



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 1, 2026 – 03:51 AM UTC

PDB ID : 1KG9 / pdb_00001kg9
Title : Structure of a "mock-trapped" early-M intermediate of bacteriorhodopsin
Authors : Facciotti, M.T.; Rouhani, S.; Burkard, F.T.; Betancourt, F.M.; Downing, K.H.; Rose, R.B.; McDermott, G.; Glaeser, R.M.
Deposited on : 2001-11-26
Resolution : 1.81 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

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

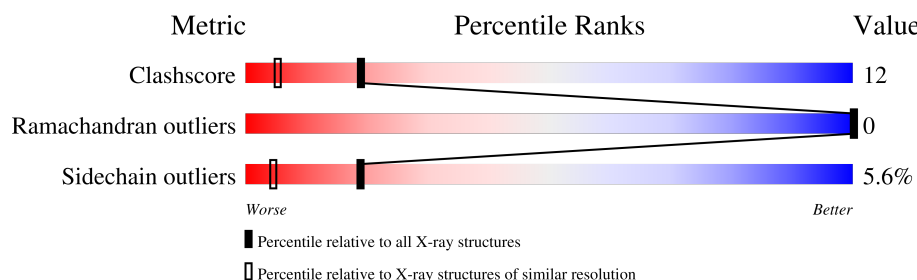
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.81 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	1148 (1.82-1.82)
Ramachandran outliers	187476	1140 (1.82-1.82)
Sidechain outliers	187428	1140 (1.82-1.82)

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	231	 68% 24% . .

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	613	X	-	-	-

2 Entry composition [i](#)

There are 4 unique types of molecules in this entry. The entry contains 1835 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.

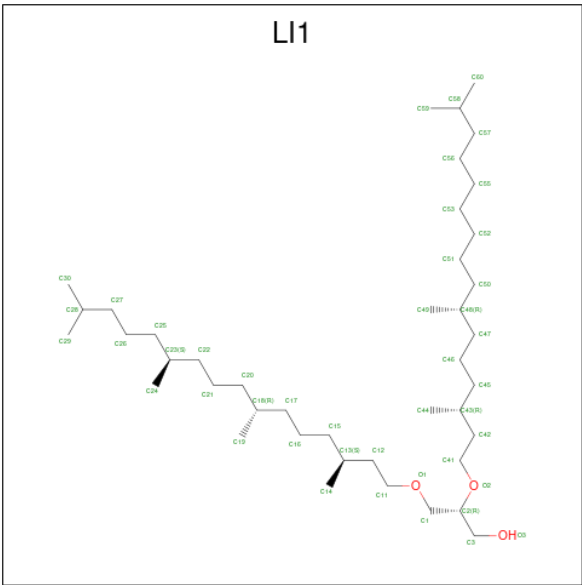
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	221	Total	C	N	O	S	0	0	0
			1714	1156	261	288	9			

- Molecule 2 is RETINAL (CCD ID: RET) (formula: C₂₀H₂₈O).



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: C₄₂H₈₆O₃).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	1	Total	C	0	0
			6	6		
3	A	1	Total	C	0	0
			6	6		
3	A	1	Total	C	0	0
			6	6		
3	A	1	Total	C	0	0
			8	8		
3	A	1	Total	C	0	0
			7	7		
3	A	1	Total	C	0	0
			9	9		
3	A	1	Total	C	0	0
			6	6		
3	A	1	Total	C	0	0
			18	18		
3	A	1	Total	C	0	0
			13	13		

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	22	Total	O	0	0
			22	22		

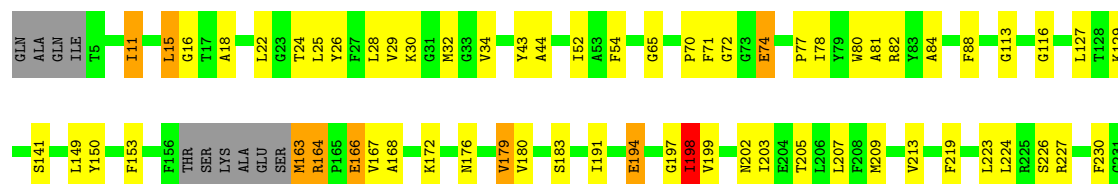
3 Residue-property plots [i](#)

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. 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. 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.

Note EDS was not executed.

- Molecule 1: bacteriorhodopsin

Chain A:  68% 24% . .



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	60.89Å 60.89Å 109.59Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 1.81	Depositor
% Data completeness (in resolution range)	(Not available) (20.00-1.81)	Depositor
R_{merge}	0.05	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	SHELXL-97	Depositor
R, R_{free}	0.165 , 0.212	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	1835	wwPDB-VP
Average B, all atoms (Å ²)	31.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: 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	0.60	0/1761	1.51	19/2405 (0.8%)

There are no bond length outliers.

All (19) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	197	GLY	CA-C-N	11.23	134.93	120.56
1	A	197	GLY	C-N-CA	11.23	134.93	120.56
1	A	116	GLY	CA-C-O	7.97	129.01	120.40
1	A	198	ILE	CA-C-N	7.52	131.71	123.43
1	A	198	ILE	C-N-CA	7.52	131.71	123.43
1	A	71	PHE	CA-CB-CG	7.13	120.93	113.80
1	A	141	SER	CA-C-O	7.12	128.10	120.55
1	A	127	LEU	CA-C-O	6.21	126.62	119.35
1	A	150	TYR	CA-C-O	5.94	127.06	120.82
1	A	113	GLY	CA-C-N	5.93	128.23	120.28
1	A	113	GLY	C-N-CA	5.93	128.23	120.28
1	A	80	TRP	CA-C-O	5.78	126.49	119.38
1	A	183	SER	CA-C-O	5.72	126.42	119.38
1	A	16	GLY	O-C-N	5.59	127.61	122.19
1	A	180	VAL	O-C-N	-5.51	116.51	121.91
1	A	179	VAL	O-C-N	-5.30	116.71	121.91
1	A	52	ILE	CA-C-O	5.19	126.67	121.17
1	A	219	PHE	CA-CB-CG	5.12	118.92	113.80
1	A	213	VAL	O-C-N	-5.03	116.99	121.87

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts ⓘ

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	1714	0	1771	38	0
2	A	20	0	27	3	0
3	A	79	0	113	11	0
4	A	22	0	0	2	0
All	All	1835	0	1911	44	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 12.

All (44) 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:198:ILE:HG22	1:A:199:VAL:HG23	1.60	0.83
1:A:18:ALA:HA	3:A:606:LI1:H211	1.64	0.79
1:A:25:LEU:O	1:A:29:VAL:HG23	1.85	0.76
1:A:18:ALA:O	1:A:22:LEU:HD13	1.90	0.72
1:A:153:PHE:HE2	1:A:179:VAL:HG21	1.61	0.65
1:A:153:PHE:CE2	1:A:179:VAL:HG21	2.34	0.63
1:A:164:ARG:HG3	1:A:167:VAL:CG2	2.30	0.62
1:A:198:ILE:HG23	3:A:605:LI1:H271	1.85	0.59
1:A:78:ILE:HD12	1:A:194:GLU:HG3	1.86	0.58
1:A:77:PRO:HD2	4:A:425:HOH:O	2.05	0.57
1:A:164:ARG:HG3	1:A:167:VAL:HG23	1.85	0.57
1:A:18:ALA:HA	3:A:606:LI1:C21	2.34	0.56
1:A:44:ALA:HA	3:A:612:LI1:H13	1.87	0.56
1:A:164:ARG:HB2	1:A:166:GLU:HG3	1.89	0.54
1:A:11:ILE:O	1:A:11:ILE:HD12	2.09	0.53
1:A:34:VAL:HG21	1:A:43:TYR:CE2	2.44	0.53
1:A:149:LEU:HD22	1:A:179:VAL:HG22	1.92	0.52
1:A:26:TYR:CZ	1:A:30:LYS:HD2	2.45	0.51
1:A:203:ILE:O	1:A:207:LEU:HG	2.10	0.51
1:A:191:ILE:O	1:A:198:ILE:HB	2.11	0.50
1:A:24:THR:CG2	3:A:612:LI1:H303	2.42	0.50
3:A:612:LI1:H143	4:A:512:HOH:O	2.12	0.50
1:A:70:PRO:HA	1:A:74:GLU:O	2.14	0.48

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:54:PHE:CE2	3:A:612:LI1:H292	2.49	0.48
1:A:223:LEU:O	1:A:226:SER:HB3	2.15	0.47
1:A:43:TYR:CE1	1:A:224:LEU:HD13	2.50	0.47
1:A:82:ARG:HH22	1:A:205:THR:HG23	1.79	0.46
3:A:602:LI1:H212	3:A:602:LI1:H243	1.62	0.46
1:A:176:ASN:CG	3:A:610:LI1:H462	2.41	0.45
1:A:72:GLY:O	1:A:74:GLU:HG2	2.16	0.45
1:A:65:GLY:HA3	1:A:81:ALA:HB2	1.99	0.44
1:A:164:ARG:HG3	1:A:167:VAL:HG21	1.99	0.44
1:A:163:MET:HE3	1:A:168:ALA:HA	2.00	0.43
1:A:29:VAL:O	1:A:32:MET:HG3	2.17	0.43
2:A:301:RET:H11	2:A:301:RET:H191	1.83	0.43
1:A:198:ILE:HG22	1:A:199:VAL:N	2.33	0.43
1:A:28:LEU:HD23	3:A:612:LI1:C14	2.49	0.42
1:A:15:LEU:HB3	1:A:209:MET:HE2	2.02	0.42
2:A:301:RET:H8	2:A:301:RET:H171	2.01	0.42
1:A:227:ARG:HD2	1:A:230:PHE:CD2	2.55	0.41
1:A:70:PRO:HG2	1:A:129:LYS:HD3	2.01	0.41
3:A:613:LI1:H162	3:A:613:LI1:H201	1.54	0.41
2:A:301:RET:H181	2:A:301:RET:H7	1.72	0.40
1:A:84:ALA:O	1:A:88:PHE:HD2	2.05	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	A	217/231 (94%)	215 (99%)	2 (1%)	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	177/185 (96%)	167 (94%)	10 (6%)	19 4

All (10) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	11	ILE
1	A	15	LEU
1	A	74	GLU
1	A	163	MET
1	A	164	ARG
1	A	166	GLU
1	A	172	LYS
1	A	194	GLU
1	A	198	ILE
1	A	202	ASN

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	105	GLN

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

10 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	LI1	A	613	-	12,12,44	0.56	0	12,12,51	1.33	2 (16%)
3	LI1	A	604	-	5,5,44	0.56	0	4,4,51	0.71	0
3	LI1	A	606	-	7,7,44	0.59	0	6,6,51	0.92	0
3	LI1	A	602	-	5,5,44	0.55	0	4,4,51	0.75	0
2	RET	A	301	1	20,20,21	0.92	1 (5%)	27,27,28	1.78	7 (25%)
3	LI1	A	610	-	5,5,44	0.54	0	4,4,51	0.75	0
3	LI1	A	607	-	6,6,44	0.51	0	5,5,51	0.77	0
3	LI1	A	605	-	5,5,44	0.55	0	4,4,51	0.74	0
3	LI1	A	609	-	8,8,44	0.63	0	7,7,51	0.93	0
3	LI1	A	612	-	17,17,44	0.55	0	18,18,51	1.08	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	LI1	A	613	-	1/1/1/8	5/11/11/49	-
3	LI1	A	604	-	-	1/3/3/49	-
3	LI1	A	606	-	-	3/5/5/49	-
3	LI1	A	602	-	-	1/3/3/49	-
2	RET	A	301	1	-	2/13/30/31	0/1/1/1
3	LI1	A	610	-	-	2/3/3/49	-
3	LI1	A	607	-	-	3/4/4/49	-
3	LI1	A	605	-	-	1/3/3/49	-
3	LI1	A	609	-	-	3/6/6/49	-
3	LI1	A	612	-	-	11/16/16/49	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	301	RET	C2-C3	-2.25	1.47	1.52

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	301	RET	C19-C9-C8	4.59	125.11	118.09
2	A	301	RET	C11-C10-C9	-3.29	122.66	127.28
2	A	301	RET	C2-C1-C6	3.06	114.89	110.44
3	A	613	LI1	C21-C20-C18	-2.70	106.98	115.97
3	A	613	LI1	C16-C17-C18	-2.41	107.95	115.97
2	A	301	RET	C7-C8-C9	2.31	129.66	126.23
2	A	301	RET	C8-C9-C10	-2.29	115.41	119.01
2	A	301	RET	C7-C6-C5	-2.23	116.41	121.56
2	A	301	RET	C19-C9-C10	-2.11	119.40	122.82

All (1) chirality outliers are listed below:

Mol	Chain	Res	Type	Atom
3	A	613	LI1	C18

All (32) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	301	RET	C20-C13-C14-C15
3	A	612	LI1	C14-C13-C15-C16
3	A	610	LI1	C45-C46-C47-C48
3	A	612	LI1	C22-C23-C25-C26
3	A	612	LI1	C26-C27-C28-C29
3	A	612	LI1	C18-C20-C21-C22
3	A	613	LI1	C16-C17-C18-C20
3	A	612	LI1	C26-C27-C28-C30
3	A	602	LI1	C21-C22-C23-C24
3	A	609	LI1	C13-C15-C16-C17
3	A	612	LI1	C23-C25-C26-C27
3	A	612	LI1	C25-C26-C27-C28
2	A	301	RET	C12-C13-C14-C15
3	A	604	LI1	C21-C22-C23-C25
3	A	606	LI1	C13-C15-C16-C17
3	A	607	LI1	C52-C53-C55-C56
3	A	612	LI1	C21-C22-C23-C25
3	A	612	LI1	C12-C13-C15-C16
3	A	613	LI1	C11-C12-C13-C15
3	A	609	LI1	C15-C16-C17-C18

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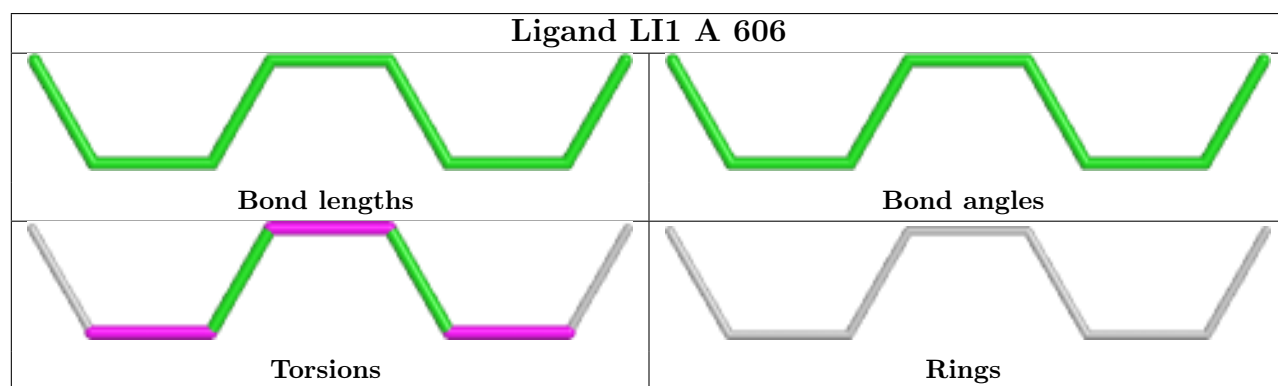
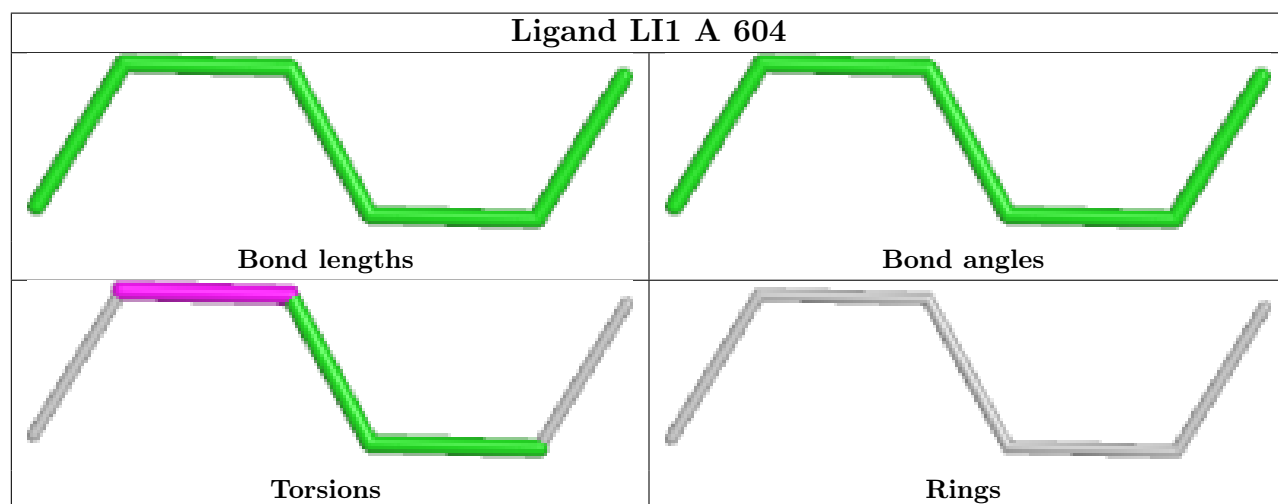
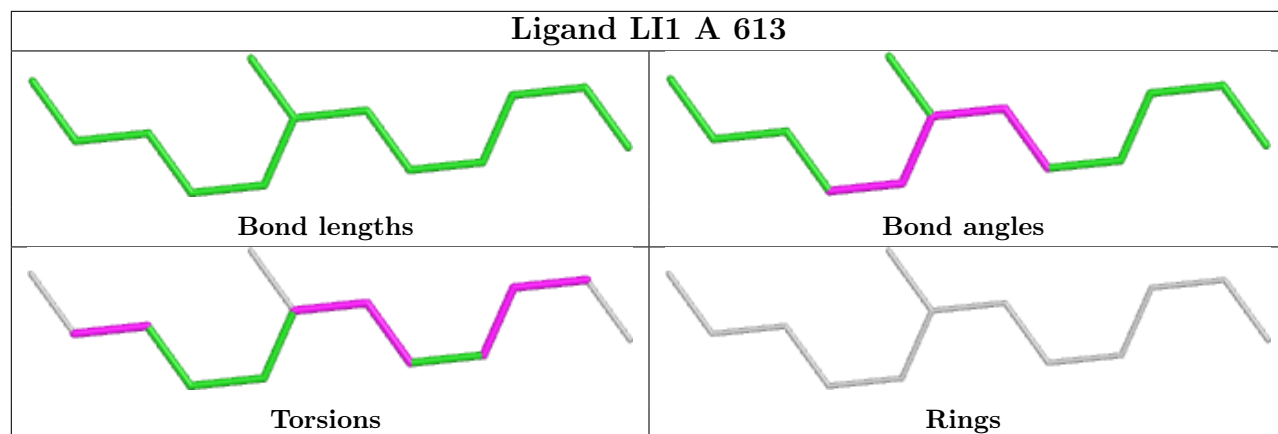
Mol	Chain	Res	Type	Atoms
3	A	612	LI1	C15-C16-C17-C18
3	A	613	LI1	C12-C13-C15-C16
3	A	613	LI1	C21-C22-C23-C24
3	A	613	LI1	C15-C16-C17-C18
3	A	606	LI1	C16-C17-C18-C20
3	A	610	LI1	C43-C45-C46-C47
3	A	606	LI1	C18-C20-C21-C22
3	A	605	LI1	C26-C27-C28-C29
3	A	607	LI1	C56-C57-C58-C60
3	A	612	LI1	C16-C17-C18-C20
3	A	609	LI1	C12-C13-C15-C16
3	A	607	LI1	C53-C55-C56-C57

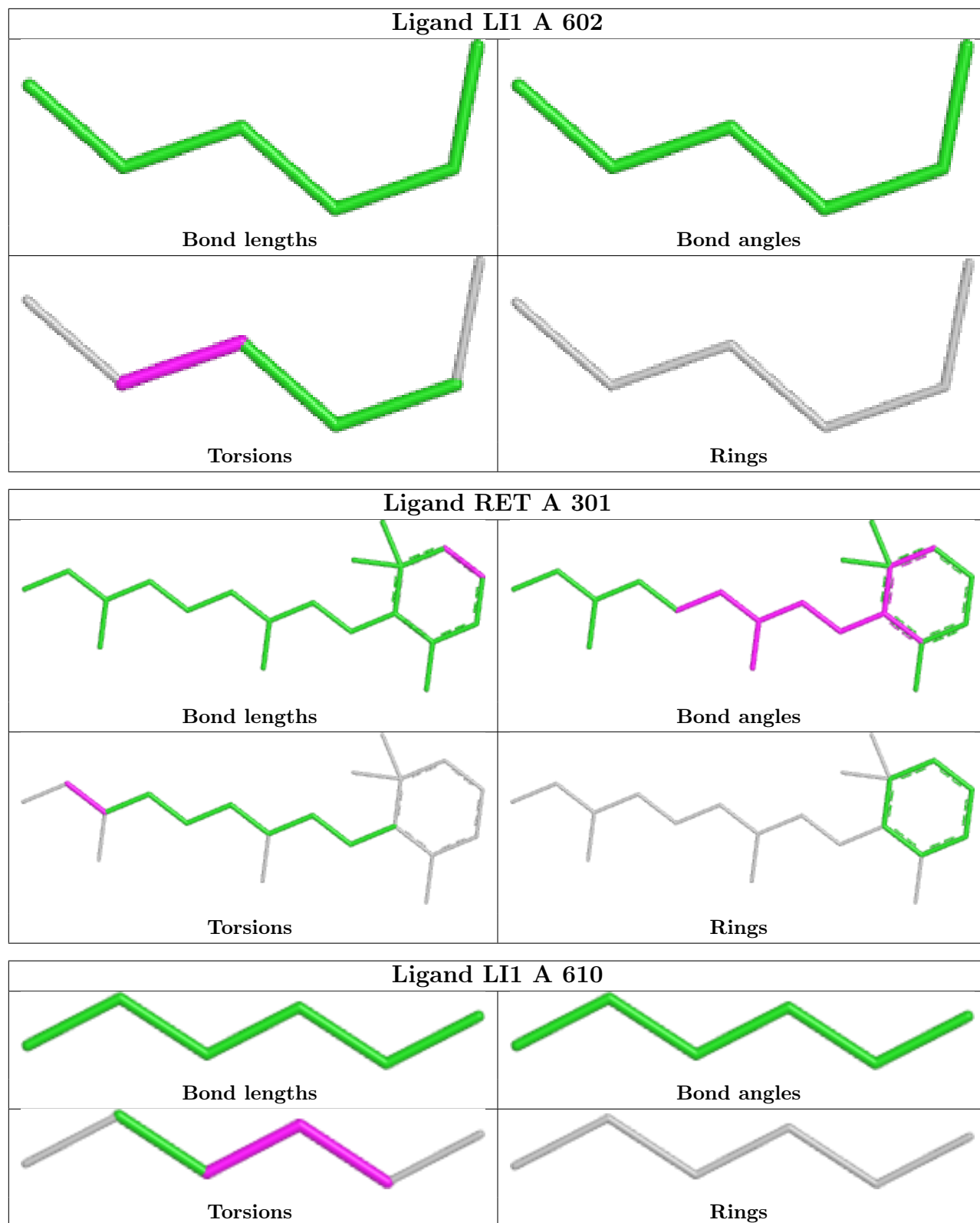
There are no ring outliers.

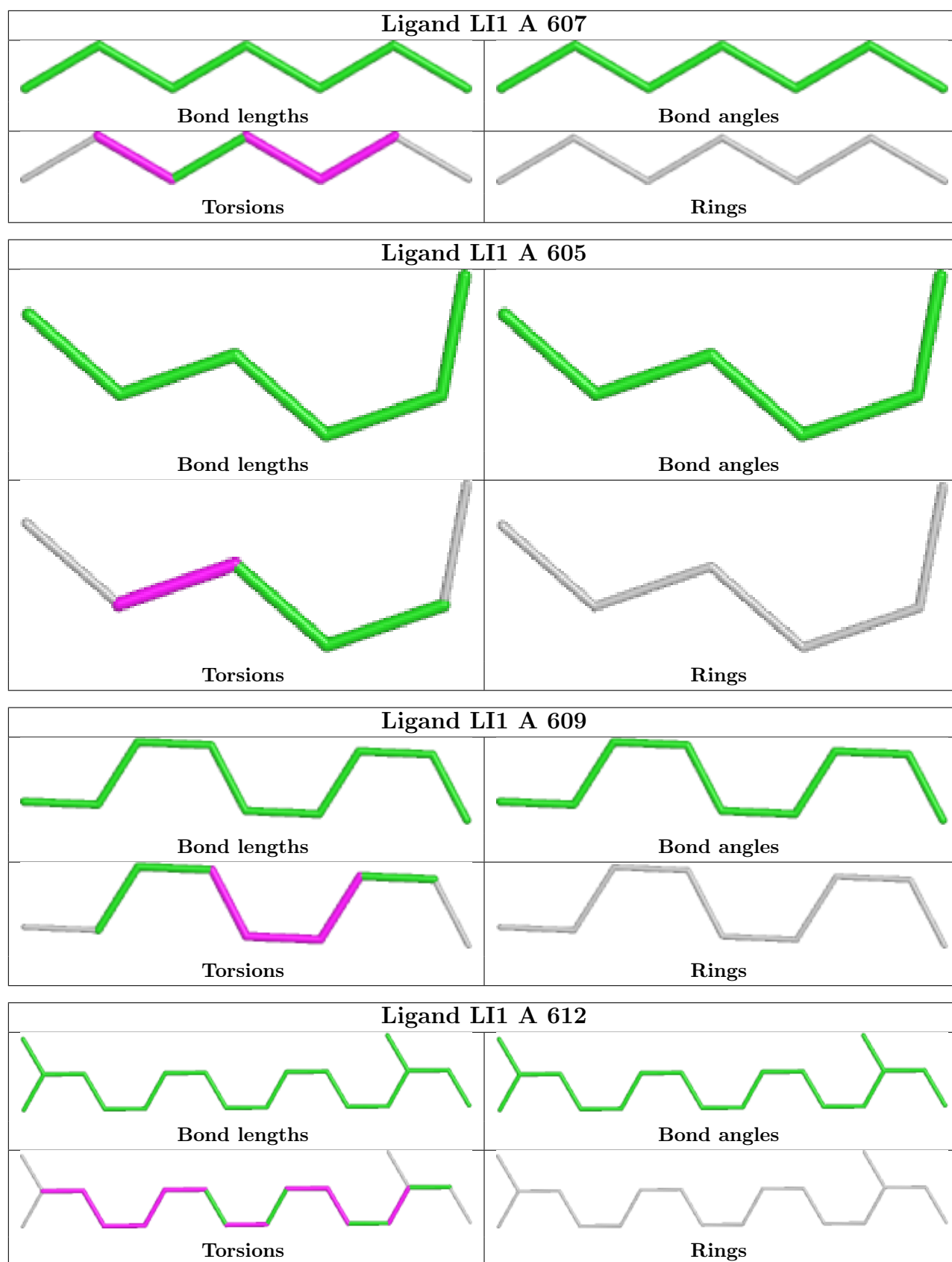
7 monomers are involved in 14 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	613	LI1	1	0
3	A	606	LI1	2	0
3	A	602	LI1	1	0
2	A	301	RET	3	0
3	A	610	LI1	1	0
3	A	605	LI1	1	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.







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

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.