



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 8, 2026 – 12:44 PM UTC

PDB ID : 2I9P / pdb_00002i9p
Title : Crystal structure of human hydroxyisobutyrate dehydrogenase complexed with NAD⁺
Authors : Kavanagh, K.L.; Papagrigoriou, E.; Salah, E.; Lukacik, P.; Smee, C.; Burgess, N.; von Delft, F.; Weigelt, J.; Arrowsmith, C.; Sundstrom, M.; Edwards, A.; Oppermann, U.; Structural Genomics Consortium (SGC)
Deposited on : 2006-09-06
Resolution : 2.55 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](#) ①) 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

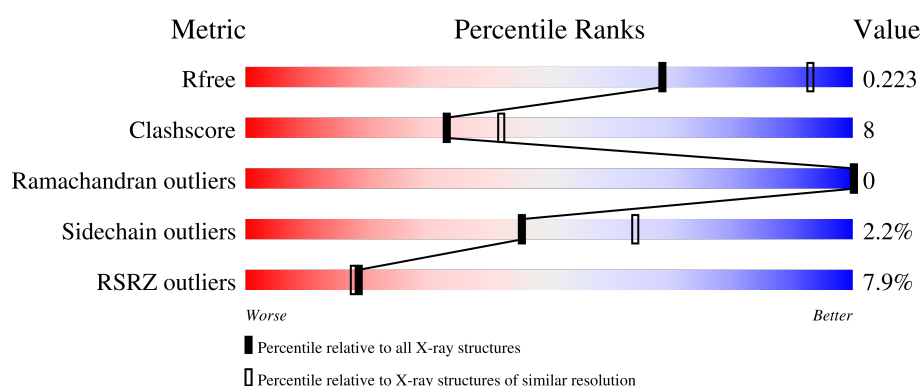
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.55 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	1091 (2.54-2.54)
Clashscore	190562	1120 (2.54-2.54)
Ramachandran outliers	187476	1106 (2.54-2.54)
Sidechain outliers	187428	1106 (2.54-2.54)
RSRZ outliers	180081	1091 (2.54-2.54)

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	319	7% 78% 14% 8%
1	B	319	2% 78% 15% 7%
1	C	319	6% 77% 13% 8%
1	D	319	14% 78% 13% 8%

2 Entry composition

There are 2 unique types of molecules in this entry. The entry contains 8559 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.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	293	Total	C	N	O	S	0	0	0
			2098	1327	346	403	22			
1	B	296	Total	C	N	O	S	0	0	0
			2116	1333	348	413	22			
1	C	293	Total	C	N	O	S	0	1	0
			2088	1318	349	399	22			
1	D	293	Total	C	N	O	S	0	0	0
			2081	1316	343	400	22			

There are 92 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	18	MET	-	cloning artifact	UNP P31937
A	19	HIS	-	cloning artifact	UNP P31937
A	20	HIS	-	cloning artifact	UNP P31937
A	21	HIS	-	cloning artifact	UNP P31937
A	22	HIS	-	cloning artifact	UNP P31937
A	23	HIS	-	cloning artifact	UNP P31937
A	24	HIS	-	cloning artifact	UNP P31937
A	25	SER	-	cloning artifact	UNP P31937
A	26	SER	-	cloning artifact	UNP P31937
A	27	GLY	-	cloning artifact	UNP P31937
A	28	VAL	-	cloning artifact	UNP P31937
A	29	ASP	-	cloning artifact	UNP P31937
A	30	LEU	-	cloning artifact	UNP P31937
A	31	GLY	-	cloning artifact	UNP P31937
A	32	THR	-	cloning artifact	UNP P31937
A	33	GLU	-	cloning artifact	UNP P31937
A	34	ASN	-	cloning artifact	UNP P31937
A	35	LEU	-	cloning artifact	UNP P31937
A	36	TYR	-	cloning artifact	UNP P31937
A	37	PHE	-	cloning artifact	UNP P31937
A	38	GLN	-	cloning artifact	UNP P31937

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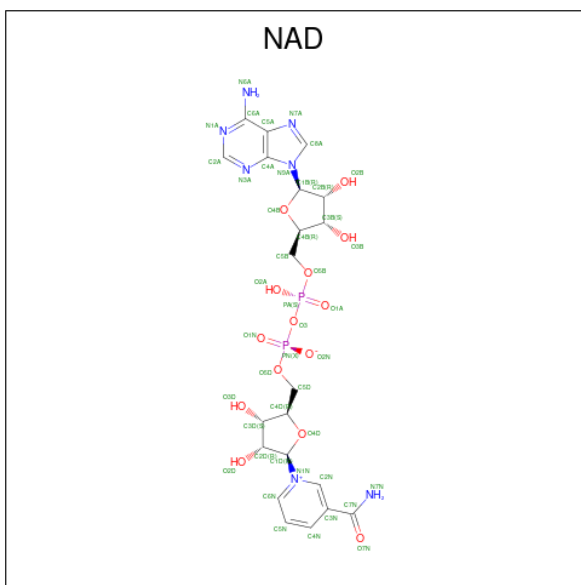
Chain	Residue	Modelled	Actual	Comment	Reference
A	39	SER	-	cloning artifact	UNP P31937
A	40	MET	-	cloning artifact	UNP P31937
B	18	MET	-	cloning artifact	UNP P31937
B	19	HIS	-	cloning artifact	UNP P31937
B	20	HIS	-	cloning artifact	UNP P31937
B	21	HIS	-	cloning artifact	UNP P31937
B	22	HIS	-	cloning artifact	UNP P31937
B	23	HIS	-	cloning artifact	UNP P31937
B	24	HIS	-	cloning artifact	UNP P31937
B	25	SER	-	cloning artifact	UNP P31937
B	26	SER	-	cloning artifact	UNP P31937
B	27	GLY	-	cloning artifact	UNP P31937
B	28	VAL	-	cloning artifact	UNP P31937
B	29	ASP	-	cloning artifact	UNP P31937
B	30	LEU	-	cloning artifact	UNP P31937
B	31	GLY	-	cloning artifact	UNP P31937
B	32	THR	-	cloning artifact	UNP P31937
B	33	GLU	-	cloning artifact	UNP P31937
B	34	ASN	-	cloning artifact	UNP P31937
B	35	LEU	-	cloning artifact	UNP P31937
B	36	TYR	-	cloning artifact	UNP P31937
B	37	PHE	-	cloning artifact	UNP P31937
B	38	GLN	-	cloning artifact	UNP P31937
B	39	SER	-	cloning artifact	UNP P31937
B	40	MET	-	cloning artifact	UNP P31937
C	18	MET	-	cloning artifact	UNP P31937
C	19	HIS	-	cloning artifact	UNP P31937
C	20	HIS	-	cloning artifact	UNP P31937
C	21	HIS	-	cloning artifact	UNP P31937
C	22	HIS	-	cloning artifact	UNP P31937
C	23	HIS	-	cloning artifact	UNP P31937
C	24	HIS	-	cloning artifact	UNP P31937
C	25	SER	-	cloning artifact	UNP P31937
C	26	SER	-	cloning artifact	UNP P31937
C	27	GLY	-	cloning artifact	UNP P31937
C	28	VAL	-	cloning artifact	UNP P31937
C	29	ASP	-	cloning artifact	UNP P31937
C	30	LEU	-	cloning artifact	UNP P31937
C	31	GLY	-	cloning artifact	UNP P31937
C	32	THR	-	cloning artifact	UNP P31937
C	33	GLU	-	cloning artifact	UNP P31937
C	34	ASN	-	cloning artifact	UNP P31937

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Chain	Residue	Modelled	Actual	Comment	Reference
C	35	LEU	-	cloning artifact	UNP P31937
C	36	TYR	-	cloning artifact	UNP P31937
C	37	PHE	-	cloning artifact	UNP P31937
C	38	GLN	-	cloning artifact	UNP P31937
C	39	SER	-	cloning artifact	UNP P31937
C	40	MET	-	cloning artifact	UNP P31937
D	18	MET	-	cloning artifact	UNP P31937
D	19	HIS	-	cloning artifact	UNP P31937
D	20	HIS	-	cloning artifact	UNP P31937
D	21	HIS	-	cloning artifact	UNP P31937
D	22	HIS	-	cloning artifact	UNP P31937
D	23	HIS	-	cloning artifact	UNP P31937
D	24	HIS	-	cloning artifact	UNP P31937
D	25	SER	-	cloning artifact	UNP P31937
D	26	SER	-	cloning artifact	UNP P31937
D	27	GLY	-	cloning artifact	UNP P31937
D	28	VAL	-	cloning artifact	UNP P31937
D	29	ASP	-	cloning artifact	UNP P31937
D	30	LEU	-	cloning artifact	UNP P31937
D	31	GLY	-	cloning artifact	UNP P31937
D	32	THR	-	cloning artifact	UNP P31937
D	33	GLU	-	cloning artifact	UNP P31937
D	34	ASN	-	cloning artifact	UNP P31937
D	35	LEU	-	cloning artifact	UNP P31937
D	36	TYR	-	cloning artifact	UNP P31937
D	37	PHE	-	cloning artifact	UNP P31937
D	38	GLN	-	cloning artifact	UNP P31937
D	39	SER	-	cloning artifact	UNP P31937
D	40	MET	-	cloning artifact	UNP P31937

- Molecule 2 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (CCD ID: NAD) (formula: $C_{21}H_{27}N_7O_{14}P_2$).

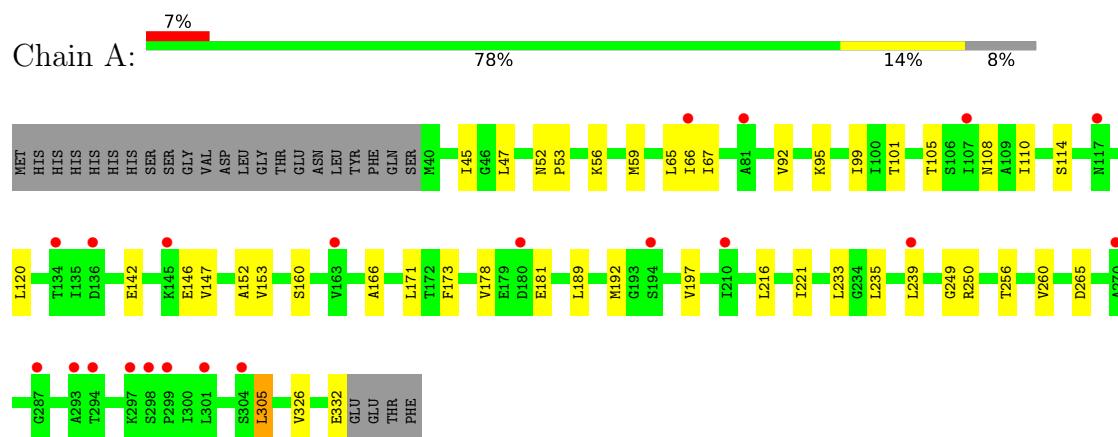


Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	B	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	C	1	Total 44	C 21	N 7	O 14	P 2	0	0
2	D	1	Total 44	C 21	N 7	O 14	P 2	0	0

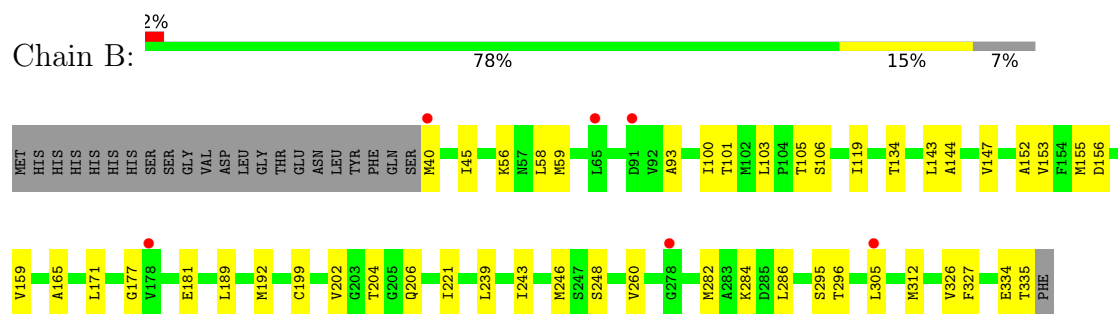
3 Residue-property plots [i](#)

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.

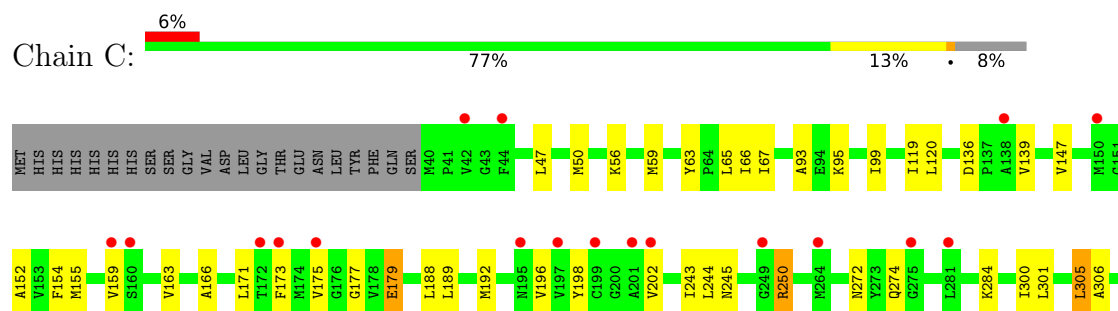
- Molecule 1: 3-hydroxyisobutyrate dehydrogenase



- Molecule 1: 3-hydroxyisobutyrate dehydrogenase

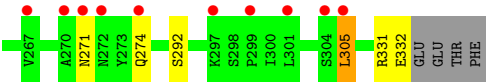
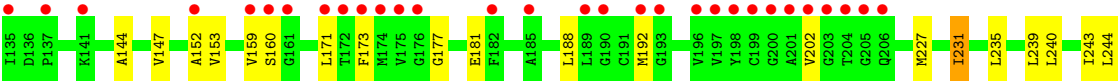
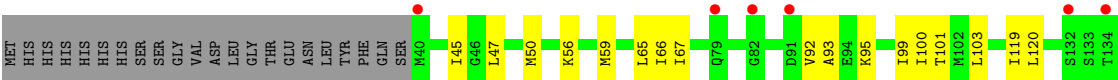
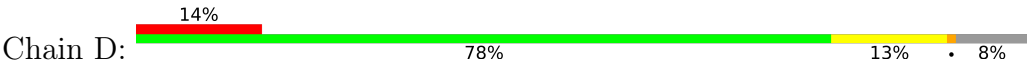


- Molecule 1: 3-hydroxyisobutyrate dehydrogenase





● Molecule 1: 3-hydroxyisobutyrate dehydrogenase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	49.63Å 167.32Å 71.09Å 90.00° 107.80° 90.00°	Depositor
Resolution (Å)	50.00 – 2.55 50.00 – 2.55	Depositor EDS
% Data completeness (in resolution range)	95.5 (50.00-2.55) 95.5 (50.00-2.55)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.86 (at 2.54Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.174 , 0.220 0.185 , 0.223	Depositor DCC
R_{free} test set	1729 reflections (4.81%)	wwPDB-VP
Wilson B-factor (Å ²)	51.3	Xtriage
Anisotropy	0.445	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 74.6	EDS
L-test for twinning ²	$\langle L \rangle = 0.48$, $\langle L^2 \rangle = 0.31$	Xtriage
Estimated twinning fraction	0.039 for h,-k,-h-l	Xtriage
F_o, F_c correlation	0.91	EDS
Total number of atoms	8559	wwPDB-VP
Average B, all atoms (Å ²)	59.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.63% 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

5.1 Standard geometry

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

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	0.75	0/2132	0.91	1/2885 (0.0%)
1	B	0.74	0/2149	0.93	3/2912 (0.1%)
1	C	0.77	1/2125 (0.0%)	0.91	1/2880 (0.0%)
1	D	0.81	0/2115	0.91	0/2867
All	All	0.77	1/8521 (0.0%)	0.92	5/11544 (0.0%)

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	306	ALA	CA-CB	-5.75	1.44	1.53

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	260	VAL	N-CA-C	7.10	114.02	107.56
1	B	40	MET	CA-C-N	5.69	125.70	119.90
1	B	40	MET	C-N-CA	5.69	125.70	119.90
1	C	119	ILE	CB-CA-C	-5.48	104.95	111.97
1	B	282	MET	N-CA-C	-5.16	105.55	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	2098	0	2070	40	0
1	B	2116	0	2053	43	0
1	C	2088	0	2048	39	0
1	D	2081	0	2033	35	0
2	A	44	0	26	0	0
2	B	44	0	26	1	0
2	C	44	0	26	0	0
2	D	44	0	26	0	0
All	All	8559	0	8308	132	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.

All (132) 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:D:47:LEU:HD11	1:D:67:ILE:HG23	1.41	1.03
1:C:305:LEU:HD22	1:D:305:LEU:HD22	1.43	0.97
1:B:45:ILE:HD12	1:B:119:ILE:HD11	1.64	0.79
1:D:56:LYS:HA	1:D:59:MET:HE3	1.64	0.78
1:D:47:LEU:HD11	1:D:67:ILE:CG2	2.15	0.77
1:A:239:LEU:HD21	1:B:199:CYS:HA	1.67	0.77
1:A:47:LEU:HD11	1:A:67:ILE:HG23	1.68	0.76
1:D:47:LEU:CD1	1:D:67:ILE:HG23	2.18	0.73
1:C:155:MET:HE2	1:C:175:VAL:HG12	1.73	0.69
1:C:272:ASN:HD21	1:C:328:GLN:HE22	1.37	0.69
1:D:100:ILE:HD13	1:D:192:MET:HE1	1.75	0.69
1:A:305:LEU:HD22	1:B:305:LEU:HD22	1.74	0.68
1:C:56:LYS:HA	1:C:59:MET:HE2	1.76	0.68
1:A:47:LEU:CD1	1:A:67:ILE:HG23	2.23	0.67
1:A:105:THR:H	1:A:108:ASN:HD22	1.42	0.67
1:D:147:VAL:HG13	1:D:152:ALA:HB3	1.78	0.65
1:C:173:PHE:HB2	1:C:196:VAL:HG22	1.78	0.64
1:B:45:ILE:HB	1:B:101:THR:HG22	1.79	0.64
1:B:153:VAL:HG11	1:B:181:GLU:HG3	1.79	0.64
1:A:305:LEU:HD11	1:D:305:LEU:HD13	1.80	0.64
1:B:147:VAL:CG1	1:B:152:ALA:HB3	2.29	0.63
1:A:153:VAL:HG11	1:A:181:GLU:HG3	1.79	0.63
1:B:305:LEU:HD21	1:D:305:LEU:HD21	1.80	0.63
1:B:56:LYS:HA	1:B:59:MET:HE3	1.82	0.61
1:A:239:LEU:CD2	1:B:199:CYS:HA	2.30	0.61
1:D:177:GLY:HA2	1:D:202:VAL:HG22	1.80	0.61

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:171:LEU:HD12	1:A:192:MET:O	2.01	0.61
1:A:173:PHE:CE2	1:A:189:LEU:HD22	2.36	0.60
1:B:147:VAL:HG12	1:B:152:ALA:HB3	1.83	0.60
1:D:50:MET:HE1	1:D:171:LEU:HD21	1.83	0.60
1:C:147:VAL:HG13	1:C:152:ALA:HB3	1.86	0.58
1:B:305:LEU:CD1	1:C:305:LEU:HD13	2.34	0.57
1:A:166:ALA:HA	1:A:171:LEU:HD11	1.86	0.57
1:C:272:ASN:HB3	1:C:274:GLN:HE21	1.68	0.57
1:D:147:VAL:CG1	1:D:152:ALA:HB3	2.35	0.57
1:A:120:LEU:HD21	1:A:147:VAL:HG22	1.85	0.56
1:D:45:ILE:HB	1:D:101:THR:HG22	1.88	0.56
1:D:47:LEU:CD1	1:D:67:ILE:CG2	2.80	0.56
1:A:178:VAL:HG23	1:A:181:GLU:HG2	1.89	0.54
1:B:260:VAL:HG22	1:B:327:PHE:CZ	2.42	0.54
1:D:159:VAL:HG12	1:D:173:PHE:CD2	2.42	0.54
1:B:58:LEU:HD21	1:B:192:MET:HE2	1.88	0.54
1:B:45:ILE:CD1	1:B:119:ILE:HD11	2.35	0.53
1:A:305:LEU:CD2	1:B:305:LEU:HD22	2.39	0.53
1:B:189:LEU:HA	1:B:192:MET:HE3	1.91	0.53
1:A:233:LEU:HD23	1:B:296:THR:HG21	1.91	0.53
1:A:305:LEU:HD11	1:C:305:LEU:HD21	1.91	0.53
1:B:221:ILE:HG12	1:B:326:VAL:HG21	1.90	0.52
1:A:235:LEU:CD2	1:B:204:THR:HG22	2.40	0.52
1:A:197:VAL:HG21	1:B:246:MET:HE1	1.91	0.52
1:D:66:ILE:HD13	1:D:95:LYS:HB2	1.92	0.51
1:B:56:LYS:HA	1:B:59:MET:CE	2.41	0.51
1:C:120:LEU:HD21	1:C:147:VAL:HG22	1.93	0.51
1:B:105:THR:OG1	1:B:106:SER:N	2.45	0.50
1:D:227:MET:O	1:D:231:ILE:HD12	2.11	0.50
1:A:52:ASN:HB3	1:A:53:PRO:CD	2.41	0.50
1:D:271:ASN:O	1:D:274:GLN:HG2	2.12	0.50
1:B:305:LEU:HD13	1:C:305:LEU:HD13	1.93	0.49
1:D:45:ILE:HG22	1:D:103:LEU:HD21	1.94	0.49
1:A:305:LEU:CD1	1:D:305:LEU:HD13	2.42	0.49
1:B:93:ALA:HB2	1:B:119:ILE:HG23	1.95	0.49
1:D:153:VAL:HG11	1:D:181:GLU:HG3	1.93	0.49
1:C:155:MET:HE2	1:C:175:VAL:CG1	2.42	0.49
1:A:147:VAL:HG13	1:A:152:ALA:HB3	1.95	0.49
1:A:56:LYS:HA	1:A:59:MET:HE2	1.94	0.49
1:A:110:ILE:O	1:A:114:SER:OG	2.28	0.49
1:B:134:THR:HB	1:B:284:LYS:NZ	2.27	0.49

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:235:LEU:HD23	1:B:204:THR:HG22	1.95	0.48
1:A:92:VAL:HG12	1:A:99:ILE:HD13	1.94	0.48
1:A:221:ILE:HG12	1:A:326:VAL:HG21	1.96	0.48
1:B:143:LEU:O	1:B:147:VAL:HG23	2.13	0.48
1:D:159:VAL:HG12	1:D:173:PHE:CE2	2.49	0.48
1:B:305:LEU:HD13	1:C:305:LEU:CD1	2.44	0.48
1:B:177:GLY:HA2	1:B:202:VAL:HG22	1.95	0.47
1:C:120:LEU:HD21	1:C:147:VAL:CG2	2.44	0.47
1:B:155:MET:HE3	1:B:177:GLY:HA3	1.96	0.47
1:C:66:ILE:HD13	1:C:95:LYS:HB2	1.94	0.47
1:A:105:THR:H	1:A:108:ASN:ND2	2.10	0.47
1:B:144:ALA:HB2	1:B:202:VAL:HG11	1.95	0.47
1:D:144:ALA:HB2	1:D:202:VAL:HG11	1.96	0.47
1:C:50:MET:HE1	1:C:171:LEU:HD21	1.96	0.47
1:C:93:ALA:HA	1:C:99:ILE:HD11	1.97	0.47
1:B:156:ASP:HB2	1:B:206:GLN:HE21	1.80	0.47
1:C:65:LEU:HD12	1:C:65:LEU:N	2.30	0.46
1:D:235:LEU:CD1	1:D:240:LEU:HD13	2.46	0.46
1:C:245:ASN:HA	1:C:250[A]:ARG:HB3	1.97	0.46
1:C:305:LEU:CD2	1:D:305:LEU:HD22	2.31	0.46
1:C:175:VAL:HG21	1:C:196:VAL:HG13	1.99	0.45
1:D:235:LEU:HD13	1:D:240:LEU:HD13	1.98	0.45
1:D:92:VAL:HG12	1:D:99:ILE:HD13	1.98	0.45
1:C:63:TYR:O	1:C:65:LEU:HD12	2.16	0.45
1:B:165:ALA:HB3	1:B:171:LEU:HD23	1.98	0.45
1:A:305:LEU:HD21	1:C:305:LEU:HD11	1.98	0.45
1:B:134:THR:HB	1:B:284:LYS:HZ1	1.81	0.45
1:C:47:LEU:HD11	1:C:67:ILE:HG23	1.99	0.44
1:A:52:ASN:HB3	1:A:53:PRO:HD3	2.00	0.44
1:B:305:LEU:HD21	1:D:305:LEU:HD11	2.00	0.44
1:B:286:LEU:HA	1:B:286:LEU:HD23	1.80	0.44
1:C:136:ASP:HB3	1:C:139:VAL:HG23	1.99	0.44
1:B:334:GLU:HG2	1:B:335:THR:N	2.32	0.43
1:D:243:ILE:O	1:D:244:LEU:C	2.61	0.43
1:A:45:ILE:HB	1:A:101:THR:HG22	2.00	0.43
1:B:312:MET:HE2	1:C:301:LEU:HD21	2.01	0.43
1:D:50:MET:CE	1:D:171:LEU:HD21	2.48	0.43
1:C:66:ILE:HD13	1:C:95:LYS:CB	2.48	0.43
1:D:56:LYS:HA	1:D:59:MET:CE	2.43	0.43
1:D:120:LEU:HD21	1:D:147:VAL:HG22	2.01	0.43
1:A:66:ILE:HD13	1:A:95:LYS:HB2	1.99	0.42

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:233:LEU:CD2	1:B:296:THR:HG21	2.48	0.42
1:C:50:MET:HE2	1:C:159:VAL:HG21	2.00	0.42
1:D:93:ALA:HB2	1:D:119:ILE:HG23	2.01	0.42
1:A:249:GLY:O	1:A:250:ARG:C	2.61	0.42
1:C:189:LEU:HA	1:C:192:MET:HE3	2.01	0.42
1:A:59:MET:HG3	1:A:65:LEU:HD11	2.02	0.42
1:A:305:LEU:CD1	1:D:305:LEU:CD1	2.98	0.42
1:D:65:LEU:HD23	1:D:67:ILE:HD11	2.02	0.41
1:A:216:LEU:HD22	1:B:248:SER:HB2	2.02	0.41
1:B:103:LEU:HD22	2:B:500:NAD:C4A	2.50	0.41
1:C:177:GLY:HA2	1:C:202:VAL:HG23	2.02	0.41
1:C:272:ASN:ND2	1:C:328:GLN:HE22	2.11	0.41
1:C:243:ILE:O	1:C:244:LEU:C	2.63	0.41
1:C:147:VAL:HG11	1:C:154:PHE:HB2	2.03	0.41
1:C:163:VAL:O	1:C:166:ALA:HB3	2.21	0.41
1:A:332:GLU:HG3	1:C:315:ALA:CB	2.51	0.41
1:B:239:LEU:HD21	1:B:243:ILE:HD12	2.03	0.41
1:C:56:LYS:CA	1:C:59:MET:HE2	2.47	0.41
1:A:256:THR:O	1:A:256:THR:HG22	2.20	0.41
1:A:142:GLU:O	1:A:146:GLU:HG2	2.21	0.40
1:C:179:GLU:HB2	1:C:198:TYR:CZ	2.55	0.40
1:C:120:LEU:CD2	1:C:147:VAL:HG22	2.51	0.40
1:A:332:GLU:HG3	1:C:315:ALA:HB1	2.04	0.40
1:B:100:ILE:CD1	1:B:192:MET:HE1	2.51	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	291/319 (91%)	281 (97%)	10 (3%)	0	100 100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	294/319 (92%)	288 (98%)	6 (2%)	0	100	100
1	C	292/319 (92%)	281 (96%)	11 (4%)	0	100	100
1	D	291/319 (91%)	284 (98%)	7 (2%)	0	100	100
All	All	1168/1276 (92%)	1134 (97%)	34 (3%)	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	214/253 (85%)	211 (99%)	3 (1%)	59	75
1	B	214/253 (85%)	212 (99%)	2 (1%)	70	82
1	C	212/253 (84%)	205 (97%)	7 (3%)	33	50
1	D	210/253 (83%)	202 (96%)	8 (4%)	29	44
All	All	850/1012 (84%)	830 (98%)	20 (2%)	45	61

All (20) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	160	SER
1	A	265	ASP
1	A	305	LEU
1	B	159	VAL
1	B	295	SER
1	C	179	GLU
1	C	188	LEU
1	C	250[A]	ARG
1	C	250[B]	ARG
1	C	284	LYS
1	C	300	ILE
1	C	305	LEU
1	D	160	SER

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Mol	Chain	Res	Type
1	D	188	LEU
1	D	231	ILE
1	D	239	LEU
1	D	292	SER
1	D	305	LEU
1	D	331	ARG
1	D	332	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (13) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	108	ASN
1	A	213	ASN
1	A	328	GLN
1	B	170	ASN
1	C	61	HIS
1	C	272	ASN
1	C	274	GLN
1	C	328	GLN
1	D	52	ASN
1	D	79	GLN
1	D	117	ASN
1	D	170	ASN
1	D	328	GLN

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

4 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	NAD	B	500	-	46,48,48	1.83	5 (10%)	64,73,73	1.56	10 (15%)
2	NAD	A	500	-	46,48,48	1.69	5 (10%)	64,73,73	1.64	12 (18%)
2	NAD	D	500	-	46,48,48	1.67	4 (8%)	64,73,73	1.61	12 (18%)
2	NAD	C	500	-	46,48,48	1.78	6 (13%)	64,73,73	1.64	8 (12%)

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	NAD	B	500	-	-	7/30/62/62	0/5/5/5
2	NAD	A	500	-	-	7/30/62/62	0/5/5/5
2	NAD	D	500	-	-	6/30/62/62	0/5/5/5
2	NAD	C	500	-	-	6/30/62/62	0/5/5/5

All (20) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	500	NAD	O7N-C7N	10.01	1.42	1.24
2	A	500	NAD	O7N-C7N	9.60	1.42	1.24
2	C	500	NAD	O7N-C7N	9.51	1.41	1.24
2	D	500	NAD	O7N-C7N	8.85	1.40	1.24
2	D	500	NAD	C2A-N3A	2.98	1.39	1.33
2	B	500	NAD	C2A-N1A	2.91	1.39	1.33
2	D	500	NAD	C2A-N1A	2.83	1.39	1.33
2	B	500	NAD	C2N-N1N	2.82	1.38	1.35
2	C	500	NAD	C2A-N3A	2.79	1.38	1.33
2	B	500	NAD	C2A-N3A	2.77	1.38	1.33

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	500	NAD	C2A-N1A	2.74	1.38	1.33
2	A	500	NAD	C2A-N1A	2.63	1.38	1.33
2	D	500	NAD	C8A-N7A	2.39	1.36	1.31
2	C	500	NAD	C8A-N7A	2.32	1.36	1.31
2	B	500	NAD	C8A-N7A	2.32	1.36	1.31
2	A	500	NAD	C5A-N7A	-2.29	1.34	1.39
2	C	500	NAD	C2N-N1N	2.19	1.37	1.35
2	A	500	NAD	C8A-N7A	2.14	1.35	1.31
2	C	500	NAD	C5A-N7A	-2.12	1.35	1.39
2	A	500	NAD	C2A-N3A	2.06	1.37	1.33

All (42) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	500	NAD	N3A-C2A-N1A	-5.74	119.90	128.58
2	B	500	NAD	N3A-C2A-N1A	-5.31	120.54	128.58
2	A	500	NAD	N3A-C2A-N1A	-5.16	120.77	128.58
2	C	500	NAD	C5A-C4A-N3A	-5.05	119.76	126.72
2	D	500	NAD	N3A-C2A-N1A	-4.81	121.30	128.58
2	D	500	NAD	C5A-C4A-N3A	-4.76	120.17	126.72
2	A	500	NAD	N9A-C8A-N7A	-4.44	107.64	113.94
2	A	500	NAD	C5A-C4A-N3A	-4.26	120.84	126.72
2	B	500	NAD	C5A-C4A-N3A	-4.13	121.03	126.72
2	A	500	NAD	C5A-N7A-C8A	4.09	109.88	103.45
2	B	500	NAD	N9A-C8A-N7A	-4.06	108.18	113.94
2	C	500	NAD	C5A-N7A-C8A	3.82	109.45	103.45
2	C	500	NAD	N9A-C8A-N7A	-3.82	108.52	113.94
2	B	500	NAD	C5A-N7A-C8A	3.77	109.37	103.45
2	D	500	NAD	C5A-N7A-C8A	3.76	109.36	103.45
2	D	500	NAD	N9A-C8A-N7A	-3.76	108.60	113.94
2	A	500	NAD	C4A-C5A-N7A	-3.72	106.33	110.58
2	C	500	NAD	C2A-N3A-C4A	3.65	120.75	111.83
2	B	500	NAD	C4A-C5A-N7A	-3.40	106.69	110.58
2	D	500	NAD	C4A-C5A-N7A	-3.23	106.88	110.58
2	D	500	NAD	C2A-N3A-C4A	3.21	119.68	111.83
2	A	500	NAD	C2A-N3A-C4A	3.21	119.68	111.83
2	C	500	NAD	N3A-C4A-N9A	3.18	132.58	127.17
2	B	500	NAD	C2A-N3A-C4A	3.17	119.58	111.83
2	D	500	NAD	N3A-C4A-N9A	2.68	131.72	127.17
2	A	500	NAD	C2N-C3N-C4N	2.66	121.35	118.26
2	C	500	NAD	C4A-C5A-N7A	-2.63	107.58	110.58
2	D	500	NAD	O3D-C3D-C4D	-2.49	103.93	111.08

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	500	NAD	C2N-C3N-C4N	2.48	121.15	118.26
2	A	500	NAD	C5A-C4A-N9A	2.37	108.40	105.81
2	D	500	NAD	O2D-C2D-C3D	2.31	119.21	111.82
2	B	500	NAD	C6N-N1N-C2N	-2.26	119.95	121.88
2	A	500	NAD	C6N-N1N-C2N	-2.24	119.97	121.88
2	B	500	NAD	C5A-C4A-N9A	2.20	108.20	105.81
2	C	500	NAD	C2N-C3N-C4N	2.13	120.74	118.26
2	A	500	NAD	C6A-C5A-C4A	2.12	120.07	117.18
2	B	500	NAD	N3A-C4A-N9A	2.12	130.76	127.17
2	A	500	NAD	N3A-C4A-N9A	2.11	130.76	127.17
2	A	500	NAD	C5N-C4N-C3N	-2.11	118.29	120.36
2	D	500	NAD	C5A-C4A-N9A	2.11	108.11	105.81
2	D	500	NAD	O2N-PN-O1N	2.06	122.05	112.44
2	B	500	NAD	C2N-C3N-C4N	2.05	120.64	118.26

There are no chirality outliers.

All (26) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	500	NAD	O4D-C1D-N1N-C2N
2	A	500	NAD	O4D-C1D-N1N-C6N
2	A	500	NAD	C2D-C1D-N1N-C2N
2	A	500	NAD	C2D-C1D-N1N-C6N
2	B	500	NAD	C5D-O5D-PN-O3
2	B	500	NAD	O4D-C1D-N1N-C2N
2	B	500	NAD	O4D-C1D-N1N-C6N
2	C	500	NAD	O4D-C1D-N1N-C2N
2	C	500	NAD	O4D-C1D-N1N-C6N
2	D	500	NAD	C5D-O5D-PN-O3
2	D	500	NAD	O4D-C1D-N1N-C2N
2	C	500	NAD	O4D-C4D-C5D-O5D
2	B	500	NAD	O4D-C4D-C5D-O5D
2	D	500	NAD	O4D-C4D-C5D-O5D
2	B	500	NAD	C3D-C4D-C5D-O5D
2	C	500	NAD	C3D-C4D-C5D-O5D
2	D	500	NAD	C3D-C4D-C5D-O5D
2	A	500	NAD	O4B-C4B-C5B-O5B
2	A	500	NAD	C3B-C4B-C5B-O5B
2	B	500	NAD	C5D-O5D-PN-O1N
2	B	500	NAD	C2D-C1D-N1N-C6N
2	C	500	NAD	C2D-C1D-N1N-C6N
2	D	500	NAD	O4D-C1D-N1N-C6N

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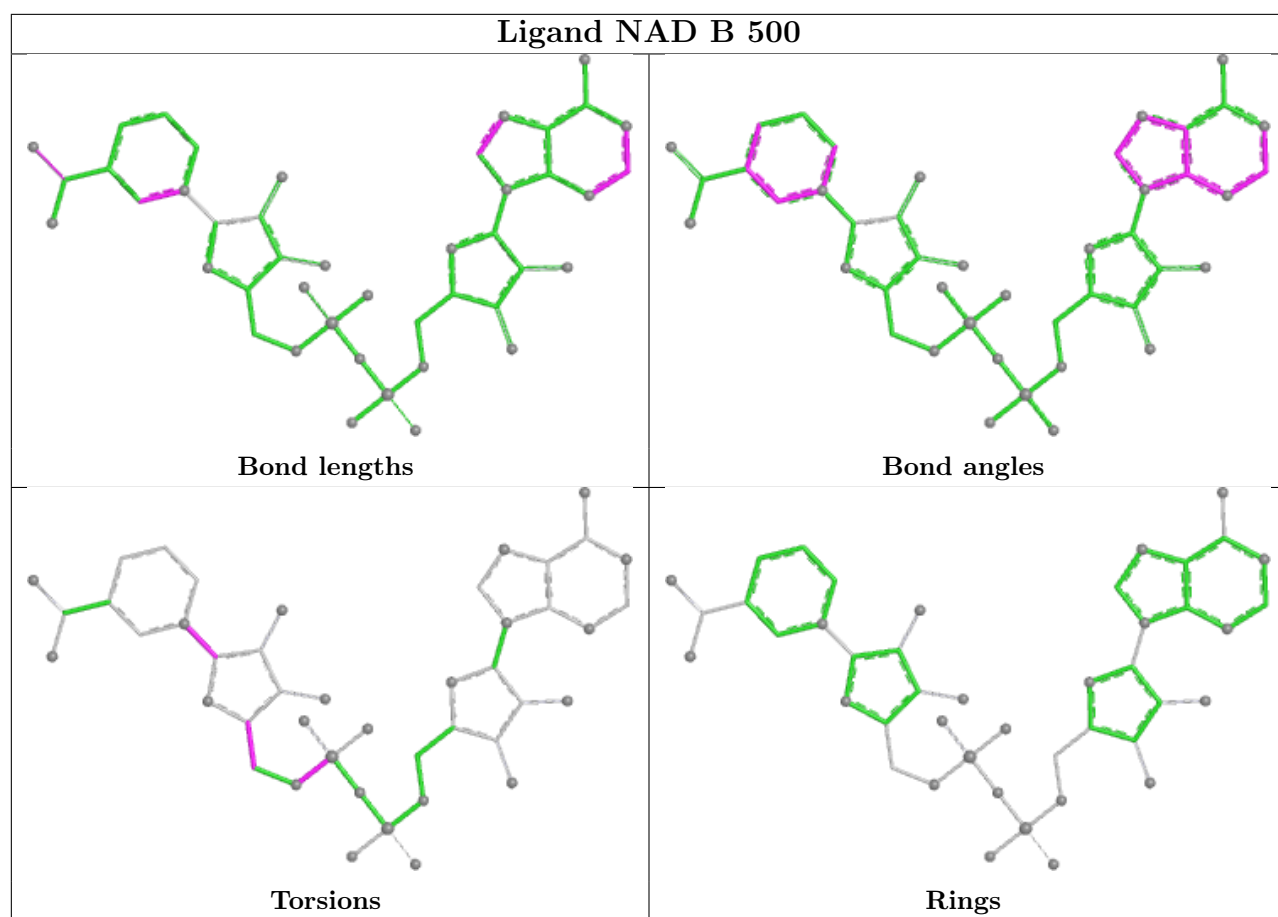
Mol	Chain	Res	Type	Atoms
2	D	500	NAD	O4B-C4B-C5B-O5B
2	A	500	NAD	C2B-C1B-N9A-C8A
2	C	500	NAD	C2B-C1B-N9A-C8A

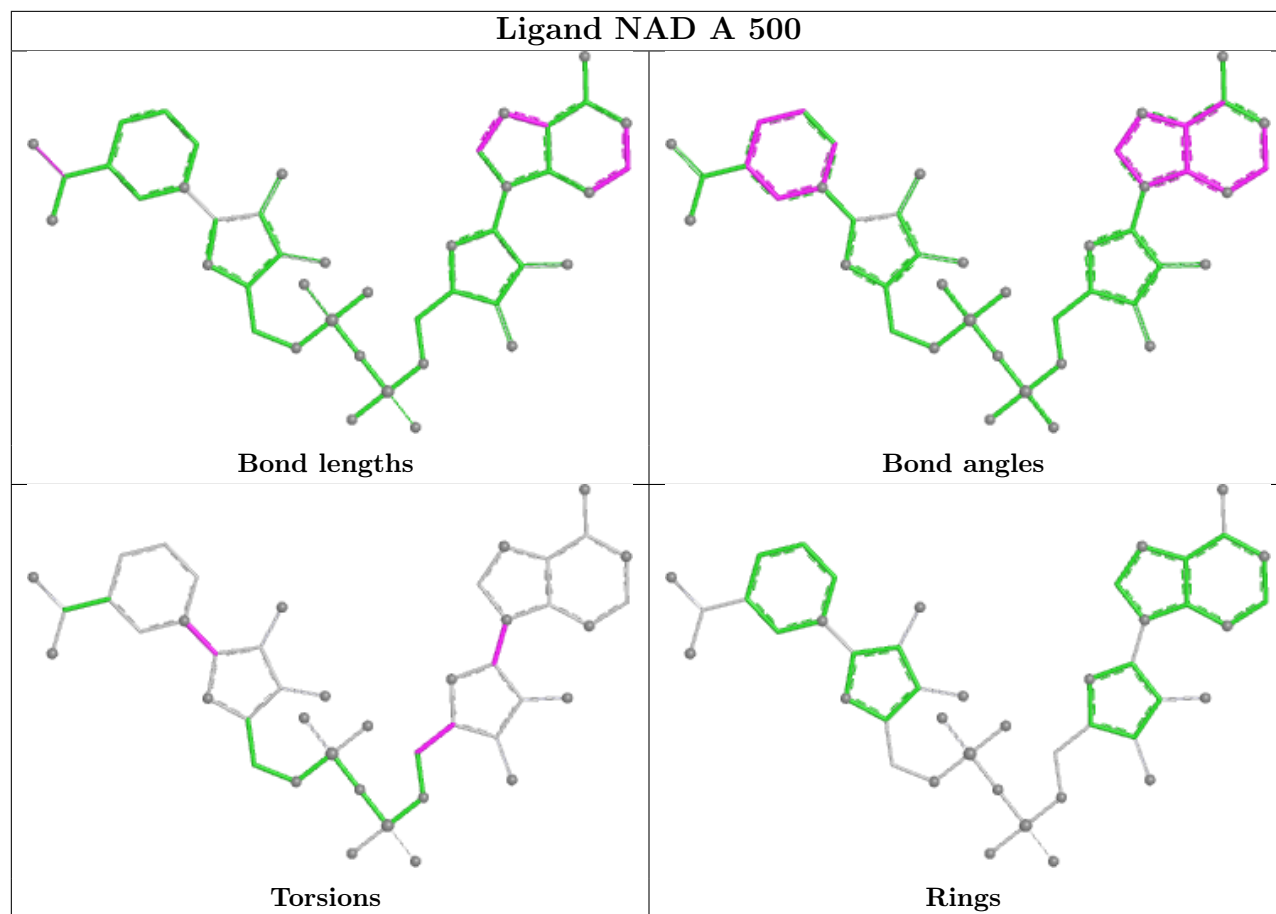
There are no ring outliers.

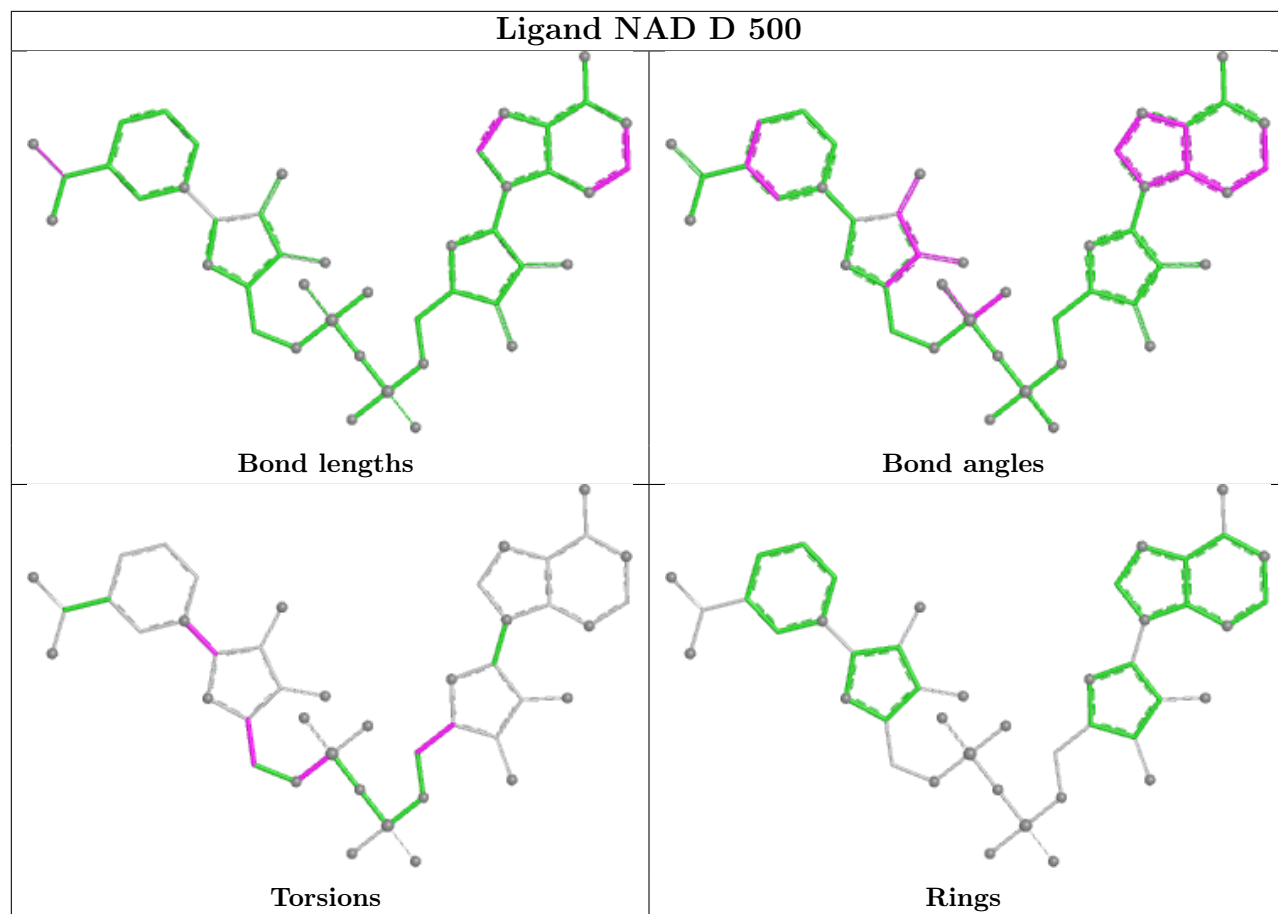
1 monomer is involved in 1 short contact:

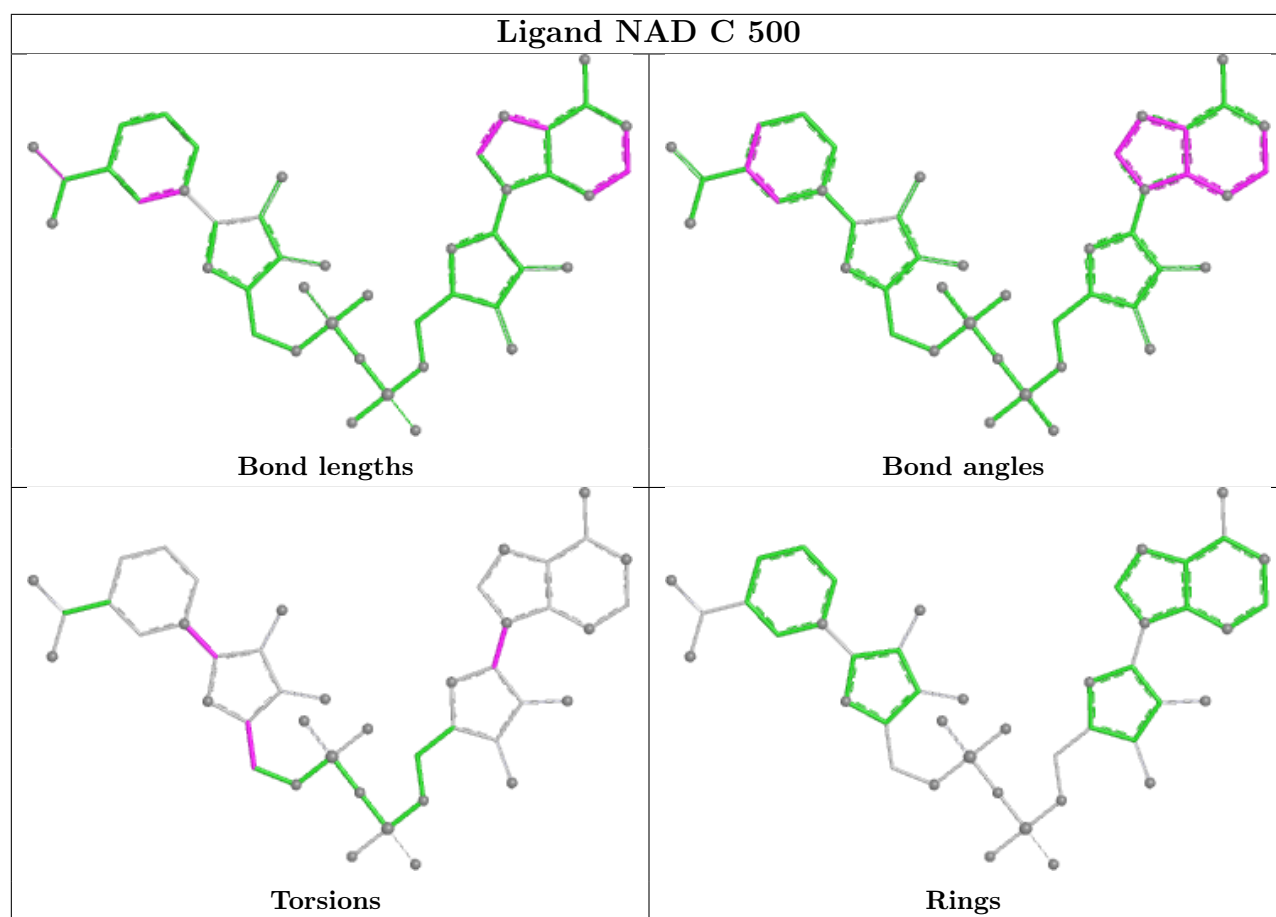
Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	B	500	NAD	1	0

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 [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	293/319 (91%)	0.96	21 (7%)	21 20	47, 59, 64, 71	0
1	B	296/319 (92%)	0.66	6 (2%)	65 65	46, 59, 65, 77	0
1	C	293/319 (91%)	0.95	20 (6%)	23 22	32, 59, 65, 75	1 (0%)
1	D	293/319 (91%)	1.06	46 (15%)	5 4	46, 59, 64, 70	0
All	All	1175/1276 (92%)	0.90	93 (7%)	18 18	32, 59, 65, 77	1 (0%)

All (93) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	D	270	ALA	4.8
1	D	199	CYS	4.0
1	D	203	GLY	3.8
1	D	173	PHE	3.8
1	D	198	TYR	3.7
1	D	160	SER	3.7
1	D	159	VAL	3.3
1	D	82	GLY	3.2
1	C	160	SER	3.2
1	D	196	VAL	3.1
1	D	79	GLN	3.1
1	B	305	LEU	3.1
1	D	175	VAL	3.1
1	D	161	GLY	3.0
1	D	189	LEU	2.9
1	D	200	GLY	2.9
1	A	81	ALA	2.9
1	A	304	SER	2.9
1	B	40	MET	2.9
1	D	271	ASN	2.9
1	C	159	VAL	2.9

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Mol	Chain	Res	Type	RSRZ
1	D	197	VAL	2.8
1	C	202	VAL	2.8
1	A	210	ILE	2.7
1	D	40	MET	2.7
1	D	137	PRO	2.7
1	A	297	LYS	2.7
1	A	134	THR	2.7
1	D	135	ILE	2.6
1	D	193	GLY	2.6
1	A	239	LEU	2.6
1	D	132	SER	2.6
1	C	175	VAL	2.5
1	D	185	ALA	2.5
1	D	202	VAL	2.5
1	D	141	LYS	2.5
1	D	171	LEU	2.5
1	D	304	SER	2.5
1	A	107	ILE	2.4
1	D	204	THR	2.4
1	A	298	SER	2.4
1	C	199	CYS	2.4
1	A	293	ALA	2.4
1	A	145	LYS	2.4
1	C	275	GLY	2.4
1	D	206	GLN	2.4
1	D	182	PHE	2.4
1	C	249	GLY	2.4
1	B	65	LEU	2.4
1	C	42	VAL	2.4
1	D	134	THR	2.3
1	D	274	GLN	2.3
1	A	287	GLY	2.3
1	D	297	LYS	2.3
1	C	172	THR	2.3
1	A	180	ASP	2.3
1	D	91	ASP	2.3
1	C	173	PHE	2.3
1	D	299	PRO	2.3
1	D	152	ALA	2.2
1	A	194	SER	2.2
1	C	138	ALA	2.2
1	D	176	GLY	2.2

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Mol	Chain	Res	Type	RSRZ
1	C	281	LEU	2.2
1	D	301	LEU	2.2
1	A	66	ILE	2.2
1	A	136	ASP	2.2
1	C	44	PHE	2.2
1	B	278	GLY	2.2
1	C	317	GLY	2.2
1	C	264	MET	2.2
1	C	314	CYS	2.2
1	A	163	VAL	2.1
1	A	270	ALA	2.1
1	C	195	ASN	2.1
1	D	272	ASN	2.1
1	B	91	ASP	2.1
1	B	178	VAL	2.1
1	A	117	ASN	2.1
1	C	150	MET	2.1
1	D	192	MET	2.1
1	C	197	VAL	2.1
1	D	267	VAL	2.1
1	A	301	LEU	2.1
1	D	305	LEU	2.1
1	D	205	GLY	2.1
1	A	294	THR	2.1
1	A	299	PRO	2.1
1	D	201	ALA	2.0
1	D	172	THR	2.0
1	C	201	ALA	2.0
1	D	190	GLY	2.0
1	D	174	MET	2.0

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 ⓘ

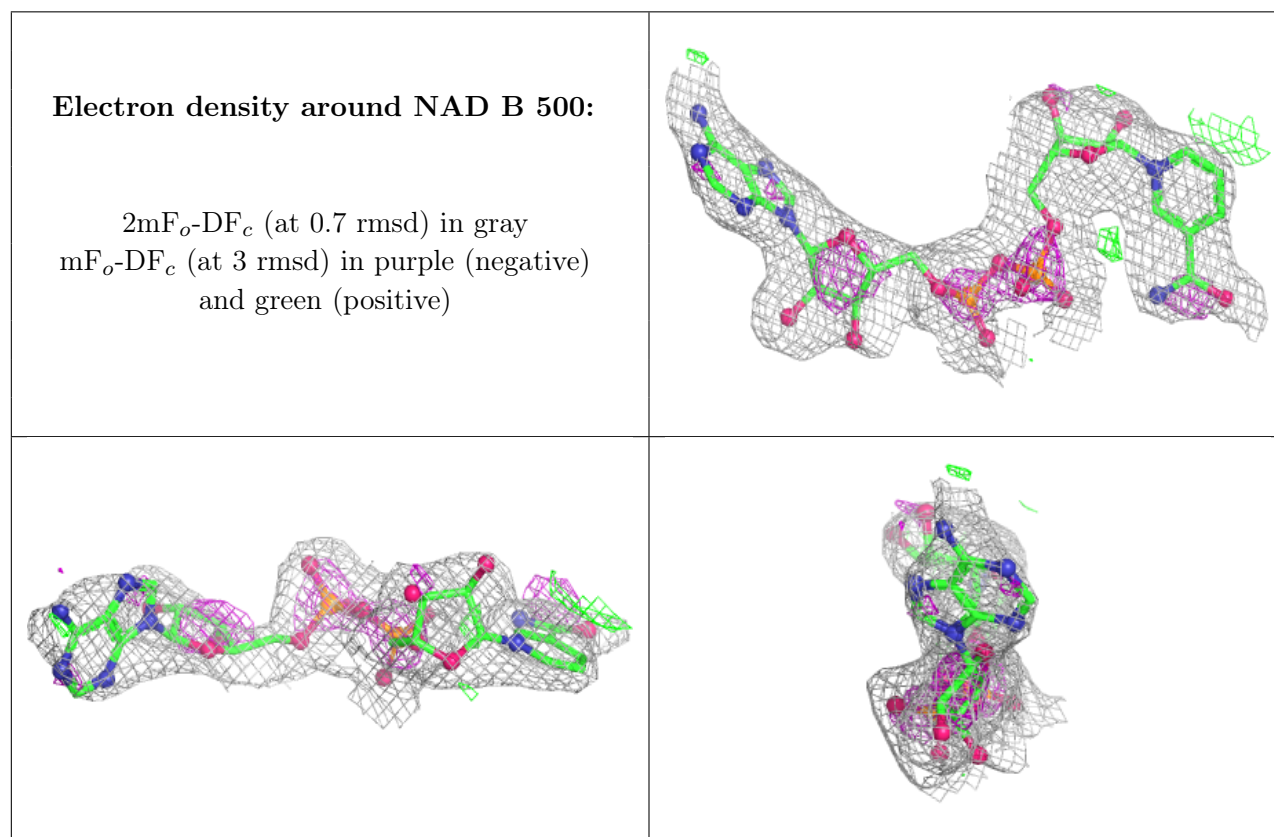
There are no oligosaccharides in this entry.

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.

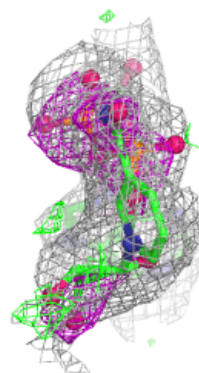
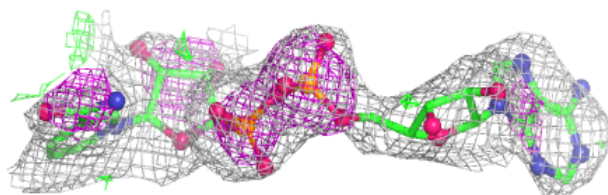
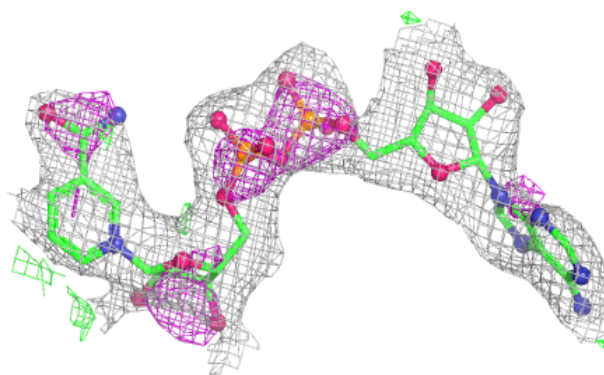
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
2	NAD	B	500	44/44	0.81	0.15	73,90,104,106	0
2	NAD	C	500	44/44	0.82	0.16	67,86,102,107	0
2	NAD	D	500	44/44	0.85	0.16	59,71,93,96	0
2	NAD	A	500	44/44	0.88	0.14	53,67,81,82	0

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.

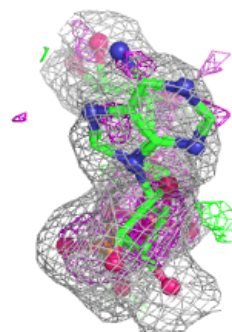
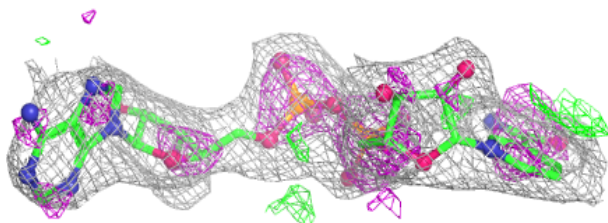
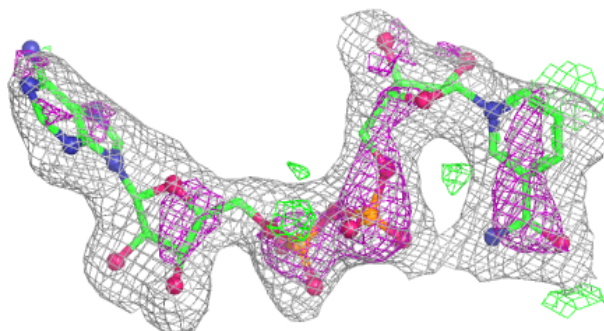


Electron density around NAD C 500:

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

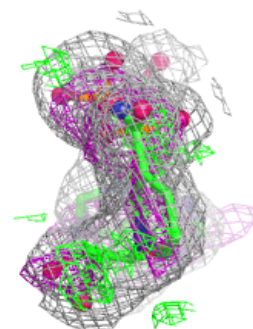
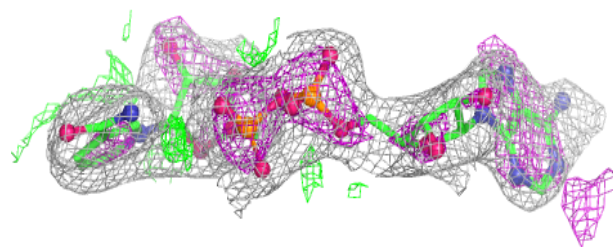
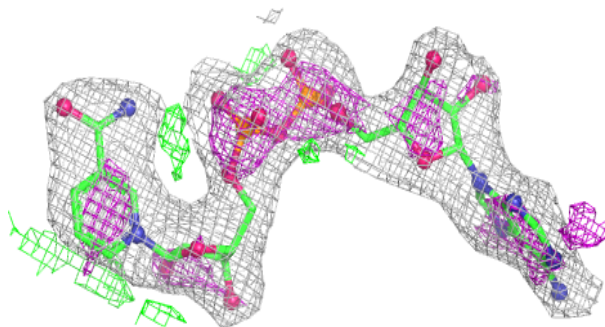
**Electron density around NAD D 500:**

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



Electron density around NAD A 500:

$2mF_o-DF_c$ (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.