wwPDB EM Validation Summary Report (i)

May 12, 2025 – 09:31 PM EDT

PDB ID	:	9CYX / pdb_00009cyx
EMDB ID	:	EMD-46053
Title	:	Cryo-EM structure of MRV full core
Authors	:	Liu, X.Y.; Xia, X.; Martynowycz, M.W.; Gonen, T.; Zhou, Z.H.
Deposited on	:	2024-08-02
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:

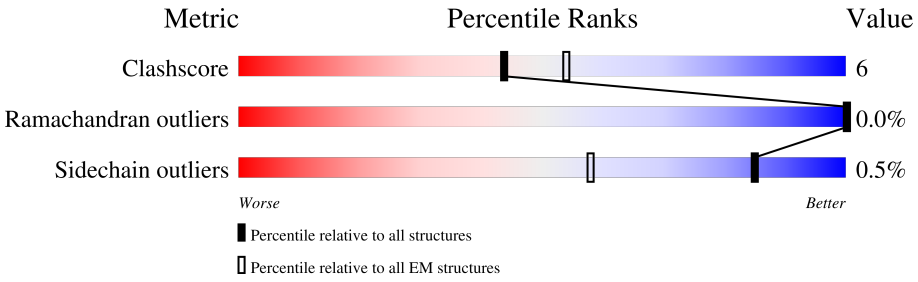
EMDB validation analysis	:	0.0.1.dev118
MolProbity	:	4-5-2 with Phenix2.0rc1
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
MapQ	:	1.9.13
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.43.1

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)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

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	B	1275	10% 89%
1	H	1275	70% 11% 19%
1	I	1275	76% 9% 15%
2	A	1288	66% 77% 22%
3	Q	417	88% 11%
3	R	417	7% 88% 12%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 34537 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 Lambda 1.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	H	1034	Total	C	N	O	S	0	0
			8164	5220	1378	1517	49		
1	I	1085	Total	C	N	O	S	0	0
			8562	5471	1450	1590	51		
1	B	140	Total	C	N	O	S	0	0
			1050	622	198	226	4		

- Molecule 2 is a protein called Outer capsid protein lambda-2.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	A	1284	Total	C	N	O	S	0	0
			10127	6468	1700	1917	42		

- Molecule 3 is a protein called Inner capsid protein sigma-2.

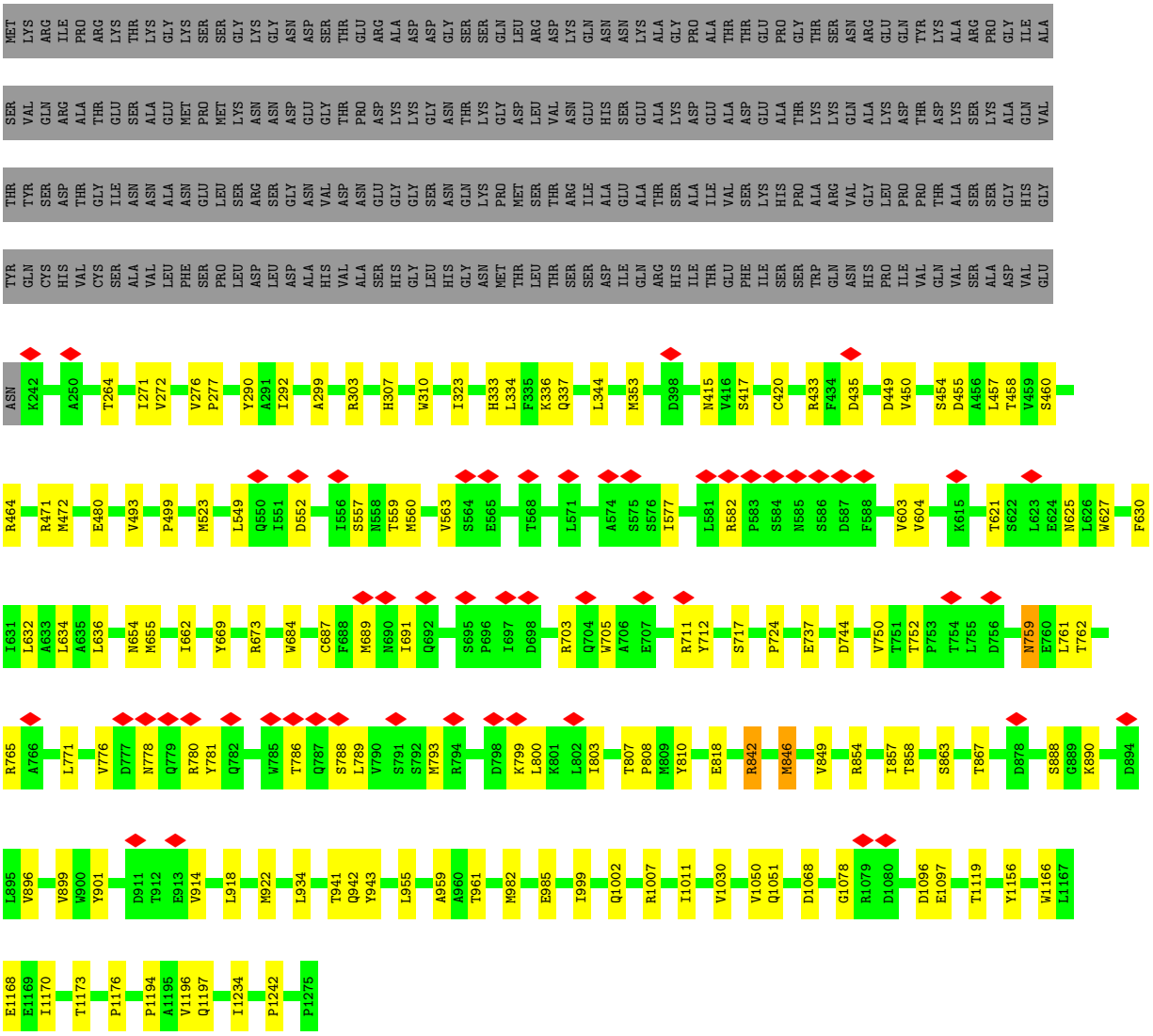
Mol	Chain	Residues	Atoms					AltConf	Trace
3	Q	417	Total	C	N	O	S	0	0
			3317	2096	599	605	17		
3	R	417	Total	C	N	O	S	0	0
			3317	2096	599	605	17		

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.

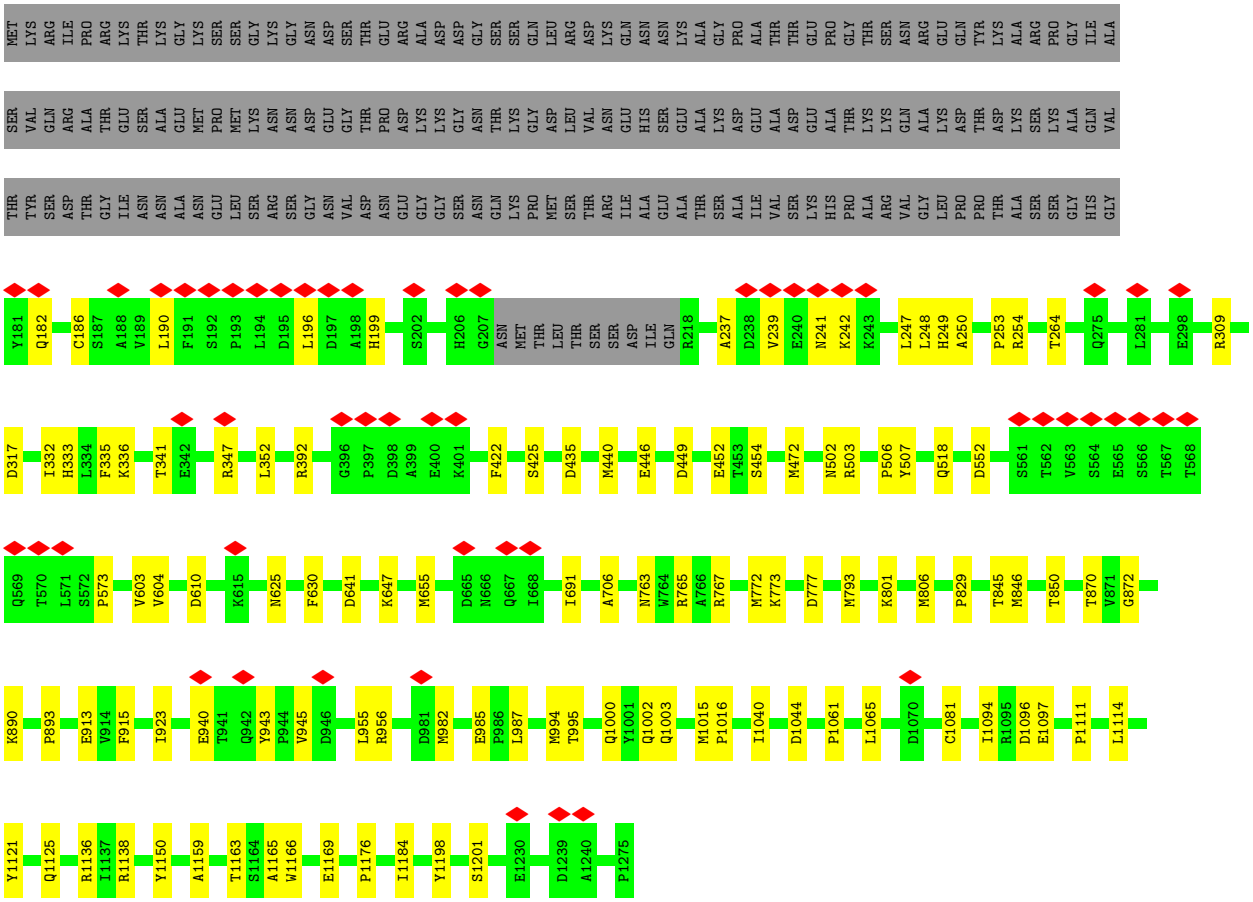
- Molecule 1: Lambda 1

Chain H:



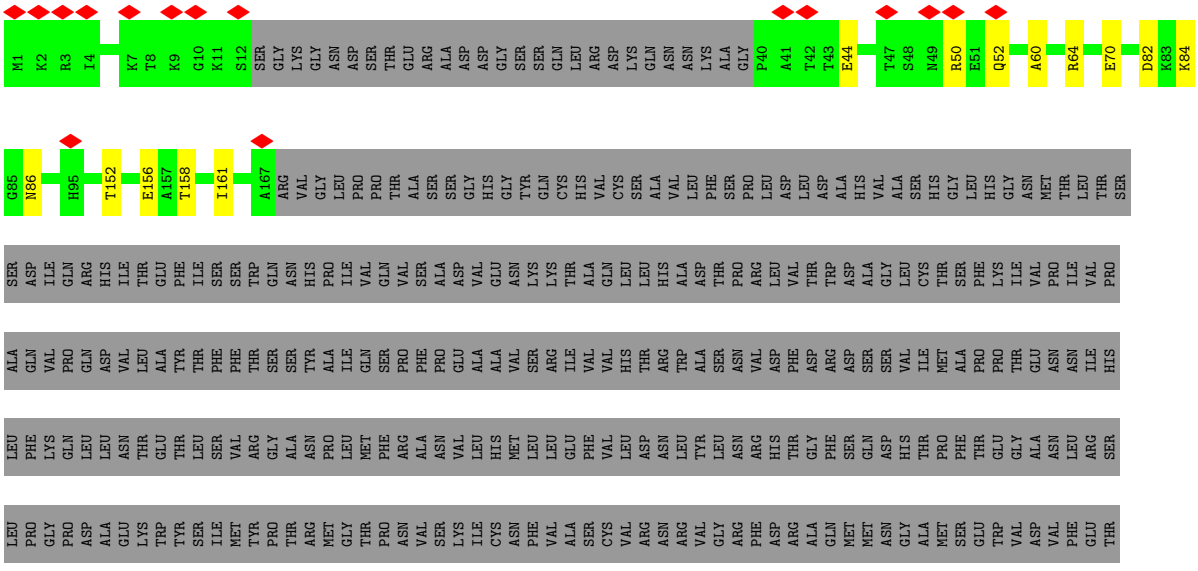
- Molecule 1: Lambda 1

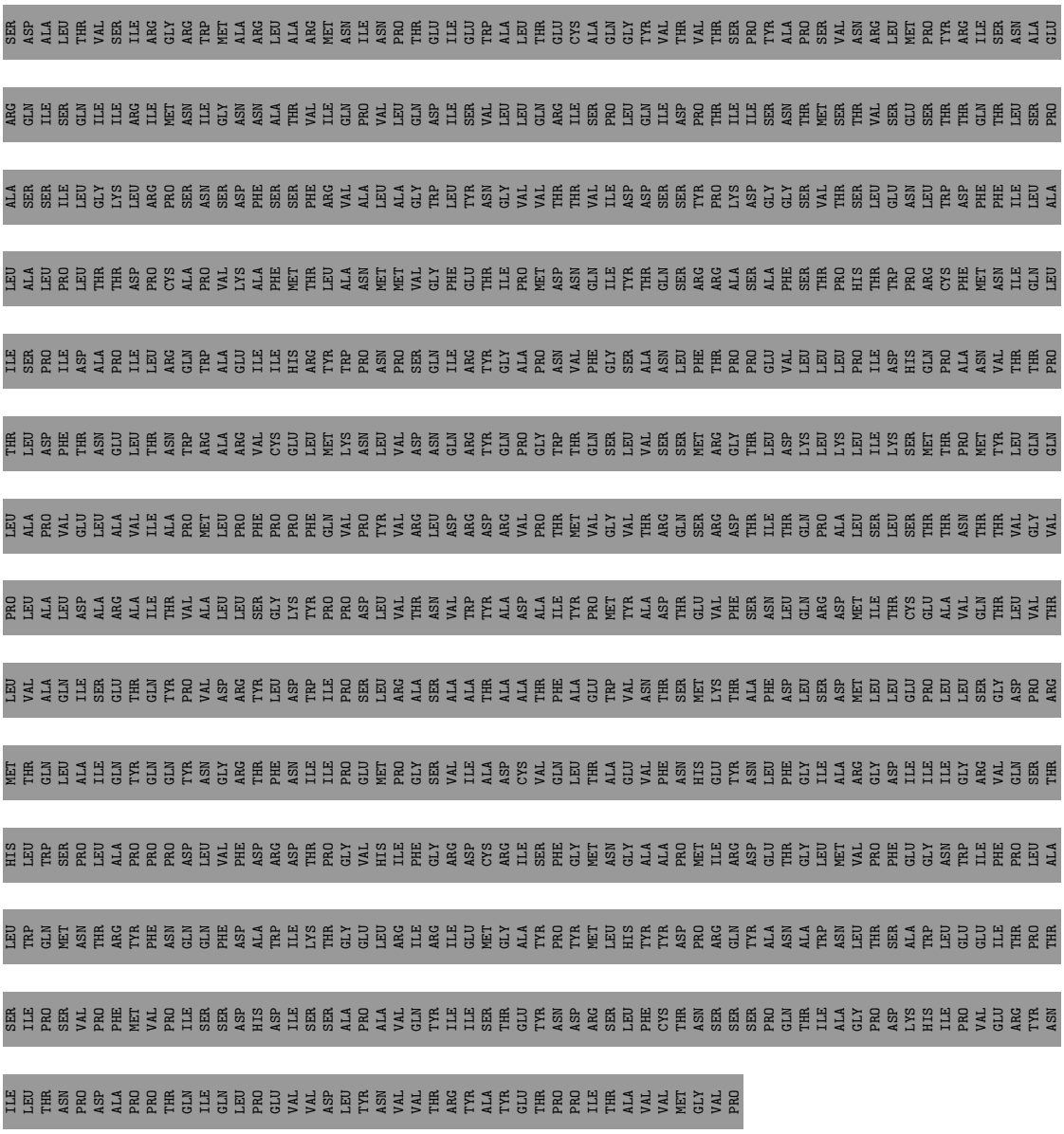
Chain I:



• Molecule 1: Lambda 1

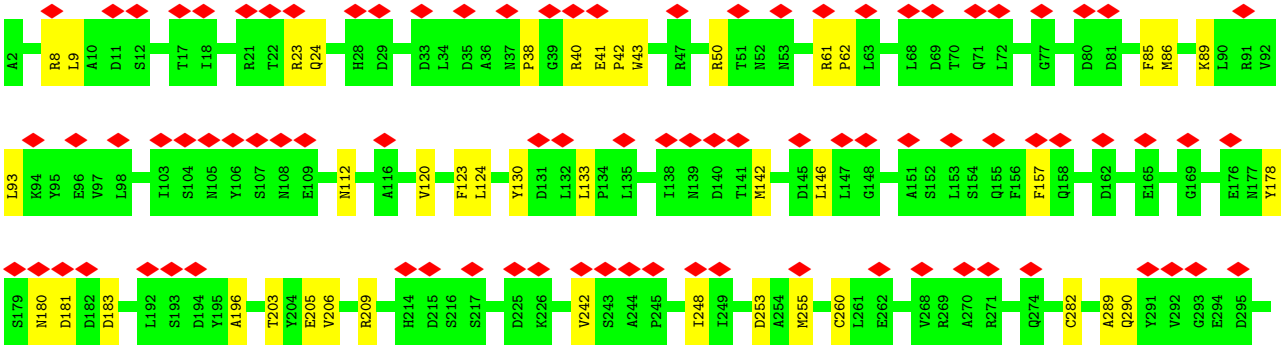
Chain B:

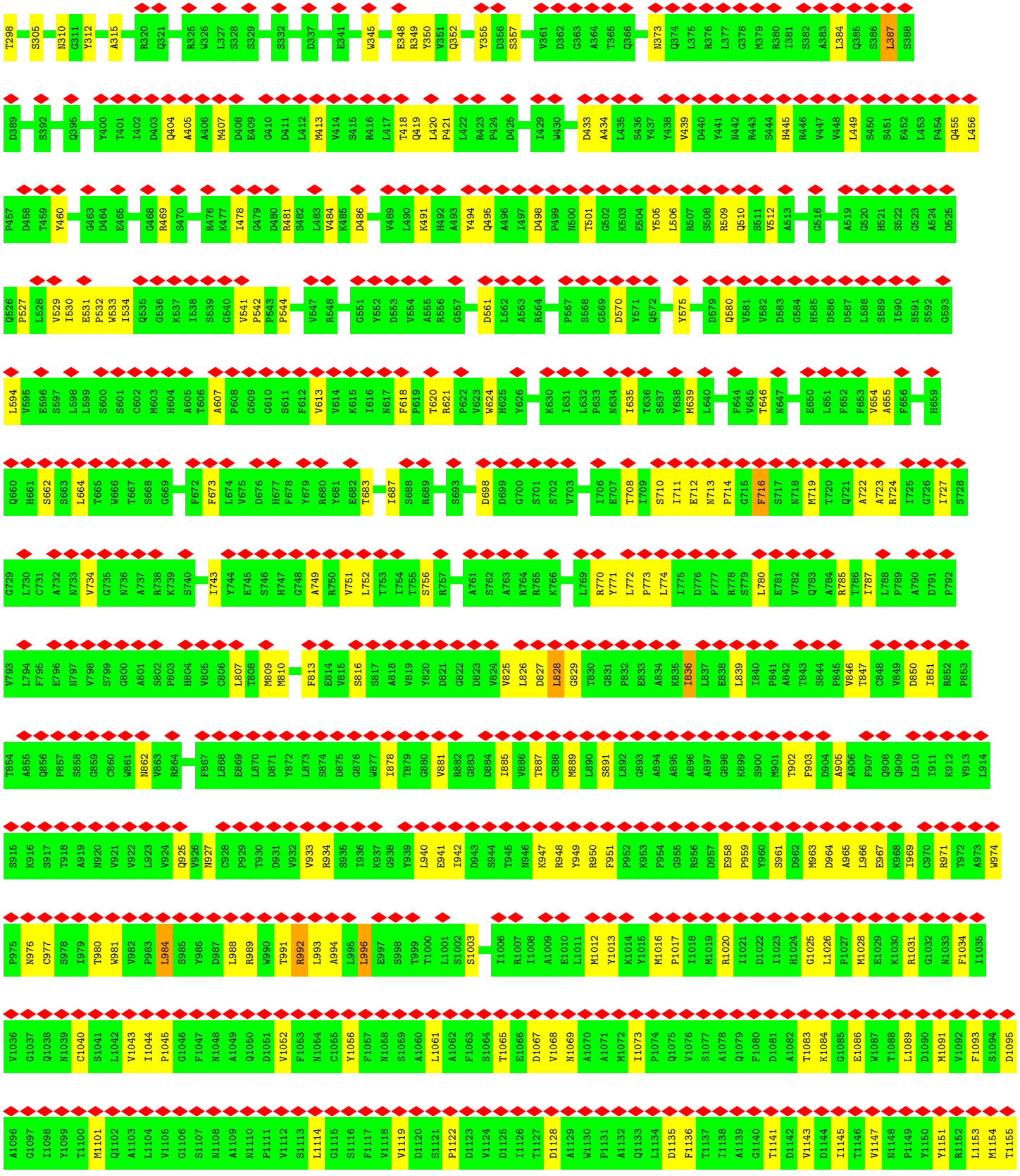


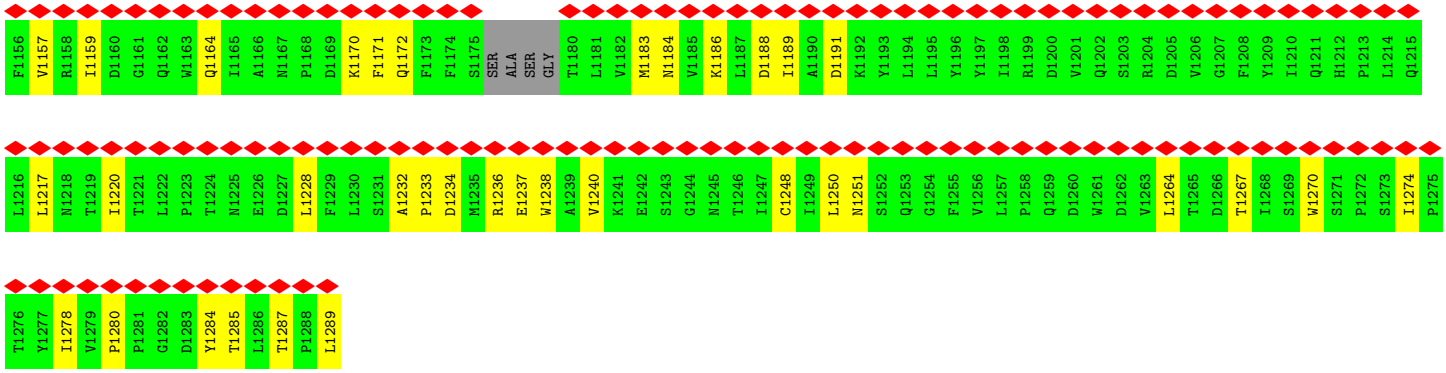


- Molecule 2: Outer capsid protein lambda-2

Chain A:

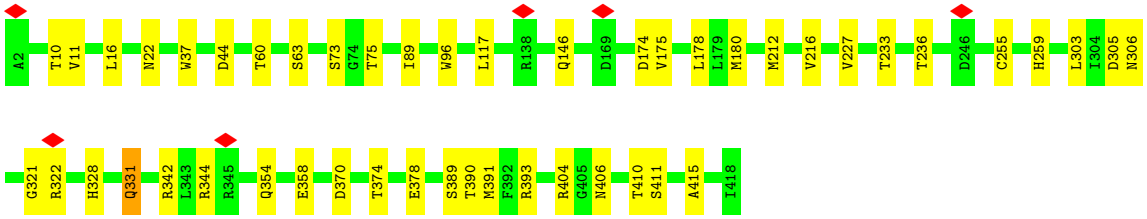



T298 S305 N310 G311 Y312 A315 R320 Q321 R325 W326 L327 S328 S329 S332 D337 E341 W345 E348 R349 Y350 V351 Q352 Y355 D356 S357 V361 D362 G363 A364 T365 Q366 N373 Q374 L375 R376 L377 G378 M379 R380 I381 S382 A383 L384 Q385 S386 L387 S388
D389 S392 Q395 Y400 T401 I402 D403 Q404 A405 A406 M407 D408 E409 G410 D411 L412 M413 V414 S415 R416 L417 T418 Q419 L420 P421 L422 R423 P424 D425 I429 W430 D433 A434 L435 S436 Y437 Y438 V439 D440 Y441 N442 R443 S444 H445 R446 V447 V448 L449 S450 S451 E452 L453 P454 Q455 L456
P457 D458 T459 Y460 G463 D464 E465 G468 R469 S470 R476 K477 I478 G479 D480 R481 S482 L483 V484 K485 D486 V489 L490 K491 H492 A493 Y494 Q495 A496 I497 D498 P499 N500 T501 G502 K503 E504 Y505 L506 R507 S508 R509 Q510 S511 V512 A513 G516 A519 G520 H521 S522 G523 A524 D525
Q526 P527 L528 V529 I530 E531 P532 W533 I534 Q535 G536 K537 I538 S539 G540 V541 P542 P543 P544 V547 R548 G551 Y552 D553 V554 A555 R556 G557 D561 L562 A563 R564 P567 S568 G569 D570 Y571 Q572 Y575 D579 Q580 V581 V582 D583 G584 H585 D586 D587 L588 S589 I590 S591 S592 G593
L594 V595 E596 S597 L598 L599 S600 S601 C602 M603 H604 A605 T606 A607 P608 G609 G610 S611 F612 V613 V614 K615 I616 N617 F618 P619 T620 R621 P622 V623 W624 H625 Y626 K630 I631 L632 P633 N634 I635 T636 S637 Y638 M639 L640 F644 V645 T646 N647 E650 L651 F652 F653 V654 A655 F656 H659
Q660 H661 S662 S663 L664 T665 W666 T667 S668 G669 F672 F673 L674 V675 D676 H677 F678 Y679 R680 Y681 E682 T683 I687 S688 R689 S693 D698 D699 G700 S701 S702 V703 I706 E707 T708 I709 S710 I711 E712 N713 P714 G715 F716 S717 N718 M719 T720 Q721 A722 A723 R724 I725 G726 I727 S728
G729 L730 C731 A732 N733 V734 G735 N736 A737 R738 K739 S740 I743 Y744 E745 S746 H747 G748 A749 R750 V751 L752 T753 I754 T755 S756 R757 A761 S762 A763 R764 R765 K766 L769 R770 Y771 L772 P773 L774 I775 D776 P777 R778 S779 L780 E781 V782 Q783 A784 R785 T786 I787 L788 P789 A790 D791 P792
V793 L794 F795 E796 N797 V798 S799 G800 A801 S802 P803 H804 V805 C806 L807 T808 M809 M810 F813 E814 V815 S816 S817 A818 V819 Y820 D821 G822 D823 V824 V825 L826 D827 L828 G829 T830 G831 P832 E833 A834 K835 I836 L837 E838 L839 I840 P841 A842 T843 S844 P845 V846 T847 C848 V849 D850 I851 R852 P853
T854 A855 Q856 P857 S858 G859 C860 W861 N862 V863 R864 F867 L868 E869 L870 D871 Y872 L873 S874 D875 G876 W877 I878 T879 G880 V881 R882 G883 D884 I885 V886 T887 C888 M889 L890 S891 L892 G893 A894 A895 A896 A897 G898 K899 S900 M901 T902 F903 D904 A905 A906 F907 Q908 Q909 L910 I911 K912 V913 L914
S915 K916 S917 T918 A919 N920 V921 V922 L923 V924 Q925 V926 N927 C928 P929 T930 D931 V932 V933 R934 S935 I936 K937 G938 Y939 L940 E941 I942 D943 S944 T945 N946 K947 R948 Y949 R950 F951 P952 K953 F954 G955 R956 D957 E958 P959 Y960 S961 D962 M963 D964 A965 L966 E967 K968 I969 C970 R971 T972 A973 W974
P975 N976 C977 S978 I979 T980 W981 V982 P983 L984 S985 Y986 D987 L988 R989 W990 T991 R992 L993 A994 L995 L996 E997 S998 T999 T1000 L1001 S1002 S1003 I1006 R1007 I1008 A1009 E1010 L1011 M1012 Y1013 K1014 Y1015 M1016 P1017 I1018 M1019 R1020 I1021 D1022 I1023 H1024 G1025 L1026 P1027 M1028 E1029 K1030 R1031 G1032 N1033 F1034 I1035
V1036 G1037 Q1038 N1039 C1040 S1041 L1042 V1043 I1044 P1045 G1046 F1047 N1048 A1049 Q1050 D1051 V1052 F1053 N1054 C1055 Y1056 F1057 N1058 S1059 A1060 L1061 A1062 F1063 S1064 T1065 E1066 D1067 V1068 N1069 A1070 A1071 M1072 I1073 P1074 Q1075 V1076 S1077 A1078 Q1079 F1080 D1081 A1082 T1083 K1084 G1085 E1086 W1087 T1088 L1089 D1090 M1091 V1092 F1093 S1094 D1095
A1096 G1097 I1098 Y1099 T1100 M1101 Q1102 A1103 L1104 V1105 G1106 S1107 N1108 A1109 N1110 P1111 V1112 S1113 L1114 G1115 S1116 F1117 V1118 V1119 D1120 S1121 P1122 D1123 V1124 D1125 I1126 T1127 D1128 A1129 W1130 P1131 A1132 Q1133 L1134 D1135 F1136 T1137 I1138 A1139 G1140 T1141 D1142 V1143 D1144 I1145 T1146 V1147 N1148 P1149 Y1150 Y1151 R1152 L1153 M1154 T1155



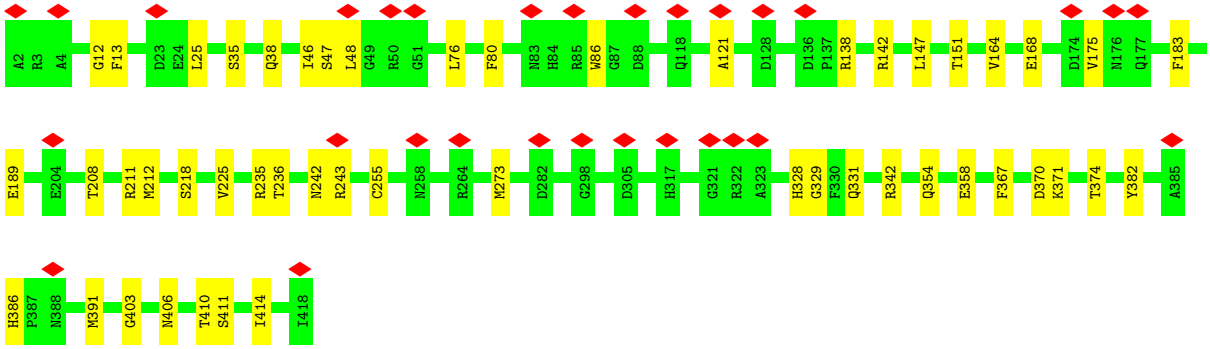
• Molecule 3: Inner capsid protein sigma-2

Chain Q:



• Molecule 3: Inner capsid protein sigma-2

Chain R:



4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C5	Depositor
Number of particles used	10857	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING ONLY	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	50	Depositor
Minimum defocus (nm)	1800	Depositor
Maximum defocus (nm)	2600	Depositor
Magnification	81000	Depositor
Image detector	GATAN K3 BIOCONTINUUM (6k x 4k)	Depositor
Maximum map value	0.086	Depositor
Minimum map value	-0.057	Depositor
Average map value	0.001	Depositor
Map value standard deviation	0.006	Depositor
Recommended contour level	0.02	Depositor
Map size (Å)	422.40002, 422.40002, 422.40002	wwPDB
Map dimensions	384, 384, 384	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	1.1, 1.1, 1.1	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	B	0.23	0/1060	0.41	0/1420
1	H	0.32	1/8385 (0.0%)	0.53	1/11486 (0.0%)
1	I	0.28	0/8795	0.47	0/12048
2	A	0.29	0/10385	0.49	0/14172
3	Q	0.25	0/3403	0.41	0/4634
3	R	0.24	0/3403	0.44	0/4634
All	All	0.29	1/35431 (0.0%)	0.48	1/48394 (0.0%)

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
2	A	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	H	854	ARG	N-CA	5.08	1.49	1.46

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	H	854	ARG	CB-CA-C	-5.11	109.72	117.07

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	A	992	ARG	Sidechain

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	B	1050	0	1035	10	0
1	H	8164	0	8082	93	0
1	I	8562	0	8451	71	0
2	A	10127	0	9910	211	0
3	Q	3317	0	3216	30	0
3	R	3317	0	3216	30	0
All	All	34537	0	33910	434	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 6.

The worst 5 of 434 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)
2:A:1237:GLU:HB2	2:A:1289:LEU:HB2	1.48	0.93
2:A:8:ARG:HB2	2:A:716:PHE:CD2	2.05	0.90
2:A:413:MET:SD	2:A:722:ALA:HB1	2.14	0.88
1:I:186:CYS:SG	1:I:199:HIS:NE2	2.48	0.86
1:H:1234:ILE:HD11	1:H:1242:PRO:HA	1.58	0.85

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	B	136/1275 (11%)	131 (96%)	5 (4%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles
1	H	1032/1275 (81%)	999 (97%)	33 (3%)	0	100 100
1	I	1081/1275 (85%)	1031 (95%)	50 (5%)	0	100 100
2	A	1280/1288 (99%)	1203 (94%)	76 (6%)	1 (0%)	48 76
3	Q	415/417 (100%)	403 (97%)	12 (3%)	0	100 100
3	R	415/417 (100%)	405 (98%)	10 (2%)	0	100 100
All	All	4359/5947 (73%)	4172 (96%)	186 (4%)	1 (0%)	100 100

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	A	850	ASP

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	B	115/1114 (10%)	115 (100%)	0	100 100
1	H	914/1114 (82%)	907 (99%)	7 (1%)	79 87
1	I	959/1114 (86%)	959 (100%)	0	100 100
2	A	1118/1120 (100%)	1108 (99%)	10 (1%)	75 85
3	Q	353/353 (100%)	352 (100%)	1 (0%)	91 94
3	R	353/353 (100%)	353 (100%)	0	100 100
All	All	3812/5168 (74%)	3794 (100%)	18 (0%)	85 91

5 of 18 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	A	984	LEU
3	Q	331	GLN
2	A	1248	CYS
2	A	387	LEU
2	A	847	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 40 such sidechains are listed below:

Mol	Chain	Res	Type
3	Q	214	GLN
3	R	300	GLN
3	Q	300	GLN
3	R	114	GLN
3	R	328	HIS

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.

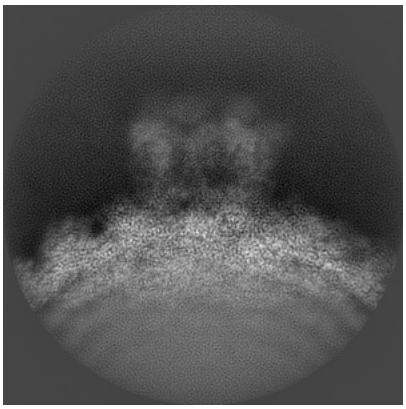
6 Map visualisation

This section contains visualisations of the EMDB entry EMD-46053. These allow visual inspection of the internal detail of the map and identification of artifacts.

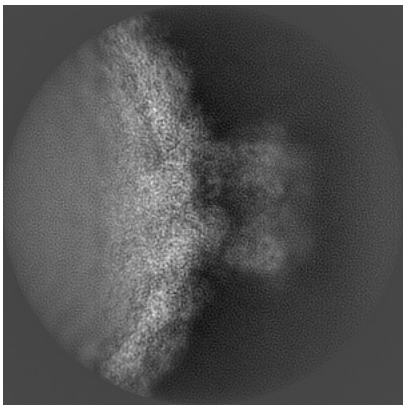
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

6.1 Orthogonal projections

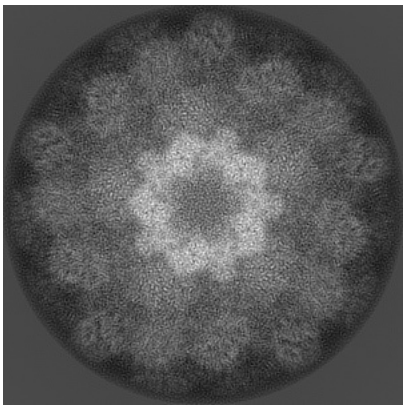
6.1.1 Primary map



X

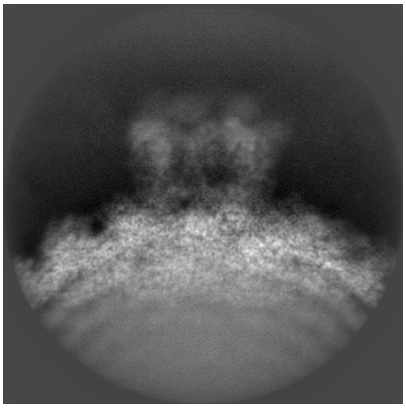


Y

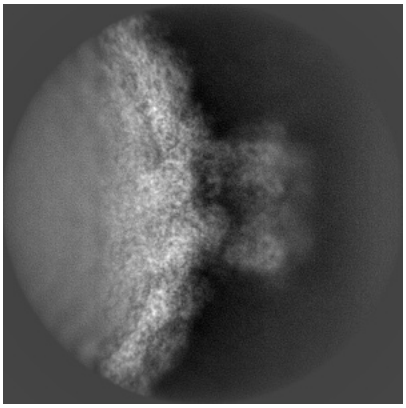


Z

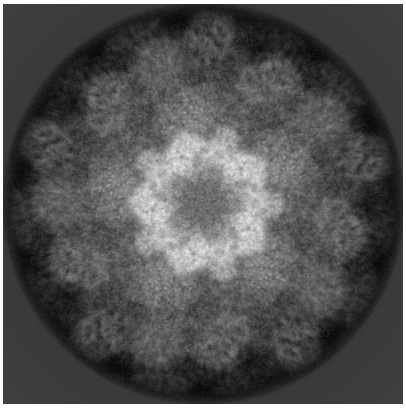
6.1.2 Raw map



X



Y

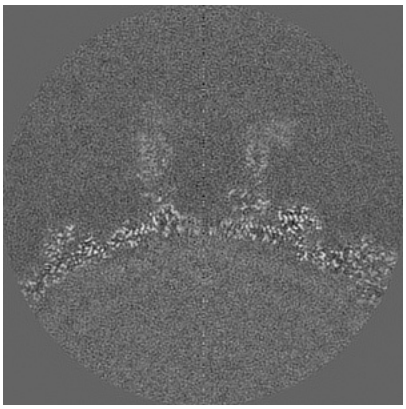


Z

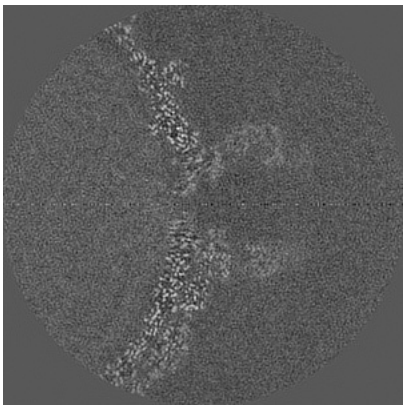
The images above show the map projected in three orthogonal directions.

6.2 Central slices (i)

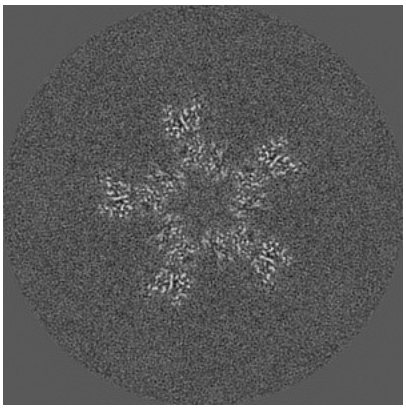
6.2.1 Primary map



X Index: 192

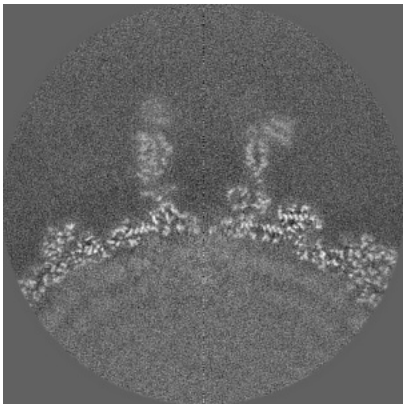


Y Index: 192

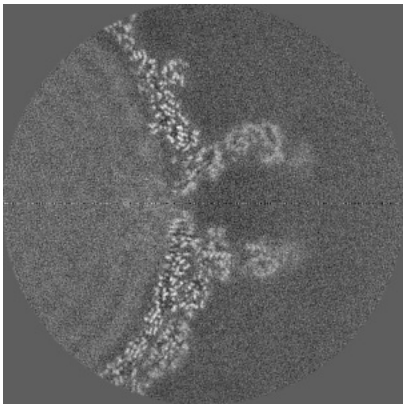


Z Index: 192

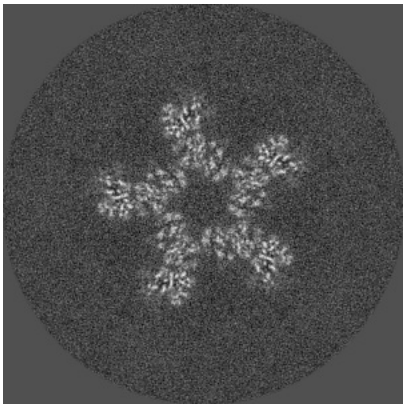
6.2.2 Raw map



X Index: 192



Y Index: 192

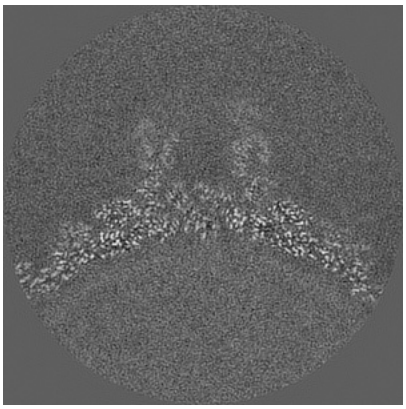


Z Index: 192

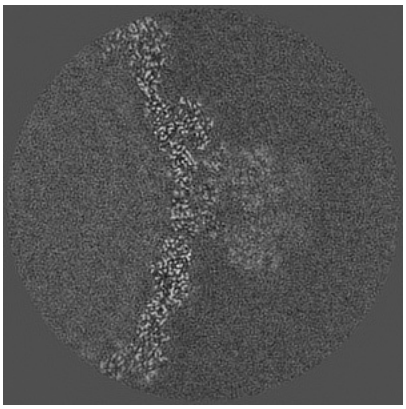
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices (i)

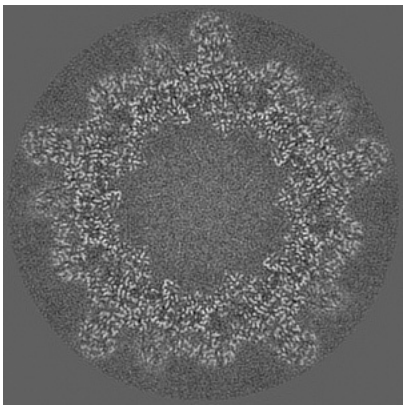
6.3.1 Primary map



X Index: 165

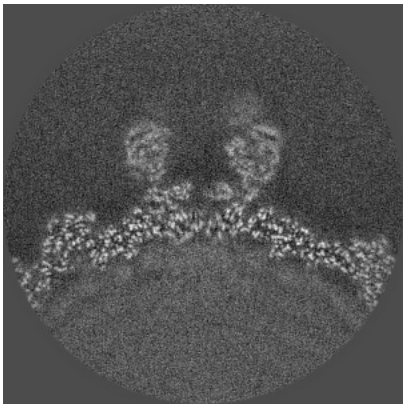


Y Index: 235

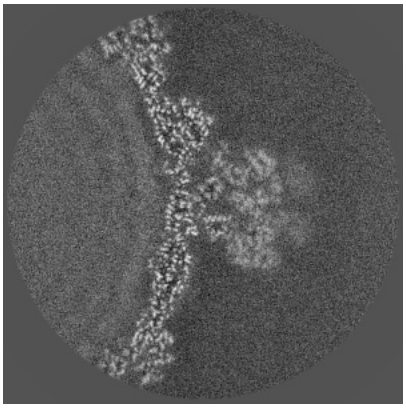


Z Index: 146

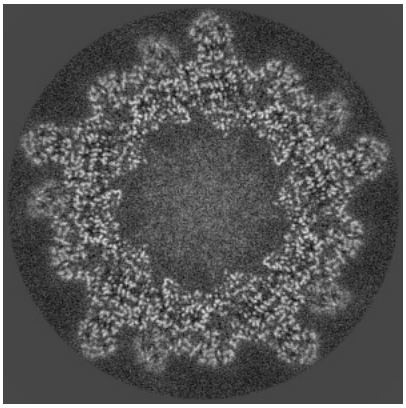
6.3.2 Raw map



X Index: 214



Y Index: 238

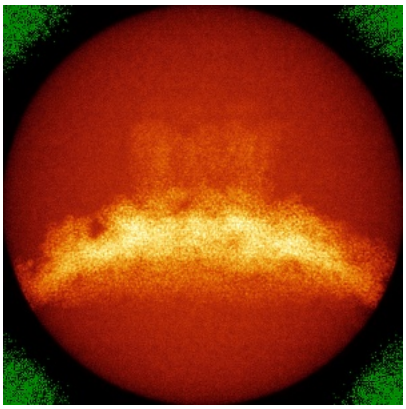


Z Index: 146

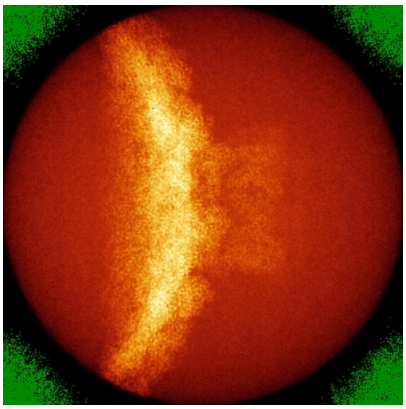
The images above show the largest variance slices of the map in three orthogonal directions.

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

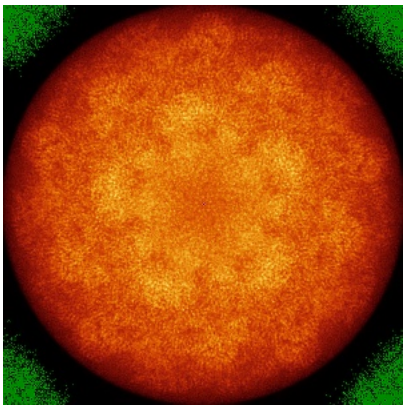
6.4.1 Primary map



X

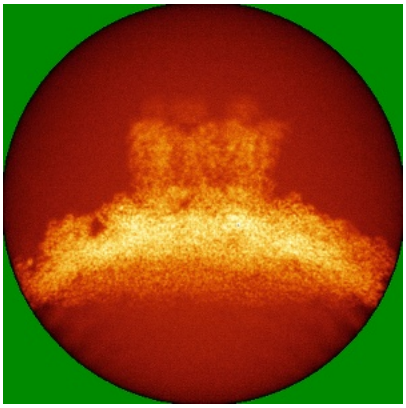


Y

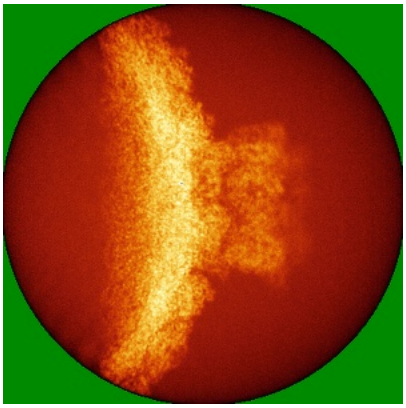


Z

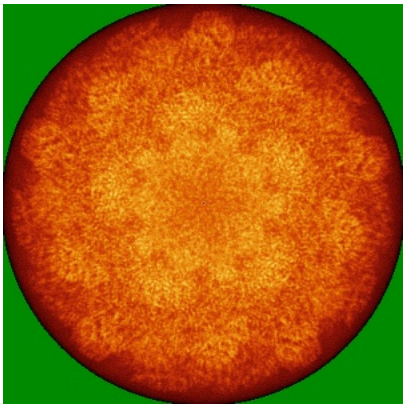
6.4.2 Raw map



X



Y

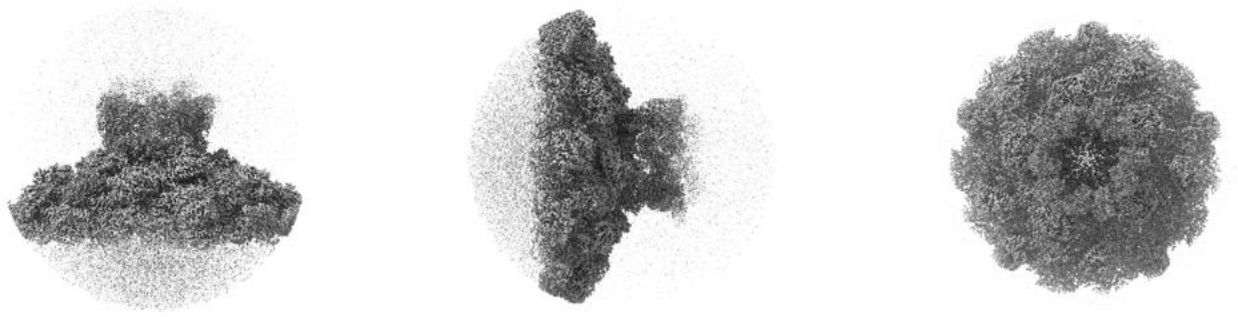


Z

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)

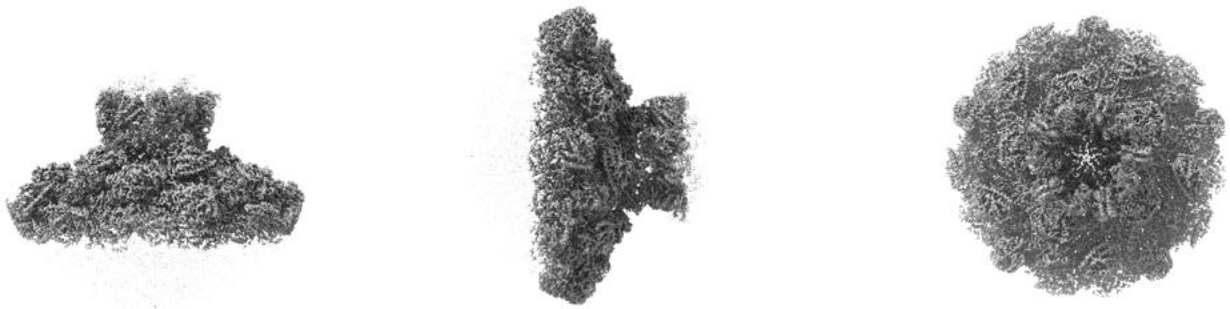
6.5.1 Primary map



X Y Z

The images above show the 3D surface view of the map at the recommended contour level 0.02. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

6.5.2 Raw map



X Y Z

These images show the 3D surface of the raw map. The raw map's contour level was selected so that its surface encloses the same volume as the primary map does at its recommended contour level.

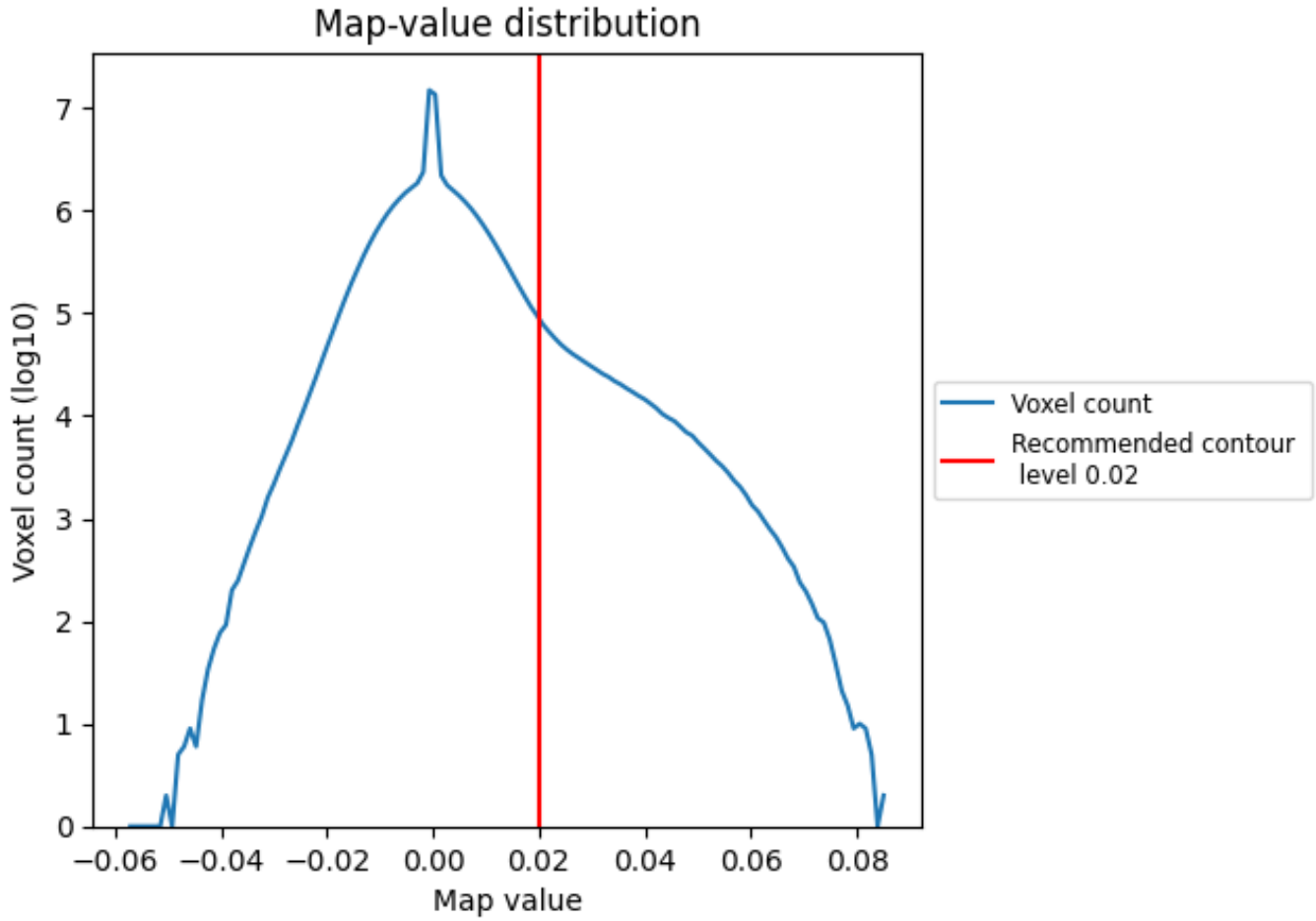
6.6 Mask visualisation (i)

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

7 Map analysis

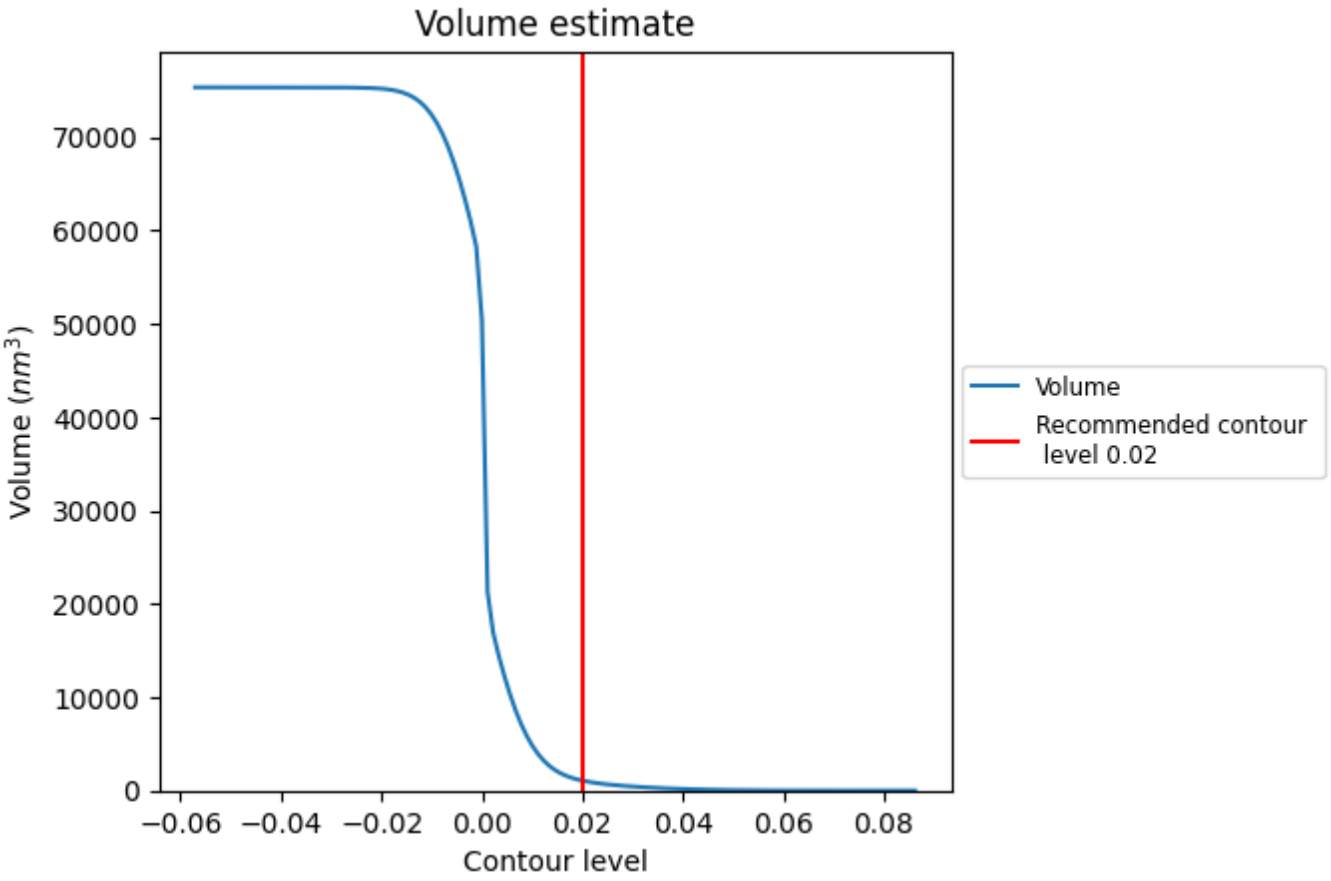
This section contains the results of statistical analysis of the map.

7.1 Map-value distribution



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.

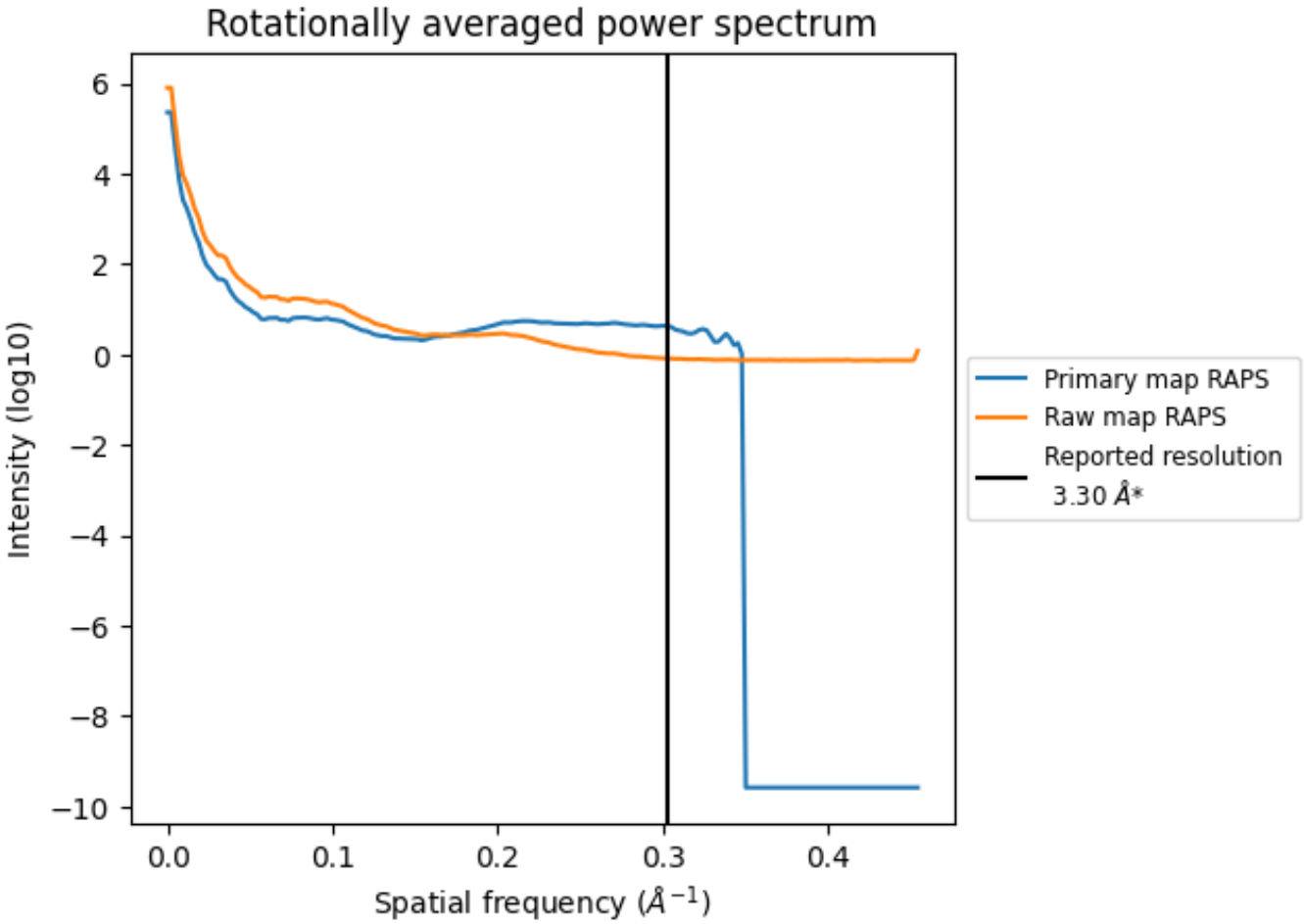
7.2 Volume estimate (i)



The volume at the recommended contour level is 1064 nm^3; this corresponds to an approximate mass of 961 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)

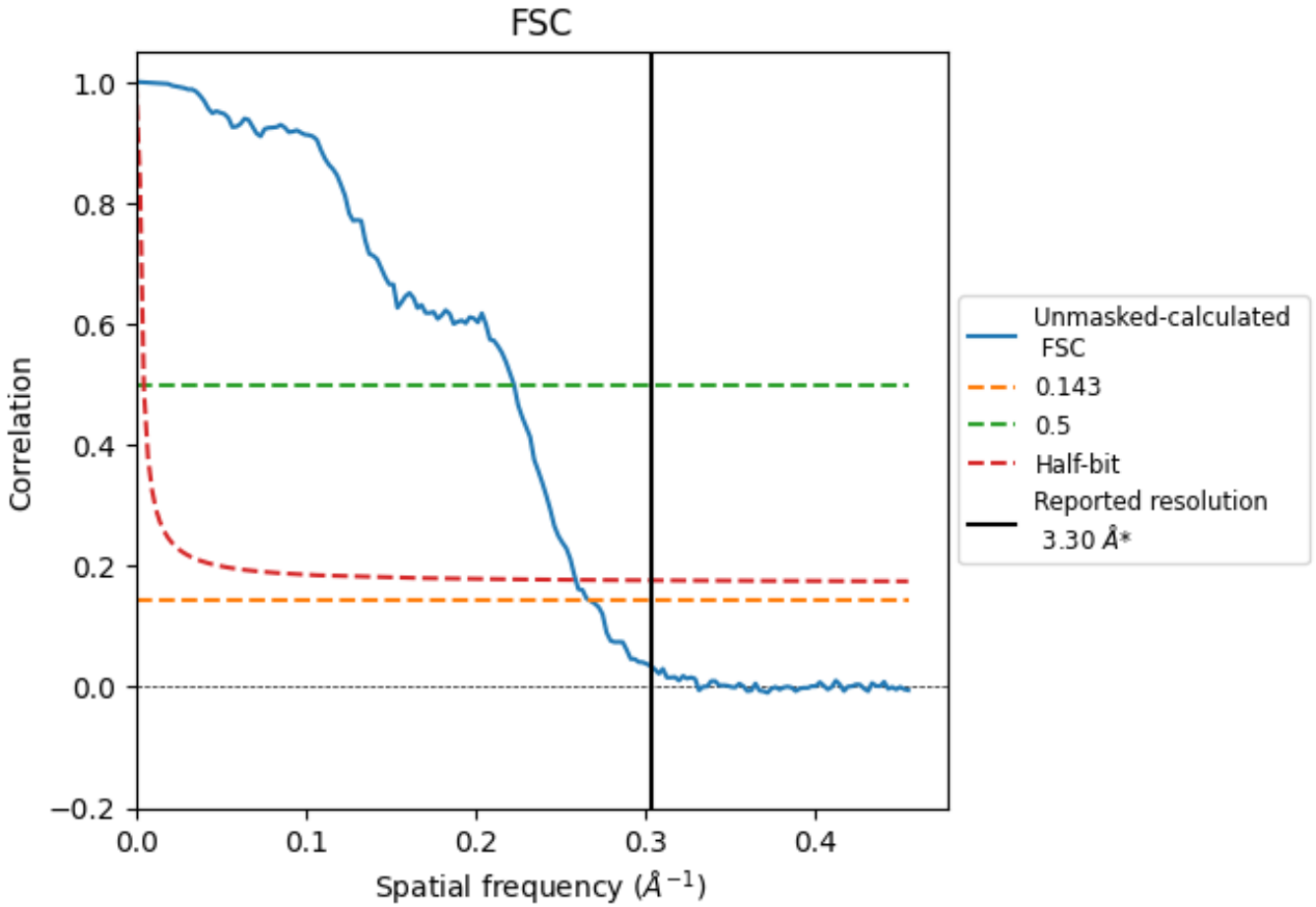


*Reported resolution corresponds to spatial frequency of 0.303 Å^{-1}

8 Fourier-Shell correlation

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



*Reported resolution corresponds to spatial frequency of 0.303 Å^{-1}

8.2 Resolution estimates (i)

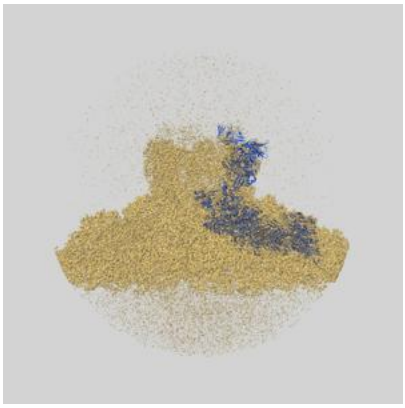
Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	3.30	-	-
Author-provided FSC curve	-	-	-
Unmasked-calculated*	3.74	4.49	3.86

*Resolution estimate based on FSC curve calculated by comparison of deposited half-maps. The value from deposited half-maps intersecting FSC 0.143 CUT-OFF 3.74 differs from the reported value 3.3 by more than 10 %

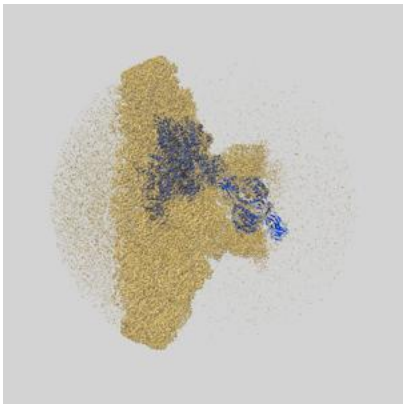
9 Map-model fit

This section contains information regarding the fit between EMDB map EMD-46053 and PDB model 9CYX. Per-residue inclusion information can be found in section 3 on page 4.

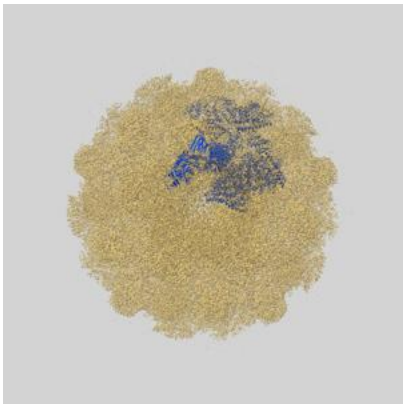
9.1 Map-model overlay



X



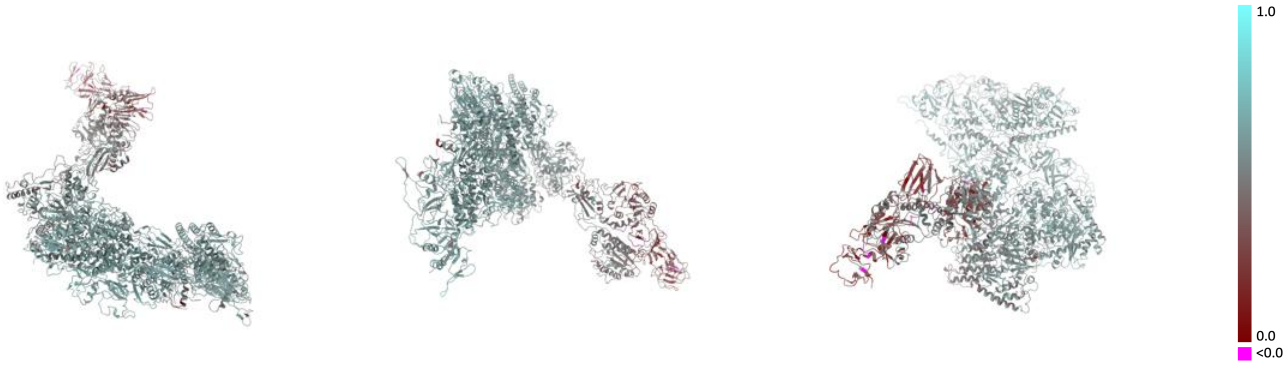
Y



Z

The images above show the 3D surface view of the map at the recommended contour level 0.02 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.

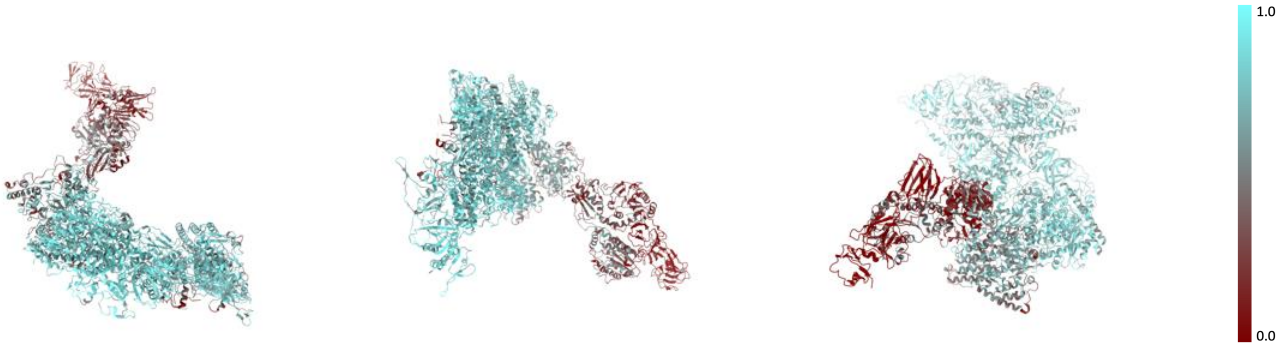
9.2 Q-score mapped to coordinate model (i)



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.

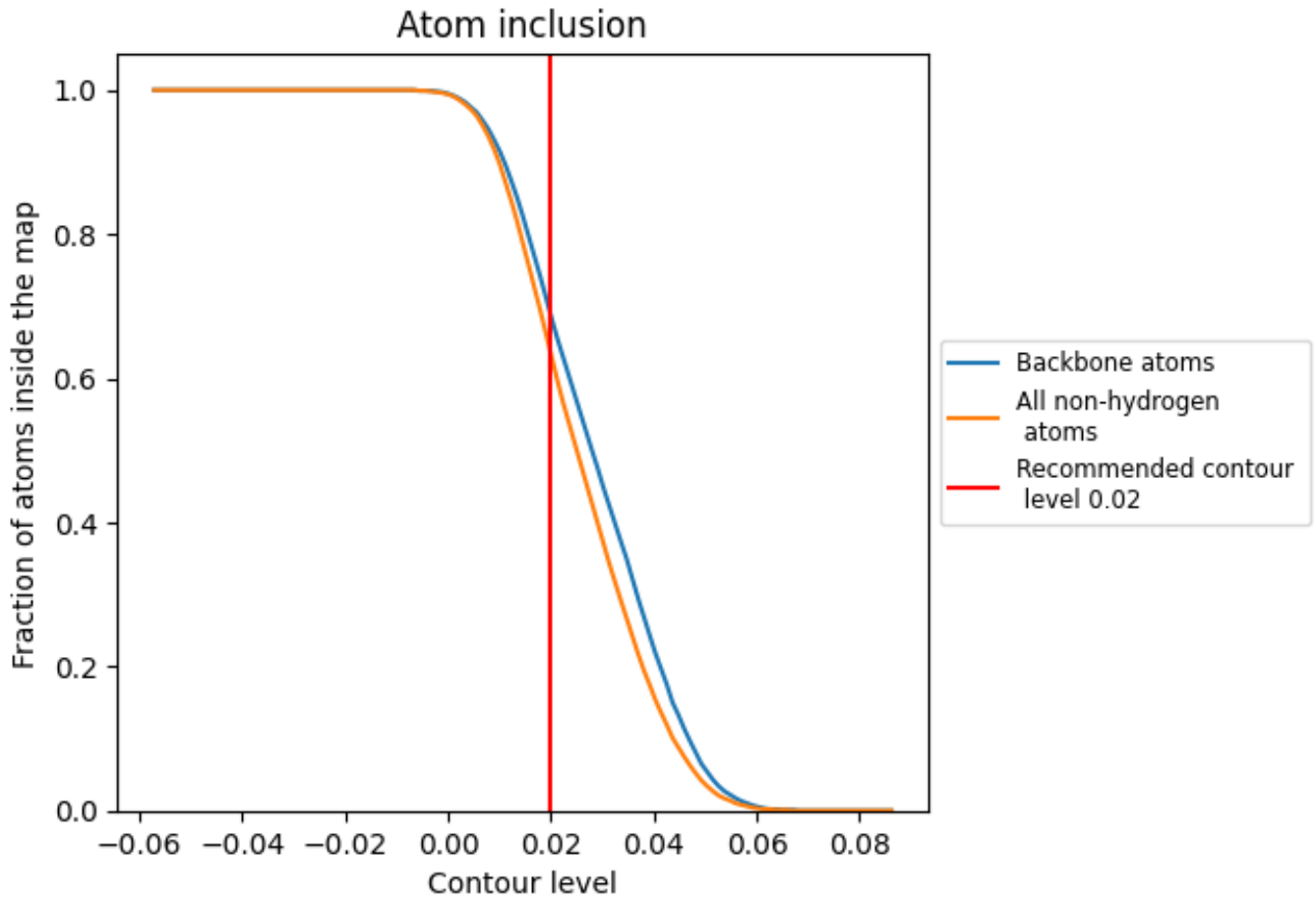
9.3 Atom inclusion mapped to coordinate model (i)



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 (0.02).

9.4 Atom inclusion (i)



At the recommended contour level, 69% of all backbone atoms, 63% 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 (0.02) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.6340	0.5350
A	0.3150	0.4260
B	0.6570	0.5750
H	0.7700	0.5740
I	0.7710	0.5810
Q	0.8140	0.5950
R	0.7310	0.5740