



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 20, 2026 – 06:51 AM UTC

PDB ID : 7MWU / pdb_00007mwu
Title : Structure of the E. coli PutA proline dehydrogenase domain (residues 86-630)
complexed with cyclobutanecarboxylic acid
Authors : Tanner, J.J.; Bogner, A.N.
Deposited on : 2021-05-17
Resolution : 1.69 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 ⓘ](#)) 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

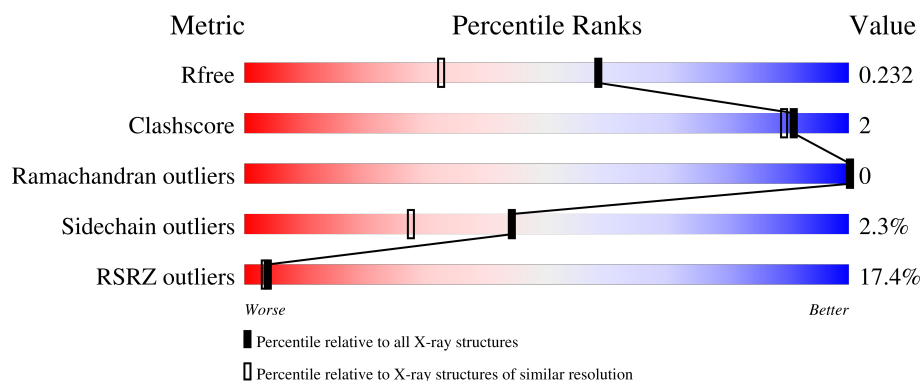
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.69 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	5551 (1.70-1.70)
Clashscore	190562	5924 (1.70-1.70)
Ramachandran outliers	187476	5846 (1.70-1.70)
Sidechain outliers	187428	5846 (1.70-1.70)
RSRZ outliers	180081	5554 (1.70-1.70)

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	551	16% 86% 5% 9%

2 Entry composition i

There are 6 unique types of molecules in this entry. The entry contains 4045 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.

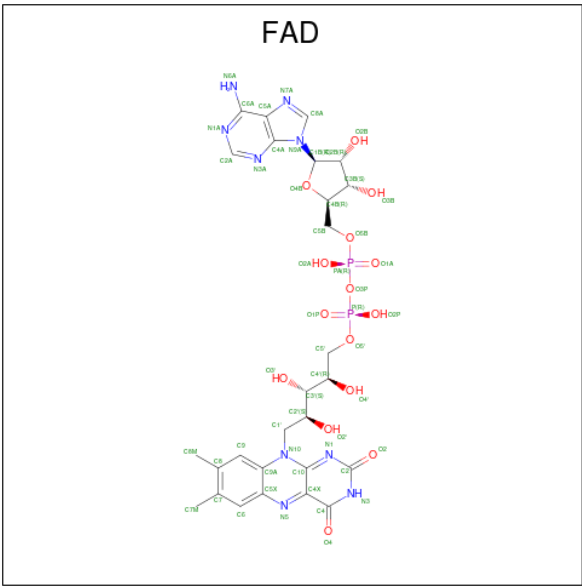
- Molecule 1 is a protein called Bifunctional protein PutA.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	499	3740	2375	664	685	16	0	1	0

There are 6 discrepancies between the modelled and reference sequences:

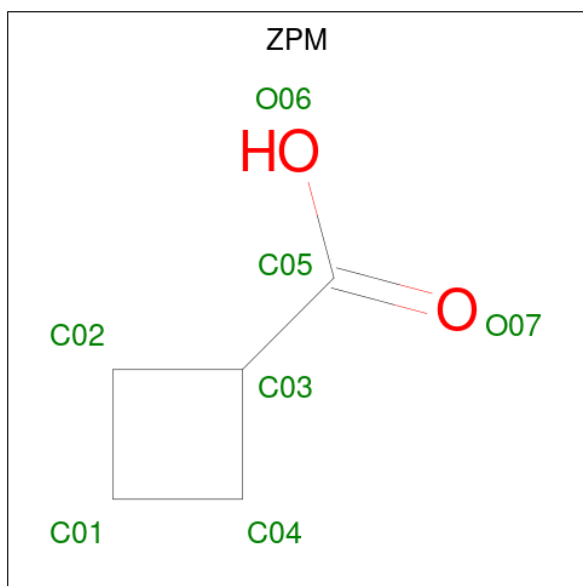
Chain	Residue	Modelled	Actual	Comment	Reference
A	631	HIS	-	expression tag	UNP A0A383H020
A	632	HIS	-	expression tag	UNP A0A383H020
A	633	HIS	-	expression tag	UNP A0A383H020
A	634	HIS	-	expression tag	UNP A0A383H020
A	635	HIS	-	expression tag	UNP A0A383H020
A	636	HIS	-	expression tag	UNP A0A383H020

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: C₂₇H₃₃N₉O₁₅P₂) (labeled as "Ligand of Interest" by depositor).



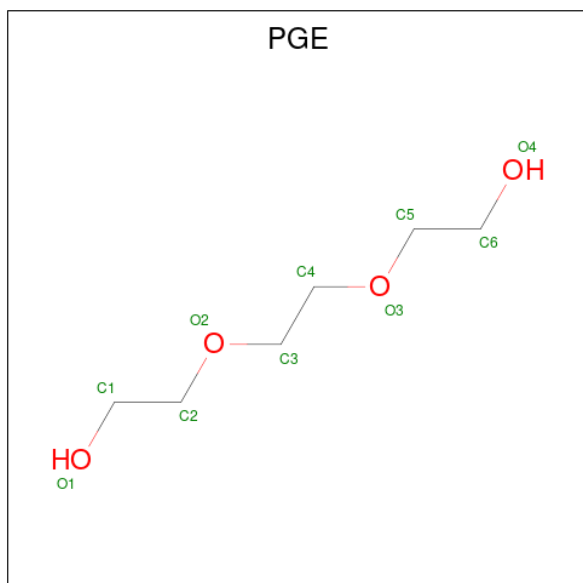
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
2	A	1	Total	C	N	O	P	0	0
			53	27	9	15	2		

- Molecule 3 is cyclobutanecarboxylic acid (CCD ID: ZPM) (formula: $C_5H_8O_2$) (labeled as "Ligand of Interest" by depositor).



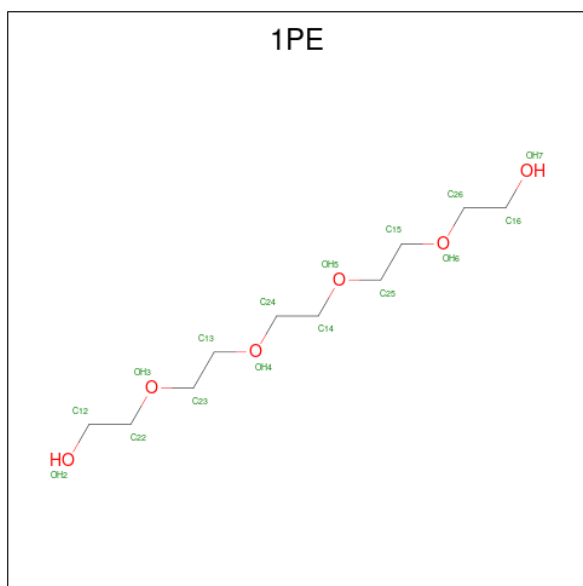
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			7	5	2		

- Molecule 4 is TRIETHYLENE GLYCOL (CCD ID: PGE) (formula: $C_6H_{14}O_4$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
4	A	1	Total	C	O	0	0
			10	6	4		

- Molecule 5 is PENTAETHYLENE GLYCOL (CCD ID: 1PE) (formula: $C_{10}H_{22}O_6$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	C	O	0	0
			16	10	6		

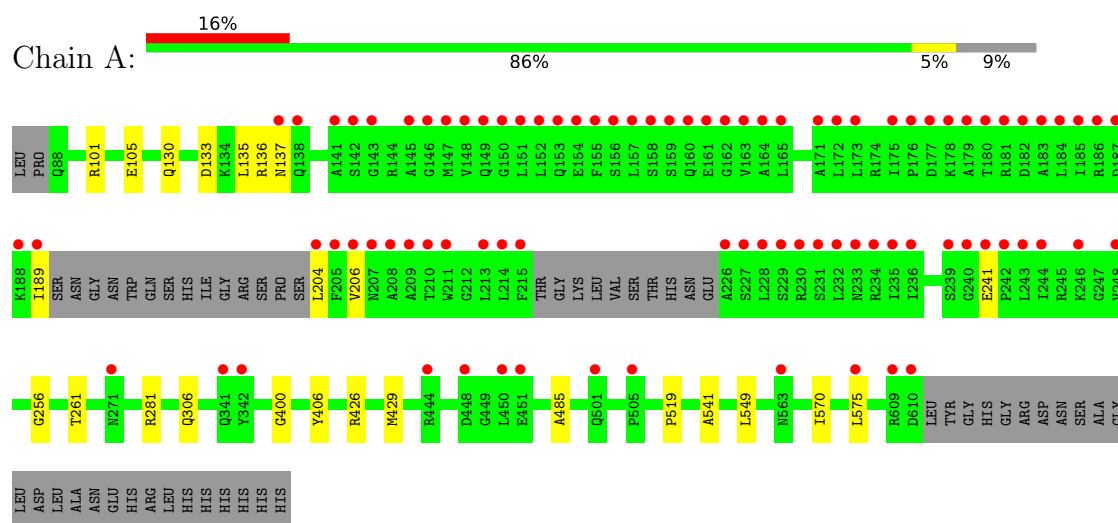
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	219	Total	O	0	0
			219	219		

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: Bifunctional protein PutA



4 Data and refinement statistics

Property	Value	Source
Space group	I 2 2 2	Depositor
Cell constants a, b, c, α , β , γ	73.08Å 141.82Å 146.64Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	70.91 – 1.69 70.91 – 1.69	Depositor EDS
% Data completeness (in resolution range)	98.4 (70.91-1.69) 99.1 (70.91-1.69)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.39 (at 1.69Å)	Xtriage
Refinement program	PHENIX 1.14-3260	Depositor
R, R_{free}	0.207 , 0.234 0.207 , 0.232	Depositor DCC
R_{free} test set	4308 reflections (5.09%)	wwPDB-VP
Wilson B-factor (Å ²)	32.6	Xtriage
Anisotropy	0.381	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 39.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.000 for -h,-l,-k	Xtriage
F_o, F_c correlation	0.96	EDS
Total number of atoms	4045	wwPDB-VP
Average B, all atoms (Å ²)	43.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 4.46% 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 [i](#)

5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: FAD, ZPM, 1PE, PGE

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	0.27	0/3811	0.43	0/5182

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3740	0	3637	11	0
2	A	53	0	31	3	0
3	A	7	0	0	0	0
4	A	10	0	14	0	0
5	A	16	0	22	0	0
6	A	219	0	0	1	0
All	All	4045	0	3704	13	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 2.

All (13) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:133:ASP:OD1	1:A:137:ASN:ND2	2.35	0.59
1:A:135:LEU:HD23	1:A:570:ILE:HD13	1.92	0.51
1:A:256:GLY:HA3	1:A:549:LEU:HD21	1.95	0.49
1:A:135:LEU:HD11	1:A:519:PRO:HB2	1.99	0.45
1:A:485:ALA:HB1	2:A:2001:FAD:C8	2.49	0.43
1:A:135:LEU:HD12	1:A:135:LEU:HA	1.81	0.43
1:A:426[A]:ARG:NH2	6:A:2105:HOH:O	2.52	0.43
1:A:261:THR:HG21	1:A:541:ALA:HB1	2.01	0.43
2:A:2001:FAD:H9	2:A:2001:FAD:H1'1	1.78	0.43
1:A:101:ARG:HD3	1:A:105:GLU:HG2	2.01	0.42
1:A:400:GLY:HA2	1:A:429:MET:O	2.19	0.41
2:A:2001:FAD:H1'1	2:A:2001:FAD:H4'	1.87	0.41
1:A:136:ARG:NH1	1:A:575:LEU:O	2.47	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	494/551 (90%)	488 (99%)	6 (1%)	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	355/450 (79%)	347 (98%)	8 (2%)	44 27

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	130	GLN
1	A	189	ILE
1	A	204	LEU
1	A	206	VAL
1	A	241	GLU
1	A	281	ARG
1	A	306	GLN
1	A	406	TYR

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (3) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	305	GLN
1	A	483	GLN
1	A	507	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
5	1PE	A	2004	-	15,15,15	0.54	0	14,14,14	0.31	0
2	FAD	A	2001	-	58,58,58	2.28	14 (24%)	85,89,89	1.77	17 (20%)
3	ZPM	A	2002	-	7,7,7	0.90	0	7,9,9	1.08	0
4	PGE	A	2003	-	9,9,9	0.50	0	8,8,8	0.26	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
5	1PE	A	2004	-	-	4/13/13/13	-
2	FAD	A	2001	-	-	4/34/50/50	0/6/6/6
3	ZPM	A	2002	-	-	2/4/10/10	0/1/1/1
4	PGE	A	2003	-	-	3/7/7/7	-

All (14) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	2001	FAD	PA-O3P	-7.67	1.51	1.59
2	A	2001	FAD	P-O3P	6.89	1.66	1.59
2	A	2001	FAD	O4-C4	6.46	1.35	1.23
2	A	2001	FAD	O2-C2	5.32	1.34	1.24
2	A	2001	FAD	C6A-N6A	4.55	1.45	1.34
2	A	2001	FAD	C4X-N5	4.04	1.39	1.30
2	A	2001	FAD	C2-N1	2.80	1.43	1.36
2	A	2001	FAD	C10-N1	2.66	1.38	1.33
2	A	2001	FAD	O2'-C2'	-2.57	1.37	1.43
2	A	2001	FAD	PA-O5B	-2.41	1.50	1.59
2	A	2001	FAD	PA-O2A	-2.21	1.45	1.55
2	A	2001	FAD	O4B-C4B	-2.14	1.40	1.45
2	A	2001	FAD	C5A-C4A	2.10	1.42	1.39
2	A	2001	FAD	C8A-N7A	2.06	1.35	1.31

All (17) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	A	2001	FAD	N3A-C2A-N1A	-6.08	119.38	128.58
2	A	2001	FAD	C5A-C4A-N3A	-4.88	120.00	126.72
2	A	2001	FAD	O2A-PA-O3P	-3.97	96.55	107.27
2	A	2001	FAD	C5A-N7A-C8A	3.86	109.51	103.45
2	A	2001	FAD	C4-C4X-N5	3.84	123.51	118.21
2	A	2001	FAD	C2A-N3A-C4A	3.70	120.87	111.83
2	A	2001	FAD	N3A-C4A-N9A	3.59	133.28	127.17
2	A	2001	FAD	C4A-C5A-N7A	-3.35	106.75	110.58
2	A	2001	FAD	N9A-C8A-N7A	-3.18	109.42	113.94
2	A	2001	FAD	C9-C9A-N10	-2.94	117.90	121.85
2	A	2001	FAD	O3P-PA-O1A	2.76	119.02	110.70
2	A	2001	FAD	C4X-C4-N3	2.58	119.83	113.25
2	A	2001	FAD	C5X-C9A-N10	2.39	120.13	117.97
2	A	2001	FAD	C2A-N1A-C6A	2.29	122.50	118.73
2	A	2001	FAD	C2'-C1'-N10	2.17	120.44	110.20
2	A	2001	FAD	C4-N3-C2	-2.13	121.86	125.64
2	A	2001	FAD	C10-C4X-N5	-2.10	120.52	124.81

There are no chirality outliers.

All (13) torsion outliers are listed below:

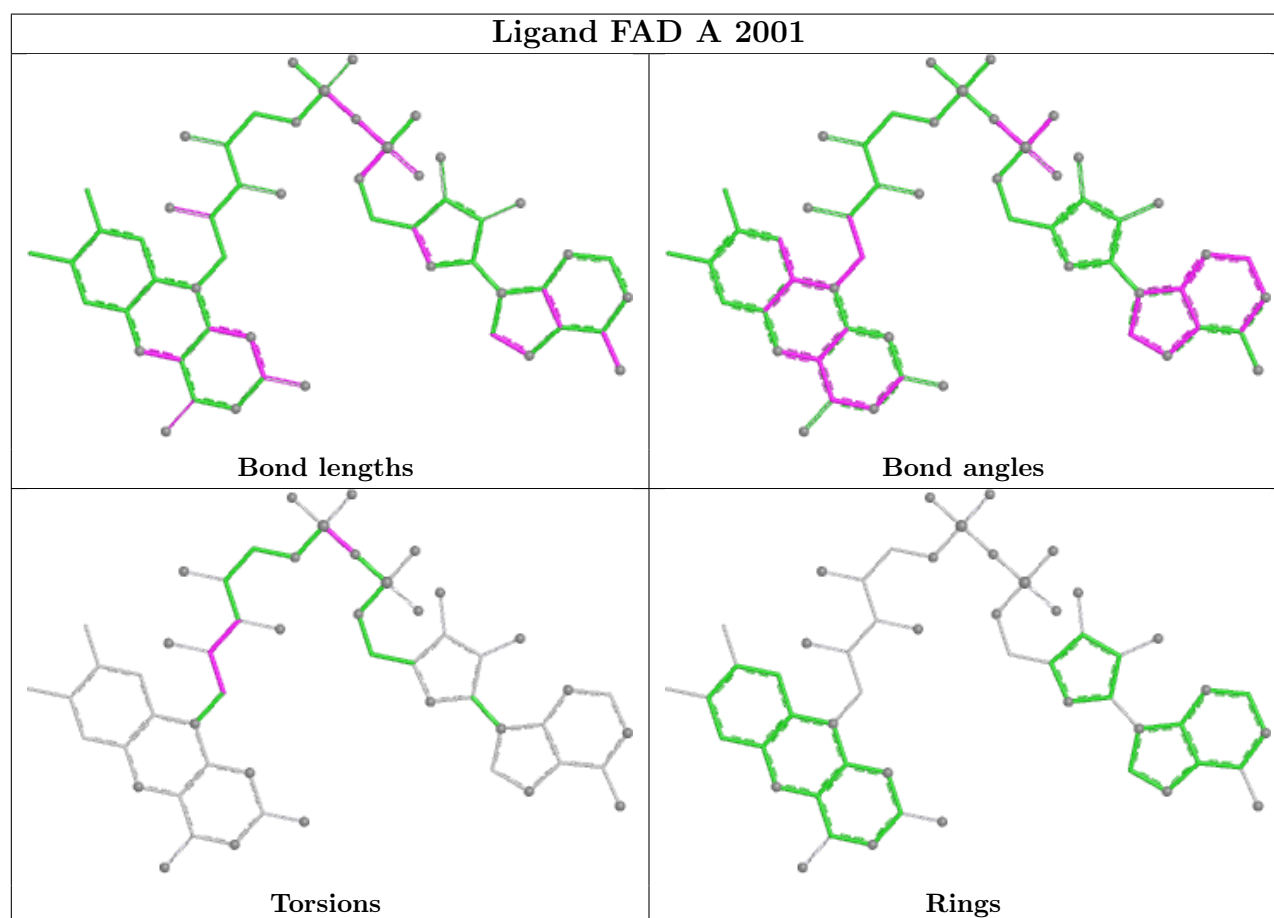
Mol	Chain	Res	Type	Atoms
2	A	2001	FAD	N10-C1'-C2'-O2'
2	A	2001	FAD	N10-C1'-C2'-C3'
2	A	2001	FAD	C1'-C2'-C3'-C4'
4	A	2003	PGE	O3-C5-C6-O4
5	A	2004	1PE	OH5-C14-C24-OH4
5	A	2004	1PE	OH6-C15-C25-OH5
4	A	2003	PGE	O1-C1-C2-O2
5	A	2004	1PE	C12-C22-OH3-C23
5	A	2004	1PE	C14-C24-OH4-C13
3	A	2002	ZPM	C04-C03-C05-O06
3	A	2002	ZPM	C04-C03-C05-O07
4	A	2003	PGE	C3-C4-O3-C5
2	A	2001	FAD	PA-O3P-P-O2P

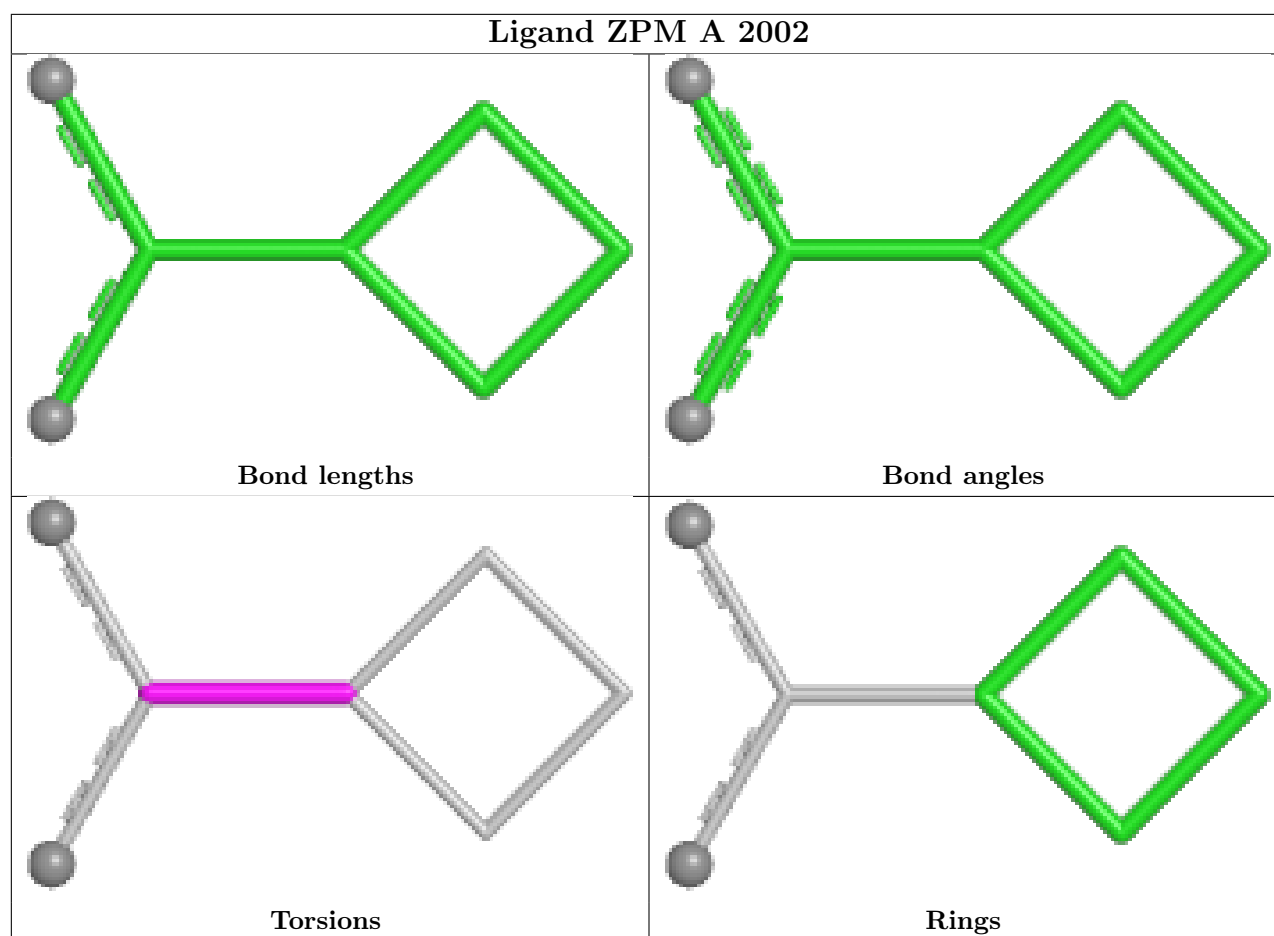
There are no ring outliers.

1 monomer is involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	A	2001	FAD	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 ⓘ

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	499/551 (90%)	0.85	87 (17%) 4 3	18, 39, 87, 108	1 (0%)

All (87) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	215	PHE	7.2
1	A	226	ALA	6.7
1	A	157	LEU	6.4
1	A	189	ILE	6.3
1	A	152	LEU	6.1
1	A	151	LEU	5.8
1	A	183	ALA	5.2
1	A	158	SER	5.1
1	A	235	ILE	4.9
1	A	179	ALA	4.9
1	A	155	PHE	4.7
1	A	149	GLN	4.6
1	A	205	PHE	4.6
1	A	213	LEU	4.5
1	A	228	LEU	4.5
1	A	175	ILE	4.5
1	A	186	ARG	4.4
1	A	148	VAL	4.3
1	A	204	LEU	4.1
1	A	231	SER	4.1
1	A	206	VAL	4.1
1	A	147	MET	4.0
1	A	185	ILE	3.9
1	A	236	ILE	3.9
1	A	145	ALA	3.9
1	A	159	SER	3.9
1	A	229	SER	3.8

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Mol	Chain	Res	Type	RSRZ
1	A	150	GLY	3.8
1	A	239	SER	3.8
1	A	165	LEU	3.8
1	A	244	ILE	3.7
1	A	451	GLU	3.7
1	A	187	ASP	3.7
1	A	138	GLN	3.6
1	A	180	THR	3.5
1	A	161	GLU	3.4
1	A	146	GLY	3.4
1	A	214	LEU	3.4
1	A	182	ASP	3.3
1	A	243	LEU	3.3
1	A	154	GLU	3.3
1	A	342	TYR	3.3
1	A	156	SER	3.3
1	A	501	GLN	3.3
1	A	177	ASP	3.3
1	A	141	ALA	3.2
1	A	227	SER	3.1
1	A	233	ASN	3.0
1	A	209	ALA	3.0
1	A	450	LEU	3.0
1	A	153	GLN	3.0
1	A	210	THR	3.0
1	A	160	GLN	3.0
1	A	240	GLY	2.9
1	A	188	LYS	2.9
1	A	208	ALA	2.9
1	A	163	VAL	2.9
1	A	234	ARG	2.8
1	A	211	TRP	2.7
1	A	184	LEU	2.7
1	A	142	SER	2.7
1	A	143	GLY	2.7
1	A	173	LEU	2.7
1	A	563	ASN	2.7
1	A	609	ARG	2.6
1	A	137	ASN	2.6
1	A	341	GLN	2.6
1	A	164	ALA	2.5
1	A	176	PRO	2.5

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Mol	Chain	Res	Type	RSRZ
1	A	232	LEU	2.5
1	A	610	ASP	2.5
1	A	448	ASP	2.4
1	A	575	LEU	2.4
1	A	230	ARG	2.3
1	A	505	PRO	2.3
1	A	444	ARG	2.3
1	A	248	VAL	2.1
1	A	181	ARG	2.1
1	A	241	GLU	2.1
1	A	242	PRO	2.1
1	A	171	ALA	2.1
1	A	207	ASN	2.0
1	A	172	LEU	2.0
1	A	178	LYS	2.0
1	A	162	GLY	2.0
1	A	271	ASN	2.0
1	A	246	LYS	2.0

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

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

6.3 Carbohydrates [i](#)

There are no oligosaccharides in this entry.

6.4 Ligands [i](#)

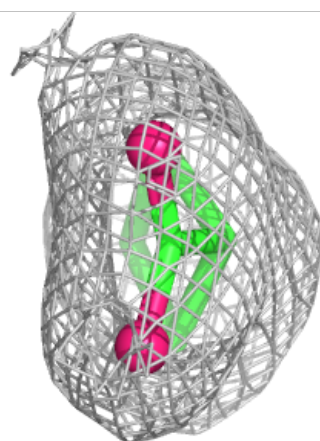
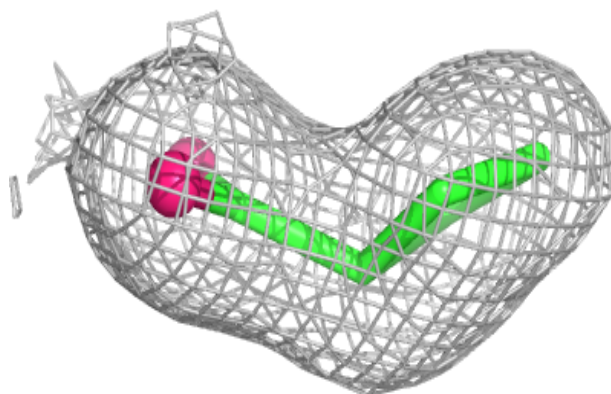
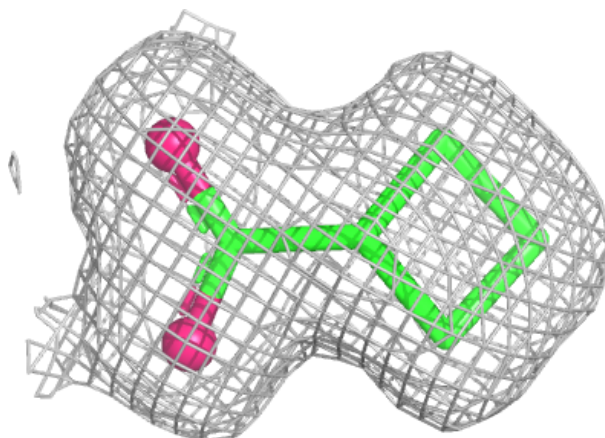
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

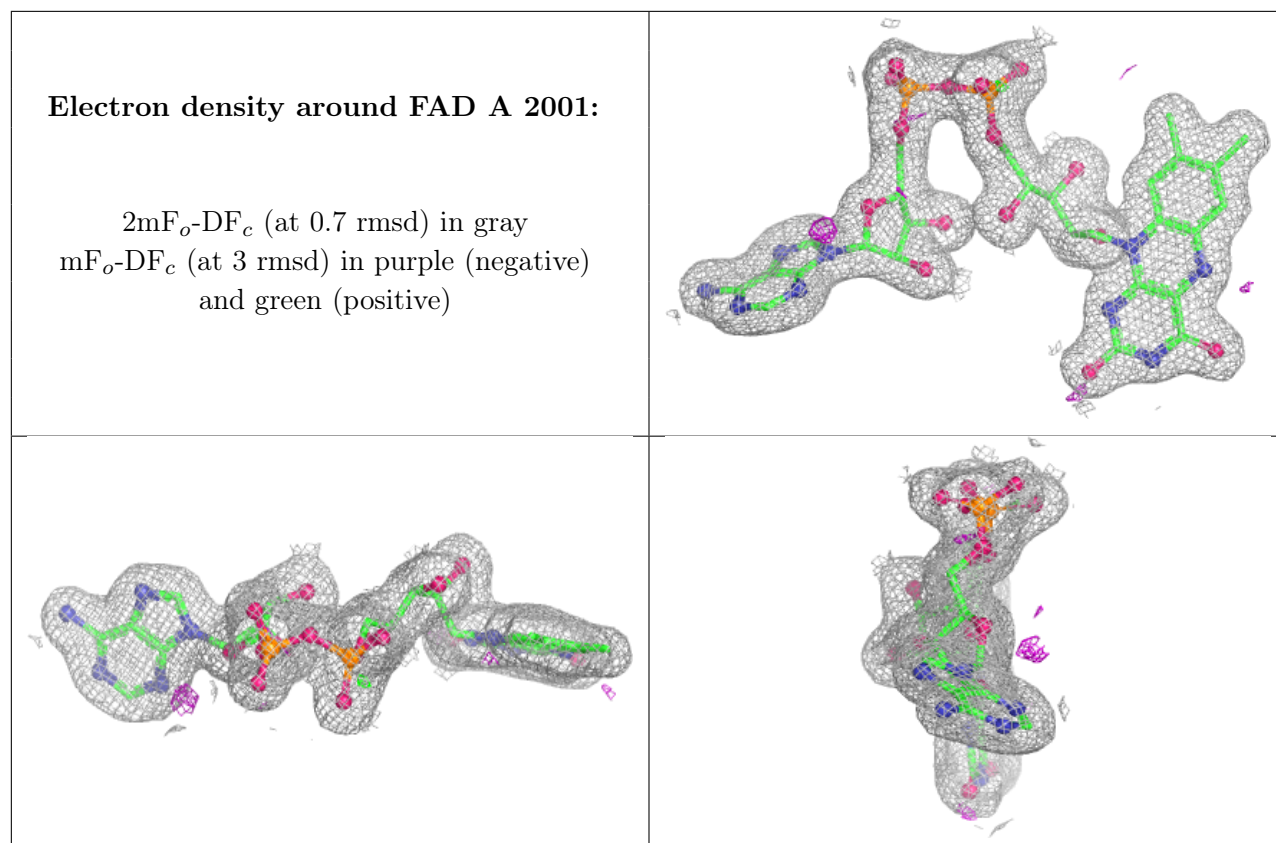
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors($\text{\AA}^2$)	Q<0.9
5	1PE	A	2004	16/16	0.84	0.17	51,57,62,63	0
4	PGE	A	2003	10/10	0.85	0.15	43,48,51,53	0
3	ZPM	A	2002	7/7	0.97	0.06	28,29,30,31	0
2	FAD	A	2001	53/53	0.98	0.05	23,26,28,29	0

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 ZPM A 2002:

$2mF_o-DF_c$ (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.