WYZD SYSTEMS

HyroScope

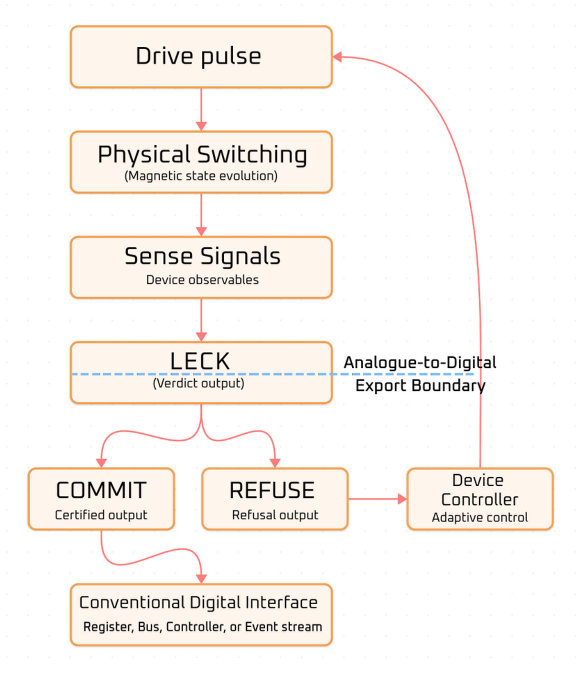
WYZD HyroScope is trace verification and evidence software for magnetic and spintronic read/write systems at the analogue-to-digital boundary. It is powered by the proprietary Legality Certified Event Kernel (LCEK), a device-adaptable, refusal-first reliability engine that evaluates whether a captured physical attempt is trustworthy enough to become a digital event. Rather than assuming that every physical attempt produces a trustworthy bit whenever it is sampled, HyroScope applies a simple LCEK-backed contract: each attempt is either certified, refused, or flagged as an invalid observation. Its purpose is to determine when a state transition and its observation together constitute a legal digital event under real conditions such as ringing, drift, coupling stress, probe loading, settle uncertainty, read noise and device degradation.

Under the hood, HyroScope uses LCEK to build on well-established physics, measurement realities and mathematical treatment of transient response and settling. The novelty is architectural: these familiar components are combined into a distinct refusal-first verification environment that detects when an attempted switching event is not merely present, but sufficiently well-formed and well-observed to be certified as a digital event. By replacing static guardbands with per-attempt legality certification, HyroScope can help reveal certifiable operating windows that fixed sampling points may miss.

In architectural terms, **HyroScope moves part of the reliability problem away from later software, ECC or recovery layers and down to the physical-to-symbolic transition itself.** In practical terms, this reframes marginal regimes from intermittent, hard-to-debug corruption into measurable behaviour: when conditions worsen, fewer events may be accepted, but accepted outputs remain certified and refusals remain explicit.

HyroScope is designed to work across different device types and measurement setups. Hardware-specific differences are handled through a device-facing adaptation layer, while the core LCEK refusal-first kernel logic remains stable. This makes HyroScope suitable as bench-level validation tooling today and positions the same LCEK core as a future governance layer for controller or firmware environments in MRAM and related spintronic systems.

LCEK at the Analogue-to-Digital Boundary



Refusal-first Operation

LCEK is designed for real-world device behaviour rather than idealized switching. Under ringing, drift, noise, settle uncertainty and other non-ideal conditions, it does not force a result through retries, averaging or timing assumptions alone. It certifies outputs only when an event is sufficiently trustworthy and otherwise refuses or invalidates the event explicitly.

This is particularly relevant in reliability-driven sectors such as **aerospace, defence and automotive**, where “good enough” is often not good enough. In these environments, explicit refusal is often more valuable than probabilistic acceptance, because it prevents uncertainty from propagating downstream as silent corruption. LCEK rejects a simple ‘settle-and-pray’ assumption by treating the settling process itself as part of the legality contract, refusing commits when the event remains too marginal, too disturbed, or too poorly observed to enter the symbolic record safely. LCEK is intended to make that distinction explicit, converting uncertainty into structured refusal rather than false confidence.

The result is a governance layer that can preserve correctness under worsening conditions by turning ambiguity into measurable back-pressure. Instead of failing silently, the system can become slower or more selective in a controlled and inspectable way. For MRAM-class and related spintronic systems, this offers a more reliability-oriented path between analogue device behaviour and digital system operation.

Where HyroScope Fits Today and Why It Matters

HyroScope is aimed at today's magnetic and spintronic bench workflows, especially MRAM and related non-volatile memory environments, where the recurring problem is often not whether a device can switch, but when an attempted physical event is trustworthy enough to be treated as a digital symbol.

In present MRAM and related spintronic workflows, this often appears as a combination of write-error risk, read disturb, degraded sensing margin under process / voltage / temperature variation, and difficult separation between true device instability and measurement-chain uncertainty. In practical terms, this is the grey zone between physical activity and certifiable digital outcome: traces that are not cleanly invalid, but are not trustworthy enough to govern as if they were stable digital events.

Under ringing, drift, coupling stress, probe loading, read noise and device variability, many workflows still depend on guardbands, retries and heuristics that can blur distinct failure modes until late in characterization, qualification or field-adjacent evaluation. HyroScope is designed to sit at that boundary as a trace-verification and evidence environment. Powered by its proprietary LCEK engine, it evaluates each captured attempt under an explicit kernel contract and produces one of three outcomes: certified, refused, or invalid. By making the grey zone more explicit and converting ambiguous bench behaviour into clear engineering outcomes, HyroScope creates practical reliability and characterization value for current spintronic workflows.

Clearer failure separation

One of the immediate benefits of HyroScope is that it helps distinguish between three realities that are often compressed together in practice: an event that is certifiable, an event that is physically active but remains in the grey zone rather than being certifiable, and an observation that is not trustworthy enough to govern at all. This can make failure analysis cleaner by separating marginal device behaviour from measurement-chain problems, rather than collapsing both into the same generic fail bucket.

Faster debug and characterization

Because the underlying LCEK engine produces structured outcomes rather than generic pass/fail impressions, teams can inspect legality behaviour, refusal patterns and operating boundaries using traces they already capture during bench evaluation. HyroScope then packages those outputs into figures, plots, summaries and reviewable evidence, enabling faster visual interpretation, reducing debug ambiguity and making refusal causes easier to understand.

Safer margin exploration

Many current workflows rely heavily on conservative worst-case timing assumptions. HyroScope provides a more explicit way to study where device behaviour is certifiable and where it begins to degrade under measured conditions rather than fixed assumptions alone. By making the refusal frontier more explicit, it can act as a reliability filter at the analogue-to-digital boundary, refusing marginal events before they are treated as trustworthy digital outcomes. In practice, that can support more disciplined margin selection, clearer legality-frontier mapping and a more inspectable transition between certifiable and non-certifiable regimes.

Auditability and evidence

Because refusals and invalid observations are returned with associated reason metadata, HyroScope can improve the auditability of characterization and screening workflows, support cleaner downstream diagnosis, and provide clearer evidence trails for why a trace was accepted, refused, or discarded. That is especially relevant in reliability-driven environments where teams need structured engineering evidence rather than isolated pass/fail results.

Qualification and screening value

In characterization, screening and production-adjacent evaluation workflows, HyroScope could help reduce ambiguity in how borderline traces are interpreted. By making refusal and invalid-observation cases explicit, the offline verifier may help reduce false confidence in marginal events and may also help teams avoid rejecting operating regions that are stable and usable. This could support stronger screening confidence, lower false reject / false accept pressure and, where externally validated, contribute to functional yield improvement in relevant workflows.

Low-friction adoption

The current value wedge is deliberately practical. HyroScope does not require immediate controller integration to start being useful. Teams can replay existing captured traces through the offline verifier using the data they already produce on real benches. That makes the first step lower-risk, easier to evaluate and well matched to current characterization, lab-validation and production-adjacent analysis environments.

Future expansion path

With further development, the same refusal-first logic that powers HyroScope can progress from offline replay into nearline analysis, in-loop software governance and later embedded controller firmware. In that role, LCEK would not only help observe operating limits, but help systems respond to them in a more structured, auditable and adaptable way. The core kernel contract remains stable while the embodiment matures: bench-side verifier first, then advisory and supervisory runtime software, and later deeper controller or firmware integration.

Over time, the same governance model may also extend into adjacent areas such as magnetic logic-in-memory systems, relaxation-based systems and wave-oriented computational systems, where the core challenge is often not producing physical behaviour, but determining when that behaviour is stable and trustworthy enough to commit as a digital outcome.

HyroScope Proprietary LCEK Tool Suite

HyroScope is the current software product embodiment of the Legality Certified Event Kernel (LCEK). It is delivered as a local, offline trace-verification and evidence environment for captured magnetic, spintronic and MRAM-class bench data. Rather than forcing engineering teams to treat captured traces as simple pass/fail records, HyroScope turns those traces into structured legality evidence, diagnostic surfaces, operating-region maps and exportable review bundles.

At the core of the system is the proprietary LCEK verifier. Around that verifier, HyroScope provides a set of dedicated LCEK tools that each answer a different engineering question. The verifier determines whether a physical attempt can be certified. The surrounding tools explain why, where, when, how strongly, how often, and under what operating conditions those outcomes occur.

The current product posture is STT-MRAM / MTJ first, with the same architecture extendable through device adapters, capture contracts and calibration layers for other magnetic or spintronic workflows.

HyroScope is built around the Verifier, which runs first in the workflow and creates the canonical evidence used by all downstream tools. The Verifier evaluates each captured physical attempt and returns one of three outcomes: certified, refused or invalid. This makes it the authoritative legality pass: downstream tools do not re-decide truth; they inspect, explain, compare, map and package the verifier’s witness-backed outputs.

Verifier

The Verifier is HyroScope’s first-order certification tool.

• Evaluates captured attempt evidence under the LCEK refusal-first contract.
• Classifies each attempt as certified, refused or invalid.
• Tests delivered drive behaviour, electrical settling, magnetic/readout stability, overlap timing and policy constraints before allowing a digital event to be certified.
• Preserves verdicts, reason chains, witness windows, timing surfaces, refusal metadata and output artifacts.
• Turns captured traces into durable evidence objects rather than loose waveform files.

Trace Inspector

Trace Inspector makes verifier results visually inspectable.

• Shows what physically happened in the captured trace.
• Displays attempt-selective views, annotated figures, witness overlays, legality lanes and verdict-linked windows.
• Helps explain why a trace that “looked acceptable” was certified, refused or invalidated.
• Supports borderline trace review, probe-timing inspection and engineering communication.

Timing Advisor

Timing Advisor analyzes timing legality and guardband pressure.

• Identifies when an event becomes certifiable and what limits safe certification.
• Separates timing pressure caused by electrical ringdown, magnetic/readout stability, overlap width, probe cadence or delivery mismatch.
• Helps teams decide whether the likely fix is damping, termination, delivery cleanup, probe retiming, pulse adjustment or guardband change.
• Replaces the simple question “how long should we wait?” with “what condition is blocking legal certification?”

Integrity Doctor

Integrity Doctor separates measurement-trust problems from device-side refusal.

• Detects issues tied to timebase, channels, capture schema, clipping, metadata, calibration or instrument-chain integrity.
• Helps distinguish a true non-certifiable device event from an invalid capture.
• Prevents bad captures from contaminating refusal statistics.
• Reduces wasted debug effort when the real issue is missing channels, timestamp precision, degraded witness fidelity or calibration mismatch.

Refusal Explorer

Refusal Explorer turns refusal populations into engineer-usable explanations.

• Groups refused attempts by refusal family, mechanism, severity, recoverability and representative examples.
• Helps identify dominant refusal causes such as plateau instability, overlap failure, electrical settle failure, readout ambiguity, delivery mismatch or policy refusal.
• Adds mechanism-level interpretation where witness data supports it.
• Makes large refusal populations navigable instead of leaving teams to scan scattered logs.

Frontier Mapper

Frontier Mapper converts verifier-backed outcomes into operating-region evidence.

• Maps certifiable, marginal and non-certifiable regions across many attempts.
• Shows safe operating regions, transition bands, refusal regions and dominant boundary mechanisms.
• Helps reveal how the certifiable frontier moves under timing, drive, readout pressure, noise, settling, probe cadence or temperature-related variation.
• Turns piles of trace outcomes into an inspectable refusal frontier and margin-pressure map.

Screening Triage

Screening Triage provides population-level review for characterization, screening and production-adjacent workflows.

• Consumes canonical verifier outputs rather than re-deciding legality.
• Summarizes what happened across a screened trace population.
• Distinguishes clean certified attempts, narrow-margin certified attempts, refused attempts, invalid measurement burden and borderline uncertainty.
• Helps teams review false-confidence risk, false-reject pressure, recoverable regions, measurement contamination and baseline/LCEK disagreement surfaces before making process, policy or timing decisions.

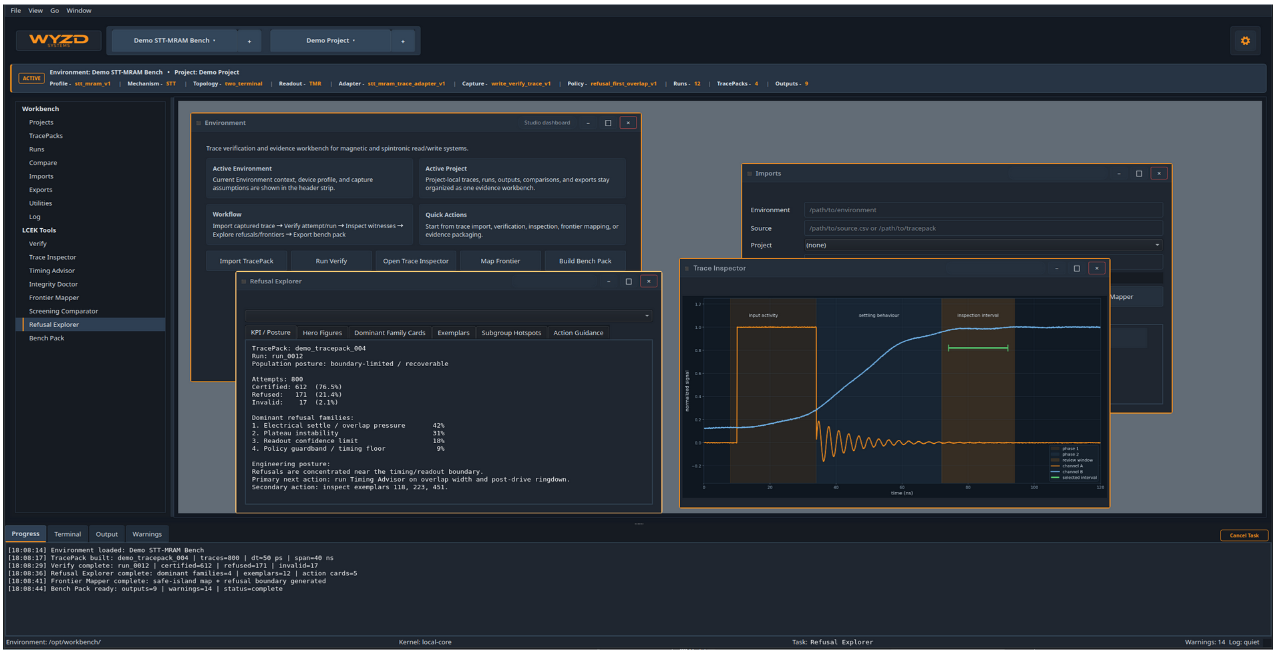
Auxiliary HyroScope Tools and Workflow Features

HyroScope also includes the workflow layer needed to make LCEK useful in real bench environments. Environment, Project, Import and TracePack tools organize device assumptions, adapters, calibration posture, capture schemas, channel mapping and verifier-ready evidence, so trace analysis remains structured rather than scattered across loose files.

Report, Compare, Export and Bench Pack tools turn completed verifier runs into reviewable engineering material. Teams can compare runs, tracepacks, policies, profiles and device conditions, then package selected outputs into compact evidence bundles for internal review, partner review, engineering handoff or later technical comparison without losing the link back to the originating run and tool session.

Together, these auxiliary tools make HyroScope more than a verifier. The proprietary LCEK tools provide the certification and refusal intelligence; the surrounding HyroScope workflow preserves that intelligence as organized, comparable and exportable engineering evidence.

HyroScope Alpha Build Screenshot



(product shown is not final and may be subject to change)

LCEK Modeling and Test Evidence

To validate the foundational claims of LCEK as an event-governance kernel, WYZD has executed extensive internal simulation campaigns built around realistic MTJ-class spintronic traces. The objective was to stress-test the kernel contract itself under **realistic noise, read disturb, settle failure and dynamic instability**, not to simulate a full architecture. Representative internal trace packs were constructed around high-speed bench-like conditions, including:

- **0-40 ns** record durations per capture
- **~ 800** samples per trace at roughly **50 ps** nominal spacing **(~20 GS/s)**
- Bandwidth on the order of **6 GHz**
- Pulse-width regime around **6.5-10 ns**
- MTJ-style parameter ranges including **R_P ~ 3.9-5.6 kΩ, R_{AP} ~ 7.5-13.1 kΩ** and TMR ratios of roughly **82-148 %**
- Ringing / relaxation behaviour in the low-GHz regime **(~ 2.3-3.7 GHz)**

The framework is trace-driven by design, allowing the same kernel logic to ingest real device captures without modification. Its first product implementation, HyroScope, operates as an offline verifier, replaying bench traces to evaluate certified and refused regimes.

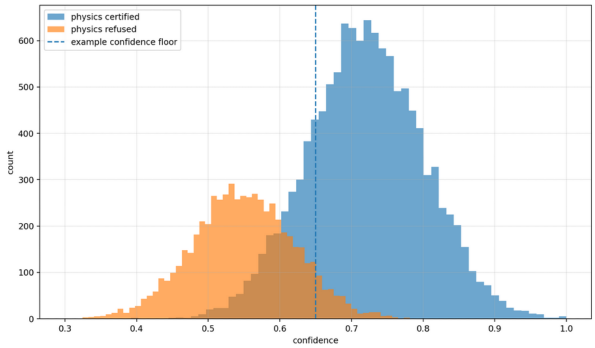
Simulations are structured to reflect real laboratory conditions rather than idealized switching, including invasive readout, non-ideal settling with ringing and drift, and dynamics shaped by noise, coupling stress and instability. Under these conditions, the test series produces a measurable legality frontier: regions where events are consistently certifiable and regions where refusal dominates, with stable and attributable failure modes. In practical terms, this makes the refusal frontier explicit as a reliability filter at the analogue-to-digital boundary, rather than leaving marginal events to be treated as trustworthy by default.

In representative internal trace packs, certified events produced legal windows on the order of **4–26 ns**, while stressed conditions remained physically active but uncertifiable due to degraded settling into the observation window. Optional confidence policy further refuses marginal observations rather than converting low-confidence evidence into incorrect digital outcomes.

These simulations do not replace real-world laboratory measurement, but they demonstrate a critical property: **LCEK fails in explicit engineering terms**, for example when no certifiable observation window exists, when residual settling remains too large or when the measurement itself is not trustworthy — LCEK returns refusal or invalid verdicts with associated reason metadata rather than producing misleading "always works" outputs under marginal conditions.

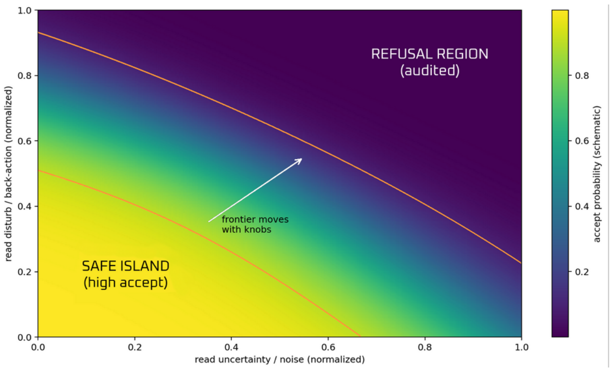
The following figures are illustrative outputs from internal simulated test campaigns.

Figure 1: Certified vs refused regimes



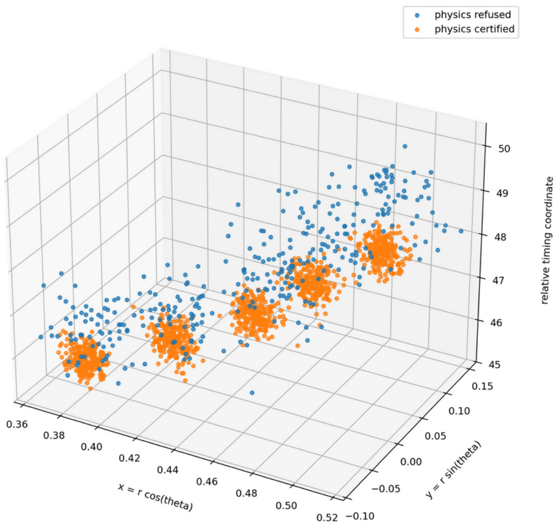
Certified and refused outcomes separate into two confidence populations: certified outcomes cluster at higher confidence, while refused outcomes cluster at lower confidence. The dashed line marks an example policy floor below which the kernel refuses rather than forcing a marginal event into a digital result, converting uncertainty into auditable back-pressure instead of silent misclassification. In reliability-driven environments, that distinction matters because explicit refusal is often more valuable than allowing uncertainty to propagate downstream as silent corruption.

Figure 2: Legality frontier, measurable 'safe island' under stress



This heatmap shows acceptance probability across two practical stress knobs: read uncertainty and read disturb (back-action). The high-acceptance "safe island" marks conditions where certified events remain frequent and more stable, while beyond the legality frontier acceptance falls into an audited refusal region. This turns operating margin from a fixed guardband into a measurable surface that can support characterization, tuning and safer margin selection, while making the transition between certifiable and marginal regimes more explicit.

Figure 3: State-space structure of certified vs refused outcomes



Certified and refused attempts occupy different regions of normalized state space. Certified outcomes cluster more tightly and coherently, while refused outcomes spread into broader, displaced populations. This suggests that LCEK is tracking structured operating behaviour with interpretable geometric separation between certifiable and non-certifiable regimes, rather than relying on ad hoc thresholding alone. That kind of separation is valuable because it helps make unstable or borderline behaviour more inspectable during debug and characterization.

Taken together, these example outputs show why HyroScope is more than a trace replay utility. It can separate certifiable events from marginal or non-certifiable attempts, make operating frontiers visible under stress, and expose structured differences between stable and unstable regimes.

For characterization and debug, this can reduce ambiguity in borderline traces and make refusal causes easier to interpret. For tuning and margin work, it can turn fixed assumptions into measurable operating surfaces. For screening and production-adjacent evaluation, it can provide a more disciplined basis for deciding whether a trace should be trusted, refused or treated as invalid.

These internal simulated results do not replace external laboratory validation. They show the intended evidence workflow, the refusal-first failure mode, and the type of engineering visibility HyroScope is designed to provide when applied to real spintronic and MRAM-class bench data.

Evaluation, Licensing and Engagement Path

HyroScope is now available for selected external evaluation as a local offline trace-verification and evidence environment. The current implementation can replay captured magnetic, spintronic and MRAM-class trace data, evaluate LCEK legality outcomes, generate structured result artifacts, and support review of refusal patterns, timing behaviour, frontier behaviour and invalid-capture conditions.

WYZD's preferred engagement path is staged. Initial discovery focuses on technical fit: the client's device class, capture format, channel availability, timing conventions, calibration posture, trace quality and intended use case. Where there is a strong fit, WYZD can provide a scoped trace-readiness and adapter-bridging engagement to connect the client's bench outputs to the HyroScope adapter layer. This may cover capture schema review, channel mapping, read/write mode interpretation, timing and pulse-width conventions, confidence-policy setup, calibration assumptions, and device-specific operating context for STT-MRAM, SOT-oriented workflows, MTJ stacks or related spintronic systems.

After discovery and adapter scoping, partners may proceed into a time-bounded pilot evaluation. A pilot is designed to answer a practical question: does HyroScope provide useful evidence value on the client's own captured traces? Typical pilot objectives may include clearer separation between certifiable, refused and invalid traces; improved interpretation of borderline events; refusal-reason analysis; timing and guardband insight; operating-frontier mapping; and production-adjacent screening review. The goal is not open-ended consulting, but a focused evaluation of product fit and technical value.

Commercially, HyroScope is intended to be licensed through a structured software and support model. Early access may take the form of a paid evaluation licence or scoped pilot package. Follow-on options may include annual lab or characterization-tool licences, industrial R&D licences, customer-specific adapter or integration work, support and maintenance packages, and partner-specific evidence workflow configuration. For larger partners, later pathways may include firmware/controller integration licences, test-flow or per-station licensing, safety-critical variants, co-development programmes, and deployment licences aligned to the partner's product or operational environment.

Pricing depends on scope, validation stage and support burden. Early lab and characterization engagements are expected to be the lowest-friction entry point, while deeper firmware, controller, manufacturing-test or safety-critical licensing requires stronger external trace validation, clearer integration scope and measurable customer value. Adapter work is scoped separately where client benches require custom capture contracts, channel semantics, calibration mapping or device-specific policy configuration.

WYZD is currently seeking selected discovery, pilot and validation partners across MRAM, spintronic devices, advanced measurement environments, magnetic systems and mixed-signal reliability workflows. The immediate priority is evaluation on real captured traces. Where results and strategic fit justify deeper collaboration, HyroScope can provide a path from offline bench verification toward nearline analysis, advisory runtime workflows and later controller or firmware-facing integration.

A more detailed technical overview of HyroScope, LCEK and the underlying adapter approach is available on request. As parts of the technology are patent pending, deeper technical materials, implementation details and partner-specific discussions may be shared confidentially and, where appropriate, under NDA.