W O R L D W I D E
wwPDB
PROTEIN DATA BANK

Full wwPDB X-ray Structure Validation Report ⓘ

Sep 24, 2024 – 10:18 am BST

PDB ID	:	8QLB
Title	:	Ultrafast structural transitions in an azobenzene photoswitch at near-atomic resolution: 100 ns structure
Authors	:	Weinert, T.; Wranik, M.; Seidel, H.-P.; Church, J.; Steinmetz, M.O.; Schapiro, I.; Standfuss, J.
Deposited on	:	2023-09-19
Resolution	:	1.80 Å(reported)

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

|		
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.002 (Gargrove)
Density-Fitness	:	1.0.11
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.38.2

1   Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:
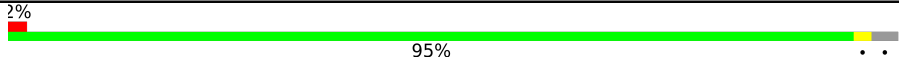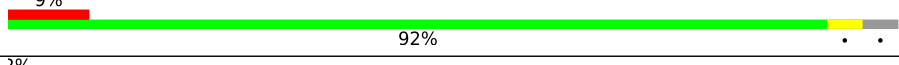*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.80 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.
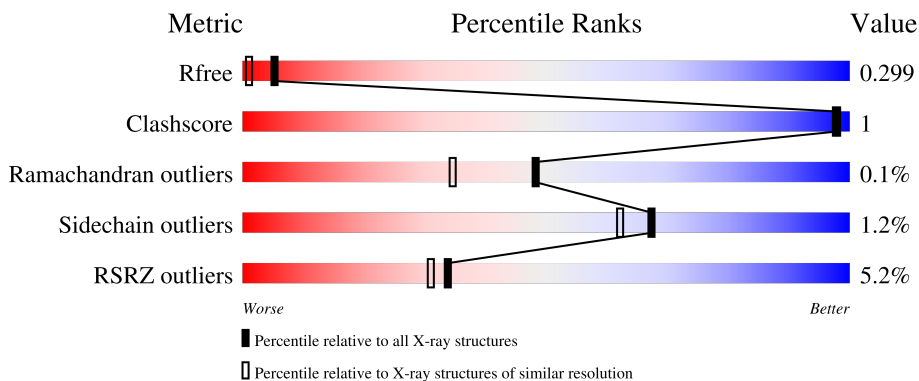
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	7108 (1.80-1.80)
Clashscore	180529	8162 (1.80-1.80)
Ramachandran outliers	177936	8077 (1.80-1.80)
Sidechain outliers	177891	8076 (1.80-1.80)
RSRZ outliers	164620	7108 (1.80-1.80)

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 of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. 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 <=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	2% 95% · ·
2	B	445	9% 92% · ·
3	F	169	2% 91% · 8%

2 Entry composition ⓘ

There are 9 unique types of molecules in this entry. The entry contains 8339 atoms, of which 0 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	437	Total	C	N	O	S	4	3	0
			3419	2166	580	650	23			

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

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	426	Total	C	N	O	S	0	2	0
			3342	2100	569	646	27			

- Molecule 3 is a protein called Designed Ankyrin Repeat Protein (DARPIN) D1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	F	155	Total	C	N	O	S	0	0	0
			1154	727	198	226	3			

- Molecule 4 is GUANOSINE-5'-TRIPHOSPHATE (three-letter code: GTP) (formula: $C_{10}H_{16}N_5O_{14}P_3$).

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

- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	1	Total 1	Mg 1	0	0

- Molecule 6 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	1	Total 1	Ca 1	0	0

- Molecule 7 is GUANOSINE-5'-DIPHOSPHATE (three-letter code: GDP) (formula: $C_{10}H_{15}N_5O_{11}P_2$).

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

- Molecule 8 is Azo-Combretastatin A4 (trans) (three-letter code: VYT) (formula: $C_{16}H_{18}N_2O_5$) (labeled as "Ligand of Interest" by depositor).
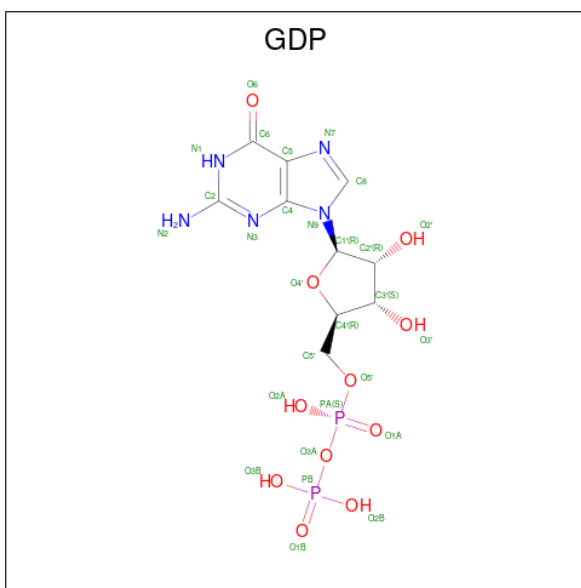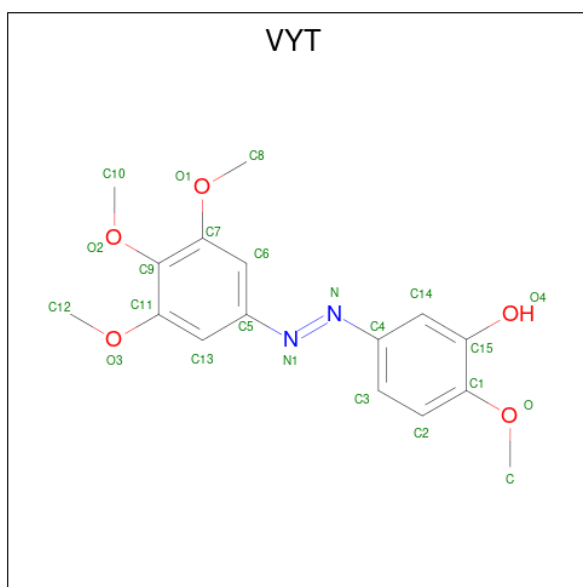
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
8	B	1	23	16	2	5	0	0

- Molecule 9 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	A	161	Total 161	O 161	0	0
9	B	113	Total 113	O 113	0	0
9	F	65	Total 65	O 65	0	0

3 Residue-property plots ⓘ

These plots are drawn for all protein, RNA, DNA and oligosaccharide 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.
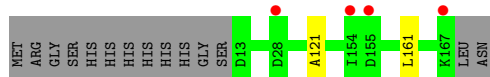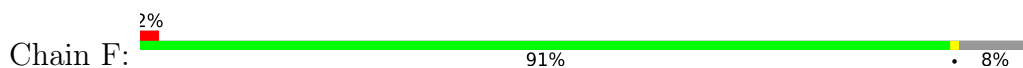
• Molecule 1: Tubulin alpha-1B chain
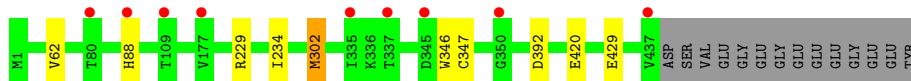
Chain A:

• Molecule 2: Tubulin beta-2B chain

Chain B:
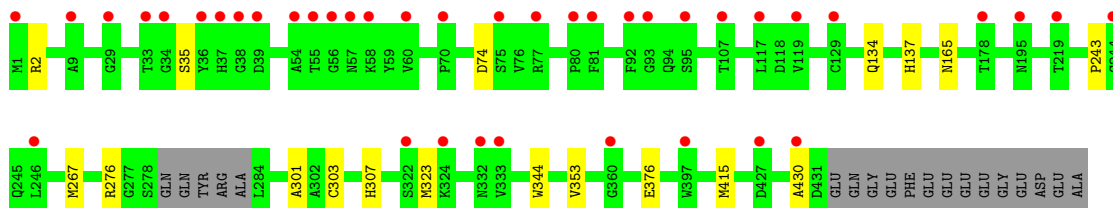
• Molecule 3: Designed Ankyrin Repeat Protein (DARPIN) D1

Chain F:

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	74.53Å　92.58Å　83.99Å 90.00°　96.71°　90.00°	Depositor
Resolution (Å)	9.49　–　1.80 9.49　–　1.80	Depositor EDS
% Data completeness (in resolution range)	98.5 (9.49-1.80) 97.8 (9.49-1.80)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	0.79 (at 1.80Å)	Xtriage
Refinement program	PHENIX 1.20_4459	Depositor
R, R_{free}	0.273　,　0.299 0.273　,　0.299	Depositor DCC
R_{free} test set	101481 reflections (1.93%)	wwPDB-VP
Wilson B-factor (Å^2)	34.0	Xtriage
Anisotropy	0.268	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.40 , 57.1	EDS
L-test for twinning[2]	$< |L| > = 0.52$, $< L^2 > = 0.36$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	8339	wwPDB-VP
Average B, all atoms (Å^2)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.11% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.
[2]Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality ⓘ

5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: VYT, MG, GTP, GDP, 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	0.45	0/3506	0.59	0/4762
2	B	0.42	0/3421	0.57	0/4633
3	F	0.49	0/1170	0.55	0/1590
All	All	0.45	0/8097	0.58	0/10985

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 ⓘ

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	3419	0	3328	5	0
2	B	3342	0	3217	5	0
3	F	1154	0	1156	1	0
4	A	32	0	12	0	0
5	A	1	0	0	0	0
6	A	1	0	0	0	0
7	B	28	0	12	0	0
8	B	23	0	0	0	0
9	A	161	0	0	0	0
9	B	113	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
9	F	65	0	0	0	0
All	All	8339	0	7725	11	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 1.

All (11) 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:62:VAL:HG11	1:A:88:HIS:CE1	2.34	0.62
2:B:323:MET:SD	2:B:353:VAL:HG11	2.42	0.59
1:A:234:ILE:HD13	1:A:302[A]:MET:SD	2.45	0.57
1:A:62:VAL:HG11	1:A:88:HIS:NE2	2.25	0.51
1:A:346:TRP:CZ3	1:A:347:CYS:SG	3.04	0.51
2:B:344:TRP:HB3	2:B:430:ALA:HB2	1.96	0.47
2:B:134:GLN:HA	2:B:165:ASN:O	2.18	0.44
1:A:392:ASP:OD2	1:A:429:GLU:OE2	2.37	0.42
2:B:307:HIS:ND1	2:B:376:GLU:OE2	2.34	0.42
2:B:267:MET:HG3	2:B:301:ALA:HB3	2.01	0.42
3:F:121:ALA:HB1	3:F:161:LEU:HD21	2.02	0.42

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	438/451 (97%)	425 (97%)	13 (3%)	0	100	100
2	B	424/445 (95%)	416 (98%)	7 (2%)	1 (0%)	44	31
3	F	153/169 (90%)	152 (99%)	1 (1%)	0	100	100
All	All	1015/1065 (95%)	993 (98%)	21 (2%)	1 (0%)	48	34

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	243	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 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	368/379 (97%)	364 (99%)	4 (1%)	70	65
2	B	366/383 (96%)	359 (98%)	7 (2%)	52	43
3	F	120/132 (91%)	120 (100%)	0	100	100
All	All	854/894 (96%)	843 (99%)	11 (1%)	67	59

All (11) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	229	ARG
1	A	302[A]	MET
1	A	302[B]	MET
1	A	420	GLU
2	B	2	ARG
2	B	35	SER
2	B	74	ASP
2	B	137	HIS
2	B	276	ARG
2	B	303	CYS
2	B	415	MET

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
3	F	36	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 oligosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 5 ligands modelled in this entry, 2 are 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	$\#|Z| > 2$
4	GTP	A	501	5	26,34,34	0.90	1 (3%)	32,54,54	0.64	0
7	GDP	B	501	-	24,30,30	0.81	0	30,47,47	0.70	0
8	VYT	B	502	-	24,24,24	0.40	0	32,32,32	1.10	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
4	GTP	A	501	5	-	5/18/38/38	0/3/3/3
7	GDP	B	501	-	-	5/12/32/32	0/3/3/3
8	VYT	B	502	-	-	5/13/13/13	0/2/2/2

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	A	501	GTP	C5-C6	-2.39	1.42	1.47

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
8	B	502	VYT	C3-C4-C14	2.20	122.05	119.45
8	B	502	VYT	O4-C15-C1	2.10	125.01	120.09

There are no chirality outliers.

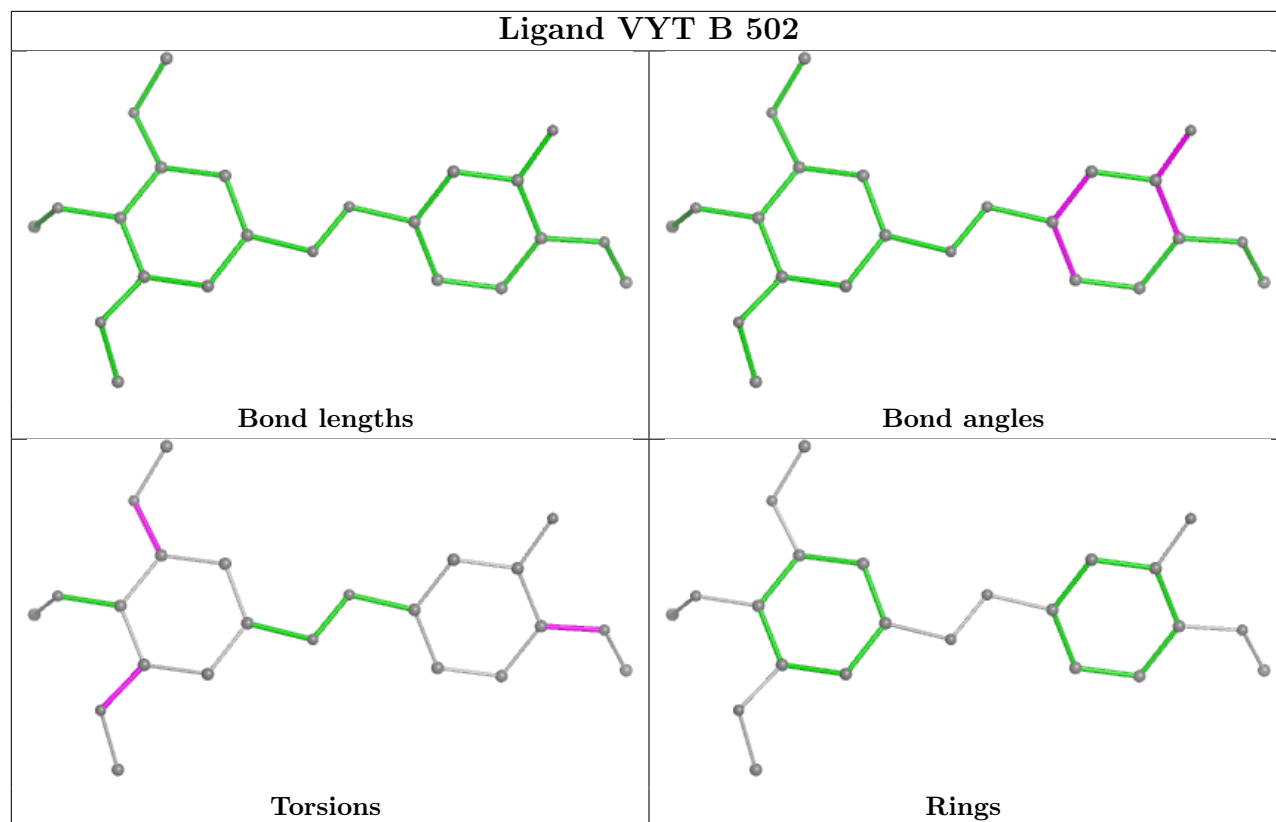All (15) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
4	A	501	GTP	PB-O3B-PG-O3G
4	A	501	GTP	C5'-O5'-PA-O1A
4	A	501	GTP	C5'-O5'-PA-O2A
7	B	501	GDP	C5'-O5'-PA-O1A
8	B	502	VYT	C9-C7-O1-C8
8	B	502	VYT	C6-C7-O1-C8
8	B	502	VYT	C15-C1-O-C
8	B	502	VYT	C2-C1-O-C
7	B	501	GDP	C5'-O5'-PA-O2A
4	A	501	GTP	C4'-C5'-O5'-PA
4	A	501	GTP	C5'-O5'-PA-O3A
7	B	501	GDP	C5'-O5'-PA-O3A
7	B	501	GDP	PB-O3A-PA-O1A
7	B	501	GDP	PB-O3A-PA-O2A
8	B	502	VYT	C13-C11-O3-C12

There are no ring outliers.

No monomer is involved in short contacts.

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier. The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

Ligand GTP A 501

Bond lengths

Bond angles

Torsions

Rings

Ligand GDP B 501

Bond lengths

Bond angles

Torsions

Rings

Ligand VYT B 502

Bond lengths

Bond angles

Torsions

Rings
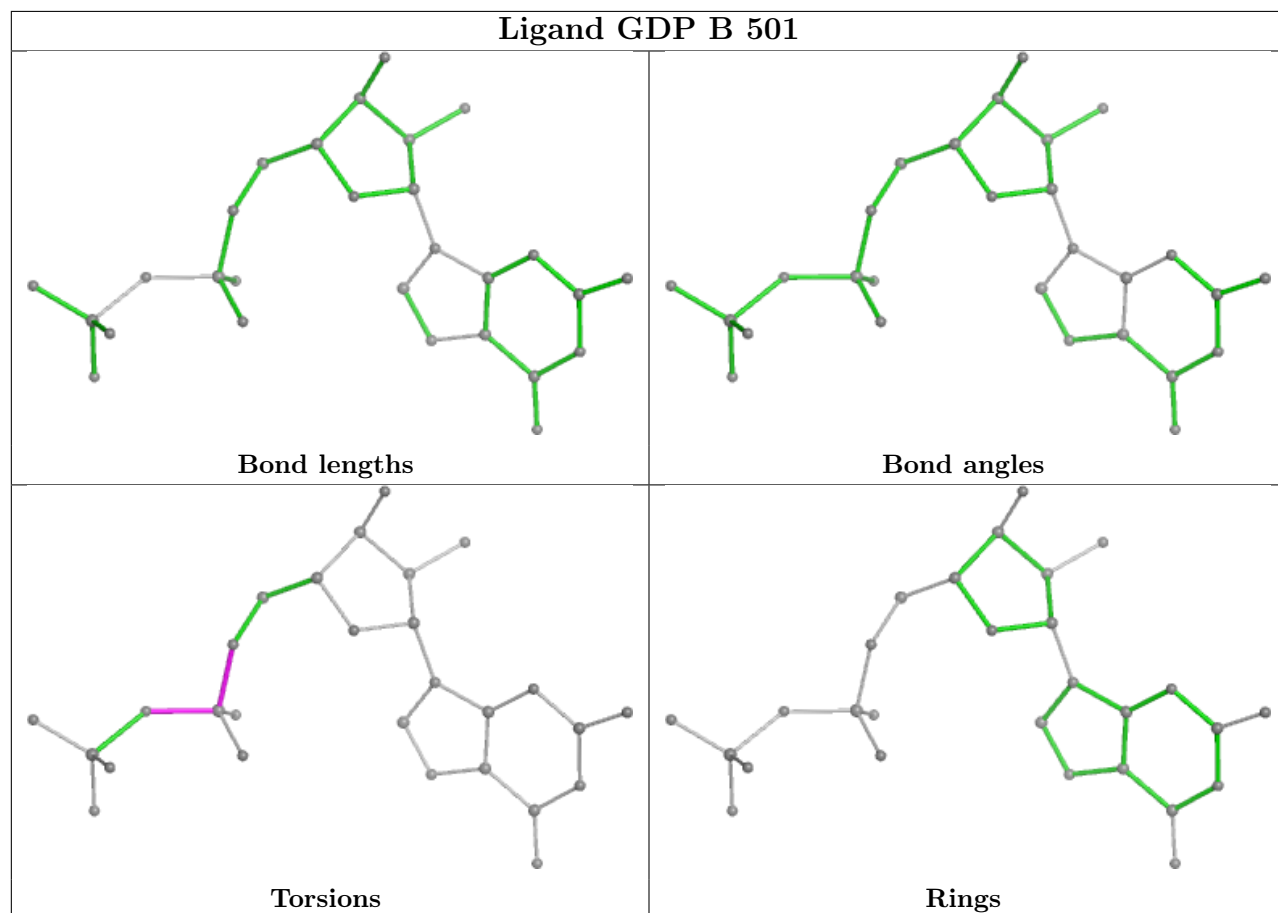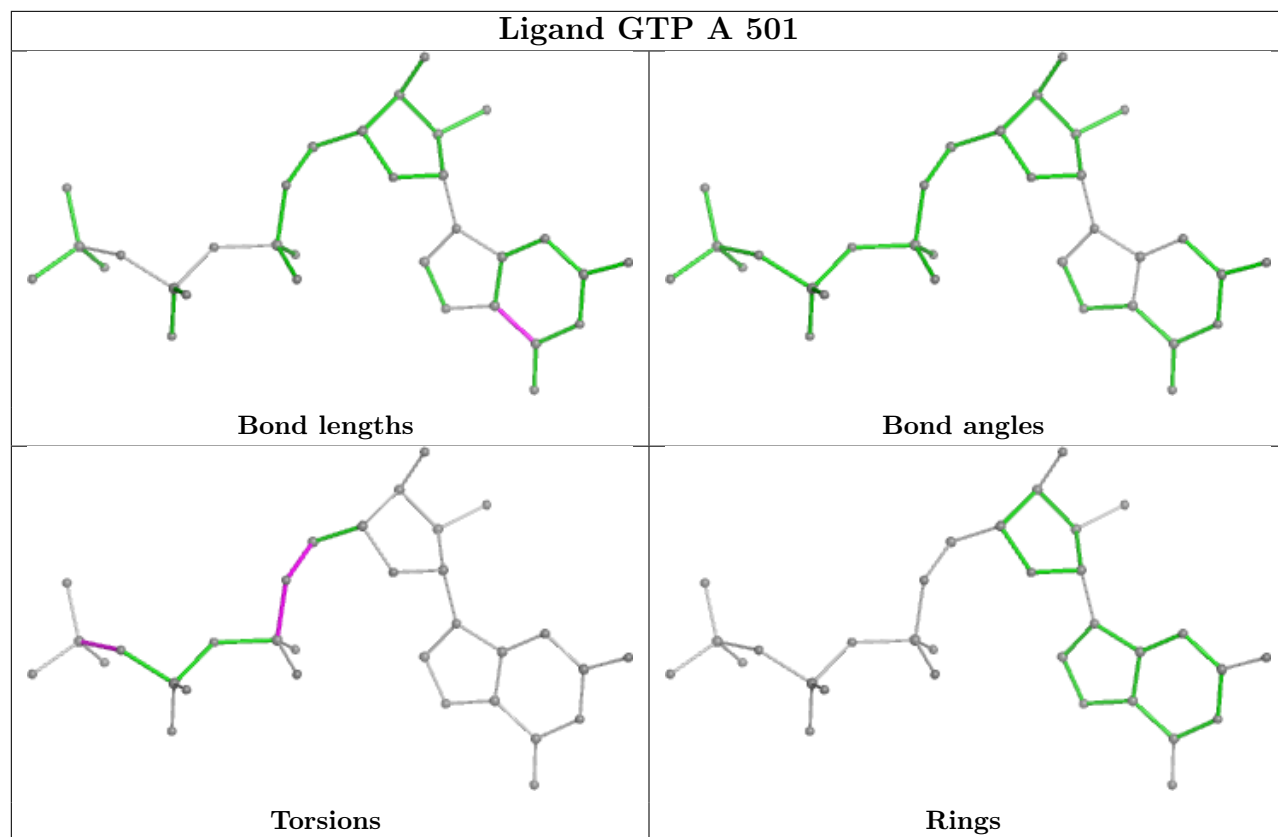
5.7 Other polymers ⓘ

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	437/451 (96%)	0.37	9 (2%)	63	62	20, 35, 54, 76	3 (0%)
2	B	426/445 (95%)	0.77	40 (9%)	15	13	21, 44, 70, 81	2 (0%)
3	F	155/169 (91%)	0.34	4 (2%)	57	55	27, 36, 50, 70	0
All	All	1018/1065 (95%)	0.53	53 (5%)	34	31	20, 38, 64, 81	5 (0%)

All (53) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	1	MET	4.8
2	B	55	THR	4.0
1	A	335	ILE	3.9
2	B	332	ASN	3.8
3	F	167	LYS	3.8
2	B	92	PHE	3.7
2	B	58	LYS	3.6
1	A	337	THR	3.3
2	B	430	ALA	3.3
1	A	88	HIS	3.1
2	B	427	ASP	3.1
2	B	244	GLY	3.0
1	A	345	ASP	3.0
2	B	56	GLY	2.9
2	B	57	ASN	2.9
3	F	154	ILE	2.6
2	B	95	SER	2.6
1	A	437	VAL	2.6
2	B	333	VAL	2.5
2	B	119	VAL	2.5
2	B	324	LYS	2.5
2	B	93	GLY	2.5
1	A	350	GLY	2.4

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Mol	Chain	Res	Type	RSRZ
2	B	178	THR	2.4
2	B	246	LEU	2.4
2	B	54	ALA	2.4
2	B	117	LEU	2.4
2	B	322	SER	2.4
3	F	28	ASP	2.3
1	A	80	THR	2.3
1	A	109	THR	2.3
2	B	34	GLY	2.3
1	A	177	VAL	2.3
2	B	37	HIS	2.3
2	B	29	GLY	2.2
2	B	360	GLY	2.2
2	B	33	THR	2.2
2	B	195	ASN	2.2
2	B	107	THR	2.2
2	B	219	THR	2.2
2	B	80	PRO	2.2
2	B	60	VAL	2.1
2	B	77	ARG	2.1
3	F	155	ASP	2.1
2	B	75	SER	2.1
2	B	39	ASP	2.1
2	B	36	TYR	2.1
2	B	38	GLY	2.1
2	B	70	PRO	2.1
2	B	9	ALA	2.0
2	B	397	TRP	2.0
2	B	129	CYS	2.0
2	B	81	PHE	2.0

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

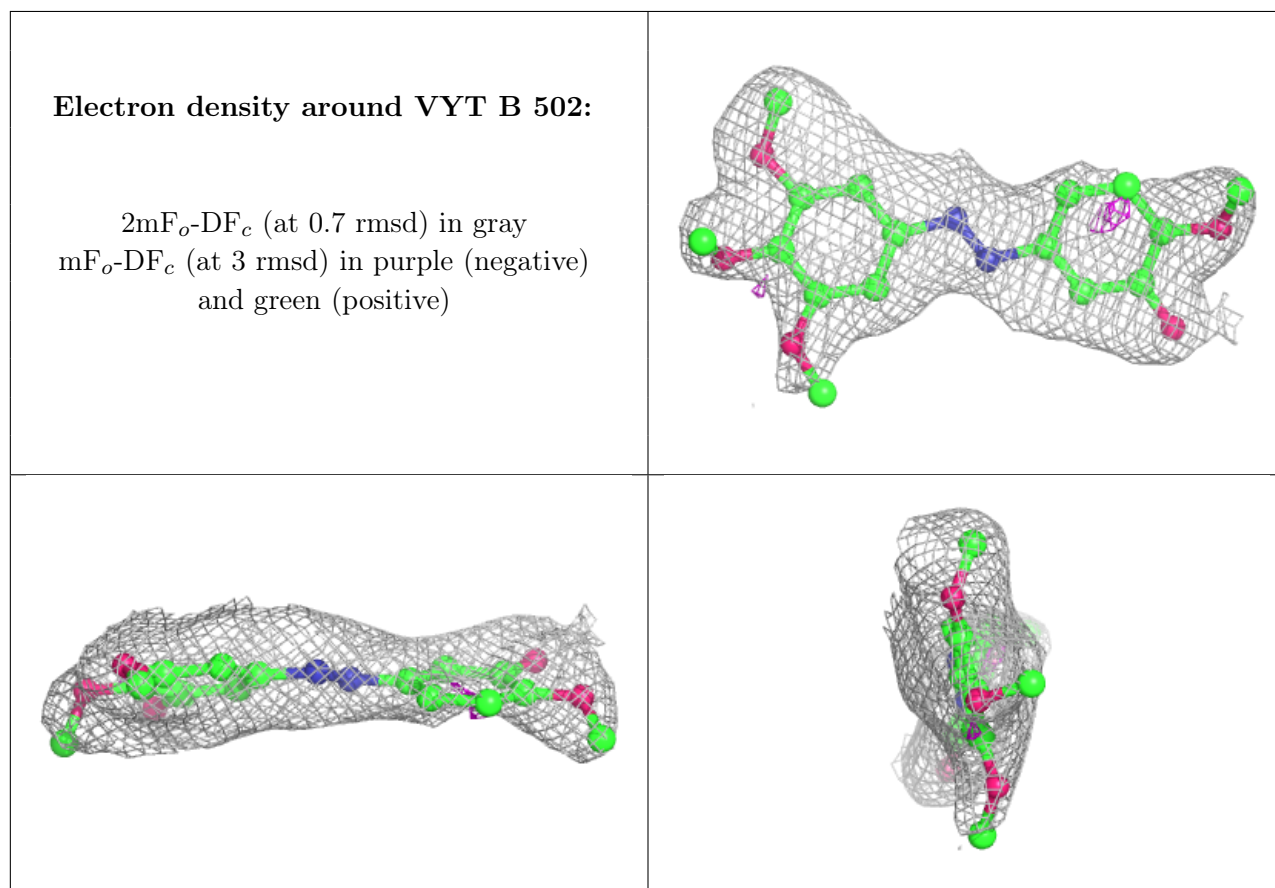There are no non-standard protein/DNA/RNA residues in this entry.

6.3　Carbohydrates ⓘ

There are no monosaccharides 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
8	VYT	B	502	23/23	0.80	0.11	34,46,53,56	0
7	GDP	B	501	28/28	0.94	0.07	31,36,40,43	0
6	CA	A	503	1/1	0.94	0.05	40,40,40,40	0
4	GTP	A	501	32/32	0.96	0.06	23,26,30,31	0
5	MG	A	502	1/1	0.97	0.11	28,28,28,28	0

The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.
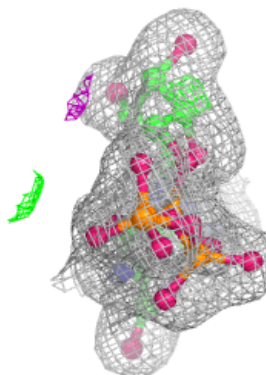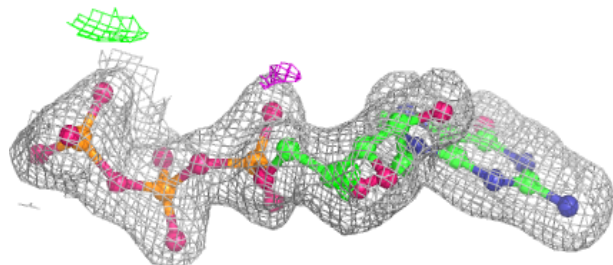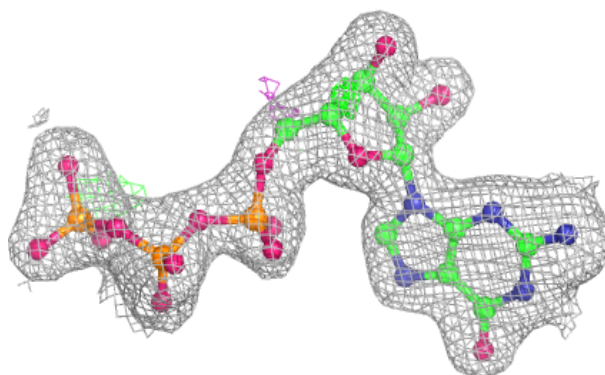
Electron density around VYT B 502:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative) and green (positive)

Electron density around GDP B 501:

2mF$_o$-DF$_c$ (at 0.7 rmsd) in gray
mF$_o$-DF$_c$ (at 3 rmsd) in purple (negative)
and green (positive)
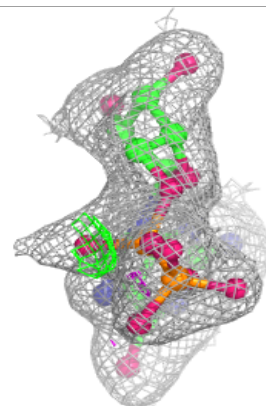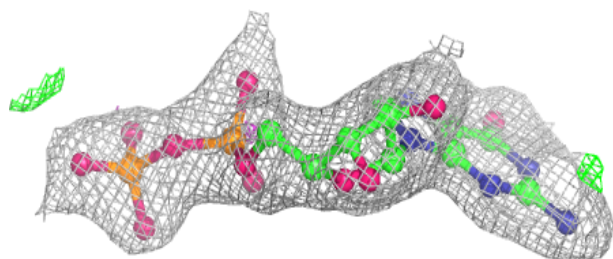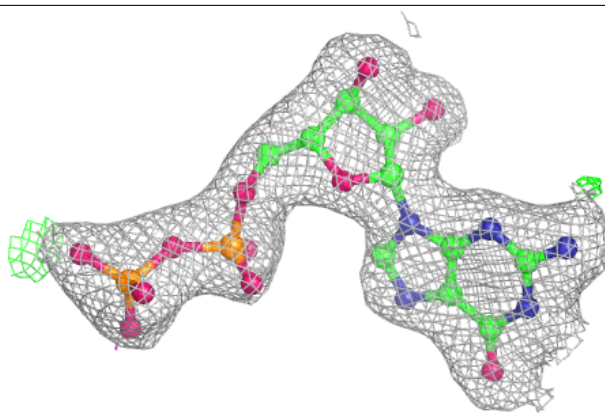
Electron density around GTP A 501:

2mF$_o$-DF$_c$ (at 0.7 rmsd) in gray
mF$_o$-DF$_c$ (at 3 rmsd) in purple (negative)
and green (positive)

6.5 Other polymers ⓘ

There are no such residues in this entry.