



wwPDB X-ray Structure Validation Summary Report ⓘ

Aug 4, 2026 – 09:08 AM EDT

PDB ID : 1FCD / pdb_00001fcd
Title : THE STRUCTURE OF FLAVOCYTOCHROME C SULFIDE DEHYDROGENASE FROM A PURPLE PHOTOTROPHIC BACTERIUM CHROMATIUM VINOSUM AT 2.5 ANGSTROMS RESOLUTION
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Deposited on : 1994-08-18
Resolution : 2.53 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	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.50

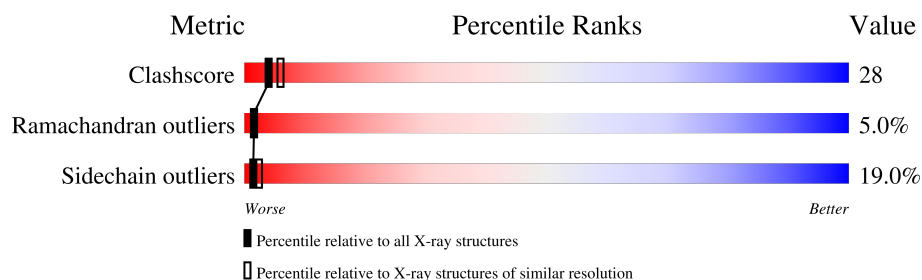
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.53 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	190562	8079 (2.54-2.50)
Ramachandran outliers	187476	7944 (2.54-2.50)
Sidechain outliers	187428	7946 (2.54-2.50)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	401	40% 38% 17% •
1	B	401	38% 38% 18% 6%
2	C	174	52% 34% 13% •
2	D	174	47% 37% 11% 5%

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
3	FAD	A	699	X	-	-	-
3	FAD	B	699	X	-	-	-
4	HEC	C	901	X	-	-	-
4	HEC	C	902	X	-	-	-
4	HEC	D	901	X	-	-	-
4	HEC	D	902	X	-	-	-

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 9002 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 FLAVOCYTOCHROME C SULFIDE DEHYDROGENASE (FLAVIN-BINDING SUBUNIT).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	401	Total	C	N	O	S	0	0	0
			3018	1918	505	584	11			
1	B	401	Total	C	N	O	S	0	0	0
			3018	1918	505	584	11			

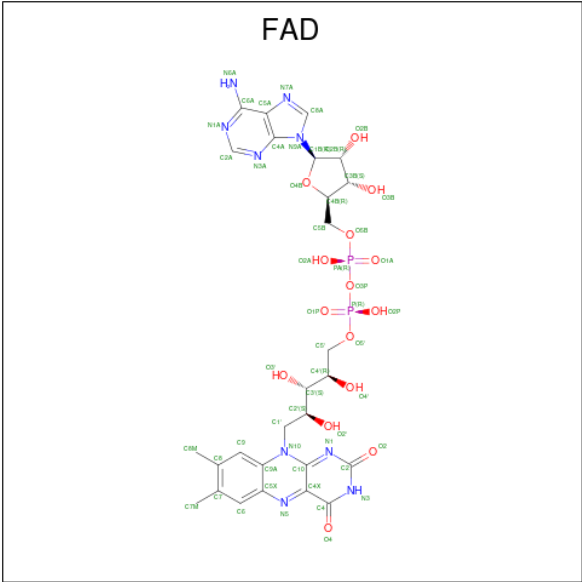
There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	182	MET	LYS	conflict	UNP Q06530
A	296	SER	CYS	conflict	UNP Q06530
A	321	VAL	ALA	conflict	UNP Q06530
B	182	MET	LYS	conflict	UNP Q06530
B	296	SER	CYS	conflict	UNP Q06530
B	321	VAL	ALA	conflict	UNP Q06530

- Molecule 2 is a protein called FLAVOCYTOCHROME C SULFIDE DEHYDROGENASE (CYTOCHROME SUBUNIT).

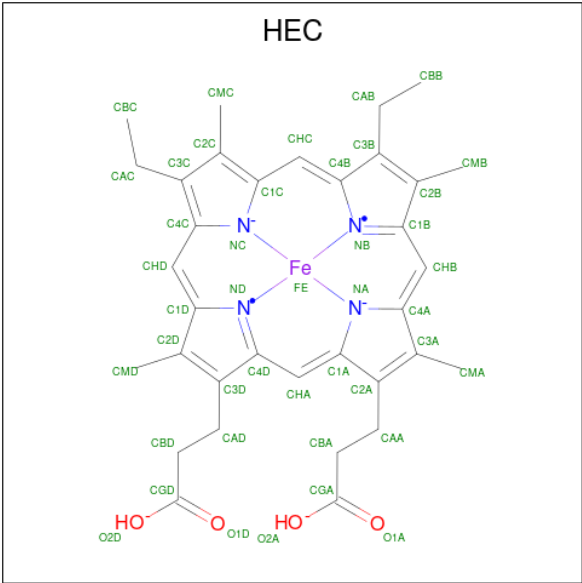
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	174	Total	C	N	O	S	0	0	0
			1344	842	225	264	13			
2	D	174	Total	C	N	O	S	0	0	0
			1344	842	225	264	13			

- Molecule 3 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: C₂₇H₃₃N₉O₁₅P₂).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total 53	C 27	N 9	O 15	P 2	0	0
3	B	1	Total 53	C 27	N 9	O 15	P 2	0	0

- Molecule 4 is HEME C (CCD ID: HEC) (formula: $C_{34}H_{36}FeN_4O_4$).

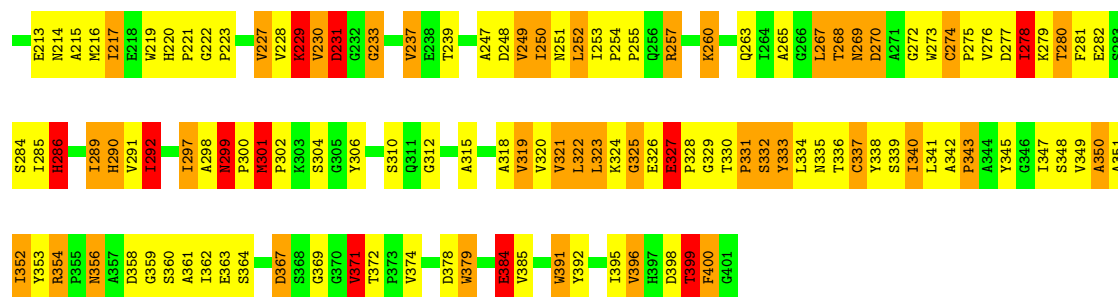


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	C	1	Total 43	C 34	Fe 1	N 4	O 4	0	0
4	C	1	Total 43	C 34	Fe 1	N 4	O 4	0	0

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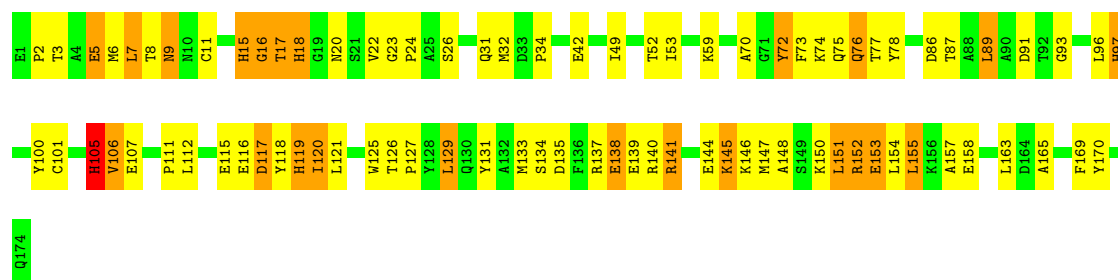
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Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	D	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		
4	D	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		



- Molecule 2: FLAVOCYTOCHROME C SULFIDE DEHYDROGENASE (CYTOCHROME SUBUNIT)

Chain C: 52% 34% 13%



- Molecule 2: FLAVOCYTOCHROME C SULFIDE DEHYDROGENASE (CYTOCHROME SUBUNIT)

Chain D: 47% 37% 11% 5%



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	168.60Å 84.60Å 106.40Å 90.00° 107.00° 90.00°	Depositor
Resolution (Å)	(Not available) – 2.53	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-2.53)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	X-PLOR	Depositor
R, R_{free}	0.237 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	9002	wwPDB-VP
Average B, all atoms (Å ²)	30.0	wwPDB-VP

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: HEC, FAD

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	1.22	15/3093 (0.5%)	2.12	129/4209 (3.1%)
1	B	1.25	14/3093 (0.5%)	2.08	130/4209 (3.1%)
2	C	1.06	2/1374 (0.1%)	1.92	39/1847 (2.1%)
2	D	1.15	5/1374 (0.4%)	1.97	47/1847 (2.5%)
All	All	1.20	36/8934 (0.4%)	2.05	345/12112 (2.8%)

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	B	0	2
2	C	0	1
All	All	0	7

The worst 5 of 36 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	399	THR	C-O	-14.64	1.05	1.24
2	D	30	ALA	C-O	-13.83	1.07	1.23
1	B	400	PHE	N-CA	12.11	1.60	1.46
1	A	399	THR	C-O	-11.28	1.09	1.24
1	A	400	PHE	CA-C	10.39	1.67	1.52

The worst 5 of 345 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	400	PHE	CA-C-O	-31.73	77.56	119.12

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	126	HIS	CA-CB-CG	15.80	129.60	113.80
1	A	180	LYS	O-C-N	-15.02	104.05	121.32
2	D	18	HIS	CA-CB-CG	14.58	128.38	113.80
1	B	399	THR	O-C-N	-14.42	101.08	122.28

There are no chirality outliers.

5 of 7 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	126	HIS	Sidechain
1	A	220	HIS	Sidechain
1	A	400	PHE	Mainchain,Peptide
1	B	60	HIS	Sidechain
2	C	105	HIS	Sidechain

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	3018	0	2953	174	0
1	B	3018	0	2954	210	0
2	C	1344	0	1282	57	0
2	D	1344	0	1282	63	0
3	A	53	0	30	7	0
3	B	53	0	30	2	0
4	C	86	0	60	2	0
4	D	86	0	60	7	0
All	All	9002	0	8651	494	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 28.

The worst 5 of 494 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:180:LYS:NZ	1:A:180:LYS:HA	1.25	1.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:293:GLY:HA3	1:A:311:GLN:HE22	1.09	1.15
1:B:300:PRO:O	1:B:301:MET:HB2	1.47	1.11
1:A:293:GLY:HA3	1:A:311:GLN:NE2	1.70	1.06
1:B:19:LYS:O	1:B:23:LEU:HB2	1.55	1.06

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 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	399/401 (100%)	330 (83%)	41 (10%)	28 (7%)	1	0
1	B	399/401 (100%)	328 (82%)	51 (13%)	20 (5%)	1	1
2	C	172/174 (99%)	144 (84%)	24 (14%)	4 (2%)	5	7
2	D	172/174 (99%)	151 (88%)	16 (9%)	5 (3%)	3	5
All	All	1142/1150 (99%)	953 (84%)	132 (12%)	57 (5%)	1	1

5 of 57 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	12	THR
1	A	82	PRO
1	A	85	LYS
1	A	90	ALA
1	A	149	THR

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	313/313 (100%)	253 (81%)	60 (19%)	1	2
1	B	313/313 (100%)	243 (78%)	70 (22%)	1	1
2	C	138/138 (100%)	121 (88%)	17 (12%)	4	9
2	D	138/138 (100%)	114 (83%)	24 (17%)	2	3
All	All	902/902 (100%)	731 (81%)	171 (19%)	1	2

5 of 171 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	231	ASP
1	B	374	VAL
1	B	270	ASP
1	B	322	LEU
2	D	28	SER

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	251	ASN
1	B	309	ASN
1	B	286	HIS
1	B	335	ASN
1	A	356	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

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
3	FAD	A	699	1	58,58,58	1.32	9 (15%)	85,89,89	1.30	7 (8%)
4	HEC	D	901	2	50,50,50	1.13	3 (6%)	68,82,82	1.20	7 (10%)
4	HEC	C	901	2	50,50,50	0.92	0	68,82,82	1.00	1 (1%)
3	FAD	B	699	1	58,58,58	1.58	12 (20%)	85,89,89	1.24	5 (5%)
4	HEC	D	902	2	50,50,50	1.07	3 (6%)	68,82,82	1.16	4 (5%)
4	HEC	C	902	2	50,50,50	0.95	3 (6%)	68,82,82	0.96	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	FAD	A	699	1	3/3/9/9	10/34/50/50	0/6/6/6
4	HEC	D	901	2	1/1/3/7	4/14/54/54	-
4	HEC	C	901	2	1/1/3/7	5/14/54/54	-
3	FAD	B	699	1	3/3/9/9	6/34/50/50	0/6/6/6
4	HEC	D	902	2	1/1/3/7	8/14/54/54	-
4	HEC	C	902	2	1/1/3/7	5/14/54/54	-

The worst 5 of 30 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	699	FAD	P-O3P	6.35	1.66	1.59
3	B	699	FAD	C10-N10	3.68	1.45	1.37
3	A	699	FAD	C10-N10	3.57	1.45	1.37
3	A	699	FAD	C2'-C3'	-2.90	1.48	1.53
3	B	699	FAD	C4X-N5	2.84	1.36	1.30

The worst 5 of 24 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	B	699	FAD	C9A-C5X-N5	5.28	128.06	122.45
3	A	699	FAD	O4B-C1B-C2B	-4.58	96.80	106.62
3	A	699	FAD	C9A-C5X-N5	4.28	126.99	122.45
3	A	699	FAD	O4'-C4'-C3'	3.80	118.14	109.25
3	B	699	FAD	C5X-N5-C4X	-3.69	112.12	118.09

5 of 10 chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
3	A	699	FAD	C3'
3	A	699	FAD	C4'
3	A	699	FAD	C2'
3	B	699	FAD	C3'
3	B	699	FAD	C4'

5 of 38 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	699	FAD	C5B-O5B-PA-O1A
3	A	699	FAD	C5B-O5B-PA-O3P
3	A	699	FAD	C2'-C1'-N10-C10
3	A	699	FAD	N10-C1'-C2'-O2'
3	A	699	FAD	N10-C1'-C2'-C3'

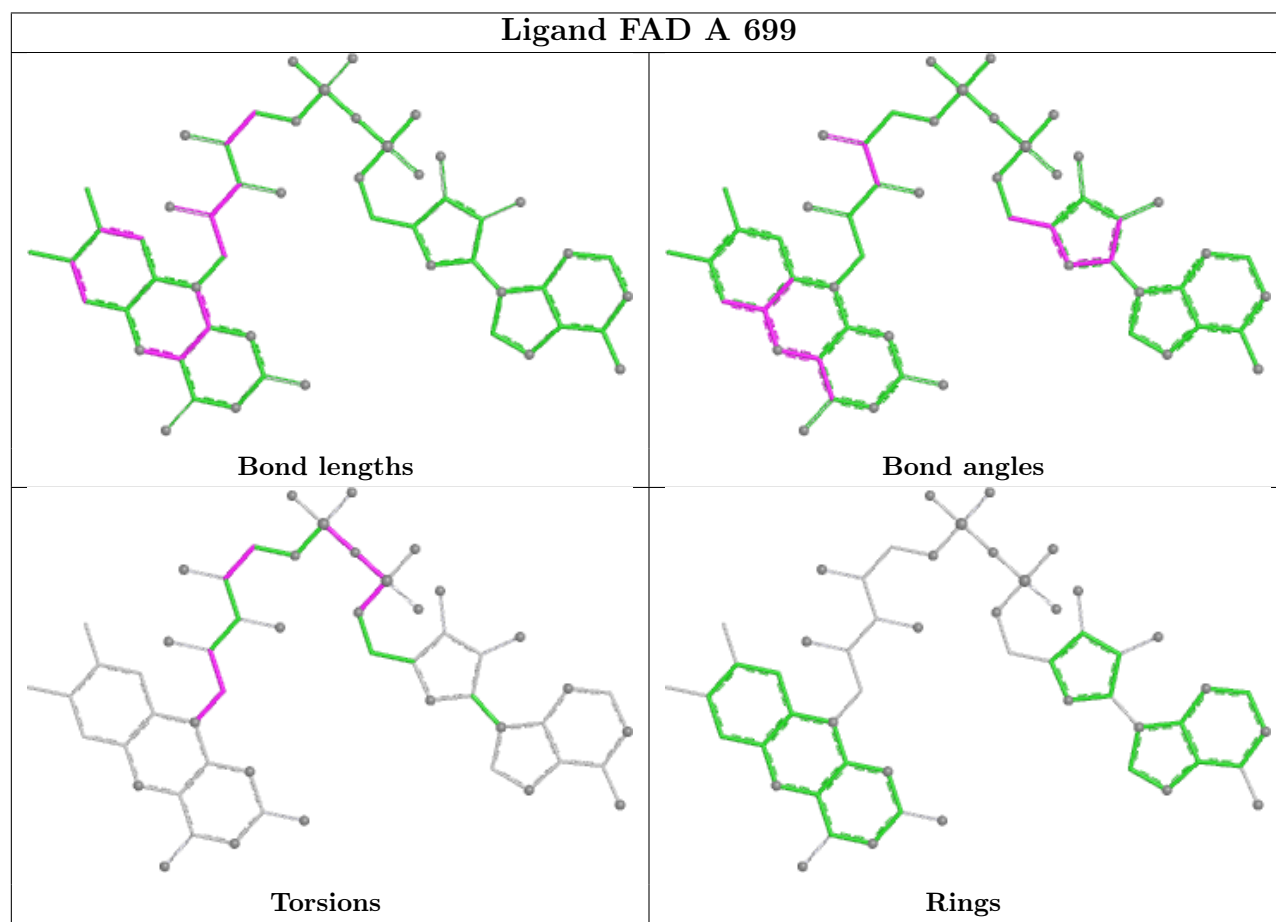
There are no ring outliers.

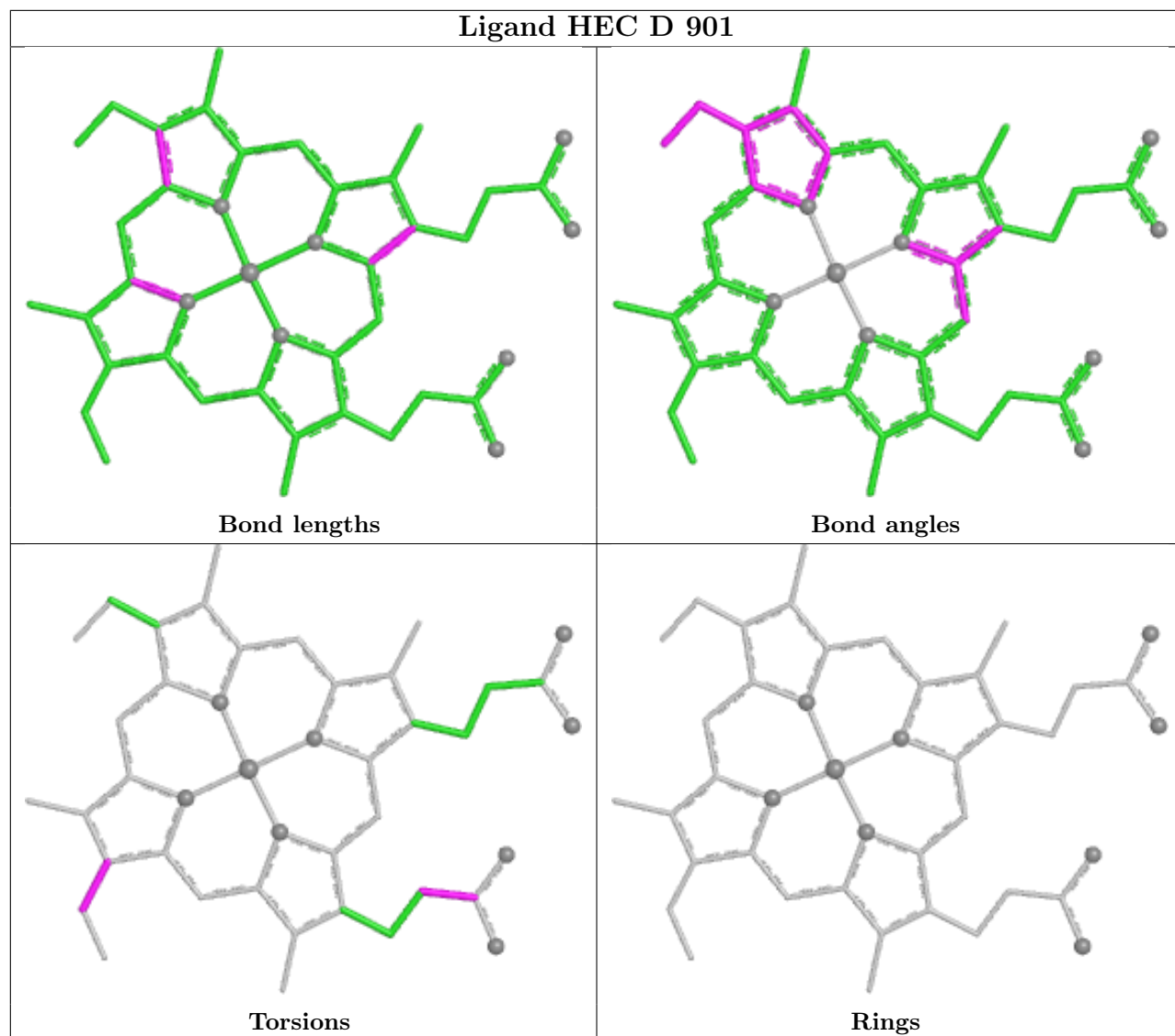
6 monomers are involved in 18 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	699	FAD	7	0
4	D	901	HEC	2	0
4	C	901	HEC	1	0
3	B	699	FAD	2	0
4	D	902	HEC	5	0
4	C	902	HEC	1	0

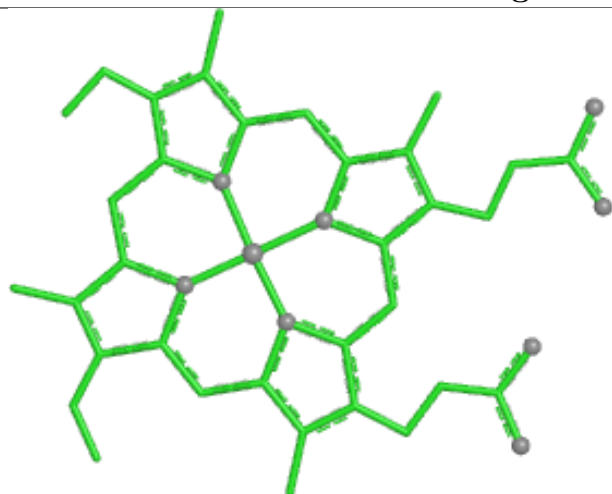
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. 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.

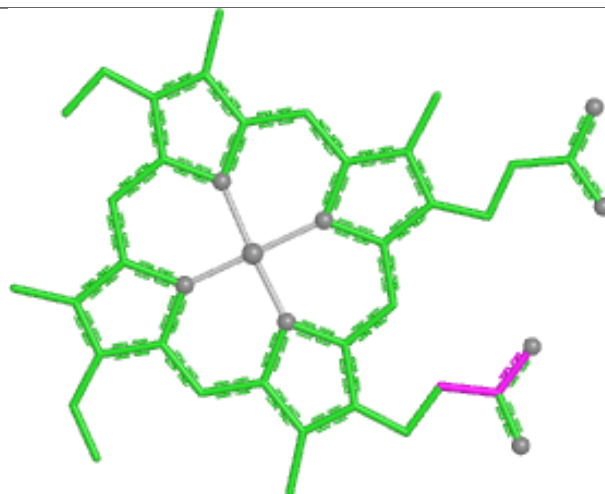




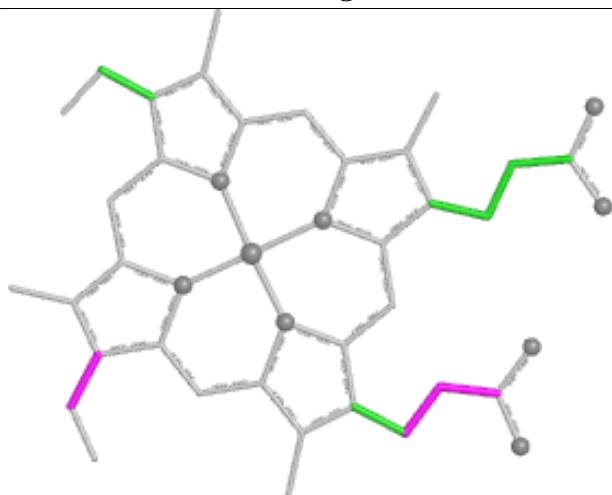
Ligand HEC C 901



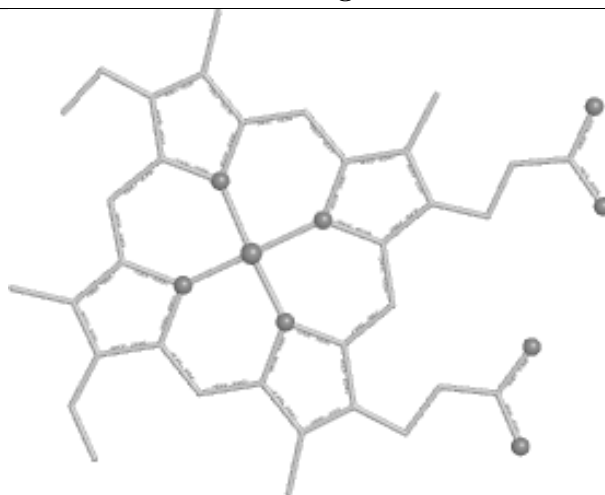
Bond lengths



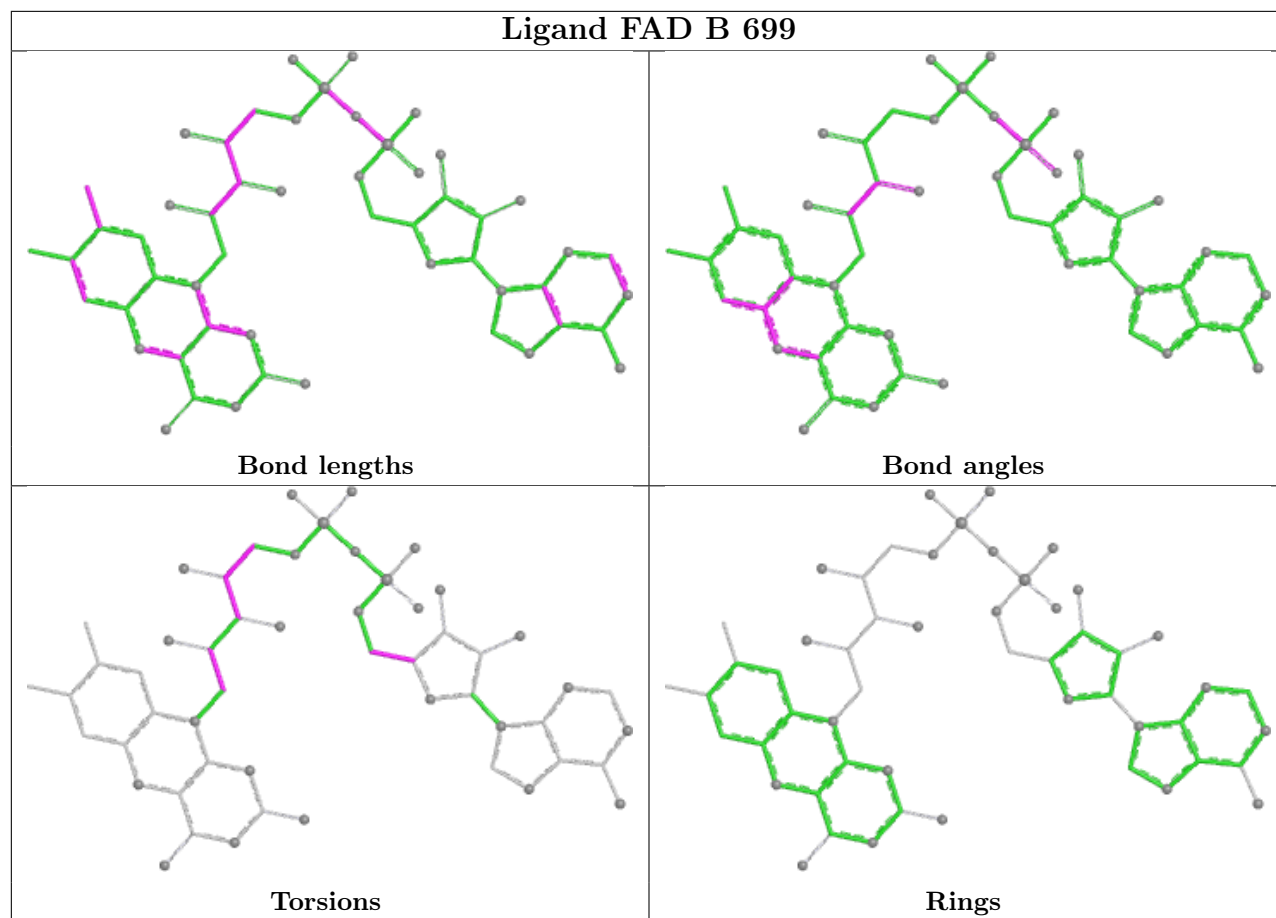
Bond angles



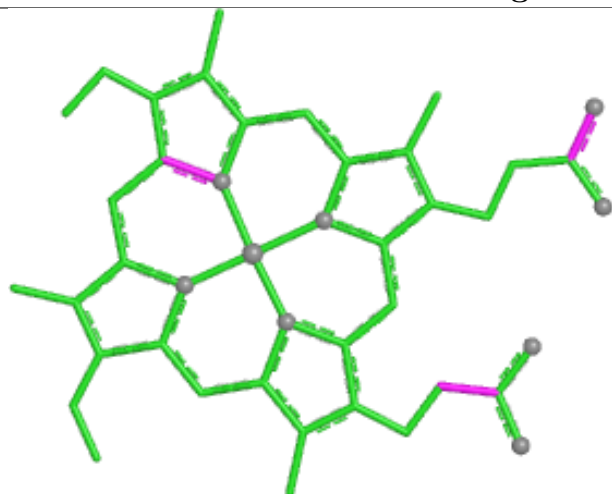
Torsions



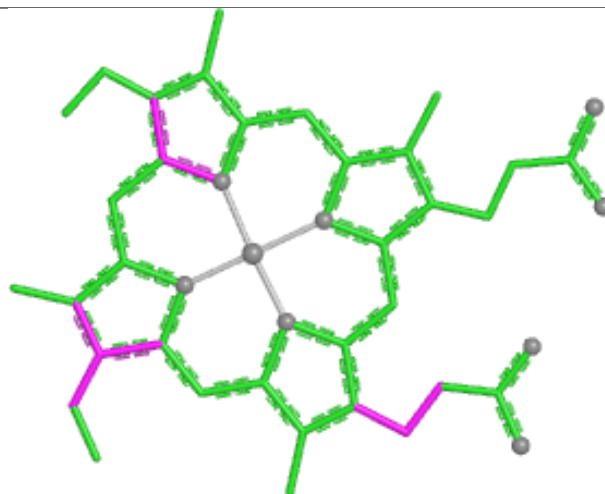
Rings



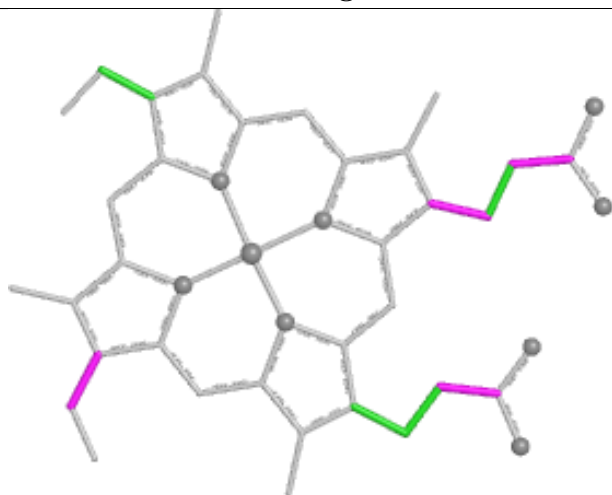
Ligand HEC D 902



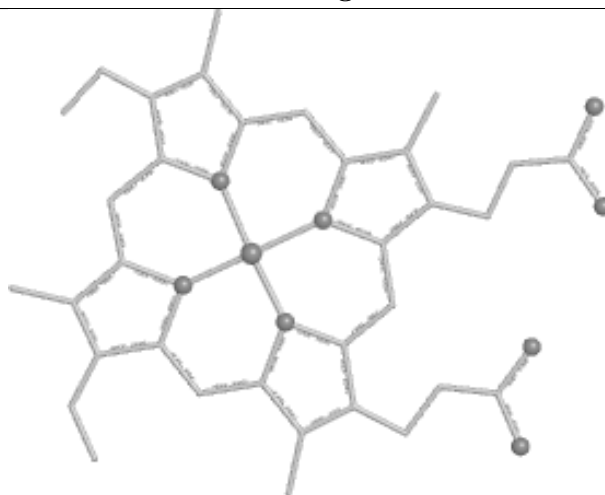
Bond lengths



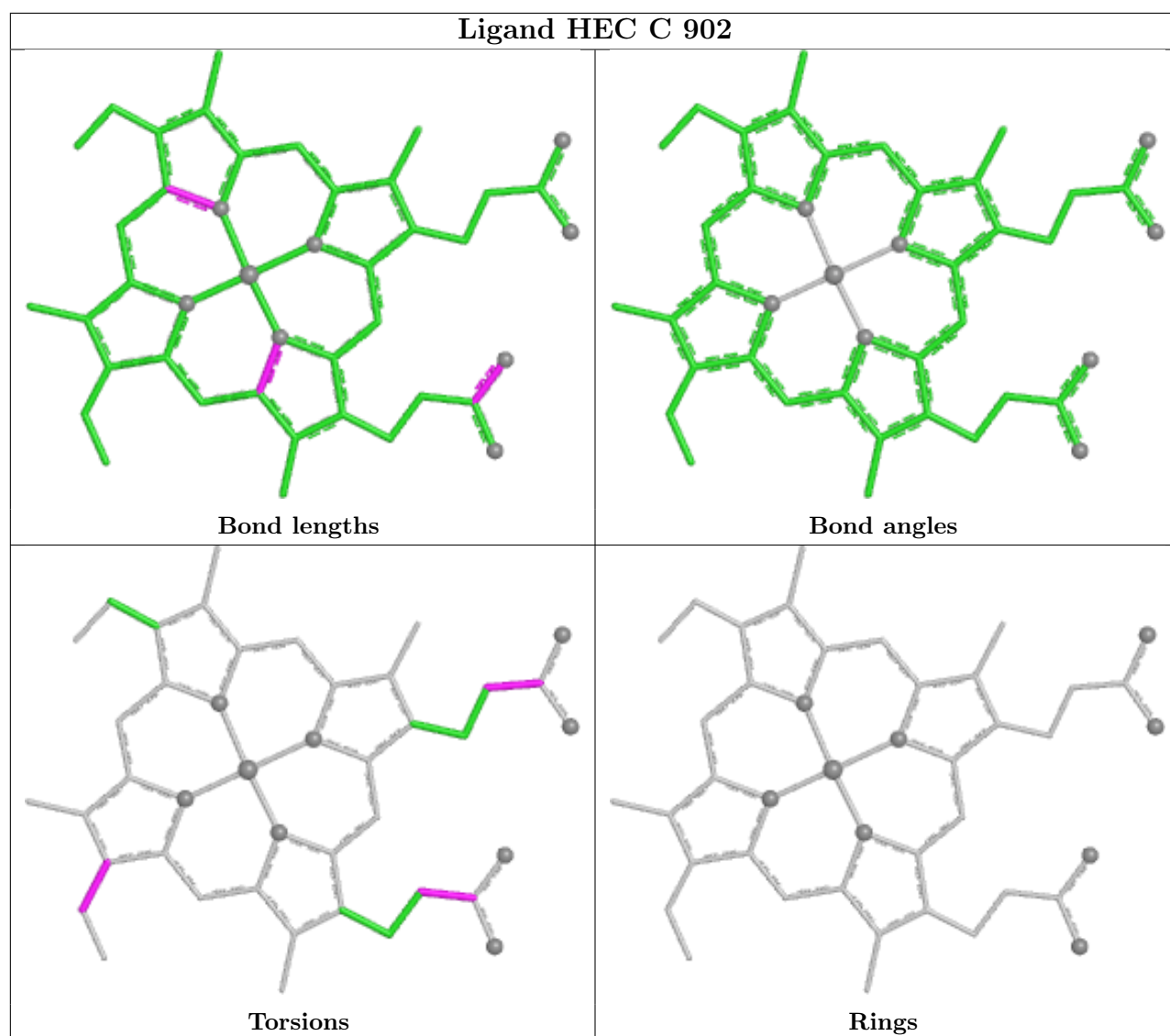
Bond angles



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 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.