Full wwPDB X-ray Structure Validation Report ⓘ

Jun 10, 2026 – 12:10 PM JST

PDB ID	:	27IL / pdb_000027il
Title	:	Crystal structure of Imine Reductase Mutant(R7) from Actinoalloteichus hymeniacidonis in complex with NADPH
Authors	:	Song, S.; Lin, L.
Deposited on	:	2026-06-02
Resolution	:	1.92 Å(reported)

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

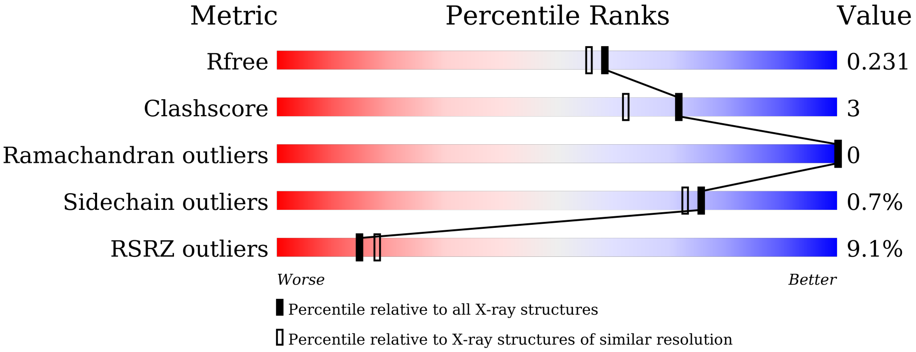
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
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

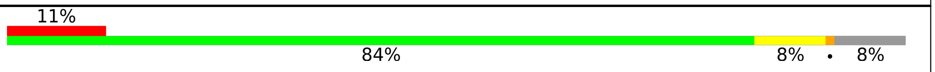
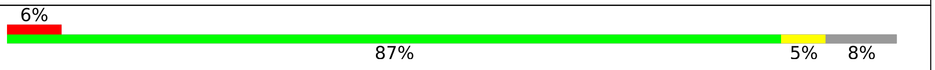
The reported resolution of this entry is 1.92 Å.

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	1188 (1.92-1.92)
Clashscore	190562	1209 (1.92-1.92)
Ramachandran outliers	187476	1195 (1.92-1.92)
Sidechain outliers	187428	1195 (1.92-1.92)
RSRZ outliers	180081	1188 (1.92-1.92)

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	316	
1	B	316	

2 Entry composition ⓘ

There are 4 unique types of molecules in this entry. The entry contains 4604 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 3-hydroxyisobutyrate dehydrogenase-like beta-hydroxyacid dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	B	292	2155	1357	380	411	7	0	0	0
1	A	290	2150	1353	381	409	7	0	1	0

There are 28 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	101	SER	ASN	engineered mutation	UNP A0AAC9HQB1
B	125	LYS	GLY	engineered mutation	UNP A0AAC9HQB1
B	129	PHE	ILE	engineered mutation	UNP A0AAC9HQB1
B	141	PHE	LEU	engineered mutation	UNP A0AAC9HQB1
B	169	ALA	HIS	engineered mutation	UNP A0AAC9HQB1
B	177	ILE	LEU	engineered mutation	UNP A0AAC9HQB1
B	187	ILE	PHE	engineered mutation	UNP A0AAC9HQB1
B	240	PHE	SER	engineered mutation	UNP A0AAC9HQB1
B	244	HIS	MET	engineered mutation	UNP A0AAC9HQB1
B	247	HIS	ALA	engineered mutation	UNP A0AAC9HQB1
B	249	ASN	PHE	engineered mutation	UNP A0AAC9HQB1
B	251	LYS	ASN	engineered mutation	UNP A0AAC9HQB1
B	252	ILE	LEU	engineered mutation	UNP A0AAC9HQB1
B	273	ILE	MET	engineered mutation	UNP A0AAC9HQB1
A	101	SER	ASN	engineered mutation	UNP A0AAC9HQB1
A	125	LYS	GLY	engineered mutation	UNP A0AAC9HQB1
A	129	PHE	ILE	engineered mutation	UNP A0AAC9HQB1
A	141	PHE	LEU	engineered mutation	UNP A0AAC9HQB1
A	169	ALA	HIS	engineered mutation	UNP A0AAC9HQB1
A	177	ILE	LEU	engineered mutation	UNP A0AAC9HQB1
A	187	ILE	PHE	engineered mutation	UNP A0AAC9HQB1
A	240	PHE	SER	engineered mutation	UNP A0AAC9HQB1
A	244	HIS	MET	engineered mutation	UNP A0AAC9HQB1
A	247	HIS	ALA	engineered mutation	UNP A0AAC9HQB1

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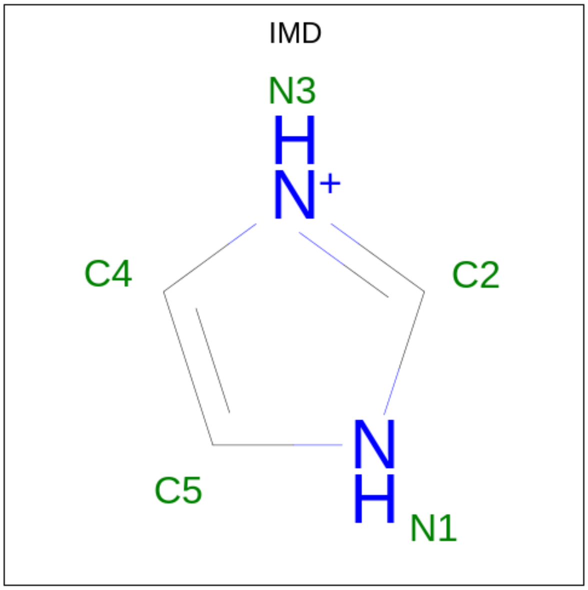
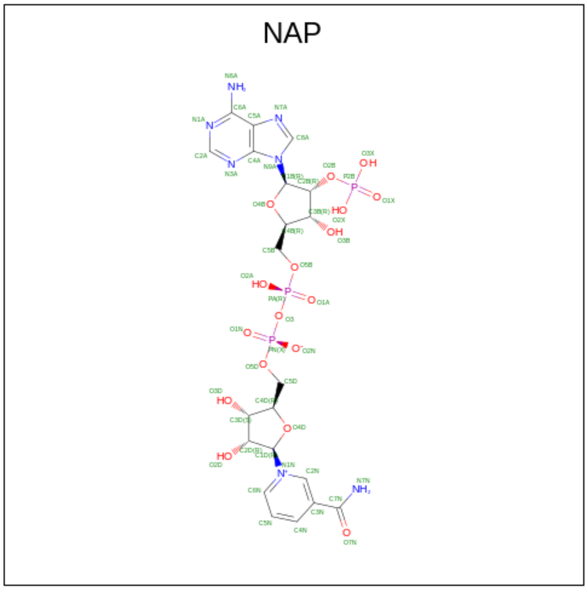
Chain	Residue	Modelled	Actual	Comment	Reference
A	249	ASN	PHE	engineered mutation	UNP A0AAC9HQB1
A	251	LYS	ASN	engineered mutation	UNP A0AAC9HQB1
A	252	ILE	LEU	engineered mutation	UNP A0AAC9HQB1
A	273	ILE	MET	engineered mutation	UNP A0AAC9HQB1

- Molecule 2 is IMIDAZOLE (CCD ID: IMD) (formula: $C_3H_5N_2$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	B	1	Total C N 5 3 2	0	0

- Molecule 3 is NADP NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (CCD ID: NAP) (formula: $C_{21}H_{28}N_7O_{17}P_3$) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
3	A	1	48	21	7	17	3	0	0

- Molecule 4 is water.

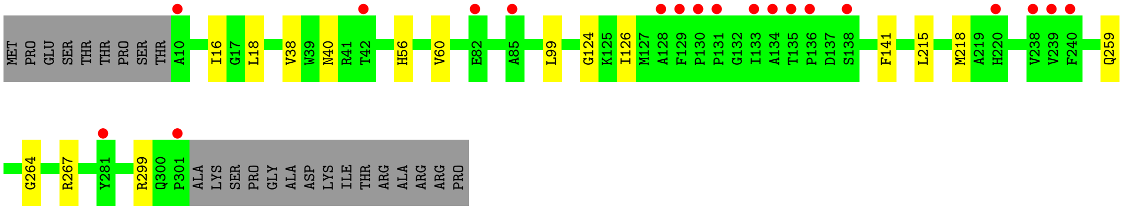
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	B	134	134	134	0	0
4	A	112	112	112	0	0

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.

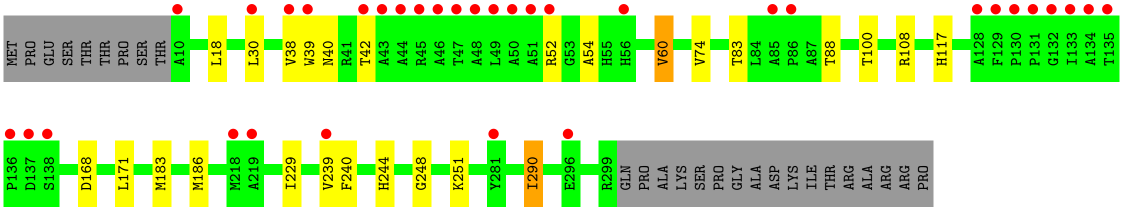
- Molecule 1: 3-hydroxyisobutyrate dehydrogenase-like beta-hydroxyacid dehydrogenase

Chain B:



- Molecule 1: 3-hydroxyisobutyrate dehydrogenase-like beta-hydroxyacid dehydrogenase

Chain A:



4 Data and refinement statistics ⓘ

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	121.77Å 62.82Å 95.01Å 90.00° 97.31° 90.00°	Depositor
Resolution (Å)	26.52 – 1.92 26.52 – 1.92	Depositor EDS
% Data completeness (in resolution range)	97.7 (26.52-1.92) 97.6 (26.52-1.92)	Depositor EDS
R_{merge}	0.06	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.67 (at 1.92Å)	Xtriage
Refinement program	PHENIX 2.1_6048	Depositor
R, R_{free}	0.194 , 0.233 0.195 , 0.231	Depositor DCC
R_{free} test set	2000 reflections (3.67%)	wwPDB-VP
Wilson B-factor (Å^2)	31.7	Xtriage
Anisotropy	0.855	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.37 , 38.8	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.34$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	4604	wwPDB-VP
Average B, all atoms (Å^2)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.29% 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 (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: NAP, IMD

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	0.26	0/2195	0.41	0/2995
1	B	0.28	0/2201	0.44	0/3005
All	All	0.27	0/4396	0.43	0/6000

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	2150	0	2106	18	0
1	B	2155	0	2109	13	0
2	B	5	0	5	3	0
3	A	48	0	25	1	0
4	A	112	0	0	1	0
4	B	134	0	0	0	0
All	All	4604	0	4245	28	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 3.

All (28) 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:B:299:ARG:HH22	2:B:401:IMD:H2	1.55	0.71
1:B:264:GLY:HA2	1:B:267:ARG:HG2	1.77	0.66
1:B:299:ARG:HH22	2:B:401:IMD:C2	2.12	0.63
1:B:299:ARG:NH2	2:B:401:IMD:H2	2.15	0.61
1:A:18:LEU:HD11	1:A:38:VAL:CG1	2.33	0.58
1:B:18:LEU:HD12	1:B:40:ASN:HB2	1.88	0.55
1:A:30:LEU:HD13	1:A:52:ARG:HD2	1.89	0.54
1:B:259:GLN:HE22	1:A:108:ARG:HH12	1.57	0.53
1:A:40:ASN:ND2	1:A:42:THR:H	2.07	0.52
1:A:248:GLY:O	1:A:251:LYS:HG2	2.10	0.51
1:A:229:ILE:HG12	1:A:290:ILE:HG21	1.93	0.51
1:A:39:TRP:CZ2	1:A:60:VAL:HG22	2.47	0.50
1:B:99:LEU:HD13	1:B:126:ILE:HD11	1.96	0.47
1:A:88:THR:HG21	1:A:117:HIS:CD2	2.49	0.47
1:B:16:ILE:HD12	1:B:60:VAL:HG23	1.97	0.45
1:A:240:PHE:CE1	1:A:244:HIS:HB3	2.50	0.45
1:A:60:VAL:HG23	4:A:573:HOH:O	2.16	0.45
1:B:218:MET:HE2	1:A:183:MET:HG3	1.99	0.45
1:A:30:LEU:HD11	1:A:54:ALA:HB2	1.98	0.44
1:B:215:LEU:HD22	1:A:186:MET:HE3	1.99	0.44
1:B:56:HIS:CD2	1:B:56:HIS:C	2.97	0.43
1:A:18:LEU:HD21	1:A:38:VAL:HG13	2.01	0.43
1:B:18:LEU:HD11	1:B:38:VAL:HB	2.00	0.41
1:A:74:VAL:O	1:A:100:THR:HG23	2.20	0.41
1:B:124:GLY:HA2	1:B:141:PHE:O	2.21	0.40
1:A:83:THR:OG1	3:A:401:NAP:H2A	2.22	0.40
1:A:168:ASP:HB3	1:A:171:LEU:HG	2.03	0.40
1:A:18:LEU:HD12	1:A:40:ASN:HB2	2.02	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	289/316 (92%)	284 (98%)	5 (2%)	0	100	100
1	B	290/316 (92%)	285 (98%)	5 (2%)	0	100	100
All	All	579/632 (92%)	569 (98%)	10 (2%)	0	100	100

There are no Ramachandran outliers to report.

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	212/233 (91%)	209 (99%)	3 (1%)	59	50
1	B	213/233 (91%)	213 (100%)	0	100	100
All	All	425/466 (91%)	422 (99%)	3 (1%)	76	73

All (3) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	60	VAL
1	A	239	VAL
1	A	290	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	B	152	HIS
1	B	213	ASN
1	B	224	HIS
1	B	227	GLN
1	B	259	GLN
1	A	56	HIS
1	A	224	HIS

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 ⓘ

2 ligands 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	IMD	B	401	-	5,5,5	0.35	0	5,5,5	0.57	0
3	NAP	A	401	-	49,52,52	1.35	2 (4%)	69,80,80	0.93	3 (4%)

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	IMD	B	401	-	-	-	0/1/1/1
3	NAP	A	401	-	-	5/35/67/67	0/5/5/5

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	401	NAP	P2B-O2B	7.94	1.74	1.59

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	A	401	NAP	O4D-C1D	-2.35	1.37	1.41

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	A	401	NAP	O4B-C1B-N9A	2.50	112.98	108.06
3	A	401	NAP	O2D-C2D-C3D	2.31	119.30	111.82
3	A	401	NAP	O3X-P2B-O2X	2.09	115.64	107.64

There are no chirality outliers.

All (5) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	401	NAP	O4D-C1D-N1N-C2N
3	A	401	NAP	O4D-C1D-N1N-C6N
3	A	401	NAP	O4B-C4B-C5B-O5B
3	A	401	NAP	C2B-O2B-P2B-O3X
3	A	401	NAP	C2D-C1D-N1N-C6N

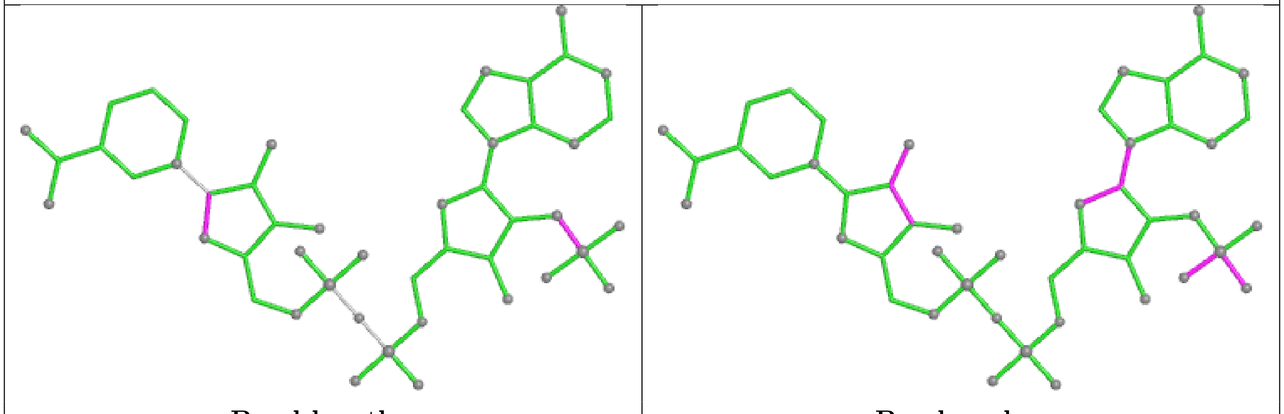
There are no ring outliers.

2 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	401	IMD	3	0
3	A	401	NAP	1	0

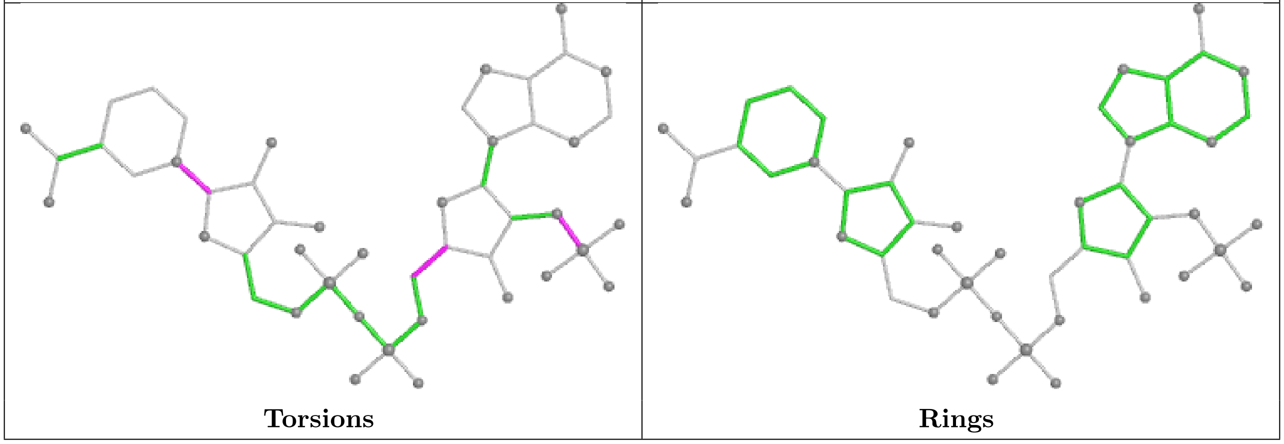
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. 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 NAP A 401



Bond lengths

Bond angles



Torsions

Rings

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, 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	290/316 (91%)	0.76	34 (11%)	9	12	16, 39, 75, 92	1 (0%)
1	B	292/316 (92%)	0.50	19 (6%)	25	29	25, 37, 60, 74	0
All	All	582/632 (92%)	0.63	53 (9%)	15	18	16, 38, 65, 92	1 (0%)

All (53) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	128	ALA	7.3
1	B	128	ALA	6.1
1	A	129	PHE	5.9
1	B	129	PHE	4.5
1	B	240	PHE	4.4
1	A	48	ALA	4.4
1	B	239	VAL	4.4
1	A	50	ALA	4.3
1	A	46	ALA	4.1
1	A	10	ALA	4.0
1	B	136	PRO	3.9
1	A	130	PRO	3.7
1	A	43	ALA	3.6
1	A	133	ILE	3.6
1	A	44	ALA	3.5
1	A	138	SER	3.5
1	A	135	THR	3.5
1	A	56	HIS	3.4
1	A	136	PRO	3.4
1	B	301	PRO	3.3
1	A	42	THR	3.1
1	B	138	SER	3.1
1	B	10	ALA	3.1
1	B	130	PRO	3.1

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Mol	Chain	Res	Type	RSRZ
1	A	239	VAL	2.9
1	A	134	ALA	2.9
1	A	219	ALA	2.9
1	A	296	GLU	2.9
1	A	47	THR	2.8
1	A	45	ARG	2.8
1	B	85	ALA	2.7
1	B	281	TYR	2.7
1	B	238	VAL	2.7
1	B	131	PRO	2.6
1	A	131	PRO	2.6
1	A	281	TYR	2.5
1	A	85	ALA	2.5
1	B	82	GLU	2.5
1	B	135	THR	2.5
1	A	218	MET	2.4
1	A	51	ALA	2.4
1	A	39	TRP	2.4
1	B	133	ILE	2.4
1	A	30	LEU	2.3
1	A	137	ASP	2.3
1	B	220	HIS	2.2
1	B	42	THR	2.1
1	A	49	LEU	2.1
1	A	52	ARG	2.1
1	A	86	PRO	2.1
1	A	132	GLY	2.1
1	B	134	ALA	2.1
1	A	38	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)

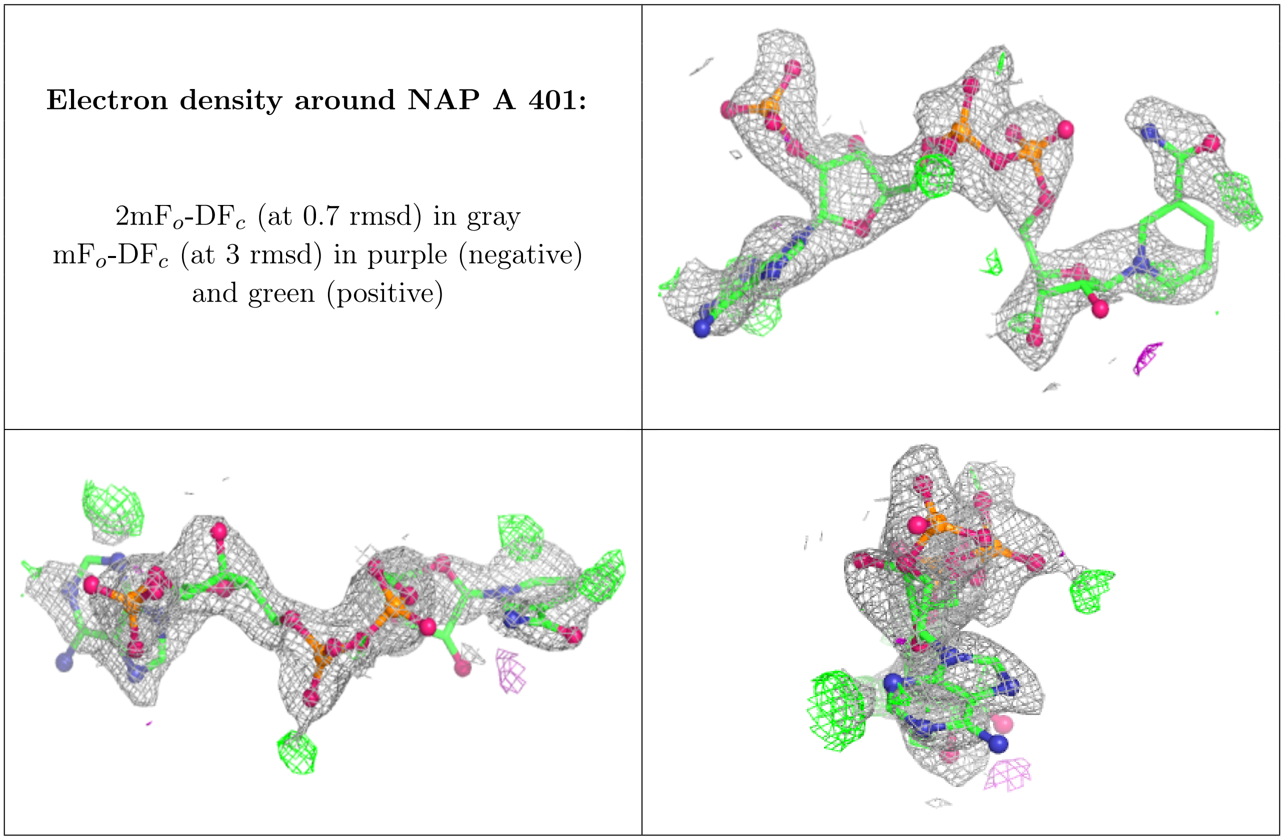
There are no oligosaccharides in this entry.

6.4 Ligands ⓘ

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	NAP	A	401	48/48	0.74	0.18	38,58,66,72	48
2	IMD	B	401	5/5	0.90	0.14	38,44,45,48	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 NAP A 401:

$2mF_o$-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.