

M13Rec001, signature b456870e

Recording

Mouse heart, spiral wave and optogenetic termination. 64 × 55 px, 9,267 frames, 1 kHz, 133 μm/px, deposit checks: negative values, nan mask all frames, temporal smoothing, spatial smoothing. Source 10.5281/zenodo.10228296; publication 10.1371/journal.pcbi.1011660; licence CC-BY-4.0; Hussaini, Sayedeh; Luther, Stefan; Lädke, Sarah L.. sha256 3f8f2e1b8f776633089b33ccd4bf3fccb4f13140b71991f1dcd0e0a12bb48cbc.

Run

c0c30a22-bf69-424a-8a7c-76e8fbac530d, 2026-10-27 23:30 UTC to 2026-10-27 23:35 UTC, status done. Protocol Mouse whole heart optical mapping (Luther lab), parameters v3 set by developer (not a domain scientist). Code 905d5bebbb29da7ad46cd5045db14330695037c3 (clean), None workers.

Methods

Recording Mouse heart, spiral wave and optogenetic termination (M13Rec001) (doi:10.5281/zenodo.10228296; 64x55 px, 9267 frames, 1000 Hz) was analysed over frames 500-8767. Deposit shows signs of prior processing (provisional): negative values, non integer, nan mask all frames, temporal smoothing, spatial smoothing. Each pixel was baseline-corrected by subtracting a 901-frame centered moving average; NaN pixels were set to zero. Dye polarity (inverted) was taken from the sign of the median per-pixel skew of dV/dt. For phase only, each frame was spatially filtered with a Gaussian (sigma 1.0 px, truncated at 4.0 sigma); no temporal low-pass was applied. Phase was the angle of the Hilbert transform with 500 frames of padding on each side. Phase singularities were plaquettes with |winding| > 0.9 turns at least 3 px inside the tissue edge; they were tracked across frames (same charge, <= 4.0 px per frame, gaps <= 5 frames), and a persistent rotor was a track lasting >= 52 frames (1 cycle(s) of the fastest segment) within 3.0 px of an opposite-charge singularity in no more than 50% of its frames. Acquisition log (LED trigger channel, provisional interpretation): illumination on over frames 500-4977 of the analysed frames 500-8767. Segments (provisional, project lead (not a domain scientist), following the paper's design): illumination with arrhythmia frames 500-3170 (expected persistent rotors: present); illumination after termination frames 3170-4977 (expected persistent rotors: absent); light off frames 4977-8767 (expected persistent rotors: absent). Sensitivity: baseline 2712, 1356, 678, 901 frames x sigma 0.5, 1.0, 2.0 px, and tracker variants. singularities: across filters holds (provisional). persistent rotors: across filters holds (provisional); across trackers holds (provisional). persistent rotors fraction superseded: across filters does not hold (provisional); across trackers does not hold (provisional). All thresholds and criteria are provisional pending review by a domain scientist.

Verdict

Verdict: report only the stable, provisional signature components; physiology_ok is null because the only cited-range check, illuminated_arrhythmia.dominant_freq_hz, is unstable across baseline windows (15.356-19.85 Hz) and therefore not reportable as a single value, even though the same-study context gives approximately 18.75-20.0 Hz and a checked range of 14.0625-25.0 Hz (DOI 10.1371/journal.pcbi.1011660). Reportable with caveats: stable absence of persistent rotors in light_off and illuminated_after_termination (0 across filter and tracker variants), stable light_off and illuminated_after_termination dominant frequencies of 2.375 Hz and 2.214 Hz without cited ranges, and stable illuminated_arrhythmia singularity-frame fraction as a range of 0.3816479400749064-0.48801498127340825 without a cited range; unstable and not reportable as single values are light_off.singularity_frames_frac (0.0029023746701846965-0.02955145118733509), illuminated_arrhythmia.persistent_rotors and persistent_rotor_tracks (4.0-15.0), illuminated_arrhythmia.persistent_rotor_count_max (1.0-2.0), illuminated_arrhythmia.dominant_freq_hz (15.356-19.85 Hz), and illuminated_after_termination.singularity_frames_frac (0.0005534034311012728-0.014941892639734366). The persistent-rotor rule itself holds under both min_frames 52 and min_frames 50, and strict/default/loose tracker rule verdicts agree even though counts differ; review the processed-data status, frame 3170 event interpretation, baseline/illumination artifact, and provisional thresholds. The ranges, the stability threshold and the criteria are provisional.

physiology_ok: None; send back: False. Reviewer sign-off: pending.

Parameters (as run)

```
% Mouse whole heart optical mapping (Luther lab), v3, read-only
% set by developer (not a domain scientist); provisional, REVIEW_NEEDED 16
baseline_frames = 901;      % >= 2 x slowest cycle (415, MAP): ok
pad_frames      = 500;      % each side, outside the window
spatial_sigma   = 1.0;      % px, Gaussian, phase only
spatial_truncate = 4.0;      % kernel radius, sigma
lowpass         = [];       % none
polarity        = -1;       % measured, skew of dV/dt
rotor_threshold = 0.9;      % turns, |winding| per plaquette
rotor_erode_px  = 3;        % px from tissue edge ignored
link_px         = 4.0;      % tracking, max step per frame
max_gap         = 5;        % frames a track may vanish
min_cycles      = 1.0;      % own rotations, min_frames = 52
pair_dist_px    = 3.0;      % opposite-charge pairing
paired_frac     = 0.5;      % max paired fraction of a track
render_step     = 4;        % movie only
```

Segments

Segment	Defined	Analysed	Cycle, frames	Expected rotors	Bounded by
Illumination with arrhythmia	0-3,170	500-3,170	52 (n = 53)	present	LED on before frame 0 (DAQ) → termination step (image, ±17 frames)
Illumination after termination	3,170-4,977	3,170-4,977	415 (n = 4)	absent	termination step (image, ±17 frames) → illumination off (DAQ, ±11 frames)
Light off	4,977-9,267	4,977-8,767	411 (n = 10)	absent	illumination off (DAQ, ±11 frames) → recording end

Metrics

Metric	Unit	Illumination with arrhythmia	Illumination after termination	Light off	Physiological range
Rhythm					
Dominant frequency	Hz	15.356-19.850 (unstable)	2.214	2.375	18.75-20 Hz, one recording provisional
Rotors					
Persistent rotors	count	4-15 (unstable)	0	0	none cited
Max concurrent persistent rotors	count	1-2 (unstable)	0	0	none cited
Frames with a singularity	fraction	0.479	0.001-0.015 (unstable)	0.003-0.030 (unstable)	none cited
Beats, where a global rhythm exists					
Beats	count	57	4	9	none cited
Global amplitude ratio	ratio	0.72	0.95	0.95	gate ≥ 0.30 provisional
APD50	ms	14	16	16	none cited
APD90	ms	25	76	75	none cited
Conduction velocity	cm/s	31.3	58.5	60.0	none cited

Criteria and reportable values

Item	Rule or segment	Result
Singularities present where the design expects them, absent elsewhere	each 'present' segment: $\text{frac} \geq 0.1$ and $\geq 2.0 \times \text{max frac}$ over 'absent' segments, at every setting	holds at 12 filter settings (provisional)
Persistent rotors present where the design expects them, absent elsewhere	each 'present' segment: $\text{count} \geq 1$; each 'absent' segment: $\text{count} \leq 0$, at every setting	holds at 12 filter settings and 3 trackers (provisional)
Persistence threshold, paper context	lifetime ≥ 52 frames (measured cycle) and ≥ 50 frames (cited agree (provisional) 20 Hz)	
persistent rotor tracks	all	4–15 count, unstable, not reportable
dominant freq (Hz)	light off	2.375 Hz, no cited range
persistent rotors	light off	0 count, no cited range
singularity frames fraction	light off	0.0029–0.0296 fraction of frames, unstable, not reportable
persistent rotor count max	light off	0 count, no cited range
dominant freq (Hz)	illuminated arrhythmia	15.4–19.9 Hz, unstable, not reportable
persistent rotors	illuminated arrhythmia	4–15 count, unstable, not reportable
dominant freq (Hz)	illuminated after termination	2.214 Hz, no cited range
singularity frames fraction	illuminated arrhythmia	0.479 fraction of frames, no cited range
persistent rotors	illuminated after termination	0 count, no cited range
persistent rotor count max	illuminated arrhythmia	1–2 count, unstable, not reportable
singularity frames fraction	illuminated after termination	0.000553–0.0149 fraction of frames, unstable, not reportable
persistent rotor count max	illuminated after termination	0 count, no cited range

Provisional rules behind this signature

Rule	Description	Expert	Status
protocol_parameter_set worker/voltage/protocol_params.py (developer_defaults, set_params)	Each protocol's fixed, versioned analysis parameters (version 1 = developer defaults); no run or agent may deviate	optical mapping analyst	provisional
baseline_window_rule worker/voltage/baseline_rule.py (FACTOR, evaluate)	A run proceeds only if the protocol's baseline window is $\geq 2 \times$ the slowest segment's cycle, the cycle from the MAP channel when a DAQ log exists, else from per-pixel dominant frequency on linearly detrended pixels; otherwise the run is held by code	optical mapping analyst	provisional
filter_defaults worker/voltage/preprocess.py (Params)	Default baseline window (frames) and spatial Gaussian sigma/truncate for phase	optical mapping analyst (cardiac electrophysiology)	provisional
tissue_mask worker/voltage/io.py (tissue_mask)	Tissue = not NaN in frame 0 and nonzero temporal std	optical mapping analyst	provisional
polarity worker/voltage/preprocess.py (polarity)	Dye polarity from sign of median per-pixel skew of dV/dt	optical mapping analyst / voltage dye chemist	provisional
singularity_detection worker/voltage/preprocess.py (Params.rotor_threshold, rotor_erode_px)	Phase singularity = $ winding > \text{threshold turns}$, $\geq$ erode px from tissue edge	computational cardiac electrophysiologist (phase mapping)	provisional
rotor_persistence worker/voltage/rotors.py (TrackParams)	Track linking distance/gap and minimum lifetime for a persistent rotor	computational cardiac electrophysiologist (phase mapping)	provisional
chirality_pairing worker/voltage/rotors.py (TrackParams.pair_dist_px, paired_frac)	Opposite-charge singularities within pair distance are a pair; tracks paired most of their life are excluded from rotors	computational cardiac electrophysiologist (phase mapping)	provisional
sensitivity_grid worker/voltage/sensitivity.py (SIGMAS, BASELINE_MULTIPLES, baseline_levels)	Filter levels tested: spatial sigma and baseline window values	optical mapping analyst	provisional
analysis_window worker/voltage/runs.py (default_window)	Frames analysed: whole recording minus one filter pad at each end (unless the plan narrows it)	cardiac electrophysiologist familiar with the dataset	provisional
prior_processing_flags worker/voltage/inspect.py (prior_processing)	Thresholds for flagging depositor processing (normalization, masking, temporal/spatial smoothing)	imaging scientist (camera acquisition and noise)	provisional
baseline_step_detection worker/voltage/events.py (detect_baseline_step)	Baseline step = consensus upward step in tissue-mean raw baseline (cause not inferred; first misread as light onset, contradicted by the DAQ)	optical mapping experimentalist	provisional

Provisional rules behind this signature

Rule	Description	Expert	Status
daq_interpretation worker/voltage/daq.py	DAQ channel names from depositor notebook; frames = first N triggers of closest burst; midpoint thresholds	experimentalist who recorded the data (or the depositor)	provisional
segment_definitions worker/voltage/annotations.py (MOUSE_SEGMENTS)	Mouse segments bounded by DAQ light events and the baseline step, interpreted as spiral termination under illumination (project lead, from Hussaini et al. 2023)	cardiac electrophysiologist (ideally the depositing authors)	provisional
rotor_finding_criterion worker/voltage/sensitivity.py (MIN_FRAC, MIN_RATIO)	Singularity before/after finding holds if $\text{frac}(\text{before}) \geq \text{min_frac}$ and $\geq \text{min_ratio} \times \text{frac}(\text{after})$ at every setting (also kept, superseded, for persistent rotors)	cardiac electrophysiologist + biostatistician	provisional
persistent_rotor_criterion worker/voltage/sensitivity.py (MIN_ROTORS_PRESENT, MAX_ROTORS_ABSENT)	Persistent-rotor finding holds if every 'present' segment has ≥ 1 persistent rotor and every 'absent' segment has none, at every setting	cardiac electrophysiologist	provisional
physiology_reference_rates worker/voltage/physiology.py (RANGES, TOLERANCE_FRAC)	Cited physiological ranges (single-study values widened by a 25% tolerance), applied to segments by their expected rhythm; used by the critic and for frame-rate sanity checks	cardiac electrophysiologist per species	provisional
stability_rule worker/agents/critic.py (STABLE_FRAC, stability)	A metric is reportable only if its spread across all sensitivity settings is $\leq 25\%$ of its median (zero spread when all values are 0); otherwise 'unstable, not reportable'	biostatistician + optical mapping analyst	provisional
persistence_threshold_variants worker/agents/critic.py (persistence_variants)	The persistent-rotor rule is run at two lifetimes, one measured cycle of the fastest segment and the paper's cited rotation period; both verdicts stored, disagreement flagged	computational cardiac electrophysiologist (phase mapping)	provisional

Review items

Topic	Detail	Severity
unstable:light_off.singularity_frames_frac	Review the filter sensitivity before reporting the light_off singularity-frame fraction; use only the range 0.0029023746701846965-0.02955145118733509 for review, not a single value.	warn
unstable:illuminated_arrhythmia.persistent_rotors	Review rotor tracking/count sensitivity; the illuminated_arrhythmia persistent-rotor count spans 4.0-15.0 and is not reportable as a single count.	warn
unstable:illuminated_arrhythmia.persistent_rotor_count_max	Review concurrent rotor-count sensitivity; the maximum concurrent count spans 1.0-2.0 and should not be reported as a single value.	warn
unstable:illuminated_arrhythmia.dominant_freq_hz	Review baseline-window dependence of the illuminated_arrhythmia frequency; it spans 15.356-19.85 Hz and is not reportable as a single value despite cited same-study context (DOI 10.1371/journal.pcbi.1011660).	warn
unstable:illuminated_after_termination.singularity_frames_frac	Review filter sensitivity before reporting the after-termination singularity-frame fraction; use only the range 0.0005534034311012728-0.014941892639734366 for review.	warn
unstable:persistent_rotor_tracks	Review persistent-track counting sensitivity; total persistent tracks span 4.0-15.0 and are not reportable as a single value.	warn
Pre-deposit processing / raw-data label	The README labels M13Rec001 as raw experimental data, but notebook and measurement flags indicate masking, spatial smoothing, temporal smoothing, and normalization; avoid analyses that require raw photon counts or independent pixel noise if treated as raw camera data.	warn
Event interpretation at frame 3170	Frame 3170 is a baseline_step only; illumination began before frame 0 and ended at frame 4977, so frame 3170 should not be treated as light onset. The stored spiral-termination label is provisional.	warn
Baseline and illumination artifact	Blue stimulation light crosstalk, re-normalization by stimulation light signal, a large slow baseline range, and a baseline step can affect absolute baseline or amplitude analyses.	warn
Provisional tool thresholds	Event detection, processing flags, SNR, rhythm, reference-rate thresholds, the stability threshold, and criteria are provisional and should be checked for critical analyses.	info

Provenance

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monophasic action potential (MAP) signal (in black) before, during, and after illumination.
It shows the sinus rhythm returns after 3190 ms of illumination. Fig 2D presents a closer
look at the MAP signal of the heart during the last few rotations of arrhythmia and the
first few action potentials of sinus rhythm. Fig 2E illustrates a"
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monophasic action potential (MAP) signal (in black) before, during, and after illumination.
It shows the sinus rhythm returns after 3190 ms of illumination. Fig 2D presents a closer
look at the MAP signal of the heart during the last few rotations of arrhythmia and the
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monophasic action potential (MAP) signal (in black) before, during, and after illumination.
It shows the sinus rhythm returns after 3190 ms of illumination. Fig 2D presents a closer
look at the MAP signal of the heart during the last few rotations of arrhythmia and the
first few action potentials of sinus rhythm. Fig 2E illustrates a"
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  "kind": "publication",
  "note": "Camera frames are 64 x 64 in the paper; the deposit is 64 x 55 (cropped).
Consistent with the DAQ: 10 samples per frame and a 5 s light pulse spanning 50,001 samples
imply a 10 kHz DAQ.",
  "quote": " 775  $\mu\text{W}$  70nm bandpass filter (FF01 $\mu\text{W}$ /140-25, Semrock) and finally
by the camera (EMCCD, Cascade 128+, Photometrics) with a spatial resolution of 64  $\times$  64
pixels (133  $\mu\text{m}$  per pixel) at 1 kHz. Optical Mapping recordings were acquired with
software MultiRecorder and analysed with software PythonAnalyser (both developed by Research
Group Biomedical Physics). Electrical s",
  "section": "Materials and methods: Optical mapping experiments on ventricular
arrhythmia and its termination in the intact mouse heart"
},
"segment_cycles_frames": {
  "light_off": 421,
  "illuminated_arrhythmia": 52,
  "illuminated_after_termination": 452
}
},
"lowpass": null,
"polarity": -1,
"tracking": {
  "link_px": 4.0,
  "max_gap": 5,
  "min_cycles": 1.0,
  "min_frames": 52,
  "paired_frac": 0.5,
  "pair_dist_px": 3.0
},
"pad_frames": 500,
"phase_method": "angle of scipy.signal.hilbert along time, on spatially filtered signal",

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    "spatial_sigma": 1.0,
    "rotor_erode_px": 3,
    "spatial_method": "scipy.ndimage.gaussian_filter per frame, mode=reflect; NaN set to 0
before filtering, non-tissue zeroed after",
    "baseline_frames": 901,
    "baseline_method": "scipy.ndimage.uniform_filter1d, mode=reflect, subtracted per pixel",
    "polarity_method": "sign of median per-pixel skew of dV/dt on baseline-corrected signal",
    "rotor_threshold": 0.9,
    "spatial_truncate": 4.0,
    "spatial_applies_to": "phase/activation only; displayed voltage is baseline-corrected
only"
},
"criteria_status": {
    "note": null,
    "rules": [
        {
            "id": "protocol_parameter_set",
            "expert": "optical mapping analyst",
            "status": "provisional",
            "values": {
                "set_by": "developer (not a domain scientist)",
                "protocol": "Mouse whole heart optical mapping (Luther lab)",
                "protocol_id": "f65d786f-f194-4be2-88b8-10d3dd25d674",
                "params_version": 3
            },
            "decision": null,
            "location": "worker/voltage/protocol_params.py (developer_defaults, set_params)",
            "reviewed": false,
            "reviewer": null,
            "description": "Each protocol's fixed, versioned analysis parameters (version 1 =
developer defaults); no run or agent may deviate",
            "reviewed_at": null
        },
        {
            "id": "baseline_window_rule",
            "expert": "optical mapping analyst",
            "status": "provisional",
            "values": {
                "ok": true,
                "factor": 2.0,
                "source": "MAP channel (DAQ log)",
                "required_min_frames": 830,
                "slowest_cycle_frames": 415
            },
            "decision": null,
            "location": "worker/voltage/baseline_rule.py (FACTOR, evaluate)",
            "reviewed": false,
            "reviewer": null,
            "description": "A run proceeds only if the protocol's baseline window is >= 2x the
slowest segment's cycle, the cycle from the MAP channel when a DAQ log exists, else from
per-pixel dominant frequency on linearly detrended pixels; otherwise the run is held by
code",
            "reviewed_at": null
        },
    ],

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{
  "id": "filter_defaults",
  "expert": "optical mapping analyst (cardiac electrophysiology)",
  "status": "provisional",
  "values": {
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    "baseline_frames": 901,
    "spatial_truncate": 4.0
  },
  "decision": null,
  "location": "worker/voltage/preprocess.py (Params)",
  "reviewed": false,
  "reviewer": null,
  "description": "Default baseline window (frames) and spatial Gaussian sigma/truncate
for phase",
  "reviewed_at": null
},
{
  "id": "tissue_mask",
  "expert": "optical mapping analyst",
  "status": "provisional",
  "values": {
    "rule": "not NaN in frame 0 and nonzero std",
    "tissue_pixels": 2332
  },
  "decision": null,
  "location": "worker/voltage/io.py (tissue_mask)",
  "reviewed": false,
  "reviewer": null,
  "description": "Tissue = not NaN in frame 0 and nonzero temporal std",
  "reviewed_at": null
},
{
  "id": "polarity",
  "expert": "optical mapping analyst / voltage dye chemist",
  "status": "provisional",
  "values": {
    "method": "median skew of dV/dt",
    "result": -1
  },
  "decision": null,
  "location": "worker/voltage/preprocess.py (polarity)",
  "reviewed": false,
  "reviewer": null,
  "description": "Dye polarity from sign of median per-pixel skew of dV/dt",
  "reviewed_at": null
},
{
  "id": "singularity_detection",
  "expert": "computational cardiac electrophysiologist (phase mapping)",
  "status": "provisional",
  "values": {
    "rotor_erode_px": 3,

```

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    "rotor_threshold": 0.9
  },
  "decision": null,
  "location": "worker/voltage/preprocess.py (Params.rotor_threshold, rotor_erode_px)",
  "reviewed": false,
  "reviewer": null,
  "description": "Phase singularity = |winding| > threshold turns, >= erode px from
tissue edge",
  "reviewed_at": null
},
{
  "id": "rotor_persistence",
  "expert": "computational cardiac electrophysiologist (phase mapping)",
  "status": "provisional",
  "values": {
    "link_px": 4.0,
    "max_gap": 5,
    "min_cycles": 1.0,
    "min_frames": 52
  },
  "decision": null,
  "location": "worker/voltage/rotors.py (TrackParams)",
  "reviewed": false,
  "reviewer": null,
  "description": "Track linking distance/gap and minimum lifetime for a persistent
rotor",
  "reviewed_at": null
},
{
  "id": "chirality_pairing",
  "expert": "computational cardiac electrophysiologist (phase mapping)",
  "status": "provisional",
  "values": {
    "paired_frac": 0.5,
    "pair_dist_px": 3.0
  },
  "decision": null,
  "location": "worker/voltage/rotors.py (TrackParams.pair_dist_px, paired_frac)",
  "reviewed": false,
  "reviewer": null,
  "description": "Opposite-charge singularities within pair distance are a pair; tracks
paired most of their life are excluded from rotors",
  "reviewed_at": null
},
{
  "id": "sensitivity_grid",
  "expert": "optical mapping analyst",
  "status": "provisional",
  "values": {
    "sigmas": {
      "light": 0.5,
      "default": 1.0,
      "heavier": 2.0
    }
  },

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"trackers": {
  "loose": [
    6.0,
    10
  ],
  "strict": [
    2.0,
    1
  ],
  "default": [
    4.0,
    5
  ]
},
"baselines": {
  "run": 901,
  "3x_cycle": 1356,
  "6x_cycle": 2712,
  "1.5x_cycle": 678
}
},
"decision": null,
"location": "worker/voltage/sensitivity.py (SIGMAS, BASELINE_MULTIPLES,
baseline_levels)",
"reviewed": false,
"reviewer": null,
"description": "Filter levels tested: spatial sigma and baseline window values",
"reviewed_at": null
},
{
  "id": "analysis_window",
  "expert": "cardiac electrophysiologist familiar with the dataset",
  "status": "provisional",
  "values": {
    "f0": 500,
    "f1": 8767
  },
  "decision": null,
  "location": "worker/voltage/runs.py (default_window)",
  "reviewed": false,
  "reviewer": null,
  "description": "Frames analysed: whole recording minus one filter pad at each end
(unless the plan narrows it)",
  "reviewed_at": null
},
{
  "id": "prior_processing_flags",
  "expert": "imaging scientist (camera acquisition and noise)",
  "status": "provisional",
  "values": {
    "flags": [
      "negative_values",
      "non_integer",
      "nan_mask_all_frames",

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    "temporal_smoothing",
    "spatial_smoothing"
  ],
  "thresholds": {
    "int_frac": 0.5,
    "neg_frac": 0.01,
    "dv_autocorr": 0.5,
    "neighbour_corr": 0.8
  }
},
"decision": null,
"location": "worker/voltage/inspect.py (prior_processing)",
"reviewed": false,
"reviewer": null,
"description": "Thresholds for flagging depositor processing (normalization, masking,
temporal/spatial smoothing)",
"reviewed_at": null
},
{
  "id": "baseline_step_detection",
  "expert": "optical mapping experimentalist",
  "status": "provisional",
  "values": {
    "frames": [
      3170
    ]
  },
  "decision": null,
  "location": "worker/voltage/events.py (detect_baseline_step)",
  "reviewed": false,
  "reviewer": null,
  "description": "Baseline step = consensus upward step in tissue-mean raw baseline
(cause not inferred; first misread as light onset, contradicted by the DAQ)",
  "reviewed_at": null
},
{
  "id": "daq_interpretation",
  "expert": "experimentalist who recorded the data (or the depositor)",
  "status": "provisional",
  "values": {
    "events": [
      "illumination_on@0",
      "arrhythmia_termination@3153",
      "illumination_off@4977"
    ]
  },
  "decision": null,
  "location": "worker/voltage/daq.py",
  "reviewed": false,
  "reviewer": null,
  "description": "DAQ channel names from depositor notebook; frames = first N triggers of
closest burst; midpoint thresholds",
  "reviewed_at": null
},

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{
  "id": "segment_definitions",
  "expert": "cardiac electrophysiologist (ideally the depositing authors)",
  "status": "provisional",
  "values": {
    "light_off": [
      4977,
      9267
    ],
    "illuminated_arrhythmia": [
      0,
      3170
    ],
    "illuminated_after_termination": [
      3170,
      4977
    ]
  },
  "decision": null,
  "location": "worker/voltage/annotations.py (MOUSE_SEGMENTS)",
  "reviewed": false,
  "reviewer": null,
  "description": "Mouse segments bounded by DAQ light events and the baseline step,
interpreted as spiral termination under illumination (project lead, from Hussaini et al.
2023)",
  "reviewed_at": null
},
{
  "id": "rotor_finding_criterion",
  "expert": "cardiac electrophysiologist + biostatistician",
  "status": "provisional",
  "values": {
    "min_frac": 0.1,
    "min_ratio": 2.0
  },
  "decision": null,
  "location": "worker/voltage/sensitivity.py (MIN_FRAC, MIN_RATIO)",
  "reviewed": false,
  "reviewer": null,
  "description": "Singularity before/after finding holds if frac(before) >= min_frac and
>= min_ratio x frac(after) at every setting (also kept, superseded, for persistent rotors)",
  "reviewed_at": null
},
{
  "id": "persistent_rotor_criterion",
  "expert": "cardiac electrophysiologist",
  "status": "provisional",
  "values": {
    "expect": {
      "light_off": "absent",
      "illuminated_arrhythmia": "present",
      "illuminated_after_termination": "absent"
    },
    "max_absent": 0,

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    "min_present": 1,
    "spanning_rotor": "counts in every segment it overlaps",
    "min_lifetime_frames": 52
},
"decision": null,
"location": "worker/voltage/sensitivity.py (MIN_ROTORS_PRESENT, MAX_ROTORS_ABSENT)",
"reviewed": false,
"reviewer": null,
"description": "Persistent-rotor finding holds if every 'present' segment has >= 1
persistent rotor and every 'absent' segment has none, at every setting",
"reviewed_at": null
},
{
    "id": "physiology_reference_rates",
    "expert": "cardiac electrophysiologist per species",
    "status": "provisional",
    "values": {
        "ranges": [
            "mouse_spiral_rotation_hz"
        ],
        "tolerance_frac": 0.25,
        "segment_rhythm_rule": "expected persistent rotors 'present' -> spiral arrhythmia"
    },
    "decision": null,
    "location": "worker/voltage/physiology.py (RANGES, TOLERANCE_FRAC)",
    "reviewed": false,
    "reviewer": null,
    "description": "Cited physiological ranges (single-study values widened by a 25%
tolerance), applied to segments by their expected rhythm; used by the critic and for frame-
rate sanity checks",
    "reviewed_at": null
},
{
    "id": "stability_rule",
    "expert": "biostatistician + optical mapping analyst",
    "status": "provisional",
    "values": {
        "unstable": [
            "light_off.singularity_frames_frac",
            "illuminated_arrhythmia.persistent_rotors",
            "illuminated_arrhythmia.persistent_rotor_count_max",
            "illuminated_arrhythmia.dominant_freq_hz",
            "illuminated_after_termination.singularity_frames_frac",
            "persistent_rotor_tracks"
        ],
        "stable_frac": 0.25
    },
    "decision": null,
    "location": "worker/agents/critic.py (STABLE_FRAC, stability)",
    "reviewed": false,
    "reviewer": null,
    "description": "A metric is reportable only if its spread across all sensitivity
settings is <= 25% of its median (zero spread when all values are 0); otherwise 'unstable,
not reportable'",

```

```

    "reviewed_at": null
  },
  {
    "id": "persistence_threshold_variants",
    "expert": "computational cardiac electrophysiologist (phase mapping)",
    "status": "provisional",
    "values": {
      "measured_cycle": 52,
      "paper_rotation": 50
    },
    "decision": null,
    "location": "worker/agents/critic.py (persistence_variants)",
    "reviewed": false,
    "reviewer": null,
    "description": "The persistent-rotor rule is run at two lifetimes, one measured cycle
of the fastest segment and the paper's cited rotation period; both verdicts stored,
disagreement flagged",
    "reviewed_at": null
  }
],
"status": "provisional",
"all_reviewed": false,
"superseded_by_run": null
}
},
"segments": [
{
  "id": "f6ca0bce-f7e9-437d-84b6-1bb1b24f80ba",
  "position": 1,
  "name": "illuminated_arrhythmia",
  "label": "illumination with arrhythmia",
  "start_frame": 0,
  "end_frame": 3170,
  "expected_persistent_rotors": "present",
  "definition": "from recording start to spiral termination (interpreted; under
illumination)",
  "defined_by": "project lead (not a domain scientist), following the paper's design",
  "citation": {
    "ref": "10.1371/journal.pcbi.1011660",
    "quote": "t stimulus with LI = 3.44 \u03bcW/mm2 and PL = 5 s. Fig 2C shows a monophasic
action potential (MAP) signal (in black) before, during, and after illumination. It shows
the sinus rhythm returns after 3190 ms of illumination. Fig 2D presents a closer look at the
MAP signal of the heart during the last few rotations of arrhythmia and the first few action
potentials of sinus rhythm. Fig 2E illustrates a"
  },
  "evidence": {
    "end": {
      "kind": "baseline_step",
      "frame": 3170,
      "label": "spiral termination (interpreted; under illumination)",
      "source": "image",
      "event_id": "46c59a51-1a01-4aed-8021-db9a63720a1d",
      "evidence": {
        "step": 1.7134565711021423,

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"per_window": [
  {
    "z": 7.62002552466645,
    "step": 1.6427573561668396,
    "frame": 3170,
    "window": 101
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    "z": 7.940594943178843,
    "step": 1.7134565711021423,
    "frame": 3154,
    "window": 151
  },
  {
    "z": 7.899171431654551,
    "step": 1.732661247253418,
    "frame": 3186,
    "window": 201
  }
],
"pre_window": [
  2870,
  3120
],
"post_window": [
  3220,
  3470
],
"baseline_pre": -0.5335609912872314,
"baseline_post": 1.2153877019882202,
"interpretation": "mean fluorescence changed; cause not determined from the image",
"beat_amplitude_p5_p95": 1.4402662966400377
},
"uncertainty_frames": 17
},
"start": {
  "illumination": {
    "timing": "before_first_frame",
    "daq_sample": 53144,
    "led_level_after": 0.0784302,
    "led_level_before": -0.000305176,
    "photodiode_after": 0.0177002,
    "photodiode_agrees": true,
    "photodiode_before": 0.015564,
    "frames_before_first_frame": 23.0
  }
}
},
"provisional": true
},
{
  "id": "c1444c59-1863-45aa-b6f3-2208392bf55a",
  "position": 2,
  "name": "illuminated_after_termination",

```

```

"label": "illumination after termination",
"start_frame": 3170,
"end_frame": 4977,
"expected_persistent_rotors": "absent",
"definition": "from spiral termination (interpreted; under illumination) to
illumination_off",
"defined_by": "project lead (not a domain scientist), following the paper's design",
"citation": {
  "ref": "10.1371/journal.pcbi.1011660",
  "quote": "t stimulus with LI = 3.44 \u03bcW/mm2 and PL = 5 s. Fig 2C shows a monophasic
action potential (MAP) signal (in black) before, during, and after illumination. It shows
the sinus rhythm returns after 3190 ms of illumination. Fig 2D presents a closer look at the
MAP signal of the heart during the last few rotations of arrhythmia and the first few action
potentials of sinus rhythm. Fig 2E illustrates a"
},
"evidence": {
  "end": {
    "kind": "illumination_off",
    "frame": 4977,
    "label": null,
    "source": "acquisition_log",
    "event_id": "db2ad5f3-9b96-4ec1-9ccd-9c82c3425609",
    "evidence": {
      "timing": "during_recording",
      "daq_sample": 103145,
      "led_level_after": -0.000610352,
      "led_level_before": 0.0784302,
      "photodiode_after": 0.015564,
      "photodiode_agrees": true,
      "photodiode_before": 0.0177002
    },
  },
  "uncertainty_frames": 11
},
"start": {
  "kind": "baseline_step",
  "frame": 3170,
  "label": "spiral termination (interpreted; under illumination)",
  "source": "image",
  "event_id": "46c59a51-1a01-4aed-8021-db9a63720a1d",
  "evidence": {
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    "per_window": [
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        "z": 7.62002552466645,
        "step": 1.6427573561668396,
        "frame": 3170,
        "window": 101
      },
      {
        "z": 7.940594943178843,
        "step": 1.7134565711021423,
        "frame": 3154,
        "window": 151
      }
    ],
  },
},

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```

{
  "z": 7.899171431654551,
  "step": 1.732661247253418,
  "frame": 3186,
  "window": 201
}
],
"pre_window": [
  2870,
  3120
],
"post_window": [
  3220,
  3470
],
"baseline_pre": -0.5335609912872314,
"baseline_post": 1.2153877019882202,
"interpretation": "mean fluorescence changed; cause not determined from the image",
"beat_amplitude_p5_p95": 1.4402662966400377
},
"uncertainty_frames": 17
}
},
"provisional": true
},
{
  "id": "4eedfd6-84c2-40d3-8a4a-8758716d02d9",
  "position": 3,
  "name": "light_off",
  "label": "light off",
  "start_frame": 4977,
  "end_frame": 9267,
  "expected_persistent_rotors": "absent",
  "definition": "from illumination_off to recording end",
  "defined_by": "project lead (not a domain scientist), following the paper's design",
  "citation": {
    "ref": "10.1371/journal.pcbi.1011660",
    "quote": "t stimulus with LI = 3.44  $\mu$ W/mm2 and PL = 5 s. Fig 2C shows a monophasic action potential (MAP) signal (in black) before, during, and after illumination. It shows the sinus rhythm returns after 3190 ms of illumination. Fig 2D presents a closer look at the MAP signal of the heart during the last few rotations of arrhythmia and the first few action potentials of sinus rhythm. Fig 2E illustrates a"
  },
  "evidence": {
    "end": {
      "recording_end_frame": 9267
    },
    "start": {
      "kind": "illumination_off",
      "frame": 4977,
      "label": null,
      "source": "acquisition_log",
      "event_id": "db2ad5f3-9b96-4ec1-9ccd-9c82c3425609",
      "evidence": {

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```

    "timing": "during_recording",
    "daq_sample": 103145,
    "led_level_after": -0.000610352,
    "led_level_before": 0.0784302,
    "photodiode_after": 0.015564,
    "photodiode_agrees": true,
    "photodiode_before": 0.0177002
  },
  "uncertainty_frames": 11
}
},
"provisional": true
}
],
"events": [
{
  "id": "e73142c8-f562-4714-9ace-dce759d293d9",
  "kind": "illumination_on",
  "frame": 0,
  "label": null,
  "source": "acquisition_log",
  "status": "detected",
  "uncertainty_frames": 11,
  "method": "midpoint threshold on DAQ channel 'led_trigger', mapped to frames via camera
triggers"
},
{
  "id": "bac2afbc-81b8-4d0e-9a26-7bee170f9239",
  "kind": "arrhythmia_termination",
  "frame": 24,
  "label": null,
  "source": "acquisition_log",
  "status": "superseded",
  "uncertainty_frames": 11,
  "method": "last activation on DAQ channel 'ecg' (MAP) followed by an interval > 2x the
arrhythmic interval; mapped to frames via camera triggers"
},
{
  "id": "d2476777-3e2a-4c5e-a20b-b858a7527678",
  "kind": "arrhythmia_termination",
  "frame": 3153,
  "label": null,
  "source": "acquisition_log",
  "status": "superseded",
  "uncertainty_frames": 11,
  "method": "last activation on DAQ channel 'ecg' (MAP) followed by an interval > 2x the
arrhythmic interval; mapped to frames via camera triggers"
},
{
  "id": "e39f76de-baaa-42c1-be7a-6852665b65a2",
  "kind": "arrhythmia_termination",
  "frame": 3153,
  "label": null,
  "source": "acquisition_log",

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```

    "status": "detected",
    "uncertainty_frames": 11,
    "method": "last activation on DAQ channel 'ecg' (MAP) followed by an interval > 2x the
arrhythmic interval; mapped to frames via camera triggers"
  },
  {
    "id": "46c59a51-1a01-4aed-8021-db9a63720a1d",
    "kind": "baseline_step",
    "frame": 3170,
    "label": "spiral termination (interpreted; under illumination)",
    "source": "image",
    "status": "detected",
    "uncertainty_frames": 17,
    "method": "consensus upward step in running-median baseline of tissue-mean raw signal"
  },
  {
    "id": "42ba71e2-c2c4-4833-abc2-467506ec90a1",
    "kind": "illumination_on",
    "frame": 3170,
    "label": null,
    "source": "image",
    "status": "contradicted",
    "uncertainty_frames": 17,
    "method": "consensus upward step in running-median baseline of tissue-mean raw signal"
  },
  {
    "id": "db2ad5f3-9b96-4ec1-9ccd-9c82c3425609",
    "kind": "illumination_off",
    "frame": 4977,
    "label": null,
    "source": "acquisition_log",
    "status": "detected",
    "uncertainty_frames": 11,
    "method": "midpoint threshold on DAQ channel 'led_trigger', mapped to frames via camera
triggers"
  }
]
}

```