



Full wwPDB X-ray Structure Validation Report ⓘ

Jan 4, 2024 – 03:04 am GMT

PDB ID : 5ADU
Title : The Mechanism of Hydrogen Activation by NiFe-hydrogenases
Authors : Evans, R.; Brooke, E.J.; Wehlin, S.A.; Nomerotskaia, E.; Sargent, F.; Carr, S.B.; Phillips, S.E.V.; Armstrong, F.A.
Deposited on : 2015-08-24
Resolution : 1.10 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
Mogul : 1.8.4, CSD as541be (2020)
Xtriage (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

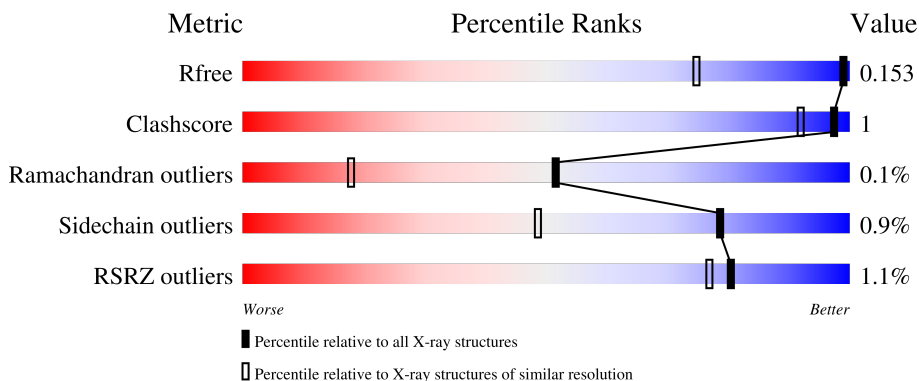
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

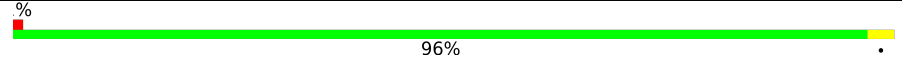
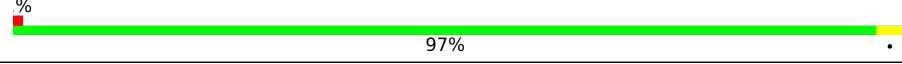
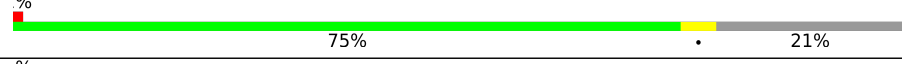

The reported resolution of this entry is 1.10 Å.

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	1619 (1.14-1.06)
Clashscore	141614	1671 (1.14-1.06)
Ramachandran outliers	138981	1615 (1.14-1.06)
Sidechain outliers	138945	1613 (1.14-1.06)
RSRZ outliers	127900	1588 (1.14-1.06)

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	L	582	 96%
1	M	582	 97%
2	S	335	 75% 21%
2	T	335	 73% 5% 21%

2 Entry composition

There are 12 unique types of molecules in this entry. The entry contains 14757 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 Hydrogenase-1 large chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	L	581	Total	C	N	O	S	0	27	0
			4707	2991	825	862	29			
1	M	581	Total	C	N	O	S	0	21	0
			4662	2966	810	857	29			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
L	118	ASN	ASP	engineered mutation	UNP P0ACD8
L	574	ASN	ASP	engineered mutation	UNP P0ACD8
M	118	ASN	ASP	engineered mutation	UNP P0ACD8
M	574	ASN	ASP	engineered mutation	UNP P0ACD8

- Molecule 2 is a protein called Hydrogenase-1 small chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	S	263	Total	C	N	O	S	0	10	0
			2089	1326	358	384	21			
2	T	264	Total	C	N	O	S	0	10	0
			2100	1334	362	383	21			

There are 16 discrepancies between the modelled and reference sequences:

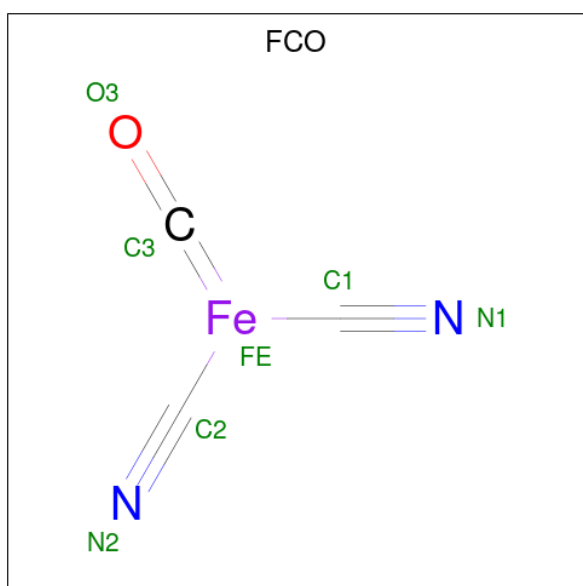
Chain	Residue	Modelled	Actual	Comment	Reference
S	328	ARG	-	expression tag	UNP P69739
S	329	SER	-	expression tag	UNP P69739
S	330	HIS	-	expression tag	UNP P69739
S	331	HIS	-	expression tag	UNP P69739
S	332	HIS	-	expression tag	UNP P69739
S	333	HIS	-	expression tag	UNP P69739
S	334	HIS	-	expression tag	UNP P69739
S	335	HIS	-	expression tag	UNP P69739

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Chain	Residue	Modelled	Actual	Comment	Reference
T	328	ARG	-	expression tag	UNP P69739
T	329	SER	-	expression tag	UNP P69739
T	330	HIS	-	expression tag	UNP P69739
T	331	HIS	-	expression tag	UNP P69739
T	332	HIS	-	expression tag	UNP P69739
T	333	HIS	-	expression tag	UNP P69739
T	334	HIS	-	expression tag	UNP P69739
T	335	HIS	-	expression tag	UNP P69739

- Molecule 3 is CARBONMONOXIDE-(DICYANO) IRON (three-letter code: FCO) (formula: C_3FeN_2O).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	
3	L	1	Total	C	Fe	N	O	0	0
			7	3	1	2	1		
3	M	1	Total	C	Fe	N	O	0	0
			7	3	1	2	1		

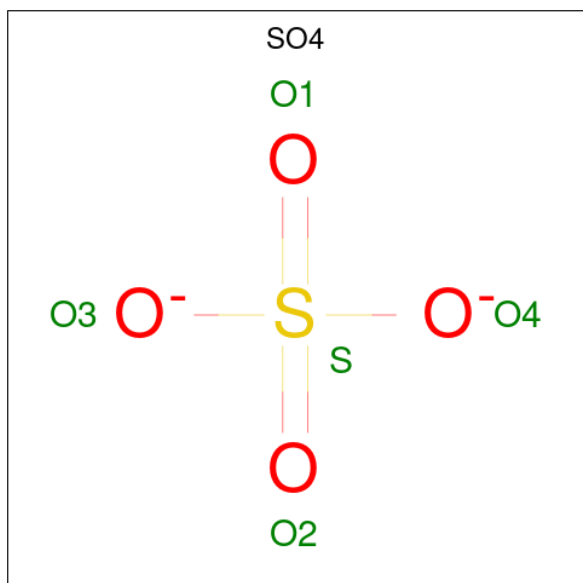
- Molecule 4 is NICKEL (II) ION (three-letter code: NI) (formula: Ni).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	L	1	Total	Ni	0	0
			1	1		
4	M	1	Total	Ni	0	0
			1	1		

- Molecule 5 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	L	1	Total	Mg	0	0
			1	1		
5	M	1	Total	Mg	0	0
			1	1		

- Molecule 6 is SULFATE ION (three-letter code: SO4) (formula: O₄S).



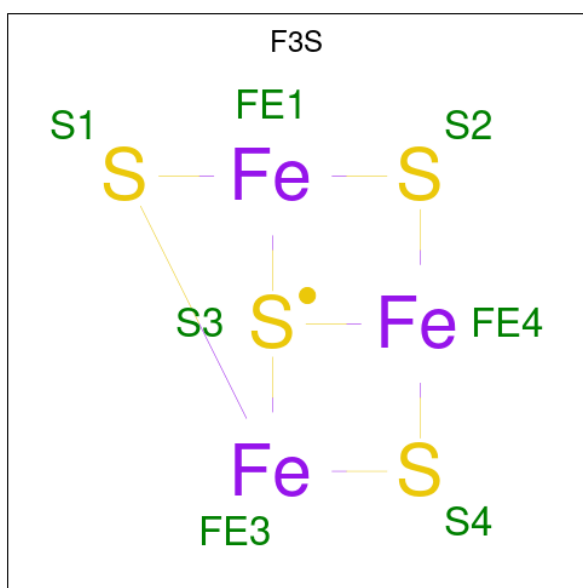
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	M	1	Total	O	S	0	0
			5	4	1		
6	S	1	Total	O	S	0	0
			5	4	1		

- Molecule 7 is IRON/SULFUR CLUSTER (three-letter code: SF4) (formula: Fe₄S₄).



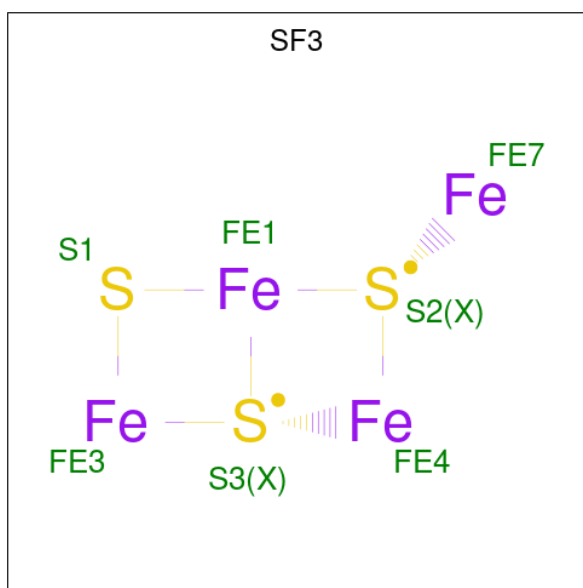
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
7	S	1	Total Fe S 8 4 4	0	0
7	T	1	Total Fe S 8 4 4	0	0

- Molecule 8 is FE3-S4 CLUSTER (three-letter code: F3S) (formula: Fe_3S_4).



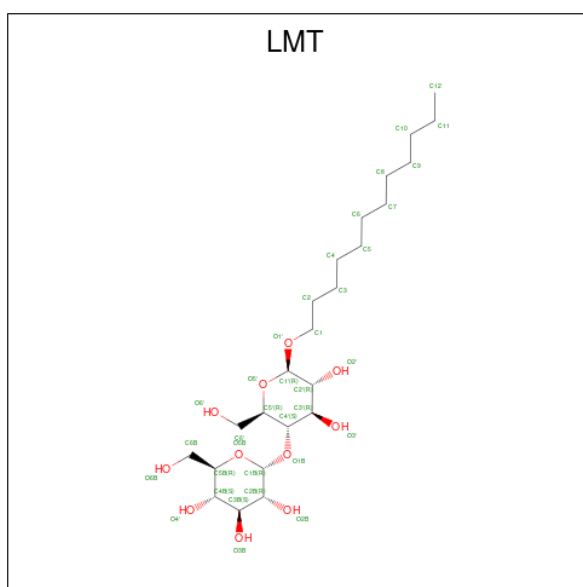
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
8	S	1	Total Fe S 7 3 4	0	0
8	T	1	Total Fe S 7 3 4	0	0

- Molecule 9 is FE4-S3 CLUSTER (three-letter code: SF3) (formula: Fe₄S₃).



Mol	Chain	Residues	Atoms		ZeroOcc	AltConf	
9	S	1	Total	Fe	S	0	1
			8	5	3		
9	T	1	Total	Fe	S	0	1
			8	5	3		

- Molecule 10 is DODECYL-BETA-D-MALTOSE (three-letter code: LMT) (formula: C₂₄H₄₆O₁₁).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
10	S	1	Total	C	O	0	0
			14	13	1		
10	T	1	Total	C	O	0	0
			14	13	1		

- Molecule 11 is CHLORIDE ION (three-letter code: CL) (formula: Cl).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
11	S	2	Total	Cl	0	0
			2	2		
11	T	2	Total	Cl	0	0
			2	2		

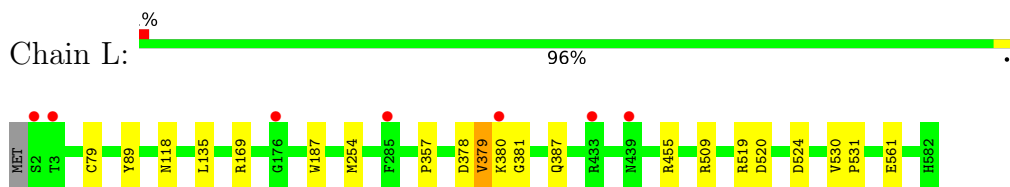
- Molecule 12 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
12	L	411	Total	O	0	0
			411	411		
12	M	418	Total	O	0	0
			418	418		
12	S	145	Total	O	0	0
			145	145		
12	T	119	Total	O	0	0
			119	119		

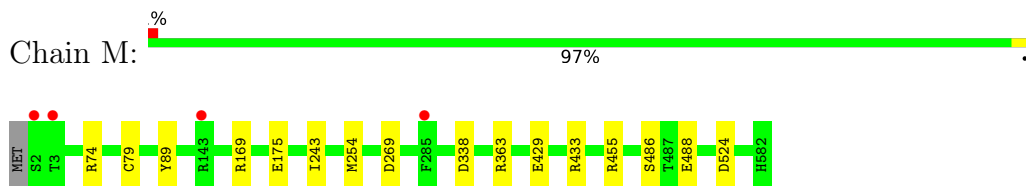
3 Residue-property plots [i](#)

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.

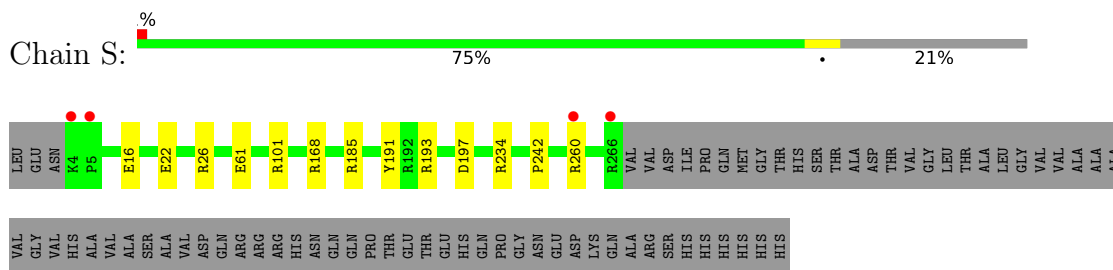
- Molecule 1: Hydrogenase-1 large chain



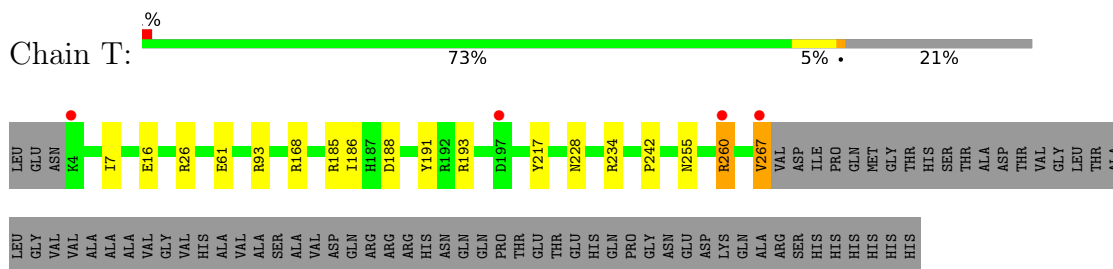
- Molecule 1: Hydrogenase-1 large chain



- Molecule 2: Hydrogenase-1 small chain



- Molecule 2: Hydrogenase-1 small chain



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	94.86Å 98.98Å 185.21Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	92.78 – 1.10 49.49 – 1.10	Depositor EDS
% Data completeness (in resolution range)	95.3 (92.78-1.10) 95.3 (49.49-1.10)	Depositor EDS
R_{merge}	0.16	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.71 (at 1.10Å)	Xtrriage
Refinement program	REFMAC 5.8.0131	Depositor
R, R_{free}	0.126 , 0.142 0.139 , 0.153	Depositor DCC
R_{free} test set	33299 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	7.8	Xtrriage
Anisotropy	0.032	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.35 , 47.4	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtrriage
Estimated twinning fraction	0.012 for k,h,-l	Xtrriage
F_o, F_c correlation	0.98	EDS
Total number of atoms	14757	wwPDB-VP
Average B, all atoms (Å ²)	10.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 7.28% 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: FCO, MG, SF3, LMT, NI, SO4, CSO, F3S, CL, SF4

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	L	0.83	1/4893 (0.0%)	0.81	10/6649 (0.2%)
1	M	0.83	0/4839	0.82	10/6576 (0.2%)
2	S	0.91	2/2171 (0.1%)	0.93	7/2945 (0.2%)
2	T	0.89	1/2182 (0.0%)	0.91	7/2959 (0.2%)
All	All	0.85	4/14085 (0.0%)	0.85	34/19129 (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
2	S	0	1
2	T	0	1
All	All	0	2

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	S	197	ASP	CB-CG	6.97	1.66	1.51
2	S	260	ARG	CZ-NH1	6.09	1.41	1.33
1	L	561	GLU	CD-OE1	5.50	1.31	1.25
2	T	260	ARG	CZ-NH1	5.50	1.40	1.33

All (34) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	T	260	ARG	NE-CZ-NH2	-10.89	114.85	120.30
2	S	260	ARG	NE-CZ-NH1	10.73	125.67	120.30
2	S	260	ARG	NE-CZ-NH2	-10.72	114.94	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	T	260	ARG	NE-CZ-NH1	9.92	125.26	120.30
1	M	363	ARG	NE-CZ-NH1	7.74	124.17	120.30
1	L	89	TYR	CB-CG-CD1	7.25	125.35	121.00
1	M	89	TYR	CB-CG-CD1	7.12	125.27	121.00
1	M	89	TYR	CB-CG-CD2	-6.63	117.02	121.00
2	S	193	ARG	NE-CZ-NH2	-6.37	117.11	120.30
2	S	193	ARG	NE-CZ-NH1	6.28	123.44	120.30
1	M	455	ARG	NE-CZ-NH2	-6.27	117.16	120.30
1	L	509	ARG	NE-CZ-NH2	-6.24	117.18	120.30
2	S	185	ARG	NE-CZ-NH1	6.14	123.37	120.30
2	T	193	ARG	NE-CZ-NH1	6.05	123.33	120.30
1	M	169	ARG	NE-CZ-NH2	-6.02	117.29	120.30
1	L	89	TYR	CB-CG-CD2	-6.01	117.39	121.00
1	M	169	ARG	NE-CZ-NH1	5.96	123.28	120.30
1	L	169	ARG	NE-CZ-NH1	5.69	123.14	120.30
1	L	379[A]	VAL	N-CA-C	-5.68	95.66	111.00
1	L	379[B]	VAL	N-CA-C	-5.68	95.66	111.00
2	T	93	ARG	NE-CZ-NH1	5.63	123.11	120.30
2	T	185	ARG	NE-CZ-NH1	5.58	123.09	120.30
2	S	197	ASP	CB-CG-OD1	5.56	123.30	118.30
2	S	22	GLU	OE1-CD-OE2	-5.54	116.65	123.30
2	T	168	ARG	NE-CZ-NH1	5.47	123.03	120.30
1	L	379[A]	VAL	CB-CA-C	5.45	121.76	111.40
1	L	379[B]	VAL	CB-CA-C	5.45	121.76	111.40
2	T	188	ASP	CB-CG-OD1	5.45	123.20	118.30
1	M	433[A]	ARG	NE-CZ-NH1	5.35	122.98	120.30
1	M	433[B]	ARG	NE-CZ-NH1	5.35	122.98	120.30
1	M	74	ARG	NE-CZ-NH2	-5.20	117.70	120.30
1	L	509	ARG	NE-CZ-NH1	5.13	122.86	120.30
1	L	455	ARG	NE-CZ-NH2	-5.09	117.75	120.30
1	M	338	ASP	CB-CG-OD1	5.07	122.86	118.30

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	S	26	ARG	Sidechain
2	T	26	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	L	4707	0	4653	7	0
1	M	4662	0	4601	6	0
2	S	2089	0	2039	3	0
2	T	2100	0	2058	7	0
3	L	7	0	0	0	0
3	M	7	0	0	0	0
4	L	1	0	0	0	0
4	M	1	0	0	0	0
5	L	1	0	0	0	0
5	M	1	0	0	0	0
6	M	5	0	0	0	0
6	S	5	0	0	0	0
7	S	8	0	0	0	0
7	T	8	0	0	0	0
8	S	7	0	0	0	0
8	T	7	0	0	0	0
9	S	8	0	0	0	0
9	T	8	0	0	0	0
10	S	14	0	25	0	0
10	T	14	0	25	1	0
11	S	2	0	0	0	0
11	T	2	0	0	0	0
12	L	411	0	0	0	0
12	M	418	0	0	3	0
12	S	145	0	0	0	0
12	T	119	0	0	1	0
All	All	14757	0	13401	21	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 1.

All (21) 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:S:61[B]:GLU:OE2	2:S:101[B]:ARG:NH1	1.80	1.15

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:S:234[A]:ARG:HD3	2:T:234[A]:ARG:NH1	1.71	1.05
1:M:175[B]:GLU:HG3	12:M:2149:HOH:O	1.77	0.83
1:M:486[A]:SER:OG	1:M:488[A]:GLU:OE2	2.03	0.76
1:M:269[B]:ASP:OD1	12:M:2225:HOH:O	2.04	0.75
1:M:243:ILE:HG23	1:M:254[B]:MET:HG2	1.73	0.70
1:L:79:CSO:OD	1:L:79:CSO:N	2.24	0.70
1:M:79:CSO:N	1:M:79:CSO:OD	2.27	0.68
2:S:234[A]:ARG:CD	2:T:234[A]:ARG:NH1	2.54	0.66
1:L:254[B]:MET:HA	1:L:254[B]:MET:HE2	1.81	0.61
2:T:61[B]:GLU:HG2	12:T:2020:HOH:O	2.04	0.57
1:M:429[B]:GLU:HG3	12:M:2350:HOH:O	2.08	0.53
2:T:255:ASN:O	2:T:260:ARG:NH2	2.36	0.52
1:L:135:LEU:HD22	1:L:187:TRP:CD1	2.45	0.51
1:L:378:ASP:OD1	1:L:379[A]:VAL:O	2.32	0.47
2:T:217:TYR:HE1	2:T:267:VAL:HG12	1.80	0.47
1:L:519[B]:ARG:HG2	1:L:520:ASP:OD2	2.16	0.44
1:L:380[A]:LYS:O	1:L:387:GLN:HB2	2.20	0.42
2:T:7:ILE:HG21	10:T:404:LMT:H62	2.02	0.41
1:L:530:VAL:CG1	1:L:531:PRO:HD2	2.51	0.40
2:T:186:ILE:HD11	2:T:228:ASN:HB3	2.04	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	L	606/582 (104%)	587 (97%)	17 (3%)	2 (0%)	41 15
1	M	600/582 (103%)	586 (98%)	14 (2%)	0	100 100
2	S	271/335 (81%)	259 (96%)	12 (4%)	0	100 100
2	T	272/335 (81%)	259 (95%)	13 (5%)	0	100 100
All	All	1749/1834 (95%)	1691 (97%)	56 (3%)	2 (0%)	51 18

All (2) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	L	381[A]	GLY
1	L	381[B]	GLY

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	L	506/480 (105%)	503 (99%)	3 (1%)	86	61
1	M	501/480 (104%)	500 (100%)	1 (0%)	93	77
2	S	226/274 (82%)	221 (98%)	5 (2%)	52	13
2	T	227/274 (83%)	222 (98%)	5 (2%)	52	13
All	All	1460/1508 (97%)	1446 (99%)	14 (1%)	78	44

All (14) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	L	118	ASN
1	L	357	PRO
1	L	524	ASP
1	M	524	ASP
2	S	16[A]	GLU
2	S	16[B]	GLU
2	S	168	ARG
2	S	191	TYR
2	S	242	PRO
2	T	16[A]	GLU
2	T	16[B]	GLU
2	T	191	TYR
2	T	242	PRO
2	T	267	VAL

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

Mol	Chain	Res	Type
1	L	328	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](#)

2 non-standard protein/DNA/RNA residues are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z > 2$	Counts	RMSZ	$\# Z > 2$
1	CSO	M	79	3,4,1	3,6,7	0.88	0	0,6,8	-	-
1	CSO	L	79	3,4,1	3,6,7	0.87	0	0,6,8	-	-

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
1	CSO	M	79	3,4,1	-	0/1/5/7	-
1	CSO	L	79	3,4,1	-	0/1/5/7	-

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.

2 monomers are involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	M	79	CSO	1	0

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Mol	Chain	Res	Type	Clashes	Symm-Clashes
1	L	79	CSO	1	0

5.5 Carbohydrates [i](#)

There are no monosaccharides in this entry.

5.6 Ligand geometry [i](#)

Of 22 ligands modelled in this entry, 8 are monoatomic - leaving 14 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	$\# Z > 2$
7	SF4	S	401	2	0,12,12	-	-	-		
9	SF3	S	403[C]	2,9	0,8,8	-	-	-		
6	SO4	M	604	-	4,4,4	0.56	0	6,6,6	0.36	0
9	SF3	S	403[B]	-	0,8,8	-	-	-		
10	LMT	S	404	-	13,13,36	0.52	0	12,12,47	0.86	0
6	SO4	S	407	-	4,4,4	0.45	0	6,6,6	0.60	0
3	FCO	M	601	12,4,1	0,6,6	-	-	-		
9	SF3	T	403[C]	2,9	0,8,8	-	-	-		
10	LMT	T	404	-	13,13,36	0.43	0	12,12,47	0.59	0
8	F3S	S	402	2	0,9,9	-	-	-		
9	SF3	T	403[B]	-	0,8,8	-	-	-		
8	F3S	T	402	2	0,9,9	-	-	-		
7	SF4	T	401	2	0,12,12	-	-	-		
3	FCO	L	601	12,4,1	0,6,6	-	-	-		

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
7	SF4	S	401	2	-	-	0/6/5/5

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
10	LMT	S	404	-	-	4/11/11/61	-
9	SF3	S	403[B]	-	-	-	0/2/2/2
9	SF3	S	403[C]	2,9	-	-	0/2/2/2
9	SF3	T	403[C]	2,9	-	-	0/2/2/2
10	LMT	T	404	-	-	6/11/11/61	-
8	F3S	S	402	2	-	-	0/3/3/3
9	SF3	T	403[B]	-	-	-	0/2/2/2
8	F3S	T	402	2	-	-	0/3/3/3
7	SF4	T	401	2	-	-	0/6/5/5

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (10) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
10	T	404	LMT	O1'-C1-C2-C3
10	S	404	LMT	O1'-C1-C2-C3
10	T	404	LMT	C2-C1-O1'-C1'
10	T	404	LMT	C4-C5-C6-C7
10	S	404	LMT	C4-C5-C6-C7
10	T	404	LMT	C1-C2-C3-C4
10	S	404	LMT	C5-C6-C7-C8
10	T	404	LMT	C2-C3-C4-C5
10	T	404	LMT	C11-C10-C9-C8
10	S	404	LMT	C2-C1-O1'-C1'

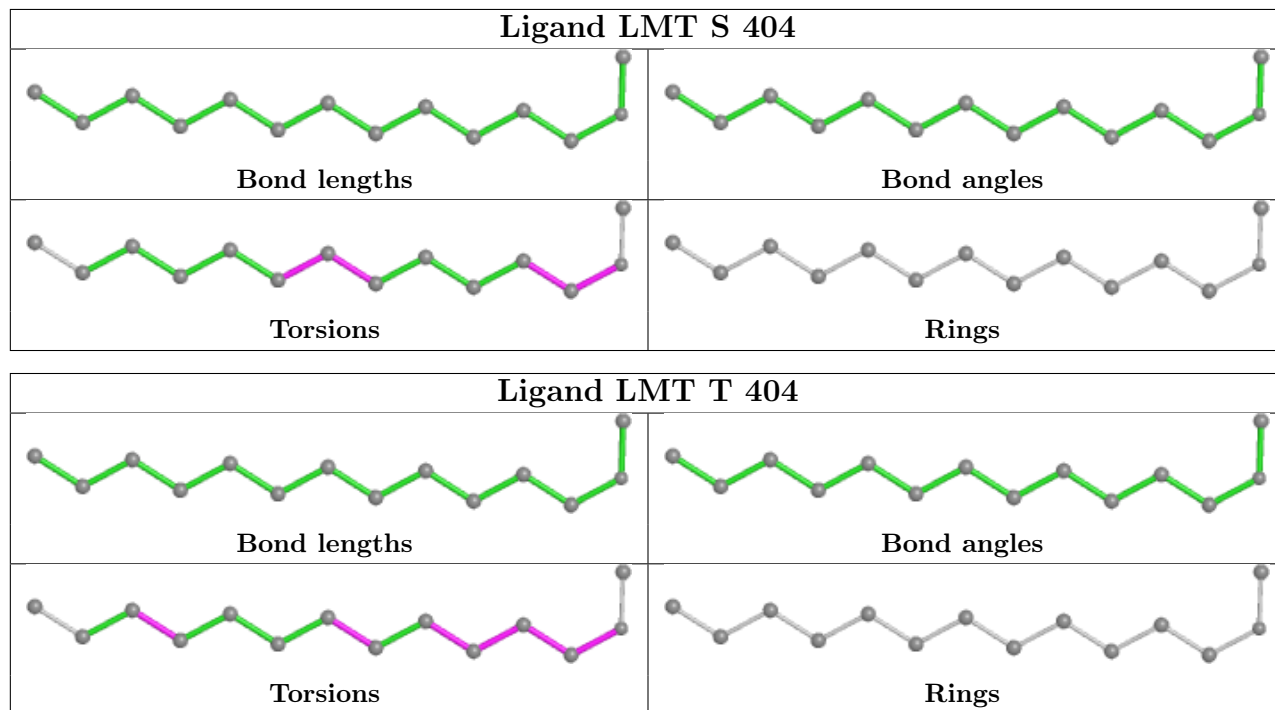
There are no ring outliers.

1 monomer is involved in 1 short contact:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
10	T	404	LMT	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 [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	L	580/582 (99%)	-0.30	7 (1%) 79 76	5, 9, 21, 45	0
1	M	580/582 (99%)	-0.36	4 (0%) 87 86	5, 9, 18, 31	0
2	S	263/335 (78%)	-0.27	4 (1%) 73 69	5, 8, 16, 46	0
2	T	264/335 (78%)	-0.25	4 (1%) 73 69	5, 9, 17, 46	0
All	All	1687/1834 (91%)	-0.31	19 (1%) 80 77	5, 9, 19, 46	0

All (19) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	T	267	VAL	7.4
2	T	4	LYS	4.7
2	S	4	LYS	3.7
1	M	143	ARG	3.3
1	L	433	ARG	3.0
1	M	2	SER	2.9
1	L	285	PHE	2.8
1	L	2	SER	2.7
1	L	439[A]	ASN	2.5
2	T	197	ASP	2.4
1	M	285	PHE	2.4
2	S	260	ARG	2.4
2	S	266	ARG	2.3
1	M	3	THR	2.3
2	S	5	PRO	2.3
1	L	380[A]	LYS	2.2
1	L	3	THR	2.2
2	T	260	ARG	2.2
1	L	176	GLY	2.2

6.2 Non-standard residues in protein, DNA, RNA chains [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
1	CSO	L	79	7/8	0.98	0.09	5,6,8,17	0
1	CSO	M	79	7/8	0.98	0.09	6,6,9,17	0

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.

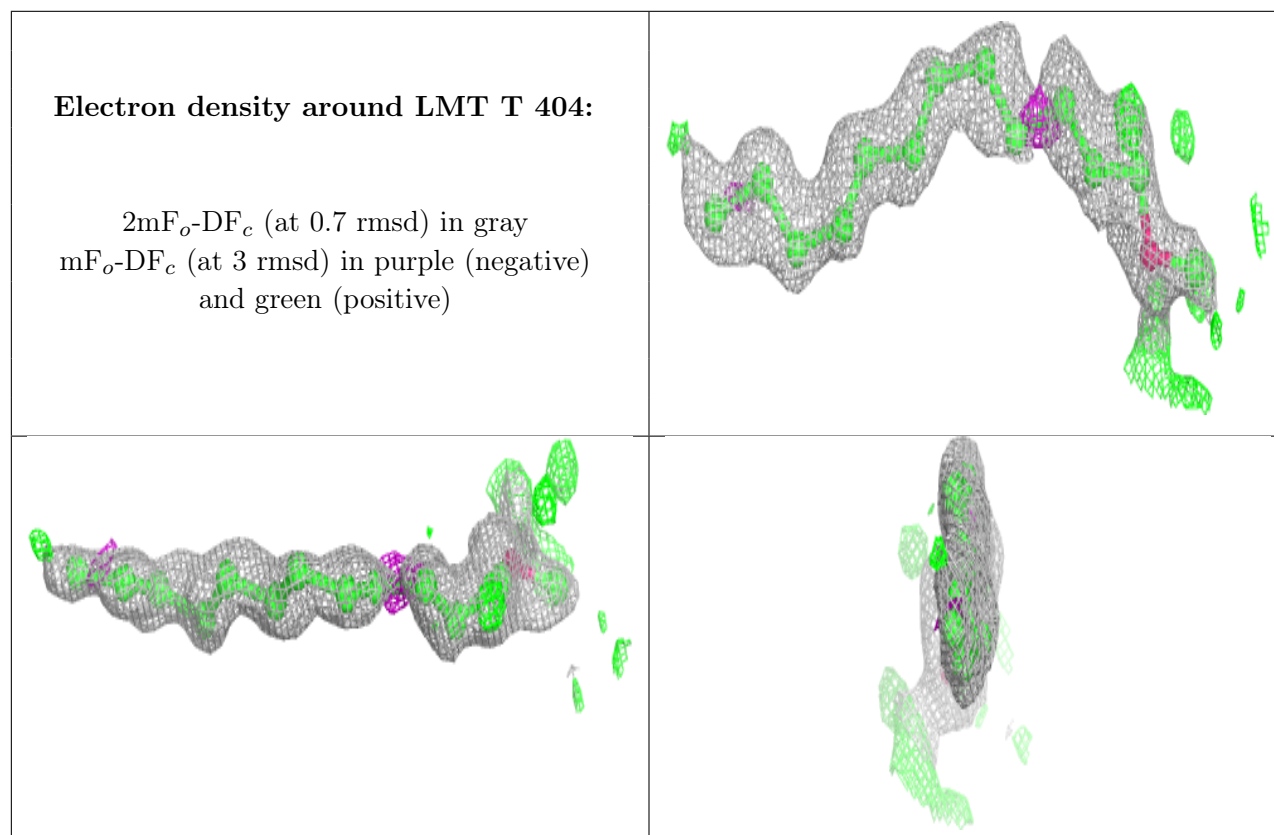
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å ²)	Q<0.9
10	LMT	T	404	14/35	0.86	0.17	18,26,33,35	0
10	LMT	S	404	14/35	0.88	0.14	15,26,34,37	0
6	SO4	M	604	5/5	0.89	0.32	38,39,52,57	0
6	SO4	S	407	5/5	0.96	0.19	17,17,22,23	0
5	MG	L	603	1/1	1.00	0.06	4,4,4,4	0
5	MG	M	603	1/1	1.00	0.08	4,4,4,4	0
3	FCO	L	601	7/7	1.00	0.05	5,6,7,7	0
3	FCO	M	601	7/7	1.00	0.05	5,6,7,7	0
7	SF4	S	401	8/8	1.00	0.04	5,5,5,5	0
7	SF4	T	401	8/8	1.00	0.04	5,5,5,5	0
8	F3S	S	402	7/7	1.00	0.04	5,5,6,6	0
8	F3S	T	402	7/7	1.00	0.04	5,5,6,6	0
9	SF3	S	403[B]	7/7	1.00	0.04	5,6,6,6	1
9	SF3	S	403[C]	7/7	1.00	0.04	5,6,6,17	1
9	SF3	T	403[B]	7/7	1.00	0.04	5,6,6,6	1
9	SF3	T	403[C]	7/7	1.00	0.04	5,6,6,17	1
4	NI	L	602	1/1	1.00	0.05	14,14,14,14	0
4	NI	M	602	1/1	1.00	0.06	14,14,14,14	0
11	CL	S	405	1/1	1.00	0.04	9,9,9,9	0
11	CL	S	406	1/1	1.00	0.05	15,15,15,15	0

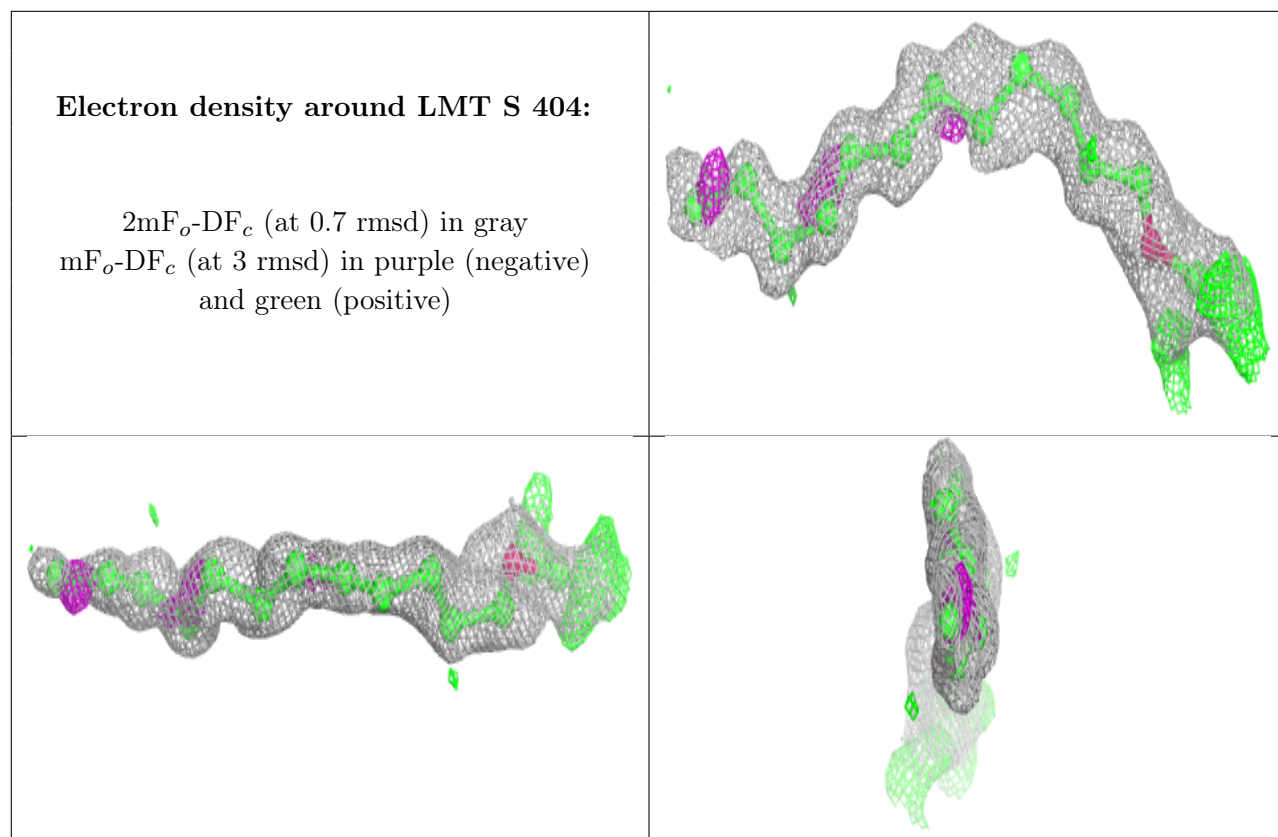
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Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(\AA^2)	Q<0.9
11	CL	T	405	1/1	1.00	0.03	10,10,10,10	0
11	CL	T	406	1/1	1.00	0.07	17,17,17,17	0

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.





6.5 Other polymers [i](#)

There are no such residues in this entry.