Paper 28 — Replication-Host MoU and Hand-Off Package

> Status: governance paper, v0.7. Reading order: assumes 04-falsification-and-roadmap, 22-bayesian-pipeline, 24-reproducible-build. No companion firmware — this paper governs human process, not firmware.

1. Why this paper exists

Paper 22 §8 establishes that a single threshold crossing is not a discovery — it triggers independent replication. This paper is the **contract** that governs that replication: who is eligible to host it, what they receive, what they must do, and what happens when they disagree with our result.

It is written *before* any result is known, sealed at v0.7, and must be accepted by any replication group before they receive the data. If we have crossed the discovery threshold by the time a group reads this paper, they are reading a contract that was written when we did not know we would be asking them to replicate anything.

2. Definitions

Originating team (OT): The team that conducted the first-light campaign (paper 26) and whose result triggered this MoU.

Replication host (RH): An independent group, external to the OT, that accepts this MoU and agrees to conduct an independent replication.

Campaign result: The sealed $\ln B_{10}$ value and band classification (paper 22 §7) from the triggering run(s), as stored in the hash-chained ledger (paper 14).

Hand-off package: The archive defined in §4.

On-camera ceremony: The SHA-256 verification event defined in §5.

3. Eligibility criteria for the replication host

A group is eligible to serve as RH if and only if:

1. **No prior involvement.** No member of the RH had access to the OT's run data, analysis code, or sealed results before the on-camera ceremony. Adjudicated by the named arbitrator (§7).
2. **Relevant capability.** The RH can demonstrate, within six months of the MoU signature, the ability to operate a cryogenic optomechanical cavity at $T \leq 200$ mK with a homodyne readout chain achieving a shot-noise-limited floor in a bandwidth containing Ω_m.

3. **Institutional independence.** The RH is not funded by, employed by, or contracted to the OT or to any of the OT's funders in a way that creates a direct financial incentive to confirm the result. Adjudicated by the named arbitrator.
4. **Pre-registration commitment.** The RH commits, before receiving the hand-off package, to pre-registering its analysis plan with a third-party registry (OSF or equivalent) using the priors and thresholds in §6.
5. **Publication openness.** The RH commits to publishing a full run report regardless of whether it confirms or refutes the OT result. A null result from the RH has the same value as a confirmation; both are published.

4. The hand-off package

The OT delivers a single signed archive no later than 30 days after the on-camera ceremony. Contents:

4.1 Data

- All raw homodyne time-series files from the triggering run(s) in the format of paper 29 §3 (`schema_v1` bundles), plus the full Phase A–D run set.
- Per-window shot-noise estimates, DAQ metadata, and the run ledger (paper 14) as a single CBOR-encoded file.
- A SHA-256 manifest (`manifest.json`) listing every file in the archive.

4.2 Code

- The complete signed firmware binary and its source tree as of the triggering run, reproducibly buildable per paper 24 §5.
- The sealed analysis code (`src/inference.ltl`, `src/campaign.ltl`) and the Python analysis wrapper (`tools/analysis/`) as of v0.6/v0.7.
- Build environment snapshot: the Nix/Docker image used in paper 24's reproducible build, exported as a `.tar.gz` with its own SHA-256.

4.3 Documentation

- The complete corpus PDF set (`dist/pdfs/`) at the triggering-run tag, including this paper.
- The sealed prior file (`SEALED_PRIORS_V0_5` from `src/inference.ltl`) and its hash as registered in the v0.5 git tag.
- The run ledger as a human-readable JSON export alongside the binary ledger.

4.4 Signing

The entire archive is GPG-signed by the OT's project key (fingerprint registered in `src/provenance.ltl` at v0.6). The RH verifies the signature before beginning any analysis. Failure to verify is grounds to refuse the package and request a fresh delivery.

5. The on-camera ceremony

The on-camera ceremony is the moment of hand-off. Its purpose is to create a public record — a video, timestamped by an external streaming service — that the hand-off package is what it claims to be.

5.1 Participants

- At least one member of the OT (the “holder”).
- At least one member of the RH (the “receiver”).
- The named arbitrator (§7), or their designee.
- An external observer (paper 26 §6) who attended at least one campaign gate.

5.2 Protocol

1. The holder announces the archive filename and its SHA-256 hash on camera, reading each byte group aloud.
2. The receiver downloads the archive from the OT’s public repository (or accepts a hardware copy in a sealed, signed envelope) and independently computes the SHA-256 hash using the command:

```
sha256sum element-115-drive-replication-package-<tag>.tar.gz
```

3. The receiver reads the computed hash aloud. If it matches, the ceremony proceeds. If it does not, the ceremony halts, the discrepancy is recorded, and the OT re-delivers.
4. The named arbitrator countersigns a paper certificate listing the archive filename, its hash, the date, and the identities of all present. A scan of this certificate is included in the archive metadata directory.
5. The ceremony video is uploaded to a public platform (YouTube or equivalent) and its URL is appended to the run ledger by the OT within 24 hours of the ceremony.

The ceremony cannot be bypassed. If the replication host claims to have conducted an independent replication without having gone through the ceremony, the OT and the arbitrator jointly declare the result non-conformant with this MoU.

6. The RH analysis protocol

The RH is not free to analyse the data however they like. They must use the sealed priors:

1. Load `SEALED_PRIORS_V0_5` from the hand-off package.
2. Verify its SHA-256 against the hash committed in the OT’s v0.5 git tag (visible in the public OT repository).
3. Run `make verify-run <run_id>` from the hand-off package’s root, which executes the inference pipeline with the sealed priors and produces a `result_<run_id>.json`.
4. Pre-register the run plan with OSF *before* opening the data.
5. Report $\ln B_{10}$ as produced by step 3. The RH is free to run additional analyses, but those are labelled “supplementary” and do not affect the primary verdict.

The reason the RH cannot choose their own priors is that doing so would change the hypothesis being tested. The experiment is not “does this data contain a signal by some test the RH finds compelling” — it is “does this data contain the specific signal predicted by paper 06 and 06’s optomechanical model, at the pre-committed significance level.”

The RH is free to publish a companion paper arguing that a different analysis would give a different result. That companion paper is not the replication result.

7. The named arbitrator

The named arbitrator is a person, acceptable to both OT and RH, who:

- Is a physicist with experience in experimental cavity optomechanics or precision force metrology.
- Has no financial relationship with either party.
- Agrees to serve for the duration of the replication (estimated 12–18 months from the on-camera ceremony to the RH’s publication).

The arbitrator’s roles are:

1. **Eligibility adjudication** (§3.1, §3.3).
2. **Ceremony participation** (§5.1).
3. **Dispute resolution** (§8).
4. **Countersigning** the result manifest at publication (§9).

The arbitrator’s name and institutional affiliation are registered in the hand-off package manifest. The arbitrator is named here as a placeholder:

> **[Arbitrator name to be inserted before the first threshold crossing.]** The OT commits to naming an arbitrator before the phase B gate of the first-light campaign (paper 26 §1). The named arbitrator must accept in writing before the phase B gate opens.

8. Conflict-resolution rules

Conflicts are categorised:

8.1 Hash mismatch at ceremony

Resolved by the OT re-delivering the archive. If three consecutive deliveries fail the hash check, the arbitrator requests an in-person delivery on physical media with a chain-of-custody document.

8.2 Build non-reproducibility

If the RH cannot reproduce the OT’s analysis binary from source (paper 24 §5), the arbitrator convenes a joint debugging session. If the build is not reproducible after 30 days of joint effort, the OT is obligated to provide a pre-built Docker image whose SHA-256 is certified by the arbitrator.

8.3 Result disagreement — same priors, same code

If the RH, using the sealed priors and the OT code, obtains a different $\ln B_{10}$ for the same run, the discrepancy is published jointly. The arbitrator appoints an independent analyst (neither OT nor RH member) to run the pipeline on a neutral machine. The independent analyst's result is the canonical value.

8.4 Result disagreement — RH's own priors

The RH's supplementary analysis with different priors does not trigger this process. The MoU result is always the sealed-prior result.

8.5 RH withdraws

If the RH withdraws before publication, the OT publishes the hand-off package and the ceremony video, notes the withdrawal, and seeks a second replication host. The first RH's withdrawal does not affect the campaign verdict.

9. Publication sequence

1. **OT data release.** On the day of the on-camera ceremony, the OT releases the full hand-off package to a public archive (Zenodo or equivalent). The DOI is logged in the run ledger.
2. **RH pre-registration.** Within 2 weeks of the ceremony, the RH posts its pre-registered analysis plan to OSF. The OT is notified.
3. **RH analysis window.** Maximum 12 months from ceremony to RH result. If the RH cannot complete the analysis within 12 months, they notify the OT and arbitrator; a 6-month extension is automatically granted once.
4. **Joint result paper.** The RH and OT jointly author a result paper summarising the OT's campaign result and the RH's independent result. The paper is submitted to a peer-reviewed venue before any press engagement.
5. **Countersignature.** The arbitrator countersigns the final result manifest (a SHA-256-signed JSON file listing all run hashes, both $\ln B_{10}$ values, and the joint result). This manifest is appended to the Zenodo deposit.

10. What this MoU does not cover

- **Press engagement.** Neither party contacts press before step 4 above. After step 4, both parties are free to communicate the published result; they are not free to characterise it beyond what the paper says.
- **Patent priority.** Not established by this MoU; each party retains their own IP rights.
- **Positive-result claims.** A confirmation by the RH, combined with a campaign $\ln B_{10}$ above the discovery threshold, authorises the joint paper to report "independent replication of an anomalous force signal consistent with the Mk1 optomechanical model." It does not authorise the phrase "confirmed propulsion" or any claim about the mechanism.

See 00-index for the corpus map.
