



Full wwPDB X-ray Structure Validation Report ⓘ

Feb 14, 2017 – 09:37 am GMT

PDB ID : 3KX4
Title : Crystal structure of Bacillus megaterium BM3 heme domain mutant I401E
Authors : Girvan, H.M.; Levy, C.W.; Leys, D.; Munro, A.W.
Deposited on : 2009-12-02
Resolution : 1.95 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

<http://wwpdb.org/validation/2016/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.7.2 (RC1), CSD as538be (2017)
Xtriage (Phenix) : 1.9-1692
EDS : trunk28620
Percentile statistics : 20161228.v01 (using entries in the PDB archive December 28th 2016)
Refmac : 5.8.0135
CCP4 : 6.5.0
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : recalc28949

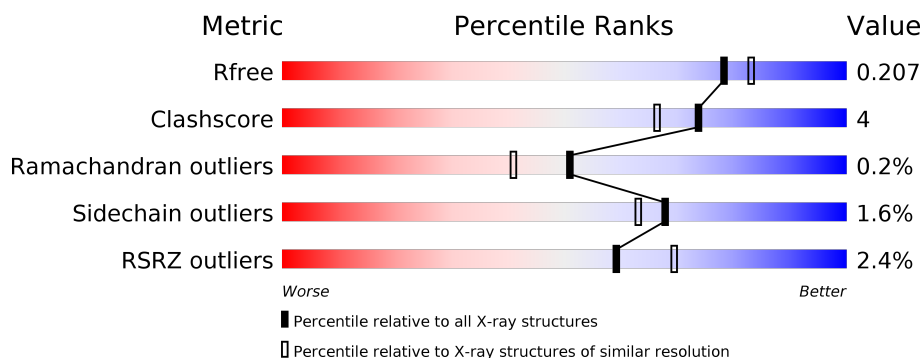
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.95 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}	100719	2004 (1.96-1.96)
Clashscore	112137	2136 (1.96-1.96)
Ramachandran outliers	110173	2117 (1.96-1.96)
Sidechain outliers	110143	2117 (1.96-1.96)
RSRZ outliers	101464	2018 (1.96-1.96)

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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 $\leq 5\%$. 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	470	<div> <div>2%</div> <div> <div></div> <div>89%</div> <div>6%</div> <div>• •</div> </div> </div>
1	B	470	<div> <div>3%</div> <div> <div></div> <div>87%</div> <div>9%</div> <div>• •</div> </div> </div>

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 8267 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.

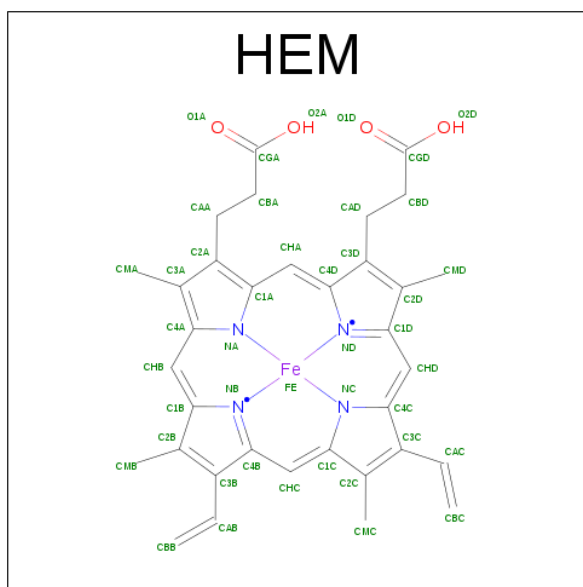
- Molecule 1 is a protein called Bifunctional P-450/NADPH-P450 reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	453	Total	C	N	O	S	0	0	0
			3645	2328	620	680	17			
1	B	454	Total	C	N	O	S	0	0	0
			3657	2336	621	683	17			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	401	GLU	ILE	ENGINEERED	UNP P14779
B	401	GLU	ILE	ENGINEERED	UNP P14779

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



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

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

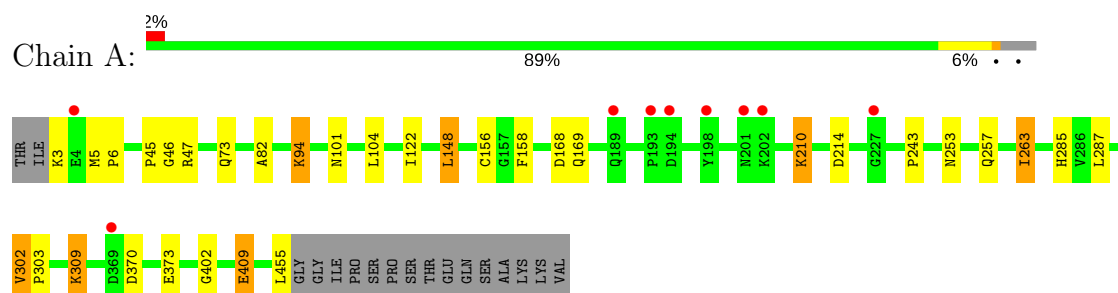
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	411	Total	O	0	0
			411	411		
3	B	468	Total	O	0	0
			468	468		

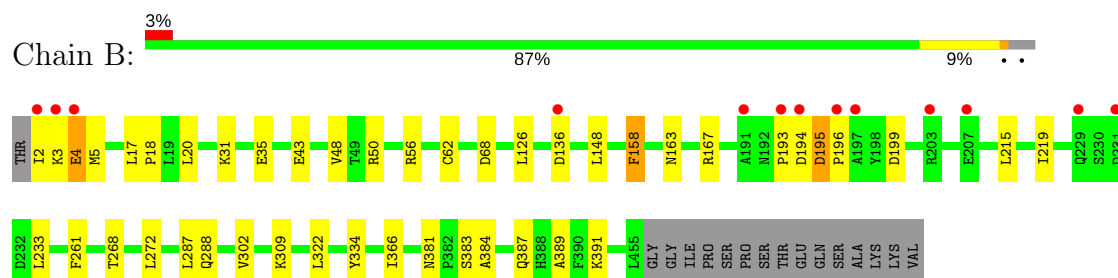
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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: Bifunctional P-450/NADPH-P450 reductase



- Molecule 1: Bifunctional P-450/NADPH-P450 reductase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	58.54Å 152.83Å 59.71Å 90.00° 94.64° 90.00°	Depositor
Resolution (Å)	29.76 – 1.95 46.95 – 1.95	Depositor EDS
% Data completeness (in resolution range)	98.2 (29.76-1.95) 98.2 (46.95-1.95)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.41 (at 1.95Å)	Xtriage
Refinement program	PHENIX (phenix.refine)	Depositor
R, R_{free}	0.163 , 0.210 0.161 , 0.207	Depositor DCC
R_{free} test set	3720 reflections (4.99%)	DCC
Wilson B-factor (Å ²)	18.2	Xtriage
Anisotropy	0.343	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 61.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.028 for l,-k,h	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	8267	wwPDB-VP
Average B, all atoms (Å ²)	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.71% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ 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: 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	0.68	2/3730 (0.1%)	0.67	0/5044
1	B	0.68	0/3742	0.69	2/5060 (0.0%)
All	All	0.68	2/7472 (0.0%)	0.68	2/10104 (0.0%)

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	B	0	1

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	409	GLU	CB-CG	6.74	1.65	1.52
1	A	156	CYS	CB-SG	-5.17	1.73	1.81

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	148	LEU	CA-CB-CG	5.75	128.52	115.30
1	B	56	ARG	NE-CZ-NH2	-5.28	117.66	120.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	136	ASP	Peptide

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	3645	0	3602	28	0
1	B	3657	0	3617	26	0
2	A	43	0	30	3	0
2	B	43	0	30	1	0
3	A	411	0	0	12	0
3	B	468	0	0	5	0
All	All	8267	0	7279	56	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 4.

All (56) 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:285:HIS:HB2	3:A:705:HOH:O	1.89	0.72
1:B:215:LEU:O	1:B:219:ILE:HD12	1.90	0.71
1:B:387:GLN:HB3	3:B:768:HOH:O	1.95	0.66
1:A:285:HIS:HB2	3:A:756:HOH:O	1.96	0.65
1:B:194:ASP:O	1:B:195:ASP:HB2	1.97	0.64
1:A:3:LYS:CB	3:A:814:HOH:O	2.47	0.61
1:A:47:ARG:HG3	3:A:619:HOH:O	2.00	0.61
1:A:45:PRO:O	3:A:619:HOH:O	2.17	0.59
1:A:94:LYS:HE2	3:A:519:HOH:O	2.02	0.58
1:B:5:MET:SD	1:B:50:ARG:HG2	2.43	0.58
1:B:31:LYS:O	1:B:35:GLU:HG2	2.06	0.56
1:B:126:LEU:HD13	1:B:126:LEU:C	2.27	0.56
1:A:73:GLN:NE2	3:A:700:HOH:O	2.38	0.56
1:B:381:ASN:ND2	3:B:910:HOH:O	2.28	0.55
1:A:122:ILE:HG22	1:A:148:LEU:HD22	1.90	0.54
1:B:43:GLU:HG2	1:B:48:VAL:HG22	1.91	0.52
1:A:148:LEU:HD13	1:A:148:LEU:C	2.29	0.52
1:A:285:HIS:CB	3:A:705:HOH:O	2.53	0.51
2:A:999:HEM:HMC2	2:A:999:HEM:HBC2	1.92	0.51
1:A:73:GLN:CD	3:A:700:HOH:O	2.49	0.50
1:A:309:LYS:HD3	3:A:831:HOH:O	2.12	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:101:ASN:HB3	1:A:243:PRO:HD2	1.94	0.49
1:B:62:CYS:SG	1:B:391:LYS:HE2	2.52	0.49
1:A:287:LEU:HD23	1:A:287:LEU:O	2.12	0.49
1:A:46:GLY:C	3:A:619:HOH:O	2.51	0.48
1:B:158:PHE:HE2	1:B:219:ILE:HD13	1.78	0.48
1:B:268:THR:HB	2:B:999:HEM:C3B	2.49	0.47
1:B:309:LYS:HE3	3:B:856:HOH:O	2.13	0.47
1:A:148:LEU:CD1	1:A:409:GLU:OE2	2.63	0.47
1:B:384:ALA:HB2	3:B:910:HOH:O	2.16	0.46
1:B:287:LEU:HD23	1:B:287:LEU:O	2.15	0.46
1:B:288:GLN:NE2	3:B:846:HOH:O	2.48	0.46
1:B:196:PRO:HA	1:B:199:ASP:OD2	2.16	0.45
1:B:68:ASP:HB3	1:B:334:TYR:CE1	2.51	0.44
1:B:158:PHE:CE2	1:B:219:ILE:HD13	2.53	0.44
1:B:366:ILE:HG21	1:B:389:ALA:HB1	1.99	0.44
1:B:17:LEU:N	1:B:18:PRO:CD	2.81	0.44
1:A:5:MET:HA	1:A:6:PRO:HD3	1.75	0.43
2:A:999:HEM:HBC2	2:A:999:HEM:CMC	2.48	0.43
1:A:302:VAL:HA	1:A:303:PRO:HD3	1.78	0.43
1:A:287:LEU:C	1:A:287:LEU:HD23	2.39	0.42
1:A:82:ALA:HB2	1:A:263:ILE:HD11	2.00	0.42
1:B:272:LEU:HD13	1:B:322:LEU:HG	2.01	0.42
1:A:104:LEU:C	1:A:104:LEU:HD23	2.39	0.42
1:A:148:LEU:HD13	1:A:409:GLU:OE2	2.20	0.41
1:A:402:GLY:HA3	2:A:999:HEM:C3C	2.55	0.41
1:B:163:ASN:O	1:B:167:ARG:HD2	2.21	0.41
1:B:233:LEU:HD13	1:B:261:PHE:CE2	2.55	0.41
1:A:168:ASP:HB2	1:A:169:GLN:OE1	2.20	0.41
1:B:20:LEU:HA	1:B:20:LEU:HD23	1.86	0.41
1:A:285:HIS:CE1	3:A:534:HOH:O	2.73	0.41
1:B:215:LEU:HG	1:B:219:ILE:CD1	2.51	0.41
1:A:370:ASP:HB2	1:A:373:GLU:HG3	2.03	0.41
1:A:210:LYS:HD3	1:A:214:ASP:OD2	2.20	0.41
1:A:253:ASN:O	1:A:257:GLN:HG2	2.21	0.40
1:B:3:LYS:HG2	1:B:4:GLU:N	2.35	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	451/470 (96%)	445 (99%)	6 (1%)	0	100	100
1	B	452/470 (96%)	437 (97%)	13 (3%)	2 (0%)	38	25
All	All	903/940 (96%)	882 (98%)	19 (2%)	2 (0%)	51	41

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	B	195	ASP
1	B	193	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	394/411 (96%)	386 (98%)	8 (2%)	60	52
1	B	396/411 (96%)	391 (99%)	5 (1%)	73	69
All	All	790/822 (96%)	777 (98%)	13 (2%)	68	63

All (13) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	94	LYS
1	A	148	LEU
1	A	158	PHE
1	A	210	LYS

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Mol	Chain	Res	Type
1	A	263	ILE
1	A	302	VAL
1	A	309	LYS
1	A	455	LEU
1	B	2	ILE
1	B	4	GLU
1	B	158	PHE
1	B	302	VAL
1	B	383	SER

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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 carbohydrates in this entry.

5.6 Ligand geometry [i](#)

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	999	1	28,50,50	2.26	9 (32%)	17,82,82	1.83	6 (35%)
2	HEM	B	999	1,3	28,50,50	2.22	13 (46%)	17,82,82	1.74	5 (29%)

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	999	1	-	0/6/54/54	0/0/8/8
2	HEM	B	999	1,3	-	0/6/54/54	0/0/8/8

All (22) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	999	HEM	C3B-C2B	-4.24	1.34	1.40
2	A	999	HEM	C3C-C2C	-3.78	1.35	1.40
2	B	999	HEM	C3B-C2B	-3.49	1.35	1.40
2	B	999	HEM	C3C-C2C	-2.98	1.36	1.40
2	B	999	HEM	CAA-C2A	2.02	1.55	1.52
2	B	999	HEM	C1D-ND	2.02	1.40	1.36
2	B	999	HEM	CMC-C2C	2.09	1.56	1.51
2	B	999	HEM	C4C-NC	2.18	1.39	1.36
2	B	999	HEM	C4D-ND	2.21	1.39	1.36
2	A	999	HEM	CMC-C2C	2.27	1.56	1.51
2	B	999	HEM	CMB-C2B	2.30	1.56	1.51
2	A	999	HEM	C1C-NC	2.32	1.39	1.36
2	B	999	HEM	CMD-C2D	2.38	1.56	1.51
2	B	999	HEM	CMA-C3A	2.43	1.56	1.51
2	A	999	HEM	C3B-CAB	3.29	1.54	1.47
2	A	999	HEM	C4D-ND	3.43	1.40	1.36
2	A	999	HEM	CAA-C2A	3.47	1.57	1.52
2	A	999	HEM	C3C-CAC	3.84	1.55	1.47
2	B	999	HEM	C3B-CAB	4.40	1.56	1.47
2	B	999	HEM	C3C-CAC	4.44	1.56	1.47
2	A	999	HEM	C3D-C2D	4.70	1.51	1.37
2	B	999	HEM	C3D-C2D	5.13	1.52	1.37

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	999	HEM	CBD-CAD-C3D	-3.00	106.75	112.47
2	B	999	HEM	CBD-CAD-C3D	-2.97	106.80	112.47
2	A	999	HEM	CBA-CAA-C2A	-2.86	107.02	112.48
2	B	999	HEM	C1D-C2D-C3D	-2.44	105.30	107.00
2	B	999	HEM	CMA-C3A-C4A	-2.38	124.80	128.46
2	B	999	HEM	CBA-CAA-C2A	-2.25	108.17	112.48

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	999	HEM	CMA-C3A-C4A	-2.04	125.33	128.46
2	B	999	HEM	CMC-C2C-C3C	2.18	128.93	124.89
2	A	999	HEM	C4C-C3C-C2C	2.35	108.54	106.90
2	A	999	HEM	C4A-C3A-C2A	2.49	108.73	107.00
2	A	999	HEM	CMB-C2B-C3B	3.19	130.81	124.89

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	999	HEM	3	0
2	B	999	HEM	1	0

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

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	453/470 (96%)	-0.18	9 (1%) 65 75	13, 23, 45, 63	0
1	B	454/470 (96%)	-0.13	13 (2%) 52 62	11, 23, 44, 68	0
All	All	907/940 (96%)	-0.16	22 (2%) 59 69	11, 23, 45, 68	0

All (22) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	198	TYR	3.9
1	B	193	PRO	3.7
1	B	194	ASP	3.6
1	B	191	ALA	3.4
1	B	196	PRO	3.2
1	B	3	LYS	3.0
1	B	197	ALA	3.0
1	B	2	ILE	3.0
1	B	203	ARG	2.6
1	B	229	GLN	2.6
1	A	193	PRO	2.5
1	B	4	GLU	2.5
1	A	194	ASP	2.3
1	A	4	GLU	2.3
1	A	202	LYS	2.3
1	B	136	ASP	2.2
1	A	369	ASP	2.2
1	A	189	GLN	2.2
1	B	231	ASP	2.1
1	A	227	GLY	2.1
1	B	207	GLU	2.1
1	A	201	ASN	2.1

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

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

6.3 Carbohydrates [i](#)

There are no carbohydrates in this entry.

6.4 Ligands [i](#)

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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors(\AA^2)	Q<0.9
2	HEM	A	999	43/43	0.98	0.09	-0.23	12,15,17,24	0
2	HEM	B	999	43/43	0.99	0.08	-0.41	9,14,16,18	0

6.5 Other polymers [i](#)

There are no such residues in this entry.