



wwPDB EM Validation Summary Report ⓘ

Sep 14, 2026 – 10:37 AM JST

PDB ID : 9WTO / pdb_00009wto
EMDB ID : EMD-66223
Title : Cryo-EM Structure of the 12-Mer ATPase Complex YsaN from the Type III Secretion System of Yersinia enterocolitica
Authors : Bhattacharyya, B.; Chakraborty, B.; Datta, S.; Patra, D.
Deposited on : 2025-09-16
Resolution : 3.51 Å(reported)
Based on initial model : .

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:

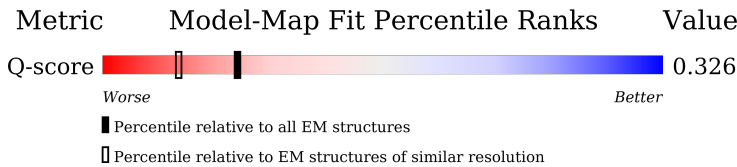
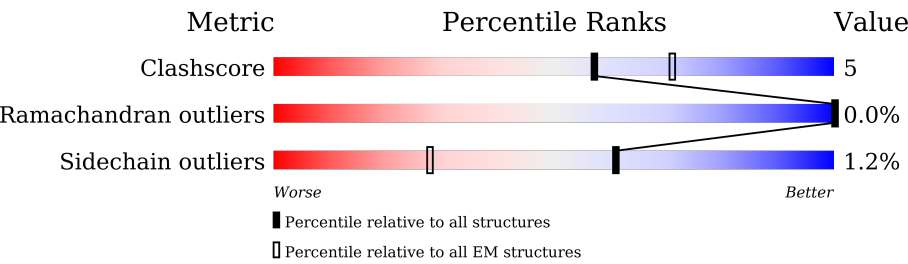
EMDB validation analysis : 0.0.1.dev133
MolProbity : 4-5-2 with Phenix2.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
EM percentile statistics : 202505.v01 (Using data in the EMDB archive up until May 2025)
MapQ : 1.9.13
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.50

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 3.51 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.



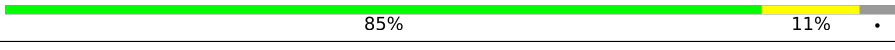
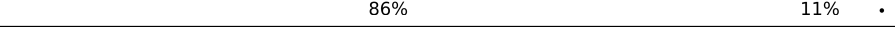
Metric	Whole archive (#Entries)	EM structures (#Entries)	Similar EM resolution (#Entries, resolution range(Å))
Clashscore	229148	23984	-
Ramachandran outliers	224038	23583	-
Sidechain outliers	223484	23102	-
Q-score	-	25397	13085 (3.01 - 4.01)

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	436	85% 11% .
1	B	436	84% 13% .
1	C	436	86% 11% .
1	D	436	6% 86% 11% .

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Mol	Chain	Length	Quality of chain
1	E	436	 87%10%.
1	F	436	 85%11%.
1	G	436	 86%11%.
1	H	436	 83%14%.
1	I	436	 86%11%.
1	J	436	 36%85%12%.
1	K	436	 88%9%.
1	L	436	 84%12%.

2 Entry composition

There is only 1 type of molecule in this entry. The entry contains 37397 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 Type 3 secretion system ATPase.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	419	Total	C	N	O	S	0	0
			3021	1912	529	565	15		
1	B	423	Total	C	N	O	S	0	0
			3123	1967	551	588	17		
1	C	422	Total	C	N	O	S	0	0
			3099	1956	543	584	16		
1	D	423	Total	C	N	O	S	0	0
			3128	1964	547	601	16		
1	E	423	Total	C	N	O	S	0	0
			3128	1964	547	601	16		
1	F	420	Total	C	N	O	S	0	0
			3100	1952	549	583	16		
1	G	423	Total	C	N	O	S	0	0
			3128	1964	547	601	16		
1	H	422	Total	C	N	O	S	0	0
			3213	2014	575	606	18		
1	I	423	Total	C	N	O	S	0	0
			3128	1964	547	601	16		
1	J	423	Total	C	N	O	S	0	0
			3128	1964	547	601	16		
1	K	423	Total	C	N	O	S	0	0
			3128	1964	547	601	16		
1	L	421	Total	C	N	O	S	0	0
			3073	1932	539	587	15		

There are 72 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-5	VAL	-	expression tag	UNP A1JQ97
A	-4	PRO	-	expression tag	UNP A1JQ97
A	-3	ARG	-	expression tag	UNP A1JQ97
A	-2	GLY	-	expression tag	UNP A1JQ97
A	-1	SER	-	expression tag	UNP A1JQ97
A	0	HIS	-	expression tag	UNP A1JQ97

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Chain	Residue	Modelled	Actual	Comment	Reference
B	-5	VAL	-	expression tag	UNP A1JQ97
B	-4	PRO	-	expression tag	UNP A1JQ97
B	-3	ARG	-	expression tag	UNP A1JQ97
B	-2	GLY	-	expression tag	UNP A1JQ97
B	-1	SER	-	expression tag	UNP A1JQ97
B	0	HIS	-	expression tag	UNP A1JQ97
C	-5	VAL	-	expression tag	UNP A1JQ97
C	-4	PRO	-	expression tag	UNP A1JQ97
C	-3	ARG	-	expression tag	UNP A1JQ97
C	-2	GLY	-	expression tag	UNP A1JQ97
C	-1	SER	-	expression tag	UNP A1JQ97
C	0	HIS	-	expression tag	UNP A1JQ97
D	-5	VAL	-	expression tag	UNP A1JQ97
D	-4	PRO	-	expression tag	UNP A1JQ97
D	-3	ARG	-	expression tag	UNP A1JQ97
D	-2	GLY	-	expression tag	UNP A1JQ97
D	-1	SER	-	expression tag	UNP A1JQ97
D	0	HIS	-	expression tag	UNP A1JQ97
E	-5	VAL	-	expression tag	UNP A1JQ97
E	-4	PRO	-	expression tag	UNP A1JQ97
E	-3	ARG	-	expression tag	UNP A1JQ97
E	-2	GLY	-	expression tag	UNP A1JQ97
E	-1	SER	-	expression tag	UNP A1JQ97
E	0	HIS	-	expression tag	UNP A1JQ97
F	-5	VAL	-	expression tag	UNP A1JQ97
F	-4	PRO	-	expression tag	UNP A1JQ97
F	-3	ARG	-	expression tag	UNP A1JQ97
F	-2	GLY	-	expression tag	UNP A1JQ97
F	-1	SER	-	expression tag	UNP A1JQ97
F	0	HIS	-	expression tag	UNP A1JQ97
G	-5	VAL	-	expression tag	UNP A1JQ97
G	-4	PRO	-	expression tag	UNP A1JQ97
G	-3	ARG	-	expression tag	UNP A1JQ97
G	-2	GLY	-	expression tag	UNP A1JQ97
G	-1	SER	-	expression tag	UNP A1JQ97
G	0	HIS	-	expression tag	UNP A1JQ97
H	-5	VAL	-	expression tag	UNP A1JQ97
H	-4	PRO	-	expression tag	UNP A1JQ97
H	-3	ARG	-	expression tag	UNP A1JQ97
H	-2	GLY	-	expression tag	UNP A1JQ97
H	-1	SER	-	expression tag	UNP A1JQ97
H	0	HIS	-	expression tag	UNP A1JQ97

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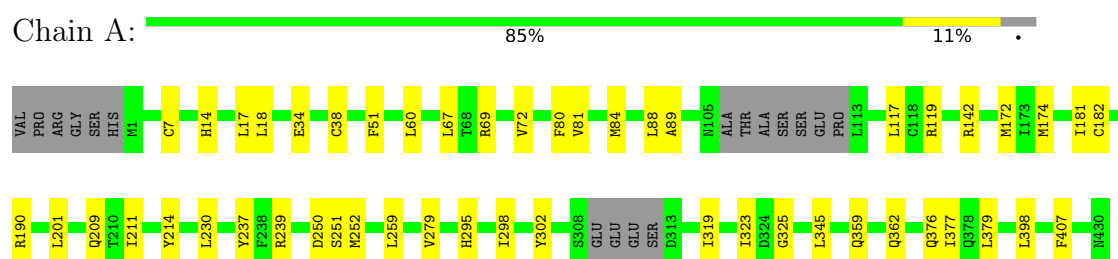
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Chain	Residue	Modelled	Actual	Comment	Reference
I	-5	VAL	-	expression tag	UNP A1JQ97
I	-4	PRO	-	expression tag	UNP A1JQ97
I	-3	ARG	-	expression tag	UNP A1JQ97
I	-2	GLY	-	expression tag	UNP A1JQ97
I	-1	SER	-	expression tag	UNP A1JQ97
I	0	HIS	-	expression tag	UNP A1JQ97
J	-5	VAL	-	expression tag	UNP A1JQ97
J	-4	PRO	-	expression tag	UNP A1JQ97
J	-3	ARG	-	expression tag	UNP A1JQ97
J	-2	GLY	-	expression tag	UNP A1JQ97
J	-1	SER	-	expression tag	UNP A1JQ97
J	0	HIS	-	expression tag	UNP A1JQ97
K	-5	VAL	-	expression tag	UNP A1JQ97
K	-4	PRO	-	expression tag	UNP A1JQ97
K	-3	ARG	-	expression tag	UNP A1JQ97
K	-2	GLY	-	expression tag	UNP A1JQ97
K	-1	SER	-	expression tag	UNP A1JQ97
K	0	HIS	-	expression tag	UNP A1JQ97
L	-5	VAL	-	expression tag	UNP A1JQ97
L	-4	PRO	-	expression tag	UNP A1JQ97
L	-3	ARG	-	expression tag	UNP A1JQ97
L	-2	GLY	-	expression tag	UNP A1JQ97
L	-1	SER	-	expression tag	UNP A1JQ97
L	0	HIS	-	expression tag	UNP A1JQ97

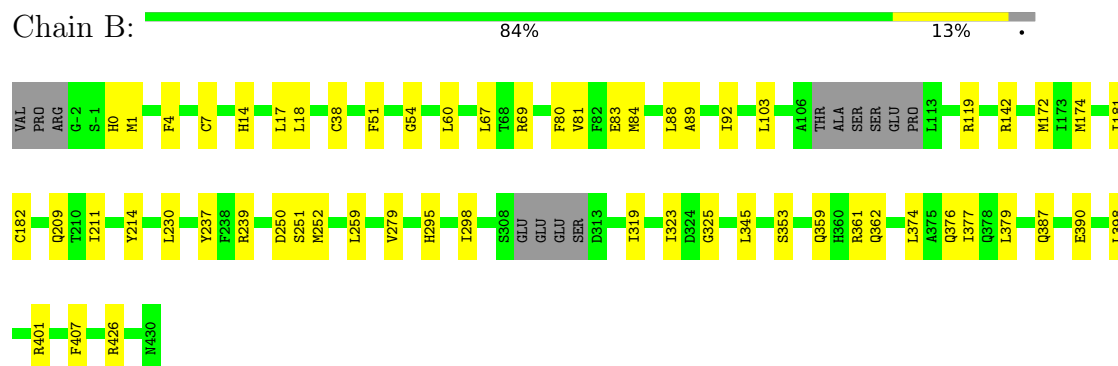
3 Residue-property plots [i](#)

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.

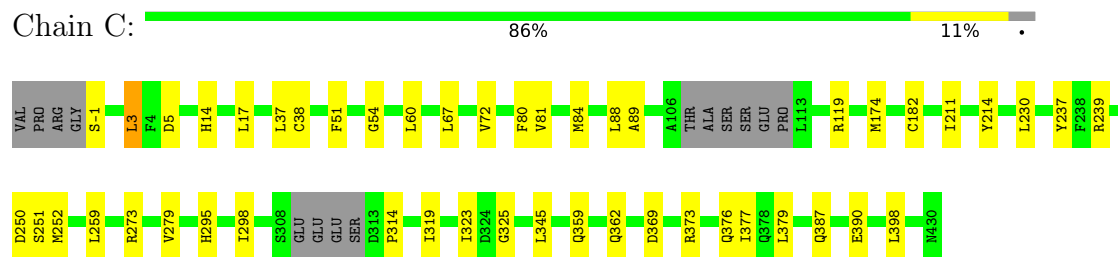
- Molecule 1: Type 3 secretion system ATPase



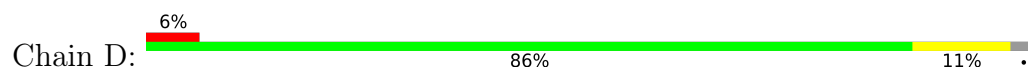
- Molecule 1: Type 3 secretion system ATPase

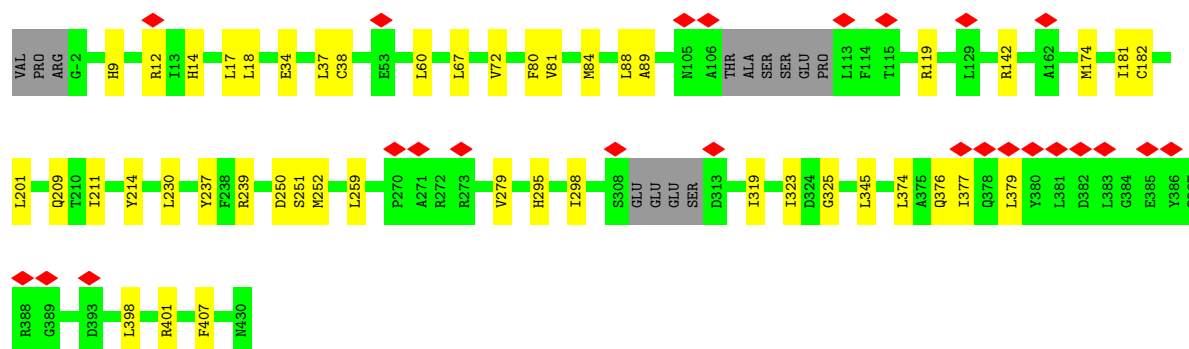


- Molecule 1: Type 3 secretion system ATPase



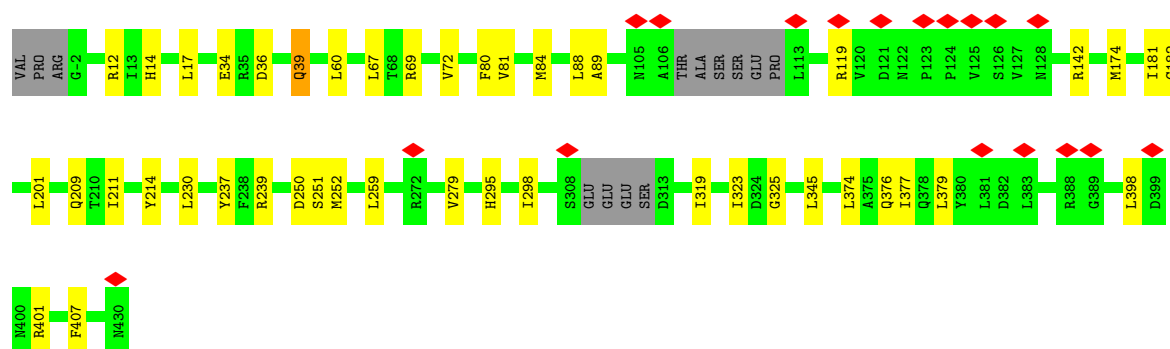
- Molecule 1: Type 3 secretion system ATPase





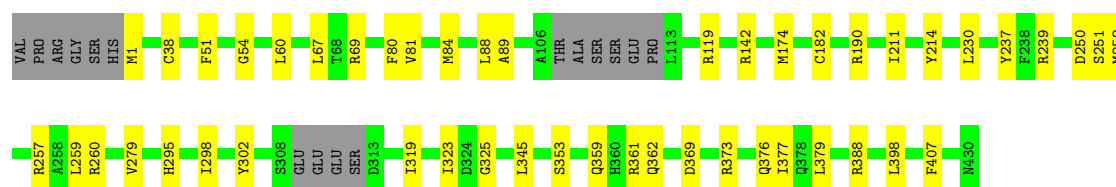
- Molecule 1: Type 3 secretion system ATPase

Chain E: 87% 10% .



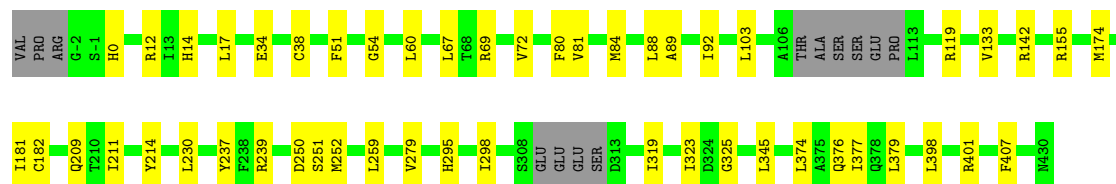
- Molecule 1: Type 3 secretion system ATPase

Chain F: 85% 11% .



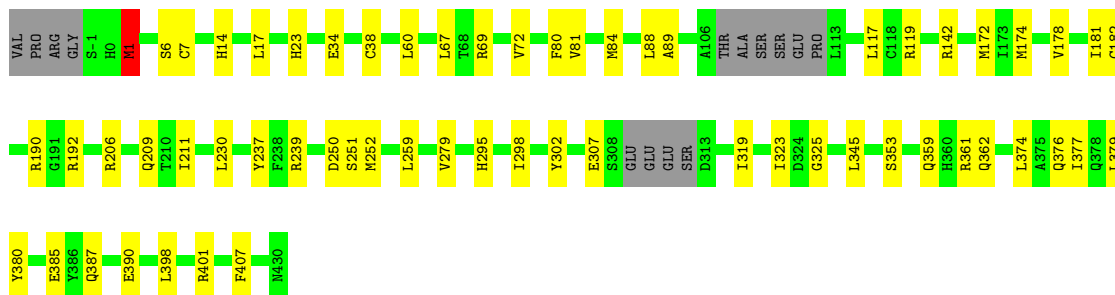
- Molecule 1: Type 3 secretion system ATPase

Chain G: 86% 11% .



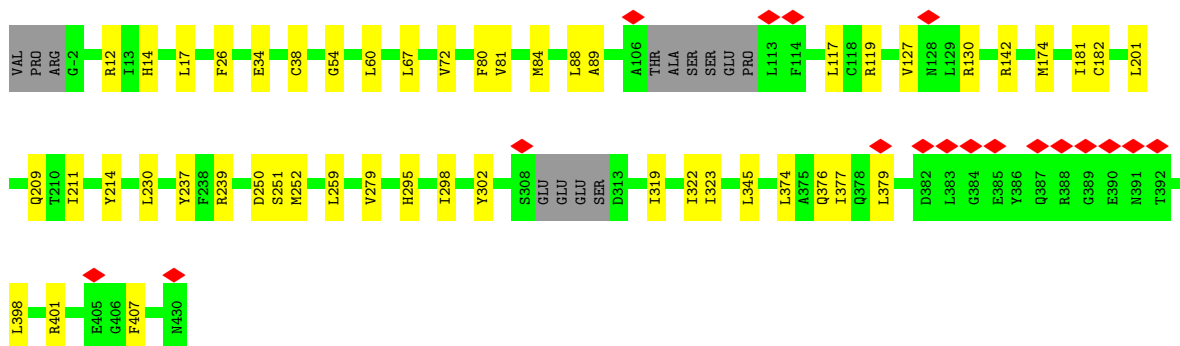
- Molecule 1: Type 3 secretion system ATPase

Chain H: 83% 14% .



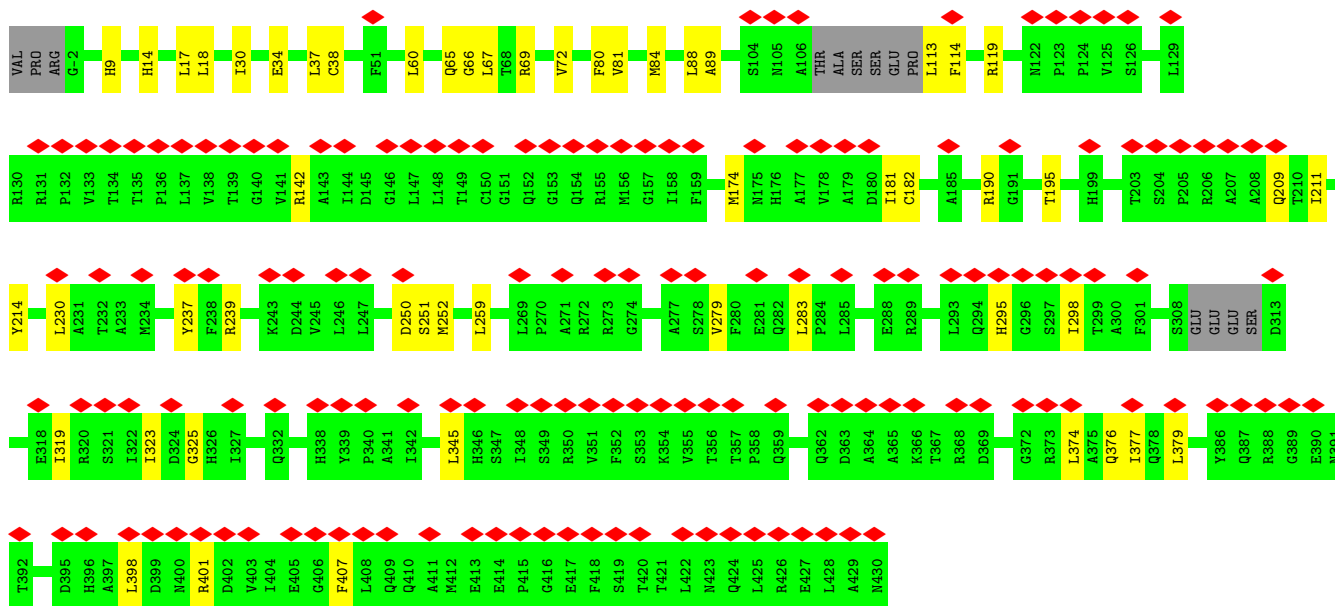
- Molecule 1: Type 3 secretion system ATPase

Chain I: 86% 11%



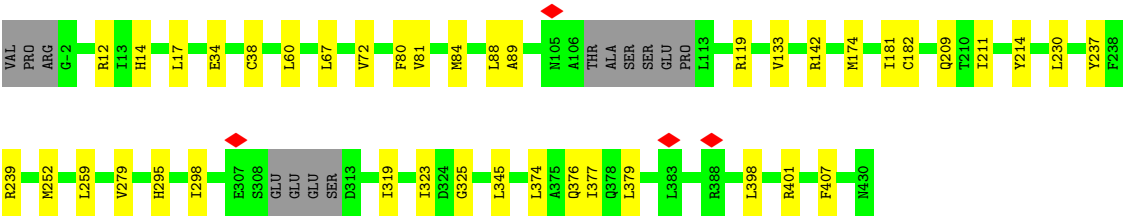
- Molecule 1: Type 3 secretion system ATPase

Chain J: 36% 85% 12%

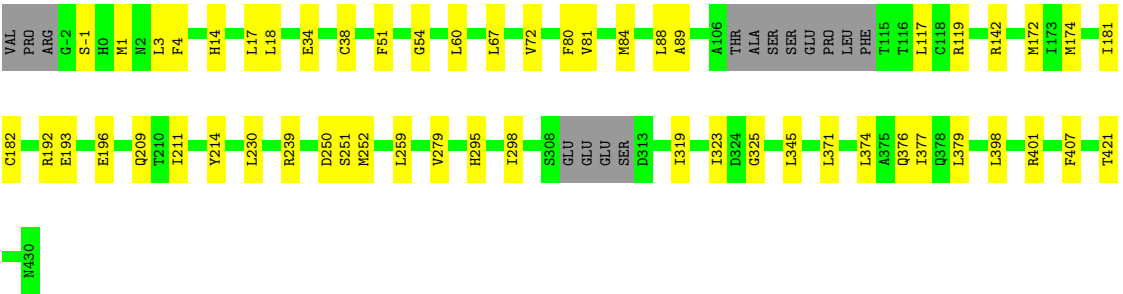
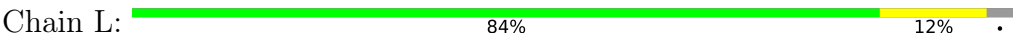


- Molecule 1: Type 3 secretion system ATPase

Chain K: 88% 9%



• Molecule 1: Type 3 secretion system ATPase



4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	174701	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	TFS TALOS	Depositor
Voltage (kV)	200	Depositor
Electron dose ($e^-/\text{\AA}^2$)	40, 40	Depositor
Minimum defocus (nm)	500	Depositor
Maximum defocus (nm)	2000	Depositor
Magnification	150000	Depositor
Image detector	FEI FALCON IV (4k x 4k), FEI FALCON IV (4k x 4k)	Depositor
Maximum map value	1.853	Depositor
Minimum map value	-0.019	Depositor
Average map value	0.001	Depositor
Map value standard deviation	0.005	Depositor
Recommended contour level	0.015	Depositor
Map size (Å)	379.80002, 379.80002, 379.80002	wwPDB
Map dimensions	600, 600, 600	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	0.633, 0.633, 0.633	Depositor

5 Model quality

5.1 Standard geometry

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	0/3072	0.33	0/4190
1	B	0.12	0/3175	0.34	0/4319
1	C	0.12	0/3151	0.34	0/4289
1	D	0.11	0/3178	0.33	0/4322
1	E	0.16	0/3178	0.34	0/4322
1	F	0.12	0/3149	0.33	0/4281
1	G	0.11	0/3178	0.33	0/4322
1	H	0.11	0/3265	0.35	0/4424
1	I	0.11	0/3178	0.33	0/4322
1	J	0.11	0/3178	0.33	0/4322
1	K	0.11	0/3178	0.33	0/4322
1	L	0.12	0/3124	0.33	0/4255
All	All	0.12	0/38004	0.33	0/51690

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	G	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	G	0	HIS	Peptide

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	3021	0	2922	34	0
1	B	3123	0	3060	36	0
1	C	3099	0	3021	30	0
1	D	3128	0	3057	26	0
1	E	3128	0	3057	28	0
1	F	3100	0	3051	30	0
1	G	3128	0	3057	30	0
1	H	3213	0	3207	38	0
1	I	3128	0	3057	35	0
1	J	3128	0	3057	36	0
1	K	3128	0	3057	25	0
1	L	3073	0	2974	32	0
All	All	37397	0	36577	354	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 354 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:69:ARG:HH12	1:B:54:GLY:H	1.26	0.80
1:C:3:LEU:HD21	1:C:72:VAL:HG11	1.69	0.74
1:I:181:ILE:HG22	1:I:209:GLN:HB3	1.71	0.73
1:G:181:ILE:HG22	1:G:209:GLN:HB3	1.71	0.72
1:E:181:ILE:HG22	1:E:209:GLN:HB3	1.71	0.72

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	413/436 (95%)	401 (97%)	12 (3%)	0	100	100
1	B	417/436 (96%)	402 (96%)	14 (3%)	1 (0%)	43	74
1	C	416/436 (95%)	403 (97%)	13 (3%)	0	100	100
1	D	417/436 (96%)	404 (97%)	13 (3%)	0	100	100
1	E	417/436 (96%)	402 (96%)	15 (4%)	0	100	100
1	F	414/436 (95%)	401 (97%)	13 (3%)	0	100	100
1	G	417/436 (96%)	403 (97%)	14 (3%)	0	100	100
1	H	416/436 (95%)	402 (97%)	13 (3%)	1 (0%)	43	74
1	I	417/436 (96%)	403 (97%)	14 (3%)	0	100	100
1	J	417/436 (96%)	404 (97%)	13 (3%)	0	100	100
1	K	417/436 (96%)	403 (97%)	14 (3%)	0	100	100
1	L	415/436 (95%)	400 (96%)	15 (4%)	0	100	100
All	All	4993/5232 (95%)	4828 (97%)	163 (3%)	2 (0%)	100	100

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	0	HIS
1	H	1	MET

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	298/356 (84%)	294 (99%)	4 (1%)	61	72
1	B	318/356 (89%)	312 (98%)	6 (2%)	50	68
1	C	312/356 (88%)	307 (98%)	5 (2%)	55	70
1	D	321/356 (90%)	318 (99%)	3 (1%)	70	76

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	E	321/356 (90%)	318 (99%)	3 (1%)	70	76
1	F	314/356 (88%)	310 (99%)	4 (1%)	61	72
1	G	321/356 (90%)	318 (99%)	3 (1%)	70	76
1	H	338/356 (95%)	332 (98%)	6 (2%)	51	69
1	I	321/356 (90%)	318 (99%)	3 (1%)	70	76
1	J	321/356 (90%)	318 (99%)	3 (1%)	70	76
1	K	321/356 (90%)	318 (99%)	3 (1%)	70	76
1	L	310/356 (87%)	306 (99%)	4 (1%)	61	72
All	All	3816/4272 (89%)	3769 (99%)	47 (1%)	61	73

5 of 47 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	H	1	MET
1	I	295	HIS
1	H	7	CYS
1	H	307	GLU
1	J	38	CYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 77 such sidechains are listed below:

Mol	Chain	Res	Type
1	J	65	GLN
1	L	23	HIS
1	J	209	GLN
1	K	176	HIS
1	L	360	HIS

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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.

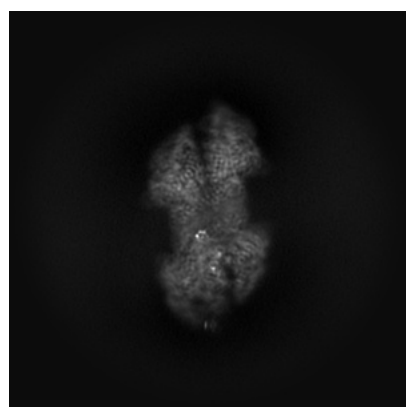
6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-66223. These allow visual inspection of the internal detail of the map and identification of artifacts.

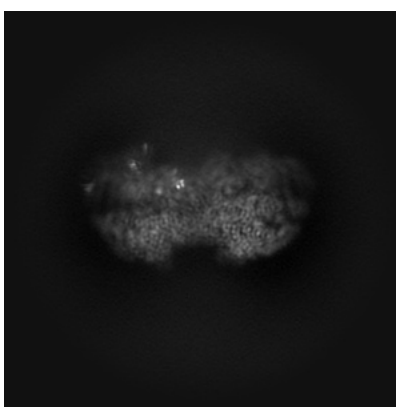
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections [i](#)

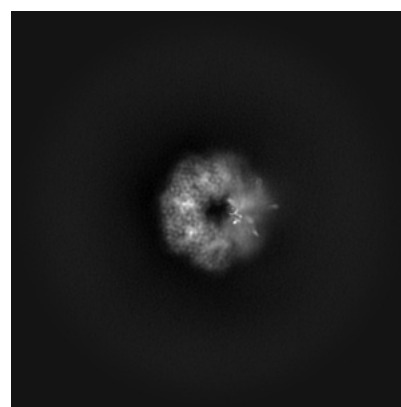
6.1.1 Primary map



X



Y

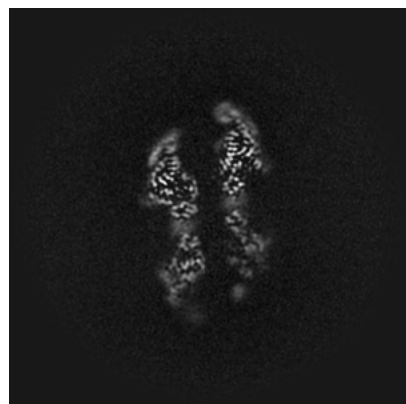


Z

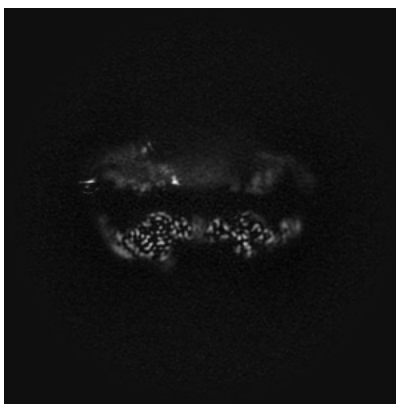
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

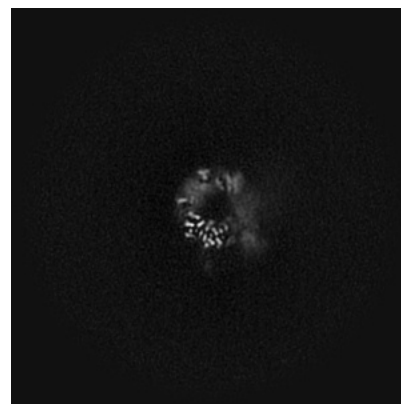
6.2.1 Primary map



X Index: 300



Y Index: 300

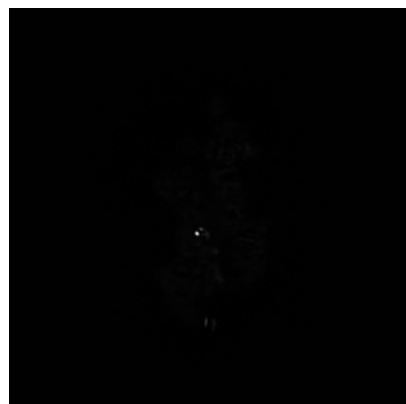


Z Index: 300

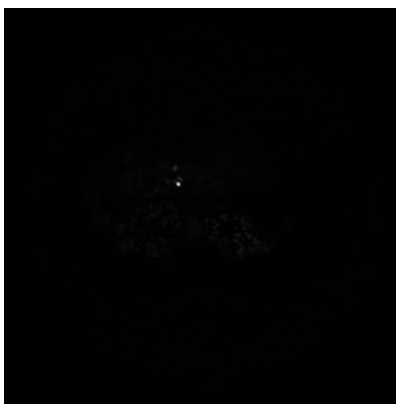
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices [i](#)

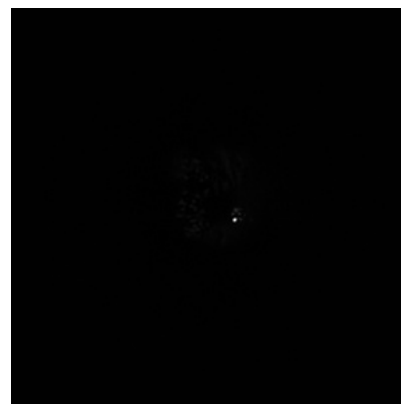
6.3.1 Primary map



X Index: 335



Y Index: 282

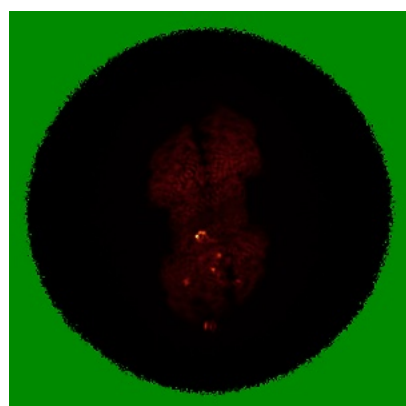


Z Index: 261

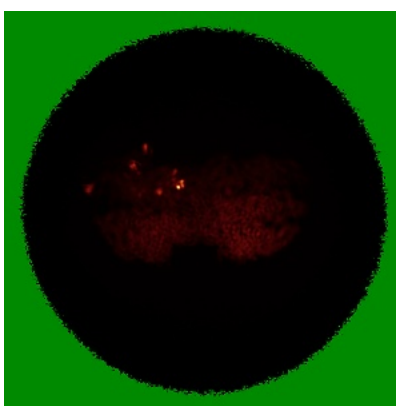
The images above show the largest variance slices of the map in three orthogonal directions.

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

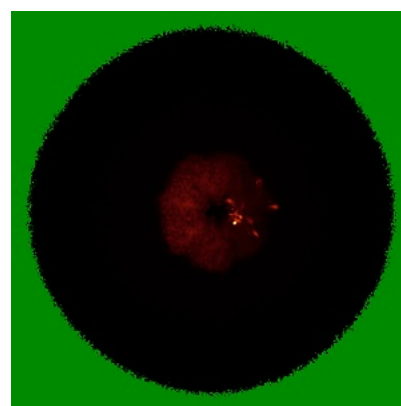
6.4.1 Primary map



X



Y

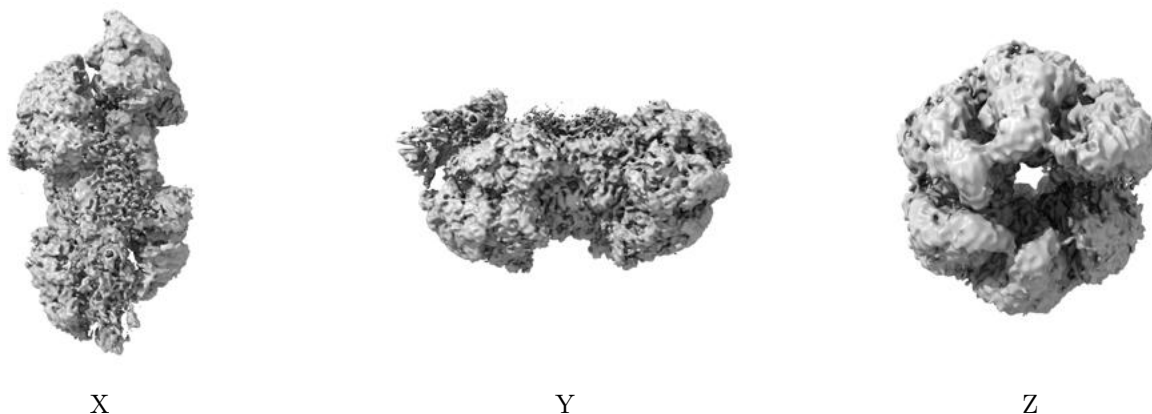


Z

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

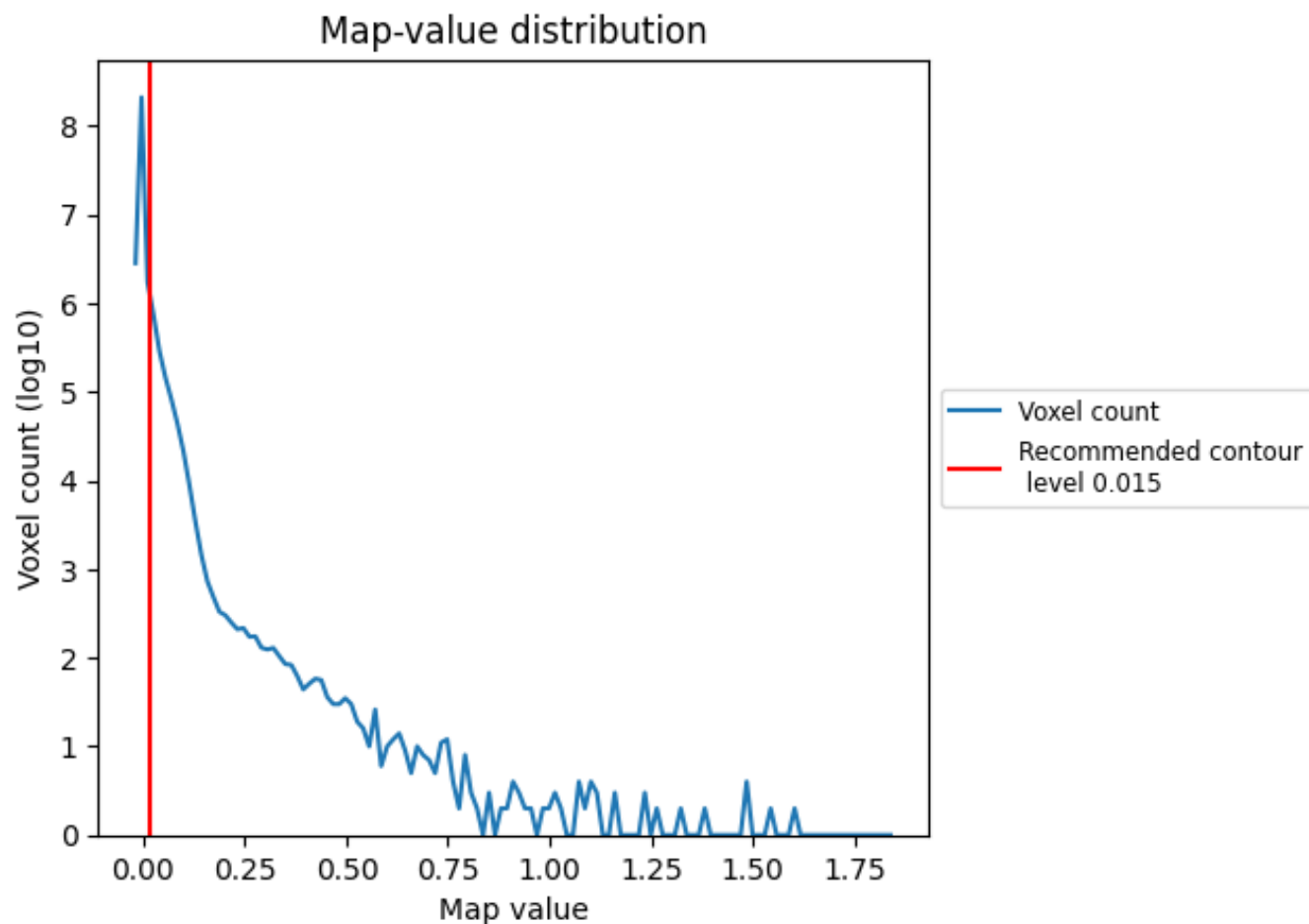
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

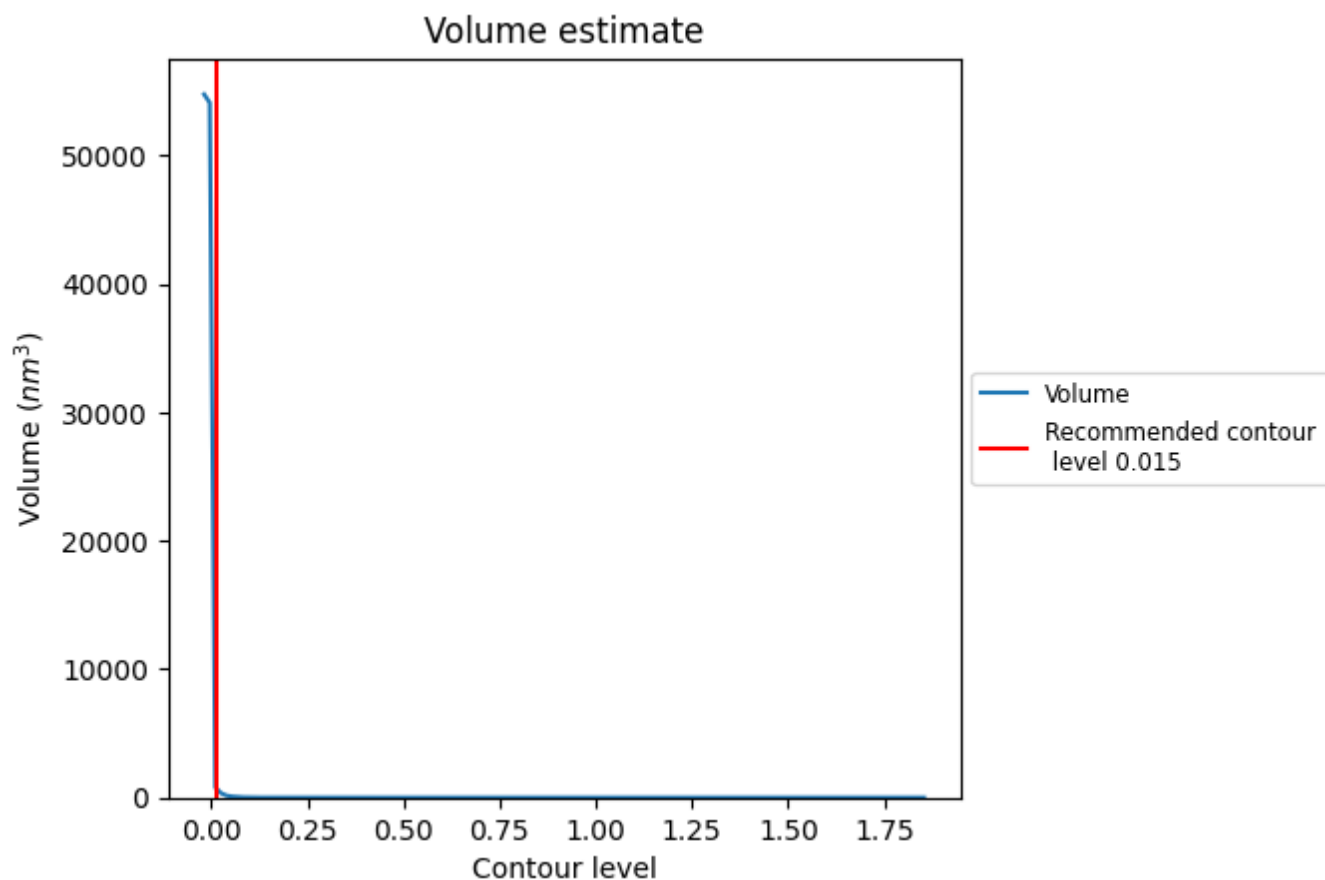
This section contains the results of statistical analysis of the map.

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.

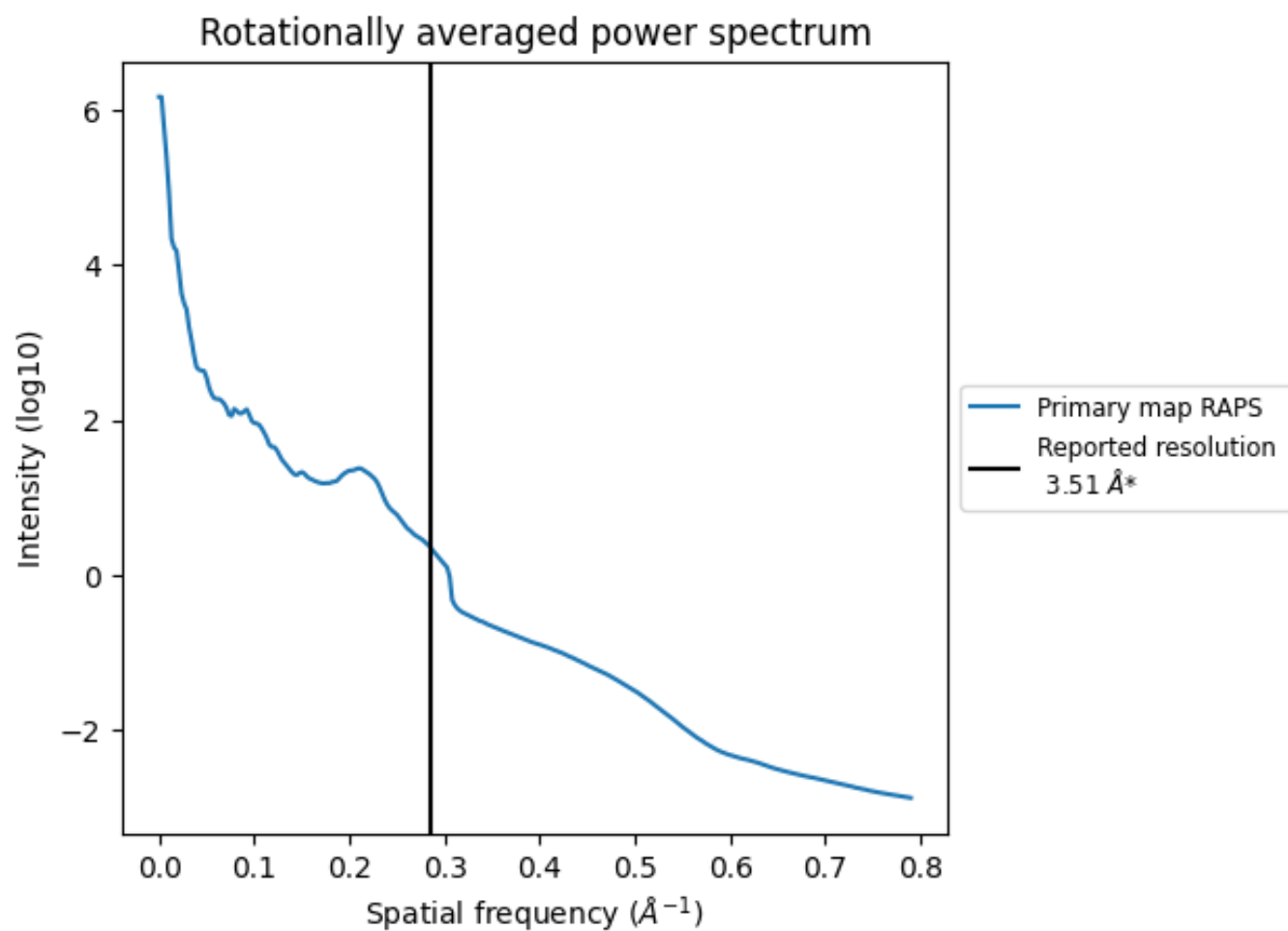
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 649 nm³; this corresponds to an approximate mass of 586 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 0.285 Å⁻¹

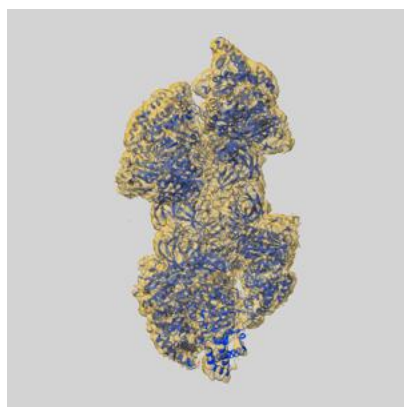
8 Fourier-Shell correlation

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

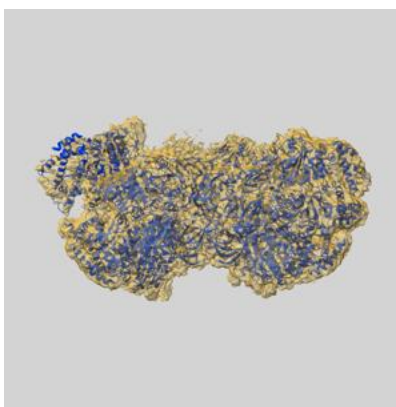
9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-66223 and PDB model 9WTO. Per-residue inclusion information can be found in [section 3](#) on [page 7](#).

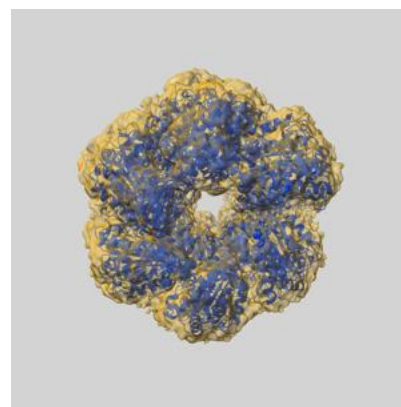
9.1 Map-model overlay [i](#)



X



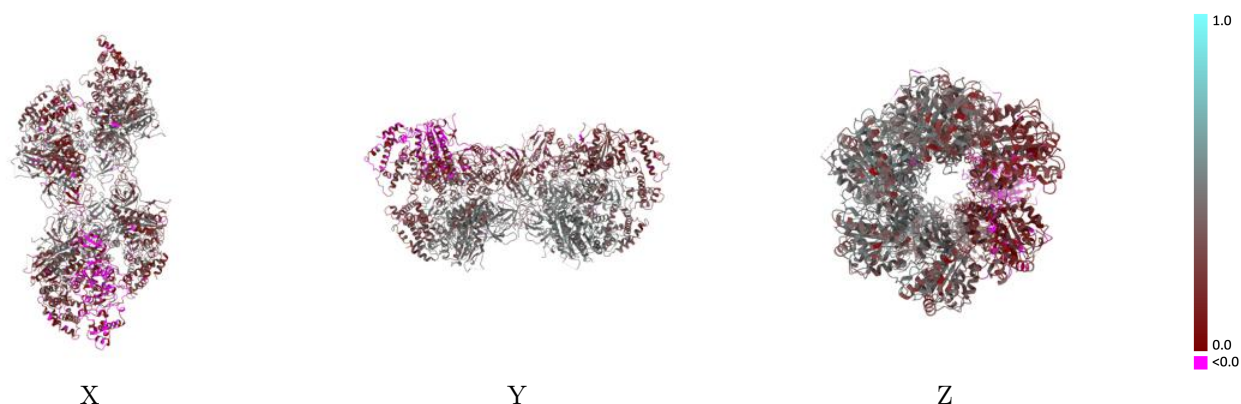
Y



Z

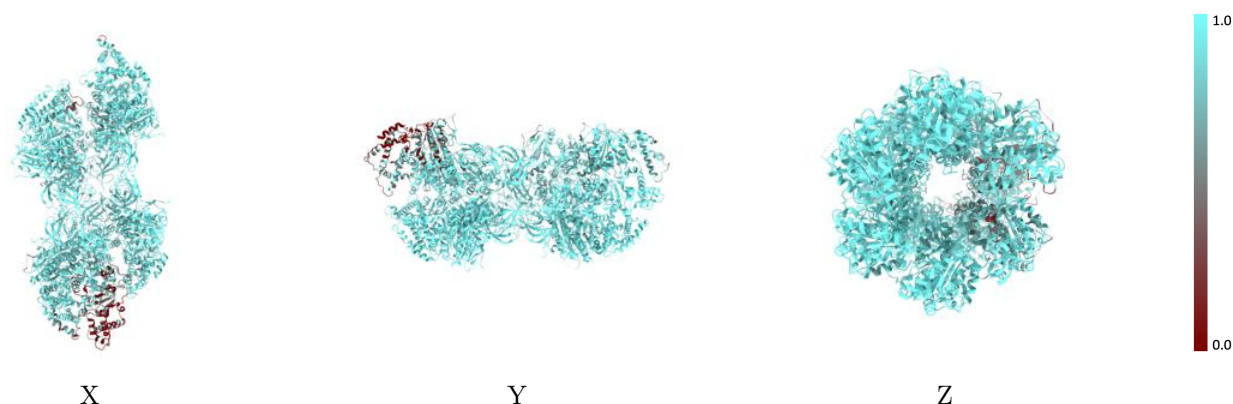
The images above show the 3D surface view of the map at the recommended contour level 0.015 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



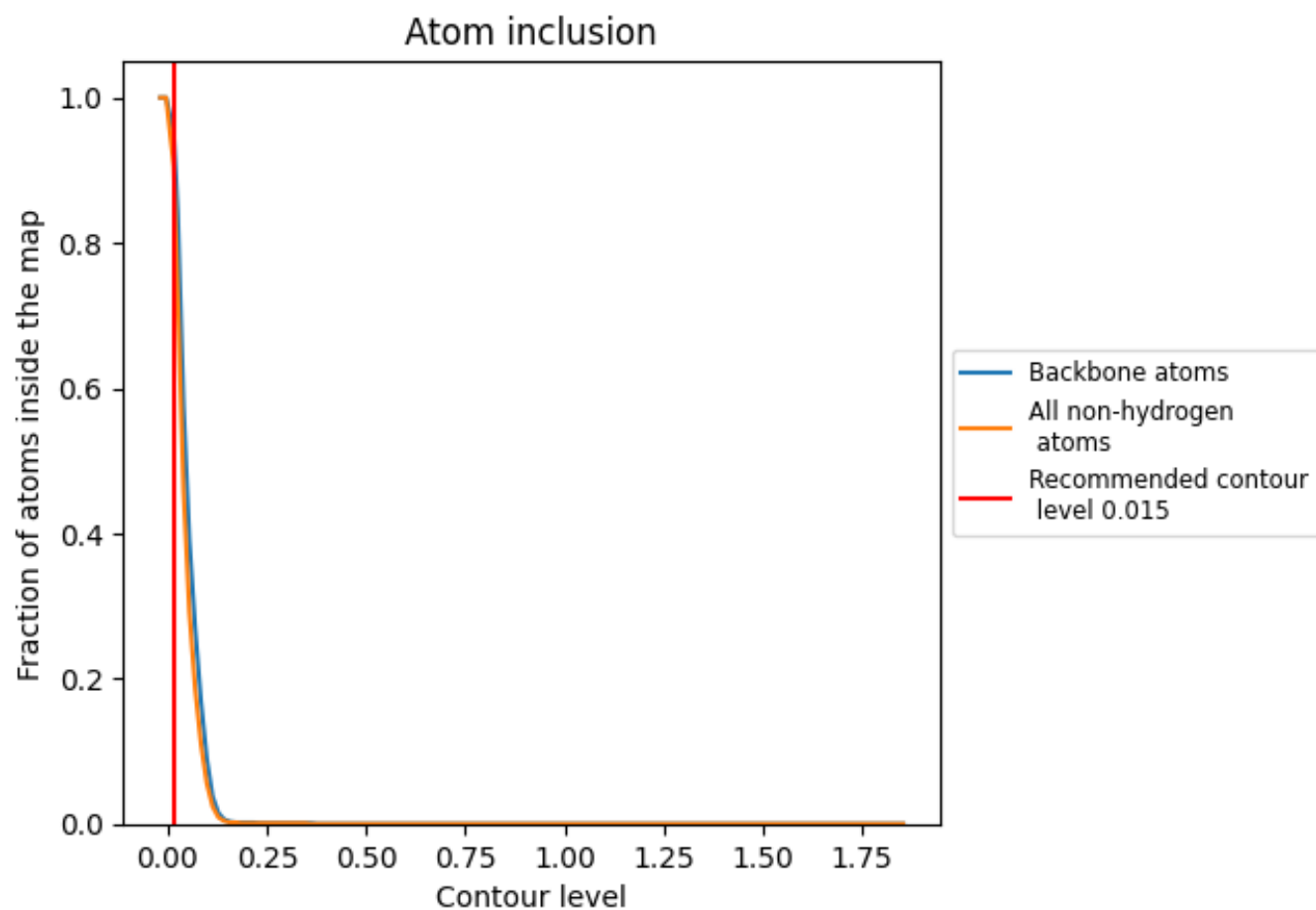
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions at which atoms can be resolved. Low Q-score values may therefore be expected for many entries.

9.3 Atom inclusion mapped to coordinate model [i](#)



The images above show the model with each residue coloured according to its atom inclusion. This shows to what extent they are inside the map at the recommended contour level (0.015).

9.4 Atom inclusion [i](#)



At the recommended contour level, 95% of all backbone atoms, 90% 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 (0.015) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	 0.9050	 0.3260
A	 0.9870	 0.4590
B	 0.9820	 0.4550
C	 0.9720	 0.4080
D	 0.8520	 0.1840
E	 0.8690	 0.2400
F	 0.9800	 0.4170
G	 0.9730	 0.4330
H	 0.9540	 0.3840
I	 0.8580	 0.2380
J	 0.5740	 0.0290
K	 0.9020	 0.2670
L	 0.9660	 0.4050

