



## Full wwPDB EM Validation Report ⓘ

Dec 23, 2020 – 08:56 AM JST

PDB ID : 7C8D  
EMDB ID : EMD-30305  
Title : Cryo-EM structure of cat ACE2 and SARS-CoV-2 RBD  
Authors : Gao, G.F.; Wang, Q.H.; Wu, L.L.  
Deposited on : 2020-05-29  
Resolution : 3.00 Å (reported)

This is a Full wwPDB EM Validation 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.

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

EMDB validation analysis : 0.0.0.dev61  
MolProbity : 4.02b-467  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.16

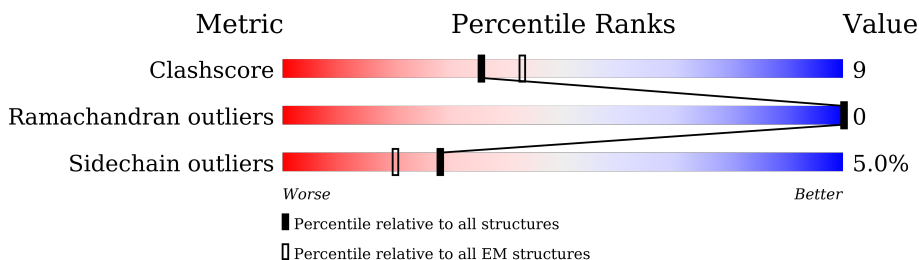
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 3.00 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	732	
2	B	195	

## 2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6359 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 Angiotensin-converting enzyme 2.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	597	4815	3085	801	901	28	0	0

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	17	MET	-	initiating methionine	UNP Q56H28
A	741	HIS	-	expression tag	UNP Q56H28
A	742	HIS	-	expression tag	UNP Q56H28
A	743	HIS	-	expression tag	UNP Q56H28
A	744	HIS	-	expression tag	UNP Q56H28
A	745	HIS	-	expression tag	UNP Q56H28
A	746	HIS	-	expression tag	UNP Q56H28
A	747	HIS	-	expression tag	UNP Q56H28
A	748	HIS	-	expression tag	UNP Q56H28

- Molecule 2 is a protein called Spike protein S1.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	B	195	1543	989	257	289	8	0	0

- Molecule 3 is ZINC ION (three-letter code: ZN) (formula: Zn) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		AltConf
3	A	1	Total	Zn	0
			1	1	





## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	195370	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	50, 50	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	Not provided	
Image detector	GATAN K3 BIOQUANTUM (6k x 4k), GATAN K3 BIOQUANTUM (6k x 4k)	Depositor
Maximum map value	0.154	Depositor
Minimum map value	-0.087	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.005	Depositor
Recommended contour level	0.026	Depositor
Map size (Å)	178.875, 178.875, 178.875	wwPDB
Map dimensions	180, 180, 180	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	0.99375, 0.99375, 0.99375	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:  
ZN

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	0.25	0/4952	0.40	0/6728
2	B	0.29	0/1587	0.46	0/2161
All	All	0.26	0/6539	0.41	0/8889

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	A	4815	0	4584	73	0
2	B	1543	0	1460	39	0
3	A	1	0	0	0	0
All	All	6359	0	6044	106	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 9.

All (106) 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:B:379:CYS:HA	2:B:432:CYS:HB3	1.66	0.76
1:A:177:ARG:NH2	1:A:495:GLU:O	2.20	0.74
1:A:95:ARG:NH2	1:A:209:GLU:OE1	2.25	0.70
1:A:245:ARG:NH2	1:A:260:GLY:O	2.25	0.70
2:B:386:LYS:H	2:B:386:LYS:HD2	1.58	0.69
1:A:245:ARG:NH1	1:A:603:PHE:O	2.26	0.69
1:A:457:GLU:HG2	1:A:513:ILE:HB	1.76	0.68
1:A:344:CYS:HA	1:A:359:LYS:HE3	1.77	0.67
1:A:460:ARG:NH2	1:A:510:TYR:O	2.28	0.65
1:A:133:CYS:HB3	1:A:141:CYS:HA	1.77	0.64
1:A:88:ILE:HD13	1:A:97:LEU:HD13	1.80	0.64
1:A:201:ASP:OD1	1:A:219:ARG:NE	2.33	0.62
1:A:30:GLU:OE1	2:B:417:LYS:NZ	2.29	0.61
2:B:454:ARG:NH2	2:B:467:ASP:O	2.32	0.61
1:A:41:TYR:OH	2:B:500:THR:OG1	2.19	0.61
2:B:349:SER:HB3	2:B:452:LEU:H	1.66	0.60
1:A:294:THR:HG23	1:A:365:THR:HA	1.84	0.60
1:A:152:MET:O	1:A:161:ARG:NH2	2.33	0.60
2:B:501:ASN:O	2:B:506:GLN:NE2	2.30	0.60
1:A:131:LYS:HG2	1:A:143:LEU:HG	1.83	0.60
2:B:364:ASP:N	2:B:364:ASP:OD1	2.35	0.59
1:A:252:TYR:HB3	1:A:255:ARG:HB2	1.85	0.59
1:A:574:VAL:HG23	1:A:576:GLU:H	1.67	0.59
1:A:42:GLN:OE1	2:B:498:GLN:NE2	2.36	0.58
1:A:177:ARG:NH1	1:A:470:LYS:O	2.36	0.58
1:A:595:LEU:O	1:A:599:ASN:ND2	2.37	0.57
2:B:462:LYS:HB2	2:B:465:GLU:HB2	1.88	0.56
1:A:353:LYS:HB3	2:B:505:TYR:CG	2.41	0.56
1:A:402:GLU:HB3	1:A:518:ARG:HG3	1.89	0.55
1:A:490:PRO:HA	1:A:612:PRO:HG2	1.89	0.55
2:B:391:CYS:HB3	2:B:522:ALA:HB1	1.89	0.54
1:A:108:LEU:HD11	1:A:190:MET:HB2	1.90	0.53
1:A:208:GLU:HB2	1:A:219:ARG:HG2	1.90	0.53
2:B:367:VAL:O	2:B:371:SER:OG	2.24	0.53
2:B:392:PHE:N	2:B:524:VAL:O	2.34	0.53
1:A:356:PHE:HB3	1:A:379:ILE:HD12	1.91	0.53
1:A:351:LEU:HB2	1:A:355:ASP:HB3	1.89	0.52
1:A:414:THR:HG22	1:A:416:ASN:H	1.73	0.52
2:B:408:ARG:NH2	2:B:414:GLN:OE1	2.41	0.52
2:B:379:CYS:CA	2:B:432:CYS:HB3	2.30	0.52
2:B:385:THR:OG1	2:B:386:LYS:N	2.43	0.52
2:B:443:SER:HB3	2:B:507:PRO:HG3	1.92	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:439:ASN:ND2	2:B:499:PRO:O	2.42	0.51
1:A:450:LEU:HD21	1:A:519:THR:HB	1.92	0.51
2:B:418:ILE:HA	2:B:422:ASN:HB2	1.94	0.50
1:A:357:ARG:HH12	2:B:500:THR:HG21	1.75	0.50
1:A:184:VAL:HG22	1:A:464:PHE:HE1	1.75	0.50
1:A:417:HIS:HB2	1:A:543:ASP:OD2	2.11	0.50
1:A:133:CYS:HB3	1:A:141:CYS:CA	2.30	0.50
1:A:368:ASP:HA	1:A:371:THR:HG22	1.93	0.50
1:A:455:MET:HE3	1:A:480:MET:HB2	1.94	0.50
1:A:48:TRP:CZ3	1:A:359:LYS:HB2	2.47	0.50
1:A:303:ASP:N	1:A:303:ASP:OD1	2.44	0.50
2:B:411:ALA:HB3	2:B:414:GLN:HG3	1.94	0.50
2:B:493:GLN:NE2	2:B:494:SER:O	2.45	0.50
1:A:404:VAL:O	1:A:408:MET:HG2	2.12	0.49
1:A:529:LEU:HD11	1:A:554:LEU:HD13	1.93	0.49
1:A:355:ASP:OD2	2:B:500:THR:OG1	2.30	0.49
1:A:48:TRP:HZ3	1:A:359:LYS:HB2	1.77	0.49
1:A:381:TYR:HD1	1:A:401:HIS:HA	1.79	0.48
1:A:400:PHE:O	1:A:404:VAL:HG23	2.14	0.48
1:A:524:GLN:HB3	1:A:574:VAL:HG11	1.95	0.48
1:A:153:GLU:OE1	1:A:154:ASN:ND2	2.47	0.48
2:B:405:ASP:OD1	2:B:405:ASP:N	2.45	0.48
1:A:132:ALA:HB3	1:A:148:LEU:HD11	1.96	0.47
2:B:350:VAL:HG22	2:B:422:ASN:HB3	1.96	0.47
1:A:385:TYR:OH	1:A:401:HIS:NE2	2.37	0.46
1:A:292:ASP:OD1	1:A:294:THR:OG1	2.31	0.46
2:B:398:ASP:HB2	2:B:512:VAL:HG13	1.97	0.46
1:A:493:HIS:ND1	1:A:499:ASP:OD2	2.40	0.46
1:A:248:LEU:HD11	1:A:278:LEU:HD21	1.97	0.46
2:B:475:ALA:HB3	2:B:487:ASN:HB3	1.98	0.46
1:A:293:VAL:HG22	1:A:366:MET:HG3	1.99	0.45
1:A:562:LYS:HE2	1:A:562:LYS:HB2	1.64	0.45
2:B:376:THR:HB	2:B:435:ALA:HB3	1.97	0.45
1:A:37:GLU:OE1	1:A:393:ARG:NH1	2.49	0.45
1:A:315:PHE:HD2	1:A:320:LEU:HD12	1.82	0.45
2:B:350:VAL:O	2:B:353:TRP:HD1	2.00	0.45
2:B:385:THR:OG1	2:B:386:LYS:HD2	2.17	0.45
2:B:334:ASN:HB2	2:B:362:VAL:HG12	1.99	0.45
2:B:358:ILE:HB	2:B:395:VAL:HG13	1.99	0.45
1:A:526:GLN:O	1:A:530:CYS:N	2.46	0.44
2:B:454:ARG:NH1	2:B:491:PRO:HB2	2.33	0.44

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:29:LEU:HD11	1:A:97:LEU:HG	1.99	0.44
2:B:503:VAL:HA	2:B:506:GLN:HB2	1.99	0.44
1:A:144:LEU:O	1:A:149:ASP:N	2.48	0.44
1:A:381:TYR:CD1	1:A:401:HIS:HA	2.52	0.43
2:B:394:ASN:HB2	2:B:516:GLU:OE1	2.17	0.43
1:A:423:LEU:HA	1:A:423:LEU:HD12	1.79	0.43
2:B:517:LEU:HA	2:B:517:LEU:HD23	1.77	0.43
1:A:237:TYR:OH	1:A:485:VAL:O	2.16	0.43
2:B:401:VAL:HG22	2:B:509:ARG:HG2	2.01	0.43
1:A:532:ILE:O	1:A:534:LYS:NZ	2.51	0.43
2:B:351:TYR:HB3	2:B:453:TYR:HA	1.99	0.43
1:A:160:GLU:HA	1:A:163:TRP:CD1	2.53	0.42
1:A:577:LYS:HB2	1:A:577:LYS:HE3	1.83	0.42
1:A:482:ARG:HD3	1:A:488:VAL:HG23	2.00	0.42
1:A:25:ALA:HB1	1:A:97:LEU:HD11	2.01	0.42
1:A:477:TRP:CZ3	1:A:500:PRO:HB3	2.55	0.42
1:A:147:GLY:O	1:A:151:ILE:HG12	2.20	0.41
1:A:365:THR:OG1	1:A:366:MET:N	2.53	0.41
1:A:318:VAL:O	1:A:551:GLY:HA3	2.20	0.41
1:A:441:LYS:O	1:A:445:THR:HG22	2.20	0.41
1:A:435:GLU:HB3	1:A:540:HIS:NE2	2.36	0.41
1:A:534:LYS:HE2	1:A:534:LYS:HB2	1.81	0.40
1:A:232:GLN:HB2	1:A:581:VAL:HG11	2.03	0.40

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	595/732 (81%)	579 (97%)	16 (3%)	0	100	100
2	B	193/195 (99%)	181 (94%)	12 (6%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
All	All	788/927 (85%)	760 (96%)	28 (4%)	0	100	100

There are no Ramachandran outliers to report.

### 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	510/652 (78%)	485 (95%)	25 (5%)	25	61
2	B	168/168 (100%)	159 (95%)	9 (5%)	22	57
All	All	678/820 (83%)	644 (95%)	34 (5%)	28	60

All (34) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	43	SER
1	A	106	SER
1	A	109	SER
1	A	128	SER
1	A	133	CYS
1	A	142	LEU
1	A	149	ASP
1	A	166	GLU
1	A	183	TYR
1	A	257	SER
1	A	261	CYS
1	A	287	GLN
1	A	317	SER
1	A	334	THR
1	A	349	TRP
1	A	365	THR
1	A	368	ASP
1	A	371	THR
1	A	381	TYR
1	A	401	HIS

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Mol	Chain	Res	Type
1	A	455	MET
1	A	512	PHE
1	A	555	LEU
1	A	572	HIS
1	A	578	LYS
2	B	336	CYS
2	B	338	PHE
2	B	351	TYR
2	B	377	PHE
2	B	385	THR
2	B	432	CYS
2	B	481	ASN
2	B	486	PHE
2	B	503	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	63	ASN
1	A	98	GLN
1	A	175	GLN
1	A	216	ASN
1	A	239	HIS
1	A	290	ASN
1	A	416	ASN
2	B	360	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

Of 1 ligands modelled in this entry, 1 is monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 5.7 Other polymers

There are no such residues in this entry.

## 5.8 Polymer linkage issues

There are no chain breaks in this entry.

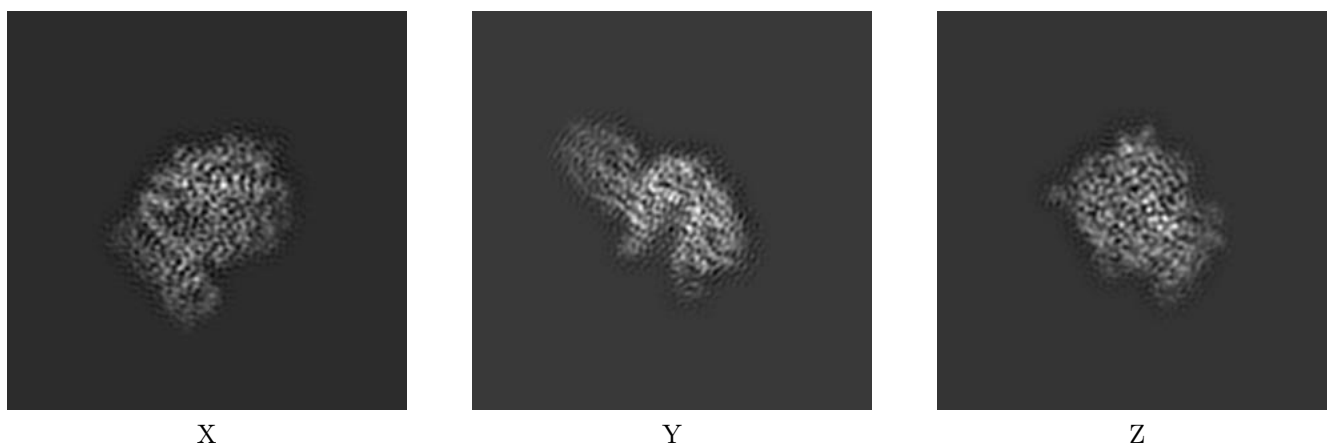
## 6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-30305. 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](#)

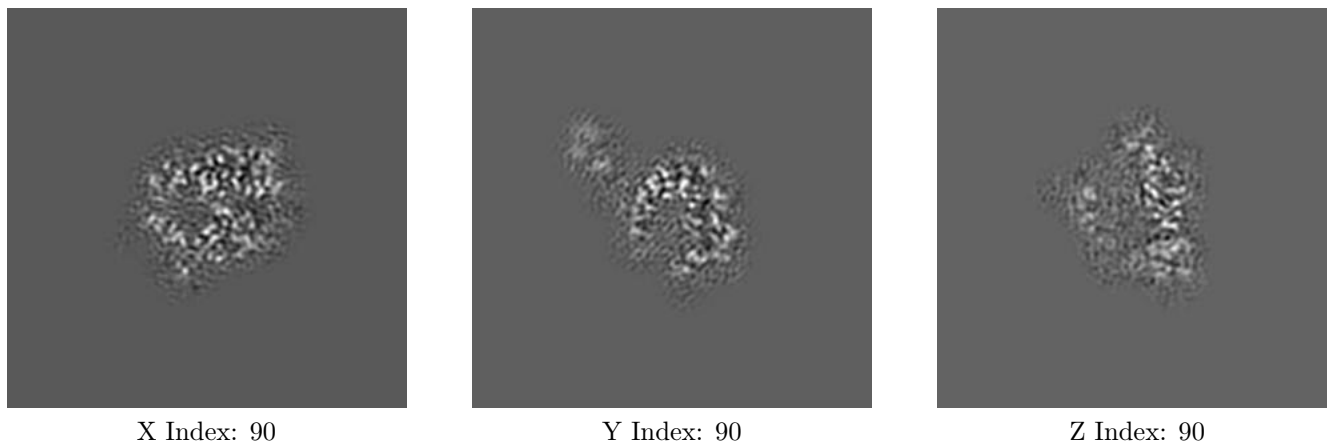
#### 6.1.1 Primary map



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

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

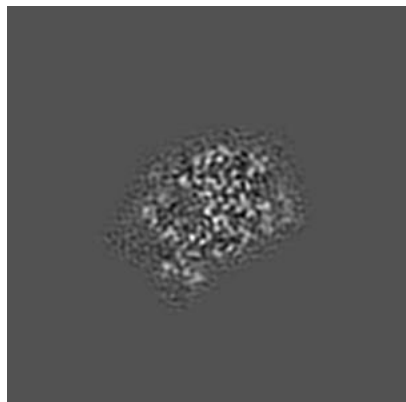
#### 6.2.1 Primary map



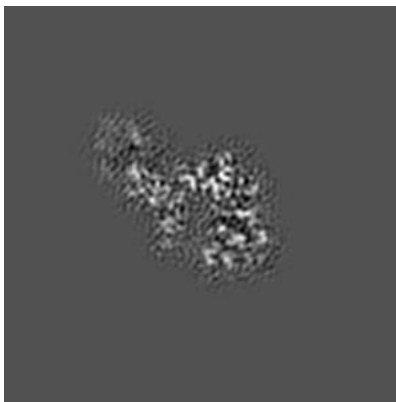
The images above show central slices of the map in three orthogonal directions.

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

### 6.3.1 Primary map



X Index: 95



Y Index: 86

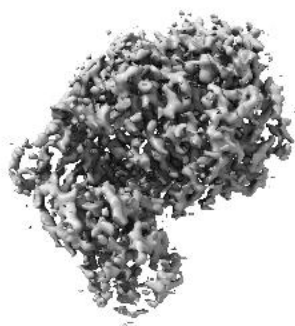


Z Index: 101

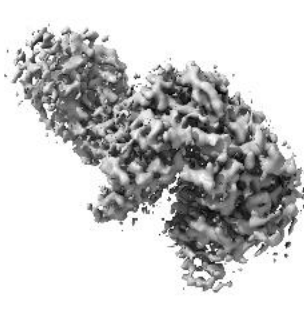
The images above show the largest variance slices of the map in three orthogonal directions.

## 6.4 Orthogonal surface views [i](#)

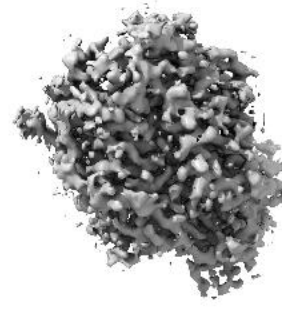
### 6.4.1 Primary map



X



Y



Z

The images above show the 3D surface view of the map at the recommended contour level 0.026. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

## 6.5 Mask visualisation

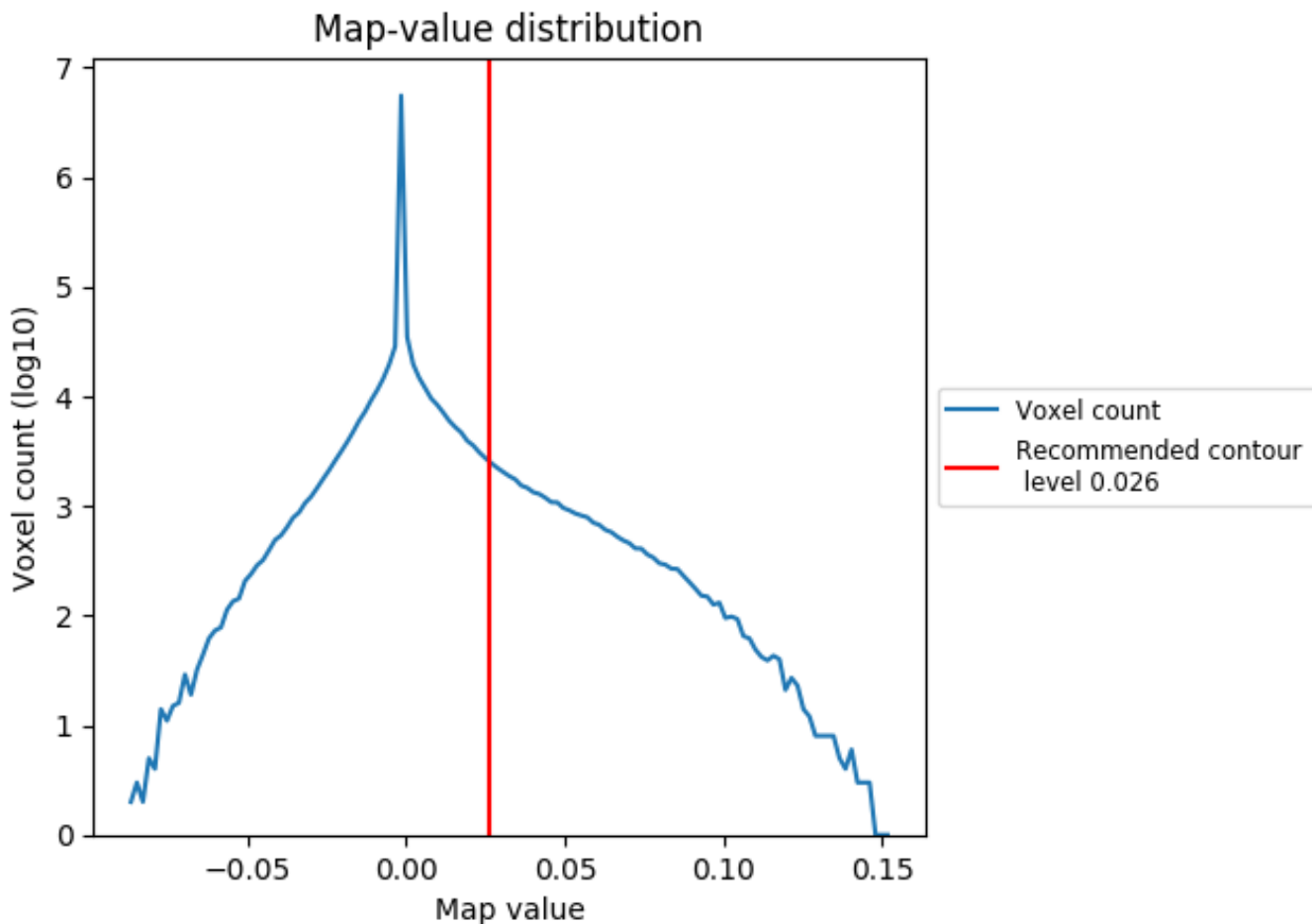
This section was not generated. No masks/segmentation were deposited.



## 7 Map analysis [i](#)

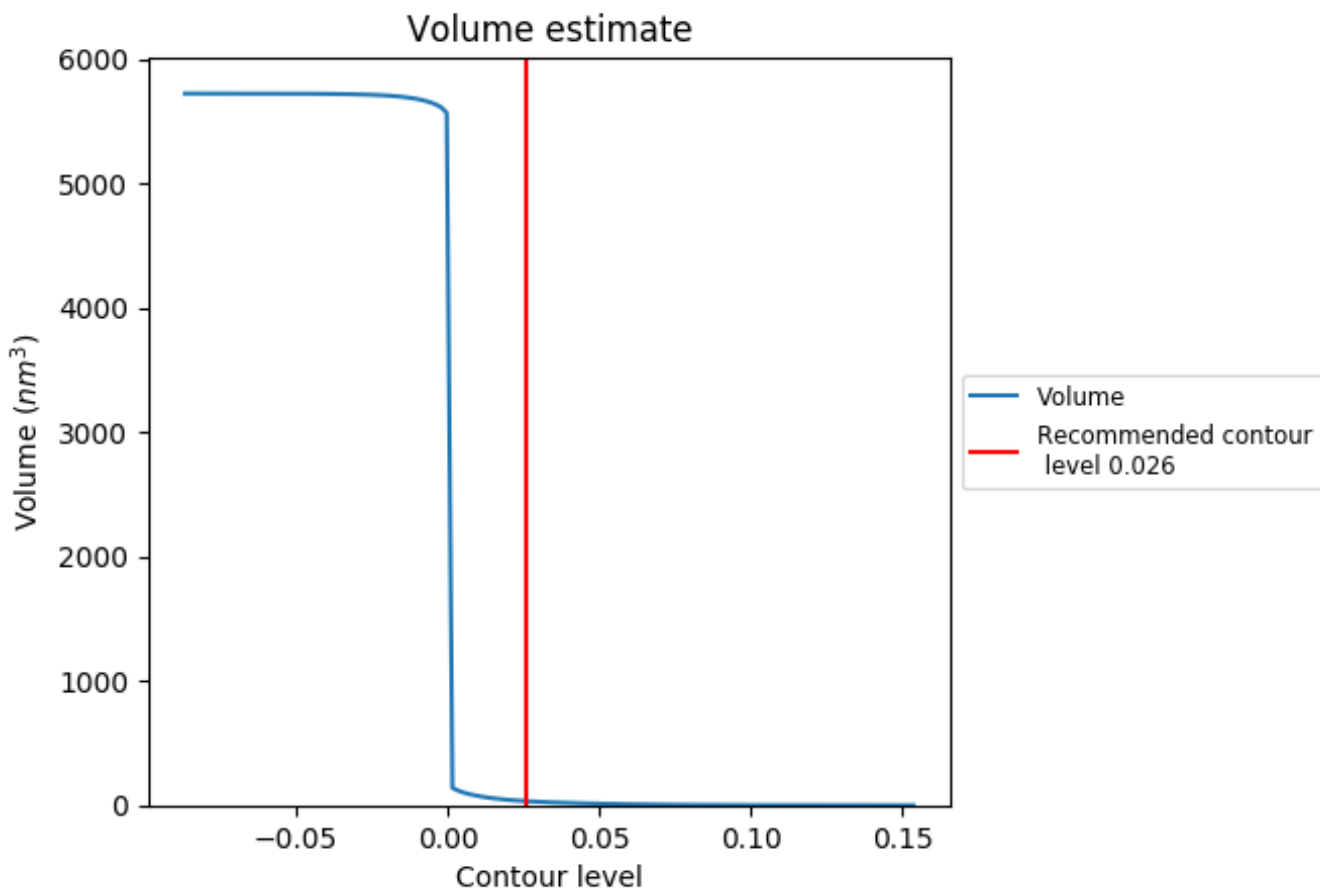
This section contains the results of statistical analysis of the map.

### 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.

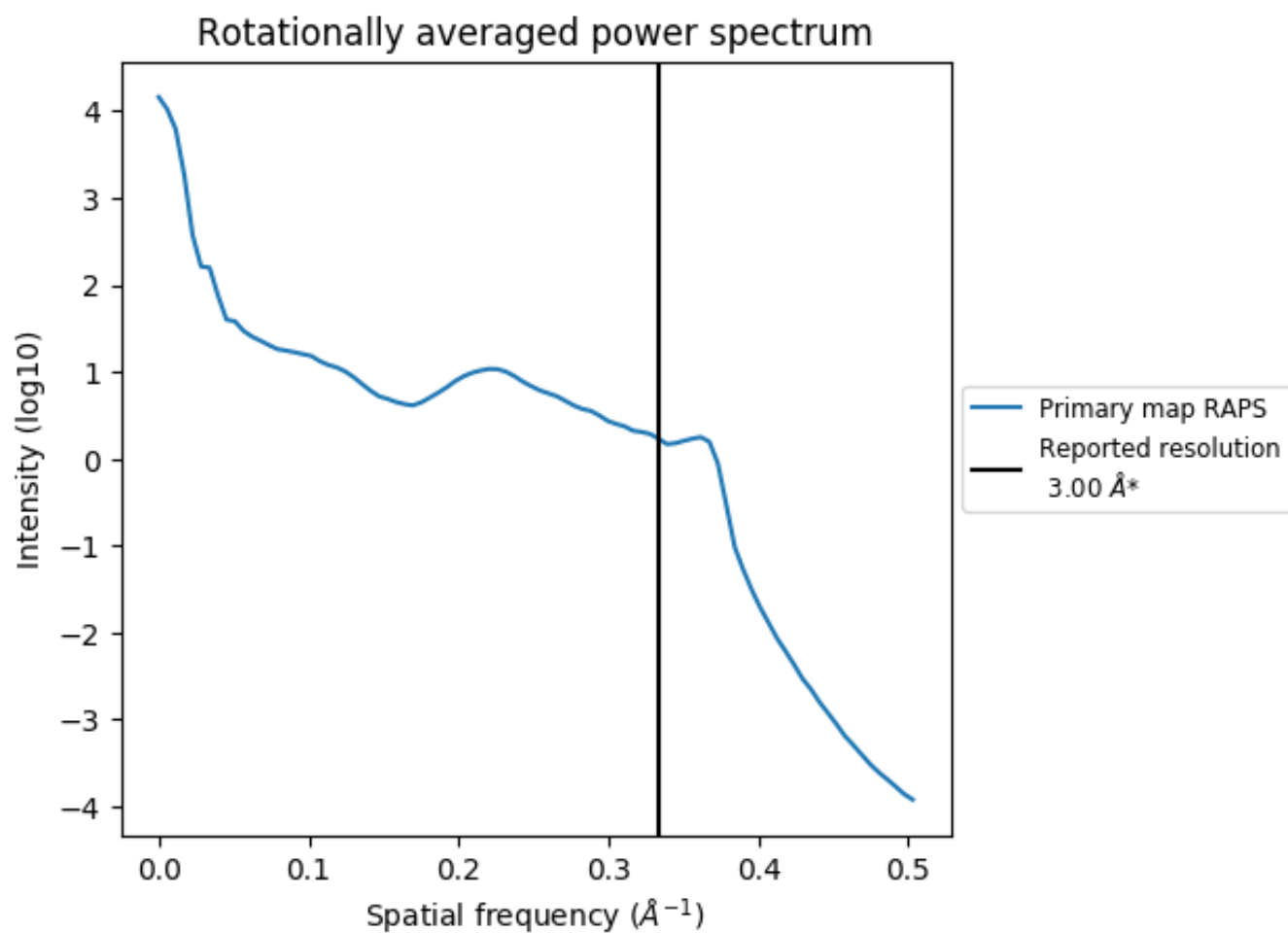
## 7.2 Volume estimate [\(i\)](#)



The volume at the recommended contour level is 33 nm<sup>3</sup>; this corresponds to an approximate mass of 30 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](#)

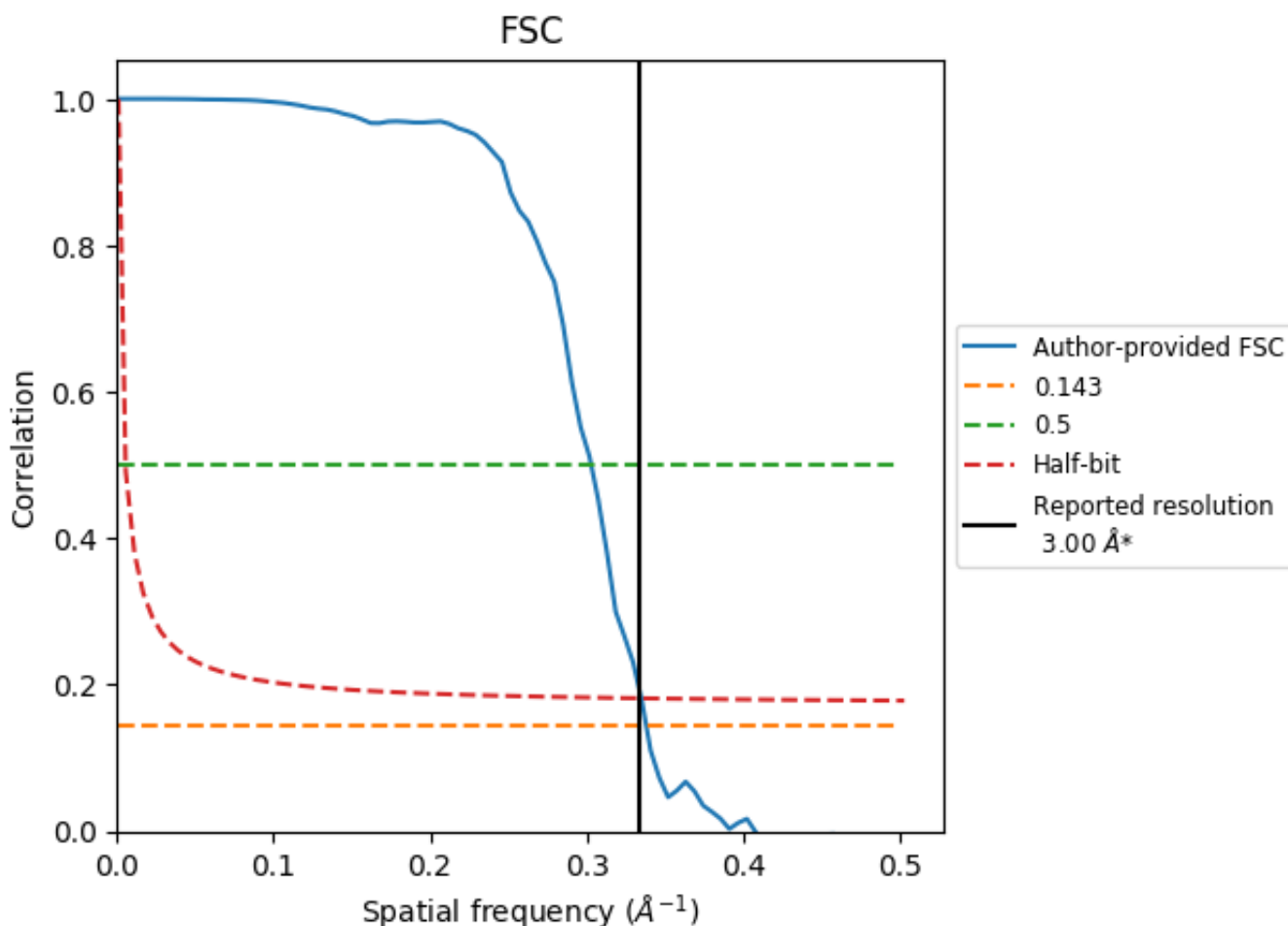


\*Reported resolution corresponds to spatial frequency of 0.333 Å<sup>-1</sup>

## 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 0.333 Å<sup>-1</sup>

## 8.2 Resolution estimates [i](#)

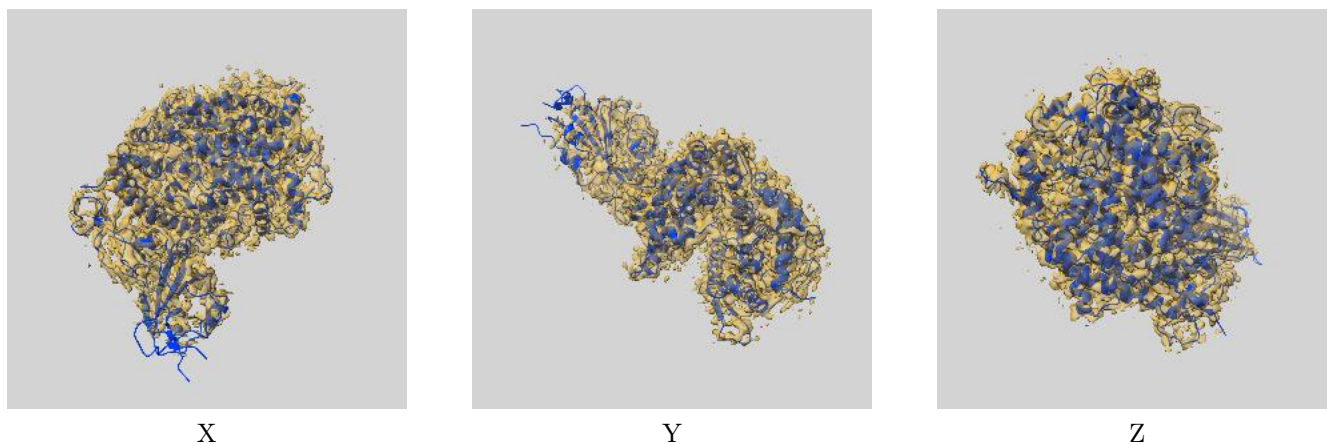
Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	3.00	-	-
Author-provided FSC curve	3.01	3.36	3.03
Calculated*	-	-	-

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

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

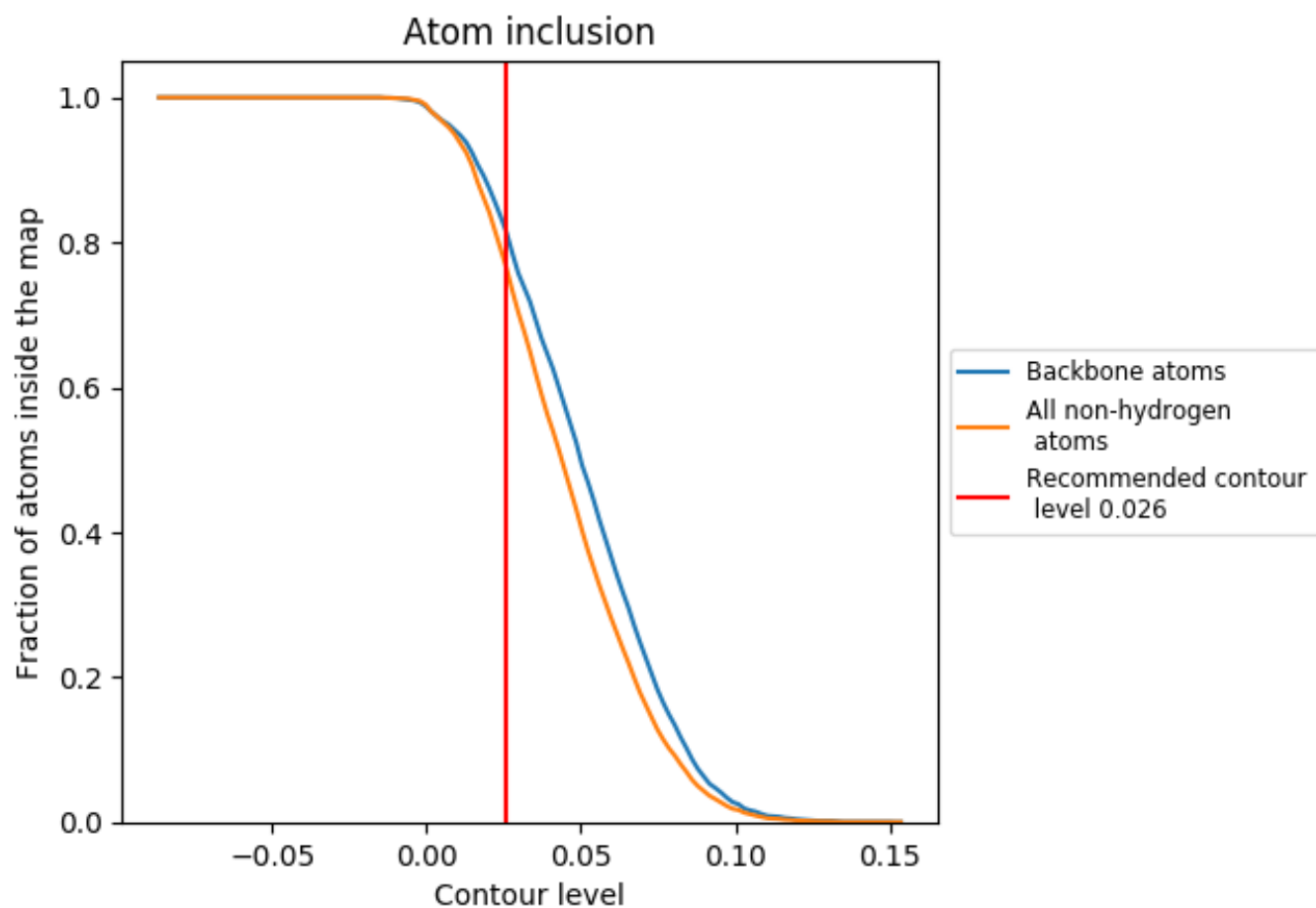
This section contains information regarding the fit between EMDB map EMD-30305 and PDB model 7C8D. Per-residue inclusion information can be found in section 3 on page 4.

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



The images above show the 3D surface view of the map at the recommended contour level 0.026 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 Atom inclusion [i](#)



At the recommended contour level, 81% of all backbone atoms, 76% of all non-hydrogen atoms, are inside the map.