W O R L D W I D E wwPDB

PROTEIN DATA BANK

wwPDB X-ray Structure Validation Summary Report ⓘ

Dec 3, 2023 – 06:54 am GMT

PDB ID	:	2BPO
Title	:	Crystal structure of the yeast CPR triple mutant: D74G, Y75F, K78A.
Authors	:	Yermalitskaya, L.V.; Kim, Y.; Waterman, M.R.; Podust, L.M.
Deposited on	:	2005-04-21
Resolution	:	2.90 Å(reported)

PERCENTILES INFOmissingINFO

1 Entry composition (i)

There are 6 unique types of molecules in this entry. The entry contains 10528 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 NADPH-CYTOCHROM P450 REDUCTASE.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	641	Total 5040	C 3213	N 833	O 979	S 15	0	0	0
1	B	641	Total 5040	C 3213	N 833	O 979	S 15	0	0	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	74	GLY	ASP	engineered mutation	UNP P16603
A	75	PHE	TYR	engineered mutation	UNP P16603
A	78	ALA	LYS	engineered mutation	UNP P16603
B	74	GLY	ASP	engineered mutation	UNP P16603
B	75	PHE	TYR	engineered mutation	UNP P16603
B	78	ALA	LYS	engineered mutation	UNP P16603

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

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		

- Molecule 3 is FLAVIN MONONUCLEOTIDE (three-letter code: FMN) (formula: $C_{17}H_{21}N_4O_9P$).
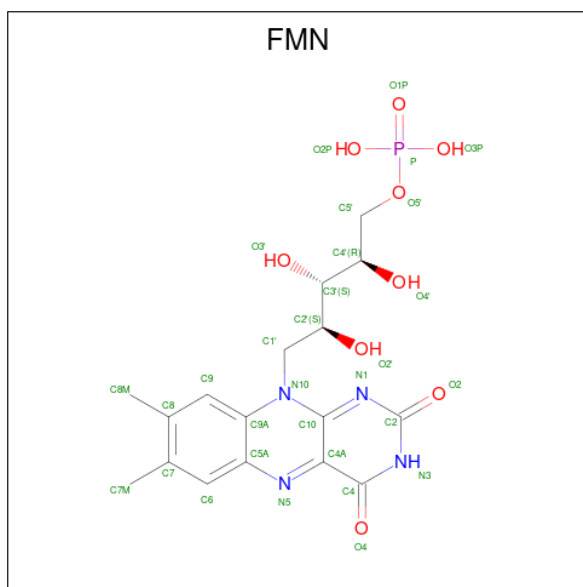
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
3	A	1	Total	C	N	O	P	0	0
			31	17	4	9	1		
3	B	1	Total	C	N	O	P	0	0
			31	17	4	9	1		

- Molecule 4 is NADP NICOTINAMIDE-ADENINE-DINUCLEOTIDE PHOSPHATE (three-letter code: NAP) (formula: $C_{21}H_{28}N_7O_{17}P_3$).

NAP

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
4	A	1	Total	C	N	O	P	0	0
			40	15	6	16	3		
4	B	1	Total	C	N	O	P	0	0
			40	15	6	16	3		

• Molecule 5 is SULFATE ION (three-letter code: SO4) (formula: O_4S).

SO4

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	O	S	0	0
			5	4	1		
5	A	1	Total	O	S	0	0
			5	4	1		

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	B	1	Total 5	O 4	S 1	0	0

- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	127	Total 127	O 127	0	0
6	B	58	Total 58	O 58	0	0

SEQUENCE-PLOTS INFOmissingINFO

2 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	78.36Å 86.60Å 259.72Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	39.18 – 2.90 50.00 – 2.89	Depositor EDS
% Data completeness (in resolution range)	87.2 (39.18-2.90) 86.9 (50.00-2.89)	Depositor EDS
R_{merge}	0.08	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	4.77 (at 2.91Å)	Xtriage
Refinement program	CNS 1.1	Depositor
R, R_{free}	0.205 , 0.268 0.205 , 0.265	Depositor DCC
R_{free} test set	3727 reflections (10.02%)	wwPDB-VP
Wilson B-factor (Å²)	51.0	Xtriage
Anisotropy	0.708	Xtriage
Bulk solvent k_{sol}(e/Å³), B_{sol}(Å²)	0.35 , 57.9	EDS
L-test for twinning[2]	$< \|L\| > = 0.49, < L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.93	EDS
Total number of atoms	10528	wwPDB-VP
Average B, all atoms (Å²)	56.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.76% 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.

3   Model quality   ⓘ

3.1   Standard geometry   ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: SO4, FMN, FAD, NAP

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	0.40	0/5156	0.65	1/7000 (0.0%)
1	B	0.38	0/5156	0.64	0/7000
All	All	0.39	0/10312	0.64	1/14000 (0.0%)

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	1

There are no bond length outliers.

All (1) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	407	ASN	N-CA-C	-5.18	97.02	111.00

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	441	TYR	Sidechain

3.2   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	5040	0	4933	259	0
1	B	5040	0	4933	297	0
2	A	53	0	31	2	0
2	B	53	0	31	4	0
3	A	31	0	19	2	0
3	B	31	0	19	1	0
4	A	40	0	19	2	0
4	B	40	0	19	2	0
5	A	10	0	0	0	0
5	B	5	0	0	0	0
6	A	127	0	0	9	0
6	B	58	0	0	8	0
All	All	10528	0	10004	556	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 27.

The worst 5 of 556 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:619:TYR:HB3	1:B:621:GLN:HE22	1.03	1.12
1:B:621:GLN:H	1:B:621:GLN:NE2	1.54	1.06
1:B:539:ILE:HG23	1:B:620:VAL:HG11	1.39	1.03
1:B:621:GLN:HE21	1:B:621:GLN:N	1.57	1.01
1:B:625:LYS:O	1:B:628:GLU:HG3	1.60	1.00

There are no symmetry-related clashes.

3.3 Torsion angles ⓘ

3.3.1 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	637/682 (93%)	568 (89%)	59 (9%)	10 (2%)	9	32
1	B	637/682 (93%)	561 (88%)	60 (9%)	16 (2%)	5	21
All	All	1274/1364 (93%)	1129 (89%)	119 (9%)	26 (2%)	7	27

5 of 26 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	121	GLY
1	B	48	ARG
1	A	96	VAL
1	A	647	ALA
1	B	493	ASN

3.3.2   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	557/590 (94%)	525 (94%)	32 (6%)	20	51
1	B	557/590 (94%)	520 (93%)	37 (7%)	16	44
All	All	1114/1180 (94%)	1045 (94%)	69 (6%)	18	47

5 of 69 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	526	PHE
1	B	545	VAL
1	B	621	GLN
1	A	568	ASN
1	A	523	ARG

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 45 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	306	HIS

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Mol	Chain	Res	Type
1	B	452	GLN
1	B	320	GLN
1	B	380	ASN
1	B	484	ASN

3.3.3 RNA ⓘ

There are no RNA molecules in this entry.

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

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

3.5 Carbohydrates ⓘ

There are no monosaccharides in this entry.

3.6 Ligand geometry ⓘ

9 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	$\#|Z| > 2$
3	FMN	B	751	-	33,33,33	1.56	7 (21%)	48,50,50	1.37	5 (10%)
2	FAD	A	750	-	53,58,58	1.48	8 (15%)	68,89,89	0.96	2 (2%)
5	SO4	B	762	-	4,4,4	0.24	0	6,6,6	0.09	0
4	NAP	B	753	-	36,43,52	1.18	5 (13%)	44,67,80	1.50	4 (9%)
5	SO4	A	761	-	4,4,4	0.27	0	6,6,6	0.05	0
5	SO4	A	760	-	4,4,4	0.27	0	6,6,6	0.12	0
4	NAP	A	753	-	36,43,52	1.24	5 (13%)	44,67,80	1.56	7 (15%)
3	FMN	A	751	-	33,33,33	1.51	5 (15%)	48,50,50	1.38	7 (14%)
2	FAD	B	750	-	53,58,58	1.56	8 (15%)	68,89,89	0.90	2 (2%)

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
3	FMN	B	751	-	-	0/18/18/18	0/3/3/3
2	FAD	A	750	-	-	7/30/50/50	0/6/6/6
4	NAP	B	753	-	-	6/23/59/67	0/4/4/5
4	NAP	A	753	-	-	7/23/59/67	0/4/4/5
3	FMN	A	751	-	-	0/18/18/18	0/3/3/3
2	FAD	B	750	-	-	7/30/50/50	0/6/6/6

The worst 5 of 38 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	750	FAD	C4X-N5	6.10	1.42	1.30
2	B	750	FAD	C4X-N5	5.90	1.42	1.30
3	A	751	FMN	C4A-N5	4.48	1.39	1.30
3	B	751	FMN	C10-N10	4.10	1.46	1.37
3	B	751	FMN	C4A-N5	4.09	1.38	1.30

The worst 5 of 27 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
4	A	753	NAP	N3A-C2A-N1A	-4.83	121.13	128.68
4	B	753	NAP	C1B-N9A-C4A	-4.62	118.53	126.64
4	B	753	NAP	N3A-C2A-N1A	-4.56	121.56	128.68
4	A	753	NAP	C1B-N9A-C4A	-4.29	119.11	126.64
3	B	751	FMN	C9A-C5A-N5	3.78	126.54	122.43

There are no chirality outliers.

5 of 27 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	A	750	FAD	C1'-C2'-C3'-C4'
2	B	750	FAD	C1'-C2'-C3'-C4'
2	B	750	FAD	C3'-C4'-C5'-O5'
2	B	750	FAD	O4'-C4'-C5'-O5'
4	A	753	NAP	C5B-O5B-PA-O1A

There are no ring outliers.
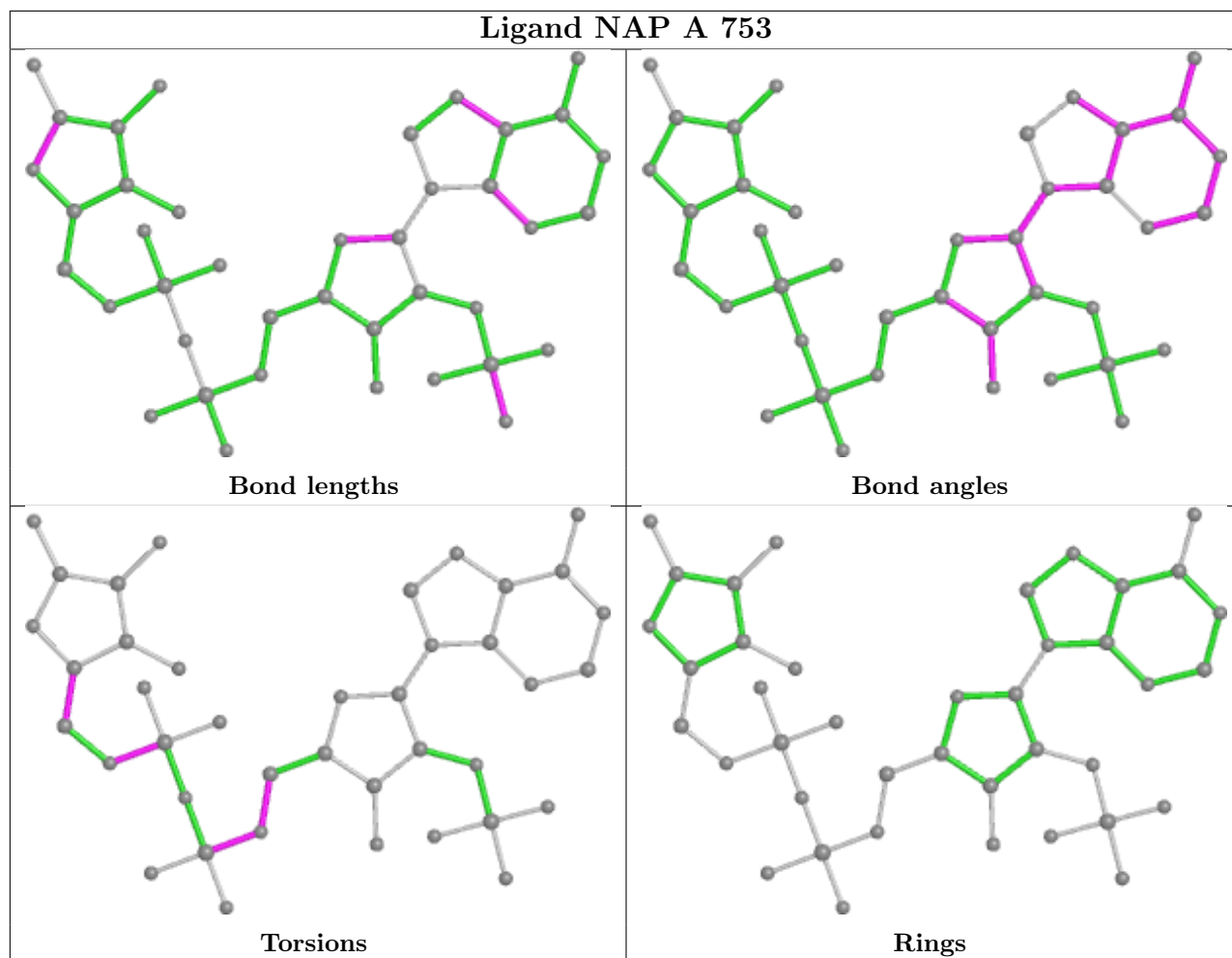
6 monomers are involved in 13 short contacts:

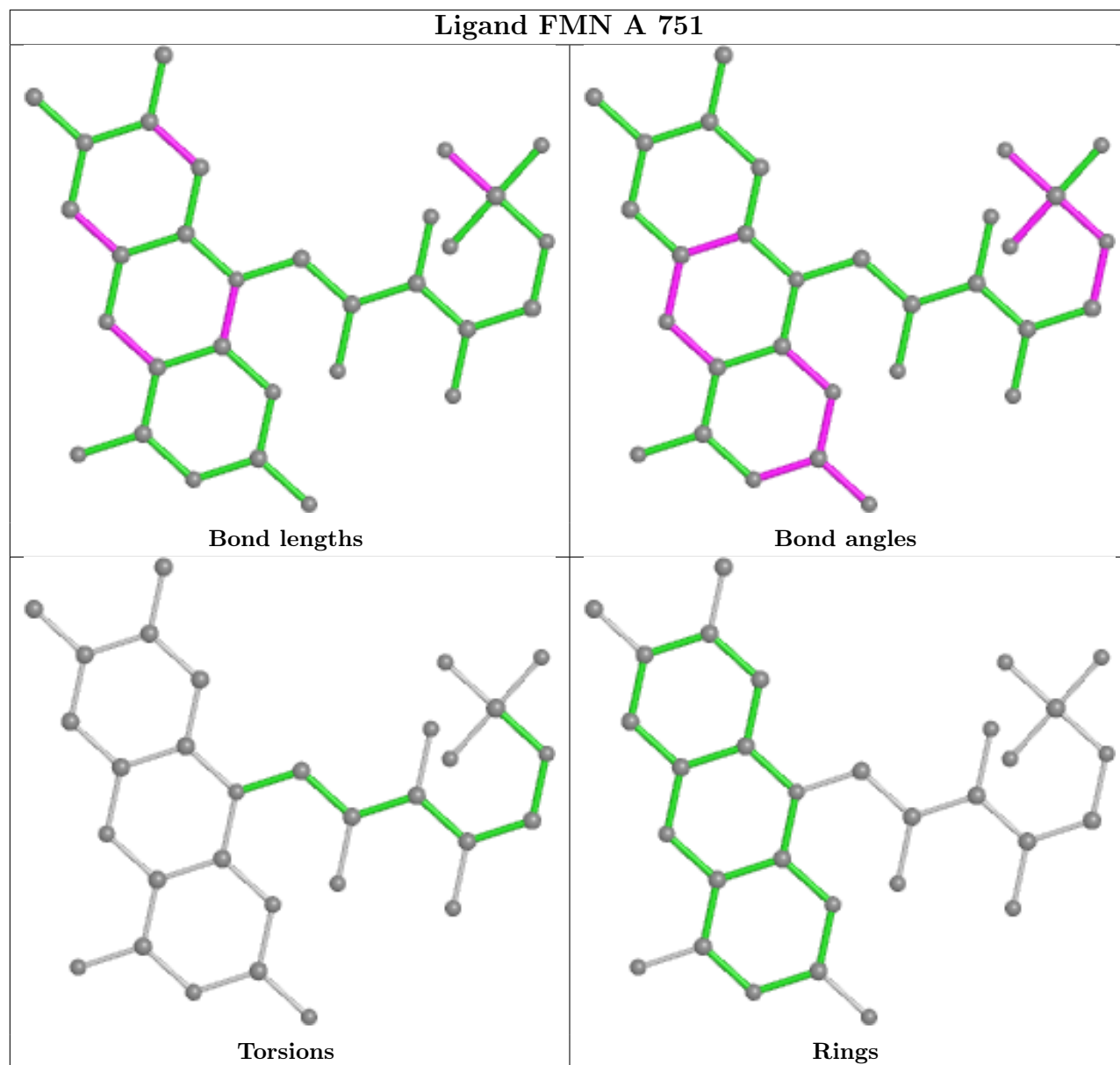| Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	751	FMN	1	0
2	A	750	FAD	2	0
4	B	753	NAP	2	0
4	A	753	NAP	2	0
3	A	751	FMN	2	0
2	B	750	FAD	4	0

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 B 751

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD A 750

Bond lengths

Bond angles

Torsions

Rings

Ligand NAP B 753

Bond lengths

Bond angles

Torsions

Rings

Ligand NAP A 753

Bond lengths

Bond angles

Torsions

Rings

Ligand FMN A 751

Bond lengths

Bond angles

Torsions

Rings

Ligand FAD B 750

Bond lengths

Bond angles

Torsions

Rings
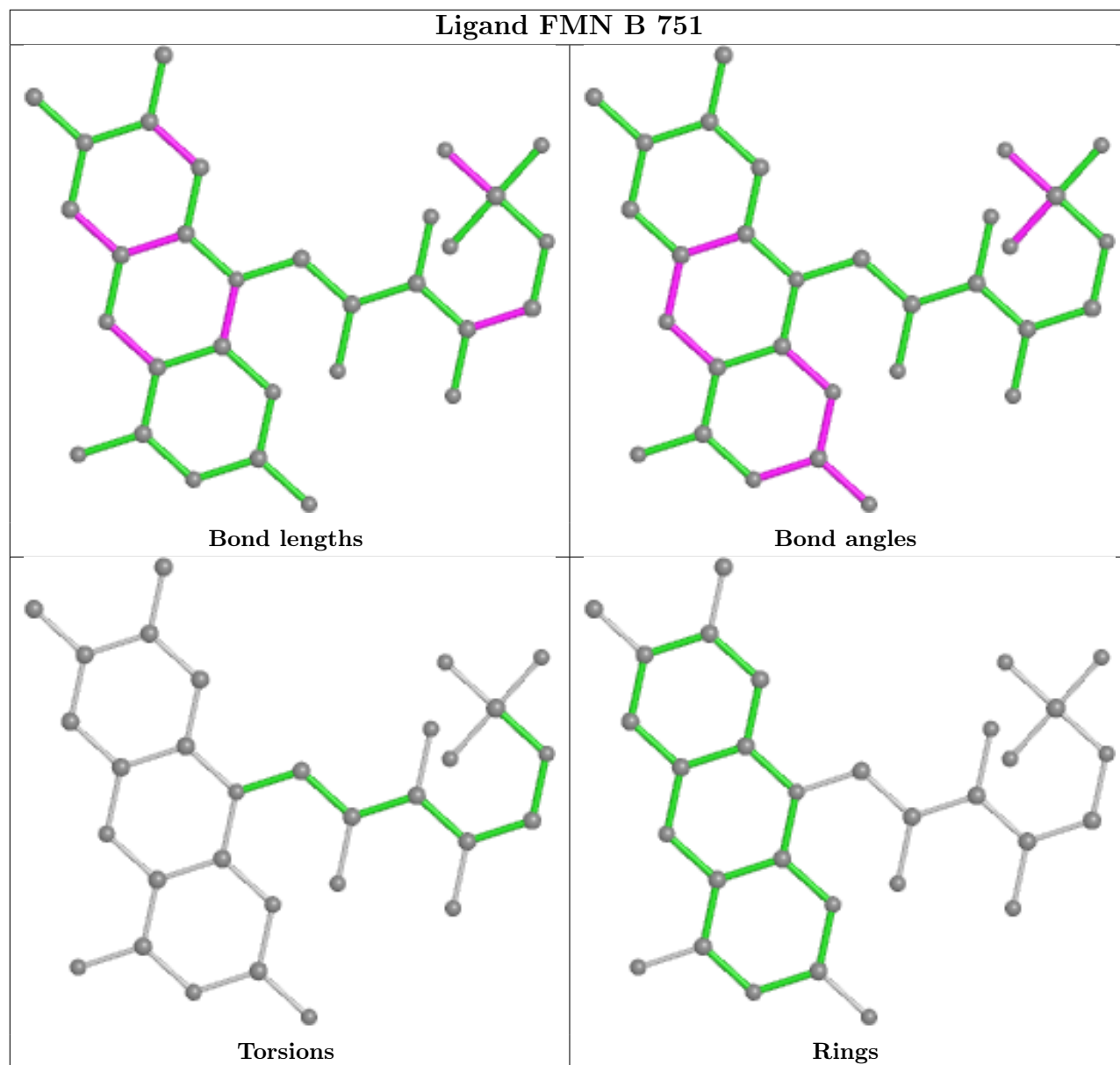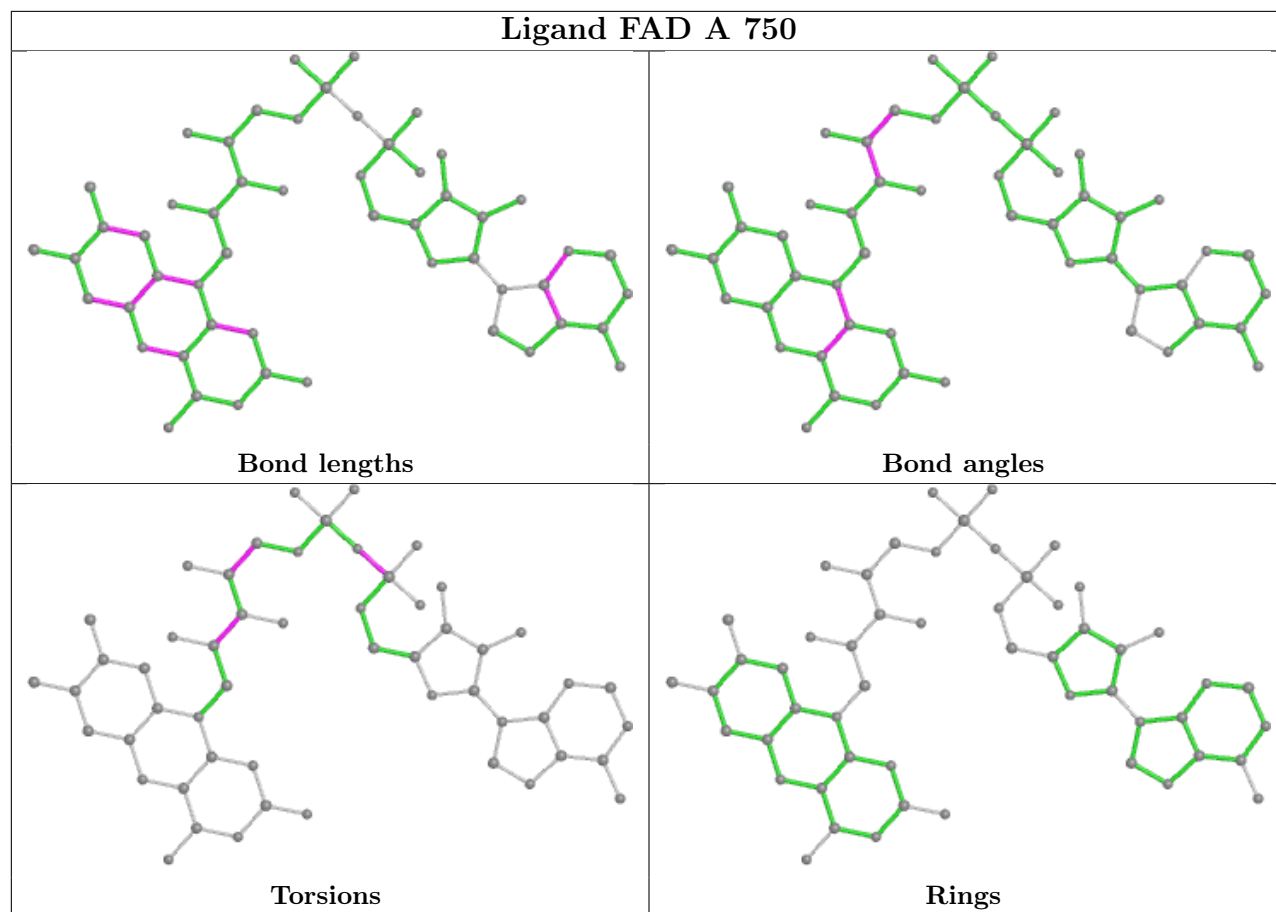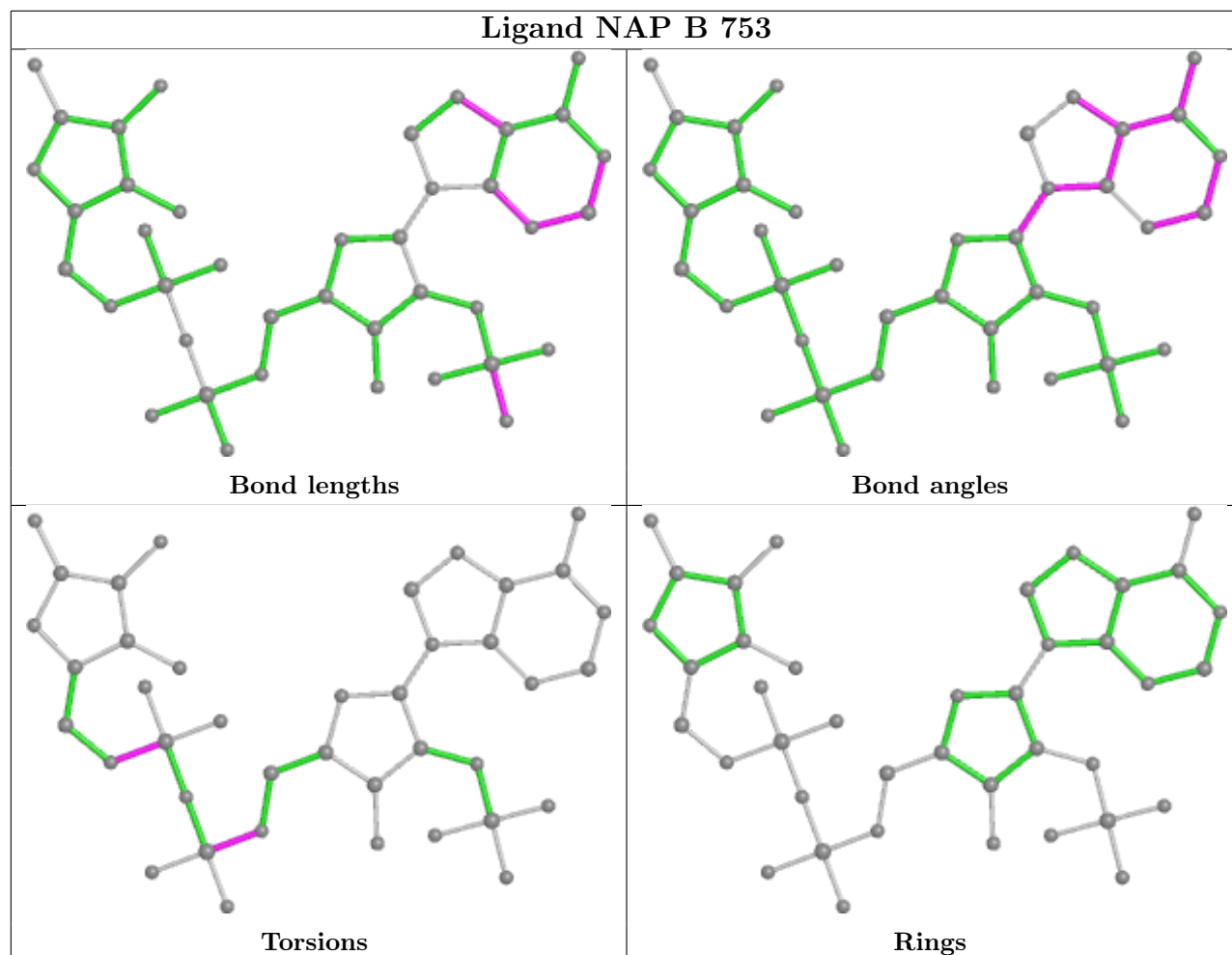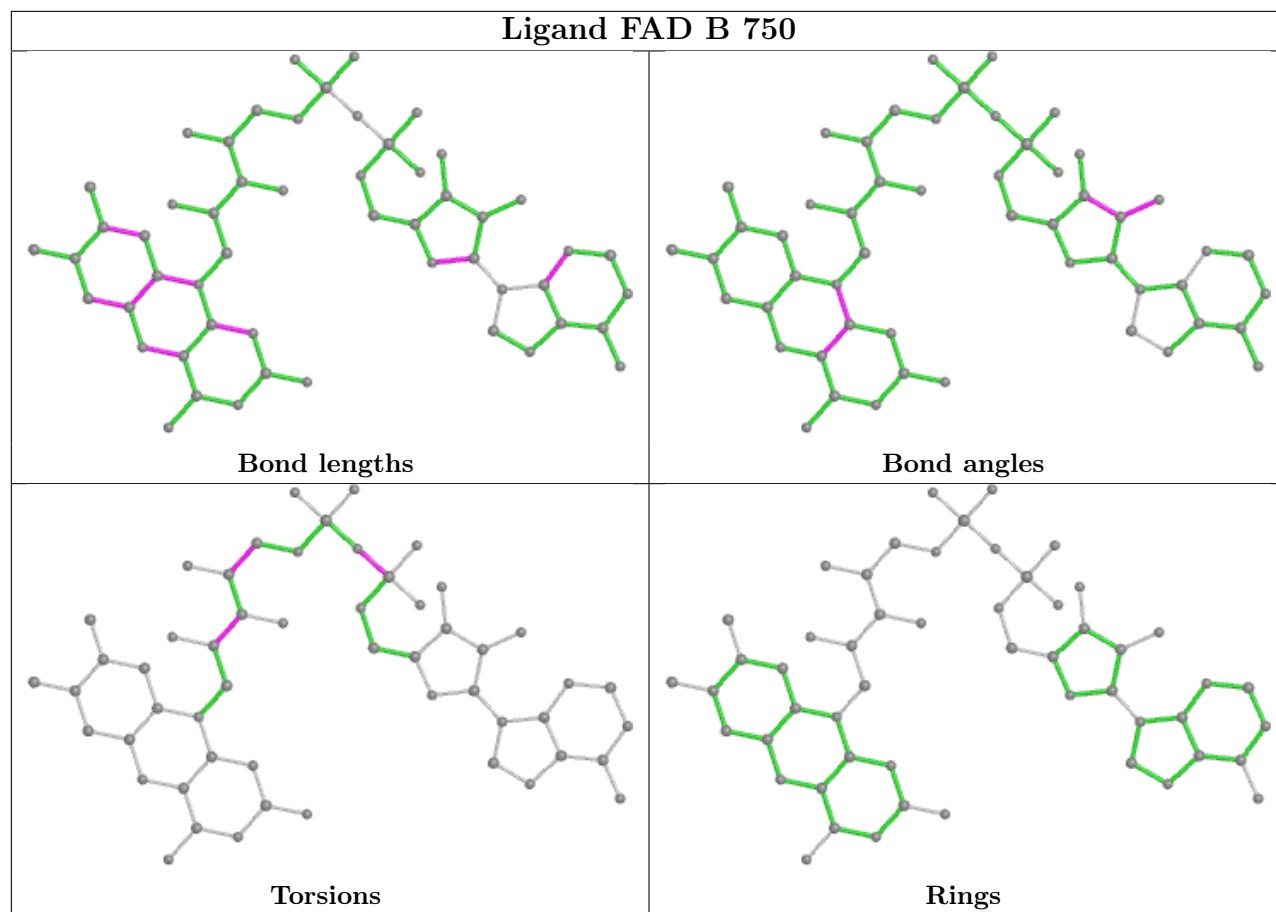
3.7 Other polymers ⓘ

There are no such residues in this entry.

3.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

4 Fit of model and data ⓘ

4.1 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	641/682 (93%)	0.07	8 (1%)	79	79	30, 50, 74, 99	0
1	B	641/682 (93%)	0.24	23 (3%)	42	37	33, 60, 81, 105	0
All	All	1282/1364 (93%)	0.15	31 (2%)	59	56	30, 55, 78, 105	0

The worst 5 of 31 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	669	THR	3.9
1	A	559	LEU	3.7
1	B	468	LEU	3.6
1	A	260	LEU	3.5
1	B	569	VAL	3.3

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

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

4.3 Carbohydrates ⓘ

There are no monosaccharides in this entry.

4.4 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
5	SO4	B	762	5/5	0.77	0.17	144,144,144,144	0
5	SO4	A	761	5/5	0.89	0.26	128,129,129,129	0
4	NAP	B	753	40/48	0.91	0.20	94,99,114,114	0
5	SO4	A	760	5/5	0.93	0.17	87,87,89,89	0
3	FMN	B	751	31/31	0.94	0.17	58,64,66,67	0
3	FMN	A	751	31/31	0.96	0.18	37,41,45,47	0
2	FAD	B	750	53/53	0.96	0.21	42,50,56,60	0
2	FAD	A	750	53/53	0.97	0.18	23,31,36,38	0
4	NAP	A	753	40/48	0.97	0.20	32,41,77,78	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 NAP B 753:

$2mF_o\text{-}DF_c$ (at 0.7 rmsd) in gray
$mF_o\text{-}DF_c$ (at 3 rmsd) in purple (negative) and green (positive)
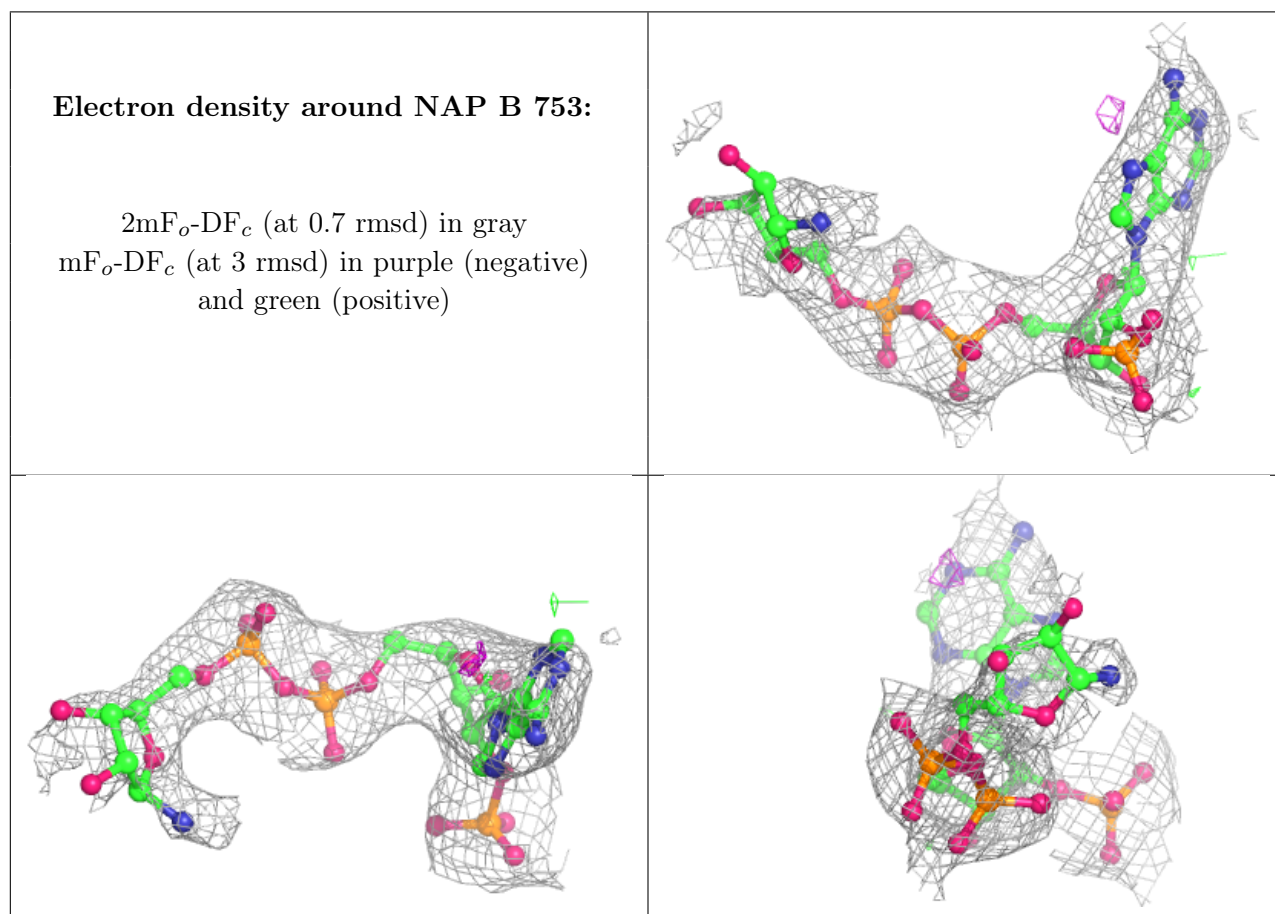
Electron density around FMN B 751:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
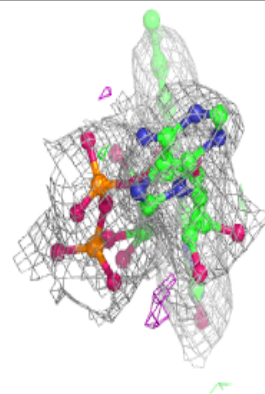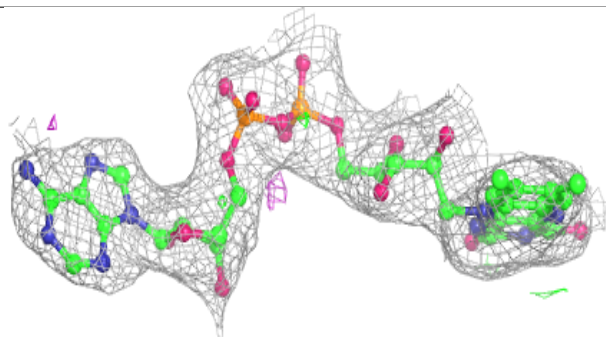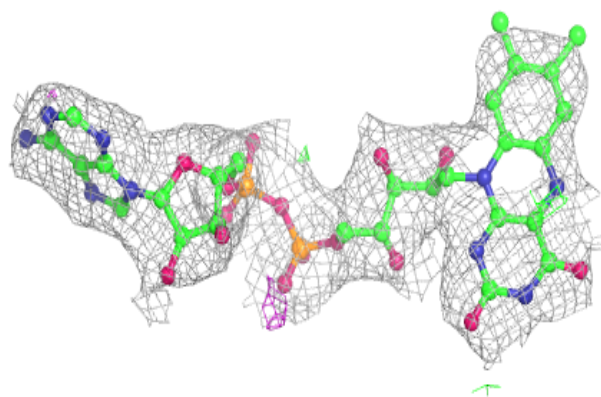and green (positive)
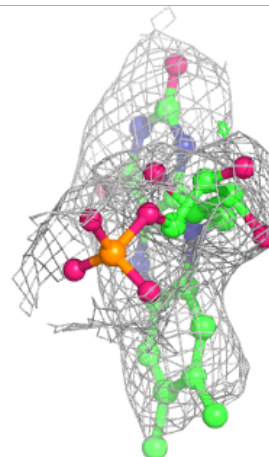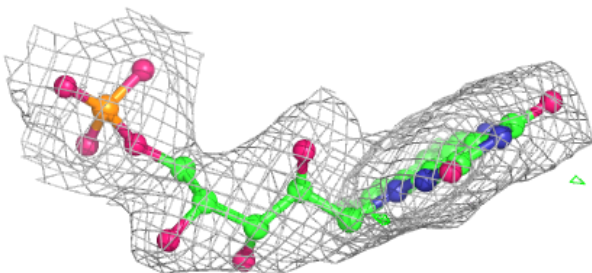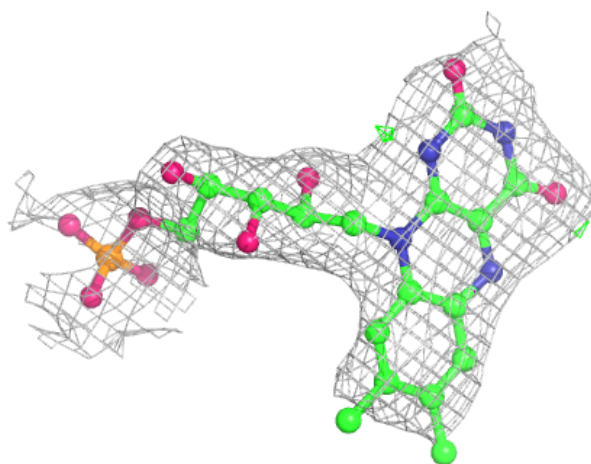
Electron density around FMN A 751:

$2mF_o$-DF_c (at 0.7 rmsd) in gray
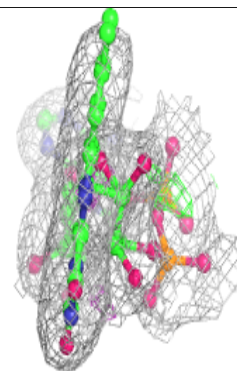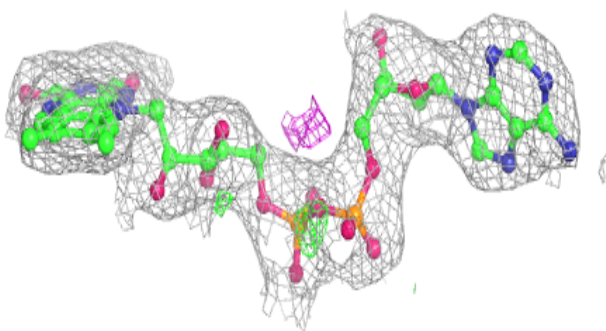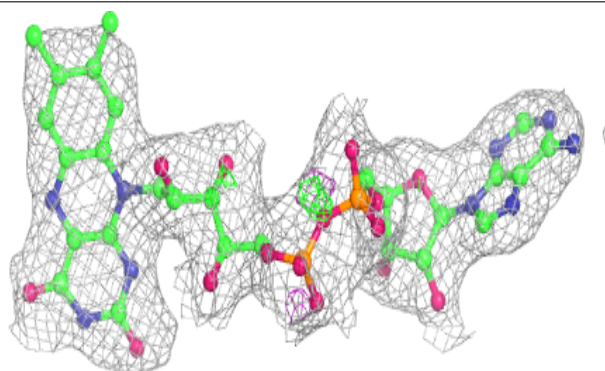mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)
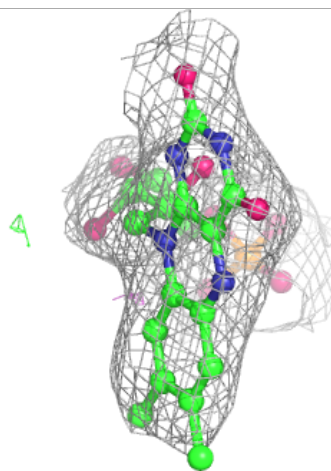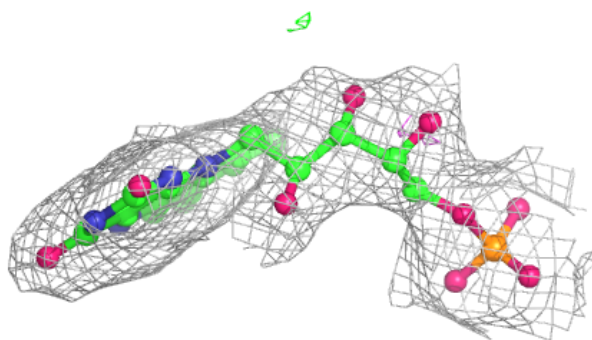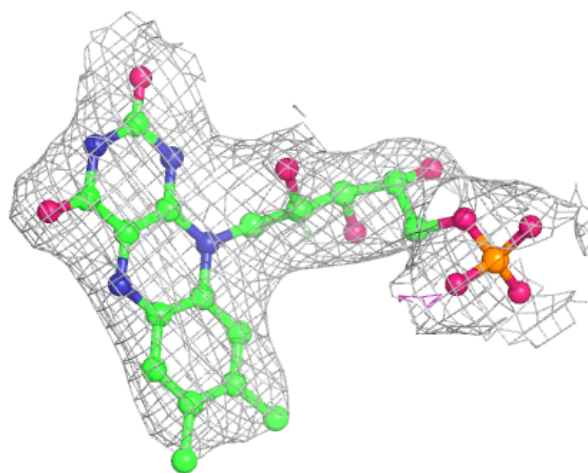
Electron density around FAD B 750:

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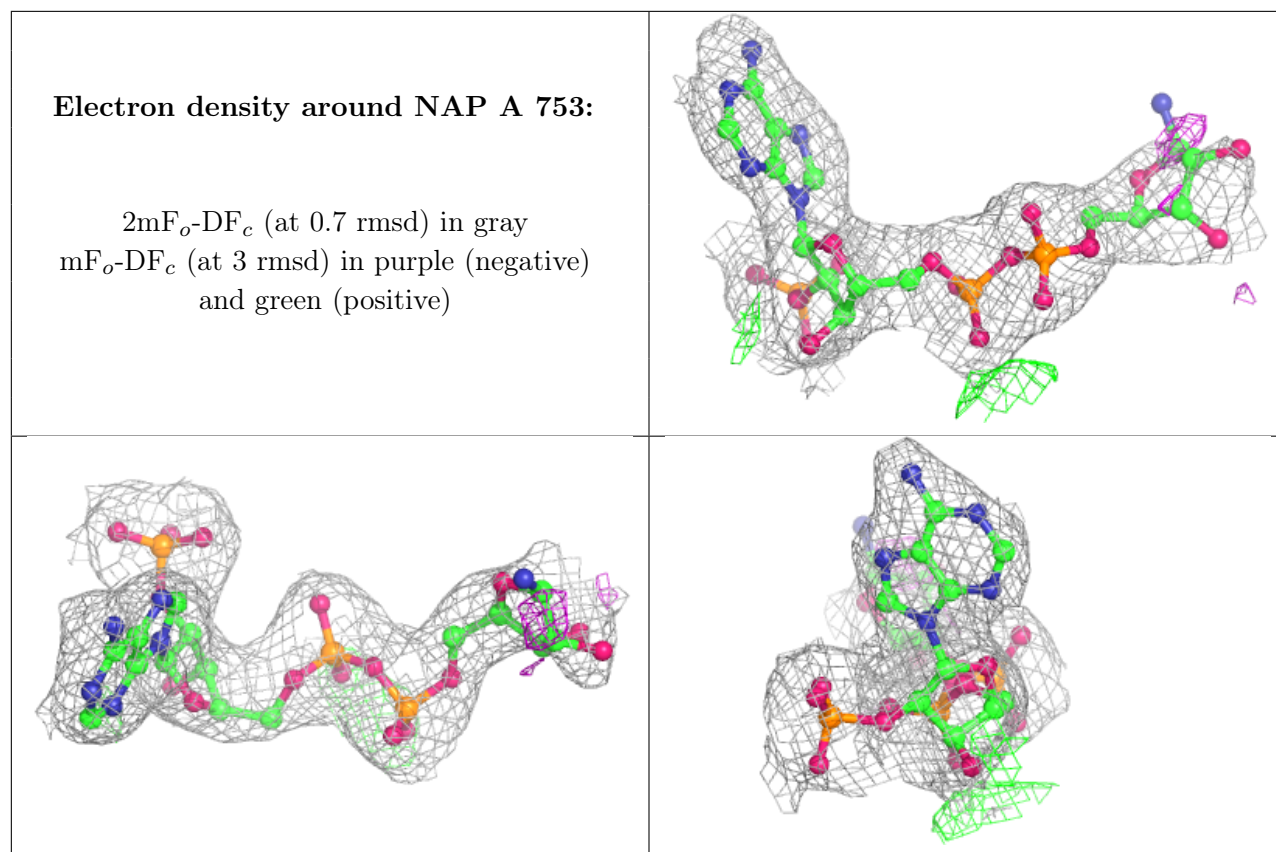mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

Electron density around FAD A 750:

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

Electron density around NAP A 753:

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

4.5 Other polymers ⓘ

There are no such residues in this entry.