wwPDB EM Validation Summary Report (i)

Nov 14, 2022 – 06:25 PM EST

PDB ID	:	6XDG
EMDB ID	:	EMD-22137
Title	:	Complex of SARS-CoV-2 receptor binding domain with the Fab fragments of two neutralizing antibodies
Authors	:	Franklin, M.C.; Saotome, K.; Romero Hernandez, A.; Zhou, Y.
Deposited on	:	2020-06-10
Resolution	:	3.90 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:

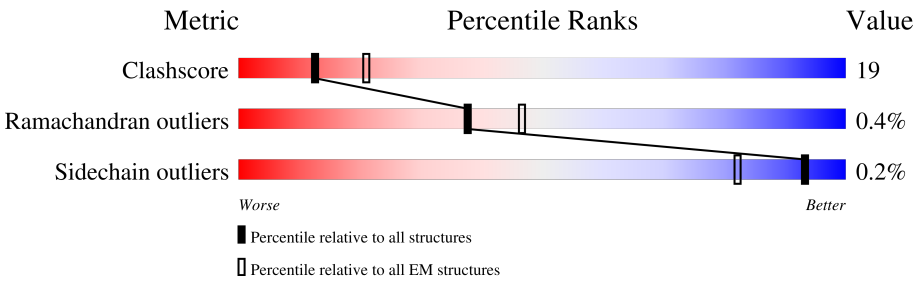
EMDB validation analysis	:	0.0.1.dev43
Mogul	:	1.8.5 (274361), CSD as541be (2020)
MolProbity	:	4.02b-467
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
MapQ	:	1.9.9
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.31.2

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 3.90 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	158937	4297
Ramachandran outliers	154571	4023
Sidechain outliers	154315	3826

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	E	251	10%, 46%, 31%, 23%
2	D	214	•, 67%, 33%
3	B	226	•, 61%, 32%, 6%
4	C	225	31%, 56%, 37%, • 6%
5	A	216	28%, 62%, 35%, •
6	F	4	50%, 75%, 25%

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 8004 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 Spike protein S1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	E	194	1542	988	257	289	8	1	0

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
E	542	GLU	-	expression tag	UNP P0DTC2
E	543	GLN	-	expression tag	UNP P0DTC2
E	544	LYS	-	expression tag	UNP P0DTC2
E	545	LEU	-	expression tag	UNP P0DTC2
E	546	ILE	-	expression tag	UNP P0DTC2
E	547	SER	-	expression tag	UNP P0DTC2
E	548	GLU	-	expression tag	UNP P0DTC2
E	549	GLU	-	expression tag	UNP P0DTC2
E	550	ASP	-	expression tag	UNP P0DTC2
E	551	LEU	-	expression tag	UNP P0DTC2
E	552	GLY	-	expression tag	UNP P0DTC2
E	553	GLY	-	expression tag	UNP P0DTC2
E	554	GLU	-	expression tag	UNP P0DTC2
E	555	GLN	-	expression tag	UNP P0DTC2
E	556	LYS	-	expression tag	UNP P0DTC2
E	557	LEU	-	expression tag	UNP P0DTC2
E	558	ILE	-	expression tag	UNP P0DTC2
E	559	SER	-	expression tag	UNP P0DTC2
E	560	GLU	-	expression tag	UNP P0DTC2
E	561	GLU	-	expression tag	UNP P0DTC2
E	562	ASP	-	expression tag	UNP P0DTC2
E	563	LEU	-	expression tag	UNP P0DTC2
E	564	HIS	-	expression tag	UNP P0DTC2
E	565	HIS	-	expression tag	UNP P0DTC2
E	566	HIS	-	expression tag	UNP P0DTC2
E	567	HIS	-	expression tag	UNP P0DTC2
E	568	HIS	-	expression tag	UNP P0DTC2
E	569	HIS	-	expression tag	UNP P0DTC2

- Molecule 2 is a protein called REGN10933 antibody Fab fragment light chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	D	214	1640	1025	272	337	6	0	0

- Molecule 3 is a protein called REGN10933 antibody Fab fragment heavy chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	B	212	1603	1020	264	312	7	0	0

- Molecule 4 is a protein called REGN10987 antibody Fab fragment heavy chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
4	C	212	1604	1019	265	314	6	0	0

- Molecule 5 is a protein called REGN10987 antibody Fab fragment light chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
5	A	211	1565	978	260	322	5	0	0

- Molecule 6 is an oligosaccharide called alpha-D-mannopyranose-(1-6)-beta-D-mannopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose.

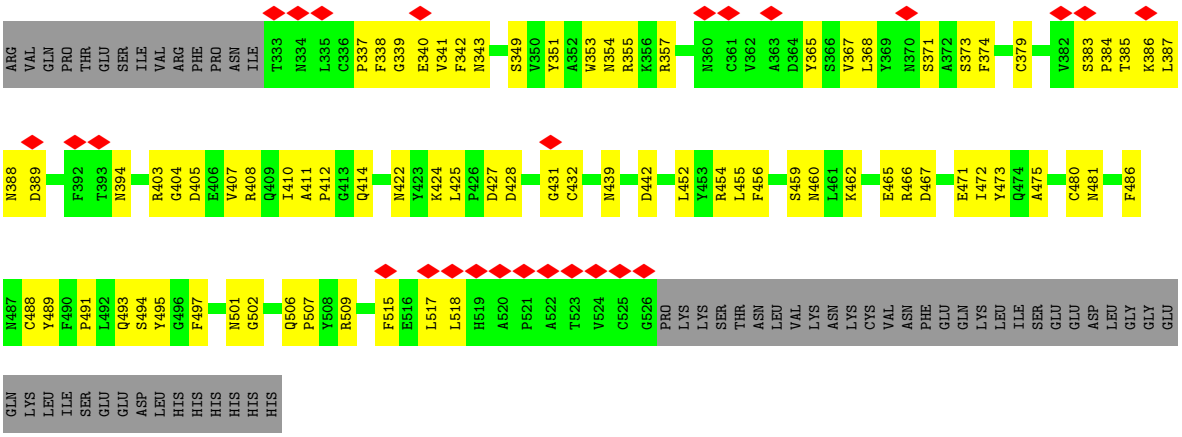
Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
6	F	4	50	28	2	20	0	0

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.

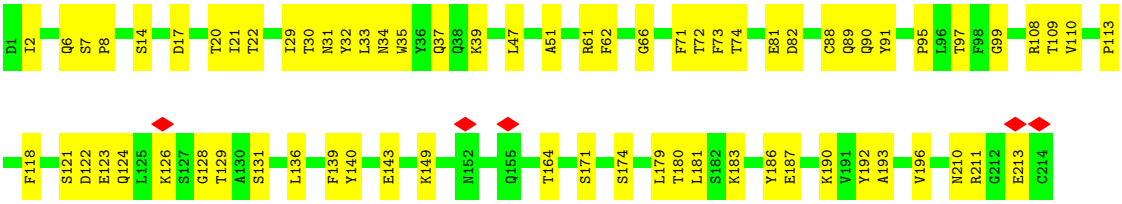
- Molecule 1: Spike protein S1

Chain E:



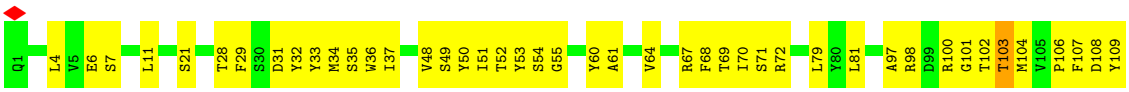
- Molecule 2: REGN10933 antibody Fab fragment light chain

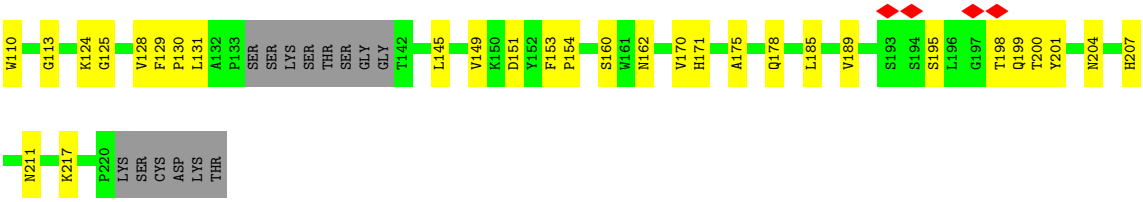
Chain D:



- Molecule 3: REGN10933 antibody Fab fragment heavy chain

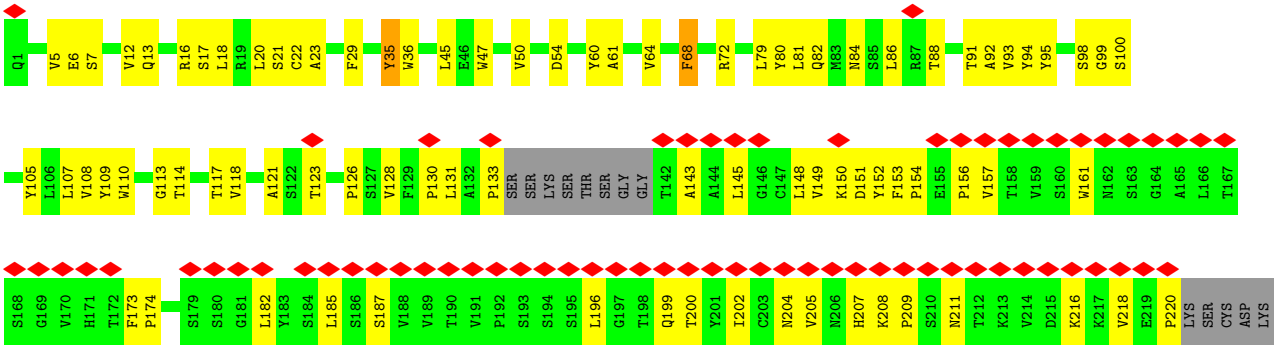
Chain B:





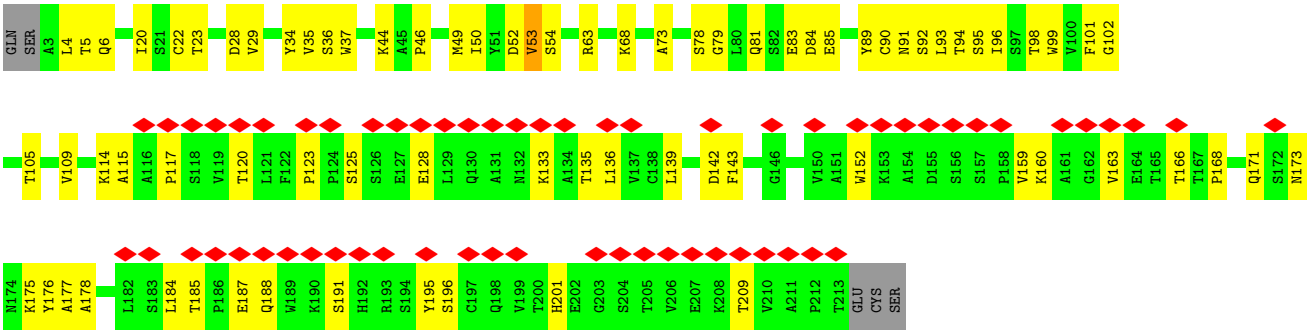
• Molecule 4: REGN10987 antibody Fab fragment heavy chain

Chain C:



• Molecule 5: REGN10987 antibody Fab fragment light chain

Chain A:



• Molecule 6: alpha-D-mannopyranose-(1-6)-beta-D-mannopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose

Chain F:

4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	48140	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 ($e^-/Å^2$)	40	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	105000	Depositor
Image detector	GATAN K3 BIOQUANTUM (6k x 4k)	Depositor
Maximum map value	0.467	Depositor
Minimum map value	-0.222	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.013	Depositor
Recommended contour level	0.1	Depositor
Map size (Å)	238.0, 238.0, 238.0	wwPDB
Map dimensions	280, 280, 280	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	0.85, 0.85, 0.85	Depositor

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: BMA, MAN, NAG

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	E	0.33	0/1588	0.48	0/2161
2	D	0.29	0/1674	0.46	0/2275
3	B	0.32	0/1643	0.49	0/2239
4	C	0.30	0/1643	0.50	0/2241
5	A	0.28	0/1603	0.46	0/2188
All	All	0.30	0/8151	0.48	0/11104

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	E	1542	0	1462	55	0
2	D	1640	0	1589	52	0
3	B	1603	0	1571	65	0
4	C	1604	0	1565	79	0
5	A	1565	0	1517	75	0
6	F	50	0	43	0	0
All	All	8004	0	7747	296	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 19.

The worst 5 of 296 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:D:37:GLN:HB2	2:D:47:LEU:HD11	1.56	0.87
1:E:379:CYS:HB3	1:E:432:CYS:HA	1.62	0.81
2:D:32:TYR:HB3	2:D:91:TYR:HB3	1.63	0.80
4:C:98:SER:HB3	4:C:109:TYR:H	1.46	0.80
4:C:161:TRP:HE1	4:C:187:SER:HG	1.32	0.76

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	E	193/251 (77%)	173 (90%)	20 (10%)	0	100	100
2	D	212/214 (99%)	195 (92%)	17 (8%)	0	100	100
3	B	208/226 (92%)	184 (88%)	22 (11%)	2 (1%)	15	52
4	C	208/225 (92%)	183 (88%)	25 (12%)	0	100	100
5	A	209/216 (97%)	190 (91%)	17 (8%)	2 (1%)	15	52
All	All	1030/1132 (91%)	925 (90%)	101 (10%)	4 (0%)	38	71

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	B	109	TYR
5	A	95	SER
3	B	103	THR
5	A	53	VAL

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all PDB entries followed by that with respect to all EM entries.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	E	168/222 (76%)	168 (100%)	0	100	100
2	D	187/187 (100%)	187 (100%)	0	100	100
3	B	179/191 (94%)	179 (100%)	0	100	100
4	C	179/190 (94%)	177 (99%)	2 (1%)	73	84
5	A	178/183 (97%)	178 (100%)	0	100	100
All	All	891/973 (92%)	889 (100%)	2 (0%)	93	96

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	C	35	TYR
4	C	68	PHE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 18 such sidechains are listed below:

Mol	Chain	Res	Type
4	C	204	ASN
5	A	112	GLN
5	A	81	GLN
3	B	39	GLN
4	C	199	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)

4 monosaccharides are 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	$\#\|Z\| > 2$
6	NAG	F	1	6,1	14,14,15	0.19	0	17,19,21	0.58	0
6	NAG	F	2	6	14,14,15	0.22	0	17,19,21	0.39	0
6	BMA	F	3	6	11,11,12	0.60	0	15,15,17	0.85	0
6	MAN	F	4	6	11,11,12	0.70	0	15,15,17	1.05	2 (13%)

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
6	NAG	F	1	6,1	-	0/6/23/26	0/1/1/1
6	NAG	F	2	6	-	2/6/23/26	0/1/1/1
6	BMA	F	3	6	-	0/2/19/22	0/1/1/1
6	MAN	F	4	6	-	0/2/19/22	0/1/1/1

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
6	F	4	MAN	C1-O5-C5	2.32	115.34	112.19
6	F	4	MAN	O2-C2-C3	-2.27	105.58	110.14

There are no chirality outliers.

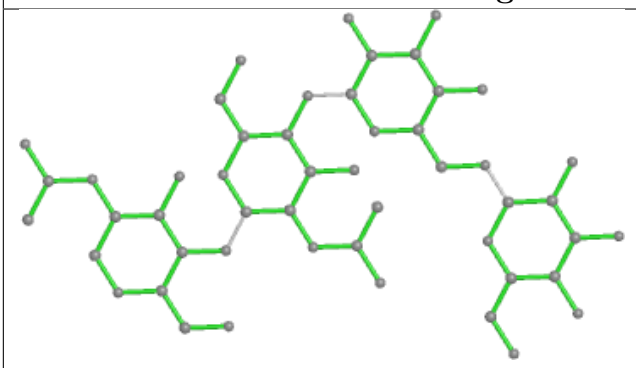
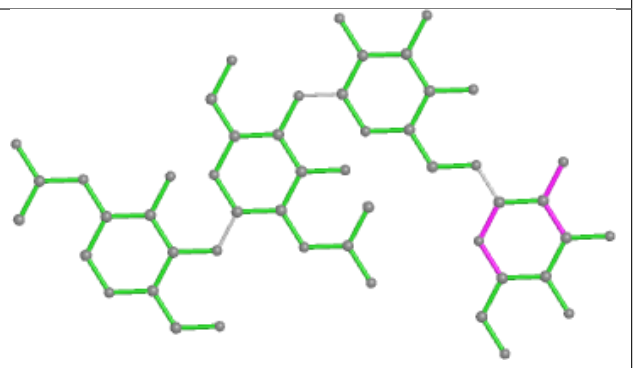
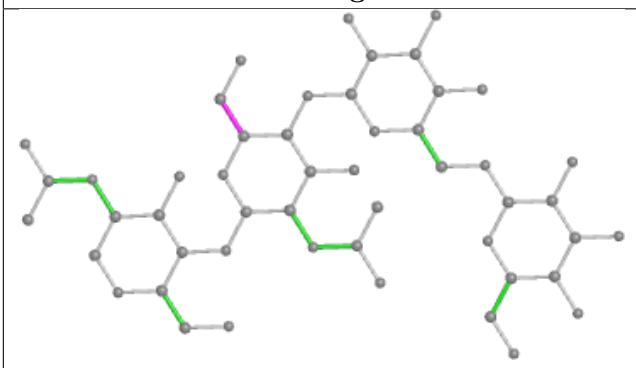
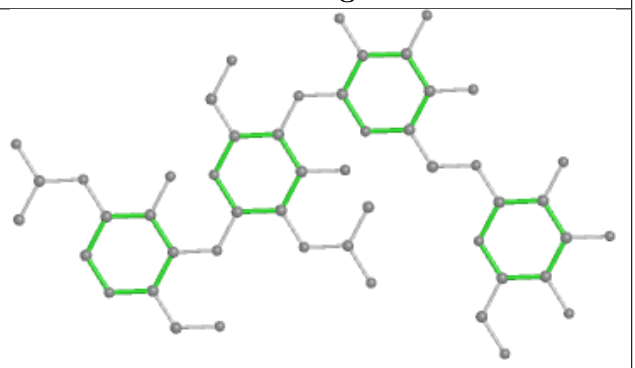
All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	F	2	NAG	O5-C5-C6-O6
6	F	2	NAG	C4-C5-C6-O6

There are no ring outliers.

No monomer is involved in short contacts.

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for oligosaccharide.

Oligosaccharide Chain F	
 Bond lengths	 Bond angles
 Torsions	 Rings

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.

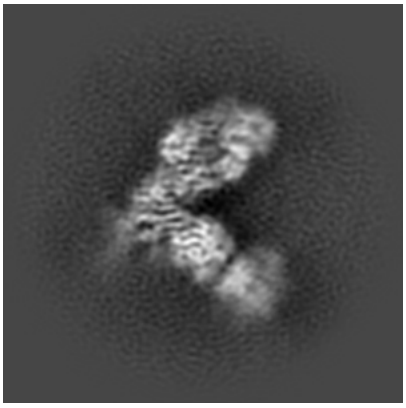
6 Map visualisation (i)

This section contains visualisations of the EMDB entry EMD-22137. These allow visual inspection of the internal detail of the map and identification of artifacts.

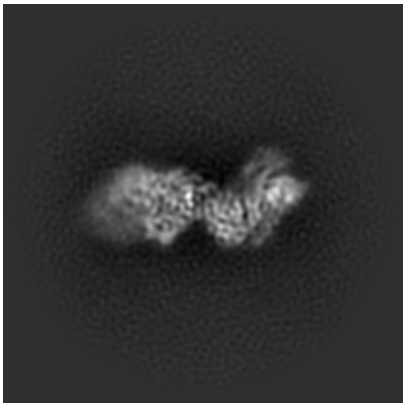
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections (i)

6.1.1 Primary map



X



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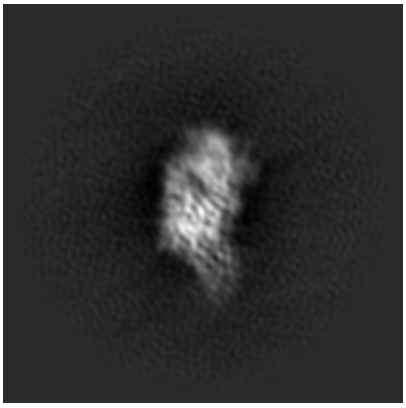
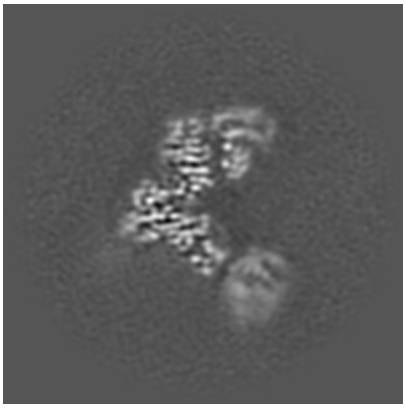


Z

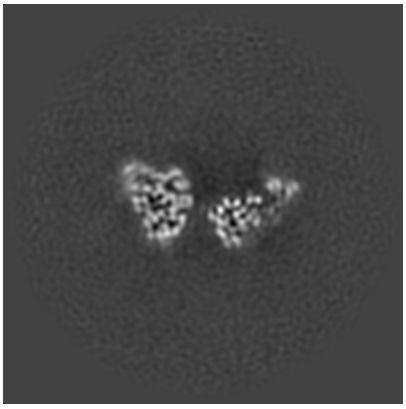
The images above show the map projected in three orthogonal directions.

6.2 Central slices (i)

6.2.1 Primary map



X Index: 140



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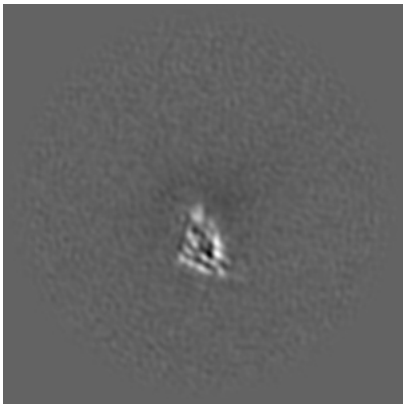
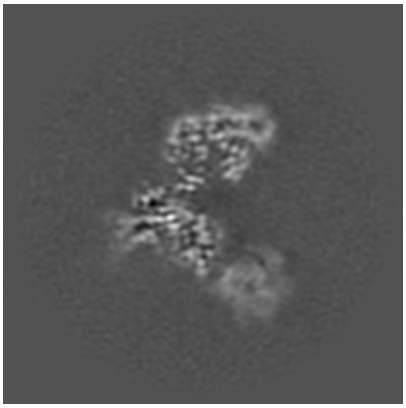


Z Index: 140

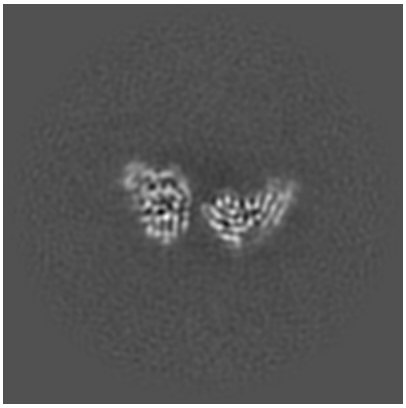
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices (i)

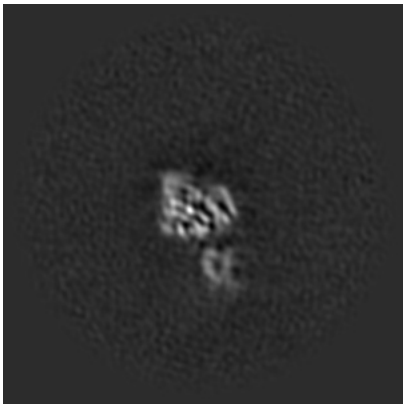
6.3.1 Primary map



X Index: 144



Y Index: 135



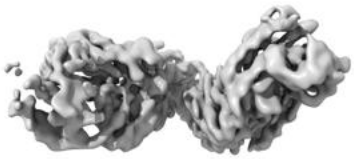
Z Index: 114

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

6.4 Orthogonal surface views (i)

6.4.1 Primary map

X



Y

Z

The images above show the 3D surface view of the map at the recommended contour level 0.1. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

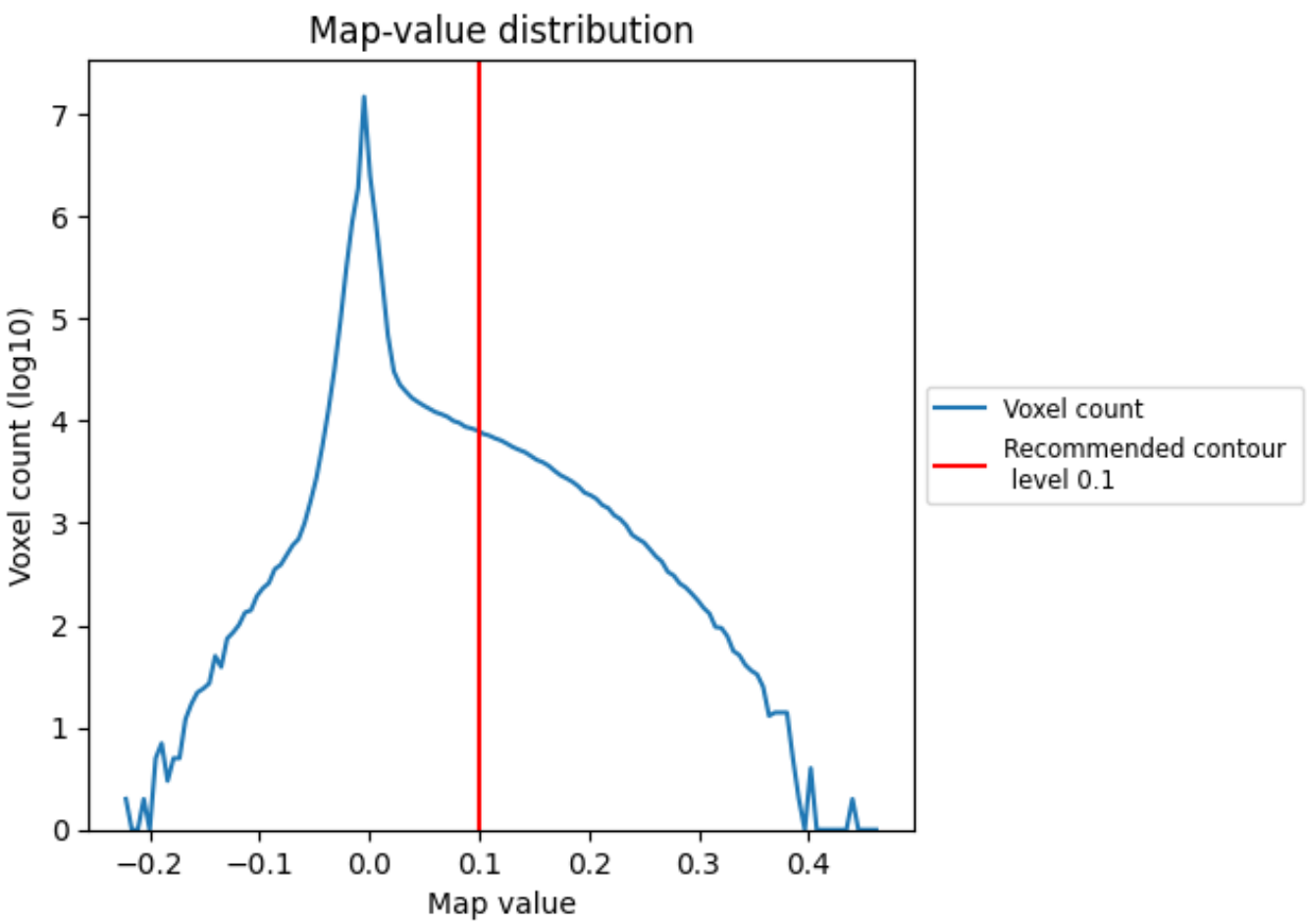
6.5 Mask visualisation (i)

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

7 Map analysis (i)

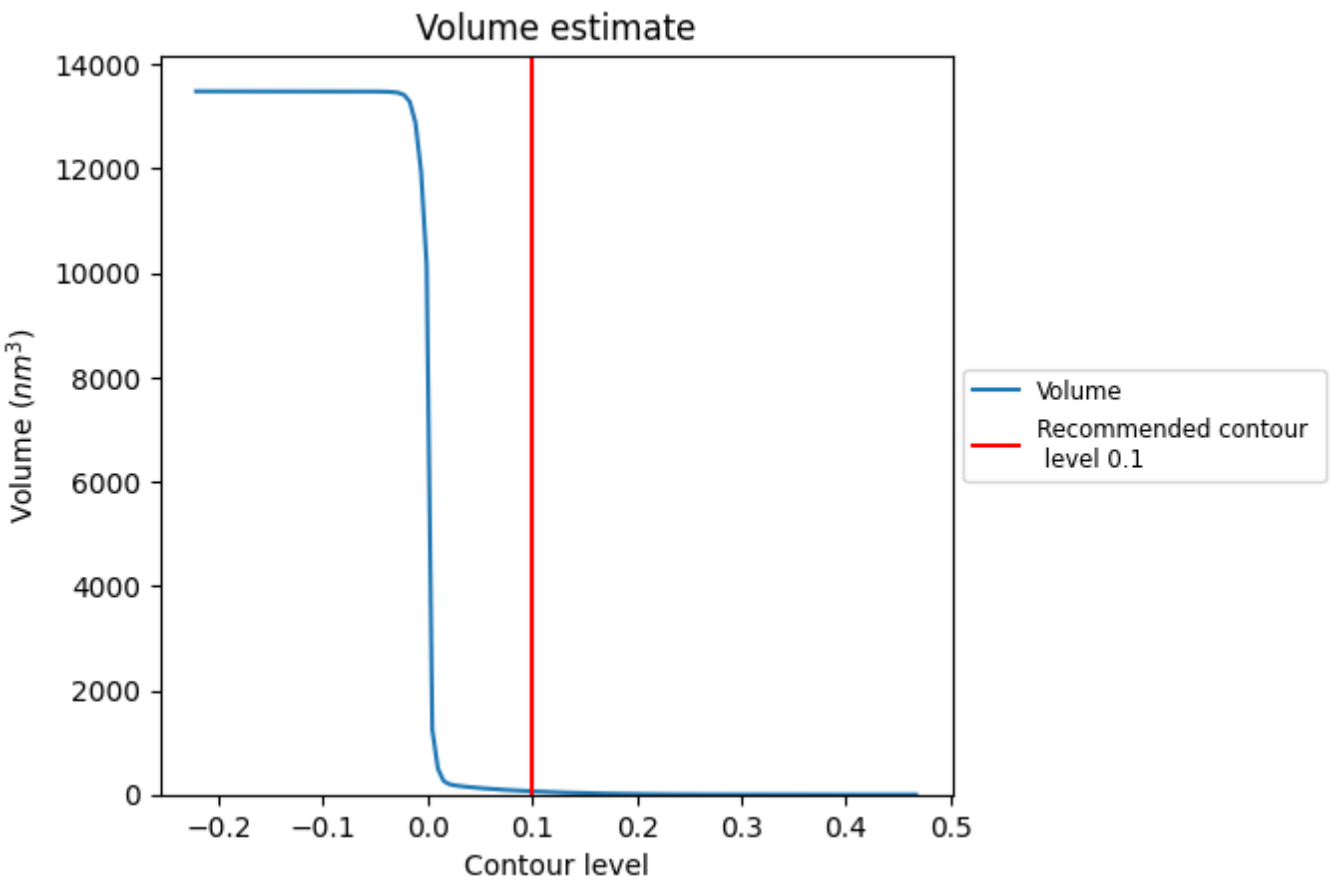
This section contains the results of statistical analysis of the map.

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.

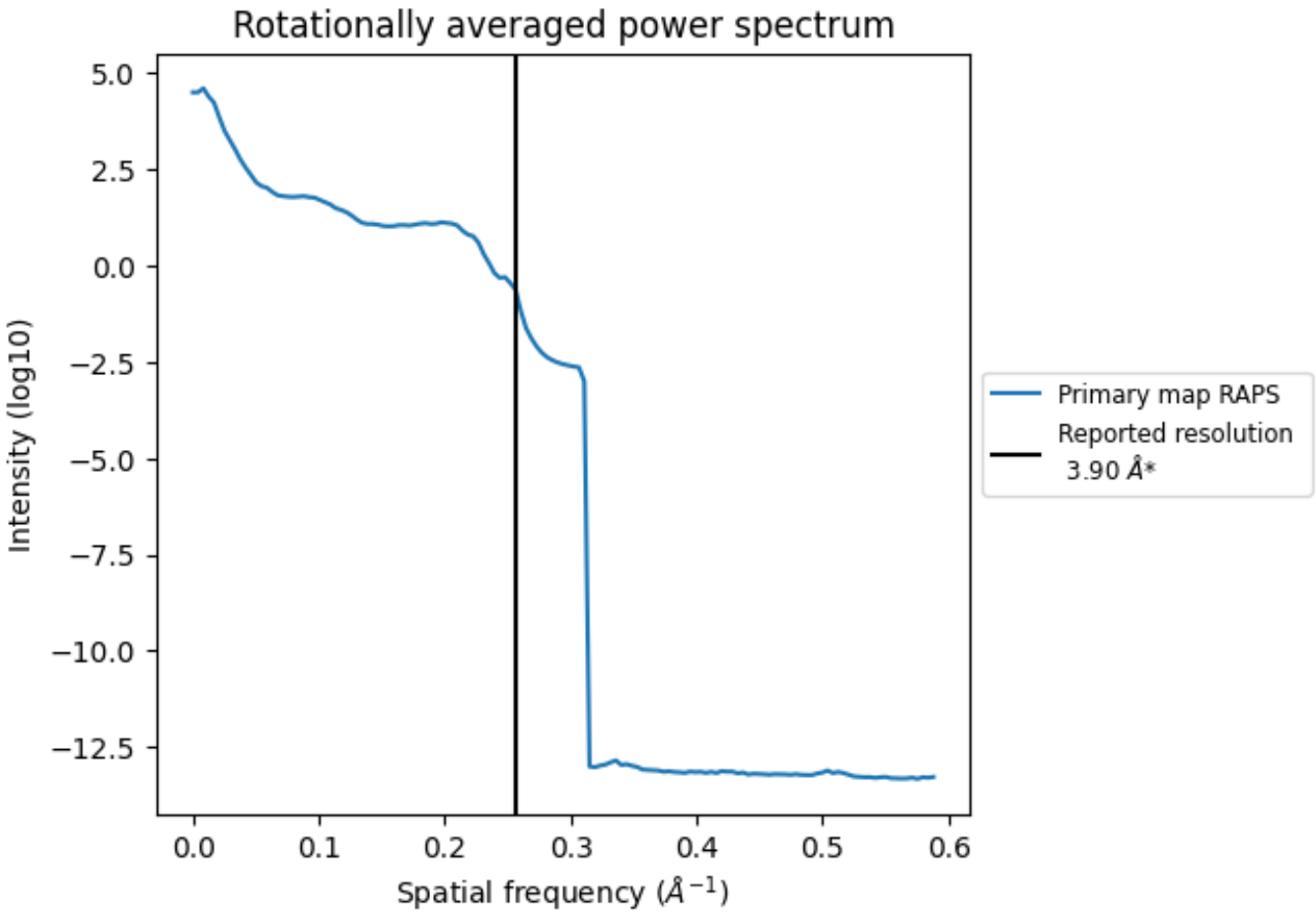
7.2 Volume estimate (i)



The volume at the recommended contour level is 63 nm^3; this corresponds to an approximate mass of 57 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 0.256 Å^{-1}

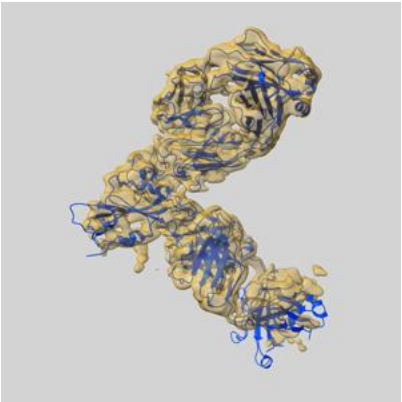
8 Fourier-Shell correlation (i)

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

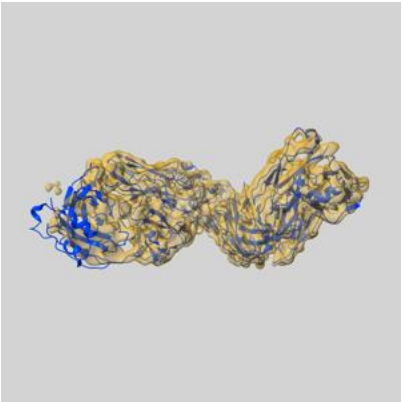
9 Map-model fit (i)

This section contains information regarding the fit between EMDB map EMD-22137 and PDB model 6XDG. Per-residue inclusion information can be found in section 3 on page 5.

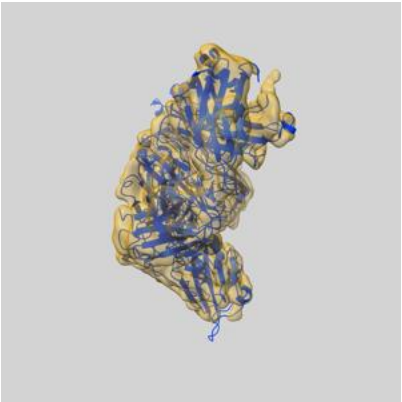
9.1 Map-model overlay (i)



X



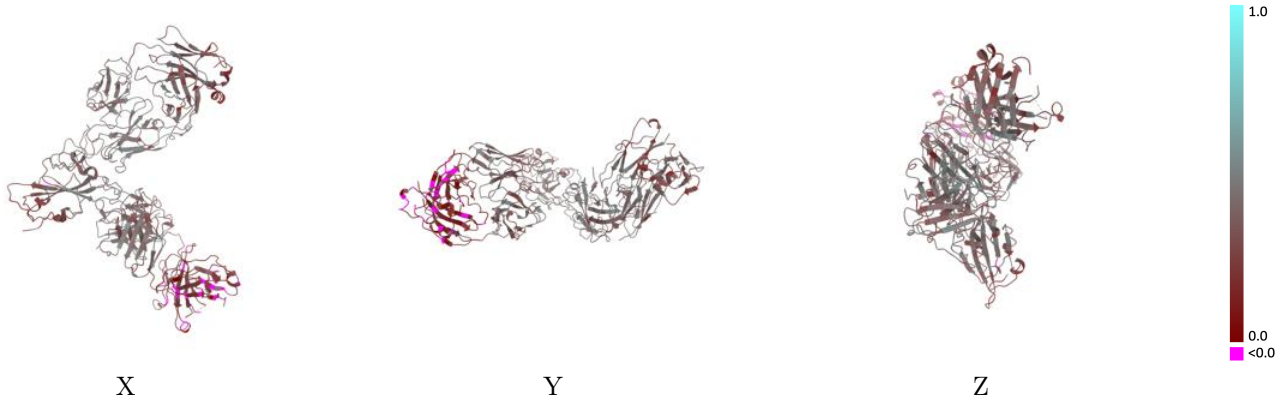
Y



Z

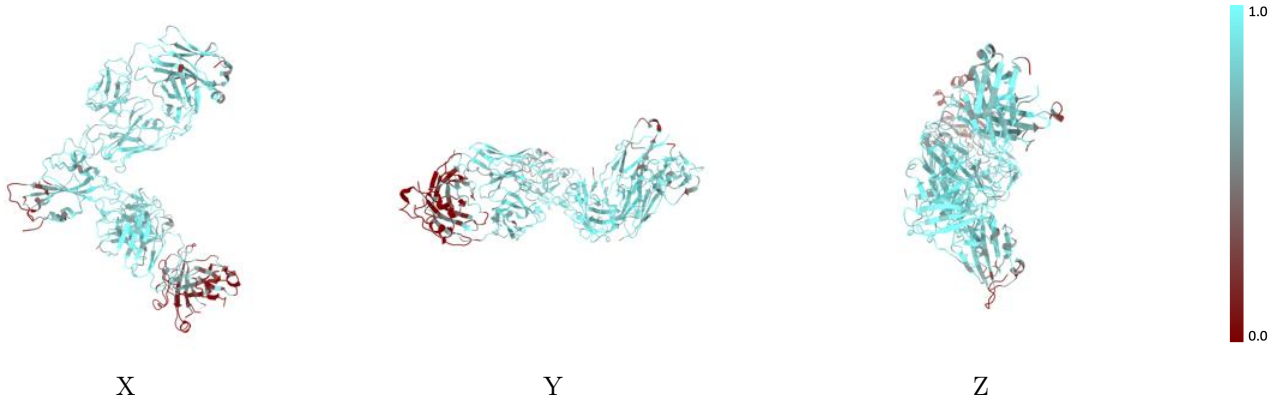
The images above show the 3D surface view of the map at the recommended contour level 0.1 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

9.2 Q-score mapped to coordinate model (i)



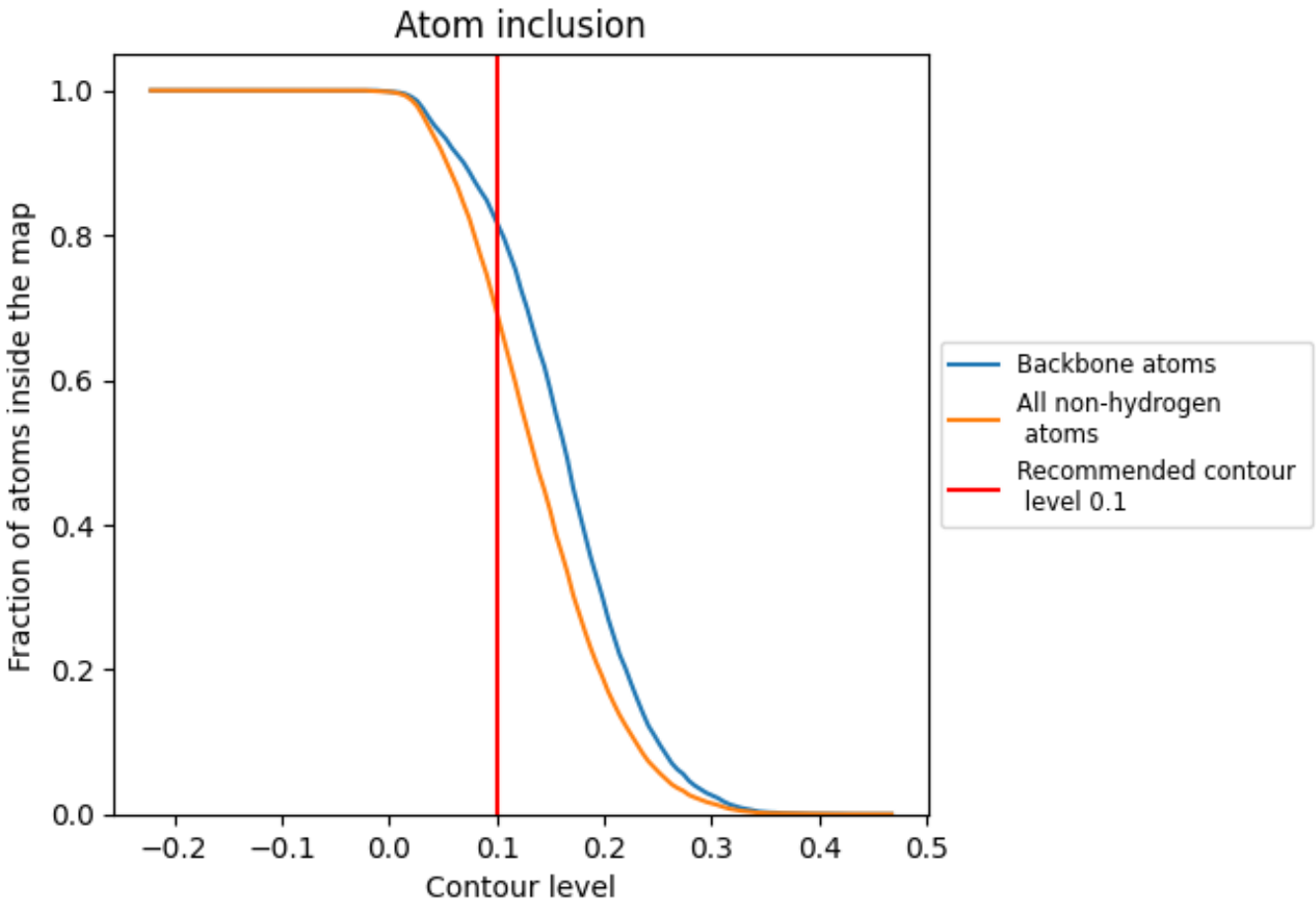
The images above show the model with each residue coloured according its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (0.1).

9.4 Atom inclusion (i)



At the recommended contour level, 82% of all backbone atoms, 69% 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 (0.1) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.6945	0.3480
A	0.5735	0.2750
B	0.8168	0.4110
C	0.5686	0.2980
D	0.7930	0.3770
E	0.7282	0.3760
F	0.3600	0.3700