



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 03:46 AM UTC

PDB ID : 1P8I / pdb_00001p8i
Title : F219L BACTERIORHODOPSIN MUTANT
Authors : Lanyi, J.K.
Deposited on : 2003-05-07
Resolution : 1.86 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

<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	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

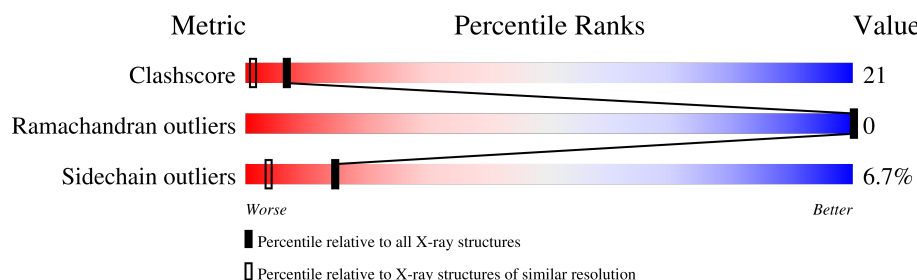
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.86 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))
Clashscore	190562	3579 (1.86-1.86)
Ramachandran outliers	187476	3553 (1.86-1.86)
Sidechain outliers	187428	3553 (1.86-1.86)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	249	

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
3	LI1	A	601	X	-	-	-
3	LI1	A	611	X	X	-	-
3	LI1	A	613	X	-	-	-
4	SQU	A	701	X	X	-	-

2 Entry composition [i](#)

There are 5 unique types of molecules in this entry. The entry contains 2070 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.

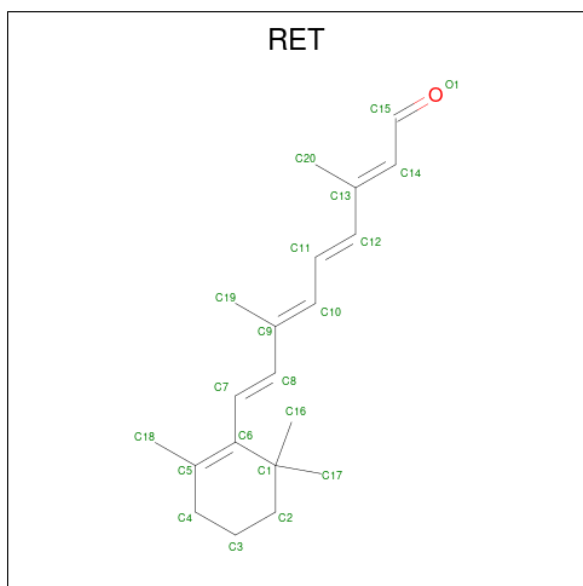
- Molecule 1 is a protein called Bacteriorhodopsin.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	222	Total	C	N	O	S	0	0	0
			1717	1156	262	290	9			

There is a discrepancy between the modelled and reference sequences:

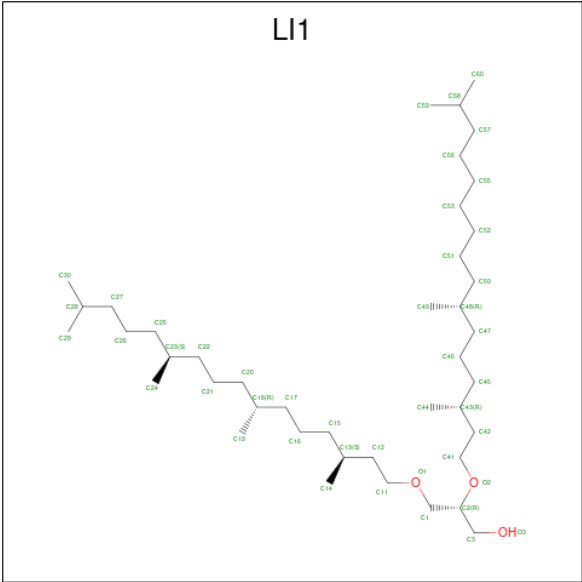
Chain	Residue	Modelled	Actual	Comment	Reference
A	219	LEU	PHE	engineered mutation	UNP P02945

- Molecule 2 is RETINAL (CCD ID: RET) (formula: $C_{20}H_{28}O$).



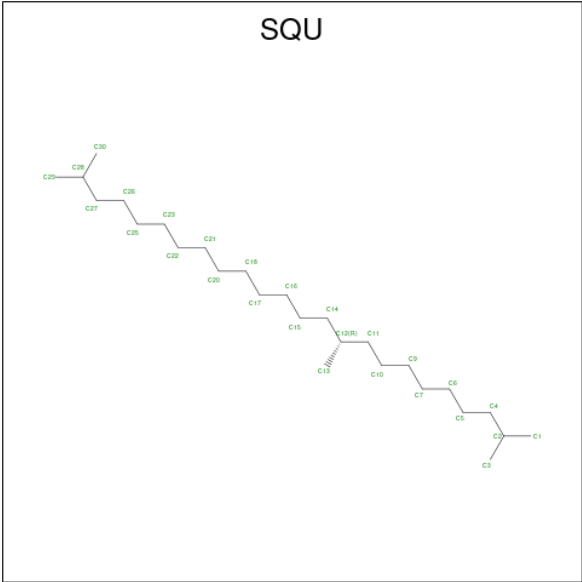
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total	C	0	0
			20	20		

- Molecule 3 is 1-[2,6,10,14-TETRAMETHYL-HEXADECAN-16-YL]-2-[2,10,14-TRIMETHYLHEXADECAN-16-YL]GLYCEROL (CCD ID: LI1) (formula: $C_{42}H_{86}O_3$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C O 31 28 3	0	0
3	A	1	Total C O 41 38 3	0	0
3	A	1	Total C 17 17	0	0
3	A	1	Total C 16 16	0	0
3	A	1	Total C 8 8	0	0
3	A	1	Total C 8 8	0	0
3	A	1	Total C O 38 35 3	0	0
3	A	1	Total C 18 18	0	0
3	A	1	Total C 16 16	0	0
3	A	1	Total C O 40 37 3	0	0
3	A	1	Total C 17 17	0	0
3	A	1	Total C 18 18	0	0
3	A	1	Total C 13 13	0	0

- Molecule 4 is 2,10,23-TRIMETHYL-TETRACOSANE (CCD ID: SQU) (formula: C₂₇H₅₆).



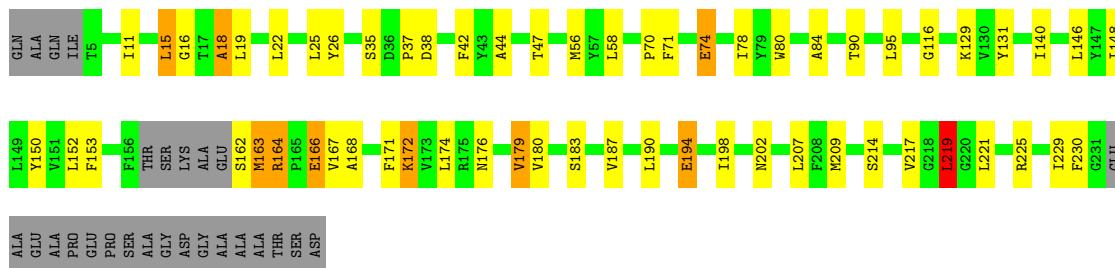
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total C 27 27	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	25	Total O 25 25	0	0

Note EDS was not executed.

- Molecule 1: Bacteriorhodopsin



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 63	Depositor
Cell constants a, b, c, α , β , γ	61.07Å 61.07Å 110.23Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	25.00 – 1.86	Depositor
% Data completeness (in resolution range)	99.5 (25.00-1.86)	Depositor
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.199 , 0.220	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2070	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

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: SQU, RET, LI1

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	0.78	1/1763 (0.1%)	1.56	16/2408 (0.7%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	219	LEU	C-N	7.27	1.43	1.33

The worst 5 of 16 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	18	ALA	CA-C-O	7.67	128.68	120.55
1	A	71	PHE	CA-CB-CG	6.88	120.68	113.80
1	A	179	VAL	CA-C-O	5.68	126.86	120.95
1	A	150	TYR	CA-C-O	5.66	126.96	120.90
1	A	58	LEU	CA-C-O	5.63	126.39	120.42

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	1717	0	1778	58	1
2	A	20	0	27	2	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	281	0	441	59	1
4	A	27	0	53	9	0
5	A	25	0	0	2	0
All	All	2070	0	2299	93	1

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 21.

The worst 5 of 93 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)
3:A:613:LI1:C19	3:A:613:LI1:C18	1.85	1.51
3:A:602:LI1:C3	3:A:602:LI1:O3	1.72	1.38
1:A:180:VAL:HG21	3:A:610:LI1:H512	1.36	1.07
3:A:613:LI1:C19	3:A:613:LI1:C17	2.30	1.07
1:A:131:TYR:CE2	3:A:602:LI1:H112	1.91	1.04

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:163:MET:O	3:A:602:LI1:O3[6_655]	2.04	0.16

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	218/249 (88%)	217 (100%)	1 (0%)	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	A	178/195 (91%)	166 (93%)	12 (7%)	15 4

5 of 12 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	166	GLU
1	A	172	LYS
1	A	219	LEU
1	A	194	GLU
1	A	95	LEU

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	176	ASN
1	A	202	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

15 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
4	SQU	A	701	-	26,26,26	1.53	6 (23%)	28,28,28	1.75	10 (35%)
3	LI1	A	601	-	30,30,44	1.49	4 (13%)	31,31,51	0.97	1 (3%)
3	LI1	A	606	-	7,7,44	0.74	0	6,6,51	0.67	0
3	LI1	A	605	-	7,7,44	1.27	1 (14%)	6,6,51	0.87	0
3	LI1	A	604	-	15,15,44	0.99	0	14,14,51	0.78	0
3	LI1	A	609	-	15,15,44	0.91	0	14,14,51	0.80	0
3	LI1	A	613	-	12,12,44	3.12	1 (8%)	12,12,51	2.98	4 (33%)
3	LI1	A	610	-	39,39,44	1.63	4 (10%)	41,41,51	1.14	3 (7%)
3	LI1	A	608	-	17,17,44	0.79	0	18,18,51	1.96	2 (11%)
2	RET	A	301	1	20,20,21	1.30	3 (15%)	27,27,28	2.55	9 (33%)
3	LI1	A	602	-	40,40,44	1.83	6 (15%)	43,45,51	2.27	12 (27%)
3	LI1	A	607	-	37,37,44	1.09	1 (2%)	37,38,51	1.86	3 (8%)
3	LI1	A	603	-	16,16,44	0.70	0	16,16,51	0.65	0
3	LI1	A	611	-	16,16,44	1.54	3 (18%)	18,18,51	4.33	7 (38%)
3	LI1	A	612	-	17,17,44	1.13	1 (5%)	18,18,51	0.85	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
4	SQU	A	701	-	1/1/3/3	20/25/25/25	-
3	LI1	A	601	-	1/1/2/8	20/30/30/49	-
3	LI1	A	606	-	-	3/5/5/49	-
3	LI1	A	605	-	-	5/5/5/49	-
3	LI1	A	604	-	-	6/13/13/49	-
3	LI1	A	609	-	-	5/13/13/49	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	LI1	A	613	-	1/1/1/8	5/11/11/49	-
3	LI1	A	610	-	-	32/39/39/49	-
3	LI1	A	608	-	-	8/16/16/49	-
2	RET	A	301	1	-	2/13/30/31	0/1/1/1
3	LI1	A	611	-	2/2/3/8	15/17/17/49	-
3	LI1	A	602	-	-	16/44/44/49	-
3	LI1	A	603	-	-	6/14/14/49	-
3	LI1	A	607	-	-	23/38/38/49	-
3	LI1	A	612	-	-	10/16/16/49	-

The worst 5 of 30 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	613	LI1	C19-C18	10.54	1.85	1.52
3	A	602	LI1	O3-C3	7.07	1.72	1.42
3	A	602	LI1	C12-C11	5.02	1.67	1.50
3	A	610	LI1	O3-C3	4.74	1.62	1.42
3	A	610	LI1	C13-C12	4.52	1.74	1.51

The worst 5 of 51 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	611	LI1	C19-C18-C17	-11.60	69.93	111.27
3	A	607	LI1	C44-C43-C42	9.51	145.17	111.27
3	A	611	LI1	C20-C18-C17	9.45	159.94	112.07
2	A	301	RET	C11-C10-C9	-8.61	115.20	127.28
3	A	602	LI1	C24-C23-C25	-7.86	83.26	111.27

All (5) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
3	A	601	LI1	C2
3	A	611	LI1	C13
3	A	611	LI1	C18
3	A	613	LI1	C18
4	A	701	SQU	C12

5 of 176 torsion outliers are listed below:

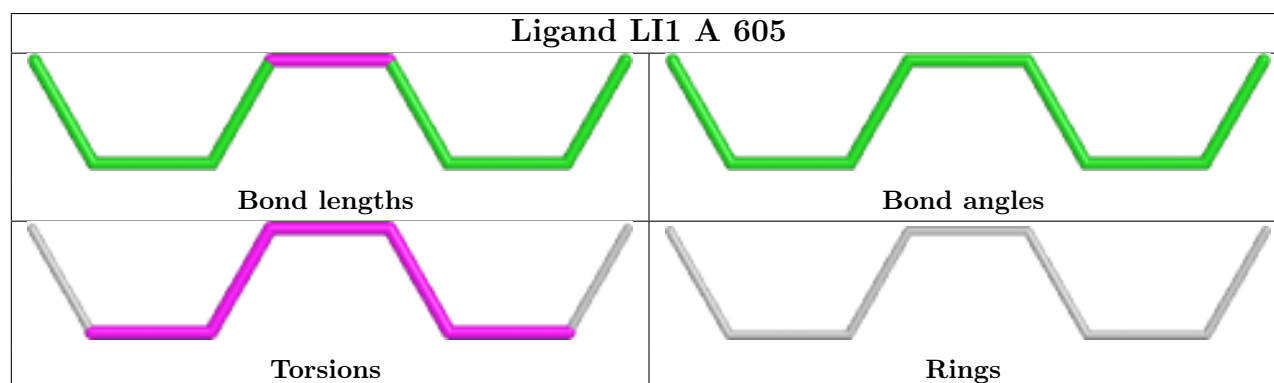
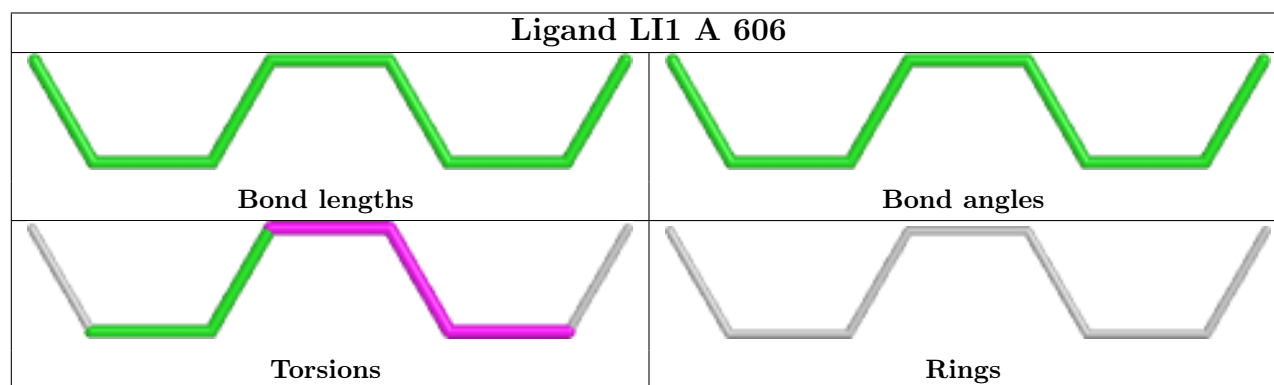
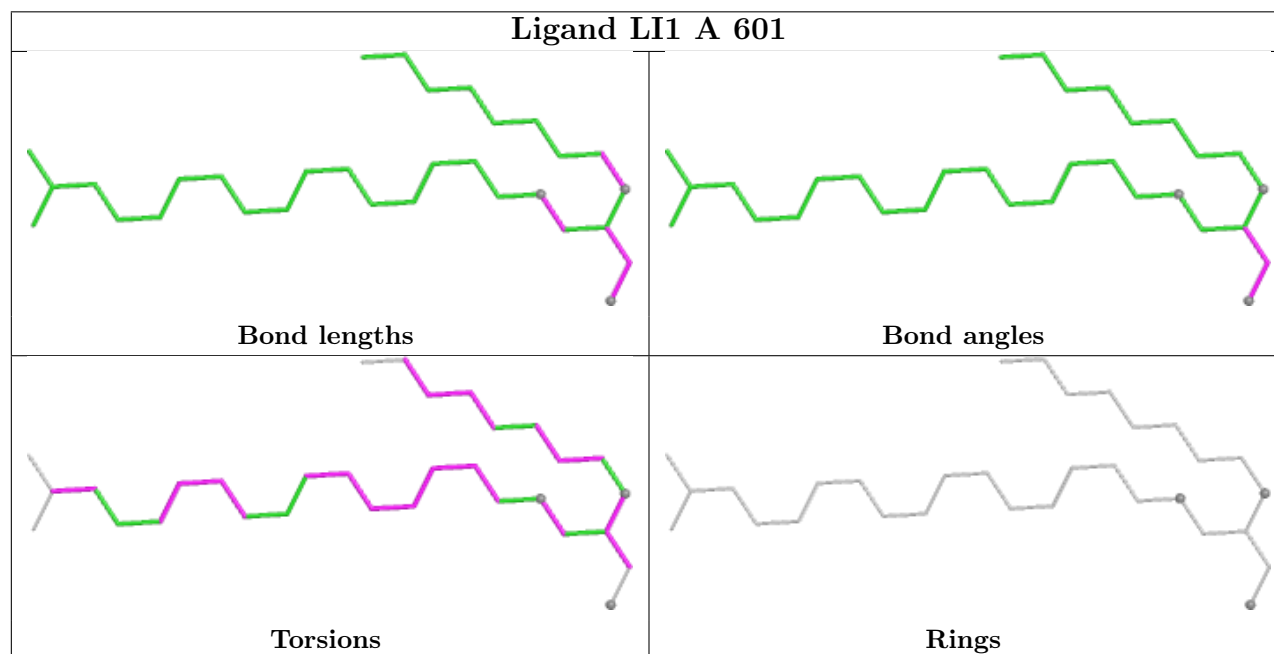
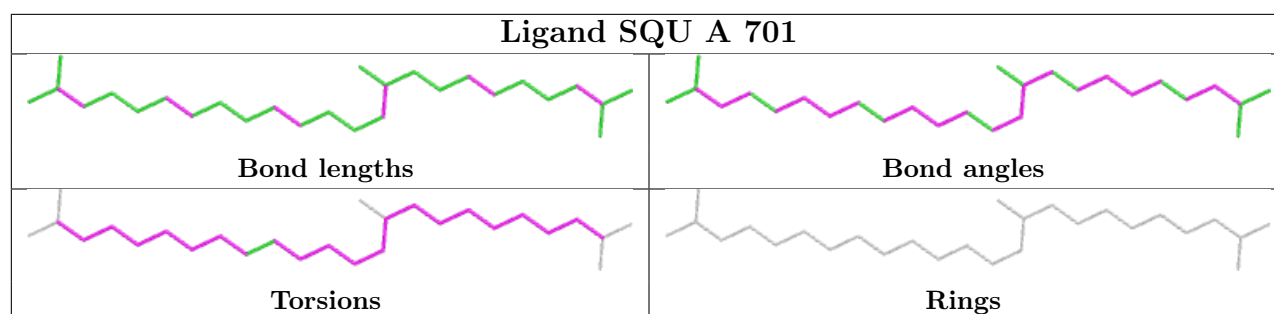
Mol	Chain	Res	Type	Atoms
2	A	301	RET	C20-C13-C14-C15
3	A	601	LI1	C1-C2-C3-O3
3	A	601	LI1	O2-C2-C3-O3
3	A	601	LI1	C1-C2-O2-C41
3	A	602	LI1	C1-C2-C3-O3

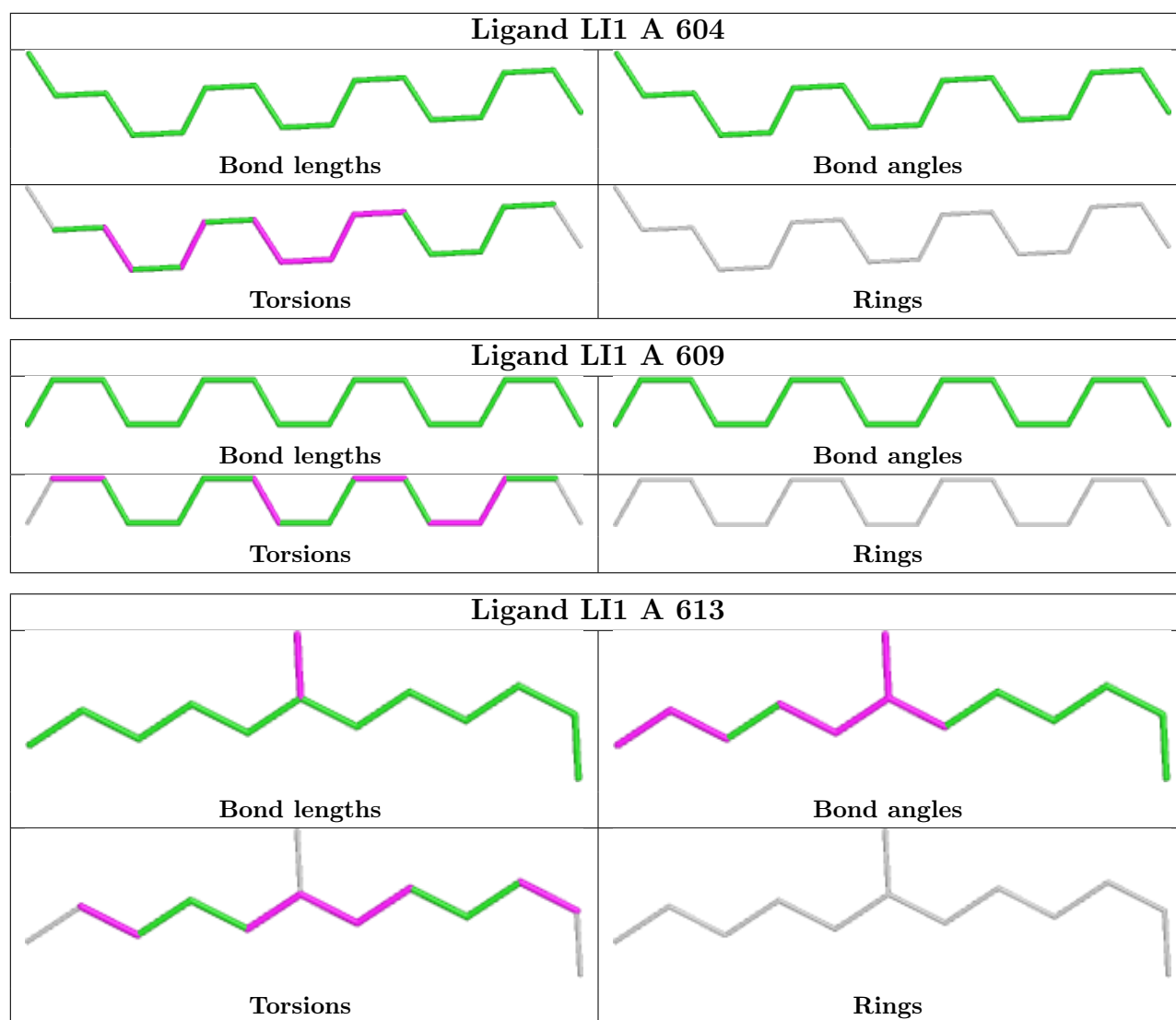
There are no ring outliers.

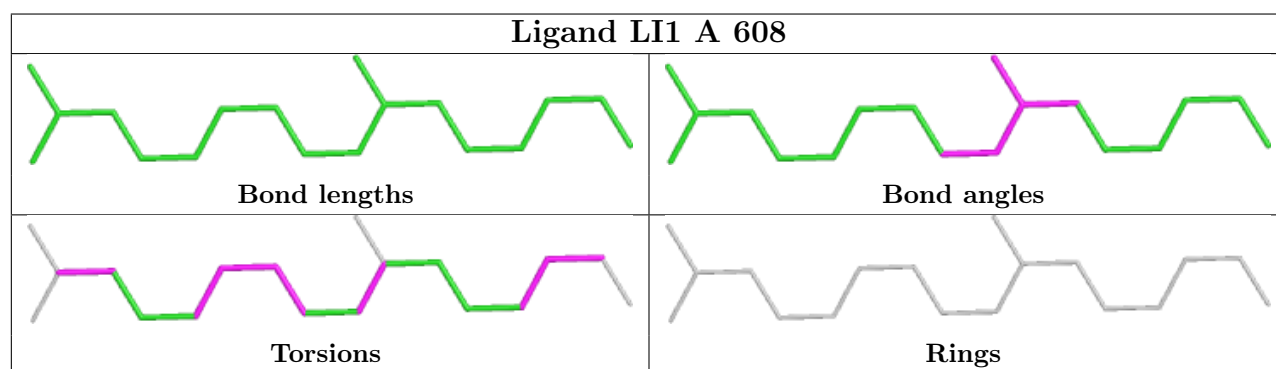
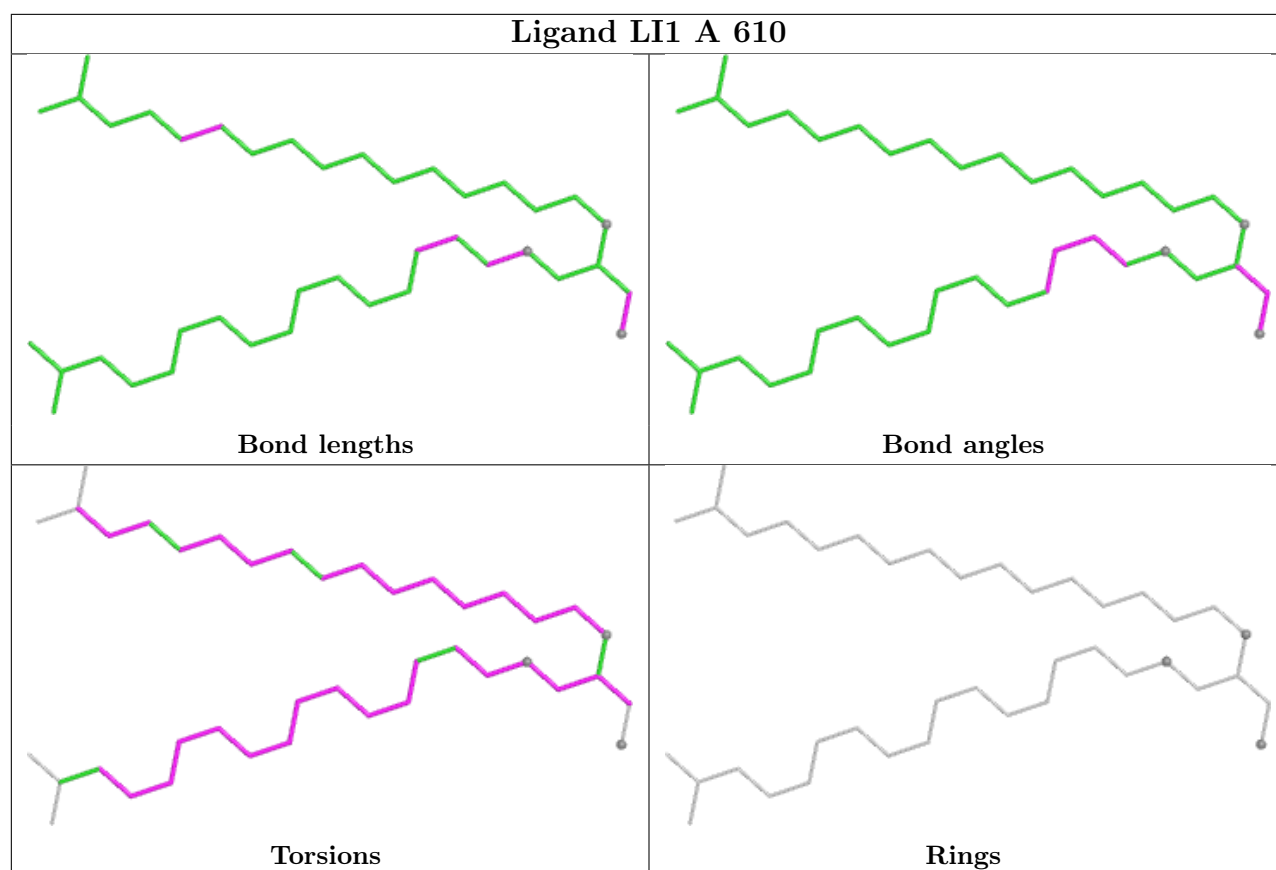
13 monomers are involved in 71 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	701	SQU	9	0
3	A	601	LI1	5	0
3	A	606	LI1	1	0
3	A	604	LI1	2	0
3	A	613	LI1	5	0
3	A	610	LI1	16	0
3	A	608	LI1	4	0
2	A	301	RET	2	0
3	A	602	LI1	14	1
3	A	607	LI1	4	0
3	A	603	LI1	4	0
3	A	611	LI1	5	0
3	A	612	LI1	5	0

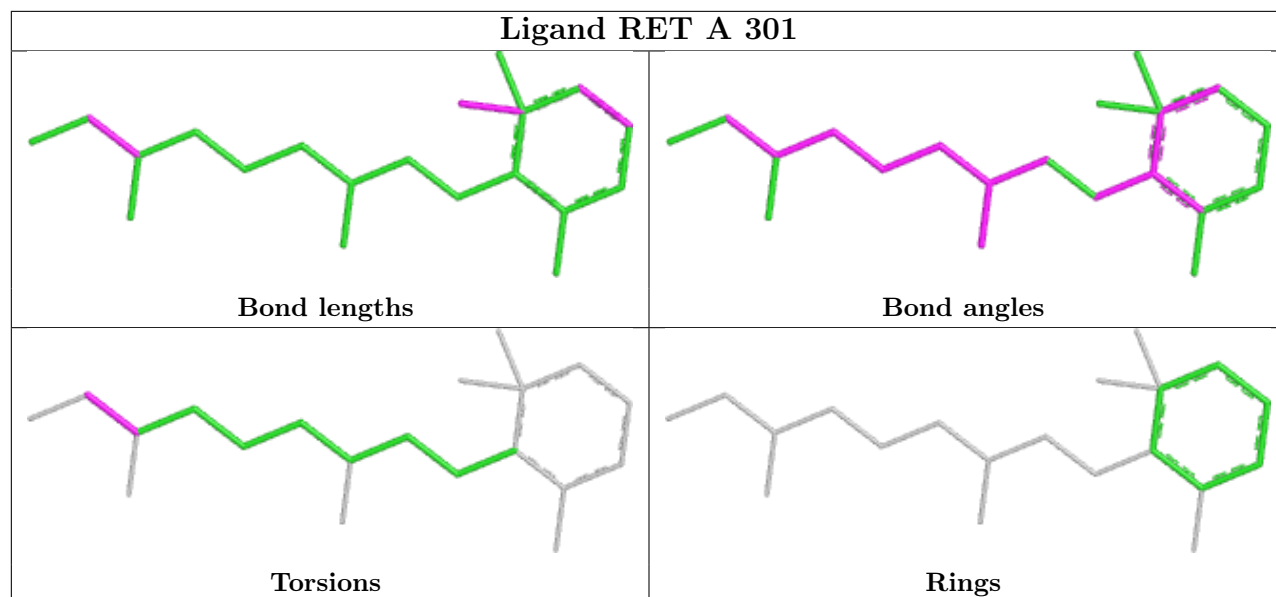
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. 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.



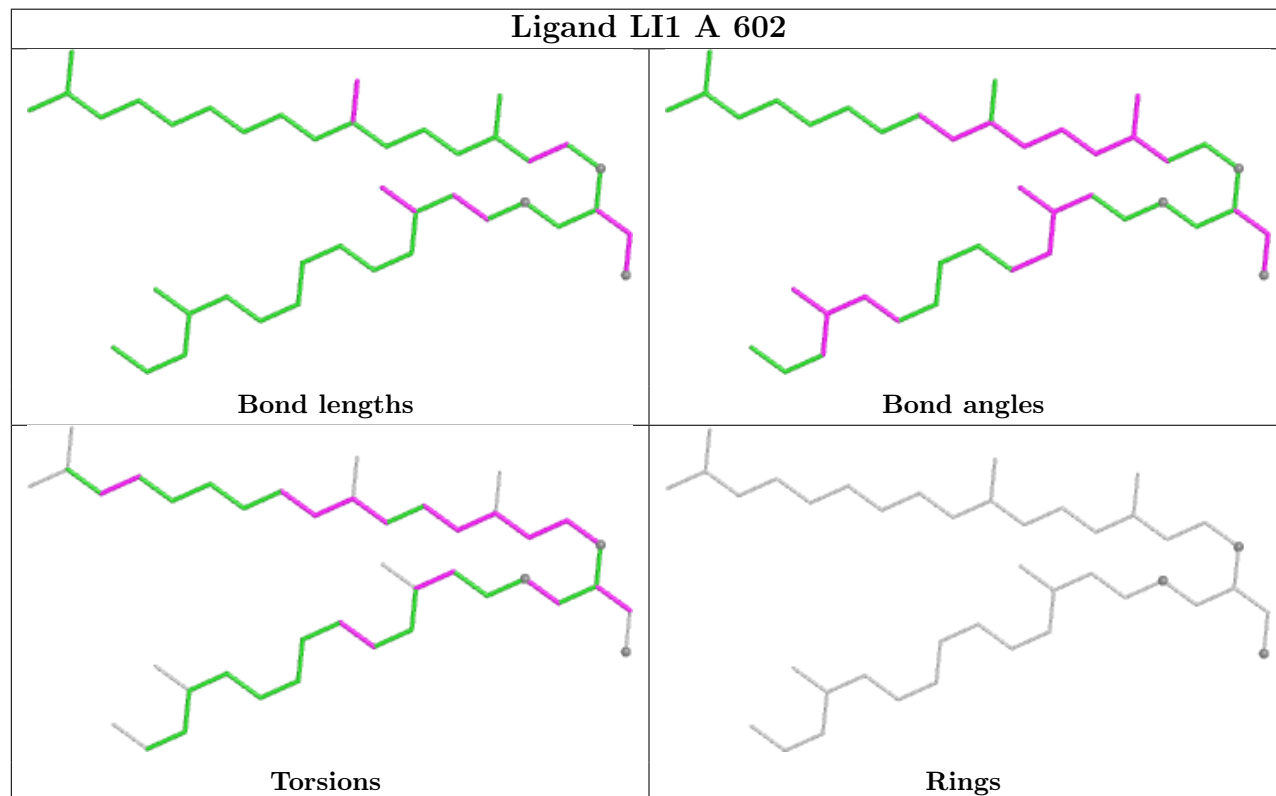


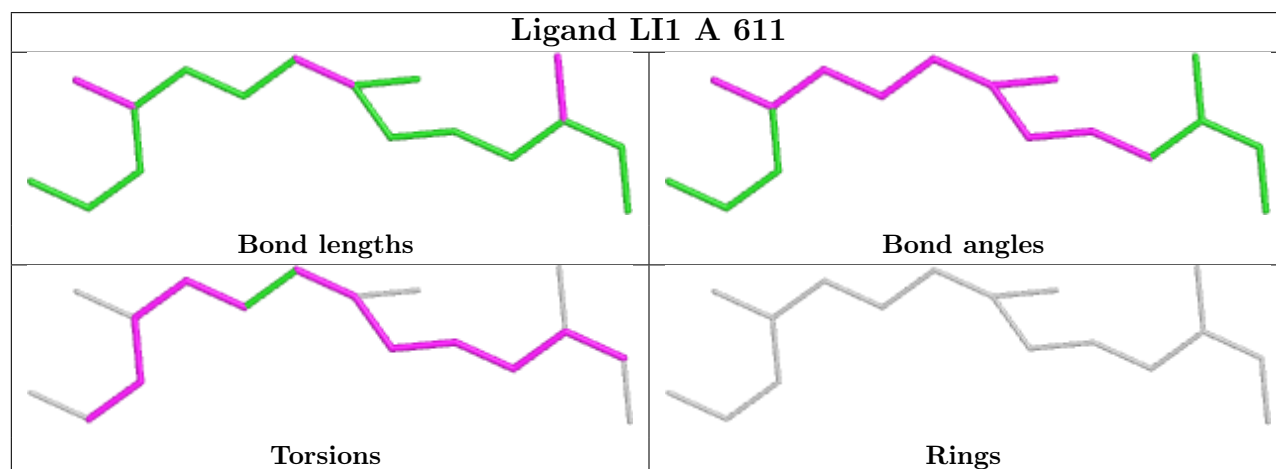
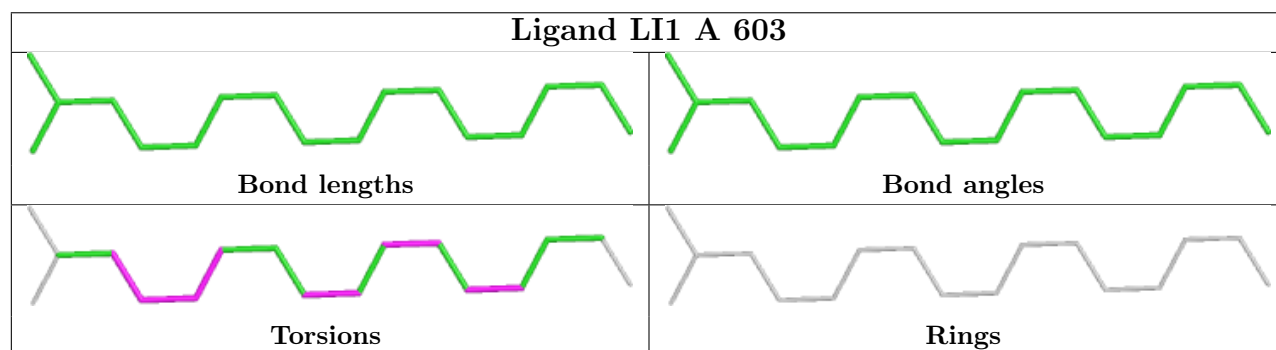
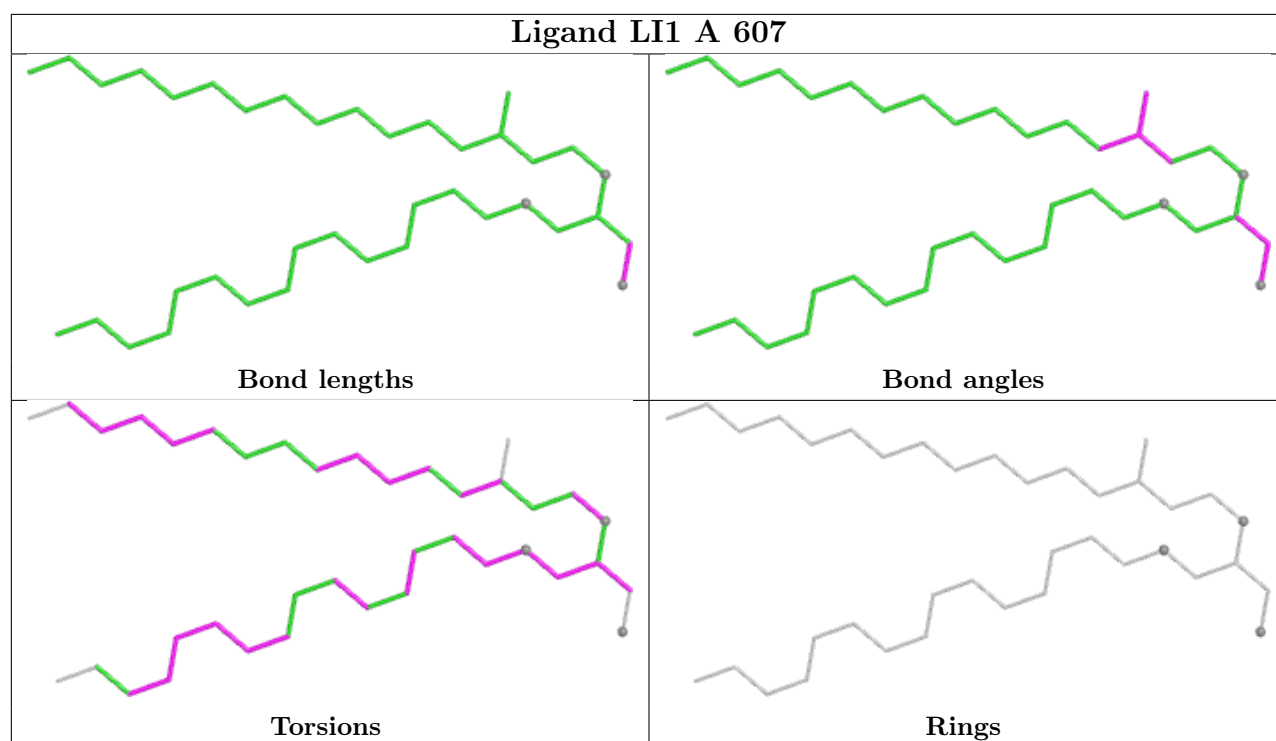


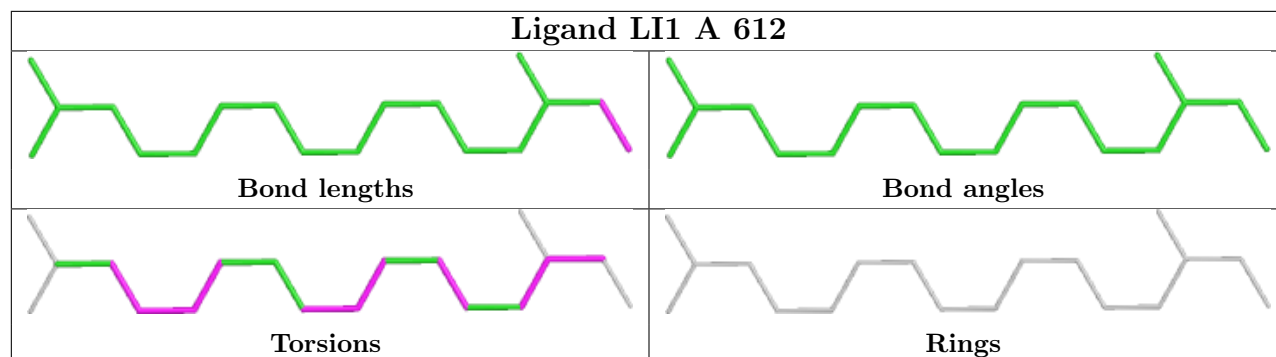
Ligand RET A 301



Ligand LI1 A 602







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](#)

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates [i](#)

EDS was not executed - this section is therefore empty.

6.4 Ligands [i](#)

EDS was not executed - this section is therefore empty.

6.5 Other polymers [i](#)

EDS was not executed - this section is therefore empty.