



# wwPDB EM Validation Summary Report ⓘ

May 13, 2024 – 10:53 pm BST

PDB ID : 6YY0  
EMDB ID : EMD-11001  
Title : bovine ATP synthase F1-peripheral stalk domain, state 1  
Authors : Spikes, T.; Montgomery, M.G.; Walker, J.E.  
Deposited on : 2020-05-04  
Resolution : 3.23 Å (reported)  
Based on initial models : 2CLY, 2V7Q

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:

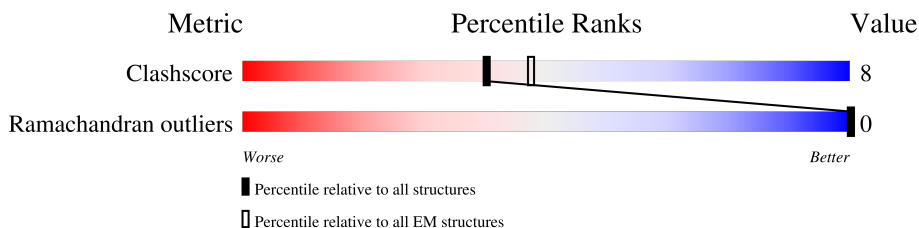
EMDB validation analysis : 0.0.1.dev92  
Mogul : 1.8.4, CSD as541be (2020)  
MolProbity : 4.02b-467  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
MapQ : **FAILED**  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.36.2

# 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 3.23 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.





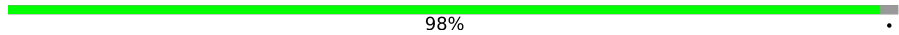

Metric	Whole archive (#Entries)	EM structures (#Entries)
Clashscore	158937	4297
Ramachandran outliers	154571	4023

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	510	86% 14%
1	B	510	82% 12% 6%
1	C	510	78% 19% .
2	D	482	78% 20% .
2	E	482	79% 18% .
2	F	482	81% 16% .
3	G	273	85% 14%
4	H	146	75% 15% 10%
5	I	50	70% 24% 6%
6	J	66	68% . 29%

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Mol	Chain	Length	Quality of chain
7	S	190	 76% 23%
8	b	214	 64% 36%
9	d	160	 98%
10	h	76	 82% 18%

## 2 Entry composition [i](#)

There are 14 unique types of molecules in this entry. The entry contains 61234 atoms, of which 30898 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 ATP synthase subunit alpha, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
1	A	508	7839	2434	3971	681	741	12	0	0
1	B	477	7393	2294	3752	645	690	12	0	0
1	C	498	7699	2390	3905	669	723	12	0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	GLU	GLN	variant	UNP P19483
A	481	GLY	SER	microheterogeneity	UNP P19483
B	1	GLU	GLN	variant	UNP P19483
B	481	GLY	SER	microheterogeneity	UNP P19483
C	1	GLU	GLN	variant	UNP P19483
C	481	GLY	SER	microheterogeneity	UNP P19483

- Molecule 2 is a protein called ATP synthase subunit beta, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
2	D	469	7163	2254	3605	605	688	11	0	0
2	E	467	7132	2243	3593	601	684	11	0	0
2	F	467	7131	2243	3592	601	684	11	0	0

- Molecule 3 is a protein called ATP synthase subunit gamma, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
3	G	272	4300	1330	2185	368	409	8	0	0

- Molecule 4 is a protein called ATP synthase subunit delta, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
4	H	132	1957	614	978	165	198	2	0	0

- Molecule 5 is a protein called ATP synthase subunit epsilon, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
5	I	47	764	237	395	66	64	2	0	0

- Molecule 6 is a protein called ATPase inhibitor, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
6	J	47	731	224	361	76	70		0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
J	61	HIS	-	expression tag	UNP P01096
J	62	HIS	-	expression tag	UNP P01096
J	63	HIS	-	expression tag	UNP P01096
J	64	HIS	-	expression tag	UNP P01096
J	65	HIS	-	expression tag	UNP P01096
J	66	HIS	-	expression tag	UNP P01096

- Molecule 7 is a protein called ATP synthase subunit O, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
7	S	188	3004	920	1557	249	269	9	0	0

- Molecule 8 is a protein called ATP synthase F(0) complex subunit B1, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
8	b	136	2274	701	1149	208	210	6	0	0

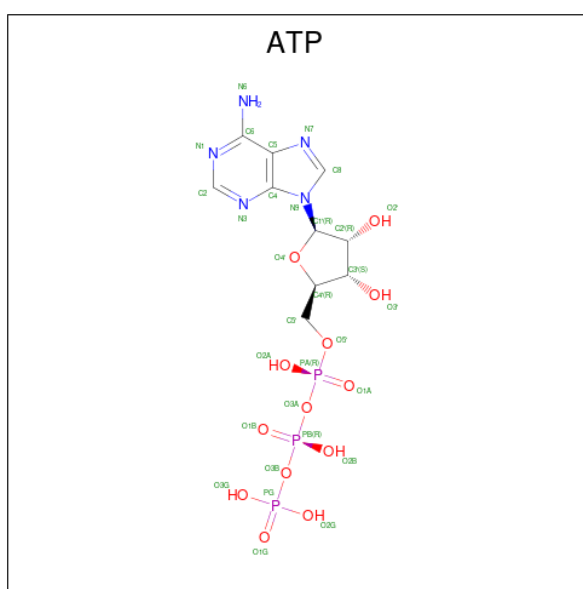
- Molecule 9 is a protein called ATP synthase subunit d, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
9	d	156	2570	827	1288	209	243	3	0	0

- Molecule 10 is a protein called ATP synthase-coupling factor 6, mitochondrial.

Mol	Chain	Residues	Atoms					AltConf	Trace	
			Total	C	H	N	O			S
10	h	62	1009	326	495	87	99	2	0	0

- Molecule 11 is ADENOSINE-5'-TRIPHOSPHATE (three-letter code: ATP) (formula:  $C_{10}H_{16}N_5O_{13}P_3$ ).



Mol	Chain	Residues	Atoms					AltConf	
			Total	C	H	N	O		P
11	A	1	43	10	12	5	13	3	0
11	B	1	43	10	12	5	13	3	0
11	C	1	43	10	12	5	13	3	0

- Molecule 12 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

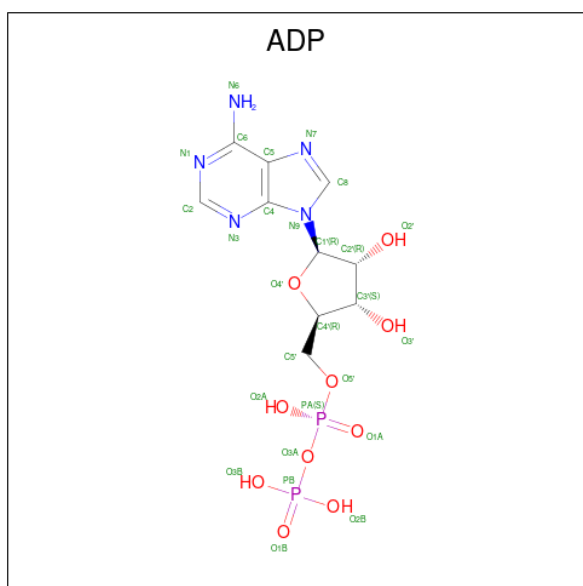
Mol	Chain	Residues	Atoms		AltConf
			Total	Mg	
12	A	1	1	1	0
12	B	1	1	1	0

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Mol	Chain	Residues	Atoms		AltConf
12	C	1	Total	Mg	0
			1	1	
12	D	1	Total	Mg	0
			1	1	
12	F	1	Total	Mg	0
			1	1	

- Molecule 13 is ADENOSINE-5'-DIPHOSPHATE (three-letter code: ADP) (formula:  $C_{10}H_{15}N_5O_{10}P_2$ ).



Mol	Chain	Residues	Atoms					AltConf	
13	D	1	Total	C	H	N	O	P	0
			39	10	12	5	10	2	
13	E	1	Total	C	H	N	O	P	0
			39	10	12	5	10	2	
13	F	1	Total	C	H	N	O	P	0
			39	10	12	5	10	2	

- Molecule 14 is water.

Mol	Chain	Residues	Atoms		AltConf
14	A	3	Total	O	0
			3	3	
14	B	3	Total	O	0
			3	3	
14	C	3	Total	O	0
			3	3	

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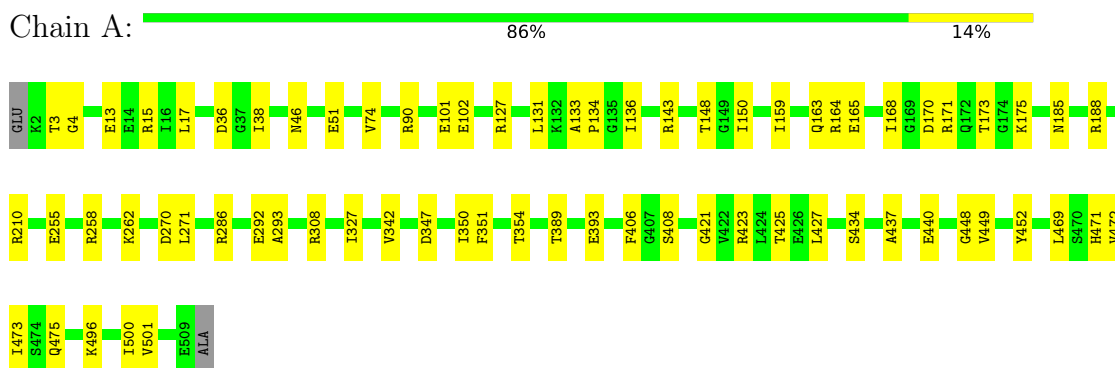
<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>AltConf</b>
14	D	4	Total 4	O 4	0
14	F	4	Total 4	O 4	0



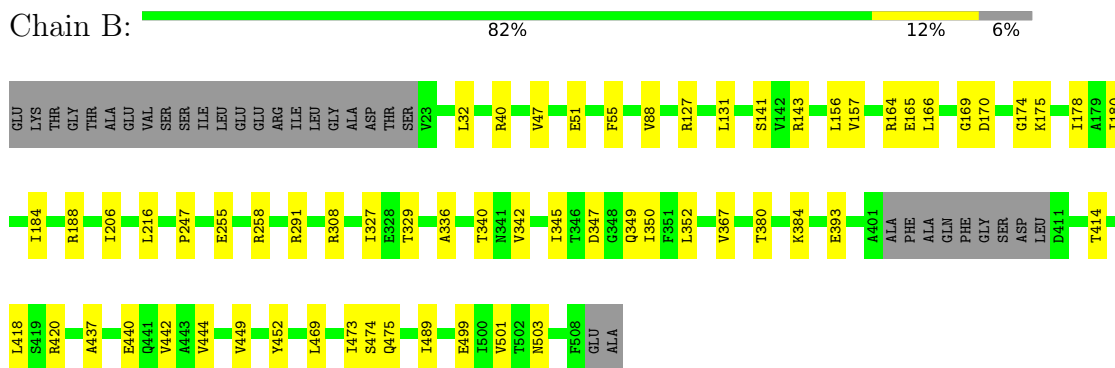
### 3 Residue-property plots

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.

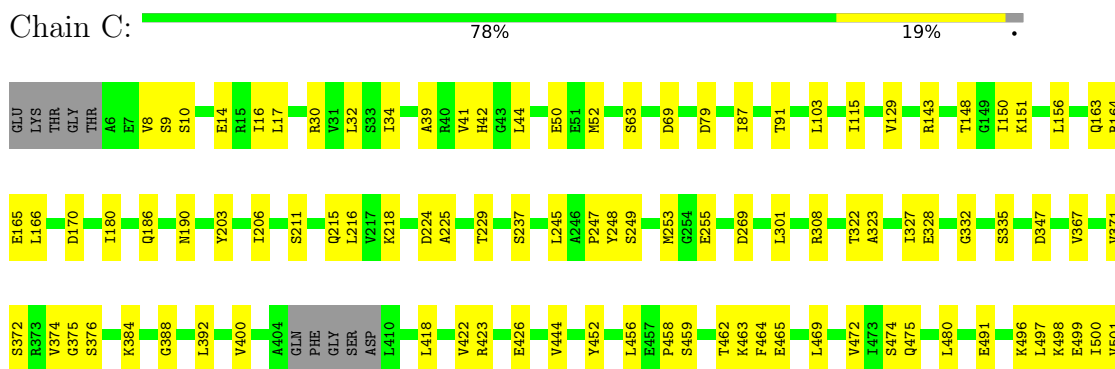
- Molecule 1: ATP synthase subunit alpha, mitochondrial

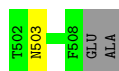


- Molecule 1: ATP synthase subunit alpha, mitochondrial

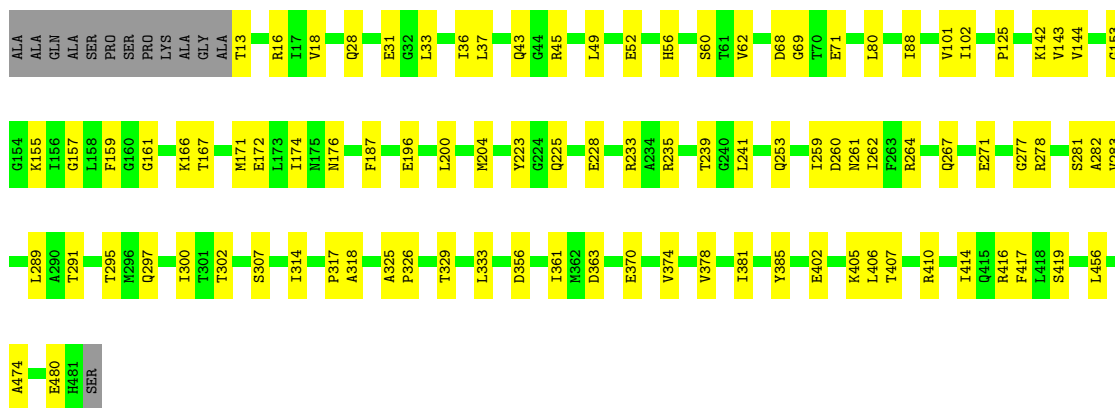
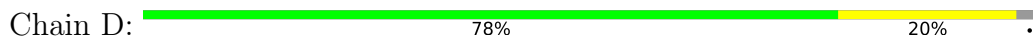


- Molecule 1: ATP synthase subunit alpha, mitochondrial

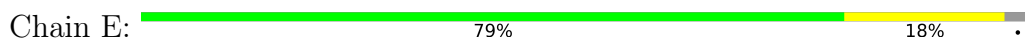




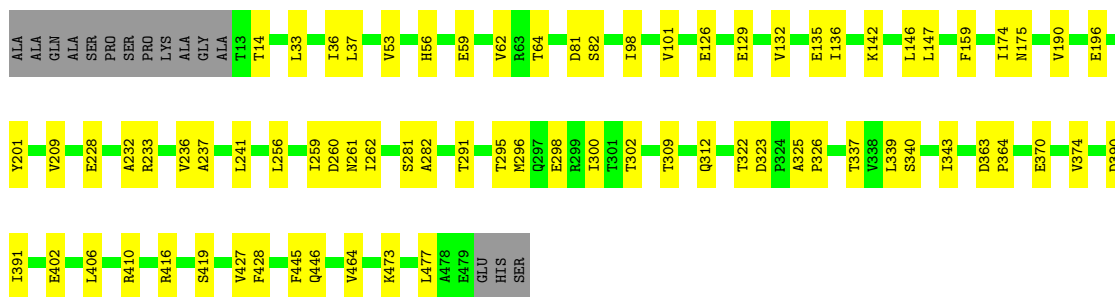
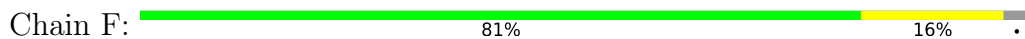
- Molecule 2: ATP synthase subunit beta, mitochondrial



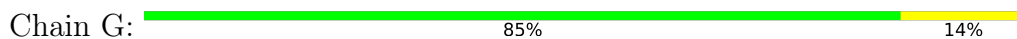
- Molecule 2: ATP synthase subunit beta, mitochondrial



- Molecule 2: ATP synthase subunit beta, mitochondrial

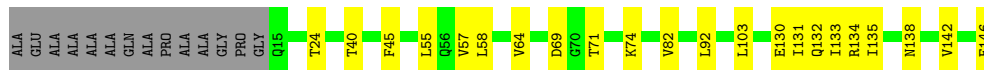


- Molecule 3: ATP synthase subunit gamma, mitochondrial





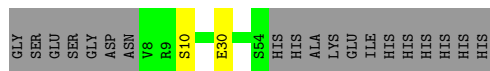
• Molecule 4: ATP synthase subunit delta, mitochondrial



• Molecule 5: ATP synthase subunit epsilon, mitochondrial



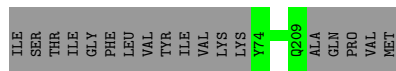
• Molecule 6: ATPase inhibitor, mitochondrial



• Molecule 7: ATP synthase subunit O, mitochondrial

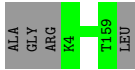


• Molecule 8: ATP synthase F(0) complex subunit B1, mitochondrial



• Molecule 9: ATP synthase subunit d, mitochondrial





- Molecule 10: ATP synthase-coupling factor 6, mitochondrial

Chain h: 82% 18%



## 4 Experimental information

Property	Value	Source
EM reconstruction method	SINGLE PARTICLE	Depositor
Imposed symmetry	POINT, C2	Depositor
Number of particles used	101165	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	PHASE FLIPPING AND AMPLITUDE CORRECTION	Depositor
Microscope	FEI TITAN KRIOS	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	4.6	Depositor
Minimum defocus (nm)	Not provided	
Maximum defocus (nm)	Not provided	
Magnification	Not provided	
Image detector	GATAN K2 QUANTUM (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: ADP, ATP, MG

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	0.35	0/3919	0.46	0/5287
1	B	0.34	0/3689	0.46	0/4975
1	C	0.35	0/3843	0.47	0/5184
2	D	0.35	0/3616	0.46	0/4906
2	E	0.33	0/3596	0.45	0/4879
2	F	0.35	0/3596	0.46	0/4879
3	G	0.31	0/2141	0.45	0/2876
4	H	0.30	0/991	0.50	0/1349
5	I	0.30	0/374	0.42	0/501
6	J	0.31	0/374	0.41	0/495
7	S	0.29	0/1464	0.43	0/1969
8	b	0.26	0/1137	0.42	0/1520
9	d	0.26	0/1313	0.43	0/1779
10	h	0.33	0/526	0.52	0/707
All	All	0.33	0/30579	0.46	0/41306

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	3868	3971	3971	50	0
1	B	3641	3752	3752	45	0
1	C	3794	3905	3905	68	0
2	D	3558	3605	3605	68	0
2	E	3539	3593	3593	58	0
2	F	3539	3592	3592	51	0
3	G	2115	2185	2185	29	0
4	H	979	978	978	19	0
5	I	369	395	395	10	0
6	J	370	361	361	2	0
7	S	1447	1557	1557	28	0
8	b	1125	1149	1149	0	0
9	d	1282	1288	1288	0	0
10	h	514	495	495	0	0
11	A	31	12	12	0	0
11	B	31	12	12	0	0
11	C	31	12	12	0	0
12	A	1	0	0	0	0
12	B	1	0	0	0	0
12	C	1	0	0	0	0
12	D	1	0	0	0	0
12	F	1	0	0	0	0
13	D	27	12	12	1	0
13	E	27	12	12	0	0
13	F	27	12	12	0	0
14	A	3	0	0	0	0
14	B	3	0	0	0	0
14	C	3	0	0	0	0
14	D	4	0	0	2	0
14	F	4	0	0	2	0
All	All	30336	30898	30898	403	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 403 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:E:310:SER:OG	2:E:312:GLN:OE1	1.85	0.93
2:D:385:TYR:OH	6:J:30:GLU:OE2	1.89	0.90
2:D:196:GLU:OE1	14:D:701:HOH:O	1.91	0.89
1:B:127:ARG:NH2	1:B:255:GLU:OE1	2.06	0.88

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:E:210:ILE:HD11	2:E:221:LEU:HD11	1.61	0.83

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	506/510 (99%)	464 (92%)	42 (8%)	0	100	100
1	B	473/510 (93%)	440 (93%)	33 (7%)	0	100	100
1	C	494/510 (97%)	449 (91%)	45 (9%)	0	100	100
2	D	467/482 (97%)	428 (92%)	39 (8%)	0	100	100
2	E	465/482 (96%)	427 (92%)	38 (8%)	0	100	100
2	F	465/482 (96%)	420 (90%)	45 (10%)	0	100	100
3	G	270/273 (99%)	253 (94%)	17 (6%)	0	100	100
4	H	130/146 (89%)	112 (86%)	18 (14%)	0	100	100
5	I	45/50 (90%)	42 (93%)	3 (7%)	0	100	100
6	J	45/66 (68%)	44 (98%)	1 (2%)	0	100	100
7	S	186/190 (98%)	172 (92%)	14 (8%)	0	100	100
8	b	134/214 (63%)	129 (96%)	5 (4%)	0	100	100
9	d	154/160 (96%)	139 (90%)	15 (10%)	0	100	100
10	h	60/76 (79%)	46 (77%)	14 (23%)	0	100	100
All	All	3894/4151 (94%)	3565 (92%)	329 (8%)	0	100	100

There are no Ramachandran outliers to report.



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

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

### 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 monosaccharides in this entry.

## 5.6 Ligand geometry [i](#)

Of 11 ligands modelled in this entry, 5 are monoatomic - leaving 6 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
11	ATP	C	600	12	26,33,33	0.89	1 (3%)	31,52,52	1.67	5 (16%)
11	ATP	B	600	12	26,33,33	0.92	1 (3%)	31,52,52	1.66	5 (16%)
13	ADP	D	600	12	24,29,29	0.95	1 (4%)	29,45,45	1.50	5 (17%)
13	ADP	E	600	-	24,29,29	0.95	1 (4%)	29,45,45	1.54	5 (17%)
11	ATP	A	600	12	26,33,33	0.90	1 (3%)	31,52,52	1.69	5 (16%)
13	ADP	F	600	12	24,29,29	0.92	1 (4%)	29,45,45	1.57	5 (17%)

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
11	ATP	C	600	12	-	0/18/38/38	0/3/3/3
11	ATP	B	600	12	-	0/18/38/38	0/3/3/3
13	ADP	D	600	12	-	2/12/32/32	0/3/3/3
13	ADP	E	600	-	-	3/12/32/32	0/3/3/3
11	ATP	A	600	12	-	1/18/38/38	0/3/3/3
13	ADP	F	600	12	-	2/12/32/32	0/3/3/3

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
13	E	600	ADP	C5-C4	2.39	1.47	1.40
13	D	600	ADP	C5-C4	2.23	1.46	1.40
11	A	600	ATP	C5-C4	2.18	1.46	1.40
13	F	600	ADP	C5-C4	2.16	1.46	1.40
11	C	600	ATP	C5-C4	2.16	1.46	1.40

The worst 5 of 30 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
11	A	600	ATP	PB-O3B-PG	-4.92	115.95	132.83
11	B	600	ATP	PA-O3A-PB	-4.32	117.99	132.83
11	C	600	ATP	PB-O3B-PG	-4.32	118.01	132.83
13	E	600	ADP	PA-O3A-PB	-3.82	119.71	132.83
13	F	600	ADP	N3-C2-N1	-3.71	122.87	128.68

There are no chirality outliers.

5 of 8 torsion outliers are listed below:

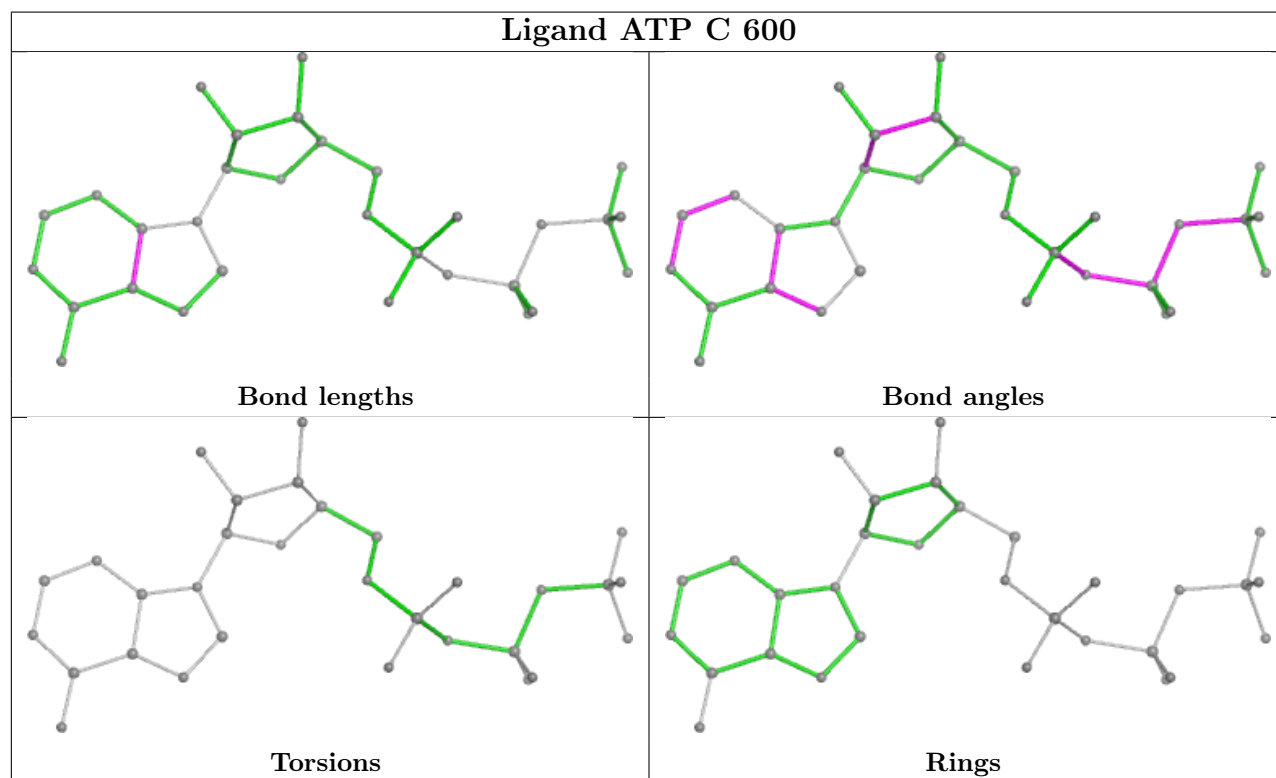
Mol	Chain	Res	Type	Atoms
13	D	600	ADP	C5'-O5'-PA-O3A
13	E	600	ADP	C5'-O5'-PA-O1A
13	E	600	ADP	C5'-O5'-PA-O3A
13	F	600	ADP	C5'-O5'-PA-O3A
11	A	600	ATP	PB-O3B-PG-O1G

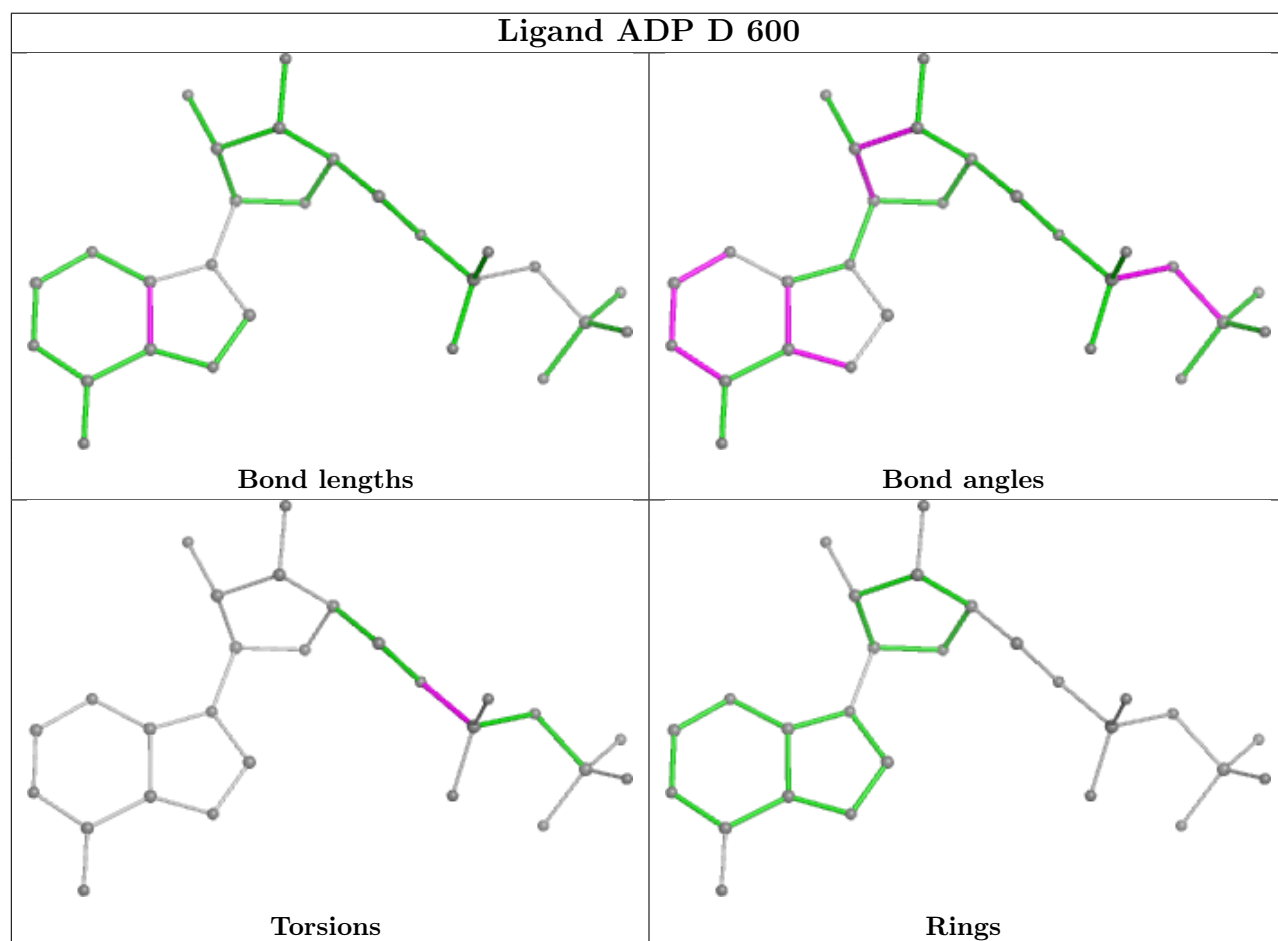
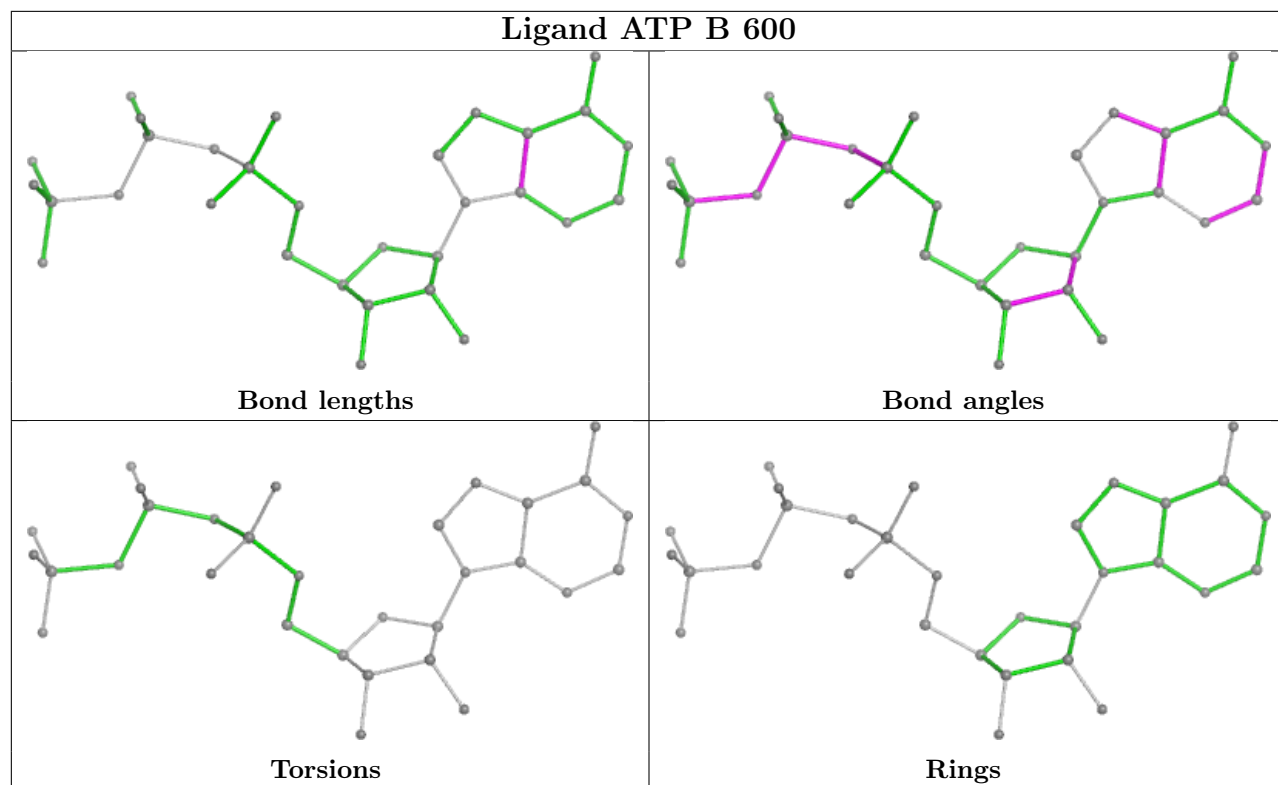
There are no ring outliers.

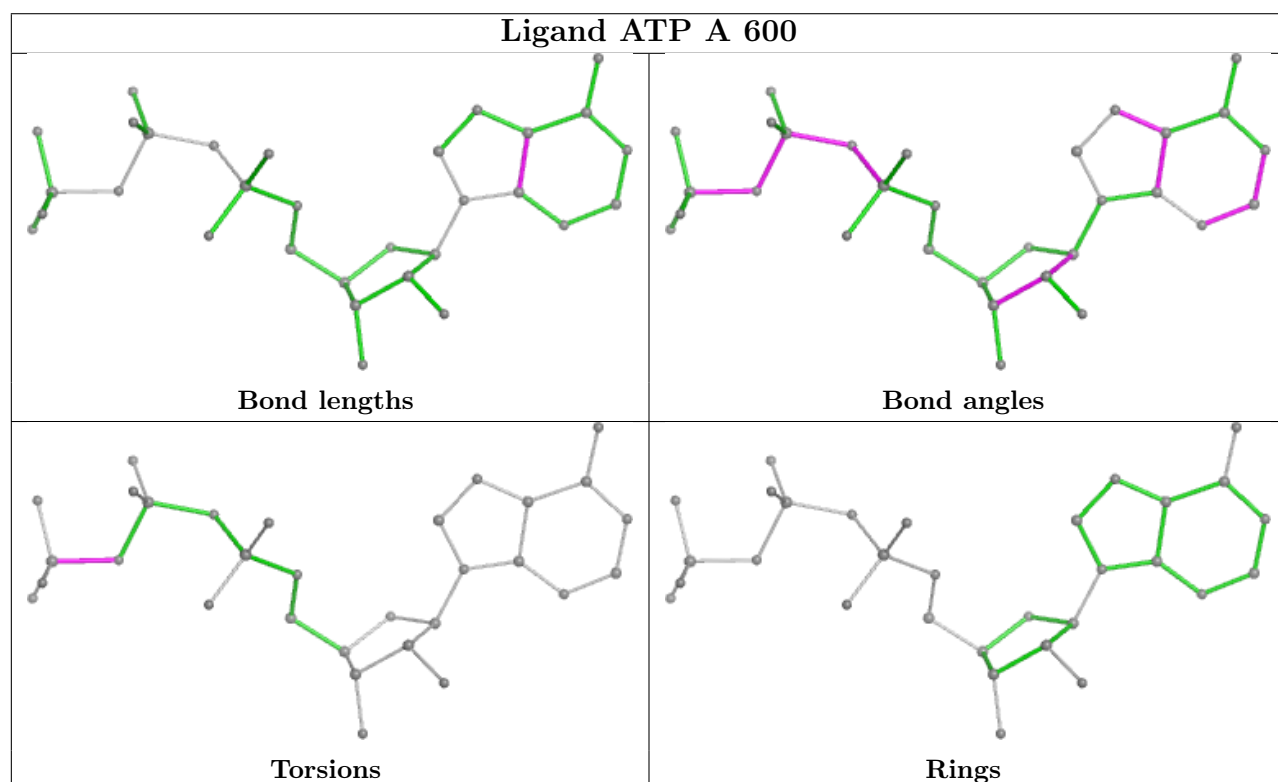
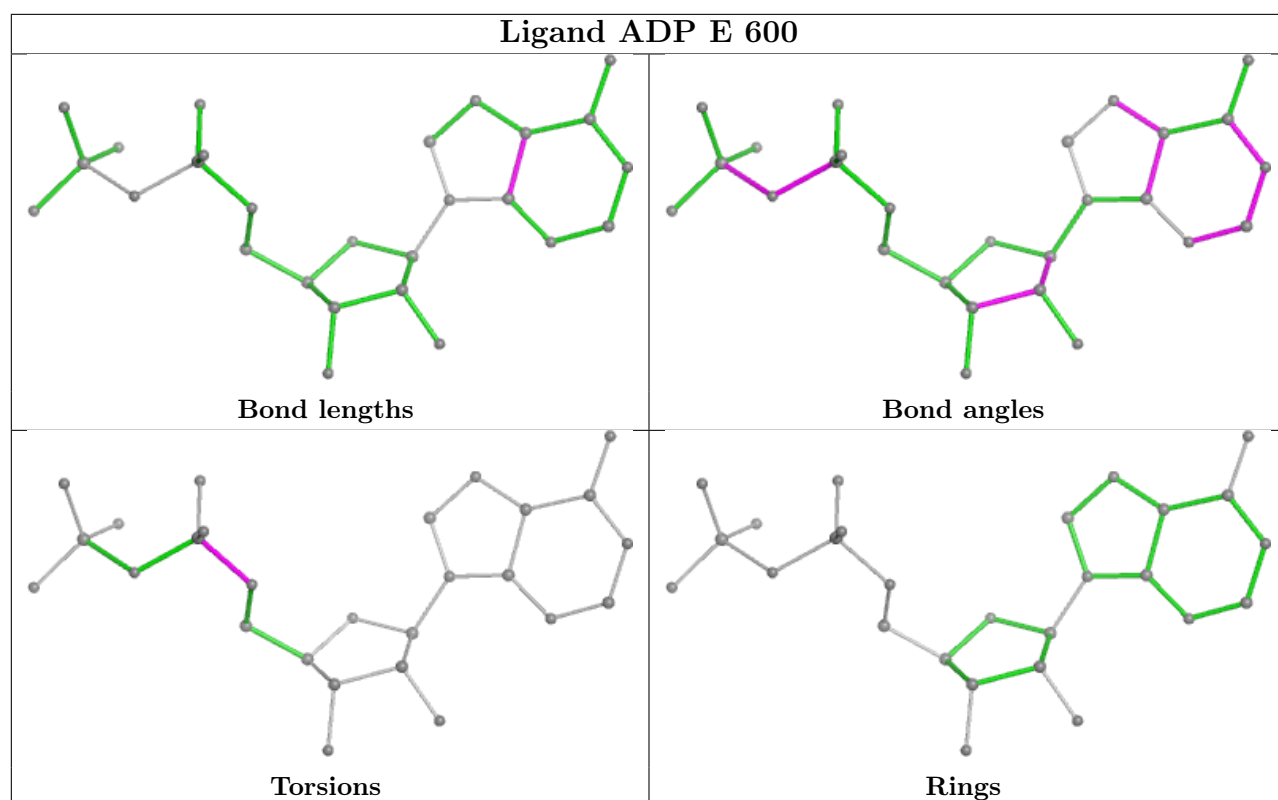
1 monomer is involved in 1 short contact:

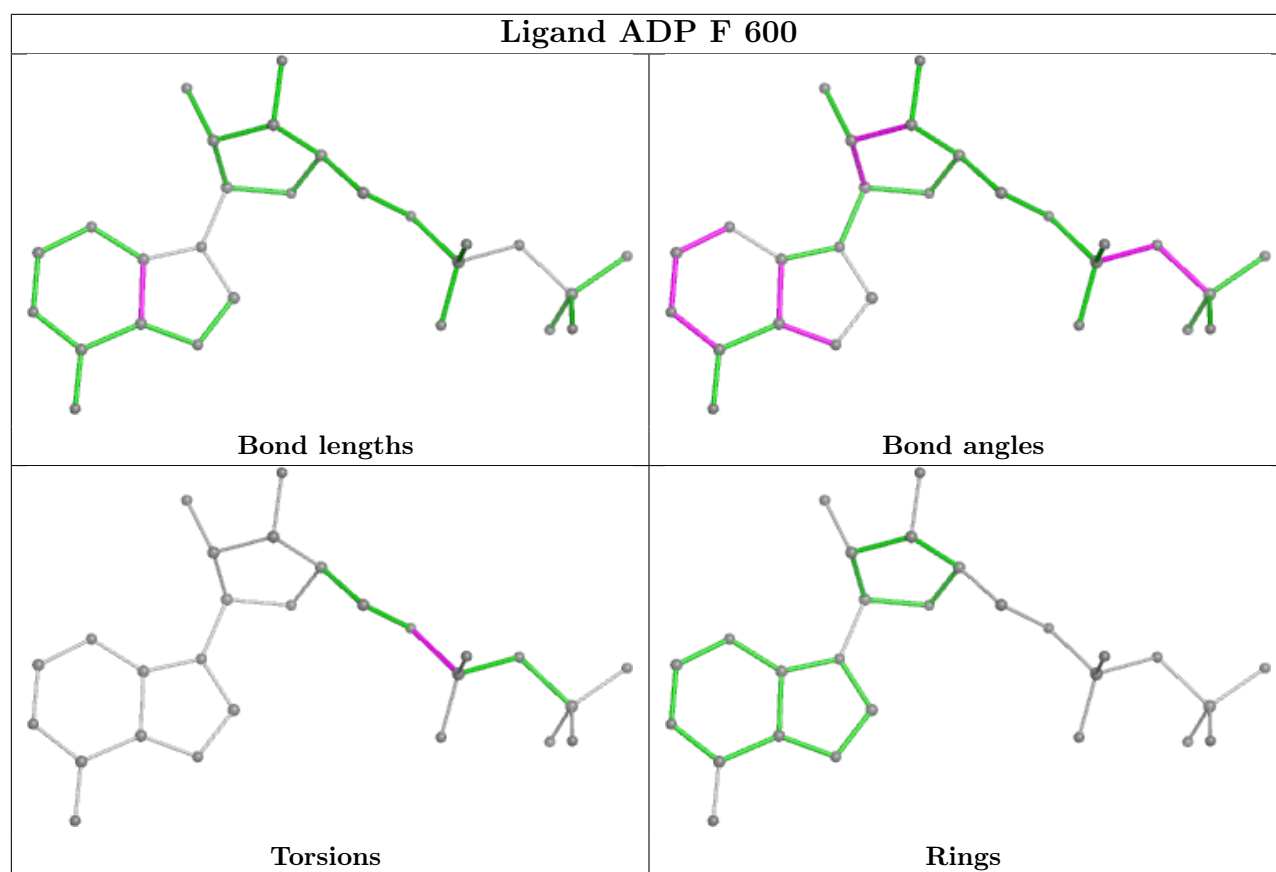
Mol	Chain	Res	Type	Clashes	Symm-Clashes
13	D	600	ADP	1	0

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.

## 6 Map visualisation

This section contains visualisations of the EMDB entry EMD-11001. These allow visual inspection of the internal detail of the map and identification of artifacts.

Images derived from a raw map, generated by summing the deposited half-maps, are presented below the corresponding image components of the primary map to allow further visual inspection and comparison with those of the primary map.

### 6.1 Orthogonal projections

This section was not generated.

### 6.2 Central slices

This section was not generated.

### 6.3 Largest variance slices

This section was not generated.

### 6.4 Orthogonal standard-deviation projections (False-color)

This section was not generated.

### 6.5 Orthogonal surface views

This section was not generated.

### 6.6 Mask visualisation

This section was not generated. No masks/segmentation were deposited.

## 7 Map analysis

This section contains the results of statistical analysis of the map.

### 7.1 Map-value distribution

This section was not generated.

### 7.2 Volume estimate versus contour level

This section was not generated.

### 7.3 Rotationally averaged power spectrum

This section was not generated. The rotationally averaged power spectrum had issues being displayed.



## 8 Fourier-Shell correlation

This section was not generated. No FSC curve or half-maps provided.

## 9 Map-model fit

This section was not generated.