wwPDB X-ray Structure Validation Summary Report (i)

Jun 18, 2024 – 02:14 AM EDT

PDB ID	:	3IC9
Title	:	The structure of dihydrolipoamide dehydrogenase from Colwellia psychrery-thraea 34H.
Authors	:	Tan, K.; Rakowski, E.; Clancy, S.; Joachimiak, A.; Midwest Center for Structural Genomics (MCSG)
Deposited on	:	2009-07-17
Resolution	:	2.15 Å(reported)

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

|		
MolProbity	:	4.02b-467
Mogul	:	2022.3.0, CSD as543be (2022)
Xtriage (Phenix)	:	1.20.1
EDS	:	2.37.1
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.37.1

1 Overall quality at a glance ⓘ

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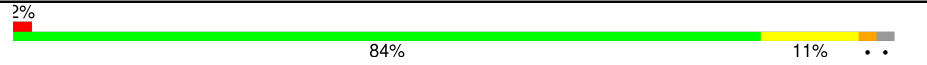*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.15 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.
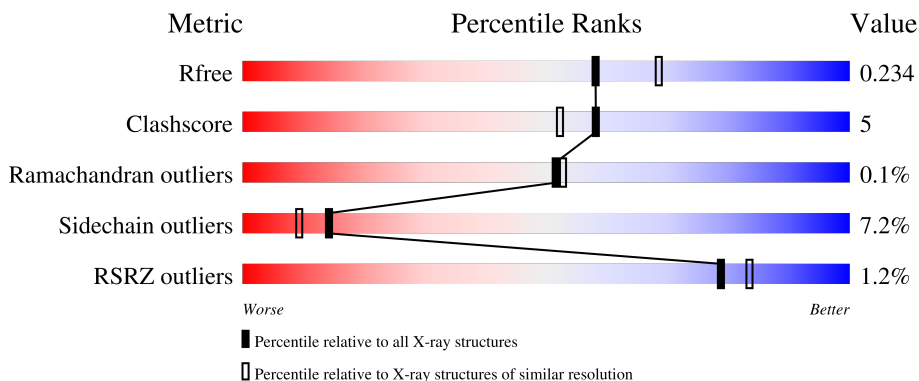
Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
R_{free}	130704	1479 (2.16-2.16)
Clashscore	141614	1585 (2.16-2.16)
Ramachandran outliers	138981	1560 (2.16-2.16)
Sidechain outliers	138945	1559 (2.16-2.16)
RSRZ outliers	127900	1456 (2.16-2.16)

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	492	
1	B	492	
1	C	492	
1	D	492	

2 Entity composition ⓘ

There are 4 unique types of molecules in this entry. The entry contains 16087 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 dihydrolipoamide dehydrogenase.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	481	Total	C	N	O	S	Se	0	3	0
			3719	2341	648	716	2	12			
1	B	481	Total	C	N	O	S	Se	0	8	0
			3745	2362	649	720	2	12			
1	C	483	Total	C	N	O	S	Se	0	1	0
			3718	2339	648	717	2	12			
1	D	481	Total	C	N	O	S	Se	0	1	0
			3708	2334	648	712	2	12			

There are 12 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-2	SER	-	expression tag	UNP Q488E0
A	-1	ASN	-	expression tag	UNP Q488E0
A	0	ALA	-	expression tag	UNP Q488E0
B	-2	SER	-	expression tag	UNP Q488E0
B	-1	ASN	-	expression tag	UNP Q488E0
B	0	ALA	-	expression tag	UNP Q488E0
C	-2	SER	-	expression tag	UNP Q488E0
C	-1	ASN	-	expression tag	UNP Q488E0
C	0	ALA	-	expression tag	UNP Q488E0
D	-2	SER	-	expression tag	UNP Q488E0
D	-1	ASN	-	expression tag	UNP Q488E0
D	0	ALA	-	expression tag	UNP Q488E0

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (three-letter code: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$).

FAD

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	B	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	C	1	Total	C	N	O	P	0	0
			53	27	9	15	2		
2	D	1	Total	C	N	O	P	0	0
			53	27	9	15	2		

- Molecule 3 is SODIUM ION (three-letter code: NA) (formula: Na).

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

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	233	Total	O	0	0
			233	233		

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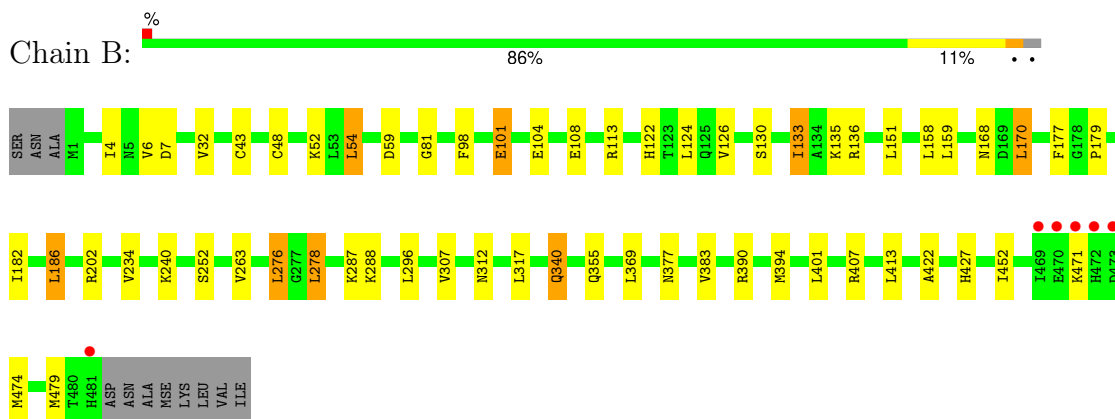| Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	240	Total 240	O 240	0	0
4	C	273	Total 273	O 273	0	0
4	D	235	Total 235	O 235	0	0

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.
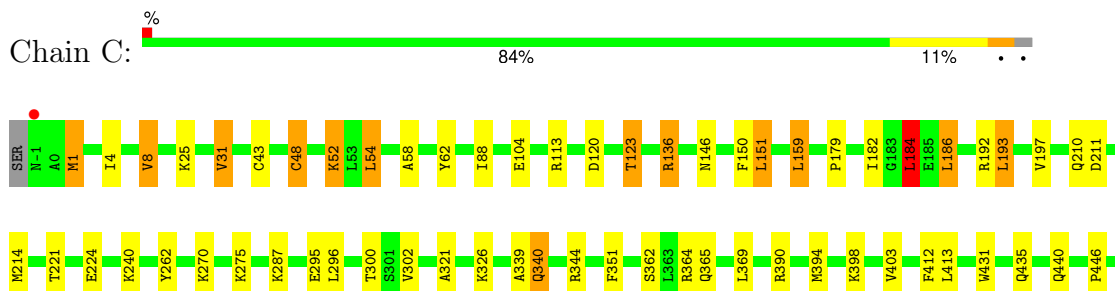
- Molecule 1: dihydrolipoamide dehydrogenase

- Molecule 1: dihydrolipoamide dehydrogenase

- Molecule 1: dihydrolipoamide dehydrogenase

H449 I452 Q465 E470 K471 H472 D473 M474 M479 T480 H481 ASP ASN ALA MSE LYS LEU VAL ILE

• Molecule 1: dihydrolipoamide dehydrogenase

%

Chain D:　　　　　　　　　　83%　　　　　　　　　　13%

SER ASN ALA M1 K2 V3 I4 N5 V6 A20 V31 V32 C43 C48 M49 P50 S51 K52 A58 V74 R92 V96 E104 R136 N146 E149 F150 L151 L159 N168 G178 P179 G180 V181 I182 G183 L184 E185 L186 L193 V197 G201

D211 M214 K215 R216 E219 N223 F226 Y227 F228 R233 G253 G268 V273 L276 I283 E284 L285 D286 K287 S290 T300 S301 V302 I305 F306 V307 N312 L317 L318 G325 A339 V350 V356 R390 M394 A430

Q435 P446 I452 Q465 I469 E470 K471 H472 D473 M474 M479 T480 H481 ASP ASN ALA MSE LYS LEU VAL ILE

4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α, β, γ	73.50Å 246.35Å 73.66Å 90.00° 90.20° 90.00°	Depositor
Resolution (Å)	43.90 – 2.15 43.90 – 2.15	Depositor EDS
% Data completeness (in resolution range)	98.9 (43.90-2.15) 98.1 (43.90-2.15)	Depositor EDS
R_{merge}	0.11	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.53 (at 2.16Å)	Xtriage
Refinement program	REFMAC 5.5.0054	Depositor
R, R_{free}	0.186 , 0.233 0.188 , 0.234	Depositor DCC
R_{free} test set	6975 reflections (5.02%)	wwPDB-VP
Wilson B-factor (Å^2)	34.1	Xtriage
Anisotropy	0.047	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.32 , 16.3	EDS
L-test for twinning[2]	$< |L| > = 0.45, < L^2 > = 0.27$	Xtriage
Estimated twinning fraction	0.047 for l,k,-h 0.266 for h,-k,-l 0.049 for l,-k,h	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	16087	wwPDB-VP
Average B, all atoms (Å^2)	27.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.23% of the height of the origin peak. No significant pseudotranslation is detected.*

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[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

5 Model quality ⓘ

5.1 Standard geometry ⓘ

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

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	0.60	0/3777	0.71	4/5083 (0.1%)
1	B	0.61	0/3818	0.70	1/5137 (0.0%)
1	C	0.64	0/3769	0.71	2/5072 (0.0%)
1	D	0.62	0/3760	0.70	0/5060
All	All	0.62	0/15124	0.71	7/20352 (0.0%)

There are no bond length outliers.

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	317	LEU	CA-CB-CG	5.79	128.60	115.30
1	A	324	ASP	CB-CG-OD1	5.55	123.29	118.30
1	C	344	ARG	NE-CZ-NH2	-5.53	117.54	120.30
1	A	33	LEU	CA-CB-CG	5.28	127.44	115.30
1	A	193	LEU	CA-CB-CG	5.24	127.36	115.30

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	3719	0	3709	31	0
1	B	3745	0	3753	32	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	C	3718	0	3701	45	0
1	D	3708	0	3699	41	0
2	A	53	0	31	0	0
2	B	53	0	31	0	0
2	C	53	0	31	0	0
2	D	53	0	31	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
3	C	1	0	0	0	0
3	D	1	0	0	0	0
4	A	233	0	0	2	0
4	B	240	0	0	1	0
4	C	273	0	0	4	0
4	D	235	0	0	1	0
All	All	16087	0	14986	139	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.

The worst 5 of 139 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:390:ARG:HG3	1:D:394:MSE:HE2	1.44	0.98
1:A:394:MSE:HE1	1:A:452:ILE:HD11	1.47	0.96
1:B:394:MSE:HE1	1:B:452:ILE:HD11	1.56	0.85
1:B:126:VAL:CG1	1:B:130:SER:HB2	2.12	0.80
1:C:52:LYS:N	1:C:52:LYS:HD3	1.96	0.79

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	482/492 (98%)	466 (97%)	15 (3%)	1 (0%)	47	46
1	B	487/492 (99%)	472 (97%)	15 (3%)	0	100	100
1	C	482/492 (98%)	464 (96%)	18 (4%)	0	100	100
1	D	480/492 (98%)	466 (97%)	13 (3%)	1 (0%)	47	46
All	All	1931/1968 (98%)	1868 (97%)	61 (3%)	2 (0%)	51	53

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	376	ALA
1	D	179	PRO

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	392/385 (102%)	358 (91%)	34 (9%)	10	6
1	B	397/385 (103%)	368 (93%)	29 (7%)	14	9
1	C	391/385 (102%)	364 (93%)	27 (7%)	15	10
1	D	390/385 (101%)	365 (94%)	25 (6%)	17	12
All	All	1570/1540 (102%)	1455 (93%)	115 (7%)	14	9

5 of 115 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	278	LEU
1	D	300	THR
1	C	113	ARG
1	D	290	SER
1	D	149	GLU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 17 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	465	GLN
1	D	435	GLN
1	B	373	GLN
1	B	377	ASN
1	B	435	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 monosaccharides in this entry.

5.6 Ligand geometry ⓘ

Of 8 ligands modelled in this entry, 4 are monoatomic - leaving 4 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	#$|Z| > 2$
2	FAD	A	490	-	54,58,58	1.20	5 (9%)	71,89,89	1.48	10 (14%)
2	FAD	C	490	-	54,58,58	1.19	5 (9%)	71,89,89	1.59	12 (16%)
2	FAD	D	490	-	54,58,58	1.27	6 (11%)	71,89,89	1.47	10 (14%)
2	FAD	B	490	-	54,58,58	1.23	7 (12%)	71,89,89	1.45	8 (11%)

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	FAD	A	490	-	-	1/30/50/50	0/6/6/6
2	FAD	C	490	-	-	1/30/50/50	0/6/6/6
2	FAD	D	490	-	-	2/30/50/50	0/6/6/6
2	FAD	B	490	-	-	2/30/50/50	0/6/6/6

The worst 5 of 23 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	490	FAD	C2A-N3A	3.82	1.38	1.32
2	D	490	FAD	C2A-N3A	3.72	1.37	1.32
2	C	490	FAD	C4X-N5	3.67	1.38	1.30
2	D	490	FAD	C4X-N5	3.57	1.38	1.30
2	A	490	FAD	C2A-N3A	3.48	1.37	1.32

The worst 5 of 40 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	C	490	FAD	N3A-C2A-N1A	-7.32	118.74	128.67
2	B	490	FAD	N3A-C2A-N1A	-7.04	119.12	128.67
2	A	490	FAD	N3A-C2A-N1A	-6.70	119.58	128.67
2	D	490	FAD	N3A-C2A-N1A	-6.61	119.70	128.67
2	D	490	FAD	C4-N3-C2	-3.36	119.67	125.64

There are no chirality outliers.
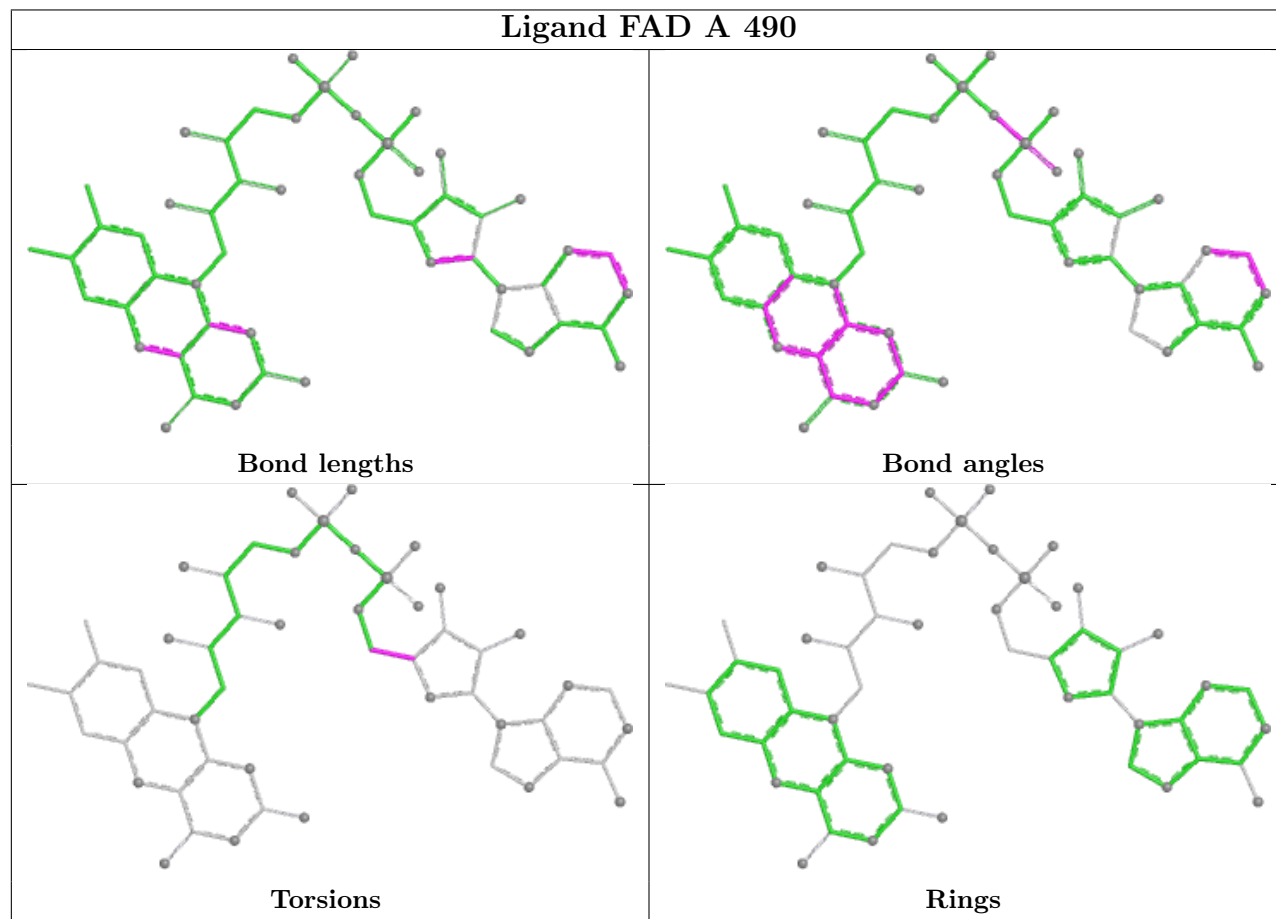
5 of 6 torsion outliers are listed below:

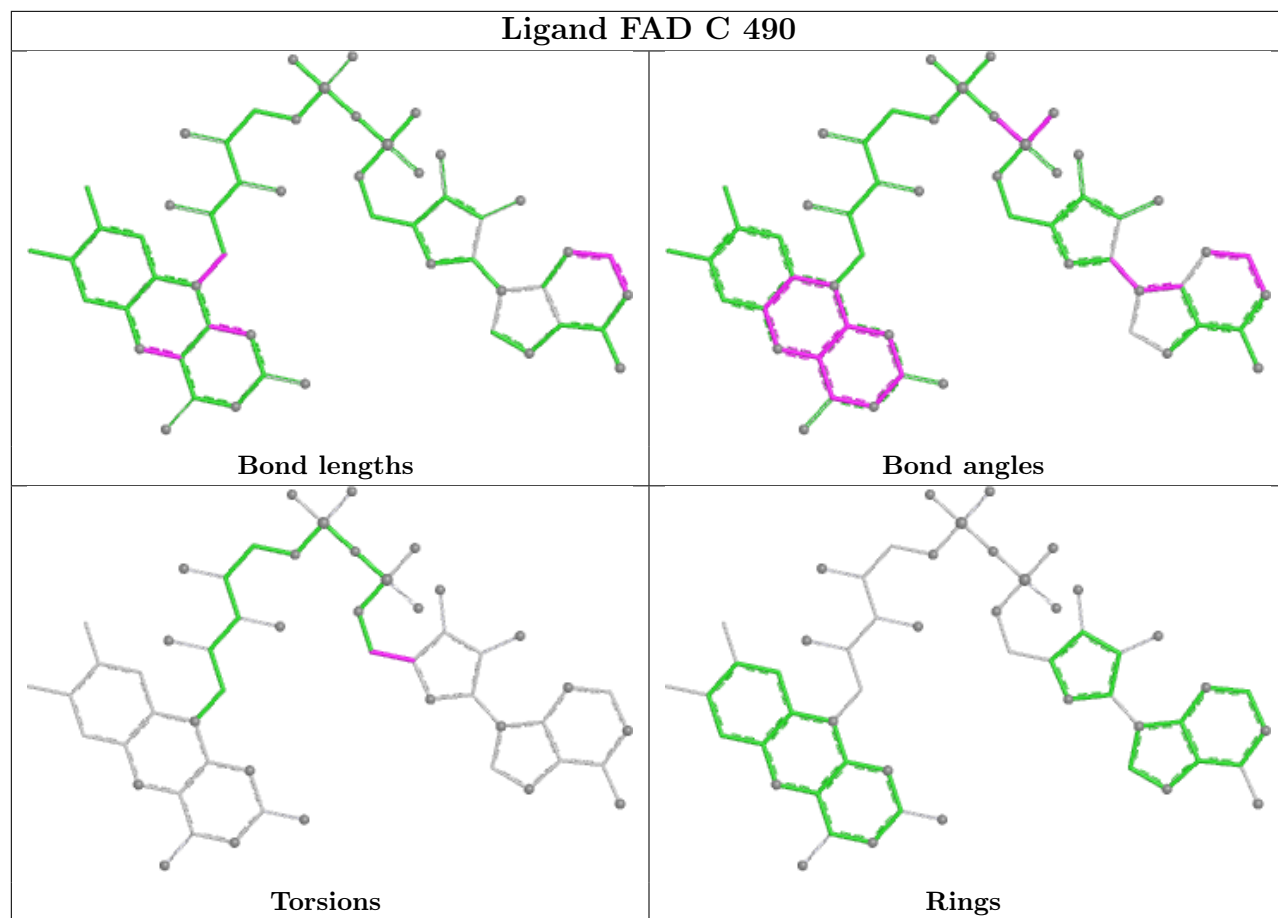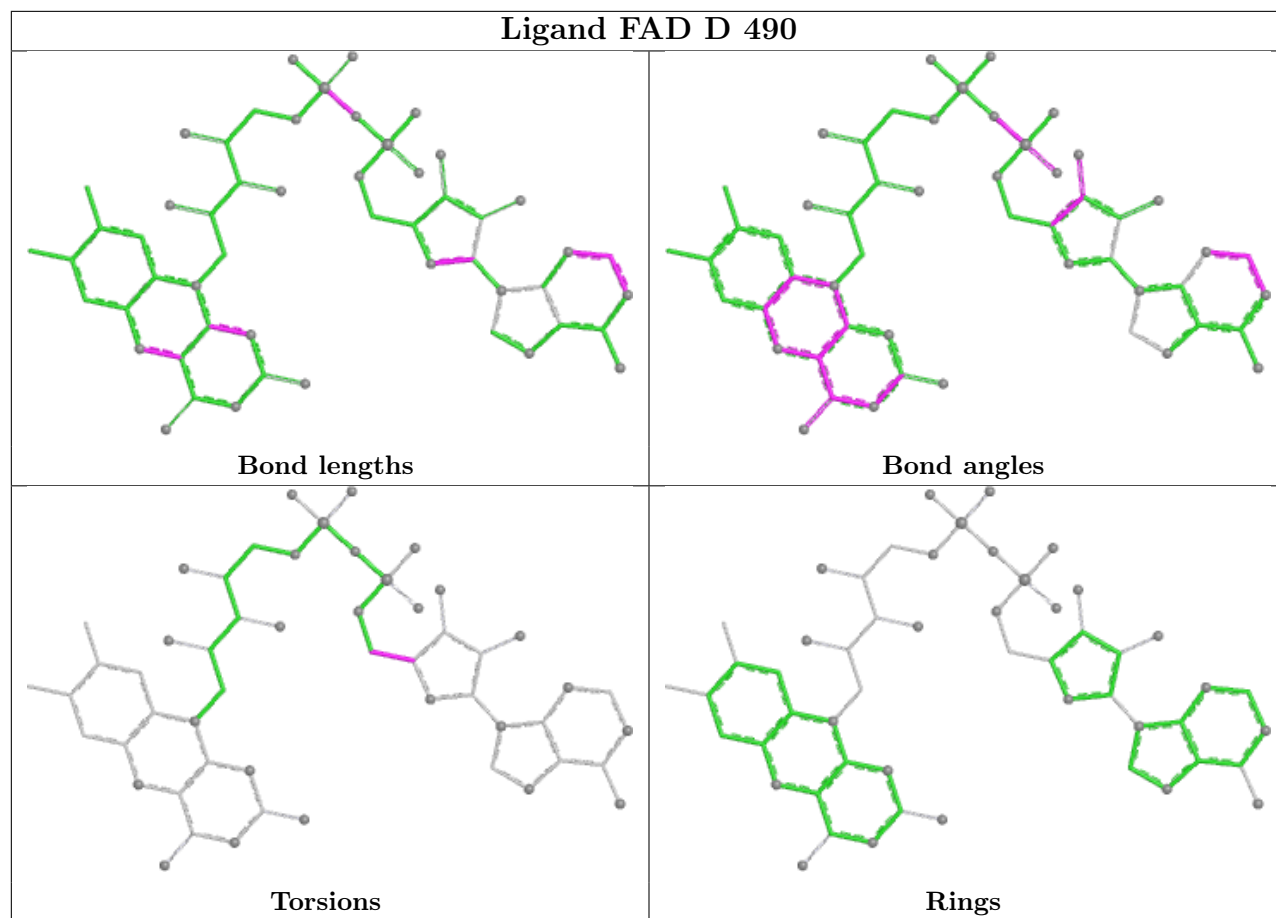| Mol	Chain	Res	Type	Atoms
2	B	490	FAD	O4B-C4B-C5B-O5B
2	B	490	FAD	C3B-C4B-C5B-O5B
2	D	490	FAD	O4B-C4B-C5B-O5B
2	A	490	FAD	O4B-C4B-C5B-O5B
2	C	490	FAD	O4B-C4B-C5B-O5B

There are no ring outliers.
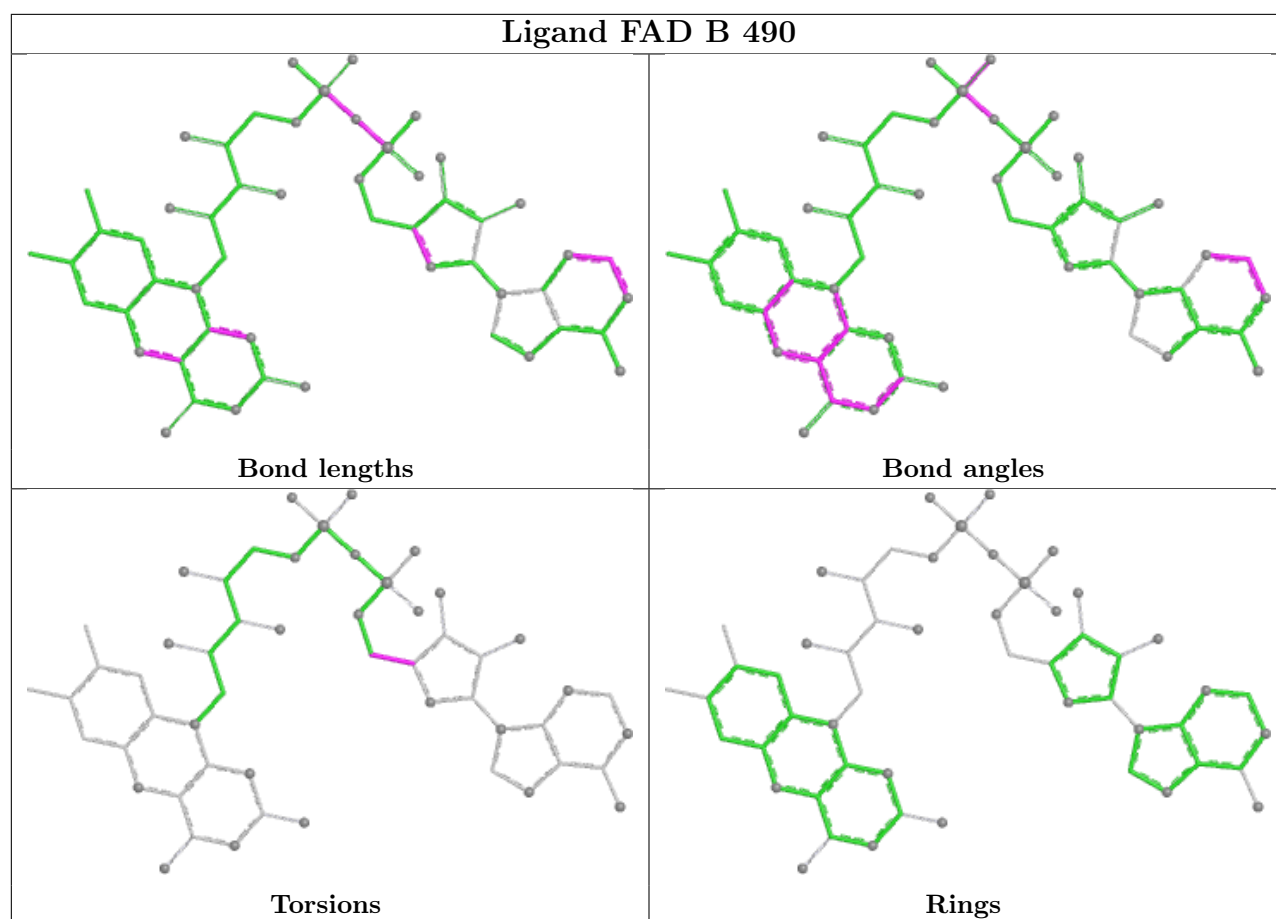
No monomer is involved in short contacts.

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 FAD A 490

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD C 490

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD D 490

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD B 490

Bond lengths

Bond angles

Torsions

Rings

5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

In the following table, the column labelled '#RSRZ> 2' contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95th percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled 'Q< 0.9' lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2			OWAB(Å²)	Q<0.9
1	A	469/492 (95%)	-0.30	9 (1%)	66	74	18, 26, 36, 55	0
1	B	469/492 (95%)	-0.39	6 (1%)	77	82	19, 27, 35, 60	0
1	C	471/492 (95%)	-0.36	4 (0%)	86	89	20, 26, 36, 58	0
1	D	469/492 (95%)	-0.34	3 (0%)	89	91	19, 26, 37, 53	0
All	All	1878/1968 (95%)	-0.35	22 (1%)	79	83	18, 26, 37, 60	0

The worst 5 of 22 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	472	HIS	4.7
1	A	481	HIS	4.3
1	C	-1	ASN	4.1
1	B	472	HIS	3.9
1	C	472	HIS	3.9

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

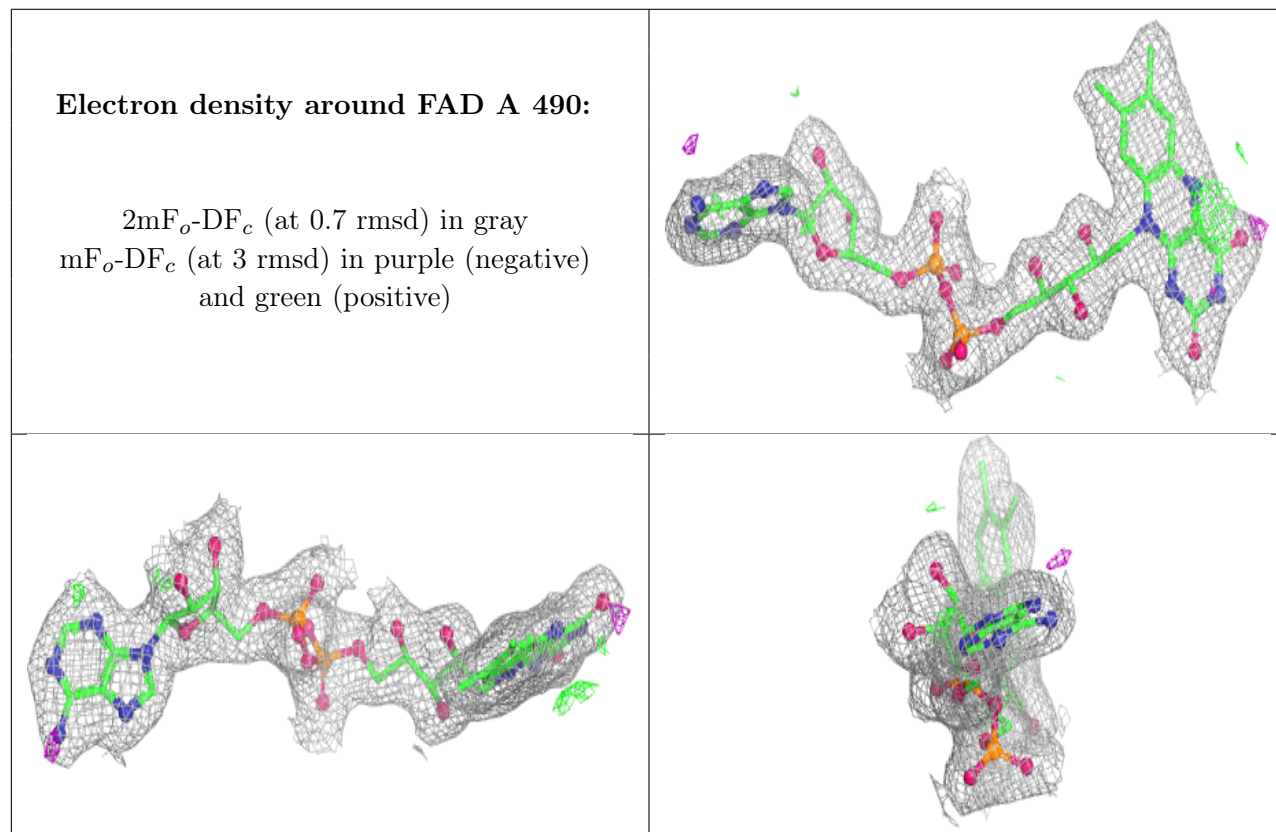There are no non-standard protein/DNA/RNA residues in this entry.

6.3 Carbohydrates ⓘ

There are no monosaccharides 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
3	NA	C	491	1/1	0.95	0.09	33,33,33,33	0
3	NA	A	491	1/1	0.96	0.07	36,36,36,36	0
2	FAD	A	490	53/53	0.97	0.09	28,31,33,34	0
2	FAD	D	490	53/53	0.98	0.09	26,30,33,33	0
2	FAD	B	490	53/53	0.98	0.09	28,31,36,37	0
3	NA	B	491	1/1	0.98	0.05	34,34,34,34	0
2	FAD	C	490	53/53	0.98	0.09	26,29,34,34	0
3	NA	D	491	1/1	0.99	0.07	29,29,29,29	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.
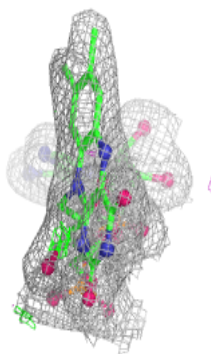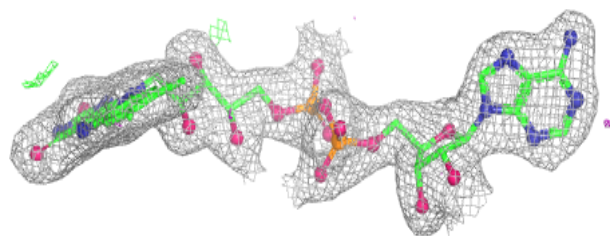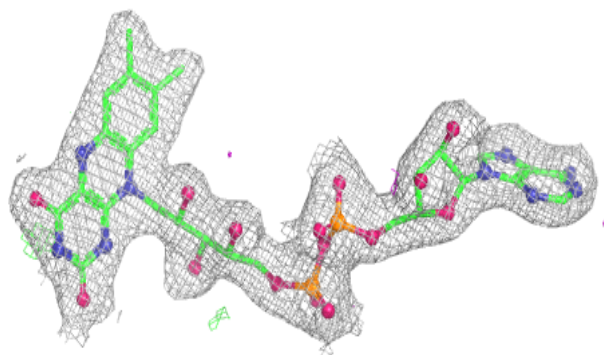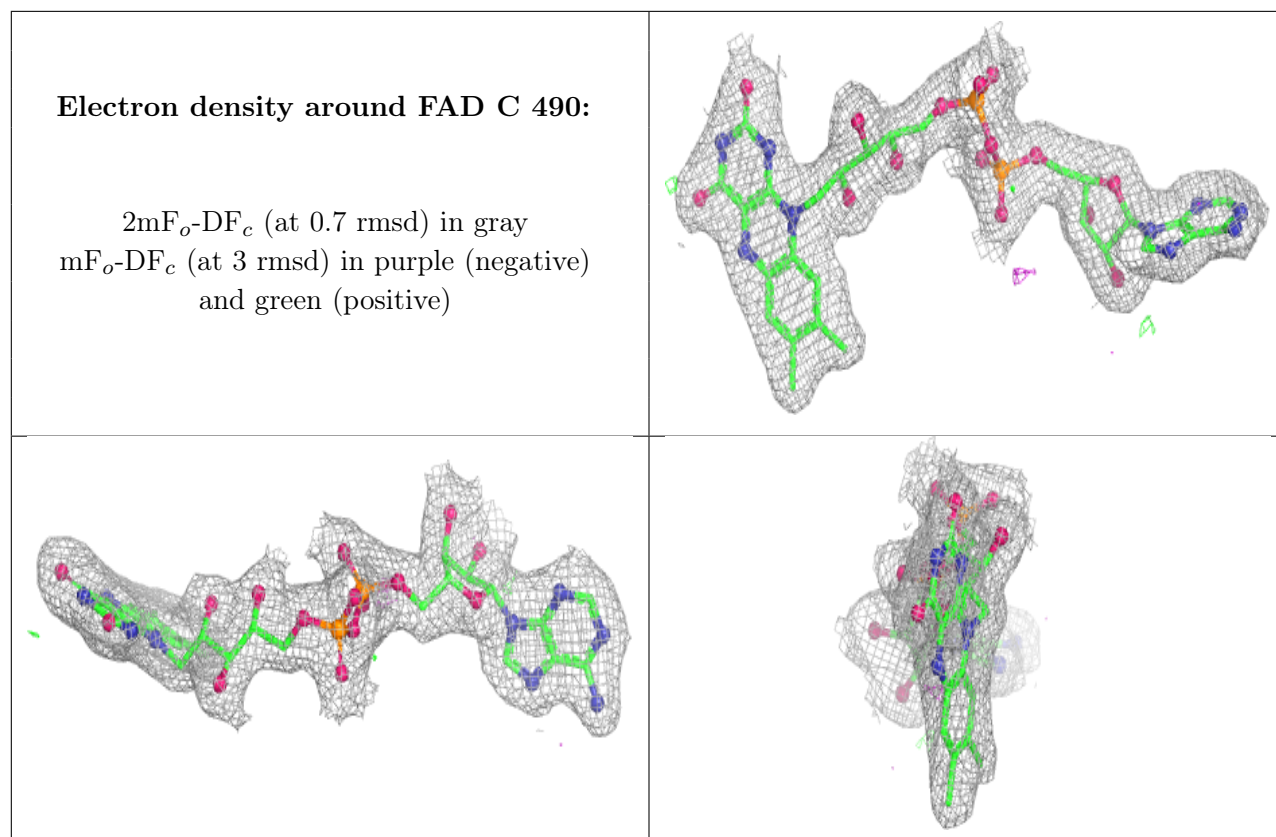

Electron density around FAD A 490:

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

Electron density around FAD D 490:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative)
and green (positive)
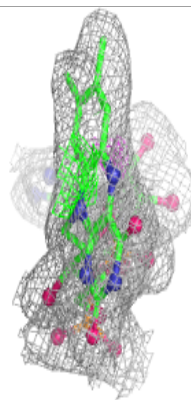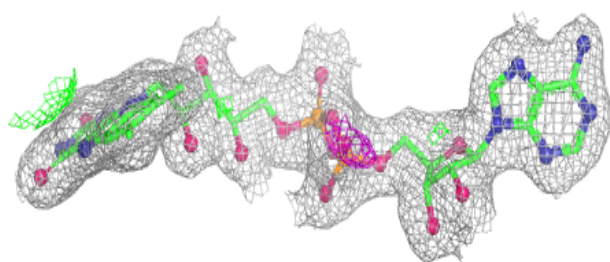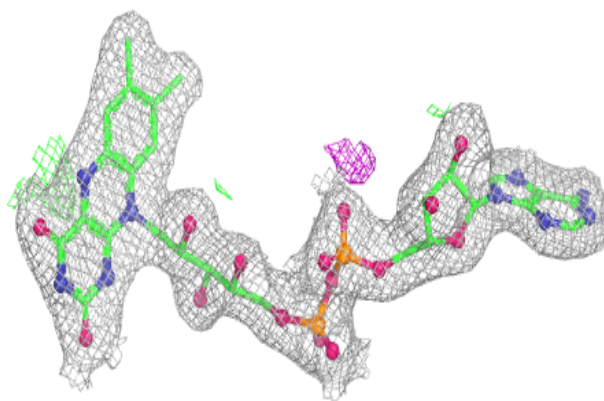
Electron density around FAD B 490:

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

Electron density around FAD C 490:

$2mF_o$-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.