Full wwPDB X-ray Structure Validation Report ⓘ

Apr 27, 2026 – 10:14 PM JST

PDB ID : 22FF / pdb_000022ff
Title : Crystal structure of thioredoxin gluthathione reductase from Schistosoma japonicum with the U597C mutation in complex with auranofin
Authors : Wang, S.Q.; Huang, S.Q.; Lin, T.W.
Deposited on : 2026-01-08
Resolution : 1.84 Å(reported)

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

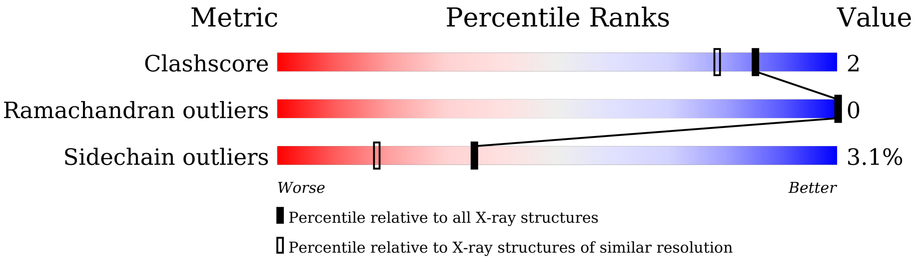
MolProbity : 4-5-2 with Phenix2.0
Mogul : 1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix) : NOT EXECUTED
EDS : NOT EXECUTED
Buster-report : wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics : 20250101.v01 (using entries in the PDB archive January 1st 2025)
Ideal geometry (proteins) : Engh & 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 1.84 Å.

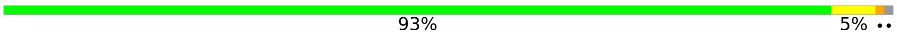
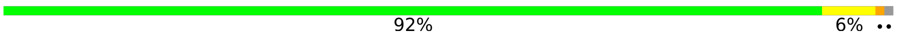
Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	190562	1329 (1.84-1.84)
Ramachandran outliers	187476	1318 (1.84-1.84)
Sidechain outliers	187428	1318 (1.84-1.84)

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%

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	598	
1	B	598	

2 Entry composition

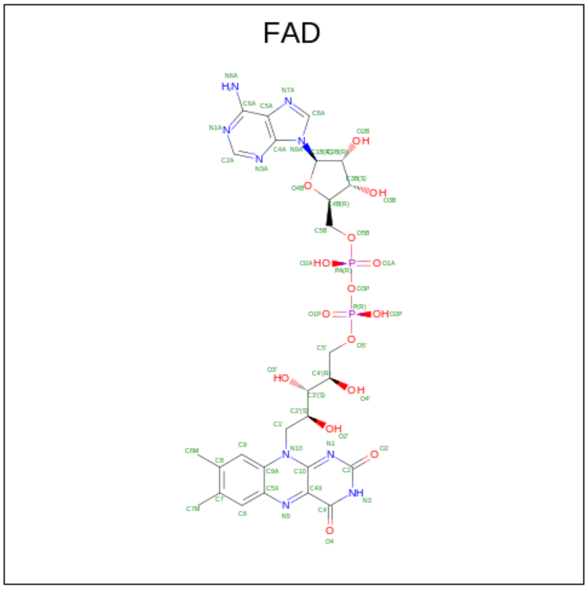
There are 4 unique types of molecules in this entry. The entry contains 9604 atoms, of which 0 are hydrogens and 0 are deuteriums.

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 thioredoxin-disulfide reductase (NADPH).

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	592	Total 4551	C 2877	N 776	O 873	S 25	0	3	0
1	B	592	Total 4525	C 2862	N 769	O 869	S 25	0	0	0

- Molecule 2 is FLAVIN-ADENINE DINUCLEOTIDE (CCD ID: FAD) (formula: $C_{27}H_{33}N_9O_{15}P_2$) (labeled as "Ligand of Interest" by depositor).



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

- Molecule 3 is GOLD ION (CCD ID: AU) (formula: Au).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	3	Total Au 3 3	0	0
3	B	3	Total Au 3 3	0	0

- Molecule 4 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	253	Total O 253 253	0	0
4	B	163	Total O 163 163	0	0

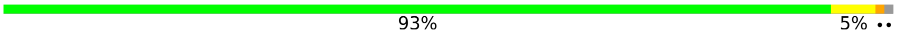
3 Residue-property plots ⓘ

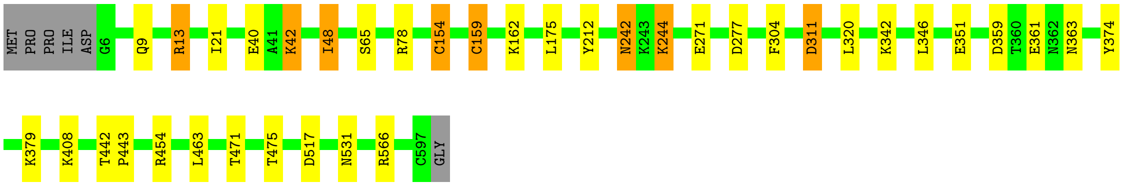
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded 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. 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.

Note EDS was not executed.

- Molecule 1: thioredoxin-disulfide reductase (NADPH)

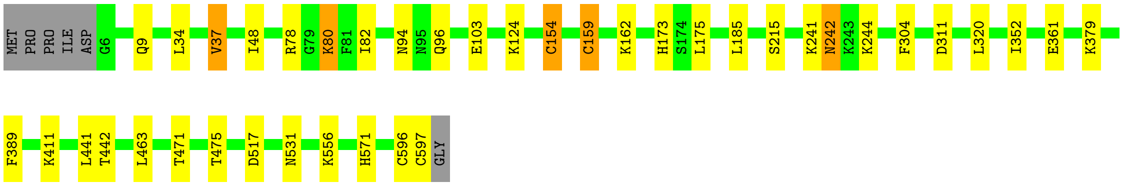
Chain A:





- Molecule 1: thioredoxin-disulfide reductase (NADPH)

Chain B:



4 Data and refinement statistics ⓘ

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	84.14Å 86.55Å 184.14Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	50.51 – 1.84	Depositor
% Data completeness (in resolution range)	100.0 (50.51-1.84)	Depositor
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	REFMAC 5.8.0425	Depositor
R, R_{free}	0.190 , 0.224	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	9604	wwPDB-VP
Average B, all atoms (Å^2)	40.0	wwPDB-VP

5 Model quality

5.1 Standard geometry

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

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	0.63	0/4639	1.05	7/6280 (0.1%)
1	B	0.60	0/4613	1.04	4/6247 (0.1%)
All	All	0.62	0/9252	1.04	11/12527 (0.1%)

Chiral center outliers are detected by calculating the chiral volume of a chiral center and verifying if the center is modelled as a planar moiety or with the opposite hand.A planarity outlier is detected by checking planarity of atoms in a peptide group, atoms in a mainchain group or atoms of a sidechain that are expected to be planar.

Mol	Chain	#Chirality outliers	#Planarity outliers
1	A	0	4
1	B	0	1
All	All	0	5

There are no bond length outliers.

All (11) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	517	ASP	CA-CB-CG	7.33	119.93	112.60
1	A	471	THR	CA-CB-OG1	-6.87	99.29	109.60
1	B	517	ASP	CA-CB-CG	6.45	119.05	112.60
1	A	271	GLU	CB-CG-CD	6.08	122.94	112.60
1	A	363	ASN	CA-CB-CG	-5.87	106.73	112.60
1	B	37	VAL	N-CA-CB	5.85	118.06	110.57
1	A	304	PHE	CA-CB-CG	5.78	119.58	113.80
1	A	311	ASP	CA-CB-CG	5.65	118.25	112.60
1	A	277	ASP	CA-CB-CG	5.43	118.03	112.60
1	B	311	ASP	CA-CB-CG	5.22	117.82	112.60
1	B	304	PHE	CA-CB-CG	5.18	118.98	113.80

There are no chirality outliers.

All (5) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	13	ARG	Sidechain
1	A	454	ARG	Sidechain
1	A	566	ARG	Sidechain
1	A	78	ARG	Sidechain
1	B	78	ARG	Sidechain

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	4551	0	4536	20	0
1	B	4525	0	4508	23	0
2	A	53	0	31	0	0
2	B	53	0	31	0	0
3	A	3	0	0	0	0
3	B	3	0	0	0	0
4	A	253	0	0	1	0
4	B	163	0	0	2	0
All	All	9604	0	9106	38	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 (38) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:352:ILE:HD11	1:B:389:PHE:HZ	1.50	0.75
1:A:175:LEU:HD23	1:B:175:LEU:HD23	1.73	0.71
1:A:359:ASP:OD1	1:A:361:GLU:HG2	1.92	0.69
1:B:154:CYS:HB2	1:B:159:CYS:SG	2.33	0.68
1:A:154:CYS:HB2	1:A:159:CYS:SG	2.36	0.66
1:B:352:ILE:HD11	1:B:389:PHE:CZ	2.32	0.64
1:A:154:CYS:SG	4:A:739:HOH:O	2.55	0.64
1:B:34:LEU:O	1:B:37:VAL:HG22	2.01	0.60

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Atom-1	**Atom-2**	**Interatomic distance (Å)**	**Clash overlap (Å)**
1:B:94:ASN:HB3	1:B:96:GLN:NE2	2.19	0.56
1:B:173:HIS:HE1	4:B:720:HOH:O	1.87	0.56
1:B:154:CYS:SG	4:B:727:HOH:O	2.57	0.56
1:A:212:TYR:CZ	1:B:596:CYS:HB2	2.42	0.54
1:B:124:LYS:HD3	1:B:215:SER:OG	2.10	0.52
1:A:9:GLN:OE1	1:A:13:ARG:NH1	2.45	0.49
1:B:241:LYS:HA	1:B:241:LYS:HE2	1.94	0.48
1:A:175:LEU:CD2	1:B:175:LEU:HD23	2.42	0.48
1:A:40:GLU:O	1:A:42:LYS:HE2	2.14	0.47
1:A:13:ARG:NH2	1:A:13:ARG:HG2	2.30	0.47
1:A:242:ASN:HD21	1:A:244:LYS:CG	2.30	0.45
1:A:175:LEU:HD23	1:B:175:LEU:CD2	2.42	0.45
1:B:441:LEU:HD11	1:B:471:THR:HG22	1.99	0.45
1:B:241:LYS:HA	1:B:241:LYS:CE	2.47	0.44
1:B:185:LEU:H	1:B:185:LEU:HD23	1.82	0.44
1:B:242:ASN:HD21	1:B:244:LYS:CG	2.30	0.44
1:A:443:PRO:HG3	1:B:571:HIS:HB2	2.01	0.43
1:A:311:ASP:OD1	1:A:342:LYS:NZ	2.52	0.43
1:B:242:ASN:C	1:B:242:ASN:HD22	2.27	0.43
1:A:21:ILE:HD11	1:A:48:ILE:HG13	2.01	0.43
1:A:13:ARG:HG2	1:A:13:ARG:HH21	1.85	0.42
1:B:556:LYS:HE2	1:B:556:LYS:HB2	1.78	0.42
1:A:162:LYS:HD2	1:A:162:LYS:C	2.45	0.42
1:B:94:ASN:HB3	1:B:96:GLN:HE22	1.84	0.42
1:A:40:GLU:O	1:A:42:LYS:CE	2.68	0.41
1:B:80:LYS:HD2	1:B:82:ILE:HD13	2.02	0.41
1:A:442:THR:HB	1:A:443:PRO:HD3	2.02	0.41
1:B:162:LYS:HD2	1:B:162:LYS:C	2.46	0.41
1:A:242:ASN:HD22	1:A:242:ASN:C	2.29	0.40
1:A:346:LEU:O	1:A:374:TYR:HA	2.21	0.40

There are no symmetry-related clashes.

5.3 Torsion angles ⓘ

5.3.1 Protein backbone ⓘ

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	593/598 (99%)	579 (98%)	14 (2%)	0	100	100
1	B	590/598 (99%)	573 (97%)	17 (3%)	0	100	100
All	All	1183/1196 (99%)	1152 (97%)	31 (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	494/496 (100%)	480 (97%)	14 (3%)	38	20
1	B	491/496 (99%)	475 (97%)	16 (3%)	33	15
All	All	985/992 (99%)	955 (97%)	30 (3%)	35	19

All (30) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	42	LYS
1	A	48	ILE
1	A	65	SER
1	A	154	CYS
1	A	159	CYS
1	A	242	ASN
1	A	244	LYS
1	A	320	LEU
1	A	351	GLU
1	A	379	LYS
1	A	408	LYS
1	A	463	LEU
1	A	475	THR
1	A	531	ASN
1	B	9	GLN

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Mol	Chain	Res	Type
1	B	48	ILE
1	B	80	LYS
1	B	103	GLU
1	B	154	CYS
1	B	159	CYS
1	B	242	ASN
1	B	320	LEU
1	B	361	GLU
1	B	379	LYS
1	B	411	LYS
1	B	442	THR
1	B	463	LEU
1	B	475	THR
1	B	531	ASN
1	B	597	CYS

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	93	ASN
1	A	173	HIS
1	A	209	ASN
1	A	225	ASN
1	A	242	ASN
1	B	12	GLN
1	B	93	ASN
1	B	96	GLN
1	B	204	HIS
1	B	209	ASN
1	B	225	ASN
1	B	242	ASN
1	B	496	ASN

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 ⓘ

Of 8 ligands modelled in this entry, 6 are monoatomic - leaving 2 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	601	-	56,58,58	0.70	1 (1%)	81,89,89	0.71	1 (1%)
2	FAD	B	601	-	56,58,58	0.61	0	81,89,89	0.84	3 (3%)

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	601	-	-	4/34/50/50	0/6/6/6
2	FAD	B	601	-	-	5/34/50/50	0/6/6/6

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	601	FAD	C1'-C2'	-2.41	1.49	1.52

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	B	601	FAD	O3B-C3B-C2B	2.29	119.22	111.82
2	B	601	FAD	C4-N3-C2	-2.24	121.50	125.64
2	B	601	FAD	O2P-P-O1P	2.08	122.51	112.24
2	A	601	FAD	O4B-C1B-C2B	-2.04	102.20	106.64

There are no chirality outliers.

All (9) torsion outliers are listed below:

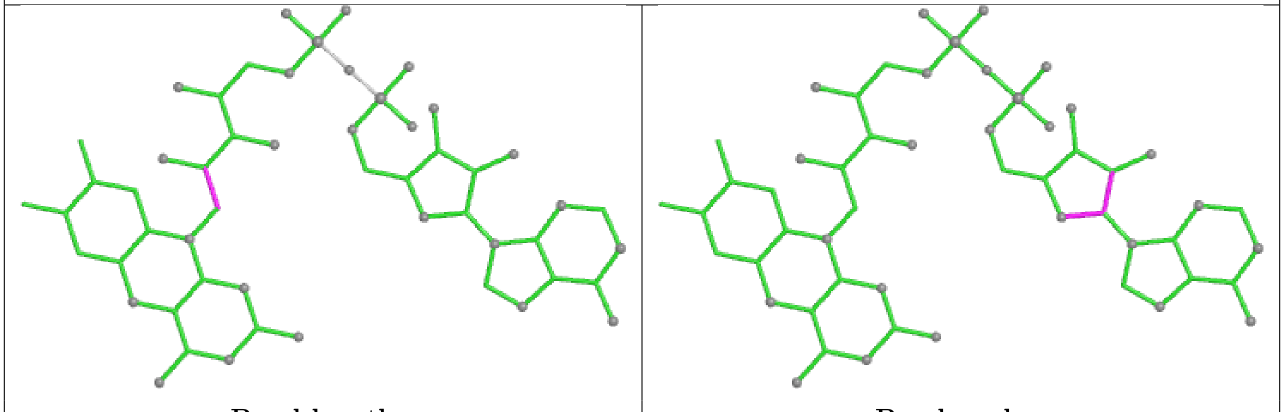
Mol	Chain	Res	Type	Atoms
2	B	601	FAD	PA-O3P-P-O5'
2	B	601	FAD	O4B-C4B-C5B-O5B
2	A	601	FAD	PA-O3P-P-O5'
2	B	601	FAD	C2B-C1B-N9A-C8A
2	B	601	FAD	C3B-C4B-C5B-O5B
2	A	601	FAD	C2B-C1B-N9A-C8A
2	A	601	FAD	O4B-C4B-C5B-O5B
2	A	601	FAD	P-O3P-PA-O1A
2	B	601	FAD	O4B-C1B-N9A-C8A

There are no ring outliers.

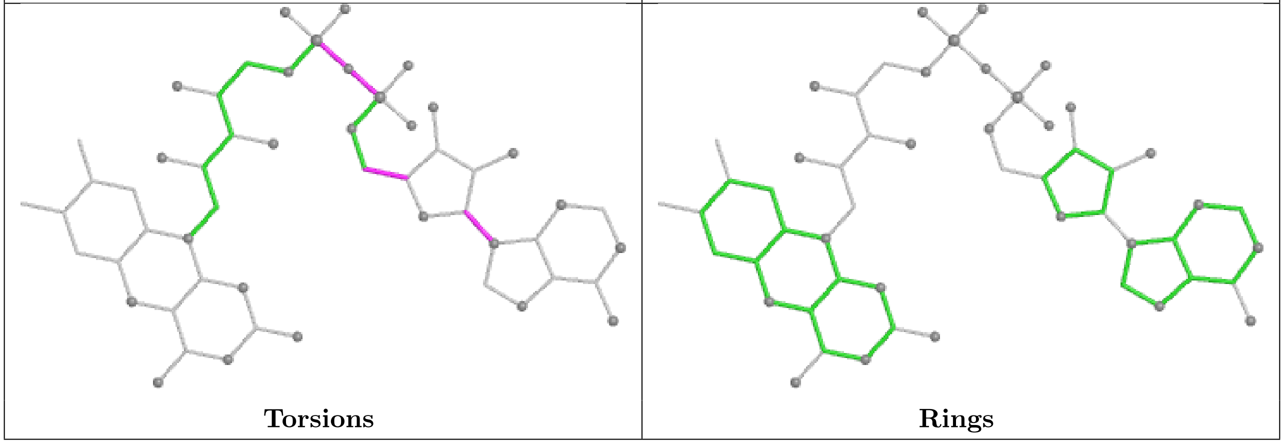
No monomer is involved in short contacts.

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.

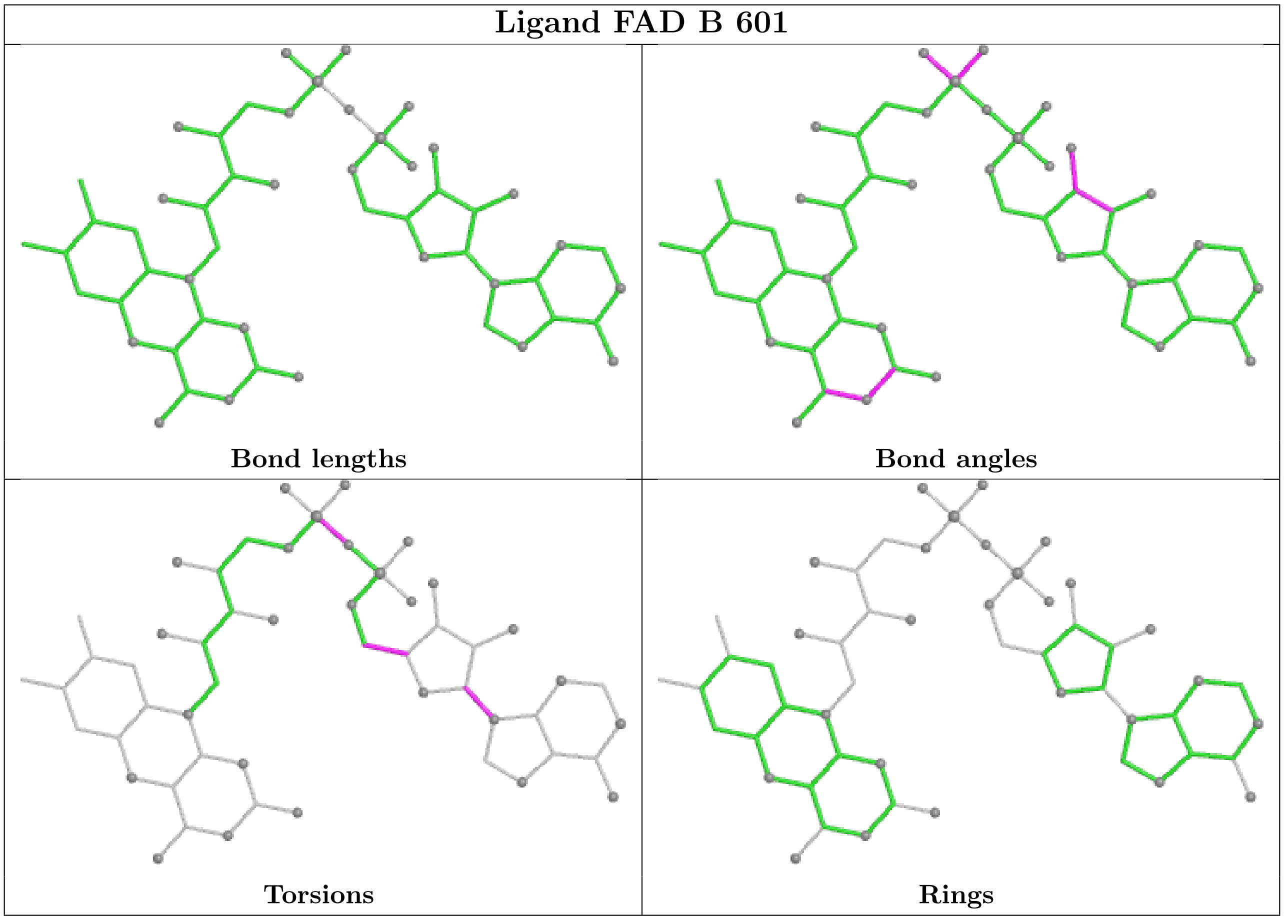
Ligand FAD A 601



Bond lengths **Bond angles**



Torsions **Rings**



Ligand FAD B 601

Bond lengths

Bond angles

Torsions

Rings

5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data ⓘ

6.1 Protein, DNA and RNA chains ⓘ

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates ⓘ

EDS was not executed - this section is therefore empty.

6.4 Ligands ⓘ

EDS was not executed - this section is therefore empty.

6.5 Other polymers ⓘ

EDS was not executed - this section is therefore empty.