



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 7, 2026 – 11:55 PM UTC

PDB ID : 1C8J / pdb_00001c8j
Title : CRYSTAL STRUCTURE OF CYTOCHROME P450CAM MUTANT (F87W/Y96F)
Authors : Liu, Y.; Jiang, F.; Guo, Q.; Chen, X.; Jin, J.; Sun, Y.; Rao, Z.
Deposited on : 2000-05-31
Resolution : 2.10 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

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) : 2.49

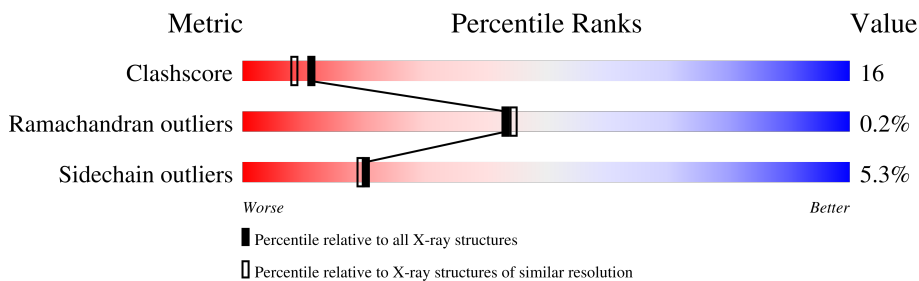
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.10 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	7164 (2.10-2.10)
Ramachandran outliers	187476	7099 (2.10-2.10)
Sidechain outliers	187428	7100 (2.10-2.10)

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	414	
1	B	414	

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 6737 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.

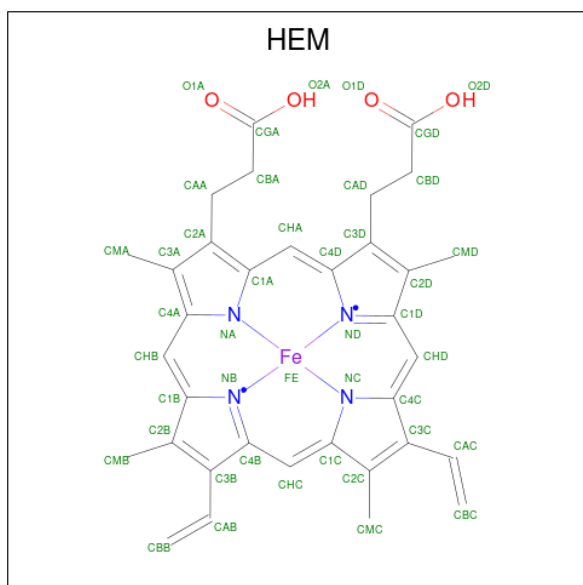
- Molecule 1 is a protein called CYTOCHROME P450-CAM.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	405	Total	C	N	O	S	0	0	0
			3209	2035	561	595	18			
1	B	405	Total	C	N	O	S	0	0	0
			3209	2035	561	595	18			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	87	TRP	PHE	engineered mutation	UNP P00183
A	96	PHE	TYR	engineered mutation	UNP P00183
B	87	TRP	PHE	engineered mutation	UNP P00183
B	96	PHE	TYR	engineered mutation	UNP P00183

- Molecule 2 is PROTOPORPHYRIN IX CONTAINING FE (CCD ID: HEM) (formula: $C_{34}H_{32}FeN_4O_4$).



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

- Molecule 3 is water.

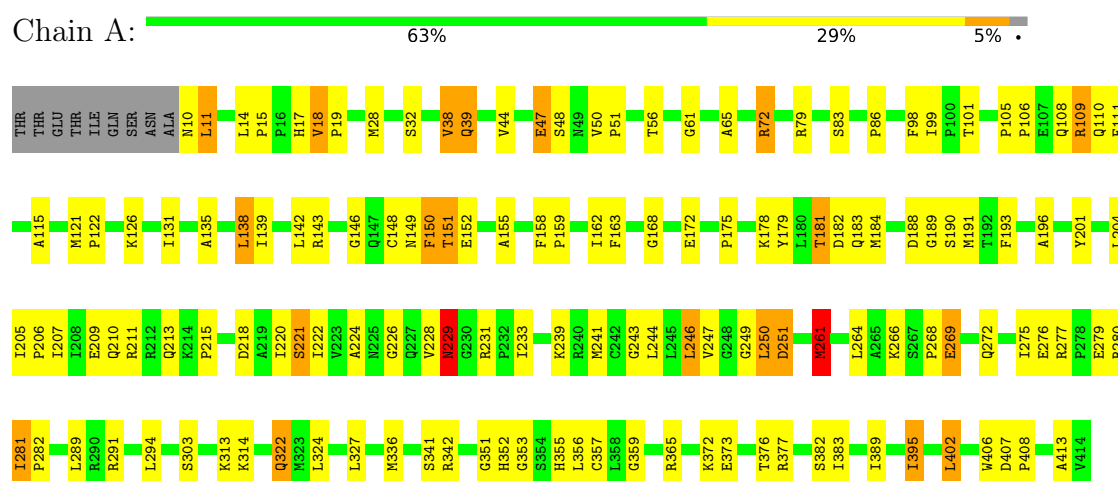
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	146	Total 146	O 146	0	0
3	B	87	Total 87	O 87	0	0

3 Residue-property plots [i](#)

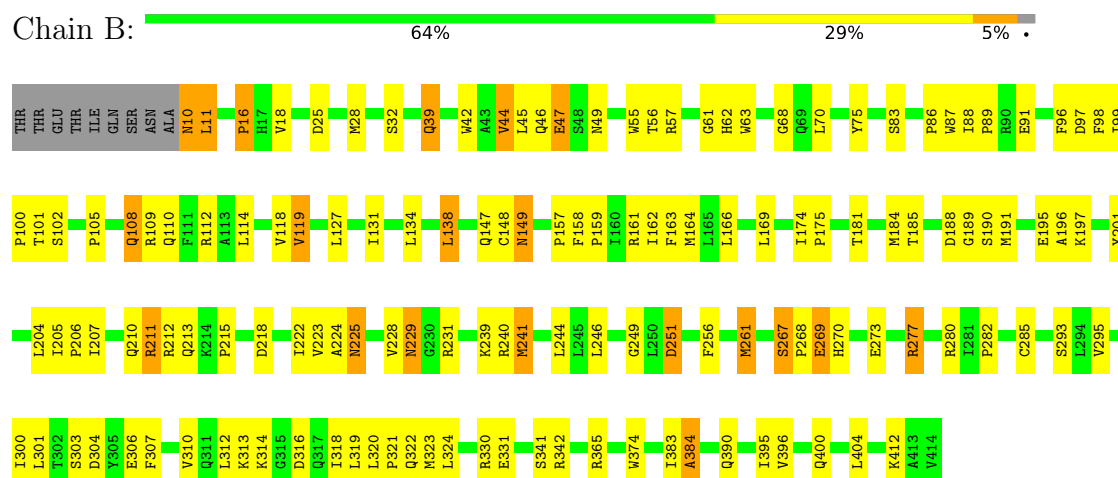
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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: CYTOCHROME P450-CAM



• Molecule 1: CYTOCHROME P450-CAM



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, α , β , γ	66.86 Å 61.99 Å 95.13 Å 90.00° 90.54° 90.00°	Depositor
Resolution (Å)	100.00 – 2.10	Depositor
% Data completeness (in resolution range)	90.0 (100.00-2.10)	Depositor
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS 1.0	Depositor
R, R_{free}	0.193 , 0.264	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	6737	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 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	0.97	2/3289 (0.1%)	1.24	31/4470 (0.7%)
1	B	0.84	1/3289 (0.0%)	1.17	19/4470 (0.4%)
All	All	0.90	3/6578 (0.0%)	1.20	50/8940 (0.6%)

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	1

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	261	MET	SD-CE	-9.95	1.54	1.79
1	B	241	MET	SD-CE	-8.27	1.58	1.79
1	A	151	THR	CA-CB	5.33	1.61	1.53

All (50) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	18	VAL	N-CA-C	9.37	116.83	107.55
1	A	251	ASP	N-CA-C	7.98	121.09	110.88
1	B	251	ASP	N-CA-C	7.78	120.33	110.61
1	B	204	LEU	N-CA-C	7.66	119.71	111.36
1	B	384	ALA	CA-C-N	7.47	129.17	119.84
1	B	384	ALA	C-N-CA	7.47	129.17	119.84
1	A	48	SER	N-CA-C	7.46	120.29	111.71
1	A	324	LEU	N-CA-C	7.21	119.14	111.28

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	105	PRO	N-CA-C	-7.16	103.60	110.47
1	A	281	ILE	CA-C-N	-7.11	111.16	119.05
1	A	281	ILE	C-N-CA	-7.11	111.16	119.05
1	A	148	CYS	CA-C-N	-6.80	114.00	122.84
1	A	148	CYS	C-N-CA	-6.80	114.00	122.84
1	B	330	ARG	N-CA-C	-6.77	104.83	113.23
1	A	275	ILE	N-CA-C	-6.67	104.26	110.53
1	A	150	PHE	N-CA-C	6.60	119.31	111.33
1	A	189	GLY	N-CA-C	-6.59	106.07	114.37
1	B	324	LEU	N-CA-C	6.58	119.46	111.82
1	B	189	GLY	N-CA-C	-6.54	105.49	114.64
1	B	32	SER	N-CA-C	6.42	117.97	110.97
1	B	105	PRO	N-CA-C	-6.38	102.91	110.70
1	B	225	ASN	N-CA-C	-6.22	105.00	112.59
1	A	38	VAL	CB-CA-C	-6.12	103.87	112.14
1	B	55	TRP	N-CA-C	6.12	118.38	108.41
1	B	224	ALA	N-CA-C	5.89	118.48	111.71
1	B	109	ARG	N-CA-C	5.87	118.44	111.33
1	B	62	HIS	N-CA-C	5.85	117.37	108.07
1	A	229	ASN	N-CA-C	-5.82	104.79	112.24
1	A	224	ALA	N-CA-C	5.56	118.10	111.71
1	A	204	LEU	N-CA-C	5.41	119.05	112.23
1	A	322	GLN	N-CA-C	-5.38	105.52	111.71
1	A	14	LEU	CA-C-N	-5.33	115.77	119.66
1	A	14	LEU	C-N-CA	-5.33	115.77	119.66
1	A	18	VAL	N-CA-C	5.33	113.14	107.76
1	B	322	GLN	N-CA-C	-5.33	105.58	111.71
1	A	327	LEU	N-CA-C	-5.33	106.78	113.28
1	B	256	PHE	N-CA-C	5.30	117.06	111.28
1	A	215	PRO	N-CA-C	5.29	118.79	110.80
1	B	44	VAL	N-CA-C	-5.27	104.50	111.09
1	A	250	LEU	N-CA-C	5.22	119.78	113.41
1	B	396	VAL	N-CA-C	-5.21	100.57	108.17
1	A	149	ASN	N-CA-C	-5.20	99.30	108.20
1	A	65	ALA	N-CA-C	-5.20	100.83	109.46
1	A	289	LEU	N-CA-C	-5.16	105.65	111.28
1	A	395	ILE	N-CA-C	-5.13	105.39	110.62
1	A	15	PRO	CA-C-N	5.10	124.89	119.28
1	A	15	PRO	C-N-CA	5.10	124.89	119.28
1	A	407	ASP	CA-C-N	5.07	125.10	119.32
1	A	407	ASP	C-N-CA	5.07	125.10	119.32
1	A	32	SER	N-CA-C	5.03	117.42	111.33

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	179	TYR	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	3209	0	3157	101	0
1	B	3209	0	3157	107	0
2	A	43	0	30	5	0
2	B	43	0	30	2	0
3	A	146	0	0	2	0
3	B	87	0	0	1	0
All	All	6737	0	6374	209	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 (209) 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:115:ALA:HB2	1:A:241:MET:HE2	1.44	0.98
1:B:131:ILE:HG12	1:B:162:ILE:HD13	1.47	0.96
1:B:188:ASP:OD1	1:B:190:SER:HB2	1.66	0.93
1:A:72:ARG:HG3	1:A:72:ARG:HH11	1.32	0.92
1:B:28:MET:HE1	1:B:395:ILE:HD13	1.55	0.85
1:A:72:ARG:HD3	1:A:352:HIS:CE1	2.17	0.80
1:A:184:MET:HE2	1:A:193:PHE:CE1	2.15	0.80
1:B:163:PHE:HE2	1:B:246:LEU:HD23	1.46	0.80
1:A:115:ALA:HB2	1:A:241:MET:CE	2.12	0.80
1:A:109:ARG:HG3	1:A:109:ARG:HH11	1.45	0.79
1:A:183:GLN:OE1	1:A:188:ASP:HB2	1.83	0.79
1:A:44:VAL:HA	1:A:47:GLU:OE2	1.82	0.79
1:A:261:MET:HE2	1:A:261:MET:HA	1.64	0.78
1:A:72:ARG:HG3	1:A:72:ARG:NH1	1.94	0.78

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:277:ARG:HB2	1:A:280:ARG:HG3	1.67	0.77
1:B:97:ASP:OD1	1:B:240:ARG:HD3	1.84	0.76
1:A:209:GLU:O	1:A:213:GLN:HG3	1.86	0.76
1:B:47:GLU:HB3	1:B:49:ASN:ND2	2.01	0.75
1:A:109:ARG:HH11	1:A:109:ARG:CG	2.00	0.75
1:B:158:PHE:HB3	1:B:159:PRO:HD3	1.69	0.75
1:A:353:GLY:O	1:A:356:LEU:HD13	1.86	0.75
1:B:212:ARG:HA	1:B:225:ASN:HD21	1.52	0.75
1:B:163:PHE:CE2	1:B:246:LEU:HD23	2.22	0.74
1:B:110:GLN:HG3	1:B:229:ASN:HB2	1.71	0.72
1:A:181:THR:CG2	1:A:251:ASP:HB2	2.19	0.72
1:A:178:LYS:HE2	1:A:250:LEU:O	1.89	0.71
1:B:295:VAL:HG11	2:B:417:HEM:HMA3	1.73	0.69
1:B:181:THR:HG21	1:B:251:ASP:HB2	1.74	0.68
1:B:223:VAL:HG22	1:B:241:MET:CE	2.23	0.68
1:B:390:GLN:NE2	1:B:400:GLN:OE1	2.27	0.68
1:A:178:LYS:NZ	1:A:182:ASP:OD2	2.28	0.65
1:A:269:GLU:CD	1:A:269:GLU:H	2.03	0.65
1:B:304:ASP:OD1	1:B:313:LYS:HG3	1.96	0.65
1:A:268:PRO:O	1:A:272:GLN:HG2	1.97	0.65
1:A:158:PHE:HB3	1:A:159:PRO:HD3	1.77	0.65
1:A:39:GLN:H	1:A:39:GLN:NE2	1.95	0.65
1:A:98:PHE:HB3	1:A:244:LEU:HB2	1.78	0.64
1:B:114:LEU:HG	1:B:241:MET:HE1	1.79	0.64
1:B:181:THR:CG2	1:B:251:ASP:HB2	2.26	0.64
1:B:206:PRO:O	1:B:210:GLN:HG2	1.97	0.64
1:A:229:ASN:CG	1:A:229:ASN:O	2.40	0.64
1:B:188:ASP:OD1	1:B:190:SER:CB	2.45	0.63
1:B:191:MET:HE2	1:B:196:ALA:HA	1.80	0.63
1:B:185:THR:HG21	1:B:251:ASP:OD1	2.00	0.62
1:A:191:MET:HE2	1:A:196:ALA:CA	2.29	0.62
1:A:218:ASP:O	1:A:222:ILE:HG12	2.00	0.62
1:B:269:GLU:CD	1:B:269:GLU:H	2.06	0.62
1:B:269:GLU:OE1	1:B:270:HIS:ND1	2.24	0.62
1:A:17:HIS:CD2	1:A:313:LYS:HG2	2.35	0.62
1:A:228:VAL:O	1:A:231:ARG:HG3	2.00	0.62
1:A:249:GLY:N	2:A:417:HEM:HBC2	2.15	0.61
1:A:109:ARG:HD3	3:A:507:HOH:O	1.99	0.61
1:B:98:PHE:HB3	1:B:244:LEU:HB2	1.83	0.61
1:B:68:GLY:HA3	1:B:331:GLU:OE2	2.01	0.60
1:B:223:VAL:HG22	1:B:241:MET:HE2	1.83	0.60

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:294:LEU:HD23	1:A:294:LEU:H	1.67	0.60
1:B:131:ILE:HA	1:B:162:ILE:HD11	1.84	0.59
1:A:303:SER:HA	1:A:314:LYS:HB2	1.84	0.59
1:B:277:ARG:HB2	1:B:280:ARG:HD3	1.84	0.59
1:B:197:LYS:HE3	1:B:201:TYR:CE2	2.37	0.59
1:B:267:SER:HB3	1:B:269:GLU:OE1	2.02	0.59
1:A:294:LEU:HD23	1:A:294:LEU:N	2.18	0.59
1:B:212:ARG:HA	1:B:225:ASN:ND2	2.18	0.58
1:A:168:GLY:O	1:A:211:ARG:NH2	2.37	0.58
1:B:83:SER:O	1:B:86:PRO:HD3	2.04	0.57
1:B:318:ILE:HG23	1:B:320:LEU:HD21	1.87	0.57
1:B:87:TRP:CZ3	1:B:184:MET:O	2.58	0.56
1:A:291:ARG:CZ	1:A:336:MET:HE3	2.37	0.55
1:A:341:SER:O	1:A:342:ARG:C	2.49	0.55
1:A:261:MET:HE2	1:A:261:MET:CA	2.37	0.55
1:B:118:VAL:HG13	1:B:119:VAL:HG13	1.89	0.55
1:A:382:SER:HB2	3:A:511:HOH:O	2.07	0.55
1:B:223:VAL:CG2	1:B:241:MET:HE2	2.37	0.54
1:A:268:PRO:HD2	1:A:269:GLU:OE2	2.07	0.54
1:B:306:GLU:HA	1:B:310:VAL:O	2.08	0.54
1:B:110:GLN:NE2	1:B:229:ASN:ND2	2.55	0.54
1:A:146:GLY:HA2	1:A:406:TRP:CD1	2.42	0.54
1:A:98:PHE:CZ	1:A:184:MET:HE1	2.42	0.54
1:A:191:MET:HE2	1:A:196:ALA:HA	1.89	0.54
1:B:83:SER:HB3	1:B:101:THR:O	2.08	0.54
1:A:151:THR:HA	1:A:155:ALA:HB3	1.90	0.53
1:A:72:ARG:HH11	1:A:72:ARG:CG	2.04	0.53
1:B:205:ILE:HB	1:B:206:PRO:HD3	1.89	0.53
1:A:28:MET:HE1	1:A:395:ILE:HD13	1.90	0.53
1:A:135:ALA:O	1:A:139:ILE:HG13	2.09	0.53
1:A:277:ARG:O	1:A:280:ARG:HG3	2.09	0.52
1:B:39:GLN:H	1:B:39:GLN:NE2	2.06	0.52
1:A:229:ASN:O	1:A:229:ASN:ND2	2.43	0.52
1:B:47:GLU:HB3	1:B:49:ASN:HD21	1.73	0.51
1:B:149:ASN:C	1:B:149:ASN:HD22	2.18	0.51
1:B:303:SER:HA	1:B:314:LYS:HD2	1.91	0.51
1:B:131:ILE:HA	1:B:162:ILE:CD1	2.40	0.51
1:A:10:ASN:CG	1:A:11:LEU:H	2.17	0.51
1:A:109:ARG:CG	1:A:109:ARG:NH1	2.67	0.51
1:A:322:GLN:HG2	1:A:351:GLY:HA2	1.93	0.51
1:A:191:MET:HE2	1:A:196:ALA:N	2.26	0.51

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:91:GLU:N	1:B:91:GLU:OE2	2.39	0.51
1:A:121:MET:HB3	1:A:122:PRO:HD3	1.93	0.51
1:A:146:GLY:HA2	1:A:406:TRP:NE1	2.25	0.51
1:B:319:LEU:O	1:B:320:LEU:HD23	2.11	0.51
1:A:83:SER:O	1:A:86:PRO:HD3	2.10	0.51
1:A:406:TRP:O	1:A:408:PRO:HD3	2.10	0.51
1:B:249:GLY:N	2:B:417:HEM:HBC2	2.26	0.51
1:B:25:ASP:OD1	1:B:57:ARG:NH2	2.42	0.50
1:A:98:PHE:HZ	1:A:184:MET:HE1	1.76	0.50
1:B:201:TYR:CD2	1:B:239:LYS:HE3	2.47	0.50
1:B:267:SER:HA	1:B:269:GLU:OE2	2.11	0.50
1:B:108:GLN:OE1	1:B:112:ARG:HD2	2.12	0.50
1:B:11:LEU:HD11	1:B:25:ASP:HB3	1.94	0.50
1:B:197:LYS:HE3	1:B:201:TYR:HE2	1.74	0.50
1:A:172:GLU:O	1:A:175:PRO:HD2	2.12	0.49
1:A:389:ILE:HD12	1:A:402:LEU:HD23	1.94	0.49
1:A:205:ILE:HB	1:A:206:PRO:HD3	1.94	0.49
1:A:122:PRO:O	1:A:126:LYS:HG2	2.13	0.49
1:B:110:GLN:CG	1:B:229:ASN:HB2	2.42	0.48
1:A:143:ARG:NH2	1:A:413:ALA:HB2	2.28	0.48
1:B:293:SER:OG	1:B:323:MET:HA	2.13	0.48
1:B:63:TRP:HB2	1:B:318:ILE:HG13	1.95	0.48
1:B:87:TRP:HZ3	1:B:184:MET:O	1.95	0.48
1:B:273:GLU:OE1	1:B:280:ARG:NH2	2.47	0.47
1:B:158:PHE:CB	1:B:159:PRO:HD3	2.42	0.47
1:B:39:GLN:H	1:B:39:GLN:HE21	1.60	0.47
1:B:28:MET:HE1	1:B:395:ILE:CD1	2.36	0.47
1:B:191:MET:HE2	1:B:196:ALA:CA	2.45	0.47
1:B:261:MET:HE3	1:B:374:TRP:CD2	2.49	0.47
1:B:383:ILE:O	1:B:384:ALA:C	2.58	0.47
1:B:97:ASP:O	1:B:240:ARG:HD2	2.14	0.47
1:B:147:GLN:HA	1:B:404:LEU:O	2.15	0.47
1:B:341:SER:O	1:B:342:ARG:C	2.57	0.47
1:B:251:ASP:CG	1:B:251:ASP:O	2.57	0.46
1:A:377:ARG:HG3	1:A:377:ARG:HH11	1.81	0.46
1:A:111:PHE:O	1:A:241:MET:HE1	2.15	0.46
1:A:56:THR:O	1:A:61:GLY:HA2	2.16	0.45
1:A:365:ARG:HA	1:A:365:ARG:NE	2.30	0.45
1:A:99:ILE:O	1:A:241:MET:HA	2.17	0.45
2:A:417:HEM:HMB1	2:A:417:HEM:HBB2	1.98	0.45
1:B:191:MET:HE2	1:B:195:GLU:C	2.42	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:307:PHE:HB3	1:B:312:LEU:HD11	1.97	0.45
1:B:10:ASN:N	1:B:10:ASN:OD1	2.50	0.45
1:B:201:TYR:CG	1:B:239:LYS:HE3	2.52	0.45
1:B:97:ASP:HA	1:B:102:SER:OG	2.16	0.45
1:B:134:LEU:HG	1:B:138:LEU:HD22	1.98	0.45
1:A:188:ASP:HB3	1:A:190:SER:H	1.82	0.44
1:A:207:ILE:HG23	1:A:211:ARG:NH1	2.32	0.44
1:B:157:PRO:O	1:B:161:ARG:HG3	2.17	0.44
1:A:294:LEU:N	1:A:294:LEU:CD2	2.81	0.44
1:B:303:SER:HA	1:B:314:LYS:HB2	1.98	0.44
1:A:110:GLN:NE2	1:A:229:ASN:HB3	2.33	0.44
1:A:50:VAL:HA	1:A:51:PRO:HD3	1.88	0.43
1:A:150:PHE:HB3	1:A:402:LEU:HB3	1.99	0.43
1:A:201:TYR:HB3	1:A:239:LYS:HD2	2.00	0.43
1:A:272:GLN:NE2	1:A:272:GLN:HA	2.33	0.43
1:B:42:TRP:O	1:B:45:LEU:HB2	2.19	0.43
1:B:86:PRO:HG3	1:B:96:PHE:CE2	2.53	0.43
1:B:218:ASP:O	1:B:222:ILE:HG12	2.17	0.43
1:A:138:LEU:O	1:A:142:LEU:HG	2.18	0.43
1:B:365:ARG:HA	1:B:365:ARG:HD2	1.86	0.43
1:A:131:ILE:HG12	1:A:162:ILE:HD13	2.01	0.43
1:A:228:VAL:O	1:A:229:ASN:HB3	2.18	0.43
1:B:108:GLN:HE21	1:B:108:GLN:HB3	1.54	0.43
1:B:228:VAL:O	1:B:231:ARG:HG3	2.19	0.43
1:B:164:MET:HE3	1:B:169:LEU:HB2	1.99	0.43
1:B:268:PRO:HG3	3:B:460:HOH:O	2.18	0.43
1:B:44:VAL:C	1:B:46:GLN:H	2.27	0.43
1:A:18:VAL:HA	1:A:19:PRO:HD3	1.90	0.43
1:A:83:SER:HB3	1:A:101:THR:O	2.18	0.43
1:A:291:ARG:NH2	1:A:336:MET:HE3	2.34	0.43
1:A:218:ASP:OD1	1:A:220:ILE:HB	2.19	0.42
1:B:99:ILE:HA	1:B:100:PRO:HA	1.74	0.42
1:A:181:THR:HG23	1:A:251:ASP:HB2	1.95	0.42
1:A:244:LEU:HD23	2:A:417:HEM:HMD2	2.00	0.42
1:B:56:THR:O	1:B:61:GLY:HA2	2.18	0.42
1:A:226:GLY:O	1:A:233:ILE:HG22	2.19	0.42
1:B:318:ILE:HG23	1:B:318:ILE:O	2.20	0.42
1:A:281:ILE:HD12	1:A:372:LYS:HD2	2.01	0.42
1:B:70:LEU:HD12	1:B:70:LEU:N	2.35	0.42
1:A:44:VAL:O	1:A:47:GLU:HB2	2.19	0.42
1:B:97:ASP:OD1	1:B:240:ARG:CD	2.62	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:163:PHE:CE2	1:A:246:LEU:HD22	2.54	0.41
1:B:318:ILE:CG2	1:B:320:LEU:HD21	2.50	0.41
1:A:266:LYS:HD2	1:A:383:ILE:HD12	2.02	0.41
1:B:46:GLN:O	1:B:47:GLU:C	2.63	0.41
1:A:279:GLU:H	1:A:279:GLU:CD	2.28	0.41
1:A:39:GLN:H	1:A:39:GLN:HE21	1.66	0.41
1:A:373:GLU:OE2	1:A:373:GLU:HA	2.21	0.41
1:B:75:TYR:CZ	1:B:320:LEU:HB2	2.56	0.41
1:B:282:PRO:O	1:B:285:CYS:HB3	2.21	0.41
1:B:301:LEU:HD13	1:B:301:LEU:HA	1.78	0.41
1:A:355:HIS:HD1	2:A:417:HEM:CGD	2.30	0.41
1:A:357:CYS:SG	1:A:359:GLY:N	2.92	0.41
1:A:211:ARG:HG3	1:A:221:SER:HB3	2.01	0.41
1:A:357:CYS:HB2	2:A:417:HEM:NA	2.36	0.41
1:B:88:ILE:HG23	1:B:89:PRO:HA	2.01	0.41
1:B:207:ILE:O	1:B:211:ARG:HD3	2.20	0.41
1:A:72:ARG:NH1	1:A:72:ARG:CG	2.64	0.41
1:A:243:GLY:O	1:A:247:VAL:HG23	2.20	0.41
1:B:188:ASP:OD1	1:B:190:SER:N	2.48	0.41
1:B:213:GLN:C	1:B:215:PRO:HD3	2.45	0.41
1:B:300:ILE:HG13	1:B:316:ASP:O	2.21	0.41
1:A:79:ARG:HH11	1:A:79:ARG:HG3	1.86	0.41
1:B:44:VAL:C	1:B:46:GLN:N	2.79	0.40
1:B:174:ILE:HB	1:B:175:PRO:HD3	2.03	0.40
1:A:264:LEU:HA	1:A:264:LEU:HD23	1.83	0.40
1:B:127:LEU:HD11	1:B:166:LEU:HD13	2.03	0.40
1:A:377:ARG:HG3	1:A:377:ARG:NH1	2.36	0.40
1:B:313:LYS:O	1:B:314:LYS:C	2.65	0.40
1:B:319:LEU:C	1:B:320:LEU:HD23	2.47	0.40
1:A:146:GLY:HA2	1:A:406:TRP:CE2	2.57	0.40
1:B:147:GLN:O	1:B:148:CYS:HB3	2.20	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	403/414 (97%)	390 (97%)	13 (3%)	0	100	100
1	B	403/414 (97%)	374 (93%)	27 (7%)	2 (0%)	24	22
All	All	806/828 (97%)	764 (95%)	40 (5%)	2 (0%)	43	44

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	16	PRO
1	B	321	PRO

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	350/358 (98%)	329 (94%)	21 (6%)	17	15
1	B	350/358 (98%)	334 (95%)	16 (5%)	24	25
All	All	700/716 (98%)	663 (95%)	37 (5%)	20	19

All (37) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	11	LEU
1	A	38	VAL
1	A	39	GLN
1	A	47	GLU
1	A	72	ARG
1	A	106	PRO
1	A	108	GLN
1	A	109	ARG
1	A	138	LEU
1	A	152	GLU
1	A	181	THR

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Mol	Chain	Res	Type
1	A	210	GLN
1	A	221	SER
1	A	229	ASN
1	A	246	LEU
1	A	261	MET
1	A	269	GLU
1	A	276	GLU
1	A	282	PRO
1	A	376	THR
1	A	402	LEU
1	B	10	ASN
1	B	11	LEU
1	B	16	PRO
1	B	39	GLN
1	B	47	GLU
1	B	108	GLN
1	B	119	VAL
1	B	138	LEU
1	B	149	ASN
1	B	211	ARG
1	B	229	ASN
1	B	261	MET
1	B	267	SER
1	B	269	GLU
1	B	277	ARG
1	B	412	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (35) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	10	ASN
1	A	30	ASN
1	A	39	GLN
1	A	46	GLN
1	A	69	GLN
1	A	108	GLN
1	A	110	GLN
1	A	129	ASN
1	A	132	GLN
1	A	145	GLN
1	A	210	GLN
1	A	225	ASN

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Mol	Chain	Res	Type
1	A	227	GLN
1	A	229	ASN
1	A	272	GLN
1	A	311	GLN
1	A	317	GLN
1	A	388	GLN
1	B	10	ASN
1	B	39	GLN
1	B	46	GLN
1	B	49	ASN
1	B	108	GLN
1	B	110	GLN
1	B	132	GLN
1	B	149	ASN
1	B	225	ASN
1	B	227	GLN
1	B	229	ASN
1	B	317	GLN
1	B	337	HIS
1	B	343	GLN
1	B	361	HIS
1	B	390	GLN
1	B	400	GLN

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 ⓘ

2 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	$\# Z > 2$
2	HEM	A	417	1	50,50,50	1.96	20 (40%)	67,82,82	1.76	15 (22%)
2	HEM	B	417	1	50,50,50	2.13	19 (38%)	67,82,82	1.59	12 (17%)

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
2	HEM	A	417	1	-	3/14/54/54	-
2	HEM	B	417	1	-	4/14/54/54	-

All (39) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	417	HEM	CBA-CGA	4.82	1.61	1.50
2	A	417	HEM	CBD-CGD	4.37	1.60	1.50
2	B	417	HEM	FE-ND	4.36	2.08	1.94
2	B	417	HEM	FE-NB	4.20	2.07	1.94
2	A	417	HEM	FE-ND	4.14	2.07	1.94
2	B	417	HEM	CAB-C3B	4.08	1.58	1.47
2	B	417	HEM	CBD-CGD	4.02	1.59	1.50
2	A	417	HEM	CAC-C3C	3.82	1.57	1.47
2	B	417	HEM	CAC-C3C	3.79	1.57	1.47
2	A	417	HEM	CBA-CGA	3.62	1.59	1.50
2	B	417	HEM	FE-NC	3.54	2.06	1.95
2	A	417	HEM	FE-NB	3.45	2.05	1.94
2	A	417	HEM	CAB-C3B	3.18	1.55	1.47
2	A	417	HEM	FE-NC	3.16	2.05	1.95
2	A	417	HEM	CMD-C2D	3.07	1.57	1.50
2	B	417	HEM	C1D-C2D	2.94	1.50	1.44
2	B	417	HEM	CMD-C2D	2.89	1.56	1.50
2	A	417	HEM	C4C-NC	-2.84	1.34	1.39
2	B	417	HEM	FE-NA	2.83	2.04	1.95

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	417	HEM	O2D-CGD	-2.70	1.21	1.30
2	A	417	HEM	FE-NA	2.65	2.03	1.95
2	B	417	HEM	C1B-C2B	2.59	1.49	1.44
2	B	417	HEM	C4A-C3A	2.45	1.48	1.43
2	A	417	HEM	CMA-C3A	2.44	1.55	1.50
2	B	417	HEM	CAA-C2A	2.42	1.57	1.51
2	A	417	HEM	C3B-C2B	-2.40	1.32	1.37
2	B	417	HEM	CMC-C2C	2.39	1.55	1.50
2	A	417	HEM	C2A-C3A	-2.39	1.32	1.38
2	A	417	HEM	CAD-C3D	2.33	1.57	1.51
2	A	417	HEM	CMC-C2C	2.27	1.55	1.50
2	A	417	HEM	C3B-C4B	2.24	1.49	1.44
2	B	417	HEM	CMB-C2B	2.23	1.55	1.50
2	B	417	HEM	C2A-C3A	-2.19	1.33	1.38
2	B	417	HEM	CHD-C4C	2.12	1.42	1.38
2	A	417	HEM	C1A-C2A	2.09	1.48	1.44
2	A	417	HEM	CAA-C2A	2.05	1.56	1.51
2	B	417	HEM	C3B-C4B	2.05	1.48	1.44
2	A	417	HEM	O2D-CGD	-2.04	1.24	1.30
2	A	417	HEM	CMB-C2B	2.03	1.54	1.50

All (27) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	417	HEM	C4D-ND-C1D	4.55	110.59	105.21
2	A	417	HEM	O2D-CGD-O1D	4.47	134.82	123.33
2	B	417	HEM	O2D-CGD-O1D	4.34	134.49	123.33
2	B	417	HEM	C4D-ND-C1D	4.13	110.10	105.21
2	A	417	HEM	C3D-C4D-ND	-3.94	105.85	110.17
2	A	417	HEM	CHD-C1D-ND	3.92	128.64	124.42
2	A	417	HEM	O1D-CGD-CBD	-3.69	111.40	123.09
2	B	417	HEM	O1D-CGD-CBD	-3.53	111.89	123.09
2	B	417	HEM	O2A-CGA-O1A	3.45	132.20	123.33
2	A	417	HEM	O2A-CGA-O1A	3.37	131.99	123.33
2	B	417	HEM	CHD-C1D-ND	3.31	127.98	124.42
2	B	417	HEM	C3D-C4D-ND	-3.11	106.76	110.17
2	B	417	HEM	CHB-C4A-NA	3.11	129.50	123.86
2	B	417	HEM	CHA-C4D-ND	2.86	127.90	124.37
2	A	417	HEM	CBD-CAD-C3D	2.84	120.40	112.53
2	A	417	HEM	C3B-C4B-NB	-2.78	107.47	109.47
2	A	417	HEM	CHA-C4D-ND	2.77	127.80	124.37
2	A	417	HEM	CHB-C4A-NA	2.75	128.85	123.86

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	417	HEM	CMA-C3A-C2A	2.70	131.35	125.62
2	A	417	HEM	CMB-C2B-C1B	-2.55	121.05	125.03
2	B	417	HEM	C2D-C1D-ND	-2.43	107.10	109.90
2	B	417	HEM	CBD-CAD-C3D	2.33	118.98	112.53
2	A	417	HEM	CMA-C3A-C4A	-2.23	122.02	125.42
2	B	417	HEM	CBC-CAC-C3C	-2.21	116.49	127.53
2	B	417	HEM	CAD-C3D-C4D	-2.11	121.02	124.70
2	A	417	HEM	CHB-C4A-C3A	-2.06	121.46	127.43
2	A	417	HEM	CBC-CAC-C3C	-2.03	117.40	127.53

There are no chirality outliers.

All (7) torsion outliers are listed below:

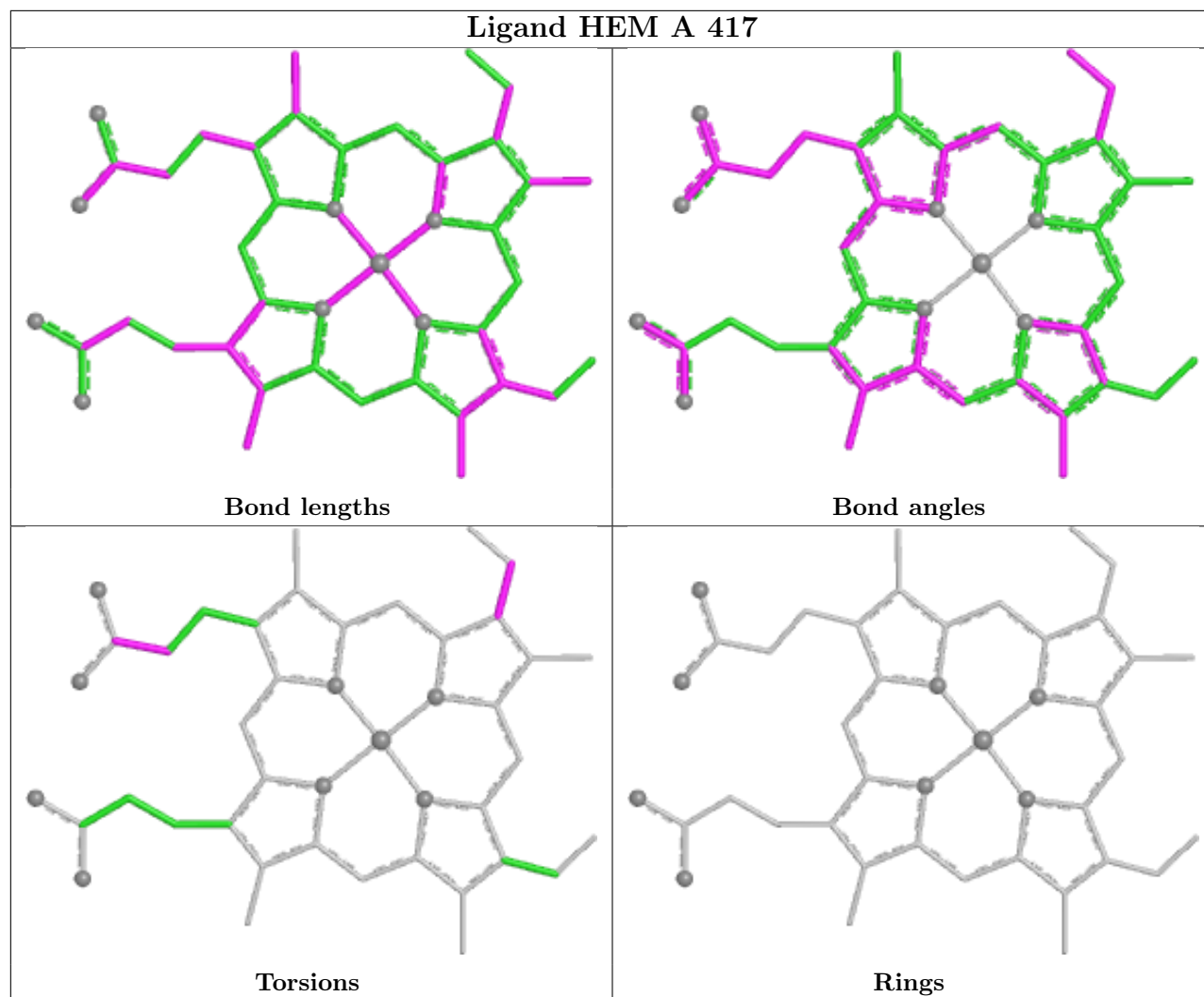
Mol	Chain	Res	Type	Atoms
2	B	417	HEM	C2C-C3C-CAC-CBC
2	B	417	HEM	C4C-C3C-CAC-CBC
2	A	417	HEM	C2C-C3C-CAC-CBC
2	A	417	HEM	C4C-C3C-CAC-CBC
2	B	417	HEM	C2B-C3B-CAB-CBB
2	A	417	HEM	CAD-CBD-CGD-O2D
2	B	417	HEM	CAD-CBD-CGD-O1D

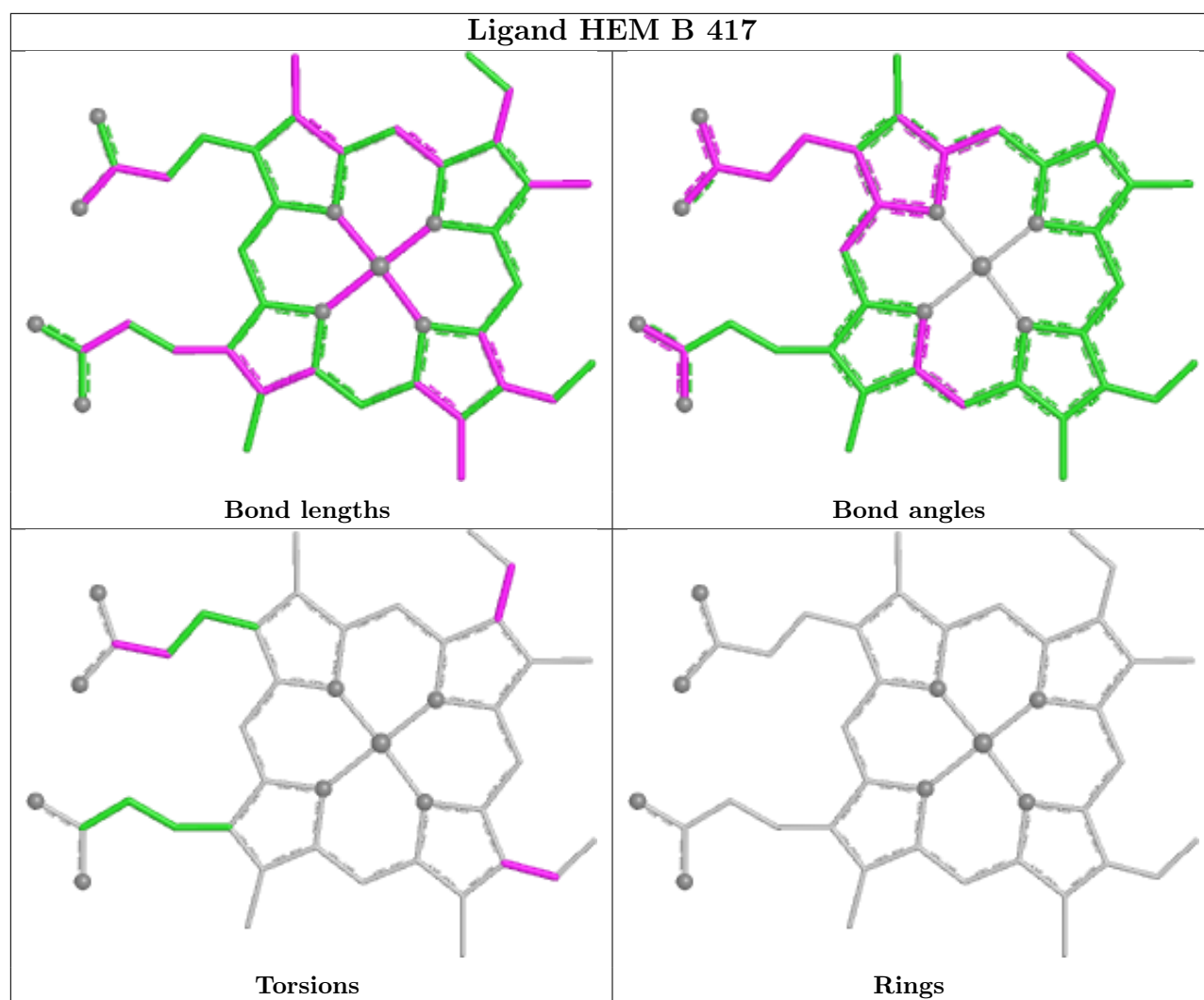
There are no ring outliers.

2 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	417	HEM	5	0
2	B	417	HEM	2	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.