



Full wwPDB EM Validation Report ⓘ

Mar 8, 2026 – 04:18 PM UTC

PDB ID : 8UOY / pdb_00008uoy
EMDB ID : EMD-42441
Title : Major interface of Streptococcal surface enolase dimer from AP53 group A streptococcus bound to a lipid vesicle
Authors : Tjia-Fleck, S.; Readnour, B.M.; Castellino, F.J.
Deposited on : 2023-10-20
Resolution : 3.40 Å(reported)

This is a Full wwPDB EM Validation Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/EMValidationReportHelp>
with specific help available everywhere you see the ⓘ 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.dev132
MolProbity : 4-5-2 with Phenix2.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
EM percentile statistics : 202505.v01 (Using data in the EMDb archive up until May 2025)
MapQ : 1.9.13
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

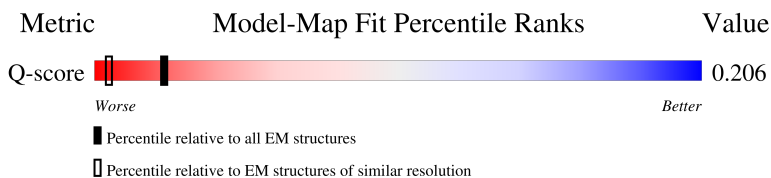
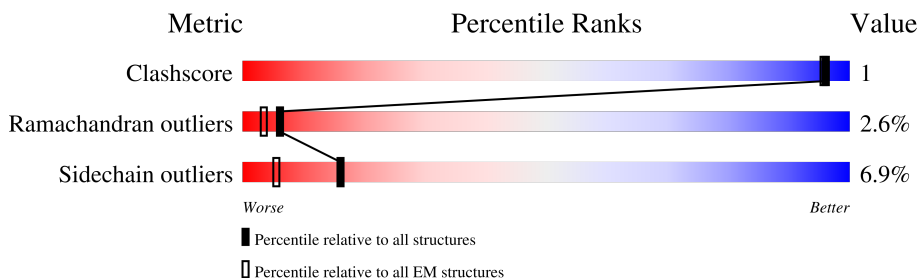
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY

The reported resolution of this entry is 3.40 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)	Similar EM resolution (#Entries, resolution range(Å))
Clashscore	229148	23984	-
Ramachandran outliers	224038	23583	-
Sidechain outliers	223484	23102	-
Q-score	-	25397	14717 (2.90 - 3.90)

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	B	436	38% 84% 14% .
1	C	436	41% 88% 10% .

2 Entry composition

There is only 1 type of molecule in this entry. The entry contains 13188 atoms, of which 6544 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 Enolase.

Mol	Chain	Residues	Atoms						AltConf	Trace
1	B	436	Total	C	H	N	O	S	0	0
			6594	2091	3272	561	659	11		
1	C	436	Total	C	H	N	O	S	0	0
			6594	2091	3272	561	659	11		

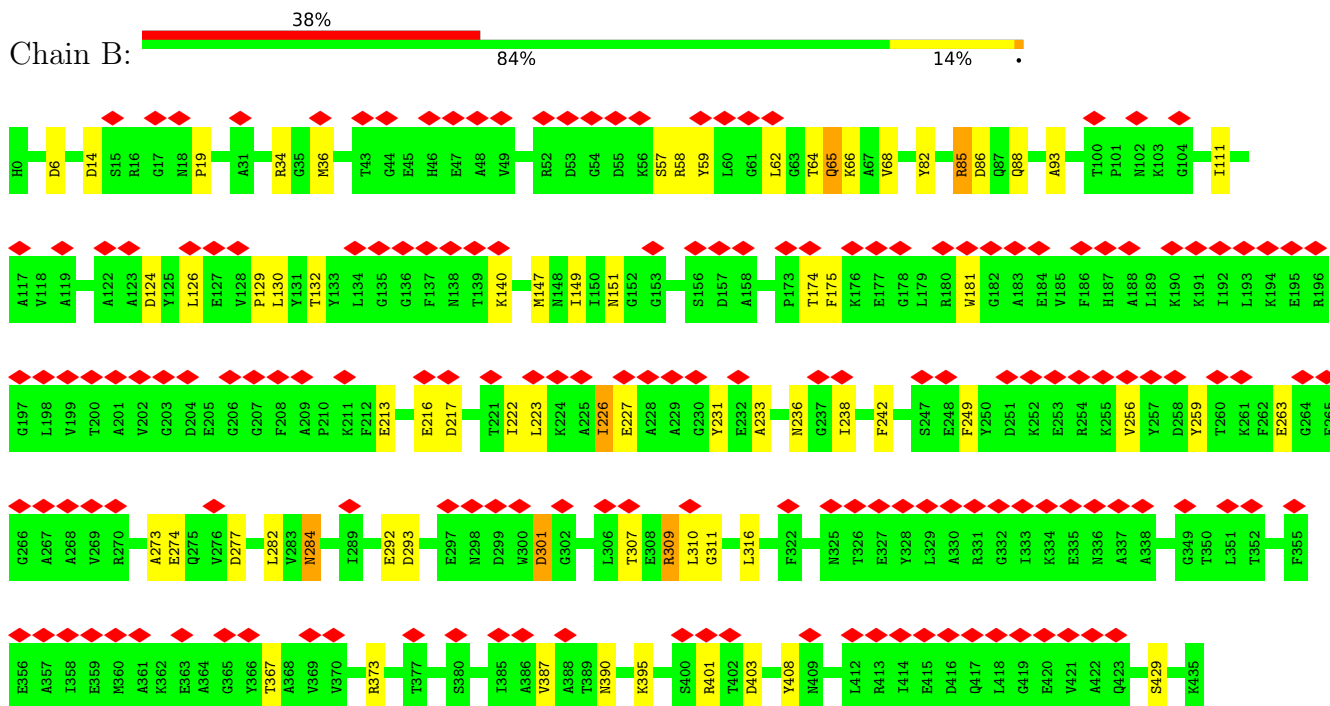
There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	0	HIS	-	expression tag	UNP A3F8V6
C	0	HIS	-	expression tag	UNP A3F8V6

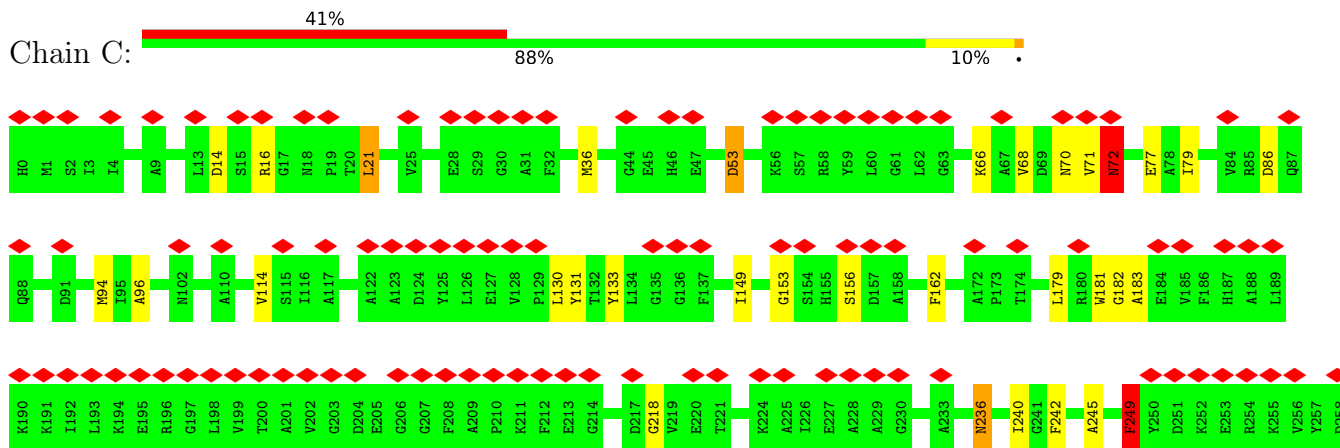
3 Residue-property plots

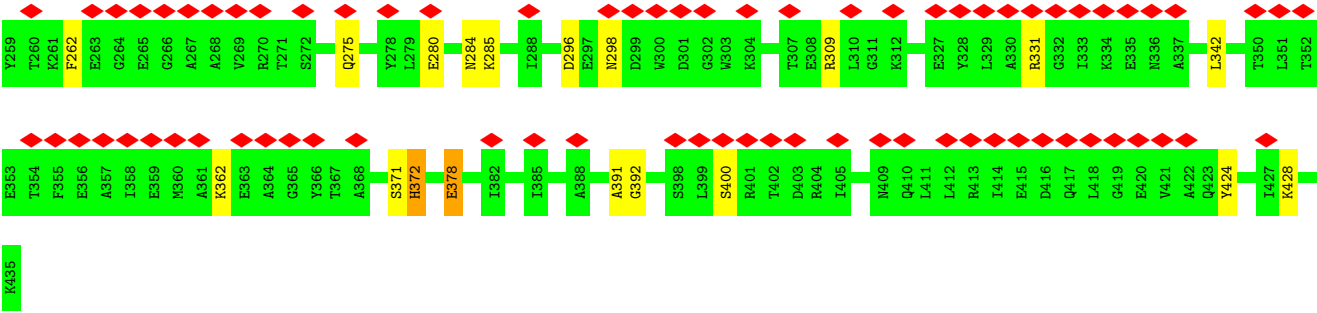
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and atom inclusion 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: Enolase



• Molecule 1: Enolase





4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C2	Depositor
Number of particles used	476281	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 ($e^-/\text{\AA}^2$)	60.0	Depositor
Minimum defocus (nm)	1000	Depositor
Maximum defocus (nm)	29000	Depositor
Magnification	81000	Depositor
Image detector	GATAN K3 (6k x 4k)	Depositor
Maximum map value	2.569	Depositor
Minimum map value	-2.525	Depositor
Average map value	-0.000	Depositor
Map value standard deviation	0.025	Depositor
Recommended contour level	0.0578	Depositor
Map size (Å)	230.69199, 230.69199, 230.69199	wwPDB
Map dimensions	214, 214, 214	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.078, 1.078, 1.078	Depositor

5 Model quality [i](#)

5.1 Standard geometry [i](#)

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z > 5$	RMSZ	$\# Z > 5$
1	B	1.00	3/3375 (0.1%)	1.58	32/4562 (0.7%)
1	C	0.95	0/3375	1.55	24/4562 (0.5%)
All	All	0.97	3/6750 (0.0%)	1.56	56/9124 (0.6%)

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	B	0	5
1	C	0	4
All	All	0	9

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	301	ASP	CG-OD2	-8.91	1.08	1.25
1	B	301	ASP	CB-CG	-7.75	1.32	1.52
1	B	301	ASP	CG-OD1	-6.29	1.13	1.25

All (56) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	249	PHE	CA-CB-CG	8.29	122.09	113.80
1	C	236	ASN	CA-CB-CG	7.98	120.58	112.60
1	B	62	LEU	CA-C-N	7.93	128.40	120.31
1	B	62	LEU	C-N-CA	7.93	128.40	120.31
1	C	284	ASN	CA-CB-CG	7.64	120.24	112.60
1	B	301	ASP	CA-CB-CG	7.61	120.21	112.60
1	B	242	PHE	CA-CB-CG	7.39	121.19	113.80
1	B	277	ASP	CA-CB-CG	7.13	119.73	112.60
1	B	249	PHE	CA-CB-CG	6.97	120.77	113.80

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	72	ASN	CA-CB-CG	6.83	119.42	112.60
1	C	296	ASP	CA-C-N	6.62	130.05	120.38
1	C	296	ASP	C-N-CA	6.62	130.05	120.38
1	B	65	GLN	CB-CG-CD	6.52	123.68	112.60
1	C	242	PHE	CA-CB-CG	6.43	120.23	113.80
1	C	162	PHE	CA-CB-CG	6.32	120.11	113.80
1	C	371	SER	N-CA-C	6.31	117.81	108.60
1	B	311	GLY	N-CA-C	5.83	120.87	114.40
1	B	284	ASN	OD1-CG-ND2	-5.77	116.83	122.60
1	C	183	ALA	CA-C-N	5.74	128.24	120.38
1	C	183	ALA	C-N-CA	5.74	128.24	120.38
1	B	6	ASP	CA-CB-CG	5.68	118.28	112.60
1	B	88	GLN	OE1-CD-NE2	-5.67	116.94	122.60
1	B	217	ASP	CA-CB-CG	5.64	118.24	112.60
1	C	331	ARG	CA-C-N	5.63	126.35	119.99
1	C	331	ARG	C-N-CA	5.63	126.35	119.99
1	B	65	GLN	OE1-CD-NE2	-5.45	117.15	122.60
1	B	403	ASP	CA-CB-CG	5.41	118.00	112.60
1	C	378	GLU	CA-C-N	5.35	130.87	122.21
1	C	378	GLU	C-N-CA	5.35	130.87	122.21
1	B	65	GLN	CA-C-N	5.30	131.66	121.54
1	B	65	GLN	C-N-CA	5.30	131.66	121.54
1	C	372	HIS	N-CA-C	5.27	116.73	110.19
1	C	70	ASN	OD1-CG-ND2	-5.26	117.34	122.60
1	B	390	ASN	N-CA-C	5.21	119.21	112.86
1	C	53	ASP	CA-CB-CG	5.20	117.80	112.60
1	B	309	ARG	CD-NE-CZ	5.20	131.68	124.40
1	B	85	ARG	CD-NE-CZ	5.20	131.68	124.40
1	B	129	PRO	CA-C-N	5.19	131.46	121.54
1	B	129	PRO	C-N-CA	5.19	131.46	121.54
1	B	64	THR	CA-C-N	-5.19	113.69	120.44
1	B	64	THR	C-N-CA	-5.19	113.69	120.44
1	B	226	ILE	CA-C-N	5.19	131.45	121.54
1	B	226	ILE	C-N-CA	5.19	131.45	121.54
1	B	223	LEU	CA-C-N	5.13	127.67	120.28
1	B	223	LEU	C-N-CA	5.13	127.67	120.28
1	C	79	ILE	N-CA-C	5.11	111.68	106.21
1	C	14	ASP	CA-CB-CG	5.09	117.69	112.60
1	B	14	ASP	CA-CB-CG	5.08	117.68	112.60
1	C	21	LEU	N-CA-CB	-5.07	103.88	111.64
1	B	175	PHE	CA-CB-CG	5.06	118.86	113.80
1	C	218	GLY	CA-C-N	5.03	126.90	120.56

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	218	GLY	C-N-CA	5.03	126.90	120.56
1	B	429	SER	N-CA-CB	-5.03	103.31	110.80
1	B	151	ASN	CA-C-N	5.02	127.68	120.56
1	B	151	ASN	C-N-CA	5.02	127.68	120.56
1	C	372	HIS	CB-CG-CD2	-5.01	124.69	131.20

There are no chirality outliers.

All (9) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	259	TYR	Sidechain
1	B	34	ARG	Sidechain
1	B	373	ARG	Sidechain
1	B	408	TYR	Sidechain
1	B	82	TYR	Sidechain
1	C	131	TYR	Sidechain
1	C	133	TYR	Sidechain
1	C	16	ARG	Sidechain
1	C	249	PHE	Sidechain

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	B	3322	3272	3271	10	0
1	C	3322	3272	3271	5	0
All	All	6644	6544	6542	12	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 1.

All (12) 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:B:181:TRP:CG	1:B:231:TYR:HH	2.24	0.56

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:93:ALA:HB1	1:C:96:ALA:HB1	1.88	0.55
1:B:181:TRP:CD1	1:B:231:TYR:HH	2.25	0.55
1:B:292:GLU:CD	1:B:395:LYS:HZ2	2.16	0.52
1:B:93:ALA:CB	1:C:96:ALA:HB1	2.42	0.49
1:B:147:MET:HG3	1:B:149:ILE:HG23	1.94	0.49
1:B:93:ALA:HA	1:C:96:ALA:HA	1.97	0.47
1:B:58:ARG:HD3	1:B:65:GLN:HG2	1.98	0.45
1:C:94:MET:HE1	1:C:114:VAL:HB	1.99	0.43
1:B:181:TRP:O	1:B:238:ILE:HD11	2.20	0.42
1:B:226:ILE:HG12	1:B:238:ILE:HD13	2.02	0.41
1:C:153:GLY:HA2	1:C:262:PHE:CE1	2.57	0.40

There are no symmetry-related clashes.

5.3 Torsion angles [i](#)

5.3.1 Protein backbone [i](#)

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

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

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	434/436 (100%)	364 (84%)	60 (14%)	10 (2%)	5	23
1	C	434/436 (100%)	376 (87%)	45 (10%)	13 (3%)	3	18
All	All	868/872 (100%)	740 (85%)	105 (12%)	23 (3%)	6	21

All (23) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	130	LEU
1	C	285	LYS
1	B	86	ASP
1	B	216	GLU
1	B	227	GLU
1	B	273	ALA
1	C	72	ASN

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Mol	Chain	Res	Type
1	C	130	LEU
1	B	233	ALA
1	C	86	ASP
1	C	245	ALA
1	C	378	GLU
1	C	391	ALA
1	C	428	LYS
1	B	66	LYS
1	C	71	VAL
1	C	400	SER
1	C	236	ASN
1	B	59	TYR
1	B	236	ASN
1	C	392	GLY
1	B	19	PRO
1	C	182	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	B	341/346 (99%)	315 (92%)	26 (8%)	12	38
1	C	341/346 (99%)	320 (94%)	21 (6%)	16	43
All	All	682/692 (99%)	635 (93%)	47 (7%)	16	40

All (47) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	36	MET
1	B	57	SER
1	B	68	VAL
1	B	85	ARG
1	B	111	ILE
1	B	124	ASP
1	B	126	LEU

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Mol	Chain	Res	Type
1	B	132	THR
1	B	140	LYS
1	B	174	THR
1	B	213	GLU
1	B	222	ILE
1	B	256	VAL
1	B	263	GLU
1	B	274	GLU
1	B	282	LEU
1	B	284	ASN
1	B	293	ASP
1	B	301	ASP
1	B	307	THR
1	B	309	ARG
1	B	310	LEU
1	B	316	LEU
1	B	367	THR
1	B	387	VAL
1	B	401	ARG
1	C	21	LEU
1	C	36	MET
1	C	53	ASP
1	C	66	LYS
1	C	68	VAL
1	C	72	ASN
1	C	77	GLU
1	C	149	ILE
1	C	156	SER
1	C	179	LEU
1	C	181	TRP
1	C	240	ILE
1	C	249	PHE
1	C	275	GLN
1	C	280	GLU
1	C	298	ASN
1	C	309	ARG
1	C	342	LEU
1	C	362	LYS
1	C	372	HIS
1	C	424	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	18	ASN
1	B	46	HIS
1	B	151	ASN
1	C	163	GLN
1	C	346	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](#)

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.

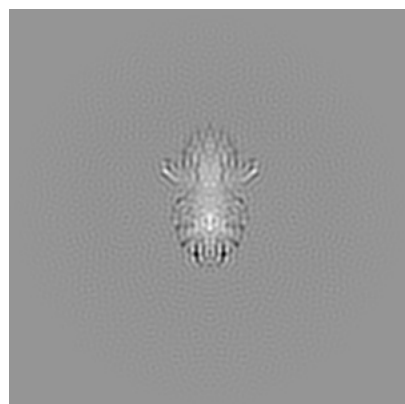
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-42441. These allow visual inspection of the internal detail of the map and identification of artifacts.

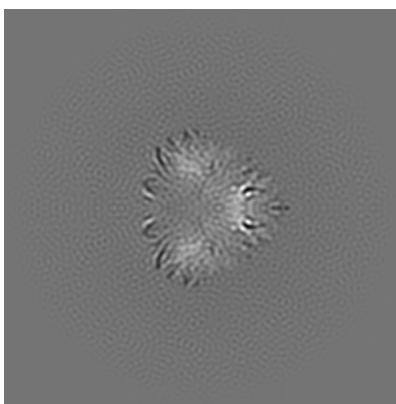
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

6.1 Orthogonal projections [i](#)

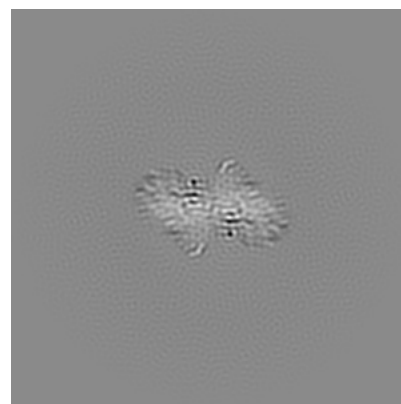
6.1.1 Primary map



X

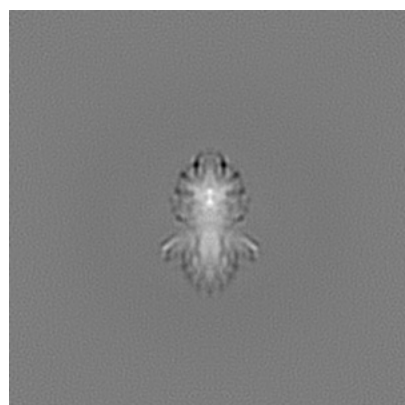


Y

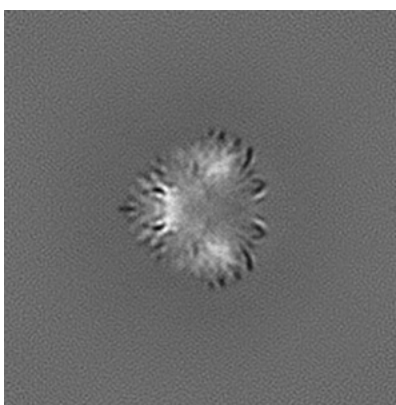


Z

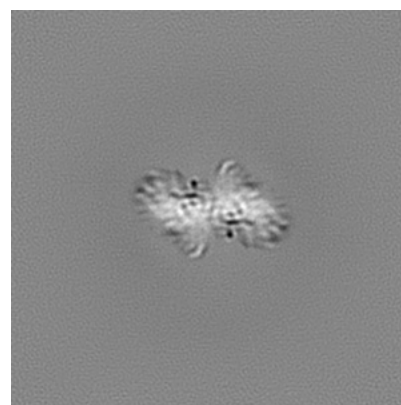
6.1.2 Raw map



X



Y

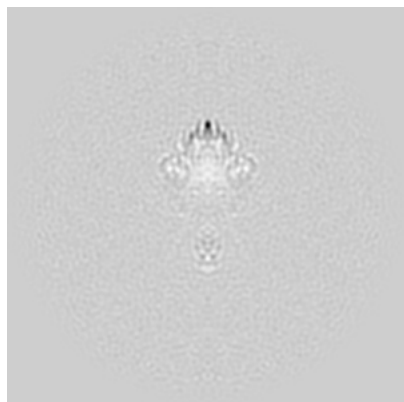


Z

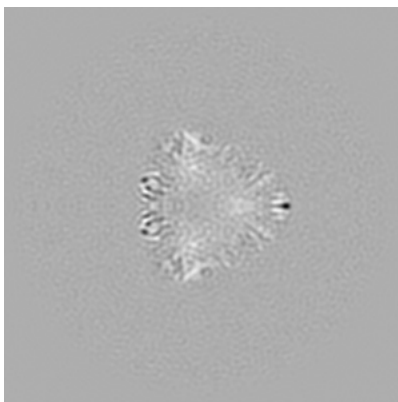
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

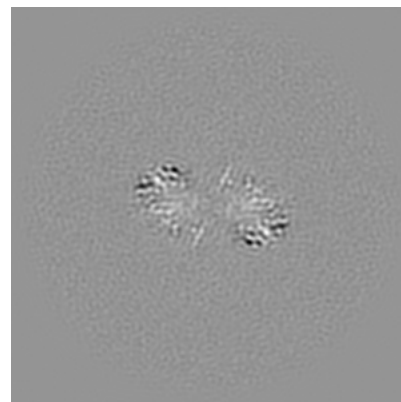
6.2.1 Primary map



X Index: 107

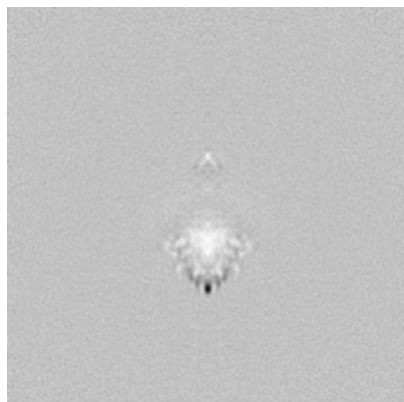


Y Index: 107

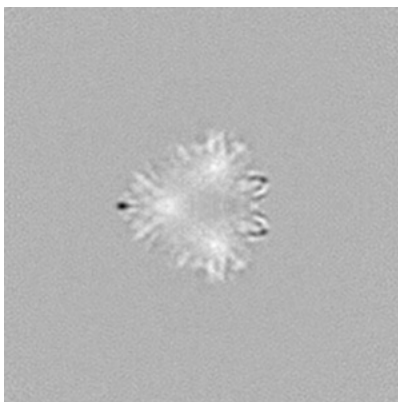


Z Index: 107

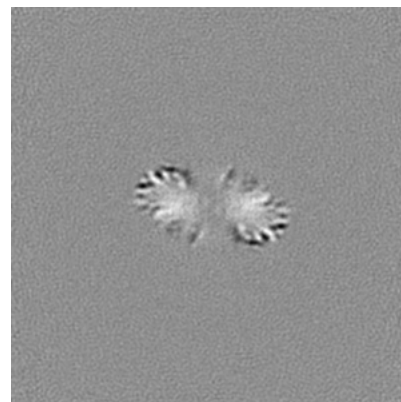
6.2.2 Raw map



X Index: 107



Y Index: 107

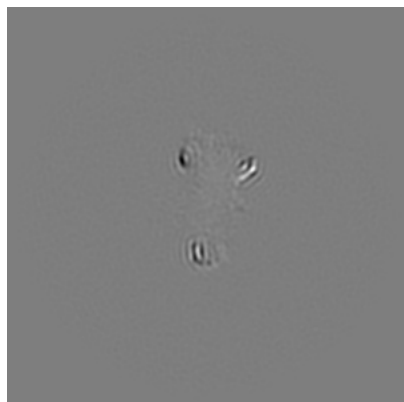


Z Index: 107

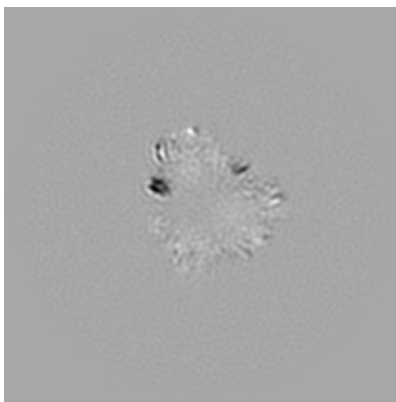
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

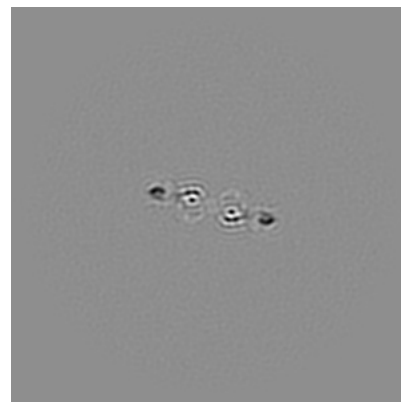
6.3.1 Primary map



X Index: 117



Y Index: 100

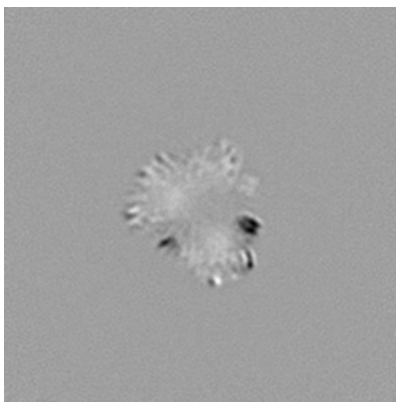


Z Index: 82

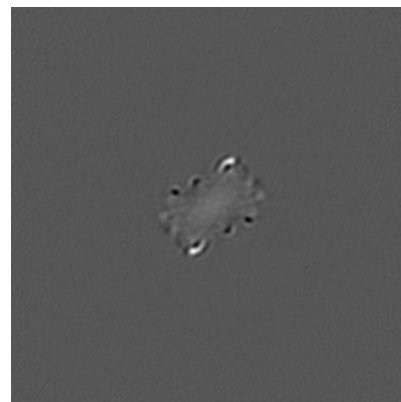
6.3.2 Raw map



X Index: 97



Y Index: 114

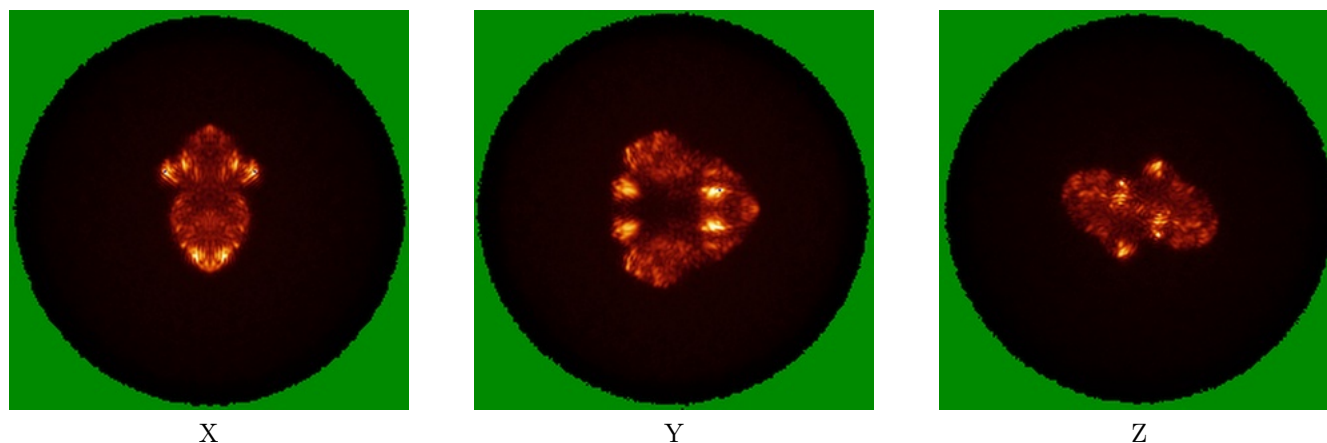


Z Index: 86

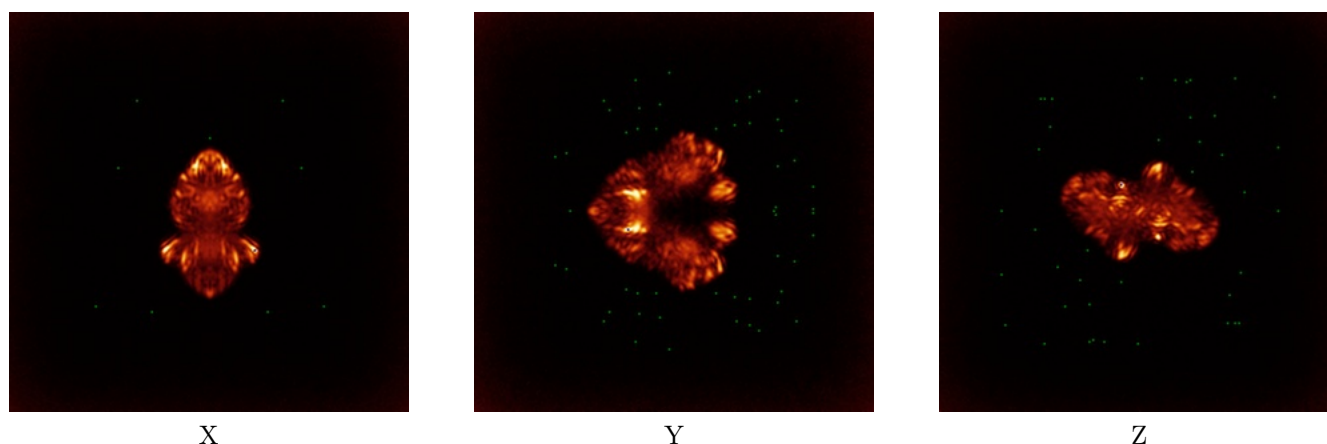
The images above show the largest variance slices of the map in three orthogonal directions.

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

6.4.1 Primary map



6.4.2 Raw map



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](#)

This section was not generated.

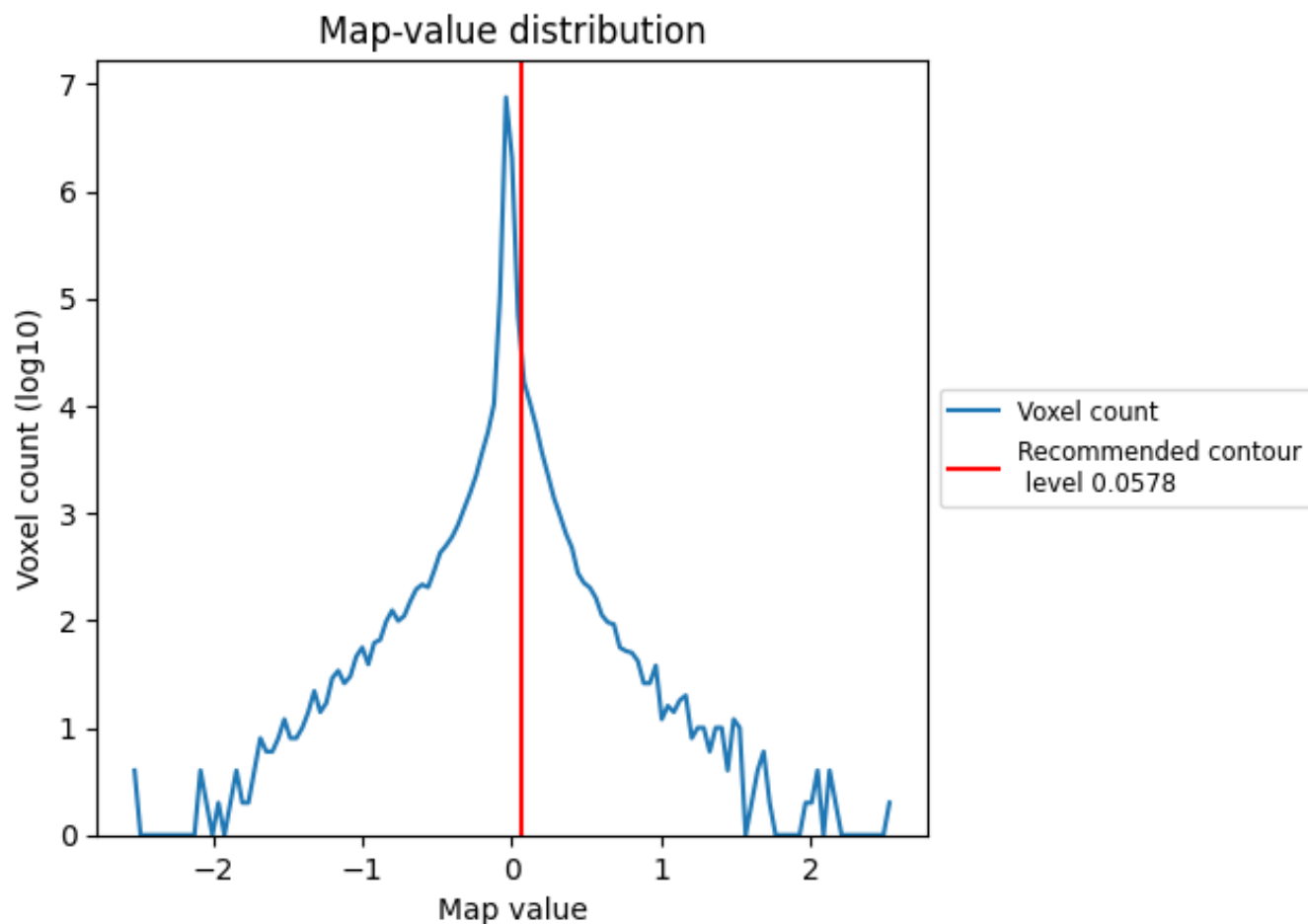
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

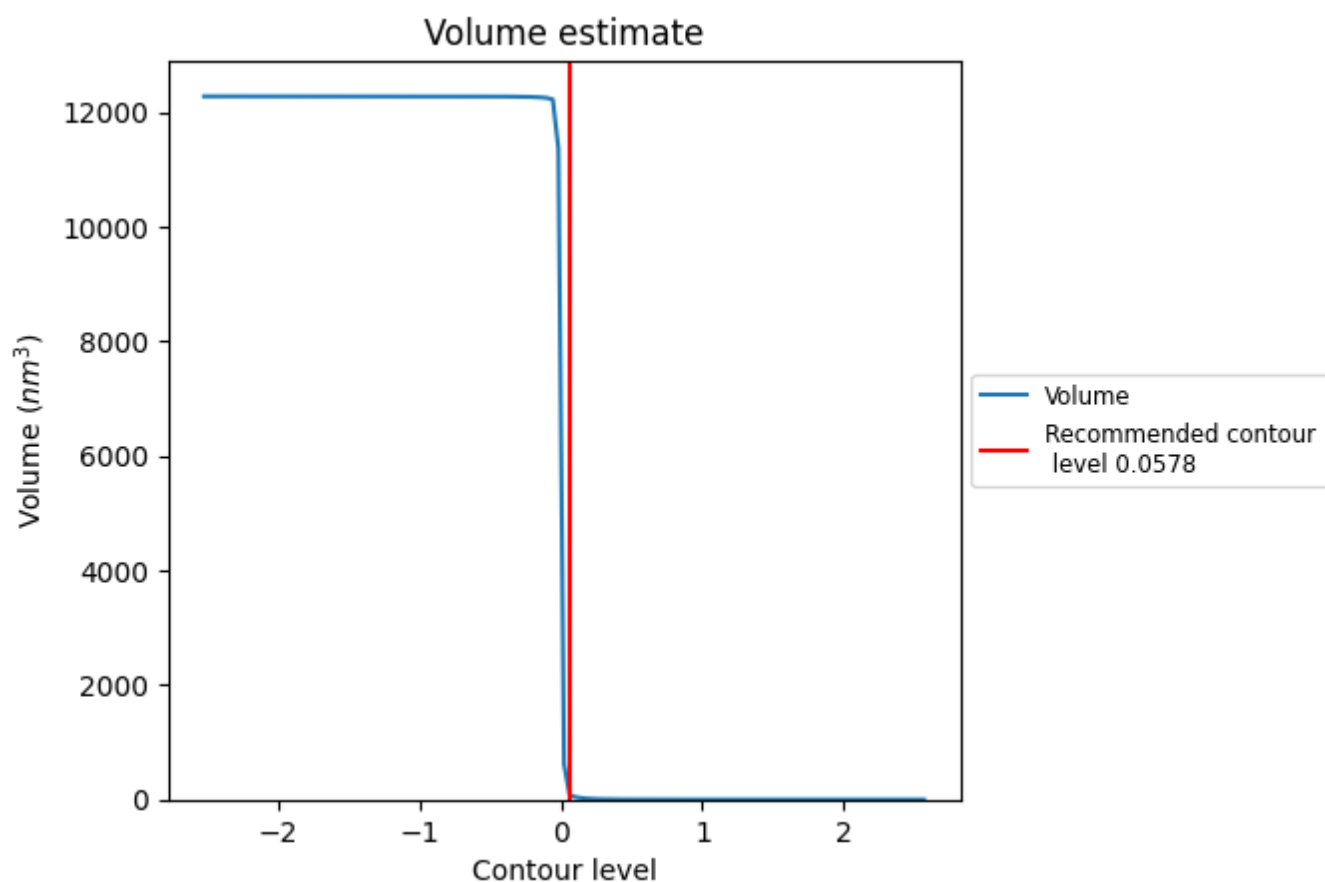
This section contains the results of statistical analysis of the map.

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.

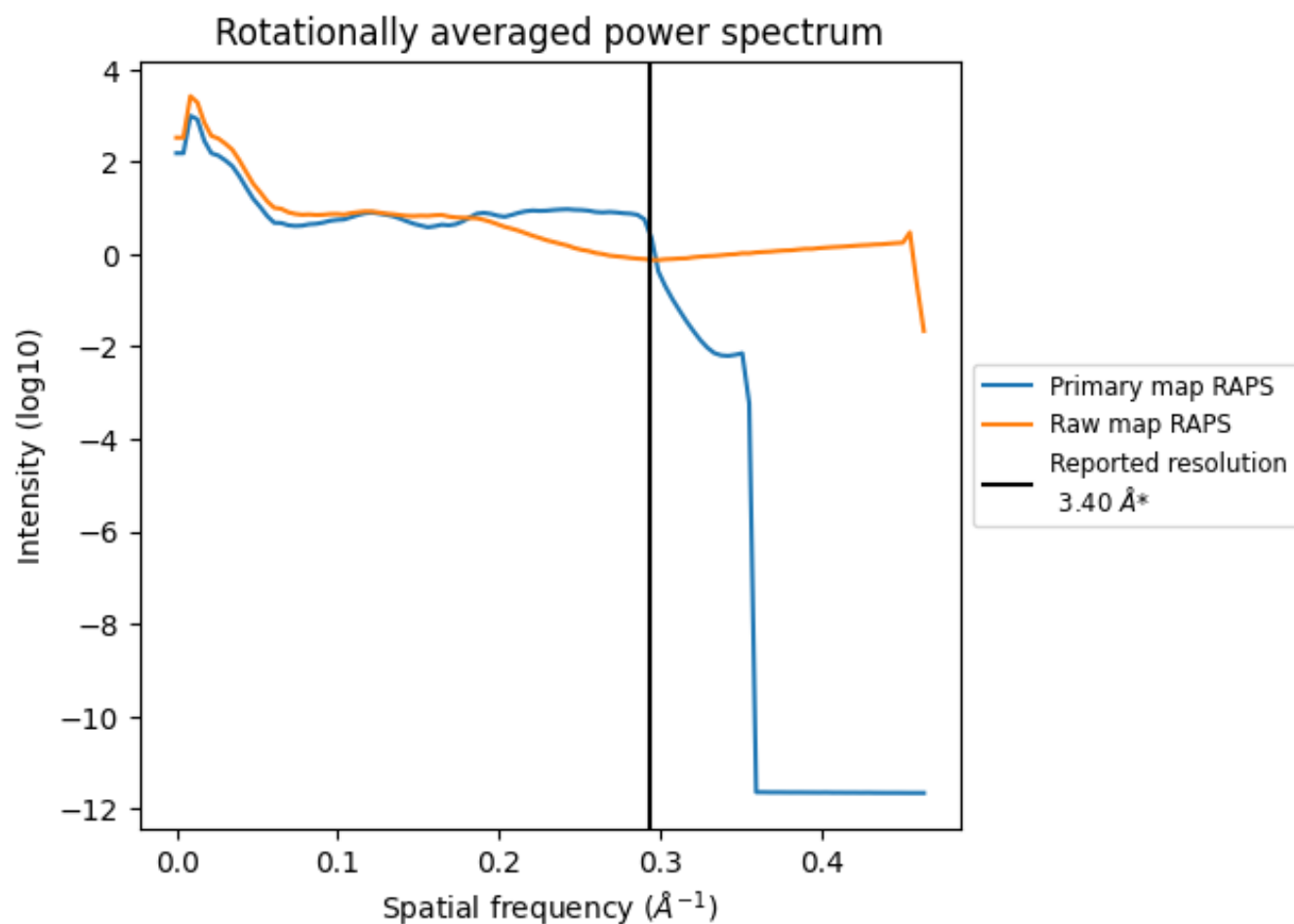
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 125 nm³; this corresponds to an approximate mass of 113 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 ⓘ

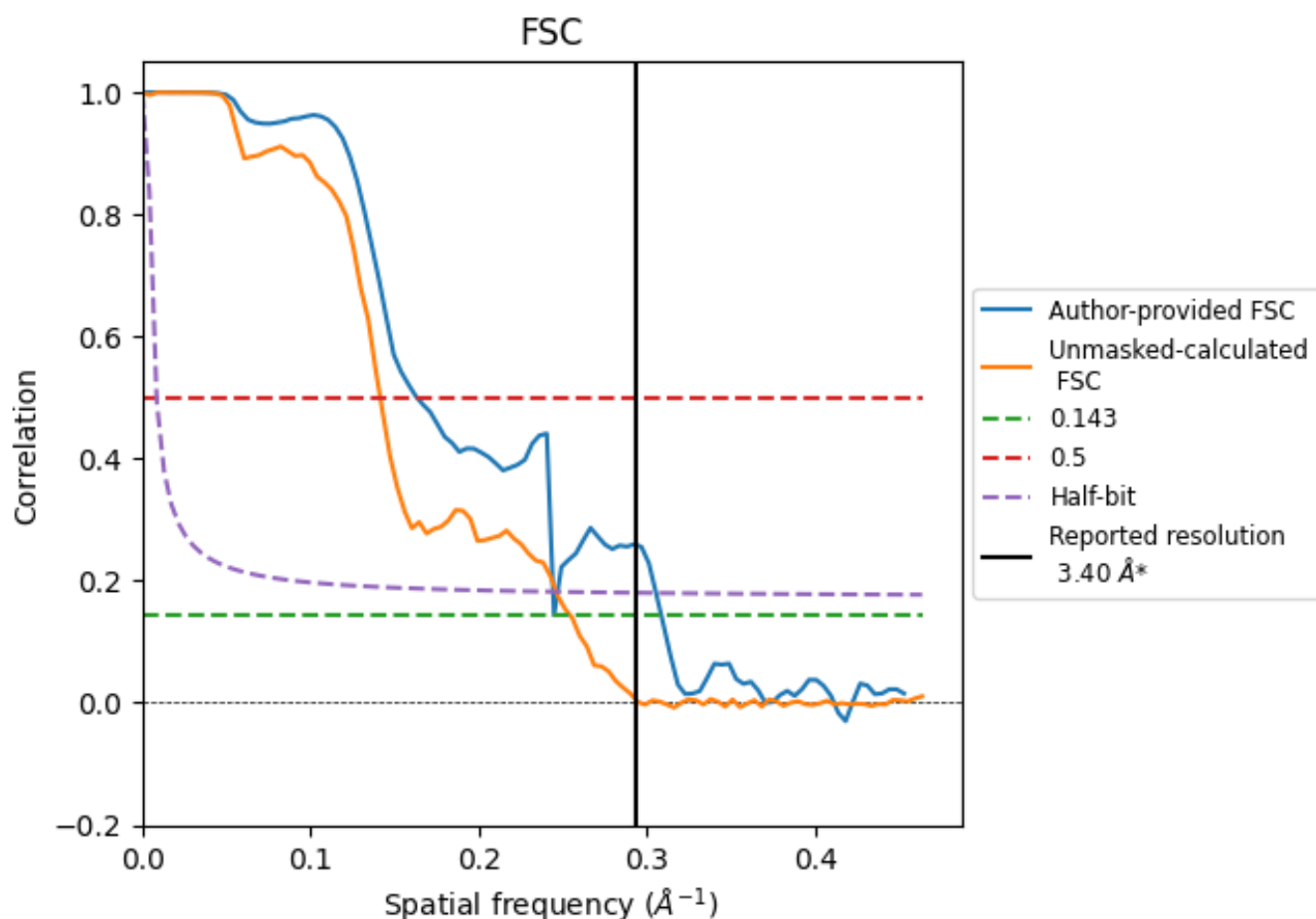


*Reported resolution corresponds to spatial frequency of 0.294 $\text{\AA}^{-1}$

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 0.294 $\text{\AA}^{-1}$

8.2 Resolution estimates [i](#)

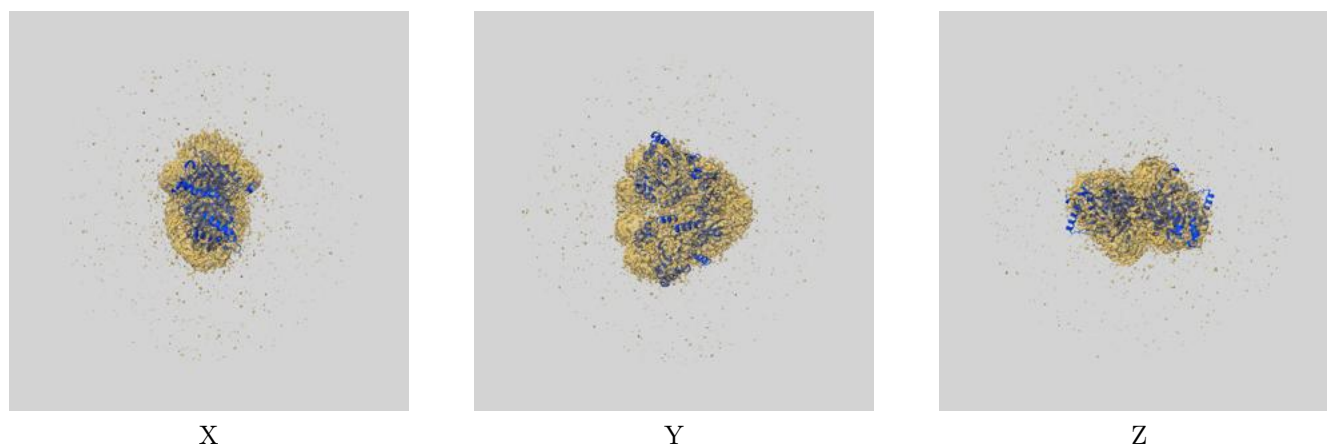
Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	3.40	-	-
Author-provided FSC curve	3.24	6.12	4.09
Unmasked-calculated*	3.93	7.06	4.06

*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 3.93 differs from the reported value 3.4 by more than 10 %

9 Map-model fit [i](#)

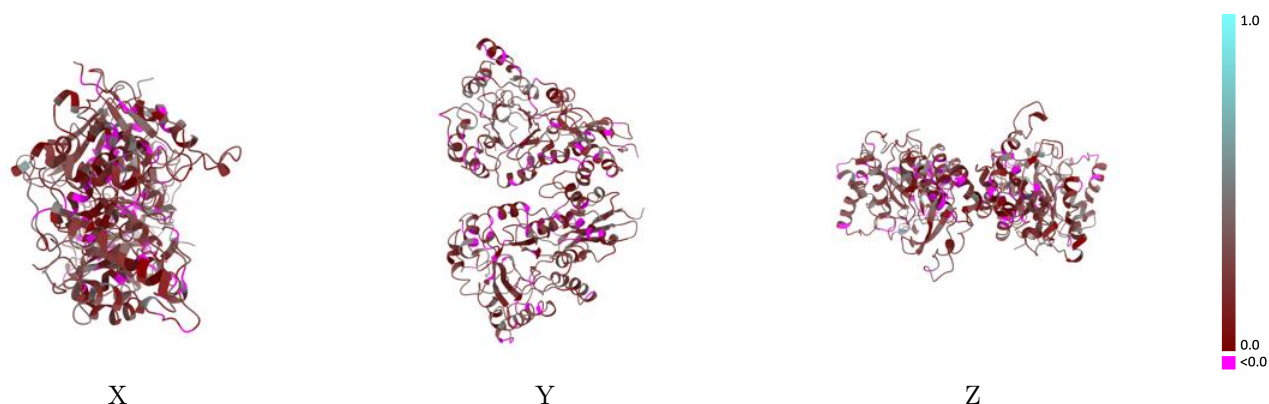
This section contains information regarding the fit between EMDB map EMD-42441 and PDB model 8UOY. Per-residue inclusion information can be found in [section 3](#) on [page 4](#).

9.1 Map-model overlay [i](#)



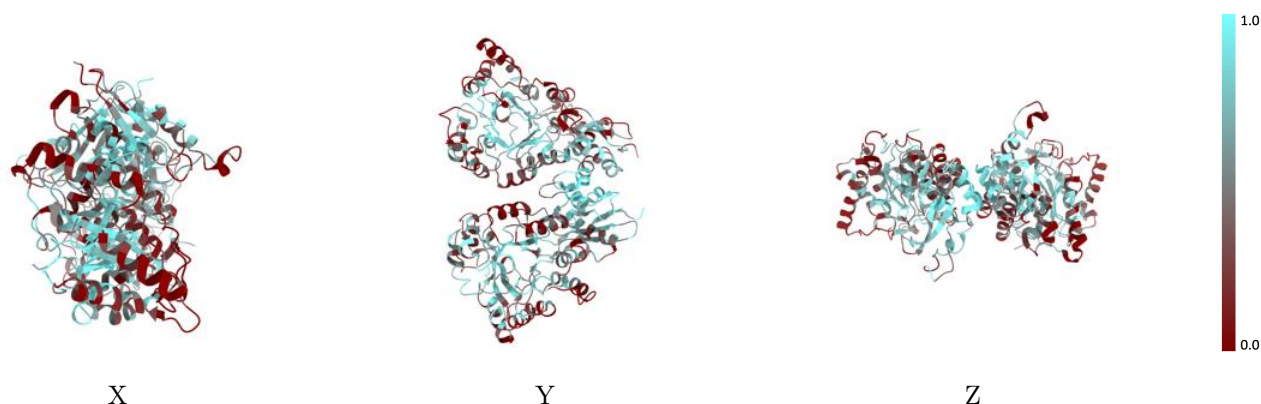
The images above show the 3D surface view of the map at the recommended contour level 0.0578 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



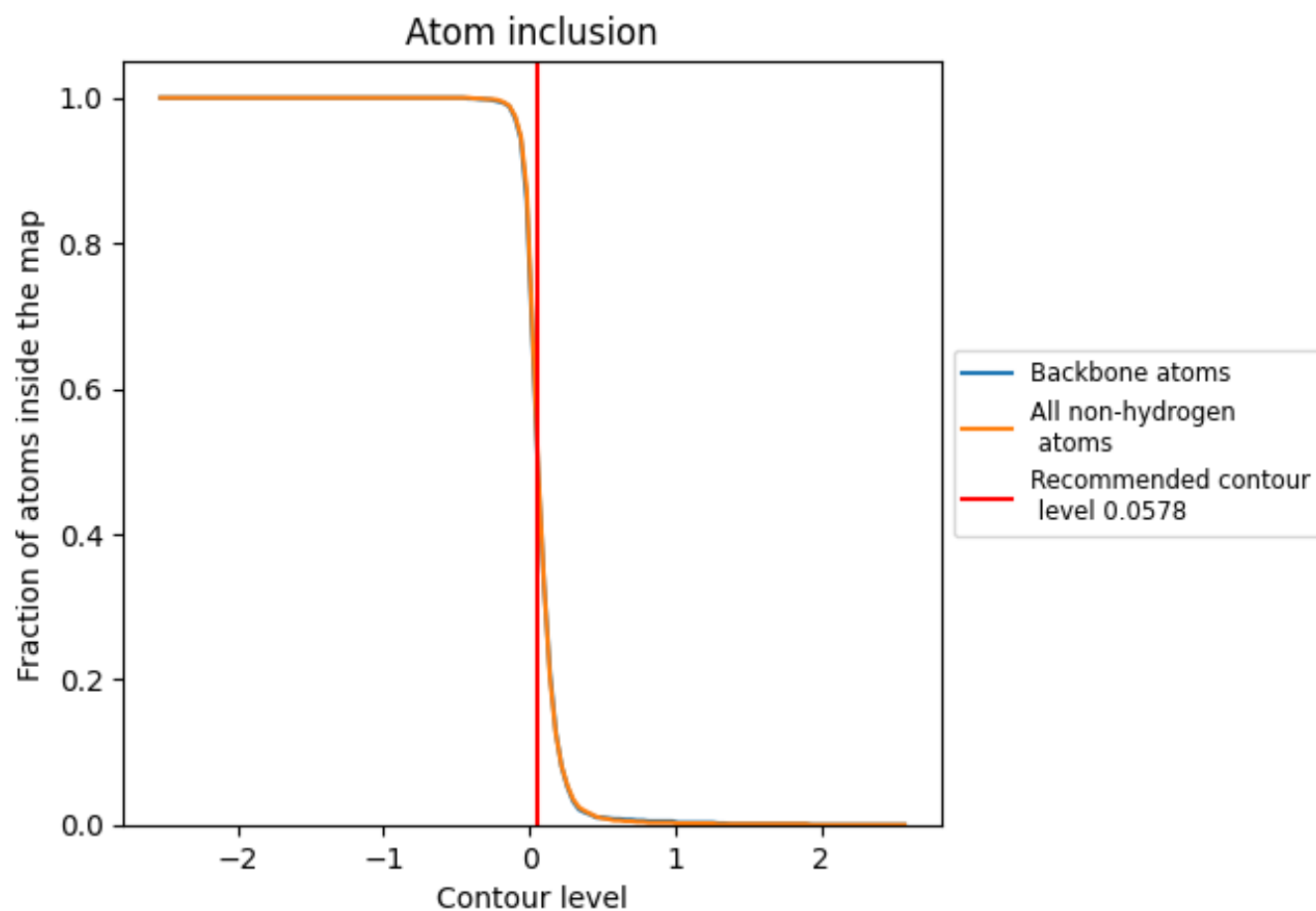
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (0.0578).

9.4 Atom inclusion [i](#)



At the recommended contour level, 49% of all backbone atoms, 50% 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 (0.0578) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.4980	0.2060
B	0.5130	0.2030
C	0.4930	0.2090

