



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 23, 2021 – 03:49 PM EDT

PDB ID : 1RVW  
Title : R STATE HUMAN HEMOGLOBIN [ALPHA V96W], CARBONMONOXY  
Authors : Puius, Y.A.; Zou, M.; Ho, N.T.; Ho, C.; Almo, S.C.  
Deposited on : 1997-03-20  
Resolution : 2.50 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)  
Xtrriage (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

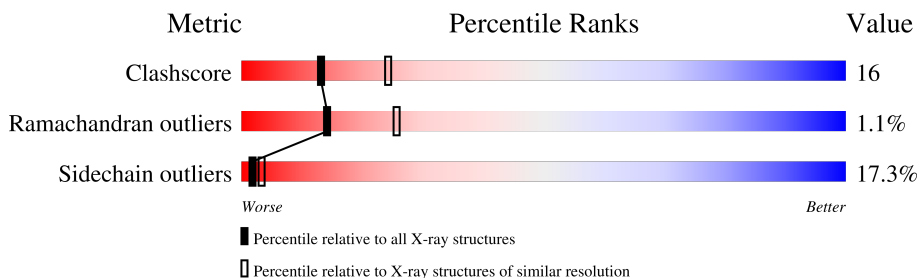
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.50 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	5346 (2.50-2.50)
Ramachandran outliers	138981	5231 (2.50-2.50)
Sidechain outliers	138945	5233 (2.50-2.50)

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  $\geq 3$ , 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	
2	B	146	

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 2319 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.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	141	1076	691	188	194	3	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	96	TRP	VAL	engineered mutation	UNP P69905

- Molecule 2 is a protein called HEMOGLOBIN.

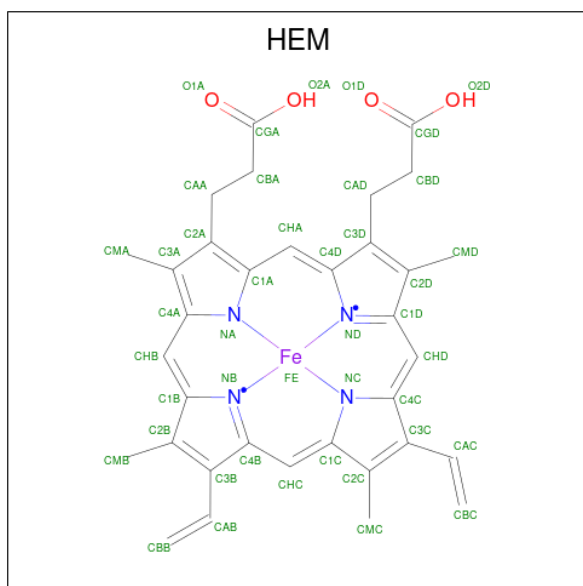
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	146	1123	724	195	201	3	0	0	0

- Molecule 3 is PHOSPHATE ION (three-letter code: PO4) (formula: O<sub>4</sub>P).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	O	P	0	0
			5	4	1		

- 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	0	0
			43	34	1	4	4		
4	B	1	Total	C	Fe	N	O	0	0
			43	34	1	4	4		

- Molecule 5 is CARBON MONOXIDE (three-letter code: CMO) (formula: CO).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	1	Total C O 2 1 1	0	0
5	B	1	Total C O 2 1 1	0	0

- Molecule 6 is water.

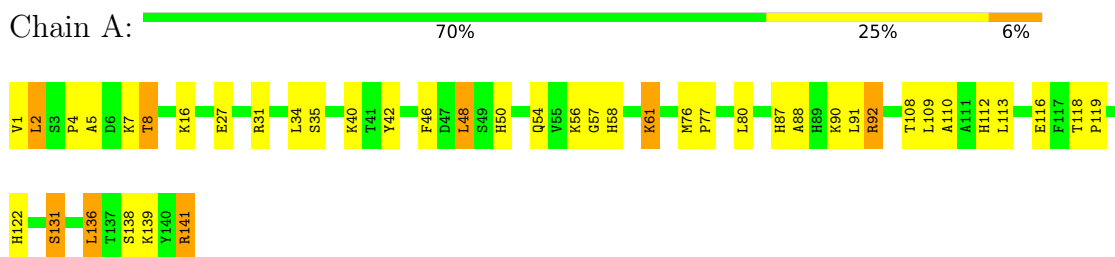
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	14	Total O 14 14	0	0
6	B	11	Total O 11 11	0	0

### 3 Residue-property plots [i](#)

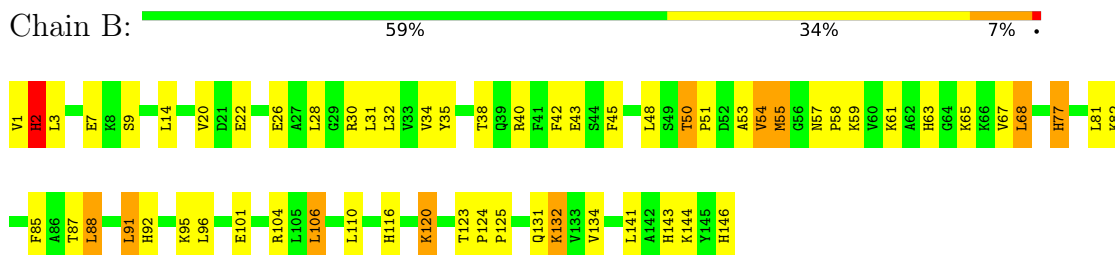
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded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



- Molecule 2: HEMOGLOBIN



## 4 Data and refinement statistics

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

Property	Value	Source
Space group	P 41 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	54.28Å 54.28Å 194.12Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	25.00 – 2.50	Depositor
% Data completeness (in resolution range)	86.7 (25.00-2.50)	Depositor
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
Refinement program	X-PLOR 3.851	Depositor
R, $R_{free}$	0.167 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	2319	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	33.0	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: HEM, CMO, PO4

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	0.40	0/1106	0.59	1/1504 (0.1%)
2	B	0.40	0/1153	0.56	0/1566
All	All	0.40	0/2259	0.57	1/3070 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	87	HIS	CG-CD2-NE2	-5.09	99.53	109.20

There are no chirality outliers.

There are no planarity outliers.

### 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	1076	0	1074	34	0
2	B	1123	0	1118	41	0
3	A	5	0	0	0	0
4	A	43	0	30	0	0
4	B	43	0	30	5	0
5	A	2	0	0	0	0
5	B	2	0	0	0	0
6	A	14	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	B	11	0	0	0	0
All	All	2319	0	2252	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 16.

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:A:4:PRO:O	1:A:8:THR:HG22	1.79	0.82
1:A:141:ARG:HG2	1:A:141:ARG:OXT	1.83	0.78
1:A:1:VAL:HG22	1:A:2:LEU:H	1.49	0.77
2:B:50:THR:HG23	2:B:53:ALA:HB2	1.70	0.73
2:B:91:LEU:O	2:B:96:LEU:HD12	1.88	0.72
2:B:81:LEU:HD22	2:B:85:PHE:HE1	1.57	0.70
1:A:46:PHE:HB3	1:A:48:LEU:HD13	1.74	0.69
1:A:58:HIS:HA	1:A:61:LYS:HG3	1.76	0.67
1:A:16:LYS:HG3	1:A:116:GLU:HG2	1.78	0.65
1:A:27:GLU:O	1:A:31:ARG:HG3	1.96	0.65
2:B:42:PHE:O	2:B:48:LEU:HD11	1.97	0.64
1:A:76:MET:HE1	1:A:131:SER:HB3	1.82	0.62
1:A:1:VAL:HG13	1:A:2:LEU:N	2.15	0.61
1:A:35:SER:HB3	2:B:131:GLN:HG3	1.81	0.60
1:A:88:ALA:CB	1:A:139:LYS:HB2	2.31	0.60
2:B:91:LEU:O	2:B:95:LYS:HB2	2.02	0.59
2:B:31:LEU:HD12	2:B:35:TYR:HD2	1.68	0.59
2:B:50:THR:O	2:B:53:ALA:HB3	2.04	0.58
1:A:46:PHE:HA	1:A:54:GLN:NE2	2.20	0.57
2:B:20:VAL:HA	2:B:68:LEU:HD12	1.88	0.56
2:B:143:HIS:HA	2:B:146:HIS:CE1	2.40	0.55
2:B:77:HIS:N	2:B:77:HIS:ND1	2.54	0.55
1:A:138:SER:HA	1:A:141:ARG:NH2	2.22	0.55
2:B:50:THR:HG23	2:B:53:ALA:CB	2.36	0.55
1:A:1:VAL:HG22	1:A:2:LEU:N	2.21	0.55
2:B:91:LEU:HD22	2:B:96:LEU:CD1	2.38	0.54
2:B:26:GLU:O	2:B:30:ARG:HG3	2.08	0.54
2:B:91:LEU:C	2:B:96:LEU:HD12	2.29	0.52
2:B:42:PHE:CE1	4:B:201:HEM:HMD3	2.44	0.52
1:A:40:LYS:HD2	1:A:48:LEU:HD23	1.91	0.51
1:A:91:LEU:C	1:A:92:ARG:HG2	2.31	0.50
2:B:7:GLU:OE1	2:B:132:LYS:HE2	2.12	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:42:PHE:CE2	4:B:201:HEM:HBC2	2.49	0.48
1:A:119:PRO:O	1:A:122:HIS:HB3	2.13	0.48
2:B:42:PHE:HE2	4:B:201:HEM:HBC2	1.78	0.48
1:A:58:HIS:HA	1:A:61:LYS:CG	2.43	0.47
2:B:106:LEU:HD12	4:B:201:HEM:HBB2	1.96	0.47
1:A:76:MET:N	1:A:77:PRO:CD	2.77	0.47
1:A:110:ALA:O	2:B:116:HIS:HA	2.15	0.47
1:A:116:GLU:OE1	1:A:116:GLU:N	2.41	0.47
2:B:31:LEU:HD22	2:B:106:LEU:HG	1.95	0.47
2:B:2:HIS:O	2:B:3:LEU:HB2	2.15	0.46
2:B:91:LEU:HD22	2:B:96:LEU:HD12	1.97	0.46
2:B:81:LEU:HD22	2:B:85:PHE:CE1	2.46	0.46
2:B:124:PRO:HB2	2:B:125:PRO:HD3	1.97	0.46
1:A:108:THR:O	1:A:112:HIS:HD2	1.99	0.45
2:B:50:THR:O	2:B:54:VAL:HG12	2.15	0.45
2:B:34:VAL:HG12	2:B:35:TYR:CE1	2.52	0.45
1:A:40:LYS:C	1:A:42:TYR:H	2.20	0.45
1:A:61:LYS:H	1:A:61:LYS:HG2	1.47	0.45
1:A:46:PHE:HA	1:A:54:GLN:HE22	1.82	0.44
1:A:92:ARG:HE	1:A:92:ARG:HB3	1.48	0.43
2:B:92:HIS:HA	2:B:96:LEU:CD1	2.48	0.43
2:B:63:HIS:O	2:B:67:VAL:HG23	2.17	0.43
2:B:51:PRO:O	2:B:55:MET:HB2	2.18	0.43
1:A:46:PHE:HB3	1:A:48:LEU:CD1	2.44	0.43
2:B:106:LEU:CD1	4:B:201:HEM:HBB2	2.49	0.43
1:A:116:GLU:O	1:A:118:THR:HG23	2.19	0.43
2:B:123:THR:OG1	2:B:125:PRO:HD2	2.19	0.42
1:A:5:ALA:O	1:A:8:THR:HG23	2.19	0.42
2:B:124:PRO:N	2:B:125:PRO:CD	2.82	0.42
2:B:50:THR:O	2:B:54:VAL:CG1	2.68	0.42
2:B:32:LEU:HA	2:B:38:THR:OG1	2.20	0.42
1:A:136:LEU:HD12	1:A:136:LEU:HA	1.89	0.41
2:B:45:PHE:CD2	2:B:59:LYS:HB3	2.55	0.41
1:A:57:GLY:O	1:A:61:LYS:HG2	2.21	0.41
1:A:16:LYS:NZ	1:A:16:LYS:N	2.69	0.41
2:B:57:ASN:HA	2:B:58:PRO:HD3	1.83	0.41
1:A:40:LYS:C	1:A:42:TYR:N	2.74	0.40
2:B:101:GLU:O	2:B:104:ARG:HB3	2.21	0.40
2:B:88:LEU:HD12	2:B:88:LEU:HA	1.79	0.40
2:B:61:LYS:HB3	2:B:61:LYS:HE2	1.93	0.40
1:A:4:PRO:O	1:A:8:THR:CG2	2.60	0.40

There are no symmetry-related clashes.

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all 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%)	125 (90%)	13 (9%)	1 (1%)	22	39
2	B	144/146 (99%)	121 (84%)	21 (15%)	2 (1%)	11	20
All	All	283/287 (99%)	246 (87%)	34 (12%)	3 (1%)	14	26

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	2	HIS
1	A	50	HIS
2	B	120	LYS

### 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	113/113 (100%)	98 (87%)	15 (13%)	4	7
2	B	118/118 (100%)	93 (79%)	25 (21%)	1	2
All	All	231/231 (100%)	191 (83%)	40 (17%)	2	3

All (40) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2	LEU
1	A	7	LYS
1	A	8	THR
1	A	34	LEU
1	A	48	LEU
1	A	56	LYS
1	A	61	LYS
1	A	80	LEU
1	A	90	LYS
1	A	92	ARG
1	A	109	LEU
1	A	113	LEU
1	A	131	SER
1	A	136	LEU
1	A	141	ARG
2	B	1	VAL
2	B	2	HIS
2	B	9	SER
2	B	14	LEU
2	B	22	GLU
2	B	28	LEU
2	B	40	ARG
2	B	43	GLU
2	B	50	THR
2	B	54	VAL
2	B	55	MET
2	B	65	LYS
2	B	68	LEU
2	B	77	HIS
2	B	82	LYS
2	B	87	THR
2	B	88	LEU
2	B	91	LEU
2	B	106	LEU
2	B	110	LEU
2	B	120	LYS
2	B	132	LYS
2	B	134	VAL
2	B	141	LEU
2	B	144	LYS

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

Mol	Chain	Res	Type
1	A	54	GLN
1	A	72	HIS
1	A	97	ASN
2	B	80	ASN
2	B	97	HIS

### 5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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

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

### 5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

5 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	PO4	A	142	1	4,4,4	2.19	2 (50%)	6,6,6	1.45	1 (16%)
4	HEM	A	201	5,1	27,50,50	1.81	7 (25%)	17,82,82	2.15	6 (35%)
5	CMO	A	202	4	0,1,1	-	-	-		
4	HEM	B	201	5,2	27,50,50	1.85	7 (25%)	17,82,82	1.83	6 (35%)
5	CMO	B	202	4	0,1,1	-	-	-		

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	B	201	5,2	-	2/6/54/54	-
4	HEM	A	201	5,1	-	0/6/54/54	-

All (16) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	201	HEM	C3C-CAC	-4.49	1.38	1.47
4	A	201	HEM	C3B-CAB	-4.30	1.39	1.47
4	A	201	HEM	C3C-CAC	-4.20	1.39	1.47
4	B	201	HEM	C3C-C2C	-4.05	1.34	1.40
4	B	201	HEM	C3B-CAB	-3.79	1.40	1.47
3	A	142	PO4	P-O1	3.42	1.58	1.50
4	A	201	HEM	C3C-C2C	-3.14	1.36	1.40
4	A	201	HEM	C1D-ND	2.68	1.41	1.36
4	B	201	HEM	CBB-CAB	2.60	1.46	1.29
4	B	201	HEM	C3B-C2B	-2.58	1.36	1.40
4	B	201	HEM	CBC-CAC	2.49	1.45	1.29
4	A	201	HEM	CBC-CAC	2.44	1.45	1.29
4	A	201	HEM	C4D-C3D	2.41	1.48	1.42
3	A	142	PO4	P-O4	2.20	1.61	1.54
4	B	201	HEM	C1C-C2C	2.14	1.47	1.42
4	A	201	HEM	CBB-CAB	2.01	1.42	1.29

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	201	HEM	C1D-C2D-C3D	-5.30	103.31	107.00
4	A	201	HEM	CBA-CAA-C2A	-3.35	106.31	112.49
4	B	201	HEM	CMA-C3A-C4A	-3.27	123.44	128.46
3	A	142	PO4	O4-P-O2	-3.18	97.77	107.97
4	A	201	HEM	C4A-C3A-C2A	-3.15	104.80	107.00
4	B	201	HEM	CBA-CAA-C2A	-3.00	106.96	112.49
4	B	201	HEM	CMA-C3A-C2A	2.99	130.57	124.94
4	A	201	HEM	CMB-C2B-C3B	2.89	130.08	124.68
4	B	201	HEM	C1D-C2D-C3D	-2.73	105.10	107.00
4	A	201	HEM	CMA-C3A-C2A	2.73	130.08	124.94
4	B	201	HEM	CBD-CAD-C3D	2.72	117.48	112.48
4	A	201	HEM	CMA-C3A-C4A	-2.19	125.10	128.46
4	B	201	HEM	C3B-C4B-NB	2.05	111.86	109.21

There are no chirality outliers.

All (2) torsion outliers are listed below:

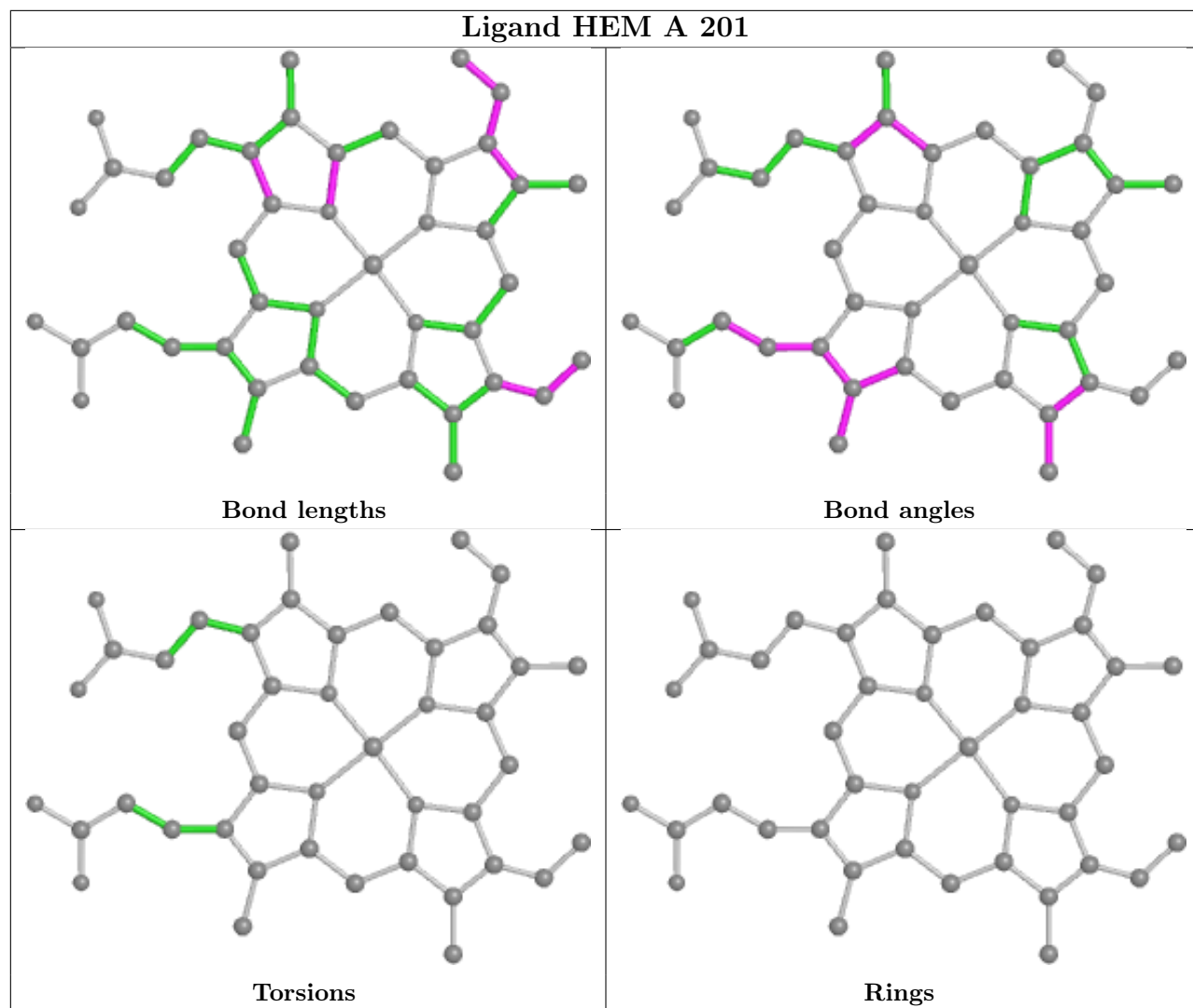
Mol	Chain	Res	Type	Atoms
4	B	201	HEM	C2D-C3D-CAD-CBD
4	B	201	HEM	C3D-CAD-CBD-CGD

There are no ring outliers.

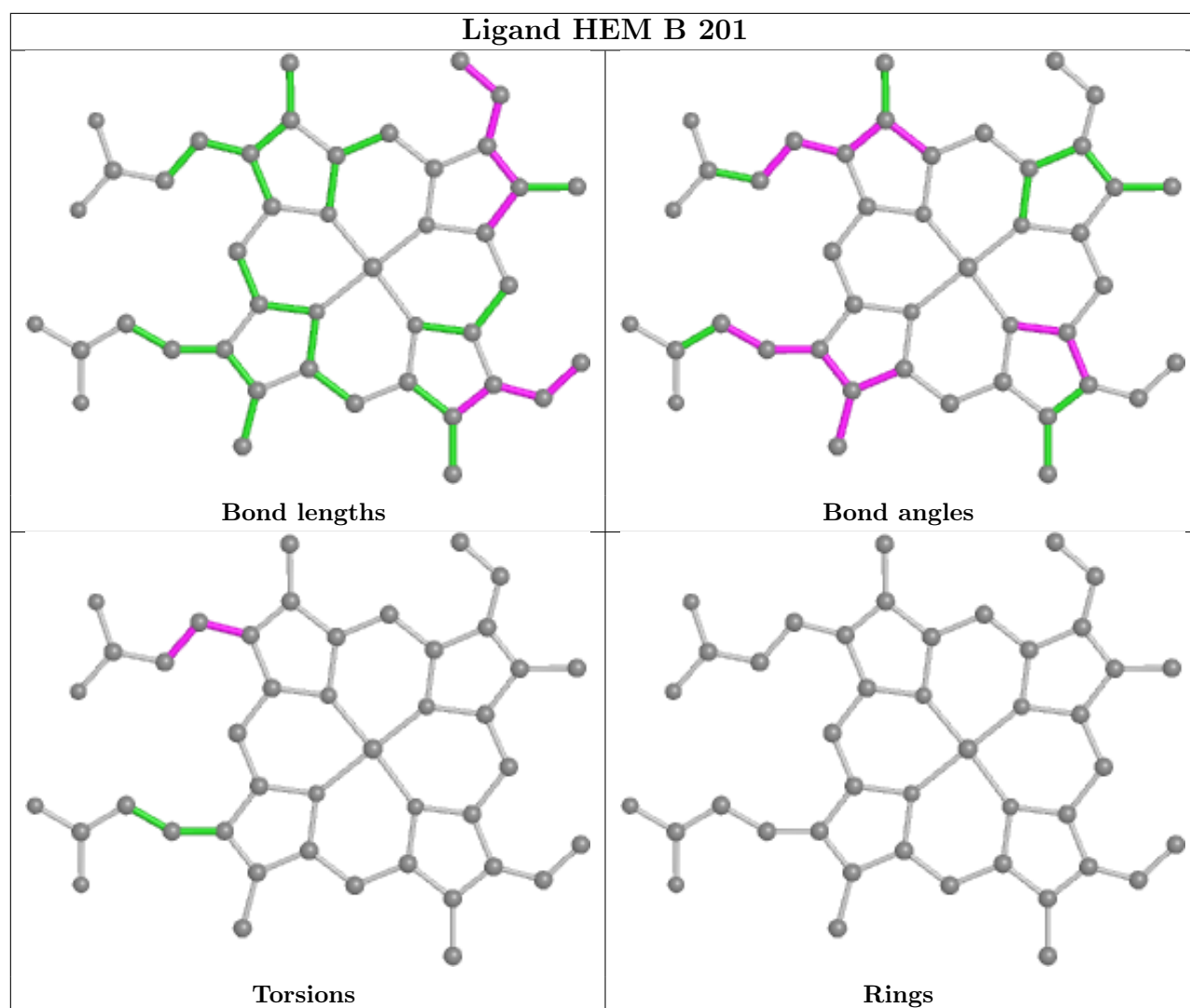
1 monomer is involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	B	201	HEM	5	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 [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.