

mouse_2609_150ms_control_MiCAM, signature 0187eb93

Recording

Open-Source Low-Cost Cardiac Optical Mapping System: mouse_2609_150ms_control_MiCAM. 100 × 100 px, 2,047 frames, 0.977 kHz, pixel size not stated, deposit checks: negative values. Source 10.5281/zenodo.5557829; publication 10.1371/journal.pone.0259174; licence cc-by-4.0; Rybashlykov Dmitry. sha256 6f7fd1ea3f1f2610645c5d235dd4bc189bcd5f58c1a038c8f8e68e2233948253e.

Run

2aec1b88-1bc3-430f-9d57-a9ddcf39928c, 2026-10-28 18:59 UTC to 2026-10-28 19:01 UTC, status done. Protocol Mouse whole heart optical mapping (Luther lab), parameters v3 set by developer (not a domain scientist). Code 0aee29346248785f557664cd859ddeb50fecdc3d5 (uncommitted changes), 4 workers.

Methods

Using provisional parameter set version 3 for protocol f65d786f-f194-4be2-88b8-10d3dd25d674, the provisional fixed criteria use 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 2047 frames of size 100x100; the frame rate used is 977.0 Hz from the recording-row admission source citing 10.1371/journal.pone.0259174, and the pixel size is not provided. The analysed frames are 500 to 1547 for the whole-recording analysis window, and the provisional segment definition is whole_recording from frame 0 to frame 2047, defined at admission with no detected or logged events.

Verdict

Send back this signature as not reportable as it stands: the whole_recording singularity-frame fraction is unstable across 0.18242597898758356 to 0.7459407831900668, persistent_rotors across 0.0 to 3.0, persistent_rotor_count_max across 0.0 to 1.0, and persistent_rotor_tracks across 0.0 to 3.0, all under the provisional stability threshold of $(\max - \min) \leq 0.25 \times \text{median}$ and provisional criteria; the only stable metric is dominant_freq_hz at 6.532 Hz across baseline-window settings, but it has no cited acceptance range for this paced control context, and the available mouse spiral-wave context instead describes approximately 18.75 to 20.0 Hz rotation in another study (DOI 10.1371/journal.pcbi.1011660). Persistent-rotor threshold tests are not applicable because there are no segment expectations, while tracker sensitivity needs review because strict/default tracking is at the lower end of the unstable rotor range and loose tracking is at the upper end; also review the frame-rate provenance for the MiCAM-labelled file using the 977.0 Hz admission value, possible pre-deposit sign or conditioning, all-negative integer values, the unsuitable rhythm-detector short-cycle result relative to the expected pacing period, and the non-biological mask; all ranges, the stability threshold, and criteria are provisional. physiology_ok: None; send back: True. 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 (22, images): 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 = 150
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
Whole recording	0-2,047	500-1,547	22 (10% of pixels)	not stated	recording start → recording end

Metrics

Metric	Unit	Whole recording	Physiological range
Rhythm			
Dominant frequency	Hz	6.532	none cited
Rotors			
Persistent rotors	count	0–3 (unstable)	none cited
Max concurrent persistent rotors	count	0–1 (unstable)	none cited
Frames with a singularity	fraction	0.182–0.746 (unstable)	none cited
Beats, where a global rhythm exists			
Beats	count	8	none cited
Global amplitude ratio	ratio	0.75	gate ≥ 0.30 provisional
APD50	ms	23	none cited
APD90	ms	58	none cited
Conduction velocity	cm/s	[not computed]	none cited

Criteria and reportable values

Item	Rule or segment	Result
Design expectations	none stated for this recording's segments	no criterion to test; counts are descriptive (provisional)
persistent rotor tracks	all	0-3 count, unstable, not reportable
dominant freq (Hz)	whole recording	6.532 Hz, no cited range
persistent rotors	whole recording	0-3 count, unstable, not reportable
singularity frames fraction	whole recording	0.182-0.746 fraction of frames, unstable, not reportable
persistent rotor count max	whole recording	0-1 count, unstable, not reportable

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_info, otsu_threshold, largest_component)	Tissue mask from, in order: (1) NaN in frame 0 when the recording has any NaN; (2) a mask or background-image variable shipped in the file whose shape matches the frame (binary as is, an intensity image thresholded with Otsu); (3) Otsu's threshold on the mean image, the class with more temporal signal as tissue, largest connected component kept; source, coverage and threshold recorded	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
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

Provisional rules behind this signature

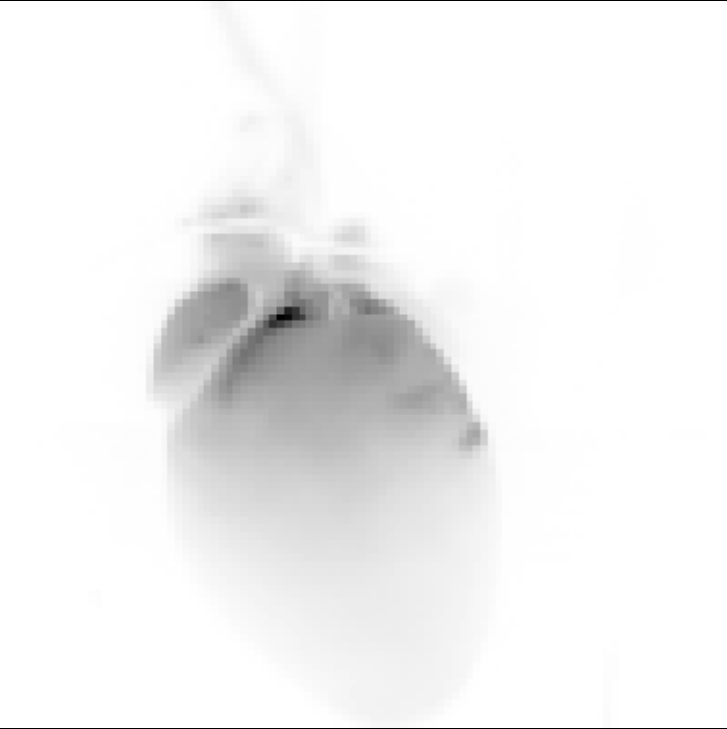
Rule	Description	Expert	Status
physiology_reference_rates worker/voltage/physiology.py (RANGES, TOLERANCE_FRAC)	Cited physiological ranges (single-study values widened by a 25% tolerance), applied to segments by their expected rhythm; used by the critic and for frame-rate sanity checks	cardiac electrophysiologist 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
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

Review items

Topic	Detail	Severity
unstable:whole_recording.singularity_frames_frac	The singularity-frame fraction is unstable across the filter grid, ranging from 0.18242597898758356 to 0.7459407831900668; do not report a definitive value without resolving parameter sensitivity.	block
unstable:whole_recording.persistent_rotors	Across sensitivity settings the range is 0.0 to 3.0; do not report persistent_rotors as a definitive result without resolving tracking and filtering sensitivity.	block
unstable:whole_recording.persistent_rotor_count_max	Across sensitivity settings the range is 0.0 to 1.0; do not report persistent_rotor_count_max as a definitive result without sensitivity review.	block
unstable:persistent_rotor_tracks	Across sensitivity settings the range is 0.0 to 3.0; track-level persistence is not reportable as a definitive result.	block
tracker_variant_count_disagreement	Strict/default tracking sits at the lower end of the unstable rotor range, while loose tracking sits at the upper end; review this as tracker sensitivity, not as proof that rotors are absent or present.	warn
Frame-rate provenance for a MiCAM file	Use the admission value of 977.0 Hz as the working frame rate, but review provenance because the cited paper quote aligns with the custom iDS system while this deposited file is labelled MiCAM, and the Zenodo metadata does not state the MiCAM frame rate.	warn
Pre-deposit sign/conditioning	The signal is consistently non-inverted even though Di-4-ANEPPS usually dims on depolarization, suggesting sign flip or other transformation before deposit/export; downstream orientation from the measurement makes this a warning rather than a block.	warn
Unexplained all-negative data values	All values are negative integers and are flagged as processed_before_deposit; the linked paper documents possible filtering/averaging workflows, but no deposit README explains this file-level transformation.	warn
Rhythm detector not suitable for the expected paced period here	Do not use the rhythm detector's short-cycle result to infer physiology or frame rate here, because the expected pacing period lies beyond the rhythm tool's baseline-correction window.	info
Mask is not a heart segmentation	The current analysis mask is based on nonzero temporal standard deviation, not a biological tissue segmentation; spatial map interpretation needs a tissue-only mask.	warn

Open-Source Low-Cost Cardiac Optical Mapping System: mouse_2609_150ms_control_MiCAM

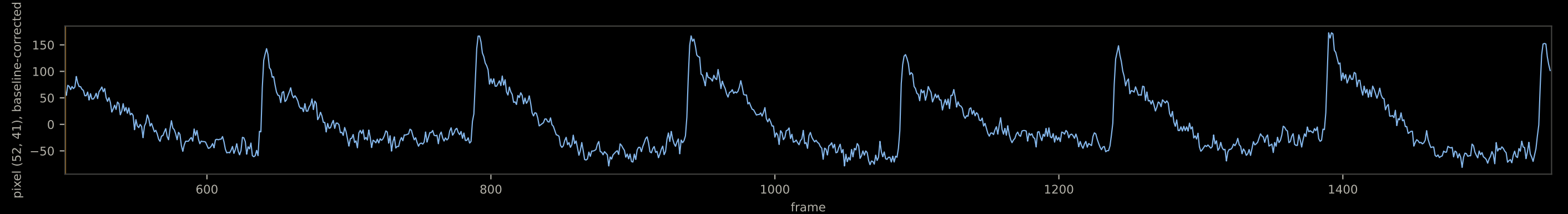
camera: frame as deposited



voltage: baseline-corrected only



phase: singularities (small), persistent rotors (ring)



Data: Public reference recording, Hussaini, Luther, Lädke (MPI Göttingen), CC-BY 4.0. doi:10.5281/zenodo.5557829. 100x100 px, 2047 frames; shown 500-1547 every 1. Frame rate: 977.0 Hz.
Camera: values as deposited (may include the depositor's processing), linear gray -1.34e+04 to -25, NaN black; nothing subtracted or filtered by us.
Voltage: baseline-corrected only (901-frame centered moving average subtracted), polarity x+1, no spatial filter, gray +/-148 (99th pct |V|).
Phase: Hilbert, on spatial Gaussian sigma=1.0 px (truncate 4.0) of the voltage signal, 500-frame pad. Singularity (small circle): |winding| > 0.9 turns, >= 3 px from tissue edge. Persistent rotor (large ring): tracked same-charge singularity lasting >= one cycle, not mostly in a close opposite-charge pair. Thresholds provisional.
Temporal low-pass: none. Display: native pixels, nearest-neighbour, no interpolation or boundary smoothing.
Opening frame 500: display choice: first analysed frame (no persistent rotor in any segment).

Provenance

```
{
  "recording": {
    "id": "ae77081e-a125-471f-8805-27dad0688848",
    "label": "Open-Source Low-Cost Cardiac Optical Mapping System:
mouse_2609_150ms_control_MiCAM",
    "source": "admission",
    "source_ref": "10.5281/zenodo.5557829",
    "publication_ref": "10.1371/journal.pone.0259174",
    "storage_path": "uploads/public/7764050e/mouse_2609_150ms_control_MiCAM.mat",
    "format": "mat",
    "sha256": "6f7fd1ea3f1f2610645c5d235dd4bc189bcd5f58c1a038c8f8e68e2233948253e",
    "size_bytes": 30452226,
    "license": "cc-by-4.0",
    "attribution": "Rybashlykov Dmitry",
    "rights_source": {
      "ref": "10.5281/zenodo.5557829",
      "kind": "deposit_metadata",
      "admitted_by": "project lead",
      "license_as_stated": "cc-by-4.0"
    },
    "frame_rate_hz": 977.0,
    "frame_rate_source": {
      "by": "project lead",
      "ref": "10.1371/journal.pone.0259174",
      "kind": "admission",
      "quote": "The custom software was designed to make recordings with a resolution of
200x200 pixels and a framerate of 977 frames per second (FPS).",
      "source": "paper_methods"
    },
    "pixel_size_um": null,
    "pixel_size_source": null,
    "frames": 2047,
    "height": 100,
    "width": 100,
    "inverted": false
  },
  "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": "2aec1b88-1bc3-430f-9d57-a9ddcf39928c",
      "status": "done",
      "started_at": "2026-10-28T18:59:24.298079+00:00",
```

```
"finished_at": "2026-10-28T19:01:51.31345+00:00",
"code": {
  "dirty": true,
  "git_commit": "0aee29346248785f557664cd859ddeb50fec3d5"
},
"workers": 4,
"steps": [
  "load",
  "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": {
  "ok": true,
  "ratio": 40.955,
  "cycles": {
    "whole_recording": {
      "n_frames": 2047,
      "cycle_frames": 22,
      "pixels_agreeing_frac": 0.09964093357271095,
      "pixels_with_rhythm_frac": 1.0,
      "interval_quartiles_frames": [
        12.0,
        22.25,
        54.0
      ]
    }
  }
},
"factor": 2.0,
```

```

"reason": null,
"source": "per-pixel dominant frequency (images)",
"status": "provisional",
"baseline_frames": 901,
"slowest_segment": "whole_recording",
"required_min_frames": 44,
"slowest_cycle_frames": 22
},
"deposit_checks": {
"flags": [
{
"flag": "negative_values",
"value": 1.0,
"suggests": "baseline-subtracted or normalized; raw fluorescence counts are non-negative",
"threshold": 0.01
}
],
"status": "provisional",
"measures": {
"max": -25.0,
"min": -13413.0,
"frames_used": 2000,
"integer_frac": 1.0,
"negative_frac": 1.0,
"frames_with_nan": 0,
"dv_lag1_autocorr_median": -0.022236137855436912,
"neighbour_dv_corr_median": 0.4009710844063593
},
"processed_before_deposit": true
},
"pipeline_check": {
"model": "openai:gpt-5.5",
"proceed": true,
"anomalies": [
{
"topic": "Frame-rate provenance for a MiCAM file",
"severity": "warn",
"effect_on_analysis": "The run should use 977.0 Hz from the recording-row admission source, but the cited paper text refers to the custom/iDS system and 200x200 acquisition while this deposited file is labelled MiCAM and is 100x100. Frame-based protocol parameters are unchanged; any time conversion or rate interpretation should note the medium-confidence provenance."
},
{
"topic": "Pre-deposit sign/conditioning",
"severity": "warn",
"effect_on_analysis": "The measured polarity is consistently non-inverted although Di-4-ANEPPS normally dims on depolarization, implying a sign flip or other transformation before deposit/export. The fixed pipeline orients from the measurement, so this does not by itself invalidate the run, but polarity-dependent interpretation should be cautious."
},
{
"topic": "Unexplained all-negative data values",

```

```

    "severity": "warn",
    "effect_on_analysis": "All sampled values are negative integers, suggesting baseline subtraction, normalization, or other processing before deposit. The protocol can still run, but amplitudes, noise estimates, and comparisons to raw fluorescence are affected by undocumented prior processing."
  },
  {
    "topic": "Mask is not a heart segmentation",
    "severity": "warn",
    "effect_on_analysis": "The analysis mask is based only on nonzero temporal standard deviation and covers 9999/10000 pixels, so spatial maps may include non-tissue/background pixels. Analyses that require tissue-only pixels need a biological mask before interpretation."
  },
  {
    "topic": "baseline-window rule",
    "severity": "info",
    "effect_on_analysis": "The coded baseline rule passed: baseline_frames 901 is at least 2.0 times the slowest segment cycle reported by the rule, with ratio 40.955. This rule is provisional and is reported as informational only."
  },
  {
    "topic": "Rhythm detector not suitable for the expected paced period here",
    "severity": "info",
    "effect_on_analysis": "The inspector cautions that the short-cycle rhythm result used in one detector should not be used to infer physiology or frame rate for this recording. The segment rhythm report for the protocol baseline gives the analysed window and dominant cycle separately; no expected outcome is inferred."
  }
],
"rationale": "The fixed protocol is appropriate to run as-is because the recording is a mouse-labelled public reference recording under the Luther lab mouse whole-heart optical-mapping protocol, and there are no recording facts that directly conflict with specified protocol fields. The protocol does not specify a required indicator, pixel size, frame rate, or image size, so the available recording facts do not create a blocking mismatch. The main limitations are provenance and preprocessing warnings: the working frame rate is admitted as 977.0 Hz but is supported by paper text for a different named camera/resolution, and the deposited data appear transformed before deposit. These issues affect interpretation and reporting rather than requiring parameter changes under the fixed version-3 protocol.",
"mismatches": [],
"hold_reason": null,
"protocol_id": "f65d786f-f194-4be2-88b8-10d3dd25d674",
"methods_text": "Using provisional parameter set version 3 for protocol f65d786f-f194-4be2-88b8-10d3dd25d674, the provisional fixed criteria use 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 2047 frames of size 100x100; the frame rate used is 977.0 Hz from the recording-row admission source citing 10.1371/journal.pone.0259174, and the pixel size is not provided. The analysed frames are 500 to 1547 for the whole-recording analysis window, and the provisional segment definition is whole_recording from frame 0 to frame 2047, defined at admission with no detected or logged events.",
"recording_id": "ae77081e-a125-471f-8805-27dad0688848",
"params_version": 3,

```

```

    "prompt_version": "pipeline-v2"
  }
},
"signature": {
  "id": "0187eb93-2c8b-4500-b11c-9d0062c96d4a",
  "created_at": "2026-10-28T19:00:32.083292+00:00",
  "movie_path": "runs/2aec1b88-1bc3-430f-9d57-a9ddcf39928c/movie.mp4",
  "frames": {
    "f0": 500,
    "f1": 1547,
    "maps": "runs/2aec1b88-1bc3-430f-9d57-a9ddcf39928c/frames/maps.npz",
    "dtype": "<f4",
    "phase": "runs/2aec1b88-1bc3-430f-9d57-a9ddcf39928c/frames/phase.npy",
    "shape": [
      1047,
      100,
      100
    ],
    "sha256": {
      "maps": "2faef5c48ac4bab2f8de7dc112bf0252495f745f2d48993e212f6d9febbe658c",
      "phase": "bbc12dc0da055e9e26dcf0f45e469f936654933dfc41fcd6c7db6814cde05a56",
      "voltage": "833b285fc616c753bdfa0e47f8c5e1baf3cdf0f3aab8d8147dbbb5767e2ba471"
    },
    "voltage": "runs/2aec1b88-1bc3-430f-9d57-a9ddcf39928c/frames/voltage.npy",
    "map_keys": [
      "activation:whole_recording",
      "dominant_frequency:whole_recording",
      "dominant_frequency>window",
      "mask"
    ],
    "map_units": {
      "mask": "tissue mask, source file_variable",
      "dominant_frequency>window": "Hz",
      "activation:whole_recording": "ms",
      "dominant_frequency:whole_recording": "Hz"
    }
  },
"filter_params": {
  "mask": "not NaN in frame 0 and nonzero temporal std",
  "render": {
    "step": 4,
    "palettes": {
      "phase": "twilight",
      "camera": "gray",
      "voltage": "gray"
    },
    "interpolation": "nearest"
  },
  "window": {
    "f0": 500,
    "f1": 1547,
    "segments": [
      {
        "name": "whole_recording",

```

```

"label": "whole recording",
"defined": [
  0,
  2047
],
"analysed": [
  500,
  1547
],
"citation": null,
"defined_by": "admission (project lead); no comparison defined",
"segment_id": "f43dd23d-fc9d-4a02-a299-3c478800b938",
"end_event_id": null,
"start_event_id": null,
"expected_persistent_rotors": null
}
],
"illumination": null,
"frame_rate_hz": 977.0,
"frame_rate_source": {
  "by": "project lead",
  "ref": "10.1371/journal.pone.0259174",
  "kind": "admission",
  "quote": "The custom software was designed to make recordings with a resolution of
200x200 pixels and a framerate of 977 frames per second (FPS).",
  "source": "paper_methods"
},
"segment_cycles_frames": {
  "whole_recording": 150
}
},
"lowpass": null,
"polarity": 1,
"tracking": {
  "link_px": 4.0,
  "max_gap": 5,
  "min_cycles": 1.0,
  "min_frames": 150,
  "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": [
    {
      "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": "per-pixel dominant frequency (images)",
        "required_min_frames": 44,
        "slowest_cycle_frames": 22
      },
      "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": {
        "lowpass": null,
        "spatial_sigma": 1.0,
        "baseline_frames": 901,
        "spatial_truncate": 4.0
      },
      "decision": null,

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    "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": "intensity variable 'bgimage' in the file, Otsu threshold 2165, class above
with more temporal signal, largest connected component",
        "side": "above",
        "source": "file_variable",
        "coverage": 0.1114,
        "variable": "bgimage",
        "threshold": 2165.203125,
        "tissue_pixels": 1114
    },
    "decision": null,
    "location": "worker/voltage/io.py (tissue_mask_info, otsu_threshold,
largest_component)",
    "reviewed": false,
    "reviewer": null,
    "description": "Tissue mask from, in order: (1) NaN in frame 0 when the recording has
any NaN; (2) a mask or background-image variable shipped in the file whose shape matches the
frame (binary as is, an intensity image thresholded with Otsu); (3) Otsu's threshold on the
mean image, the class with more temporal signal as tissue, largest connected component kept;
source, coverage and threshold recorded",
    "reviewed_at": null
},
{
    "id": "polarity",
    "expert": "optical mapping analyst / voltage dye chemist",
    "status": "provisional",
    "values": {
        "method": "median skew of dV/dt",
        "result": 1
    },
    "decision": null,
    "location": "worker/voltage/preprocess.py (polarity)",
    "reviewed": false,
    "reviewer": null,
    "description": "Dye polarity from sign of median per-pixel skew of dV/dt",
    "reviewed_at": null
},
{
    "id": "singularity_detection",
    "expert": "computational cardiac electrophysiologist (phase mapping)",
    "status": "provisional",
    "values": {
        "rotor_erode_px": 3,

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    "rotor_threshold": 0.9
  },
  "decision": null,
  "location": "worker/voltage/preprocess.py (Params.rotor_threshold, rotor_erode_px)",
  "reviewed": false,
  "reviewer": null,
  "description": "Phase singularity = |winding| > threshold turns, >= erode px from
tissue edge",
  "reviewed_at": null
},
{
  "id": "rotor_persistence",
  "expert": "computational cardiac electrophysiologist (phase mapping)",
  "status": "provisional",
  "values": {
    "link_px": 4.0,
    "max_gap": 5,
    "min_cycles": 1.0,
    "min_frames": 150
  },
  "decision": null,
  "location": "worker/voltage/rotors.py (TrackParams)",
  "reviewed": false,
  "reviewer": null,
  "description": "Track linking distance/gap and minimum lifetime for a persistent
rotor",
  "reviewed_at": null
},
{
  "id": "chirality_pairing",
  "expert": "computational cardiac electrophysiologist (phase mapping)",
  "status": "provisional",
  "values": {
    "paired_frac": 0.5,
    "pair_dist_px": 3.0
  },
  "decision": null,
  "location": "worker/voltage/rotors.py (TrackParams.pair_dist_px, paired_frac)",
  "reviewed": false,
  "reviewer": null,
  "description": "Opposite-charge singularities within pair distance are a pair; tracks
paired most of their life are excluded from rotors",
  "reviewed_at": null
},
{
  "id": "sensitivity_grid",
  "expert": "optical mapping analyst",
  "status": "provisional",
  "values": {
    "sigmas": {
      "light": 0.5,
      "default": 1.0,
      "heavier": 2.0
    }
  },

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"trackers": {
  "loose": [
    6.0,
    10
  ],
  "strict": [
    2.0,
    1
  ],
  "default": [
    4.0,
    5
  ]
},
"baselines": {
  "run": 901,
  "3x_cycle": 450,
  "6x_cycle": 900,
  "1.5x_cycle": 225
}
},
"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": 1547
  },
  "decision": null,
  "location": "worker/voltage/runs.py (default_window)",
  "reviewed": false,
  "reviewer": null,
  "description": "Frames analysed: whole recording minus one filter pad at each end
(unless the plan narrows it)",
  "reviewed_at": null
},
{
  "id": "prior_processing_flags",
  "expert": "imaging scientist (camera acquisition and noise)",
  "status": "provisional",
  "values": {
    "flags": [
      "negative_values"
    ],
    "thresholds": {

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    "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": "pipeline_check",
  "expert": "optical mapping analyst",
  "status": "provisional",
  "values": {
    "model": "openai:gpt-5.5",
    "proceed": true,
    "anomalies": [
      "Frame-rate provenance for a MiCAM file",
      "Pre-deposit sign/conditioning",
      "Unexplained all-negative data values",
      "Mask is not a heart segmentation",
      "baseline-window rule",
      "Rhythm detector not suitable for the expected paced period here"
    ],
    "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,

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    "description": "Cited physiological ranges (single-study values widened by a 25%
tolerance), applied to segments by their expected rhythm; used by the critic and for frame-
rate sanity checks",
    "reviewed_at": null
},
{
    "id": "stability_rule",
    "expert": "biostatistician + optical mapping analyst",
    "status": "provisional",
    "values": {
        "unstable": [
            "whole_recording.singularity_frames_frac",
            "whole_recording.persistent_rotors",
            "whole_recording.persistent_rotor_count_max",
            "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": 150,
        "paper_rotation": null
    },
    "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
},
{
    "id": "persistent_rotor_criterion",
    "expert": "cardiac electrophysiologist",
    "status": "provisional",
    "values": {
        "max_absent": 0,
        "min_present": 1
    },
    "decision": null,
    "location": "worker/voltage/sensitivity.py (MIN_ROTORS_PRESENT, MAX_ROTORS_ABSENT)",

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    "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
  }
],
  "status": "provisional",
  "all_reviewed": false,
  "superseded_by_run": null
}
},
"segments": [
  {
    "id": "f43dd23d-fc9d-4a02-a299-3c478800b938",
    "position": 1,
    "name": "whole_recording",
    "label": "whole recording",
    "start_frame": 0,
    "end_frame": 2047,
    "expected_persistent_rotors": null,
    "definition": "whole recording; no events detected or logged at admission",
    "defined_by": "admission (project lead); no comparison defined",
    "citation": null,
    "evidence": {},
    "provisional": true
  }
],
"events": []
}
```