



wwPDB EM Validation Summary Report ⓘ

Mar 8, 2026 – 03:17 AM UTC

PDB ID : 9VO1 / pdb_00009vo1
EMDB ID : EMD-65221
Title : Cryo-EM structure of Gi coupled Sphingosine 1-phosphate receptor bound with SAR247799
Authors : Yu, L.Y.; Jiao, H.Z.; Ti, R.J.; Pang, B.; Gan, B.; Ren, R.B.
Deposited on : 2025-07-01
Resolution : 2.97 Å(reported)

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

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

A user guide is available at

<https://www.wwpdb.org/validation/2017/EMValidationReportHelp>
with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

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

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

EMDB validation analysis : 0.0.1.dev132
Mogul : 2022.3.0, CSD as543be (2022)
MolProbity : 4-5-2 with Phenix2.0
Buster-report : wwPDB partial adaption of 1.1.7 (2018)
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

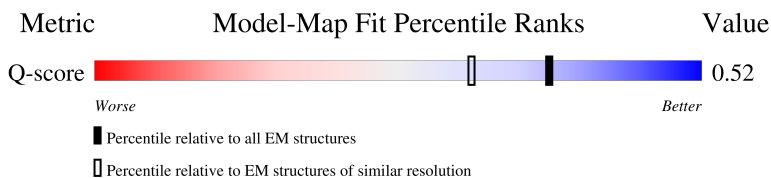
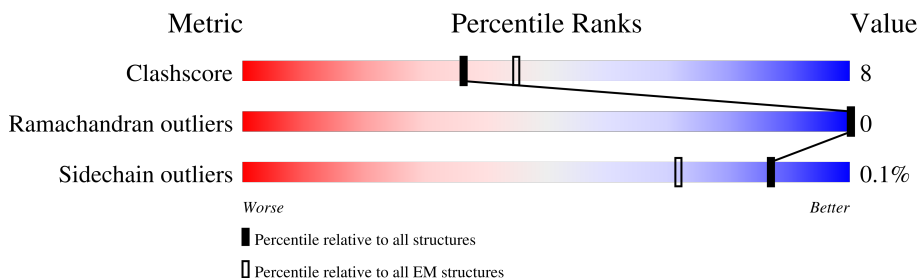
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY

The reported resolution of this entry is 2.97 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	13205 (2.47 - 3.47)

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	357	 8% 78% 17% 5%
2	C	71	 8% 68% 13% 20%
3	E	251	 8% 84% 10% 6%
4	F	534	 44% 9% 47%

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Mol	Chain	Length	Quality of chain
5	D	354	55% 8% 37%

2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 8861 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 Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	338	2595	1598	467	509	21	0	0

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-17	HIS	-	expression tag	UNP P62873
A	-16	HIS	-	expression tag	UNP P62873
A	-15	HIS	-	expression tag	UNP P62873
A	-14	HIS	-	expression tag	UNP P62873
A	-13	HIS	-	expression tag	UNP P62873
A	-12	HIS	-	expression tag	UNP P62873
A	-11	LEU	-	expression tag	UNP P62873
A	-10	GLU	-	expression tag	UNP P62873
A	-9	VAL	-	expression tag	UNP P62873
A	-8	LEU	-	expression tag	UNP P62873
A	-7	PHE	-	expression tag	UNP P62873
A	-6	GLN	-	expression tag	UNP P62873
A	-5	GLY	-	expression tag	UNP P62873
A	-4	PRO	-	expression tag	UNP P62873
A	-3	GLY	-	expression tag	UNP P62873
A	-2	SER	-	expression tag	UNP P62873
A	-1	SER	-	expression tag	UNP P62873
A	0	GLY	-	expression tag	UNP P62873

- Molecule 2 is a protein called Guanine nucleotide-binding protein G(I)/G(S)/G(O) subunit gamma-2.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	C	57	436	273	77	83	3	0	0

- Molecule 3 is a protein called scFv16.

Mol	Chain	Residues	Atoms					AltConf	Trace
3	E	235	Total	C	N	O	S	0	0
			1804	1143	299	352	10		

- Molecule 4 is a protein called Soluble cytochrome b562,Sphingosine 1-phosphate receptor 1.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	F	281	Total	C	N	O	S	0	0
			2202	1470	358	359	15		

There are 49 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	-139	MET	-	initiating methionine	UNP P0ABE7
F	-138	LYS	-	expression tag	UNP P0ABE7
F	-137	THR	-	expression tag	UNP P0ABE7
F	-136	ILE	-	expression tag	UNP P0ABE7
F	-135	ILE	-	expression tag	UNP P0ABE7
F	-134	ALA	-	expression tag	UNP P0ABE7
F	-133	LEU	-	expression tag	UNP P0ABE7
F	-132	SER	-	expression tag	UNP P0ABE7
F	-131	TYR	-	expression tag	UNP P0ABE7
F	-130	ILE	-	expression tag	UNP P0ABE7
F	-129	PHE	-	expression tag	UNP P0ABE7
F	-128	CYS	-	expression tag	UNP P0ABE7
F	-127	LEU	-	expression tag	UNP P0ABE7
F	-126	VAL	-	expression tag	UNP P0ABE7
F	-125	PHE	-	expression tag	UNP P0ABE7
F	-124	ALA	-	expression tag	UNP P0ABE7
F	-123	ASP	-	expression tag	UNP P0ABE7
F	-122	TYR	-	expression tag	UNP P0ABE7
F	-121	LYS	-	expression tag	UNP P0ABE7
F	-120	ASP	-	expression tag	UNP P0ABE7
F	-119	ASP	-	expression tag	UNP P0ABE7
F	-118	ASP	-	expression tag	UNP P0ABE7
F	-117	ASP	-	expression tag	UNP P0ABE7
F	-116	LYS	-	expression tag	UNP P0ABE7
F	-115	LEU	-	expression tag	UNP P0ABE7
F	-114	GLU	-	expression tag	UNP P0ABE7
F	-113	VAL	-	expression tag	UNP P0ABE7
F	-112	LEU	-	expression tag	UNP P0ABE7
F	-111	PHE	-	expression tag	UNP P0ABE7
F	-110	GLN	-	expression tag	UNP P0ABE7
F	-109	GLY	-	expression tag	UNP P0ABE7

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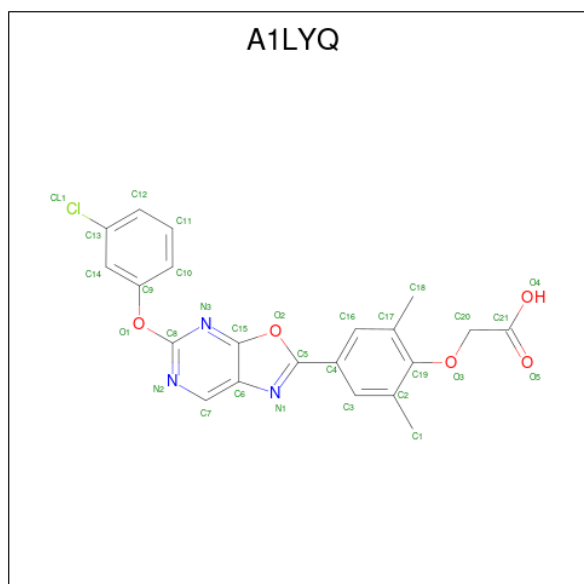
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Chain	Residue	Modelled	Actual	Comment	Reference
F	-108	PRO	-	expression tag	UNP P0ABE7
F	-107	GLY	-	expression tag	UNP P0ABE7
F	-106	SER	-	expression tag	UNP P0ABE7
F	-99	TRP	MET	conflict	UNP P0ABE7
F	-4	ILE	HIS	conflict	UNP P0ABE7
F	0	LEU	ARG	conflict	UNP P0ABE7
F	383	LEU	-	expression tag	UNP P21453
F	384	GLU	-	expression tag	UNP P21453
F	385	HIS	-	expression tag	UNP P21453
F	386	HIS	-	expression tag	UNP P21453
F	387	HIS	-	expression tag	UNP P21453
F	388	HIS	-	expression tag	UNP P21453
F	389	HIS	-	expression tag	UNP P21453
F	390	HIS	-	expression tag	UNP P21453
F	391	HIS	-	expression tag	UNP P21453
F	392	HIS	-	expression tag	UNP P21453
F	393	HIS	-	expression tag	UNP P21453
F	394	HIS	-	expression tag	UNP P21453

- Molecule 5 is a protein called Guanine nucleotide-binding protein G(i) subunit alpha-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
5	D	223	Total	C	N	O	S	0	0
			1794	1144	298	338	14		

- Molecule 6 is SAR247799 (CCD ID: A1LYQ) (formula: C₂₁H₁₆ClN₃O₅) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					AltConf
6	F	1	Total	C	Cl	N	O	0
			30	21	1	3	5	

4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	94216	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	TFS KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/\text{\AA}^2$)	56.14	Depositor
Minimum defocus (nm)	1100	Depositor
Maximum defocus (nm)	1900	Depositor
Magnification	Not provided	
Image detector	GATAN K3 (6k x 4k)	Depositor
Maximum map value	2.083	Depositor
Minimum map value	-1.517	Depositor
Average map value	-0.000	Depositor
Map value standard deviation	0.053	Depositor
Recommended contour level	0.16	Depositor
Map size ($\text{\AA}$)	238.0, 238.0, 238.0	wwPDB
Map dimensions	280, 280, 280	wwPDB
Map angles ($^\circ$)	90.0, 90.0, 90.0	wwPDB
Pixel spacing ($\text{\AA}$)	0.85, 0.85, 0.85	Depositor

5 Model quality [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: A1LYQ

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	0.12	0/2641	0.32	0/3580
2	C	0.13	0/442	0.46	0/597
3	E	0.10	0/1848	0.32	0/2504
4	F	0.19	0/2250	0.38	0/3062
5	D	0.19	0/1823	0.37	0/2444
All	All	0.15	0/9004	0.35	0/12187

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	2595	0	2496	46	0
2	C	436	0	448	15	0
3	E	1804	0	1740	17	0
4	F	2202	0	2293	46	0
5	D	1794	0	1792	22	0
6	F	30	0	0	0	0
All	All	8861	0	8769	136	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including

hydrogen atoms). The all-atom clashscore for this structure is 8.

The worst 5 of 136 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)
4:F:28:HIS:CE1	4:F:197:LEU:HD13	1.71	1.24
1:A:224:HIS:HE2	1:A:242:THR:HG1	1.08	1.01
1:A:13:LEU:CD2	2:C:20:LYS:HE2	1.92	1.00
1:A:250:ARG:HG2	1:A:262:THR:HG22	1.49	0.93
1:A:13:LEU:HD23	2:C:20:LYS:HE2	1.50	0.92

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	336/357 (94%)	313 (93%)	23 (7%)	0	100	100
2	C	55/71 (78%)	52 (94%)	3 (6%)	0	100	100
3	E	231/251 (92%)	223 (96%)	8 (4%)	0	100	100
4	F	275/534 (52%)	259 (94%)	16 (6%)	0	100	100
5	D	217/354 (61%)	203 (94%)	14 (6%)	0	100	100
All	All	1114/1567 (71%)	1050 (94%)	64 (6%)	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	280/297 (94%)	280 (100%)	0	100	100
2	C	46/58 (79%)	46 (100%)	0	100	100
3	E	199/201 (99%)	199 (100%)	0	100	100
4	F	236/470 (50%)	235 (100%)	1 (0%)	84	90
5	D	198/305 (65%)	198 (100%)	0	100	100
All	All	959/1331 (72%)	958 (100%)	1 (0%)	87	94

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

Mol	Chain	Res	Type
4	F	198	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 9 such sidechains are listed below:

Mol	Chain	Res	Type
4	F	156	ASN
4	F	307	ASN
2	C	11	GLN
3	E	186	GLN
4	F	63	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](#)

1 ligand 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	$\# Z > 2$
6	A1LYQ	F	401	-	32,33,33	2.74	16 (50%)	45,47,47	2.08	13 (28%)

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
6	A1LYQ	F	401	-	-	6/13/13/13	0/4/4/4

The worst 5 of 16 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	F	401	A1LYQ	C4-C5	6.15	1.60	1.47
6	F	401	A1LYQ	C8-N2	5.72	1.39	1.32
6	F	401	A1LYQ	C20-C21	4.65	1.64	1.50
6	F	401	A1LYQ	C8-N3	4.28	1.41	1.33
6	F	401	A1LYQ	C15-N3	4.09	1.38	1.32

The worst 5 of 13 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	F	401	A1LYQ	C8-N3-C15	-5.23	110.67	115.09
6	F	401	A1LYQ	C3-C4-C16	-4.42	114.48	119.65
6	F	401	A1LYQ	C7-C6-C15	-4.19	111.66	116.24
6	F	401	A1LYQ	N2-C8-N3	-4.06	124.85	128.35
6	F	401	A1LYQ	C8-O1-C9	3.35	127.08	118.72

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	F	401	A1LYQ	C10-C9-O1-C8

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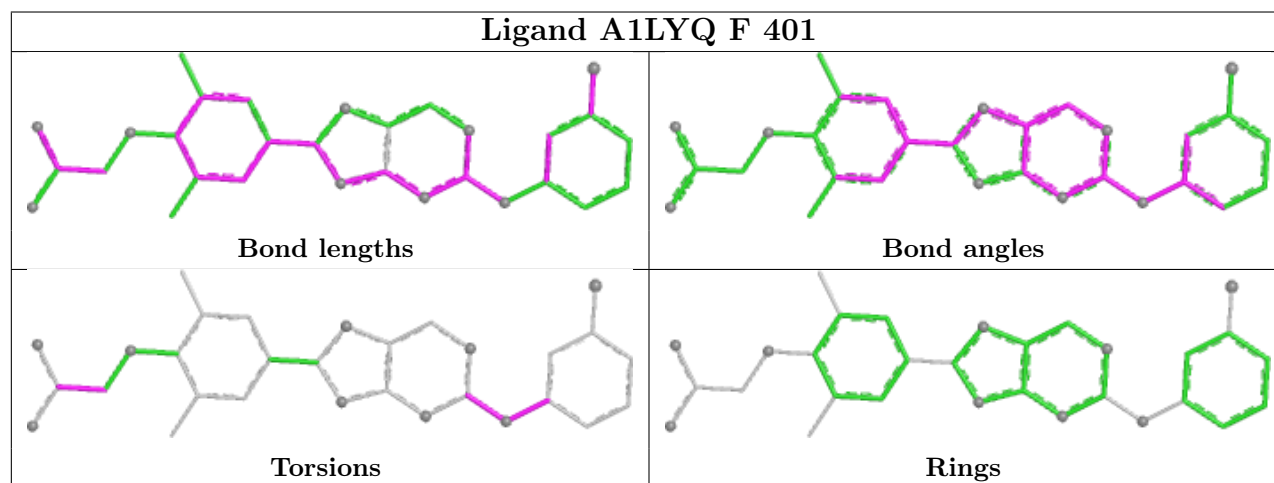
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Mol	Chain	Res	Type	Atoms
6	F	401	A1LYQ	C14-C9-O1-C8
6	F	401	A1LYQ	O3-C20-C21-O5
6	F	401	A1LYQ	O3-C20-C21-O4
6	F	401	A1LYQ	N3-C8-O1-C9

There are no ring outliers.

No monomer is involved in short contacts.

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



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.

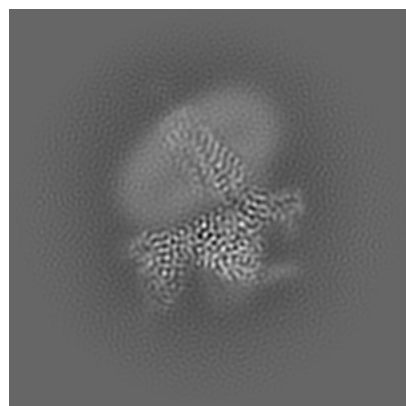
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-65221. These allow visual inspection of the internal detail of the map and identification of artifacts.

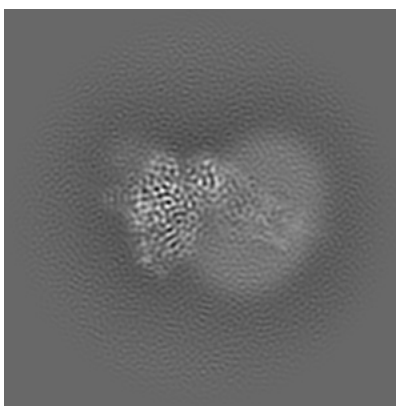
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

6.1 Orthogonal projections [i](#)

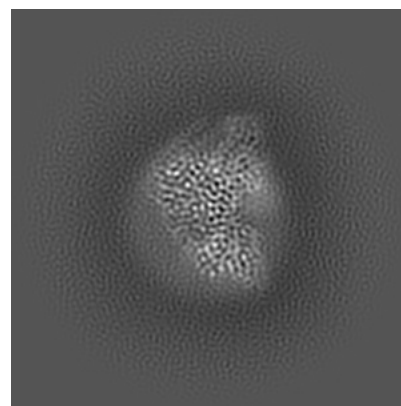
6.1.1 Primary map



X

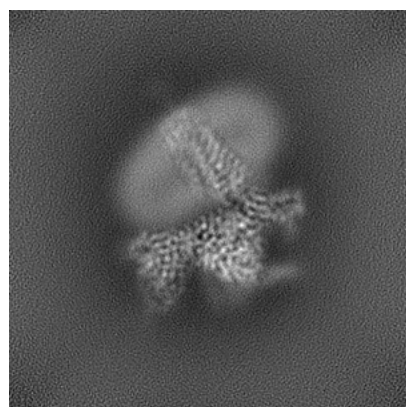


Y

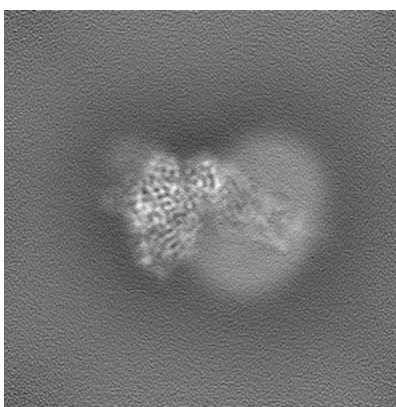


Z

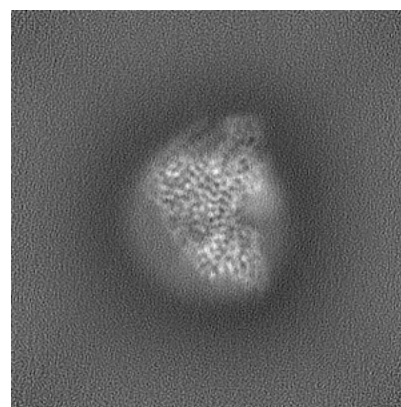
6.1.2 Raw map



X



Y

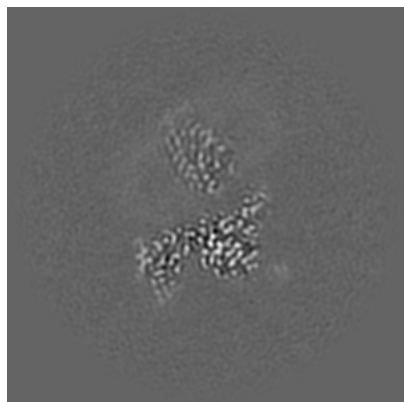


Z

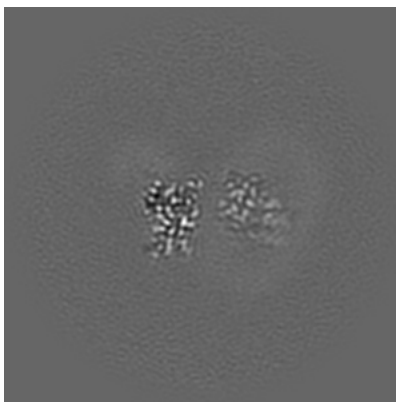
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

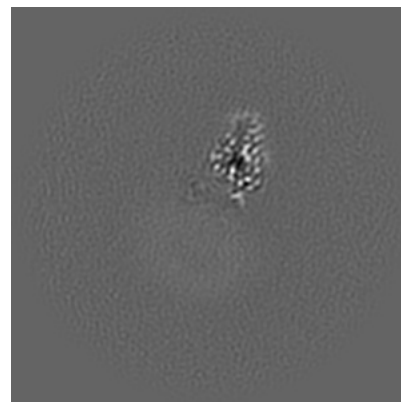
6.2.1 Primary map



X Index: 140

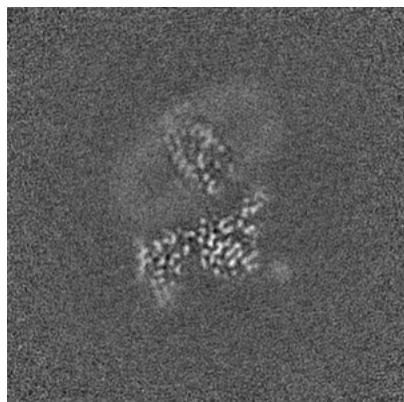


Y Index: 140

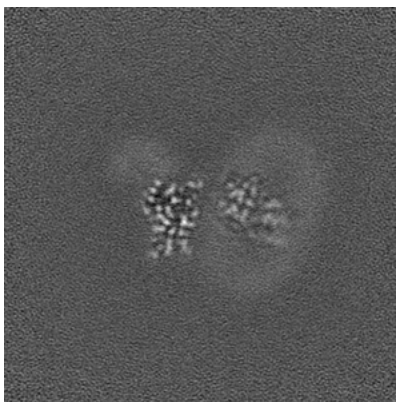


Z Index: 140

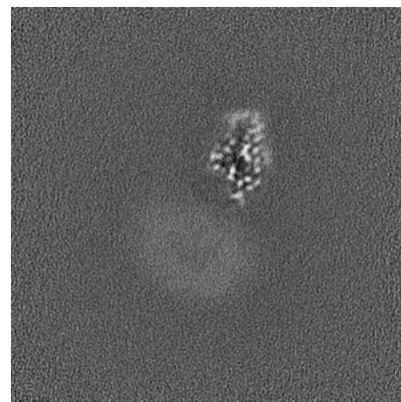
6.2.2 Raw map



X Index: 140



Y Index: 140

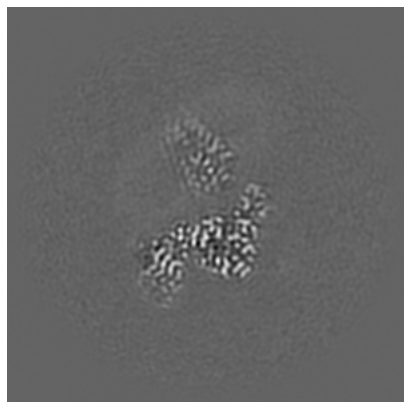


Z Index: 140

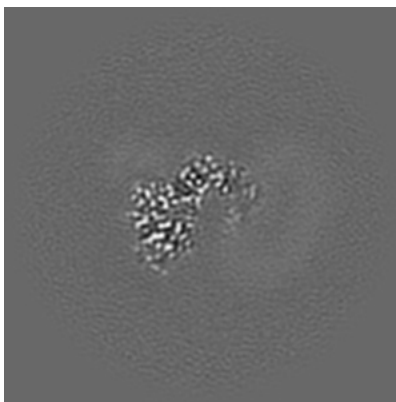
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

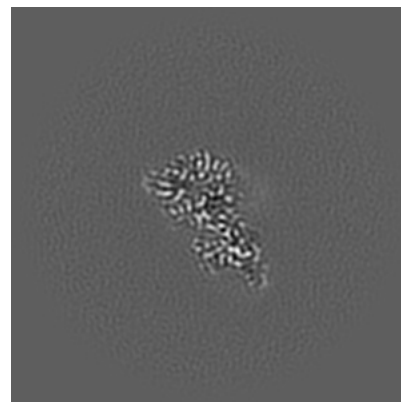
6.3.1 Primary map



X Index: 143

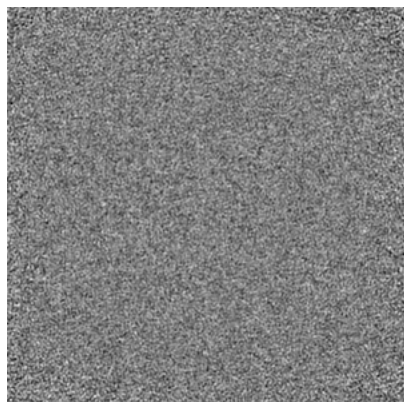


Y Index: 160

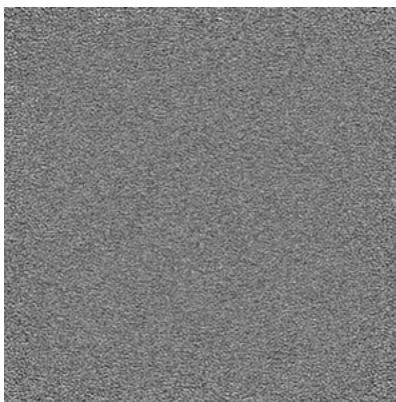


Z Index: 111

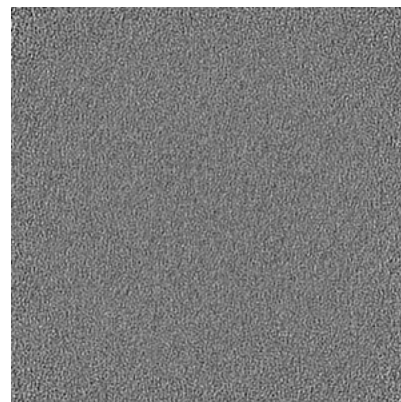
6.3.2 Raw map



X Index: 0



Y Index: 0

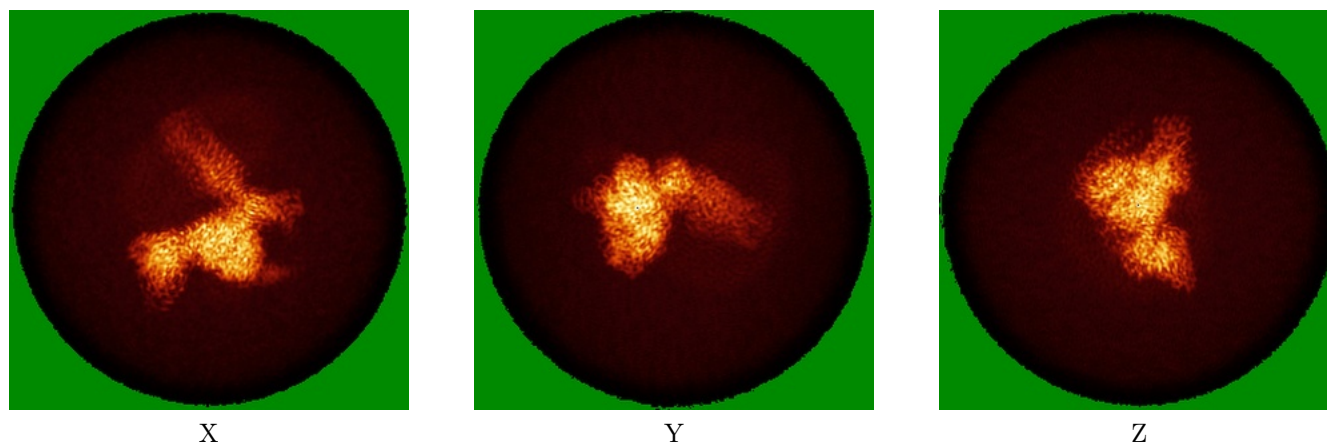


Z Index: 0

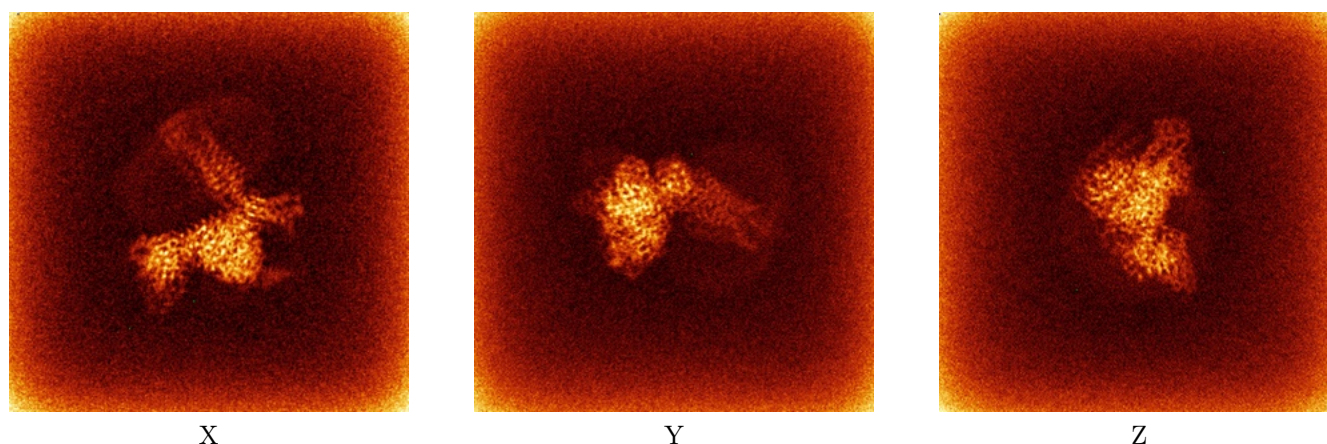
The images above show the largest variance slices of the map in three orthogonal directions.

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.

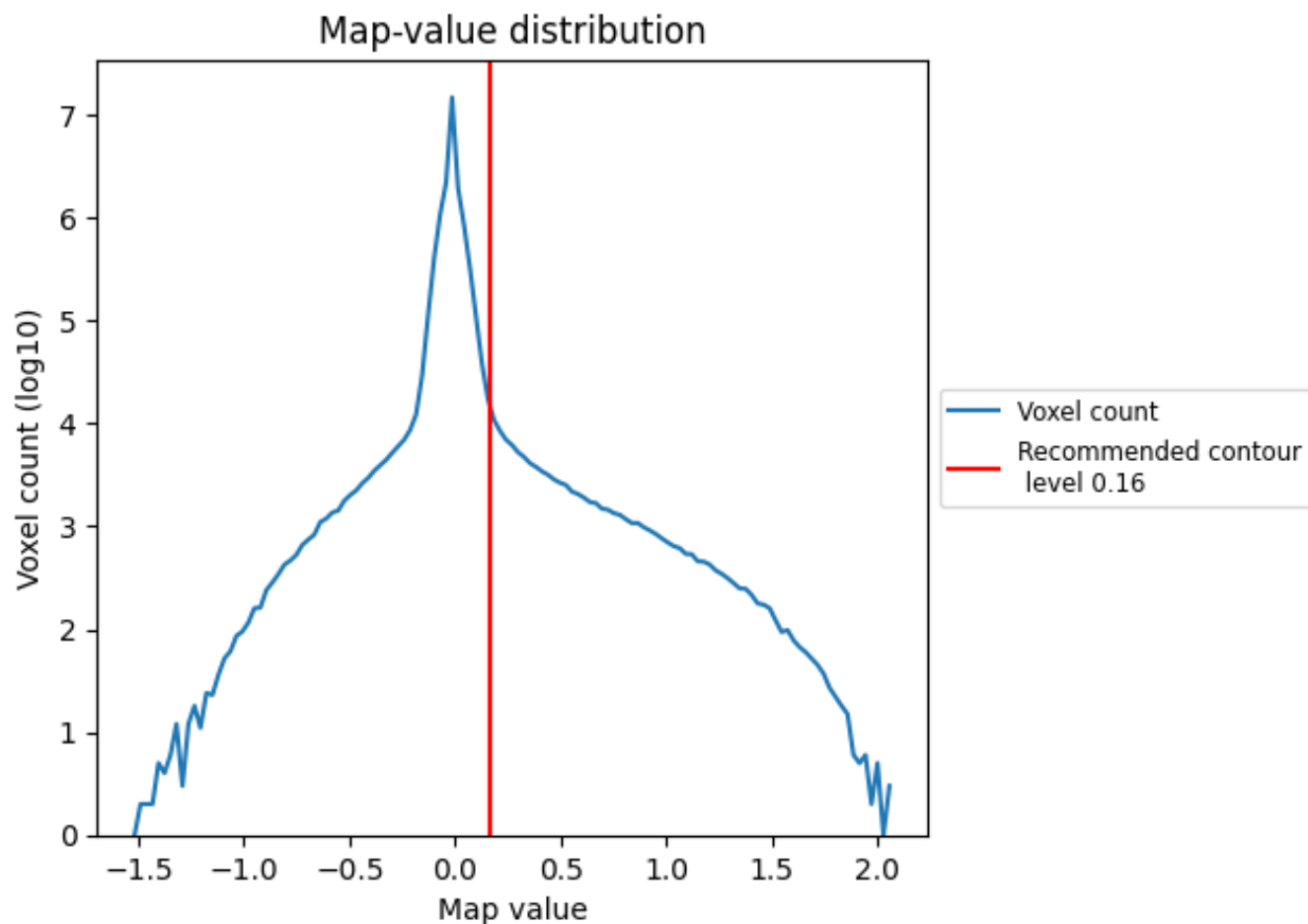
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

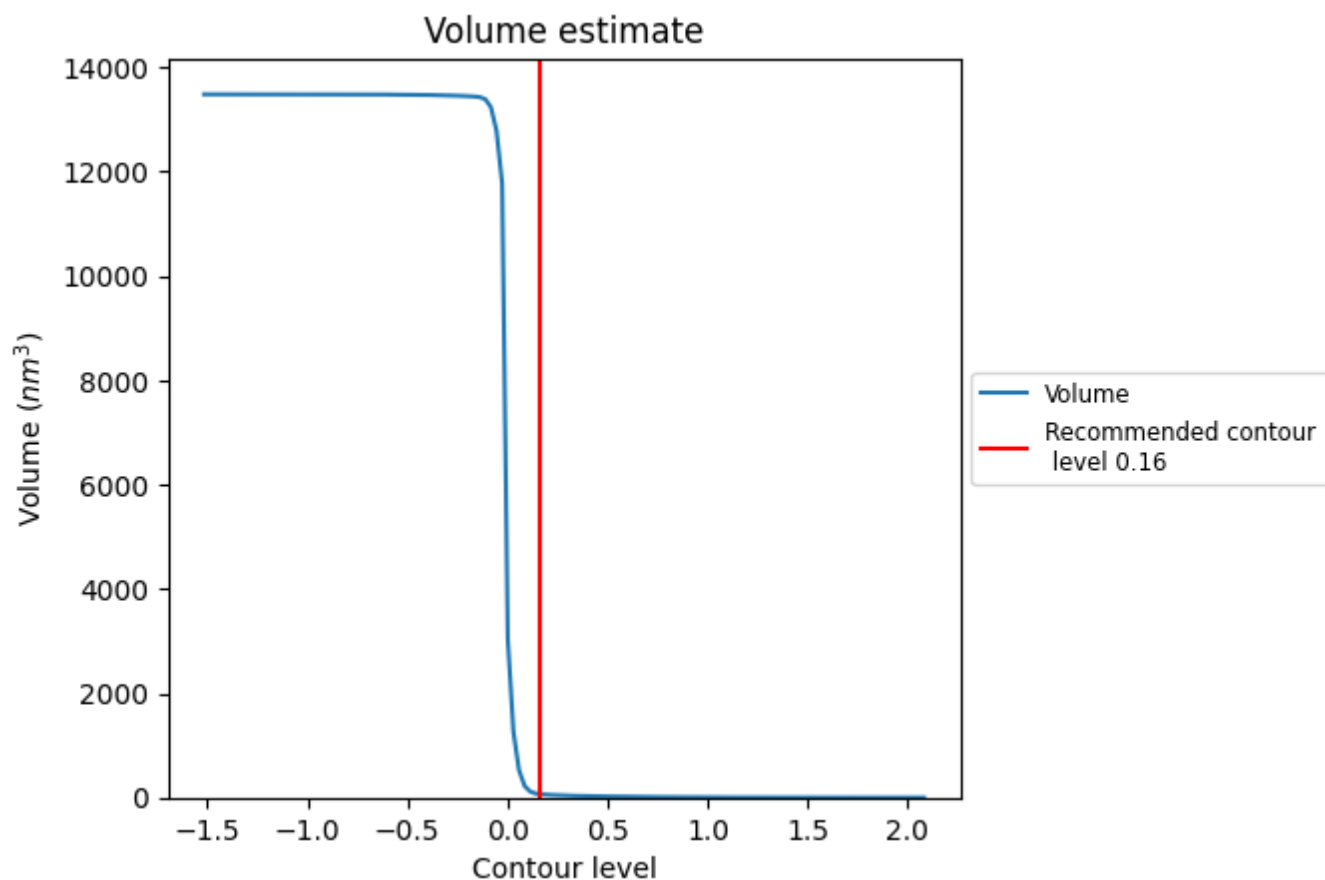
This section contains the results of statistical analysis of the map.

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.

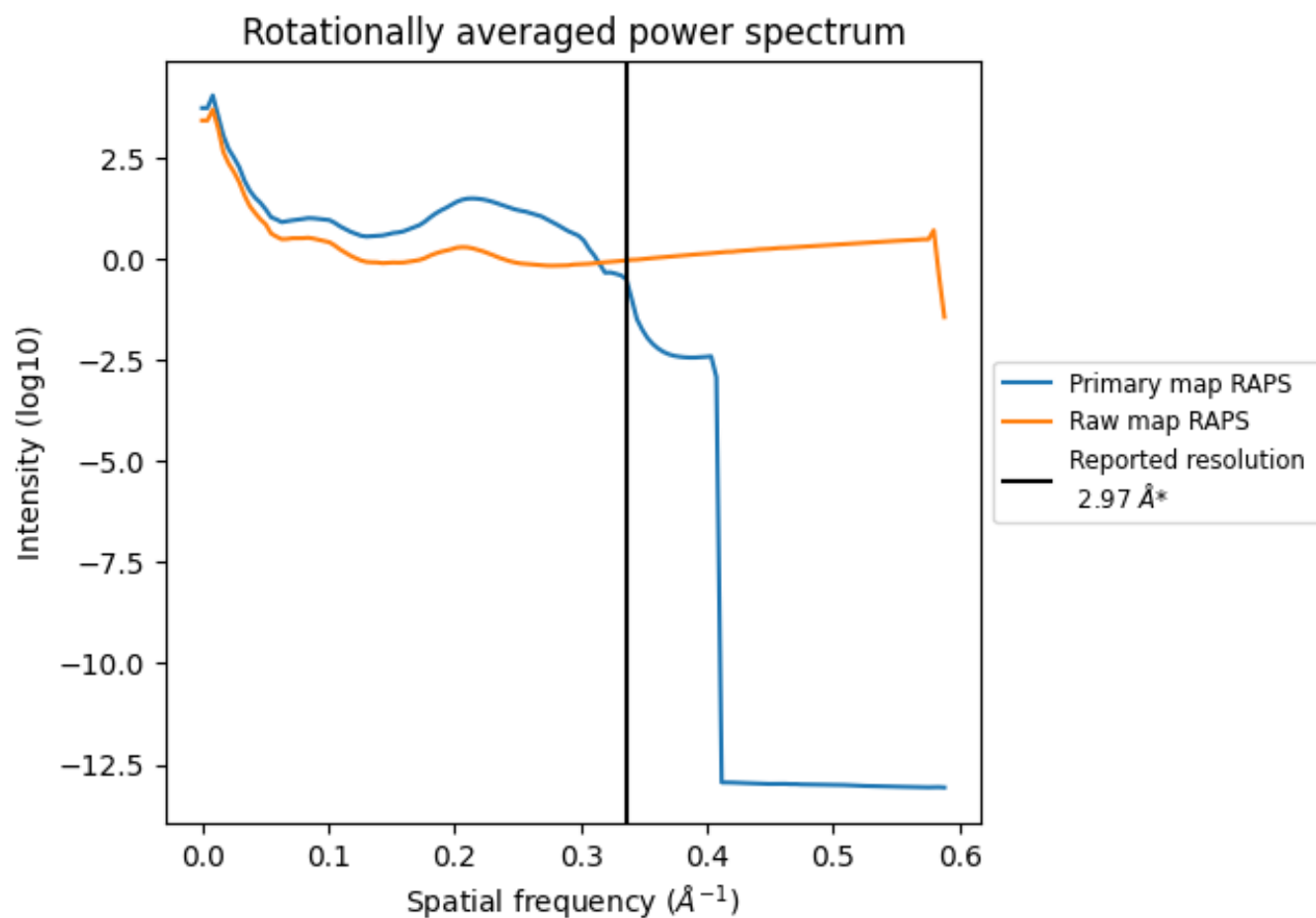
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 68 nm³; this corresponds to an approximate mass of 61 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 ⓘ

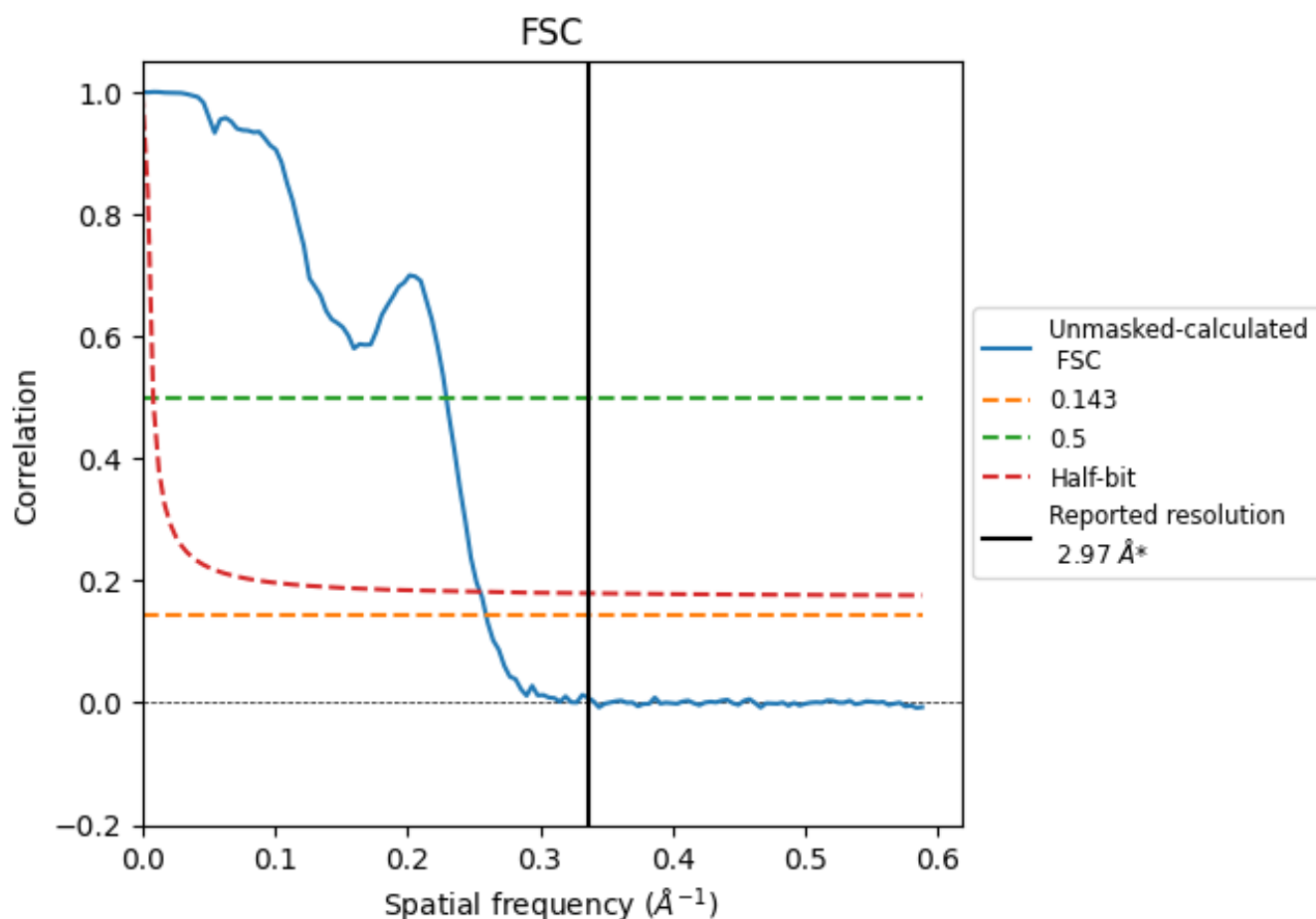


*Reported resolution corresponds to spatial frequency of 0.337 Å⁻¹

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 0.337 $\text{\AA}^{-1}$

8.2 Resolution estimates [i](#)

Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	2.97	-	-
Author-provided FSC curve	-	-	-
Unmasked-calculated*	3.86	4.36	3.92

*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 3.86 differs from the reported value 2.97 by more than 10 %

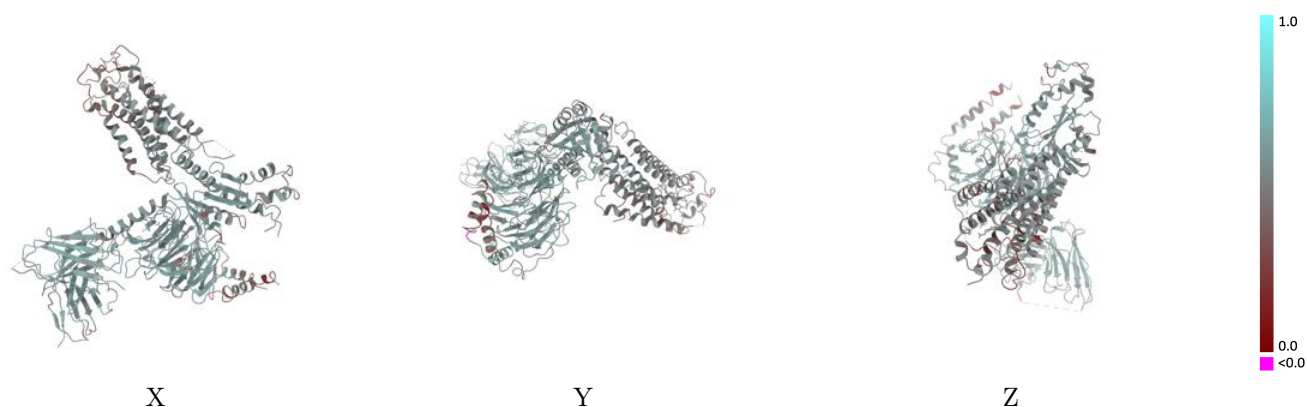
9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-65221 and PDB model 9VO1. Per-residue inclusion information can be found in section 3 on page 8.

9.1 Map-model overlay [i](#)

This section was not generated.

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

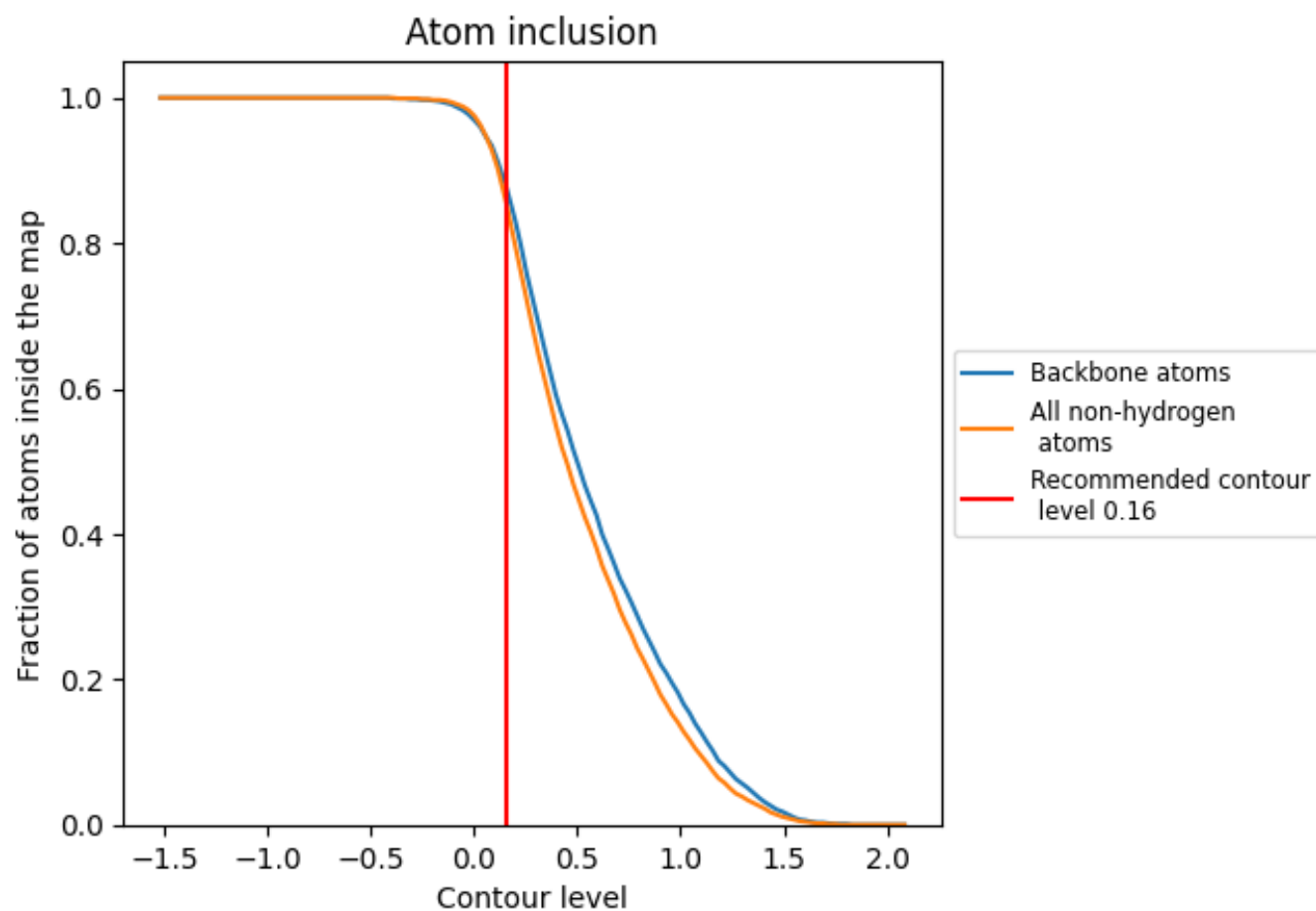


The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions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

This section was not generated.

9.4 Atom inclusion [i](#)



At the recommended contour level, 87% of all backbone atoms, 85% 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 (0.16) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.8510	0.5200
A	0.9030	0.5510
C	0.7410	0.4660
D	0.8550	0.5250
E	0.8990	0.5540
F	0.7680	0.4630

