



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 6, 2026 – 10:09 PM UTC

PDB ID : 3S2C / pdb_00003s2c
Title : Structure of the thermostable GH51 alpha-L-arabinofuranosidase from *Thermotoga petrophila* RKU-1
Authors : Souza, T.A.C.B.; Santos, C.R.; Souza, A.R.; Oldiges, D.P.; Ruller, R.; Prade, R.A.; Squina, F.M.; Murakami, M.T.
Deposited on : 2011-05-16
Resolution : 3.00 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 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
Xtrriage (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

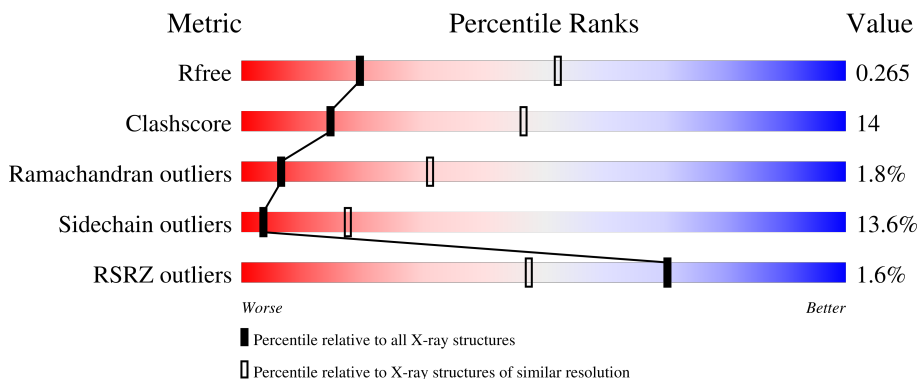
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.00 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}	180053	2672 (3.00-3.00)
Clashscore	190562	2977 (3.00-3.00)
Ramachandran outliers	187476	2877 (3.00-3.00)
Sidechain outliers	187428	2880 (3.00-3.00)
RSRZ outliers	180081	2671 (3.00-3.00)

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 ≥ 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	484	
1	B	484	
1	C	484	
1	D	484	
1	E	484	

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Mol	Chain	Length	Quality of chain
1	F	484	<p>% 64% 31% 5%</p>
1	G	484	<p>% 65% 26% 8%</p>
1	H	484	<p>% 60% 32% 7%</p>
1	I	484	<p>4% 63% 29% 7%</p>
1	J	484	<p>3% 65% 27% 7%</p>
1	K	484	<p>2% 67% 26% 7%</p>
1	L	484	<p>2% 60% 34% 6%</p>

2 Entry composition [i](#)

There are 2 unique types of molecules in this entry. The entry contains 47152 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 Alpha-N-arabinofuranosidase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	483	3893	2499	649	730	15	0	0	0
1	B	483	3893	2499	649	730	15	0	0	0
1	C	483	3893	2499	649	730	15	0	0	0
1	D	483	3893	2499	649	730	15	0	0	0
1	E	483	3893	2499	649	730	15	0	0	0
1	F	483	3893	2499	649	730	15	0	0	0
1	G	483	3904	2505	653	731	15	0	1	0
1	H	483	3893	2499	649	730	15	0	0	0
1	I	483	3893	2499	649	730	15	0	0	0
1	J	481	3876	2488	647	726	15	0	0	0
1	K	483	3893	2499	649	730	15	0	0	0
1	L	483	3902	2504	650	733	15	0	1	0

- Molecule 2 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	A	42	Total	O	0	0
			42	42		
2	B	43	Total	O	0	0
			43	43		

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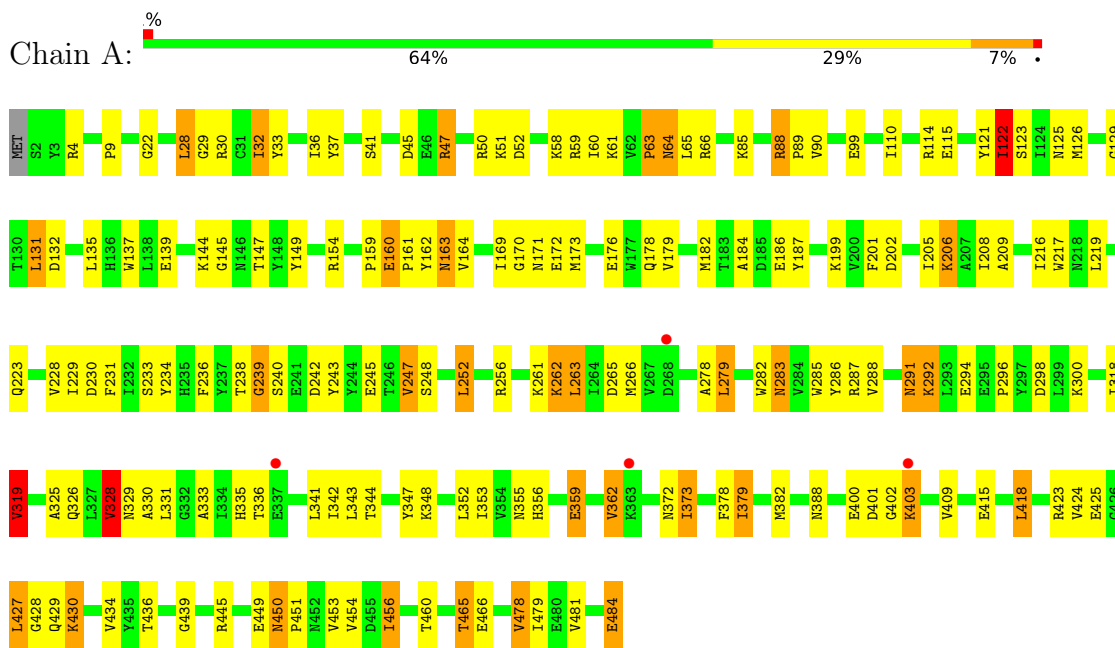
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Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
2	C	50	Total 50	O 50	0	0
2	D	54	Total 54	O 54	0	0
2	E	45	Total 45	O 45	0	0
2	F	39	Total 39	O 39	0	0
2	G	30	Total 30	O 30	0	0
2	H	28	Total 28	O 28	0	0
2	I	27	Total 27	O 27	0	0
2	J	23	Total 23	O 23	0	0
2	K	32	Total 32	O 32	0	0
2	L	20	Total 20	O 20	0	0

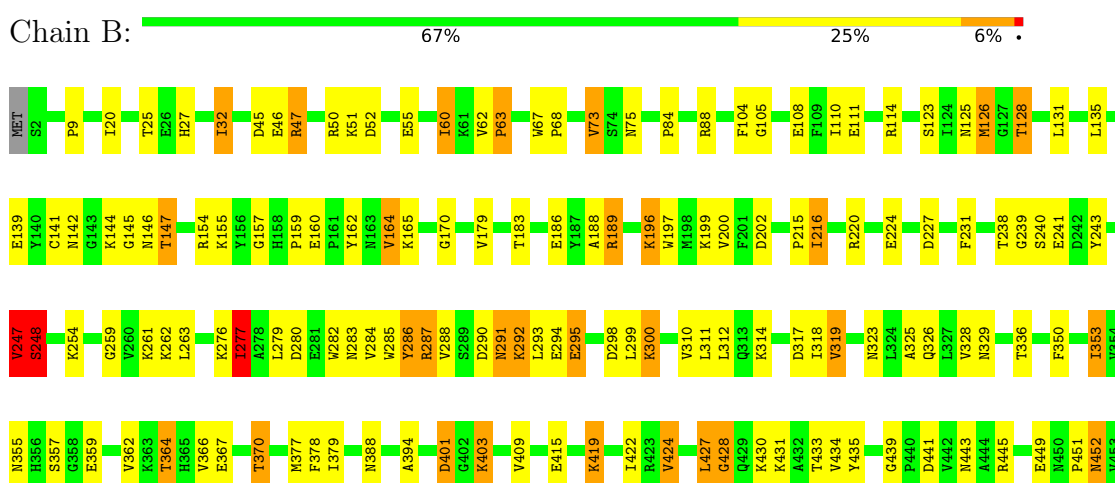
3 Residue-property plots [i](#)

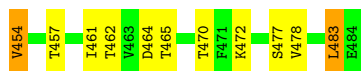
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. 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: Alpha-N-arabinofuranosidase

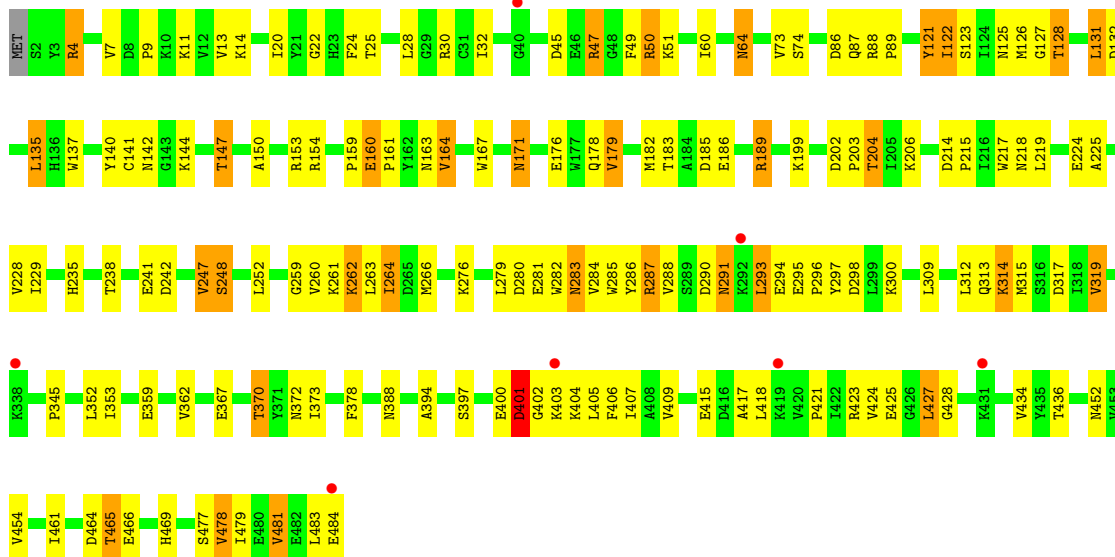


- Molecule 1: Alpha-N-arabinofuranosidase

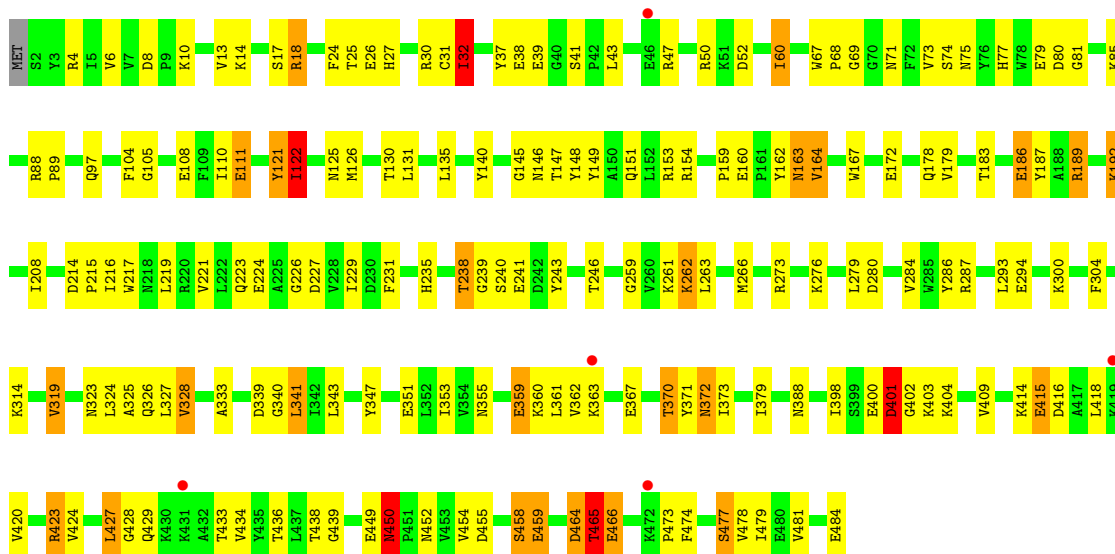




- Molecule 1: Alpha-N-arabinofuranosidase

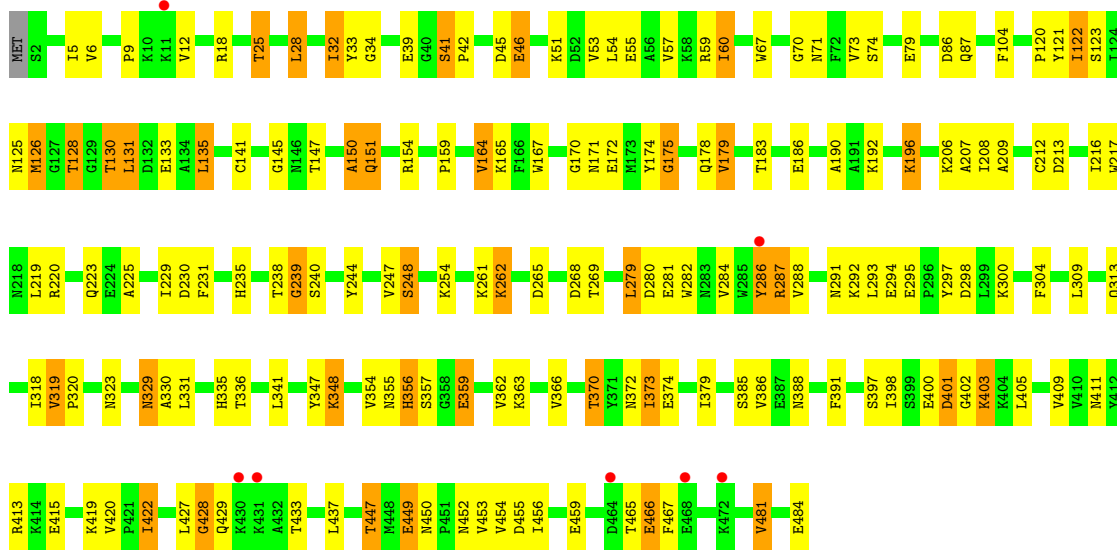


- Molecule 1: Alpha-N-arabinofuranosidase

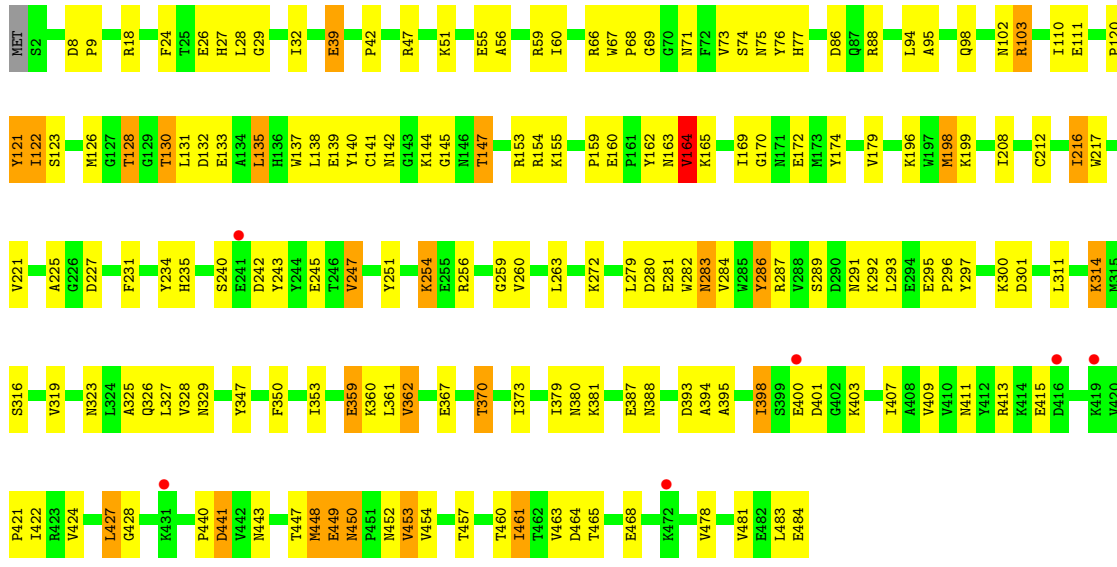


- Molecule 1: Alpha-N-arabinofuranosidase

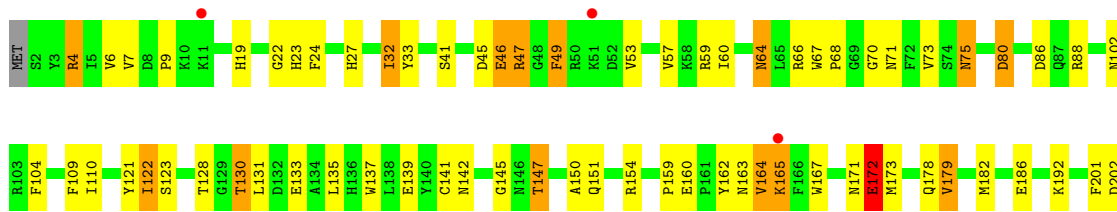


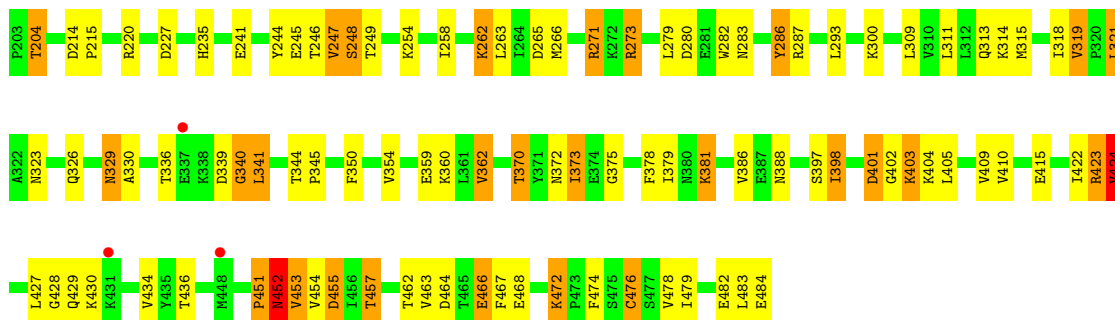


• Molecule 1: Alpha-N-arabinofuranosidase

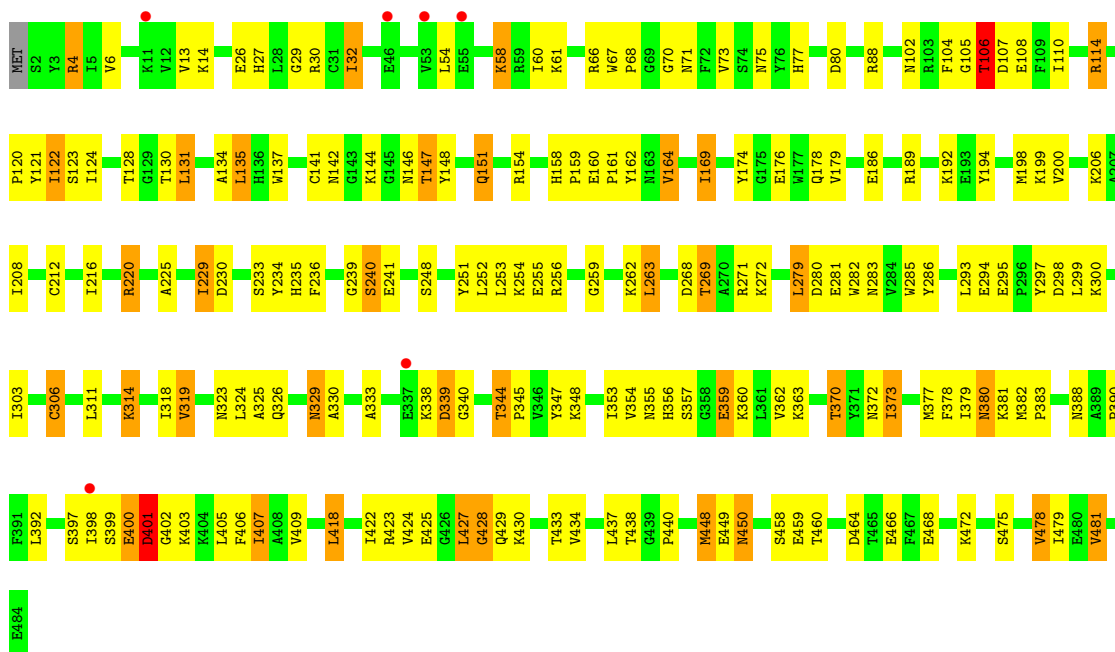


• Molecule 1: Alpha-N-arabinofuranosidase

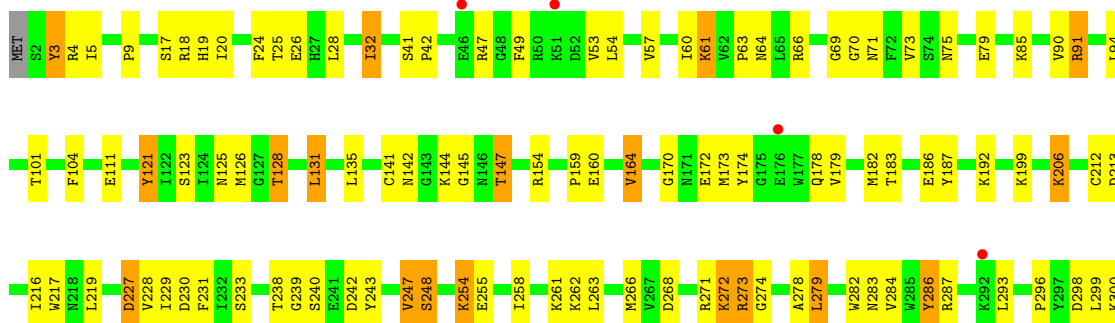


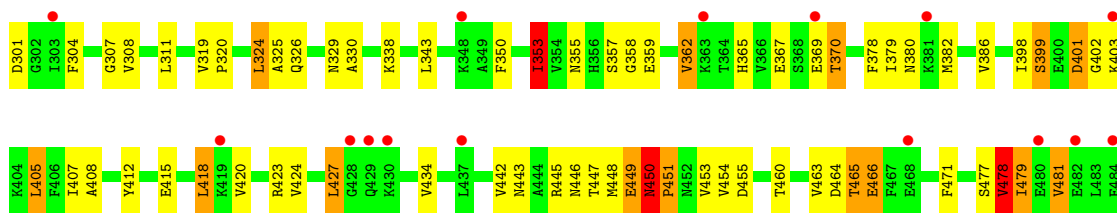


● Molecule 1: Alpha-N-arabinofuranosidase

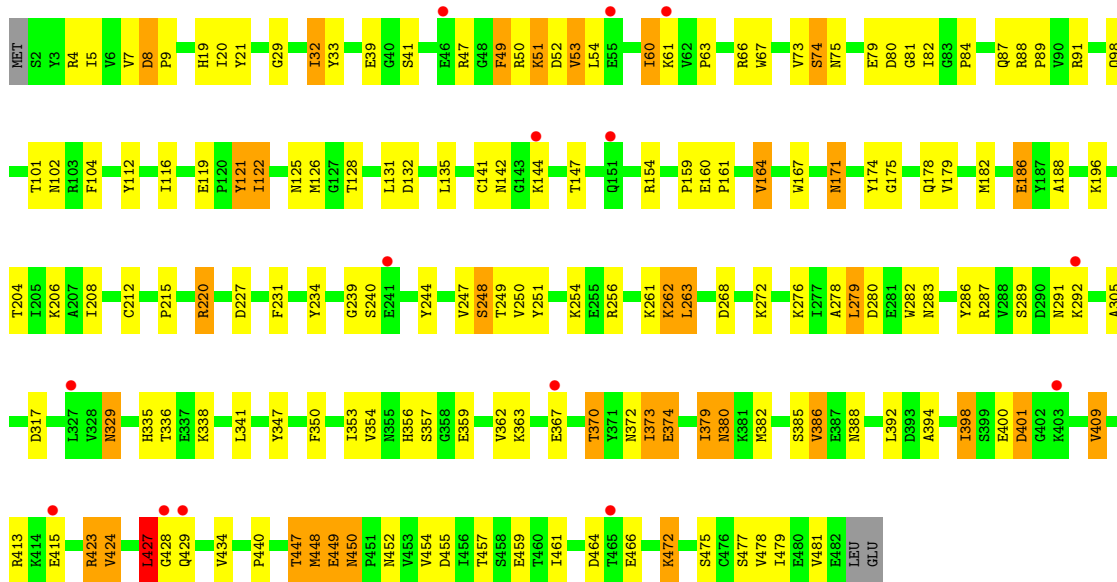


● Molecule 1: Alpha-N-arabinofuranosidase

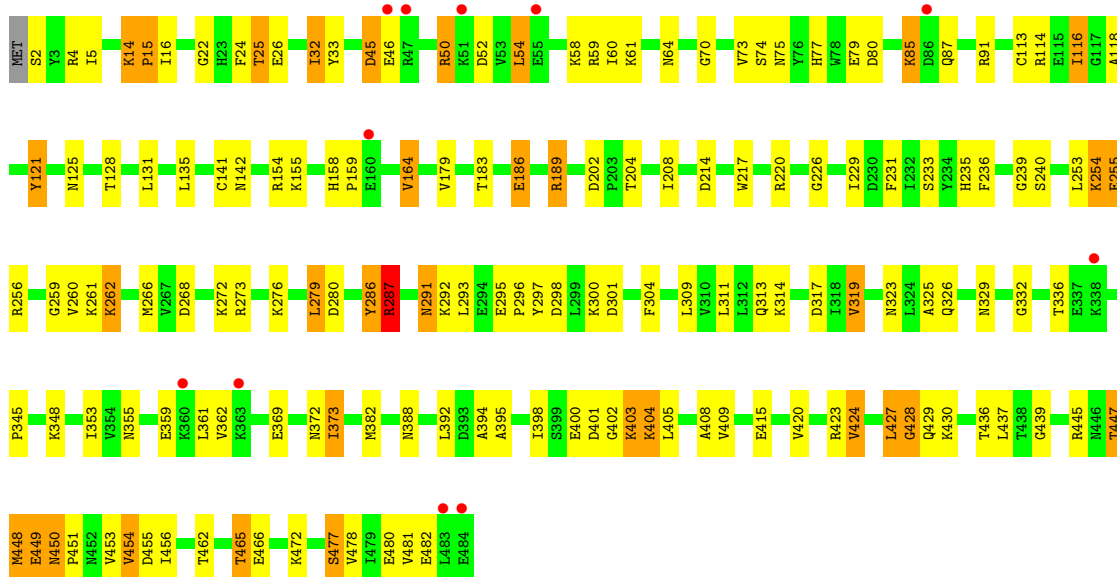




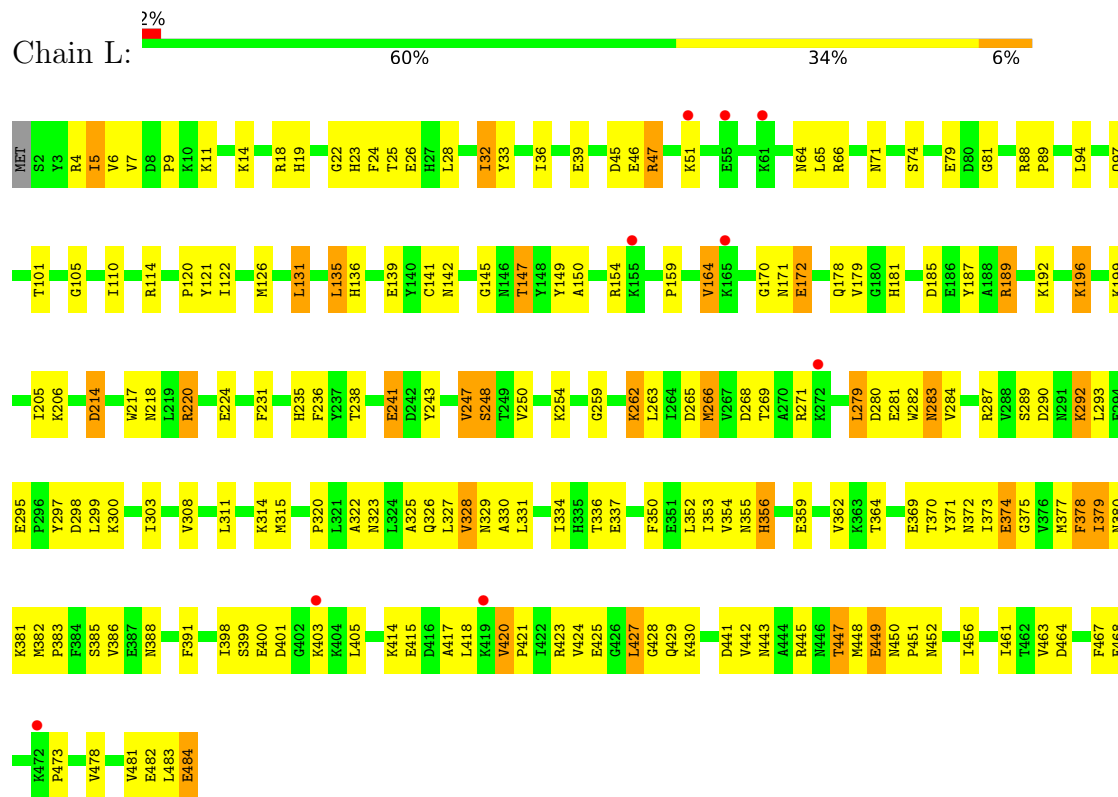
• Molecule 1: Alpha-N-arabinofuranosidase



• Molecule 1: Alpha-N-arabinofuranosidase



- Molecule 1: Alpha-N-arabinofuranosidase



4 Data and refinement statistics

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, α , β , γ	105.95Å 187.29Å 180.64Å 90.00° 90.87° 90.00°	Depositor
Resolution (Å)	49.24 – 3.00 49.24 – 3.00	Depositor EDS
% Data completeness (in resolution range)	97.2 (49.24-3.00) 97.6 (49.24-3.00)	Depositor EDS
R_{merge}	(Not available)	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	2.01 (at 3.01Å)	Xtrriage
Refinement program	REFMAC 5.5.0102	Depositor
R, R_{free}	0.195 , 0.268 0.195 , 0.265	Depositor DCC
R_{free} test set	6914 reflections (4.89%)	wwPDB-VP
Wilson B-factor (Å ²)	54.9	Xtrriage
Anisotropy	0.120	Xtrriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.31 , 48.8	EDS
L-test for twinning ²	$\langle L \rangle = 0.50$, $\langle L^2 \rangle = 0.34$	Xtrriage
Estimated twinning fraction	0.000 for -h,-l,-k 0.000 for -h,l,k 0.013 for h,-k,-l	Xtrriage
F_o, F_c correlation	0.93	EDS
Total number of atoms	47152	wwPDB-VP
Average B, all atoms (Å ²)	45.0	wwPDB-VP

Xtrriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.38% 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](#)

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	0.66	0/3990	0.99	14/5413 (0.3%)
1	B	0.67	0/3990	0.99	11/5413 (0.2%)
1	C	0.67	0/3990	0.99	11/5413 (0.2%)
1	D	0.66	0/3990	1.00	11/5413 (0.2%)
1	E	0.70	0/3990	0.99	11/5413 (0.2%)
1	F	0.67	1/3990 (0.0%)	0.96	4/5413 (0.1%)
1	G	0.64	0/4001	0.98	7/5427 (0.1%)
1	H	0.65	0/3990	0.97	3/5413 (0.1%)
1	I	0.63	0/3990	0.94	3/5413 (0.1%)
1	J	0.61	0/3973	0.97	12/5390 (0.2%)
1	K	0.63	0/3990	0.97	10/5413 (0.2%)
1	L	0.62	0/3999	0.98	10/5426 (0.2%)
All	All	0.65	1/47883 (0.0%)	0.98	107/64960 (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
1	A	0	1
1	B	0	1
1	D	0	2
1	J	0	1
1	K	0	2
All	All	0	7

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	F	164	VAL	CA-CB	5.61	1.60	1.53

The worst 5 of 107 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	F	401	ASP	N-CA-C	10.29	122.08	111.07
1	G	401	ASP	N-CA-C	8.96	120.66	111.07
1	J	427	LEU	N-CA-C	8.89	116.07	108.78
1	D	401	ASP	N-CA-C	8.38	122.00	111.69
1	C	401	ASP	N-CA-C	8.31	120.11	111.14

There are no chirality outliers.

5 of 7 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	63	PRO	Peptide
1	B	63	PRO	Peptide
1	D	238	THR	Peptide
1	D	240	SER	Peptide
1	J	448	MET	Peptide

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	3893	0	3818	124	0
1	B	3893	0	3818	98	0
1	C	3893	0	3818	104	0
1	D	3893	0	3818	120	0
1	E	3893	0	3818	115	0
1	F	3893	0	3818	98	0
1	G	3904	0	3830	109	0
1	H	3893	0	3818	124	0
1	I	3893	0	3818	115	0
1	J	3876	0	3801	91	0
1	K	3893	0	3818	103	0
1	L	3902	0	3824	128	0
2	A	42	0	0	1	0
2	B	43	0	0	3	0
2	C	50	0	0	0	0
2	D	54	0	0	1	0
2	E	45	0	0	3	0
2	F	39	0	0	4	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
2	G	30	0	0	3	0
2	H	28	0	0	3	0
2	I	27	0	0	2	0
2	J	23	0	0	2	0
2	K	32	0	0	1	0
2	L	20	0	0	1	0
All	All	47152	0	45817	1290	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 14.

The worst 5 of 1290 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:B:291:ASN:HB3	2:B:495:HOH:O	1.43	1.19
1:E:125:ASN:HD21	1:E:128:THR:HG22	1.05	1.11
1:L:154:ARG:HG2	1:L:159:PRO:HA	1.36	1.05
1:G:4:ARG:HG3	1:G:4:ARG:HH11	1.21	1.02
1:F:154:ARG:HG2	1:F:159:PRO:HA	1.37	1.01

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	481/484 (99%)	434 (90%)	42 (9%)	5 (1%)	12 45
1	B	481/484 (99%)	435 (90%)	39 (8%)	7 (2%)	8 35
1	C	481/484 (99%)	433 (90%)	42 (9%)	6 (1%)	10 40
1	D	481/484 (99%)	434 (90%)	38 (8%)	9 (2%)	6 30
1	E	481/484 (99%)	431 (90%)	41 (8%)	9 (2%)	6 30

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Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	F	481/484 (99%)	433 (90%)	39 (8%)	9 (2%)	6	30
1	G	482/484 (100%)	424 (88%)	47 (10%)	11 (2%)	5	25
1	H	481/484 (99%)	418 (87%)	53 (11%)	10 (2%)	5	27
1	I	481/484 (99%)	426 (89%)	42 (9%)	13 (3%)	4	22
1	J	479/484 (99%)	416 (87%)	50 (10%)	13 (3%)	4	22
1	K	481/484 (99%)	433 (90%)	42 (9%)	6 (1%)	10	40
1	L	482/484 (100%)	420 (87%)	54 (11%)	8 (2%)	7	32
All	All	5772/5808 (99%)	5137 (89%)	529 (9%)	106 (2%)	6	31

5 of 106 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	450	ASN
1	B	227	ASP
1	B	428	GLY
1	D	450	ASN
1	D	465	THR

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	419/420 (100%)	370 (88%)	49 (12%)	5	23
1	B	419/420 (100%)	356 (85%)	63 (15%)	3	14
1	C	419/420 (100%)	362 (86%)	57 (14%)	3	17
1	D	419/420 (100%)	366 (87%)	53 (13%)	4	20
1	E	419/420 (100%)	361 (86%)	58 (14%)	3	17
1	F	419/420 (100%)	365 (87%)	54 (13%)	4	19
1	G	420/420 (100%)	355 (84%)	65 (16%)	2	13
1	H	419/420 (100%)	353 (84%)	66 (16%)	2	13
1	I	419/420 (100%)	367 (88%)	52 (12%)	4	20

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Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	J	417/420 (99%)	359 (86%)	58 (14%)	3	17
1	K	419/420 (100%)	361 (86%)	58 (14%)	3	17
1	L	420/420 (100%)	367 (87%)	53 (13%)	4	20
All	All	5028/5040 (100%)	4342 (86%)	686 (14%)	3	17

5 of 686 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	H	478	VAL
1	J	478	VAL
1	I	179	VAL
1	H	468	GLU
1	J	49	PHE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 150 such sidechains are listed below:

Mol	Chain	Res	Type
1	J	98	GLN
1	L	291	ASN
1	J	178	GLN
1	K	223	GLN
1	D	469	HIS

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](#)

There are no ligands in this entry.

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	483/484 (99%)	-0.36	4 (0%) 82 64	17, 38, 55, 63	6 (1%)
1	B	483/484 (99%)	-0.41	0 100 100	23, 35, 50, 68	5 (1%)
1	C	483/484 (99%)	-0.31	7 (1%) 73 51	21, 37, 57, 71	8 (1%)
1	D	483/484 (99%)	-0.35	5 (1%) 79 59	22, 37, 55, 68	11 (2%)
1	E	483/484 (99%)	-0.28	7 (1%) 73 51	21, 37, 60, 72	8 (1%)
1	F	483/484 (99%)	-0.26	6 (1%) 76 55	19, 39, 59, 69	14 (2%)
1	G	483/484 (99%)	-0.23	6 (1%) 76 55	17, 45, 59, 72	12 (2%)
1	H	483/484 (99%)	0.04	6 (1%) 76 55	29, 55, 68, 81	8 (1%)
1	I	483/484 (99%)	0.05	19 (3%) 43 24	8, 48, 75, 86	22 (4%)
1	J	481/484 (99%)	0.08	14 (2%) 53 31	8, 55, 78, 87	22 (4%)
1	K	483/484 (99%)	-0.21	11 (2%) 61 38	25, 45, 60, 79	13 (2%)
1	L	483/484 (99%)	-0.07	9 (1%) 66 43	23, 50, 77, 86	13 (2%)
All	All	5794/5808 (99%)	-0.19	94 (1%) 70 47	8, 44, 67, 87	142 (2%)

The worst 5 of 94 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	I	468	GLU	20.2
1	I	428	GLY	12.5
1	J	428	GLY	11.5
1	H	46	GLU	7.5
1	F	400	GLU	7.0

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](#)

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.