



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 6, 2026 – 07:05 PM UTC

PDB ID : 5UHG / pdb_00005uhg
Title : Crystal structure of Mycobacterium tuberculosis transcription initiation complex in complex with D-AAP1 and Rifampin
Authors : Lin, W.; Das, K.; Feng, Y.; Ebright, R.H.
Deposited on : 2017-01-11
Resolution : 3.97 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

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)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

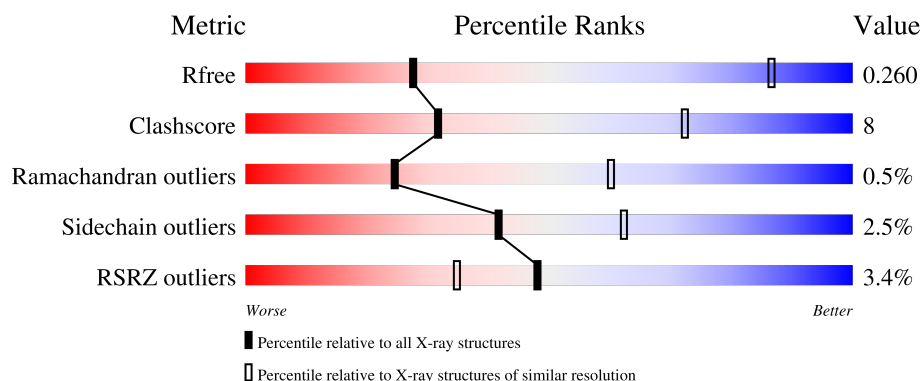
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.97 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}	180053	1016 (4.18-3.78)
Clashscore	190562	1007 (4.16-3.80)
Ramachandran outliers	187476	1000 (4.18-3.78)
Sidechain outliers	187428	1131 (4.20-3.76)
RSRZ outliers	180081	1016 (4.18-3.78)

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 $\leq 5\%$. 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	347	 3% 55% 9% 35%
1	B	347	 4% 50% 15% 35%
2	C	1178	 2% 75% 19% 2%
3	D	1316	 2% 74% 22% 2%
4	E	110	 2% 56% 16% 26%

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Mol	Chain	Length	Quality of chain
5	F	528	5% 47% 13% 39%
6	H	23	39% 35% 61%
7	G	16	62% 50% 25% 25%

2 Entry composition [i](#)

There are 11 unique types of molecules in this entry. The entry contains 26004 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 DNA-directed RNA polymerase subunit alpha.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	224	Total	C	N	O	S	0	0	0
			1704	1072	295	335	2			
1	B	227	Total	C	N	O	S	0	0	0
			1715	1080	291	342	2			

- Molecule 2 is a protein called DNA-directed RNA polymerase subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	C	1126	Total	C	N	O	S	0	0	0
			8714	5454	1528	1693	39			

- Molecule 3 is a protein called DNA-directed RNA polymerase subunit beta'.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	D	1265	Total	C	N	O	S	0	0	0
			9887	6188	1793	1866	40			

- Molecule 4 is a protein called DNA-directed RNA polymerase subunit omega.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
4	E	81	Total	C	N	O	0	0	0
			637	408	106	123			

- Molecule 5 is a protein called RNA polymerase sigma factor SigA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
5	F	321	Total	C	N	O	S	0	0	0
			2541	1582	457	493	9			

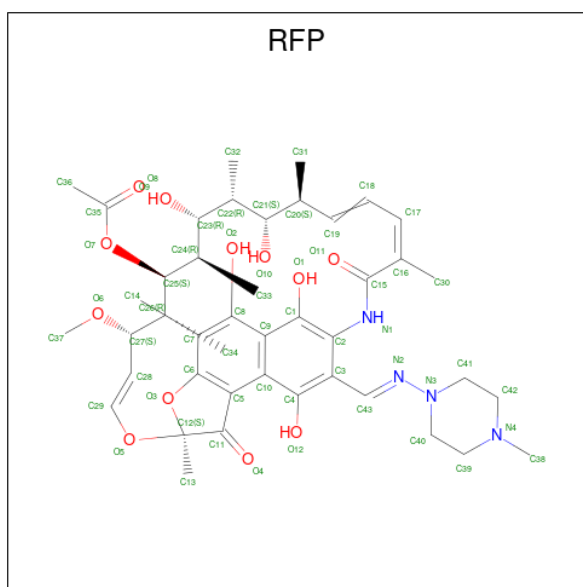
- Molecule 6 is a DNA chain called DNA (5'-D(*TP*AP*TP*AP*AP*TP*GP*GP*GP*AP*GP*CP*TP*GP*TP*CP*AP*CP*GP*GP*AP*TP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
6	H	23	Total	C	N	O	P	0	0	0
			476	227	91	136	22			

- Molecule 7 is a DNA chain called DNA (5'-D(*CP*AP*TP*CP*CP*GP*TP*GP*AP*GP*TP*CP*CP*AP*GP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
7	G	12	Total	C	N	O	P	0	0	0
			241	116	43	71	11			

- Molecule 8 is RIFAMPICIN (CCD ID: RFP) (formula: C₄₃H₅₈N₄O₁₂).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
8	C	1	Total	C	N	O	0	0
			59	43	4	12		

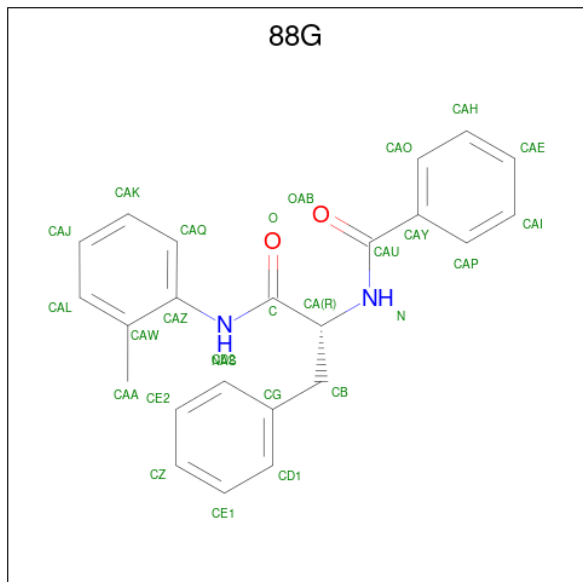
- Molecule 9 is ZINC ION (CCD ID: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
9	D	2	Total	Zn	0	0
			2	2		

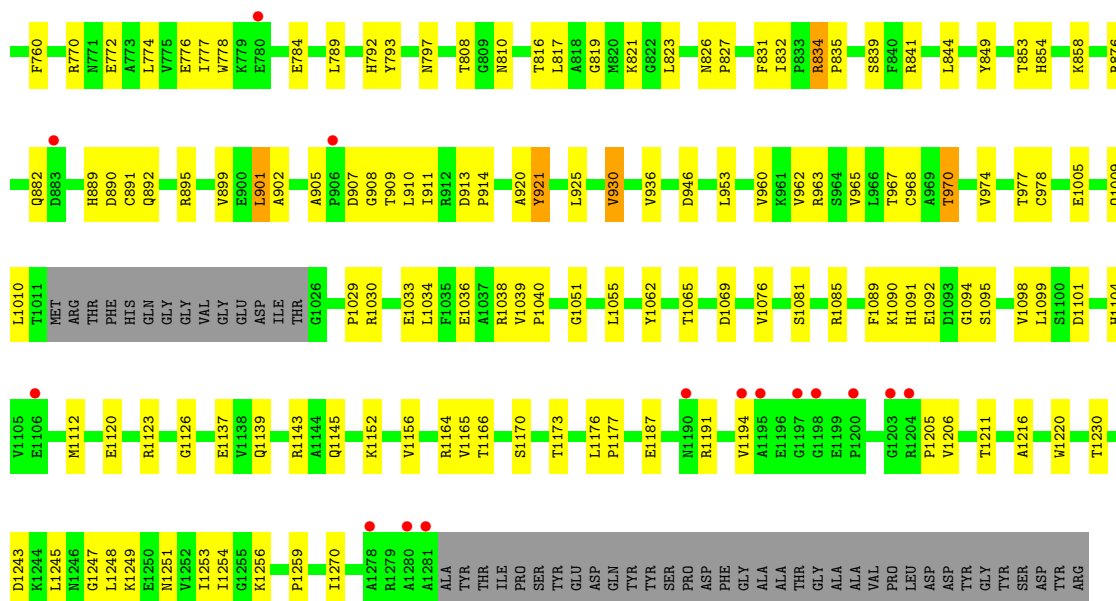
- Molecule 10 is MAGNESIUM ION (CCD ID: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
10	D	1	Total	Mg	0	0
			1	1		

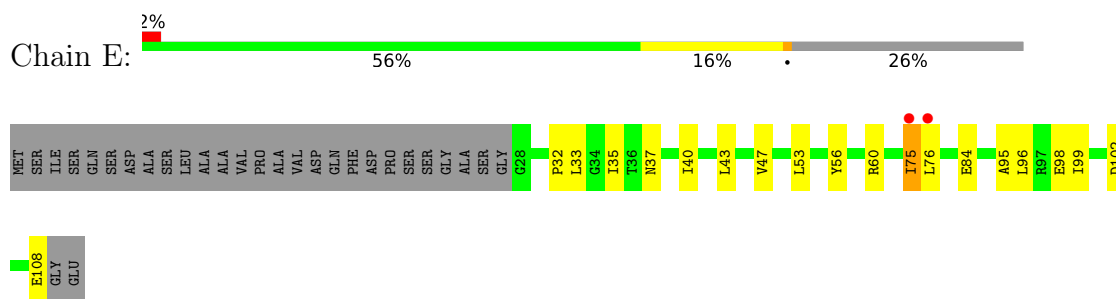
- Molecule 11 is Nalpha-(benzenecarbonyl)-N-(2-methylphenyl)-D-phenylalaninamide (CCD ID: 88G) (formula: C₂₃H₂₂N₂O₂).



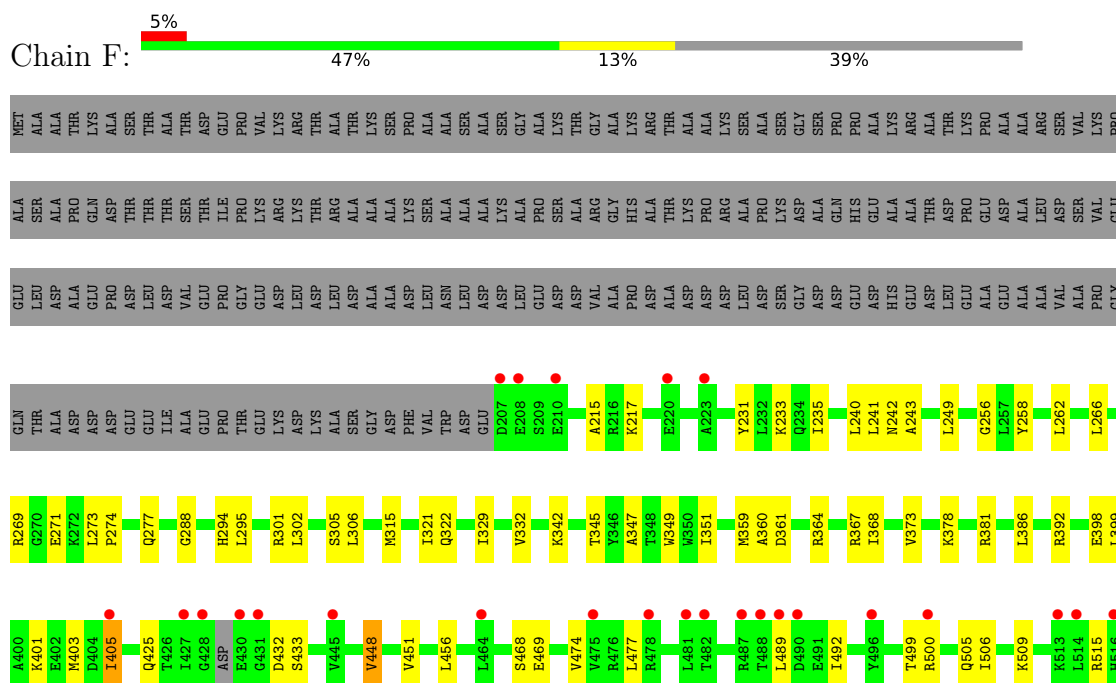
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
11	D	1	27	23	2	2	0	0

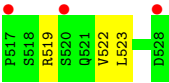


• Molecule 4: DNA-directed RNA polymerase subunit omega

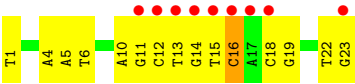


• Molecule 5: RNA polymerase sigma factor SigA

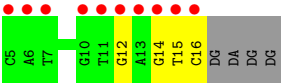




● Molecule 6: DNA (5'-D(*TP*AP*TP*AP*AP*TP*GP*GP*GP*AP*GP*CP*TP*GP*TP*CP*AP*CP*GP*GP*AP*TP*G)-3')



● Molecule 7: DNA (5'-D(*CP*AP*TP*CP*CP*GP*TP*GP*AP*GP*TP*CP*CP*AP*GP*G)-3')



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	151.43Å 162.15Å 194.32Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	49.24 – 3.97 49.24 – 3.97	Depositor EDS
% Data completeness (in resolution range)	93.9 (49.24-3.97) 93.9 (49.24-3.97)	Depositor EDS
R_{merge}	0.24	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.85 (at 4.00Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.223 , 0.260 0.227 , 0.260	Depositor DCC
R_{free} test set	2016 reflections (5.12%)	wwPDB-VP
Wilson B-factor (Å ²)	40.7	Xtriage
Anisotropy	0.301	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.26 , 25.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.42$, $\langle L^2 \rangle = 0.24$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.83	EDS
Total number of atoms	26004	wwPDB-VP
Average B, all atoms (Å ²)	54.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 1.94% of the height of the origin peak. No significant pseudotranslation is detected.*

¹Intensities estimated from amplitudes.

²Theoretical 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: MG, ZN, RFP, 88G

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	0.29	0/1730	0.78	0/2354
1	B	0.29	0/1741	0.79	2/2371 (0.1%)
2	C	0.30	0/8873	0.76	3/12031 (0.0%)
3	D	0.32	0/10052	0.77	14/13591 (0.1%)
4	E	0.33	0/650	0.76	0/886
5	F	0.30	0/2570	0.73	0/3464
6	H	0.21	0/535	0.42	1/826 (0.1%)
7	G	0.16	0/269	0.34	0/413
All	All	0.31	0/26420	0.75	20/35936 (0.1%)

There are no bond length outliers.

The worst 5 of 20 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	D	1126	GLY	CA-C-N	6.40	127.84	119.84
3	D	1126	GLY	C-N-CA	6.40	127.84	119.84
3	D	321	PRO	CA-C-N	5.64	125.31	119.05
3	D	321	PRO	C-N-CA	5.64	125.31	119.05
3	D	738	VAL	CA-C-N	5.40	123.60	119.66

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	1704	0	1741	20	0
1	B	1715	0	1739	34	0
2	C	8714	0	8636	143	0
3	D	9887	0	9943	174	0
4	E	637	0	635	14	0
5	F	2541	0	2563	48	0
6	H	476	0	261	20	0
7	G	241	0	137	6	0
8	C	59	0	58	10	0
9	D	2	0	0	0	0
10	D	1	0	0	0	0
11	D	27	0	0	0	0
All	All	26004	0	25713	417	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 8.

The worst 5 of 417 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)
3:D:913:ASP:OD2	3:D:914:PRO:HD2	1.35	1.24
6:H:16:DC:N3	7:G:12:DG:N1	2.17	0.91
3:D:908:GLY:O	3:D:909:THR:OG1	1.91	0.88
6:H:16:DC:O2	7:G:12:DG:N2	2.15	0.79
3:D:905:ALA:HB3	3:D:908:GLY:O	1.83	0.78

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	222/347 (64%)	210 (95%)	11 (5%)	1 (0%)	24 60

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	225/347 (65%)	207 (92%)	15 (7%)	3 (1%)	9	41
2	C	1124/1178 (95%)	1055 (94%)	63 (6%)	6 (0%)	24	60
3	D	1261/1316 (96%)	1200 (95%)	56 (4%)	5 (0%)	30	65
4	E	79/110 (72%)	77 (98%)	2 (2%)	0	100	100
5	F	317/528 (60%)	300 (95%)	16 (5%)	1 (0%)	36	70
All	All	3228/3826 (84%)	3049 (94%)	163 (5%)	16 (0%)	24	60

5 of 16 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
3	D	678	PRO
1	A	184	GLU
2	C	47	PRO
3	D	593	PRO
3	D	892	GLN

5.3.2 Protein sidechains ⓘ

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	192/297 (65%)	188 (98%)	4 (2%)	47	65
1	B	192/297 (65%)	192 (100%)	0	100	100
2	C	948/998 (95%)	926 (98%)	22 (2%)	44	64
3	D	1048/1095 (96%)	1015 (97%)	33 (3%)	35	56
4	E	68/90 (76%)	66 (97%)	2 (3%)	37	58
5	F	269/427 (63%)	261 (97%)	8 (3%)	36	57
All	All	2717/3204 (85%)	2648 (98%)	69 (2%)	42	62

5 of 69 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
3	D	1099	LEU

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Mol	Chain	Res	Type
4	E	75	ILE
5	F	361	ASP
2	C	1099	ARG
2	C	1002	VAL

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 16 such sidechains are listed below:

Mol	Chain	Res	Type
5	F	377	ASN
4	E	70	GLN
3	D	303	GLN
3	D	1227	GLN
2	C	841	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 5 ligands modelled in this entry, 3 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
11	88G	D	1404	-	29,29,29	1.83	4 (13%)	38,38,38	0.90	2 (5%)
8	RFP	C	1201	-	63,63,63	2.68	12 (19%)	94,94,94	2.15	18 (19%)

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
11	88G	D	1404	-	-	0/20/20/20	0/3/3/3
8	RFP	C	1201	-	-	23/60/85/85	0/5/5/5

The worst 5 of 16 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
8	C	1201	RFP	O4-C11	12.08	1.40	1.21
8	C	1201	RFP	C43-N2	8.23	1.50	1.27
8	C	1201	RFP	C17-C16	7.81	1.55	1.34
11	D	1404	88G	CAA-CAW	-5.83	1.40	1.51
8	C	1201	RFP	C15-N1	5.12	1.46	1.35

The worst 5 of 20 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
8	C	1201	RFP	C43-N2-N3	-7.66	109.61	120.55
8	C	1201	RFP	C2-C3-C43	-7.07	116.48	123.99
8	C	1201	RFP	C30-C16-C17	-6.69	107.40	123.67
8	C	1201	RFP	C38-N4-C42	6.47	122.95	110.63
8	C	1201	RFP	O3-C6-C7	5.37	130.26	121.16

There are no chirality outliers.

5 of 23 torsion outliers are listed below:

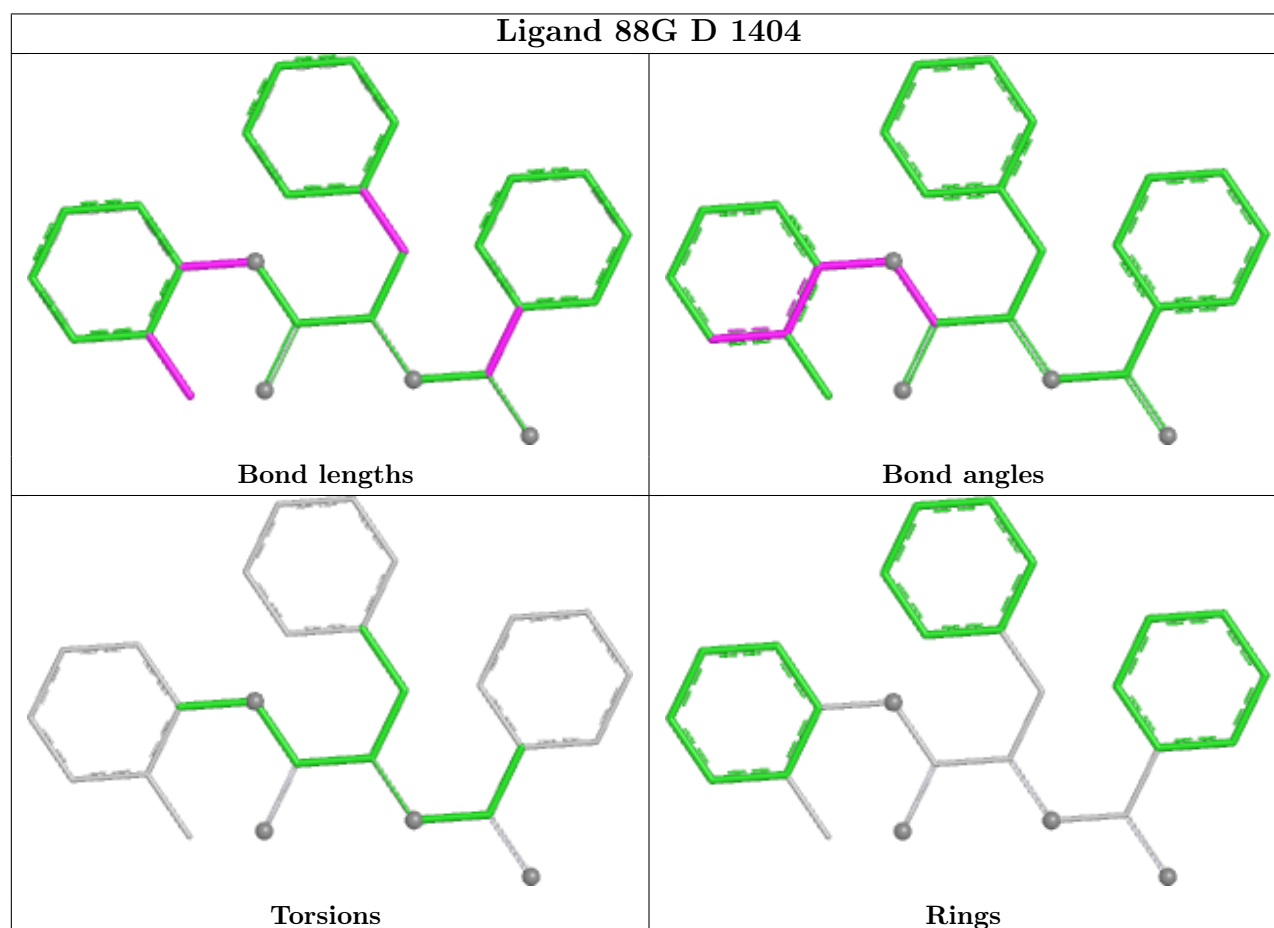
Mol	Chain	Res	Type	Atoms
8	C	1201	RFP	C4-C3-C43-N2
8	C	1201	RFP	C11-C12-O5-C29
8	C	1201	RFP	O3-C12-O5-C29
8	C	1201	RFP	C26-C27-C28-C29
8	C	1201	RFP	C27-C28-C29-O5

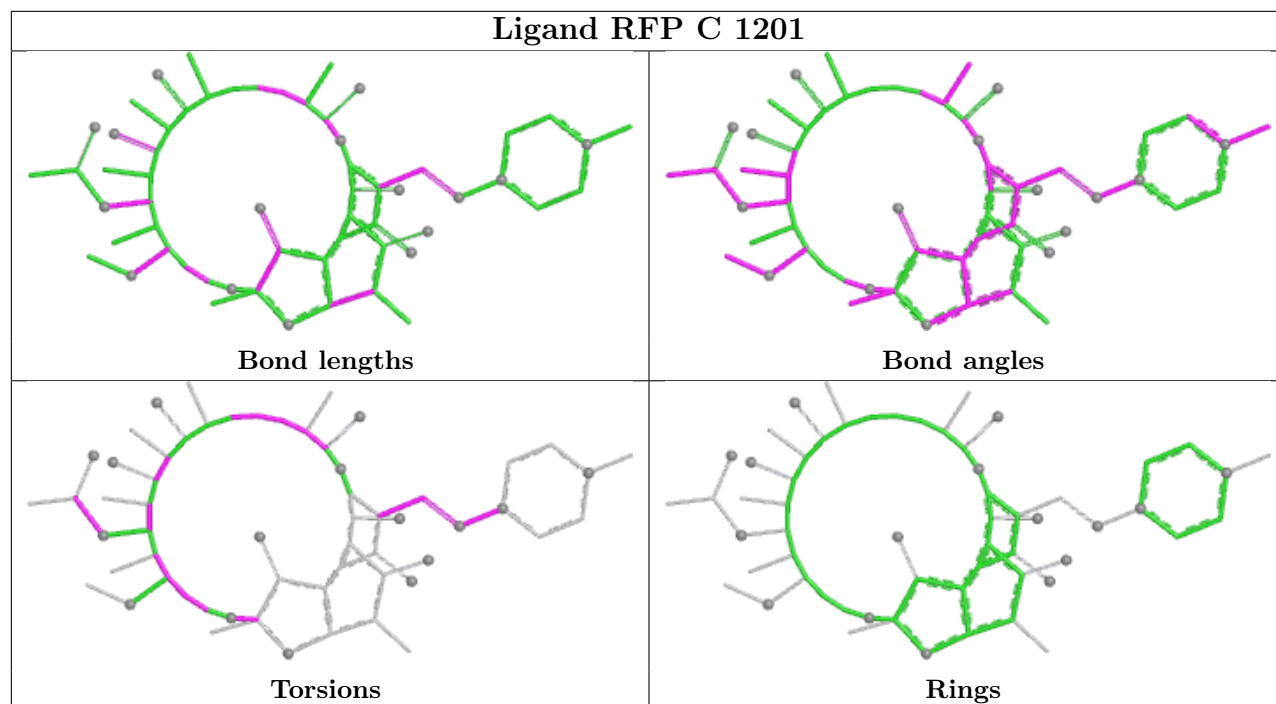
There are no ring outliers.

1 monomer is involved in 10 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
8	C	1201	RFP	10	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, 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	224/347 (64%)	0.41	9 (4%) 42 32	12, 52, 117, 140	0
1	B	227/347 (65%)	0.82	13 (5%) 29 25	45, 88, 136, 159	0
2	C	1126/1178 (95%)	0.24	20 (1%) 67 49	3, 34, 116, 141	0
3	D	1265/1316 (96%)	0.16	20 (1%) 70 51	4, 35, 101, 148	0
4	E	81/110 (73%)	0.16	2 (2%) 58 43	18, 41, 71, 92	0
5	F	321/528 (60%)	0.62	28 (8%) 16 17	7, 62, 159, 183	0
6	H	23/23 (100%)	1.56	9 (39%) 1 1	27, 124, 234, 273	0
7	G	12/16 (75%)	2.96	10 (83%) 0 0	134, 224, 283, 283	0
All	All	3279/3865 (84%)	0.31	111 (3%) 48 35	3, 43, 122, 283	0

The worst 5 of 111 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
7	G	14	DG	4.6
7	G	13	DA	4.3
5	F	430	GLU	4.2
3	D	1194	VAL	4.1
6	H	14	DG	3.9

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

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

6.3 Carbohydrates [i](#)

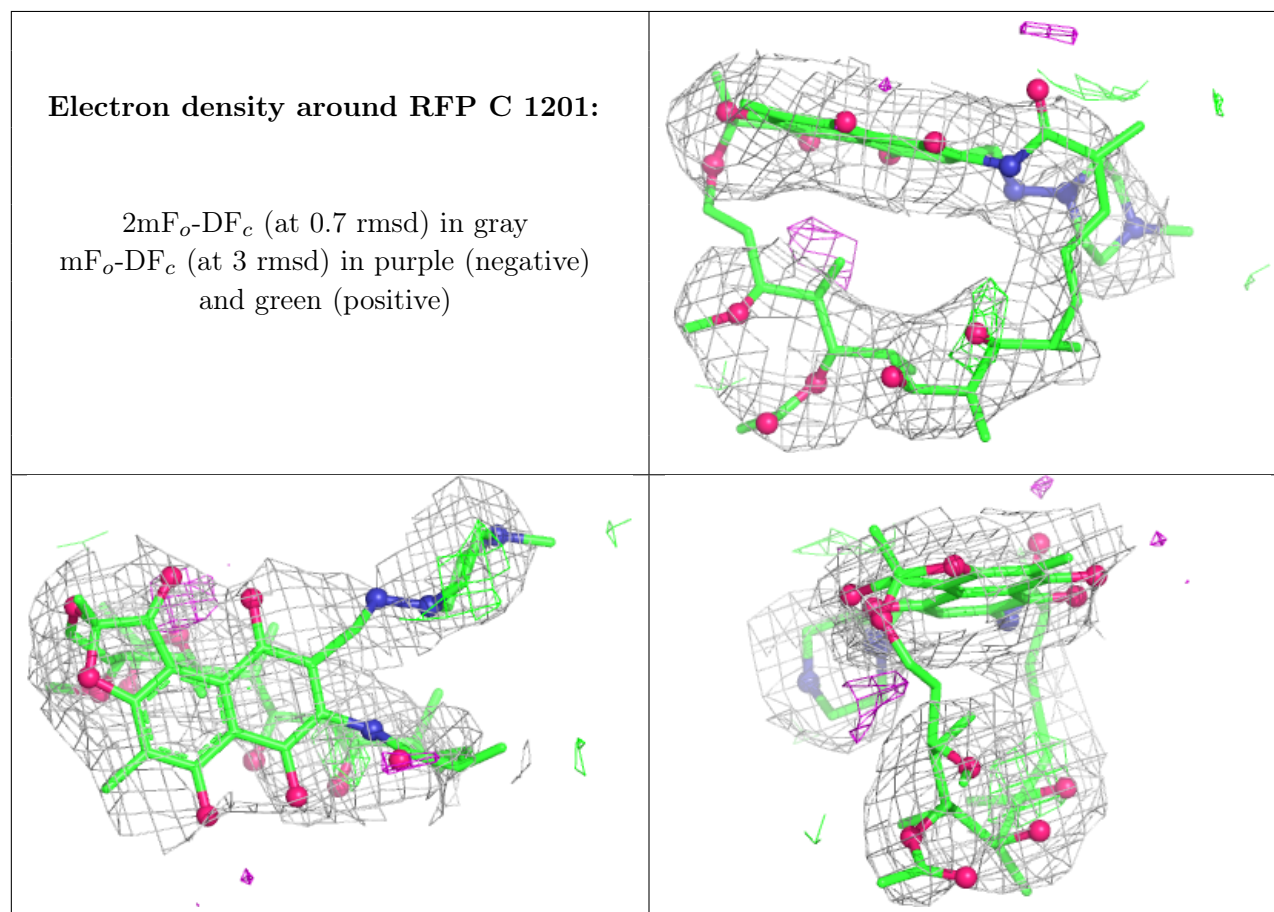
There are no oligosaccharides in this entry.

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.

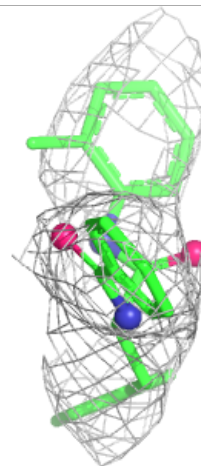
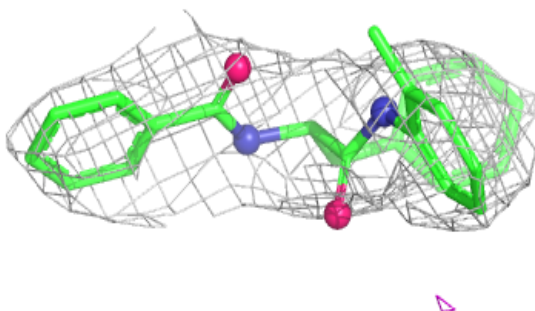
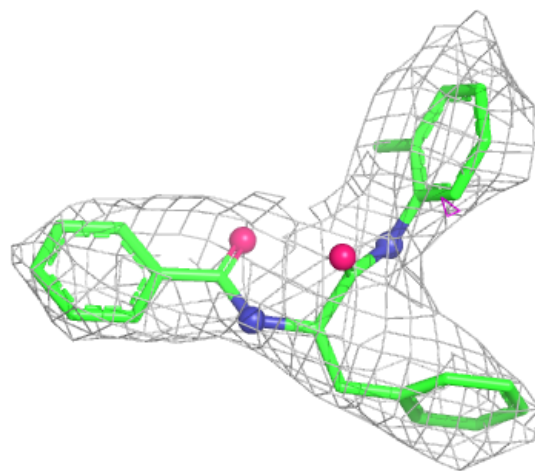
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
8	RFP	C	1201	59/59	0.92	0.16	22,26,50,66	0
11	88G	D	1404	27/27	0.93	0.11	27,35,40,43	0
10	MG	D	1403	1/1	0.97	0.18	5,5,5,5	0
9	ZN	D	1402	1/1	0.99	0.03	52,52,52,52	0
9	ZN	D	1401	1/1	1.00	0.04	34,34,34,34	0

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 88G D 1404:

$2mF_o-DF_c$ (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.