



wwPDB EM Validation Summary Report ⓘ

Mar 5, 2026 – 11:46 AM UTC

PDB ID : 8PB9 / pdb_00008pb9
EMDB ID : EMD-17581
Title : Cryo-EM structure of the c-di-GMP-bound FleQ-FleN master regulator complex from *Pseudomonas aeruginosa*
Authors : Torres-Sanchez, L.T.; Krasteva, P.V.
Deposited on : 2023-06-08
Resolution : 3.30 Å(reported)
Based on initial model : .

This is a wwPDB EM Validation Summary Report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at

<https://www.wwpdb.org/validation/2017/EMValidationReportHelp>
with specific help available everywhere you see the ⓘ symbol.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

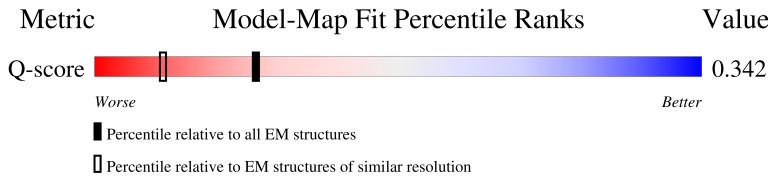
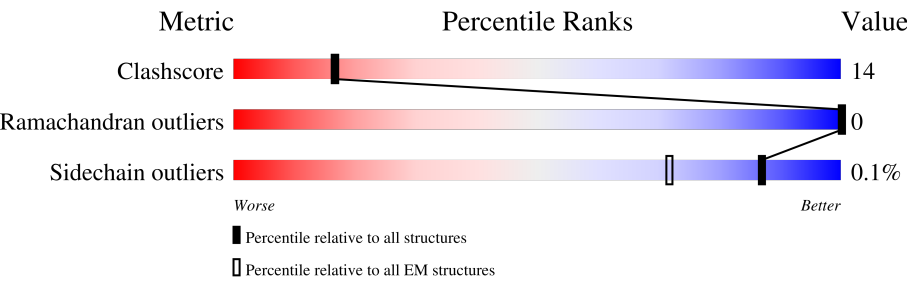
EMDB validation analysis : 0.0.1.dev132
Mogul : 2022.3.0, CSD as543be (2022)
MolProbity : 4-5-2 with Phenix2.0
Buster-report : wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
EM percentile statistics : 202505.v01 (Using data in the EMDB archive up until May 2025)
MapQ : 1.9.13
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.49

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)	Similar EM resolution (#Entries, resolution range(Å))
Clashscore	229148	23984	-
Ramachandran outliers	224038	23583	-
Sidechain outliers	223484	23102	-
Q-score	-	25397	15087 (2.80 - 3.80)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the EM map (all-atom inclusion $< 40\%$). The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	C	396	11% 43% 21% 36%
1	D	396	68% 31%
1	E	396	9% 68% 28%
2	A	284	63% 30% 7%

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Mol	Chain	Length	Quality of chain
2	B	284	 63% 30% 7%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 12265 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 Transcriptional regulator FleQ.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	D	390	Total	C	N	O	S	0	0
			3097	1943	563	576	15		
1	C	252	Total	C	N	O	S	0	0
			1995	1256	367	361	11		
1	E	380	Total	C	N	O	S	0	0
			3013	1896	542	560	15		

There are 9 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
D	-1	MET	-	initiating methionine	UNP G3XCV0
D	0	GLY	-	expression tag	UNP G3XCV0
D	1	SER	-	expression tag	UNP G3XCV0
C	-1	MET	-	initiating methionine	UNP G3XCV0
C	0	GLY	-	expression tag	UNP G3XCV0
C	1	SER	-	expression tag	UNP G3XCV0
E	-1	MET	-	initiating methionine	UNP G3XCV0
E	0	GLY	-	expression tag	UNP G3XCV0
E	1	SER	-	expression tag	UNP G3XCV0

- Molecule 2 is a protein called Antiactivator FleN.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	A	265	Total	C	N	O	S	0	0
			2003	1272	359	365	7		
2	B	265	Total	C	N	O	S	0	0
			2003	1272	359	365	7		

There are 12 discrepancies between the modelled and reference sequences:

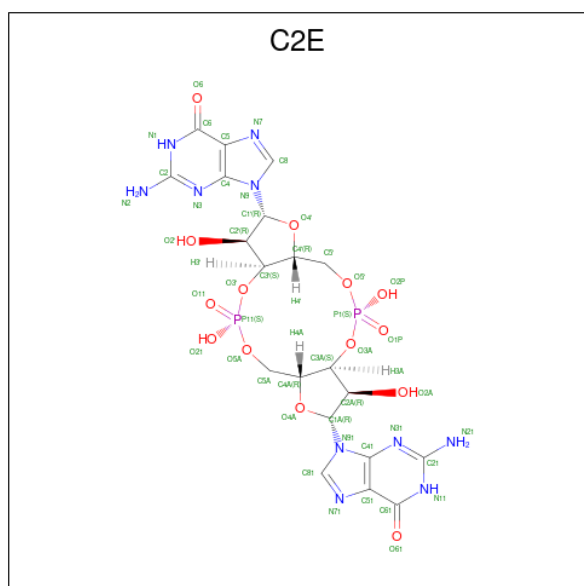
Chain	Residue	Modelled	Actual	Comment	Reference
A	-3	GLY	-	expression tag	UNP G3XD64
A	-2	PRO	-	expression tag	UNP G3XD64

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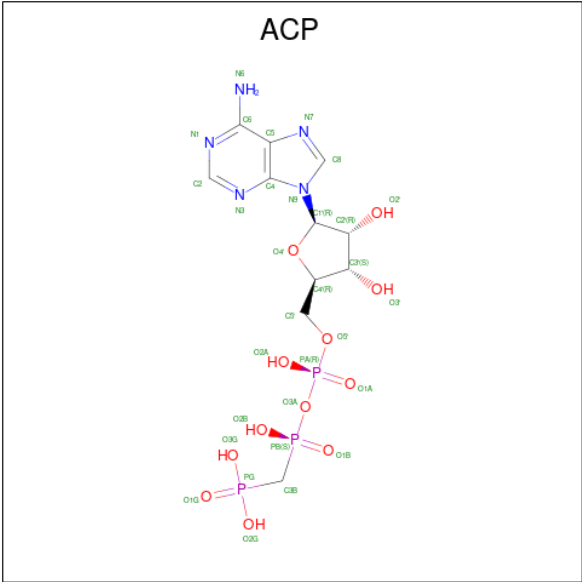
Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	MET	-	expression tag	UNP G3XD64
A	0	GLY	-	expression tag	UNP G3XD64
A	1	SER	-	expression tag	UNP G3XD64
A	48	ALA	ASP	engineered mutation	UNP G3XD64
B	-3	GLY	-	expression tag	UNP G3XD64
B	-2	PRO	-	expression tag	UNP G3XD64
B	-1	MET	-	expression tag	UNP G3XD64
B	0	GLY	-	expression tag	UNP G3XD64
B	1	SER	-	expression tag	UNP G3XD64
B	48	ALA	ASP	engineered mutation	UNP G3XD64

- Molecule 3 is 9,9'-[(2R,3R,3aS,5S,7aR,9R,10R,10aS,12S,14aR)-3,5,10,12-tetrahydroxy-5,12-dioxidoctahydro-2H,7H-difuro[3,2-d:3',2'-j][1,3,7,9,2,8]tetraoxadiphosphacyclododecine-2,9-diyl]bis(2-amino-1,9-dihydro-6H-purin-6-one) (CCD ID: C2E) (formula: C₂₀H₂₄N₁₀O₁₄P₂) (labeled as "Ligand of Interest" by depositor).

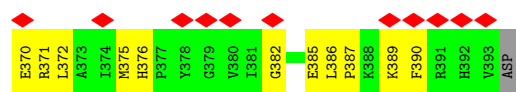


Mol	Chain	Residues	Atoms					AltConf
3	D	1	Total	C	N	O	P	0
			46	20	10	14	2	
3	D	1	Total	C	N	O	P	0
			46	20	10	14	2	

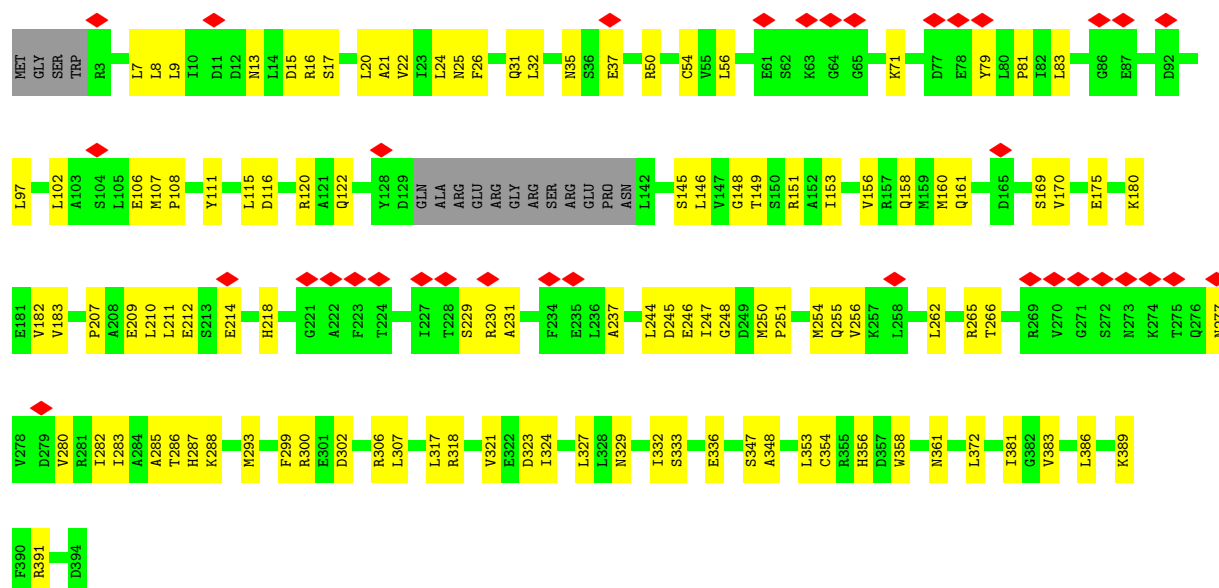
- Molecule 4 is PHOSPHOMETHYLPHOSPHONIC ACID ADENYLATE ESTER (CCD ID: ACP) (formula: C₁₁H₁₈N₅O₁₂P₃) (labeled as "Ligand of Interest" by depositor).



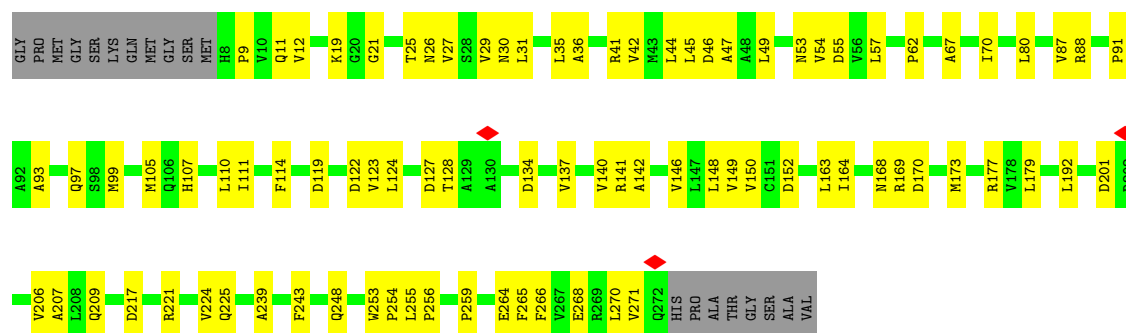
Mol	Chain	Residues	Atoms					AltConf
4	A	1	Total	C	N	O	P	0
			31	11	5	12	3	
4	B	1	Total	C	N	O	P	0
			31	11	5	12	3	



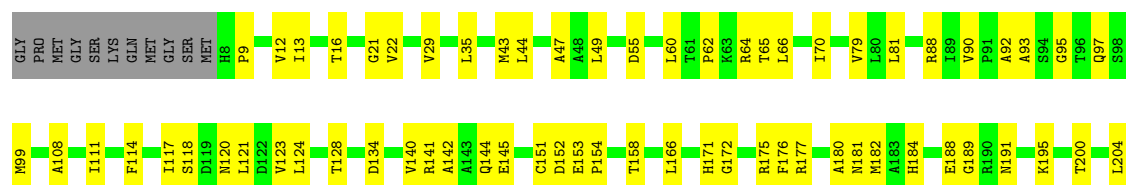
• Molecule 1: Transcriptional regulator FleQ



• Molecule 2: Antiactivator FleN



• Molecule 2: Antiactivator FleN



L208	Q209	Y210	V213	Y216	K249	V250	D251	S252	W253	P254	L255	P256	A257	H262	L263	E264	E268	R269	L270	Q272	V271	HIS	PRO	ALA	THR	GLY	SER	ALA	VAL
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4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	1283732	Depositor
Resolution determination method	OTHER	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION; Gctf through cryoSPARC interface	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/\text{\AA}^2$)	50.3	Depositor
Minimum defocus (nm)	800	Depositor
Maximum defocus (nm)	2000	Depositor
Magnification	Not provided	
Image detector	GATAN K3 BIOQUANTUM (6k x 4k)	Depositor
Maximum map value	1.989	Depositor
Minimum map value	-0.002	Depositor
Average map value	0.001	Depositor
Map value standard deviation	0.025	Depositor
Recommended contour level	0.05	Depositor
Map size ($\text{\AA}$)	283.8, 283.8, 283.8	wwPDB
Map dimensions	200, 200, 200	wwPDB
Map angles ($^\circ$)	90.0, 90.0, 90.0	wwPDB
Pixel spacing ($\text{\AA}$)	1.4189999, 1.4189999, 1.4189999	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: C2E, ACP

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	C	0.11	0/2029	0.32	0/2733
1	D	0.12	0/3150	0.33	0/4253
1	E	0.11	0/3064	0.29	0/4136
2	A	0.13	0/2035	0.34	0/2765
2	B	0.13	0/2035	0.34	0/2765
All	All	0.12	0/12313	0.32	0/16652

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	C	1995	0	2027	61	0
1	D	3097	0	3121	101	0
1	E	3013	0	3037	82	0
2	A	2003	0	2072	65	0
2	B	2003	0	2074	71	0
3	D	92	0	44	3	0
4	A	31	0	14	2	0
4	B	31	0	14	3	0
All	All	12265	0	12403	346	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 14.

The worst 5 of 346 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:E:145:SER:HB3	1:E:182:VAL:HG11	1.68	0.76
1:C:172:ILE:HA	1:C:312:ILE:HB	1.67	0.75
1:D:55:VAL:HG11	1:D:73:LEU:HD21	1.68	0.74
2:A:70:ILE:HD11	2:A:110:LEU:HD12	1.67	0.74
1:D:160:MET:HE1	1:D:183:VAL:HA	1.66	0.74

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	C	250/396 (63%)	234 (94%)	16 (6%)	0	100	100
1	D	388/396 (98%)	369 (95%)	19 (5%)	0	100	100
1	E	376/396 (95%)	364 (97%)	12 (3%)	0	100	100
2	A	263/284 (93%)	248 (94%)	15 (6%)	0	100	100
2	B	263/284 (93%)	256 (97%)	7 (3%)	0	100	100
All	All	1540/1756 (88%)	1471 (96%)	69 (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	C	214/339 (63%)	214 (100%)	0	100	100
1	D	334/339 (98%)	334 (100%)	0	100	100
1	E	325/339 (96%)	324 (100%)	1 (0%)	86	86
2	A	215/228 (94%)	215 (100%)	0	100	100
2	B	215/228 (94%)	215 (100%)	0	100	100
All	All	1303/1473 (88%)	1302 (100%)	1 (0%)	87	90

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	122	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 16 such sidechains are listed below:

Mol	Chain	Res	Type
1	E	122	GLN
1	E	31	GLN
2	B	272	GLN
1	C	361	ASN
2	B	30	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry

4 ligands 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$
3	C2E	D	402	-	52,52,52	0.39	0	78,82,82	0.48	0
4	ACP	A	301	-	31,33,33	0.77	1 (3%)	47,52,52	0.74	2 (4%)
3	C2E	D	401	-	52,52,52	0.39	0	78,82,82	0.43	0
4	ACP	B	301	-	31,33,33	0.74	1 (3%)	47,52,52	0.62	0

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
3	C2E	D	402	-	-	0/30/62/62	0/6/7/7
4	ACP	A	301	-	-	4/19/38/38	0/3/3/3
3	C2E	D	401	-	-	0/30/62/62	0/6/7/7
4	ACP	B	301	-	-	4/19/38/38	0/3/3/3

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	301	ACP	PB-O2B	-2.29	1.50	1.56
4	A	301	ACP	PB-O2B	-2.06	1.51	1.56

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	301	ACP	PB-O3A-PA	2.73	141.28	132.37
4	A	301	ACP	O1G-PG-C3B	-2.01	106.98	111.37

There are no chirality outliers.

5 of 8 torsion outliers are listed below:

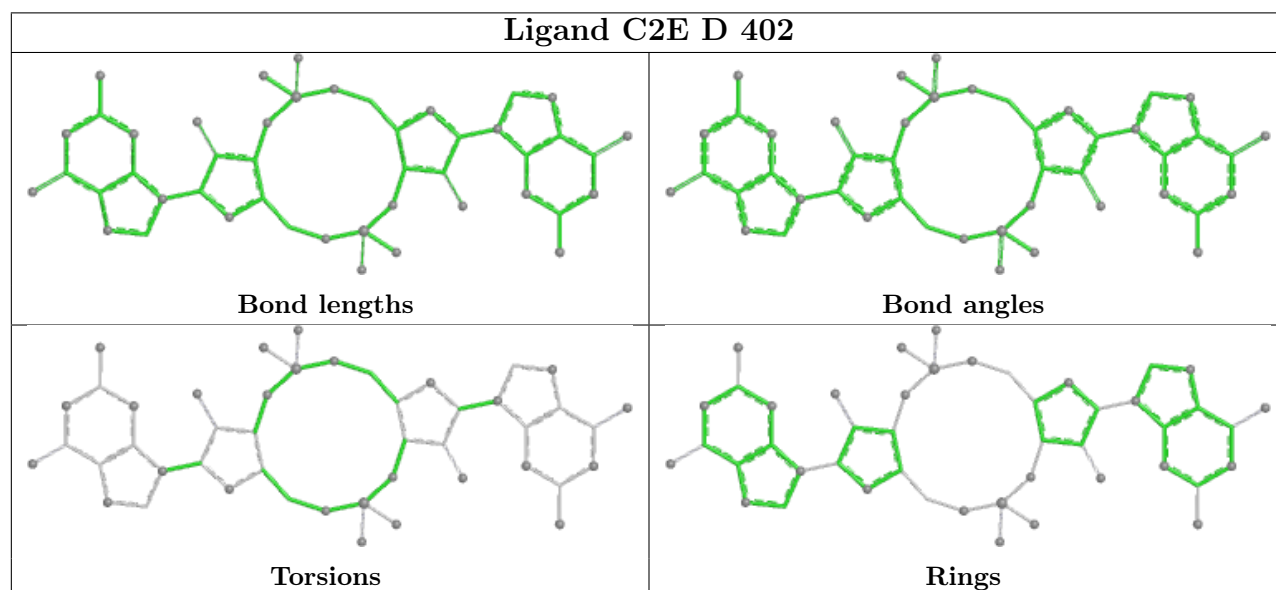
Mol	Chain	Res	Type	Atoms
4	B	301	ACP	PG-C3B-PB-O1B
4	B	301	ACP	PG-C3B-PB-O2B
4	B	301	ACP	PG-C3B-PB-O3A
4	A	301	ACP	PB-O3A-PA-O5'
4	A	301	ACP	PG-C3B-PB-O2B

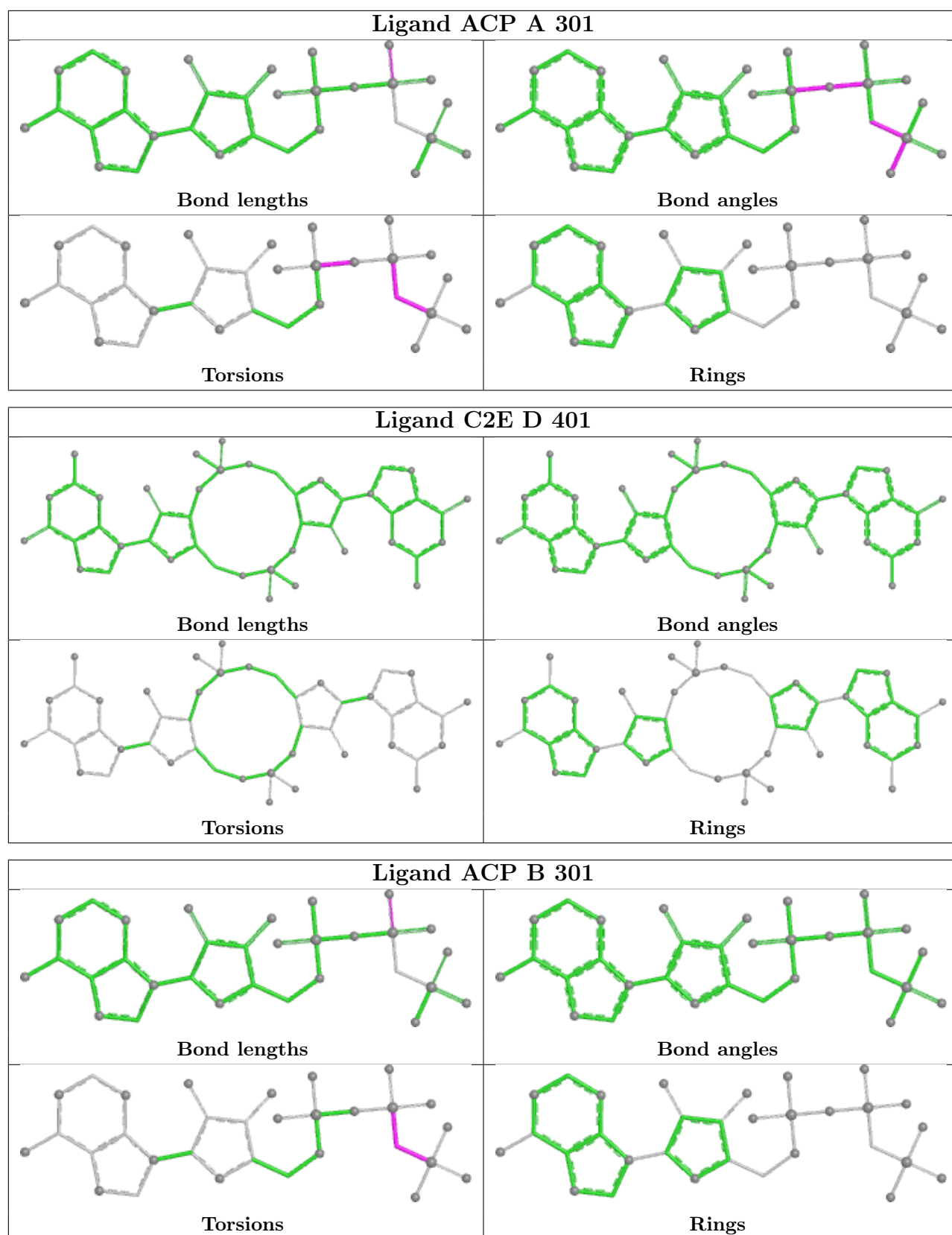
There are no ring outliers.

4 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	D	402	C2E	1	0
4	A	301	ACP	2	0
3	D	401	C2E	2	0
4	B	301	ACP	3	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less than 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.





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-17581. These allow visual inspection of the internal detail of the map and identification of artifacts.

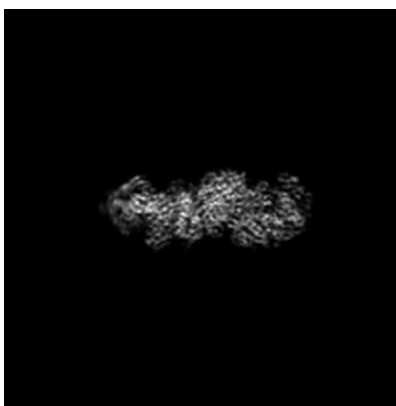
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

6.1 Orthogonal projections [i](#)

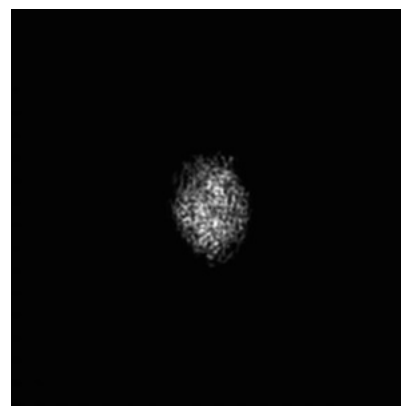
6.1.1 Primary map



X

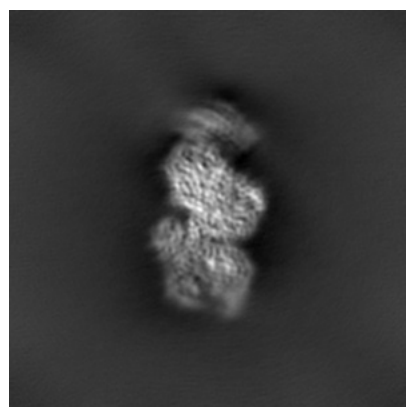


Y

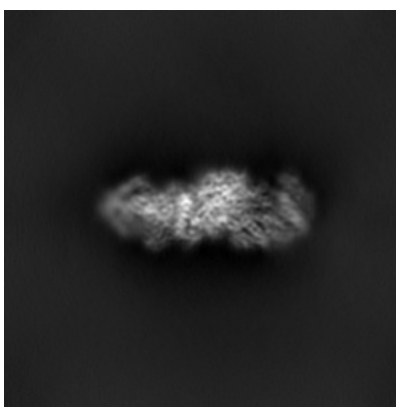


Z

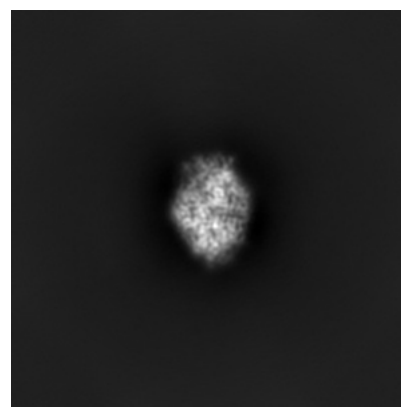
6.1.2 Raw map



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: 100

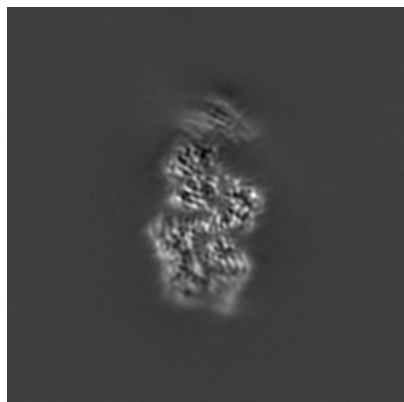


Y Index: 100

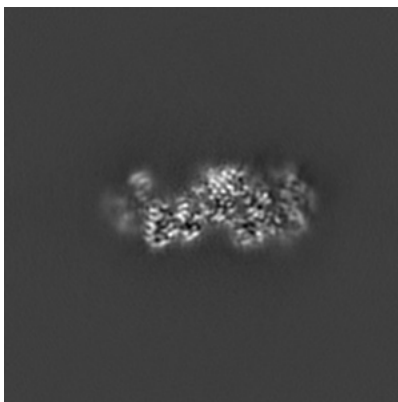


Z Index: 100

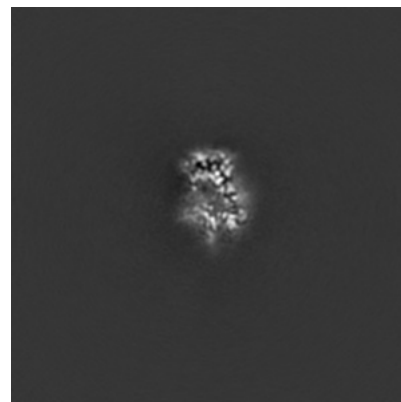
6.2.2 Raw map



X Index: 100



Y Index: 100



Z Index: 100

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

6.3 Largest variance slices [i](#)

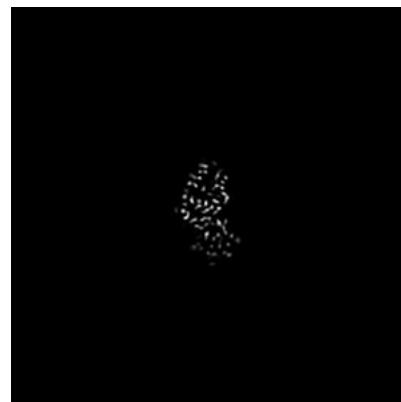
6.3.1 Primary map



X Index: 102

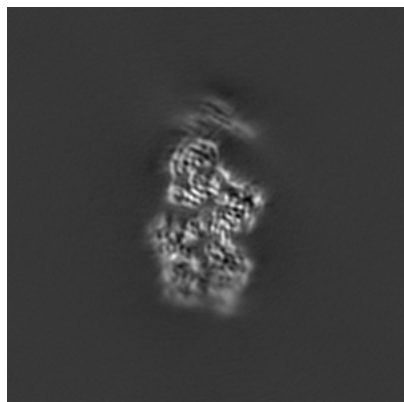


Y Index: 94

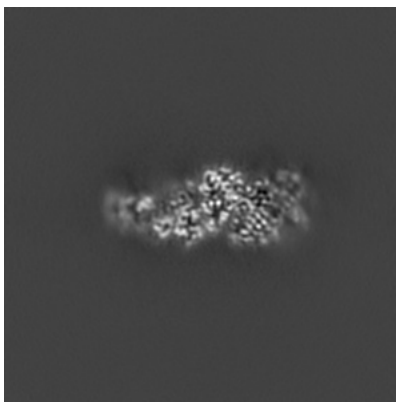


Z Index: 89

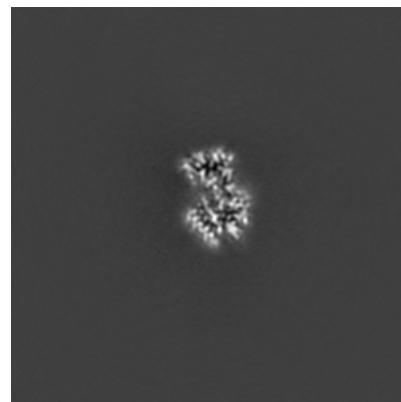
6.3.2 Raw map



X Index: 102



Y Index: 94

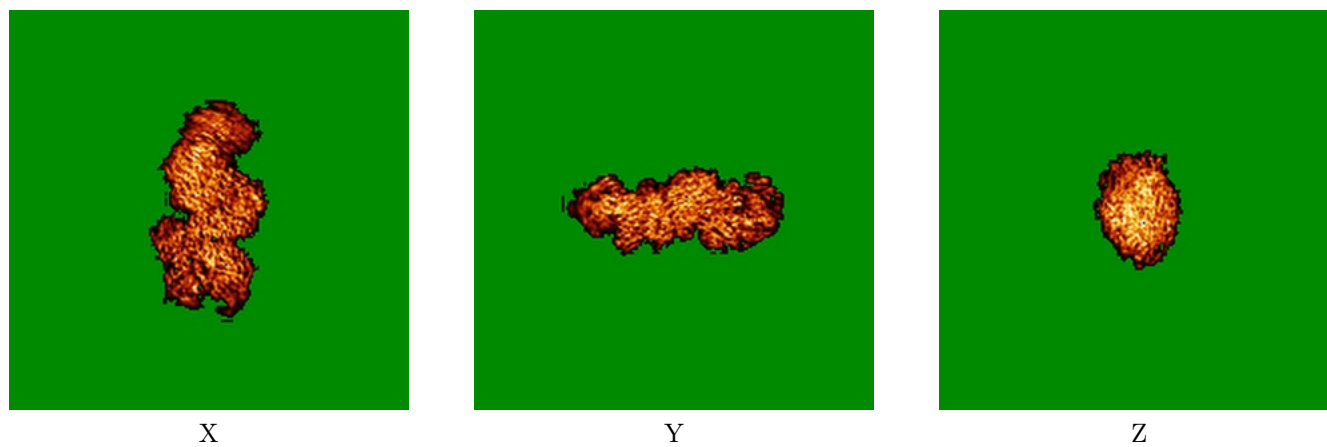


Z Index: 103

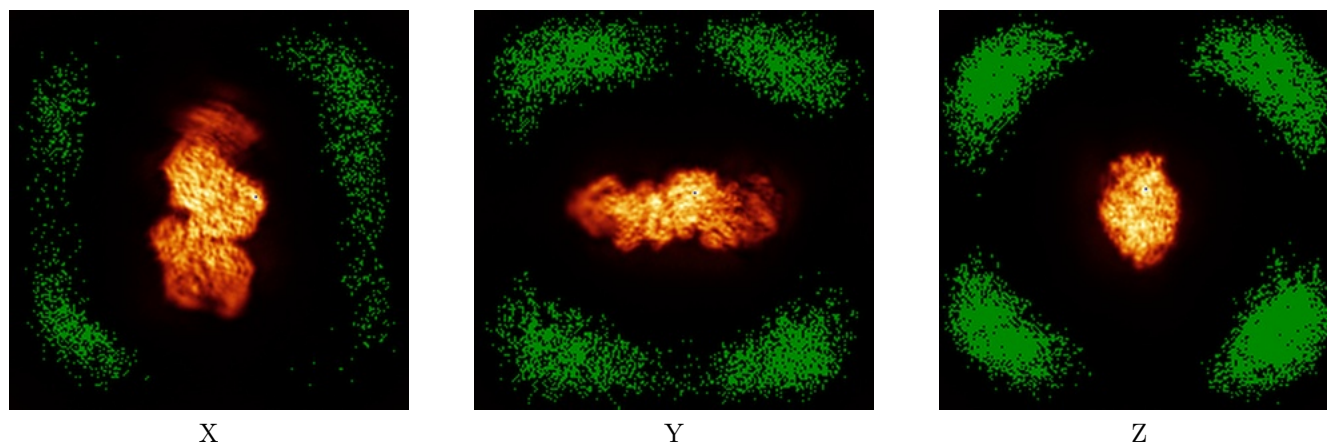
The images above show the largest variance slices of the map in three orthogonal directions.

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

6.4.1 Primary map



6.4.2 Raw map



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](#)

This section was not generated.

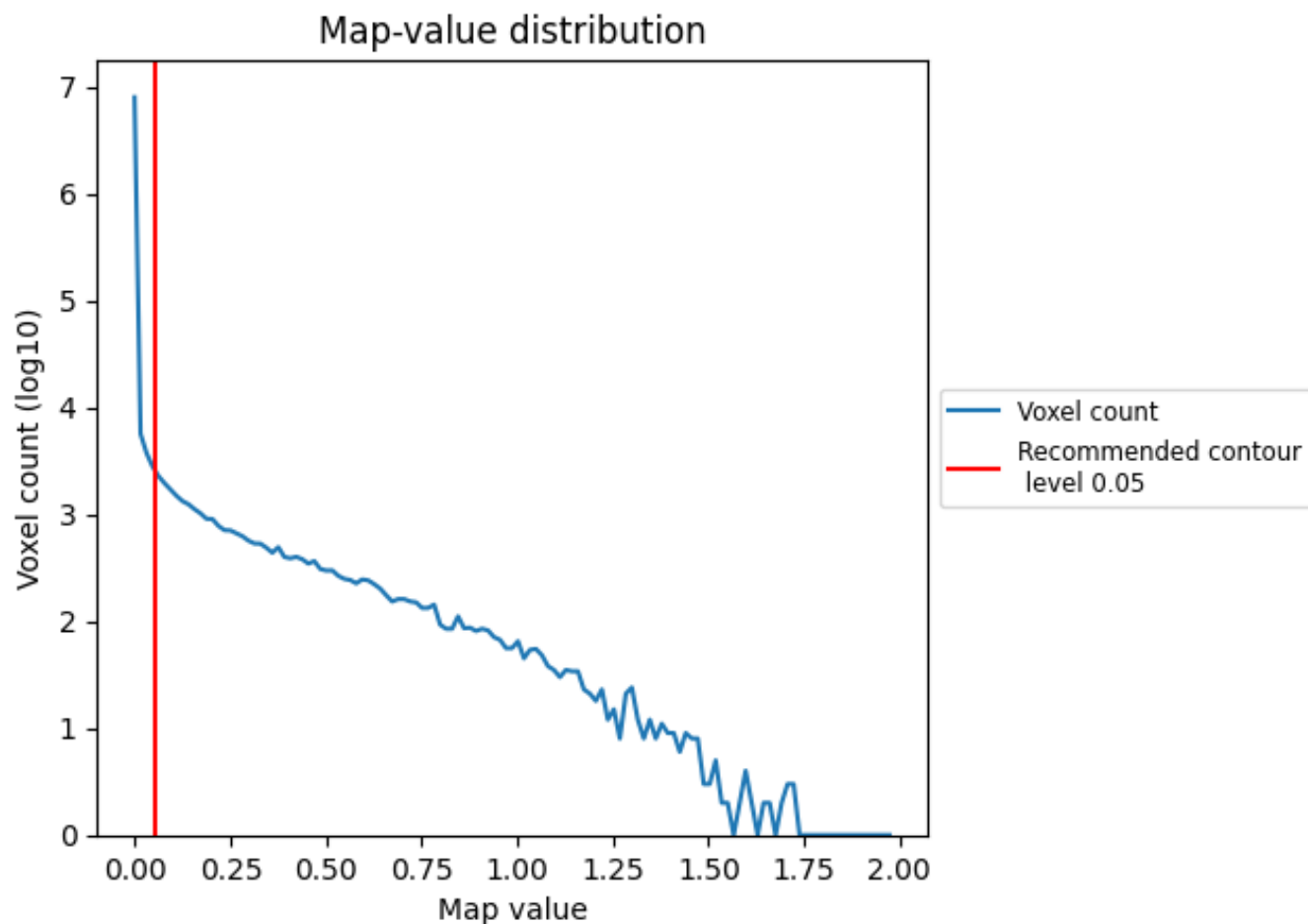
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

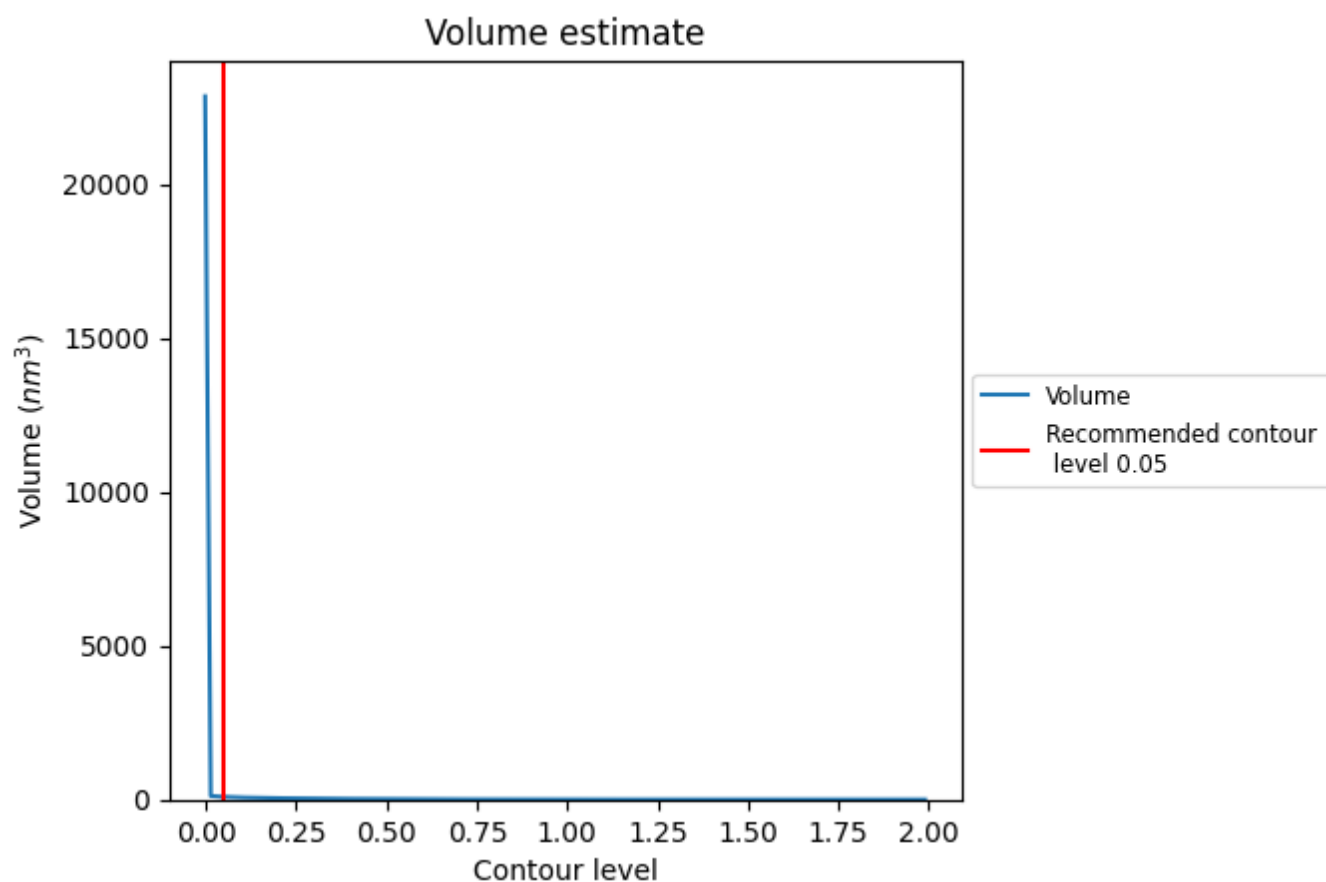
This section contains the results of statistical analysis of the map.

7.1 Map-value distribution [i](#)



The map-value distribution is plotted in 128 intervals along the x-axis. The y-axis is logarithmic. A spike in this graph at zero usually indicates that the volume has been masked.

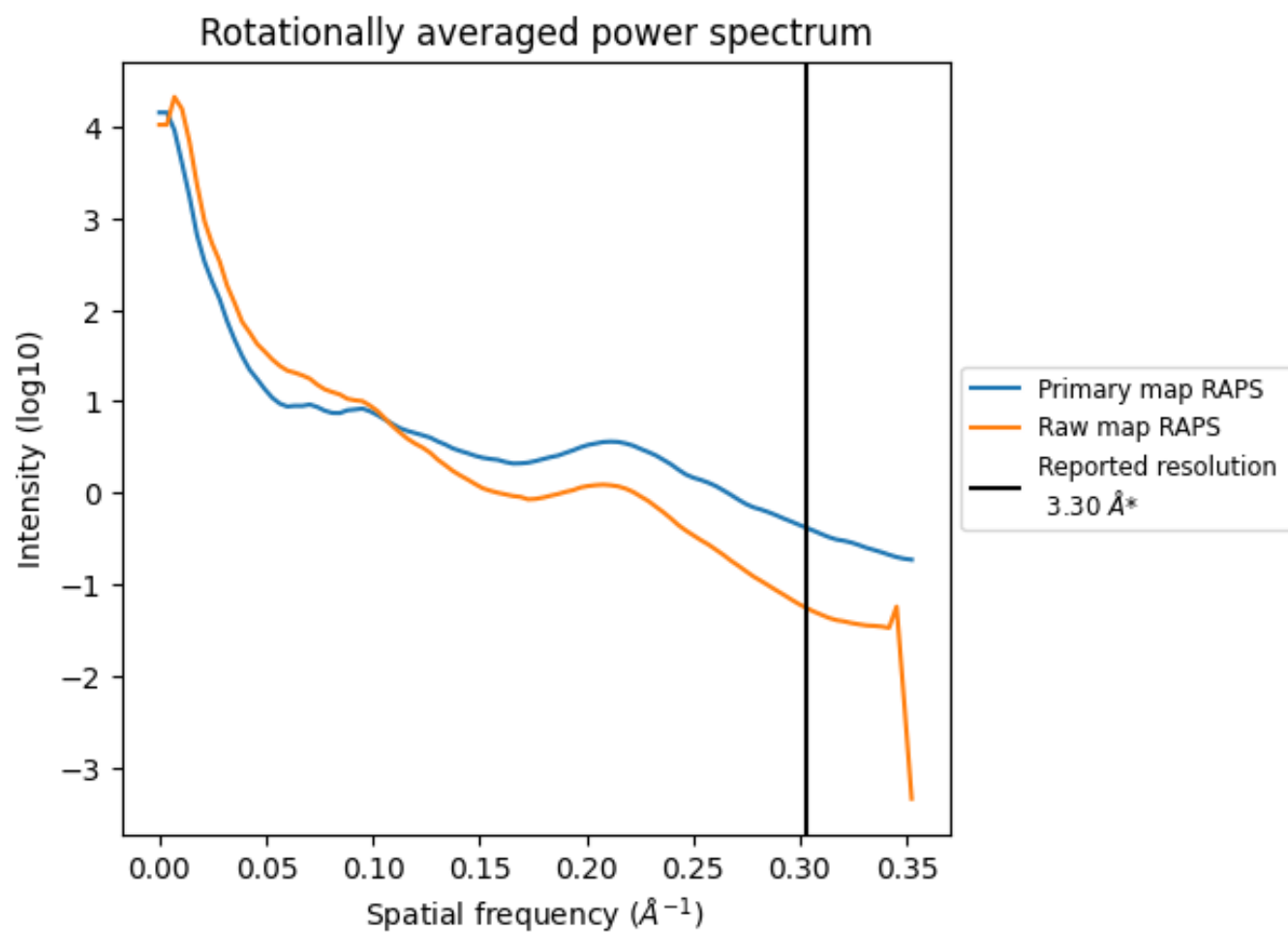
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 88 nm^3 ; this corresponds to an approximate mass of 79 kDa.

The volume estimate graph shows how the enclosed volume varies with the contour level. The recommended contour level is shown as a vertical line and the intersection between the line and the curve gives the volume of the enclosed surface at the given level.

7.3 Rotationally averaged power spectrum ⓘ

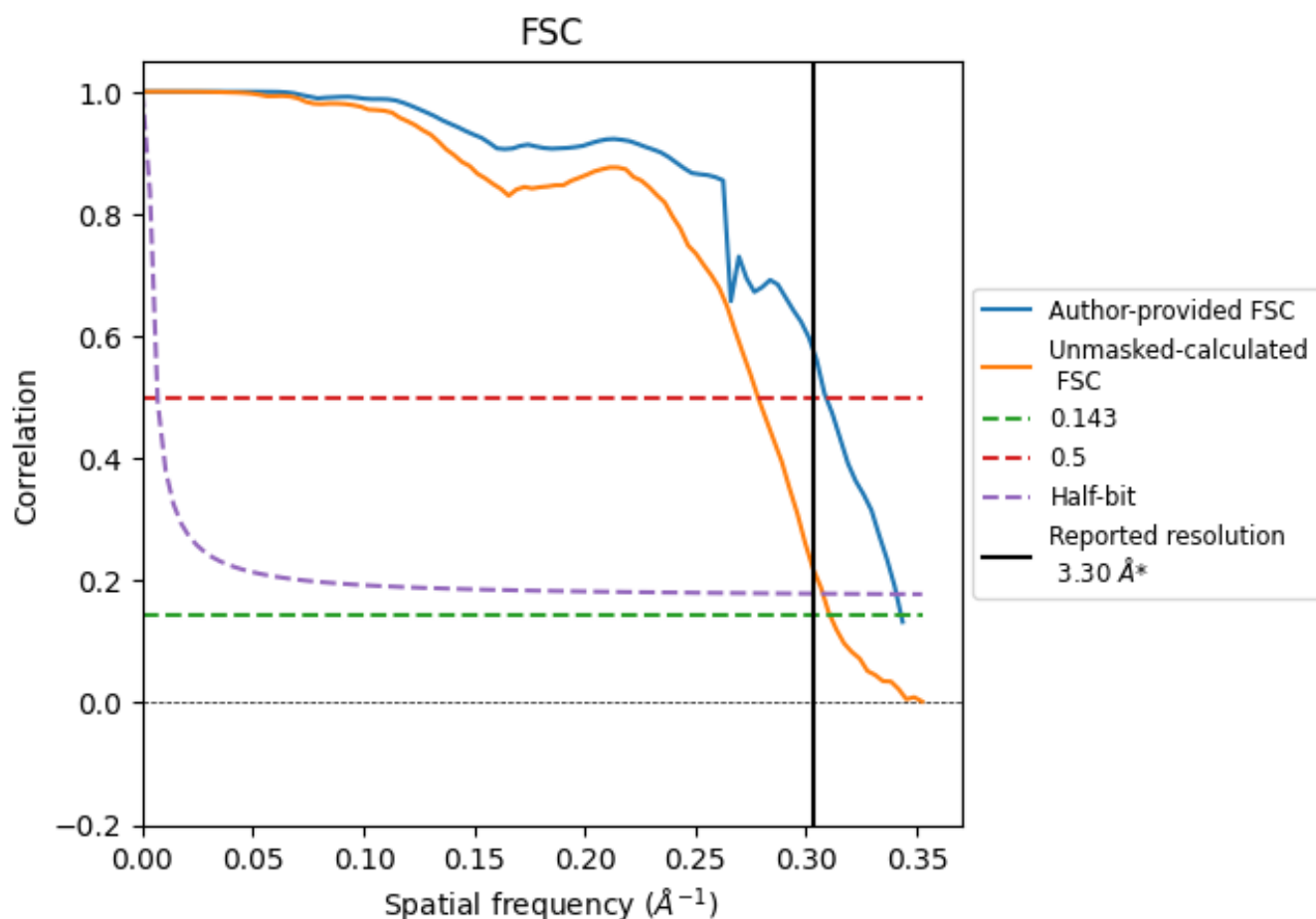


*Reported resolution corresponds to spatial frequency of 0.303 Å⁻¹

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 0.303 Å⁻¹

8.2 Resolution estimates [i](#)

Resolution estimate (Å)	Estimation criterion (FSC cut-off)			
	0.143	0.5	Half-bit	Other
Reported by author	-	-	-	3.30
Author-provided FSC curve	2.92	3.24	2.93	-
Unmasked-calculated*	3.22	3.59	3.25	-

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

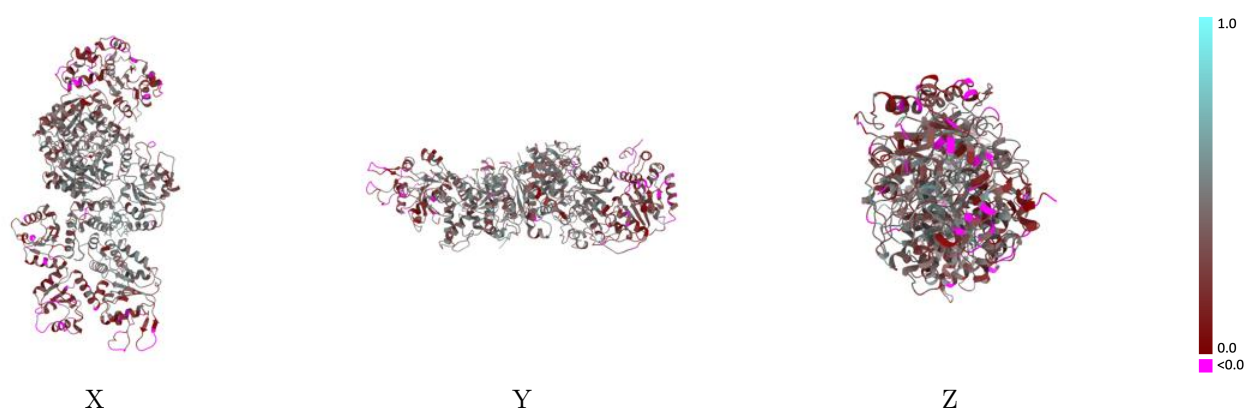
9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-17581 and PDB model 8PB9. Per-residue inclusion information can be found in section 3 on page 7.

9.1 Map-model overlay [i](#)

This section was not generated.

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

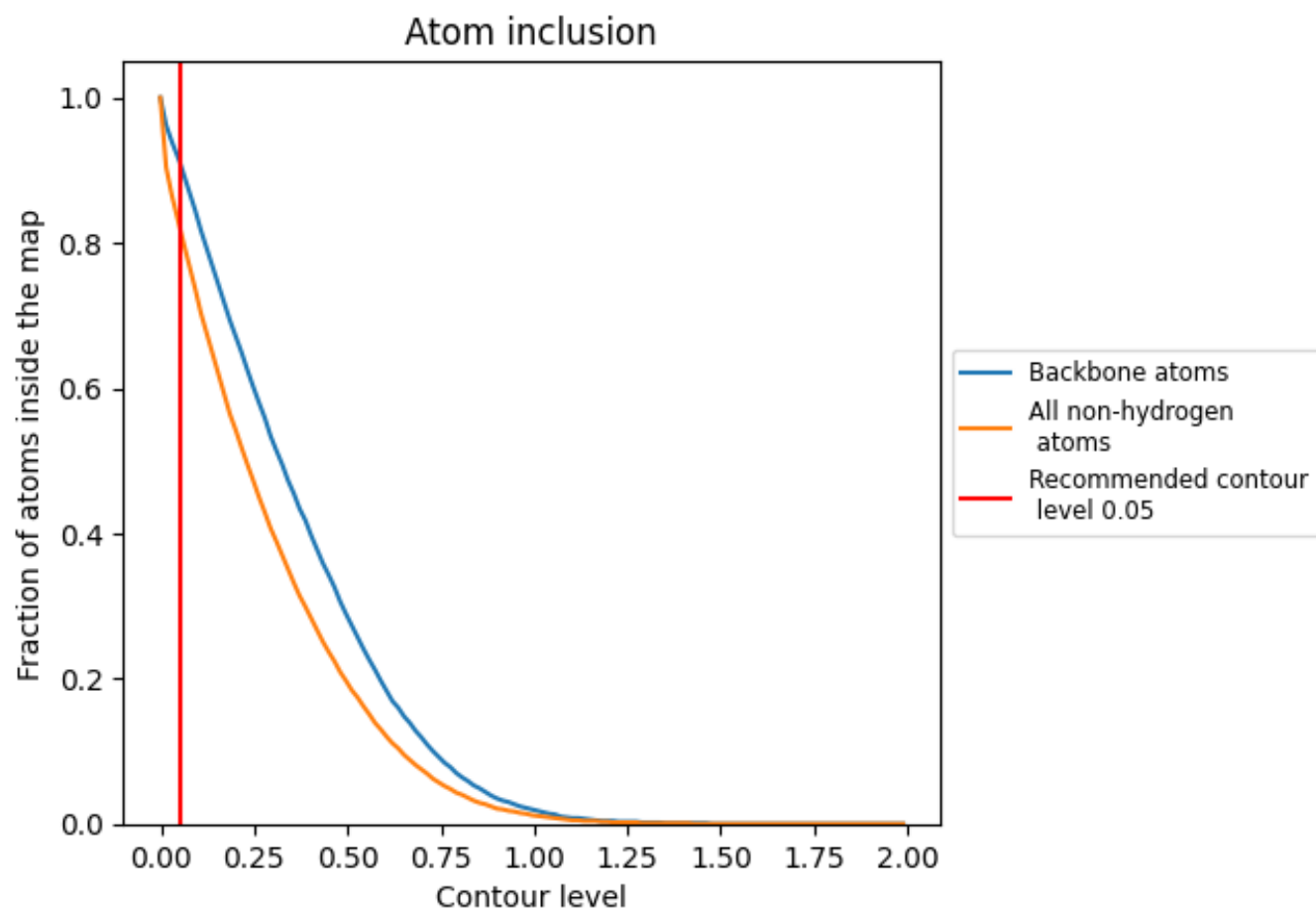


The images above show the model with each residue coloured according its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions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

This section was not generated.

9.4 Atom inclusion [i](#)



At the recommended contour level, 91% of all backbone atoms, 82% 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 (0.05) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.8220	0.3420
A	0.8680	0.3770
B	0.9150	0.4380
C	0.6750	0.2220
D	0.8630	0.3780
E	0.7820	0.2930

