



## Full wwPDB EM Validation Report ⓘ

Nov 13, 2024 – 10:30 AM JST

PDB ID : 8ZAM  
EMDB ID : EMD-39880  
Title : EndoChR2 channelrhodopsin  
Authors : Zhang, M.F.  
Deposited on : 2024-04-25  
Resolution : 2.50 Å (reported)

This is a Full wwPDB EM 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/EMValidationReportHelp>

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:

EMDB validation analysis : **FAILED**  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
MolProbity : 4.02b-467  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
MapQ : **FAILED**  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.39

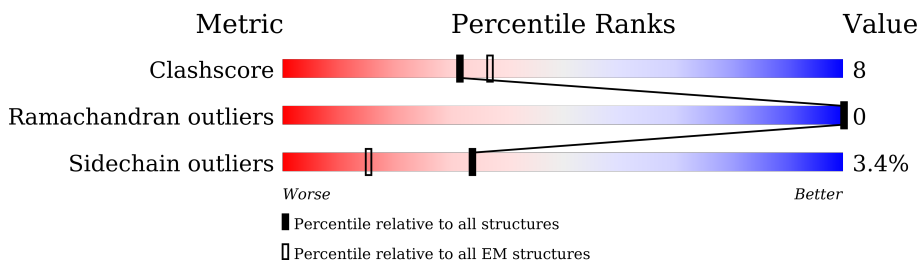
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 2.50 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)	EM structures (#Entries)
Clashscore	210492	15764
Ramachandran outliers	207382	16835
Sidechain outliers	206894	16415

The table below summarises the geometric issues observed across the polymeric chains and their fit to the map. The red, orange, yellow and green segments of the 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  $\leq 5\%$ .

Mol	Chain	Length	Quality of chain
1	A	315	 61% 16% • 22%
1	B	315	 61% 17% • 22%

## 2 Entry composition [i](#)

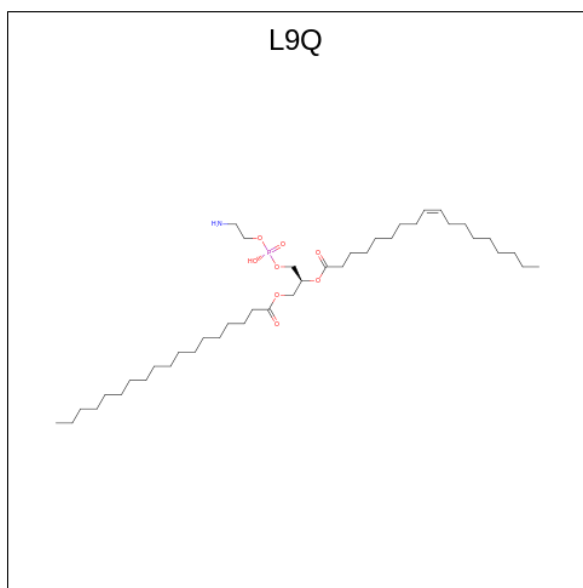
There are 2 unique types of molecules in this entry. The entry contains 4000 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, 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 Archaeal-type opsin 2.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	246	Total	C	N	O	S	0	0
			1949	1289	316	327	17		
1	B	246	Total	C	N	O	S	0	0
			1949	1289	316	327	17		

- Molecule 2 is (1S)-2-{[(S)-(2-aminoethoxy)(hydroxy)phosphoryl]oxy}-1-[(octadecanoyl oxy)methyl]ethyl (9Z)-octadec-9-enoate (three-letter code: L9Q) (formula: C<sub>41</sub>H<sub>80</sub>NO<sub>8</sub>P) (labeled as "Ligand of Interest" by depositor).

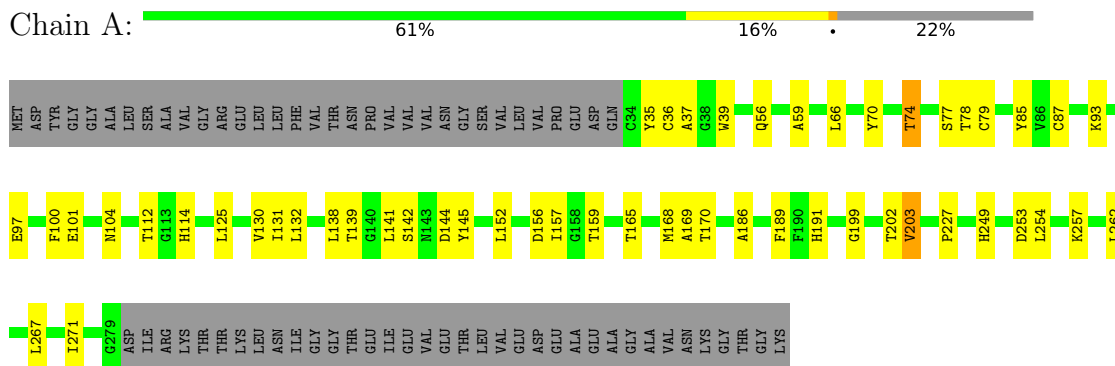


Mol	Chain	Residues	Atoms					AltConf
			Total	C	N	O	P	
2	A	1	Total	C	N	O	P	0
			51	41	1	8	1	
2	B	1	Total	C	N	O	P	0
			51	41	1	8	1	

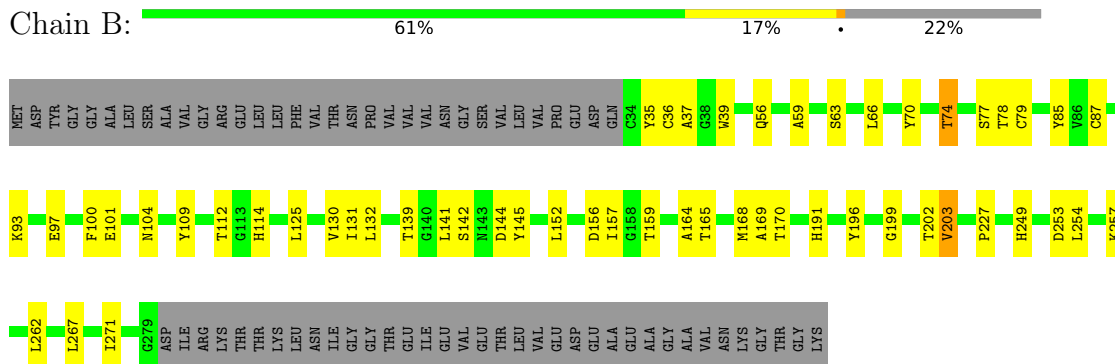
### 3 Residue-property plots [i](#)

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.

- Molecule 1: Archaeal-type opsin 2



- Molecule 1: Archaeal-type opsin 2



## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	120000	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	60	Depositor
Minimum defocus (nm)	1200	Depositor
Maximum defocus (nm)	2000	Depositor
Magnification	Not provided	
Image detector	FEI FALCON IV (4k x 4k)	Depositor

## 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: L9Q

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	0.26	0/2010	0.44	0/2736
1	B	0.26	0/2010	0.44	0/2736
All	All	0.26	0/4020	0.44	0/5472

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	1949	0	1923	35	0
1	B	1949	0	1923	36	0
2	A	51	0	79	4	0
2	B	51	0	79	5	0
All	All	4000	0	4004	68	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 8.

All (68) 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:B:227:PRO:HB3	2:B:401:L9Q:H41	1.72	0.71
1:A:227:PRO:HB3	2:A:401:L9Q:H41	1.73	0.70
1:A:132:LEU:HD13	1:A:152:LEU:HD22	1.74	0.70
1:B:132:LEU:HD13	1:B:152:LEU:HD22	1.74	0.70
1:B:77:SER:OG	1:B:78:THR:N	2.27	0.68
1:A:77:SER:OG	1:A:78:THR:N	2.27	0.67
1:A:74:THR:HG23	1:A:79:CYS:HB3	1.80	0.64
1:B:74:THR:HG23	1:B:79:CYS:HB3	1.80	0.64
1:A:144:ASP:HB2	1:B:144:ASP:HB2	1.82	0.61
1:B:131:ILE:HD11	1:B:257:LYS:HG2	1.85	0.58
1:A:131:ILE:HD11	1:A:257:LYS:HG2	1.85	0.57
1:A:97:GLU:HG3	1:A:101:GLU:HG3	1.87	0.57
1:B:97:GLU:O	1:B:101:GLU:HB2	2.05	0.57
1:B:165:THR:O	1:B:169:ALA:HB2	2.05	0.57
1:A:165:THR:O	1:A:169:ALA:HB2	2.05	0.56
1:B:97:GLU:HG3	1:B:101:GLU:HG3	1.87	0.56
1:A:97:GLU:O	1:A:101:GLU:HB2	2.05	0.56
1:A:145:TYR:O	1:B:145:TYR:N	2.42	0.53
1:B:203:VAL:HG21	1:B:267:LEU:HD11	1.90	0.53
1:A:203:VAL:HG21	1:A:267:LEU:HD11	1.90	0.53
1:A:59:ALA:HA	1:A:254:LEU:HD21	1.91	0.52
1:A:36:CYS:HB3	1:A:39:TRP:CD2	2.45	0.52
1:B:36:CYS:HB3	1:B:39:TRP:CD2	2.45	0.51
1:B:59:ALA:HA	1:B:254:LEU:HD21	1.91	0.51
1:A:70:TYR:O	1:A:74:THR:OG1	2.27	0.51
1:B:70:TYR:O	1:B:74:THR:OG1	2.27	0.51
1:A:145:TYR:N	1:B:145:TYR:O	2.42	0.50
1:B:112:THR:HG21	1:B:170:THR:HG21	1.94	0.49
1:B:249:HIS:O	1:B:253:ASP:HB2	2.13	0.49
1:A:249:HIS:O	1:A:253:ASP:HB2	2.13	0.49
1:A:112:THR:HG21	1:A:170:THR:HG21	1.94	0.49
1:A:186:ALA:HA	2:A:401:L9Q:H33	1.93	0.49
1:A:125:LEU:HD22	1:B:125:LEU:HD22	1.95	0.49
1:B:152:LEU:HG	1:B:191:HIS:HB3	1.95	0.48
1:A:170:THR:HG23	1:A:170:THR:O	2.14	0.48
1:A:152:LEU:HG	1:A:191:HIS:HB3	1.95	0.48
1:B:170:THR:HG23	1:B:170:THR:O	2.14	0.47
1:A:168:MET:O	1:B:104:ASN:ND2	2.43	0.46
1:B:196:TYR:HB3	2:B:401:L9Q:H21	1.98	0.46
2:B:401:L9Q:H17A	2:B:401:L9Q:H20	1.57	0.46
1:A:66:LEU:HD21	1:A:262:LEU:HD22	1.98	0.46
1:A:189:PHE:HB3	2:A:401:L9Q:H3	1.97	0.45

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:35:TYR:CZ	1:B:37:ALA:HB2	2.52	0.45
1:A:35:TYR:CZ	1:A:37:ALA:HB2	2.52	0.45
1:B:66:LEU:HD21	1:B:262:LEU:HD22	1.98	0.45
2:B:401:L9Q:H42A	2:B:401:L9Q:H45A	1.53	0.44
1:A:104:ASN:ND2	1:B:168:MET:O	2.43	0.44
1:A:56:GLN:NE2	1:A:97:GLU:HG2	2.33	0.44
1:A:156:ASP:O	1:A:159:THR:HG22	2.18	0.44
1:B:156:ASP:O	1:B:159:THR:HG22	2.18	0.44
1:A:85:TYR:CD2	1:A:130:VAL:HG21	2.53	0.44
1:B:56:GLN:NE2	1:B:97:GLU:HG2	2.33	0.43
1:B:85:TYR:CD2	1:B:130:VAL:HG21	2.53	0.43
1:A:157:ILE:HD11	1:B:157:ILE:HD11	2.00	0.43
2:A:401:L9Q:H42A	2:A:401:L9Q:H45A	1.52	0.42
1:A:138:LEU:HD23	1:A:138:LEU:HA	1.93	0.42
2:B:401:L9Q:H15A	2:B:401:L9Q:H18	1.77	0.42
1:A:139:THR:HA	1:A:271:ILE:HD13	2.02	0.42
1:B:199:GLY:O	1:B:203:VAL:HB	2.20	0.42
1:B:139:THR:HA	1:B:271:ILE:HD13	2.02	0.41
1:A:199:GLY:O	1:A:203:VAL:HB	2.20	0.41
1:B:59:ALA:O	1:B:63:SER:OG	2.33	0.41
1:B:139:THR:O	1:B:141:LEU:N	2.48	0.41
1:B:39:TRP:NE1	1:B:109:TYR:O	2.54	0.40
1:A:139:THR:O	1:A:141:LEU:N	2.48	0.40
1:A:199:GLY:HA2	1:A:202:THR:HG22	2.04	0.40
1:B:199:GLY:HA2	1:B:202:THR:HG22	2.04	0.40
1:B:164:ALA:O	1:B:168:MET:HG3	2.22	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 PDB entries followed by that with respect to all EM entries.

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	244/315 (78%)	231 (95%)	13 (5%)	0	100	100
1	B	244/315 (78%)	231 (95%)	13 (5%)	0	100	100
All	All	488/630 (78%)	462 (95%)	26 (5%)	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 PDB entries followed by that with respect to all EM entries.

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	203/259 (78%)	196 (97%)	7 (3%)	32	58
1	B	203/259 (78%)	196 (97%)	7 (3%)	32	58
All	All	406/518 (78%)	392 (97%)	14 (3%)	34	58

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	74	THR
1	A	87	CYS
1	A	93	LYS
1	A	100	PHE
1	A	114	HIS
1	A	142	SER
1	A	203	VAL
1	B	74	THR
1	B	87	CYS
1	B	93	LYS
1	B	100	PHE
1	B	114	HIS
1	B	142	SER
1	B	203	VAL

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](#)

2 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
2	L9Q	B	401	-	50,50,50	1.06	3 (6%)	53,55,55	1.12	3 (5%)
2	L9Q	A	401	-	50,50,50	1.05	3 (6%)	53,55,55	1.10	4 (7%)

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	L9Q	B	401	-	-	34/54/54/54	-
2	L9Q	A	401	-	-	31/54/54/54	-

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	401	L9Q	O3-C11	4.34	1.46	1.33

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	401	L9Q	O3-C11	4.20	1.45	1.33
2	B	401	L9Q	O2-C31	4.12	1.45	1.34
2	A	401	L9Q	O2-C31	4.06	1.45	1.34
2	B	401	L9Q	C40-C39	3.62	1.52	1.31
2	A	401	L9Q	C40-C39	3.62	1.52	1.31

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	401	L9Q	O2-C31-C32	4.26	120.67	111.50
2	B	401	L9Q	O2-C31-C32	4.24	120.64	111.50
2	B	401	L9Q	O3-C11-C12	2.89	120.97	111.91
2	A	401	L9Q	C2-O2-C31	-2.55	111.52	117.79
2	A	401	L9Q	O3-C11-C12	2.52	119.81	111.91
2	A	401	L9Q	O2-C31-O31	-2.09	118.65	123.70
2	B	401	L9Q	C2-O2-C31	-2.07	112.69	117.79

There are no chirality outliers.

All (65) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	401	L9Q	C4-O4P-P-O2P
2	A	401	L9Q	O4P-C4-C5-N
2	B	401	L9Q	C4-O4P-P-O2P
2	B	401	L9Q	O11-C11-O3-C3
2	B	401	L9Q	C12-C11-O3-C3
2	B	401	L9Q	O4P-C4-C5-N
2	B	401	L9Q	C23-C24-C25-C26
2	A	401	L9Q	C23-C24-C25-C26
2	A	401	L9Q	C19-C20-C21-C22
2	A	401	L9Q	C12-C11-O3-C3
2	B	401	L9Q	C17-C18-C19-C20
2	B	401	L9Q	C11-C12-C13-C14
2	A	401	L9Q	O11-C11-O3-C3
2	B	401	L9Q	C31-C32-C33-C34
2	A	401	L9Q	C4-O4P-P-O3P
2	B	401	L9Q	C4-O4P-P-O3P
2	B	401	L9Q	C21-C22-C23-C24
2	A	401	L9Q	C18-C19-C20-C21
2	B	401	L9Q	C25-C26-C27-C28
2	A	401	L9Q	C16-C17-C18-C19
2	B	401	L9Q	C12-C13-C14-C15

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Mol	Chain	Res	Type	Atoms
2	A	401	L9Q	C20-C21-C22-C23
2	A	401	L9Q	C12-C13-C14-C15
2	B	401	L9Q	C14-C15-C16-C17
2	A	401	L9Q	C21-C22-C23-C24
2	B	401	L9Q	C38-C39-C40-C41
2	B	401	L9Q	C16-C17-C18-C19
2	A	401	L9Q	C42-C43-C44-C45
2	B	401	L9Q	C18-C19-C20-C21
2	A	401	L9Q	C41-C42-C43-C44
2	B	401	L9Q	C42-C43-C44-C45
2	B	401	L9Q	C41-C42-C43-C44
2	A	401	L9Q	C38-C39-C40-C41
2	A	401	L9Q	C33-C34-C35-C36
2	B	401	L9Q	C20-C21-C22-C23
2	B	401	L9Q	C15-C16-C17-C18
2	A	401	L9Q	C34-C35-C36-C37
2	A	401	L9Q	C40-C41-C42-C43
2	B	401	L9Q	C34-C35-C36-C37
2	A	401	L9Q	C32-C33-C34-C35
2	A	401	L9Q	C31-C32-C33-C34
2	A	401	L9Q	C35-C36-C37-C38
2	B	401	L9Q	C43-C44-C45-C46
2	B	401	L9Q	C40-C41-C42-C43
2	A	401	L9Q	C43-C44-C45-C46
2	A	401	L9Q	C14-C15-C16-C17
2	B	401	L9Q	C35-C36-C37-C38
2	A	401	L9Q	C5-C4-O4P-P
2	B	401	L9Q	C5-C4-O4P-P
2	A	401	L9Q	C22-C23-C24-C25
2	A	401	L9Q	C1-O3P-P-O4P
2	B	401	L9Q	C1-O3P-P-O4P
2	A	401	L9Q	C15-C16-C17-C18
2	B	401	L9Q	C37-C38-C39-C40
2	A	401	L9Q	C25-C26-C27-C28
2	A	401	L9Q	C39-C40-C41-C42
2	B	401	L9Q	O2-C31-C32-C33
2	B	401	L9Q	O2-C2-C3-O3
2	B	401	L9Q	C39-C40-C41-C42
2	B	401	L9Q	O3-C11-C12-C13
2	A	401	L9Q	C37-C38-C39-C40
2	B	401	L9Q	C13-C14-C15-C16
2	B	401	L9Q	O31-C31-C32-C33

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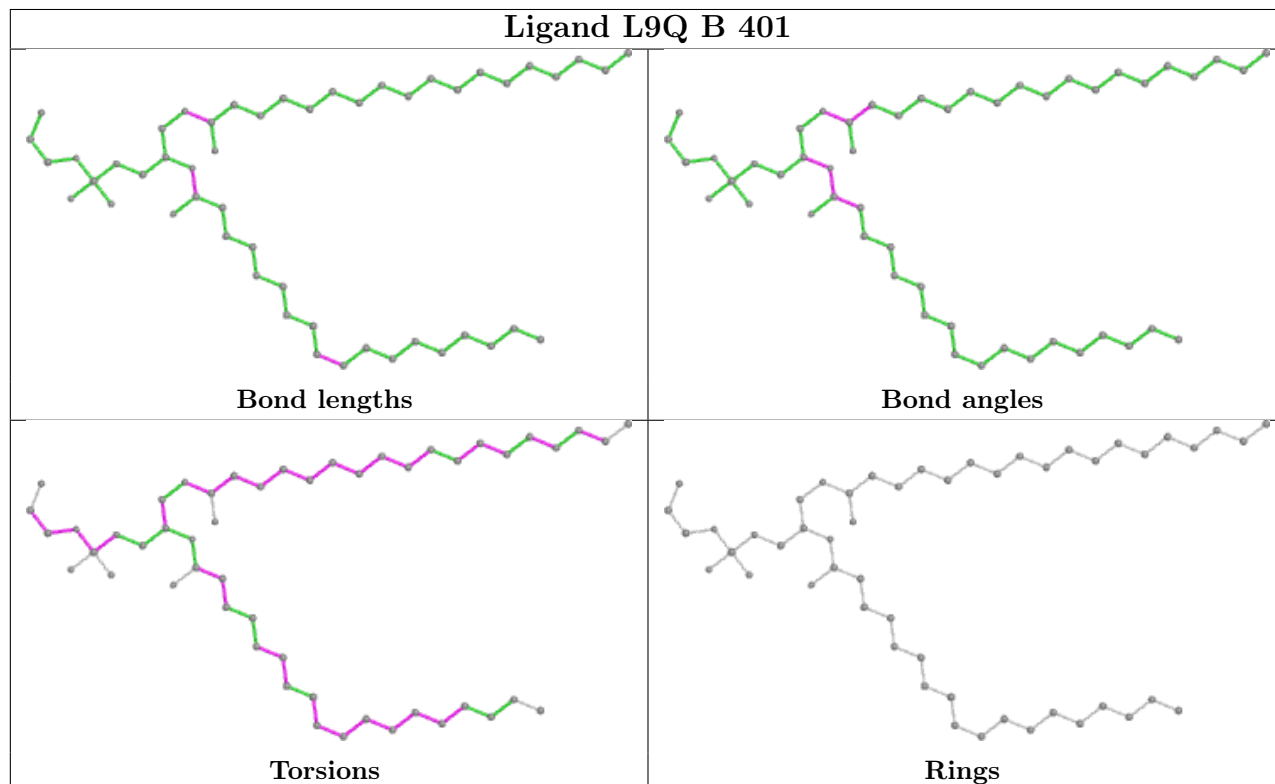
Mol	Chain	Res	Type	Atoms
2	A	401	L9Q	O3-C11-C12-C13
2	B	401	L9Q	O11-C11-C12-C13

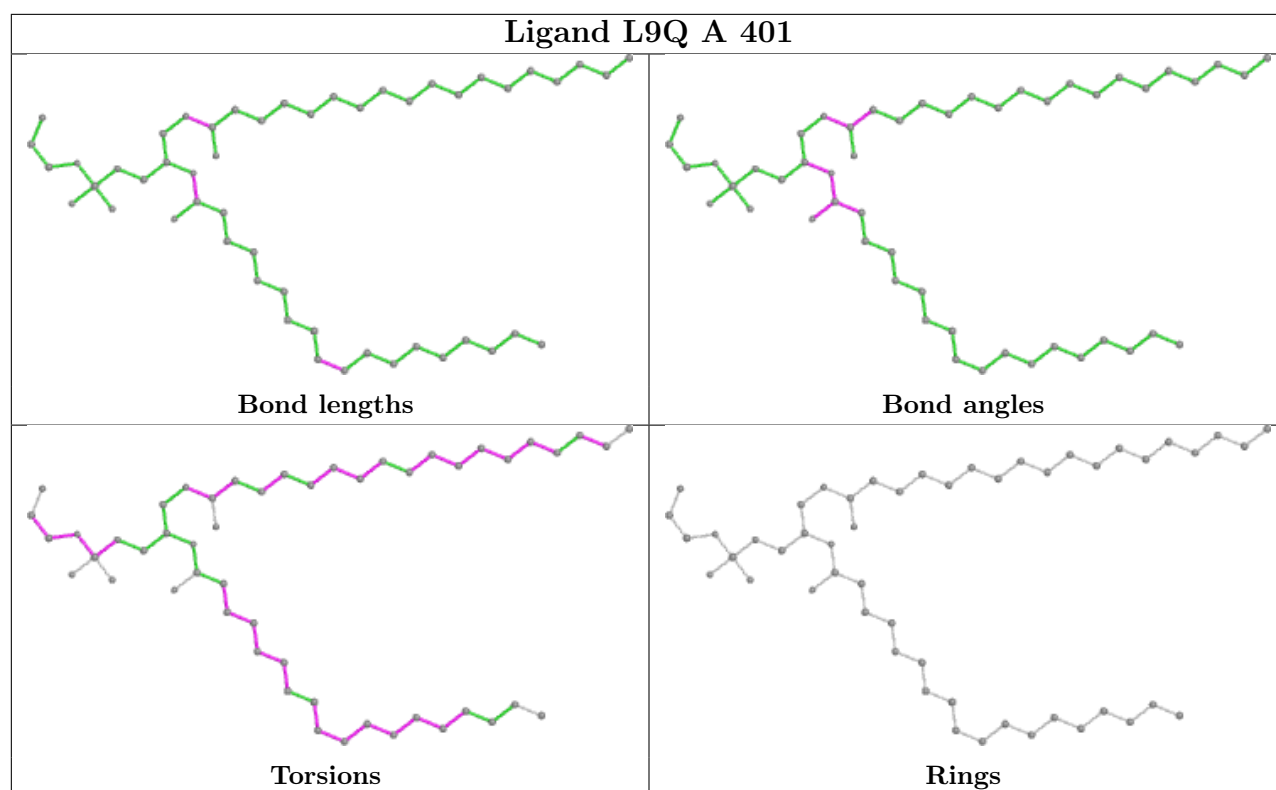
There are no ring outliers.

2 monomers are involved in 9 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	401	L9Q	5	0
2	A	401	L9Q	4	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.