



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 11, 2024 – 03:09 pm GMT

PDB ID : 9EML
Title : SARS-CoV-2 methyltransferase nsp10-16 in complex with SAM and m7GpppA (Cap0-analog)/m7GpppAm (Cap1-analog)
Authors : Kremling, V.; Sprenger, J.; Oberthuer, D.; Kiene, A.
Deposited on : 2024-03-08
Resolution : 2.40 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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 : 4.02b-467
Mogul : 1.8.4, CSD as541be (2020)
Xtrriage (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

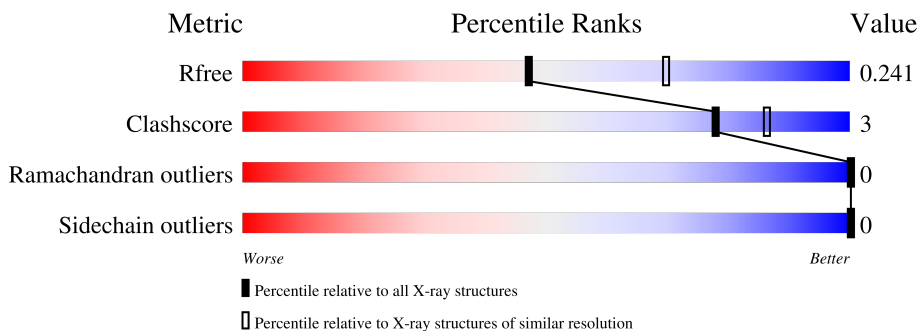
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.40 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	3907 (2.40-2.40)
Clashscore	141614	4398 (2.40-2.40)
Ramachandran outliers	138981	4318 (2.40-2.40)
Sidechain outliers	138945	4319 (2.40-2.40)

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 $\leq 5\%$.

Mol	Chain	Length	Quality of chain
1	A	304	 93% 6%
2	B	140	 76% 7% 17%

2 Entry composition [i](#)

There are 10 unique types of molecules in this entry. The entry contains 7135 atoms, of which 3412 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 2'-O-methyltransferase nsp16.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace	
			Total	C	H	N	O				S
1	A	300	4806	1532	2404	407	446	17	0	6	0

There are 6 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	7097	GLU	-	expression tag	UNP P0DTD1
A	7098	ASN	-	expression tag	UNP P0DTD1
A	7099	LEU	-	expression tag	UNP P0DTD1
A	7100	TYR	-	expression tag	UNP P0DTD1
A	7101	PHE	-	expression tag	UNP P0DTD1
A	7102	GLN	-	expression tag	UNP P0DTD1

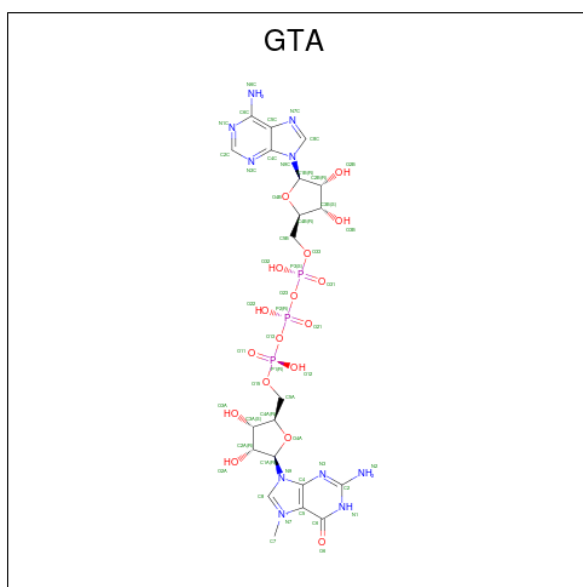
- Molecule 2 is a protein called Non-structural protein 10.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace	
			Total	C	H	N	O				S
2	B	116	1697	539	827	147	168	16	0	4	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	4253	GLY	-	expression tag	UNP P0DTD1

- Molecule 3 is P1-7-METHYLGUANOSINE-P3-ADENOSINE-5',5'-TRIPHOSPHAT E (three-letter code: GTA) (formula: C₂₁H₃₀N₁₀O₁₇P₃) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
			Total	C	H	N	O			P
3	A	1	78	21	27	10	17	3	0	1

- Molecule 4 is 1,2-ETHANEDIOL (three-letter code: EDO) (formula: C₂H₆O₂).



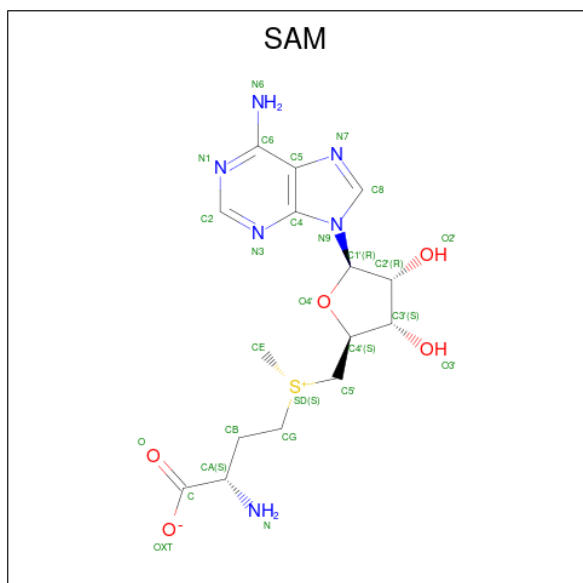
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf	
			Total	C	H			O
4	A	1	10	2	6	2	0	0
4	A	1	10	2	6	2	0	0
4	A	1	10	2	6	2	0	0

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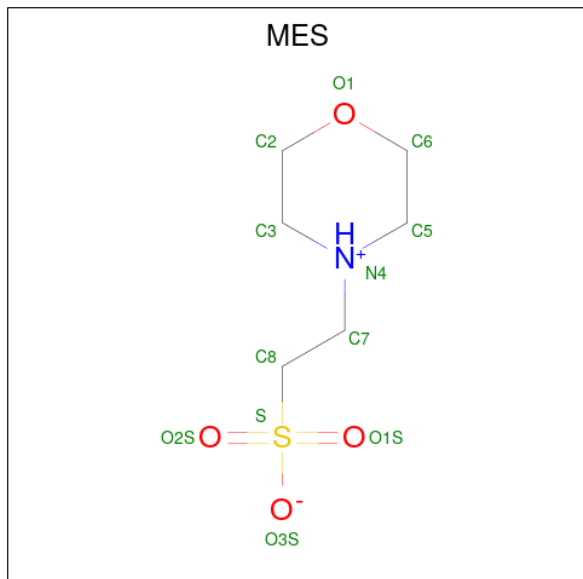
Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	A	1	Total	C	H	O	0	0
			10	2	6	2		
4	B	1	Total	C	H	O	0	0
			10	2	6	2		
4	B	1	Total	C	H	O	0	0
			10	2	6	2		

- Molecule 5 is S-ADENOSYLMETHIONINE (three-letter code: SAM) (formula: C₁₅H₂₂N₆O₅S).



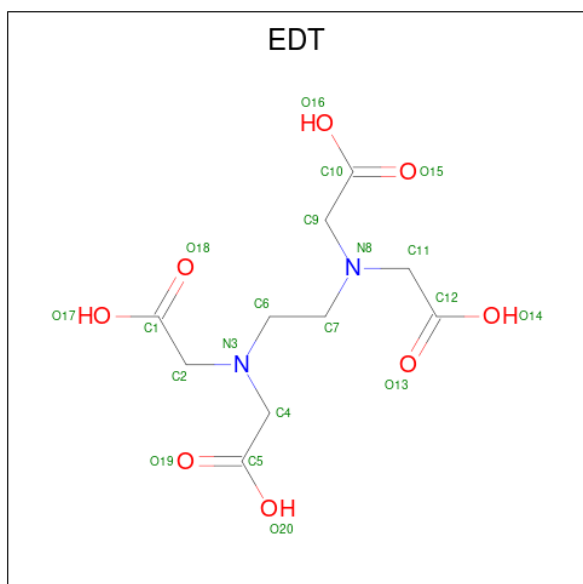
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
5	A	1	Total	C	H	N	O	S	0	0
			49	15	22	6	5	1		

- Molecule 6 is 2-(N-MORPHOLINO)-ETHANESULFONIC ACID (three-letter code: MES) (formula: $C_6H_{13}NO_4S$).



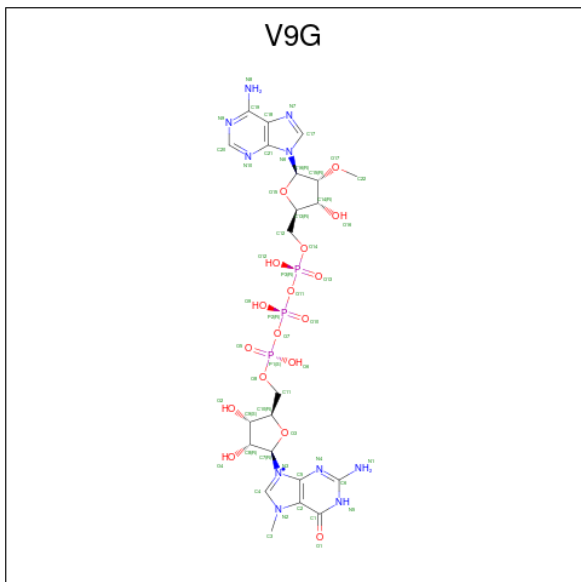
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
			Total	C	H	N	O			S
6	A	1	25	6	13	1	4	1	0	0

- Molecule 7 is {[-(BIS-CARBOXYMETHYL-AMINO)-ETHYL]-CARBOXYMETHYL-AMINO}-ACETIC ACID (three-letter code: EDT) (formula: $C_{10}H_{16}N_2O_8$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	H	N	O		
7	A	1	32	10	12	2	8	0	0

- Molecule 8 is 7-METHYL-GUANOSINE-5'-TRIPHOSPHATE-5'-(2'-O-METHYL)-ADENOSINE (three-letter code: V9G) (formula: C₂₂H₃₂N₁₀O₁₇P₃) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	
			Total	C	H	N	O			P
8	A	1	81	22	29	10	17	3	0	1

- Molecule 9 is ZINC ION (three-letter code: ZN) (formula: Zn).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Zn		
9	B	2	2	2	0	0

- Molecule 10 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
10	A	181	181	181	0	0
10	B	54	54	54	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.

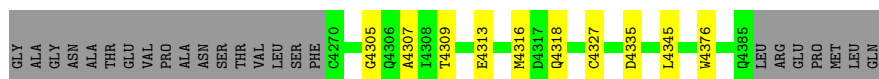
- Molecule 1: 2'-O-methyltransferase nsp16

Chain A:  93% 6%



- Molecule 2: Non-structural protein 10

Chain B:  76% 7% 17%



4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, α , β , γ	167.74Å 167.74Å 52.13Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	49.07 – 2.40 49.07 – 1.51	Depositor EDS
% Data completeness (in resolution range)	99.9 (49.07-2.40) 52.0 (49.07-1.51)	Depositor EDS
R_{merge}	0.32	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	-0.28 (at 1.50Å)	Xtrriage
Refinement program	PHENIX 1.19.2_4158	Depositor
R, R_{free}	0.178 , 0.240 0.178 , 0.241	Depositor DCC
R_{free} test set	2039 reflections (1.59%)	wwPDB-VP
Wilson B-factor (Å ²)	9.9	Xtrriage
Anisotropy	0.004	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.19 , -10.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.029 for -h,-k,l	Xtrriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	7135	wwPDB-VP
Average B, all atoms (Å ²)	58.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.86% 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: EDT, GTA, SAM, V9G, EDO, MES, ZN

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	0.57	0/2459	0.73	1/3331 (0.0%)
2	B	0.55	0/902	0.72	1/1225 (0.1%)
All	All	0.57	0/3361	0.73	2/4556 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	6981	LEU	CB-CG-CD2	-5.57	101.52	111.00
2	B	4335	ASP	CB-CG-OD2	-5.37	113.47	118.30

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	2402	2404	2394	11	0
2	B	870	827	812	6	0
3	A	51	27	24	2	0
4	A	44	66	66	1	0
4	B	8	12	12	0	0
5	A	27	22	21	0	0
6	A	12	13	12	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
7	A	20	12	12	0	0
8	A	52	29	0	0	0
9	B	2	0	0	0	0
10	A	181	0	0	1	2
10	B	54	0	0	2	0
All	All	3723	3412	3353	20	2

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 3.

The worst 5 of 20 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)
3:A:7201[A]:GTA:C4B	3:A:7201[A]:GTA:O4B	1.63	1.14
1:A:6968:LYS:NZ	1:A:7001:GLU:OE1	2.00	0.94
1:A:6928:ASP:OD1	1:A:6968:LYS:HE2	1.76	0.84
3:A:7201[A]:GTA:O4B	3:A:7201[A]:GTA:C5B	2.47	0.60
1:A:6847:GLN:OE1	1:A:6995:VAL:HG22	2.09	0.52

All (2) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
10:A:7400:HOH:O	10:A:7400:HOH:O[5_555]	1.90	0.30
10:A:7447:HOH:O	10:A:7474:HOH:O[5_555]	2.08	0.12

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	304/304 (100%)	294 (97%)	10 (3%)	0	100 100

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
2	B	118/140 (84%)	112 (95%)	6 (5%)	0	100	100
All	All	422/444 (95%)	406 (96%)	16 (4%)	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	266/264 (101%)	266 (100%)	0	100	100
2	B	98/113 (87%)	98 (100%)	0	100	100
All	All	364/377 (97%)	364 (100%)	0	100	100

There are no protein residues with a non-rotameric sidechain to report.

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	4301	HIS

5.3.3 RNA [i](#)

There are no RNA molecules in this entry.

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

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

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 20 ligands modelled in this entry, 2 are monoatomic - leaving 18 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
4	EDO	B	4404	-	3,3,3	0.47	0	2,2,2	0.52	0
4	EDO	A	7206	-	3,3,3	0.50	0	2,2,2	0.19	0
6	MES	A	7204	-	12,12,12	1.96	2 (16%)	14,16,16	2.57	5 (35%)
4	EDO	A	7202	-	3,3,3	0.37	0	2,2,2	0.50	0
4	EDO	A	7210	-	3,3,3	0.57	0	2,2,2	0.27	0
4	EDO	B	4403	-	3,3,3	0.52	0	2,2,2	0.82	0
4	EDO	A	7215	-	3,3,3	0.56	0	2,2,2	0.70	0
4	EDO	A	7209	-	3,3,3	0.70	0	2,2,2	0.27	0
4	EDO	A	7207	-	3,3,3	0.54	0	2,2,2	0.57	0
4	EDO	A	7212	-	3,3,3	0.57	0	2,2,2	0.36	0
3	GTA	A	7201[A]	-	46,56,56	4.49	18 (39%)	46,88,88	1.34	5 (10%)
7	EDT	A	7213	-	19,19,19	1.52	4 (21%)	24,24,24	1.05	1 (4%)
4	EDO	A	7211	-	3,3,3	0.65	0	2,2,2	0.29	0
4	EDO	A	7208	-	3,3,3	0.56	0	2,2,2	0.15	0
4	EDO	A	7205	-	3,3,3	0.52	0	2,2,2	0.36	0
8	V9G	A	7216[B]	-	46,57,57	4.89	17 (36%)	46,89,89	1.46	7 (15%)
5	SAM	A	7203	-	24,29,29	4.23	11 (45%)	23,42,42	2.08	9 (39%)
4	EDO	A	7214	-	3,3,3	0.46	0	2,2,2	0.21	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. '2' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	EDO	B	4404	-	-	0/1/1/1	-
4	EDO	A	7206	-	-	1/1/1/1	-
6	MES	A	7204	-	-	1/6/14/14	0/1/1/1
4	EDO	A	7202	-	-	1/1/1/1	-
4	EDO	A	7210	-	-	1/1/1/1	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	EDO	B	4403	-	-	1/1/1/1	-
4	EDO	A	7215	-	-	1/1/1/1	-
4	EDO	A	7209	-	-	1/1/1/1	-
4	EDO	A	7207	-	-	1/1/1/1	-
4	EDO	A	7212	-	-	1/1/1/1	-
3	GTA	A	7201[A]	-	-	7/24/64/64	0/6/6/6
7	EDT	A	7213	-	-	9/21/21/21	-
4	EDO	A	7211	-	-	0/1/1/1	-
4	EDO	A	7208	-	-	1/1/1/1	-
4	EDO	A	7205	-	-	1/1/1/1	-
8	V9G	A	7216[B]	-	-	7/26/94/94	0/6/6/6
5	SAM	A	7203	-	-	2/12/33/33	0/3/3/3
4	EDO	A	7214	-	-	1/1/1/1	-

The worst 5 of 52 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
8	A	7216[B]	V9G	C8-C7	-15.55	1.30	1.53
3	A	7201[A]	GTA	O4A-C1A	15.26	1.62	1.41
8	A	7216[B]	V9G	O3-C7	14.95	1.61	1.41
3	A	7201[A]	GTA	C2A-C1A	-14.63	1.31	1.53
8	A	7216[B]	V9G	O15-C16	14.25	1.61	1.41

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
6	A	7204	MES	O2S-S-C8	6.84	115.15	106.92
3	A	7201[A]	GTA	N3C-C2C-N1C	-4.60	121.48	128.68
8	A	7216[B]	V9G	N10-C20-N9	-4.55	121.57	128.68
5	A	7203	SAM	N3-C2-N1	-3.97	122.47	128.68
6	A	7204	MES	O1S-S-C8	3.75	111.43	106.92

There are no chirality outliers.

5 of 37 torsion outliers are listed below:

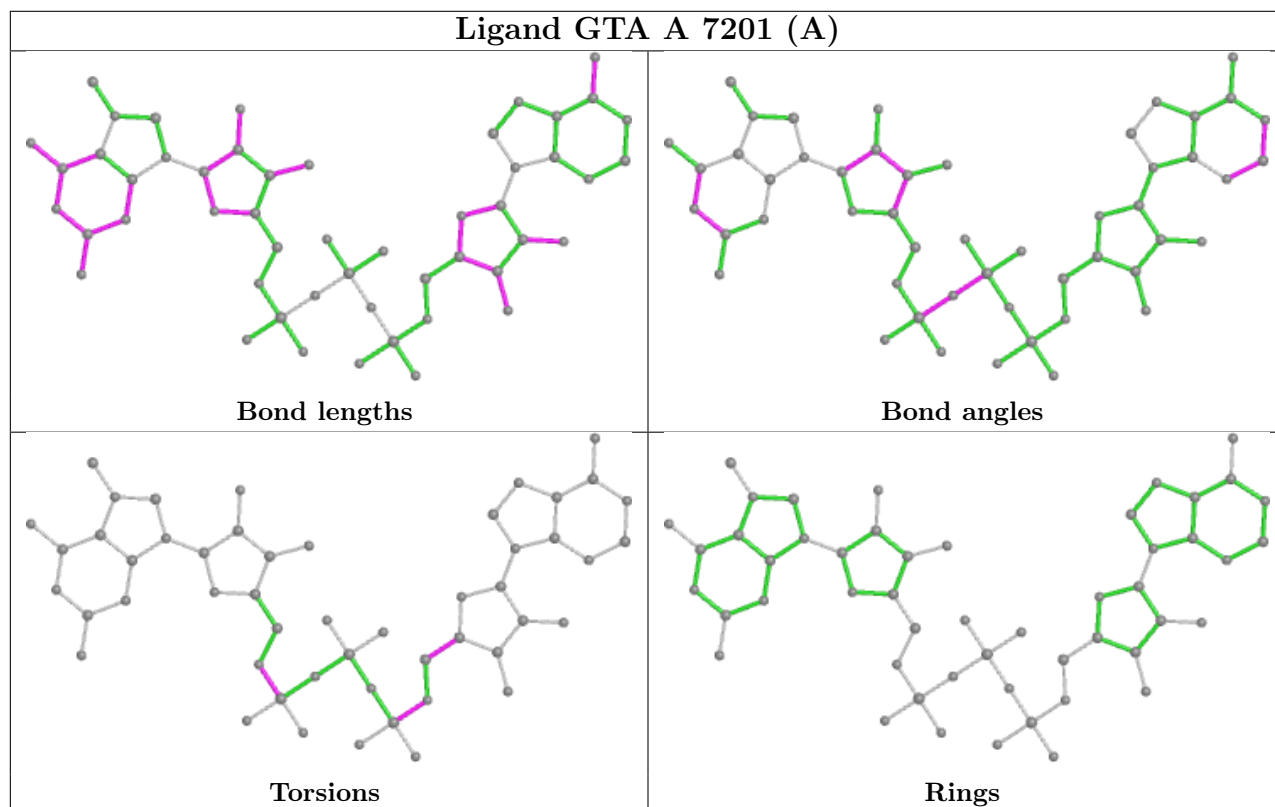
Mol	Chain	Res	Type	Atoms
3	A	7201[A]	GTA	C5A-O15-P1-O11
3	A	7201[A]	GTA	C5A-O15-P1-O13
3	A	7201[A]	GTA	C5B-O33-P3-O23
7	A	7213	EDT	O15-C10-C9-N8
8	A	7216[B]	V9G	O14-C12-C13-O15

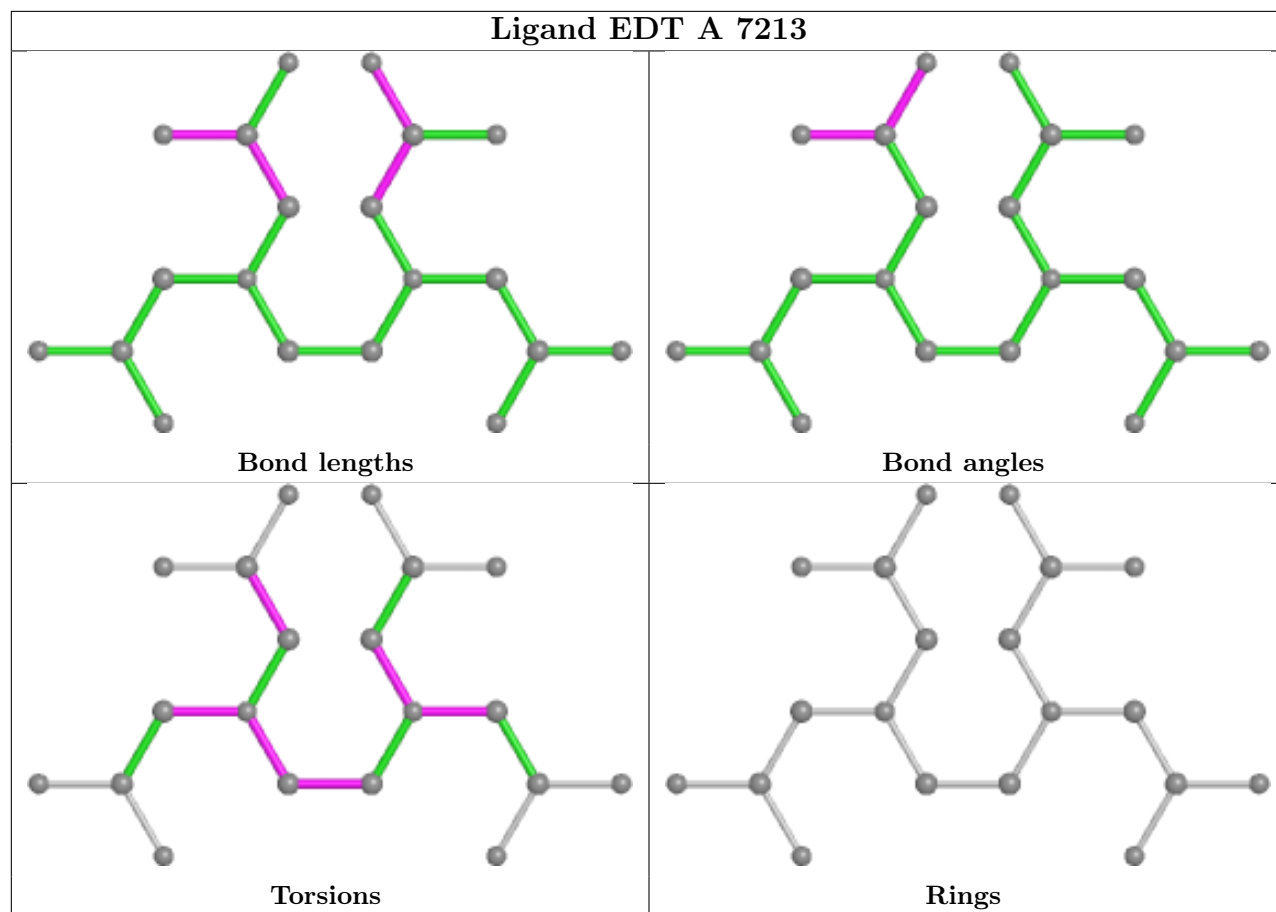
There are no ring outliers.

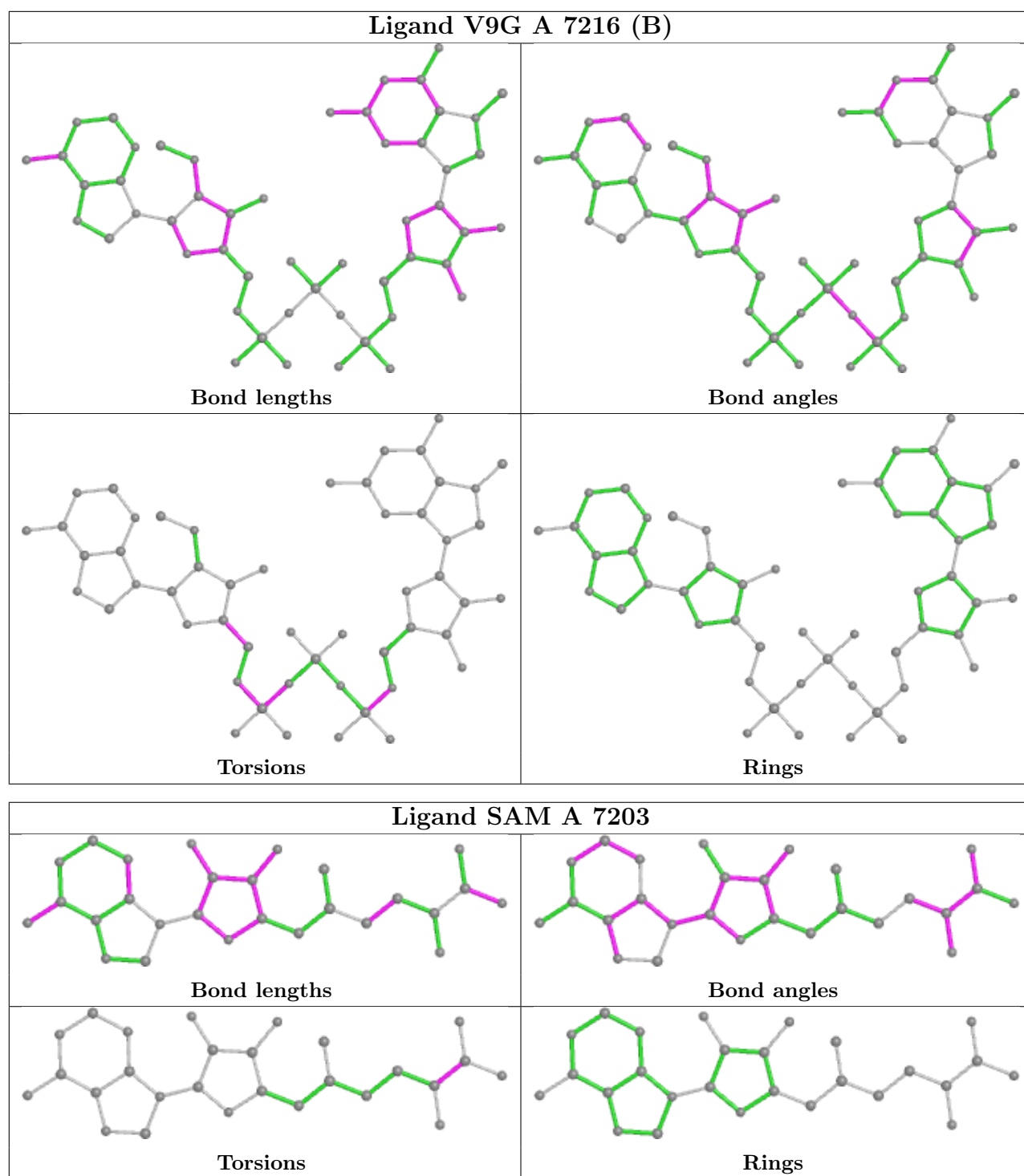
2 monomers are involved in 3 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	7201[A]	GTA	2	0
4	A	7211	EDO	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 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

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.

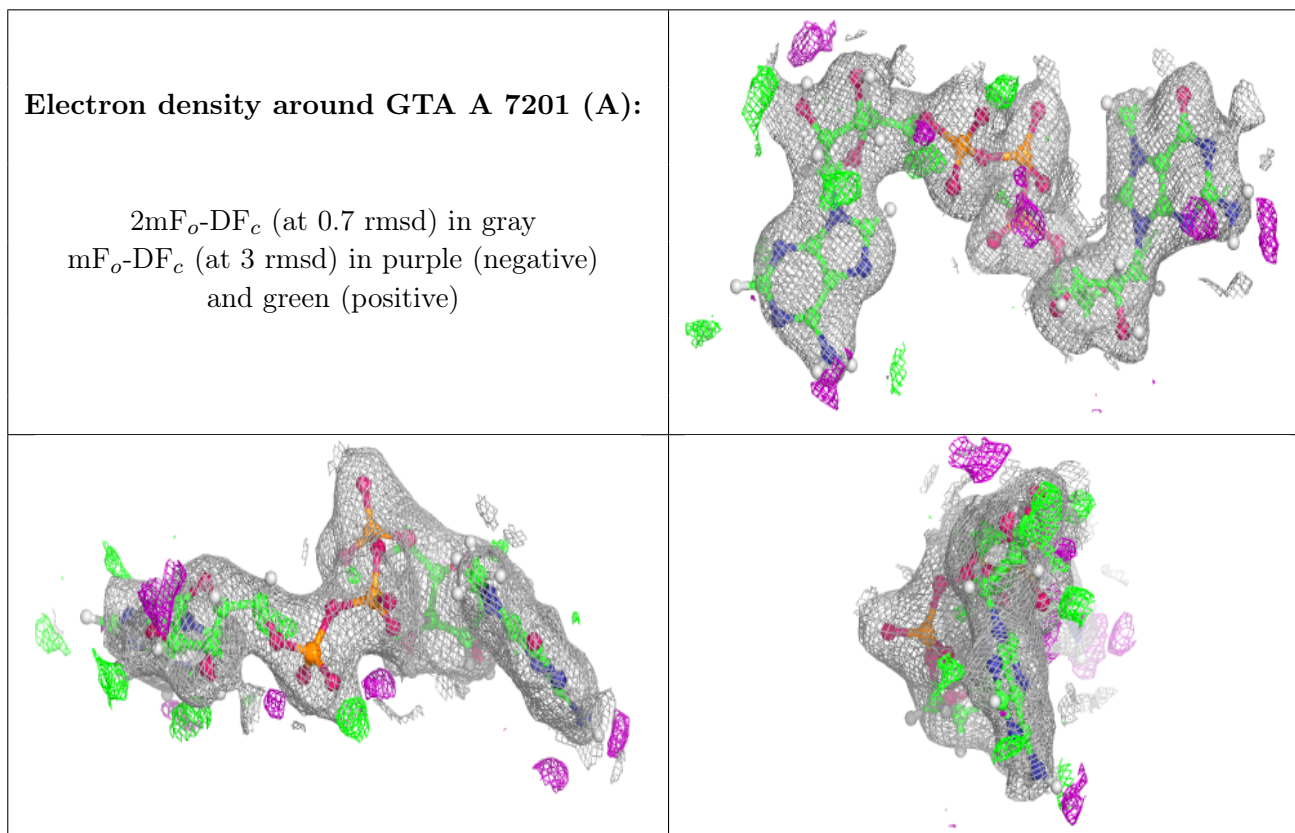
6.3 Carbohydrates [i](#)

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

6.4 Ligands [i](#)

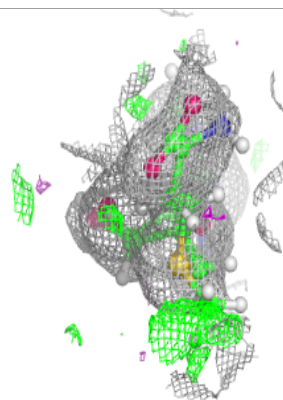
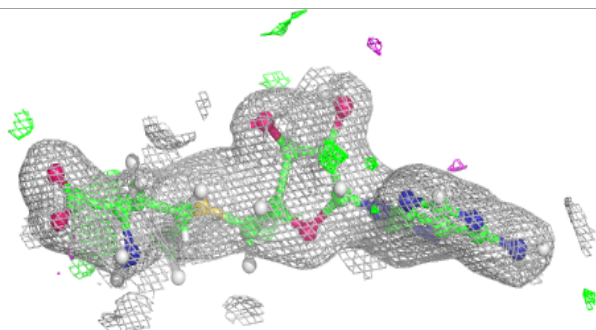
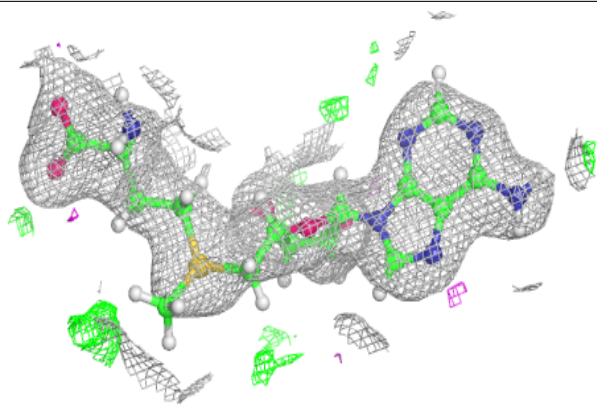
Unable to reproduce the depositors R factor - this section is therefore empty.

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.



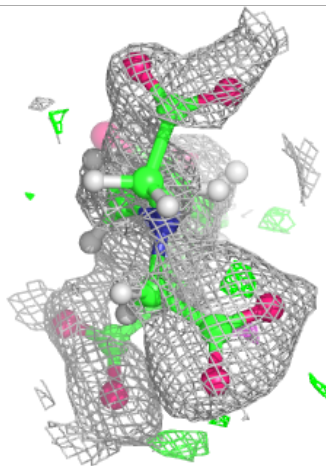
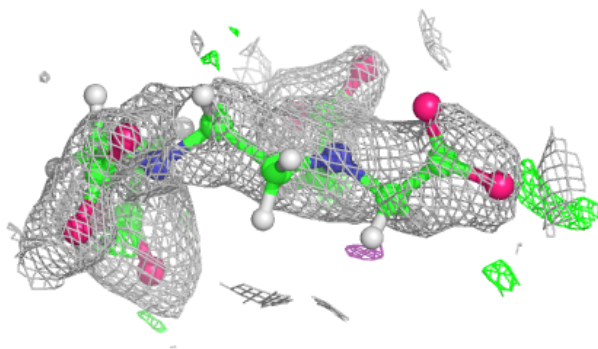
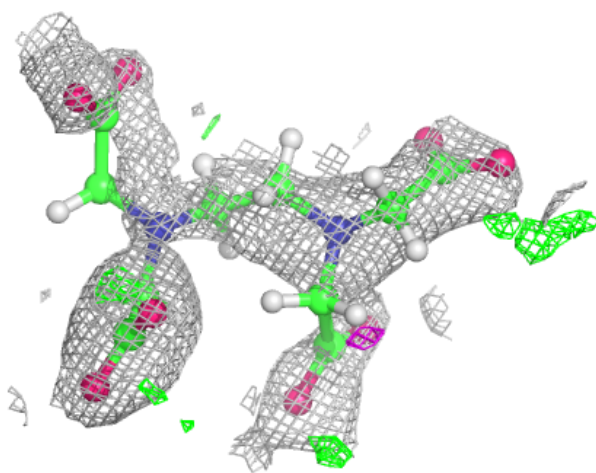
Electron density around SAM A 7203:

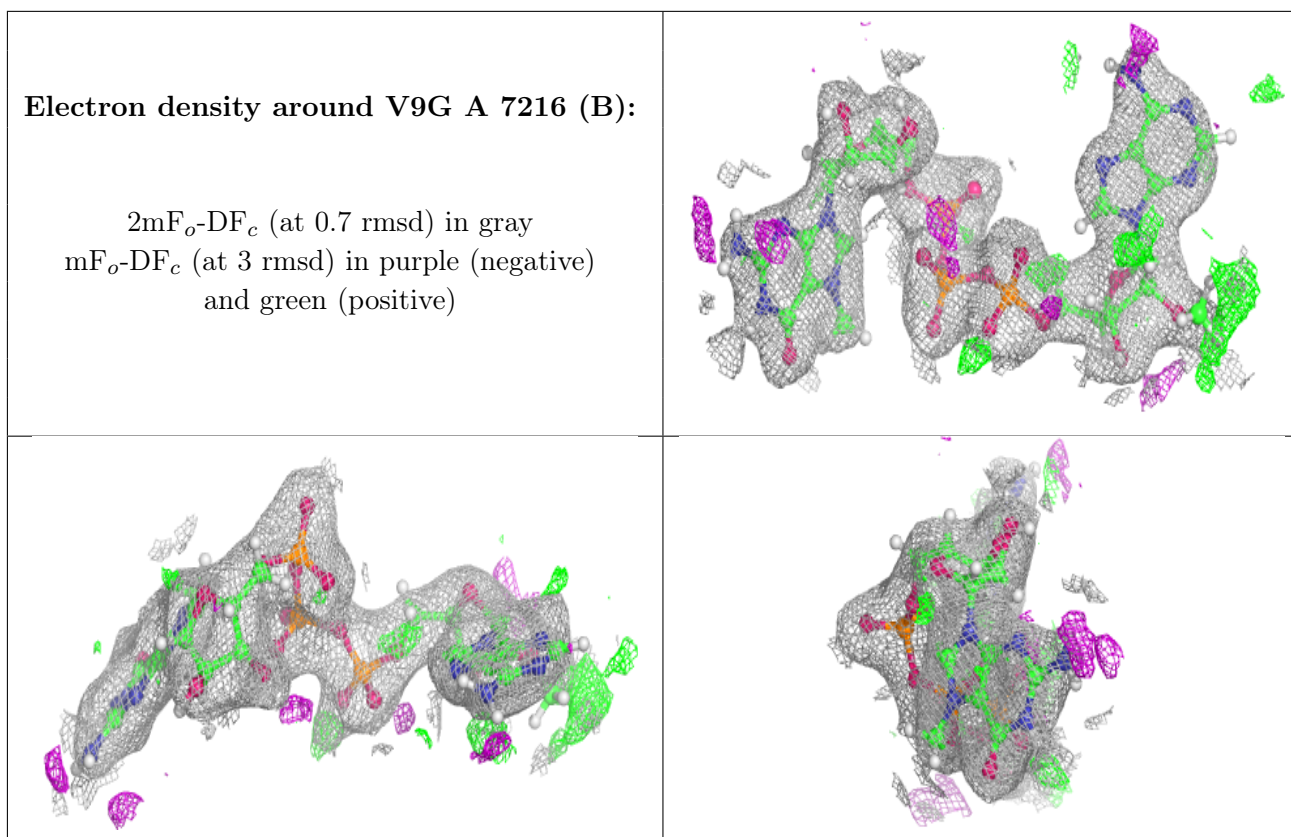
$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around EDT A 7213:

$2mF_o-DF_c$ (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.