



wwPDB EM Validation Summary Report ⓘ

Mar 7, 2026 – 03:09 AM UTC

PDB ID : 4UX8 / pdb_00004ux8
EMDB ID : EMD-2712
Title : RET recognition of GDNF-GFRalpha1 ligand by a composite binding site promotes membrane-proximal self-association
Authors : Goodman, K.; Kjaer, S.; Beuron, F.; Knowles, P.; Nawrotek, A.; Burns, E.; Purkiss, A.; George, R.; Santoro, M.; Morris, E.P.; McDonald, N.Q.
Deposited on : 2014-08-19
Resolution : 24.00 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 ⓘ 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:

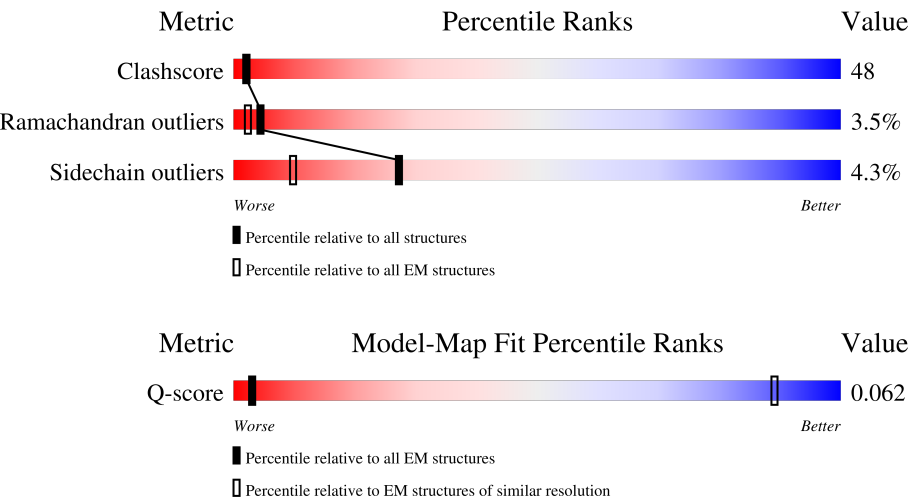
EMDB validation analysis : 0.0.1.dev132
Mogul : 2022.3.0, CSD as543be (2022)
MolProbity : 4-5-2 with Phenix2.0
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
EM percentile statistics : 202505.v01 (Using data in the EMDb archive up until May 2025)
MapQ : 1.9.13
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 24.00 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)	Similar EM resolution (#Entries, resolution range(Å))
Clashscore	229148	23984	-
Ramachandran outliers	224038	23583	-
Sidechain outliers	223484	23102	-
Q-score	-	25397	9 (23.50 - 24.00)

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	A	607	31%27%13%•26%
1	B	607	32%26%13%•26%
2	C	463	42%18%••39%
2	E	463	42%18%••39%

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Mol	Chain	Length	Quality of chain
3	D	134	57%8%31%
3	F	134	57%8%31%
4	G	2	50%100%
4	H	2	50%100%

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 13046 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 PROTO-ONCOGENE TYROSINE-PROTEIN KINASE RECEPTOR RET.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	448	Total	C	N	O	S	0	0
			3569	2264	632	660	13		
1	B	448	Total	C	N	O	S	0	0
			3569	2264	632	660	13		

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	87	ARG	CYS	engineered mutation	UNP P07949
A	98	GLN	ASN	conflict	UNP P07949
A	199	GLN	ASN	conflict	UNP P07949
A	216	SER	CYS	engineered mutation	UNP P07949
B	87	ARG	CYS	engineered mutation	UNP P07949
B	98	GLN	ASN	conflict	UNP P07949
B	199	GLN	ASN	conflict	UNP P07949
B	216	SER	CYS	engineered mutation	UNP P07949

- Molecule 2 is a protein called GDNF FAMILY RECEPTOR ALPHA-1.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	C	284	Total	C	N	O	S	0	0
			2203	1349	398	422	34		
2	E	284	Total	C	N	O	S	0	0
			2203	1349	398	422	34		

- Molecule 3 is a protein called GLIAL CELL LINE-DERIVED NEUROTROPHIC FACTOR.

Mol	Chain	Residues	Atoms					AltConf	Trace
3	D	93	Total	C	N	O	S	0	0
			720	450	126	138	6		
3	F	93	Total	C	N	O	S	0	0
			720	450	126	138	6		

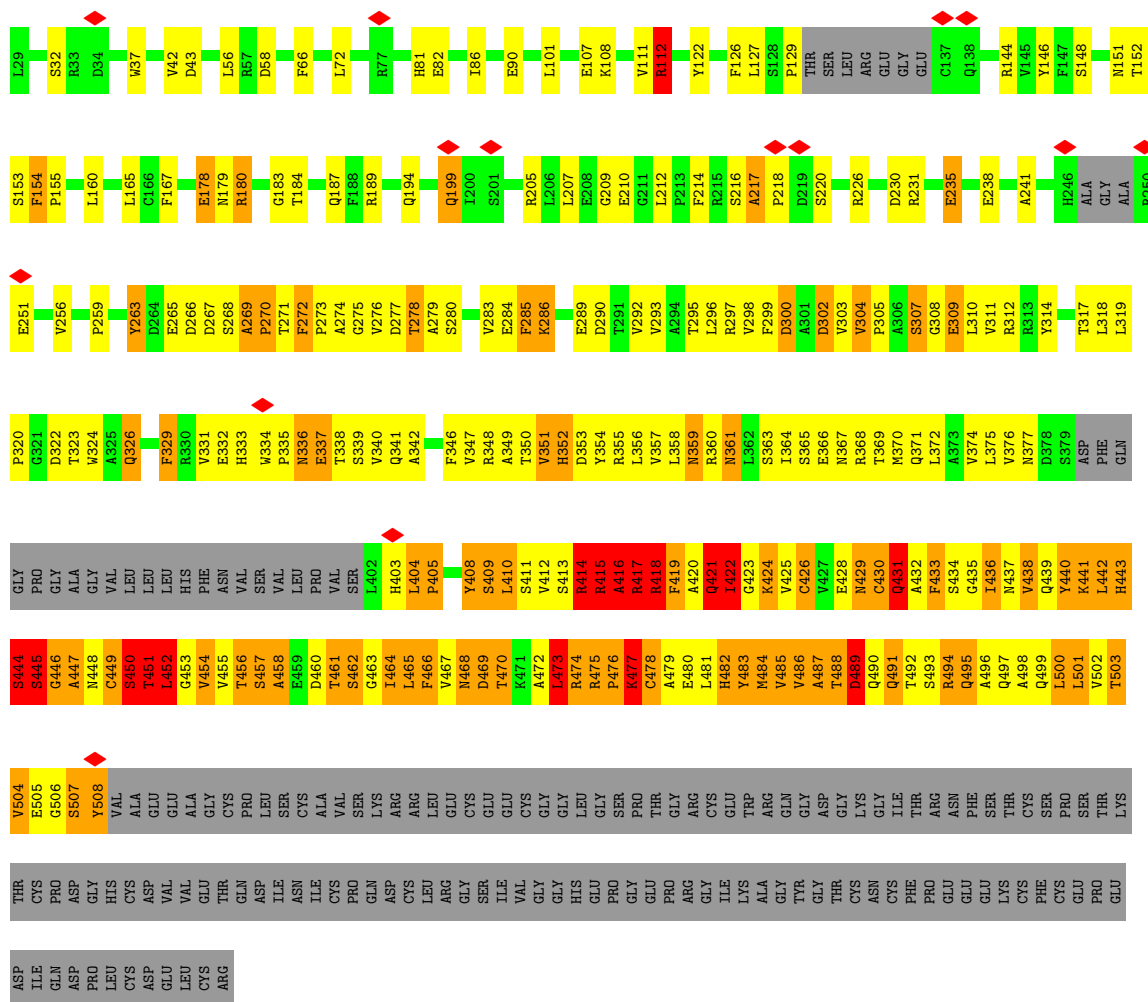
- Molecule 4 is an oligosaccharide called 2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose.



Mol	Chain	Residues	Atoms				AltConf	Trace
4	G	2	Total	C	N	O	0	0
			28	16	2	10		
4	H	2	Total	C	N	O	0	0
			28	16	2	10		

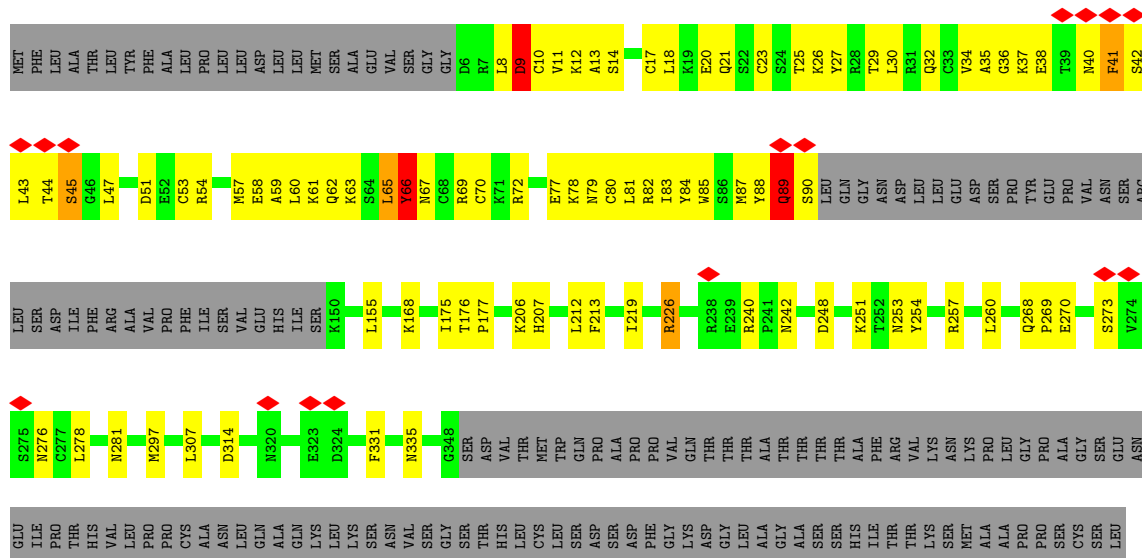
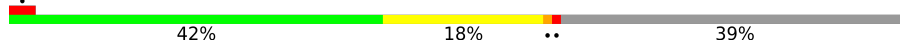
- Molecule 5 is CALCIUM ION (CCD ID: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		AltConf
5	A	3	Total	Ca	0
			3	3	
5	B	3	Total	Ca	0
			3	3	

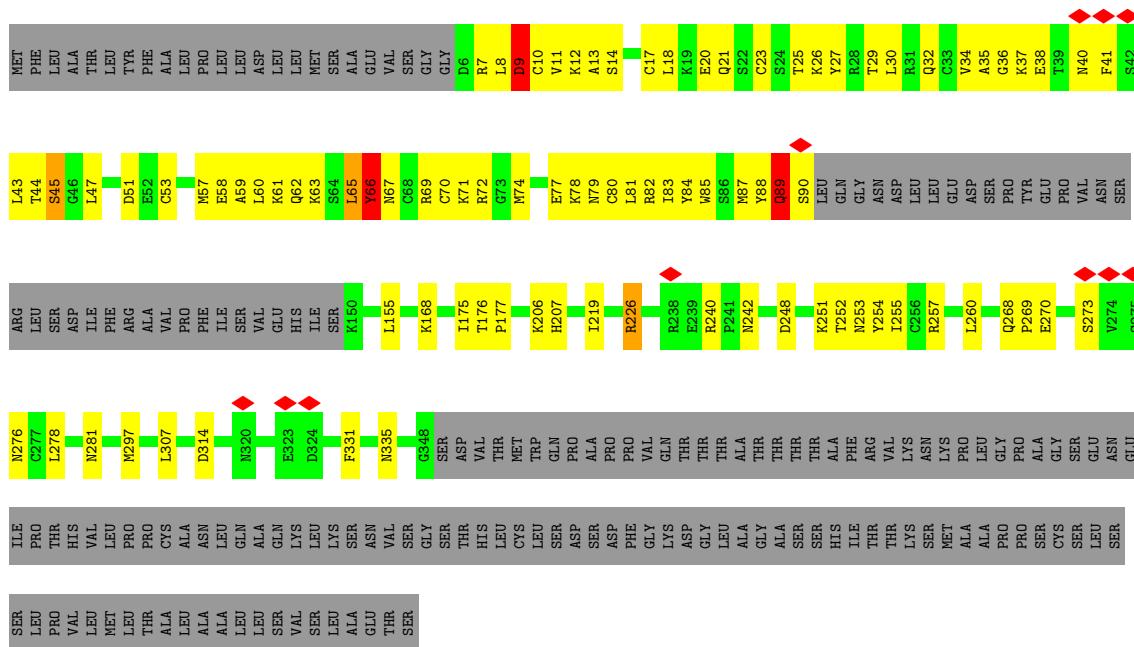


• Molecule 2: GDNF FAMILY RECEPTOR ALPHA-1

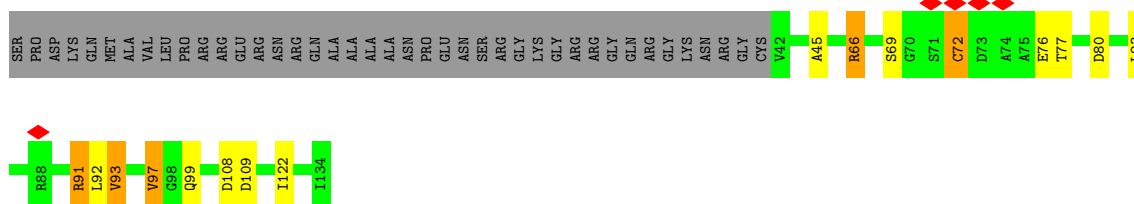
Chain C:



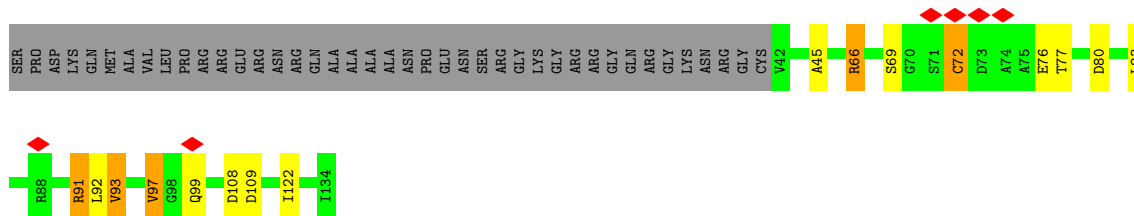
- Molecule 2: GDNF FAMILY RECEPTOR ALPHA-1



- Molecule 3: GLIAL CELL LINE-DERIVED NEUROTROPHIC FACTOR



- Molecule 3: GLIAL CELL LINE-DERIVED NEUROTROPHIC FACTOR



- Molecule 4: 2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose



- Molecule 4: 2-acetamido-2-deoxy-beta-D-glucopyranose-(1-4)-2-acetamido-2-deoxy-beta-D-glucopyranose



4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C2	Depositor
Number of particles used	8519	Depositor
Resolution determination method	Not provided	
CTF correction method	Not provided	
Microscope	FEI TECNAI F20	Depositor
Voltage (kV)	200	Depositor
Electron dose ($e^-/\text{\AA}^2$)	100	Depositor
Minimum defocus (nm)	900	Depositor
Maximum defocus (nm)	Not provided	
Magnification	80000	Depositor
Image detector	TVIPS TEMCAM-F415 (4k x 4k)	Depositor
Maximum map value	26.869	Depositor
Minimum map value	-19.560	Depositor
Average map value	0.000	Depositor
Map value standard deviation	1.000	Depositor
Recommended contour level	2.42	Depositor
Map size ($\text{\AA}$)	416.64, 416.64, 416.64	wwPDB
Map dimensions	96, 96, 96	wwPDB
Map angles ($^\circ$)	90.0, 90.0, 90.0	wwPDB
Pixel spacing ($\text{\AA}$)	4.34, 4.34, 4.34	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: CA, 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	A	2.16	93/3655 (2.5%)	2.37	204/4977 (4.1%)
1	B	2.16	92/3655 (2.5%)	2.37	203/4977 (4.1%)
2	C	0.84	0/2236	1.19	14/3005 (0.5%)
2	E	0.84	0/2236	1.19	14/3005 (0.5%)
3	D	0.45	0/730	0.77	0/985
3	F	0.45	0/730	0.77	0/985
All	All	1.68	185/13242 (1.4%)	1.91	435/17934 (2.4%)

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	4	2
1	B	4	2
All	All	8	4

The worst 5 of 185 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	451	THR	CA-C	29.27	1.92	1.52
1	A	451	THR	CA-C	29.21	1.92	1.52
1	A	410	LEU	N-CA	24.89	1.76	1.45
1	B	410	LEU	N-CA	24.85	1.76	1.45
1	B	452	LEU	N-CA	-18.95	1.21	1.46

The worst 5 of 435 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	263	TYR	O-C-N	-38.05	78.17	122.68
1	B	263	TYR	O-C-N	-37.99	78.23	122.68
1	A	450	SER	CB-CA-C	-21.65	67.33	110.42
1	B	450	SER	CB-CA-C	-21.64	67.36	110.42
1	A	447	ALA	CB-CA-C	-20.93	76.65	110.14

5 of 8 chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
1	A	445	SER	CA
1	A	452	LEU	CA
1	A	491	GLN	CA
1	A	507	SER	CA
1	B	445	SER	CA

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	112	ARG	Sidechain
1	A	263	TYR	Peptide
1	B	112	ARG	Sidechain
1	B	263	TYR	Peptide

5.2 Too-close contacts

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	3569	0	3460	451	0
1	B	3569	0	3462	447	0
2	C	2203	0	2105	144	0
2	E	2203	0	2105	154	0
3	D	720	0	697	19	0
3	F	720	0	697	17	0
4	G	28	0	25	0	0
4	H	28	0	25	0	0
5	A	3	0	0	0	0
5	B	3	0	0	0	0
All	All	13046	0	12576	1221	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 48.

The worst 5 of 1221 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:A:486:VAL:CA	1:A:497:GLN:HE22	1.06	1.65
1:B:486:VAL:CA	1:B:497:GLN:HE22	1.06	1.62
1:A:482:HIS:CD2	1:A:501:LEU:HD21	1.37	1.60
2:C:78:LYS:CE	2:C:254:TYR:CA	1.75	1.59
1:B:482:HIS:CD2	1:B:501:LEU:HD21	1.37	1.59

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	440/607 (72%)	385 (88%)	33 (8%)	22 (5%)	1	16
1	B	440/607 (72%)	385 (88%)	33 (8%)	22 (5%)	1	16
2	C	280/463 (60%)	260 (93%)	15 (5%)	5 (2%)	6	34
2	E	280/463 (60%)	260 (93%)	15 (5%)	5 (2%)	6	34
3	D	91/134 (68%)	84 (92%)	6 (7%)	1 (1%)	11	46
3	F	91/134 (68%)	84 (92%)	6 (7%)	1 (1%)	11	46
All	All	1622/2408 (67%)	1458 (90%)	108 (7%)	56 (4%)	4	20

5 of 56 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	349	ALA
1	A	351	VAL
1	A	414	ARG

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Mol	Chain	Res	Type
1	A	416	ALA
1	A	417	ARG

5.3.2 Protein sidechains ⓘ

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	390/528 (74%)	371 (95%)	19 (5%)	22	43
1	B	390/528 (74%)	371 (95%)	19 (5%)	22	43
2	C	247/408 (60%)	239 (97%)	8 (3%)	34	56
2	E	247/408 (60%)	239 (97%)	8 (3%)	34	56
3	D	78/113 (69%)	74 (95%)	4 (5%)	21	42
3	F	78/113 (69%)	74 (95%)	4 (5%)	21	42
All	All	1430/2098 (68%)	1368 (96%)	62 (4%)	27	47

5 of 62 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	267	ASP
2	E	248	ASP
1	B	473	LEU
2	E	226	ARG
3	F	72	CYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 32 such sidechains are listed below:

Mol	Chain	Res	Type
2	E	89	GLN
2	E	281	ASN
1	B	187	GLN
1	B	81	HIS
2	E	330	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 ⓘ

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
4	NAG	G	1	4,3	14,14,15	0.55	0	17,19,21	1.14	1 (5%)
4	NAG	G	2	4	14,14,15	0.79	1 (7%)	17,19,21	1.39	2 (11%)
4	NAG	H	1	4,3	14,14,15	0.57	0	17,19,21	1.15	1 (5%)
4	NAG	H	2	4	14,14,15	0.78	1 (7%)	17,19,21	1.38	2 (11%)

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
4	NAG	G	1	4,3	-	0/6/23/26	0/1/1/1
4	NAG	G	2	4	-	0/6/23/26	0/1/1/1
4	NAG	H	1	4,3	-	0/6/23/26	0/1/1/1
4	NAG	H	2	4	-	0/6/23/26	0/1/1/1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	G	2	NAG	C1-C2	2.18	1.55	1.52
4	H	2	NAG	C1-C2	2.16	1.55	1.52

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	H	1	NAG	C1-O5-C5	3.45	116.81	112.19
4	H	2	NAG	C4-C3-C2	3.42	116.03	111.02
4	G	2	NAG	C4-C3-C2	3.40	116.00	111.02
4	G	1	NAG	C1-O5-C5	3.38	116.71	112.19
4	G	2	NAG	O5-C1-C2	2.24	114.76	111.29

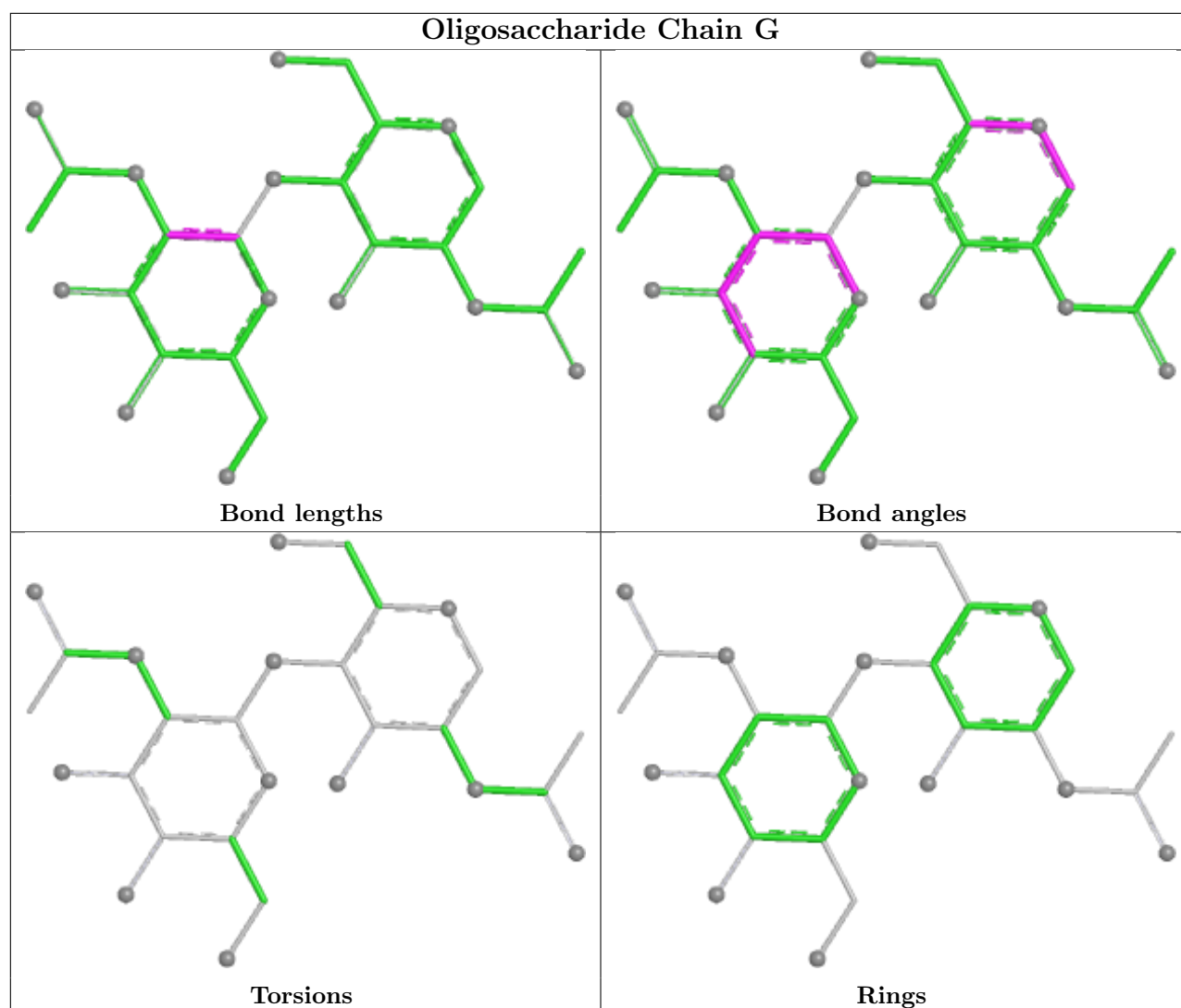
There are no chirality outliers.

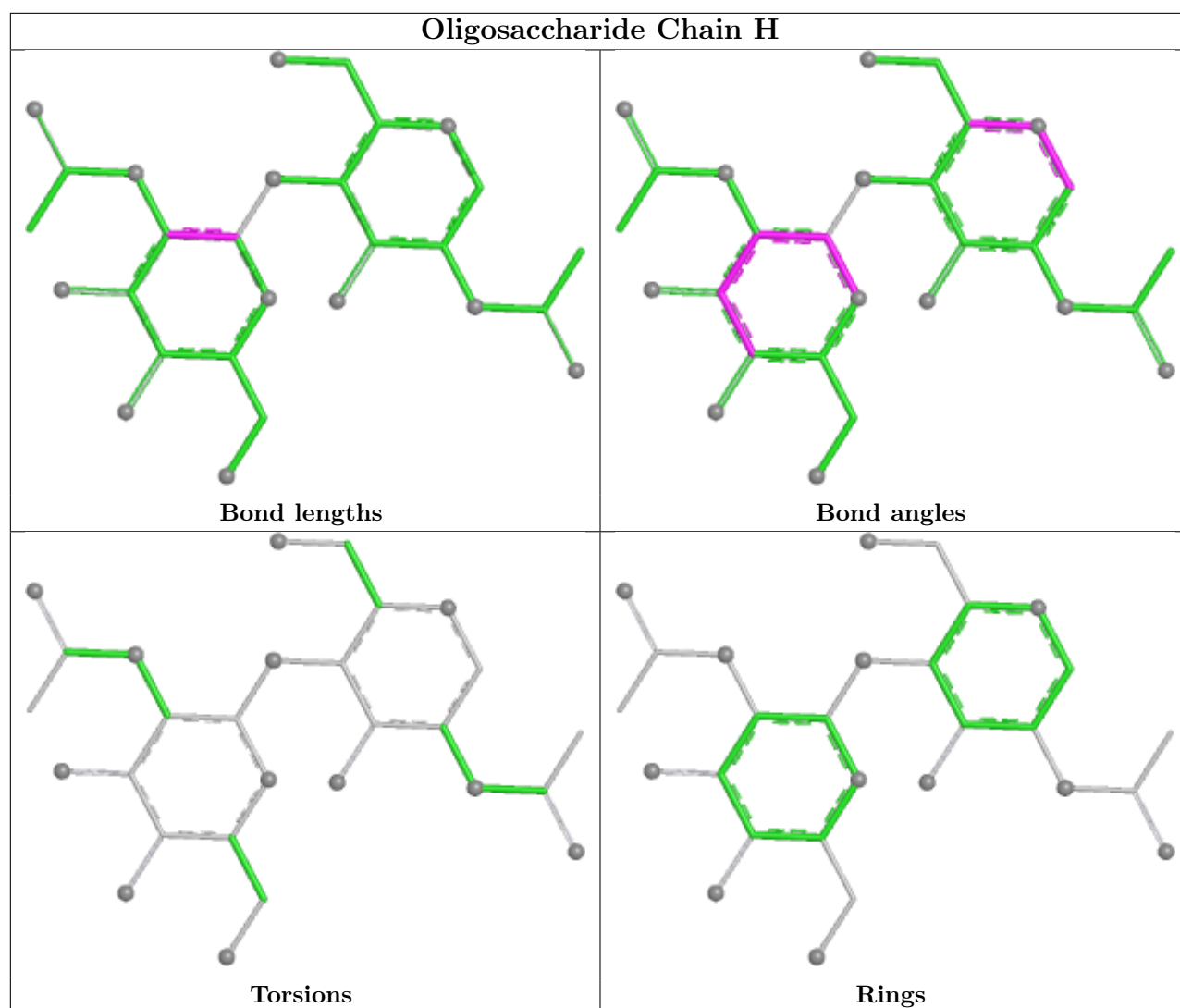
There are no torsion outliers.

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.





5.6 Ligand geometry [i](#)

Of 6 ligands modelled in this entry, 6 are 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 [i](#)

There are no such residues in this entry.

5.8 Polymer linkage issues

The following chains have linkage breaks:

Mol	Chain	Number of breaks
1	A	1
1	B	1

All chain breaks are listed below:

Model	Chain	Residue-1	Atom-1	Residue-2	Atom-2	Distance (Å)
1	A	269:ALA	C	270:PRO	N	1.64
1	B	269:ALA	C	270:PRO	N	1.64

6 Map visualisation [i](#)

This section contains visualisations of the EMDB entry EMD-2712. These allow visual inspection of the internal detail of the map and identification of artifacts.

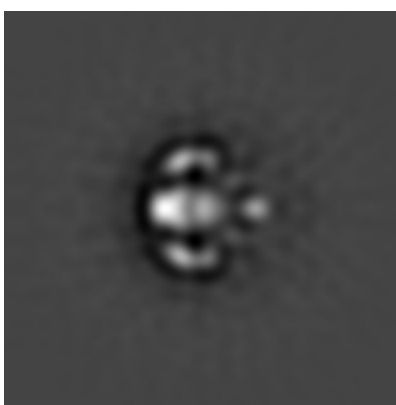
No raw map or half-maps were deposited for this entry and therefore no images, graphs, etc. pertaining to the raw map can be shown.

6.1 Orthogonal projections [i](#)

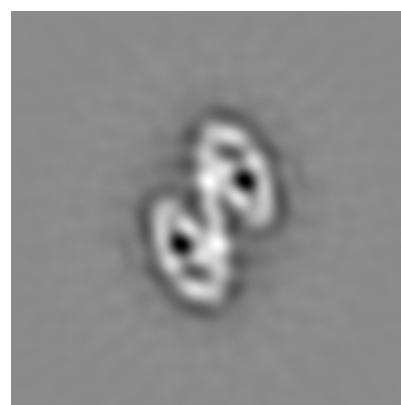
6.1.1 Primary map



X



Y



Z

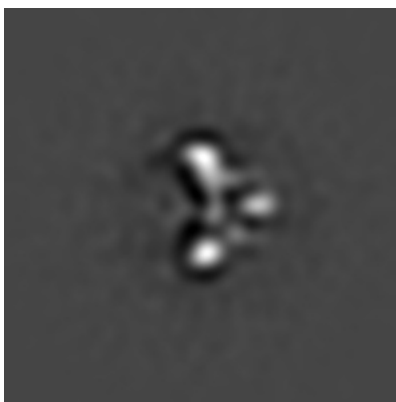
The images above show the map projected in three orthogonal directions.

6.2 Central slices [i](#)

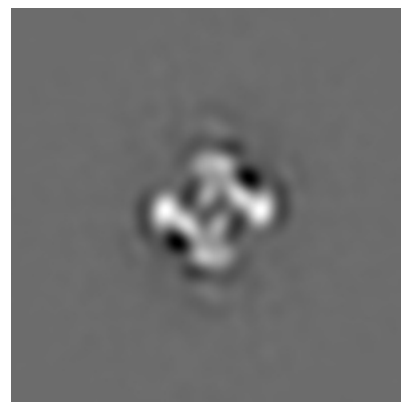
6.2.1 Primary map



X Index: 48



Y Index: 48



Z Index: 48

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: 48



Y Index: 47

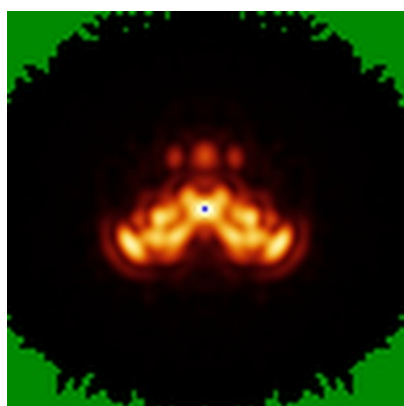


Z Index: 41

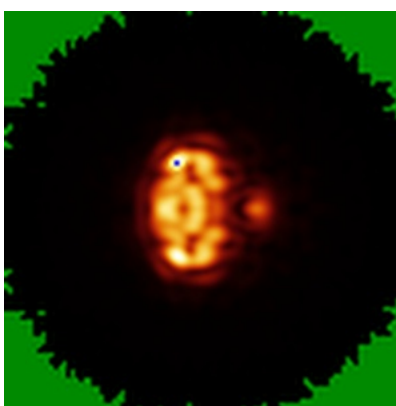
The images above show the largest variance slices of the map in three orthogonal directions.

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

6.4.1 Primary map



X



Y

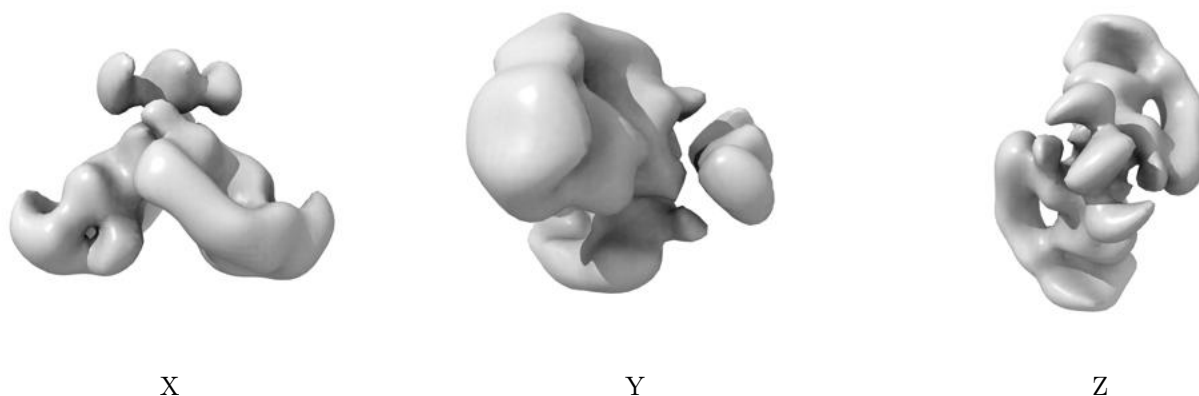


Z

The images above show the map standard deviation projections with false color in three orthogonal directions. Minimum values are shown in green, max in blue, and dark to light orange shades represent small to large values respectively.

6.5 Orthogonal surface views [i](#)

6.5.1 Primary map



The images above show the 3D surface view of the map at the recommended contour level 2.42. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

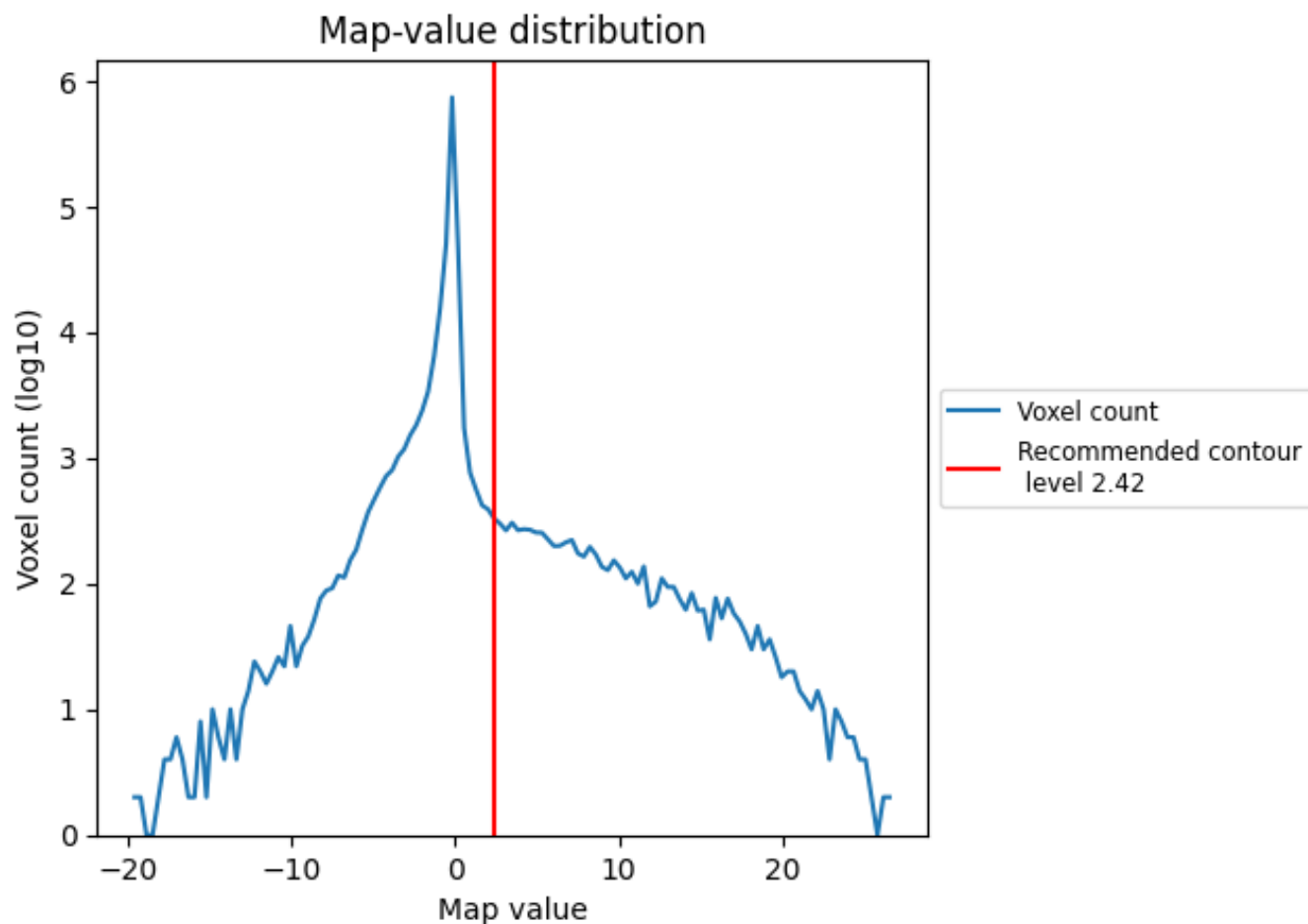
6.6 Mask visualisation [i](#)

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

7 Map analysis [i](#)

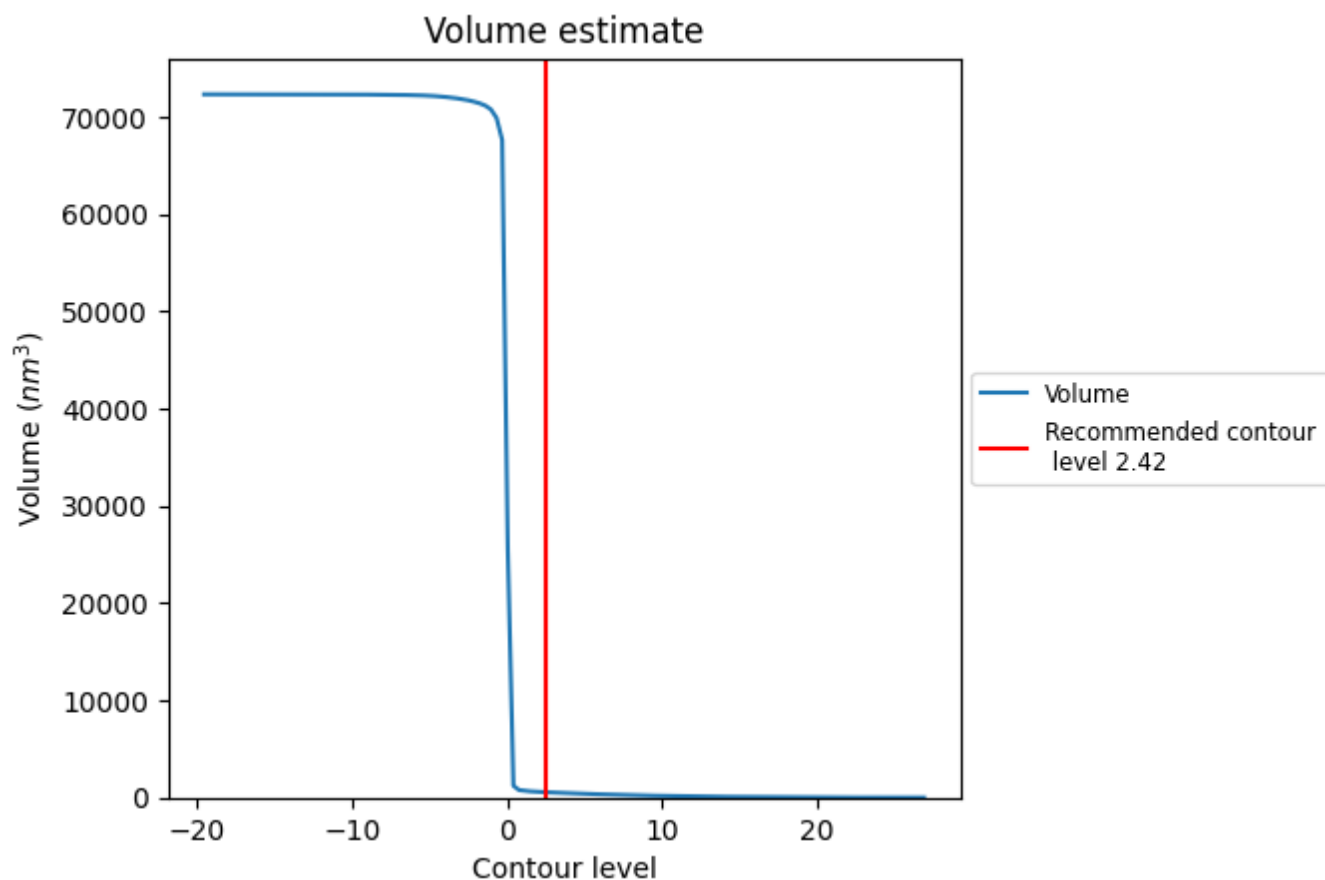
This section contains the results of statistical analysis of the map.

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.

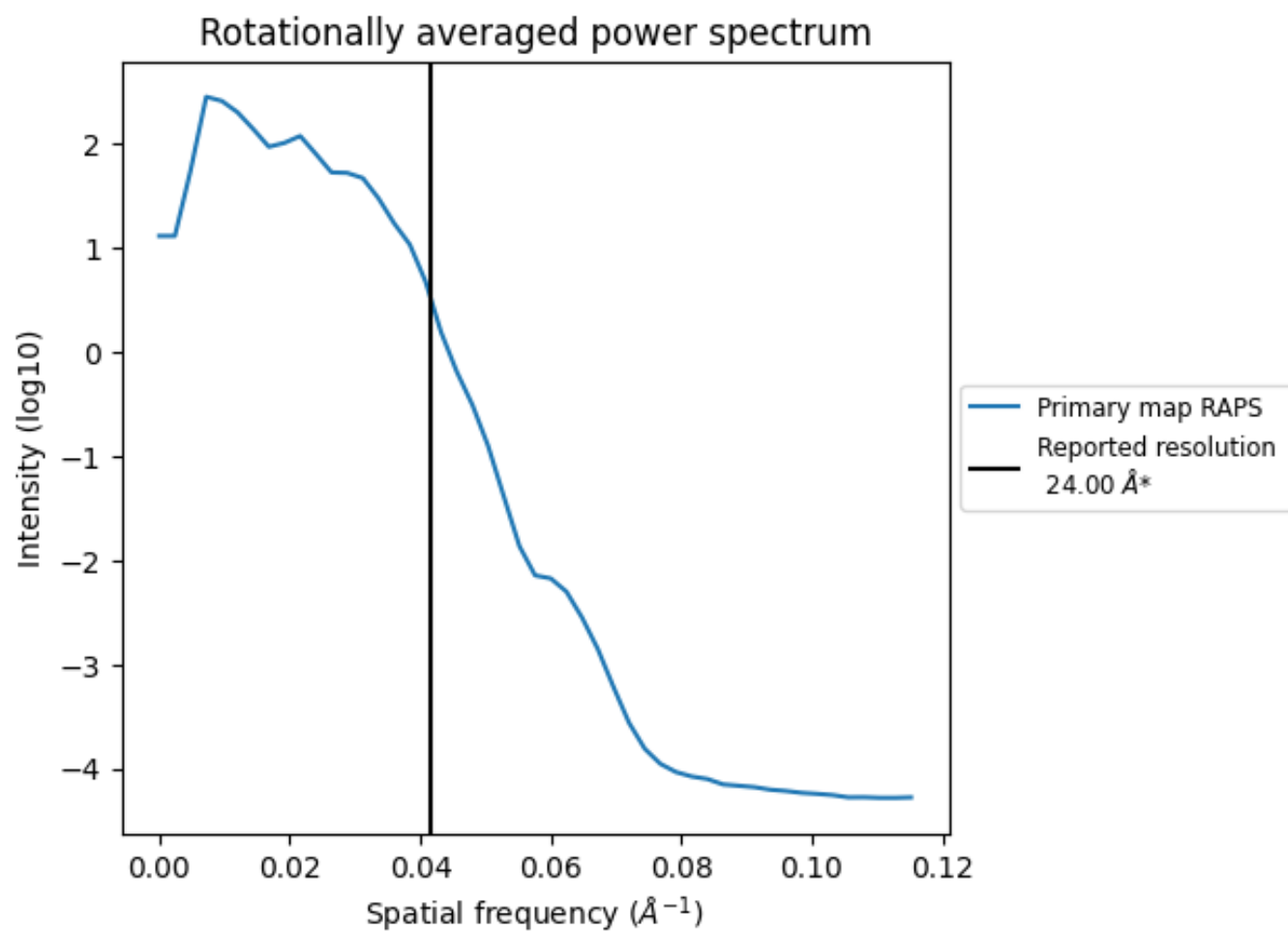
7.2 Volume estimate [i](#)



The volume at the recommended contour level is 552 nm³; this corresponds to an approximate mass of 499 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 0.042 Å⁻¹

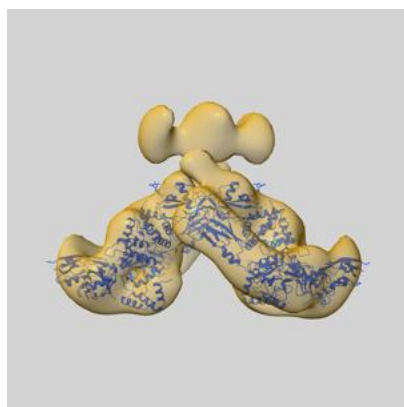
8 Fourier-Shell correlation

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

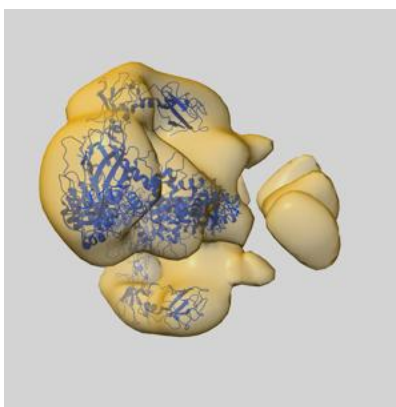
9 Map-model fit [i](#)

This section contains information regarding the fit between EMDB map EMD-2712 and PDB model 4UX8. Per-residue inclusion information can be found in section [3](#) on page [6](#).

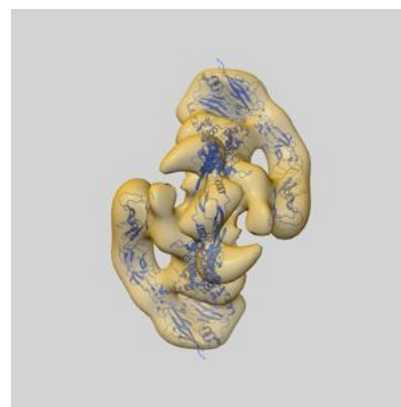
9.1 Map-model overlay [i](#)



X



Y



Z

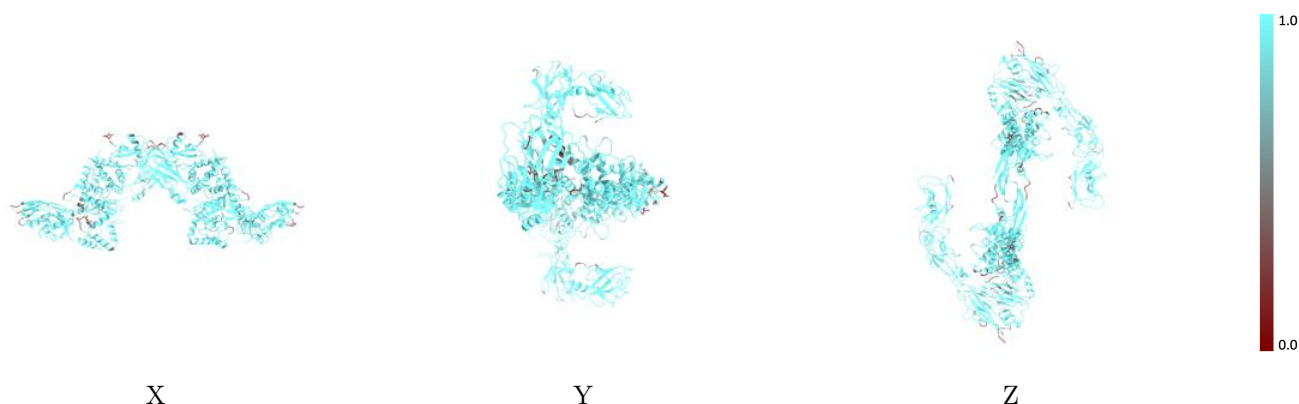
The images above show the 3D surface view of the map at the recommended contour level 2.42 at 50% transparency in yellow overlaid with a ribbon representation of the model coloured in blue. These images allow for the visual assessment of the quality of fit between the atomic model and the map.

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



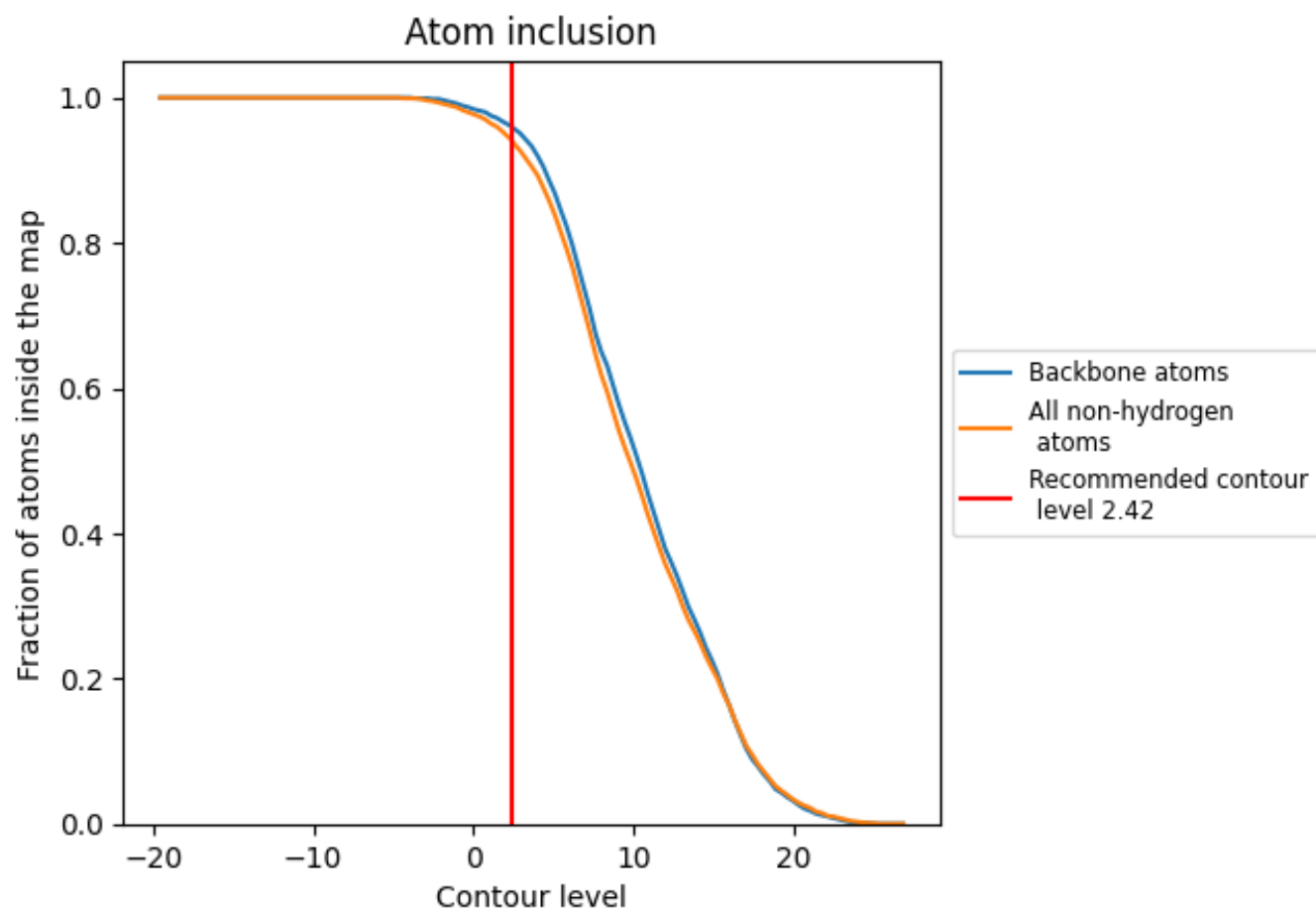
The images above show the model with each residue coloured according to its Q-score. This shows their resolvability in the map with higher Q-score values reflecting better resolvability. Please note: Q-score is calculating the resolvability of atoms, and thus high values are only expected at resolutions 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 (2.42).

9.4 Atom inclusion [i](#)



At the recommended contour level, 96% of all backbone atoms, 94% 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 (2.42) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.9410	0.0620
A	0.9470	0.0710
B	0.9460	0.0700
C	0.9330	0.0470
D	0.9300	0.0560
E	0.9520	0.0550
F	0.9260	0.0590
G	0.3570	0.0490
H	0.3570	0.0390

1.0

0.0

<0.0