



wwPDB X-ray Structure Validation Summary Report ⓘ

Jun 12, 2024 – 11:06 am BST

PDB ID : 9F9A
Title : Crystal structure of MUS81-EME1 bound by compound 12.
Authors : Collie, G.W.
Deposited on : 2024-05-07
Resolution : 2.91 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

<https://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 : 4.02b-467
Mogul : 1.8.4, CSD as541be (2020)
Xtriage (Phenix) : 1.13
EDS : 2.36.2
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) : 2.36.2

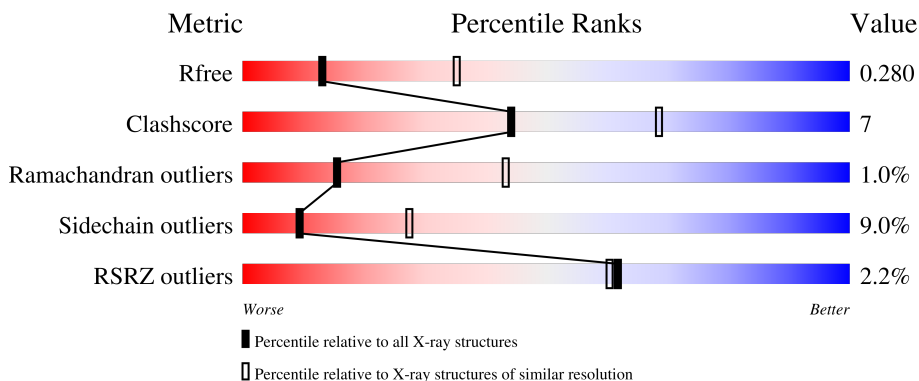
1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.91 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	2307 (2.94-2.90)
Clashscore	141614	2531 (2.94-2.90)
Ramachandran outliers	138981	2462 (2.94-2.90)
Sidechain outliers	138945	2464 (2.94-2.90)
RSRZ outliers	127900	2248 (2.94-2.90)

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 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	308	
1	C	308	
1	E	308	
1	G	308	
2	B	326	

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Mol	Chain	Length	Quality of chain
2	D	326	 2% 32% 10% 57%
2	F	326	 2% 32% 10% 57%
2	H	326	 % 32% 10% 58%

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 10093 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 Crossover junction endonuclease MUS81.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	185	1458	924	265	265	4	0	0	0
1	C	186	1468	929	267	268	4	0	0	0
1	E	187	1472	933	267	268	4	0	0	0
1	G	185	1458	924	265	265	4	0	0	0

There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	244	GLY	-	expression tag	UNP Q96NY9
A	245	SER	-	expression tag	UNP Q96NY9
C	244	GLY	-	expression tag	UNP Q96NY9
C	245	SER	-	expression tag	UNP Q96NY9
E	244	GLY	-	expression tag	UNP Q96NY9
E	245	SER	-	expression tag	UNP Q96NY9
G	244	GLY	-	expression tag	UNP Q96NY9
G	245	SER	-	expression tag	UNP Q96NY9

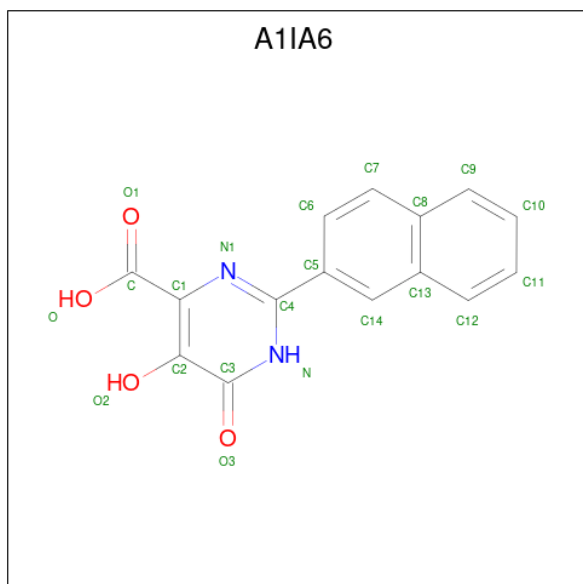
- Molecule 2 is a protein called Crossover junction endonuclease EME1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	138	1031	653	170	200	8	0	0	0
2	D	139	1045	664	172	201	8	0	0	0
2	F	139	1045	664	172	201	8	0	0	0
2	H	137	1024	648	169	199	8	0	0	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	245	GLY	-	expression tag	UNP Q96AY2
D	245	GLY	-	expression tag	UNP Q96AY2
F	245	GLY	-	expression tag	UNP Q96AY2
H	245	GLY	-	expression tag	UNP Q96AY2

- Molecule 3 is 2-naphthalen-2-yl-5-oxidanyl-6-oxidanylidene-1H-pyrimidine-4-carboxylic acid (three-letter code: A1IA6) (formula: C₁₅H₁₀N₂O₄) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
3	A	1	Total	C	N	O	0	0
			21	15	2	4		
3	C	1	Total	C	N	O	0	0
			21	15	2	4		
3	E	1	Total	C	N	O	0	0
			21	15	2	4		
3	G	1	Total	C	N	O	0	0
			21	15	2	4		

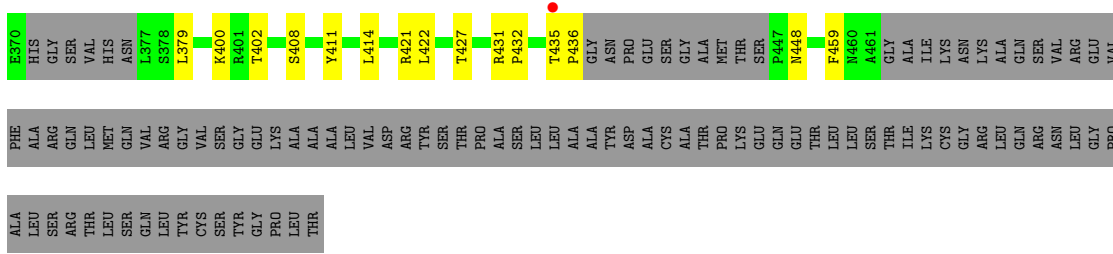
- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
4	A	2	Total	Mg	0	0
			2	2		
4	C	2	Total	Mg	0	0
			2	2		

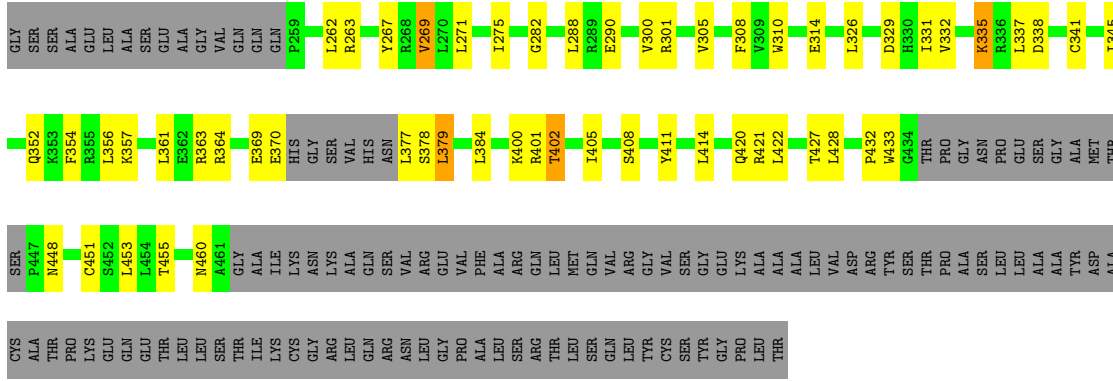
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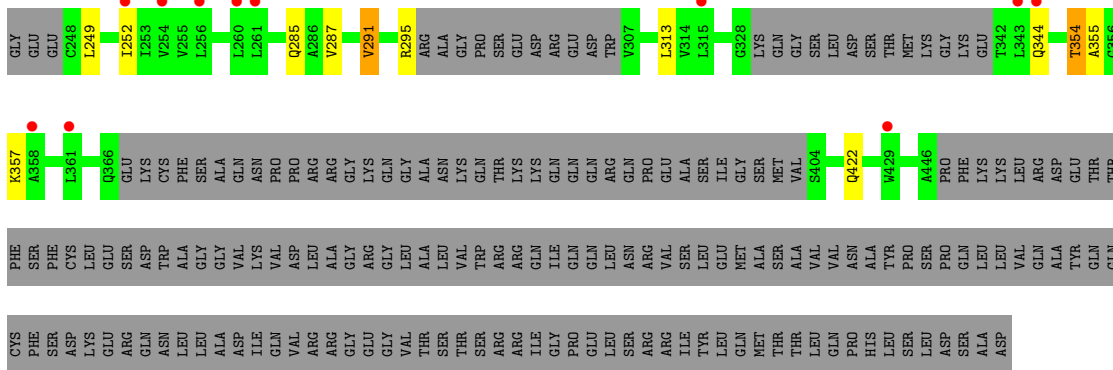
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	E	2	Total 2	Mg 2	0	0
4	G	2	Total 2	Mg 2	0	0



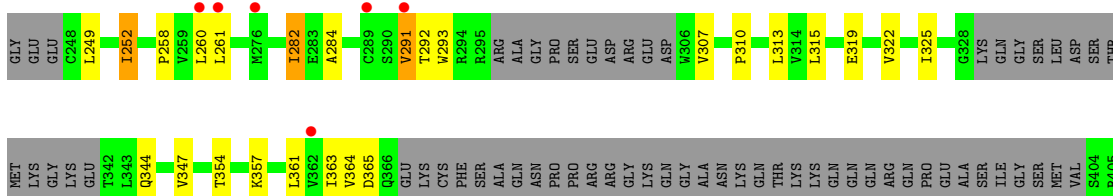
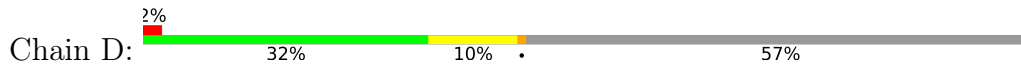
• Molecule 1: Crossover junction endonuclease MUS81

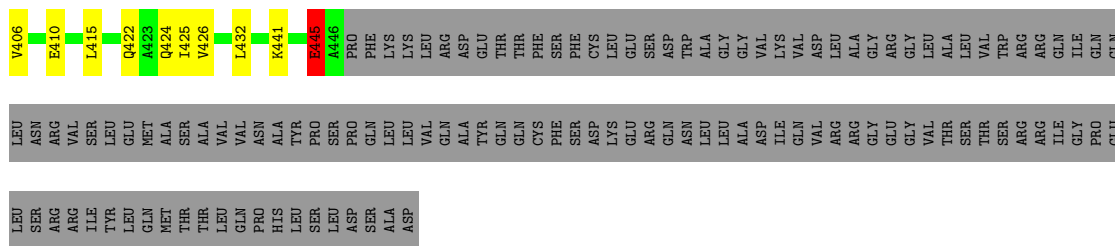


• Molecule 2: Crossover junction endonuclease EME1

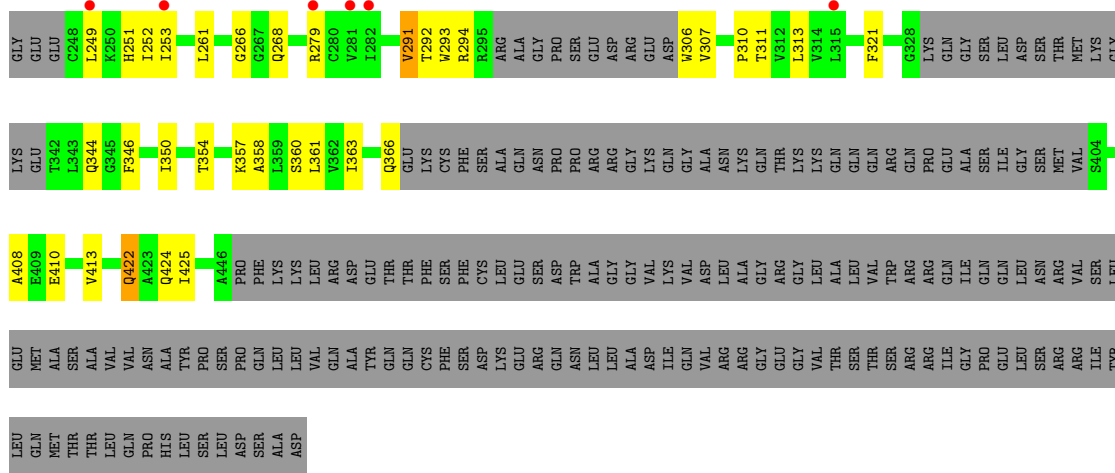
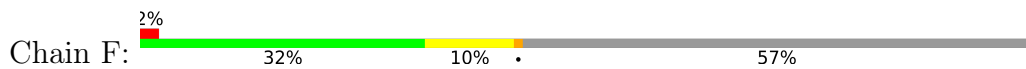


• Molecule 2: Crossover junction endonuclease EME1

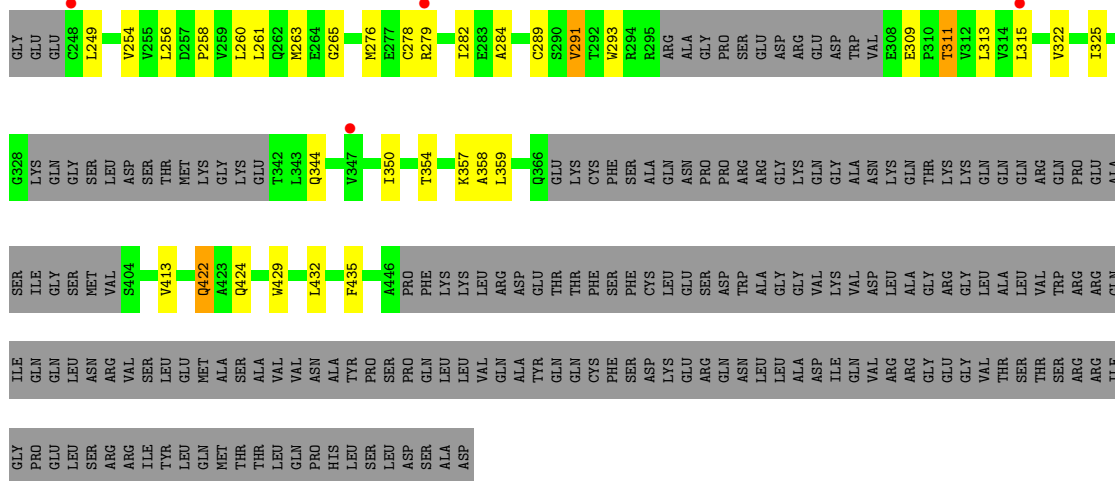
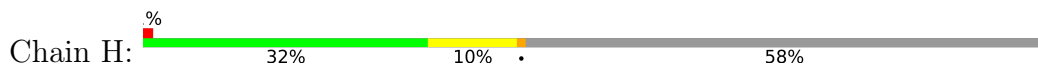




● Molecule 2: Crossover junction endonuclease EME1



● Molecule 2: Crossover junction endonuclease EME1



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	111.87Å 124.35Å 217.57Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	83.17 – 2.91 83.17 – 2.91	Depositor EDS
% Data completeness (in resolution range)	60.8 (83.17-2.91) 60.8 (83.17-2.91)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.76 (at 2.91Å)	Xtrriage
Refinement program	BUSTER 2.11.8	Depositor
R, R_{free}	0.243 , 0.278 0.243 , 0.280	Depositor DCC
R_{free} test set	2051 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å ²)	72.1	Xtrriage
Anisotropy	0.086	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 47.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.29$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.89	EDS
Total number of atoms	10093	wwPDB-VP
Average B, all atoms (Å ²)	74.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.13% 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: MG, A1IA6

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	0.38	0/1486	0.62	0/2014
1	C	0.38	0/1496	0.63	0/2028
1	E	0.34	0/1501	0.59	0/2036
1	G	0.35	0/1486	0.57	0/2014
2	B	0.30	0/1040	0.51	0/1413
2	D	0.33	0/1056	0.54	0/1436
2	F	0.32	0/1056	0.50	0/1436
2	H	0.31	0/1033	0.47	0/1403
All	All	0.34	0/10154	0.56	0/13780

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 [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	1458	0	1446	16	0
1	C	1468	0	1457	17	0
1	E	1472	0	1460	23	0
1	G	1458	0	1446	26	0
2	B	1031	0	1036	3	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	D	1045	0	1046	19	0
2	F	1045	0	1046	15	0
2	H	1024	0	1027	20	0
3	A	21	0	0	0	0
3	C	21	0	0	0	0
3	E	21	0	0	0	0
3	G	21	0	0	0	0
4	A	2	0	0	0	0
4	C	2	0	0	0	0
4	E	2	0	0	0	0
4	G	2	0	0	0	0
All	All	10093	0	9964	132	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 7.

The worst 5 of 132 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:C:304:HIS:CD2	1:C:305:VAL:HG12	2.10	0.85
1:E:335:LYS:NZ	1:E:352:GLN:HE22	1.73	0.84
2:D:258:PRO:HD2	2:D:284:ALA:HA	1.61	0.82
2:D:310:PRO:HA	2:D:357:LYS:HG2	1.64	0.78
2:F:253:ILE:HD11	2:F:306:TRP:CE2	2.22	0.75

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	179/308 (58%)	172 (96%)	5 (3%)	2 (1%)	14 41

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	C	180/308 (58%)	169 (94%)	10 (6%)	1 (1%)	25	57
1	E	181/308 (59%)	172 (95%)	7 (4%)	2 (1%)	14	41
1	G	179/308 (58%)	164 (92%)	13 (7%)	2 (1%)	14	41
2	B	130/326 (40%)	125 (96%)	4 (3%)	1 (1%)	19	49
2	D	131/326 (40%)	121 (92%)	7 (5%)	3 (2%)	6	22
2	F	131/326 (40%)	118 (90%)	12 (9%)	1 (1%)	19	49
2	H	129/326 (40%)	121 (94%)	8 (6%)	0	100	100
All	All	1240/2536 (49%)	1162 (94%)	66 (5%)	12 (1%)	15	43

5 of 12 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	432	PRO
1	A	282	GLY
2	D	307	VAL
1	E	282	GLY
1	E	432	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	A	156/260 (60%)	147 (94%)	9 (6%)	20	48
1	C	158/260 (61%)	140 (89%)	18 (11%)	5	17
1	E	158/260 (61%)	146 (92%)	12 (8%)	13	35
1	G	156/260 (60%)	138 (88%)	18 (12%)	5	16
2	B	111/275 (40%)	104 (94%)	7 (6%)	18	44
2	D	112/275 (41%)	101 (90%)	11 (10%)	8	23
2	F	112/275 (41%)	99 (88%)	13 (12%)	5	16
2	H	110/275 (40%)	101 (92%)	9 (8%)	11	31
All	All	1073/2140 (50%)	976 (91%)	97 (9%)	9	27

5 of 97 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	F	249	LEU
1	G	275	ILE
2	F	252	ILE
2	F	361	LEU
1	G	301	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 16 such sidechains are listed below:

Mol	Chain	Res	Type
1	G	448	ASN
1	G	352	GLN
1	C	352	GLN
1	G	292	GLN
1	C	316	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 monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 12 ligands modelled in this entry, 8 are monoatomic - leaving 4 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
3	A1IA6	E	601	4	21,23,23	0.33	0	26,33,33	0.45	0
3	A1IA6	A	601	4	21,23,23	0.33	0	26,33,33	0.41	0
3	A1IA6	C	601	4	21,23,23	0.23	0	26,33,33	0.48	0
3	A1IA6	G	601	4	21,23,23	0.23	0	26,33,33	0.41	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
3	A1IA6	E	601	4	-	3/8/8/8	0/3/3/3
3	A1IA6	A	601	4	-	0/8/8/8	0/3/3/3
3	A1IA6	C	601	4	-	4/8/8/8	0/3/3/3
3	A1IA6	G	601	4	-	6/8/8/8	0/3/3/3

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 13 torsion outliers are listed below:

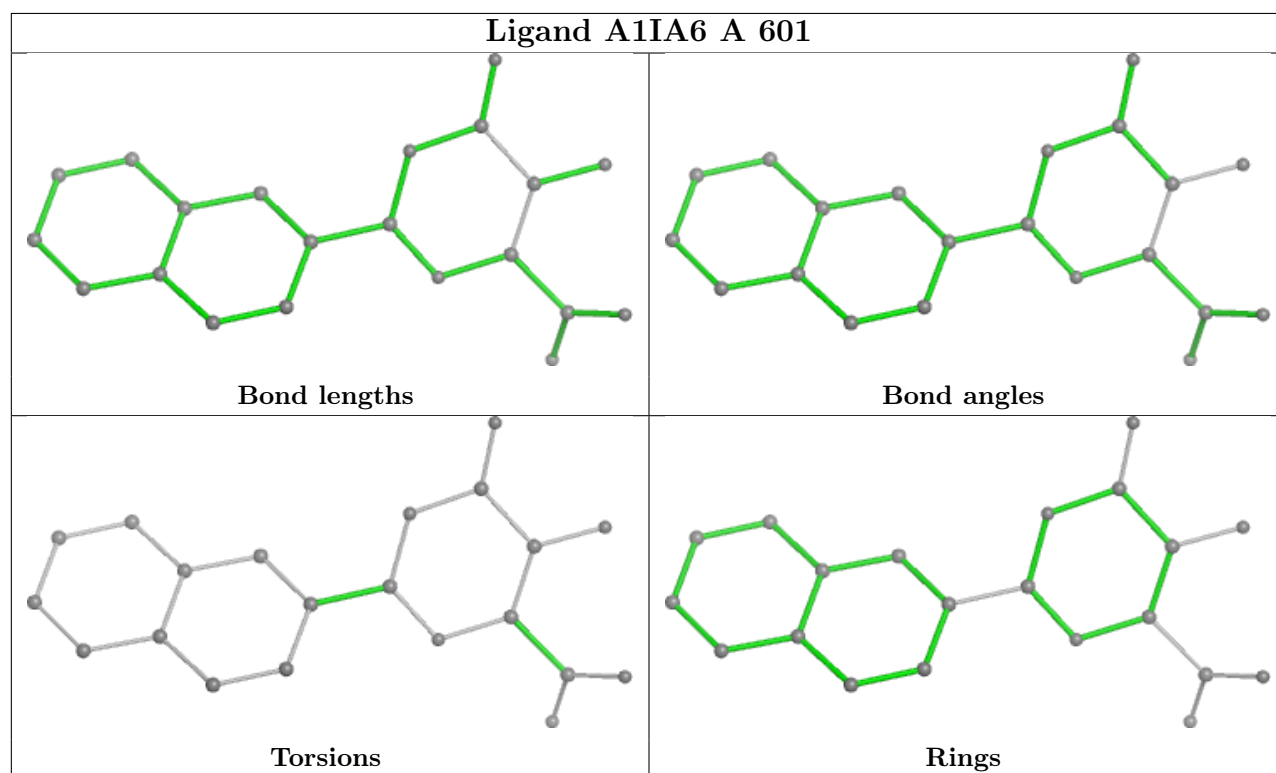
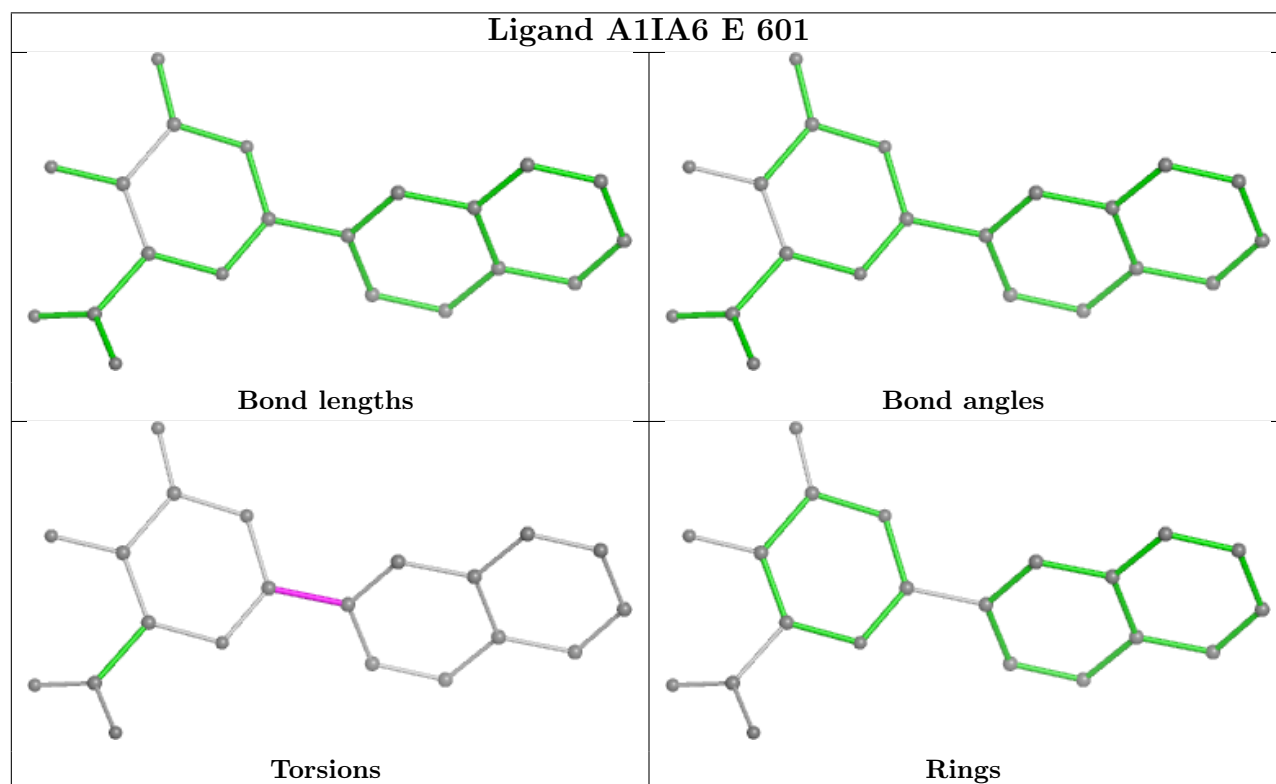
Mol	Chain	Res	Type	Atoms
3	G	601	A1IA6	O1-C-C1-C2
3	G	601	A1IA6	N-C4-C5-C14
3	G	601	A1IA6	N-C4-C5-C6
3	G	601	A1IA6	N1-C4-C5-C6
3	G	601	A1IA6	N1-C4-C5-C14

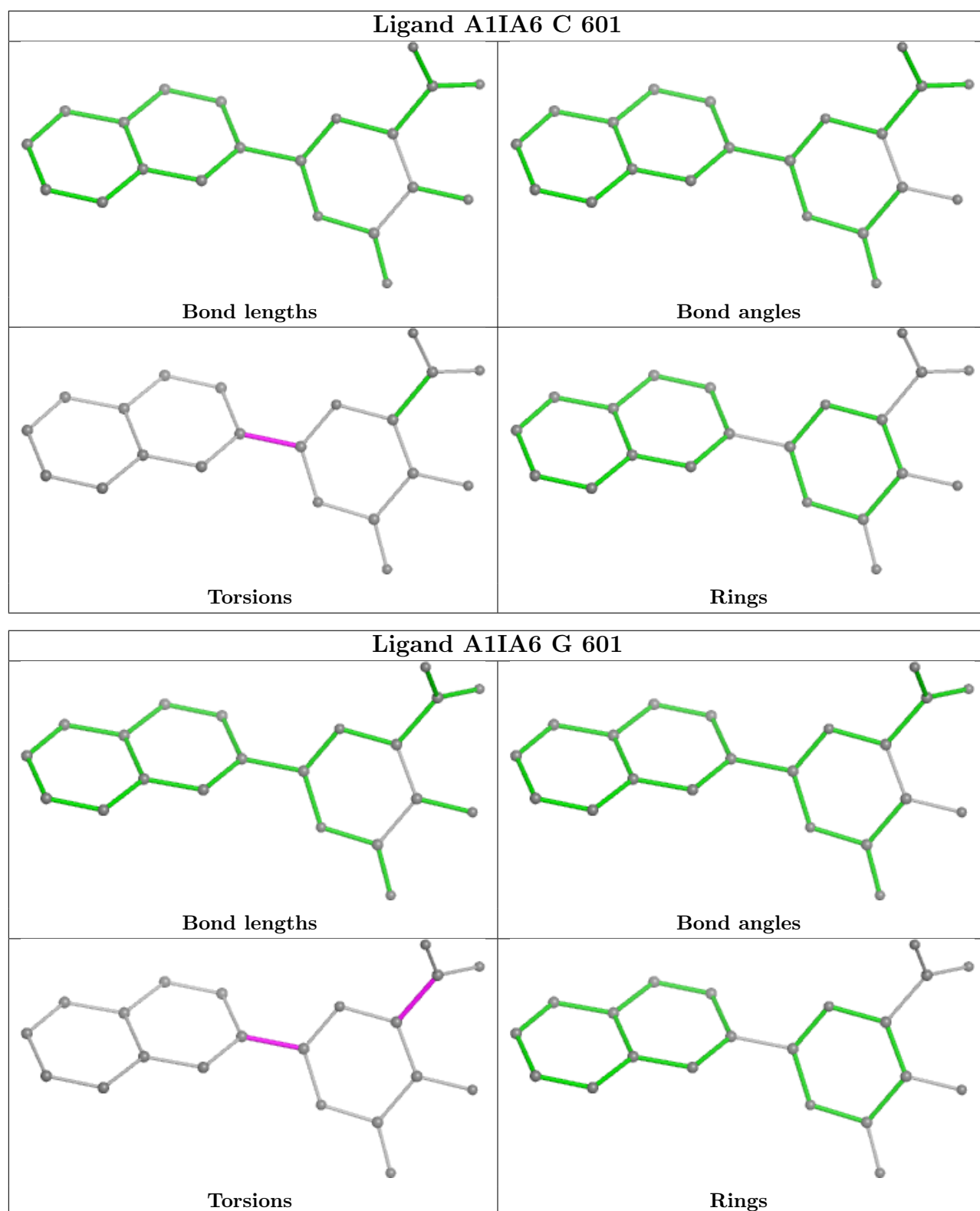
There are no ring outliers.

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 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

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	185/308 (60%)	0.13	1 (0%) 91 91	35, 57, 80, 88	0
1	C	186/308 (60%)	0.03	0 100 100	39, 58, 76, 82	0
1	E	187/308 (60%)	0.06	1 (0%) 91 91	40, 67, 93, 101	0
1	G	185/308 (60%)	0.11	0 100 100	43, 70, 95, 101	0
2	B	138/326 (42%)	0.59	11 (7%) 12 10	66, 87, 111, 122	0
2	D	139/326 (42%)	0.32	6 (4%) 35 32	60, 85, 104, 108	0
2	F	139/326 (42%)	0.36	6 (4%) 35 32	62, 87, 104, 109	0
2	H	137/326 (42%)	0.24	4 (2%) 51 48	64, 90, 106, 113	0
All	All	1296/2536 (51%)	0.21	29 (2%) 62 60	35, 76, 102, 122	0

The worst 5 of 29 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	D	261	LEU	3.9
2	B	260	LEU	3.8
2	B	344	GLN	3.0
1	A	448	ASN	3.0
2	F	279	ARG	2.9

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

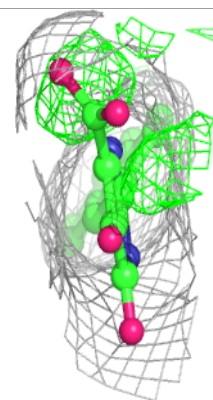
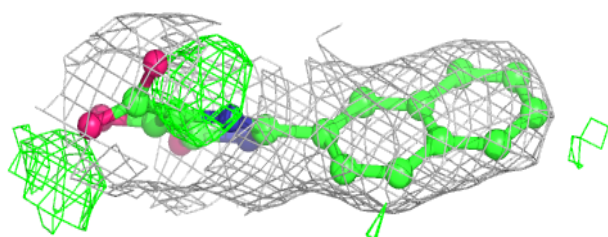
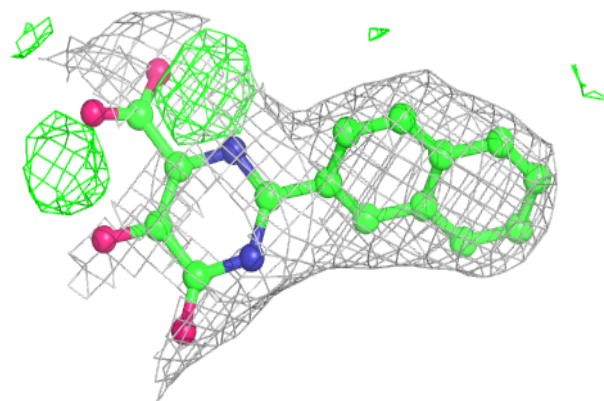
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
4	MG	C	602	1/1	0.93	0.24	51,51,51,51	0
3	A1IA6	C	601	21/21	0.94	0.23	66,67,67,67	0
3	A1IA6	A	601	21/21	0.95	0.23	53,54,54,54	0
4	MG	G	603	1/1	0.95	0.15	24,24,24,24	0
3	A1IA6	E	601	21/21	0.96	0.21	60,61,63,63	0
4	MG	E	602	1/1	0.96	0.24	33,33,33,33	0
4	MG	A	602	1/1	0.96	0.25	37,37,37,37	0
3	A1IA6	G	601	21/21	0.97	0.21	61,62,64,64	0
4	MG	E	603	1/1	0.98	0.18	29,29,29,29	0
4	MG	G	602	1/1	0.98	0.18	42,42,42,42	0
4	MG	C	603	1/1	0.98	0.17	38,38,38,38	0
4	MG	A	603	1/1	0.99	0.20	27,27,27,27	0

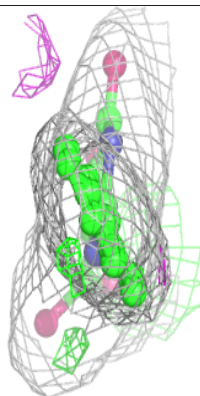
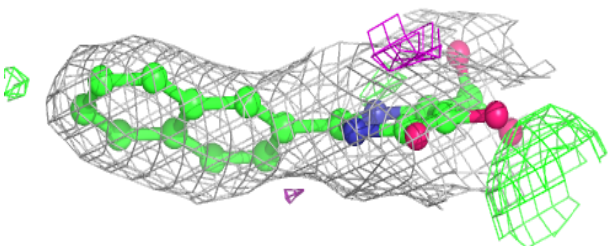
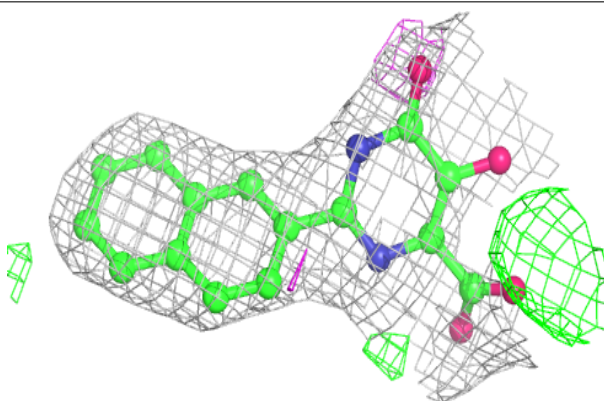
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

Electron density around A1IA6 C 601:

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

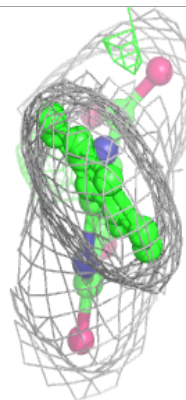
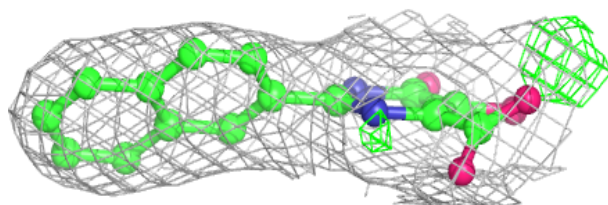
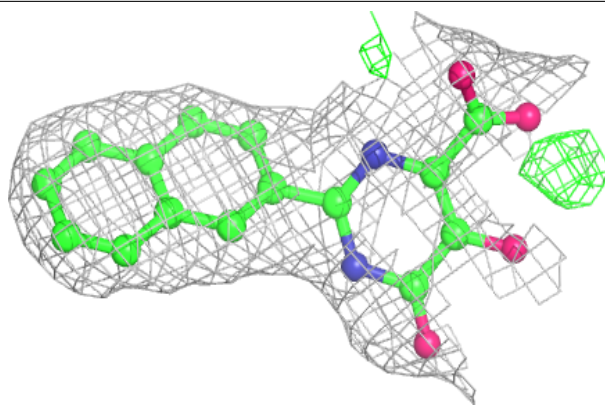
**Electron density around A1IA6 A 601:**

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

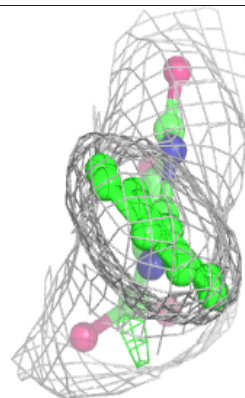
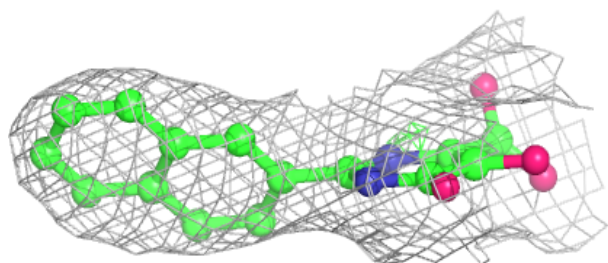
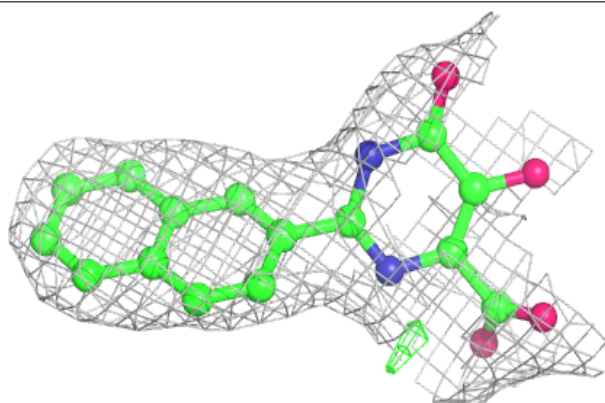


Electron density around A1IA6 E 601:

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

**Electron density around A1IA6 G 601:**

$2mF_o-DF_c$ (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.