



# wwPDB X-ray Structure Validation Summary Report ⓘ

Nov 19, 2023 – 07:45 PM JST

PDB ID : 6M4L  
Title : X-ray crystal structure of the E249Q mutant of alpha-amylase I from *Eisenia fetida*  
Authors : Hirano, Y.; Tsukamoto, K.; Ariki, S.; Naka, Y.; Ueda, M.; Tamada, T.  
Deposited on : 2020-03-07  
Resolution : 1.60 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](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>.

---

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 : 2.36  
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

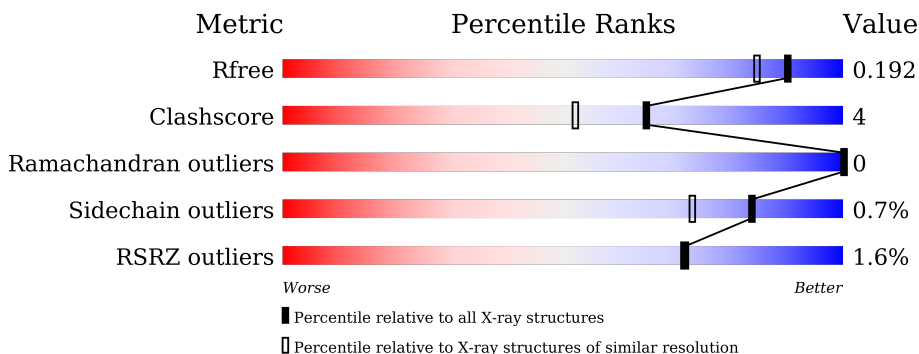
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.60 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	3398 (1.60-1.60)
Clashscore	141614	3665 (1.60-1.60)
Ramachandran outliers	138981	3564 (1.60-1.60)
Sidechain outliers	138945	3563 (1.60-1.60)
RSRZ outliers	127900	3321 (1.60-1.60)

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	A	520	

## 2 Entry composition [i](#)

There are 10 unique types of molecules in this entry. The entry contains 4993 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 Alpha-amylase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	496	4378	2737	776	839	26	0	60	0

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	14	GLU	-	expression tag	UNP A0A173N065
A	15	ALA	-	expression tag	UNP A0A173N065
A	16	GLU	-	expression tag	UNP A0A173N065
A	17	PHE	-	expression tag	UNP A0A173N065
A	249	GLN	GLU	engineered mutation	UNP A0A173N065
A	511	PHE	-	expression tag	UNP A0A173N065
A	512	LEU	-	expression tag	UNP A0A173N065
A	513	GLU	-	expression tag	UNP A0A173N065
A	514	GLN	-	expression tag	UNP A0A173N065
A	515	LYS	-	expression tag	UNP A0A173N065
A	516	LEU	-	expression tag	UNP A0A173N065
A	517	ILE	-	expression tag	UNP A0A173N065
A	518	SER	-	expression tag	UNP A0A173N065
A	519	GLU	-	expression tag	UNP A0A173N065
A	520	GLU	-	expression tag	UNP A0A173N065
A	521	ASP	-	expression tag	UNP A0A173N065
A	522	LEU	-	expression tag	UNP A0A173N065
A	523	ASN	-	expression tag	UNP A0A173N065
A	524	SER	-	expression tag	UNP A0A173N065
A	525	ALA	-	expression tag	UNP A0A173N065
A	526	VAL	-	expression tag	UNP A0A173N065
A	527	ASP	-	expression tag	UNP A0A173N065
A	528	HIS	-	expression tag	UNP A0A173N065
A	529	HIS	-	expression tag	UNP A0A173N065
A	530	HIS	-	expression tag	UNP A0A173N065
A	531	HIS	-	expression tag	UNP A0A173N065
A	532	HIS	-	expression tag	UNP A0A173N065

*Continued on next page...*

Continued from previous page...

Chain	Residue	Modelled	Actual	Comment	Reference
A	533	HIS	-	expression tag	UNP A0A173N065

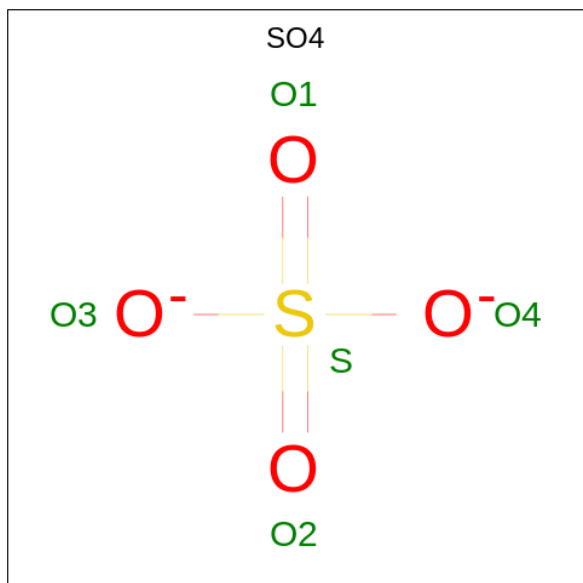
- Molecule 2 is CALCIUM ION (three-letter code: CA) (formula: Ca) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total Ca 1 1	0	0

- Molecule 3 is CHLORIDE ION (three-letter code: CL) (formula: Cl) (labeled as "Ligand of Interest" by depositor).

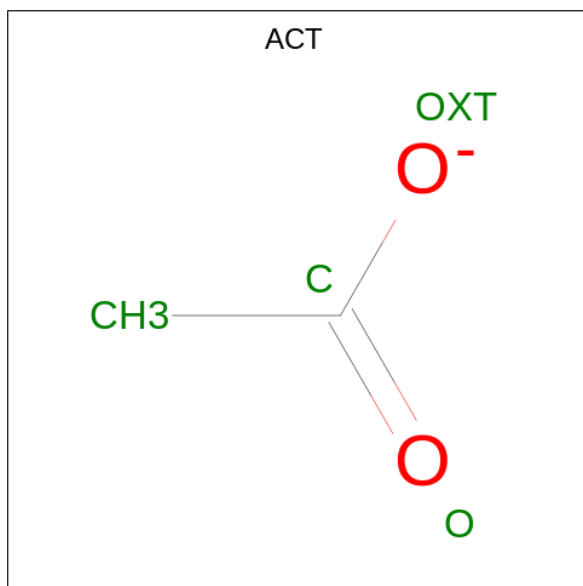
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Cl 1 1	0	0

- Molecule 4 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).



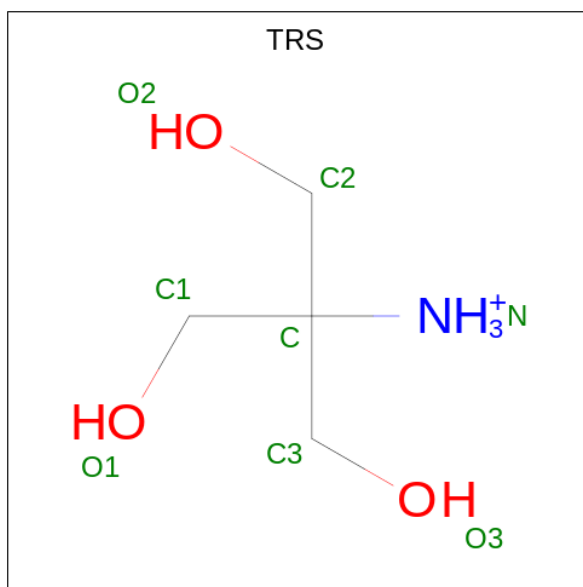
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total O S 10 8 2	0	1
4	A	1	Total O S 10 8 2	0	1
4	A	1	Total O S 5 4 1	0	0

- Molecule 5 is ACETATE ION (three-letter code: ACT) (formula:  $C_2H_3O_2$ ).



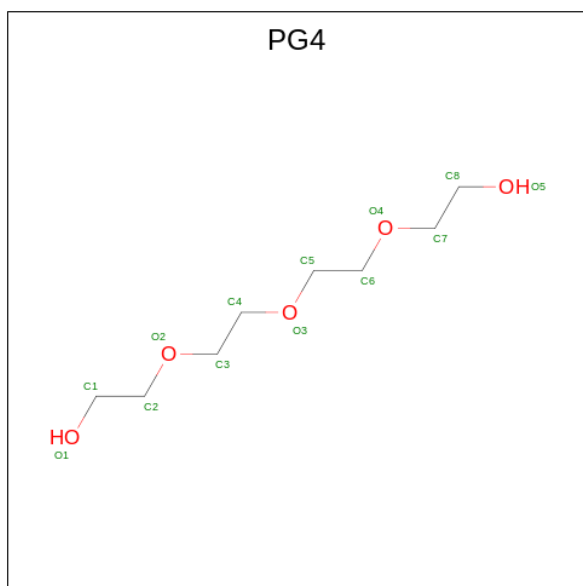
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	1	Total C O 4 2 2	0	0
5	A	1	Total C O 4 2 2	0	0

- Molecule 6 is 2-AMINO-2-HYDROXYMETHYL-PROPANE-1,3-DIOL (three-letter code: TRS) (formula:  $C_4H_{12}NO_3$ ).



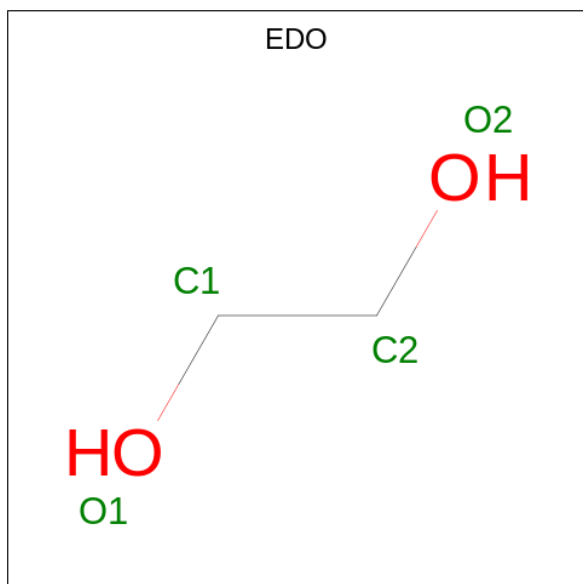
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	
			Total	C	N			O
6	A	1	8	4	1	3	0	0

- Molecule 7 is TETRAETHYLENE GLYCOL (three-letter code: PG4) (formula: C<sub>8</sub>H<sub>18</sub>O<sub>5</sub>).



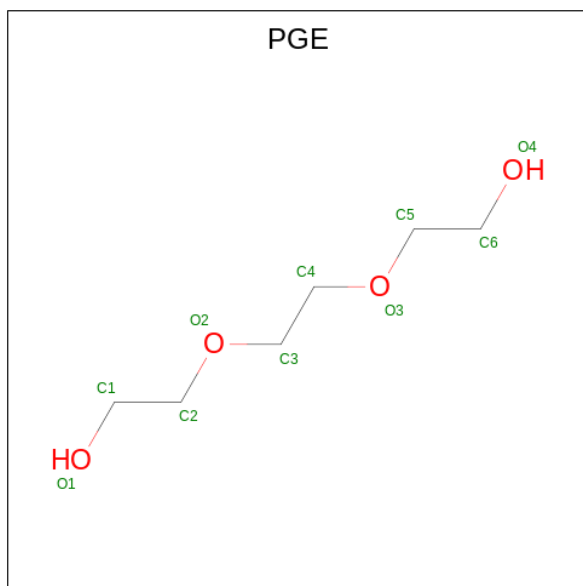
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
7	A	1	13	8	5	0	0
7	A	1	13	8	5	0	0

- Molecule 8 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C<sub>2</sub>H<sub>6</sub>O<sub>2</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
8	A	1	Total	C	O	0	0
			4	2	2		
8	A	1	Total	C	O	0	0
			4	2	2		
8	A	1	Total	C	O	0	0
			4	2	2		

- Molecule 9 is TRIETHYLENE GLYCOL (three-letter code: PGE) (formula: C<sub>6</sub>H<sub>14</sub>O<sub>4</sub>).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
9	A	1	Total	C	O	0	0
			10	6	4		

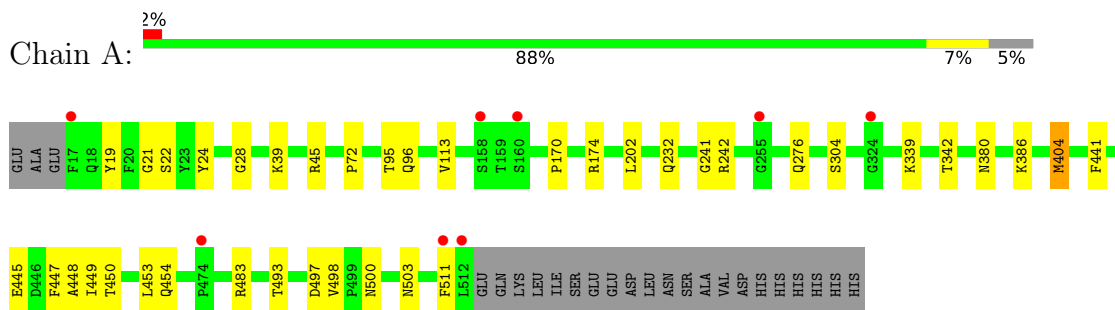
- Molecule 10 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	A	515	Total	O	0	9
			524	524		

### 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: Alpha-amylase





## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	96.90Å 96.90Å 121.96Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	41.96 – 1.60 49.33 – 1.60	Depositor EDS
% Data completeness (in resolution range)	99.9 (41.96-1.60) 99.9 (49.33-1.60)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.79 (at 1.60Å)	Xtrriage
Refinement program	PHENIX 1.10.1_2155	Depositor
R, $R_{free}$	0.168 , 0.190 0.168 , 0.192	Depositor DCC
$R_{free}$ test set	4354 reflections (4.97%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	19.9	Xtrriage
Anisotropy	0.258	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.35 , 49.2	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.018 for -h,-k,l	Xtrriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	4993	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	23.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.48% 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: PGE, CA, ACT, CL, EDO, SO4, PG4, TRS

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	0.36	0/4504	0.56	0/6126

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	4378	0	3963	30	0
2	A	1	0	0	0	0
3	A	1	0	0	0	0
4	A	25	0	0	0	0
5	A	8	0	6	0	0
6	A	8	0	12	3	0
7	A	26	0	36	7	0
8	A	12	0	18	1	0
9	A	10	0	14	1	0
10	A	524	0	0	6	0
All	All	4993	0	4049	35	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 4.

The worst 5 of 35 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:96:GLN:HE22	6:A:608:TRS:H12	1.34	0.92
1:A:45[B]:ARG:NH2	10:A:702:HOH:O	2.04	0.88
1:A:386[B]:LYS:HE3	7:A:614:PG4:H31	1.57	0.85
1:A:22[A]:SER:OG	10:A:701[A]:HOH:O	1.96	0.83
1:A:22[B]:SER:OG	10:A:982[B]:HOH:O	2.09	0.71

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	553/520 (106%)	538 (97%)	15 (3%)	0	<a href="#">100</a> <a href="#">100</a>

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	A	458/431 (106%)	454 (99%)	4 (1%)	<a href="#">78</a> <a href="#">65</a>

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

Mol	Chain	Res	Type
1	A	304	SER
1	A	404[A]	MET
1	A	404[B]	MET
1	A	511	PHE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	364	ASN
1	A	380	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 16 ligands modelled in this entry, 2 are monoatomic - leaving 14 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	$\# Z  > 2$
4	SO4	A	603[B]	-	4,4,4	0.18	0	6,6,6	0.06	0
4	SO4	A	604[A]	-	4,4,4	0.13	0	6,6,6	0.07	0
4	SO4	A	605	-	4,4,4	0.15	0	6,6,6	0.08	0
7	PG4	A	614	-	12,12,12	0.50	0	11,11,11	0.28	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
8	EDO	A	610	-	3,3,3	0.53	0	2,2,2	0.28	0
5	ACT	A	607	-	3,3,3	0.79	0	3,3,3	1.37	0
8	EDO	A	612	-	3,3,3	0.44	0	2,2,2	0.37	0
4	SO4	A	603[A]	-	4,4,4	0.16	0	6,6,6	0.06	0
5	ACT	A	606	-	3,3,3	0.69	0	3,3,3	1.54	0
7	PG4	A	609	-	12,12,12	0.52	0	11,11,11	0.22	0
8	EDO	A	611	-	3,3,3	0.48	0	2,2,2	0.40	0
6	TRS	A	608	-	7,7,7	0.35	0	9,9,9	0.40	0
4	SO4	A	604[B]	-	4,4,4	0.14	0	6,6,6	0.06	0
9	PGE	A	613	-	9,9,9	0.33	0	8,8,8	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
7	PG4	A	614	-	-	7/10/10/10	-
8	EDO	A	610	-	-	0/1/1/1	-
8	EDO	A	612	-	-	1/1/1/1	-
7	PG4	A	609	-	-	1/10/10/10	-
8	EDO	A	611	-	-	0/1/1/1	-
6	TRS	A	608	-	-	6/9/9/9	-
9	PGE	A	613	-	-	4/7/7/7	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

5 of 19 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	A	608	TRS	N-C-C2-O2
6	A	608	TRS	C2-C-C3-O3
6	A	608	TRS	N-C-C3-O3
9	A	613	PGE	C3-C4-O3-C5
7	A	614	PG4	O2-C3-C4-O3

There are no ring outliers.

5 monomers are involved in 12 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
7	A	614	PG4	6	0
8	A	610	EDO	1	0
7	A	609	PG4	1	0
6	A	608	TRS	3	0
9	A	613	PGE	1	0

## 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, 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	496/520 (95%)	-0.32	8 (1%) 72 71	14, 21, 32, 59	0

The worst 5 of 8 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	512	LEU	4.1
1	A	511	PHE	3.9
1	A	324[A]	GLY	2.9
1	A	474	PRO	2.6
1	A	17[A]	PHE	2.5

### 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
7	PG4	A	614	13/13	0.68	0.25	27,36,43,44	13
8	EDO	A	612	4/4	0.79	0.10	45,50,52,56	0

*Continued on next page...*

*Continued from previous page...*

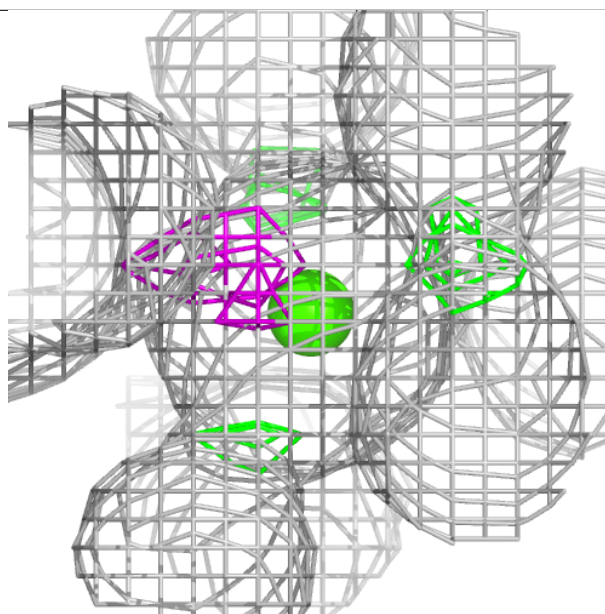
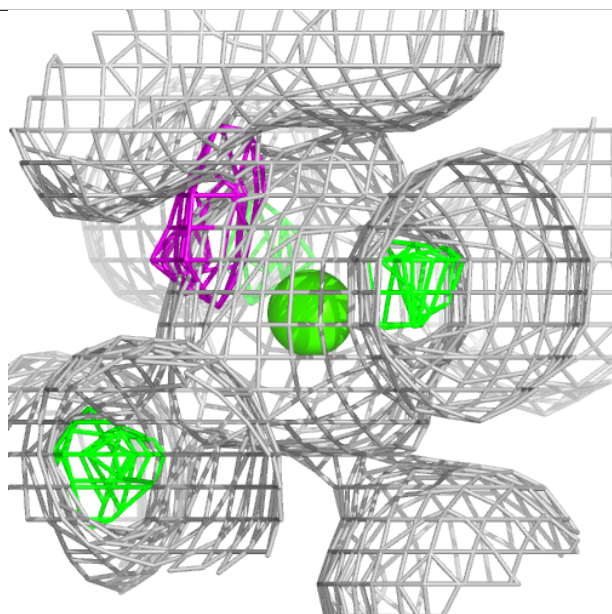
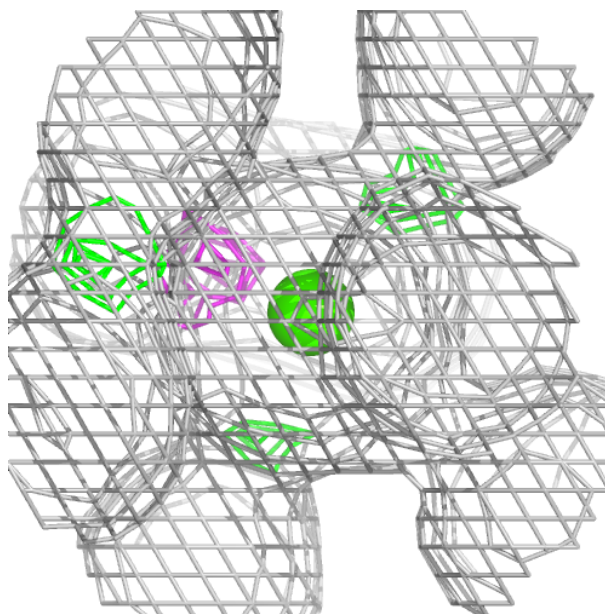
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
8	EDO	A	610	4/4	0.81	0.11	30,36,40,41	0
6	TRS	A	608	8/8	0.81	0.26	29,51,59,59	0
9	PGE	A	613	10/10	0.85	0.17	44,52,58,59	0
8	EDO	A	611	4/4	0.89	0.09	35,39,51,52	0
5	ACT	A	607	4/4	0.92	0.12	42,45,47,48	0
4	SO4	A	604[B]	5/5	0.93	0.26	53,54,63,65	5
5	ACT	A	606	4/4	0.93	0.17	17,24,24,33	4
4	SO4	A	604[A]	5/5	0.93	0.26	50,51,61,65	5
7	PG4	A	609	13/13	0.95	0.12	23,28,32,34	13
4	SO4	A	603[A]	5/5	0.96	0.09	21,23,29,30	5
4	SO4	A	603[B]	5/5	0.96	0.09	20,25,32,32	5
4	SO4	A	605	5/5	0.96	0.08	42,42,45,47	5
2	CA	A	601	1/1	0.99	0.06	18,18,18,18	0
3	CL	A	602	1/1	1.00	0.09	16,16,16,16	0

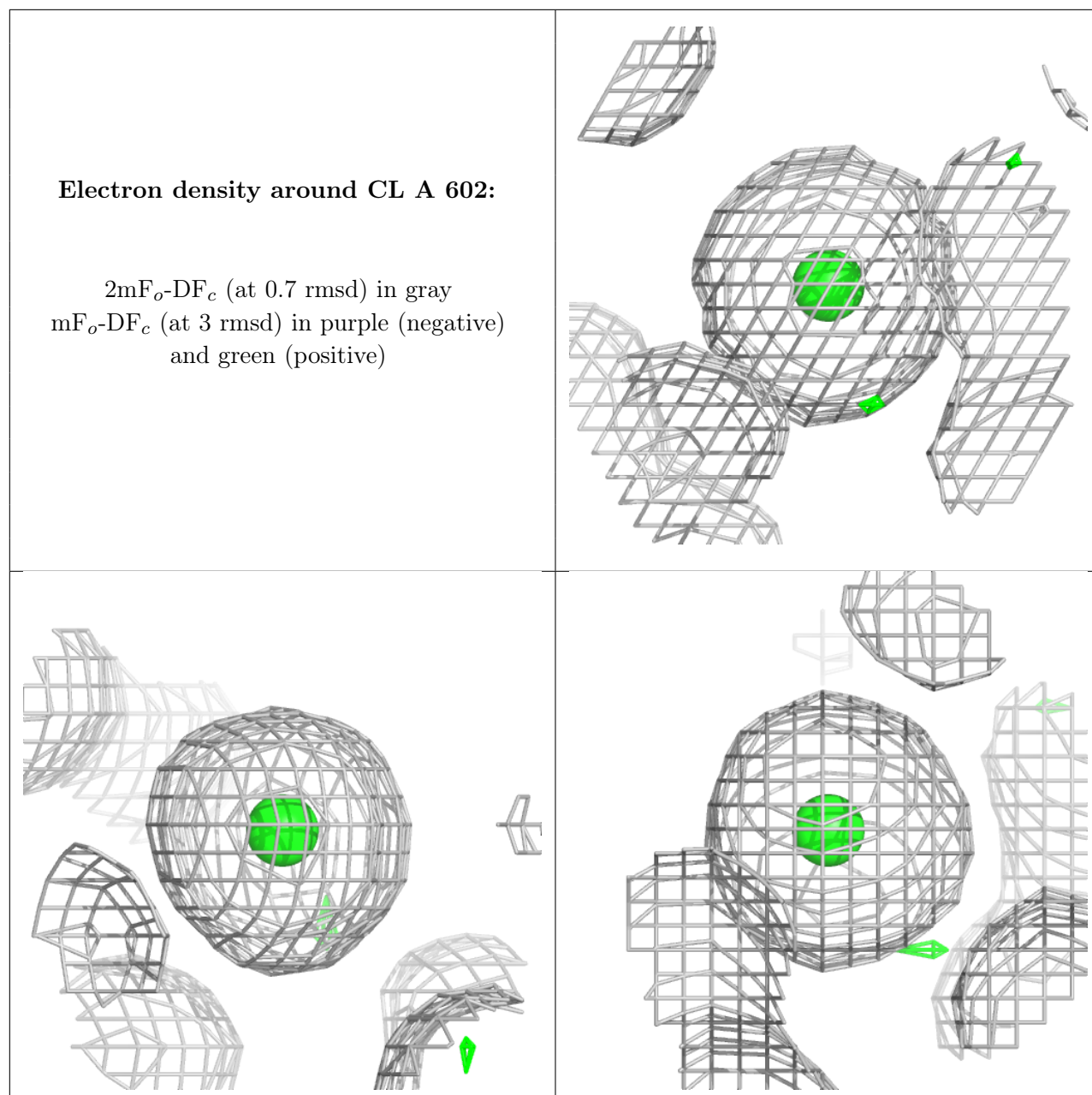
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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



**Electron density around CA 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)





## 6.5 Other polymers ⓘ

There are no such residues in this entry.