From architecture to testable models.

Research addendum | 30 October 2026

Companion to *Quantum-Mirror Network Architecture*, technical whitepaper, 24 July 2026. This dated update preserves the original edition and records what the current software establishes, what it does not establish, and which tests should come next.

A research program built over time

November 2023. Qalice research begins, as reported by founder Keaton McCune. This project-history date is not an independently archived priority claim for later quantum-mirror protocols.

24 July 2026. The 21-page whitepaper defines quantum-controlled scattering, implementation-neutral node roles, classical coordination and a staged validation framework. It attributes the physical baseline to independent literature [1-3].

30 October 2026. The web companion gains an ideal analytical slice, resource-to-light pathways, a continuity budget, clearer source attribution and a live read-only IBM integration check.

The theory boundary

A physical quantum mirror is a qubit-controlled optical scatterer. Qalice's qMirror Control Layer is the proposed software and coordination architecture around it. A classical feedback loop, passive interface board or gate-model processor does not by itself implement that optical device.

This addendum develops explicit, testable consequences of the cited model. It does not introduce a new fundamental theory, report optical hardware measurements, or claim that the full networking protocol has been reproduced.

An analytical slice of the mirror model.

Basis: the ideal conditional coherent-state map in the July whitepaper and Uria et al. [1], equation (1). Modes 1 and 2 are distinct spatial optical modes; alpha and beta are coherent-state amplitudes.

```
|0>|alpha,beta> -> |0>|alpha,beta>
|1>|alpha,beta> -> |1>|-beta,-alpha>
```

Choose one occupied input and one vacuum input

Set beta = 0 and n = |alpha|^2. Prepare the control in sqrt(p)|0> + sqrt(1-p)|1>, with 0 <= p <= 1 and relative phase set to zero. The ideal joint output is:

```
sqrt(p)|0>|alpha,0>
+ sqrt(1-p)|1>|0,-alpha>
```

The overlap of its optical branches is s = <alpha,0|0,-alpha> = exp(-n). Tracing over the optical modes gives the control-state purity:

```
Tr(rho_c^2) = p^2 + (1-p)^2
+ 2p(1-p) exp(-2n)
```

Checks and interpretation

For n = 0 the optical branches are both vacuum, so the control purity is one. For p = 0 or p = 1, purity also stays one. At p = 1/2 and large n, it approaches 1/2. The joint state remains pure: the reduced control becomes mixed because it is entangled with the optical modes, not because the ideal model includes environmental decoherence.

The displayed weights p and 1-p are control-branch preparation weights, not individual photon-detection probabilities. The model omits loss, finite reflectivity, detector response and dynamics. It does not predict network rate or measured teleportation fidelity.

Open the analytical model

Resources, light and steady service.

Astro connects two engineering paths. Energy sources supply useful laser light; local materials could support collectors, structures, storage, receivers and manufacturing. Mining and refining require their own energy inputs. Materials are not automatically a source of continuous electrical power.

Close the conversion chain first

The Solar & Resource Lab starts with solar flux 1361/r^2 W/m^2, where r is a fixed scenario distance in AU. Its revised single-link calculation uses an ideal Gaussian envelope, finite circular receiver and declared pointing jitter. Launch/relay optical throughput and path transmission are separate inputs. This supersedes the earlier uniform area-ratio approximation. Page 6 documents the energy-accounting revision.

```
Receiver electrical output = incident solar power
x solar-electric efficiency x laser efficiency
x optics x path transmission x capture
x receiver efficiency
```

Then size interruptions and replenishment

Let L be the steady electrical load, a the source availability fraction, eta_c the charging efficiency and eta_d the discharge efficiency. Over a recurring cycle, online power supports the online load and replenishes energy used offline:

```
P_online = L[1 + (1-a)/(a eta_c eta_d)]
E_usable = L t / (1000 eta_d) kWh
```

Here t is the design interruption in hours; eta_c = eta_d = 0.90 are declared assumptions. For L = 500 W, a = 0.5 and t = 12 h, online delivery must be at least 1.1173 kW and usable stored energy at least 6.6667 kWh.

Availability sets the average energy balance. The longest interruption is a separate reserve constraint. Usable stored energy is not nameplate battery capacity. Battery aging, depth of discharge, charge-rate limits, auxiliaries, thermal rejection, orbit scheduling and pointing outages still need a mission model. Satisfying this balance does not guarantee continuous service.

Open Astro continuity model

What the engineering and IBM checks establish.

CL-001: classical control and timing interface

A passive 3.3 V breakout: J1 has six host pins; J2 and J3 have three pins each; J4 has four UART/power pins. R1 and R2 are 1 kohm series paths; C1 is 100 nF and C2 is 1 uF. The generated schematic, PCB, netlist and generic 3D model derive from the same circuit source. There is no onboard microcontroller, regulator, detector analogue front end or laser power driver.

Next evidence: select actual parts and connector footprints, complete protection and mounting design, review all nets and loads, run independent ERC/DRC and signal-integrity checks, then collect bench measurements. Generated geometry is not fabrication approval.

ME-001: preliminary optical mounting geometry

A 220 x 140 x 6 mm baseplate and two slotted brackets are generated from build123d parameters. Bracket/base hole coordinates have source checks. Fasteners, optical holders, mating tolerances, material certification, thermal stability and vibration qualification remain unresolved.

IBM: read-only verification, not an optical experiment

On 30 October 2026, live IBM IAM authentication, backend listing, existing job details and existing results returned HTTP 200. The supplied us-east instance exposed ibm_fez, ibm_kingston and ibm_marrakesh, each reporting 156 computational qubits at check time. A completed ibm_fez Executor workload contained two classified-result items with 256 shots each. It was created on 29 October 2026 in US Mountain time. No new job was submitted for this verification.

Authentication and retrieval establish account access and the API integration path. The circuit purpose has not been established here from the compiled inputs; neither its status nor its histogram establishes optical quantum-mirror physics, entanglement certification or teleportation. Public hosted job submission remains disabled pending secure deployment configuration.

The next theory test

Implement a trace-preserving loss-channel extension; compare against a converged Fock-space representation; check positivity, trace, vacuum and basis-state limits; quantify coherence as well as populations. Define the reference protocol and matched resources before claiming improvement. Do not use a heuristic optical score as quantum fidelity.

Independent sources and where they connect.

1. Uria et al., Alice and Bob through a quantum mirror (March 2026 preprint).

Conditional-scattering definition and theoretical network protocols. Physical model adopted in the July architecture; not a Qalice experiment.

2. Srakaew et al., Nature Physics 19, 714-719 (2023).

Experimental control of an atomic array's optical response. Relevant building block; not evidence that Qalice's node-pair network is built.

3. Uria et al., Continuous-Variable Quantum State Tomography Enabled by Quantum Mirrors (June 2026 preprint).

Proposed optical-state characterization through control-system measurements. A future benchmarking direction; not implemented here.

4. NASA / UCSB, Moonbeam-Beamed Lunar Power (2021 project description).

Laser power distribution, photovoltaic receiving, pointing and thermal-management research. Project goals are not flight performance.

5. Ruperto Hernandez et al., NASA OPAL white paper (2025).

Orbit-to-lunar-surface optical power architecture. Context for mobility and lunar-night power; not an Astro mission design.

6. NASA, Overview: In-Situ Resource Utilization.

Local resource extraction and processing into useful exploration products.

7. NASA, Deep Space Optical Communications mission record.

Optical data communication and link engineering. Data transfer is distinct from useful power delivery.

8. DARPA, POWER receiver demonstration (16 May 2025).

Reports >800 W delivered for 30 s across 8.6 km on Earth. This does not establish steady power in space.

9. IBM Quantum Compute Service REST API, version 2026-04-15.

Authentication, backend access and existing workload retrieval. No physical optical model.

Sources checked 30 October 2026. Links identify independent work, not partnerships, endorsements or validation of Qalice hardware. Prepared for Qalice with software assistance; further scientific and engineering review remains required.

Energy accounting and fair comparisons.

Energy-model revision | 30 October 2026

Use a single ideal Gaussian link, not a full relay network. Let w0 = D/2 be the intensity 1/e^2 launch-waist radius, lambda the wavelength and R the range in consistent SI units. A zero-mean Gaussian pointing distribution has per-axis angular standard deviation sigma_theta.

```
theta = lambda/(pi w0)
w(R)^2 = w0^2 + (theta R)^2
w_mean^2 = w(R)^2 + 4(R sigma_theta)^2
Capture = 1 - exp[-2 a^2 / w_mean^2]
```

Here a is the centered circular receiver radius. The jitter-broadened intensity and capture are time averages. The model assumes M^2 = 1 and omits static bias, aperture truncation, non-Gaussian structure, turbulence, scheduling and temperature-dependent component response. D is a beam diameter, not a hard aperture.

A conservation ledger, not a lossless claim

Incident power equals useful receiver electricity plus sunlight not converted, laser conversion losses, optical throughput losses, assumed path loss, missed light and receiver conversion losses. Missed light carries energy elsewhere; not every residual is local heat. Quantum state-control calculations do not add source energy. Photon energy is E = hc/lambda and photon flux is P/E.

Normalize the comparison input

With the default 32% solar-electric, 55% laser, 95% optical and 58% receiver efficiencies, 100% path transmission, D = 1.5 m, R = 12,000 km, a = 4 m and 0.5 microradian per-axis jitter at 1064 nm, each 100 kWh of incident sunlight gives: direct PV electricity 32.00 kWh; PV with an assumed 81% local storage cycle 25.92 kWh; current laser route 1.63 kWh; perfect capture with the same conversions 9.70 kWh. These are scenario calculations, not measured Qalice results. Local routes do not serve the same remote load without additional infrastructure.

EIA 2025 full-load, capacity-weighted tested heat rates imply approximately 45.3% natural-gas combined-cycle, 34.0% coal-steam and 32.7% nuclear-steam conversion, using 3412 divided by heat rate in Btu/kWh. Their denominator is thermal fuel input, not sunlight. These figures cannot establish a Qalice efficiency advantage.

Gaussian beam optics - Newport | Finite-aperture transmission - Khwaja and Reza

EIA Electric Power Annual Table 8.2 - 2025 data | Interactive comparison