



## wwPDB EM Validation Summary Report ⓘ

Dec 24, 2025 – 12:16 PM JST

PDB ID : 9IKZ / pdb\_00009ikz  
EMDB ID : EMD-60663  
Title : SARS-CoV-2 E-RTC bound to pRNA-nsp9 and GDP-BeF3-  
Authors : Yan, L.M.; Huang, Y.C.; Liu, Y.X.; Rao, Z.H.; Lou, Z.Y.  
Deposited on : 2024-06-29  
Resolution : 3.14 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](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 : 4-5-2 with Phenix2.0  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
EM percentile statistics : **NOT EXECUTED**  
MapQ : **FAILED**  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.47

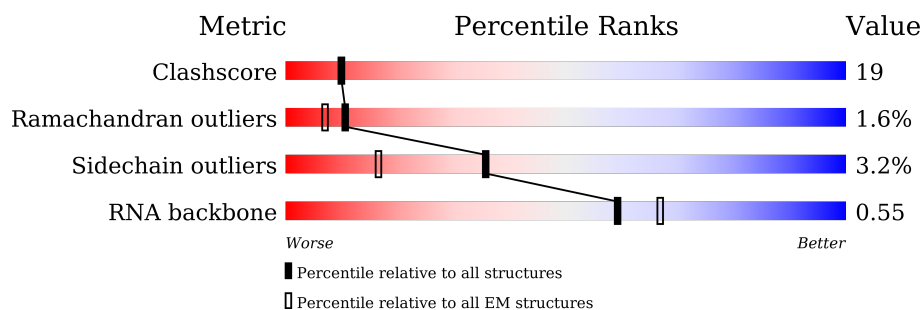
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 3.14 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
RNA backbone	6643	2191

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	931	82% 16% .
2	B	187	76% 20% . .
2	D	187	63% 35% .
3	C	78	86% 14%
4	E	593	57% 34% 6% . .
4	F	593	59% 38% . .
5	G	113	39% 49% 12% .
6	I	25	84% 12% .

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Mol	Chain	Length	Quality of chain
7	J	27	

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
10	BEF	A	1004	-	-	X	-

## 2 Entry composition

There are 11 unique types of molecules in this entry. The entry contains 21944 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 RNA-directed RNA polymerase nsp12.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	A	931	Total	C	N	O	S	0	0
			7492	4784	1256	1398	54		

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

Mol	Chain	Residues	Atoms					AltConf	Trace
2	B	187	Total	C	N	O	S	0	0
			1396	872	240	273	11		
2	D	187	Total	C	N	O	S	0	0
			1422	893	244	274	11		

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

Mol	Chain	Residues	Atoms					AltConf	Trace
3	C	78	Total	C	N	O	S	0	0
			600	376	98	119	7		

- Molecule 4 is a protein called Helicase nsp13.

Mol	Chain	Residues	Atoms					AltConf	Trace
4	E	586	Total	C	N	O	S	1	0
			4513	2878	751	849	35		
4	F	585	Total	C	N	O	S	1	0
			4502	2872	747	848	35		

- Molecule 5 is a protein called Viral protein genome-linked nsp9.

Mol	Chain	Residues	Atoms					AltConf	Trace
5	G	113	Total	C	N	O	S	0	0
			868	549	150	164	5		

- Molecule 6 is a RNA chain called RNA (25-MER).

Mol	Chain	Residues	Atoms					AltConf	Trace
6	I	25	Total	C	N	O	P	0	0
			545	242	105	173	25		

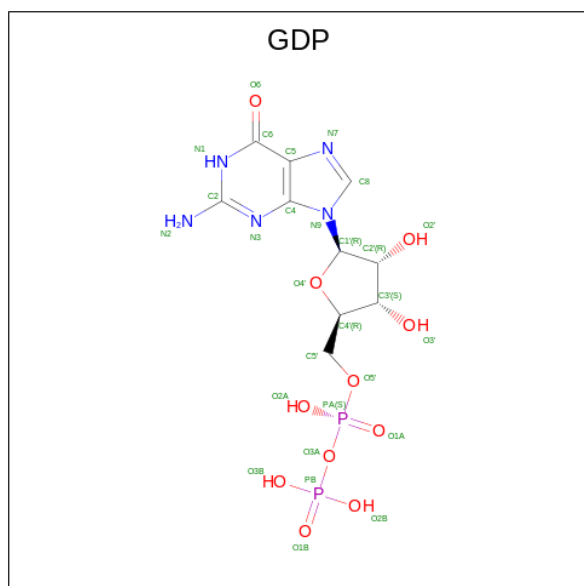
- Molecule 7 is a RNA chain called RNA (27-MER).

Mol	Chain	Residues	Atoms					AltConf	Trace
7	J	27	Total	C	N	O	P	0	0
			565	253	94	191	27		

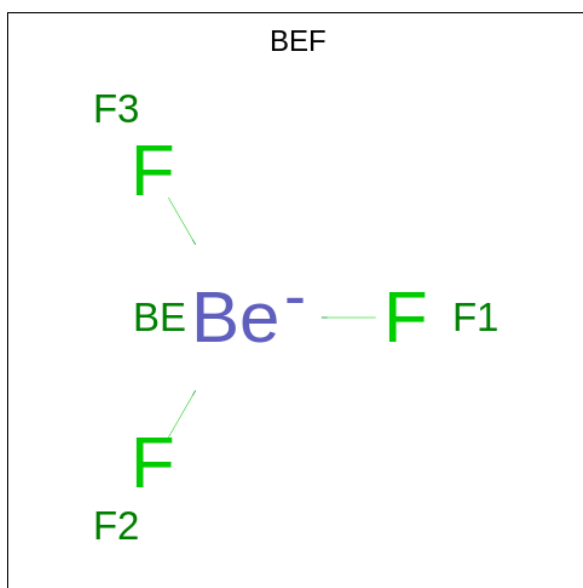
- Molecule 8 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		AltConf
8	A	2	Total	Zn	0
			2	2	
8	E	3	Total	Zn	0
			3	3	
8	F	3	Total	Zn	0
			3	3	

- Molecule 9 is GUANOSINE-5'-DIPHOSPHATE (CCD ID: GDP) (formula: C<sub>10</sub>H<sub>15</sub>N<sub>5</sub>O<sub>11</sub>P<sub>2</sub>) (labeled as "Ligand of Interest" by depositor).



as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms			AltConf
10	A	1	Total	Be	F	0
			4	1	3	

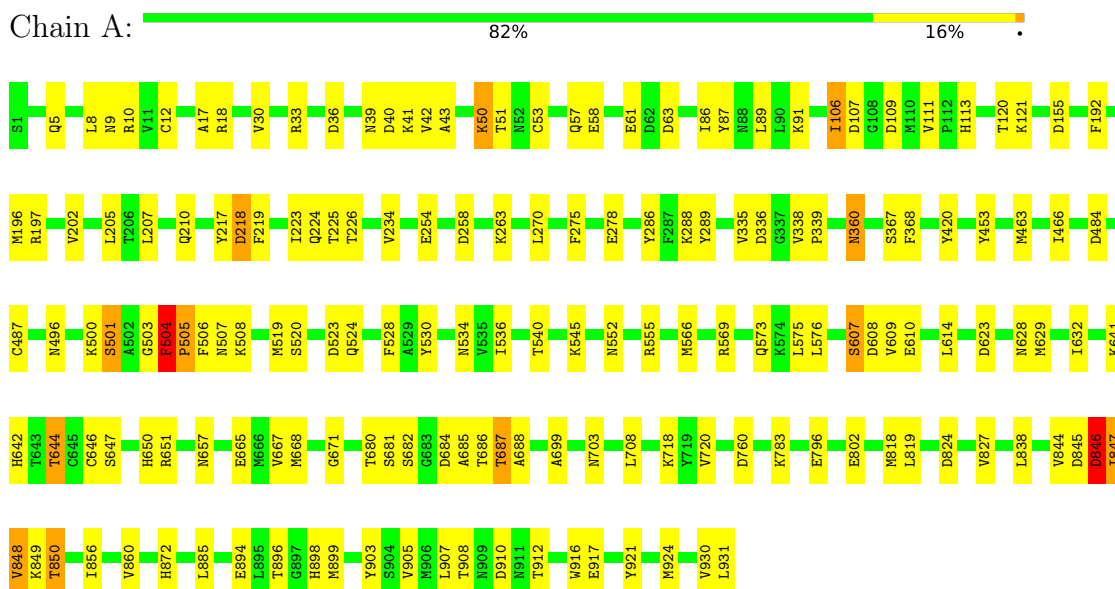
- Molecule 11 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		AltConf
11	A	1	Total	Mg	0
			1	1	

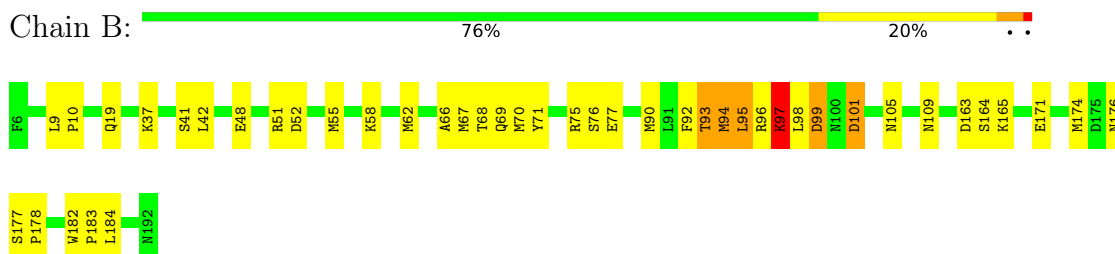
### 3 Residue-property plots

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.

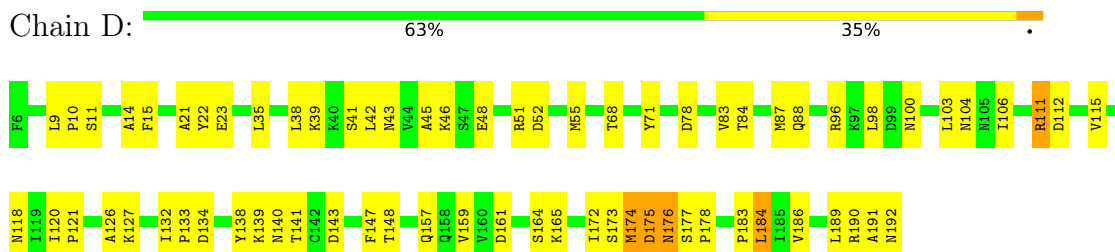
#### • Molecule 1: RNA-directed RNA polymerase nsp12



#### • Molecule 2: Non-structural protein 8

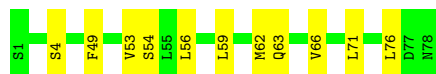


#### • Molecule 2: Non-structural protein 8



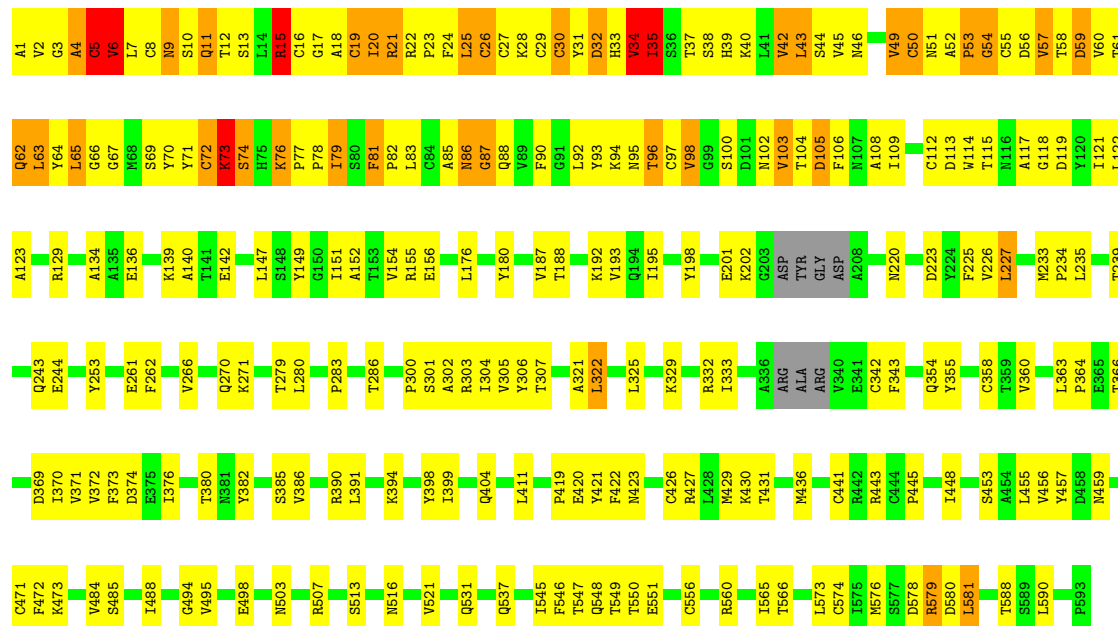
- Molecule 3: Non-structural protein 7

Chain C:  86% 14%



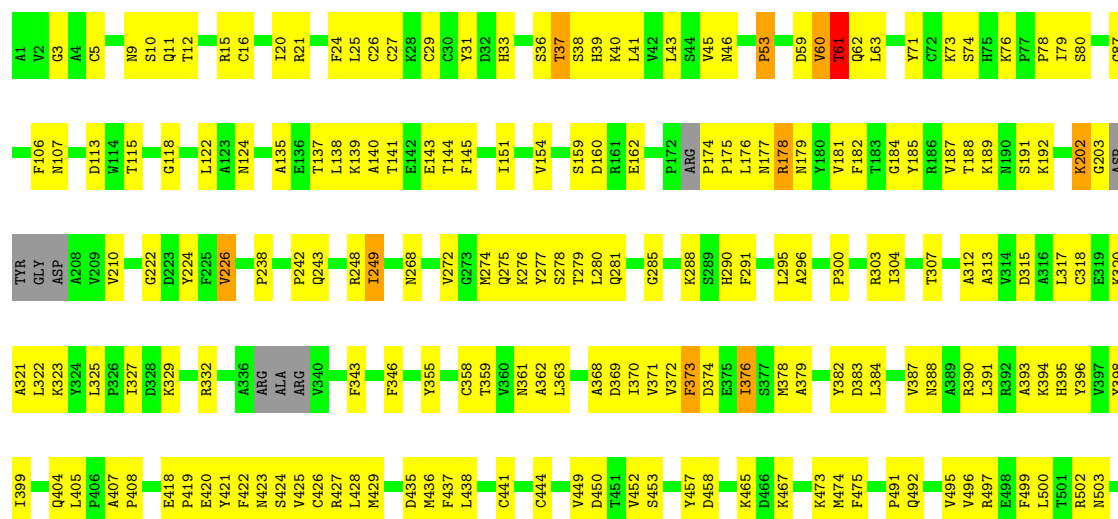
- Molecule 4: Helicase nsp13

Chain E:  57% 34% 6% ..



- Molecule 4: Helicase nsp13

Chain F:  59% 38% ..



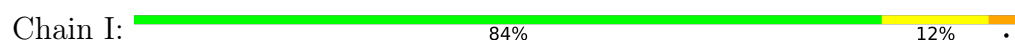




- Molecule 5: Viral protein genome-linked nsp9



- Molecule 6: RNA (25-MER)



- Molecule 7: RNA (27-MER)



## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, Not provided	
Number of particles used	156590	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	TFS KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	60.0	Depositor
Minimum defocus (nm)	1000	Depositor
Maximum defocus (nm)	2000	Depositor
Magnification	Not provided	
Image detector	GATAN K3 (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: GDP, ZN, MG, BEF

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	0.45	7/7681 (0.1%)	0.65	20/10426 (0.2%)
2	B	0.42	0/1414	0.87	8/1922 (0.4%)
2	D	0.51	1/1441 (0.1%)	0.83	6/1955 (0.3%)
3	C	0.27	0/603	0.69	1/812 (0.1%)
4	E	0.51	1/4615 (0.0%)	0.66	7/6290 (0.1%)
4	F	0.41	2/4603 (0.0%)	0.63	4/6272 (0.1%)
5	G	0.51	0/884	0.99	8/1200 (0.7%)
6	I	0.25	0/611	0.30	0/953
7	J	0.26	0/628	0.45	0/974
All	All	0.45	11/22480 (0.0%)	0.68	54/30804 (0.2%)

The worst 5 of 11 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	848	VAL	CA-C	-8.29	1.42	1.52
4	F	226	VAL	CB-CG1	-7.49	1.27	1.52
1	A	210	GLN	CA-C	-6.47	1.45	1.52
2	D	191	ALA	CA-C	-6.45	1.50	1.53
1	A	845	ASP	CA-C	5.82	1.59	1.53

The worst 5 of 54 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	76	SER	N-CA-CB	-11.97	90.88	110.40
1	A	850	THR	N-CA-C	-11.72	95.55	113.02
5	G	34	THR	N-CA-C	-11.21	98.82	111.71
1	A	106	ILE	CB-CA-C	10.16	124.98	111.87
1	A	217	TYR	N-CA-C	9.49	131.02	110.80

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	7492	0	7231	122	0
2	B	1396	0	1365	30	0
2	D	1422	0	1422	69	0
3	C	600	0	629	13	0
4	E	4513	0	4439	243	0
4	F	4502	0	4422	279	0
5	G	868	0	880	69	0
6	I	545	0	272	4	0
7	J	565	0	291	20	0
8	A	2	0	0	0	0
8	E	3	0	0	0	0
8	F	3	0	0	0	0
9	A	28	0	12	1	0
10	A	4	0	0	4	0
11	A	1	0	0	0	0
All	All	21944	0	20963	819	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 19.

The worst 5 of 819 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)
4:F:290:HIS:CE1	4:F:320:LYS:NZ	1.68	1.60
4:F:421:TYR:CB	4:F:427:ARG:HH21	1.23	1.51
4:F:421:TYR:CA	4:F:427:ARG:HH21	1.30	1.42
4:F:421:TYR:CB	4:F:427:ARG:NH2	1.76	1.41
4:F:421:TYR:HB3	4:F:427:ARG:NH2	1.01	1.31

There are no symmetry-related clashes.

## 5.3 Torsion angles ⓘ

### 5.3.1 Protein backbone ⓘ

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	929/931 (100%)	854 (92%)	67 (7%)	8 (1%)	14	43
2	B	185/187 (99%)	164 (89%)	19 (10%)	2 (1%)	12	37
2	D	185/187 (99%)	157 (85%)	27 (15%)	1 (0%)	25	55
3	C	76/78 (97%)	69 (91%)	7 (9%)	0	100	100
4	E	581/593 (98%)	491 (84%)	71 (12%)	19 (3%)	3	15
4	F	578/593 (98%)	512 (89%)	57 (10%)	9 (2%)	8	29
5	G	111/113 (98%)	89 (80%)	18 (16%)	4 (4%)	3	14
All	All	2645/2682 (99%)	2336 (88%)	266 (10%)	43 (2%)	10	29

5 of 43 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	504	PHE
1	A	505	PRO
1	A	607	SER
1	A	846	ASP
4	E	34	VAL

### 5.3.2 Protein sidechains ⓘ

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	821/822 (100%)	807 (98%)	14 (2%)	56	75
2	B	144/159 (91%)	140 (97%)	4 (3%)	38	63

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
2	D	150/159 (94%)	142 (95%)	8 (5%)	19	44
3	C	73/73 (100%)	73 (100%)	0	100	100
4	E	498/516 (96%)	467 (94%)	31 (6%)	15	39
4	F	497/516 (96%)	487 (98%)	10 (2%)	50	71
5	G	94/94 (100%)	87 (93%)	7 (7%)	11	33
All	All	2277/2339 (97%)	2203 (97%)	74 (3%)	36	60

5 of 74 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
4	F	37	THR
5	G	23	CYS
4	F	61	THR
4	F	547	THR
2	D	176	ASN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 34 such sidechains are listed below:

Mol	Chain	Res	Type
4	F	281	GLN
4	F	290	HIS
5	G	11	GLN
2	B	100	ASN
2	B	69	GLN

### 5.3.3 RNA ⓘ

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
6	I	24/25 (96%)	1 (4%)	0
7	J	26/27 (96%)	3 (11%)	0
All	All	50/52 (96%)	4 (8%)	0

All (4) RNA backbone outliers are listed below:

Mol	Chain	Res	Type
6	I	10	C
7	J	46	U
7	J	47	A

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Mol	Chain	Res	Type
7	J	50	G

There are no RNA pucker outliers to report.

## 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](#)

Of 11 ligands modelled in this entry, 9 are monoatomic - leaving 2 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	$\# Z  > 2$
10	BEF	A	1004	1,9	0,3,3	-	-	-		
9	GDP	A	1003	11,10	24,30,30	1.27	2 (8%)	30,47,47	1.22	3 (10%)

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
9	GDP	A	1003	11,10	-	4/12/32/32	0/3/3/3

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
9	A	1003	GDP	C6-N1	-4.47	1.31	1.37
9	A	1003	GDP	C2-N1	-2.40	1.31	1.37

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
9	A	1003	GDP	C3'-C2'-C1'	2.89	105.33	100.98
9	A	1003	GDP	C5-C6-N1	2.42	118.22	113.95
9	A	1003	GDP	C8-N7-C5	2.22	107.23	102.99

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
9	A	1003	GDP	C5'-O5'-PA-O1A
9	A	1003	GDP	O4'-C4'-C5'-O5'
9	A	1003	GDP	C3'-C4'-C5'-O5'
9	A	1003	GDP	C5'-O5'-PA-O3A

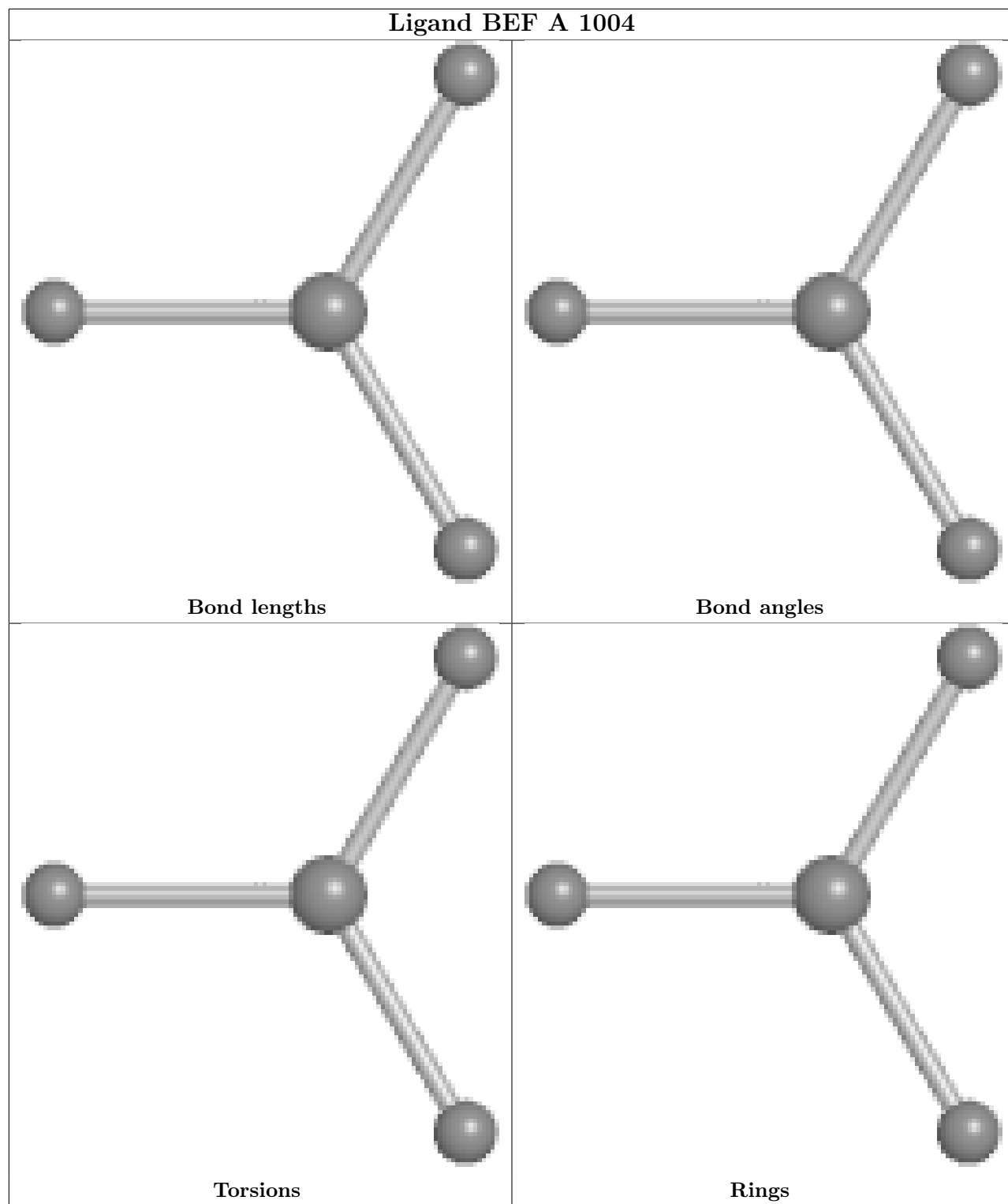
There are no ring outliers.

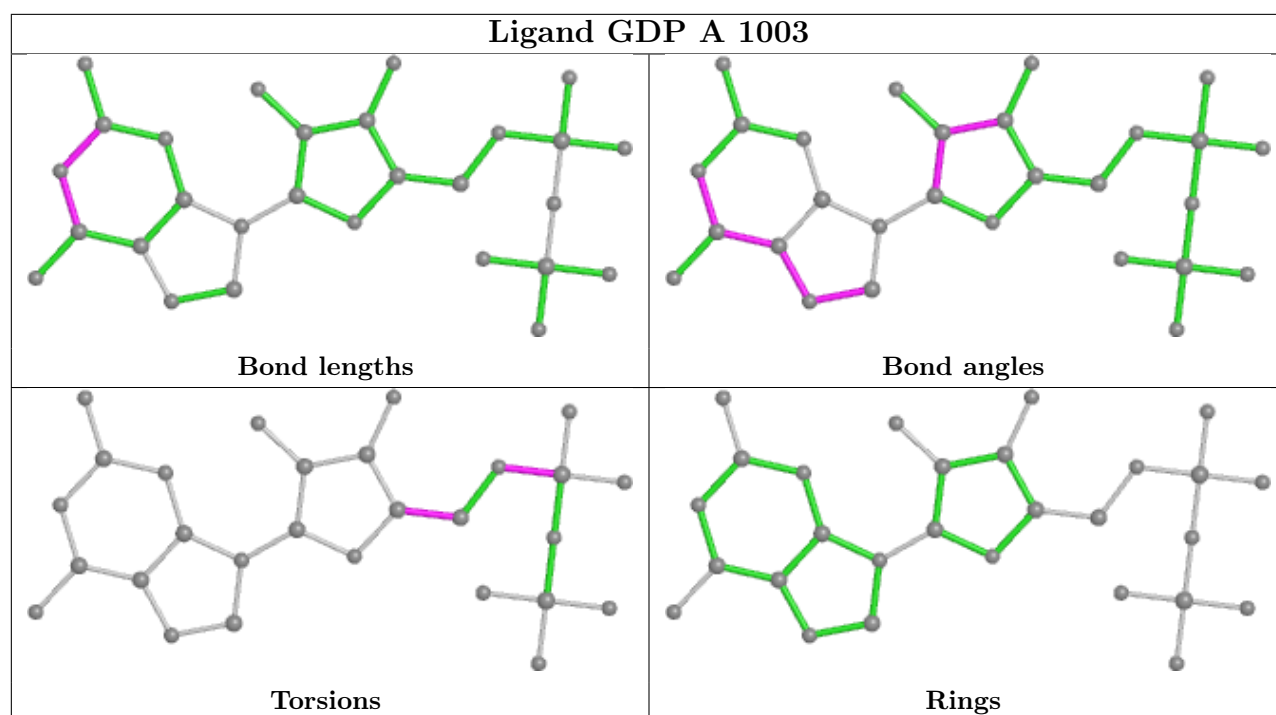
2 monomers are involved in 5 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
10	A	1004	BEF	4	0
9	A	1003	GDP	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.