



wwPDB EM Validation Summary Report ⓘ

Mar 17, 2025 – 12:04 pm GMT

PDB ID : 9I81
EMDB ID : EMD-52704
Title : SARS-CoV-2 RdRp bound to a stack of three HeE1-2Tyr molecules
Authors : Kabinger, F.; Doze, V.; Schmitzova, J.; Lidschreiber, M.; Dienemann, C.; Cramer, P.
Deposited on : 2025-02-04
Resolution : 2.98 Å(reported)

This is a wwPDB EM 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/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>.

The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

EMDB validation analysis	: FAILED
Mogul	: 1.8.4, 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)	: 2.41

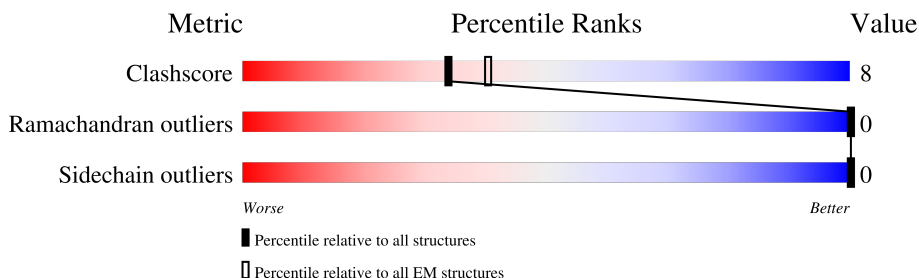
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY


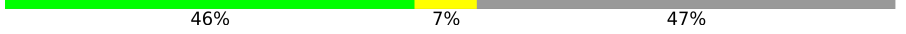


The reported resolution of this entry is 2.98 Å.

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 ≥ 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	932	
2	B	217	
2	D	217	
3	C	84	

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 17163 atoms, of which 8416 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 RNA-directed RNA polymerase nsp12.

Mol	Chain	Residues	Atoms						AltConf	Trace
1	A	859	Total	C	H	N	O	S	0	0
			13552	4424	6649	1154	1279	46		

- Molecule 2 is a protein called Non-structural protein 8.

Mol	Chain	Residues	Atoms						AltConf	Trace
2	B	114	Total	C	H	N	O	S	0	0
			1731	547	866	143	168	7		
2	D	43	Total	C	H	N	O	S	0	0
			635	199	320	51	60	5		

There are 38 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-18	MET	-	initiating methionine	UNP P0DTD1
B	-17	GLY	-	expression tag	UNP P0DTD1
B	-16	SER	-	expression tag	UNP P0DTD1
B	-15	SER	-	expression tag	UNP P0DTD1
B	-14	HIS	-	expression tag	UNP P0DTD1
B	-13	HIS	-	expression tag	UNP P0DTD1
B	-12	HIS	-	expression tag	UNP P0DTD1
B	-11	HIS	-	expression tag	UNP P0DTD1
B	-10	HIS	-	expression tag	UNP P0DTD1
B	-9	HIS	-	expression tag	UNP P0DTD1
B	-8	GLU	-	expression tag	UNP P0DTD1
B	-7	ASN	-	expression tag	UNP P0DTD1
B	-6	LEU	-	expression tag	UNP P0DTD1
B	-5	TYR	-	expression tag	UNP P0DTD1
B	-4	PHE	-	expression tag	UNP P0DTD1
B	-3	GLN	-	expression tag	UNP P0DTD1
B	-2	SER	-	expression tag	UNP P0DTD1
B	-1	ASN	-	expression tag	UNP P0DTD1
B	0	ALA	-	expression tag	UNP P0DTD1

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Chain	Residue	Modelled	Actual	Comment	Reference
D	-18	MET	-	initiating methionine	UNP P0DTD1
D	-17	GLY	-	expression tag	UNP P0DTD1
D	-16	SER	-	expression tag	UNP P0DTD1
D	-15	SER	-	expression tag	UNP P0DTD1
D	-14	HIS	-	expression tag	UNP P0DTD1
D	-13	HIS	-	expression tag	UNP P0DTD1
D	-12	HIS	-	expression tag	UNP P0DTD1
D	-11	HIS	-	expression tag	UNP P0DTD1
D	-10	HIS	-	expression tag	UNP P0DTD1
D	-9	HIS	-	expression tag	UNP P0DTD1
D	-8	GLU	-	expression tag	UNP P0DTD1
D	-7	ASN	-	expression tag	UNP P0DTD1
D	-6	LEU	-	expression tag	UNP P0DTD1
D	-5	TYR	-	expression tag	UNP P0DTD1
D	-4	PHE	-	expression tag	UNP P0DTD1
D	-3	GLN	-	expression tag	UNP P0DTD1
D	-2	SER	-	expression tag	UNP P0DTD1
D	-1	ASN	-	expression tag	UNP P0DTD1
D	0	ALA	-	expression tag	UNP P0DTD1

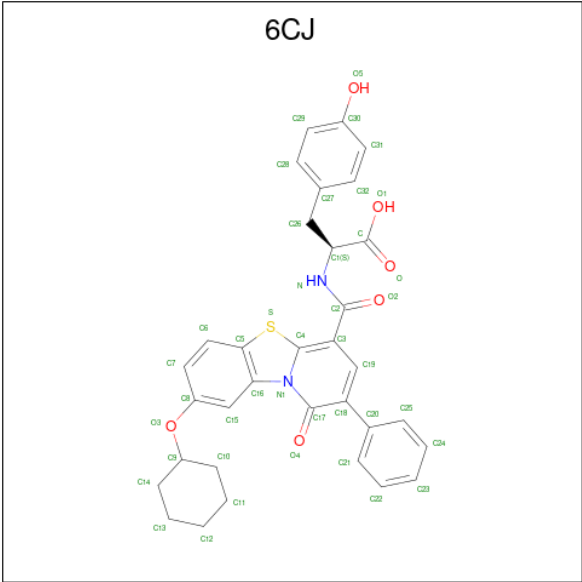
- Molecule 3 is a protein called Non-structural protein 7.

Mol	Chain	Residues	Atoms						AltConf	Trace
3	C	70	Total	C	H	N	O	S	0	0
			1113	341	575	89	103	5		

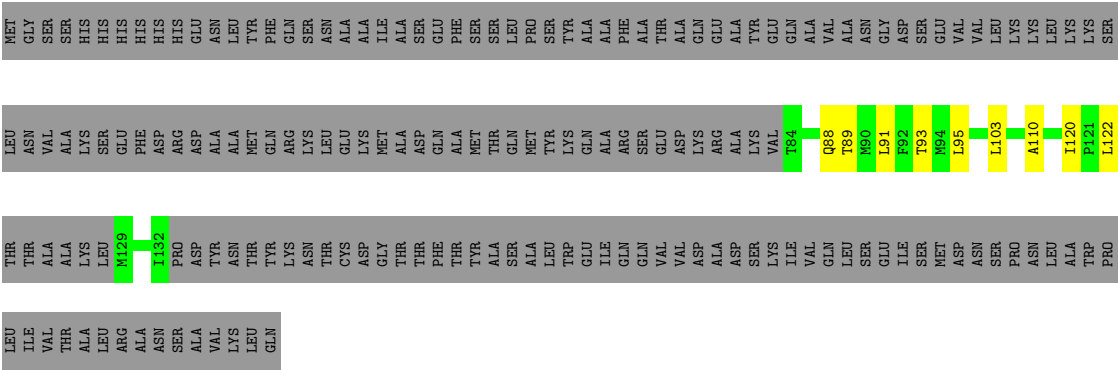
There are 3 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	-2	SER	-	expression tag	UNP P0DTD1
C	-1	ASN	-	expression tag	UNP P0DTD1
C	0	ALA	-	expression tag	UNP P0DTD1

- Molecule 4 is N-[8-(cyclohexyloxy)-1-oxo-2-phenyl-1H-pyrido[2,1-b][1,3]benzothiazole-4-carbonyl]-L-tyrosine (three-letter code: 6CJ) (formula: C₃₃H₃₀N₂O₆S) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms						AltConf
4	A	1	Total	C	H	N	O	S	0
			44	33	2	2	6	1	
4	A	1	Total	C	H	N	O	S	0
			44	33	2	2	6	1	
4	A	1	Total	C	H	N	O	S	0
			44	33	2	2	6	1	



● Molecule 3: Non-structural protein 7



4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	189000	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	NONE	Depositor
Microscope	TFS KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ($e^-/\text{\AA}^2$)	57.9	Depositor
Minimum defocus (nm)	400	Depositor
Maximum defocus (nm)	2200	Depositor
Magnification	105000	Depositor
Image detector	GATAN K3 BIOQUANTUM (6k 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: 6CJ

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	0.30	0/7078	0.47	0/9609
2	B	0.47	1/878 (0.1%)	0.75	0/1202
2	D	0.26	0/316	0.39	0/429
3	C	0.28	0/541	0.46	0/729
All	All	0.32	1/8813 (0.0%)	0.50	0/11969

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	139	LYS	C-N	-5.43	1.21	1.34

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	6903	6649	6644	105	0
2	B	865	866	865	13	0
2	D	315	320	318	11	0
3	C	538	575	574	23	0
4	A	126	6	0	1	0
All	All	8747	8416	8401	137	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.

The worst 5 of 137 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)
2:B:135:TYR:HE1	2:B:172:ILE:HG22	1.25	0.99
1:A:194:ASP:OD1	1:A:289:TYR:OH	1.90	0.89
2:B:135:TYR:CE1	2:B:172:ILE:HG22	2.11	0.84
1:A:332:LYS:NZ	2:B:104:ASN:OD1	2.14	0.81
1:A:867:TYR:OH	1:A:922:GLU:OE1	1.99	0.80

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	849/932 (91%)	816 (96%)	33 (4%)	0	100	100
2	B	112/217 (52%)	106 (95%)	6 (5%)	0	100	100
2	D	39/217 (18%)	38 (97%)	1 (3%)	0	100	100
3	C	68/84 (81%)	67 (98%)	1 (2%)	0	100	100
All	All	1068/1450 (74%)	1027 (96%)	41 (4%)	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	749/823 (91%)	749 (100%)	0	100	100
2	B	96/184 (52%)	96 (100%)	0	100	100
2	D	36/184 (20%)	36 (100%)	0	100	100
3	C	65/77 (84%)	65 (100%)	0	100	100
All	All	946/1268 (75%)	946 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	705	ASN
2	B	108	ASN
2	B	140	ASN

5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

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

5.5 Carbohydrates ⓘ

There are no oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

3 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	6CJ	A	1001	-	47,47,47	0.99	2 (4%)	61,67,67	1.46	11 (18%)
4	6CJ	A	1003	-	47,47,47	1.05	3 (6%)	61,67,67	1.39	7 (11%)
4	6CJ	A	1002	-	47,47,47	1.00	1 (2%)	61,67,67	1.39	7 (11%)

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	6CJ	A	1001	-	-	8/24/32/32	0/6/6/6
4	6CJ	A	1003	-	-	6/24/32/32	0/6/6/6
4	6CJ	A	1002	-	-	8/24/32/32	0/6/6/6

The worst 5 of 6 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	1001	6CJ	O1-C	-2.69	1.21	1.30
4	A	1002	6CJ	O1-C	-2.61	1.22	1.30
4	A	1003	6CJ	O1-C	-2.61	1.22	1.30
4	A	1003	6CJ	C17-N1	-2.22	1.38	1.42
4	A	1003	6CJ	C1-N	2.16	1.50	1.45

The worst 5 of 25 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	A	1003	6CJ	C5-S-C4	-4.88	85.38	90.29
4	A	1001	6CJ	C5-S-C4	-4.83	85.43	90.29
4	A	1002	6CJ	C5-S-C4	-4.34	85.93	90.29
4	A	1002	6CJ	C20-C18-C17	4.13	123.20	119.50
4	A	1003	6CJ	S-C4-N1	3.99	118.37	112.93

There are no chirality outliers.

5 of 22 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	1001	6CJ	O2-C2-C3-C4
4	A	1001	6CJ	N-C2-C3-C4
4	A	1001	6CJ	O2-C2-C3-C19
4	A	1001	6CJ	N-C2-C3-C19

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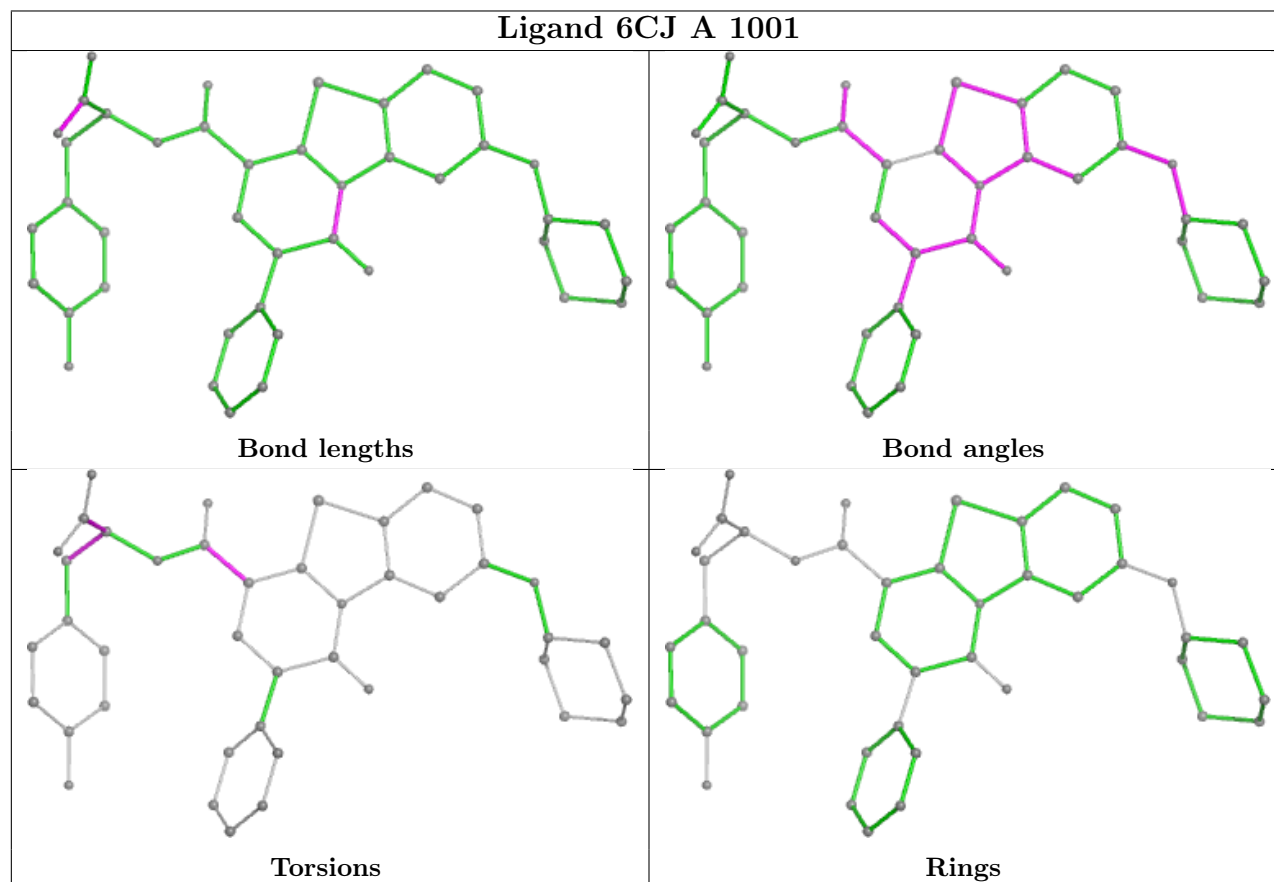
Mol	Chain	Res	Type	Atoms
4	A	1003	6CJ	O2-C2-C3-C4

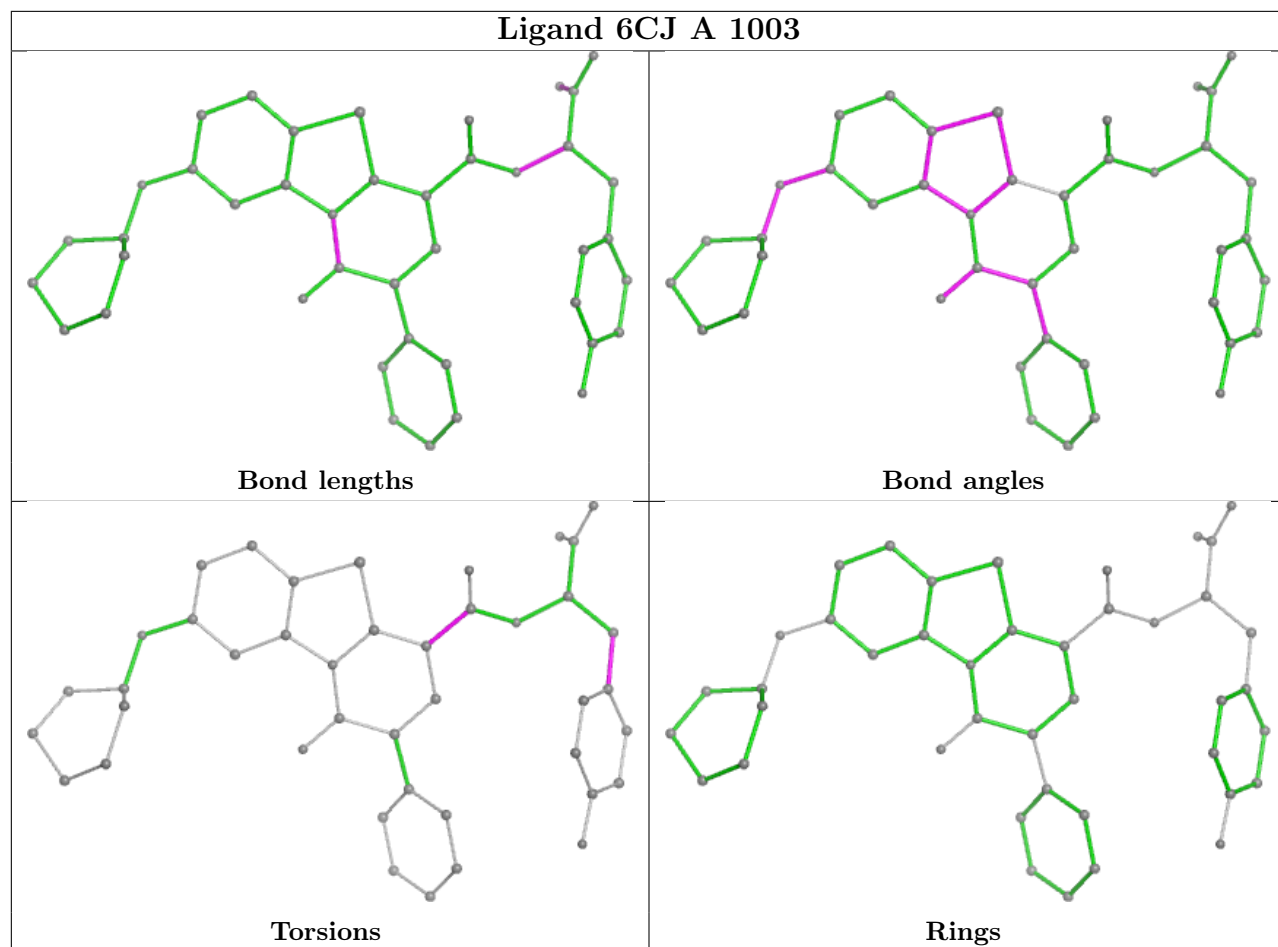
There are no ring outliers.

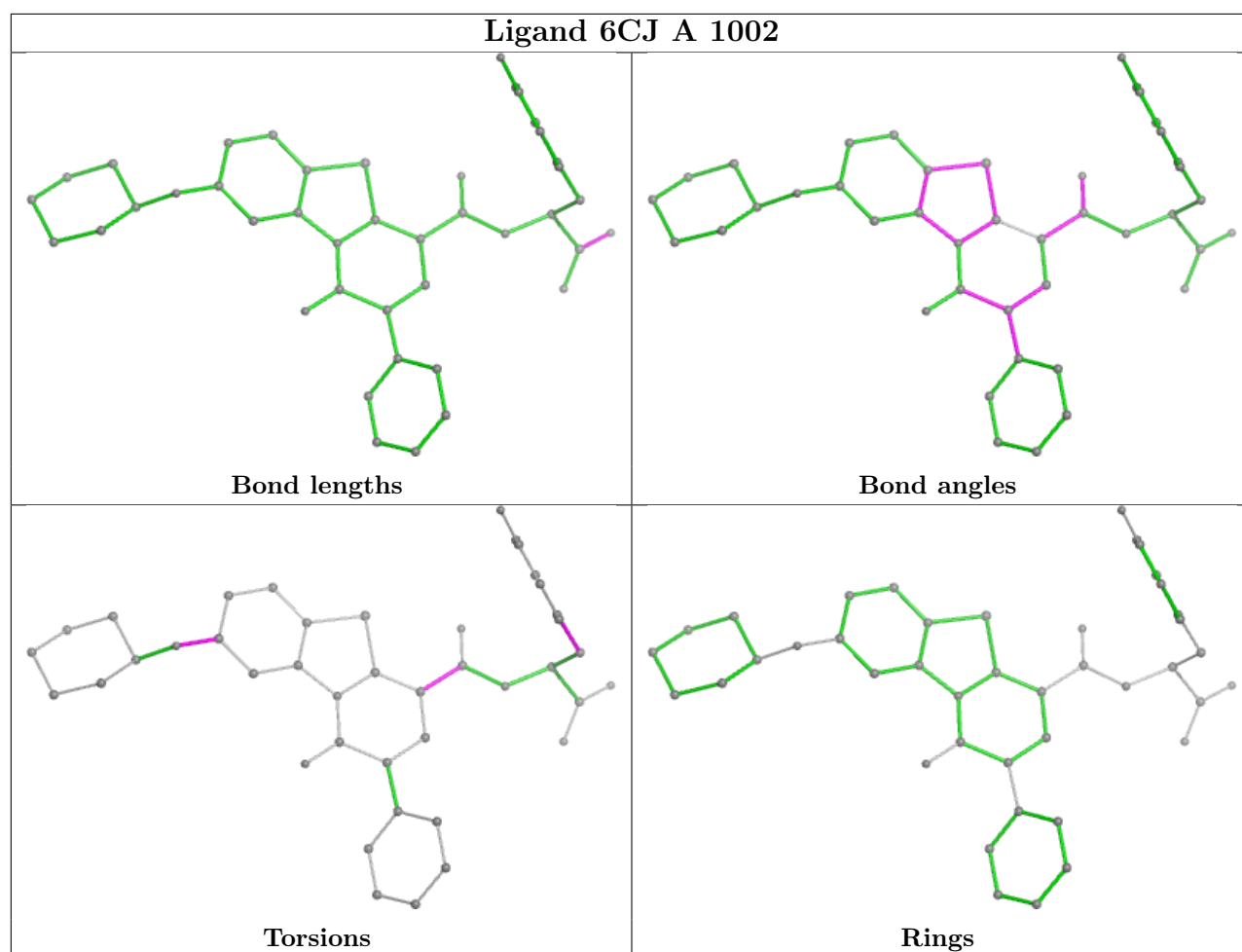
1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	1002	6CJ	1	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.