wwPDB EM Validation Summary Report (i)

Jan 19, 2026 – 01:33 pm GMT

PDB ID	:	9QOO / pdb_00009qoo
EMDB ID	:	EMD-53265
Title	:	Composite model: Ternary complex of the human 20S proteasome in complex with Importin-9 and two homodimers of Akirin-2
Authors	:	Brunner, H.L.; Grundmann, L.; David, H.
Deposited on	:	2025-03-26
Resolution	:	3.30 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 (i) 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 (i)) were used in the production of this report:

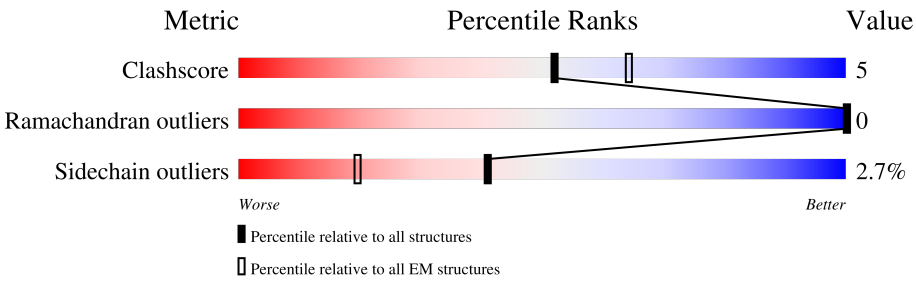
EMDB validation analysis	:	0.0.1.dev129
MolProbity	:	4-5-2 with Phenix2.0
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
EM percentile statistics	:	202505.v01 (Using data in the EMDB archive up until May 2025)
MapQ	:	1.9.13
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.47

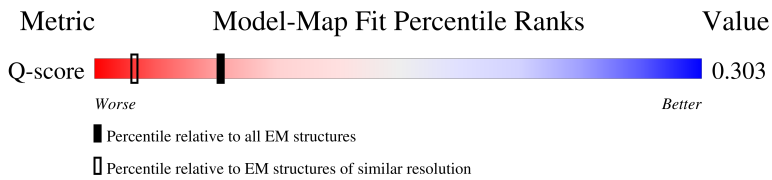
1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 3.30 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	210492	15764	-
Ramachandran outliers	207382	16835	-
Sidechain outliers	206894	16415	-
Q-score	-	25397	15087 (2.80 - 3.80)

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 <=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	1041	5% 84% 5% 11%
2	B	203	• 23% 7% 70%
2	C	203	5% 36% 8% 56%
2	D	203	5% 33% • 66%

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Mol	Chain	Length	Quality of chain
2	I	203	22% 78%
3	F	255	78% 17% 5%
4	G	246	87% 11%
5	O	234	88% 9%
6	P	261	80% 14% 5%
7	Q	248	83% 12%
8	R	241	89% 11%
9	S	263	75% 14% 10%

2 Entry composition (i)

There are 9 unique types of molecules in this entry. The entry contains 39201 atoms, of which 18702 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 Importin-9.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
1	A	924	9392	3368	3936	1017	1054	17	0	0

- Molecule 2 is a protein called Akirin-2.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
2	B	61	1033	328	512	90	100	3	0	0
2	C	90	1476	470	725	137	140	4	0	0
2	D	70	726	261	297	86	81	1	0	0
2	I	45	Total	C	H	N	O		0	0
			321	134	97	45	45			

- Molecule 3 is a protein called Proteasome subunit alpha type-3.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
3	F	242	3776	1201	1883	323	358	11	0	0

- Molecule 4 is a protein called Proteasome subunit alpha type-6.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
4	G	242	3781	1197	1895	315	361	13	0	0

- Molecule 5 is a protein called Proteasome subunit alpha type-2.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
5	O	231	3609	1155	1802	306	340	6	0	0

- Molecule 6 is a protein called Proteasome subunit alpha type-4.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
6	P	248	3928	1234	1975	336	373	10	0	0

- Molecule 7 is a protein called Proteasome subunit alpha type-7.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
7	Q	237	3765	1174	1895	331	360	5	0	0

- Molecule 8 is a protein called Proteasome subunit alpha type-5.

Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
8	R	241	3686	1163	1836	305	370	12	0	0

- Molecule 9 is a protein called Proteasome subunit alpha type-1.

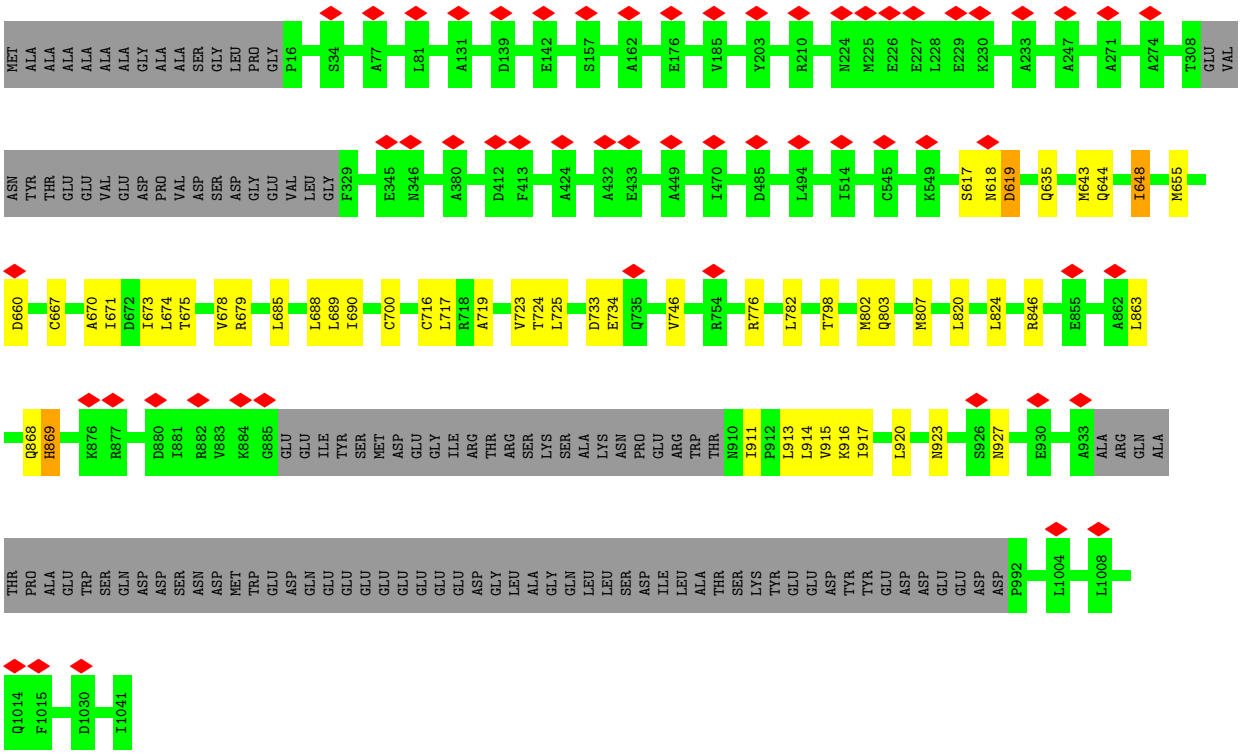
Mol	Chain	Residues	Atoms						AltConf	Trace
			Total	C	H	N	O	S		
9	S	236	3708	1166	1849	334	348	11	0	0

3 Residue-property plots (i)

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.

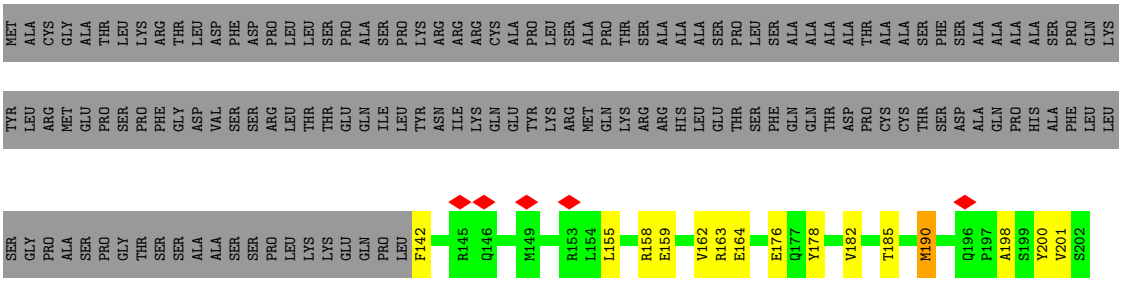
- Molecule 1: Importin-9

Chain A:



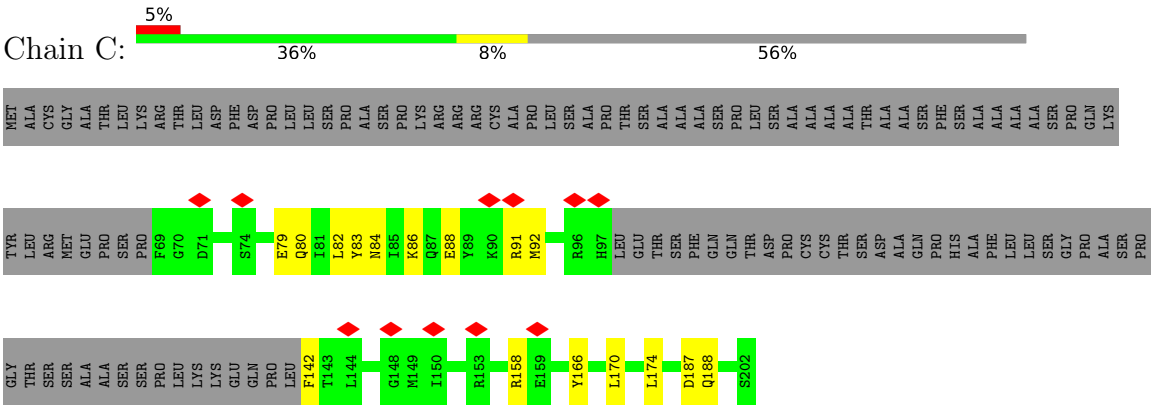
- Molecule 2: Akirin-2

Chain B:



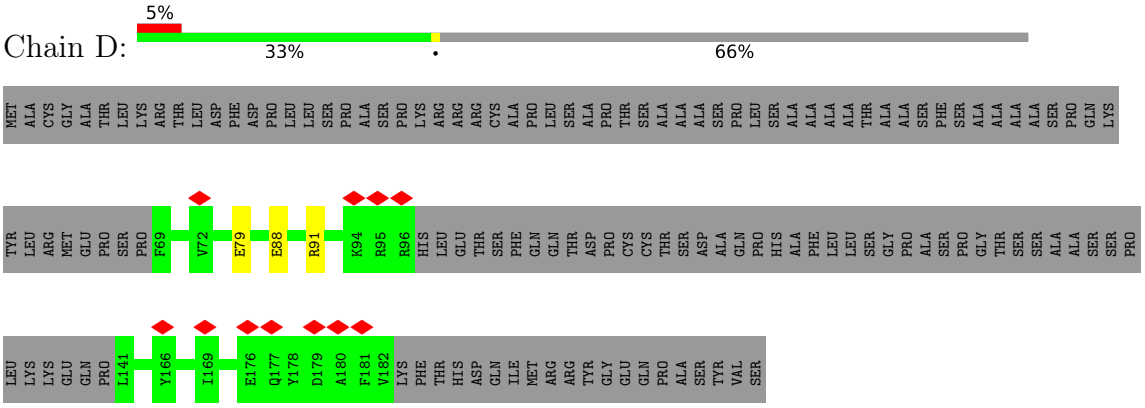
- Molecule 2: Akirin-2

Chain C:



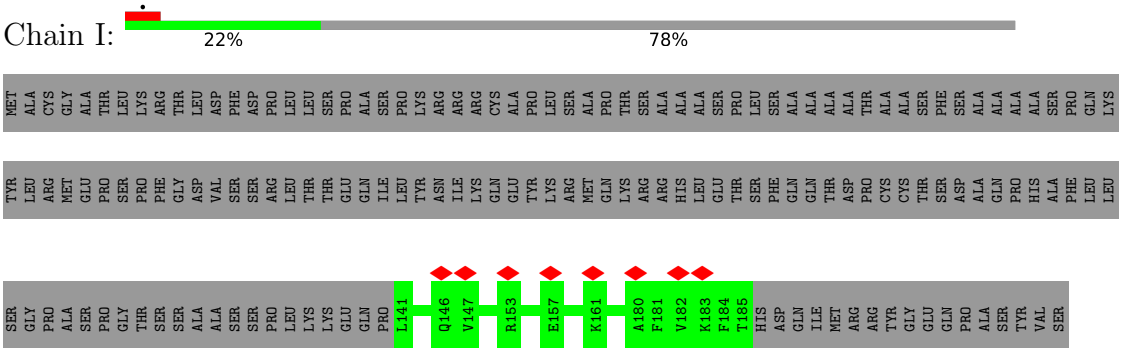
- Molecule 2: Akirin-2

Chain D:



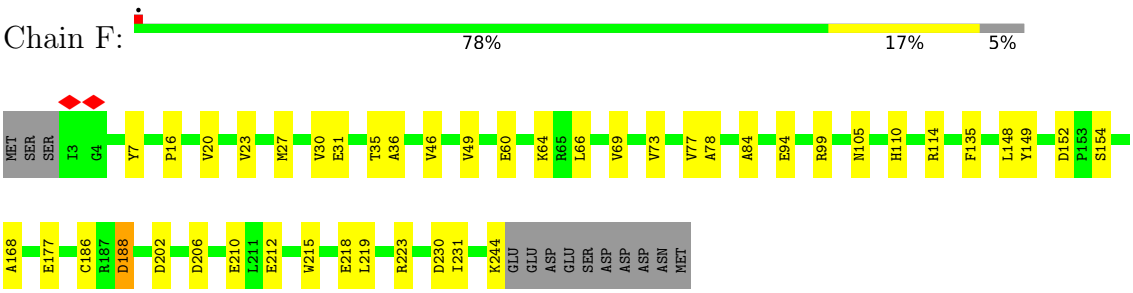
- Molecule 2: Akirin-2

Chain I:



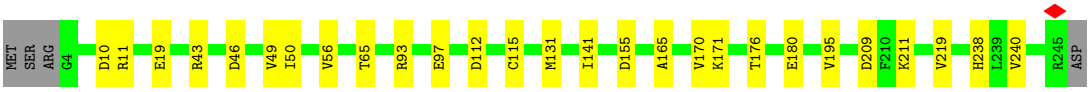
- Molecule 3: Proteasome subunit alpha type-3

Chain F:



- Molecule 4: Proteasome subunit alpha type-6

Chain G:

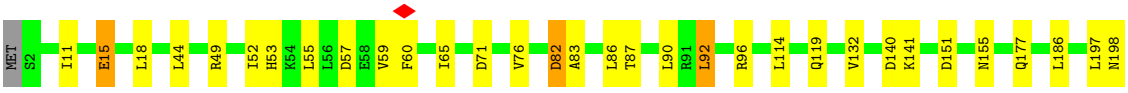


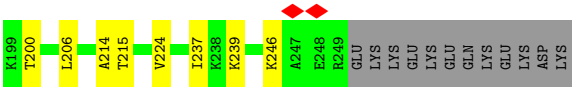
- Molecule 5: Proteasome subunit alpha type-2

Chain O:

- Molecule 6: Proteasome subunit alpha type-4

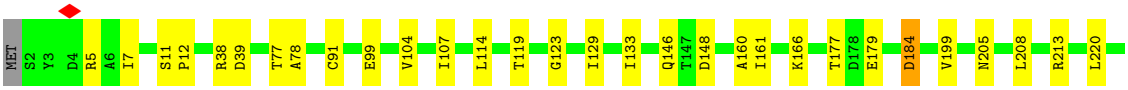
Chain P:

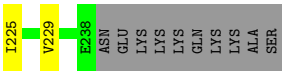




- Molecule 7: Proteasome subunit alpha type-7

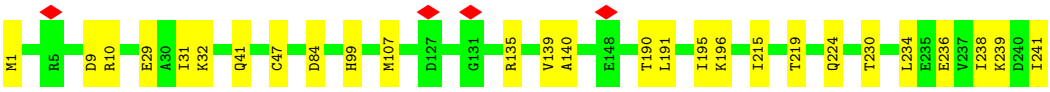
Chain Q:





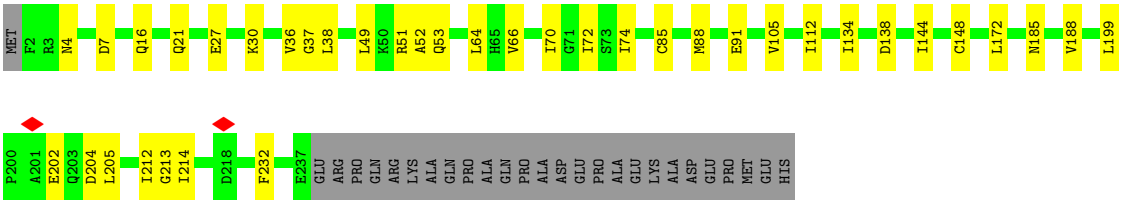
- Molecule 8: Proteasome subunit alpha type-5

Chain R:



- Molecule 9: Proteasome subunit alpha type-1

Chain S:


MET
F2
R3
N4
D7
Q16
Q21
E27
K30
V36
G37
L38
L49
K50
R51
A52
Q53
L64
H65
V66
I70
G71
I72
S73
I74
C85
M88
E91
V105
I112
I134
D138
I144
C148
L172
N185
V188
L199
P200
A201
E202
Q203
D204
L205
I212
G213
I214
D218
F232
E237
GLU
ARG
PRO
GLN
ARG
LYS
ALA
GLN
PRO
ALA
GLN
PRO
ALA
ASP
GLU
PRO
ALA
GLU
LYS
ALA
ASP
GLU
PRO
MET
GLU
HIS

4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	61740	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	TFS KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	44.4	Depositor
Minimum defocus (nm)	1000	Depositor
Maximum defocus (nm)	1900	Depositor
Magnification	Not provided	
Image detector	GATAN K3 BIOQUANTUM (6k x 4k)	Depositor
Maximum map value	51.672	Depositor
Minimum map value	-0.003	Depositor
Average map value	0.026	Depositor
Map value standard deviation	0.603	Depositor
Recommended contour level	1.3	Depositor
Map size (Å)	428.99997, 428.99997, 428.99997	wwPDB
Map dimensions	300, 300, 300	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.43, 1.43, 1.43	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	0.12	0/5521	0.32	0/7637
2	B	0.15	0/529	0.29	0/706
2	C	0.13	0/761	0.33	0/1014
2	D	0.11	0/429	0.20	0/582
2	I	0.13	0/223	0.19	0/310
3	F	0.15	0/1928	0.32	0/2596
4	G	0.15	0/1920	0.30	0/2595
5	O	0.15	0/1846	0.31	0/2500
6	P	0.15	0/1983	0.31	0/2671
7	Q	0.15	0/1896	0.30	0/2558
8	R	0.14	0/1879	0.30	0/2536
9	S	0.15	0/1894	0.30	0/2559
All	All	0.14	0/20809	0.31	0/28264

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	5456	3936	3934	39	0
2	B	521	512	511	11	0
2	C	751	725	723	10	0
2	D	429	297	295	1	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	I	224	97	96	0	0
3	F	1893	1883	1882	27	0
4	G	1886	1895	1893	18	0
5	O	1807	1802	1801	19	0
6	P	1953	1975	1973	34	0
7	Q	1870	1895	1893	20	0
8	R	1850	1836	1836	13	0
9	S	1859	1849	1848	27	0
All	All	20499	18702	18685	204	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 5.

The worst 5 of 204 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)
7:Q:99:GLU:N	7:Q:99:GLU:OE1	2.14	0.81
9:S:204:ASP:OD1	9:S:205:LEU:N	2.14	0.80
1:A:617:SER:OG	1:A:619:ASP:OD1	2.00	0.78
4:G:10:ASP:OD1	4:G:11:ARG:N	2.18	0.78
3:F:230:ASP:OD1	3:F:231:ILE:N	2.18	0.77

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	916/1041 (88%)	901 (98%)	15 (2%)	0	100	100
2	B	59/203 (29%)	57 (97%)	2 (3%)	0	100	100
2	C	86/203 (42%)	81 (94%)	5 (6%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	D	66/203 (32%)	65 (98%)	1 (2%)	0	100	100
2	I	43/203 (21%)	43 (100%)	0	0	100	100
3	F	240/255 (94%)	233 (97%)	7 (3%)	0	100	100
4	G	240/246 (98%)	232 (97%)	8 (3%)	0	100	100
5	O	229/234 (98%)	220 (96%)	9 (4%)	0	100	100
6	P	246/261 (94%)	237 (96%)	9 (4%)	0	100	100
7	Q	235/248 (95%)	229 (97%)	6 (3%)	0	100	100
8	R	239/241 (99%)	233 (98%)	6 (2%)	0	100	100
9	S	234/263 (89%)	223 (95%)	11 (5%)	0	100	100
All	All	2833/3601 (79%)	2754 (97%)	79 (3%)	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	282/894 (32%)	275 (98%)	7 (2%)	42	67
2	B	56/171 (33%)	53 (95%)	3 (5%)	18	46
2	C	76/171 (44%)	73 (96%)	3 (4%)	27	55
2	D	19/171 (11%)	18 (95%)	1 (5%)	19	47
3	F	199/212 (94%)	192 (96%)	7 (4%)	31	58
4	G	206/210 (98%)	202 (98%)	4 (2%)	52	72
5	O	190/191 (100%)	186 (98%)	4 (2%)	48	70
6	P	208/221 (94%)	202 (97%)	6 (3%)	37	63
7	Q	201/211 (95%)	196 (98%)	5 (2%)	42	67
8	R	203/203 (100%)	198 (98%)	5 (2%)	42	67
9	S	202/224 (90%)	198 (98%)	4 (2%)	50	71
All	All	1842/2879 (64%)	1793 (97%)	49 (3%)	41	65

5 of 49 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
5	O	221	THR
7	Q	114	LEU
6	P	15	GLU
6	P	92	LEU
7	Q	166	LYS

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

Mol	Chain	Res	Type
5	O	188	HIS
6	P	142	HIS
9	S	185	ASN
8	R	227	HIS
4	G	150	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)

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.

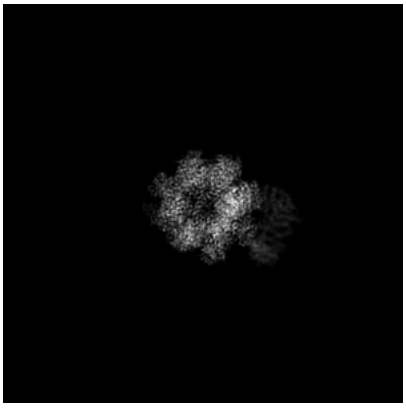
6 Map visualisation (i)

This section contains visualisations of the EMDB entry EMD-53265. These allow visual inspection of the internal detail of the map and identification of artifacts.

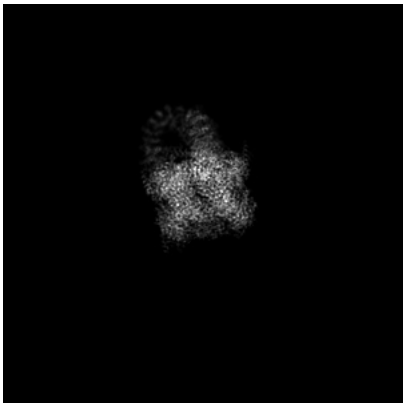
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections (i)

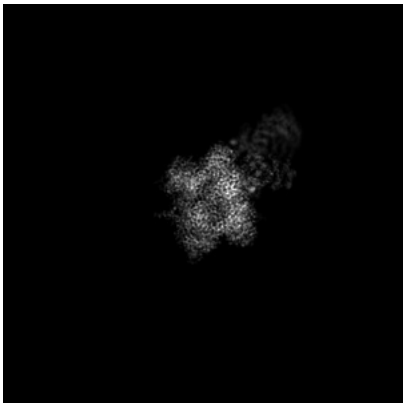
6.1.1 Primary map



X



Y

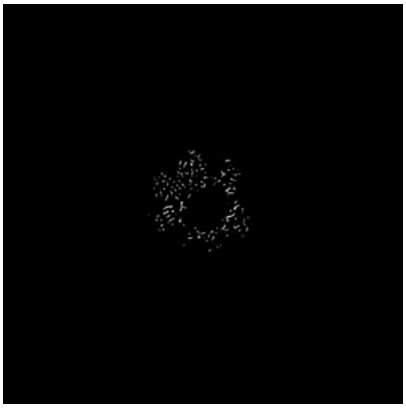


Z

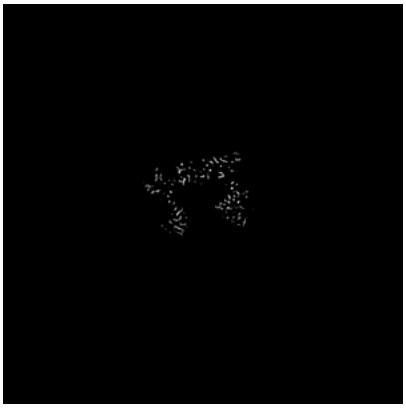
The images above show the map projected in three orthogonal directions.

6.2 Central slices (i)

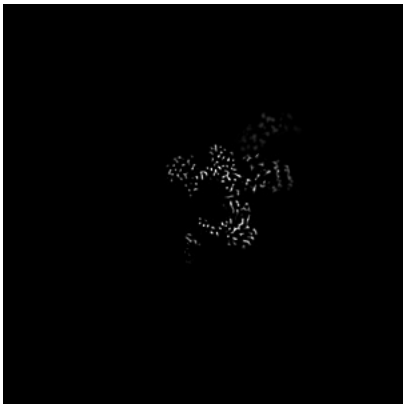
6.2.1 Primary map



X Index: 150



Y Index: 150

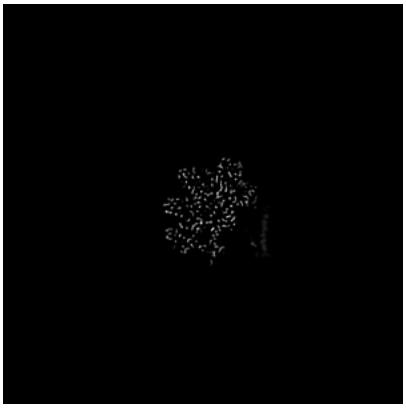


Z Index: 150

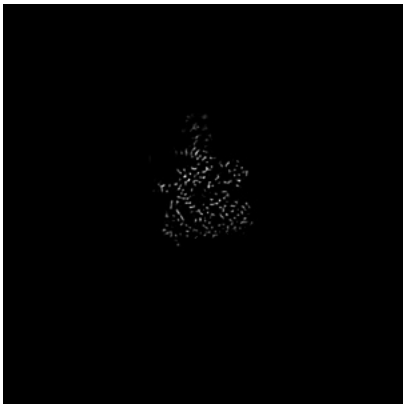
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices (i)

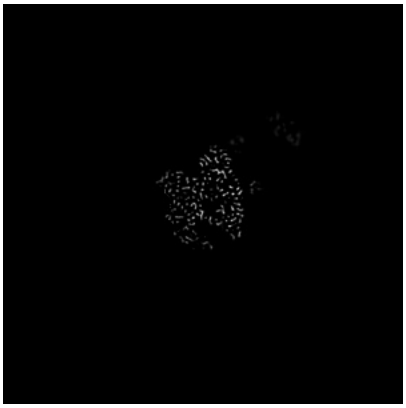
6.3.1 Primary map



X Index: 172



Y Index: 168

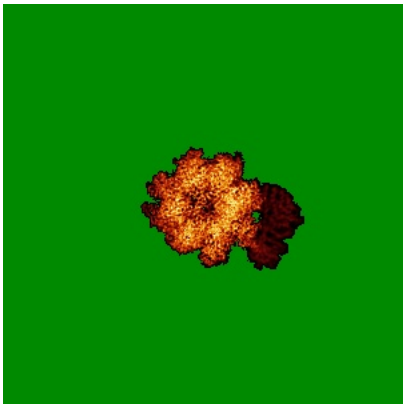


Z Index: 131

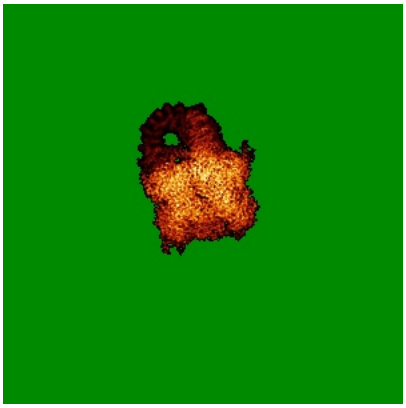
The images above show the largest variance slices of the map in three orthogonal directions.

6.4 Orthogonal standard-deviation projections (False-color) (i)

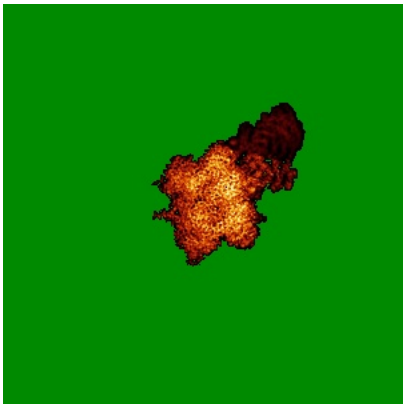
6.4.1 Primary map



X



Y

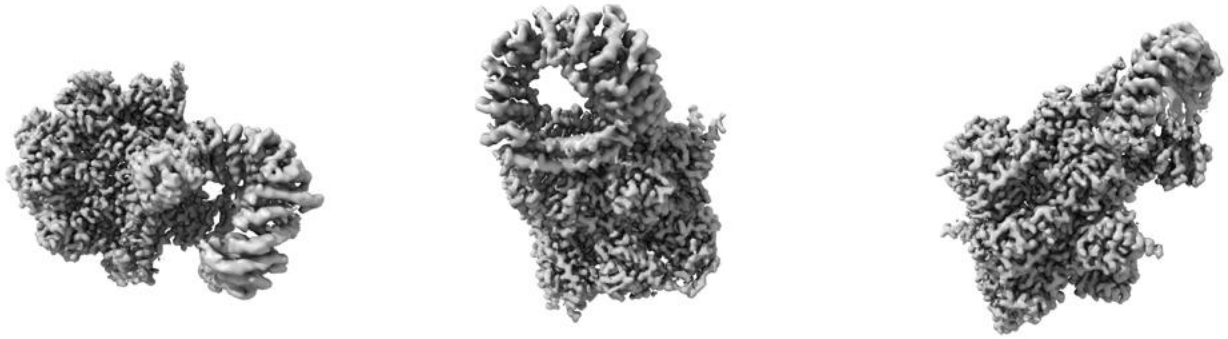


Z

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



X Y Z

The images above show the 3D surface view of the map at the recommended contour level 1.3. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

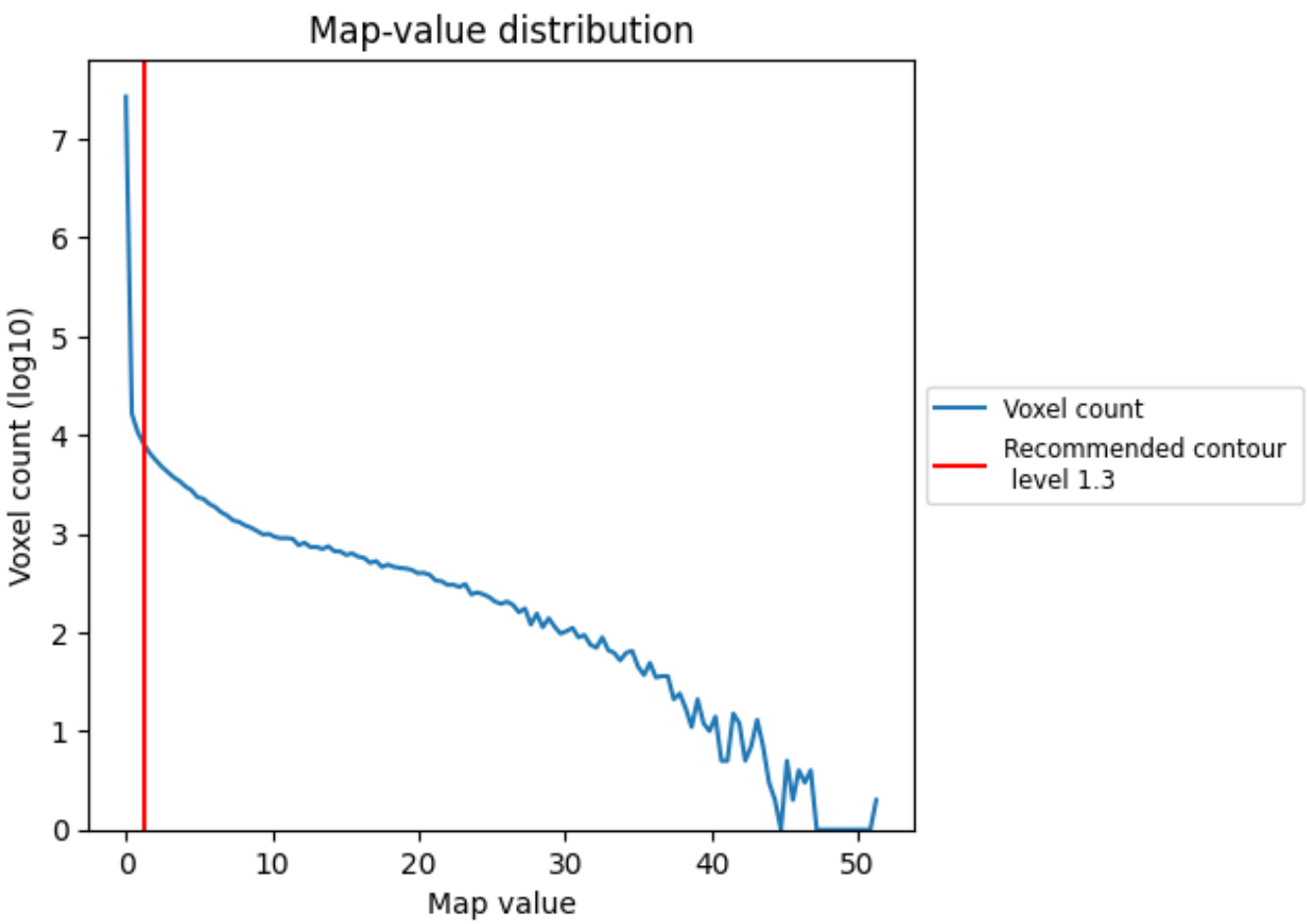
6.6 Mask visualisation (i)

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

7 Map analysis (i)

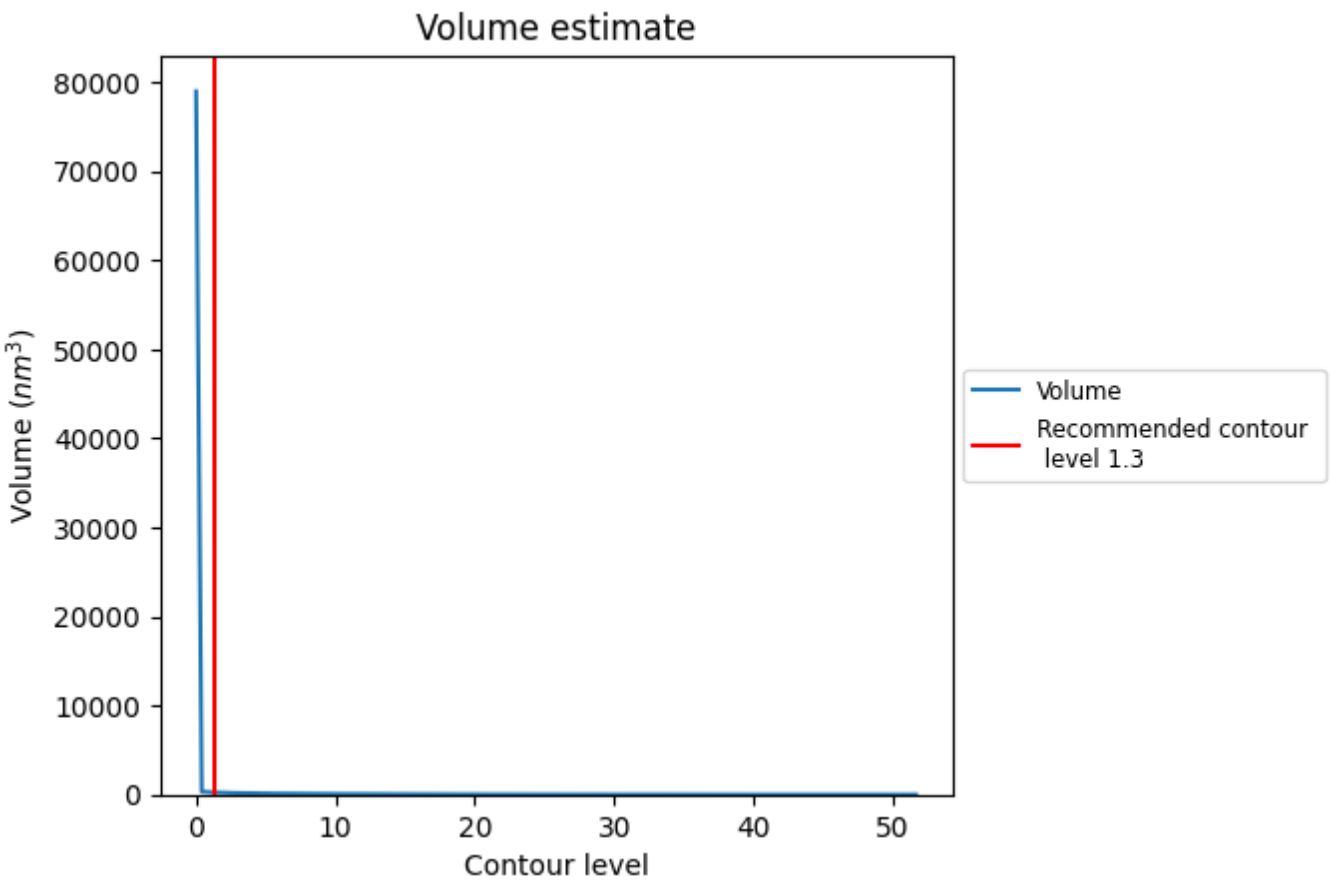
This section contains the results of statistical analysis of the map.

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.

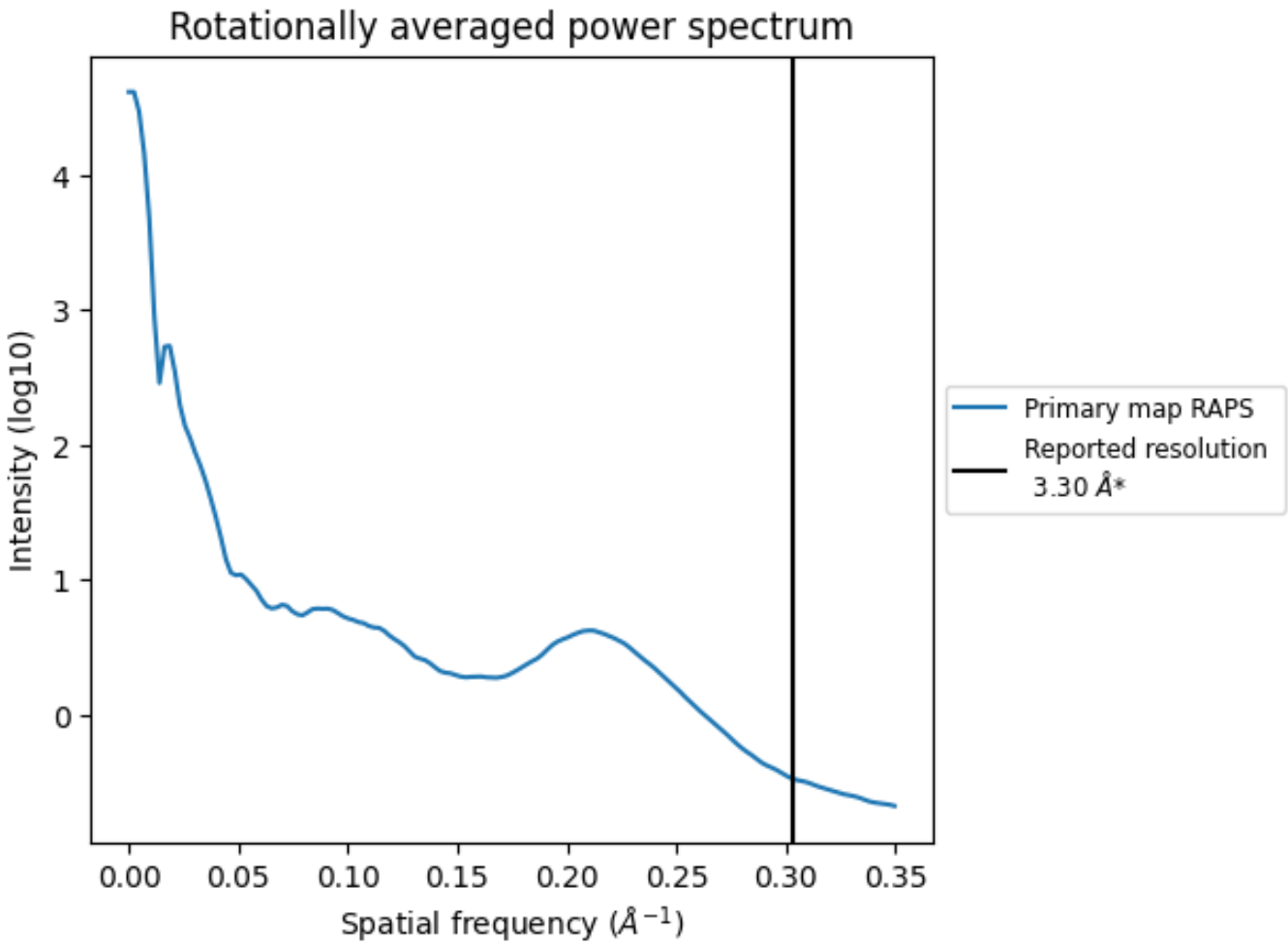
7.2 Volume estimate (i)



The volume at the recommended contour level is 244 nm^3; this corresponds to an approximate mass of 220 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 0.303 Å^{-1}

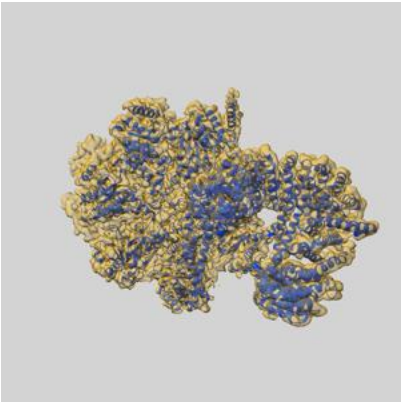
8 Fourier-Shell correlation (i)

This section was not generated. No FSC curve or half-maps provided.

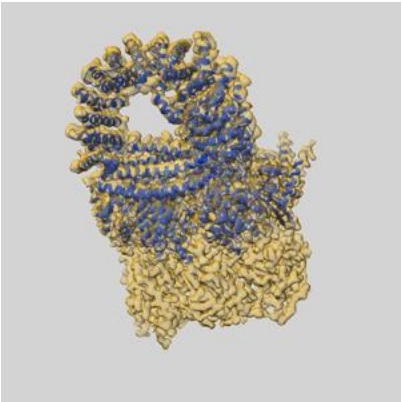
9 Map-model fit (i)

This section contains information regarding the fit between EMDB map EMD-53265 and PDB model 9QOO. Per-residue inclusion information can be found in section 3 on page 6.

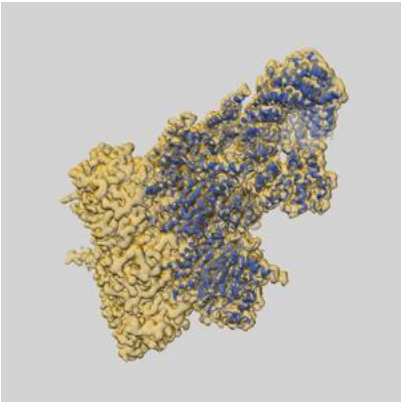
9.1 Map-model overlay (i)



X



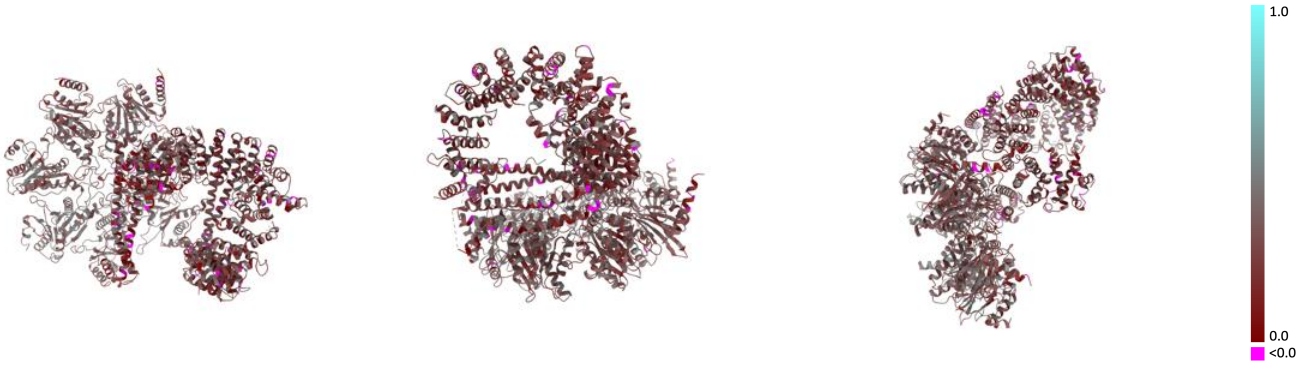
Y



Z

The images above show the 3D surface view of the map at the recommended contour level 1.3 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.

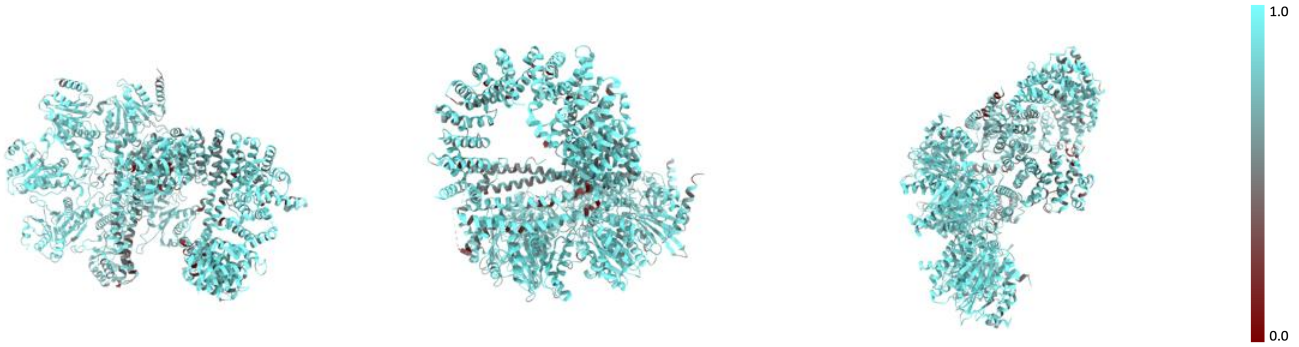
9.2 Q-score mapped to coordinate model (i)



X Y Z

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.

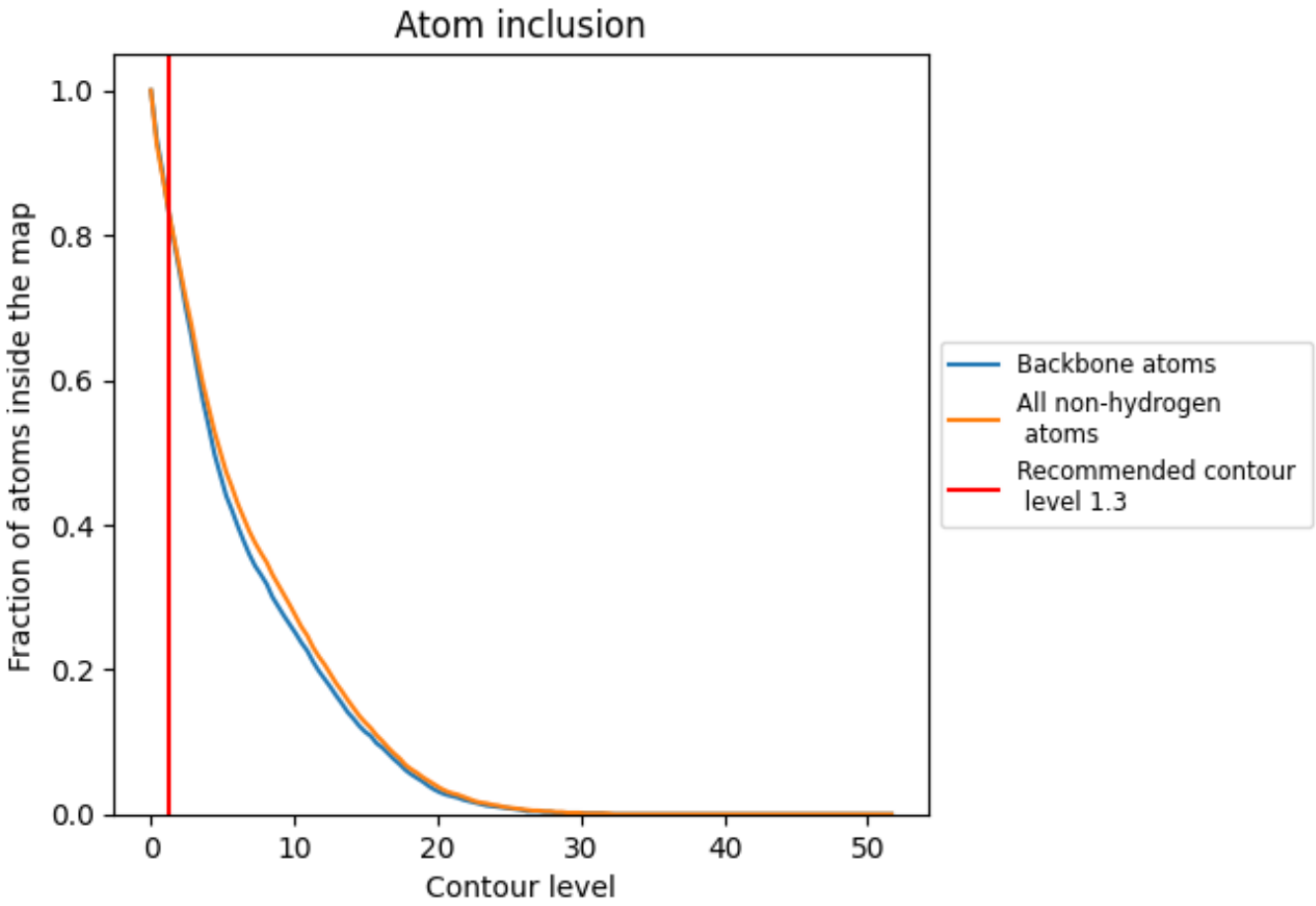
9.3 Atom inclusion mapped to coordinate model (i)



X Y Z

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 (1.3).

9.4 Atom inclusion (i)



At the recommended contour level, 82% of all backbone atoms, 83% of all non-hydrogen atoms, are inside the map.

9.5 Map-model fit summary (i)

The table lists the average atom inclusion at the recommended contour level (1.3) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.8260	0.3030
A	0.8020	0.2540
B	0.7030	0.2260
C	0.6880	0.2340
D	0.7080	0.2330
F	0.8770	0.3570
G	0.8700	0.3270
I	0.7950	0.2440
O	0.8750	0.3150
P	0.8510	0.3030
Q	0.8610	0.3210
R	0.8550	0.3450
S	0.8980	0.3730