



Full wwPDB/EMDatabank EM Map/Model Validation Report ⓘ

Oct 27, 2018 – 12:47 PM EDT

PDB ID : 6E7C
EMDB ID: : EMD-8998
Title : 14-pf 3-start GMPCPP-human alpha1B/beta2B microtubules
Authors : Ti, S.C.; Alushin, G.M.; Kapoor, T.M.
Deposited on : 2018-07-25
Resolution : 3.65 Å(reported)
Based on PDB ID : 3JAT

This is a Full wwPDB/EMDatabank EM Map/Model Validation Report
for a publicly released PDB/EMDB entry.

We welcome your comments at 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.

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

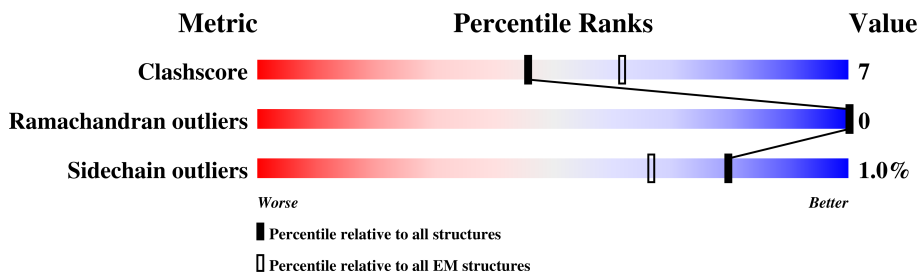
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

ELECTRON MICROSCOPY



The reported resolution of this entry is 3.65 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	136327	1886
Ramachandran outliers	132723	1663
Sidechain outliers	132532	1531

The table below summarises the geometric issues observed across the polymeric chains. The red, orange, yellow and green segments on the 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 $\leq 5\%$.

Mol	Chain	Length	Quality of chain
1	B	426	 81% 19%
2	A	437	 78% 19% .

2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 6780 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 Tubulin beta-2B chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
1	B	426	Total	C	N	O	S	0	0
			3356	2108	575	646	27		

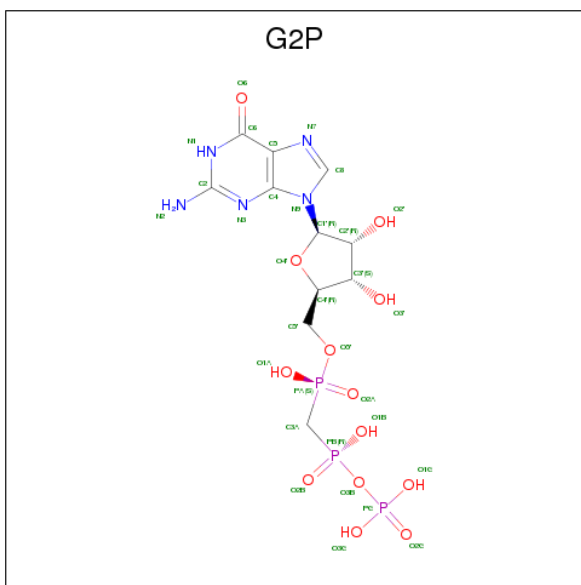
- Molecule 2 is a protein called Tubulin alpha-1B chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
2	A	428	Total	C	N	O	S	0	0
			3358	2130	571	635	22		

- Molecule 3 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

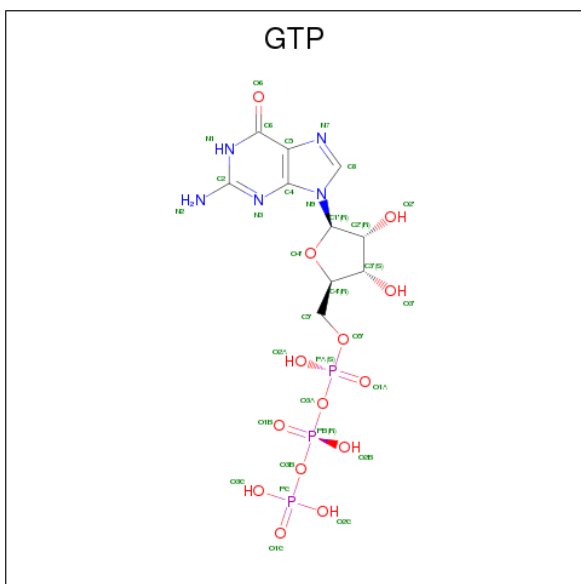
Mol	Chain	Residues	Atoms		AltConf
3	B	1	Total	Mg	0
			1	1	
3	A	1	Total	Mg	0
			1	1	

- Molecule 4 is PHOSPHOMETHYLPHOSPHONIC ACID GUANYLATE ESTER (three-letter code: G2P) (formula: C₁₁H₁₈N₅O₁₃P₃).



Mol	Chain	Residues	Atoms					AltConf
4	B	1	Total	C	N	O	P	0
			32	11	5	13	3	

- Molecule 5 is GUANOSINE-5'-TRIPHOSPHATE (three-letter code: GTP) (formula: $\text{C}_{10}\text{H}_{16}\text{N}_5\text{O}_{14}\text{P}_3$).

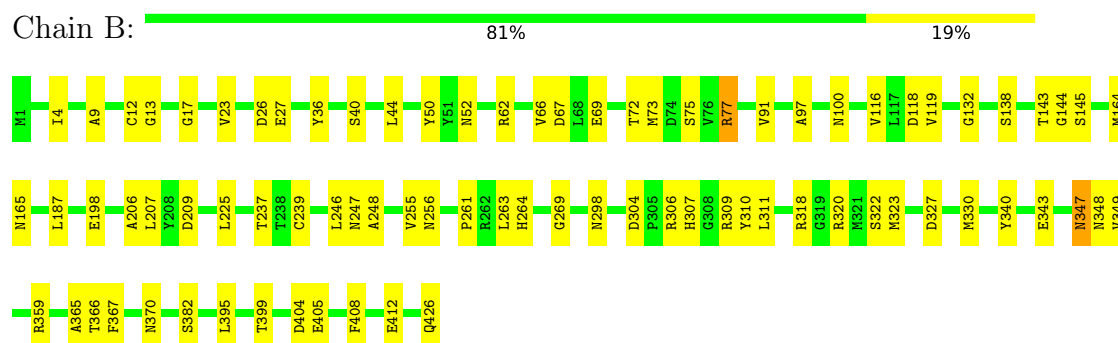


Mol	Chain	Residues	Atoms					AltConf
5	A	1	Total 32	C 10	N 5	O 14	P 3	0

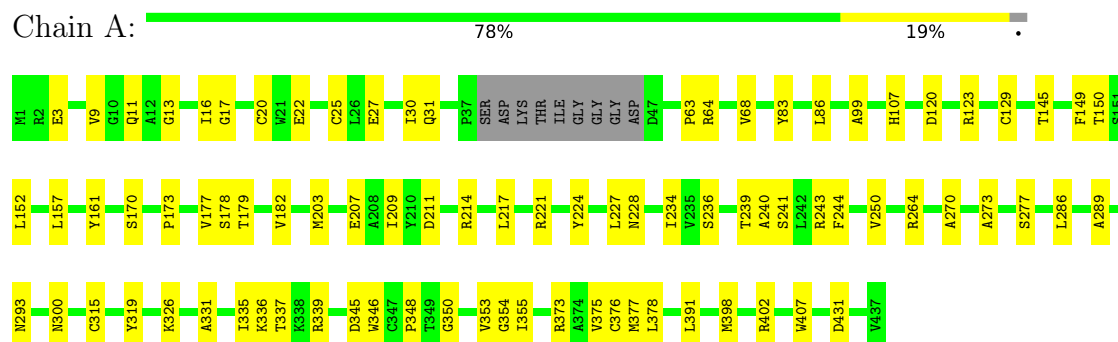
3 Residue-property plots

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of 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: Tubulin beta-2B chain



- Molecule 2: Tubulin alpha-1B chain



4 Experimental information

Property	Value	Source
Reconstruction method	HELICAL	Depositor
Imposed symmetry	HELICAL, twist=-25.71°, rise=8.759 Å, axial sym=C1	Depositor
Number of segments used	46624	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 ($e^-/\text{\AA}^2$)	1.6	Depositor
Minimum defocus (nm)	Not provided	Depositor
Maximum defocus (nm)	Not provided	Depositor
Magnification	Not provided	Depositor
Image detector	GATAN K2 SUMMIT (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: GTP, MG, G2P

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	$\# Z > 2$	RMSZ	$\# Z > 2$
1	B	0.32	0/3431	0.56	0/4646
2	A	0.33	0/3435	0.57	0/4663
All	All	0.32	0/6866	0.57	0/9309

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	B	3356	0	3241	50	0
2	A	3358	0	3277	51	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	B	32	0	14	5	0
5	A	32	0	12	1	0
All	All	6780	0	6544	96	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 7.

All (96) 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)
1:B:67:ASP:OD2	1:B:69:GLU:HB3	1.76	0.86
1:B:322:SER:OG	2:A:221:ARG:HG3	1.78	0.82
1:B:143:THR:HG22	4:B:502:G2P:O2G	1.87	0.74
2:A:336:LYS:NZ	2:A:348:PRO:O	2.21	0.73
1:B:52:ASN:OD1	1:B:62:ARG:NH2	2.21	0.73
4:B:502:G2P:O1A	4:B:502:G2P:O1B	2.08	0.72
1:B:12:CYS:SG	1:B:138:SER:OG	2.48	0.69
1:B:143:THR:N	4:B:502:G2P:O3G	2.25	0.69
1:B:165:ASN:ND2	1:B:198:GLU:OE1	2.26	0.68
1:B:239:CYS:SG	1:B:248:ALA:N	2.66	0.68
2:A:3:GLU:OE1	2:A:64:ARG:NH2	2.26	0.68
2:A:289:ALA:O	2:A:293:ASN:ND2	2.25	0.68
1:B:311:LEU:O	1:B:348:ASN:ND2	2.29	0.66
1:B:143:THR:H	4:B:502:G2P:PG	2.19	0.65
1:B:261:PRO:O	1:B:264:HIS:ND1	2.29	0.65
1:B:263:LEU:O	1:B:370:ASN:ND2	2.29	0.65
2:A:234:ILE:CD1	2:A:270:ALA:HB1	2.28	0.63
1:B:144:GLY:N	4:B:502:G2P:O3G	2.26	0.63
2:A:234:ILE:HD11	2:A:270:ALA:HB1	1.80	0.63
1:B:27:GLU:OE2	1:B:318:ARG:NH1	2.33	0.62
2:A:264:ARG:NH1	2:A:431:ASP:OD2	2.32	0.62
2:A:64:ARG:NH2	2:A:129:CYS:SG	2.73	0.61
2:A:170:SER:OG	2:A:203:MET:SD	2.59	0.60
2:A:319:TYR:N	2:A:354:GLY:O	2.35	0.60
2:A:398:MET:O	2:A:402:ARG:N	2.33	0.60
2:A:241:SER:OG	2:A:250:VAL:N	2.36	0.58
2:A:16:ILE:O	2:A:20:CYS:N	2.37	0.58
2:A:239:THR:OG1	2:A:243:ARG:NH1	2.37	0.57
2:A:376:CYS:SG	2:A:377:MET:N	2.77	0.57
1:B:13:GLY:O	1:B:17:GLY:N	2.38	0.57
1:B:395:LEU:O	1:B:399:THR:N	2.39	0.55
1:B:382:SER:OG	1:B:412:GLU:OE2	2.24	0.55
1:B:187:LEU:HD11	1:B:408:PHE:CE1	2.42	0.55
1:B:36:TYR:OH	1:B:40:SER:O	2.25	0.54
1:B:91:VAL:HG21	1:B:116:VAL:HG12	1.92	0.52
1:B:97:ALA:HB3	1:B:143:THR:HG23	1.93	0.51
1:B:304:ASP:OD1	1:B:306:ARG:NE	2.37	0.50
1:B:247:ASN:ND2	2:A:11:GLN:OE1	2.44	0.49
1:B:50:TYR:CE2	1:B:237:THR:HG21	2.48	0.49
2:A:209:ILE:HG21	2:A:227:LEU:HG	1.94	0.49
2:A:224:TYR:O	2:A:228:ASN:ND2	2.45	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:A:30:ILE:HD12	2:A:31:GLN:O	2.12	0.48
1:B:36:TYR:CD1	1:B:44:LEU:HD21	2.48	0.48
2:A:22:GLU:OE1	2:A:83:TYR:OH	2.23	0.48
1:B:330:MET:HB3	1:B:349:VAL:HG11	1.96	0.48
1:B:404:ASP:OD1	1:B:405:GLU:N	2.46	0.48
2:A:353:VAL:HG12	2:A:355:ILE:HD11	1.96	0.47
1:B:118:ASP:OD1	1:B:119:VAL:N	2.48	0.47
1:B:66:VAL:CG1	1:B:116:VAL:HG11	2.45	0.47
2:A:27:GLU:OE2	2:A:236:SER:OG	2.33	0.46
2:A:236:SER:OG	2:A:243:ARG:NH2	2.48	0.46
2:A:107:HIS:O	2:A:152:LEU:HD22	2.15	0.46
2:A:377:MET:C	2:A:378:LEU:HD22	2.35	0.46
2:A:315:CYS:N	2:A:350:GLY:O	2.45	0.46
1:B:26:ASP:O	1:B:359:ARG:NH1	2.49	0.45
1:B:9:ALA:O	1:B:145:SER:OG	2.20	0.45
2:A:63:PRO:HD3	2:A:86:LEU:HD13	1.98	0.45
2:A:68:VAL:HG11	2:A:149:PHE:CE2	2.51	0.45
2:A:217:LEU:O	2:A:277:SER:OG	2.35	0.45
2:A:120:ASP:OD1	2:A:123:ARG:NH2	2.48	0.45
1:B:347:ASN:OD1	2:A:178:SER:N	2.44	0.45
2:A:337:THR:O	2:A:339:ARG:NH1	2.50	0.44
1:B:309:ARG:NH1	1:B:343:GLU:OE1	2.51	0.44
1:B:23:VAL:O	1:B:27:GLU:N	2.47	0.44
1:B:164:MET:SD	1:B:164:MET:N	2.90	0.44
1:B:50:TYR:O	1:B:62:ARG:NH1	2.51	0.44
2:A:157:LEU:O	2:A:161:TYR:N	2.45	0.44
2:A:240:ALA:O	2:A:244:PHE:N	2.50	0.44
2:A:345:ASP:OD1	2:A:346:TRP:N	2.50	0.44
1:B:12:CYS:SG	1:B:13:GLY:N	2.91	0.44
1:B:207:LEU:HD23	1:B:225:LEU:HD11	2.00	0.44
1:B:4:ILE:HD12	1:B:132:GLY:O	2.18	0.44
1:B:246:LEU:CD1	2:A:179:THR:HG21	2.47	0.44
1:B:72:THR:O	1:B:75:SER:OG	2.25	0.44
2:A:331:ALA:O	2:A:335:ILE:HD12	2.17	0.43
1:B:269:GLY:O	1:B:367:PHE:N	2.45	0.43
1:B:365:ALA:O	1:B:366:THR:OG1	2.33	0.43
2:A:13:GLY:O	2:A:17:GLY:N	2.46	0.43
2:A:211:ASP:OD1	2:A:214:ARG:NH2	2.50	0.43
1:B:310:TYR:N	1:B:340:TYR:O	2.52	0.43
2:A:286:LEU:O	2:A:373:ARG:NH1	2.50	0.42
2:A:9:VAL:HG11	2:A:150:THR:HG23	2.02	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:A:177:VAL:HG21	2:A:207:GLU:OE1	2.20	0.42
2:A:25:CYS:SG	2:A:30:ILE:HD11	2.59	0.42
2:A:273:ALA:O	2:A:375:VAL:N	2.49	0.42
2:A:173:PRO:HG2	2:A:391:LEU:HD21	2.02	0.42
2:A:68:VAL:O	2:A:68:VAL:HG13	2.19	0.41
2:A:145:THR:HG22	5:A:502:GTP:O3G	2.21	0.41
1:B:73:MET:O	1:B:77:ARG:NE	2.53	0.41
1:B:256:ASN:OD1	2:A:182:VAL:HG22	2.21	0.41
1:B:307:HIS:O	1:B:426:GLN:NE2	2.53	0.41
2:A:68:VAL:HG11	2:A:149:PHE:HE2	1.87	0.40
1:B:255:VAL:HG23	2:A:407:TRP:CG	2.56	0.40
1:B:323:MET:O	1:B:327:ASP:N	2.54	0.40
2:A:99:ALA:HB3	2:A:145:THR:HB	2.03	0.40
1:B:206:ALA:O	1:B:209:ASP:N	2.54	0.40

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	B	424/426 (100%)	395 (93%)	29 (7%)	0	100	100
2	A	424/437 (97%)	395 (93%)	29 (7%)	0	100	100
All	All	848/863 (98%)	790 (93%)	58 (7%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains [i](#)

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	B	369/369 (100%)	364 (99%)	5 (1%)	69	87
2	A	362/368 (98%)	360 (99%)	2 (1%)	87	94
All	All	731/737 (99%)	724 (99%)	7 (1%)	80	90

All (7) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	77	ARG
1	B	100	ASN
1	B	298	ASN
1	B	320	ARG
1	B	347	ASN
2	A	300	ASN
2	A	326	LYS

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 4 ligands modelled in this entry, 2 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
5	GTP	A	502	3	27,34,34	1.11	2 (7%)	29,54,54	2.45	11 (37%)
4	G2P	B	502	3	26,34,34	2.63	7 (26%)	28,54,54	1.17	2 (7%)

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	502	3	-	0/18/38/38	0/3/3/3
4	G2P	B	502	3	-	0/18/38/38	0/3/3/3

All (9) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	502	G2P	C4-N9	-11.03	1.33	1.47
4	B	502	G2P	C8-N9	-4.10	1.34	1.46
4	B	502	G2P	C5-C6	-2.75	1.48	1.52
4	B	502	G2P	C2-N1	-2.23	1.35	1.44
4	B	502	G2P	PB-O1B	2.01	1.61	1.56
4	B	502	G2P	PA-O1A	2.03	1.61	1.56
5	A	502	GTP	C5-C4	2.63	1.46	1.40
4	B	502	G2P	PA-O5'	2.70	1.61	1.57
5	A	502	GTP	C6-C5	3.91	1.48	1.41

All (13) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	502	GTP	C6-C5-C4	-4.42	116.51	120.85
5	A	502	GTP	PB-O3B-PG	-4.33	118.07	132.63
5	A	502	GTP	C4'-O4'-C1'	-4.19	105.46	109.83
5	A	502	GTP	C5-C6-N1	-3.83	118.03	123.47
5	A	502	GTP	PA-O3A-PB	-3.39	121.23	132.63
5	A	502	GTP	C4-C5-N7	-3.34	106.18	109.41
5	A	502	GTP	N3-C2-N1	-3.16	122.78	127.41
4	B	502	G2P	PG-O3B-PB	-3.08	121.59	132.40
5	A	502	GTP	C1'-N9-C4	-2.78	121.84	126.64

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	502	GTP	O3G-PG-O2G	2.23	116.42	107.59
4	B	502	G2P	C4-C5-N7	3.00	106.43	102.46
5	A	502	GTP	C6-N1-C2	4.35	122.32	116.06
5	A	502	GTP	C2-N3-C4	4.89	120.87	115.16

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 6 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	502	GTP	1	0
4	B	502	G2P	5	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.