Joint CASP14-CAPRI50 assembly prediction round of 2020

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Izmir Biomedicine and Genome Center, Izmir, Turkey

CAPRI

CAPRI	CASP

CAPRI

Since 2002

Critical **A**ssessment of
PRedicted **I**nteractions

Joint prediction rounds since 2014:

25 Targets	Round 30
10 Targets	Round 37
21 Targets	Round 46
12 Targets	Round 50

Prediction rounds on a "rolling" basis

Fits with publication schedule
3 to 4 weeks per prediction round

CASP

Since 1994

Structure **P**redictions

CASP11	2014
CASP12	2016
CASP13	2018
CASP14	2020

Prediction season

CAPRI

CAPRI

Since 2002

Critical **A**ssessment of
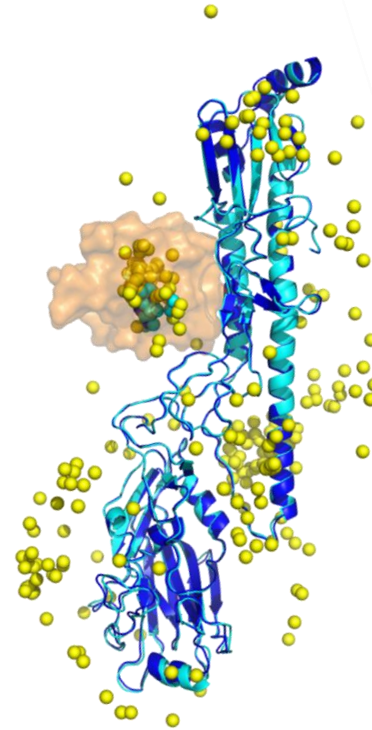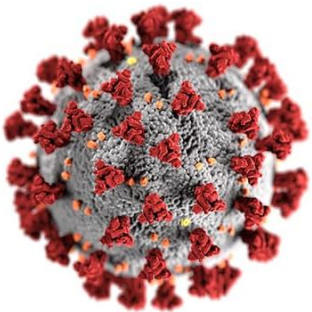   **PR**edicted **I**nteractions

Dynamic experiment

Docking different molecules
Docking experiment
Scoring experiment

The targets are not the same

Proteins, Nucleic acids, Polysaccharides, Water, Peptides, Interfaces, Assemblies, SAXS, Binding affinities, Multi-domain organization

Marc   Shoshana   Guillaume   Sameer   Nurul

assessment, organization, website, operations, infrastructure

CAPRI

CAPRI

Since 2002

Critical **A**ssessment of
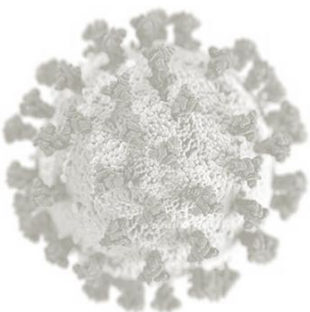
PRedicted **I**nteractions

Dynamic experiment

Docking different molecules
Docking experiment
Scoring experiment

COVID-19 Open Science Initiative

Round 51   Sep 15, 2020 – Jan 4, 2021

Targets: 3x SARS-CoV-2 with human host

1x multi-component complex SARS-CoV-2 + RNA

All models (5000+) available for download:

http://cb.iri.univ-lille1.fr/capri/covid.html

3D-BioInfo community-wide initiative
February – July 2021

Benchmarking tools to discriminate between physiological/non-physiological protein-protein interfaces

Standard benchmark dataset (PDB) derived with QSalign and ProtCID – R. Dunbrack, E. Levy

Contact: shoshana.wodak@gmail.com

elixir
3D
Bio
Info

CAPRI

CAPRI

Since 2002

Critical **A**ssessment of
      PRedicted **I**nteractions

Dynamic experiment

    Docking different molecules
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Contact: shoshana.wodak@gmail.com

Website

CAPRI

Since 2002

Critical **A**ssessment of

PRedicted **I**nteractions

https://www.pdbe.org/capri
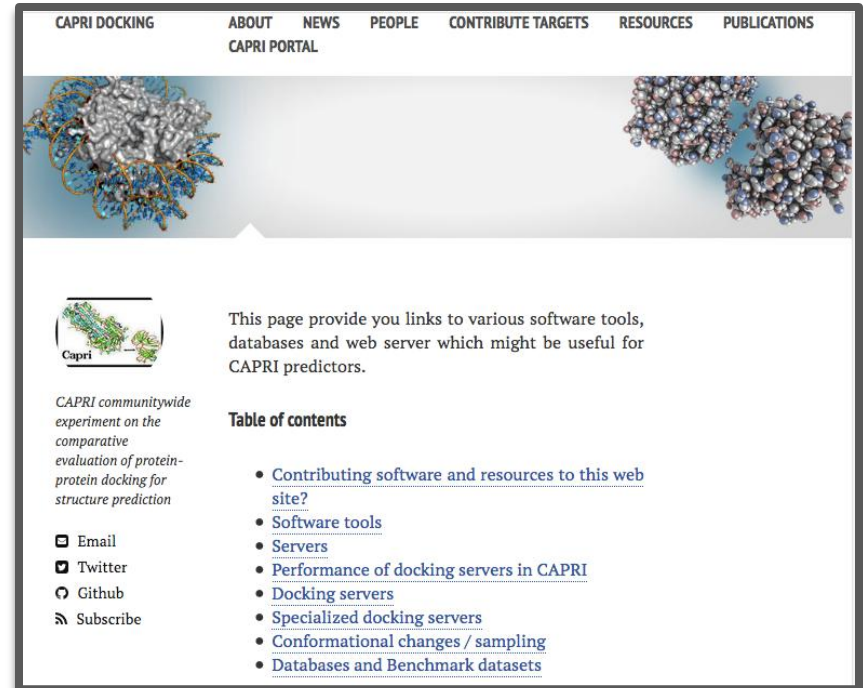
(for prediction submission)

https://www.capri-docking.org/

(community exchange portal)

@CAPRIdock

https://www.ebi.ac.uk/pdbe/complex-pred/capri/covid-capri/

Meetings

CAPRI

Since 2002

Critical **A**ssessment of

      PRedicted **I**nteractions

Dynamic experiment

    Docking different molecules
    Docking experiment
    Scoring experiment

Assessment meetings

La Londe-des-Maures	France	2002
Gaeta	Italy	2004
Toronto	Canada	2007
Barcelona	Spain	2009
Utrecht	The Netherlands	2013
Tel Aviv	Israel	2016
EBI Hinxton	UK	2019

CAPRI evaluation meetings

La Londe Des Maures France, 2002

Toronto Canada 2007

Gaeta Italy, 2004

EBI Hinxton, UK April 2019

Tel Aviv, Israel April 2016

Utrecht, The Netherland, 2013

Barcelona Spain 2009

To date: 50 rounds, 181 targets. 7 Evaluation meetings + CASP11/12/13/14
7 Special Issues of Proteins dedicated to CAPRI, 2003 – 2020

Management committee

CAPRI

Since 2002

Critical **A**ssessment of
PRedicted **I**nteractions

Dynamic experiment

    Docking different molecules
    Docking experiment
    Scoring experiment

Assessment meetings

Management committee

Alexandre Bonvin	The Netherlands
Marc Lensink	France
Michael Sternberg	UK
Sandor Vajda	USA
Ilya Vakser	USA
Sameer Velankar	UK
Shoshana Wodak	Belgium
Joel Janin	France

CAPRI Assessment

- Assessment criteria established as community consensus

Nº receptor interface residues (≤ 10Å)

Nº ligand interface residues (≤ 10Å)

Nº residue-residue contacts (≤ 5Å)

Target

R   L

i-rms

f_{native}

$f_{\text{non-native}}$

L

R

Model

F1 may be used, but is not yet official.

L-rms

d_L ϑ_L

L

L

R
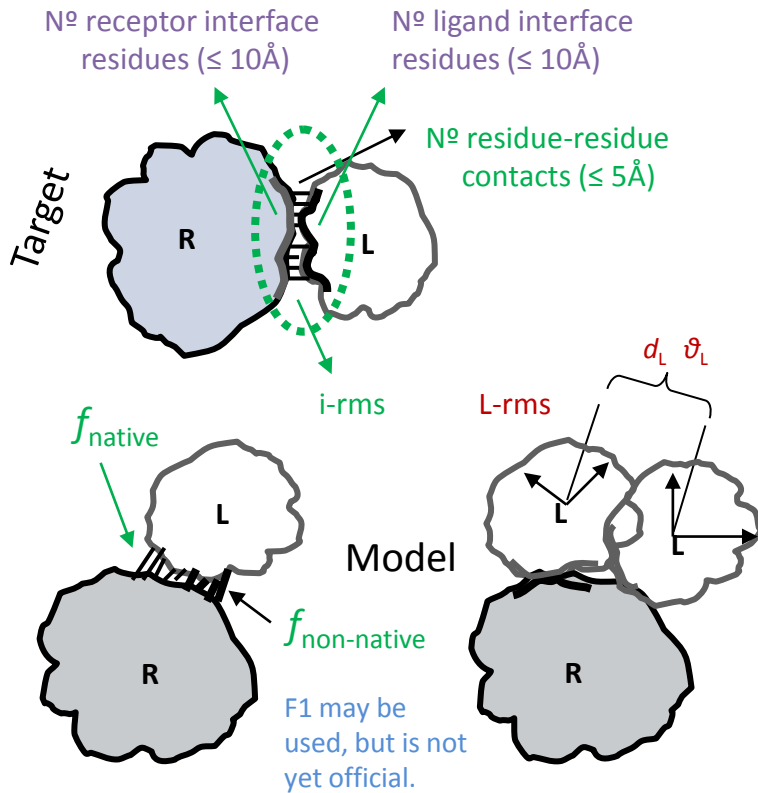
f_{native}
residue-residue
5 Å

i-rms
Interface backbone
10 Å

S-rms
Interface side-chain
10 Å

L-rms
ligand backbone

n_{clashes}
atom-atom
3 Å

d_L

ϑ_L

*Only **L-rms**, **i-rms** and f_{nat} are used to classify protein-protein interaction models in CAPRI.*

Additional quantities are being calculated, such as S-rms, which are useful quality measures for protein-peptide interaction models.
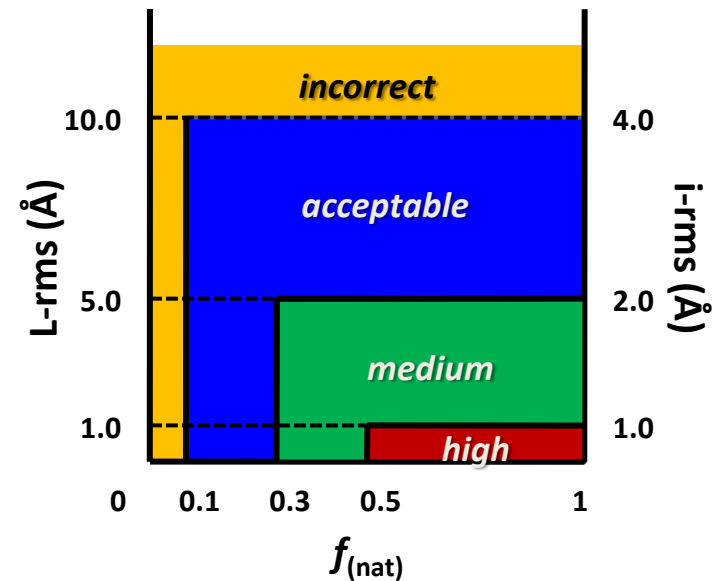
- Evaluation of 5 submitted models
- Focusing on individual interfaces of interaction

CAPRI Assessment

1. CAPRI assessment is (a) receptor/ligand and (b) interface based
   - fraction of native contacts f(nat)
   - i-rms
   - L-rms

2. Four categories
   - incorrect, acceptable, medium, high

3. For multimeric targets, each interface is assessed separately

4. Final target score (set of interfaces) is a combination of individual interface scores
   - Either an AverageOf or BestOf

5. Final predictor score is the sum of these scores

$$\text{Score} = \omega_1 \cdot N_{ACC} + \omega_2 \cdot N_{MED} + \omega_3 \cdot N_{HIGH}$$

$$\omega_1 = 1; \; \omega_2 = 2; \; \omega_3 = 3$$

Targets & Participation

CAPRI predictor groups that submitted more than 10 models
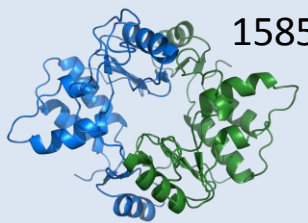
CAPRI ID	CASP ID	Stoichiometry	Difficulty	# interfaces	Predictors	Uploaders (>10)	CASP
T164	T1032	A2	Easy	1	28	18	29
T165	H1036	A:HL	Easy	1	27	12	32
T166	H1045	AB	Easy	1	24	16	36
T167	T1050		Cancelled		25	15	29
T168	T1052	A3	Easy	1	24	11	29
T169	T1054	A2	Difficult	1	27	16	32
T170	H1060	A6B12C3D6	Difficult	9	23	12	22
T171	T1063		No structure		26	13	31
T172	H1066		No structure		27	17	37
T173	H1069		No structure		27	17	37
T174	T1070	A3	Difficult	1	24	13	31
T175	T1073	A4/A2	Cancelled		25	13	31
T176	T1078	A2	Difficult	1	27	16	33
T177	H1081	A10:A10	Easy	3	24	12	27
T178	T1083	A2	Difficult	1	26	13	33
T179	T1087	A2	Difficult	1	25	13	32
T180	T1099	A2:A2	Easy	2	25	11	30
T181	H1103		No structure		27	15	34

Easy targets

Difficult targets

12 Targets
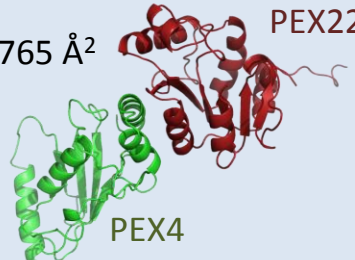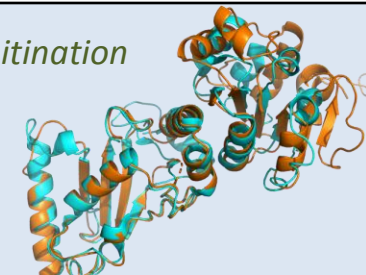
The targets: 2 easy dimers 1/2

T164

T1032

6n64

but 2 contact regions

1585 Å^2

Structural maintenance of chromosomes (SMC)
Flexible hinge domain-containing protein 1

Template	RMSD	LGA	Seq.ID
1gxk (PPI3D)	2.8 Å (complex)	50.5	30%

1gxk	acceptable
f(nat)	0.5575
L-rms	5.84 Å
i-rms	3.84 Å

EASY

Quality	Group
**	Gray, Seok, **MDOCKPP**
*	Kihara, Chang, Bates, Venclovas, Zou, Huang, Shen, Pierce, Kozakov/Vajda, Nakamura
	SWARMDOCK, HDOCK, HAWKDOCK, CLUSPRO, GALAXYPPDOCK, LZERD
	Baker, CoDock, DATE, Elofsson, Risoluto, htjcadd, Takeda-Shitaka, Seok-naïve-assembly
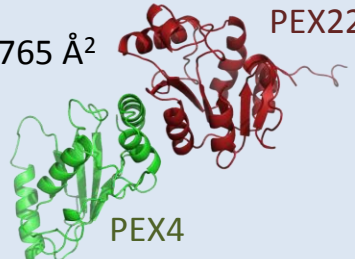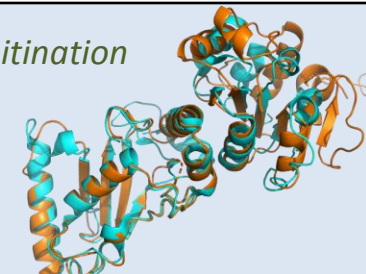
The targets: 2 easy dimers 2/2

T166
H1045
n/a

765 Å²

PEX22

PEX4

PEX4 – protein peroxin-4 – may be involved in ubiquitination
PEX22 – peroxisome biogenesis protein

heterodimer

"[...] ubiquitin conjugating enzyme Pex4p in complex with [...] Pex22p"

Individual templates

Template for the complex

Ubiquitin-conjugating enzyme   *Deoxyribonucleotidase*

Template	3ptf	3bwv
RMSD	0.5 Å	1.6 Å
LGA	94.8	56.0
Seq.ID	39%	21%

	5nkz	PEX-4	PEX22
RMSD	0.6 Å	2.6 Å	
LGA	94.4	N/A*	
Seq.ID	39%	37%	

* not listed in the first 25 hits
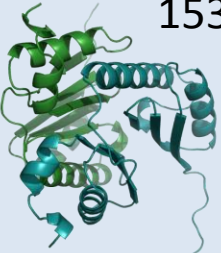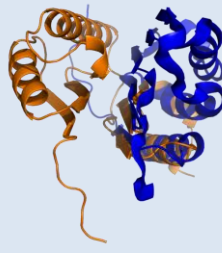
The targets: 2 easy dimers 2/2

T166

H1045

n/a

765 Å²

PEX22

PEX4

PEX4 – protein peroxin-4 – may be involved in ubiquitination
PEX22 – peroxisome biogenesis protein

heterodimer

"[...] ubiquitin conjugating enzyme Pex4p in complex with [...] Pex22p"

EASY
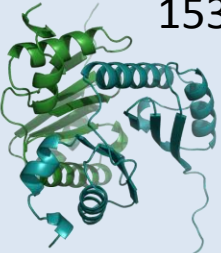
Quality	Group
***	Venclovas, *Takeda-Shitaka*
**	Huang, Vakser, Kozakov/Vajda, Chang, Shen, Fernandez-Recio, Bates, Pierce, Zou, Kihara, Seok, Nakamura
	AILON, Lamoureux, CoDock, DATE
*	**MDOCKPP, SWARMDOCK, GALAXYPPDOCK, HDOCK**, *DellaCorte*

The targets: 4 difficult dimers 1/4

T169

T1054

n/a

1530 Å^2 *Uncharacterized protein from Acinetobacter baumannii*

No templates for the assembly

Template	2kgs
RMSD (half)	2.8 Å
RMSD (whole)	8.8 Å
LGA	44.7

The targets: 4 difficult dimers 1/4

T169

T1054

n/a

1530 Å² *Uncharacterized protein from Acinetobacter baumannii*

No templates for the assembly
No acceptable submissions

Template	2kgs
RMSD (half)	2.8 Å
RMSD (whole)	8.8 Å
LGA	44.7

The targets: 4 difficult dimers 2/4

T176

1480 Å^2

T1078

n/a

Tsp1 protein from Trichoderma virens, Cysteine rich protein
Plays an important role in fungi-host interactions

DIFFICULT

Major allergen from Alternaria alternata
Hypersensitive response-inducing protein from Verticillium dahliae

Template	3v0r	4aud	5xmz
RMSD	3.8 Å	4.5 Å	6.9 Å
LGA	53.9	52.2	52.6
Seq.ID	11.0%	16.8%	No alignment

T1078

AlphaFold2

4aud onto target
Single-chain: 4.5 Å
Double-chain: 10.5 Å

The targets: 4 difficult dimers 2/4

T176

T1078

n/a

1480 Å^2

Tsp1 protein from Trichoderma virens, Cysteine rich protein
Plays an important role in fungi-host interactions
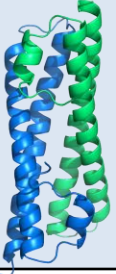
DIFFICULT

Quality	Group
*	**MDOCKPP**, Seok, Zou, *Elofsson*

AlphaFold2

The targets: 4 difficult dimers 3&4

T178

T1083

n/a

Protein segment from
Nitrosococcus oceani

1650 Å²

Alpha-pore forming toxin

Template	6h2f	6grj	6r1j
RMSD	5.7 Å	4.7 Å	5.2 Å
Seq.ID	7%	7%	7%

T179

T1087

n/a

Protein segment from
Methylobacter tundripaludum

1620 Å²

Bacillus thuringiensis Cry6aa2 prototoxin

Template	5kuc	5ghe
RMSD	5.4 Å	5.4 Å
Seq.ID	7.1%	7.4%

T1087   TBM-hard

DIFFICULT

T1087

Distance Cutoff, A

Percent of Residues (CA)

AlphaFold2

The targets: 4 difficult dimers 3&4

T178
T1083
n/a

Protein segment from Nitrosococcus oceani

1650 Å²

Alpha-pore forming toxin

Template	6h2f	6grj	6r1j
RMSD	5.7 Å	4.7 Å	5.2 Å
Seq.ID	7%	7%	7%

T179
T1087
n/a

Protein segment from Methylobacter tundripaludum

1620 Å²

Bacillus thuringiensis Cry6aa2 prototoxin

Template	5kuc	5ghe
RMSD	5.4 Å	5.4 Å
Seq.ID	7.1%	7.4%

Quality	Group T178	Group T179
**	Venclovas	
*	Chang, Lubecka, Pierce, Seok, Kihara, Bates, Fernandez-Recio, Zou, Liwo	Zou, Venclovas, Liwo, Chang, Shen, Seok, Vakser, Pierce
	LZERD, MDOCKPP, HAWKDOCK	**LZERD, MDOCKPP**
	Baker, CoDock, UNRES, McGuffin, htjcadd, UNRES-contact	*Baker, CoDock, UNRES*

The targets: 3 trimers

Herpesvirus envelope glycoprotein Human monoclonal antibody

Tail fibre of the Salmonella virus epsilon15

Phage tail protein, attachment region

A,B,C

L

H
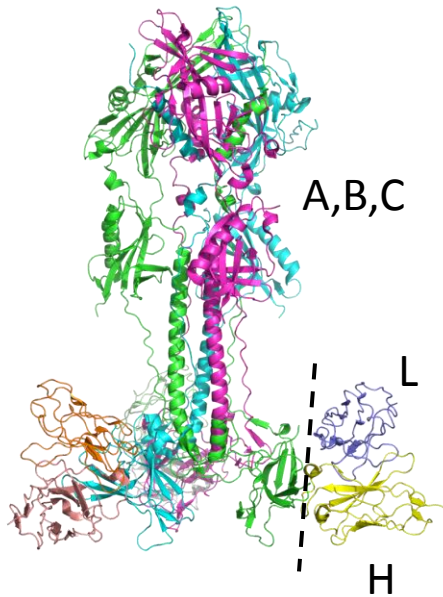
T165
H1036
6vn1

T168
T1052
N/A

T174
T1070
N/A

EASY

6f7k
0.75 Å
42%
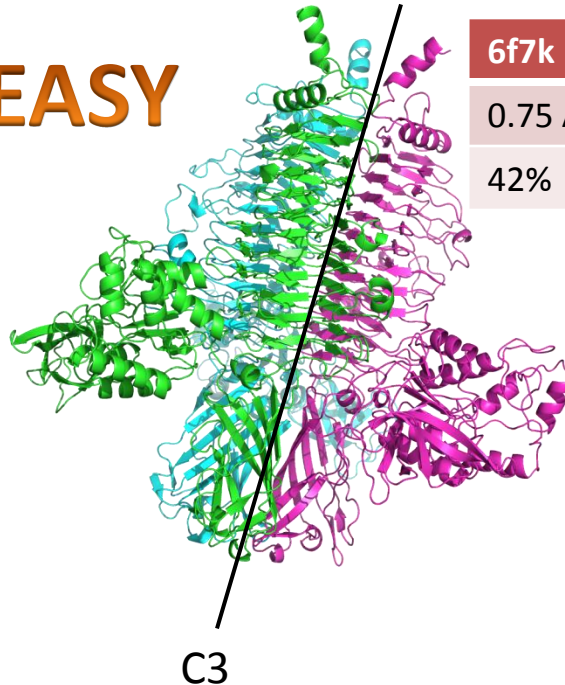
DIFFICULT

6esc	4oaw
1.0 Å	1.2 Å
60%	75% (H)
	86% (L)
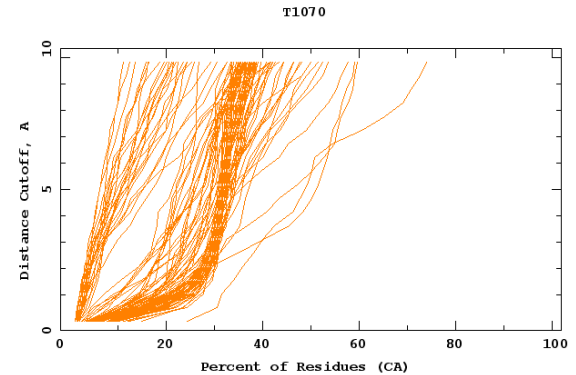
C3

T1070

The targets: 3 trimers

Herpesvirus envelope glycoprotein Human monoclonal antibody

Tail fibre of the Salmonella virus epsilon15

Phage tail protein, attachment region

T165		T168		T174
H1036		T1052		T1070
6vn1		N/A		N/A

No acceptable solutions for T165 and T174

Quality	Group T168
***	Zou, **GALAXYPPDOCK**
**	Kihara, Vakser, Fernandez-Recio, Chang, Pierce, Huang, Venclovas
	LZERD
*	*Baker, CoDock, Lamoureux, UNRES-template, Takeda-Shitaka*
	Seok, Kozakov/Vajda, Czaplewski, *UNRES*

The remaining 3 targets
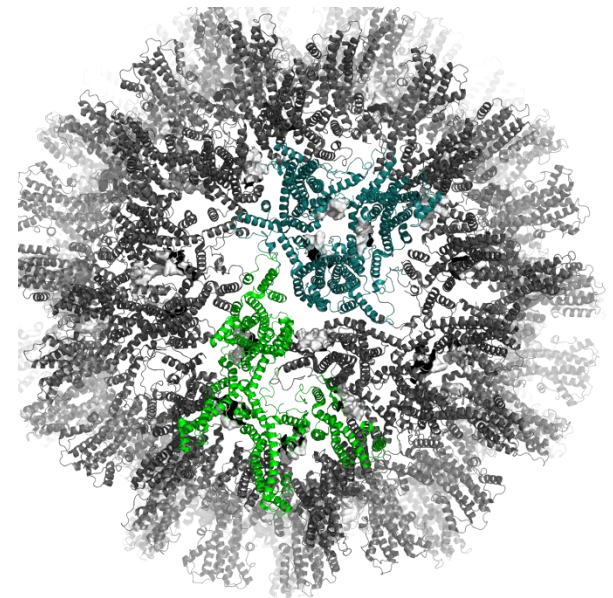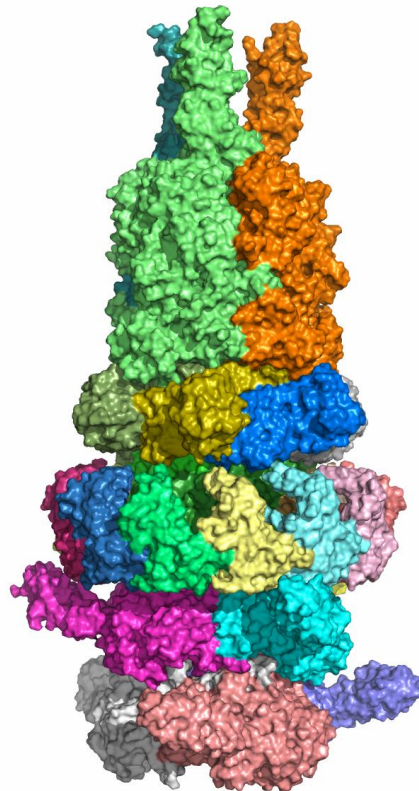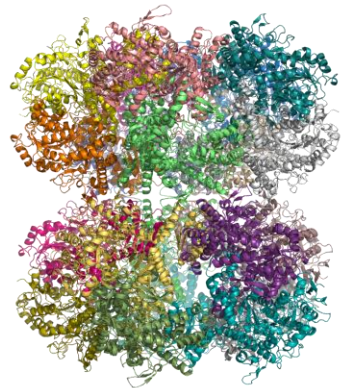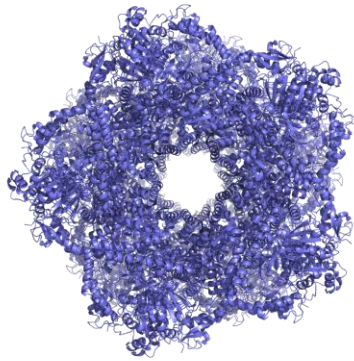
The decarboxylase

T170

H1060

N/A

*Arginine decarboxylase involved in bacterial stress response; cryo-EM Stoichiometry: 2 stacked decamers, each adopting D5 symmetry. The main challenge for this target is to **predict the stacking interface***
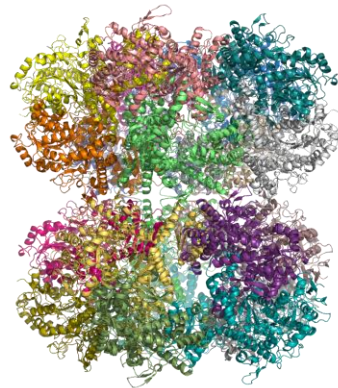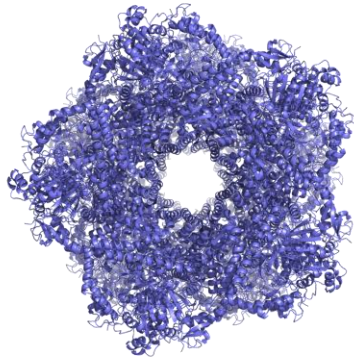
EASY

Template	Stoich.		RMSD	Seq.ID
2vyc	10		0.46 Å	71%
5fkz	1		1.55 Å	35%
3n75	5	10*	0.97 Å	33%
6q6i	1		1.36 Å	39%
1c4k	1	2*	1.38 Å	29%

applying symmetry operations
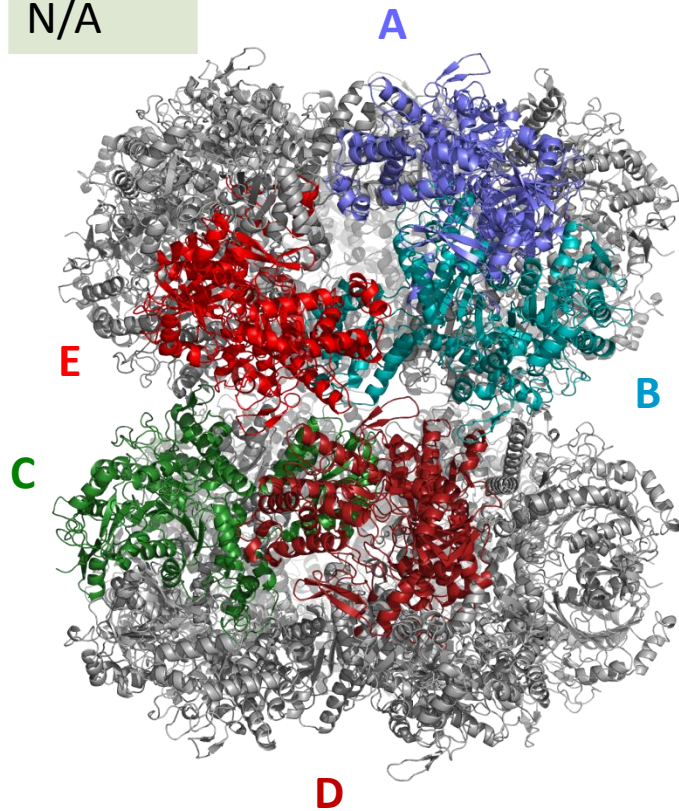
2vyc crystal stacking

The decarboxylase

T170

H1060

N/A

Interface		Area	Location	Occurrence
1	**A:B**	5000 Å²	Intra	10x
2	**C:D**	1250 Å²	Intra	20x
3	**D:E**	300 Å²	**Inter**	5x
		180 Å²	Intra	10x

Green monomer is crystal packing from template 2vyc

The decarboxylase
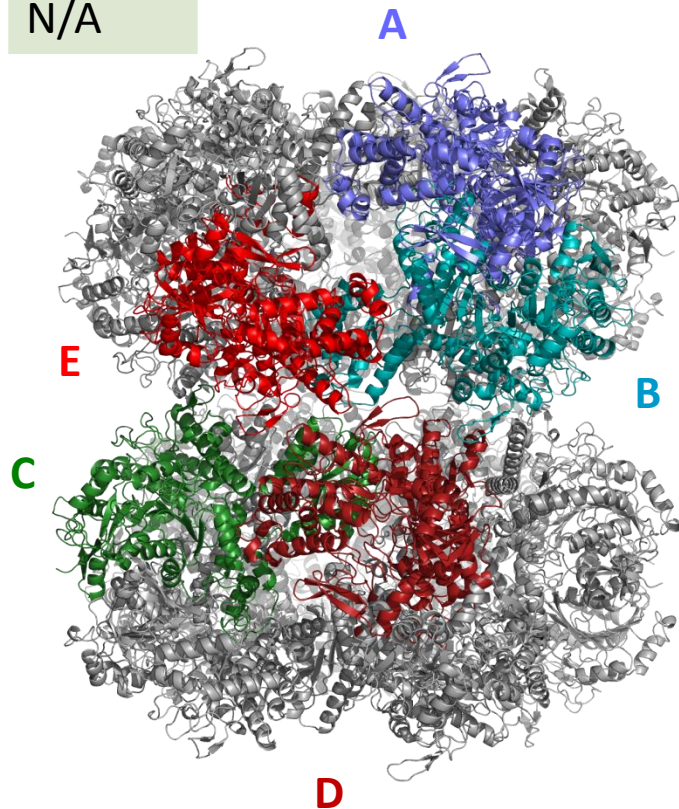
T170
H1060
N/A

A
E
B
C
D

Interface		Area	Location	Occurrence
1	A:B	5000 Å^2	Intra	10x
2	C:D	1250 Å^2	Intra	20x
3	**D:E**	300 Å^2	**Inter**	5x

*** predictions for interfaces 1 and 2,
including the **top-1 of server predictions**

Quality	Group T177 Interface 3
***	**MDOCKPP**
**	Venclovas, Zou, Grudinin, Kozakov/Vajda, Pierce, CLUSPRO, *VoroCNN-select*, *Ornate-select*
*	Bates, Seok, Del Carpio, Huang, Nakamura
	SWARMDOCK, **HDOCK**

The viral capsid

The target represents the cryo-EM structure of the capsid of the duck hepatitis B virus, which features T=4 icosahedral symmetry with a total of 240 subunits.

We invite predictors to submit models containing the minimum number of subunits necessary to define the unique interfaces.

x60

T=4 icosahedral assymmetric unit

x20
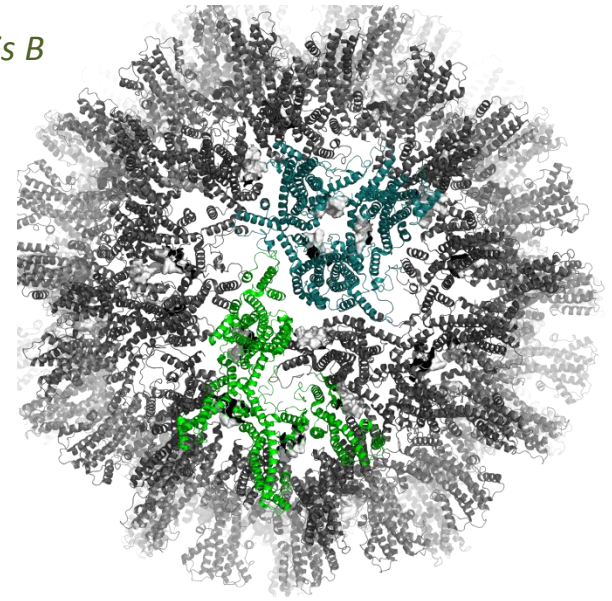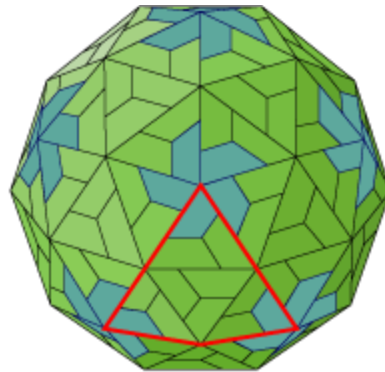
Triangular facet

T=4

viralzone.expasy.org

The capsid is composed of 60 asymmetric units made of 4 proteins, for a total of 240 capsid proteins.
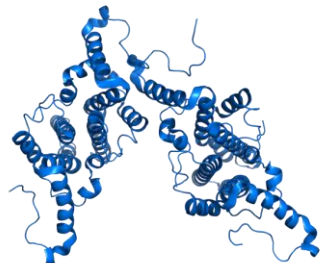
Target

Hepatitis B virus core antigen
Cryo-EM 3.5 Å
19.5 % sequence identity

EASY

CASP14

28

The viral capsid

The target represents the cryo-EM structure of the capsid of the duck hepatitis B virus, which features T=4 icosahedral symmetry with a total of 240 subunits.

We invite predictors to submit models containing the minimum number of subunits necessary to define the unique interfaces.

#chains	2	3	**4**	6	7	8	9	12	16	20	52
#models	7	4	**42**	25	15	5	1	5	5	11	5

*The capsid is composed 60 asymmetric **units made of 4 proteins**, for a total of 240 capsid proteins.*

Target

The viral capsid

A:B

C:D

Target

Interface	Area	Chains
1	1970 Å²	A:B
2	1110 Å²	B:C
2b		D:A′
2c		A:D′

2b

1

2

2c
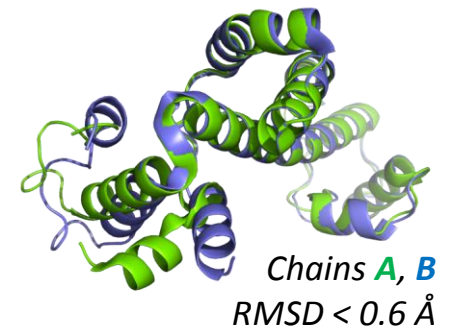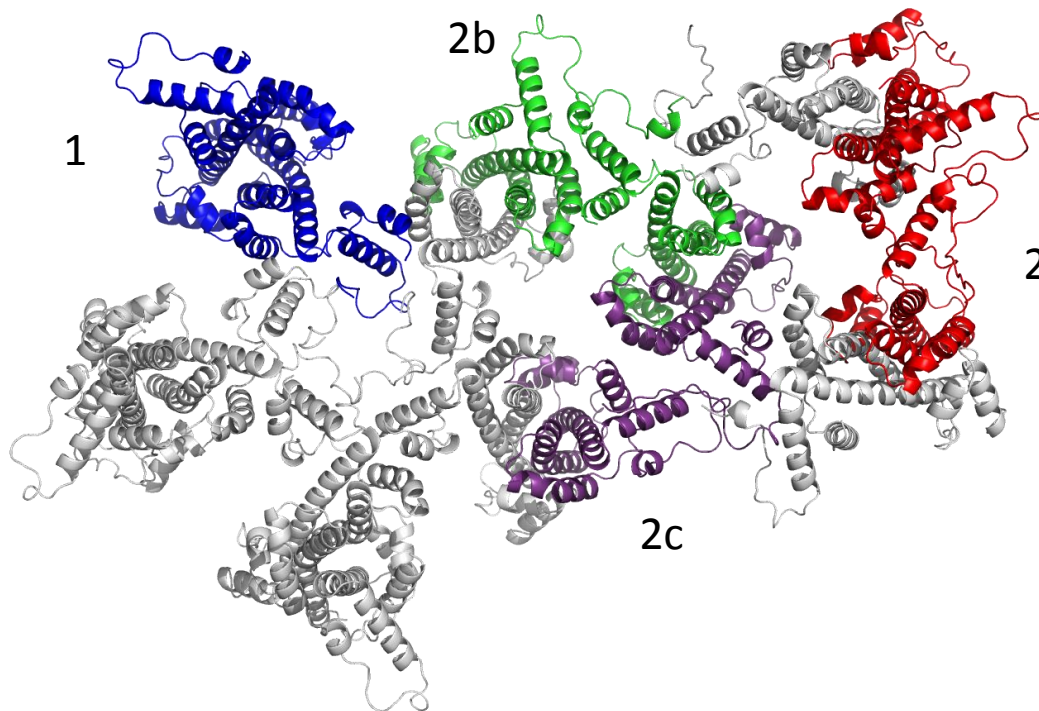
Chains *A*, *B*
RMSD < 0.6 Å

Pseudo-symmetry for interfaces 2/2b/2c

(Å)	A	B	C	D
A	0	0.44	0.55	0.51
B		0	0.63	0.62
C			0	0.74
D				0

The viral capsid
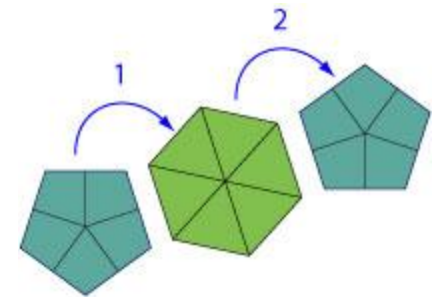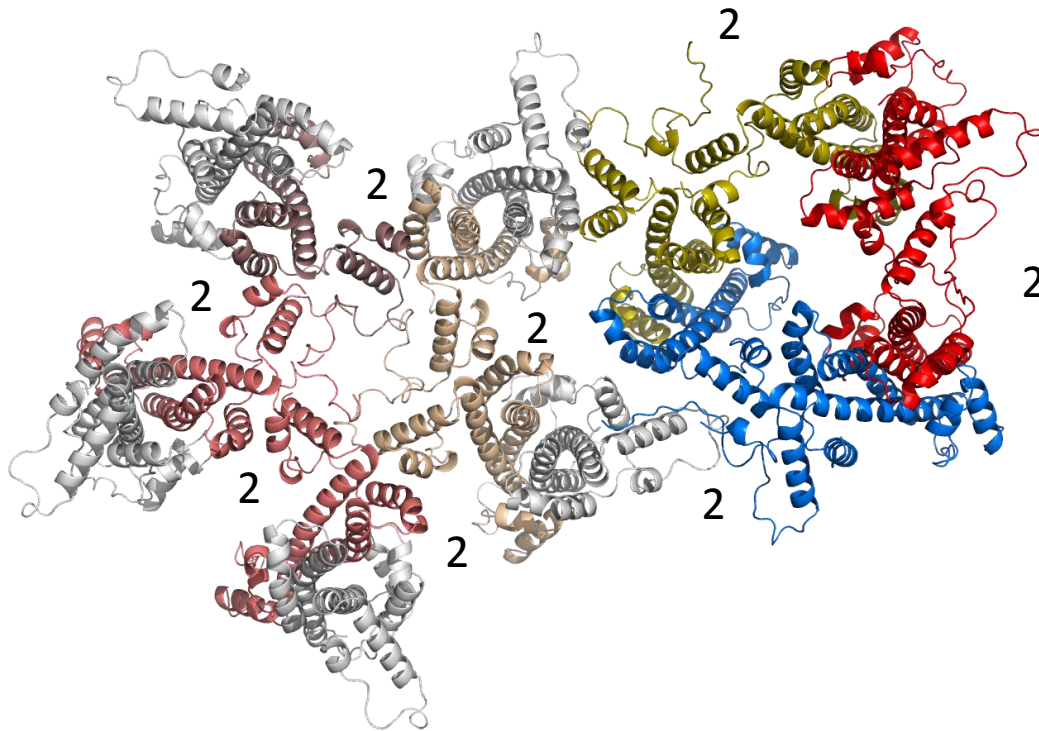
Interface	Area	Chains
1	1970 Å^2	A:B
2	1110 Å^2	B:C
2b		D:A'
2c		A:D'

$h=2, k=0$
$T=(2)^2+(2)(0)+(0)^2=4$

The viral capsid

Interface	Area	Chains
1	1970 Å^2	A:B
2	1110 Å^2	B:C
2b		D:A'
2c		A:D'

2b

2c
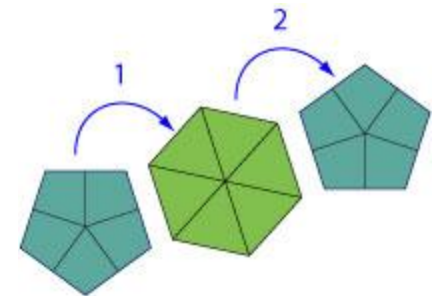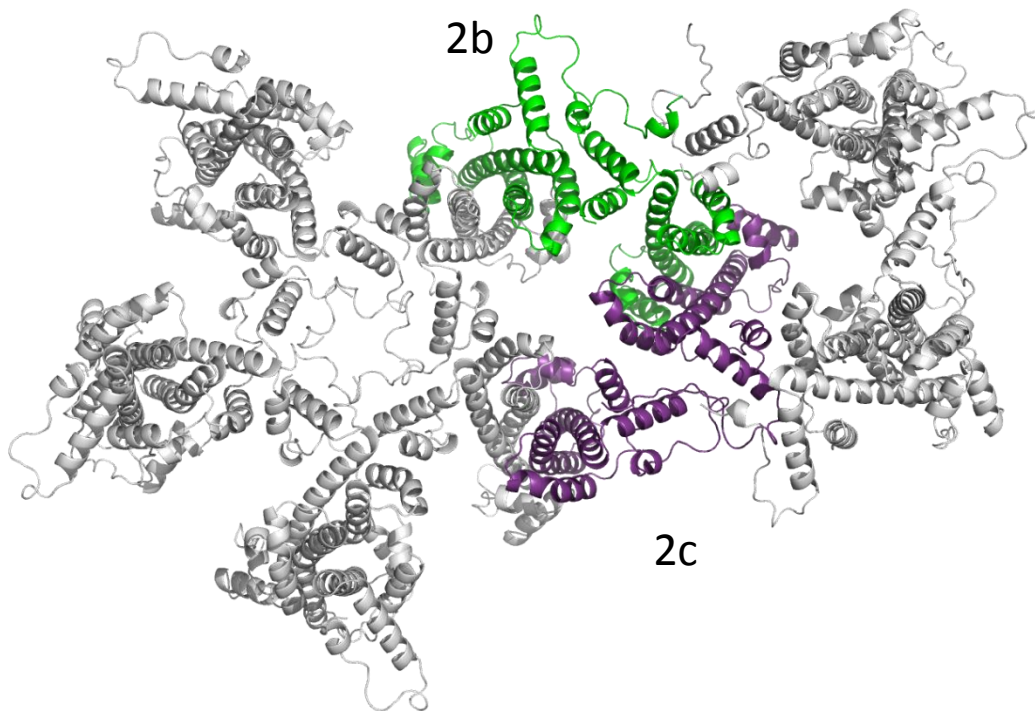
$h=2, k=0$

$T=(2)^2 +(2)(0) + (0)^2 =4$

The viral capsid

T1099
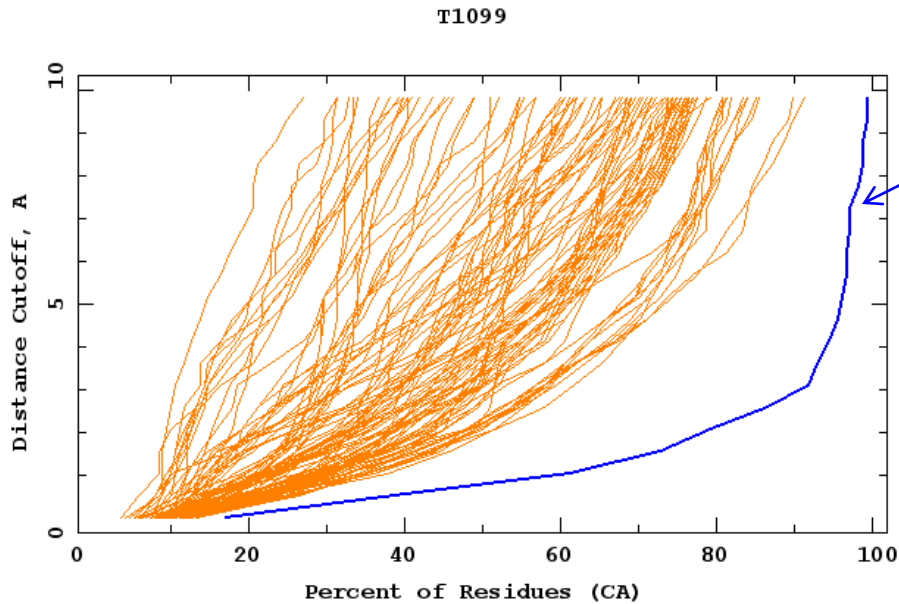
AlphaFold2

Did not participate in assembly prediction

Template	Seq.ID	RMSD	LGA
3j2v	19.5%	2.0 Å	48.6
3kxs	20.1%	3.8 Å	43.6
5t2p	19.5%	4.4 Å	48.2
6ecs	18.1%	5.8 Å	

Identified by hhpred

Interface 1

target
template 3j2v

Interface 2

CASP14

33
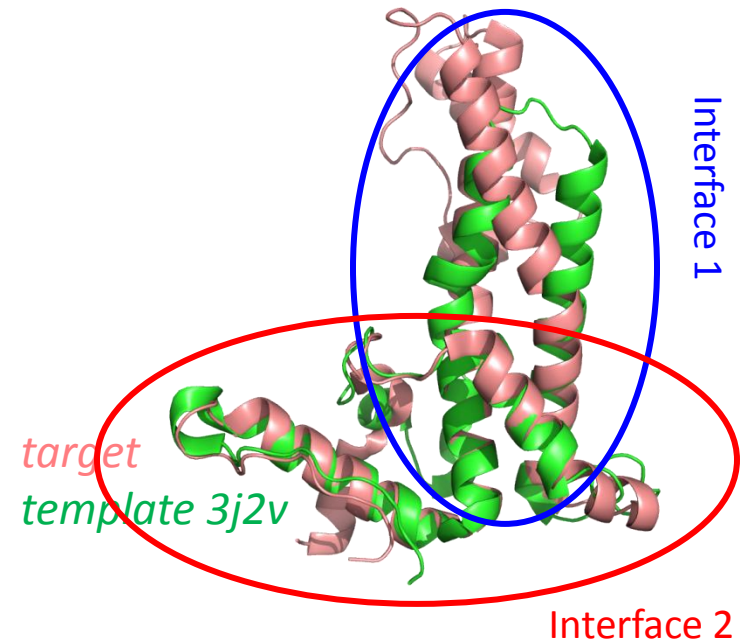
The viral capsid

T1099
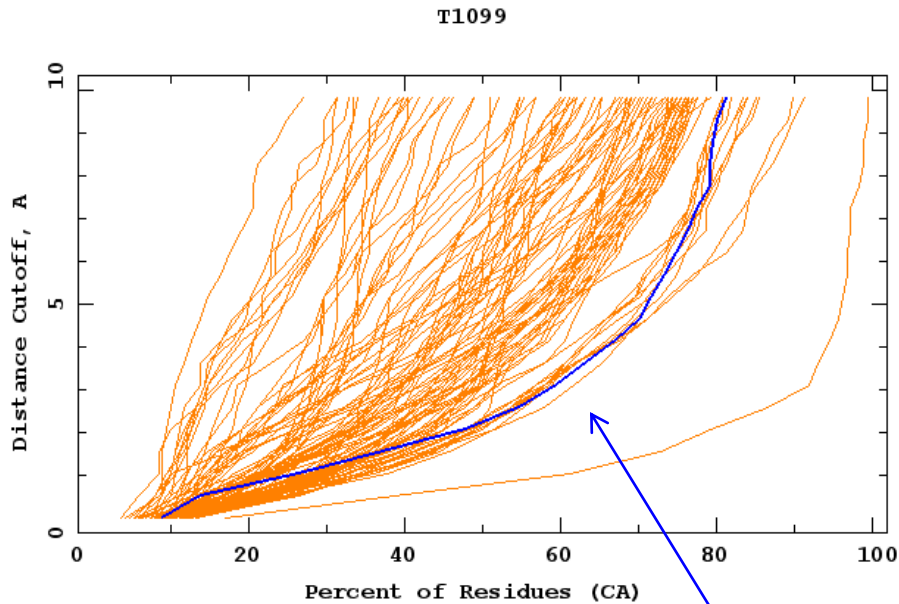
Seok

Interface	Area	Chains
1	1970 Å^2	A:B
2	1110 Å^2	B:C

12 groups have ** in top-1 for interface 2, Including **CLUSPRO**, **LZERD**, **GALAXYPPDOCK**

Venclovas has *** in top-5.

Only Seok got * for interface 1 (model 2)

3j2v

Target

Seok

The phage tail

E3
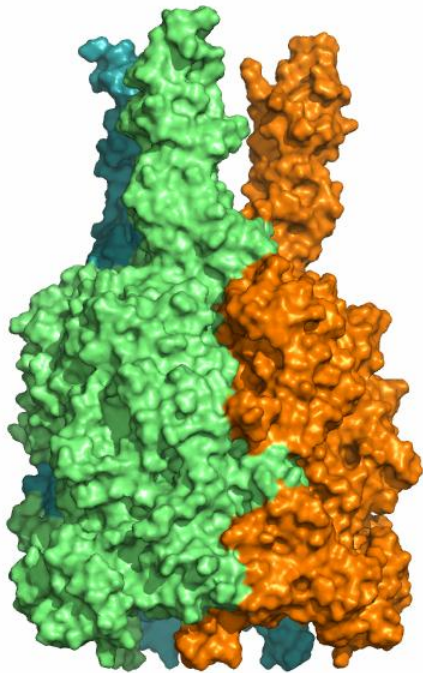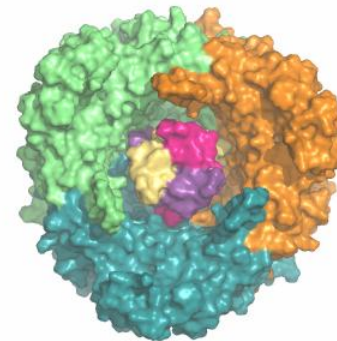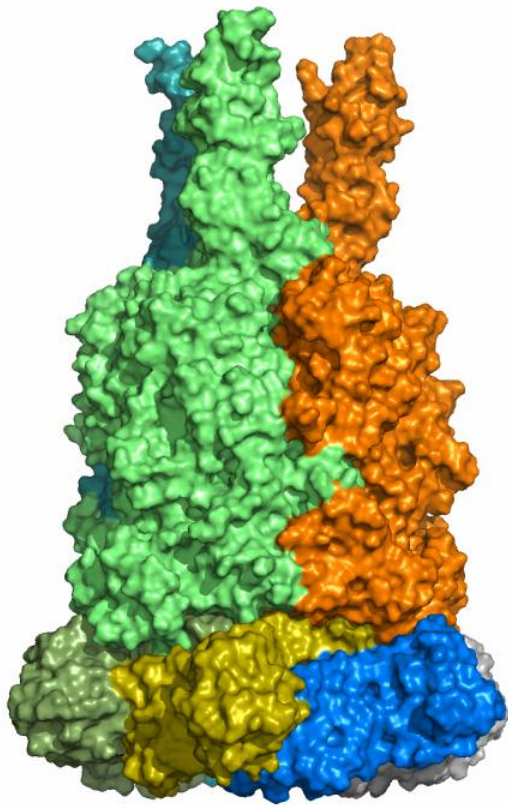
The phage tail

E3

D6

12000 Å²

The phage tail

E3

D6

B3

12000 Å²

9800 Å²

The phage tail

E3
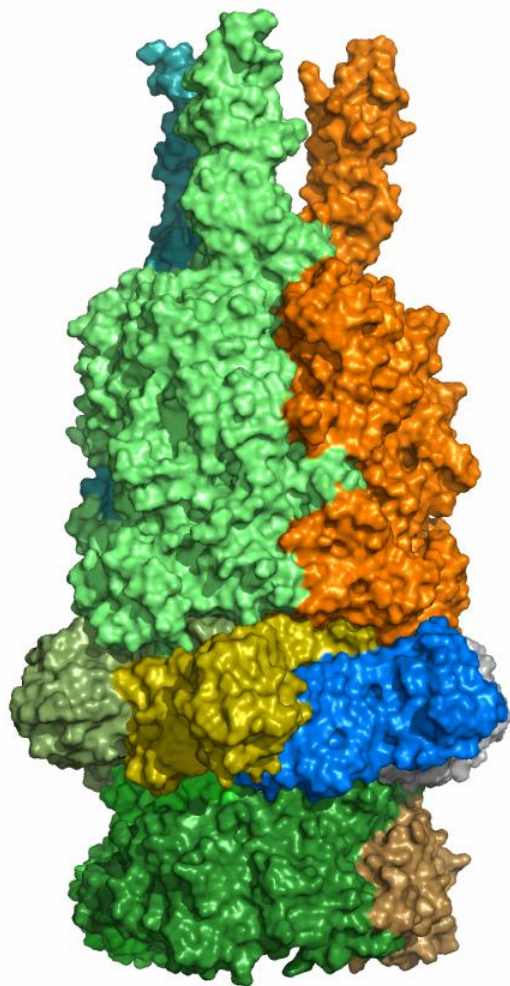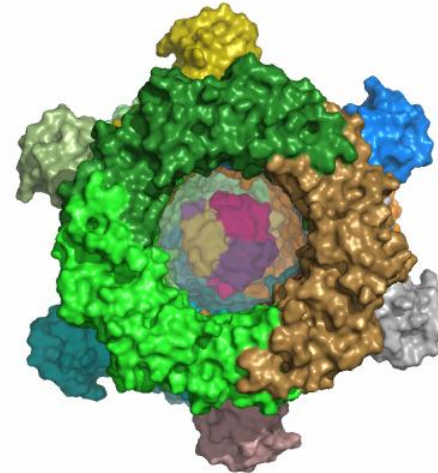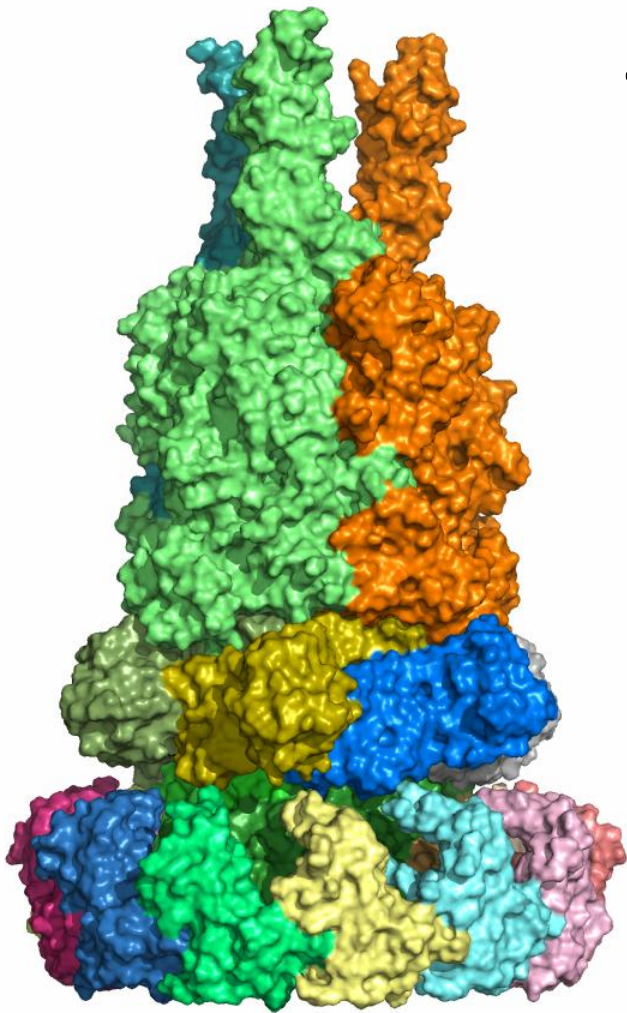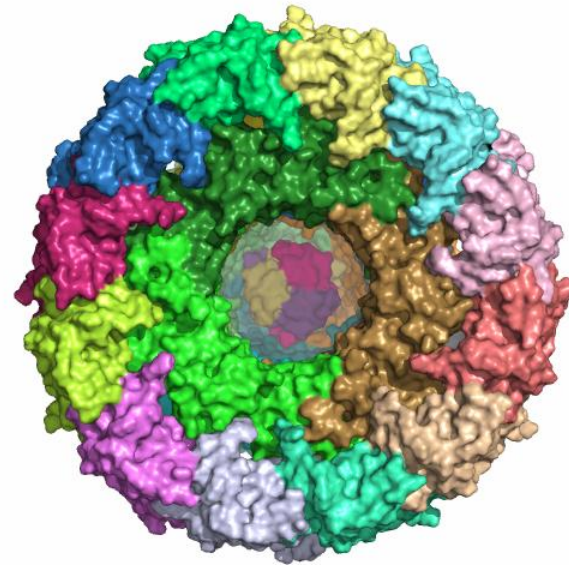
D6   12000 Å²

C12   9800 Å²

B3   15000 Å²

The phage tail

E3

D6

C12

B3

A3
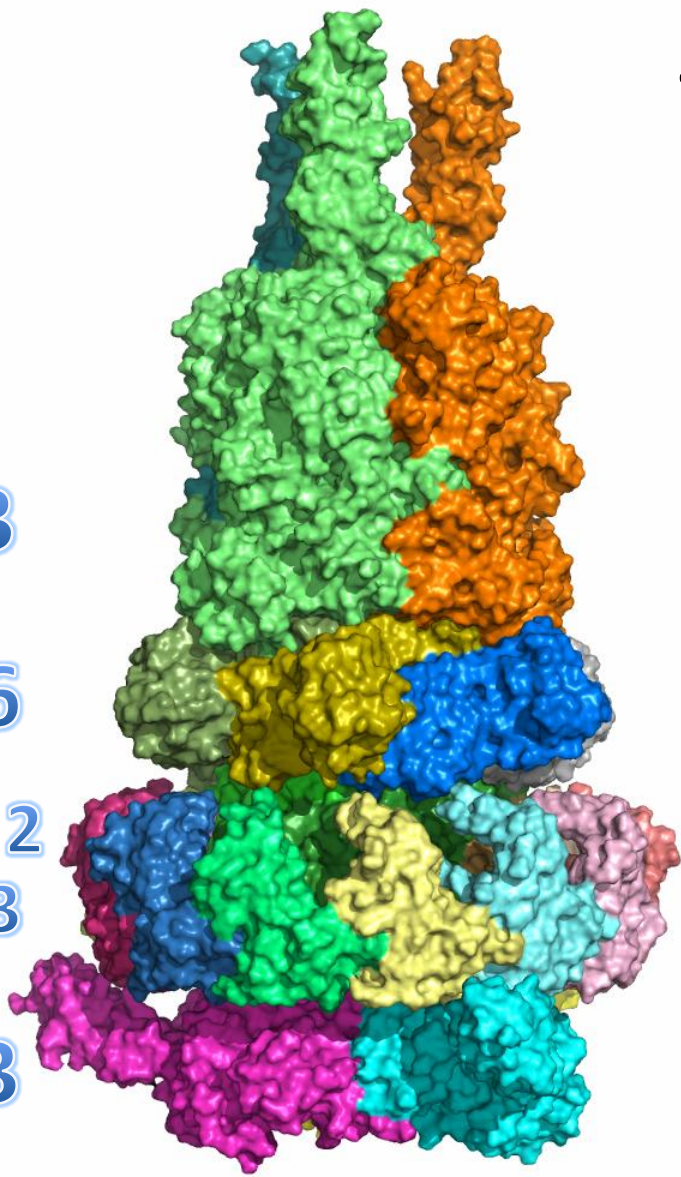
12000 Å²

9800 Å²

15000 Å²

11000 Å²

The phage tail

E3

D6

C12

B3

A3

A3
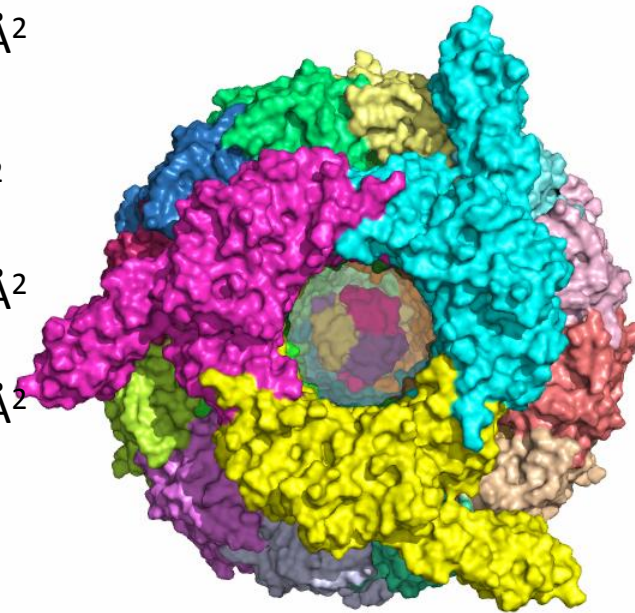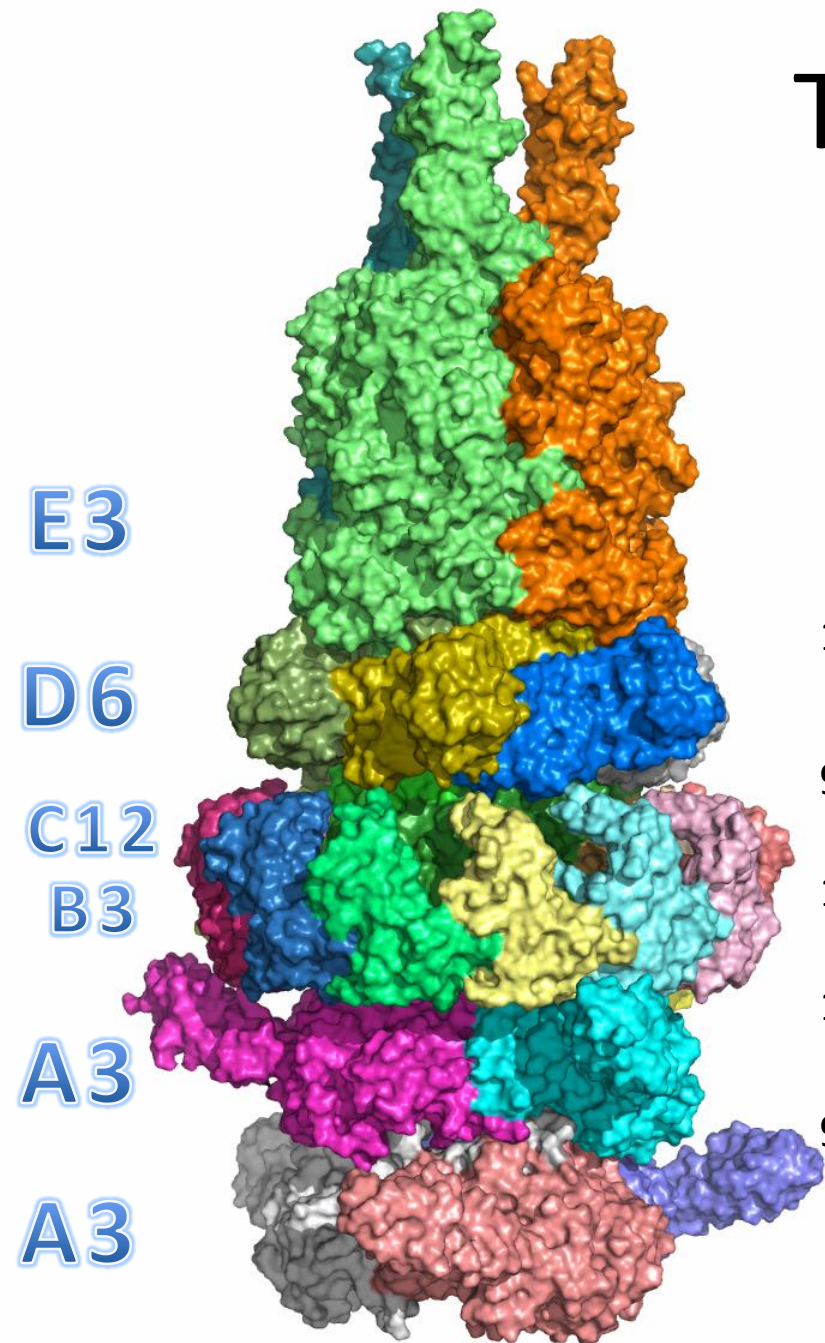
12000 Å²

9800 Å²

15000 Å²

11000 Å²

9900 Å²
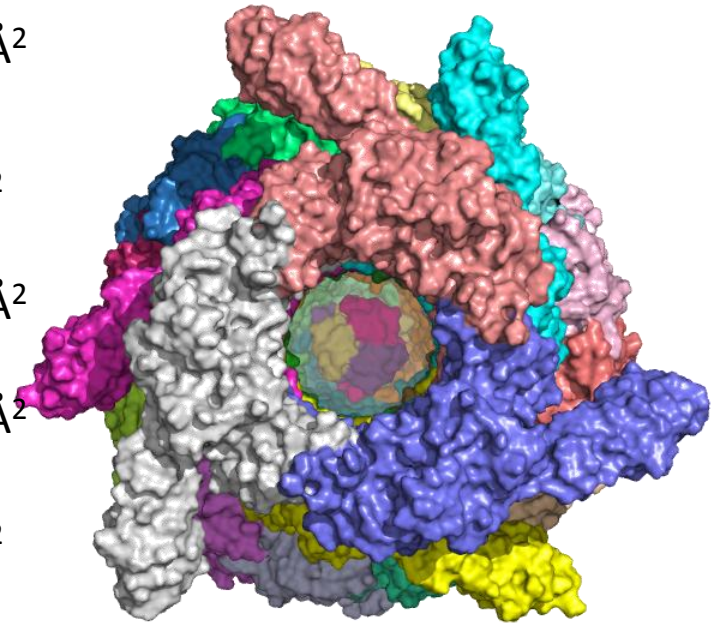
The phage tail

Each interface between rings ≈10000 Å²

E3 F3

C12 ≈15000 Å², but not connected to A3 or D6

D6

B3

C12

A3

A3
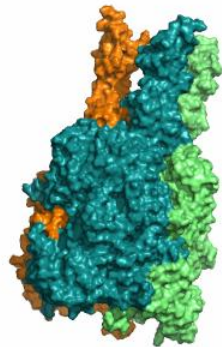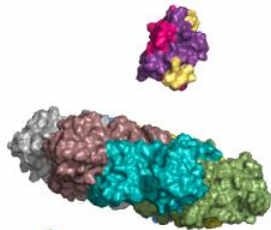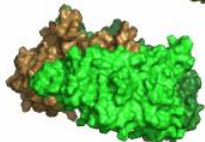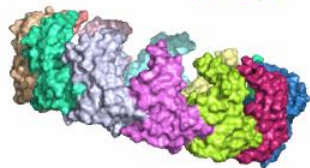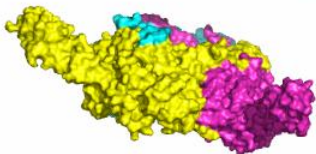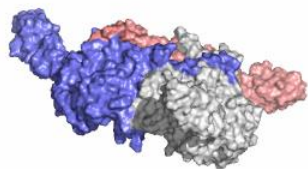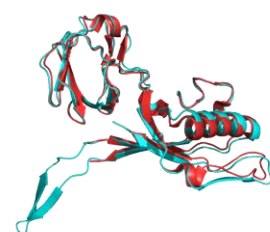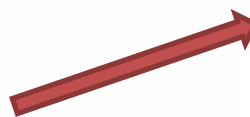
Template	6f2m
RMSD	0.9 Å
Seq.ID	94%

EASY

N-terminal 370 residues of the same template
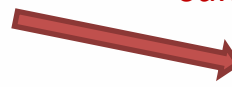
Template	5ngj
RMSD	7.1 Å
Seq.ID	10%

EASY

Template is monomeric (dimeric through crystal contacts)
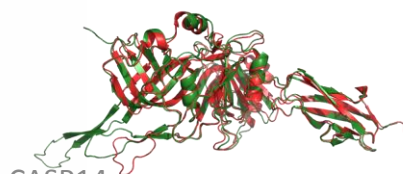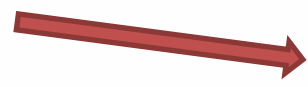
Template	5ngj
RMSD	0.9 Å
Seq.ID	100%

CASP14

41

The phage tail

Each interface between rings ≈10000 Å²

C12 ≈15000 Å², but not connected to A3 or D6

E3F3

D6

B3

C12

A3

A3

T170

H1060

N/A
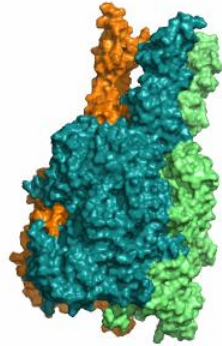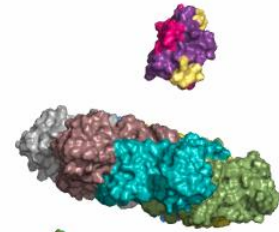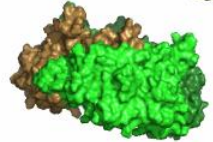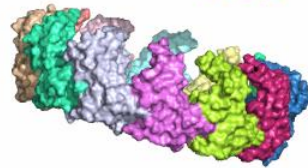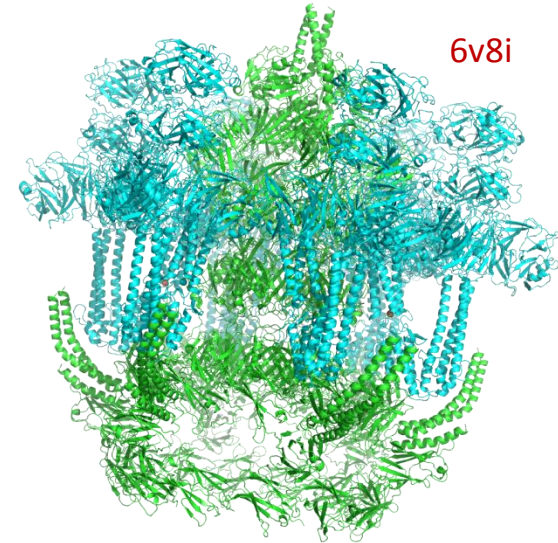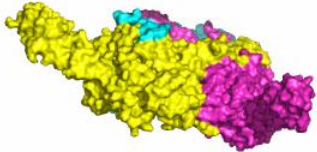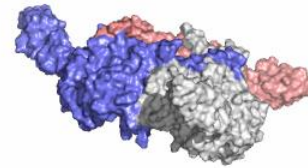
6v8i

DIFFICULT

Template	3uh8	4v96 (EM)	6v8i (EM)
RMSD	6.4 Å	3.8 Å	7.7 Å
Seq.ID	11%	9 %	15 %
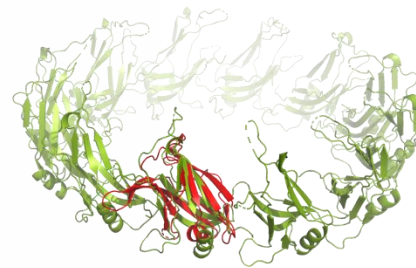
4v96

3uh8
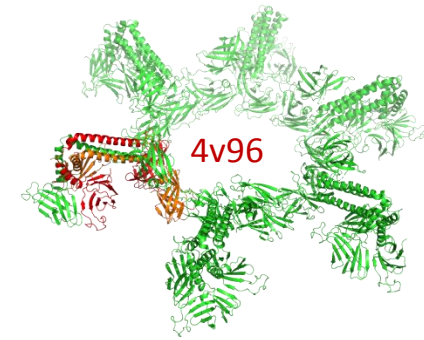
The phage tail
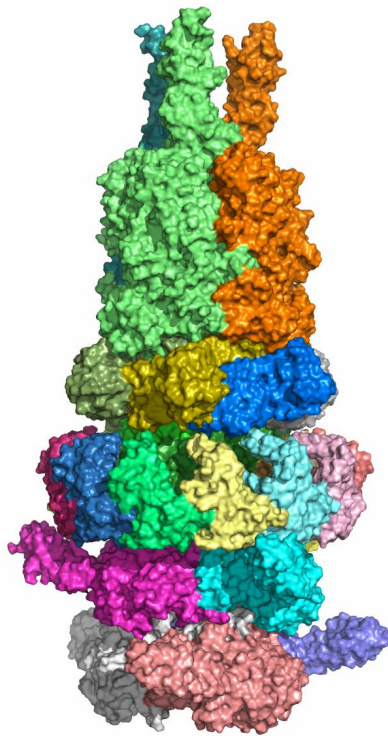
D   1:2:3:4:5:6 (204)

Z C   J:K:L:M:N:O:P:Q:R:S:T:U (140)
           G:H:I (298)

   B   D:E:F (464)

   A   A:B:C (464)

Interface		Chains	Area/Å²	Difficulty
9	CD	G:2	750	Easy
8	D	1:2	1200	Easy
7	CZ	H:K	550	Difficult
6	CZ	H:L	680	Difficult
5	Z	K:L	680	Difficult
4	BC	E:G	980	Easy
3	C	G:H	1650	Easy
2	AB	A:E	1650	Easy
1	A	A:B	1800	Easy

T170

H1060
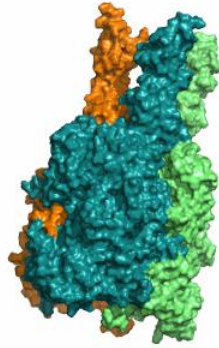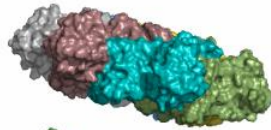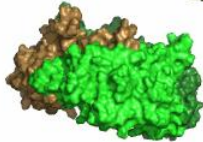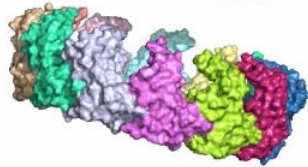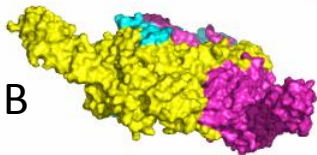
N/A
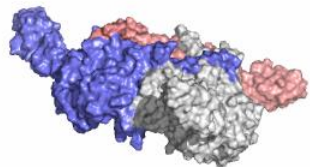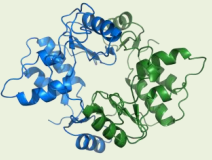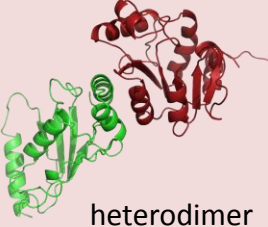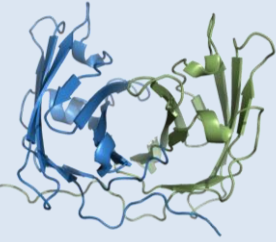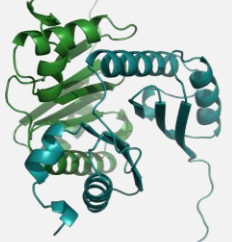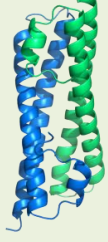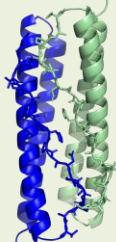
Interface	Rings	Difficulty	Performance
1	A:A	Easy	13/5**
2	A:B	Easy	1
3	C:C	Easy	5
4	B:C	Easy	4
5	Z:Z	Difficult	12/5**
6	C:Z	Difficult	1
7	C:Z	Difficult	1
8	D:D	Easy	7/1**
9	C:D	Easy	6
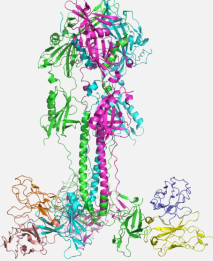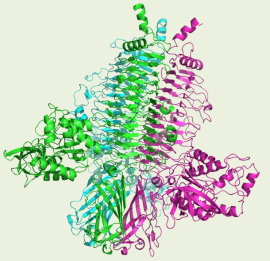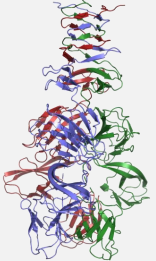
	Group
1	HDOCK, Huang, MDOCKPP, Shen, Zou, Chang, Venclovas, Seok, Fernandez-Recio, Kozakov/Vajda, Kihara, Nakamura, CLUSPRO, *Takeda-Shitaka*, *DATE*
2	Fernandez-Recio
3	Venclovas, Seok, MDOCKPP, Zou, Shen
4	HDOCK, Huang, Venclovas, Chang
5	Chang, Shen, Nakamura, Kozakov/Vajda, CLUSPRO, *DATE*, HDOCK, Huang, Venclovas, Kihara, Seok, Grudinin, Vakser, *Baker*, *VoroCNN-select*
6	Shen
7	Kihara
8	Venclovas, *Baker*, Chang, LZERD, Grudinin, Seok, Shen, Kihara
9	Huang, HDOCK, Shen, Chang, Kihara, Seok, *Takeda-Shitaka*
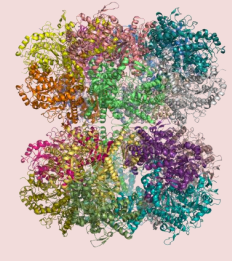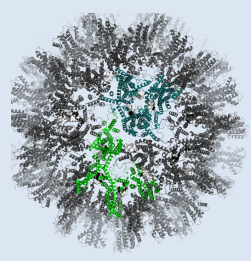
Group	1	2	3	4	5	6	7	8	9		Score
Shen	**		*		**	*		*	*	6/2**	8
Venclovas	*		*	*	*			**		5/1**	6
Chang	*			*	**			*	*	5/1**	6
HDOCK	**			*	*				*	4/1**	5
Huang	**			*	*				*	4/1**	5
Seok	*		*		*			*	*	5	5
Kihara	*				*		*	*	*	5	5
CLUSPRO	*				**					2/1**	3
MDOCKPP	**		*							2/1**	3
Zou	**		*							2/1**	3
Kozakov/Vajda	*				**					2/1**	3
Nakamura	*				**					2/1**	3
Takeda-Shitaka	*								*	2	2
Fernandez-Recio	*	*								2	2
Grudinin					*			*		2	2
DATE	*									1	1
Vakser					*					1	1
LZERD								*		1	1
	15/5**	1	5	4	12/5**	1	1	7/1**	7		
	A	A:B	C	B:C	Z	C:Z	C:Z	D	C:D		
	Easy	Easy	Easy	Easy	Diff.	Diff.	Diff.	Easy	Easy		

Summary

Two easy dimers

	heterodimer
19/**3****	**17**/**1*****/**12****

Four difficult dimers

4	No acceptable	**19**/**1****	**13**/**1****

Three trimers

antibody binding		
No acceptable	**24**/**21****	No acceptable

Three big assemblies

		phage tail
33/**1*****/**22****	**15**	**0 – 1 – 6**

Predictor performance

Score = $\omega_1 \cdot N_{ACC} + \omega_2 \cdot N_{MED} + \omega_3 \cdot N_{HIGH}$

$\omega_1 = 1$; $\omega_2 = 2$; $\omega_3 = 3$

Best top-5 prediction

Same formula applied for multi-interface targets, divided by number of interfaces

Rank	Group	Performance	Participation	Score
1	Seok	9/4**	16	13
	Venclovas, *Baker*	8/1***/3**	16	13
4	Zou, Chang	8/3**	16	11
	MDOCKPP	7/1***/2**	16	11
7	Pierce, Kihara	7/3**	15, 16	10
9	Huang, Bates, Kozakov/Vajda, Fernandez-Recio	5/3**	16	8
	LZERD, *CoDock*	6/2**	16, 12	8
15	Shen	6/1**	16	7
	Vakser	4/3**	16	7
	Takeda-Shitaka	4/1***/1**	16	7
18	**GALAXYPPDOCK**	5/1**	16	6
	SWARMDOCK	4/2**	16	6
	Lamoureux	3**	13	6
21	Nakamura	3/2**	13	5
22	**HDOCK**, **CLUSPRO**	3/1**	16	4
24	Czaplewski, Liwo, *DellaCorte*, *UNRES*, *DATE*	2/1** or 3	6 – 16	3

Ranking does not change significantly if Top-10 is considered, Top-1 gives:

1 *Baker*

2 Seok

3 Venclovas, Chang, Pierce

6 Zou, Kihara, Huang

Rank	Group	Performance	Participation	Score
	Seok	9/4**	16	13
	Venclovas, *Baker*	8/1***/3**	16	13
	Zou, Chang	8/3**	16	11
1	**MDOCKPP**	7/1***/2**	16	11
	Pierce, Kihara	7/3**	15, 16	10
	Huang, Bates, Kozakov/Vajda, Fernandez-Recio	5/3**	16	8
2	**LZERD**, *CoDock*	6/2**	16, 12	8
	Shen	6/1**	16	7
	Vakser	4/3**	16	7
	Takeda-Shitaka	4/1***/1**	16	7
3	**GALAXYPPDOCK**	5/1**	16	6
	SWARMDOCK	4/2**	16	6
	Lamoureux	3**	13	6
	Nakamura	3/2**	13	5
4	**HDOCK**, **CLUSPRO**	3/1**	16	4
	Czaplewski, Liwo, *DellaCorte, UNRES, DATE*	2/1** or 3	6 – 16	3

Each predictor's best model

- acceptable (blue)
- medium (green)
- high (red)

x Baker
+ Seok
* Venclovas

○ LZERD
◇ MDOCKPP

F1

S-rms /Å
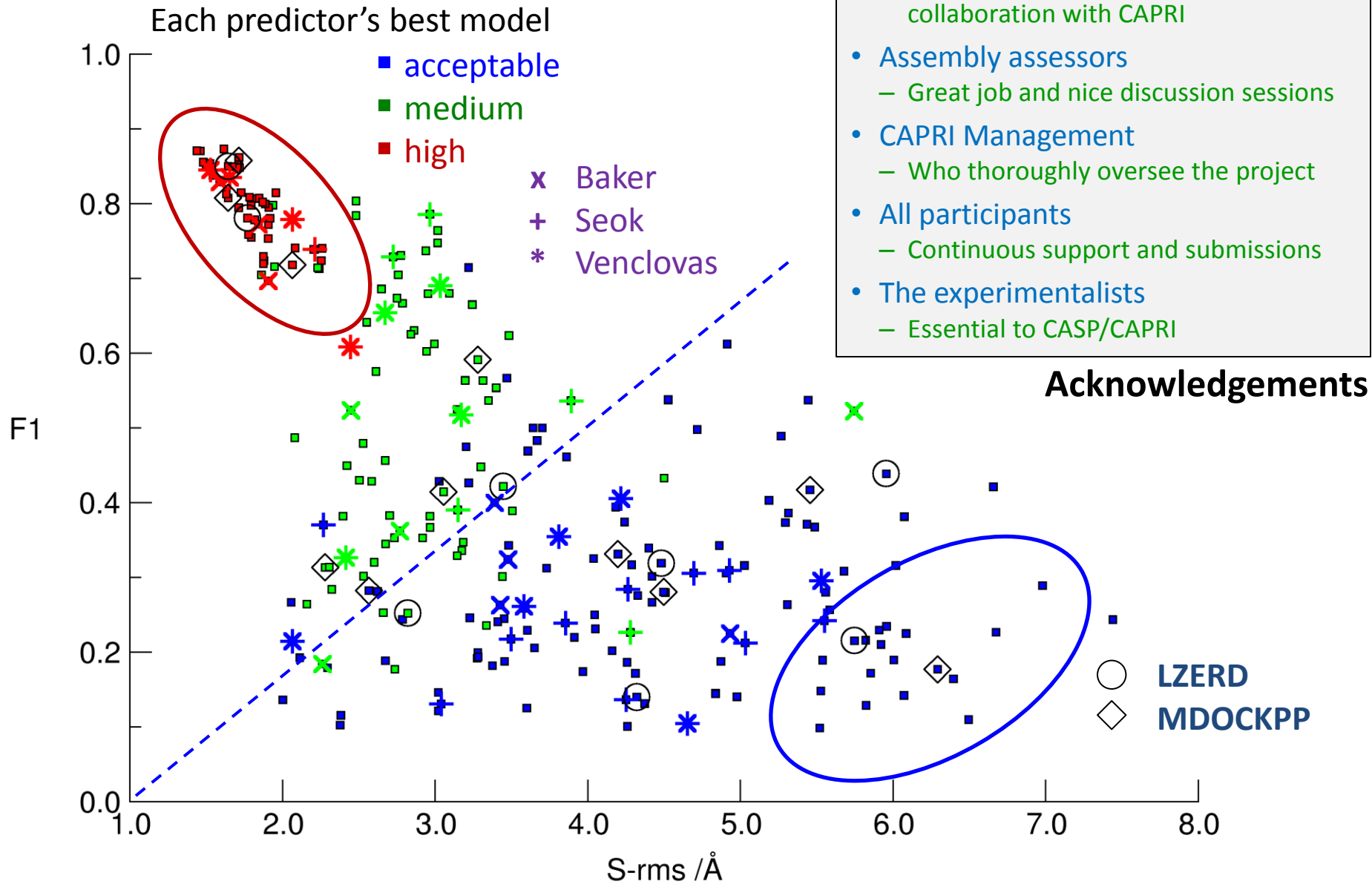
Conclusions

- The best predictors stand out by producing acceptable models for difficult targets
  - They do a good job in side-chain modeling
  - Shared 1st place for Baker, Seok and Venclovas
    - One more acceptable target for Seok; Venclovas significantly improved scoring
  - Everybody can do Template-based "docking", but naïve modeling did not do very well this time
  - MDOCKPP is the best-performing server, on-par with human predictors
- Human predictors do better than their server counterparts
  - Most docking servers still require a significant amount of human input
- Most targets were obligate
  - Templates work well; flexibility and conformational change less an issue