A mask typically either:

- Encompasses the whole structure
- Separates out a domain, a functional unit, a monomer or an area of interest from a larger structure

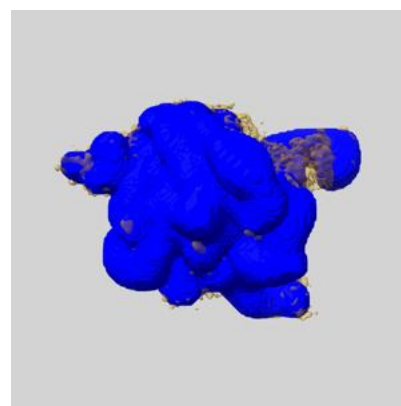
### 6.6.1 emd\_52979\_msk\_1.map [i](#)



X



Y

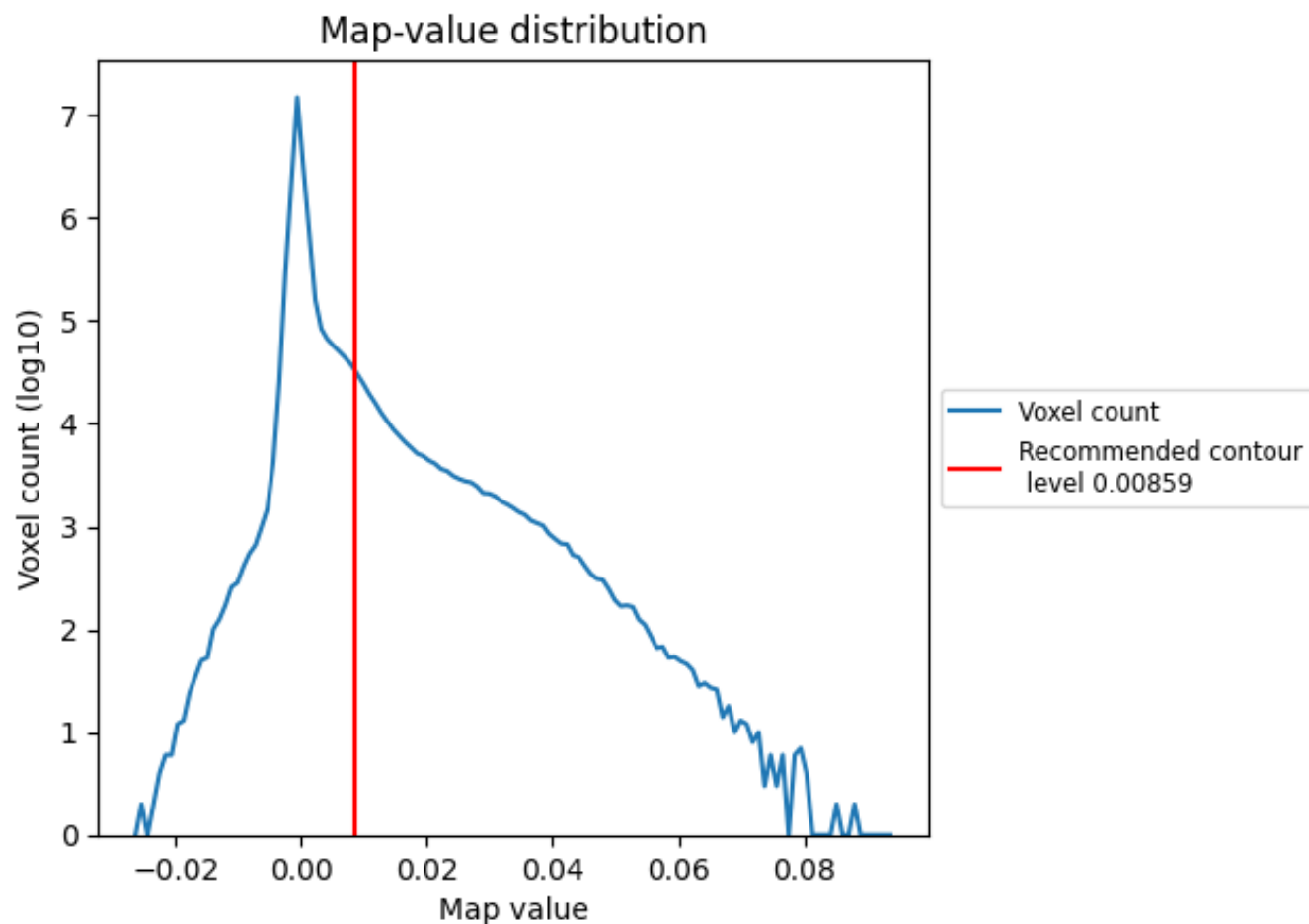


Z

## 7 Map analysis [i](#)

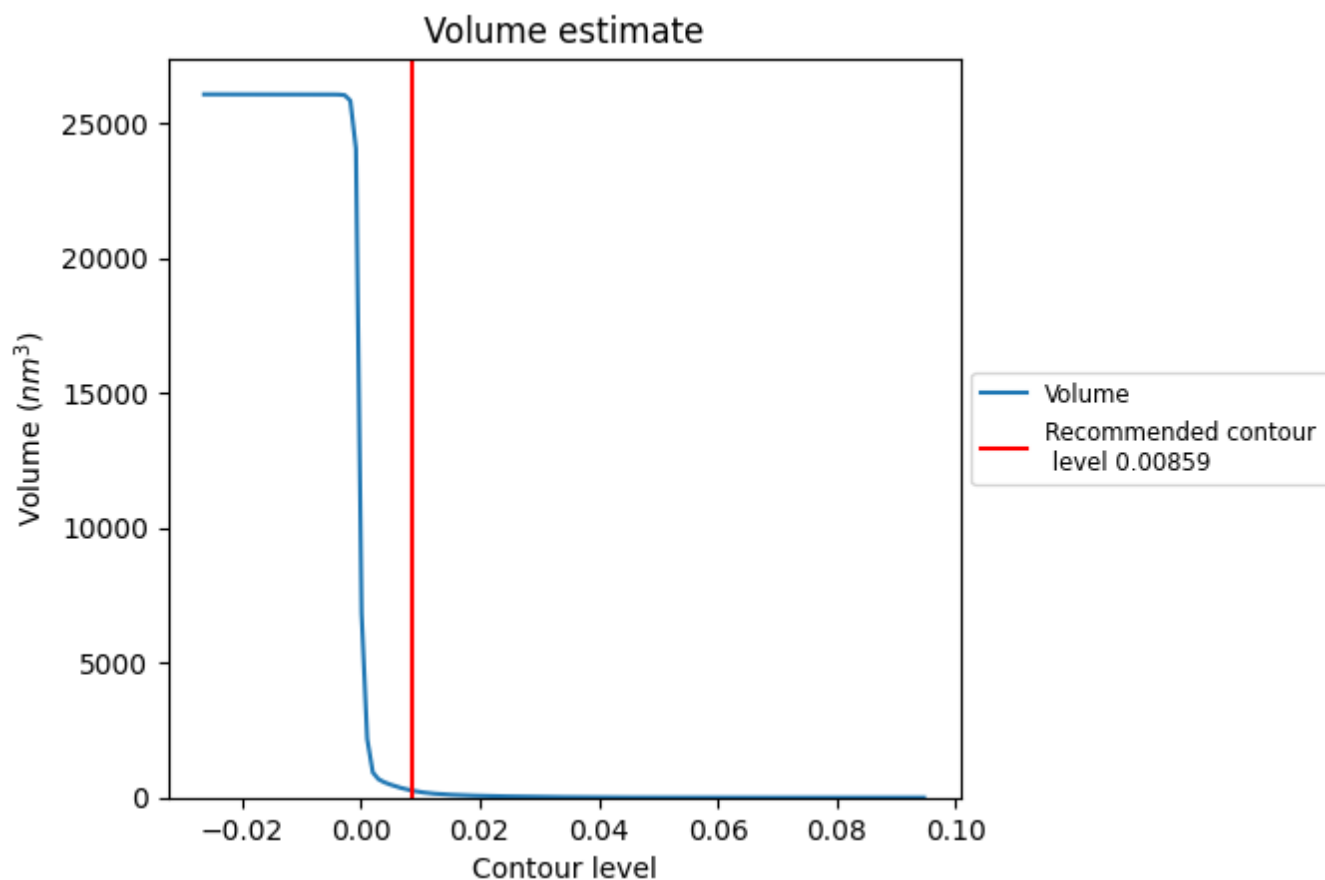
This section contains the results of statistical analysis of the map.

### 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.

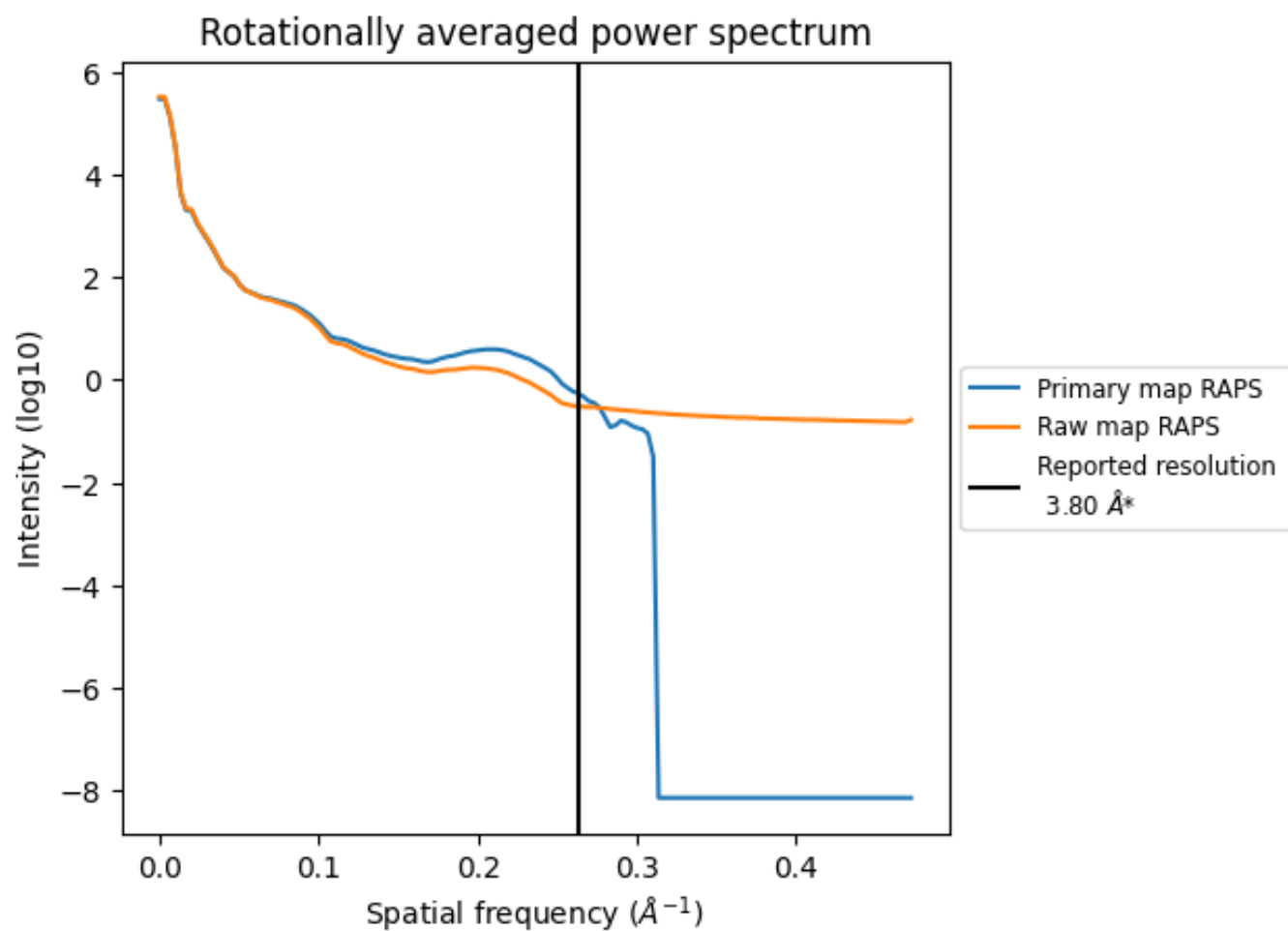
## 7.2 Volume estimate [i](#)



The volume at the recommended contour level is 260  $\text{nm}^3$ ; this corresponds to an approximate mass of 235 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 ⓘ

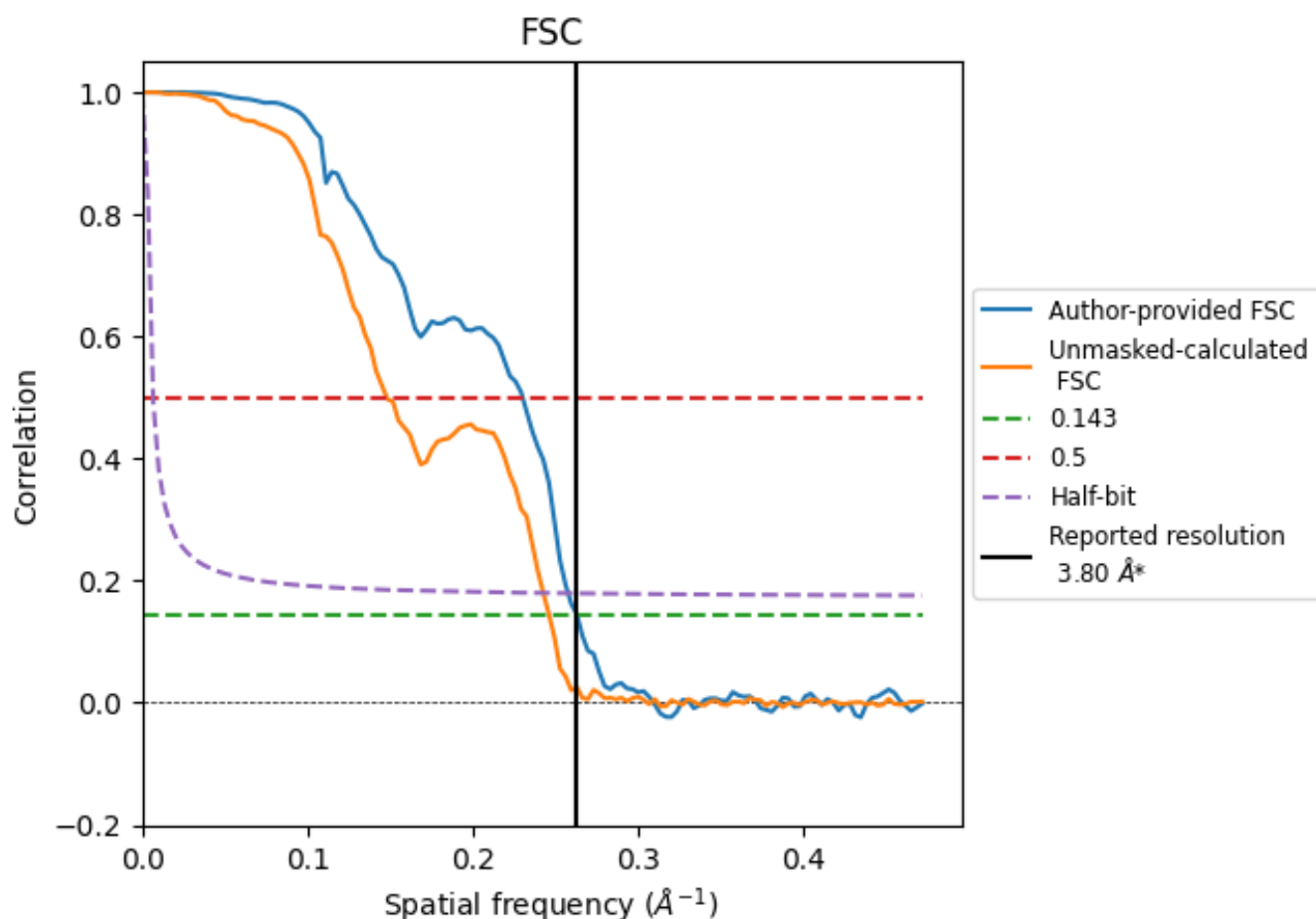


\*Reported resolution corresponds to spatial frequency of 0.263  $\text{\AA}^{-1}$

## 8 Fourier-Shell correlation [i](#)

Fourier-Shell Correlation (FSC) is the most commonly used method to estimate the resolution of single-particle and subtomogram-averaged maps. The shape of the curve depends on the imposed symmetry, mask and whether or not the two 3D reconstructions used were processed from a common reference. The reported resolution is shown as a black line. A curve is displayed for the half-bit criterion in addition to lines showing the 0.143 gold standard cut-off and 0.5 cut-off.

### 8.1 FSC [i](#)



\*Reported resolution corresponds to spatial frequency of  $0.263 \text{ \AA}^{-1}$

## 8.2 Resolution estimates [i](#)

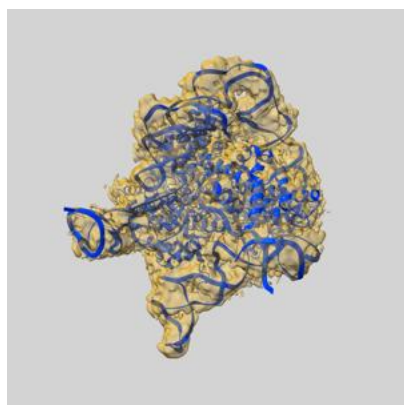
Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	3.80	-	-
Author-provided FSC curve	3.80	4.34	3.88
Unmasked-calculated*	4.06	6.76	4.12

\*Resolution estimate based on FSC curve calculated by comparison of deposited half-maps.

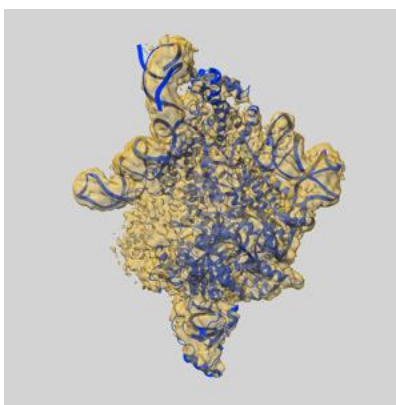
## 9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-52979 and PDB model 9QAY. Per-residue inclusion information can be found in [section 3](#) on [page 4](#).

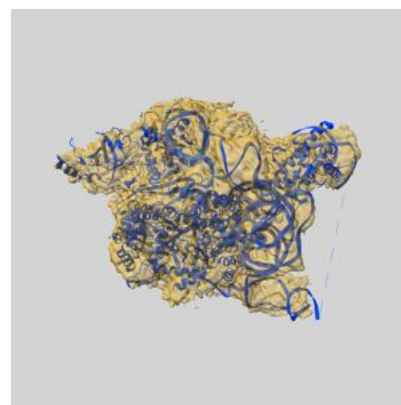
### 9.1 Map-model overlay [i](#)



X



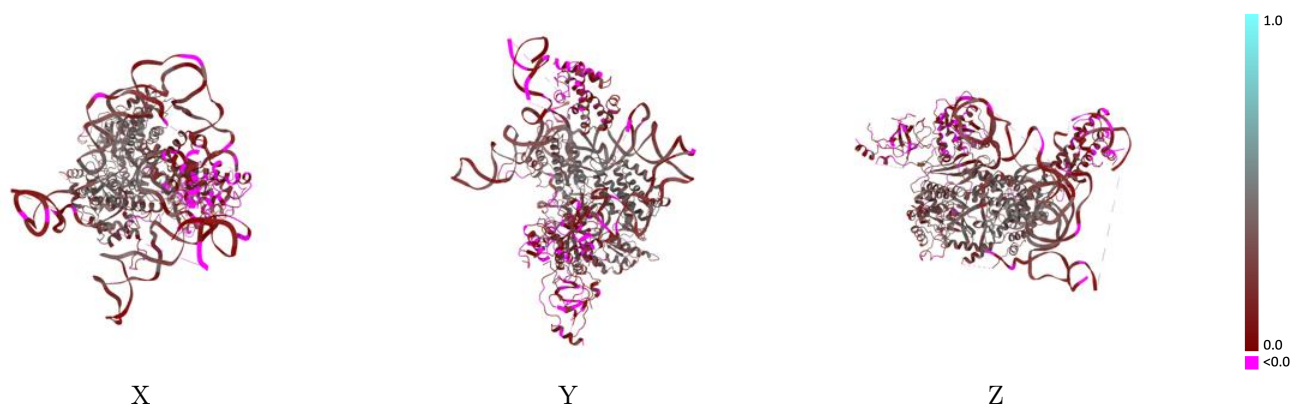
Y



Z

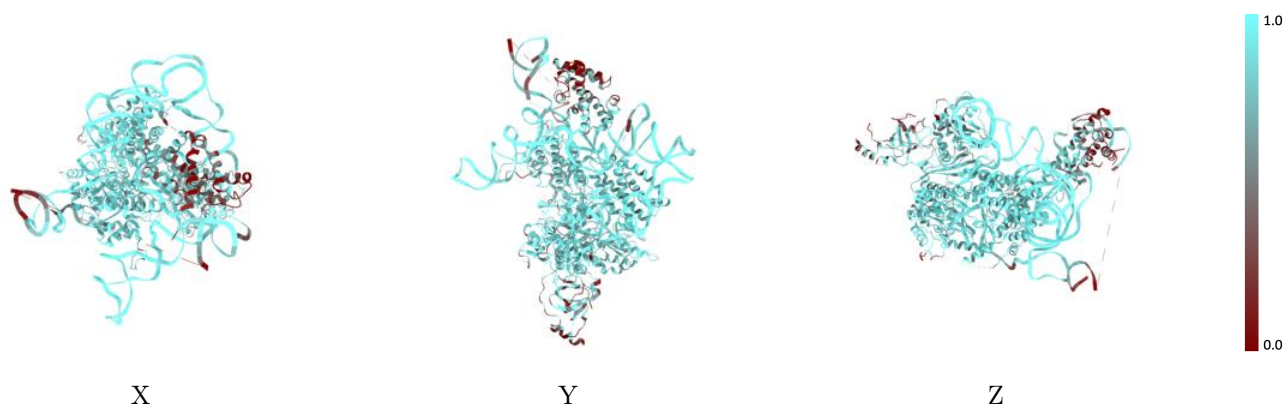
The images above show the 3D surface view of the map at the recommended contour level 0.00859 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



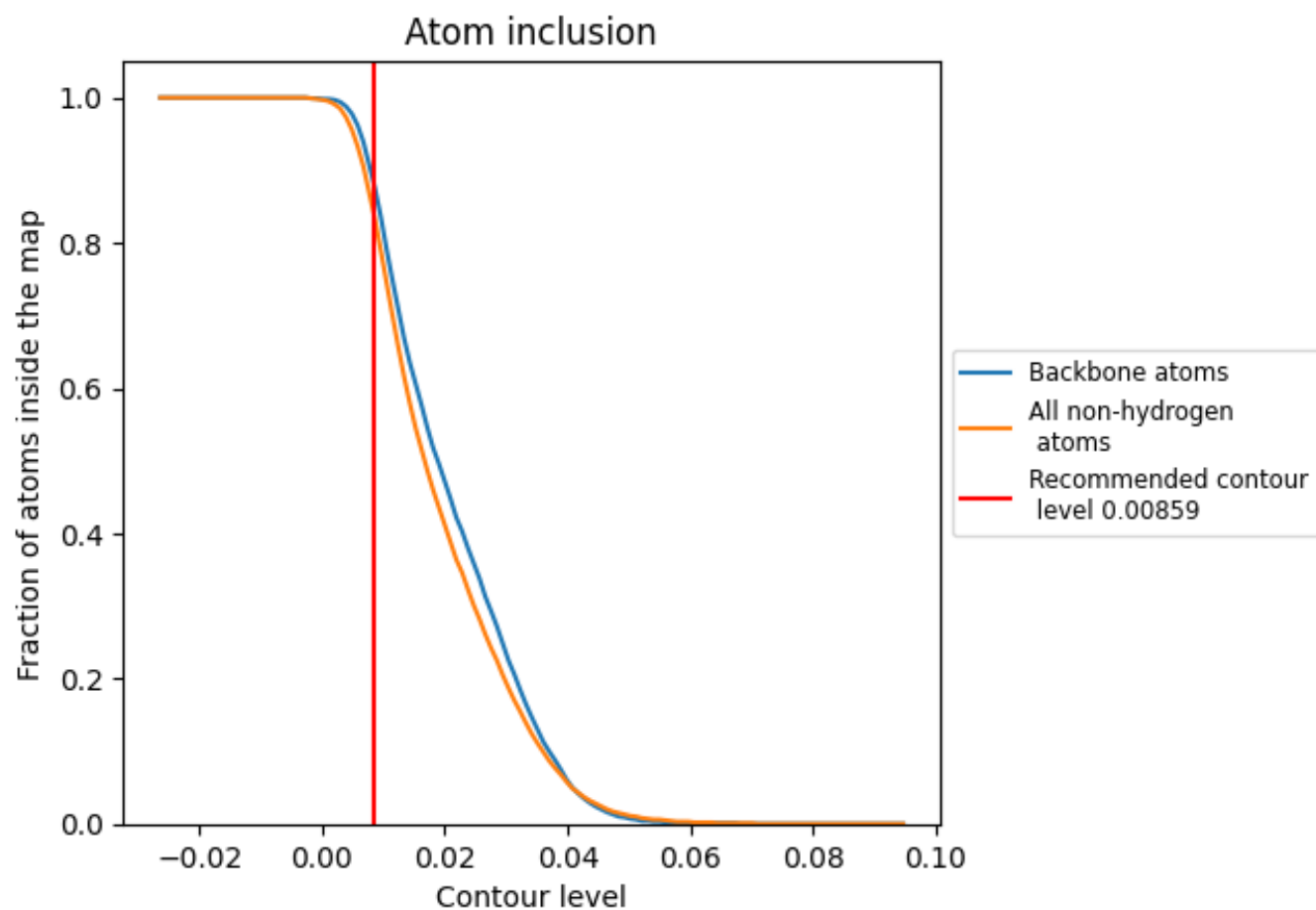
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (0.00859).

## 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 (0.00859) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	<div><div></div>0.8350</div>	<div><div></div>0.2260</div>
A	<div><div></div>0.8790</div>	<div><div></div>0.2750</div>
B	<div><div></div>0.8940</div>	<div><div></div>0.2120</div>
L	<div><div></div>0.5110</div>	<div><div></div>0.1040</div>
M	<div><div></div>0.4360</div>	<div><div></div>0.0920</div>
N	<div><div></div>0.9600</div>	<div><div></div>0.3480</div>
O	<div><div></div>0.6270</div>	<div><div></div>0.0770</div>

1.0

0.0

<0.0