



wwPDB X-ray Structure Validation Summary Report ⓘ

Jun 23, 2018 – 09:42 AM EDT

PDB ID : 6CDK
Title : Characterization of the P1+ intermediate state of nitrogenase P-cluster
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Deposited on : 2018-02-08
Resolution : 2.10 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 ⓘ symbol.

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

MolProbity : 4.02b-467
Mogul : 1.7.3 (157068), CSD as539be (2018)
Xtriage (Phenix) : 1.13
EDS : rb-20031172
Percentile statistics : 20171227.v01 (using entries in the PDB archive December 27th 2017)
Refmac : 5.8.0158
CCP4 : 7.0 (Gargrove)
Ideal geometry (proteins) : Engh & Huber (2001)
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP) : rb-20031172

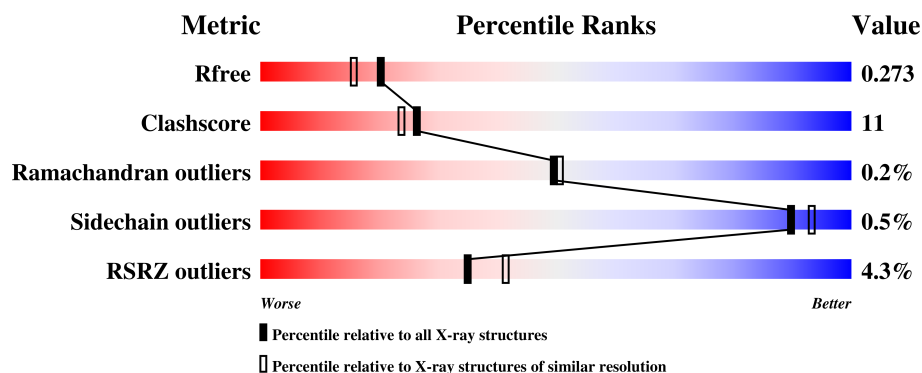
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.10 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}	111664	4608 (2.10-2.10)
Clashscore	122126	5109 (2.10-2.10)
Ramachandran outliers	120053	5059 (2.10-2.10)
Sidechain outliers	120020	5060 (2.10-2.10)
RSRZ outliers	108989	4497 (2.10-2.10)

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 on the lower bar indicate the fraction of residues that contain outliers for ≥ 3 , 2, 1 and 0 types of geometric quality criteria. 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	492	<div> <div>4%</div> <div>78% 16% 5%</div> </div>
1	C	492	<div> <div>5%</div> <div>75% 19% 5%</div> </div>
2	B	523	<div> <div>4%</div> <div>86% 13% .</div> </div>
2	D	523	<div> <div>3%</div> <div>84% 16%</div> </div>

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard

residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
5	CLF	C	503	-	-	X	-

2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 16611 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.

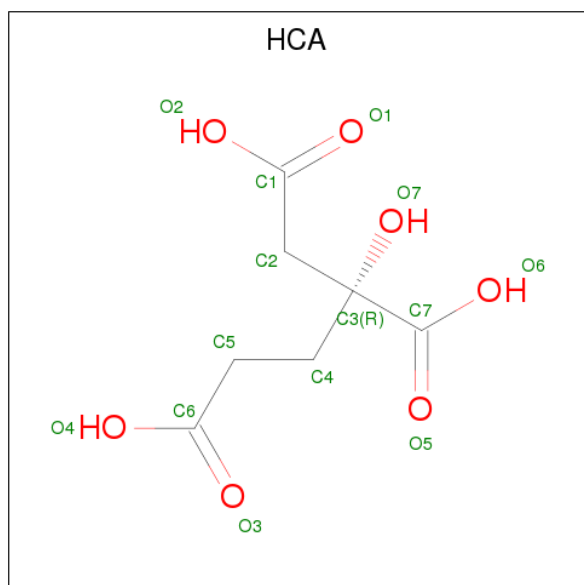
- Molecule 1 is a protein called Nitrogenase molybdenum-iron protein alpha chain.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	467	Total	C	N	O	S	0	0	0
			3716	2363	633	696	24			
1	C	466	Total	C	N	O	S	0	0	0
			3711	2361	632	693	25			

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

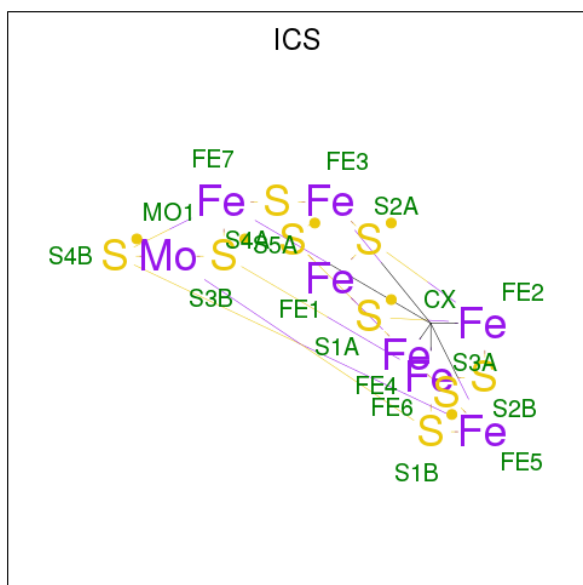
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	522	Total	C	N	O	S	0	0	0
			4174	2666	705	775	28			
2	D	522	Total	C	N	O	S	0	0	0
			4173	2666	705	774	28			

- Molecule 3 is 3-HYDROXY-3-CARBOXY-ADIPIC ACID (three-letter code: HCA) (formula: C₇H₁₀O₇).



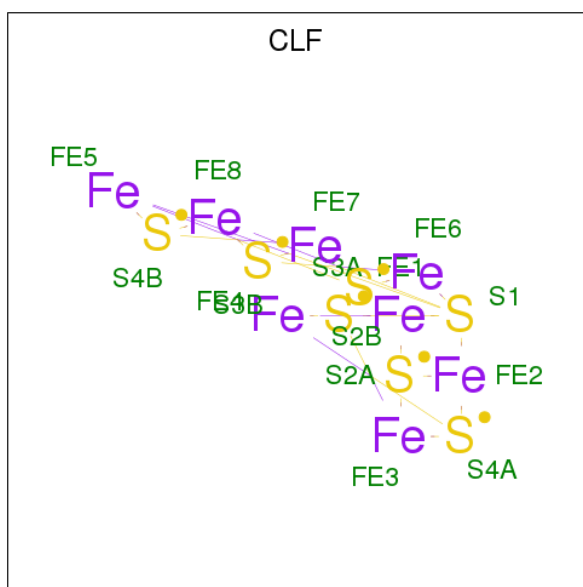
Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			14	7	7		
3	C	1	Total	C	O	0	0
			14	7	7		

- Molecule 4 is iron-sulfur-molybdenum cluster with interstitial carbon (three-letter code: ICS) (formula: CFe_7MoS_9).



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

- Molecule 5 is FE(8)-S(7) CLUSTER (three-letter code: CLF) (formula: Fe_8S_7).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
5	A	1	Total	Fe	S	0	0
			15	8	7		
5	C	1	Total	Fe	S	0	0
			15	8	7		

- Molecule 6 is FE (III) ION (three-letter code: FE) (formula: Fe).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	2	Total	Fe	0	0
			2	2		

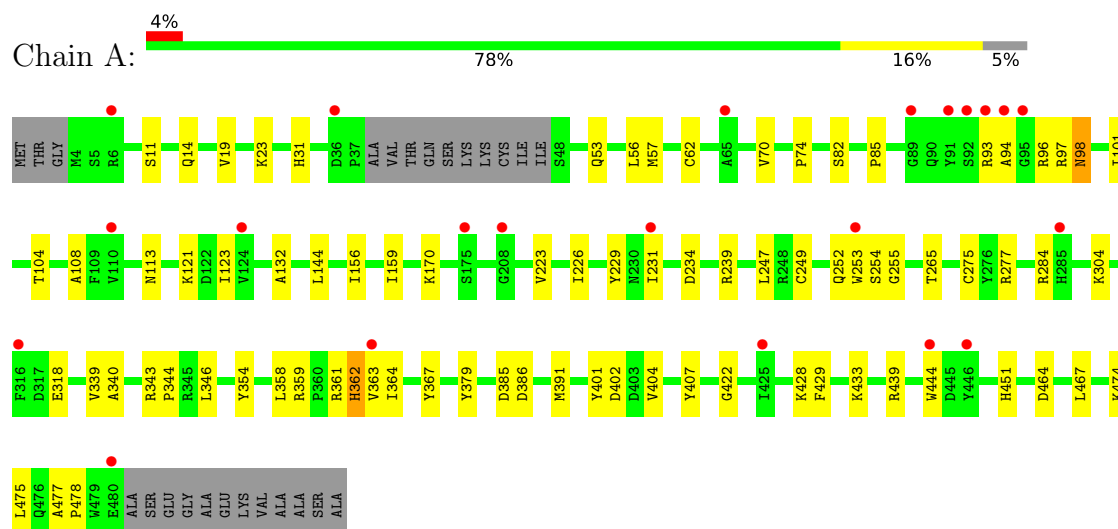
- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	158	Total	O	0	0
			158	158		
7	B	215	Total	O	0	0
			215	215		
7	C	154	Total	O	0	0
			154	154		
7	D	214	Total	O	0	0
			214	214		

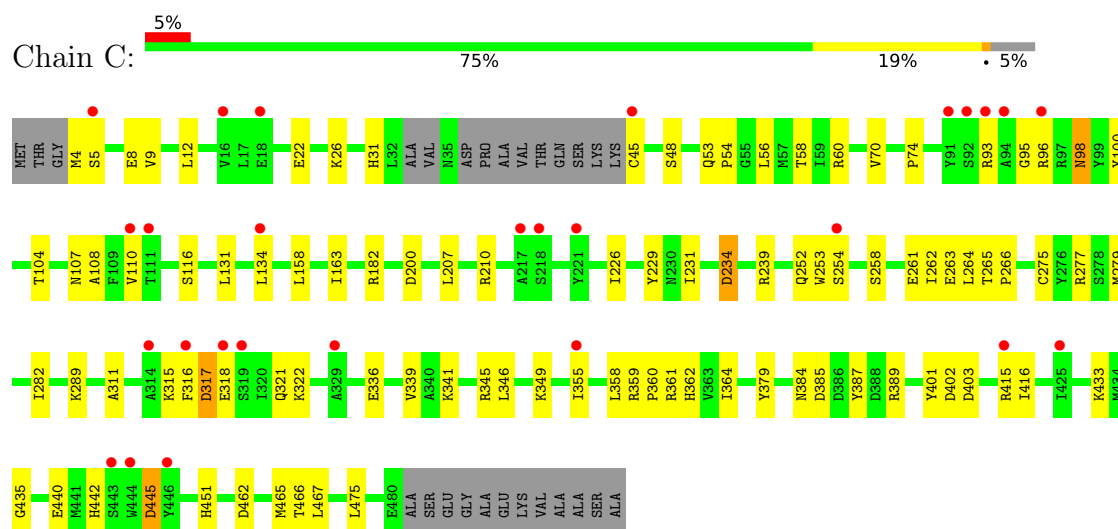
3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA and DNA 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.

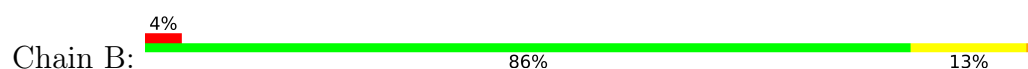
- Molecule 1: Nitrogenase molybdenum-iron protein alpha chain

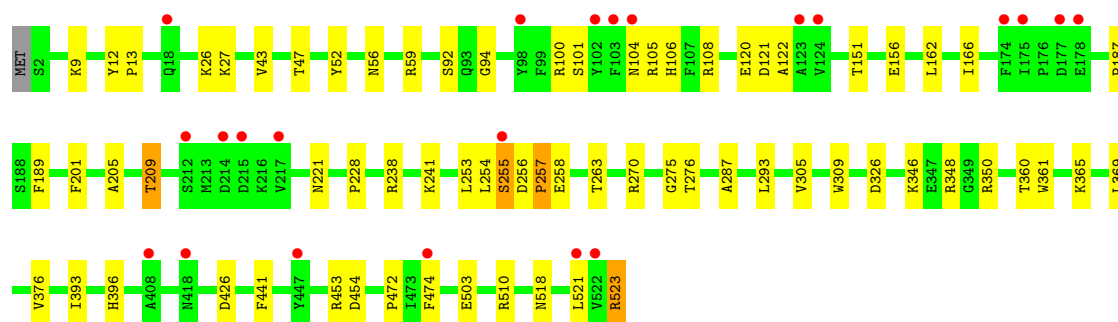


- Molecule 1: Nitrogenase molybdenum-iron protein alpha chain

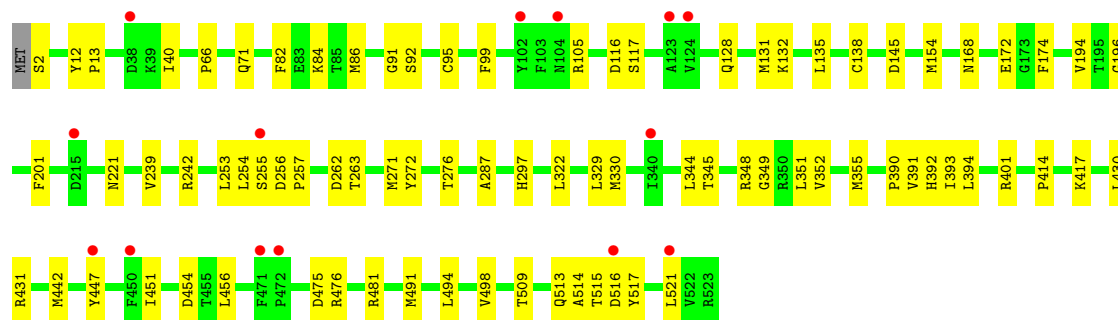
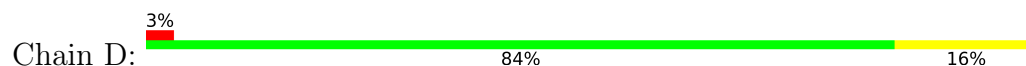


- Molecule 2: Nitrogenase molybdenum-iron protein beta chain





• Molecule 2: Nitrogenase molybdenum-iron protein beta chain



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	107.88Å 130.78Å 80.79Å 90.00° 110.85° 90.00°	Depositor
Resolution (Å)	50.01 – 2.10 40.01 – 2.10	Depositor EDS
% Data completeness (in resolution range)	57.1 (50.01-2.10) 57.1 (40.01-2.10)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	0.14	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.76 (at 2.10Å)	Xtriage
Refinement program	REFMAC 5.8.0135	Depositor
R, R_{free}	0.232 , 0.263 0.246 , 0.273	Depositor DCC
R_{free} test set	3503 reflections (5.04%)	wwPDB-VP
Wilson B-factor (Å ²)	24.5	Xtriage
Anisotropy	1.135	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.33 , 40.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	0.034 for -h-l,-k,l	Xtriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	16611	wwPDB-VP
Average B, all atoms (Å ²)	41.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 11.94% 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: ICS, CLF, HCA, FE

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	0.78	0/3803	0.87	1/5127 (0.0%)
1	C	0.72	0/3796	0.86	3/5114 (0.1%)
2	B	0.68	0/4280	0.82	0/5786
2	D	0.69	0/4279	0.85	2/5785 (0.0%)
All	All	0.72	0/16158	0.85	6/21812 (0.0%)

There are no bond length outliers.

The worst 5 of 6 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	D	92	SER	N-CA-CB	-6.90	100.15	110.50
1	C	45	CYS	N-CA-C	6.45	128.41	111.00
2	D	92	SER	N-CA-C	5.77	126.57	111.00
1	C	234	ASP	CB-CG-OD1	5.64	123.37	118.30
1	A	255	GLY	N-CA-C	-5.37	99.67	113.10

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	3716	0	3641	92	0
1	C	3711	0	3642	115	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	B	4174	0	4087	83	0
2	D	4173	0	4087	84	0
3	A	14	0	6	0	0
3	C	14	0	6	1	0
4	A	18	0	0	0	0
4	C	18	0	0	3	0
5	A	15	0	0	2	0
5	C	15	0	0	6	0
6	B	2	0	0	0	0
7	A	158	0	0	20	0
7	B	215	0	0	17	0
7	C	154	0	0	23	0
7	D	214	0	0	21	0
All	All	16611	0	15469	348	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 11.

The worst 5 of 348 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:106:HIS:HB2	2:B:474:PHE:HE1	1.11	1.16
1:A:93:ARG:HD2	1:A:113:ASN:HB2	1.23	1.14
1:C:435:GLY:HA2	1:C:475:LEU:HD11	1.43	1.00
1:C:440:GLU:HB2	1:C:445:ASP:OD1	1.62	0.99
1:C:289:LYS:HA	7:C:658:HOH:O	1.60	0.99

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	463/492 (94%)	438 (95%)	24 (5%)	1 (0%)	49	51
1	C	461/492 (94%)	434 (94%)	26 (6%)	1 (0%)	49	51
2	B	520/523 (99%)	494 (95%)	24 (5%)	2 (0%)	36	34
2	D	520/523 (99%)	505 (97%)	15 (3%)	0	100	100
All	All	1964/2030 (97%)	1871 (95%)	89 (4%)	4 (0%)	49	51

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	C	317	ASP
1	A	318	GLU
2	B	255	SER
2	B	257	PRO

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	398/415 (96%)	395 (99%)	3 (1%)	83	88
1	C	398/415 (96%)	395 (99%)	3 (1%)	83	88
2	B	454/455 (100%)	451 (99%)	3 (1%)	85	89
2	D	454/455 (100%)	454 (100%)	0	100	100
All	All	1704/1740 (98%)	1695 (100%)	9 (0%)	90	93

5 of 9 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	B	209	THR
1	C	401	TYR
1	C	98	ASN
1	A	401	TYR
2	B	523	ARG

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 10 such

sidechains are listed below:

Mol	Chain	Res	Type
1	C	31	HIS
1	C	98	ASN
1	C	321	GLN
2	B	457	HIS
1	C	252	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 carbohydrates in this entry.

5.6 Ligand geometry [i](#)

Of 8 ligands modelled in this entry, 2 are monoatomic - leaving 6 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	HCA	A	501	-	4,13,13	1.37	1 (25%)	3,18,18	1.73	1 (33%)
4	ICS	A	502	1	6,30,30	1.37	1 (16%)	0,78,78	0.00	-
5	CLF	A	503	1,2	0,24,24	0.00	-	0,57,57	0.00	-
3	HCA	C	501	-	4,13,13	1.80	1 (25%)	3,18,18	2.42	2 (66%)
4	ICS	C	502	1	6,30,30	1.45	1 (16%)	0,78,78	0.00	-
5	CLF	C	503	1,2	0,24,24	0.00	-	0,57,57	0.00	-

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	HCA	A	501	-	-	0/7/17/17	0/0/0/0
4	ICS	A	502	1	-	0/0/204/204	0/0/13/13
5	CLF	A	503	1,2	-	0/0/132/132	0/12/10/10
3	HCA	C	501	-	-	0/7/17/17	0/0/0/0
4	ICS	C	502	1	-	0/0/204/204	0/0/13/13
5	CLF	C	503	1,2	-	0/0/132/132	0/12/10/10

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
4	C	502	ICS	S3A-FE4	-2.43	2.19	2.24
3	A	501	HCA	C4-C3	2.23	1.56	1.53
4	A	502	ICS	S3A-FE5	2.29	2.30	2.24
3	C	501	HCA	C4-C3	3.14	1.57	1.53

All (3) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	501	HCA	C4-C3-C7	-3.02	106.11	111.46
3	A	501	HCA	O7-C3-C4	2.73	113.72	107.01
3	C	501	HCA	O7-C3-C4	2.91	114.16	107.01

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

4 monomers are involved in 12 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
5	A	503	CLF	2	0
3	C	501	HCA	1	0
4	C	502	ICS	3	0
5	C	503	CLF	6	0

5.7 Other polymers ⓘ

There are no such residues in this entry.

5.8 Polymer linkage issues ⓘ

There are no chain breaks in this entry.

6 Fit of model and data [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	467/492 (94%)	0.30	22 (4%) 31 37	25, 40, 61, 84	0
1	C	466/492 (94%)	0.42	27 (5%) 23 29	27, 44, 63, 81	0
2	B	522/523 (99%)	0.22	22 (4%) 36 43	25, 39, 58, 88	0
2	D	522/523 (99%)	0.12	14 (2%) 54 61	25, 37, 57, 74	0
All	All	1977/2030 (97%)	0.26	85 (4%) 35 41	25, 40, 61, 88	0

The worst 5 of 85 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	214	ASP	4.2
2	B	521	LEU	3.9
2	D	38	ASP	3.6
1	C	329	ALA	3.6
2	B	212	SER	3.5

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 carbohydrates 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(\AA^2)	Q<0.9
3	HCA	C	501	14/14	0.92	0.23	26,30,35,35	0
5	CLF	C	503	15/15	0.95	0.06	28,30,36,40	0
5	CLF	A	503	15/15	0.96	0.06	23,25,27,29	0
4	ICS	A	502	18/18	0.96	0.07	28,30,32,33	0
4	ICS	C	502	18/18	0.97	0.06	27,31,34,34	0
3	HCA	A	501	14/14	0.97	0.14	28,32,36,40	0
6	FE	B	602	1/1	0.98	0.08	40,40,40,40	0
6	FE	B	601	1/1	0.99	0.07	40,40,40,40	0

6.5 Other polymers [i](#)

There are no such residues in this entry.