WORLDWIDE PDB PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report ⓘ

Dec 12, 2022 – 03:29 pm GMT

PDB ID	:	7QFK
Title	:	Crystal structure of S-layer protein SlpX from Lactobacillus acidophilus, domain II, Co-Crystallization with HgCl2, Mutation Ser316Cys (aa 194-362)
Authors	:	Sagmeister, T.; Pavkov-Keller, T.; Buhlheller, C.
Deposited on	:	2021-12-06
Resolution	:	2.48 Å(reported)

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

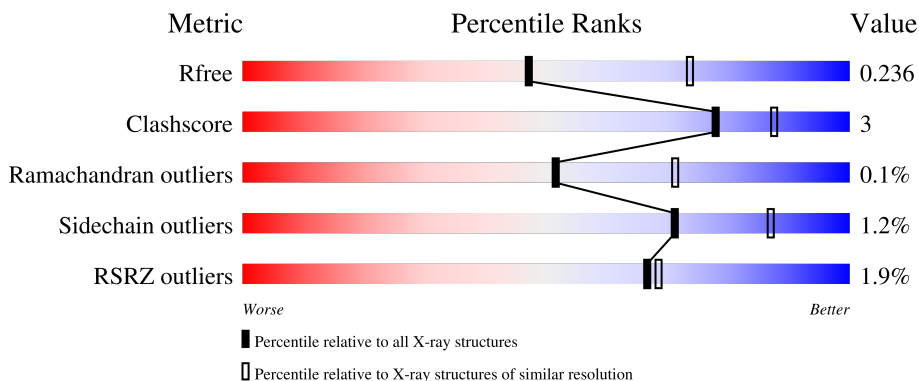|		
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.31.3
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0267
CCP4	:	7.1.010 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.31.3

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 2.48 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	Percentile Ranks	Value
Rfree		0.236
Clashscore		3
Ramachandran outliers		0.1%
Sidechain outliers		1.2%
RSRZ outliers		1.9%

Worse — *Better*

▌ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	5857 (2.50-2.46)
Clashscore	141614	6594 (2.50-2.46)
Ramachandran outliers	138981	6469 (2.50-2.46)
Sidechain outliers	138945	6471 (2.50-2.46)
RSRZ outliers	127900	5738 (2.50-2.46)

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	A	189	2% / 86% / 6% / 8%
1	B	189	83% / 7% · 9%
1	C	189	% / 89% · 7%
1	D	189	4% / 89% ·· 6%

2   Entry composition ⓘ

There are 6 unique types of molecules in this entry. The entry contains 5552 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 SlpX.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	174	Total	C	N	O	S	0	0	0
			1305	798	224	282	1			
1	B	172	Total	C	N	O	S	0	0	0
			1293	792	221	279	1			
1	C	175	Total	C	N	O	S	0	0	0
			1313	802	225	285	1			
1	D	178	Total	C	N	O	S	0	0	0
			1342	821	232	288	1			

There are 44 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	182	MET	-	initiating methionine	UNP Q5FLN0
A	183	GLY	-	expression tag	UNP Q5FLN0
A	316	CYS	SER	engineered mutation	UNP Q5FLN0
A	363	LEU	-	expression tag	UNP Q5FLN0
A	364	GLU	-	expression tag	UNP Q5FLN0
A	365	HIS	-	expression tag	UNP Q5FLN0
A	366	HIS	-	expression tag	UNP Q5FLN0
A	367	HIS	-	expression tag	UNP Q5FLN0
A	368	HIS	-	expression tag	UNP Q5FLN0
A	369	HIS	-	expression tag	UNP Q5FLN0
A	370	HIS	-	expression tag	UNP Q5FLN0
B	182	MET	-	initiating methionine	UNP Q5FLN0
B	183	GLY	-	expression tag	UNP Q5FLN0
B	316	CYS	SER	engineered mutation	UNP Q5FLN0
B	363	LEU	-	expression tag	UNP Q5FLN0
B	364	GLU	-	expression tag	UNP Q5FLN0
B	365	HIS	-	expression tag	UNP Q5FLN0
B	366	HIS	-	expression tag	UNP Q5FLN0
B	367	HIS	-	expression tag	UNP Q5FLN0
B	368	HIS	-	expression tag	UNP Q5FLN0
B	369	HIS	-	expression tag	UNP Q5FLN0

Continued on next page...

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
B	370	HIS	-	expression tag	UNP Q5FLN0
C	182	MET	-	initiating methionine	UNP Q5FLN0
C	183	GLY	-	expression tag	UNP Q5FLN0
C	316	CYS	SER	engineered mutation	UNP Q5FLN0
C	363	LEU	-	expression tag	UNP Q5FLN0
C	364	GLU	-	expression tag	UNP Q5FLN0
C	365	HIS	-	expression tag	UNP Q5FLN0
C	366	HIS	-	expression tag	UNP Q5FLN0
C	367	HIS	-	expression tag	UNP Q5FLN0
C	368	HIS	-	expression tag	UNP Q5FLN0
C	369	HIS	-	expression tag	UNP Q5FLN0
C	370	HIS	-	expression tag	UNP Q5FLN0
D	182	MET	-	initiating methionine	UNP Q5FLN0
D	183	GLY	-	expression tag	UNP Q5FLN0
D	316	CYS	SER	engineered mutation	UNP Q5FLN0
D	363	LEU	-	expression tag	UNP Q5FLN0
D	364	GLU	-	expression tag	UNP Q5FLN0
D	365	HIS	-	expression tag	UNP Q5FLN0
D	366	HIS	-	expression tag	UNP Q5FLN0
D	367	HIS	-	expression tag	UNP Q5FLN0
D	368	HIS	-	expression tag	UNP Q5FLN0
D	369	HIS	-	expression tag	UNP Q5FLN0
D	370	HIS	-	expression tag	UNP Q5FLN0

- Molecule 2 is 4-(2-HYDROXYETHYL)-1-PIPERAZINE ETHANESULFONIC ACID (three-letter code: EPE) (formula: $C_8H_{18}N_2O_4S$).
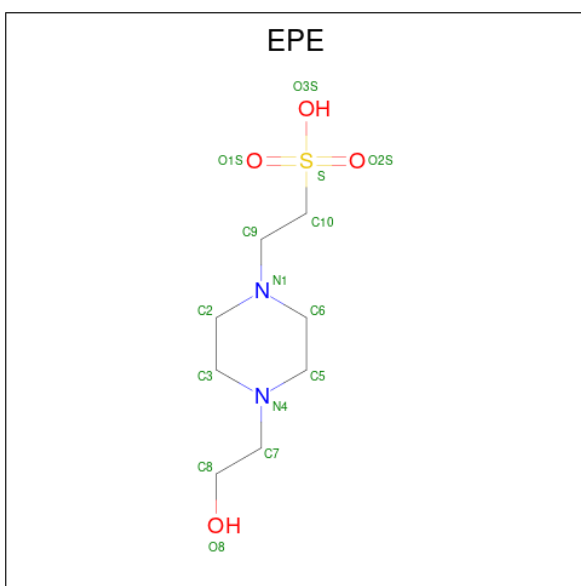
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total 15	C 8	N 2	O 4	S 1	0	0
2	B	1	Total 15	C 8	N 2	O 4	S 1	0	0

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

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total 1	Cl 1	0	0
3	B	1	Total 1	Cl 1	0	0

- Molecule 4 is BROMIDE ION (three-letter code: BR) (formula: Br).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total 1	Br 1	0	0
4	B	1	Total 1	Br 1	0	0
4	C	1	Total 1	Br 1	0	0
4	D	1	Total 1	Br 1	0	0

- Molecule 5 is MERCURY (II) ION (three-letter code: HG) (formula: Hg) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	C	1	Total 1	Hg 1	0	0
5	D	1	Total 1	Hg 1	0	0

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	78	Total 78	O 78	0	0
6	B	76	Total 76	O 76	0	0
6	C	56	Total 56	O 56	0	0

Continued on next page...

WORLDWIDE
PDB
PROTEIN DATA BANK

Continued from previous page...

| Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	D	51	Total O 51 51		0	0

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.
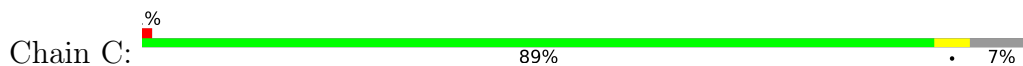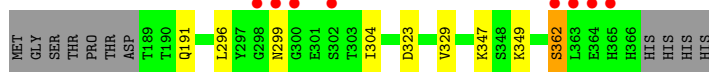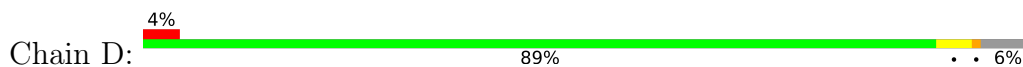
• Molecule 1: SlpX

Chain A:

• Molecule 1: SlpX

Chain B:

• Molecule 1: SlpX

Chain C:

• Molecule 1: SlpX

Chain D:
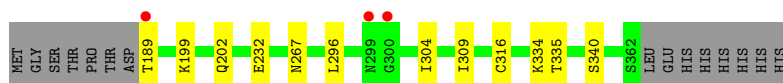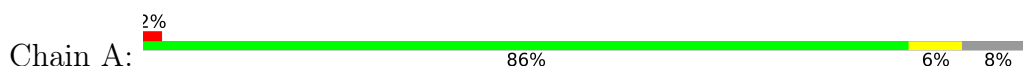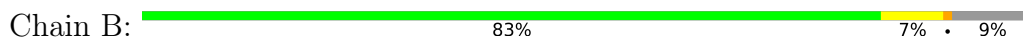
4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	63.17Å 98.88Å 155.13Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.98 – 2.48 48.98 – 2.48	Depositor EDS
% Data completeness (in resolution range)	99.6 (48.98-2.48) 99.6 (48.98-2.48)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.08 (at 2.48Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.202 , 0.231 0.207 , 0.236	Depositor DCC
R_{free} test set	1749 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å^2)	42.4	Xtriage
Anisotropy	0.363	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	(Not available) , (Not available)	EDS
L-test for twinning[2]	$< |L| > = 0.46, < L^2 > = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	5552	wwPDB-VP
Average B, all atoms (Å^2)	47.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 16.28% of the height of the origin peak. No significant pseudotranslation is detected.*

---

[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: EPE, CL, BR, HG

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	0.66	0/1325	0.76	0/1806
1	B	0.66	0/1312	0.78	0/1787
1	C	0.64	0/1333	0.76	0/1817
1	D	0.62	0/1364	0.79	1/1859 (0.1%)
All	All	0.64	0/5334	0.77	1/7269 (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

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	D	323	ASP	CB-CG-OD1	6.70	124.33	118.30

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	B	361	THR	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	1305	0	1249	12	0
1	B	1293	0	1239	11	0
1	C	1313	0	1253	4	0
1	D	1342	0	1280	4	0
2	A	15	0	18	3	0
2	B	15	0	17	2	0
3	A	1	0	0	1	0
3	B	1	0	0	1	0
4	A	1	0	0	0	0
4	B	1	0	0	0	0
4	C	1	0	0	0	0
4	D	1	0	0	0	0
5	C	1	0	0	0	0
5	D	1	0	0	0	0
6	A	78	0	0	2	0
6	B	76	0	0	1	0
6	C	56	0	0	0	0
6	D	51	0	0	1	0
All	All	5552	0	5056	30	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 3.

The worst 5 of 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:B:267:ASN:HD21	2:B:401:EPE:H91	1.27	0.98
1:A:232:GLU:OE2	6:A:501:HOH:O	2.08	0.70
1:A:335:THR:HG22	1:A:340:SER:HA	1.84	0.59
1:A:189:THR:N	6:A:503:HOH:O	2.36	0.58
1:B:232:GLU:OE1	6:B:501:HOH:O	2.17	0.56

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	172/189 (91%)	167 (97%)	5 (3%)	0	100	100
1	B	168/189 (89%)	164 (98%)	4 (2%)	0	100	100
1	C	173/189 (92%)	169 (98%)	4 (2%)	0	100	100
1	D	176/189 (93%)	171 (97%)	4 (2%)	1 (1%)	25	40
All	All	689/756 (91%)	671 (97%)	17 (2%)	1 (0%)	51	71

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	D	362	SER

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	151/165 (92%)	150 (99%)	1 (1%)	84	93
1	B	150/165 (91%)	147 (98%)	3 (2%)	55	77
1	C	152/165 (92%)	151 (99%)	1 (1%)	84	93
1	D	155/165 (94%)	153 (99%)	2 (1%)	69	86
All	All	608/660 (92%)	601 (99%)	7 (1%)	71	87

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

Mol	Chain	Res	Type
1	B	322	LYS
1	C	316	CYS
1	D	347	LYS
1	D	299	ASN
1	B	295	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	275	ASN
1	C	267	ASN
1	D	220	ASN
1	C	332	GLN
1	A	353	ASN

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 10 ligands modelled in this entry, 8 are monoatomic - leaving 2 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	$\#\|Z\| > 2$
2	EPE	B	401	-	15,15,15	0.96	1 (6%)	18,20,20	1.33	2 (11%)
2	EPE	A	401	-	15,15,15	0.53	0	18,20,20	0.73	0

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	EPE	B	401	-	-	2/9/19/19	0/1/1/1
2	EPE	A	401	-	-	3/9/19/19	0/1/1/1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	401	EPE	O2S-S	3.47	1.55	1.45

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	401	EPE	O2S-S-C10	-3.61	102.56	106.92
2	B	401	EPE	O3S-S-O1S	3.44	119.67	111.27

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	401	EPE	C8-C7-N4-C5
2	A	401	EPE	S-C10-C9-N1
2	B	401	EPE	S-C10-C9-N1
2	B	401	EPE	N4-C7-C8-O8
2	A	401	EPE	N4-C7-C8-O8

There are no ring outliers.

2 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	401	EPE	2	0
2	A	401	EPE	3	0

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 (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, 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	174/189 (92%)	-0.15	3 (1%)	70	71	28, 41, 68, 96	0
1	B	172/189 (91%)	-0.10	0	100	100	30, 42, 79, 99	0
1	C	175/189 (92%)	-0.18	2 (1%)	80	82	30, 44, 72, 100	0
1	D	178/189 (94%)	-0.07	8 (4%)	33	35	33, 49, 80, 123	0
All	All	699/756 (92%)	-0.13	13 (1%)	66	68	28, 44, 79, 123	0

The worst 5 of 13 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	299	ASN	3.2
1	C	299	ASN	3.0
1	D	363	LEU	2.9
1	D	300	GLY	2.8
1	A	299	ASN	2.6

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

There are no non-standard protein/DNA/RNA residues in this entry.
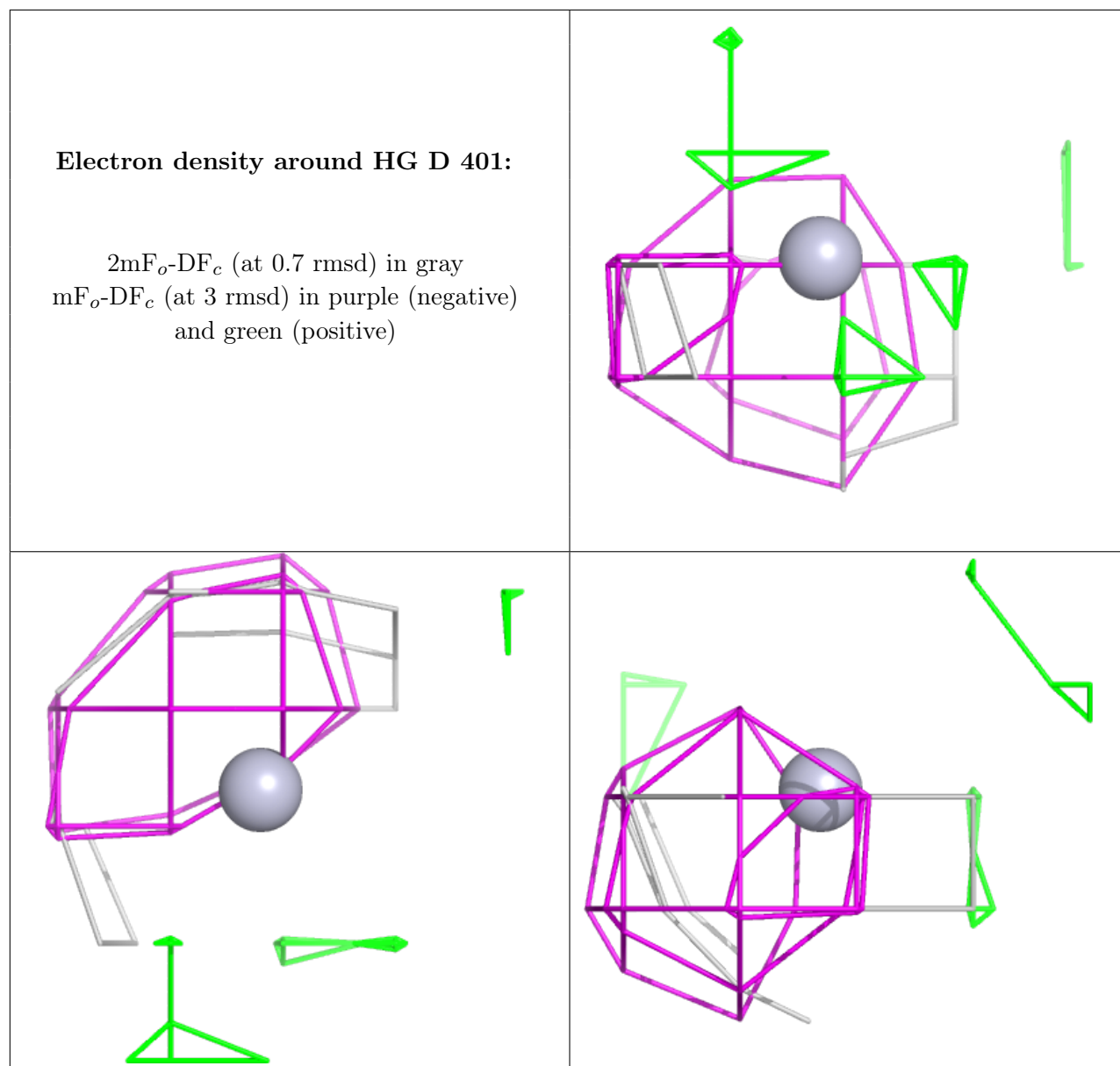
6.3 Carbohydrates (i)
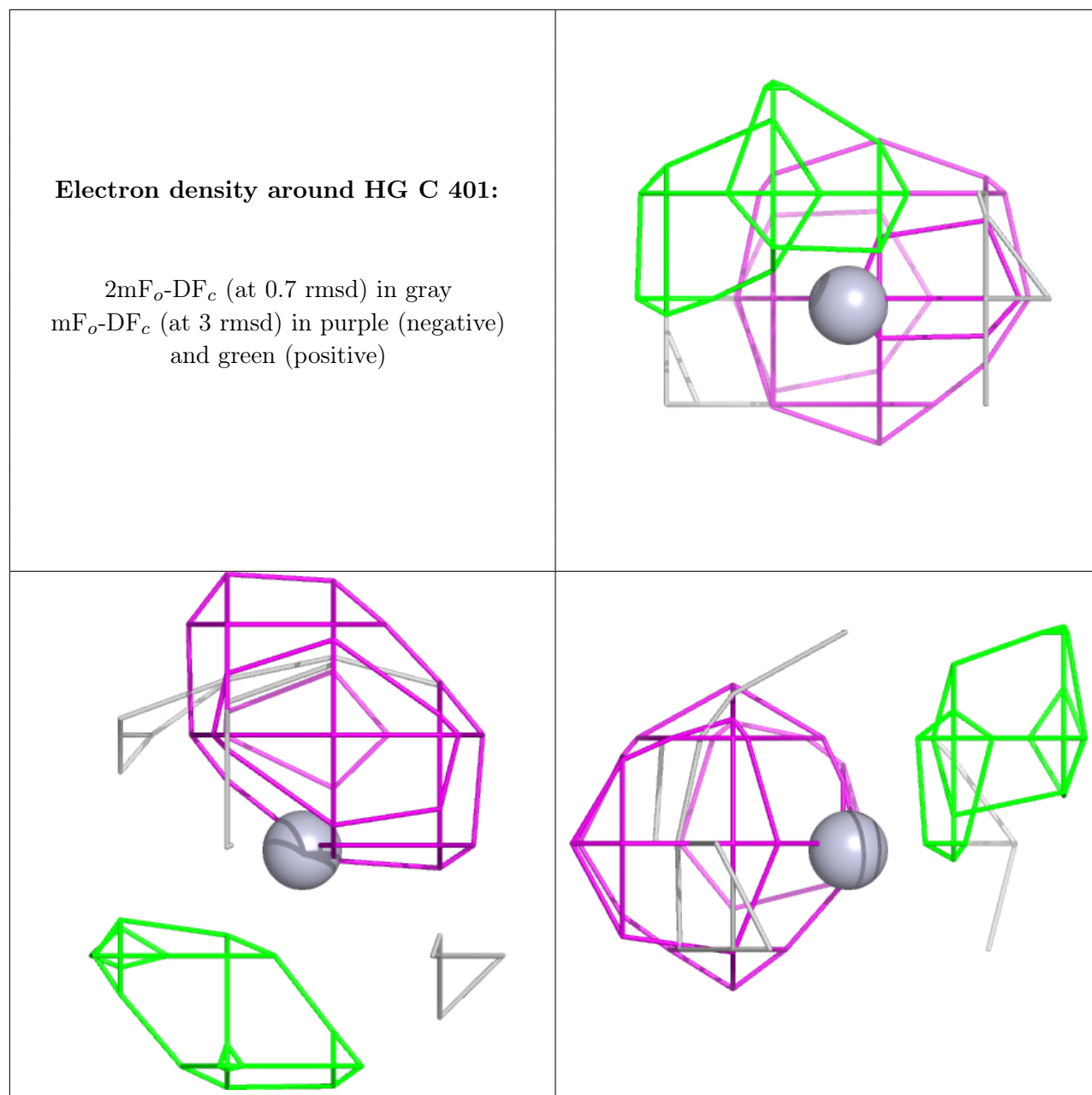
There are no monosaccharides in this entry.

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
5	HG	D	401	1/1	0.65	0.10	49,49,49,49	1
3	CL	B	402	1/1	0.74	0.10	65,65,65,65	0
2	EPE	A	401	15/15	0.77	0.33	53,60,71,71	15
2	EPE	B	401	15/15	0.77	0.35	53,63,81,86	15
5	HG	C	401	1/1	0.86	0.11	43,43,43,43	1
3	CL	A	402	1/1	0.89	0.10	60,60,60,60	0
4	BR	B	403	1/1	0.97	0.10	37,37,37,37	1
4	BR	D	402	1/1	0.97	0.09	49,49,49,49	1
4	BR	C	402	1/1	0.98	0.09	41,41,41,41	1
4	BR	A	403	1/1	0.98	0.09	40,40,40,40	1

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 HG D 401:

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

Electron density around HG C 401:

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

6.5 Other polymers ⓘ

There are no such residues in this entry.