



# Full wwPDB X-ray Structure Validation Report ⓘ

Oct 13, 2025 – 02:16 PM EDT

PDB ID : 9PPS / pdb\_00009pps  
Title : Co- and Bi-bound structure of the H77C variant of TriCyt2  
Authors : Eng, V.H.; Tezcan, F.A.  
Deposited on : 2025-07-21  
Resolution : 2.00 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](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>.

---

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 : 20231227.v01 (using entries in the PDB archive December 27th 2023)  
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) : 2.46

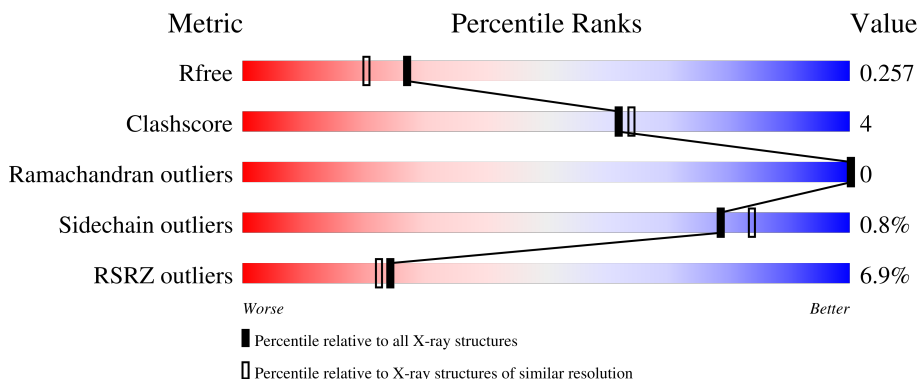
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.00 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))
$R_{free}$	164625	9409 (2.00-2.00)
Clashscore	180529	10737 (2.00-2.00)
Ramachandran outliers	177936	10628 (2.00-2.00)
Sidechain outliers	177891	10627 (2.00-2.00)
RSRZ outliers	164620	9409 (2.00-2.00)

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	106	<div> <div>5%</div> <div>92%</div> <div>8%</div> </div>
1	B	106	<div> <div>4%</div> <div>89%</div> <div>11%</div> </div>
1	C	106	<div> <div>12%</div> <div>88%</div> <div>12%</div> </div>

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 2785 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 Soluble cytochrome b562.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	106	Total	C	N	O	S	0	0	0
			833	522	145	162	4			
1	B	106	Total	C	N	O	S	0	1	0
			841	526	147	164	4			
1	C	106	Total	C	N	O	S	0	1	0
			844	528	149	163	4			

There are 36 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	3	TRP	LEU	conflict	UNP P0ABE7
A	41	LYS	GLN	conflict	UNP P0ABE7
A	54	ALA	ASP	conflict	UNP P0ABE7
A	59	ILE	LYS	conflict	UNP P0ABE7
A	63	VAL	HIS	conflict	UNP P0ABE7
A	69	LEU	VAL	conflict	UNP P0ABE7
A	70	TRP	GLY	conflict	UNP P0ABE7
A	73	HIS	ASP	conflict	UNP P0ABE7
A	77	CYS	LYS	variant	UNP P0ABE7
A	98	VAL	ARG	conflict	UNP P0ABE7
A	101	HIS	TYR	conflict	UNP P0ABE7
A	102	TRP	HIS	conflict	UNP P0ABE7
B	3	TRP	LEU	conflict	UNP P0ABE7
B	41	LYS	GLN	conflict	UNP P0ABE7
B	54	ALA	ASP	conflict	UNP P0ABE7
B	59	ILE	LYS	conflict	UNP P0ABE7
B	63	VAL	HIS	conflict	UNP P0ABE7
B	69	LEU	VAL	conflict	UNP P0ABE7
B	70	TRP	GLY	conflict	UNP P0ABE7
B	73	HIS	ASP	conflict	UNP P0ABE7
B	77	CYS	LYS	variant	UNP P0ABE7
B	98	VAL	ARG	conflict	UNP P0ABE7
B	101	HIS	TYR	conflict	UNP P0ABE7

*Continued on next page...*

*Continued from previous page...*

Chain	Residue	Modelled	Actual	Comment	Reference
B	102	TRP	HIS	conflict	UNP P0ABE7
C	3	TRP	LEU	conflict	UNP P0ABE7
C	41	LYS	GLN	conflict	UNP P0ABE7
C	54	ALA	ASP	conflict	UNP P0ABE7
C	59	ILE	LYS	conflict	UNP P0ABE7
C	63	VAL	HIS	conflict	UNP P0ABE7
C	69	LEU	VAL	conflict	UNP P0ABE7
C	70	TRP	GLY	conflict	UNP P0ABE7
C	73	HIS	ASP	conflict	UNP P0ABE7
C	77	CYS	LYS	variant	UNP P0ABE7
C	98	VAL	ARG	conflict	UNP P0ABE7
C	101	HIS	TYR	conflict	UNP P0ABE7
C	102	TRP	HIS	conflict	UNP P0ABE7

- Molecule 2 is Bismuth(III) ION (CCD ID: BS3) (formula: Bi) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total Bi 1 1	0	0

- Molecule 3 is SODIUM ION (CCD ID: NA) (formula: Na).

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

- Molecule 4 is COBALT (II) ION (CCD ID: CO) (formula: Co) (labeled as "Ligand of Interest" by depositor).

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total Co 1 1	0	0

- Molecule 5 is water.

Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
5	A	103	Total O 103 103	0	0
5	B	74	Total O 74 74	0	0

*Continued on next page...*

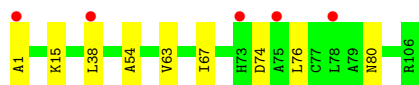
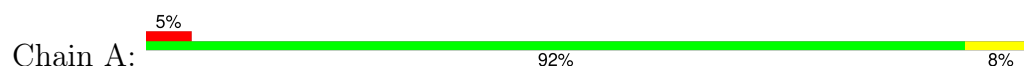
*Continued from previous page...*

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	C	87	Total	O	0	0
			87	87		

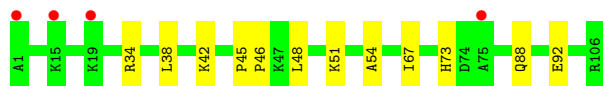
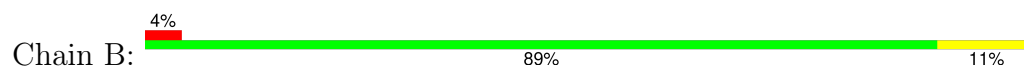
### 3 Residue-property plots [i](#)

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.

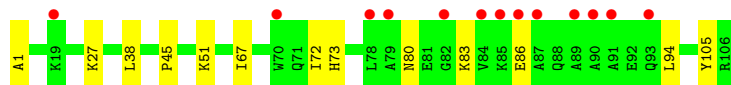
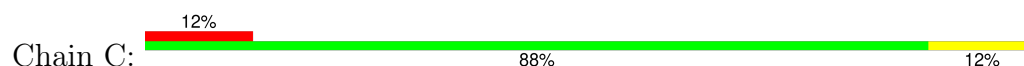
- Molecule 1: Soluble cytochrome b562



- Molecule 1: Soluble cytochrome b562



- Molecule 1: Soluble cytochrome b562



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	55.54Å 71.09Å 75.44Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	43.77 – 2.00 43.77 – 2.00	Depositor EDS
% Data completeness (in resolution range)	99.5 (43.77-2.00) 99.7 (43.77-2.00)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.93 (at 2.00Å)	Xtriage
Refinement program	PHENIX 1.20.1_4487	Depositor
R, $R_{free}$	0.218 , 0.257 0.218 , 0.257	Depositor DCC
$R_{free}$ test set	1984 reflections (9.60%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	30.1	Xtriage
Anisotropy	0.120	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.33 , 39.6	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.94	EDS
Total number of atoms	2785	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	36.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 6.37% 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

### 5.1 Standard geometry

Bond lengths and bond angles in the following residue types are not validated in this section: BS3, NA, CO

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	0.09	0/847	0.21	0/1144
1	B	0.10	0/855	0.23	0/1155
1	C	0.09	0/858	0.21	0/1158
All	All	0.09	0/2560	0.22	0/3457

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts

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	833	0	832	8	0
1	B	841	0	836	9	0
1	C	844	0	843	9	0
2	A	1	0	0	0	0
3	A	1	0	0	0	0
4	A	1	0	0	0	0
5	A	103	0	0	2	0
5	B	74	0	0	0	0
5	C	87	0	0	3	0
All	All	2785	0	2511	20	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 (20) 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:38:LEU:HD13	1:C:67:ILE:HG12	1.68	0.74
1:A:74:ASP:OD2	1:B:34:ARG:NH1	2.27	0.66
1:B:67:ILE:HG12	1:C:38:LEU:HD13	1.84	0.60
1:C:83:LYS:HD2	1:C:86:GLU:HG3	1.84	0.60
1:A:67:ILE:HG12	1:B:38:LEU:HD13	1.84	0.60
1:A:76:LEU:O	1:A:80:ASN:ND2	2.37	0.58
1:A:15:LYS:NZ	5:A:304:HOH:O	2.36	0.57
1:C:1:ALA:N	5:C:209:HOH:O	2.39	0.56
1:A:1:ALA:N	5:A:312:HOH:O	2.44	0.50
1:C:51:LYS:NZ	5:C:208:HOH:O	2.37	0.46
1:C:80:ASN:ND2	5:C:214:HOH:O	2.46	0.46
1:C:72:ILE:HG12	1:C:94:LEU:HD21	1.98	0.45
1:A:63:VAL:HG11	1:B:42:LYS:HG3	1.98	0.45
1:B:45:PRO:HG2	1:B:48:LEU:HB2	1.99	0.44
1:B:48:LEU:HD22	1:B:51:LYS:HG3	2.00	0.43
1:C:27:LYS:HD3	1:C:80:ASN:OD1	2.19	0.43
1:B:88:GLN:O	1:B:92:GLU:HG2	2.20	0.42
1:C:45:PRO:HB2	1:C:105:TYR:HB3	2.00	0.42
1:B:45:PRO:HA	1:B:46:PRO:HD3	1.99	0.40
1:A:54:ALA:HB1	1:B:54:ALA:HB2	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	A	104/106 (98%)	104 (100%)	0	0	100	100

*Continued on next page...*

*Continued from previous page...*

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	B	105/106 (99%)	104 (99%)	1 (1%)	0	100	100
1	C	105/106 (99%)	102 (97%)	3 (3%)	0	100	100
All	All	314/318 (99%)	310 (99%)	4 (1%)	0	100	100

There are no Ramachandran outliers to report.

### 5.3.2 Protein sidechains ⓘ

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	86/86 (100%)	86 (100%)	0	100	100
1	B	87/86 (101%)	86 (99%)	1 (1%)	70	76
1	C	87/86 (101%)	86 (99%)	1 (1%)	70	76
All	All	260/258 (101%)	258 (99%)	2 (1%)	79	84

All (2) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	73	HIS
1	C	73	HIS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (8) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	13	ASN
1	A	80	ASN
1	B	6	ASN
1	B	71	GLN
1	B	73	HIS
1	B	93	GLN
1	C	73	HIS
1	C	99	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 3 ligands modelled in this entry, 3 are monoatomic - leaving 0 for Mogul analysis.

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

## 5.7 Other polymers [i](#)

There are no such residues in this entry.

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

There are no chain breaks in this entry.

## 6 Fit of model and data

### 6.1 Protein, DNA and RNA chains

In the following table, the column labelled ‘#RSRZ > 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 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	106/106 (100%)	0.41	5 (4%) 37 35	19, 29, 50, 57	0
1	B	106/106 (100%)	0.62	4 (3%) 44 42	15, 35, 56, 69	1 (0%)
1	C	106/106 (100%)	0.85	13 (12%) 9 8	16, 36, 62, 76	1 (0%)
All	All	318/318 (100%)	0.63	22 (6%) 24 22	15, 33, 58, 76	2 (0%)

All (22) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	70	TRP	3.6
1	C	89	ALA	3.4
1	A	78	LEU	3.2
1	C	78	LEU	3.0
1	C	91	ALA	3.0
1	A	38	LEU	2.8
1	C	87	ALA	2.7
1	C	90	ALA	2.7
1	A	75	ALA	2.6
1	A	1	ALA	2.5
1	B	19	LYS	2.4
1	C	79	ALA	2.4
1	C	85	LYS	2.4
1	A	73	HIS	2.3
1	B	1	ALA	2.3
1	B	75	ALA	2.3
1	C	93	GLN	2.3
1	C	82	GLY	2.3
1	C	86	GLU	2.3
1	C	19	LYS	2.3
1	B	15	LYS	2.1
1	C	84	VAL	2.0

## 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](#)

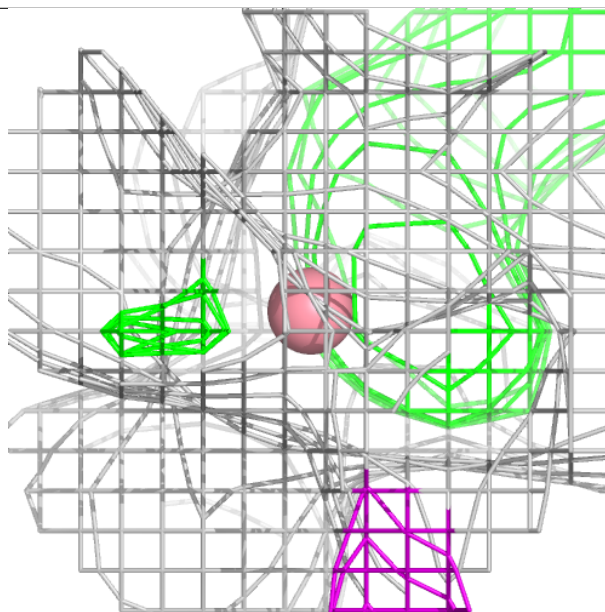
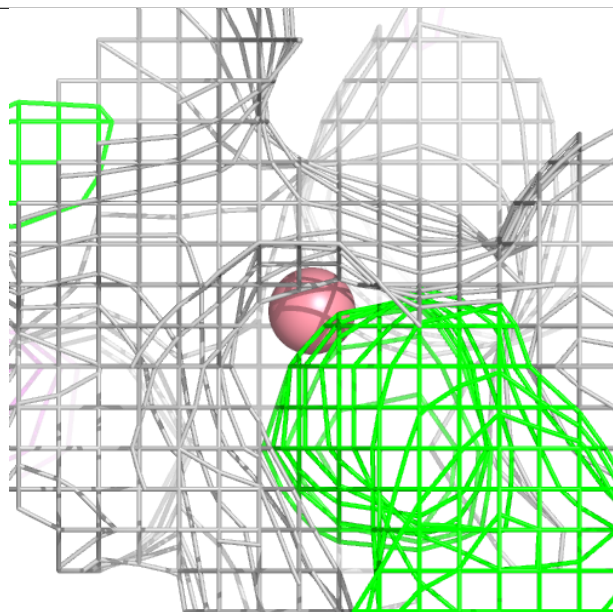
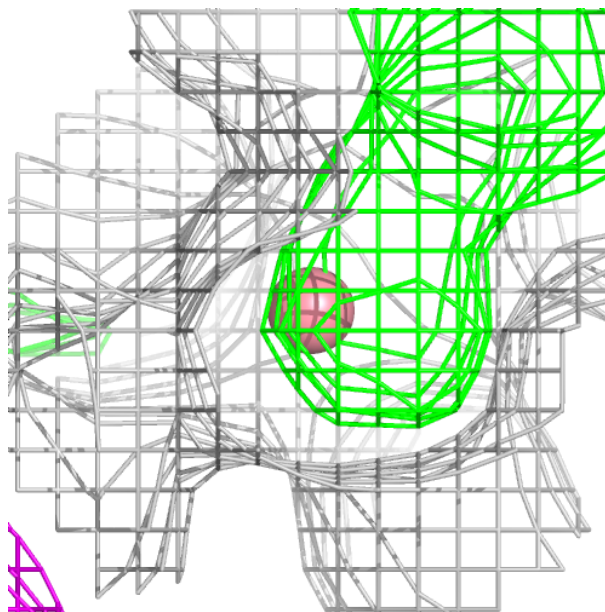
In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q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

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
4	CO	A	203	1/1	0.64	0.18	48,48,48,48	1
3	NA	A	202	1/1	0.96	0.15	31,31,31,31	0
2	BS3	A	201	1/1	0.99	0.10	41,41,41,41	1

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.

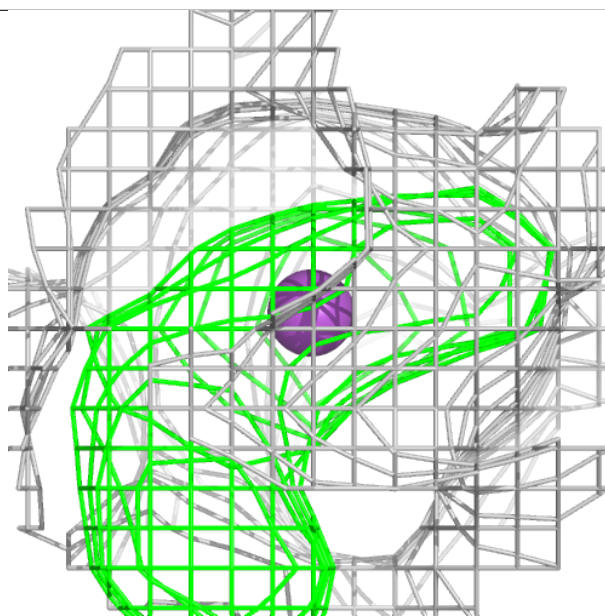
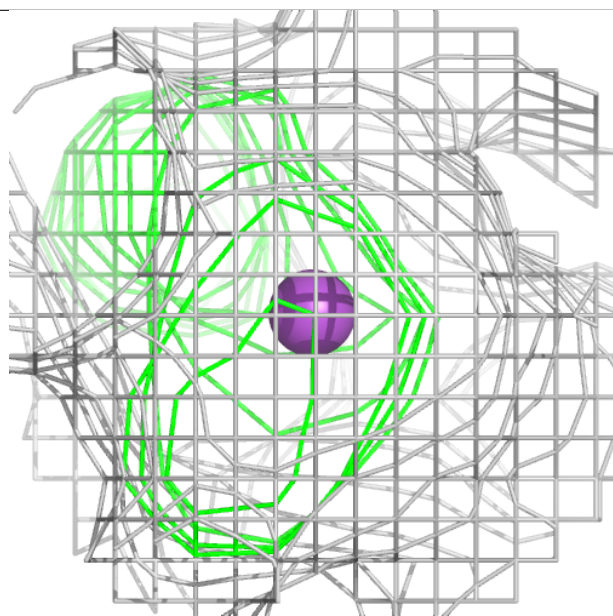
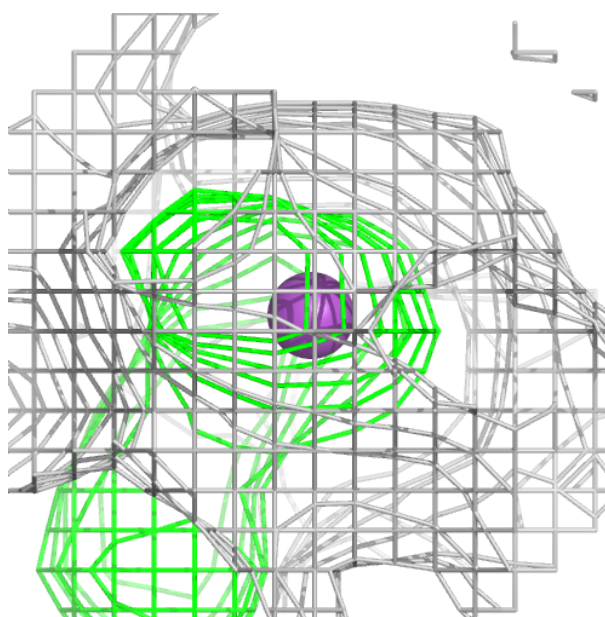
**Electron density around CO A 203:**

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



**Electron density around BS3 A 201:**

$2mF_o-DF_c$  (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.