



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 04:35 PM UTC

PDB ID : 8GMB / pdb_00008gmb
Title : Crystal structure of the full-length Bruton's tyrosine kinase (PH-TH domain not visible)
Authors : Lin, D.Y.; Andreotti, A.H.
Deposited on : 2023-03-24
Resolution : 3.40 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)	:	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

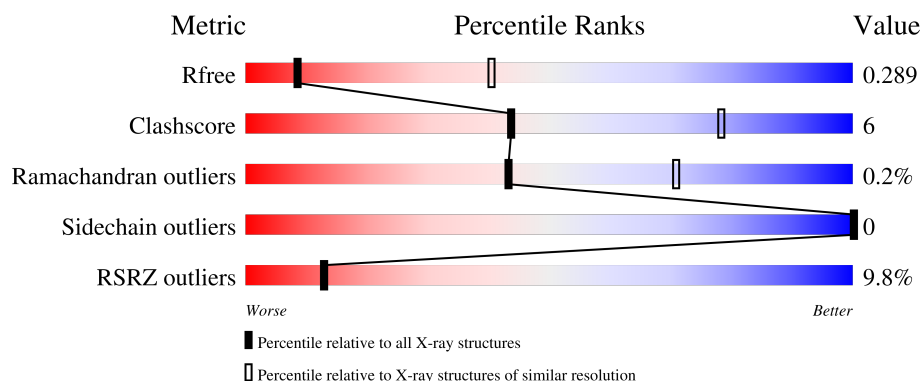
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.40 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	1001 (3.44-3.36)
Clashscore	190562	1022 (3.44-3.36)
Ramachandran outliers	187476	1012 (3.44-3.36)
Sidechain outliers	187428	1012 (3.44-3.36)
RSRZ outliers	180081	1001 (3.44-3.36)

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	659	7% 58% 8% 34%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 5661 atoms, of which 2493 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.

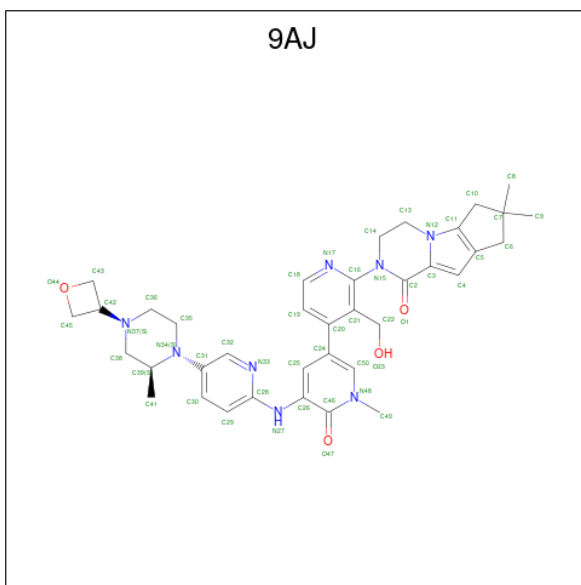
- Molecule 1 is a protein called Tyrosine-protein kinase BTK.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	438	Total	C	H	N	O	S	0	0	0
			5568	1982	2449	533	583	21			

There are 16 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	298	ALA	GLU	engineered mutation	UNP P35991
A	300	ALA	LYS	engineered mutation	UNP P35991
A	301	ALA	GLU	engineered mutation	UNP P35991
A	384	PRO	ALA	engineered mutation	UNP P35991
A	386	PRO	SER	engineered mutation	UNP P35991
A	387	PRO	THR	engineered mutation	UNP P35991
A	388	PRO	ALA	engineered mutation	UNP P35991
A	390	PHE	LEU	engineered mutation	UNP P35991
A	430	ARG	LYS	engineered mutation	UNP P35991
A	542	MET	LEU	engineered mutation	UNP P35991
A	543	THR	SER	engineered mutation	UNP P35991
A	555	THR	VAL	engineered mutation	UNP P35991
A	562	LYS	ARG	engineered mutation	UNP P35991
A	564	ALA	SER	engineered mutation	UNP P35991
A	565	SER	PRO	engineered mutation	UNP P35991
A	617	PRO	TYR	engineered mutation	UNP P35991

- Molecule 2 is 2-[3'-(hydroxymethyl)-1-methyl-5-({5-[(2S)-2-methyl-4-(oxetan-3-yl)piperazin-1-yl]pyridin-2-yl}amino)-6-oxo[1,6-dihydro[3,4'-bipyridine]]-2'-yl]-7,7-dimethyl-3,4,7,8-tetrahydro-2H-cyclopenta[4,5]pyrrolo[1,2-a]pyrazin-1(6H)-one (CCD ID: 9AJ) (formula: C₃₇H₄₄N₈O₄) (labeled as "Ligand of Interest" by depositor).

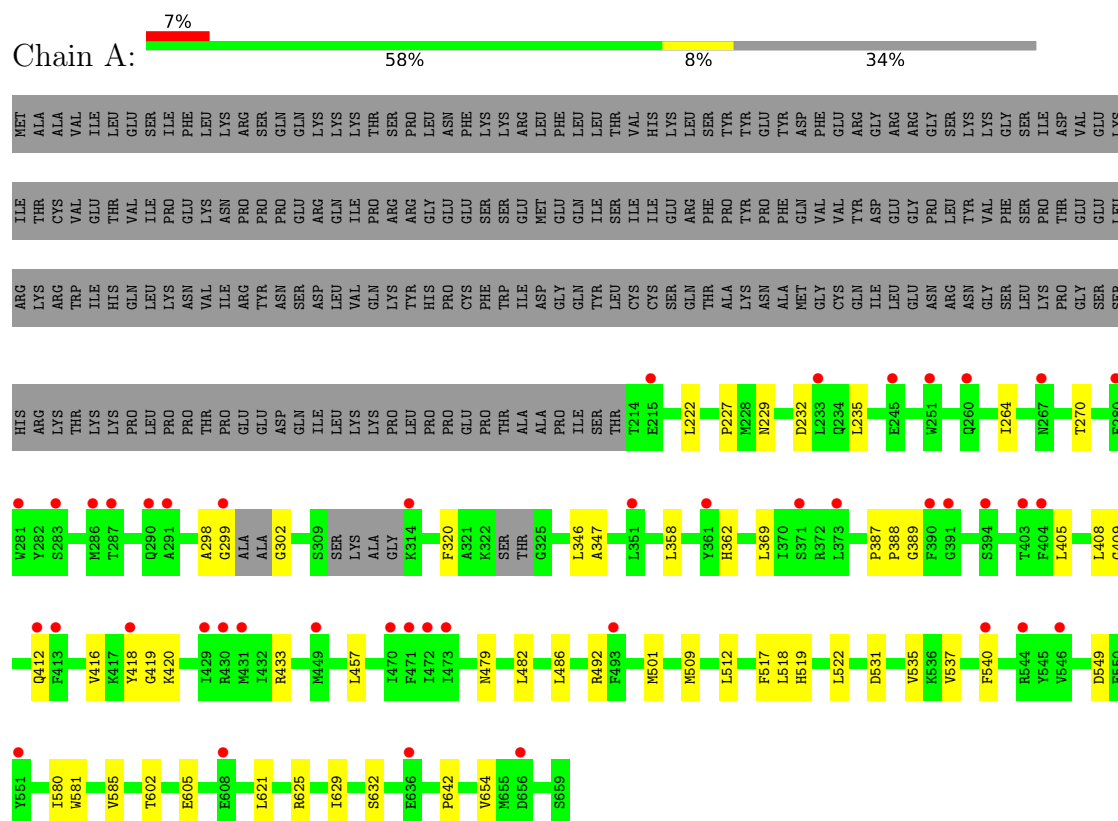


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total 93	C 37	H 44	N 8	O 4	0	0

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: Tyrosine-protein kinase BTK



4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	125.72Å 125.72Å 110.09Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	19.94 – 3.40 19.94 – 3.40	Depositor EDS
% Data completeness (in resolution range)	79.6 (19.94-3.40) 74.8 (19.94-3.40)	Depositor EDS
R_{merge}	0.27	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.47 (at 3.19Å)	Xtriage
Refinement program	PHENIX 1.20.1-4487-000	Depositor
R, R_{free}	0.272 , 0.289 0.272 , 0.289	Depositor DCC
R_{free} test set	624 reflections (3.66%)	wwPDB-VP
Wilson B-factor (Å ²)	123.9	Xtriage
Anisotropy	0.016	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.28 , 132.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.038 for -h,-k,l	Xtriage
F_o, F_c correlation	0.90	EDS
Total number of atoms	5661	wwPDB-VP
Average B, all atoms (Å ²)	170.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.43% 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: 9AJ

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	0.09	0/3201	0.22	0/4380

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	3119	2449	2583	35	0
2	A	49	44	0	1	0
All	All	3168	2493	2583	35	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 6.

All (35) 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:580:ILE:HD13	1:A:642:PRO:O	1.95	0.65
1:A:479:ASN:OD1	1:A:492:ARG:NH1	2.37	0.58

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:482:LEU:HD13	1:A:535:VAL:HG21	1.85	0.56
1:A:387:PRO:O	1:A:389:GLY:N	2.39	0.56
1:A:408:LEU:HD11	1:A:418:TYR:HB2	1.87	0.55
1:A:416:VAL:HG21	2:A:701:9AJ:C19	2.36	0.55
1:A:605:GLU:OE1	1:A:605:GLU:N	2.38	0.55
1:A:227:PRO:HB3	1:A:232:ASP:HB2	1.88	0.55
1:A:346:LEU:HD23	1:A:347:ALA:N	2.22	0.54
1:A:408:LEU:HB2	1:A:416:VAL:HG23	1.91	0.53
1:A:302:GLY:HA2	1:A:320:PHE:HB3	1.94	0.50
1:A:457:LEU:HD11	1:A:540:PHE:CD2	2.47	0.50
1:A:235:LEU:HD21	1:A:264:ILE:HG21	1.93	0.49
1:A:405:LEU:HD11	1:A:420:LYS:HG3	1.93	0.49
1:A:581:TRP:O	1:A:585:VAL:HG23	2.14	0.48
1:A:229:ASN:HB3	1:A:232:ASP:OD2	2.13	0.47
1:A:621:LEU:HD12	1:A:621:LEU:N	2.31	0.46
1:A:222:LEU:HD21	1:A:270:THR:CB	2.47	0.45
1:A:362:HIS:ND1	1:A:369:LEU:HD11	2.31	0.45
1:A:457:LEU:HD12	1:A:537:VAL:HG23	1.99	0.45
1:A:405:LEU:HG	1:A:419:GLY:HA2	1.99	0.45
1:A:625:ARG:HG2	1:A:654:VAL:HG12	1.99	0.44
1:A:602:THR:OG1	1:A:605:GLU:OE1	2.35	0.44
1:A:409:GLY:O	1:A:416:VAL:HG22	2.18	0.44
1:A:517:PHE:C	1:A:518:LEU:HD22	2.44	0.43
1:A:509:MET:SD	1:A:512:LEU:HD21	2.59	0.43
1:A:358:LEU:C	1:A:358:LEU:HD23	2.44	0.43
1:A:412:GLN:O	1:A:433:ARG:NH2	2.49	0.42
1:A:549:ASP:OD1	1:A:549:ASP:N	2.53	0.42
1:A:519:HIS:HD2	1:A:522:LEU:HD13	1.85	0.41
1:A:298:ALA:O	1:A:299:GLY:C	2.63	0.41
1:A:531:ASP:N	1:A:531:ASP:OD1	2.54	0.41
1:A:486:LEU:HD11	1:A:501:MET:HE1	2.02	0.41
1:A:408:LEU:HD21	1:A:418:TYR:HB2	2.03	0.40
1:A:629:ILE:O	1:A:632:SER:OG	2.39	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	430/659 (65%)	403 (94%)	26 (6%)	1 (0%)	43 71

All (1) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	388	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	262/593 (44%)	262 (100%)	0	100 100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

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](#)

1 ligand is 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	9AJ	A	701	-	54,56,56	2.57	25 (46%)	59,85,85	2.05	16 (27%)

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	9AJ	A	701	-	-	7/21/64/64	0/8/8/8

All (25) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	701	9AJ	C46-N48	7.11	1.49	1.39
2	A	701	9AJ	C25-C26	6.62	1.49	1.36
2	A	701	9AJ	C50-C24	6.28	1.52	1.37
2	A	701	9AJ	C50-N48	5.19	1.49	1.36
2	A	701	9AJ	C26-N27	4.34	1.46	1.37
2	A	701	9AJ	C3-C2	4.00	1.55	1.47
2	A	701	9AJ	C43-C42	-3.80	1.44	1.53
2	A	701	9AJ	C2-N15	3.67	1.44	1.38
2	A	701	9AJ	C20-C24	3.47	1.53	1.48
2	A	701	9AJ	C6-C5	3.25	1.55	1.51
2	A	701	9AJ	C45-C42	-2.87	1.47	1.53
2	A	701	9AJ	C10-C11	2.75	1.55	1.50
2	A	701	9AJ	C28-N27	2.73	1.46	1.40

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	701	9AJ	C19-C20	-2.65	1.35	1.39
2	A	701	9AJ	C10-C7	-2.63	1.49	1.54
2	A	701	9AJ	C11-C5	2.59	1.41	1.37
2	A	701	9AJ	C25-C24	2.58	1.49	1.42
2	A	701	9AJ	C6-C7	-2.53	1.49	1.54
2	A	701	9AJ	C22-C21	2.33	1.53	1.51
2	A	701	9AJ	C31-N34	2.27	1.46	1.40
2	A	701	9AJ	C26-C46	2.22	1.53	1.48
2	A	701	9AJ	C20-C21	-2.11	1.36	1.40
2	A	701	9AJ	C16-N15	2.11	1.45	1.39
2	A	701	9AJ	O47-C46	-2.06	1.18	1.23
2	A	701	9AJ	O1-C2	-2.01	1.19	1.23

All (16) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	701	9AJ	C46-C26-N27	6.43	118.06	112.05
2	A	701	9AJ	C3-C2-N15	4.79	121.28	115.51
2	A	701	9AJ	C14-C13-N12	4.59	116.17	109.06
2	A	701	9AJ	C7-C6-C5	4.04	108.00	104.05
2	A	701	9AJ	C36-N37-C38	3.98	112.09	108.17
2	A	701	9AJ	C26-C46-N48	3.89	120.06	116.41
2	A	701	9AJ	C19-C18-N17	-3.31	119.92	123.97
2	A	701	9AJ	C32-N33-C28	2.75	120.41	117.83
2	A	701	9AJ	C13-N12-C3	-2.58	117.73	122.19
2	A	701	9AJ	C2-C3-N12	-2.46	118.52	120.96
2	A	701	9AJ	N27-C28-N33	2.22	121.52	114.87
2	A	701	9AJ	C49-N48-C46	2.18	120.12	117.14
2	A	701	9AJ	C18-N17-C16	2.14	119.89	115.05
2	A	701	9AJ	O1-C2-C3	-2.12	119.37	122.45
2	A	701	9AJ	C13-C14-N15	2.06	114.39	110.66
2	A	701	9AJ	C29-C28-N33	-2.05	119.49	122.61

There are no chirality outliers.

All (7) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	701	9AJ	N17-C16-N15-C14
2	A	701	9AJ	C21-C16-N15-C14
2	A	701	9AJ	C32-C31-N34-C35
2	A	701	9AJ	N33-C28-N27-C26
2	A	701	9AJ	C29-C28-N27-C26

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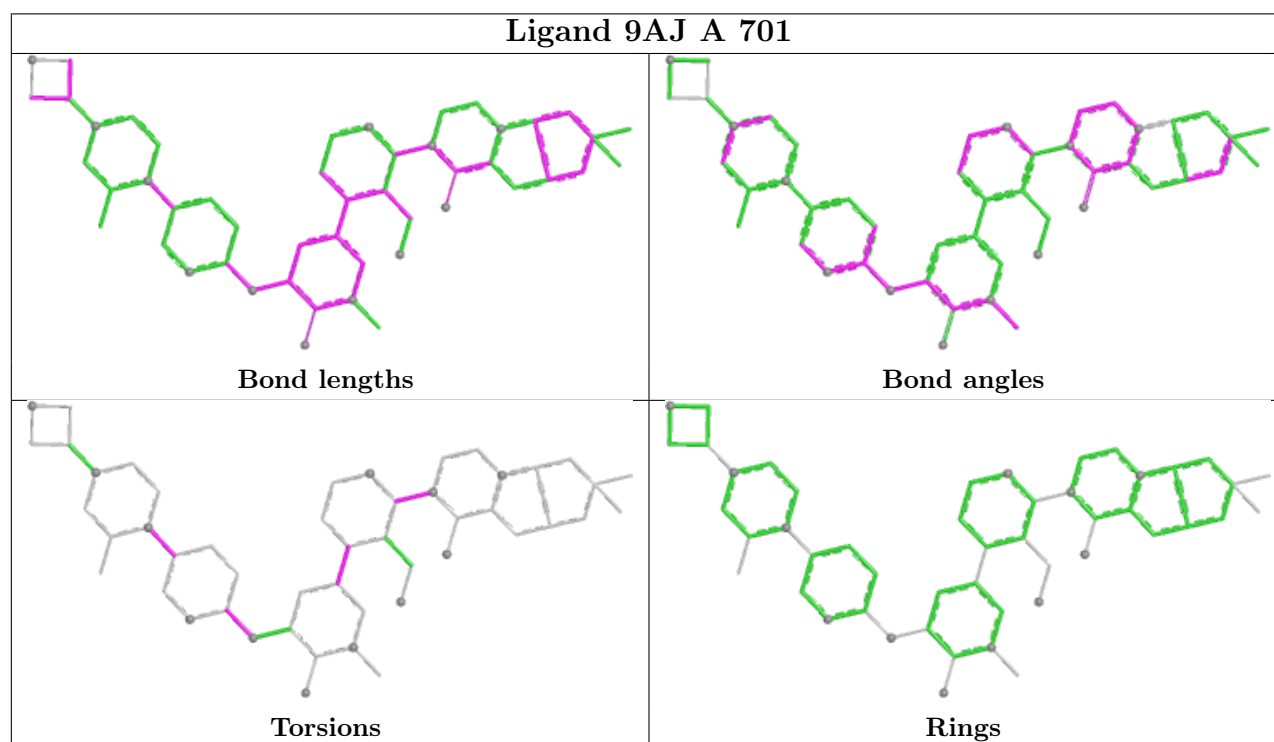
Mol	Chain	Res	Type	Atoms
2	A	701	9AJ	C32-C31-N34-C39
2	A	701	9AJ	C21-C20-C24-C25

There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	701	9AJ	1	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

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	438/659 (66%)	0.74	43 (9%) 13 13	89, 169, 236, 305	0

All (43) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	299	GLY	5.6
1	A	390	PHE	4.3
1	A	287	THR	4.3
1	A	314	LYS	4.1
1	A	280	GLU	4.1
1	A	291	ALA	3.7
1	A	373	LEU	3.6
1	A	470	ILE	3.5
1	A	430	ARG	3.3
1	A	431	MET	3.2
1	A	418	TYR	3.2
1	A	473	ILE	3.1
1	A	413	PHE	3.0
1	A	286	MET	3.0
1	A	283	SER	3.0
1	A	429	ILE	3.0
1	A	493	PHE	2.9
1	A	267	ASN	2.8
1	A	404	PHE	2.7
1	A	540	PHE	2.7
1	A	251	TRP	2.6
1	A	472	ILE	2.6
1	A	394	SER	2.5
1	A	371	SER	2.5
1	A	403	THR	2.5
1	A	471	PHE	2.4
1	A	290	GLN	2.4

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Mol	Chain	Res	Type	RSRZ
1	A	391	GLY	2.4
1	A	281	TRP	2.3
1	A	608	GLU	2.3
1	A	544	ARG	2.2
1	A	636	GLU	2.2
1	A	551	TYR	2.2
1	A	233	LEU	2.2
1	A	449	MET	2.2
1	A	361	TYR	2.2
1	A	215	GLU	2.2
1	A	260	GLN	2.1
1	A	245	GLU	2.1
1	A	412	GLN	2.1
1	A	351	LEU	2.0
1	A	656	ASP	2.0
1	A	546	VAL	2.0

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 [i](#)

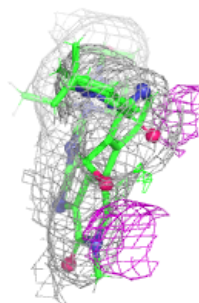
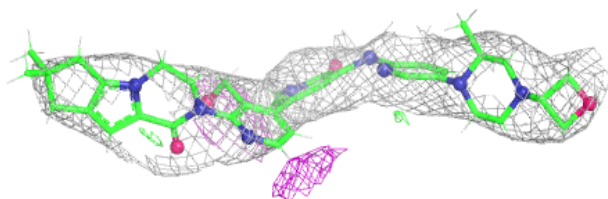
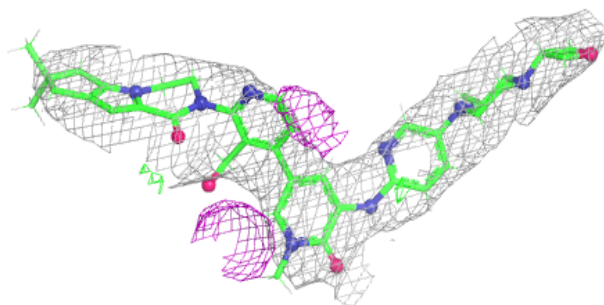
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
2	9AJ	A	701	49/49	0.91	0.12	71,147,207,226	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 9AJ A 701:

$2mF_o - DF_c$ (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.