

Analysis of the imaging experiment

mouse name: 059

task: NearFar

experimentalist: Snezana Raus-Balind

1. Load the necessary object class

We use a custom-made class, `ImagingSessionData`, that will contain all behavioral and imaging data. We also load the matplotlib widgets to make graphs interactive under the notebook environment.

```
In [1]: from ImageAnal import *  
        %matplotlib widget
```

2. Tell python where the data is

The required file structure is the following:

- All data should be in the data folder
- Within the data folder separate subfolders are needed for each mouse. Folder name starts with the **name** of the mouse.
- For each mouse there should be at least two folders: one for the **imaging** data and one for the **behavioral** data.
- The behavioral folder is named as `MouseName_TaskName` - so we need a separate folder for each different task
- The behavioral log files are in separate subfolders named by the experiment's start time within the behavioral folder - e.g. `2021-02-03_10-15-50`
- The imaging folder is named as `MouseName_imaging`
- The suite2p imaging files are also in separate folders for each experiment below the imaging folder.

```
In [2]: datapath = os.getcwd() + '/' #current working directory - look for  
date_time = '2021-02-03_10-15-50' # date and time of the imaging ses  
name = 'srb059' # mouse name  
task = 'NearFar' # task name  
  
## locate the suite2p folder  
suite2p_folder = datapath + 'data/' + name + '_imaging/Suite2P_4_19-  
  
## the name and location of the imaging log file  
imaging_logfile_name = suite2p_folder + 'srb059_TSeries-02032021-10-  
  
## the name and location of the trigger voltage file  
TRIGGER_VOLTAGE_FILENAME = suite2p_folder + 'srb059_TSeries-02032021-
```

3. Load all the data - this takes ~20 secs in my computer

Python looks for the data in the specified folders. It loads the behavioral data (position,

lick and rewards) as well as the imaging data. It calculates the activity of the cells as a function of position in the different corridors and calculates their spatial tuning measures and corridor selectivity.

The name of the object that contains all the data is D1 here - Data 1.

```
In [3]: # 3. load all the data - this takes ~20 secs in my computer
D1 = ImagingSessionData(datapath, date_time, name, task, suite2p_fo
```

```
trigger logfile loaded
trigger voltage signal loaded
triggers after: 22
n_extra_indexes 5
candidate log indexes [0, 99, 178]
min recorded trigger length: 0.0120000000000000455
relevant behavior located, lap time of the first frame: 870.993125
, log reference index: 99
slight warning - testing some late candidates failed
suite2p data loaded
corrected offset: 870.9851249999999 voltage_delay: 0.00800000000000
382
suite2p time axis loaded
calculating dF/F and SNR...

/Users/ubi/Projects/KOKI/VR/MiceData/ImageAnal.py:408: RuntimeWarn
ing: invalid value encountered in true_divide
    self.dF_F[i_cell,] = (self.F[i_cell,] - baseline) / baseline

SNR done
dF/F calculated for cell ROI-s
ExpStateMachineLog time interval > 1s: 10 times
[ 5.03966018 178.07813661 184.49403693 186.90899334 207.4688
484
213.4257944 217.7201534 392.68928535 653.35621006 1802.0791
4619]
calculating rate, reliability and Fano factor...
calculating Skaggs spatial info...
calculating proportion of active laps...
calculating proportion of active laps based on dF/F ...
calculating linear tuning specificity ...
calculating rate, reliability and Fano factor...

/Users/ubi/Projects/KOKI/VR/MiceData/utils.py:17: RuntimeWarning:
invalid value encountered in true_divide
    r = np.divide(r_num, r_den, out=out_vec, where=vec_nonzero)

calculating Skaggs spatial info...
calculating proportion of active laps...
calculating proportion of active laps based on dF/F ...
calculating linear tuning specificity ...
calculating corridor selectivity ...
calculating corridor similarity ...
```

The behavior is divided into laps (trials or runs). You can check the **number of laps** and which lap is associated with imaging data in the following way:

```
In [4]: print(D1.n_laps)
print(D1.i_Laps_ImData)
```

```

178
[ 33  34  35  36  37  38  39  40  41  42  43  44  45  46  47  48
49  50
   51  52  53  54  55  56  57  58  59  60  61  62  63  64  65  66
67  68
   69  70  71  72  73  74  75  76  77  78  79  80  81  82  83  84
85  86
   87  88  89  90  91  92  93  94  95  96  97  98  99 100 101 102 1
103 104
   105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 1
121 122
   123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 1
139 140
   141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 1
157 158
   159 160 161 162 163 164 165 166 167

```

So we have 178 laps and laps 33-167 contain imaging data.

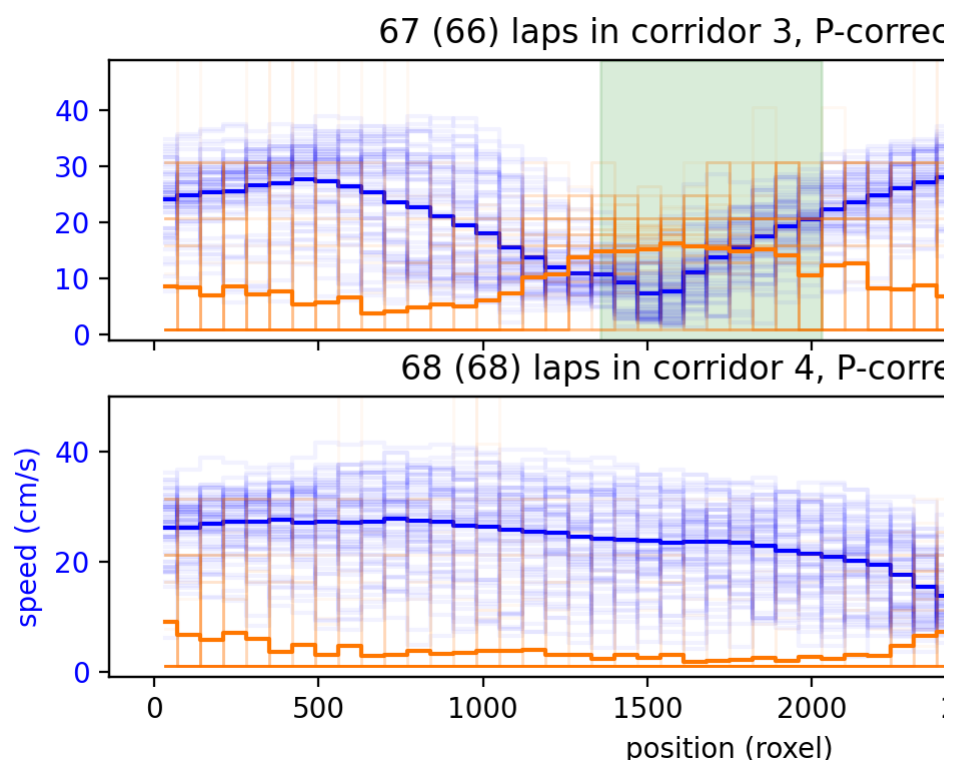
4. Plotting the behavioral data

You can plot the behavioral data of the session:

```
In [5]: D1.plot_session(selected_laps=D1.i_Laps_ImData)
```



Figure 1

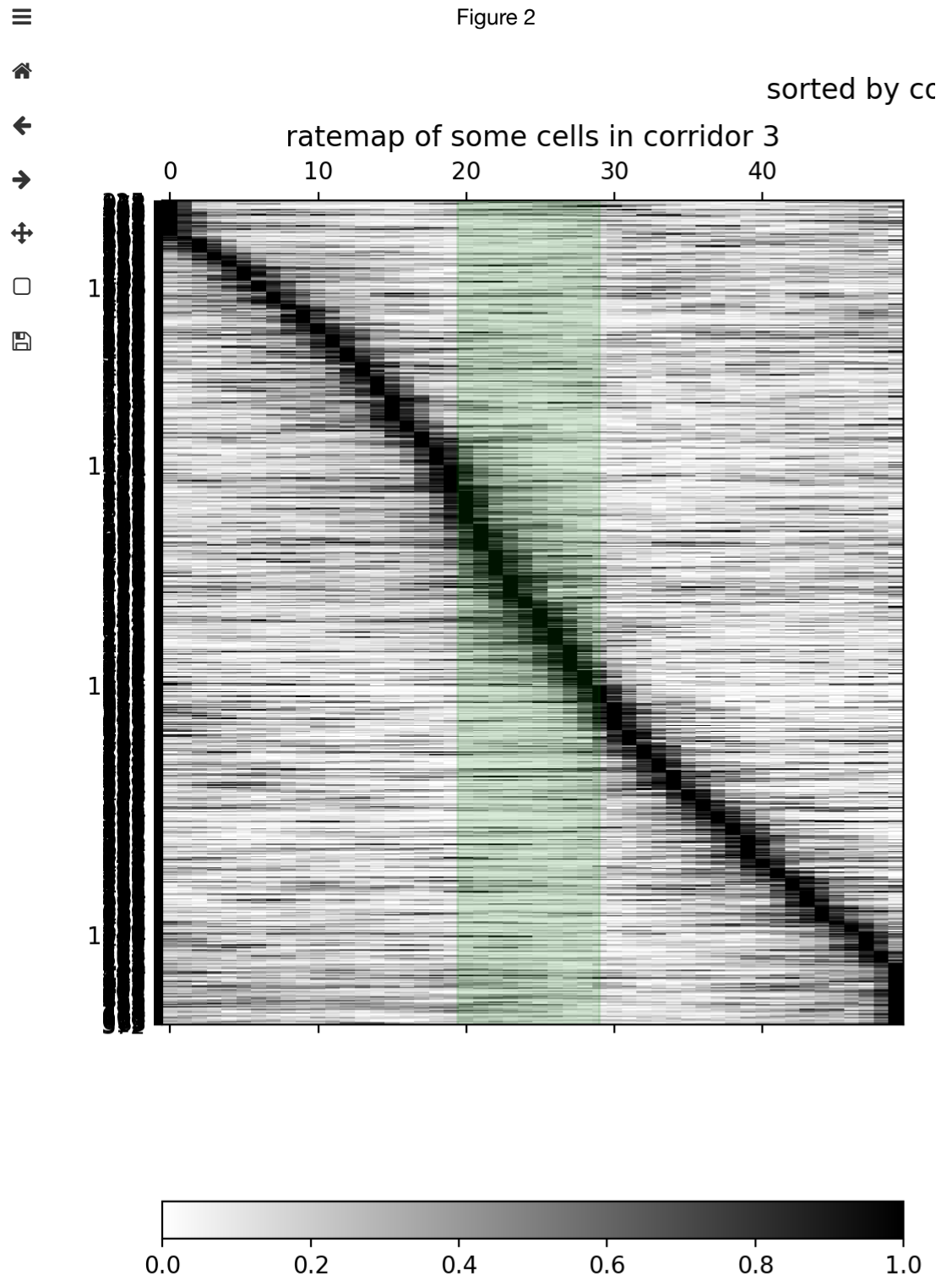


5. Plot the ratemaps

First, we plot the ratemaps of some neurons. There are several options - selecting the cells, sorting and normalising the ratemaps.

- selection: here we select all active cells (activity in at least 20% of laps), but any other selection criteria
- sorting: place fields can be sorted by either corridors
- place cells can be normalised - so the peak has the same height

```
In [6]: cellids = np.nonzero(((D1.cell_activelaps[0]>0.2) + (D1.cell_active
D1.plot_ratemaps(cellids = cellids, sorted=True, corridor_sort=3, no
```

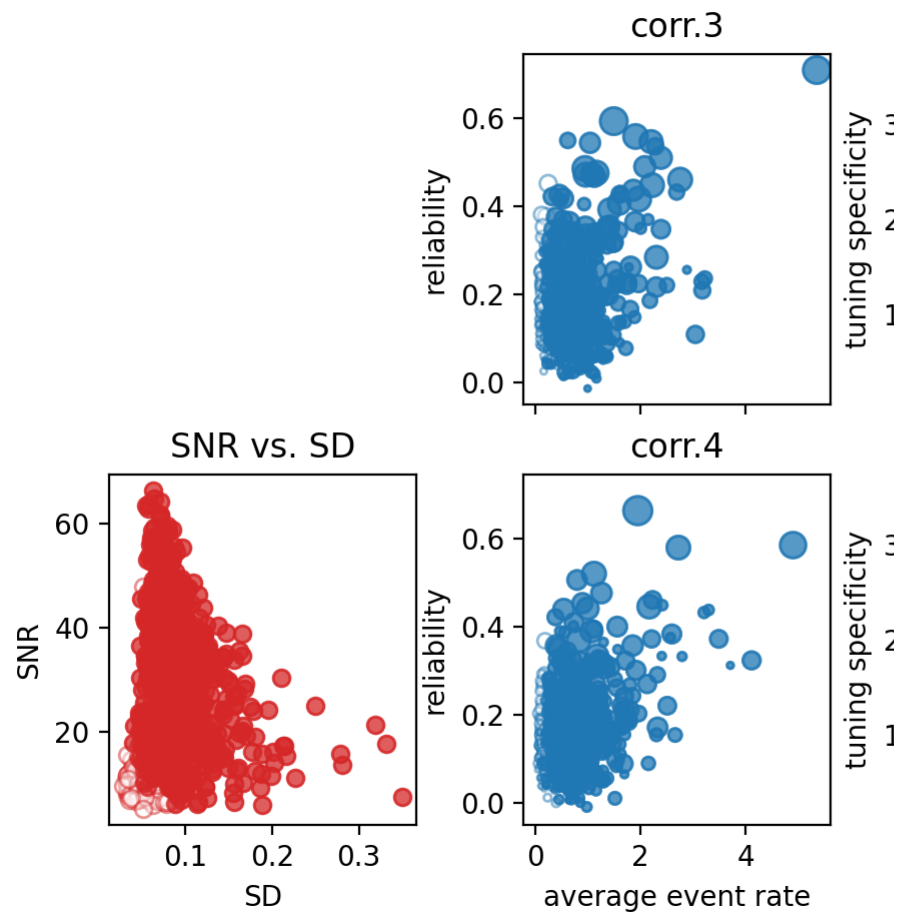


6. Plot the spatial properties of the neurons

```
In [7]: D1.plot_properties(cellids=cellids, interactive=False)
```



Figure 3



7. Calculate significance of tuning by shuffling the imaging data

```
In [8]: D1.calc_shuffle(cellids, 1000, 'shift', batchsize=50)
```

```
loading shuffling P-values from file...
```

```
0
```

```
1
```

```
selective cells: [ 3  5 15 16 23 26 29 33 34 35 36 56  
68 72 74 76 77 79  
82 84 85 87 88 89 93 95 107 115 122 125 126 141 143 144 1  
52 154  
158 160 162 166 168 172 182 187 191 195 211 213 217 221 223 224 2
```

```
In [13]: print(D1.tuned_cells)
```

[array([2,	5,	8,	9,	10,	12,	13,	14,	16,	1
9,	22,									
	23,	24,	26,	27,	28,	30,	31,	35,	36,	38,
40,		41,	42,	43,	45,	46,	47,	49,	51,	52,
65,										
	66,	68,	69,	70,	71,	72,	73,	76,	77,	78,
79,										
	80,	81,	85,	86,	87,	88,	89,	90,	92,	94,
95,										
	98,	99,	100,	103,	104,	107,	109,	110,	112,	115,
117,										
	119,	120,	121,	122,	125,	128,	132,	133,	134,	136,
137,										
	141,	142,	143,	144,	145,	147,	148,	149,	151,	152,
153,										
	154,	156,	157,	158,	159,	160,	161,	162,	163,	168,
170,										
	171,	172,	174,	175,	177,	178,	179,	185,	187,	189,
190,										
	191,	193,	194,	195,	198,	200,	201,	204,	208,	211,
212,										
	213,	215,	217,	220,	221,	223,	224,	226,	229,	231,
233,										
	234,	235,	236,	237,	239,	240,	241,	242,	243,	249,
252,										
	256,	259,	264,	265,	267,	269,	274,	276,	277,	278,
279,										
	280,	282,	285,	286,	289,	290,	291,	292,	293,	294,
296,										
	297,	300,	304,	307,	308,	310,	311,	313,	314,	315,
316,										
	319,	320,	323,	325,	326,	327,	329,	330,	331,	334,
335,										
	341,	343,	347,	349,	351,	352,	353,	357,	361,	363,
365,										
	366,	368,	370,	371,	373,	375,	376,	377,	379,	380,
385,										
	388,	389,	396,	397,	399,	401,	402,	406,	409,	410,
411,										
	412,	415,	418,	419,	422,	427,	429,	430,	433,	434,
435,										
	436,	439,	442,	443,	444,	446,	447,	449,	450,	451,
454,										
	455,	456,	461,	463,	464,	466,	468,	472,	476,	493,
494,										
	496,	499,	500,	501,	502,	504,	505,	508,	509,	511,
517,										
	518,	519,	521,	524,	525,	526,	528,	530,	531,	532,
533,										
	536,	540,	541,	542,	543,	544,	545,	546,	548,	549,
550,										
	556,	557,	558,	559,	562,	564,	569,	570,	573,	574,
579,										
	580,	581,	582,	585,	586,	589,	590,	592,	595,	599,
603,										
	608,	612,	613,	620,	624,	627,	628,	629,	630,	632,
633,										
	638,	643,	645,	648,	654,	656,	657,	670,	674,	676,
683,										


```

684, 686, 687, 689, 692, 693, 695, 696, 697, 699,
701,
702, 708, 709, 712, 713, 714, 716, 718, 731, 752,
753,
754, 762, 774, 776, 780, 783, 795, 804, 810, 818,
830,
844, 846, 851, 855, 856, 858, 861, 876, 884, 886,
888,
890, 892, 903, 909, 910, 913, 918, 932, 941, 947,
992,
1016, 1017]), array([ 0, 1, 2, 4, 7, 8,
9, 10, 11, 12, 13,
14, 15, 16, 19, 21, 22, 24, 26, 27, 28,
29,
30, 33, 35, 38, 40, 42, 44, 47, 49, 50,
51,
52, 54, 56, 58, 65, 70, 72, 74, 75, 76,
77,
78, 79, 80, 81, 82, 84, 85, 86, 89, 92,
93,
96, 98, 99, 102, 103, 104, 105, 106, 108, 109,
110,
112, 115, 117, 119, 120, 121, 122, 123, 124, 125,
126,
128, 131, 133, 134, 136, 137, 141, 142, 144, 147,
148,
150, 152, 154, 155, 156, 157, 158, 159, 160, 161,
166,
168, 169, 170, 171, 172, 176, 177, 178, 179, 180,
182,
183, 186, 187, 188, 189, 191, 193, 194, 195, 198,
199,
200, 201, 204, 207, 209, 211, 212, 213, 215, 220,

```

```
In [14]: print(len(cellids))
```

```
680
```

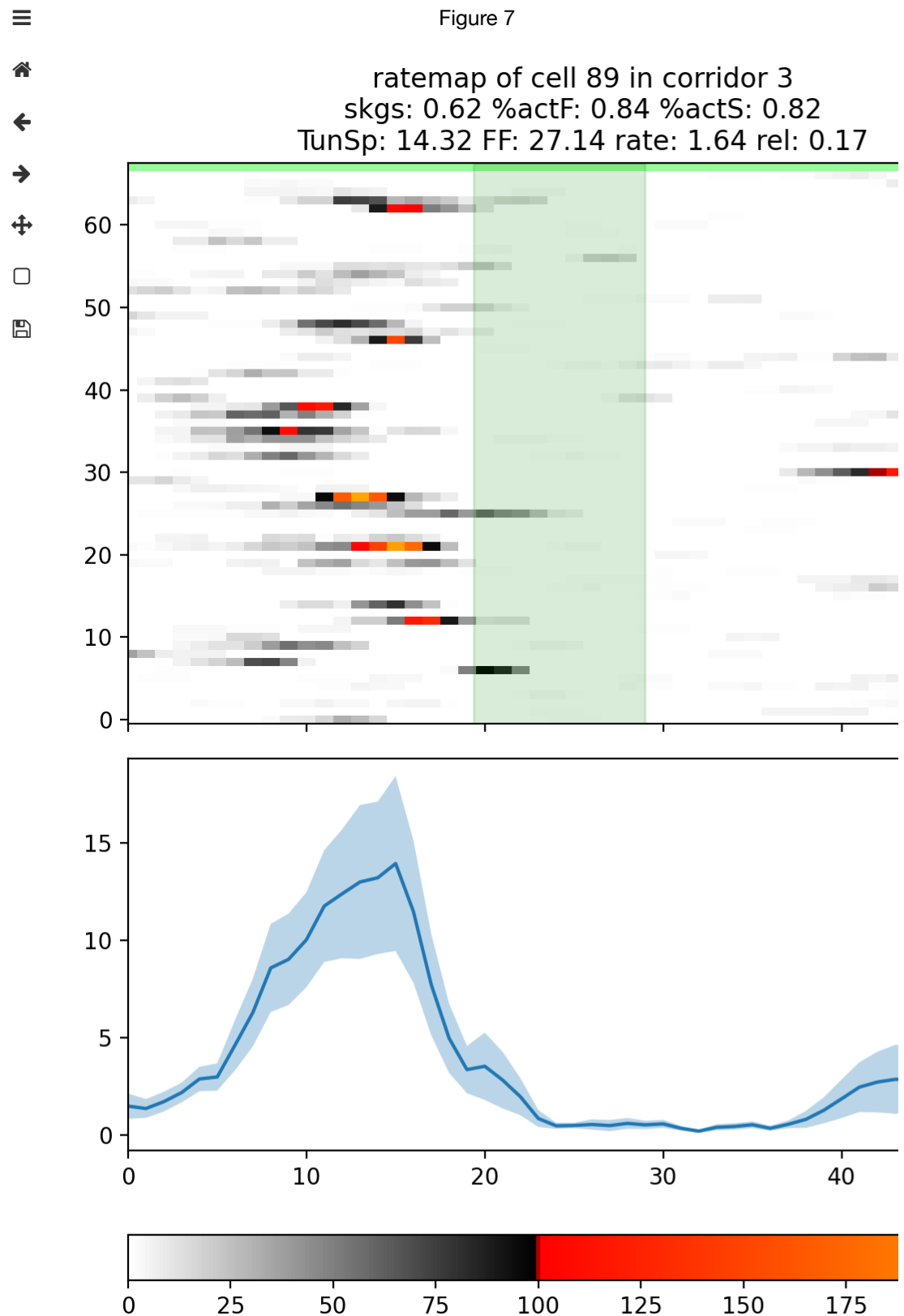
```
In [15]: print(D1.similar_cells)
```

```
[ 13  89 106 185 221 310 313 320 327 357 409 468 521 571 818 913]
```

8. Plot the activity lap by lap

We can also plot the lap by lap activity of a selected cell. Again, there are several options, but the simplest is to plot the rate as a function of position.

```
In [19]: D1.plot_cell_laps(cellid=89, signal='rate') ## look at lap 20
```



```
In [16]: D1.save_data()
```

Session parameters written into file: cell_properties_corridor_3_N1022.csv
cell properties for corridor 3 saved into file: /Users/ubi/Projects/KOKI/VR/MiceData/data/srb059_imaging/Suite2P_4_19-05-2021/analysed_data/cell_properties_corridor_3_N1022.csv
Session parameters written into file: cell_properties_corridor_4_N1022.csv
cell properties for corridor 4 saved into file: /Users/ubi/Projects/KOKI/VR/MiceData/data/srb059_imaging/Suite2P_4_19-05-2021/analysed_data/cell_properties_corridor_4_N1022.csv
Session parameters written into file: ratemaps_corridor_3_N1022.csv
ratemap for corridor 3 saved into file: /Users/ubi/Projects/KOKI/VR/MiceData/data/srb059_imaging/Suite2P_4_19-05-2021/analysed_data/ratemaps_corridor_3_N1022.csv
Session parameters written into file: ratemaps_corridor_4_N1022.csv
ratemap for corridor 4 saved into file: /Users/ubi/Projects/KOKI/VR/MiceData/data/srb059_imaging/Suite2P_4_19-05-2021/analysed_data/ratemaps_corridor_4_N1022.csv
Session parameters written into file: lapdata_lap_33_N1022.csv
Session parameters written into file: lapdata_lap_34_N1022.csv
Session parameters written into file: lapdata_lap_35_N1022.csv
Session parameters written into file: lapdata_lap_36_N1022.csv
Session parameters written into file: lapdata_lap_37_N1022.csv
Session parameters written into file: lapdata_lap_38_N1022.csv
Session parameters written into file: lapdata_lap_39_N1022.csv
Session parameters written into file: lapdata_lap_40_N1022.csv
Session parameters written into file: lapdata_lap_41_N1022.csv
Session parameters written into file: lapdata_lap_42_N1022.csv
Session parameters written into file: lapdata_lap_43_N1022.csv
Session parameters written into file: lapdata_lap_44_N1022.csv
Session parameters written into file: lapdata_lap_45_N1022.csv
Session parameters written into file: lapdata_lap_46_N1022.csv
Session parameters written into file: lapdata_lap_47_N1022.csv
Session parameters written into file: lapdata_lap_48_N1022.csv
Session parameters written into file: lapdata_lap_49_N1022.csv
Session parameters written into file: lapdata_lap_50_N1022.csv
Session parameters written into file: lapdata_lap_51_N1022.csv
Session parameters written into file: lapdata_lap_52_N1022.csv
Session parameters written into file: lapdata_lap_53_N1022.csv
Session parameters written into file: lapdata_lap_54_N1022.csv
Session parameters written into file: lapdata_lap_55_N1022.csv
Session parameters written into file: lapdata_lap_56_N1022.csv
Session parameters written into file: lapdata_lap_57_N1022.csv
Session parameters written into file: lapdata_lap_58_N1022.csv
Session parameters written into file: lapdata_lap_59_N1022.csv
Session parameters written into file: lapdata_lap_60_N1022.csv
Session parameters written into file: lapdata_lap_61_N1022.csv
Session parameters written into file: lapdata_lap_62_N1022.csv
Session parameters written into file: lapdata_lap_63_N1022.csv
Session parameters written into file: lapdata_lap_64_N1022.csv
Session parameters written into file: lapdata_lap_65_N1022.csv
Session parameters written into file: lapdata_lap_66_N1022.csv
Session parameters written into file: lapdata_lap_67_N1022.csv
Session parameters written into file: lapdata_lap_68_N1022.csv
Session parameters written into file: lapdata_lap_69_N1022.csv
Session parameters written into file: lapdata_lap_70_N1022.csv
Session parameters written into file: lapdata_lap_71_N1022.csv
Session parameters written into file: lapdata_lap_72_N1022.csv

[illegible]

```
Session parameters written into file: lapdata_lap_133_N1022.csv
Session parameters written into file: lapdata_lap_134_N1022.csv
Session parameters written into file: lapdata_lap_135_N1022.csv
Session parameters written into file: lapdata_lap_136_N1022.csv
Session parameters written into file: lapdata_lap_137_N1022.csv
Session parameters written into file: lapdata_lap_138_N1022.csv
Session parameters written into file: lapdata_lap_139_N1022.csv
Session parameters written into file: lapdata_lap_140_N1022.csv
Session parameters written into file: lapdata_lap_141_N1022.csv

Session parameters written into file: lapdata_lap_146_N1022.csv
Session parameters written into file: lapdata_lap_147_N1022.csv
Session parameters written into file: lapdata_lap_148_N1022.csv
Session parameters written into file: lapdata_lap_149_N1022.csv
Session parameters written into file: lapdata_lap_150_N1022.csv
Session parameters written into file: lapdata_lap_151_N1022.csv
Session parameters written into file: lapdata_lap_152_N1022.csv
Session parameters written into file: lapdata_lap_153_N1022.csv
Session parameters written into file: lapdata_lap_154_N1022.csv
Session parameters written into file: lapdata_lap_155_N1022.csv
Session parameters written into file: lapdata_lap_156_N1022.csv
Session parameters written into file: lapdata_lap_157_N1022.csv
Session parameters written into file: lapdata_lap_158_N1022.csv
Session parameters written into file: lapdata_lap_159_N1022.csv
Session parameters written into file: lapdata_lap_160_N1022.csv
Session parameters written into file: lapdata_lap_161_N1022.csv
Session parameters written into file: lapdata_lap_162_N1022.csv
Session parameters written into file: lapdata_lap_163_N1022.csv
Session parameters written into file: lapdata_lap_164_N1022.csv
Session parameters written into file: lapdata_lap_165_N1022.csv
Session parameters written into file: lapdata_lap_166_N1022.csv
Session parameters written into file: lapdata_lap_167_N1022.csv
lapdata saved into file: /Users/ubi/Projects/KOKI/VR/MiceData/data
/srb059_imaging/Suite2P_4_19-05-2021/analysed_data/lapdata_lap_167
_N1022.csv
```

In []: