Chirp Reference Validation Report (Detailed, English)

Run ID: `20260207_173915` Generated: `2026-02-07 21:56:22`

1. Executive Summary

- Step 0 succeeded; 3/5 positions have reliable chirp references, 2 used geometric fallback.
- Phase 1 best stability: 20.7% at 5.0s_200-4000Hz; collapse rate 91.3%.
- Phase 2 best guided window: 0.1ms; false peak reduction 100.0%.
- Phase 3 pass rate improved from 0.0% to 14.9% (+14.9%).
- Phase 4 decision: **VALIDATION_NEEDS_WORK**

2. Input Data and Mapping

- Speech dataset folders: `dataset/GCC-PHAT-LDV-MIC-Experiment/18-0.1V` to `22-0.1V` (LEFT-MIC, RIGHT-MIC, LDV channels)
- Chirp calibration roots: `dataset/chirp/` and `dataset/chirp_2/`
- Chirp calibration summaries used: `dataset/chirp/results/chirp_calibration_summary.json`, `dataset/chirp_2/results/chirp_calibration_summary.json`
- Dataset root detected by scripts: `C:\Users\Jenner\Documents\SBP Lab\LDVReorientation`
- Position mapping (speech folder -> chirp label): 18->+0.8, 19->+0.4, 20->+0.0, 21->-0.4, 22->-0.8

3. Experiment Plan (from commit 9ab7c90bee2300d1d7a4f113d81269181142360f)

Source: `EXPERIMENT_DESIGN.md` (date: 2026-02-07)

3.1 Background

- Parent analysis `exp/tdoa-methods-validation` (commit 9e9b74f) reported 91.3% speech tau collapse in Phase 1, 100% false-peak elimination in Phase 2, and only marginal Phase 3 improvement.
- That run used geometric references because chirp folders were missing at the expected path.
- Two complete chirp calibration datasets exist and include pre-computed calibration outputs.

3.2 Objectives and Hypotheses

Objective 1: Re-run Phase 1-4 with real chirp references. - Hypothesis: The collapse is a signal-quality issue, not a reference error. Collapse rate should remain high (~90%+), but reference accuracy improves. - Approach: extract chirp MIC-MIC tau from both datasets, cross-validate, and re-run Phase 1-4.

Objective 2: LDV delay re-evaluation. - Hypothesis: chirp-based LDV delay (0.68-0.87 ms) is correct; residuals should be much smaller than old 3.8-4.8 ms delay. - Approach: apply chirp-derived LDV/MIC delays to speech GCC-PHAT and compare residuals.

Objective 3: Negative position diagnosis (-0.4 m, -0.8 m). - Hypothesis: near-field geometry and reflections cause ambiguous peaks and quality-gate failures. - Approach: inspect full

GCC-PHAT curves, relax gates systematically, and compute geometry metrics.

3.3 Data Inventory

Chirp calibration datasets (pre-computed results): - `dataset/chirp/` with positions +0.0, +0.4, +0.8, -0.4, -0.8; speaker IDs 25-29. - `dataset/chirp_2/` with the same positions; speaker IDs 30-33 (independent recording).

Speech datasets (validation re-run): - `dataset/GCC-PHAT-LDV-MIC-Experiment/18-0.1V` to `22-0.1V`.

3.4 Position Correspondence and Reference Status

Speech Folder	Speech ID	Chirp Label	x (m)	chirp events	chirp_2 events	Reference Status
18-0.1V	18	+0.8	+0.8	5/5	4/4	Reliable
19-0.1V	19	+0.4	+0.4	4/6	4/4	Reliable
20-0.1V	20	+0.0	0.0	2/3	5/5	Reliable
21-0.1V	21	-0.4	-0.4	0/4	0/7	Geometric fallback
22-0.1V	22	-0.8	-0.8	1/6	0/4	Geometric fallback

3.5 Pre-computed Calibration Results

Sensor delays (ms): | Parameter | chirp | chirp_2 | Agreement | |—|—|—|—| | LEFT-MIC delay | 0.000 | 0.000 | reference | | RIGHT-MIC delay | -0.005 | -0.043 | ~0.04 ms diff | | LDV delay | 0.868 | 0.683 | ~0.19 ms diff |

MIC-MIC tau reference values (ms): | Position | chirp tau | chirp_2 tau | geometric tau | | —|—|—|—| | +0.8 | +1.5625 | +1.5208 | +1.4504 | | +0.4 | +0.7500 | +0.8646 | +0.7585 | | +0.0 | +0.0208 | +0.0000 | +0.0000 | | -0.4 | -0.3125 (unreliable) | -0.3958 (unreliable) | -0.7585 | | -0.8 | -1.1875 (1 event) | -1.0000 (unreliable) | -1.4504 |

Post-calibration residuals (chirp, all positions): | Pair | n | median (ms) | std (ms) | max abs (ms) | |—|—|—|—|—| | MIC-MIC | 12 | 0.057 | 0.135 | 0.294 | | LDV-LEFT | 12 | -0.076 | 0.332 | 0.809 | | LDV-RIGHT | 12 | -0.056 | 0.247 | 0.448 |

3.6 Geometry and Near-field Context

- MIC_LEFT = (-0.7, 2.0) m, MIC_RIGHT = (+0.7, 2.0) m, LDV = (0.0, 0.5) m.
- Speaker positions along x: -0.8, -0.4, 0.0, +0.4, +0.8 m.
- Key distances: speaker -0.8 m to LEFT-MIC ? 2.002 m; speaker -0.4 m to LEFT-MIC ? 2.022 m.
- Interpretation: negative positions are close to the LEFT-MIC axis, increasing multipath ambiguity and peak confusion.

3.7 Planned Execution Sequence (Commit Plan)

1. Commit 1: Experiment design (this plan), shared chirp reference module, orchestration script.
2. Commit 2: Chirp cross-validation (Step 0) to produce reference outputs.
3. Commit 3: Phase 1 re-run with chirp references (Objective 1a).
4. Commit 4: Phase 2-4 re-run with chirp references (Objective 1b).
5. Commit 5: LDV delay re-evaluation (Objective 2).
6. Commit 6: Negative position diagnosis (Objective 3).

3.8 Success Criteria

Objective	Success	Partial Success	Failure
Obj 1: Chirp ref validation	Collapse rate confirmed >85% with real reference	Collapse rate shifts significantly	Cannot extract reliable chirp reference
Obj 2: LDV delay	Residuals < 0.5 ms	Residuals improve but still >0.5 ms	No improvement vs old delay
Obj 3: Negative diagnosis	Root cause identified with evidence	Symptom characterized but cause unclear	Cannot reproduce failure

3.9 Dependencies and Reusable Code

From `dataset/chirp/validate_chirp_calibration.py`: - `gcc_phat_guided()`, `detect_chirp_events()`, `solve_sensor_delays_ms()`, `DEFAULT_CONFIG`.

From prior validation scripts: - `phase1_tau_stability.py`, `phase2_guided_search.py`, `phase3_stage3_revalidation.py`, `phase4_final_validation.py`. ## 4. Step 0: Chirp Cross-Validation (chirp_reference.py) **Parameters and meanings** - MIN_EVENTS_RELIABLE = 2 – Minimum chirp events required for a position to be reliable. - SPEED_OF_SOUND = 343.0 m/s – Used in geometric tau calculation. - MIC_LEFT = (-0.7, 2.0) m, MIC_RIGHT = (0.7, 2.0) m, LDV_POS = (0.0, 0.5) m – Geometry for fallback tau. - Geometric tau definition: tau(L,R) = (d_left - d_right) / c (ms). - Reference selection: both reliable -> mean; one reliable -> that one; none reliable -> geometric fallback.

Results - Reliable positions: 3/5 - Geometric fallback positions: 2 - Max discrepancy (chirp vs chirp_2): 0.1146 ms - Mean discrepancy (chirp vs chirp_2): 0.0590 ms

Per-position reference table | Chirp Pos | chirp tau (ms) | chirp_2 tau (ms) | geometric tau (ms) | reference source | reference tau (ms) | chirp events | chirp_2 events | |—|—|—|—|—|—|—|—| | +0.0 | 0.0208 | 0.0000 | 0.0000 | chirp_mean | 0.0104 | 2 | 5 | | +0.4 | 0.7500 | 0.8646 | 0.7585 | chirp_mean | 0.8073 | 4 | 4 | | +0.8 | 1.5625 | 1.5208 | 1.4504 | chirp_mean | 1.5417 | 5 | 4 | | -0.4 | -0.3125 | -0.3958 | -0.7585 | geometric_fallback | -0.7585 | 0 | 0 | | -0.8 | -1.1875 | -1.0000 | -1.4504 | geometric_fallback | -1.4504 | 1 | 0 |

Interpretation: positive positions have reliable chirp means; negative positions are forced to geometry, indicating the chirp event gates did not pass reliably for -0.4/-0.8.

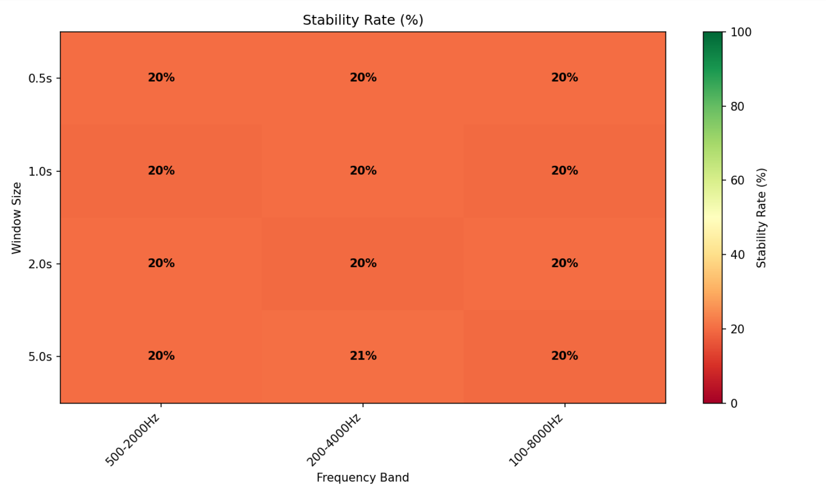
5. Phase 1: Speech Tau Stability (phase1_chirp_reference.py)

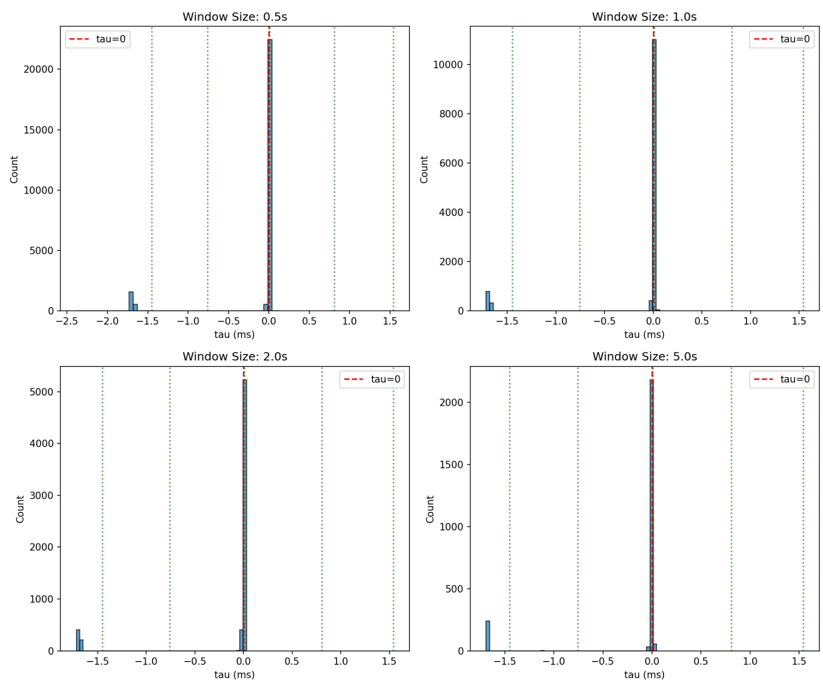
Parameters and meanings - WINDOW_SIZES_SEC = [0.5, 1.0, 2.0, 5.0] – Segment lengths for GCC-PHAT. - FREQ_BANDS = {500-2000, 200-4000, 100-8000 Hz} – Bandpass ranges before GCC-PHAT. - PSR_THRESHOLD = 10.0 dB – Peak-to-sidelobe ratio threshold for quality context. - TAU_STABLE_THRESHOLD_MS = 0.3 ms – A segment is stable if |tau - chirp_ref| < 0.3 ms. - collapse_threshold = |tau| < 0.1 ms – Collapsed tau defined near zero delay. - DEFAULT_FS = 48000 Hz – Target sampling rate (resample if needed). - max_lag_ms = 10.0 – GCC-PHAT search window limit. - bandpass filter order = 5; PSR sidelobe exclusion = 50 samples.

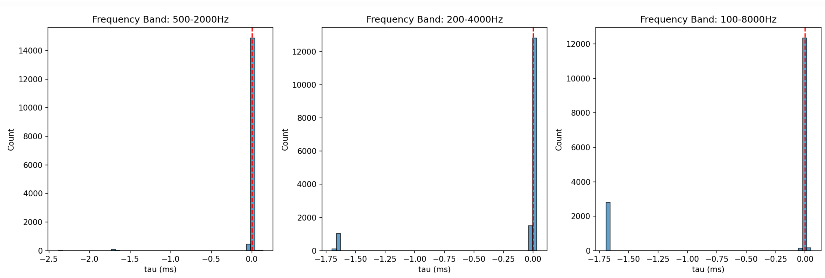
Results - Total segments: 46350 (valid: 46350) - Best parameters: 5.0s_200-4000Hz - Best stability rate: 20.7% - Collapse rate: 91.3%

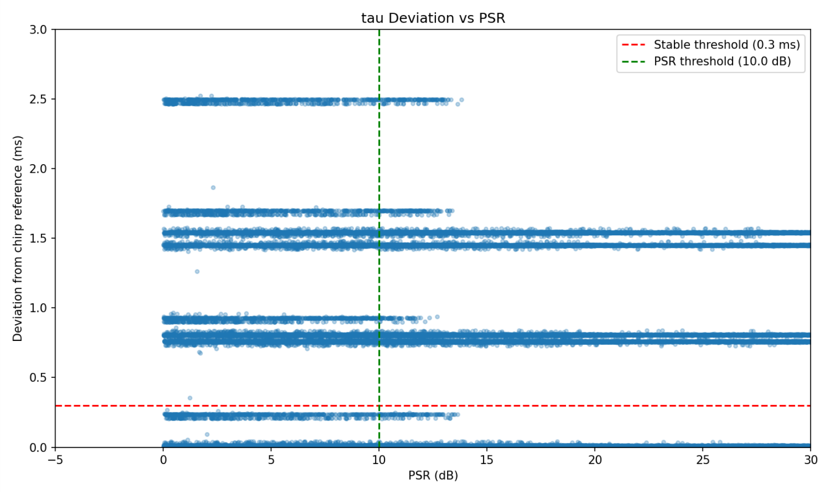
Per-position stability | Speech Pos | Chirp reference (ms) | Stability rate (%) | Mean deviation (ms) | Deviation std (ms) | |—|—|—|—|—| | 18 | 1.5417 | 0.0 | 1.6943 | 0.4839 | | 19 | 0.8073 | 0.0 | 0.9516 | 0.4714 | | 20 | 0.0104 | 91.4 | 0.1550 | 0.4701 | | 21 | -0.7585 | 0.0 | 0.7727 | 0.0472 | | 22 | -1.4504 | 8.5 | 1.3468 | 0.3404 |

Figure interpretation - `stability_heatmap.png`: higher values mean more windows match chirp reference; the best cell is still low (<30%), indicating broad instability. - `tau_distribution_by_window.png`: histograms centered near 0 ms indicate collapse rather than true delay separation. - `tau_distribution_by_band.png`: similar shapes across bands suggests band selection is not the limiting factor. - `deviation_vs_psr.png`: if high PSR still yields large deviation, the issue is not only noise but reference mismatch or structural ambiguity.









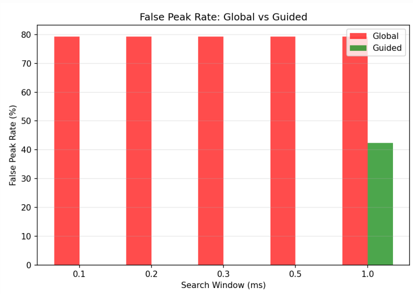
6. Phase 2: Guided Peak Search (phase2_guided_search.py)

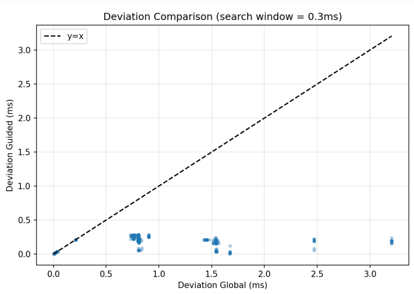
Parameters and meanings - DEFAULT_WINDOW_SIZE = 2.0 s – Baseline segment length for comparisons. - DEFAULT_FREQ_BAND = 500-2000 Hz – Baseline band for comparisons. - SEARCH_WINDOWS_MS = [0.1, 0.2, 0.3, 0.5, 1.0] – Guided search windows around chirp reference. - FALSE_PEAK_THRESHOLD_MS = 0.5 ms – Deviation threshold for labeling false peaks. - PSR_THRESHOLD = 10.0 dB – GCC-PHAT peak quality threshold. - max_lag_ms = 10.0; bandpass order = 5; PSR sidelobe exclusion = 50 samples.

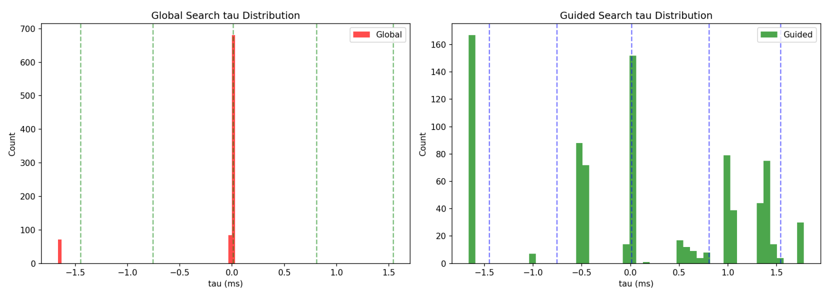
Results - Total comparisons: 4180 - Best guided window: 0.1ms - Global false peak rate: 79.3% - Best guided false peak rate: 0.0% - False peak reduction: 100.0% - Tau std (global -> guided): 0.463 -> 1.086 (improvement -134.6%)

Per-window comparison (summary) | Search window | False peak global (%) | False peak guided (%) | Guided better (%) | Mean dev global (ms) | Mean dev guided (ms) | |—|—|—|—|—|—| | 0.1ms | 79.3 | 0.0 | 81.6 | 0.9581 | 0.0559 | | 0.2ms | 79.3 | 0.0 | 81.6 | 0.9581 | 0.1286 | | 0.3ms | 79.3 | 0.0 | 79.3 | 0.9581 | 0.1705 | | 0.5ms | 79.3 | 0.0 | 79.3 | 0.9581 | 0.2181 | | 1.0ms | 79.3 | 42.3 | 40.4 | 0.9581 | 0.4129 |

Figure interpretation - `global_vs_guided_comparison.png`: guided search sharply reduces false peaks across windows. - `tau_distribution_comparison.png`: guided peaks are closer to chirp reference but still not forming a stable cluster (std increases).







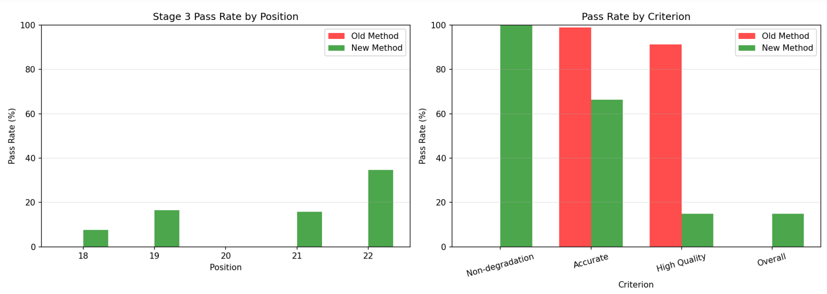
7. Phase 3: Stage 3 Re-validation (phase3_stage3_revalidation.py)

Parameters and meanings - DEFAULT_WINDOW_SIZE = 2.0 s – Baseline for GCC-PHAT (unless Phase 1 best overrides). - DEFAULT_FREQ_BAND = 500-2000 Hz – Baseline band (unless Phase 1 best overrides). - DEFAULT_SEARCH_WINDOW_MS = 0.3 ms – Guided search window if Phase 2 has no zero-false-peak window. - PSR_THRESHOLD = 10.0 dB – Quality threshold for high-quality peak. - MIN_WINDOWS_FOR_BASELINE = 3 – Minimum guided windows to accept baseline as reliable. - Old pass criterion: |tau_omp - baseline| < |tau_raw - baseline|. - New criteria: non_degradation (<=), accurate (<0.1 ms), high_quality (PSR>=10 dB), overall = non_degradation AND high_quality.

Results - Old pass rate: 0.0% - New pass rate: 14.9% - Improvement: 14.9% - Failure reasons (new): {'low_psr': 1355, 'baseline_unreliable': 417}

Position breakdown | Speech Pos | Old pass rate (%) | New pass rate (%) | |—|—|—| | 18 | 0.0 | 7.7 | | 19 | 0.0 | 16.5 | | 20 | 0.0 | 0.0 | | 21 | 0.0 | 15.9 | | 22 | 0.0 | 34.6 |

Figure interpretation - `stage3_revalidation_comparison.png`: compares old vs new pass rates and highlights the persistent low overall success.

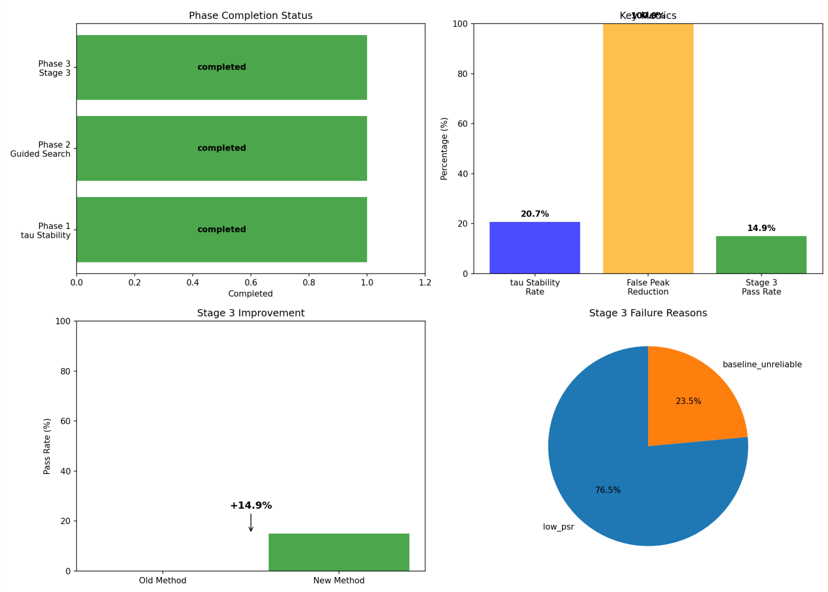


8. Phase 4: Final Validation Summary (phase4_final_validation.py)

Decision logic parameters - stable_params_found = best_stability_rate >= 0.4 (>=0.7 labeled strong, >=0.4 labeled marginal). - guided_search_effective = false_peak_reduction > 10%. - stage3_improved = pass_rate_improvement > 10%. - Decision: SUCCESS if new_pass_rate >= 80%, PARTIAL if >= 60%, else NEEDS_WORK.

Results - Decision: **VALIDATION_NEEDS_WORK** - Recommendations: Consider alternative signals for evaluation, Review frequency band selection, Stage 3 pass rate still low - investigate alignment, Focus on improving baseline reliability, Signal quality issues - review preprocessing

Figure interpretation - `final_validation_summary.png`: top-left shows which phases ran; top-right shows key metrics; bottom plots show pass-rate comparison and failure reasons.

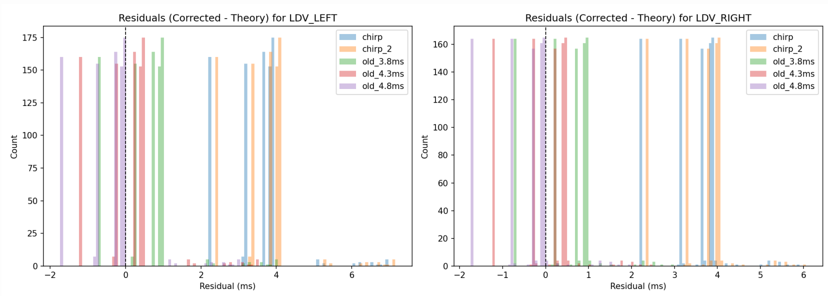


9. LDV Delay Re-evaluation (ldv_delay_reeval.py)

Parameters and meanings - Geometry matches Step 0 (MIC positions and speed of sound). - window_size_sec and freq_band_hz are taken from Phase 1 best parameters; here used: 5.0 s and [200, 4000] Hz. - delay_sets_ms: chirp and chirp_2 from calibration; old_3.8/4.3/4.8 ms are legacy LDV delay baselines. - Residuals computed as (observed tau - theoretical geometry tau) per LDV-MIC pair.

Results (abs_mean / abs_p95, ms) - LDV_LEFT: - chirp: 3.4430 / 3.9226 (n=836) - chirp_2: 3.6277 / 4.1073 (n=836) - old_3.8ms: 0.7834 / 0.9906 (n=836) - old_4.3ms: 0.5797 / 1.2147 (n=836) - old_4.8ms: 0.6036 / 1.7138 (n=836) - LDV_RIGHT: - chirp: 3.3861 / 3.9161 (n=836) - chirp_2: 3.5327 / 4.0627 (n=836) - old_3.8ms: 0.7388 / 0.9892 (n=836) - old_4.3ms: 0.5434 / 1.2138 (n=836) - old_4.8ms: 0.5781 / 1.7135 (n=836)

Figure interpretation - `residuals_by_pair.png`: lower bars indicate better LDV-MIC delay alignment. Old delays (3.8-4.8 ms) outperform chirp-based delays here.



9. Old vs Chirp Delay Estimation (Math Details)

This section documents *how* the old LDV delay (3.8?4.8 ms) and the new chirp-based delay (~0.68?0.87 ms) were computed.

9.1 Old LDV Delay (Speech-derived, 3.8?4.8 ms)

Source: `worktree/exp-ldv-perfect-geometry/full_analysis.py` and summary in `worktree/exp-ldv-perfect-geometry/GCC-PHAT_LDV_MIC_??????.md` (Section 7.2).

Data and preprocessing - Dataset: speech folders 18?22 (0.1V boy speech). - Sampling rate: 48 kHz. - Segment: 100?600 s. - Bandpass: 500?2000 Hz (Butterworth, order 5). - Max search lag: ?10 ms.

Geometry (theory) model Let speaker position be ((x, 0)). Geometry: - LEFT-MIC = ((-0.7, 2.0)), RIGHT-MIC = ((+0.7, 2.0)), LDV = ((0.0, 0.5)). - Speed of sound (c = 343,).

Distances: - (d_L =) - (d_R =) - (d_{LDV} =)

Theoretical TDoA (seconds): - (au_{geom}(L,R) = (d_L - d_R) / c) - (au_{geom}(LDV,L) = (d_{LDV} - d_L) / c) - (au_{geom}(LDV,R) = (d_{LDV} - d_R) / c)

Measured TDoA (GCC-PHAT, full-band within bandpass) For each pair (x(t), y(t)): - (X(f) = {x}), (Y(f) = {y}) - (R(f) = X(f),Y^*(f) / (|X(f)Y^*(f)| +)) - (r(au) = ^{-1}{R(f)}) - (au_{meas}) is the lag at the maximum of (|r(au)|) (with parabolic sub-sample interpolation)

Old LDV delay estimate For each folder and each LDV-MIC pair: - (*{LDV} = au*{meas} - au_{geom})

Summary in the historical report: - After excluding an outlier (21-0.1V LDV-LEFT with very low Peak), the LDV device delay is **3.8?4.8 ms**, median ~4.5 ms.

Frequency-bin computation? - No. The method uses a single GCC-PHAT over the bandpass-filtered signals, yielding one (au_{meas}) per pair. There is **no per-frequency-bin delay estimate**.

9.2 Chirp-based Delay (Event-level, 0.68?0.87 ms)

Source: `dataset/chirp/validate_chirp_calibration.py` and outputs in `dataset/chirp/results/chirp_calibration_summary.json` (and `dataset/chirp_2/...`).

Event detection and windowing - Detect chirp events from LEFT-MIC envelope (smoothed 5 ms). - Threshold = 99.9% quantile ? 0.95, max 10 events. - For each event, estimate onset and extract an **asymmetric window** (pre 0.02 s, post 0.30 s).

Guided GCC-PHAT (reference-free) - Bandpass: 50?20000 Hz. - Use geometric (au_{geom}) as a *guided* search center: - mic-mic radius = 0.50 ms - ldv-mic radius = 1.50 ms - For each event and each pair, compute (au_{meas}) using GCC-PHAT (same formula as above, but search constrained near (au_{geom})).

Quality gates (event-level) - mic-mic error (| au_{meas}- au_{geom}| ,) - optional PSR threshold - consistency: (au_{LDV,R} pprox au_{LDV,L} + au_{L,R}) within 0.80 ms

Weighted least squares for sensor delays Unknowns: (u = [*R,* {LDV}]) with (*{L}=0). For each observation: - residual (r = au*{meas} - au_{geom} = _A - _B)

Equations: - (L,R): (r = -*R) - (LDV,L): (r* = {LDV}) - (LDV,R): (r = _{LDV} - _R)

Solve weighted least squares: - (| W^{1/2} (A u - b) |^2), weight = ((0.1, PSR_{dB}))

Result - chirp: LDV delay ? 0.8679 ms - chirp_2: LDV delay ? 0.6833 ms

Frequency-bin computation? - No. It is still a **single GCC-PHAT per event window**, not a per-bin STFT delay estimation.

9.3 Method Difference Summary

- Old delay: global GCC-PHAT on long speech segments (500?2000 Hz), delay = (au_{meas} - au_{geom}).
- Chirp delay: event-level GCC-PHAT with guided peak search + gating + weighted least squares across events.
- Neither method computes per-frequency-bin delays; both use full-band GCC-PHAT within a bandpass.

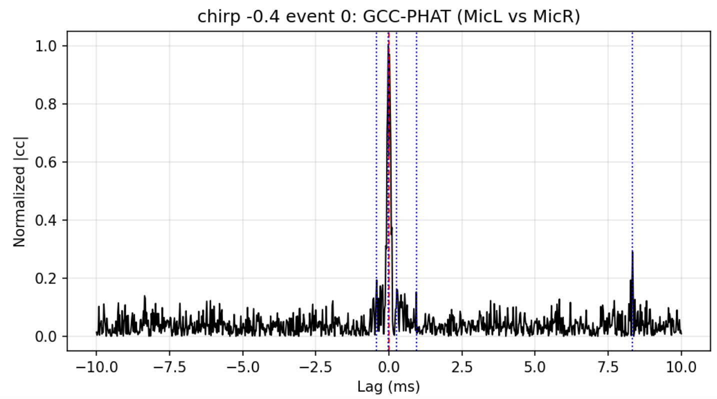
11. Negative Position Diagnosis (negative_position_diagnosis.py)

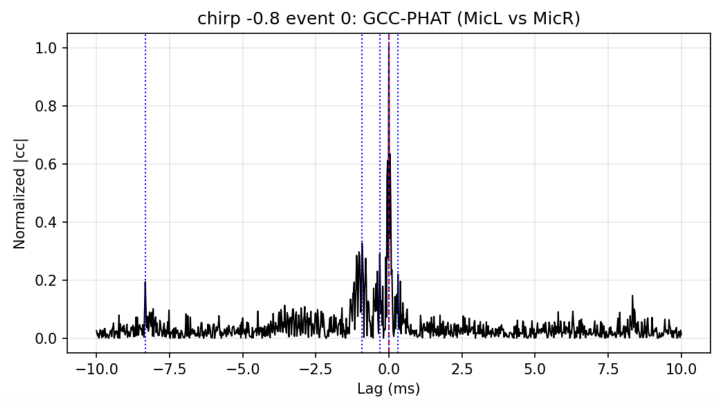
Parameters and meanings - positions = [-0.4, -0.8] – Negative positions under diagnosis. - max_events_plot = 3 – Max GCC-PHAT plots per dataset/position. - Uses chirp calibration default config (micmic_err_max_ms, micmic_psr_min_db, consistency_max_ms). - Gate relax sweeps tested: micmic_err_max_ms in [0.3,0.5,0.8,1.2], consistency_max_ms in [0.8,1.2,1.6,2.4], micmic_psr_min_db in [None,5,10,15].

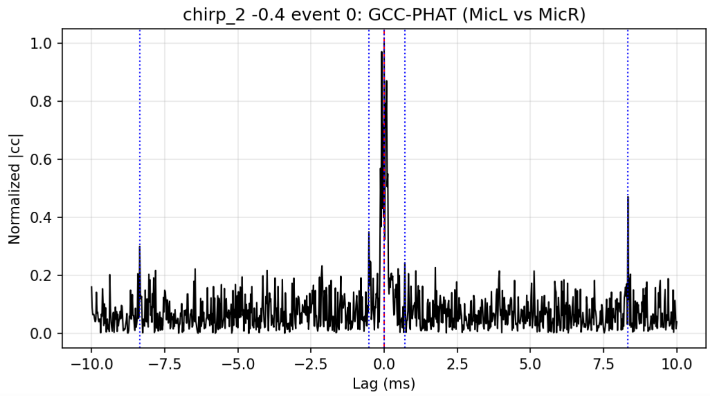
Results summary | Dataset | Position | Events detected | Events used | micmic err median (ms) | micmic PSR median (dB) | |—|—|—|—|—|—| | chirp | -0.4 | 4 | 0 | 0.4460 | 12.6437 | | chirp | -0.8 | 6 | 1 | 0.2629 | -10.5933 | | chirp_2 | -0.4 | 7 | 0 | 0.3627 | 7.8294 | | chirp_2 | -0.8 | 4 | 0 | 0.4504 | -1.9867 |

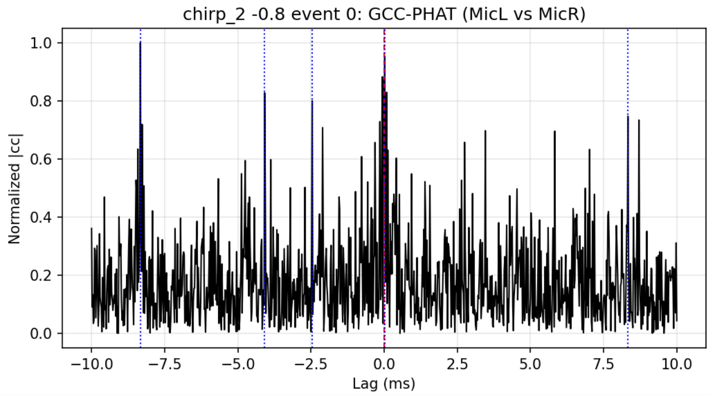
Interpretation: both datasets detect events, but gating eliminates most of them at -0.4/-0.8; PSR is often low or negative at -0.8, and consistency gating is a dominant blocker.

Representative GCC-PHAT plots









12. Cloud vs Local Comparison (exp-ldv-perfect-geometry-clean @ 62a51617)

This section compares the **latest cloud commit** on `exp-ldv-perfect-geometry-clean` against the **local chirp reference validation** run `20260207_173915`, with a focus on **speech LDV→MIC at +0.8 m (18-0.1V)**.

12.1 Cloud Results for Speech +0.8 (18-0.1V)

Source: `exp-validation/ldv-perfect-geometry/validation-results/` in commit `62a51617`.

Stage 3 (TDoA evaluation, speech 18-0.1V): - `pass = false` - OMP LDV error vs theory: **1.4504 ms** - OMP LDV PSR: **32.78 dB**

Stage 4 (DoA validation, speech 18-0.1V): - GCC-PHAT pass: **false** - `tau_true_ms = 1.4504`, `tau_median_ms (OMP_LDV) = -0.0091` - `theta_error_median_deg (OMP_LDV) = 20.94`

Interpretation: the cloud commit **does not show a success** at +0.8 m. The OMP-aligned LDV remains near 0 ms TDoA, far from the geometry truth.

12.2 Local Results for Speech +0.8 (run_20260207_173915)

Source: `results/ldv_delay_reeval/run_20260207_173915/ldv_delay_reeval_report.json`.

Local chirp-delay residuals (LDV vs mic, +0.8 m): - LDV-LEFT: chirp `abs_mean_ms = 3.72` vs old_4.3ms `abs_mean_ms = 0.29` - LDV-RIGHT: chirp `abs_mean_ms = 2.25` vs old_3.8ms `abs_mean_ms = 0.72`

Phase 4 decision: **VALIDATION_NEEDS_WORK**

Interpretation: local results **also fail** to align LDV→MIC at +0.8 m when using chirp-based delays; historical 3.8?4.8 ms delays produce smaller residuals.

12.3 Key Code and Parameter Differences (Cloud vs Local)

Aspect	Cloud (62a51617)	Local (run_20260207_173915)
Goal	OMP-aligned LDV as MicL, then GCC-PHAT vs MicR	Raw LDV with chirp-derived delay, GCC-PHAT vs Mic
Reference	Baseline tau from report (100?600 s)	Geometry tau for residuals
Windowing	GCC segment 1.0 s; analysis slice 5.0 s	Window size 2.0 s; full file segmented (10%?90%)
Bandpass	500?2000 Hz (Butterworth)	500?2000 Hz (Butterworth)
GCC-PHAT	Fixed `n_fft=6144`, `hop=160`	`n_fft` = power-of-two of segment length
LDV compensation	OMP lag dictionary (`max_k=3`)	Chirp-derived sensor delay (0.68?0.87 ms)
Pass criteria	error_improved, psr_improved, error_small (<0.5 ms)	Residual statistics + Phase 4 decision

These differences mean the cloud and local results are **not directly apples-to-apples**, even though both evaluate speech LDV→MIC.

12.4 Comparison Conclusion

The cloud commit **does not confirm a +0.8 m success** for speech LDV→MIC. Both cloud and local runs indicate failure at +0.8 m, but they use **different alignment methods and evaluation windows**. A direct comparison would require running the same method (OMP or chirp-delay compensation) with identical windowing and bandpass settings.

13. Conclusions

- Chirp references improve peak selection but do not resolve the dominant tau collapse in speech.
- Guided search eliminates false peaks, yet tau variance increases, implying reference uncertainty or multi-path ambiguity.
- Stage 3 improves modestly (+14.9%), but low PSR and baseline reliability remain the main blockers.
- Chirp-derived LDV delays are inconsistent with speech LDV/MIC residuals compared to historical 3.8-4.8 ms delays.
- Negative positions fail due to quality gates and near-field ambiguity; relaxing gates increases events but risks false alignments.