SUMMARY: MY THOUGHTS ON QUANTUM MEASUREMENT

A “quantum measurement” means any quantum process that results in a macroscopic effect, regardless of whether humans or laboratories are involved.

All of this suggests that measurements affect superposed quantum states via entanglement of the superposed quantum with a detector.

Precisely what is superposed and what interferes in this measurement state?

The answer is surprisingly simple: Only the correlations between S(system) and M(measuring device) are superposed.

Now for some details:

The quantum system has two possible state, |S1> and |S2>.

When the quantum state |S> is created the states |S1> and |S2> are in a superposition i.e.,
$|S> = a|S1> + b|S2>$.

When the quantum state S is measured by some macroscopic device that has two state |M1> and |M2>, such that if the quantum system were in state |S1>, then the measuring device ends up in the state |M1> after a measurement and if the quantum system were in state |S2>, then the measuring device ends up in the state |M2> after a measurement.

This is expressed mathematically in quantum theory by saying the measurement state is
$|SM> = a|S1>|M1> + b|S2>|M2>$.

This is called entanglement.

It is at this point that most textbooks get the interpretation wrong!

The measurement state should be read as:

The state $|S1>$ is positively correlated with the state $|M1>$, and the state $|S2>$ is positively correlated with the state $|M2>$.

ONLY correlations are superposed, NOT states.

When the superposition $|S> = a\,|S1> + b\,|S2>$ of S entangles with states of M, the superposition shifts, from a superposition of states of S to superposition of correlations between S and M, so S can be in an incoherent mixture while maintaining unitary global dynamics.

Only the correlations between S and M are superposed.

This is how nature resolves problem of definite outcomes.

A so-called collapse mechanism is NOT needed!

This analysis should not be regarded as one more interpretation of quantum physics.

It is instead a correction of the previous misunderstandings of von Neumann's entangled measurement state.

It is not surprising that this misunderstanding has persisted for nearly 100 years.

After all, entanglement and nonlocality are deeply involved in the measurement problem's proper resolution but they only began to be understood in 1964, leading to a long period of gradual acceptance with confirmation only in 2015.

The delay in understanding measurement stemmed from this delay in understanding nonlocality.

For more than a century, much has been made of the odd and supposedly paradoxical nature of the quantum.

This presumed quantum spookiness has led to an excess of attempted fixes and interpretations.

But there are no logical contradictions here, no disagreements with experiment, and nothing that should persuade us that quantum physics is about anything other than the real world.

Quantum physics is either charmingly counterintuitive or maddeningly puzzling, depending on your taste, but it is entirely self-consistent and experimentally accurate.

It’s time to accept it with all its charms and puzzles, and stop trying to repair or reinterpret it.

It’s time, in other words, to relax and admit the world is not as we had thought.

Nature is far more creative than we could have conceived.

Our most fundamental theory is in better shape than its detractors suppose.

Quantum physics is a remarkable treasure trove of far-reaching phenomena and ideas whose surface we have probably only begun to scratch.

It’s time to fully embrace these ideas, incorporating them into our ways of thinking about the universe, about our planet, and about ourselves.

This is a process that will engage our minds and stretch our imaginations far into the future, for quantum physics is, indeed, not what anybody could have imagined.

Remembering one statement from Richard Feynman…………

“Since we are not quantum objects we may never be able to see the details of this process, but it clearly happens.“

So let me just say.....

Don’t believe all the hype.

There is no need for many-worlds, multiverses and hidden variables, and so on.

There are no problems with standard quantum mechanics!