

evidence, a sound recording of the assassination itself that has been only recently turned up.

The photographic experiments were conducted by the committee's photographic panel of experts. They involved attempts to analyze camera "jiggle" in an effort to record what may well have been the startled reactions to gunshot.

The thought was that Zapruder may have reflexively moved his camera when he heard each shot. By measuring the intensities of blurs on a given frame, it was hoped that the timing of the shots could be indirectly pinpointed.

Dr. William Hartmann was in charge of what has come to be known on the staff as the jiggle analysis. Dr. Hartmann received a B.S. degree in physics from Pennsylvania University in 1961, an M.S. degree in geology from the University of Arizona in 1965 and Ph. D. degree in astronomy from the University of Arizona in 1966. He has been assistant professor at the University of Arizona Lunar and Planetary Laboratory, associate and senior scientist at the IIT Research Institute and currently is the senior scientist at the Planetary Science Institute of Scientific Applications, Inc.

Dr. Hartmann is a member of the American Astronomical Society and is the cowinner of the 1965-66 Ninniger Meteorite Award. He has written numerous professional articles and has served as an associate editor of the Journal of Geophysical Research. He has authored a planetary textbook and coauthored a book on the planet Mars.

Dr. Hartmann served as a photo analyst for the U.S. Air Force/University of Colorado study of UFO's and served as photo analyst and coinvestigator on the Mariner 9 mission to photograph Mars.

It would be appropriate at this time, Mr. Chairman, to call Dr. Hartmann.

Chairman STOKES. The committee calls Dr. Hartmann.

Sir, will you raise your right hand to be sworn?

Do you solemnly swear that the testimony you will give before this committee is the truth, the whole truth, and nothing but the truth, so help you God?

Dr. HARTMANN. I do.

Chairman STOKES. Thank you.

You may be seated.

The Chair recognizes counsel Gary Cornwell.

Mr. CORNWELL. Thank you, Mr. Chairman.

Dr. Hartmann, as a member of the photo panel, did you conduct photographic analysis in order to determine if there was any measurable reaction on the part of photographers who were taking pictures in Dealey Plaza at the time of the assassination which might be associated with the sound of gunfire?

TESTIMONY OF WILLIAM HARTMANN

Dr. HARTMANN. Yes.

Mr. CORNWELL. What theoretical reason or justification would there be for conducting that type of analysis?

Dr. HARTMANN. I think there are several possible justifications for it that add together.

First, psychological experiments have shown that there is a rather universal startle reaction, and interestingly enough, the

classic work on this published in 1939 used gunshots before unsuspecting witnesses as the source of the stimulus to cause the startle reaction.

Second, using a motion picture camera such, as Mr. Zapruder's camera and his film, is an ideal test for startle reaction, because the photographer is attempting to hold this camera still or pan very smoothly, so that any startle reaction would cause a disturbance of that smooth panning motion.

Third, then there would be a question, was the stimulus, the gunfire in Dealey Plaza, loud enough to cause such a startle reaction.

I was present on August 20 when the committee did some test firing with the rifle similar to the one believed to have been used, and I found, first of all, that this was a very loud noise, louder than I had suspected, and in fact I attempted to take some pictures simultaneously with the gunfire and found that in three out of three cases my pictures were blurred when they were taken with gunfire and not when they were taken at other times.

In fact I think my pictures were probably more blurred, showed a larger startle reaction than Mr. Zapruder's.

Finally, it is a reasonable investigation to undertake because we know that there are some episodes of blur in the Zapruder film as you watch it.

Mr. CORNWELL. When did you first undertake this analysis?

Dr. HARTMANN. It was proposed in February, but we did not undertake it until July when it began to be apparent to the committee that there might be data from the acoustic analysis with which we could compare it, so that we would have some independent information to compare with.

Mr. CORNWELL. Who did you work with in the analysis?

Dr. HARTMANN. Frank Scott, who is a photo scientist with Perkin Elmer, and Elmer was also a member of the photo panel, and he did an independent set of measurements on the same film.

Mr. CORNWELL. Did the procedures which were selected, were they followed both by you and Mr. Scott, the same procedures?

Dr. HARTMANN. No. We used separate procedures. We both made a series of measurements on the film, but each decided for himself what system might be best to record in a quantitative way these blurs or jiggles.

Mr. CORNWELL. Just very briefly, would you tell us what the differences were between the two approaches that you took?

Dr. HARTMANN. Briefly, I measured the amount of blur or smearing of the image in each frame of the film, one frame at a time, and what Mr. Scott did was to follow from one frame to the next the position of the camera, where it was pointed in the landscape, and to see how smooth that tracking was between one frame and the next frame.

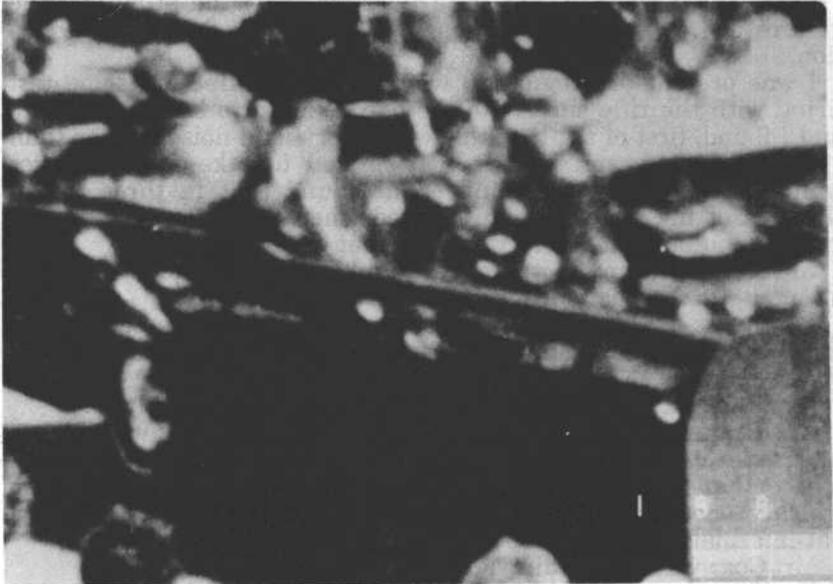
Mr. CORNWELL. So then would it be accurate to state that you measured the blur internally within the frame and Mr. Scott measured the blur which occurred between two frames?

Dr. HARTMANN. Yes, in a real sense mine is a measure of the blur while the shutter was open, and Mr. Scott's is a measure of the blur that occurred from the middle of the time the shutter was open on one frame to the time it was open on the next frame.

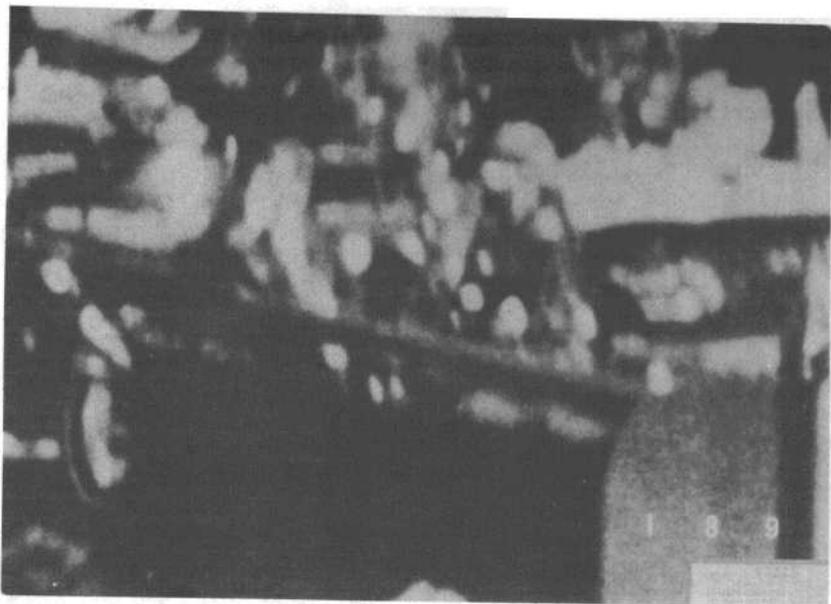
Mr. CORNWELL. I would like to show you exhibits F-224, 225, 226, and 227, which I believe have been previously admitted in this case.

The photographs correspond to frames 188 to 191 of the Zapruder film. I ask you if you would use those exhibits to illustrate first the technique which you applied.

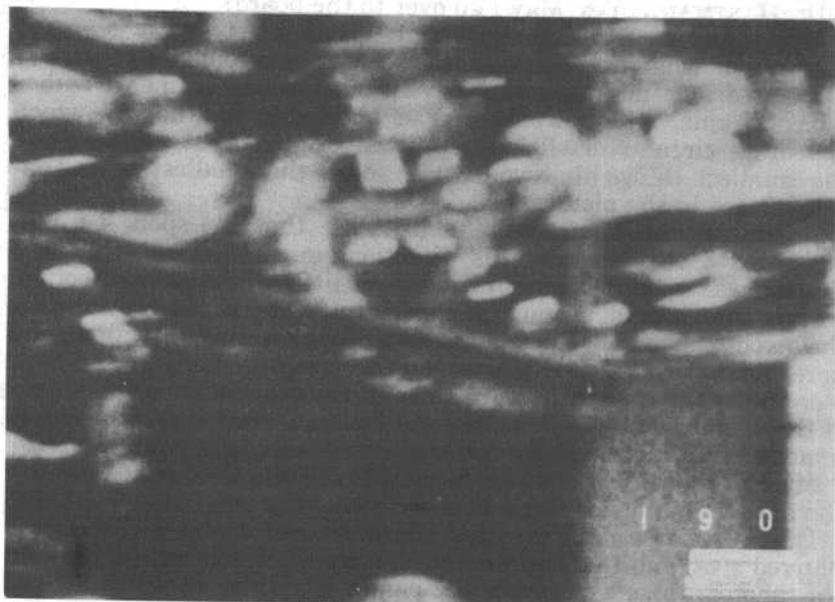
[The information follows:]



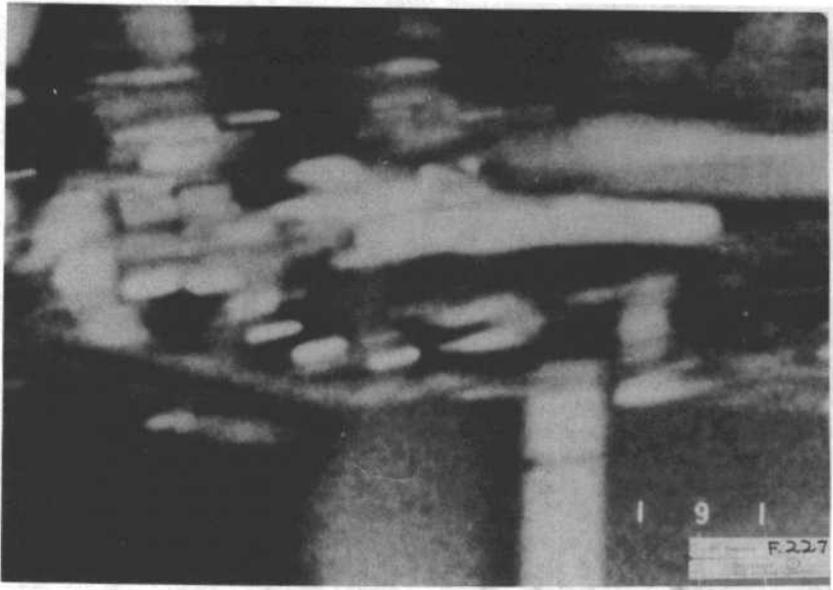
JFK EXHIBIT F-224



JFK EXHIBIT F-225



JFK EXHIBIT F-226



JFK EXHIBIT F-227

Dr. HARTMANN. Yes. May I go over to the board?

Now these are frames 188 through 191 in order and it is a good example of what can be done. These are enlargements of part of the frame, but here you see a reasonably sharp frame, a rather typical frame, and there are some highlights on the car which appear as circular or slightly elliptical bright spots. So these are the smallest things that you can resolve, the smallest spots that you can see in the picture.

On this frame, you may be able to see that the spots are now elongated a little bit in this direction, meaning that while the shutter was open, the camera moved a little bit in that direction.

Now the camera is moving considerably more violently during the exposure, and we have an elongation in this direction, and here, finally, frame 191, which is quite seriously blurred and is in fact one of the more blurred frames in the sequence. So the length of these spots can be measured from frame to frame, and that gives a measurement of what we call the blur or the jiggle.

Mr. CORNWELL. So it would be possible then, I take it, to quantify the amount of blur or jiggle in the frame.

Dr. HARTMANN. Yes, by direct measurement of the length of this blurred spot, and that, in essence, is a measurement of the error in the photographer's accuracy in panning on the Presidential car that went by.

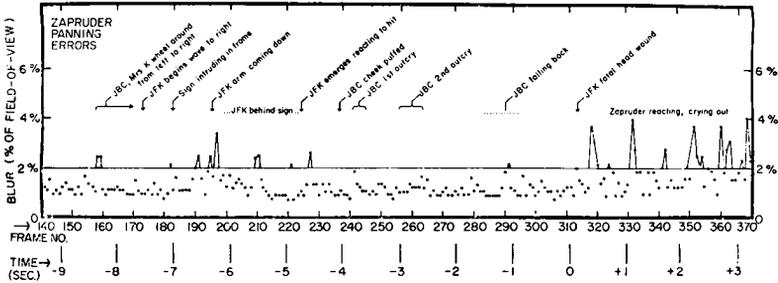
Mr. CORNWELL. I would like to show you JFK exhibit F-175 and ask you if you can identify that.

Dr. HARTMANN. Yes. This is a plot of the amount of blur that we measured by the technique I used on each frame.

Mr. CORNWELL. Mr. Chairman, at this time I would request that that exhibit be admitted into evidence.

Chairman STOKES. Without objection, it may be entered into the record at this point.

[The information follows:]



JFK EXHIBIT F-175

Mr. CORNWELL. Would you explain, Dr. Hartmann, what that exhibit illustrates or what it shows?

Dr. HARTMANN. Yes; I tried to plot the amount of blur. So the amount of blur is plotted in this vertical direction and it is expressed here in terms of the percent of the width of the field so that a blur right along here of this magnitude is about 1 percent of the width of the field. Up here it is about 6 percent of the width of the field.

These are the frame numbers. This is a running count of the time in seconds. I chose to use zero at about frames 310 to 311 because that would be the moment in essence when the man pulled the trigger on the gun. The bullet is seen to strike the head in 313, or the head is seen to explode at that time, so zero can be considered one known gunshot time.

Now each dot is a frame. And if you asked for a threshold and said are there any blurs greater than 6 percent, let's say, well, there would be none. And if you start to lower your threshold, coming down to about 4 percent, we start to pick up a blur. This one is frame 330, and as we come on down, we pick up more blurs.

Well, of course, if you go too low, you are getting into basically noise, just the ordinary jiggle, and we don't want to clutter up our analysis with looking at the ordinary jiggle. So I arbitrarily chose a threshold, and to make it a little bit clearer, drew a line here, and any jiggles or blurs or errors in panning that stick up above that line then are outlined with solid lines to make them clearer. So there are some patterns, or clusters of jiggles, which may be response to some sort of stimulus.

Mr. CORNWELL. I would like to ask you, if you could use the blackboard now which is behind you, and illustrate for us, if you would, Mr. Scott's analysis.

Dr. HARTMANN. Yes; he reasoned as follows: Suppose the car is coming by and the photographer is following the car precisely. He would be aiming his camera at the middle of each exposure as the

shutter opens and closes and opens and closes at a series of points which would be arranged in a nice smooth line and relatively equally spaced.

Now if any stimulus or any cause made him jiggle the camera or jerk the camera, we would have this pattern of regular pointing spots going on, and then perhaps, let's say, the camera moves in a downward direction. And so in the first case, we would have a line of points like that, but in the second case, a line like this, and this would betray an irregularity in the panning on the Presidential car.

Mr. CORNWELL. I would like to show you now JFK exhibits F-371, 372, and 373, and ask you if you would tell us what those are.

Dr. HARTMANN. I might just comment also, as that is being set up, that a way to express this measurement quantitatively and in a similar fashion to the other diagram would be to say that at this particular frame the photographer should move, in the next frame, he should move to this position, but, in fact, we discover that he has moved down here, so that this distance is a measure of the error. So it is possible to convert these into a set of quantitative measurements of the error. This is essentially a method known as just vector subtraction between these two lines.

Yes, and these are, first, an explanation of his method and enlargement of one sequence of frames in the fashion that he measured them and his entire sequence of measurements.

Mr. CORNWELL. So referring to JFK exhibit F-373, that is the entire sequence of the frames in the Zapruder film beginning at what point and ending at what other point.

Dr. HARTMANN. Yes; these run from in the 130's, when the Presidential motorcade comes around the corner, all the way to the 390's, as it disappears.

Mr. CORNWELL. And, would it be accurate to state that, JFK exhibit F-372 is simply a blowup of one portion of 373?

Dr. HARTMANN. Yes, it is; it is the first portion.

Mr. CORNWELL. May we have these three exhibits admitted into evidence, Mr. Chairman?

Chairman STOKES. Without objection, they may be entered into the record.

[The information follows:]

PANNING OR JIGGLE RECORD OF ZAPRUDER FILM

EXPLANATION

IF ZAPRUDER PANNED HIS CAMERA PERFECTLY, THE JIGGLE RECORD WOULD LOOK LIKE THIS:



IF ZAPRUDER PANNED HIS CAMERA PERFECTLY, EXCEPT FOR A RAPID MOVEMENT WHERE HE MOVED HIS CAMERA DOWNWARD, THE JIGGLE RECORD WOULD LOOK LIKE THIS:



IF ZAPRUDER PANNED HIS CAMERA PERFECTLY, AND MAINTAINED GOOD HORIZONTAL PANNING BUT DID NOT PAN SMOOTHLY, THE JIGGLE RECORD WOULD LOOK LIKE THIS:



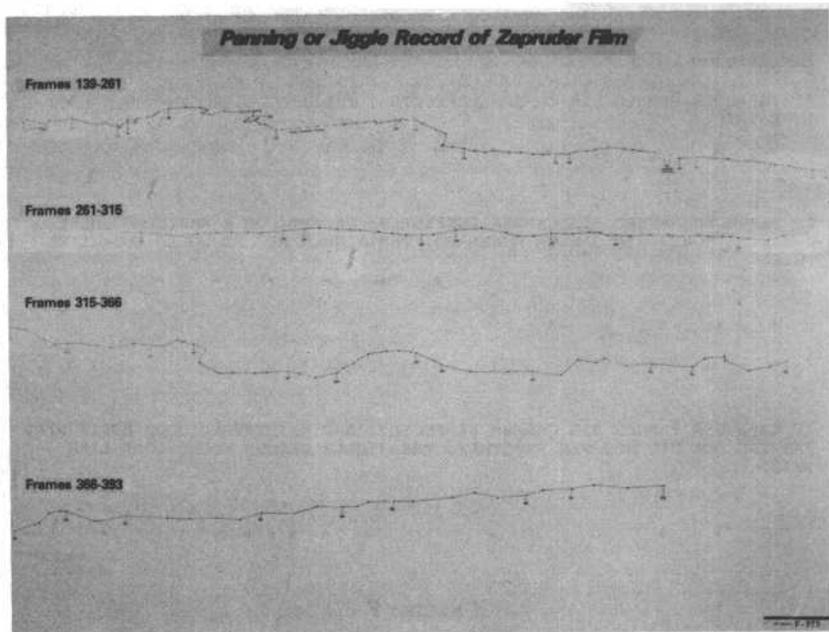
JFK EXHIBIT F-371

ZAPRUDER FILM

FRAMES 139-208



JFK EXHIBIT F-372



JFK EXHIBIT F-373

Mr. CORNWELL. Dr. Hartmann, referring to the center JFK exhibit F-372, would it be accurate to state that the blowup there illustrates that at some points in the film Mr. Zapruder in fact doubled back instead of going forward with his panning as you would expect?

Dr. HARTMANN. Yes. There is a slight doubling back, and I would just caution that there are different types of panning errors. In other words, there is this type that I sketched here. There is the type where you actually double back, but there is the type where you are going along in a straight smooth direction and suddenly move a great distance in this direction, all right, just to the right in the same direction, but by more than you should have, so that that produces a line, a straight line, still, and yet there is a very large error here. So don't be fooled into thinking that the only reactions or jiggles are the places where the line gets tangled. There may be some reactions in places where the line is spaced out by more than the usual amount.

Mr. CORNWELL. As the exhibits were being put up, you stated that you could quantify the results of the technique applied by Mr. Scott, the same as the technique that you had applied.

I would like at this time to show you JFK exhibit F-176, and ask you if you can identify that.

Dr. HARTMANN. Yes, sir. This is the same type of plot that was done with the set of measurements I made. The set of frame numbers are along the bottom and the amount of jiggle or blur plotted for each frame.

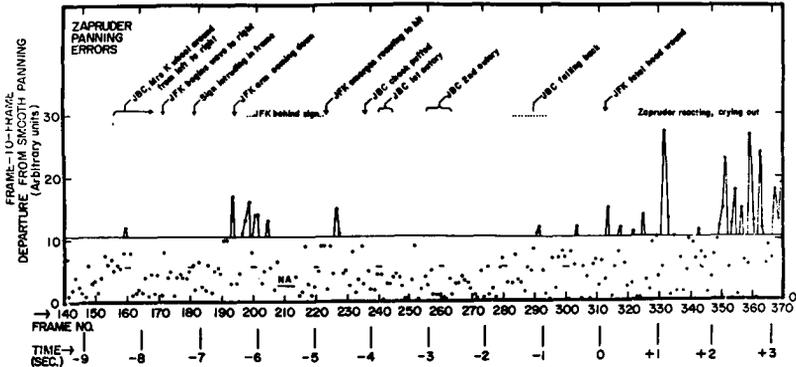
Mr. CORNWELL. In this case it relates to the Scott technique?

Dr. HARTMANN. Correct.

Mr. CORNWELL. We would ask at this time that that exhibit be placed into evidence, Mr. Chairman.

Chairman STOKES. Without objection it may be entered into the record.

[The information follows:]



JFK EXHIBIT F-176

Mr. CORNWELL. Now, in addition to the two approaches you have described, are you aware of any other way in which jiggle might be measured?

Dr. HARTMANN. Yes. The physicist, Luis Alvarez, has in 1976 published in the American Journal of Physics an analysis of the same film using a third method, and that method was basically to take the set of blurs similar to what I described first, what I was quoting in my method, and his reasoning is as follows: That if the blur, if the amount of blur stays the same from one frame to the next to the next, then essentially nothing is happening. But if there is a sudden change in the amount of blur, then that is a sensitive measurement of a disturbance. And so what he plotted was the difference in blur from one frame to the next. So that is a third set of measurements.

Mr. CORNWELL. When did you first become aware of Dr. Alvarez—

Dr. HARTMANN. That paper was circulated to us on the photo panel some months ago, but I purposely did not study his results until I finished mine and Scott's.

Mr. CORNWELL. I would like at this time to show you exhibit 177 and ask you if you can identify that.

Dr. HARTMANN. Yes, sir. This is an analysis or a plot showing all three sets of information on the same time scale now. So, for the first time we have a chance to really compare what the three independent and different types of measurements show, the same boxes here with the same set of frame numbers and the same timings, and, incidentally, I have noted some events as they happen along the sequence in the film, just to give you a reference to what is happening in the motorcade.

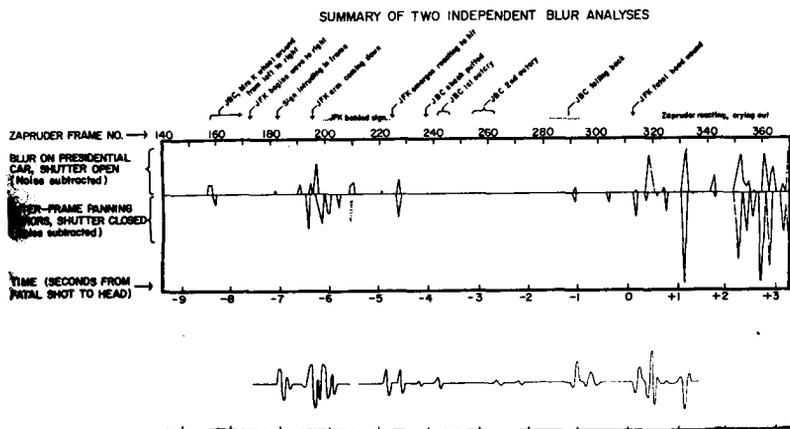
Now above the little line are the peaks, the greatest blurs that were measured by my technique, this is taken directly off that earlier graph. Below the line is just a flipped over image of the blurs or jiggles measured by Mr. Scott's technique, and I think you

find some pretty good agreement there. And then down at the bottom in red has been added directly, hand-copied from Alvarez's graph published in his paper, the set of measurements that he made, and, incidentally, they jiggle in both directions because he kept track of either what he called a positive blur in one direction or a negative in the other direction, so his are a kind of a squiggle, and ours are just motions up or down.

Mr. CORNWELL. I would like at this time, Mr. Chairman, to ask that JFK exhibit F-177 be admitted into evidence.

Chairman STOKES. Without objection, it may be entered into evidence at this point.

[The information follows:]



JFK EXHIBIT F-177

Mr. CORNWELL. Dr. Hartmann, can you tell us, from the analysis that you have just described, precisely when the shots were fired?

Dr. HARTMANN. Well, in my opinion, if you look only at this record of blur, in spite of the fact that there is pretty good agreement, it would be very difficult to say that a particular episode of jiggling here, a particular set of blurs, is the response to a gunshot.

The question is, we believe, that if there was a loud gunshot, there probably was a startle reaction. But there could have been other kinds of reactions that would cause jiggles, just false alarms. And so on the basis of looking just at the blur, I would say no.

However, if we then look at the photo visual evidence of what is happening in the parade, I think we can begin to identify some of these as gunshots.

Mr. CORNWELL. Would you explain that if you could in relation to frame 313—

Dr. HARTMANN. Yes.

Mr. CORNWELL [continuing]. Where the gunshot occurred?

Dr. HARTMANN. That, in particular, is perhaps the most significant one, where we know that there has been a gunshot. And we see that there is a very strong episode of this jiggling initiated at that time. The lapse time the jiggles begin—of course one has to define how do you detect when the jiggle really begins?

And perhaps the best way is to go, is to look at the frame group from when the jiggle initiates to when it reaches a maximum. In this case that is about 313 to 319. The shot was probably fired at 310, as I mentioned before, and that number of frames is consistent with the measures of startle reaction time that were reported in the book that I mentioned. So I think that is a good confirmation that we are really seeing here the reaction to both the sound of the gunshot and probably the visual sight of what happened on that shot.

Mr. CORNWELL. And would it be accurate to state that the second largest area of blur or jiggle, apart from the one which occurred shortly after the head shot, would be in the earlier portion of the film?

Dr. HARTMANN. That is correct.

Mr. CORNWELL. What frame is that associated with?

Dr. HARTMANN. About frames 190 to 200 there is a strong blur reaction initiated. So having concluded that this is in fact, that the blur sequence around 313 to 319 is in fact a response to the gunshots, I would think that the logical inference would be that the blur sequence, the blur episode, running typically from 190 to 200 is also a response to a possible gunshot. And we know that the President emerged from behind the sign somewhat later, some frames later, showing in fact a reaction to such a wound. So this could very well be the blur or startle reaction to the gunshot that caused the back wound to the President.

Mr. CORNWELL. And what, if any, corroboration is provided by this analysis to the Warren Commission's conclusion that the President and the Governor may have been shot in the vicinity of frame 210.

Dr. HARTMANN. Yes, they picked 210. I would say that to pick 210 in the face of this current evidence, to pick 210 as the time for that first shot, which is the Warren Commission's conclusion, would not be warranted from this evidence, because the blur before frame 210, from 190 to 200, is clearly much larger than any blur after frame 210. In fact, there is really very little evidence for a blur in the appropriate amount of time after frame 210.

Furthermore, there is some photo evidence that tends to support the thought of a shot in the time frame shortly before 190. For example, there is the Phillip Willis photograph which shows Mr. Zapruder in the background and the motorcade passing in between. Because the motorcade is in between, it is quite possible, quite easy, to determine exactly which Zapruder frame that corresponds to, because you can tell which part of the motorcade is passing between Zapruder and Willis. And Willis said that he took that photograph as a reaction. He pressed the shutter as a reaction to what he perceived as the first shot, at least a shot.

Well, it turns out that that frame is 202. So that means that Mr. Willis is telling us that he pressed the shutter as part of his reaction to a shot, and he was reacting at frame 202, while here we see that Mr. Zapruder is in the middle of his reaction at frame 202. So that is very nice consistent evidence that something happened, say, at 190 or shortly before 190.

Mr. CORNWELL. Mr. Chairman, I was incorrect earlier when I stated that JFK exhibits F-224, 225, 226, and 227, the Zapruder

film blowups, had been previously admitted into evidence. I would at this time ask that they be admitted into evidence.

Chairman STOKES. Without objection, they may be entered into the record at this point.

Mr. CORNWELL. I have no further questions.

Thank you, Dr. Hartmann.

Dr. HARTMANN. Thank you.

Chairman STOKES. The committee will defer questioning of this witness until later this afternoon after the committee has had the advantage of hearing the acoustical evidence, which will come into the record shortly.

Sir, we will defer our questioning of you until later this afternoon.

Dr. HARTMANN. Thank you.

Chairman STOKES. Thank you.

The Chair recognizes Professor Blakey.

STATEMENT OF G. ROBERT BLAKEY, CHIEF COUNSEL

Mr. BLAKEY. Thank you, Mr. Chairman.

In September 1977 the committee learned of the existence of a Dallas police tape, one that had recorded the sounds of the assassination from the transmitter of a motorcycle policeman who had accidentally left his microphone switch in the on position.

There was immediate hope that by scientifically enhancing the tape, the sound of the shots could be made audible.

The committee was told by the Dallas Police Department that it thought that all of its assassination evidence had been turned over to the FBI. It did not therefore have a copy of the tape. One was obtained, nevertheless, from Mary Ferrell, a critic who lived in the city of Dallas.

The committee then set out to find an acoustical consultant to analyze the tape. After consideration of five possible candidates, the committee picked the firm of Bolt, Beranek & Newman of Cambridge, Mass.

Bolt, Beranek & Newman can count among its many important forensic accomplishments an analysis of the tape-recorded sounds of the Kent State shooting incident in 1970 and the discovery and analysis of the 18-minute gap in the Watergate tapes.

B.B. & N. first analyzed the segment of the radio program, "Four Days that Shocked the World," that had been believed to have covered the assassination. As it turned out, it was not contemporaneous with the actual shooting of the President.

The committee then forwarded the tape it had obtained from Mary Ferrell to B.B. & N., but no audible sounds could be discerned in the analysis.

Meanwhile, committee investigators working on the case in Dallas were in contact with Paul McCaghren, a retired assistant police chief who had been assigned to a special Dallas police assassination investigating squad.

McCaghren was one of several Dallas police veterans who donated their firsthand knowledge of the city to the committee. They "read us into their backyard," so to speak, as one of our investigators so aptly put it. Their help has been invaluable.