



Full wwPDB X-ray Structure Validation Report ⓘ

Oct 14, 2023 – 07:43 PM EDT

PDB ID : 7MXX
Title : Crystal structure of human exonuclease 1 Exo1 (R92A) in complex with 5' flap DNA (uf4)
Authors : Shi, Y.; Beese, L.S.
Deposited on : 2021-05-19
Resolution : 2.85 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 : 4.02b-467
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

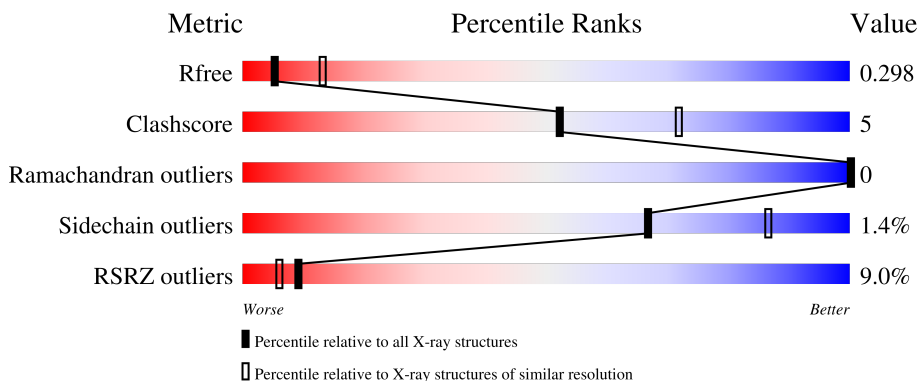
1 Overall quality at a glance i

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.85 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	3168 (2.90-2.82)
Clashscore	141614	3438 (2.90-2.82)
Ramachandran outliers	138981	3348 (2.90-2.82)
Sidechain outliers	138945	3351 (2.90-2.82)
RSRZ outliers	127900	3103 (2.90-2.82)

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	Z	352	
2	A	14	
3	B	14	

2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 3229 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 Exonuclease 1.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	Z	344	2703	1721	467	497	18	0	0	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
Z	92	ALA	ARG	engineered mutation	UNP Q9UQ84

- Molecule 2 is a DNA chain called DNA (5'-D(*CP*GP*CP*TP*AP*GP*TP*GP*AP*C)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
2	A	10	202	97	38	58	9	0	0	0

- Molecule 3 is a DNA chain called DNA (5'-D(P*TP*CP*TP*CP*GP*TP*CP*AP*CP*TP*AP*GP*CP*G)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	P			
3	B	14	284	135	48	87	14	0	0	0

- Molecule 4 is MANGANESE (II) ION (three-letter code: MN) (formula: Mn) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	Z	4	Total	Mn	0	0
			4	4		

- Molecule 5 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	Z	1	Total Ca 1 1	0	0

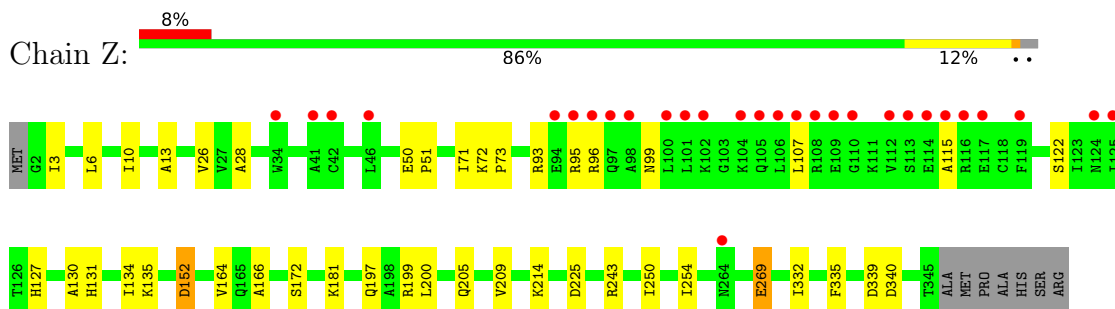
- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	Z	31	Total O 31 31	0	0
6	B	4	Total O 4 4	0	0

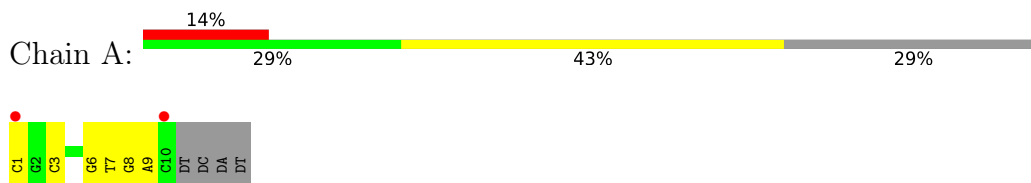
3 Residue-property plots [i](#)

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 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.

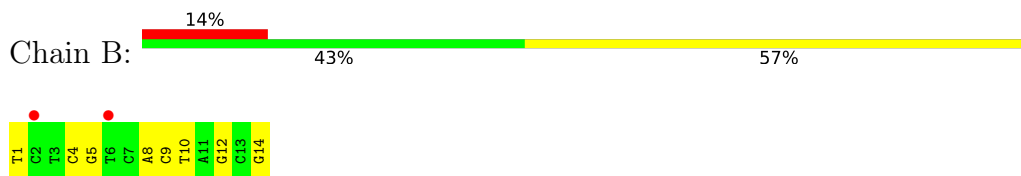
- Molecule 1: Exonuclease 1



- Molecule 2: DNA (5'-D(*CP*GP*CP*TP*AP*GP*TP*GP*AP*C)-3')



- Molecule 3: DNA (5'-D(P*TP*CP*TP*CP*GP*TP*CP*AP*CP*TP*AP*GP*CP*G)-3')



4 Data and refinement statistics

Property	Value	Source
Space group	P 43 21 2	Depositor
Cell constants a, b, c, α , β , γ	70.89Å 70.89Å 182.46Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	32.45 – 2.85 48.33 – 2.85	Depositor EDS
% Data completeness (in resolution range)	91.6 (32.45-2.85) 85.8 (48.33-2.85)	Depositor EDS
R_{merge}	0.09	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.07 (at 2.86Å)	Xtrriage
Refinement program	PHENIX 1.14_3260	Depositor
R, R_{free}	0.258 , 0.298 0.258 , 0.298	Depositor DCC
R_{free} test set	866 reflections (8.18%)	wwPDB-VP
Wilson B-factor (Å ²)	73.9	Xtrriage
Anisotropy	0.513	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 53.0	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	No twinning to report.	Xtrriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	3229	wwPDB-VP
Average B, all atoms (Å ²)	102.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.17% 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: MN, CA

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	Z	0.23	0/2748	0.35	0/3703
2	A	0.51	0/226	0.87	0/347
3	B	0.82	1/316 (0.3%)	0.99	0/483
All	All	0.36	1/3290 (0.0%)	0.51	0/4533

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	1	DT	OP3-P	-10.59	1.48	1.61

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	Z	2703	0	2759	22	0
2	A	202	0	114	8	0
3	B	284	0	159	10	0
4	Z	4	0	0	0	0
5	Z	1	0	0	0	0
6	B	4	0	0	0	0
6	Z	31	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	3229	0	3032	33	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 5.

All (33) 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)
2:A:3:DC:H42	3:B:12:DG:H1	1.24	0.83
2:A:8:DG:H2''	2:A:9:DA:H5''	1.75	0.68
2:A:7:DT:H3	3:B:8:DA:H61	1.43	0.66
2:A:1:DC:H42	3:B:14:DG:H1	1.46	0.64
1:Z:6:LEU:O	1:Z:10:ILE:HG12	2.03	0.59
1:Z:107:LEU:HB3	1:Z:115:ALA:HA	1.84	0.58
2:A:6:DG:H1	3:B:9:DC:H42	1.54	0.55
1:Z:209:VAL:HG13	1:Z:214:LYS:HB3	1.89	0.55
1:Z:99:ASN:HB2	1:Z:122:SER:HB3	1.89	0.54
1:Z:93:ARG:HE	1:Z:96:ARG:HH21	1.56	0.54
1:Z:127:HIS:CE1	1:Z:332:ILE:HG13	2.43	0.53
1:Z:13:ALA:O	1:Z:199:ARG:NH1	2.40	0.53
2:A:3:DC:N4	3:B:12:DG:H1	2.00	0.53
1:Z:197:GLN:HA	1:Z:200:LEU:HD13	1.92	0.52
1:Z:339:ASP:OD1	1:Z:340:ASP:N	2.42	0.51
3:B:4:DC:H2''	3:B:5:DG:H8	1.77	0.49
3:B:4:DC:H2''	3:B:5:DG:O5'	2.14	0.48
1:Z:250:ILE:O	1:Z:254:ILE:HG12	2.14	0.48
1:Z:28:ALA:HB2	1:Z:164:VAL:HG11	1.98	0.45
1:Z:3:ILE:H	1:Z:172:SER:HB3	1.82	0.44
1:Z:26:VAL:HG22	1:Z:72:LYS:HD3	1.98	0.44
1:Z:131:HIS:CD2	1:Z:135:LYS:HE3	2.52	0.44
2:A:7:DT:H3	3:B:8:DA:N6	2.12	0.44
1:Z:95:ARG:O	1:Z:99:ASN:ND2	2.49	0.43
1:Z:152:ASP:OD2	1:Z:152:ASP:N	2.52	0.43
1:Z:71:ILE:O	1:Z:73:PRO:HD3	2.19	0.43
2:A:1:DC:N4	3:B:14:DG:H1	2.16	0.43
1:Z:269:GLU:H	1:Z:269:GLU:CD	2.21	0.43
1:Z:50:GLU:HA	1:Z:51:PRO:HD3	1.87	0.42
1:Z:205:GLN:O	1:Z:243:ARG:NH1	2.52	0.41
1:Z:166:ALA:HA	1:Z:181:LYS:HB2	2.03	0.41
1:Z:130:ALA:O	1:Z:134:ILE:HG13	2.21	0.41
3:B:9:DC:H2''	3:B:10:DT:H5'	2.02	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	Z	342/352 (97%)	322 (94%)	20 (6%)	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	Z	291/297 (98%)	287 (99%)	4 (1%)	67 86

All (4) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	Z	152	ASP
1	Z	225	ASP
1	Z	269	GLU
1	Z	335	PHE

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

Mol	Chain	Res	Type
1	Z	69	HIS

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Mol	Chain	Res	Type
1	Z	188	GLN
1	Z	205	GLN

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 5 ligands modelled in this entry, 5 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

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	Z	344/352 (97%)	0.72	29 (8%) 11 7	58, 84, 155, 183	0
2	A	10/14 (71%)	1.01	2 (20%) 1 0	107, 143, 192, 200	0
3	B	14/14 (100%)	0.86	2 (14%) 2 2	147, 156, 202, 214	0
All	All	368/380 (96%)	0.73	33 (8%) 9 6	58, 86, 163, 214	0

All (33) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	Z	101	LEU	8.6
1	Z	106	LEU	7.7
1	Z	119	PHE	7.0
1	Z	98	ALA	5.6
1	Z	46	LEU	5.3
1	Z	107	LEU	4.8
1	Z	102	LYS	4.7
1	Z	114	GLU	4.6
1	Z	100	LEU	4.6
1	Z	116	ARG	4.4
1	Z	97	GLN	4.3
2	A	10	DC	4.1
1	Z	110	GLY	4.1
1	Z	113	SER	3.8
1	Z	105	GLN	3.8
1	Z	96	ARG	3.8
1	Z	42	CYS	3.5
1	Z	104	LYS	3.5
1	Z	125	ILE	3.5
1	Z	112	VAL	3.1
1	Z	34	TRP	2.9
1	Z	264	ASN	2.8
1	Z	94	GLU	2.7

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Mol	Chain	Res	Type	RSRZ
1	Z	95	ARG	2.7
3	B	6	DT	2.7
1	Z	41	ALA	2.6
3	B	2	DC	2.6
2	A	1	DC	2.5
1	Z	108	ARG	2.5
1	Z	117	GLU	2.4
1	Z	124	ASN	2.2
1	Z	115	ALA	2.2
1	Z	109	GLU	2.1

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 monosaccharides in this entry.

6.4 Ligands [i](#)

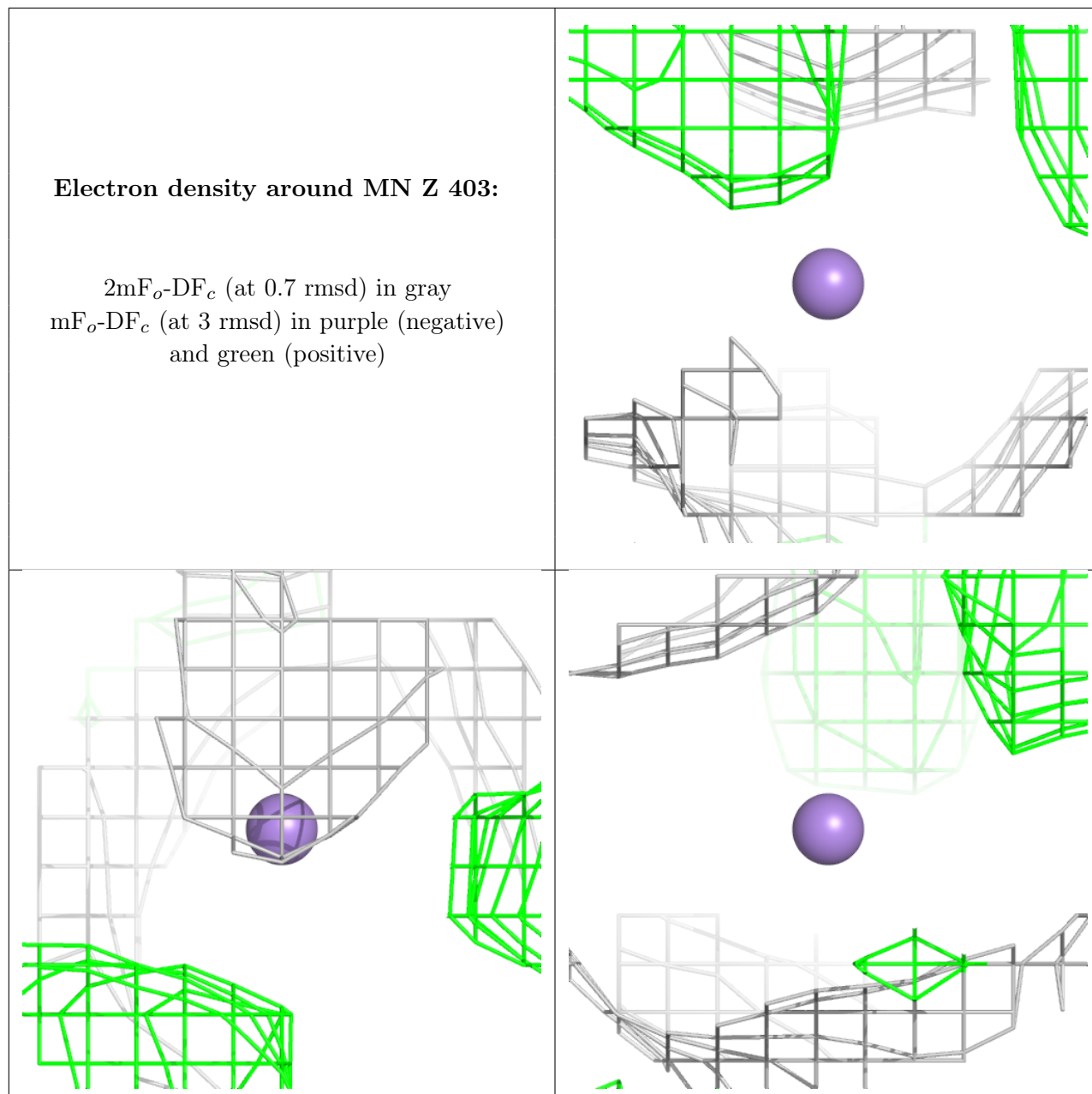
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists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

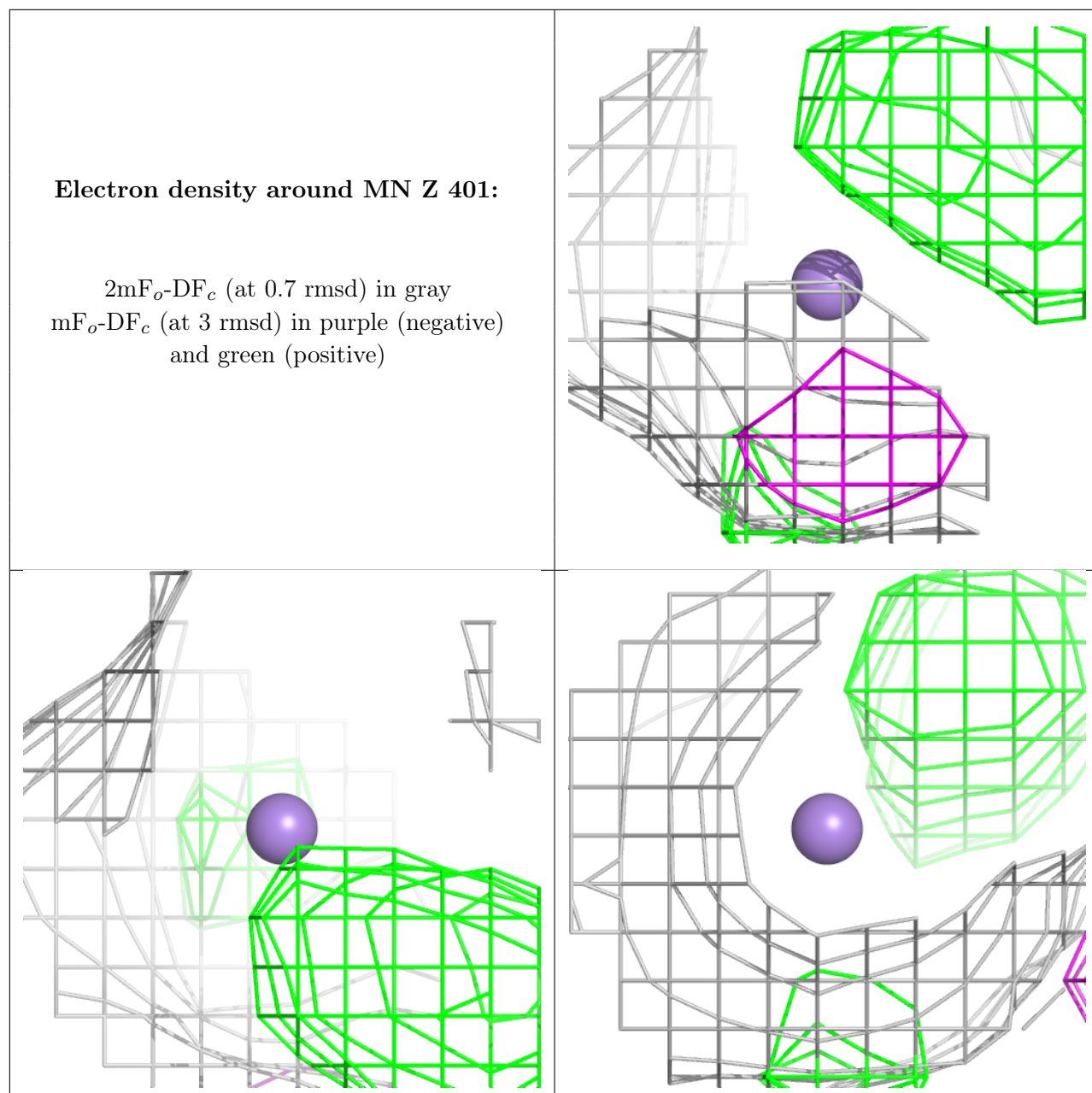
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
5	CA	Z	405	1/1	0.81	0.24	102,102,102,102	0
4	MN	Z	403	1/1	0.91	0.10	98,98,98,98	0
4	MN	Z	401	1/1	0.95	0.22	69,69,69,69	0
4	MN	Z	404	1/1	0.96	0.15	80,80,80,80	0
4	MN	Z	402	1/1	0.97	0.19	64,64,64,64	0

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 MN Z 403:

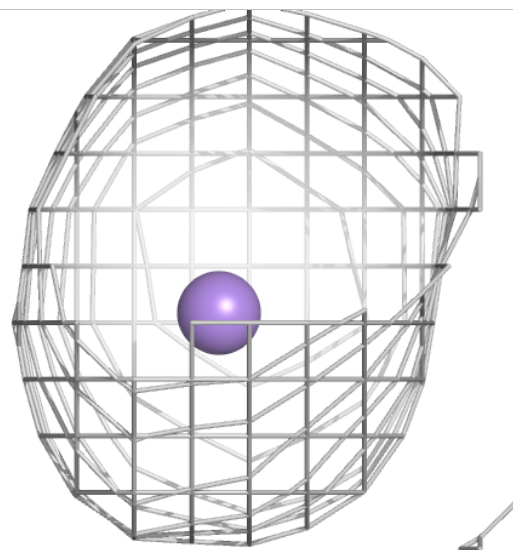
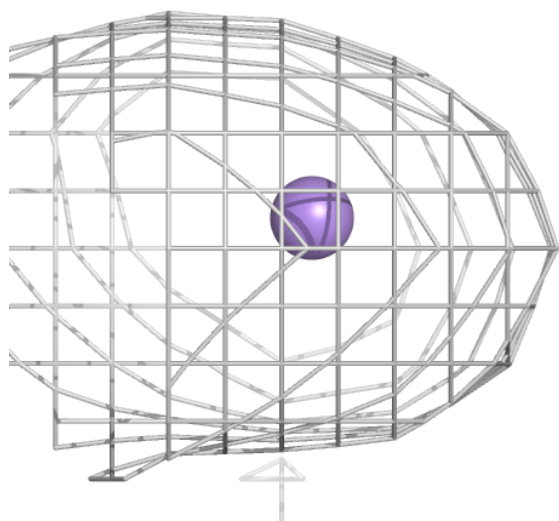
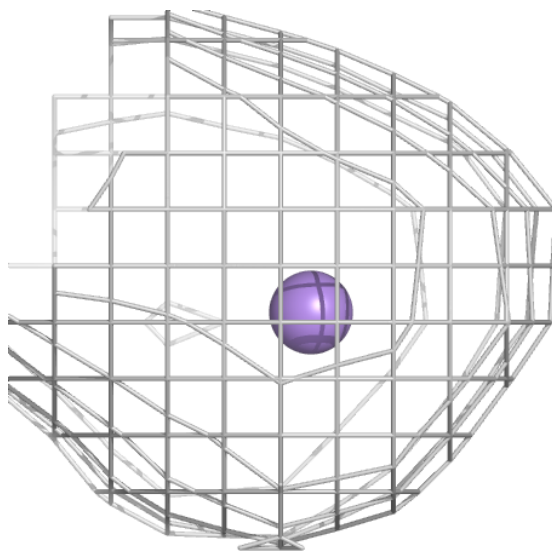
$2mF_o-DF_c$ (at 0.7 rmsd) in gray
 mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)

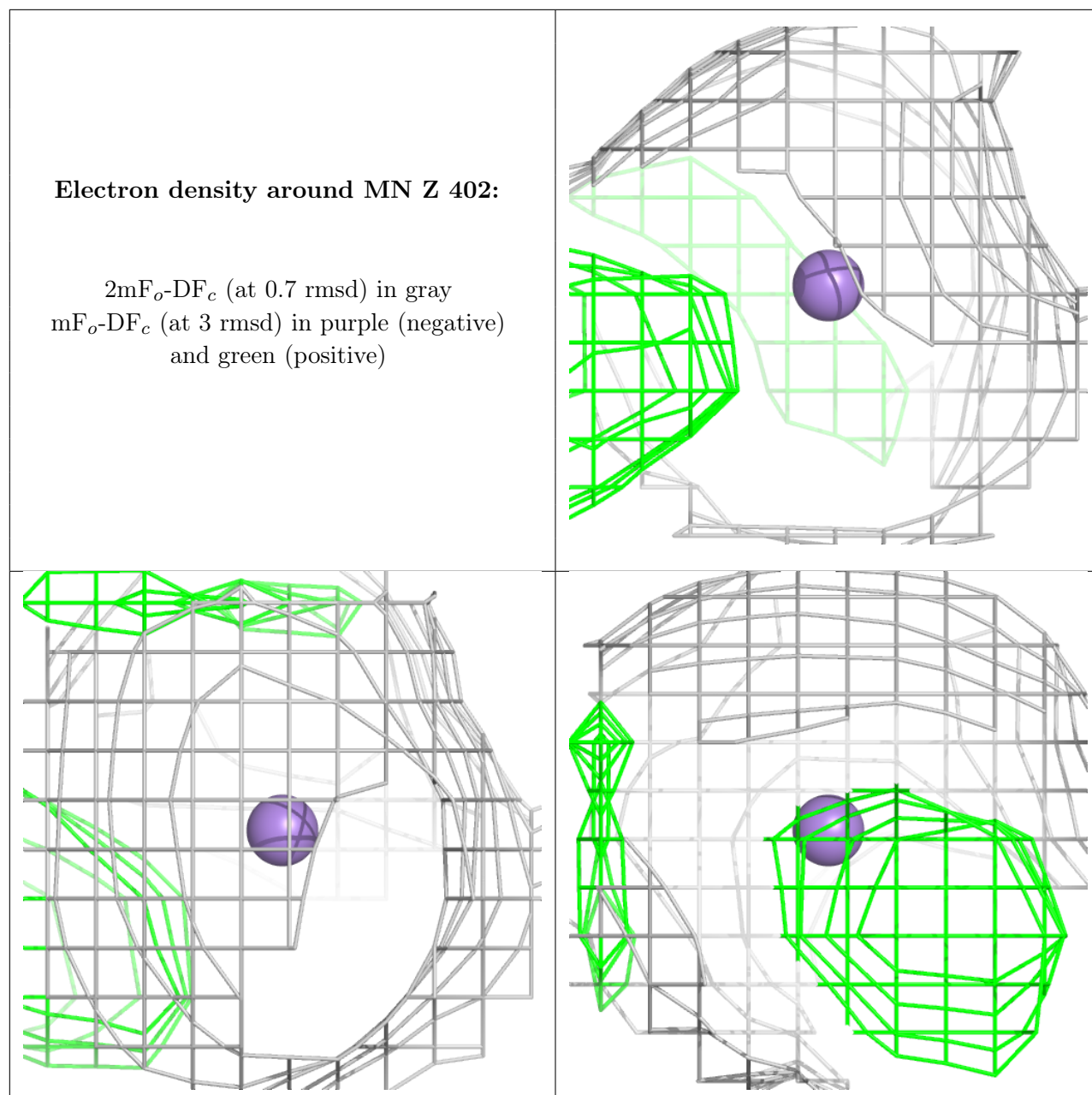




Electron density around MN Z 404:

$2mF_o-DF_c$ (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.