



wwPDB X-ray Structure Validation Summary Report ⓘ

Mar 1, 2026 – 09:00 PM UTC

PDB ID : 2QE7 / pdb_00002qe7
Title : Crystal structure of the f1-atpase from the thermoalkaliphilic bacterium bacillus sp. ta2.a1
Authors : Stocker, A.; Keis, S.; Vonck, J.; Cook, G.M.; Dimroth, P.
Deposited on : 2007-06-25
Resolution : 3.06 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
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

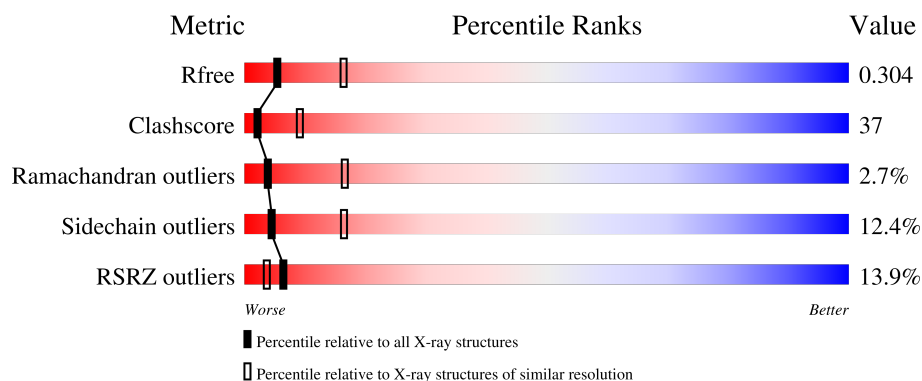
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 3.06 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	2469 (3.10-3.02)
Clashscore	190562	2569 (3.10-3.02)
Ramachandran outliers	187476	2424 (3.10-3.02)
Sidechain outliers	187428	2423 (3.10-3.02)
RSRZ outliers	180081	2469 (3.10-3.02)

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	502	5% 53% 33% 8% 6%
1	B	502	7% 52% 32% 10% 6%
1	C	502	5% 53% 33% 8% 6%
2	D	462	5% 52% 37% 9%
2	E	462	3% 54% 35% 9%

Continued on next page...

Continued from previous page...

Mol	Chain	Length	Quality of chain
2	F	462	4% 51% 38% 9%
3	G	286	68% 8% 55% 16% 21%
4	H	135	74% 13% 76% 11%

2 Entry composition

There are 4 unique types of molecules in this entry. The entry contains 30018 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 ATP synthase subunit alpha.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	474	Total	C	N	O	S	0	0	0
			3640	2295	628	703	14			
1	B	474	Total	C	N	O	S	0	0	0
			3640	2295	628	703	14			
1	C	474	Total	C	N	O	S	0	0	0
			3640	2295	628	703	14			

- Molecule 2 is a protein called ATP synthase subunit beta.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	D	461	Total	C	N	O	S	0	0	0
			3522	2218	608	683	13			
2	E	461	Total	C	N	O	S	0	0	0
			3522	2218	608	683	13			
2	F	461	Total	C	N	O	S	0	0	0
			3522	2218	608	683	13			

- Molecule 3 is a protein called ATP synthase subunit gamma.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	G	227	Total	C	N	O	S	0	227	0
			5382	3396	954	1005	27			

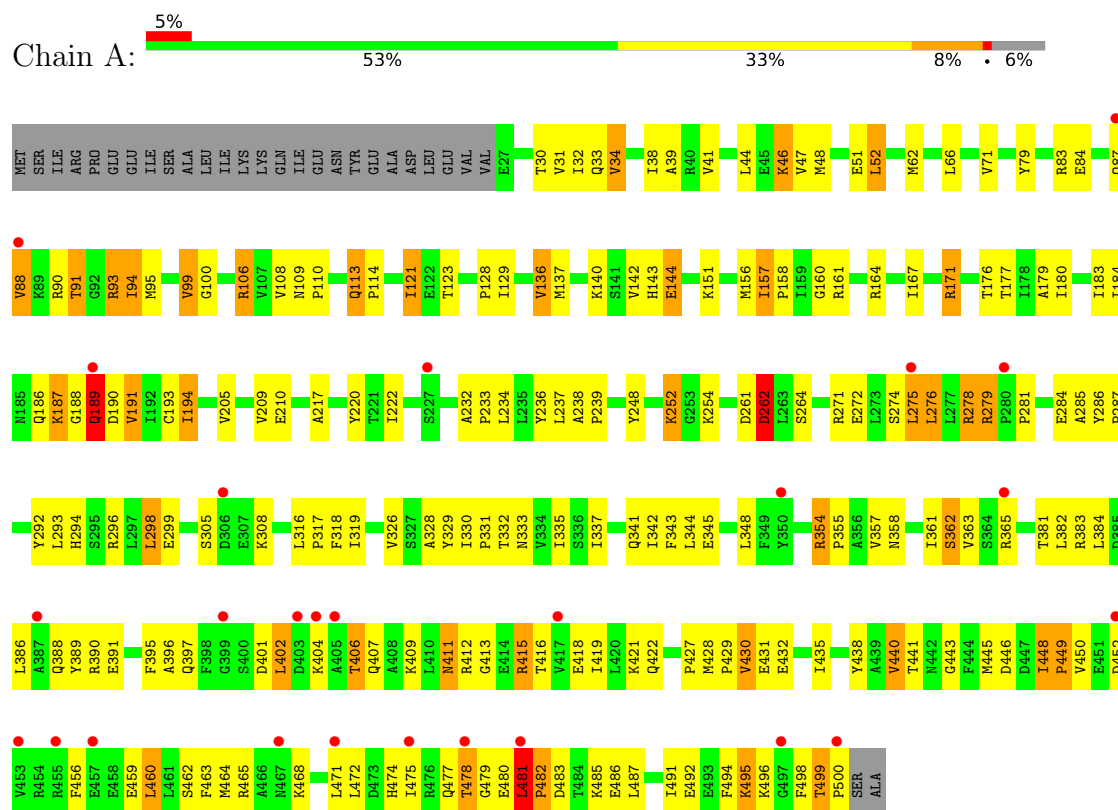
- Molecule 4 is a protein called ATP synthase subunit epsilon.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
4	H	135	Total	C	N	O	S	0	135	0
			3150	1974	579	591	6			

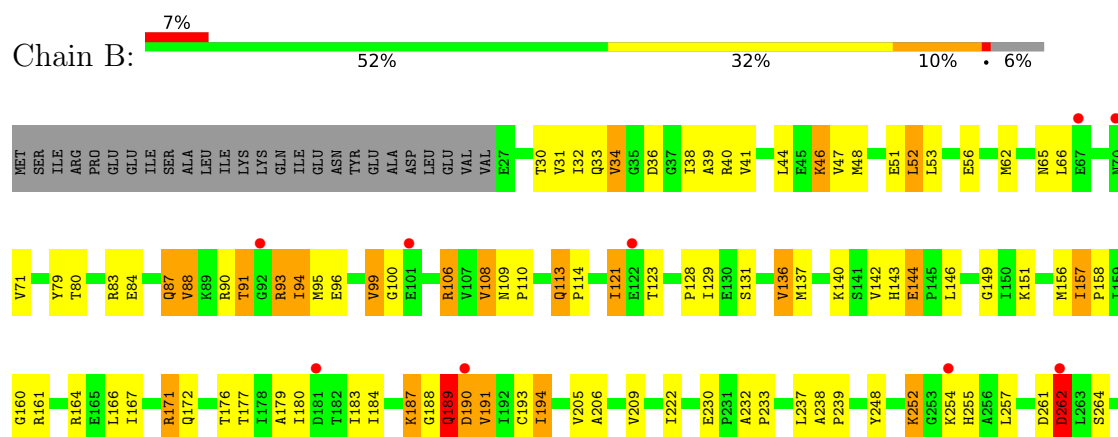
3 Residue-property plots [i](#)

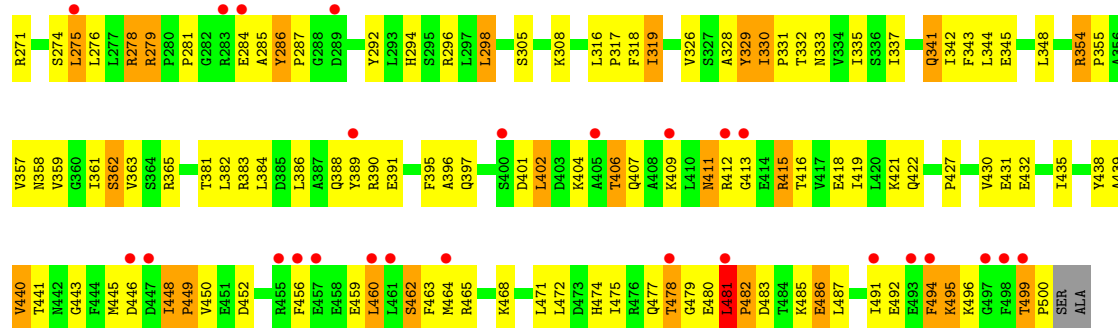
These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density.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

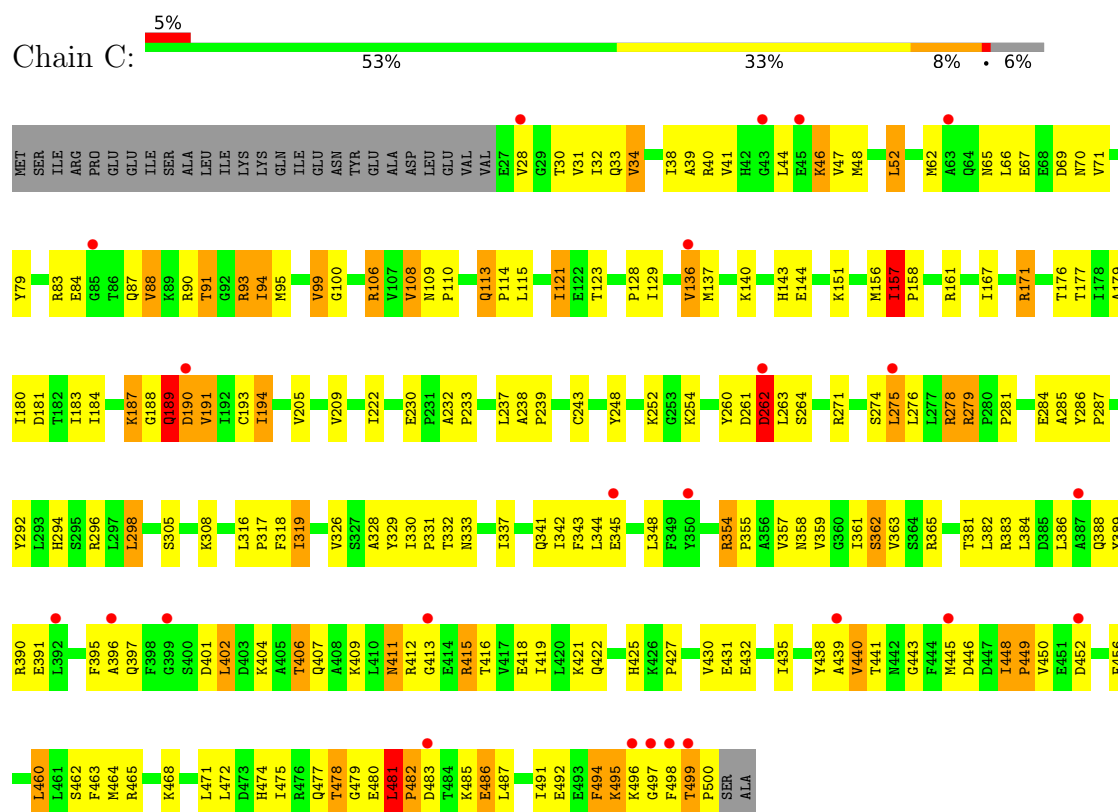


• Molecule 1: ATP synthase subunit alpha

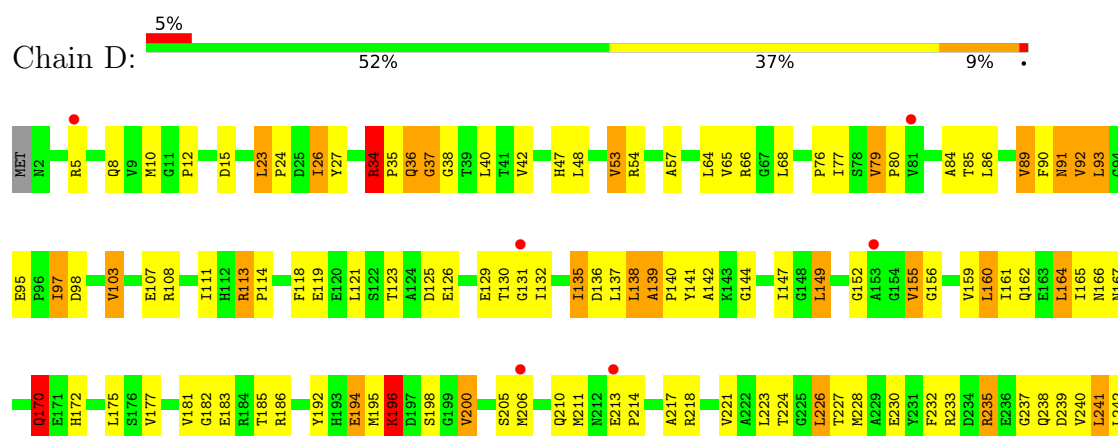


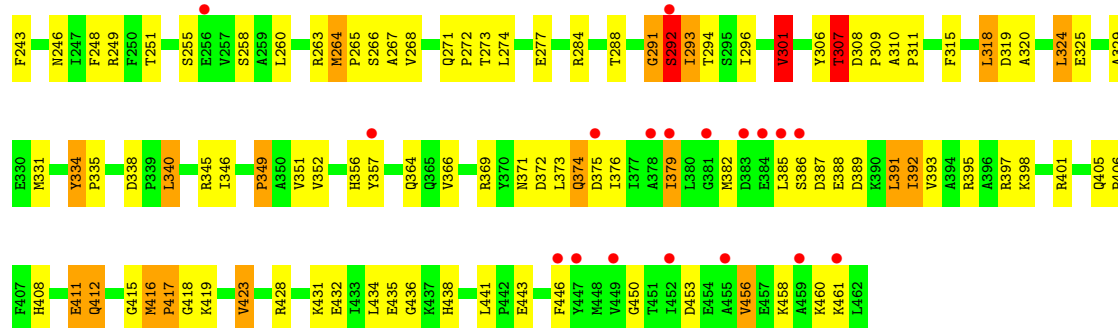


• Molecule 1: ATP synthase subunit alpha

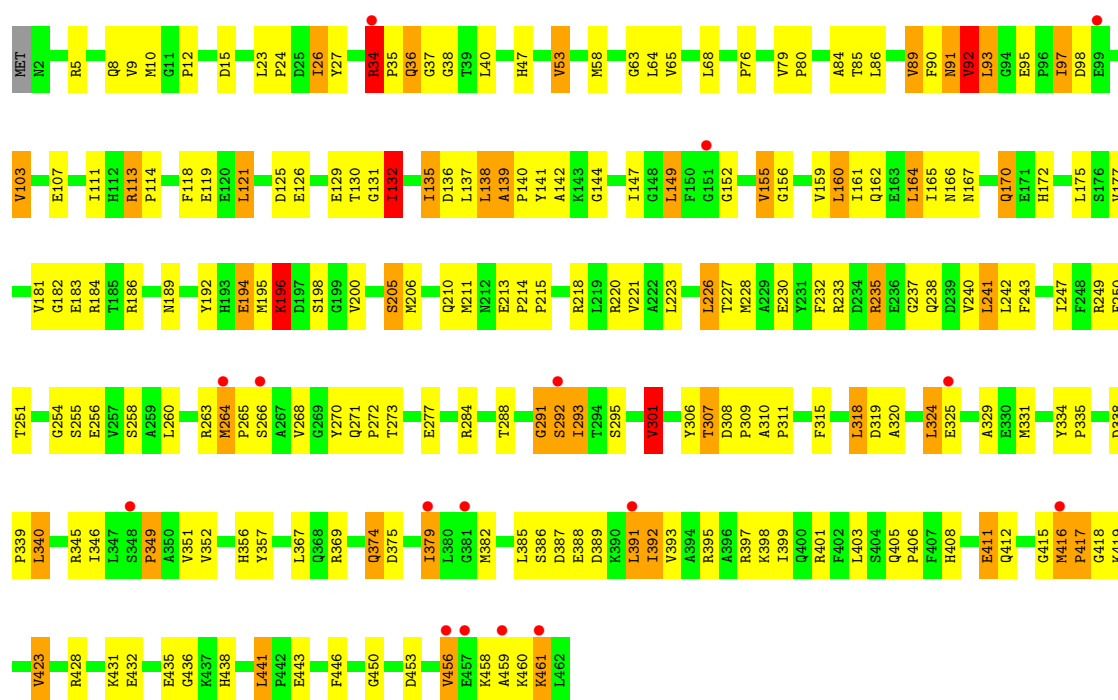


• Molecule 2: ATP synthase subunit beta

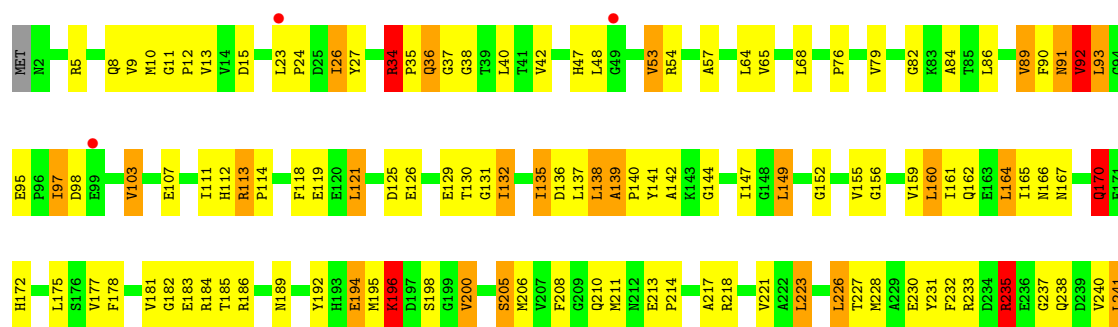


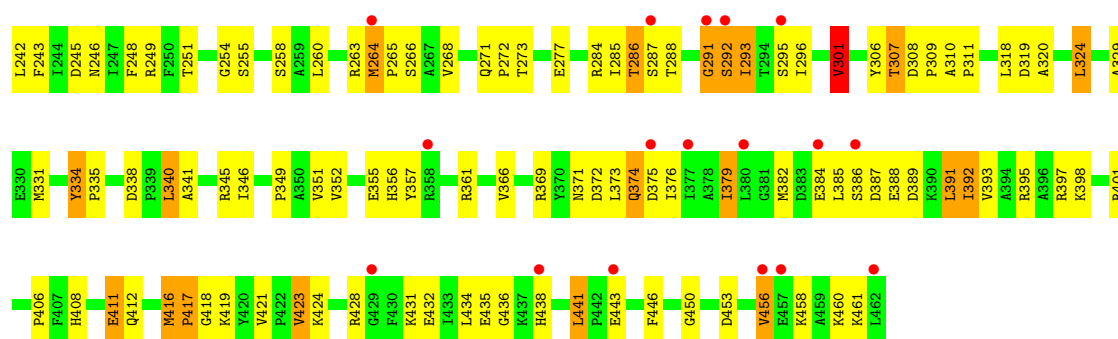


• Molecule 2: ATP synthase subunit beta

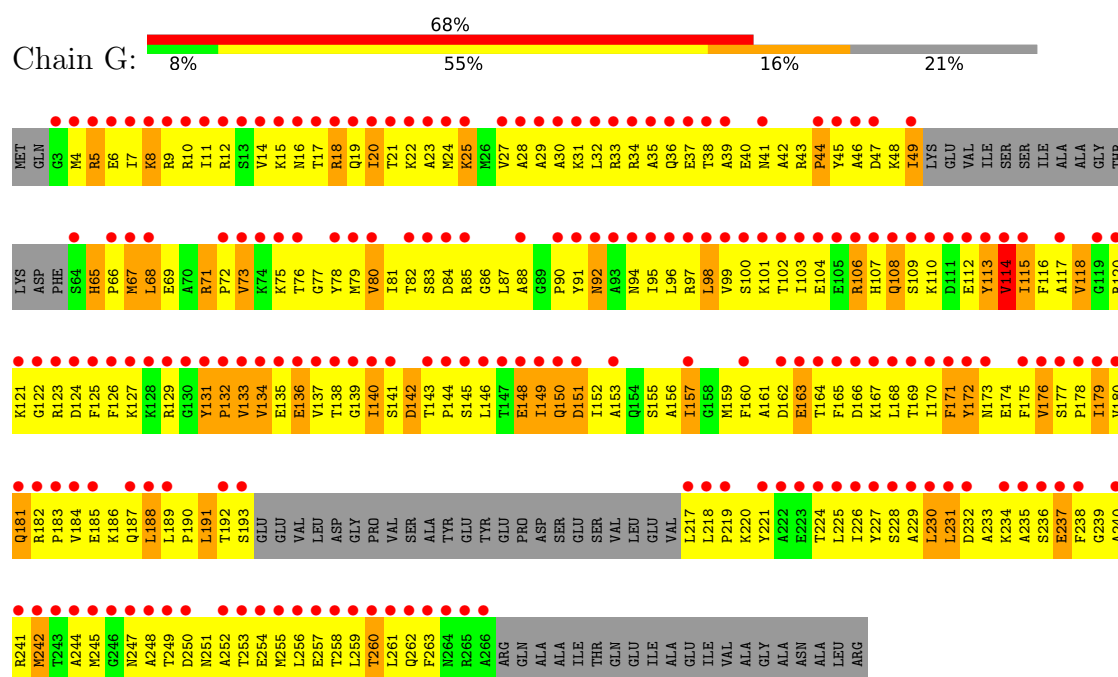


• Molecule 2: ATP synthase subunit beta

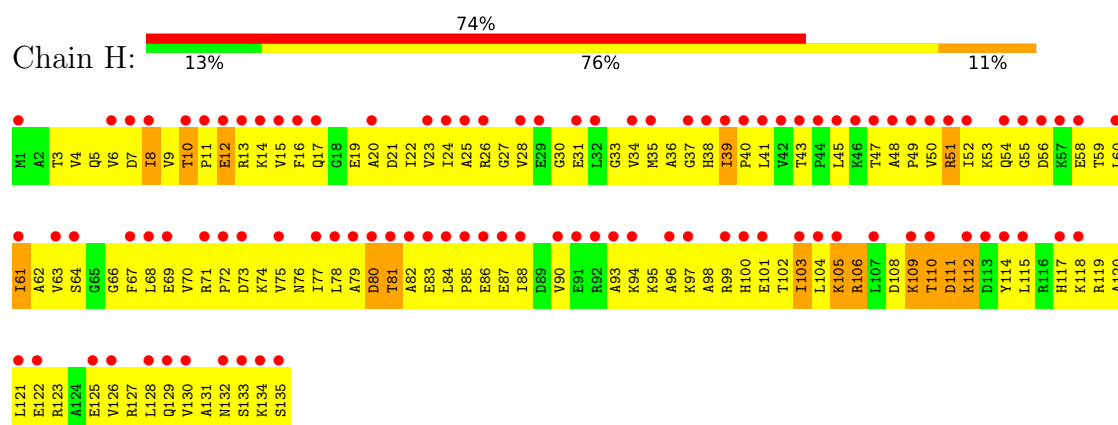




• Molecule 3: ATP synthase subunit gamma



• Molecule 4: ATP synthase subunit epsilon



4 Data and refinement statistics

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α , β , γ	123.21Å 173.02Å 218.05Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	40.00 – 3.06 40.00 – 3.06	Depositor EDS
% Data completeness (in resolution range)	94.6 (40.00-3.06) 94.6 (40.00-3.06)	Depositor EDS
R_{merge}	0.12	Depositor
R_{sym}	0.12	Depositor
$\langle I/\sigma(I) \rangle$ ¹	1.46 (at 2.81Å)	Xtriage
Refinement program	PHENIX	Depositor
R, R_{free}	0.252 , 0.306 0.244 , 0.304	Depositor DCC
R_{free} test set	2577 reflections (2.50%)	wwPDB-VP
Wilson B-factor (Å ²)	63.9	Xtriage
Anisotropy	0.477	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.25 , 122.7	EDS
L-test for twinning ²	$\langle L \rangle = 0.46$, $\langle L^2 \rangle = 0.29$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o, F_c correlation	0.87	EDS
Total number of atoms	30018	wwPDB-VP
Average B, all atoms (Å ²)	78.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.81% 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	0.62	0/3699	1.00	11/5006 (0.2%)
1	B	0.63	1/3699 (0.0%)	1.00	18/5006 (0.4%)
1	C	0.62	0/3699	0.99	14/5006 (0.3%)
2	D	0.61	0/3582	0.98	18/4852 (0.4%)
2	E	0.71	0/3582	1.02	17/4852 (0.4%)
2	F	0.69	0/3582	1.03	21/4852 (0.4%)
3	G	0.22	0/5460	0.52	0/7344
4	H	0.18	0/3183	0.45	0/4287
All	All	0.56	1/30486 (0.0%)	0.89	99/41205 (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	D	0	1
2	E	0	1
2	F	0	1
3	G	0	2
4	H	0	1
All	All	0	6

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	330	ILE	CA-CB	-5.54	1.51	1.54

The worst 5 of 99 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	276	LEU	N-CA-C	-8.38	101.38	111.69
2	F	293	ILE	N-CA-C	7.79	119.44	108.93

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	191	VAL	N-CA-C	7.57	118.71	108.11
2	F	334	TYR	CA-C-N	-7.52	110.44	119.84
2	F	334	TYR	C-N-CA	-7.52	110.44	119.84

There are no chirality outliers.

5 of 6 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
2	D	334	TYR	Peptide
2	E	334	TYR	Peptide
2	F	334	TYR	Peptide
3	G	171[B]	PHE	Peptide
3	G	171[C]	PHE	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	3640	0	3675	269	0
1	B	3640	0	3675	268	0
1	C	3640	0	3675	260	0
2	D	3522	0	3530	223	1
2	E	3522	0	3530	216	0
2	F	3522	0	3530	219	0
3	G	5382	0	5529	644	0
4	H	3150	0	3331	292	1
All	All	30018	0	30475	2253	1

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 37.

The worst 5 of 2253 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:F:371:ASN:CB	3:G:10[B]:ARG:NH1	1.78	1.45

Continued on next page...

Continued from previous page...

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:F:371:ASN:HB3	3:G:10[B]:ARG:NH1	1.03	1.35
1:B:83:ARG:HB2	2:E:47:HIS:CE1	1.64	1.31
3:G:28[C]:ALA:HA	3:G:238[C]:PHE:HD1	1.04	1.17
1:A:275:LEU:HD22	2:D:264:MET:HA	1.28	1.15

All (1) symmetry-related close contacts are listed below. The label for Atom-2 includes the symmetry operator and encoded unit-cell translations to be applied.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:D:37:GLY:O	4:H:111[C]:ASP:O[2_454]	2.11	0.09

5.3 Torsion angles

5.3.1 Protein backbone

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	472/502 (94%)	418 (89%)	44 (9%)	10 (2%)	5	21
1	B	472/502 (94%)	417 (88%)	44 (9%)	11 (2%)	5	19
1	C	472/502 (94%)	417 (88%)	44 (9%)	11 (2%)	5	19
2	D	459/462 (99%)	406 (88%)	44 (10%)	9 (2%)	6	21
2	E	459/462 (99%)	408 (89%)	43 (9%)	8 (2%)	7	25
2	F	459/462 (99%)	407 (89%)	43 (9%)	9 (2%)	6	21
3	G	663/286 (232%)	468 (71%)	141 (21%)	54 (8%)	1	3
4	H	399/135 (296%)	294 (74%)	78 (20%)	27 (7%)	1	4
All	All	3855/3313 (116%)	3235 (84%)	481 (12%)	139 (4%)	4	12

5 of 139 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	189	GLN

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
1	A	396	ALA
1	A	404	LYS
1	A	481	LEU
1	A	482	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	388/413 (94%)	341 (88%)	47 (12%)	5	17
1	B	388/413 (94%)	339 (87%)	49 (13%)	4	16
1	C	388/413 (94%)	342 (88%)	46 (12%)	5	18
2	D	375/376 (100%)	328 (88%)	47 (12%)	4	16
2	E	375/376 (100%)	326 (87%)	49 (13%)	4	15
2	F	375/376 (100%)	327 (87%)	48 (13%)	4	15
3	G	576/239 (241%)	486 (84%)	90 (16%)	2	10
4	H	339/113 (300%)	321 (95%)	18 (5%)	20	47
All	All	3204/2719 (118%)	2810 (88%)	394 (12%)	4	16

5 of 394 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
2	E	411	GLU
3	G	5[A]	ARG
2	F	5	ARG
2	F	194	GLU
3	G	25[C]	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 78 such sidechains are listed below:

Mol	Chain	Res	Type
2	E	238	GLN

Continued on next page...

Continued from previous page...

Mol	Chain	Res	Type
2	F	280	GLN
2	E	323	ASN
2	F	2	ASN
2	F	374	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 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	474/502 (94%)	0.40	26 (5%)	30 16	44, 69, 152, 234	0
1	B	474/502 (94%)	0.36	35 (7%)	20 10	38, 61, 167, 246	0
1	C	474/502 (94%)	0.44	24 (5%)	33 17	45, 67, 128, 185	0
2	D	461/462 (99%)	0.49	24 (5%)	33 16	43, 76, 129, 174	0
2	E	461/462 (99%)	0.20	16 (3%)	47 26	36, 55, 113, 170	0
2	F	461/462 (99%)	0.32	20 (4%)	40 21	40, 62, 124, 173	0
3	G	227/286 (79%)	3.63	195 (85%)	0 0	3, 17, 34, 47	227 (100%)
4	H	135/135 (100%)	3.20	100 (74%)	0 0	27, 44, 65, 71	135 (100%)
All	All	3167/3313 (95%)	0.73	440 (13%)	6 4	3, 62, 136, 246	362 (11%)

The worst 5 of 440 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
3	G	223[A]	GLU	13.2
3	G	143[A]	THR	10.1
3	G	145[A]	SER	9.8
3	G	132[A]	PRO	9.1
3	G	227[A]	TYR	8.0

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.