

How to produce precise full neuronal reconstructions efficiently through Vaa3D-TeraVR platform

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SEU-ALLEN Joint Center

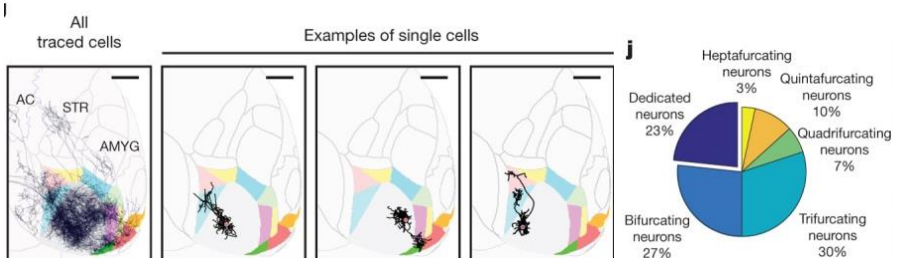
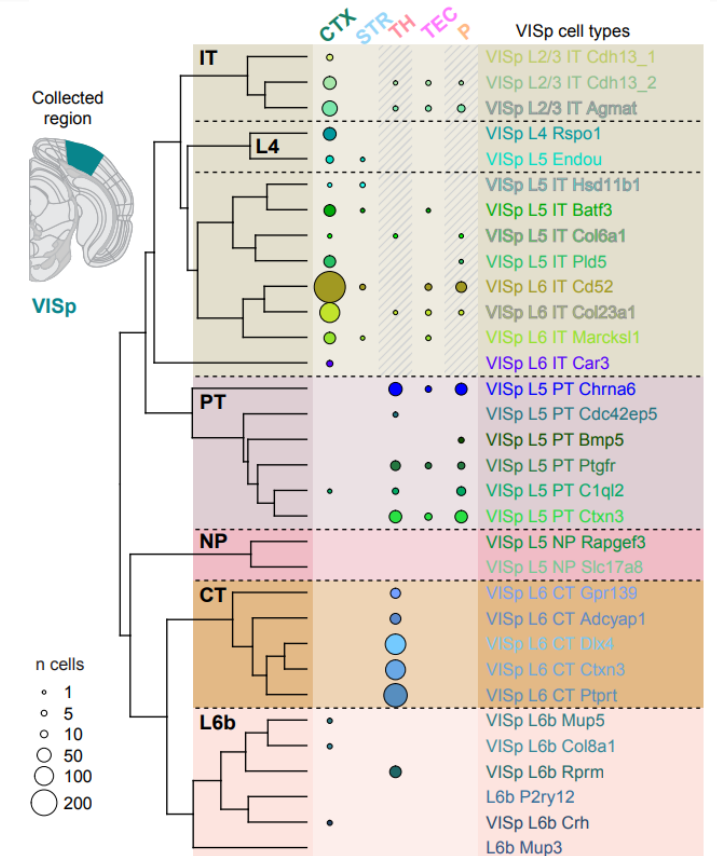
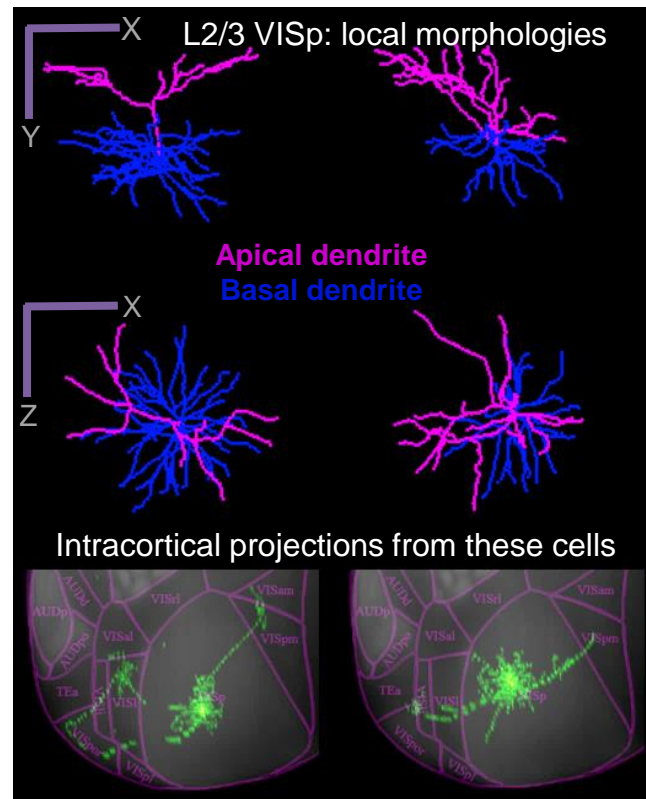
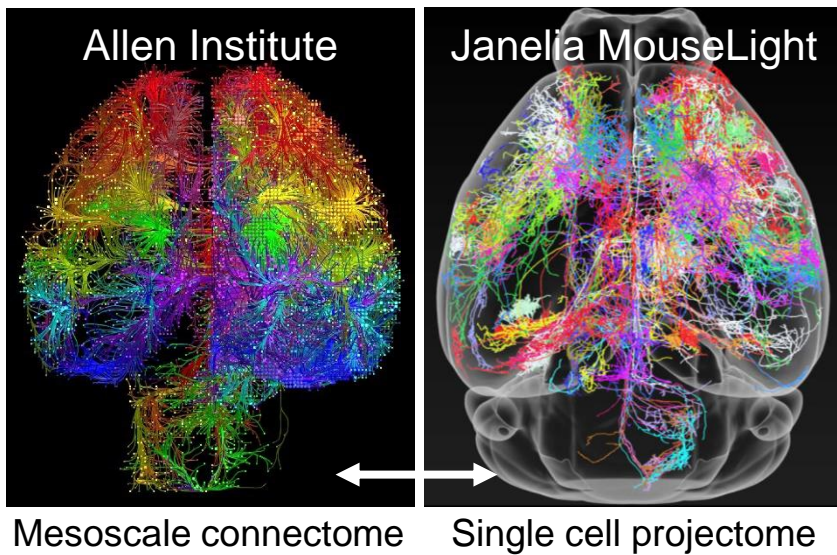
“Full” Morphological Reconstruction – Why?

Classify and identify novel cell types using brain-wide morphological descriptions of single projection neurons

What is the specificity and diversity of projection targets at the single cell level?

How does local morphology relate to long-distance projection patterns?

How does full morphology/target specificity relate to cell type classification?

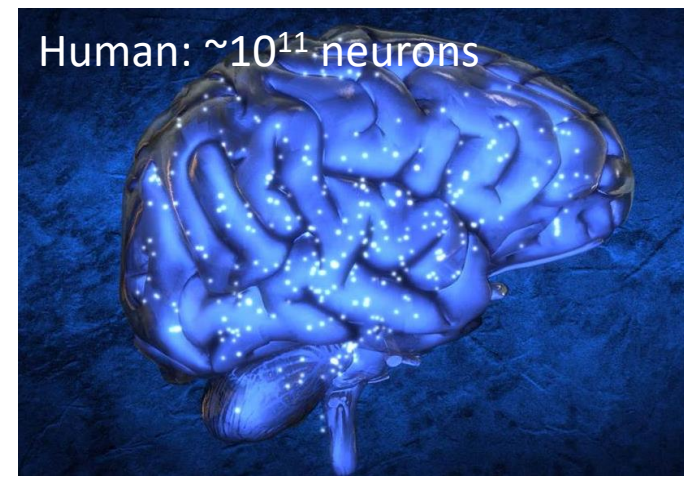
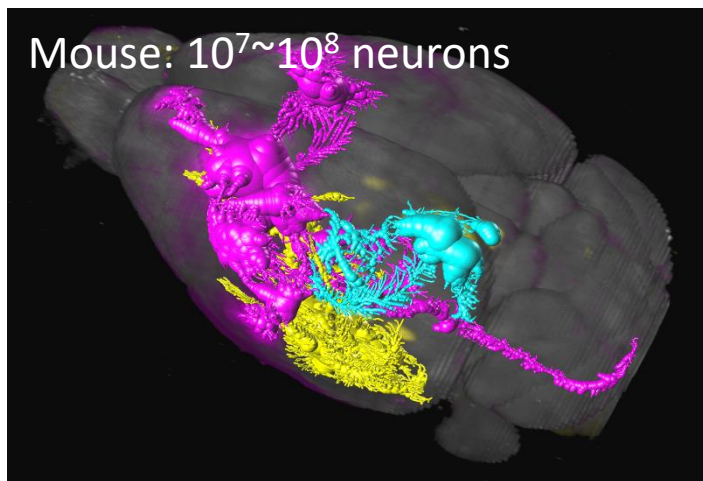
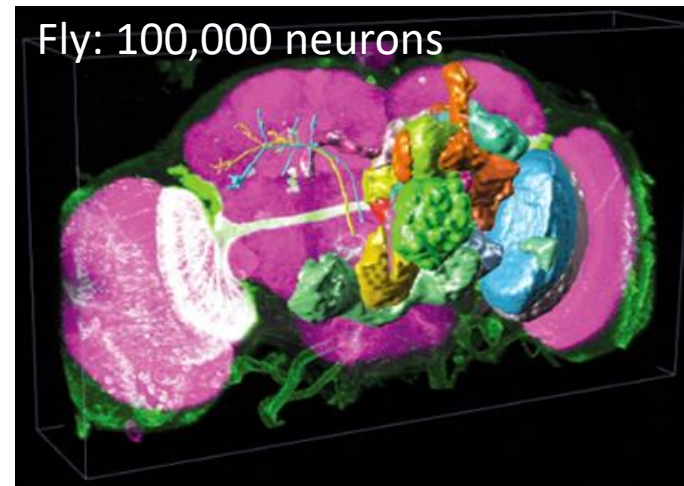
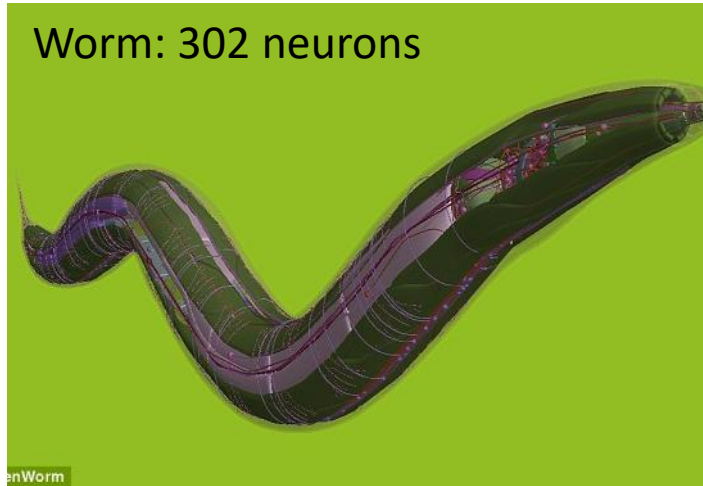


Han et al. 2018

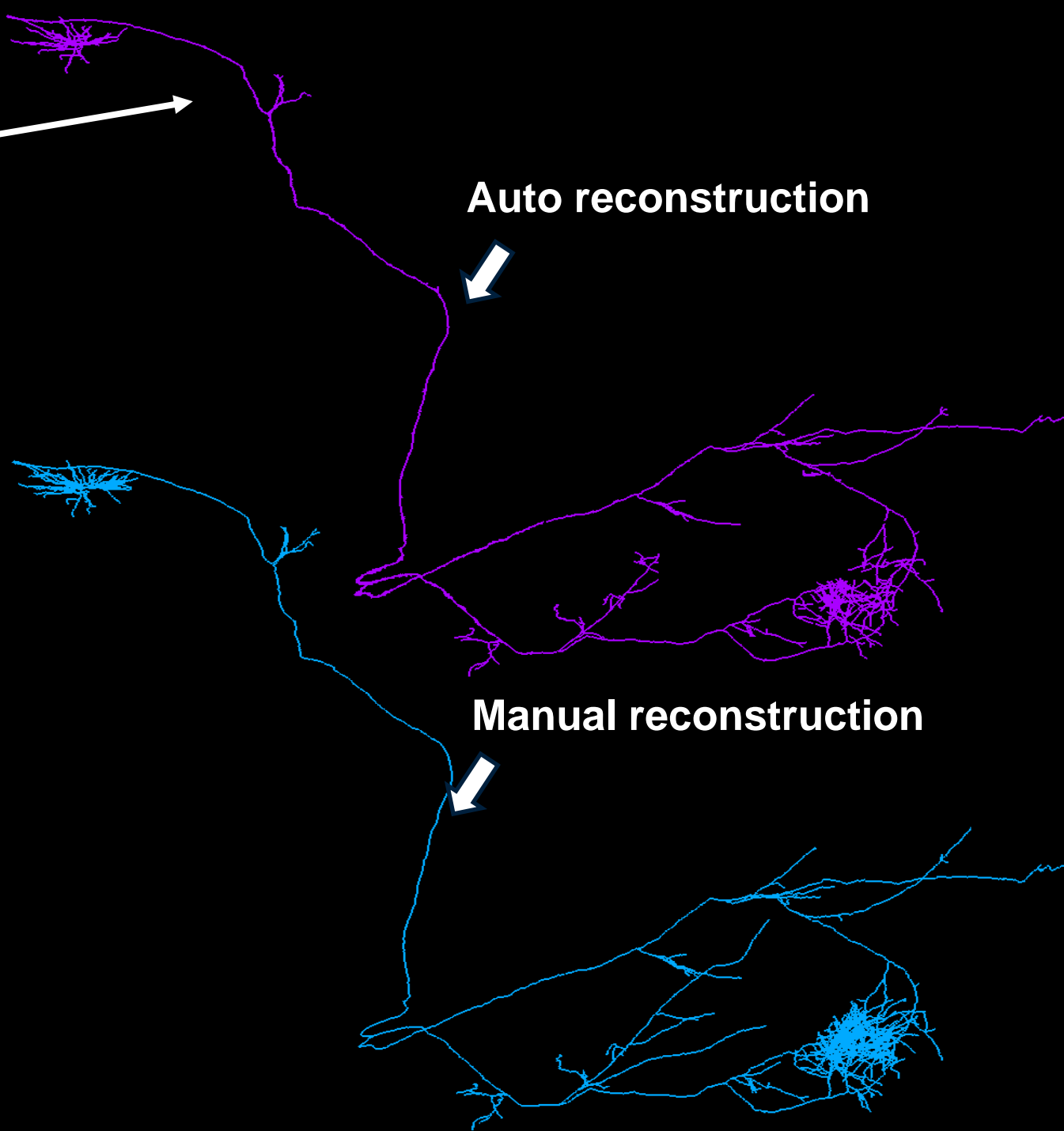
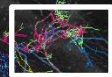
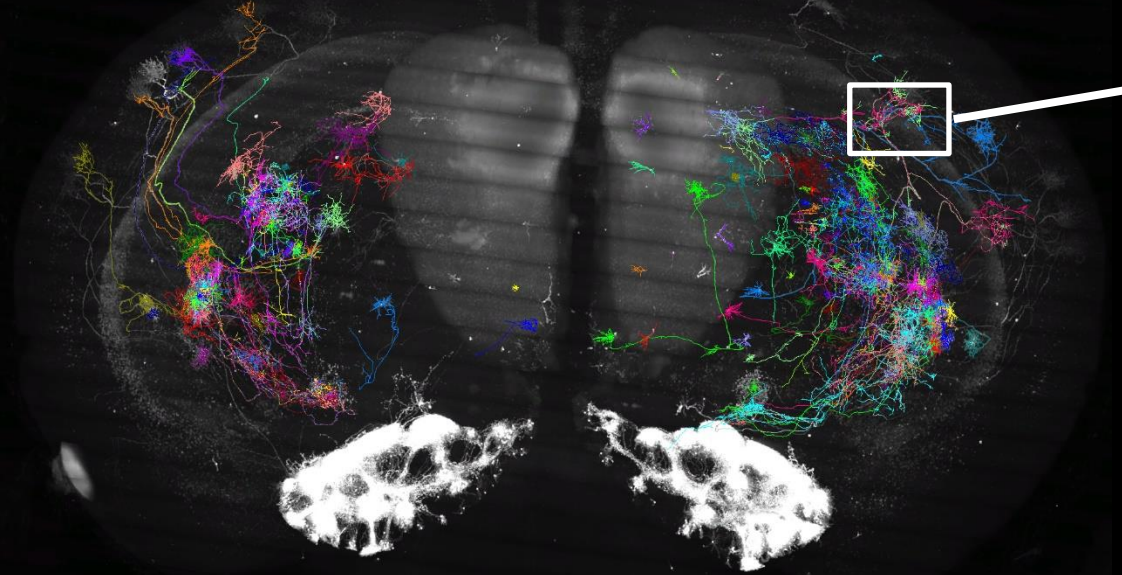
Tasic et al. 2017 bioRxiv 2

alleninstitute.org | brain-map.org

Billions of neurons in Brain



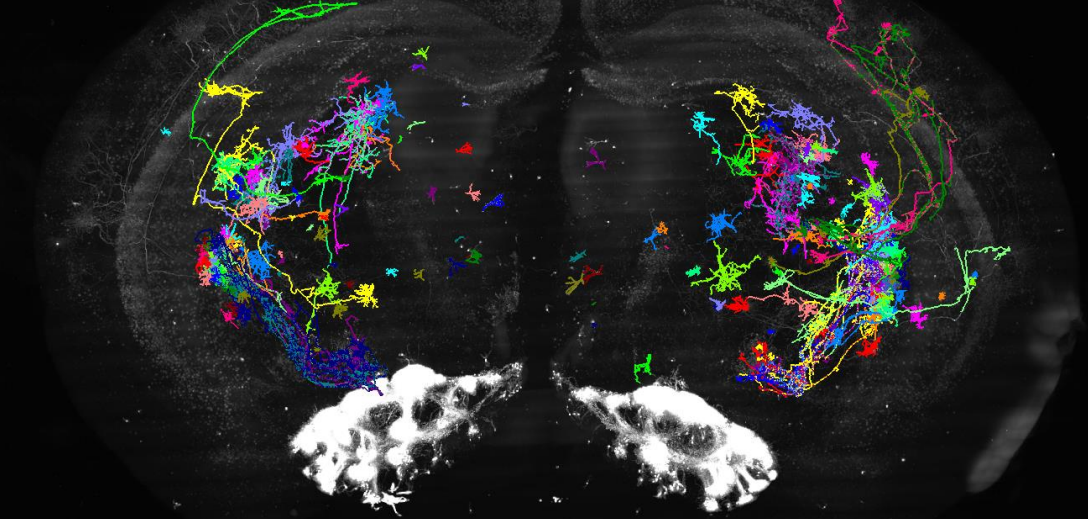
124 Auto reconstructions on brain 17302



Auto reconstruction

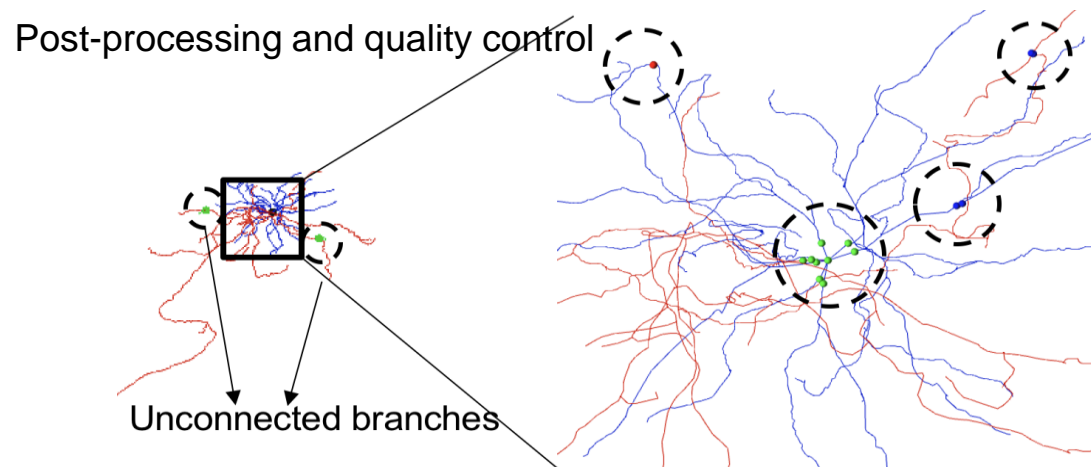
Manual reconstruction

174 Auto reconstructions on brain 17545

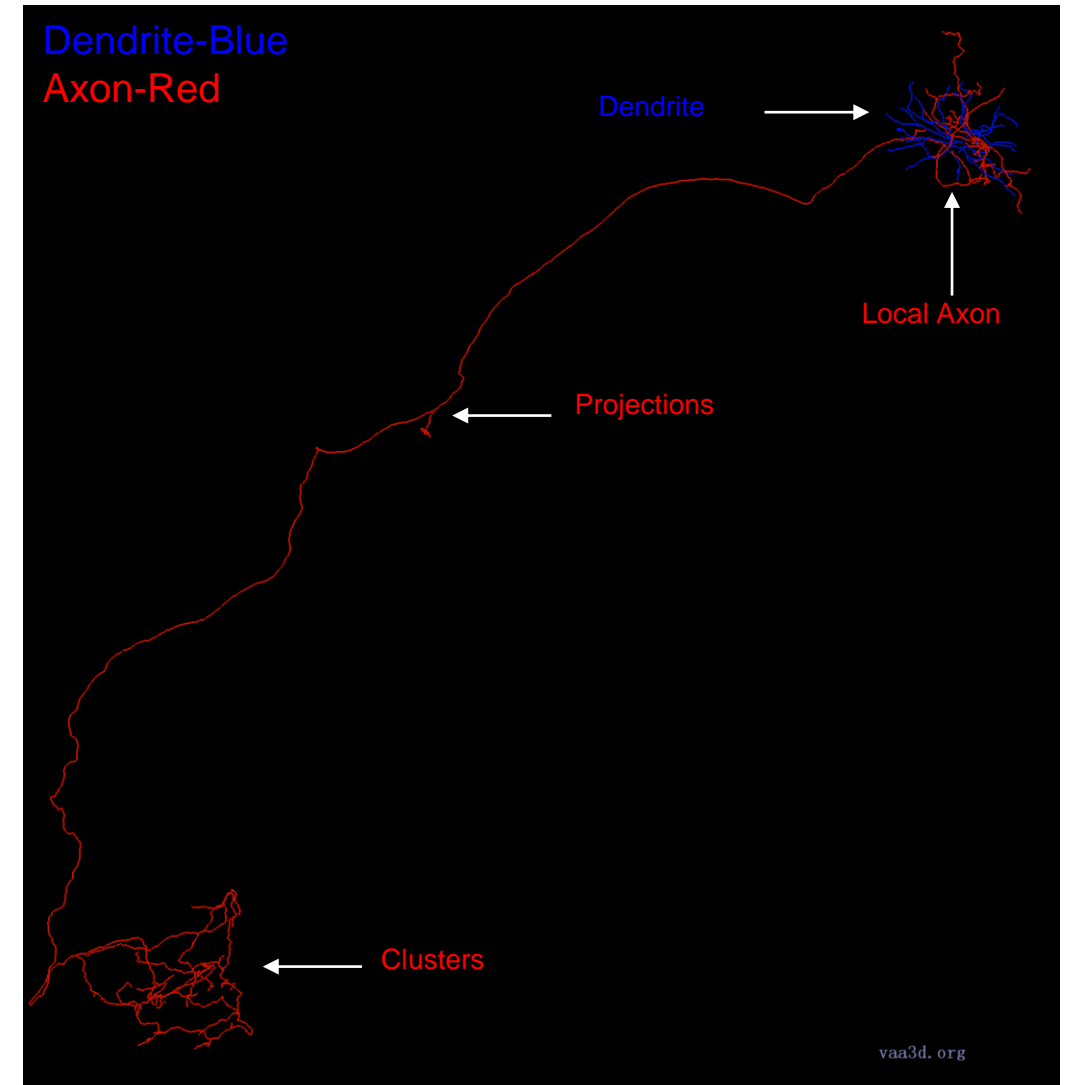


Protocol for full morphology reconstruction

- **Level-1:** Dendrite, Major branches of Axon and Long projection axon without fully-traced cluster;
- **Level-2:** Level-1 and clusters of axon in detail



An example of Level-2 reconstruction



Get To KNOW Vaa3D

Vaa3D



File Image/Data Visualize Advanced Plug-In Window Work-Mode Help





Image data
http://home.penglab.com/proj/vaa3d/data_v1.0/ex_Repo_hb9_eve.tif

Views [XY: upper-left] [ZY: upper-right] [XZ: lower-left]

Options

Focus Coordinates
Z < [52]
X < [118]
Y < [124]

Focus cross Link out Linked

Zoom (Regular x1/4~x8, Looking glass x4)
< [] > XY-plane
< [] > ZY-plane
< [] > XZ-plane

Use looking glass

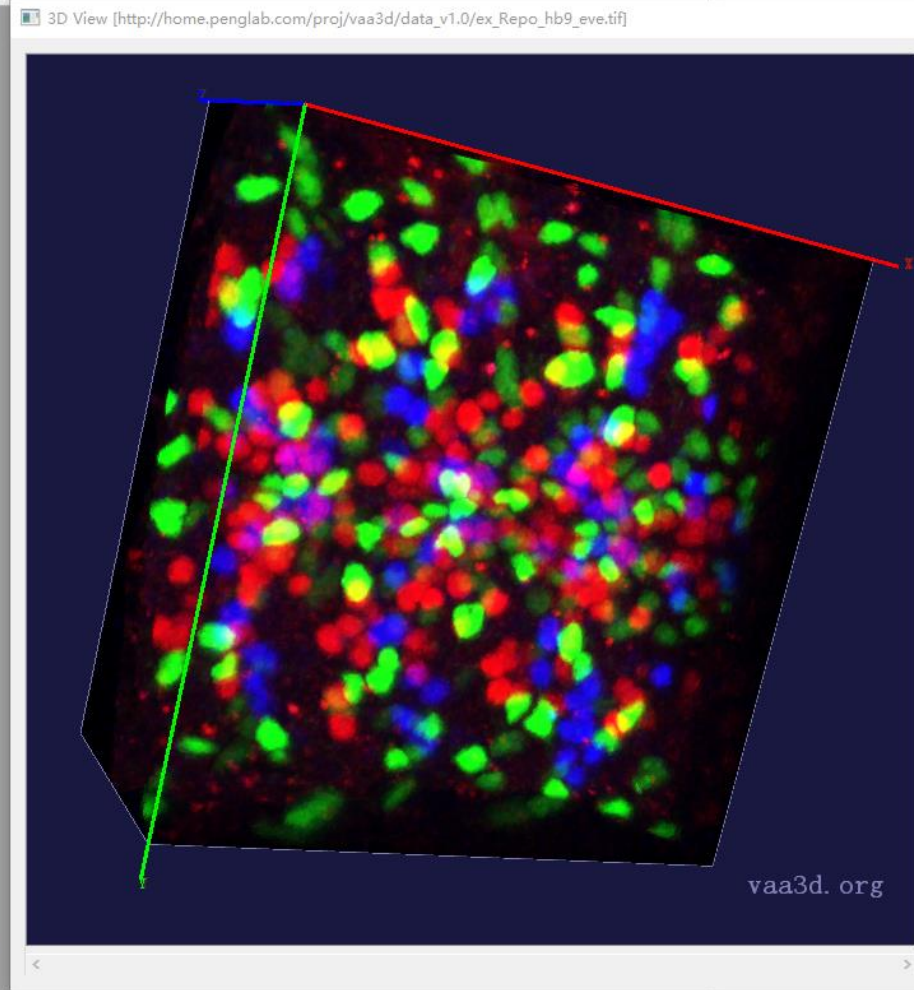
Tri-view zoom=1. Click to set.

Channels (3)	Intensity	Misc
<input checked="" type="checkbox"/> #ff0000 c1	<input checked="" type="checkbox"/>	<input checked="" type="radio"/> Max
<input checked="" type="checkbox"/> #00ff00 c2	<input checked="" type="checkbox"/>	<input type="radio"/> Sum
<input checked="" type="checkbox"/> #0000ff c3	<input checked="" type="checkbox"/>	<input type="radio"/> Mean
		<input type="radio"/> OIT
		<input type="radio"/> Index

R G B 0~255

Landmark controls

Landmark/Atlas/Color Manager



Controls

Volume Surf/Object Others

MIP mIP Alpha X-section

Threshold < [] >

Z-thick x1.00 M-chan all (only for m)

R G B Compress

Contrast < [] >

Volume Cut Surface Cut

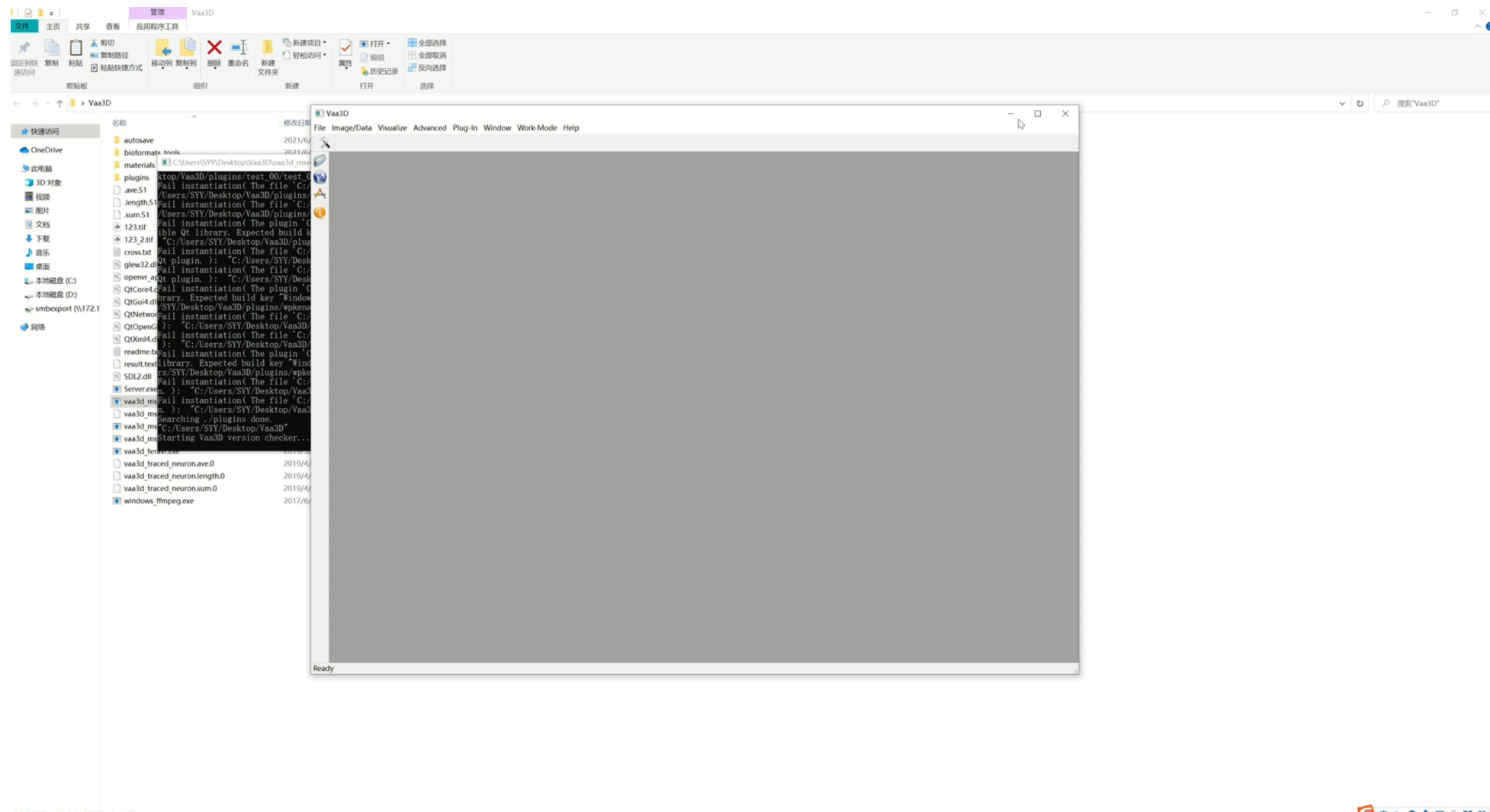
X-out < [] >
Y-out < [] >
Z-out < [] >
Front []

Rotation Zoom & Shift

X= [] Y= [] Z= []

10° 42° 347°

Vaa3D'S demonstration of common functions of reconstruction

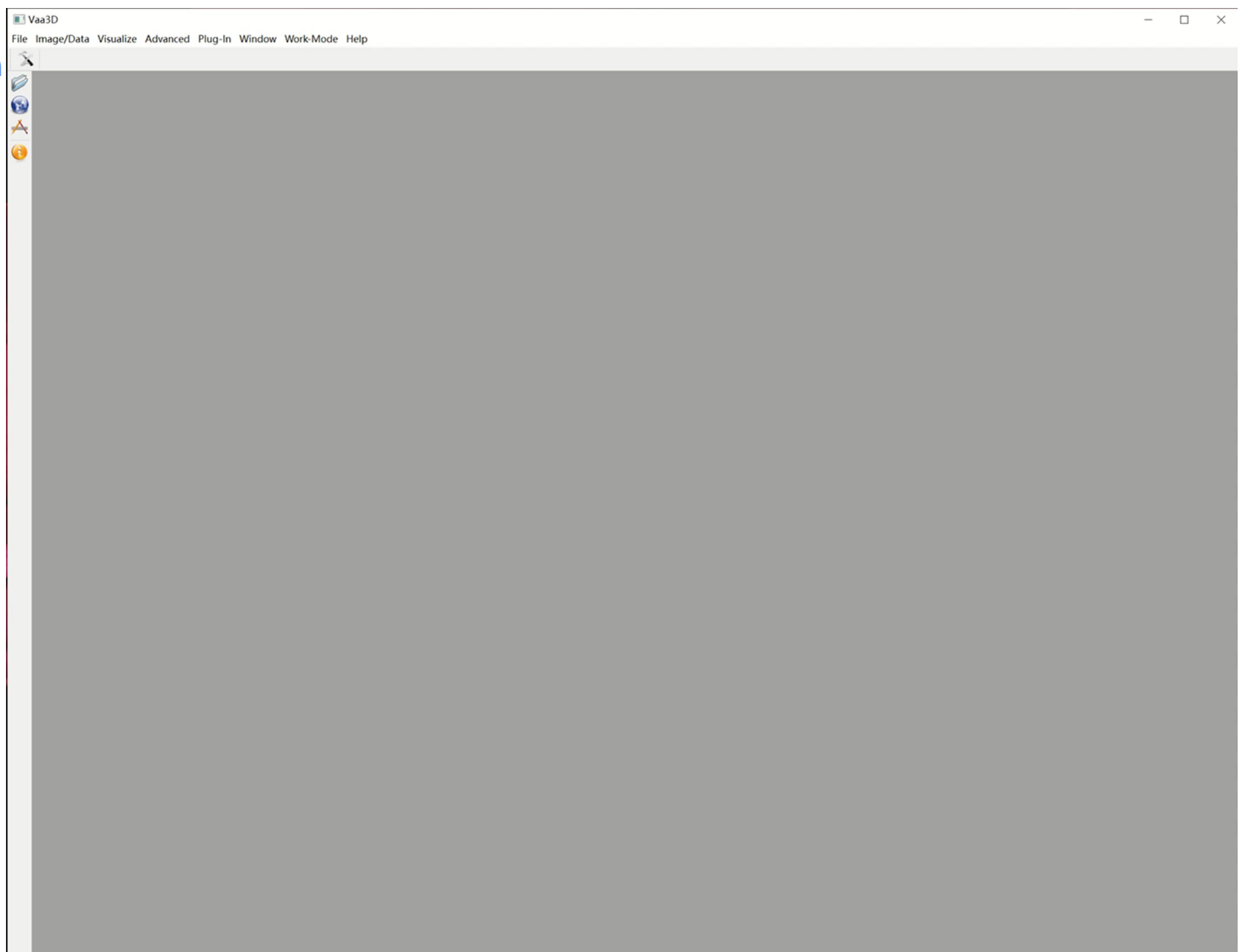


Vaa3D/Analysis

Neuron_radius_plugin



Neuron_radius_plugin

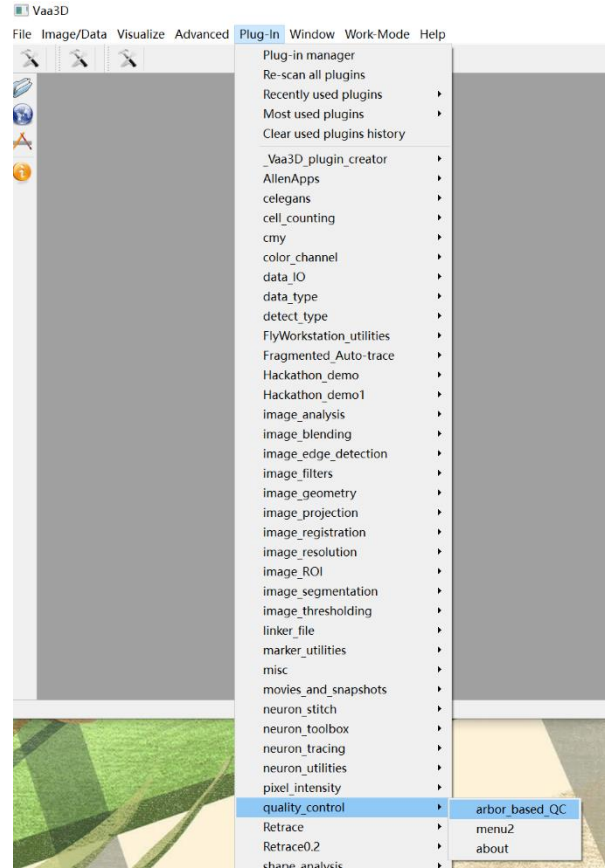


The bronze, silver and gold standard for quality control of neuron reconstruction

How?



1. Select the "quality control" plug-in



2. Input data and information

- .swc file (Registration)
- .csv excel(Contains information such as ID, region CellType_Rogh.)

3. Output result

- Sorted file: " sort_neuron_swc " plug-in applied.
- Features information table: " global_neuron_feature " plug-in applied.
- Results information table: "0" means unqualified, "1" means qualified.

Name	Region	Celltype_Rough	Tips	Width	Height	Depth	Length	MaxBranchOrder	QC_result
17300_00056	CP	CNU	20	21.555	15.634	9.788	202.66	10	0
17300_00057	VISpor	CTX	21	10.651	9.543	15.282	126.12	5	0
17300_00058	CP	CNU	9	9.138	6.744	6.182	58.205	6	0
17300_00073	SSs	CTX	30	18.984	10.553	14.456	179.46	7	1
17300_00106	CP	CNU	29	13.658	9.743	10.407	164.08	10	1
17300_00116	TEa	CTX	29	18.111	9.149	16.319	204.96	11	1
17300_00120	CP	CNU	5	21.914	10.225	11.07	68.664	2	0
17300_00149	CA1	CTX	40	18.233	14.95	11.232	285.78	9	1
17300_00205	VISpor	CTX	8	20.075	9.889	18.452	78.8	2	0
17300_00284	CP	CNU	23	18.78	16.567	11.095	206.45	8	0
17300_00315	SSp-n	CTX	32	12.349	12.025	11.194	187.34	12	1
17300_00519	VISli	CTX	6	10.888	8.342	11.375	38.758	2	0
17300_00572	SSp-m	CTX	41	14.427	11.143	11.974	216.03	24	1
17300_00644	SSp-bfd	CTX	48	17.41	13.438	8.149	251.08	20	1
17300_00755	SSp-m	CTX	64	14.534	12.924	14.196	361.02	17	1
17300_00809	VISp	CTX	41	14.691	13.381	12.763	250.79	10	1
17300_00813	VISp	CTX	24	15.557	12.322	7.839	165.86	9	1
17300_00814	SSp-bfd	CTX	36	14.105	14.439	10.097	199.91	14	1
17300_00886	RSPv	CTX	15	10.319	6.705	8.733	74.669	3	0
17300_00898	SSp-ul	CTX	41	16.104	16.855	11.365	282.39	11	1
17300_00941	SSp-ul	CTX	15	10.687	11.255	7.096	84.857	8	0
17300_00974	SSp-tr	CTX	54	13.7	10.728	9.42	243.62	19	1
17300_01015	RSPv	CTX	20	10.507	7.987	8.589	101.51	5	0
17300_01151	COAp	CTX	4	4.048	3.308	2.552	11.234	2	0
17300_01161	PAA	CTX	17	6.557	7.312	9.9	88.62	6	0
17300_01387	SI	CNU	17	19.038	6.968	8.449	197.1	5	1

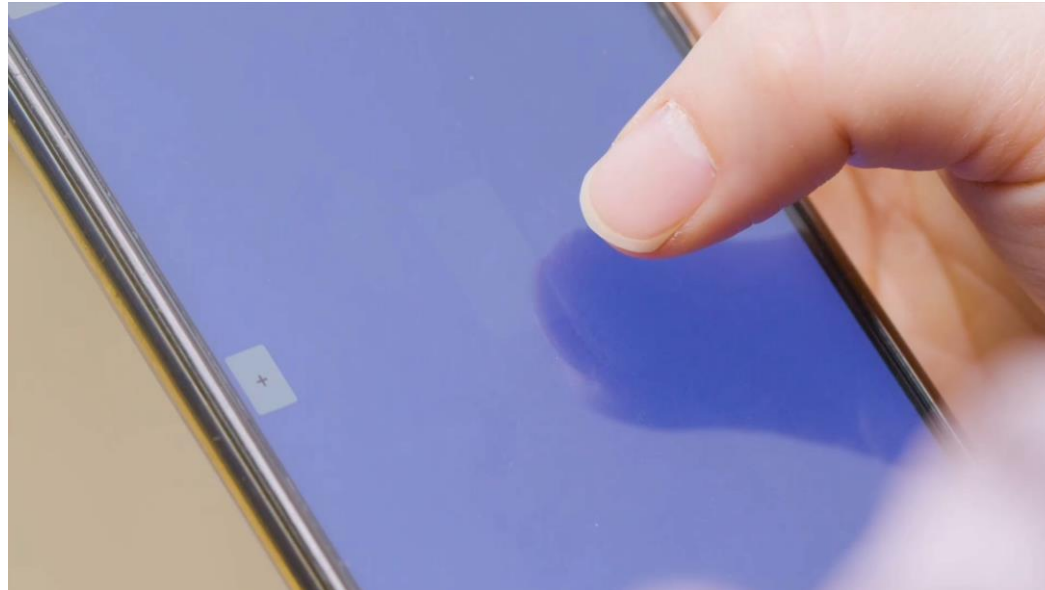
Silver standard and silver standard checking

- **Silver standard:**

1. The 3D space the actual arbor occupied is fully covered;
2. The missing branches of the arbor are less than 1/3;
3. No jumping to neighboring neurons;
4. No over-tracing into background;

- **Silver standard checking:**

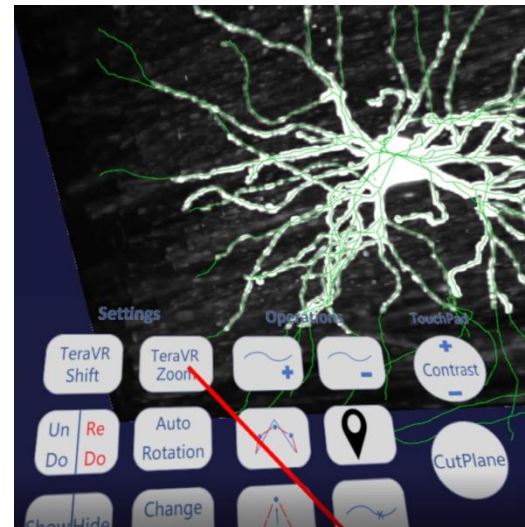
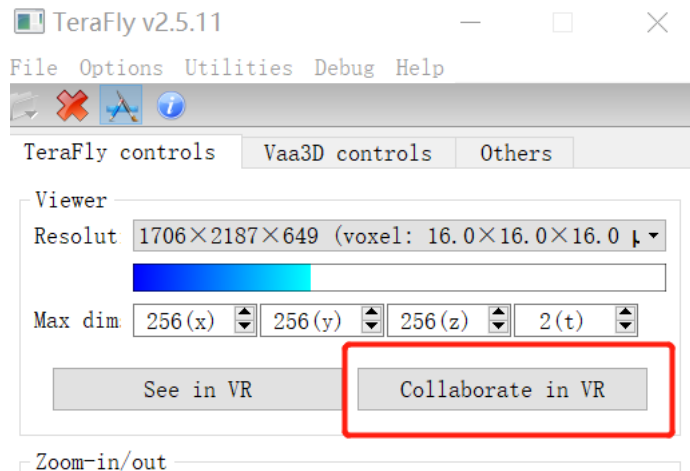
we developed functions check mode under the Hi5 mobile application. Check mode supports efficient browsing and annotating operations, saving the time for data loading and recording.



Gold standard and gold standard checking and revising

- **Gold standard:**
 1. Soma node is defined and labeled as type '1';
 2. The primary branches start at soma node;
 3. No missing branches;
 4. No crossing between branches;
 5. No background traced;
 6. No gaps in branches;
 7. No circle or multifurcation.

Gold standard manual checking: Mainly use MR-Farm



```
C:\WINDOWS\system32\cmd.exe
Starting Vaa3D version checker...

C:\Users\dell>D:\Vaa3D_604\vaa3d_msvc.exe /x D:\Vaa3D_604\plugins\neuronQC0.6 /f neuronQC_batch /i C:\Users\dell\Desktop\100sorted_2 /o C:\Users\dell\Desktop\100sorted_2\100sorted.csv /p 10 15 1
```

```
C:\WINDOWS\system32\cmd.exe
after segSize: 1542
start detect loop-----
9482_10940_2921 8
whole end
points size: 1543
0 1
6 1
17 1
43 1
52 1
1512 1
1527 1
1536 1
link map end
1 link size: 8
23 link size: 4
628 link size: 4
971 link size: 4
1175 link size: 4
outputError size: 5
loop end
outputError loop size: 5
end detect loop-----
soma xyz: 9482 10940 2921
done with saving file: C:/Users/dell/Desktop/5_11_15_10_ano.swc_sorted.swc.apo
*** the plugin preprocessing takes [ 8843 ]
"D:\Vaa3D_604"
Starting Vaa3D version checker...

C:\Users\dell>
```

100sorted.csv - Excel

Wang Yaping

文件 开始 插入 页面布局 公式 数据 审阅 视图 帮助 操作说明搜索

等线 11 A A 自动换行 常规

B I U 字体 对齐方式 数字 条件格式 套用 单元格样式 插入 删除 格式 排序和筛选 查找和选择

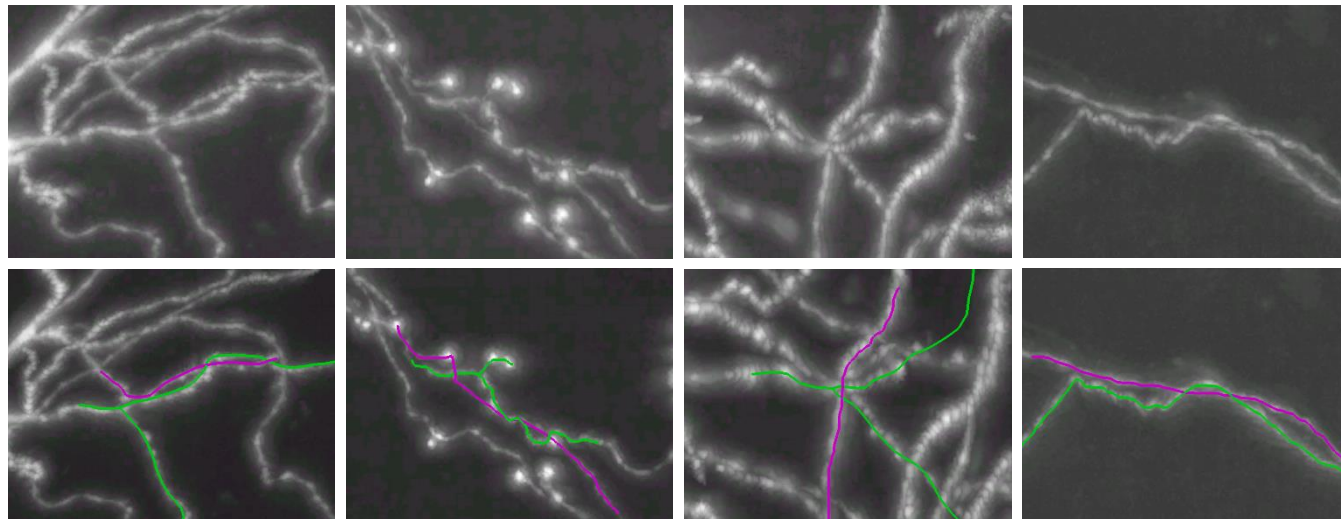
threeBifurcation

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	neuronId	loop	loop Info	threeBifurcation	threeBifurc	isSort	isSort Info	somaType	somaType	gap	gap Info	allTypes	allTypes In	shortBranc	shortBranc	nodeLengt	nodeLeng
2	pre_18864_00420	1	number of	0	15	1	continuous	1	1	1	0	0	1 2 3 7 typ	0	929	0	minLengt
3	pre_18864_00424	1	number of	0	6	1	continuous	1	1	1	0	0	1 2 3 4 typ	0	432	0	minLengt
4	pre_18864_00426	1	number of	0	14	1	continuous	1	1	1	0	0	1 2 3 type	0	716	0	minLengt
5	pre_18864_00427	1	number of	0	9	1	continuous	1	1	1	0	1	1 2 3	0	555	0	minLengt
6	pre_18864_00432	1	number of	0	8	1	continuous	1	1	1	0	0	1 2 3 4 5 t	0	575	0	minLengt
7	pre_18864_00442	1	number of	0	4	1	continuous	1	1	1	0	0	1 2 3 type	0	622	0	minLengt
8	pre_18864_00457	1	number of	0	3	1	continuous	1	1	1	0	1	1 2 3	0	345	0	minLengt
9	pre_18864_00460	1	number of	0	10	1	continuous	1	1	1	0	0	1 2 3 type	0	426	0	minLengt
10	pre_18868_00443	1	number of	0	10	1	continuous	1	1	1	0	0	1 2 3 7 typ	0	185	0	minLengt
11	pre_18868_00465	1	number of	0	4	1	continuous	1	1	1	0	0	1 2 3 type	0	227	0	minLengt

就绪 100%



Signals that are difficult to judge:



Use MR-Farm Collaborative discussion



Thank you!

To download Vaa3D, and for the latest information
& help visit the Vaa3D website at <http://vaa3d.org>

Visit us: <http://braintell.seu.edu.cn/allencenter/>

