A Serious Challenge to Quantization

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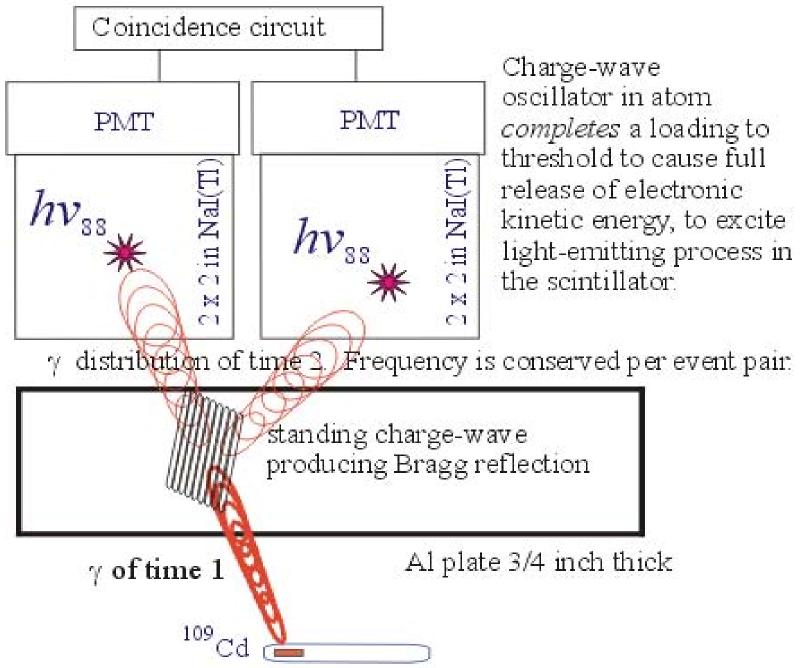
Note: This paper describes early tests to show how *the unquantum effect* was discovered and developed. The perfected method is described in *Photon Violation Spectroscopy*, and that paper is better for a first understanding of the experiment. Certain details of experimental method and elimination of artifact are described only here.

Abstract

In a thought experiment, Einstein proposed that a single light quantum (photon) would go one way or another at a beam splitter. In testing this model I have implemented a series of experiments using gamma-rays from spontaneous decay of ^{109}Cd and ^{57}Co, whereby a single primary gamma-ray splits and is detected in coincidence in two detectors. The experimental coincidence rates are found to substantially exceed the chance coincidence rate. These results directly violate the quantum mechanical probabilistic model of light, and indirectly violate the concept of quantized charge. These are full-height pulses, characteristic of the chosen gamma under study. To help understand how all this can possibly be true, I have identified conceptual and experimental flaws in previous works, and have developed the long abandoned Loading Theory. The loading theory avoids wave-particle duality by thresholds, a pre-loaded state and by having electromagnetic energy emitted quantized but absorbed continuously. By forcing a choice between conservation of energy and photons, the experimental results spell the long overdue death of the photon.



To understand this experiment, picture a single pulse of initially directed gamma light *emitted* with energy $h\nu$. A fraction Bragg-reflects with no frequency loss while the remainder passes through. The two classical pulses trigger two full-energy events by a loading effect at the detector. Energy is always conserved, but an average over more events is necessary to measure the energy balance.

Eric Reiter, Pacifica CA May 2003

Introduction

The experiment is a famous beam splitter test, modified to use gamma rays. By considering a long abandoned Loading Theory, we realize a single nuclear γ-ray decay can release an $h\nu_\gamma$ of energy in an initially directed classical electromagnetic pulse, where h = Planck's constant, and ν_γ = electromagnetic frequency of the gamma-ray. We will show that the gamma energy radiates, scatters classically, and can complete a loading to a threshold to cause more than one simultaneous detection event. Each of the two coincident detection events can indicate an energy proportional to the original $h\nu_\gamma$ release. My beam splitter experiments are not about some known wave property of light; they test the model of quantized light. If these experiments are not refuted, it puts to rest the concept of quantized light. If the concept of quantized charge is the chief reason behind quantized light in the photoelectric effect, it calls into question the concept of quantized charge. In quantum mechanics, it is the amplitude of a wave function Ψ that interferes and diffracts. $|\Psi|^2$ = (probability) is used to statistically determine when and where an $h\nu$ of energy, a *photon*, is to appear. Lets call this the photon principle. If light behaves like photons, a whole emitted $h\nu$ would deposit itself as a whole absorbed $h\nu$.

My challenge is to the concept of quantization itself. This challenge comprises: (**a**) an identification of flaws in previous experiment that made physics believe quantized light and charge was right, (**b**) a wave-oriented derivation of the photoelectric effect and other famous experiments in a Threshold-Ratio Model[1] (TRM), (**c**) an experimental prediction from TRM for how to violate quantum mechanics, and (**d**) experiments that confirm TRM.

Criticism of Past Experiments Favoring Quantum Mechanics

Concerning the nature of light

In Bohr's book[5] he describes his 1927 discussions with Einstein, and describes Einstein's thought experiment:

> "If a semi-reflecting mirror is placed in the way of a photon, leaving two possibilities for its direction of propagation, the photon may either be recorded on one, and only one, of two photographic plates situated at great distances in the two directions in question, or else we may, by replacing the plates by mirrors, observe effects exhibiting an interference between the two reflected wave-trains."

This is a definition of the photon, another way to write the photon principle. The first half of this quote describes a particle property (see also ref. 6); the second half describes a wave property. Beware; with all its strange properties, most literature will describe light in terms of photons. A semi-classical model of light will not resolve the wave-particle paradox because the paradox exists for both matter and light. This work aims toward resolving the entire paradox.

The earliest test that I could find for this thought experiment was by Givens[7] in 1946, whereby x-rays from a Coolidge tube were directed at a NaCl target. The x-rays would then Bragg-reflect and split into two beams toward Geiger-Mueller detectors. A coincidence circuit recorded only the low rate of coincident detector pulses expected by chance, and quantum mechanics (QM). An alternative model to photons would be a classical electromagnetic pulse. To design a fair test to make the distinction between a classical pulse and the photon model, consider the conditions required for an electromagnetic pulse to split and cause coincidences. If a Coolidge tube happens to generate overlapping Gaussian envelopes of electromagnetic energy, such envelopes would superimpose into a smooth energy flux which could not trigger coincidence rates that would surpass chance. In addition, the wide-band x-ray emitter and detectors used by Givens would further obscure a classical result. This was obviously an unfair test.

An experimental attempt to split one emitted $h\nu$ of energy released at a time, was not published until 1974 by Clauser,[8] who measured no coincidences between the two paths past an optical beam splitter. He concluded that Maxwell's equations were not generally valid. Amazingly, he used a polarized beam splitter to split polarized light released from an atom. One problem is that each pulse of $h\nu$ energy emitted from an atom is polarized, and its polarization is randomly oriented. Random polarization is concluded from the Kocher-Commins experiment.[9] Therefore, polarized light, upon interacting with a polarized beam splitter, would be routed in unequal fractions toward the two photomultiplier tube (PMT) detectors, thereby prematurely eliminating the classical alternative the experiment was supposed to distinguish from QM.

Another important oversight concerns the assumptions behind using a PMT to detect an individual "photon" event. If the source of light is monochromatic, contrary to popular wisdom,[23] the PMT will still generate a wide distribution of pulse amplitudes.[1] Pulse discriminators are always used with PMTs to eliminate smaller noise pulses, but Clauser did not mention them. By eliminating a small pulse, which could be a PMT response from an emitted $h\nu$, it further lowered the possibility of detecting coincidences. Essentially, this type of experiment cannot make the classical/quantum distinction by using optical light and PMTs. In my research of over a hundred articles, all praising Clauser's paper, including an experimental rework[10] and a review article,[24] these obvious important technical oversights were uncorrected.

Concerning the nature of charge

Problems in understanding charge have led to problems in understanding light. These problems relate to measuring charge quantization, such as Millikan's oil-drop experiments.[2,3,4] A closely related experiment performs the photoelectric effect upon oil drops. Those authors claim that whole electrons are released in the photoelectric effect from ultraviolet light aimed at micro-drops balanced to measure charge. The drop's velocities in response to ultraviolet light were measured to be quantized.

Issue 1: Interpretation of photoelectric and charge quantization experiments can hold a false assumption. If charge is quantized as part of an atom, it was assumed to be similarly quantized in free space.

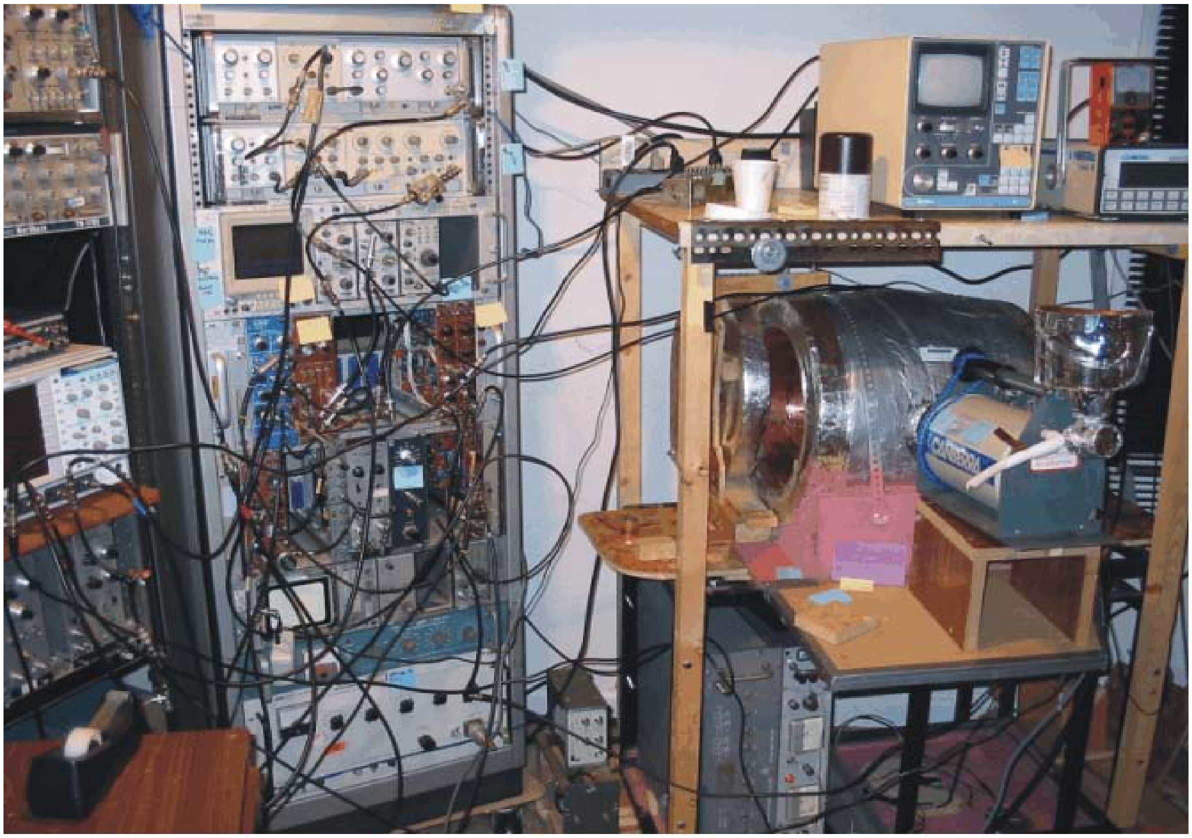
Issue 2: Millikan considered but prematurely rejected the loading theory[4] in his


Constructing the lead shield. Bent lead bricks are strapped around a concrete mold. Shown is preparation to mount on horizontal bar for rotation on axis for further construction. Hose straps were removed. Jan 2003 Eric Reiter

discussion of the photoelectric effect. The loading theory could allow unquantized charge to exist at a sub-*e* quantity and could provide stability at multiples of *e*. Quantization altogether excludes the existence of sub-*e*. Sub-*e* should have been considered possible during the acceleration time of the drop. Physicists considered only a very limited form of the loading theory, whereby the loading always starts from an initially unloaded state. Amazingly, even though Millikan wrote of the pre-loaded state, he and others exclude that idea in interpreting their charge quantization data.

Issue 3: a great confounding factor in oil-drop charge quantization experiments was that they were performed in an atmosphere containing oxygen and/or mercury. These experiments tested the photoelectric effect upon oil-drops using ultraviolet light. The measured quantized velocities may have been caused by the oil-drop acquiring a whole *e* from an ultraviolet-caused ion in the surrounding gas, instead of a whole *e* exiting the oil-drop.

These oversights and problems have obscured nature's message. If charge is always quantized, the photon concept looks plausable.



A satisfactory nuclear detection laboratory in operation. The lead disk shield door is rolled back to open. Canberra HPGe shows home made funnel for pouring liquid nitrogen. Frost is on vent tube. Tracor-Northern multichannel analyzer above shield is tethered to a PC through serial. Three NIM (nuclear instrumentation module) racks hold modules. HV power supplies below. Signal injector system top-center. LeCroy oscilloscope to the left. Several components shown here are from Ken Kitlas.
Photo of May 8, 2003. Eric Reiter, Pacifica, CA

Experimental Tests of Quantum Mechanics Using Gamma-Rays

We have devised a method of performing Einstein's thought experiment that overcomes the shortcomings of the experiments of Givens, Clauser, and others**.** It is a beam-split experiment that uses singly emitted gamma-rays from spontaneous nuclear decay.

With γ-rays, the duration of atomic emission is much shorter than from visible light, so the time between adjacent emissions is discernable to the detector. It is this γ-ray shock-wave nature that I am taking advantage of. By comparing a calculated coincidence chance rate R_c with an experimentally measured coincidence rate R_e, it is easy to distinguish between classical and quantum mechanical models of light. If light really consisted of photons, or if light always deposited itself in a photon's worth of energy, it would be a quantum mechanical wave function Ψ assigned to a <u>single</u> gamma-ray particle that would split, and the only source of overlapping detector events would be from chance. The alternative to quantum mechanics I offer is that an $h\nu$ of light is emitted as a classical directed wave-pulse; it spreads and splits, and could trigger multiple events in coincidence surpassing a chance rate. A loading/trigger/accumulation model suggesting such an effect was first proposed by Lenard and later by Planck[15,16] and Sommerfeld & Debye. It was considered in Millikan's[4] and Compton's[20] books, but was rejected by them. In the loading theory $E = h\nu$ is a property of matter, not light. In the loading theory, a detection event will have an energy proportional to the frequency of light. The purpose of this experiment is to determine whether $E = h\nu$ applies to matter as a loading effect, or to photons by quantum mechanics.

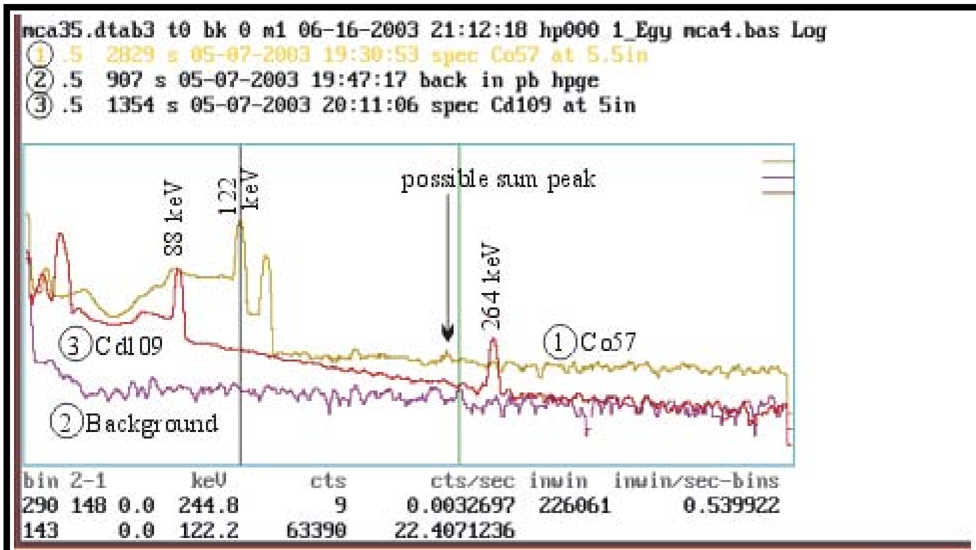
With two detectors, the chance rate of two events is expressed by[7,8,11,12]

$$R_{2c} = 2\tau\, R_{tr}\, R_{an}\,, \tag{1}$$

where τ is the duration of a circuit-generated square shaped pulse preceding an AND gate, and R_{tr} and R_{an} are the singles rates (non coincident) at a trigger and an analyzer detector.

The γ sources used were 10 μCi of ^{109}Cd and 1 μCi of ^{57}Co. Actually these were the activities at purchase, and were about ½ potency in the experiments. Two types of detectors were used: NaI(Tl) scintillators, and high purity germanium (HPGe) cooled with liquid notrogen. I predicted ^{109}Cd would work well because it emits a single low-energy γ at 88 k*e*V with no higher "energies" present to confound interpretation. NaI(Tl) detectors peak in their total

Lead shield and the HPGe (high purity germanium) detector. The HPGe was purchased from the winner of an ebay auction for $1000 without anyone knowing if it worked at all. It is reverse electrode type with a beryllium window. The lead was mostly from Allan's Steel in Redwood City. Photo of May 5, 2003. Eric Reiter efficiency near 88 k*e*V, and at this energy its photoelectric response is 15 times greater than its Compton effect response.[11]



```
mca35.dtab3 t0 bk 0 m1 06-16-2003 21:12:18 hp000 1_Egy mca4.bas Log
① .5  2829 s 05-07-2003 19:30:53 spec Co57 at 5.5in
② .5   907 s 05-07-2003 19:47:17 back in pb hpge
③ .5  1354 s 05-07-2003 20:11:06 spec Cd109 at 5in
```

```
bin 2-1        keV       cts        cts/sec  inwin   inwin/sec-bins
290 148 0.0  244.8         9      0.0032697  226061        0.539922
143     0.0  122.2     63390     22.4071236
```

HPGe plots of Cd109, Co57, and background, all done in the Pb shield. The 264 keV is from Cd113 contamination in the Cd109 source. Cd113 is also responsible for the high noise floor at "energies" above the 88 keV photopeak. This makes it difficult to attempt to find an anomalous sum peak at 2 x 88 keV. Notice that beyond the photopeaks in Co57, the plot falls to become relatively flat. This means that if we see something beyond the photopeak using a NaI(Tl) detector, it is not due to contamination as found for Cd109. A possible anomalous sum peak is identified, not present in background, and will be explored in more detail in my future work. Plot is from a program I wrote in QUICKBASIC to convert the serial output of the TN-7200 MCA and analyze the data. Plots are log scale. These plots have been labeled with CorelDraw.

Incidentally, terms like γ-ray "energy" and "*e*V" came from the photon principle. Although the detector does deliver a pulse of energy, the photon principle implies that a photon's wave function somehow collapses[19] from macroscopic space with the ability to propel a whole electron. One enters the paradox straight-away when we talk of whole "electrons," because charge diffracts**.** With wave effects like diffraction at play, you cannot use a particle concept without *winking* particles in and out of existence. You will see those patchwork concepts fail view of new evidence presented here. I use "*e*V" only for the reader's convenience. My experiments say we should be using a frequency scale instead of energy. Particle-oriented language and assumption must be carefully set aside to understand the message of experiment.

The experimental variations to be described cover (1) different detector geometries, (2) strategies using one detector or two detectors, (3) different radioactive isotopes and (4) different circuits toward developing the best experimental design. Many experiments were performed within a lead shield of my own construction. The shield chamber is 12 inch diameter, 15 inch long, 3 inch thick, and is lined with 1 mm tin and 3 mm copper. In a spectral region of interest from 56 to 324 k*e*V, the ambient background count rate inside the shield was 1/31 of that outside the shield.

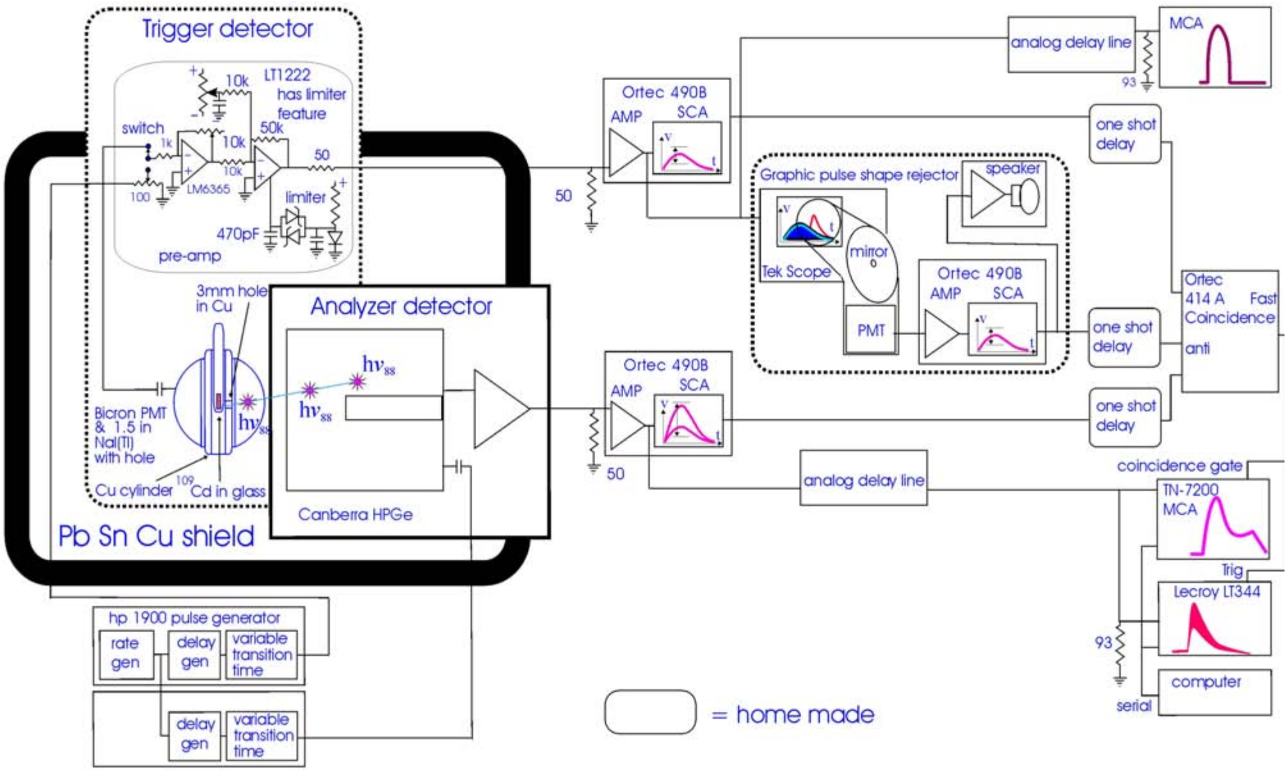
HPGe Spectrums

Spectrums of ^{109}Cd and ^{57}Co were taken with a Canberra GR1520 reverse electrode HPGe detector inside the Pb shield. It was found that the ^{109}Cd source was contaminated with ^{113}Cd that produces a 264 k*e*V peak, and a continuum from 88 to 264 k*e*V. This contamination ruined my early attempt to detect an anomalously large sum-peak, that I predicted. Presence of ^{113}Cd would not affect a two-detector coincidence experiment because emission from the two mixed isotopes occur independently, and coincidences would occur only by chance. A ^{57}Co source does not have this contamination, but it does have two closely spaced gamma photopeaks. The ^{57}Co "energy" level diagram, devised from "rad-lab" coincidence tests, shows separate pathways to these γ emissions, which means that these two gammas occur independently. Therefore a coincidence test using NaI(Tℓ) detectors windowed over both ^{57}Co gamma "energies" can be treated as one gamma *h*ν emitted, upon each radioisotope decay. ^{57}Co does not emit coincident gammas.

This is inside the shield. Accept for some aluminum tape, it is all lined with copper. Cd109 is in the central part of a well-hole in a 1.5 inch NaI(Tl) scintillator. HPGe is on right. Radiation must pass through the NaI to get to the HPGe. If some radiation was to scatter to the HPGe more directly, it would not matter because that is covered by the chance component we calculate and compare to. NaI generously sold by Dave Bliss. May 9, 2003. Eric Reiter.

Two detectors in tandem

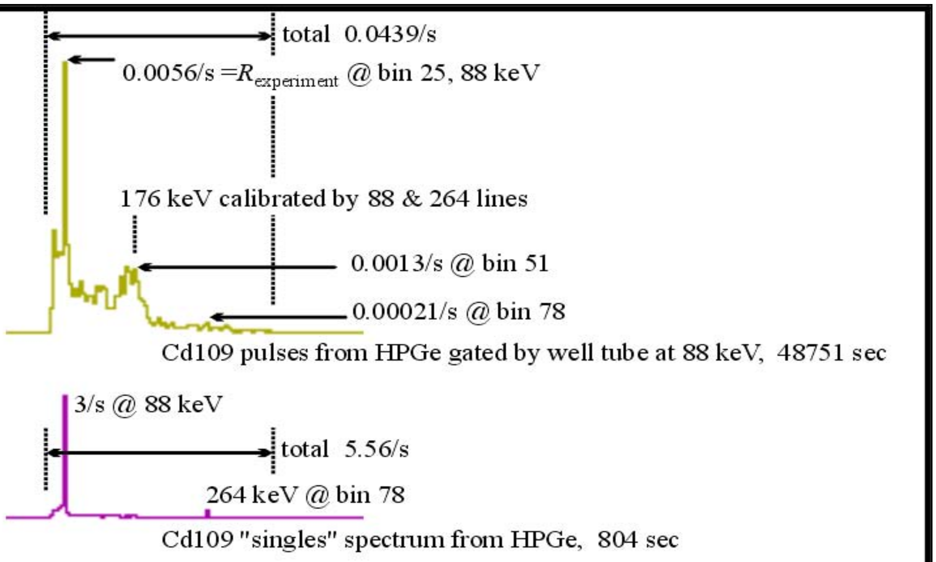
By tandem I mean a gamma-ray must go through a



Coincidence experiment with HPGe and well-tube scintillator

Eric Reiter 2003

trigger detector to encounter an analyzer detector.   A Bicron 1.5 inch diameter by 1.5 inch long NaI(Tℓ) scintillator, with a hole through its side, a well-tube, was used as a trigger detector.   The ^{109}Cd source was in a ¼ inch diameter glass tube, sheathed by a 5 mm thick Cu cylinder with a 3 mm hole in its side.   The Cu was a collimator to aim γ rays that would pass through the trigger detector and toward the HPGe analyzer detector.   Gamma radiation must pass through the trigger detector to reach the analyzer detector. The scintillator detector's preamplifier was of my own design using an LT1222 op-amp, chosen for its output voltage-limiter feature. Amazingly, a limiter feature is not available on nuclear industry pre-amplifiers. The gain of the amplifier was set to make the limiter clip electrical pulses caused by detector events exceeding 600 keV. The limiter was found necessary to eliminate large cosmic-ray pulses that can cause a bounce in downstream shaping amplifiers that could sneak a pulse through the SCA (single channel analyzer) windows. An SCA is a pulse height filter with knobs for setting upper-level and lower-



Cd109 HPGe Coincidence Spectrum.

Cd109 was in a copper sleeve with a 5 mm hole aiming at the HPGe.
The Cd and Cu sleeve were inside the 1.5" NaI well tube (not tilted).

Coincidence gate pulses were set at $\tau = 100$ ns. Trigger-tube windowed @ 88 keV gave rate of 1289/s = R_t.   Singles rate from HPGe at the 88 keV bin = R_a = 3/s..

$R_{\text{chance}} = 2\tau R_t R_a = 1/1293$s. $R_{\text{experiment}}/R_{\text{chance}} =$ 7.2 x > chance.
At 2x the 88 keV gamma, a peak is clearly visible, which is a feature not present at all in the singles spectrum.   Spectrums are linear scale.
Experiment done May 9, 2003. Eric Reiter Pacifica, CA..

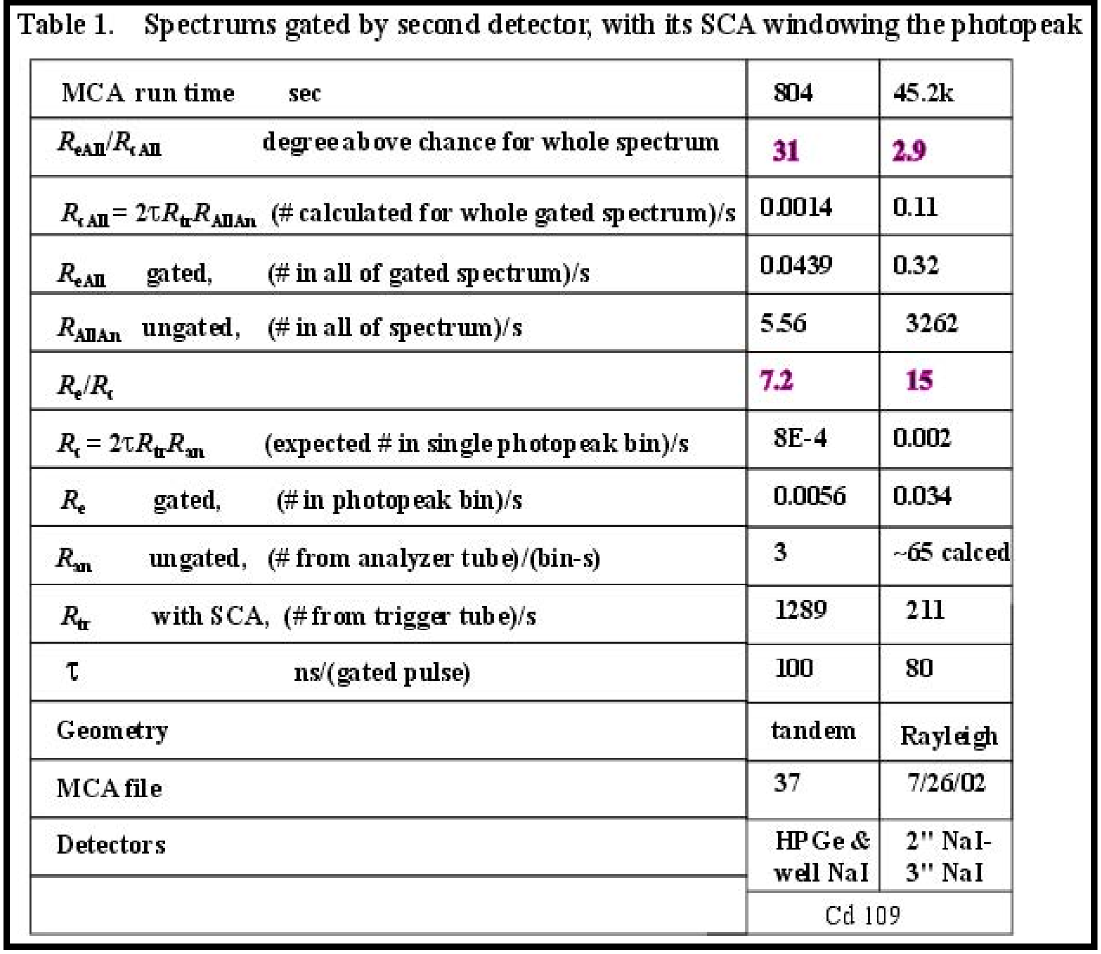


Table 1.   Spectrums gated by second detector, with its SCA windowing the photopeak

MCA run time sec	804	45.2k
$R_{eAll}/R_{\tau All}$ degree above chance for whole spectrum	**31**	**2.9**
$R_{\tau All} = 2\tau R_{tr} R_{AllAn}$ (# calculated for whole gated spectrum)/s	0.0014	0.11
R_{eAll} gated, (# in all of gated spectrum)/s	0.0439	0.32
R_{AllAn} ungated, (# in all of spectrum)/s	5.56	3262
R_e/R_τ	**7.2**	**15**
$R_\tau = 2\tau R_{tr} R_{an}$ (expected # in single photopeak bin)/s	8E-4	0.002
R_e gated, (# in photopeak bin)/s	0.0056	0.034
R_{an} ungated, (# from analyzer tube)/(bin-s)	3	~65 calced
R_{tr} with SCA, (# from trigger tube)/s	1289	211
τ ns/(gated pulse)	100	80
Geometry	tandem	Rayleigh
MCA file	37	7/26/02
Detectors	HPGe & well NaI	2" NaI- 3" NaI
	Cd 109	

level of pulse heights. Only pulses within the upper-level and lower-level settings will trigger the SCA to deliver an output pulse. Two SCA's are used, one for each detector. SCA output square-wave pulses were ANDed together by an Ortec 414A coincidence gate instrument. ANDing means, when the pulses overlap in time it gives an output pulse

I test each instrument to ensure they perform without delivering false pulses. I can tell you of certain brand name factory-good instruments that are worthless.

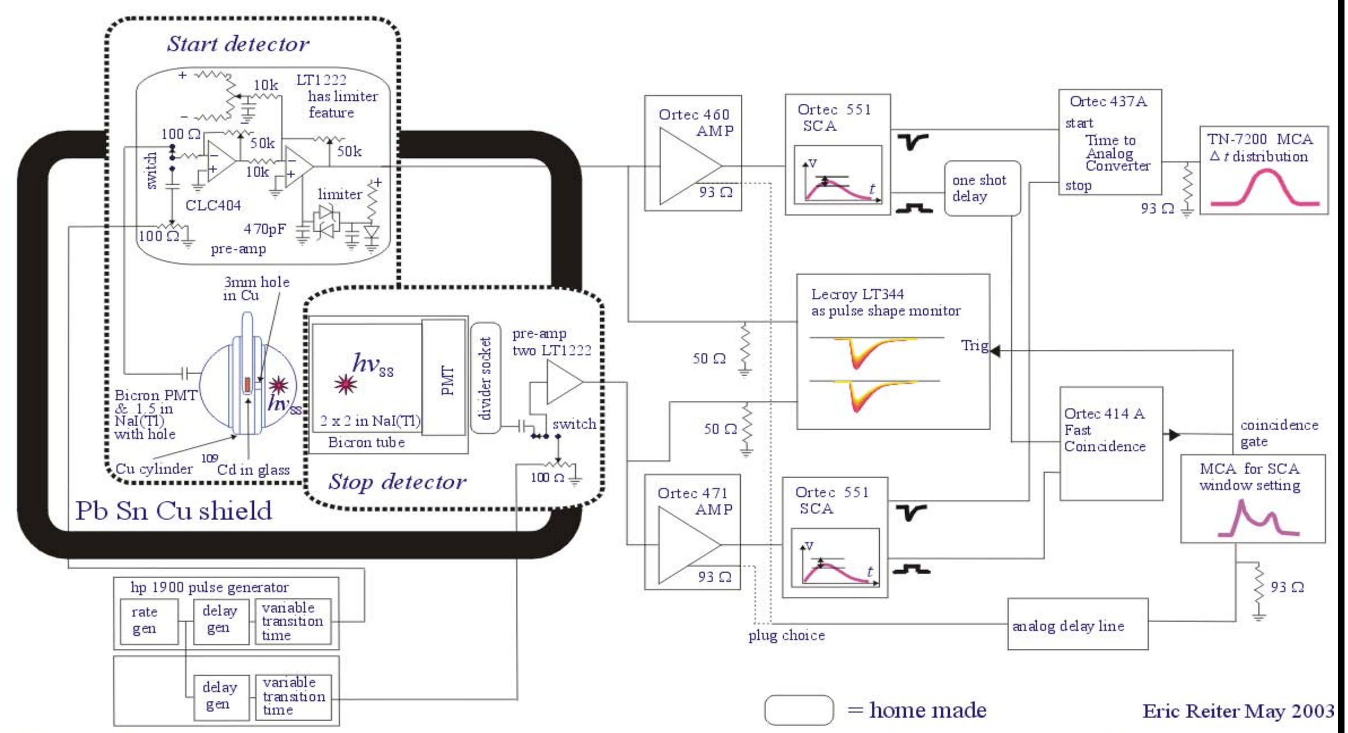
For the data of **Table 1** the SCA analyzer (#1) detector window was widened to observe the spectrum of what passed through in-coincidence. The trigger (#2) detector window ΔE, was kept smaller than half the largest allowed energy E, to eliminates the argument that one emitted high "energy photon" might split and cause two lower "energy" coincident scintillations. In these early experiments I built one-shots with pulse delay and width controls to create square pulses fed to the Ortec 414A fast coincidence module. The 414A had its internal overlapping square wave time adjusted to $\tau = 100$ ns. The 414A led to the gate of a TN-7200 multi-channel analyzer (MCA) that recorded time-delayed pulses from the analyzer detector's shaping amplifier. An an analog delay line box was used. The adjustment of overlapping two 100 ns pulses was accomplished by tests with signal injection, and was also tested by an experiment using ^{22}Na, which emits a coincident pair of annihilation $h\nu$.

In early experiments I took special care to eliminate distorted pulses from the trigger detector by designing and building a high speed pile-up rejector. An analog oscilloscope was rigged with a PMT covering its display, and a black tape mask was cut to fit the display face to hide light from correctly shaped scope trace pulses. Pulses appearing above the mask made light that sent a signal to an SCA and then to the 414A anti-coincidence input. The degree of pile-up elimination was approximately 1% of the singles rate. This method was later replaced with tests using a LeCroy LT344 oscilloscope. With the LeCroy scope, I also found that less than 1% of these pulses occurred outside the preset 100 ns coincidence window. This rate of false pulses would not significantly affect the pulse height spectrum and resulting statistics. The digital oscilloscope method is best because one can record every pair of coincident analog pulses and see the number of distorted pulses to be subtracted.

Counters from each SCA recorded R_{tr}, R_{an} , (trigger detector rate, analyzer detector rate) and a counter from the coincidence module recorded R_e (experimental coincidence rate). The analyzer spectrum revealed an incredible distinct peak only one bin wide at 88 keV with 0.0056 counts/s (experiment MCA37). With $R_{tr} = 1289$/s, Eq. (1) gives $R_c = 1/(1293 \text{ seconds})$. Therefore chance was exceeded by $\boldsymbol{R_e / R_c = 7.2}$ (see **CD109 HPGe Coincidence Spectrum** and **Table 1**). Any such calculation greater than unity defies quantum mechanics. None of this is understood by quantum mechanics. At pulse heights twice as big (2x) as the 88 keV photopeak, at 176 keV, the gated spectrum clearly shows a feature absent from the singles spectrum. I predicted this 2x peak would be present. If a single γ can trigger events in two detectors, it should trigger two events in one detector, like this 2x peak shows it did. Even a 3x feature was detected above the noise floor. Note of 2012: this was one of my most sophisticated experiments but a repeat using the HPGe detector was not attempted in later years.

Coincidence-time distribution of ^{109}Cd in beam-split geometry

Beam-split geometry is with two detectors side to side with a scatterer between the source and the detectors. A series of tests were undertaken (see **Table 2**) with a time to analog converter (TAC). In **Table 2** I labeled beam-split "Rayleigh" geometry. The TAC method was far easier than the 414A



Coincidence time distribution experiment with two scintillators

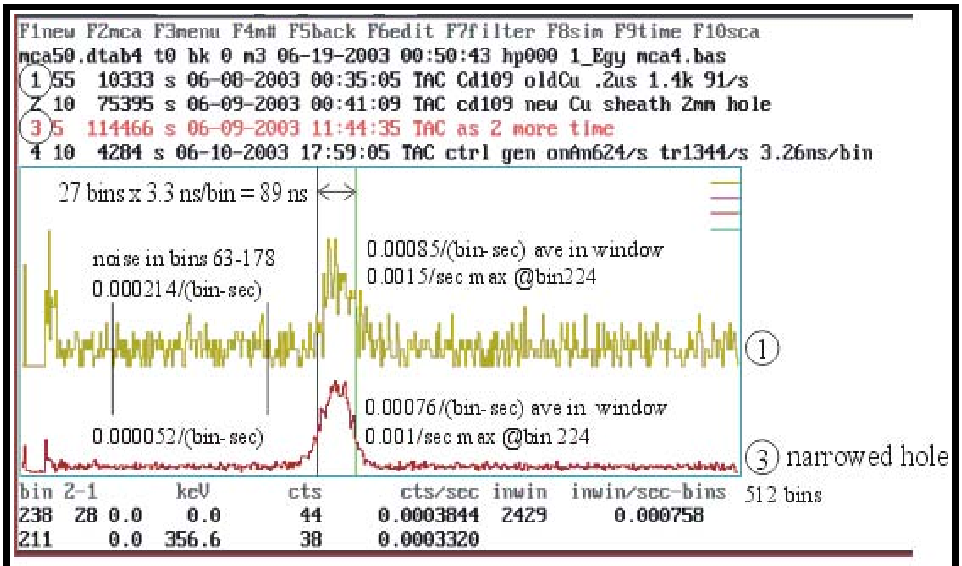
Table 2. Two Detector Δt tests with well-NaI and 2"NaI *corrected for cosmic-ray background

Bump width ns	84 fwhmx2	~80 fw			172 fwhmx2		132 fwhmx2	~92 fwhmx2	146 fwhmx2	96 fw	56 fw	145 fw	92 fw	106 fw	86 fw
MCA run time sec	7158	46.5k	11.7k	10.3k	114.5k	4284	19.9k	56.7k	44.9k	38.4k	4229	27.7k	39.9k	15.3k	70.1k
R_{bump}/R_c degree above chance for whole Δt spectrum	**1.8**	**~2.3**		**~3.4**	**9.8**		**~14**		**~10** *	**24** *	**68** *	**8.6** *		**1.6** *	**2.8** *
R_{bump} (# in whole bump)/s	9.2E-4	11.7E-4		6.7E-4	5.3E-4		~9E-4	0.1E-4	~6E-4	2.4E-4	6.8E-4	2.4E-4	0.28E-4	5.2E-4	1.8E-4
R_{peak}/R_c	**~2**	**~3**		**~7**	**18.5** *		**~31** *		**17.9** *	**68** *	**190** *	**~30** *		**~3** *	**4.3** *
R_c (# in wings)/(bin-s)	5.2E-4	7.9E-4	7.7E-4	~2E-4	5.4E-5	0.56E-4	0.66E-4	0 none in wings	0.581 E-4	9.2E-6	~0/s 2 in wings	~4E-7 5 in wings	0 none in wings	2.8E-4	3.6E-5
R_{peak} (# in peak bin)/s	11E-4	17E-4		14.5E-4	10.3E-4		21E-4	0.3E-4	10.7E-4	6.8E-4	0.0019	8.6E-4	~1E-4	9.7E-4	2.8E-4
R_{stop} (detector stops)/s		3108	2900	91		1344	50		24	65	16	20		367	110
R_{start} (detector starts)/s		1223	1200	1400		624	164k		775	48	20	17		445	122
τ_b ns/bin	0.8	0.8	0.8	3.3	3.3	3.3	3.3	3.3	3.3	8	8	6.6	6.6	6.6	6.6
Geometry and note	Rayleigh 1mm Cu	Rayleigh 1/8" Al	signal gen on start	tandem 5mm hole in Cu	tandem 2.5 mm slanted hole in Cu	signal gen on start	tandem tightened SCA from MCA50	background cosmic-ray	Tandem 2" NaI start (swapped)	tandem Pb sheath in well tube	Tandem tightened SCA from #1	tandem	Background cosmic-ray	Rayleigh 1/8" Al	Rayleigh 3/4" Al
MCA file	46 #1	46 #2	46 #3	50 #1	50 #3	50 #4	51 #3	55 #1	55 #2	47 #1	47 #2	49 #1	49 #2	49 #3	49 #4
source	Cd 109							None	Cd109	Co57			None	Co57	

coincidence gate method. Here the chance rate can be calculated from[12]

$$R_c = \tau_b R_{start} R_{stop}\,, \qquad (2)$$

where τ_b is the time resolution of one bin on the MCA, R_{start} is the rate at the start detector, and R_{stop} is the rate at the stop detector. Careful examination of my reported R_{start} and R_{stop} will calculate chance rates different from rates read from the side wings of the Δt plots. This is because the TAC has dead time, and that a TAC forces $R_{start} = R_{stop}$. A separate test confirmed Eq. (2) to give the same rate as from the measured noise present in the side wings of the time-difference spectrum. I also tested to see that the same noise floor rate is generated if a periodic pulse signal is inserted at the TAC start input.

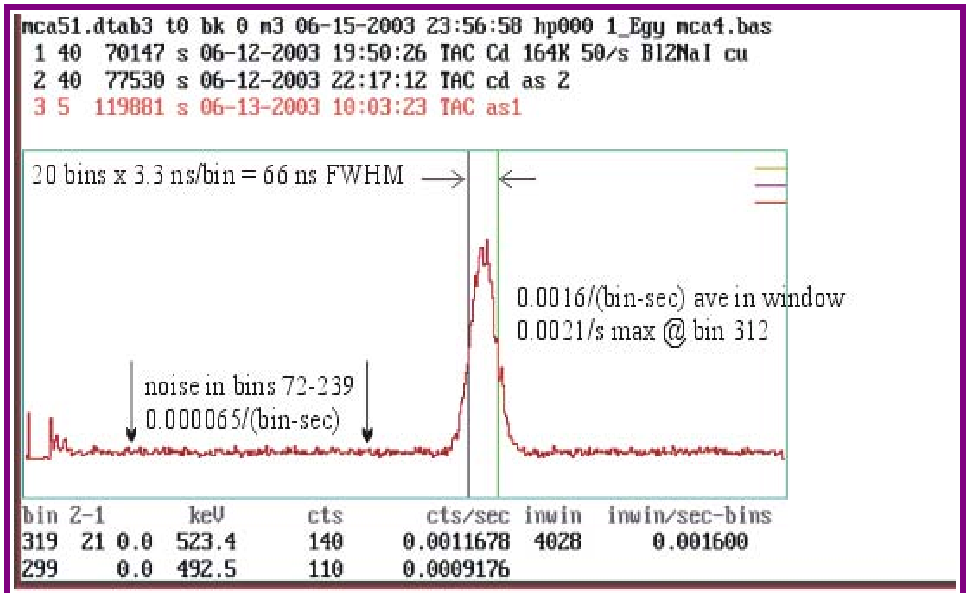


```
mca50.dtab4 t0 bk 0 m3 06-19-2003 00:50:43 hp000 1_Egy mca4.bas
 1 55  10333 s 06-08-2003 00:35:05 TAC Cd109 oldCu .2us 1.4k 91/s
 2 10  75395 s 06-09-2003 00:41:09 TAC cd109 new Cu sheath 2mm hole
 3 5  114466 s 06-09-2003 11:44:35 TAC as 2 more time
 4 10   4284 s 06-10-2003 17:59:05 TAC ctrl gen onAm624/s tr1344/s 3.26ns/bin
```

```
bin 2-1      keV      cts       cts/sec  inwin  inwin/sec-bins
238  28 0.0    0.0      44     0.0003844  2429       0.000758
211     0.0  356.6      38     0.0003320
```

Δt plots of Cd109 using NaI well tube and 2" NaI. Plot 1 used 5 mm hole in Cu; plot 3 used 2.5 mm slanted hole in Cu. Plotting scale factors were adjusted to compensate for time of data collection to aid graphic comparison. Linear scale.

The definition of Rayleigh scattering, also called elastic or coherent scattering, is that no frequency change takes place. I expect the inner mechanism is similar to my description of the Compton effect described in *An Understanding of the Particle-like Property of Light and Charge.* It is like Bragg scattering except that the charge-wave system is in a standing wave pattern and does not recoil to cause a Doppler shift.



```
mca51.dtab3 t0 bk 0 m3 06-15-2003 23:56:58 hp000 1_Egy mca4.bas
 1 40  70147 s 06-12-2003 19:50:26 TAC Cd 164K 50/s B12NaI cu
 2 40  77530 s 06-12-2003 22:17:12 TAC cd as 2
 3 5  119881 s 06-13-2003 10:03:23 TAC as1
```

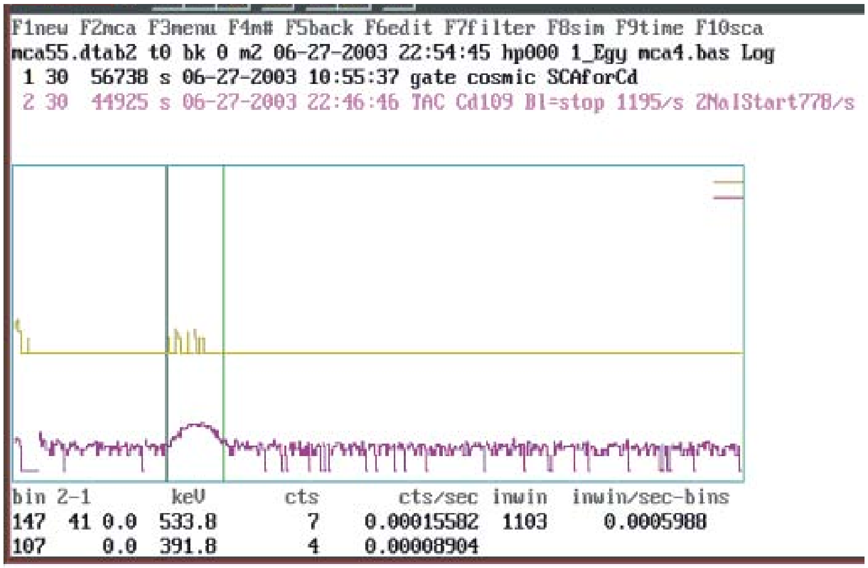
```
bin 2-1      keV      cts       cts/sec  inwin  inwin/sec-bins
319  21 0.0  523.4     140     0.0011678  4028       0.001600
299     0.0  492.5     110     0.0009176
```

Δt TAC plot from Cd109 in NaI well with Cu sheath to 2" NaI. SCA windows were tightened on both channels with resulting enhanced resolution.

Coincidence time distribution of ^{109}Cd in tandem geometry

Tandem geometry is with a thin detector in front of a thick detector as shown in the graphic:

"Coincidence time distribution with two scintillators."



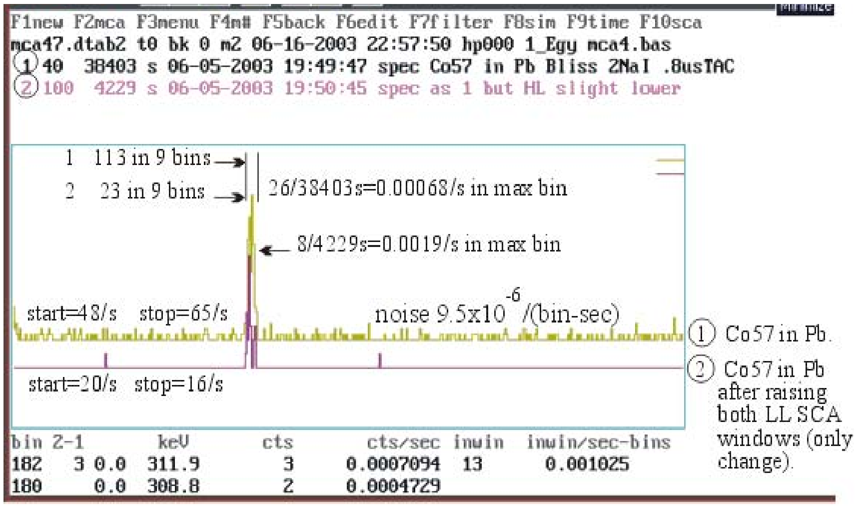
```
F1new F2mca F3menu F4m# F5back F6edit F7filter F8sim F9time F10sca
mca55.dtab2 t0 bk 0 m2 06-27-2003 22:54:45 hp000 1_Egy mca4.bas Log
 1 30  56738 s 06-27-2003 10:55:37 gate cosmic SCAforCd
 2 30  44925 s 06-27-2003 22:46:46 TAC Cd109 Bl=stop 1195/s 2NaIStart778/s
```

```
bin 2-1        keV        cts        cts/sec  inwin    inwin/sec-bins
147  41 0.0   533.8        7     0.00015582  1103       0.0005988
107     0.0   391.8        4     0.00008904
```

Cd109 in tandem to test TAC start/stop swap, and read background.

In Plot **MCA 50#1** I get immediate results but I was dissatisfied with the signal to noise ratio. I guessed that too many overlapping γ-ray pulses in the trigger detector might obscure my effect. For **MCA 50#3** I made a new copper insert (no Pb) with a hole at half the previous diameter, drilled at an angle. The well-tube was tilted at an angle to have the γ-rays travel a shorter-path in a corner of the scintillator crystal. The only difference between the two plots is the Cu insert. The degree above chance improved, confirming my hunch. The LeCroy scope recording of every coincident pulse pair revealed excellent pulse quality.

For plot **MCA 51#3** I tightened the SCA window to about 25% of full scale. This markedly improved the signal/noise of my effect; and the degree above chance was improved. This demonstrates that my effect is not due to either noise or a wide SCA setting. This revealed **9.8 times above chance**.



```
F1new F2mca F3menu F4m# F5back F6edit F7filter F8sim F9time F10sca
mca47.dtab2 t0 bk 0 m2 06-16-2003 22:57:50 hp000 1_Egy mca4.bas
① 40   38403 s 06-05-2003 19:49:47 spec Co57 in Pb Bliss 2NaI .8usTAC
② 100  4229 s 06-05-2003 19:50:45 spec as 1 but HL slight lower
```

```
bin 2-1        keV        cts        cts/sec  inwin    inwin/sec-bins
182   3 0.0   311.9        3     0.0007094    13       0.001025
180     0.0   308.8        2     0.0004729
```

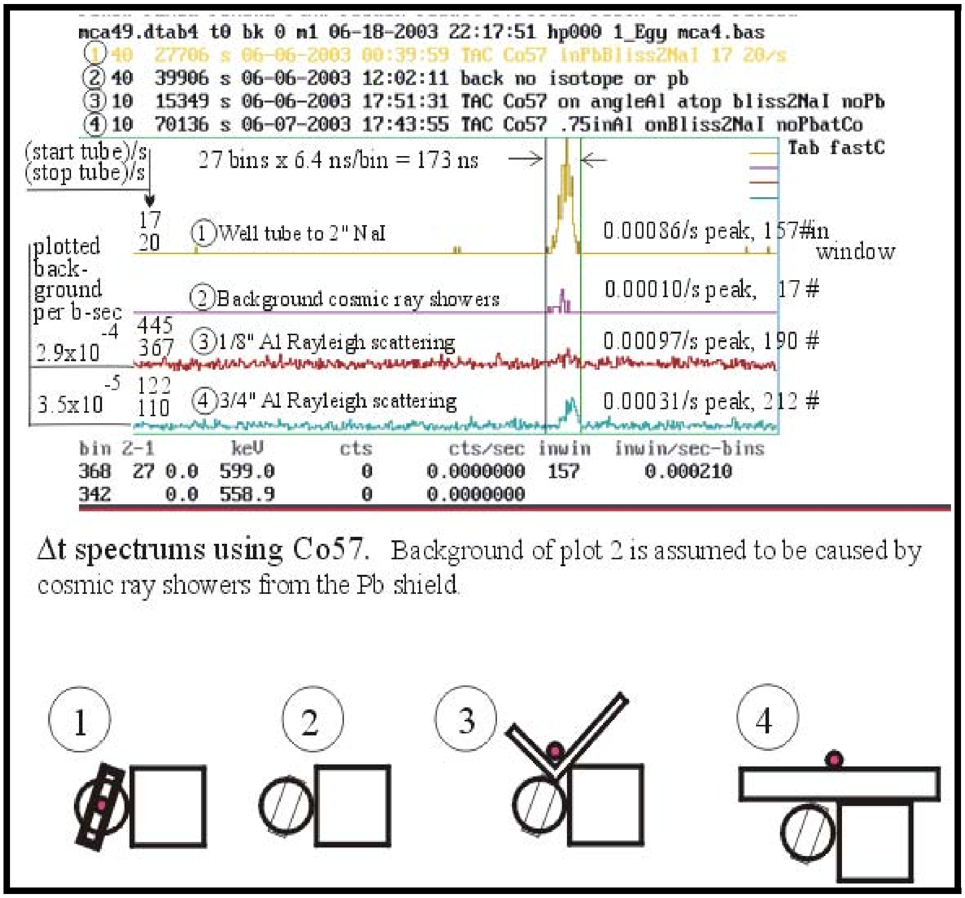
Coincidence time distribution using Co57 with Pb insert in well tube in tandem. Time resolution is 8 ns/bin.

In plots **MCA 55#2** I return after some adjustments to the ^{109}Cd tandem test, but I swaped which detector drives the TAC start and stop. Compare ratio of rate above chance in **Table 2** to to experiment MCA 50#3 to see that this made no substantial change. In **MCA 55#1** I did a cosmic-ray background test and used it as a correction factor. I performed a similar test earlier in 2001 to eliminate cosmic rays as an artifact.

Coincidence time distribution of ^{57}Co in tandem geometry

It was very important for me to show that the effect I found was not limited to ^{109}Cd. My first attempt at seeing what I call *the unquantum effect* with ^{57}Co just gave noise (chance). This was because I did not shield the source with a collimator of lead. I thought there was a problem with Pb fluorescence. Then I realized it was OK to use Pb because the x-ray fluorescence line could be windowed by the SCA. I fashioned a Pb insert for the well tube and ran the experiment giving plot **MCA 47 #1.**

For **47#2** the only change I made was to tighten the SCA from approx. 35% used in **47#1** to approx. 20% of full scale. Referring to **Table 2**, the degree above chance climbed from 68 to 190. It seems that there was some Pb fluorescence in plot **47#1** that was picked up in the wider SCA window that caused noise, and that noise was eliminated in plot **47#2**. Plot **MCA 49 #1** also used ^{57}Co in tandem. The coincident pulses were monitored on the LeCroy and the pulse shapes were not distorted from pile-ups.



```
mca49.dtab4 t0 bk 0 m1 06-18-2003 22:17:51 hp000 1_Egy mca4.bas
①40  27706 s 06-06-2003 00:39:59 TAC Co57 inPbBlissZNaI 17 20/s
②40  39906 s 06-06-2003 12:02:11 back no isotope or pb
③10  15349 s 06-06-2003 17:51:31 TAC Co57 on angleAl atop bliss2NaI noPb
④10  70136 s 06-07-2003 17:43:55 TAC Co57 .75inAl onBliss2NaI noPbatCo
```

```
bin Z-1       keV       cts       cts/sec  inwin  inwin/sec-bins
368  27 0.0   599.0       0     0.0000000   157       0.000210
342     0.0   558.9       0     0.0000000
```

Δt spectrums using Co57. Background of plot 2 is assumed to be caused by cosmic ray showers from the Pb shield.

Cosmic-ray coincidence test

In plot **MCA 49 #2** there was no source inside the Pb shield, but a low level of coincidences were still detected. This is assumed to be from cosmic rays interacting with the Pb shield and showering x-rays to the detectors in coincidence. This is a background to be subtracted at similar test setups. No background coincidences were found outside the 173 ns window shown, and the total rate was 17 pairs/39906s ≈ (1.5 event-pairs)/hour. This background test was also performed using SCA window settings used for ^{109}Cd. Similar results were found and recorded on file **MCA55**. My coincidence effect is not some cosmic ray artifact.

Coincidence time distribution of ^{57}Co in Rayleigh geometry

Plot **MCA 49#3** shows a barely visible effect using γ from ^{57}Co Rayleigh scattered from a 1/8" thick aluminum angle-bar; perhaps it only needed more time to average out the noise. In plot **MCA 49#4**, everything is the same accept the thickness of the Al scatterer was increased to ¾ inch, and the run time was longer. Here the effect is readily observed at 4.3 times greater than the calculated chance rate. Though the rates were attenuated, the thicker Al gave a greater chance of scattering, as expected.

The pulses were monitored on the LeCroy and were reasonably well behaved (few mis-shaped pulses).

Table 3.
Single detector sum-peak tests

R_e/R_{pu}	chance is assumed	1.98 *
$R_{pu} = \tau R^2$ #/s	set to 1.6	0.0072
R_e at shelf #/s	0.16	0.0370
background at shelf #/(bin-s)	0.00348	0.0224
R at photo-peak	367	79
τ_{pulse} pulse width at shaping amp	1.16 µs calced	1.16µs
MCA file	57	54
detector	2" NaI	3" from source
source	Cs137	Co57

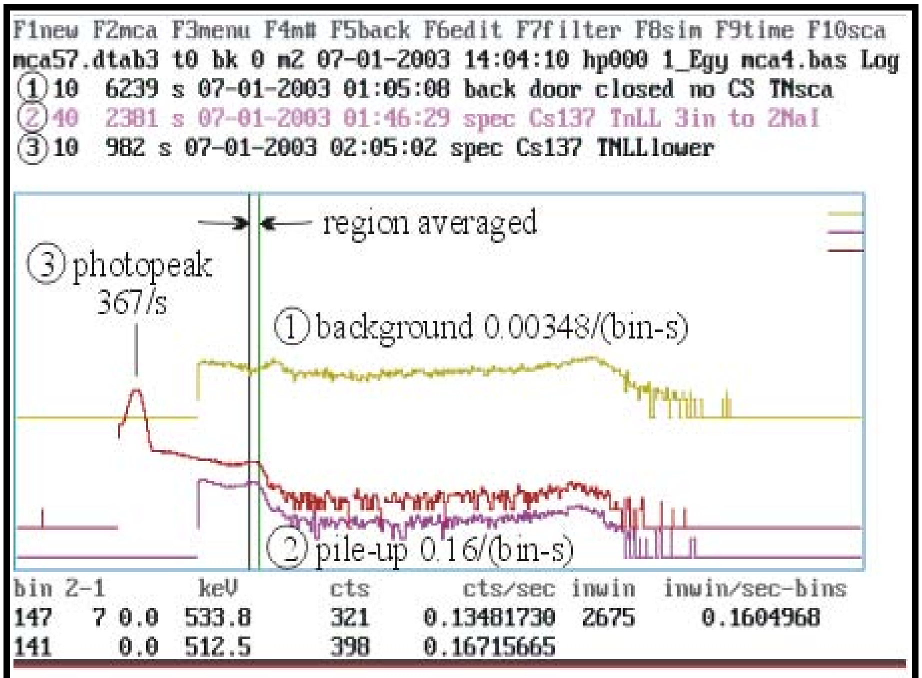
* corrected for pile-up (-2%) & background

Single detector spectrum showing anomalous sum-peak in ^{57}Co

If two detectors show coincidences defying the photon principle, we expected to see the effect in only one detector as an anomalously large pile-up peak in the spectrum. Since ^{113}Cd obscures this part of the ^{109}Cd spectrum, it is more practical to attempt this measurement with ^{57}Co. In preparation, it is useful to understand a normal pile-up effect in a spectrum. The pile-up rate at twice the photopeak "energy" is readily calculated from[11,12]

$$R_{pu} = \tau_{pulse} R^2. \qquad (3)$$

With ^{137}Cs the photopeak at 662 k*e*V and its pile-up point are well studied and is known to conform to chance. I tested this, and also studied the sum peaks of ^{57}Mn and ^{22}Na, and found only chance. Note of 2012: later with different detectors I did break chance with ^{22}Na. This is to be expected due to the lower photoelectric efficiency with NaI(Tl) at higher k*e*V. At comparable k*e*V, we can use Eq. (3) to calculate τ_{pulse}. To take this spectrum I lowered the PMT high voltage so that the preamp limiter would not block the larger pulse heights. PMT HV lowering also made the amplifiers respond comparable to when 122 k*e*V γ were used. I also gated-out the photopeak with an SCA when measuring the pile-up region, and took a background reading. Gating out the photopeak was done to remove dead-time errors. Using Eq. (3) for the data shown in **Table 3** for file **MCA57**, and subtracting background in the pile-up region gave τ = 1.16 µs. A calculation from the



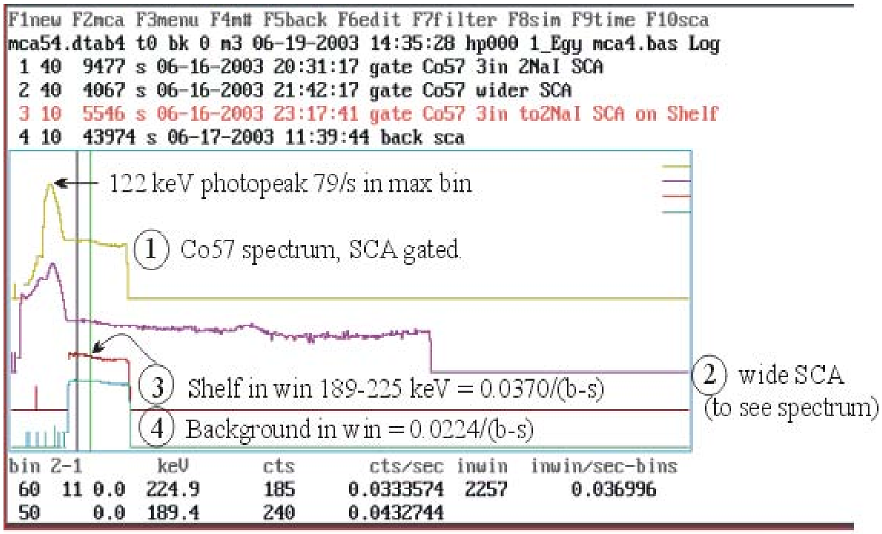
```
mca57.dtab3 t0 bk 0 m2 07-01-2003 14:04:10 hp000 1_Egy mca4.bas Log
①10   6239 s 07-01-2003 01:05:08 back door closed no CS TMsca
②40   2381 s 07-01-2003 01:46:29 spec Cs137 TnLL 3in to 2NaI
③10   982 s 07-01-2003 02:05:02 spec Cs137 TNLLlower
```

```
bin Z-1         keV        cts        cts/sec  inwin   inwin/sec-bins
147    7 0.0  533.8        321     0.13481730   2675       0.1604968
141      0.0  512.5        398     0.16715665
```

Cs137 pile-up analysis.

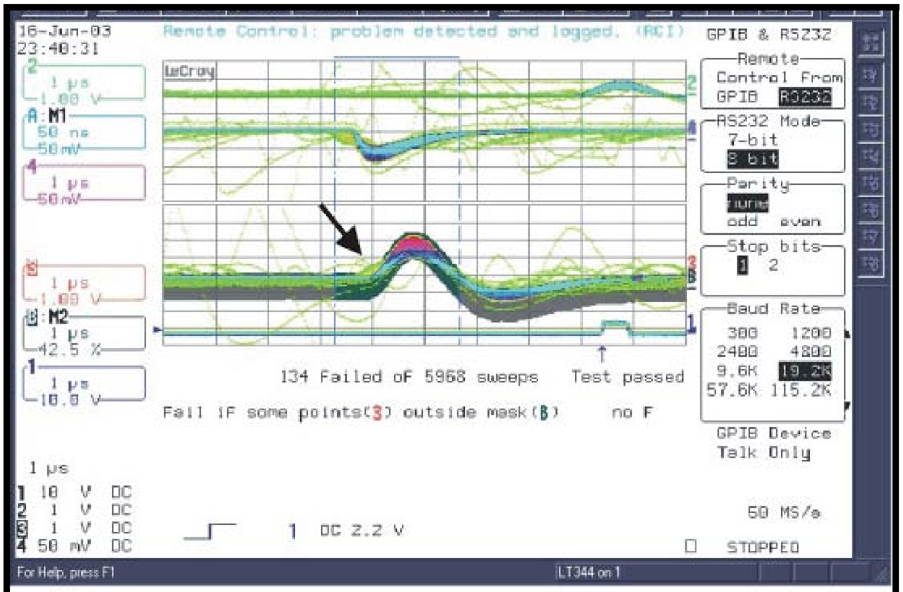
shaping amplifier FWHM pulse rate agreed at τ = 1.1 μs.

For the ^{57}Co spectrum of **MCA 54**, I windowed the MCA to include a shelf in the pulse height spectrum, but took an extra precaution by using the SCA to also trigger the LeCroy for a mask test pile-up correction. This test shows 2% should be subtracted from the shelf count of **MCA 54 #3**. Recall that even though ^{57}Co has two peaks hidden by the low resolution of the NaI detector it can be treated as one because they are emitted independently. Putting the numbers together yields R_e = [0.037–(0.037x0.02)] – 0.022 = 0.014, and R_e/R_{pu} = 1.98 times greater than chance. This calculation gave a small advantage to chance because a pile-up correction implies a shorter τ, but my effect rises above chance regardless.



```
F1new F2mca F3menu F4m# F5back F6edit F7filter F8sim F9time F10sca
mca54.dtab4 t0 bk 0 m3 06-19-2003 14:35:28 hp000 1_Egy mca4.bas Log
 1 40   9477 s 06-16-2003 20:31:17 gate Co57 3in 2NaI SCA
 2 40   4067 s 06-16-2003 21:42:17 gate Co57 wider SCA
 3 10   5546 s 06-16-2003 23:17:41 gate Co57 3in to2NaI SCA on Shelf
 4 10  43974 s 06-17-2003 11:39:44 back sca
bin Z-1        keV        cts        cts/sec  inwin   inwin/sec-bins
 60  11 0.0   224.9       185      0.0333574  2257        0.036996
 50     0.0   189.4       240      0.0432744
```

Search for non-chance sum region (shelf) in spectrum of Co57. Source was 3 inches from 2 inch dia NaI(Tl). Pulse from SCA and delay box gated the MCA. Log scale.



```
Remote Control: problem detected and logged. (RCI)
134 Failed of 5968 sweeps    Test passed
Fail if some points(3) outside mask(B)    no F
```

Mask test for MCA54 #3 to test if mis-shaped pulses cause anomalous shelf. ~2% were detected, mostly in the marked problem area (arrow). This fraction can be subtracted.

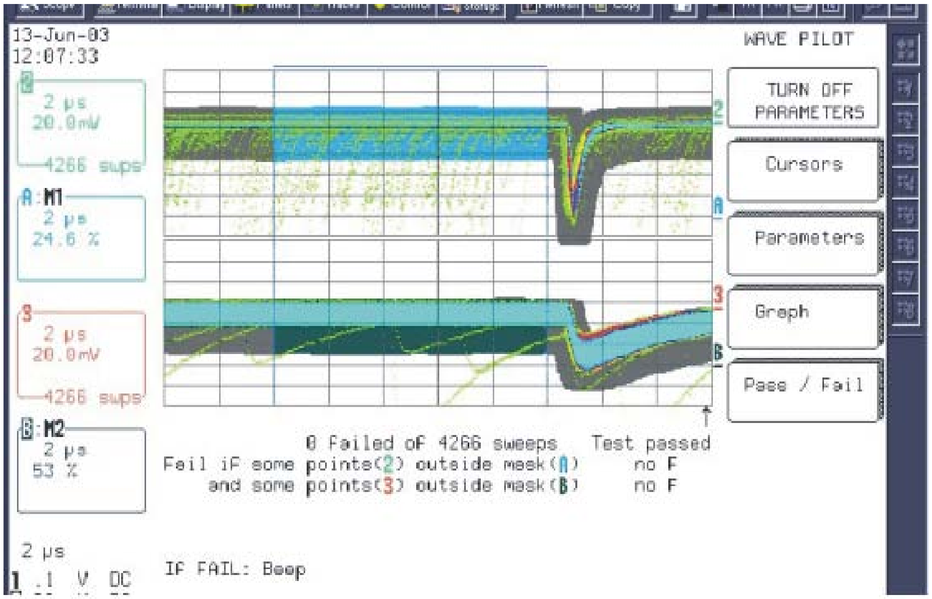
Some confounding factors addressed

It occurred to us to check for the possibility of stimulated emission at the source. For this test I heated and squeezed a glass tube to create a hollow chisel shape so that an added isotope solution would evaporate and deposit the ^{109}Cd solid along a concentrated line. In a line, like like a laser rod, gammas could interact with more of the isotope to perform stimulated emission if such an effect was at play. The glass was mailed to Spectrum Techniques where they added 1 μCi of ^{109}Cd. Then I did a careful study of the region of the spectrum at twice the photopeak, where I compared counts in two orientations: (1) with the line of isotope aimed at the detector and (2) with the line perpendicular to the detector. Comparing full spectral peak widths, the normalized exposed anomalous sum peak rate was 7% larger from the perpendicular source than from the aimed source. If there was such a stimulated emission effect, the enhancement would have been the other way around.

A calculation was also performed using Mossbauer theory and the Debye temperature of cadmium to see if stimulated emission was possible at room temperature. If stimulated emission in ^{109}Cd was to be found to cause the effects of this report, it would be a great discovery in itself, but we eliminate this possibility. With ^{57}Co it is only the lower "energy" 14.4 k*e*V emission from ^{57}Co that has recoilless emission. At 14.4 k*e*V a resonant link to the crystal lattice removes recoil, making it monochromatic and capable of stimulated emission. Stimulated emission requires that an external gamma ray match the frequency of a nuclear internal mode by not having too much Doppler shift in a recoilless nuclear resonance absorption. The condition for this is $E_r = E_0^2/2mc^2 < kT_d$, where E_0 is the 88 k*e*V photopeak, m the mass of ^{109}Cd , and T_d is the Debye temperature at 209 K for Cd. Since E_r is larger by ~2, stimulated emission is not expected at room temperature.[11] It is extremely far fetched that my effect could be due to some new form of stimulated emission, or some strange particle for that matter, emitted from both ^{109}Cd and ^{57}Co**.**

An altogether new effect I predicted and tested, is that coincidences should be enhanced by using a weaker source. It is like observing a swarm of fireflies through a cardboard tube; you see the flickering. But if you looked at the whole swarm through a plate of smoked glass you would see a steady dull glow. It is the fluctuations in intensity that set off coincidences. This cannot at all be explained by photons. The chisel shaped tube of ^{109}Cd was placed in front of a 14 mm thick sheet of Pb with a 1.5 mm slit in front of a detector.

Notation: rate of photopeak with less Cd exposed is R_{pl}, more R_{pm}, anomalous photopeak rates in Al and Americium are R_{al}, R_{am}. $R_{pl}/R_{al} = R_l = 19$; $R_{pm}/R_{am} = R_m = 11.1$. R_l/R_m = a 71% increase in normalized anomalous counts due to fewer atoms at the source. This flicker coincidence effect is partially influenced by the Compton effect coincidence effect explored previously.



```
13-Jun-03
12:07:33
            0 Failed of 4266 sweeps   Test passed
Fail if some points(2) outside mask(A)     no F
    and some points(3) outside mask(B)     no F

IF FAIL: Beep
```

Satellite pulse mask test for MCA51. Preamp pulses from both channels are triggered from coincidence gate that overlaps 2.5µs pulses. Zero pulses were measured in coincidence in a 10µs test window preceding the coincidence trigger.

There is an effect in photomultiplier tubes called satellite pulses whereby a light flash can stimulate a current pulse to be followed by a second smaller current pulse up to 3 µs later. A cosmic-ray could conceivably set off coincidences within the SCA window from such an effect. It is easy to test for this using the digital storage scope in mask-test mode to examine the time preceding the coincident pulse pair. The test was applied to the setup used for plot **MCA51** with ^{109}Cd and tandem detectors. From testing 4622 sweeps, there were zero pulses large enough to enter the SCA window in a block of 5 μs preceding the coincident pulse pair. Tests were also performed to see if the gamma source affects the PMT directly, and no effect was seen.

I have explored background, cosmic-rays, stimulated emission, lead fluorescence, and pile-up errors. Since my effect improves when lowering noise, SCA width, Pb presence, and background, these factors are not the source of my effect. There is no evidence of some confounding factor causing the unquantum effect.

Some protests against my method and conclusion

I have been told that I would need to use a Bragg reflection filter to assure that only the 88 k*e*V gamma was present ahead of my pair of detectors. It is not necessary because the procedure for calculating chance will take into account extraneous source effects. Perhaps this will be done by die-hard skeptics in the future in some great facility capable of generating the necessary intense flux.

How can it be that something so fundamental has not been done before?

It is easy to understand why no one previously found anomalous sum-peaks or thought of a γ-ray quantum-busting coincidence test:

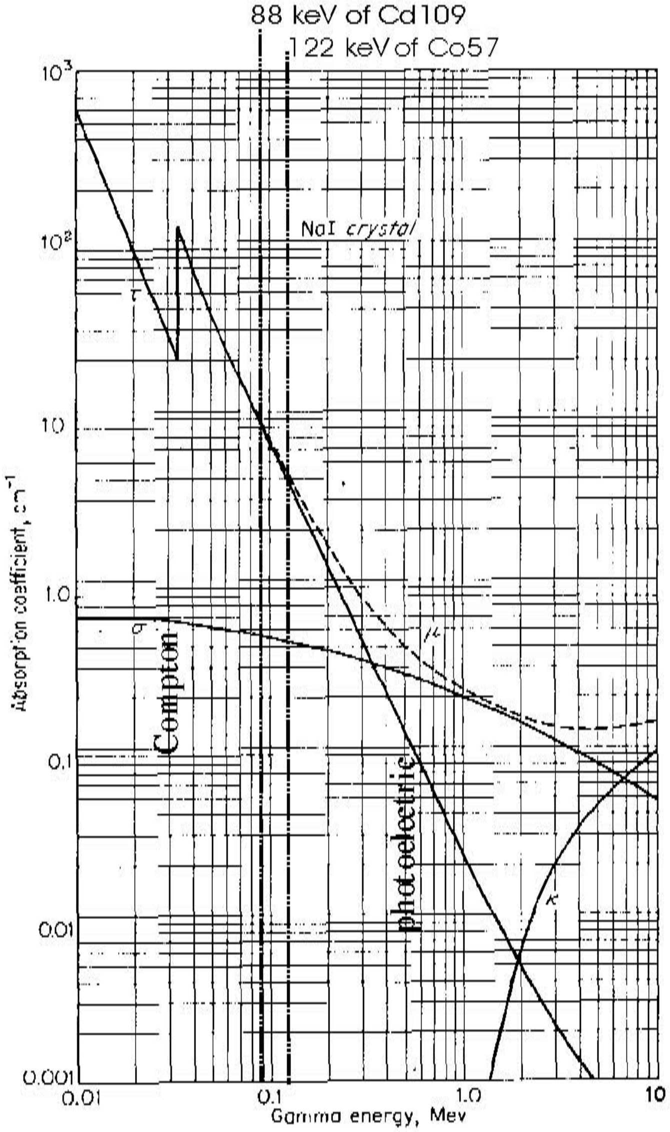
- ✓ There are few isotopes that emit a lone low-“energy” gamma. If a higher “energy” gamma-ray is also present it will obscure the measurement. If the gamma-ray “energy” is not low enough, the photoelectric efficiency of the detector will not be high enough to reveal the unquantum effect.
- ✓ Anomalously large sum-peaks cannot be detected with our higher resolution HPGe detectors, because of their lower photoelectric efficiency. So in this situation, where we think we see better, we see the unquantum effect worse. HPGe works poorly in the simpler single-detector experiments, but does reveal the unquantum effect in the more complicated two-detector experiments.
- ✓ In the manufacture of ^{109}Cd, had the process been developed to routinely purify out ^{113}Cd, a sum-peak may have been found and would have attracted attention. If the ^{57}Co sum-peak found above was noticed before, it would not have been impressive enough to inspire a research effort. There is a momentum of thought that influences what gets published and taught. There are mistakes that have been propagated concerning the history and interpretation of past experiments (see chapter *List of Physics Misconceptions* and my 2001 theory paper[1]).
- ✓ Concerning this very same experimental issue (is the photon principle maintained in a beam-split test?) one would need to have seen through the conceptual and experimental flaws of previous workers and ignore their conclusions. Concerning most experiments in modern physics, one would need to see through the dominant paradigm, ignore the models used by our most famous experimentalists, and freshly analyze their experimental setup and data in order to see what nature is saying, not people. Then one would need to solve the theoretical riddle, predict the unquantum effect, and understand how to look for it. In the electromagnetic spectrum, gamma-rays are thought to be the most particle-like. One would need to understand how a wave effect could be seen with gamma-rays, and would not be seen with lower frequency light.

Experimental Conclusion

In every experiment, where detector photoelectric efficiency exceeds Compton effect efficiency for the chosen gamma ray, chance is broken. The graphs of absorption efficiencies for NaI and Ge show the degree photoelectric efficiency surpasses Compton effect efficiency. It seems that nature has provided only a narrow corner of available γ sources and suitable photoelectric detectors to reveal the effect, but that is all I needed.

It would be interesting to continue this work with other low "energy" lone gamma sources, which are not readily available due to shorter half-lives. Also, there are other detector types, and variations of similar theme to those described above, that will undoubtedly reveal insight and practical application to the unquantum effect. Higher "energy" gamma-rays need to be tested to see if the effect persists with two detectors. I expect with lower photoelectric efficiency the effect will disappear, the same way it is barely seen with one detector. ^{57}Co needs to be tested with HPGe gated in tandem, etc.

I expect that the ability to detect the unquantum effect will decline if the source is separated in distance from the detectors. Then the pulse of classical gamma-ray would lose intensity, along with its ability to trigger events. In this manner one could link the solid angle spread with electromagnetic frequency. The experiments outlined here suggest many exciting explorations... not to see if the effect I have found is real, but to gain a confident understanding of the microworld.



Gamma absorption coefficients for sodium iodide verses gamma-ray energy.

The Tables of data summarize my work. There was no sorting-out of experimental runs, with similar set-ups to those reported, that would add evidence in favor quantum mechanics. The effect is repeatable, robust, and since it works with two isotopes, is not some strange special case. Tests and calculations were performed to eliminate confounding factors: background, stimulated emission, direct effects on the PMT, cosmic-rays, lead fluorescence, and pile-up errors. Since my effect improves when lowering noise, SCA width, Pb presence, and background, these factors are not the source of the effect. There is no evidence of some confounding factor causing the effect.

These experiments do not ask you politely to consider an alternative to quantum mechanics. The existence of this effect constitutes a serious challenge to quantization itself and requires a fresh interpretation of our most famous experiments of modern physics. We now have strong evidence that the nature of light, even during exchange of energy, is nothing like particles. If it was a particle it would go one way or another at the beam splitter, but it does not.

Experimental designs similar in theme should have been attempted since 1905. We were warned[1] against light quanta by:

Planck,[15] "explosive emission, continuous absorption"

Lorentz, "…light quanta just won't do."

Schrödinger,[25] "Let me say at the outset, that in this discourse, I am opposing not a few special statements of quantum mechanics held today, I am opposing as it were the whole of it, I am opposing its basic views that have been shaped 25 years ago, when Max Born put forward his probability interpretation, which was accepted by almost everybody."

Einstein,[13] "On a heuristic point of view concerning the production and transformation of light." Also note the famous Einstein Rosen Pedolsky (EPR) paper of 1935.

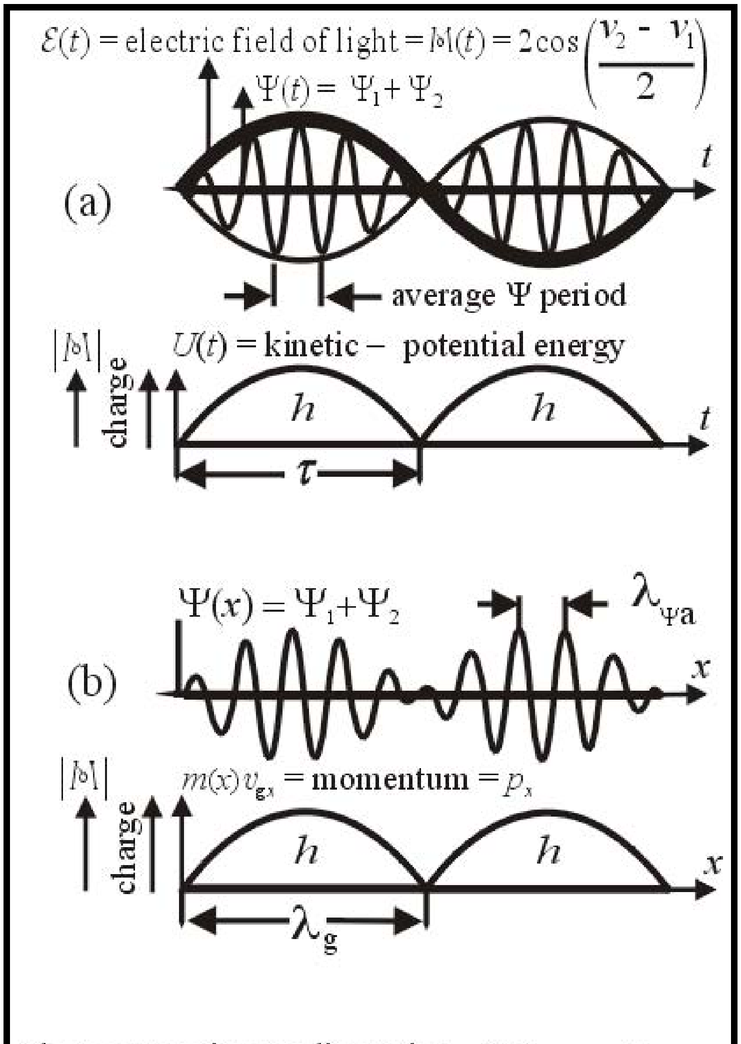
The experiment had just never previously been perfected that would reveal evidence to force the distinction between a quantum mechanical probability wave and a physical wave. The reasoning behind my research effort was really very simple. There is no way particles can source the wave field, and there is no way a field can collapse to a particle. Particles do not diffract. Amazingly, in the presence of obvious paradox, most scientists and their publishers have an attitude**:** they emphatically proclaim that quantum mechanics is right ("we know that light is made of particles"[23]). To put it metaphorically, I knew science has been delivering a distortion, because I know nature is not crazy. The experimental evidence above shows you can know that also.

Theory

The original argument for light having a particle property is Einstein's model of the photoelectric effect.[13] If we had a wave derivation, perhaps that would clarify things. Contrary to widespread opinion, Einstein did not properly derive the photoelectric effect equation;[4, 14] the equation was a statement of his model. I present here a derivation from wave principles that avoids wave-particle duality by attributing the particle-like effects to non-classical properties of the charge-wave.

Consider replacing λ_Ψ in de Broglie's $h = m_e \mathbf{v}_\Psi \lambda_\Psi$ with λ_g, the length of either a beat or a standing-wave envelope in a charge-wave construct (see drawing below). An "electron" diffraction experiment will not distinguish between λ_g and λ_Ψ. In place of particle electrons, consider m_e as a resistance to acceleration of the beat, and $\mathbf{v}_g$ as the velocity of the beat. I introduce a non-dualistic wavelength equation:

$$\mathbf{v}_g \lambda_g = h/m_e = Q_{h/m}. \tag{4}$$



Charge wave in one dimension. . (a) Time graph. (b) Space graph.

The structure of the Balmer equation of the hydrogen spectrum tells us that electromagnetic light frequency has something to do with internal difference frequencies. A trigonometric identity shows that a beating charge-wave is the product of a modulator wave *M* of frequency ν_o and the average wave function Ψ. *M* oscillates at the light frequency ν_L such that $\nu_L = \nu_{\Psi 2} - \nu_{\Psi 1}$. The modulator wave fits the beat and oscillates at two beats per wavelength: $\nu_L = \boldsymbol{V}_g /2\lambda_g = \nu_o$ (see figure). This model assumes light couples to charge in this manner in all situations, and that the difference-frequency phenomenon observed in the atom is really due to a property of the charge-wave. Substitute the above equations into $\nu_g = \boldsymbol{V}_g/\lambda_g$ to derive the photoelectric effect equation (ignoring the escape potential): $h\nu_L = m_e\boldsymbol{V}_g^{\,2} / 2$.

In the photoelectric effect derivation above, the steps leading to the non-dualistic wavelength equation (eq. 4) are substantiated[1] by noting that this equation aids in understanding: (1) standing-wave solutions of Schrödinger's equation where $\lambda_\Psi = \lambda_g$, (2) a wave derivation of the Compton effect equation, (2) a matter wave derivation of the Planck distribution, (3) the uncertainty principle, (3) spin, and (4) matter/antimatter annihilation.

The photoelectric experiment does not deliver *e* or *h*, independently, so the message of the experiment may be expressed for clarity as $\nu_L = Q_{m/h}\boldsymbol{V}_g^{\,2}/2$, where $Q_{m/h} = m_e /h$, or written $\nu_L = Q_{e/h}V$, where $Q_{e/h} = e/h$ and V = electric potential. Similarly, define $Q_{e/m} = e/m_e$. In this model, as the charge-wave escapes into space and thins out, the mass/action, charge/action, and charge/mass ratios are all preserved in such a way that this thinning-out is not noticed in our experiments or equations. It is a simple ratio concept. The constants *h*, *e*, and m_e here denote maxima. This is a simple threshold concept. As electromagnetic energy enters a charge-beat in a photocathode, the velocity $\boldsymbol{V}_g$ and envelope frequency ($= 2\nu_L$) of the escaping charge-beat, are established. By allowing sub-*h* and sub-*e* charge-beats in free space, a photocathode can release less than an electron, as one way to account for cases of short accumulation time. Alternatively the atom may be pre-loaded to hold partial kinetic energy to emit an electron with an arbitrarily short loading time. In a brilliant 1911 work of Planck[15] the threshold concept was applied to energy, but he did not extend this concept to action, mass and charge as I do here.[1] His derivation shows the threshold concept is consistent with his black body and zero-point energy theories.

Physicists have deciphered the individual constants h, e, and m_e only in experiments with atoms, as in the black body and Millikan oil drop experiments. Here, values, h, e, and m_e, are maximums at a threshold. In atoms, the heavier nuclear-waves being more particle-like in a solid state ensemble will balance the charges (make charge look quantized) and cause a stable threshold effect. In such experiments with equations that rely only on our thresholds, the Q ratios may not appear. However, in the case of the free charge-wave, our experimental equations exhibit these ratios: e/h in photoelectric and Aharonov-Bohm equations, e/m_e in J. J. Thomson's ratio discovery, and h/m_e in the Compton and photoelectric effects.

Here, the γ-ray was split to defy the photon in three geometries: (a) tandem detectors, (b) single detector analysis of sum peaks, and (c) scattering to two detectors. To preserve conservation of energy in the photoelectric effect, failure of the photon model implies either an accumulation of electron kinetic energy, or electrons are not at all like particles (or both). The above experiments and my derivation of the photoelectric effect offer guidance. This, along with the obvious, that the point electron model fails in diffraction and electron spin resonance, guides us toward the idea of adding properties to the charge-wave to explain the particle properties of matter as well as light. Planck[16] clarified in 1906 that $E = h\nu$ describes a property of matter, not light. Experiment and theory introduced here lead us to teachings similar to that of Planck[15] and Schrödinger**:**[17, 25] energy is absorbed in a charge-wave beat or envelope, continuously and selectively by resonators of similar frequency until they reach energy threshold $h\nu$. An $h\nu$ of electromagnetic energy is emitted in a burst, initially directed and coherent, but spreads classically.

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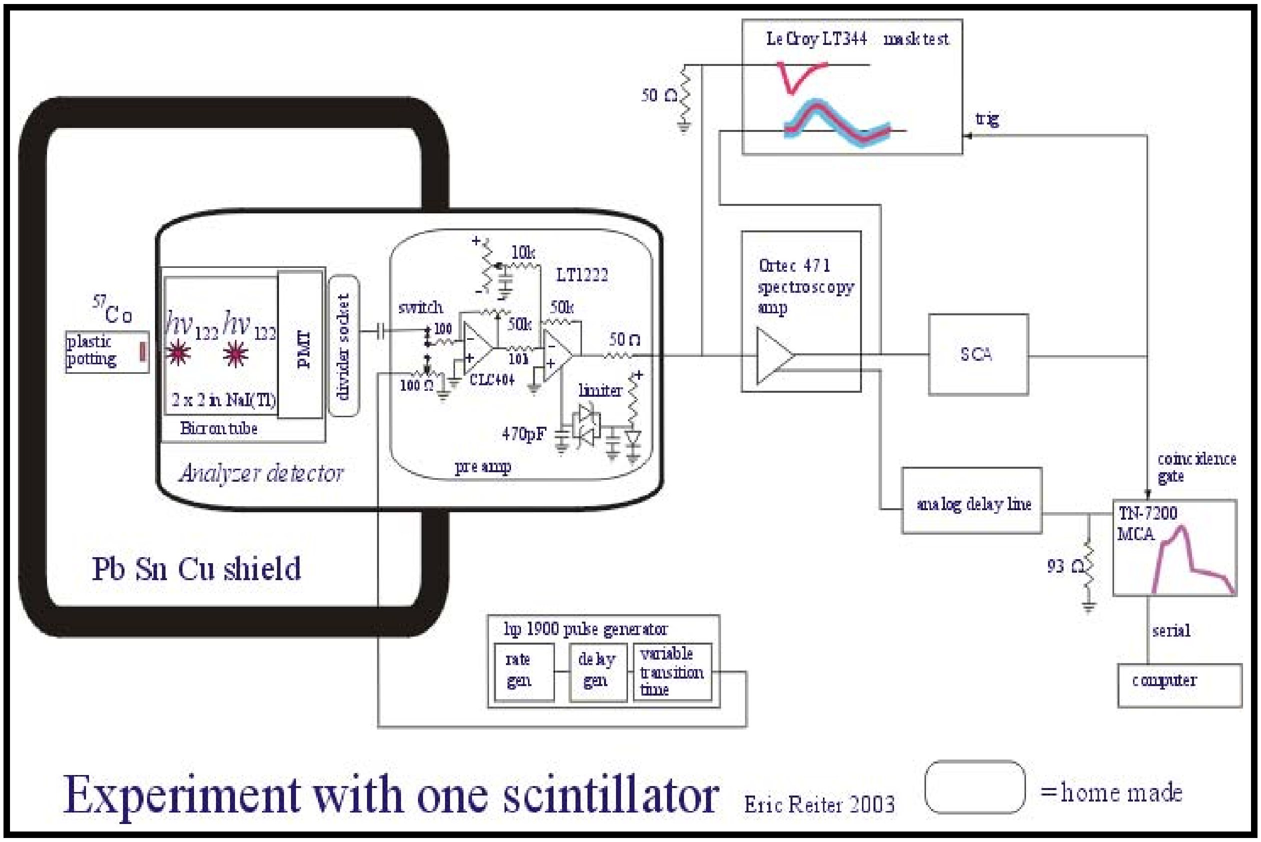
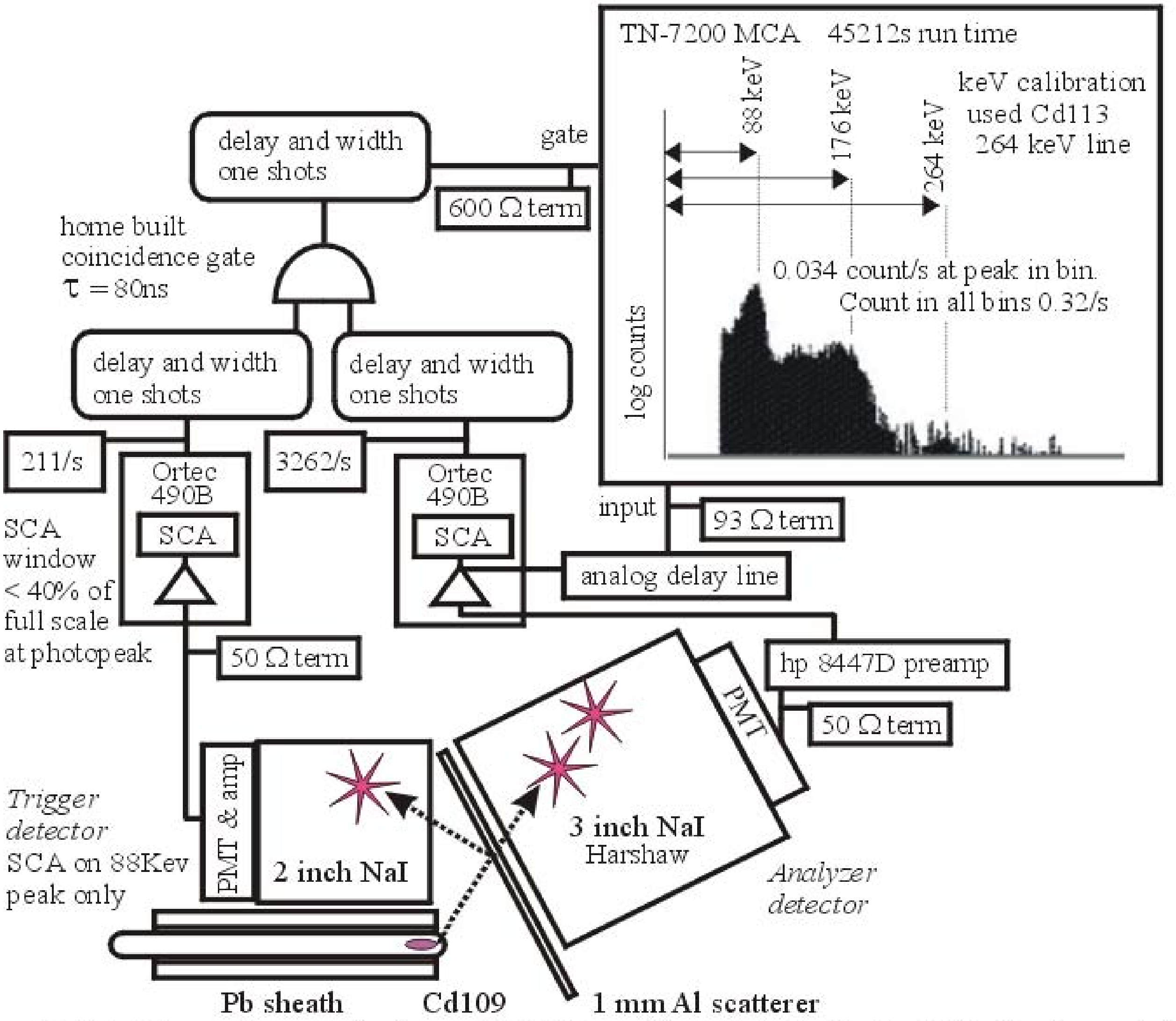
Supplemental graphics





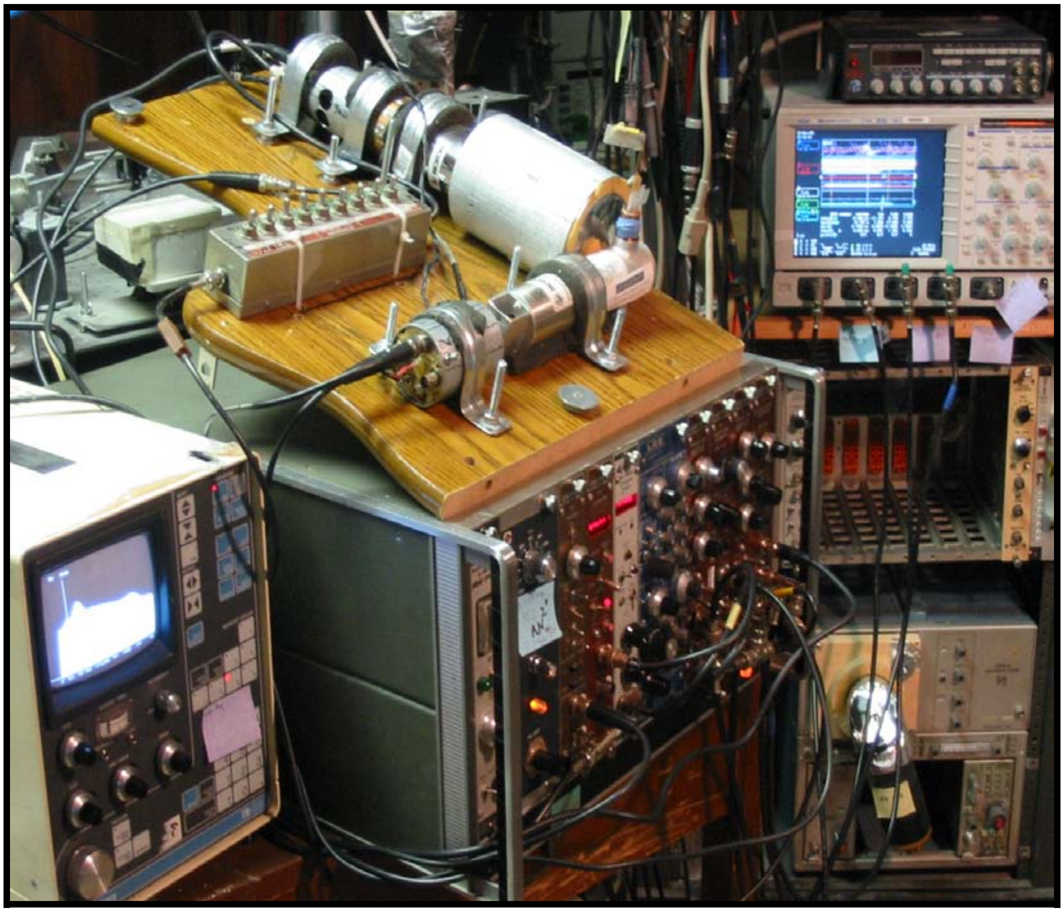
MCA video capture and setup of Cd109 read by a 3 inch dia NaI(Tl) detector gated in coincidence with a 2 inch dia NaI(Tl). Pb sheath and Pb blocks were present. If Pb fluorescence was at play it would also violate the photon concept. The spectral shape is similar to that obtained with my later experiment using an HPGe detector. Preamp in 2" PMT housing was home built. 3" NaI & PMT was assembled by Ken Kitlas. 2" is Bicron NaI/PMT. Experiment performed on July 26, 2002. This is only one of ~9 similar experiments done that week with similar results. Eric Reiter, Pacifica, CA

The peak at 176 KeV shows the sum-peak of one released gamma-ray causing two events in the 3” NaI in coincidence with a full gamma event in the 2” NaI detector. If it can split in two, it can split in three. This is my earliest evidence of the predicted multiplicity effect.

Shield now has two layers of lead bricks and another 3/4 inch of sheet Pb wrapped around the central part of the cylinder. It awaits inner liner of tin and copper. Materials were tested prior to construction to assure gamma emission did not surpass background. Fiberglass tape was used to hold it together during construction and remains inside and outside the layers of lead. It rests on a concrete cradle. I had to winch it on a cart from the garage to the lab. Fully assembled weighs ~800 Lb. Photo of January 5, 2003, Eric Reiter.

A portable gamma-splitting experiment in the lab.

This was used at the San Francisco Tesla Society meeting of December 14, 2003, the first public demonstration of the *unquantum effect*.



Detail of the Pb insert used for files MCA47 & MCA49. As seen on the right there was an inner 1mm thick insert with a 5 mm square hole and an outer 2 mm thick cylinder with a slit. The Co57 is embedded 2 mm from the end of plastic sample holder. I lathed down to 1/4 inch dia the original isotope holder from Spectrum Techniques . Photo of June 6, 2003. Eric Reiter