# CONCEPTS OF V-COMPUTING — EN_52 — COMPENDIUM

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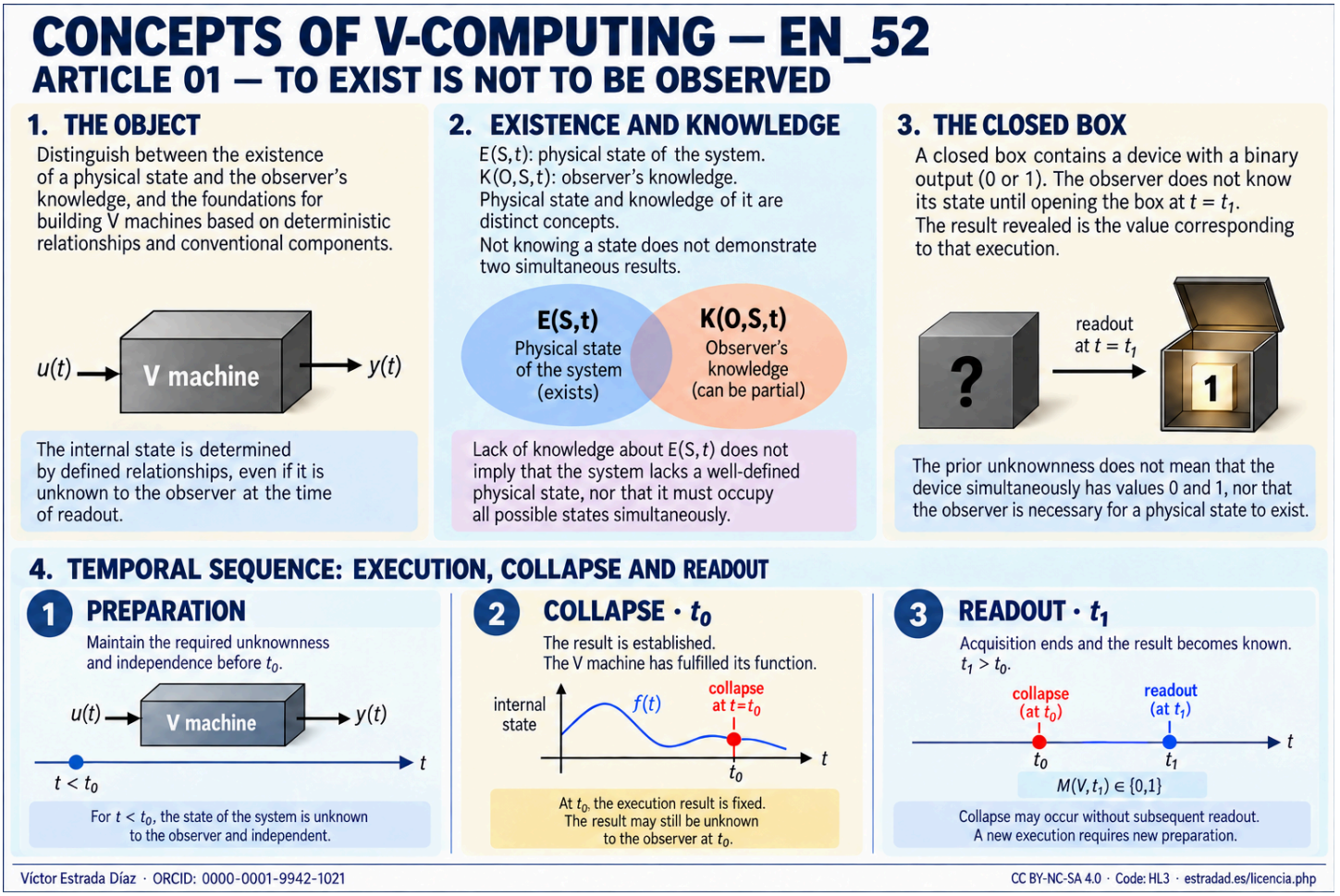
Complete compendium of articles 01–07 and the local V1 report. Each document retains its content and is presented with its image. Later drafts and publication metadata are excluded.

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# ARTICLE 01 — TO EXIST IS NOT TO BE OBSERVED




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 01 — TO EXIST IS NOT TO BE OBSERVED

Author: Víctor Estrada Díaz ORCID: 0000-0001-9942-1021 Project: ES_52 Status: Conceptual revision 2 Dual license — Ethics and use

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1. PURPOSE

This article establishes the fundamental distinction between the existence of a physical state and an observer's knowledge of that state.

V-computing starts from its own definitions and relations, without depending on interpretations of other physical theories.

Its purpose is to establish the foundations for building deterministic machines using conventional electronic or computational components, whose internal states are unknown to the observer until the measurement instant defined by the protocol.

Lack of knowledge of a state does not constitute a physical property of the state itself.

The properties of a V machine must follow from its construction, the relations governing its operation and results that can be checked experimentally.

The demonstrative objective of ES_52 is to build machines using operational concepts associated with qubits without needing quantum mechanics to define their operation.

This is not about simulating quantum amplitudes or artificially reproducing a mathematical description of the Q machine.

It is about building a V machine, subjecting it to specific operations and establishing through tests which operational equivalences exist between the two architectures.

2. EXISTENCE AND KNOWLEDGE

Consider a physical system S and an observer O.

We denote the physical state of the system at time t by E(S,t).

We denote the information available to observer O about system S at that instant by K(O,S,t).

These are distinct concepts.

E(S,t) represents the system's state.

K(O,S,t) represents the observer's knowledge.

The absence of complete knowledge about E(S,t) does not imply that E(S,t) lacks physical definition.

Nor does it imply that the system must simultaneously occupy every state the observer considers possible.

The expression "I do not know the state" describes a limitation of knowledge.

The expression “the system is in several states simultaneously” makes a different physical claim.

The first expression does not prove the second.

In a V machine, the internal state is defined by its construction and deterministic evolution, even though it is unknown to the observer.

The existence of the state does not depend on its observation.

## 3. THE CLOSED BOX

Imagine a closed box containing a device with a binary output.

At the instant considered, the device has a definite physical value, 0 or 1, determined by its operation.

The observer remains outside the box and has no access to the internal state.

The state is unknown to the observer.

At $t = t_0$, collapse occurs and the execution’s result is established. On completing readout at $t_1$, the observer learns the value 1.

Readout provides the result established at $t_0$, even if knowledge of it is completed later.

The earlier lack of knowledge did not mean that the device simultaneously had the values 0 and 1.

Nor was the observer’s intervention necessary for the device to have a physical state.

Measurement allows the observer to know it.

This example represents a V machine and is not, by itself, a demonstration of the internal behavior of a quantum system.

The distinction between a physical state and knowledge of it is the concept we seek to establish.

## 4. TIME, MEASUREMENT AND COLLAPSE

V-computing explicitly introduces time into the description of the system’s state and internal relations.

Let $f(t)$ be an internal function of the system and let $t_0$ be the instant of collapse. We denote the instant when acquisition of the result is completed by $t_1$.

Before $t_0$, the state to be observed is unknown to the observer, according to the established protocol.

The physical evolution of the V machine is determined by its internal relations.

At $t = t_0$, collapse establishes a binary result. Readout is completed at $t_1$:

$M(S,t_1) \in \{0,1\}$

Measurement provides a single definite result.

Before $t_0$, the result of that execution has not been established through collapse.

A distinction must be made between the physical state before observation and the result obtained when observation takes place.

In V-computing, we call the event that establishes the execution's result collapse. That result may remain unknown to whoever will read it until $t_1$, with $t_1 > t_0$ if readout is completed later.

Measurement encompasses the process needed to acquire the result. Its recipient may be a person or another machine.

The operational readout correspondence between $Q_\beta$ and $Q_v$ concerns obtaining a definite binary result. Establishing the result must be distinguished from acquiring or consulting it later, as developed in EN_52_04.

This correspondence does not require identical internal physical mechanisms to be attributed to $Q_\beta$ and $Q_v$.

Nor does it require interpreting the earlier lack of knowledge as the physical coexistence of mutually exclusive results.

Measurement may interact physically with the system. Its possible effects must be distinguished from the change in the observer's knowledge.

## 5. INITIAL DEFINITION OF THE V MACHINE

A V machine is a system built using conventional electronic or computational components, whose evolution is determined by defined relations.

Let $x(t)$ be its internal state and $u(t)$ the applied input.

For discrete evolution, we can write:

$$x(t + \Delta t) = F(x(t),u(t))$$

Its physical output is represented by:

$$y(t) = G(x(t))$$

F and G are defined by the machine's architecture.

The state $x(t)$ is unknown to the observer before the measurement established by the protocol.

This lack of knowledge does not introduce indeterminacy into the relations F and G.

Collapse at to establishes the result. Readout completed at $t_1$ makes it possible to know the output corresponding to that execution:

$M(V,t_1) = y(t_0)$

Readout is assumed to be suitable for obtaining that output. If the readout operation physically modifies the system, that effect must be described separately.

The construction does not require storing $2^n$ states, simulating quantum amplitudes or executing random decisions to determine its evolution.

Any randomness used in preparation must be distinguished from subsequent deterministic operation.

The V architecture may incorporate relations between multiple units, memory and circuit composition.

The possibility of building a complex machine from V units will be addressed in later articles.

## 6. OPERATIONAL DEFINITION OF $Q_\beta$ AND $Q_v$

We will call a binary quantum unit, or qubit, $Q_\beta$; its measurement in the computational basis yields one of the results:

$M(Q_\beta,t_1) \in \{0,1\}$

We will call a binary V-computing unit, built through deterministic relations, $Q_v$; its measurement yields:

$M(Q_v,t_1) \in \{0,1\}$

In the protocol we study, the state corresponding to each unit is unknown to the observer before measurement.

In both cases, a definite binary result is available when acquisition is completed at $t_1$.

$Q_\beta$ and $Q_v$ therefore share an initial operational correspondence between unknown state, measurement and observable result.

The conventional mathematical description of $Q_\beta$ uses quantum amplitudes; the construction of $Q_v$ does not need them.

The initial equivalence between these units concerns the readout event and the set of possible binary results.

This equivalence must not be confused with proof that all circuits built with $Q_\beta$ and $Q_v$ reproduce the same results.

That requires examining transformations, relations between units, correlations, interference and resources used.

These checks form part of the ES_52 experimental program.

## 7. THE TIME FUNCTION f(t)

The internal function f(t) allows time to be incorporated into the description of the system's evolution.

The existence of a function, its mathematical definition and the observer's knowledge of its values must be distinguished.

A function may be defined without an observer knowing its value at a particular instant.

In a V machine, internal relations determine the system's physical evolution.

Readout completed at $t_1$ provides the result established by collapse at $t_0$.

Distinguishing temporal evolution, physical state and knowledge allows the measurement event to be described without turning lack of knowledge into an additional physical property.

The full mathematical development of f(t), its temporal conditions and its relation to observable states belong to article EN_52_05.

## 8. DEFINITION, CONSTRUCTION AND DEMONSTRATION

In ES_52, we distinguish three levels:

### A. CONCEPTUAL DEFINITION

A physical state and knowledge of that state are different concepts.

Ignorance about a state does not prove the physical coexistence of mutually exclusive values.

### B. CONSTRUCTION

The V machine is built using deterministic relations and conventional components.

Its architecture must be described in a concrete and verifiable way.

### C. OPERATIONAL DEMONSTRATION

The V machine must be subjected to the same problems and to protocols comparable to those of the corresponding Q machine.

Comparisons will include the operations performed, measurement results, relevant correlations and computational resources.

An isolated agreement does not prove general equivalence.

The conclusion must correspond exactly to the scope of the tests performed.

The aim is not to give priority to a theoretical interpretation, but to establish what the machines built are capable of doing.

## 9. CONCLUSION

To exist is not to be observed.

The physical state of a V machine is determined by the relations governing its evolution, even though it is unknown to the observer.

Collapse at $t = t_0$ establishes the execution's result; readout completed at $t_1$ makes it possible to know it.

In V-computing, collapse completes that execution's function, even if the result has not yet been read. A new execution requires repeating preparation and restoring the required unknownness of the inputs.

The operational correspondence between $Q_\beta$ and $Q_v$ establishes common terms for describing measurement without imposing Q's physical foundations on V.

V-computing aims to build and verify machines that perform operations associated with quantum computing through deterministic relations and conventional technology.

The scope of equivalence between Q and V machines must be established through reproducible constructions and results.

## 10. RELATION TO THE FOLLOWING ARTICLES

EN_52_02 — The box and Schrödinger's cat.

EN_52_03 — The $Q_\beta$ bit and the $Q_v$ bit.

EN_52_04 — Collapse at $t = t_0$ and measurement.

EN_52_05 — The internal function f(t).

EN_52_06 — Relations and superposition.

EN_52_07 — Correlations and Bell.

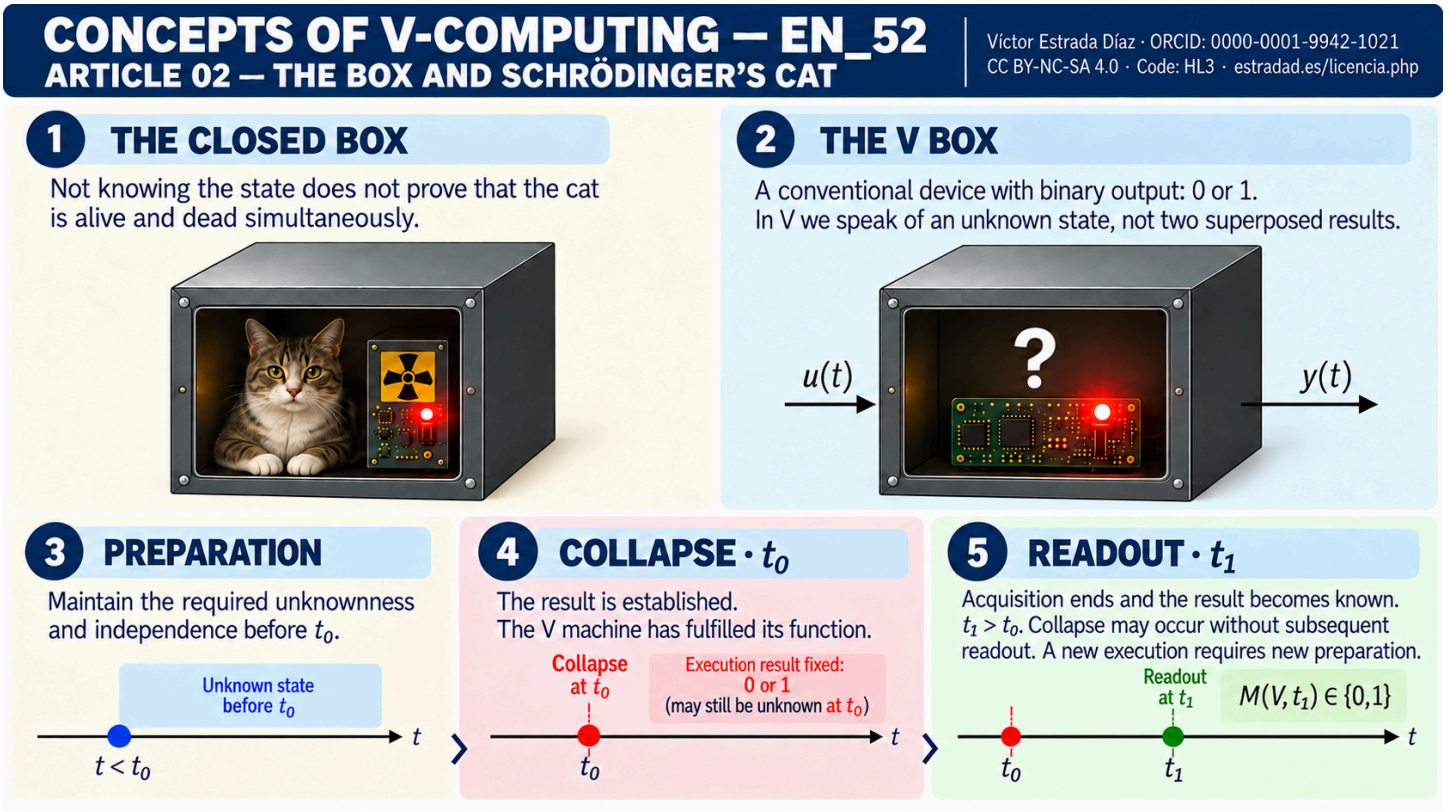
EN_52_08 — Construction of Q4 and V4.

EN_52_09 — The V4 cryptomachine.

END OF ARTICLE 01

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# ARTICLE 02 — THE BOX AND SCHRÖDINGER'S CAT




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 02 — THE BOX AND SCHRÖDINGER'S CAT

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1. PURPOSE

The Schrödinger’s cat thought experiment allows us to examine a fundamental question: the distinction between a system’s physical state and an observer’s knowledge of it.

In V-computing, this distinction is a construction principle.

A system may evolve through deterministic relations without the observer having access to its state.

This article aims to show how the closed box can be used to define unknown states, internal operations and measurements, without attributing physical properties to lack of knowledge that do not follow from it.

The box is not a quantum mechanism. It represents the observer’s inability to access the state.

2. THE CAT AND THE BOX

Consider a closed box containing a cat and a device whose operation may affect its survival.

While the box remains closed, an external observer does not know the cat’s state.

We denote:

G(t) = physical state of the cat at time t

K(O,G,t) = observer O’s knowledge of that state

These concepts must remain distinct.

The observer does not know the cat’s state, but this circumstance does not prove that the cat is alive and dead simultaneously.

The description “alive or dead” identifies mutually exclusive alternatives for the result of an ordinary observation.

The description “alive and dead simultaneously” is a different physical claim that does not follow from the observer’s ignorance.

Schrödinger’s thought experiment addresses precisely the problem of relating quantum description to macroscopic experience.

Formal superposition of quantum states must therefore not be confused with simple lack of knowledge of a classical alternative.

## 3. WHAT THE CLOSED BOX DOES NOT PROVE

The closed box prevents access to certain information.

It does not, by itself, prove:

A. That the system lacks a physical state.

B. That the physical state depends on a human observer opening the box.

C. That all imaginable alternatives are realized simultaneously.

D. That the act of knowing necessarily creates what is observed.

These conclusions would require grounds independent of mere lack of knowledge.

The reverse claim must also be considered: the closed box, by itself, is not general proof that all physical systems possess pre-existing classical values for every possible measurement.

V-computing does not need to resolve that general question to define and build its own machines.

It needs to specify the V machine's relations and check its results.

## 4. FROM THE CAT'S BOX TO THE V BOX

Replace the cat with a conventional device with a binary output.

The device can produce the physical values 0 or 1.

Let x(t) be its internal state.

Let y(t) be its output:

$y(t) = G(x(t))$

Construction determines the relation G.

The device remains inside a box that prevents the observer from knowing its state.

In the V-computing protocol, the state is unknown to the observer before measurement is performed.

This does not mean that the device physically contains two simultaneous results.

It means that there is operational inaccessibility defined by construction.

At $t = t_0$, collapse establishes the execution's result. Readout completed at $t_1$ allows it to be obtained:

$M(V,t_1) \in \{0,1\}$

The box allows the machine's internal evolution to be separated from the knowledge acquired by the observer.

## 5. TIME AND THE MEASUREMENT EVENT

We explicitly introduce time.

Let f(t) be an internal function describing the system's evolution according to the relations governing its operation.

Let $t_0$ be the instant of collapse and $t_1$ the instant when acquisition of the result is completed.

Before $t_0$, the system's state is unknown to the observer within the established protocol.

The machine continues its physical evolution according to its internal relations.

Collapse at $t_0$ establishes the result. Readout completed at $t_1$ makes it possible to know it:

$M(V,t_1) \in \{0,1\}$

Before collapse, that execution's result has not been established.

The physical system and its temporal evolution exist.

The result is established at $t_0$, even though its recipient does not know it until $t_1$. That person or machine may complete readout after collapse.

## 6. COLLAPSE IN V-COMPUTING

In V-computing, we call the event that establishes the execution's result at $t = t_0$ collapse.

At that instant, the execution's result is resolved, even though it is still unknown to whoever will read it.

Collapse is not introduced as an additional logic gate or an artificial mechanism intended to imitate a supposed internal transformation of another machine.

Collapse completes that execution's function. Readout allows acquisition of the result and may be completed later.

The temporal representation is:

$t < t_0$ State unknown to the observer

$t = t_0$ Collapse: result established, not yet necessarily known

$t = t_1$ Acquisition completed: result known; $t_1 > t_0$ if readout finishes later

The knowledge acquired at $t_1$ corresponds to the result established at $t_0$. Collapse may occur without subsequent readout. A new V execution requires repeating preparation, including the required unknownness of the inputs. This distinction is developed in EN_52_04.

## 7. THE CORRESPONDENCE BETWEEN $Q_\beta$ AND $Q_v$

Consider a quantum unit $Q_\beta$ and a V-computing unit $Q_v$.

Both are subjected to a binary measurement protocol.

For $Q_\beta$:

$M(Q_\beta,t_1) \in \{0,1\}$

For $Q_v$:

$M(Q_v,t_1) \in \{0,1\}$

The state corresponding to measurement is unknown to the observer before it is performed.

When acquisition is completed at $t_1$, both operations provide a definite binary value.

From the perspective of binary readout, the correspondence is explicit.

However, obtaining the same possible values does not, by itself, prove that two machines produce the same correlations, interference or results under any sequence of operations.

The elementary $Q_\beta/Q_v$ correspondence therefore allows a common operational vocabulary to be built, while circuit equivalence must be established through tests.

## 8. AN EXAMPLE WITH A DETERMINISTIC RELATION

Let us build a binary V device with an inverting relation.

Let b(t) be its binary input and z(t) its output.

We define:

$z(t) = 1 - b(t)$

This relation is deterministic.

If the input is 0, the output is 1.

If the input is 1, the output is 0.

The observer remains isolated from the input and output before readout.

During that interval, the state is unknown to the observer.

Collapse at to establishes the result; on completing readout at $t_1$, the observer obtains that definite result.

It is not necessary to introduce a superposition of values to build the inverter, execute its operation or read its result.

This example demonstrates the possibility of building an elementary V unit with an operationally unknown state and deterministic output.

It does not, by itself, prove that this inverter reproduces every operation of a qubit subjected to general quantum transformations.

## 9. THE DIFFERENCE BETWEEN IGNORANCE AND SUPERPOSITION

Lack of knowledge and superposition must not be used as synonyms.

Lack of knowledge describes a limitation of the observer's information.

In quantum mechanics, superposition belongs to the state formalism and allows effects such as interference to be calculated.

Stating that an observer does not know the state does not prove that superposition exists.

Stating that a V machine operates without quantum superposition does not automatically prove that it can reproduce every quantum phenomenon either.

ES_52 research consists of building specific V relations and subjecting them to the relevant tests.

The aim is to establish which operations associated with quantum systems can be built with conventional electronics and software without simulating amplitudes.

## 10. CONCLUSION

The closed box represents a limitation of access to information.

The physical system does not need the observer in order to evolve.

In V-computing, its evolution is determined by internal relations, even though the state is unknown before measurement.

Collapse at t = to establishes the execution's result. Knowledge of it is completed through acquisition at $t_1$, which may be later.

This construction allows operational concepts of measurement and unknown state to be used without relying on quantum mechanics to underpin the V machine's operation.

The cat's box thus serves as a conceptual tool for separating existence, knowledge and observation.

Construction and testing will determine which correspondences can be established between Q and V.

11. RELATION TO THE SERIES

Previous article:

EN_52_01 — To exist is not to be observed.

Following articles:

EN_52_03 — The $Q_{\beta}$ bit and the $Q_{v}$ bit.

EN_52_04 — Collapse at t = to and measurement.

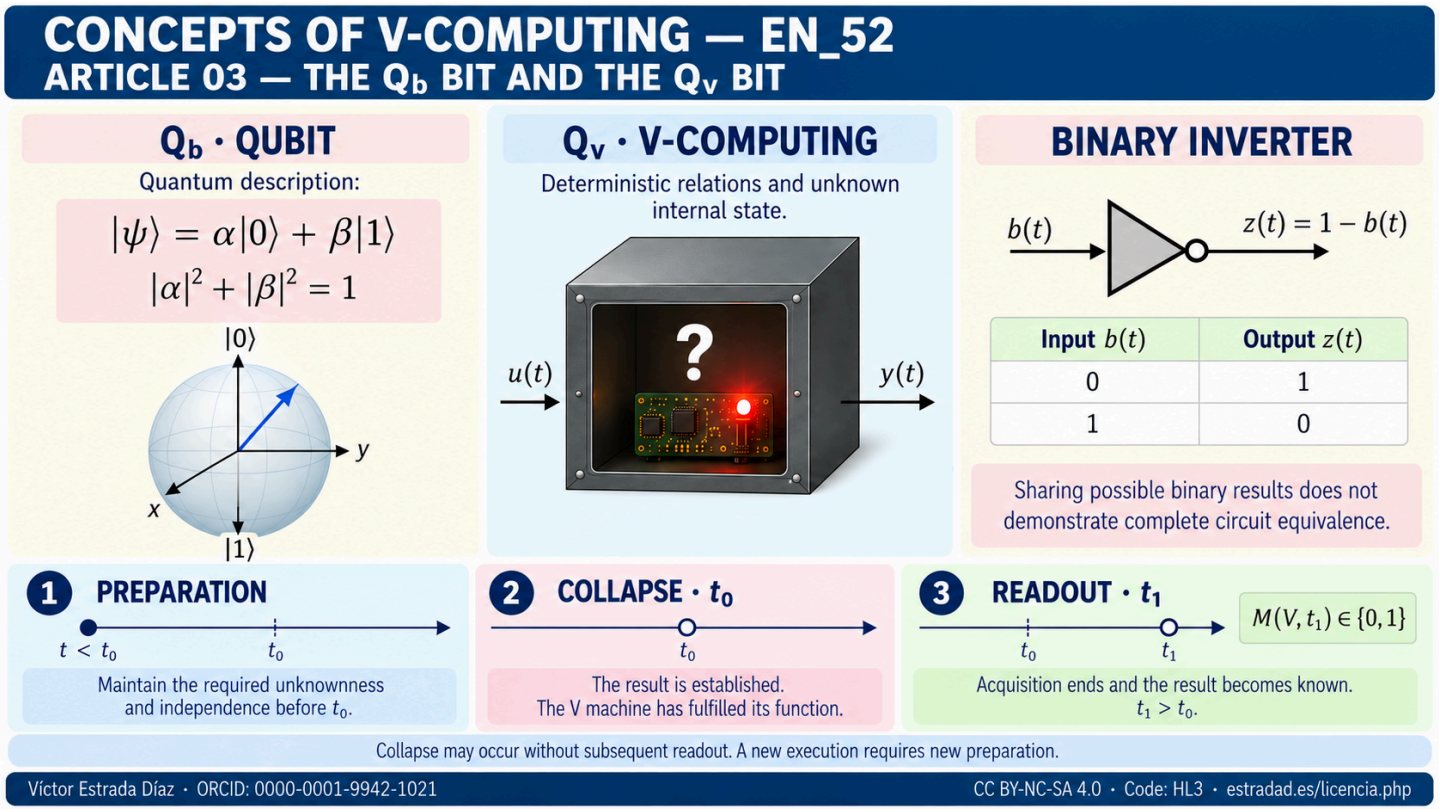
EN_52_05 — The internal function f(t).

EN_52_06 — Relations and superposition.

EN_52_07 — Correlations and Bell.

END OF ARTICLE 02

# ARTICLE 03 — THE $Q_\beta$ BIT AND THE $Q_v$ BIT




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 03 — THE $Q_\beta$ BIT AND THE $Q_v$ BIT

Author: Víctor Estrada Díaz ORCID: 0000-0001-9942-1021 Project: ES_52 Series: Concepts of V-computing Status: Conceptual revision 1 Dual license — Ethics and use

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1. PURPOSE

This article defines the units $Q_\beta$ and $Q_v$ and establishes the conditions of their operational correspondence.

V-computing proposes building machines with conventional electronic or computational components capable of performing operations associated with qubits, without needing quantum formalism to determine their operation.

To develop this construction, we need to distinguish three concepts:

The physical state of a unit.

The observer's knowledge of that state.

The result obtained when a measurement is performed.

This distinction allows a correspondence between $Q_\beta$ and $Q_v$ to be established without imposing on V the physical interpretations used to describe Q.

## 2. DEFINITION OF $Q_\beta$

We will call a binary quantum unit, usually called a qubit, $Q_\beta$.

When measurement is performed in the computational basis, the operation provides one of the values:

$M(Q_\beta,t_1) \in \{0,1\}$

The usual quantum description uses a state vector:

$|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$

With the normalization condition:

$|\alpha|^2 + |\beta|^2 = 1$

This expression belongs to the mathematical formalism of quantum mechanics.

It does not, by itself, mean that an observer has verified the simultaneous existence of two mutually exclusive classical values.

Superposition allows the results of different quantum operations to be calculated, including operations that produce interference.

In the protocol studied, the state of $Q_\beta$ is unknown to the observer before the corresponding measurement is performed.

When acquisition of the result is completed at $t_1$, a definite binary value is obtained.

## 3. DEFINITION OF $Q_v$

We will call the fundamental binary unit of V-computing $Q_v$.

$Q_v$ is built using conventional physical or computational components and deterministic relations.

Its internal state is determined by its construction and evolution.

In the defined protocol, that state is unknown to the observer before measurement is performed.

Collapse at $t_0$ establishes the execution's result. On completing readout at $t_1$, we obtain:

$M(Q_v,t_1) \in \{0,1\}$

The construction of $Q_v$ does not require assigning quantum amplitudes to the state, storing all possible values or executing random decisions during its evolution.

The inaccessibility of the state before measurement forms part of the machine's operational conditions.

It does not mean that the unit simultaneously contains the values 0 and 1.

## 4. STATE, VALUE AND MEASUREMENT

Consider a binary unit B and an observer O.

We define:

$E(B,t)$ = physical state of B at t

$K(O,B,t)$ = observer's knowledge of B at t

$M(B,t_1)$ = result acquired when readout of B is completed at $t_1$

These three conceptual objects are not interchangeable.

Before $t_0$, the unit's state is unknown to the observer, according to the protocol.

In V, collapse at $t_0$ establishes a definite value. Acquisition completed at $t_1$ makes it possible to know it.

The result must not be confused with a record already known before that operation is performed.

V-computing uses precisely the distinction between state and knowledge to build systems whose operation is independent of the observer's access to their internal state.

## 5. TIME AND COLLAPSE

We introduce an internal function f(t) describing the system's evolution.

Let $t_0$ be the instant of collapse and $t_1$ the instant when acquisition of the result is completed.

The operational sequence is:

$t < t_0$ State unknown to the observer.

$t = t_0$ Collapse: result established, not yet necessarily known.

$t = t_1$ Acquisition completed: result known; $t_1 > t_0$ if readout finishes later.

In V-computing, collapse establishes the result and completes that execution's function, even though the result is not yet known to whoever will read it.

The correspondence with $Q_\beta$ readout concerns acquiring a definite binary result. The distinction between establishing and acquiring the result is developed in EN_52_04.

In both units, acquisition provides a value from the set {0,1}. Its recipient may be a person or another machine.

In V, collapse may occur without subsequent readout, but acquiring the result requires it to have been established. A new execution requires repeating preparation and restoring the required unknownness of the inputs.

The time function and internal relations determine the V unit's evolution.

Readout completed at $t_1$ makes it possible to know the result established at $t_0$.

6. $Q_\beta/Q_v$ OPERATIONAL CORRESPONDENCE

The initial correspondence is established through the same binary measurement protocol.

For $Q_\beta$:

$M(Q_\beta,t_1) \in \{0,1\}$

For $Q_v$:

$M(Q_v,t_1) \in \{0,1\}$

Both units share:

A. A state inaccessible to the observer before the established measurement.

B. A measurement operation whose acquisition is completed at $t_1$.

C. A definite binary result.

D. A temporal description distinguishing prior evolution from the measurement event.

This correspondence allows a common operational vocabulary to be used.

However, sharing possible results does not imply that two units necessarily respond in the same way to every preparation and transformation.

The equivalence of a specific operation requires demonstrating correspondence between its results under comparable conditions.

## 7. ELEMENTARY CONSTRUCTION OF $Q_v$

Consider a conventional unit consisting of a binary register and a logic inverter.

Let b(t) be the register's value.

We define the inverting operation:

$N(b) = 1 - b$

Its operating table is:

Input 0 → Output 1

Input 1 → Output 0

The operation is completely deterministic.

If the register and its output remain inaccessible to the observer until readout, the corresponding state is unknown to the observer.

Collapse at $t_0$ establishes one of the two possible results. Readout completed at $t_1$ makes it possible to know it.

The construction satisfies the elementary conditions of a $Q_v$ unit.

The conventional inverter reproduces the action of the quantum X gate on computational-basis states:

$X|0\rangle = |1\rangle$

$X|1\rangle = |0\rangle$

The agreement of these two transformations constitutes a verifiable correspondence for those inputs.

It does not prove that the conventional inverter reproduces the action of X on every possible quantum state or on entangled systems.

The extension of the correspondence must be analyzed operation by operation.

## 8. CONSTRUCTION OF V REGISTERS

A V machine can be built by composing several $Q_v$ units.

Consider a register of n units:

$V_n = (Q_v1, Q_v2, \ldots, Q_{vn})$

The register's physical state evolves through relations defined by the architecture.

The units can be related through logical operations, memories, connections and conventional circuits.

The observer has no access to the register's internal state before the established measurement operation.

A complete readout may produce a binary string:

$M(V_n, t_1) \in \{0,1\}^n$

The construction does not require simultaneously storing the $2^n$ possible configurations.

A distinction must be made between the number of configurations that can be described mathematically and the number of states the machine needs to store during an execution.

Any equivalence between a V register and a quantum register must be checked for the operations intended to be reproduced.

## 9. COMPOSITION OF OPERATIONS

V-computing allows complex machines to be built by connecting elementary units.

Let $R_1$ and $R_2$ be two deterministic relations.

Their composition is represented by:

$R = R_2 \circ R_1$

An input is transformed first by $R_1$ and then by $R_2$.

The composition remains deterministic if the relations and evolution conditions are defined.

Building V circuits requires specifying their inputs, internal states, relations, connections and outputs.

Merely assigning the name of a quantum gate to a conventional relation is not enough to establish equivalence.

The correspondence must be demonstrated for the relevant set of inputs, operations and measurements.

## 10. WHAT HAS BEEN ESTABLISHED

This article establishes:

A. An operational definition of $Q_\beta$ and $Q_v$ based on binary measurement.

B. The distinction between physical state, knowledge of the state and measurement result.

C. The distinction in V between collapse at $t_0$ and acquisition of the result completed at $t_1$.

D. An elementary construction of $Q_v$ using a register and a conventional operation.

E. The correspondence of binary inversion for computational-basis inputs.

F. The possibility of composing V units through deterministic relations.

It remains to establish to what extent V machines can reproduce other operations, transformations, interference and correlations associated with Q machines.

These questions will be addressed through explicit constructions and test protocols.

## 11. CONCLUSION

$Q_\beta$ and $Q_v$ can be described using common operational terms when studying their unknown state, measurement and the result acquired when readout is completed at $t_1$.

The $Q_v$ unit is built with deterministic relations and conventional components.

Its operation does not need to simulate quantum amplitudes or interpret lack of knowledge as coexistence of mutually exclusive values.

The elementary readout agreement provides a starting point for building and comparing machines.

The objective of ES_52 is to extend this correspondence through specific operations and determine its limits experimentally.

The aim is not to replace one explanation with another through a conceptual assertion, but to build machines and verify which operations they can perform.

## 12. RELATION TO THE SERIES

Previous articles:

EN_52_01 — To exist is not to be observed.

EN_52_02 — The box and Schrödinger’s cat.

Following articles:

EN_52_04 — Collapse at t = to and measurement.

EN_52_05 — The internal function f(t).

EN_52_06 — Relations and superposition.

EN_52_07 — Correlations and Bell.

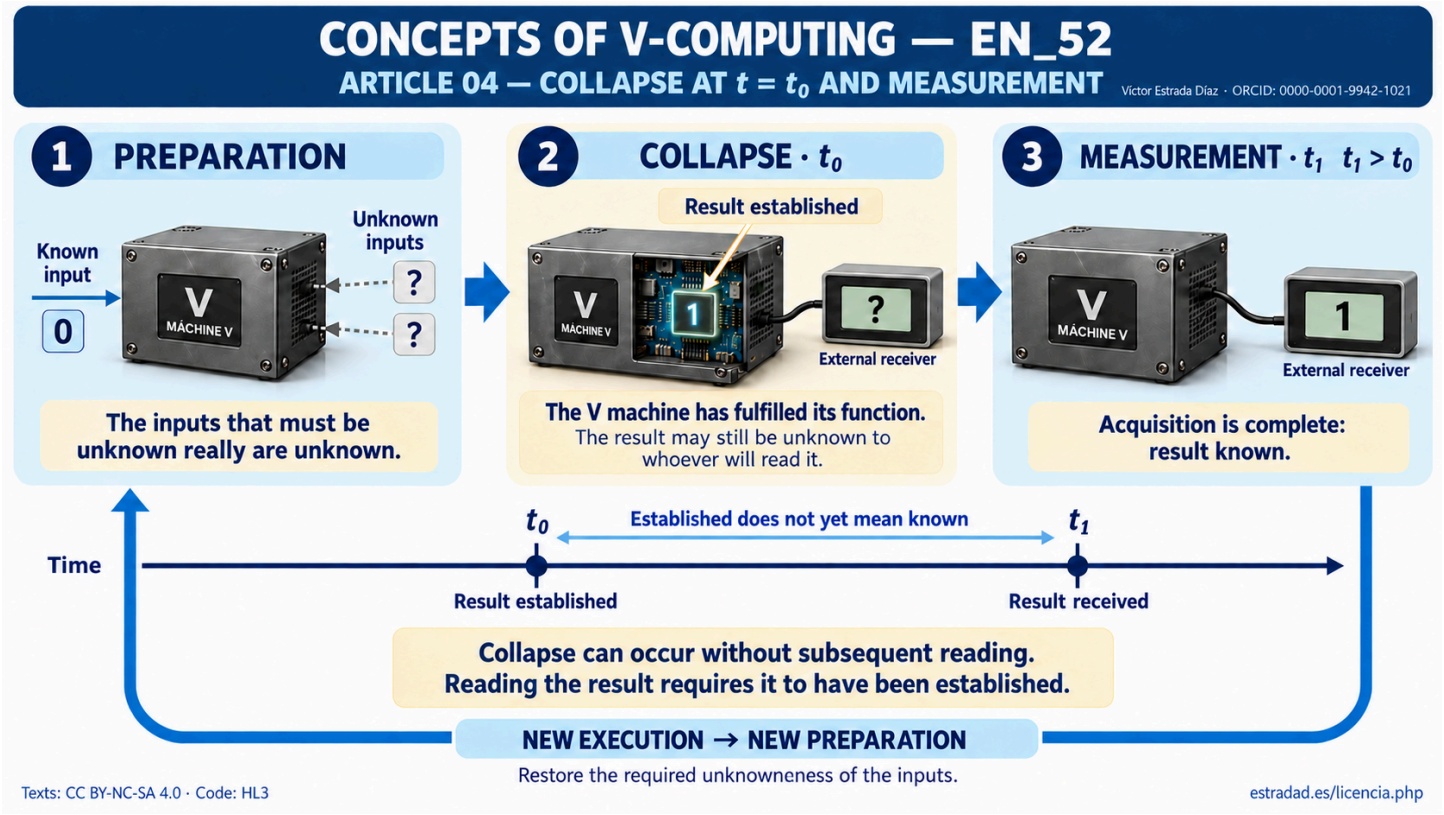
EN_52_08 — Construction of Q4 and V4.

EN_52_09 — The V4 cryptomachine.

END OF ARTICLE 03

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# ARTICLE 04 — COLLAPSE AT t = to AND MEASUREMENT




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 04 — COLLAPSE AT t = to AND MEASUREMENT

Author: Víctor Estrada Díaz ORCID: 0000-0001-9942-1021 Project: ES_52 Series: Concepts of V-computing Status: Draft for author review Dual license — Ethics and use

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1. PURPOSE

This article distinguishes preparation, collapse and measurement in an execution of the V machine.

Collapse establishes the execution's result. Measurement allows it to be obtained and known.

The recipient of the result may be a person or another machine.

2. PREPARATION

V execution begins with preparation.

The inputs that must be unknown must really be unknown to whoever will perform readout.

Lack of knowledge forms part of this V machine's preparation conditions.

3. COLLAPSE AT $t = t_0$

We denote the instant when collapse occurs by $t_0$.

In the definition of V used here, collapse establishes the execution's result and resolves the uncertainties corresponding to that result.

Once collapse has occurred, the V machine has fulfilled its function in that execution.

The fact that the result has been established does not mean it is already known to whoever will read it.

At $t_0$ it may remain unknown to that person or machine.

Collapse does not require subsequent readout to take place.

4. MEASUREMENT AND KNOWLEDGE OF THE RESULT

Measurement encompasses the process needed to obtain the result. It does not require a person's intervention: another machine may perform measurement and receive it.

We denote the instant when acquisition of the result is completed and it becomes known to its recipient by $t_1$.

If readout is completed after collapse:

$t_1 > t_0$

The result is established at $t_0$ and knowledge of it is completed at $t_1$.

Subsequent readout obtains that execution's result; it does not retrospectively change what was established at collapse.

## 5. COLLAPSING AND MEASURING

Collapse and measurement designate different aspects of the described process.

Collapse may occur without the result being read afterwards.

In this definition of V, obtaining an execution's result through measurement requires that result to have been established by collapse.

For example, an experiment may be arranged in which collapse occurs at 2 o'clock and readout of the result is completed at 4 o'clock.

Between these times, the result is already established, even though its recipient still does not know it.

## 6. REUSING THE V MACHINE

The V machine can be reused for a new execution.

To do so, it must go through all preparation phases again.

In particular, inputs that must be unknown must really be unknown in the new execution.

Reading the previous result again does not constitute a new V execution.

A readout that dispenses with the required preparation and collapse does not correspond to the V-machine process defined in this article.

## 7. RELATION TO Q

To compare Q and V, we distinguish establishing a result from subsequently acquiring or consulting it.

In Q, a result can also be recorded and consulted later. In usual quantum terminology, the interaction producing that record already forms part of measurement.

The temporal distinction allows us to describe when the result is recorded and when another person or machine receives it. It does not, by itself, identify the physical mechanisms of Q and V.

## 8. CONCLUSION

Preparation establishes the conditions of a V execution, including the required unknownness of the inputs.

Collapse at $t = t_0$ establishes the result and completes the machine's function in that execution.

Measurement allows that result to be obtained. Knowledge of it is completed at $t_1$, which may be later than $t_0$.

A new execution requires new preparation.

## 9. RELATION TO THE SERIES

Previous articles:

EN_52_01 — To exist is not to be observed.

EN_52_02 — The box and Schrödinger's cat.

EN_52_03 — The $Q_\beta$ bit and the $Q_v$ bit.

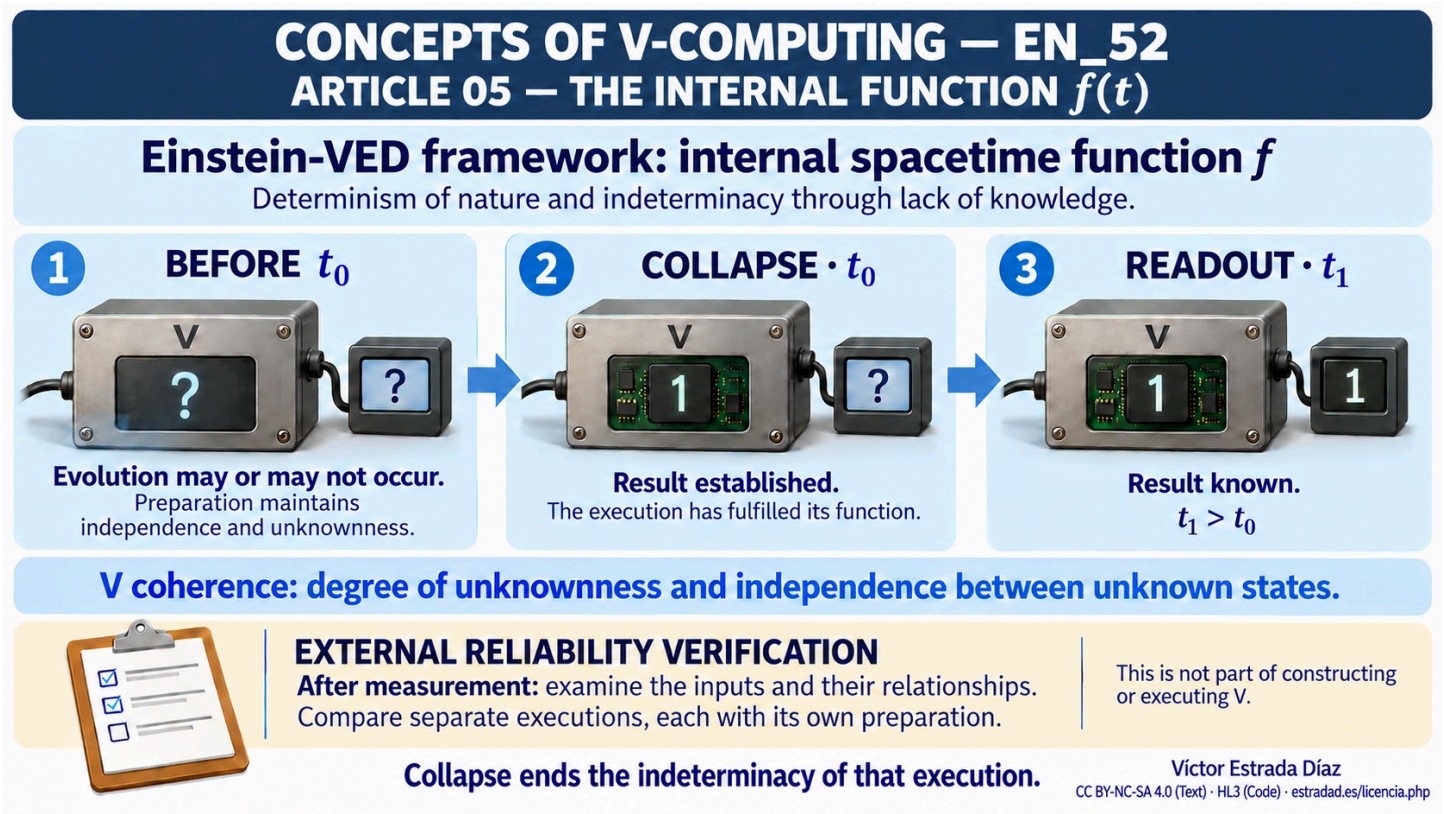
Next article:

EN_52_05 — The internal function f(t).

END OF ARTICLE 04

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# ARTICLE 05 — THE INTERNAL FUNCTION f(t)




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 05 — THE INTERNAL FUNCTION f(t)

Author: Víctor Estrada Díaz ORCID: 0000-0001-9942-1021 Project: ES_52 Series: Concepts of V-computing Status: Checked and closed by the author — 22 October 2026

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1. PURPOSE

Within the Einstein-VED framework, the author introduces a function f internal to spacetime to address the relation between nature's determinism and the indeterminacy associated with lack of knowledge of its internal reality.

In this proposal, nature is deterministic, but indeterminacy exists through lack of knowledge of its internal reality. What is unknown does not cease to have reality because the machine does not know its state.

The function f internal to spacetime is the one the author introduces in Einstein-VED to relate that determinism to quantum indeterminacy. This is the premise of the framework from which V is built.

Knowing the construction, its purpose and its relations does not amount to knowing the internal state of a prepared execution.

2. EVOLUTION AND RESULT

The V machine can be built for a purpose and tested with fixed values. Once prepared for the execution considered, its internal state must remain unknown to the machine before $t = t_0$.

No particular form of internal evolution is required. What matters is maintaining independence and unknownness before $t = t_0$.

Preparation must ensure both conditions hold throughout that interval, not only at the initial moment.

Internal evolution may or may not occur. If an unknown state evolves in an unknown way and the required independence is maintained, it continues to satisfy the V condition.

If it converges to a state known or deducible by the machine before $t_0$, it ceases to satisfy that condition. Convergence alone does not violate it if the state remains unknown and independent.

In the author's framework, V coherence expresses the degree to which what is not known is genuinely unknown and independent of the other unknown states.

Preparation must maintain that condition before $t_0$. Coherence can only be measured after collapse; no prior measurement is introduced that provides access to states that must remain unknown.

Checking coherence or decoherence is an external verification and reliability mechanism. It is not part of the V machine's construction and does not add a phase to its execution.

Once measurement is completed, after $t_0$, the previously unknown inputs can be known and examined. Their degree of independence and their relations are then checked to assess whether the required conditions were maintained before collapse.

Separate executions may also be performed, each with its own preparation, and the resulting data compared to check whether the inputs that had to be unknown really were unknown and maintained the required independence.

This subsequent verification examines execution reliability. It does not give V advance knowledge of its inputs or intervene to determine its result.

## 3. COLLAPSE AND READOUT

At $t_0$, collapse establishes that execution's result and the V machine has fulfilled its function.

Triggering collapse ends the indeterminacy of that execution's result: what previously remained unresolved is fixed in a specific result.

This is the meaning of the end of indeterminism in V within the author's framework. It does not mean that no internal state existed beforehand or that its evolution had to be known for the machine to operate.

Before $t_0$, preparation maintains the required independence and unknownness. At $t_0$, collapse resolves the result. Its acquisition may be completed afterwards.

The indeterminacy resolved by collapse must be distinguished from the lack of knowledge that the result's recipient may still have. The machine has already fulfilled its function even if that result has not yet been communicated or read.

At $t_1$, acquisition of the result is completed. It may be the case that $t_1 > t_0$.

Once obtained, that execution's result is known: it is not treated as a probability of what might have resulted.

Subsequent readout obtains the result established at $t_0$. It does not turn that result into the value the function might have at another instant.

Collapse may occur without subsequent readout. A new execution requires repeating preparation and again ensuring the required independence and unknownness before the new $t_0$.

## 4. RELATION TO V1

V1 provides an already established example for the Deutsch problem: distinguishing constant and balanced binary functions.

The local report establishes, for the answer bit:

$q_0 = f_o(0)$ XOR $f_o(1)$

Here $f_o$ denotes the Deutsch oracle function; it is not the time function f(t).

The answer is 0 for tables 00 and 11, and 1 for 01 and 10. All four cases agree with the protocol's Q1 reference.

The local structural analysis gives a cost of O(1) per execution for this fixed-size circuit. That count does not measure latencies against a physical quantum computer.

The reference documentation for the V1/Q1 comparison and its time order is the ES_52 work in UNIHOLOG and DEMUESTRA/Proyectos/ES_52. Complexity order is distinguished from actual duration in seconds.

In DEMUESTRA, documentary verification will be performed exclusively on the Spanish .md files in Proyectos/ES_52. This reference identifies the documentation to be checked; it does not declare that a new verification of its results has been performed.

5. CONCLUSION

The internal function f belongs to the Einstein-VED framework from which V construction is proposed. The proposal distinguishes internal reality from knowledge of it.

For the V machine, internal evolution may or may not occur: the requirement before collapse is to maintain independence and unknownness. Their degree defines V coherence, which is measured only after collapse. Preparation must maintain these conditions before $t_0$. Collapse establishes the result and acquisition allows it to be known afterwards.

This is why triggering collapse ends the indeterminacy of that execution: the result is established at $t_0$, even if knowledge of it is completed at $t_1$. To set up another execution under V conditions, the machine must be prepared again.

6. LOCAL ES_52 REFERENCES

Base project, section 9: ./../UNIHOLOG/ES_52_Maquina_V_UNIHOLOG.pdf Established V1 result for Deutsch: ./../UNIHOLOG/ES_52_Resultados_preparacion.pdf Demonstration: ./../DEMUESTRA/Proyectos/ES_52/ES_52_Maquina_V_UNIHOLOG.pdf Relations, measurement and Bell: ./../DEMUESTRA/Proyectos/ES_52/ES_52_Relaciones_medida_y_Bell.pdf

Scope of verification in DEMUESTRA: Spanish .md files only. Translations or other formats will not be used as substitutes for that review.

Local reports previously consulted in UNIHOLOG:
./datos/ES_52_EnsayoBellV1/resultado_asentado_v1.json
./datos/ES_52_EnsayoBellV1/analisis_complejidad_v1.json

RELATION TO THE SERIES

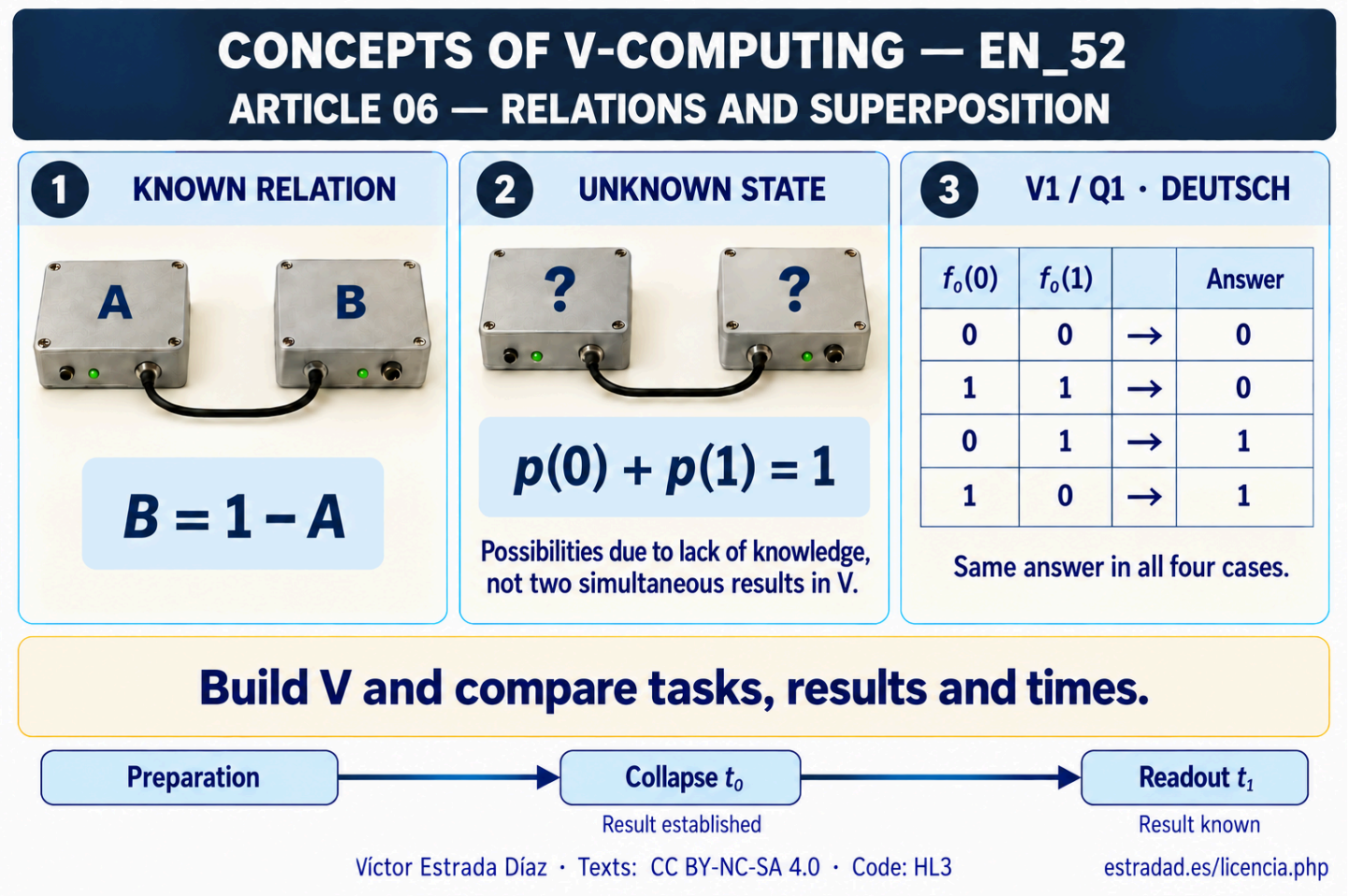
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END OF ARTICLE 05

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# ARTICLE 06 — RELATIONS AND SUPERPOSITION




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 06 — RELATIONS AND SUPERPOSITION

Author: Víctor Estrada Díaz ORCID: 0000-0001-9942-1021 Project: ES_52 Series: Concepts of V-computing Status: Text checked and closed by the author — 22 October 2026

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1. PURPOSE

A relation may be known even though its values are unknown. This distinction allows a V machine to be built, its operations defined and a result obtained without prior knowledge of its internal states.

The objective is to build V and confront it with the same problems as its Q reference to compare results and times. There is no need to adopt an interpretation of Q’s internal reality to define V’s construction.

2. KNOWING THE RELATION

Consider two binary values A and B related by:

$B = 1 - A$

Knowing this relation allows us to state that the values are opposite without knowing which is 0 and which is 1.

The compatible possibilities are:

$A = 0, B = 1$

$A = 1, B = 0$

Listing those possibilities in an explanation does not imply that the machine must store or iterate through them in order to operate.

3. OPERATING WITH UNKNOWN VALUES

Preparing a relation does not require first reading its unknown inputs. Construction establishes connections and operations; values that must remain unknown are not obtained in advance to perform those operations.

Internal evolution may or may not occur. Preparation must maintain the required unknownness and independence before $t_0$, as explained in EN_52_05.

In V, preparation, collapse at $t_0$ and acquisition completed at $t_1$ retain the meaning given in article 04.

A new execution requires new preparation. Rereading an already established result does not replace that preparation.

## 4. UNKNOWN STATES AND UNCERTAINTY

In V, the unknown state is not defined as a superposition of the values 0 and 1.

The fact that both results are possible in the description of someone who does not know them does not mean that the V unit must contain both values simultaneously as execution results.

The degree of unknownness can be expressed through uncertainty or probabilities. For a valid binary output:

$p(0) + p(1) = 1$

This expression does not require the probabilities to be equal or replace the machine's physical or computational relations.

Probabilities describe possibilities before the result is known. The result obtained in an execution is a specific value, not two superposed values.

The term superposition appears in the title to situate the topic within the series. It is not introduced as a requirement or an internal definition of V. The article does not seek to resolve interpretations of Q.

## 5. V1 AS A VERIFIED EXAMPLE

In the Deutsch task, V1 and the Q1 reference agree on the bit distinguishing constant and balanced functions.

Constant 0: table 00 → answer 0. Constant 1: table 11 → answer 0. Identity: table 01 → answer 1. Inverter: table 10 → answer 1.

The answer bit satisfies:

$q_0 = f_o(0)$ XOR $f_o(1)$

$f_o$ is the Deutsch oracle function, distinct from the internal function f of the Einstein-VED framework.

The table above presents the inputs of the four checked cases and their answers; it does not describe an advance query of V1's unknown internal states.

This agreement demonstrates a specific task solved by V1 with the same answer as Q1. The example supports the explanation of V relations; it does not replace the central topic with a discussion of Q's internal nature.

## 6. COMPARING WHAT MACHINES SOLVE

The comparison starts with the same problem, the corresponding inputs and the result each machine must deliver.

In addition to checking answers, time is compared under a common criterion: which operations are included and whether the discussion concerns complexity order or measured duration.

The local V1 analysis establishes O(1) per execution for this fixed-size protocol. The ES_52 documentation in UNIHOLOG and DEMUESTRA/Proyectos/ES_52 is the reference for the scope of the V1/Q1 comparison. In DEMUESTRA, only Spanish .md files will be verified.

Equivalence concerns the tasks, results and costs actually compared. It does not require V to have the same internal structure or interpretation as Q.

Checking coherence or decoherence is external to V's construction and execution, and is performed after measurement, according to EN_52_05.

7. CONCLUSION

Knowing a relation and knowing its values are different things.

V is built through known relations and states that remain unknown under preparation conditions. This lack of knowledge is expressed as uncertainty, without attributing superposition to it.

Collapse establishes a specific result; acquisition makes it possible to know it. V1/Q1 provides the verified Deutsch example. Comparisons aim to establish which problems each construction solves and at what time cost.

8. LOCAL ES_52 REFERENCES

Relations between unknown values: ./../UNIHOLOG/ES_52_Maquina_V_UNIHOLOG.pdf
./datos/ES_52_EnsayoBellV1/resultado_asentado_v1.json
./datos/ES_52_EnsayoBellV1/analisis_complejidad_v1.json
./../UNIHOLOG/ES_52_Resultados_preparacion.pdf
./../DEMUESTRA/Proyectos/ES_52/ES_52_Maquina_V_UNIHOLOG.pdf

Documentary verification in DEMUESTRA: Spanish .md files only.

RELATION TO THE SERIES

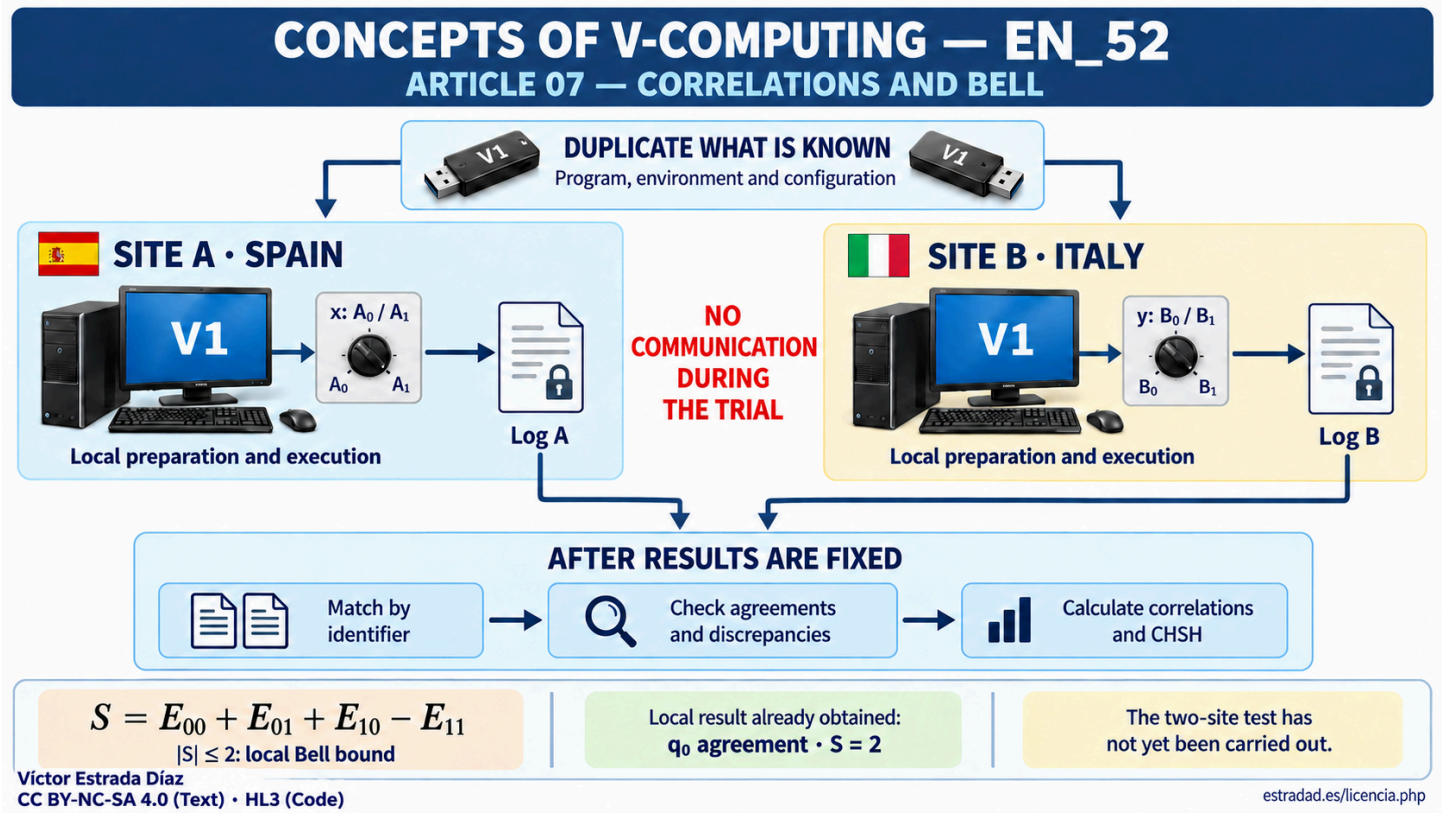
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Next: ./pdfs/EN_52_07_ConceptosVcomputacion.pdf

END OF ARTICLE 06

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# ARTICLE 07 — CORRELATIONS AND BELL




CONCEPTS OF V-COMPUTING — EN_52

ARTICLE 07 — CORRELATIONS AND BELL

Author: Víctor Estrada Díaz ORCID: 0000-0001-9942-1021 Project: ES_52 Series: Concepts of V-computing Status: Draft for author review — unpublished

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1. PURPOSE

A correlation expresses a relation between results. This article distinguishes a correlation constructed through known relations from the specific conditions of a Bell test.

## 2. A SIMPLE RELATION

If two binary outputs satisfy:

$B = 1 - A$

their values are opposite. Not knowing A and B does not prevent knowledge of that relation.

On completing readout, the values obtained in that execution become known. The relation allows them to be interpreted, but does not, by itself, turn the device into a Bell experiment.

## 3. WHAT TO COMPARE

Comparing correlations requires identifying the inputs, operations and pairs of results belonging to each execution.

In the V process of this series, collapse establishes the result at $t_0$ and acquisition is completed at $t_1$. Each new execution repeats the required preparation.

No readouts of unknown internal values during preparation are added to explain correlations.

## 4. THE SCOPE OF BELL

Bell inequalities limit the correlations of particular classes of models under explicit assumptions, including locality and independence of measurement choices from shared variables.

Quantum experiments have shown violations of these inequalities. Presenting two identical or opposite results is not enough to claim a violation.

If a V construction shares information between its parts or receives their settings jointly, that feature must be described when comparing it with Bell conditions.

A local computational selector trial with two V1 Python processes has been performed. Its results and limitations are presented in section 6. It is not a loophole-free physical Bell test.

## 5. WHAT V1 CONTRIBUTES

The V1/Q1 verification for Deutsch establishes agreement of the answer bit for the four binary functions considered.

That result is an example of operational comparison. It is not, by itself, a Bell test or a demonstration of the correlations of a multi-unit machine.

The following trial uses only the installed V1, without modifying its construction. Later constructions remain reserved.

## 6. LOCAL V1 TRIAL WITH SELECTORS

Two branches receive the same known oracle input. Each branch has two selection labels, 0 and 1, identifying interchangeable V1 copies, not different measurement operations.

Each trial prepares a new instance per branch. Each process receives only its local selector and the common input. The controller collects both results afterwards and calculates correlations externally.

8,192 paired trials were performed, equivalent to 16,384 V1 executions: 4,096 trials with ordered selection and another 4,096 with external random selection.

The $q_0$ bit, which answers the Deutsch problem, agreed between branches and with $f_o(0)$ XOR $f_o(1)$ in every execution and for all four oracles. The selectors do not generate V's internal states or outputs.

For each selector pair, a product of +1 is assigned if the outputs agree and −1 if they differ. $E_{00}$, $E_{01}$, $E_{10}$ and $E_{11}$ are the averages of those products in each group.

The convention used is:

$$S = E_{00} + E_{01} + E_{10} - E_{11}$$

For $q_0$, both selection modes gave:

$$E_{00} = E_{01} = E_{10} = E_{11} = 1$$

$$S = 2$$

Complete agreement in the Deutsch answer was therefore observed, but not a violation of the local Bell bound, $|S| \leq 2$.

The two V1 machines on one computer passed the local checks performed: agreement of the Deutsch answer and compliance with the Bell inequality. No violation of that inequality was found in the trial data; $q_0$ gave $S = 2$. Passing these checks means satisfying those criteria, not exceeding the Bell bound or certifying a loophole-free physical test.

$q_1$ was also analyzed, without selecting the most favorable bit afterwards. It gave $S = 1.998046875$ with ordered selection and $S = 2$ with random selection.

The trial ran on a single computer with two Python processes. Neither Prolog nor a Spain–Italy setup was run, and physical isolation, independence of time references and absence of side channels were not certified. The controller knows both settings. Ordered selection is a control, not a test of setting independence.

In this trial, selectors are generated before the new instances are prepared; a physical choice following shared preparation is not certified. The records contain $t_0$ and software durations, not an independent measurement of $t_1$. There is no time comparison with Q hardware either.

The additional external check of the 16 possible local binary assignments gave a maximum $|S| = 2$ and a maximum 75% CHSH success rate with uniform settings. It is not part of V's internal operation.

The result concerns the setup executed. It does not decide the behavior of all V constructions. Studying different measurement alternatives requires defining local operations, shared preparation and conditions of access to information.

Specific report with formulas, tables and relative links, PDF version: ./pdfs/EN_52_EnsayoBellV1.pdf

Results summary: ./datos/ES_52_EnsayoBellV1/resultados.json

Complete records: ./datos/ES_52_EnsayoBellV1/registros.jsonl

## 7. PROPOSED EXTENSION TO SPAIN–ITALY

Verification can be extended to one site in Spain and another in Italy, by transporting a computer or installing a verifiable V1 copy there. The code, its environment and the known preparation are taken; not an execution in progress or already fixed unknown internal results.

In the USB variant proposed by the author, the program, environment and known configuration are duplicated before startup. Each site then starts its environment and prepares its own execution within the agreed window. A prepared execution in RAM is not copied. The branches share what is known, do not communicate during preparation or execution, and perform only the agreed tests without connections between them. Records are compared on completion.

Before starting, both sites agree on identifiers, oracles, trial count and incident handling. Each site prepares a new instance per trial and receives only its local selector. In the proposed random block, that selector is obtained externally after preparation and before triggering. Results are fixed and stored without consulting the remote selection or output.

Both bits, the oracle, selector, trigger, acquisition completion and incidents are recorded. After the records are closed, files are exchanged and their hashes verified. The analyzer pairs records by identifier, checks missing and duplicate records, checks the Deutsch answer and calculates the four correlations and CHSH. It does not select favorable pairs or hide failures.

The supplied local program does not yet implement autonomous branches between sites or all these time records. Local per-branch controllers and a subsequent comparator are needed. Running the current program twice, once in each country, is not equivalent to performing the distributed trial.

If equivalent copies continue to agree on $q_0$, the expected result is again S = 2. That would verify geographically distributed agreement, not a Bell violation.

A physical Bell test also requires justifying setting independence and the impossibility of communication during the trial through recorded positions, times and uncertainties. Distance or programming language alone does not guarantee them. These are conditions of external verification, not additions to V's construction.

The superconducting Q reference used 30 meters in 2023. Photonic experiments at 1,203 km were published in 2017; they are not confused here with two general-purpose Q computers or identical loophole-closing conditions.

The detailed preparation, start, recording and comparison protocol is in section 9 of the report: ./pdfs/EN_52_EnsayoBellV1.pdf

This extension is proposed and has not been executed. The established results remain those of the local trial.

Each site will obtain and retain its own set of records. Once the agreed tests have been performed, both sets will be compared to evaluate correlations and compliance with test conditions. The distributed test's result will be determined then, without declaring it passed or failed in advance.

## 8. CONCLUSION

Relating unknown values and checking correlations are different steps from demonstrating a Bell violation.

The local V1 trial preserves the Deutsch answer between selected copies and gives S = 2. This agreement is not a Bell violation. Evaluating another setup requires describing and checking its own conditions.

## 9. SOURCES

./pdfs/EN_52_EnsayoBellV1.pdf ./datos/ES_52_EnsayoBellV1/resultado_asentado_v1.json CHSH protocol: https://quantum.cloud.ibm.com/learning/en/courses/basics-of-quantum-information/entanglement-in-action/chsh-game Scientific background of the 2022 Nobel Prize in Physics: https://www.nobelprize.org/uploads/2026/05/advanced-physicsprize-2022-5.pdf Superconducting Q experiment, 30 meters: https://www.nature.com/articles/s41586-023-05885-0 Photonic experiment with stations separated by 1,203 km: https://arxiv.org/abs/1707.01339

RELATION TO THE SERIES

Previous: ./pdfs/EN_52_06_ConceptosVcomputacion.pdf

This stage of the exposition ends at article 07. The following constructions will be presented at a later stage.

The concepts are published from v-computacion, a project separate from UNIHOLOG. The ES_52 base project remains in UNIHOLOG. DEMUESTRA will work on the Spanish version of that base project; its documentary verification is limited to Spanish .md files.

THE BELL PROTOCOL AT TWO SITES WITH THE SAME V1 MACHINE

1. DEFINE THE CAMPAIGN

Sites A, in Spain, and B, in Italy, are designated. Before execution, the campaign identifier, trial count, known oracles, identifiers of each trial and handling of errors and missing records are agreed. It is decided to analyze $q_0$ as the Deutsch answer and $q_1$ separately as an additional output.

2. DUPLICATE WHAT IS KNOWN

The V1 program, its modules, environment and known configuration are copied to two USB drives before startup. Versions and SHA-256 hashes are recorded. A prepared execution in RAM is not duplicated, and future results are not introduced. One copy remains at each site.

3. CHECK THE INSTALLATION

Each site starts its computer and locally checks the four known Deutsch cases. These installation runs are kept separate from the campaign to be analyzed. Each new execution requires its own preparation.

4. AGREE ON THE START AND ISOLATE THE BRANCHES

A start window and a public trial-identification plan are established in advance. Queries to the other site are removed from the test program and exchange channels are blocked during preparation and execution. A remote response is not used as a condition for producing the local output.

An agreed time does not demonstrate exact physical simultaneity. If Bell spacetime isolation is to be certified, positions, choices, results and clock uncertainties must be recorded, according to the specific report. A setup without these controls is presented as a geographically distributed computational check.

5. PREPARE EACH TRIAL LOCALLY

For the same identifier, both sites receive the corresponding known oracle and locally prepare a new V1. The unknownness and independence required by V's definition are maintained. Preparation does not deliver the internal values that must remain unknown.

6. PERFORM LOCAL SELECTION

Each branch has two selection labels: $A_0$ or $A_1$ in Spain and $B_0$ or $B_1$ in Italy. In this repetition, they represent equivalent copies of the same V1, not different measurement operations.

An ordered control block may be performed first. In the random block, each external local selector obtains its bit after preparation and before triggering, without consulting the remote selector. Shared seeds or joint lists predetermining future choices in the random block are not distributed. How independence of settings from relevant internal variables is maintained is documented.

7. TRIGGER COLLAPSE AND ACQUIRE THE RESULT

Each site triggers its V1's collapse and records $t_0$. That execution's result is established. Readout acquires that result and records its completion, $t_1$. A person need not observe during the process: the local controller records the data automatically.

The other computer is not consulted during this process. A consumed preparation is not repeated to replace an unfavorable result. If a trial fails, the incident is retained with its identifier.

8. RETAIN LOCAL RECORDS

For each trial, each site stores: campaign and trial identifier; known oracle; local selector; $q_0$ and $q_1$; acquisition status; choice instant; $t_0$; $t_1$; code version and hash; and incidents. Local clocks are distinguished from a common time reference and their uncertainty is noted where applicable.

The internal values needed for external coherence verification are examined only after collapse and measurement, following article 05's procedure. Their independence is not considered certified merely because copies run in different countries.

9. CLOSE AND GATHER THE FILES

Once the block's results have been fixed, each file is closed and its hash calculated. The files can then be sent over a network or transported by USB to the external analyzer. This subsequent transfer does not participate in obtaining the outputs.

Hashes are checked and records paired by campaign and identifier. Duplicates, missing records, differing inputs and errors are detected. Pairs are not sought retrospectively to increase agreement, and failed trials are not hidden.

10. VERIFY V1'S ANSWER

At each site separately, $q_0$ is checked to satisfy:

$q_0 = f_o(0)$ XOR $f_o(1)$

Discrepancies between sites are counted for each oracle. This first check evaluates functional agreement and is reported separately from CHSH.

## 11. CALCULATE BELL CORRELATIONS

For $q_0$ and then $q_1$, records are grouped by selector pair: 00, 01, 10 and 11. Equal and different outputs are counted in each group:

$E_{xy}$ = (number of equal outputs − number of different outputs) / $N_{xy}$

Each group is normalized by its own record count. If a setting pair is missing, CHSH cannot be estimated from those data. We calculate:

$S = E_{00} + E_{01} + E_{10} - E_{11}$

The trial count per group, incidents, four correlations and S are reported for each bit. Only the most favorable bit is not selected afterwards.

## 12. EVALUATE THE OBSERVED NON-VIOLATION

The result is compared with the local Bell bound:

$|S| \leq 2$

If outputs always agree in all four groups, all four correlations are 1 and S = 2. It is reported that no violation was observed in that sample. This finite observation is not turned into proof of absence of violation for every setup or future execution.

Statistical uncertainty and the conditions actually met are also evaluated. An estimate greater than 2 requires statistical analysis and auditing before it is attributed to a violation. An estimate less than or equal to 2 is described as observed non-violation, not as universal proof of locality.

If losses or failures occurred, correlations of only the successful cases are not assigned the scope of a loophole-free test. The agreed treatment is applied and, where necessary, that Bell interpretation is declared inconclusive.

## 13. ESTABLISH THE CAMPAIGN'S RESULT

The final report retains both original files, their hashes, the prior plan, versions, selection procedure, counts and analysis. It explicitly distinguishes V1 agreement, the observed CHSH value and the isolation and independence conditions verified.

In the trial already performed on a single computer, $q_0$ agreed completely and S = 2. No result is anticipated for Spain–Italy: it will be determined by executing and comparing records from both sites.

The distributed controller, choice after preparation and separate recording of $t_1$ remain to be implemented. The supplied program runs two branches on one computer; it must not be presented as an already available distributed executor.

The PDF articles and their reference files are available on the author's website: https://estradad.es
Consult mainly the V-COMPUTACION, UNIHOLOG and DEMUESTRA projects.

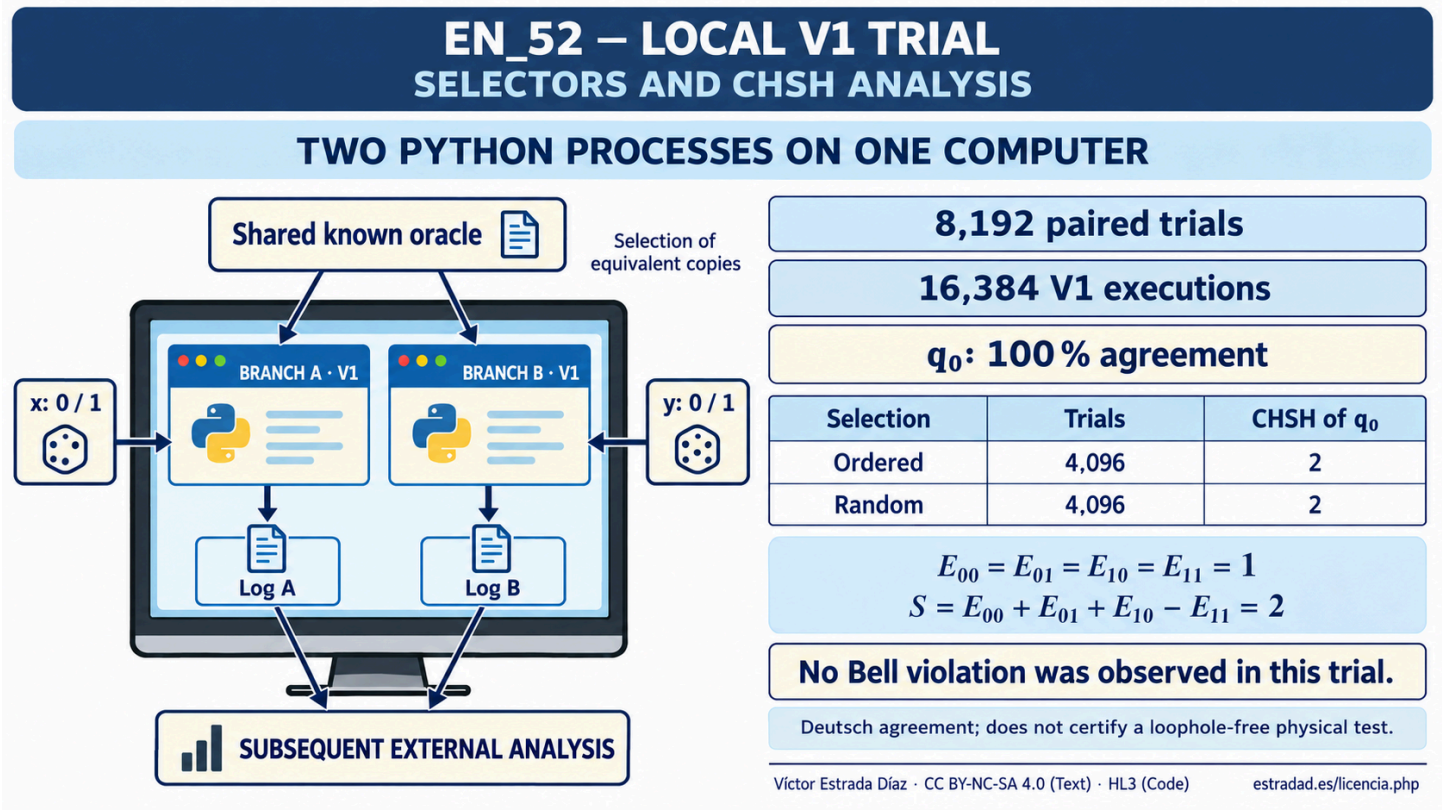
Direct web access to the developed protocol and its formulas, PDF version:
https://estradad.es/teorias/pdf/V-COMPUTACION/pdfs/EN_52_EnsayoBellV1.pdf

Relative link to the same PDF within the project: ./pdfs/EN_52_EnsayoBellV1.pdf

END OF ARTICLE 07

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## Local V1 trial with selectors and CHSH analysis




# EN_52 — Local V1 trial with selectors and CHSH analysis

**Project author:** Víctor Estrada Díaz
**ORCID:** 0000-0001-9942-1021
**Trial date:** 22 October 2026
**Status:** report of a local computational execution; awaiting author review.

# 1. Purpose and main result

The installed V1 is subjected to two execution branches with a common known input and external selectors. The objective is to check agreement between branches and calculate their correlations using the CHSH criterion.

**8,192 paired trials** were performed, corresponding to **16,384 V1 executions**, with fresh preparation per machine and trial. The Deutsch answer bit, `q0`, agreed between branches and with the expected answer in every case.

The result was:

$$E_{00} = E_{01} = E_{10} = E_{11} = 1, \qquad S = 2 .$$

**No Bell violation was observed.** The setup checks agreement between V1 copies and reaches the local CHSH bound for the answer bit.

In that precise sense, the two V1 machines on one computer passed the local checks performed: they agreed on the Deutsch answer and their correlations respected the Bell inequality. No violation was found in the data from this trial. This does not mean exceeding the Bell bound or ruling out any violation in other setups.

The Spain–Italy test is defined to obtain two separate sets of records and compare them afterwards. Its results and compliance with its conditions will be evaluated when it is executed, without anticipating the outcome.

It is not a loophole-free physical trial: two Python processes ran on the same computer, without a Prolog implementation or execution between countries.

## 2. V1 and the inputs used

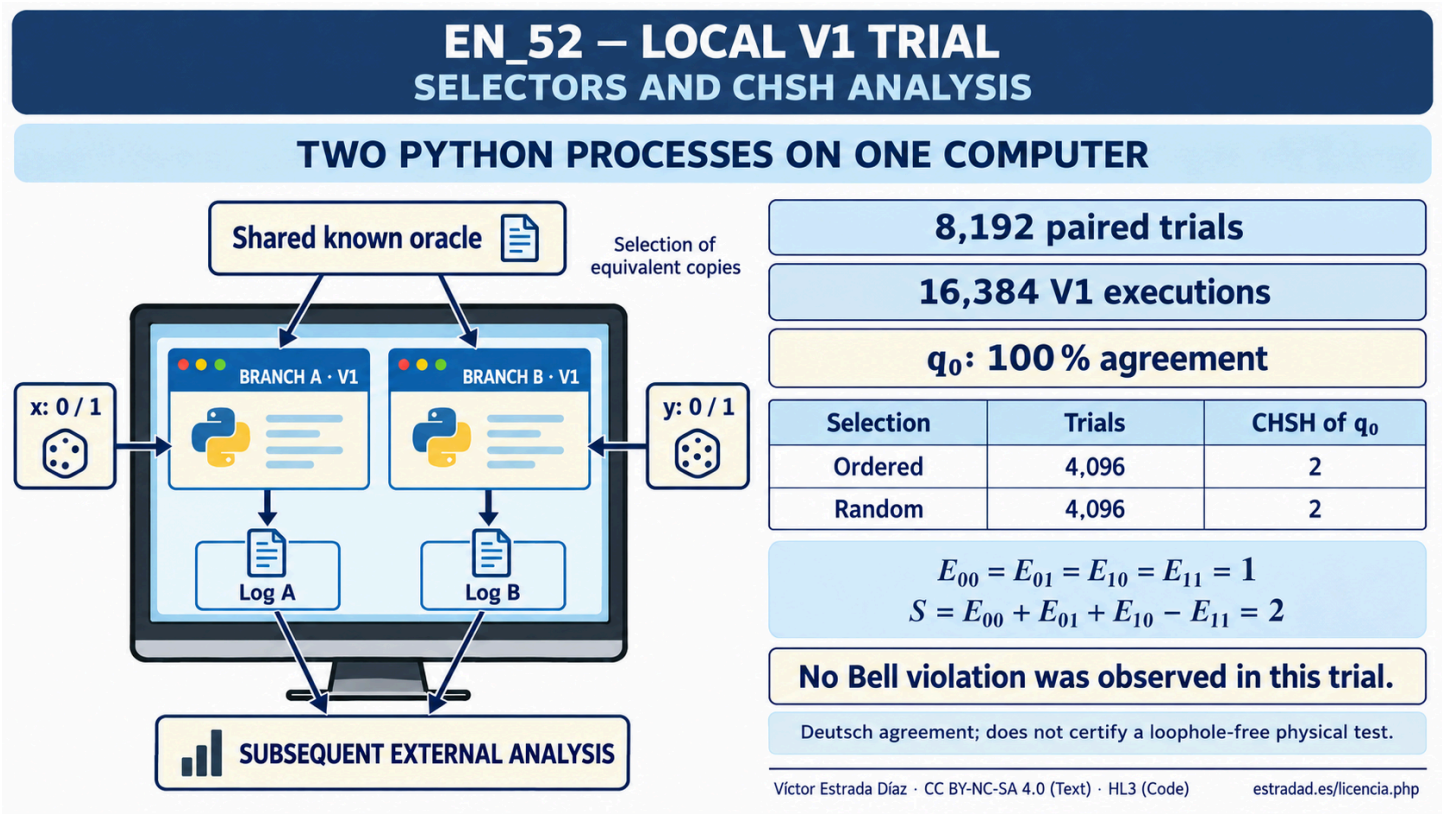



*Figure 1. Two Python processes on one computer, subsequent external analysis and q0 results. It summarizes the trial performed, not the proposed Spain–Italy extension.*

V1 solves the Deutsch task for a one-input binary function, denoted here by $f_o$. This notation distinguishes it from the internal function $f$ of the Einstein-VED framework.

The register is prepared with the known values (0, 1). The case input defines a reversible oracle block. The four available cases were used:

| Oracle | $f_o(0)$ | $f_o(1)$ | Deutsch answer $q_0$ |
|---|---|---|---|
| Constant 0 | 0 | 0 | 0 |
| Constant 1 | 1 | 1 | 0 |
| Identity | 0 | 1 | 1 |
| Inverter | 1 | 0 | 1 |

The checked answer satisfies:

$$q_0 = f_o(0) \oplus f_o(1).$$

The table describes the trials' known inputs and the answer checked afterwards. It is not used as a substitute for the V circuit to manufacture its output. Execution imports the installed V1 and its signal implementation; the XOR comparison is external and subsequent.

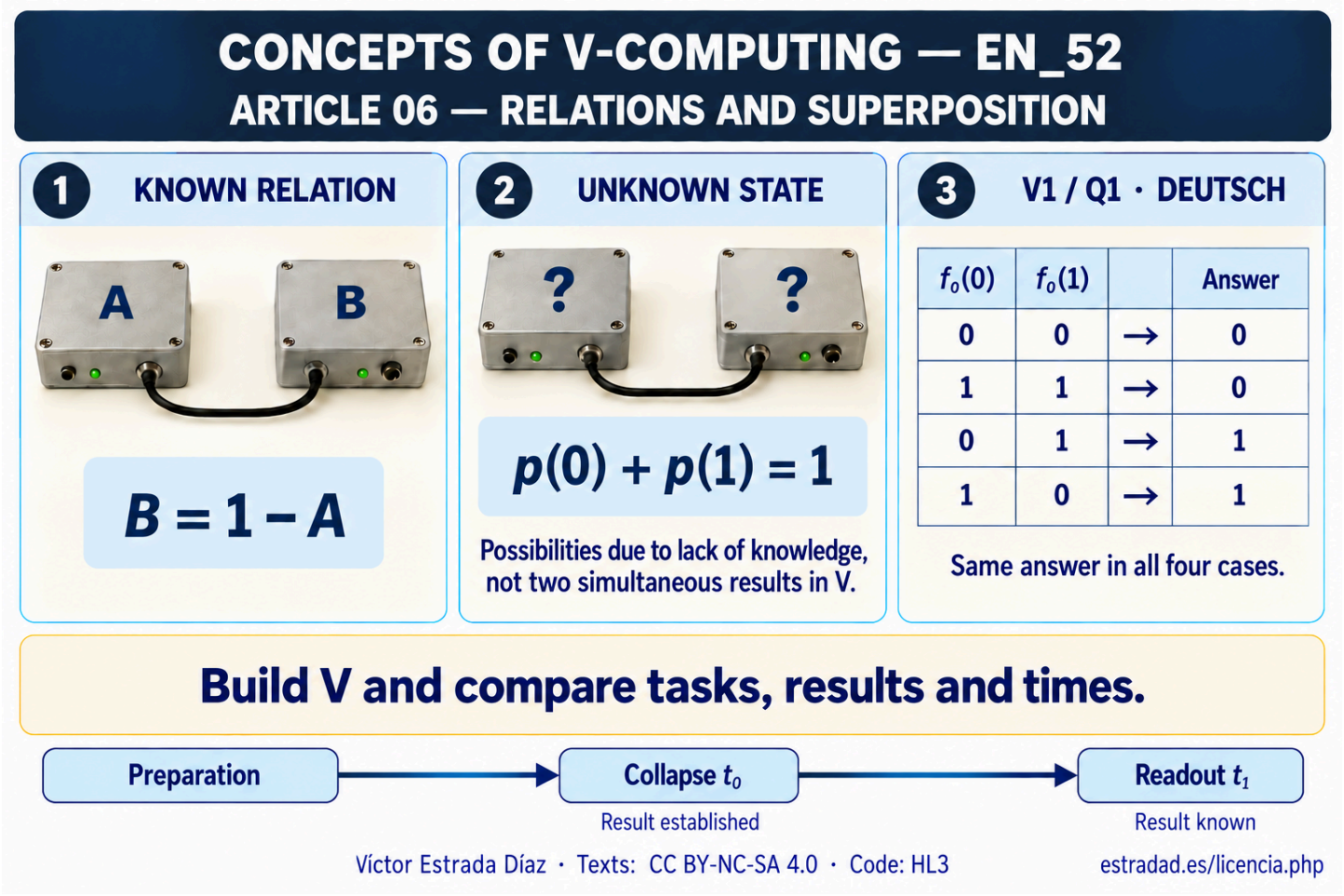



*Figure 2. Illustration from article 06 to situate the Deutsch example. It does not represent a Bell trial or a speed measurement against Q hardware.*

## 3. Setup executed

| Element | Actual implementation |
|---|---|
| Branch A | Python process with V1 |
| Branch B | Another Python process with V1 |
| A selector | External bit $x \in \{0, 1\}$ |
| B selector | External bit $y \in \{0, 1\}$ |
| A0/A1 alternatives | Interchangeable copies of the same V1 |
| B0/B1 alternatives | Interchangeable copies of the same V1 |
| Common known input | The same oracle table for both branches |

| Element | Actual implementation |
|---|---|
| Recorded outputs | Both bits from each execution |
| Preparation | Fresh in each branch and trial |

The A0/A1 and B0/B1 labels **do not change the operation performed by V1**. The selector identifies an equivalent copy. This choice implements the proposed case of machines that should give the same answer to the same problem; it does not, by itself, introduce two different observables per branch.

Each process receives only its own local setting, the trial identifier and the common input. It does not receive the other branch's setting or result before producing its record. The external controller knows both settings and gathers outputs afterwards.

The program does not introduce random draws to generate V's internal states or results. Randomness, when used, belongs exclusively to the external selectors.

### Sequence per trial

1. The controller fixes the common oracle input following a predefined cycle independent of random selection.
2. Local labels $x$ and $y$ are selected.
3. Each branch creates and prepares a new V1 with its known input. Changing the label does not execute another measurement operation.
4. Each V1 triggers and returns its capture.
5. The controller collects both outputs and incorporates them into the external record.
6. After executions finish, agreements and correlations are calculated.

In this control implementation, selectors are generated before each new instance is prepared. A physical choice following shared preparation or relativistic separation of events has not been certified.

The series' conceptual notation distinguishes collapse at $t_0$, which fixes the result, from acquisition completed at $t_1$. The software record includes trigger instant `t0` and preparation and measurement durations; **it does not record an independent `t1` instant**. These data do not provide a measurement of the physical separation between the events.

## 4. Correlations and CHSH convention

For each output bit analyzed separately, let $a, b \in \{0, 1\}$ be the results from A and B. They are transformed into signs:

$$A = (-1)^a, \qquad B = (-1)^b.$$

Therefore:

$$AB = \begin{cases} +1, & a = b, \\ -1, & a \neq b\,. \end{cases}$$

For each selector pair $(x, y)$, with $N_{xy}$ records, we calculate:

$$E_{xy} = \frac{1}{N_{xy}} \sum_{i \in I_{xy}} A_i B_i = \frac{N_{xy}^{\text{equal}} - N_{xy}^{\text{different}}}{N_{xy}}\,.$$

A single convention is adopted throughout the report:

$$S = E_{00} + E_{01} + E_{10} - E_{11}\,.$$

The local Bell-model bound, with settings independent of relevant internal variables, is:

$$|S| \leq 2\,.$$

Normalization is performed within each setting group; differences in group size are not confused with changes in correlation.

## Equivalent CHSH game

The per-trial success criterion is:

$$a \oplus b = xy\,.$$

| **Settings** $(x, y)$ | **Success condition** |
|---|---|
| 00 | $a = b$ |
| 01 | $a = b$ |
| 10 | $a = b$ |
| 11 | $a \neq b$ |

With uniform settings and in terms of conditional probabilities:

$$P_{\text{success}} = \frac{1}{2} + \frac{S}{8}\,.$$

The local bound for this success criterion is 3 / 4. The raw success fraction of a sample with differently sized groups need not exactly match the average giving each setting equal weight.

# 5. Results measured in the software trial

## 5.1. Ordered selection

4,096 paired trials were executed, with 1,024 records of each selector combination.

| Bit analyzed | $E_{00}$ | $E_{01}$ | $E_{10}$ | $E_{11}$ | $S$ | A/B agreement |
|---|---|---|---|---|---|---|
| q0, Deutsch answer | 1 | 1 | 1 | 1 | 2 | 100% |
| q1, second bit | 1 | 1 | 0.998046875 | 1 | 1.998046875 | 99.9755859375% |

For q0 there were 3,072 CHSH-game successes: 75%. For q1 there were 3,071: 74.9755859375%.

Ordered selection is an agreement control with predictable settings. It is not presented as a physical test of setting independence.

## 5.2. External random selection

Another 4,096 paired trials were executed.

| Settings | Records |
|---|---|
| 00 | 981 |
| 01 | 1,013 |
| 10 | 1,050 |
| 11 | 1,052 |

For both bits:

$$E_{00} = E_{01} = E_{10} = E_{11} = 1, \qquad S = 2\,.$$

A/B agreement was 100% for both q0 and q1. The raw game-success fraction was:

$$\frac{3044}{4096} = 0.7431640625\,.$$

There is no contradiction between this 74.31640625% and $S = 2$: there were 1,052 selections of 11, precisely those that fail when both outputs always agree. The average giving equal weight to the four pairs still gives 75%.

### 5.3. Comparison with the Deutsch answer

In all 16,384 executions, q0 agreed with $f_o(0) \oplus f_o(1)$. There were no discrepancies for any of the four oracles.

The most favorable bit was not selected retrospectively: q0 and q1 were retained and analyzed separately. Trials were not discarded according to their results either; no execution failures occurred in this run.

## 6. External mathematical check

In addition to executing V1, the analyzer enumerated the 16 binary assignments of local responses $(a_0, a_1, b_0, b_1)$. This enumeration is not used inside V and does not generate its states or outputs.

For a fixed assignment of local signs:

$$C = A_0 B_0 + A_0 B_1 + A_1 B_0 - A_1 B_1 = A_0 (B_0 + B_1) + A_1 (B_0 - B_1).$$

Since $B_0, B_1 \in \{-1, +1\}$, one parenthesis is zero and the other equals ±2. Hence:

$$C \in \{-2, +2\}, \qquad |\langle C \rangle| \leq 2.$$

Enumeration confirmed $|C| = 2$ for all 16 assignments and a maximum 75% success rate with uniform settings. Not knowing the local responses does not change that bound under the stated assumptions.

This mathematical check is distinguished from correlations estimated in a finite sample. No statistical significance test was performed, and no violation is declared from fluctuations.

## 7. What it demonstrates and what it does not

**Demonstrated for the setup executed:**

- Complete q0 agreement between the two V1 copies for all four oracles.
- Preservation of that agreement with ordered and external random selectors.
- q0 correlations equal to 1 and CHSH equal to 2.
- Absence of a Bell violation observed in this trial.

**Not checked in this trial:**

- Equivalence between Python and Prolog implementations: both branches were Python.
- Execution between Spain and Italy or isolation through spacetime separation.
- Absence of side channels or physical independence of settings.
- Independence of the internal deterministic time references of the two implementations.

- Internal unknownness certified merely by using separate processes.
- A quantum-hardware result or a speed comparison with Q.
- A general conclusion about all V constructions.

The controller knows both settings and the branches share a computer. Interface isolation is not equivalent to a loophole-free physical Bell test.

The trial is external verification. V1's construction was not modified and the analyzer introduced no prior measurements of its internal states. This does not, by itself, certify all coherence conditions defined by the author.

# 8. Interpretation for article 07

In this setup, choosing equivalent copies produces the expected agreement but does not introduce measurement alternatives that change the local answer for the same common input. All four q0 correlations equal 1 and their CHSH combination gives 2.

Studying another setup would require describing the operations distinguishing A0/A1 and B0/B1, shared preparation and each branch's access to information during the trial. Sharing preparation is allowed in Bell; making each response depend on the remote setting is not allowed within the local model being tested.

The result obtained is incorporated into EN_52_07 — Correlations and Bell, PDF. This stage of the exposition ends at 07; later constructions will be presented subsequently.

# 9. Proposed extension: Spain–Italy

**Status: proposed protocol, not yet executed.** Its first purpose is to check V1 agreement and correlations between two sites. A loophole-free physical Bell test would require additional isolation, independence and timing controls.

## 9.1. What is taken to Italy

One installation is placed in Spain, A, and another in Italy, B. An already prepared computer may be physically transported, or a verifiable software copy installed on a computer at the Italian site. It is not necessary to transport an unknown internal state or preserve an execution in progress during travel.

The V1 code and required modules, a compatible Python environment, the preparation specification and the public trial plan are taken. File versions and SHA-256 hashes are recorded at each site. Future results or internal values of an execution are not copied as substitutes for unknown sources.

The portable arrangement keeps these sibling directories:

```
SRC-VED/
 v-computacion/
   EN_52_EnsayoBellV1.md
   datos/ES_52_EnsayoBellV1/
 UNIHOLOG/
   Traductores_V/
```

The four selection labels are distributed across two sites: A0/A1 in Spain and B0/B1 in Italy. In the first repetition they remain equivalent V1 copies. They may be new instances of the same local application; four computers are not required.

A later Prolog implementation would first be checked against the four Deutsch cases and the preparation and capture contract. It is not declared available or verified by this protocol.

## USB variant clarified by the author

The program, execution environment and known configuration are duplicated onto two USB drives before the machines are started. The intention is not to copy a prepared execution in RAM or transport an execution in progress.

One copy is installed in Spain and the other in Italy. Each site starts its own environment and prepares execution locally. Both preparations occur within the agreed start window, without communication between sites during preparation and execution.

The copies share the defined start and known relations. The agreed plan includes no connections between branches or instructions consulting the other environment. There is no requirement to share values that must remain unknown or fix future execution results by duplication.

Records are retained separately and gathered on completion. Inspection and analysis follow the local collapses and acquisitions.

Matching known environments does not invalidate the trial: it constitutes common public preparation. Operational separation thus established is distinguished from statistical independence of local choices, which must be documented if the campaign is interpreted as a Bell trial. An agreed start time does not, by itself, certify section 9.6's spacetime conditions either.

## 9.2. Public preparation before starting

Both sites agree on a campaign identifier, trial count, trial identifiers, public oracle order and record format. For example, the two original blocks of 4,096 trials may be repeated: an ordered control block and a block with local random selection.

The bits to be analyzed are fixed before execution: q0 as the Deutsch answer and q1 as an additional output, without choosing the most favorable afterwards. How errors, missing records and delays will be recorded is documented. Cases detrimental to correlation are not removed.

The common plan contains only what is known. In the random block, it does not include future choices of both selectors, a joint seed predetermining them or output results. Each site receives only its local information during the trial.

## 9.3. How it starts and runs

1. Before the campaign, versions, inputs and hashes are checked. Basic Deutsch cases are run separately as an installation control.
2. The public plan is distributed and a start window fixed. A network signal may coordinate the campaign before local choices; a response from the other site is not used to decide an output.
3. For each identifier, each site prepares a new V1 with that trial's known oracle. Preparation maintains V's internal conditions and does not deliver its unknown values.
4. In the random block, an external local device or controller obtains its selector after instance preparation and before triggering. A receives only x; B receives only y. Selecting equivalent copies does not change their operation, but is recorded. Future choices are not exchanged.
5. Each site locally triggers collapse, records t0 and completes acquisition. Readout completion, obtained bits, selector, trial status and available times are recorded separately.
6. Records remain local until both sites have fixed their results. Missing remote results do not authorize repeating a consumed preparation or choosing another result for the same identifier.

Acquisition does not read internal values before collapse to calculate an answer. Selectors and subsequent analysis belong to the external verification apparatus.

**The supplied program reproduces the two-process trial on a single computer. It does not yet implement autonomous branches, choice after preparation or separate recording of readout completion.** Execution between sites requires a local controller per branch and a subsequent comparator. Running the complete program in both countries is not sufficient: it would produce two local trials, not one distributed trial.

## 9.4. Records to retain

| Field | Spain, branch A | Italy, branch B |
|---|---|---|
| Identification | Campaign and trial identifier | Same campaign and identifier |
| Common input | Known oracle | Same known oracle |
| Local selection | x | y |

| Field | Spain, branch A | Italy, branch B |
|---|---|---|
| Capture | q0, q1 and acquisition status | q0, q1 and acquisition status |
| Times | Local choice, trigger and acquisition end | Local choice, trigger and acquisition end |
| Provenance | Version, code hash and configuration | Version, code hash and configuration |
| Incidents | Failures, missing records and clock conditions | Failures, missing records and clock conditions |

After closing the block, a hash of the complete local file is calculated. The hash allows subsequent modifications to be detected; it does not, by itself, prove internal independence or the physical instant when each output was fixed.

## 9.5. How results are gathered and verified

The two closed files are transferred to the external analyzer. This may be done over a network after results are fixed, or using physical media. Subsequent comparison does not require machines to remain connected during the trial.

The analyzer performs these checks:

1. Verifies hashes, versions and matching campaign.
2. Pairs by identifier, never searching afterwards for the pairs that agree most. Checks duplicates, missing records, differing oracles and incidents.
3. Checks each site's q0 against the Deutsch answer and calculates discrepancies between Spain and Italy. This measures functional agreement independently of CHSH.
4. Groups by 00, 01, 10 and 11 and calculates the four correlations and S using this report's formulas. Calculates q0 and q1 separately.
5. Declares a group without data non-estimable. If failures or unpaired trials occur, retains them in the report and applies the agreed treatment; it does not characterize a selection of successful cases as a loophole-free test.
6. Reports sample size and uncertainty. An estimate above 2 requires statistical analysis and an audit of conditions; a violation is not declared automatically.

If q0 always agrees for equivalent copies, the expected result is again:

$$E_{00} = E_{01} = E_{10} = E_{11} = 1, \qquad S = 2 .$$

That would be a geographically distributed agreement result. Distance alone does not turn S = 2 into a Bell violation.

## 9.6. Isolation and spacetime condition

For computational verification, data exchange between branches during choice and result acquisition is documented and blocked. Network channels, shared files and control services are reviewed. Using Python or Prolog does not, by itself, guarantee that isolation.

To physically close the possibility of communication at or below light speed, the positions and distance D between sites, choice events and result events must be identified, with bounded timing uncertainty.

Let uA and uB be local choice times and vA and vB recorded-result times, expressed in a common time reference. A sufficient criterion, including a conservative uncertainty margin ε, is:

$$v_A - u_B + \varepsilon < \frac{D}{c}, \qquad v_B - u_A + \varepsilon < \frac{D}{c}.$$

The local choice–result ordering must also hold. This criterion checks that the remote setting could not reach the other output through a light-speed or slower signal. Without adequate time metrology, separation between countries and ordinary computer clocks are not sufficient to certify it.

These are external Bell-trial conditions, not new internal V components. A campaign may be valid as a cross-site reliability check without yet satisfying the conditions of a loophole-free physical Bell test.

## 9.7. Distances used in Q

Cryogenics is not a Bell requirement. It is an operating condition of certain devices. The 2023 superconducting-qubit experiment used as a reference separated its two sites by 30 meters; it was not a Spain–Italy setup.

Quantum experiments at much greater distances also exist: in 2017 photon pairs were distributed from a satellite to ground stations separated by 1,203 km and S = 2.37 ± 0.09 was reported. This is a photonic platform, not two general-purpose quantum computers. Its loophole closure is not equated here with that of the superconducting trial either.

- Superconducting-circuit experiment, 30 m, 2023.
- Authors' paper on photon distribution over 1,203 km, 2017.

Comparison must always identify platform, separation and conditions actually checked, not only a country name or distance.

# 10. Data and reproduction

The concepts and this report belong to v-computacion, a separate project. ES_52 in UNIHOLOG is the base project. DEMUESTRA will work on the Spanish version of that base project; its construction is not transferred here or modified by this report.

- Summary, correlations and source hashes.
- Complete records of the 8,192 paired trials.
- External trial program, with portable local path.
- Documentary copy of V1 inputs.
- Documentary copy of the V1 structural analysis.
- Documentary copy of the established V1 result.
- ES_52 base project in UNIHOLOG, PDF.
- ES_52 demonstration in DEMUESTRA/Proyectos/ES_52, PDF.

In DEMUESTRA, documentary verification is limited to Spanish `.md` files. Its document is identified as a reference; no new review of all DEMUESTRA has been performed for this report.

The documentary copy of the established result comes from `../UNIHOLOG/Traductores_V/Pruebas_V/resultado_asentado_v1.json` and is retained without changing its content. It is included inside `datos/ES_52_EnsayoBellV1/` so that its link does not depend on UNIHOLOG's web publication. When this project is published, its `datos/` and `img/` directories must accompany the documents, preserving the relative structure.

From this document's directory, to repeat the trial without overwriting original records:

```
python -B ./datos/ES_52_EnsayoBellV1/ensayo_bell_v1.py --output
./datos/ES_52_EnsayoBellV1/repeticion --trials 4096
```

The portable copy adapts the UNIHOLOG path and adds a small-sample control: if a setting pair is missing in a group, its correlation and CHSH are recorded as `null` and are not estimated. That control does not change the original results, whose groups were complete. The hashes in `resultados.json` correspond to the original execution. A repetition will generate its own hashes, selectors, times and results; identical random counts or q1 values are not expected.

## Links and PDF conversion

File links and images use paths relative to this document's directory, with `/` to facilitate use by converters. There are no local `file://` links or user paths in the text.

Reading links point to PDF, not `.md` sources. The concept and report PDFs are in `./pdfs/`; the base project is consulted in `../UNIHOLOG/` and the demonstration in `../DEMUESTRA/Proyectos/ES_52/`. When generating HTML and PDF, `publica.py` adapts paths from their respective output directories without changing the destination format: documents continue to link to PDF. JSON data, the program and images retain their extensions and must accompany the collection to keep their links accessible.

## 11. Protocol reference

IBM Quantum — CHSH game: rules and local-strategy bound.

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Reference for the dual license and the author's conditions.

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## References to related documents

- ARTICLE 01 — TO EXIST IS NOT TO BE OBSERVED
- ARTICLE 02 — THE BOX AND SCHRÖDINGER'S CAT
- ARTICLE 03 — THE $Q_{\beta}$ BIT AND THE $Q_{v}$ BIT
- ARTICLE 04 — COLLAPSE AT t = t0 AND MEASUREMENT
- ARTICLE 05 — THE INTERNAL FUNCTION f(t)
- ARTICLE 06 — RELATIONS AND SUPERPOSITION
- ARTICLE 07 — CORRELATIONS AND BELL
- Local V1 trial with selectors and CHSH analysis

## Additional references

Labels are in English; external scientific publications retain their original sources, without claiming nonexistent translations.

- Clauser, Horne, Shimony and Holt (1969): proposed experiment to test local hidden-variable theories.
- IBM Quantum: CHSH game and local-strategy bound.
- Deutsch (1985): quantum theory, the Church–Turing principle and the universal quantum computer.

## Special references

- This work — V-COMPUTACION / ES_52: DOI 10.5281/zenodo.23562770.
- This work — V-COMPUTACION / ES_52 — General record of versions: DOI 10.5281/zenodo.23562769.
- Einstein-VED / UNIHOLOG — General record of versions: DOI 10.5281/zenodo.17172925.
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- Author's website.
- Author's catalog.
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