Full wwPDB EM Validation Report (i)

Aug 27, 2026 – 04:21 pm BST

PDB ID	:	8BED / pdb_00008bed
EMDB ID	:	EMD-15998
Title	:	Cryo-EM structure of the Arabidopsis thaliana I+III2 supercomplex (CI peripheral tip)
Authors	:	Klusch, N.; Kuehlbrandt, W.
Deposited on	:	2022-10-21
Resolution	:	2.03 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/EMValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

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

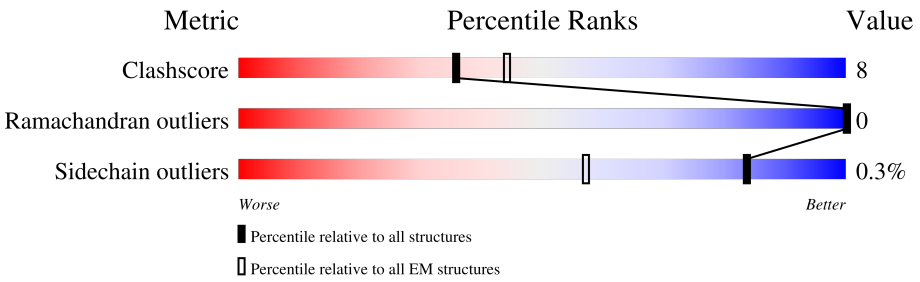
EMDB validation analysis	:	0.0.1.dev133
Mogul	:	1.8.4, CSD as541be (2020)
MolProbity	:	4-5-2 with Phenix2.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
EM percentile statistics	:	202505.v01 (Using data 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)	:	2.50

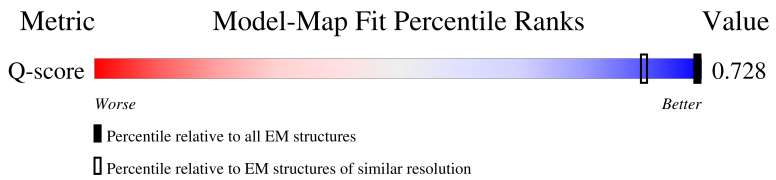
1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
ELECTRON MICROSCOPY

The reported resolution of this entry is 2.03 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	1771 (1.55 - 2.53)

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

Mol	Chain	Length	Quality of chain
1	E	255	7%, 62%, 13%, ·, 25%
2	F	486	·, 74%, 15%, 11%
3	G	748	·, 78%, 14%, 8%
4	I	222	·, 96%

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Mol	Chain	Length	Quality of chain
5	Q	154	10% 64% 32%
6	R	110	6% 59% 7% 34%
7	S	97	78% 18%
8	W	133	7% 5% 89%

2 Entry composition (i)

There are 13 unique types of molecules in this entry. The entry contains 13154 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 NADH dehydrogenase [ubiquinone] flavoprotein 2, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	E	192	1500	954	248	287	11	0	0

- Molecule 2 is a protein called NADH dehydrogenase [ubiquinone] flavoprotein 1, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	F	434	3368	2125	600	618	25	0	0

- Molecule 3 is a protein called NADH dehydrogenase [ubiquinone] iron-sulfur protein 1, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
3	G	687	5243	3285	919	1000	39	0	0

- Molecule 4 is a protein called NADH dehydrogenase [ubiquinone] iron-sulfur protein 8-A, mitochondrial.

Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
4	I	8	67	36	14	17	0	0

- Molecule 5 is a protein called NADH dehydrogenase [ubiquinone] iron-sulfur protein 4, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
5	Q	105	837	536	144	156	1	0	0

- Molecule 6 is a protein called NADH dehydrogenase [ubiquinone] iron-sulfur protein 6, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
6	R	73	571	359	101	105	6	0	0

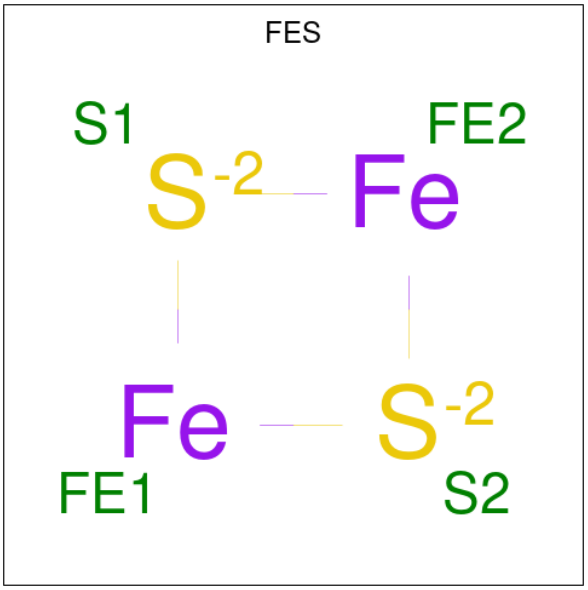
- Molecule 7 is a protein called NADH dehydrogenase [ubiquinone] 1 alpha subcomplex subunit 2.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
7	S	93	727	459	129	133	6	0	0

- Molecule 8 is a protein called NADH dehydrogenase [ubiquinone] 1 alpha subcomplex subunit 6.

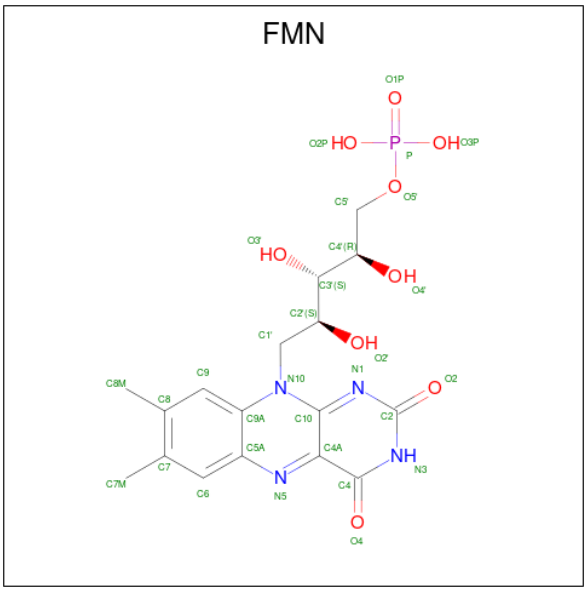
Mol	Chain	Residues	Atoms				AltConf	Trace
			Total	C	N	O		
8	W	15	131	88	19	24	0	0

- Molecule 9 is FE2/S2 (INORGANIC) CLUSTER (CCD ID: FES) (formula: Fe_2S_2) (labeled as "Ligand of Interest" by depositor).



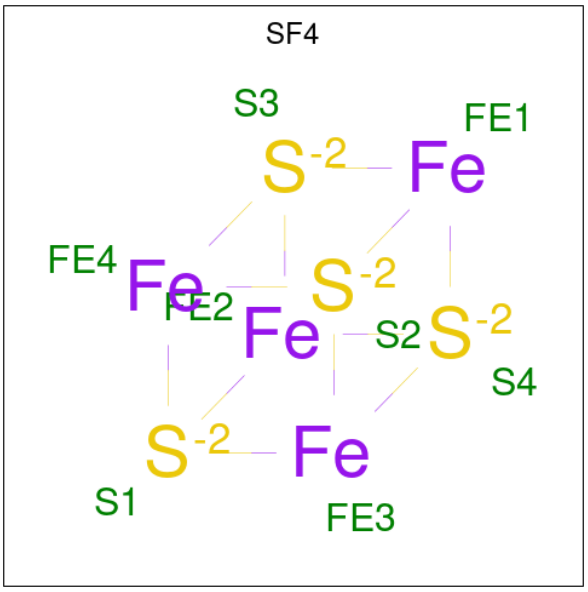
Mol	Chain	Residues	Atoms			AltConf
			Total	Fe	S	
9	E	1	4	2	2	0
9	G	1	4	2	2	0

- Molecule 10 is FLAVIN MONONUCLEOTIDE (CCD ID: FMN) (formula: $C_{17}H_{21}N_4O_9P$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					AltConf
			Total	C	N	O	P	
10	F	1	31	17	4	9	1	0

- Molecule 11 is IRON/SULFUR CLUSTER (CCD ID: SF4) (formula: Fe_4S_4) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms			AltConf
			Total	Fe	S	
11	F	1	8	4	4	0
11	G	1	8	4	4	0

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Mol	Chain	Residues	Atoms			AltConf
			Total	Fe	S	
11	G	1	8	4	4	0

- Molecule 12 is ZINC ION (CCD ID: ZN) (formula: Zn) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		AltConf
			Total	Zn	
12	R	1	1	1	0

- Molecule 13 is water.

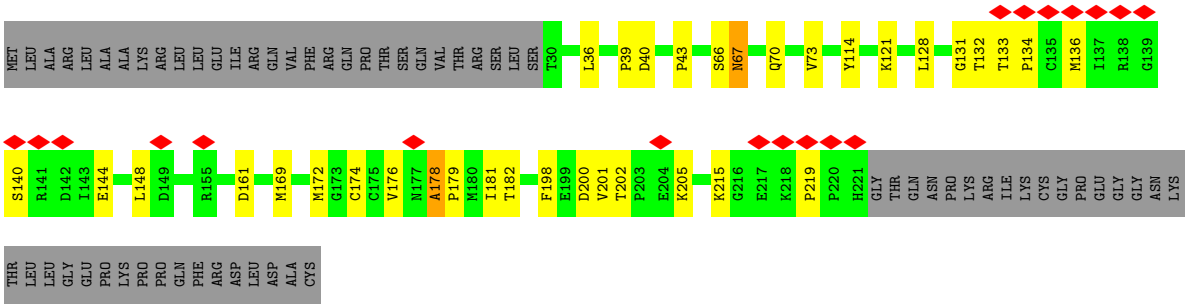
Mol	Chain	Residues	Atoms		AltConf
			Total	O	
13	E	89	89	89	0
13	F	149	149	149	0
13	G	316	316	316	0
13	I	8	8	8	0
13	Q	20	20	20	0
13	R	45	45	45	0
13	S	17	17	17	0
13	W	2	2	2	0

3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and atom inclusion in map density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red diamond above a residue indicates a poor fit to the EM map for this residue (all-atom inclusion < 40%). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

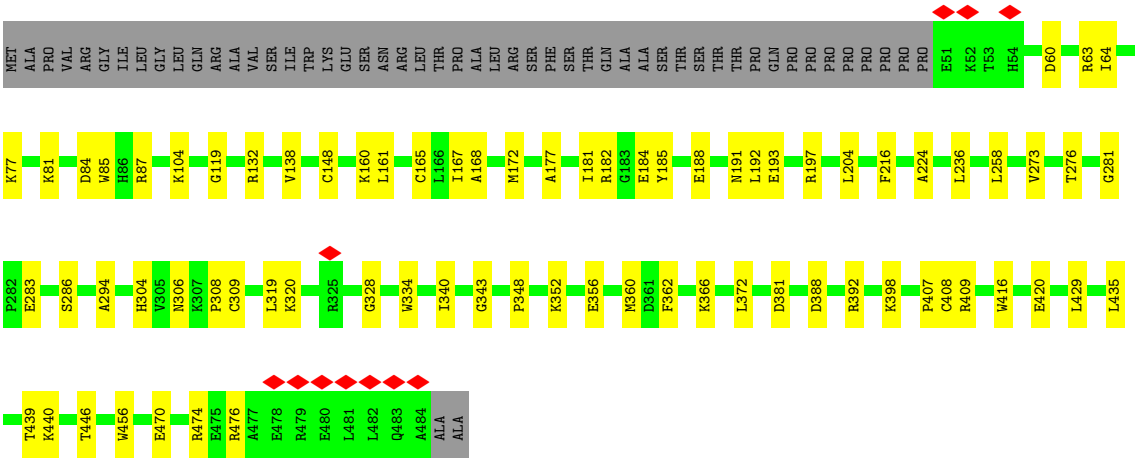
• Molecule 1: NADH dehydrogenase [ubiquinone] flavoprotein 2, mitochondrial

Chain E:



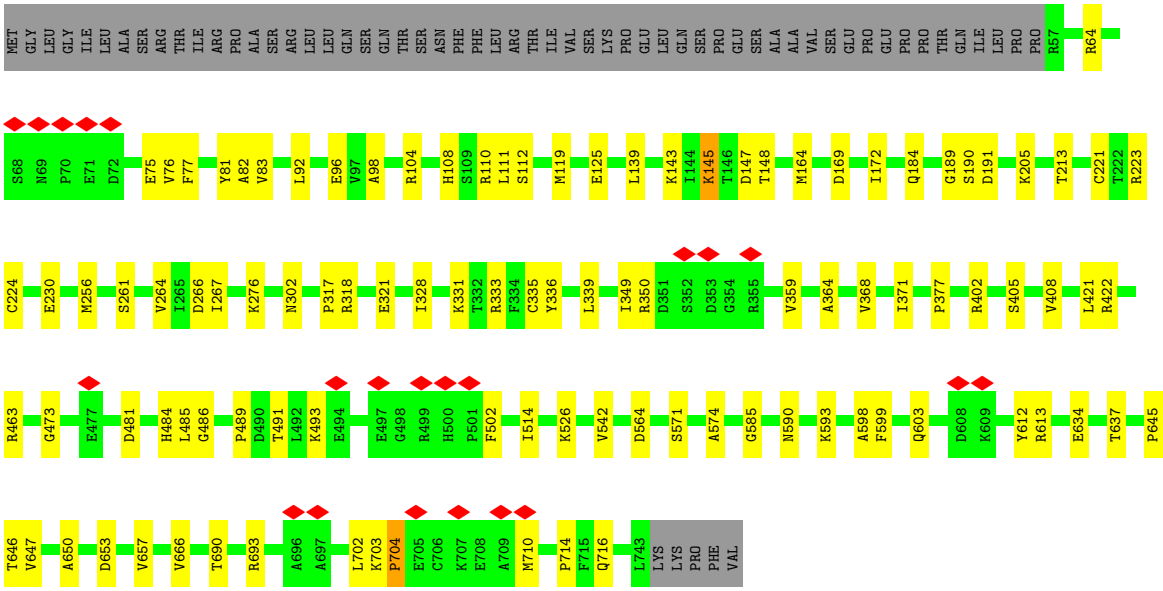
• Molecule 2: NADH dehydrogenase [ubiquinone] flavoprotein 1, mitochondrial

Chain F:



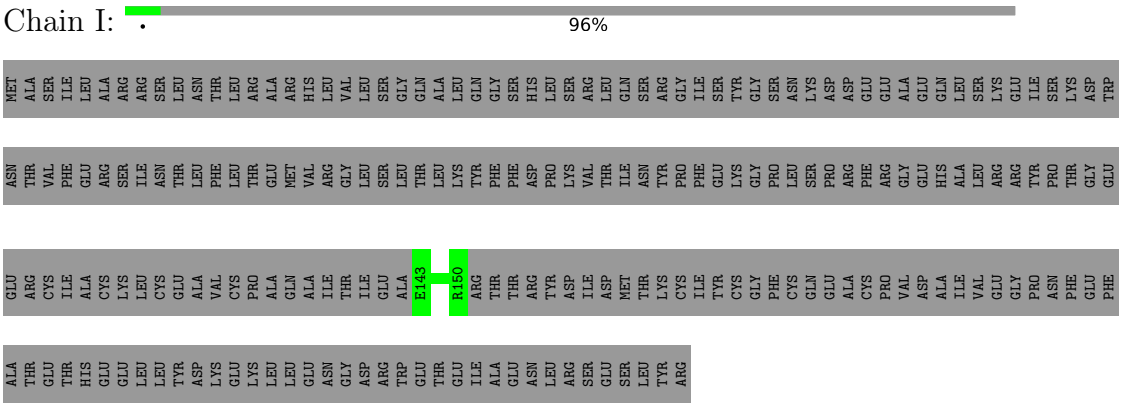
• Molecule 3: NADH dehydrogenase [ubiquinone] iron-sulfur protein 1, mitochondrial

Chain G:



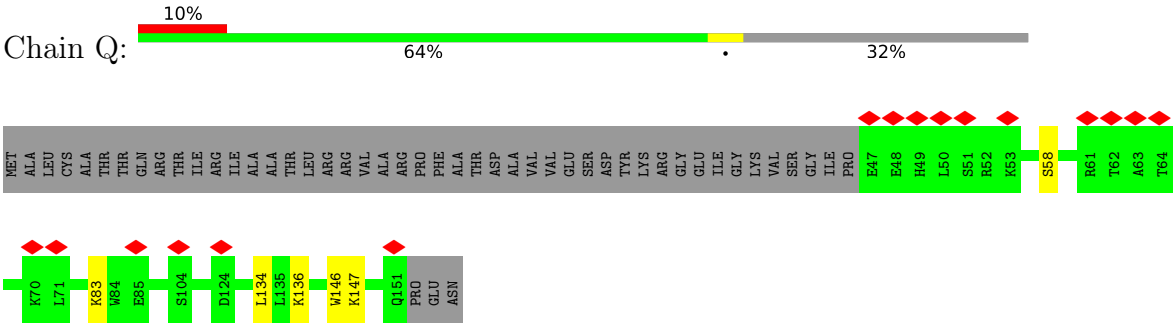
• Molecule 4: NADH dehydrogenase [ubiquinone] iron-sulfur protein 8-A, mitochondrial

Chain I:



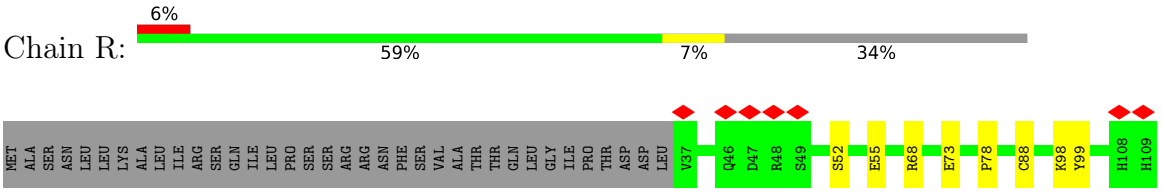
• Molecule 5: NADH dehydrogenase [ubiquinone] iron-sulfur protein 4, mitochondrial

Chain Q:



• Molecule 6: NADH dehydrogenase [ubiquinone] iron-sulfur protein 6, mitochondrial

Chain R:



HIS

• Molecule 7: NADH dehydrogenase [ubiquinone] 1 alpha subcomplex subunit 2

Chain S: 78% 18%

MET A2 W3 R4 S10 L14 L18 R29 Y36 K37 C53 P58 Q59 M60 Y64 L74 L86 L89 Y90 K91 S92 G93 A94 THR LYS ALA

• Molecule 8: NADH dehydrogenase [ubiquinone] 1 alpha subcomplex subunit 6

Chain W: 7% 5% 89%

MET ALA ALA PRO PHE ALA LEU ARG LYS ILE GLY VAL PRO PRO ASN SER ALA ASN LEU THR GLU ALA ARG ARG ARG VAL PHE ASP PHE PHE ARG ALA ALA CYS ARG SER ILE PRO THR ILE MET ASP ILE TYR ASN LEU GLN ASP VAL VAL ALA PRO SER GLN LEU ARG TYR ALA ILE SER

ALA GLN ILE ARG ASN ASN ALA HIS ILE THR ASP PRO LYS VAL ILE ASP LEU LEU ILE PHE LYS GLY MET GLU GLU LEU THR ASP ILE VAL ASP HIS ALA LYS GLN ARG HIS HIS ILE ILE GLY GLN TYR VAL VAL GLY GLU GLY LEU VAL GLN ASN THR GLY ASN LYS ASP GLN G119 K120

T121 D122 F123 L124 K125 Y128 F133

4 Experimental information (i)

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C1	Depositor
Number of particles used	213993	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/Å^2$)	50	Depositor
Minimum defocus (nm)	500	Depositor
Maximum defocus (nm)	1500	Depositor
Magnification	215000	Depositor
Image detector	FEI FALCON IV (4k x 4k)	Depositor
Maximum map value	14.342	Depositor
Minimum map value	-8.949	Depositor
Average map value	0.000	Depositor
Map value standard deviation	0.434	Depositor
Recommended contour level	0.8	Depositor
Map size (Å)	105.432, 146.115, 116.892006	wwPDB
Map dimensions	204, 255, 184	wwPDB
Map angles (°)	90.0, 90.0, 90.0	wwPDB
Pixel spacing (Å)	0.573, 0.573, 0.573	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: FMN, ZN, FES, SF4

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

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\#\|Z\|>5$	RMSZ	$\#\|Z\|>5$
1	E	0.77	6/1535 (0.4%)	0.74	0/2084
2	F	0.13	0/3441	0.28	0/4641
3	G	0.34	1/5338 (0.0%)	0.53	10/7231 (0.1%)
4	I	0.06	0/66	0.16	0/85
5	Q	0.08	0/862	0.24	0/1166
6	R	0.33	0/585	0.52	0/793
7	S	0.51	0/739	0.61	0/996
8	W	0.08	0/135	0.18	0/180
All	All	0.38	7/12701 (0.1%)	0.49	10/17176 (0.1%)

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	E	0	1

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	E	67	ASN	C-O	-7.21	1.14	1.24
1	E	73	VAL	C-O	-6.37	1.16	1.24
1	E	43	PRO	C-O	-6.27	1.16	1.24
1	E	39	PRO	C-O	-5.87	1.16	1.24
1	E	66	SER	C-O	-5.77	1.16	1.24
1	E	70	GLN	C-O	-5.51	1.17	1.24
3	G	147	ASP	C-O	-5.21	1.16	1.24

All (10) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	G	191	ASP	CB-CA-C	-12.14	89.50	109.53
3	G	189	GLY	CA-C-N	-7.25	111.20	122.08
3	G	189	GLY	C-N-CA	-7.25	111.20	122.08
3	G	190	SER	N-CA-CB	7.20	119.52	110.45
3	G	484	HIS	CB-CA-C	6.43	120.84	110.29
3	G	473	GLY	CA-C-N	6.28	124.24	119.66
3	G	473	GLY	C-N-CA	6.28	124.24	119.66
3	G	704	PRO	N-CD-CG	-5.16	95.46	103.20
3	G	190	SER	O-C-N	5.03	129.62	122.68
3	G	147	ASP	CB-CA-C	5.00	119.06	110.85

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	E	178	ALA	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	E	1500	0	1473	26	0
2	F	3368	0	3354	70	0
3	G	5243	0	5228	66	0
4	I	67	0	55	0	0
5	Q	837	0	818	7	0
6	R	571	0	559	10	0
7	S	727	0	759	20	0
8	W	131	0	119	9	0
9	E	4	0	0	1	0
9	G	4	0	0	1	0
10	F	31	0	19	0	0
11	F	8	0	0	1	0
11	G	16	0	0	0	0
12	R	1	0	0	0	0
13	E	89	0	0	3	0
13	F	149	0	0	18	0
13	G	316	0	0	6	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
13	I	8	0	0	0	0
13	Q	20	0	0	1	0
13	R	45	0	0	4	0
13	S	17	0	0	8	0
13	W	2	0	0	0	0
All	All	13154	0	12384	193	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 8.

All (193) 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)
8:W:120:LYS:HD3	8:W:124:LEU:CD2	1.67	1.22
2:F:77:LYS:HZ2	2:F:81:LYS:CE	1.52	1.22
2:F:77:LYS:HZ2	2:F:81:LYS:NZ	1.41	1.17
8:W:120:LYS:HD3	8:W:124:LEU:HD23	1.04	1.03
8:W:120:LYS:CD	8:W:124:LEU:HD23	1.92	0.99
2:F:77:LYS:NZ	2:F:81:LYS:CE	2.26	0.98
2:F:77:LYS:NZ	2:F:81:LYS:NZ	2.13	0.95
2:F:309:CYS:HB2	13:F:742:HOH:O	1.67	0.93
2:F:77:LYS:HZ2	2:F:81:LYS:HE3	1.30	0.92
3:G:339:LEU:HG	13:G:935:HOH:O	1.72	0.90
1:E:136:MET:HB3	2:F:392:ARG:HH21	1.40	0.86
2:F:77:LYS:HZ2	2:F:81:LYS:HZ2	1.21	0.86
6:R:73:GLU:OE1	6:R:78:PRO:HG3	1.75	0.86
7:S:4:ARG:HD3	13:S:117:HOH:O	1.75	0.86
2:F:309:CYS:CB	13:F:742:HOH:O	2.24	0.84
2:F:281:GLY:HA3	13:F:699:HOH:O	1.79	0.82
8:W:124:LEU:HD11	8:W:128:TYR:CZ	2.18	0.79
1:E:132:THR:HG23	1:E:134:PRO:HD2	1.67	0.77
2:F:77:LYS:NZ	2:F:81:LYS:HE3	1.90	0.76
7:S:60:MET:HE2	7:S:89:LEU:HD12	1.67	0.76
3:G:704:PRO:HA	7:S:37:LYS:HE3	1.67	0.75
2:F:258:LEU:HA	13:F:713:HOH:O	1.87	0.75
8:W:120:LYS:CD	8:W:124:LEU:CD2	2.58	0.74
6:R:73:GLU:OE2	13:R:301:HOH:O	2.02	0.74
2:F:236:LEU:HB3	13:F:713:HOH:O	1.87	0.73
7:S:4:ARG:CD	13:S:117:HOH:O	2.34	0.73
7:S:2:ALA:N	13:S:101:HOH:O	2.21	0.72
8:W:120:LYS:HD3	8:W:124:LEU:HD21	1.71	0.71

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
7:S:14:LEU:HD11	7:S:60:MET:HE3	1.74	0.70
1:E:121:LYS:O	13:E:601:HOH:O	2.10	0.69
3:G:350:ARG:NH2	3:G:612:TYR:O	2.27	0.67
2:F:409:ARG:HA	13:G:1100:HOH:O	1.94	0.67
1:E:172:MET:HB3	2:F:182:ARG:NH1	2.10	0.66
9:E:500:FES:S1	13:E:685:HOH:O	2.54	0.65
3:G:264:VAL:HA	3:G:267:ILE:HG12	1.79	0.64
3:G:266:ASP:OD2	3:G:333:ARG:NH2	2.23	0.64
2:F:319:LEU:HD21	2:F:340:ILE:HG21	1.79	0.64
2:F:182:ARG:HE	2:F:184:GLU:CD	2.06	0.63
2:F:334:TRP:NE1	2:F:356:GLU:OE2	2.32	0.63
2:F:185:TYR:HB3	2:F:188:GLU:HB2	1.81	0.62
2:F:470:GLU:OE2	2:F:474:ARG:NH2	2.33	0.61
2:F:77:LYS:NZ	2:F:81:LYS:HZ2	1.87	0.61
6:R:73:GLU:OE1	6:R:78:PRO:CG	2.49	0.60
2:F:388:ASP:OD1	2:F:392:ARG:NH1	2.35	0.60
7:S:53:CYS:SG	13:S:111:HOH:O	2.57	0.60
3:G:92:LEU:O	3:G:96:GLU:HG2	2.02	0.59
13:F:686:HOH:O	3:G:164:MET:CE	2.51	0.59
1:E:172:MET:HB3	2:F:182:ARG:CZ	2.34	0.57
7:S:3:TRP:N	13:S:101:HOH:O	2.05	0.57
2:F:398:LYS:NZ	13:F:603:HOH:O	2.30	0.57
7:S:60:MET:HE1	7:S:86:LEU:HA	1.87	0.57
7:S:4:ARG:CG	13:S:117:HOH:O	2.53	0.56
3:G:349:ILE:HD12	3:G:359:VAL:HG21	1.86	0.56
3:G:704:PRO:HA	7:S:37:LYS:CE	2.35	0.56
1:E:144:GLU:O	1:E:148:LEU:HD22	2.06	0.56
7:S:18:LEU:HD13	7:S:29:ARG:HG2	1.88	0.56
7:S:10:SER:HB2	7:S:94:ALA:HB1	1.89	0.55
3:G:349:ILE:HD11	3:G:364:ALA:HA	1.87	0.55
3:G:485:LEU:HD21	3:G:502:PHE:CD2	2.41	0.55
1:E:172:MET:CB	2:F:182:ARG:NH1	2.70	0.55
2:F:304:HIS:HD2	2:F:381:ASP:H	1.53	0.55
3:G:112:SER:N	13:G:930:HOH:O	2.39	0.54
7:S:37:LYS:HB2	13:S:102:HOH:O	2.06	0.54
1:E:128:LEU:HB2	1:E:182:THR:HB	1.90	0.54
7:S:37:LYS:CB	13:S:102:HOH:O	2.54	0.54
2:F:306:ASN:ND2	2:F:328:GLY:O	2.34	0.54
2:F:181:ILE:HD11	2:F:192:LEU:HD23	1.88	0.53
3:G:317:PRO:HG3	3:G:328:ILE:HG12	1.90	0.53
2:F:348:PRO:HG3	2:F:456:TRP:HB3	1.89	0.53

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:G:646:THR:OG1	3:G:650:ALA:HB3	2.09	0.53
2:F:309:CYS:SG	13:F:742:HOH:O	2.59	0.53
3:G:336:TYR:HA	13:G:935:HOH:O	2.08	0.53
1:E:174:CYS:SG	13:F:745:HOH:O	2.55	0.53
2:F:148:CYS:N	13:F:621:HOH:O	2.42	0.53
3:G:76:VAL:HG12	3:G:139:LEU:O	2.09	0.53
5:Q:134:LEU:HD12	5:Q:136:LYS:HZ3	1.74	0.52
1:E:40:ASP:OD1	1:E:121:LYS:HD2	2.09	0.52
2:F:456:TRP:CE2	13:F:723:HOH:O	2.60	0.52
3:G:169:ASP:HB2	3:G:172:ILE:HG12	1.92	0.52
3:G:421:LEU:HD12	3:G:703:LYS:HE3	1.92	0.52
3:G:514:ILE:HD12	3:G:542:VAL:HG11	1.91	0.52
7:S:58:PRO:HB2	7:S:74:LEU:HB2	1.91	0.52
1:E:179:PRO:O	1:E:201:VAL:HG22	2.10	0.52
2:F:286:SER:HA	2:F:294:ALA:HB1	1.91	0.51
3:G:83:VAL:HG11	3:G:98:ALA:HB2	1.92	0.51
6:R:88:CYS:SG	13:R:332:HOH:O	2.60	0.51
1:E:181:ILE:HG23	1:E:201:VAL:HG21	1.92	0.51
6:R:98:LYS:HD2	13:R:312:HOH:O	2.10	0.51
8:W:121:THR:HG23	8:W:123:PHE:H	1.75	0.50
2:F:64:ILE:HG12	2:F:276:THR:HG21	1.93	0.50
3:G:408:VAL:HG13	13:G:903:HOH:O	2.12	0.50
2:F:87:ARG:H	2:F:87:ARG:CZ	2.24	0.49
3:G:145:LYS:HB3	3:G:148:THR:HG23	1.94	0.49
7:S:64:TYR:HE1	7:S:94:ALA:HB2	1.76	0.49
2:F:388:ASP:OD1	2:F:392:ARG:HD2	2.12	0.49
2:F:456:TRP:CD2	13:F:723:HOH:O	2.55	0.49
3:G:119:MET:HG2	3:G:184:GLN:HE22	1.78	0.48
3:G:714:PRO:O	3:G:716:GLN:NE2	2.45	0.48
3:G:422:ARG:NH1	3:G:564:ASP:OD2	2.47	0.48
1:E:133:THR:OG1	2:F:392:ARG:HB3	2.14	0.47
2:F:416:TRP:NE1	2:F:420:GLU:OE2	2.48	0.47
3:G:125:GLU:HB2	3:G:143:LYS:HB2	1.96	0.47
3:G:224:CYS:HA	3:G:267:ILE:HD11	1.97	0.47
2:F:283:GLU:HG2	13:F:699:HOH:O	2.13	0.47
1:E:133:THR:CG2	13:F:739:HOH:O	2.63	0.47
13:F:686:HOH:O	3:G:164:MET:HE2	2.13	0.47
3:G:481:ASP:N	3:G:481:ASP:OD1	2.46	0.47
2:F:64:ILE:HG21	2:F:273:VAL:HG12	1.97	0.47
2:F:182:ARG:NH2	2:F:184:GLU:OE1	2.44	0.46
2:F:104:LYS:HG2	2:F:119:GLY:HA3	1.96	0.46

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:F:476:ARG:HB3	13:F:634:HOH:O	2.15	0.46
5:Q:58:SER:OG	13:Q:201:HOH:O	2.08	0.46
2:F:362:PHE:O	2:F:366:LYS:HB2	2.16	0.46
1:E:132:THR:HB	13:E:679:HOH:O	2.14	0.46
3:G:645:PRO:HG3	5:Q:83:LYS:HG2	1.97	0.46
2:F:132:ARG:HG2	5:Q:146:TRP:CE3	2.50	0.46
3:G:408:VAL:HG13	3:G:408:VAL:O	2.16	0.46
2:F:193:GLU:HG3	2:F:197:ARG:NH1	2.31	0.46
3:G:526:LYS:HB3	3:G:526:LYS:HE3	1.71	0.45
2:F:334:TRP:O	2:F:352:LYS:NZ	2.47	0.45
6:R:52:SER:OG	6:R:55:GLU:HG3	2.16	0.45
2:F:408:CYS:HB3	11:F:501:SF4:S4	2.56	0.45
3:G:302:ASN:HB3	3:G:318:ARG:HB3	1.98	0.45
7:S:64:TYR:CE1	7:S:94:ALA:HB2	2.52	0.45
2:F:84:ASP:OD1	2:F:160:LYS:HG2	2.16	0.45
3:G:364:ALA:O	3:G:368:VAL:HG23	2.17	0.45
5:Q:83:LYS:HB3	5:Q:83:LYS:HE2	1.86	0.45
3:G:408:VAL:CG1	13:G:903:HOH:O	2.64	0.45
3:G:489:PRO:HB3	3:G:710:MET:SD	2.56	0.45
2:F:343:GLY:HA3	2:F:372:LEU:O	2.15	0.45
2:F:407:PRO:HG2	2:F:446:THR:HG22	1.98	0.45
1:E:178:ALA:CB	1:E:200:ASP:H	2.30	0.45
3:G:402:ARG:CZ	3:G:666:VAL:HG13	2.47	0.44
3:G:703:LYS:HD3	3:G:703:LYS:HA	1.59	0.44
1:E:198:PHE:CZ	1:E:219:PRO:HG2	2.53	0.44
3:G:702:LEU:HB3	7:S:36:TYR:CD2	2.51	0.44
3:G:371:ILE:HD13	3:G:599:PHE:CD1	2.53	0.44
3:G:637:THR:HG22	3:G:690:THR:HG22	1.98	0.44
3:G:169:ASP:HA	6:R:99:TYR:OH	2.18	0.44
3:G:514:ILE:HD11	3:G:542:VAL:HG21	2.00	0.44
8:W:125:LYS:H	8:W:125:LYS:HG2	1.66	0.44
2:F:429:LEU:HD22	2:F:470:GLU:HG2	2.00	0.44
3:G:256:MET:HE2	3:G:261:SER:HB2	2.00	0.44
2:F:168:ALA:HB1	2:F:172:MET:HE3	2.00	0.43
2:F:360:MET:HE3	2:F:360:MET:HB3	1.86	0.43
1:E:161:ASP:OD1	1:E:161:ASP:N	2.48	0.43
2:F:191:ASN:HB2	13:F:732:HOH:O	2.17	0.43
3:G:486:GLY:HA3	3:G:491:THR:OG1	2.19	0.43
3:G:205:LYS:O	3:G:213:THR:OG1	2.30	0.43
3:G:634:GLU:CD	3:G:693:ARG:HH12	2.26	0.43
3:G:75:GLU:OE2	3:G:82:ALA:HB1	2.19	0.43

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:F:435:LEU:O	2:F:439:THR:HG23	2.19	0.43
1:E:136:MET:HA	1:E:140:SER:H	1.83	0.43
3:G:598:ALA:O	3:G:613:ARG:NH2	2.44	0.43
3:G:317:PRO:HB3	3:G:328:ILE:HG23	2.01	0.43
2:F:138:VAL:HG21	2:F:165:CYS:SG	2.59	0.42
1:E:202:THR:H	1:E:205:LYS:HB3	1.83	0.42
3:G:230:GLU:HG2	3:G:463:ARG:CZ	2.50	0.42
2:F:60:ASP:HA	2:F:63:ARG:HG3	2.01	0.42
2:F:77:LYS:NZ	2:F:81:LYS:HZ1	2.10	0.42
3:G:702:LEU:HB3	7:S:36:TYR:HD2	1.85	0.42
2:F:77:LYS:CG	2:F:81:LYS:HE3	2.49	0.42
3:G:221:CYS:SG	3:G:223:ARG:HG3	2.60	0.42
3:G:653:ASP:O	3:G:657:VAL:HG23	2.20	0.42
1:E:131:GLY:HA2	1:E:169:MET:HG2	2.00	0.42
6:R:73:GLU:OE1	6:R:78:PRO:HB3	2.19	0.42
6:R:73:GLU:OE1	6:R:78:PRO:CB	2.67	0.42
3:G:110:ARG:HH22	3:G:321:GLU:CD	2.26	0.42
3:G:108:HIS:HB3	3:G:111:LEU:HD12	2.01	0.42
1:E:67:ASN:O	5:Q:147:LYS:NZ	2.51	0.41
2:F:440:LYS:HD3	2:F:440:LYS:HA	1.82	0.41
2:F:138:VAL:HG11	2:F:161:LEU:HD11	2.02	0.41
3:G:104:ARG:HB2	9:G:801:FES:S2	2.60	0.41
3:G:377:PRO:O	3:G:405:SER:HB2	2.20	0.41
1:E:205:LYS:HE2	1:E:205:LYS:HB2	1.61	0.41
2:F:85:TRP:CD2	2:F:204:LEU:HD13	2.56	0.41
3:G:571:SER:HB2	3:G:574:ALA:HB2	2.03	0.41
3:G:590:ASN:ND2	3:G:593:LYS:HG3	2.34	0.41
6:R:68:ARG:NH2	13:R:304:HOH:O	2.53	0.41
8:W:124:LEU:HG	8:W:128:TYR:CE2	2.55	0.41
3:G:77:PHE:HA	3:G:81:TYR:O	2.21	0.41
1:E:215:LYS:HA	1:E:215:LYS:HD3	1.67	0.41
2:F:148:CYS:SG	13:F:745:HOH:O	2.55	0.41
3:G:585:GLY:N	3:G:603:GLN:O	2.53	0.41
2:F:177:ALA:HB2	2:F:216:PHE:CZ	2.55	0.41
3:G:276:LYS:HE3	3:G:276:LYS:HB2	1.87	0.41
1:E:114:TYR:HB3	2:F:224:ALA:O	2.21	0.40
1:E:176:VAL:HG13	2:F:308:PRO:HG2	2.02	0.40
3:G:493:LYS:HE2	3:G:493:LYS:HB3	1.83	0.40
2:F:320:LYS:HZ3	2:F:334:TRP:CG	2.39	0.40
3:G:331:LYS:O	3:G:335:CYS:HB3	2.22	0.40
2:F:416:TRP:O	2:F:420:GLU:HG2	2.21	0.40

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
3:G:64:ARG:NH1	5:Q:134:LEU:HD23	2.36	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	E	190/255 (74%)	178 (94%)	12 (6%)	0	100	100
2	F	432/486 (89%)	421 (98%)	11 (2%)	0	100	100
3	G	685/748 (92%)	670 (98%)	15 (2%)	0	100	100
4	I	6/222 (3%)	6 (100%)	0	0	100	100
5	Q	103/154 (67%)	100 (97%)	3 (3%)	0	100	100
6	R	71/110 (64%)	70 (99%)	1 (1%)	0	100	100
7	S	91/97 (94%)	89 (98%)	2 (2%)	0	100	100
8	W	13/133 (10%)	12 (92%)	1 (8%)	0	100	100
All	All	1591/2205 (72%)	1546 (97%)	45 (3%)	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	E	166/220 (76%)	165 (99%)	1 (1%)	78	79
2	F	353/396 (89%)	352 (100%)	1 (0%)	86	86
3	G	570/625 (91%)	568 (100%)	2 (0%)	84	84
4	I	7/195 (4%)	7 (100%)	0	100	100
5	Q	89/128 (70%)	89 (100%)	0	100	100
6	R	64/97 (66%)	64 (100%)	0	100	100
7	S	82/85 (96%)	82 (100%)	0	100	100
8	W	14/114 (12%)	14 (100%)	0	100	100
All	All	1345/1860 (72%)	1341 (100%)	4 (0%)	84	86

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	E	36	LEU
2	F	167	ILE
3	G	145	LYS
3	G	647	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	E	196	ASN
2	F	72	HIS
2	F	187	ASN
3	G	284	ASN
3	G	455	ASN
3	G	548	ASN
5	Q	65	GLN
6	R	109	HIS

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 oligosaccharides in this entry.

5.6 Ligand geometry (i)

Of 7 ligands modelled in this entry, 1 is monoatomic - leaving 6 for Mogul analysis.

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	$\#\|Z\| > 2$
9	FES	E	500	1	0,4,4	-	-	-		
11	SF4	G	802	3	0,12,12	-	-	-		
10	FMN	F	500	-	33,33,33	0.61	0	48,50,50	0.66	1 (2%)
11	SF4	F	501	2	0,12,12	-	-	-		
11	SF4	G	803	3	0,12,12	-	-	-		
9	FES	G	801	3	0,4,4	-	-	-		

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
9	FES	E	500	1	-	-	0/1/1/1
11	SF4	G	802	3	-	-	0/6/5/5
10	FMN	F	500	-	-	2/18/18/18	0/3/3/3
11	SF4	F	501	2	-	-	0/6/5/5
11	SF4	G	803	3	-	-	0/6/5/5
9	FES	G	801	3	-	-	0/1/1/1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
10	F	500	FMN	C4-N3-C2	-2.04	121.87	125.64

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
10	F	500	FMN	N10-C1'-C2'-O2'
10	F	500	FMN	N10-C1'-C2'-C3'

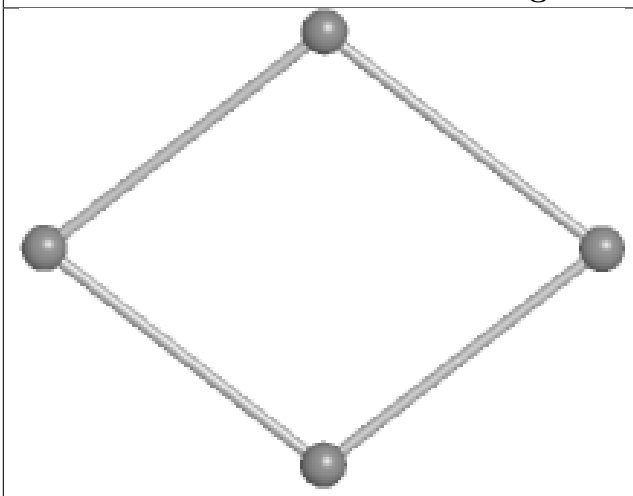
There are no ring outliers.

3 monomers are involved in 3 short contacts:

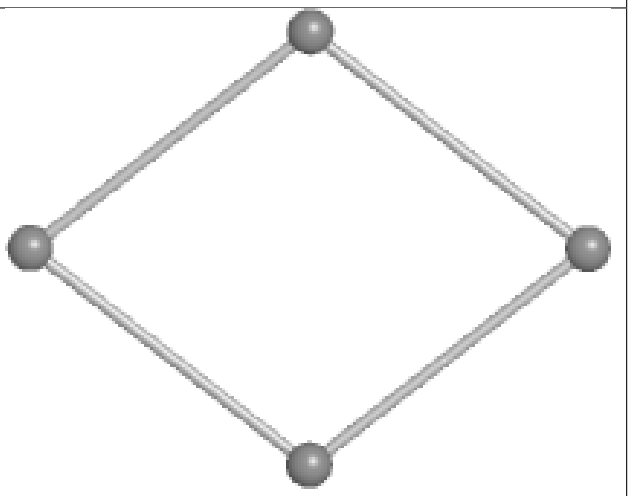
Mol	Chain	Res	Type	Clashes	Symm-Clashes
9	E	500	FES	1	0
11	F	501	SF4	1	0
9	G	801	FES	1	0

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 then 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.

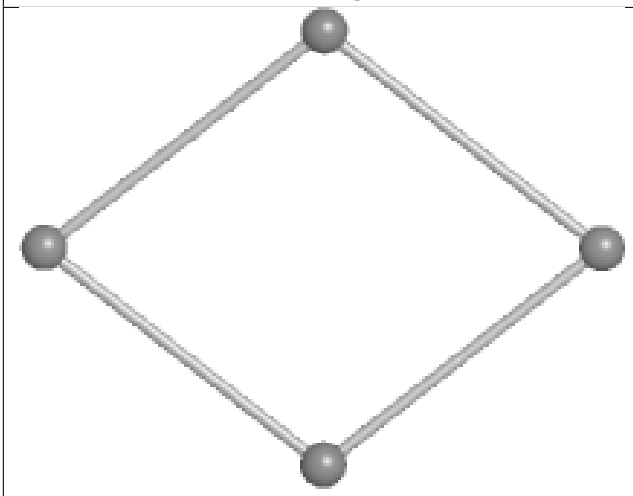
Ligand FES E 500



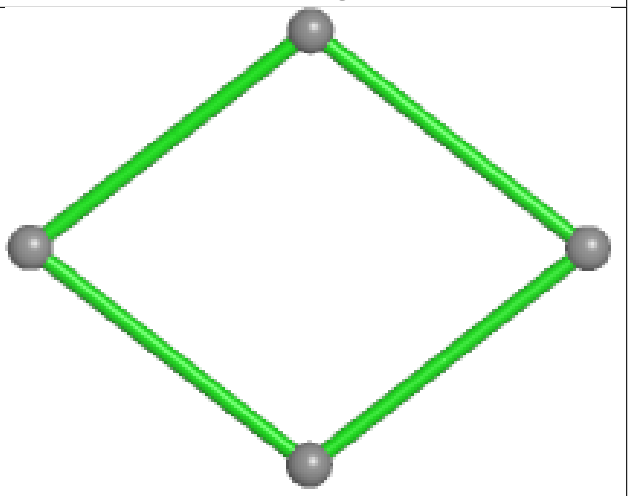
Bond lengths



Bond angles

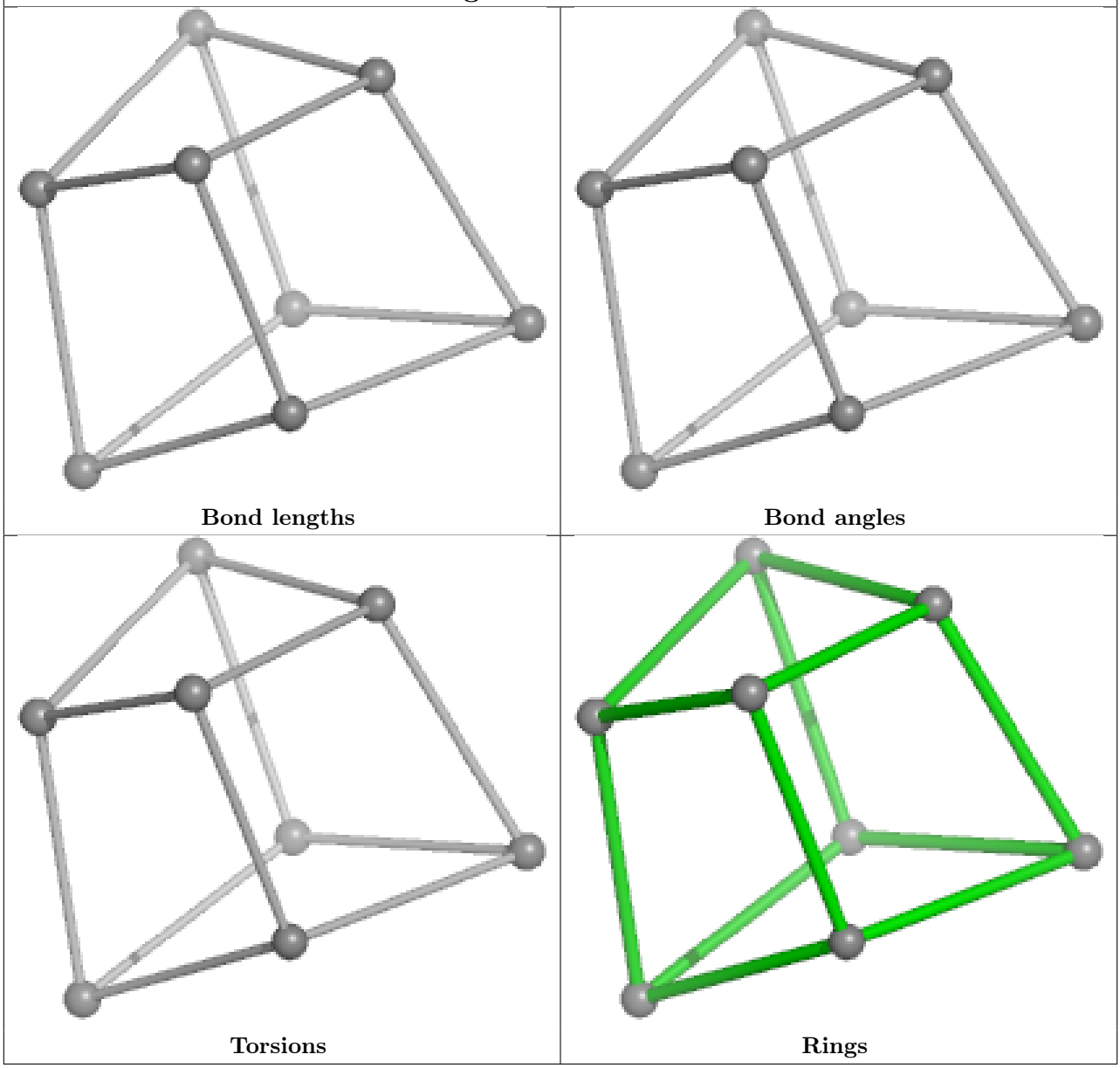


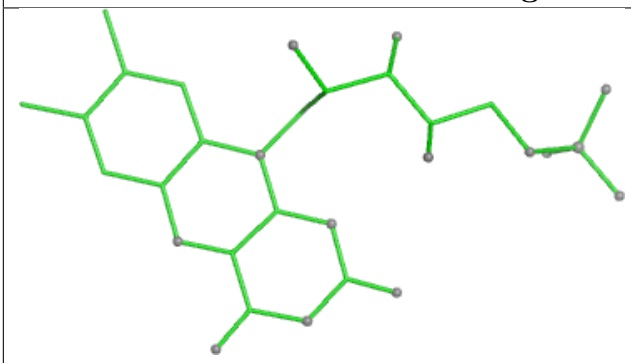
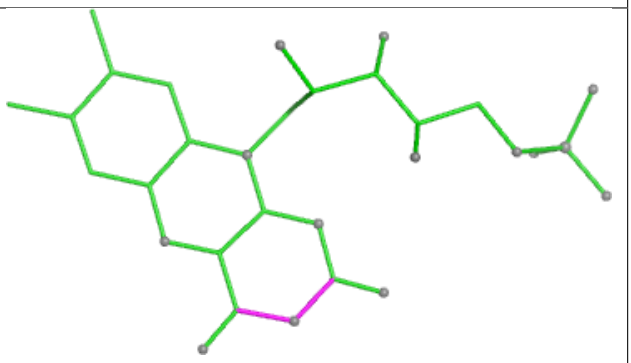
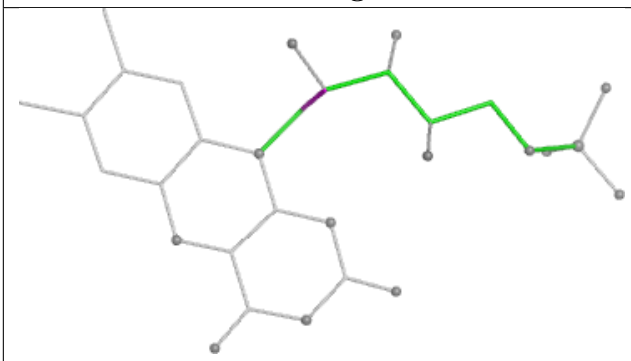
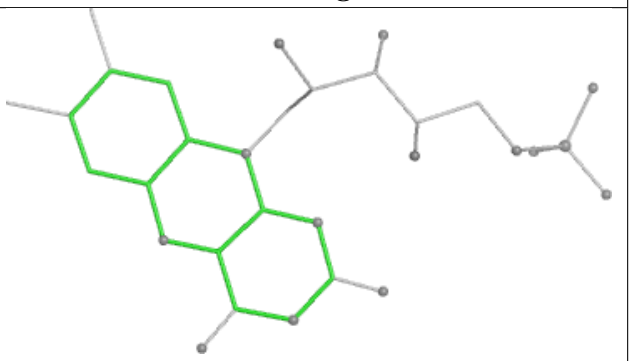
Torsions



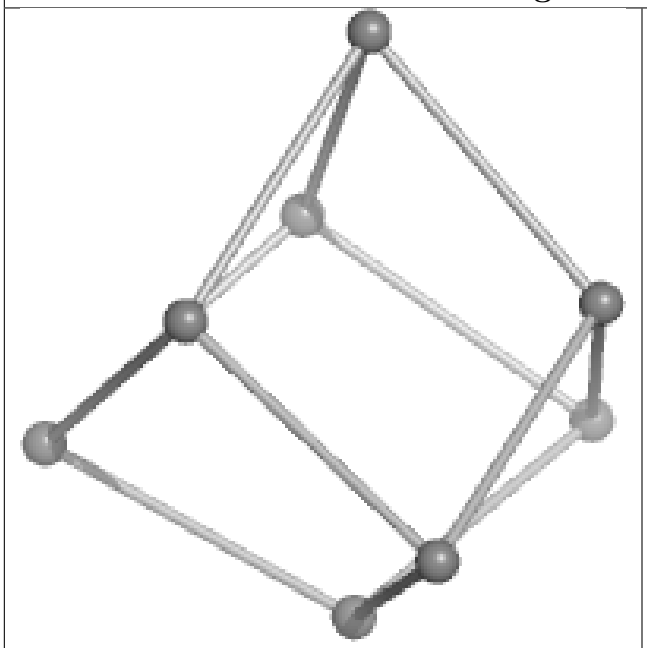
Rings

Ligand SF4 G 802

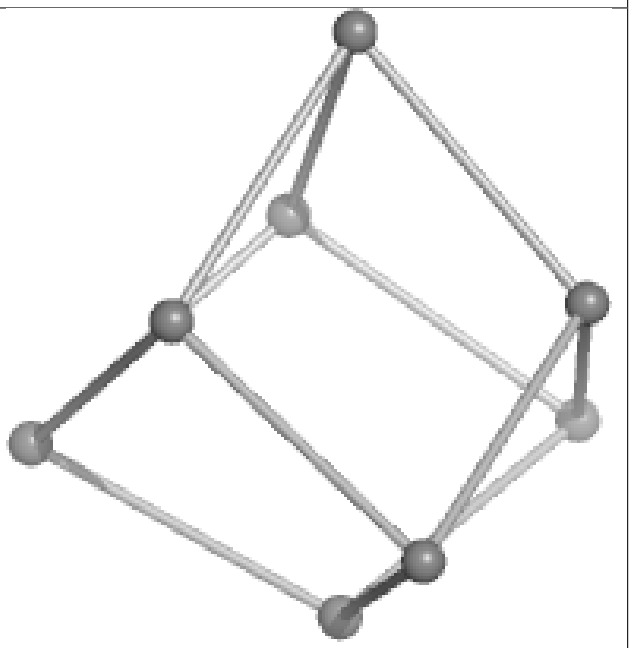


Ligand FMN F 500	
 Bond lengths	 Bond angles
 Torsions	 Rings

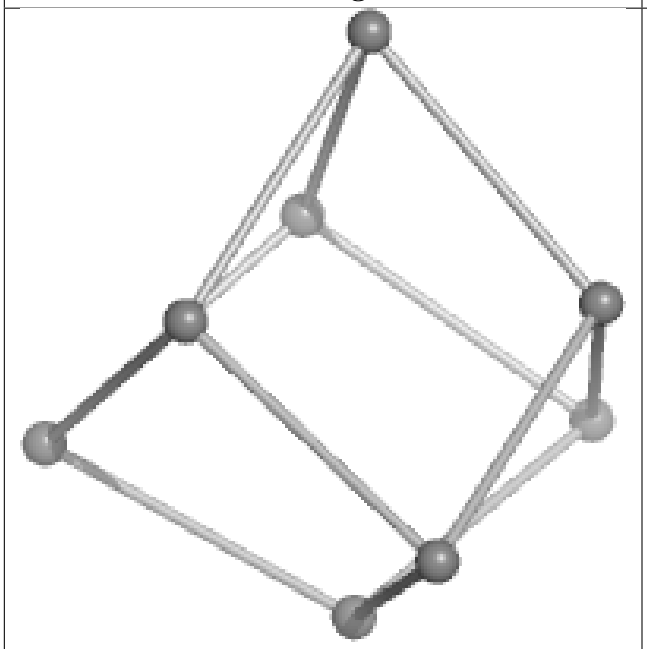
Ligand SF4 F 501



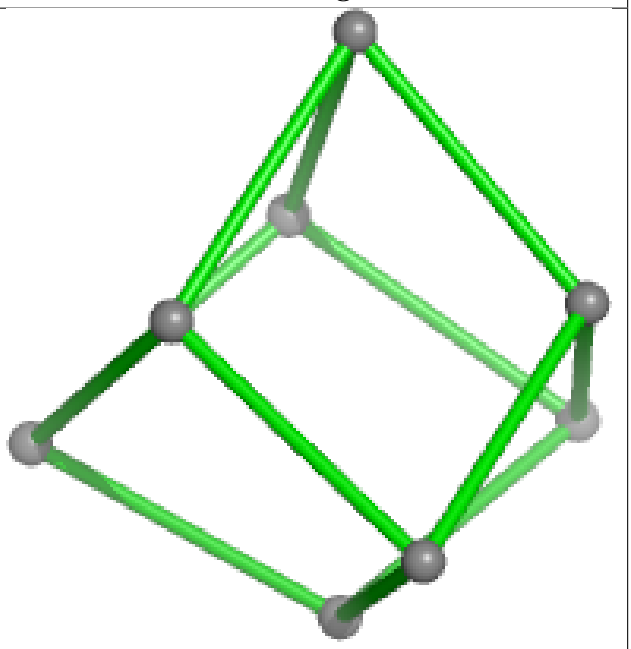
Bond lengths



Bond angles

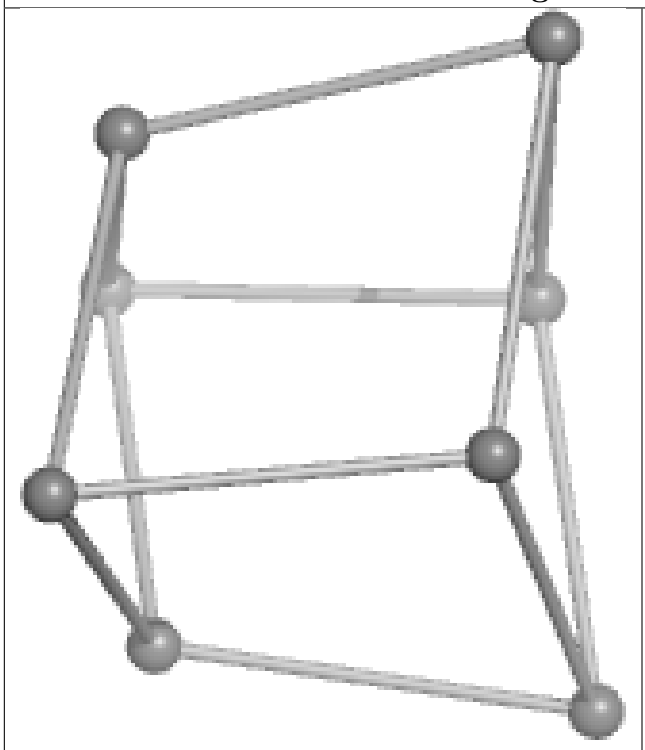


Torsions

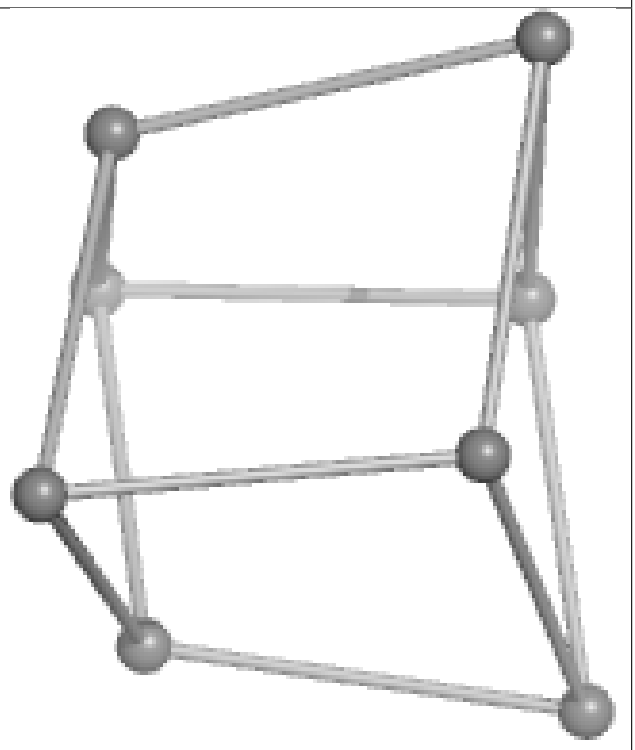


Rings

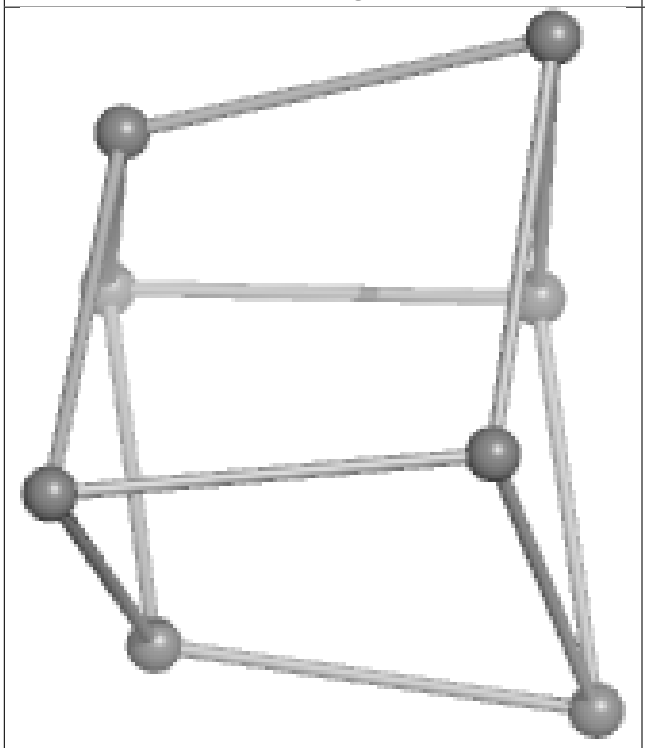
Ligand SF4 G 803



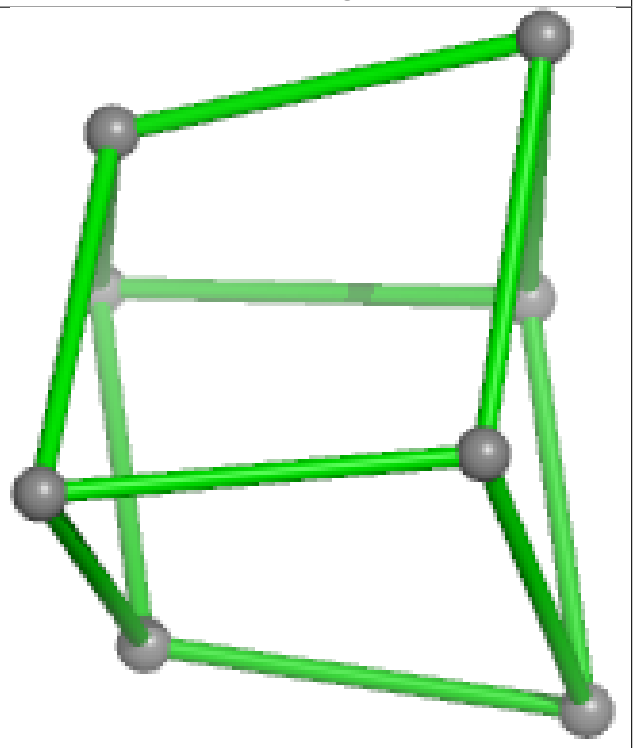
Bond lengths



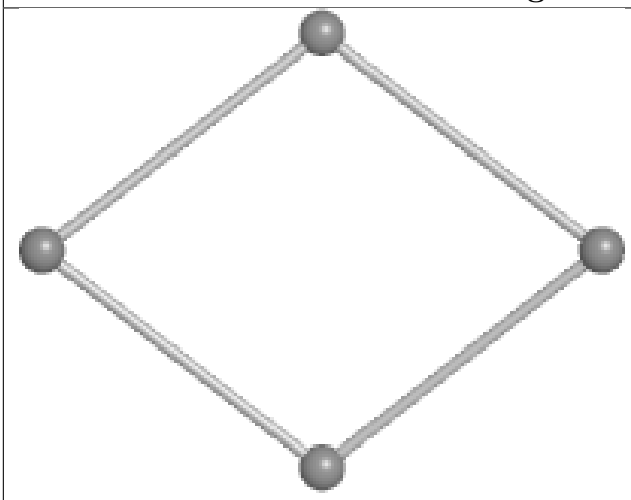
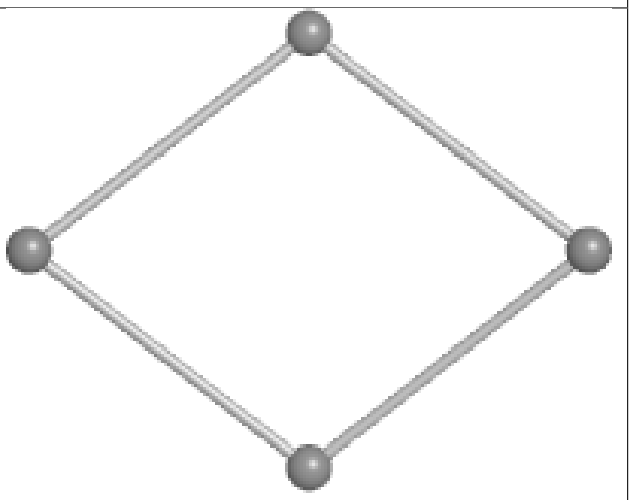
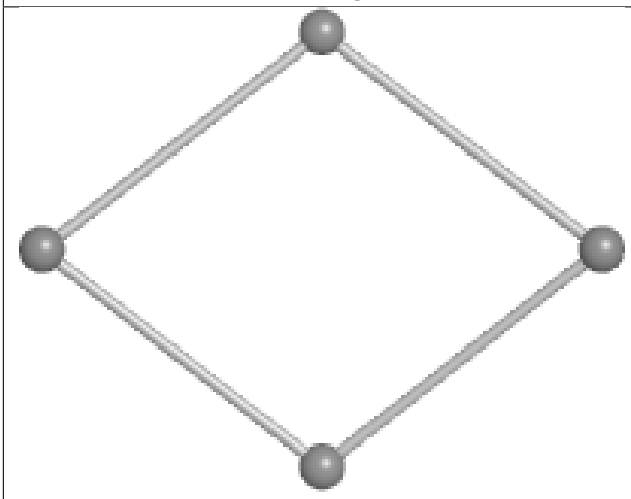
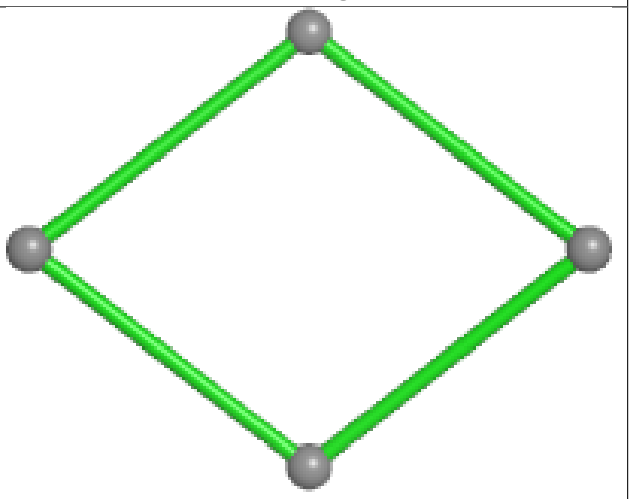
Bond angles



Torsions



Rings

Ligand FES G 801	
 Bond lengths	 Bond angles
 Torsions	 Rings

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.

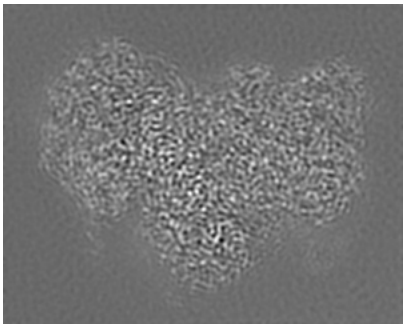
6 Map visualisation (i)

This section contains visualisations of the EMDB entry EMD-15998. These allow visual inspection of the internal detail of the map and identification of artifacts.

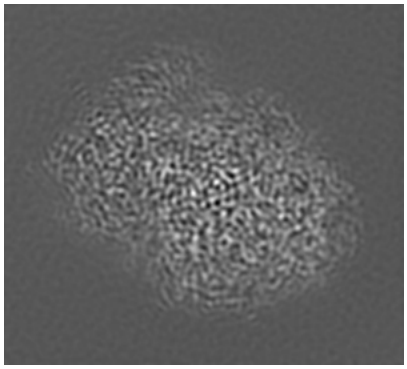
Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

6.1 Orthogonal projections (i)

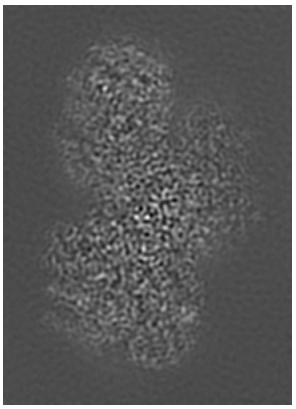
6.1.1 Primary map



X

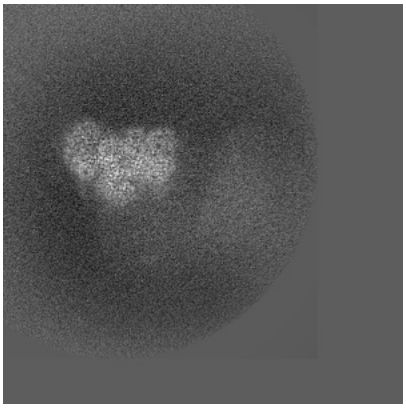


Y

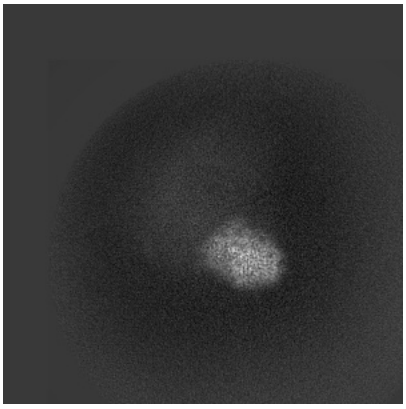


Z

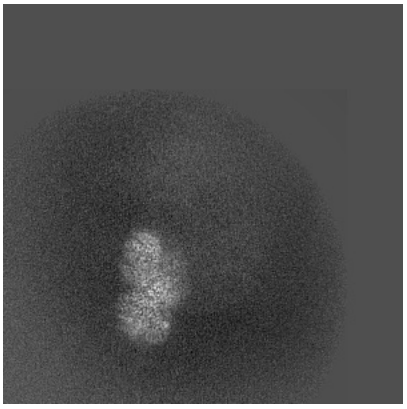
6.1.2 Raw map



X



Y

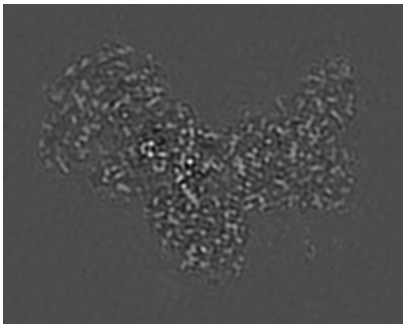


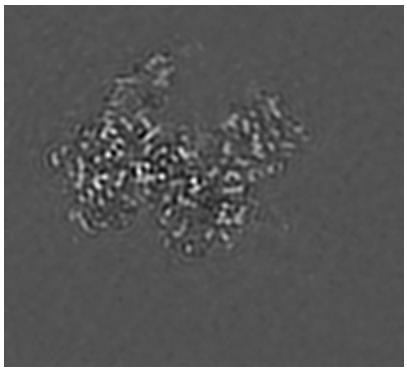
Z

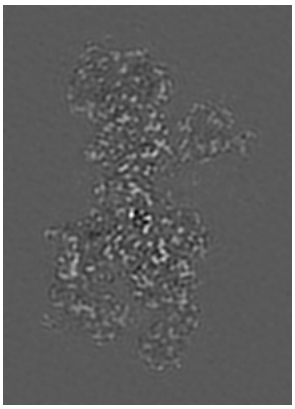
The images above show the map projected in three orthogonal directions.

6.2 Central slices (i)

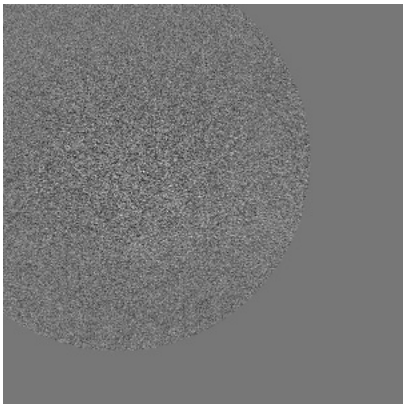
6.2.1 Primary map

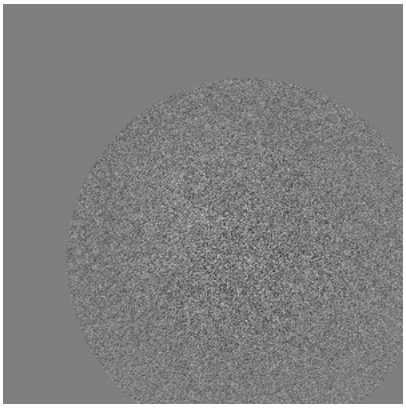

X Index: 92

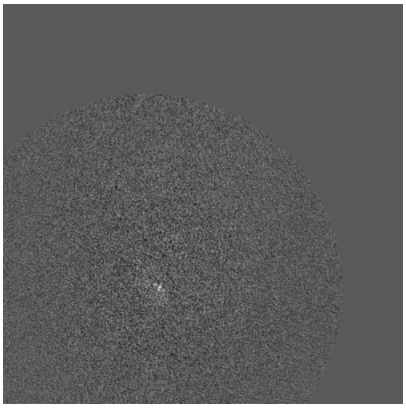

Y Index: 127


Z Index: 102

6.2.2 Raw map


X Index: 375

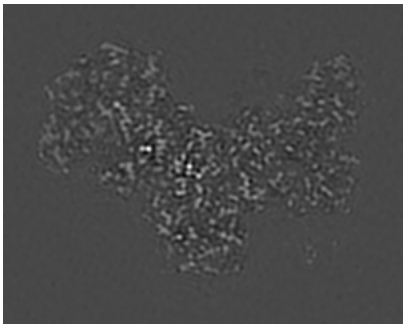

Y Index: 375


Z Index: 375

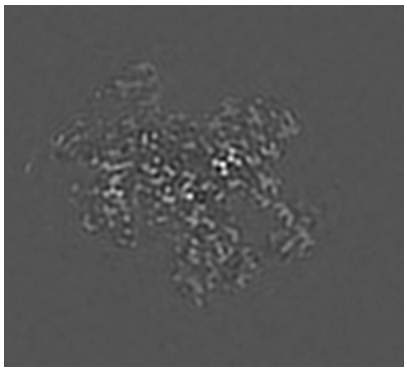
The images above show central slices of the map in three orthogonal directions.

6.3 Largest variance slices (i)

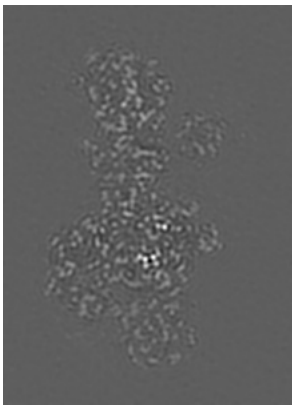
6.3.1 Primary map



X Index: 90

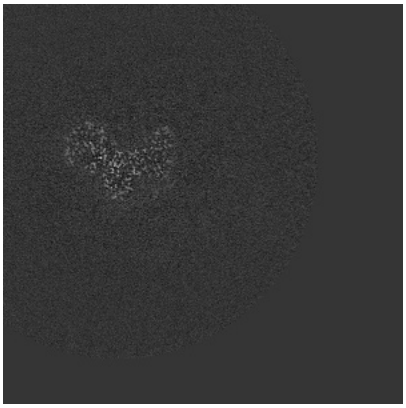


Y Index: 113

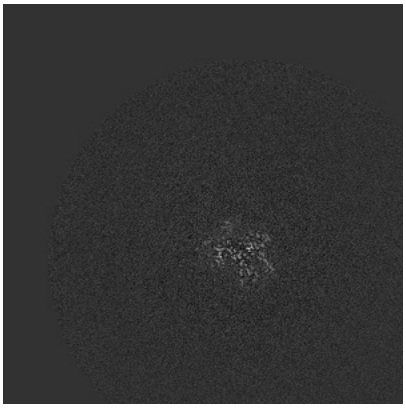


Z Index: 111

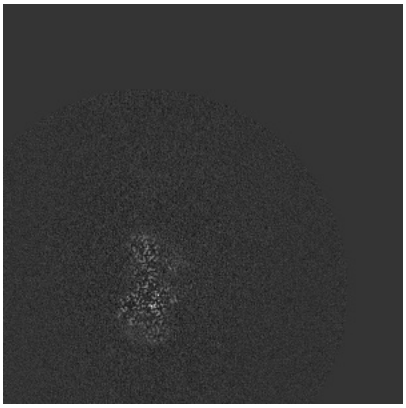
6.3.2 Raw map



X Index: 278



Y Index: 204

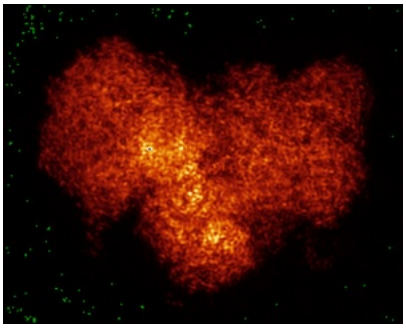


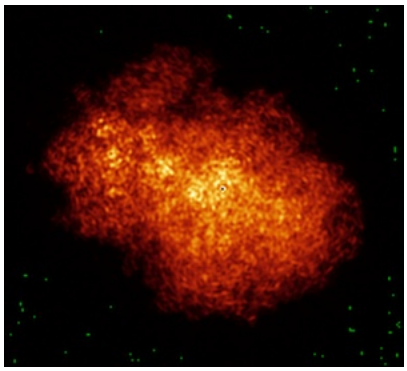
Z Index: 461

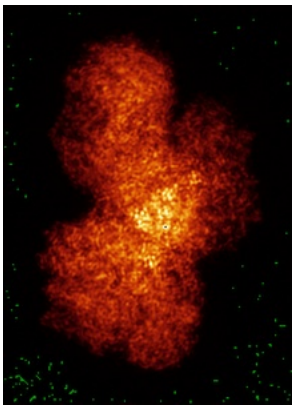
The images above show the largest variance slices of the map in three orthogonal directions.

6.4 Orthogonal standard-deviation projections (False-color) (i)

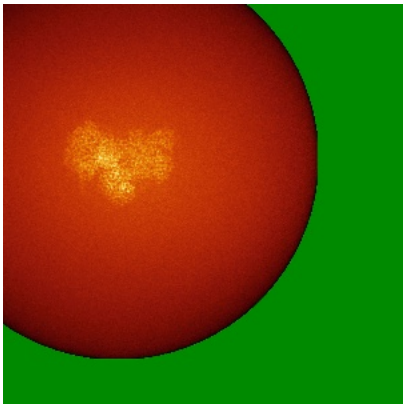
6.4.1 Primary map

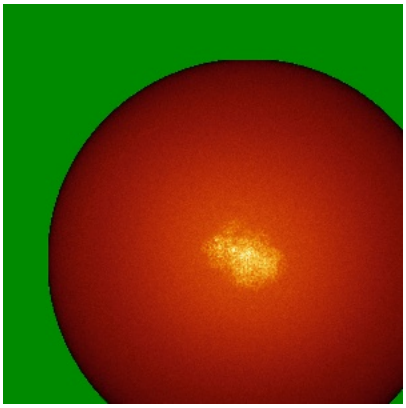

X

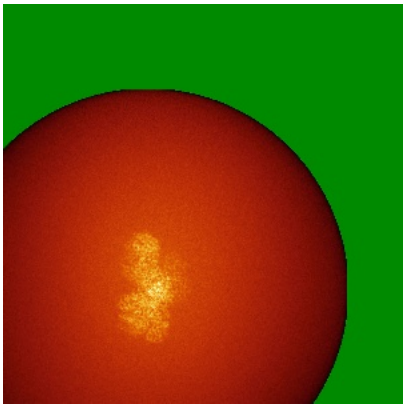

Y


Z

6.4.2 Raw 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.

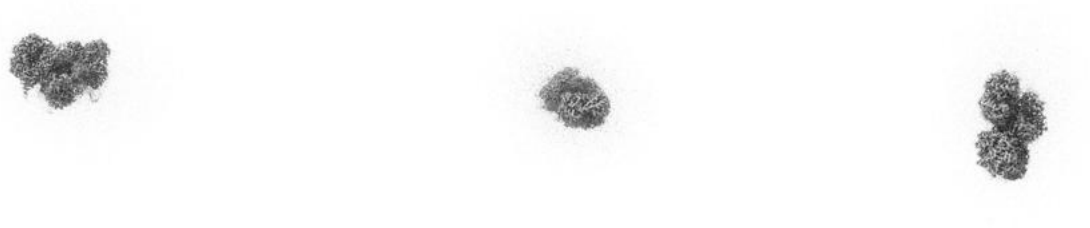
6.5 Orthogonal surface views (i)

6.5.1 Primary map

X Y Z

The images above show the 3D surface view of the map at the recommended contour level 0.8. These images, in conjunction with the slice images, may facilitate assessment of whether an appropriate contour level has been provided.

6.5.2 Raw map



X Y Z

These images show the 3D surface of the raw map. The raw map's contour level was selected so that its surface encloses the same volume as the primary map does at its recommended contour level.

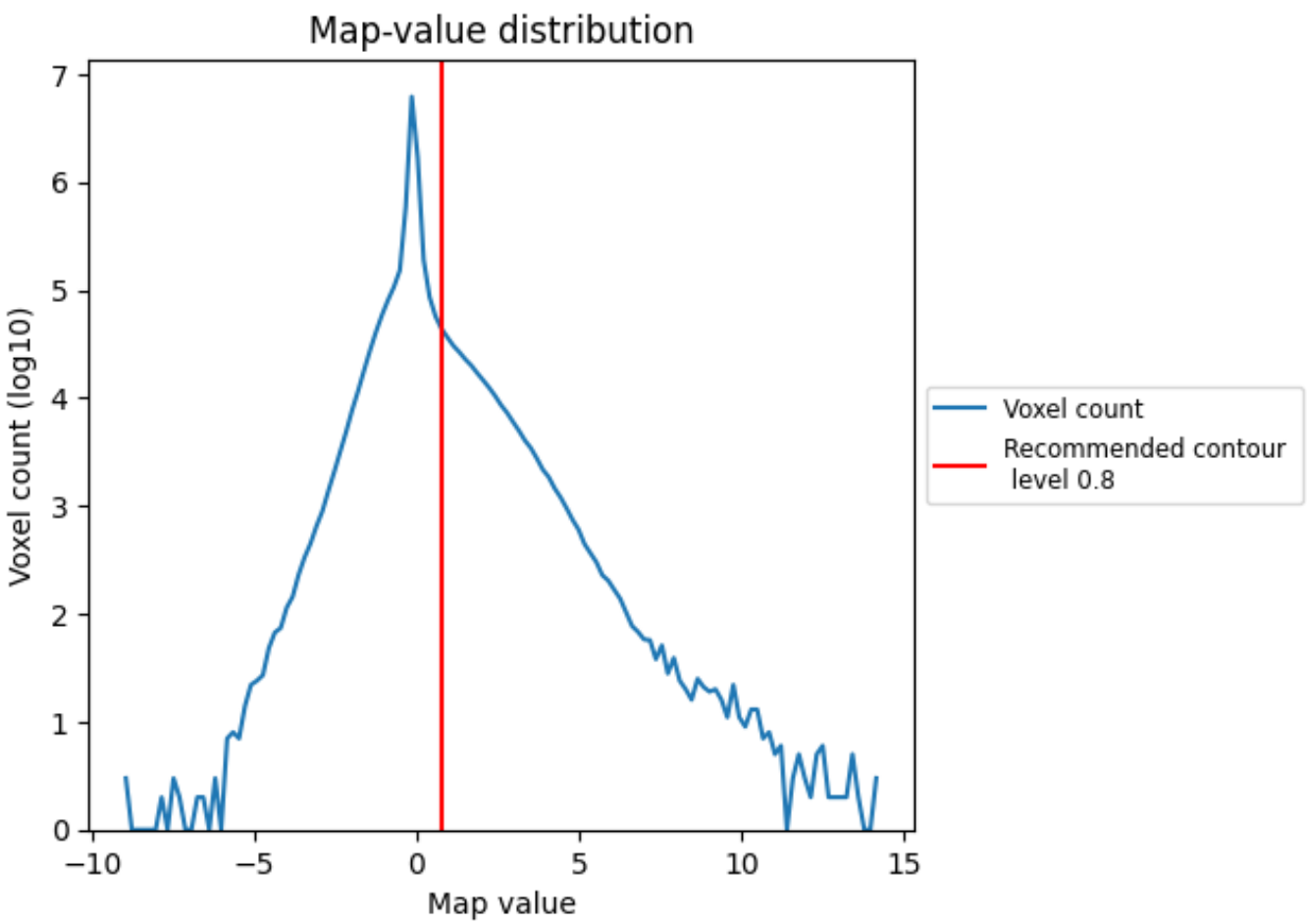
6.6 Mask visualisation (i)

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

7 Map analysis (i)

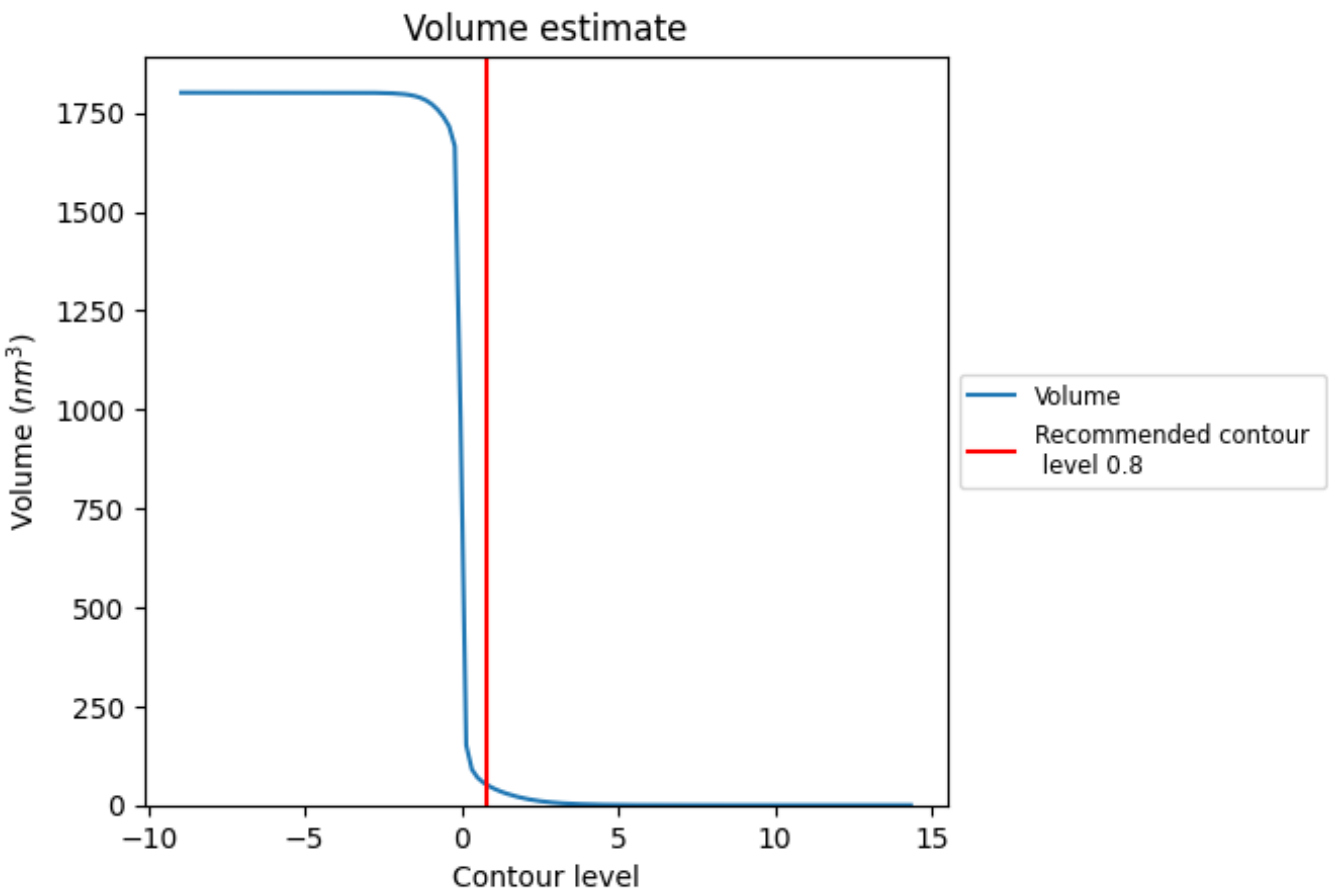
This section contains the results of statistical analysis of the map.

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 52 nm^3; this corresponds to an approximate mass of 47 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.

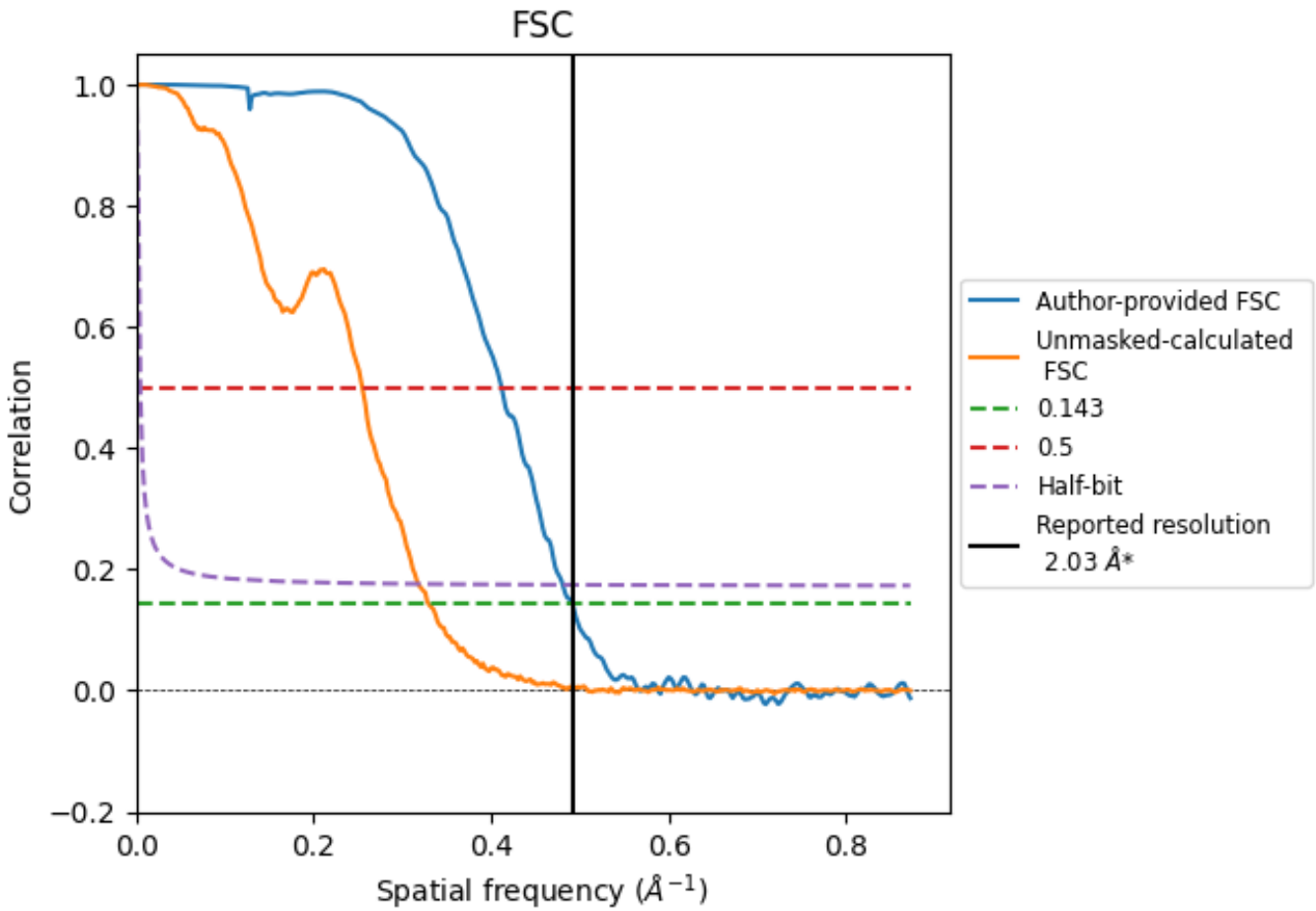
7.3 Rotationally averaged power spectrum (i)

This section was not generated. The rotationally averaged power spectrum is only generated for cubic maps.

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 0.493 Å^{-1}

8.2 Resolution estimates (i)

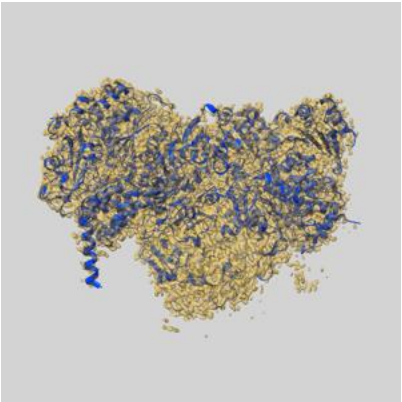
Resolution estimate (Å)	Estimation criterion (FSC cut-off)		
	0.143	0.5	Half-bit
Reported by author	2.03	-	-
Author-provided FSC curve	2.03	2.43	2.08
Unmasked-calculated*	3.03	3.92	3.15

*Resolution estimate based on FSC curve calculated by comparison of deposited half-maps. The value from deposited half-maps intersecting FSC 0.143 CUT-OFF 3.03 differs from the reported value 2.03 by more than 10 %

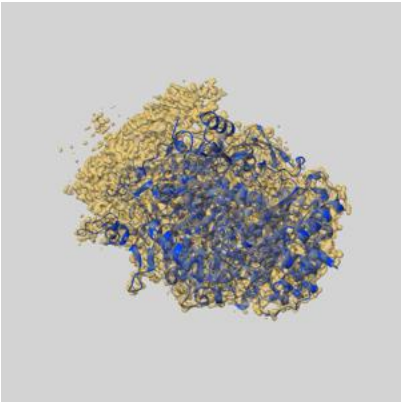
9 Map-model fit (i)

This section contains information regarding the fit between EMDB map EMD-15998 and PDB model 8BED. Per-residue inclusion information can be found in section 3 on page 8.

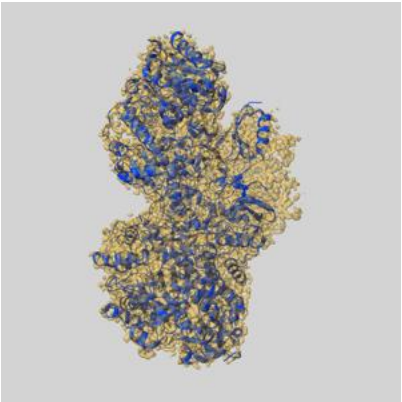
9.1 Map-model overlay (i)



X



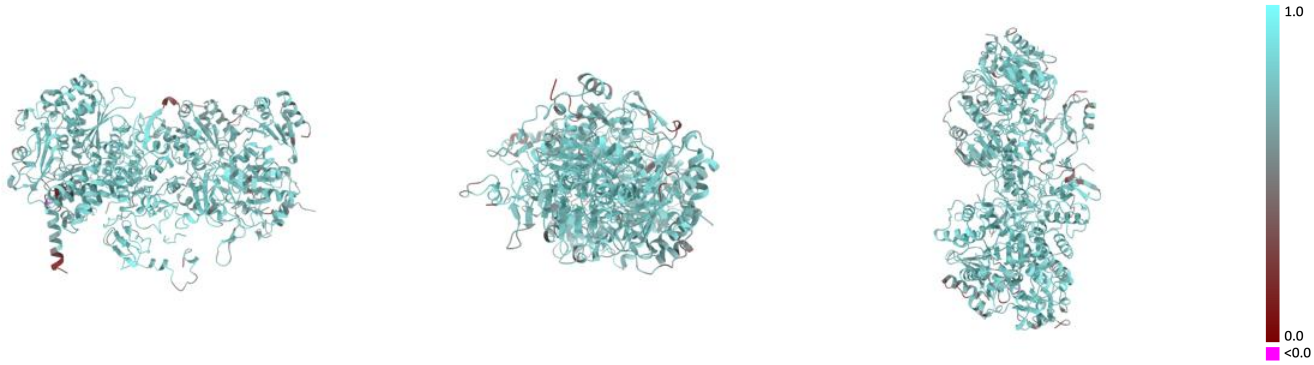
Y



Z

The images above show the 3D surface view of the map at the recommended contour level 0.8 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.

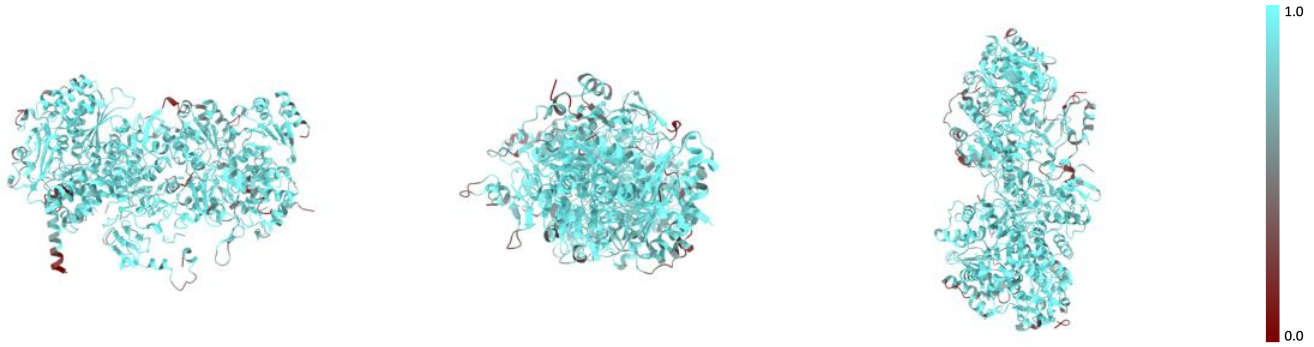
9.2 Q-score mapped to coordinate model (i)



X Y Z

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.

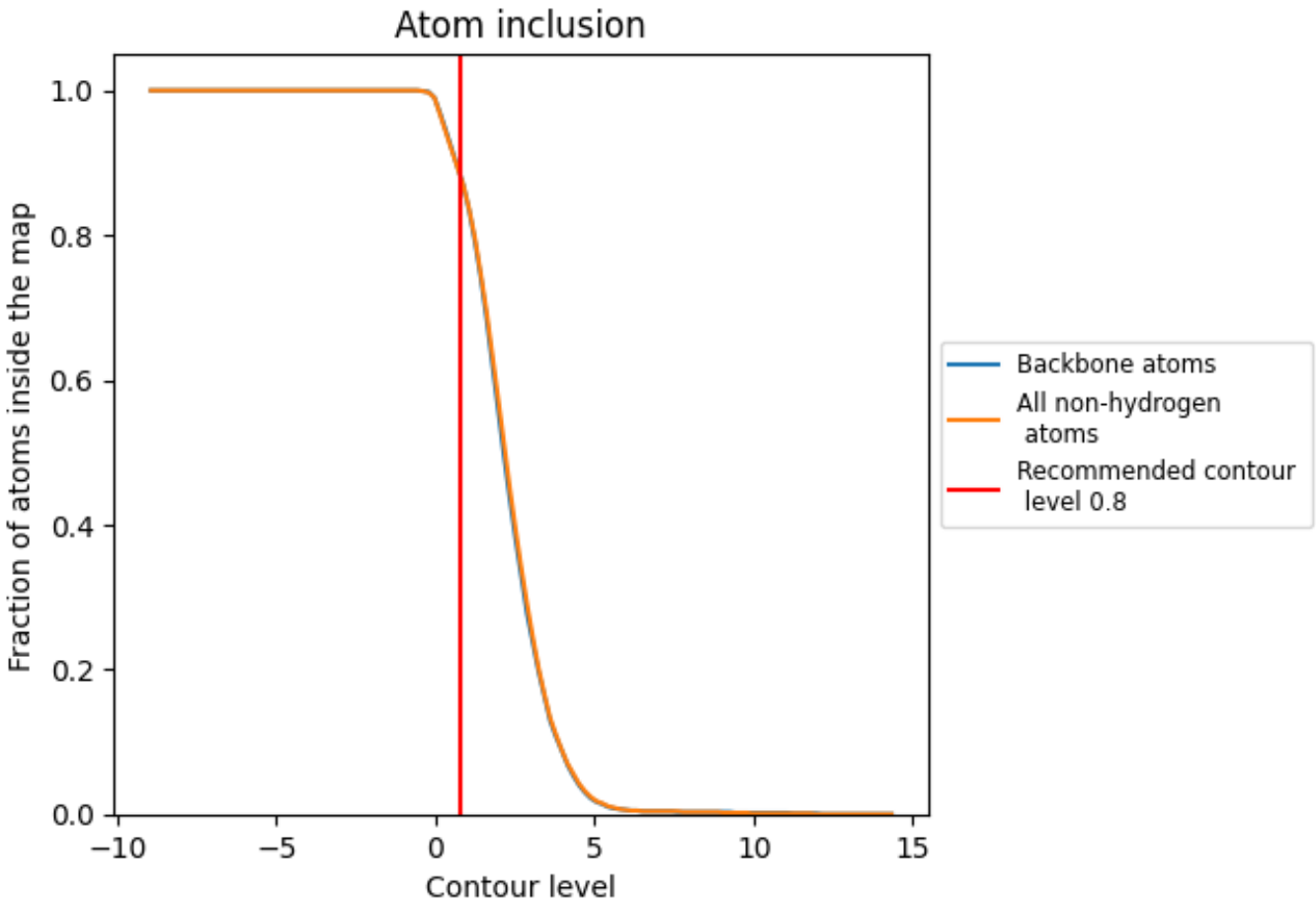
9.3 Atom inclusion mapped to coordinate model (i)



X Y Z

The images above show the model with each residue coloured according to its atom inclusion. This shows to what extent they are inside the map at the recommended contour level (0.8).

9.4 Atom inclusion (i)



At the recommended contour level, 88% of all backbone atoms, 88% of all non-hydrogen atoms, are inside the map.

9.5 Map-model fit summary (i)

The table lists the average atom inclusion at the recommended contour level (0.8) and Q-score for the entire model and for each chain.

Chain	Atom inclusion	Q-score
All	0.8790	0.7280
E	0.8180	0.6730
F	0.9210	0.7480
G	0.9040	0.7450
I	0.9050	0.7920
Q	0.7070	0.6650
R	0.8490	0.7210
S	0.8860	0.7060
W	0.7980	0.6710