



Full wwPDB EM Validation Report ⓘ

Dec 19, 2022 – 11:12 am GMT

PDB ID : 7NNU
EMDB ID : EMD-12484
Title : Cryo-EM structure of the folate-specific ECF transporter complex in MSP2N2 lipid nanodiscs
Authors : Thangaratnarajah, C.; Rheinberger, J.; Paulino, C.; Slotboom, D.J.
Deposited on : 2021-02-25
Resolution : 2.70 Å (reported)
Based on initial model : 7NNT

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 ⓘ 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.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

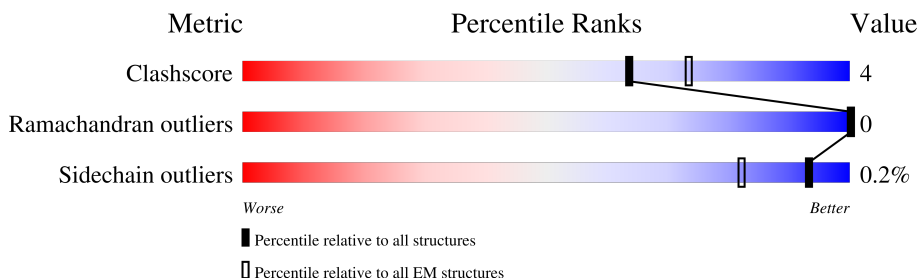
1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY

The reported resolution of this entry is 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 $\leq 5\%$. 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	300	
2	B	287	
3	C	184	
4	D	265	

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 7724 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 Energy-coupling factor transporter ATP-binding protein EcfA1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	279	2137	1346	359	428	4	0	0

There are 19 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-17	MET	-	initiating methionine	UNP Q1GBJ0
A	-16	HIS	-	expression tag	UNP Q1GBJ0
A	-15	HIS	-	expression tag	UNP Q1GBJ0
A	-14	HIS	-	expression tag	UNP Q1GBJ0
A	-13	HIS	-	expression tag	UNP Q1GBJ0
A	-12	HIS	-	expression tag	UNP Q1GBJ0
A	-11	HIS	-	expression tag	UNP Q1GBJ0
A	-10	HIS	-	expression tag	UNP Q1GBJ0
A	-9	HIS	-	expression tag	UNP Q1GBJ0
A	-8	HIS	-	expression tag	UNP Q1GBJ0
A	-7	HIS	-	expression tag	UNP Q1GBJ0
A	-6	GLY	-	expression tag	UNP Q1GBJ0
A	-5	GLU	-	expression tag	UNP Q1GBJ0
A	-4	ASN	-	expression tag	UNP Q1GBJ0
A	-3	LEU	-	expression tag	UNP Q1GBJ0
A	-2	TYR	-	expression tag	UNP Q1GBJ0
A	-1	PHE	-	expression tag	UNP Q1GBJ0
A	0	GLN	-	expression tag	UNP Q1GBJ0
A	1	GLY	-	expression tag	UNP Q1GBJ0

- Molecule 2 is a protein called Energy-coupling factor transporter ATP-binding protein EcfA2.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	B	273	2131	1362	362	399	8	0	0

- Molecule 3 is a protein called Conserved hypothetical membrane protein.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	C	169	1321	893	208	210	10	0	0

There are 8 discrepancies between the modelled and reference sequences:

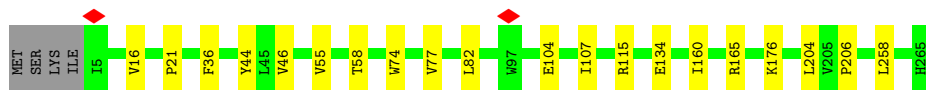
Chain	Residue	Modelled	Actual	Comment	Reference
C	177	TRP	-	expression tag	UNP Q1G929
C	178	SER	-	expression tag	UNP Q1G929
C	179	HIS	-	expression tag	UNP Q1G929
C	180	PRO	-	expression tag	UNP Q1G929
C	181	GLN	-	expression tag	UNP Q1G929
C	182	PHE	-	expression tag	UNP Q1G929
C	183	GLU	-	expression tag	UNP Q1G929
C	184	LYS	-	expression tag	UNP Q1G929

- Molecule 4 is a protein called Energy-coupling factor transporter transmembrane protein EcfT.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
4	D	261	2100	1403	337	346	14	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		AltConf
5	A	12	Total 12	O 12	0
5	B	9	Total 9	O 9	0
5	C	3	Total 3	O 3	0
5	D	11	Total 11	O 11	0



4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	166524	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TALOS ARCTICA	Depositor
Voltage (kV)	200	Depositor
Electron dose ($e^-/\text{\AA}^2$)	51.1	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	165000	Depositor
Image detector	GATAN K2 SUMMIT (4k x 4k)	Depositor
Maximum map value	0.138	Depositor
Minimum map value	-0.081	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.003	Depositor
Recommended contour level	0.0209	Depositor
Map size (Å)	296.06403, 296.06403, 296.06403	wwPDB
Map dimensions	384, 384, 384	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	0.7710001, 0.7710001, 0.7710001	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	0.33	0/2167	0.54	0/2937
2	B	0.33	0/2174	0.51	0/2931
3	C	0.34	0/1355	0.47	0/1837
4	D	0.34	0/2154	0.49	0/2925
All	All	0.33	0/7850	0.51	0/10630

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	2137	0	2155	23	0
2	B	2131	0	2137	22	0
3	C	1321	0	1394	16	0
4	D	2100	0	2203	13	0
5	A	12	0	0	0	0
5	B	9	0	0	1	0
5	C	3	0	0	0	0
5	D	11	0	0	1	0
All	All	7724	0	7889	67	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.

All (67) 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:11:VAL:HG22	2:B:60:THR:HG21	1.82	0.61
4:D:176:LYS:NZ	5:D:302:HOH:O	2.34	0.60
1:A:167:LEU:HD11	1:A:186:VAL:HG11	1.83	0.60
3:C:36:ASN:O	3:C:40:GLN:NE2	2.35	0.60
1:A:20:ARG:HD2	1:A:21:PRO:HD2	1.85	0.59
2:B:233:PHE:HA	2:B:239:LEU:HD11	1.85	0.58
3:C:50:MET:HG2	3:C:167:LEU:HD11	1.87	0.57
2:B:189:LYS:NZ	2:B:211:TYR:O	2.39	0.55
2:B:81:LYS:NZ	5:B:302:HOH:O	2.38	0.55
2:B:117:SER:HB3	2:B:120:GLU:HG3	1.89	0.54
3:C:163:ILE:HD12	4:D:204:LEU:HD22	1.90	0.53
2:B:173:ALA:HB1	2:B:181:ARG:HG3	1.90	0.53
1:A:46:LYS:NZ	1:A:169:GLU:OE1	2.42	0.52
3:C:105:ILE:HD12	3:C:164:LEU:HB3	1.92	0.50
1:A:130:ASP:O	1:A:188:LYS:NZ	2.45	0.50
1:A:14:THR:O	1:A:17:ASP:N	2.45	0.50
2:B:23:LEU:HD22	2:B:26:LEU:HD11	1.93	0.49
2:B:135:LYS:HB2	2:B:138:LEU:HD13	1.93	0.49
1:A:98:VAL:N	1:A:105:ASP:OD1	2.45	0.49
3:C:66:LEU:HD22	4:D:160:ILE:HD11	1.94	0.49
1:A:61:ASP:HB3	1:A:64:LYS:HG2	1.95	0.49
1:A:6:ILE:HD12	1:A:28:PHE:CZ	2.49	0.47
3:C:73:VAL:HG12	3:C:74:ILE:HG23	1.96	0.47
3:C:140:VAL:HG13	4:D:82:LEU:HB3	1.96	0.47
4:D:16:VAL:HG11	4:D:58:THR:HG22	1.95	0.47
1:A:204:LEU:HD11	1:A:242:LEU:HD22	1.97	0.46
1:A:46:LYS:HB3	1:A:216:LEU:HD12	1.96	0.46
2:B:138:LEU:HD23	2:B:146:LEU:HD22	1.96	0.46
1:A:77:ASP:OD1	1:A:77:ASP:N	2.48	0.46
2:B:64:ILE:HB	2:B:71:ILE:HB	1.98	0.46
1:A:257:ARG:HB3	2:B:278:LYS:HD2	1.98	0.45
1:A:67:ILE:HB	1:A:74:LEU:HD12	1.98	0.45
2:B:256:LEU:HG	2:B:261:LEU:HD12	1.99	0.45
4:D:46:VAL:HG11	4:D:258:LEU:HB3	1.97	0.45
3:C:133:MET:HA	4:D:36:PHE:HE1	1.81	0.45
2:B:128:TRP:CD1	2:B:161:ALA:HA	2.51	0.45
3:C:65:ALA:HB2	3:C:90:ALA:HB2	1.99	0.45
3:C:46:ILE:O	3:C:50:MET:HG3	2.18	0.44
1:A:87:GLY:HA3	1:A:157:ILE:HG23	1.98	0.44
1:A:133:MET:HE3	1:A:136:TYR:HB2	1.99	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:90:ALA:HB3	2:B:169:LEU:HD23	1.98	0.44
3:C:137:ASN:OD1	3:C:138:PHE:N	2.51	0.43
4:D:55:VAL:O	4:D:58:THR:OG1	2.34	0.43
1:A:36:THR:HG23	1:A:212:GLN:HB3	2.00	0.43
4:D:74:TRP:HA	4:D:77:VAL:HG22	2.01	0.43
1:A:23:LEU:HD23	1:A:219:GLY:HA2	2.01	0.43
2:B:164:PRO:O	2:B:191:TYR:OH	2.28	0.43
1:A:92:ASN:HB3	1:A:95:ASN:HB2	2.01	0.43
2:B:246:GLU:HB3	2:B:250:ALA:HB3	2.00	0.42
1:A:12:THR:HA	1:A:21:PRO:HA	2.00	0.42
2:B:132:VAL:O	2:B:153:ARG:NH1	2.52	0.42
4:D:104:GLU:HA	4:D:107:ILE:HG12	2.02	0.42
1:A:254:LEU:HD21	2:B:277:ILE:HG21	2.02	0.42
4:D:44:TYR:HE2	4:D:115:ARG:HG3	1.84	0.42
3:C:119:VAL:HA	3:C:123:ILE:HB	2.02	0.41
2:B:235:ASP:OD1	2:B:235:ASP:N	2.52	0.41
2:B:219:GLU:HB2	2:B:224:ILE:HD13	2.03	0.41
2:B:96:ALA:O	4:D:206:PRO:HB3	2.20	0.41
3:C:49:VAL:HG21	3:C:160:VAL:HG22	2.02	0.41
4:D:21:PRO:HG2	4:D:134:GLU:HB3	2.01	0.41
1:A:182:ILE:HD13	1:A:182:ILE:HA	1.91	0.40
1:A:23:LEU:HD22	1:A:26:LEU:HD22	2.03	0.40
3:C:23:ILE:HD11	3:C:63:GLY:HA2	2.03	0.40
3:C:153:PRO:O	3:C:157:MET:HG3	2.21	0.40
1:A:51:LYS:HB3	1:A:57:LEU:HG	2.02	0.40
2:B:166:ILE:HG12	2:B:197:THR:HB	2.03	0.40
3:C:142:LEU:O	3:C:146:ILE:N	2.55	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all PDB entries followed by that with respect to all EM entries.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	275/300 (92%)	271 (98%)	4 (2%)	0	100	100
2	B	269/287 (94%)	262 (97%)	7 (3%)	0	100	100
3	C	167/184 (91%)	163 (98%)	4 (2%)	0	100	100
4	D	259/265 (98%)	254 (98%)	5 (2%)	0	100	100
All	All	970/1036 (94%)	950 (98%)	20 (2%)	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	239/259 (92%)	239 (100%)	0	100	100
2	B	224/234 (96%)	223 (100%)	1 (0%)	91	97
3	C	140/155 (90%)	140 (100%)	0	100	100
4	D	229/233 (98%)	228 (100%)	1 (0%)	91	97
All	All	832/881 (94%)	830 (100%)	2 (0%)	93	98

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	85	ARG
4	D	165	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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.

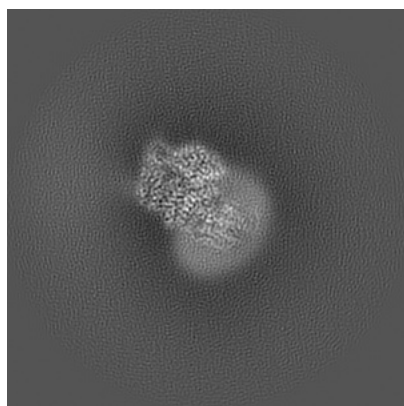
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-12484. These allow visual inspection of the internal detail of the map and identification of artifacts.

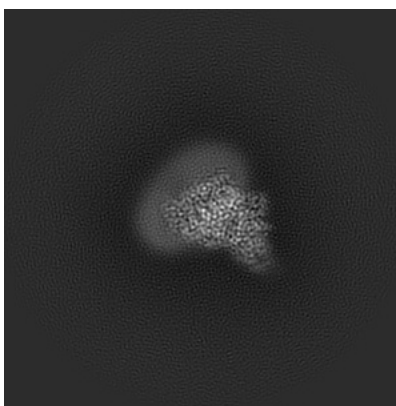
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

6.1 Orthogonal projections [i](#)

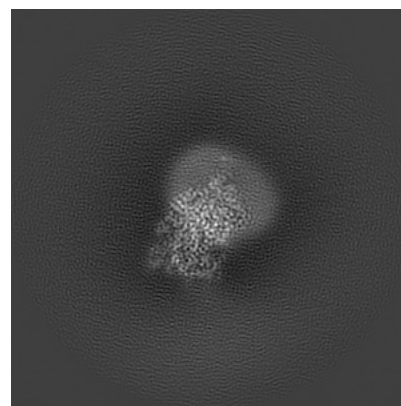
6.1.1 Primary map



X

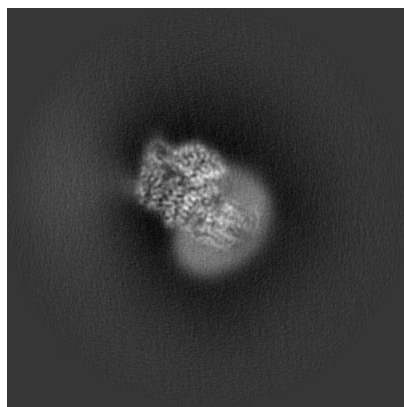


Y

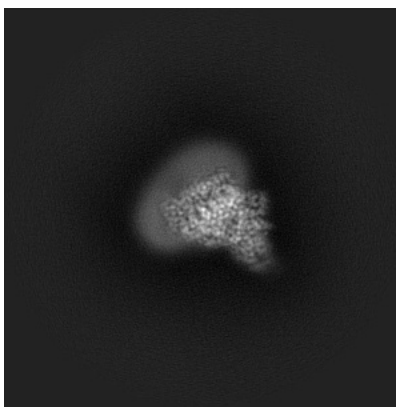


Z

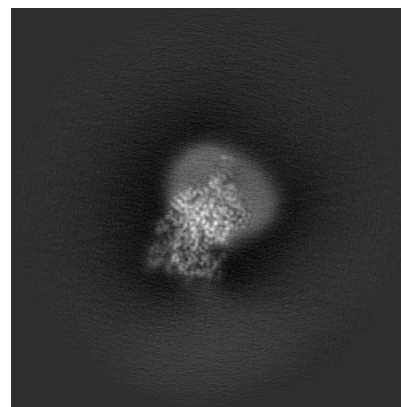
6.1.2 Raw map



X



Y

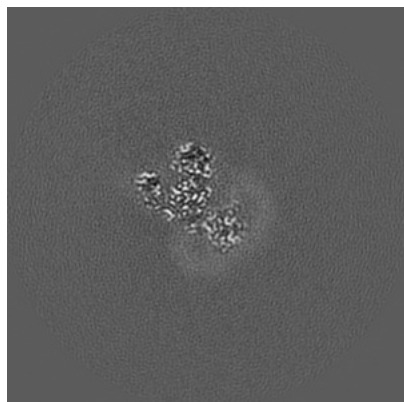


Z

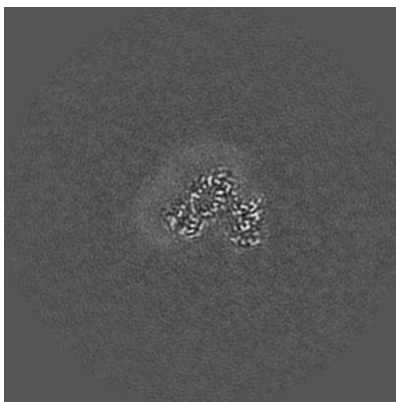
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

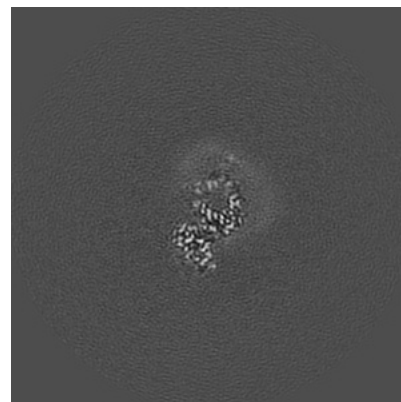
6.2.1 Primary map



X Index: 192

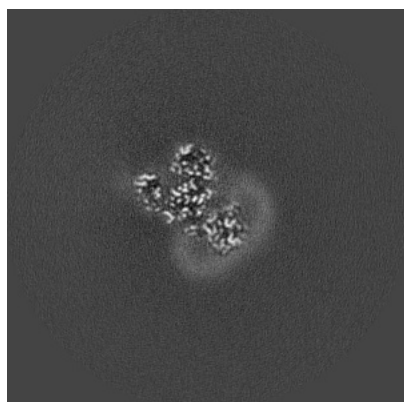


Y Index: 192

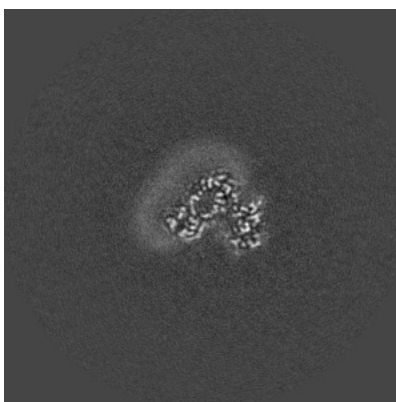


Z Index: 192

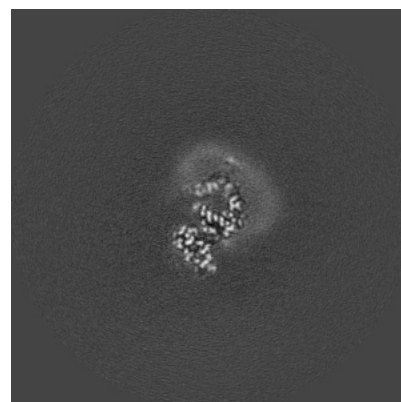
6.2.2 Raw map



X Index: 192



Y Index: 192

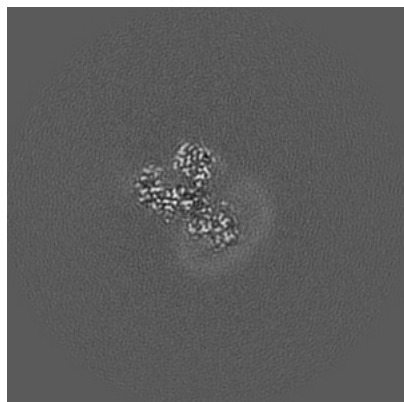


Z Index: 192

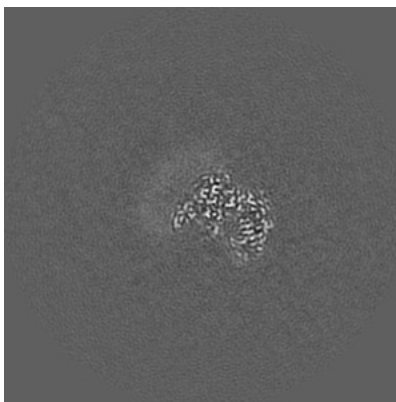
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

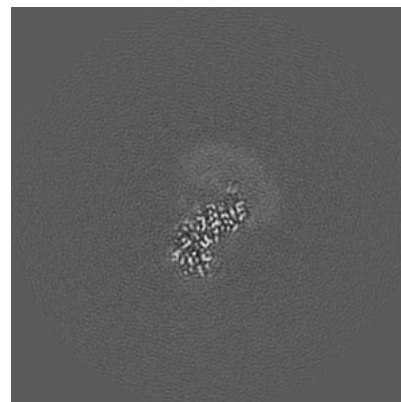
6.3.1 Primary map



X Index: 187

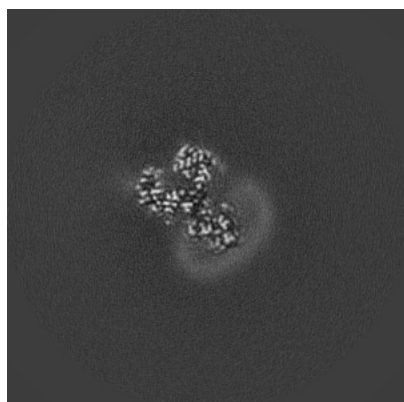


Y Index: 177

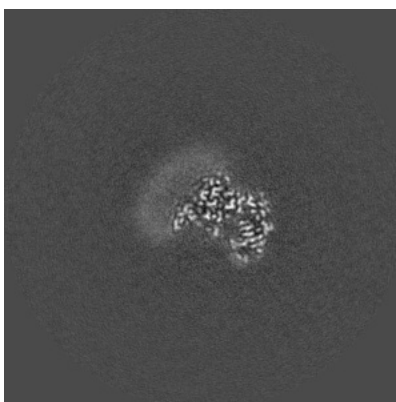


Z Index: 202

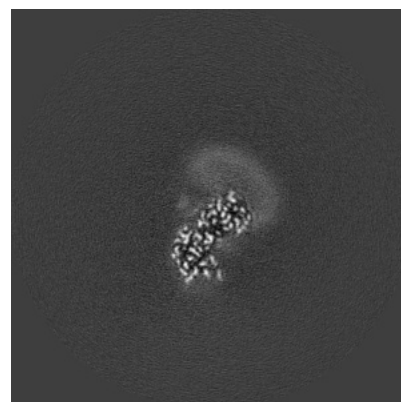
6.3.2 Raw map



X Index: 187



Y Index: 177

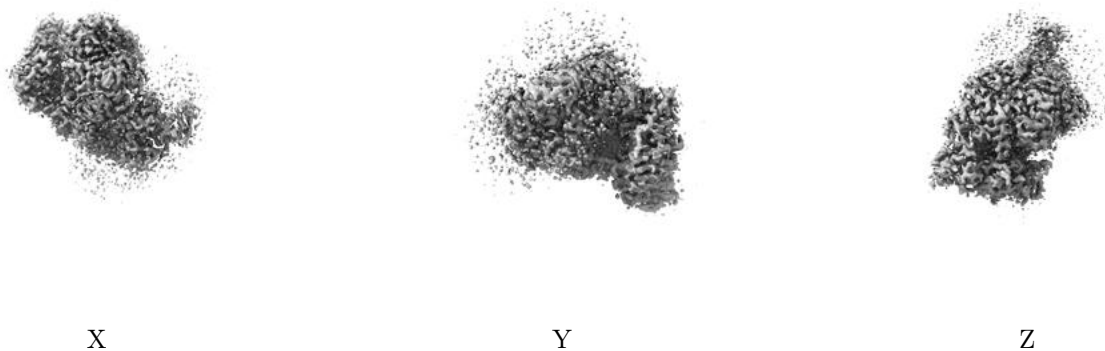


Z Index: 206

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

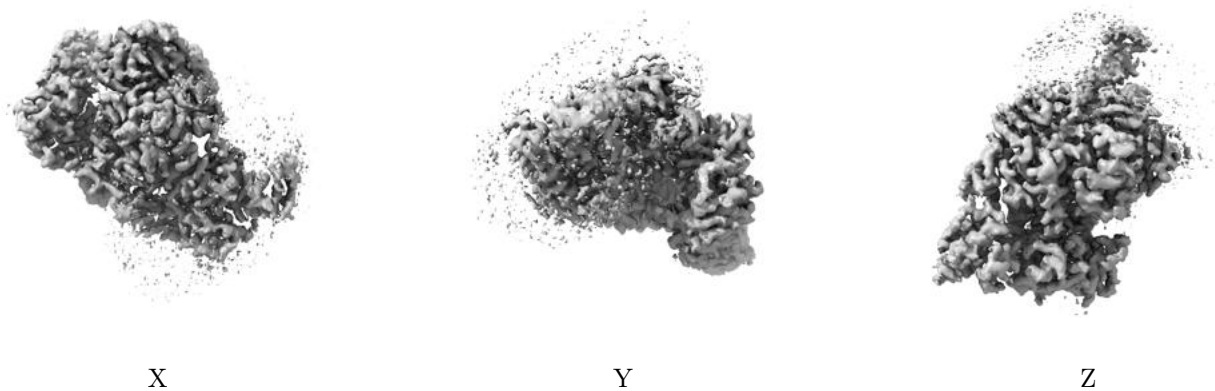
6.4 Orthogonal surface views [i](#)

6.4.1 Primary map



The images above show the 3D surface view of the map at the recommended contour level 0.0209. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

6.4.2 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.

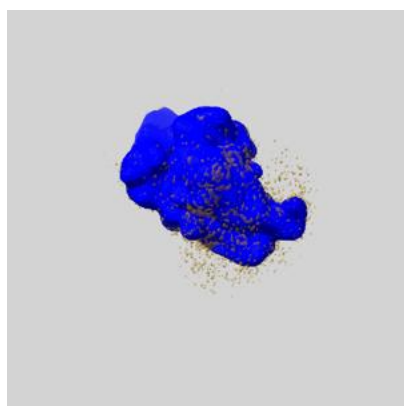
6.5 Mask visualisation [i](#)

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

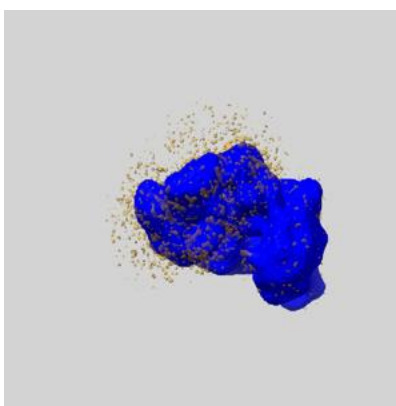
A mask typically either:

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

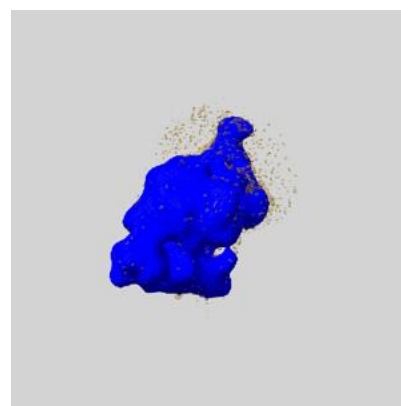
6.5.1 emd_12484_msk_1.map [i](#)



X



Y

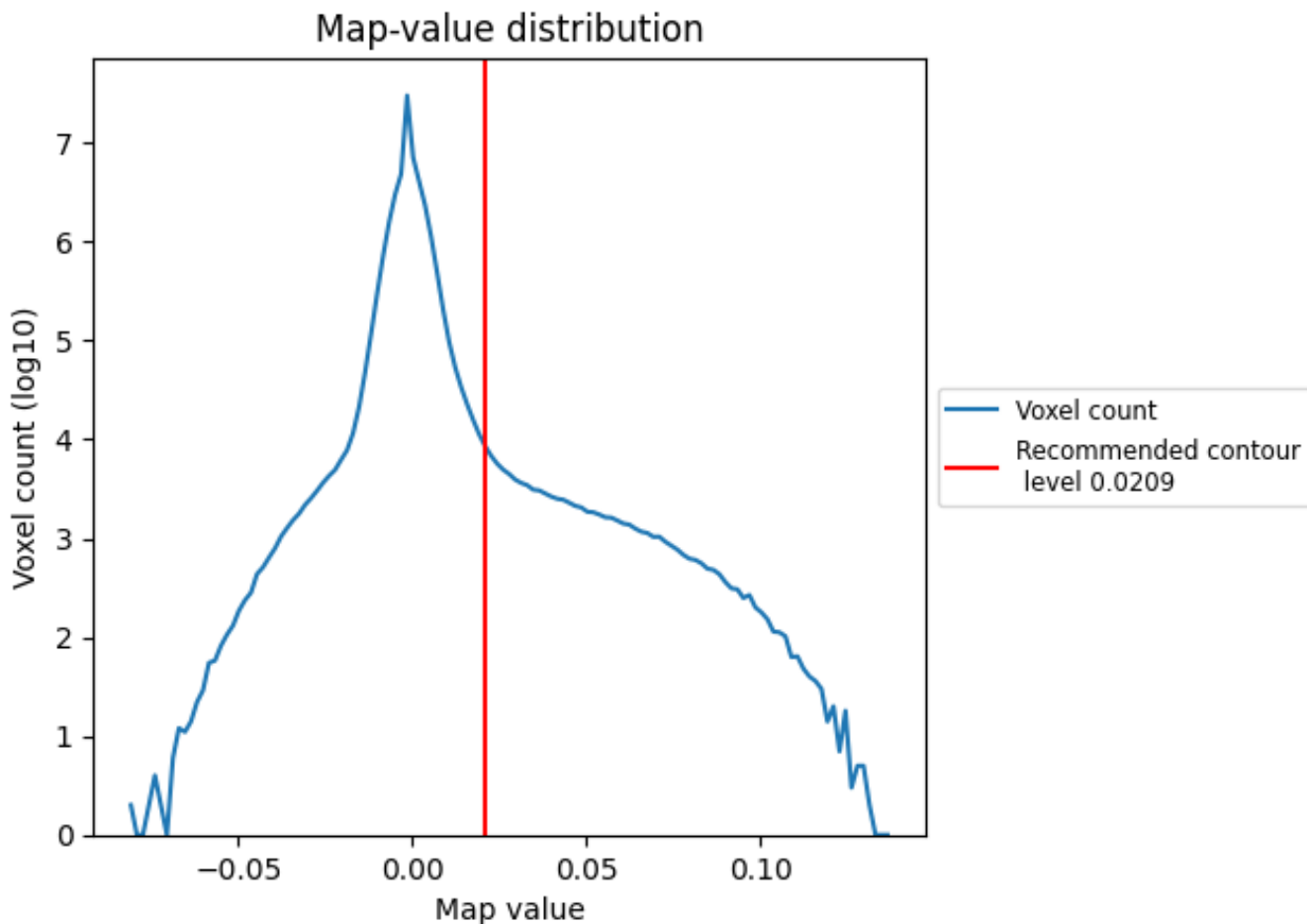


Z

7 Map analysis [i](#)

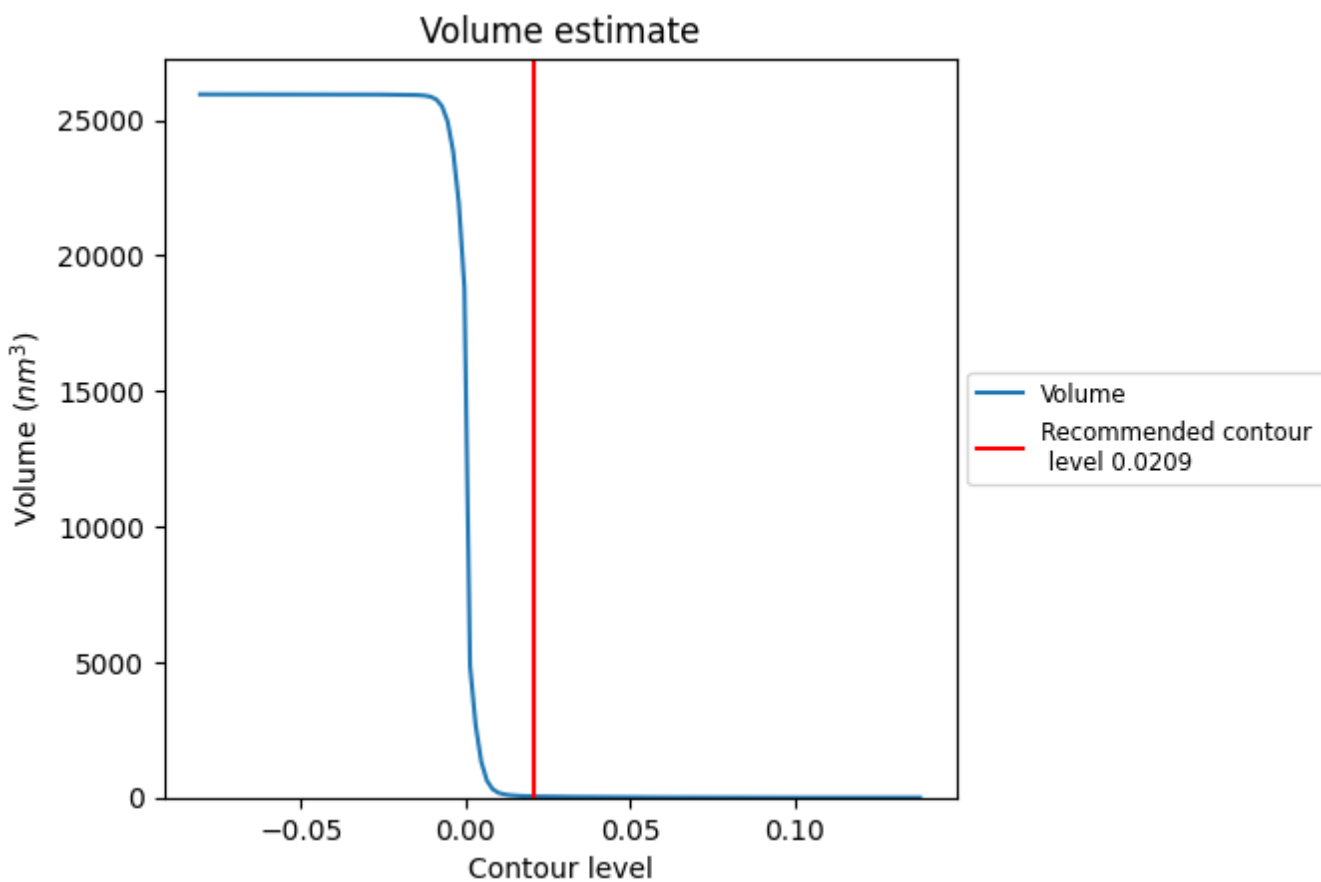
This section contains the results of statistical analysis of the map.

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.

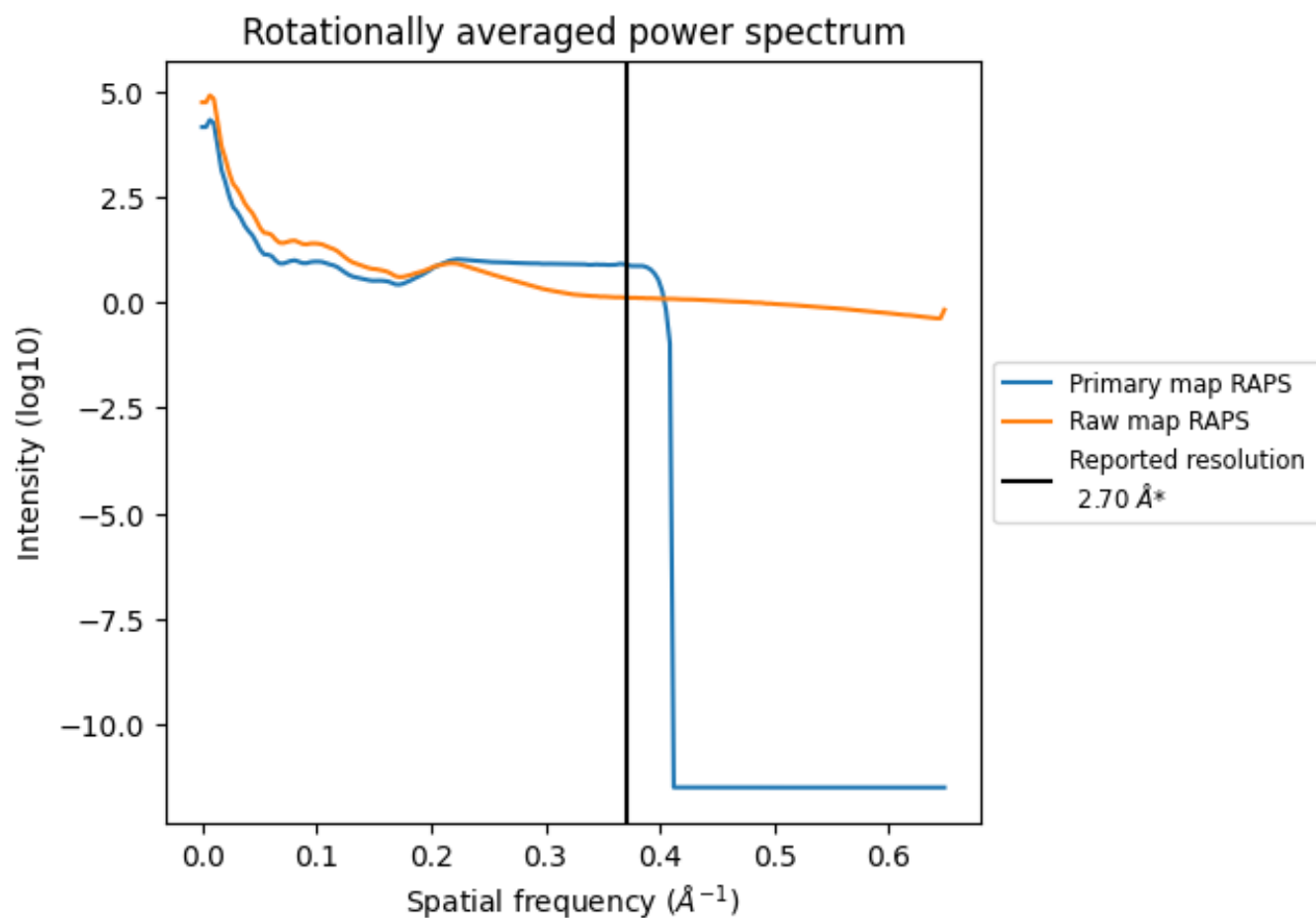
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 43 nm^3 ; this corresponds to an approximate mass of 38 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

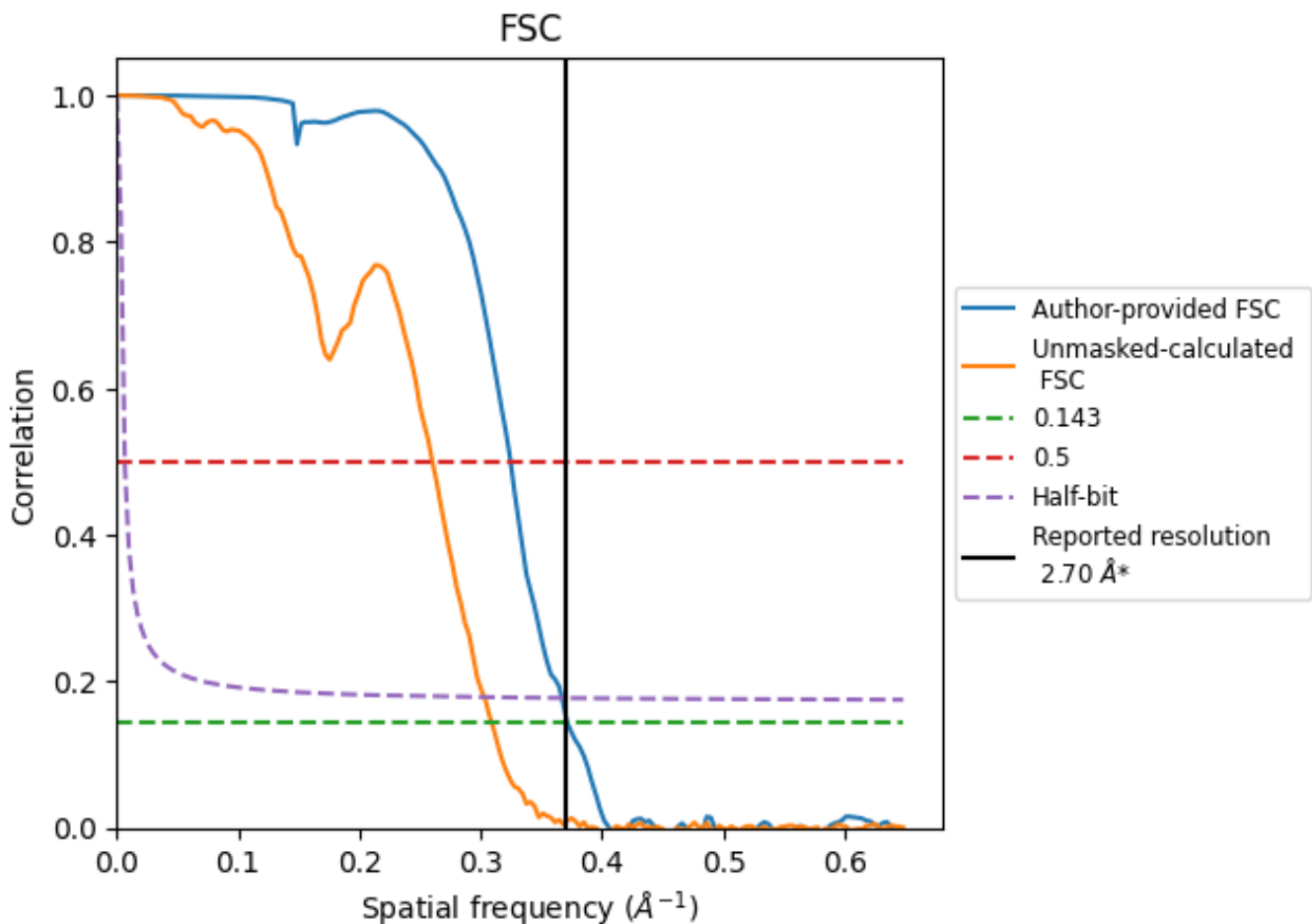


*Reported resolution corresponds to spatial frequency of 0.370 Å⁻¹

8 Fourier-Shell correlation [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 0.370 Å⁻¹

8.2 Resolution estimates [i](#)

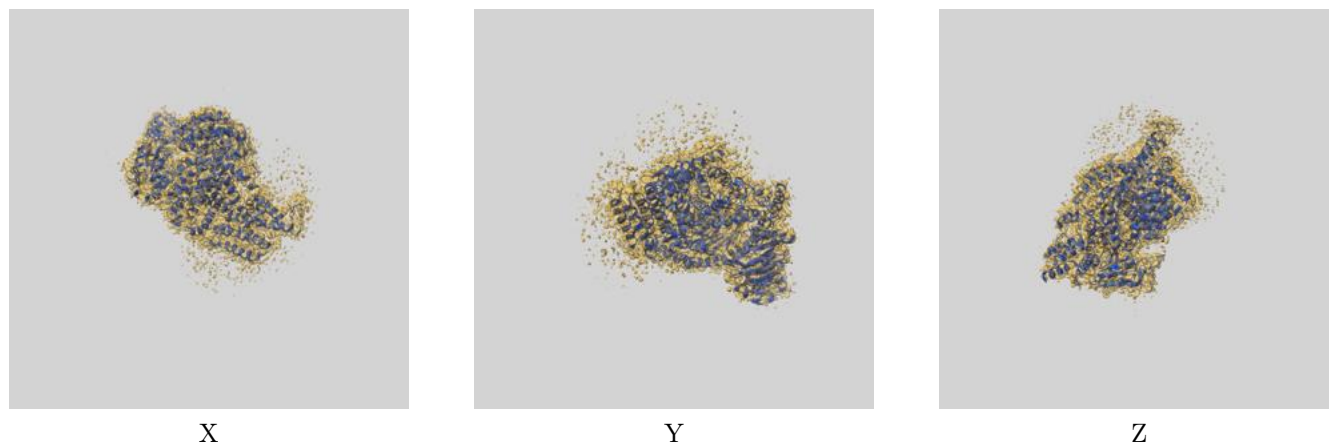
Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	2.70	-	-
Author-provided FSC curve	2.69	3.08	2.72
Unmasked-calculated*	3.23	3.84	3.30

*Resolution estimate based on FSC curve calculated by comparison of deposited half-maps. The value from deposited half-maps intersecting FSC 0.143 CUT-OFF 3.23 differs from the reported value 2.7 by more than 10 %

9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-12484 and PDB model 7NNU. Per-residue inclusion information can be found in section [3](#) on page [5](#).

9.1 Map-model overlay [i](#)



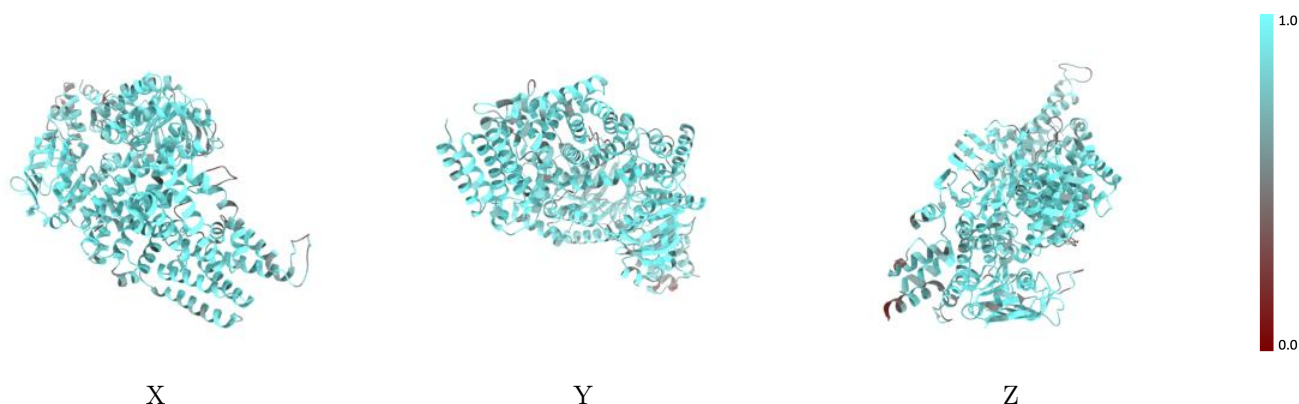
The images above show the 3D surface view of the map at the recommended contour level 0.0209 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



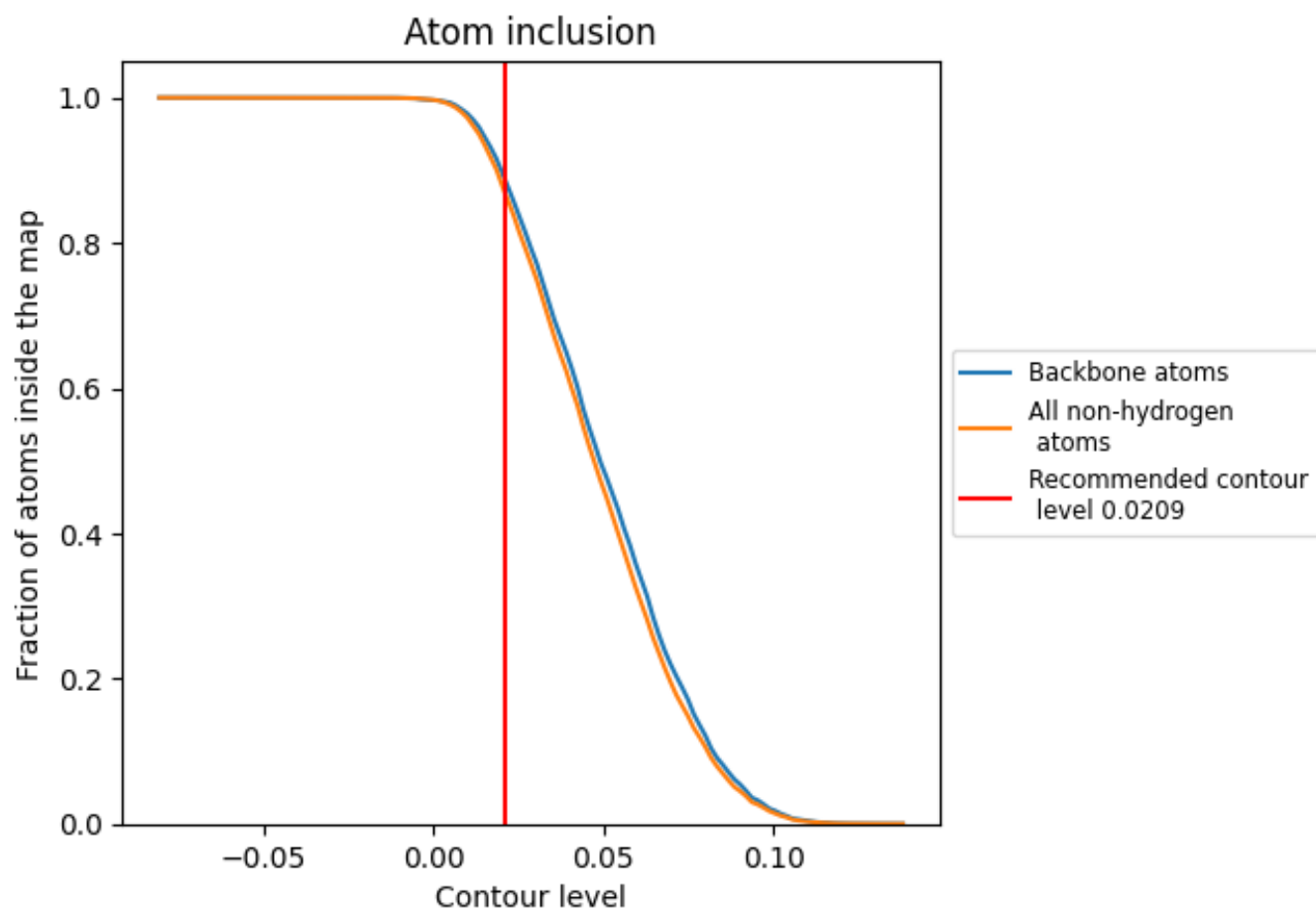
The images above show the model with each residue coloured according its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (0.0209).




9.4 Atom inclusion [i](#)



At the recommended contour level, 89% of all backbone atoms, 87% 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 (0.0209) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	 0.8692	 0.6150
A	 0.8693	 0.6190
B	 0.8639	 0.6080
C	 0.9031	 0.6320
D	 0.8603	 0.6050

