Full wwPDB X-ray Structure Validation Report (i)

Jul 28, 2024 – 02:22 am BST

PDB ID	:	8CAJ
Title	:	Crystal structure of SARS-CoV-2 Mpro-E166V mutant in complex with 13b-K
Authors	:	El Kilani, H.; Hilgenfeld, R.
Deposited on	:	2023-01-24
Resolution	:	2.20 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) 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 (i)) were used in the production of this report:

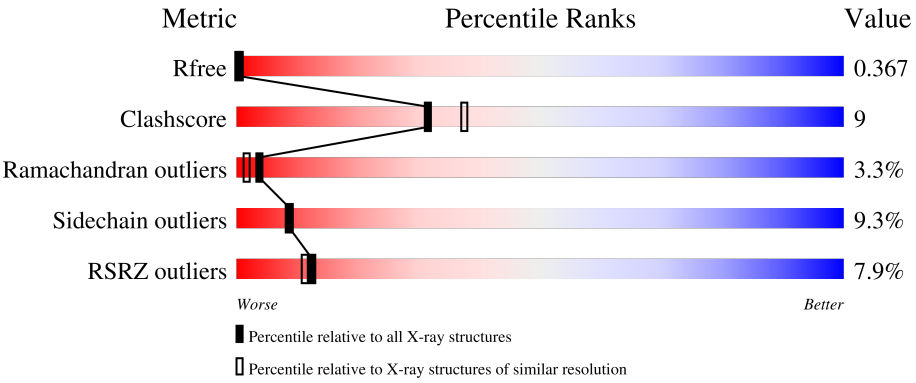
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.37.1
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.37.1

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.20 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	4898 (2.20-2.20)
Clashscore	141614	5594 (2.20-2.20)
Ramachandran outliers	138981	5503 (2.20-2.20)
Sidechain outliers	138945	5504 (2.20-2.20)
RSRZ outliers	127900	4800 (2.20-2.20)

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	302	8% 72% 26% .

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 2428 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.

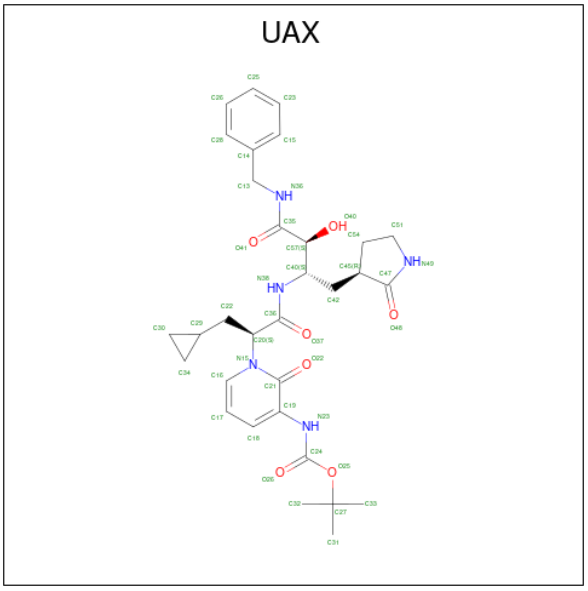
- Molecule 1 is a protein called Non-structural protein 11.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	AAA	302	Total	C	N	O	S	0	0	0
			2331	1476	397	436	22			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
AAA	166	VAL	GLU	engineered mutation	UNP P0DTC1

- Molecule 2 is {tert}-butyl {N}-[1-[(2 {S})-3-cyclopropyl-1-oxidanylidene-1-[[(2 {S},3 {S})-3-oxidanyl-4-oxidanylidene-1-[(3 {R})-2-oxidanylidenepyrrolidin-3-yl]-4-[(phenylmethyl)amino]butan-2-yl]amino]propan-2-yl]-2-oxidanylidene-pyridin-3-yl]carbamate (three-letter code: UAX) (formula: $C_{31}H_{41}N_5O_7$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	AAA	1	Total	C	N	O	0	0
			43	31	5	7		

- Molecule 3 is water.

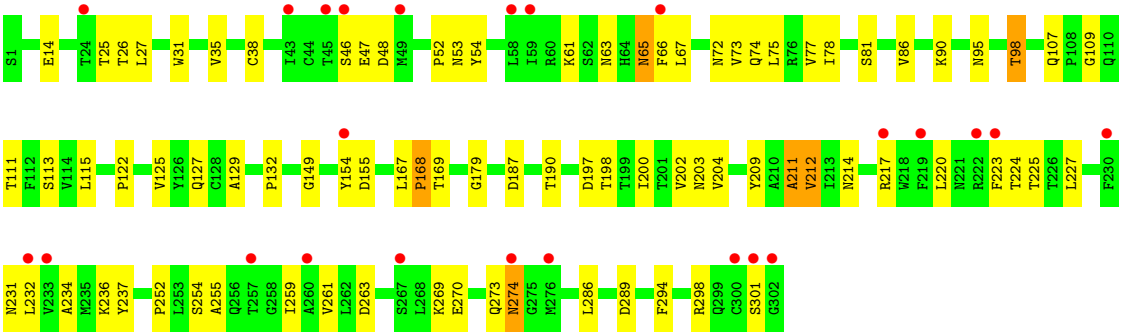
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	AAA	54	Total O 54 54	0	0

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: Non-structural protein 11

Chain AAA:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	115.78Å 53.52Å 45.47Å 90.00° 99.91° 90.00°	Depositor
Resolution (Å)	44.83 – 2.20 44.79 – 2.20	Depositor EDS
% Data completeness (in resolution range)	98.6 (44.83-2.20) 98.6 (44.79-2.20)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.28 (at 2.20Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.261 , 0.364 0.264 , 0.367	Depositor DCC
R_{free} test set	677 reflections (4.88%)	wwPDB-VP
Wilson B-factor (Å^2)	38.9	Xtriage
Anisotropy	0.033	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 34.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.51$, $< L^2 > = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	2428	wwPDB-VP
Average B, all atoms (Å^2)	55.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 11.53% 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: UAX

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	0.67	0/2383	0.83	0/3239

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

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	AAA	2331	0	2283	42	0
2	AAA	43	0	0	0	0
3	AAA	54	0	0	6	0
All	All	2428	0	2283	42	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 9.

All (42) 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:AAA:31:TRP:CH2	1:AAA:95:ASN:HA	2.10	0.86

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:AAA:63:ASN:HB3	3:AAA:538:HOH:O	1.88	0.72
1:AAA:46:SER:O	1:AAA:48:ASP:N	2.26	0.69
1:AAA:294:PHE:CZ	1:AAA:298:ARG:HD3	2.32	0.65
1:AAA:77:VAL:HB	3:AAA:538:HOH:O	1.97	0.64
1:AAA:231:ASN:O	1:AAA:234:ALA:HB3	2.00	0.62
1:AAA:75:LEU:HD11	3:AAA:552:HOH:O	2.01	0.60
1:AAA:65:ASN:HD22	1:AAA:65:ASN:C	2.06	0.58
1:AAA:211:ALA:O	1:AAA:214:ASN:N	2.36	0.58
1:AAA:212:VAL:HA	1:AAA:217:ARG:HG2	1.87	0.57
1:AAA:220:LEU:HB3	3:AAA:515:HOH:O	2.03	0.57
1:AAA:204:VAL:HG23	1:AAA:289:ASP:HB3	1.87	0.56
1:AAA:65:ASN:C	1:AAA:65:ASN:ND2	2.59	0.55
1:AAA:202:VAL:HG13	1:AAA:203:ASN:HD22	1.75	0.52
1:AAA:224:THR:HG22	1:AAA:225:THR:N	2.25	0.52
1:AAA:187:ASP:OD1	1:AAA:187:ASP:N	2.39	0.51
1:AAA:31:TRP:CZ2	1:AAA:95:ASN:HA	2.45	0.51
1:AAA:132:PRO:HD2	1:AAA:197:ASP:OD1	2.09	0.51
1:AAA:72:ASN:O	1:AAA:74:GLN:N	2.44	0.50
1:AAA:26:THR:HG23	3:AAA:507:HOH:O	2.13	0.49
1:AAA:273:GLN:O	1:AAA:274:ASN:HB2	2.12	0.49
1:AAA:211:ALA:O	1:AAA:212:VAL:C	2.51	0.49
1:AAA:52:PRO:HG2	1:AAA:54:TYR:CE2	2.49	0.48
1:AAA:237:TYR:OH	1:AAA:273:GLN:HB3	2.14	0.48
1:AAA:52:PRO:CG	1:AAA:54:TYR:CE2	2.98	0.46
1:AAA:95:ASN:HB3	1:AAA:98:THR:OG1	2.15	0.46
1:AAA:109:GLY:HA2	1:AAA:200:ILE:HD13	1.98	0.46
1:AAA:31:TRP:CE3	1:AAA:95:ASN:ND2	2.84	0.46
1:AAA:224:THR:CG2	1:AAA:225:THR:N	2.80	0.45
1:AAA:61:LYS:HD3	1:AAA:66:PHE:CE1	2.51	0.44
1:AAA:223:PHE:HB3	3:AAA:526:HOH:O	2.17	0.44
1:AAA:254:SER:OG	1:AAA:259:ILE:O	2.21	0.44
1:AAA:209:TYR:OH	1:AAA:261:VAL:HA	2.18	0.43
1:AAA:212:VAL:HA	1:AAA:217:ARG:CG	2.48	0.43
1:AAA:217:ARG:HB3	1:AAA:220:LEU:HD12	2.01	0.43
1:AAA:111:THR:HG22	1:AAA:129:ALA:HB2	2.01	0.42
1:AAA:115:LEU:HD11	1:AAA:122:PRO:HB3	2.03	0.41
1:AAA:167:LEU:O	1:AAA:168:PRO:C	2.59	0.41
1:AAA:86:VAL:HG22	1:AAA:179:GLY:HA3	2.01	0.41
1:AAA:113:SER:O	1:AAA:149:GLY:HA2	2.20	0.41
1:AAA:227:LEU:O	1:AAA:231:ASN:ND2	2.55	0.40
1:AAA:14:GLU:HG2	1:AAA:122:PRO:HG2	2.02	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	AAA	300/302 (99%)	248 (83%)	42 (14%)	10 (3%)	4 2

All (10) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	AAA	47	GLU
1	AAA	73	VAL
1	AAA	255	ALA
1	AAA	301	SER
1	AAA	274	ASN
1	AAA	78	ILE
1	AAA	154	TYR
1	AAA	211	ALA
1	AAA	212	VAL
1	AAA	252	PRO

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	AAA	259/259 (100%)	235 (91%)	24 (9%)	9 8

All (24) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	AAA	25	THR
1	AAA	27	LEU
1	AAA	35	VAL
1	AAA	38	CYS
1	AAA	53	ASN
1	AAA	65	ASN
1	AAA	67	LEU
1	AAA	81	SER
1	AAA	90	LYS
1	AAA	98	THR
1	AAA	107	GLN
1	AAA	125	VAL
1	AAA	127	GLN
1	AAA	155	ASP
1	AAA	168	PRO
1	AAA	169	THR
1	AAA	190	THR
1	AAA	198	THR
1	AAA	232	LEU
1	AAA	236	LYS
1	AAA	263	ASP
1	AAA	269	LYS
1	AAA	270	GLU
1	AAA	286	LEU

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 (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	UAX	AAA	401	1	46,46,46	0.67	1 (2%)	57,65,65	0.87	4 (7%)

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	UAX	AAA	401	1	-	16/42/54/54	0/4/4/4

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	AAA	401	UAX	C19-C21	-3.38	1.39	1.47

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	AAA	401	UAX	C21-C19-N23	2.78	114.84	112.30
2	AAA	401	UAX	C18-C19-N23	-2.65	123.62	127.20
2	AAA	401	UAX	C18-C19-C21	2.18	121.54	120.30
2	AAA	401	UAX	O22-C21-C19	2.13	124.77	122.29

There are no chirality outliers.

All (16) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	AAA	401	UAX	O26-C24-O25-C27
2	AAA	401	UAX	N23-C24-O25-C27
2	AAA	401	UAX	O26-C24-N23-C19

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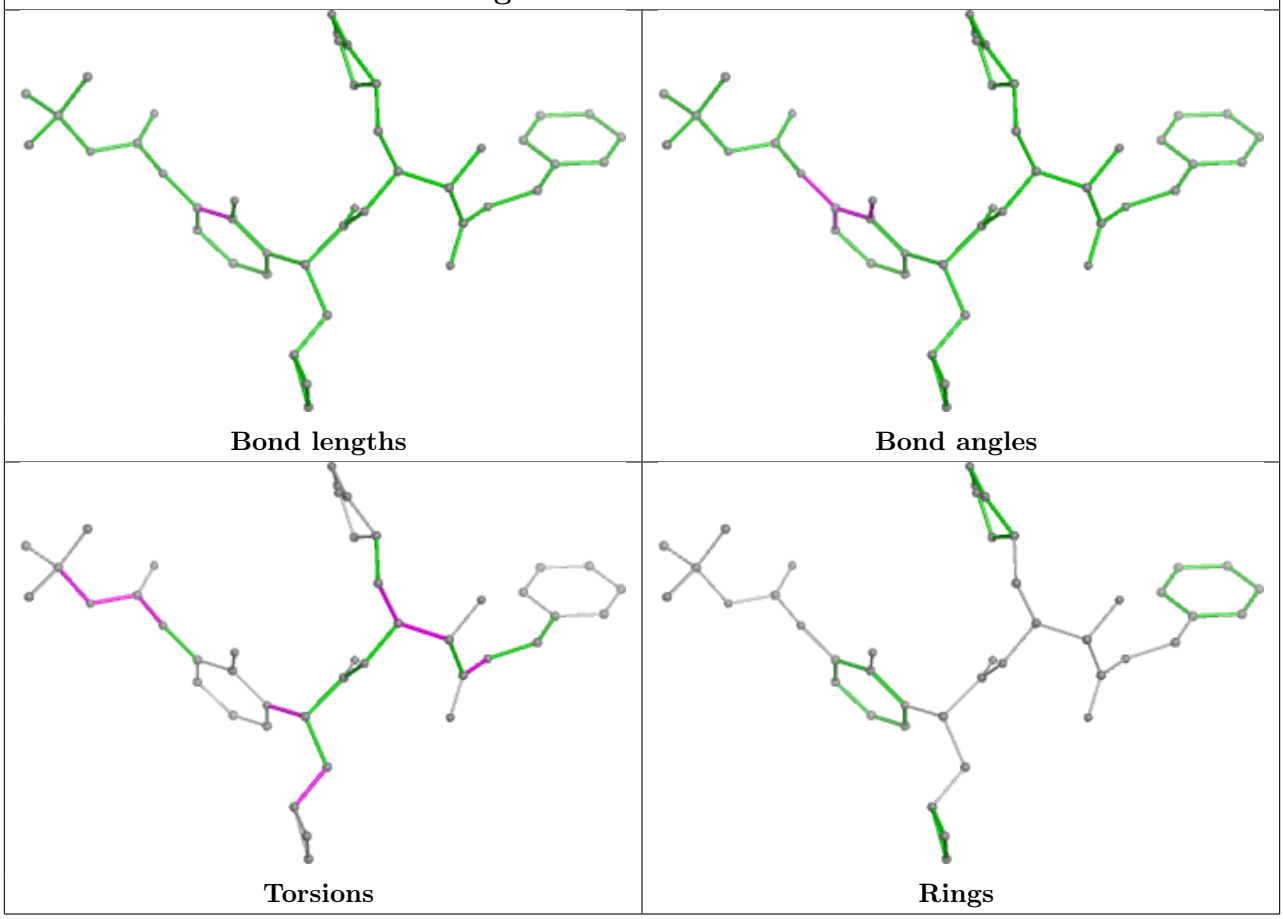
Mol	Chain	Res	Type	Atoms
2	AAA	401	UAX	O25-C24-N23-C19
2	AAA	401	UAX	C22-C20-N15-C16
2	AAA	401	UAX	C20-C22-C29-C30
2	AAA	401	UAX	C57-C40-C42-C45
2	AAA	401	UAX	C57-C35-N36-C13
2	AAA	401	UAX	O41-C35-N36-C13
2	AAA	401	UAX	C32-C27-O25-C24
2	AAA	401	UAX	C33-C27-O25-C24
2	AAA	401	UAX	C31-C27-O25-C24
2	AAA	401	UAX	N38-C40-C42-C45
2	AAA	401	UAX	C22-C20-N15-C21
2	AAA	401	UAX	N38-C40-C57-O40
2	AAA	401	UAX	C36-C20-N15-C21

There are no ring outliers.

No monomer is involved in short contacts.

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 UAX AAA 401



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^{th} 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	AAA	302/302 (100%)	0.47	24 (7%)	12	11	26, 53, 88, 117	0

All (24) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	AAA	49	MET	5.5
1	AAA	46	SER	3.5
1	AAA	300	CYS	3.4
1	AAA	154	TYR	3.3
1	AAA	302	GLY	3.2
1	AAA	45	THR	3.2
1	AAA	59	ILE	3.2
1	AAA	274	ASN	2.9
1	AAA	219	PHE	2.8
1	AAA	222	ARG	2.8
1	AAA	257	THR	2.7
1	AAA	267	SER	2.5
1	AAA	58	LEU	2.5
1	AAA	43	ILE	2.5
1	AAA	301	SER	2.5
1	AAA	66	PHE	2.4
1	AAA	223	PHE	2.4
1	AAA	217	ARG	2.3
1	AAA	230	PHE	2.2
1	AAA	233	VAL	2.2
1	AAA	24	THR	2.1
1	AAA	276	MET	2.1
1	AAA	260	ALA	2.1
1	AAA	232	LEU	2.1

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)

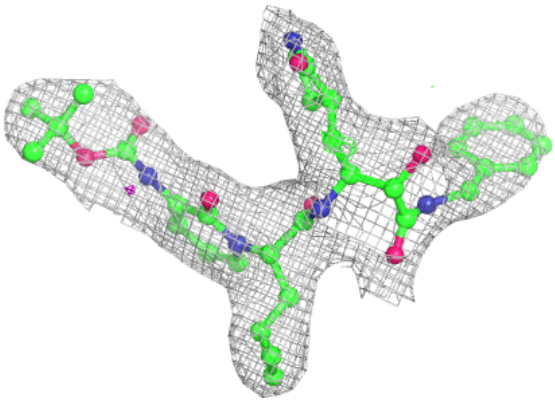
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

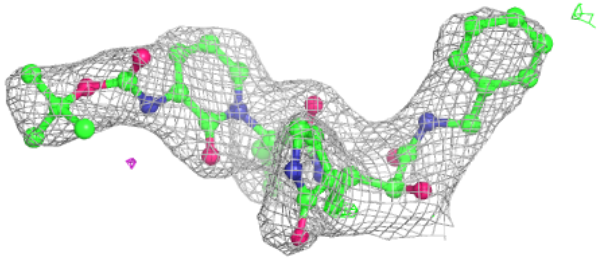
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
2	UAX	AAA	401	43/43	0.91	0.16	50,55,64,68	0

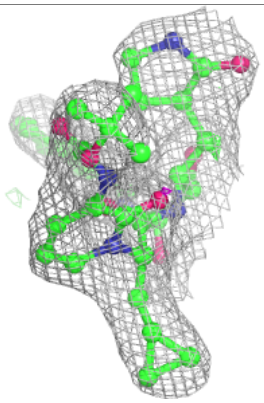
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around UAX AAA 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 (i)

There are no such residues in this entry.