wwPDB X-ray Structure Validation Summary Report (i)

May 14, 2020 – 06:50 am BST

PDB ID	:	6R76
Title	:	Crystal structure of trans-3-Hydroxy-L-proline dehydratase from Thermococcus litoralis - open conformation
Authors	:	Ferraris, D.M.; Miggiano, R.; Rizzi, M.
Deposited on	:	2019-03-28
Resolution	:	2.40 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 (i) symbol.

The following versions of software and data (see references (1)) were used in the production of this report:

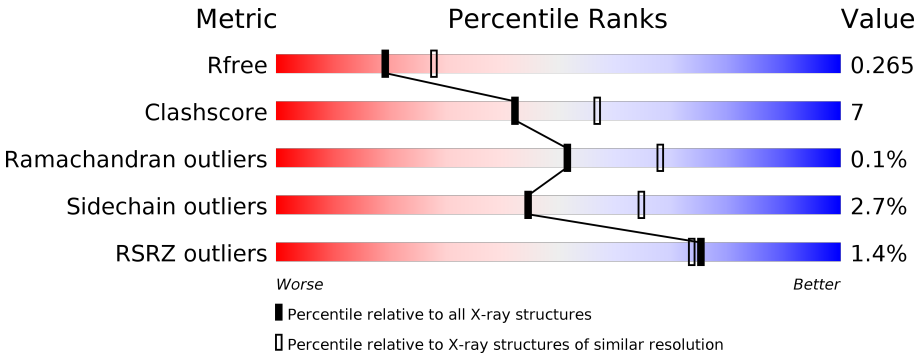
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.11
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.11

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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}	130704	3907 (2.40-2.40)
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)
RSRZ outliers	127900	3811 (2.40-2.40)

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 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 <=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	368	76% 18% • 5%
1	C	368	75% 18% • 6%
2	B	368	78% 12% • 9%
2	D	368	76% 13% • 8%

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 10911 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 Proline racemase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	348	Total	C	N	O	S	0	0	0
			2768	1788	451	515	14			
1	C	345	Total	C	N	O	S	0	0	0
			2742	1773	448	508	13			

There are 40 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-19	MET	-	initiating methionine	UNP H3ZMH8
A	-18	GLY	-	expression tag	UNP H3ZMH8
A	-17	SER	-	expression tag	UNP H3ZMH8
A	-16	HIS	-	expression tag	UNP H3ZMH8
A	-15	HIS	-	expression tag	UNP H3ZMH8
A	-14	HIS	-	expression tag	UNP H3ZMH8
A	-13	HIS	-	expression tag	UNP H3ZMH8
A	-12	HIS	-	expression tag	UNP H3ZMH8
A	-11	HIS	-	expression tag	UNP H3ZMH8
A	-10	SER	-	expression tag	UNP H3ZMH8
A	-9	SER	-	expression tag	UNP H3ZMH8
A	-8	GLY	-	expression tag	UNP H3ZMH8
A	-7	GLU	-	expression tag	UNP H3ZMH8
A	-6	ASN	-	expression tag	UNP H3ZMH8
A	-5	LEU	-	expression tag	UNP H3ZMH8
A	-4	TYR	-	expression tag	UNP H3ZMH8
A	-3	PHE	-	expression tag	UNP H3ZMH8
A	-2	GLN	-	expression tag	UNP H3ZMH8
A	-1	GLY	-	expression tag	UNP H3ZMH8
A	0	HIS	-	expression tag	UNP H3ZMH8
C	-19	MET	-	initiating methionine	UNP H3ZMH8
C	-18	GLY	-	expression tag	UNP H3ZMH8
C	-17	SER	-	expression tag	UNP H3ZMH8
C	-16	HIS	-	expression tag	UNP H3ZMH8
C	-15	HIS	-	expression tag	UNP H3ZMH8

Continued on next page...

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
C	-14	HIS	-	expression tag	UNP H3ZMH8
C	-13	HIS	-	expression tag	UNP H3ZMH8
C	-12	HIS	-	expression tag	UNP H3ZMH8
C	-11	HIS	-	expression tag	UNP H3ZMH8
C	-10	SER	-	expression tag	UNP H3ZMH8
C	-9	SER	-	expression tag	UNP H3ZMH8
C	-8	GLY	-	expression tag	UNP H3ZMH8
C	-7	GLU	-	expression tag	UNP H3ZMH8
C	-6	ASN	-	expression tag	UNP H3ZMH8
C	-5	LEU	-	expression tag	UNP H3ZMH8
C	-4	TYR	-	expression tag	UNP H3ZMH8
C	-3	PHE	-	expression tag	UNP H3ZMH8
C	-2	GLN	-	expression tag	UNP H3ZMH8
C	-1	GLY	-	expression tag	UNP H3ZMH8
C	0	HIS	-	expression tag	UNP H3ZMH8

- Molecule 2 is a protein called Proline racemase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
2	B	336	Total	C	N	O	P	S	0	0	0
			2674	1725	434	501	1	13			
2	D	340	Total	C	N	O	P	S	0	0	0
			2711	1750	443	504	1	13			

There are 40 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-19	MET	-	initiating methionine	UNP H3ZMH8
B	-18	GLY	-	expression tag	UNP H3ZMH8
B	-17	SER	-	expression tag	UNP H3ZMH8
B	-16	HIS	-	expression tag	UNP H3ZMH8
B	-15	HIS	-	expression tag	UNP H3ZMH8
B	-14	HIS	-	expression tag	UNP H3ZMH8
B	-13	HIS	-	expression tag	UNP H3ZMH8
B	-12	HIS	-	expression tag	UNP H3ZMH8
B	-11	HIS	-	expression tag	UNP H3ZMH8
B	-10	SER	-	expression tag	UNP H3ZMH8
B	-9	SER	-	expression tag	UNP H3ZMH8
B	-8	GLY	-	expression tag	UNP H3ZMH8
B	-7	GLU	-	expression tag	UNP H3ZMH8
B	-6	ASN	-	expression tag	UNP H3ZMH8
B	-5	LEU	-	expression tag	UNP H3ZMH8

Continued on next page...

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
B	-4	TYR	-	expression tag	UNP H3ZMH8
B	-3	PHE	-	expression tag	UNP H3ZMH8
B	-2	GLN	-	expression tag	UNP H3ZMH8
B	-1	GLY	-	expression tag	UNP H3ZMH8
B	0	HIS	-	expression tag	UNP H3ZMH8
D	-19	MET	-	initiating methionine	UNP H3ZMH8
D	-18	GLY	-	expression tag	UNP H3ZMH8
D	-17	SER	-	expression tag	UNP H3ZMH8
D	-16	HIS	-	expression tag	UNP H3ZMH8
D	-15	HIS	-	expression tag	UNP H3ZMH8
D	-14	HIS	-	expression tag	UNP H3ZMH8
D	-13	HIS	-	expression tag	UNP H3ZMH8
D	-12	HIS	-	expression tag	UNP H3ZMH8
D	-11	HIS	-	expression tag	UNP H3ZMH8
D	-10	SER	-	expression tag	UNP H3ZMH8
D	-9	SER	-	expression tag	UNP H3ZMH8
D	-8	GLY	-	expression tag	UNP H3ZMH8
D	-7	GLU	-	expression tag	UNP H3ZMH8
D	-6	ASN	-	expression tag	UNP H3ZMH8
D	-5	LEU	-	expression tag	UNP H3ZMH8
D	-4	TYR	-	expression tag	UNP H3ZMH8
D	-3	PHE	-	expression tag	UNP H3ZMH8
D	-2	GLN	-	expression tag	UNP H3ZMH8
D	-1	GLY	-	expression tag	UNP H3ZMH8
D	0	HIS	-	expression tag	UNP H3ZMH8

- Molecule 3 is water.

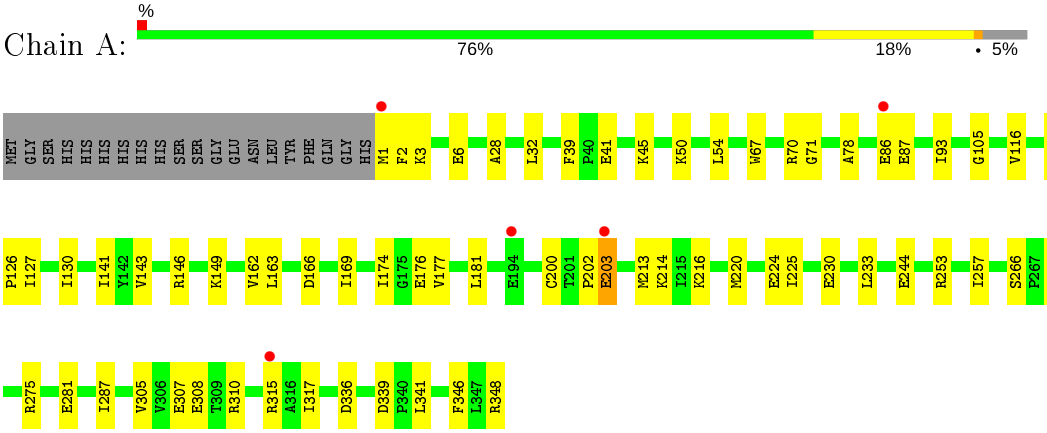
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	6	Total O 6 6	0	0
3	B	4	Total O 4 4	0	0
3	C	5	Total O 5 5	0	0
3	D	1	Total O 1 1	0	0

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.

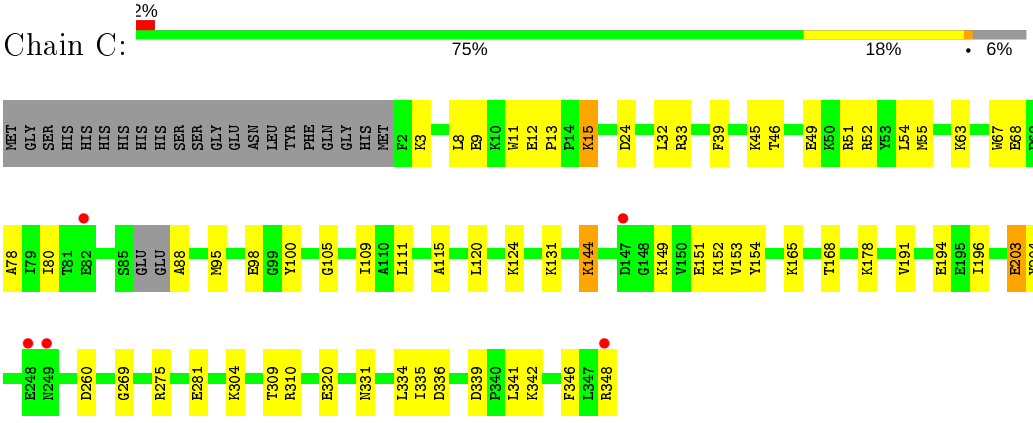
- Molecule 1: Proline racemase

Chain A:



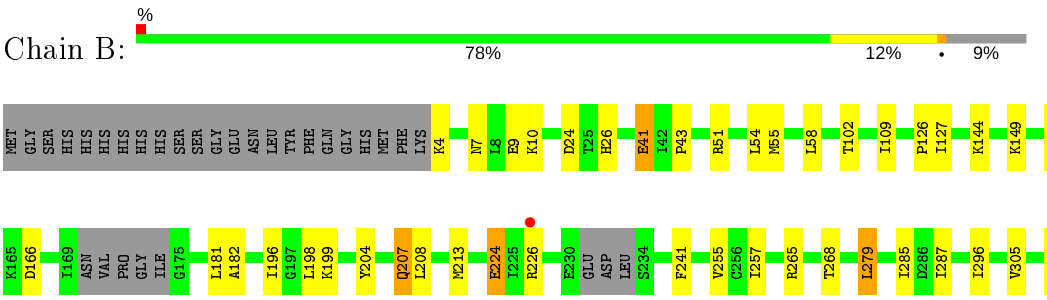
- Molecule 1: Proline racemase

Chain C:



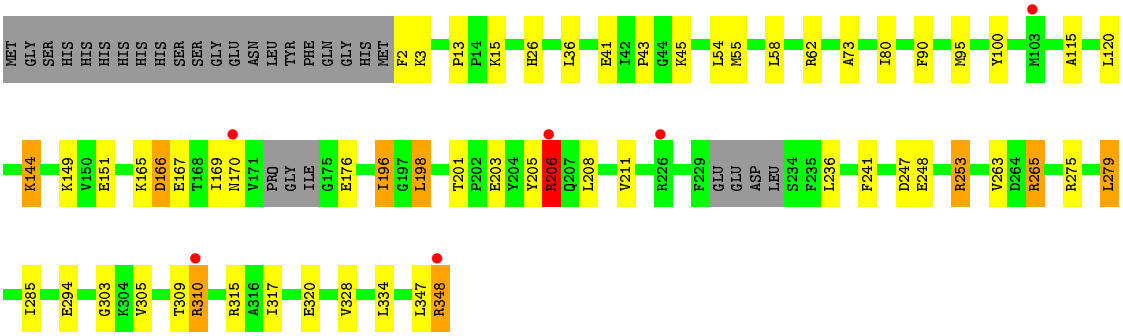
- Molecule 2: Proline racemase

Chain B:



- Molecule 2: Proline racemase

Chain D:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	109.92Å 46.09Å 143.51Å 90.00° 110.48° 90.00°	Depositor
Resolution (Å)	44.80 – 2.40 48.99 – 2.40	Depositor EDS
% Data completeness (in resolution range)	99.3 (44.80-2.40) 99.4 (48.99-2.40)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.18 (at 2.39Å)	Xtriage
Refinement program	PHENIX (1.13_2998: ???)	Depositor
R, R_{free}	0.205 , 0.265 0.207 , 0.265	Depositor DCC
R_{free} test set	2681 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å^2)	36.0	Xtriage
Anisotropy	0.195	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 43.9	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.000 for h,-k,-h-l	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	10911	wwPDB-VP
Average B, all atoms (Å^2)	44.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 47.64 % of the origin peak, indicating pseudo-translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo-translational symmetry is equal to 9.6387e-05. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

[1] Intensities estimated from amplitudes.

[2] Theoretical values of $< |L| >$, $< L^2 >$ 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: PHD

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	0.52	0/2833	0.85	13/3828 (0.3%)
1	C	0.53	2/2806 (0.1%)	0.76	7/3791 (0.2%)
2	B	0.49	0/2722	0.72	4/3674 (0.1%)
2	D	0.50	1/2760 (0.0%)	0.79	9/3724 (0.2%)
All	All	0.51	3/11121 (0.0%)	0.78	33/15017 (0.2%)

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
2	D	0	2

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	D	45	LYS	CE-NZ	5.83	1.63	1.49
1	C	45	LYS	CE-NZ	-5.61	1.35	1.49
1	C	124	LYS	CD-CE	5.02	1.63	1.51

The worst 5 of 33 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	D	310	ARG	NE-CZ-NH2	-11.27	114.67	120.30
2	D	45	LYS	CD-CE-NZ	-10.74	86.99	111.70
2	D	310	ARG	NE-CZ-NH1	9.49	125.05	120.30
1	A	315	ARG	NE-CZ-NH1	9.06	124.83	120.30
2	B	226	ARG	NE-CZ-NH2	-8.53	116.04	120.30

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	D	170	ASN	Peptide
2	D	206	ARG	Sidechain

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	2768	0	2767	37	2
1	C	2742	0	2742	46	0
2	B	2674	0	2660	26	2
2	D	2711	0	2704	49	0
3	A	6	0	0	0	0
3	B	4	0	0	0	0
3	C	5	0	0	1	0
3	D	1	0	0	0	0
All	All	10911	0	10873	151	2

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 7.

The worst 5 of 151 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:15:LYS:H	1:C:15:LYS:HE2	1.10	1.16
2:D:73:ALA:CB	2:D:348:ARG:CZ	2.31	1.09
2:D:73:ALA:HB3	2:D:348:ARG:CZ	1.89	1.03
2:D:73:ALA:HB1	2:D:348:ARG:NH1	1.76	1.00
2:D:73:ALA:HB1	2:D:348:ARG:CZ	1.95	0.95

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:176:GLU:OE2	2:B:310:ARG:NH2[2_7511]	1.85	0.35
1:A:214:LYS:NZ	2:B:224:GLU:OE1[2_7511]	2.17	0.03

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	346/368 (94%)	341 (99%)	5 (1%)	0	100	100
1	C	341/368 (93%)	338 (99%)	3 (1%)	0	100	100
2	B	329/368 (89%)	322 (98%)	6 (2%)	1 (0%)	41	55
2	D	333/368 (90%)	326 (98%)	7 (2%)	0	100	100
All	All	1349/1472 (92%)	1327 (98%)	21 (2%)	1 (0%)	51	68

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	268	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	296/313 (95%)	289 (98%)	7 (2%)	49	68
1	C	293/313 (94%)	286 (98%)	7 (2%)	49	68
2	B	284/312 (91%)	275 (97%)	9 (3%)	39	59

Continued on next page...

Continued from previous page...

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	D	288/312 (92%)	280 (97%)	8 (3%)	43	63
All	All	1161/1250 (93%)	1130 (97%)	31 (3%)	44	65

5 of 31 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	265	ARG
1	C	15	LYS
2	D	265	ARG
2	B	279	LEU
1	C	39	PHE

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	338	GLN
2	D	331	ASN

5.3.3 RNA (i)

There are no RNA molecules in this entry.

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

2 non-standard protein/DNA/RNA residues 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	PHD	D	74	2	9,11,12	2.17	1 (11%)	10,15,17	2.62	4 (40%)
2	PHD	B	74	2	9,11,12	2.08	2 (22%)	10,15,17	2.34	4 (40%)

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	PHD	D	74	2	-	4/8/11/13	-
2	PHD	B	74	2	-	3/8/11/13	-

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	D	74	PHD	P-OD1	5.31	1.67	1.59
2	B	74	PHD	P-OD1	4.61	1.66	1.59
2	B	74	PHD	P-OP3	-2.12	1.46	1.54

The worst 5 of 8 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	D	74	PHD	OD1-CG-CB	5.32	125.74	111.11
2	B	74	PHD	OD1-CG-CB	4.95	124.72	111.11
2	D	74	PHD	OP3-P-OD1	3.29	115.27	105.25
2	D	74	PHD	OD2-CG-CB	-3.22	117.61	124.73
2	D	74	PHD	OP2-P-OD1	2.68	113.42	105.25

There are no chirality outliers.

5 of 7 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	D	74	PHD	C-CA-CB-CG
2	D	74	PHD	N-CA-CB-CG
2	B	74	PHD	N-CA-CB-CG
2	B	74	PHD	C-CA-CB-CG
2	B	74	PHD	CG-OD1-P-OP2

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates (i)

There are no carbohydrates in this entry.

5.6 Ligand geometry (i)

There are no ligands in this entry.

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, 95^{th} 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	348/368 (94%)	-0.01	5 (1%)	75 73	25, 43, 67, 79	0
1	C	345/368 (93%)	-0.09	6 (1%)	70 68	26, 41, 63, 78	0
2	B	335/368 (91%)	-0.14	2 (0%)	89 88	28, 41, 60, 77	0
2	D	339/368 (92%)	-0.13	6 (1%)	68 66	29, 42, 61, 69	0
All	All	1367/1472 (92%)	-0.09	19 (1%)	75 73	25, 42, 64, 79	0

The worst 5 of 19 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1	MET	3.7
1	C	224	GLU	3.1
2	B	226	ARG	2.7
2	D	348	ARG	2.6
1	A	194	GLU	2.6

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

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. The B-factors column lists the minimum, median, 95^{th} 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	B-factors(Å^2)	Q<0.9
2	PHD	D	74	12/13	0.93	0.15	34,43,58,73	0
2	PHD	B	74	12/13	0.94	0.11	33,44,58,67	0

6.3 Carbohydrates

There are no carbohydrates in this entry.

6.4 Ligands

There are no ligands in this entry.

6.5 Other polymers

There are no such residues in this entry.