wwPDB X-ray Structure Validation Summary Report (i)

Nov 12, 2025 – 12:12 am GMT

PDB ID	:	9SFM / pdb_00009sfm
Title	:	Crystal structure of Cereblon-DDB1 in complex with SB-405483 and Lenalidomide
Authors	:	Chung, C.
Deposited on	:	2025-08-19
Resolution	:	2.39 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 (i) 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 (i)) were used in the production of this report:

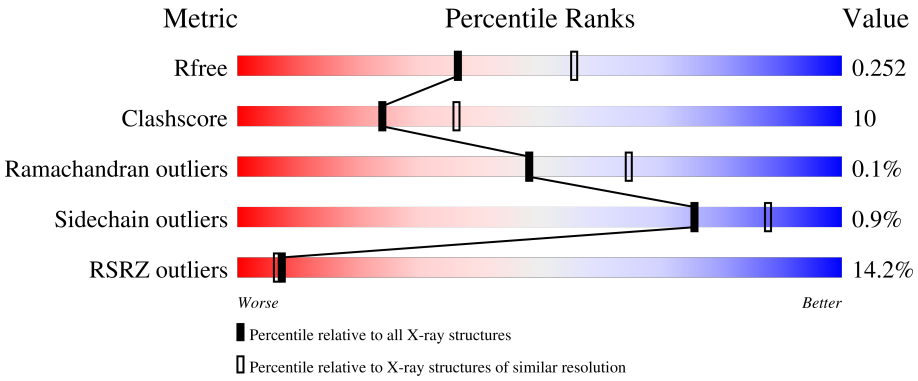
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20231227.v01 (using entries in the PDB archive December 27th 2023)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.46

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.39 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}	164625	4642 (2.40-2.40)
Clashscore	180529	5218 (2.40-2.40)
Ramachandran outliers	177936	5158 (2.40-2.40)
Sidechain outliers	177891	5159 (2.40-2.40)
RSRZ outliers	164620	4642 (2.40-2.40)

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	1148	14% 78% 19%
2	B	382	14% 73% 24%

2 Entry composition (i)

There are 7 unique types of molecules in this entry. The entry contains 12372 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
			Total	C	N	O	S			
1	A	1124	8798	5578	1490	1681	49	0	4	0

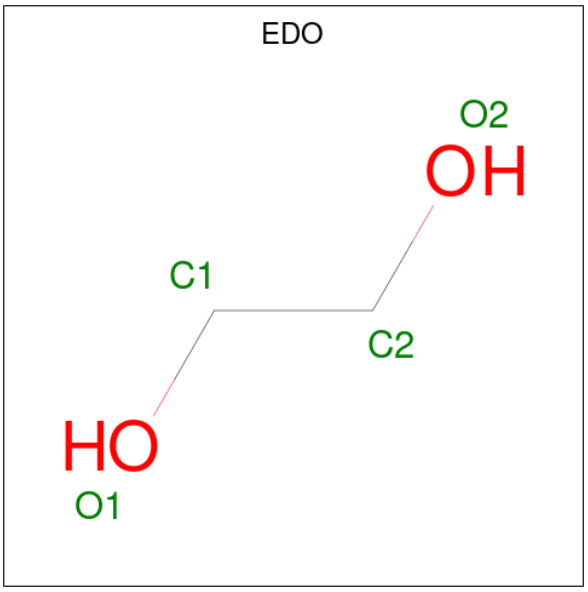
There are 8 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1141	TRP	-	expression tag	UNP Q16531
A	1142	SER	-	expression tag	UNP Q16531
A	1143	HIS	-	expression tag	UNP Q16531
A	1144	PRO	-	expression tag	UNP Q16531
A	1145	GLN	-	expression tag	UNP Q16531
A	1146	PHE	-	expression tag	UNP Q16531
A	1147	GLU	-	expression tag	UNP Q16531
A	1148	LYS	-	expression tag	UNP Q16531

- Molecule 2 is a protein called Protein cereblon.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	376	3053	1949	523	557	24	0	3	0

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: $C_2H_6O_2$).

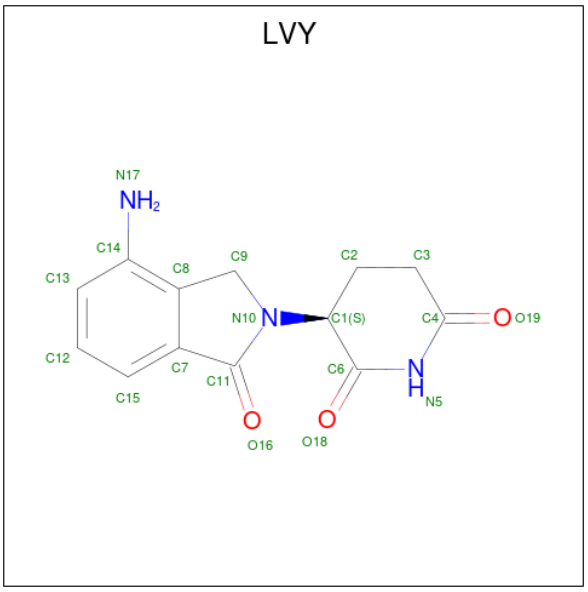


Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C O 4 2 2	0	0
3	A	1	Total C O 4 2 2	0	0
3	A	1	Total C O 4 2 2	0	0
3	A	1	Total C O 4 2 2	0	0
3	A	1	Total C O 4 2 2	0	0
3	B	1	Total C O 4 2 2	0	0

- Molecule 4 is ZINC ION (CCD ID: ZN) (formula: Zn) (labeled as "Ligand of Interest" by depositor).

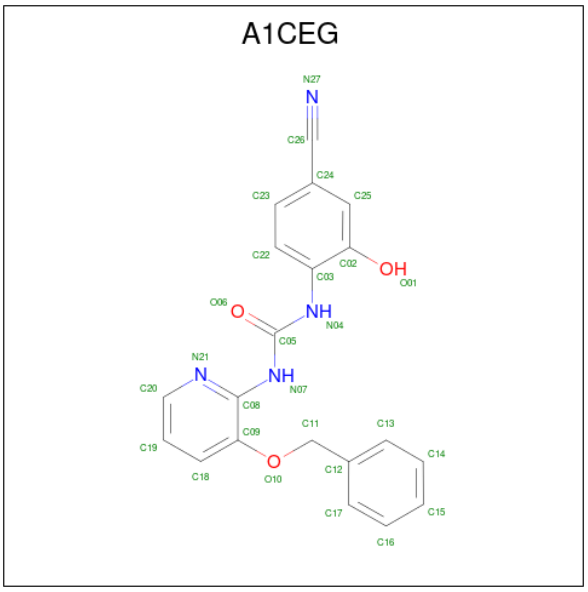
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	B	1	Total Zn 1 1	0	0

- Molecule 5 is S-Lenalidomide (CCD ID: LVY) (formula: $C_{13}H_{13}N_3O_3$).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
5	B	1	19	13	3	3	0	0

- Molecule 6 is N-[3-(benzyloxy)pyridin-2-yl]-N'-(4-cyano-2-hydroxyphenyl)urea (CCD ID: A1CEG) (formula: $C_{20}H_{16}N_4O_3$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
			Total	C	N	O		
6	B	1	27	20	4	3	0	0

- Molecule 7 is water.

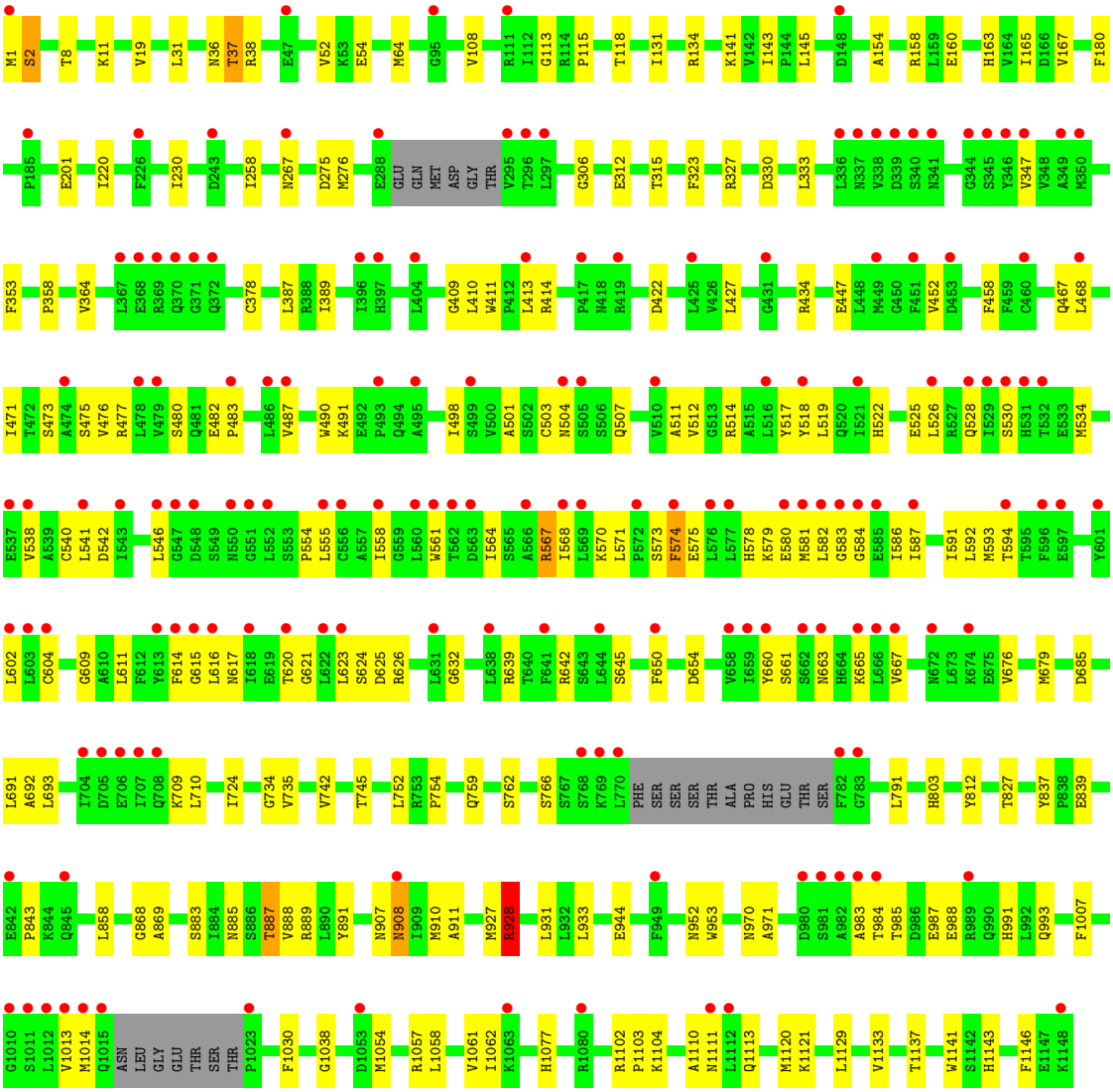
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	A	371	Total O 371 371	0	0
7	B	79	Total O 79 79	0	0

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 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.

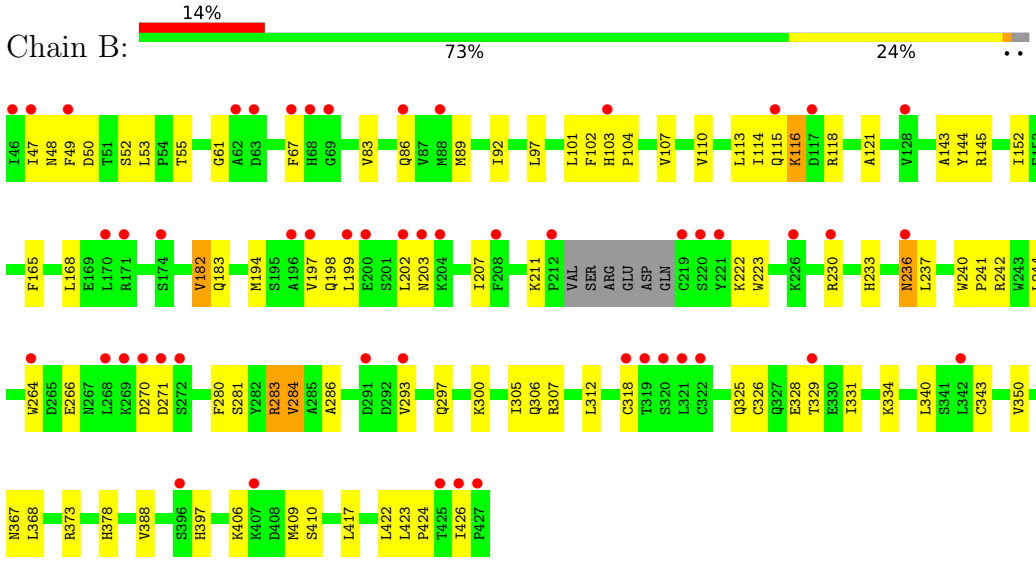
• Molecule 1: DNA damage-binding protein 1

Chain A:



• Molecule 2: Protein cereblon

Chain B:


14%
73%
24%
I46 I47 N48 F49 D50 T51 S52 L53 P54 T55 G61 A62 D63 F67 H68 G69 V83 Q86 V87 M88 M89 I92 L97 L101 F102 H103 P104 V107 V110 L113 I114 Q115 K116 D117 R118 A121 V128 A143 Y144 R145 I152 E153 I154 V155 K158
F165 L168 E169 L170 R171 S174 V182 Q183 M194 S195 A196 V197 Q198 L199 E200 S201 L202 N203 K204 I207 F208 K211 P212 VAL SER ARG GLU ASP GLN C219 S220 Y221 K222 W223 K226 R230 H233 N236 L237 W240 P241 R242 W243 L244 A250 I257
W264 D265 E266 N267 L268 K269 D270 D271 S272 F280 S281 Y282 R283 V284 A285 A286 D291 D292 V293 Q297 K300 I305 Q306 R307 L312 C318 T319 S320 L321 C322 Q325 C326 Q327 E328 T329 E330 I331 K334 L340 S341 L342 C343 V350 Y355 Y363
N367 L368 R373 H378 V388 S396 H397 K406 K407 D408 M409 S410 L417 L422 L423 P424 T425 I426 P427

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	72.16Å 129.52Å 198.80Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	99.40 – 2.39 99.40 – 2.39	Depositor EDS
% Data completeness (in resolution range)	99.8 (99.40-2.39) 100.0 (99.40-2.39)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.16 (at 2.40Å)	Xtriage
Refinement program	PHENIX (1.20.1_4487: ???)	Depositor
R, R_{free}	0.195 , 0.244 0.216 , 0.252	Depositor DCC
R_{free} test set	3697 reflections (4.94%)	wwPDB-VP
Wilson B-factor (Å^2)	54.5	Xtriage
Anisotropy	0.105	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.30 , 44.0	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.94	EDS
Total number of atoms	12372	wwPDB-VP
Average B, all atoms (Å^2)	67.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.53% of the height of the origin peak. No significant pseudotranslation is detected.*

[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: LVY, A1CEG, EDO, ZN

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	0.73	0/8961	0.97	2/12139 (0.0%)
2	B	0.94	0/3127	1.21	0/4244
All	All	0.79	0/12088	1.04	2/16383 (0.0%)

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	5
2	B	0	2
All	All	0	7

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	984	THR	N-CA-C	-5.80	106.85	114.04
1	A	574	PHE	CA-CB-CG	5.38	119.18	113.80

There are no chirality outliers.

5 of 7 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	37	THR	Mainchain
1	A	434	ARG	Sidechain
1	A	567	ARG	Sidechain
1	A	928	ARG	Sidechain

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Group
2	B	242	ARG	Sidechain

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	8798	0	8738	170	1
2	B	3053	0	3038	73	1
3	A	20	0	30	1	0
3	B	4	0	6	1	0
4	B	1	0	0	0	0
5	B	19	0	13	0	0
6	B	27	0	0	1	0
7	A	371	0	0	5	1
7	B	79	0	0	1	1
All	All	12372	0	11825	236	2

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 10.

The worst 5 of 236 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:650:PHE:HB3	1:A:679:MET:HE2	1.49	0.91
1:A:570:LYS:HB2	1:A:573:SER:HB2	1.54	0.87
1:A:498:ILE:HA	1:A:512:VAL:HG12	1.60	0.82
2:B:86:GLN:NE2	2:B:103[B]:HIS:HD2	1.78	0.81
2:B:86:GLN:NE2	2:B:103[B]:HIS:CD2	2.50	0.79

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:447:GLU:OE2	2:B:373:ARG:CD[3_544]	1.76	0.44
7:A:1641:HOH:O	7:B:651:HOH:O[4_554]	2.12	0.08

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	1120/1148 (98%)	1089 (97%)	31 (3%)	0	100 100
2	B	375/382 (98%)	369 (98%)	4 (1%)	2 (0%)	25 38
All	All	1495/1530 (98%)	1458 (98%)	35 (2%)	2 (0%)	48 65

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	116	LYS
2	B	325	GLN

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	975/1007 (97%)	967 (99%)	8 (1%)	79 90
2	B	341/346 (99%)	337 (99%)	4 (1%)	67 82
All	All	1316/1353 (97%)	1304 (99%)	12 (1%)	75 88

5 of 12 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	928	ARG
2	B	182	VAL
2	B	284	VAL
2	B	222	LYS

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	745	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 23 such sidechains are listed below:

Mol	Chain	Res	Type
1	A	991	HIS
2	B	112	ASN
2	B	100	GLN
2	B	129	GLN
1	A	672	ASN

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 9 ligands modelled in this entry, 1 is monoatomic - leaving 8 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	EDO	A	1203	-	3,3,3	0.51	0	2,2,2	0.46	0
3	EDO	A	1205	-	3,3,3	0.71	0	2,2,2	0.14	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\|>2$	Counts	RMSZ	$\#\|Z\|>2$
6	A1CEG	B	504	-	29,29,29	0.64	0	35,38,38	1.19	5 (14%)
3	EDO	A	1202	-	3,3,3	0.54	0	2,2,2	0.28	0
5	LVY	B	503	-	21,21,21	1.01	1 (4%)	28,31,31	4.18	11 (39%)
3	EDO	A	1201	-	3,3,3	0.42	0	2,2,2	0.82	0
3	EDO	B	502	-	3,3,3	0.55	0	2,2,2	0.28	0
3	EDO	A	1204	-	3,3,3	0.46	0	2,2,2	0.66	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
3	EDO	A	1203	-	-	1/1/1/1	-
3	EDO	A	1205	-	-	1/1/1/1	-
6	A1CEG	B	504	-	-	2/15/15/15	0/3/3/3
3	EDO	A	1202	-	-	1/1/1/1	-
5	LVY	B	503	-	-	0/4/29/29	0/3/3/3
3	EDO	A	1201	-	-	1/1/1/1	-
3	EDO	B	502	-	-	0/1/1/1	-
3	EDO	A	1204	-	-	0/1/1/1	-

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
5	B	503	LVY	C14-C8	-2.36	1.39	1.40

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

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	B	503	LVY	C8-C9-N10	12.05	105.65	101.79
5	B	503	LVY	C9-N10-C11	-11.40	108.43	113.12
5	B	503	LVY	C7-C11-N10	8.78	111.62	106.44
5	B	503	LVY	C9-N10-C1	4.81	128.30	123.69
5	B	503	LVY	C3-C4-N5	4.70	121.93	116.65

There are no chirality outliers.

5 of 6 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	1202	EDO	O1-C1-C2-O2

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms
3	A	1203	EDO	O1-C1-C2-O2
3	A	1205	EDO	O1-C1-C2-O2
3	A	1201	EDO	O1-C1-C2-O2
6	B	504	A1CEG	C18-C09-O10-C11

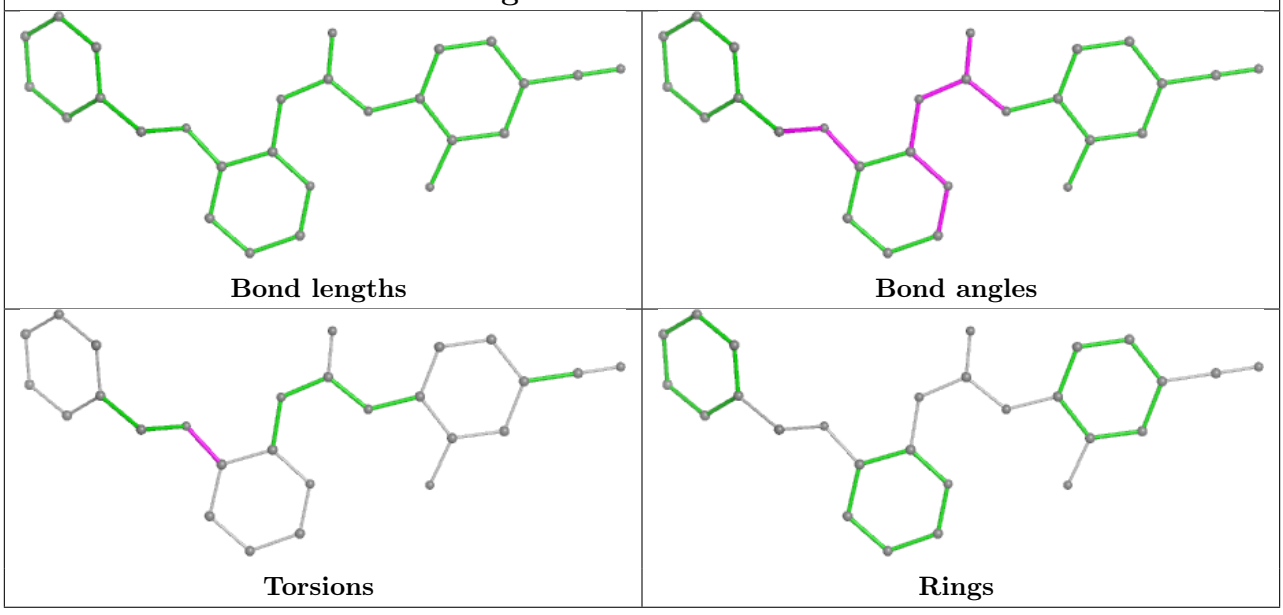
There are no ring outliers.

3 monomers are involved in 3 short contacts:

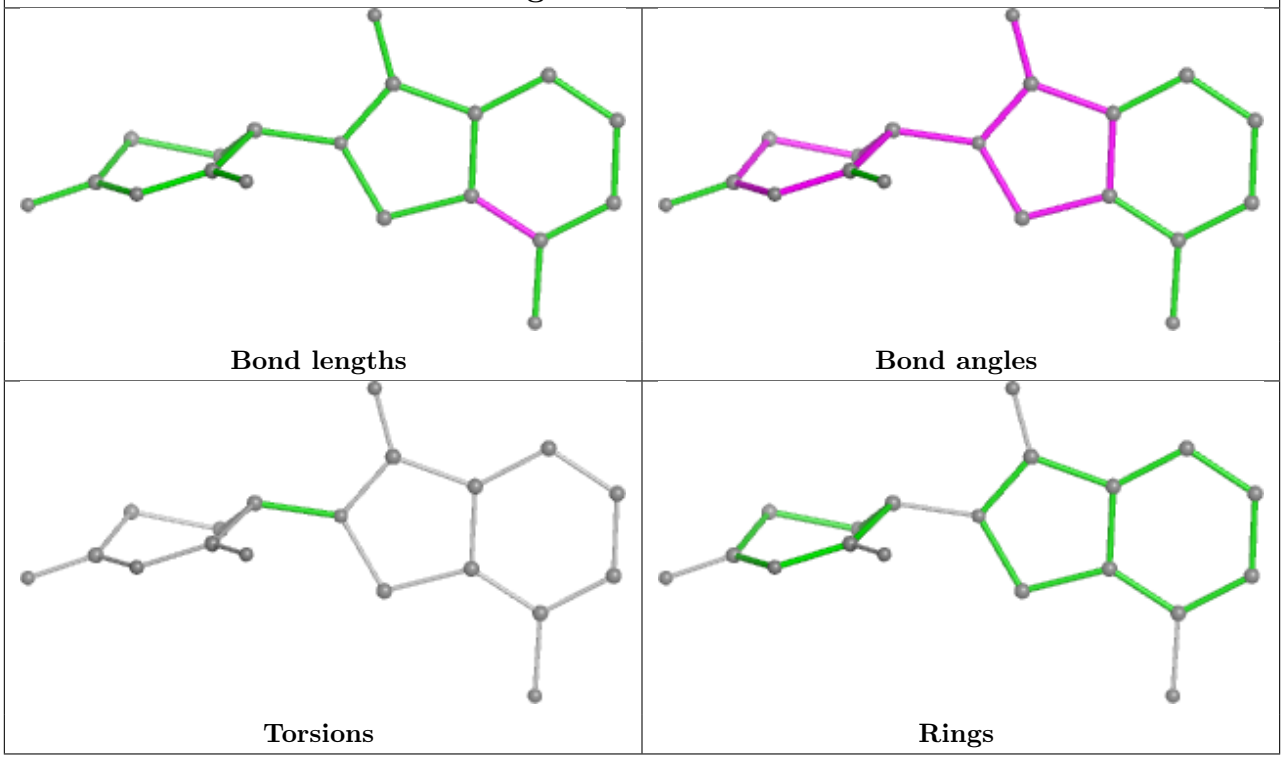
Mol	Chain	Res	Type	Clashes	Symm-Clashes
6	B	504	A1CEG	1	0
3	B	502	EDO	1	0
3	A	1204	EDO	1	0

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 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 A1CEG B 504



Ligand LVY B 503



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

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^{th} 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	1124/1148 (97%)	0.64	159 (14%) 7 6	21, 56, 126, 184	4 (0%)
2	B	376/382 (98%)	1.05	54 (14%) 7 6	29, 64, 122, 176	3 (0%)
All	All	1500/1530 (98%)	0.74	213 (14%) 7 6	21, 58, 126, 184	7 (0%)

The worst 5 of 213 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	346	TYR	5.9
2	B	212	PRO	5.4
1	A	574	PHE	5.3
1	A	295	VAL	5.2
2	B	426	ILE	5.2

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

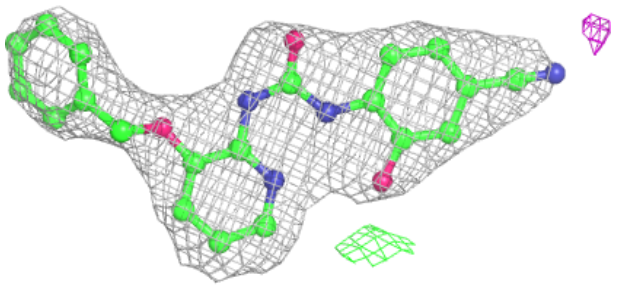
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95^{th} percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9'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

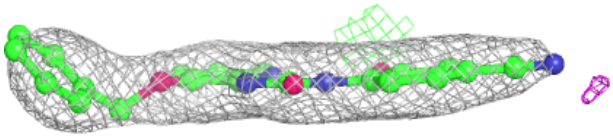
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
3	EDO	B	502	4/4	0.78	0.17	68,78,78,79	0
3	EDO	A	1204	4/4	0.82	0.15	57,58,69,70	0
3	EDO	A	1205	4/4	0.87	0.18	62,69,70,82	0
3	EDO	A	1201	4/4	0.90	0.13	42,42,43,61	0
3	EDO	A	1202	4/4	0.93	0.11	47,48,48,65	0
6	A1CEG	B	504	27/27	0.93	0.11	62,69,86,87	0
5	LVY	B	503	19/19	0.96	0.07	39,50,56,63	0
3	EDO	A	1203	4/4	0.97	0.10	43,43,44,50	0
4	ZN	B	501	1/1	0.98	0.04	56,56,56,56	0

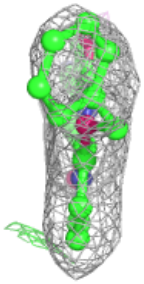
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.

Electron density around A1CEG B 504:

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

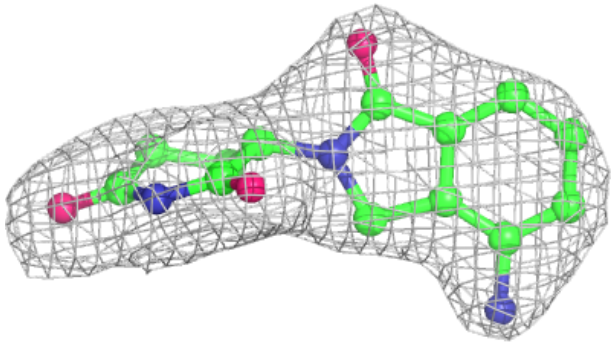


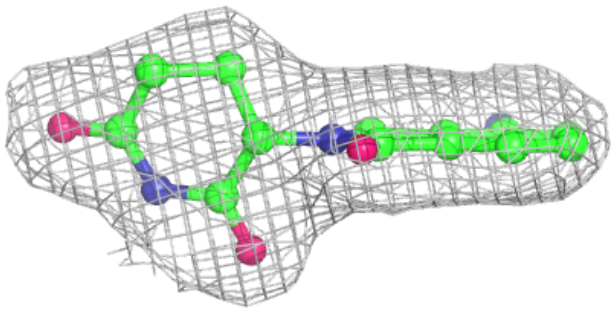


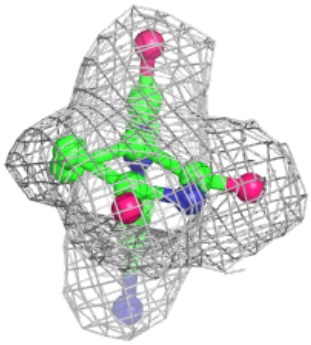


Electron density around LVY B 503:

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

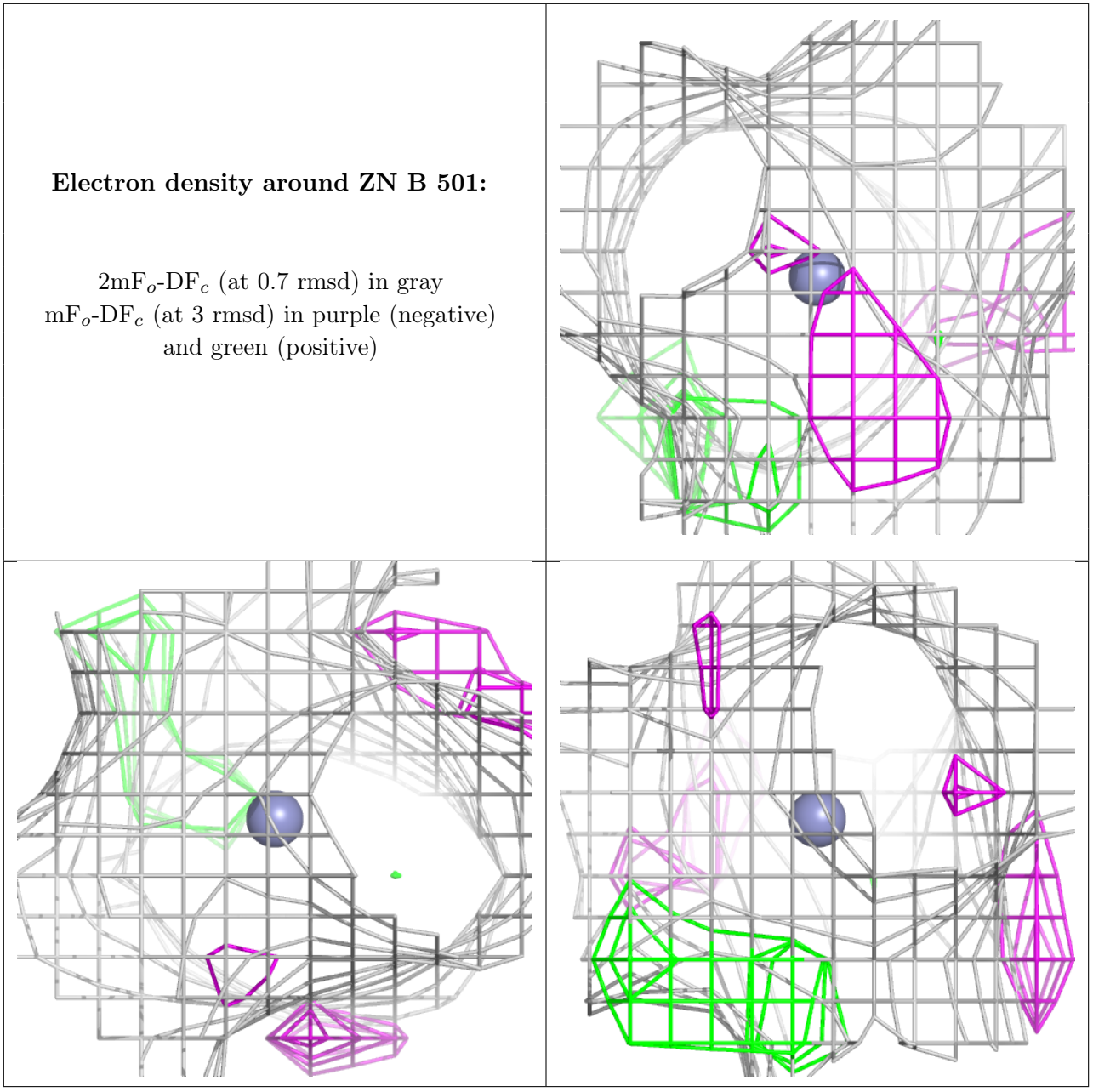






Electron density around ZN B 501:

$2mF_o$-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.