



# Full wwPDB X-ray Structure Validation Report ⓘ

Mar 30, 2026 – 04:19 PM EDT

PDB ID : 9O9P / pdb\_00009o9p  
Title : Structure of wild type full-length Streptococcus mutans GtfD (GTF-S)  
Authors : Schormann, N.; Deivanayagam, C.  
Deposited on : 2025-04-18  
Resolution : 2.25 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](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.

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  
Xtrriage (Phenix) : 2.0  
EDS : 3.0  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
CCP4 : 9.0.010 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.48.1

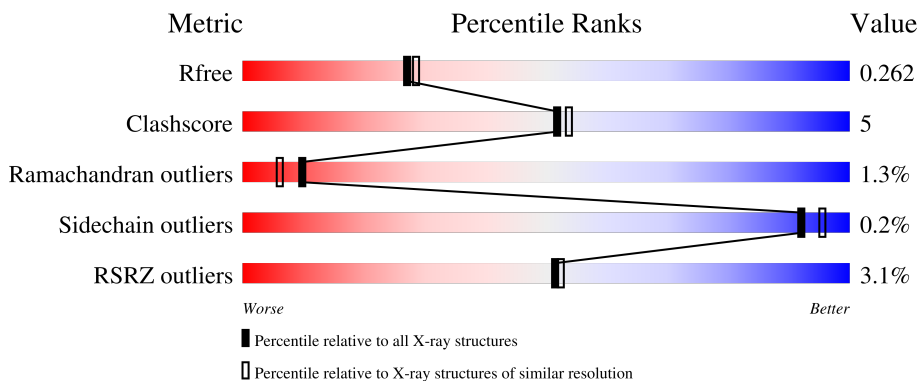
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.25 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))
$R_{free}$	164625	1763 (2.26-2.26)
Clashscore	180529	1919 (2.26-2.26)
Ramachandran outliers	177936	1884 (2.26-2.26)
Sidechain outliers	177891	1885 (2.26-2.26)
RSRZ outliers	164620	1763 (2.26-2.26)

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  $\geq 3$ , 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	1438	

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 10314 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 Glucosyltransferase-S.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	1275	9935	6216	1706	1993	20	0	0	0

There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	33	MET	-	expression tag	UNP P49331
A	34	ALA	-	expression tag	UNP P49331
A	1463	LEU	-	expression tag	UNP P49331
A	1464	GLU	-	expression tag	UNP P49331
A	1465	HIS	-	expression tag	UNP P49331
A	1466	HIS	-	expression tag	UNP P49331
A	1467	HIS	-	expression tag	UNP P49331
A	1468	HIS	-	expression tag	UNP P49331
A	1469	HIS	-	expression tag	UNP P49331
A	1470	HIS	-	expression tag	UNP P49331

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	Ca	0	0
			1	1		

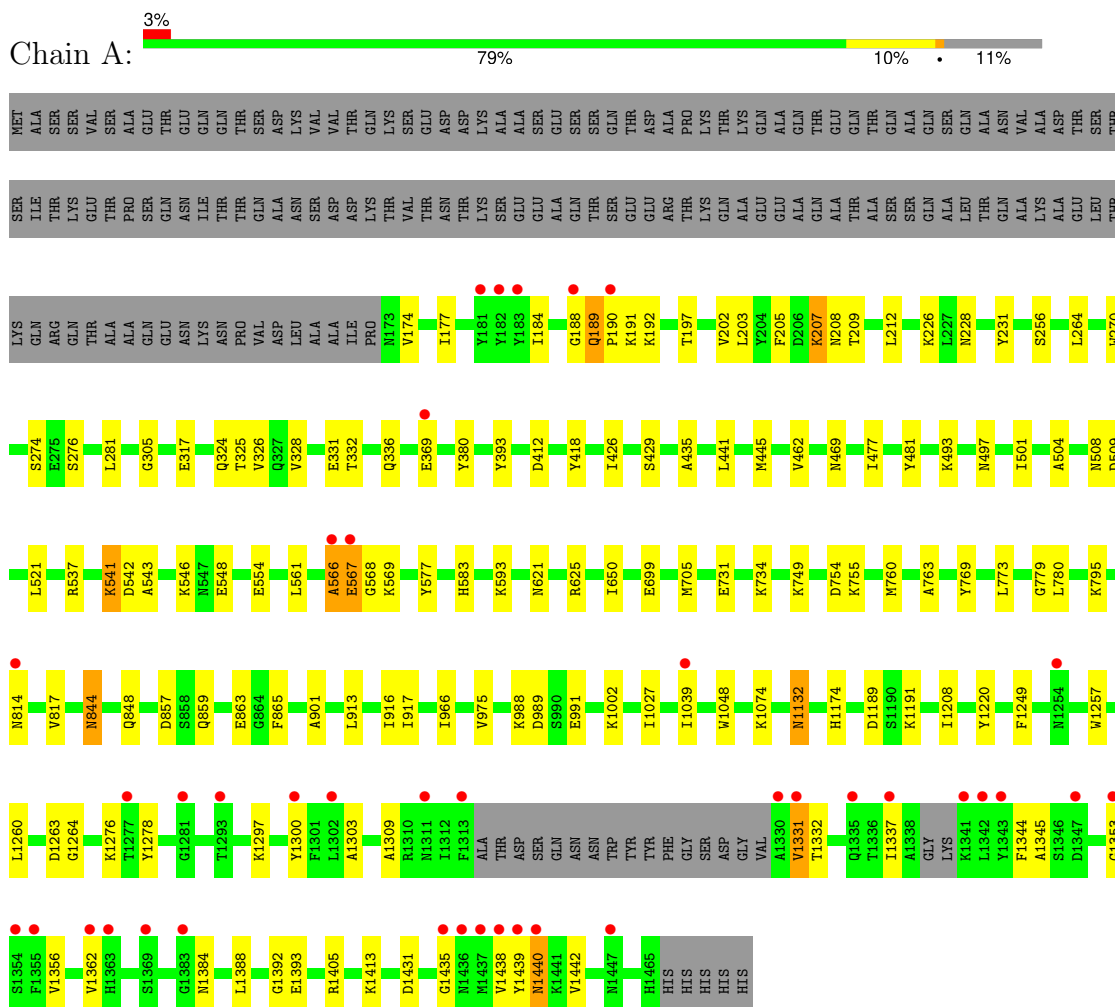
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	378	Total	O	0	0
			378	378		

### 3 Residue-property plots

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: Glucosyltransferase-S



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	78.11Å 94.83Å 174.72Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.97 – 2.25 19.97 – 2.25	Depositor EDS
% Data completeness (in resolution range)	98.1 (19.97-2.25) 97.9 (19.97-2.25)	Depositor EDS
$R_{merge}$	0.10	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.82 (at 2.26Å)	Xtrriage
Refinement program	PHENIX (1.18.2_3874)	Depositor
R, $R_{free}$	0.207 , 0.263 0.208 , 0.262	Depositor DCC
$R_{free}$ test set	3042 reflections (4.88%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	42.6	Xtrriage
Anisotropy	0.058	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.29 , 25.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	10314	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	48.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.29% 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 [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section:  
CA

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	0.28	0/10133	0.50	1/13726 (0.0%)

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	567	GLU	N-CA-C	-5.76	108.05	114.62

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	A	9935	0	9389	96	0
2	A	1	0	0	0	0
3	A	378	0	0	6	0
All	All	10314	0	9389	96	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 5.

All (96) 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:1438:VAL:HG23	1:A:1439:TYR:CD2	2.00	0.97
1:A:1438:VAL:HG23	1:A:1439:TYR:HD2	1.36	0.89
1:A:779:GLY:CA	1:A:814:ASN:HD22	2.00	0.75
1:A:189:GLN:O	1:A:191:LYS:N	2.21	0.73
1:A:814:ASN:OD1	1:A:817:VAL:N	2.24	0.71
1:A:537:ARG:HD2	1:A:548:GLU:HG3	1.73	0.70
1:A:988:LYS:HD3	1:A:989:ASP:HB2	1.79	0.65
1:A:795:LYS:NZ	3:A:1607:HOH:O	2.32	0.63
1:A:779:GLY:O	1:A:814:ASN:ND2	2.33	0.62
1:A:226:LYS:HE2	1:A:228:ASN:HB2	1.81	0.62
1:A:493:LYS:HE3	1:A:497:ASN:OD1	2.01	0.61
1:A:779:GLY:C	1:A:814:ASN:HD22	2.10	0.60
1:A:779:GLY:HA2	1:A:814:ASN:HD22	1.67	0.59
1:A:779:GLY:C	1:A:814:ASN:ND2	2.61	0.58
1:A:332:THR:O	1:A:336:GLN:HG2	2.03	0.58
1:A:1309:ALA:HB2	3:A:1949:HOH:O	2.03	0.57
1:A:177:ILE:H	1:A:188:GLY:HA2	1.70	0.57
1:A:177:ILE:HD11	1:A:205:PHE:HZ	1.70	0.57
1:A:567:GLU:HG2	1:A:568:GLY:N	2.20	0.57
1:A:913:LEU:HA	1:A:916:ILE:HD12	1.88	0.56
1:A:256:SER:O	1:A:281:LEU:HD23	2.08	0.54
1:A:593:LYS:HD2	3:A:1764:HOH:O	2.07	0.54
1:A:913:LEU:O	1:A:917:ILE:HG12	2.06	0.54
1:A:779:GLY:HA2	1:A:814:ASN:ND2	2.22	0.54
1:A:435:ALA:HB2	1:A:1039:ILE:HG23	1.89	0.53
1:A:369:GLU:N	1:A:1189:ASP:OD2	2.41	0.53
1:A:1132:ASN:N	1:A:1132:ASN:OD1	2.43	0.52
1:A:317:GLU:OE2	1:A:317:GLU:N	2.40	0.52
1:A:844:ASN:ND2	1:A:848:GLN:O	2.41	0.52
1:A:1074:LYS:NZ	3:A:1602:HOH:O	2.21	0.52
1:A:441:LEU:HD11	1:A:445:MET:HE3	1.93	0.51
1:A:991:GLU:OE2	1:A:1174:HIS:NE2	2.36	0.51
1:A:264:LEU:O	1:A:331:GLU:HG2	2.11	0.51
1:A:477:ILE:HG12	1:A:1039:ILE:HD11	1.93	0.51
1:A:504:ALA:HB1	1:A:509:ASP:OD2	2.11	0.50
1:A:305:GLY:HA2	1:A:326:VAL:HG12	1.92	0.50
1:A:369:GLU:HG3	1:A:1189:ASP:CG	2.36	0.50
1:A:779:GLY:CA	1:A:814:ASN:ND2	2.71	0.50
1:A:412:ASP:HB3	1:A:508:ASN:ND2	2.27	0.50
1:A:426:ILE:HD11	1:A:966:ILE:HD11	1.93	0.50
1:A:274:SER:O	1:A:276:SER:N	2.41	0.49
1:A:177:ILE:HD11	1:A:205:PHE:CZ	2.47	0.49

*Continued on next page...*

*Continued from previous page...*

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:481:TYR:HA	1:A:1027:ILE:HD11	1.95	0.49
1:A:380:TYR:CE1	1:A:975:VAL:HG21	2.48	0.48
1:A:1405:ARG:HD2	1:A:1438:VAL:HG22	1.95	0.48
1:A:857:ASP:OD1	3:A:1601:HOH:O	2.20	0.48
1:A:543:ALA:O	1:A:546:LYS:HE2	2.13	0.48
1:A:567:GLU:N	1:A:567:GLU:OE1	2.47	0.48
1:A:1276:LYS:N	1:A:1276:LYS:HD3	2.28	0.48
1:A:541:LYS:HD2	1:A:541:LYS:H	1.79	0.47
1:A:1191:LYS:HD2	1:A:1220:TYR:CG	2.49	0.47
1:A:197:THR:HG22	1:A:202:VAL:HG22	1.97	0.46
1:A:1249:PHE:HB3	1:A:1257:TRP:CE3	2.51	0.46
1:A:1438:VAL:CG2	1:A:1439:TYR:CD2	2.88	0.46
1:A:1332:THR:HA	1:A:1337:ILE:HA	1.98	0.46
1:A:393:TYR:O	1:A:429:SER:OG	2.34	0.45
1:A:760:MET:HE2	1:A:769:TYR:CE2	2.51	0.45
1:A:1431:ASP:H	1:A:1435:GLY:HA2	1.81	0.45
1:A:1263:ASP:HB2	3:A:1681:HOH:O	2.17	0.45
1:A:1362:VAL:HG21	1:A:1393:GLU:HG2	1.98	0.45
1:A:1276:LYS:O	1:A:1303:ALA:HA	2.15	0.45
1:A:426:ILE:HD11	1:A:966:ILE:CD1	2.46	0.45
1:A:1278:TYR:HB2	1:A:1297:LYS:HE2	1.98	0.44
1:A:754:ASP:O	1:A:755:LYS:HD3	2.17	0.44
1:A:865:PHE:CG	1:A:901:ALA:HB2	2.53	0.44
1:A:773:LEU:HD22	1:A:780:LEU:HG	2.00	0.44
1:A:1002:LYS:HA	1:A:1048:TRP:O	2.17	0.44
1:A:1388:LEU:HD12	1:A:1392:GLY:O	2.18	0.44
1:A:734:LYS:HE3	1:A:763:ALA:O	2.17	0.44
1:A:192:LYS:HB3	1:A:207:LYS:O	2.19	0.43
1:A:542:ASP:OD1	1:A:542:ASP:N	2.31	0.43
1:A:1260:LEU:HB3	1:A:1264:GLY:HA2	2.00	0.43
1:A:418:TYR:O	1:A:469:ASN:HA	2.19	0.43
1:A:325:THR:O	1:A:328:VAL:HG22	2.18	0.43
1:A:1276:LYS:HE2	1:A:1276:LYS:HB2	1.78	0.43
1:A:566:ALA:C	1:A:569:LYS:HG2	2.43	0.43
1:A:501:ILE:HD13	1:A:521:LEU:HB2	1.99	0.42
1:A:203:LEU:HB3	1:A:212:LEU:HD11	2.01	0.42
1:A:1249:PHE:HB3	1:A:1257:TRP:CZ3	2.54	0.42
1:A:264:LEU:HB2	1:A:270:TRP:CZ3	2.54	0.42
1:A:705:MET:HE2	1:A:749:LYS:H	1.84	0.42
1:A:561:LEU:HD23	1:A:561:LEU:HA	1.95	0.41
1:A:583:HIS:N	1:A:863:GLU:OE2	2.49	0.41

*Continued on next page...*

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:554:GLU:H	1:A:554:GLU:CD	2.28	0.41
1:A:621:ASN:O	1:A:625:ARG:HG2	2.20	0.41
1:A:1431:ASP:N	1:A:1435:GLY:HA2	2.35	0.41
1:A:566:ALA:HB3	1:A:567:GLU:OE1	2.20	0.41
1:A:445:MET:CE	1:A:462:VAL:HB	2.51	0.41
1:A:501:ILE:HG23	1:A:577:TYR:CZ	2.56	0.41
1:A:208:ASN:O	1:A:209:THR:OG1	2.34	0.40
1:A:650:ILE:HD13	1:A:859:GLN:HB2	2.04	0.40
1:A:1384:ASN:HB3	1:A:1413:LYS:HG3	2.03	0.40
1:A:731:GLU:O	1:A:734:LYS:HG2	2.21	0.40
1:A:1440:ASN:O	1:A:1442:VAL:HG23	2.22	0.40
1:A:231:TYR:CD2	1:A:324:GLN:HG2	2.56	0.40
1:A:1439:TYR:O	1:A:1440:ASN:HB2	2.21	0.40

There are no symmetry-related clashes.

## 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	1269/1438 (88%)	1179 (93%)	73 (6%)	17 (1%)	<b>10</b> <b>6</b>

All (17) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	174	VAL
1	A	190	PRO
1	A	184	ILE
1	A	541	LYS
1	A	1208	ILE
1	A	207	LYS
1	A	566	ALA
1	A	1300	TYR

Continued on next page...

*Continued from previous page...*

Mol	Chain	Res	Type
1	A	844	ASN
1	A	1132	ASN
1	A	1345	ALA
1	A	1353	GLY
1	A	1356	VAL
1	A	1440	ASN
1	A	1344	PHE
1	A	189	GLN
1	A	1331	VAL

### 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	1036/1216 (85%)	1034 (100%)	2 (0%)	<a href="#">92</a> <a href="#">95</a>

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	699	GLU
1	A	1331	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (9) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	316	GLN
1	A	336	GLN
1	A	397	ASN
1	A	588	GLN
1	A	848	GLN
1	A	994	ASN
1	A	1032	GLN
1	A	1144	ASN
1	A	1366	HIS

### 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 oligosaccharides in this entry.

### 5.6 Ligand geometry [i](#)

Of 1 ligands modelled in this entry, 1 is monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

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

### 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<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	1275/1438 (88%)	-0.15	40 (3%) 51 52	30, 45, 79, 97	0

All (40) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1330	ALA	5.9
1	A	1331	VAL	4.4
1	A	1438	VAL	4.1
1	A	1353	GLY	3.9
1	A	190	PRO	3.8
1	A	1439	TYR	3.7
1	A	1343	TYR	3.4
1	A	1354	SER	3.4
1	A	566	ALA	3.2
1	A	1437	MET	3.2
1	A	188	GLY	3.1
1	A	1355	PHE	3.1
1	A	1039	ILE	2.9
1	A	1337	ILE	2.8
1	A	1277	THR	2.7
1	A	1293	THR	2.7
1	A	814	ASN	2.7
1	A	1342	LEU	2.6
1	A	1363	HIS	2.6
1	A	1313	PHE	2.5
1	A	181	TYR	2.5
1	A	183	TYR	2.5
1	A	1369	SER	2.5
1	A	182	TYR	2.5
1	A	1362	VAL	2.3
1	A	1300	TYR	2.3
1	A	369	GLU	2.3

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type	RSRZ
1	A	1347	ASP	2.2
1	A	1281	GLY	2.2
1	A	567	GLU	2.2
1	A	1447	ASN	2.2
1	A	1335	GLN	2.2
1	A	1302	LEU	2.2
1	A	1435	GLY	2.1
1	A	1254	ASN	2.1
1	A	1440	ASN	2.1
1	A	1311	ASN	2.1
1	A	1383	GLY	2.0
1	A	1436	ASN	2.0
1	A	1341	LYS	2.0

## 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](#)

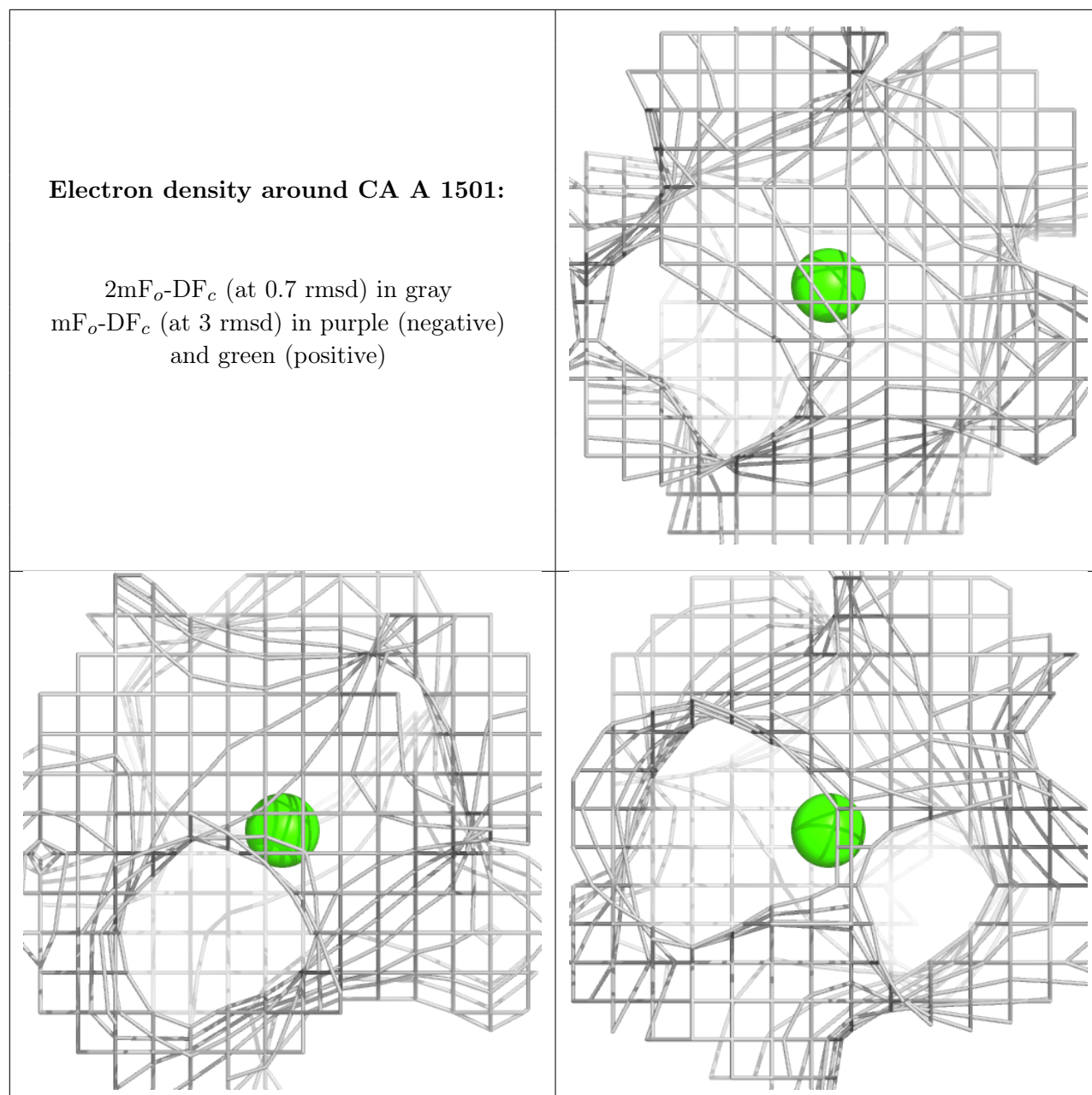
There are no oligosaccharides in this entry.

## 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
2	CA	A	1501	1/1	0.99	0.02	39,39,39,39	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.



## 6.5 Other polymers [i](#)

There are no such residues in this entry.