



wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 10, 2024 – 10:44 AM EST

PDB ID : 2PCC
Title : CRYSTAL STRUCTURE OF A COMPLEX BETWEEN ELECTRON TRANSFER PARTNERS, CYTOCHROME C PEROXIDASE AND CYTOCHROME C
Authors : Pelletier, H.; Kraut, J.
Deposited on : 1993-04-14
Resolution : 2.30 Å(reported)

This is a wwPDB X-ray Structure 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/XrayValidationReportHelp>

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:

MolProbity : 4.02b-467
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.36
buster-report : 1.1.7 (2018)
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac : 5.8.0158
CCP4 : 7.0.044 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : 2.36

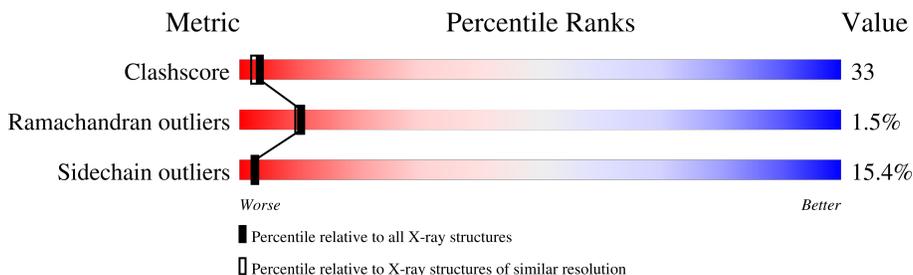
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.30 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)	Similar resolution (#Entries, resolution range(Å))
Clashscore	141614	5643 (2.30-2.30)
Ramachandran outliers	138981	5575 (2.30-2.30)
Sidechain outliers	138945	5575 (2.30-2.30)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower 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 $\leq 5\%$

Mol	Chain	Length	Quality of chain
1	A	296	44% (green) 40% (yellow) 12% (orange) 4% (red) 0% (grey)
1	C	296	46% (green) 38% (yellow) 13% (orange) 3% (red) 0% (grey)
2	B	108	39% (green) 45% (yellow) 15% (orange) 1% (red) 0% (grey)
2	D	108	32% (green) 46% (yellow) 19% (orange) 3% (red) 0% (grey)

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 7115 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, 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 CYTOCHROME C PEROXIDASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	294	2371	1514	395	456	6	0	0	0
1	C	294	2371	1514	395	456	6	0	0	0

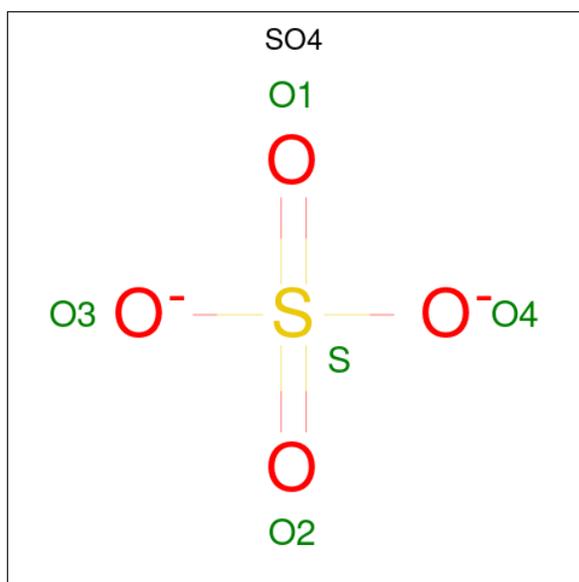
There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	53	ILE	THR	conflict	UNP P00431
A	152	GLY	ASP	conflict	UNP P00431
C	53	ILE	THR	conflict	UNP P00431
C	152	GLY	ASP	conflict	UNP P00431

- Molecule 2 is a protein called ISO-1-CYTOCHROME C.

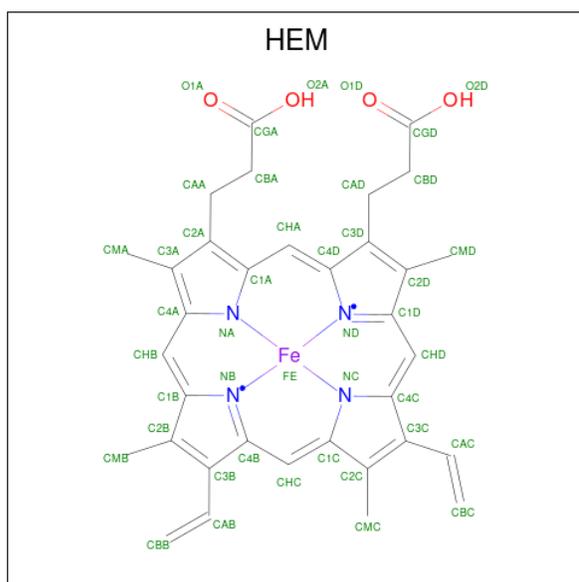
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	108	847	534	151	157	5	0	0	0
2	D	108	847	534	151	157	5	0	0	0

- Molecule 3 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total O S 2 1 1	0	0
3	C	1	Total O S 2 1 1	0	0

- Molecule 4 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total C Fe N O 43 34 1 4 4	0	0

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	
4	B	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
4	C	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
4	D	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		

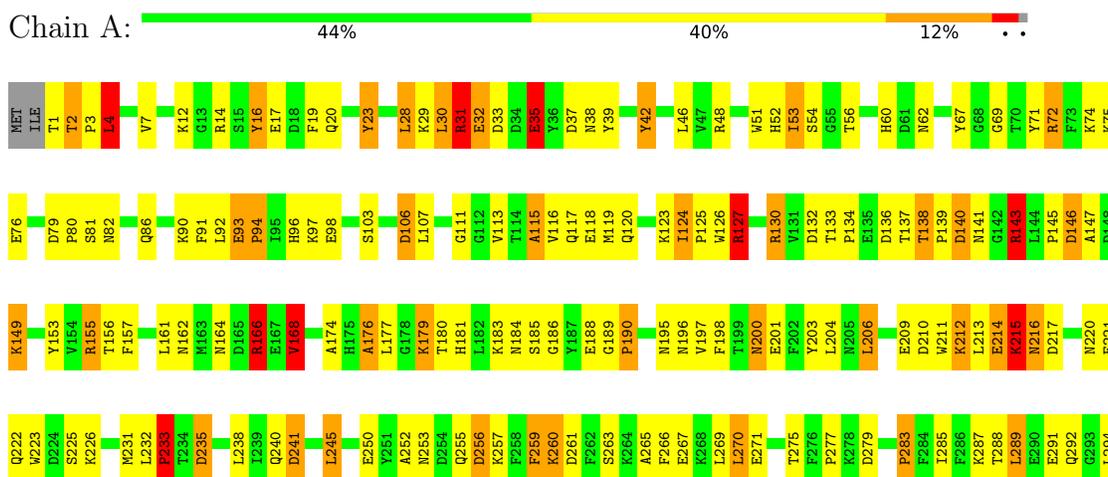
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	203	Total	O	0	0
			203	203		
5	B	46	Total	O	0	0
			46	46		
5	C	212	Total	O	0	0
			212	212		
5	D	42	Total	O	0	0
			42	42		

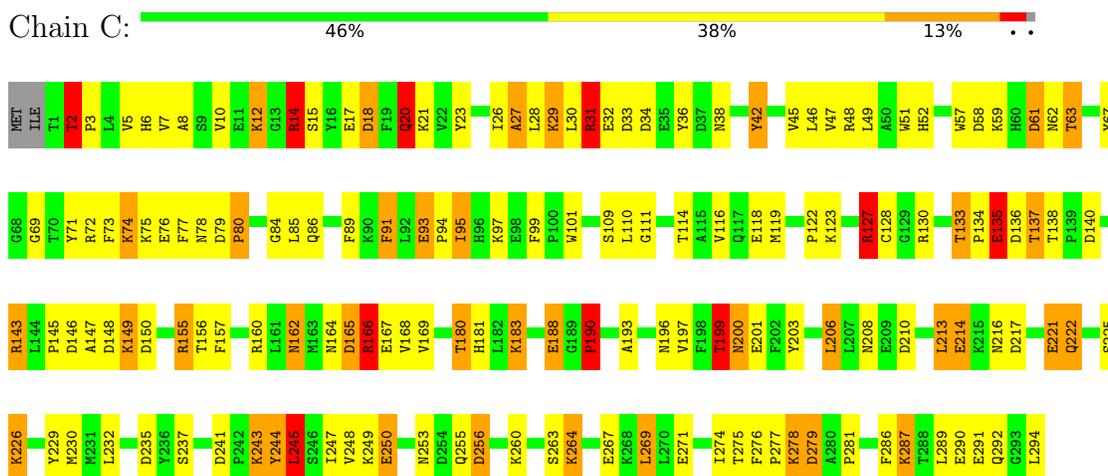
3 Residue-property plots

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. 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. 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.

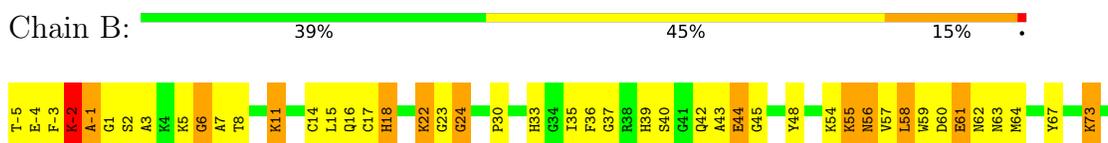
- Molecule 1: CYTOCHROME C PEROXIDASE



- Molecule 1: CYTOCHROME C PEROXIDASE



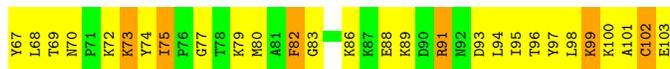
- Molecule 2: ISO-1-CYTOCHROME C





• Molecule 2: ISO-1-CYTOCHROME C

Chain D: 32% 46% 19%



4 Data and refinement statistics i

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	88.40Å 118.60Å 45.10Å 90.00° 104.60° 90.00°	Depositor
Resolution (Å)	6.00 – 2.30 35.89 – 2.25	Depositor EDS
% Data completeness (in resolution range)	(Not available) (6.00-2.30) 87.4 (35.89-2.25)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	8.10 (at 2.24Å)	Xtrriage
Refinement program	PROLSQ, X-PLOR	Depositor
R, R_{free}	0.167 , (Not available) 0.284 , (Not available)	Depositor DCC
R_{free} test set	No test flags present.	wwPDB-VP
Wilson B-factor (Å ²)	30.4	Xtrriage
Anisotropy	0.379	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 127.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.095 for -h-l,-k,l	Xtrriage
F_o, F_c correlation	0.86	EDS
Total number of atoms	7115	wwPDB-VP
Average B, all atoms (Å ²)	33.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.13% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

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: HEM, SO4

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	1.21	0/2438	2.08	74/3302 (2.2%)
1	C	1.18	2/2438 (0.1%)	2.09	97/3302 (2.9%)
2	B	0.93	0/865	1.71	4/1156 (0.3%)
2	D	0.93	0/865	1.73	11/1156 (1.0%)
All	All	1.13	2/6606 (0.0%)	2.00	186/8916 (2.1%)

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	A	0	4
1	C	0	3
All	All	0	7

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	225	SER	CA-CB	-5.76	1.44	1.52
1	C	181	HIS	CA-CB	5.43	1.65	1.53

The worst 5 of 186 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	23	TYR	CB-CG-CD2	15.44	130.26	121.00
1	A	155	ARG	NE-CZ-NH2	15.05	127.83	120.30
1	A	155	ARG	NE-CZ-NH1	-14.84	112.88	120.30
1	C	146	ASP	CB-CG-OD2	-14.44	105.31	118.30
1	A	130	ARG	NE-CZ-NH2	13.91	127.25	120.30

There are no chirality outliers.

5 of 7 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	127	ARG	Sidechain
1	A	143	ARG	Sidechain
1	A	166	ARG	Sidechain
1	A	31	ARG	Sidechain
1	C	31	ARG	Sidechain

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2371	0	2252	105	1
1	C	2371	0	2252	136	5
2	B	847	0	851	75	1
2	D	847	0	851	103	0
3	A	2	0	0	1	0
3	C	2	0	0	1	0
4	A	43	0	30	0	0
4	B	43	0	30	16	0
4	C	43	0	30	4	0
4	D	43	0	30	19	0
5	A	203	0	0	12	4
5	B	46	0	0	5	0
5	C	212	0	0	23	1
5	D	42	0	0	11	0
All	All	7115	0	6326	423	6

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 33.

The worst 5 of 423 close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:14:CYS:SG	4:B:104:HEM:CAB	2.29	1.20
1:C:74:LYS:HE3	1:C:78:ASN:HD21	1.14	1.13

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:17:CYS:SG	4:B:104:HEM:CAC	2.39	1.10
2:B:8:THR:HA	2:B:11:LYS:HD2	1.34	1.08
2:D:17:CYS:SG	4:D:104:HEM:CAC	2.43	1.06

The worst 5 of 6 symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:221:GLU:OE2	5:A:549:HOH:O[1_656]	1.11	1.09
1:C:221:GLU:CD	5:A:549:HOH:O[1_656]	1.12	1.08
1:C:221:GLU:CG	5:A:549:HOH:O[1_656]	1.91	0.29
1:A:240:GLN:NE2	5:C:635:HOH:O[1_455]	2.15	0.05
2:B:54:LYS:CE	1:C:253:ASN:ND2[2_646]	2.15	0.05

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 X-ray entries followed by that with respect to entries of similar resolution.

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	292/296 (99%)	264 (90%)	27 (9%)	1 (0%)	41	50
1	C	292/296 (99%)	272 (93%)	19 (6%)	1 (0%)	41	50
2	B	106/108 (98%)	91 (86%)	9 (8%)	6 (6%)	1	1
2	D	106/108 (98%)	89 (84%)	13 (12%)	4 (4%)	3	1
All	All	796/808 (98%)	716 (90%)	68 (8%)	12 (2%)	10	10

5 of 12 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	-2	LYS
2	B	-1	ALA
2	B	56	ASN

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Mol	Chain	Res	Type
1	C	2	THR
2	D	61	GLU

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 X-ray entries followed by that with respect to entries of similar resolution.

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	252/254 (99%)	221 (88%)	31 (12%)	4	5
1	C	252/254 (99%)	214 (85%)	38 (15%)	3	2
2	B	89/89 (100%)	73 (82%)	16 (18%)	1	1
2	D	89/89 (100%)	69 (78%)	20 (22%)	1	0
All	All	682/686 (99%)	577 (85%)	105 (15%)	2	2

5 of 105 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	91	PHE
1	C	197	VAL
2	D	72	LYS
1	C	109	SER
1	C	156	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 28 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	38	ASN
2	D	63	ASN
1	C	86	GLN
1	C	292	GLN
1	C	78	ASN

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains [i](#)

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

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

6 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
4	HEM	B	104	2	41,50,50	1.70	6 (14%)	45,82,82	1.48	9 (20%)
4	HEM	A	296	3,1	41,50,50	1.81	13 (31%)	45,82,82	1.49	8 (17%)
4	HEM	D	104	2	41,50,50	1.43	5 (12%)	45,82,82	1.28	8 (17%)
4	HEM	C	296	3,1	41,50,50	1.41	7 (17%)	45,82,82	1.65	8 (17%)
3	SO4	C	300	4	0,1,4	-	-	-	-	-
3	SO4	A	299	4	0,1,4	-	-	-	-	-

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
4	HEM	C	296	3,1	-	2/12/54/54	-
4	HEM	D	104	2	-	0/12/54/54	-
4	HEM	B	104	2	-	1/12/54/54	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	HEM	A	296	3,1	-	3/12/54/54	-

The worst 5 of 31 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	104	HEM	C3C-C2C	-5.95	1.32	1.40
4	B	104	HEM	C3C-CAC	4.19	1.56	1.47
4	D	104	HEM	C3C-CAC	4.12	1.56	1.47
4	D	104	HEM	C3C-C2C	-3.92	1.34	1.40
4	A	296	HEM	C3C-C2C	-3.79	1.35	1.40

The worst 5 of 33 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	296	HEM	CMA-C3A-C4A	-4.22	121.98	128.46
4	A	296	HEM	CMA-C3A-C4A	-4.04	122.25	128.46
4	B	104	HEM	O2D-CGD-O1D	3.86	132.91	123.30
4	C	296	HEM	CBA-CAA-C2A	3.48	118.55	112.62
4	C	296	HEM	C4C-CHD-C1D	3.47	127.13	122.56

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	C	296	HEM	CAA-CBA-CGA-O2A
4	A	296	HEM	CAA-CBA-CGA-O2A
4	A	296	HEM	CAA-CBA-CGA-O1A
4	B	104	HEM	CAA-CBA-CGA-O1A
4	A	296	HEM	CAD-CBD-CGD-O2D

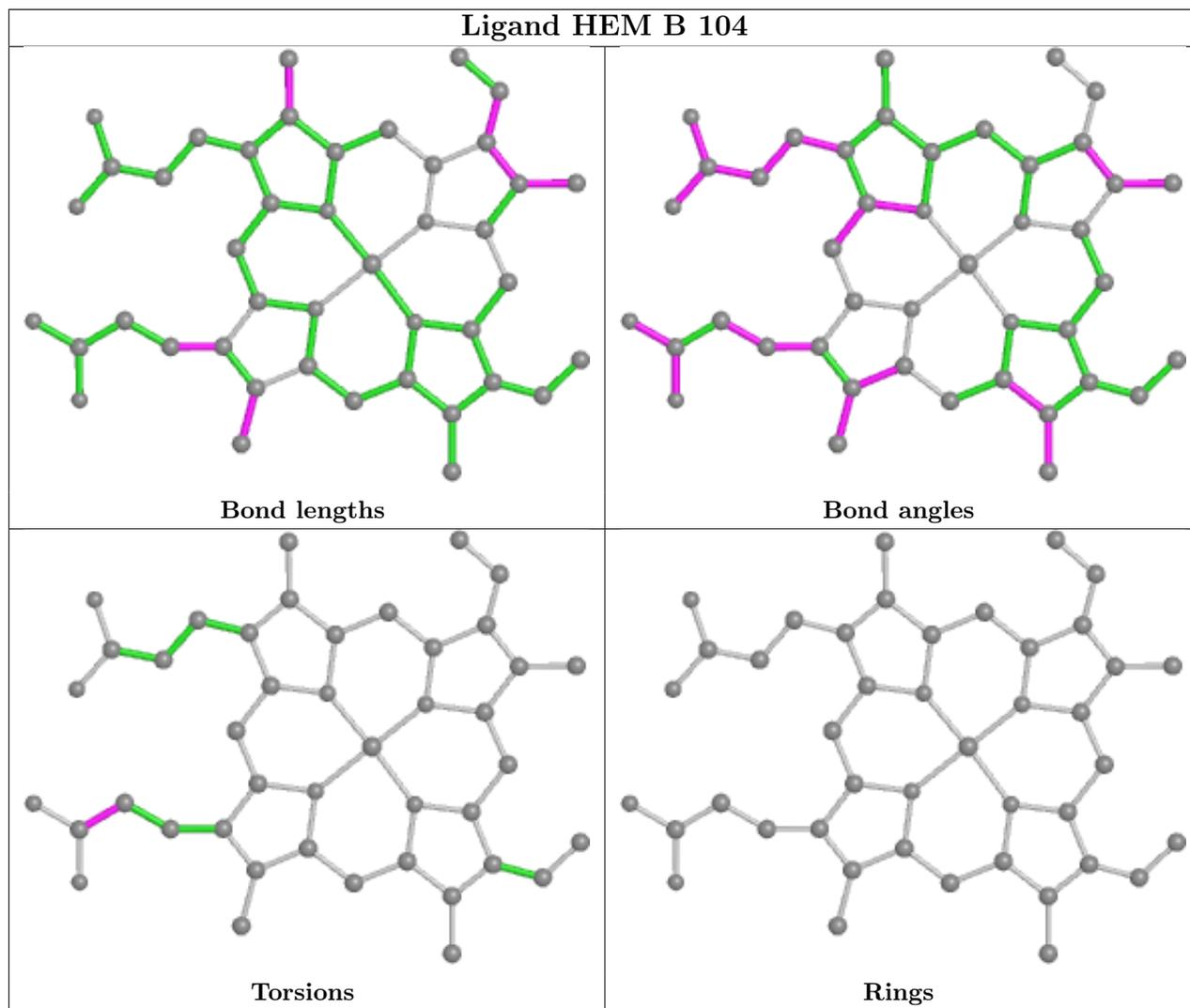
There are no ring outliers.

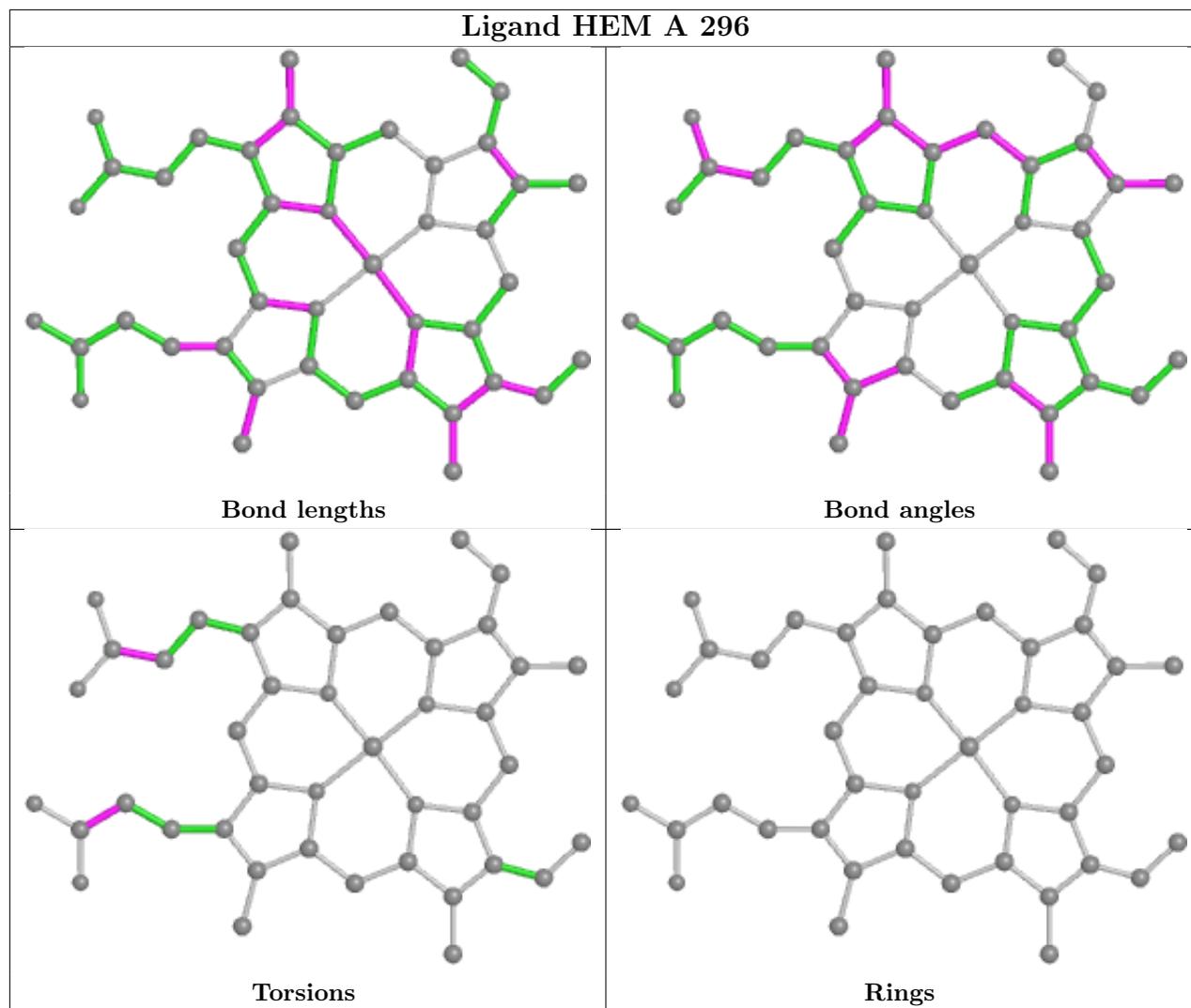
5 monomers are involved in 41 short contacts:

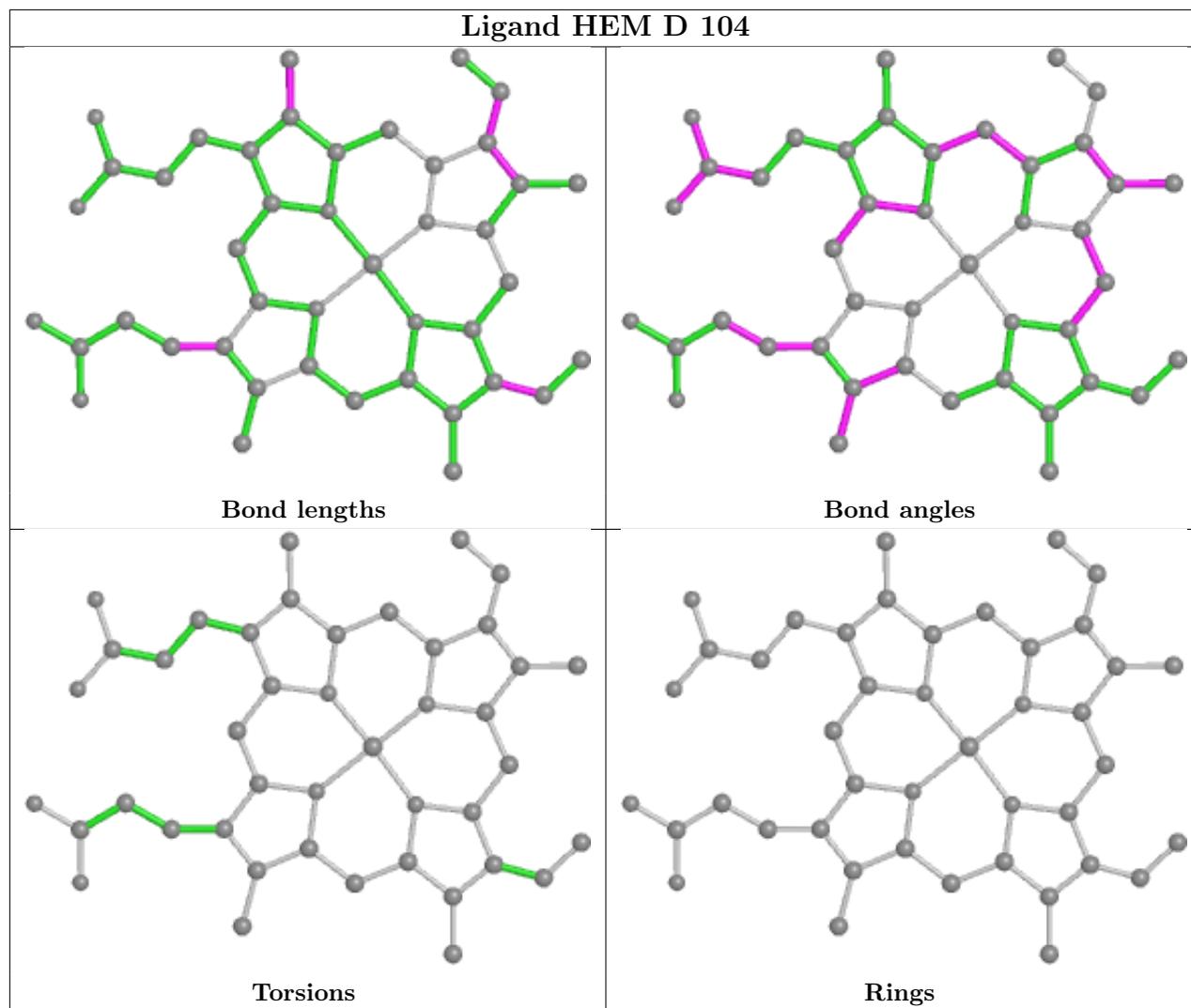
Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	104	HEM	16	0
4	D	104	HEM	19	0
4	C	296	HEM	4	0
3	C	300	SO4	1	0
3	A	299	SO4	1	0

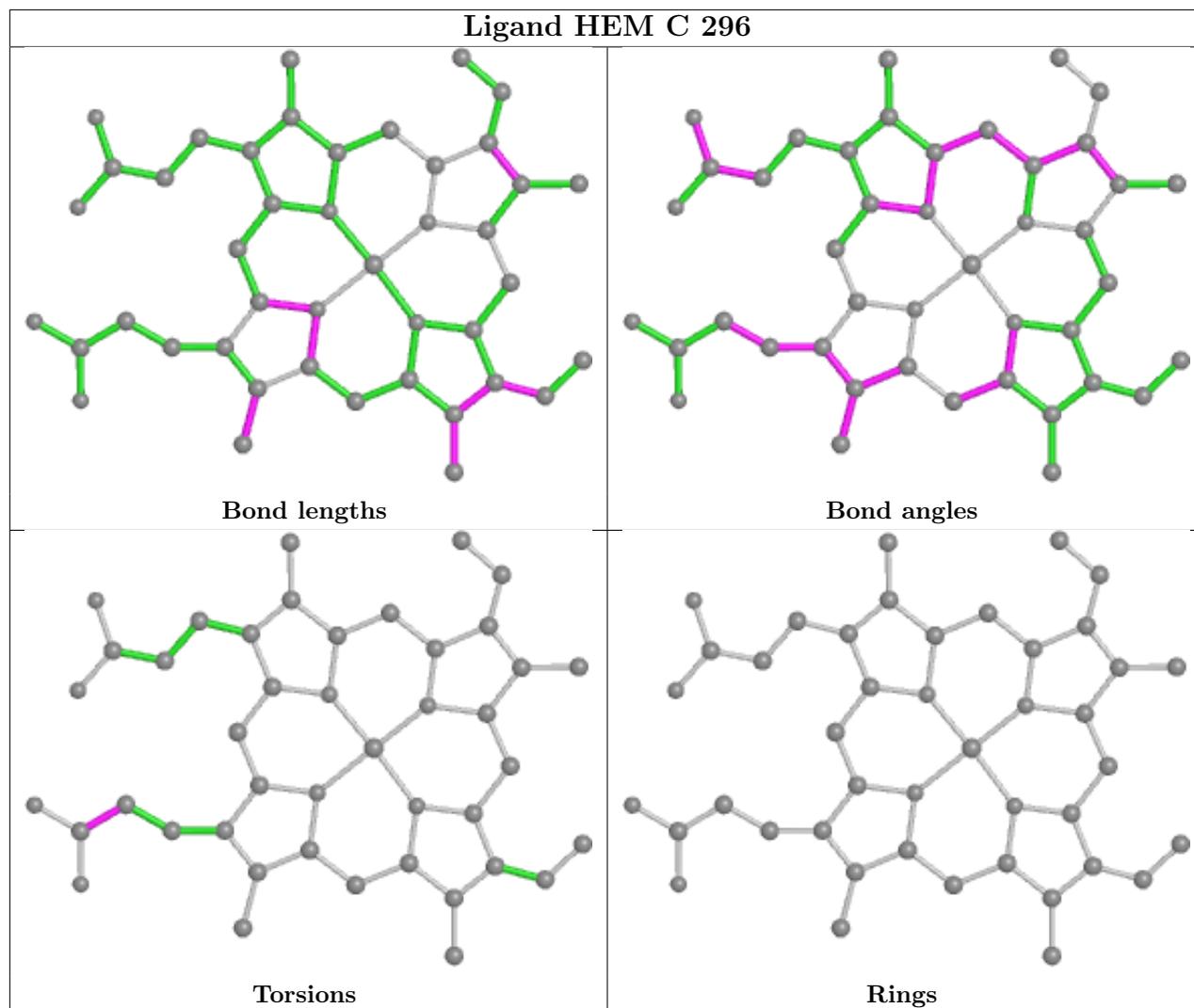
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths,

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 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 Fit of model and data

6.1 Protein, DNA and RNA chains

Unable to reproduce the depositors R factor - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains

Unable to reproduce the depositors R factor - this section is therefore empty.

6.3 Carbohydrates

Unable to reproduce the depositors R factor - this section is therefore empty.

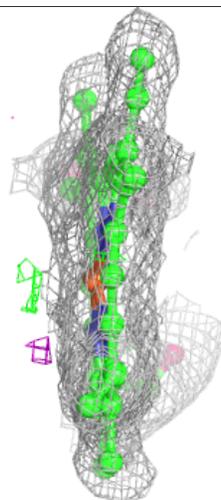
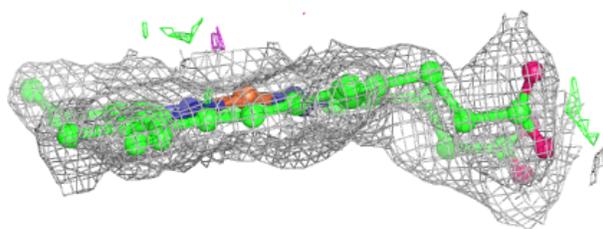
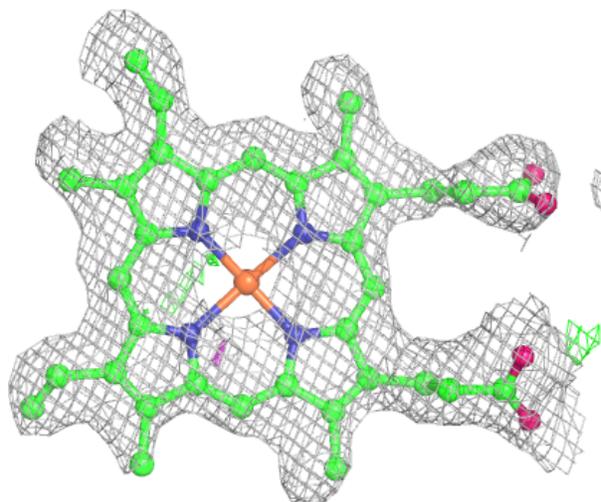
6.4 Ligands

Unable to reproduce the depositors R factor - this section is therefore empty.

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

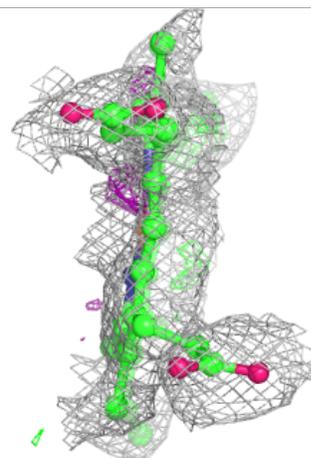
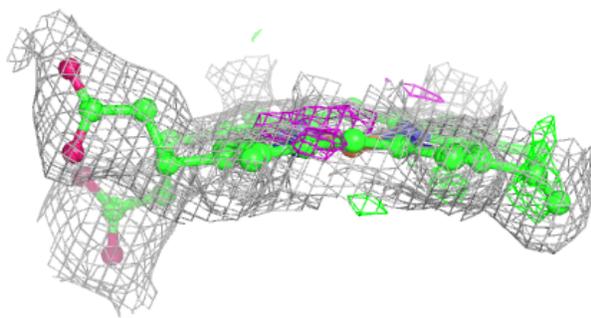
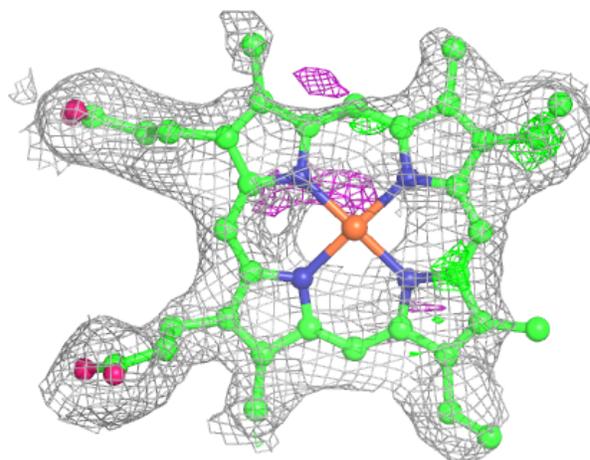
Electron density around HEM A 296:

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



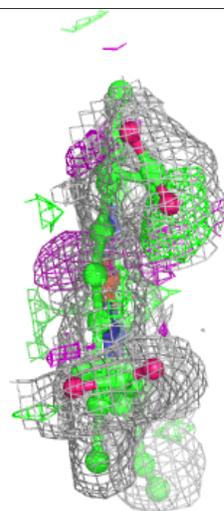
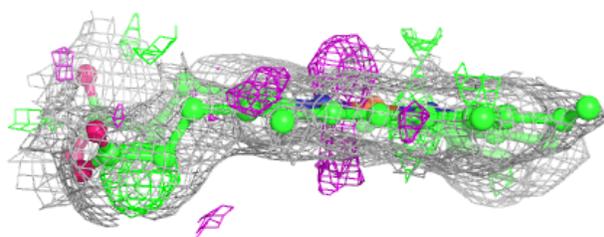
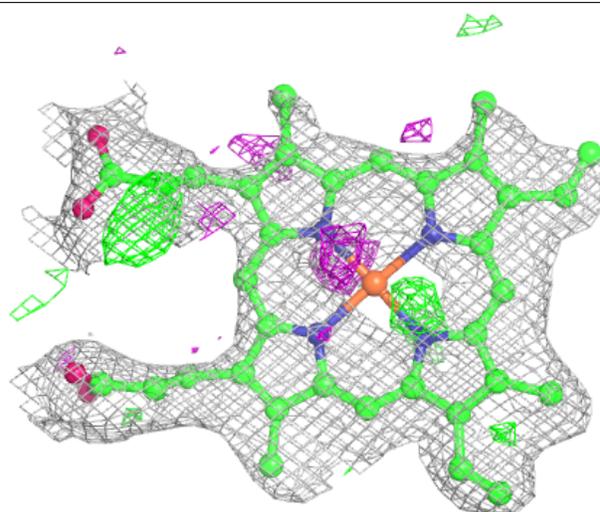
Electron density around HEM B 104:

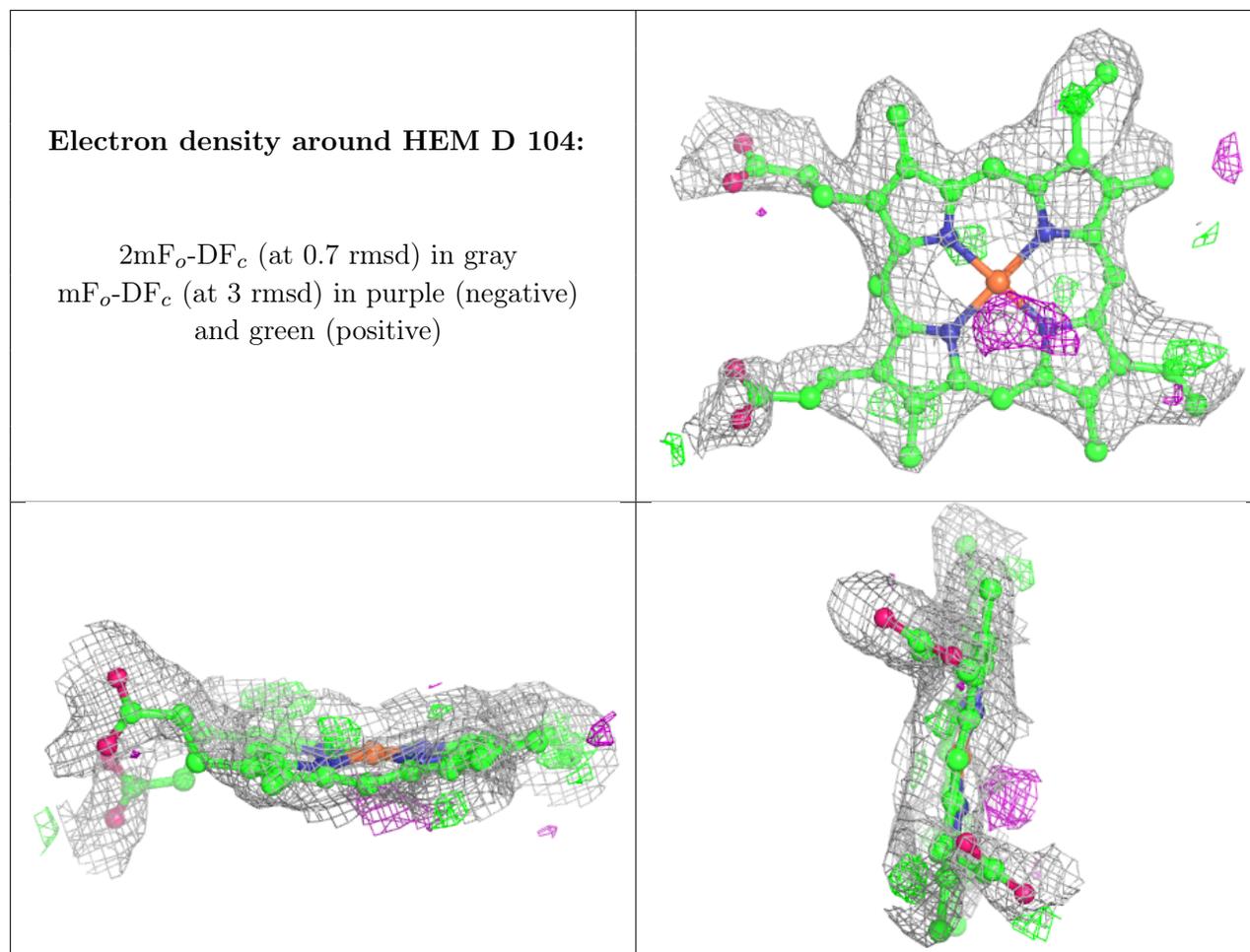
$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around HEM C 296:

$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)





6.5 Other polymers [i](#)

Unable to reproduce the depositors R factor - this section is therefore empty.