

Noise-Stationary Interferometer Locking

A tabletop Mach-Zehnder experiment to test whether locking to a normalized noise slope-null can reduce jitter-induced measurement noise versus conventional power locking.

Immediate ask: \$10K prototype/data sprint

Vnorm

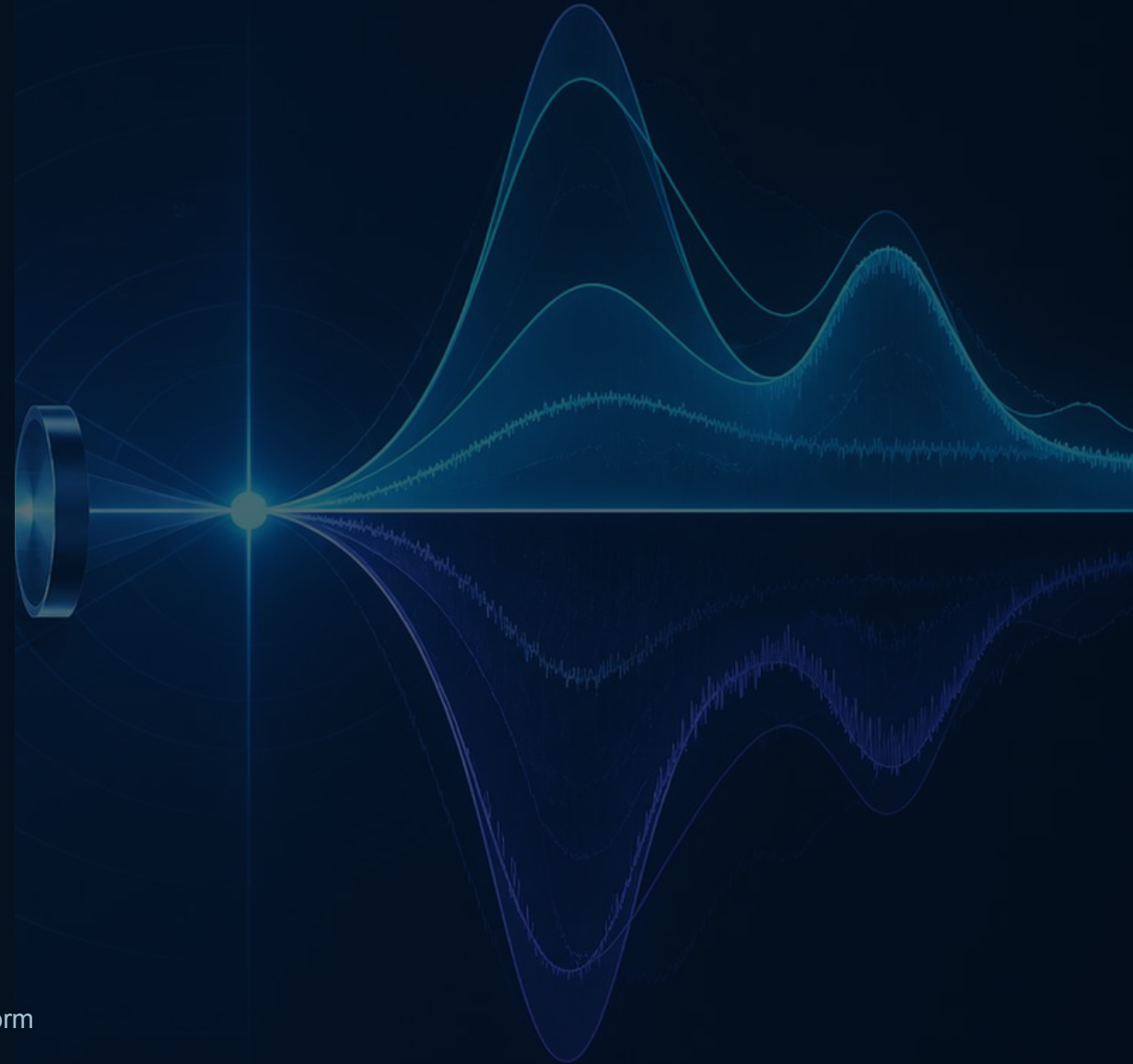
Nband / P^k objective

δ

slope-null operating point

MZI

first validation platform



Power locks protect the fringe — not necessarily the measurement noise.

Fieldable interferometric sensors face nonstationary disturbances: vibration, thermal drift, laser frequency noise, pointing jitter, speckle, platform motion, and mutual interference.

- Conventional locks stabilize optical power or a power-derived error signal.
- The power extremum can differ from the noise-optimal operating point.
- Detuning jitter can be converted into excess readout noise in the protected measurement band.

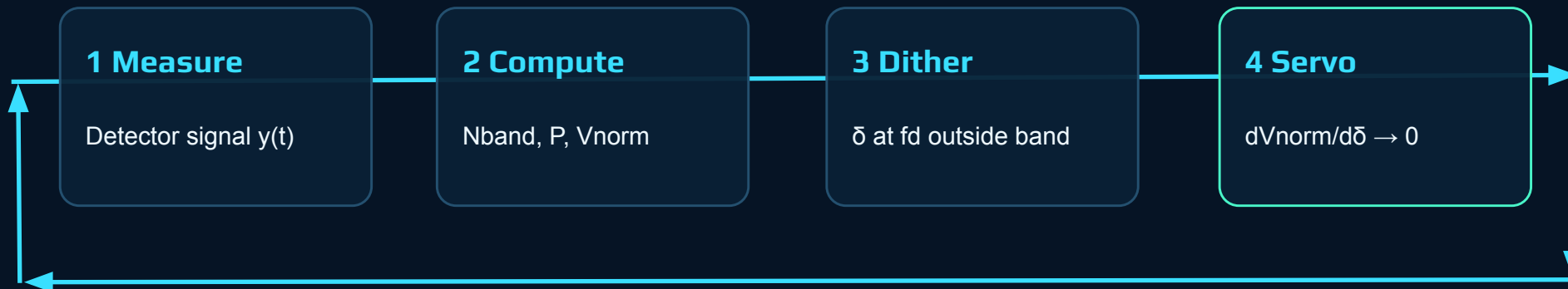
The gap: a robust control layer that optimizes measurement noise directly.



SOLUTION

Lock at the Vnorm slope-null.

NSL turns the detector stream into a control objective tied to measurement noise, then servos the operating point to a slope-null condition.



Core equation

$$V_{\text{norm}} = N_{\text{band}} / P^k$$

$k \in [0,2]$
+ power-floor penalty
+ mislock recovery

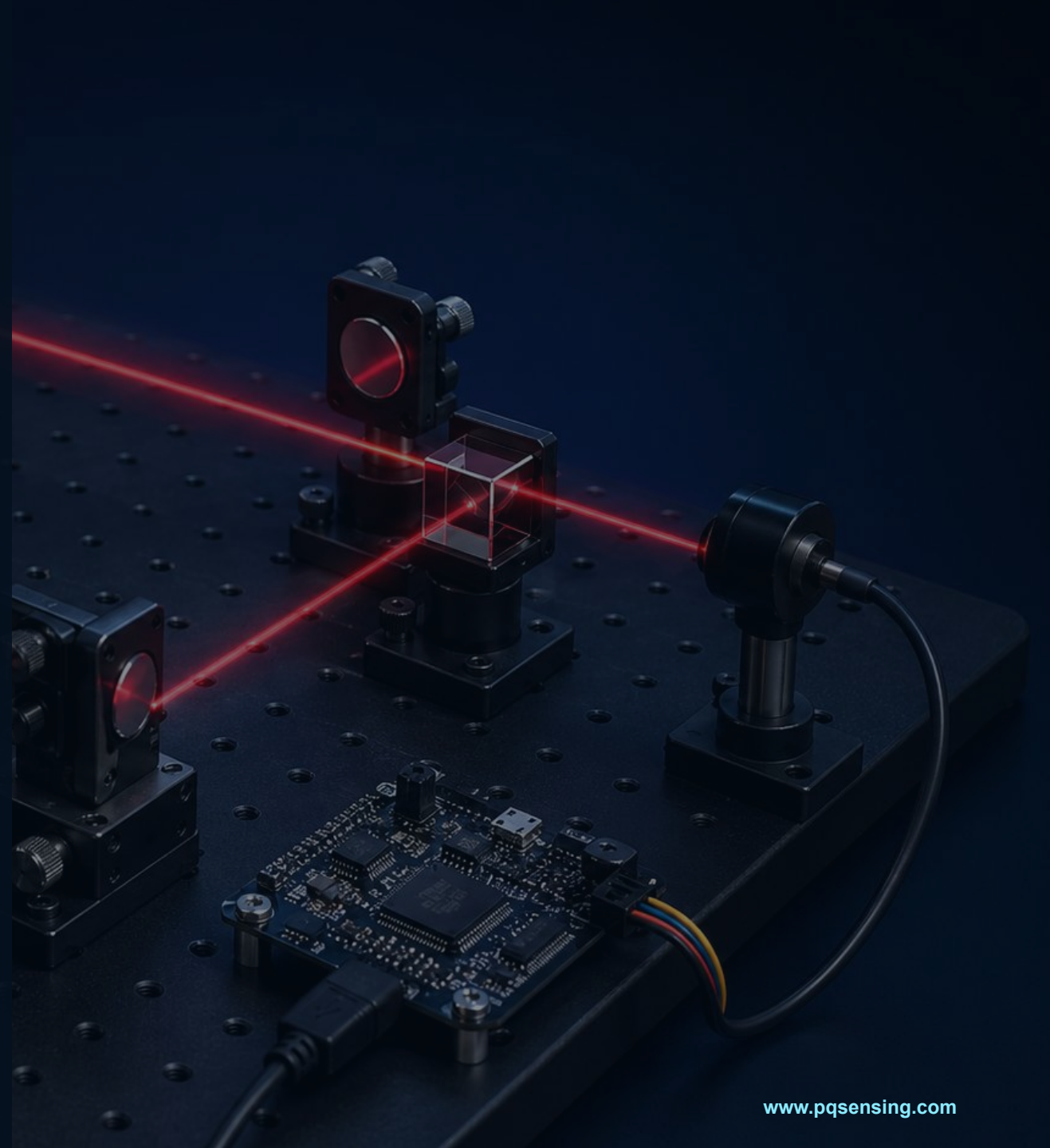
The technical wedge is not “dither locking.” It is demodulating a normalized band-limited noise objective and driving its operating-point slope toward zero.

Tabletop MZI proves or kills the thesis.

The first experiment is classical and intentionally small: produce defensible traces that compare power locking against NSL under controlled detuning jitter.

- Sweep δ** Map $P(\delta)$, $N_{band}(\delta)$, $V_{norm}(\delta)$.
- Inject jitter** Apply repeatable detuning disturbance.
- Engage NSL** Dither/demod V_{norm} ; servo slope-null.
- Compare** Power lock vs NSL data package.

Success targets: ≥ 6 dB first-demo reduction; stretch 10–20 dB; ≥ 5 successful re-acquisitions.

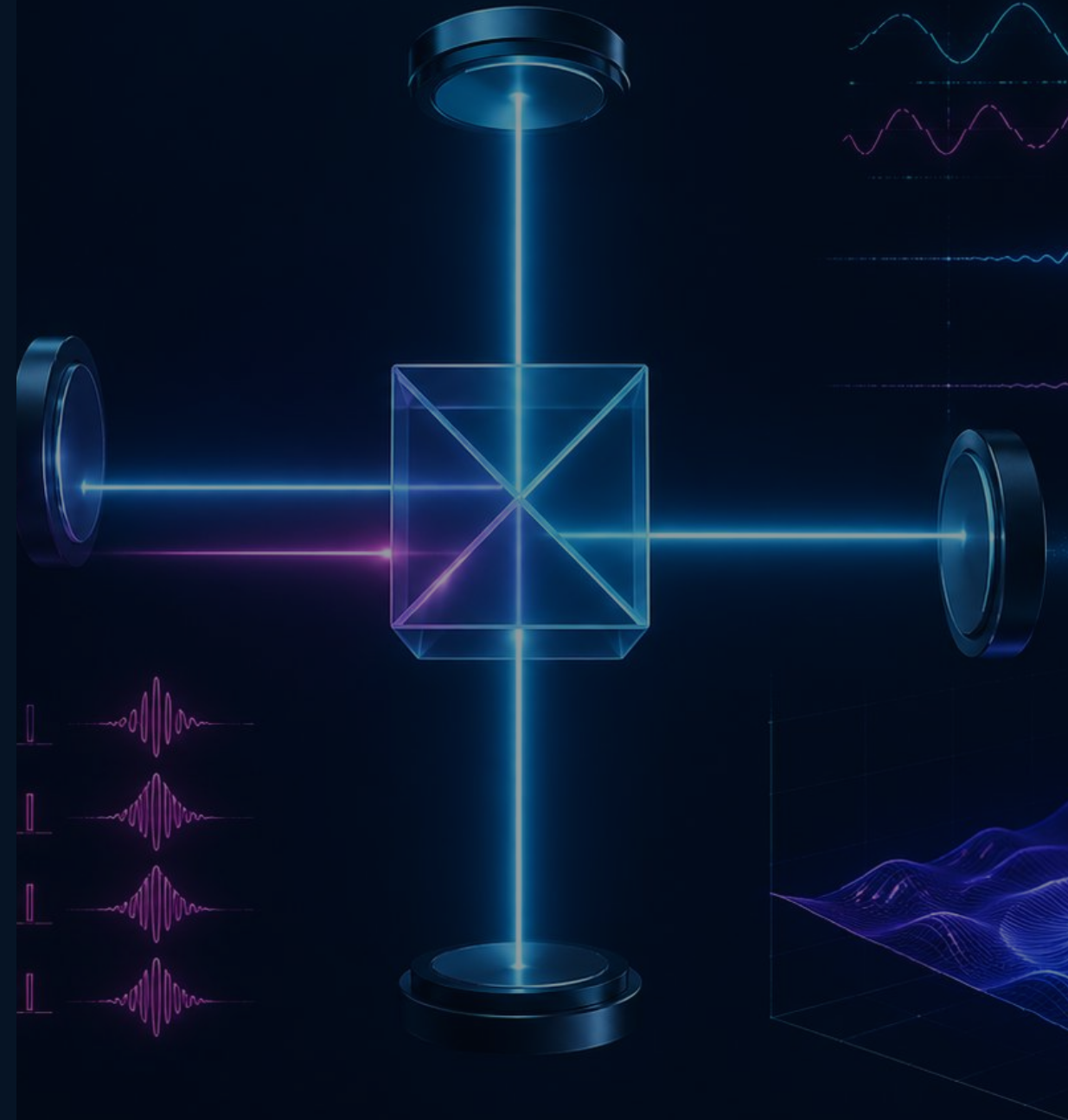


A field architecture with fallback claim depth.

The IP narrative is anchored to a specific control stack rather than a generic “better interferometer.”

- 01 NSL control** PSD/Welch or bandpass-square Nband, P metric, $V_{norm} = N_{band} / P^k$.
- 02 Control specificity** Dither outside protected band, demodulate V_{norm} , drive δ to slope-null.
- 03 Robust operation** Power-floor penalty and mislock-to-reacquisition state logic.
- 04 Expansion layer** Dark-port $g(t)$ coding, homodyne recovery, squeezed-state variants, PIC/SU(1,1).

Licensing wedge: a control method / firmware layer for interferometric sensor OEMs.



MARKET

Robust sensing is the transition bottleneck.

The first market is not a finished quantum sensor. It is a robust control layer that can improve interferometric readout in systems where field disturbances erase lab-grade sensitivity.

\$7-10B

quantum sensing by 2035
(McKinsey scenario)

\$1.3-1.5B

quantum sensor market by 2034
(market-research estimates)

Defense PNT / ISR

GPS-denied sensing, inertial/gravimetry, platform vibration.

Metrology OEMs

Cavities, MZI, Michelson, mode cleaners, precision phase sensing.

LiDAR / FSOC

Dark-port coding, interference rejection, correlation signatures.

Sources: DARPA RoQS; McKinsey Quantum Technology Monitor 2025; Precedence Research and Fortune Business Insights quantum sensor market pages.

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OPERATING MODEL

Lean validation. Partner-ready.

PQSensing is advancing through a practical, evidence-first path: accessible hardware, open-source DSP, reproducible analysis, and a partner-ready data package before larger capital.

- Practical hardware discipline: prove the core effect before scaling.
- Open-source DSP and reproducible analysis for credibility.
- University lab path for OPO/squeezed-light integration after classical validation.
- SBIR/STTR and licensing path for non-dilutive or strategic capital.

First data package: \$10K.

Minimum useful prototype budget: build the tabletop MZI, implement NSL, inject jitter, and package the data for investors, companies, and non-dilutive funding.

Budget allocation

Optics + mechanics	\$3.0K
Laser/readout/DAQ path	\$2.5K
Actuator + driver + control	\$2.0K
DSP, safety, misc.	\$1.5K
Shipping/contingency	\$1.0K

Milestones

- 0–2 wks assemble MZI + baseline fringe
- 2–4 wks sweep δ ; choose V_{norm} band/k
- 4–6 wks closed-loop NSL + jitter tests
- 6–8 wks raw data, plots, outreach package

Outcome: first credible NSL data package for licensing/SBIR/investor conversations.

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