Project Helios: ICF Data Request Checklist

(What to Provide to Validate RS Coherence-Controlled Fusion)

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Purpose (plain language)

We are building an **ICF-first control and audit system** that computes:

- C_ϕ: timing/phase alignment of a pulsed driver schedule ("ϕ-coherence").
- C_σ: symmetry/synchronization derived from diagnostic mode ratios via the RS symmetry ledger.
- $S = 1/(1 + C_\phi + C_\sigma)$: barrier scale factor.
- **Enhancement** E: predicted multiplicative improvement in tunneling/reactivity proxy implied by S.

This document specifies the **minimum shot-level diagnostics** needed to run the control/analysis pipeline on real facility data and produce auditable certificate bundles.

Important: we are not asking for classified design details. If raw data cannot be exported, we include a fallback "reduced export" option below.

A. Minimum viable dataset (per shot)

A1. Shot identity + metadata

- **shot_id**: unique shot identifier.
- **timestamp** (ISO-8601): when the shot occurred.
- **facility**: e.g. NIF, OMEGA, OMEGA-EP.
- **target type / campaign** (free text ok).
- **notes**: any caveats (diagnostic outages, known timing offsets, etc.).

A2. Pulse timing (for C_ϕ)

Provide two arrays of equal length N (units: seconds):

- **expected_pulse_times[0..N-1]**: planned driver event times for the schedule.
- **measured_pulse_times[0..N-1]**: measured driver event times from timing diagnostics.

Optional (improves fidelity, still minimal):

- **channel_phases[0..M-1]** (radians): phase angles for relevant channels in the timing window.
- **channel_time_offsets[0..M-1]** (seconds): per-channel offsets / skews (if measured).
- **jitter_scale** (seconds): facility-defined scale for interpreting RMS timing jitter.
- **skew_scale** (seconds): facility-defined scale for interpreting RMS channel skew.

A3. Symmetry diagnostic mode ratios (for C_σ)

Provide K mode ratios (dimensionless), plus *definitions*:

- **mode_ratios[0..K-1]**: e.g. P_2/P_0, P_4/P_0, etc. (ideally all near 1.0).
- **mode_labels[0..K-1]**: strings describing each ratio (e.g. "P2/P0").
- **mode_weights[0..K-1]**: nonnegative weights for the symmetry ledger aggregation.

A4. Optional outcome proxies (for validation)

These are not required to compute C_ϕ, C_σ, S, E, but they are needed to test whether predicted enhancement correlates with performance:

- **yield proxy**: neutron yield / burn proxy / alpha yield proxy (as allowed).
- **bang time**, ρR proxy, or other standard campaign metrics (as allowed).

B. Preferred file format

B1. One JSON per shot (recommended)

Filename: `shot_<shot_id>.json`

Minimal JSON structure (example):

```
{
  "shot_id": "NIF-YYYYMMDD-####",
  "timestamp": "2026-01-25T00:00:00Z",
  "facility": "NIF",

  "expected_pulse_times": [1.0e-9, 1.618e-9, 2.618e-9],
  "measured_pulse_times": [1.00002e-9, 1.61798e-9, 2.61801e-9],

  "mode_labels": ["P2/P0", "P4/P0"],
  "mode_ratios": [1.03, 0.97],
  "mode_weights": [0.5, 0.5],

  "yield_proxy": null,
  "notes": "ok"
}
```

B2. CSV (acceptable)

If CSV is easier, we can provide a schema on request. The key is keeping: `expected_pulse_times` and `measured_pulse_times` paired and ordered, and mode ratios labeled.

C. Reduced export option (if raw arrays cannot be shared)

If you cannot export raw pulse times or mode ratios, provide instead:

- **Computed** C_ϕ (and the jitter RMS / scales used)
- **Computed ledger value** (symmetry ledger) and resulting C_σ
- **Calibration/provenance**: which diagnostics, which time windows, and any smoothing/filters applied
- **Hashes** of the raw internal records (so we can cross-check consistency in an on-site audit)

D. Where this plugs into Project Helios

Once you have shot JSONs, we can ingest them into the control/analysis pipeline and emit:

- **Per-shot certificates** with computed C_ϕ, C_σ, S, E and theorem references.
- **Validation plots/tables**: observed yield proxy vs predicted E.

For development without facility data, a synthetic demo exists in the repo:

- `python scripts/icf_control_demo.py`

E. Access pointers (public portals)

These sites document user access workflows (shot data is typically account-controlled):

- NIF "Shot RI Resources": https://lasers.llnl.gov/for-users/shot-ri-resources
- OMEGA "Omega Users": https://www.lle.rochester.edu/omega-users/