



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 12, 2026 – 01:07 PM UTC

PDB ID : 8UMZ / pdb_00008umz
Title : Crystal Structure of Engineered Mouse Protocadherin-15 EC4-EC7 Connection
Authors : De-la-Torre, P.; Martinez-Perez, K.; Indzhykulian, A.
Deposited on : 2023-10-18
Resolution : 1.63 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	:	4-5-2 with Phenix2.0
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.010 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.49

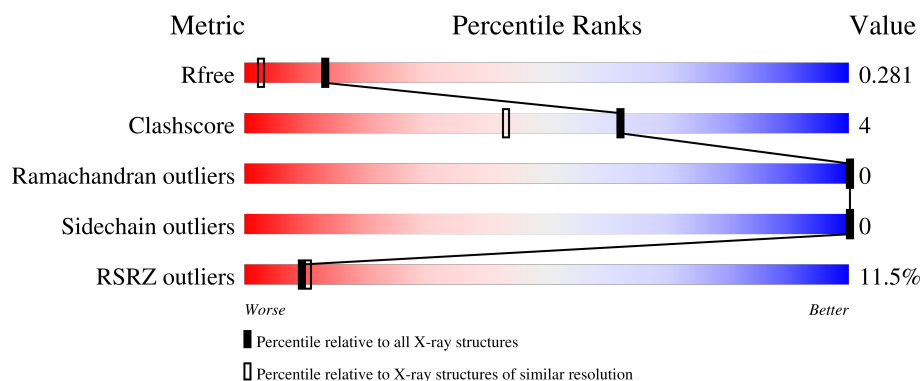
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 1.63 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}	180053	1141 (1.64-1.64)
Clashscore	190562	1171 (1.64-1.64)
Ramachandran outliers	187476	1151 (1.64-1.64)
Sidechain outliers	187428	1150 (1.64-1.64)
RSRZ outliers	180081	1141 (1.64-1.64)

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	A	230	3% 86% 11% .
1	B	230	19% 85% 10% .

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 3829 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 Protocadherin-15 EC4-EC7.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	223	Total	C	N	O	S	0	5	0
			1790	1135	296	357	2			
1	B	221	Total	C	N	O	S	0	4	0
			1765	1120	290	353	2			

There are 18 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	365	MET	-	initiating methionine	UNP Q99PJ1
A	587	LEU	-	expression tag	UNP Q99PJ1
A	588	GLU	-	expression tag	UNP Q99PJ1
A	589	HIS	-	expression tag	UNP Q99PJ1
A	590	HIS	-	expression tag	UNP Q99PJ1
A	591	HIS	-	expression tag	UNP Q99PJ1
A	592	HIS	-	expression tag	UNP Q99PJ1
A	593	HIS	-	expression tag	UNP Q99PJ1
A	594	HIS	-	expression tag	UNP Q99PJ1
B	365	MET	-	initiating methionine	UNP Q99PJ1
B	587	LEU	-	expression tag	UNP Q99PJ1
B	588	GLU	-	expression tag	UNP Q99PJ1
B	589	HIS	-	expression tag	UNP Q99PJ1
B	590	HIS	-	expression tag	UNP Q99PJ1
B	591	HIS	-	expression tag	UNP Q99PJ1
B	592	HIS	-	expression tag	UNP Q99PJ1
B	593	HIS	-	expression tag	UNP Q99PJ1
B	594	HIS	-	expression tag	UNP Q99PJ1

- Molecule 2 is CALCIUM ION (CCD ID: CA) (formula: Ca) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	5	Total Ca 5 5	0	0
2	B	5	Total Ca 5 5	0	0

- Molecule 3 is SODIUM ION (CCD ID: NA) (formula: Na) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Na 1 1	0	0
3	B	1	Total Na 1 1	0	0

- Molecule 4 is water.

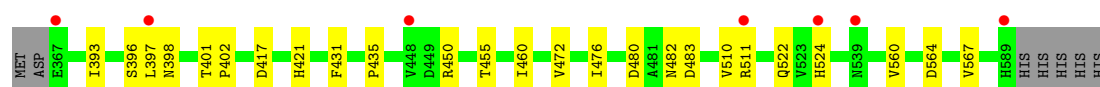
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	171	Total O 171 171	0	0
4	B	91	Total O 91 91	0	0

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.

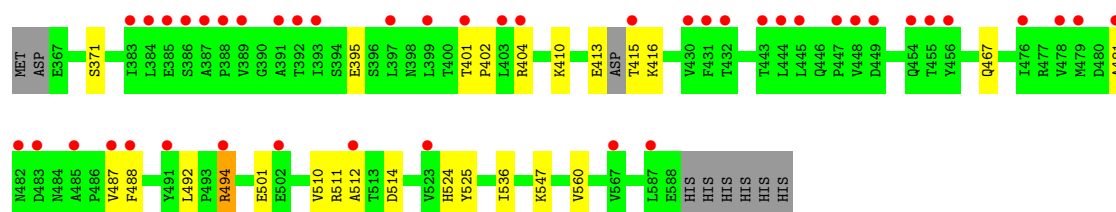
• Molecule 1: Protocadherin-15 EC4-EC7

Chain A: 



• Molecule 1: Protocadherin-15 EC4-EC7

Chain B: 



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	49.28Å 50.61Å 88.26Å 90.00° 94.01° 90.00°	Depositor
Resolution (Å)	49.20 – 1.63 49.20 – 1.63	Depositor EDS
% Data completeness (in resolution range)	92.9 (49.20-1.63) 93.1 (49.20-1.63)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.15 (at 1.63Å)	Xtriage
Refinement program	REFMAC 5.8.0419	Depositor
R, R_{free}	0.223 , 0.274 0.230 , 0.281	Depositor DCC
R_{free} test set	2561 reflections (4.70%)	wwPDB-VP
Wilson B-factor (Å ²)	19.6	Xtriage
Anisotropy	0.607	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.34 , 37.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.47$, $\langle L^2 \rangle = 0.30$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.94	EDS
Total number of atoms	3829	wwPDB-VP
Average B, all atoms (Å ²)	25.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 8.71% 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

5.1 Standard geometry

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

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	0.81	0/1841	1.16	6/2522 (0.2%)
1	B	0.72	0/1810	1.12	3/2478 (0.1%)
All	All	0.76	0/3651	1.14	9/5000 (0.2%)

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
1	B	0	3
All	All	0	4

There are no bond length outliers.

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	417	ASP	CA-CB-CG	5.94	118.54	112.60
1	A	483	ASP	CA-CB-CG	5.38	117.98	112.60
1	A	431	PHE	CA-CB-CG	5.34	119.14	113.80
1	A	455	THR	CA-CB-OG1	-5.24	101.73	109.60
1	B	524	HIS	CA-CB-CG	5.19	118.99	113.80
1	B	481	ALA	CA-C-O	-5.14	115.35	121.16
1	B	488	PHE	CB-CA-C	5.12	118.41	109.65
1	A	435	PRO	N-CA-C	5.02	121.05	114.27
1	A	482	ASN	CA-CB-CG	-5.00	107.60	112.60

There are no chirality outliers.

All (4) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	511	ARG	Sidechain
1	B	404	ARG	Sidechain
1	B	494	ARG	Sidechain
1	B	511	ARG	Sidechain

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	1790	0	1742	16	0
1	B	1765	0	1723	14	0
2	A	5	0	0	0	0
2	B	5	0	0	0	0
3	A	1	0	0	0	0
3	B	1	0	0	0	0
4	A	171	0	0	2	0
4	B	91	0	0	2	0
All	All	3829	0	3465	29	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 4.

All (29) 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:A:460:ILE:HG23	1:A:472:VAL:CG1	2.20	0.71
1:A:460:ILE:CG2	1:A:472:VAL:HG13	2.27	0.64
1:A:401[A]:THR:CG2	1:A:402:PRO:HD2	2.29	0.62
1:A:401[A]:THR:HG23	1:A:402:PRO:HD2	1.85	0.57
1:B:487:VAL:HA	4:B:778:HOH:O	2.04	0.57
1:A:567:VAL:HG22	4:A:834:HOH:O	2.05	0.56
1:B:514:ASP:O	4:B:701:HOH:O	2.18	0.56
1:A:522:GLN:O	1:A:564:ASP:HA	2.06	0.55
1:A:460:ILE:HG23	1:A:472:VAL:HG12	1.89	0.55
1:B:492:LEU:O	1:B:494:ARG:NH1	2.37	0.52
1:B:525:TYR:HB3	1:B:536:ILE:HD13	1.91	0.52
1:B:510:VAL:HG21	1:B:560:VAL:HG11	1.93	0.50

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:B:401[A]:THR:OG1	1:B:402:PRO:HD2	2.12	0.49
1:A:460:ILE:CG2	1:A:472:VAL:CG1	2.85	0.49
1:B:415:THR:O	1:B:415:THR:HG23	2.13	0.49
1:A:421:HIS:HE1	4:A:852:HOH:O	1.96	0.49
1:A:393:ILE:HG21	1:A:476[B]:ILE:HD12	1.95	0.48
1:B:501:GLU:HA	1:B:547:LYS:HB3	1.96	0.48
1:B:395:GLU:OE2	1:B:401[A]:THR:HG23	2.16	0.45
1:A:460:ILE:HG22	1:A:472:VAL:HG13	1.97	0.45
1:B:413:GLU:HB2	1:B:416:LYS:HG2	2.00	0.43
1:A:510:VAL:HG21	1:A:560:VAL:HG11	2.00	0.43
1:B:413:GLU:O	1:B:415:THR:HA	2.19	0.43
1:B:487:VAL:O	1:B:512:ALA:HA	2.19	0.43
1:A:396:SER:OG	1:A:398:ASN:OD1	2.37	0.43
1:A:397:LEU:C	1:A:397:LEU:HD12	2.44	0.42
1:A:450:ARG:HD3	1:A:480:ASP:HB2	2.02	0.42
1:A:524[A]:HIS:CE1	1:B:410:LYS:HD2	2.56	0.40
1:B:371:SER:HB3	1:B:467:GLN:HG3	2.04	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	226/230 (98%)	224 (99%)	2 (1%)	0	100	100
1	B	221/230 (96%)	217 (98%)	4 (2%)	0	100	100
All	All	447/460 (97%)	441 (99%)	6 (1%)	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	204/206 (99%)	204 (100%)	0	100	100
1	B	201/206 (98%)	201 (100%)	0	100	100
All	All	405/412 (98%)	405 (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 (7) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	421	HIS
1	A	484	ASN
1	A	520	ASN
1	A	522	GLN
1	B	380	GLN
1	B	446	GLN
1	B	484	ASN

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 oligosaccharides in this entry.

5.6 Ligand geometry

Of 12 ligands modelled in this entry, 12 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

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

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	A	223/230 (96%)	0.46	7 (3%) 51 56	10, 19, 29, 57	5 (2%)
1	B	221/230 (96%)	1.35	44 (19%) 3 4	13, 28, 39, 51	4 (1%)
All	All	444/460 (96%)	0.91	51 (11%) 9 10	10, 24, 37, 57	9 (2%)

All (51) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	391	ALA	5.1
1	A	589	HIS	4.7
1	B	384	LEU	4.0
1	B	448	VAL	3.9
1	B	401[A]	THR	3.9
1	B	397	LEU	3.8
1	B	387	ALA	3.7
1	B	481	ALA	3.7
1	B	399	LEU	3.7
1	B	444	LEU	3.6
1	B	431	PHE	3.3
1	B	383	ILE	3.2
1	B	478	VAL	3.0
1	B	415	THR	2.9
1	B	491	TYR	2.9
1	B	482	ASN	2.8
1	A	397	LEU	2.8
1	B	502	GLU	2.7
1	B	456	TYR	2.7
1	B	485	ALA	2.7
1	B	523	VAL	2.7
1	B	386	SER	2.6
1	B	479	MET	2.6
1	B	494	ARG	2.6

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Mol	Chain	Res	Type	RSRZ
1	B	476[A]	ILE	2.6
1	B	388	PRO	2.6
1	B	432	THR	2.5
1	B	487	VAL	2.5
1	B	385	GLU	2.5
1	B	445	LEU	2.4
1	B	455	THR	2.4
1	B	567	VAL	2.4
1	B	447	PRO	2.4
1	B	404	ARG	2.4
1	A	524[A]	HIS	2.3
1	B	488	PHE	2.3
1	B	430	VAL	2.3
1	A	539	ASN	2.3
1	A	448	VAL	2.3
1	B	392	THR	2.2
1	A	511	ARG	2.2
1	B	393	ILE	2.2
1	B	454	GLN	2.2
1	B	403	LEU	2.2
1	B	483	ASP	2.1
1	B	389	VAL	2.1
1	B	449	ASP	2.1
1	B	512	ALA	2.1
1	B	587	LEU	2.1
1	B	443	THR	2.1
1	A	367	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 oligosaccharides 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,

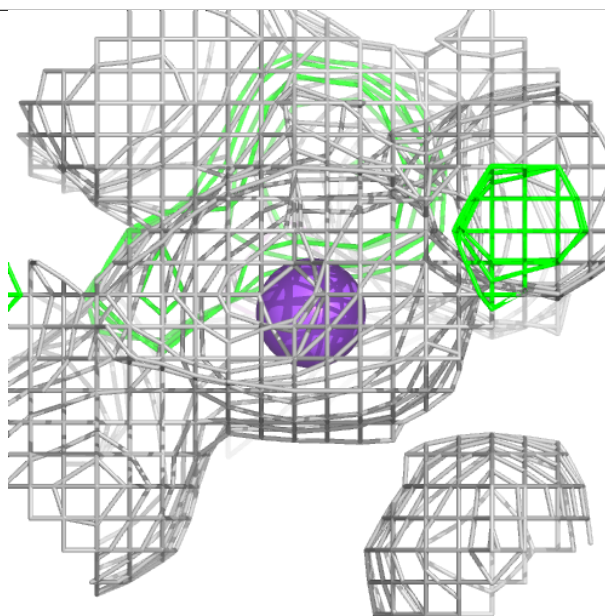
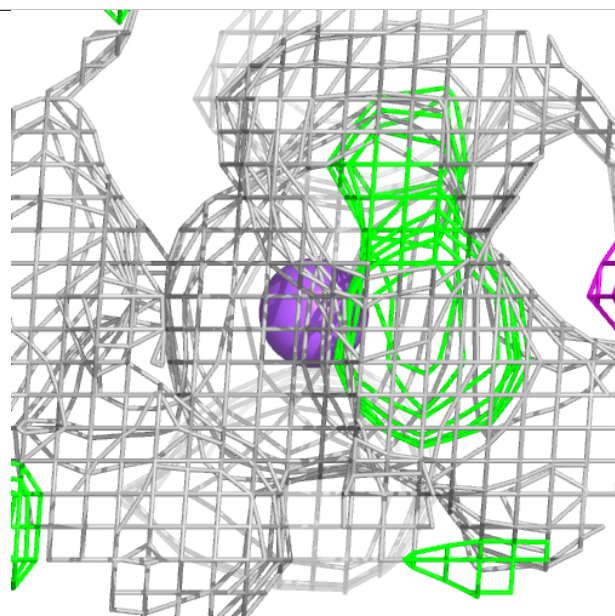
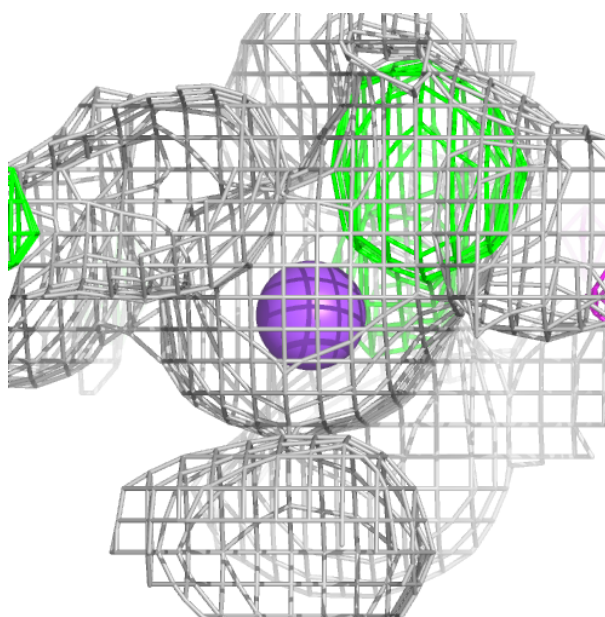
median, 95th percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
3	NA	A	606	1/1	0.93	0.06	15,15,15,15	0
2	CA	A	605	1/1	0.97	0.04	16,16,16,16	0
2	CA	B	602	1/1	0.97	0.07	27,27,27,27	0
2	CA	B	603	1/1	0.97	0.07	25,25,25,25	0
2	CA	B	605	1/1	0.97	0.06	27,27,27,27	0
2	CA	A	602	1/1	0.97	0.06	21,21,21,21	0
2	CA	B	604	1/1	0.98	0.05	26,26,26,26	0
3	NA	B	606	1/1	0.98	0.04	17,17,17,17	0
2	CA	A	601	1/1	0.99	0.03	18,18,18,18	0
2	CA	B	601	1/1	0.99	0.04	25,25,25,25	0
2	CA	A	603	1/1	0.99	0.03	17,17,17,17	0
2	CA	A	604	1/1	0.99	0.03	17,17,17,17	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.

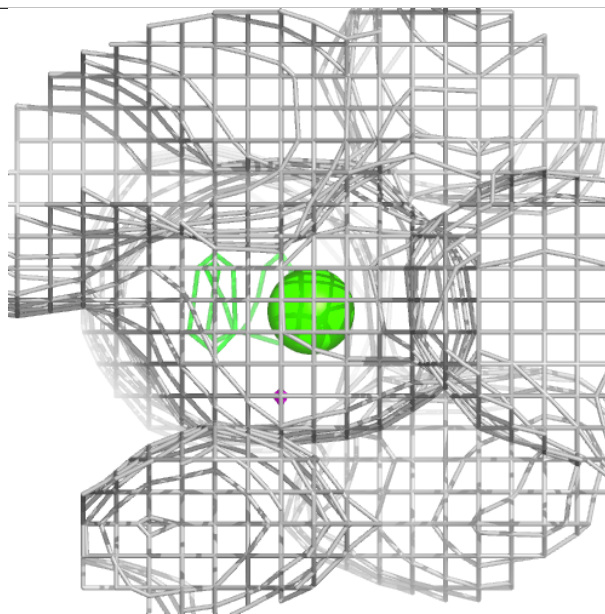
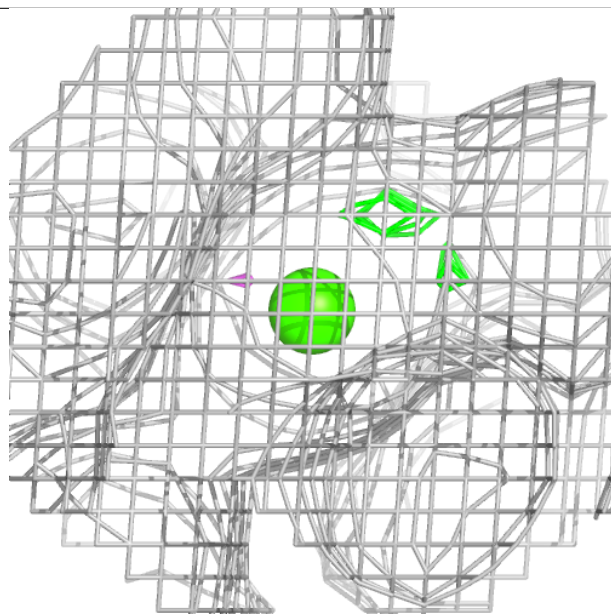
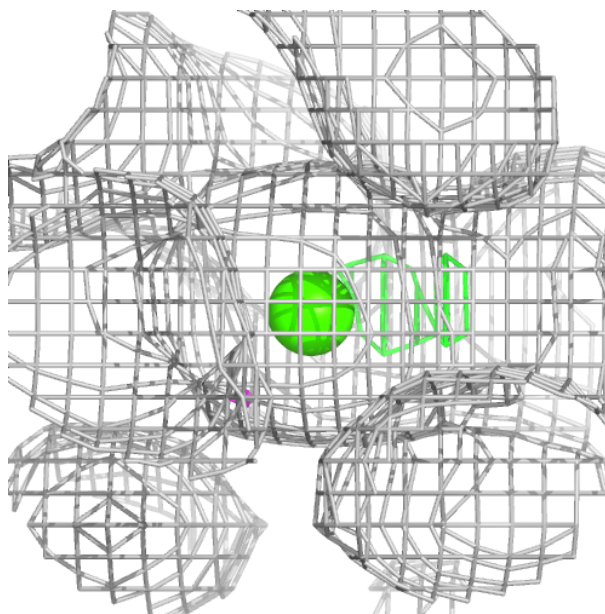
Electron density around NA A 606:

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



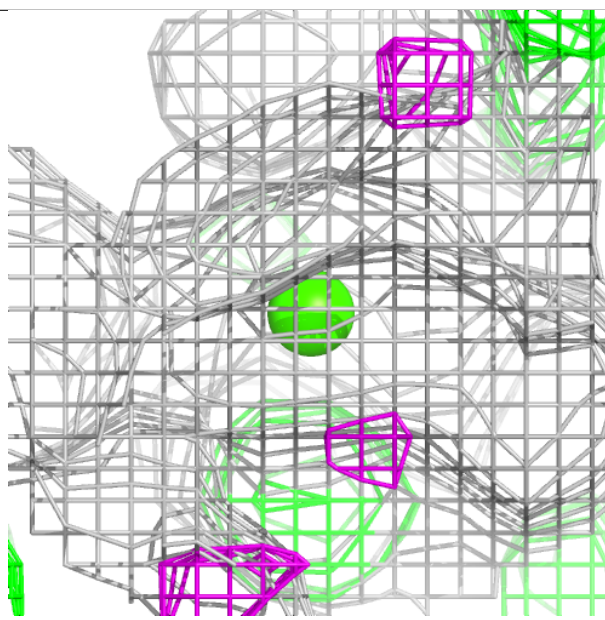
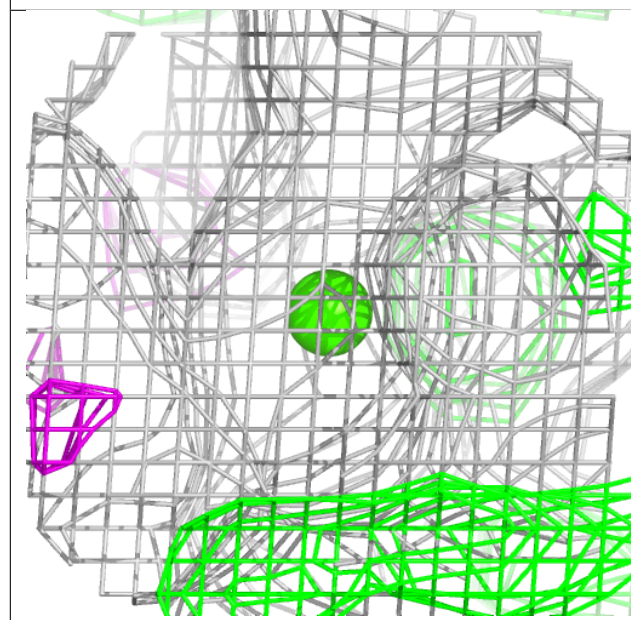
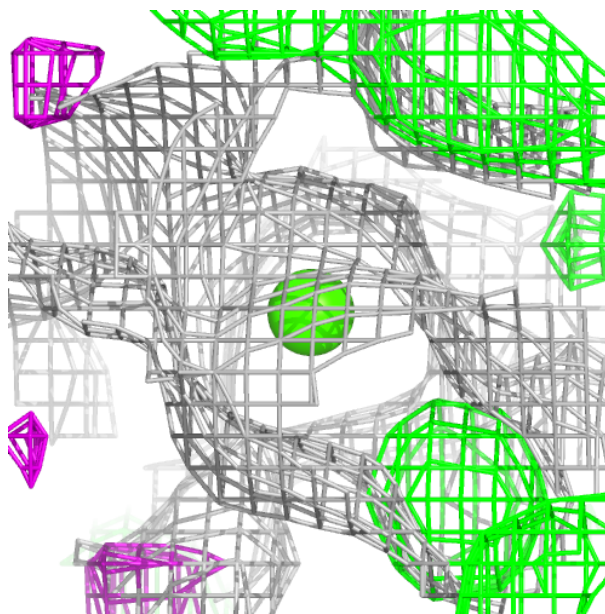
Electron density around CA A 605:

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



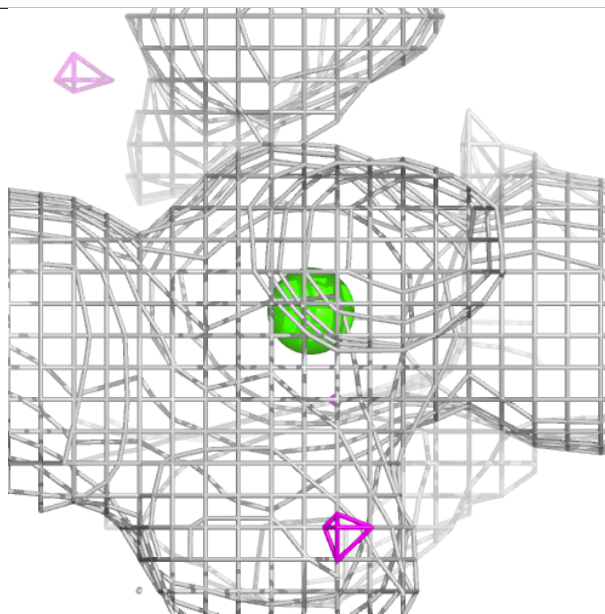
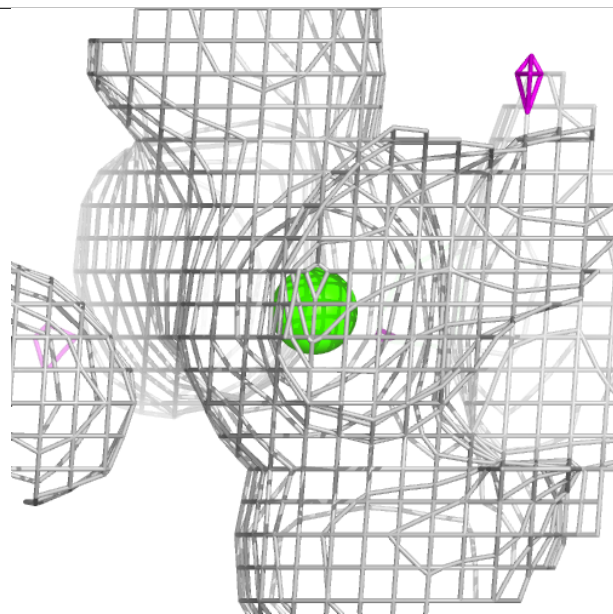
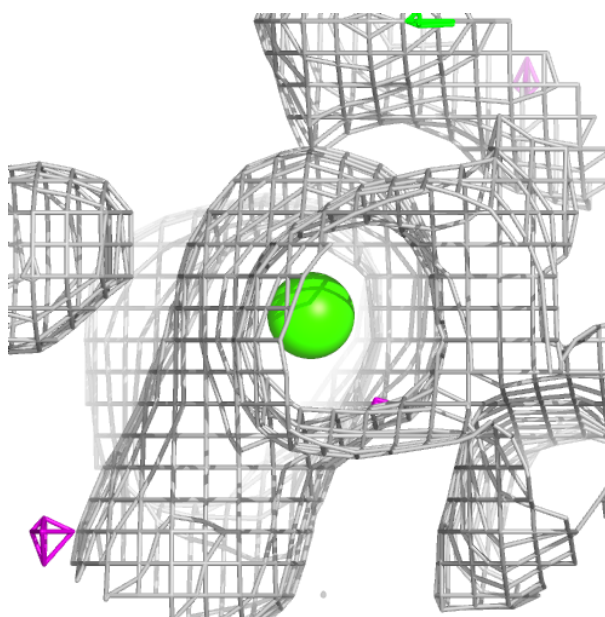
Electron density around CA B 602:

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



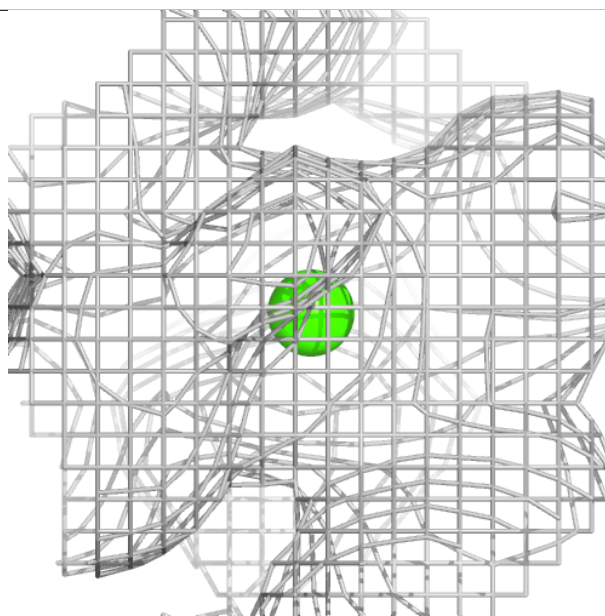
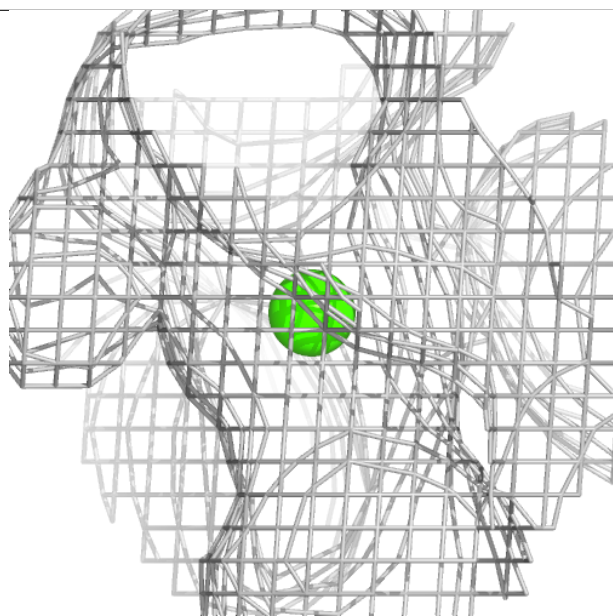
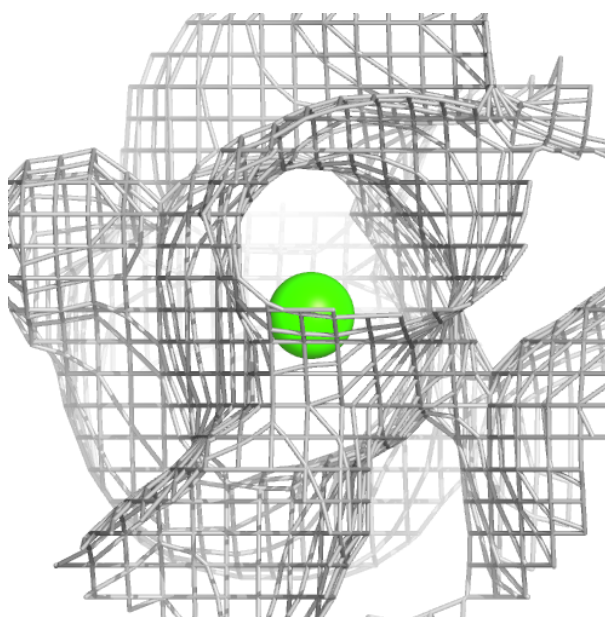
Electron density around CA B 603:

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



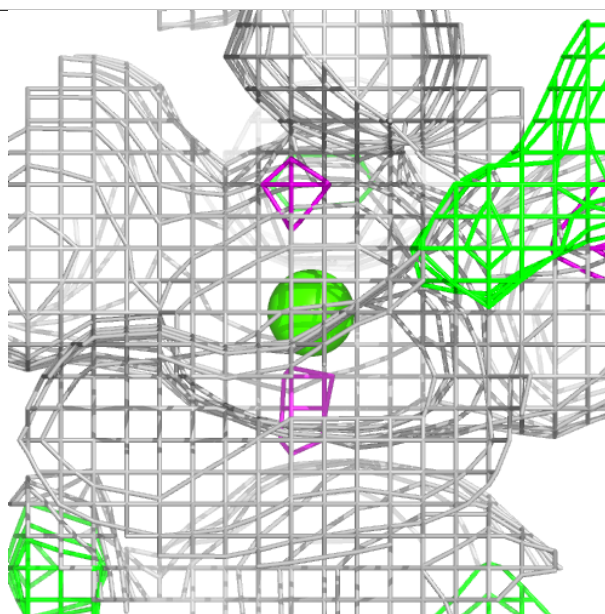
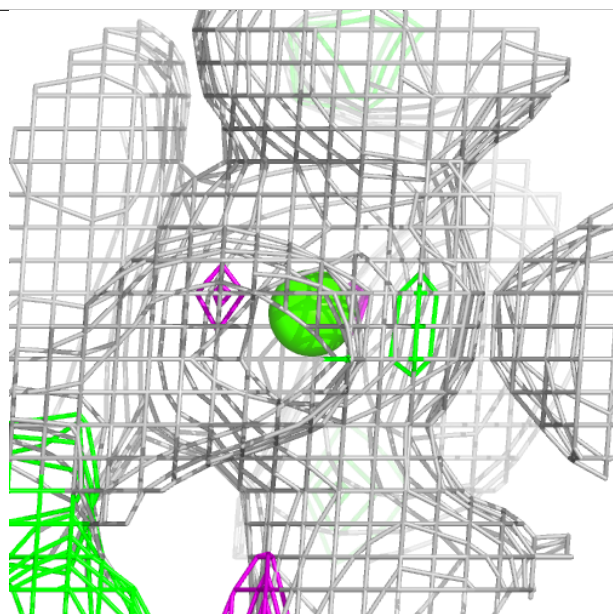
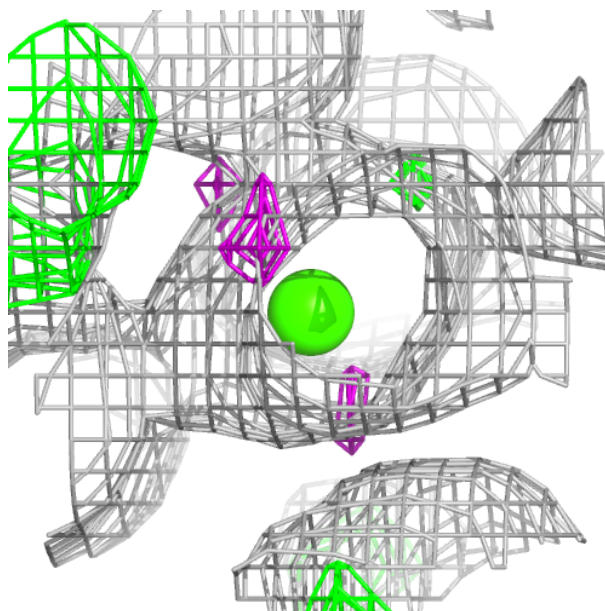
Electron density around CA B 605:

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



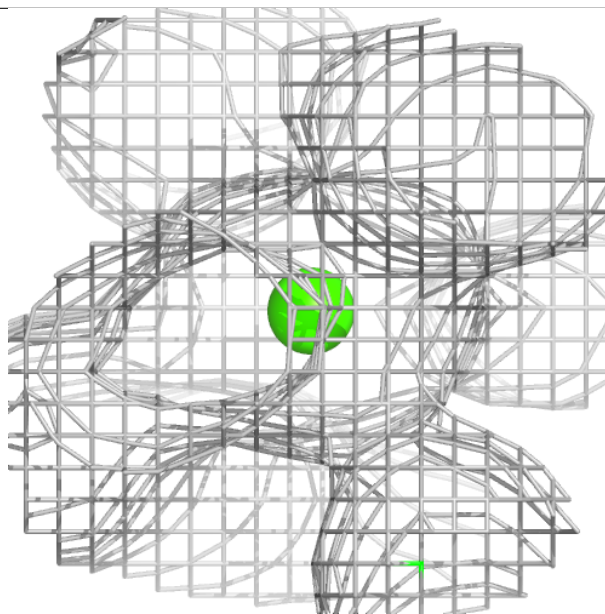
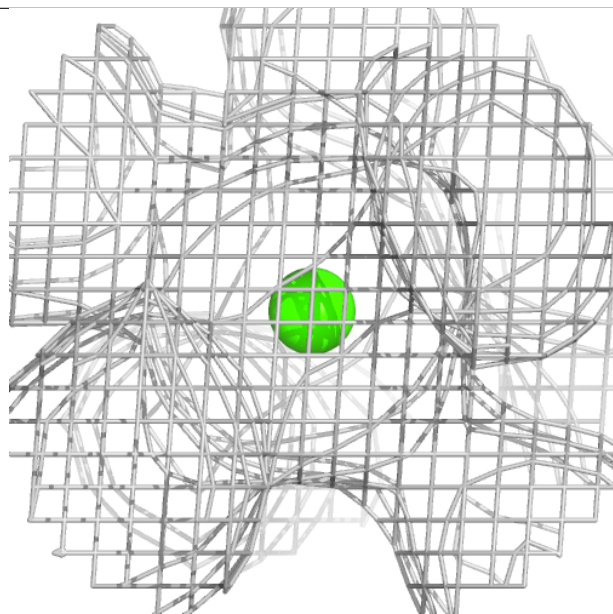
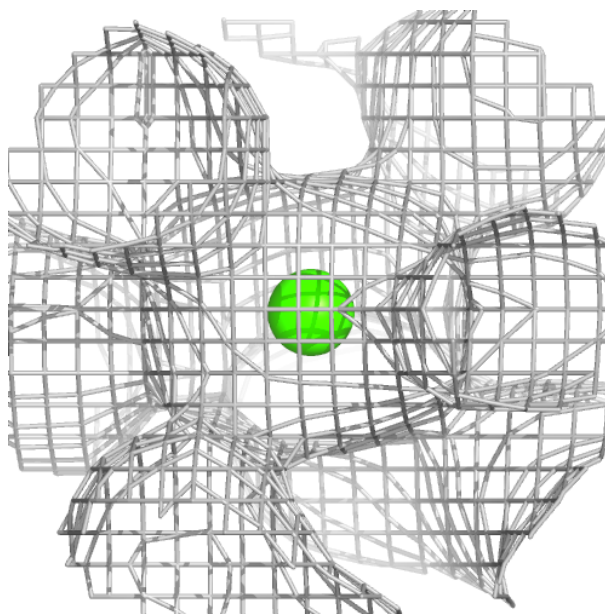
Electron density around CA A 602:

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



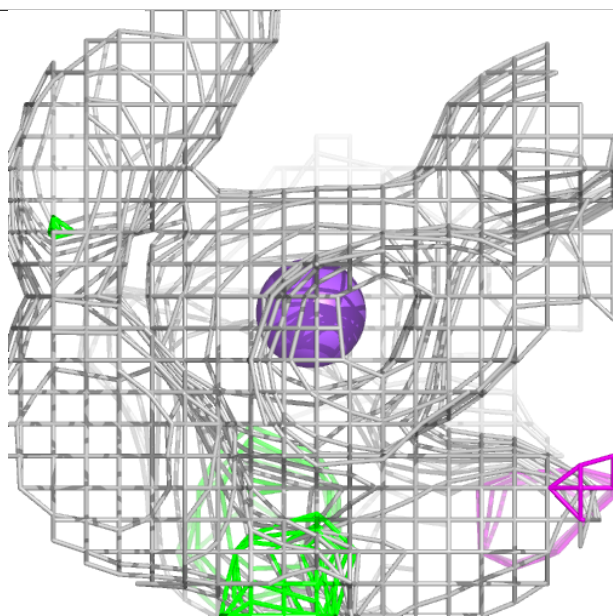
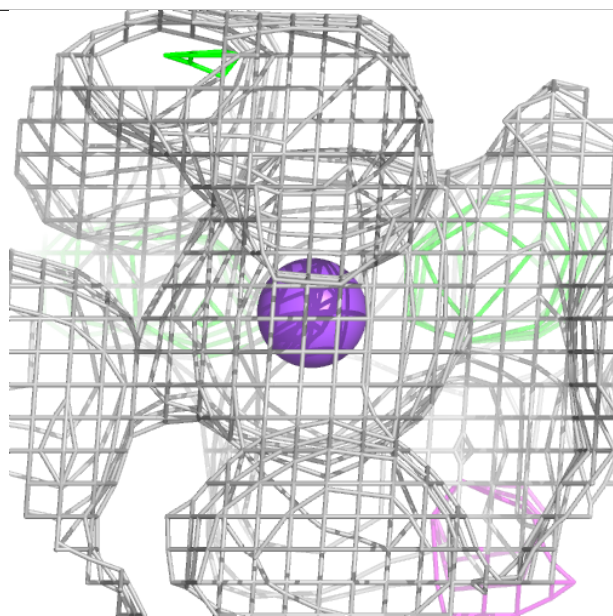
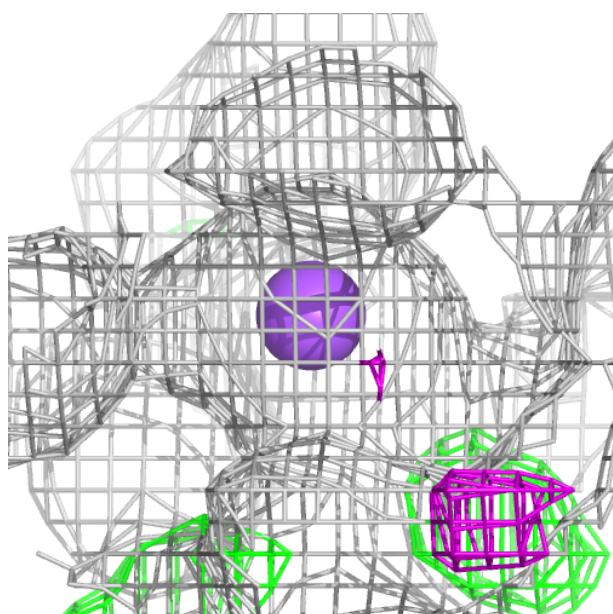
Electron density around CA B 604:

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



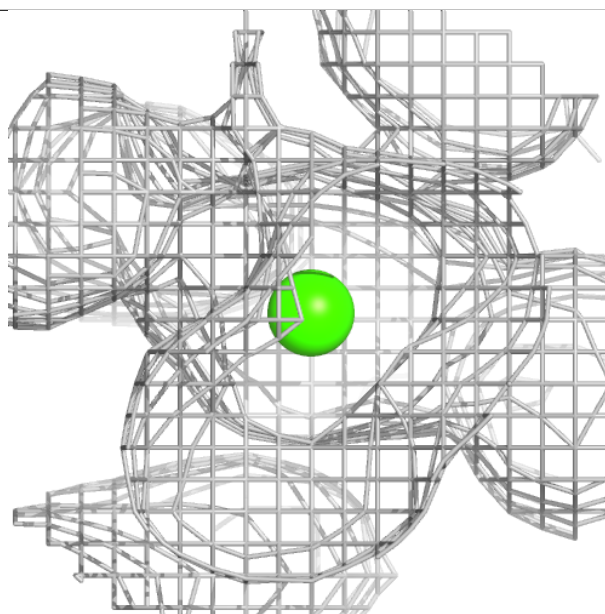
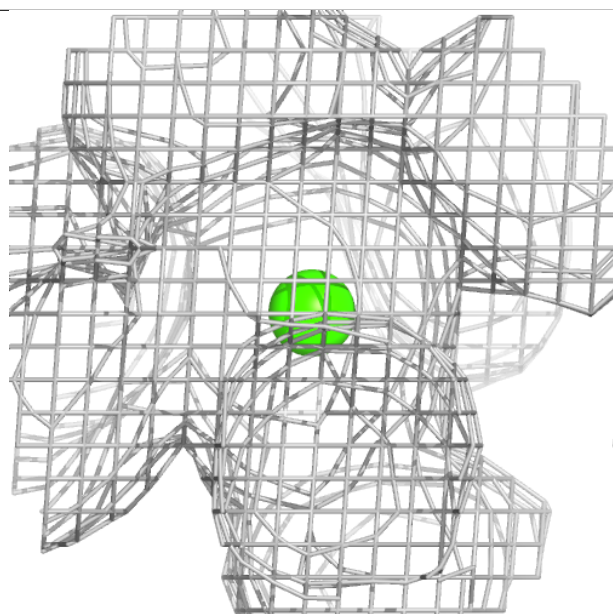
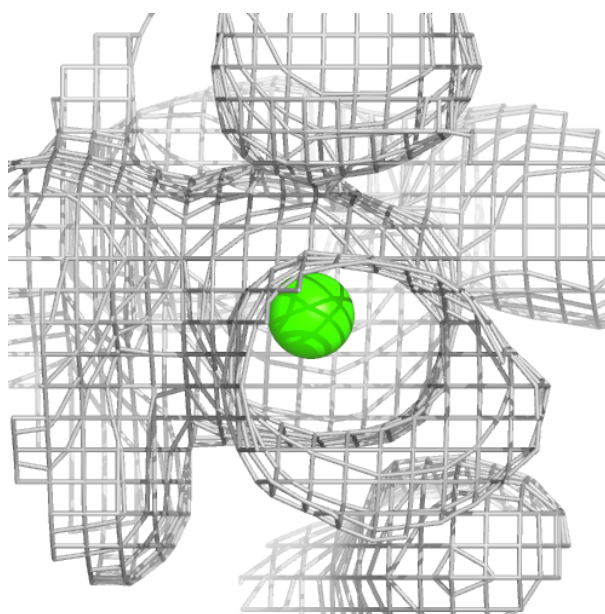
Electron density around NA B 606:

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



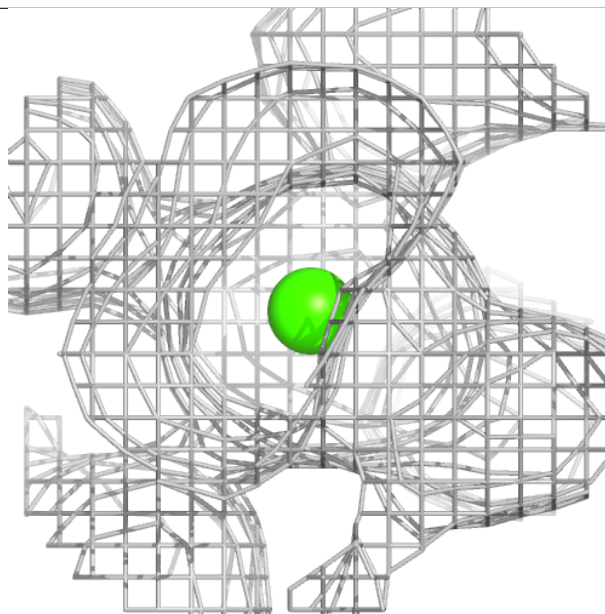
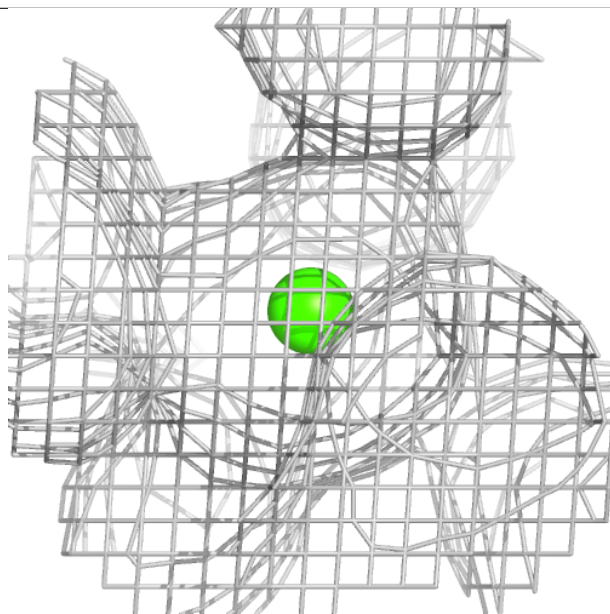
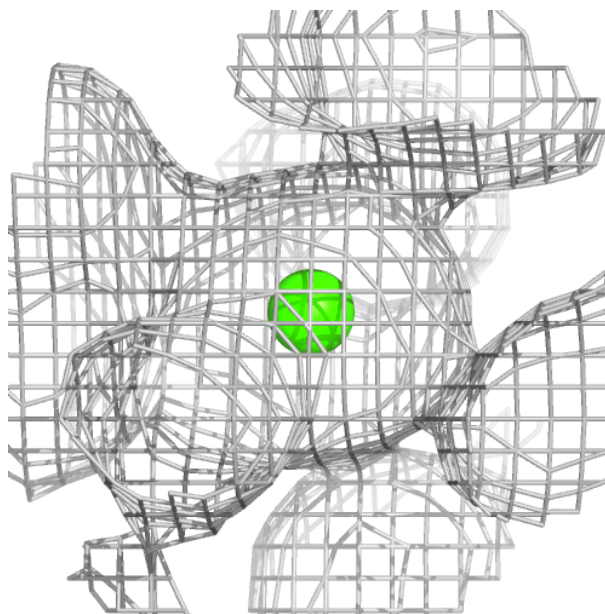
Electron density around CA A 601:

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



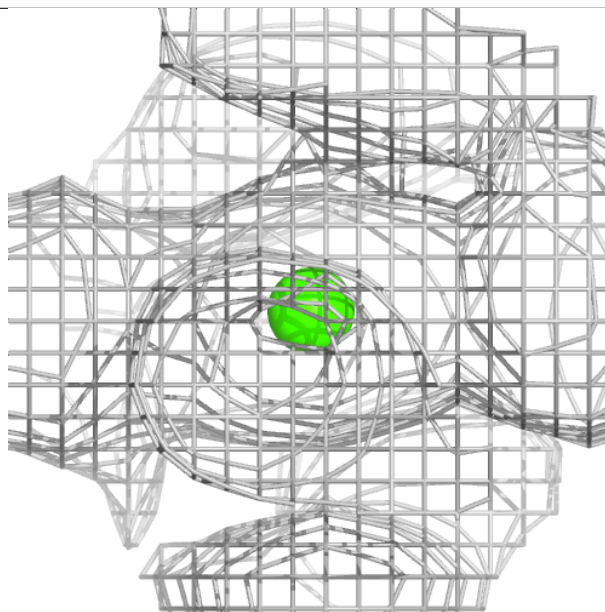
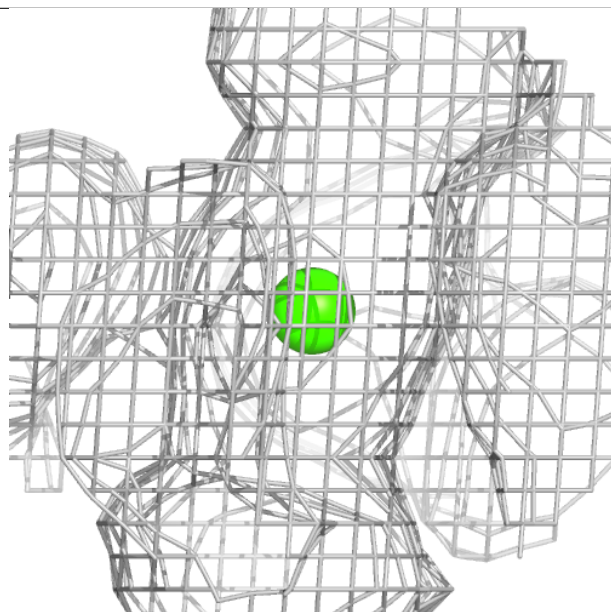
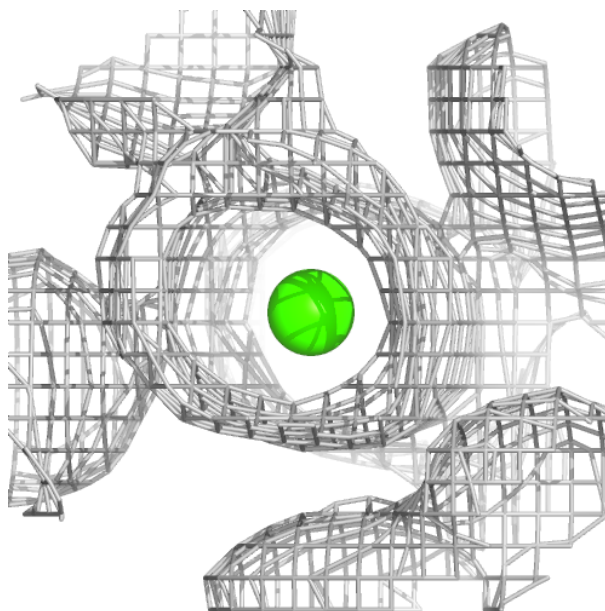
Electron density around CA B 601:

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



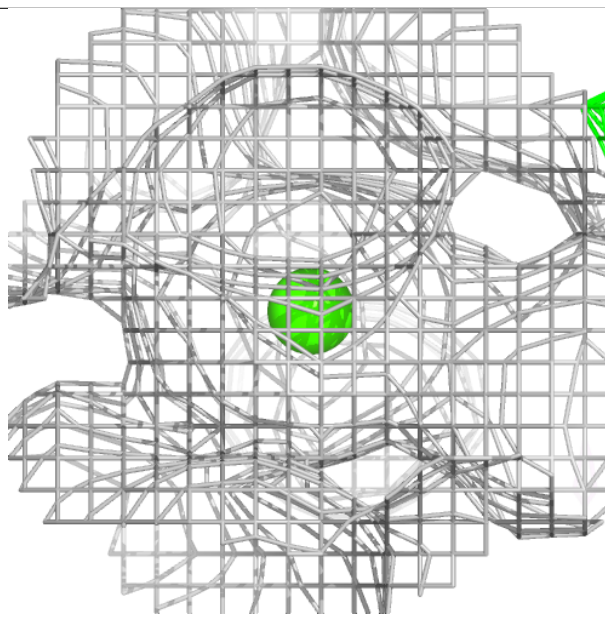
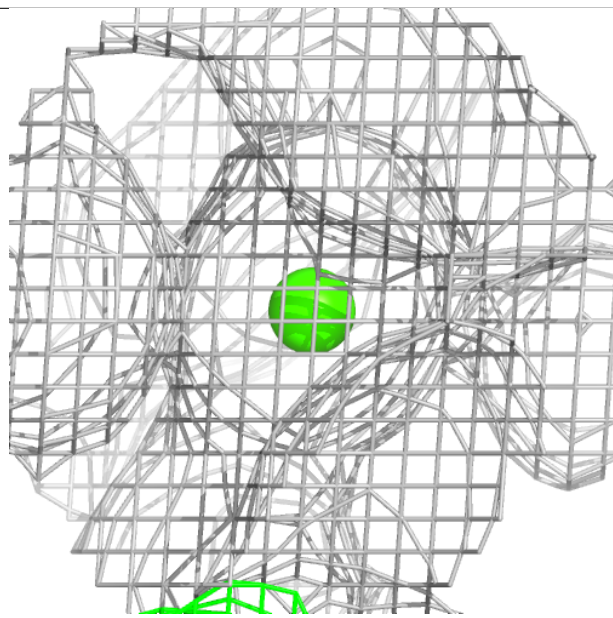
Electron density around CA A 603:

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



Electron density around CA A 604:

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



6.5 Other polymers ⓘ

There are no such residues in this entry.