Full wwPDB X-ray Structure Validation Report ⓘ

Oct 10, 2023 – 12:38 AM EDT

PDB ID	:	7MFN
Title	:	N-Acetylmannosamine-6-phosphate 2-epimerase E180A from Staphylococcus aureus (strain MRSA USA300)
Authors	:	Currie, M.J.; Dobson, R.C.J.
Deposited on	:	2021-04-10
Resolution	:	1.55 Å(reported)

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	:	2.35.1
buster-report	:	1.1.7 (2018)
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)	:	2.35.1

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 1.55 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.
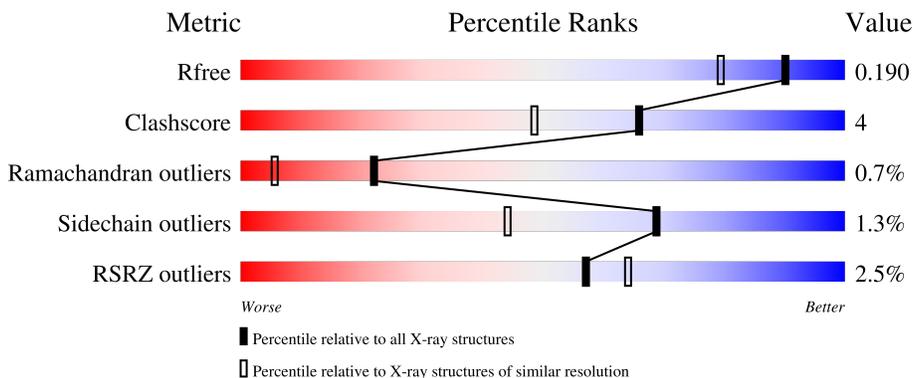
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	1483 (1.56-1.56)
Clashscore	141614	1529 (1.56-1.56)
Ramachandran outliers	138981	1498 (1.56-1.56)
Sidechain outliers	138945	1495 (1.56-1.56)
RSRZ outliers	127900	1465 (1.56-1.56)

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 <=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	AAA	222	3% / 92% / 7%
1	BBB	222	2% / 89% / 10%

2 Entry composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 4406 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 N-acetylmannosamine-6-phosphate 2-epimerase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	BBB	222	Total	C	N	O	S	0	17	0
			1846	1167	306	360	13			
1	AAA	222	Total	C	N	O	S	0	19	0
			1863	1177	308	366	12			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
BBB	180	ALA	GLU	engineered mutation	UNP X5EM89
AAA	180	ALA	GLU	engineered mutation	UNP X5EM89

- Molecule 2 is CITRIC ACID (three-letter code: CIT) (formula: $C_6H_8O_7$) (labeled as "Ligand of Interest" by depositor).
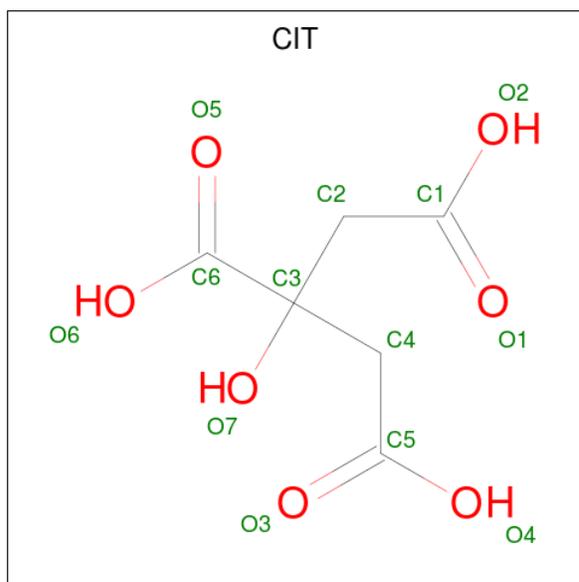
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	BBB	1	Total	C	O	0	0
			13	6	7		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	AAA	1	Total 13	C 6	O 7	0	0

- Molecule 3 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	BBB	1	Total 1	Cl 1	0	0
3	AAA	1	Total 1	Cl 1	0	0

- Molecule 4 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: $C_2H_6O_2$).
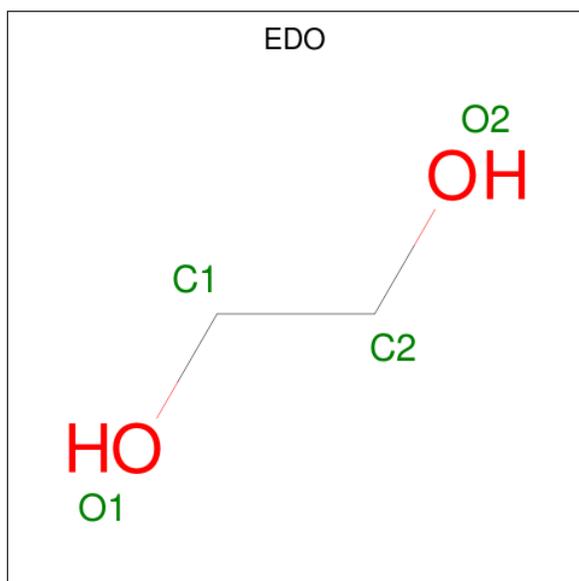
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	AAA	1	Total 4	C 2	O 2	0	0

- Molecule 5 is water.

| Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	BBB	348	Total 348	O 348	0	0
5	AAA	317	Total 317	O 317	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 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: N-acetylmannosamine-6-phosphate 2-epimerase

Chain BBB:

• Molecule 1: N-acetylmannosamine-6-phosphate 2-epimerase

Chain AAA:
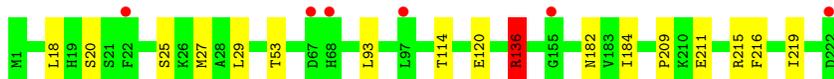
4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 2	Depositor
Cell constants a, b, c, α, β, γ	77.00Å 174.45Å 44.52Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	42.00 – 1.55 46.40 – 1.55	Depositor EDS
% Data completeness (in resolution range)	99.4 (42.00-1.55) 99.5 (46.40-1.55)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.06 (at 1.55Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.150 , 0.178 0.164 , 0.190	Depositor DCC
R_{free} test set	4414 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å^2)	18.9	Xtriage
Anisotropy	0.083	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.35 , 42.8	EDS
L-test for twinning[2]	$< |L| > = 0.49, < L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	4406	wwPDB-VP
Average B, all atoms (Å^2)	22.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.10% of the height of the origin peak. No significant pseudotranslation is detected.*

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[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 (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: CIT, CL, EDO

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	AAA	0.78	1/1903 (0.1%)	0.93	1/2576 (0.0%)
1	BBB	0.82	2/1885 (0.1%)	0.93	2/2549 (0.1%)
All	All	0.80	3/3788 (0.1%)	0.93	3/5125 (0.1%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	BBB	45	GLU	CD-OE1	5.75	1.31	1.25
1	AAA	120	GLU	CD-OE1	-5.70	1.19	1.25
1	BBB	129	GLU	CD-OE2	-5.13	1.20	1.25

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	BBB	208	ARG	NE-CZ-NH2	-6.66	116.97	120.30
1	AAA	136	ARG	CG-CD-NE	6.24	124.89	111.80
1	BBB	149	TYR	CB-CG-CD1	-6.15	117.31	121.00

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	AAA	1863	0	1875	15	0
1	BBB	1846	0	1873	16	0
2	AAA	13	0	6	1	0
2	BBB	13	0	5	0	0
3	AAA	1	0	0	0	0
3	BBB	1	0	0	0	0
4	AAA	4	0	6	0	0
5	AAA	317	0	0	6	1
5	BBB	348	0	0	9	2
All	All	4406	0	3765	30	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 4.

All (30) 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:BBB:211[A]:GLU:OE1	5:BBB:805:HOH:O	1.70	1.06
1:AAA:211[B]:GLU:HG3	5:AAA:426:HOH:O	1.55	1.06
1:AAA:215[B]:ARG:HD2	5:AAA:653:HOH:O	1.68	0.92
1:BBB:211[A]:GLU:HG3	5:BBB:949:HOH:O	1.75	0.86
1:AAA:211[B]:GLU:CG	5:AAA:426:HOH:O	2.18	0.79
1:AAA:114[B]:THR:HG23	5:AAA:593:HOH:O	1.83	0.79
1:BBB:44[A]:LYS:NZ	1:BBB:85:GLU:OE2	2.24	0.70
2:AAA:301:CIT:O6	5:AAA:405:HOH:O	2.13	0.67
1:BBB:172[B]:SER:OG	5:BBB:806:HOH:O	2.16	0.62
1:BBB:182:ASN:HA	1:BBB:184[A]:ILE:HD11	1.82	0.60
1:BBB:132[B]:LYS:NZ	5:BBB:811:HOH:O	2.35	0.59
1:BBB:211[A]:GLU:CG	5:BBB:949:HOH:O	2.43	0.57
1:BBB:190:LYS:HE3	5:BBB:1087:HOH:O	2.04	0.56
1:AAA:211[B]:GLU:CD	5:AAA:426:HOH:O	2.43	0.55
1:AAA:182:ASN:HA	1:AAA:184[B]:ILE:HD11	1.89	0.54
1:BBB:44[B]:LYS:HD3	1:BBB:85:GLU:HB2	1.88	0.54
1:BBB:209:PRO:HG3	1:AAA:27[B]:MET:SD	2.48	0.53
1:AAA:25:SER:O	1:AAA:53[B]:THR:HG21	2.13	0.48
1:BBB:215[A]:ARG:NE	5:BBB:809:HOH:O	2.32	0.48
1:BBB:27[B]:MET:CE	1:BBB:207:THR:HA	2.44	0.47
1:AAA:18:LEU:CD1	1:AAA:27[B]:MET:HE3	2.45	0.47
1:AAA:29:LEU:HB2	1:AAA:53[B]:THR:HG22	1.97	0.46
1:BBB:114[A]:THR:HG23	5:BBB:998:HOH:O	2.15	0.46
1:BBB:1[B]:MET:HE2	5:BBB:958:HOH:O	2.15	0.45
1:AAA:136:ARG:CG	1:AAA:136:ARG:HH21	2.29	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:BBB:216:PHE:O	1:BBB:219[A]:ILE:HG22	2.17	0.44
1:AAA:216:PHE:O	1:AAA:219[B]:ILE:HG22	2.17	0.43
1:BBB:27[A]:MET:SD	1:AAA:209:PRO:HG3	2.59	0.42
1:AAA:29:LEU:HB2	1:AAA:53[B]:THR:CG2	2.50	0.42
1:AAA:18:LEU:HD13	1:AAA:27[B]:MET:CE	2.51	0.40

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)
5:BBB:1036:HOH:O	5:AAA:406:HOH:O[4_556]	2.02	0.18
5:BBB:952:HOH:O	5:BBB:986:HOH:O[4_556]	2.08	0.12

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	AAA	240/222 (108%)	233 (97%)	6 (2%)	1 (0%)	34	14
1	BBB	237/222 (107%)	228 (96%)	7 (3%)	2 (1%)	19	4
All	All	477/444 (107%)	461 (97%)	13 (3%)	3 (1%)	22	7

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	AAA	20	SER
1	BBB	20	SER
1	BBB	43	THR

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	AAA	209/189 (111%)	207 (99%)	2 (1%)	76	57
1	BBB	207/189 (110%)	204 (99%)	3 (1%)	67	41
All	All	416/378 (110%)	411 (99%)	5 (1%)	69	49

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	BBB	93	LEU
1	BBB	106	ASP
1	BBB	129	GLU
1	AAA	93	LEU
1	AAA	136	ARG

Sometimes 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 monosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 5 ligands modelled in this entry, 2 are monoatomic - leaving 3 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	$\#|Z| > 2$
4	EDO	AAA	303	-	3,3,3	0.16	0	2,2,2	0.51	0
2	CIT	BBB	301	-	12,12,12	1.51	1 (8%)	17,17,17	1.38	3 (17%)
2	CIT	AAA	301	-	12,12,12	1.37	2 (16%)	17,17,17	2.27	8 (47%)

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	EDO	AAA	303	-	-	1/1/1/1	-
2	CIT	BBB	301	-	-	2/16/16/16	-
2	CIT	AAA	301	-	-	2/16/16/16	-

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	BBB	301	CIT	C3-C6	2.92	1.56	1.53
2	AAA	301	CIT	O2-C1	2.85	1.40	1.30
2	AAA	301	CIT	C3-C6	2.37	1.55	1.53

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	AAA	301	CIT	O1-C1-C2	-5.19	107.77	122.94
2	AAA	301	CIT	O2-C1-C2	4.02	127.25	114.35
2	BBB	301	CIT	O5-C6-C3	-2.91	118.14	122.25
2	BBB	301	CIT	O6-C6-C3	2.73	117.78	113.05
2	AAA	301	CIT	C2-C3-C6	-2.59	104.53	110.11
2	AAA	301	CIT	O5-C6-C3	-2.56	118.62	122.25
2	AAA	301	CIT	O7-C3-C4	-2.55	103.43	109.40
2	AAA	301	CIT	O3-C5-C4	-2.38	115.98	122.94
2	BBB	301	CIT	O7-C3-C6	2.17	111.91	108.86

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	AAA	301	CIT	O6-C6-C3	2.14	116.76	113.05
2	AAA	301	CIT	C4-C3-C2	2.06	114.54	109.16

There are no chirality outliers.
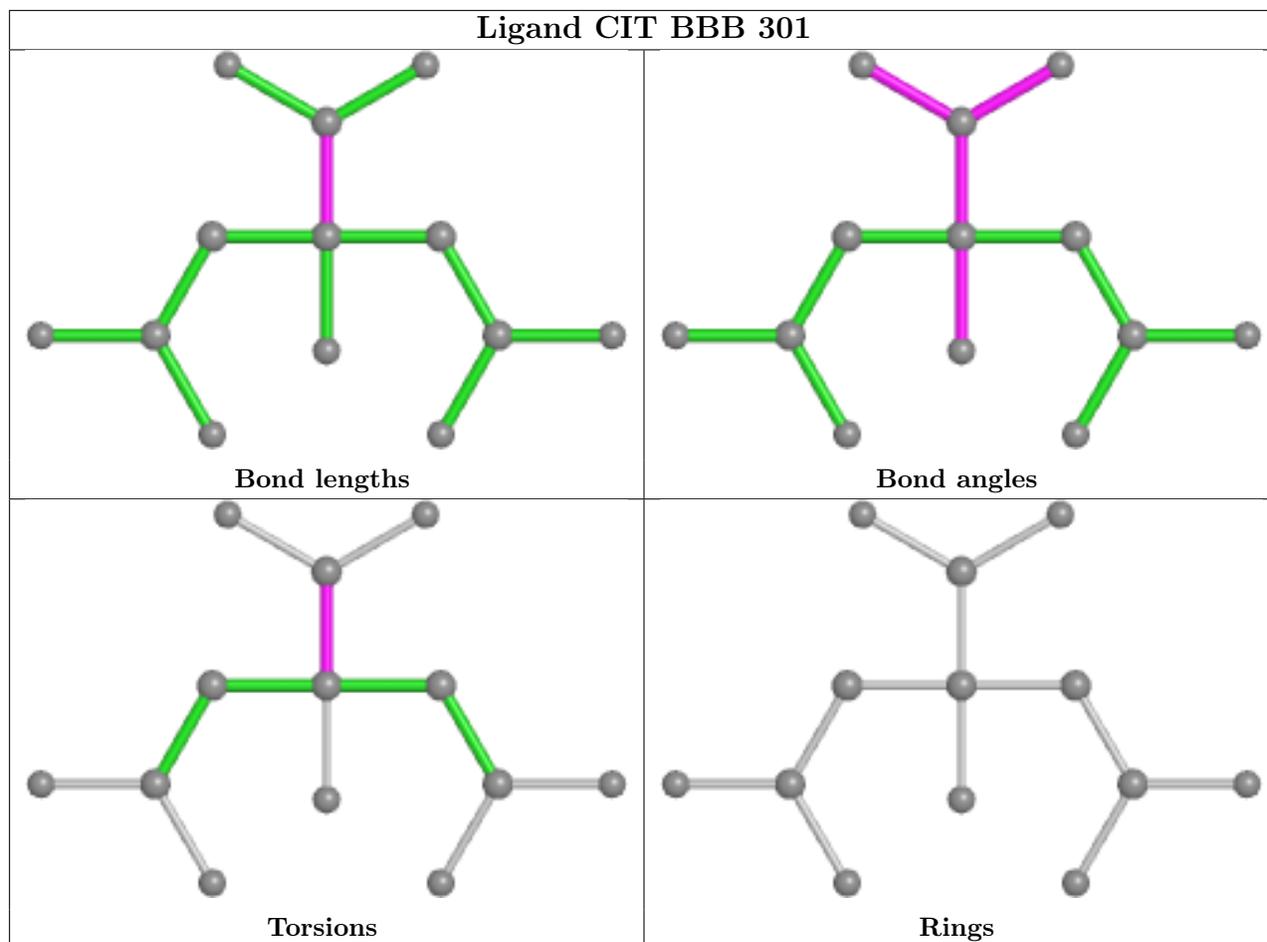
All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	AAA	303	EDO	O1-C1-C2-O2
2	BBB	301	CIT	C2-C3-C6-O6
2	BBB	301	CIT	C4-C3-C6-O6
2	AAA	301	CIT	C3-C4-C5-O3
2	AAA	301	CIT	C3-C4-C5-O4

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	AAA	301	CIT	1	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 then 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.

Ligand CIT BBB 301

Bond lengths

Bond angles

Torsions

Rings

Ligand CIT AAA 301

Bond lengths

Bond angles

Torsions

Rings
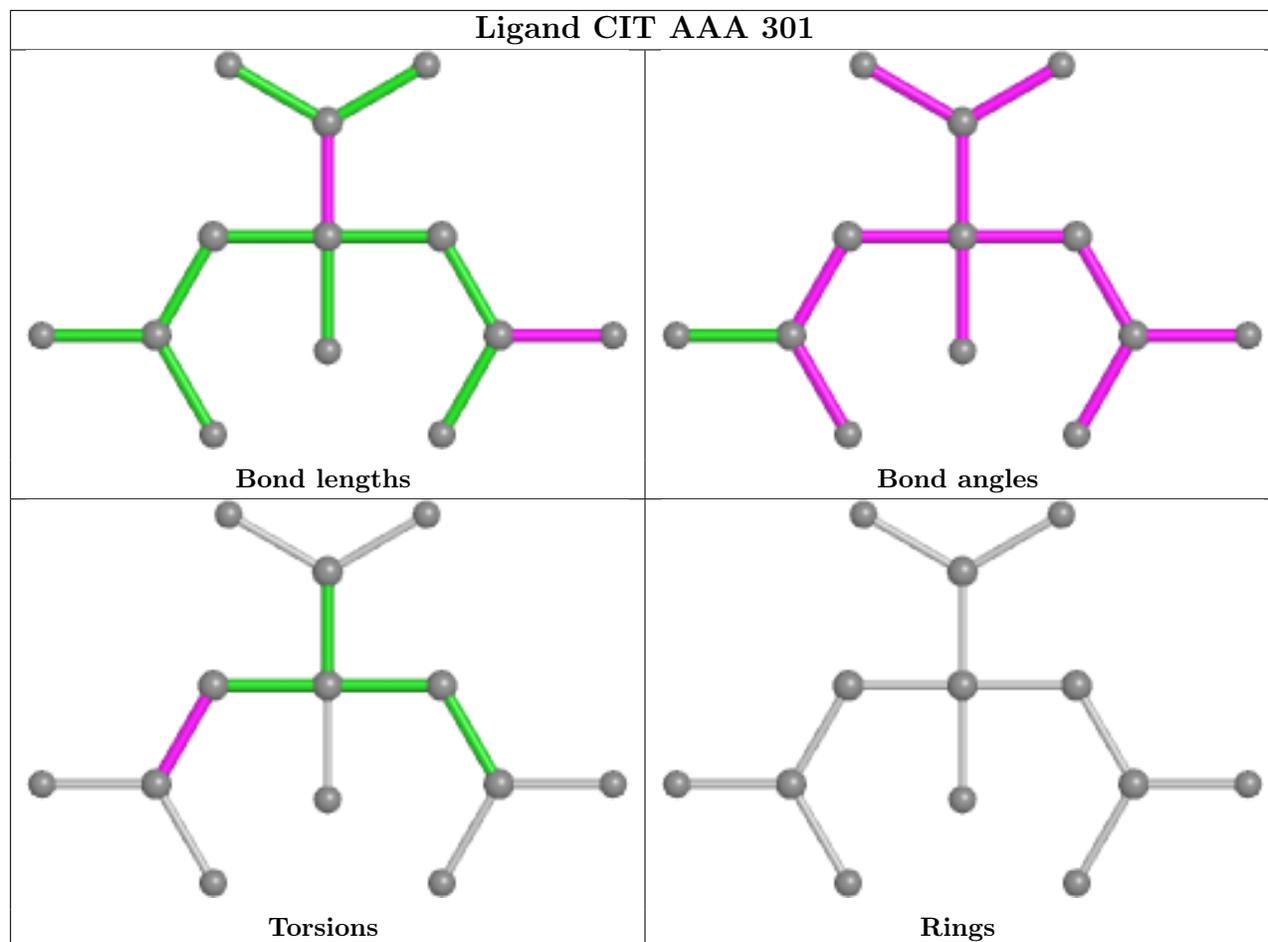
5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

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(Å²)	Q<0.9
1	AAA	222/222 (100%)	0.06	6 (2%)	54	62	13, 18, 32, 47	0
1	BBB	222/222 (100%)	0.05	5 (2%)	60	66	12, 18, 29, 55	0
All	All	444/444 (100%)	0.06	11 (2%)	57	64	12, 18, 32, 55	0

All (11) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	BBB	68	HIS	3.7
1	AAA	97	LEU	3.3
1	BBB	222	ASP	2.9
1	AAA	222	ASP	2.8
1	BBB	171	GLN	2.8
1	BBB	114[A]	THR	2.5
1	BBB	111	TYR	2.4
1	AAA	68	HIS	2.4
1	AAA	67	ASP	2.4
1	AAA	155	GLY	2.2
1	AAA	22[A]	PHE	2.1

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

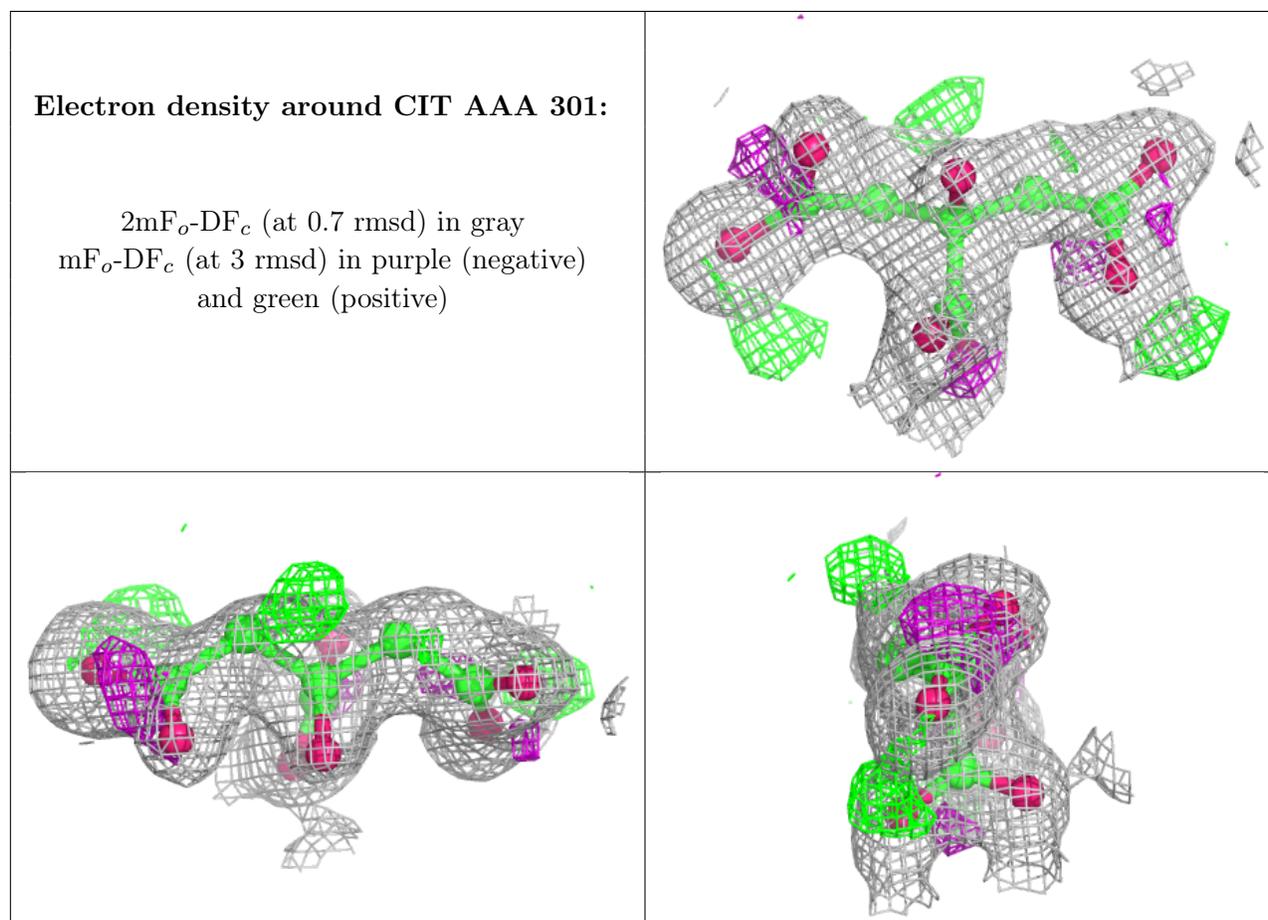There are no non-standard protein/DNA/RNA residues in this entry.

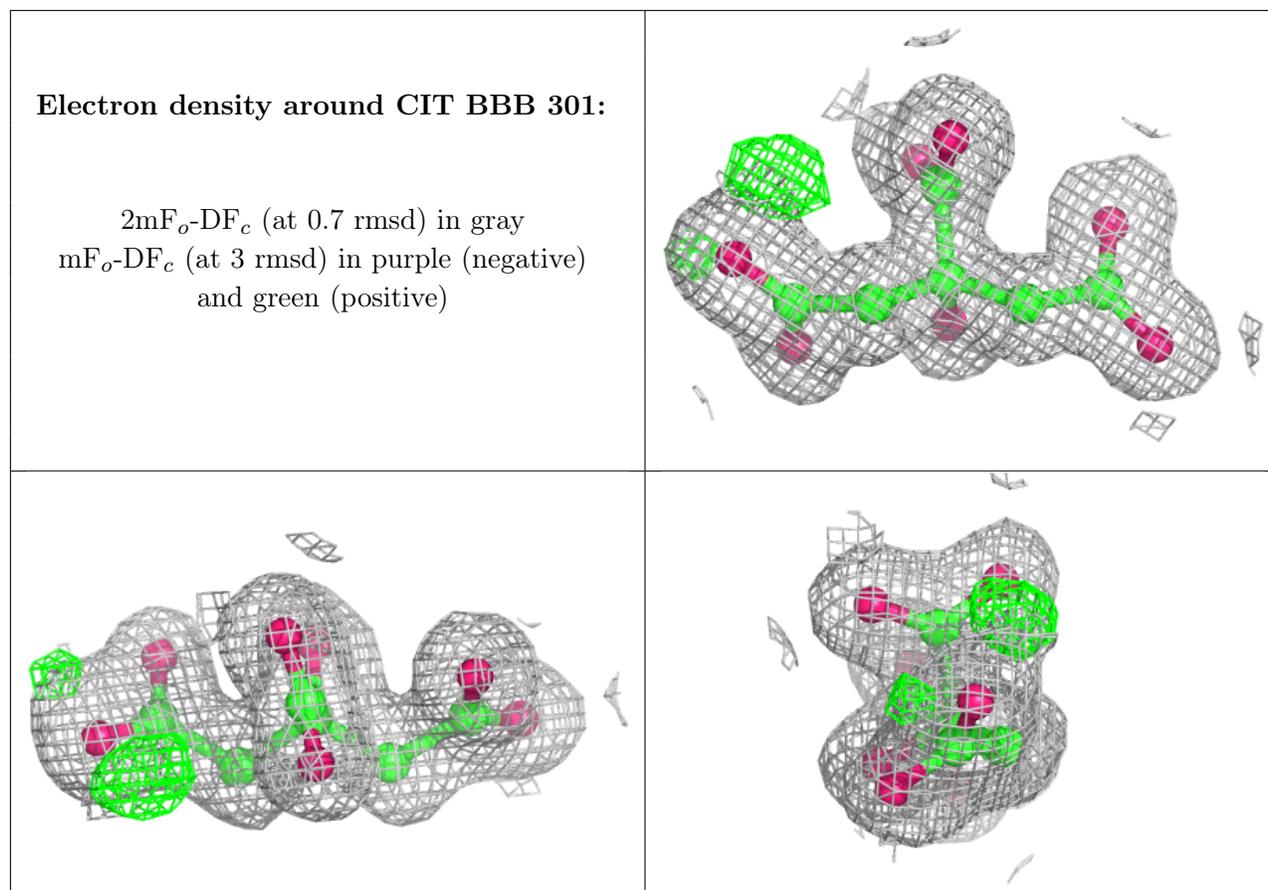## 6.3 Carbohydrates ⓘ

There are no monosaccharides 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, 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	B-factors(Å^2)	Q<0.9
4	EDO	AAA	303	4/4	0.76	0.11	50,52,52,55	0
2	CIT	AAA	301	13/13	0.88	0.12	19,33,37,39	0
2	CIT	BBB	301	13/13	0.95	0.09	18,20,24,26	0
3	CL	AAA	302	1/1	0.99	0.06	17,17,17,17	0
3	CL	BBB	302	1/1	0.99	0.06	20,20,20,20	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around CIT AAA 301:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative) and green (positive)

Electron density around CIT BBB 301:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

6.5 Other polymers (i)

There are no such residues in this entry.