wwPDB X-ray Structure Validation Summary Report (i)

Aug 24, 2026 – 05:49 am BST

PDB ID	:	8P8G / pdb_00008p8g
Title	:	Nitrogenase MoFe protein from A. vinelandii beta double mutant D353G/D357G
Authors	:	Maslac, N.; Wagner, T.
Deposited on	:	2023-06-01
Resolution	:	1.55 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 (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:

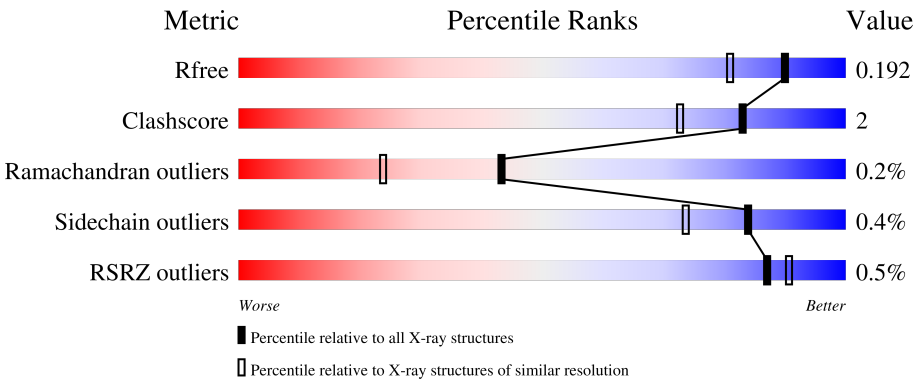
MolProbity	:	4-5-2 with Phenix2.0
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	2.0
EDS	:	3.0
Buster-report	:	wwPDB partial adaption of 1.1.7 (2018)
Percentile statistics	:	20250101.v01 (using entries in the PDB archive January 1st 2025)
CCP4	:	9.0.015 (Gargrove)
Density-Fitness	:	1.0.12
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.50

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 1.55 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	2145 (1.56-1.56)
Clashscore	190562	2189 (1.56-1.56)
Ramachandran outliers	187476	2153 (1.56-1.56)
Sidechain outliers	187428	2150 (1.56-1.56)
RSRZ outliers	180081	2146 (1.56-1.56)

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% 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	500	.% 90% 5% 5%
1	C	500	89% 6% 5%
2	B	523	.% 94% 6%
2	D	523	93% 6%

2 Entry composition (i)

There are 12 unique types of molecules in this entry. The entry contains 18458 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 Nitrogenase protein alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	477	3820	2430	650	713	27	0	5	0
1	C	477	3817	2428	649	713	27	0	5	0

There are 20 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-7	MET	-	initiating methionine	UNP C1DGZ7
A	-6	THR	-	expression tag	UNP C1DGZ7
A	-5	HIS	-	expression tag	UNP C1DGZ7
A	-4	HIS	-	expression tag	UNP C1DGZ7
A	-3	HIS	-	expression tag	UNP C1DGZ7
A	-2	HIS	-	expression tag	UNP C1DGZ7
A	-1	HIS	-	expression tag	UNP C1DGZ7
A	0	HIS	-	expression tag	UNP C1DGZ7
A	1	HIS	-	expression tag	UNP C1DGZ7
A	2	HIS	-	expression tag	UNP C1DGZ7
C	-7	MET	-	initiating methionine	UNP C1DGZ7
C	-6	THR	-	expression tag	UNP C1DGZ7
C	-5	HIS	-	expression tag	UNP C1DGZ7
C	-4	HIS	-	expression tag	UNP C1DGZ7
C	-3	HIS	-	expression tag	UNP C1DGZ7
C	-2	HIS	-	expression tag	UNP C1DGZ7
C	-1	HIS	-	expression tag	UNP C1DGZ7
C	0	HIS	-	expression tag	UNP C1DGZ7
C	1	HIS	-	expression tag	UNP C1DGZ7
C	2	HIS	-	expression tag	UNP C1DGZ7

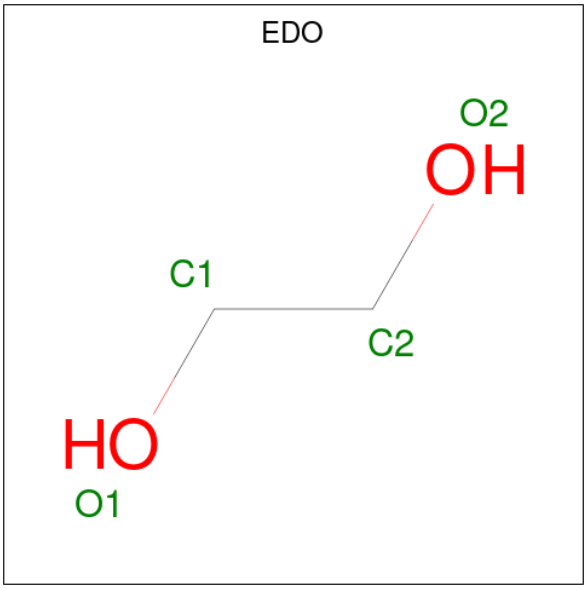
- Molecule 2 is a protein called Nitrogenase molybdenum-iron protein beta chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	522	4186	2675	708	774	29	0	3	0
2	D	522	4177	2669	706	773	29	0	2	0

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	353	GLY	ASP	engineered mutation	UNP C1DGZ8
B	357	GLY	ASP	engineered mutation	UNP C1DGZ8
D	353	GLY	ASP	engineered mutation	UNP C1DGZ8
D	357	GLY	ASP	engineered mutation	UNP C1DGZ8

- Molecule 3 is 1,2-ETHANEDIOL (CCD ID: EDO) (formula: $C_2H_6O_2$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	A	1	4	2	2	0	0
3	A	1	4	2	2	0	0
3	A	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0

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Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	B	1	4	2	2	0	0
3	C	1	4	2	2	0	0
3	C	1	4	2	2	0	0
3	C	1	4	2	2	0	0
3	C	1	4	2	2	0	0
3	C	1	4	2	2	0	1
3	C	1	4	2	2	0	0
3	C	1	4	2	2	0	0
3	D	1	4	2	2	0	0
3	D	1	4	2	2	0	0
3	D	1	4	2	2	0	0
3	D	1	4	2	2	0	0
3	D	1	4	2	2	0	0
3	D	1	4	2	2	0	0
3	D	1	4	2	2	0	0

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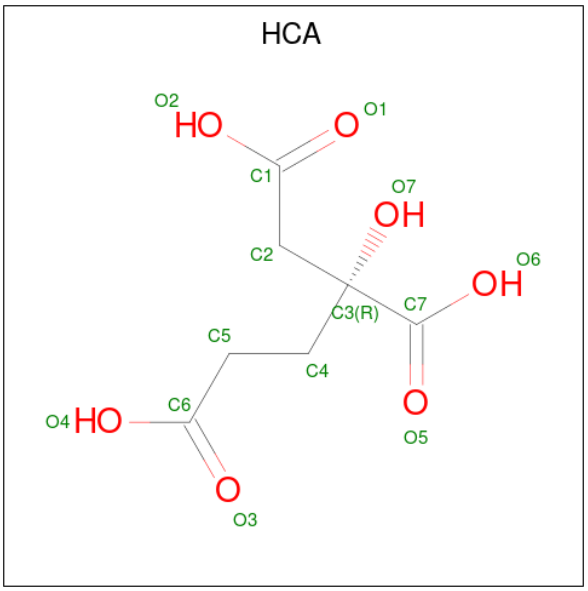
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	D	1	Total C O 4 2 2	0	0
3	D	1	Total C O 4 2 2	0	0
3	D	1	Total C O 4 2 2	0	0
3	D	1	Total C O 4 2 2	0	0
3	D	1	Total C O 4 2 2	0	0
3	D	1	Total C O 4 2 2	0	1
3	D	1	Total C O 4 2 2	0	1
3	D	1	Total C O 4 2 2	0	0

- Molecule 4 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

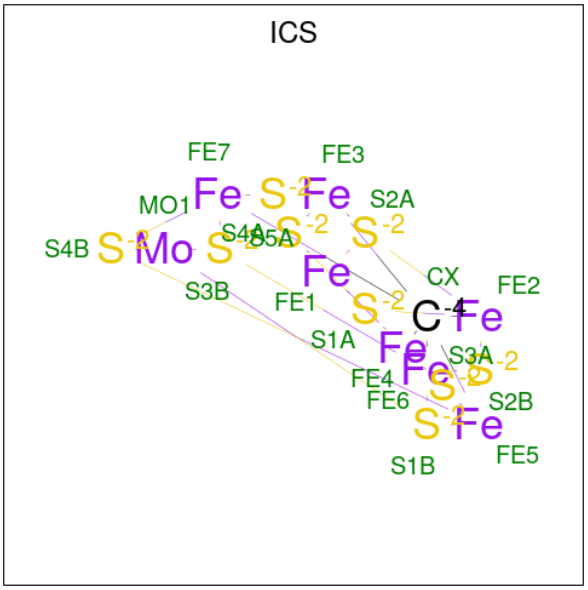
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total Cl 1 1	0	0
4	C	1	Total Cl 1 1	0	0

- Molecule 5 is 3-HYDROXY-3-CARBOXY-ADIPIC ACID (CCD ID: HCA) (formula: $C_7H_{10}O_7$) (labeled as "Ligand of Interest" by depositor).



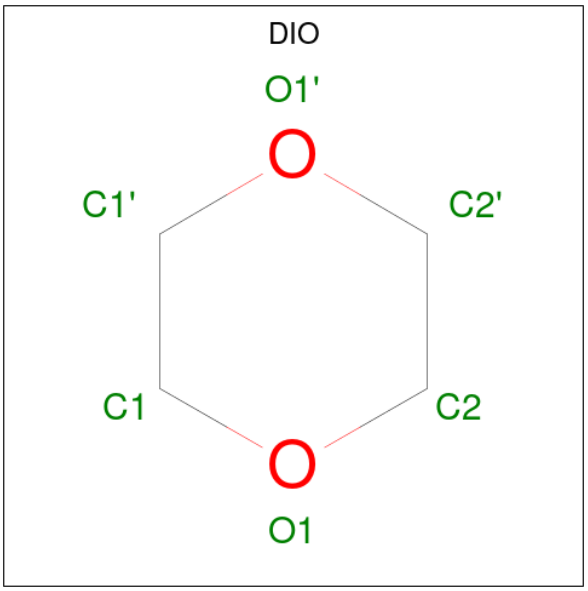
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
5	A	1	14	7	7	0	0
			Total	C	O		
5	C	1	14	7	7	0	0

- Molecule 6 is iron-sulfur-molybdenum cluster with interstitial carbon (CCD ID: ICS) (formula: CFe_7MoS_9) (labeled as "Ligand of Interest" by depositor).



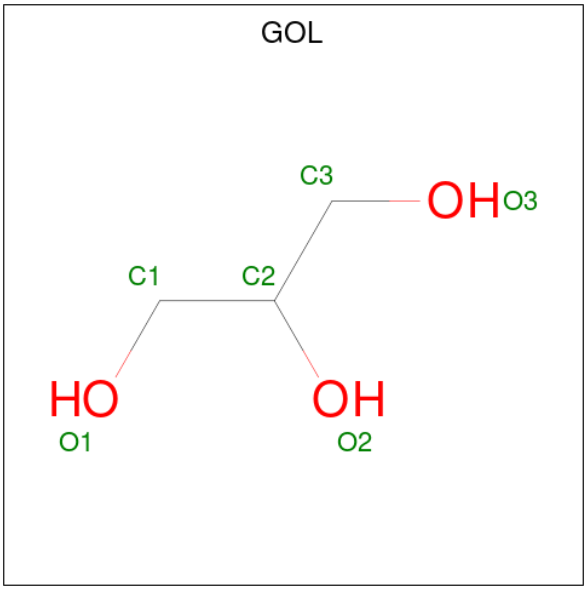
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	Fe	Mo	S		
6	A	1	18	1	7	1	9	0	0
			Total	C	Fe	Mo	S		
6	C	1	18	1	7	1	9	0	0

- Molecule 7 is 1,4-DIETHYLENE DIOXIDE (CCD ID: DIO) (formula: $C_4H_8O_2$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
7	B	1	6	4	2	0	0
			Total	C	O		
7	D	1	6	4	2	0	0

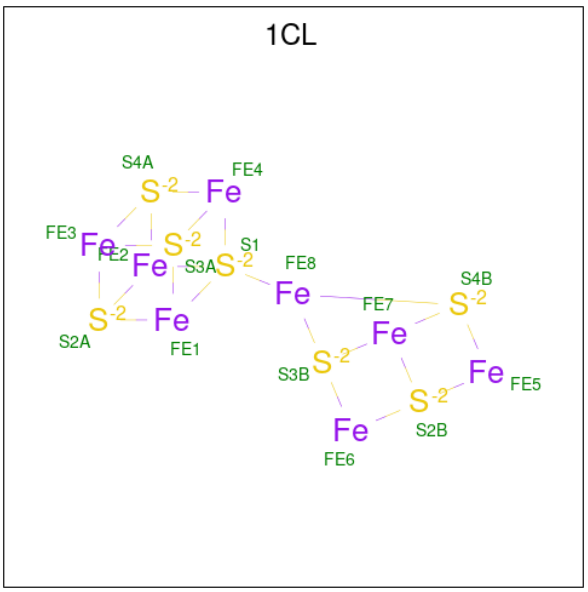
- Molecule 8 is GLYCEROL (CCD ID: GOL) (formula: $C_3H_8O_3$).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	C	O		
8	B	1	6	3	3	0	0

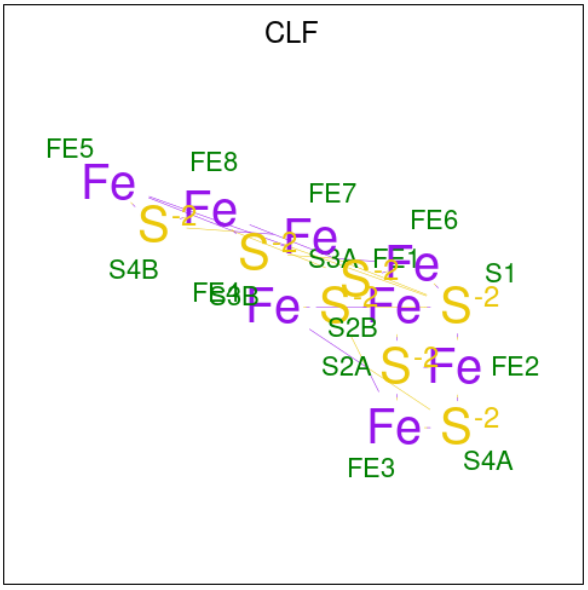
- Molecule 9 is FE(8)-S(7) CLUSTER, OXIDIZED (CCD ID: 1CL) (formula: Fe_8S_7) (labeled

as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	Fe	S		
9	B	1	15	8	7	0	1
			Total	Fe	S		
9	D	1	15	8	7	0	1

- Molecule 10 is FE(8)-S(7) CLUSTER (CCD ID: CLF) (formula: Fe_8S_7) (labeled as "Ligand of Interest" by depositor).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
			Total	Fe	S		
10	B	1	15	8	7	0	1
			Total	Fe	S		
10	D	1	15	8	7	0	1

- Molecule 11 is SODIUM ION (CCD ID: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Na		
11	C	1	1	1	0	0

- Molecule 12 is water.

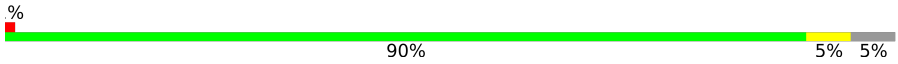
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
12	A	478	478	478	0	20
			Total	O		
12	B	564	564	564	0	28
			Total	O		
12	C	526	526	526	0	23
			Total	O		
12	D	605	605	605	0	26

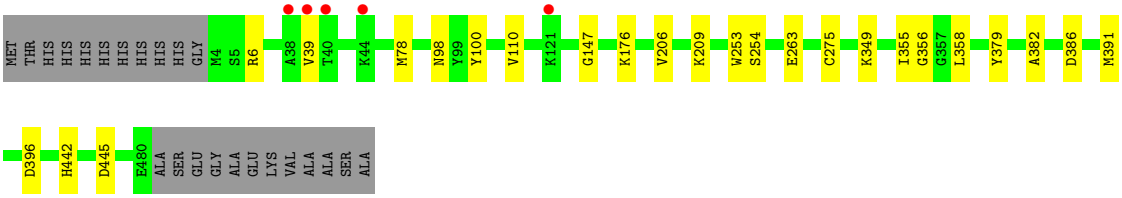
3 Residue-property plots (i)

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: Nitrogenase protein alpha chain

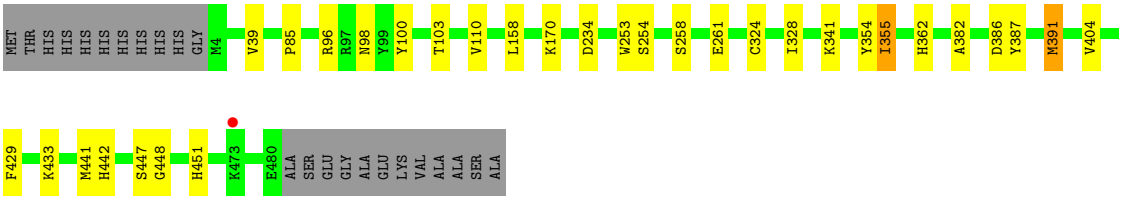
Chain A:





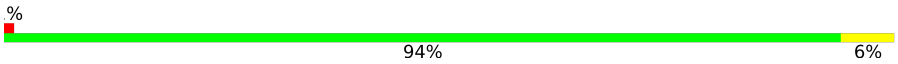
• Molecule 1: Nitrogenase protein alpha chain

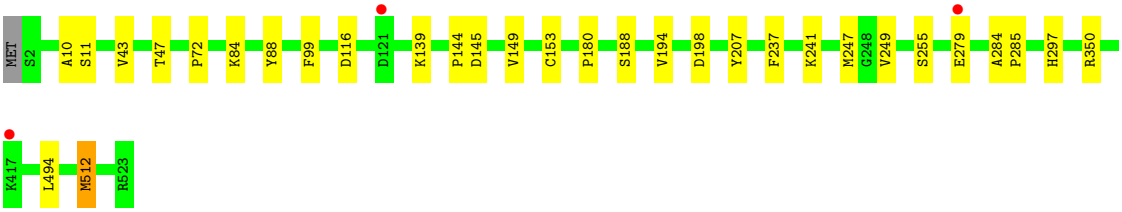
Chain C:



• Molecule 2: Nitrogenase molybdenum-iron protein beta chain

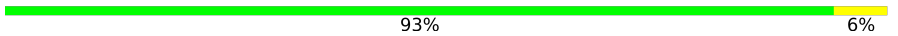
Chain B:

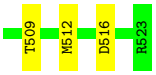




• Molecule 2: Nitrogenase molybdenum-iron protein beta chain

Chain D:




T509
M512
D516
R523

4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α, β, γ	167.49Å 74.47Å 208.47Å 90.00° 103.25° 90.00°	Depositor
Resolution (Å)	48.32 – 1.55 48.32 – 1.55	Depositor EDS
% Data completeness (in resolution range)	48.7 (48.32-1.55) 48.7 (48.32-1.55)	Depositor EDS
R_{merge}	0.18	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	1.59 (at 1.55Å)	Xtriage
Refinement program	PHENIX (1.20.1_4487: ???)	Depositor
R, R_{free}	0.155 , 0.187 0.162 , 0.192	Depositor DCC
R_{free} test set	8765 reflections (2.40%)	wwPDB-VP
Wilson B-factor (Å^2)	14.0	Xtriage
Anisotropy	0.080	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.33 , 33.7	EDS
L-test for twinning[2]	$< \|L\| > = 0.50$, $< L^2 > = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.96	EDS
Total number of atoms	18458	wwPDB-VP
Average B, all atoms (Å^2)	18.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.30% 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: NA, 1CL, GOL, CLF, ICS, DIO, CL, EDO, HCA

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	0.54	0/3917	0.59	0/5281
1	C	0.59	1/3914 (0.0%)	0.63	0/5277
2	B	0.52	0/4295	0.56	0/5803
2	D	0.56	0/4286	0.59	0/5792
All	All	0.55	1/16412 (0.0%)	0.59	0/22153

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	C	0	1

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	C	441	MET	SD-CE	-5.30	1.66	1.79

There are no bond angle outliers.

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	C	96	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	3820	0	3766	17	0
1	C	3817	0	3763	21	0
2	B	4186	0	4110	20	0
2	D	4177	0	4098	20	0
3	A	12	0	18	0	0
3	B	40	0	60	0	0
3	C	28	0	42	0	0
3	D	60	0	90	1	0
4	A	1	0	0	0	0
4	C	1	0	0	0	0
5	A	14	0	6	1	0
5	C	14	0	6	2	0
6	A	18	0	0	0	0
6	C	18	0	0	0	0
7	B	6	0	8	0	0
7	D	6	0	8	0	0
8	B	6	0	8	0	0
9	B	15	0	0	0	0
9	D	15	0	0	1	0
10	B	15	0	0	0	0
10	D	15	0	0	1	0
11	C	1	0	0	0	0
12	A	478	0	0	1	0
12	B	564	0	0	0	0
12	C	526	0	0	0	0
12	D	605	0	0	1	0
All	All	18458	0	15983	76	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 2.

The worst 5 of 76 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:B:279:GLU:H	2:B:279:GLU:CD	2.18	0.52

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:C:85:PRO:HB2	9:D:717[A]:1CL:S2B	2.50	0.51
1:A:39:VAL:CG2	1:A:391:MET:CE	2.89	0.51
1:A:442:HIS:CG	5:A:1003:HCA:H52	2.46	0.51
1:A:39:VAL:HG22	1:A:391:MET:HE2	1.94	0.50

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	A	480/500 (96%)	461 (96%)	18 (4%)	1 (0%)	43	24
1	C	480/500 (96%)	459 (96%)	20 (4%)	1 (0%)	43	24
2	B	523/523 (100%)	512 (98%)	10 (2%)	1 (0%)	43	24
2	D	522/523 (100%)	514 (98%)	7 (1%)	1 (0%)	43	24
All	All	2005/2046 (98%)	1946 (97%)	55 (3%)	4 (0%)	43	24

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
2	B	255	SER
2	D	255	SER
1	C	355	ILE
1	A	355	ILE

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	412/423 (97%)	410 (100%)	2 (0%)	81	68
1	C	412/423 (97%)	408 (99%)	4 (1%)	68	47
2	B	455/453 (100%)	453 (100%)	2 (0%)	84	73
2	D	454/453 (100%)	454 (100%)	0	100	100
All	All	1733/1752 (99%)	1725 (100%)	8 (0%)	84	68

5 of 8 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	391	MET
1	C	362	HIS
1	C	98	ASN
2	B	512[B]	MET
1	C	355	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (4) such sidechains are listed below:

Mol	Chain	Res	Type
2	B	518	ASN
2	D	18	GLN
2	D	130	ASN
2	D	136	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 oligosaccharides in this entry.

5.6 Ligand geometry (i)

Of 49 ligands modelled in this entry, 3 are monoatomic - leaving 46 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	$\#\|Z\| > 2$
3	EDO	C	506	-	3,3,3	0.53	0	2,2,2	0.83	0
8	GOL	B	611	-	5,5,5	0.09	0	5,5,5	0.35	0
6	ICS	C	504	5,1	18,30,30	2.81	8 (44%)	-		
3	EDO	D	709	-	3,3,3	0.48	0	2,2,2	0.73	0
3	EDO	B	604	-	3,3,3	0.67	0	2,2,2	0.24	0
3	EDO	B	602	-	3,3,3	0.51	0	2,2,2	0.60	0
3	EDO	B	606	-	3,3,3	0.11	0	2,2,2	0.38	0
3	EDO	D	706	-	3,3,3	0.91	0	2,2,2	0.58	0
3	EDO	D	713	-	3,3,3	0.15	0	2,2,2	0.42	0
3	EDO	D	703	-	3,3,3	0.51	0	2,2,2	0.15	0
3	EDO	C	511	-	3,3,3	0.06	0	2,2,2	0.22	0
3	EDO	C	507	-	3,3,3	0.16	0	2,2,2	0.13	0
3	EDO	D	701	-	3,3,3	0.57	0	2,2,2	0.45	0
3	EDO	C	508	-	3,3,3	0.06	0	2,2,2	0.17	0
3	EDO	A	1001	-	3,3,3	0.09	0	2,2,2	0.21	0
3	EDO	D	708	-	3,3,3	0.59	0	2,2,2	0.81	0
3	EDO	C	505	-	3,3,3	0.60	0	2,2,2	0.50	0
3	EDO	D	705	-	3,3,3	0.33	0	2,2,2	0.88	0
7	DIO	B	608	-	6,6,6	0.17	0	6,6,6	0.06	0
3	EDO	D	710	-	3,3,3	0.58	0	2,2,2	0.27	0
7	DIO	D	712	-	6,6,6	0.18	0	6,6,6	0.06	0
3	EDO	B	605	-	3,3,3	0.71	0	2,2,2	1.10	0
3	EDO	B	612	-	3,3,3	0.13	0	2,2,2	0.16	0
6	ICS	A	1004	5,1	18,30,30	3.10	13 (72%)	-		
3	EDO	A	1005	-	3,3,3	0.84	0	2,2,2	0.17	0
3	EDO	D	704	-	3,3,3	0.75	0	2,2,2	0.83	0
3	EDO	D	714[B]	-	3,3,3	0.06	0	2,2,2	0.15	0
3	EDO	D	711	-	3,3,3	0.49	0	2,2,2	0.58	0
10	CLF	D	718[B]	2,1	0,24,24	-	-	-		
3	EDO	B	609	-	3,3,3	0.06	0	2,2,2	0.19	0
3	EDO	C	510	-	3,3,3	0.05	0	2,2,2	0.20	0
3	EDO	B	610	-	3,3,3	0.07	0	2,2,2	0.17	0

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
5	HCA	C	503	6	13,13,13	1.23	2 (15%)	14,18,18	1.52	2 (14%)
9	1CL	D	717[A]	2,1	0,22,22	-	-	-		
3	EDO	C	509[A]	-	3,3,3	0.77	0	2,2,2	0.54	0
5	HCA	A	1003	6	13,13,13	1.31	3 (23%)	14,18,18	1.34	2 (14%)
3	EDO	A	1006	-	3,3,3	0.13	0	2,2,2	0.32	0
3	EDO	D	707	-	3,3,3	0.62	0	2,2,2	0.06	0
3	EDO	B	607	-	3,3,3	0.07	0	2,2,2	0.31	0
10	CLF	B	614[B]	2,1	0,24,24	-	-	-		
3	EDO	D	702	-	3,3,3	0.97	0	2,2,2	0.44	0
9	1CL	B	613[A]	2,1	0,22,22	-	-	-		
3	EDO	D	715[A]	-	3,3,3	0.03	0	2,2,2	0.21	0
3	EDO	D	716	-	3,3,3	0.07	0	2,2,2	0.17	0
3	EDO	B	603	-	3,3,3	0.44	0	2,2,2	0.28	0
3	EDO	B	601	-	3,3,3	0.69	0	2,2,2	0.45	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. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	EDO	C	506	-	-	0/1/1/1	-
8	GOL	B	611	-	-	4/4/4/4	-
3	EDO	D	709	-	-	1/1/1/1	-
3	EDO	B	604	-	-	1/1/1/1	-
3	EDO	B	602	-	-	0/1/1/1	-
3	EDO	B	606	-	-	0/1/1/1	-
3	EDO	D	706	-	-	0/1/1/1	-
3	EDO	D	713	-	-	1/1/1/1	-
3	EDO	D	703	-	-	0/1/1/1	-
3	EDO	C	511	-	-	1/1/1/1	-
3	EDO	C	507	-	-	1/1/1/1	-
3	EDO	D	701	-	-	1/1/1/1	-
3	EDO	C	508	-	-	1/1/1/1	-
3	EDO	A	1001	-	-	1/1/1/1	-
3	EDO	D	708	-	-	1/1/1/1	-
3	EDO	C	505	-	-	1/1/1/1	-
3	EDO	D	705	-	-	1/1/1/1	-
7	DIO	B	608	-	-	-	0/1/1/1
3	EDO	D	710	-	-	1/1/1/1	-
7	DIO	D	712	-	-	-	0/1/1/1
3	EDO	B	605	-	-	0/1/1/1	-

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	EDO	B	612	-	-	0/1/1/1	-
3	EDO	A	1005	-	-	0/1/1/1	-
3	EDO	D	704	-	-	0/1/1/1	-
3	EDO	D	714[B]	-	-	1/1/1/1	-
3	EDO	D	711	-	-	0/1/1/1	-
10	CLF	D	718[B]	2,1	-	-	0/12/10/10
3	EDO	B	609	-	-	1/1/1/1	-
3	EDO	C	510	-	-	1/1/1/1	-
3	EDO	B	610	-	-	1/1/1/1	-
5	HCA	C	503	6	-	0/17/17/17	-
9	1CL	D	717[A]	2,1	-	-	0/10/8/8
3	EDO	C	509[A]	-	-	0/1/1/1	-
5	HCA	A	1003	6	-	6/17/17/17	-
3	EDO	A	1006	-	-	0/1/1/1	-
3	EDO	D	707	-	-	1/1/1/1	-
3	EDO	B	607	-	-	0/1/1/1	-
10	CLF	B	614[B]	2,1	-	-	0/12/10/10
3	EDO	D	702	-	-	1/1/1/1	-
9	1CL	B	613[A]	2,1	-	-	0/10/8/8
3	EDO	D	715[A]	-	-	0/1/1/1	-
3	EDO	D	716	-	-	0/1/1/1	-
3	EDO	B	603	-	-	1/1/1/1	-
3	EDO	B	601	-	-	1/1/1/1	-

The worst 5 of 26 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
6	A	1004	ICS	S4B-FE5	-6.19	2.17	2.32
6	A	1004	ICS	S3B-FE6	-5.42	2.19	2.32
6	C	504	ICS	S3B-FE7	-5.08	2.19	2.32
6	C	504	ICS	S3B-FE6	-4.88	2.20	2.32
6	C	504	ICS	S1B-FE5	-4.75	2.20	2.32

All (4) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
5	C	503	HCA	O5-C7-C3	-3.35	117.51	122.25
5	A	1003	HCA	O5-C7-C3	-3.07	117.91	122.25
5	C	503	HCA	O6-C7-C3	2.54	117.46	113.05
5	A	1003	HCA	O6-C7-C3	2.34	117.11	113.05

There are no chirality outliers.

5 of 30 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
5	A	1003	HCA	C2-C3-C4-C5
8	B	611	GOL	O1-C1-C2-C3
8	B	611	GOL	C1-C2-C3-O3
3	B	601	EDO	O1-C1-C2-O2
3	B	604	EDO	O1-C1-C2-O2

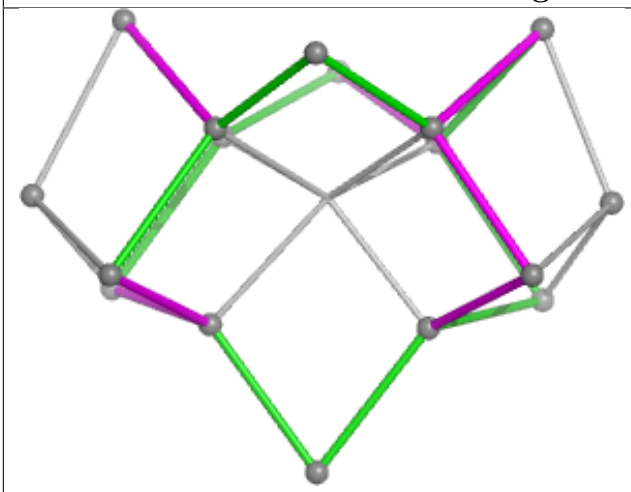
There are no ring outliers.

5 monomers are involved in 6 short contacts:

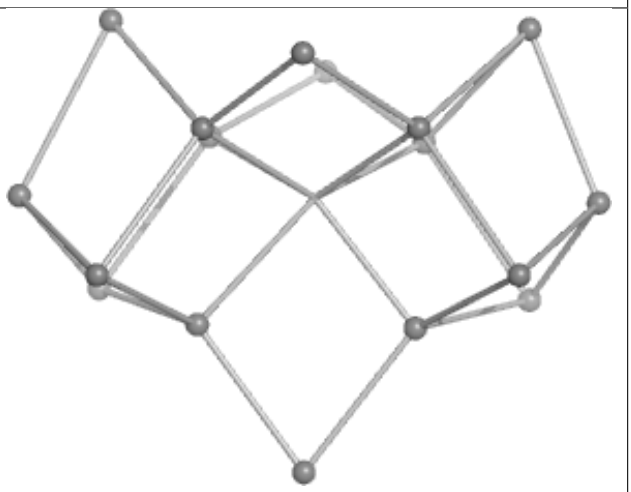
Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	D	714[B]	EDO	1	0
10	D	718[B]	CLF	1	0
5	C	503	HCA	2	0
9	D	717[A]	1CL	1	0
5	A	1003	HCA	1	0

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.

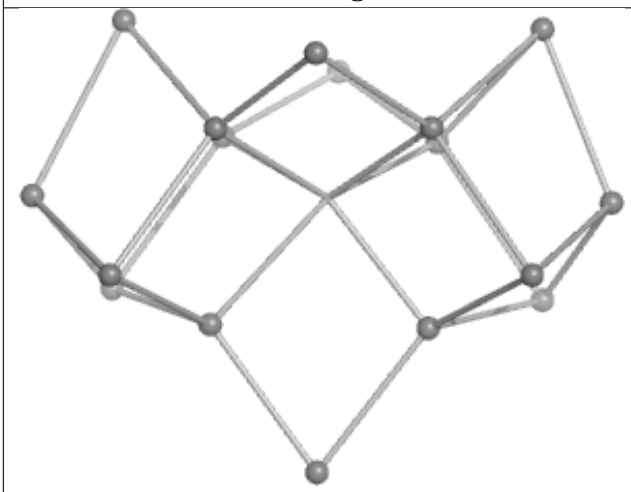
Ligand ICS C 504



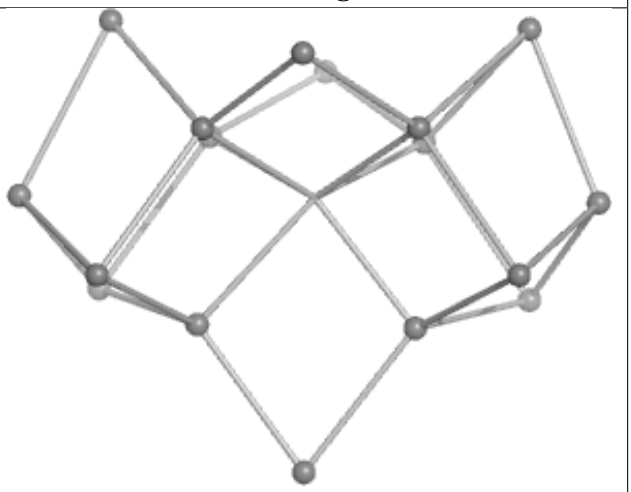
Bond lengths



Bond angles

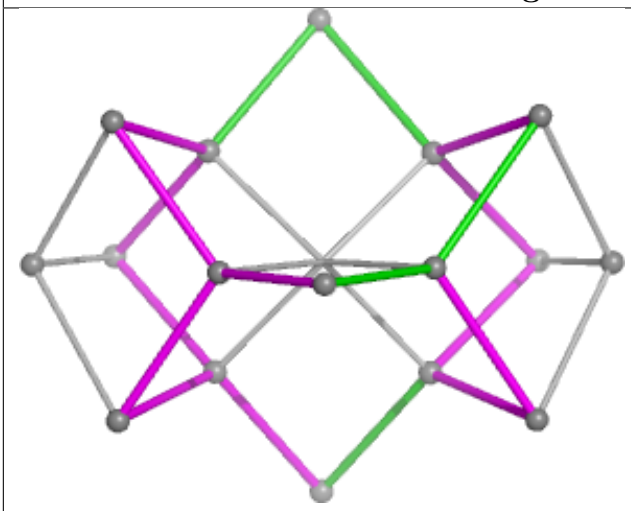


Torsions

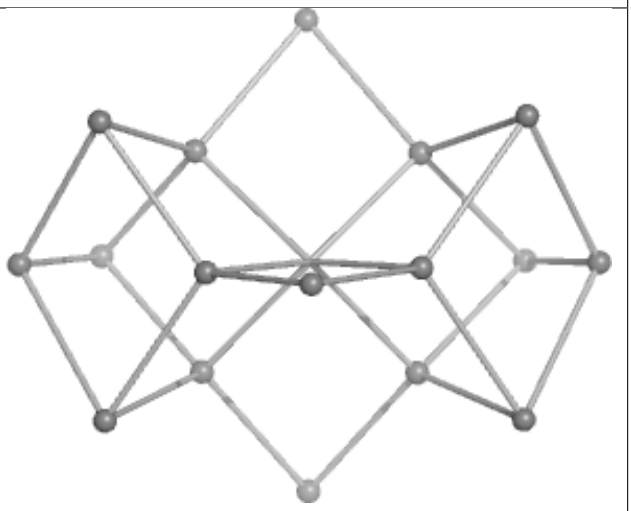


Rings

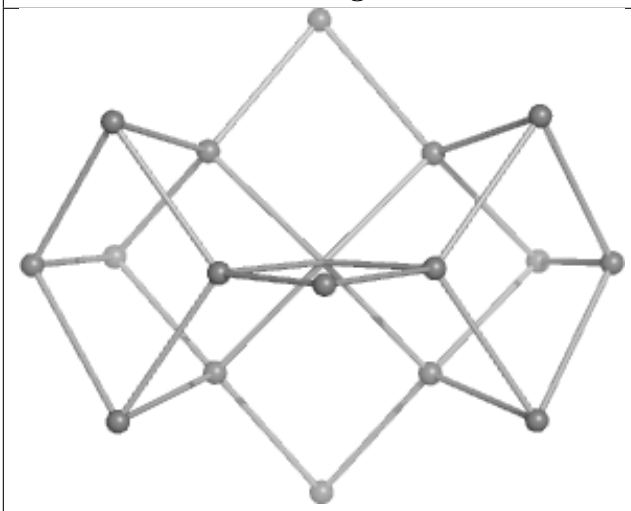
Ligand ICS A 1004



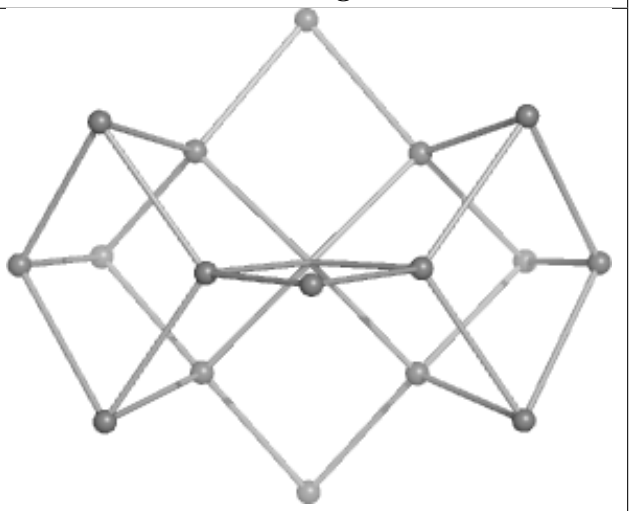
Bond lengths



Bond angles

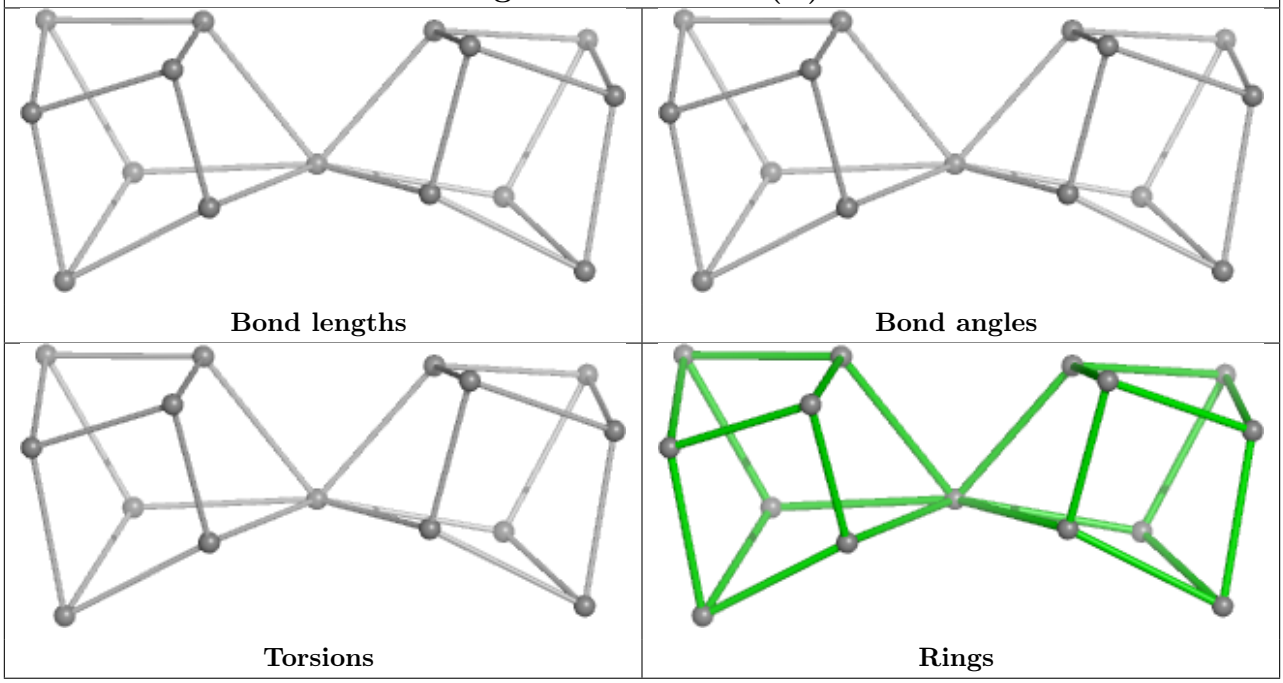


Torsions

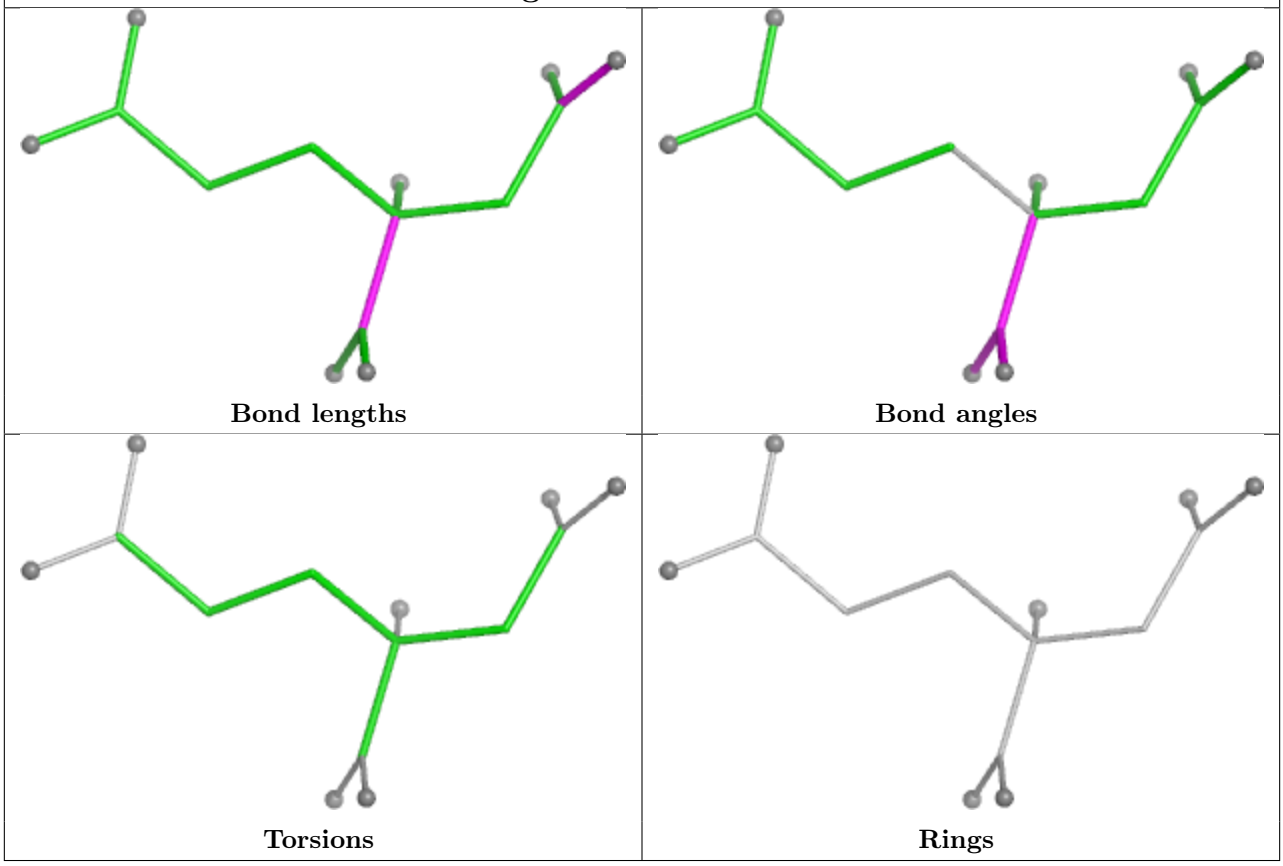


Rings

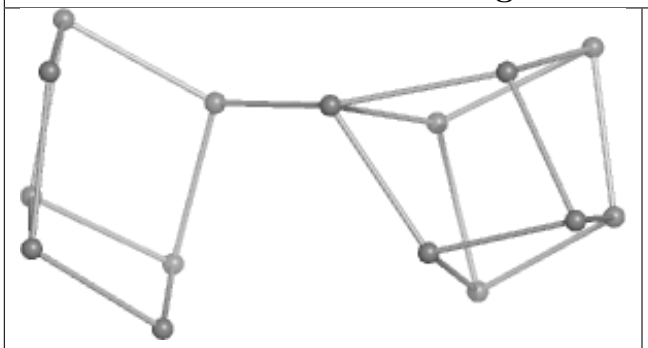
Ligand CLF D 718 (B)



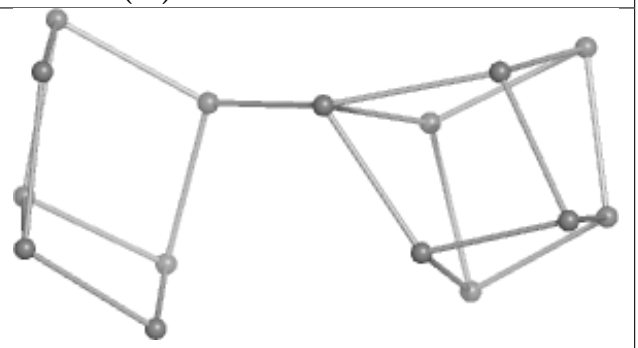
Ligand HCA C 503



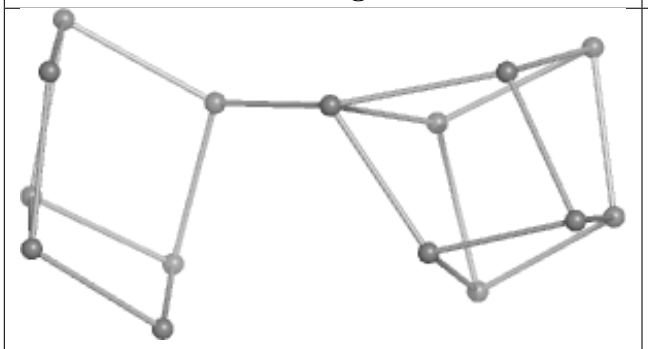
Ligand 1CL D 717 (A)



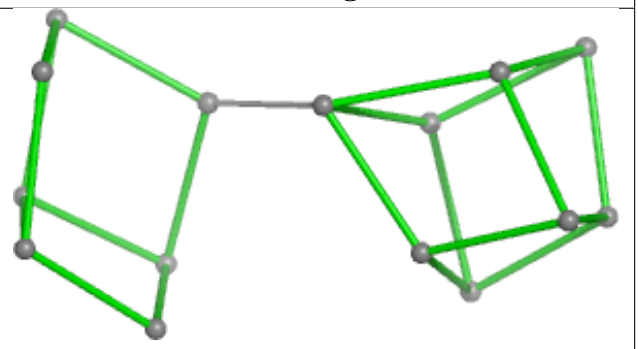
Bond lengths



Bond angles

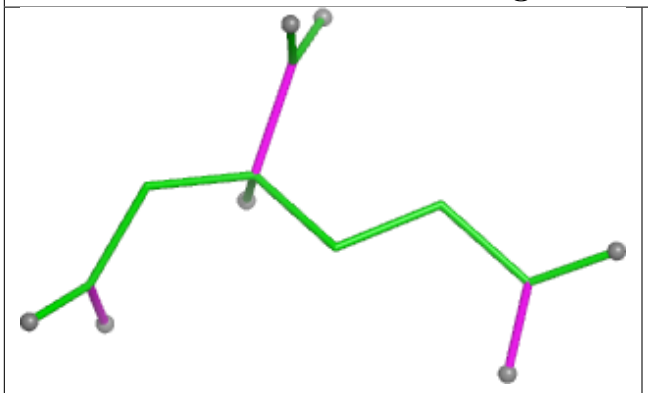


Torsions

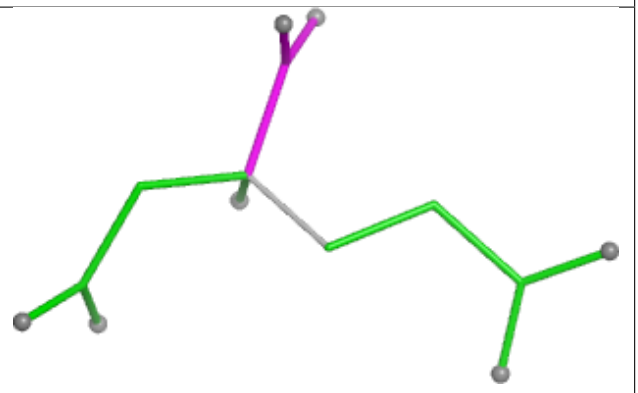


Rings

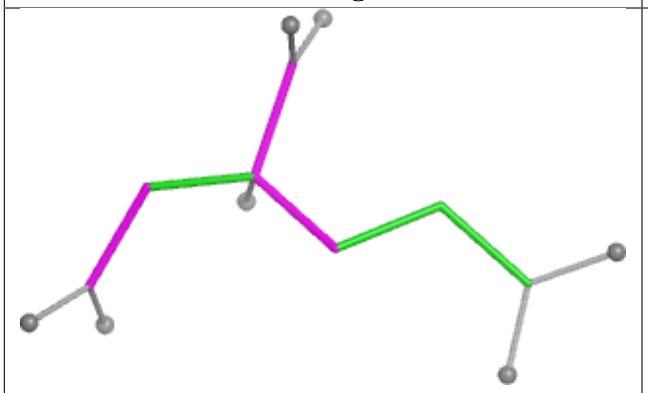
Ligand HCA A 1003



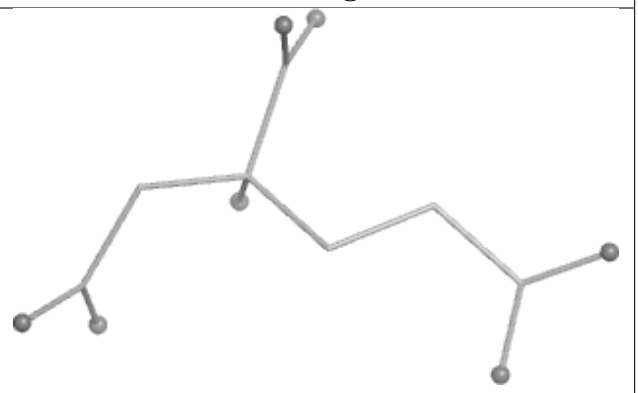
Bond lengths



Bond angles

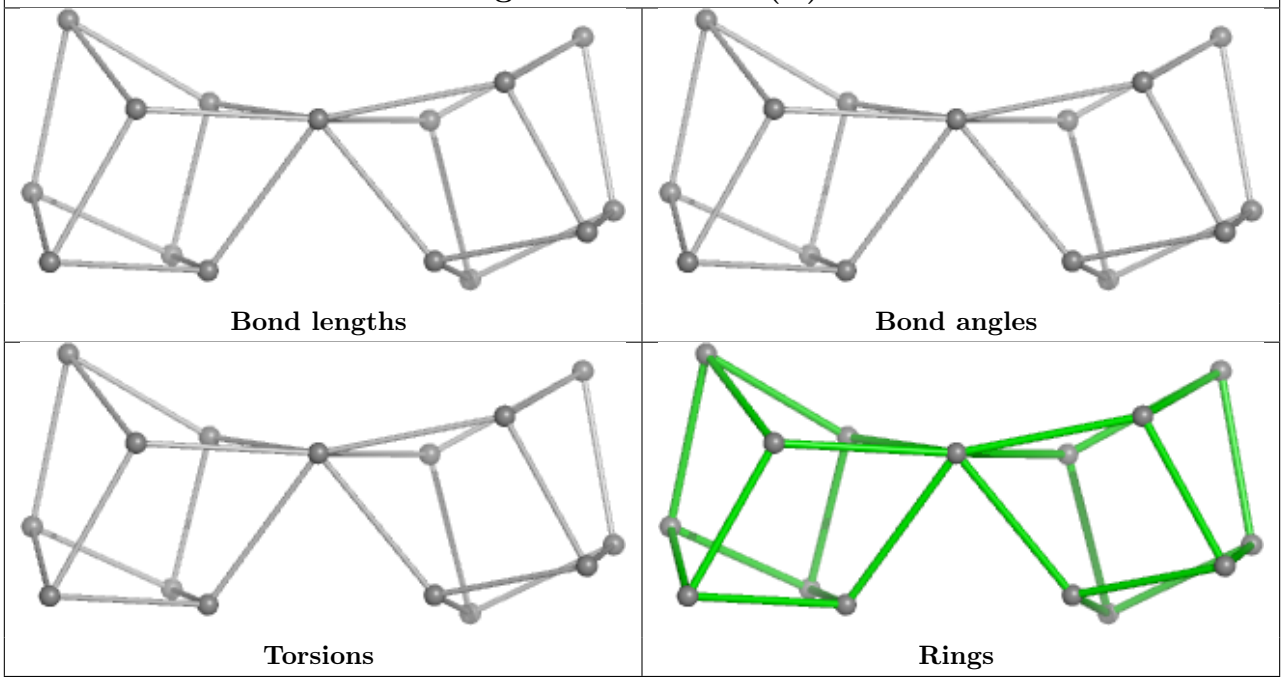


Torsions

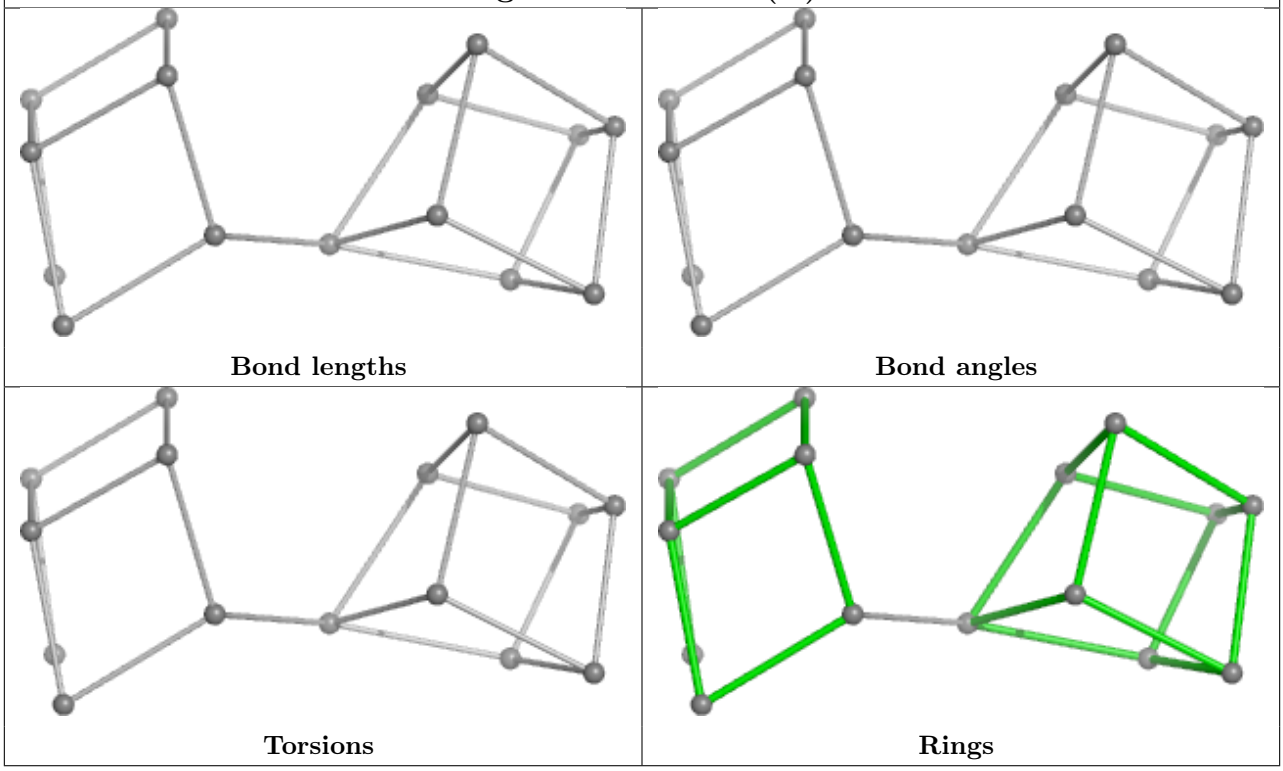


Rings

Ligand CLF B 614 (B)



Ligand 1CL B 613 (A)



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)

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	477/500 (95%)	-0.25	5 (1%)	79	85	8, 17, 34, 46	5 (1%)
1	C	477/500 (95%)	-0.45	1 (0%)	91	94	5, 13, 28, 46	5 (1%)
2	B	522/523 (99%)	-0.27	3 (0%)	85	89	7, 19, 32, 46	3 (0%)
2	D	522/523 (99%)	-0.48	0	100	100	6, 14, 26, 40	2 (0%)
All	All	1998/2046 (97%)	-0.36	9 (0%)	87	90	5, 16, 31, 46	15 (0%)

The worst 5 of 9 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	39	VAL	3.0
1	C	473	LYS	2.7
1	A	121	LYS	2.5
2	B	417[A]	LYS	2.4
1	A	38	ALA	2.2

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	EDO	D	716	4/4	0.60	0.18	36,40,42,59	0
8	GOL	B	611	6/6	0.60	0.19	48,52,54,58	0
3	EDO	D	715[A]	4/4	0.67	0.14	15,17,17,19	4
7	DIO	D	712	6/6	0.68	0.24	28,31,37,40	0
3	EDO	B	610	4/4	0.73	0.17	41,46,50,51	0
3	EDO	D	713	4/4	0.75	0.17	33,39,44,46	0
3	EDO	D	706	4/4	0.77	0.14	28,29,30,37	0
3	EDO	B	607	4/4	0.78	0.20	33,33,34,54	0
3	EDO	A	1001	4/4	0.78	0.15	27,31,45,46	0
3	EDO	C	508	4/4	0.79	0.16	28,29,37,41	0
3	EDO	D	702	4/4	0.82	0.13	26,34,36,40	0
7	DIO	B	608	6/6	0.82	0.21	18,32,40,40	0
3	EDO	B	609	4/4	0.83	0.15	35,44,45,46	0
3	EDO	C	511	4/4	0.83	0.16	35,37,44,53	0
3	EDO	B	606	4/4	0.84	0.12	35,41,42,44	0
3	EDO	C	510	4/4	0.84	0.14	37,41,41,44	0
3	EDO	D	714[B]	4/4	0.84	0.11	15,17,17,19	4
3	EDO	D	704	4/4	0.84	0.14	25,37,38,43	0
3	EDO	C	507	4/4	0.86	0.18	24,26,28,32	0
3	EDO	C	509[A]	4/4	0.86	0.12	24,28,28,29	4
3	EDO	A	1006	4/4	0.87	0.10	26,29,31,32	0
3	EDO	D	701	4/4	0.87	0.12	26,27,31,32	0
3	EDO	B	612	4/4	0.87	0.15	25,25,26,30	0
3	EDO	C	505	4/4	0.88	0.13	20,20,29,36	0
3	EDO	A	1005	4/4	0.88	0.11	21,23,31,34	0
3	EDO	D	703	4/4	0.88	0.11	25,26,27,32	0
3	EDO	C	506	4/4	0.89	0.10	20,25,27,33	0
3	EDO	D	705	4/4	0.89	0.11	27,28,32,34	0
3	EDO	B	605	4/4	0.90	0.11	27,31,38,40	0
3	EDO	D	708	4/4	0.91	0.12	17,20,25,35	0
3	EDO	B	602	4/4	0.91	0.13	20,25,26,32	0
3	EDO	D	709	4/4	0.92	0.09	25,25,26,28	0
3	EDO	B	601	4/4	0.92	0.08	22,23,25,33	0
11	NA	C	502	1/1	0.93	0.13	46,46,46,46	0
3	EDO	B	603	4/4	0.94	0.07	14,15,17,19	0
3	EDO	D	707	4/4	0.94	0.10	15,17,17,18	0
3	EDO	D	710	4/4	0.95	0.06	18,18,21,30	0
5	HCA	A	1003	14/14	0.95	0.06	6,11,15,16	0
3	EDO	B	604	4/4	0.95	0.10	19,20,20,24	0
3	EDO	D	711	4/4	0.97	0.05	15,15,16,20	0
5	HCA	C	503	14/14	0.97	0.05	5,8,12,14	0
10	CLF	B	614[B]	15/15	0.97	0.05	13,15,16,17	15
4	CL	A	1002	1/1	0.97	0.12	24,24,24,24	0

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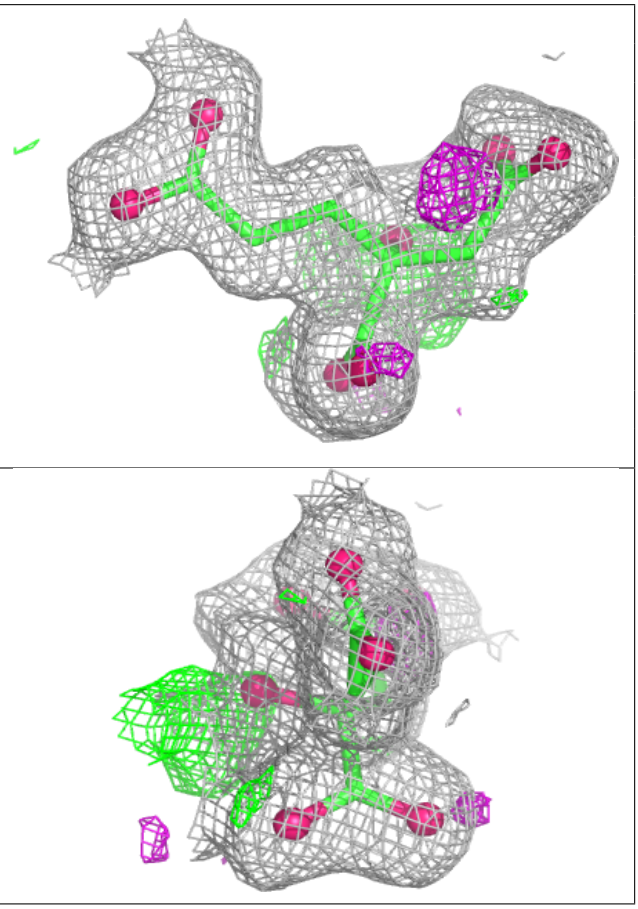
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å^2)	Q<0.9
9	1CL	B	613[A]	15/15	0.99	0.02	13,15,16,16	0
9	1CL	D	717[A]	15/15	0.99	0.02	9,10,11,12	0
6	ICS	A	1004	18/18	0.99	0.02	6,10,11,12	0
10	CLF	D	718[B]	15/15	0.99	0.04	9,10,13,13	15
4	CL	C	501	1/1	0.99	0.07	19,19,19,19	0
6	ICS	C	504	18/18	1.00	0.02	5,7,8,10	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.

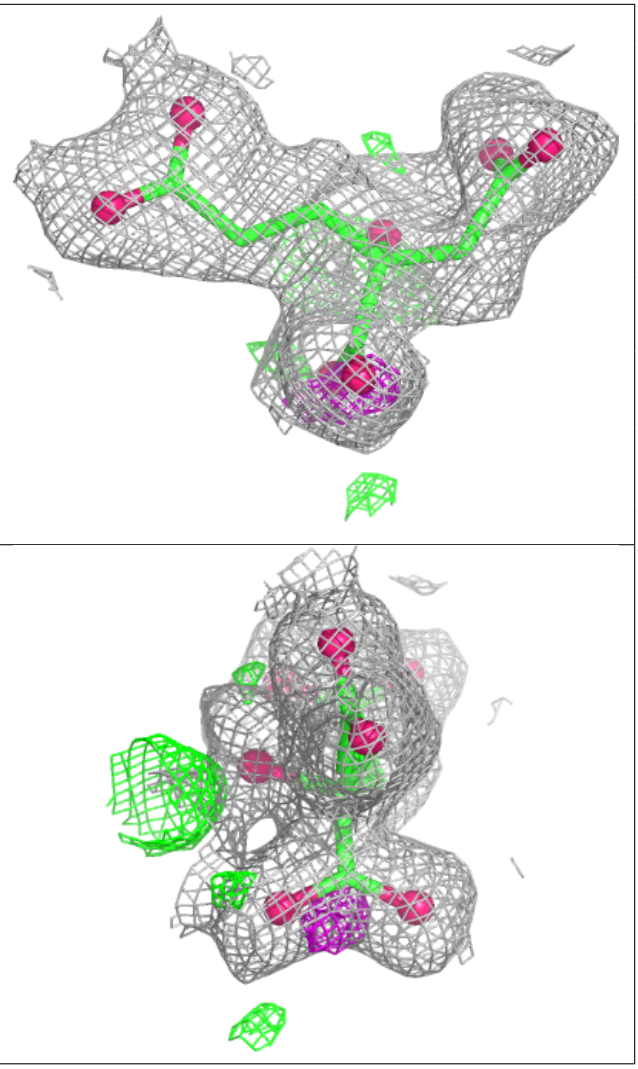
Electron density around HCA A 1003:

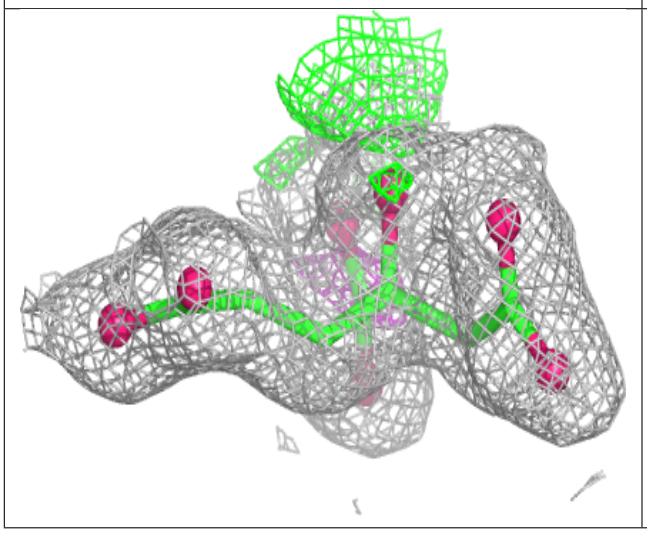
2mF$_o$-DF$_c$ (at 0.7 rmsd) in gray
mF$_o$-DF$_c$ (at 3 rmsd) in purple (negative) and green (positive)



Electron density around HCA C 503:

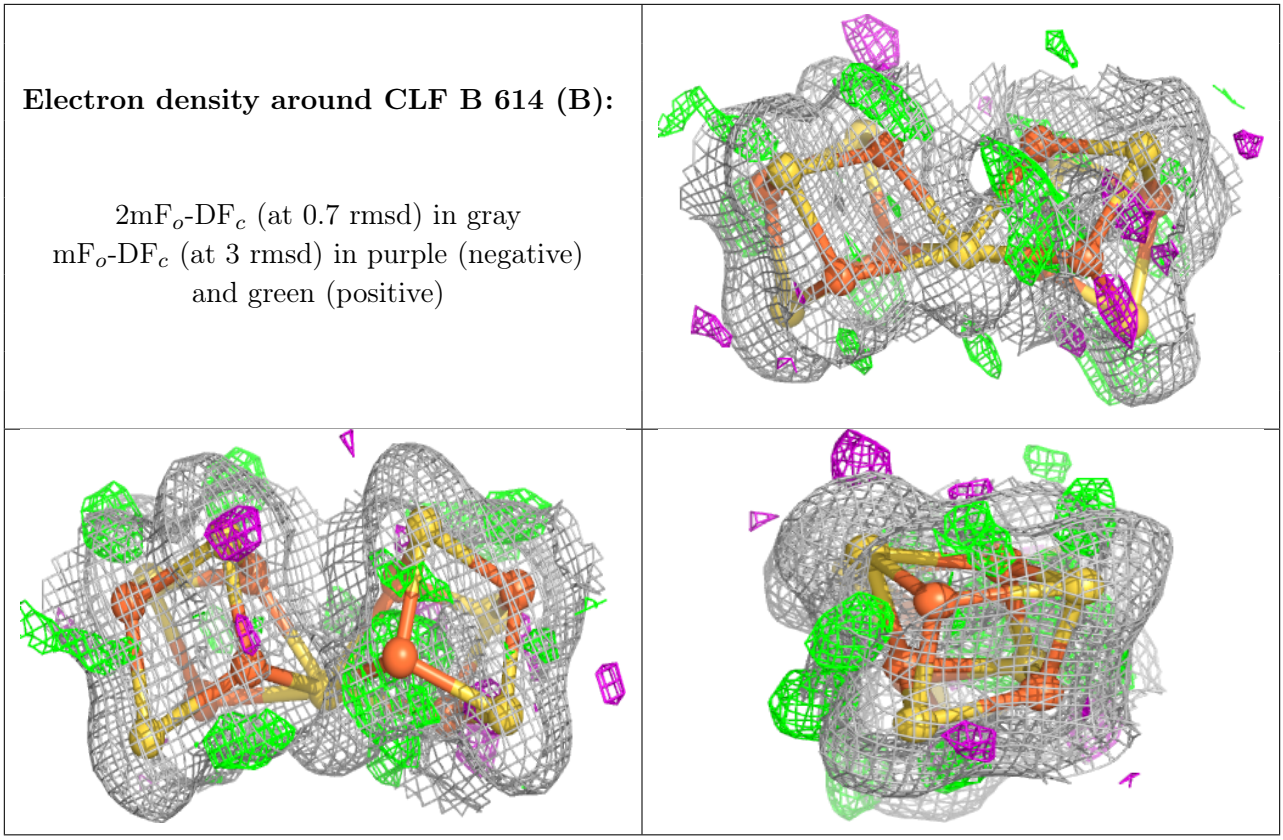
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)





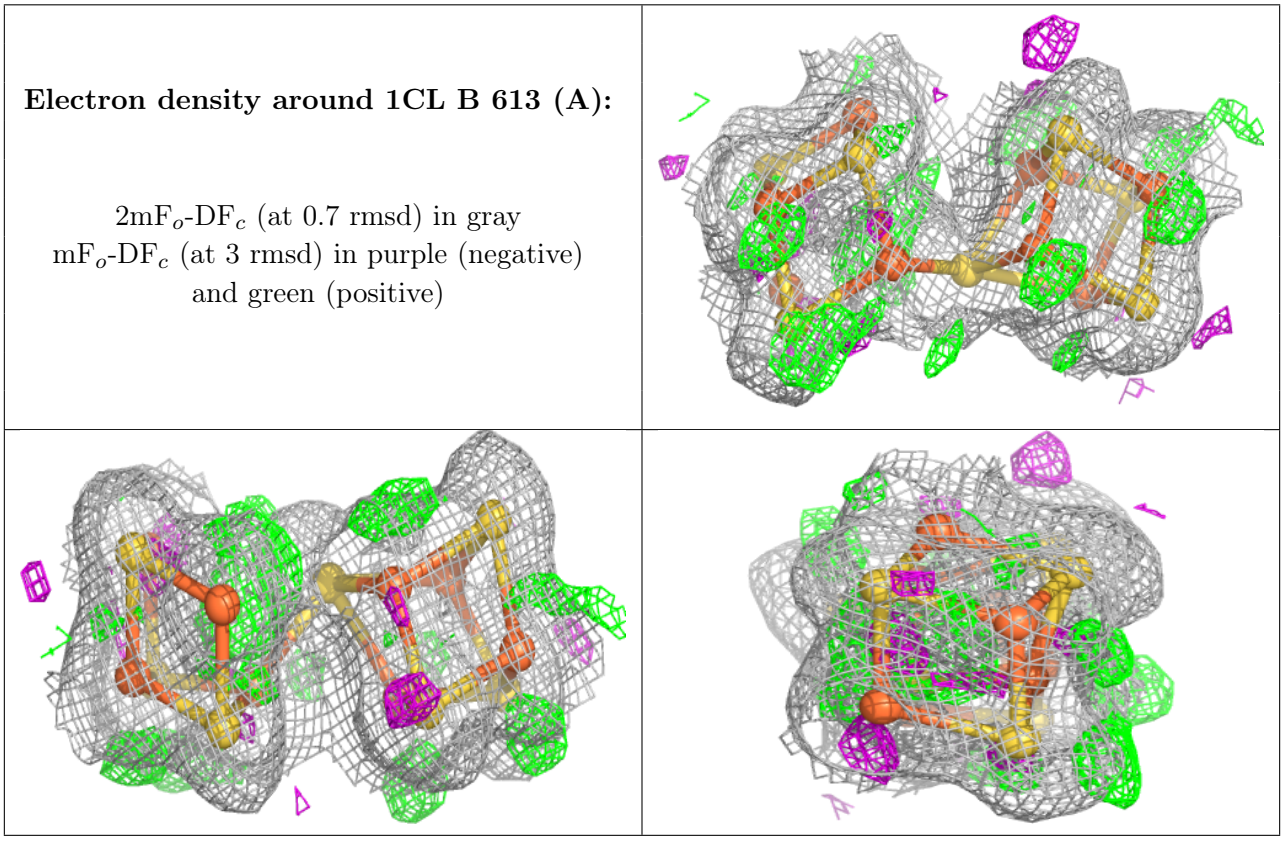
Electron density around CLF B 614 (B):

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



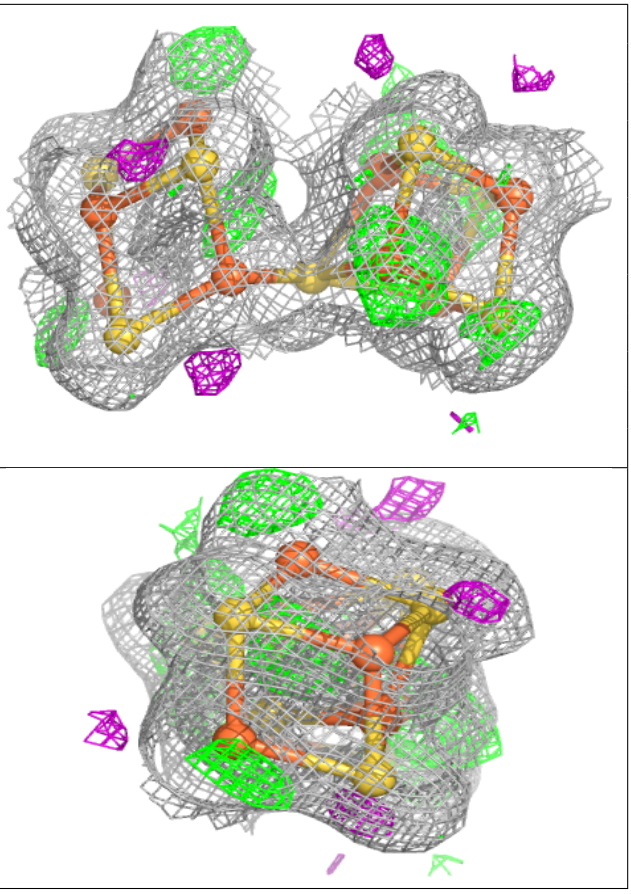
Electron density around 1CL B 613 (A):

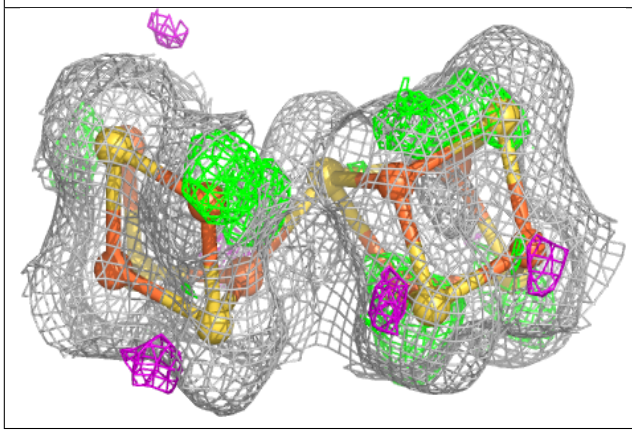
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)



Electron density around 1CL D 717 (A):

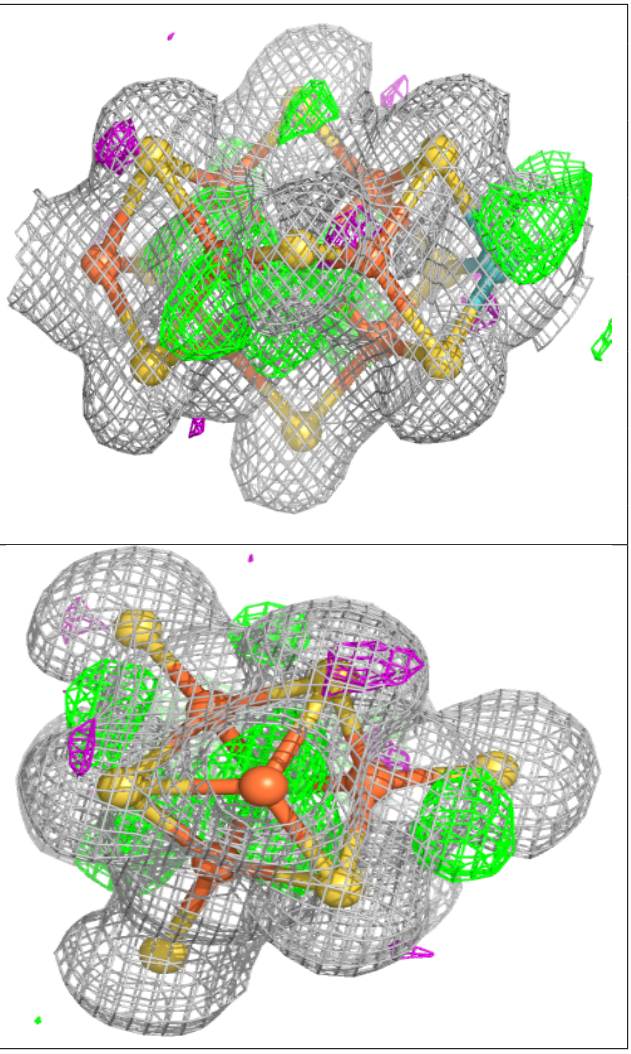
$2mF_o$-DF_c (at 0.7 rmsd) in gray
mF_o-DF_c (at 3 rmsd) in purple (negative)
and green (positive)





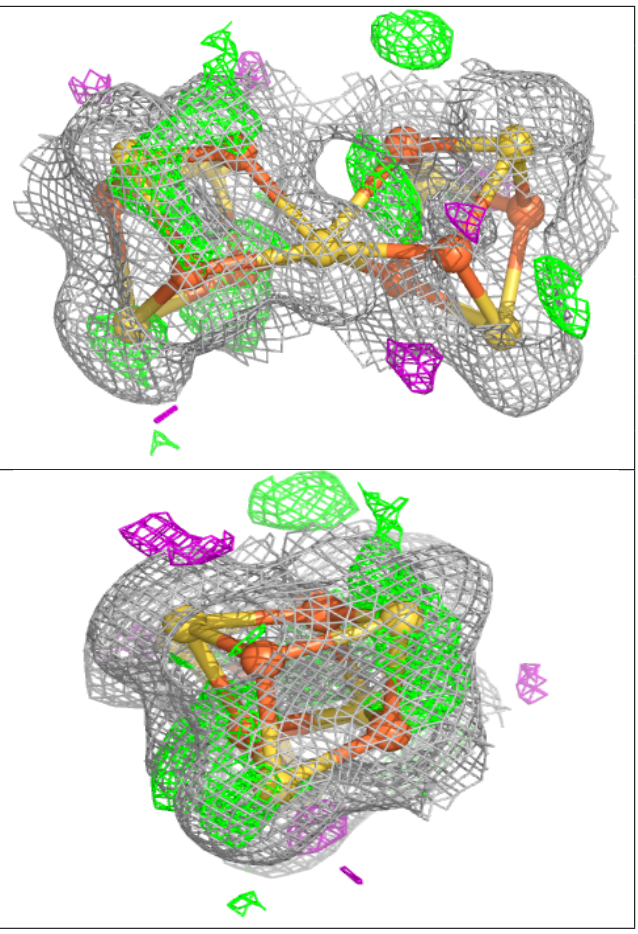
Electron density around ICS A 1004:

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



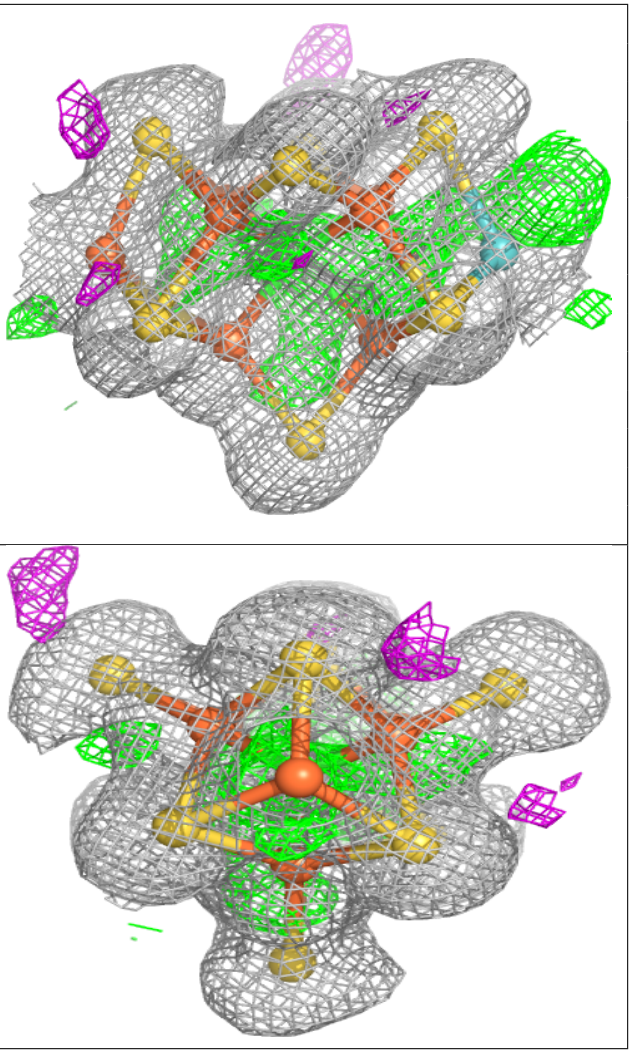
Electron density around CLF D 718 (B):

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



Electron density around ICS C 504:

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.