



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 22, 2025 – 12:05 AM EDT

PDB ID : 2DFD / pdb\_00002dfd  
Title : Crystal Structure of Human Malate Dehydrogenase Type 2  
Authors : Ugochukwu, E.; Shafqat, N.; Rojkova, A.; Sundstrom, M.; Arrowsmith, C.; Weigelt, J.; Edwards, A.; von Delft, F.; Oppermann, U.; Structural Genomics Consortium (SGC)  
Deposited on : 2006-02-28  
Resolution : 1.90 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](mailto: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>.

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

MolProbity : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
Xtrriage (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

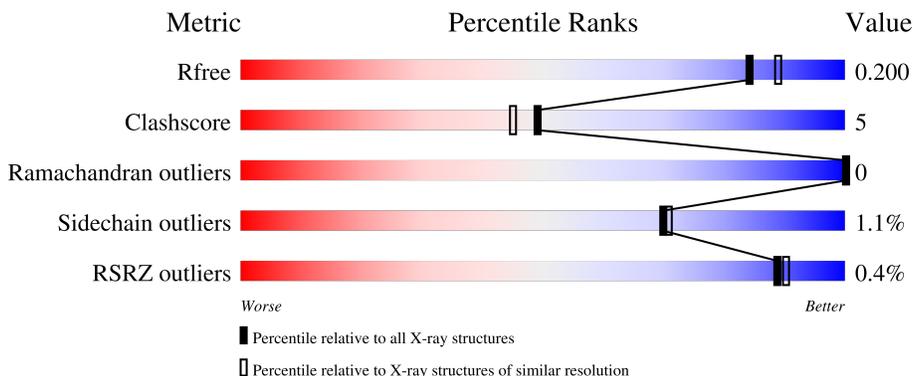
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.90 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	7293 (1.90-1.90)
Clashscore	180529	8090 (1.90-1.90)
Ramachandran outliers	177936	8022 (1.90-1.90)
Sidechain outliers	177891	8022 (1.90-1.90)
RSRZ outliers	164620	7292 (1.90-1.90)

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  $\geq 3$ , 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	342	86% 6% 8%
1	B	342	84% 8% 8%
1	C	342	87% 5% 8%
1	D	342	87% 5% 8%

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 10300 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 Malate dehydrogenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	314	2320	1481	384	440	15	0	5	0
1	B	314	2294	1464	380	436	14	0	4	0
1	C	314	2320	1476	385	446	13	0	7	0
1	D	314	2313	1475	387	437	14	0	4	0

There are 92 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-21	MET	-	cloning artifact	UNP P40926
A	-20	HIS	-	cloning artifact	UNP P40926
A	-19	HIS	-	cloning artifact	UNP P40926
A	-18	HIS	-	cloning artifact	UNP P40926
A	-17	HIS	-	cloning artifact	UNP P40926
A	-16	HIS	-	cloning artifact	UNP P40926
A	-15	HIS	-	cloning artifact	UNP P40926
A	-14	SER	-	cloning artifact	UNP P40926
A	-13	SER	-	cloning artifact	UNP P40926
A	-12	GLY	-	cloning artifact	UNP P40926
A	-11	VAL	-	cloning artifact	UNP P40926
A	-10	ASP	-	cloning artifact	UNP P40926
A	-9	LEU	-	cloning artifact	UNP P40926
A	-8	GLY	-	cloning artifact	UNP P40926
A	-7	THR	-	cloning artifact	UNP P40926
A	-6	GLU	-	cloning artifact	UNP P40926
A	-5	ASN	-	cloning artifact	UNP P40926
A	-4	LEU	-	cloning artifact	UNP P40926
A	-3	TYR	-	cloning artifact	UNP P40926
A	-2	PHE	-	cloning artifact	UNP P40926
A	-1	GLN	-	cloning artifact	UNP P40926

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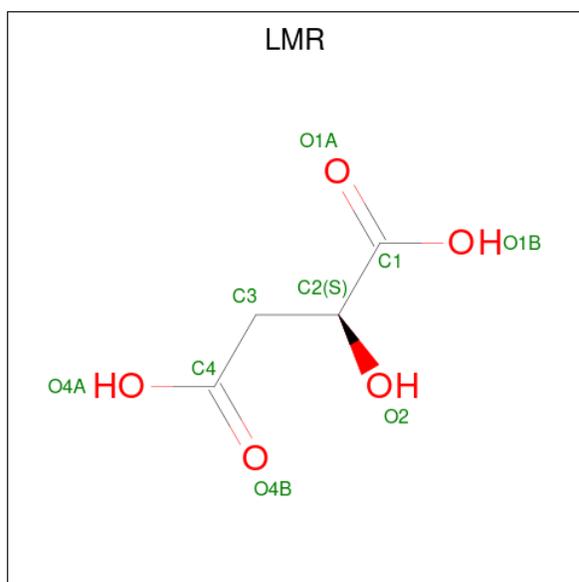
Chain	Residue	Modelled	Actual	Comment	Reference
A	0	SER	-	cloning artifact	UNP P40926
A	1	MET	-	cloning artifact	UNP P40926
B	-21	MET	-	cloning artifact	UNP P40926
B	-20	HIS	-	cloning artifact	UNP P40926
B	-19	HIS	-	cloning artifact	UNP P40926
B	-18	HIS	-	cloning artifact	UNP P40926
B	-17	HIS	-	cloning artifact	UNP P40926
B	-16	HIS	-	cloning artifact	UNP P40926
B	-15	HIS	-	cloning artifact	UNP P40926
B	-14	SER	-	cloning artifact	UNP P40926
B	-13	SER	-	cloning artifact	UNP P40926
B	-12	GLY	-	cloning artifact	UNP P40926
B	-11	VAL	-	cloning artifact	UNP P40926
B	-10	ASP	-	cloning artifact	UNP P40926
B	-9	LEU	-	cloning artifact	UNP P40926
B	-8	GLY	-	cloning artifact	UNP P40926
B	-7	THR	-	cloning artifact	UNP P40926
B	-6	GLU	-	cloning artifact	UNP P40926
B	-5	ASN	-	cloning artifact	UNP P40926
B	-4	LEU	-	cloning artifact	UNP P40926
B	-3	TYR	-	cloning artifact	UNP P40926
B	-2	PHE	-	cloning artifact	UNP P40926
B	-1	GLN	-	cloning artifact	UNP P40926
B	0	SER	-	cloning artifact	UNP P40926
B	1	MET	-	cloning artifact	UNP P40926
C	-21	MET	-	cloning artifact	UNP P40926
C	-20	HIS	-	cloning artifact	UNP P40926
C	-19	HIS	-	cloning artifact	UNP P40926
C	-18	HIS	-	cloning artifact	UNP P40926
C	-17	HIS	-	cloning artifact	UNP P40926
C	-16	HIS	-	cloning artifact	UNP P40926
C	-15	HIS	-	cloning artifact	UNP P40926
C	-14	SER	-	cloning artifact	UNP P40926
C	-13	SER	-	cloning artifact	UNP P40926
C	-12	GLY	-	cloning artifact	UNP P40926
C	-11	VAL	-	cloning artifact	UNP P40926
C	-10	ASP	-	cloning artifact	UNP P40926
C	-9	LEU	-	cloning artifact	UNP P40926
C	-8	GLY	-	cloning artifact	UNP P40926
C	-7	THR	-	cloning artifact	UNP P40926
C	-6	GLU	-	cloning artifact	UNP P40926
C	-5	ASN	-	cloning artifact	UNP P40926

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Chain	Residue	Modelled	Actual	Comment	Reference
C	-4	LEU	-	cloning artifact	UNP P40926
C	-3	TYR	-	cloning artifact	UNP P40926
C	-2	PHE	-	cloning artifact	UNP P40926
C	-1	GLN	-	cloning artifact	UNP P40926
C	0	SER	-	cloning artifact	UNP P40926
C	1	MET	-	cloning artifact	UNP P40926
D	-21	MET	-	cloning artifact	UNP P40926
D	-20	HIS	-	cloning artifact	UNP P40926
D	-19	HIS	-	cloning artifact	UNP P40926
D	-18	HIS	-	cloning artifact	UNP P40926
D	-17	HIS	-	cloning artifact	UNP P40926
D	-16	HIS	-	cloning artifact	UNP P40926
D	-15	HIS	-	cloning artifact	UNP P40926
D	-14	SER	-	cloning artifact	UNP P40926
D	-13	SER	-	cloning artifact	UNP P40926
D	-12	GLY	-	cloning artifact	UNP P40926
D	-11	VAL	-	cloning artifact	UNP P40926
D	-10	ASP	-	cloning artifact	UNP P40926
D	-9	LEU	-	cloning artifact	UNP P40926
D	-8	GLY	-	cloning artifact	UNP P40926
D	-7	THR	-	cloning artifact	UNP P40926
D	-6	GLU	-	cloning artifact	UNP P40926
D	-5	ASN	-	cloning artifact	UNP P40926
D	-4	LEU	-	cloning artifact	UNP P40926
D	-3	TYR	-	cloning artifact	UNP P40926
D	-2	PHE	-	cloning artifact	UNP P40926
D	-1	GLN	-	cloning artifact	UNP P40926
D	0	SER	-	cloning artifact	UNP P40926
D	1	MET	-	cloning artifact	UNP P40926

- Molecule 2 is (2S)-2-hydroxybutanedioic acid (CCD ID: LMR) (formula: C<sub>4</sub>H<sub>6</sub>O<sub>5</sub>).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total C O 9 4 5	0	0
2	B	1	Total C O 9 4 5	0	0
2	C	1	Total C O 9 4 5	0	0
2	D	1	Total C O 9 4 5	0	0

- Molecule 3 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

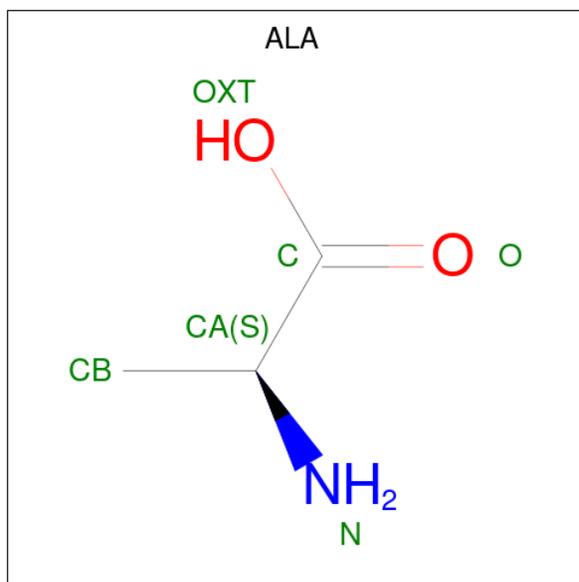
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	2	Total Cl 2 2	0	0
3	B	1	Total Cl 1 1	0	0
3	C	2	Total Cl 2 2	0	0
3	D	2	Total Cl 2 2	0	0

- Molecule 4 is NICOTINAMIDE-ADENINE-DINUCLEOTIDE (CCD ID: NAD) (formula: C<sub>21</sub>H<sub>27</sub>N<sub>7</sub>O<sub>14</sub>P<sub>2</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	C	N	O	0	0
			10	6	3	1		
5	B	1	Total	C	N	O	0	0
			10	6	3	1		
5	C	1	Total	C	N	O	0	0
			10	6	3	1		

- Molecule 6 is ALANINE (CCD ID: ALA) (formula: C<sub>3</sub>H<sub>7</sub>NO<sub>2</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
6	A	1	Total	C	N	O	0	0
			5	3	1	1		

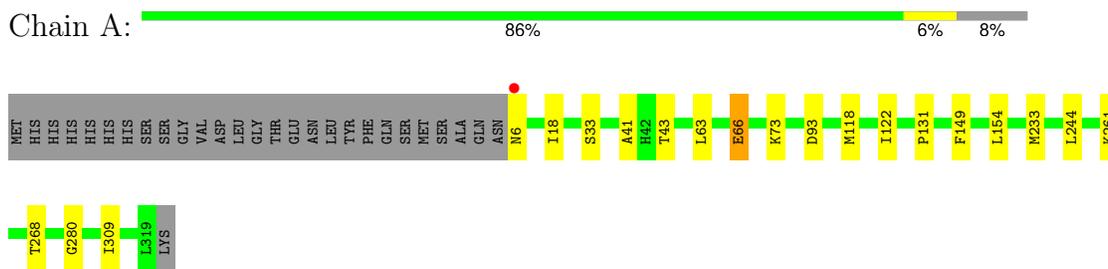
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	194	Total	O	0	0
			194	194		
7	B	140	Total	O	0	0
			140	140		
7	C	252	Total	O	0	0
			252	252		
7	D	213	Total	O	0	0
			213	213		

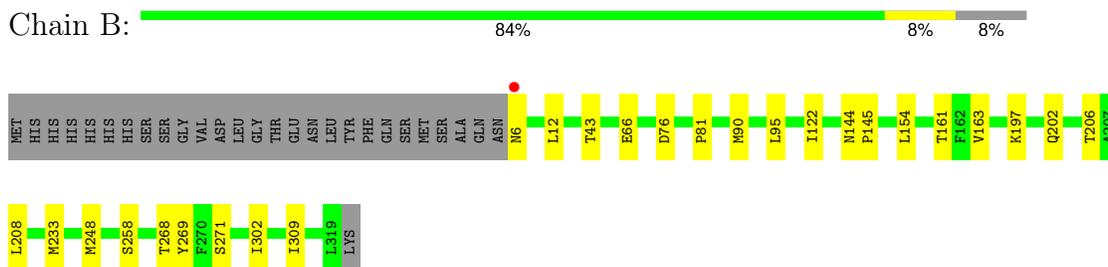
### 3 Residue-property plots [i](#)

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.

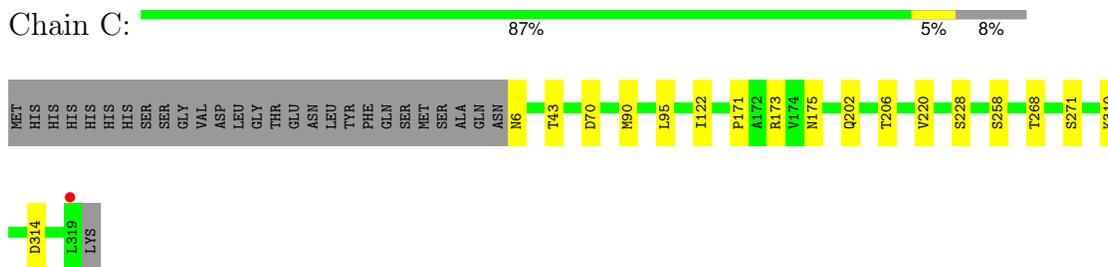
- Molecule 1: Malate dehydrogenase



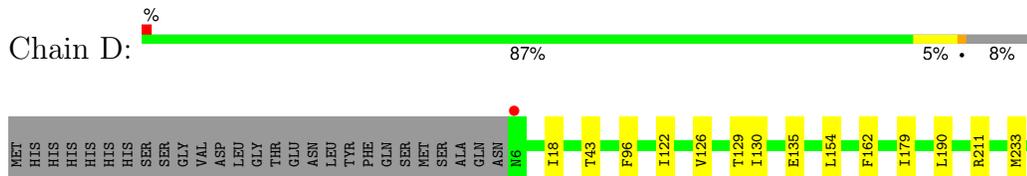
- Molecule 1: Malate dehydrogenase



- Molecule 1: Malate dehydrogenase



- Molecule 1: Malate dehydrogenase





## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	59.94Å 152.53Å 154.83Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	6.01 – 1.90 6.01 – 1.90	Depositor EDS
% Data completeness (in resolution range)	99.8 (6.01-1.90) 96.4 (6.01-1.90)	Depositor EDS
$R_{merge}$	(Not available)	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.73 (at 1.90Å)	Xtrriage
Refinement program	REFMAC 5.2.0019	Depositor
R, $R_{free}$	0.156 , 0.194 0.163 , 0.200	Depositor DCC
$R_{free}$ test set	5640 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	28.0	Xtrriage
Anisotropy	0.006	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.50 , 56.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.48$ , $\langle L^2 \rangle = 0.31$	Xtrriage
Estimated twinning fraction	0.011 for -h,l,k	Xtrriage
$F_o, F_c$ correlation	0.95	EDS
Total number of atoms	10300	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	33.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.15% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

## 5 Model quality [i](#)

### 5.1 Standard geometry [i](#)

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

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	0.87	0/2376	0.90	0/3230
1	B	0.85	1/2348 (0.0%)	0.85	0/3196
1	C	1.01	0/2387	0.90	0/3249
1	D	0.97	2/2365 (0.1%)	0.92	0/3216
All	All	0.93	3/9476 (0.0%)	0.89	0/12891

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	D	315	PHE	C-O	6.84	1.31	1.24
1	D	315	PHE	C-N	6.51	1.41	1.34
1	B	302	ILE	CA-CB	5.62	1.57	1.54

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	2320	0	2389	28	0
1	B	2294	0	2336	28	0
1	C	2320	0	2362	11	0
1	D	2313	0	2374	26	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	A	9	0	4	1	0
2	B	9	0	4	1	0
2	C	9	0	4	2	0
2	D	9	0	4	1	0
3	A	2	0	0	0	0
3	B	1	0	0	1	0
3	C	2	0	0	0	0
3	D	2	0	0	1	0
4	A	44	0	26	5	0
4	B	44	0	26	3	0
4	C	44	0	26	3	0
4	D	44	0	26	9	0
5	A	10	0	6	0	0
5	B	10	0	6	0	0
5	C	10	0	6	1	0
6	A	5	0	5	0	0
7	A	194	0	0	4	0
7	B	140	0	0	3	0
7	C	252	0	0	4	0
7	D	213	0	0	5	0
All	All	10300	0	9604	101	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 5.

All (101) 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:154:LEU:HD22	1:D:233[A]:MET:HE2	1.23	1.13
1:A:118[B]:MET:HE2	1:A:244:LEU:HD11	1.21	1.11
1:A:118[B]:MET:HE3	1:A:149:PHE:HE2	1.26	1.00
1:D:233[A]:MET:HE3	4:D:3004:NAD:H4N	1.39	1.00
1:A:118[B]:MET:CE	1:A:244:LEU:HD11	1.98	0.93
1:A:233[A]:MET:HE3	4:A:3003:NAD:H4N	1.52	0.91
1:D:154:LEU:HB2	1:D:233[A]:MET:HE1	1.52	0.90
1:C:268[B]:THR:HG21	7:C:3569:HOH:O	1.69	0.90
1:D:268[A]:THR:HG22	7:D:3305:HOH:O	1.72	0.90
1:D:268[A]:THR:HG21	7:D:3300:HOH:O	1.71	0.89
1:D:233[A]:MET:HE3	4:D:3004:NAD:C4N	2.00	0.89
1:A:118[B]:MET:HE3	1:A:149:PHE:CE2	2.09	0.86
2:A:3104:LMR:H2	4:A:3003:NAD:C4N	2.07	0.85

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:C:3103:LMR:H2	4:C:3002:NAD:C4N	2.08	0.83
1:D:154:LEU:HD22	1:D:233[A]:MET:CE	2.08	0.81
1:D:154:LEU:CD2	1:D:233[A]:MET:HE2	2.09	0.80
1:A:154:LEU:HD22	1:A:233[A]:MET:HE2	1.66	0.78
2:D:3101:LMR:H2	4:D:3004:NAD:C4N	2.14	0.78
1:D:154:LEU:CB	1:D:233[A]:MET:HE1	2.14	0.78
1:B:202:GLN:HE21	1:B:206:THR:CG2	1.97	0.78
1:B:90:MET:HE1	1:B:95:LEU:HD23	1.67	0.76
1:D:154:LEU:HB2	1:D:233[A]:MET:CE	2.15	0.76
1:B:90:MET:HE1	1:B:95:LEU:CD2	2.16	0.76
1:B:154:LEU:HB2	1:B:233[A]:MET:CE	2.17	0.74
1:B:154:LEU:HB2	1:B:233[A]:MET:HE1	1.70	0.74
2:B:3102:LMR:H2	4:B:3001:NAD:C4N	2.18	0.73
1:A:233[A]:MET:HE3	4:A:3003:NAD:C4N	2.20	0.70
1:A:118[B]:MET:HE2	1:A:244:LEU:CD1	2.12	0.69
3:D:3207:CL:CL	7:D:3416:HOH:O	2.48	0.69
1:A:118[B]:MET:HE1	1:A:280:GLY:HA2	1.76	0.68
1:D:233[A]:MET:CE	4:D:3004:NAD:H4N	2.22	0.66
1:A:154:LEU:HB2	1:A:233[A]:MET:HE1	1.76	0.66
1:B:202:GLN:HE21	1:B:206:THR:HG23	1.61	0.65
1:A:154:LEU:HB2	1:A:233[A]:MET:CE	2.28	0.64
1:B:268[A]:THR:HG23	1:B:269:TYR:CD2	2.35	0.61
1:A:154:LEU:HD22	1:A:233[A]:MET:CE	2.31	0.60
1:B:154:LEU:HD22	1:B:233[A]:MET:HE2	1.84	0.60
1:B:154:LEU:CB	1:B:233[A]:MET:HE1	2.31	0.59
1:A:118[B]:MET:CE	1:A:149:PHE:HE2	2.07	0.59
1:A:154:LEU:CB	1:A:233[A]:MET:HE1	2.32	0.59
1:A:118[B]:MET:CE	1:A:149:PHE:CE2	2.85	0.58
1:A:66:GLU:H	1:A:66:GLU:CD	2.12	0.57
1:A:268[B]:THR:HG22	7:A:3326:HOH:O	2.04	0.57
1:B:154:LEU:CB	1:B:233[A]:MET:CE	2.85	0.55
1:A:118[B]:MET:HE1	1:A:280:GLY:CA	2.36	0.55
1:C:310:LYS:NZ	1:C:314:ASP:OD2	2.40	0.54
1:D:268[A]:THR:HG23	1:D:309:ILE:HG21	1.91	0.53
3:B:3206:CL:CL	7:B:3533:HOH:O	2.56	0.53
1:B:154:LEU:HB2	1:B:233[A]:MET:HE2	1.91	0.52
1:B:90:MET:HE1	1:B:95:LEU:HD21	1.92	0.51
1:B:268[A]:THR:HG23	1:B:269:TYR:HD2	1.76	0.51
1:D:154:LEU:CD2	1:D:233[A]:MET:CE	2.79	0.50
1:A:18:ILE:HD11	4:A:3003:NAD:C6N	2.42	0.50
1:A:118[B]:MET:CE	1:A:280:GLY:HA2	2.42	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:315:PHE:CD2	1:D:315:PHE:C	2.90	0.49
1:B:268[A]:THR:CG2	1:B:309:ILE:HG21	2.43	0.49
1:B:90:MET:CE	1:B:95:LEU:CD2	2.90	0.48
1:B:233[A]:MET:HE2	1:B:233[A]:MET:HA	1.95	0.48
1:B:197:LYS:NZ	7:B:3520:HOH:O	2.47	0.48
1:D:211[B]:ARG:NH2	7:D:3297:HOH:O	2.46	0.48
1:C:175[B]:ASN:ND2	7:C:3532:HOH:O	2.24	0.47
1:A:154:LEU:CB	1:A:233[A]:MET:CE	2.93	0.46
7:A:3442:HOH:O	4:D:3004:NAD:H8A	2.16	0.46
1:A:6:ASN:HA	1:A:33:SER:HB3	1.98	0.46
1:D:233[A]:MET:HE3	4:D:3004:NAD:O7N	2.15	0.46
1:B:12:LEU:O	1:B:81:PRO:HD2	2.15	0.45
1:D:96:PHE:CG	1:D:311:LYS:HE3	2.51	0.45
1:C:175[B]:ASN:ND2	7:C:3622:HOH:O	2.36	0.45
1:C:202:GLN:O	1:C:206:THR:HG23	2.17	0.45
1:B:233[A]:MET:HE3	4:B:3001:NAD:H4N	1.98	0.45
1:C:90:MET:HE1	1:C:95:LEU:HD23	1.98	0.45
1:A:154:LEU:CD2	1:A:233[A]:MET:CE	2.95	0.45
1:A:233[A]:MET:HE2	1:A:233[A]:MET:HA	1.99	0.44
1:B:122:ILE:O	4:B:3001:NAD:H2N	2.17	0.44
1:A:122:ILE:O	4:A:3003:NAD:H2N	2.17	0.44
1:D:154:LEU:CB	1:D:233[A]:MET:CE	2.85	0.44
1:C:70:ASP:CG	7:C:3749:HOH:O	2.61	0.44
1:D:162:PHE:CE2	1:D:211[B]:ARG:HG2	2.53	0.43
1:D:135:GLU:OE1	7:D:3299:HOH:O	2.21	0.43
1:B:144:ASN:HA	1:B:145:PRO:HD2	1.89	0.43
1:D:18:ILE:HD11	4:D:3004:NAD:C6N	2.49	0.43
1:C:171:PRO:O	5:C:3501:HIS:HE1	2.02	0.42
1:B:76:ASP:HB3	1:B:248:MET:HE1	2.00	0.42
1:B:163:VAL:HG22	1:B:208:LEU:HD21	2.02	0.42
1:C:122:ILE:O	4:C:3002:NAD:H2N	2.18	0.42
2:C:3103:LMR:H2	4:C:3002:NAD:C3N	2.50	0.42
1:B:268[A]:THR:HG22	7:B:3509:HOH:O	2.20	0.42
1:A:131:PRO:HG2	1:A:309:ILE:HA	2.01	0.42
1:A:41:ALA:HA	1:A:63:LEU:HD11	2.01	0.42
7:A:3375:HOH:O	1:B:161:THR:HG23	2.19	0.42
1:B:202:GLN:O	1:B:206:THR:HG23	2.20	0.41
1:A:261:LYS:NZ	7:A:3418:HOH:O	2.49	0.41
1:C:258:SER:O	1:C:271:SER:HA	2.21	0.41
1:C:220:VAL:HG22	1:C:228:SER:HB3	2.03	0.41
1:D:233[A]:MET:HE3	4:D:3004:NAD:C7N	2.51	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:D:126:VAL:HA	1:D:129:THR:OG1	2.22	0.40
1:D:122:ILE:O	4:D:3004:NAD:H2N	2.21	0.40
1:D:179:ILE:HD13	1:D:190:LEU:HD11	2.03	0.40
1:B:258:SER:O	1:B:271:SER:HA	2.21	0.40
1:D:130:ILE:HD13	1:D:130:ILE:HA	1.98	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	317/342 (93%)	312 (98%)	5 (2%)	0	100	100
1	B	316/342 (92%)	309 (98%)	7 (2%)	0	100	100
1	C	319/342 (93%)	311 (98%)	8 (2%)	0	100	100
1	D	316/342 (92%)	309 (98%)	7 (2%)	0	100	100
All	All	1268/1368 (93%)	1241 (98%)	27 (2%)	0	100	100

There are no Ramachandran outliers to report.

### 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	252/278 (91%)	248 (98%)	4 (2%)	58	56

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	B	246/278 (88%)	244 (99%)	2 (1%)	79	80
1	C	253/278 (91%)	250 (99%)	3 (1%)	67	68
1	D	249/278 (90%)	246 (99%)	3 (1%)	67	68
All	All	1000/1112 (90%)	988 (99%)	12 (1%)	70	68

All (12) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	43	THR
1	A	66	GLU
1	A	73	LYS
1	A	93	ASP
1	B	6	ASN
1	B	43	THR
1	C	6	ASN
1	C	43	THR
1	C	173	ARG
1	D	43	THR
1	D	268[A]	THR
1	D	268[B]	THR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (12) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	28	ASN
1	A	146	ASN
1	A	249	ASN
1	B	6	ASN
1	B	28	ASN
1	B	113	HIS
1	B	202	GLN
1	B	249	ASN
1	C	6	ASN
1	C	28	ASN
1	C	249	ASN
1	D	202	GLN

### 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 19 ligands modelled in this entry, 7 are monoatomic - leaving 12 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
4	NAD	C	3002	-	42,48,48	2.10	7 (16%)	50,73,73	1.94	11 (22%)
2	LMR	C	3103	-	8,8,8	1.64	1 (12%)	10,10,10	1.47	2 (20%)
4	NAD	D	3004	-	42,48,48	1.82	6 (14%)	50,73,73	1.90	10 (20%)
5	HIS	B	3401	-	5,10,11	1.07	0	3,12,14	1.70	1 (33%)
5	HIS	A	3301	6	5,10,11	0.79	0	3,12,14	1.71	1 (33%)
2	LMR	A	3104	-	8,8,8	1.74	1 (12%)	10,10,10	1.69	3 (30%)
2	LMR	B	3102	-	8,8,8	1.64	1 (12%)	10,10,10	1.83	3 (30%)
5	HIS	C	3501	-	5,10,11	0.86	0	3,12,14	1.65	1 (33%)
4	NAD	A	3003	-	42,48,48	1.94	7 (16%)	50,73,73	1.61	11 (22%)
2	LMR	D	3101	-	8,8,8	1.33	0	10,10,10	1.29	1 (10%)
4	NAD	B	3001	-	42,48,48	1.83	5 (11%)	50,73,73	1.77	7 (14%)
6	ALA	A	3302	5	3,4,5	0.79	0	2,4,6	1.07	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
4	NAD	C	3002	-	-	4/26/62/62	0/5/5/5
2	LMR	C	3103	-	-	0/8/8/8	-
4	NAD	D	3004	-	-	4/26/62/62	0/5/5/5
5	HIS	B	3401	-	-	1/5/6/8	0/1/1/1
5	HIS	A	3301	6	-	2/5/6/8	0/1/1/1
2	LMR	A	3104	-	-	4/8/8/8	-
2	LMR	B	3102	-	-	3/8/8/8	-
5	HIS	C	3501	-	-	2/5/6/8	0/1/1/1
4	NAD	A	3003	-	-	4/26/62/62	0/5/5/5
2	LMR	D	3101	-	-	0/8/8/8	-
4	NAD	B	3001	-	-	4/26/62/62	0/5/5/5
6	ALA	A	3302	5	-	0/1/2/4	-

All (28) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	C	3002	NAD	O7N-C7N	8.52	1.40	1.24
4	B	3001	NAD	O7N-C7N	8.23	1.39	1.24
4	A	3003	NAD	O7N-C7N	8.12	1.39	1.24
4	D	3004	NAD	O7N-C7N	6.80	1.36	1.24
4	C	3002	NAD	PN-O3	6.15	1.66	1.59
4	D	3004	NAD	PN-O3	4.67	1.64	1.59
4	D	3004	NAD	C2A-N3A	4.60	1.39	1.32
4	A	3003	NAD	C2N-N1N	4.29	1.39	1.35
4	C	3002	NAD	PA-O3	4.06	1.63	1.59
2	A	3104	LMR	C2-C1	-3.80	1.46	1.52
4	A	3003	NAD	PN-O3	3.62	1.63	1.59
4	B	3001	NAD	C2A-N3A	3.56	1.37	1.32
4	B	3001	NAD	C2A-N1A	3.56	1.40	1.33
4	A	3003	NAD	C2A-N3A	3.34	1.37	1.32
4	B	3001	NAD	C2N-N1N	3.31	1.38	1.35
2	C	3103	LMR	C2-C1	-3.27	1.47	1.52
2	B	3102	LMR	C2-C1	-3.26	1.47	1.52
4	C	3002	NAD	C2A-N3A	3.17	1.37	1.32
4	A	3003	NAD	C2A-N1A	2.92	1.39	1.33
4	C	3002	NAD	C2A-N1A	2.91	1.39	1.33
4	C	3002	NAD	C4N-C3N	2.89	1.43	1.39
4	C	3002	NAD	O4D-C1D	2.70	1.44	1.40
4	A	3003	NAD	PA-O3	2.58	1.62	1.59

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	B	3001	NAD	PN-O3	2.44	1.62	1.59
4	D	3004	NAD	C8A-N7A	2.34	1.39	1.34
4	A	3003	NAD	O4B-C4B	-2.12	1.40	1.45
4	D	3004	NAD	O4D-C4D	-2.07	1.40	1.45
4	D	3004	NAD	C2A-N1A	2.01	1.37	1.33

All (51) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	3002	NAD	N3A-C2A-N1A	-7.58	118.38	128.67
4	D	3004	NAD	N3A-C2A-N1A	-7.29	118.78	128.67
4	B	3001	NAD	N3A-C2A-N1A	-6.41	119.97	128.67
4	B	3001	NAD	C4B-O4B-C1B	-6.02	104.41	109.92
4	A	3003	NAD	N3A-C2A-N1A	-5.87	120.71	128.67
4	C	3002	NAD	C4B-O4B-C1B	-5.62	104.78	109.92
4	D	3004	NAD	C3N-C7N-N7N	4.90	123.78	117.74
4	B	3001	NAD	O2N-PN-O1N	4.14	131.71	112.44
4	D	3004	NAD	O7N-C7N-C3N	-3.89	114.84	119.60
4	D	3004	NAD	O4B-C1B-N9A	3.61	113.53	108.75
4	A	3003	NAD	O4B-C1B-N9A	3.53	113.42	108.75
4	D	3004	NAD	O2N-PN-O1N	3.51	128.78	112.44
2	A	3104	LMR	O1B-C1-C2	3.33	119.79	112.74
4	C	3002	NAD	O7N-C7N-C3N	-3.31	115.56	119.60
4	C	3002	NAD	O2N-PN-O1N	3.25	127.56	112.44
4	C	3002	NAD	O4B-C1B-N9A	3.24	113.04	108.75
2	B	3102	LMR	O1B-C1-C2	3.15	119.40	112.74
4	A	3003	NAD	C4B-O4B-C1B	-3.05	107.13	109.92
4	B	3001	NAD	O4B-C1B-N9A	2.94	112.64	108.75
2	B	3102	LMR	O4A-C4-C3	2.91	123.03	114.00
4	A	3003	NAD	C4A-C5A-N7A	-2.85	106.33	109.34
4	B	3001	NAD	O7N-C7N-C3N	-2.73	116.26	119.60
2	B	3102	LMR	O1A-C1-C2	-2.71	117.19	122.60
4	C	3002	NAD	O3-PA-O1A	-2.70	102.57	110.70
4	D	3004	NAD	C6N-N1N-C2N	-2.67	119.61	121.88
2	A	3104	LMR	O1A-C1-C2	-2.64	117.32	122.60
2	C	3103	LMR	O2-C2-C3	2.64	116.30	109.96
4	B	3001	NAD	O4B-C4B-C3B	2.59	110.30	105.15
4	C	3002	NAD	O5D-PN-O1N	-2.59	98.65	108.94
4	C	3002	NAD	C3N-C7N-N7N	2.58	120.92	117.74
4	D	3004	NAD	C4B-O4B-C1B	-2.58	107.56	109.92
4	A	3003	NAD	C3N-C7N-N7N	2.57	120.91	117.74
4	A	3003	NAD	O2N-PN-O1N	2.50	124.06	112.44

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	3101	LMR	O1B-C1-C2	2.42	117.87	112.74
4	D	3004	NAD	C5N-C4N-C3N	-2.33	118.07	120.36
4	C	3002	NAD	O4B-C4B-C3B	2.31	109.74	105.15
2	A	3104	LMR	O4A-C4-C3	2.31	121.17	114.00
4	A	3003	NAD	O3-PA-O1A	-2.30	103.78	110.70
2	C	3103	LMR	O1B-C1-C2	2.28	117.56	112.74
4	C	3002	NAD	C2N-C3N-C4N	2.21	120.83	118.26
4	D	3004	NAD	C1B-N9A-C4A	-2.21	122.76	126.64
4	B	3001	NAD	O3-PN-O1N	-2.16	104.22	110.70
4	D	3004	NAD	C4D-O4D-C1D	2.14	111.88	109.92
4	A	3003	NAD	O7N-C7N-C3N	-2.09	117.05	119.60
4	C	3002	NAD	C5N-C6N-N1N	2.08	123.22	120.38
4	A	3003	NAD	O2A-PA-O3	-2.08	101.65	107.27
5	B	3401	HIS	CB-CG-CD2	2.06	131.42	127.75
4	A	3003	NAD	C6N-N1N-C2N	-2.04	120.14	121.88
5	A	3301	HIS	CB-CG-CD2	2.02	131.36	127.75
5	C	3501	HIS	CD2-NE2-CE1	2.01	108.90	105.72
4	A	3003	NAD	O2D-C2D-C3D	2.00	118.23	111.82

There are no chirality outliers.

All (28) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	B	3102	LMR	O1B-C1-C2-C3
4	A	3003	NAD	O4D-C1D-N1N-C2N
4	A	3003	NAD	O4D-C1D-N1N-C6N
4	A	3003	NAD	C2D-C1D-N1N-C2N
4	A	3003	NAD	C2D-C1D-N1N-C6N
4	B	3001	NAD	O4D-C1D-N1N-C2N
4	B	3001	NAD	O4D-C1D-N1N-C6N
4	B	3001	NAD	C2D-C1D-N1N-C2N
4	B	3001	NAD	C2D-C1D-N1N-C6N
4	C	3002	NAD	O4D-C1D-N1N-C2N
4	C	3002	NAD	O4D-C1D-N1N-C6N
4	C	3002	NAD	C2D-C1D-N1N-C2N
4	C	3002	NAD	C2D-C1D-N1N-C6N
4	D	3004	NAD	O4D-C1D-N1N-C2N
4	D	3004	NAD	O4D-C1D-N1N-C6N
4	D	3004	NAD	C2D-C1D-N1N-C2N
4	D	3004	NAD	C2D-C1D-N1N-C6N
5	C	3501	HIS	CA-CB-CG-CD2
2	A	3104	LMR	O1A-C1-C2-C3

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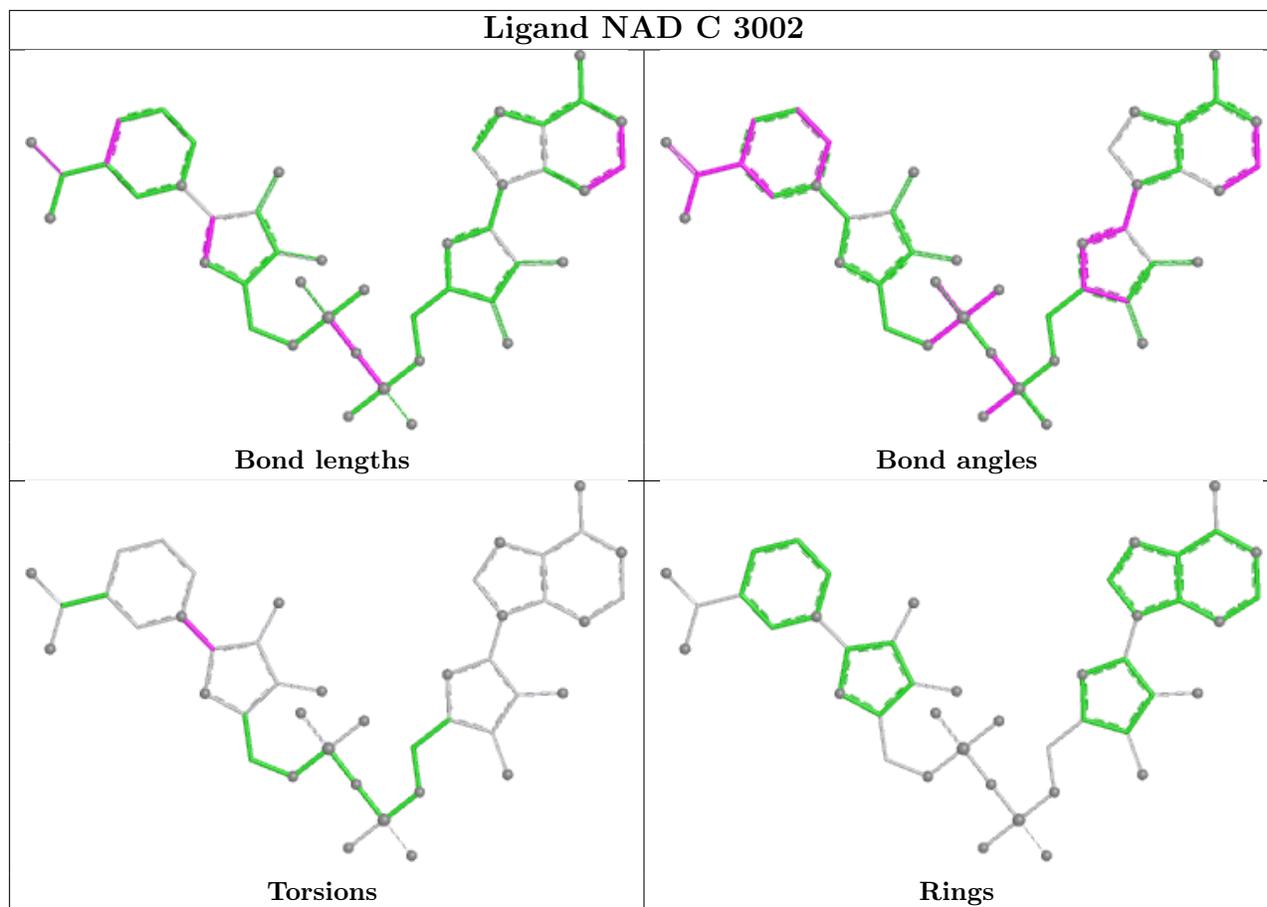
Mol	Chain	Res	Type	Atoms
2	A	3104	LMR	O1B-C1-C2-C3
2	B	3102	LMR	O1A-C1-C2-C3
5	A	3301	HIS	CA-CB-CG-ND1
5	A	3301	HIS	CA-CB-CG-CD2
5	C	3501	HIS	CA-CB-CG-ND1
5	B	3401	HIS	N-CA-CB-CG
2	A	3104	LMR	O1B-C1-C2-O2
2	B	3102	LMR	O1B-C1-C2-O2
2	A	3104	LMR	O1A-C1-C2-O2

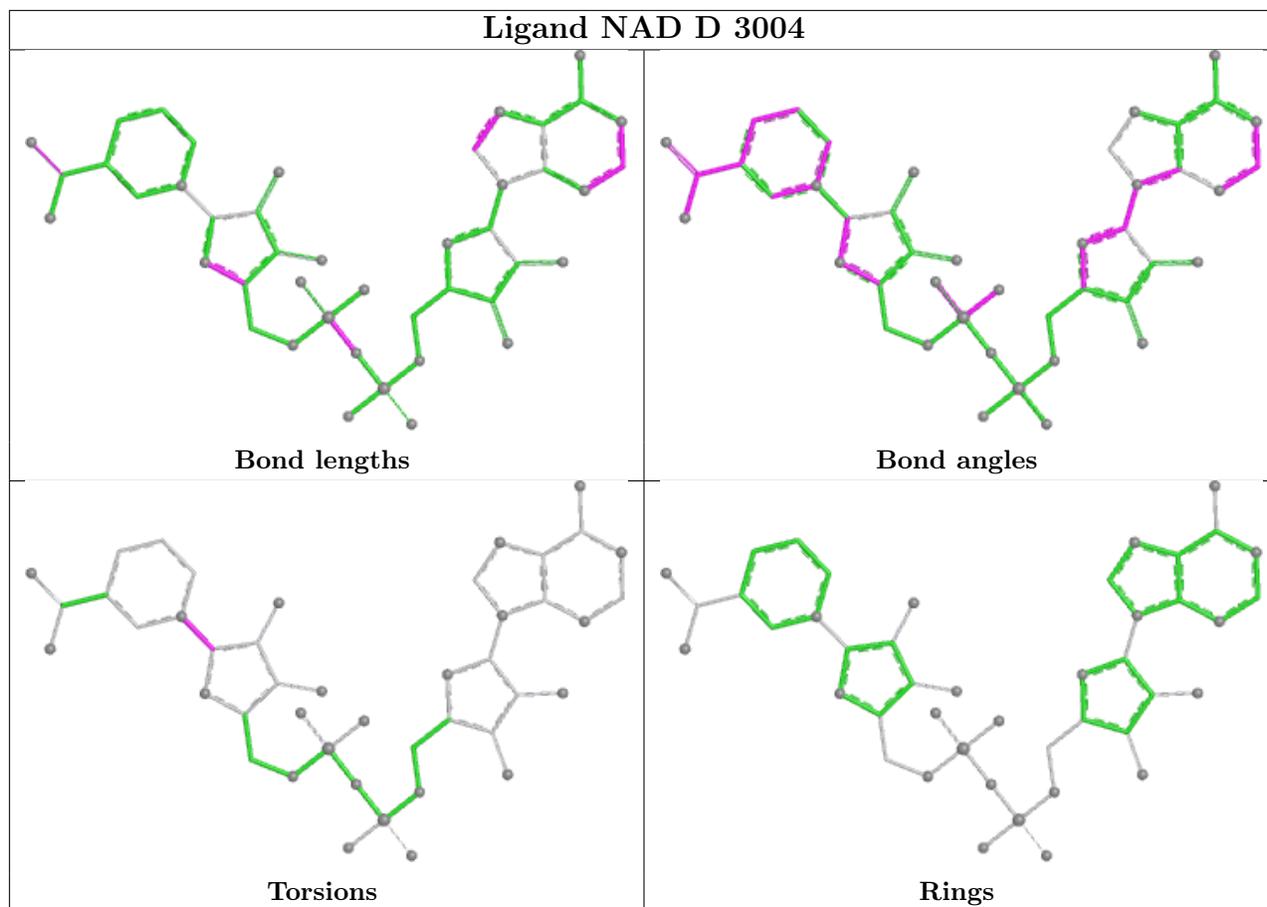
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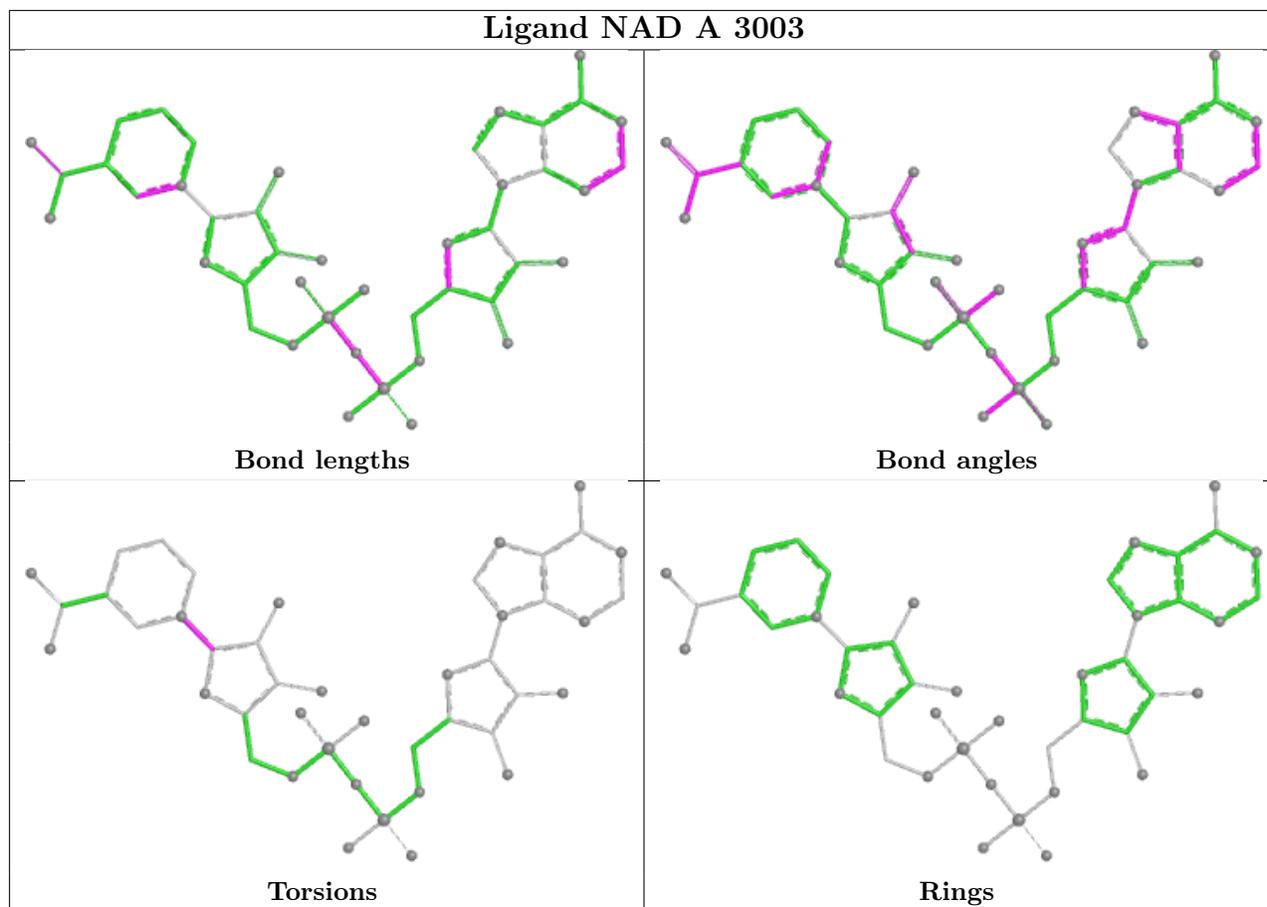
9 monomers are involved in 21 short contacts:

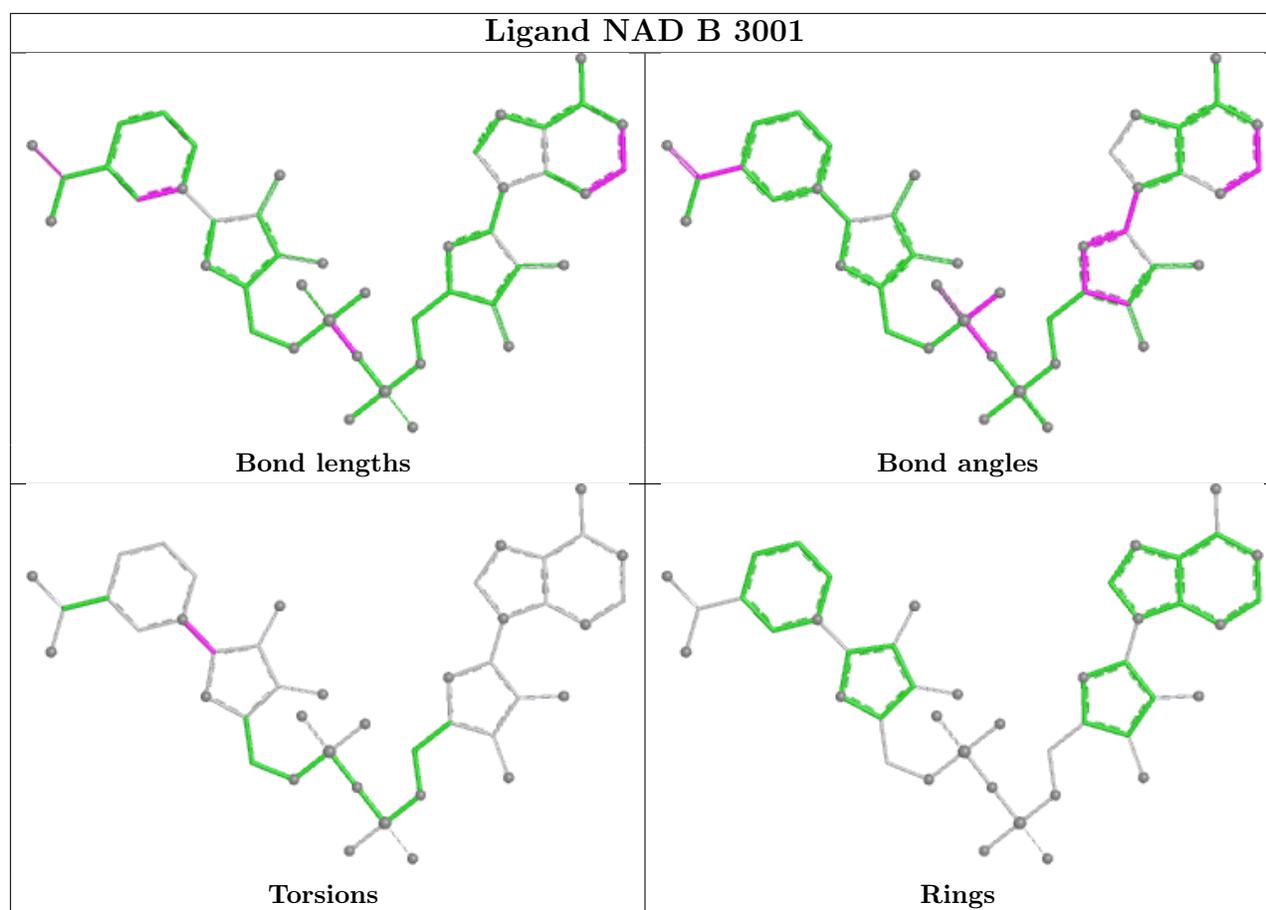
Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	C	3002	NAD	3	0
2	C	3103	LMR	2	0
4	D	3004	NAD	9	0
2	A	3104	LMR	1	0
2	B	3102	LMR	1	0
5	C	3501	HIS	1	0
4	A	3003	NAD	5	0
2	D	3101	LMR	1	0
4	B	3001	NAD	3	0

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 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 [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

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<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	314/342 (91%)	-0.55	1 (0%) 90 91	20, 32, 38, 49	5 (1%)
1	B	314/342 (91%)	-0.33	1 (0%) 90 91	19, 32, 37, 46	4 (1%)
1	C	314/342 (91%)	-0.51	1 (0%) 90 91	20, 32, 38, 49	7 (2%)
1	D	314/342 (91%)	-0.31	2 (0%) 85 87	19, 32, 38, 49	4 (1%)
All	All	1256/1368 (91%)	-0.43	5 (0%) 89 90	19, 32, 38, 49	20 (1%)

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	319	LEU	3.1
1	D	316	VAL	2.8
1	B	6	ASN	2.8
1	D	6	ASN	2.5
1	A	6	ASN	2.1

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

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

### 6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

### 6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum,

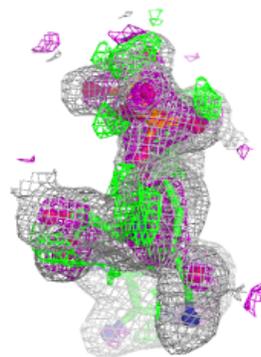
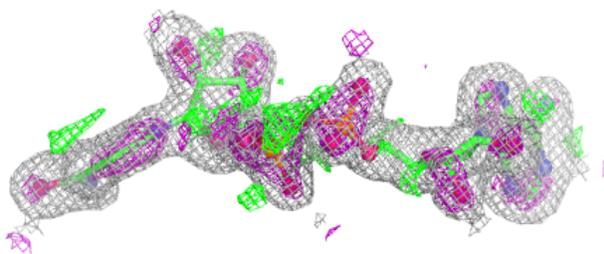
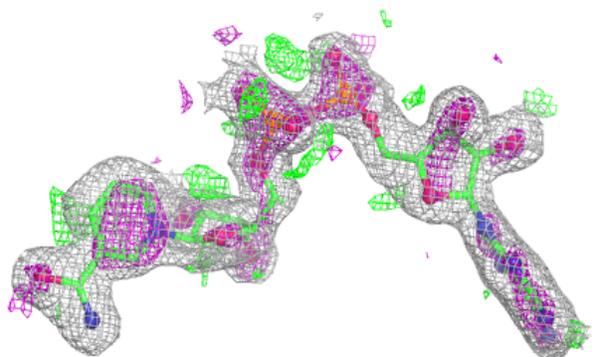
median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
6	ALA	A	3302	5/6	0.58	0.15	53,53,54,55	0
3	CL	A	3205	1/1	0.67	0.07	86,86,86,86	0
5	HIS	B	3401	10/11	0.72	0.14	49,52,57,58	0
5	HIS	C	3501	10/11	0.75	0.17	40,47,51,52	0
5	HIS	A	3301	10/11	0.77	0.14	45,49,53,53	0
3	CL	D	3207	1/1	0.80	0.07	77,77,77,77	0
3	CL	C	3204	1/1	0.82	0.14	69,69,69,69	0
3	CL	B	3206	1/1	0.89	0.12	76,76,76,76	0
2	LMR	B	3102	9/9	0.90	0.15	32,36,38,38	0
2	LMR	D	3101	9/9	0.94	0.13	25,29,32,33	0
4	NAD	A	3003	44/44	0.95	0.06	20,26,29,29	0
2	LMR	A	3104	9/9	0.96	0.12	28,31,32,33	0
2	LMR	C	3103	9/9	0.96	0.13	20,24,26,27	0
4	NAD	B	3001	44/44	0.96	0.06	23,28,30,32	0
4	NAD	D	3004	44/44	0.96	0.06	21,24,30,31	0
4	NAD	C	3002	44/44	0.97	0.06	17,22,24,26	0
3	CL	D	3202	1/1	0.98	0.15	38,38,38,38	0
3	CL	C	3201	1/1	0.99	0.14	28,28,28,28	0
3	CL	A	3203	1/1	0.99	0.19	36,36,36,36	0

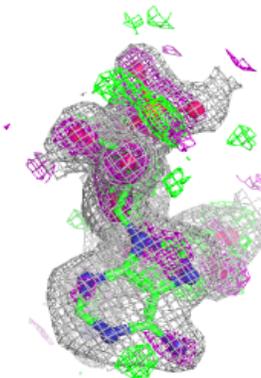
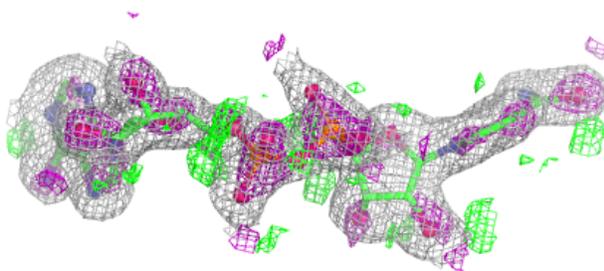
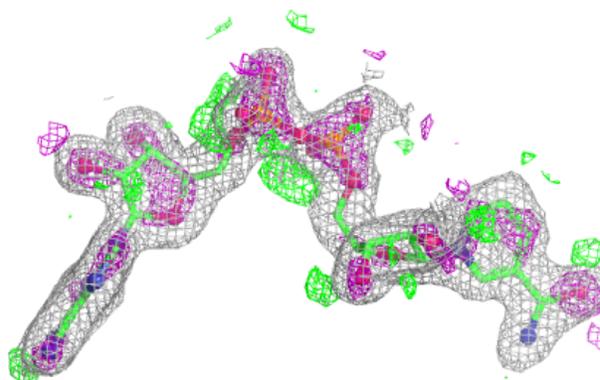
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation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

**Electron density around NAD A 3003:**

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

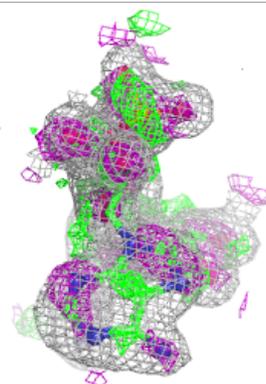
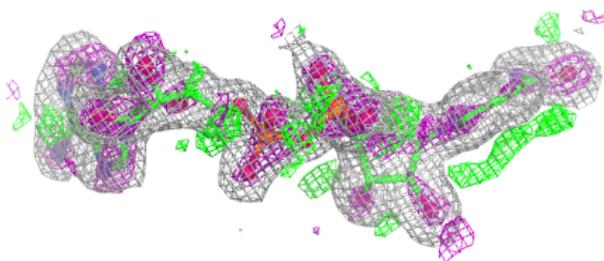
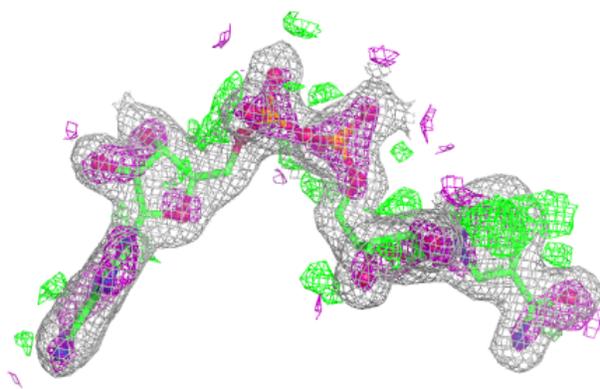
**Electron density around NAD B 3001:**

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

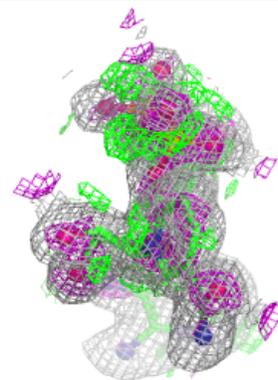
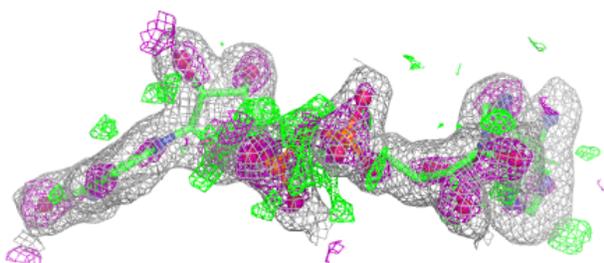
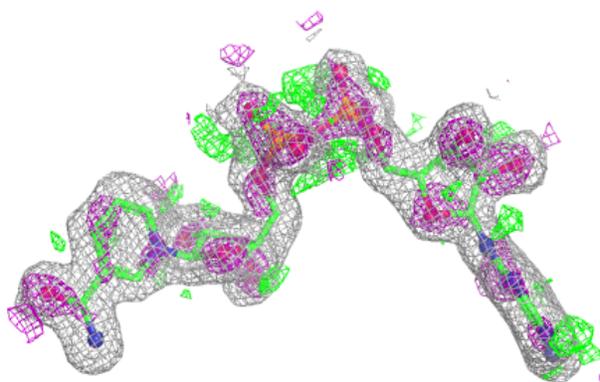


**Electron density around NAD D 3004:**

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

**Electron density around NAD C 3002:**

$2mF_o-DF_c$  (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.