



## wwPDB EM Validation Summary Report ⓘ

Nov 9, 2022 – 01:39 AM JST

PDB ID : 6ACK  
EMDB ID : EMD-9594  
Title : Trypsin-cleaved and low pH-treated SARS-CoV spike glycoprotein and ACE2 complex, ACE2-bound conformation 3  
Authors : Gui, M.; Song, W.  
Deposited on : 2018-07-26  
Resolution : 4.50 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](mailto: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>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

EMDB validation analysis : 0.0.1.dev43  
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

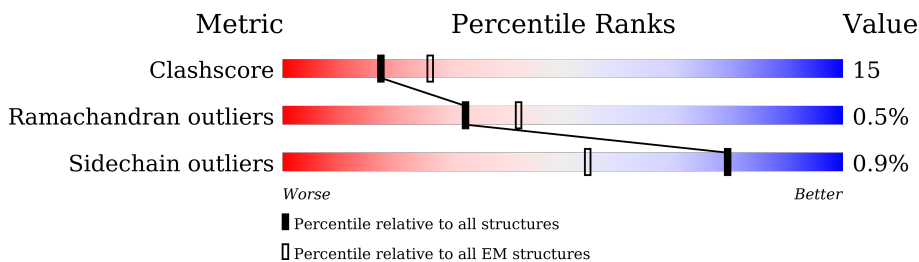
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 4.50 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  $\geq 3$ , 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	1203	
1	B	1203	
1	C	1203	
2	D	603	

## 2 Entry composition i

There are 2 unique types of molecules in this entry. The entry contains 29715 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 glycoprotein.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	1065	8302	5304	1374	1579	45	0	0
1	B	1065	8302	5304	1374	1579	45	0	0
1	C	1057	8241	5264	1364	1568	45	0	0

There are 21 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1197	SER	-	expression tag	UNP P59594
A	1198	HIS	-	expression tag	UNP P59594
A	1199	PRO	-	expression tag	UNP P59594
A	1200	GLN	-	expression tag	UNP P59594
A	1201	PHE	-	expression tag	UNP P59594
A	1202	GLU	-	expression tag	UNP P59594
A	1203	LYS	-	expression tag	UNP P59594
B	1197	SER	-	expression tag	UNP P59594
B	1198	HIS	-	expression tag	UNP P59594
B	1199	PRO	-	expression tag	UNP P59594
B	1200	GLN	-	expression tag	UNP P59594
B	1201	PHE	-	expression tag	UNP P59594
B	1202	GLU	-	expression tag	UNP P59594
B	1203	LYS	-	expression tag	UNP P59594
C	1197	SER	-	expression tag	UNP P59594
C	1198	HIS	-	expression tag	UNP P59594
C	1199	PRO	-	expression tag	UNP P59594
C	1200	GLN	-	expression tag	UNP P59594
C	1201	PHE	-	expression tag	UNP P59594
C	1202	GLU	-	expression tag	UNP P59594
C	1203	LYS	-	expression tag	UNP P59594

- Molecule 2 is a protein called Angiotensin-converting enzyme 2.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	D	597	4870	3115	806	920	29	0	0

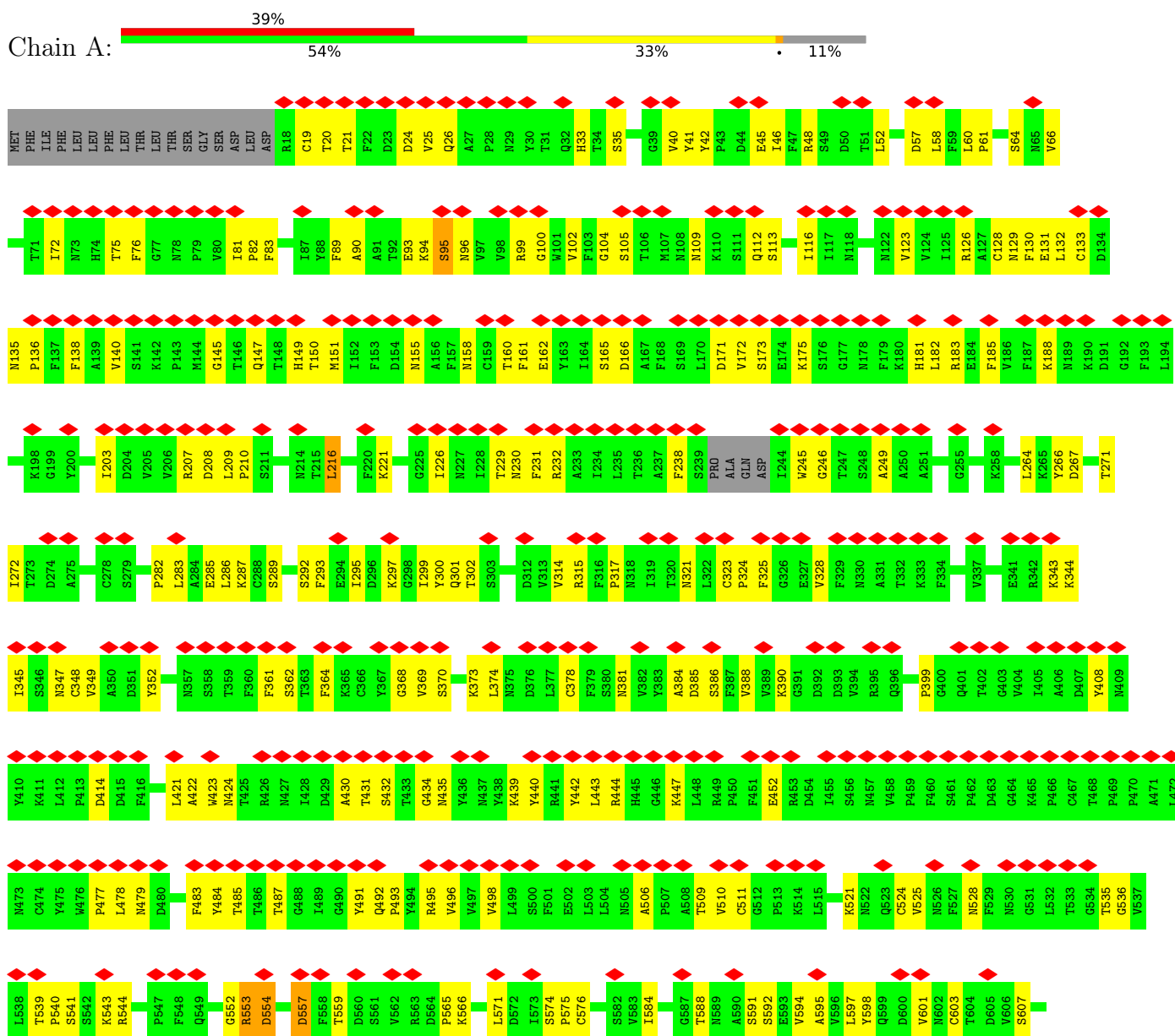
There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	616	HIS	-	expression tag	UNP Q9BYF1
D	617	HIS	-	expression tag	UNP Q9BYF1
D	618	HIS	-	expression tag	UNP Q9BYF1
D	619	HIS	-	expression tag	UNP Q9BYF1
D	620	HIS	-	expression tag	UNP Q9BYF1
D	621	HIS	-	expression tag	UNP Q9BYF1

### 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: Spike glycoprotein



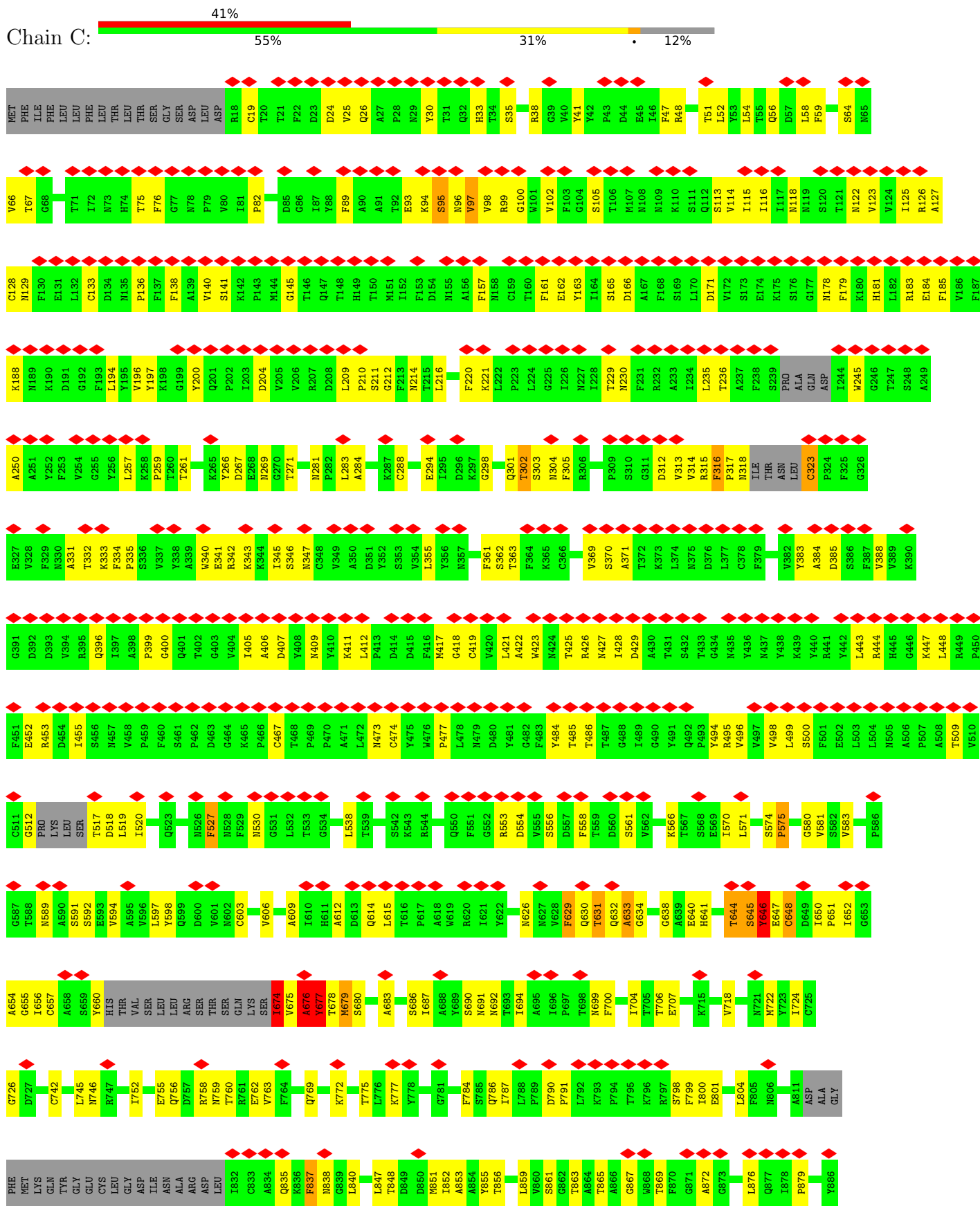


LYS	F1077	A1004	I916	G780	N626	R544	T468	I405	E341	G255
ASN	V1078	M1005	Q917	G781	N627	F945	P469	A406	R342	Y256
HIS	F1079	L1006	L920	F782	V628	F946	P470	D407	R343	L257
THR	M1080	K1010	T921	F783	F629	P947	A471	Y408	K344	K258
SER	S1083	K1011	T925	F784	Q630	F948	M409	M409	I345	P259
PRO	F1084	M1011	A926	S785	T631	Q949	L472	Y410	I346	T261
ASP	F1085	S1012	L927	S786	Q632	Q850	M473	K411	T262	F262
VAL	I1086	E1013	L927	T787	A633	G552	C474	C348	M263	M263
LEU	I1087	C1014	T863	L788	A634	G553	Y475	D414	L264	L264
GLY	Q1088	A864	A864	F789	C635	R553	W476	D415	K265	K265
ILE	R1089	T865	T865	S790	A639	D854	P477	F416	T266	T266
ASP	M1090	A866	A866	L704	E640	V555	L478	M417	D267	D267
SER	F1091	G867	G867	E707	S645	F558	M479	L421	G270	G270
ILE	F1092	T868	T868	W708	V646	T559	D480	A422	D274	D274
ASN	S1093	F870	F870	M709	E647	D860	G482	W423	A275	A275
ALA	F1094	G871	G871	P710	E648	S561	F483	M424	Q280	Q280
SER	F1094	T795	T795	V711	C648	S561	Y484	T425	K287	K287
VAL	Q1095	A872	A872	W715	D649	E569	T485	M427	S292	S292
VAL	I1096	A873	A873	N721	L652	I570	T486	I428	F923	F923
ASN	I1097	A874	A874	C725	G653	L571	T487	D429	E294	E294
ASN	T1098	A875	A875	G726	A654	I573	T487	A430	I295	I295
GLN	T1098	L876	L876	D727	G655	S574	T487	T431	D296	D296
LYS	D1100	G877	G877	S728	C657	P575	T487	G434	K297	K297
GLU	T1101	I878	I878	S729	A658	V581	T488	M435	T302	T302
ILE	T1102	P879	P879	S730	A659	V582	T489	M435	S303	S303
ASP	F1103	F880	F880	E730	Y660	G587	T489	Y436	M304	M304
LEU	V1104	A881	A881	L734	HIS	THR	T489	M437	F305	F305
ASN	S1105	ALA	ALA	L735	THR	THR	T489	Y438	G311	G311
GLU	G1106	GLY	GLY	L735	THR	THR	T489	K439	D312	D312
VAL	M1107	PHE	PHE	L735	THR	THR	T489	K439	V313	V313
ALA	M1107	MET	MET	L735	THR	THR	T489	Y440	V314	V314
LYS	C1108	LYS	LYS	L735	THR	THR	T489	R441	G311	G311
ASN	V1109	GLN	GLN	L735	THR	THR	T489	Y442	D312	D312
LEU	D1109	TVR	TVR	L735	THR	THR	T489	L443	V313	V313
ASN	V1110	GLY	GLY	L735	THR	THR	T489	R444	V314	V314
GLU	V1111	CYS	CYS	L735	THR	THR	T489	H445	G311	G311
SER	I1112	ARG	ARG	L735	THR	THR	T489	G446	D322	D322
LEU	I1113	LEU	LEU	L735	THR	THR	T489	K447	L322	L322
ILE	I1114	ASP	ASP	L735	THR	THR	T489	L448	C323	C323
ASP	I1114	ILE	ILE	L735	THR	THR	T489	R449	P324	P324
LEU	M1117	LEU	LEU	L735	THR	THR	T489	R449	E327	E327
GLN	T1118	LEU	LEU	L735	THR	THR	T489	P450	V328	V328
LEU	V1119	GLY	GLY	L735	THR	THR	T489	A451	F329	F329
TYR	ASP	LEU	LEU	L735	THR	THR	T489	E452	N330	N330
PRO	PRO	ASP	ASP	L735	THR	THR	T489	D454	A331	A331
LEU	PRO	SER	SER	L735	THR	THR	T489	I455	T332	T332
GLN	LEU	PHE	PHE	L735	THR	THR	T489	S456	A333	A333
TYR	LEU	LYS	LYS	L735	THR	THR	T489	M457	F334	F334
GLN	GLN	GLU	GLU	L735	THR	THR	T489	V458	P335	P335
TYR	GLN	GLU	GLU	L735	THR	THR	T489	V458	S336	S336
ILE	PRO	LEU	LEU	L735	THR	THR	T489	P459	V337	V337
ILE	PRO	LEU	LEU	L735	THR	THR	T489	F460	Y338	Y338
LYS	LEU	ASP	ASP	L735	THR	THR	T489	S461	A339	A339
TRP	ASP	LYS	LYS	L735	THR	THR	T489	P462	G400	G400
PRO	TRP	TYR	TYR	L735	THR	THR	T489	D463	Q401	Q401
ASP	TRP	PHE	PHE	L735	THR	THR	T489	G464	T402	T402
SER	PHE	LYS	LYS	L735	THR	THR	T489	K465	G403	G403
HIS	LYS	TYR	TYR	L735	THR	THR	T489	P466	V404	V404

PRO  
GLN  
PHE  
GLU  
LYS

• Molecule 1: Spike glycoprotein











## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	56553	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 ( $e^-/\text{\AA}^2$ )	50	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	Not provided	
Image detector	GATAN K2 SUMMIT (4k x 4k)	Depositor
Maximum map value	29.588	Depositor
Minimum map value	-14.552	Depositor
Average map value	-0.001	Depositor
Map value standard deviation	0.908	Depositor
Recommended contour level	8.0	Depositor
Map size ( $\text{\AA}$ )	380.16, 380.16, 380.16	wwPDB
Map dimensions	288, 288, 288	wwPDB
Map angles ( $^\circ$ )	90.0, 90.0, 90.0	wwPDB
Pixel spacing ( $\text{\AA}$ )	1.32, 1.32, 1.32	Depositor

## 5 Model quality i

### 5.1 Standard geometry i

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 5$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	# $ Z  > 5$	RMSZ	# $ Z  > 5$
1	A	0.54	2/8499 (0.0%)	0.73	5/11568 (0.0%)
1	B	0.53	1/8499 (0.0%)	0.73	2/11568 (0.0%)
1	C	0.59	5/8435 (0.1%)	0.76	7/11477 (0.1%)
2	D	0.34	0/5007	0.58	0/6803
All	All	0.53	8/30440 (0.0%)	0.72	14/41416 (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
1	A	0	13
1	B	0	14
1	C	0	18
All	All	0	45

The worst 5 of 8 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	725	CYS	CB-SG	-9.21	1.66	1.82
1	A	731	CYS	CB-SG	-8.50	1.67	1.82
1	C	677	TYR	CE2-CZ	-8.19	1.27	1.38
1	B	725	CYS	CB-SG	-6.59	1.71	1.82
1	C	676	ALA	C-O	-6.38	1.11	1.23

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	677	TYR	CB-CG-CD2	-6.45	117.13	121.00
1	C	674	ILE	CB-CA-C	-6.36	98.89	111.60
1	B	557	ASP	CB-CG-OD1	6.35	124.02	118.30
1	C	644	THR	O-C-N	5.97	132.25	122.70

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	644	THR	CA-C-N	-5.78	104.49	117.20

There are no chirality outliers.

5 of 45 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	506	ALA	Peptide
1	A	629	PHE	Peptide
1	A	632	GLN	Peptide
1	A	633	ALA	Peptide
1	A	95	SER	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	8302	0	8082	286	0
1	B	8302	0	8082	259	0
1	C	8241	0	8009	293	0
2	D	4870	0	4643	99	0
All	All	29715	0	28816	884	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 15.

The worst 5 of 884 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:C:646:TYR:HB2	1:C:677:TYR:CE2	1.47	1.48
1:C:646:TYR:CB	1:C:677:TYR:CE2	2.02	1.41
1:C:646:TYR:O	1:C:680:SER:OG	1.62	1.15
1:C:646:TYR:HB2	1:C:677:TYR:CD2	1.84	1.11
1:C:646:TYR:CA	1:C:677:TYR:CE2	2.36	1.07

There are no symmetry-related clashes.

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

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

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

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	1057/1203 (88%)	874 (83%)	180 (17%)	3 (0%)	41	76
1	B	1057/1203 (88%)	852 (81%)	201 (19%)	4 (0%)	34	72
1	C	1045/1203 (87%)	843 (81%)	192 (18%)	10 (1%)	15	54
2	D	595/603 (99%)	564 (95%)	31 (5%)	0	100	100
All	All	3754/4212 (89%)	3133 (84%)	604 (16%)	17 (0%)	32	68

5 of 17 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	554	ASP
1	B	560	ASP
1	B	1072	PRO
1	C	645	SER
1	B	632	GLN

### 5.3.2 Protein sidechains [i](#)

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

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

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	922/1048 (88%)	916 (99%)	6 (1%)	84	90
1	B	922/1048 (88%)	917 (100%)	5 (0%)	88	93
1	C	914/1048 (87%)	903 (99%)	11 (1%)	71	84
2	D	527/533 (99%)	521 (99%)	6 (1%)	73	85
All	All	3285/3677 (89%)	3257 (99%)	28 (1%)	79	87

5 of 28 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	333	LYS
2	D	436	ILE
1	C	674	ILE
2	D	114	LYS
1	C	646	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 64 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	1005	ASN
2	D	33	ASN
1	B	699	ASN
1	B	692	ASN
2	D	53	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 monosaccharides 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

There are no chain breaks in this entry.



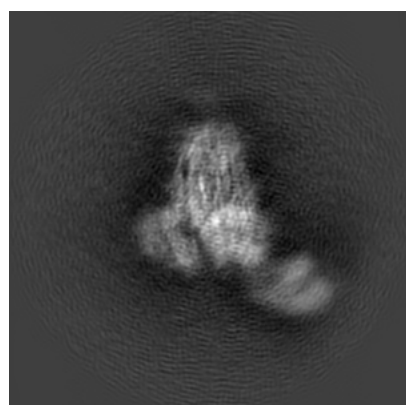
## 6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-9594. These allow visual inspection of the internal detail of the map and identification of artifacts.

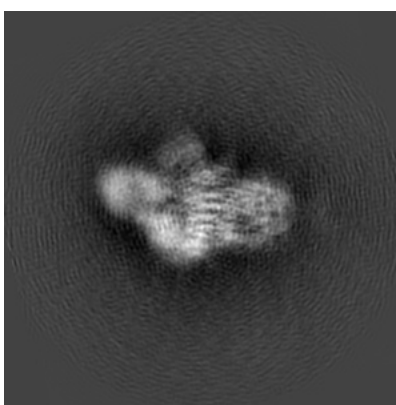
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

### 6.1 Orthogonal projections [i](#)

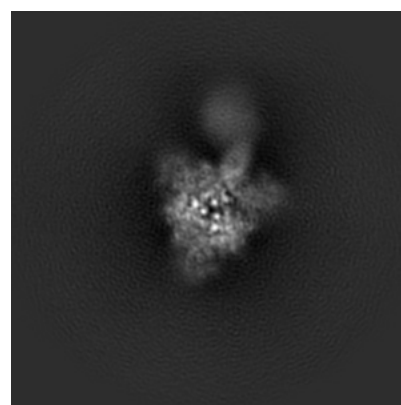
#### 6.1.1 Primary map



X



Y

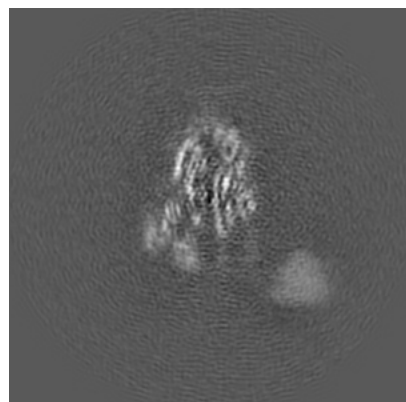


Z

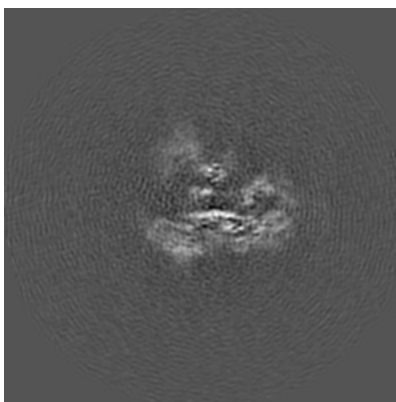
The images above show the map projected in three orthogonal directions.

### 6.2 Central slices [i](#)

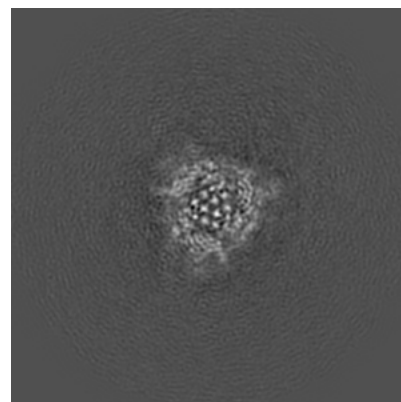
#### 6.2.1 Primary map



X Index: 144



Y Index: 144

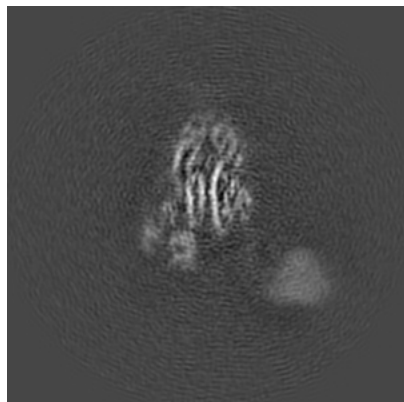


Z Index: 144

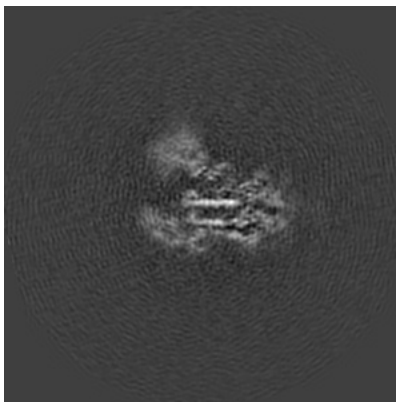
The images above show central slices of the map in three orthogonal directions.

## 6.3 Largest variance slices [i](#)

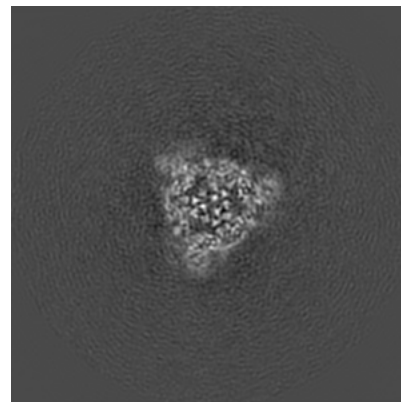
### 6.3.1 Primary map



X Index: 146



Y Index: 149

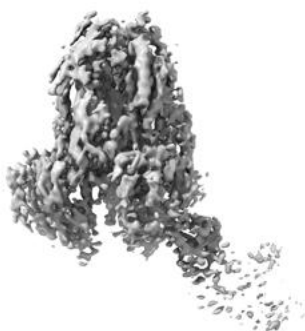


Z Index: 141

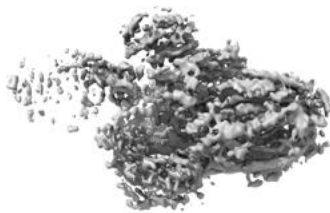
The images above show the largest variance slices of the map in three orthogonal directions.

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

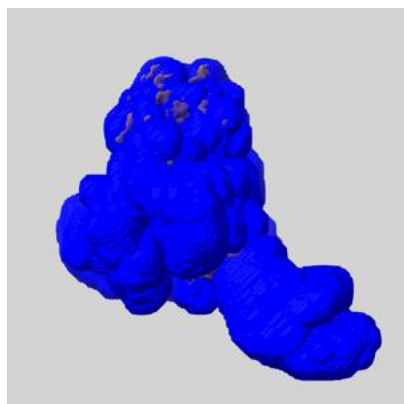
## 6.5 Mask visualisation [i](#)

This section shows the 3D surface view of the primary map at 50% transparency overlaid with the specified mask at 0% transparency

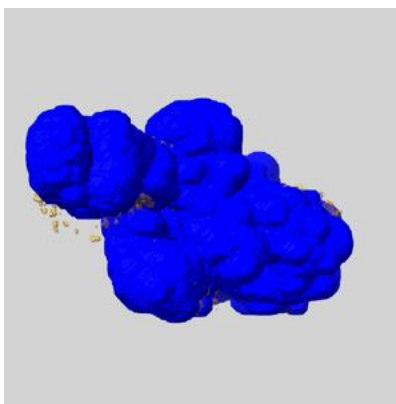
A mask typically either:

- Encompasses the whole structure
- Separates out a domain, a functional unit, a monomer or an area of interest from a larger structure

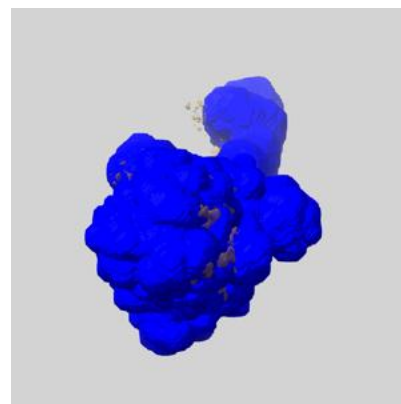
### 6.5.1 emd\_9594\_msk\_1.map [i](#)



X



Y

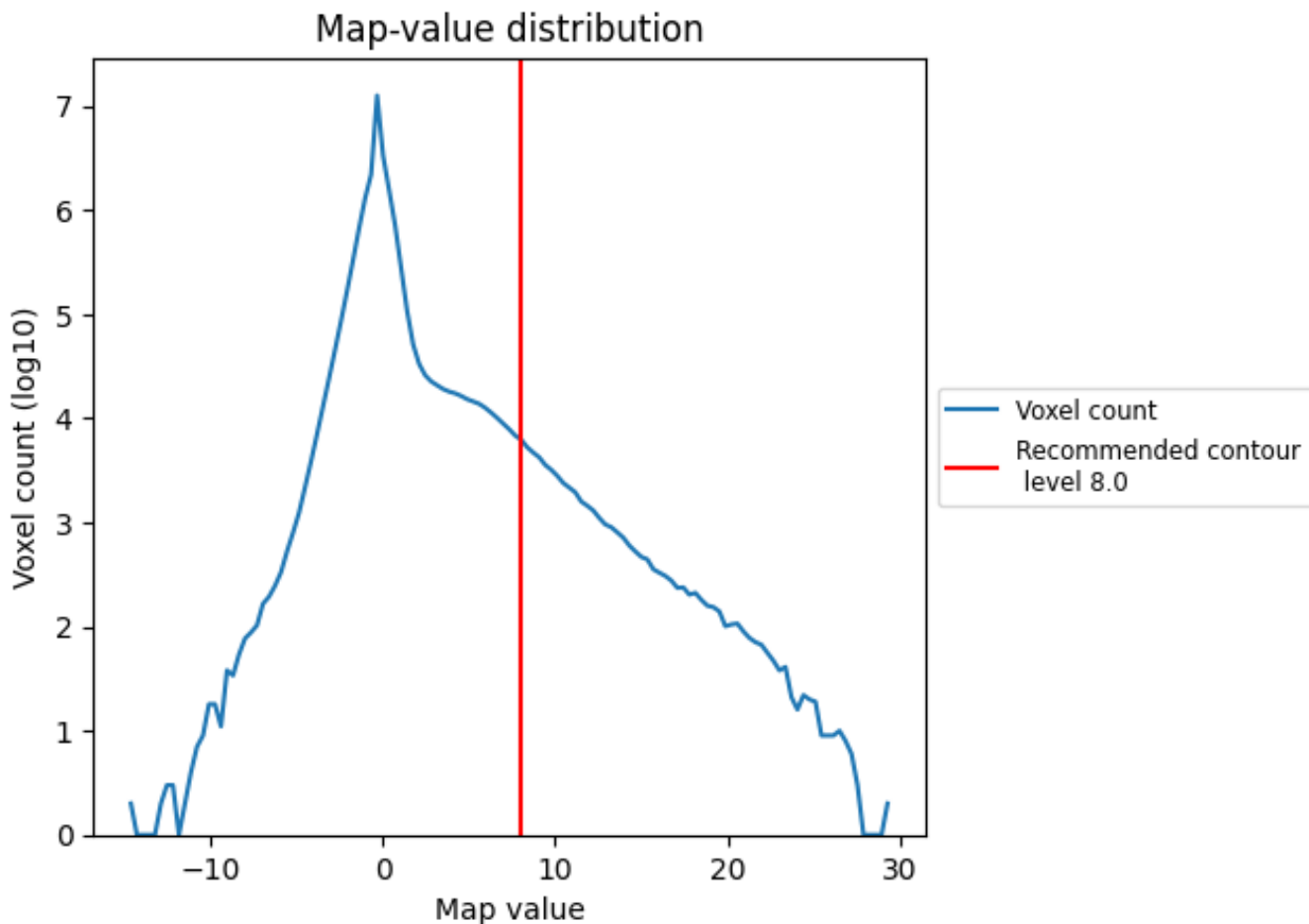


Z

## 7 Map analysis [i](#)

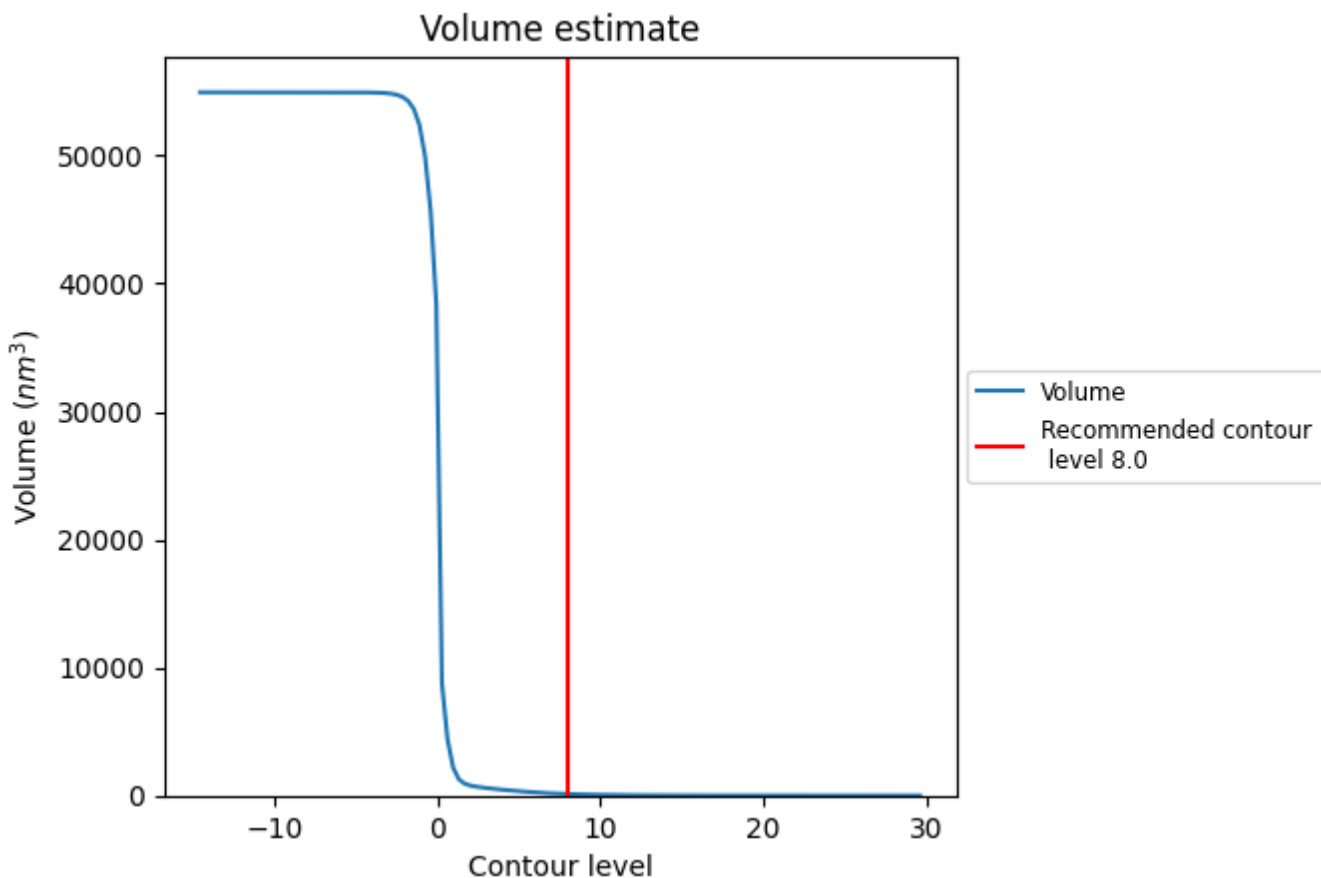
This section contains the results of statistical analysis of the map.

### 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.

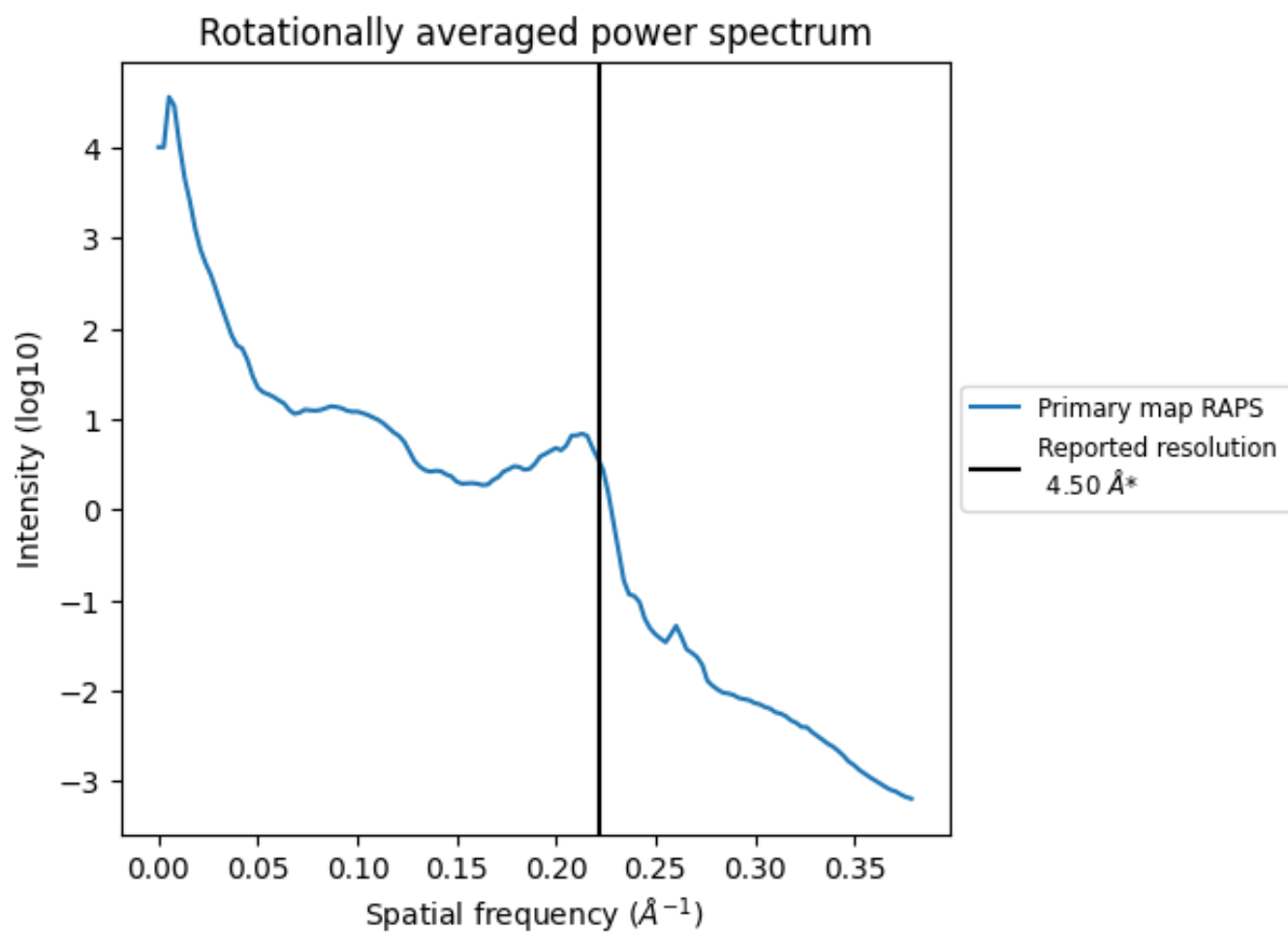
## 7.2 Volume estimate [i](#)



The volume at the recommended contour level is 119  $\text{nm}^3$ ; this corresponds to an approximate mass of 108 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](#)

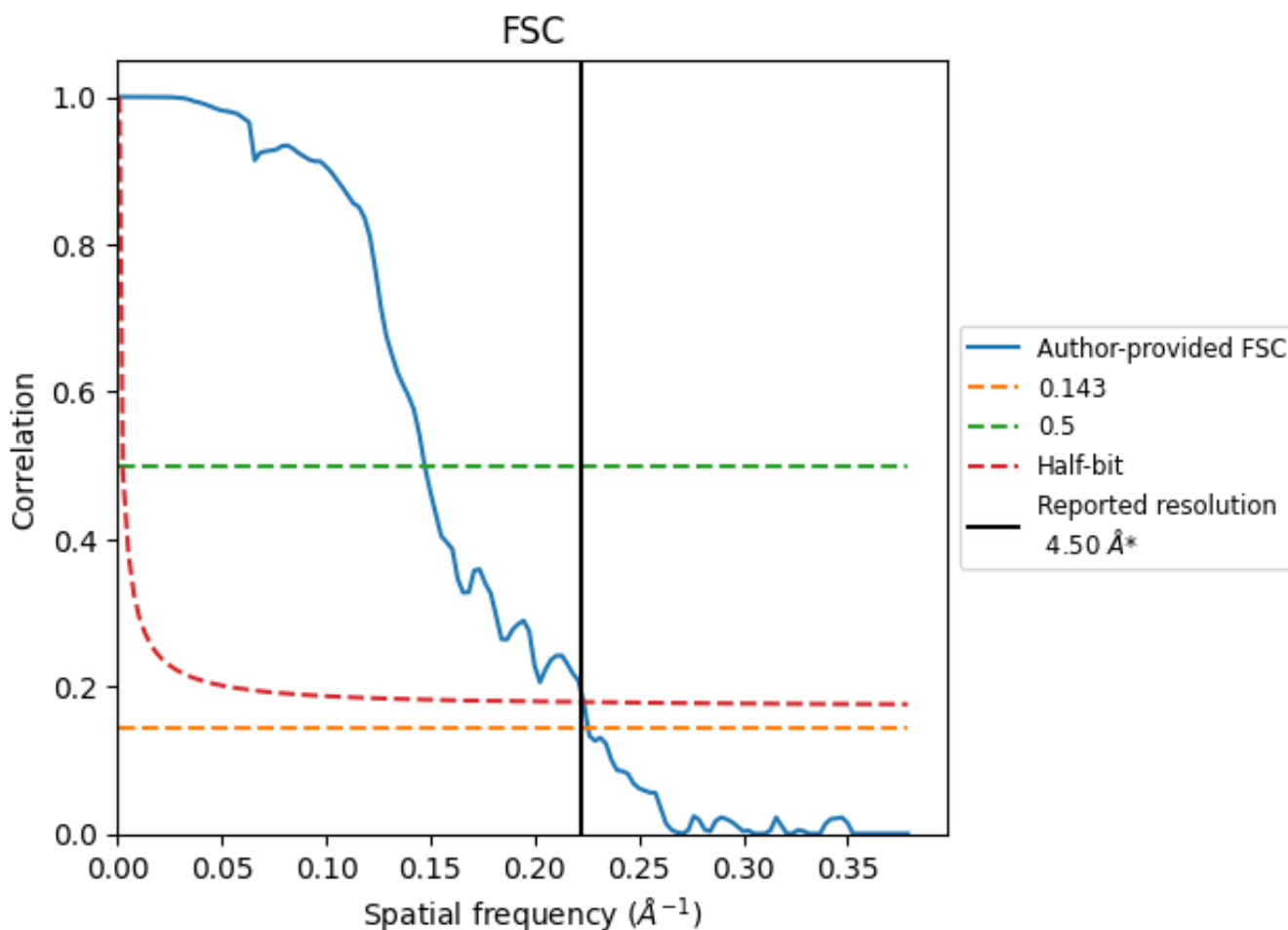


\*Reported resolution corresponds to spatial frequency of  $0.222 \text{\AA}^{-1}$

## 8 Fourier-Shell correlation [i](#)

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 [i](#)



\*Reported resolution corresponds to spatial frequency of 0.222 Å<sup>-1</sup>

## 8.2 Resolution estimates [i](#)

Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	4.50	-	-
Author-provided FSC curve	4.43	6.79	4.48
Unmasked-calculated*	-	-	-

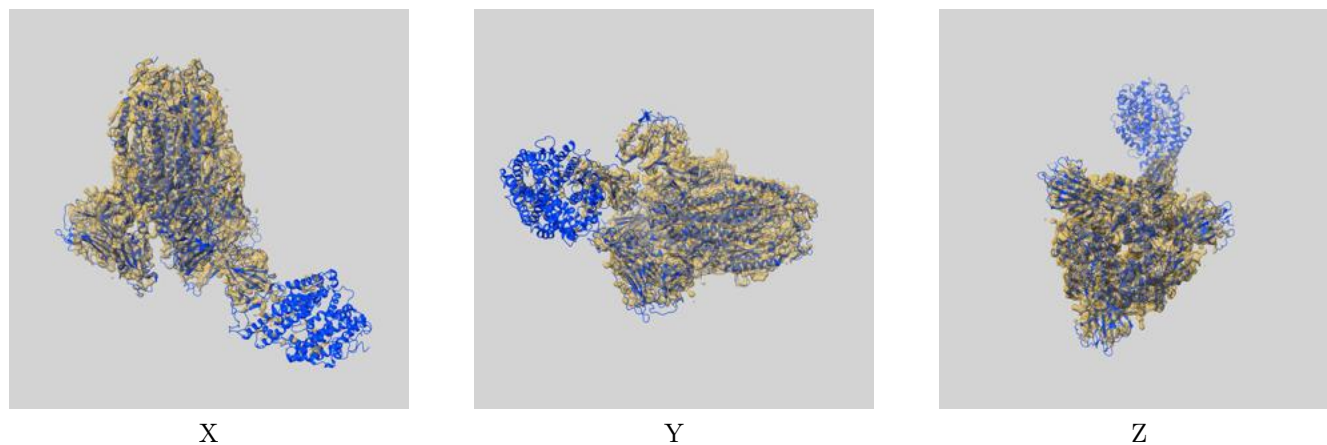
\*Resolution estimate based on FSC curve calculated by comparison of deposited half-maps.



## 9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-9594 and PDB model 6ACK. Per-residue inclusion information can be found in section 3 on page 5.

### 9.1 Map-model overlay [i](#)



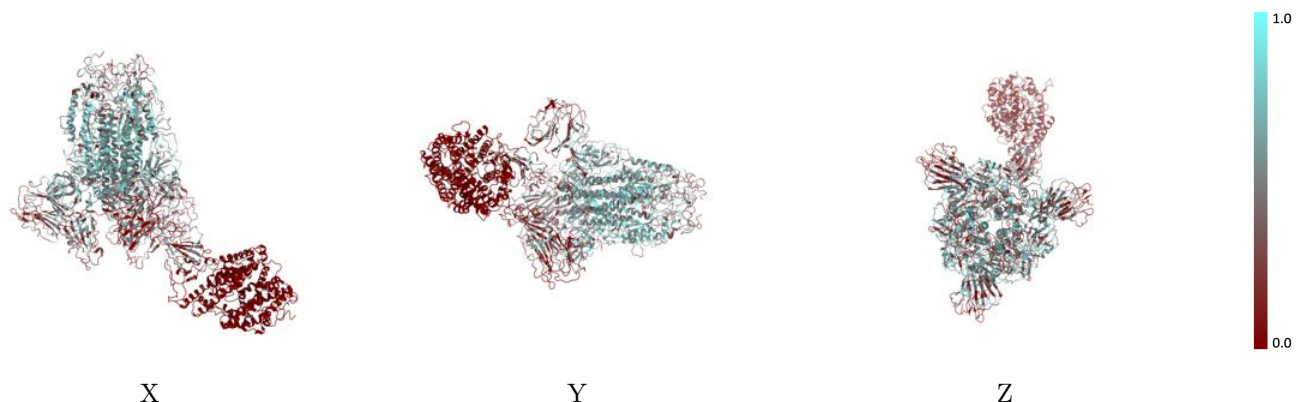
The images above show the 3D surface view of the map at the recommended contour level 8.0 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



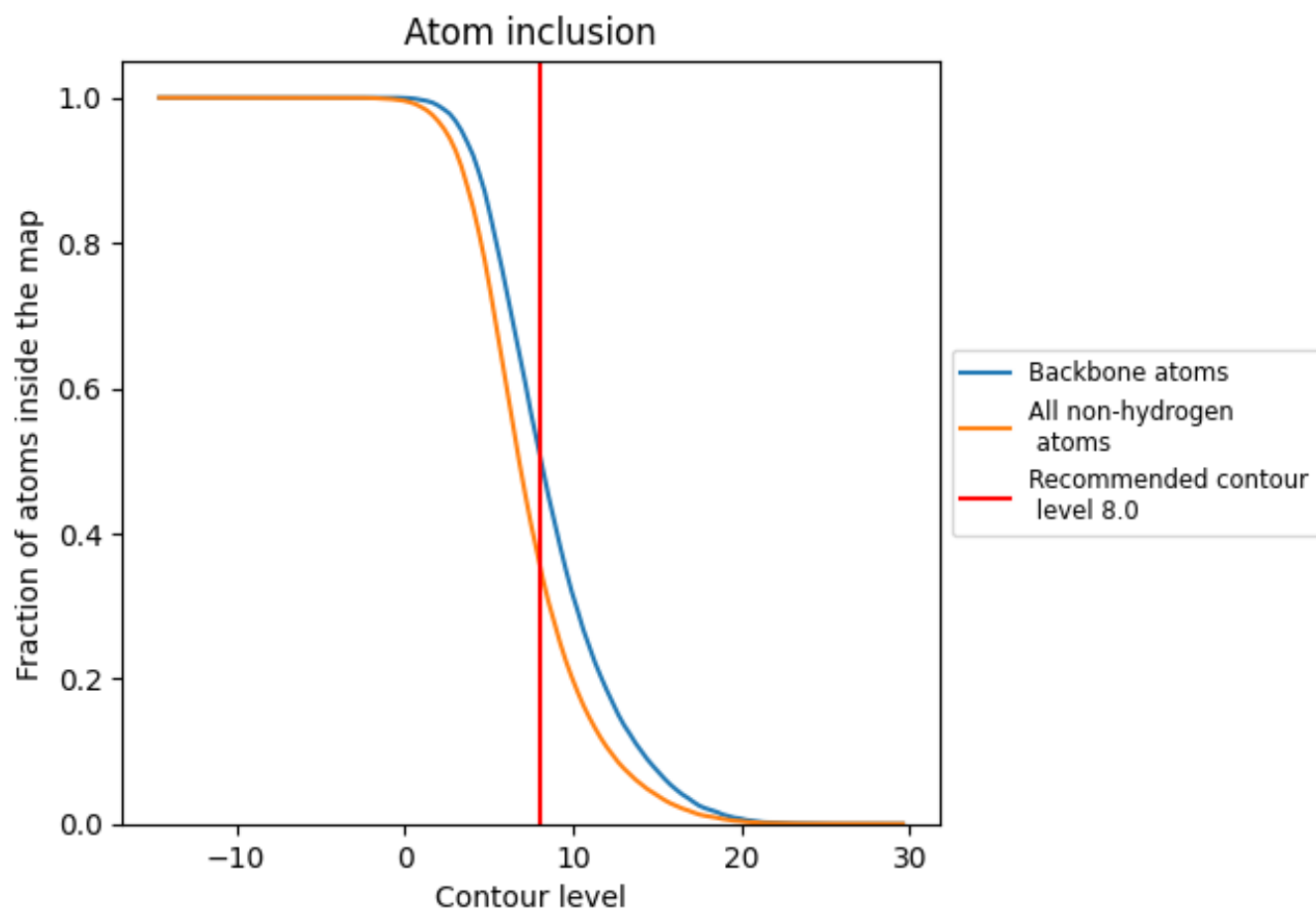
The images above show the model with each residue coloured according its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (8.0).











## 9.4 Atom inclusion [i](#)



At the recommended contour level, 51% of all backbone atoms, 36% 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 (8.0) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	 0.3592	 0.2390
A	 0.4339	 0.2750
B	 0.4372	 0.2630
C	 0.4106	 0.2560
D	 0.0115	 0.1050

