



wwPDB EM Validation Summary Report ⓘ

Mar 9, 2026 – 08:37 PM UTC

PDB ID : 3JBX / pdb_00003jbx
EMDB ID : EMD-6487
Title : Cryo-electron microscopy structure of RAG Signal End Complex (C2 symmetry)
Authors : Ru, H.; Chambers, M.G.; Fu, T.-M.; Tong, A.B.; Liao, M.; Wu, H.
Deposited on : 2015-10-22
Resolution : 3.40 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
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

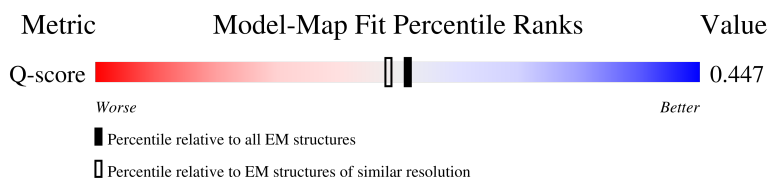
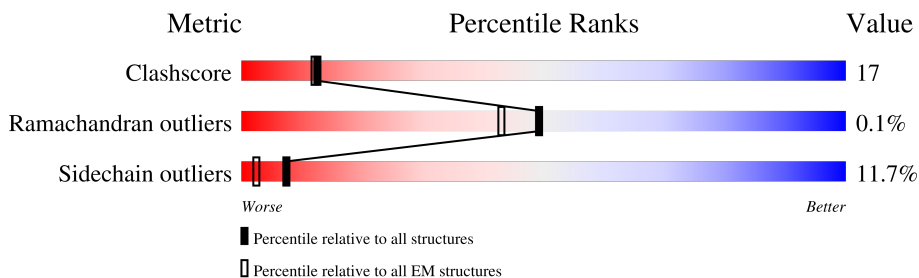
1 Overall quality at a glance

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	A	764	
1	C	764	
2	B	533	
2	D	533	

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Mol	Chain	Length	Quality of chain
3	E	15	
3	H	15	
4	F	15	
4	G	15	
5	I	14	
5	K	14	
6	J	14	
6	L	14	

2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 16670 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 V(D)J recombination-activating protein 1.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	550	Total	C	N	O	S	0	0
			4435	2781	786	834	34		
1	C	550	Total	C	N	O	S	0	0
			4435	2781	786	834	34		

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	268	GLY	-	expression tag	UNP O13033
A	269	GLY	-	expression tag	UNP O13033
A	270	SER	-	expression tag	UNP O13033
C	268	GLY	-	expression tag	UNP O13033
C	269	GLY	-	expression tag	UNP O13033
C	270	SER	-	expression tag	UNP O13033

- Molecule 2 is a protein called V(D)J recombination-activating protein 2.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	B	351	Total	C	N	O	S	0	0
			2714	1716	470	509	19		
2	D	351	Total	C	N	O	S	0	0
			2714	1716	470	509	19		

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-2	GLY	-	expression tag	UNP Q1RLW7
B	-1	GLY	-	expression tag	UNP Q1RLW7
B	0	SER	-	expression tag	UNP Q1RLW7
D	-2	GLY	-	expression tag	UNP Q1RLW7
D	-1	GLY	-	expression tag	UNP Q1RLW7
D	0	SER	-	expression tag	UNP Q1RLW7

- Molecule 3 is a DNA chain called 5'-D(*CP*AP*CP*AP*GP*TP*GP*CP*TP*AP*CP*A P*GP*AP*C)-3'.

Mol	Chain	Residues	Atoms					AltConf	Trace
3	E	15	Total	C	N	O	P	0	0
			303	145	59	85	14		
3	H	15	Total	C	N	O	P	0	0
			303	145	59	85	14		

- Molecule 4 is a DNA chain called 5'-D(P*GP*TP*CP*TP*GP*TP*AP*GP*CP*AP*CP*TP*GP*TP*G)-3'.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	F	15	Total	C	N	O	P	0	0
			309	147	54	93	15		
4	G	15	Total	C	N	O	P	0	0
			309	147	54	93	15		

- Molecule 5 is a DNA chain called 5'-D(*GP*CP*GP*AP*TP*GP*GP*TP*TP*AP*AP*C P*CP*A)-3'.

Mol	Chain	Residues	Atoms					AltConf	Trace
5	I	14	Total	C	N	O	P	0	0
			286	137	55	81	13		
5	K	14	Total	C	N	O	P	0	0
			286	137	55	81	13		

- Molecule 6 is a DNA chain called 5'-D(P*TP*GP*GP*TP*TP*AP*AP*CP*CP*AP*TP*C P*GP*C)-3'.

Mol	Chain	Residues	Atoms					AltConf	Trace
6	J	14	Total	C	N	O	P	0	0
			285	136	50	85	14		
6	L	14	Total	C	N	O	P	0	0
			285	136	50	85	14		

- Molecule 7 is ZINC ION (CCD ID: ZN) (formula: Zn).

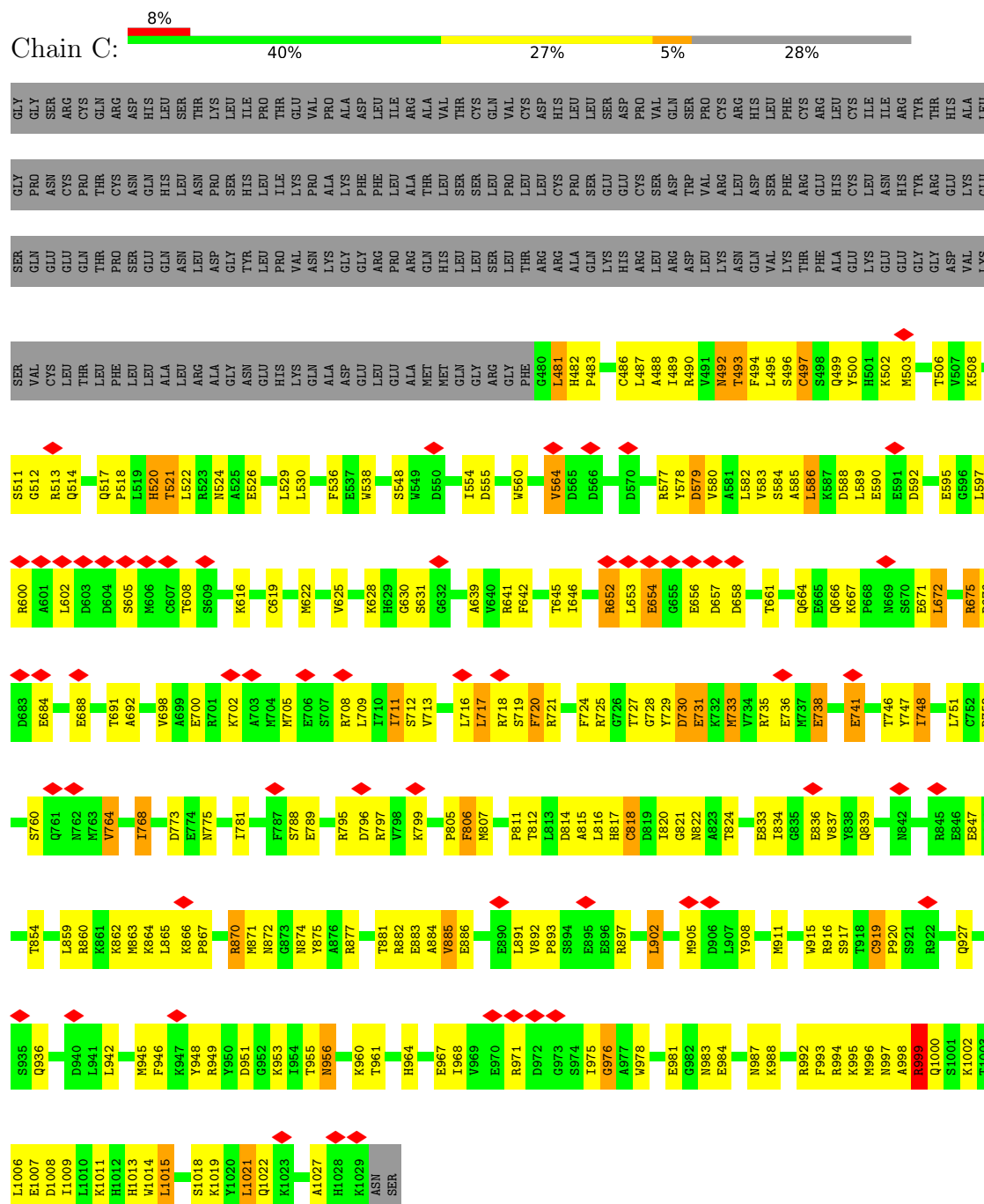
Mol	Chain	Residues	Atoms		AltConf
7	A	1	Total	Zn	0
			1	1	
7	C	1	Total	Zn	0
			1	1	

- Molecule 8 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		AltConf
8	A	2	Total 2	Mg 2	0
8	C	2	Total 2	Mg 2	0

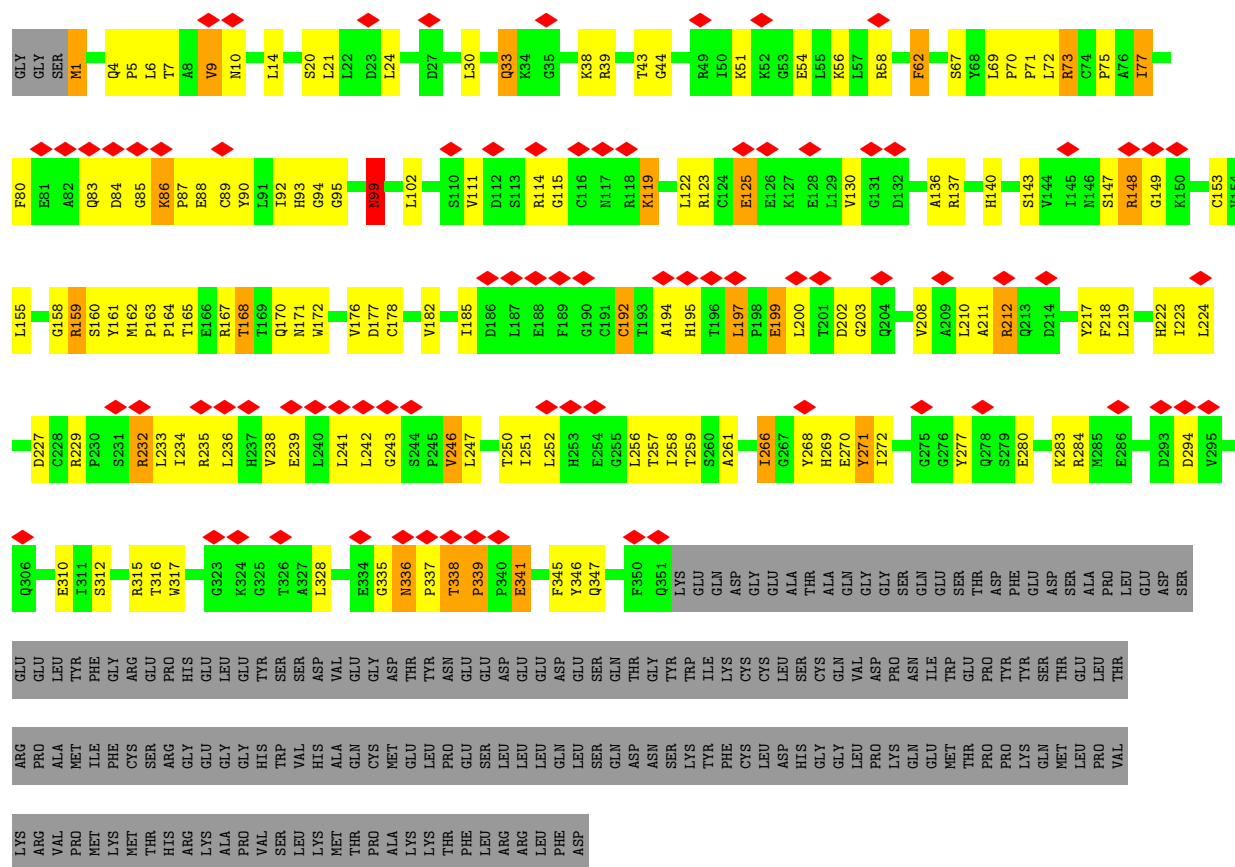


• Molecule 1: V(D)J recombination-activating protein 1

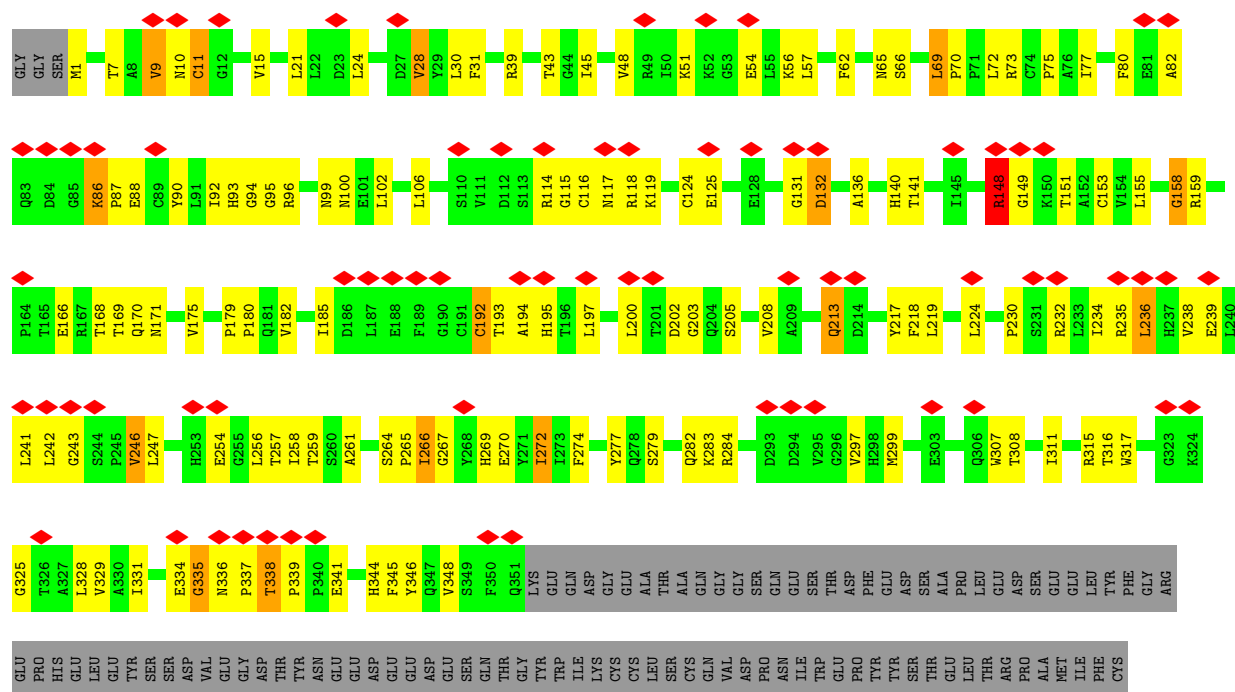


• Molecule 2: V(D)J recombination-activating protein 2





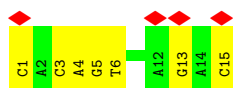
• Molecule 2: V(D)J recombination-activating protein 2



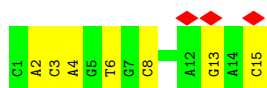
SER ARG GLY GLY HIS TRP VAL HIS ALA GLN CYS MET LEU PRO GLU SER LEU LEU LEU LEU LEU SER GLN ASP ASN SER LYS TYR PHE CYS LEU ASP HIS GLY GLY LEU PRO LYS GLN LEU MET THR PRO LYS GLN MET LEU PRO VAL ARG VAL PRO MET LYS MET

THR HIS ARG LYS ALA PRO VAL SER LEU LYS MET THR PRO ALA LYS THR PHE ARG ARG LEU PHE ASP

- Molecule 3: 5'-D(*CP*AP*CP*AP*GP*TP*GP*CP*TP*AP*CP*AP*GP*AP*C)-3'



- Molecule 3: 5'-D(*CP*AP*CP*AP*GP*TP*GP*CP*TP*AP*CP*AP*GP*AP*C)-3'



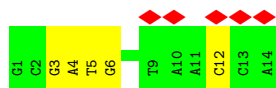
- Molecule 4: 5'-D(P*GP*TP*CP*TP*GP*TP*AP*GP*CP*AP*CP*TP*GP*TP*G)-3'



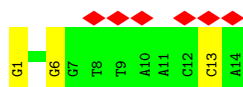
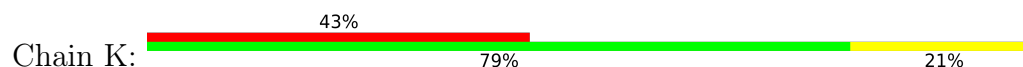
- Molecule 4: 5'-D(P*GP*TP*CP*TP*GP*TP*AP*GP*CP*AP*CP*TP*GP*TP*G)-3'



- Molecule 5: 5'-D(*GP*CP*GP*AP*TP*GP*GP*TP*TP*AP*AP*CP*CP*A)-3'



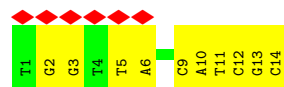
- Molecule 5: 5'-D(*GP*CP*GP*AP*TP*GP*GP*TP*TP*AP*AP*CP*CP*A)-3'



- Molecule 6: 5'-D(P*TP*GP*GP*TP*TP*AP*AP*CP*CP*AP*TP*CP*GP*C)-3'



- Molecule 6: 5'-D(P*TP*GP*GP*TP*TP*AP*AP*CP*CP*AP*TP*CP*GP*C)-3'



4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C2	Depositor
Number of particles used	63853	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	Each particle	Depositor
Microscope	FEI POLARA 300	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/\text{\AA}^2$)	41	Depositor
Minimum defocus (nm)	1500	Depositor
Maximum defocus (nm)	2500	Depositor
Magnification	40607	Depositor
Image detector	GATAN K2 (4k x 4k)	Depositor
Maximum map value	0.173	Depositor
Minimum map value	-0.089	Depositor
Average map value	-0.000	Depositor
Map value standard deviation	0.008	Depositor
Recommended contour level	0.04	Depositor
Map size ($\text{\AA}$)	236.16, 236.16, 236.16	wwPDB
Map dimensions	192, 192, 192	wwPDB
Map angles ($^\circ$)	90.0, 90.0, 90.0	wwPDB
Pixel spacing ($\text{\AA}$)	1.23, 1.23, 1.23	Depositor

5 Model quality

5.1 Standard geometry

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

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	0.38	0/4526	0.89	5/6095 (0.1%)
1	C	0.38	0/4526	0.91	9/6095 (0.1%)
2	B	0.37	0/2784	0.93	10/3784 (0.3%)
2	D	0.37	0/2784	0.96	11/3784 (0.3%)
3	E	0.23	0/340	0.41	0/522
3	H	0.23	0/340	0.41	0/522
4	F	0.25	0/345	0.41	0/531
4	G	0.26	0/345	0.42	0/531
5	I	0.19	0/321	0.38	0/494
5	K	0.18	0/321	0.35	0/494
6	J	0.22	0/318	0.42	0/488
6	L	0.25	0/318	0.45	0/488
All	All	0.36	0/17268	0.85	35/23828 (0.1%)

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	1
1	C	0	3
2	B	0	1
All	All	0	5

There are no bond length outliers.

The worst 5 of 35 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	842	ASN	CA-C-N	10.51	130.61	120.31

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	842	ASN	C-N-CA	10.51	130.61	120.31
1	C	733	MET	O-C-N	-9.21	112.14	122.09
2	D	339	PRO	N-CA-C	7.28	119.58	110.70
2	B	197	LEU	CA-C-N	6.74	127.29	119.47

There are no chirality outliers.

All (5) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	992	ARG	Sidechain
2	B	86	LYS	Peptide
1	C	1027	ALA	Peptide
1	C	870	ARG	Sidechain
1	C	994	ARG	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	A	4435	0	4377	173	0
1	C	4435	0	4377	170	0
2	B	2714	0	2665	106	0
2	D	2714	0	2665	95	0
3	E	303	0	169	8	0
3	H	303	0	169	10	0
4	F	309	0	170	10	0
4	G	309	0	171	10	0
5	I	286	0	159	6	0
5	K	286	0	159	7	0
6	J	285	0	159	14	0
6	L	285	0	159	10	0
7	A	1	0	0	0	0
7	C	1	0	0	0	0
8	A	2	0	0	0	0
8	C	2	0	0	0	0
All	All	16670	0	15399	538	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 17.

The worst 5 of 538 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:C:731:GLU:OE2	1:C:960:LYS:NZ	1.82	1.11
1:A:999:ARG:HG3	1:A:1004:PHE:HB3	1.52	0.91
2:B:339:PRO:HB2	2:B:341:GLU:H	1.37	0.89
1:C:490:ARG:NH2	1:C:497:CYS:SG	2.50	0.83
1:C:727:THR:HG21	1:C:978:TRP:HB3	1.61	0.83

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	548/764 (72%)	509 (93%)	39 (7%)	0	100	100
1	C	548/764 (72%)	511 (93%)	37 (7%)	0	100	100
2	B	349/533 (66%)	329 (94%)	19 (5%)	1 (0%)	36	65
2	D	349/533 (66%)	333 (95%)	15 (4%)	1 (0%)	36	65
All	All	1794/2594 (69%)	1682 (94%)	110 (6%)	2 (0%)	49	78

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	9	VAL
2	D	9	VAL

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	489/681 (72%)	427 (87%)	62 (13%)	4	17
1	C	489/681 (72%)	428 (88%)	61 (12%)	4	18
2	B	303/465 (65%)	272 (90%)	31 (10%)	7	25
2	D	303/465 (65%)	271 (89%)	32 (11%)	6	23
All	All	1584/2292 (69%)	1398 (88%)	186 (12%)	7	20

5 of 186 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	652	ARG
1	C	885	VAL
1	C	672	LEU
1	C	738	GLU
1	C	1004	PHE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	1000	GLN
2	D	171	ASN
2	D	16	GLN
2	D	173	ASN
2	B	282	GLN

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](#)

Of 6 ligands modelled in this entry, 6 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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.

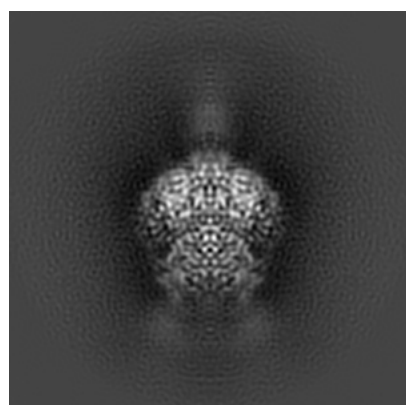
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-6487. These allow visual inspection of the internal detail of the map and identification of artifacts.

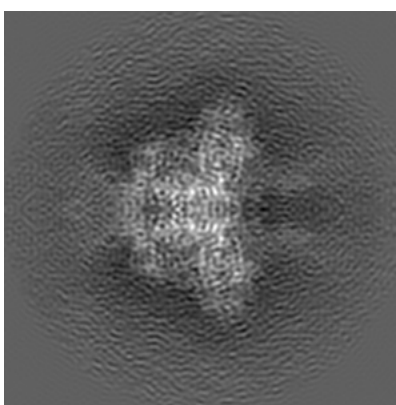
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections [i](#)

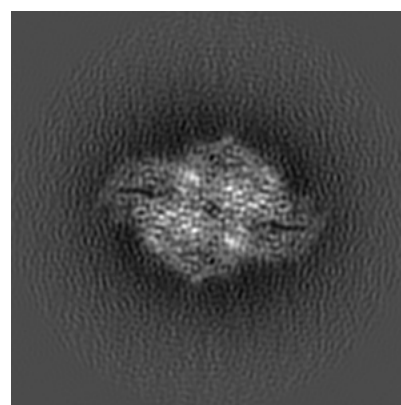
6.1.1 Primary map



X



Y

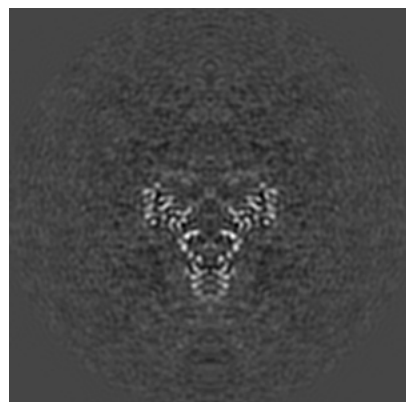


Z

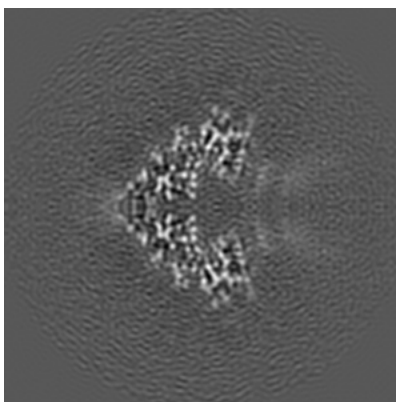
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

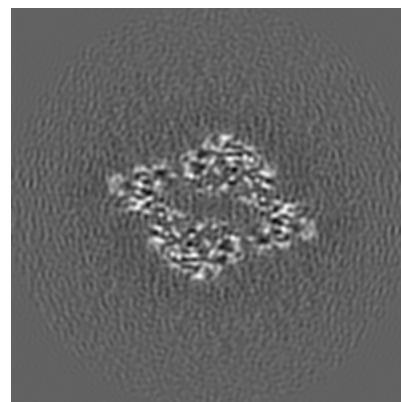
6.2.1 Primary map



X Index: 96



Y Index: 96

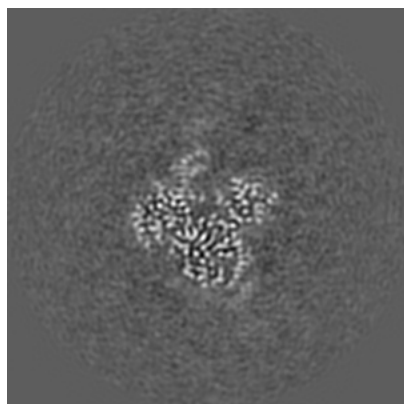


Z Index: 96

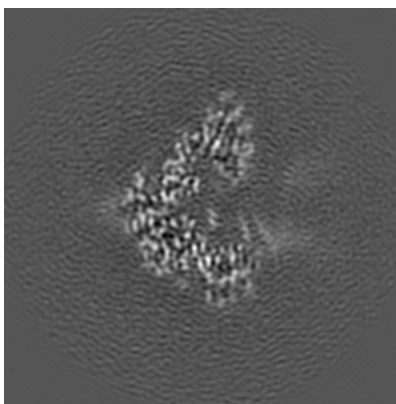
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

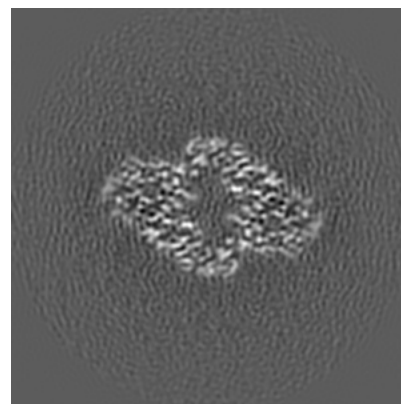
6.3.1 Primary map



X Index: 88



Y Index: 93

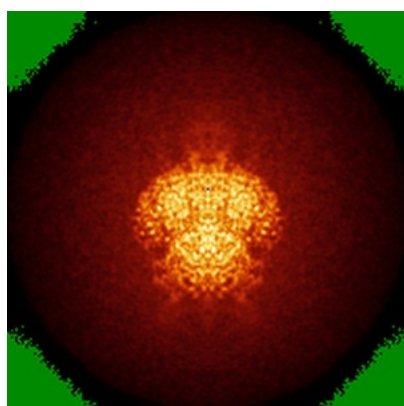


Z Index: 103

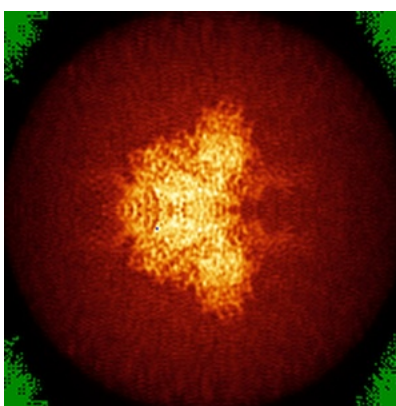
The images above show the largest variance slices of the map in three orthogonal directions.

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

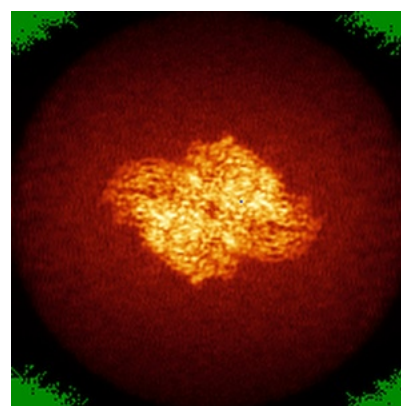
6.4.1 Primary map



X



Y

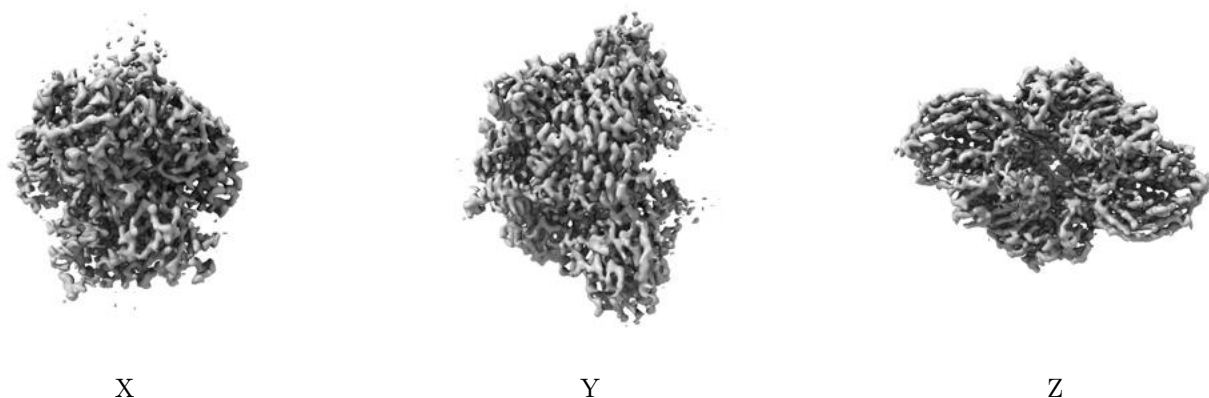


Z

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 0.04. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

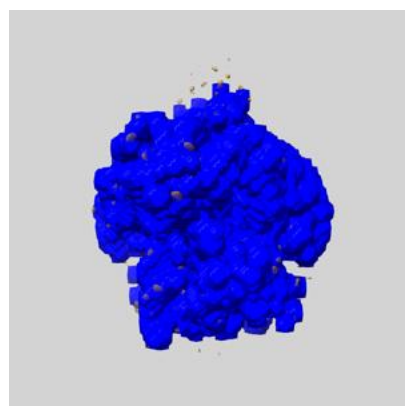
6.6 Mask visualisation [i](#)

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

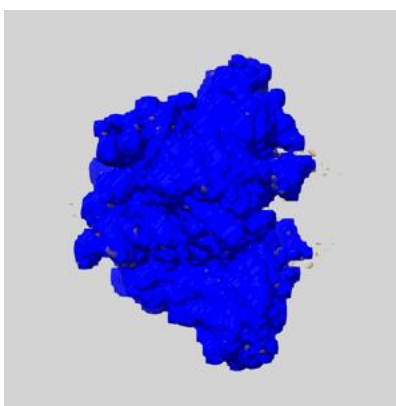
A mask typically either:

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

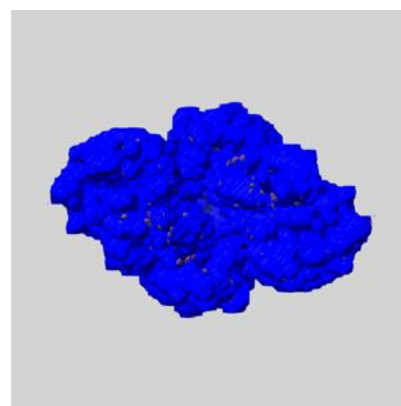
6.6.1 emd_6487_msk_1.map [i](#)



X



Y

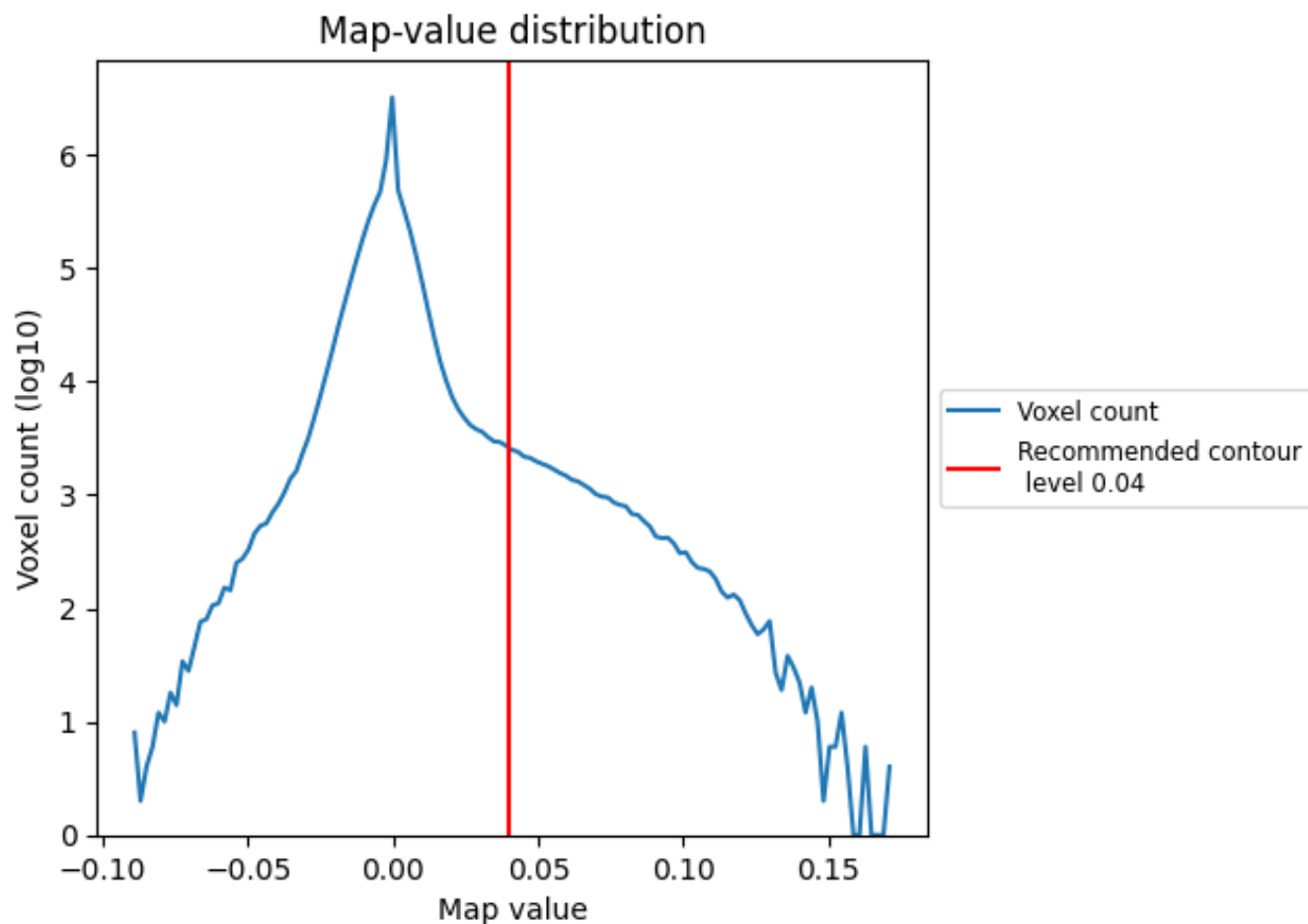


Z

7 Map analysis [i](#)

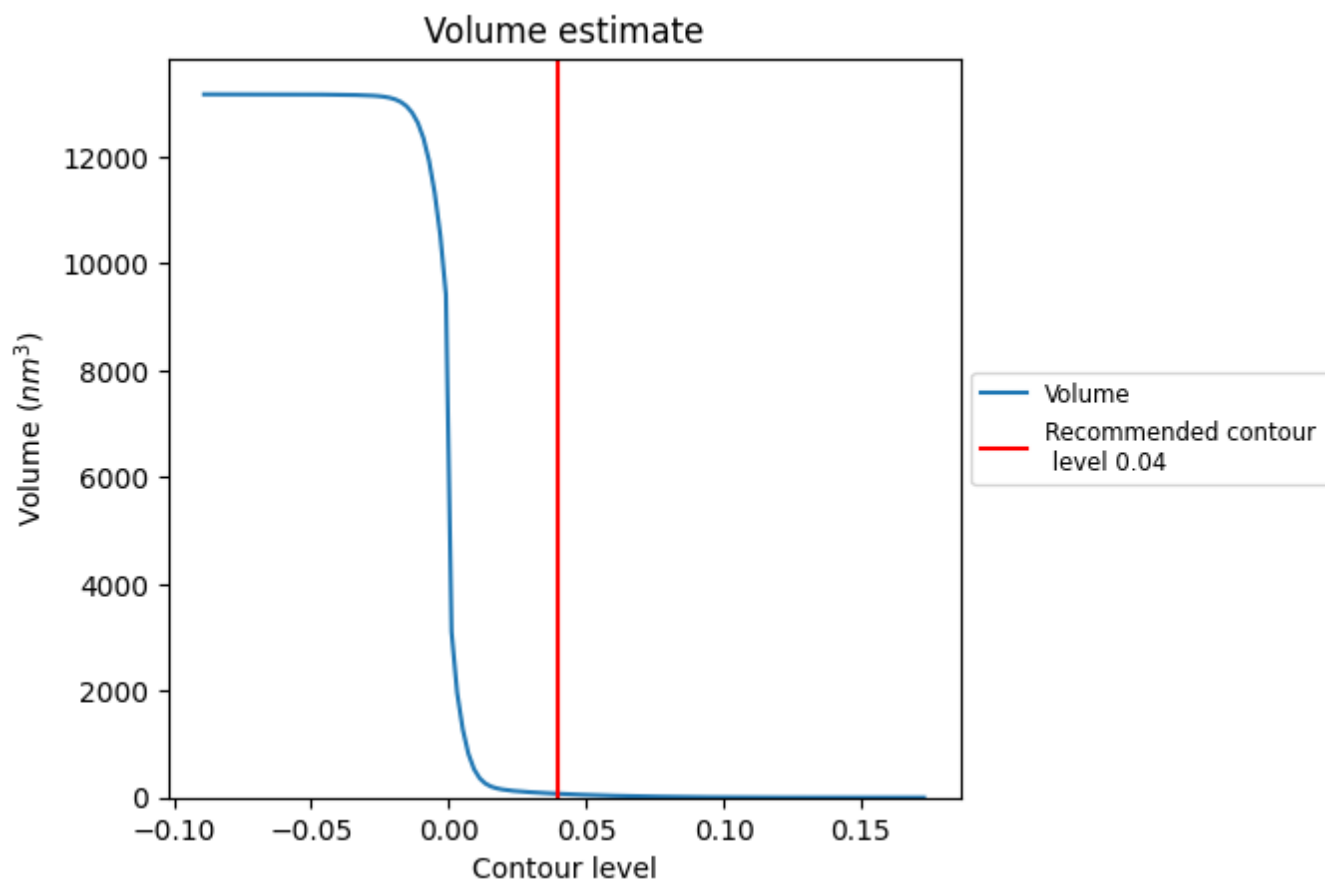
This section contains the results of statistical analysis of the map.

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.

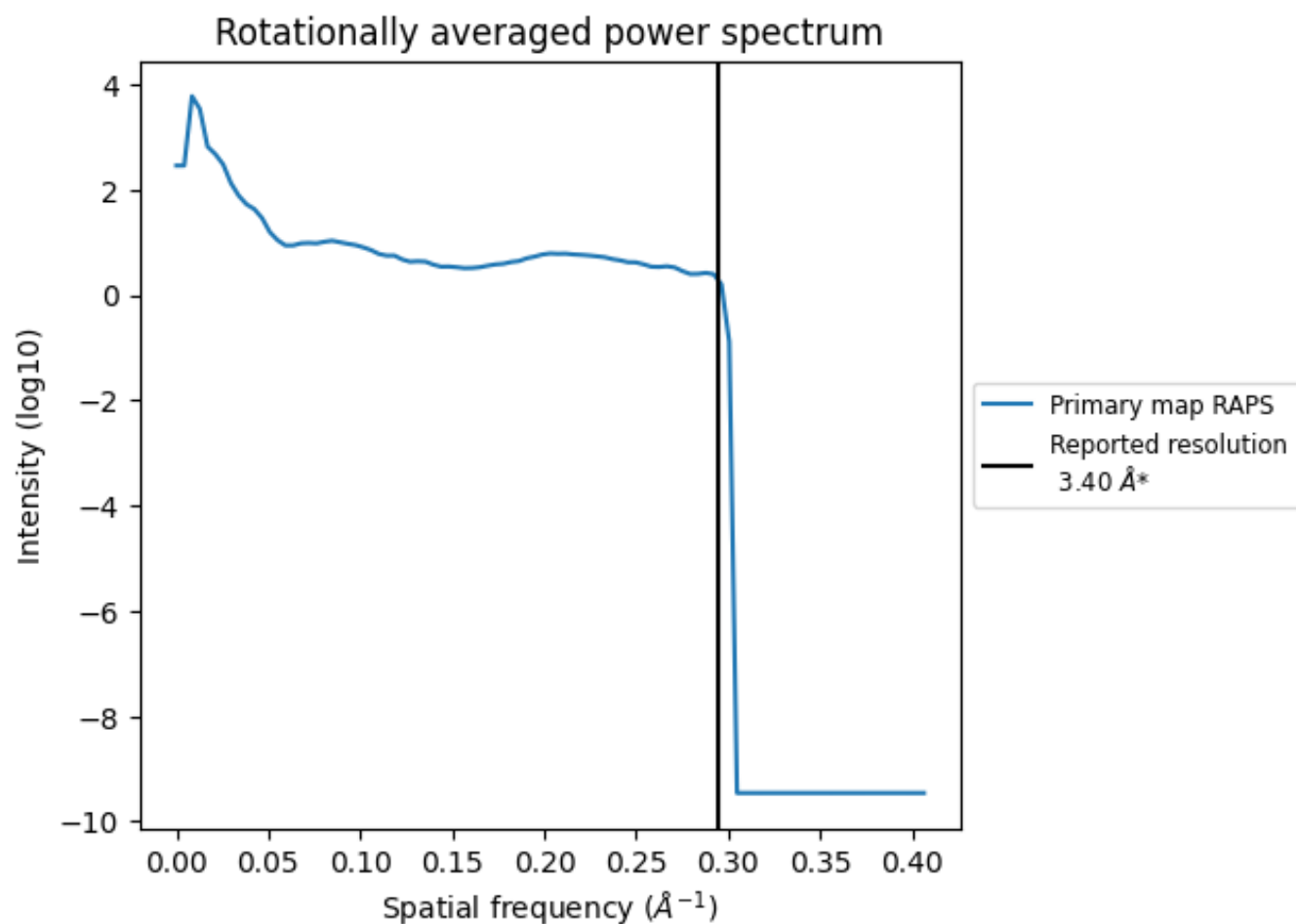
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 71 nm^3 ; this corresponds to an approximate mass of 64 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 ⓘ

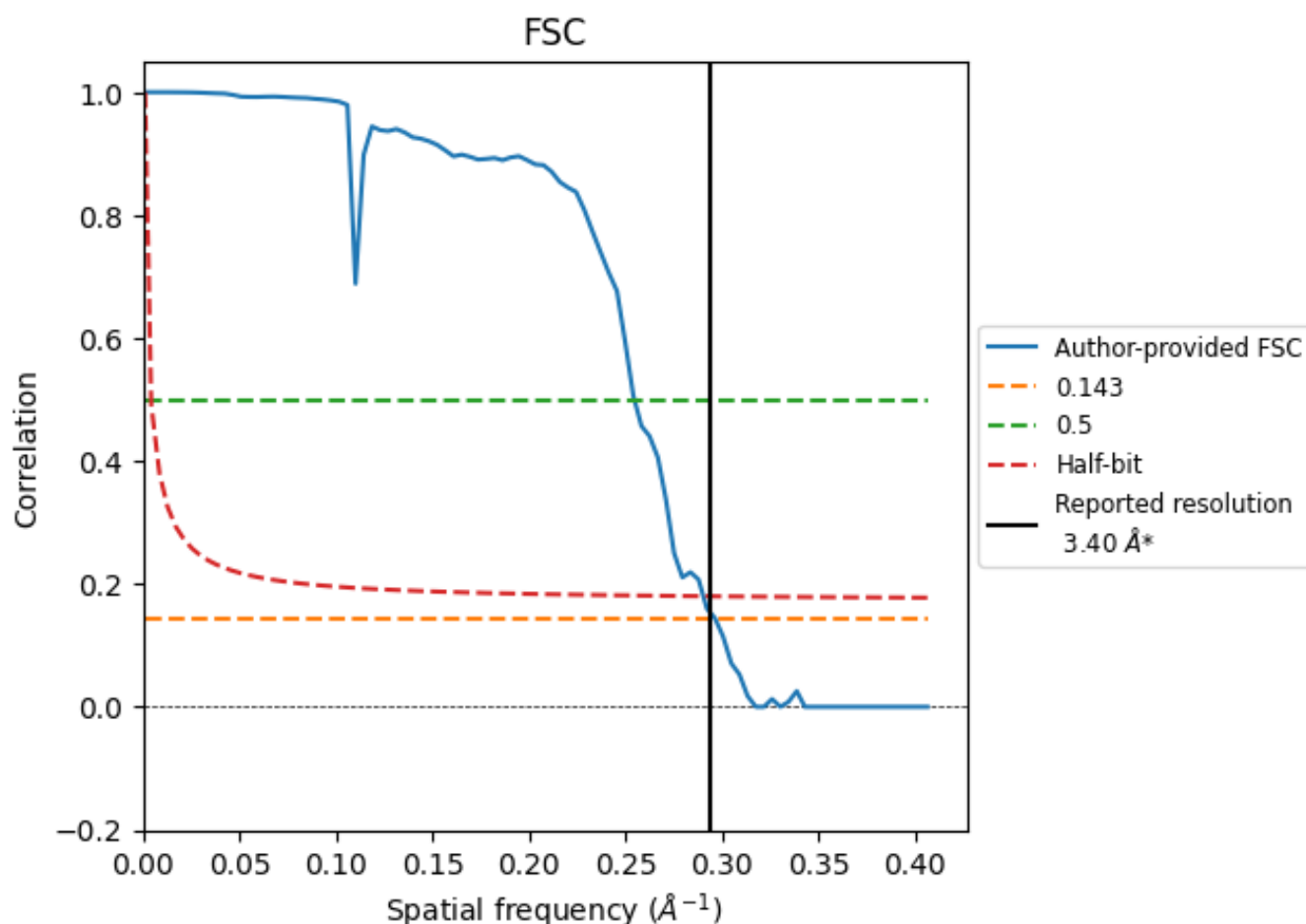


*Reported resolution corresponds to spatial frequency of 0.294 $\text{\AA}^{-1}$

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	3.37	3.93	3.44
Unmasked-calculated*	-	-	-

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

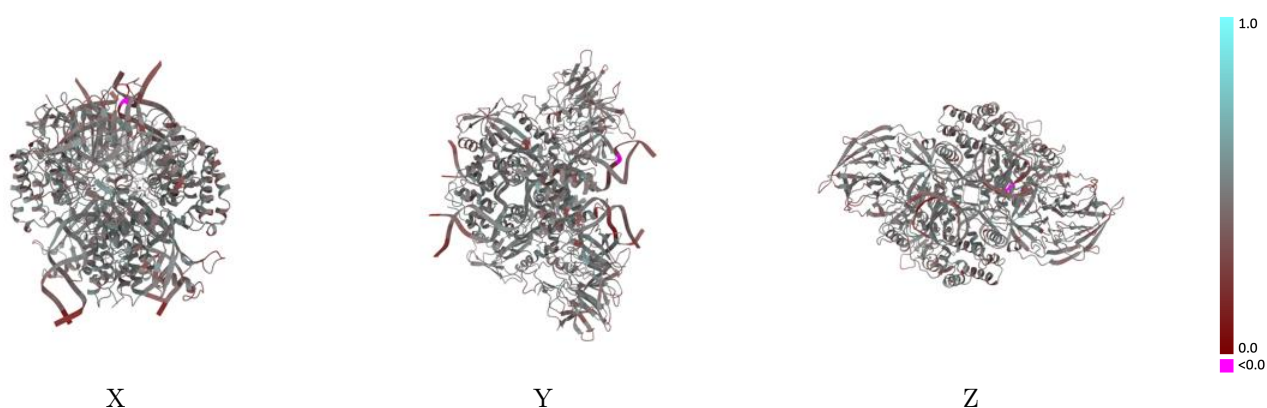
9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-6487 and PDB model 3JBX. Per-residue inclusion information can be found in section 3 on page 7.

9.1 Map-model overlay [i](#)

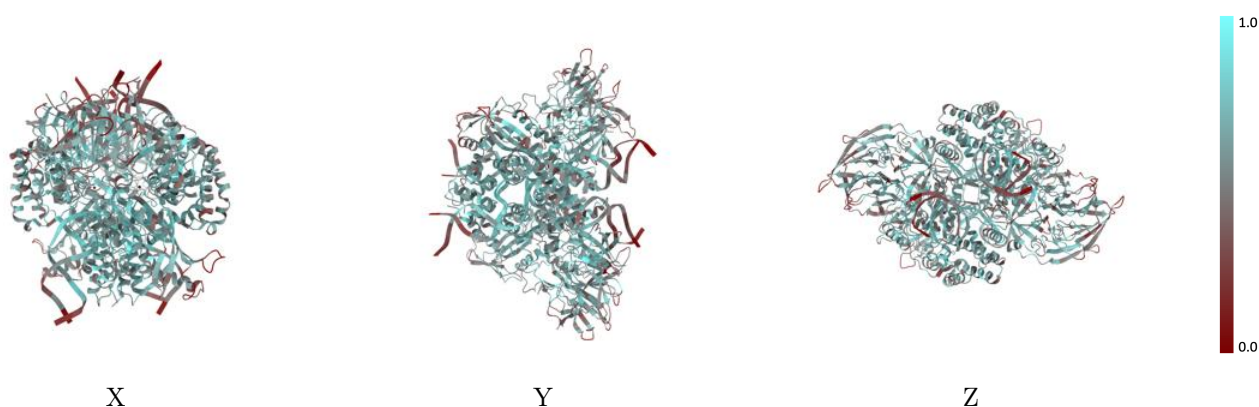
This section was not generated.

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



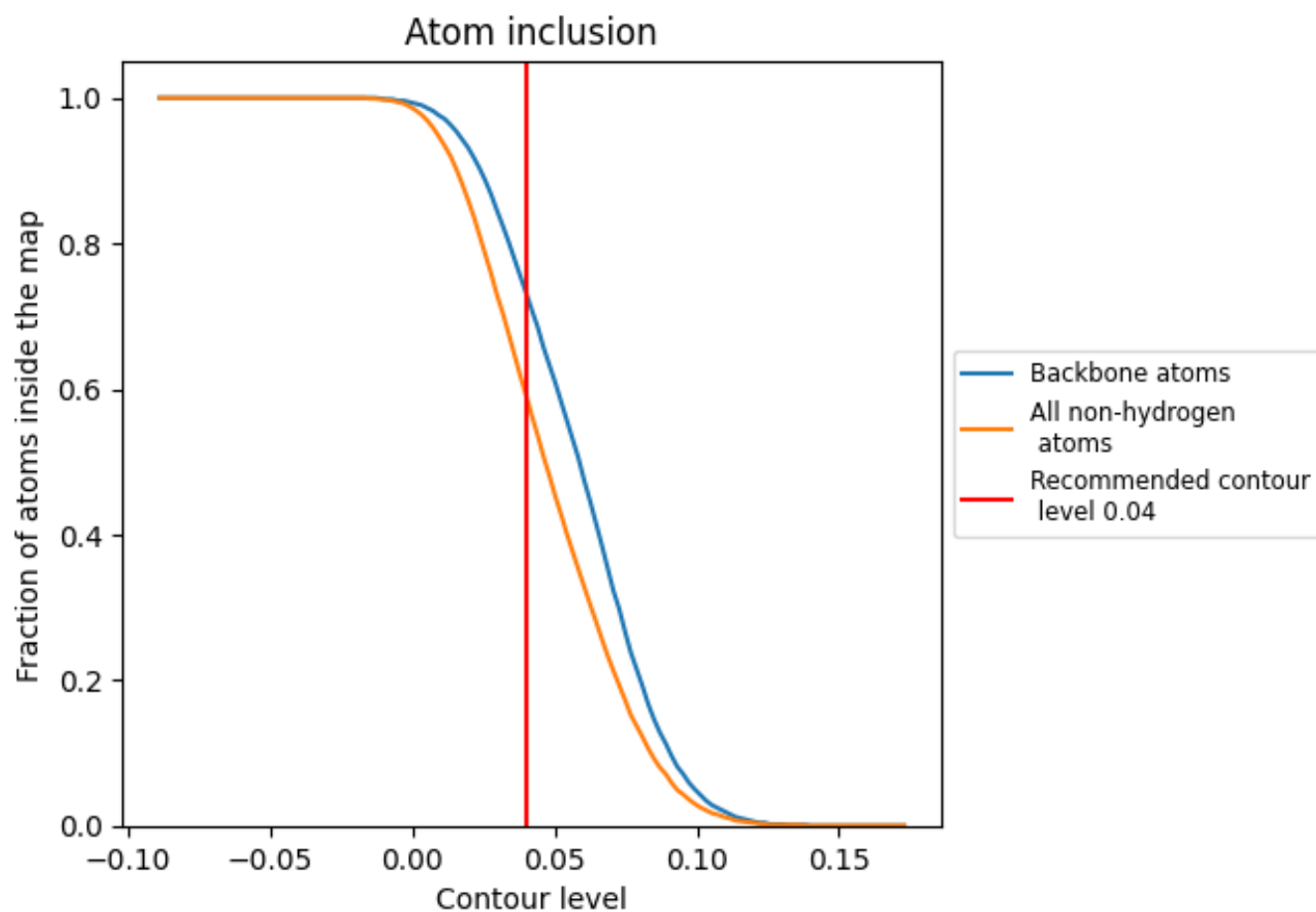
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions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



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 (0.04).

9.4 Atom inclusion [i](#)



At the recommended contour level, 73% of all backbone atoms, 59% 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 (0.04) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.5910	0.4470
A	0.6170	0.4590
B	0.5570	0.4440
C	0.6220	0.4610
D	0.5610	0.4440
E	0.6140	0.4270
F	0.6570	0.4340
G	0.6440	0.4330
H	0.6300	0.4290
I	0.5170	0.4350
J	0.4530	0.3350
K	0.5070	0.4290
L	0.4490	0.3350

