

QICT Note: Why Experiments Highlight 470 GeV (and Other Scales) Reconciling Collider “Heavy Scales” with the QICT Golden-Relation Structural Band at 58.1GeV

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Article

QICT Note: Why Experiments Highlight 470 GeV (And Other Scales Reconciling Collider “Heavy Scales” with the QICT Golden-Relation Structural Band at 58.1 GeV

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Abstract

In the QICT programme, mass is not an intrinsic invariant but an *operational certification cost* governed by an audit depth and an information-copy (certification) latency. Separately, a QICT *Golden Relation* for the singlet-scalar mass yields a structural reference band centered on $m_0 = 58.1 \pm 1.5$ GeV. Collider searches for type-III seesaw heavy leptons, however, report a sequence of characteristic *mass limits* (e.g. 335 GeV, 470 GeV, 790 GeV, 870 GeV, 910 GeV in ATLAS; 840 GeV and 880 GeV in CMS), all quoted at 95% CL and accompanied by “no significant excess” statements. This note explains, in a logically closed manner, why an analysis may foreground a particular high scale such as 470 GeV rather than the lower structural value: (i) the collider numbers are *limits*, not directly measured resonance peaks, and (ii) in QICT, the reconstructed event-scale mass corresponds to a regime-dependent effective mass m_{eff} that can occupy stable *plateaus* when the certification latency compresses toward a speed-limit bound. The existence of multiple reported scales strengthens the defense by showing that the highlighted number depends systematically on channel content, luminosity, and statistical procedure, consistent with a regime/plateau picture rather than a unique intrinsic mass.

Keywords: LHC; ATLAS; CMS; collider searches; beyond the Standard Model (BSM); heavy leptons; Type-III seesaw; fermion triplet; heavy neutral lepton (HNL); vector-like leptons; multilepton final states; pp collisions; mass exclusion limits; 95% CL; CLs method; statistical interpretation; mass benchmarks; resonance searches; effective mass / effective scale; regime dependence; model reinterpretation; reproducibility and robustness tests; information-theoretic mass (QICT); Golden Relation; structural mass band (58 GeV)

1. QICT Golden Relation: The Structural Reference Band at 58.1 GeV

A key QICT claim relevant here is that a *structural* mass can be derived from a Golden Relation linking a singlet-scalar mass m_S to QICT and FRG inputs. In the Version 3 Preprints.org text one finds the schematic Golden Relation

$$m_S = C_\Lambda \sqrt{\kappa_{\text{eff}} \chi_Y^2}, \tag{1}$$

and, using the explicit benchmark inputs stated there, the numerical band

$$\begin{aligned} m_0 \equiv m_S &= 58.1 \pm 1.5 \text{ GeV}, \\ m_S &\in [56.6, 59.6] \text{ GeV (cons.).} \end{aligned}$$

(2)

We emphasise the intended logical status of (2): it is a *structural reference* attached to a specific QICT matching regime, not a guarantee that any collider analysis must report the same number as a highlighted scale.

2. What “470 GeV” Is in the Documented Collider Context (And the Other Reported Scales)

The number 470 GeV appears in ATLAS type-III seesaw heavy-lepton discussions as a *Run 1 exclusion improvement* by adding the three-lepton channel (still using Run 1 data) [9,11]. In the same experimental programme, both collaborations report a *sequence* of 95% CL lower limits (exclusions) with “no significant excess” language, summarised below.

Table 1. Selected published/posted 95% CL limits in type-III seesaw heavy-lepton searches. These are *exclusion lower bounds*, not resonance-mass measurements.

Collab.	Dataset	Limit (95% CL)	Channel / note (as described in the cited sources)
ATLAS	Run 1 (8 TeV)	335 GeV	Two light leptons (e/μ) + two jets (Run 1 exclusion) [9]
ATLAS	Run 1 (8 TeV)	470 GeV	Improved Run 1 limit by adding the three-lepton channel [9,11]
ATLAS	Run 2 (13 TeV, 139 fb ⁻¹)	790 GeV	Dilepton + jets + large E_T^{miss} ; no significant excess [10]
ATLAS	Run 2 (13 TeV, 139 fb ⁻¹)	870 GeV	Three-/four-lepton channels alone; no significant excess [11]
ATLAS	Run 2 (13 TeV, 139 fb ⁻¹)	910 GeV	Combination of 2-, 3-, 4-lepton channels; no significant excess [11]
CMS	2016 (13 TeV, 35.9 fb ⁻¹)	840 GeV	Multileptons; equal branching fractions (flavour-democratic) [12]
CMS	Full Run 2 (13 TeV, 137 fb ⁻¹)	880 GeV	Multileptons; flavour-democratic; no significant excess [13,14]

Two immediate consequences follow from Table 1:

- The collider numbers (including 470 GeV) are, in these sources, *limits* set by an analysis pipeline (statistics + reconstruction + channel definition), not a directly measured “mass of a discovered particle”.
- Multiple distinct scales are highlighted across channels and datasets, indicating that the foregrounded number is *analysis- and regime-dependent*, consistent with a QICT view in which m_{eff} depends on operational conditions.

3. QICT Operational Mass and the Regime-Dependent Uplift

3.1. Master Relation

In QICT, the event-level effective mass is governed by an audit depth and a certification latency:

$$m_{\text{eff}}c^2 = \frac{\hbar \theta}{2 D_{\text{audit}} \tau_{\text{copy}}}, \quad D_{\text{audit}} \geq D_{\text{min}}.$$

(3)

Here D_{min} encodes the locality-imposed minimal audit depth, and τ_{copy} is the *realised* copy/certification latency during the event (not necessarily equal to the reference value used in the Golden-Relation matching).

3.2. Structural Reference Point and Synchronization Gain

The structural band (2) corresponds to a reference regime

$$D_{\text{audit}} = D_{\text{min}}, \quad \tau_{\text{copy}} = \tau_0 \quad \Rightarrow \quad m_0c^2 = \frac{\hbar \theta}{2 D_{\text{min}} \tau_0}.$$

(4)

Define a dimensionless *synchronization gain* $\kappa \geq 1$ via

$$\tau_{\text{copy}} = \frac{\tau_0}{\kappa}. \quad (5)$$

Then, keeping locality intact ($D_{\text{audit}} = D_{\text{min}}$),

$$m_{\text{eff}} = \kappa m_0. \quad (6)$$

Interpretation.

Within this logic, a collider-highlighted high scale (e.g. 470 GeV) corresponds to sampling an event regime with $\kappa \gg 1$ —a compressed certification latency relative to the Golden-Relation reference regime. Crucially, the existence of multiple reported limits (335, 470, 790, 870, 910, 840, 880 GeV) supports the claim that the foregrounded scale is not a unique intrinsic mass, but a regime/analysis-dependent characteristic scale compatible with a variable m_{eff} .

4. Why a *Specific* High Scale Is Highlighted (Plateau Selection + Analysis Dependence)

The defense is strongest when one explains not only why m_{eff} can exceed m_0 , but why analyses may highlight *particular* scales.

4.1. Speed-Limit Bound and Upper Plateau

QICT posits that latency compression is bounded by an information-theoretic speed limit:

$$\tau_{\text{copy}} \geq \tau_{\text{min}}. \quad (7)$$

When stiffness is maximal, $\tau_{\text{copy}} \approx \tau_{\text{min}}$, producing an *upper plateau*

$$m_* c^2 = \frac{\hbar \theta}{2 D_{\text{min}} \tau_{\text{min}}}. \quad (8)$$

A high characteristic scale highlighted by a search can then be read as an empirical indicator that the relevant event population (and the analysis sensitivity) is probing the saturated/near-saturated branch.

4.2. Why 470 GeV Appears in Run 1 (And Why It Changes Later)

In the documented ATLAS narrative, 470 GeV is explicitly obtained by expanding the Run 1 search programme to include the three-lepton channel [9,11]. This is exactly what one expects if the highlighted scale is *not* a fixed intrinsic mass but a sensitivity-dependent characteristic: adding channels changes the statistical power, background composition, and the mapping from event kinematics to a quoted mass bound. Later, with Run 2 data and different final states, the reported limits move to 790 GeV (dilepton+jets+ E_T^{miss}) [10] and to 910 GeV in the combined multi-lepton analysis [11], while CMS reports 840 GeV (2016) and 880 GeV (full Run 2) in flavour-democratic scenarios [12–14]. The *variation itself* is an empirical reinforcement of the QICT defense: the experiment is not “measuring m_0 ” but producing analysis-dependent bounds on a heavy scale.

5. Conclusions

The QICT Golden Relation yields a structural reference band centered on $m_0 = 58.1 \pm 1.5$ GeV [8]. In type-III seesaw heavy-lepton searches, ATLAS and CMS report multiple 95% CL exclusion scales, including 470 GeV in Run 1 and higher Run 2 values [9–14]. In QICT language, this is consistent with a regime-dependent effective mass m_{eff} whose value can be uplifted by latency compression, and whose *highlighted* numerical scale depends on (i) the analysis role of the number (limit vs peak), (ii) the channels and dataset, and (iii) plateau selection near a speed-limit bound.

6. QICT Golden-Relation Prediction (v3) and Experimental Observability of the 58.1 ± 1.5 GeV Branch

6.1. Exact QICT Theoretical Prediction (Golden Relation, Version 3)

In the QICT preprint (Version 3; submitted 10 December 2025 and posted 11 December 2025), the *Golden Relation* is stated in the Abstract in the form

$$m_S = C_\Lambda \sqrt{\kappa_{\text{eff}} \chi_Y^2} \quad (9)$$

where m_S denotes the physical mass of the real singlet scalar S , C_Λ is a QICT constant, χ_Y^2 is the (quadratic) hypercharge susceptibility evaluated at a benchmark temperature, and κ_{eff} is an FRG-derived dimensionless mass parameter with quantified uncertainty [?].

The same Abstract lists explicit numerical benchmarks (including the matching temperature $T_\star = 3.1$ GeV):

$$\begin{aligned} a &= 0.197 \text{ GeV}^{-1}, \quad D_Y \simeq 0.10 \text{ GeV}^{-1}, \quad T_\star = 3.1 \text{ GeV}, \\ \frac{\chi_Y^2}{T_\star^2} &= 0.145 \pm 0.010, \quad \kappa_{\text{eff}} = 0.136 \pm 0.019, \\ C_\Lambda &= 1.6 \pm 0.2 \text{ GeV}^{-1}. \end{aligned} \quad (10)$$

Propagating these inputs through Eq. (9), the preprint reports the *exact theoretical band*

$$m_S = 58.1 \pm 1.5 \text{ GeV} \quad (11)$$

together with a stated *conservative interval*

$$m_S \in [56.6, 59.6] \text{ GeV}. \quad (12)$$

In the present interpretation, Eq. (11) defines the *structural (reference) branch* associated with the Golden-Relation matching regime, and it must be distinguished from collider-highlighted heavy scales that can arise from different operational regimes or from statistical limit-setting.

6.2. When Can an Experiment Reconstruct the 58.1 ± 1.5 GeV Branch?

A reconstructed experimental scale can be consistent with the Golden-Relation band (11) *only if* the event population and the analysis pipeline probe the *baseline (reference) certification branch* rather than a stiff/saturated branch.

Baseline-Branch Condition ($\kappa \simeq 1$).

Recall the operational uplift relation (introduced earlier in the QICT framework)

$$m_{\text{eff}} = \kappa m_0, \quad \tau_{\text{copy}} = \frac{\tau_0}{\kappa},$$

so that observing the structural band requires that the realized certification latency remain close to the baseline:

$$\kappa \approx 1 \quad \Longleftrightarrow \quad \tau_{\text{copy}} \approx \tau_0. \quad (13)$$

Equivalently, the system must *not* enter a stiffness-driven speed-limit regime; i.e. it must avoid the saturation attractor associated with τ_{min} .

Quantitative compatibility (including detector resolution).

Let $\Delta_{\text{QICT}} \approx 1.5$ GeV denote the intrinsic half-width of the Golden-Relation band and Δ_{exp} the experimental mass resolution (or the effective resolution of a recoil/missing-mass reconstruction). A reconstructed mass m_{rec} is consistent with the structural signal when

$$|m_{\text{rec}} - m_0| \leq \Delta_{\text{tot}}, \quad \Delta_{\text{tot}} = \sqrt{\Delta_{\text{QICT}}^2 + \Delta_{\text{exp}}^2}. \quad (14)$$

Using $m_{\text{eff}} = \kappa m_0$, this can be rewritten as a bound on deviations from baseline synchronization:

$$|\kappa - 1| \lesssim \frac{\Delta_{\text{tot}}}{m_0}. \quad (15)$$

Operational circumstances favoring the 58 GeV branch.

Within the QICT logic, the baseline branch is favored whenever the event does *not* induce strong informational stiffness. Operationally, this corresponds to conditions such as:

- **Low stiffness / weak audit acceleration:** regimes in which the synchronization gain is not triggered (no approach to τ_{min}), hence τ_{copy} remains near τ_0 .
- **Production regimes near threshold:** kinematics that do not demand ultra-fast certification, so that the audit remains quasi-adiabatic relative to the baseline timing.
- **Analyses explicitly targeting a light scale:** strategies optimized for a narrow structure near ~ 58 GeV (as opposed to heavy-mass reinterpretations or limit-setting optimized for large masses).

These criteria are structural consequences of the monotonicity $m_{\text{eff}} \propto \tau_{\text{copy}}^{-1}$ and of the existence of a stiffness-driven speed-limit attractor.

Phenomenological measurement modes consistent with a 58 GeV reconstruction.

Typical experimental modes compatible with reconstructing a light mass near m_0 include:

1. **Visible-decay invariant-mass reconstruction:** if the 58 GeV excitation decays to visible pairs (e.g., $\ell^+\ell^-$, $b\bar{b}$, $\tau^+\tau^-$), one may directly search for an invariant-mass peak and assess compatibility using Eq. (14).
2. **Recoil / missing-mass reconstruction:** if the state is long-lived or invisible, a recoil method may reconstruct the mass scale; here Δ_{exp} is the resolution entering Eq. (14).
3. **Branch-selection diagnostics:** if QICT stiffness admits event-level proxies, one expects:

$$\begin{aligned} \text{low-stiffness} &\Rightarrow m_{\text{rec}} \approx m_0, \\ \text{high-stiffness} &\Rightarrow m_{\text{rec}} \rightarrow \text{upper plateau.} \end{aligned}$$

Why the 58 GeV band is not expected in heavy-lepton limit tables.

Finally, note the logical separation of objects: collider tables quoting limits in the few-hundred-GeV to TeV range concern *type-III seesaw heavy leptons* and report *exclusion limits* (not discovered resonance masses). The QICT Golden-Relation band (11) refers instead to a *distinct structural excitation* (the singlet-scalar S in the cited QICT construction). Therefore, one should not expect heavy-lepton limit-setting programmes to “measure 58 GeV” unless an analysis is explicitly designed to target that light degree of freedom and the sampled events remain on the baseline branch (13).

7. When Can the 58.1±1.5 GeV Scale be Experimentally “Captured”?

In the QICT Golden-Relation construction, the singlet-scalar prediction $m_0 \equiv m_S = 58.1 \pm 1.5$ GeV defines a *structural (reference) branch* rather than an unconditional collider output. An experiment can reconstruct a mass consistent with this band only if *both* (i) the relevant degree of freedom is actually

produced in the selected event sample, and (ii) the operational certification regime remains close to the baseline branch (i.e. it does not transition into the stiff/saturated branch).

7.1. QICT Regime Requirement: Baseline Certification ($\kappa \simeq 1$)

Within the operational QICT parametrization,

$$m_{\text{eff}} = \kappa m_0, \quad \tau_{\text{copy}} = \frac{\tau_0}{\kappa}, \quad (16)$$

so that observing the structural value requires

$$\boxed{\kappa \approx 1 \iff \tau_{\text{copy}} \approx \tau_0,} \quad (17)$$

i.e. events must avoid a stiffness-driven speed-limit regime in which $\tau_{\text{copy}} \rightarrow \tau_{\text{min}}$ and the effective scale uplifts toward an upper plateau.

7.2. Object Requirement: One Must Search for the Correct Degree of Freedom

The 58 GeV band pertains to the *singlet-scalar* S in the Golden-Relation construction. It is therefore not expected to appear in analyses that are designed to set limits on unrelated heavy states (e.g. type-III seesaw heavy leptons). Capturing a 58 GeV signal requires an analysis explicitly targeting a light state around that mass, with appropriate triggers and background control.

7.3. Measurement Modes That Can Reconstruct a 58 GeV Mass

Provided Eqs. (16)–(17) are satisfied and S is produced, the following experimental modes can in principle reconstruct a scale near m_0 :

1. **Visible two-body decay (direct invariant-mass peak).** If S decays to visible pairs (model-dependent), e.g. $S \rightarrow b\bar{b}$, $S \rightarrow \tau^+\tau^-$, or $S \rightarrow \ell^+\ell^-$, one can search for a localized excess (“bump”) in the corresponding invariant-mass distribution near $m_{\text{rec}} \simeq 58$ GeV.
2. **Associated production + recoil (missing-mass reconstruction).** If S is partially invisible or long-lived, a recoil technique can be used: produce S in association with a well-measured tag object (e.g. a prompt lepton system or photon), and reconstruct m_{rec} from the recoil/missing-mass estimator.
3. **Branch-selection diagnostics (stiffness tagging).** If QICT stiffness admits event-level proxies (timing/coherence-sensitive observables), the prediction is that “low-stiffness” tagged events preferentially populate the baseline branch, whereas “high-stiffness” events drift upward toward the saturated plateau. Consequently, restricting to low-stiffness events enhances the visibility of a peak near m_0 .

7.4. Resolution Requirement: Practical Compatibility Window

Let $\Delta_{\text{QICT}} \approx 1.5$ GeV denote the intrinsic half-width of the Golden-Relation band and Δ_{exp} the effective experimental mass resolution of the chosen reconstruction method. Consistency with the structural band may be operationally defined by

$$\boxed{|m_{\text{rec}} - m_0| \leq \Delta_{\text{tot}}, \quad \Delta_{\text{tot}} = \sqrt{\Delta_{\text{QICT}}^2 + \Delta_{\text{exp}}^2}.} \quad (18)$$

Equivalently, in terms of the synchronization gain,

$$\boxed{|\kappa - 1| \lesssim \frac{\Delta_{\text{tot}}}{m_0},} \quad (19)$$

showing that the observability of the 58 GeV branch is limited jointly by the intrinsic Golden-Relation uncertainty and the detector-level resolution.

Appendix A. Exclusion-Scale Audit: Why 470 GeV (And Its Companions) Keep Reappearing

Appendix A.1. Definitions and Conventions

We compare collider exclusion scales against the QICT “Golden-Relation” structural band

$$m_0 = (58.1 \pm 1.5) \text{ GeV}, \quad (\text{A1})$$

and define the dimensionless ratio

$$\kappa \equiv \frac{m_{\text{eff}}}{m_0}. \quad (\text{A2})$$

Throughout this appendix, the uncertainty on κ is propagated from m_0 only:

$$\sigma_\kappa \simeq \kappa \frac{\sigma_{m_0}}{m_0}. \quad (\text{A3})$$

This choice is conservative for our purpose (it avoids over-interpreting experimental systematics that are not quoted as a single number in the publications).

Appendix A.2. Minimal Predictive Map Used to Populate the Table

To make the table operational (i.e. not merely a list of quoted limits), we introduce a deliberately minimal transfer model that turns a channel definition and luminosity into a predicted effective scale. The intent is *not* to claim a full theory of sensitivity; rather, it is a compact, falsifiable map you can refine.

Run 1 (8 TeV) anchor.

We define the 8 TeV baseline and multilepton uplift by the two ATLAS Run 1 numbers:

$$m_{2\ell}^{(8)} \equiv 335 \text{ GeV}, \quad G_8 \equiv \frac{470}{335} = 1.403. \quad (\text{A4})$$

Thus

$$m_{3\ell}^{(8)} \equiv G_8 m_{2\ell}^{(8)}. \quad (\text{A5})$$

Run 2 (13 TeV) anchor.

We use ATLAS Run 2 to define the 13 TeV baseline and the multilepton uplift:

$$m_{2\ell}^{(13)}(L) \equiv 790 \text{ GeV} \left(\frac{L}{139 \text{ fb}^{-1}} \right)^\alpha, \quad G_{13} \equiv \frac{870}{790} = 1.101. \quad (\text{A6})$$

We take a weak luminosity exponent

$$\alpha = 0.03, \quad (\text{A7})$$

motivated empirically by the fact that the multilepton limits change only mildly between CMS 2016 (35.9 fb^{-1}) and full Run 2 (137 fb^{-1}). The multilepton prediction is

$$m_{\geq 3\ell}^{(13)}(L) \equiv G_{13} m_{2\ell}^{(13)}(L). \quad (\text{A8})$$

Combination rule.

To model the observed fact that the ATLAS combination (2ℓ plus $3/4\ell$) pushes beyond either single channel, we use a smooth-max aggregation

$$m_{\text{comb}}^{(13)}(L) \equiv \left(\left[m_{2\ell}^{(13)}(L) \right]^p + \left[m_{\geq 3\ell}^{(13)}(L) \right]^p \right)^{1/p}, \quad (\text{A9})$$

with p fixed by the ATLAS combined limit at $L = 139 \text{ fb}^{-1}$:

$$p = 8.27. \quad (\text{A10})$$

Pull definition.

For rows treated as predictions, we quote

$$\text{Pull} \equiv \frac{\kappa_{\text{exp}} - \kappa}{\sigma_{\kappa}}, \quad (\text{A11})$$

and we mark calibration rows with “–” in the pull column.

Appendix A.3. Filled Audit Table (All Entries in GeV)

Table A1. Exclusion-scale audit table. The values m_{eff} are the quoted 95% CL lower mass limits in the corresponding experimental interpretations. The map in Sec. A.2 is calibrated on ATLAS (Run 1 and Run 2) and then transferred to CMS as a prediction. The κ uncertainties are propagated from m_0 only.

Dataset	Channel/selection	m_{eff}	m_{eff}	κ_{exp}	κ	Pull
ATLAS Run 1 (8 TeV, 20.3 fb ⁻¹)	2 ℓ + 2 jets + E_T^{miss}	335	335.0	5.766 $\pm$ 0.149	5.766	–
ATLAS Run 1 (8 TeV, 20.3 fb ⁻¹)	3 ℓ channel added (improved Run-1)	470	470.0	8.090 $\pm$ 0.209	8.090	–
ATLAS Run 2 (13 TeV, 139 fb ⁻¹)	2 ℓ + jets + large E_T^{miss}	790	790.0	13.597 $\pm$ 0.351	13.597	–
ATLAS Run 2 (13 TeV, 139 fb ⁻¹)	3/4 ℓ channels (alone)	870	870.0	14.974 $\pm$ 0.387	14.974	–
ATLAS Run 2 (13 TeV, 139 fb ⁻¹)	Combined 2 ℓ + 3/4 ℓ	910	910.0	15.663 $\pm$ 0.404	15.663	–
CMS 2016 (13 TeV, 35.9 fb ⁻¹)	Multileptons (flavour-democratic)	840	835.4	14.458 $\pm$ 0.373	14.378	0.21
CMS Run 2 (13 TeV, 137 fb ⁻¹)	Multileptons (flavour-democratic)	880	869.6	15.146 $\pm$ 0.391	14.968	0.46

Appendix A.4. Interpretation Bullet Points (For a Referee/Defense Committee)

1. **Nontrivial clustering:** the appearance of specific scales (335, 470, 790, 870, 910, 840, 880 GeV) is not random bookkeeping; it is a structured ladder once expressed as $\kappa = m_{\text{eff}}/m_0$.
2. **Channel dependence is dominant:** the step from 2 ℓ to $\geq 3\ell$ behaves like a multiplicative uplift G (different in Run 1 vs Run 2), consistent with the QICT notion that the observable scale is a *map* from analysis stiffness/selection to an effective mass parameter rather than a direct measurement of a single underlying pole mass.
3. **Cross-experiment transfer works at the 1 σ level (here):** using only ATLAS anchors plus a weak luminosity exponent, the CMS limits land within $\lesssim 0.5\sigma$ in the κ metric (with σ_{κ} conservatively set by the Golden-Relation width).
4. **What would falsify this appendix quickly:** a future multilepton result that shifts the CMS/ATLAS Run 2 multilepton ratio far away from $G_{13} \simeq 1.10$, or a combined-channel result incompatible with any smooth-max p in Eq. (A.11) without introducing new degrees of freedom.

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