Full wwPDB X-ray Structure Validation Report (i)

Jul 1, 2025 – 10:04 AM EDT

PDB ID	:	9NFR / pdb_00009nfr
Title	:	Crystal structure of CRBN-DDB1 and MRT-23227 in complex with VAV1
Authors	:	Trenh, P.; Bunker, R.D.; Lucas, X.; Gainza, P.; Tsai, J.H.C.
Deposited on	:	2025-02-21
Resolution	:	3.40 Å(reported)

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

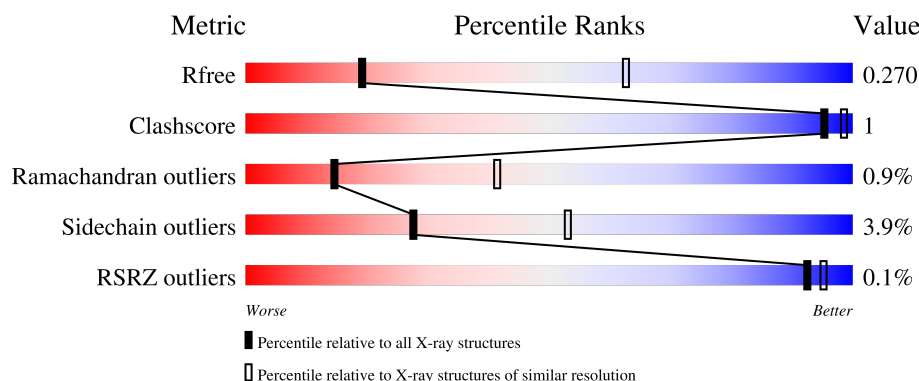|		
MolProbity	:	4-5-2 with Phenix2.0rc1
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	2.0rc1
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.006 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.44

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	Percentile Ranks	Value
Rfree		0.270
Clashscore		1
Ramachandran outliers		0.9%
Sidechain outliers		3.9%
RSRZ outliers		0.1%

Worse   *Better*

▮ Percentile relative to all X-ray structures

▯ Percentile relative to X-ray structures of similar resolution

Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	164625	1140 (3.46-3.34)
Clashscore	180529	1172 (3.46-3.34)
Ramachandran outliers	177936	1172 (3.46-3.34)
Sidechain outliers	177891	1172 (3.46-3.34)
RSRZ outliers	164620	1140 (3.46-3.34)

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	1140	91% 7% ••
2	B	442	76% • 20%
3	C	59	88% 5% 7%

2 Entry composition ⓘ

There are 5 unique types of molecules in this entry. The entry contains 12092 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 damage-binding protein 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	1119	Total	C	N	O	S	0	0	0
			8770	5555	1481	1687	47			

- Molecule 2 is a protein called Protein cereblon.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	353	Total	C	N	O	S	0	0	0
			2846	1817	485	521	23			

- Molecule 3 is a protein called Proto-oncogene vav.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	55	Total	C	N	O	S	0	0	0
			454	289	82	82	1			

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
C	781	GLY	-	expression tag	UNP P15498

- Molecule 4 is ZINC ION (CCD ID: ZN) (formula: Zn).

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

- Molecule 5 is (3R)-3-{2-chloro-4'-[(1-methyl-1H-pyrazol-3-yl)methoxy][1,1'-biphenyl]-3-yl}piperidine-2,6-dione (CCD ID: A1BYX) (formula: $C_{22}H_{20}ClN_3O_3$) (labeled as "Ligand of Interest" by depositor).

A1BYX
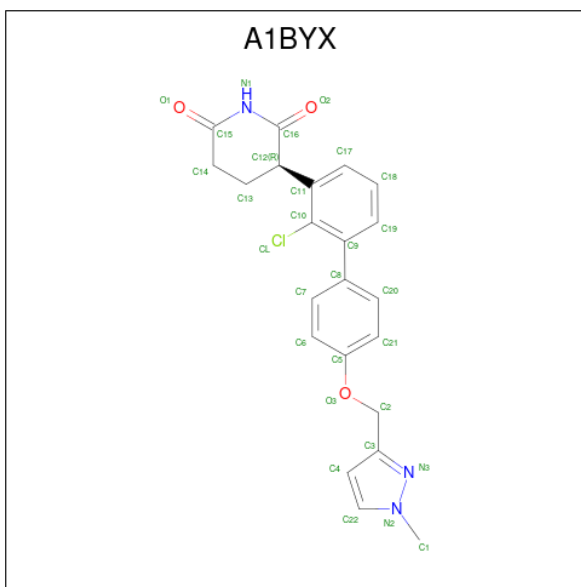
| Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
5	B	1	Total	C	Cl	N	O	0	0
			21	17	1	1	2		

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.
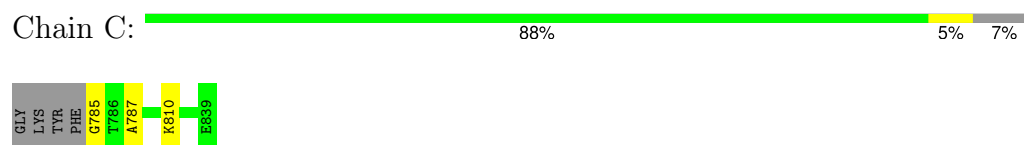
• Molecule 1: DNA damage-binding protein 1

Chain A:
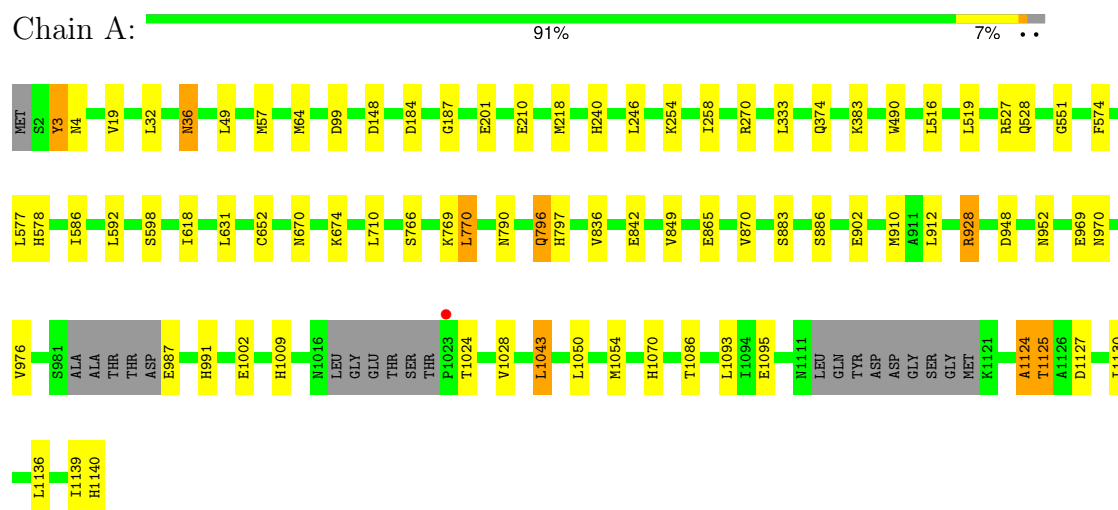
• Molecule 2: Protein cereblon

Chain B:
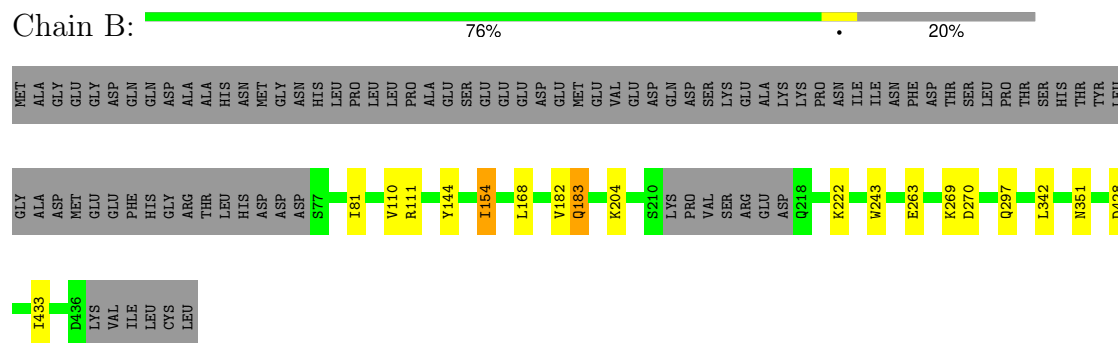
• Molecule 3: Proto-oncogene vav

Chain C:

4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	P 61 2 2	Depositor
Cell constants a, b, c, α, β, γ	143.60Å 143.60Å 367.64Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	55.45 – 3.40 55.45 – 3.40	Depositor EDS
% Data completeness (in resolution range)	97.8 (55.45-3.40) 97.7 (55.45-3.40)	Depositor EDS
R_{merge}	0.34	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	0.94 (at 3.26Å)	Xtriage
Refinement program	PHENIX dev_5430	Depositor
R, R_{free}	0.211 , 0.271 0.211 , 0.270	Depositor DCC
R_{free} test set	2235 reflections (4.92%)	wwPDB-VP
Wilson B-factor (Å^2)	109.4	Xtriage
Anisotropy	0.029	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 94.1	EDS
L-test for twinning[2]	$< |L| > = 0.46, < L^2 > = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	12092	wwPDB-VP
Average B, all atoms (Å^2)	129.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 1.96% 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: ZN, A1BYX

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	0.70	0/8931	0.89	1/12094 (0.0%)
2	B	0.73	1/2912 (0.0%)	0.90	0/3950
3	C	0.75	0/465	0.84	0/622
All	All	0.71	1/12308 (0.0%)	0.89	1/16666 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	154	ILE	CA-CB	5.03	1.60	1.54

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	1124	ALA	N-CA-C	6.23	117.74	111.07

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	8770	0	8744	21	0
2	B	2846	0	2852	4	0
3	C	454	0	439	1	0

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

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
4	B	1	0	0	0	0
5	B	21	0	0	3	0
All	All	12092	0	12035	27	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 (27) 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:210:GLU:OE1	1:A:240:HIS:ND1	2.30	0.62
2:B:111:ARG:NH1	2:B:144:TYR:OH	2.34	0.61
5:B:502:A1BYX:CL	5:B:502:A1BYX:C7	2.92	0.55
1:A:836:VAL:HG21	2:B:243:TRP:NE1	2.26	0.51
5:B:502:A1BYX:CL	5:B:502:A1BYX:C16	2.96	0.49
3:C:785:GLY:N	3:C:810:LYS:HZ2	2.10	0.49
1:A:36:ASN:ND2	1:A:1002:GLU:OE2	2.46	0.48
1:A:952:ASN:ND2	1:A:969:GLU:OE1	2.45	0.48
1:A:1095:GLU:OE2	1:A:1140:HIS:NE2	2.47	0.47
1:A:796:GLN:NE2	1:A:797:HIS:CE1	2.83	0.46
1:A:490:TRP:CD1	1:A:519:LEU:HD21	2.51	0.46
1:A:1136:LEU:O	1:A:1139:ILE:HG12	2.15	0.46
1:A:1050:LEU:O	1:A:1054:MET:SD	2.75	0.45
1:A:928:ARG:HB2	1:A:952:ASN:O	2.16	0.44
1:A:948:ASP:OD2	1:A:991:HIS:NE2	2.50	0.44
1:A:1124:ALA:O	1:A:1125:THR:O	2.36	0.44
2:B:351:ASN:HD22	5:B:502:A1BYX:C18	2.31	0.44
1:A:19:VAL:HG22	1:A:64:MET:HE3	1.99	0.43
1:A:4:ASN:ND2	1:A:976:VAL:HG21	2.33	0.43
1:A:1127:ASP:HA	1:A:1130:ILE:HD12	2.00	0.43
1:A:1070:HIS:CE1	1:A:1093:LEU:HD22	2.53	0.43
1:A:184:ASP:OD1	1:A:187:GLY:O	2.38	0.41
1:A:1024:THR:HG22	1:A:1043:LEU:HG	2.01	0.41
1:A:218:MET:HE1	1:A:258:ILE:HG22	2.02	0.41
2:B:168:LEU:HD21	2:B:183:GLN:HB2	2.03	0.41
1:A:1009:HIS:CE1	1:A:1028:VAL:HG22	2.55	0.41
1:A:770:LEU:HD13	1:A:865:GLU:HB2	2.02	0.40

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	1111/1140 (98%)	1035 (93%)	66 (6%)	10 (1%)	14	41
2	B	349/442 (79%)	327 (94%)	20 (6%)	2 (1%)	22	50
3	C	53/59 (90%)	45 (85%)	7 (13%)	1 (2%)	6	26
All	All	1513/1641 (92%)	1407 (93%)	93 (6%)	13 (1%)	14	41

All (13) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	1125	THR
1	A	574	PHE
1	A	578	HIS
1	A	970	ASN
2	B	428	ASP
3	C	787	ALA
1	A	3	TYR
1	A	148	ASP
1	A	36	ASN
1	A	710	LEU
1	A	598	SER
2	B	270	ASP
1	A	551	GLY

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	983/999 (98%)	943 (96%)	40 (4%)	26	51
2	B	320/398 (80%)	308 (96%)	12 (4%)	28	54
3	C	44/47 (94%)	44 (100%)	0	100	100
All	All	1347/1444 (93%)	1295 (96%)	52 (4%)	27	53

All (52) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	3	TYR
1	A	32	LEU
1	A	49	LEU
1	A	57	MET
1	A	99	ASP
1	A	201	GLU
1	A	246	LEU
1	A	254	LYS
1	A	270	ARG
1	A	333	LEU
1	A	374	GLN
1	A	383	LYS
1	A	516	LEU
1	A	527	ARG
1	A	528	GLN
1	A	577	LEU
1	A	586	ILE
1	A	592	LEU
1	A	618	ILE
1	A	631	LEU
1	A	652	CYS
1	A	670	ASN
1	A	674	LYS
1	A	766	SER
1	A	769	LYS
1	A	770	LEU
1	A	790	ASN
1	A	796	GLN
1	A	842	GLU
1	A	849	VAL
1	A	870	VAL
1	A	883	SER
1	A	886	SER
1	A	902	GLU

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Mol	Chain	Res	Type
1	A	910	MET
1	A	912	LEU
1	A	928	ARG
1	A	987	GLU
1	A	1043	LEU
1	A	1086	THR
2	B	81	ILE
2	B	110	VAL
2	B	154	ILE
2	B	182	VAL
2	B	183	GLN
2	B	204	LYS
2	B	222	LYS
2	B	263	GLU
2	B	269	LYS
2	B	297	GLN
2	B	342	LEU
2	B	433	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (22) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	4	ASN
1	A	189	HIS
1	A	209	GLN
1	A	234	GLN
1	A	462	ASN
1	A	466	GLN
1	A	600	HIS
1	A	670	ASN
1	A	696	ASN
1	A	731	GLN
1	A	796	GLN
1	A	797	HIS
1	A	826	ASN
1	A	941	ASN
1	A	950	ASN
1	A	1059	ASN
2	B	100	GLN
2	B	105	GLN
2	B	173	GLN
2	B	233	HIS

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Mol	Chain	Res	Type
2	B	260	GLN
2	B	351	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 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	$\#|Z| > 2$
5	A1BYX	B	502	-	23,23,32	0.29	0	27,32,45	0.45	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
5	A1BYX	B	502	-	-	0/8/21/26	0/3/3/4

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	B	502	A1BYX	3	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 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 A1BYX B 502
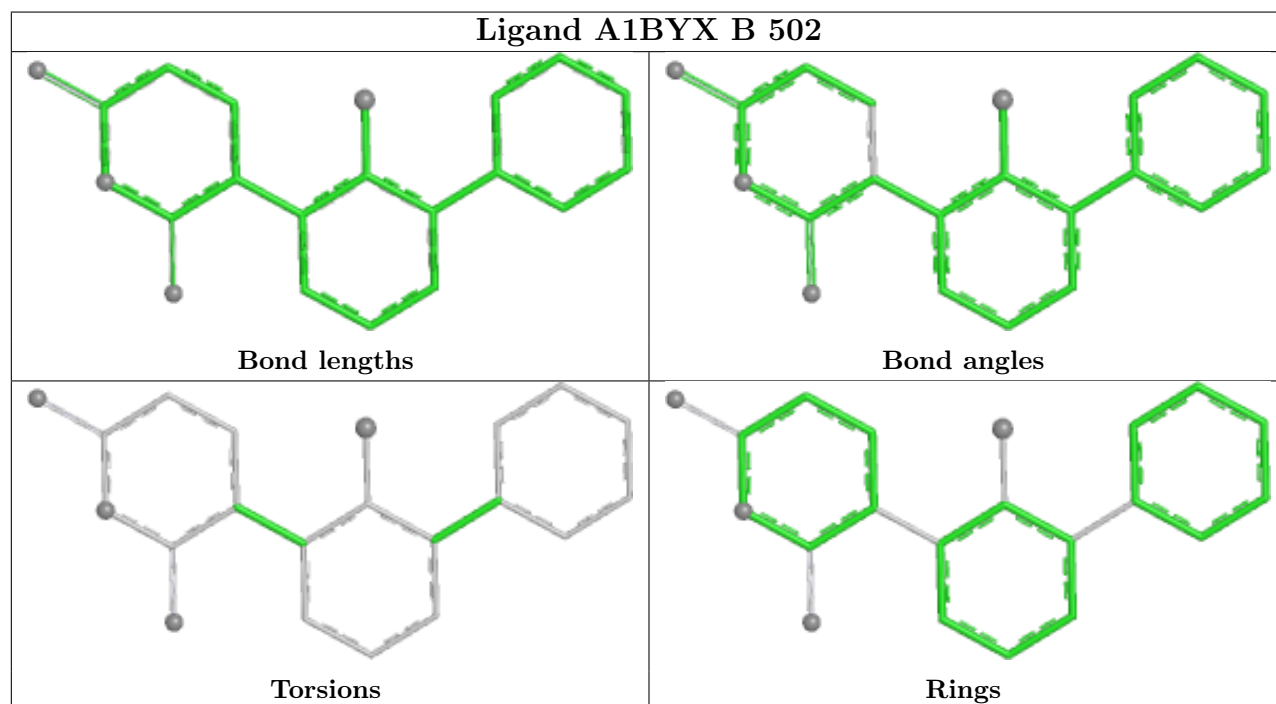
5.7 Other polymers ⓘ

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 ⓘ

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(Å²)	Q<0.9
1	A	1119/1140 (98%)	-0.58	1 (0%)	92	95	66, 122, 182, 277	0
2	B	353/442 (79%)	-0.53	0	100	100	74, 120, 201, 247	0
3	C	55/59 (93%)	-0.14	0	100	100	134, 186, 231, 284	0
All	All	1527/1641 (93%)	-0.55	1 (0%)	92	95	66, 123, 195, 284	0

All (1) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	1023	PRO	2.3

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

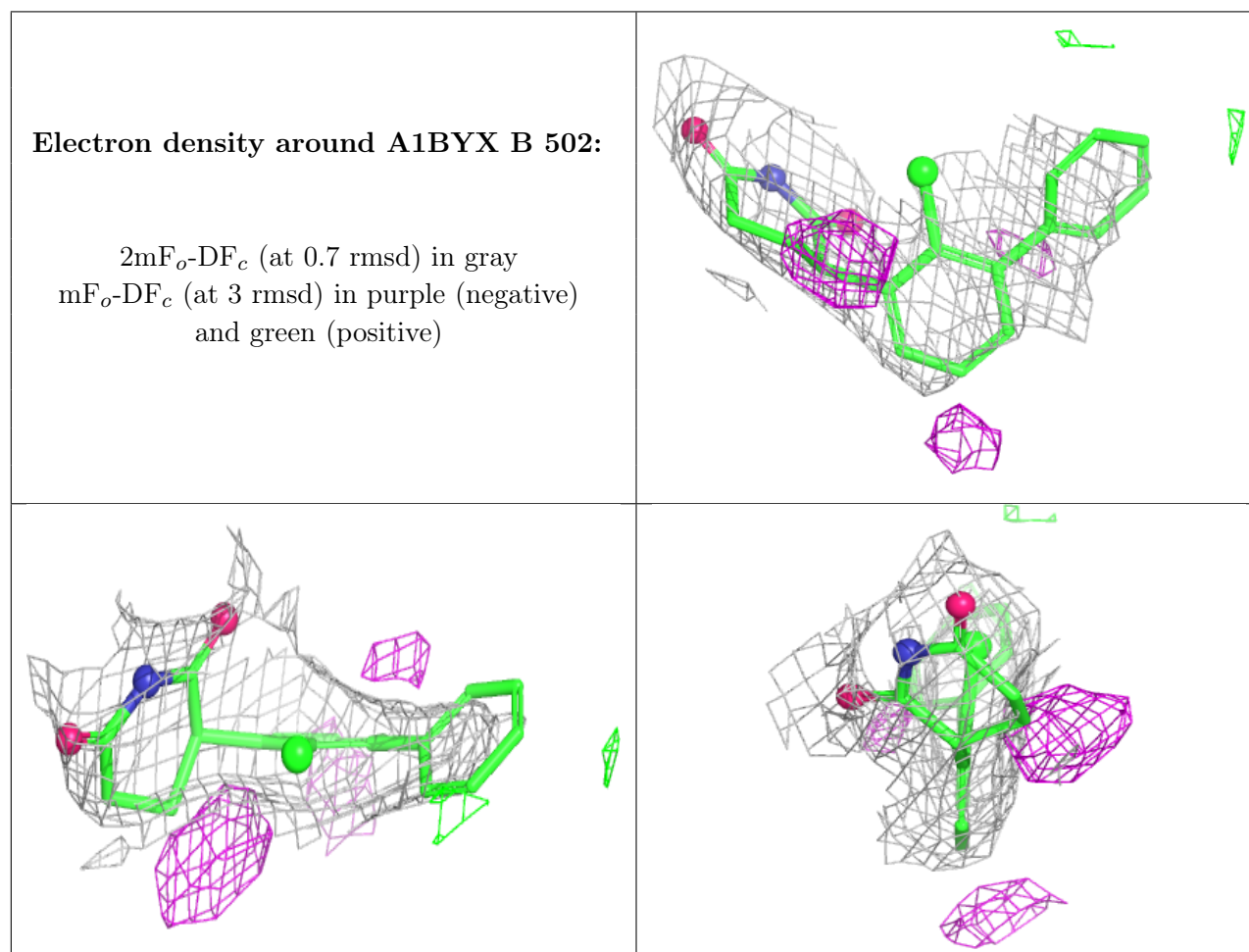There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no 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(Å²)	Q<0.9
5	A1BYX	B	502	21/29	0.81	0.10	109,145,156,161	0
4	ZN	B	501	1/1	0.98	0.07	151,151,151,151	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 A1BYX B 502:

$2mF_o$-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.