

M13Rec001, signature 6ed9c8e5

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

202e66c5-944f-4d65-bbb1-a060487247e1, 2026-10-27 23:02 UTC to 2026-10-27 23:08 UTC, status done. Protocol Mouse whole heart optical mapping (Luther lab), parameters v3 set by developer (not a domain scientist). Code b1be82429ddde2ad90ee88afacaae98a173e4403 (uncommitted changes), None workers.

Methods

Using the provisional parameter set version 3, with provisional segment definitions and provisional criteria, the recording was checked under the Mouse whole heart optical mapping (Luther lab) protocol 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 recording has 9267 frames in npy format with image size 64 × 55, frame rate 1000 Hz from the publication, and pixel size 133 µm from the publication. The analysed window is frames 500–8767; the provisional segments are illuminated_arrhythmia, frames 0–3170; illuminated_after_termination, frames 3170–4977; and light_off, frames 4977–9267.

Verdict

Verdict: the signature has no stable metric outside a cited range, but the only ranged check, illuminated_arrhythmia.dominant_freq_hz, is unstable and therefore not reportable as a single value; physiology_ok is null. Reportable items are limited to provisional algorithmic findings: singularity presence in illuminated_arrhythmia is stable over 0.3816479400749064–0.48801498127340825 fraction of frames, persistent-rotor presence in illuminated_arrhythmia holds across filters and trackers, and absence of persistent rotors is stable at 0 in light_off and illuminated_after_termination. Unstable items 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, illuminated_after_termination.singularity_frames_frac 0.0005534034311012728–0.014941892639734366, and persistent_rotor_tracks 4.0–15.0. Persistence-threshold criteria agree at 52 frames and 50 frames; the cited mouse spiral-wave context reports approximately 20 Hz before illumination and approximately 18.75 Hz during illumination (DOI 10.1371/journal.pcbi.1011660). Review is needed for pre-deposit processing/raw-data labeling, frame-3170 interpretation, baseline and illumination artifact, and all provisional thresholds; the ranges, stability threshold, and 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
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 $\leq 25\%$ 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	Filter-grid dependence is large: 0.0029023746701846965-0.02955145118733509 fraction of frames, so the light-off singularity fraction is not reportable as a single value.	warn
unstable:illuminated_arrhythmia.persistent_rotors	The persistent-rotor count varies across filter and tracker settings from 4.0 to 15.0; keep only the qualitative presence/rule result until tracking sensitivity is reviewed.	warn
unstable:illuminated_arrhythmia.persistent_rotor_count_max	The maximum simultaneous persistent-rotor count varies from 1.0 to 2.0, so it is not reportable as a single value.	warn
unstable:illuminated_arrhythmia.dominant_freq_hz	Dominant frequency depends on baseline-window choice, 15.356-19.85 Hz, despite cited context of approximately 20 Hz and 18.75 Hz for this study; resolve baseline-window dependence before reporting a value.	warn
unstable:illuminated_after_termination.singularity_frames_frac	Filter-grid dependence is large: 0.0005534034311012728-0.014941892639734366 fraction of frames, so the post-termination singularity fraction is not reportable as a single value.	warn
unstable:persistent_rotor_tracks	Total persistent-rotor tracks vary from 4.0 to 15.0 across filter and tracker settings, so the total track count is not reportable as a single value.	warn
Pre-deposit processing / raw-data label	The README labels M13Rec001 as raw experimental data, but the notebook documents masking, spatial smoothing, temporal smoothing, and normalization with Python Analyser; prior_processing measurements support processed data. Analyses requiring raw photon counts or independent pixel noise would be misleading if this is treated as raw camera data.	swarn
Event interpretation at frame 3170	The image event at frame 3170 is a baseline_step only. The DAQ shows illumination began before frame 0 and ended at frame 4977, so treating frame 3170 as light onset would be wrong. The stored spiral-termination label is provisional and based on timing relative to the paper, not a direct measurement.	warn
Baseline and illumination artifact	The publication reports blue stimulation light crosstalk causing an increase in fluorescence baseline and re-normalization by division to the recorded stimulation light signal; the recording also has a large slow baseline range and a baseline step. Analyses using absolute baseline or amplitude should account for illumination/crosstalk/normalization effects.	warn
Provisional tool thresholds	Event detection, processing flags, SNR, rhythm, and reference-rate thresholds are provisional and not yet reviewed by a domain scientist; conclusions depending on them should be checked for critical analyses.	info

Provenance

```
{
  "recording": {
    "id": "55cb4aa3-6502-45a6-a14c-85cb676fe8c3",
    "label": "Mouse heart, spiral wave and optogenetic termination (M13Rec001)",
    "source": "public",
    "source_ref": "10.5281/zenodo.10228296",
    "publication_ref": "10.1371/journal.pcbi.1011660",
    "storage_path": "public/M13Rec001_complete.npy",
    "format": "npy",
    "sha256": "3f8f2e1b8f776633089b33ccd4bf3fccb4f13140b71991f1dcd0e0a12bb48cbc",
    "size_bytes": 260958848,
    "license": "CC-BY-4.0",
    "attribution": "Hussaini, Sayedeh; Luther, Stefan; L\u00e4dke, Sarah L.",
    "rights_source": {
      "ref": "10.5281/zenodo.10228296",
      "url": "https://zenodo.org/records/10228296",
      "kind": "deposit_metadata",
      "creators": [
        "Hussaini, Sayedeh",
        "Luther, Stefan",
        "L\u00e4dke, Sarah L."
      ],
      "license_as_stated": "cc-by-4.0"
    },
    "frame_rate_hz": 1000,
    "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\u2013140-25, Semrock) and finally by the camera (EMCCD, Cascade 128+, Photometrics) with a spatial resolution of 64 \u00d7 64 pixels (133 \u00b5m 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"
    },
    "pixel_size_um": 133,
    "pixel_size_source": {
      "ref": "10.1371/journal.pcbi.1011660",
      "kind": "publication",
      "note": "paper states 64 x 64 px at 133 \u00b5m; the deposit is 64 x 55 (cropped, not rebinned)",
      "quote": "rst collected by a 775 \u00b1 70nm bandpass filter (FF01\u2013140-25, Semrock) and finally by the camera (EMCCD, Cascade 128+, Photometrics) with a spatial resolution of 64 \u00d7 64 pixels (133 \u00b5m 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"
    },
    "frames": 9267,
```

```

    "height": 64,
    "width": 55,
    "inverted": true
  },
  "protocol": {
    "id": "f65d786f-f194-4be2-88b8-10d3dd25d674",
    "name": "Mouse whole heart optical mapping (Luther lab)",
    "species": "mouse",
    "tissue": "whole_heart",
    "params_version": 3,
    "params_set_by": "developer (not a domain scientist)",
    "params_note": "version 3: baseline 901 frames = 2.1 x the 433-frame (2.31 Hz) post-
termination cycle resolved under v2; v2's 641 frames was 1.48 cycles, on the 1.5-cycle line,
and the pipeline check held one run and passed another on the same inputs. pad 500 >= half
the window. Provisional (REVIEW_NEEDED item 16).",
  },
  "run": {
    "id": "202e66c5-944f-4d65-bbb1-a060487247e1",
    "status": "done",
    "started_at": "2026-10-27T23:02:29.97199+00:00",
    "finished_at": "2026-10-27T23:08:06.753472+00:00",
    "code": {
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    },
  },
  "workers": null,
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    "deposit_checks",
    "baseline_correct",
    "polarity",
    "spatial_filter(phase only)",
    "hilbert_phase",
    "phase_singularities",
    "track_and_pair",
    "beats_apd_cv",
    "sensitivity",
    "render"
  ],
  "protocol_params": {
    "params": {
      "link_px": 4.0,
      "max_gap": 5,
      "min_cycles": 1.0,
      "pad_frames": 500,
      "paired_frac": 0.5,
      "render_step": 4,
      "pair_dist_px": 3.0,
      "spatial_sigma": 1.0,
      "rotor_erode_px": 3,
      "baseline_frames": 901,
      "rotor_threshold": 0.9,
      "spatial_truncate": 4.0
    },
  },

```

```

"version": 3,
"protocol_id": "f65d786f-f194-4be2-88b8-10d3dd25d674"
},
"baseline_rule": {
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  "cycles": {
    "light_off": {
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      "n_activations": 10,
      "polarity_used": -1,
      "median_interval_ms": 410.9
    },
    "illuminated_arrhythmia": {
      "cycle_frames": 52,
      "n_activations": 53,
      "polarity_used": -1,
      "median_interval_ms": 52.25
    },
    "illuminated_after_termination": {
      "cycle_frames": 415,
      "n_activations": 4,
      "polarity_used": -1,
      "median_interval_ms": 415.0
    }
  },
  "factor": 2.0,
  "reason": null,
  "source": "MAP channel (DAQ log)",
  "status": "provisional",
  "daq_file": "0111210010.txt",
  "baseline_frames": 901,
  "slowest_segment": "illuminated_after_termination",
  "required_min_frames": 830,
  "slowest_cycle_frames": 415
},
"deposit_checks": {
  "flags": [
    {
      "flag": "negative_values",
      "value": 0.3231635934819897,
      "suggests": "baseline-subtracted or normalized; raw fluorescence counts are non-negative",
      "threshold": 0.01
    },
    {
      "flag": "non_integer",
      "value": 0.0,
      "suggests": "not raw camera counts (camera output is integer); weak alone",
      "threshold": 0.5
    },
    {
      "flag": "nan_mask_all_frames",
      "value": 1188,

```

```

    "suggests": "tissue masked by depositor; the mask is theirs"
  },
  {
    "flag": "temporal_smoothing",
    "value": 0.9120054707808141,
    "suggests": "temporally low-pass filtered (white shot noise gives dV lag-1 autocorr
near -0.5)",
    "threshold": 0.5
  },
  {
    "flag": "spatial_smoothing",
    "value": 0.9957938301611564,
    "suggests": "spatially filtered or binned (shot noise is independent between pixels)",
    "threshold": 0.8
  }
],
"status": "provisional",
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  "max": 4.49806547164917,
  "min": -6.050762176513672,
  "frames_used": 2000,
  "integer_frac": 0.0,
  "negative_frac": 0.3231635934819897,
  "frames_with_nan": 9267,
  "dv_lag1_autocorr_median": 0.9120054707808141,
  "neighbour_dv_corr_median": 0.9957938301611564
},
"processed_before_deposit": true
},
"pipeline_check": {
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  "proceed": true,
  "anomalies": [
    {
      "topic": "Pre-deposit processing / raw-data label",
      "severity": "warn",
      "effect_on_analysis": "The deposited movie should not be treated as raw camera counts:
depositor documentation and measurements indicate masking, temporal smoothing, spatial
smoothing, and normalization. The fixed pipeline may still be run, but its Gaussian phase
smoothing is added on top of prior filtering of unknown effective total, and any
interpretation requiring independent pixel noise or raw photon-count amplitudes would be
misleading."
    },
    {
      "topic": "Event interpretation at frame 3170",
      "severity": "warn",
      "effect_on_analysis": "The segment boundary at frame 3170 is based on a provisional
termination/baseline-step interpretation, not a directly measured light onset. The fixed
segment definitions can be analysed as defined, but results should be described relative to
the provisional boundary and not as an illumination-on transition."
    },
    {
      "topic": "Baseline and illumination artifact",
      "severity": "warn",

```

```

    "effect_on_analysis": "Blue-light crosstalk, re-normalization by stimulation-light
signal, a large slow baseline range, and a baseline step can affect absolute baseline and
amplitude. The fixed phase/rotor pipeline can proceed, but baseline- or amplitude-dependent
interpretations need caution."
  },
  {
    "topic": "Baseline-window rule",
    "severity": "info",
    "effect_on_analysis": "The coded rule reports ok: the 901-frame baseline is at least 2
times the slowest segment cycle from the MAP-channel DAQ log, so this rule does not hold the
run."
  }
],
  "rationale": "The protocol is the intended mouse whole-heart optical-mapping protocol for
this public reference recording, and the recording facts do not conflict with the protocol:
the frame rate is 1000 Hz from the publication, the pixel size is 133 \u00b5m from the
publication, and the 64 \u00d7 55 deposited movie is consistent with a cropped version of
the 64 \u00d7 64 camera acquisition. The fixed version-3 parameters are therefore applicable
as provisional pipeline settings, and the coded baseline-window rule passes for the slowest
segment. The main limitations are not protocol mismatches but interpretation caveats: the
deposited data are already masked, smoothed, and normalized; frame 3170 is a provisional
termination/baseline-step boundary rather than light onset; and
illumination/crosstalk/normalization affect baseline and amplitude.",
  "mismatches": [],
  "hold_reason": null,
  "protocol_id": "f65d786f-f194-4be2-88b8-10d3dd25d674",
  "methods_text": "Using the provisional parameter set version 3, with provisional segment
definitions and provisional criteria, the recording was checked under the Mouse whole heart
optical mapping (Luther lab) protocol 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 recording has 9267 frames in npy format with image size 64 \u00d7 55, frame rate
1000 Hz from the publication, and pixel size 133 \u00b5m from the publication. The analysed
window is frames 500\u201338767; the provisional segments are illuminated_arrhythmia, frames
0\u20133170; illuminated_after_termination, frames 3170\u20134977; and light_off, frames
4977\u201339267.",
  "recording_id": "55cb4aa3-6502-45a6-a14c-85cb676fe8c3",
  "params_version": 3,
  "prompt_version": "pipeline-v2"
}
},
"signature": {
  "id": "6ed9c8e5-4bef-4549-b04f-f5014db32b5b",
  "created_at": "2026-10-27T23:08:06.969496+00:00",
  "movie_path": "runs/202e66c5-944f-4d65-bbb1-a060487247e1/movie.mp4",
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  "filter_params": {
    "mask": "not NaN in frame 0 and nonzero temporal std",
    "render": {
      "step": 4,
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        "camera": "gray",
        "voltage": "gray"
      }
    }
  }
}

```

```

},
"interpolation": "nearest"
},
"window": {
  "f0": 500,
  "f1": 8767,
  "segments": [
    {
      "name": "illuminated_arrhythmia",
      "label": "illumination with arrhythmia",
      "defined": [
        0,
        3170
      ],
      "analysed": [
        500,
        3170
      ],
      "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"
      },
      "defined_by": "project lead (not a domain scientist), following the paper's design",
      "segment_id": "f6ca0bce-f7e9-437d-84b6-1bb1b24f80ba",
      "end_event_id": "46c59a51-1a01-4aed-8021-db9a63720a1d",
      "start_event_id": null,
      "expected_persistent_rotors": "present"
    },
    {
      "name": "illuminated_after_termination",
      "label": "illumination after termination",
      "defined": [
        3170,
        4977
      ],
      "analysed": [
        3170,
        4977
      ],
      "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"
      },
      "defined_by": "project lead (not a domain scientist), following the paper's design",
      "segment_id": "c1444c59-1863-45aa-b6f3-2208392bf55a",
      "end_event_id": "db2ad5f3-9b96-4ec1-9ccd-9c82c3425609",

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    "start_event_id": "46c59a51-1a01-4aed-8021-db9a63720a1d",
    "expected_persistent_rotors": "absent"
  },
  {
    "name": "light_off",
    "label": "light off",
    "defined": [
      4977,
      9267
    ],
    "analysed": [
      4977,
      8767
    ],
    "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"
    },
    "defined_by": "project lead (not a domain scientist), following the paper's design",
    "segment_id": "4eedfd6-84c2-40d3-8a4a-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  $\mu$ m 70nm bandpass filter (FF01-13775/140-25, Semrock) and finally
by the camera (EMCCD, Cascade 128+, Photometrics) with a spatial resolution of 64  $\times$  64
pixels (133  $\mu$ 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,

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"tracking": {
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  "max_gap": 5,
  "min_cycles": 1.0,
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  "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
      },
    },
    {
      "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
    },
  },

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    "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
},
{
    "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
},
{
    "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,

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    "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,
      "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
  },
  },

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{
  "id": "sensitivity_grid",
  "expert": "optical mapping analyst",
  "status": "provisional",
  "values": {
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      "light": 0.5,
      "default": 1.0,
      "heavier": 2.0
    },
    "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
}

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},
{
  "id": "prior_processing_flags",
  "expert": "imaging scientist (camera acquisition and noise)",
  "status": "provisional",
  "values": {
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      "non_integer",
      "nan_mask_all_frames",
      "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"
    ]
  }
}

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    ],
    },
    "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
  },
  {
    "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
  },
  {

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    "id": "persistent_rotor_criterion",
    "expert": "cardiac electrophysiologist",
    "status": "provisional",
    "values": {
      "expect": {
        "light_off": "absent",
        "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",
        "Baseline-window rule"
      ],
      "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,

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    "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
}
],
"status": "provisional",

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    "all_reviewed": false,
    "superseded_by_run": null
  }
},
"segments": [
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    "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  $\mu\text{W}/\text{mm}^2$  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,
          "per_window": [
            {
              "z": 7.62002552466645,
              "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": [

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    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",

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"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": {
    "step": 1.7134565711021423,
    "per_window": [
      {
        "z": 7.62002552466645,
        "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
},
{
  "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 \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": {
      "kind": "illumination_off",
      "frame": 4977,
      "label": null,
      "source": "acquisition_log",
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      "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
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      "uncertainty_frames": 11
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  "provisional": true
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"events": [
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    "id": "e73142c8-f562-4714-9ace-dce759d293d9",
    "kind": "illumination_on",
    "frame": 0,
    "label": null,
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    "status": "detected",
    "uncertainty_frames": 11,
    "method": "midpoint threshold on DAQ channel 'led_trigger', mapped to frames via camera
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  {
    "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,
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arrhythmic interval; mapped to frames via camera triggers"
  },
  {
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    "kind": "arrhythmia_termination",
    "frame": 3153,
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    "source": "acquisition_log",
    "status": "detected",
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    "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"
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  {
    "id": "42ba71e2-c2c4-4833-abc2-467506ec90a1",
    "kind": "illumination_on",
    "frame": 3170,
    "label": null,
    "source": "image",

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    "status": "contradicted",
    "uncertainty_frames": 17,
    "method": "consensus upward step in running-median baseline of tissue-mean raw signal"
  },
  {
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    "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"
  }
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}
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