



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 10, 2026 – 09:41 AM UTC

PDB ID : 7AIY / pdb_00007aiy
Title : Crystal structure of human butyrylcholinesterase in complex with 2-{1-[4-(12-Amino-3-chloro-6,7,10,11-tetrahydro-7,11-methanocycloocta[b]quinolin-9-yl)butyl]-1H-1,2,3-triazol-4-yl}-N-[4-hydroxy-3-methoxybenzyl]acetamide
Authors : Coquelle, N.; Colletier, J.P.
Deposited on : 2020-09-28
Resolution : 2.94 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 ⓘ 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
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
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)	:	2.49

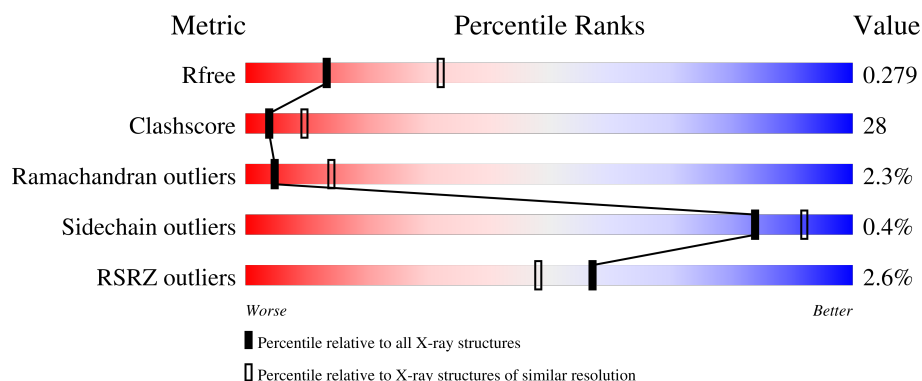
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.94 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}	180053	1159 (2.96-2.92)
Clashscore	190562	1184 (2.96-2.92)
Ramachandran outliers	187476	1131 (2.96-2.92)
Sidechain outliers	187428	1131 (2.96-2.92)
RSRZ outliers	180081	1159 (2.96-2.92)

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 $\leq 5\%$. 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	602	
1	B	602	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

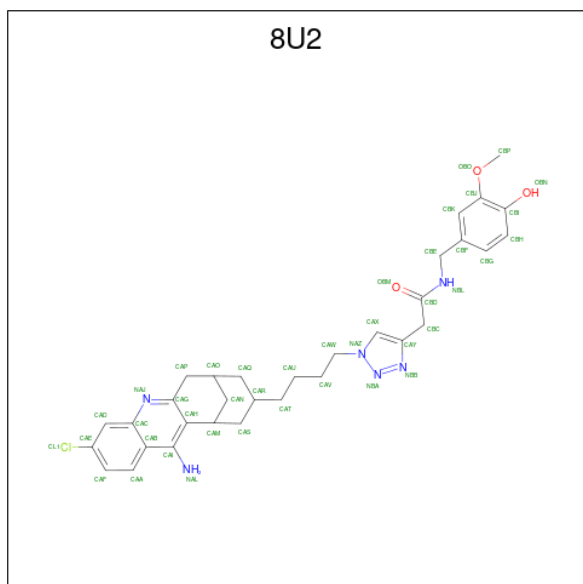
Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	8U2	A	601	X	-	-	-

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 Cholinesterase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	527	Total 4228	C 2725	N 714	O 774	S 15	5	5	0
1	B	527	Total 4228	C 2725	N 714	O 774	S 15	5	5	0

- Molecule 2 is 2-{1-[4-(12-Amino-3-chloro-6,7,10,11-tetrahydro-7,11-methanocycloocta[b]quinolin-9-yl)butyl]-1H-1,2,3-triazol-4-yl}-N-[4-hydroxy-3-methoxybenzyl]acetamide (CCD ID: 8U2) (formula: $C_{32}H_{37}ClN_6O_3$) (labeled as "Ligand of Interest" by depositor).

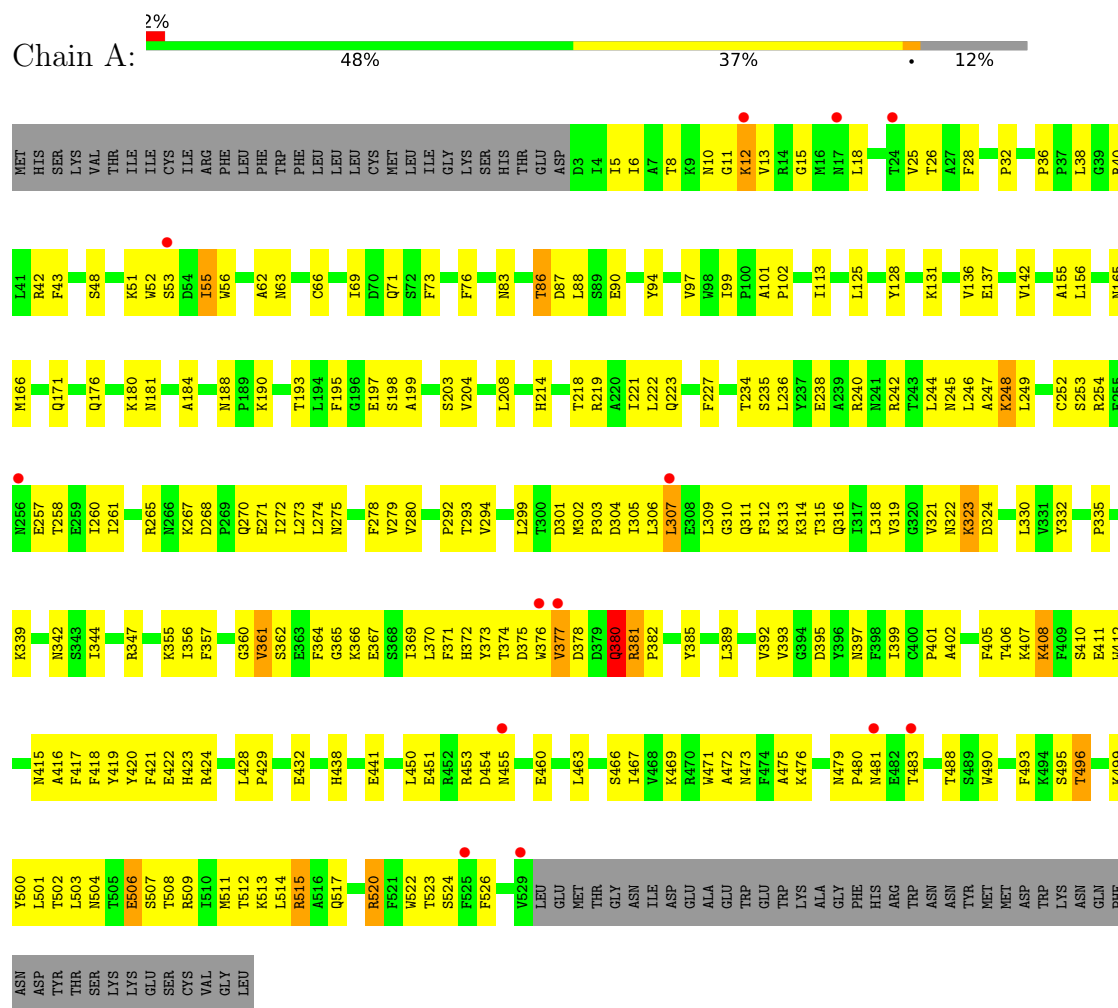


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	Cl	N	O	0	0
			42	32	1	6	3		

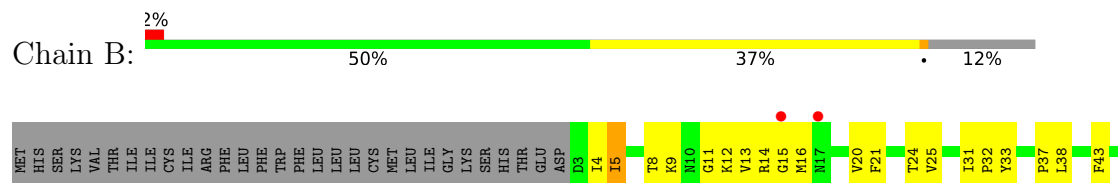
3 Residue-property plots

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: Cholinesterase



• Molecule 1: Cholinesterase



R520	F521	W522	T523	S524	F525	F526	F527	K528	V529	LEU	GLU	MET	THR	GLY	ASN	ILE	ASP	GLU	ALA	GLU	TRP	TRP	GLU	TRP	LYS	ALA	GLY	PHE	HIS	ARG	TRP	ASN	ASN	TYR	MET	MET	ASP	TRP	LYS	ASN	GLN	PHE	ASN	ASP	TYR	THR	SER	LYS	LYS	GLU	SER	CYS	VAL	GLY	LEU																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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L49	T50	K51	W52	S53	D54	I55	W56	N57	A58	T59	N63	S64	G65	C66	Q67	N68	I69	F76	H77	G78	M81	P84	S89	L93	Y94	T99	P100	A101	P102	F103	P104	K105	I111	G116	G117	F118	Q119	T122	S123	K131	R135	V136	E137	N145	Y146	R147																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	73.88Å 79.32Å 228.71Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.87 – 2.94 48.87 – 2.94	Depositor EDS
% Data completeness (in resolution range)	91.3 (48.87-2.94) 81.0 (48.87-2.94)	Depositor EDS
R_{merge}	0.14	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	0.70 (at 2.96Å)	Xtriage
Refinement program	PHENIX 1.10.1_2155	Depositor
R, R_{free}	0.225 , 0.300 (Not available) , 0.279	Depositor DCC
R_{free} test set	1358 reflections (5.03%)	wwPDB-VP
Wilson B-factor (Å ²)	63.2	Xtriage
Anisotropy	0.462	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 52.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	8498	wwPDB-VP
Average B, all atoms (Å ²)	76.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.40% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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: 8U2

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	0.60	5/4357 (0.1%)	0.89	14/5918 (0.2%)
1	B	0.50	0/4357	0.86	8/5918 (0.1%)
All	All	0.55	5/8714 (0.1%)	0.88	22/11836 (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
1	A	0	1
1	B	0	2
All	All	0	3

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	520	ARG	NE-CZ	-10.35	1.21	1.33
1	A	520	ARG	CZ-NH2	-8.64	1.22	1.33
1	A	520	ARG	CD-NE	-8.26	1.34	1.46
1	A	520	ARG	CZ-NH1	-8.25	1.21	1.32
1	A	36	PRO	C-N	-5.50	1.21	1.33

The worst 5 of 22 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	53	SER	N-CA-C	11.66	125.18	110.61
1	A	55	ILE	CG1-CB-CG2	-9.15	83.24	110.70
1	A	53	SER	N-CA-C	9.00	123.82	112.03
1	B	53	SER	CA-C-N	8.81	137.56	121.70

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	B	53	SER	C-N-CA	8.81	137.56	121.70

There are no chirality outliers.

All (3) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	155	ALA	Peptide
1	B	155	ALA	Peptide
1	B	481	ASN	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	4228	0	4122	257	1
1	B	4228	0	4125	219	1
2	A	42	0	0	5	0
All	All	8498	0	8247	473	1

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 28.

The worst 5 of 473 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:38:LEU:HD21	1:A:90:GLU:HB2	1.32	1.05
1:B:5:ILE:HD11	1:B:14:ARG:HA	1.37	1.05
1:B:428:LEU:HD23	1:B:430:TRP:H	1.18	1.04
1:B:369:ILE:HG22	1:B:521:PHE:CZ	1.93	1.02
1:B:369:ILE:HG22	1:B:521:PHE:HZ	1.24	0.96

All (1) 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:520:ARG:NH1	1:B:375[B]:ASP:OD1[3_455]	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	169/602 (28%)	147 (87%)	15 (9%)	7 (4%)	2	5
1	B	530/602 (88%)	482 (91%)	39 (7%)	9 (2%)	7	20
All	All	699/1204 (58%)	629 (90%)	54 (8%)	16 (2%)	5	14

5 of 16 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	380	GLN
1	B	51	LYS
1	B	361	VAL
1	B	496	THR
1	B	506	GLU

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	456/521 (88%)	454 (100%)	2 (0%)	84	92
1	B	456/521 (88%)	454 (100%)	2 (0%)	84	92
All	All	912/1042 (88%)	908 (100%)	4 (0%)	84	92

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	48	SER
1	A	86	THR
1	B	81	MET
1	B	252	CYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 12 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	172	GLN
1	B	351	GLN
1	B	498	GLN
1	B	415	ASN
1	B	10	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](#)

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](#)

1 ligand is 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	8U2	A	601	-	47,47,47	3.14	16 (34%)	60,67,67	4.16	33 (55%)

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	8U2	A	601	-	3/3/4/5	8/18/38/38	0/7/6/6

The worst 5 of 16 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	601	8U2	NAZ-NBA	11.64	1.53	1.34
2	A	601	8U2	CAG-NAJ	10.06	1.44	1.32
2	A	601	8U2	CAI-CAB	-5.53	1.37	1.44
2	A	601	8U2	CAH-CAM	-5.33	1.43	1.51
2	A	601	8U2	CBE-CBF	-4.64	1.41	1.51

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	601	8U2	CAM-CAN-CAO	-9.86	76.04	110.60
2	A	601	8U2	CAH-CAG-NAJ	-9.37	119.54	123.65
2	A	601	8U2	CAI-CAB-CAC	8.66	123.06	118.23
2	A	601	8U2	CAX-NAZ-NBA	-7.94	103.02	110.75
2	A	601	8U2	CAF-CAE-CL1	-7.72	107.97	119.36

All (3) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
2	A	601	8U2	CAM
2	A	601	8U2	CAO
2	A	601	8U2	CAR

5 of 8 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	601	8U2	CAU-CAV-CAW-NAZ
2	A	601	8U2	CBK-CBJ-OBO-CBP
2	A	601	8U2	CAQ-CAR-CAT-CAU

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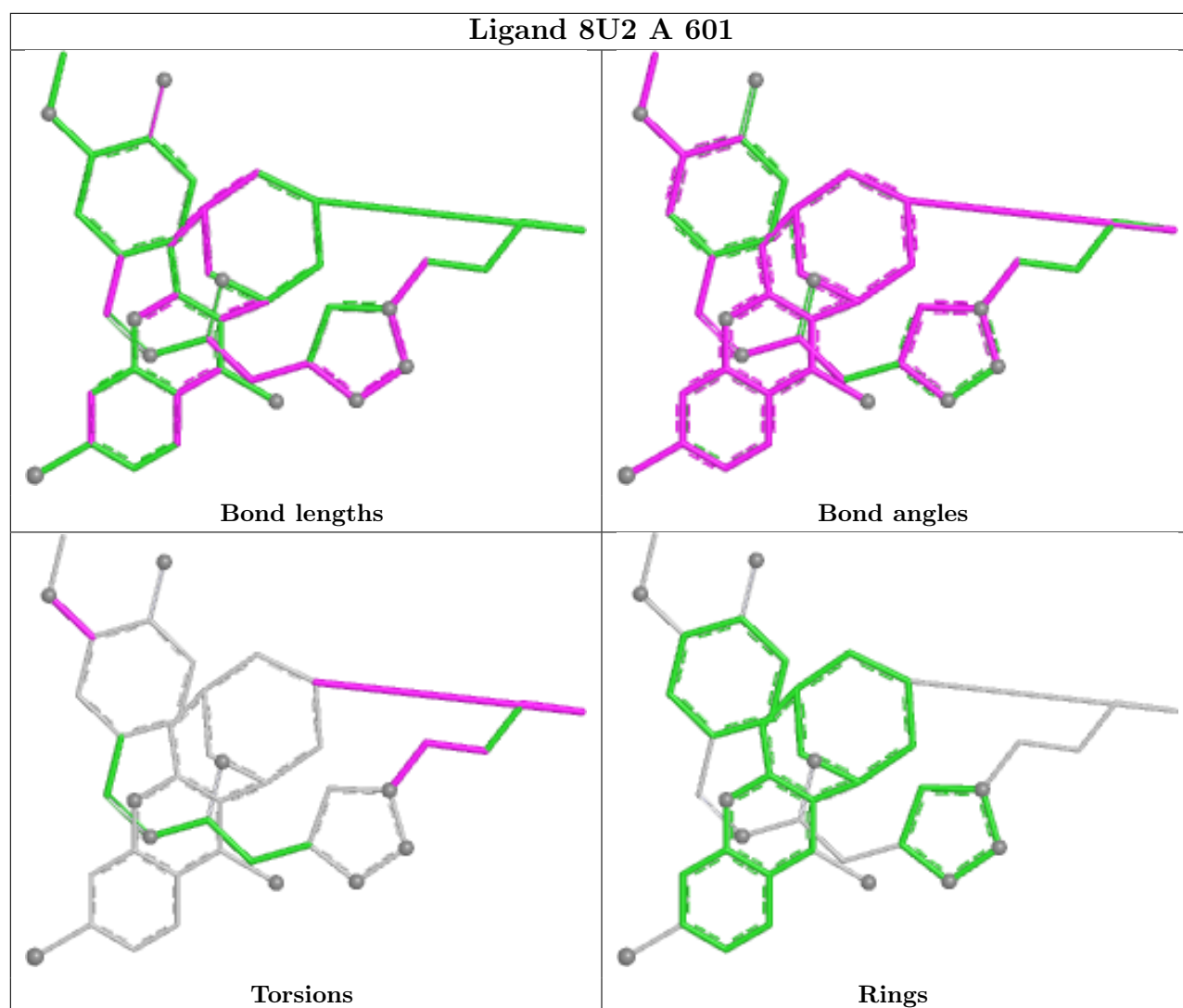
Mol	Chain	Res	Type	Atoms
2	A	601	8U2	CBI-CBJ-OBO-CBP
2	A	601	8U2	CAS-CAR-CAT-CAU

There are no ring outliers.

1 monomer is involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	601	8U2	5	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 than 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.



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, 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	527/602 (87%)	0.24	13 (2%)	58 49	38, 74, 102, 127	11 (2%)
1	B	527/602 (87%)	0.17	14 (2%)	56 47	34, 72, 102, 136	10 (1%)
All	All	1054/1204 (87%)	0.21	27 (2%)	57 48	34, 74, 102, 136	21 (1%)

The worst 5 of 27 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	481	ASN	5.9
1	A	525	PHE	3.9
1	A	481	ASN	3.8
1	A	529	VAL	3.7
1	B	529	VAL	3.6

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](#)

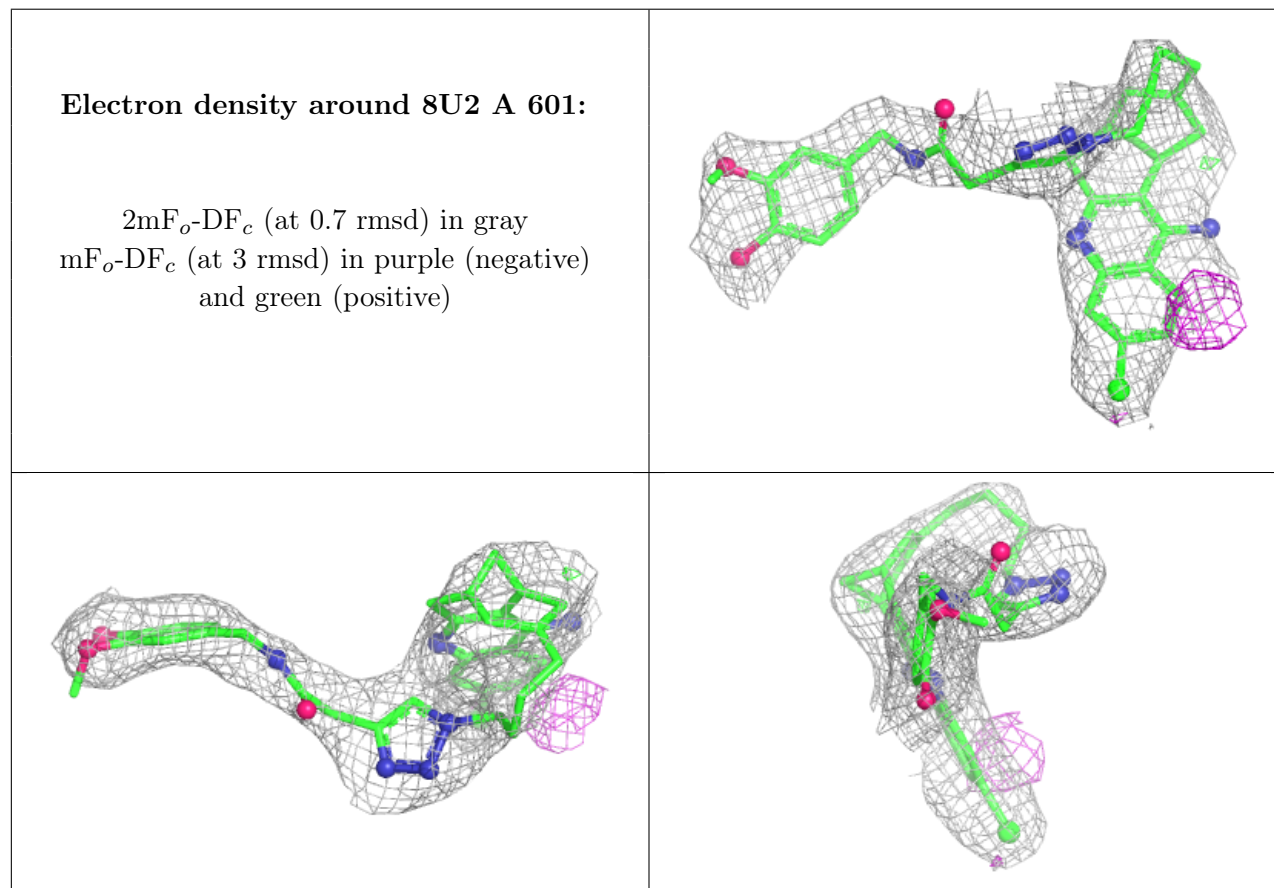
There are no oligosaccharides in this entry.

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, 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($\text{\AA}^2$)	Q<0.9
2	8U2	A	601	42/42	0.88	0.12	59,76,90,91	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.