



# Full wwPDB/EMDataBank EM Map/Model Validation Report ⓘ

Jan 25, 2017 – 12:29 PM EST

PDB ID : 5SYC  
EMDB ID: : EMD-8320  
Title : Near-atomic resolution cryo-EM reconstruction of peloruside-stabilized micro-tubule  
Authors : Kellogg, E.H.; Nogales, E.  
Deposited on : 2016-08-10  
Resolution : 3.50 Å(reported)

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](mailto:validation@mail.wwpdb.org)  
A user guide is available at  
<http://wwpdb.org/validation/2016/EMValidationReportHelp>  
with specific help available everywhere you see the ⓘ symbol.

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MolProbity : 4.02b-467  
Mogul : unknown  
Percentile statistics : 20151230.v01 (using entries in the PDB archive December 30th 2015)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et. al. (1996)  
Validation Pipeline (wwPDB-VP) : rb-20028442

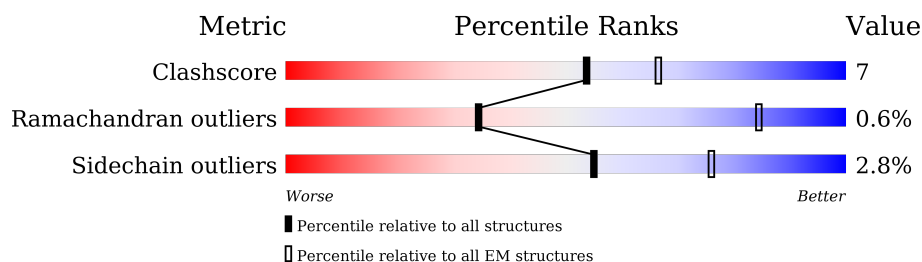
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*ELECTRON MICROSCOPY*

The reported resolution of this entry is 3.50 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)	EM structures (#Entries)
Clashscore	114402	924
Ramachandran outliers	111179	726
Sidechain outliers	111093	686

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  $\geq 3$ , 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	A	437	
2	B	426	

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 6778 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.

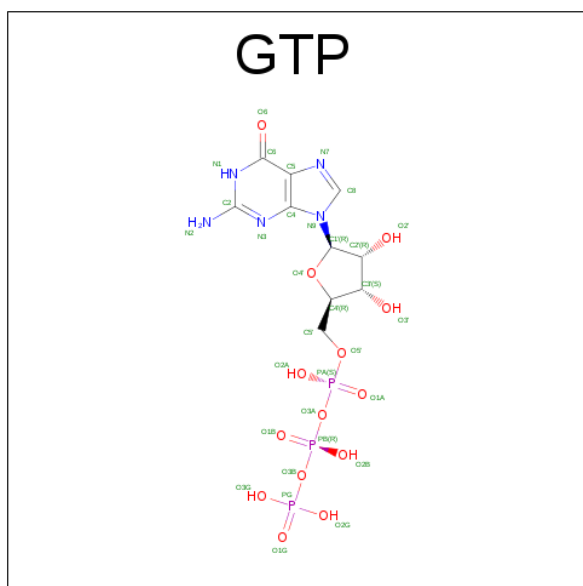
- Molecule 1 is a protein called Tubulin alpha chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
1	A	424	3327	2112	567	627	21	0	0

- Molecule 2 is a protein called Tubulin beta chain.

Mol	Chain	Residues	Atoms					AltConf	Trace
			Total	C	N	O	S		
2	B	426	3352	2106	575	645	26	0	0

- Molecule 3 is GUANOSINE-5'-TRIPHOSPHATE (three-letter code: GTP) (formula:  $C_{10}H_{16}N_5O_{14}P_3$ ).

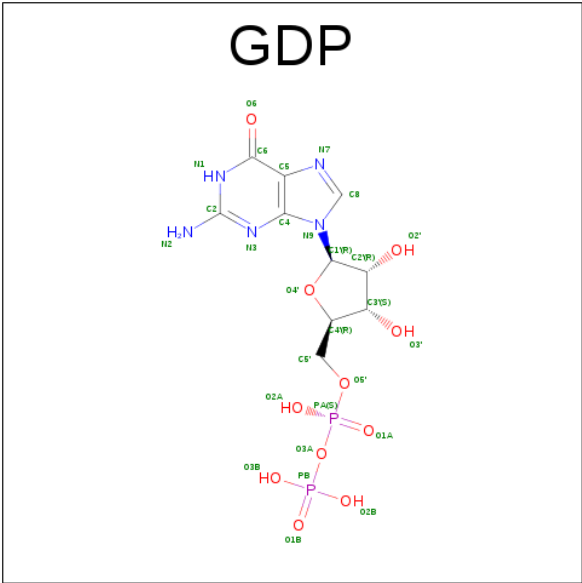


Mol	Chain	Residues	Atoms					AltConf
			Total	C	N	O	P	
3	A	1	32	10	5	14	3	0

- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

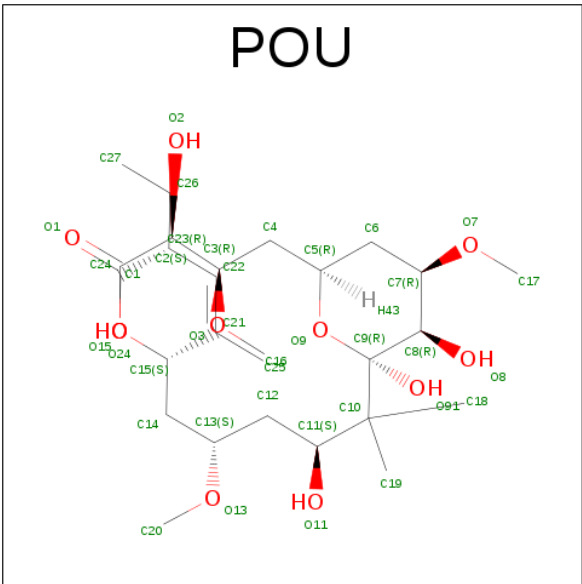
Mol	Chain	Residues	Atoms		AltConf
4	A	1	Total	Mg	0
			1	1	

- Molecule 5 is GUANOSINE-5'-DIPHOSPHATE (three-letter code: GDP) (formula: C<sub>10</sub>H<sub>15</sub>N<sub>5</sub>O<sub>11</sub>P<sub>2</sub>).



Mol	Chain	Residues	Atoms					AltConf
5	B	1	Total	C	N	O	P	0
			28	10	5	11	2	

- Molecule 6 is Peloruside A (three-letter code: POU) (formula: C<sub>27</sub>H<sub>48</sub>O<sub>11</sub>).

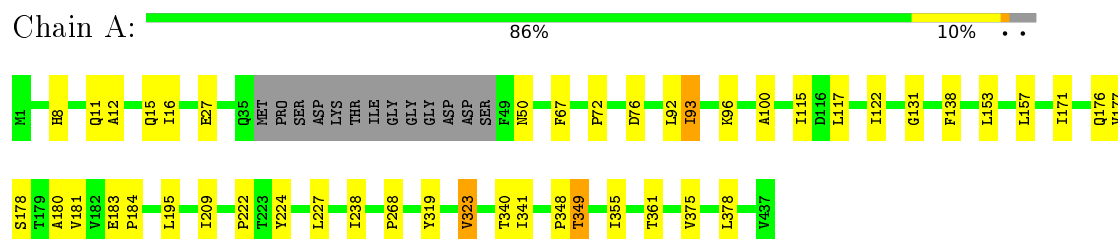


Mol	Chain	Residues	Atoms			AltConf
6	B	1	Total	C	O	0
			38	27	11	

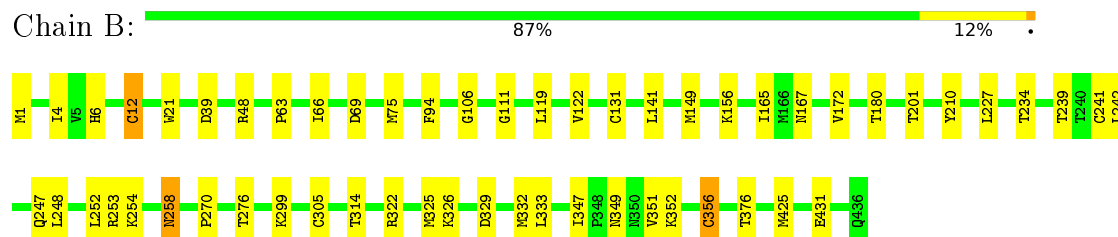
### 3 Residue-property plots

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. 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 alpha chain



- Molecule 2: Tubulin beta chain



## 4 Experimental information

Property	Value	Source
Reconstruction method	HELICAL	Depositor
Imposed symmetry	POINT, Not provided	Depositor
Number of segments used	17069	Depositor
Resolution determination method	FSC 0.143 CUT-OFF	Depositor
CTF correction method	Not provided	Depositor
Microscope	FEI TITAN	Depositor
Voltage (kV)	300	Depositor
Electron dose ( $e^-/\text{\AA}^2$ )	Not provided	Depositor
Minimum defocus (nm)	1000	Depositor
Maximum defocus (nm)	2500	Depositor
Magnification	27500	Depositor
Image detector	Not provided	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: GDP, GTP, MG, POU

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	A	0.37	0/3402	0.61	0/4615
2	B	0.37	0/3427	0.58	0/4641
All	All	0.37	0/6829	0.60	0/9256

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	3327	0	3247	62	0
2	B	3352	0	3237	70	0
3	A	32	0	12	1	0
4	A	1	0	0	0	0
5	B	28	0	12	1	0
6	B	38	0	48	5	0
All	All	6778	0	6556	89	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 (89) 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:A:96:LYS:HD3	2:B:131:CYS:SG	1.69	1.33
1:A:178:SER:HB3	2:B:349:ASN:OD1	1.43	1.18
1:A:176:GLN:O	2:B:333:LEU:HD13	1.49	1.12
1:A:96:LYS:HD3	2:B:131:CYS:HG	1.04	1.01
1:A:181:VAL:HG22	2:B:349:ASN:O	1.63	0.97
1:A:224:TYR:CD1	2:B:325:MET:HG3	2.03	0.92
1:A:178:SER:CB	2:B:349:ASN:OD1	2.18	0.91
1:A:11:GLN:NE2	2:B:247:GLN:O	2.10	0.85
1:A:340:THR:CA	1:A:341:ILE:N	2.44	0.81
1:A:178:SER:HB3	2:B:349:ASN:CG	2.01	0.81
2:B:1:MET:SD	2:B:131:CYS:SG	2.81	0.79
2:B:299:LYS:NZ	6:B:502:POU:H34	1.98	0.78
1:A:222:PRO:HG2	2:B:326:LYS:CB	2.16	0.76
1:A:222:PRO:CD	2:B:326:LYS:HD3	2.17	0.75
1:A:96:LYS:CD	2:B:131:CYS:SG	2.64	0.75
1:A:222:PRO:HG3	2:B:326:LYS:HD2	1.67	0.75
1:A:12:ALA:HB2	3:A:501:GTP:C8	2.22	0.74
1:A:222:PRO:HG2	2:B:326:LYS:HB2	1.68	0.73
1:A:96:LYS:CD	2:B:131:CYS:HG	1.94	0.70
1:A:176:GLN:O	2:B:333:LEU:CD1	2.36	0.70
1:A:100:ALA:HA	2:B:254:LYS:HG3	1.76	0.68
1:A:222:PRO:HG3	2:B:326:LYS:CD	2.25	0.67
1:A:100:ALA:HB1	2:B:254:LYS:HA	1.79	0.65
1:A:72:PRO:O	2:B:48:ARG:NH2	2.31	0.64
1:A:76:ASP:CG	2:B:48:ARG:HH22	2.01	0.63
2:B:1:MET:CE	2:B:131:CYS:SG	2.86	0.63
1:A:222:PRO:HD3	2:B:326:LYS:HD3	1.80	0.62
2:B:299:LYS:HZ2	6:B:502:POU:H34	1.65	0.60
1:A:222:PRO:CG	2:B:326:LYS:CD	2.79	0.60
1:A:100:ALA:HA	2:B:254:LYS:CG	2.32	0.60
1:A:177:VAL:HB	2:B:329:ASP:OD1	2.01	0.59
1:A:96:LYS:CD	2:B:1:MET:SD	2.91	0.58
1:A:181:VAL:CG2	2:B:349:ASN:O	2.44	0.58
1:A:181:VAL:N	2:B:258:ASN:OD1	2.32	0.58
1:A:224:TYR:CE1	2:B:325:MET:HG3	2.38	0.58
2:B:234:THR:HG21	2:B:270:PRO:HB2	1.85	0.57
2:B:1:MET:SD	2:B:131:CYS:HB2	2.44	0.57
1:A:96:LYS:HD3	2:B:1:MET:SD	2.45	0.56
2:B:210:TYR:CE2	2:B:227:LEU:HD11	2.43	0.54
1:A:181:VAL:CG1	2:B:347:ILE:CG2	2.86	0.54
1:A:222:PRO:HG2	2:B:326:LYS:HB3	1.90	0.54

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:247:GLN:OE1	2:B:325:MET:SD	2.67	0.53
1:A:181:VAL:HB	2:B:258:ASN:OD1	2.10	0.52
1:A:181:VAL:HG11	2:B:347:ILE:CG2	2.40	0.52
1:A:16:ILE:HD11	1:A:171:ILE:HD11	1.92	0.51
2:B:299:LYS:HZ1	6:B:502:POU:H34	1.72	0.50
2:B:4:ILE:HD11	2:B:242:LEU:CD1	2.41	0.50
1:A:222:PRO:CG	2:B:326:LYS:HD3	2.40	0.49
2:B:165:ILE:HD11	2:B:253:ARG:HB2	1.94	0.49
1:A:222:PRO:CG	2:B:326:LYS:CB	2.90	0.49
1:A:115:ILE:HD11	1:A:153:LEU:HA	1.93	0.49
1:A:67:PHE:CB	1:A:92:LEU:HD23	2.43	0.48
2:B:1:MET:HE1	2:B:131:CYS:SG	2.54	0.47
2:B:119:LEU:HD21	2:B:156:LYS:CB	2.45	0.46
1:A:181:VAL:H	2:B:258:ASN:CG	2.18	0.46
2:B:239:THR:HG22	2:B:252:LEU:HD21	1.98	0.45
1:A:180:ALA:HA	2:B:352:LYS:HG3	1.96	0.45
6:B:502:POU:H27	6:B:502:POU:O15	2.17	0.45
1:A:319:TYR:CD2	1:A:375:VAL:HG22	2.52	0.45
1:A:122:ILE:HD13	1:A:157:LEU:HD21	1.99	0.44
1:A:177:VAL:CB	2:B:329:ASP:OD1	2.64	0.44
1:A:11:GLN:O	1:A:15:GLN:HG2	2.17	0.44
2:B:106:GLY:O	2:B:111:GLY:HA3	2.17	0.44
2:B:21:TRP:CZ3	2:B:63:PRO:HB3	2.52	0.44
1:A:177:VAL:HG12	2:B:333:LEU:HB2	1.98	0.44
2:B:1:MET:SD	2:B:131:CYS:CB	3.04	0.44
2:B:66:ILE:CD1	2:B:122:VAL:HG22	2.47	0.44
2:B:141:LEU:HD22	2:B:172:VAL:HG12	2.00	0.44
1:A:209:ILE:HG21	1:A:227:LEU:HG	1.99	0.43
1:A:93:ILE:HD11	1:A:117:LEU:HG	2.00	0.43
2:B:69:ASP:O	2:B:94:PHE:HA	2.17	0.43
1:A:27:GLU:HG2	1:A:361:THR:HG21	2.00	0.43
1:A:238:ILE:HD11	1:A:378:LEU:HD21	2.00	0.42
1:A:181:VAL:O	1:A:181:VAL:HG12	2.19	0.42
6:B:502:POU:H46	6:B:502:POU:H40	1.91	0.42
1:A:181:VAL:CB	2:B:258:ASN:OD1	2.66	0.42
1:A:222:PRO:HD2	2:B:326:LYS:HB3	2.01	0.42
1:A:323:VAL:CG2	1:A:355:ILE:HG23	2.50	0.42
1:A:8:HIS:CE1	1:A:138:PHE:CD1	3.08	0.41
1:A:76:ASP:CG	2:B:48:ARG:NH2	2.72	0.41
1:A:11:GLN:HE22	2:B:248:LEU:HA	1.85	0.41
2:B:241:CYS:HA	2:B:356:CYS:SG	2.60	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:B:119:LEU:HD21	2:B:156:LYS:HB2	2.03	0.41
2:B:332:MET:SD	2:B:351:VAL:HG11	2.61	0.41
1:A:176:GLN:C	1:A:177:VAL:HG13	2.41	0.41
1:A:183:GLU:N	1:A:184:PRO:CD	2.83	0.40
2:B:75:MET:CE	2:B:94:PHE:HB3	2.51	0.40
2:B:12:CYS:HB2	5:B:501:GDP:C4	2.56	0.40
1:A:100:ALA:CA	2:B:254:LYS:HG3	2.50	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	A	418/437 (96%)	381 (91%)	32 (8%)	5 (1%)	16	61
2	B	424/426 (100%)	415 (98%)	9 (2%)	0	100	100
All	All	842/863 (98%)	796 (94%)	41 (5%)	5 (1%)	34	75

All (5) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	50	ASN
1	A	349	THR
1	A	348	PRO
1	A	131	GLY
1	A	268	PRO

### 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	A	357/368 (97%)	353 (99%)	4 (1%)	80	92
2	B	367/367 (100%)	351 (96%)	16 (4%)	35	73
All	All	724/735 (98%)	704 (97%)	20 (3%)	55	82

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	93	ILE
1	A	195	LEU
1	A	323	VAL
1	A	349	THR
2	B	6	HIS
2	B	12	CYS
2	B	39	ASP
2	B	149	MET
2	B	167	ASN
2	B	180	THR
2	B	201	THR
2	B	258	ASN
2	B	276	THR
2	B	305	CYS
2	B	314	THR
2	B	322	ARG
2	B	356	CYS
2	B	376	THR
2	B	425	MET
2	B	431	GLU

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	101	ASN
1	A	216	ASN
2	B	350	ASN

### 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, 1 is monoatomic - leaving 3 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$
3	GTP	A	501	4	26,34,34	1.36	3 (11%)	29,54,54	1.89	6 (20%)
5	GDP	B	501	-	24,30,30	1.33	3 (12%)	26,47,47	2.44	5 (19%)
6	POU	B	502	-	35,39,39	2.26	7 (20%)	29,57,57	2.45	10 (34%)

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
3	GTP	A	501	4	-	0/18/38/38	0/3/3/3
5	GDP	B	501	-	-	0/12/32/32	0/3/3/3
6	POU	B	502	-	-	1/54/76/76	0/0/2/2

All (13) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	B	502	POU	C2-C1	-5.25	1.38	1.52
3	A	501	GTP	PG-O3G	-2.97	1.44	1.54
6	B	502	POU	C9-C8	-2.54	1.50	1.53
3	A	501	GTP	C2'-C1'	-2.19	1.50	1.53

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	B	501	GDP	C2'-C1'	-2.11	1.50	1.53
6	B	502	POU	C14-C13	2.21	1.57	1.52
6	B	502	POU	C23-C22	2.30	1.53	1.50
6	B	502	POU	O11-C11	2.31	1.47	1.43
5	B	501	GDP	C6-C5	2.45	1.46	1.41
3	A	501	GTP	C6-C5	2.67	1.46	1.41
6	B	502	POU	O91-C9	3.02	1.44	1.39
5	B	501	GDP	O4'-C1'	4.41	1.47	1.41
6	B	502	POU	C22-C21	9.82	1.55	1.33

All (21) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	B	502	POU	C13-C12-C11	-8.25	103.68	114.39
5	B	501	GDP	C1'-N9-C4	-6.68	119.35	126.81
5	B	501	GDP	C6-C5-C4	-4.36	115.88	120.86
3	A	501	GTP	C5-C6-N1	-4.26	117.95	123.52
5	B	501	GDP	C5-C6-N1	-3.97	118.33	123.52
3	A	501	GTP	C6-C5-C4	-3.77	116.55	120.86
5	B	501	GDP	N3-C2-N1	-3.67	122.56	127.56
3	A	501	GTP	C1'-N9-C4	-3.38	123.04	126.81
3	A	501	GTP	N3-C2-N1	-3.29	123.08	127.56
6	B	502	POU	C3-C4-C5	-2.88	107.79	114.93
6	B	502	POU	C7-C6-C5	-2.37	107.23	111.07
6	B	502	POU	C25-C21-C22	-2.25	117.75	123.66
6	B	502	POU	O9-C5-C6	2.00	112.97	108.83
3	A	501	GTP	O3G-PG-O2G	2.06	115.00	107.44
6	B	502	POU	C14-C13-C12	2.09	116.11	112.76
6	B	502	POU	O9-C5-C4	2.28	109.97	106.00
6	B	502	POU	O15-C15-C21	2.89	117.81	109.69
6	B	502	POU	O15-C15-C14	4.16	114.88	106.28
6	B	502	POU	C15-O15-C1	4.59	126.40	116.81
3	A	501	GTP	C6-N1-C2	5.52	122.34	115.88
5	B	501	GDP	C6-N1-C2	6.34	123.31	115.88

There are no chirality outliers.

All (1) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
6	B	502	POU	C23-C22-C21-C15

There are no ring outliers.

3 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	501	GTP	1	0
5	B	501	GDP	1	0
6	B	502	POU	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.