# Data Synchronisation

The synchronisation is done by means of a TTL impulse timestamping the GPIO channel and a light bulb in the video camera field. Two separate TTLs channels were employed for safety reasons. The video recording and the miniscope recording start independently and are synchronised with the synchronous TTL timestamp on the GPIO channel/LED switch in the video frame.
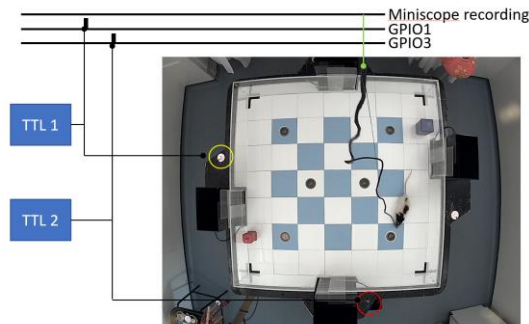
The resulting data is saved as follows:

Animal	Ego/Allo	Session	Stage	Vid Trial	Trial	Trial start	Time SW	Trial end	Trial durat	RW	Errors	Correctness	Vid LED time	GPIO time	Correction	Trial start corrected	Time SW corrected	Trial end corrected	Trial duration corrected
H2231	E	28	CHO	1	0	41	47	52	11	6	1	2	10.64	12.484	1.844	42.844	48.844	53.844	11
H2231	E	28	CHO	1	1	123	127	142	19	6	0	0	10.64	12.484	1.844	124.844	128.844	143.844	19
H2231	E	28	CHO	2	2	197	207	217	20	6	2	3	164.48	3.146	-161.334	35.666	45.666	55.666	20
H2231	E	28	CHO	2	3	280	290	300	20	6	1	2	164.48	3.146	-161.334	118.666	128.666	138.666	20
H2231	E	28	CHO	3	4	352	361	367	15	6	2	3	322.08	3.146	-318.934	33.066	42.066	48.066	15
H2231	E	28	CHO	3	5	434	441	447	13	6	0	0	322.08	3.146	-318.934	115.066	122.066	128.066	13
H2231	E	28	CHO	4	6	493	498	505	12	6	0	1	469.04	5.55	-463.49	29.51	34.51	41.51	12
H2231	E	28	CHO	4	7	575	581	590	15	6	1	1	469.04	5.55	-463.49	111.51	117.51	126.51	15
H2231	E	28	SAM	1	0	30	52	61	31	6	3	3	3.72	7.551	3.831	33.831	55.831	64.831	31
H2231	E	28	SAM	1	1	153	156	179	26	6	0	0	3.72	7.551	3.831	156.831	159.831	182.831	26
H2231	E	28	SAM	2	2	243	248	270	27	6	3	3	204	6.512	-197.488	45.512	50.512	72.512	27
H2231	E	28	SAM	2	3	323	325	368	45	6	0	0	204	6.512	-197.488	125.512	127.512	170.512	45
H2231	E	28	SAM	3	4	416	419	427	11	6	0	0	387.76	6.181	-381.579	34.421	37.421	45.421	11
H2231	E	28	SAM	3	5	486	488	528	42	6	1	1	387.76	6.181	-381.579	104.421	106.421	146.421	42
H2231	E	29	CHO	1	0	60	63	69	9	1	0	0	3.56	4.561	1.001	61.001	64.001	70.001	9
H2231	E	29	CHO	1	1	127	130	139	12	1	0	0	3.56	4.561	1.001	128.001	131.001	140.001	12
H2231	E	29	CHO	2	2	177	181	189	12	1	0	0	157.84	4.759	-153.081	23.919	27.919	35.919	12

Trial: trial number

Vid Trial: trial number in video (each video recording contains 2 trials)

Trial start: Start of the trial (animal moving out of startbox) as time in video

Time SW: Time where animal reached the sandwell

Trial End: Return to Starbox (video timestamp)

Vid LED time: Time where LED light connected to TTL1 is switched on.

GPIO time: Time when the TTL impulse is timestamped on the GPIO channel

Correction: GPIO/LED correction: the animal positions detected in video will be time shifted and aligned with calcium recording

Trial start corrected, Time SW corrected, Trial End corrected: same as above but aligned to calcium recording timeline

Example Data

This folder contain example data to run the Jupyter notebook files. Individual files are saved using the same Folder network structure so that the Home directory should be changed to "Example Data". Animal and Stage, and extra folders, should be modified following code annotation.

The following code is provided as Jupyter notebooks in Python.

The code can be run via Anaconda Navigator
(https://www.anaconda.com/products/navigator)

Place Cells.ipynb

This Jupyter notebook contains the code to calculate place cells map from aligned calcium and extracted video data. Mutual information and maps are calculated here.

Place Cells Remapping.ipynb

This Jupyter notebook contains code to calculate Place cells properties such as stability (to evaluate remapping) and direction dependency.

Trial_identification paper.ipynb

This Jupyter notebook contains code for the automatic identification of trial starts from animal coordinates.

Startbox activity Export.ipynb

This Jupyter notebook contains code to export the information content of cells active in the startbox in the 10s prior to trial start.

Common SB cells.ipynb

This Jupyter notebook contains code to calculate the fraction of common cells across startboxes before trial start.

arena.py and **place_cells.py** contain functions used in the Jupyter notebooks.

Our code design saves intermediate steps as data tables in csv format that are then read by separate Jupyter notebooks for later analysis. Data are grouped by animal for convenience. in ALL_META.csv . Below are an example that describse the format.

ALL_META.csv

This table is generated by concatenation of all trials after automatic trial identification and quality check. Each animal has an individual table

Rewarded TRIALS	Trial	Trial Start	Trial Status	Location	LED_frame	Tone (s)	Combo	cap_x	cap_y	leftear_x	leftear_y	rightear_x	rightear_y	tailbase_x	tailbase_y	Speed	Movement	Time (s)	Session	Stage	C000	C001	C002	C003	C004	C005
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0.049999	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0.099998	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0.149997	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0.199996	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0.249995	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-169	477	-169	477	-169	477	200	650	0	stationary	0.299994	A28	SAM1	0	0	0	0	0	0

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6	1	1 W	Correct	SB	0	[20.417, 4	WN	-12.4619	428.3082	-11.5576	419.7545	-23.5908	427.8959	334.7202	573.4357	1.143256	stationary	35.54929	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-12.3725	427.8604	-11.4954	419.349	-23.64	427.8125	334.8058	573.0846	1.078312	stationary	35.59929	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-12.4922	427.2234	-12.5777	418.9374	-23.4816	427.3873	334.8914	572.7336	0.988079	stationary	35.64929	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-12.2283	427.2165	-12.3015	418.9862	-23.1319	427.2661	334.9485	572.4996	0.941941	stationary	35.69929	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	SB	0	[20.417, 4	WN	-11.9799	427.4153	-12.0982	419.2152	-22.9621	427.6027	335.0055	572.2656	0.93405	stationary	35.74929	A28	SAM1	0	0	0	0	0	0
6	1	1 W	Correct	Trial start	0	[20.417, 4	WN	-12.3382	426.6899	-12.319	418.2986	-22.6743	426.3849	335.0911	571.9146	0.958036	stationary	35.79928	A28	SAM1	0	0	0	0	0	0

Trial Start: Starting startbox

Trial Status: Automatic classification of correct of incorrect trials based on trajectory

Location: Position of animal in that time frame; SB = startbox. Trial start: start of the trial. Outbound: animal traveling to sandwell

LED_frame: synchronising LED status

Combo: use of startboxes in trial (start/end)

Cap_x, …. Tailbase_y: x and y coordinates of animal body parts (head, ears, tail) after correction and translation.

Speed: movement speed

Movement: classification as moving or stationary

Time (s) : time

Session: Session type and number

Stage: SAM or CHO trial

C000…. Event vector of cells; 0: no events, non-zero value: event amplitude (note: events are binarized in analysis