



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 23, 2021 – 02:20 PM EDT

PDB ID : 1HDB  
Title : ANALYSIS OF THE CRYSTAL STRUCTURE, MOLECULAR MODELING AND INFRARED SPECTROSCOPY OF THE DISTAL BETA-HEME POCKET VALINE67(E11)-THREONINE MUTATION OF HEMOGLOBIN  
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Deposited on : 1995-04-14  
Resolution : 2.20 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto: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.

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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)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.23.2

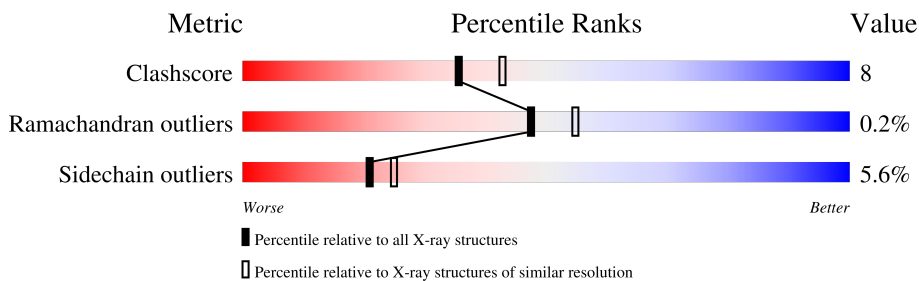
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.20 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	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)

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  $\geq 3$ , 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	141	77% 18% . .
1	C	141	76% 21% ..
2	B	146	73% 25% ..
2	D	146	78% 21% .

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 5000 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 HEMOGLOBIN (DEOXY) BETA-V67T.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	141	Total	C	N	O	S	0	0	0
			1069	685	187	194	3			
1	C	141	Total	C	N	O	S	0	0	0
			1069	685	187	194	3			

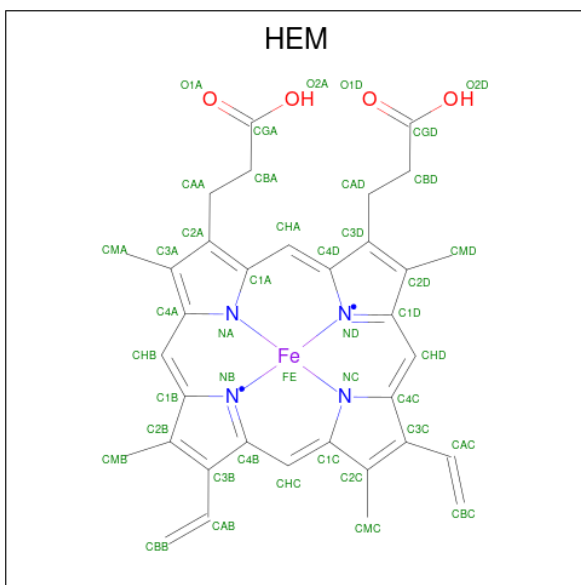
- Molecule 2 is a protein called HEMOGLOBIN (DEOXY) BETA-V67T.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	146	Total	C	N	O	S	0	0	0
			1123	723	195	202	3			
2	D	146	Total	C	N	O	S	0	0	0
			1123	723	195	202	3			

There are 2 discrepancies between the modelled and reference sequences:

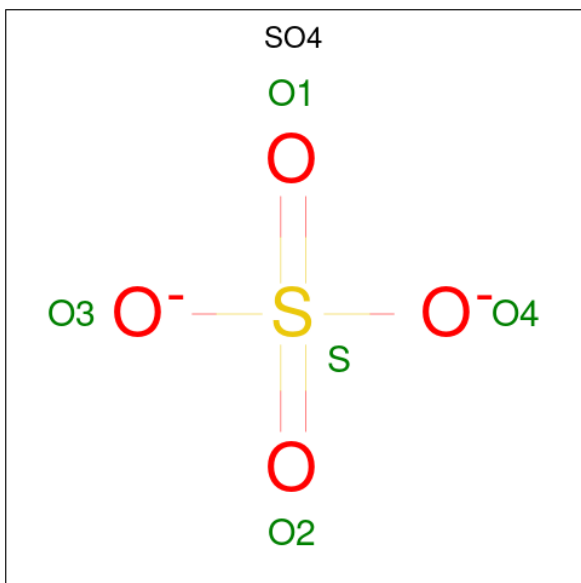
Chain	Residue	Modelled	Actual	Comment	Reference
B	67	THR	VAL	engineered mutation	UNP P02023
D	67	THR	VAL	engineered mutation	UNP P02023

- Molecule 3 is PROTOPORPHYRIN IX CONTAINING FE (three-letter code: HEM) (formula:  $C_{34}H_{32}FeN_4O_4$ ).



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

- Molecule 4 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	B	1	Total	O	S	0	0
			5	4	1		
4	D	1	Total	O	S	0	0
			5	4	1		

- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	110	Total	O	0	0
			110	110		
5	B	112	Total	O	0	0
			112	112		
5	C	120	Total	O	0	0
			120	120		
5	D	92	Total	O	0	0
			92	92		

### 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. 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.

Note EDS was not executed.

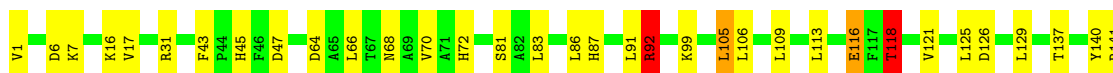
#### • Molecule 1: HEMOGLOBIN (DEOXY) BETA-V67T

Chain A: 



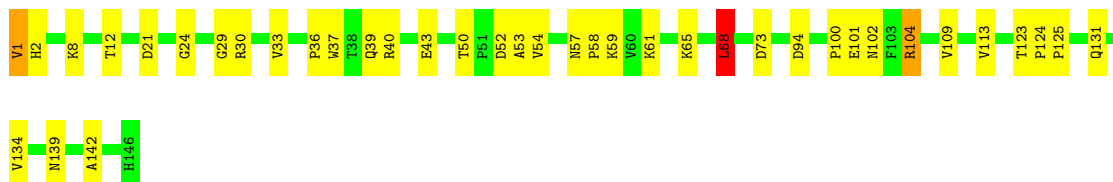
#### • Molecule 1: HEMOGLOBIN (DEOXY) BETA-V67T

Chain C: 




#### • Molecule 2: HEMOGLOBIN (DEOXY) BETA-V67T

Chain B: 



#### • Molecule 2: HEMOGLOBIN (DEOXY) BETA-V67T

Chain D: 



## 4 Data and refinement statistics

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

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	63.54Å 83.19Å 54.02Å 90.00° 99.15° 90.00°	Depositor
Resolution (Å)	6.00 – 2.20	Depositor
% Data completeness (in resolution range)	(Not available) (6.00-2.20)	Depositor
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
Refinement program	GPRLSA	Depositor
R, $R_{free}$	0.149 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	5000	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	21.0	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: SO4, HEM

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	0.98	0/1097	1.67	19/1491 (1.3%)
1	C	1.03	0/1097	1.62	14/1491 (0.9%)
2	B	0.99	0/1153	1.58	15/1566 (1.0%)
2	D	0.97	0/1153	1.61	13/1566 (0.8%)
All	All	0.99	0/4500	1.62	61/6114 (1.0%)

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	2
1	C	0	1
All	All	0	3

There are no bond length outliers.

All (61) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	30	ARG	NE-CZ-NH2	-13.76	113.42	120.30
1	C	92	ARG	NE-CZ-NH2	-13.37	113.61	120.30
2	B	73	ASP	CB-CG-OD1	11.59	128.73	118.30
1	A	92	ARG	NE-CZ-NH2	-11.03	114.79	120.30
2	D	94	ASP	CB-CG-OD2	-10.50	108.85	118.30
2	D	40	ARG	NE-CZ-NH1	10.25	125.42	120.30
2	B	40	ARG	NE-CZ-NH2	-9.86	115.37	120.30
2	B	30	ARG	NE-CZ-NH1	9.83	125.21	120.30
1	A	31	ARG	CD-NE-CZ	9.78	137.29	123.60
1	A	47	ASP	CB-CG-OD1	9.73	127.06	118.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	92	ARG	NE-CZ-NH1	8.97	124.78	120.30
1	A	46	PHE	CA-CB-CG	8.77	134.94	113.90
2	B	104	ARG	NE-CZ-NH2	8.40	124.50	120.30
1	C	6	ASP	CB-CG-OD2	-8.40	110.74	118.30
1	C	141	ARG	NE-CZ-NH2	-8.40	116.10	120.30
2	B	30	ARG	NE-CZ-NH2	-8.31	116.14	120.30
1	A	85	ASP	CB-CG-OD2	-8.13	110.98	118.30
2	D	22	GLU	OE1-CD-OE2	7.85	132.72	123.30
1	A	6	ASP	CB-CG-OD2	-7.73	111.34	118.30
2	D	30	ARG	NE-CZ-NH1	7.63	124.11	120.30
1	A	141	ARG	NE-CZ-NH2	7.38	123.99	120.30
1	C	47	ASP	CB-CG-OD1	6.93	124.54	118.30
2	D	73	ASP	CB-CG-OD1	6.91	124.52	118.30
1	C	105	LEU	CA-CB-CG	6.74	130.81	115.30
1	C	31	ARG	CD-NE-CZ	6.67	132.93	123.60
1	A	116	GLU	CG-CD-OE1	6.58	131.45	118.30
1	A	89	HIS	CA-CB-CG	-6.52	102.51	113.60
2	B	94	ASP	CB-CG-OD1	6.50	124.15	118.30
1	C	118	THR	N-CA-CB	-6.39	98.15	110.30
1	C	6	ASP	CB-CG-OD1	6.37	124.03	118.30
1	C	141	ARG	NE-CZ-NH1	6.33	123.47	120.30
1	A	6	ASP	CB-CG-OD1	6.27	123.94	118.30
2	D	2	HIS	CA-CB-CG	-6.00	103.41	113.60
2	D	40	ARG	CD-NE-CZ	5.95	131.93	123.60
1	A	126	ASP	CB-CG-OD1	5.93	123.63	118.30
1	A	64	ASP	CB-CG-OD1	5.89	123.60	118.30
2	B	43	GLU	CG-CD-OE1	5.89	130.07	118.30
1	A	74	ASP	CB-CG-OD1	5.88	123.59	118.30
1	A	47	ASP	N-CA-C	-5.81	95.33	111.00
1	A	116	GLU	OE1-CD-OE2	-5.76	116.38	123.30
1	A	106	LEU	CB-CG-CD2	-5.71	101.30	111.00
2	D	43	GLU	CG-CD-OE1	5.70	129.70	118.30
2	B	43	GLU	CG-CD-OE2	-5.67	106.96	118.30
2	D	40	ARG	NE-CZ-NH2	-5.67	117.47	120.30
2	D	72	SER	N-CA-CB	5.53	118.80	110.50
1	A	47	ASP	OD1-CG-OD2	-5.51	112.82	123.30
1	A	141	ARG	CD-NE-CZ	5.40	131.16	123.60
1	C	64	ASP	CB-CG-OD1	5.39	123.16	118.30
2	B	101	GLU	OE1-CD-OE2	5.39	129.77	123.30
2	B	68	LEU	CA-CB-CG	5.33	127.56	115.30
2	B	134	VAL	CA-CB-CG2	5.29	118.83	110.90
1	C	126	ASP	CB-CA-C	5.28	120.96	110.40

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	68	LEU	CB-CA-C	5.28	120.23	110.20
2	D	45	PHE	CB-CG-CD2	-5.28	117.11	120.80
1	C	31	ARG	NE-CZ-NH1	5.24	122.92	120.30
2	D	15	TRP	CB-CA-C	5.20	120.81	110.40
1	A	137	THR	CA-CB-CG2	5.13	119.58	112.40
2	B	104	ARG	CD-NE-CZ	-5.13	116.42	123.60
2	B	52	ASP	CB-CG-OD2	-5.12	113.69	118.30
2	B	104	ARG	NH1-CZ-NH2	-5.11	113.78	119.40
1	C	17	VAL	CA-CB-CG1	5.06	118.50	110.90

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	36	PHE	Mainchain
1	A	92	ARG	Sidechain
1	C	92	ARG	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	1069	0	1073	12	0
1	C	1069	0	1073	20	0
2	B	1123	0	1116	24	0
2	D	1123	0	1116	16	0
3	A	43	0	30	0	0
3	B	43	0	30	2	0
3	C	43	0	30	4	0
3	D	43	0	30	0	0
4	B	5	0	0	1	0
4	D	5	0	0	0	0
5	A	110	0	0	1	0
5	B	112	0	0	0	0
5	C	120	0	0	3	0
5	D	92	0	0	0	0
All	All	5000	0	4498	73	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 (73) 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:C:113:LEU:HB3	1:C:116:GLU:HG2	1.65	0.76
1:A:16:LYS:HG3	1:A:116:GLU:HG2	1.68	0.75
2:D:20:VAL:HG13	2:D:68:LEU:HB3	1.68	0.74
2:D:50:THR:HG23	2:D:53:ALA:H	1.54	0.73
2:D:50:THR:HG22	2:D:53:ALA:HB2	1.74	0.69
1:C:118:THR:HG22	1:C:121:VAL:H	1.59	0.67
2:B:37:TRP:HA	1:C:92:ARG:HD3	1.78	0.65
2:B:58:PRO:HA	2:B:61:LYS:HE3	1.80	0.63
1:C:109:LEU:HD12	1:C:125:LEU:HD13	1.81	0.61
1:A:60:LYS:HB3	1:A:60:LYS:NZ	2.15	0.61
1:C:66:LEU:O	1:C:70:VAL:HG23	2.01	0.61
1:A:60:LYS:HB3	1:A:60:LYS:HZ2	1.66	0.60
2:B:2:HIS:H	2:B:2:HIS:CD2	2.23	0.57
2:D:19:ASN:ND2	2:D:21:ASP:H	2.03	0.56
1:C:83:LEU:HD11	3:C:142:HEM:HMA1	1.88	0.56
1:C:118:THR:HG21	5:C:205:HOH:O	2.07	0.54
2:B:104:ARG:NH2	2:B:139:ASN:OD1	2.41	0.53
1:A:105:LEU:O	1:A:109:LEU:HD22	2.09	0.52
1:C:16:LYS:HG3	1:C:116:GLU:HG3	1.92	0.51
2:D:19:ASN:HD22	2:D:19:ASN:C	2.12	0.51
2:B:58:PRO:HA	2:B:61:LYS:CE	2.40	0.51
2:D:29:GLY:O	2:D:33:VAL:HG23	2.11	0.51
1:A:73:VAL:HG22	1:A:73:VAL:O	2.11	0.50
1:A:35:SER:HB3	2:B:131:GLN:HG3	1.95	0.49
2:B:29:GLY:O	2:B:33:VAL:HG23	2.12	0.49
1:C:109:LEU:CD1	1:C:125:LEU:HD13	2.42	0.48
3:C:142:HEM:HMC1	3:C:142:HEM:HBC2	1.96	0.48
2:B:57:ASN:O	2:B:61:LYS:HG3	2.14	0.48
1:A:16:LYS:HD3	5:A:170:HOH:O	2.14	0.48
2:B:8:LYS:O	2:B:12:THR:HG23	2.13	0.48
2:B:50:THR:O	2:B:54:VAL:HG23	2.14	0.48
1:C:16:LYS:NZ	1:C:116:GLU:OE1	2.39	0.46
1:A:76:MET:N	1:A:77:PRO:HD2	2.30	0.46
1:A:66:LEU:O	1:A:70:VAL:HG23	2.16	0.46
2:B:36:PRO:O	2:B:39:GLN:HG3	2.15	0.46
1:C:87:HIS:HA	1:C:91:LEU:HB2	1.98	0.46
2:D:82:LYS:HE3	2:D:143:HIS:CD2	2.51	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:45:HIS:ND1	1:C:45:HIS:N	2.59	0.45
2:B:109:VAL:O	2:B:113:VAL:HG23	2.16	0.45
1:C:86:LEU:HD21	3:C:142:HEM:HBA2	1.97	0.45
3:C:142:HEM:HBC2	3:C:142:HEM:CMC	2.46	0.45
2:B:58:PRO:HA	2:B:61:LYS:HZ2	1.81	0.45
1:C:106:LEU:CD1	1:C:129:LEU:HD12	2.47	0.45
2:D:17:LYS:NZ	2:D:121:GLU:OE1	2.50	0.45
2:D:19:ASN:ND2	2:D:19:ASN:C	2.70	0.44
1:C:92:ARG:NE	5:C:218:HOH:O	2.42	0.44
2:B:50:THR:H	2:B:53:ALA:HB3	1.83	0.44
2:B:123:THR:OG1	2:B:125:PRO:HD2	2.18	0.44
1:A:16:LYS:HE2	1:A:116:GLU:CG	2.47	0.44
2:B:102:ASN:HB3	3:B:148:HEM:HMC1	2.00	0.44
2:D:68:LEU:O	2:D:71:PHE:HB3	2.19	0.43
2:D:50:THR:CG2	2:D:53:ALA:HB2	2.47	0.43
2:D:19:ASN:HD22	2:D:20:VAL:N	2.17	0.43
2:D:50:THR:HG23	2:D:53:ALA:N	2.30	0.42
2:B:1:VAL:N	4:B:147:SO4:O4	2.53	0.42
1:A:28:ALA:CB	1:A:105:LEU:HD13	2.50	0.42
2:B:58:PRO:HA	2:B:61:LYS:NZ	2.34	0.42
1:C:43:PHE:HA	1:C:45:HIS:CE1	2.55	0.42
2:B:124:PRO:HD2	2:B:125:PRO:HD3	2.01	0.42
2:D:75:LEU:HD23	2:D:75:LEU:HA	1.90	0.42
1:C:68:ASN:O	1:C:72:HIS:HD2	2.02	0.41
2:B:24:GLY:HA2	2:B:68:LEU:HG	2.02	0.41
2:B:58:PRO:CA	2:B:61:LYS:HE3	2.47	0.41
1:C:7:LYS:NZ	5:C:160:HOH:O	2.49	0.41
2:B:100:PRO:HB3	2:B:142:ALA:HB2	2.03	0.41
1:C:137:THR:HA	1:C:140:TYR:CD1	2.56	0.41
1:A:133:SER:O	1:A:137:THR:HB	2.21	0.41
3:B:148:HEM:CMB	3:B:148:HEM:HBB2	2.50	0.41
2:D:19:ASN:ND2	2:D:21:ASP:OD1	2.45	0.41
1:C:83:LEU:HD23	1:C:83:LEU:HA	1.83	0.41
2:B:21:ASP:OD2	2:B:65:LYS:HD2	2.20	0.41
2:B:57:ASN:OD1	2:B:59:LYS:HB2	2.20	0.41
2:D:50:THR:O	2:D:53:ALA:HB3	2.21	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	139/141 (99%)	133 (96%)	5 (4%)	1 (1%)	22	22
1	C	139/141 (99%)	137 (99%)	2 (1%)	0	100	100
2	B	144/146 (99%)	142 (99%)	2 (1%)	0	100	100
2	D	144/146 (99%)	141 (98%)	3 (2%)	0	100	100
All	All	566/574 (99%)	553 (98%)	12 (2%)	1 (0%)	47	55

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	18	GLY

### 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	113/113 (100%)	105 (93%)	8 (7%)	14	16
1	C	113/113 (100%)	107 (95%)	6 (5%)	22	27
2	B	118/118 (100%)	116 (98%)	2 (2%)	60	74
2	D	118/118 (100%)	108 (92%)	10 (8%)	10	10
All	All	462/462 (100%)	436 (94%)	26 (6%)	21	25

All (26) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	60	LYS
1	A	61	LYS
1	A	78	ASN
1	A	81	SER
1	A	99	LYS
1	A	105	LEU
1	A	109	LEU
1	A	137	THR
2	B	1	VAL
2	B	68	LEU
1	C	1	VAL
1	C	81	SER
1	C	99	LYS
1	C	105	LEU
1	C	116	GLU
1	C	118	THR
2	D	6	GLU
2	D	19	ASN
2	D	32	LEU
2	D	52	ASP
2	D	59	LYS
2	D	61	LYS
2	D	68	LEU
2	D	78	LEU
2	D	79	ASP
2	D	120	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (5) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	2	HIS
1	C	72	HIS
2	D	19	ASN
2	D	117	HIS
2	D	143	HIS

### 5.3.3 RNA ⓘ

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$
3	HEM	B	148	2	27,50,50	1.88	7 (25%)	17,82,82	1.93	6 (35%)
4	SO4	D	147	-	4,4,4	1.31	0	6,6,6	0.88	0
3	HEM	A	142	1	27,50,50	1.92	6 (22%)	17,82,82	1.56	5 (29%)
3	HEM	D	148	2	27,50,50	1.72	6 (22%)	17,82,82	2.16	8 (47%)
4	SO4	B	147	-	4,4,4	1.49	0	6,6,6	0.39	0
3	HEM	C	142	1	27,50,50	2.02	6 (22%)	17,82,82	2.03	6 (35%)

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	HEM	D	148	2	-	0/6/54/54	-
3	HEM	B	148	2	-	0/6/54/54	-
3	HEM	A	142	1	-	0/6/54/54	-
3	HEM	C	142	1	-	0/6/54/54	-

All (25) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	142	HEM	C3B-C2B	-4.86	1.33	1.40
3	A	142	HEM	C3B-C2B	-4.52	1.34	1.40
3	C	142	HEM	C3C-C2C	-4.24	1.34	1.40
3	A	142	HEM	C3C-CAC	4.23	1.56	1.47
3	D	148	HEM	C3C-C2C	-4.23	1.34	1.40
3	B	148	HEM	C3B-C2B	-4.07	1.34	1.40
3	D	148	HEM	C3B-C2B	-3.96	1.34	1.40
3	B	148	HEM	C3C-C2C	-3.91	1.34	1.40
3	A	142	HEM	C3C-C2C	-3.84	1.35	1.40
3	B	148	HEM	C3B-CAB	3.71	1.55	1.47
3	C	142	HEM	C3B-CAB	3.65	1.55	1.47
3	C	142	HEM	C3C-CAC	3.38	1.54	1.47
3	C	142	HEM	CAA-C2A	3.18	1.56	1.52
3	D	148	HEM	C3C-CAC	2.86	1.53	1.47
3	B	148	HEM	C3C-CAC	2.73	1.53	1.47
3	B	148	HEM	CAA-C2A	2.65	1.55	1.52
3	A	142	HEM	C3B-CAB	2.61	1.53	1.47
3	A	142	HEM	CAD-C3D	2.55	1.56	1.52
3	D	148	HEM	C3B-CAB	2.36	1.52	1.47
3	D	148	HEM	CAD-C3D	2.24	1.56	1.52
3	B	148	HEM	C1D-ND	2.21	1.40	1.36
3	B	148	HEM	C1A-NA	2.14	1.40	1.36
3	A	142	HEM	CMB-C2B	2.12	1.56	1.51
3	C	142	HEM	CMD-C2D	2.10	1.56	1.51
3	D	148	HEM	C1C-C2C	2.06	1.47	1.42

All (25) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	148	HEM	CMA-C3A-C4A	-4.48	121.58	128.46
3	C	142	HEM	CMA-C3A-C4A	-4.37	121.75	128.46
3	D	148	HEM	CBA-CAA-C2A	3.92	119.71	112.49
3	B	148	HEM	CMD-C2D-C1D	-3.91	122.46	128.46
3	B	148	HEM	CMA-C3A-C4A	-3.73	122.73	128.46
3	C	142	HEM	CMA-C3A-C2A	3.41	131.38	124.94
3	D	148	HEM	CMA-C3A-C2A	3.18	130.94	124.94
3	A	142	HEM	CAA-CBA-CGA	2.90	117.53	112.67
3	A	142	HEM	CMA-C3A-C4A	-2.81	124.14	128.46
3	B	148	HEM	CMD-C2D-C3D	2.79	130.20	124.94
3	C	142	HEM	CAD-CBD-CGD	2.77	117.32	112.67
3	B	148	HEM	CMA-C3A-C2A	2.76	130.14	124.94
3	C	142	HEM	CMB-C2B-C3B	2.75	129.83	124.68
3	C	142	HEM	CMD-C2D-C1D	-2.69	124.33	128.46

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	148	HEM	CAA-CBA-CGA	-2.47	108.52	112.67
3	D	148	HEM	CMD-C2D-C1D	-2.40	124.78	128.46
3	B	148	HEM	CMB-C2B-C3B	2.39	129.15	124.68
3	C	142	HEM	CAA-CBA-CGA	-2.38	108.68	112.67
3	D	148	HEM	CMB-C2B-C3B	2.35	129.08	124.68
3	D	148	HEM	CMC-C2C-C3C	2.11	128.63	124.68
3	B	148	HEM	CBA-CAA-C2A	-2.11	108.59	112.49
3	A	142	HEM	CMD-C2D-C1D	-2.10	125.24	128.46
3	A	142	HEM	CMA-C3A-C2A	2.05	128.80	124.94
3	A	142	HEM	CMC-C2C-C3C	2.02	128.45	124.68
3	D	148	HEM	CMD-C2D-C3D	2.00	128.72	124.94

There are no chirality outliers.

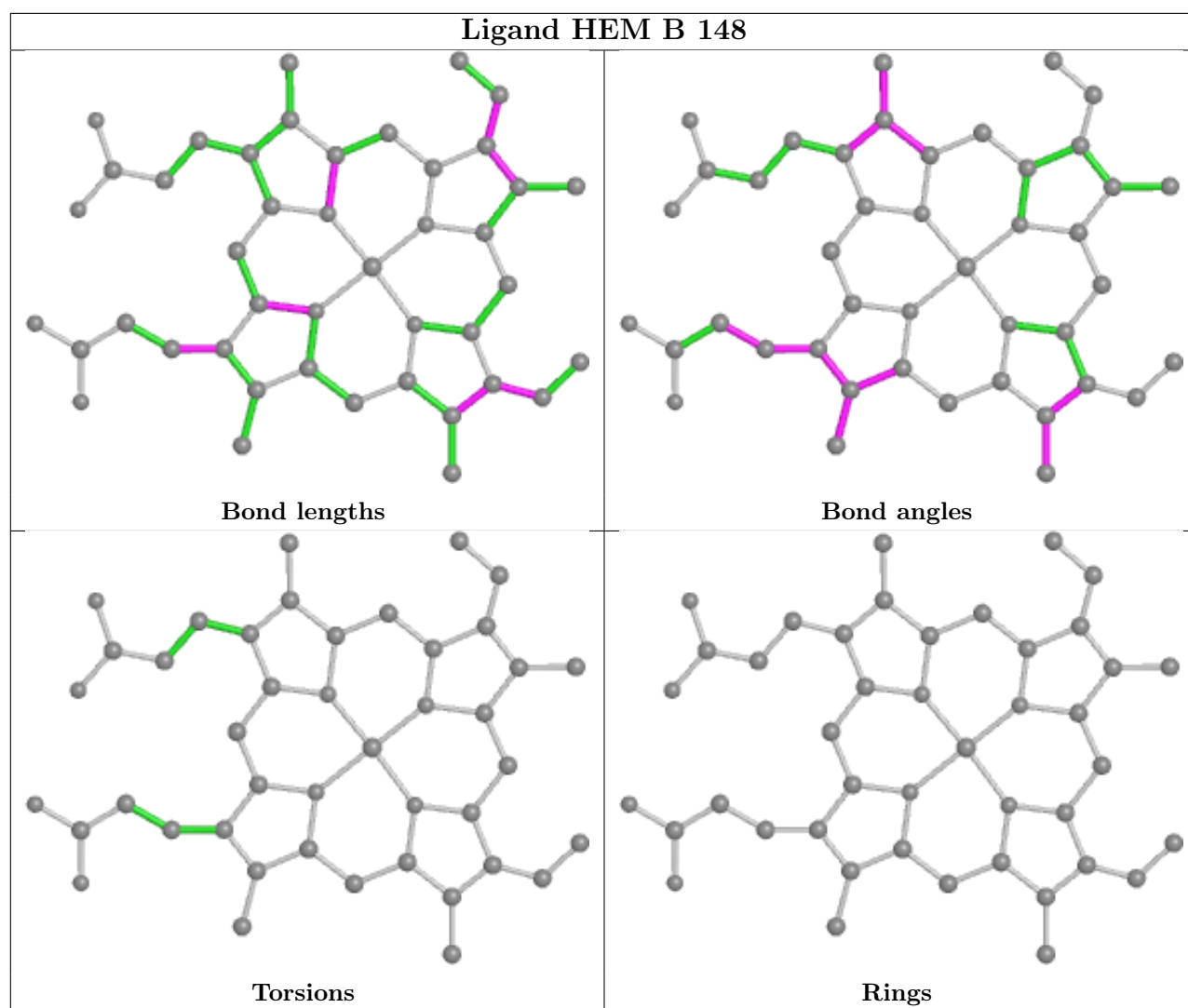
There are no torsion outliers.

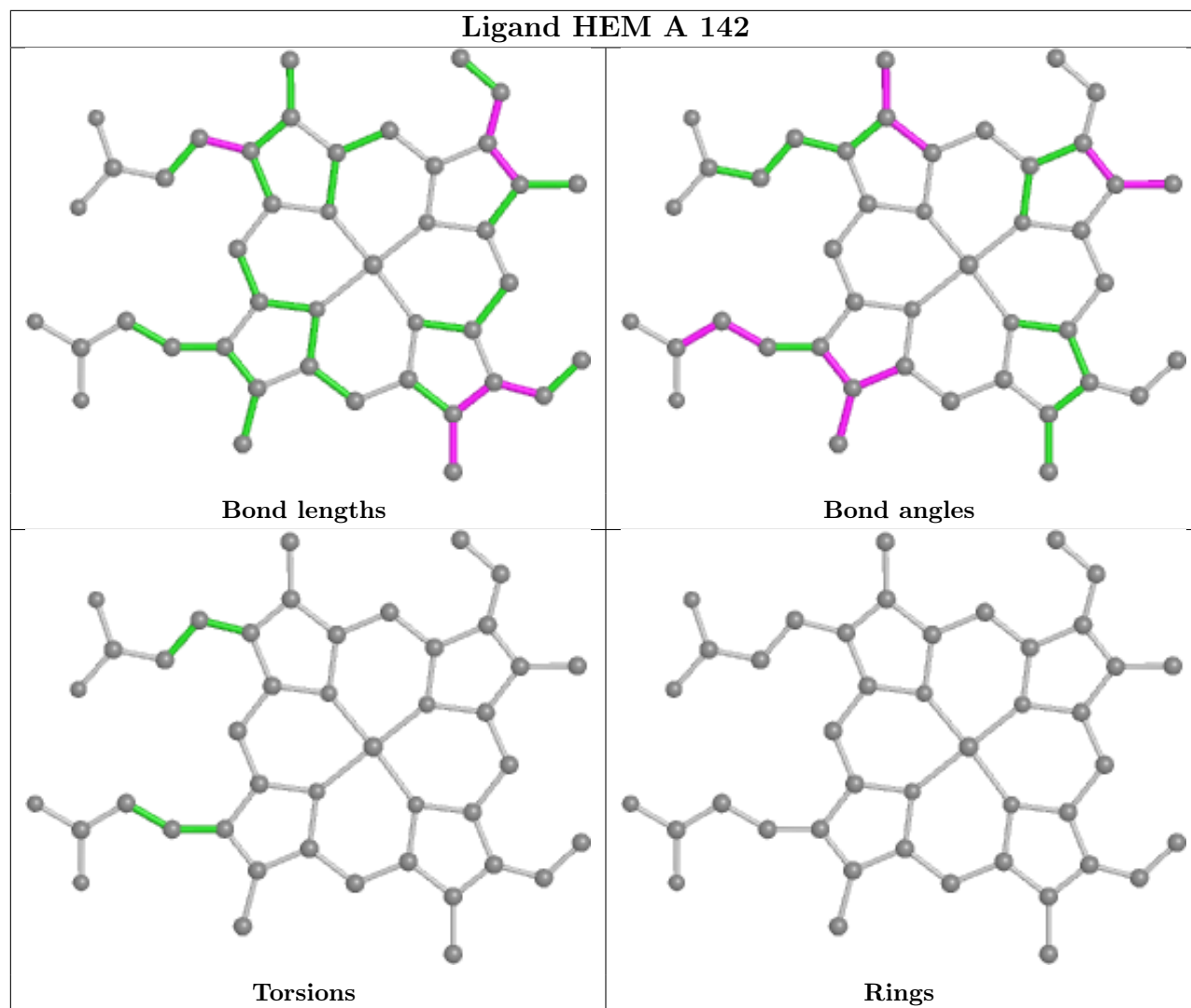
There are no ring outliers.

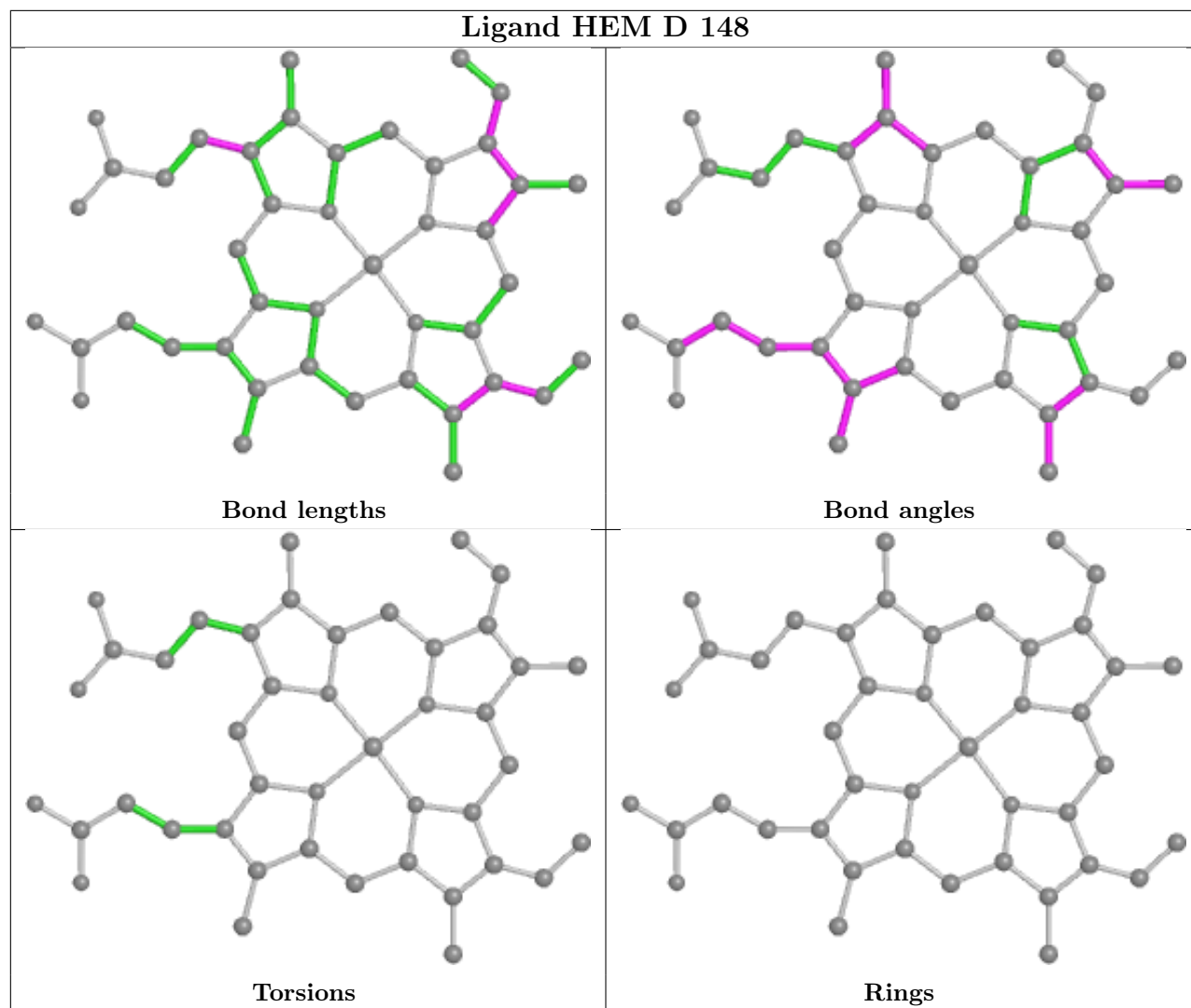
3 monomers are involved in 7 short contacts:

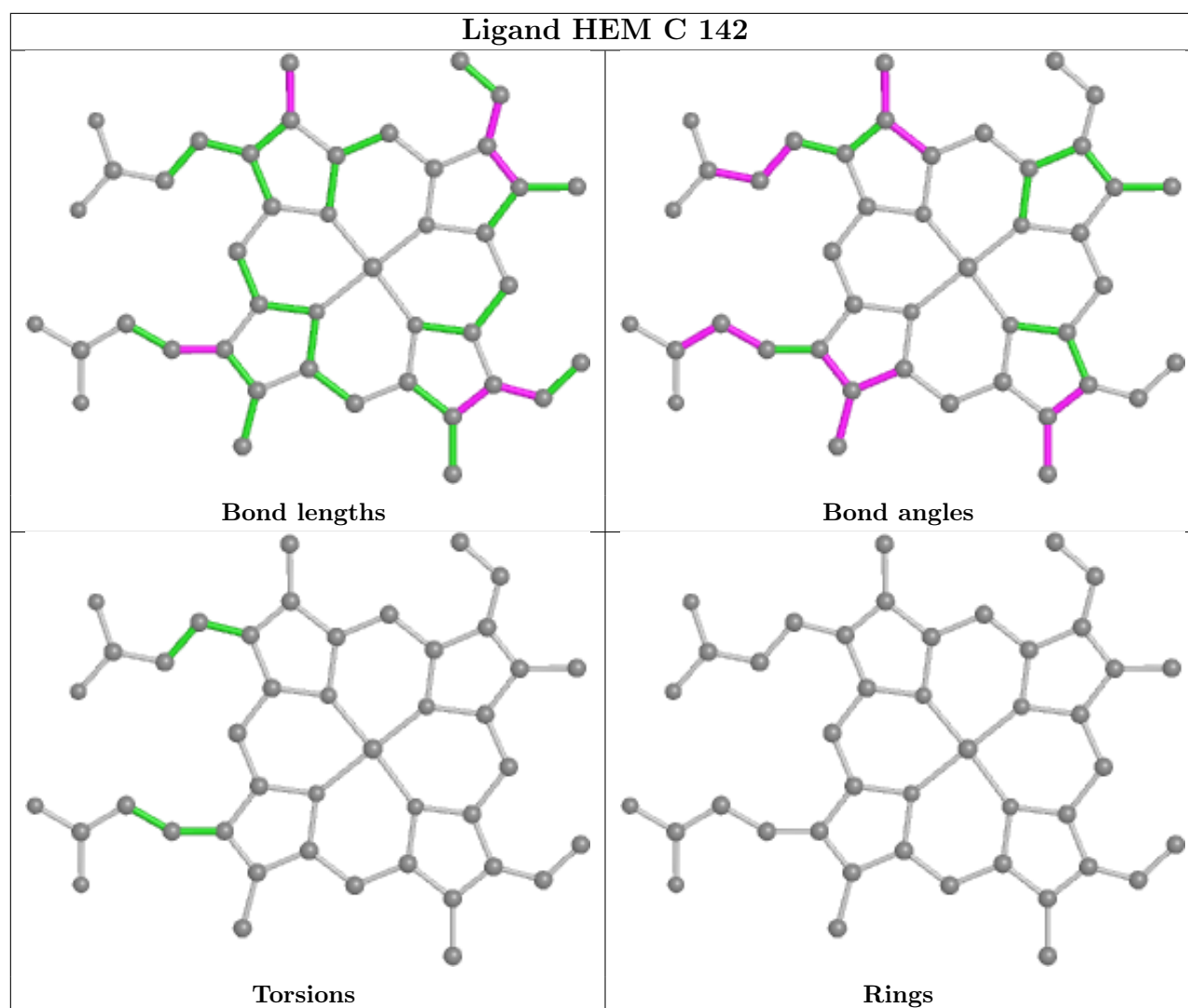
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	148	HEM	2	0
4	B	147	SO4	1	0
3	C	142	HEM	4	0

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

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

### 6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

### 6.4 Ligands

EDS was not executed - this section is therefore empty.

### 6.5 Other polymers

EDS was not executed - this section is therefore empty.