BIO-482 Neuroscience: cellular and circuit mechanisms

Mini-project: Neurophysiological data analysis

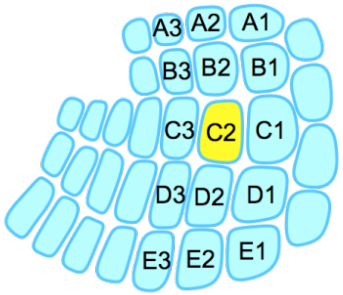
Sylvain Crochet & Carl Petersen

Laboratory of Sensory Processing

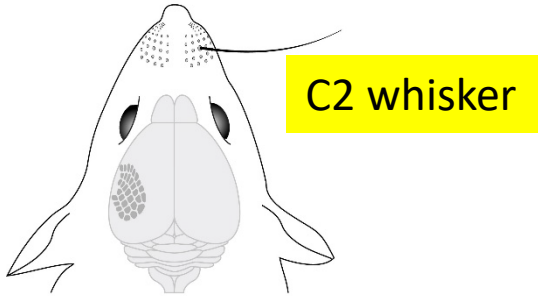
Recordings

Primary somatosensory area (wS1) ***"Barrel cortex"***

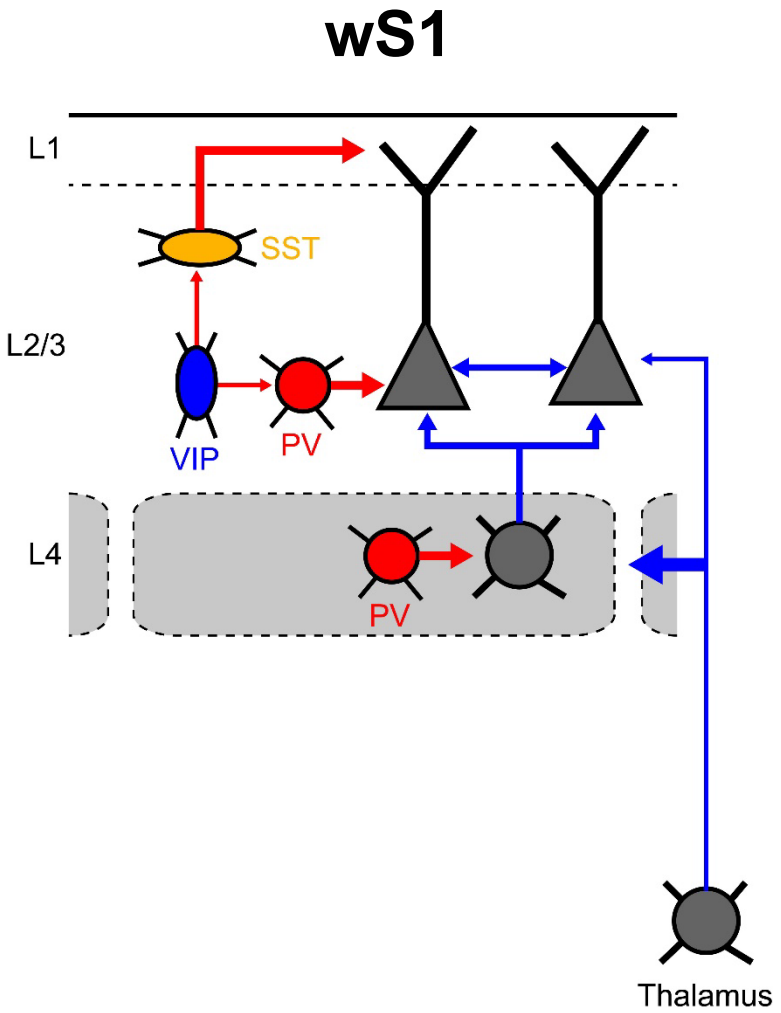
Cortex



Thalamus VPM/POM



C2 whisker

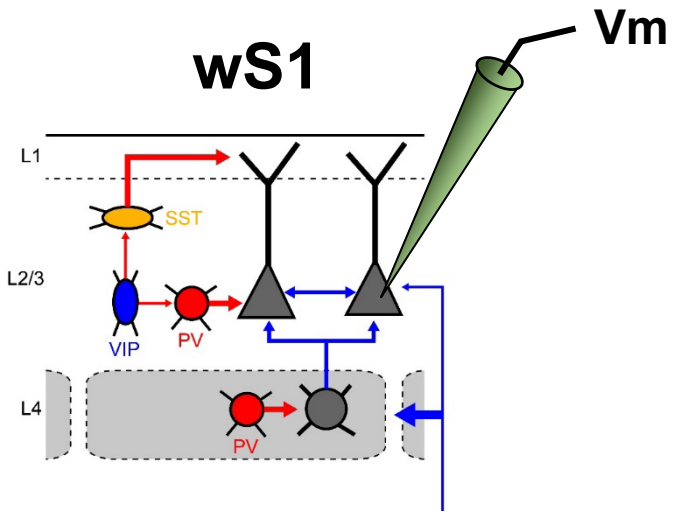


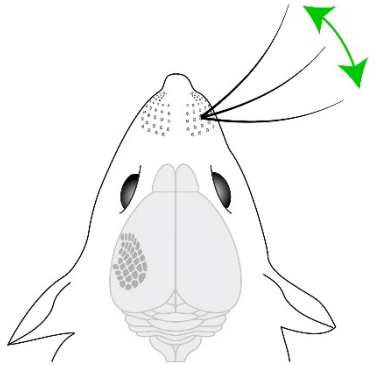
Excitatory cells (Glutamate)

Inhibitory interneurons (GABA):

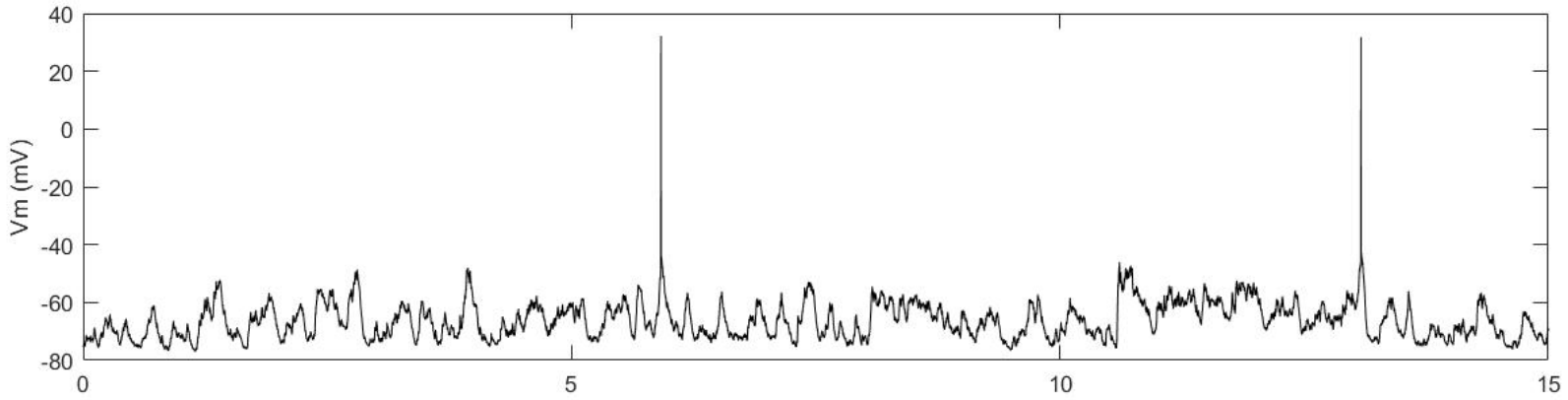
- Parvalbumine (PV)
- Vasointestinal peptide (VIP)
- Somatostatin (SST)

Recordings

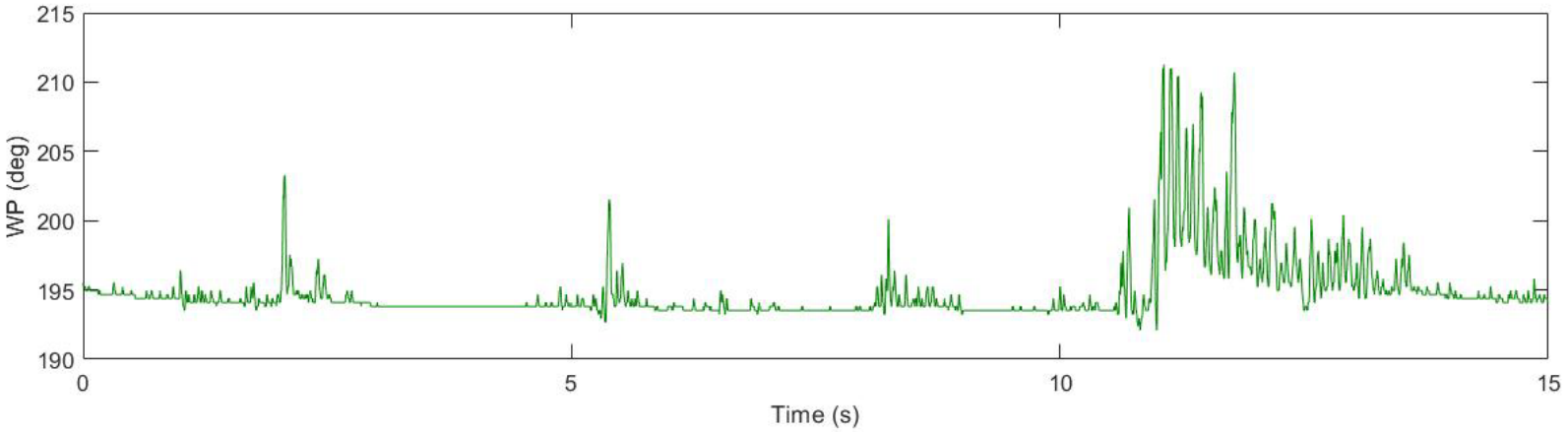




Membrane potential (Vm) – SR = 20 kHz

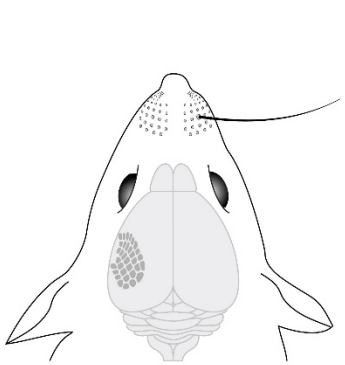


Whisker position (WP) – SR = 100 Hz

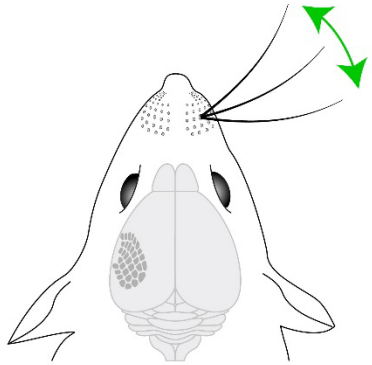


Recordings

Free whisking

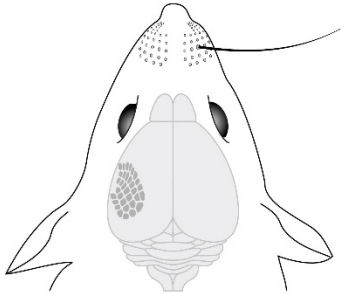


Quiet

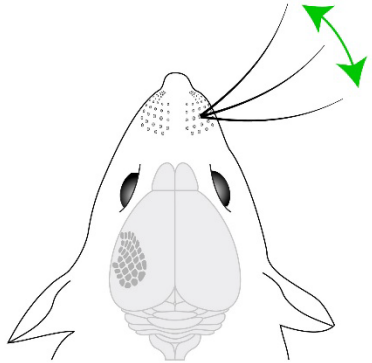


Whisking

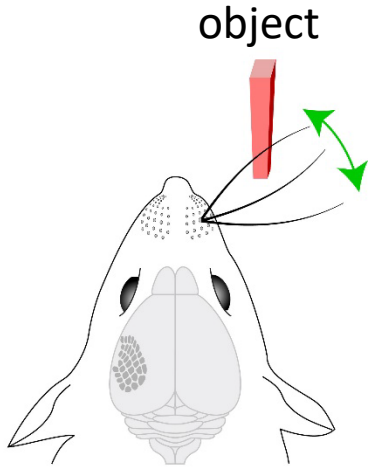
Active touch



Quiet

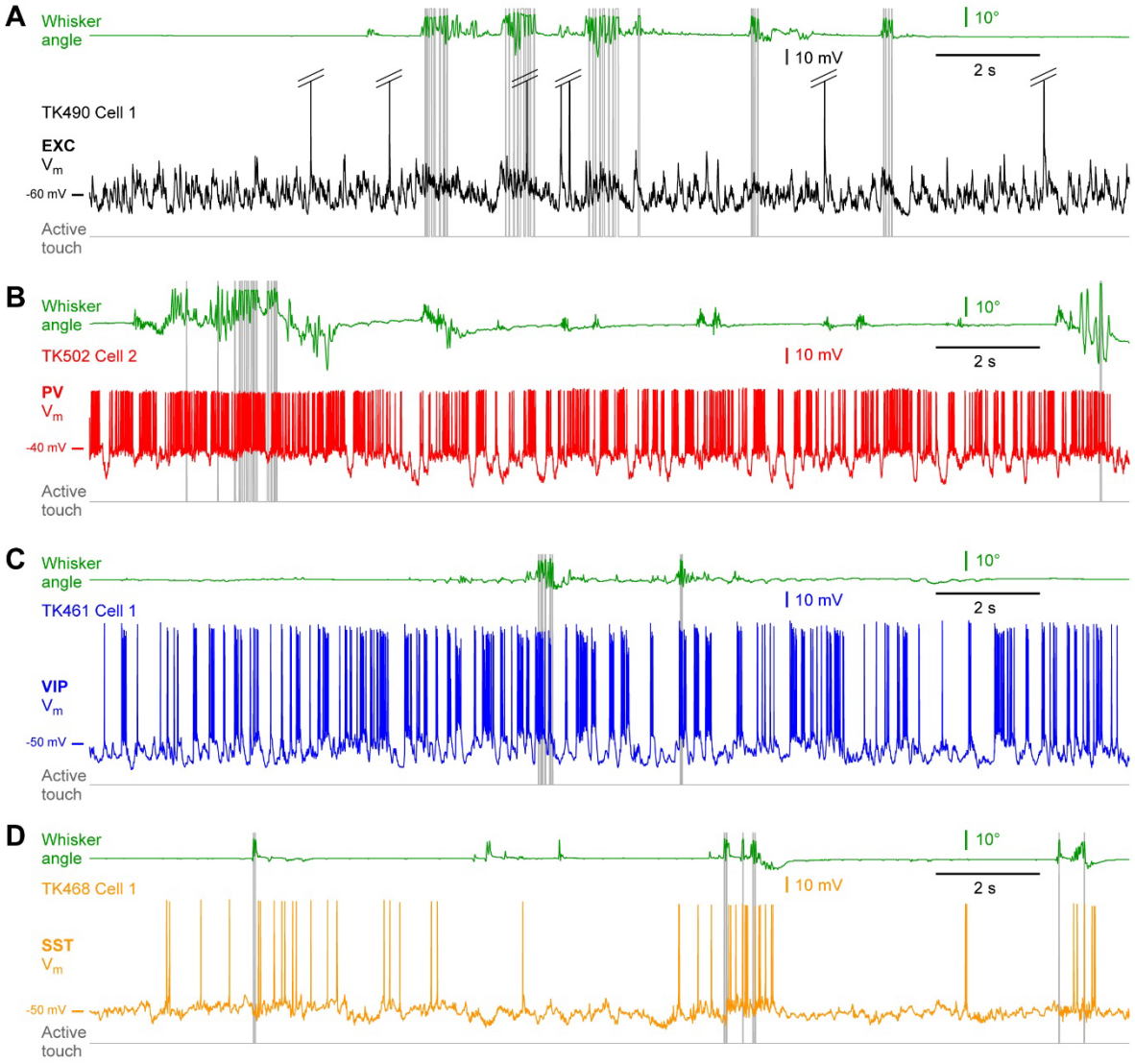


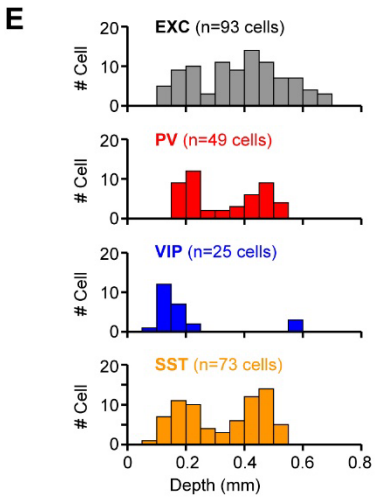
Whisking

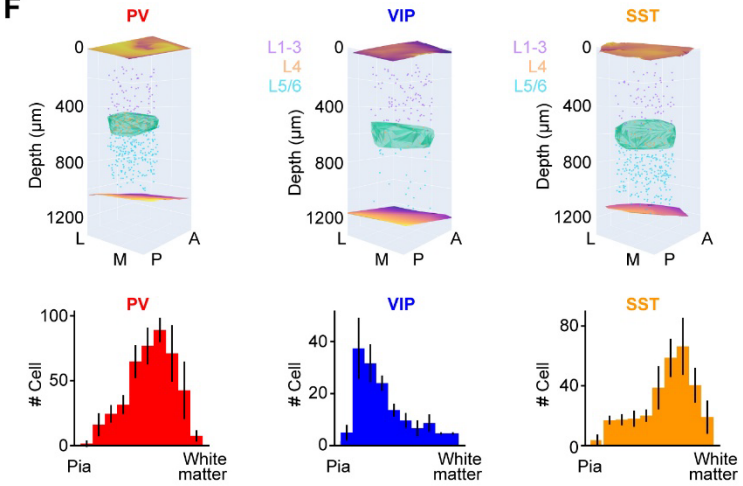


Active Touch

Kiritani et al., BioRxiv 2022







Data structure => flat data structure : 1 line = 1 continuous recording (Sweep)

	Field 1	Field 2	…	Field N
Trial 1				
Trial 2				
…				
…				
…				
Trial N				

=> Fields can contain Meta-Data or Data of different types: String, Number, Vector …

=> 1 Sweep = 1 continuous recording from 1 neuron (~30-90 s)

Meta-Data

Mouse Name	Mouse DOB	Mouse …	Cell Counter	Cell ID	Cell Type	Cell …	Sweep Counter	Sweep Type	Sweep …
TK355			1	TK355_1	EXC		1	Free Whisking	
TK355			1	TK355_1	EXC		2	Active Touch	
TK355			1	TK355_1	EXC		3	Free Whisking	
TK355			2	TK355_2	PV		1	Free Whisking	
TK358			1	TK358_1	SST		1	Active Touch	
TK358			1	TK358_1	SST		2	Active Touch	

Mouse | Cell | Sweep

Mouse Name	Mouse DOB	Mouse …	Cell Counter	Cell ID	Cell Type	Cell …	Sweep Counter	Sweep Type	Sweep …
TK355			1	TK355_1	EXC		1	Free Whisking	
TK355			1	TK355_1	EXC		2	Active Touch	
TK355			1	TK355_1	EXC		3	Free Whisking	
TK355			2	TK355_2	PV		1	Free Whisking	
TK358			1	TK358_1	SST		1	Active Touch	
TK358			1	TK358_1	SST		2	Active Touch	

Data structure

Meta-Data ⟷ Data

Mouse Name	Cell Counter	Sweep Counter	Sweep Type	Whisker Angle	Whisker Angle SR	Vm	Vm SR	Whisking Times	Contact Times
TK355	1	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 double	[ ]
TK355	1	2	Active Touch	30000x1 double	500	2400000x 1 double	40000	Nx2 double	Nx2 double
TK355	1	3	Free Whisking	15000x1 double	500	1200000x 1 double	40000	Nx2 Double	[ ]
TK355	2	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 Double	[ ]
TK358	1	1	Active Touch	30000x1 double	500	2400000x 1 double	40000	Nx2 Double	Nx2 double
TK358	1	2	Active Touch	45000x1 double	500	3600000x 1 double	40000	Nx2 double	Nx2 double

Data structure

1 Cell = unique Mouse Name + unique Cell Counter (ex: TK355_1) => Cell ID

Mouse Name	Cell Counter	Sweep Counter	Sweep Type	Whisker Angle	Whisker Angle SR	Vm	Vm SR	Whisking Times	Contact Times
TK355	1	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 double	[ ]
TK355	1	2	Active Touch					Nx2 double	Nx2 double
TK355	1	3	Free Whisking					Nx2 Double	[ ]
TK355	2	1	Free Whisking					Nx2 Double	[ ]
TK358	1	1	Active Touch					Nx2 Double	Nx2 double
TK358	1	2	Active Touch					Nx2 double	Nx2 double

=> 1 Cell

Data structure

Mouse Name	Cell Counter	Sweep Counter	Sweep Type	Whisker Angle	Whisker Angle SR	Vm	Vm SR	Whisking Times	Contact Times
TK355	1	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 double	[ ]
TK355	1	2	Active Touch	30000x1 double	500	2400000x 1 double	40000	Nx2 double	Nx2 double
TK355	1	3	Free Whisking	15000x1 double	500	1200000x 1 double	40000	Nx2 Double	[ ]
TK355	2	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 Double	[ ]
TK358	1	1	Active Touch	30000x1 double	500	2400000x 1 double	40000	Nx2 Double	Nx2 double
TK358	1	2	Active Touch	45000x1 double	500	3600000x 1 double	40000	Nx2 double	Nx2 double

⇒ 1 Cell TK355_1

⇒ 1 Cell TK355_2

⇒ 1 Cell TK358_1

Data structure

Mouse Name	Cell Counter	Sweep Counter	Sweep Type	Whisker Angle	Whisker Angle SR	Vm	Vm SR	Whisking Times	Contact Times
TK355	1	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 double	[ ]
TK355	1	2	Active Touch	30000x1 double	500	2400000x 1 double	40000	Nx2 double	Nx2 double
TK355	1	3	Free Whisking	15000x1 double	500	1200000x 1 double	40000	Nx2 Double	[ ]
TK355	2	1	Free Whisking	30000x1 double	500	2400000x 1 double	40000	Nx2 Double	[ ]
TK358	1	1	Active Touch	30000x1 double	500	2400000x 1 double	40000	Nx2 Double	Nx2 double
TK358	1	2	Active Touch	45000x1 double	500	3600000x 1 double	40000	Nx2 double	Nx2 double

‘free whisking’ sweeps for Cell TK355_1

Data structure – fields description

Data.Mouse_Name : Name of the mouse ('LLNNN')

Data.Mouse_DateOfBirth : Mouse date of birth [Year; Month; day]

Data.Mouse_Sex : Mouse sex ('f' or 'm')

Data.Mouse_Genotype : Mouse genotype [Parent1 ; Parent2]

Data.Cell_Counter : Cell counter (Numb)

Data.Cell_Type : Cell Type ['EXC', 'PV', 'VIP' or 'SST']

Data.Cell_Depth : Cell recording depth (in µm from brain surface)

Data.Cell_Layer : Cell cortical layer ['L2/3', 'L4' or 'L5']

Data.Cell_TargetedBrainArea : Cell cortical area ['C2 barrel column of wS1']

Data.Cell_tdTomatoExpressing : Expression of tdTomato ['true' or 'false']

Data.Cell_ID : unique Cell ID (Mouse_Name _ Cell_Counter)

Data.Cell_APThreshold_Slope : Threshold to detect AP initiation from dVm/dt ($V.s^{-1}$)

Data.Sweep_Counter : Recording sweep counter (Numb)

Data.Sweep_Type : Recording sweep type ['free whisking' or 'active touch']

Data.Sweep_StartTime : Recording sweep start time [Year; Month; day; hour; minute; second]

Data.Sweep_MembranePotential : Membrane potential recording (vector; V)

Data.Sweep_MembranePotential_SamplingRate : Sampling rate of membrane potential ($sample.s^{-1}$)

Data.Sweep_WhiskerAngle : Whisker angle position (vector, deg)

Data.Sweep_WhiskerAngle_SamplingRate : Sampling rate of whisker angle ($sample.s^{-1}$)

Data.Sweep_QuietTimes : Onset and Offset times of quiet periods (2xN matrix, s)

Data.Sweep_WhiskingTimes : Onset and Offset times of whisking periods (2xN matrix, s)

Data.Sweep_ActiveContactTimes : Onset and Offset times of active contacts (2xN matrix, s)

Data.Sweep_PassiveContactTimes : Onset and Offset times of passive contacts (2xN matrix, s)

Data.Cell_Anatomy : Cell anatomy for identified cells ['layer'; 'barrel column']

Dataviewer demo