



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 5, 2023 – 04:13 AM EDT

PDB ID : 6UQ8  
Title : Crystal structure of R421A variant of cytosolic fumarate hydratase from Leishmania major in a complex with S-malate and malonate  
Authors : Feliciano, P.R.; Drennan, C.L.  
Deposited on : 2019-10-18  
Resolution : 1.34 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](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 : **FAILED**  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtrriage (Phenix) : 1.13  
EDS : **FAILED**  
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) : 2.35.1

# 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 1.34 Å.

There are no overall percentile quality scores available for this entry.

MolProbity and EDS failed to run properly - the sequence quality summary graphics cannot be shown.

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	LMR	B	602	-	X	-	-

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 18356 atoms, of which 8666 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 Fumarate hydratase 2.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
			Total	C	H	N	O	S			
1	A	532	8675	2772	4319	754	807	23	0	43	0
1	B	530	8668	2771	4297	762	815	23	0	46	0

There are 74 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-35	MET	-	expression tag	UNP E9AE57
A	-34	GLY	-	expression tag	UNP E9AE57
A	-33	SER	-	expression tag	UNP E9AE57
A	-32	SER	-	expression tag	UNP E9AE57
A	-31	HIS	-	expression tag	UNP E9AE57
A	-30	HIS	-	expression tag	UNP E9AE57
A	-29	HIS	-	expression tag	UNP E9AE57
A	-28	HIS	-	expression tag	UNP E9AE57
A	-27	HIS	-	expression tag	UNP E9AE57
A	-26	HIS	-	expression tag	UNP E9AE57
A	-25	SER	-	expression tag	UNP E9AE57
A	-24	SER	-	expression tag	UNP E9AE57
A	-23	GLY	-	expression tag	UNP E9AE57
A	-22	LEU	-	expression tag	UNP E9AE57
A	-21	VAL	-	expression tag	UNP E9AE57
A	-20	PRO	-	expression tag	UNP E9AE57
A	-19	ARG	-	expression tag	UNP E9AE57
A	-18	GLY	-	expression tag	UNP E9AE57
A	-17	SER	-	expression tag	UNP E9AE57
A	-16	HIS	-	expression tag	UNP E9AE57
A	-15	MET	-	expression tag	UNP E9AE57
A	-14	ALA	-	expression tag	UNP E9AE57
A	-13	SER	-	expression tag	UNP E9AE57
A	-12	MET	-	expression tag	UNP E9AE57
A	-11	THR	-	expression tag	UNP E9AE57

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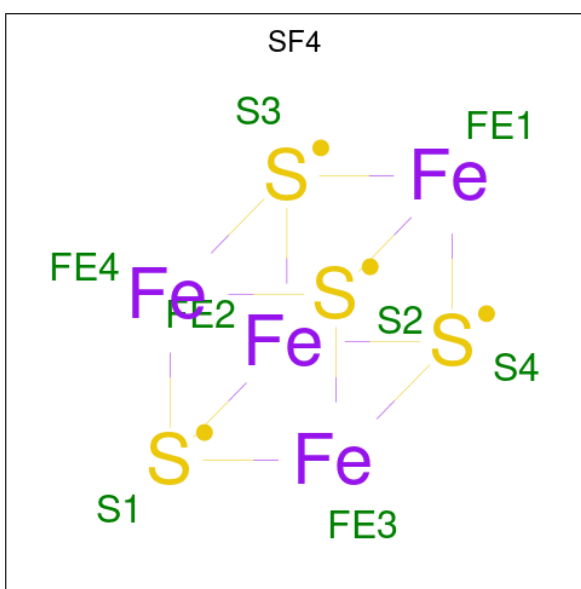
Chain	Residue	Modelled	Actual	Comment	Reference
A	-10	GLY	-	expression tag	UNP E9AE57
A	-9	GLY	-	expression tag	UNP E9AE57
A	-8	GLN	-	expression tag	UNP E9AE57
A	-7	GLN	-	expression tag	UNP E9AE57
A	-6	MET	-	expression tag	UNP E9AE57
A	-5	GLY	-	expression tag	UNP E9AE57
A	-4	ARG	-	expression tag	UNP E9AE57
A	-3	GLY	-	expression tag	UNP E9AE57
A	-2	SER	-	expression tag	UNP E9AE57
A	-1	GLU	-	expression tag	UNP E9AE57
A	0	PHE	-	expression tag	UNP E9AE57
A	421	ALA	ARG	engineered mutation	UNP E9AE57
B	-35	MET	-	expression tag	UNP E9AE57
B	-34	GLY	-	expression tag	UNP E9AE57
B	-33	SER	-	expression tag	UNP E9AE57
B	-32	SER	-	expression tag	UNP E9AE57
B	-31	HIS	-	expression tag	UNP E9AE57
B	-30	HIS	-	expression tag	UNP E9AE57
B	-29	HIS	-	expression tag	UNP E9AE57
B	-28	HIS	-	expression tag	UNP E9AE57
B	-27	HIS	-	expression tag	UNP E9AE57
B	-26	HIS	-	expression tag	UNP E9AE57
B	-25	SER	-	expression tag	UNP E9AE57
B	-24	SER	-	expression tag	UNP E9AE57
B	-23	GLY	-	expression tag	UNP E9AE57
B	-22	LEU	-	expression tag	UNP E9AE57
B	-21	VAL	-	expression tag	UNP E9AE57
B	-20	PRO	-	expression tag	UNP E9AE57
B	-19	ARG	-	expression tag	UNP E9AE57
B	-18	GLY	-	expression tag	UNP E9AE57
B	-17	SER	-	expression tag	UNP E9AE57
B	-16	HIS	-	expression tag	UNP E9AE57
B	-15	MET	-	expression tag	UNP E9AE57
B	-14	ALA	-	expression tag	UNP E9AE57
B	-13	SER	-	expression tag	UNP E9AE57
B	-12	MET	-	expression tag	UNP E9AE57
B	-11	THR	-	expression tag	UNP E9AE57
B	-10	GLY	-	expression tag	UNP E9AE57
B	-9	GLY	-	expression tag	UNP E9AE57
B	-8	GLN	-	expression tag	UNP E9AE57
B	-7	GLN	-	expression tag	UNP E9AE57
B	-6	MET	-	expression tag	UNP E9AE57

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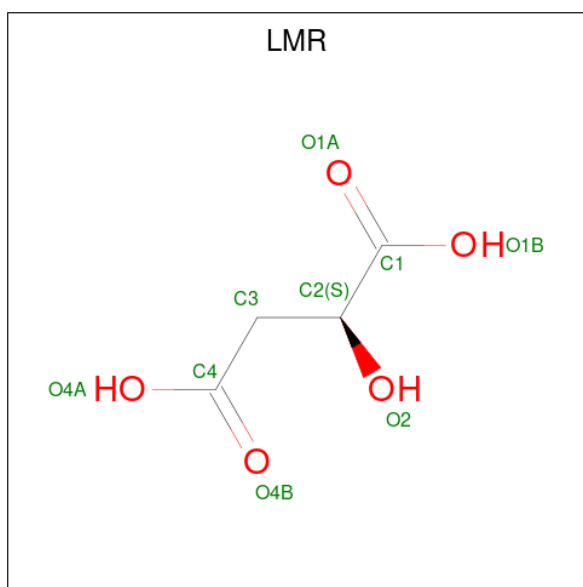
Chain	Residue	Modelled	Actual	Comment	Reference
B	-5	GLY	-	expression tag	UNP E9AE57
B	-4	ARG	-	expression tag	UNP E9AE57
B	-3	GLY	-	expression tag	UNP E9AE57
B	-2	SER	-	expression tag	UNP E9AE57
B	-1	GLU	-	expression tag	UNP E9AE57
B	0	PHE	-	expression tag	UNP E9AE57
B	421	ALA	ARG	engineered mutation	UNP E9AE57

- Molecule 2 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe<sub>4</sub>S<sub>4</sub>) (labeled as "Ligand of Interest" by depositor).



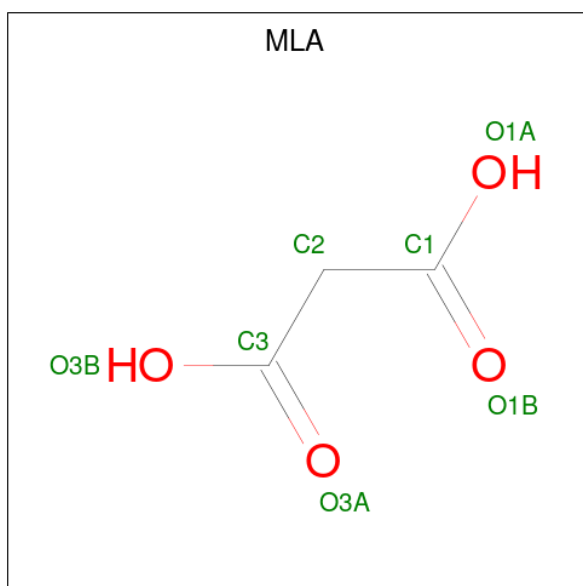
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total Fe S 8 4 4	0	0
2	B	1	Total Fe S 8 4 4	0	0

- Molecule 3 is (2S)-2-hydroxybutanedioic acid (three-letter code: LMR) (formula: C<sub>4</sub>H<sub>6</sub>O<sub>5</sub>) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
3	A	1	Total	C	H	O	0	0
			13	4	4	5		
3	B	1	Total	C	H	O	0	0
			13	4	4	5		

- Molecule 4 is MALONIC ACID (three-letter code: MLA) (formula:  $C_3H_4O_4$ ) (labeled as "Ligand of Interest" by depositor).



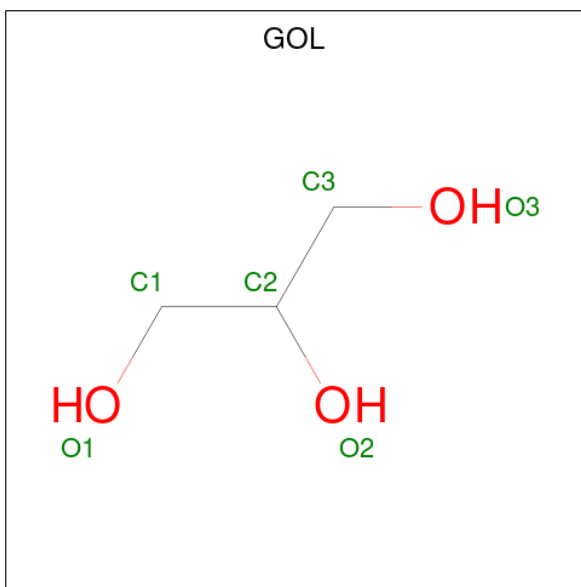
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	H	O	0	0
			9	3	2	4		

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Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	H	O	0	0
			9	3	2	4		
4	B	1	Total	C	H	O	0	0
			9	3	2	4		
4	B	1	Total	C	H	O	0	0
			9	3	2	4		

- Molecule 5 is GLYCEROL (three-letter code: GOL) (formula:  $C_3H_8O_3$ ).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	C	H	O	0	0
			12	3	6	3		
5	A	1	Total	C	H	O	0	0
			14	3	8	3		
5	A	1	Total	C	H	O	0	0
			12	3	6	3		
5	B	1	Total	C	H	O	0	0
			13	3	7	3		
5	B	1	Total	C	H	O	0	0
			13	3	7	3		

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	442	Total	O	0	3
			445	445		

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<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
6	B	424	Total 426	O 426	0	2

MolProbity and EDS failed to run properly - this section is therefore empty.



### 3 Data and refinement statistics

EDS failed to run properly - this section is therefore incomplete.

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	65.73Å 84.75Å 240.12Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	48.99 – 1.34	Depositor
% Data completeness (in resolution range)	94.2 (48.99-1.34)	Depositor
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.20 (at 1.34Å)	Xtrriage
Refinement program	PHENIX 1.13_2998	Depositor
R, $R_{free}$	0.134 , 0.143	Depositor
Wilson B-factor (Å <sup>2</sup> )	14.9	Xtrriage
Anisotropy	0.247	Xtrriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	18356	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	20.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.99% 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.

## 4 Model quality [i](#)

### 4.1 Standard geometry [i](#)

MolProbity failed to run properly - this section is therefore empty.

### 4.2 Too-close contacts [i](#)

MolProbity failed to run properly - this section is therefore empty.

### 4.3 Torsion angles [i](#)

#### 4.3.1 Protein backbone [i](#)

MolProbity failed to run properly - this section is therefore empty.

#### 4.3.2 Protein sidechains [i](#)

MolProbity failed to run properly - this section is therefore empty.

#### 4.3.3 RNA [i](#)

MolProbity failed to run properly - this section is therefore empty.

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

There are no non-standard protein/DNA/RNA residues in this entry.

### 4.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

### 4.6 Ligand geometry [i](#)

13 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
5	GOL	A	605	-	5,5,5	0.85	0	5,5,5	0.97	0
4	MLA	A	603	-	6,6,6	1.13	0	7,7,7	1.24	1 (14%)
2	SF4	A	601	3,1	0,12,12	-	-	-	-	-
3	LMR	B	602	2	8,8,8	1.12	0	10,10,10	1.71	4 (40%)
5	GOL	A	607	-	5,5,5	0.88	0	5,5,5	1.01	0
3	LMR	A	602	2	8,8,8	1.27	0	10,10,10	1.75	4 (40%)
4	MLA	A	604	-	6,6,6	1.23	0	7,7,7	1.50	2 (28%)
5	GOL	B	606	-	5,5,5	0.97	0	5,5,5	0.86	0
5	GOL	A	606	-	5,5,5	0.65	0	5,5,5	0.79	0
4	MLA	B	603	-	6,6,6	1.17	0	7,7,7	0.92	0
2	SF4	B	601	3,1	0,12,12	-	-	-	-	-
4	MLA	B	604	-	6,6,6	1.26	0	7,7,7	1.50	1 (14%)
5	GOL	B	605	-	5,5,5	0.82	0	5,5,5	0.91	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
5	GOL	A	605	-	-	0/4/4/4	-
4	MLA	A	603	-	-	4/4/4/4	-
3	LMR	B	602	2	-	7/8/8/8	-
2	SF4	A	601	3,1	-	-	0/6/5/5
5	GOL	A	607	-	-	0/4/4/4	-
3	LMR	A	602	2	-	3/8/8/8	-
4	MLA	A	604	-	-	0/4/4/4	-
5	GOL	B	606	-	-	0/4/4/4	-
5	GOL	A	606	-	-	0/4/4/4	-
4	MLA	B	603	-	-	4/4/4/4	-
2	SF4	B	601	3,1	-	-	0/6/5/5
4	MLA	B	604	-	-	0/4/4/4	-
5	GOL	B	605	-	-	0/4/4/4	-

There are no bond length outliers.

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	A	602	LMR	O1B-C1-C2	2.85	118.97	112.72
3	B	602	LMR	O1B-C1-C2	2.81	118.89	112.72
4	B	604	MLA	O1A-C1-C2	2.57	122.74	114.54
3	A	602	LMR	O1A-C1-C2	-2.53	117.59	122.54
3	A	602	LMR	C3-C2-C1	-2.48	104.48	110.33
3	B	602	LMR	O4A-C4-C3	2.47	121.98	114.07
4	A	604	MLA	O1A-C1-C2	2.25	121.73	114.54
3	B	602	LMR	O4B-C4-C3	-2.24	115.62	122.80
3	A	602	LMR	O4A-C4-C3	2.16	120.99	114.07
4	A	603	MLA	C3-C2-C1	-2.14	105.35	112.87
3	B	602	LMR	O1A-C1-C2	-2.06	118.52	122.54
4	A	604	MLA	O1A-C1-O1B	-2.00	118.31	123.30

There are no chirality outliers.

All (18) torsion outliers are listed below:

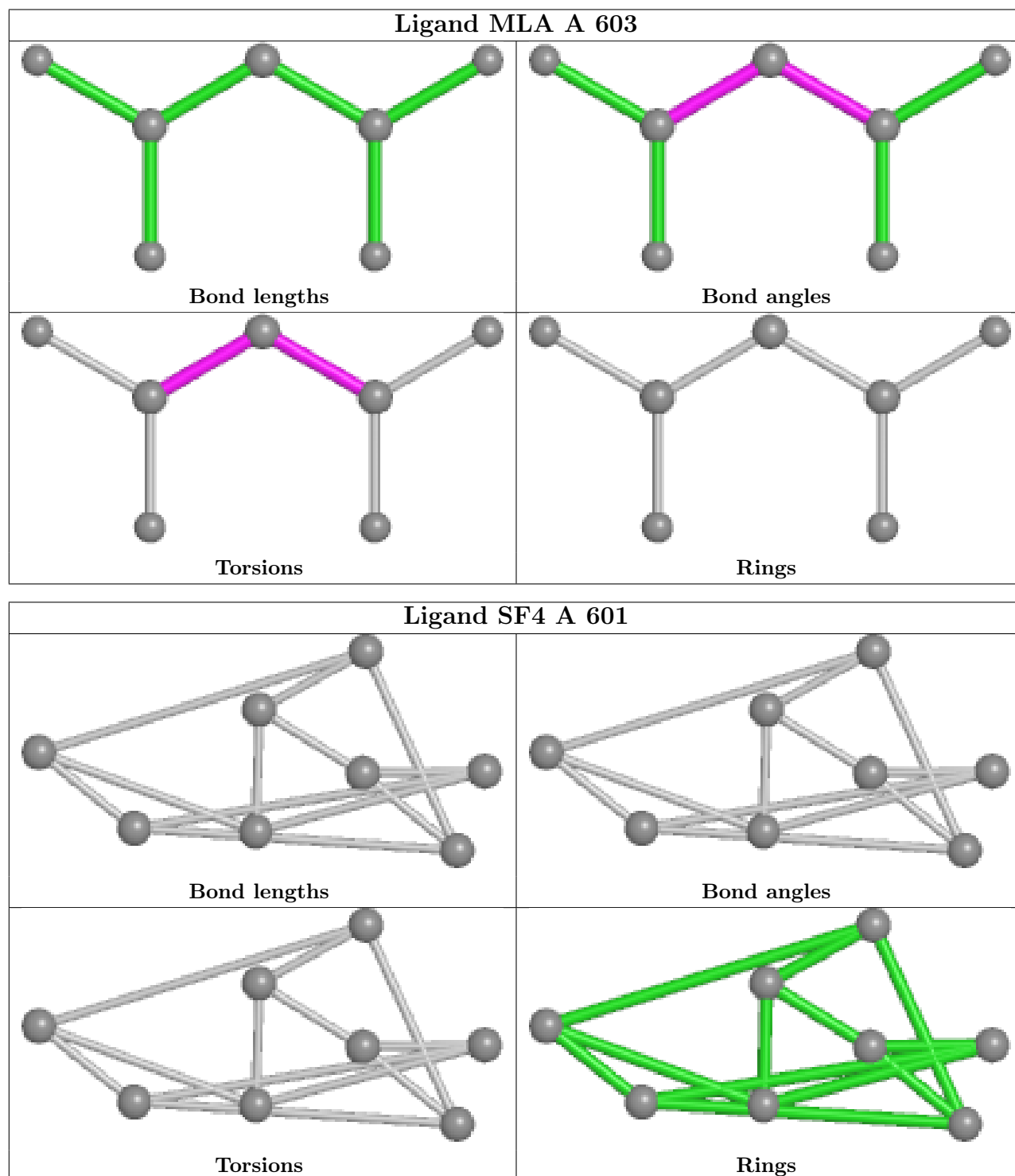
Mol	Chain	Res	Type	Atoms
4	A	603	MLA	O1A-C1-C2-C3
4	A	603	MLA	C1-C2-C3-O3B
4	B	603	MLA	C1-C2-C3-O3B
4	A	603	MLA	C1-C2-C3-O3A
4	A	603	MLA	O1B-C1-C2-C3
4	B	603	MLA	C1-C2-C3-O3A
4	B	603	MLA	O1B-C1-C2-C3
4	B	603	MLA	O1A-C1-C2-C3
3	B	602	LMR	O2-C2-C3-C4
3	B	602	LMR	C2-C3-C4-O4A
3	A	602	LMR	O1A-C1-C2-O2
3	A	602	LMR	O1B-C1-C2-O2
3	B	602	LMR	O1A-C1-C2-O2
3	B	602	LMR	O1B-C1-C2-O2
3	A	602	LMR	C2-C3-C4-O4A
3	B	602	LMR	C2-C3-C4-O4B
3	B	602	LMR	O1A-C1-C2-C3
3	B	602	LMR	O1B-C1-C2-C3

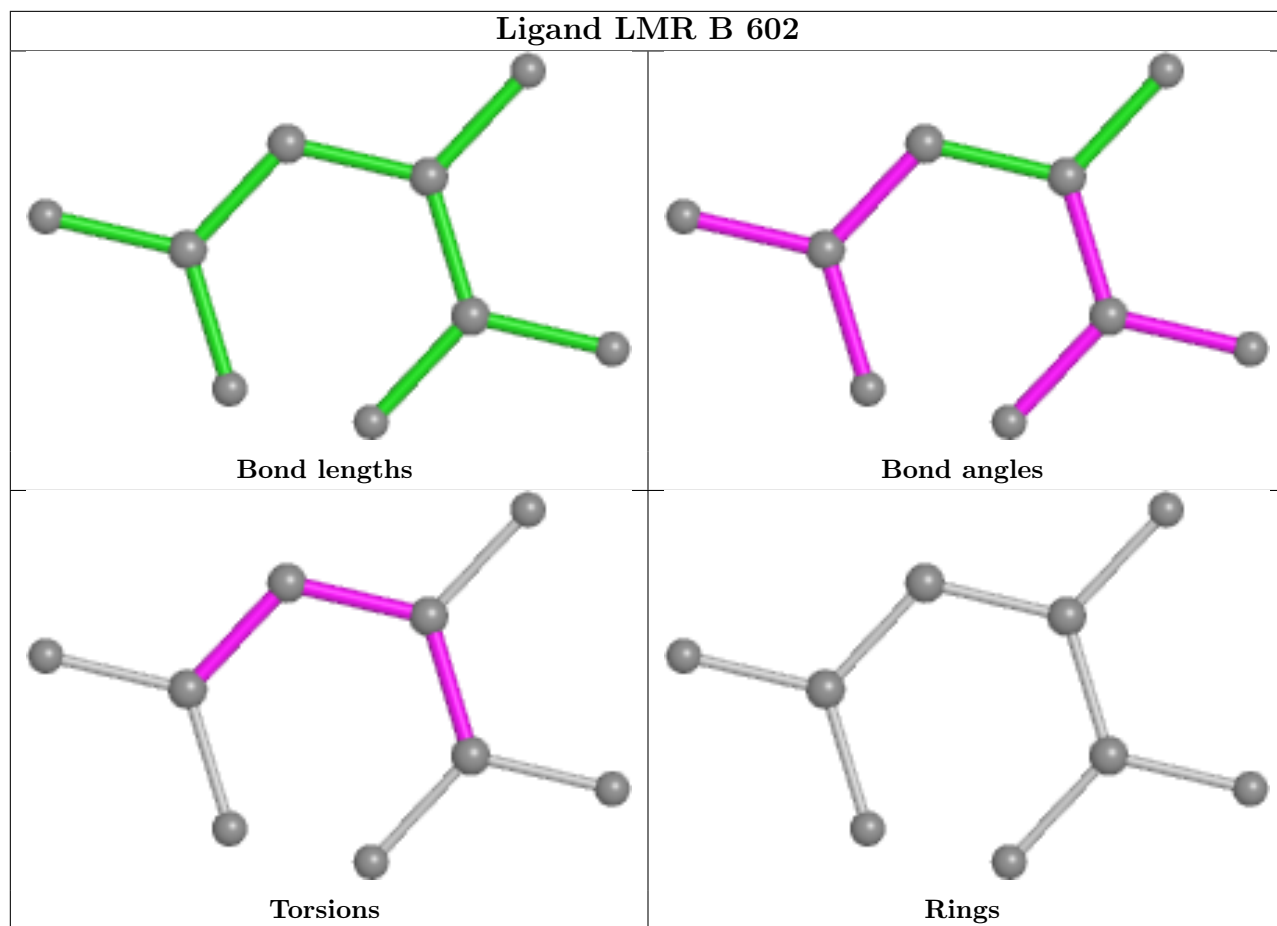
There are no ring outliers.

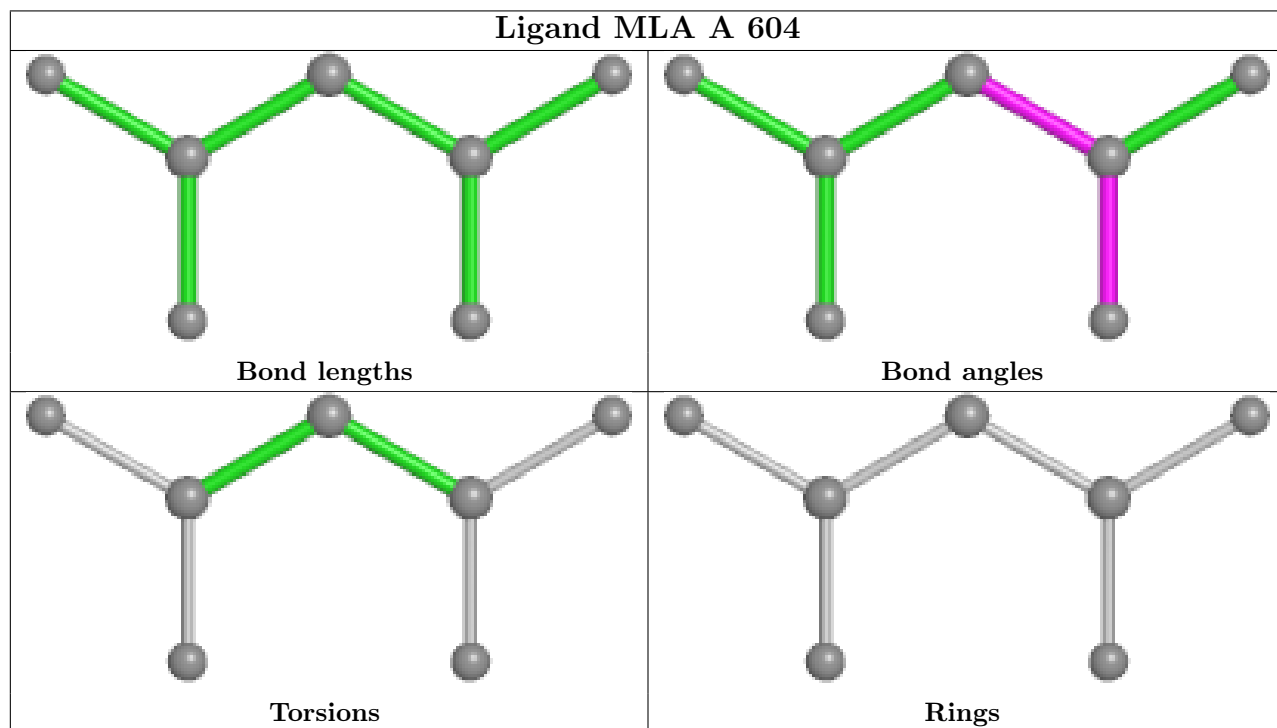
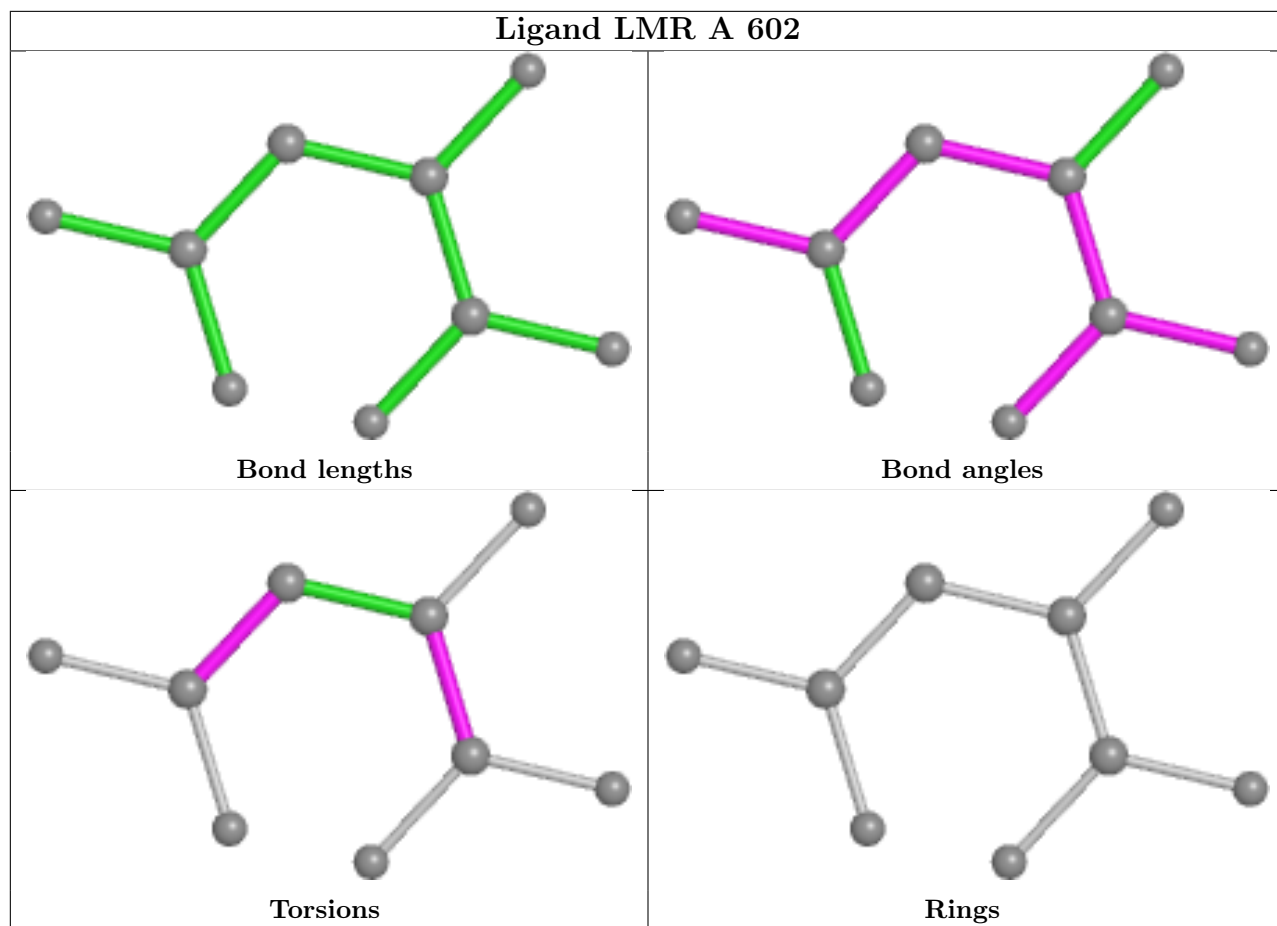
No monomer is involved in short contacts.

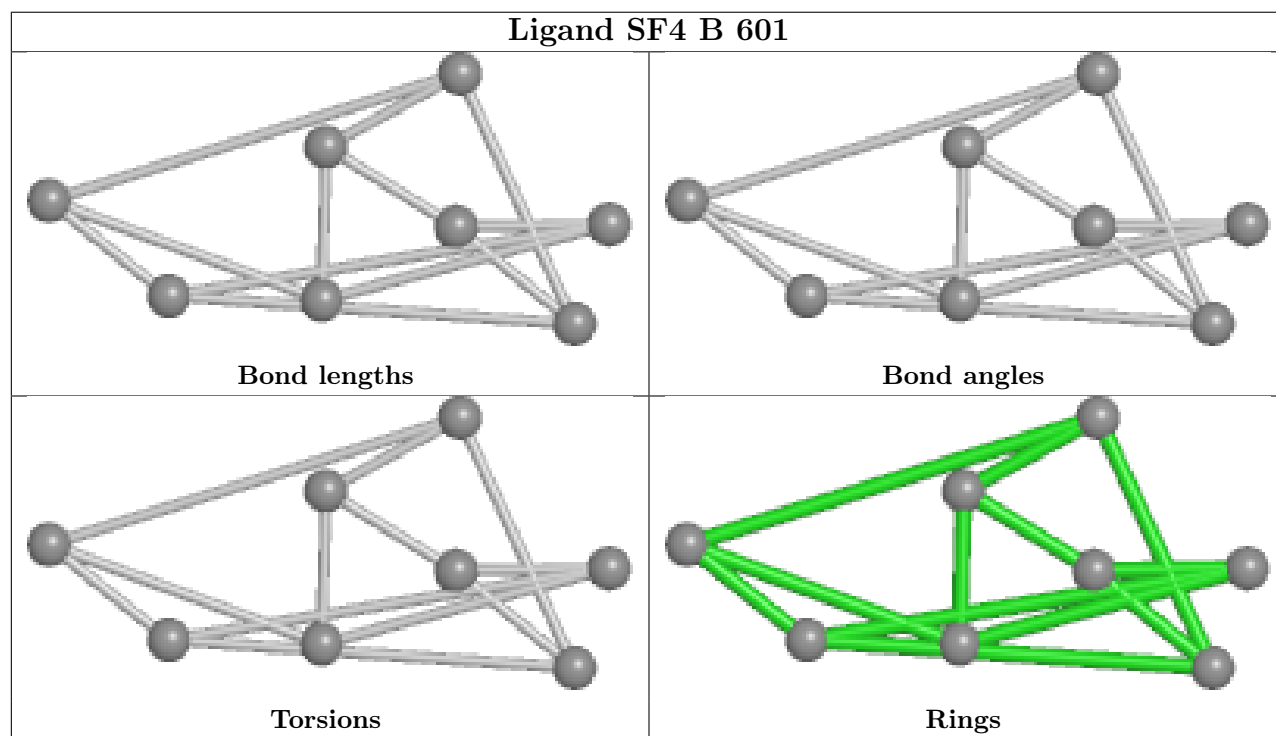
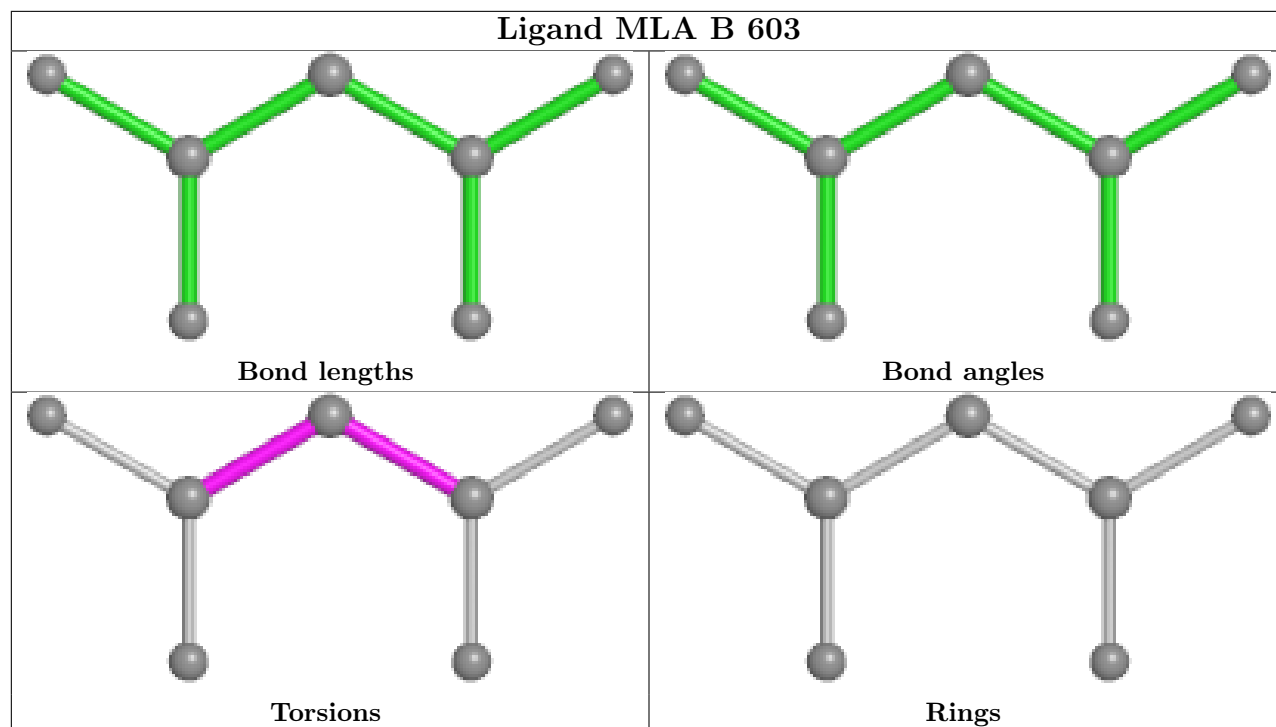
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included.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

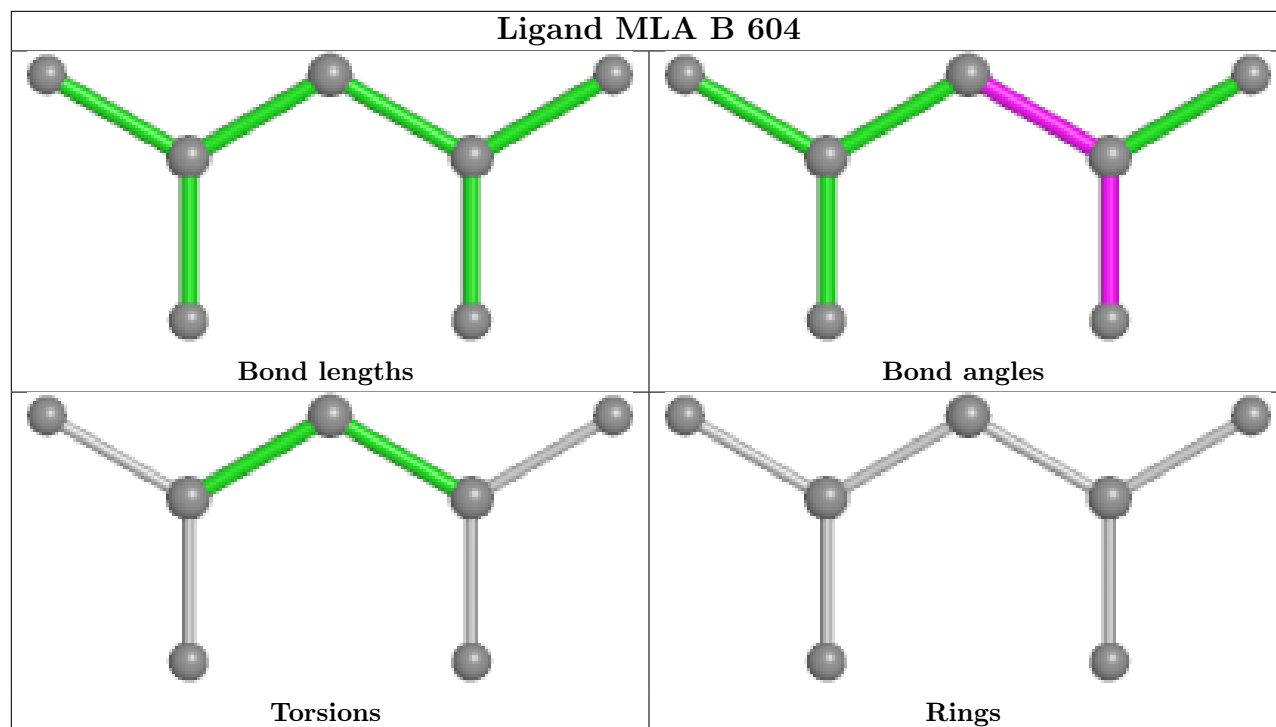












#### 4.7 Other polymers [i](#)

There are no such residues in this entry.

#### 4.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

## 5 Fit of model and data [i](#)

### 5.1 Protein, DNA and RNA chains [i](#)

EDS failed to run properly - this section is therefore empty.

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

EDS failed to run properly - this section is therefore empty.

### 5.3 Carbohydrates [i](#)

EDS failed to run properly - this section is therefore empty.

### 5.4 Ligands [i](#)

EDS failed to run properly - this section is therefore empty.

### 5.5 Other polymers [i](#)

EDS failed to run properly - this section is therefore empty.