



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 18, 2020 – 09:02 pm BST

PDB ID : 5FAY  
Title : Y208F mutant of choline TMA-lyase  
Authors : Funk, M.A.; Drennan, C.L.  
Deposited on : 2015-12-12  
Resolution : 1.90 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](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) : 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

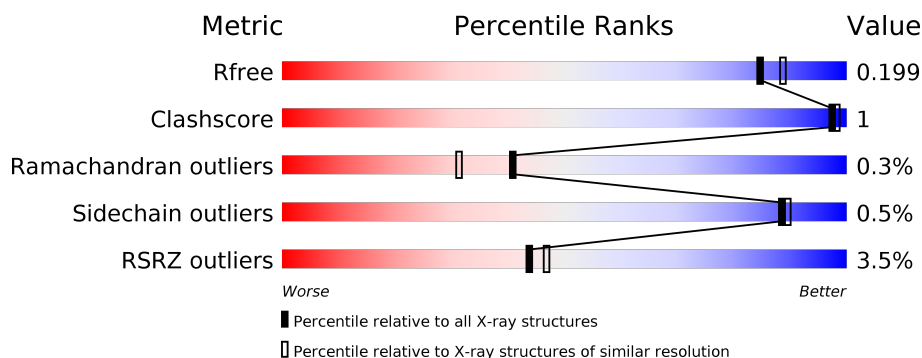
# 1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.90 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	6207 (1.90-1.90)
Clashscore	141614	6847 (1.90-1.90)
Ramachandran outliers	138981	6760 (1.90-1.90)
Sidechain outliers	138945	6760 (1.90-1.90)
RSRZ outliers	127900	6082 (1.90-1.90)

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  $\geq 3$ , 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  $\leq 5\%$ . 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	815	<div> <div>2%</div> <div> <div></div> <div>96%</div> <div></div> </div> <div></div> </div>
1	B	815	<div> <div>5%</div> <div> <div></div> <div>93%</div> <div></div> </div> <div></div> </div>

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 27368 atoms, of which 12356 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 Choline trimethylamine-lyase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	803	Total	C	H	N	O	S	0	20	0
			12634	4039	6257	1086	1205	47			
1	B	780	Total	C	H	N	O	S	0	13	0
			12236	3918	6053	1046	1173	46			

There are 44 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	32	MET	-	initiating methionine	UNP Q30W70
A	33	GLY	-	expression tag	UNP Q30W70
A	34	SER	-	expression tag	UNP Q30W70
A	35	SER	-	expression tag	UNP Q30W70
A	36	HIS	-	expression tag	UNP Q30W70
A	37	HIS	-	expression tag	UNP Q30W70
A	38	HIS	-	expression tag	UNP Q30W70
A	39	HIS	-	expression tag	UNP Q30W70
A	40	HIS	-	expression tag	UNP Q30W70
A	41	HIS	-	expression tag	UNP Q30W70
A	42	SER	-	expression tag	UNP Q30W70
A	43	SER	-	expression tag	UNP Q30W70
A	44	GLY	-	expression tag	UNP Q30W70
A	45	LEU	-	expression tag	UNP Q30W70
A	46	VAL	-	expression tag	UNP Q30W70
A	47	PRO	-	expression tag	UNP Q30W70
A	48	ARG	-	expression tag	UNP Q30W70
A	49	GLY	-	expression tag	UNP Q30W70
A	50	SER	-	expression tag	UNP Q30W70
A	51	HIS	-	expression tag	UNP Q30W70
A	52	MET	-	expression tag	UNP Q30W70
A	208	PHE	TYR	engineered mutation	UNP Q30W70
B	32	MET	-	initiating methionine	UNP Q30W70
B	33	GLY	-	expression tag	UNP Q30W70
B	34	SER	-	expression tag	UNP Q30W70

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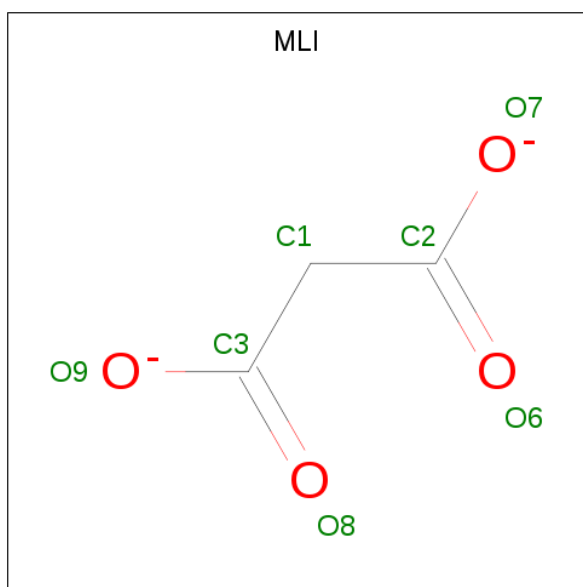
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Chain	Residue	Modelled	Actual	Comment	Reference
B	35	SER	-	expression tag	UNP Q30W70
B	36	HIS	-	expression tag	UNP Q30W70
B	37	HIS	-	expression tag	UNP Q30W70
B	38	HIS	-	expression tag	UNP Q30W70
B	39	HIS	-	expression tag	UNP Q30W70
B	40	HIS	-	expression tag	UNP Q30W70
B	41	HIS	-	expression tag	UNP Q30W70
B	42	SER	-	expression tag	UNP Q30W70
B	43	SER	-	expression tag	UNP Q30W70
B	44	GLY	-	expression tag	UNP Q30W70
B	45	LEU	-	expression tag	UNP Q30W70
B	46	VAL	-	expression tag	UNP Q30W70
B	47	PRO	-	expression tag	UNP Q30W70
B	48	ARG	-	expression tag	UNP Q30W70
B	49	GLY	-	expression tag	UNP Q30W70
B	50	SER	-	expression tag	UNP Q30W70
B	51	HIS	-	expression tag	UNP Q30W70
B	52	MET	-	expression tag	UNP Q30W70
B	208	PHE	TYR	engineered mutation	UNP Q30W70

- Molecule 2 is SODIUM ION (three-letter code: NA) (formula: Na).

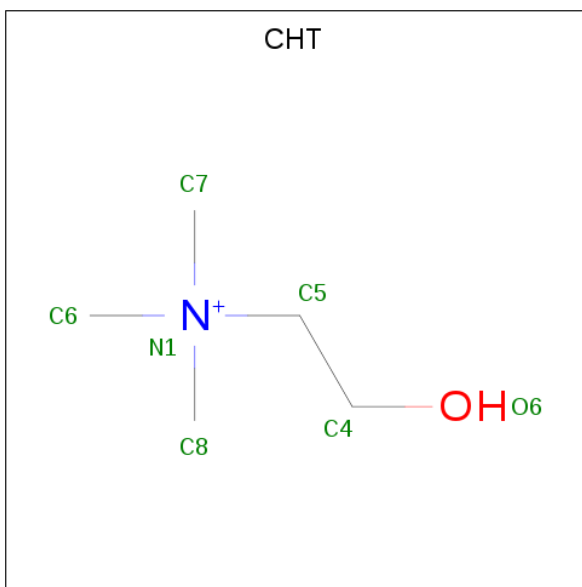
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	B	1	Total Na 1 1	0	0
2	A	2	Total Na 2 2	0	0

- Molecule 3 is MALONATE ION (three-letter code: MLI) (formula: C<sub>3</sub>H<sub>2</sub>O<sub>4</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	H	O	0	0
			9	3	2	4		
3	A	1	Total	C	H	O	0	0
			9	3	2	4		
3	A	1	Total	C	H	O	0	0
			9	3	2	4		
3	A	1	Total	C	H	O	0	0
			9	3	2	4		
3	A	1	Total	C	H	O	0	0
			9	3	2	4		
3	B	1	Total	C	H	O	0	0
			9	3	2	4		
3	B	1	Total	C	H	O	0	0
			9	3	2	4		
3	B	1	Total	C	H	O	0	0
			9	3	2	4		

- Molecule 4 is CHOLINE ION (three-letter code: CHT) (formula: C<sub>5</sub>H<sub>14</sub>NO).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	H	N	O	0	0
			21	5	14	1	1		
4	B	1	Total	C	H	N	O	0	0
			21	5	14	1	1		

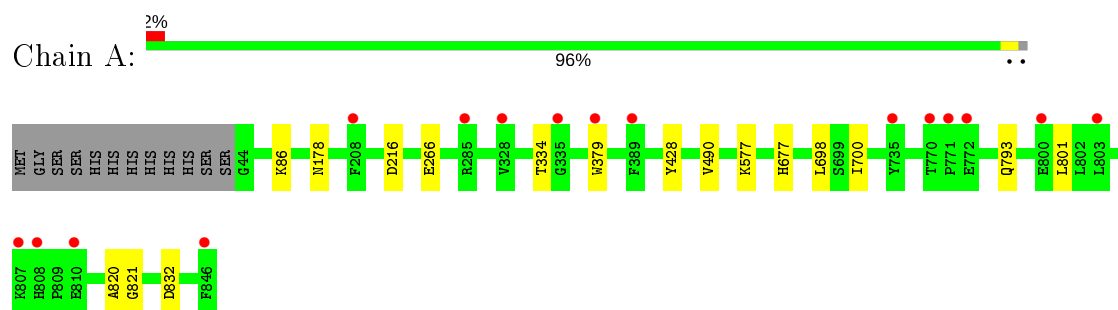
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	1243	Total	O	0	1
			1244	1244		
5	B	1126	Total	O	0	2
			1128	1128		

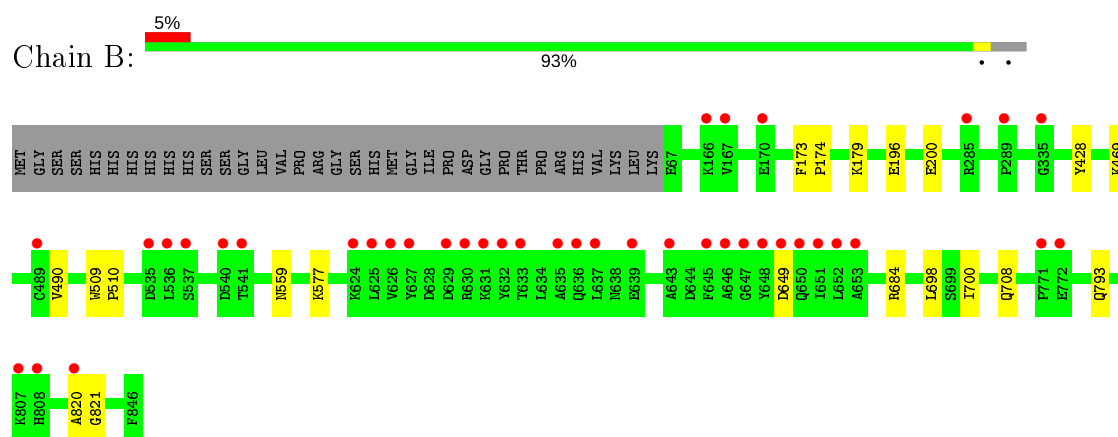
### 3 Residue-property plots [i](#)

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: Choline trimethylamine-lyase



- Molecule 1: Choline trimethylamine-lyase



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 42 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	228.94Å 228.94Å 78.95Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.48 – 1.90 49.48 – 1.90	Depositor EDS
% Data completeness (in resolution range)	99.7 (49.48-1.90) 95.5 (49.48-1.90)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	0.12	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.44 (at 1.90Å)	Xtriage
Refinement program	PHENIX 1.9_1692	Depositor
R, $R_{free}$	0.159 , 0.193 0.170 , 0.199	Depositor DCC
$R_{free}$ test set	4902 reflections (3.00%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	18.7	Xtriage
Anisotropy	0.485	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.45 , 70.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.43$ , $\langle L^2 \rangle = 0.26$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	27368	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.93% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: NA, MLI, CHT

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	0.32	0/6573	0.46	0/8897
1	B	0.32	0/6356	0.46	0/8604
All	All	0.32	0/12929	0.46	0/17501

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 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	6377	6257	6151	9	0
1	B	6183	6053	5992	10	3
2	A	2	0	0	0	0
2	B	1	0	0	0	0
3	A	35	10	10	0	0
3	B	28	8	8	0	0
4	A	7	14	14	0	0
4	B	7	14	14	0	0
5	A	1244	0	0	6	0
5	B	1128	0	0	5	0
All	All	15012	12356	12189	19	3

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 1.

The worst 5 of 19 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:B:559:ASN:ND2	5:B:1002:HOH:O	2.20	0.75
1:A:216:ASP:OD1	5:A:1001:HOH:O	2.04	0.74
1:A:266[B]:GLU:OE2	5:A:1002:HOH:O	2.06	0.73
1:A:832:ASP:OD2	5:A:1003:HOH:O	2.10	0.67
1:B:469:LYS:NZ	5:B:1008:HOH:O	2.28	0.67

All (3) 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:B:179:LYS:NZ	1:B:179:LYS:HZ2[7_555]	0.90	0.70
1:B:179:LYS:HZ1	1:B:179:LYS:HZ2[7_555]	0.95	0.65
1:B:179:LYS:NZ	1:B:179:LYS:NZ[7_555]	1.80	0.40

## 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	814/815 (100%)	795 (98%)	17 (2%)	2 (0%)	47	38
1	B	787/815 (97%)	762 (97%)	23 (3%)	2 (0%)	41	31
All	All	1601/1630 (98%)	1557 (97%)	40 (2%)	4 (0%)	41	38

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	700	ILE
1	B	700	ILE

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Mol	Chain	Res	Type
1	A	490	VAL
1	B	490	VAL

### 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	685/687 (100%)	681 (99%)	4 (1%)	86	87
1	B	662/687 (96%)	659 (100%)	3 (0%)	88	89
All	All	1347/1374 (98%)	1340 (100%)	7 (0%)	88	89

5 of 7 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	801	LEU
1	B	698	LEU
1	B	428	TYR
1	A	577	LYS
1	B	577	LYS

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

### 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 carbohydrates in this entry.

## 5.6 Ligand geometry

Of 14 ligands modelled in this entry, 3 are monoatomic - leaving 11 for Mogul analysis.

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	MLI	A	903	-	0,6,6	0.00	-	0,7,7	0.00	-
3	MLI	A	902	-	0,6,6	0.00	-	0,7,7	0.00	-
4	CHT	B	906	-	6,6,6	1.49	1 (16%)	8,8,8	0.67	0
3	MLI	B	904	-	0,6,6	0.00	-	0,7,7	0.00	-
4	CHT	A	908	-	6,6,6	1.42	0	8,8,8	0.60	0
3	MLI	B	903	-	0,6,6	0.00	-	0,7,7	0.00	-
3	MLI	A	904	-	0,6,6	0.00	-	0,7,7	0.00	-
3	MLI	B	902	-	0,6,6	0.00	-	0,7,7	0.00	-
3	MLI	B	905	-	0,6,6	0.00	-	0,7,7	0.00	-
3	MLI	A	905	-	0,6,6	0.00	-	0,7,7	0.00	-
3	MLI	A	906	-	0,6,6	0.00	-	0,7,7	0.00	-

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	MLI	A	903	-	-	0/0/4/4	-
3	MLI	A	902	-	-	0/0/4/4	-
4	CHT	B	906	-	-	0/4/4/4	-
3	MLI	B	904	-	-	0/0/4/4	-
4	CHT	A	908	-	-	1/4/4/4	-
3	MLI	B	903	-	-	0/0/4/4	-
3	MLI	A	904	-	-	0/0/4/4	-
3	MLI	B	902	-	-	0/0/4/4	-
3	MLI	B	905	-	-	0/0/4/4	-
3	MLI	A	905	-	-	0/0/4/4	-
3	MLI	A	906	-	-	0/0/4/4	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	906	CHT	C6-N1	-2.02	1.44	1.50

There are no bond angle outliers.

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	908	CHT	O6-C4-C5-N1

There are no ring outliers.

No monomer is involved in short contacts.

## 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](#)

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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	803/815 (98%)	-0.04	16 (1%) 65 68	11, 20, 33, 50	0
1	B	780/815 (95%)	0.14	40 (5%) 28 31	13, 22, 38, 58	0
All	All	1583/1630 (97%)	0.05	56 (3%) 44 47	11, 21, 36, 58	0

The worst 5 of 56 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	630	ARG	4.7
1	B	651	ILE	4.5
1	B	646	ALA	4.2
1	B	536	LEU	4.1
1	A	285	ARG	3.8

### 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. The B-factors column lists the minimum, median, 95<sup>th</sup> 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( $\text{\AA}^2$ )	Q<0.9
3	MLI	B	903	7/7	0.70	0.20	51,60,76,76	0
3	MLI	B	905	7/7	0.76	0.35	64,76,92,92	0
3	MLI	A	906	7/7	0.81	0.20	52,65,78,80	0
3	MLI	B	904	7/7	0.84	0.29	51,57,69,77	0
3	MLI	A	904	7/7	0.84	0.16	47,57,69,75	0
4	CHT	A	908	7/7	0.91	0.37	28,42,51,51	0
3	MLI	A	905	7/7	0.91	0.14	38,55,66,66	0
3	MLI	A	903	7/7	0.91	0.14	24,47,56,59	0
2	NA	A	907	1/1	0.92	0.13	52,52,52,52	0
4	CHT	B	906	7/7	0.93	0.42	37,45,51,53	0
3	MLI	B	902	7/7	0.93	0.11	32,38,45,47	0
3	MLI	A	902	7/7	0.96	0.15	25,43,52,52	0
2	NA	B	901	1/1	0.97	0.09	27,27,27,27	0
2	NA	A	901	1/1	0.97	0.06	27,27,27,27	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.