



wwPDB EM Validation Summary Report ⓘ

Mar 26, 2026 – 06:55 AM UTC

PDB ID : 7LXD / pdb_00007lxd
EMDB ID : EMD-23570
Title : Structure of yeast DNA Polymerase Zeta (apo)
Authors : Truong, C.D.; Craig, T.A.; Cui, G.; Botuyan, M.V.; Serkasevich, R.A.; Chan, K.-Y.; Mer, G.; Chiu, P.-L.; Kumar, R.
Deposited on : 2021-03-03
Resolution : 4.11 Å(reported)
Based on initial model : 6V8P

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:

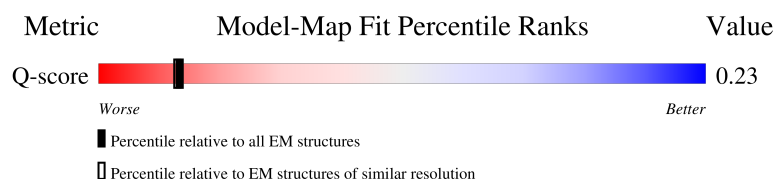
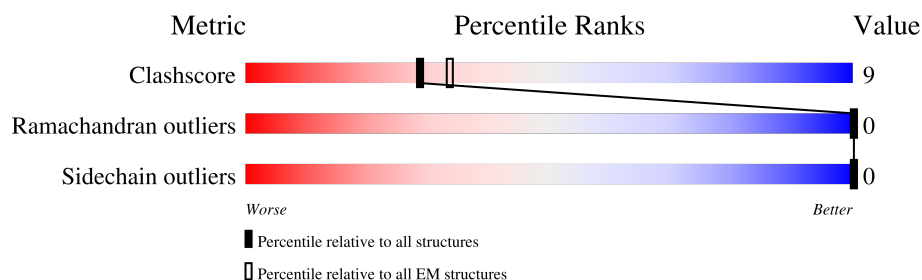
EMDB validation analysis : 0.0.1.dev132
Mogul : 2022.3.0, CSD as543be (2022)
MolProbity : 4-5-2 with Phenix2.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
EM percentile statistics : 202505.v01 (Using data in the EMDB archive up until May 2025)
MapQ : 1.9.13
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 4.11 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	5659 (3.62 - 4.61)

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	1504	
2	D	245	
2	E	245	
3	F	489	

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
4	G	350	 A horizontal bar chart showing the quality of chain G. The bar is divided into three segments: a green segment on the left labeled '25%', a yellow segment in the middle labeled '9%', and a grey segment on the right labeled '66%'. A small red dot is at the beginning of the bar.

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 17456 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 DNA polymerase zeta catalytic subunit.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	1190	Total	C	N	O	S	0	0
			9725	6268	1640	1777	40		

- Molecule 2 is a protein called DNA polymerase zeta processivity subunit.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	D	163	Total	C	N	O	S	0	0
			1364	897	217	246	4		
2	E	205	Total	C	N	O	S	0	0
			1718	1109	284	320	5		

- Molecule 3 is a protein called DNA polymerase delta small subunit.

Mol	Chain	Residues	Atoms					AltConf	Trace
3	F	459	Total	C	N	O	S	0	0
			3668	2340	608	699	21		

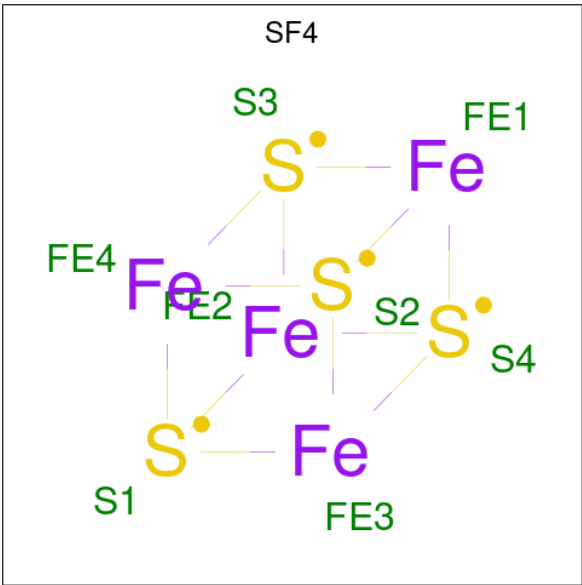
There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	-1	LEU	-	expression tag	UNP P46957
F	0	HIS	-	expression tag	UNP P46957

- Molecule 4 is a protein called DNA polymerase delta subunit 3.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	G	118	Total	C	N	O	S	0	0
			973	635	149	180	9		

- Molecule 5 is IRON/SULFUR CLUSTER (CCD ID: SF4) (formula: Fe₄S₄).

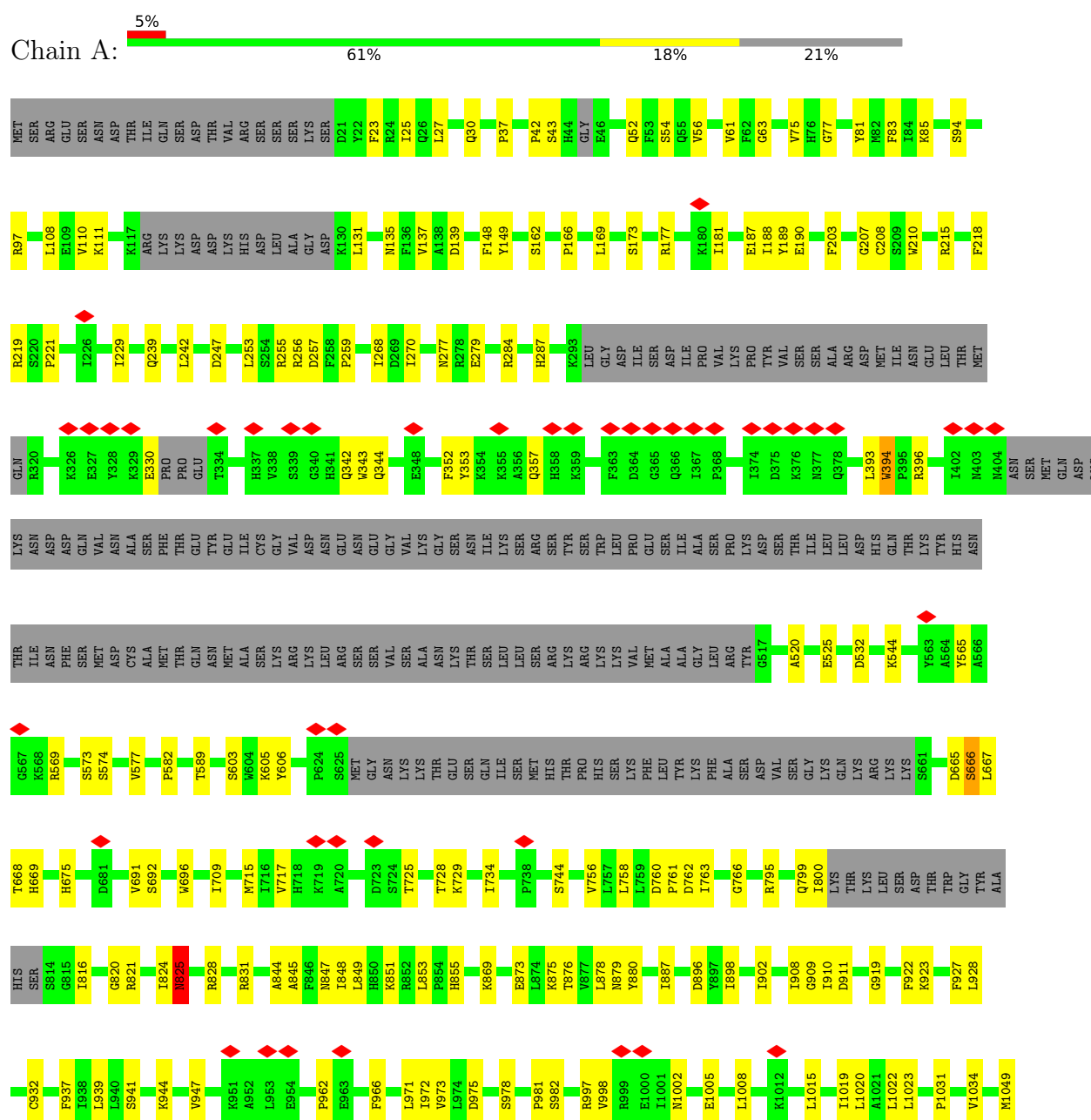


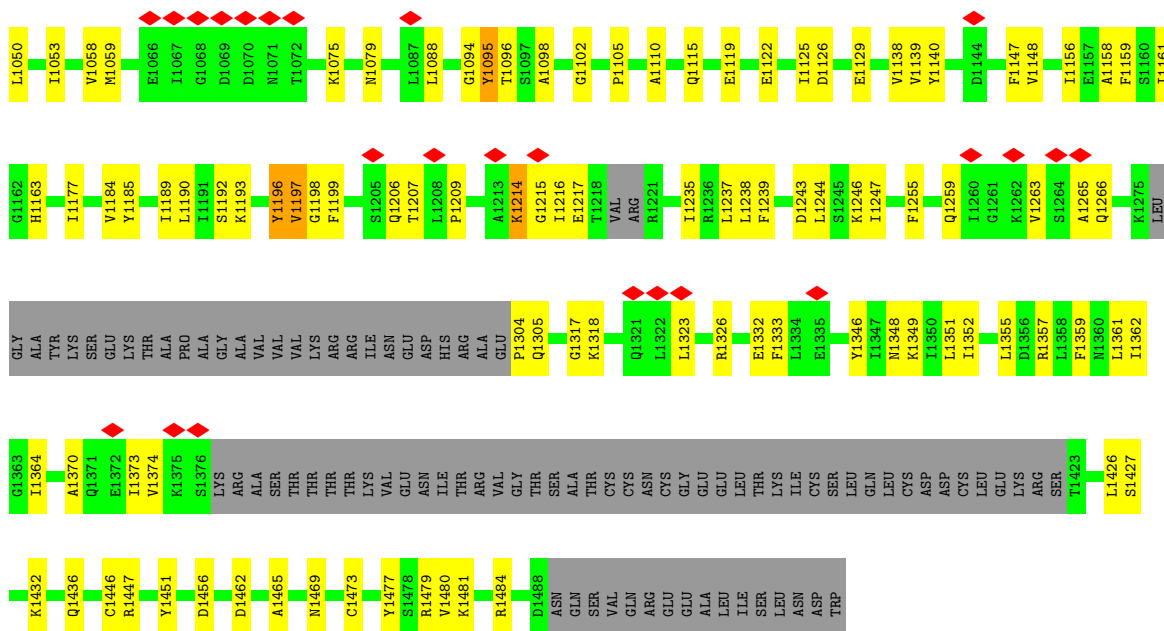
Mol	Chain	Residues	Atoms			AltConf
			Total	Fe	S	
5	A	1	8	4	4	0

3 Residue-property plots

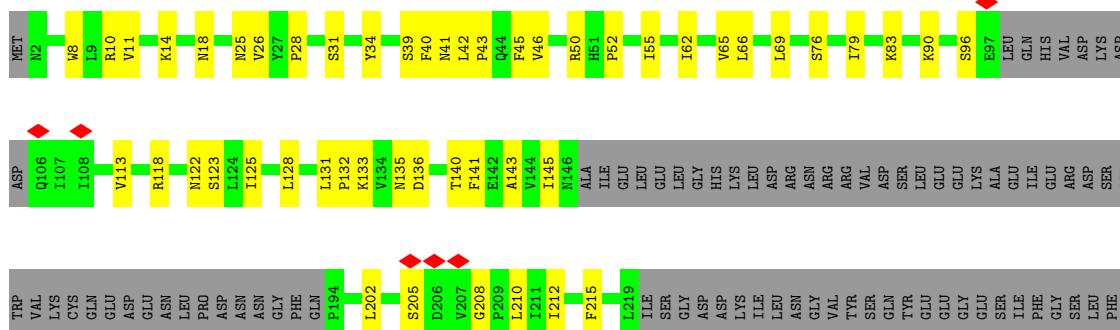
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and atom inclusion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

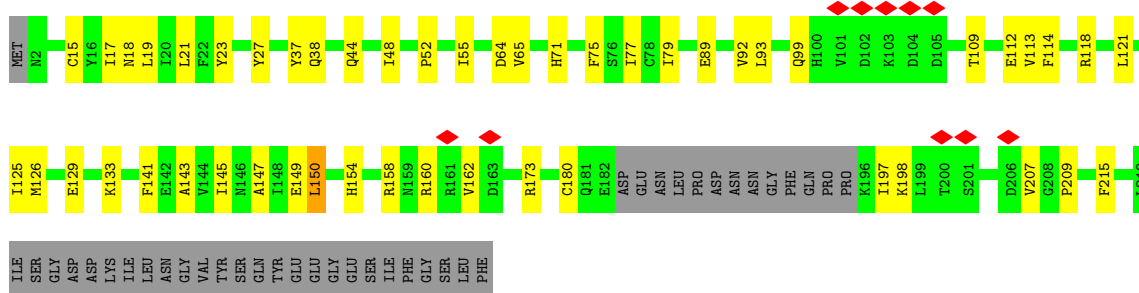




• Molecule 2: DNA polymerase zeta processivity subunit



• Molecule 2: DNA polymerase zeta processivity subunit



• Molecule 3: DNA polymerase delta small subunit





THR	LYS	ARG	PRO	ALA	THR	SER	ASN	SER	GLU	THR	SER	W1
LYS	PRO	ALA	ASP	LYS	ASN	LYS	ASN	GLU	ASN	GLU	THR	A5
THR	THR	THR	LYS	ASP	LYS	ASP	GLU	GLU	GLN	ARG	ILE	E11
SER	SER	SER	LYS	ASN	LYS	ASN	GLU	GLU	ASN	GLU	GLU	K18
THR	THR	THR	ASN	ASN	ASN	ASN	LEU	LEU	LEU	THR	THR	P19
PRO	PRO	PRO	ASP	ASP	ASP	ASP	ARG	ARG	ARG	LYS	LYS	V20
PRO	PRO	PRO	ASP	ASP	ASP	THR	LYS	ARG	LYS	THR	THR	L21
LYS	LYS	GLU	GLU	GLU	GLU	GLU	LYS	ARG	LEU	LEU	GLU	F22
PRO	PRO	ASP	ASP	ASP	ASP	GLU	LYS	GLU	GLU	GLU	GLU	T23
SER	SER	LEU	LEU	LEU	LEU	GLU	GLU	GLU	GLU	LYS	LYS	T26
PRO	PRO	VAL	GLU	GLU	GLU	ASN	ASN	ASN	SER	SER	SER	H27
VAL	VAL	THR	THR	THR	THR	GLN	GLN	GLN	PRO	PRO	PRO	L29
LYS	LYS	ARG	ALA	ALA	ALA	ILE	ILE	VAL	VAL	VAL	VAL	G32
ALA	ALA	GLU	GLU	GLU	GLU	ASN	ASN	ARG	ARG	ARG	ARG	P33
SER	SER	LEU	ASP	ASP	ASP	LYS	LYS	PRO	PRO	PRO	PRO	S34
LEU	LEU	SER	LEU	LEU	LEU	GLN	GLN	THR	THR	THR	THR	P35
SER	SER	SER	LEU	LEU	LEU	ASN	ASN	ALA	ALA	ALA	ALA	A36
LYS	LYS	LYS	ASP	ASP	ASP	MET	MET	PRO	PRO	ARG	ARG	K37
LYS	LYS	VAL	VAL	VAL	VAL	ASP	ASP	GLU	GLU	SER	SER	X51
GLN	GLN	THR	PRO	PRO	PRO	VAL	VAL	ARG	ARG	LYS	LYS	X51
GLU	GLU	THR	GLU	GLU	GLU	THR	THR	GLU	GLU	THR	THR	C54
THR	THR	LYS	ILE	ILE	ILE	GLN	GLN	ALA	ALA	PRO	PRO	V55
PRO	PRO	PRO	GLU	GLU	GLU	MET	MET	GLU	GLU	GLU	GLU	V56
SER	SER	SER	GLN	GLN	GLN	LYS	LYS	VAL	VAL	THR	THR	I57
ASN	ASN	THR	LYS	LYS	LYS	THR	THR	LEU	LEU	THR	THR	V60
LYS	LYS	ARG	PRO	PRO	PRO	ASN	ASN	GLY	GLY	GLY	GLY	K61
ARG	ARG	GLU	GLU	GLU	GLU	ASN	ASN	ARG	ARG	ARG	ARG	D62
LEU	LEU	LEU	SER	SER	SER	LEU	LEU	LYS	LYS	LYS	LYS	O63
LYS	LYS	THR	THR	THR	THR	PHE	PHE	SER	SER	SER	SER	T64
LYS	LYS	GLU	GLU	GLU	GLU	VAL	VAL	LYS	LYS	LYS	LYS	I65
GLN	GLN	THR	HIS	HIS	HIS	GLU	GLU	SER	SER	SER	SER	X66
GLY	GLY	THR	LYS	LYS	LYS	ASP	ASP	LYS	LYS	LYS	LYS	Q76
THR	THR	GLU	LYS	LYS	LYS	ASP	ASP	ASP	ASP	ASP	ASP	T61
LEU	LEU	GLU	PRO	PRO	PRO	LEU	LEU	GLY	GLY	GLY	GLY	T61
GLU	GLU	SER	SER	SER	SER	THR	THR	LEU	LEU	LEU	LEU	T61
PHE	PHE	PHE	GLU	GLU	GLU	GLU	GLU	ARG	ARG	ARG	ARG	F84
LYS	LYS	LYS	GLU	GLU	GLU	VAL	VAL	THR	THR	THR	THR	I85
ARG	ARG	ARG	GLU	GLU	GLU	ASN	ASN	ALA	ALA	ALA	ALA	X86
LYS	LYS	LYS	PRO	PRO	PRO	GLY	GLY	LEU	LEU	LEU	LEU	F88
ALA	ALA	ALA	SER	SER	SER	GLY	GLY	ALA	ALA	ALA	ALA	R89
LYS	LYS	LYS	PHE	PHE	PHE	LYS	LYS	LYS	LYS	LYS	LYS	P90
THR	THR	THR	ILE	ILE	ILE	PRO	PRO	MET	MET	MET	MET	N91
ASP	ASP	ASP	ASP	ASP	ASP	ASN	ASN	LYS	LYS	LYS	LYS	D92
GLY	GLY	GLY	GLU	GLU	GLU	SER	SER	ASP	ASP	ASP	ASP	P96
TYR	TYR	TYR	GLY	GLY	GLY	PRO	PRO	ARG	ARG	ARG	ARG	N111
THR	THR	THR	THR	THR	THR	GLU	GLU	ASP	ASP	ASP	ASP	N111
VAL	VAL	VAL	VAL	VAL	VAL	THR						

4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	213120	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 ($e^-/\text{\AA}^2$)	45.7	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	48780	Depositor
Image detector	GATAN K2 SUMMIT (4k x 4k)	Depositor
Maximum map value	41.500	Depositor
Minimum map value	-12.993	Depositor
Average map value	-0.000	Depositor
Map value standard deviation	1.000	Depositor
Recommended contour level	3.35	Depositor
Map size (Å)	328.02002, 328.02002, 328.02002	wwPDB
Map dimensions	220, 220, 220	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.491, 1.491, 1.491	Depositor

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: SF4

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	0.28	0/9950	0.73	10/13442 (0.1%)
2	D	0.28	0/1397	0.72	0/1896
2	E	0.28	0/1754	0.77	1/2375 (0.0%)
3	F	0.30	0/3746	0.82	4/5079 (0.1%)
4	G	0.28	0/996	0.77	2/1346 (0.1%)
All	All	0.28	0/17843	0.76	17/24138 (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	7
2	E	0	1
3	F	0	6
4	G	0	1
All	All	0	15

There are no bond length outliers.

The worst 5 of 17 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	709	ILE	CG1-CB-CG2	-6.39	91.53	110.70
1	A	1215	GLY	CA-C-N	6.01	128.78	120.49
1	A	1215	GLY	C-N-CA	6.01	128.78	120.49
3	F	478	LEU	CA-CB-CG	5.95	137.12	116.30
4	G	11	GLU	N-CA-CB	5.93	118.67	110.07

There are no chirality outliers.

5 of 15 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	394	TRP	Peptide
1	A	666	SER	Peptide
1	A	744	SER	Peptide
1	A	824	ILE	Peptide
1	A	825	ASN	Peptide

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	9725	0	9743	177	0
2	D	1364	0	1380	32	0
2	E	1718	0	1720	31	0
3	F	3668	0	3654	88	0
4	G	973	0	976	19	0
5	A	8	0	0	0	0
All	All	17456	0	17473	327	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 9.

The worst 5 of 327 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:A:1196:TYR:HE2	1:A:1214:LYS:HD3	1.04	1.13
1:A:1196:TYR:CE2	1:A:1214:LYS:HD3	1.90	1.05
3:F:65:ARG:O	3:F:69:LEU:HB2	1.78	0.84
1:A:23:PHE:HA	1:A:210:TRP:HE1	1.56	0.71
3:F:273:LYS:HG2	3:F:277:MET:HE1	1.73	0.70

There are no symmetry-related clashes.

5.3 Torsion angles

5.3.1 Protein backbone

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	1168/1504 (78%)	1135 (97%)	33 (3%)	0	100	100
2	D	157/245 (64%)	157 (100%)	0	0	100	100
2	E	201/245 (82%)	198 (98%)	3 (2%)	0	100	100
3	F	451/489 (92%)	435 (96%)	16 (4%)	0	100	100
4	G	116/350 (33%)	112 (97%)	4 (3%)	0	100	100
All	All	2093/2833 (74%)	2037 (97%)	56 (3%)	0	100	100

There are no Ramachandran outliers to report.

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	A	1088/1369 (80%)	1088 (100%)	0	100	100
2	D	159/233 (68%)	159 (100%)	0	100	100
2	E	198/233 (85%)	198 (100%)	0	100	100
3	F	420/447 (94%)	420 (100%)	0	100	100
4	G	113/331 (34%)	113 (100%)	0	100	100
All	All	1978/2613 (76%)	1978 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

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

Mol	Chain	Res	Type
2	E	122	ASN
3	F	245	ASN
3	F	15	GLN
3	F	262	ASN
1	A	560	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
5	SF4	A	1601	1	0,12,12	-	-	-		

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
5	SF4	A	1601	1	-	-	0/6/5/5

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.

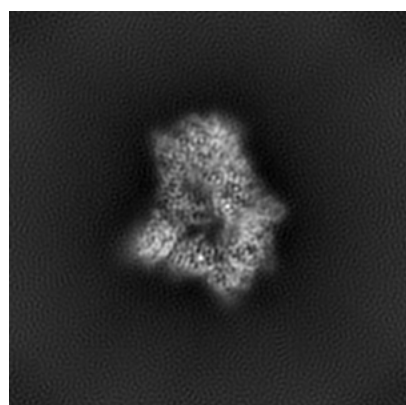
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-23570. These allow visual inspection of the internal detail of the map and identification of artifacts.

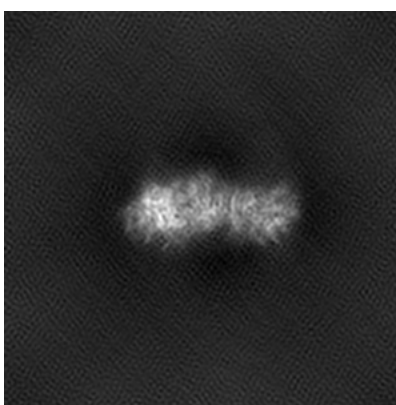
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections [i](#)

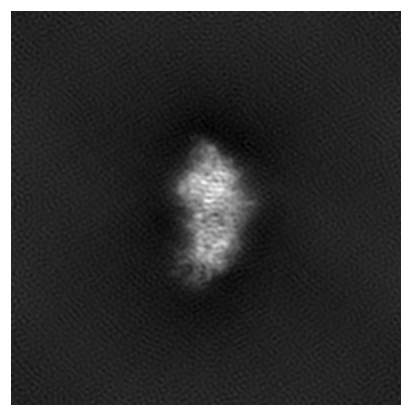
6.1.1 Primary map



X



Y

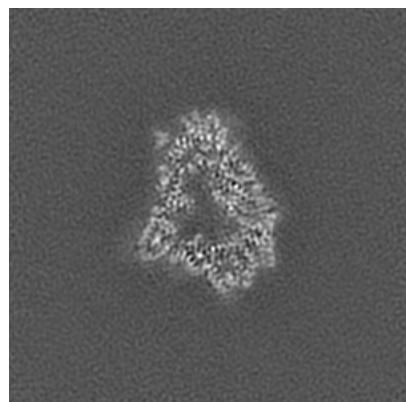


Z

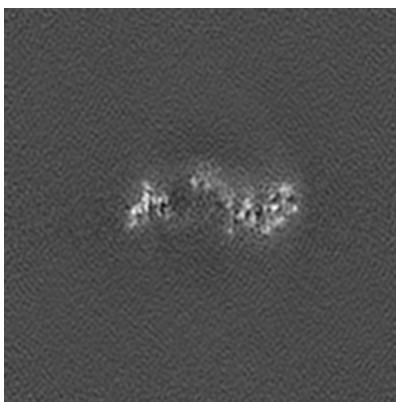
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

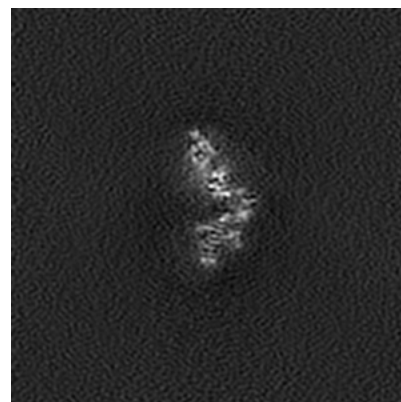
6.2.1 Primary map



X Index: 110



Y Index: 110

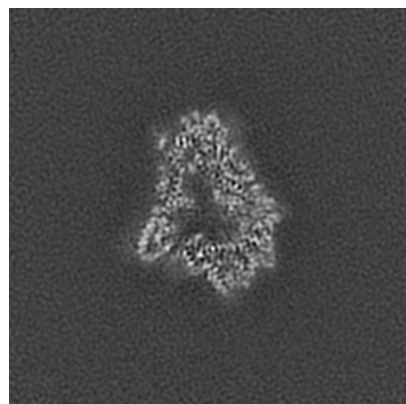


Z Index: 110

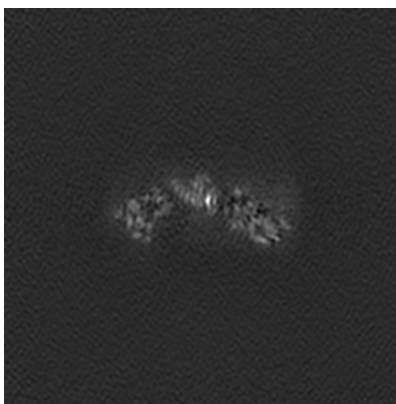
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

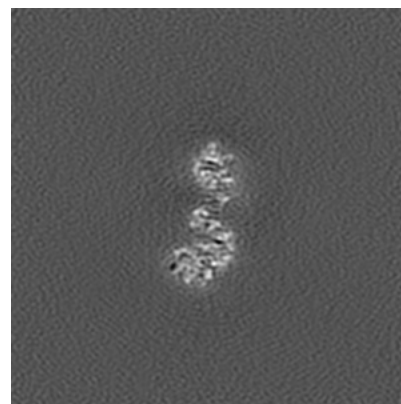
6.3.1 Primary map



X Index: 109



Y Index: 120

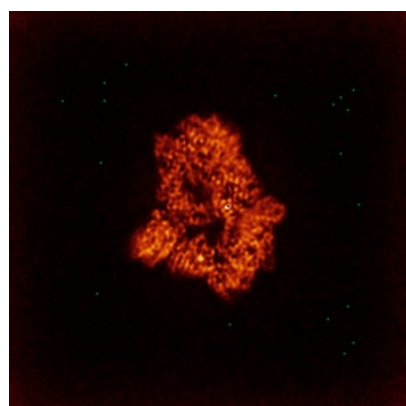


Z Index: 90

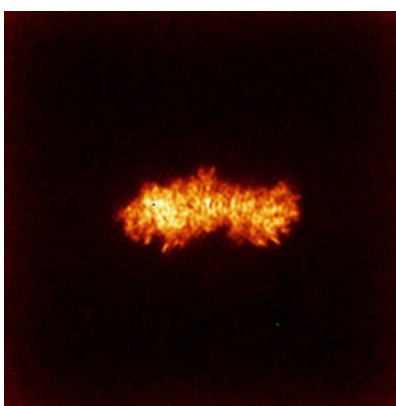
The images above show the largest variance slices of the map in three orthogonal directions.

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

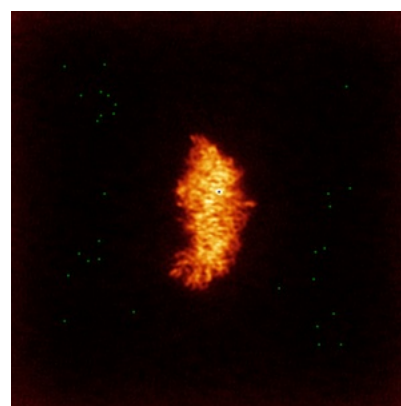
6.4.1 Primary map



X



Y

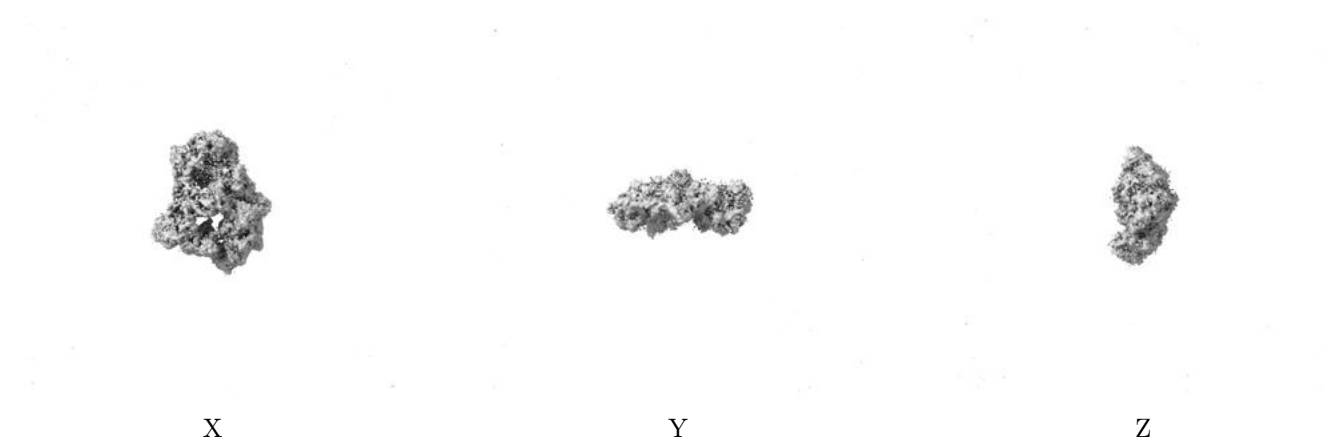


Z

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

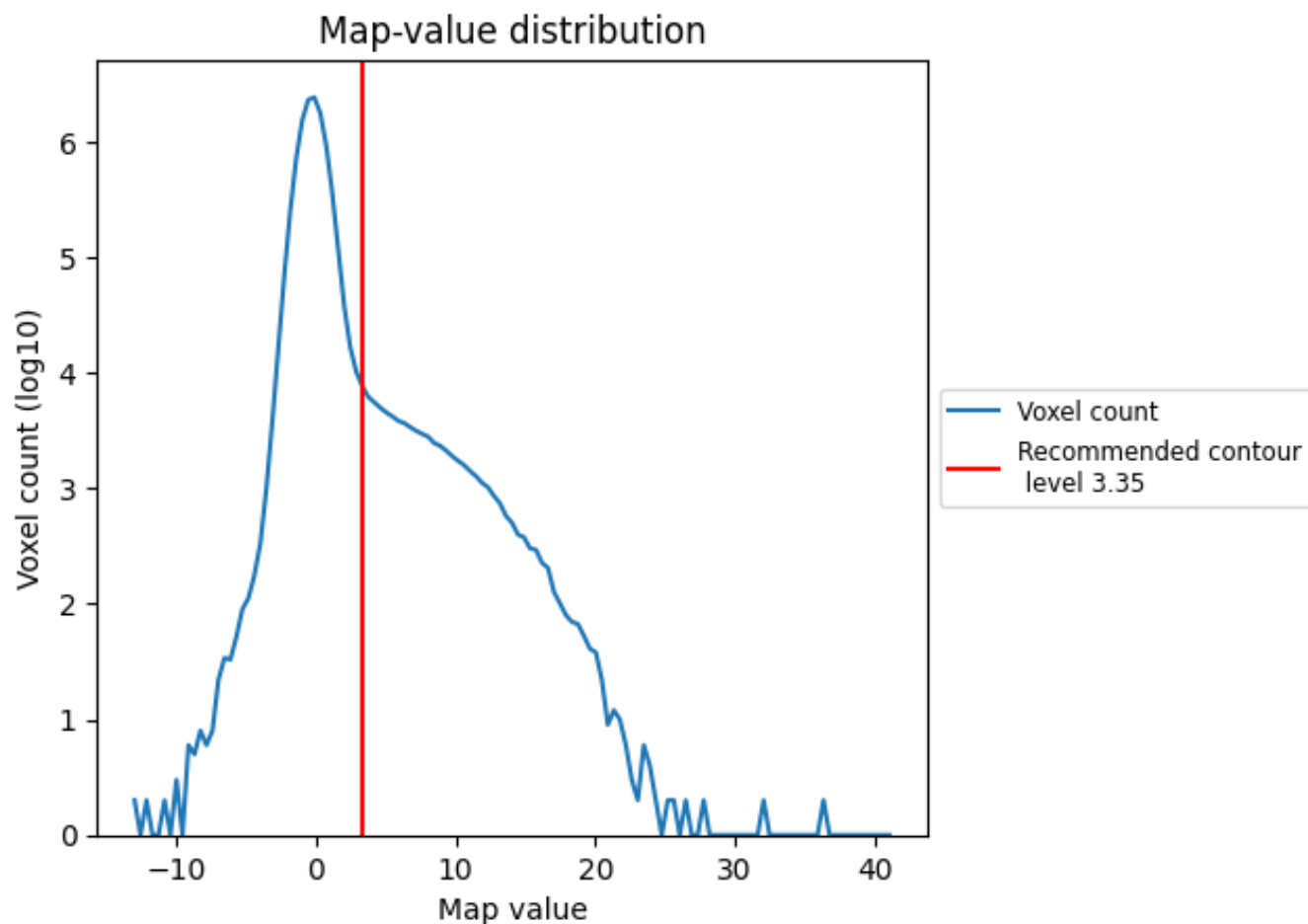
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

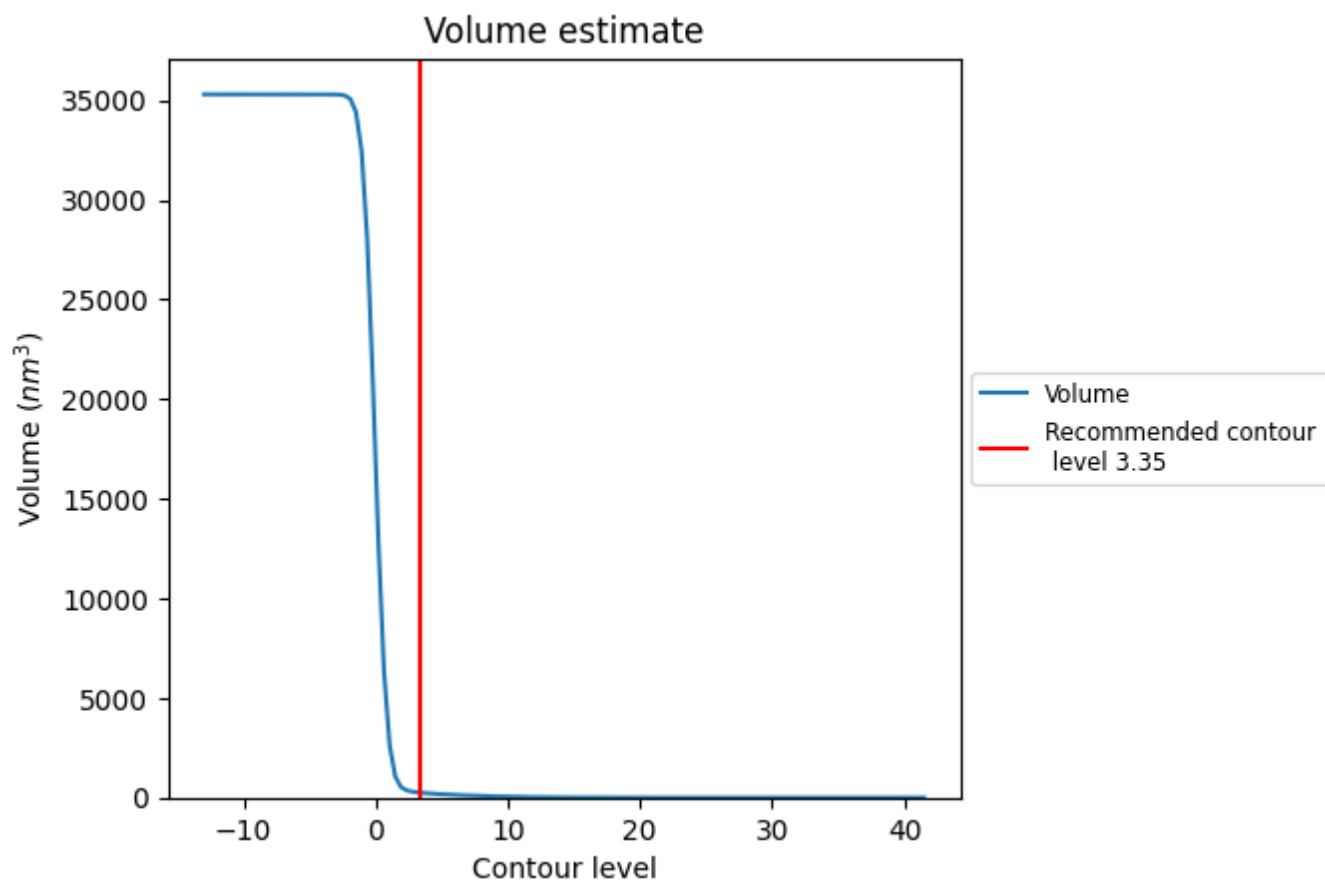
This section contains the results of statistical analysis of the map.

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.

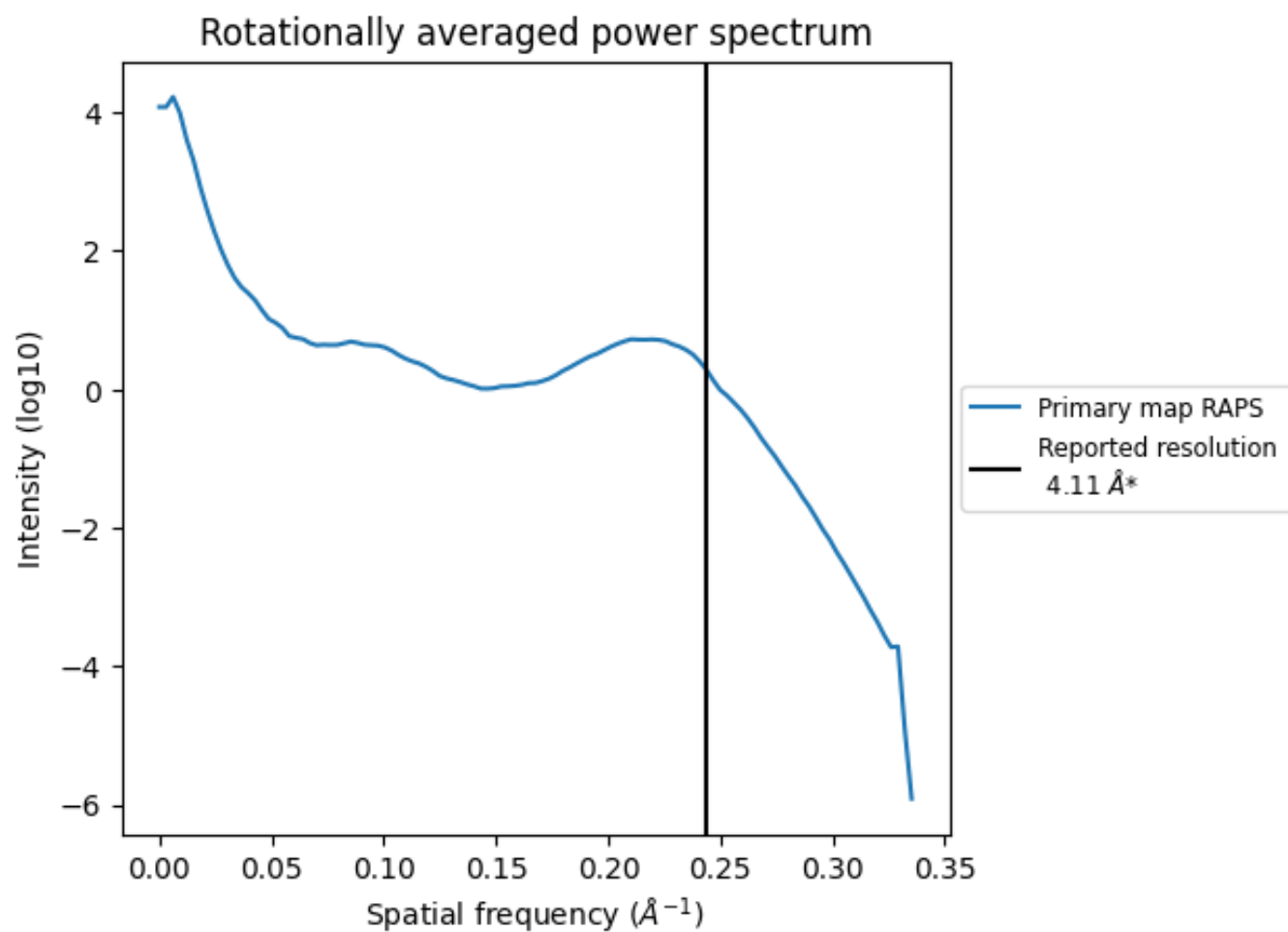
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 247 nm^3 ; this corresponds to an approximate mass of 223 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 0.243 Å⁻¹

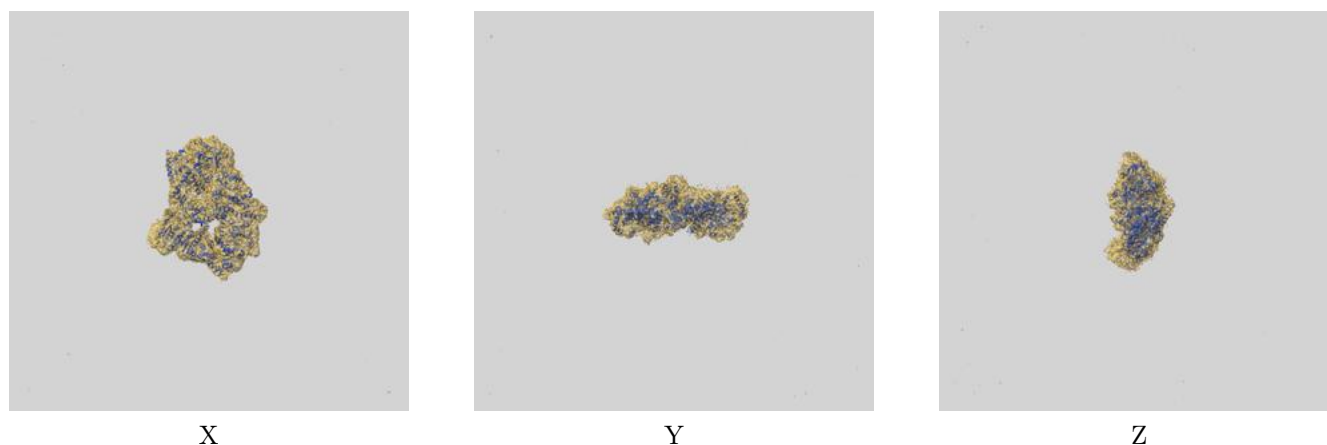
8 Fourier-Shell correlation

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

9 Map-model fit [i](#)

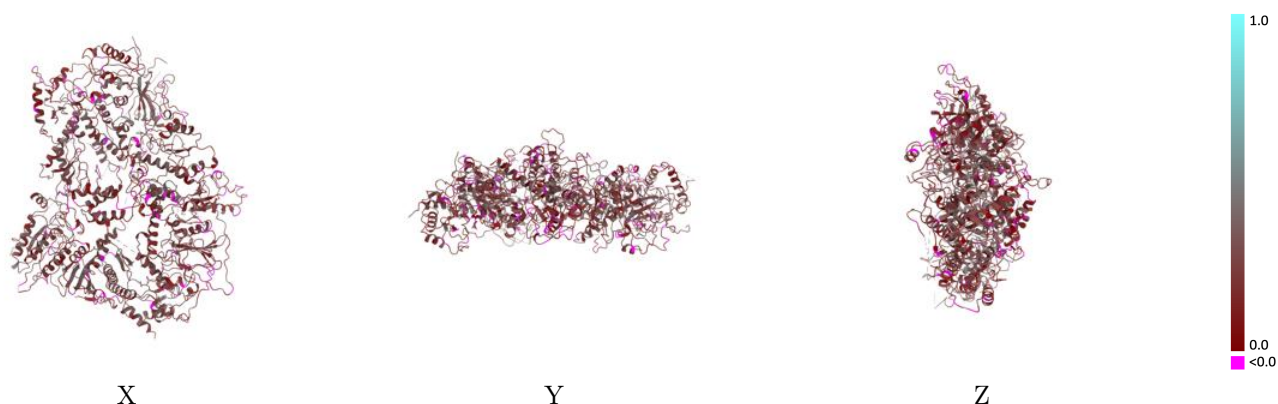
This section contains information regarding the fit between EMDB map EMD-23570 and PDB model 7LXD. Per-residue inclusion information can be found in [section 3](#) on [page 6](#).

9.1 Map-model overlay [i](#)



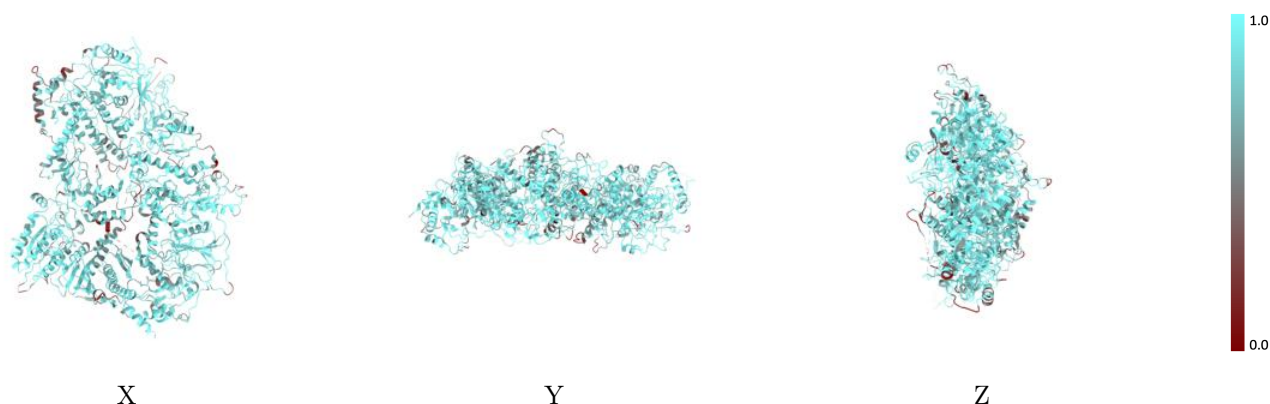
The images above show the 3D surface view of the map at the recommended contour level 3.35 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



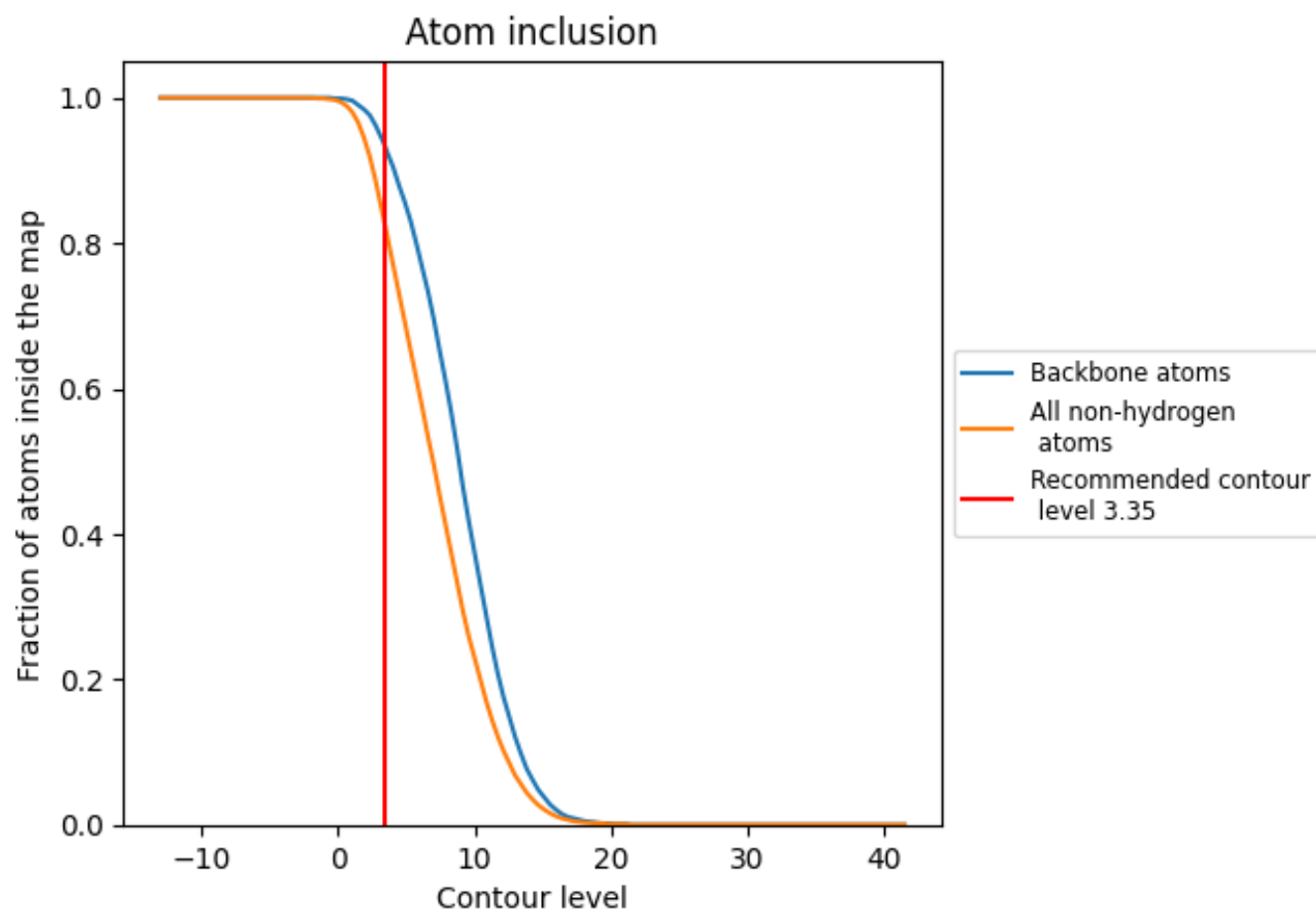
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (3.35).

9.4 Atom inclusion [i](#)



At the recommended contour level, 94% of all backbone atoms, 83% 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 (3.35) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.8340	0.2300
A	0.8260	0.2360
D	0.9000	0.2510
E	0.8310	0.2360
F	0.8270	0.2000
G	0.8580	0.2480

