



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 9, 2026 – 09:26 PM UTC

PDB ID : 5NM4 / pdb\_00005nm4  
Title : A2A Adenosine receptor room-temperature structure determined by serial femtosecond crystallography  
Authors : Weinert, T.; Cheng, R.; James, D.; Gashi, D.; Nogly, P.; Jaeger, K.; Hennig, M.; Standfuss, J.  
Deposited on : 2017-04-05  
Resolution : 1.70 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>.

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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 Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtrriage (Phenix) : 2.0  
EDS : 3.0  
Buster-report : wwPDB partial adaption of 1.1.7 (2018)  
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)  
CCP4 : 9.0.010 (Gargrove)  
Density-Fitness : 1.0.12  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.49

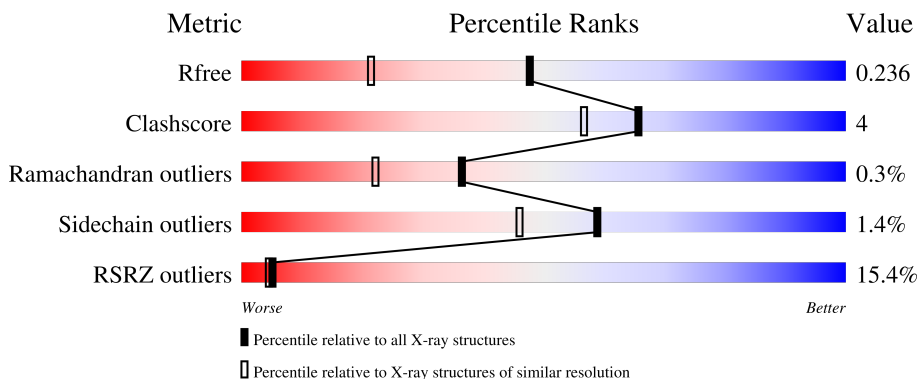
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.70 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))
$R_{free}$	180053	5551 (1.70-1.70)
Clashscore	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)
RSRZ outliers	180081	5554 (1.70-1.70)

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	433	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
2	OLA	A	503	-	-	-	X

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 6377 atoms, of which 3220 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 Adenosine receptor A2a,Soluble cytochrome b562,Adenosine receptor A2a.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace	
			Total	C	H	N	O				S
1	A	382	5825	1911	2926	472	494	22	0	11	0

There are 33 discrepancies between the modelled and reference sequences:

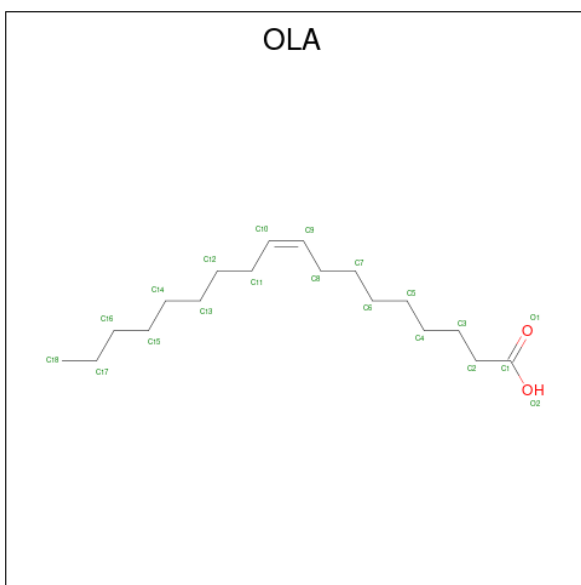
Chain	Residue	Modelled	Actual	Comment	Reference
A	1	ASP	-	expression tag	UNP P29274
A	2	TYR	-	expression tag	UNP P29274
A	3	LYS	-	expression tag	UNP P29274
A	4	ASP	-	expression tag	UNP P29274
A	5	ASP	-	expression tag	UNP P29274
A	6	ASP	-	expression tag	UNP P29274
A	7	ASP	-	expression tag	UNP P29274
A	8	GLY	-	expression tag	UNP P29274
A	9	ALA	-	expression tag	UNP P29274
A	10	PRO	-	expression tag	UNP P29274
A	63	LEU	ALA	engineered mutation	UNP P29274
A	97	ALA	THR	engineered mutation	UNP P29274
A	116	ALA	ARG	engineered mutation	UNP P29274
A	131	ALA	LYS	engineered mutation	UNP P29274
A	163	ALA	ASN	engineered mutation	UNP P29274
A	211	ALA	LEU	engineered mutation	UNP P29274
A	224	TRP	MET	conflict	UNP P0ABE7
A	319	ILE	HIS	conflict	UNP P0ABE7
A	323	LEU	-	linker	UNP P0ABE7
A	340	ALA	LEU	engineered mutation	UNP P29274
A	344	ALA	VAL	engineered mutation	UNP P29274
A	382	ALA	SER	engineered mutation	UNP P29274
A	423	ALA	-	expression tag	UNP P29274
A	424	HIS	-	expression tag	UNP P29274
A	425	HIS	-	expression tag	UNP P29274
A	426	HIS	-	expression tag	UNP P29274

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Chain	Residue	Modelled	Actual	Comment	Reference
A	427	HIS	-	expression tag	UNP P29274
A	428	HIS	-	expression tag	UNP P29274
A	429	HIS	-	expression tag	UNP P29274
A	430	HIS	-	expression tag	UNP P29274
A	431	HIS	-	expression tag	UNP P29274
A	432	HIS	-	expression tag	UNP P29274
A	433	HIS	-	expression tag	UNP P29274

- Molecule 2 is OLEIC ACID (CCD ID: OLA) (formula:  $C_{18}H_{34}O_2$ ).

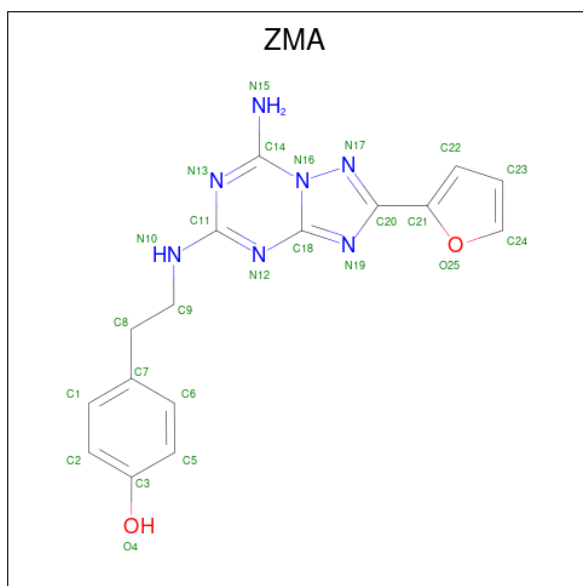


Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
2	A	1	Total	C	H	O	0	0
			53	18	33	2		
2	A	1	Total	C	H	O	0	0
			53	18	33	2		
2	A	1	Total	C	H	O	0	0
			31	11	18	2		
2	A	1	Total	C	H	O	0	0
			53	18	33	2		
2	A	1	Total	C	H	O	0	0
			40	14	24	2		

- Molecule 3 is SODIUM ION (CCD ID: NA) (formula: Na).

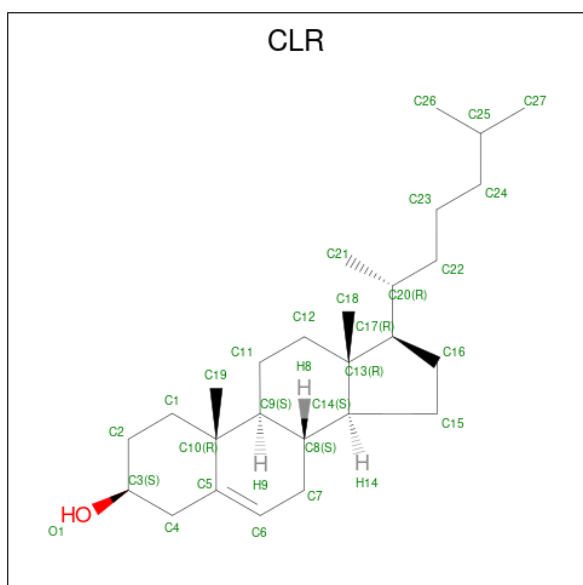
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Na 1 1	0	0

- Molecule 4 is 4-{2-[(7-amino-2-furan-2-yl[1,2,4]triazolo[1,5-a][1,3,5]triazin-5-yl)amino]ethyl} phenol (CCD ID: ZMA) (formula: C<sub>16</sub>H<sub>15</sub>N<sub>7</sub>O<sub>2</sub>).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total C H N O 40 16 15 7 2	0	0

- Molecule 5 is CHOLESTEROL (CCD ID: CLR) (formula: C<sub>27</sub>H<sub>46</sub>O).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	C	H	O	0	0
			74	27	46	1		
5	A	1	Total	C	H	O	0	0
			74	27	46	1		
5	A	1	Total	C	H	O	0	0
			74	27	46	1		

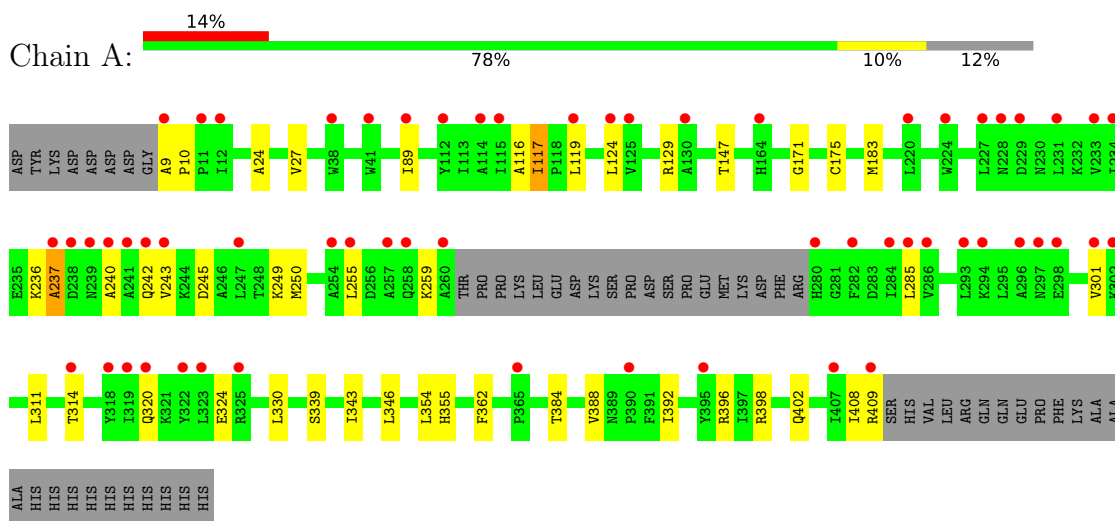
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	59	Total	O	0	0
			59	59		

### 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: Adenosine receptor A2a,Soluble cytochrome b562,Adenosine receptor A2a



## 4 Data and refinement statistics

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	39.89Å 179.15Å 141.20Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	19.59 – 1.70 19.59 – 1.70	Depositor EDS
% Data completeness (in resolution range)	94.7 (19.59-1.70) 94.6 (19.59-1.70)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.08 (at 1.70Å)	Xtrriage
Refinement program	PHENIX (1.10.1_2155: ???)	Depositor
R, $R_{free}$	0.212 , 0.235 0.214 , 0.236	Depositor DCC
$R_{free}$ test set	2607 reflections (4.63%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	40.8	Xtrriage
Anisotropy	0.037	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.46 , 85.0	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.43$ , $\langle L^2 \rangle = 0.26$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	6377	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	70.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.73% 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: NA, OLA, ZMA, CLR

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	0.58	0/2996	0.65	0/4098

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	2899	2926	2925	24	0
2	A	89	141	137	0	0
3	A	1	0	0	0	0
4	A	25	15	15	2	0
5	A	84	138	138	0	0
6	A	59	0	0	1	0
All	All	3157	3220	3215	24	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 24 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:320:GLN:NE2	1:A:324:GLU:OE2	2.19	0.75
1:A:171:GLY:O	6:A:601:HOH:O	2.11	0.69
1:A:255:LEU:O	1:A:259:LYS:N	2.38	0.55
1:A:245:ASP:OD1	1:A:249:LYS:NZ	2.39	0.55
1:A:339:SER:OG	1:A:396:ARG:HD3	2.07	0.55

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	389/433 (90%)	382 (98%)	6 (2%)	1 (0%)	36 22

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	237	ALA

### 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	292/353 (83%)	288 (99%)	4 (1%)	59 46

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

Mol	Chain	Res	Type
1	A	117	ILE
1	A	147	THR
1	A	285	LEU
1	A	330	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	33	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 oligosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 10 ligands modelled in this entry, 1 is monoatomic - leaving 9 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	$\# Z  > 2$
2	OLA	A	503	-	12,12,19	0.89	0	12,12,19	1.19	0
5	CLR	A	510	-	31,31,31	0.15	0	48,48,48	0.30	0
5	CLR	A	509	-	31,31,31	0.14	0	48,48,48	0.30	0
2	OLA	A	501	-	19,19,19	0.72	0	19,19,19	1.06	1 (5%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z  > 2	Counts	RMSZ	# Z  > 2
4	ZMA	A	507	-	26,28,28	1.71	5 (19%)	30,39,39	1.99	8 (26%)
2	OLA	A	502	-	19,19,19	0.74	0	19,19,19	0.97	0
5	CLR	A	508	-	31,31,31	0.16	0	48,48,48	0.32	0
2	OLA	A	504	-	19,19,19	0.73	0	19,19,19	1.04	0
2	OLA	A	505	-	15,15,19	0.82	0	15,15,19	1.00	1 (6%)

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	OLA	A	503	-	-	1/10/10/17	-
5	CLR	A	510	-	-	0/10/68/68	0/4/4/4
5	CLR	A	509	-	-	1/10/68/68	0/4/4/4
2	OLA	A	501	-	-	3/17/17/17	-
4	ZMA	A	507	-	-	0/10/10/10	0/4/4/4
2	OLA	A	502	-	-	12/17/17/17	-
5	CLR	A	508	-	-	0/10/68/68	0/4/4/4
2	OLA	A	504	-	-	7/17/17/17	-
2	OLA	A	505	-	-	6/13/13/17	-

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	507	ZMA	C18-N16	-4.82	1.31	1.38
4	A	507	ZMA	C14-N15	3.12	1.39	1.34
4	A	507	ZMA	C14-N16	-2.82	1.34	1.37
4	A	507	ZMA	O4-C3	2.70	1.43	1.37
4	A	507	ZMA	C20-N17	-2.13	1.30	1.33

The worst 5 of 10 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	507	ZMA	N15-C14-N16	5.35	125.03	118.32
4	A	507	ZMA	C9-C8-C7	-4.99	101.59	112.83
4	A	507	ZMA	C20-N17-N16	3.10	104.59	101.39
4	A	507	ZMA	N16-C18-N12	-2.83	120.14	122.61
4	A	507	ZMA	N17-C20-N19	-2.81	112.20	115.38

There are no chirality outliers.

5 of 30 torsion outliers are listed below:

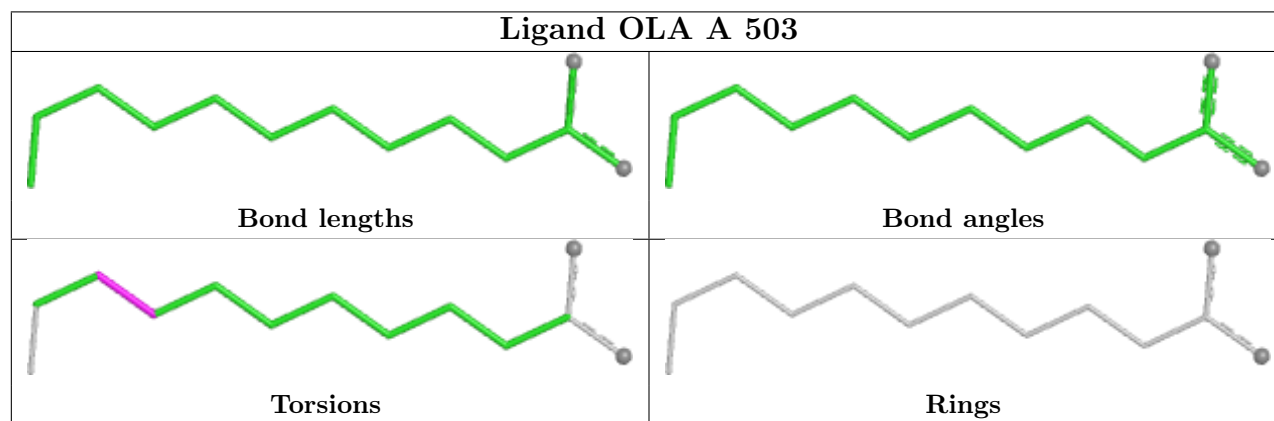
Mol	Chain	Res	Type	Atoms
5	A	509	CLR	C22-C23-C24-C25
2	A	502	OLA	C3-C4-C5-C6
2	A	502	OLA	C11-C12-C13-C14
2	A	502	OLA	C12-C13-C14-C15
2	A	505	OLA	C10-C11-C12-C13

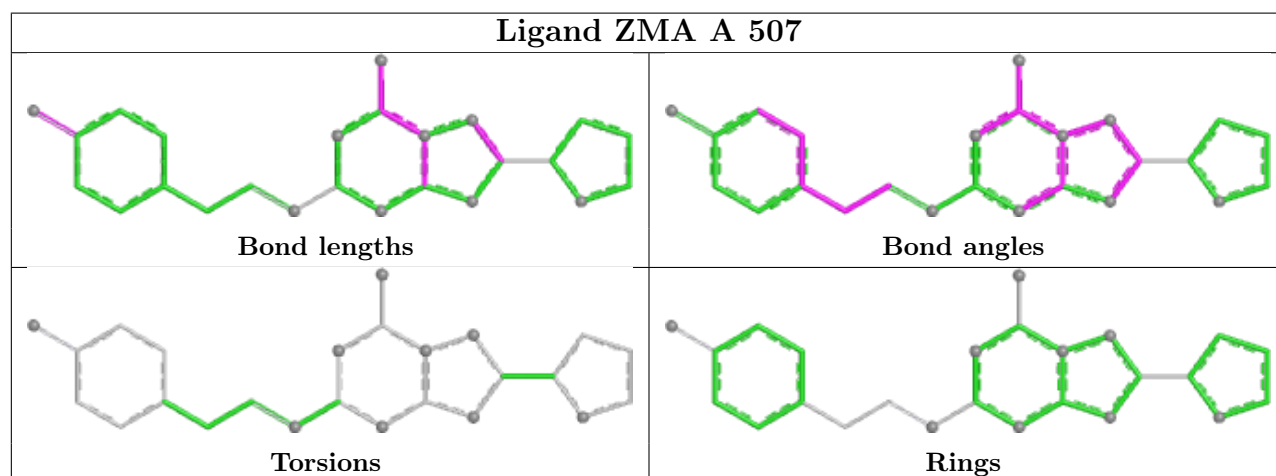
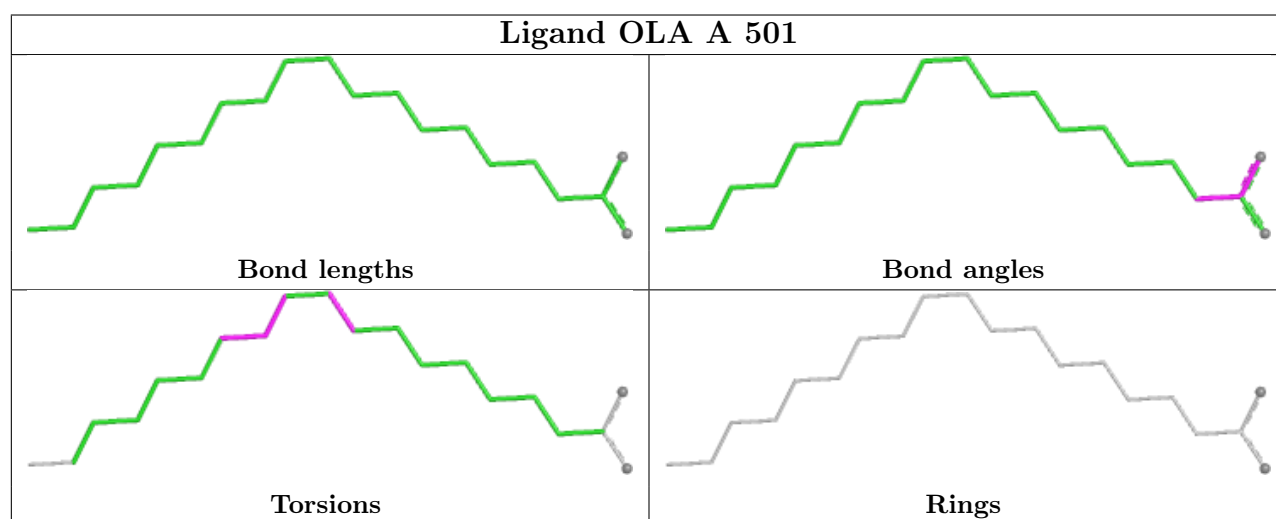
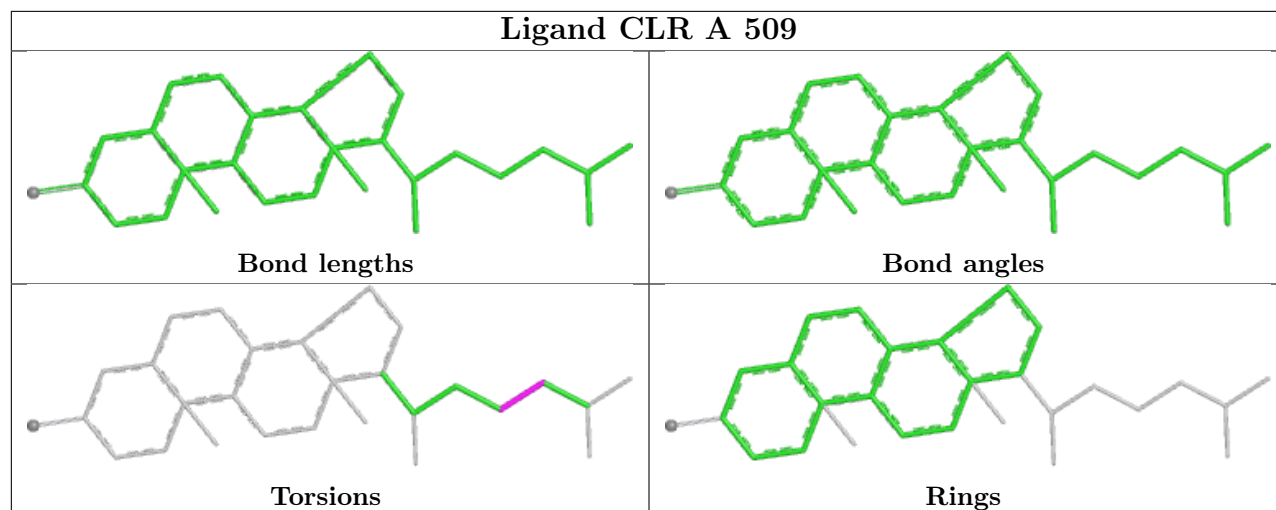
There are no ring outliers.

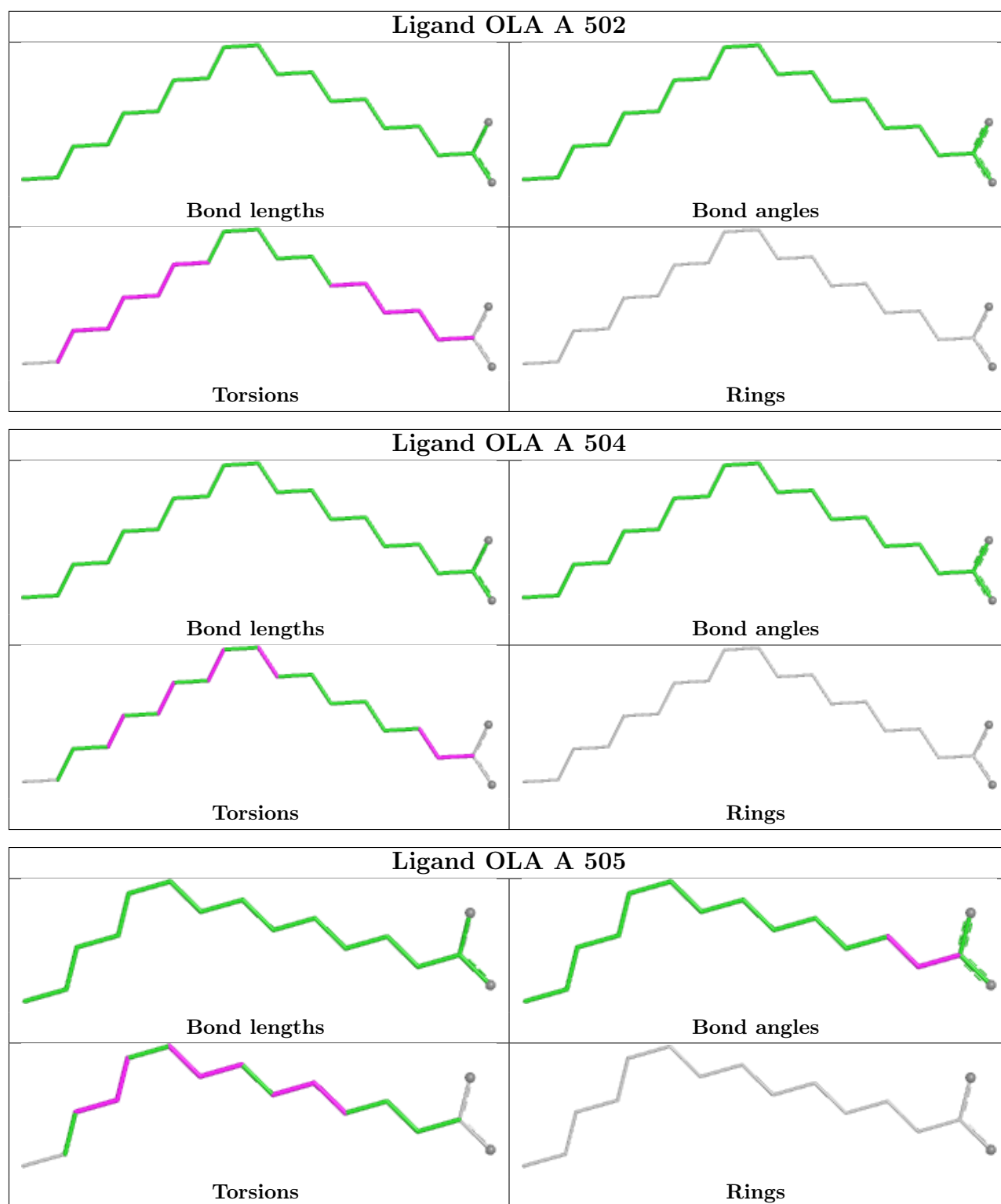
1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	507	ZMA	2	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 [\(i\)](#)

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, 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	382/433 (88%)	0.93	59 (15%) <b>5</b> <b>4</b>	23, 57, 112, 164	11 (2%)

The worst 5 of 59 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	280	HIS	7.7
1	A	390	PRO	5.9
1	A	409	ARG	5.0
1	A	229	ASP	4.2
1	A	227	LEU	4.0

### 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 oligosaccharides 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.

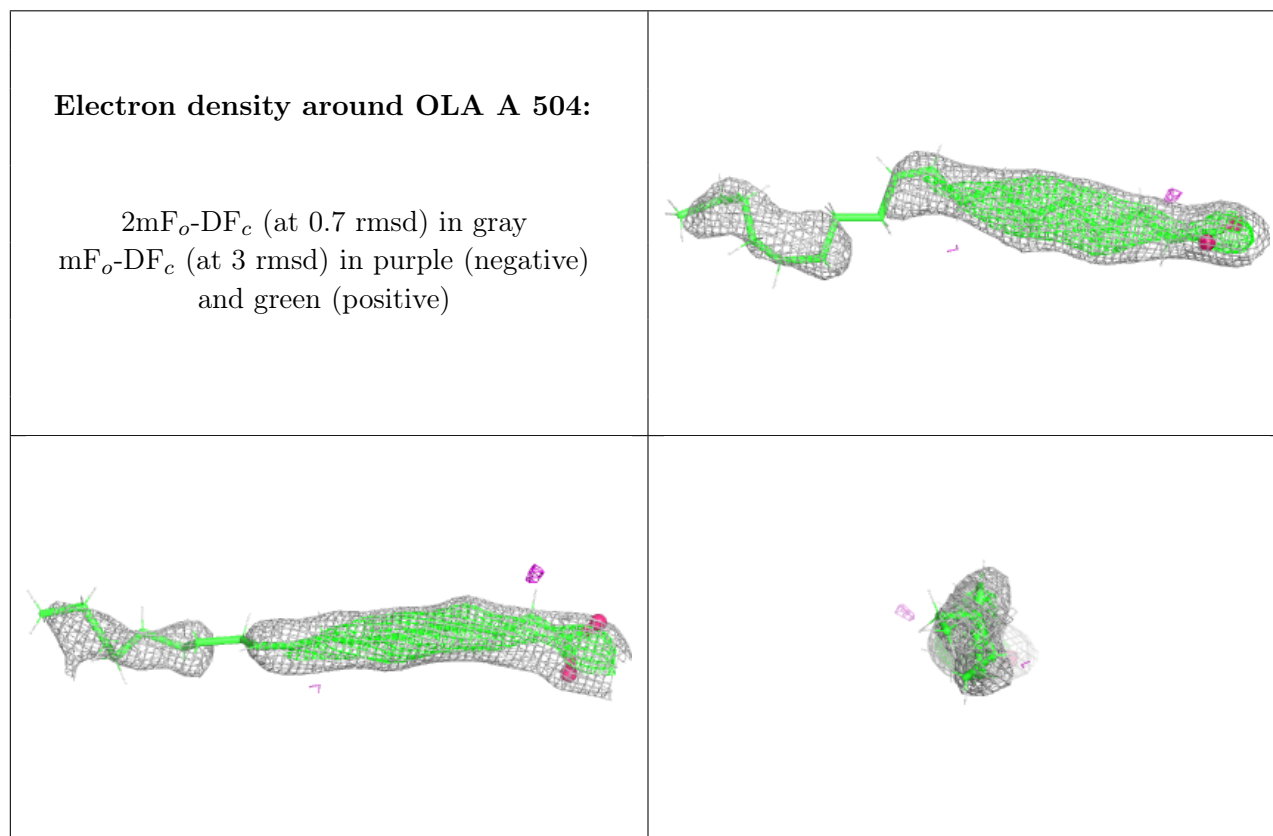
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
2	OLA	A	504	20/20	0.76	0.38	104,157,196,197	0
2	OLA	A	503	13/20	<b>0.78</b>	<b>0.47</b>	142,188,226,227	0

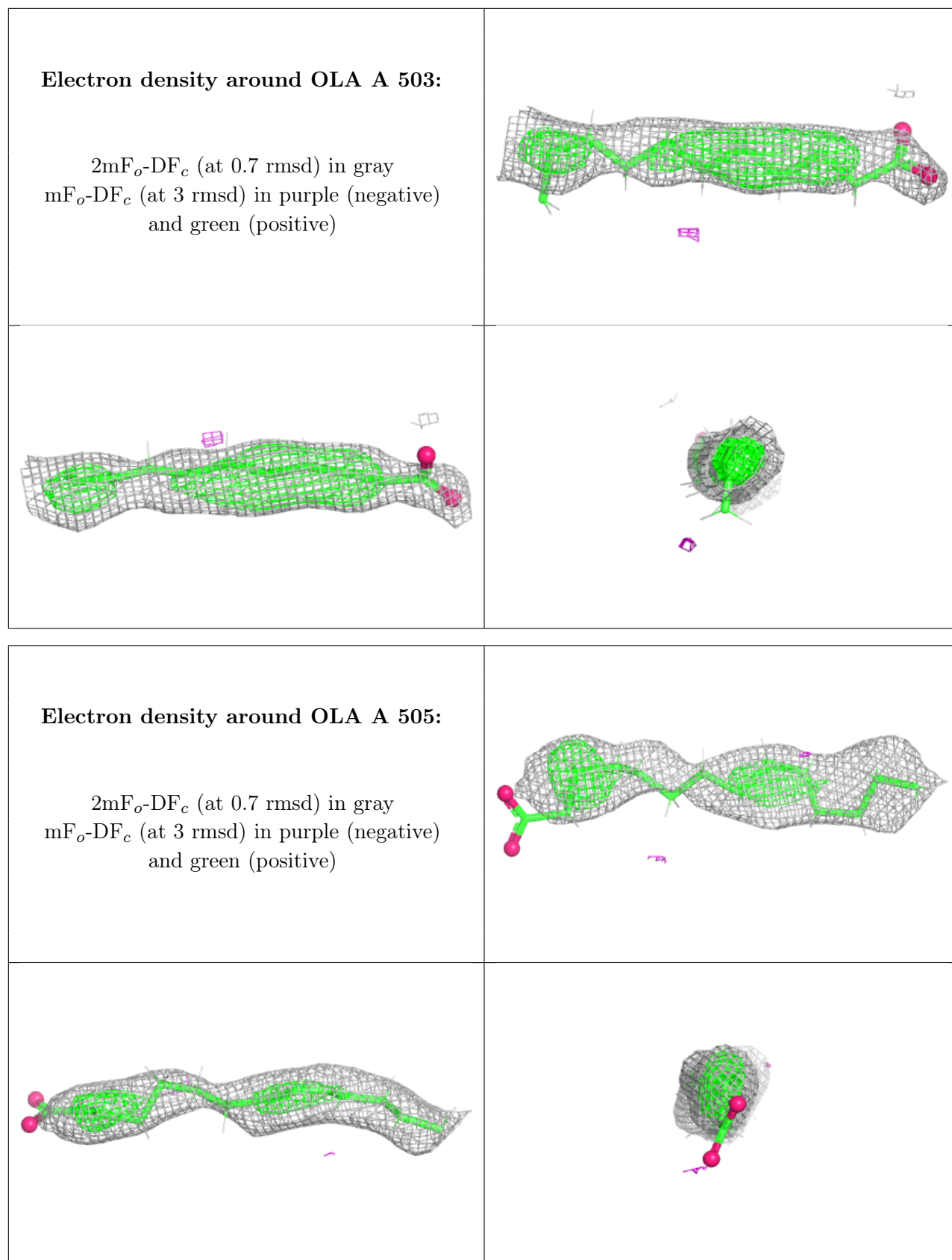
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
2	OLA	A	505	16/20	0.79	0.40	110,167,203,206	0
2	OLA	A	502	20/20	0.80	0.46	155,204,243,245	0
2	OLA	A	501	20/20	0.80	0.30	117,144,179,182	0
5	CLR	A	510	28/28	0.86	0.33	96,129,189,189	0
5	CLR	A	509	28/28	0.87	0.23	75,125,192,193	0
5	CLR	A	508	28/28	0.90	0.24	106,133,168,169	0
3	NA	A	506	1/1	0.94	0.08	48,48,48,48	0
4	ZMA	A	507	25/25	0.96	0.06	29,38,57,64	0

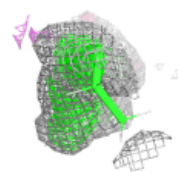
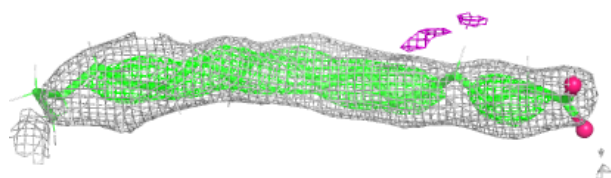
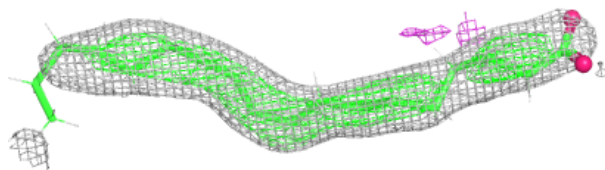
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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



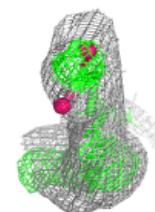
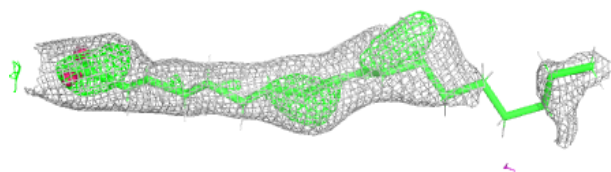
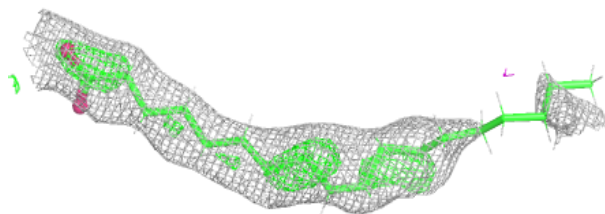


**Electron density around OLA A 502:**

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

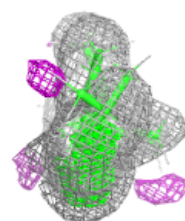
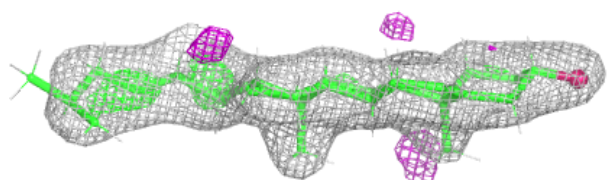
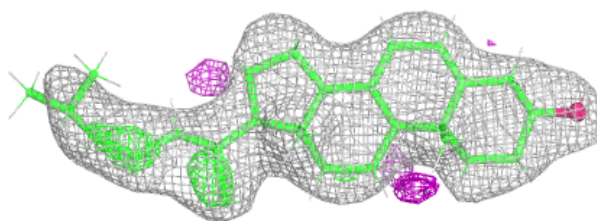
**Electron density around OLA A 501:**

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

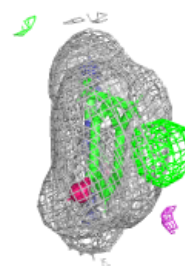
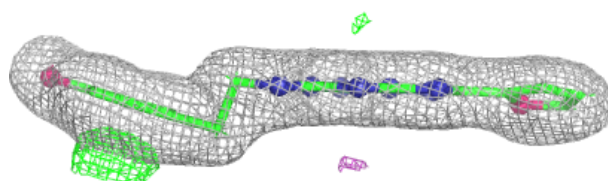
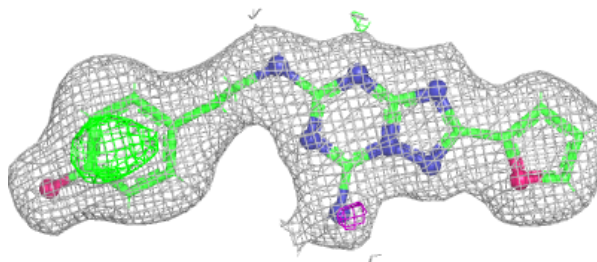


**Electron density around CLR A 509:**

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

**Electron density around ZMA A 507:**

$2mF_o-DF_c$  (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.