



wwPDB X-ray Structure Validation Summary Report

May 20, 2014 – 05:05 AM EDT

PDB ID : 4MQ9
Title : Crystal structure of Thermus thermophilus RNA polymerase holoenzyme in complex with GE23077
Authors : Ho, M.X.; Arnold, E.; Ebright, R.H.; Zhang, Y.; Tuske, S.
Deposited on : 2013-09-16
Resolution : 3.35 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>

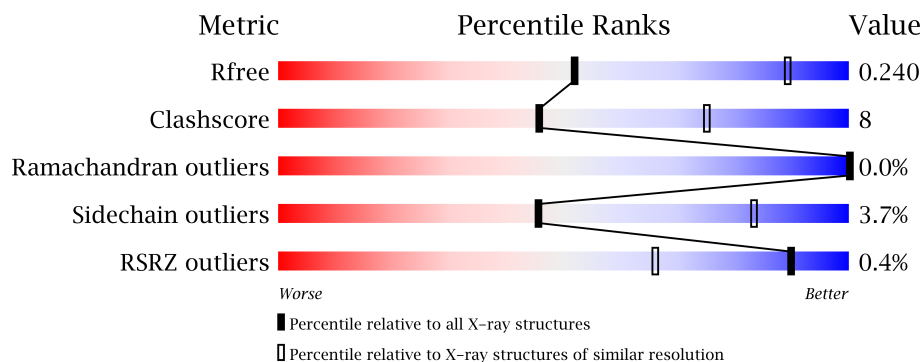
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity : 4.02b-467
Mogul : 1.16 November 2013
Xtriage (Phenix) : dev-1439
EDS : stable22978
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) : stable22978

1 Overall quality at a glance

The reported resolution of this entry is 3.35 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	1141 (3.50-3.22)
Clashscore	79885	1030 (3.48-3.24)
Ramachandran outliers	78287	1008 (3.48-3.24)
Sidechain outliers	78261	1007 (3.48-3.24)
RSRZ outliers	66119	1141 (3.50-3.22)

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	314	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>
1	B	314	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>
2	C	1119	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>
3	D	1524	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>
4	E	99	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>
5	F	443	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>
6	I	7	<div><div></div><div><div></div><div></div><div></div><div></div></div></div>

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

Mol	Type	Chain	Res	Geometry	Electron density
9	MB8	I	101	-	X

2 Entry composition

There are 10 unique types of molecules in this entry. The entry contains 26552 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-directed RNA polymerase subunit alpha.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	226	Total	C	N	O	S	0	0	0
			1777	1135	309	331	2			
1	B	224	Total	C	N	O	S	0	0	0
			1750	1118	303	327	2			

- Molecule 2 is a protein called DNA-directed RNA polymerase subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	1100	Total	C	N	O	S	0	0	0
			8677	5487	1552	1614	24			

- Molecule 3 is a protein called DNA-directed RNA polymerase subunit beta'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	1365	Total	C	N	O	S	0	0	0
			10781	6821	1912	2014	34			

- Molecule 4 is a protein called DNA-directed RNA polymerase subunit omega.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	E	93	Total	C	N	O	S	0	0	0
			754	481	131	138	4			

- Molecule 5 is a protein called RNA polymerase sigma factor.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	F	339	Total	C	N	O	S	0	0	0
			2754	1736	501	513	4			

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	-19	MET	-	EXPRESSION TAG	UNP Q5SKW1
F	-18	GLY	-	EXPRESSION TAG	UNP Q5SKW1
F	-17	SER	-	EXPRESSION TAG	UNP Q5SKW1
F	-16	SER	-	EXPRESSION TAG	UNP Q5SKW1
F	-15	HIS	-	EXPRESSION TAG	UNP Q5SKW1
F	-14	HIS	-	EXPRESSION TAG	UNP Q5SKW1
F	-13	HIS	-	EXPRESSION TAG	UNP Q5SKW1
F	-12	HIS	-	EXPRESSION TAG	UNP Q5SKW1
F	-11	HIS	-	EXPRESSION TAG	UNP Q5SKW1
F	-10	HIS	-	EXPRESSION TAG	UNP Q5SKW1
F	-9	SER	-	EXPRESSION TAG	UNP Q5SKW1
F	-8	SER	-	EXPRESSION TAG	UNP Q5SKW1
F	-7	GLY	-	EXPRESSION TAG	UNP Q5SKW1
F	-6	LEU	-	EXPRESSION TAG	UNP Q5SKW1
F	-5	VAL	-	EXPRESSION TAG	UNP Q5SKW1
F	-4	PRO	-	EXPRESSION TAG	UNP Q5SKW1
F	-3	ARG	-	EXPRESSION TAG	UNP Q5SKW1
F	-2	GLY	-	EXPRESSION TAG	UNP Q5SKW1
F	-1	SER	-	EXPRESSION TAG	UNP Q5SKW1
F	0	HIS	-	EXPRESSION TAG	UNP Q5SKW1

- Molecule 6 is a protein called GE23077.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
6	I	7	Total	C	N	O	0	0	0
			50	26	9	15			

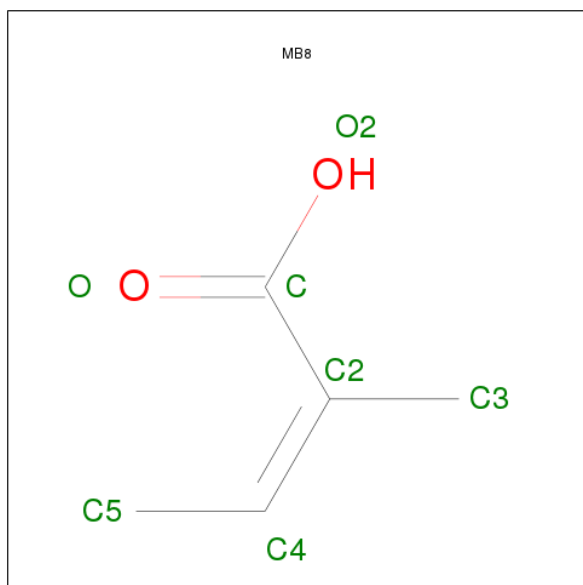
- Molecule 7 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	D	2	Total	Zn	0	0
			2	2		

- Molecule 8 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	D	1	Total	Mg	0	0
			1	1		

- Molecule 9 is (2Z)-2-METHYLBUT-2-ENOICACID (three-letter code: MB8) (formula: C₅H₈O₂).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
9	I	1	Total	C	O	0	0
			2	1	1		

- Molecule 10 is water.

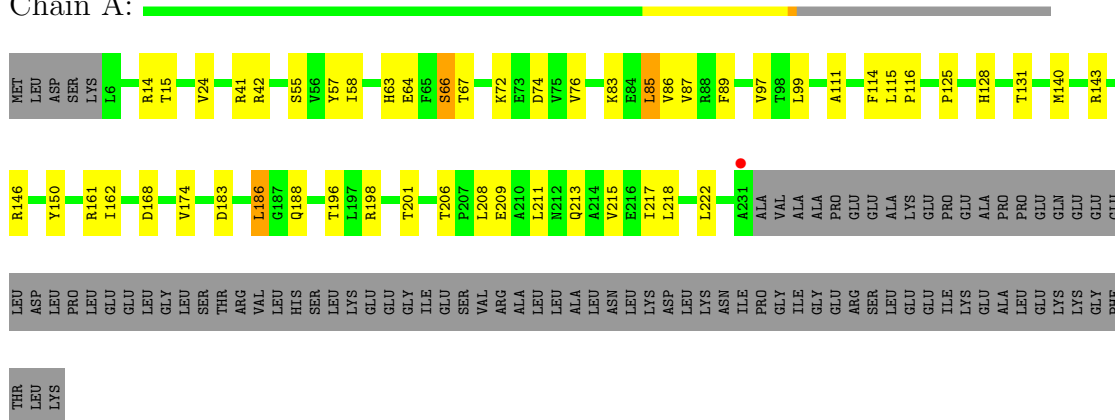
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	D	4	Total	O	0	0
			4	4		

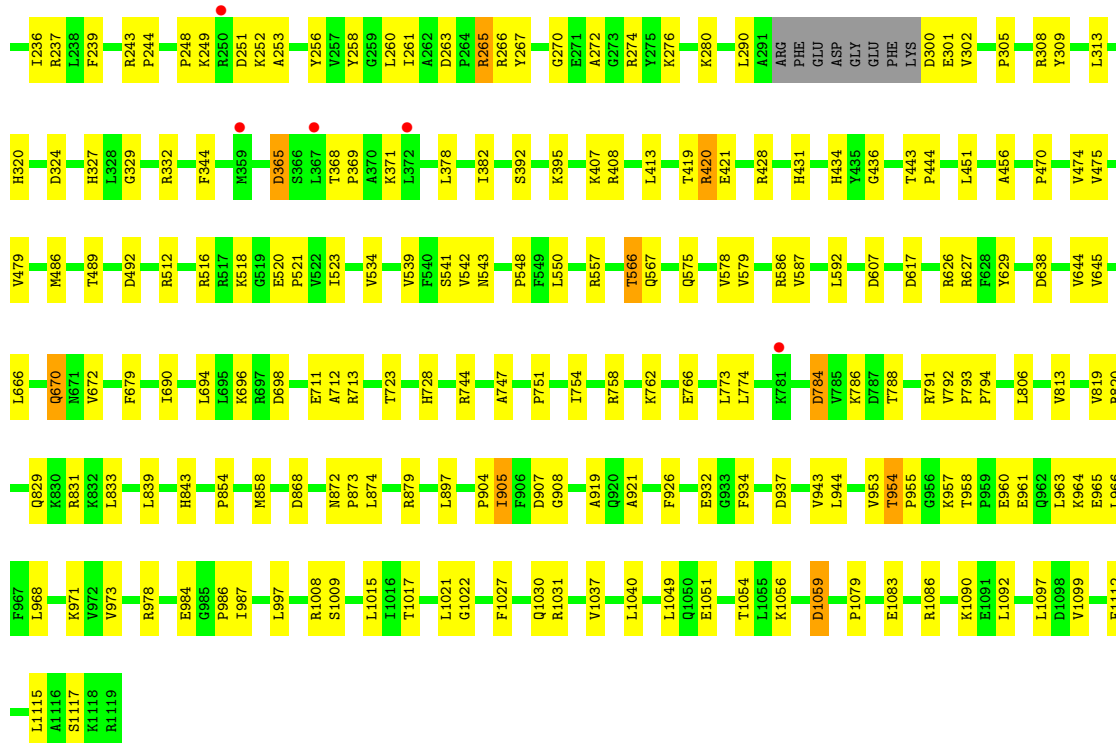
3 Residue-property plots

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-directed RNA polymerase subunit alpha

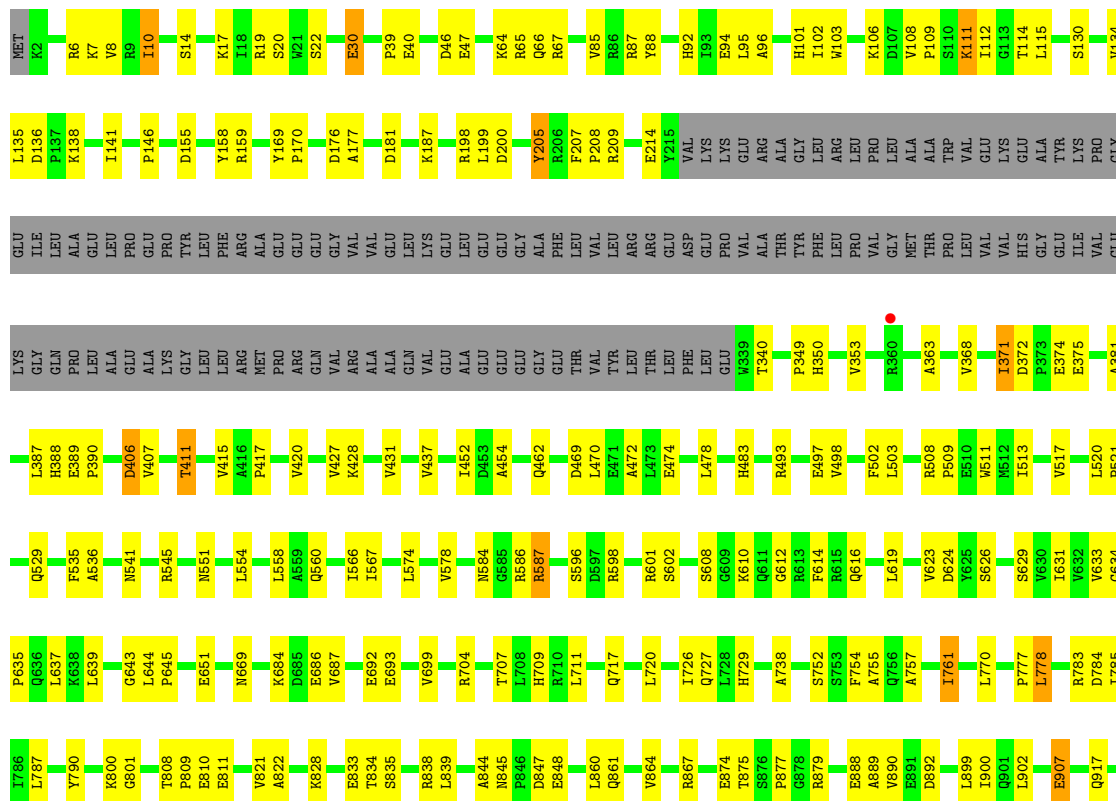
Chain A:





• Molecule 3: DNA-directed RNA polymerase subunit beta'

Chain D:



4 Data and refinement statistics

Property	Value	Source
Space group	P 65	Depositor
Cell constants a, b, c, α , β , γ	236.57Å 236.57Å 252.31Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	38.97 – 3.35 38.97 – 3.35	Depositor EDS
% Data completeness (in resolution range)	98.9 (38.97-3.35) 98.9 (38.97-3.35)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.58 (at 3.32Å)	Xtriage
Refinement program	PHENIX (phenix.refine: 1.8.1069)	Depositor
R, R_{free}	0.214 , 0.242 0.212 , 0.240	Depositor DCC
R_{free} test set	2267 reflections (2.00%)	DCC
Wilson B-factor (Å ²)	126.0	Xtriage
Anisotropy	0.350	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.27 , 80.5	EDS
Estimated twinning fraction	0.032 for h,-h-k,-l	Xtriage
L-test for twinning	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Outliers	0 of 113402 reflections	Xtriage
F_o, F_c correlation	0.95	EDS
Total number of atoms	26552	wwPDB-VP
Average B, all atoms (Å ²)	140.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 1.79% of the height of the origin peak. No significant pseudotranslation is detected.*

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: DSN, ZN, 2TL, DVA, MG, 2RA, FGL, MB8, 0QZ, R2T

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	0.24	0/1809	0.47	0/2461
1	B	0.23	0/1781	0.44	0/2426
2	C	0.25	0/8841	0.46	0/11956
3	D	0.25	0/10966	0.47	0/14820
4	E	0.23	0/768	0.41	0/1035
5	F	0.23	0/2797	0.41	0/3761
All	All	0.25	0/26962	0.46	0/36459

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand. A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
6	I	0	1

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
6	I	5	2TL	Peptide

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	1777	0	1826	32	0
1	B	1750	0	1794	35	0
2	C	8677	0	8791	164	0
3	D	10781	0	10998	206	0
4	E	754	0	769	15	0
5	F	2754	0	2826	42	0
6	I	50	0	26	1	0
7	D	2	0	0	0	0
8	D	1	0	0	0	0
9	I	2	0	0	0	0
10	D	4	0	0	0	0
All	All	26552	0	27030	442	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 8.

The worst 5 of 442 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
1:B:104:GLU:HB2	1:B:137:ARG:HA	1.60	0.82
2:C:102:HIS:HB3	2:C:105:THR:HB	1.65	0.77
3:D:508:ARG:HD3	3:D:509:PRO:HD2	1.66	0.77
2:C:904:PRO:HB2	2:C:907:ASP:HB3	1.69	0.73
3:D:95:LEU:HD11	3:D:517:VAL:HG23	1.70	0.73

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	224/314 (71%)	223 (100%)	1 (0%)	0	100	100
1	B	220/314 (70%)	217 (99%)	3 (1%)	0	100	100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	C	1094/1119 (98%)	1059 (97%)	35 (3%)	0	100	100
3	D	1359/1524 (89%)	1317 (97%)	41 (3%)	1 (0%)	59	95
4	E	91/99 (92%)	90 (99%)	1 (1%)	0	100	100
5	F	335/443 (76%)	328 (98%)	7 (2%)	0	100	100
All	All	3323/3813 (87%)	3234 (97%)	88 (3%)	1 (0%)	100	100

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	D	406	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	197/272 (72%)	188 (95%)	9 (5%)	37	80
1	B	193/272 (71%)	187 (97%)	6 (3%)	52	87
2	C	926/941 (98%)	895 (97%)	31 (3%)	50	86
3	D	1155/1279 (90%)	1115 (96%)	40 (4%)	48	85
4	E	82/88 (93%)	80 (98%)	2 (2%)	61	90
5	F	295/388 (76%)	279 (95%)	16 (5%)	31	74
All	All	2848/3240 (88%)	2744 (96%)	104 (4%)	45	83

5 of 104 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	D	30	GLU
3	D	406	ASP
5	F	232	ARG
3	D	101	HIS
3	D	135	LEU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 7 such sidechains are listed below:

Mol	Chain	Res	Type
3	D	709	HIS
5	F	217	ASN
3	D	1441	GLN
2	C	204	GLN
3	D	1442	ASN

5.3.3 RNA ⓘ

There are no RNA chains in this entry.

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

7 non-standard protein/DNA/RNA residues 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	$\# Z > 2$
6	2RA	I	1	9,6	5,5,6	7.58	1 (20%)	3,5,7	0.68	0
6	DSN	I	2	6	5,5,6	7.71	2 (40%)	3,5,7	0.30	0
6	DVA	I	3	6	6,6,7	7.43	3 (50%)	5,7,9	0.26	0
6	R2T	I	4	6	10,10,11	5.29	4 (40%)	11,13,15	1.19	1 (9%)
6	2TL	I	5	6	6,6,7	7.73	2 (33%)	5,7,9	0.86	0
6	0QZ	I	6	6	5,5,6	7.45	3 (60%)	2,5,7	0.72	0
6	FGL	I	7	6	6,6,7	6.95	2 (33%)	5,7,9	9.16	2 (40%)

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
6	2RA	I	1	9,6	-	0/2/4/6	0/0/0/0
6	DSN	I	2	6	-	0/2/4/6	0/0/0/0
6	DVA	I	3	6	-	0/4/6/8	0/0/0/0

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
6	R2T	I	4	6	-	0/12/14/16	0/0/0/0
6	2TL	I	5	6	-	0/4/6/8	0/0/0/0
6	0QZ	I	6	6	-	0/2/4/6	0/0/0/0
6	FGL	I	7	6	-	0/4/6/8	0/0/0/0

The worst 5 of 17 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	I	5	2TL	O-C	18.66	1.24	1.11
6	I	3	DVA	O-C	17.24	1.23	1.11
6	I	2	DSN	O-C	16.99	1.23	1.11
6	I	1	2RA	O-C	16.76	1.22	1.11
6	I	7	FGL	O-C	16.58	1.22	1.11

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	I	7	FGL	C-CA-N	-20.21	110.98	113.27
6	I	7	FGL	OG1-CB-CA	2.60	120.14	113.61
6	I	4	R2T	CB-CA-N	2.31	114.25	109.59

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

5.5 Carbohydrates

There are no carbohydrates in this entry.

5.6 Ligand geometry

Of 4 ligands modelled in this entry, 3 are monoatomic - leaving 1 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	$\# Z > 2$
9	MB8	I	101	6	1,1,6	0.25	0	0,0,7	0.00	-

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	MB8	I	101	6	-	0/0/0/6	0/0/0/0

There are no bond length outliers.

There are no bond angle outliers.

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	226/314 (71%)	-0.19	1 (0%) 90 66	84, 110, 169, 199	0
1	B	224/314 (71%)	0.01	0 100 100	97, 165, 233, 259	0
2	C	1100/1119 (98%)	-0.05	9 (0%) 83 47	67, 135, 240, 281	0
3	D	1365/1524 (89%)	-0.10	2 (0%) 93 81	68, 114, 213, 249	0
4	E	93/99 (93%)	-0.11	0 100 100	96, 142, 212, 216	0
5	F	339/443 (76%)	-0.03	0 100 100	89, 153, 249, 267	0
6	I	4/7 (57%)	-0.78	0 100 100	87, 89, 98, 98	0
All	All	3351/3820 (87%)	-0.08	12 (0%) 90 66	67, 129, 230, 281	0

The worst 5 of 12 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	C	250	ARG	3.4
2	C	372	LEU	3.3
3	D	360	ARG	3.3
2	C	217	LEU	2.7
3	D	1239	ARG	2.6

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

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
6	DVA	I	3	7/8	0.26	4.36	81,85,91,93	0

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Mol	Type	Chain	Res	Atoms	RSR	LLDF	B-factors(\AA^2)	Q<0.9
6	2RA	I	1	6/7	0.17	-0.68	85,96,99,111	0
6	DSN	I	2	6/7	0.11	-0.78	80,85,93,97	0
6	2TL	I	5	7/8	0.20	-0.78	78,84,91,93	0
6	FGL	I	7	7/8	0.15	-1.15	82,93,106,108	0
6	0QZ	I	6	6/7	0.20	-1.23	75,79,86,87	0
6	R2T	I	4	11/12	0.16	-1.83	77,87,94,97	0

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(\AA^2)	Q<0.9
9	MB8	I	101	2/7	0.35	3.87	102,102,102,107	0
7	ZN	D	1602	1/1	0.19	1.55	105,105,105,105	0
7	ZN	D	1601	1/1	0.07	-1.59	159,159,159,159	0
8	MG	D	1603	1/1	0.11	-1.76	75,75,75,75	0

6.5 Other polymers

There are no such residues in this entry.