Full wwPDB X-ray Structure Validation Report (i)

Dec 16, 2023 – 06:24 PM EST

PDB ID	:	3F2T
Title	:	Crystal structure of the FMN riboswitch bound to FMN, iridium hexamine soak.
Authors	:	Serganov, A.A.; Huang, L.
Deposited on	:	2008-10-30
Resolution	:	3.00 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 (i) 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 (i)) were used in the production of this report:

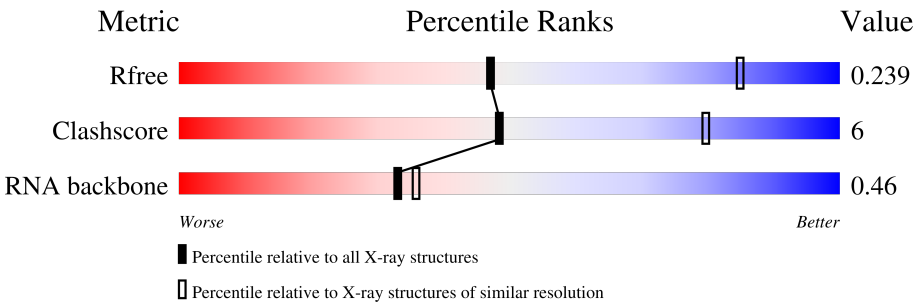
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

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

The reported resolution of this entry is 3.00 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	2092 (3.00-3.00)
Clashscore	141614	2416 (3.00-3.00)
RNA backbone	3102	1173 (3.30-2.70)

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 <=5%

Mol	Chain	Length	Quality of chain
1	X	112	52% 33% 12% •

2 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 2467 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.

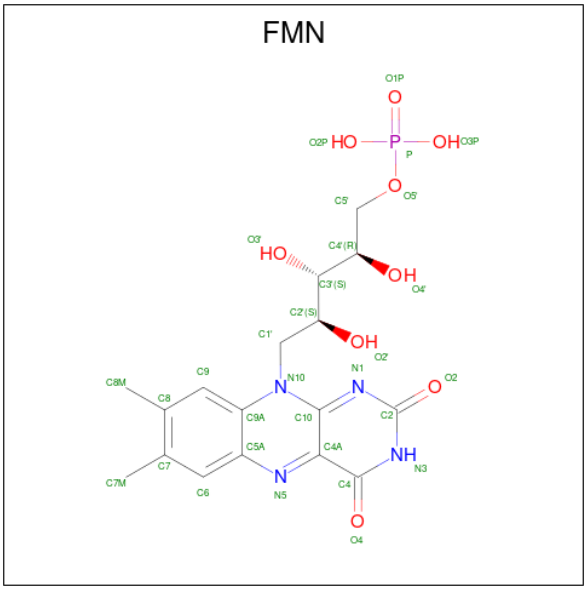
- Molecule 1 is a RNA chain called FMN riboswitch.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
1	X	109	2343	1040	424	767	112	0	0	0

There are 5 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
X	1	GTP	-	insertion	GB 20095250
X	2	G	-	insertion	GB 20095250
X	110	U	-	insertion	GB 20095250
X	111	U	-	insertion	GB 20095250
X	112	CCC	-	insertion	GB 20095250

- Molecule 2 is FLAVIN MONONUCLEOTIDE (three-letter code: FMN) (formula: $C_{17}H_{21}N_4O_9P$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	P		
2	X	1	31	17	4	9	1	0	0

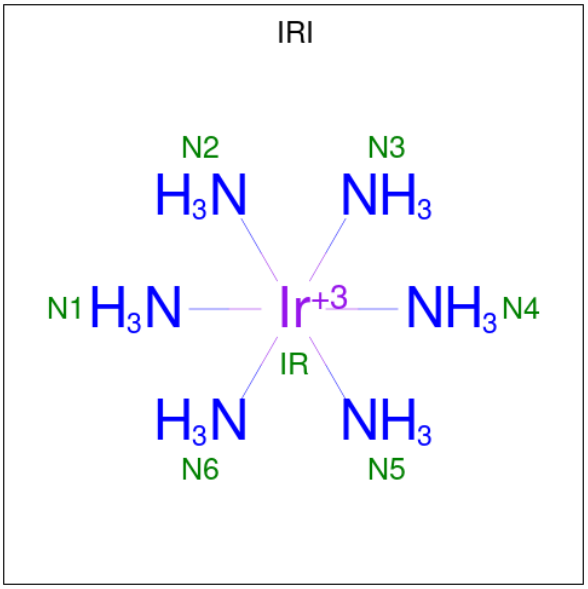
- Molecule 3 is POTASSIUM ION (three-letter code: K) (formula: K).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	X	1	Total K 1 1	0	0

- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	X	7	Total Mg 7 7	0	0

- Molecule 5 is IRIDIUM HEXAMMINE ION (three-letter code: IRI) (formula: $H_{18}IrN_6$).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	X	1	Total Ir N 14 2 12	0	1
5	X	1	Total Ir N 7 1 6	0	0
5	X	1	Total Ir N 7 1 6	0	0
5	X	1	Total Ir N 7 1 6	0	0
5	X	1	Total Ir N 7 1 6	0	0
5	X	1	Total Ir N 7 1 6	0	0
5	X	1	Total Ir N 7 1 6	0	0

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	Ir	N		
5	X	1	7	1	6	0	0
			Total	Ir	N		
5	X	1	7	1	6	0	0
			Total	Ir	N		
5	X	1	7	1	6	0	0
			Total	Ir	N		
5	X	1	7	1	6	0	0

- Molecule 6 is water.

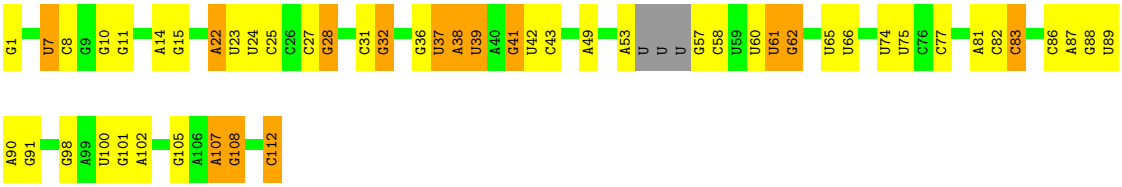
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
6	X	1	1	1	0	0

3 Residue-property plots (i)

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

- Molecule 1: FMN riboswitch

Chain X:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α, β, γ	71.49Å 71.49Å 138.72Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	20.00 – 3.00 19.78 – 3.00	Depositor EDS
% Data completeness (in resolution range)	98.6 (20.00-3.00) 98.6 (19.78-3.00)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.74 (at 2.98Å)	Xtriage
Refinement program	REFMAC 5.2.0019	Depositor
R, R_{free}	0.208 , 0.252 0.206 , 0.239	Depositor DCC
R_{free} test set	400 reflections (4.72%)	wwPDB-VP
Wilson B-factor (Å^2)	100.2	Xtriage
Anisotropy	0.132	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.26 , 107.5	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	0.040 for -h,-k,l	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	2467	wwPDB-VP
Average B, all atoms (Å^2)	111.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.54% of the height of the origin peak. No significant pseudotranslation is detected.*

[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 (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: IRI, GTP, MG, FMN, K, CCC

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	X	0.61	0/2561	1.00	3/3990 (0.1%)

There are no bond length outliers.

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	X	7	U	O4'-C1'-N1	5.57	112.65	108.20
1	X	38	A	C1'-O4'-C4'	-5.48	105.52	109.90
1	X	38	A	O4'-C1'-N9	5.08	112.26	108.20

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	X	2343	0	1168	22	0
2	X	31	0	19	0	0
3	X	1	0	0	0	0
4	X	7	0	0	0	0
5	X	84	0	0	1	0
6	X	1	0	0	1	0
All	All	2467	0	1187	22	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 6.

All (22) 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:X:49:A:H61	1:X:60:U:H3	1.18	0.89
1:X:60:U:H2'	1:X:61:U:H5'	1.57	0.87
1:X:31:C:O2'	1:X:32:G:H5'	1.93	0.68
1:X:36:G:H2'	1:X:37:U:O4'	2.02	0.60
1:X:60:U:C2'	1:X:61:U:H5'	2.34	0.56
1:X:10:G:N2	1:X:11:G:C2	2.74	0.55
1:X:62:G:H5"	6:X:500:HOH:O	2.08	0.53
1:X:86:C:H2'	1:X:87:A:H8	1.75	0.52
1:X:101:G:H2'	1:X:102:A:C8	2.47	0.49
1:X:57:G:H2'	1:X:58:C:O4'	2.13	0.48
1:X:65:U:H2'	1:X:66:U:H6	1.79	0.48
1:X:101:G:H2'	1:X:102:A:H8	1.78	0.47
1:X:41:G:N2	1:X:83:C:C2	2.82	0.47
1:X:39:U:OP2	1:X:75:U:N3	2.45	0.47
1:X:86:C:H2'	1:X:87:A:C8	2.50	0.46
1:X:22:A:O2'	1:X:24:U:OP2	2.21	0.46
1:X:81:A:C2'	1:X:82:C:H5'	2.49	0.42
1:X:107:A:H5'	1:X:108:G:OP2	2.19	0.42
1:X:27:C:H2'	1:X:28:G:O4'	2.19	0.42
1:X:88:G:H2'	1:X:89:U:O4'	2.20	0.42
1:X:65:U:H2'	1:X:66:U:C6	2.55	0.42
1:X:98:G:O6	5:X:401[A]:IRI:N3	2.54	0.40

There are no symmetry-related clashes.

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

There are no protein molecules in this entry.

5.3.2 Protein sidechains (i)

There are no protein molecules in this entry.

5.3.3 RNA (i)

Mol	Chain	Analysed	Backbone Outliers	Pucker Outliers
1	X	106/112 (94%)	25 (23%)	5 (4%)

All (25) RNA backbone outliers are listed below:

Mol	Chain	Res	Type
1	X	7	U
1	X	8	C
1	X	14	A
1	X	15	G
1	X	23	U
1	X	25	C
1	X	28	G
1	X	32	G
1	X	37	U
1	X	38	A
1	X	39	U
1	X	41	G
1	X	43	C
1	X	53	A
1	X	62	G
1	X	74	U
1	X	77	C
1	X	83	C
1	X	90	A
1	X	91	G
1	X	100	U
1	X	105	G
1	X	107	A
1	X	108	G
1	X	112	CCC

All (5) RNA pucker outliers are listed below:

Mol	Chain	Res	Type
1	X	22	A
1	X	23	U
1	X	37	U
1	X	42	U
1	X	61	U

5.4 Non-standard residues in protein, DNA, RNA chains (i)

2 non-standard protein/DNA/RNA residues 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	$\#\|Z\| > 2$
1	GTP	X	1	1	26,34,34	1.08	2 (7%)	32,54,54	1.55	6 (18%)
1	CCC	X	112	1	20,25,26	2.73	4 (20%)	28,38,41	1.45	6 (21%)

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
1	GTP	X	1	1	-	4/18/38/38	0/3/3/3
1	CCC	X	112	1	-	0/7/35/36	0/3/3/3

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	X	112	CCC	C5-C4	-7.05	1.26	1.42
1	X	112	CCC	C6-C5	-6.40	1.20	1.35
1	X	112	CCC	C6-N1	-6.29	1.22	1.38
1	X	1	GTP	C5-C6	-3.80	1.39	1.47
1	X	112	CCC	C2-N1	-3.11	1.33	1.40
1	X	1	GTP	C2-N3	2.28	1.38	1.33

All (12) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	X	1	GTP	PA-O3A-PB	-3.85	119.60	132.83
1	X	112	CCC	O3'-C3'-C2'	3.27	111.08	105.08
1	X	1	GTP	C5-C6-N1	3.25	119.70	113.95
1	X	1	GTP	PB-O3B-PG	-3.21	121.80	132.83
1	X	112	CCC	O2'-C2'-C3'	3.05	110.67	105.08

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	X	112	CCC	C6-C5-C4	3.01	122.36	117.50
1	X	1	GTP	C8-N7-C5	2.98	108.67	102.99
1	X	1	GTP	C2-N1-C6	-2.85	119.85	125.10
1	X	112	CCC	C4-N3-C2	-2.41	116.36	120.25
1	X	112	CCC	O3'-PC-O1C	-2.20	109.96	115.76
1	X	1	GTP	O6-C6-C5	-2.06	120.35	124.37
1	X	112	CCC	O2'-PC-O1C	-2.05	110.35	115.76

There are no chirality outliers.

All (4) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
1	X	1	GTP	PB-O3A-PA-O5'
1	X	1	GTP	PG-O3B-PB-O2B
1	X	1	GTP	PA-O3A-PB-O2B
1	X	1	GTP	PA-O3A-PB-O1B

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

Of 21 ligands modelled in this entry, 8 are monoatomic - leaving 13 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	FMN	X	200	4	33,33,33	1.08	2 (6%)	48,50,50	1.20	8 (16%)
5	IRI	X	404	-	0,6,6	-	-	-		

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
5	IRI	X	406	-	0,6,6	-	-	-		
5	IRI	X	405	-	0,6,6	-	-	-		
5	IRI	X	401[B]	-	0,6,6	-	-	-		
5	IRI	X	409	-	0,6,6	-	-	-		
5	IRI	X	411	-	0,6,6	-	-	-		
5	IRI	X	407	-	0,6,6	-	-	-		
5	IRI	X	402	-	0,6,6	-	-	-		
5	IRI	X	403	-	0,6,6	-	-	-		
5	IRI	X	401[A]	-	0,6,6	-	-	-		
5	IRI	X	408	-	0,6,6	-	-	-		
5	IRI	X	410	-	0,6,6	-	-	-		

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	FMN	X	200	4	-	3/18/18/18	0/3/3/3

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	X	200	FMN	C4A-N5	3.99	1.38	1.30
2	X	200	FMN	C10-N1	2.58	1.38	1.33

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	X	200	FMN	C4-N3-C2	-2.94	120.20	125.64
2	X	200	FMN	C4A-C4-N3	2.58	119.74	113.19
2	X	200	FMN	C4A-C10-N10	2.39	119.97	116.48
2	X	200	FMN	O4-C4-C4A	-2.37	120.30	126.60
2	X	200	FMN	O5'-P-O1P	2.32	112.98	106.47
2	X	200	FMN	C9A-C5A-N5	-2.20	120.04	122.43
2	X	200	FMN	C10-C4A-N5	-2.18	120.24	124.86
2	X	200	FMN	C4A-C10-N1	-2.10	119.85	124.73

There are no chirality outliers.

All (3) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	X	200	FMN	C5'-O5'-P-O1P
2	X	200	FMN	C5'-O5'-P-O2P
2	X	200	FMN	C5'-O5'-P-O3P

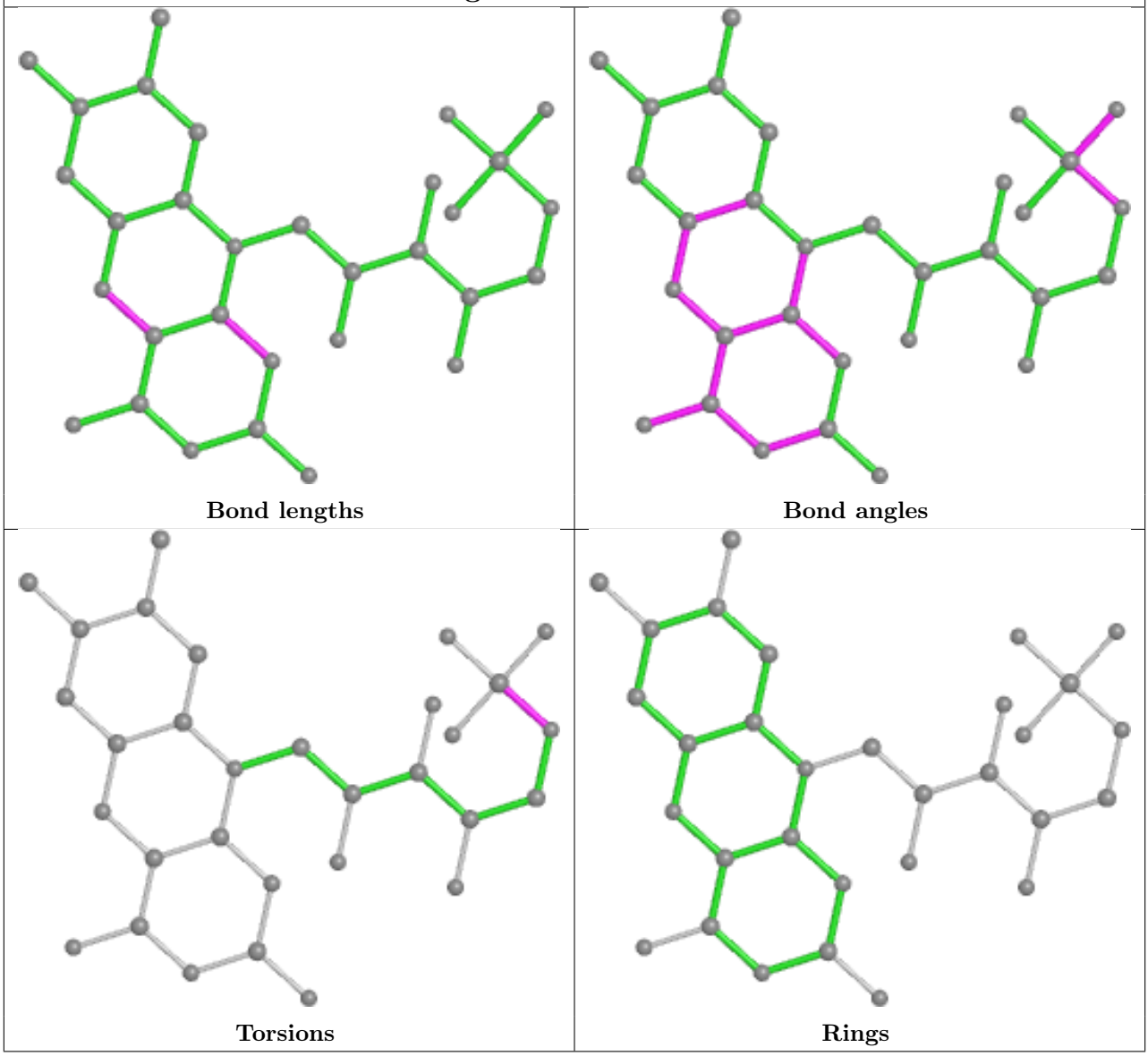
There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	X	401[A]	IRI	1	0

The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less 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 FMN X 200



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)

Unable to reproduce the depositors R factor - this section is therefore empty.

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

Unable to reproduce the depositors R factor - this section is therefore empty.

6.3 Carbohydrates (i)

Unable to reproduce the depositors R factor - this section is therefore empty.

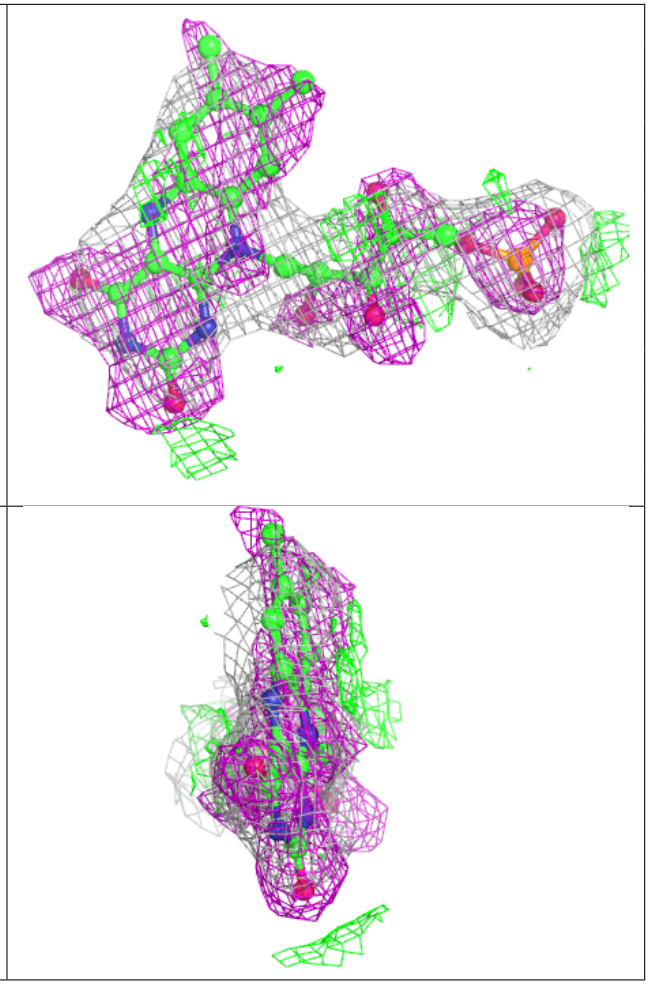
6.4 Ligands (i)

Unable to reproduce the depositors R factor - this section is therefore empty.

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 FMN X 200:

$2mF_o$-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)

Unable to reproduce the depositors R factor - this section is therefore empty.