



wwPDB X-ray Structure Validation Summary Report

Feb 26, 2014 – 03:25 PM GMT

PDB ID : 2IA6
Title : Bypass of Major Benzopyrene-dG Adduct by Y-Family DNA Polymerase with Unique Structural Gap
Authors : Bauer, J.; Ling, H.; Sayer, J.M.; Xing, G.; Yagi, H.; Jerina, D.M.
Deposited on : 2006-09-07
Resolution : 2.50 Å(reported)

This is a wwPDB validation summary report for a publicly released PDB entry.

We welcome your comments at validation@mail.wwpdb.org

A user guide is available at <http://wwpdb.org/ValidationPDFNotes.html>

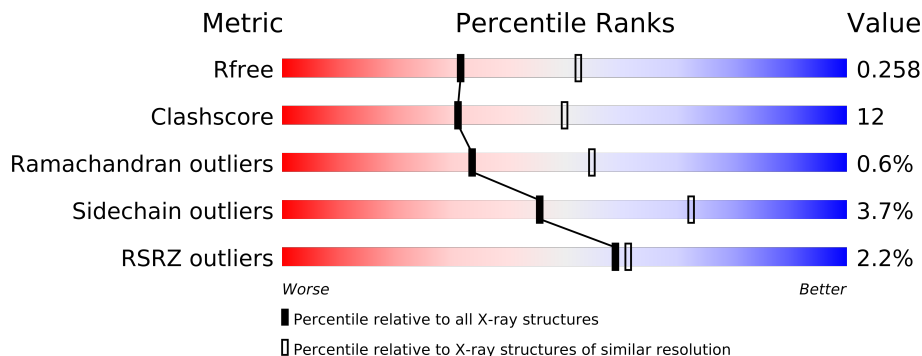
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity	:	4.02b-467
Mogul	:	1.15 2013
Xtriage (Phenix)	:	dev-1323
EDS	:	stable22639
Percentile statistics	:	21963
Refmac	:	5.8.0049
CCP4	:	6.3.0 (Settle)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et. al. (1996)
Validation Pipeline (wwPDB-VP)	:	stable22683

1 Overall quality at a glance

The reported resolution of this entry is 2.50 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))
R_{free}	66092	2784 (2.50-2.50)
Clashscore	79885	3562 (2.50-2.50)
Ramachandran outliers	78287	3480 (2.50-2.50)
Sidechain outliers	78261	3482 (2.50-2.50)
RSRZ outliers	66119	2785 (2.50-2.50)

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 ≥ 3 , 2, 1 and 0 types of geometric quality criteria. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	352	
1	B	352	
2	C	13	
2	E	13	
3	D	17	
3	F	17	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
4	EDO	C	605	-	X
4	EDO	C	606	-	X

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Mol	Type	Chain	Res	Geometry	Electron density
4	EDO	C	607	-	X
4	EDO	F	602	-	X
6	BAP	F	2906	-	X
7	GOL	B	603	-	X
7	GOL	E	601	-	X
7	GOL	F	604	-	X
9	ATP	A	401	-	X

2 Entry composition

There are 10 unique types of molecules in this entry. The entry contains 7214 atoms, of which 0 are hydrogen and 0 are deuterium.

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 DNA polymerase IV.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	341	Total	C	N	O	S	0	0	0
			2743	1760	472	504	7			
1	B	341	Total	C	N	O	S	0	0	0
			2743	1760	472	504	7			

- Molecule 2 is a DNA chain called 5'-D(*GP*GP*GP*GP*GP*AP*AP*GP*GP*AP*TP*TP*A)-3'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	13	Total	C	N	O	P	0	0	0
			275	130	59	74	12			
2	E	13	Total	C	N	O	P	0	0	0
			275	130	59	74	12			

- Molecule 3 is a DNA chain called 5'-D(*TP*CP*AP*TP*GP*AP*AP*TP*CP*CP*TP*TP*CP*CP*CP*CP*C)-3'.

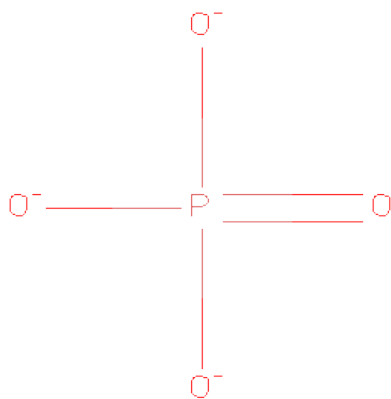
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	14	Total	C	N	O	P	0	0	1
			257	123	42	79	13			
3	F	16	Total	C	N	O	P	0	0	0
			316	152	52	96	16			

- Molecule 4 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C₂H₆O₂).



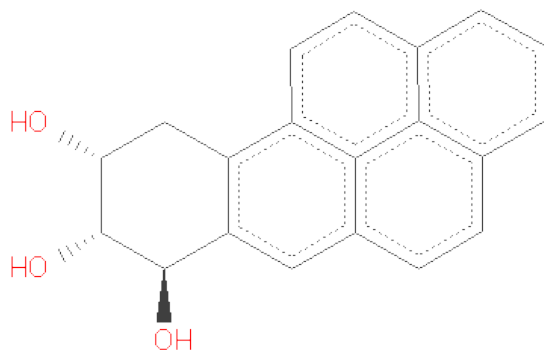
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	C	1	Total	C	O	0	0
			4	2	2		
4	C	1	Total	C	O	0	0
			4	2	2		
4	C	1	Total	C	O	0	0
			4	2	2		
4	F	1	Total	C	O	0	0
			4	2	2		

- Molecule 5 is PHOSPHATE ION (three-letter code: PO4) (formula: O₄P).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	O	P	0	0
			4	3	1		
5	A	1	Total	O	P	0	0
			5	4	1		

- Molecule 6 is 1,2,3-TRIHYDROXY-1,2,3,4-TETRAHYDROBENZO[A]PYRENE (three-letter code: BAP) (formula: C₂₀H₁₆O₃).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	D	1	Total	C	O	0	0
			23	20	3		
6	F	1	Total	C	O	0	0
			23	20	3		

- Molecule 7 is GLYCEROL (three-letter code: GOL) (formula: C₃H₈O₃).

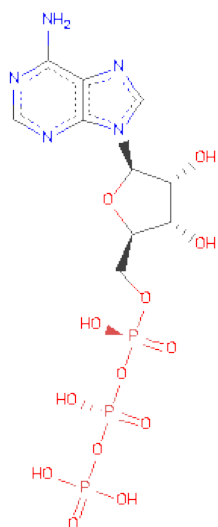


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
7	E	1	Total	C	O	0	0
			6	3	3		
7	F	1	Total	C	O	0	0
			6	3	3		
7	B	1	Total	C	O	0	0
			6	3	3		

- Molecule 8 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	B	3	Total	Ca	0	0
			3	3		
8	A	2	Total	Ca	0	0
			2	2		

- Molecule 9 is ADENOSINE-5'-TRIPHOSPHATE (three-letter code: ATP) (formula: C₁₀H₁₆N₅O₁₃P₃).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
9	A	1	Total	C	N	O	P	0	0
			30	10	5	12	3		
9	B	1	Total	C	N	O	P	0	0
			30	10	5	12	3		

- Molecule 10 is water.

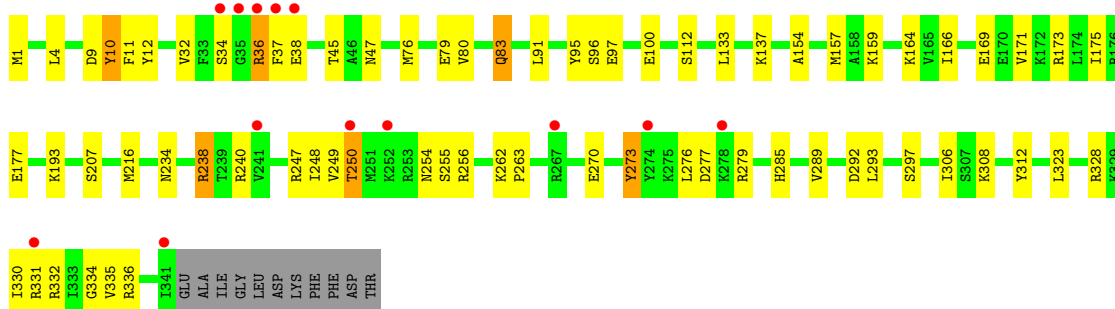
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	A	160	Total	O	0	0
			160	160		
10	B	170	Total	O	0	0
			170	170		
10	C	28	Total	O	0	0
			28	28		
10	D	18	Total	O	0	0
			18	18		
10	E	38	Total	O	0	0
			38	38		
10	F	37	Total	O	0	0
			37	37		

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 errors displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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. A red dot above a residue indicates a poor fit to the electron density ($RSRZ > 2$). 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.

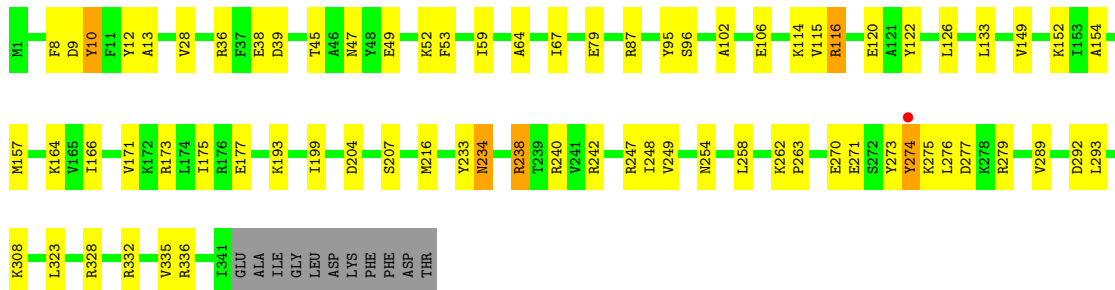
- Molecule 1: DNA polymerase IV

Chain A: 



- Molecule 1: DNA polymerase IV

Chain B: 



- Molecule 2: 5'-D(*GP*GP*GP*GP*GP*AP*AP*GP*GP*AP*TP*TP*A)-3'

Chain C: 



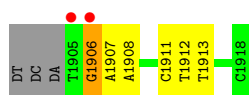
- Molecule 2: 5'-D(*GP*GP*GP*GP*GP*AP*AP*GP*GP*AP*TP*TP*A)-3'

Chain E: 



- Molecule 3: 5'-D(*TP*CP*AP*TP*GP*AP*AP*TP*CP*CP*TP*TP*CP*CP*CP*CP*C)-3',

Chain D: 



- Molecule 3: 5'-D(*TP*CP*AP*TP*GP*AP*AP*TP*CP*CP*TP*TP*CP*CP*CP*CP*C)-3',

Chain F: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	98.22Å 102.58Å 106.15Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	30.00 – 2.50 29.92 – 2.50	Depositor EDS
% Data completeness (in resolution range)	99.7 (30.00-2.50) 99.7 (29.92-2.50)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.17 (at 2.51Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.216 , 0.247 0.235 , 0.258	Depositor DCC
R_{free} test set	943 reflections (2.51%)	DCC
Wilson B-factor (Å ²)	48.6	Xtriage
Anisotropy	0.225	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 33.4	EDS
Estimated twinning fraction	0.011 for -h,l,k	Xtriage
L-test for twinning	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	0 of 37640 reflections	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	7214	wwPDB-VP
Average B, all atoms (Å ²)	50.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The analyses of the Patterson function reveals a significant off-origin peak that is 34.62 % of the origin peak, indicating pseudo translational symmetry. The chance of finding a peak of this or larger height randomly in a structure without pseudo translational symmetry is equal to 6.6263e-04. The detected translational NCS is most likely also responsible for the elevated intensity ratio.*

¹Intensities estimated from amplitudes.

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: GOL, BAP, PO4, EDO, ATP, CA

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	0.53	0/2782	0.70	0/3736
1	B	0.53	0/2782	0.68	0/3736
2	C	0.62	0/311	0.73	0/481
2	E	0.64	0/311	0.75	0/481
3	D	0.76	1/284 (0.4%)	0.83	0/433
3	F	0.74	0/351	0.80	0/536
All	All	0.57	1/6821 (0.0%)	0.71	0/9403

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	D	1906	DG	C2-N2	6.24	1.40	1.34

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2743	0	2889	57	0
1	B	2743	0	2889	71	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	C	275	0	147	2	0
2	E	275	0	147	9	0
3	D	257	0	144	8	0
3	F	316	0	178	14	0
4	C	12	0	18	4	0
4	F	4	0	6	0	0
5	A	9	0	0	0	0
6	D	23	0	15	1	0
6	F	23	0	15	8	0
7	B	6	0	8	0	0
7	E	6	0	8	2	0
7	F	6	0	8	0	0
8	A	2	0	0	0	0
8	B	3	0	0	0	0
9	A	30	0	10	4	0
9	B	30	0	10	4	0
10	A	160	0	0	6	0
10	B	170	0	0	9	0
10	C	28	0	0	4	0
10	D	18	0	0	2	0
10	E	38	0	0	2	0
10	F	37	0	0	2	0
All	All	7214	0	6492	155	0

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 12.

The worst 5 of 155 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:242:ARG:NH2	3:F:1908:DA:H5''	1.67	1.07
3:D:1906:DG:H2''	3:D:1907:DA:H5'	1.39	1.00
1:B:274:TYR:CG	6:F:2906:BAP:H10	2.01	0.96
1:B:274:TYR:CD2	6:F:2906:BAP:H10	2.04	0.93
3:F:1904:DA:N3	3:F:1904:DA:H2'	1.88	0.87

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 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	A	339/352 (96%)	324 (96%)	13 (4%)	2 (1%)	33	55
1	B	339/352 (96%)	326 (96%)	11 (3%)	2 (1%)	33	55
All	All	678/704 (96%)	650 (96%)	24 (4%)	4 (1%)	33	55

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	10	TYR
1	B	10	TYR
1	A	277	ASP
1	B	277	ASP

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 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	A	300/309 (97%)	285 (95%)	15 (5%)	34	58
1	B	300/309 (97%)	293 (98%)	7 (2%)	63	87
All	All	600/618 (97%)	578 (96%)	22 (4%)	45	72

5 of 22 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	238	ARG
1	A	297	SER
1	B	323	LEU
1	A	250	THR
1	A	273	TYR

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 6 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	254	ASN
1	B	285	HIS
1	B	188	ASN
1	A	234	ASN
1	B	234	ASN

5.3.3 RNA ⓘ

There are no RNA chains 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 carbohydrates in this entry.

5.6 Ligand geometry ⓘ

Of 18 ligands modelled in this entry, 5 are monoatomic - leaving 13 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	$\# Z > 2$
5	PO4	A	1919	-	1,3,4	2.32	1 (100%)	0,3,6	0.00	-
5	PO4	A	1920	-	4,4,4	1.46	1 (25%)	6,6,6	0.33	0
9	ATP	A	401	8	31,32,33	1.66	5 (16%)	46,50,52	2.20	8 (17%)
9	ATP	B	501	8	31,32,33	1.30	5 (16%)	46,50,52	2.47	14 (30%)
7	GOL	B	603	-	5,5,5	0.61	0	5,5,5	0.47	0
4	EDO	C	605	-	3,3,3	0.57	0	2,2,2	0.29	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
4	EDO	C	606	-	3,3,3	0.58	0	2,2,2	0.42	0
4	EDO	C	607	-	3,3,3	0.51	0	2,2,2	0.43	0
6	BAP	D	2906	3	27,27,27	2.32	9 (33%)	42,42,42	1.04	3 (7%)
7	GOL	E	601	-	5,5,5	0.35	0	5,5,5	0.37	0
6	BAP	F	2906	3	27,27,27	2.52	11 (40%)	42,42,42	1.10	3 (7%)
4	EDO	F	602	-	3,3,3	1.09	0	2,2,2	0.09	0
7	GOL	F	604	-	5,5,5	0.47	0	5,5,5	0.24	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	PO4	A	1919	-	-	0/0/0/0	0/0/0/0
5	PO4	A	1920	-	-	0/0/0/0	0/0/0/0
9	ATP	A	401	8	-	0/22/34/38	0/1/3/3
9	ATP	B	501	8	-	0/22/34/38	0/1/3/3
7	GOL	B	603	-	-	0/4/4/4	0/0/0/0
4	EDO	C	605	-	-	0/1/1/1	0/0/0/0
4	EDO	C	606	-	-	0/1/1/1	0/0/0/0
4	EDO	C	607	-	-	0/1/1/1	0/0/0/0
6	BAP	D	2906	3	-	0/0/16/16	0/0/5/5
7	GOL	E	601	-	-	0/4/4/4	0/0/0/0
6	BAP	F	2906	3	-	0/0/16/16	0/0/5/5
4	EDO	F	602	-	-	0/1/1/1	0/0/0/0
7	GOL	F	604	-	-	0/4/4/4	0/0/0/0

The worst 5 of 32 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
9	A	401	ATP	C2'-C3'	6.28	1.56	1.52
6	F	2906	BAP	C8-C7	6.16	1.45	1.36
6	D	2906	BAP	C8-C7	5.99	1.45	1.36
6	D	2906	BAP	C6-C7	5.70	1.49	1.37
6	F	2906	BAP	C6-C7	5.33	1.48	1.37

The worst 5 of 28 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
9	B	501	ATP	N3-C2-N1	-8.05	121.98	128.71
9	A	401	ATP	N3-C2-N1	-6.62	123.17	128.71

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
9	A	401	ATP	PB-O3B-PG	-6.38	112.98	131.68
9	B	501	ATP	PA-O3A-PB	-6.05	113.94	131.68
9	A	401	ATP	PA-O3A-PB	-5.90	114.39	131.68

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å ²)	Q<0.9
1	A	341/352 (96%)	0.00	13 (3%) 38 40	22, 44, 76, 114	0
1	B	341/352 (96%)	-0.11	1 (0%) 91 93	24, 44, 75, 112	0
2	C	13/13 (100%)	-0.17	0 100 100	37, 51, 67, 68	0
2	E	13/13 (100%)	-0.46	0 100 100	33, 40, 52, 71	0
3	D	14/17 (82%)	0.26	2 (14%) 3 3	51, 65, 104, 111	0
3	F	16/17 (94%)	-0.00	0 100 100	37, 45, 101, 147	0
All	All	738/764 (96%)	-0.05	16 (2%) 59 61	22, 45, 77, 147	0

The worst 5 of 16 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	35	GLY	5.2
1	A	34	SER	4.1
1	A	252	LYS	4.1
1	A	38	GLU	3.7
1	A	37	PHE	3.7

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

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

6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

6.4 Ligands ⓘ

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q < 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSR	LLDF	B-factors(Å ²)	Q<0.9
7	GOL	B	603	6/6	0.48	32.20	76,77,78,79	0
7	GOL	F	604	6/6	0.42	17.66	88,89,89,89	0
4	EDO	C	607	4/4	0.35	6.75	74,74,74,74	0
6	BAP	F	2906	23/23	0.40	4.29	66,68,71,72	0
4	EDO	F	602	4/4	0.22	4.14	44,45,45,46	0
4	EDO	C	605	4/4	0.26	4.11	66,67,68,69	0
4	EDO	C	606	4/4	0.24	3.66	55,55,57,58	0
9	ATP	A	401	30/31	0.24	2.49	60,79,88,90	0
7	GOL	E	601	6/6	0.15	2.44	74,74,75,76	0
9	ATP	B	501	30/31	0.19	1.96	42,49,67,69	0
6	BAP	D	2906	23/23	0.27	1.15	75,79,87,88	0
8	CA	B	503	1/1	0.17	0.68	64,64,64,64	0
8	CA	B	502	1/1	0.14	-0.30	35,35,35,35	0
8	CA	A	403	1/1	0.14	-0.91	36,36,36,36	0
5	PO4	A	1920	5/5	0.14	-1.45	90,91,92,92	0
8	CA	A	404	1/1	0.07	-1.85	57,57,57,57	0
5	PO4	A	1919	4/5	0.17	-1.90	90,90,91,94	0
8	CA	B	504	1/1	0.07	-2.51	39,39,39,39	0

6.5 Other polymers ⓘ

There are no such residues in this entry.