



# Full wwPDB X-ray Structure Validation Report ⓘ

May 18, 2020 – 03:46 am BST

PDB ID : 4I6H  
Title : Selective & Brain-Permeable Polo-like Kinase-2 (Plk-2) Inhibitors that Reduce  
alpha-Synuclein Phosphorylation in Rat Brain  
Authors : Pan, H.  
Deposited on : 2012-11-29  
Resolution : 1.91 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.

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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  
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) : 2.11

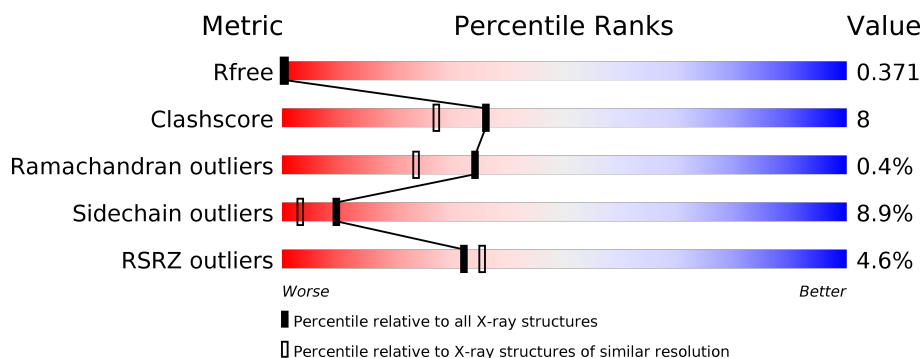
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.91 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	7937 (1.94-1.90)
Clashscore	141614	8644 (1.94-1.90)
Ramachandran outliers	138981	8530 (1.94-1.90)
Sidechain outliers	138945	8530 (1.94-1.90)
RSRZ outliers	127900	7793 (1.94-1.90)

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	308	<div> <div>4%</div> <div> <div></div> <div>70%</div> <div>19%</div> <div>•</div> <div>7%</div> </div> </div>

## 2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2503 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.

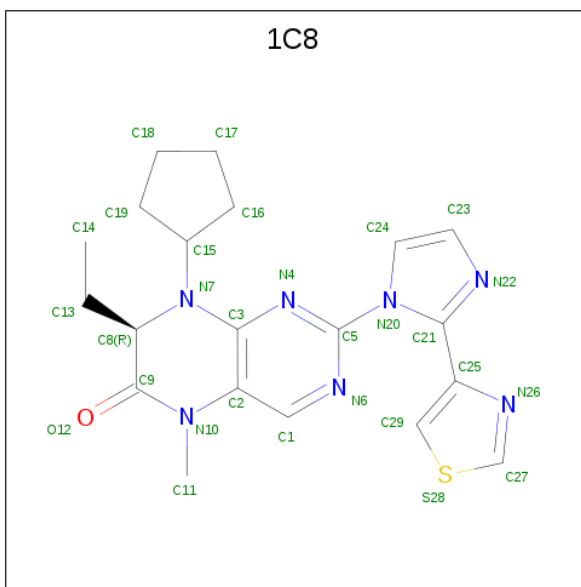
- Molecule 1 is a protein called Serine/threonine-protein kinase PLK2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	285	Total	C	N	O	S	0	1	0
			2340	1487	424	416	13			

There are 11 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	53	MET	-	INITIATING METHIONINE	UNP Q9NYY3
A	54	MET	-	EXPRESSION TAG	UNP Q9NYY3
A	55	HIS	-	EXPRESSION TAG	UNP Q9NYY3
A	56	HIS	-	EXPRESSION TAG	UNP Q9NYY3
A	83	SER	CYS	ENGINEERED MUTATION	UNP Q9NYY3
A	87	THR	VAL	ENGINEERED MUTATION	UNP Q9NYY3
A	119	SER	ALA	ENGINEERED MUTATION	UNP Q9NYY3
A	216	SER	ALA	ENGINEERED MUTATION	UNP Q9NYY3
A	259	ALA	CYS	ENGINEERED MUTATION	UNP Q9NYY3
A	291	SER	CYS	ENGINEERED MUTATION	UNP Q9NYY3
A	335	THR	LEU	ENGINEERED MUTATION	UNP Q9NYY3

- Molecule 2 is (7R)-8-cyclopentyl-7-ethyl-5-methyl-2-[2-(1,3-thiazol-4-yl)-1H-imidazol-1-yl]-7,8-dihydropteridin-6(5H)-one (three-letter code: 1C8) (formula: C<sub>20</sub>H<sub>23</sub>N<sub>7</sub>OS).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	S	0	0
			29	20	7	1	1		

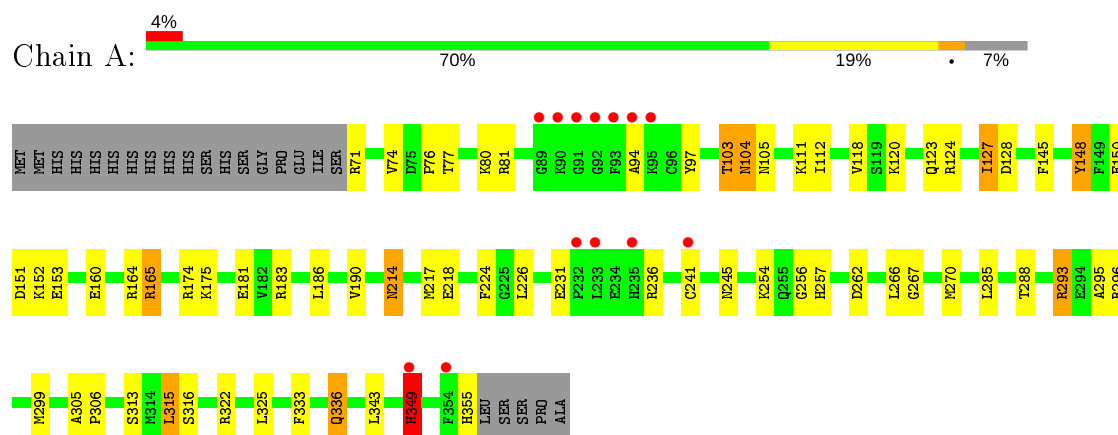
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	134	Total	O	0	0
			134	134		

### 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: Serine/threonine-protein kinase PLK2



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	104.75Å 60.85Å 53.39Å 90.00° 107.36° 90.00°	Depositor
Resolution (Å)	51.99 – 1.91 51.98 – 1.91	Depositor EDS
% Data completeness (in resolution range)	84.8 (51.99-1.91) 84.8 (51.98-1.91)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.19 (at 1.91Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.296 , 0.351 0.311 , 0.371	Depositor DCC
$R_{free}$ test set	1067 reflections (5.01%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	20.6	Xtriage
Anisotropy	0.320	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 38.9	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.51$ , $\langle L^2 \rangle = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.87	EDS
Total number of atoms	2503	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	27.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.92% 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: 1C8

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	0.56	1/2401 (0.0%)	0.83	9/3238 (0.3%)

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	2

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	150	GLU	CB-CG	-6.09	1.40	1.52

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	104	ASN	N-CA-CB	-19.87	74.84	110.60
1	A	165	ARG	NE-CZ-NH2	-10.01	115.29	120.30
1	A	104	ASN	N-CA-C	9.71	137.21	111.00
1	A	349	HIS	CB-CA-C	6.86	124.12	110.40
1	A	165	ARG	NE-CZ-NH1	6.09	123.34	120.30
1	A	224	PHE	C-N-CA	-6.02	109.66	122.30
1	A	224	PHE	CB-CA-C	5.87	122.14	110.40
1	A	293	ARG	C-N-CA	5.59	135.68	121.70
1	A	224	PHE	CA-C-N	5.50	127.21	116.20

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	103	THR	Peptide
1	A	293	ARG	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	2340	0	2349	36	0
2	A	29	0	23	4	0
3	A	134	0	0	1	0
All	All	2503	0	2372	38	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 8.

All (38) 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:164:ARG:HD2	1:A:217:MET:HE2	1.43	1.00
1:A:103:THR:HG22	1:A:104:ASN:N	1.87	0.88
1:A:118:VAL:HG11	1:A:127:ILE:HD11	1.62	0.81
1:A:164:ARG:HD2	1:A:217:MET:CE	2.12	0.79
1:A:164:ARG:CD	1:A:217:MET:HE2	2.14	0.74
1:A:214:ASN:ND2	1:A:218:GLU:H	1.91	0.69
1:A:164:ARG:CD	1:A:217:MET:CE	2.71	0.68
1:A:174:ARG:HD2	1:A:349:HIS:O	1.95	0.67
1:A:336:GLN:HA	1:A:336:GLN:HE21	1.65	0.62
1:A:103:THR:HG22	1:A:104:ASN:H	1.64	0.59
1:A:183:ARG:HD3	1:A:333:PHE:O	2.05	0.57
1:A:236:ARG:HD2	1:A:256:GLY:HA3	1.88	0.54
1:A:174:ARG:CD	1:A:349:HIS:O	2.54	0.54
1:A:305:ALA:HB3	1:A:306:PRO:HD3	1.89	0.53
1:A:214:ASN:HD22	1:A:214:ASN:C	2.12	0.52
1:A:257:HIS:HE1	1:A:262:ASP:OD1	1.92	0.51
1:A:181:GLU:HG2	1:A:343:LEU:HD21	1.91	0.51
1:A:267:GLY:HA3	1:A:315:LEU:HD13	1.93	0.50
1:A:151:ASP:OD1	1:A:151:ASP:C	2.50	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:190:VAL:HG13	1:A:325:LEU:HD22	1.95	0.49
1:A:186:LEU:HD11	1:A:270:MET:HB2	1.94	0.48
1:A:104:ASN:O	1:A:105:ASN:CB	2.61	0.47
1:A:104:ASN:O	1:A:105:ASN:HB3	2.16	0.45
1:A:160:GLU:O	2:A:401:1C8:H19	2.17	0.45
1:A:164:ARG:HD3	1:A:217:MET:CE	2.47	0.45
1:A:165:ARG:HA	2:A:401:1C8:C29	2.47	0.45
1:A:104:ASN:HB2	3:A:509:HOH:O	2.16	0.45
1:A:316:SER:HB2	1:A:322:ARG:HG3	2.00	0.44
1:A:94:ALA:HB2	1:A:111:LYS:HD3	2.00	0.44
1:A:231:GLU:HB2	1:A:236:ARG:HG3	2.00	0.43
1:A:76:PRO:HG2	1:A:151:ASP:HA	2.01	0.43
2:A:401:1C8:H8	2:A:401:1C8:H12	2.00	0.43
1:A:97:TYR:CD1	1:A:112:ILE:HD12	2.54	0.43
1:A:74:VAL:HG22	1:A:81:ARG:HG2	2.01	0.42
1:A:145:PHE:HZ	1:A:148:TYR:HB3	1.83	0.42
2:A:401:1C8:H1	2:A:401:1C8:H19	1.81	0.42
1:A:120:LYS:HB2	1:A:123:GLN:HG2	2.02	0.40
1:A:226:LEU:HD22	1:A:241:CYS:SG	2.61	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	284/308 (92%)	266 (94%)	17 (6%)	1 (0%)	34 24

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	295	ALA

### 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	258 / 278 (93%)	235 (91%)	23 (9%)	9 3

All (23) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	71	ARG
1	A	77	THR
1	A	80	LYS
1	A	124	ARG
1	A	127	ILE
1	A	128	ASP
1	A	148	TYR
1	A	152	LYS
1	A	153	GLU
1	A	175	LYS
1	A	214	ASN
1	A	245	ASN
1	A	254	LYS
1	A	266	LEU
1	A	285	LEU
1	A	288	THR
1	A	296	ARG
1	A	299	MET
1	A	313	SER
1	A	315	LEU
1	A	336	GLN
1	A	349	HIS
1	A	355	HIS

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (11) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	105	ASN
1	A	144	GLN

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Mol	Chain	Res	Type
1	A	169	HIS
1	A	188	GLN
1	A	199	GLN
1	A	210	ASN
1	A	214	ASN
1	A	245	ASN
1	A	257	HIS
1	A	318	ASN
1	A	336	GLN

### 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 carbohydrates 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	1C8	A	401	-	27,33,33	2.39	5 (18%)	29,48,48	3.04	13 (44%)

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	1C8	A	401	-	-	2/8/41/41	0/5/5/5

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	401	1C8	C24-N20	-8.62	1.30	1.38
2	A	401	1C8	C5-N20	-5.82	1.31	1.45
2	A	401	1C8	C2-C3	4.73	1.46	1.41
2	A	401	1C8	C9-N10	2.93	1.42	1.36
2	A	401	1C8	C8-C9	-2.23	1.47	1.51

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	401	1C8	C25-C29-S28	-9.76	99.90	111.83
2	A	401	1C8	C1-N6-C5	6.84	121.78	115.61
2	A	401	1C8	N4-C5-N20	4.42	118.92	115.24
2	A	401	1C8	C8-C9-N10	4.27	122.01	116.36
2	A	401	1C8	N6-C5-N4	-3.79	121.78	126.08
2	A	401	1C8	C2-C3-N4	-3.39	118.68	123.67
2	A	401	1C8	N6-C5-N20	2.94	119.17	115.14
2	A	401	1C8	C5-N4-C3	2.90	120.58	114.89
2	A	401	1C8	O12-C9-N10	-2.87	119.55	122.44
2	A	401	1C8	C29-S28-C27	2.80	98.08	92.37
2	A	401	1C8	C2-N10-C9	-2.24	119.92	122.43
2	A	401	1C8	C16-C15-C19	2.09	109.77	104.72
2	A	401	1C8	C9-C8-N7	2.04	116.28	112.26

There are no chirality outliers.

All (2) torsion outliers are listed below:

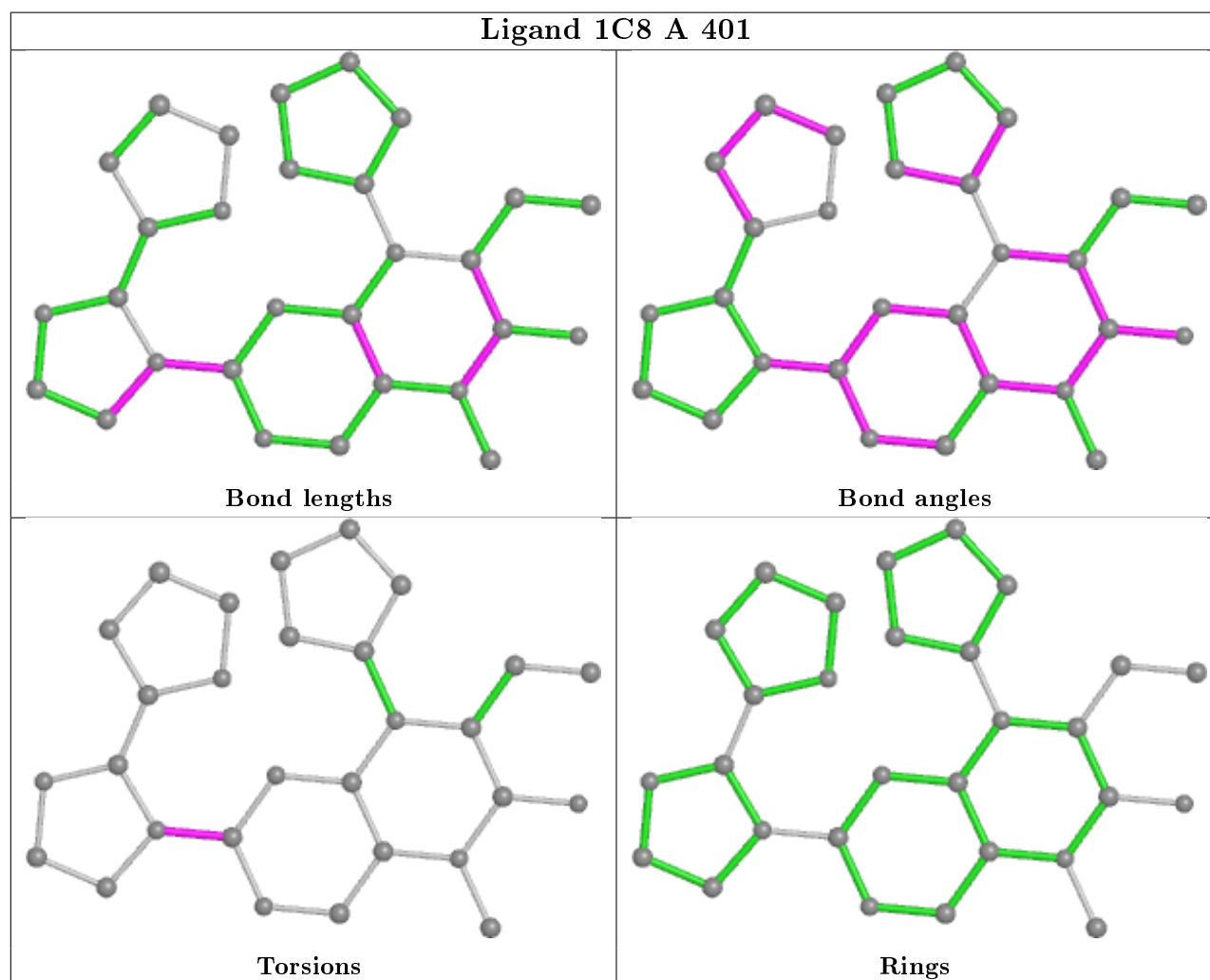
Mol	Chain	Res	Type	Atoms
2	A	401	1C8	N4-C5-N20-C24
2	A	401	1C8	N6-C5-N20-C24

There are no ring outliers.

1 monomer is involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	401	1C8	4	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

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, 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	285/308 (92%)	0.65	13 (4%) 32 35	15, 26, 44, 50	0

All (13) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	93	PHE	6.1
1	A	94	ALA	3.4
1	A	91	GLY	3.4
1	A	89	GLY	3.4
1	A	90	LYS	3.1
1	A	233	LEU	3.0
1	A	349	HIS	2.9
1	A	235	HIS	2.6
1	A	95	LYS	2.5
1	A	241	CYS	2.2
1	A	92	GLY	2.2
1	A	232	PRO	2.1
1	A	354	PHE	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](#)

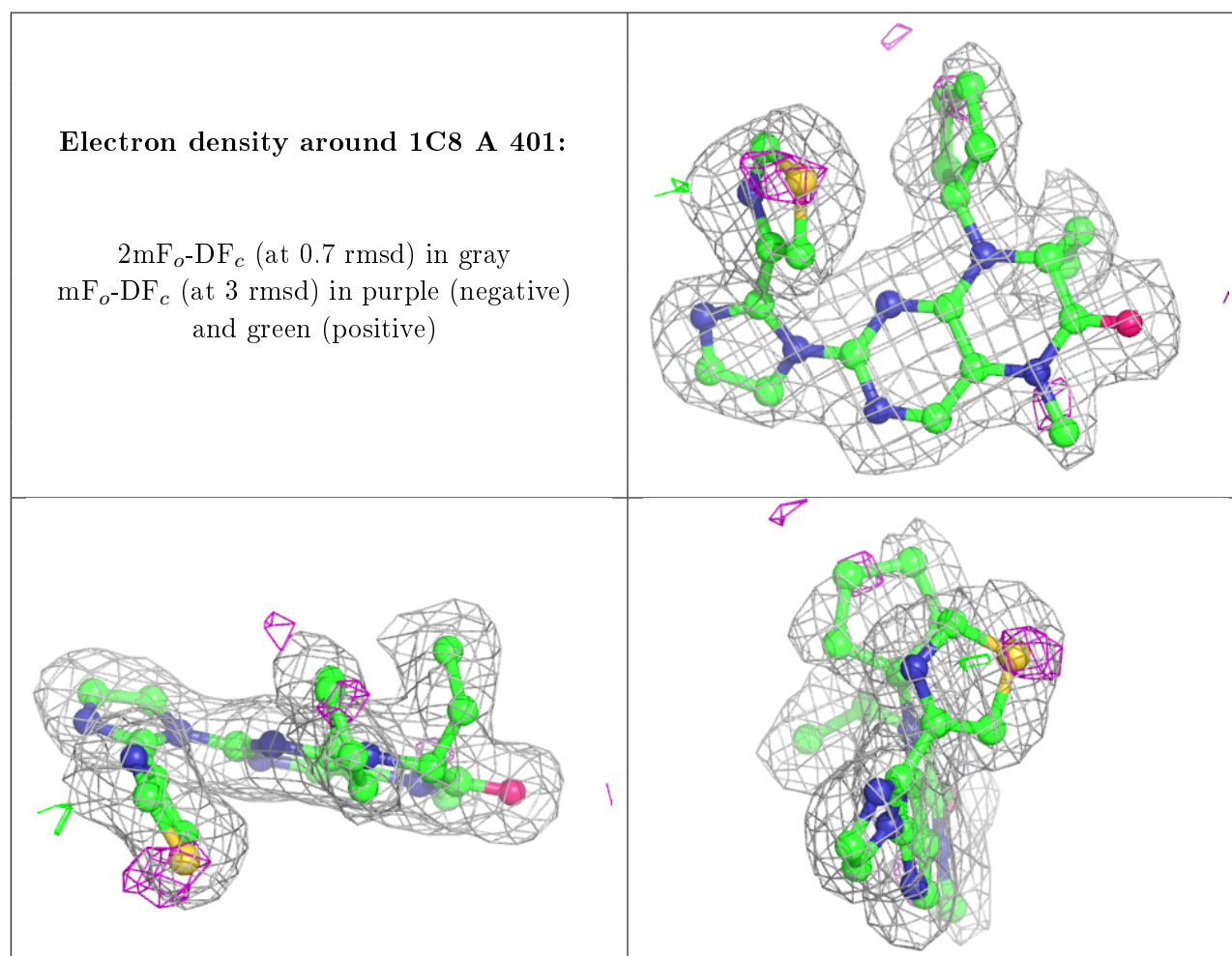
There are no carbohydrates in this entry.

## 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
2	1C8	A	401	29/29	0.87	0.14	15,17,21,25	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.