



wwPDB X-ray Structure Validation Summary Report ⓘ

Dec 10, 2018 – 10:30 PM EST

PDB ID : 6F7C
Title : TUBULIN-Compound 12 complex
Authors : Muehlethaler, T.; Protá, A.E.; Steinmetz, M.O.
Deposited on : 2017-12-08
Resolution : 2.00 Å(reported)

This is a wwPDB X-ray Structure 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/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.7.3 (157068), CSD as539be (2018)
Xtriage (Phenix) : 1.13
EDS : rb-20031633
Percentile statistics : 20171227.v01 (using entries in the PDB archive December 27th 2017)
Refmac : 5.8.0158
CCP4 : 7.0 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20031633

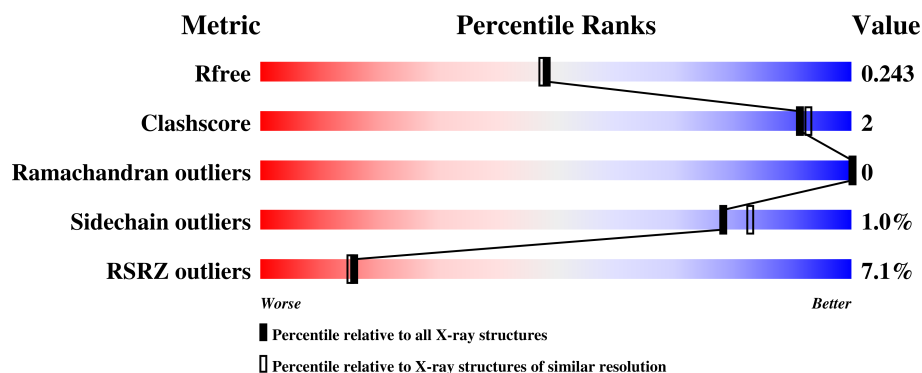
1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.00 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}	111664	7193 (2.00-2.00)
Clashscore	122126	8267 (2.00-2.00)
Ramachandran outliers	120053	8166 (2.00-2.00)
Sidechain outliers	120020	8165 (2.00-2.00)
RSRZ outliers	108989	7011 (2.00-2.00)

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. 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 $\leq 5\%$. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	451	<div> <div>0%</div> <div>92%</div> <div>• •</div> </div>
1	C	451	<div> <div>2%</div> <div>92%</div> <div>5% •</div> </div>
2	B	445	<div> <div>2%</div> <div>90%</div> <div>5% 5%</div> </div>
2	D	445	<div> <div>10%</div> <div>88%</div> <div>6% 6%</div> </div>
3	E	143	<div> <div>10%</div> <div>78%</div> <div>• 17%</div> </div>

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Mol	Chain	Length	Quality of chain
4	F	384	<div><div></div><div>18%</div><div></div><div>70%</div><div></div><div>27%</div></div>

2 Entry composition

There are 12 unique types of molecules in this entry. The entry contains 34179 atoms, of which 16500 are hydrogens and 0 are deuteriums.

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 Tubulin alpha-1B chain.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	431	Total	C	H	N	O	S	0	3	0
			6665	2133	3295	572	641	24			
1	C	440	Total	C	H	N	O	S	0	4	0
			6831	2188	3379	584	658	22			

- Molecule 2 is a protein called Tubulin beta-2B chain.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
2	B	424	Total	C	H	N	O	S	0	2	0
			6596	2108	3240	576	646	26			
2	D	420	Total	C	H	N	O	S	0	2	0
			6500	2081	3191	561	640	27			

- Molecule 3 is a protein called Stathmin-4.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
3	E	118	Total	C	H	N	O	S	0	1	0
			1984	605	1006	178	191	4			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
E	3	MET	ILE	cloning artifact	UNP P63043
E	4	ALA	SER	cloning artifact	UNP P63043

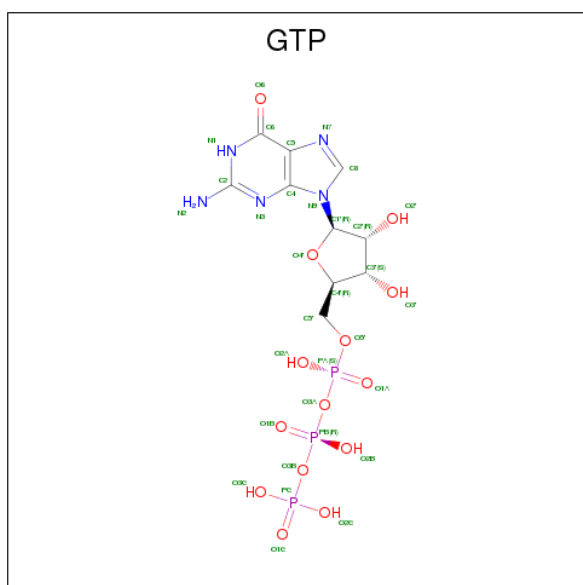
- Molecule 4 is a protein called Tubulin tyrosine ligase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
4	F	281	Total	C	H	N	O	S	0	0	0
			4609	1492	2306	388	411	12			

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
F	379	HIS	-	expression tag	UNP E1BQ43
F	380	HIS	-	expression tag	UNP E1BQ43
F	381	HIS	-	expression tag	UNP E1BQ43
F	382	HIS	-	expression tag	UNP E1BQ43
F	383	HIS	-	expression tag	UNP E1BQ43
F	384	HIS	-	expression tag	UNP E1BQ43

- Molecule 5 is GUANOSINE-5'-TRIPHOSPHATE (three-letter code: GTP) (formula: $C_{10}H_{16}N_5O_{14}P_3$).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
5	A	1	Total	C	H	N	O	P	0	0
			41	10	9	5	14	3		
5	C	1	Total	C	H	N	O	P	0	0
			41	10	9	5	14	3		

- Molecule 6 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	1	Total	Mg	0	0
			1	1		
6	A	1	Total	Mg	0	0
			1	1		
6	D	1	Total	Mg	0	0
			1	1		
6	C	1	Total	Mg	0	0
			1	1		

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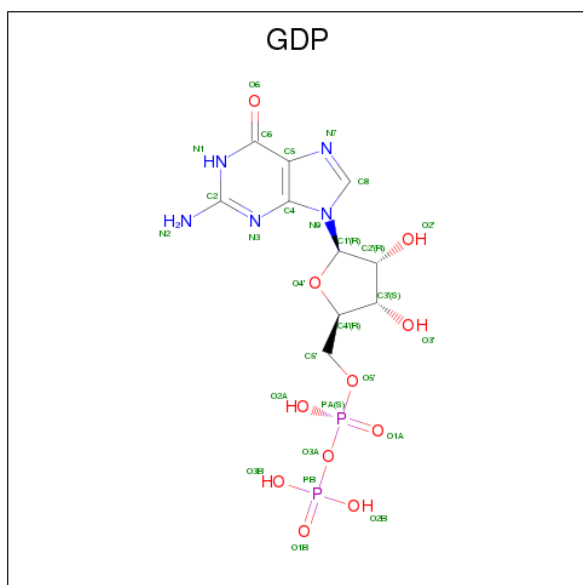
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	F	1	Total	Mg	0	0
			1	1		

- Molecule 7 is CALCIUM ION (three-letter code: CA) (formula: Ca).

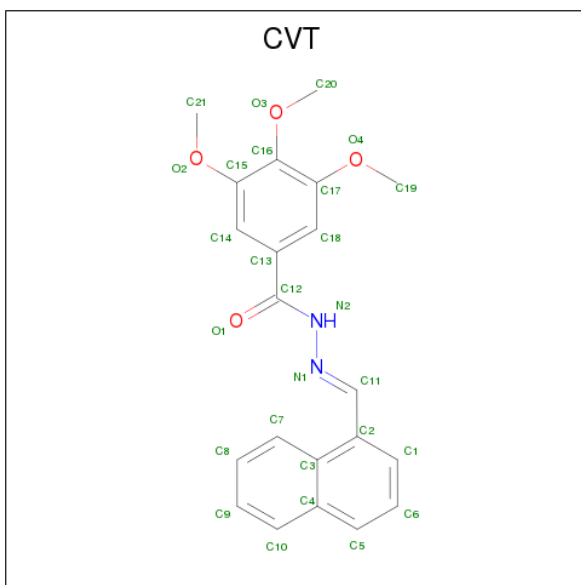
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	1	Total	Ca	0	0
			1	1		
7	C	2	Total	Ca	0	0
			2	2		

- Molecule 8 is GUANOSINE-5'-DIPHOSPHATE (three-letter code: GDP) (formula: C₁₀H₁₅N₅O₁₁P₂).



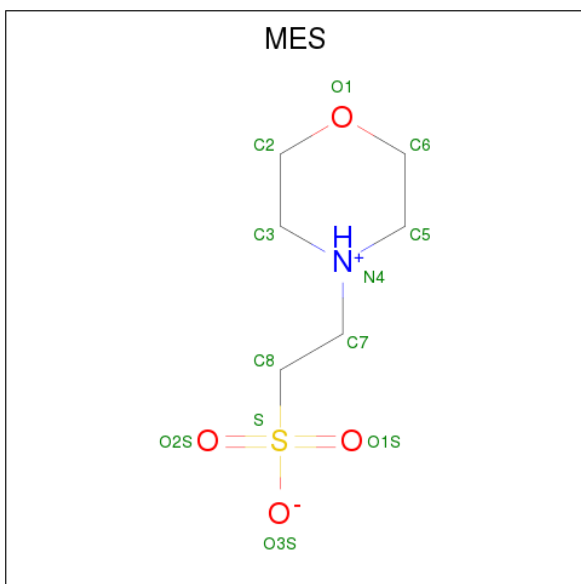
Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
8	B	1	Total 37	C 10	H 9	N 5	O 11	P 2	0	0
8	D	1	Total 37	C 10	H 9	N 5	O 11	P 2	0	0

- Molecule 9 is 3,4,5-trimethoxy- {N}-[({E})-naphthalen-1-ylmethylideneamino]benzamide (three-letter code: CVT) (formula: C₂₁H₂₀N₂O₄).



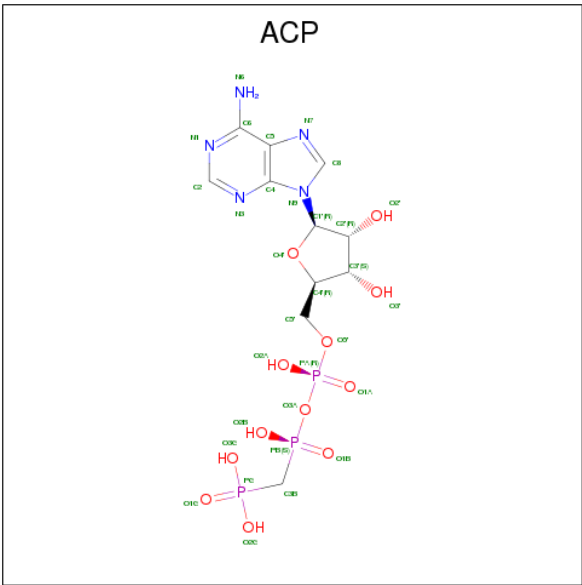
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
9	B	1	Total	C	H	N	O	0	0
			47	21	20	2	4		

- Molecule 10 is 2-(N-MORPHOLINO)-ETHANESULFONIC ACID (three-letter code: MES) (formula: $C_6H_{13}NO_4S$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
10	B	1	Total	C	H	N	O	S	
			25	6	13	1	4	1	0

- Molecule 11 is PHOSPHOMETHYLPHOSPHONIC ACID ADENYLATE ESTER (three-letter code: ACP) (formula: $C_{11}H_{18}N_5O_{12}P_3$).



Mol	Chain	Residues	Atoms						ZeroOcc	AltConf
11	F	1	Total	C	H	N	O	P	0	0
			45	11	14	5	12	3		

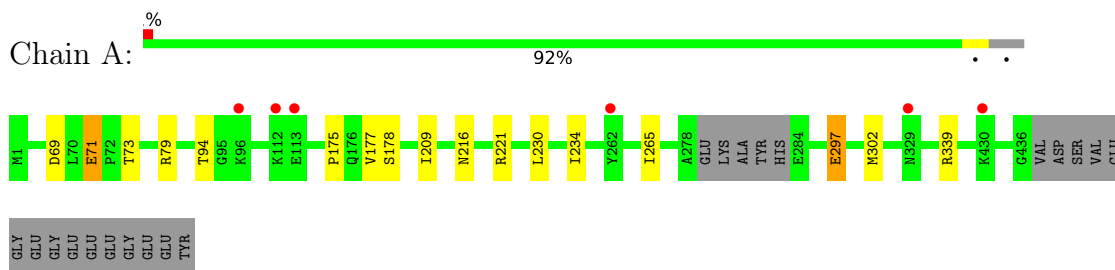
- Molecule 12 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
12	A	127	Total	O	0	0
			127	127		
12	B	161	Total	O	0	0
			161	161		
12	C	293	Total	O	0	0
			293	293		
12	D	63	Total	O	0	0
			63	63		
12	E	29	Total	O	0	0
			29	29		
12	F	40	Total	O	0	0
			40	40		

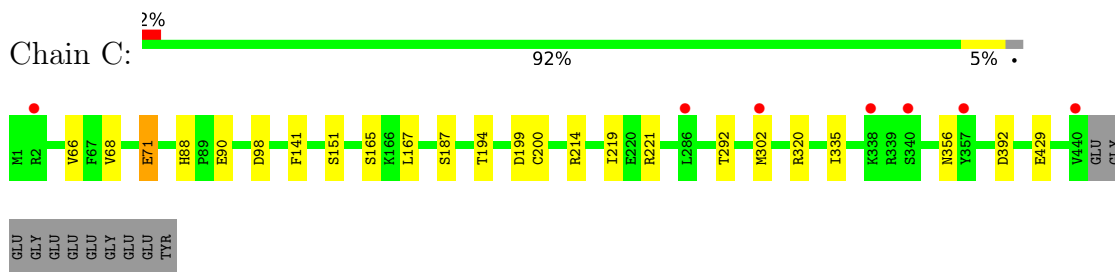
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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 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.

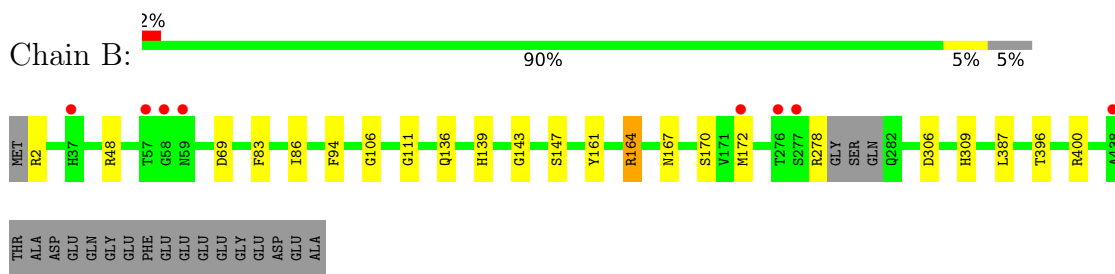
- Molecule 1: Tubulin alpha-1B chain



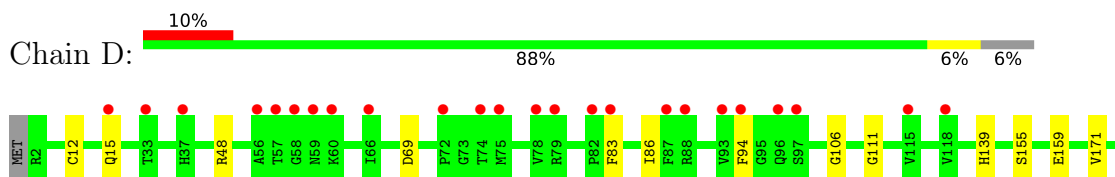
- Molecule 1: Tubulin alpha-1B chain



- Molecule 2: Tubulin beta-2B chain



- Molecule 2: Tubulin beta-2B chain



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	104.81Å 157.90Å 180.77Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	59.54 – 2.00 59.54 – 2.00	Depositor EDS
% Data completeness (in resolution range)	99.2 (59.54-2.00) 99.2 (59.54-2.00)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.01 (at 2.00Å)	Xtriage
Refinement program	PHENIX (dev_2863: ???)	Depositor
R, R_{free}	0.212 , 0.243 0.211 , 0.243	Depositor DCC
R_{free} test set	10120 reflections (5.06%)	wwPDB-VP
Wilson B-factor (Å ²)	45.1	Xtriage
Anisotropy	0.108	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.38 , 50.1	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	34179	wwPDB-VP
Average B, all atoms (Å ²)	72.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.58% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical values of $\langle |L| \rangle$, $\langle L^2 \rangle$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

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, MG, CVT, GTP, ACP, MES, 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	0.33	0/3456	0.50	0/4690
1	C	0.42	0/3542	0.56	0/4811
2	B	0.38	0/3433	0.52	0/4648
2	D	0.32	0/3388	0.48	0/4590
3	E	0.36	0/989	0.43	0/1311
4	F	0.30	0/2354	0.45	0/3178
All	All	0.36	0/17162	0.50	0/23228

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	3370	3295	3286	14	0
1	C	3452	3379	3378	11	0
2	B	3356	3240	3238	11	0
2	D	3309	3191	3191	17	0
3	E	978	1006	1005	4	0
4	F	2303	2306	2306	5	0
5	A	32	9	12	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
5	C	32	9	12	0	0
6	A	1	0	0	0	0
6	B	1	0	0	0	0
6	C	1	0	0	0	0
6	D	1	0	0	0	0
6	F	1	0	0	0	0
7	A	1	0	0	0	0
7	C	2	0	0	0	0
8	B	28	9	12	0	0
8	D	28	9	12	2	0
9	B	27	20	0	0	0
10	B	12	13	13	0	0
11	F	31	14	14	0	0
12	A	127	0	0	0	0
12	B	161	0	0	1	0
12	C	293	0	0	0	0
12	D	63	0	0	2	0
12	E	29	0	0	0	0
12	F	40	0	0	1	0
All	All	17679	16500	16479	59	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 2.

The worst 5 of 59 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:200:ASP:OD1	4:F:222:ARG:HB2	1.81	0.80
2:D:15:GLN:NE2	8:D:501:GDP:O6	2.34	0.58
1:A:297:GLU:OE1	1:A:339:ARG:NH2	2.37	0.57
2:D:417:GLU:OE2	3:E:129:HIS:NE2	2.40	0.54
4:F:16:GLU:OE2	4:F:19:ARG:NH2	2.41	0.53

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	430/451 (95%)	418 (97%)	12 (3%)	0	100	100
1	C	442/451 (98%)	433 (98%)	9 (2%)	0	100	100
2	B	422/445 (95%)	413 (98%)	9 (2%)	0	100	100
2	D	418/445 (94%)	408 (98%)	10 (2%)	0	100	100
3	E	115/143 (80%)	114 (99%)	1 (1%)	0	100	100
4	F	269/384 (70%)	257 (96%)	12 (4%)	0	100	100
All	All	2096/2319 (90%)	2043 (98%)	53 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	365/379 (96%)	361 (99%)	4 (1%)	76	80
1	C	375/379 (99%)	372 (99%)	3 (1%)	83	87
2	B	369/383 (96%)	365 (99%)	4 (1%)	76	80
2	D	365/383 (95%)	363 (100%)	2 (0%)	90	93
3	E	107/127 (84%)	106 (99%)	1 (1%)	81	85
4	F	253/342 (74%)	249 (98%)	4 (2%)	65	70
All	All	1834/1993 (92%)	1816 (99%)	18 (1%)	78	83

5 of 18 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	71	GLU
1	C	221	ARG
4	F	73	ARG
2	B	164	ARG
2	B	278	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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 carbohydrates in this entry.

5.6 Ligand geometry ⓘ

Of 15 ligands modelled in this entry, 8 are monoatomic - leaving 7 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	GTP	A	501	6	27,34,34	0.94	1 (3%)	26,54,54	1.24	4 (15%)
8	GDP	B	501	6	25,30,30	1.42	4 (16%)	24,47,47	1.12	3 (12%)
9	CVT	B	503	-	29,29,29	1.35	1 (3%)	39,39,39	1.35	5 (12%)
10	MES	B	504	-	11,12,12	2.25	1 (9%)	15,16,16	1.48	2 (13%)
5	GTP	C	501	6	27,34,34	1.07	2 (7%)	26,54,54	1.10	1 (3%)

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	# Z > 2	Counts	RMSZ	# Z > 2
8	GDP	D	501	6	25,30,30	1.35	3 (12%)	24,47,47	1.28	3 (12%)
11	ACP	F	401	6	27,33,33	1.34	5 (18%)	30,52,52	1.87	2 (6%)

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	GTP	A	501	6	-	0/18/38/38	0/3/3/3
8	GDP	B	501	6	-	0/12/32/32	0/3/3/3
9	CVT	B	503	-	-	0/16/16/16	0/3/3/3
10	MES	B	504	-	-	0/6/14/14	0/1/1/1
5	GTP	C	501	6	-	0/18/38/38	0/3/3/3
8	GDP	D	501	6	-	0/12/32/32	0/3/3/3
11	ACP	F	401	6	-	0/15/38/38	0/3/3/3

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

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
10	B	504	MES	C8-S	-6.85	1.67	1.77
11	F	401	ACP	PB-O2B	-3.27	1.48	1.56
8	B	501	GDP	C6-N1	-3.11	1.32	1.36
11	F	401	ACP	C8-N9	-3.06	1.33	1.36
11	F	401	ACP	PG-O3G	-2.65	1.48	1.54

The worst 5 of 20 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
11	F	401	ACP	N3-C2-N1	-8.83	121.31	128.86
8	D	501	GDP	PA-O3A-PB	-2.65	123.73	132.63
5	A	501	GTP	PA-O3A-PB	-2.53	124.12	132.63
11	F	401	ACP	C4-C5-N7	-2.50	106.99	109.41
5	A	501	GTP	PB-O3B-PG	-2.44	124.43	132.63

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
8	D	501	GDP	2	0

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 Fit of model and data [i](#)

6.1 Protein, DNA and RNA chains [i](#)

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	431/451 (95%)	0.28	6 (1%) 75 74	38, 59, 92, 114	0
1	C	440/451 (97%)	0.27	7 (1%) 72 71	31, 45, 72, 125	0
2	B	424/445 (95%)	0.41	8 (1%) 66 65	32, 53, 95, 137	0
2	D	420/445 (94%)	0.67	44 (10%) 6 6	41, 69, 105, 141	0
3	E	118/143 (82%)	0.81	15 (12%) 3 3	45, 73, 115, 152	0
4	F	281/384 (73%)	1.26	70 (24%) 0 0	49, 77, 124, 153	0
All	All	2114/2319 (91%)	0.54	150 (7%) 16 15	31, 60, 103, 153	0

The worst 5 of 150 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
4	F	132	LEU	8.0
4	F	130	VAL	7.8
4	F	182	ILE	7.6
4	F	99	VAL	7.4
4	F	131	PHE	7.4

6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

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

6.3 Carbohydrates [i](#)

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. 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	RSCC	RSR	B-factors(Å ²)	Q<0.9
6	MG	F	402	1/1	0.85	0.06	102,102,102,102	0
6	MG	D	502	1/1	0.86	0.09	68,68,68,68	0
7	CA	C	504	1/1	0.87	0.19	38,38,38,38	0
11	ACP	F	401	31/31	0.88	0.18	85,110,130,151	0
9	CVT	B	503	27/27	0.89	0.21	49,74,90,91	0
7	CA	A	503	1/1	0.92	0.12	80,80,80,80	0
6	MG	C	502	1/1	0.95	0.22	43,43,43,43	0
10	MES	B	504	12/12	0.95	0.19	49,65,79,89	0
8	GDP	D	501	28/28	0.95	0.14	63,76,93,105	0
6	MG	A	502	1/1	0.96	0.21	47,47,47,47	0
7	CA	C	503	1/1	0.97	0.14	64,64,64,64	0
5	GTP	A	501	32/32	0.97	0.19	36,48,56,60	0
5	GTP	C	501	32/32	0.98	0.22	38,42,48,50	0
6	MG	B	502	1/1	0.98	0.26	41,41,41,41	0
8	GDP	B	501	28/28	0.98	0.18	39,46,59,60	0

6.5 Other polymers

There are no such residues in this entry.