



# wwPDB X-ray Structure Validation Summary Report ⓘ

May 13, 2020 – 05:51 am BST

PDB ID : 2RCR  
Title : STRUCTURE OF THE MEMBRANE-BOUND PROTEIN PHOTOSYN-  
THETIC REACTION CENTER FROM RHODOBACTER SPHAEROIDES  
Authors : Chang, C.-H.; Norris, J.; Schiffer, M.  
Deposited on : 1991-02-04  
Resolution : 3.10 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.

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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) : **NOT EXECUTED**  
EDS : **NOT EXECUTED**  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.11

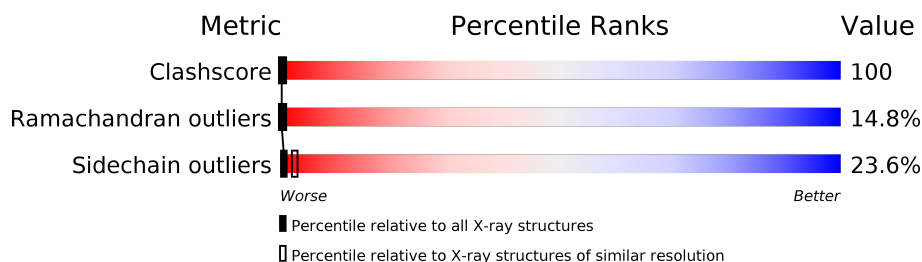
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 3.10 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	141614	1184 (3.10-3.10)
Ramachandran outliers	138981	1141 (3.10-3.10)
Sidechain outliers	138945	1141 (3.10-3.10)

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 on 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  $\leq 5\%$ .

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	L	281	<div> <div>15%</div> <div>56%</div> <div>23%</div> <div>• •</div> </div>
2	M	307	<div> <div>13%</div> <div>57%</div> <div>24%</div> <div>6% •</div> </div>
3	H	260	<div> <div>17%</div> <div>51%</div> <div>24%</div> <div>7% •</div> </div>

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
4	BCL	L	350	-	-	X	-
4	BCL	L	450	-	-	X	-

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Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
4	BCL	M	400	-	-	X	-
4	BCL	M	601	-	-	X	-
5	BPH	M	500	-	-	X	-
6	UQ	L	800	-	-	X	-
6	UQ	M	750	-	-	X	-

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 7049 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 PHOTOSYNTHETIC REACTION CENTER (L SUBUNIT).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	L	278	Total	C	N	O	S	0	0	0
			2203	1491	349	355	8			

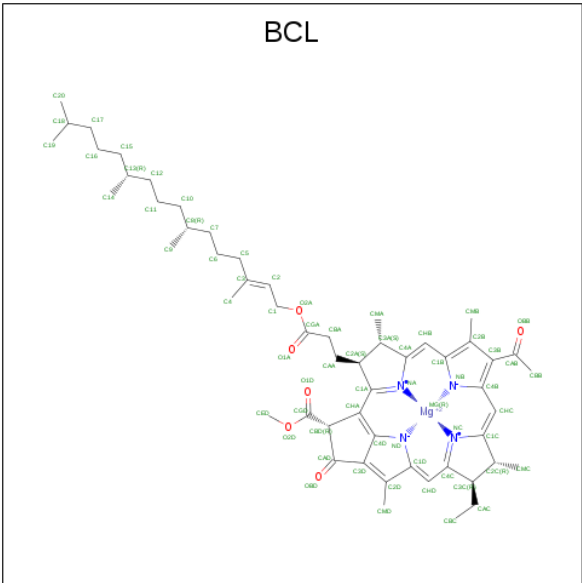
- Molecule 2 is a protein called PHOTOSYNTHETIC REACTION CENTER (M SUBUNIT).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	M	305	Total	C	N	O	S	0	0	0
			2428	1620	397	400	11			

- Molecule 3 is a protein called PHOTOSYNTHETIC REACTION CENTER (H SUBUNIT).

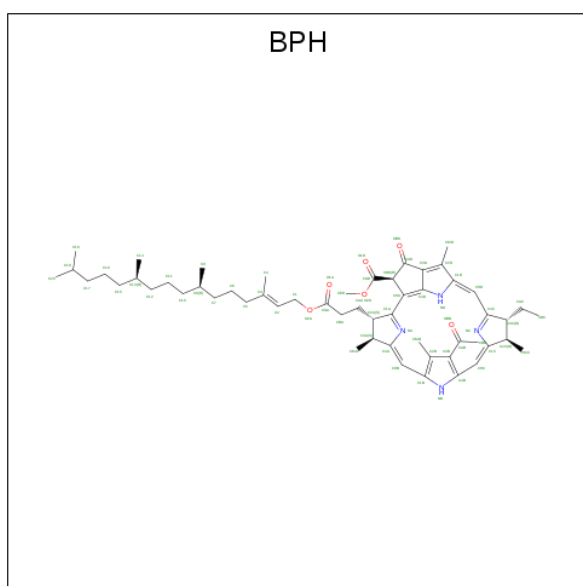
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	H	255	Total	C	N	O	S	73	0	0
			1927	1232	330	354	11			

- Molecule 4 is BACTERIOCHLOROPHYLL A (three-letter code: BCL) (formula: C<sub>55</sub>H<sub>74</sub>MgN<sub>4</sub>O<sub>6</sub>).



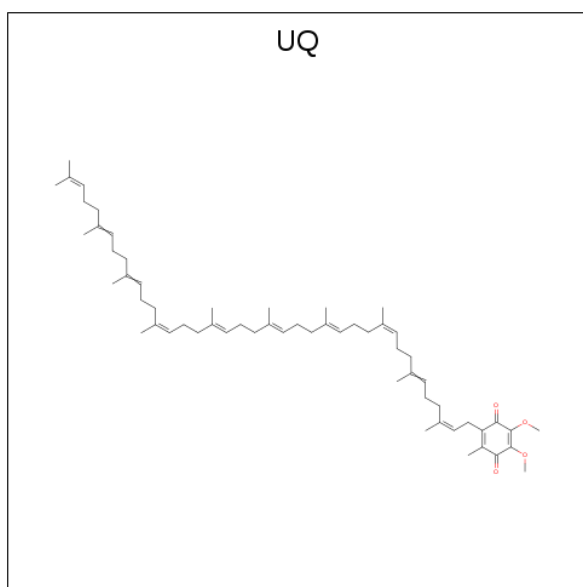
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	L	1	Total 66	C 55	Mg 1	N 4	O 6	0	0
4	L	1	Total 66	C 55	Mg 1	N 4	O 6	6	0
4	M	1	Total 66	C 55	Mg 1	N 4	O 6	7	0
4	M	1	Total 66	C 55	Mg 1	N 4	O 6	3	0

- Molecule 5 is BACTERIOPHEOPHYTIN A (three-letter code: BPH) (formula:  $C_{55}H_{76}N_4O_6$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	L	1	Total	C	N	O	0	0
			65	55	4	6		
5	M	1	Total	C	N	O	7	0
			65	55	4	6		

- Molecule 6 is Coenzyme Q10, (2Z,6E,10Z,14E,18E,22E,26Z)-isomer (three-letter code: UQ) (formula:  $C_{59}H_{90}O_4$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	L	1	Total	C	O	16	0
			48	44	4		
6	M	1	Total	C	O	16	0
			48	44	4		

- Molecule 7 is FE (III) ION (three-letter code: FE) (formula: Fe).


Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	M	1	Total	Fe	0	0
			1	1		

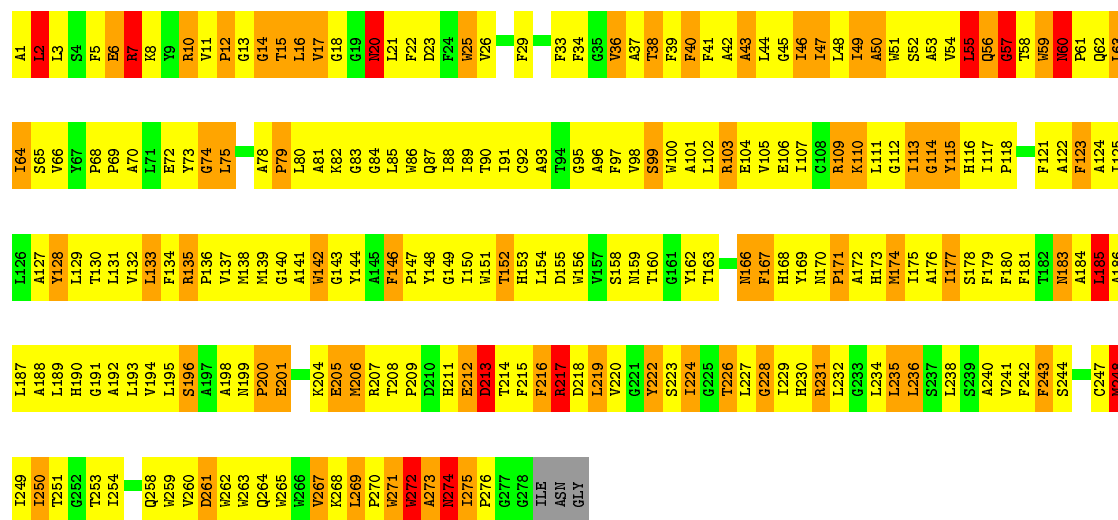
### 3 Residue-property plots

These plots are drawn for all protein, RNA and DNA 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.

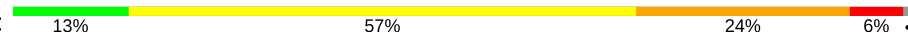
Note EDS was not executed.

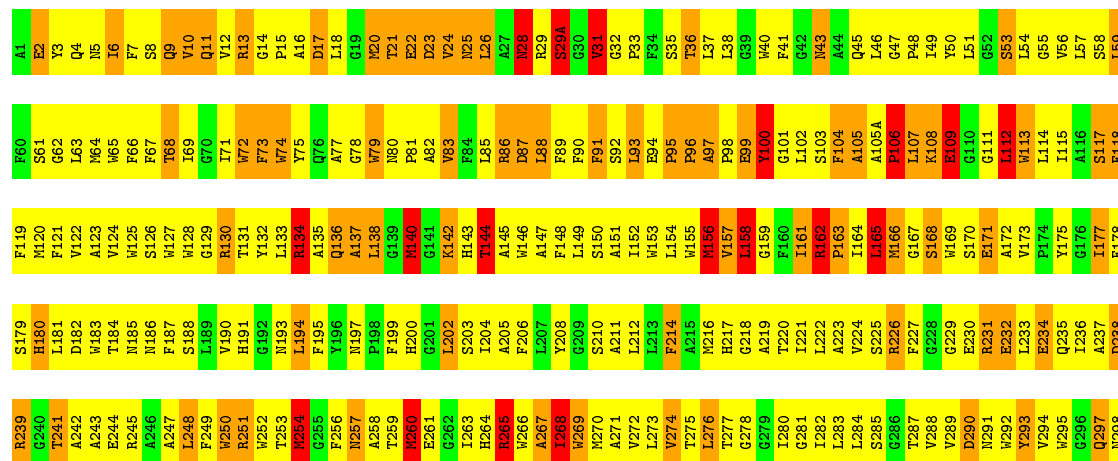
#### • Molecule 1: PHOTOSYNTHETIC REACTION CENTER (L SUBUNIT)

Chain L: 



#### • Molecule 2: PHOTOSYNTHETIC REACTION CENTER (M SUBUNIT)

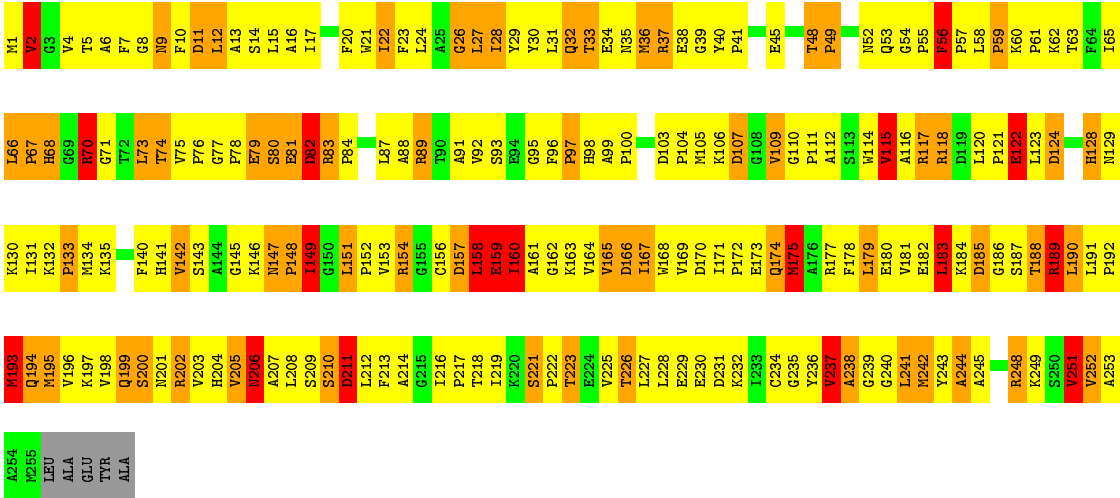
Chain M: 



P399  
G300  
M301  
A302  
P303  
LEU  
ASN

• Molecule 3: PHOTOSYNTHETIC REACTION CENTER (H SUBUNIT)

Chain H: 17% 51% 24% 7%





## 4 Data and refinement statistics

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

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	142.20Å 139.60Å 78.70Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	(Not available) – 3.10	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-3.10)	Depositor
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
Refinement program	PROLSQ	Depositor
R, $R_{free}$	0.220 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	7049	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	0.0	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: BCL, BPH, UQ, FE

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	L	1.00	2/2291 (0.1%)	1.47	24/3137 (0.8%)
2	M	1.21	6/2521 (0.2%)	1.57	36/3442 (1.0%)
3	H	0.96	4/1977 (0.2%)	1.52	23/2689 (0.9%)
All	All	1.07	12/6789 (0.2%)	1.52	83/9268 (0.9%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
2	M	0	5

The worst 5 of 12 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	M	250	TRP	CA-CB	-17.94	1.14	1.53
2	M	93	LEU	C-O	16.21	1.54	1.23
2	M	93	LEU	CA-C	-12.85	1.19	1.52
2	M	93	LEU	C-N	10.05	1.57	1.34
2	M	112	LEU	C-N	8.74	1.54	1.34

The worst 5 of 83 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	M	112	LEU	O-C-N	-24.12	84.11	122.70
1	L	166	ASN	CA-CB-CG	18.90	154.98	113.40
1	L	166	ASN	N-CA-CB	17.93	142.88	110.60
2	M	109	GLU	CA-C-N	-15.78	84.64	116.20
2	M	112	LEU	CA-C-N	13.93	147.85	117.20

There are no chirality outliers.

All (5) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	M	109	GLU	Mainchain,Peptide
2	M	112	LEU	Mainchain,Peptide
2	M	265	ARG	Sidechain

## 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	L	2203	0	2156	482	1
2	M	2428	0	2342	596	1
3	H	1927	0	1927	364	2
4	L	132	0	148	46	0
4	M	132	0	148	63	0
5	L	65	0	76	16	0
5	M	65	0	76	33	0
6	L	48	0	59	21	0
6	M	48	0	63	33	0
7	M	1	0	0	0	0
All	All	7049	0	6995	1373	2

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 100.

The worst 5 of 1373 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)
6:M:750:UQ:C13	6:M:750:UQ:C12	1.84	1.50
1:L:183:ASN:ND2	1:L:236:LEU:HB2	1.24	1.48
2:M:96:PRO:HG2	2:M:170:SER:CA	1.57	1.33
1:L:183:ASN:HD22	1:L:236:LEU:CB	1.44	1.30
2:M:96:PRO:CG	2:M:170:SER:HA	1.75	1.17

All (2) 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)
2:M:293:TYR:OH	3:H:166:ASP:OD1[4_445]	1.59	0.61
1:L:265:TRP:CB	3:H:49:PRO:O[1_556]	2.17	0.03

### 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	L	276/281 (98%)	187 (68%)	52 (19%)	37 (13%)	0	1
2	M	303/307 (99%)	189 (62%)	72 (24%)	42 (14%)	0	1
3	H	253/260 (97%)	144 (57%)	65 (26%)	44 (17%)	0	0
All	All	832/848 (98%)	520 (62%)	189 (23%)	123 (15%)	0	0

5 of 123 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	L	7	ARG
1	L	20	ASN
1	L	55	LEU
1	L	60	ASN
1	L	74	GLY

#### 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	L	216/220 (98%)	169 (78%)	47 (22%)	1	4

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	M	238/240 (99%)	179 (75%)	59 (25%)	0	2
3	H	203/208 (98%)	154 (76%)	49 (24%)	0	2
All	All	657/668 (98%)	502 (76%)	155 (24%)	1	2

5 of 155 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	M	134	ARG
2	M	210	SER
3	H	193	MET
2	M	142	LYS
2	M	161	ILE

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 20 such sidechains are listed below:

Mol	Chain	Res	Type
2	M	43	ASN
2	M	45	GLN
3	H	9	ASN
2	M	25	ASN
2	M	28	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 carbohydrates in this entry.

## 5.6 Ligand geometry [i](#)

Of 9 ligands modelled in this entry, 1 is monoatomic - leaving 8 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
6	UQ	L	800	-	48,48,63	2.39	15 (31%)	58,61,79	2.43	24 (41%)
6	UQ	M	750	-	48,48,63	2.22	9 (18%)	58,61,79	2.04	17 (29%)
4	BCL	M	601	2	58,74,74	1.37	9 (15%)	69,115,115	1.63	12 (17%)
5	BPH	L	550	-	64,70,70	1.17	7 (10%)	76,101,101	1.42	13 (17%)
4	BCL	L	450	-	58,74,74	1.28	7 (12%)	69,115,115	1.56	11 (15%)
4	BCL	L	350	-	58,74,74	1.57	8 (13%)	69,115,115	1.82	14 (20%)
4	BCL	M	400	2	58,74,74	1.75	9 (15%)	69,115,115	1.73	14 (20%)
5	BPH	M	500	-	64,70,70	1.22	7 (10%)	76,101,101	1.30	10 (13%)

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
6	UQ	L	800	-	-	14/45/69/87	0/1/1/1
6	UQ	M	750	-	-	18/45/69/87	0/1/1/1
4	BCL	M	601	2	-	17/37/137/137	-
5	BPH	L	550	-	-	15/54/105/105	0/5/6/6
4	BCL	L	450	-	-	15/37/137/137	-
4	BCL	L	350	-	-	20/37/137/137	-
4	BCL	M	400	2	-	26/37/137/137	-
5	BPH	M	500	-	-	20/54/105/105	0/5/6/6

The worst 5 of 71 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	M	750	UQ	C12-C13	10.31	1.84	1.50
6	L	800	UQ	C16-C17	-8.80	1.24	1.53
4	M	400	BCL	MG-NA	8.79	2.27	2.06
6	L	800	UQ	C7-C8	6.82	1.60	1.50

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	L	350	BCL	MG-NC	5.00	2.18	2.06

The worst 5 of 115 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	M	400	BCL	C4A-NA-C1A	7.95	110.28	106.71
4	L	350	BCL	C4A-NA-C1A	7.06	109.88	106.71
4	M	601	BCL	C4A-NA-C1A	6.50	109.63	106.71
4	L	350	BCL	C4D-C3D-CAD	-5.62	105.34	108.47
6	L	800	UQ	C20-C19-C21	5.42	124.39	115.27

There are no chirality outliers.

5 of 145 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	L	800	UQ	C18-C19-C21-C22
6	L	800	UQ	C20-C19-C21-C22
6	L	800	UQ	C30-C29-C31-C32
6	L	800	UQ	C29-C31-C32-C33
6	M	750	UQ	C21-C22-C23-C24

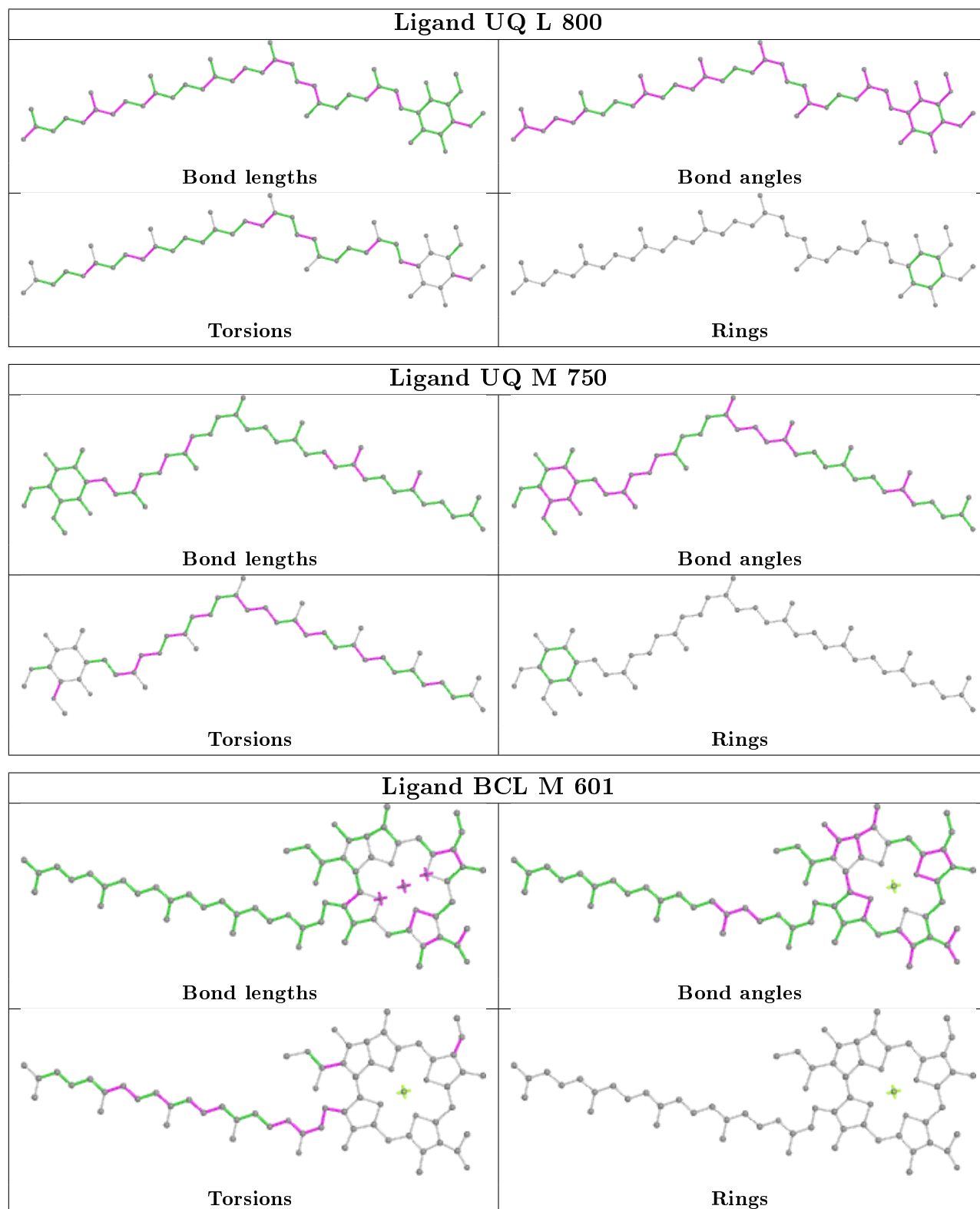
There are no ring outliers.

8 monomers are involved in 190 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	L	800	UQ	21	0
6	M	750	UQ	33	0
4	M	601	BCL	22	0
5	L	550	BPH	16	0
4	L	450	BCL	22	0
4	L	350	BCL	35	0
4	M	400	BCL	47	0
5	M	500	BPH	33	0

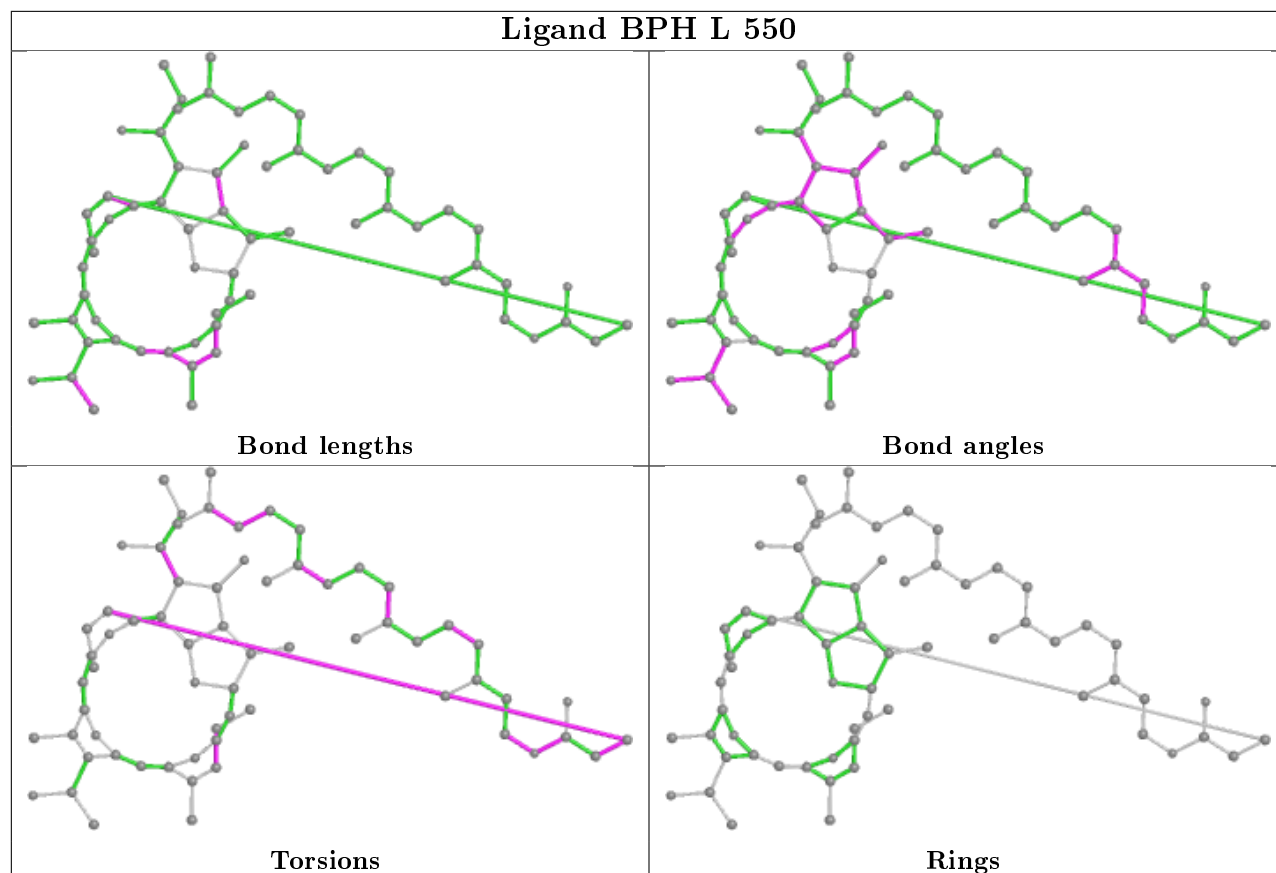
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included.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

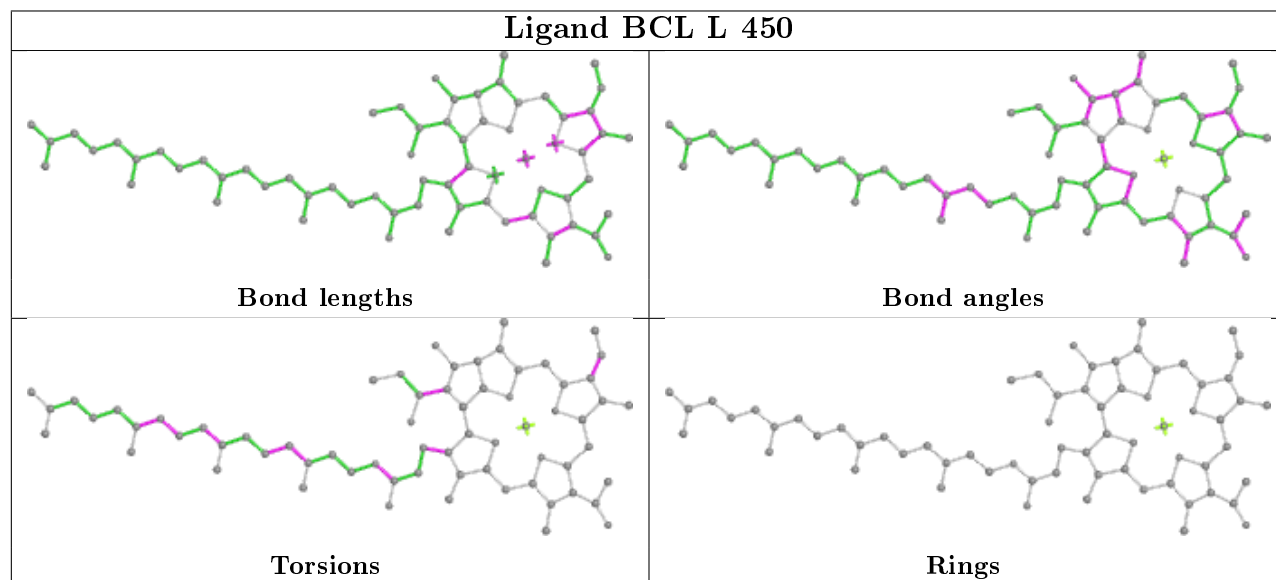


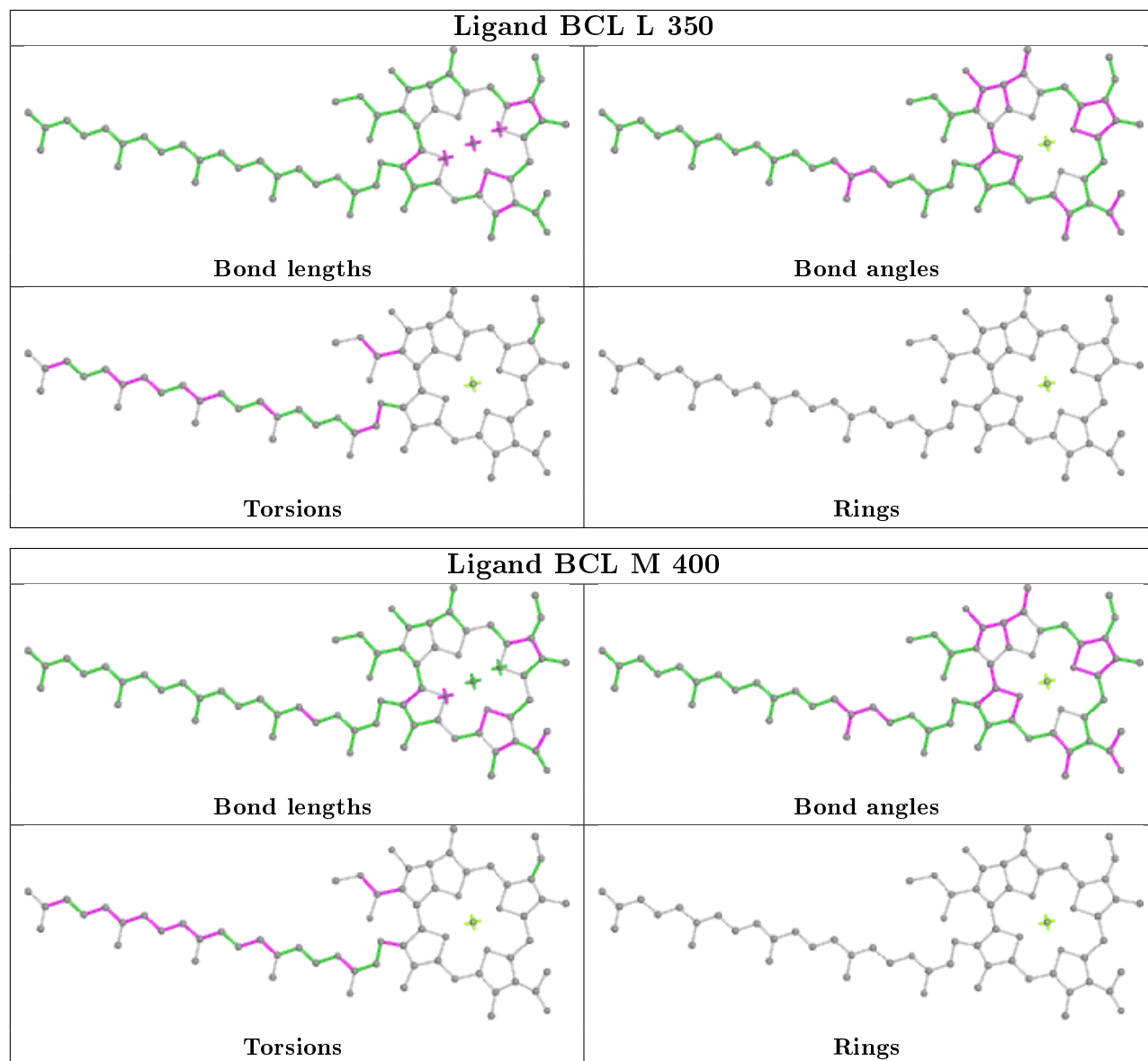


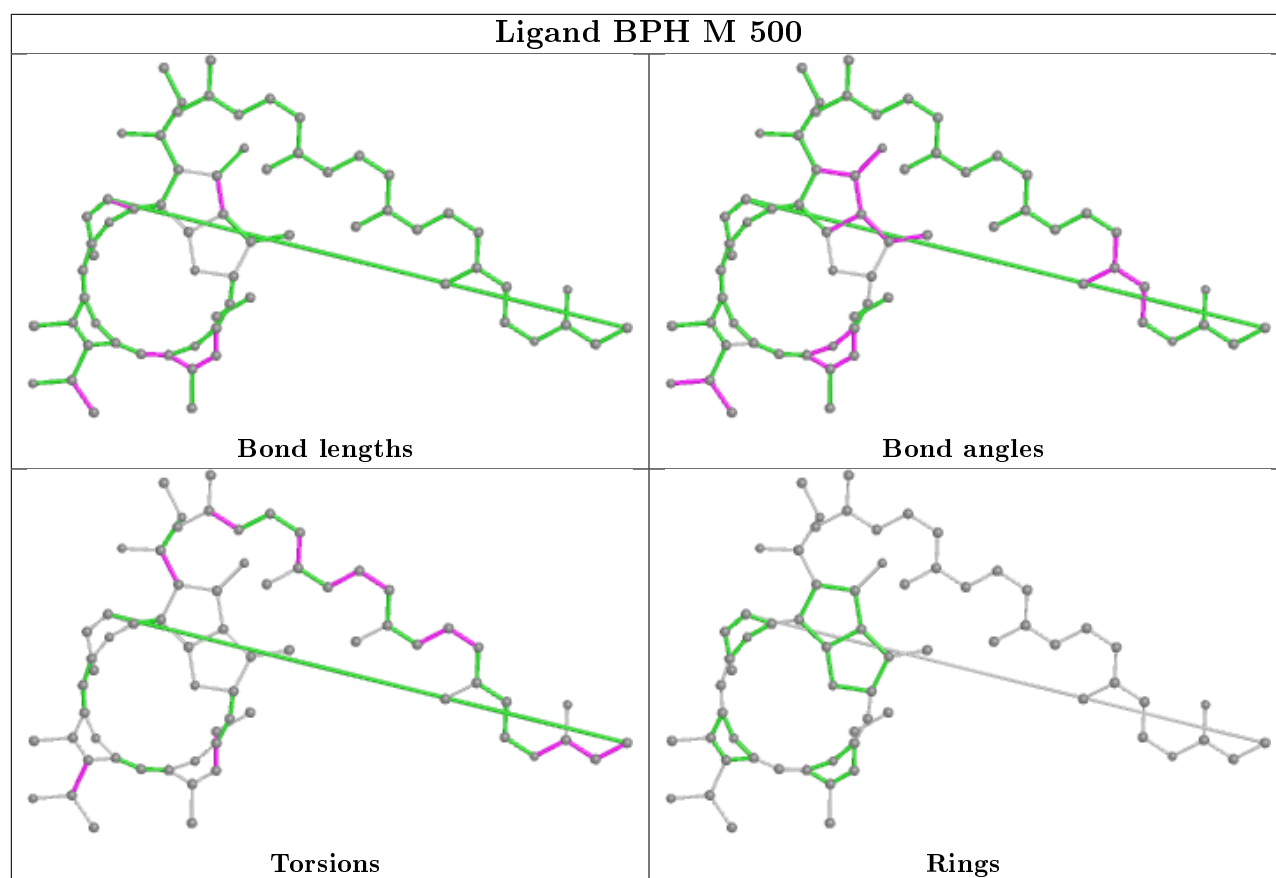
## Ligand BPH L 550



## Ligand BCL L 450







## 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.