



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 6, 2026 – 08:04 AM UTC

PDB ID : 521P / pdb_0000521p
Title : THREE-DIMENSIONAL STRUCTURES OF H-RAS P21 MUTANTS:
MOLECULAR BASIS FOR THEIR INABILITY TO FUNCTION AS SIG-
NAL SWITCH MOLECULES
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Deposited on : 1991-06-06
Resolution : 2.60 Å(reported)

This is a Full wwPDB X-ray Structure Validation 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 types of validation reports are described at

<http://www.wwpdb.org/validation/2017/FAQs#types>.

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

MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

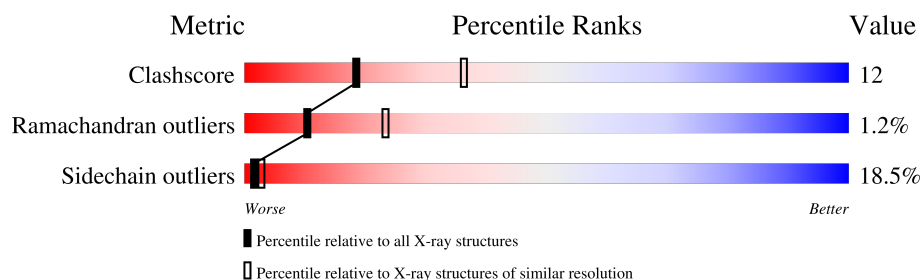
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.60 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))
Clashscore	190562	4347 (2.60-2.60)
Ramachandran outliers	187476	4277 (2.60-2.60)
Sidechain outliers	187428	4277 (2.60-2.60)

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 $\leq 5\%$.

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	166	40% 42% 16% .

2 Entry composition [i](#)

There are 3 unique types of molecules in this entry. The entry contains 1360 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 H-RAS P21 PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	166	Total	C	N	O	S	0	0	0
			1327	827	228	265	7			

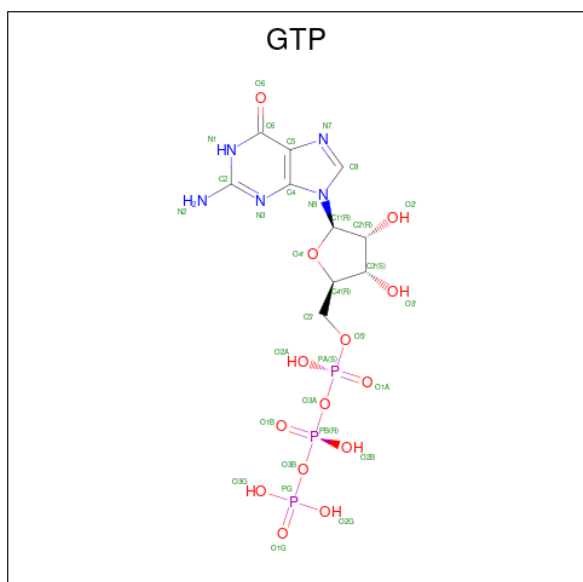
There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	12	VAL	GLY	engineered mutation	UNP P01112
A	59	THR	ALA	engineered mutation	UNP P01112

- Molecule 2 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

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

- Molecule 3 is GUANOSINE-5'-TRIPHOSPHATE (CCD ID: GTP) (formula: C₁₀H₁₆N₅O₁₄P₃).



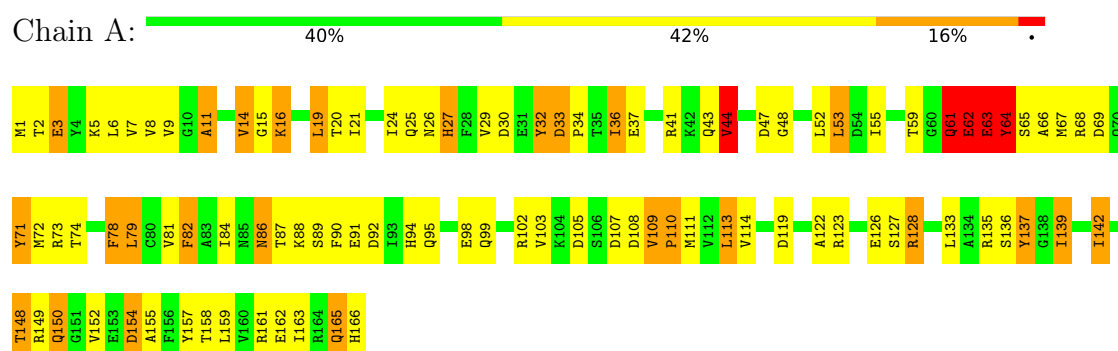
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			32	10	5	14	3		

3 Residue-property plots [i](#)

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. 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.

Note EDS was not executed.

• Molecule 1: H-RAS P21 PROTEIN



4 Data and refinement statistics

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 32 2 1	Depositor
Cell constants a, b, c, α , β , γ	40.50Å 40.50Å 161.30Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	(Not available) – 2.60	Depositor
% Data completeness (in resolution range)	(Not available) ((Not available)-2.60)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	X-PLOR	Depositor
R, R_{free}	0.214 , (Not available)	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	1360	wwPDB-VP
Average B, all atoms (Å ²)	20.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: GTP, MG

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	1.44	7/1346 (0.5%)	2.37	76/1816 (4.2%)

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
1	A	0	1

All (7) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	29	VAL	CA-CB	8.09	1.62	1.53
1	A	94	HIS	CD2-NE2	-6.71	1.30	1.37
1	A	108	ASP	CA-CB	6.62	1.62	1.53
1	A	9	VAL	CA-CB	6.00	1.62	1.54
1	A	27	HIS	CD2-NE2	-5.91	1.31	1.37
1	A	105	ASP	CA-CB	5.67	1.62	1.53
1	A	166	HIS	CG-ND1	-5.51	1.32	1.38

All (76) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	108	ASP	CA-CB-CG	14.48	127.08	112.60
1	A	44	VAL	N-CA-CB	-11.59	96.29	112.52
1	A	82	PHE	CA-CB-CG	10.69	124.49	113.80
1	A	154	ASP	CA-CB-CG	10.55	123.15	112.60
1	A	92	ASP	CA-CB-CG	10.23	122.83	112.60
1	A	30	ASP	CA-CB-CG	9.22	121.82	112.60

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	14	VAL	N-CA-C	9.02	120.90	110.62
1	A	81	VAL	N-CA-C	8.86	120.58	108.17
1	A	11	ALA	N-CA-C	8.60	120.99	110.41
1	A	105	ASP	CA-CB-CG	8.55	121.15	112.60
1	A	71	TYR	CA-CB-CG	7.95	128.21	113.90
1	A	135	ARG	CA-CB-CG	7.86	129.81	114.10
1	A	21	ILE	N-CA-C	7.84	118.61	110.62
1	A	61	GLN	N-CA-C	7.65	122.37	112.12
1	A	155	ALA	O-C-N	7.64	129.94	122.07
1	A	37	GLU	CA-CB-CG	7.35	128.81	114.10
1	A	62	GLU	N-CA-C	7.35	126.46	110.80
1	A	63	GLU	N-CA-C	-7.25	104.32	113.02
1	A	27	HIS	O-C-N	-7.19	115.21	123.33
1	A	34	PRO	N-CD-CG	-6.89	92.86	103.20
1	A	139	ILE	CA-C-N	6.84	127.23	119.92
1	A	139	ILE	C-N-CA	6.84	127.23	119.92
1	A	122	ALA	N-CA-C	-6.82	102.09	110.61
1	A	20	THR	N-CA-C	-6.68	103.69	110.97
1	A	128	ARG	CA-CB-CG	6.44	126.99	114.10
1	A	74	THR	N-CA-C	6.35	121.02	113.28
1	A	119	ASP	CA-CB-CG	6.33	118.94	112.60
1	A	152	VAL	CA-C-O	-6.24	114.61	121.29
1	A	44	VAL	CB-CA-C	6.23	120.04	110.82
1	A	21	ILE	CB-CG1-CD1	6.09	126.60	113.80
1	A	9	VAL	O-C-N	-6.08	114.97	122.57
1	A	33	ASP	CA-CB-CG	6.04	118.64	112.60
1	A	158	THR	N-CA-C	-6.04	103.87	111.11
1	A	47	ASP	O-C-N	6.02	129.81	122.58
1	A	155	ALA	CA-C-N	6.02	129.46	120.31
1	A	155	ALA	C-N-CA	6.02	129.46	120.31
1	A	66	ALA	N-CA-C	-6.01	106.00	113.15
1	A	94	HIS	CB-CG-CD2	-5.94	123.47	131.20
1	A	163	ILE	N-CA-C	-5.92	104.74	110.72
1	A	19	LEU	CA-C-N	5.92	128.47	120.65
1	A	19	LEU	C-N-CA	5.92	128.47	120.65
1	A	92	ASP	O-C-N	-5.90	113.66	122.39
1	A	3	GLU	N-CA-C	5.89	118.13	109.24
1	A	43	GLN	CB-CG-CD	5.89	122.61	112.60
1	A	136	SER	CA-CB-OG	5.67	122.44	111.10
1	A	64	TYR	CA-CB-CG	5.64	124.04	113.90
1	A	110	PRO	CB-CA-C	5.64	117.70	111.56
1	A	73	ARG	CB-CA-C	-5.63	101.44	110.79

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	163	ILE	CA-C-O	-5.52	115.00	120.85
1	A	1	MET	CA-CB-CG	-5.51	103.08	114.10
1	A	63	GLU	CA-CB-CG	5.45	124.99	114.10
1	A	69	ASP	N-CA-C	5.44	122.38	110.80
1	A	137	TYR	CA-CB-CG	5.43	123.68	113.90
1	A	20	THR	CA-C-O	-5.39	115.34	121.00
1	A	139	ILE	N-CA-CB	-5.35	103.72	111.21
1	A	98	GLU	N-CA-C	-5.34	104.89	111.40
1	A	79	LEU	CB-CA-C	-5.33	102.25	110.78
1	A	110	PRO	CA-C-N	5.31	130.58	121.87
1	A	110	PRO	C-N-CA	5.31	130.58	121.87
1	A	7	VAL	O-C-N	-5.28	117.75	123.14
1	A	86	ASN	OD1-CG-ND2	-5.25	117.35	122.60
1	A	64	TYR	N-CA-C	-5.22	98.50	108.17
1	A	21	ILE	O-C-N	-5.22	116.81	121.87
1	A	165	GLN	CG-CD-NE2	5.22	124.22	116.40
1	A	123	ARG	NE-CZ-NH2	-5.21	114.51	119.20
1	A	55	ILE	N-CA-C	5.18	116.26	109.21
1	A	98	GLU	CA-C-O	-5.16	115.03	120.55
1	A	64	TYR	CB-CG-CD1	5.12	128.48	120.80
1	A	165	GLN	OE1-CD-NE2	-5.12	117.48	122.60
1	A	88	LYS	CA-CB-CG	5.11	124.32	114.10
1	A	48	GLY	O-C-N	-5.10	117.41	122.41
1	A	107	ASP	CA-CB-CG	5.10	117.70	112.60
1	A	36	ILE	O-C-N	-5.09	116.20	122.57
1	A	139	ILE	N-CA-C	5.07	119.83	108.88
1	A	16	LYS	CA-C-O	-5.04	115.51	120.70
1	A	78	PHE	N-CA-C	5.01	117.13	109.07

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	137	TYR	Sidechain

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	1327	0	1298	32	0
2	A	1	0	0	0	0
3	A	32	0	12	0	0
All	All	1360	0	1310	32	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 12.

All (32) 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:148:THR:HG22	1:A:150:GLN:H	1.45	0.80
1:A:62:GLU:HG3	1:A:64:TYR:HB2	1.80	0.62
1:A:41:ARG:NH2	1:A:52:LEU:HD21	2.13	0.61
1:A:61:GLN:HG3	1:A:62:GLU:N	2.15	0.61
1:A:86:ASN:HB3	1:A:89:SER:OG	2.01	0.60
1:A:87:THR:O	1:A:91:GLU:HG3	2.04	0.58
1:A:11:ALA:O	1:A:16:LYS:NZ	2.42	0.53
1:A:41:ARG:CZ	1:A:52:LEU:HD21	2.40	0.52
1:A:15:GLY:O	1:A:19:LEU:HG	2.11	0.51
1:A:26:ASN:HD21	1:A:149:ARG:NH2	2.10	0.49
1:A:148:THR:HG22	1:A:150:GLN:N	2.21	0.49
1:A:68:ARG:HG2	1:A:71:TYR:CZ	2.46	0.48
1:A:109:VAL:HG12	1:A:110:PRO:HD2	1.96	0.48
1:A:32:TYR:O	1:A:33:ASP:HB3	2.14	0.47
1:A:90:PHE:CE1	1:A:133:LEU:HD22	2.50	0.47
1:A:82:PHE:HD2	1:A:113:LEU:HD11	1.80	0.46
1:A:72:MET:HB3	1:A:103:VAL:HG21	1.98	0.46
1:A:142:ILE:HD11	1:A:154:ASP:HB3	1.98	0.46
1:A:99:GLN:HA	1:A:102:ARG:HB3	1.98	0.46
1:A:90:PHE:CZ	1:A:133:LEU:HD22	2.52	0.45
1:A:63:GLU:O	1:A:67:MET:SD	2.74	0.45
1:A:157:TYR:O	1:A:161:ARG:HG3	2.17	0.44
1:A:150:GLN:O	1:A:150:GLN:HG3	2.14	0.43
1:A:113:LEU:HD12	1:A:114:VAL:H	1.83	0.42
1:A:44:VAL:HG21	1:A:53:LEU:HD22	2.01	0.42
1:A:159:LEU:O	1:A:162:GLU:HB2	2.19	0.42
1:A:62:GLU:HG3	1:A:64:TYR:H	1.84	0.41
1:A:8:VAL:HG13	1:A:79:LEU:HD12	2.02	0.41
1:A:5:LYS:HB3	1:A:5:LYS:HE2	1.81	0.41
1:A:78:PHE:HB2	1:A:111:MET:HG3	2.02	0.41
1:A:82:PHE:CD2	1:A:113:LEU:HD11	2.55	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:11:ALA:O	1:A:14:VAL:HG22	2.21	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 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	164/166 (99%)	144 (88%)	18 (11%)	2 (1%)	10 23

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	62	GLU
1	A	65	SER

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	146/146 (100%)	119 (82%)	27 (18%)	1 3

All (27) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	2	THR

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Mol	Chain	Res	Type
1	A	3	GLU
1	A	6	LEU
1	A	24	ILE
1	A	25	GLN
1	A	27	HIS
1	A	32	TYR
1	A	36	ILE
1	A	44	VAL
1	A	53	LEU
1	A	59	THR
1	A	61	GLN
1	A	62	GLU
1	A	63	GLU
1	A	64	TYR
1	A	84	ILE
1	A	95	GLN
1	A	109	VAL
1	A	113	LEU
1	A	126	GLU
1	A	127	SER
1	A	128	ARG
1	A	139	ILE
1	A	142	ILE
1	A	148	THR
1	A	150	GLN
1	A	165	GLN

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	25	GLN
1	A	26	ASN
1	A	27	HIS
1	A	43	GLN
1	A	86	ASN
1	A	129	GLN
1	A	131	GLN
1	A	166	HIS

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 2 ligands modelled in this entry, 1 is 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	$\# Z > 2$
3	GTP	A	167	2	33,34,34	2.23	4 (12%)	50,54,54	1.33	7 (14%)

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	167	2	-	0/22/38/38	0/3/3/3

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	167	GTP	PA-O3A	10.68	1.71	1.59
3	A	167	GTP	PB-O3A	4.38	1.64	1.59
3	A	167	GTP	O2'-C2'	2.22	1.48	1.43
3	A	167	GTP	PB-O3B	2.07	1.61	1.59

All (7) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed($^{\circ}$)	Ideal($^{\circ}$)
3	A	167	GTP	O4'-C1'-N9	-3.31	100.85	108.36
3	A	167	GTP	O2A-PA-O3A	3.00	115.39	107.27
3	A	167	GTP	O3'-C3'-C4'	-2.74	103.20	111.08
3	A	167	GTP	O3B-PB-O1B	-2.58	102.95	110.70
3	A	167	GTP	C5'-C4'-C3'	-2.46	106.36	115.21
3	A	167	GTP	O4'-C4'-C5'	2.37	116.93	109.33
3	A	167	GTP	O2G-PG-O3B	2.16	111.87	104.64

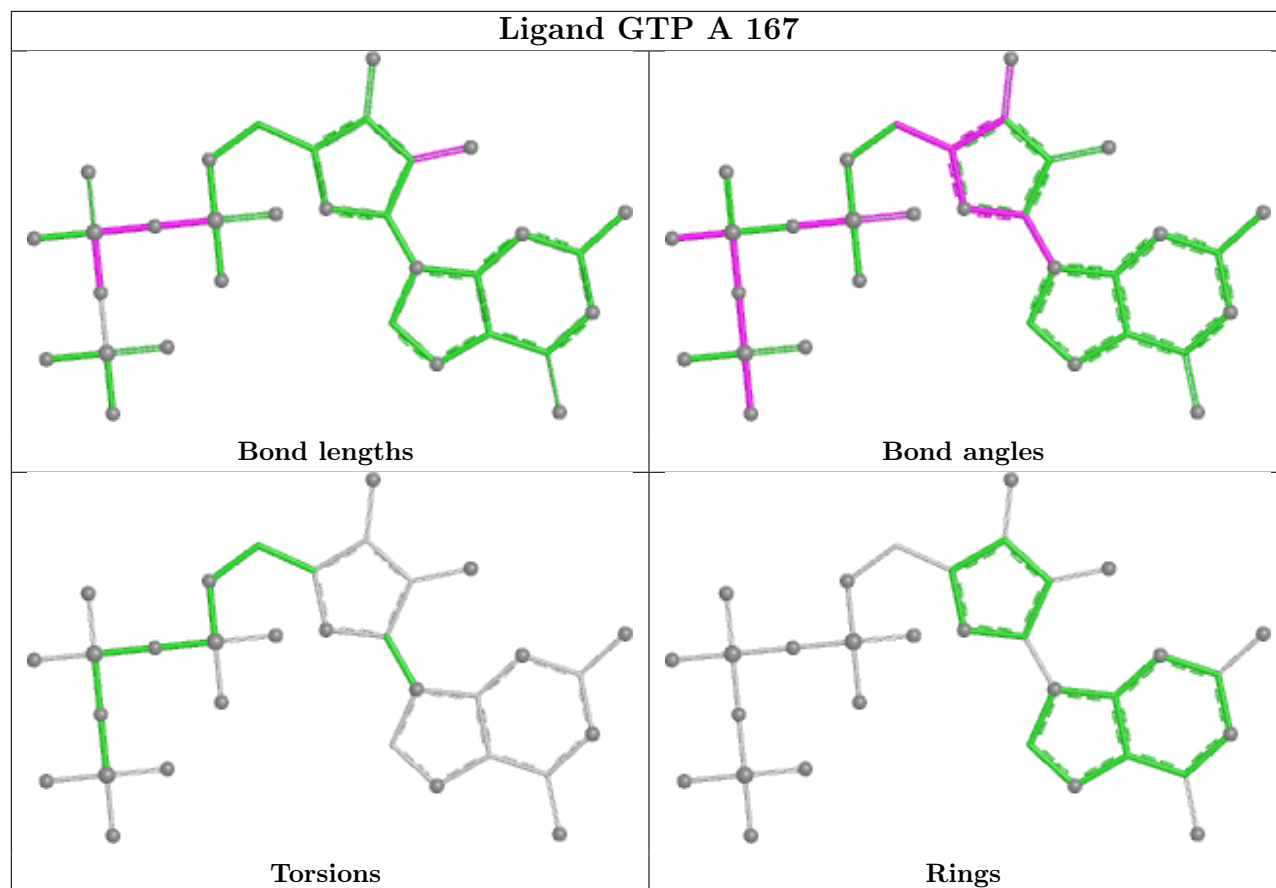
There are no chirality outliers.

There are no torsion outliers.

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 than 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.



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

6.1 Protein, DNA and RNA chains

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

6.4 Ligands

EDS was not executed - this section is therefore empty.

6.5 Other polymers

EDS was not executed - this section is therefore empty.