M13Rec001, signature 056f9e28

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

6d6015e6-82f2-4762-97e2-5663d547c549, 2026-10-27 22:21 UTC to 2026-10-27 22:26 UTC, status done. Protocol Mouse whole heart optical mapping (Luther lab), parameters v3 set by developer (not a domain scientist). Code 13d8ceb123e64ab2c7eaba9fbf51605361856f11 (clean), None workers.

Methods

For this run, the provisional parameter set and criteria are protocol f65d786f-f194-4be2-88b8-10d3dd25d674 version 3 with baseline_frames = 901, spatial_sigma = 1.0, spatial_truncate = 4.0, pad_frames = 500, rotor_threshold = 0.9, rotor_erode_px = 3, link_px = 4.0, max_gap = 5, min_cycles = 1.0, pair_dist_px = 3.0, paired_frac = 0.5, and render_step = 4. The frame rate is 1000 Hz from the publication, and the pixel size is 133 µm from the publication. The analysed window is frames 500 to 8767. The provisional segment definitions are illuminated_arrhythmia, frames 0 to 3170; illuminated_after_termination, frames 3170 to 4977; and light_off, frames 4977 to 9267.

Verdict

Verdict: report only stable descriptive findings and the provisional qualitative pattern, not unstable single values; physiology_ok is null because no stable ranged metric was available for pass/fail. Reportable items include stable absence of persistent rotors in light_off and illuminated_after_termination, stable maximum concurrent persistent-rotor count of 0 in those segments, stable dominant frequencies of 2.375 Hz in light_off and 2.214 Hz after termination, and a stable illuminated_arrhythmia singularity-frame fraction of 0.47902621722846445 with sensitivity range 0.3816479400749064–0.48801498127340825; the provisional persistent-rotor presence/absence rule holds using both the 52-frame measured-cycle threshold and the 50-frame paper-derived threshold from the 20.0 Hz context in DOI 10.1371/journal.pcbi.1011660. Not reportable as single values are light_off.singularity_frames_frac 0.0029023746701846965–0.02955145118733509, illuminated_arrhythmia.persistent_rotors 4.0–15.0, illuminated_arrhythmia.persistent_rotor_count_max 1.0–2.0, illuminated_arrhythmia.dominant_freq_hz 15.356–19.85 Hz, illuminated_after_termination.singularity_frames_frac 0.0005534034311012728–0.014941892639734366, and persistent_rotor_tracks 4.0–15.0. Needs review: pre-deposit processing/raw-data labeling, the provisional frame-3170 event interpretation, baseline/illumination artifact effects, and all provisional tool thresholds, ranges, stability threshold and criteria; the same-study frequency context is approximately 18.75–20.0 Hz, provisionally checked over 14.0625–25.0 Hz, in DOI 10.1371/journal.pcbi.1011660. 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;     % no baseline rule recorded for this run
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	[not measured]	present	LED on before frame 0 (DAQ) → termination step (image, ±17 frames)
Illumination after termination	3,170–4,977	3,170–4,977	[not measured]	absent	termination step (image, ±17 frames) → illumination off (DAQ, ±11 frames)
Light off	4,977–9,267	4,977–8,767	[not measured]	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: frac >= 0.1 and >= 2.0 x 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: count >= 1; each 'absent' segment: count <= 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 20 Hz)	agree (provisional)
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
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| > threshold turns, >= 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
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

Provisional rules behind this signature

Rule	Description	Expert	Status
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 frac(before) >= min_frac and >= min_ratio x frac(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
pipeline_check worker/agents/pipeline.py (INSTRUCTIONS, validator)	The pipeline agent's hold/proceed decision from protocol mismatches and inspector anomalies; it chooses no parameter	optical mapping analyst	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 <= 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	Sensitivity range 0.0029023746701846965–0.02955145118733509 across the filter grid; do not report a single value until filter dependence is reviewed.	warn
unstable:illuminated_arrhythmia.persistent_rotors	Sensitivity range 4.0–15.0 across filters and trackers; do not report a single count until tracking/filter dependence is reviewed.	warn
unstable:illuminated_arrhythmia.persistent_rotor_count_max	Sensitivity range 1.0–2.0 across filters and trackers; do not report a single maximum concurrent count until tracking/filter dependence is reviewed.	warn
unstable:illuminated_arrhythmia.dominant_freq_hz	Sensitivity range 15.356–19.85 Hz across baseline windows; do not report a single frequency until baseline-window dependence is reviewed against the same-study context in DOI 10.1371/journal.pcbi.1011660.	warn
unstable:illuminated_after_termination.singularity_frames_frac	Sensitivity range 0.0005534034311012728–0.014941892639734366 across the filter grid; do not report a single value until filter dependence is reviewed.	warn
unstable:persistent_rotor_tracks	Sensitivity range 4.0–15.0 across filters and trackers; do not report a single track count until tracking/filter dependence is reviewed.	warn
Pre-deposit processing / raw-data label	README labels the recording as raw experimental data, but notebook documentation and measurements indicate masking, spatial smoothing, temporal smoothing, and normalization; avoid analyses that assume raw photon counts or independent pixel noise.	warn
Event interpretation at frame 3170	Frame 3170 is a baseline_step only; illumination began before frame 0 and ended at frame 4977, so the stored spiral-termination label is provisional and should not be treated as direct light-onset evidence.	warn
Baseline and illumination artifact	Blue stimulation light crosstalk, re-normalization by stimulation-light signal, slow baseline range, and a baseline step mean analyses using absolute baseline or amplitude must account for illumination/crosstalk/normalization effects.	warn
Provisional tool thresholds	Event detection, processing flags, SNR, rhythm, reference-rate thresholds, ranges, stability threshold, and criteria are provisional and not yet reviewed by a domain scientist.	info

Provenance


```
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  "publication_ref": "10.1371/journal.pcbi.1011660",
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  "format": "npy",
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  "size_bytes": 260958848,
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   "url": "https://zenodo.org/records/10228296",
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    "Luther, Stefan",
    "L\u00e4dke, Sarah L."
   ],
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  },
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  "frame_rate_source": {
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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
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the camera (EMCCD, Cascade 128+, Photometrics) with a spatial resolution of 64 \u00d7 64
pixels (133 \u03bcm 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
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Semrock) and finally by the camera (EMCCD, Cascade 128+, Photometrics) with a spatial
resolution of 64 \u00d7 64 pixels (133 \u03bcm 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). El"
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termination cycle resolved under v2; v2's 641 frames was 1.48 cycles, on the 1.5-cycle line,
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the window. Provisional (REVIEW_NEEDED item 16)."
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```

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    },
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   "mismatches": [],
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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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       "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"
      },
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       "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"
      },
      "defined_by": "project lead (not a domain scientist), following the paper's design",
      "segment_id": "4eeedfd6-84c2-40d3-8a4a-8758716d02d9",
      "end_event_id": null,
      "start_event_id": "db2ad5f3-9b96-4ec1-9ccd-9c82c3425609",
      "expected_persistent_rotors": "absent"
     }
    ],
    "illumination": "Acquisition log (LED trigger channel, provisional interpretation):
illumination on over frames 500-4977 of the analysed frames 500-8767.",
    "frame_rate_hz": 1000.0,
    "frame_rate_source": {
     "ref": "10.1371/journal.pcbi.1011660",
     "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 \u00b1 70nm bandpass filter (FF01\u2013775/140-25, Semrock) and finally
```

```
by the camera (EMCCD, Cascade 128+, Photometrics) with a spatial resolution of 64 \u00d7 64
pixels (133 \u03bcm 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
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    "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",
   "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": [
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     "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
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     "decision": null,
     "location": "worker/voltage/protocol_params.py (developer_defaults, set_params)",
     "reviewed": false,
     "reviewer": null,
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     "description": "Each protocol's fixed, versioned analysis parameters (version 1 =
developer defaults); no run or agent may deviate",
     "reviewed_at": null
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    {
     "id": "filter_defaults",
     "expert": "optical mapping analyst (cardiac electrophysiology)",
     "status": "provisional",
     "values": {
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      "spatial_sigma": 1.0,
      "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
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     "id": "polarity",
     "expert": "optical mapping analyst / voltage dye chemist",
     "status": "provisional",
     "values": {
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      "result": -1
     },
     "decision": null,
     "location": "worker/voltage/preprocess.py (polarity)",
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     "reviewer": null,
     "description": "Dye polarity from sign of median per-pixel skew of dV/dt",
     "reviewed_at": null
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     "id": "singularity_detection",
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     "expert": "computational cardiac electrophysiologist (phase mapping)",
     "status": "provisional",
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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
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     "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": {
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       "light": 0.5,
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       "heavier": 2.0
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        10
       ],
       "strict": [
        2.0,
        1
       ],
       "default": [
        4.0,
        5
       ]
      },
      "baselines": {
       "run": 901,
       "3x_cycle": 1356,
       "6x_cycle": 2712,
       "1.5x_cycle": 678
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     },
     "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
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    {
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     "expert": "cardiac electrophysiologist familiar with the dataset",
     "status": "provisional",
     "values": {
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     "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
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    {
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     "expert": "imaging scientist (camera acquisition and noise)",
     "status": "provisional",
     "values": {
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       "nan_mask_all_frames",
       "temporal_smoothing",
       "spatial_smoothing"
      ],
      "thresholds": {
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       "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": [
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       "arrhythmia_termination@3153",
       "illumination_off@4977"
      ]
     },
     "decision": null,
     "location": "worker/voltage/daq.py",
     "reviewed": false,
     "reviewer": null,
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     "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",
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```
        "illuminated_arrhythmia": "present",
        "illuminated_after_termination": "absent"
       },
       "max_absent": 0,
       "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": "pipeline_check",
      "expert": "optical mapping analyst",
      "status": "provisional",
      "values": {
       "model": "openai:gpt-5.5",
       "proceed": true,
       "anomalies": [
        "Pre-deposit processing / raw-data label",
        "Event interpretation at frame 3170",
        "Baseline and illumination artifact"
       ],
       "mismatches": []
      },
      "decision": null,
      "location": "worker/agents/pipeline.py (INSTRUCTIONS, validator)",
      "reviewed": false,
      "reviewer": null,
      "description": "The pipeline agent's hold/proceed decision from protocol mismatches and
inspector anomalies; it chooses no parameter",
      "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": {
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       "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
    }
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   "all_reviewed": false,
   "superseded_by_run": null
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   "start_frame": 0,
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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": {
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      "per_window": [
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        "z": 7.62002552466645,
        "step": 1.6427573561668396,
        "frame": 3170,
        "window": 101
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        "z": 7.940594943178843,
        "step": 1.7134565711021423,
        "frame": 3154,
        "window": 151
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        "z": 7.899171431654551,
        "step": 1.732661247253418,
        "frame": 3186,
        "window": 201
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      ],
      "pre_window": [
       2870,
       3120
      ],
      "post_window": [
       3220,
       3470
      ],
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       "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
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     }
    },
    "provisional": true
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    "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,
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      "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,
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    "photodiode_agrees": true,
    "photodiode_before": 0.0177002
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   "uncertainty_frames": 11
  },
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   "source": "image",
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    "per_window": [
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      "step": 1.6427573561668396,
      "frame": 3170,
      "window": 101
     },
     {
      "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
  }
 },
 "provisional": true
},
{
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 "position": 3,
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   "name": "light_off",
   "label": "light off",
   "start_frame": 4977,
   "end_frame": 9267,
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   "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": {
     "recording_end_frame": 9267
    },
    "start": {
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     "frame": 4977,
     "label": null,
     "source": "acquisition_log",
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     "evidence": {
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      "daq_sample": 103145,
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      "led_level_before": 0.0784302,
      "photodiode_after": 0.015564,
      "photodiode_agrees": true,
      "photodiode_before": 0.0177002
     },
     "uncertainty_frames": 11
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   },
   "provisional": true
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   "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",
```

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   "kind": "arrhythmia_termination",
   "frame": 24,
   "label": null,
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   "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",
   "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",
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   "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"
  }
 ]
}
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