Full wwPDB X-ray Structure Validation Report (i)

Nov 5, 2023 – 10:28 pm GMT

PDB ID	:	7QGK
Title	:	The mRubyFT protein, Genetically Encoded Blue-to-Red Fluorescent Timer in its red state
Authors	:	Boyko, K.M.; Nikolaeva, A.Y.; Gaivoronskii, F.A.; Vlaskina, A.V.; Subach, O.M.; Popov, V.O.; Subach, F.V.
Deposited on	:	2021-12-08
Resolution	:	1.50 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*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) 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 (i)) were used in the production of this report:

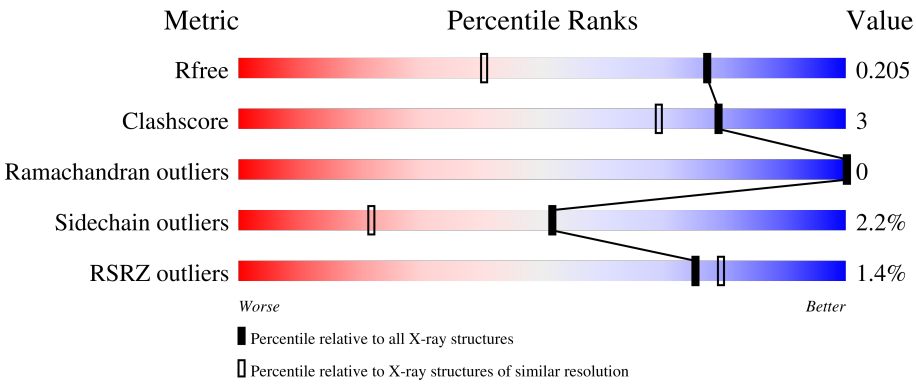
MolProbity	:	4.02b-467
Mogul	:	1.8.4, CSD as541be (2020)
Xtriage (Phenix)	:	1.13
EDS	:	2.36
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Refmac	:	5.8.0158
CCP4	:	7.0.044 (Gargrove)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.36

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

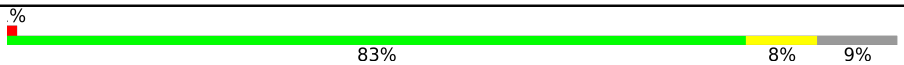
The reported resolution of this entry is 1.50 Å.

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}	130704	2936 (1.50-1.50)
Clashscore	141614	3144 (1.50-1.50)
Ramachandran outliers	138981	3066 (1.50-1.50)
Sidechain outliers	138945	3064 (1.50-1.50)
RSRZ outliers	127900	2884 (1.50-1.50)

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 <=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	239	

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 1990 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 The red form of the mRubyFT protein, Genetically Encoded Blue-to-Red Fluorescent Timer.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	218	1831	1161	312	339	19	0	26	0

There are 54 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-3	GLY	-	expression tag	UNP Q8ISF8
A	-2	HIS	-	expression tag	UNP Q8ISF8
A	-1	MET	-	expression tag	UNP Q8ISF8
A	0	ARG	-	expression tag	UNP Q8ISF8
A	1	SER	-	expression tag	UNP Q8ISF8
A	2	MET	-	expression tag	UNP Q8ISF8
A	3	VAL	-	expression tag	UNP Q8ISF8
A	4	SER	-	expression tag	UNP Q8ISF8
A	5	LYS	-	expression tag	UNP Q8ISF8
A	6	GLY	-	expression tag	UNP Q8ISF8
A	7	GLU	-	expression tag	UNP Q8ISF8
A	8	GLU	-	expression tag	UNP Q8ISF8
A	17	LYS	MET	engineered mutation	UNP Q8ISF8
A	27	HIS	TYR	engineered mutation	UNP Q8ISF8
A	36	GLU	ASP	engineered mutation	UNP Q8ISF8
A	51	ILE	VAL	engineered mutation	UNP Q8ISF8
A	68	NRP	MET	chromophore	UNP Q8ISF8
A	68	NRP	TYR	chromophore	UNP Q8ISF8
A	68	NRP	GLY	chromophore	UNP Q8ISF8
A	72	ARG	LYS	engineered mutation	UNP Q8ISF8
A	77	TYR	HIS	engineered mutation	UNP Q8ISF8
A	78	PRO	THR	engineered mutation	UNP Q8ISF8
A	107	VAL	PHE	engineered mutation	UNP Q8ISF8
A	124	VAL	ALA	engineered mutation	UNP Q8ISF8
A	125	GLN	LYS	engineered mutation	UNP Q8ISF8
A	127	ARG	THR	engineered mutation	UNP Q8ISF8

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Chain	Residue	Modelled	Actual	Comment	Reference
A	130	ASP	ASN	engineered mutation	UNP Q8ISF8
A	136	PRO	ALA	engineered mutation	UNP Q8ISF8
A	148	SER	ASN	engineered mutation	UNP Q8ISF8
A	152	MET	LEU	engineered mutation	UNP Q8ISF8
A	163	THR	SER	engineered mutation	UNP Q8ISF8
A	164	HIS	GLN	engineered mutation	UNP Q8ISF8
A	168	LYS	ASN	engineered mutation	UNP Q8ISF8
A	174	HIS	TYR	engineered mutation	UNP Q8ISF8
A	180	VAL	GLU	engineered mutation	UNP Q8ISF8
A	190	GLY	GLU	engineered mutation	UNP Q8ISF8
A	192	ILE	PHE	engineered mutation	UNP Q8ISF8
A	197	ILE	PHE	engineered mutation	UNP Q8ISF8
A	199	ALA	PHE	engineered mutation	UNP Q8ISF8
A	212	ASN	LYS	engineered mutation	UNP Q8ISF8
A	218	LEU	GLN	engineered mutation	UNP Q8ISF8
A	219	ARG	HIS	engineered mutation	UNP Q8ISF8
A	222	SER	ALA	engineered mutation	UNP Q8ISF8
A	227	ALA	-	expression tag	UNP Q8ISF8
A	228	GLY	-	expression tag	UNP Q8ISF8
A	229	ARG	-	expression tag	UNP Q8ISF8
A	230	GLY	-	expression tag	UNP Q8ISF8
A	231	GLY	-	expression tag	UNP Q8ISF8
A	232	MET	-	expression tag	UNP Q8ISF8
A	233	ASP	-	expression tag	UNP Q8ISF8
A	234	GLU	-	expression tag	UNP Q8ISF8
A	235	LEU	-	expression tag	UNP Q8ISF8
A	236	TYR	-	expression tag	UNP Q8ISF8
A	237	LYS	-	expression tag	UNP Q8ISF8

- Molecule 2 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	Mg		
2	A	3	3	3	0	0

- Molecule 3 is water.

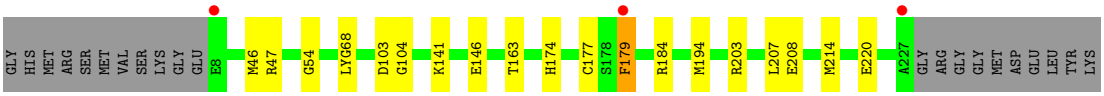
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
3	A	156	156	156	0	0

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: The red form of the mRubyFT protein, Genetically Encoded Blue-to-Red Fluorescent Timer

Chain A:



4 Data and refinement statistics (i)

Property	Value	Source
Space group	P 21 21 21	Depositor
Cell constants a, b, c, α, β, γ	31.34Å 66.25Å 96.50Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	54.62 – 1.50 54.62 – 1.50	Depositor EDS
% Data completeness (in resolution range)	99.8 (54.62-1.50) 99.8 (54.62-1.50)	Depositor EDS
R_{merge}	0.03	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	3.50 (at 1.50Å)	Xtriage
Refinement program	REFMAC 5.8.0267	Depositor
R, R_{free}	0.174 , 0.195 0.184 , 0.205	Depositor DCC
R_{free} test set	1616 reflections (4.90%)	wwPDB-VP
Wilson B-factor (Å^2)	19.2	Xtriage
Anisotropy	0.064	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.36 , 41.2	EDS
L-test for twinning[2]	$< \|L\| > = 0.49$, $< L^2 > = 0.32$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
F_o,F_c correlation	0.97	EDS
Total number of atoms	1990	wwPDB-VP
Average B, all atoms (Å^2)	21.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 13.39% of the height of the origin peak. No significant pseudotranslation is detected.*

[1]Intensities estimated from amplitudes.

[2]Theoretical values of $< |L| >$, $< L^2 >$ 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: MG, NRP

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	0.75	2/1938 (0.1%)	1.01	2/2607 (0.1%)

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

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	220[A]	GLU	CD-OE1	-5.07	1.20	1.25
1	A	220[B]	GLU	CD-OE1	-5.07	1.20	1.25

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	203	ARG	NE-CZ-NH1	5.41	123.01	120.30
1	A	179	PHE	CB-CG-CD2	-5.06	117.26	120.80

There are no chirality outliers.

All (1) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	103	ASP	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	1831	0	1756	10	0
2	A	3	0	0	0	0
3	A	156	0	0	6	0
All	All	1990	0	1756	10	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.

All (10) 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:208[B]:GLU:OE2	3:A:405:HOH:O	1.54	1.20
1:A:194[A]:MET:SD	3:A:517:HOH:O	1.97	1.19
1:A:194[A]:MET:CG	3:A:517:HOH:O	2.14	0.90
1:A:146[B]:GLU:OE2	1:A:174:HIS:NE2	2.28	0.66
1:A:194[A]:MET:HG2	3:A:517:HOH:O	1.87	0.64
1:A:184[B]:ARG:NH1	3:A:406:HOH:O	2.08	0.58
1:A:163[B]:THR:HG22	1:A:179:PHE:HB2	1.87	0.56
1:A:104[A]:GLY:HA2	3:A:403:HOH:O	2.11	0.49
1:A:46[B]:MET:HE2	1:A:46[B]:MET:HB2	1.68	0.44
1:A:54:GLY:HA3	1:A:214[A]:MET:SD	2.60	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	239/239 (100%)	237 (99%)	2 (1%)	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	204/202 (101%)	199 (98%)	5 (2%)	47	18

All (5) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	47	ARG
1	A	141	LYS
1	A	177[A]	CYS
1	A	177[B]	CYS
1	A	207	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

5.3.3 RNA (i)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

1 non-standard protein/DNA/RNA residue is modelled in this entry.

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	$\#\|Z\| > 2$
1	NRP	A	68	1	23,24,25	3.92	6 (26%)	25,33,35	3.97	9 (36%)

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
1	NRP	A	68	1	-	0/9/31/32	0/2/2/2

All (6) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	A	68	NRP	CB2-CA2	15.64	1.48	1.35
1	A	68	NRP	CA2-C2	-7.82	1.40	1.48
1	A	68	NRP	C1-N2	3.31	1.40	1.33
1	A	68	NRP	C1-N3	-3.04	1.33	1.38
1	A	68	NRP	O2-C2	2.71	1.28	1.23
1	A	68	NRP	CE2-CZ	2.39	1.43	1.38

All (9) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	A	68	NRP	O2-C2-CA2	-13.64	123.30	130.96
1	A	68	NRP	CA2-C2-N3	10.74	108.45	103.37
1	A	68	NRP	O3-C3-CA3	-4.56	112.63	126.39
1	A	68	NRP	CB2-CA2-N2	4.13	134.56	128.83
1	A	68	NRP	CB2-CA2-C2	-3.27	118.38	122.28
1	A	68	NRP	C2-CA2-N2	-2.69	107.05	108.93
1	A	68	NRP	N3-C1-N2	-2.45	110.05	113.28
1	A	68	NRP	CE2-CD2-CG2	-2.35	118.18	121.25
1	A	68	NRP	CD2-CG2-CD1	2.32	121.07	117.64

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

No monomer is involved in short contacts.

5.5 Carbohydrates (i)

There are no monosaccharides 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 (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	217/239 (90%)	-0.16	3 (1%) 75 79	13, 20, 31, 53	3 (1%)

All (3) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	227	ALA	2.9
1	A	179	PHE	2.8
1	A	8	GLU	2.4

6.2 Non-standard residues in protein, DNA, RNA chains (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(Å^2)	Q<0.9
1	NRP	A	68	23/24	0.84	0.14	19,24,26,27	0

6.3 Carbohydrates (i)

There are no monosaccharides 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(Å^2)	Q<0.9
2	MG	A	301	1/1	0.97	0.07	25,25,25,25	0
2	MG	A	303	1/1	0.98	0.12	21,21,21,21	0
2	MG	A	302	1/1	0.99	0.06	27,27,27,27	0

6.5 Other polymers (i)

There are no such residues in this entry.