

# The Audit Trilogy: Bell + GHZ V10.4

## 审计三部曲：贝尔分母审计 + GHZ V10.4 计算曲线

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**Date / 日期:** April 2026 / 2026年4月

**Version / 版本:** 1.2.0 — GHZ leg anchored to `v10_4_real_cost_curve.py` (not `ghz_loop_explosion_v19.py`) / GHZ 侧以 V10.4 为准 (不含 v19 证据链)

**Source code & data / 源代码与数据:** <https://github.com/tomnattle/chain-explosion-model>

Run § 6 commands from the **repository root** after cloning. / 克隆后在**仓库根目录**执行第 6 节命令。

### ENGLISH

Two frozen workflows: (i) NIST CSV CHSH with pairing tolerances in **grid-index** units on `t`. (ii) **V10.4** — `scripts/explore/ghz_medium_v10/v10_4_real_cost_curve.py` sweeps soft-detector `gate_k` on one fixed phase sample; outputs `F_gated`, mean retention `R_gated`, and matched-retention `F_random_mean ± 1σ` under `artifacts/ghz_medium_v10/`. Legacy `ghz_loop_explosion_v19.py` is **explicitly out of scope** for this trilogy revision.

### 中文对照

两条冻结工作流：(i) NIST CSV 上 CHSH，`t` 上网格指数配对容差。(ii) **V10.4**——`scripts/explore/ghz_medium_v10/v10_4_real_cost_curve.py` 在固定相位样本上扫描软探测器 `gate_k`；产出 `F_gated`、平均保留 `R_gated`、同保留率 `F_random_mean ± 1σ`，目录 `artifacts/ghz_medium_v10/`。旧脚本 `ghz_loop_explosion_v19.py` 在本版三部曲中明确排除。

## 1. What This Package Is — and Is Not / 本包是什么、不是什么

**Is:** Bell audit numbers from `battle_results/nist_completeblind_2015-09-19/battle_result.json`; GHZ narrative from `computed_curve` artifacts ( `V10_4_REAL_COST_CURVE.meta.json` states type: `computed_curve` ). **Is not:** a bench replay of one hardware GHZ run; **not** a dependence on v19 “loop explosion” thresholds.

是：贝尔数字来自 `battle_results/nist_completeblind_2015-09-19/battle_result.json`；GHZ 叙事来自 `computed_curve` 产物（`V10_4_REAL_COST_CURVE.meta.json` 中 `type: computed_curve`）。不是：某一硬件 GHZ 实验的逐台复刻；不依赖 v19「环路爆发」阈值叙事。

## 2. Synthesis of Evidence / 证据综合

### 2.1 Bell / CHSH / 贝尔

`S_strict = 2.336276` (tolerance 0.0) vs `S_standard = 2.839387` (15.0); pairs **136632** vs **148670**.  
Bootstrap file `chsh_bootstrap_ci_standard15.json` : `ci_contains_tsirelson: true` .

`S_strict = 2.336276` （容差 0.0）对 `S_standard = 2.839387` （15.0）；配对数 **136632 / 148670**。Bootstrap： `chsh_bootstrap_ci_standard15.json` 中 `ci_contains_tsirelson: true` 。

### 2.2 GHZ V10.4 (medium-v10) / GHZ V10.4

**Script:** `scripts/explore/ghz_medium_v10/v10_4_real_cost_curve.py` . **Physics stub:** three inner-ring sources; observers sum distance-weighted delayed cosines. **Sample:** default `states=120000` , `seed=20260423` . **Gating:** thresholds `gate_k × RMS` per channel; `F_gated` from simultaneous non-zero hits; `R_gated` = mean of four setting retentions. **Sweep:** `gate_k` default 0.35–0.95 (40 points). **Random control:** default 120 trials, seed 20260424, same per-setting counts as gated. **Canonical outputs:**

`artifacts/ghz_medium_v10/V10_4_REAL_COST_CURVE.png` , `.csv` , `.meta.json` , `V10_4_REAL_COST_CURVE_REPORT.md` .

**脚本：** `scripts/explore/ghz_medium_v10/v10_4_real_cost_curve.py` 。

**物理骨架：** 内环三源；观测点为带延迟、距离加权的余弦叠加。

**样本：** 默认 `states=120000` , `seed=20260423` 。

**门控：** 每通道 `gate_k × RMS` ； `F_gated` 来自三通道同时非零； `R_gated` 为四设定保留率均值。

**扫描：** `gate_k` 默认 0.35–0.95（40 点）。

**随机对照：** 默认 120 次试验，种子 20260424，各设定计数与门控一致。

**规范产物：** `artifacts/ghz_medium_v10/` 下 PNG、CSV、meta.json、REPORT.md。

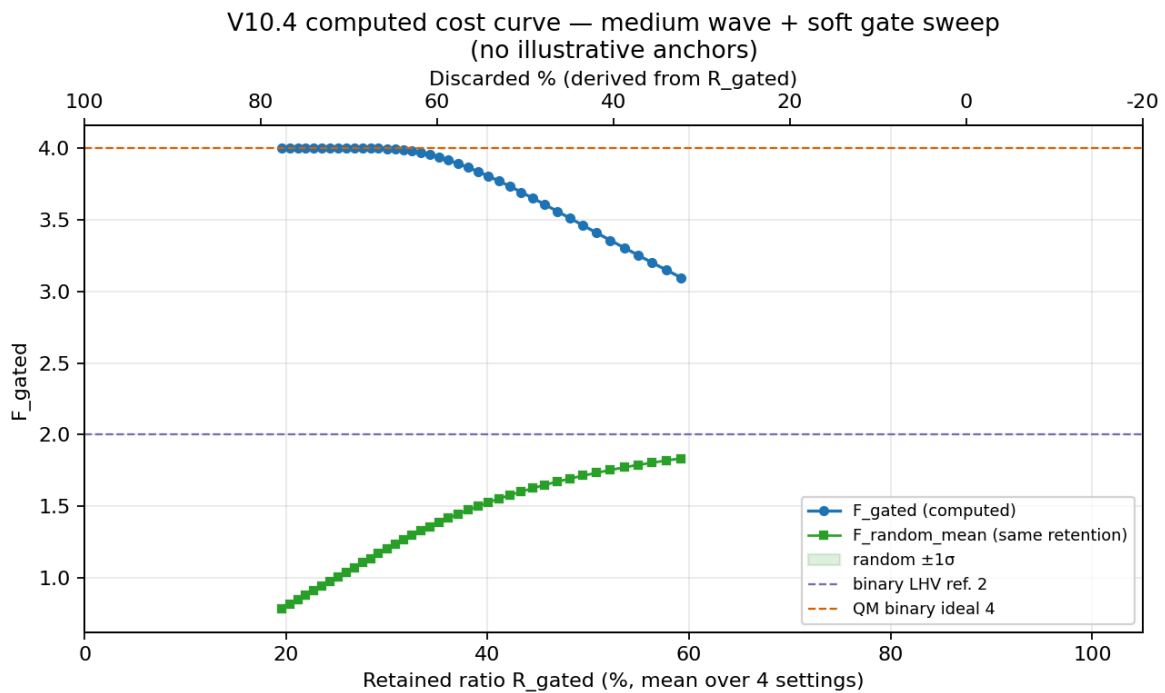


Figure 1: V10.4 computed cost curve — blue  $F_{\text{gated}}$ , green  $F_{\text{random\_mean}} \pm 1\sigma$  vs retained % (self-contained copy; regenerate via script). / 图 1: V10.4 计算代价曲线 ——蓝  $F_{\text{gated}}$ , 绿  $F_{\text{random\_mean}} \pm 1\sigma$  对保留率 (本包自包含拷贝; 脚本可重算)。

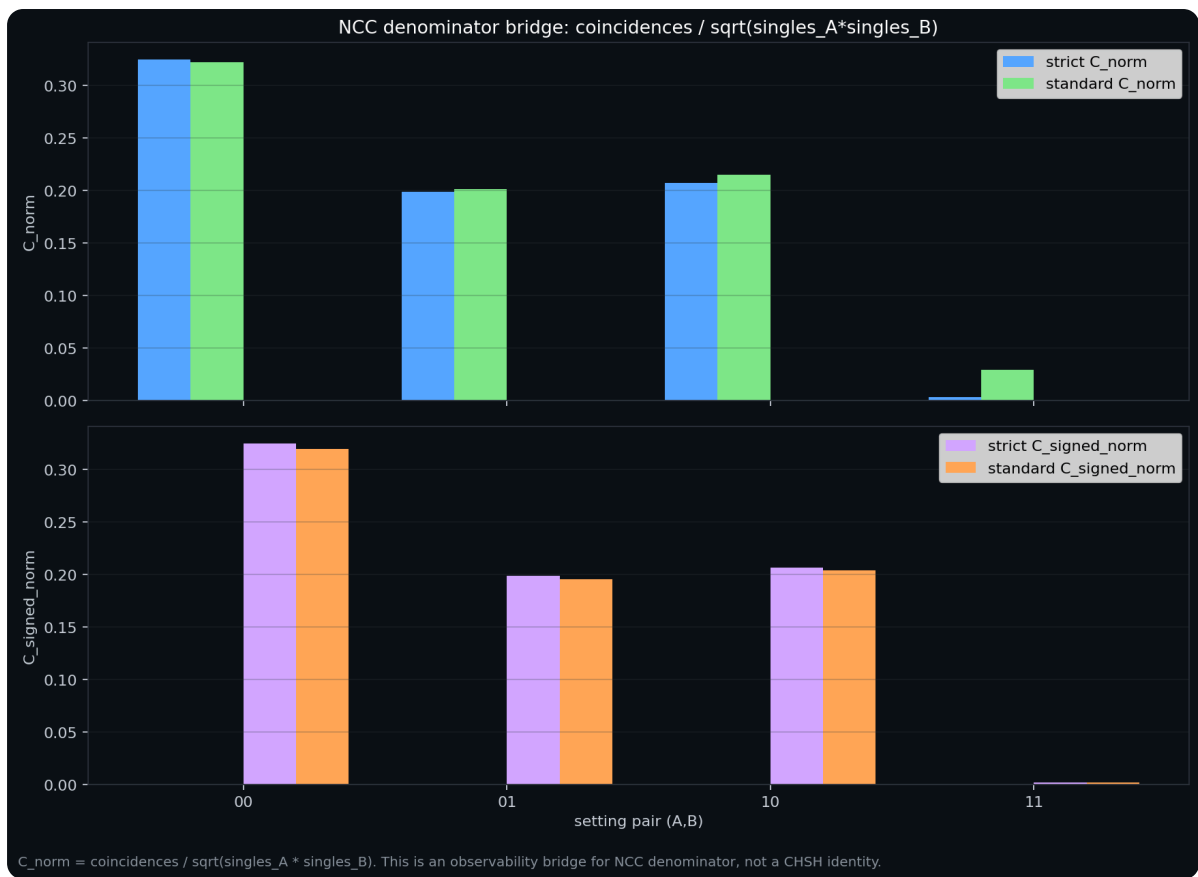
## 2.3 Optional: NCC bridge (Bell-side) / 可选: NCC 桥接 (贝尔侧)

**Not part of V10.4.**  $C_{\text{norm}}$  diagnostic on NIST CSV — see

`artifacts/reports/ncc_singles_bridge_real.json` (**observability bridge, not CHSH identity**).

**不属于 V10.4。** NIST CSV 上  $C_{\text{norm}}$  诊断——见

`artifacts/reports/ncc_singles_bridge_real.json` (可观测性桥接, 非 CHSH 恒等式)。



Supplemental Bell-side figure / 贝尔侧补充图

### 3. Interpretation Boundary / 解释边界

**Bell:** the  $s$  jump is pair-inclusion bookkeeping on fixed rows. **GHZ V10.4:** large  $F_{\text{gated}}$  at low  $R_{\text{gated}}$  is gating mechanics on a **classical wave model**; excess over  $F_{\text{random\_mean}}$  at matched retention is a claim **inside this script**, not about a lab device.

**贝尔:**  $s$  跳变是固定行表上的符合纳入账目。**GHZ V10.4:** 低  $R_{\text{gated}}$  时高  $F_{\text{gated}}$  是经典波模型上门控机制；同保留率下相对  $F_{\text{random\_mean}}$  的超出是本脚本内命题，非实验装置鉴定。

### 4. Implications for Quantum Computing (interpretive hypothesis) / 对量子计算的含义（解释性假说）

**Not established by § 2.** Conditional, speculative reasoning—authors’ **research suspicion** about engineering KPIs if headline correlation inherits the same bookkeeping sensitivities audited above. **No claim** about any specific program’s success or failure.

非 § 2 所确立。条件性、推测性推理——若头条关联继承上文账目敏感性，对工程 KPI 的研究怀疑。不对任一具体项目成败作断言。

**Hypothesis:** *f* production KPIs only peak after aggressive **post-selection**, roadmaps may need to budget **effective sample rate** and **inclusion logs**, not only peak  $F$  or  $S$ .

**假说:** 若工程指标仅在激进后选择后才冲高, 路线图或许需要核算有效样本率与纳入日志, 而非仅峰值  $F$  或  $S$ 。

*V10.4 documents a **computed** cost curve — not an illustrative sketch tied to legacy v19.*

*V10.4 记录的是**计算型**代价曲线——与旧版 v19 示意链脱钩。*

## 5. Conclusion / 结论

Methodological bundle: **NIST pairing audit** + **V10.4** `computed_curve`. Publish inclusion logs and RNG seeds with every headline plot.

方法论捆绑: **NIST 配对审计** + **V10.4** `computed_curve`。headline 图须配纳入日志与 RNG 种子。

## 6. Reproducibility / 最小复现

Repository / 仓库: <https://github.com/tomnattle/chain-explosion-model>

**Bell:** `python scripts/explore/chsh_denominator_audit.py` •  
`data/nist_completeblind_side_streams.csv` • `battle_results/nist_completeblind_2015-09-19/battle_result.json`

**GHZ V10.4:** `python scripts/explore/ghz_medium_v10/v10_4_real_cost_curve.py` →  
`artifacts/ghz_medium_v10/V10_4_REAL_COST_CURVE.*`

**Excluded from this trilogy revision / 本版排除:** `scripts/explore/ghz_loop_explosion_v19.py`

**Papers / 论文:** `papers_final/01_Bell_Audit`, `02_GHZ_Audit`, `03_Audit_Triology`

**GitHub / 仓库:** <https://github.com/tomnattle/chain-explosion-model>