



# Full wwPDB X-ray Structure Validation Report ⓘ

May 7, 2025 – 04:12 pm BST

PDB ID : 9GRR / pdb\_00009grr  
Title : Crystal structure of Arabidopsis thaliana Acyl-ACP Thioesterase (At-FatA) complexed with Cinnemethylin  
Authors : Montgomery, M.G.  
Deposited on : 2024-09-12  
Resolution : 1.40 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.

The types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

MolProbity	:	4-5-2 with Phenix2.0rc1
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0rc1
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.003 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.43.1

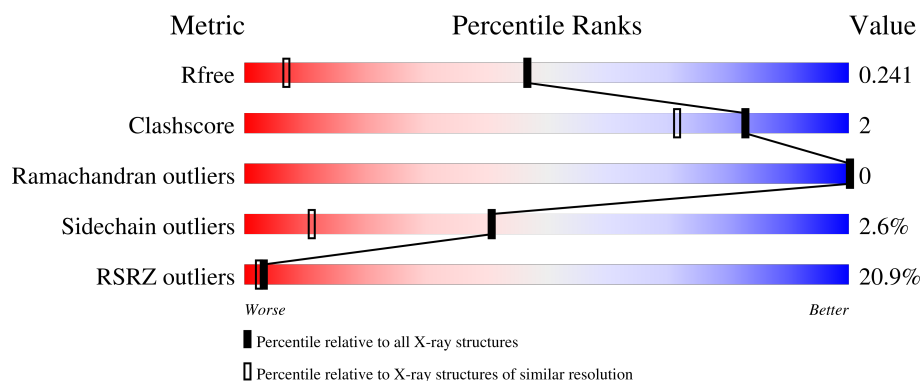
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.40 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))
$R_{free}$	164625	2247 (1.40-1.40)
Clashscore	180529	2446 (1.40-1.40)
Ramachandran outliers	177936	2398 (1.40-1.40)
Sidechain outliers	177891	2397 (1.40-1.40)
RSRZ outliers	164620	2246 (1.40-1.40)

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  $\geq 3$ , 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	AaA	295	<div> <div>18%</div> <div>80%</div> <div>7%</div> <div>13%</div> </div>

## 2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 2330 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.

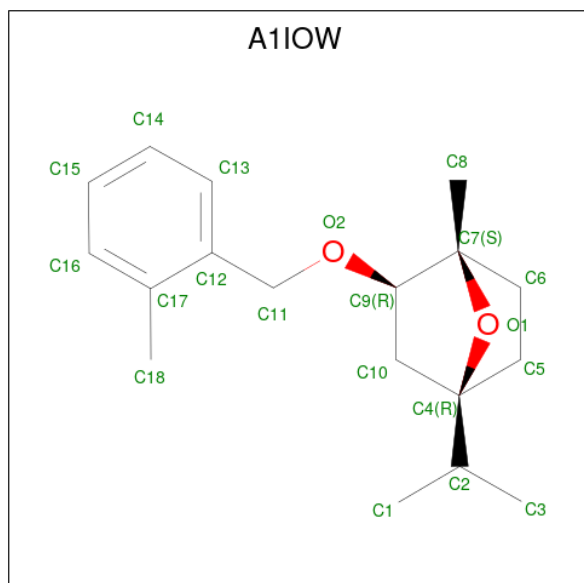
- Molecule 1 is a protein called Oleoyl-acyl carrier protein thioesterase 1, chloroplastic.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	AaA	258	2135	1341	376	407	11	0	9	0

There are 7 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
AaA	74	MET	-	initiating methionine	UNP Q42561
AaA	363	HIS	-	expression tag	UNP Q42561
AaA	364	HIS	-	expression tag	UNP Q42561
AaA	365	HIS	-	expression tag	UNP Q42561
AaA	366	HIS	-	expression tag	UNP Q42561
AaA	367	HIS	-	expression tag	UNP Q42561
AaA	368	HIS	-	expression tag	UNP Q42561

- Molecule 2 is (1 {S},2 {R},4 {R})-1-methyl-2-[(2-methylphenyl)methoxy]-4-propan-2-yl-7-oxabicyclo[2.2.1]heptane (CCD ID: A1IOW) (formula: C<sub>18</sub>H<sub>26</sub>O<sub>2</sub>) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
2	AaA	1	Total	C	O	0	0
			20	18	2		

- Molecule 3 is SULFATE ION (CCD ID: SO4) (formula: O<sub>4</sub>S).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	AaA	1	Total	O	S	0	0
			5	4	1		
3	AaA	1	Total	O	S	0	0
			5	4	1		

- Molecule 4 is GLYCEROL (CCD ID: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	AaA	1	Total	C	O	0	0
			6	3	3		

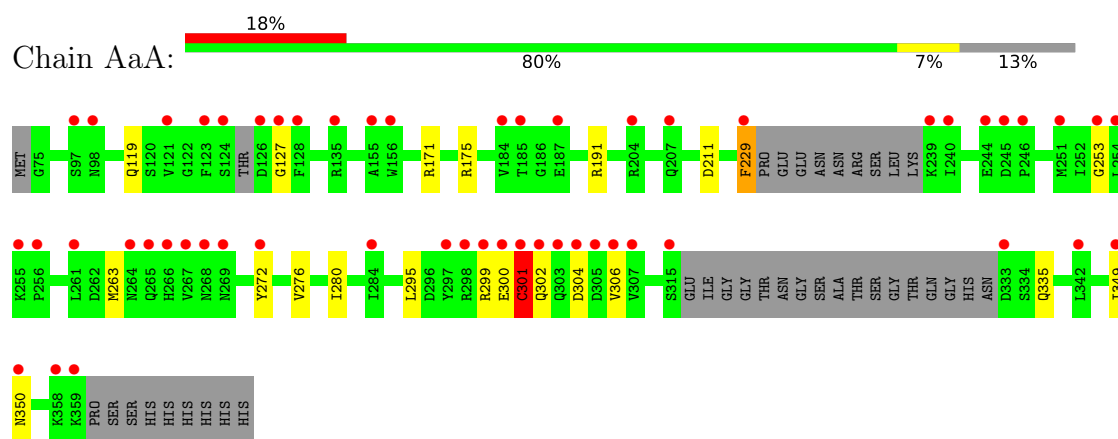
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	AaA	159	Total	O	0	1
			159	159		

### 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: Oleoyl-acyl carrier protein thioesterase 1, chloroplastic



## 4 Data and refinement statistics

Property	Value	Source
Space group	I 4 2 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	98.43Å 98.43Å 126.17Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	77.61 – 1.40 77.61 – 1.40	Depositor EDS
% Data completeness (in resolution range)	97.4 (77.61-1.40) 97.4 (77.61-1.40)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.57 (at 1.40Å)	Xtriage
Refinement program	REFMAC 5.8.0253	Depositor
R, $R_{free}$	0.216 , 0.233 0.225 , 0.241	Depositor DCC
$R_{free}$ test set	3014 reflections (5.08%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	20.3	Xtriage
Anisotropy	0.031	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 22.4	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	0.96	EDS
Total number of atoms	2330	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	26.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.13% 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: SO4, A1IOW, GOL

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	0.98	1/2193 (0.0%)	1.16	4/2968 (0.1%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	AaA	302	GLN	N-CA	5.28	1.52	1.45

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	AaA	229	PHE	CB-CA-C	7.33	124.03	110.10
1	AaA	175	ARG	NE-CZ-NH2	5.97	124.57	119.20
1	AaA	301	CYS	CA-C-O	-5.55	114.85	121.56
1	AaA	175	ARG	NE-CZ-NH1	-5.37	116.13	121.50

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	AaA	2135	0	2110	10	0
2	AaA	20	0	0	0	0
3	AaA	10	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	AaA	6	0	8	0	0
5	AaA	159	0	0	0	0
All	All	2330	0	2118	10	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 2.

All (10) 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:349[A]:ILE:HG22	1:AaA:350:ASN:ND2	2.13	0.64
1:AaA:300:GLU:HG2	1:AaA:301:CYS:N	2.20	0.55
1:AaA:300:GLU:CG	1:AaA:301:CYS:N	2.71	0.53
1:AaA:191[B]:ARG:NH1	1:AaA:229:PHE:HA	2.24	0.53
1:AaA:253:GLY:HA2	1:AaA:306:VAL:CG1	2.40	0.51
1:AaA:127:GLY:HA2	1:AaA:263:MET:SD	2.51	0.51
1:AaA:191[B]:ARG:HG3	1:AaA:229:PHE:CZ	2.49	0.47
1:AaA:272:TYR:OH	1:AaA:301:CYS:HB3	2.21	0.41
1:AaA:276:VAL:HG21	1:AaA:295:LEU:HD21	2.03	0.40
1:AaA:171:ARG:NH2	1:AaA:211:ASP:OD1	2.45	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	259/295 (88%)	255 (98%)	4 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 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	239/263 (91%)	232 (97%)	7 (3%)	37 9

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	AaA	119[A]	GLN
1	AaA	119[B]	GLN
1	AaA	280	ILE
1	AaA	299	ARG
1	AaA	301	CYS
1	AaA	304	ASP
1	AaA	335	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 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](#)

4 ligands are 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	$\# Z  > 2$
3	SO4	AaA	403	-	4,4,4	0.36	0	6,6,6	0.14	0
4	GOL	AaA	404	-	5,5,5	0.20	0	5,5,5	0.64	0
2	AlIOW	AaA	401	-	22,22,22	0.59	0	29,34,34	0.84	0
3	SO4	AaA	402	-	4,4,4	0.58	0	6,6,6	0.35	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	AlIOW	AaA	401	-	-	0/11/35/35	0/4/3/3
4	GOL	AaA	404	-	-	0/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

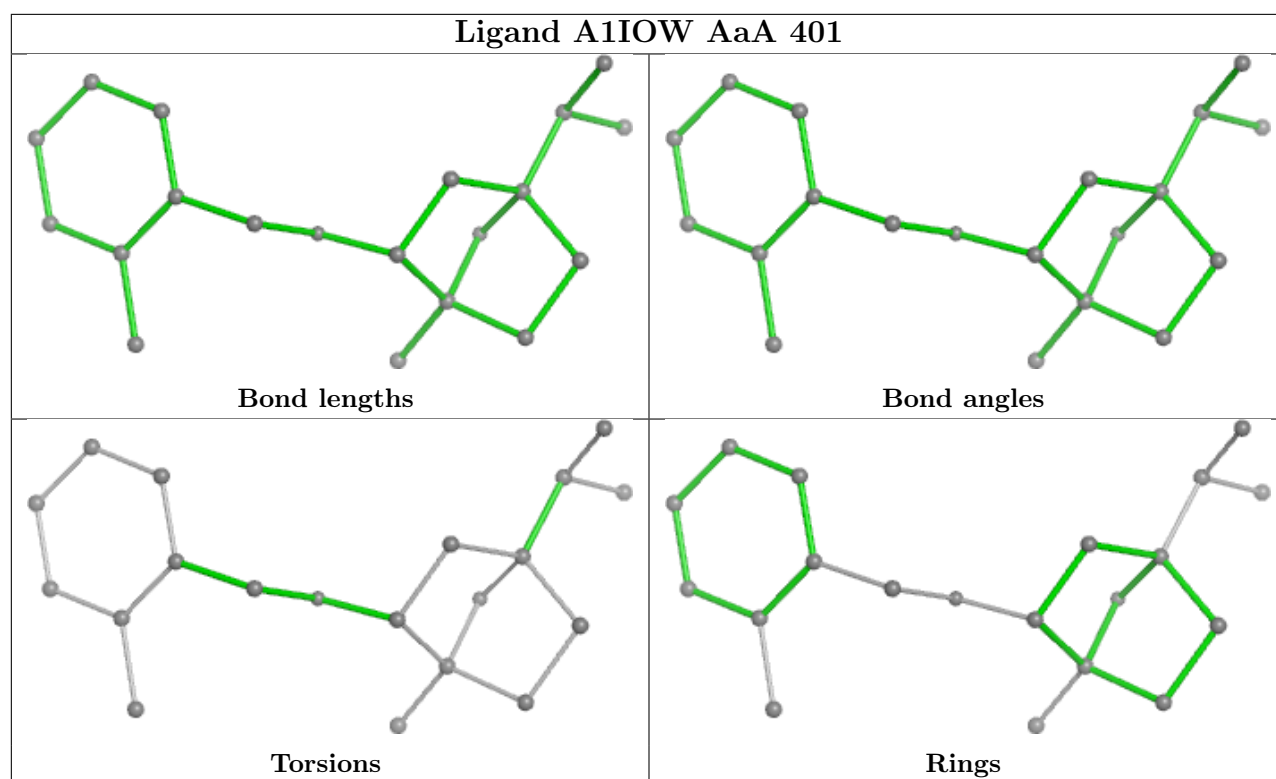
There are no chirality outliers.

There are no torsion outliers.

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 [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<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	AaA	258/295 (87%)	1.01	54 (20%) 3 2	11, 23, 43, 53	10 (3%)

All (54) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	AaA	128	PHE	6.2
1	AaA	304	ASP	4.8
1	AaA	127	GLY	4.7
1	AaA	267	VAL	4.6
1	AaA	256	PRO	4.4
1	AaA	156[A]	TRP	4.4
1	AaA	306	VAL	4.0
1	AaA	305	ASP	3.9
1	AaA	266	HIS	3.7
1	AaA	299	ARG	3.7
1	AaA	349[A]	ILE	3.7
1	AaA	98	ASN	3.6
1	AaA	255	LYS	3.5
1	AaA	261	LEU	3.5
1	AaA	229	PHE	3.5
1	AaA	307	VAL	3.5
1	AaA	239	LYS	3.4
1	AaA	184	VAL	3.4
1	AaA	342	LEU	3.4
1	AaA	269	ASN	3.4
1	AaA	300	GLU	3.3
1	AaA	253	GLY	3.2
1	AaA	315	SER	3.2
1	AaA	185	THR	3.1
1	AaA	187	GLU	3.1
1	AaA	303	GLN	3.1
1	AaA	297	TYR	3.0

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Mol	Chain	Res	Type	RSRZ
1	AaA	301	CYS	3.0
1	AaA	254	LEU	3.0
1	AaA	124	SER	2.9
1	AaA	97	SER	2.9
1	AaA	268	ASN	2.9
1	AaA	123	PHE	2.8
1	AaA	302	GLN	2.8
1	AaA	126	ASP	2.8
1	AaA	272	TYR	2.8
1	AaA	350	ASN	2.7
1	AaA	246	PRO	2.6
1	AaA	244	GLU	2.6
1	AaA	359	LYS	2.6
1	AaA	265	GLN	2.6
1	AaA	204	ARG	2.6
1	AaA	298	ARG	2.6
1	AaA	155[A]	ALA	2.5
1	AaA	207	GLN	2.5
1	AaA	358	LYS	2.4
1	AaA	240	ILE	2.3
1	AaA	245	ASP	2.3
1	AaA	264	ASN	2.2
1	AaA	333	ASP	2.2
1	AaA	284	ILE	2.2
1	AaA	121	VAL	2.2
1	AaA	135	ARG	2.1
1	AaA	251	MET	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 monosaccharides in this entry.

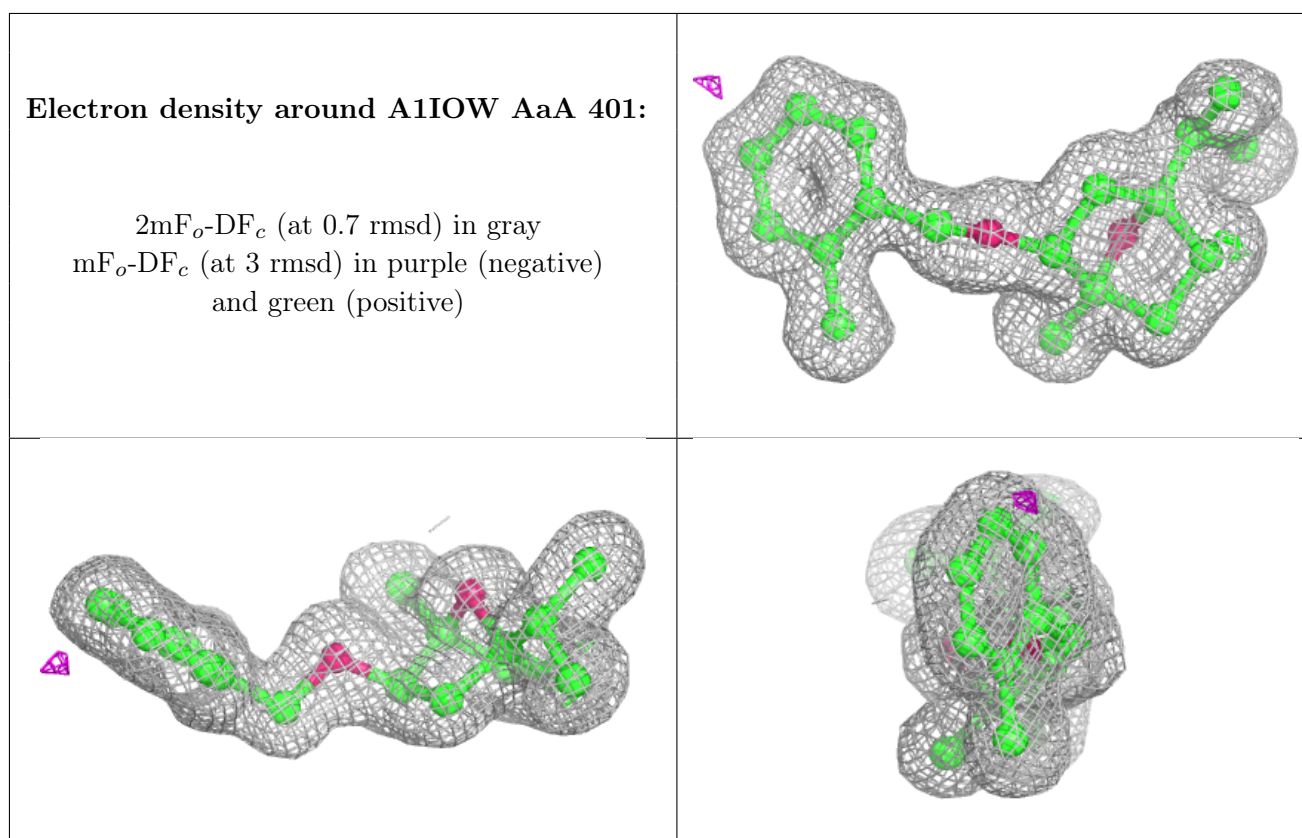
## 6.4 Ligands [i](#)

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<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(Å <sup>2</sup> )	Q<0.9
3	SO4	AaA	403	5/5	0.83	0.18	25,26,27,29	5
4	GOL	AaA	404	6/6	0.90	0.12	29,35,39,41	0
2	A1IOW	AaA	401	20/20	0.96	0.07	15,17,19,20	0
3	SO4	AaA	402	5/5	0.99	0.05	13,14,16,16	5

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 ⓘ

There are no such residues in this entry.