



# wwPDB X-ray Structure Validation Summary Report ⓘ

Dec 7, 2023 – 09:31 pm GMT

PDB ID : 1H4Q  
Title : Prolyl-tRNA synthetase from *Thermus thermophilus* complexed with tRNA<sup>Pro</sup>(CGG), ATP and prolinol  
Authors : Yaremchuk, A.; Tukalo, M.; Cusack, S.  
Deposited on : 2001-05-13  
Resolution : 3.00 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](mailto: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 : 4.02b-467  
Mogul : 1.8.4, CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.36  
buster-report : 1.1.7 (2018)  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.36

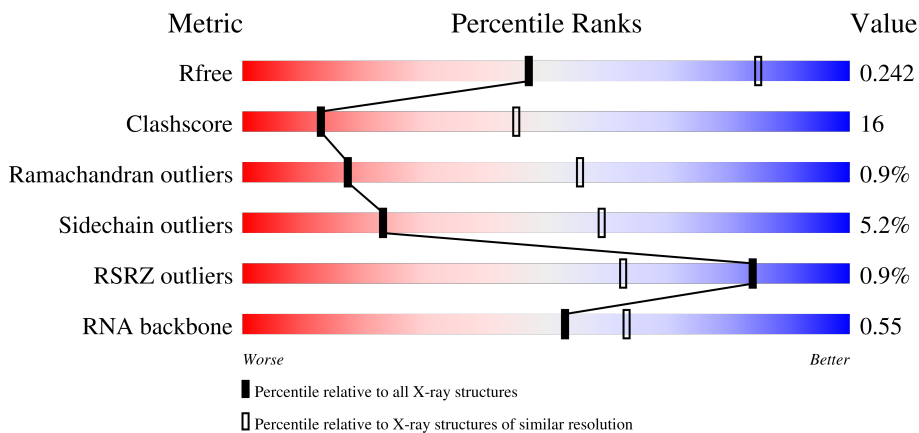
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 3.00 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))
$R_{free}$	130704	2092 (3.00-3.00)
Clashscore	141614	2416 (3.00-3.00)
Ramachandran outliers	138981	2333 (3.00-3.00)
Sidechain outliers	138945	2336 (3.00-3.00)
RSRZ outliers	127900	1990 (3.00-3.00)
RNA backbone	3102	1173 (3.30-2.70)

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  $\geq 3$ , 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  $\leq 5\%$ . 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	477	 8% 65% 29% . .
1	B	477	 59% 35% . .
2	T	77	 8% 36% 32% 12% 6% 13%

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 9027 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.

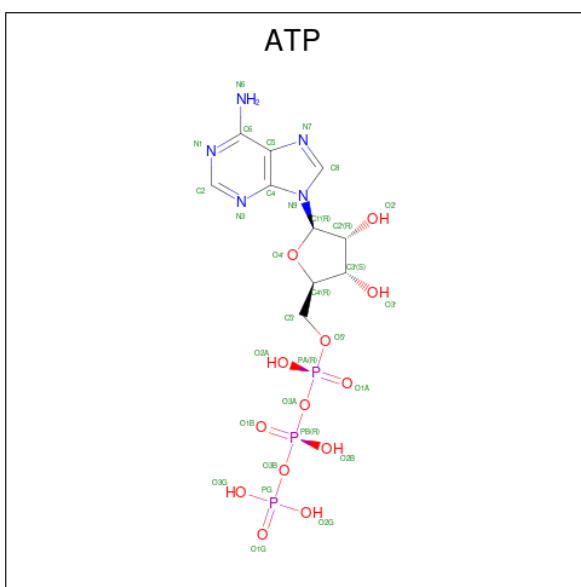
- Molecule 1 is a protein called PROLYL-TRNA SYNTHETASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	465	Total	C	N	O	S	78	0	0
			3743	2397	654	681	11			
1	B	464	Total	C	N	O	S	72	0	0
			3736	2393	653	679	11			

- Molecule 2 is a RNA chain called TRNAPRO(CG G).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
2	T	67	Total	C	N	O	P	0	0	0
			1436	640	262	468	66			

- Molecule 3 is ADENOSINE-5'-TRIPHOSPHATE (three-letter code: ATP) (formula:  $C_{10}H_{16}N_5O_{13}P_3$ ).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
3	A	1	Total	C	N	O	P	0	0
			31	10	5	13	3		

*Continued on next page...*

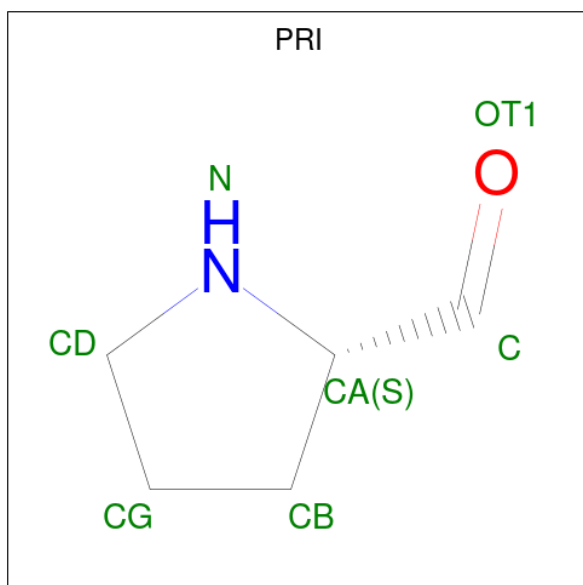
Continued from previous page...

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
3	B	1	31	10	5	13	3	0	0

- Molecule 4 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Zn		
4	A	1	1	1	0	0
4	B	1	1	1	0	0

- Molecule 5 is PYRROLIDINE-2-CARBALDEHYDE (three-letter code: PRI) (formula: C<sub>5</sub>H<sub>9</sub>NO).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
5	A	1	7	5	1	1	0	0
5	B	1	7	5	1	1	0	0

- Molecule 6 is SULFATE ION (three-letter code: SO4) (formula: O<sub>4</sub>S).

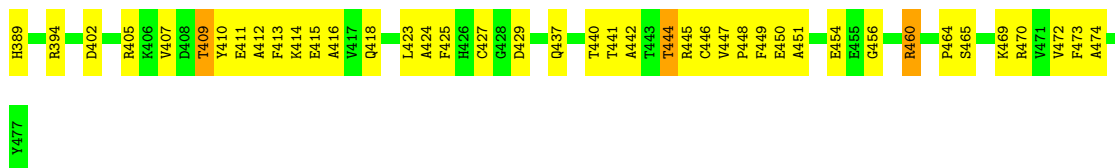


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	O	S	0	0
			5	4	1		
6	B	1	Total	O	S	0	0
			5	4	1		

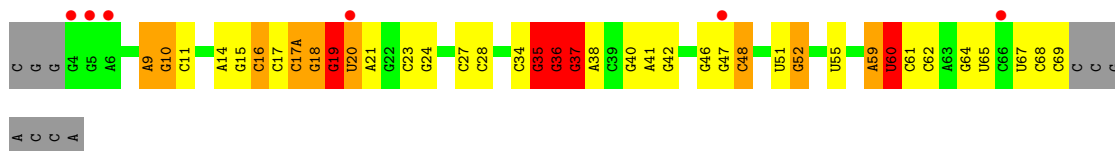
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	13	Total	O	0	0
			13	13		
7	B	8	Total	O	0	0
			8	8		
7	T	3	Total	O	0	0
			3	3		





• Molecule 2: TRNAPRO(CG)G



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	141.29Å 141.29Å 237.56Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	20.00 – 3.00 19.98 – 3.00	Depositor EDS
% Data completeness (in resolution range)	99.8 (20.00-3.00) 99.8 (19.98-3.00)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.71 (at 2.98Å)	Xtrriage
Refinement program	CNS 0.4	Depositor
R, $R_{free}$	0.221 , 0.254 0.211 , 0.242	Depositor DCC
$R_{free}$ test set	2452 reflections (5.05%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	62.2	Xtrriage
Anisotropy	0.054	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 60.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
$F_o, F_c$ correlation	0.92	EDS
Total number of atoms	9027	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	53.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.87% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: ZN, SO4, PSU, ATP, PRI, 5MU

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	0.37	0/3840	0.66	0/5204
1	B	0.37	0/3833	0.64	0/5194
2	T	0.41	0/1560	0.91	6/2434 (0.2%)
All	All	0.38	0/9233	0.71	6/12832 (0.0%)

There are no bond length outliers.

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	T	37	G	N9-C1'-C2'	7.32	123.52	114.00
2	T	35	G	N9-C1'-C2'	7.26	123.44	114.00
2	T	36	G	N9-C1'-C2'	6.10	121.93	114.00
2	T	19	G	N9-C1'-C2'	5.98	121.77	114.00
2	T	48	C	N1-C1'-C2'	5.39	121.01	114.00

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	3743	0	3664	115	0
1	B	3736	0	3661	134	0
2	T	1436	0	730	34	0

*Continued on next page...*

Continued from previous page...

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
3	A	31	0	12	3	0
3	B	31	0	12	1	0
4	A	1	0	0	0	0
4	B	1	0	0	0	0
5	A	7	0	9	2	0
5	B	7	0	9	2	0
6	A	5	0	0	0	0
6	B	5	0	0	0	0
7	A	13	0	0	0	0
7	B	8	0	0	0	0
7	T	3	0	0	0	0
All	All	9027	0	8097	274	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 16.

The worst 5 of 274 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:168:ARG:HH11	1:A:168:ARG:HB3	1.20	1.02
1:B:120:TRP:NE1	1:B:132:GLN:HG2	1.81	0.94
1:A:353:LYS:HG3	1:A:354:ASP:H	1.33	0.92
1:A:97:ALA:HB3	1:A:102:LEU:HD21	1.59	0.84
1:B:97:ALA:HB3	1:B:102:LEU:HD21	1.59	0.82

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	461/477 (97%)	419 (91%)	36 (8%)	6 (1%)	12 45

Continued on next page...

*Continued from previous page...*

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	460/477 (96%)	415 (90%)	43 (9%)	2 (0%)	34	72
All	All	921/954 (96%)	834 (91%)	79 (9%)	8 (1%)	17	55

5 of 8 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	354	ASP
1	A	298	ASP
1	A	327	ARG
1	A	467	TYR
1	B	7	LEU

### 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	383/395 (97%)	363 (95%)	20 (5%)	23	59
1	B	383/395 (97%)	363 (95%)	20 (5%)	23	59
All	All	766/790 (97%)	726 (95%)	40 (5%)	23	59

5 of 40 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	263	TRP
1	B	402	ASP
1	B	284	ARG
1	B	359	GLN
1	B	444	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 18 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	337	HIS
1	B	403	HIS

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Res	Type
1	B	389	HIS
1	B	132	GLN
1	B	329	GLN

### 5.3.3 RNA [i](#)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
2	T	66/77 (85%)	13 (19%)	6 (9%)

5 of 13 RNA backbone outliers are listed below:

Mol	Chain	Res	Type
2	T	9	A
2	T	10	G
2	T	17(A)	C
2	T	18	G
2	T	20	U

5 of 6 RNA pucker outliers are listed below:

Mol	Chain	Res	Type
2	T	19	G
2	T	20	U
2	T	60	U
2	T	16	C
2	T	9	A

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

2 non-standard protein/DNA/RNA residues are modelled in this entry.

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
2	PSU	T	55	2	18,21,22	1.53	2 (11%)	22,30,33	1.37	3 (13%)
2	5MU	T	54	2	19,22,23	0.37	0	28,32,35	0.42	0

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
2	PSU	T	55	2	-	2/7/25/26	0/2/2/2
2	5MU	T	54	2	-	0/7/25/26	0/2/2/2

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	T	55	PSU	C2-N1	5.06	1.43	1.36
2	T	55	PSU	C6-C5	2.33	1.38	1.35

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	T	55	PSU	C6-C5-C4	4.07	121.05	118.20
2	T	55	PSU	C6-N1-C2	-2.87	119.75	122.68
2	T	55	PSU	O2-C2-N1	2.86	125.94	122.79

There are no chirality outliers.

All (2) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	T	55	PSU	O4'-C1'-C5-C4
2	T	55	PSU	O4'-C1'-C5-C6

There are no ring outliers.

No monomer is involved in short contacts.

## 5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

## 5.6 Ligand geometry

Of 8 ligands modelled in this entry, 2 are monoatomic - leaving 6 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	ATP	B	1478	-	26,33,33	0.58	0	31,52,52	1.02	2 (6%)
6	SO4	A	1481	-	4,4,4	0.29	0	6,6,6	0.07	0
3	ATP	A	1478	-	26,33,33	0.58	0	31,52,52	1.03	2 (6%)
6	SO4	B	1481	-	4,4,4	0.27	0	6,6,6	0.10	0
5	PRI	A	1480	-	5,7,7	0.78	0	7,8,8	1.54	1 (14%)
5	PRI	B	1480	-	5,7,7	0.72	0	7,8,8	1.27	1 (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	ATP	B	1478	-	-	4/18/38/38	0/3/3/3
5	PRI	A	1480	-	-	0/0/9/9	0/1/1/1
3	ATP	A	1478	-	-	3/18/38/38	0/3/3/3
5	PRI	B	1480	-	-	0/0/9/9	0/1/1/1

There are no bond length outliers.

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	A	1480	PRI	OT1-C-CA	-3.23	116.31	124.78
5	B	1480	PRI	OT1-C-CA	-2.58	118.01	124.78
3	A	1478	ATP	C5-C6-N6	2.54	124.21	120.35
3	B	1478	ATP	C5-C6-N6	2.48	124.11	120.35
3	B	1478	ATP	O3G-PG-O2G	2.35	116.62	107.64

There are no chirality outliers.

5 of 7 torsion outliers are listed below:

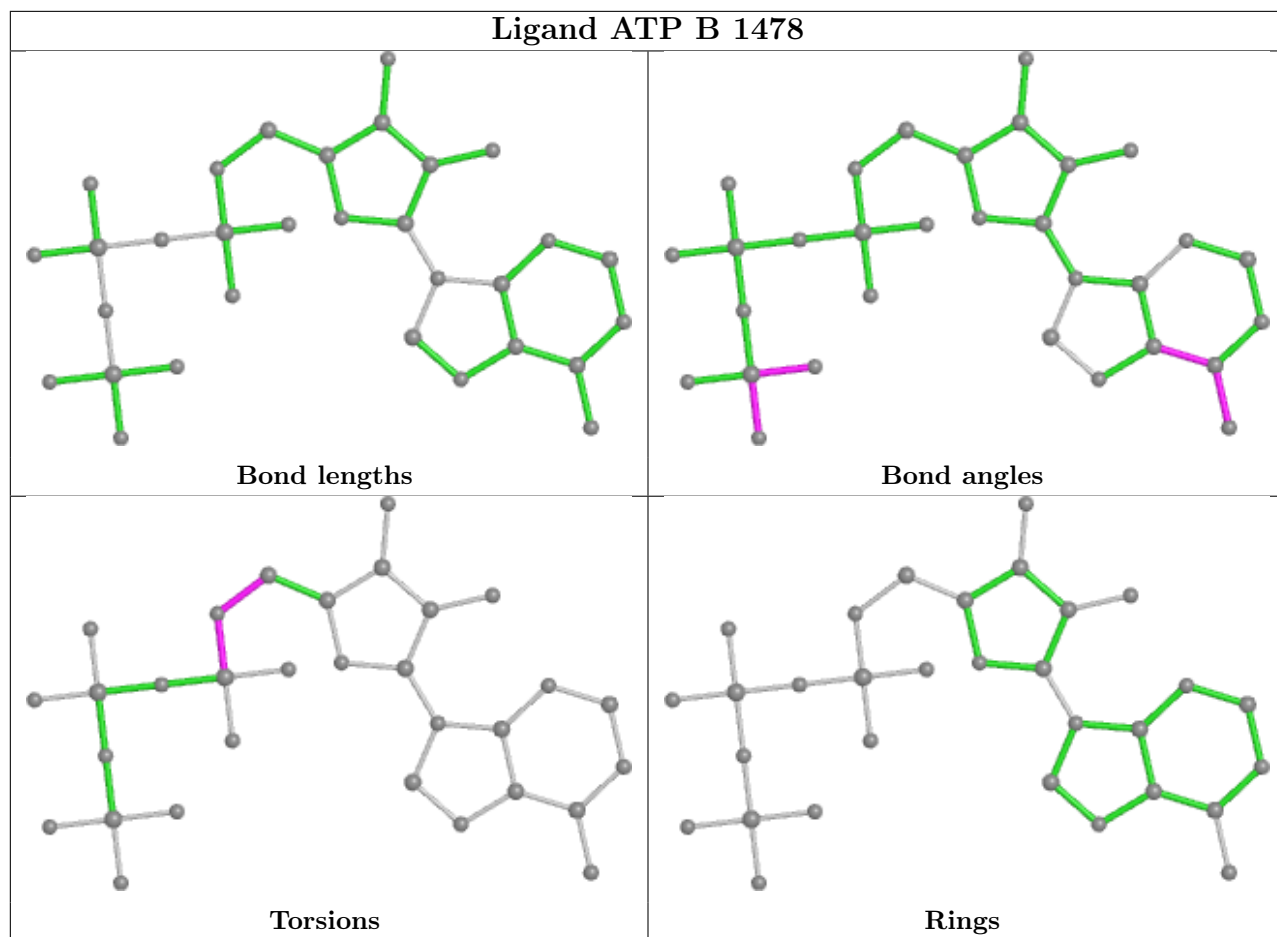
Mol	Chain	Res	Type	Atoms
3	A	1478	ATP	C5'-O5'-PA-O1A
3	A	1478	ATP	C5'-O5'-PA-O2A
3	B	1478	ATP	C5'-O5'-PA-O2A
3	A	1478	ATP	C5'-O5'-PA-O3A
3	B	1478	ATP	C5'-O5'-PA-O3A

There are no ring outliers.

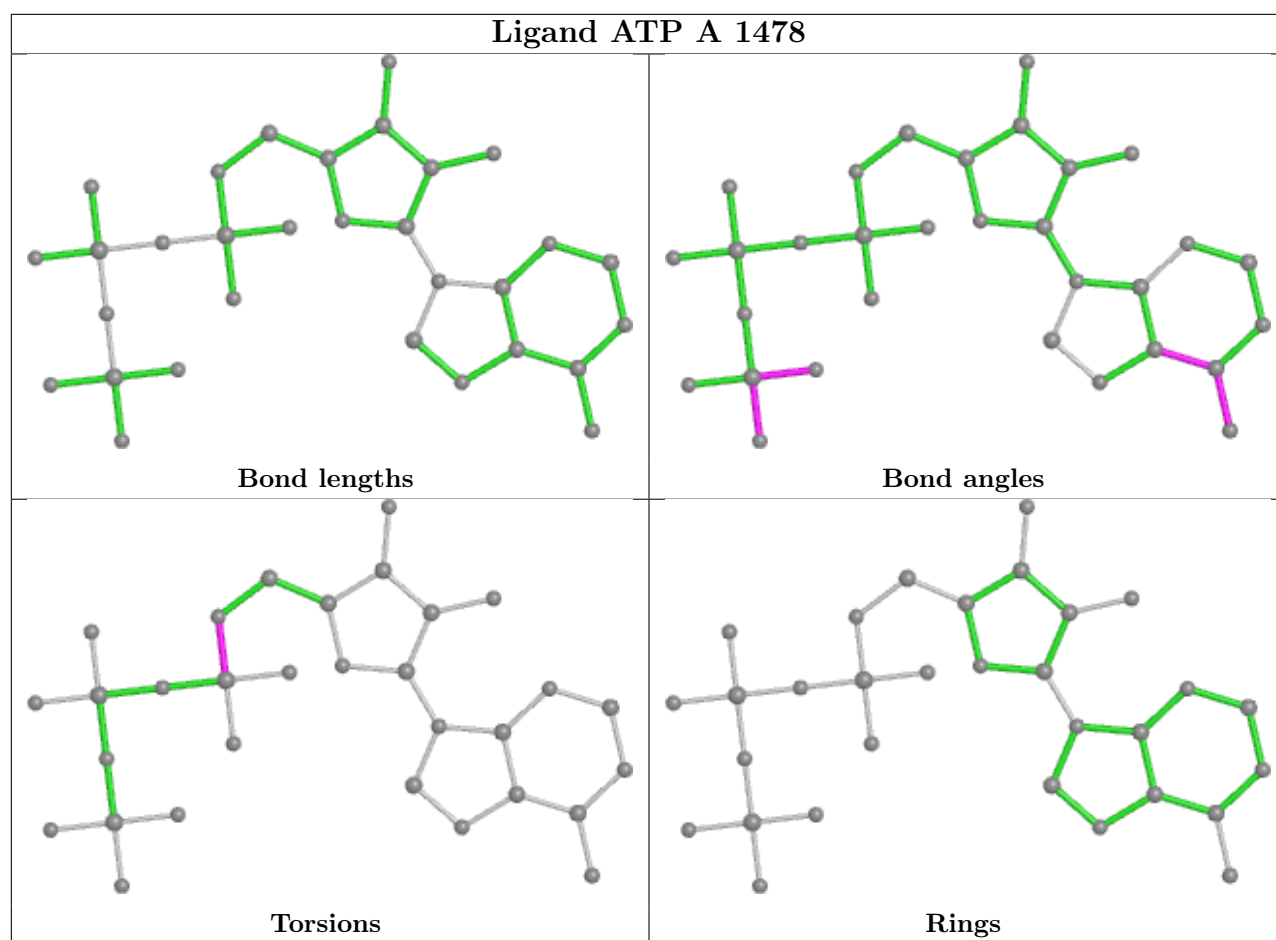
4 monomers are involved in 7 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	1478	ATP	1	0
3	A	1478	ATP	3	0
5	A	1480	PRI	2	0
5	B	1480	PRI	2	0

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 [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	464/477 (97%)	-0.43	1 (0%) 95 87	21, 46, 81, 107	17 (3%)
1	B	463/477 (97%)	-0.34	2 (0%) 92 79	25, 50, 85, 104	14 (3%)
2	T	65/77 (84%)	0.24	6 (9%) 9 3	27, 62, 93, 108	7 (10%)
All	All	992/1031 (96%)	-0.34	9 (0%) 84 63	21, 49, 85, 108	38 (3%)

The worst 5 of 9 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	T	4	G	4.5
2	T	5	G	3.9
2	T	20	U	2.5
1	B	101	GLU	2.3
2	T	6	A	2.3

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

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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
2	5MU	T	54	21/22	0.96	0.16	27,46,66,68	0
2	PSU	T	55	20/21	0.98	0.15	39,48,55,58	0

### 6.3 Carbohydrates [i](#)

There are no monosaccharides in this entry.

## 6.4 Ligands

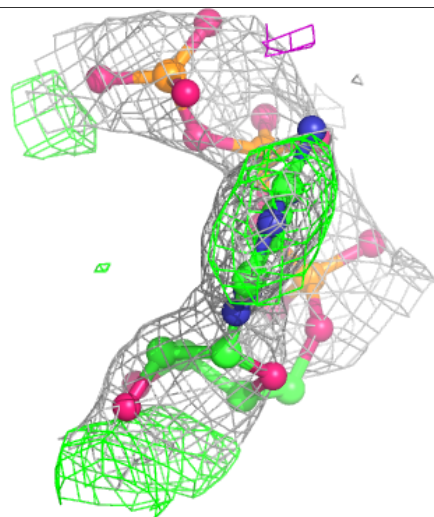
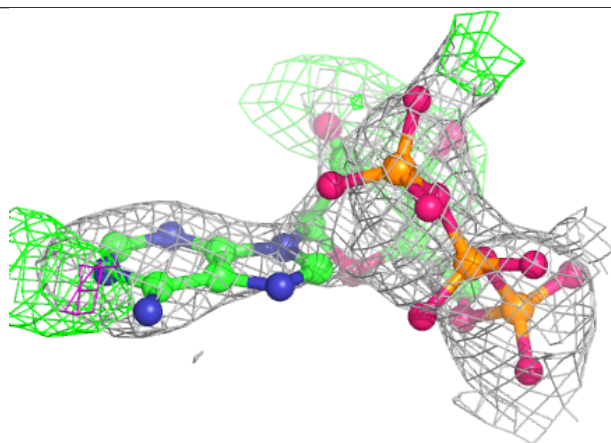
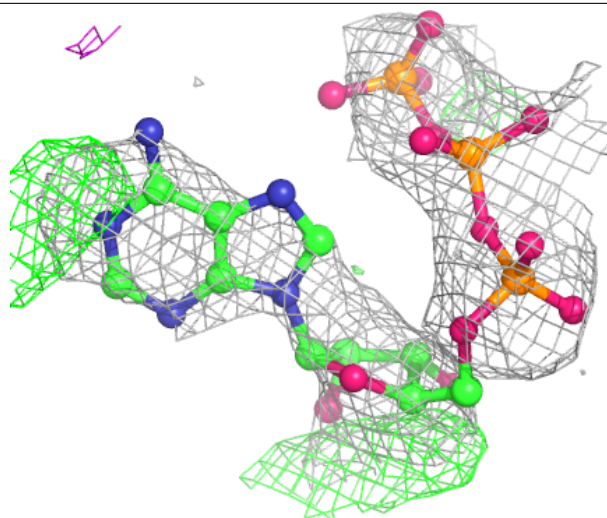
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

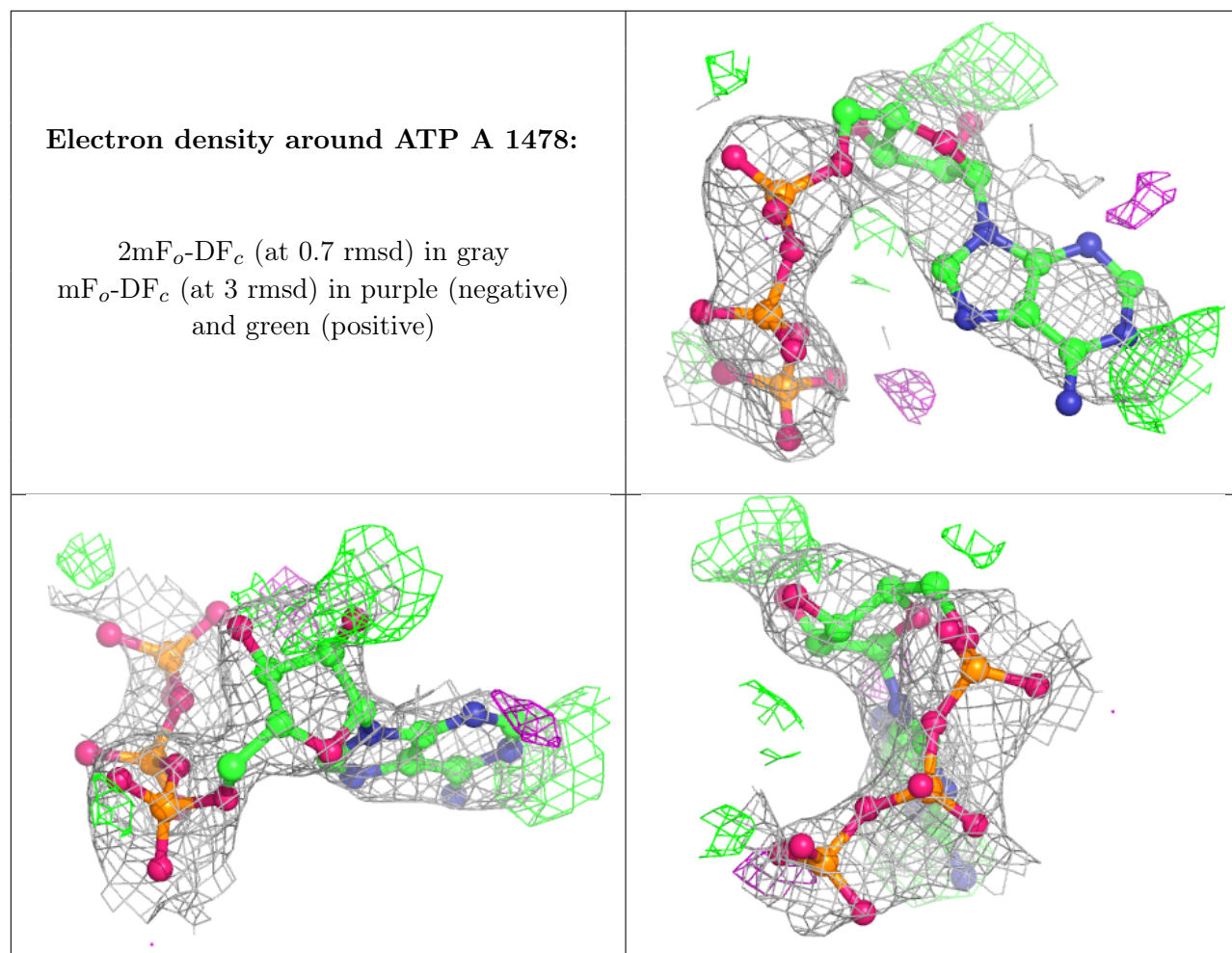
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
3	ATP	B	1478	31/31	0.72	0.36	69,86,105,106	31
4	ZN	B	1479	1/1	0.75	0.07	88,88,88,88	0
3	ATP	A	1478	31/31	0.79	0.33	54,62,95,97	31
5	PRI	B	1480	7/7	0.90	0.27	58,59,60,60	7
5	PRI	A	1480	7/7	0.92	0.20	26,31,40,44	7
4	ZN	A	1479	1/1	0.94	0.08	59,59,59,59	0
6	SO4	A	1481	5/5	0.94	0.14	75,75,78,78	5
6	SO4	B	1481	5/5	0.95	0.14	56,59,61,61	5

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 ATP B 1478:**

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





## 6.5 Other polymers [i](#)

There are no such residues in this entry.