

# Integrative Structure Validation Report

October 09, 2025 - 04:40 PM PDT

*The following software was used in the production of this report:*

*IHMValidation Version 3.0*


*Python-IHM Version 2.5*

*MolProbity Version 4.5.2*

PDB ID	9A21   pdb_00009a21
PDB-Dev ID	PDBDEV_00000138
Structure Title	Photoinduced intermediate I of bacteriorhodopsin at ~400 femtosecond with an expanded retinal binding pocket
Structure Authors	Ren, Z.
Deposited on	2022-07-15

*This is a PDB-IHM Structure Validation Report.*

*We welcome your comments at [helpdesk@pdb-ihm.org](mailto:helpdesk@pdb-ihm.org)*

*A user guide is available at [https://pdb-ihm.org/validation\\_help.html](https://pdb-ihm.org/validation_help.html) with specific help available everywhere you see the  symbol.*

*List of references used to build this report is available [here](#).*

## 1. Overview

### 1.1. Summary

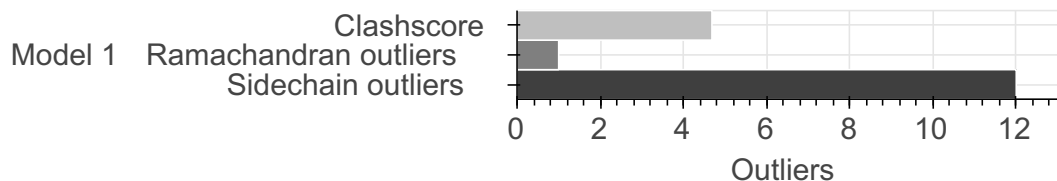
*This entry consists of 1 model(s). A total of 21 dataset(s) were used to build this entry.*

Name	Type	Count
X-ray diffraction data	Experimental data	20
Experimental model	Starting model	1

### 1.2. Overall quality

This validation report contains model quality assessments for all structures, data quality and fit to model assessments for SAS and crosslinking-MS datasets. Data quality and fit to model assessments for other datasets and model uncertainty are under development. Number of plots is limited to 256.

### Model Quality: MolProbity Analysis ?



## 2. Model Details ?

### 2.1. Ensemble information ?

This entry consists of 0 distinct ensemble(s).

### 2.2. Representation ?

This entry has 1 representation(s).

ID	Model(s)	Entity ID	Molecule name	Chain(s) [auth]	Total residues	Rigid segments	Flexible segments	Model coverage/ Starting model coverage (%)	Scale
1	1	1	BACTERIORHODOPSIN	A	248	-	1-248	100.00 / 100.00	Atomic
		2	RETINAL	B [A]	Non-polymeric	-	-	Not available / Not available	Atomic
		3	water	C [A]	Non-polymeric	-	-	Not available / Not available	Atomic

### 2.3. Datasets used for modeling ?

There are 21 unique datasets used to build the models in this entry.

ID	Dataset type	Database name	Data access code
1	Experimental model	PDB	<a href="#">pdb_00006g7h</a>
2	X-ray diffraction data	PDB	<a href="#">pdb_00006g7h</a>
3	X-ray diffraction data	PDB	<a href="#">pdb_00006g7i</a>
4	X-ray diffraction data	PDB	<a href="#">pdb_00006g7j</a>
5	X-ray diffraction data	PDB	<a href="#">pdb_00006g7k</a>
6	X-ray diffraction data	PDB	<a href="#">pdb_00006ga2</a>
7	X-ray diffraction data	PDB	<a href="#">pdb_00006ga4</a>
8	X-ray diffraction data	PDB	<a href="#">pdb_00006ga5</a>
9	X-ray diffraction data	PDB	<a href="#">pdb_00006ga6</a>

ID	Dataset type	Database name	Data access code
10	X-ray diffraction data	PDB	<a href="#">pdb_00006ga7</a>
11	X-ray diffraction data	PDB	<a href="#">pdb_00006ga8</a>
12	X-ray diffraction data	PDB	<a href="#">pdb_00006ga9</a>
13	X-ray diffraction data	PDB	<a href="#">pdb_00006gaa</a>
14	X-ray diffraction data	PDB	<a href="#">pdb_00006gab</a>
15	X-ray diffraction data	PDB	<a href="#">pdb_00006gac</a>
16	X-ray diffraction data	PDB	<a href="#">pdb_00006gad</a>
17	X-ray diffraction data	PDB	<a href="#">pdb_00006gae</a>
18	X-ray diffraction data	PDB	<a href="#">pdb_00006gaf</a>
19	X-ray diffraction data	PDB	<a href="#">pdb_00006gag</a>
20	X-ray diffraction data	PDB	<a href="#">pdb_00006gah</a>
21	X-ray diffraction data	PDB	<a href="#">pdb_00006gai</a>

## 2.4. Methodology and software ?

*This entry is a result of 1 distinct protocol(s).*

Step number	Protocol ID	Method name	Method type	Method description	Number of computed models	Multi state modeling	Multi scale modeling
1	1	Singular value decomposition analysis of difference Fourier maps	Singular value decomposition	Not available	1	False	False

*There are 2 software packages reported in this entry.*

ID	Software name	Software version	Software classification	Software location
1	<a href="#">PHENIX</a>	(1.13_2998: ???)	refinement	<a href="https://phenix-online.org/">https://phenix-online.org/</a>
2	dynamiX	Not available	Data reduction	Not available

## 3. Data quality ?

### 3.4. X-ray diffraction ?

Validation for this section is under development.

## 4. Model quality ?

For models with atomic structures, MolProbity analysis is performed. For models with coarse-grained or multi-scale structures, excluded volume analysis is performed.

### 4.1b. MolProbity Analysis ?

*Excluded volume satisfaction for the models in the entry are listed below. The Analysed column shows the number of particle-particle or*

particle-atom pairs for which excluded volume was analysed.

### Standard geometry: bond outliers ?

There are no bond length outliers.

### Standard geometry: angle outliers ?

There are no bond angle outliers.

### Too-close contacts ?

The following all-atom clashscore is based on a MolProbity analysis. All-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The table below contains clashscores for all atomic models in this entry.

Model ID	Clash score	Number of clashes
1	4.68	17

There are 17 clashes. The table below contains the detailed list of all clashes based on a MolProbity analysis. Bad clashes are  $\geq 0.4$  Angstrom.

Atom 1	Atom 2	Clash(Å)	Model ID (Worst)	Models (Total)
A:159:LYS:O	A:162:SER:OG	0.78	1	1
A:20:MET:HE2	A:213:VAL:HG22	0.76	1	1
A:157:THR:OG1	A:175:ARG:NH1	0.71	1	1
A:149:LEU:HD13	A:179:VAL:HG13	0.63	1	1
A:176:ASN:O	A:180:VAL:HG23	0.63	1	1
A:141:SER:HB3	B:1:RET:H41	0.57	1	1
A:156:PHE:HB3	A:171:PHE:CZ	0.55	1	1
A:153:PHE:CE2	A:179:VAL:HG21	0.52	1	1
A:181:LEU:HD13	A:215:ALA:HB2	0.49	1	1
A:68:MET:HB3	A:75:GLN:HG3	0.46	1	1
A:141:SER:CB	B:1:RET:H41	0.46	1	1
A:5:THR:OG1	A:6:GLY:N	0.43	1	1
A:156:PHE:HB3	A:171:PHE:HZ	0.43	1	1
A:218:GLY:O	A:222:ILE:HG13	0.42	1	1
A:66:LEU:HD11	A:77:PRO:HB2	0.41	1	1
A:83:TYR:CD1	A:83:TYR:N	0.41	1	1
A:157:THR:HA	A:171:PHE:HE2	0.41	1	1

### Torsion angles: Protein backbone ?

In the following table, Ramachandran outliers are listed. The Analysed column shows the number of residues for which the backbone conformation was analysed.

Model ID	Analysed	Favored	Allowed	Outliers
1	228	218	9	1

There are 1 unique backbone outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	161	GLU	1

### Torsion angles : Protein sidechains ?

In the following table, sidechain rotameric outliers are listed. The Analysed column shows the number of residues for which the sidechain conformation was analysed.

Model ID	Analysed	Favored	Allowed	Outliers
1	181	154	15	12

There are 12 unique sidechain outliers. Detailed list of outliers are tabulated below.

Chain	Res	Type	Models (Total)
A	29	VAL	1
A	34	VAL	1
A	46	THR	1
A	87	LEU	1
A	107	THR	1
A	128	THR	1
A	141	SER	1
A	164	ARG	1
A	166	GLU	1
A	173	VAL	1
A	177	VAL	1
A	178	THR	1

## 5. Fit to Data Used for Modeling Assessment ?

### 5.4. X-ray diffraction ?

Validation for this section is under development.

## 6. Fit to Data Used for Validation Assessment ?

Validation for this section is under development.

### *Acknowledgments*

*The development of integrative model validation metrics, implementation of a model validation pipeline, and creation of a*

validation report for integrative structures are funded by NSF awards to the [PDB-IHM team](#) (DBI-1756248, DBI-2112966, DBI-2112967, DBI-2112968, and DBI-1756250) and awards from NSF, NIH, and DOE to the [RCSB PDB](#) (DBI-2321666, R01GM157729, and DE-SC0019749). The PDB-IHM team and members of the [Sali lab](#) contributed model validation metrics and software packages.

Dr. Jill Trewhella, Dr. Dina Schneidman, and members of the [SASBDB](#) repository are acknowledged for their advice and support in implementing SAS validation methods. Team members from the labs of Dr. Juri Rappsilber, Dr. Alexander Leitner, Dr. Andrea Graziadei, and members of [PRIDE](#) database are acknowledged for their advice and support in implementing crosslinking-MS validation methods. We are grateful to Dr. Shruthi Viswanath for discussions about uncertainty assessment of integrative structural models.

Members of the [wwPDB Integrative/Hybrid Methods Task Force](#) provided recommendations and community support for the project.