



# wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 5, 2026 – 01:03 PM UTC

PDB ID : 6VCF / pdb\_00006vcf  
Title : Crystal structure of Nitrosotalea devanaterrea carotenoid cleavage dioxygenase, iron form  
Authors : Daruwalla, A.; Shi, W.; Kiser, P.D.  
Deposited on : 2019-12-20  
Resolution : 2.69 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](mailto: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>.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4-5-2 with Phenix2.0  
Mogul : 2022.3.0, CSD as543be (2022)  
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

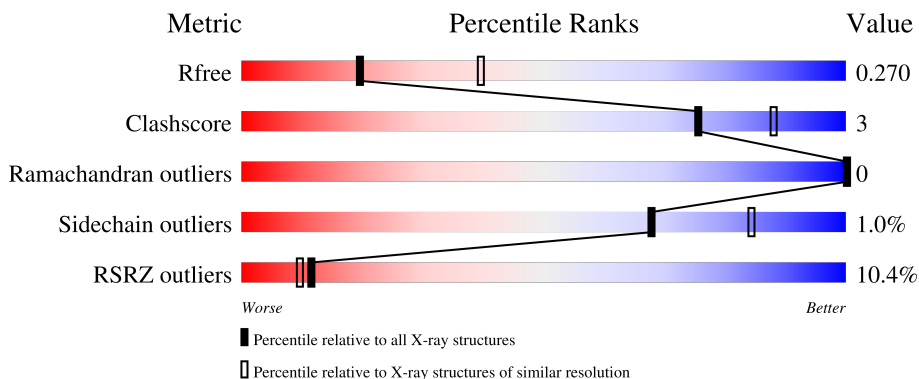
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.69 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	5070 (2.70-2.66)
Clashscore	190562	5409 (2.70-2.66)
Ramachandran outliers	187476	5324 (2.70-2.66)
Sidechain outliers	187428	5324 (2.70-2.66)
RSRZ outliers	180081	5070 (2.70-2.66)

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  $\geq 3$ , 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	472	 3% 87% 9%
1	B	472	 % 88% 8%
1	C	472	 % 88% 8%
1	D	472	 4% 87% 8%
1	E	472	 23% 84% 7% 8%

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Mol	Chain	Length	Quality of chain
1	F	472	 <p>A horizontal bar chart representing the quality of chain. The bar is divided into four segments: a red segment on the left labeled '26%', a large green segment labeled '84%', a small yellow segment labeled '7%', and a small grey segment on the far right labeled '8%'.</p>

## 2 Entry composition [i](#)

There are 6 unique types of molecules in this entry. The entry contains 21655 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 carotenoid cleavage dioxygenase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	453	Total 3636	C 2343	N 594	O 692	S 7	0	1	0
1	B	455	Total 3655	C 2357	N 599	O 692	S 7	0	0	0
1	C	453	Total 3630	C 2342	N 594	O 687	S 7	0	0	0
1	D	452	Total 3617	C 2332	N 592	O 686	S 7	0	0	0
1	E	432	Total 3421	C 2204	N 556	O 654	S 7	0	0	0
1	F	434	Total 3435	C 2213	N 567	O 648	S 7	0	0	0

- Molecule 2 is FE (II) ION (CCD ID: FE2) (formula: Fe) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	1	Total 1	Fe 1	0	0
2	B	1	Total 1	Fe 1	0	0
2	C	1	Total 1	Fe 1	0	0
2	D	1	Total 1	Fe 1	0	0
2	E	1	Total 1	Fe 1	0	0
2	F	1	Total 1	Fe 1	0	0

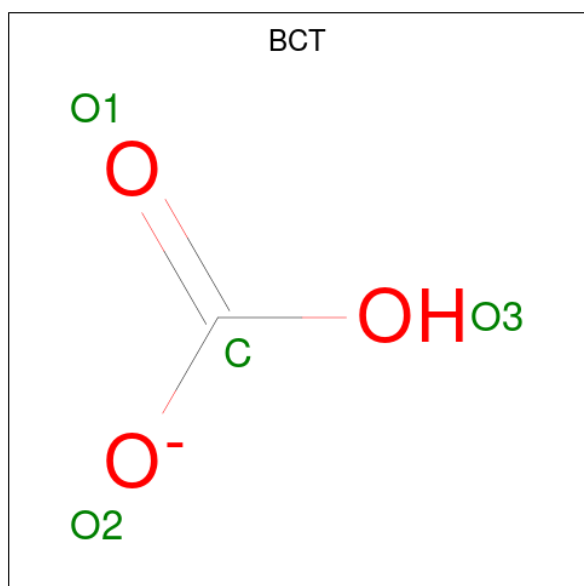
- Molecule 3 is CHLORIDE ION (CCD ID: CL) (formula: Cl).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total Cl 1 1	0	0

- Molecule 4 is SODIUM ION (CCD ID: NA) (formula: Na).

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

- Molecule 5 is BICARBONATE ION (CCD ID: BCT) (formula:  $\text{CHO}_3^-$ ).



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

- Molecule 6 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
6	A	68	Total O 68 68	0	0
6	B	68	Total O 68 68	0	0

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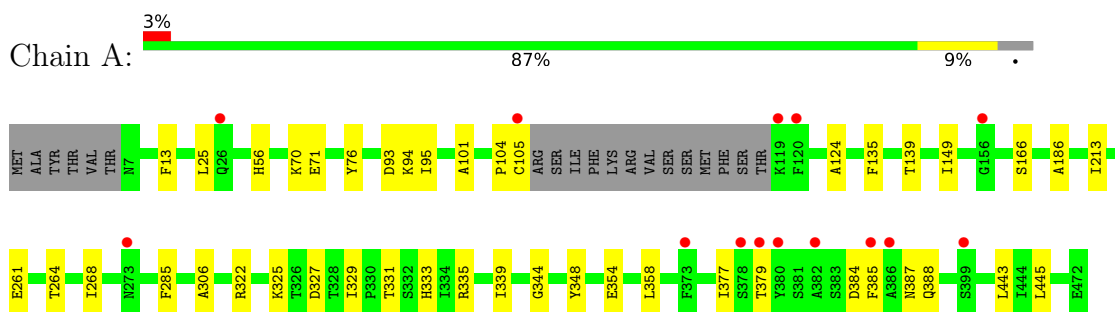
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<b>Mol</b>	<b>Chain</b>	<b>Residues</b>	<b>Atoms</b>		<b>ZeroOcc</b>	<b>AltConf</b>
6	C	42	Total 42	O 42	0	0
6	D	45	Total 45	O 45	0	0
6	E	12	Total 12	O 12	0	0
6	F	9	Total 9	O 9	0	0

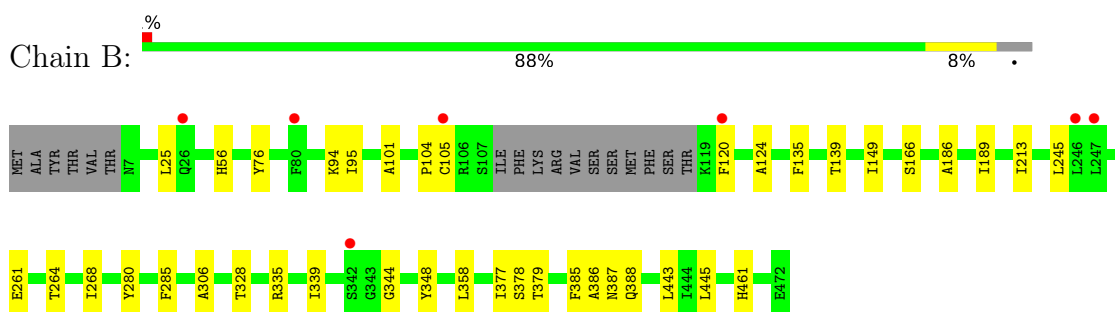
### 3 Residue-property plots [i](#)

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.

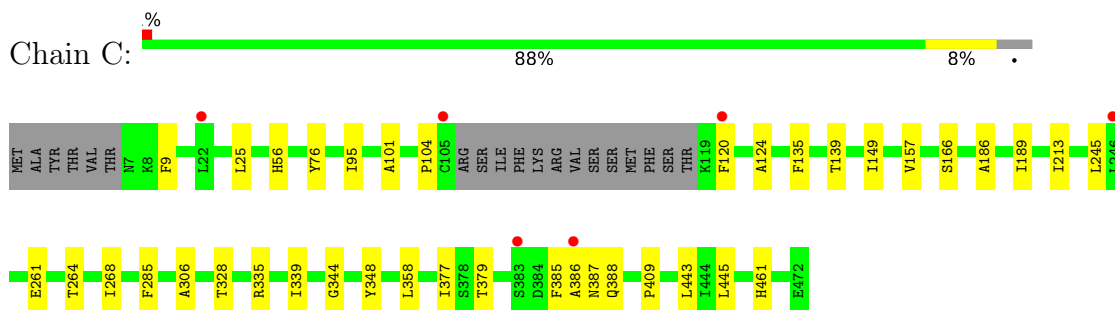
- Molecule 1: carotenoid cleavage dioxygenase



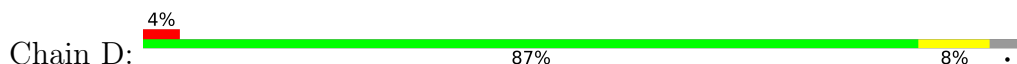
- Molecule 1: carotenoid cleavage dioxygenase

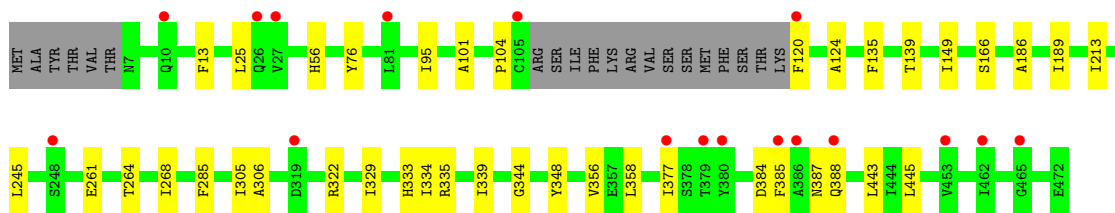


- Molecule 1: carotenoid cleavage dioxygenase

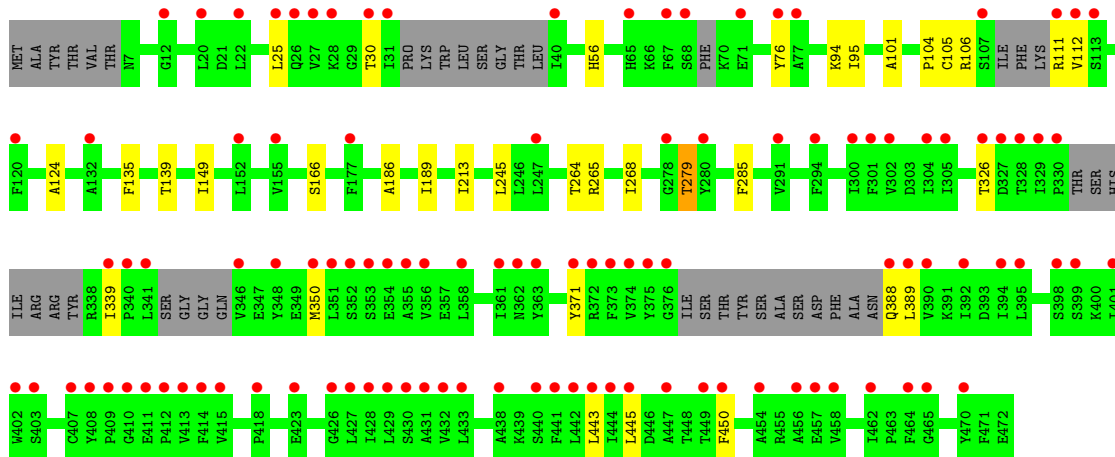
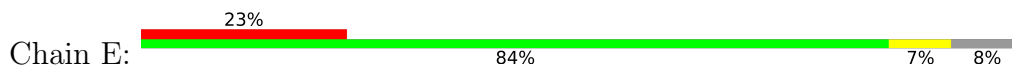


- Molecule 1: carotenoid cleavage dioxygenase

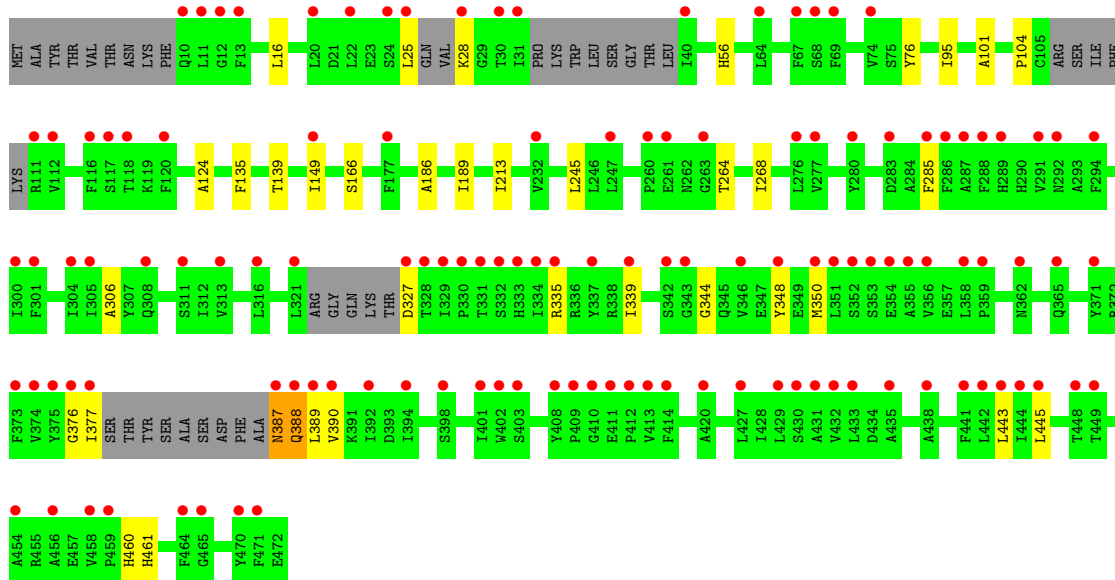
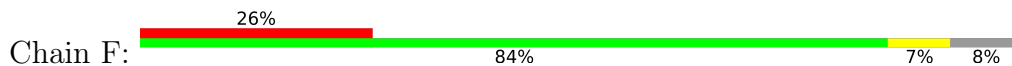




• Molecule 1: carotenoid cleavage dioxygenase



• Molecule 1: carotenoid cleavage dioxygenase



## 4 Data and refinement statistics i

Property	Value	Source
Space group	P 61	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	107.27Å 107.27Å 491.11Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	49.15 – 2.69 49.15 – 2.69	Depositor EDS
% Data completeness (in resolution range)	99.7 (49.15-2.69) 99.7 (49.15-2.69)	Depositor EDS
$R_{merge}$	0.18	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.03 (at 2.69Å)	Xtrriage
Refinement program	REFMAC 5.8.0258	Depositor
R, $R_{free}$	0.252 , 0.271 0.252 , 0.270	Depositor DCC
$R_{free}$ test set	4373 reflections (4.96%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	69.2	Xtrriage
Anisotropy	0.048	Xtrriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 69.5	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtrriage
Estimated twinning fraction	0.047 for h,-h-k,-l	Xtrriage
$F_o, F_c$ correlation	0.93	EDS
Total number of atoms	21655	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	91.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.83% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical 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: BCT, CL, FE2, 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	1.01	0/3729	1.30	1/5061 (0.0%)
1	B	1.00	0/3748	1.29	1/5080 (0.0%)
1	C	1.01	0/3723	1.29	1/5050 (0.0%)
1	D	1.01	0/3710	1.29	1/5034 (0.0%)
1	E	1.01	0/3502	1.28	0/4747
1	F	1.02	0/3518	1.29	1/4771 (0.0%)
All	All	1.01	0/21930	1.29	5/29743 (0.0%)

There are no bond length outliers.

All (5) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	344	GLY	CA-C-O	-5.75	118.26	122.23
1	A	344	GLY	CA-C-O	-5.69	118.31	122.23
1	D	344	GLY	CA-C-O	-5.67	118.32	122.23
1	B	344	GLY	CA-C-O	-5.67	118.32	122.23
1	F	344	GLY	CA-C-O	-5.63	118.34	122.23

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	3636	0	3505	26	0
1	B	3655	0	3558	20	0
1	C	3630	0	3518	21	0
1	D	3617	0	3495	22	0
1	E	3421	0	3263	23	0
1	F	3435	0	3281	22	0
2	A	1	0	0	0	0
2	B	1	0	0	0	0
2	C	1	0	0	0	0
2	D	1	0	0	0	0
2	E	1	0	0	0	0
2	F	1	0	0	0	0
3	A	1	0	0	0	0
4	A	1	0	0	0	0
4	B	1	0	0	0	0
5	B	4	0	0	0	0
5	C	4	0	0	0	0
6	A	68	0	0	0	0
6	B	68	0	0	0	0
6	C	42	0	0	0	0
6	D	45	0	0	0	0
6	E	12	0	0	0	0
6	F	9	0	0	0	0
All	All	21655	0	20620	127	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 3.

The worst 5 of 127 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:354[B]:GLU:OE1	1:A:354[B]:GLU:N	2.12	0.82
1:F:376:GLY:O	1:F:377:ILE:HG22	1.80	0.80
1:D:334:ILE:HG13	1:D:356:VAL:HG21	1.73	0.70
1:E:389:LEU:HG	1:E:450:PHE:CZ	2.27	0.69
1:D:306:ALA:HB3	1:D:335:ARG:HD3	1.76	0.67

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	450/472 (95%)	423 (94%)	27 (6%)	0	100	100
1	B	451/472 (96%)	425 (94%)	26 (6%)	0	100	100
1	C	449/472 (95%)	421 (94%)	28 (6%)	0	100	100
1	D	448/472 (95%)	419 (94%)	29 (6%)	0	100	100
1	E	418/472 (89%)	390 (93%)	28 (7%)	0	100	100
1	F	422/472 (89%)	397 (94%)	25 (6%)	0	100	100
All	All	2638/2832 (93%)	2475 (94%)	163 (6%)	0	100	100

There are no Ramachandran outliers to report.

### 5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	392/417 (94%)	390 (100%)	2 (0%)	81	91
1	B	397/417 (95%)	392 (99%)	5 (1%)	61	81
1	C	392/417 (94%)	387 (99%)	5 (1%)	61	81
1	D	390/417 (94%)	387 (99%)	3 (1%)	73	87
1	E	365/417 (88%)	362 (99%)	3 (1%)	73	87
1	F	363/417 (87%)	359 (99%)	4 (1%)	65	83
All	All	2299/2502 (92%)	2277 (99%)	22 (1%)	68	84

5 of 22 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	D	388	GLN
1	E	388	GLN
1	E	371	TYR
1	F	28	LYS
1	B	461	HIS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 16 such sidechains are listed below:

Mol	Chain	Res	Type
1	F	367	ASN
1	F	208	ASN
1	D	461	HIS
1	F	180	ASN
1	D	208	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 [i](#)

Of 11 ligands modelled in this entry, 9 are monoatomic - leaving 2 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
5	BCT	B	502	2	3,3,3	0.98	0	2,3,3	1.66	1 (50%)
5	BCT	C	502	2	3,3,3	1.04	0	2,3,3	1.58	1 (50%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
5	B	502	BCT	O2-C-O1	2.18	125.25	119.68
5	C	502	BCT	O2-C-O1	2.05	124.93	119.68

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 5.7 Other polymers [i](#)

There are no such residues in this entry.

## 5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

## 6 Fit of model and data [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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	453/472 (95%)	0.30	14 (3%) 51 47	32, 74, 105, 127	1 (0%)
1	B	455/472 (96%)	0.17	7 (1%) 72 69	38, 70, 107, 126	0
1	C	453/472 (95%)	0.24	6 (1%) 75 73	47, 79, 115, 138	0
1	D	452/472 (95%)	0.44	17 (3%) 44 39	47, 87, 133, 168	0
1	E	432/472 (91%)	1.31	110 (25%) 1 1	49, 101, 203, 246	0
1	F	434/472 (91%)	1.45	124 (28%) 1 1	61, 114, 215, 244	0
All	All	2679/2832 (94%)	0.64	278 (10%) 11 10	32, 84, 175, 246	1 (0%)

The worst 5 of 278 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	E	376	GLY	6.6
1	F	374	VAL	6.1
1	E	374	VAL	5.8
1	F	351	LEU	5.7
1	F	376	GLY	5.3

### 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](#)

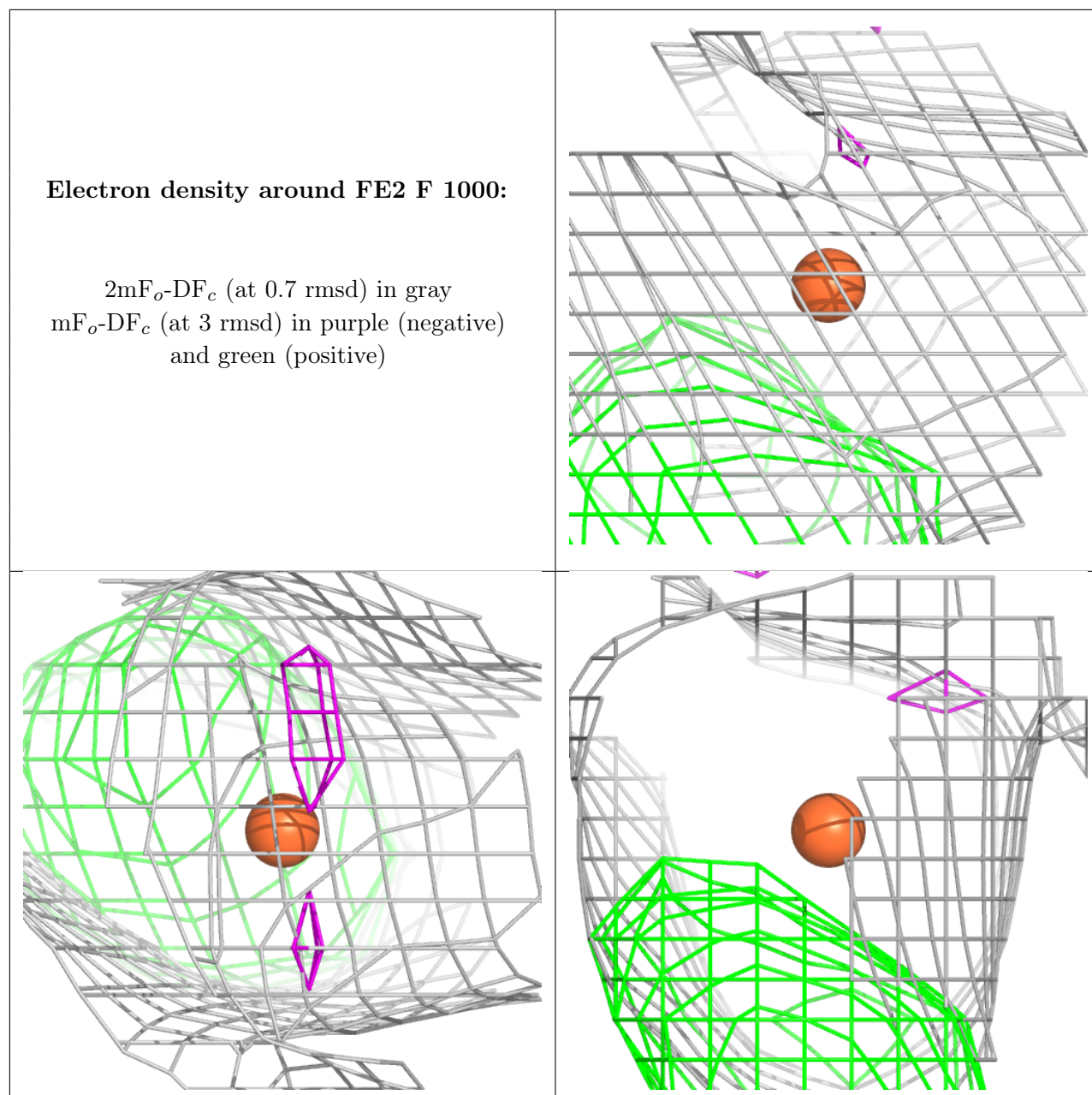
There are no oligosaccharides in this entry.

## 6.4 Ligands

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, 95<sup>th</sup> 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.

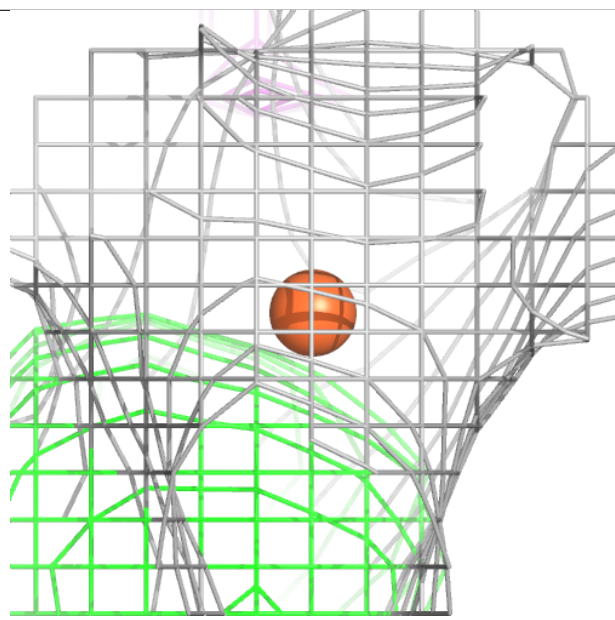
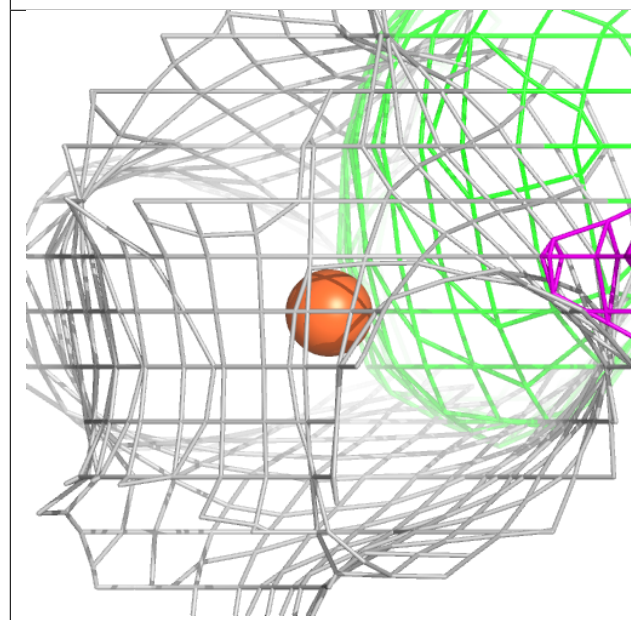
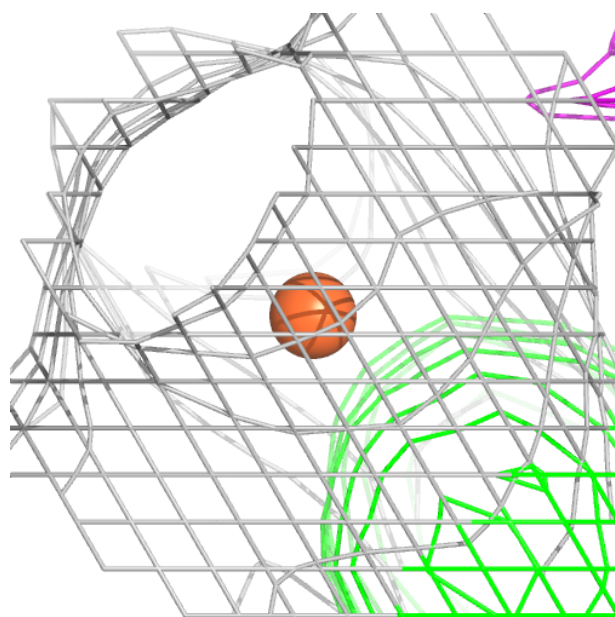
Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
2	FE2	F	1000	1/1	0.85	0.09	93,93,93,93	0
4	NA	B	503	1/1	0.89	0.10	80,80,80,80	0
3	CL	A	502	1/1	0.91	0.09	88,88,88,88	0
5	BCT	C	502	4/4	0.91	0.14	71,71,72,73	0
2	FE2	A	501	1/1	0.93	0.05	53,53,53,53	0
4	NA	A	503	1/1	0.93	0.11	70,70,70,70	0
5	BCT	B	502	4/4	0.94	0.10	58,59,59,60	0
2	FE2	E	1000	1/1	0.95	0.05	73,73,73,73	0
2	FE2	C	501	1/1	0.99	0.02	54,54,54,54	0
2	FE2	D	1000	1/1	0.99	0.02	61,61,61,61	0
2	FE2	B	501	1/1	0.99	0.03	45,45,45,45	0

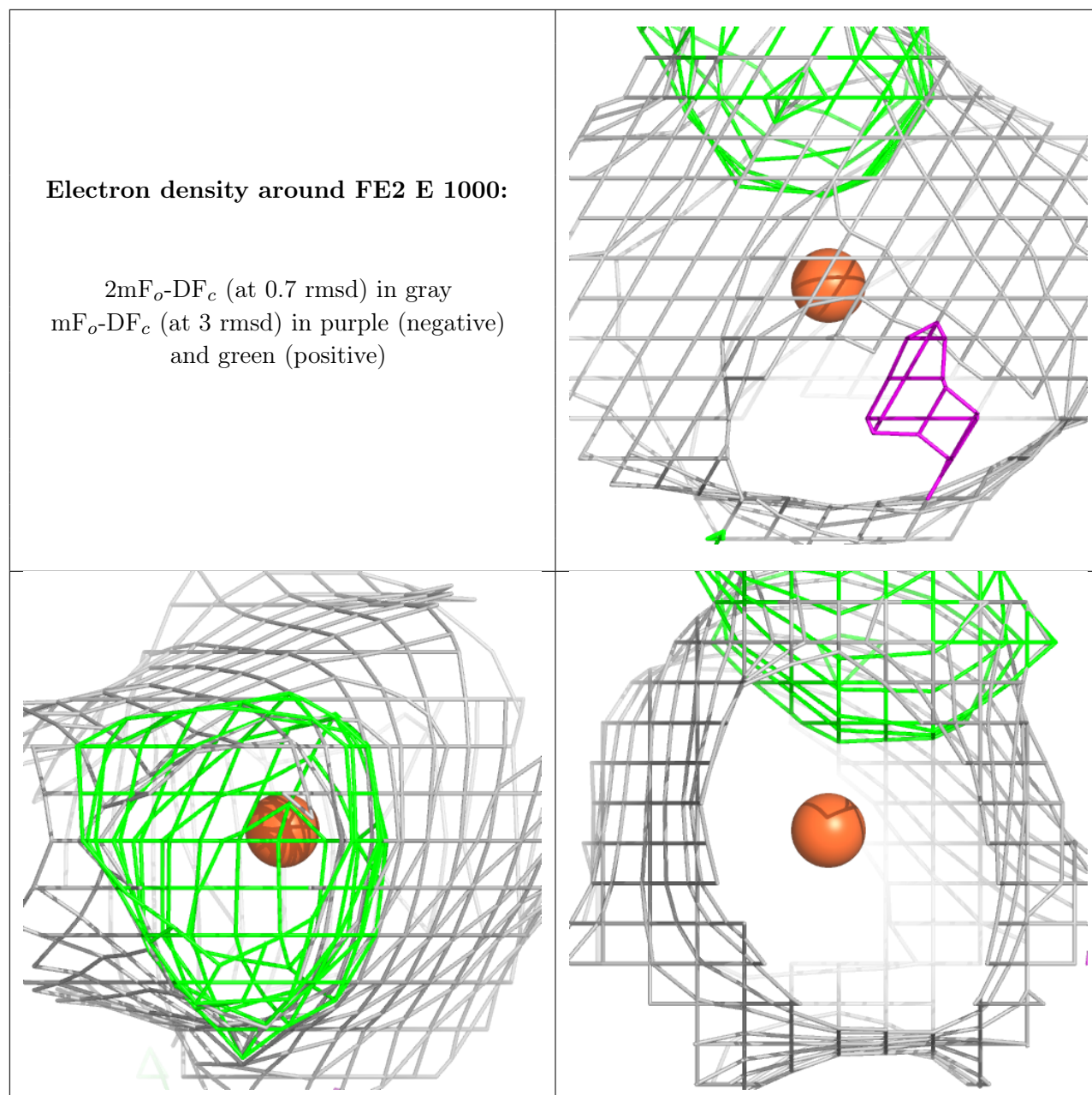
The following is a graphical depiction of the model fit to experimental electron density of all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the geometry validation Tables will also be included. Each fit is shown from different orientation to approximate a three-dimensional view.



**Electron density around FE2 A 501:**

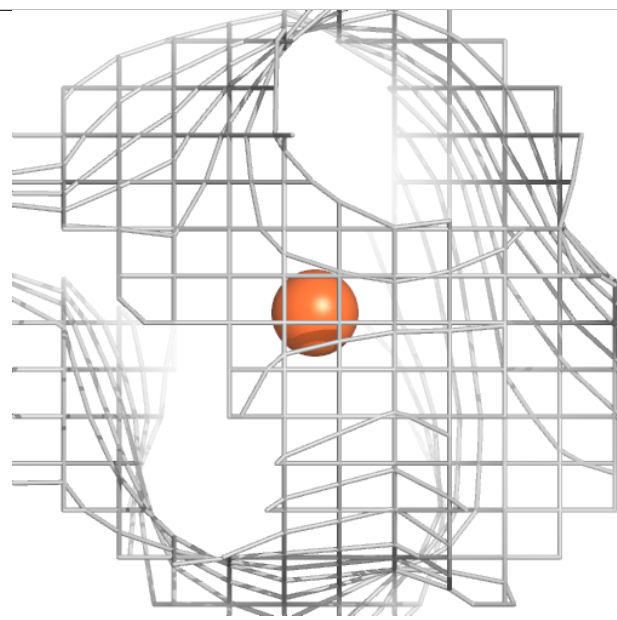
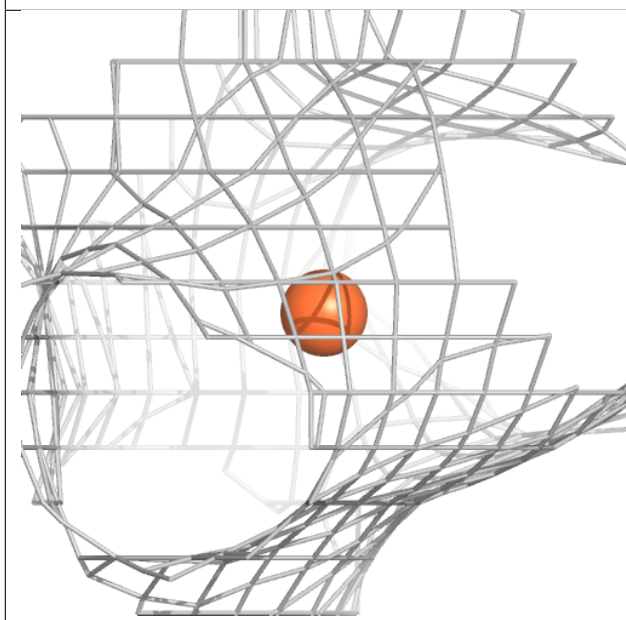
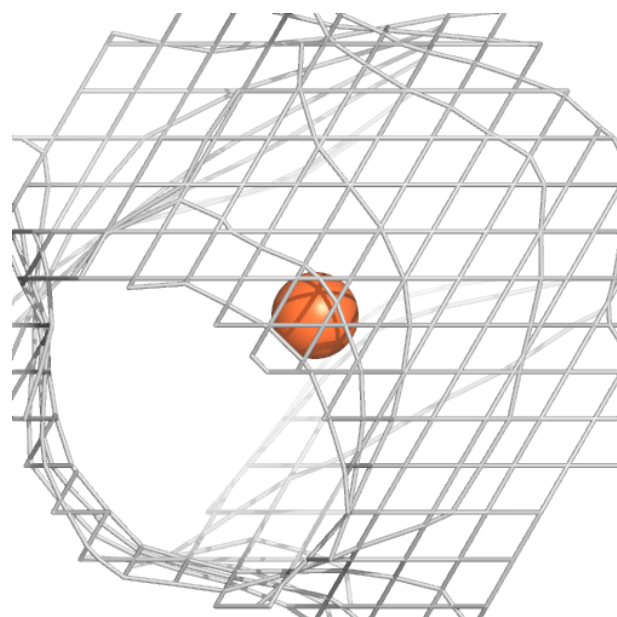
$2mF_o-DF_c$  (at 0.7 rmsd) in gray  
 $mF_o-DF_c$  (at 3 rmsd) in purple (negative)  
and green (positive)

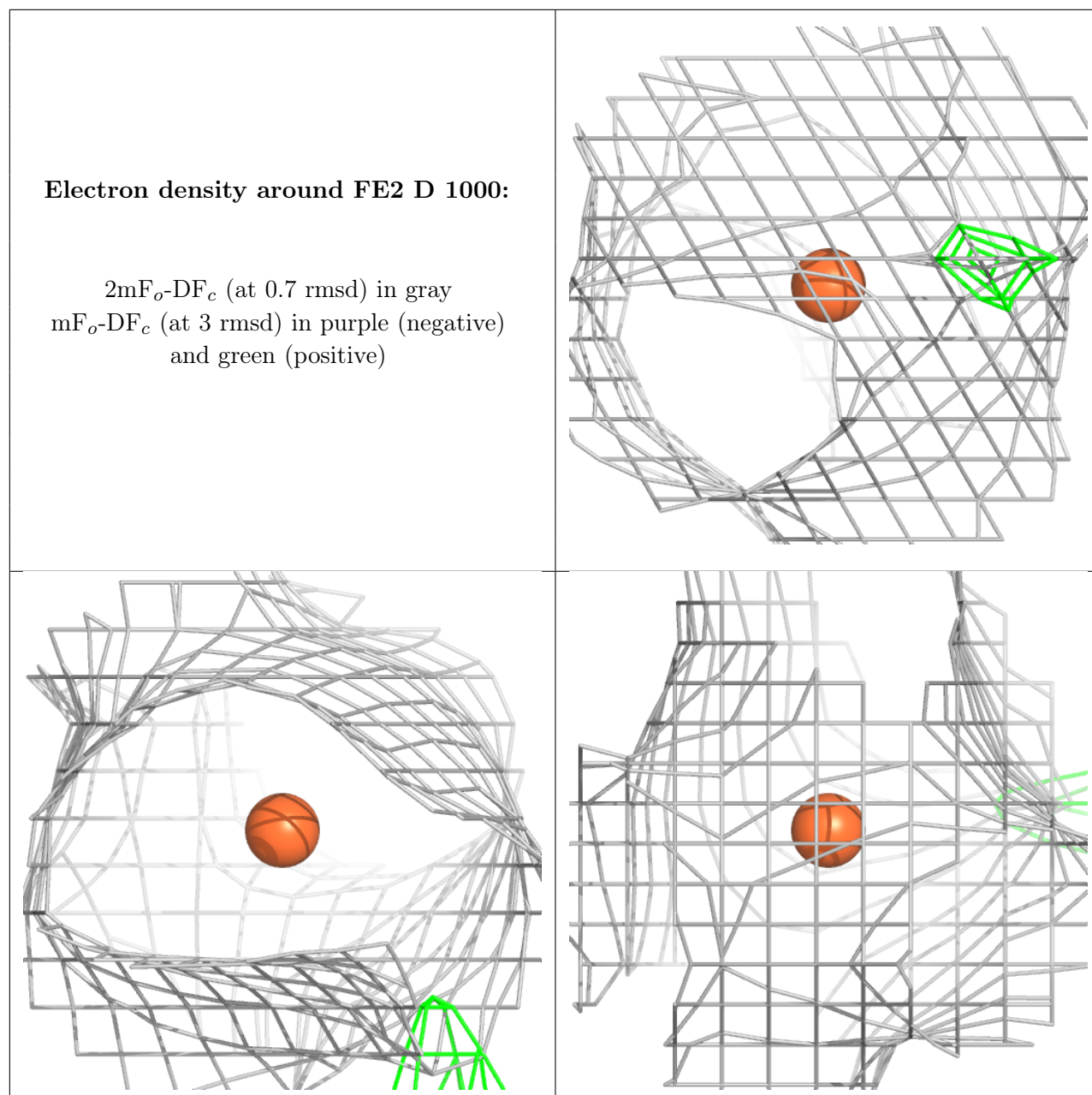


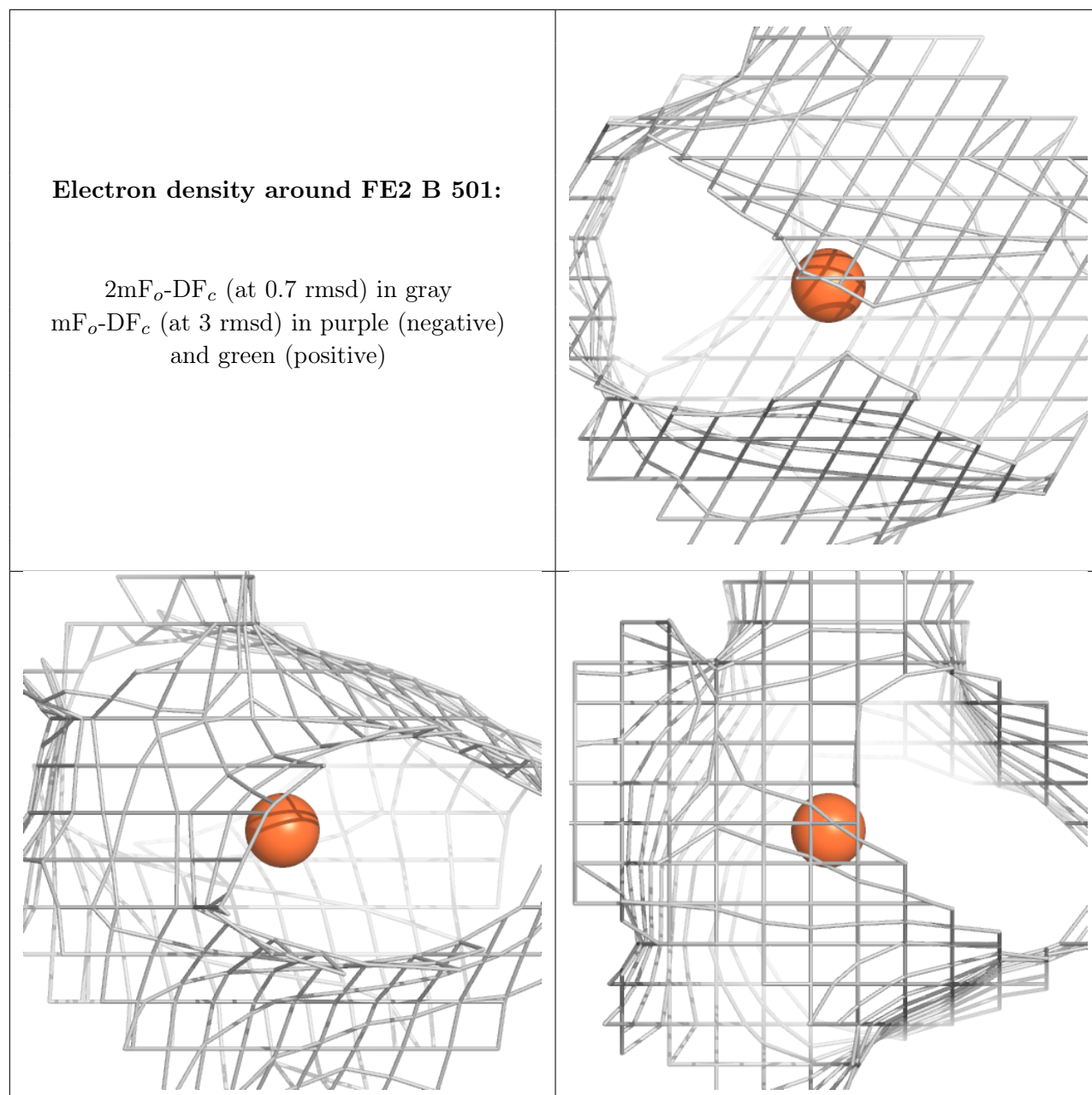


**Electron density around FE2 C 501:**

$2mF_o-DF_c$  (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.