Full wwPDB X-ray Structure Validation Report (i)

Dec 16, 2025 – 10:18 PM EST

PDB ID	:	2B7R / pdb_00002b7r
Title	:	Structure of E378D mutant flavocytochrome c3
Authors	:	Pankhurst, K.L.; Mowat, C.G.; Rothery, E.L.; Miles, C.S.; Walkinshaw, M.D.; Reid, G.A.; Chapman, S.K.
Deposited on	:	2005-10-05
Resolution	:	1.70 Å(reported)

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

|		
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.47

1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:
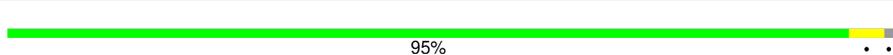*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.70 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.
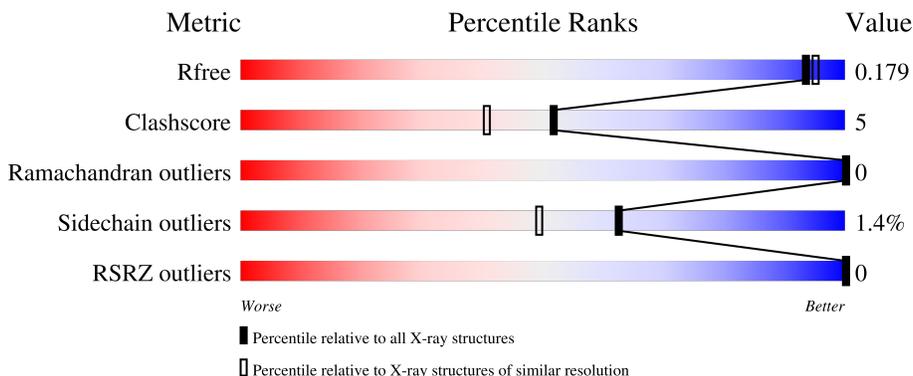
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	5161 (1.70-1.70)
Clashscore	180529	5671 (1.70-1.70)
Ramachandran outliers	177936	5594 (1.70-1.70)
Sidechain outliers	177891	5594 (1.70-1.70)
RSRZ outliers	164620	5159 (1.70-1.70)

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 <=5% The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	571	95%

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
4	FAD	A	1805	X	-	-	-

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 5494 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 Fumarate reductase flavoprotein subunit.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	568	Total	C	N	O	S	0	0	0
			4176	2592	736	823	25			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	378	ASP	GLU	engineered mutation	UNP Q02469

- Molecule 2 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Na	0	0
			1	1		

- Molecule 3 is HEME C (CCD ID: HEC) (formula: $C_{34}H_{34}FeN_4O_4$).
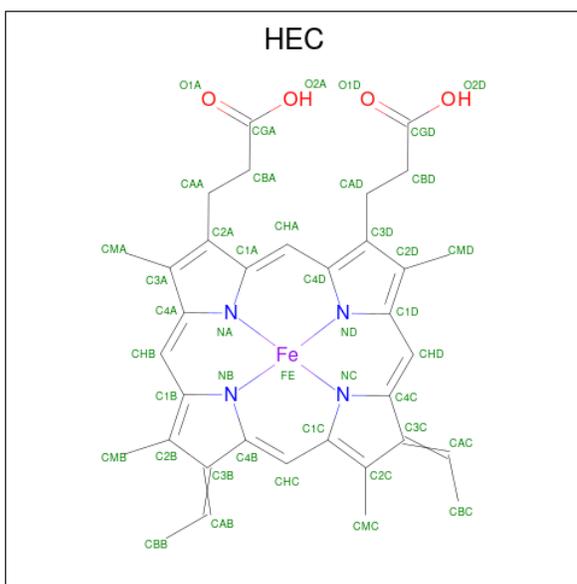
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
3	A	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
3	A	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
3	A	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		

- Molecule 4 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$).
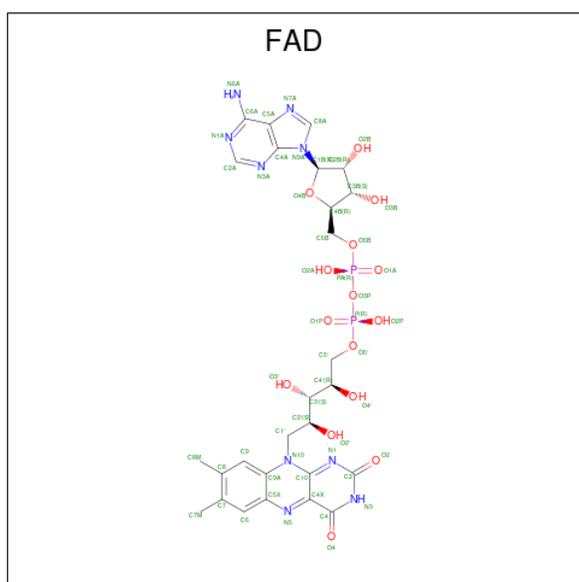
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	N	O	P	0	0
			53	27	9	15	2		

- Molecule 5 is FUMARIC ACID (CCD ID: FUM) (formula: $C_4H_4O_4$).
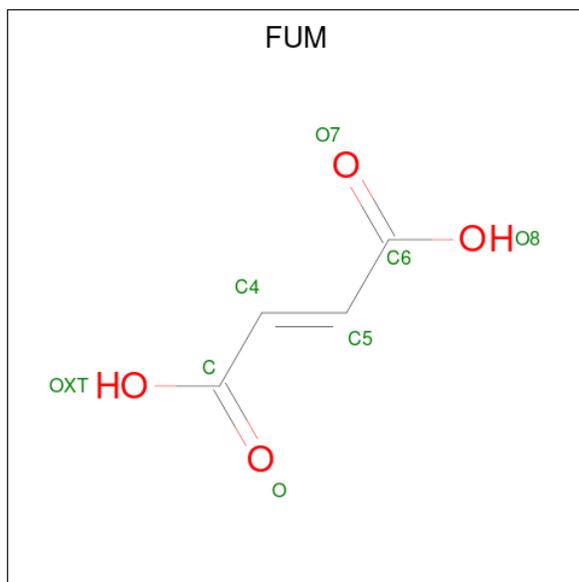
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total 8	C 4	O 4	0	0

• Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	1084	Total 1084	O 1084	0	0

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 and electron 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 dot above a residue indicates a poor fit to the electron density (RSRZ > 2). 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: Fumarate reductase flavoprotein subunit

Chain A:
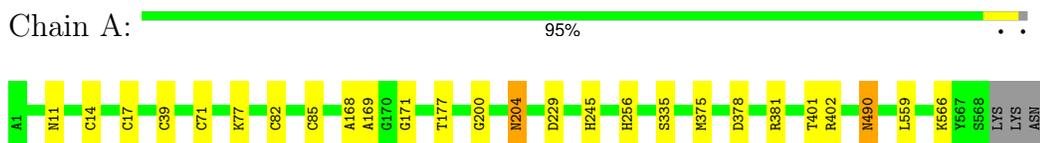
4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	45.96Å 92.88Å 79.49Å 90.00° 91.17° 90.00°	Depositor
Resolution (Å)	20.00 – 1.70 20.00 – 1.70	Depositor EDS
% Data completeness (in resolution range)	98.2 (20.00-1.70) 98.3 (20.00-1.70)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.43 (at 1.69Å)	Xtriage
Refinement program	REFMAC 5.2.0003	Depositor
R, R_{free}	0.156 , 0.180 0.155 , 0.179	Depositor DCC
R_{free} test set	3629 reflections (4.94%)	wwPDB-VP
Wilson B-factor (Å^2)	14.5	Xtriage
Anisotropy	0.060	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.42 , 77.7	EDS
L-test for twinning [2]	$< |L| > = 0.50, < L^2 > = 0.33$	Xtriage
Estimated twinning fraction	0.024 for h,-k,-l	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	5494	wwPDB-VP
Average B, all atoms (Å^2)	18.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.60% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5   Model quality ⓘ

5.1   Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: FAD, NA, HEC, FUM

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

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	#$|Z|$>5	RMSZ	#$|Z|$>5
1	A	0.94	0/4246	0.88	1/5746 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	171	GLY	N-CA-C	5.85	118.51	110.56

There are no chirality outliers.

There are no planarity outliers.

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	4176	0	4074	37	0
2	A	1	0	0	0	0
3	A	172	0	125	16	0
4	A	53	0	29	7	0
5	A	8	0	1	1	0
6	A	1084	0	0	3	0
All	All	5494	0	4229	37	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 5.

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All (37) 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:14:CYS:SG	3:A:801:HEC:HAB	1.62	1.38
1:A:71:CYS:SG	3:A:803:HEC:HAC	1.91	1.07
1:A:375:MET:CE	4:A:1805:FAD:H6	1.86	1.05
1:A:17:CYS:SG	3:A:801:HEC:HAC	1.99	1.01
1:A:375:MET:HE1	4:A:1805:FAD:H6	1.44	0.95
1:A:229:ASP:H	1:A:256:HIS:HE1	1.14	0.92
1:A:85:CYS:SG	3:A:804:HEC:HAC	2.16	0.86
1:A:375:MET:HE1	4:A:1805:FAD:C6	2.05	0.85
1:A:169:ALA:O	6:A:2598:HOH:O	1.96	0.82
1:A:375:MET:CE	4:A:1805:FAD:C6	2.56	0.82
1:A:204:ASN:HD22	1:A:204:ASN:H	1.28	0.81
1:A:229:ASP:H	1:A:256:HIS:CE1	2.03	0.75
1:A:375:MET:HE2	4:A:1805:FAD:H6	1.70	0.72
1:A:378:ASP:OD1	1:A:381:ARG:NH2	2.25	0.68
1:A:82:CYS:SG	3:A:804:HEC:CBB	2.79	0.68
1:A:200:GLY:HA3	1:A:204:ASN:HD21	1.60	0.66
1:A:204:ASN:H	1:A:204:ASN:ND2	1.98	0.59
1:A:71:CYS:SG	3:A:803:HEC:CBC	2.91	0.57
1:A:82:CYS:SG	3:A:804:HEC:C3B	2.91	0.57
1:A:17:CYS:SG	3:A:801:HEC:C3C	2.96	0.53
1:A:177:THR:OG1	1:A:245:HIS:HE1	1.91	0.52
1:A:402:ARG:HH22	5:A:1806:FUM:C4	2.24	0.51
1:A:14:CYS:SG	3:A:801:HEC:CBB	2.91	0.50
1:A:85:CYS:SG	3:A:804:HEC:CBC	2.97	0.49
1:A:229:ASP:N	1:A:256:HIS:HE1	1.96	0.48
1:A:17:CYS:HG	3:A:801:HEC:HAC	1.77	0.47
1:A:71:CYS:SG	3:A:803:HEC:C3C	3.00	0.47
1:A:77:LYS:HG2	6:A:2151:HOH:O	2.13	0.47
1:A:17:CYS:SG	3:A:801:HEC:CBC	2.97	0.46
1:A:85:CYS:SG	3:A:804:HEC:C3C	3.02	0.45
1:A:566:LYS:HG3	6:A:2235:HOH:O	2.17	0.45
1:A:490:ASN:HD22	1:A:490:ASN:C	2.25	0.44
1:A:14:CYS:SG	3:A:801:HEC:C3B	2.99	0.43
1:A:168:ALA:HA	4:A:1805:FAD:N5	2.35	0.42
1:A:39:CYS:SG	3:A:802:HEC:C3C	3.07	0.42
1:A:375:MET:SD	4:A:1805:FAD:C6	3.07	0.42
1:A:204:ASN:ND2	1:A:204:ASN:N	2.69	0.40

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	566/571 (99%)	552 (98%)	14 (2%)	0	100	100

There are no Ramachandran outliers to report.

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 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	429/445 (96%)	423 (99%)	6 (1%)	62	49

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	11	ASN
1	A	204	ASN
1	A	335	SER
1	A	401	THR
1	A	490	ASN
1	A	559	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (13) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	12	GLN
1	A	56	ASN

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Mol	Chain	Res	Type
1	A	116	GLN
1	A	173	ASN
1	A	201	GLN
1	A	204	ASN
1	A	245	HIS
1	A	256	HIS
1	A	269	ASN
1	A	275	ASN
1	A	484	ASN
1	A	490	ASN
1	A	548	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

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	$\#|Z| > 2$
5	FUM	A	1806	-	7,7,7	2.87	4 (57%)	8,8,8	1.22	1 (12%)
3	HEC	A	802	1	32,50,50	2.13	5 (15%)	30,82,82	1.67	5 (16%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	#|Z| > 2	Counts	RMSZ	#|Z| > 2
3	HEC	A	801	1	32,50,50	2.16	6 (18%)	30,82,82	1.72	7 (23%)
3	HEC	A	804	1	32,50,50	2.16	7 (21%)	30,82,82	1.64	5 (16%)
4	FAD	A	1805	-	54,58,58	2.33	22 (40%)	71,89,89	2.04	16 (22%)
3	HEC	A	803	1	32,50,50	2.16	9 (28%)	30,82,82	1.87	7 (23%)

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
5	FUM	A	1806	-	-	2/5/5/5	-
3	HEC	A	802	1	-	2/10/54/54	-
3	HEC	A	801	1	-	4/10/54/54	-
3	HEC	A	804	1	-	4/10/54/54	-
4	FAD	A	1805	-	1/1/9/9	7/30/50/50	0/6/6/6
3	HEC	A	803	1	-	2/10/54/54	-

All (53) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1805	FAD	C6-C5X	6.49	1.49	1.40
3	A	802	HEC	C3D-C2D	5.32	1.53	1.37
3	A	801	HEC	C2B-C3B	-5.19	1.34	1.40
3	A	803	HEC	C3D-C2D	5.14	1.52	1.37
3	A	801	HEC	C3D-C2D	5.07	1.52	1.37
3	A	804	HEC	C3D-C2D	5.07	1.52	1.37
4	A	1805	FAD	C2A-N3A	5.01	1.39	1.32
3	A	802	HEC	C2B-C3B	-4.90	1.35	1.40
3	A	803	HEC	C2B-C3B	-4.87	1.35	1.40
3	A	804	HEC	C2B-C3B	-4.83	1.35	1.40
3	A	803	HEC	C3C-C2C	-4.76	1.35	1.40
3	A	804	HEC	C3C-C2C	-4.69	1.35	1.40
4	A	1805	FAD	C6-C7	-4.62	1.33	1.39
4	A	1805	FAD	C4'-C3'	4.53	1.61	1.53
4	A	1805	FAD	P-O3P	4.32	1.64	1.59
3	A	801	HEC	C3C-C2C	-4.31	1.35	1.40
3	A	802	HEC	C3C-C2C	-4.19	1.36	1.40
3	A	802	HEC	CBC-CAC	-4.09	1.34	1.49
5	A	1806	FUM	O-C	4.07	1.33	1.23

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1805	FAD	C1B-N9A	-3.93	1.40	1.49
4	A	1805	FAD	O2'-C2'	3.89	1.51	1.43
5	A	1806	FUM	O8-C6	-3.89	1.20	1.30
4	A	1805	FAD	C5X-N5	3.86	1.46	1.39
3	A	804	HEC	CBC-CAC	-3.79	1.35	1.49
3	A	801	HEC	CBC-CAC	-3.74	1.35	1.49
3	A	801	HEC	CBB-CAB	-3.72	1.35	1.49
5	A	1806	FUM	O7-C6	3.65	1.32	1.23
4	A	1805	FAD	C9A-N10	3.61	1.47	1.41
3	A	803	HEC	CBC-CAC	-3.48	1.36	1.49
5	A	1806	FUM	OXT-C	-3.47	1.21	1.30
3	A	802	HEC	CBB-CAB	-3.47	1.36	1.49
4	A	1805	FAD	C2-N1	3.34	1.44	1.36
3	A	804	HEC	CBB-CAB	-3.31	1.37	1.49
3	A	803	HEC	CBB-CAB	-3.21	1.37	1.49
4	A	1805	FAD	O4-C4	-2.89	1.18	1.23
4	A	1805	FAD	C10-N1	-2.82	1.27	1.33
3	A	803	HEC	CAA-C2A	2.73	1.57	1.52
4	A	1805	FAD	O3'-C3'	2.59	1.49	1.43
4	A	1805	FAD	PA-O3P	2.53	1.62	1.59
4	A	1805	FAD	O3B-C3B	2.39	1.48	1.43
4	A	1805	FAD	C9A-C5X	2.37	1.45	1.41
4	A	1805	FAD	C8-C7	2.35	1.46	1.40
4	A	1805	FAD	C2-N3	2.33	1.44	1.39
4	A	1805	FAD	C5'-C4'	-2.24	1.48	1.51
3	A	803	HEC	C4B-C3B	2.20	1.47	1.43
3	A	801	HEC	CAA-C2A	2.17	1.56	1.52
4	A	1805	FAD	C4A-N3A	2.15	1.38	1.35
4	A	1805	FAD	O4B-C1B	-2.10	1.38	1.40
3	A	803	HEC	C4D-ND	2.08	1.40	1.36
3	A	803	HEC	C1D-ND	2.06	1.40	1.36
3	A	804	HEC	C1D-ND	2.06	1.40	1.36
4	A	1805	FAD	C4X-C4	2.04	1.52	1.44
3	A	804	HEC	C4B-C3B	2.02	1.46	1.43

All (41) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	1805	FAD	O3B-C3B-C2B	-6.09	92.29	111.82
4	A	1805	FAD	O2B-C2B-C3B	5.76	130.28	111.82
3	A	803	HEC	CBD-CAD-C3D	-4.90	104.30	112.54
4	A	1805	FAD	O4B-C1B-N9A	4.83	115.15	108.75

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	1805	FAD	O4'-C4'-C3'	-4.59	98.51	109.25
4	A	1805	FAD	C9A-C5X-N5	-4.43	117.75	122.45
3	A	801	HEC	CBD-CAD-C3D	-3.97	105.86	112.54
4	A	1805	FAD	C9-C8-C7	3.95	125.49	119.69
3	A	803	HEC	CBB-CAB-C3B	-3.91	118.34	127.49
3	A	802	HEC	CBB-CAB-C3B	-3.88	118.42	127.49
4	A	1805	FAD	O4'-C4'-C5'	3.79	118.35	109.99
3	A	802	HEC	CMC-C2C-C1C	-3.72	123.00	128.46
3	A	801	HEC	CBB-CAB-C3B	-3.60	119.07	127.49
3	A	803	HEC	CMC-C2C-C1C	-3.53	123.29	128.46
3	A	804	HEC	CMB-C2B-C1B	-3.52	123.30	128.46
4	A	1805	FAD	C8M-C8-C9	-3.51	113.39	119.57
3	A	804	HEC	CBB-CAB-C3B	-3.50	119.30	127.49
4	A	1805	FAD	O5'-C5'-C4'	-3.36	100.39	109.36
3	A	802	HEC	CMB-C2B-C1B	-3.36	123.54	128.46
4	A	1805	FAD	C1B-N9A-C4A	3.29	132.43	126.64
3	A	804	HEC	CMC-C2C-C1C	-3.22	123.74	128.46
3	A	803	HEC	CMB-C2B-C1B	-3.10	123.91	128.46
3	A	804	HEC	CBA-CAA-C2A	-2.93	107.73	112.55
4	A	1805	FAD	N3A-C2A-N1A	-2.92	124.72	128.67
3	A	801	HEC	CMC-C2C-C1C	-2.60	124.64	128.46
3	A	801	HEC	C3B-C4B-NB	-2.53	106.16	110.94
3	A	804	HEC	CMB-C2B-C3B	2.47	128.72	125.82
4	A	1805	FAD	C6-C5X-C9A	2.43	122.39	119.05
3	A	802	HEC	CBA-CAA-C2A	-2.42	108.56	112.55
3	A	801	HEC	C2B-C3B-C4B	2.41	108.96	106.35
5	A	1806	FUM	OXT-C-O	-2.41	117.80	122.70
3	A	801	HEC	CMB-C2B-C1B	-2.39	124.96	128.46
4	A	1805	FAD	C7M-C7-C8	2.37	125.60	120.76
3	A	803	HEC	C3C-C4C-NC	-2.25	106.70	110.94
3	A	803	HEC	C1D-C2D-C3D	-2.21	105.45	107.00
3	A	802	HEC	C3B-C4B-NB	-2.15	106.88	110.94
3	A	801	HEC	O2D-CGD-CBD	2.14	120.76	114.00
4	A	1805	FAD	C4A-C5A-N7A	-2.11	107.11	109.34
4	A	1805	FAD	O3'-C3'-C2'	-2.09	104.19	108.93
4	A	1805	FAD	O4-C4-N3	-2.04	116.28	120.11
3	A	803	HEC	CBA-CAA-C2A	-2.03	109.21	112.55

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
4	A	1805	FAD	C2B

All (21) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	1805	FAD	N10-C1'-C2'-O2'
4	A	1805	FAD	C2'-C3'-C4'-C5'
5	A	1806	FUM	C4-C5-C6-O7
5	A	1806	FUM	C4-C5-C6-O8
4	A	1805	FAD	C2'-C3'-C4'-O4'
4	A	1805	FAD	O3'-C3'-C4'-C5'
3	A	804	HEC	C2D-C3D-CAD-CBD
3	A	804	HEC	C4D-C3D-CAD-CBD
4	A	1805	FAD	O3'-C3'-C4'-O4'
3	A	804	HEC	CAA-CBA-CGA-O2A
3	A	804	HEC	CAA-CBA-CGA-O1A
3	A	803	HEC	CAA-CBA-CGA-O1A
3	A	803	HEC	CAA-CBA-CGA-O2A
3	A	801	HEC	CAA-CBA-CGA-O2A
3	A	801	HEC	CAA-CBA-CGA-O1A
3	A	802	HEC	CAD-CBD-CGD-O2D
3	A	802	HEC	CAD-CBD-CGD-O1D
3	A	801	HEC	CAD-CBD-CGD-O1D
3	A	801	HEC	CAD-CBD-CGD-O2D
4	A	1805	FAD	O4B-C4B-C5B-O5B
4	A	1805	FAD	P-O3P-PA-O2A

There are no ring outliers.

6 monomers are involved in 24 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	1806	FUM	1	0
3	A	802	HEC	1	0
3	A	801	HEC	7	0
3	A	804	HEC	5	0
4	A	1805	FAD	7	0
3	A	803	HEC	3	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less 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
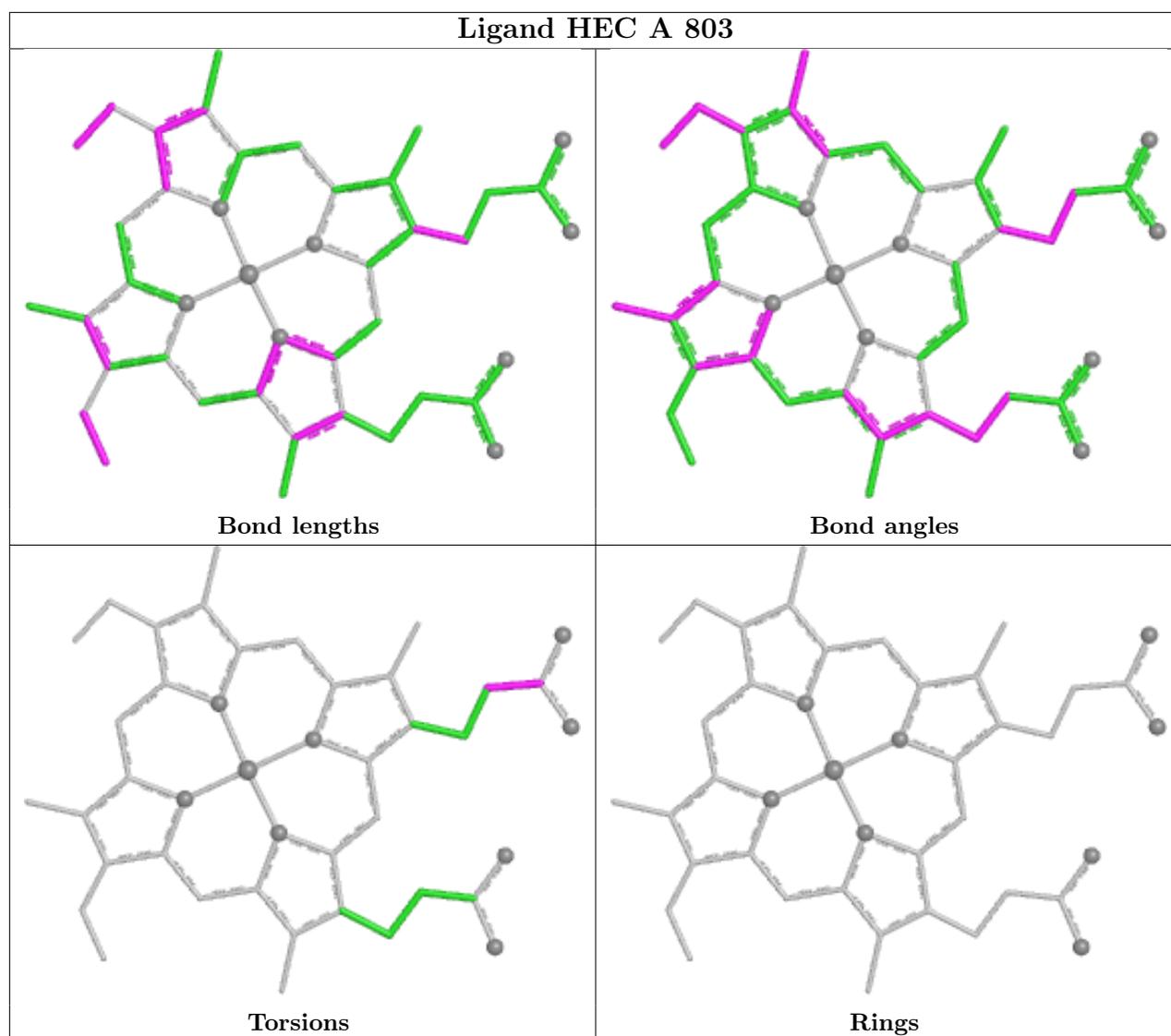
any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand HEC A 802

Bond lengths

Bond angles

Torsions

Rings

Ligand HEC A 801

Bond lengths

Bond angles

Torsions

Rings

Ligand HEC A 804

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD A 1805

Bond lengths

Bond angles

Torsions

Rings

Ligand HEC A 803

Bond lengths

Bond angles

Torsions

Rings
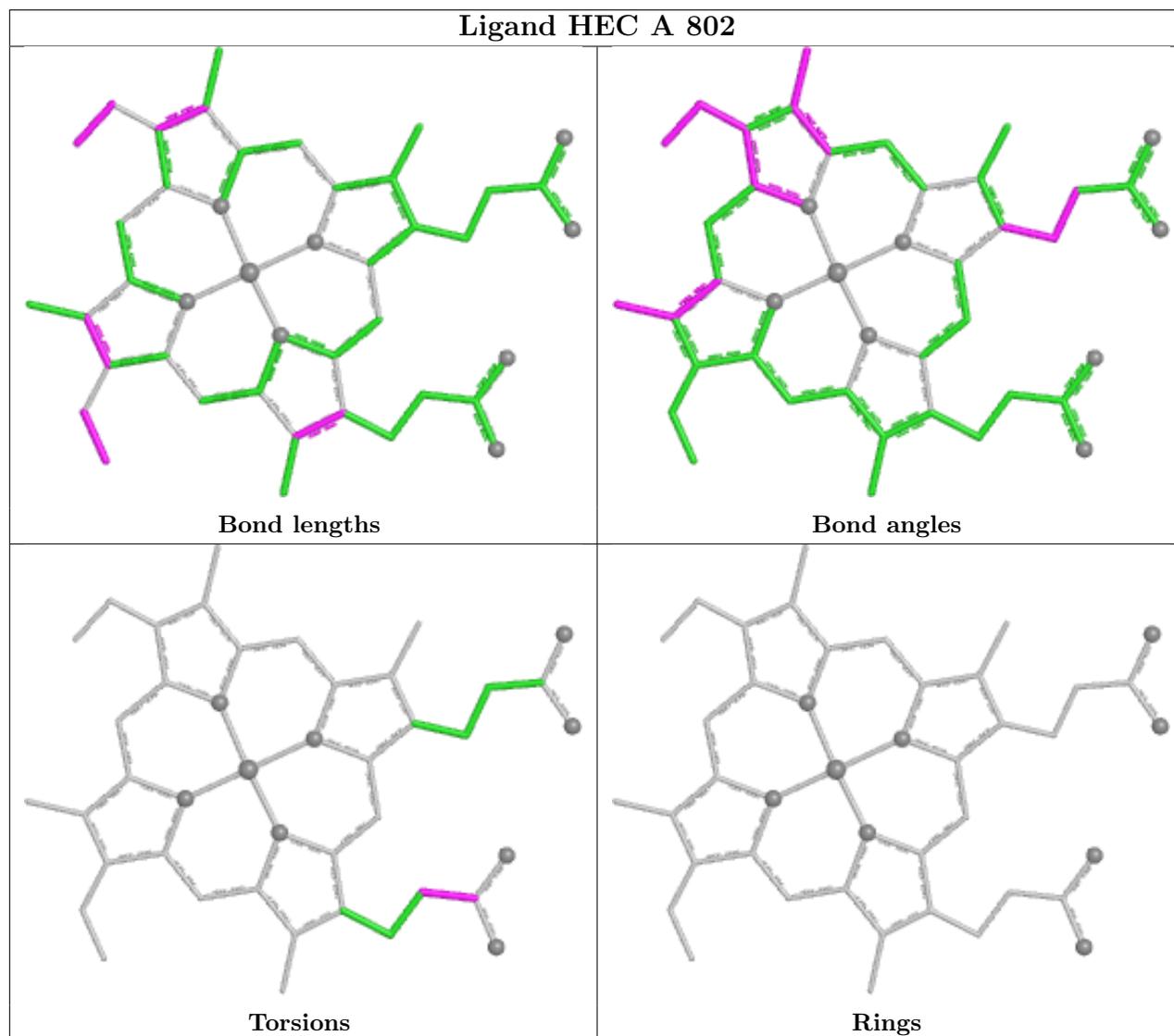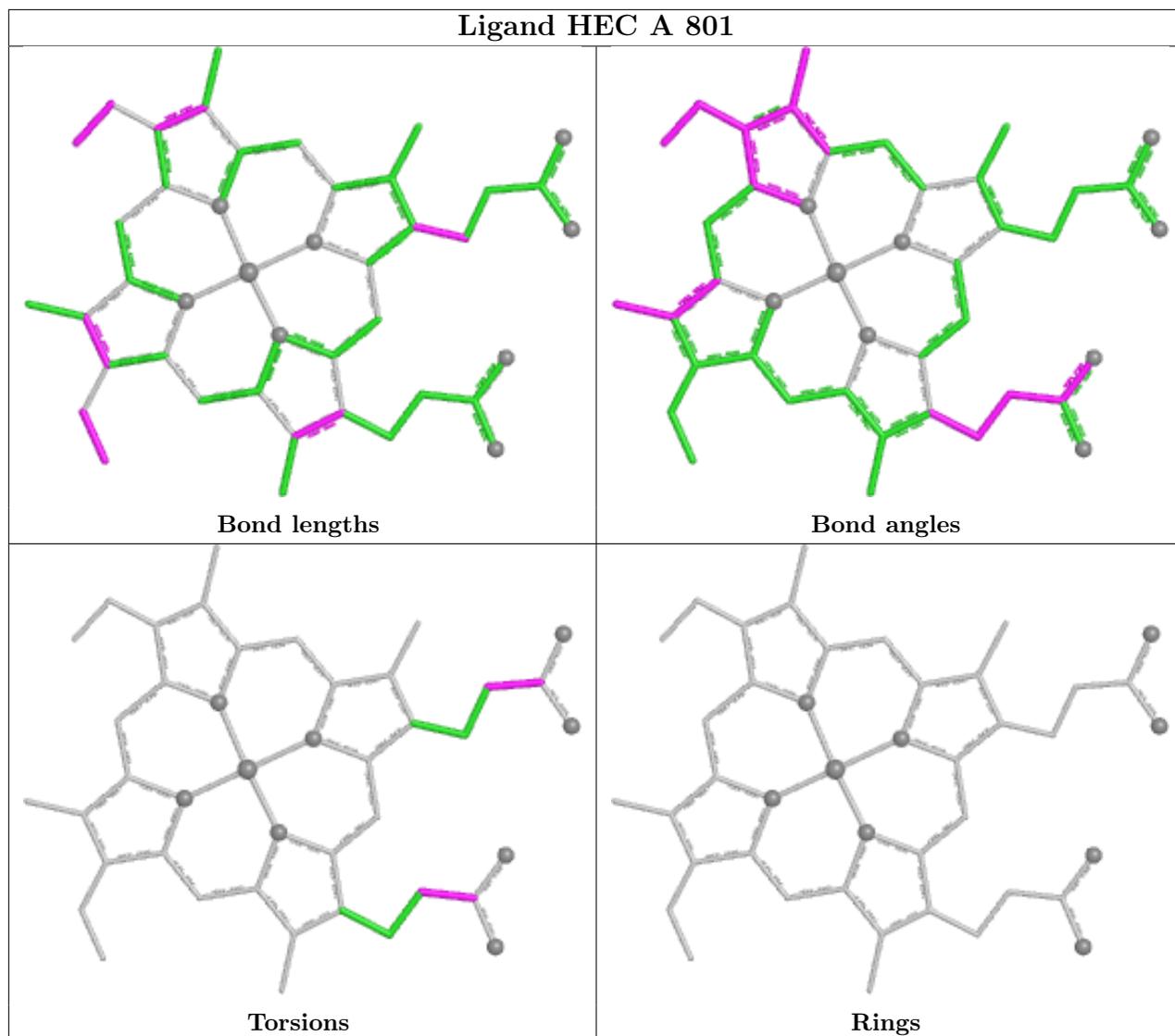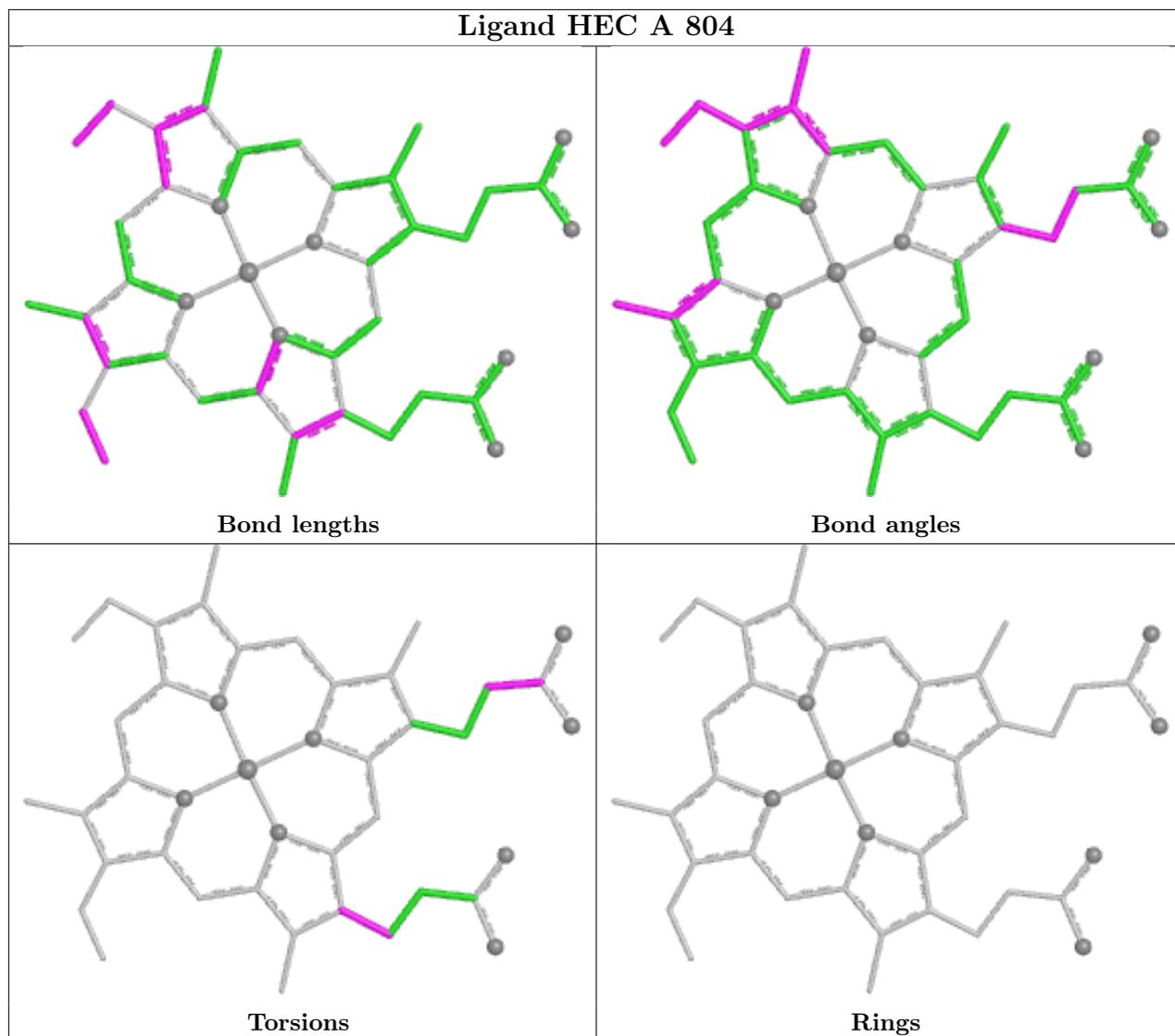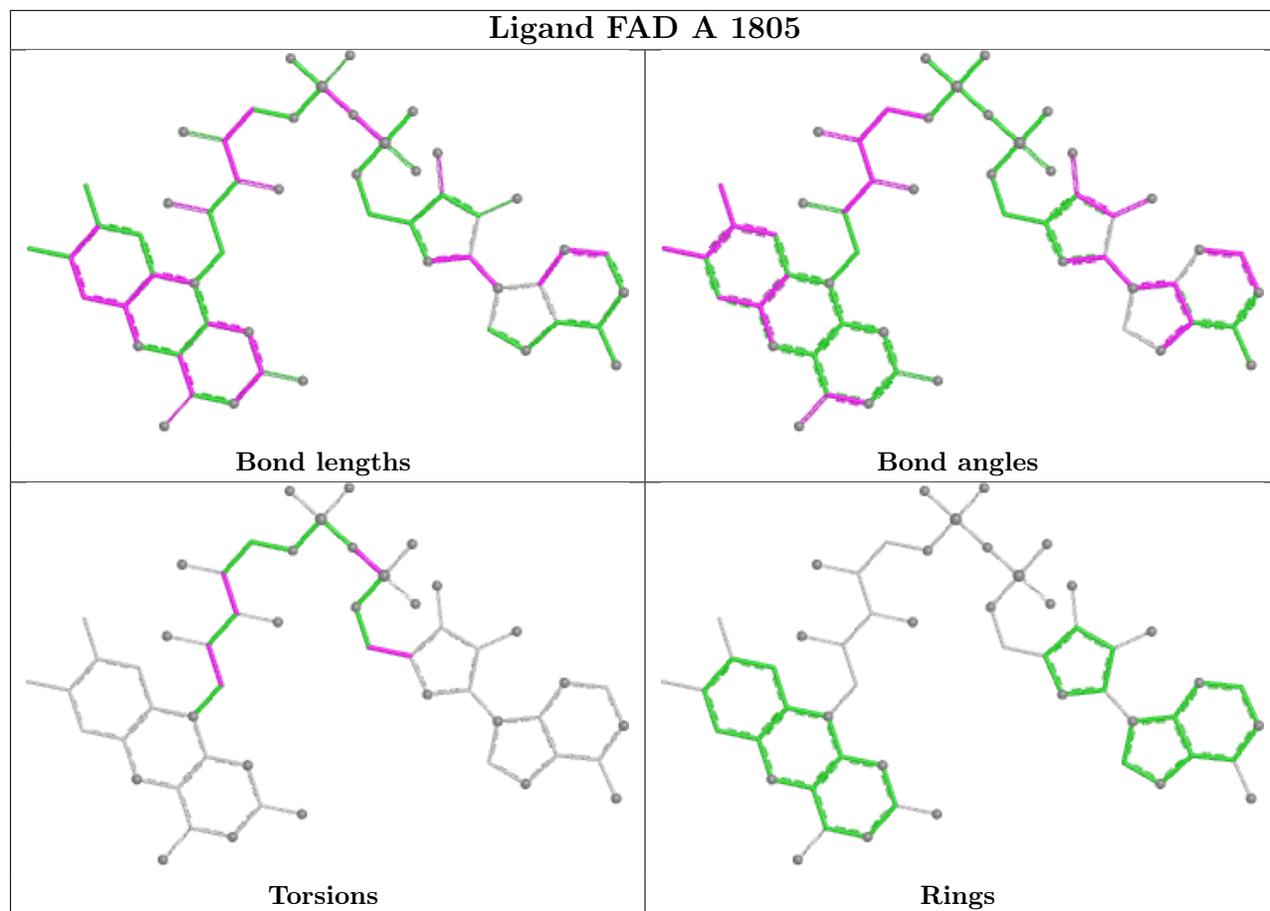
5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2			OWAB(Å^2)	Q<0.9
1	A	568/571 (99%)	-0.46	0	100	100	6, 13, 22, 29	0

There are no RSRZ outliers to report.

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

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

6.3 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	HEC	A	802	43/43	0.96	0.08	12,16,24,29	0
3	HEC	A	801	43/43	0.97	0.07	10,14,18,23	0
3	HEC	A	803	43/43	0.97	0.07	9,13,25,32	0
3	HEC	A	804	43/43	0.98	0.06	7,10,13,14	0
4	FAD	A	1805	53/53	0.98	0.04	6,8,11,12	0
5	FUM	A	1806	8/8	0.98	0.05	10,11,13,13	0
2	NA	A	1810	1/1	0.99	0.02	8,8,8,8	0

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 HEC A 802:

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

Electron density around HEC A 801:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)
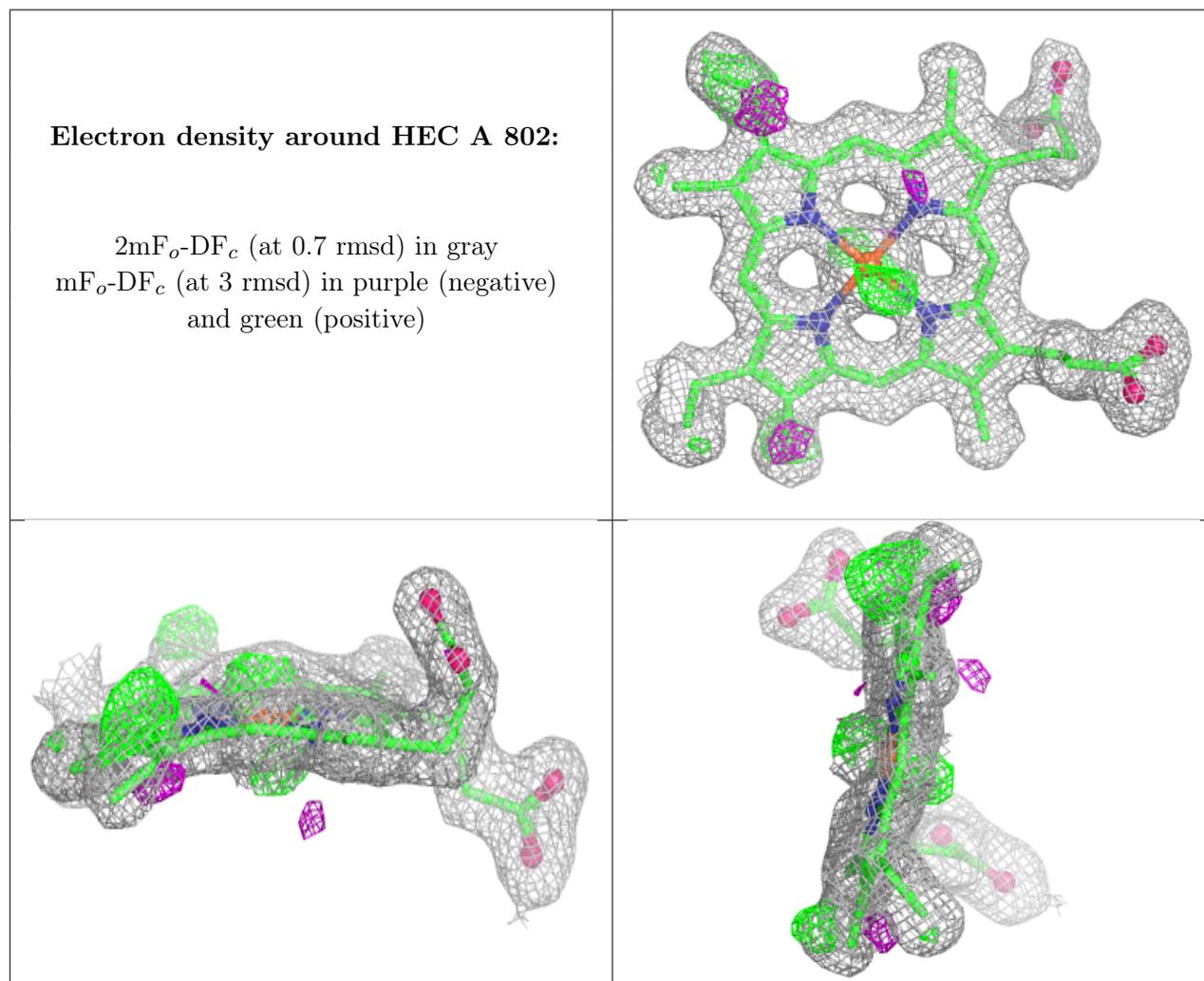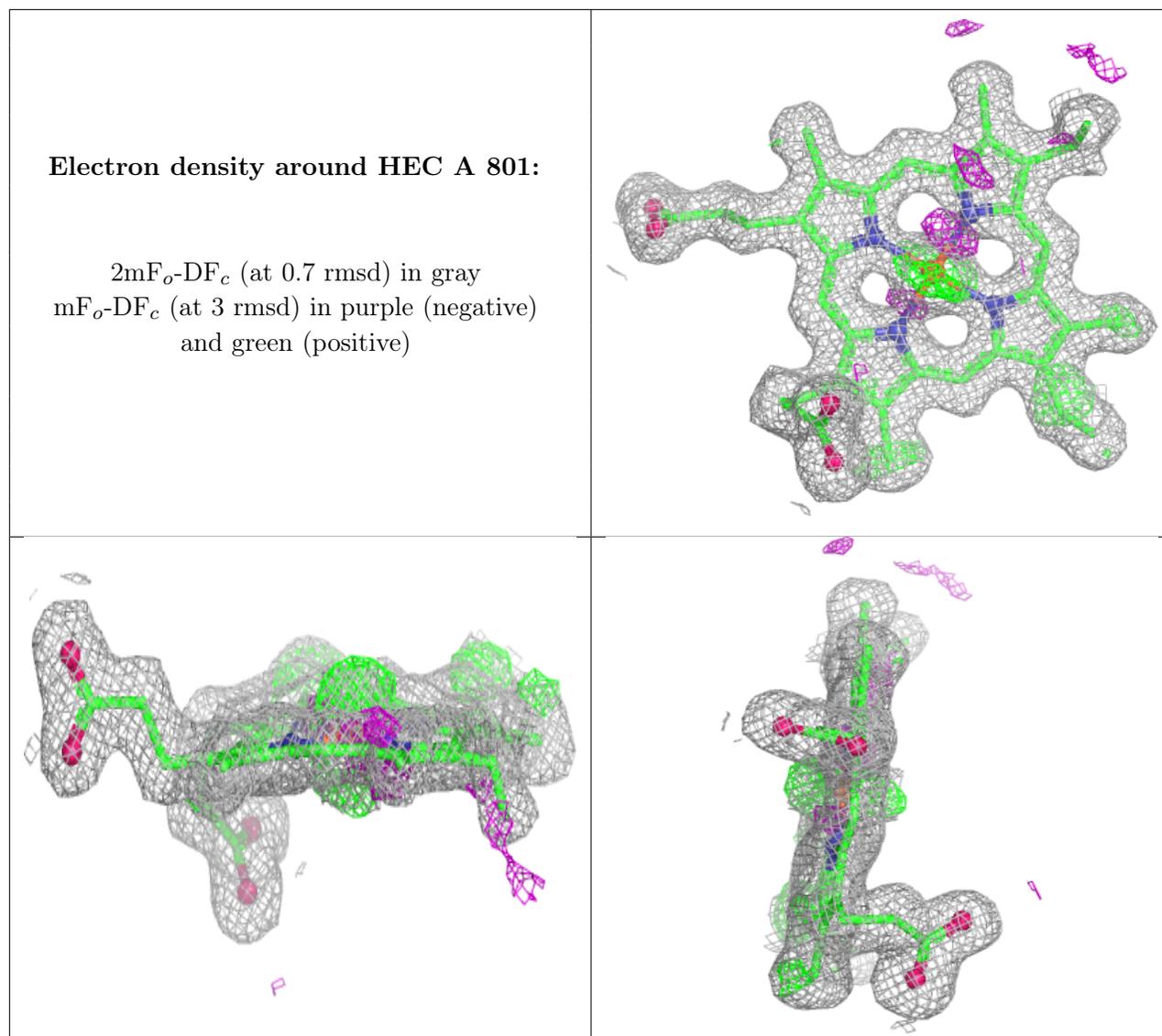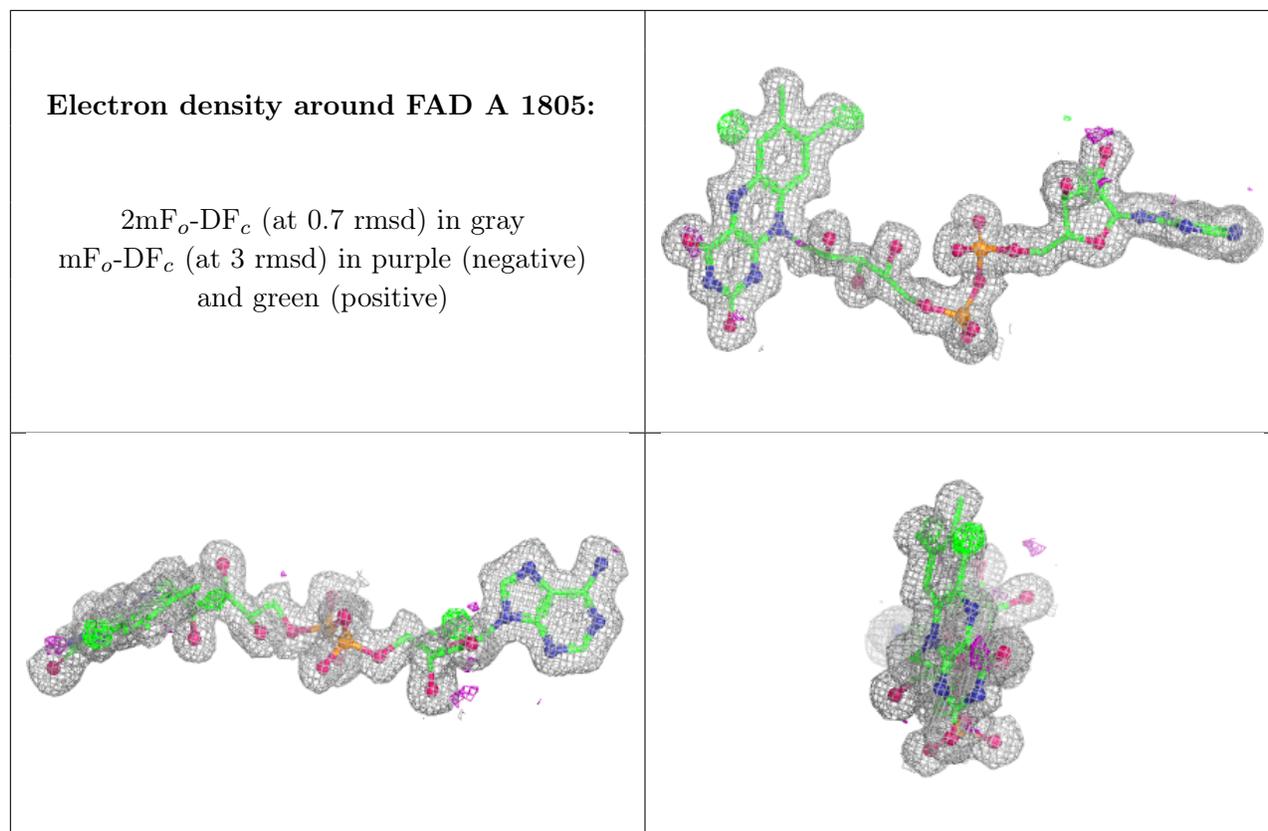
Electron density around HEC A 803:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)
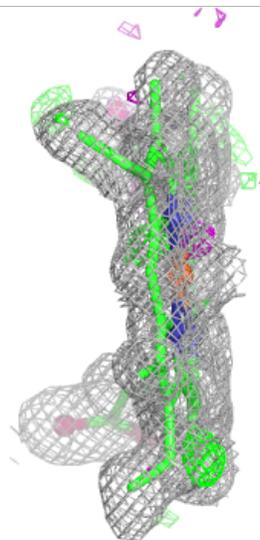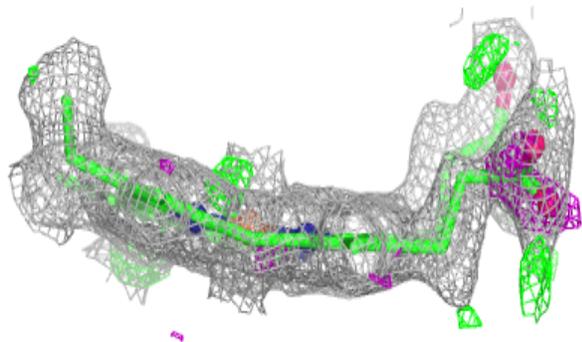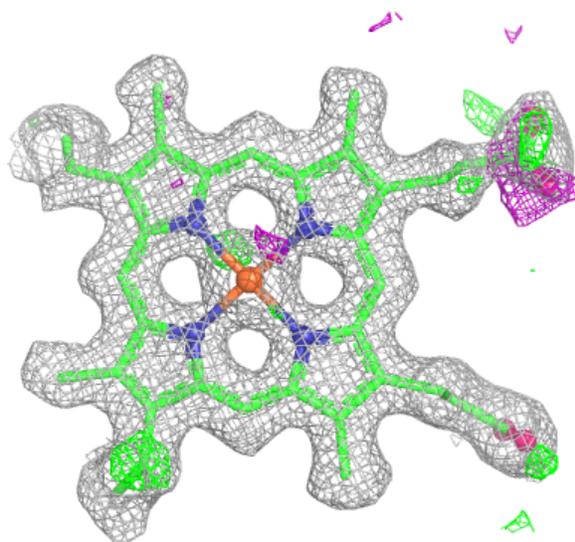
Electron density around HEC A 804:

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

Electron density around FAD A 1805:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)
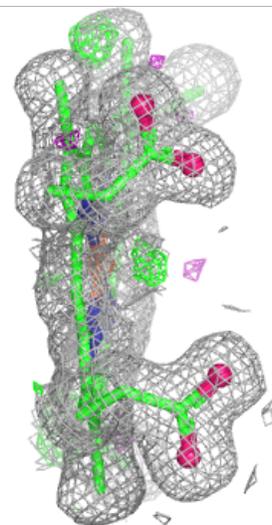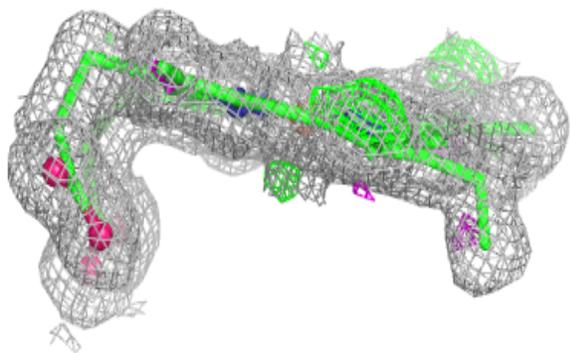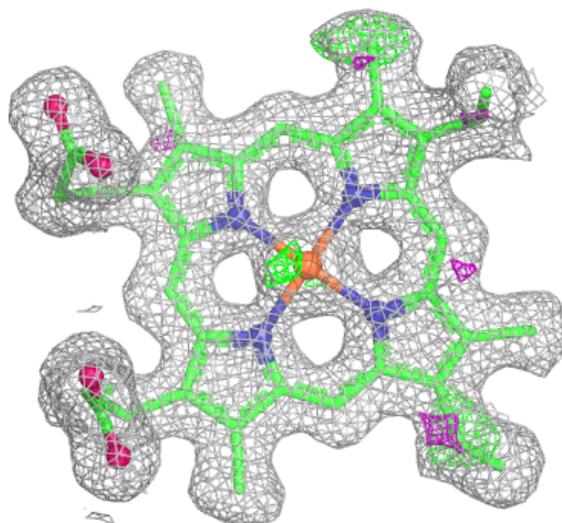
6.5 Other polymers (i)

There are no such residues in this entry.