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William W.Moses, MS 55-121
Lawrence Berkeley Laboratory
1 Cyclotron Road
Berkeley, CA 94720

Dear Bill:

Some enclosurea as follows that may be of interest -

1. First SSCS - Program and list of attendees at what we retroactively designated the First Scintillation and Semiconductor Counter Symposium, University of Rochester, July 22 & 23, 1948.

2. 2nd Annual Meeting - Copy of cover of program brochure for "2nd National Annual Meeting of the PGNS," Sept 1955, Oak Ridge, TN

Question - who knows about the First?

3. 9th Annual Meeting - Copy of cover of program brochure for "9th National Annual Meeting of the PGNS," October 1962, Detroit, MI.

4. 10th Anniversary (Annual) Meeting - Copy of cover of program brochure for "Tenth Anniversary Meeting - IEEE PTGNS," October - November 1963, San Diego, CA.

5. 11th NSS - Program for 11th NSS, October 1964, Philadelphia, Pa

NOW TO PAUSE AND REFLECT -

Item 5, the 11th NSS, was the first of our "annual meetings" to be designated the NSS and to refer to them by the year rather than by numerical sequence.

FAST FORWARD TO 1972

6. 1972 NSS - Program brochure for 1972 NSS of the IEEE Nuclear Science Group, Miami, FL, December 1972

7. 1973 NSS - Copy of cover and first pages of Program brochure for 1973 NSS of the IEEE Nuclear and Plasma Sciences Society, November 1973, San Francisco, November 1973.

NOW TO PAUSE AND REFLECT ONCE AGAIN -

The 1973 NSS program brochure was the first to list the IEEE Nuclear and Plasma Sciences Society as the NSS sponsor.

AND NOW FAST FORWARD TO Y2K and LYON

Best wishes,
Louis Costrell

NIST

Persons invited to conference at

University of Rochester
July 22 and 23, 1948.

*	Ahern	Bell Labs
	Allen	University of Chicago
*	Axel	University of Illinois
*	Barry	Eastman Kodak
*	Bell	Oak Ridge
*	Bleuler	Purdue
*	Conchine	Naval Radiation Lab (San Francisco)
*	Corson	Cornell
*	Costrell	Bureau of Standards
	Crane	University of Michigan
	Dana	Union Carbideand Carbon
*	Deutsch	M.I.T.
*	Goodal	G.E.
*	Glover	RCA
	Hanchett	RCA
*	Higginbotham	Brookhaven
*	Hofstadter	Princetcn
*	Jordon	Oak Ridge
*	Kuper	Brookhaven
*	Lawson	G.E.
*	Liddel	Office of Naval Research
	Lyman	University of Illinois
*	Madansky	Brookhaven
*	McKay	Bell Labs
	Moon	University of Chicago
	Morton	RCA
	Parkinson	University of Michigan
*	Ridd	Brookhaven
	Rainwater	Columbia
	Seitz	Carnegie Tech
	Sevick	Wayne University
	Sheerer	Columbia
	Street	Harvard
	Ulrey	RCA
*	Van Heerden	Harvard
*	Wakefield	Radiation Counter Lab
*	Webb	Eastman Kodak
	Wiedenbeck	University of Michigan
	White	Bell Labs
*	Whittemore	Harvard
	Wilson	Cornell
	Sands	MIT

* Attended conference. Several of the others listed also attended but I do not know their names.

CONFERENCE ON SCINTILLATION COUNTERS AND CRYSTAL COUNTERS

Sponsored by the Office of Naval Research, the Atomic Energy Commission, and the University of Rochester

Held at Rochester, New York, July 22 and 23, 1948

These notes are prepared for the convenience of those who participated in the conference. Much of the information was presented through informal discussion, and we are attempting here merely to summarize the remarks which were made. These notes have not been submitted to the various speakers for correction, and any errors are the responsibility of those at the University of Rochester who compiled this summary.

On July 22 the conference concerned itself primarily with scintillation counters, and on July 23 with crystal counters.

SCINTILLATION COUNTERS

Summary of Present Status

Dr. Collins (University of Rochester) opened this part of the conference with a summary of the present state of scintillation counters.

The term 'scintillation counter' is used to describe the method of detecting high-energy ionizing particles which employs a phosphor and a photomultiplier tube. An experimental arrangement suitable for detection of high-energy particles is shown in Figure 1.

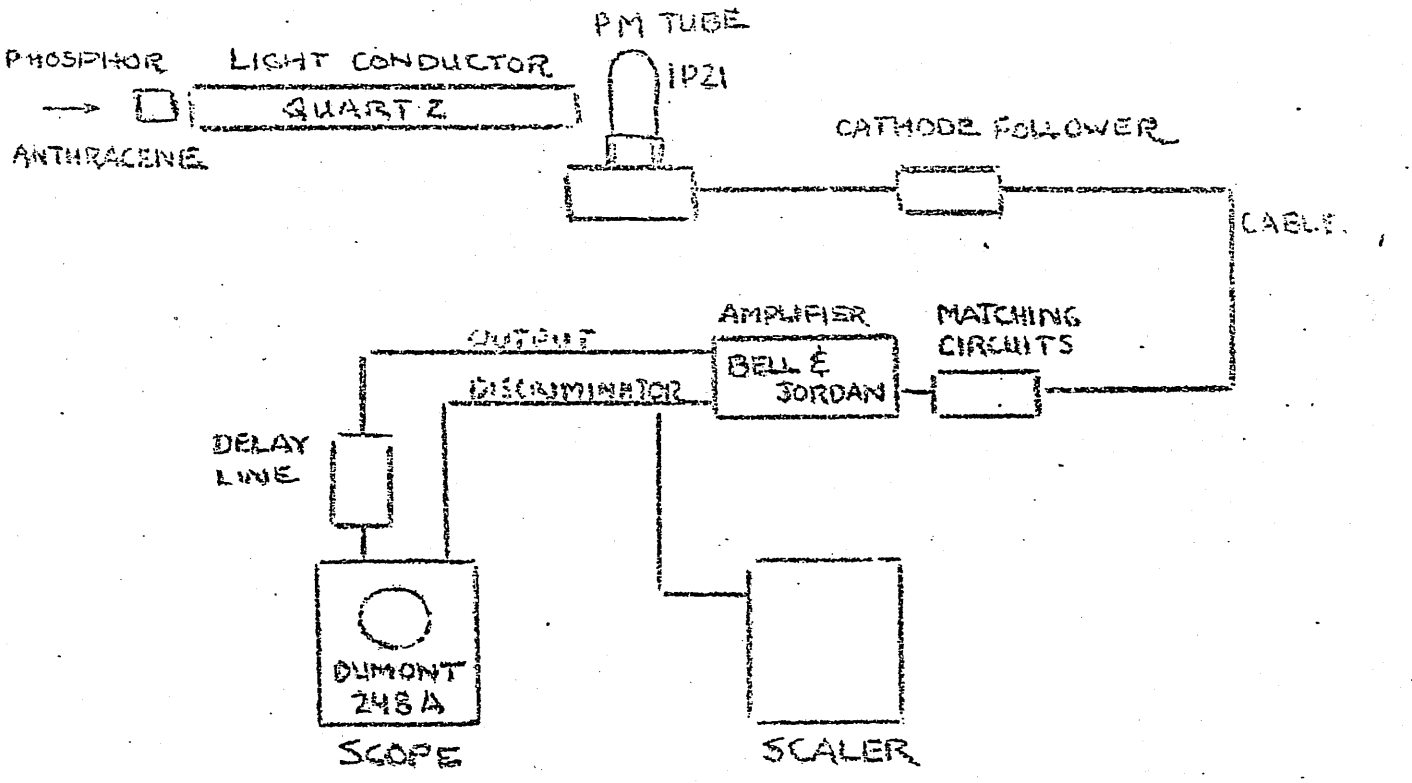

Fig. 1

Some of the reasons why scintillation counters are useful follow:

They are sensitive. α-particles and β-particles with energies greater than 0.1 Mev are counted 100%, and gammas at energy 1 Mev are counted with an efficiency at least as large as what one would expect from the Klein-Nishina formula.

They are fast. The resolving time would seem to lie between 10^{-7} and 10^{-8} seconds if suitable phosphors are used. There is no dead time.

There is hope that they may be made reasonably proportional particularly for heavily ionizing particles. Data have been obtained which indicate as well that a distinction can be made between gamma rays at different energies.

They are versatile. Since the phosphor can be separated from the photomultiplier tube, particle counting can be effected in strong magnetic fields and in restricted spaces. Furthermore, the counting volume can be made very small and the background reduced proportionately.

Lastly, these counters seem to be reliable, relatively simple, and to have a long life.

The main shortcomings seem to be (a) they will not measure low-energy particles; (b) large counting volumes seem impractical; (c) 10^{-8} seconds would appear to be the lower limit for time resolution.

The characteristics and functions of the main components of the system illustrated in Figure 1 are:

(1) Phosphors

A very wide variety of phosphors has been investigated. So far these fall into 2 categories: (a) organic (b) inorganic. Organic phosphors seem always to consist of benzene ring compounds. Light emission from these phosphors takes place in a time less than 0.2 microsecond, and they are sensitive to both α and β-particles. Anthracene seems to be as good an inorganic phosphor as any, although phenanthene, pyrene and picene are quite effective. Inorganic phosphors seem in the main to consist of activated transparent salts. With the possible exception of fluorite, they all have decay times greater than 0.2 microseconds, and in general show far greater response to α-particles than to β-particles. An important characteristic of phosphors is that they be available in large, transparent blocks.

(2) Light conductors

Except for very small size phosphors, light piping appears to be superior to conventional optical systems using lenses and mirrors. The light pipe must subtend a large solid angle at the source, must transmit in the near ultraviolet, must deliver the light to a sensitive surface of dimensions 1 cm x 2 cm located within the photomultiplier tube. It is also required that the conductor not itself act as a phosphor under high-speed particle bombardment.

Lucite, quartz rods and a quartz tube filled with oil of high index have been used successfully. All three substances scintillate weakly when bombarded with α-particles. The scintillations are, however, very weak in intensity and few in number.

The efficiency of several systems has been tested using a ZnS screen under α bombardment and using as a measure of light intensity the 1P21 photo current. The following results were obtained for 3/4" diameter clear cast Lucite rod.

Screen at tube envelope	100%
2" of Lucite	85%
12" of "	60%
47" of "	20%

From these data we conclude that the transmission factor is .967 per inch and that we have a geometrical factor (solid angle) of .9.

Mineral oil in a 3/4" diameter quartz tube gave 50% for 12". Solid quartz rod diameter 15mm gave 70% for 12". Further investigation of quartz is now in process.

(3) Photomultiplier tubes

This tube is the heart of scintillation counters and only the high photosensitivity and high gain of the tube make this method possible.

Noise resulting from thermally emitted electrons from the cathode is troublesome if weak scintillations are to be detected. This noise can be greatly reduced by cooling the tube to CO_2 or liquid nitrogen temperatures. If selected 1P21's are used in conjunction with anthracene phosphors, noise is, however, not objectionable in the detection of 1 Mev quanta even at room temperatures. The variation in the characteristics of 931A's or 1P21's is perhaps the most serious objection to these tubes. The duration of the current pulse at the plate of these tubes is determined by the decay time of the phosphor and not by the characteristics of the tube. If care is taken to keep the capacity of the anode circuit small, voltage pulses as high as 5 or 10 volts may be obtained by raising the accelerating potential to values above 100 volts per stage. Very reliable operation can be obtained with plate voltages which give voltage outputs of around 0.1 volt.

(4) Amplifiers

In view of the relatively high voltage of the output pulse of the photomultiplier tube, a large fraction of the gain band width product associated with amplifiers can be devoted to band width.

Below is a table showing the amplifier gain necessary for various purposes assuming an input signal of 0.1 volt.

	Gain
For oscilloscope requiring 50 volts	500
For pulse height selector requiring 10 volts	100
For coincidence circuits " 5 "	50
For counters requiring 1/4 volt	2.5

Phosphors

Mr. P. R. Bell (Oak Ridge) gave a short discussion of his research on both organic and inorganic phosphors.

Fluorite was tested; weak pulses were detected in several specimens. Selected pieces produced pulses half the amplitude of those of anthracene when using a 1P21 tube, and, upon substituting an ultraviolet-transmitting 1P28, the pulses exceeded those of anthracene (~ 2x). Several other minerals were tested with negative results. Synthetic white sapphire gave only very feeble pulses.

In addition to napthalene and anthracene other organic materials were tried. Fluorene and fluoranthrene did not exceed anthracene. A discussion of phenanthrene followed. Dr. Deutsch (M.I.T.) stated that he had found phenanthrene to be as efficient as anthracene with the 1P21 and better (~2x) with the 1P28. Some doubts as to ease of crystallization were expressed; the melting point of phenanthrene is less than that of anthracene.

A strong temperature dependence was noted for the organic phosphors, although the effect was not too strong with napthalene and anthracene. Lowering the phosphor to dry ice temperature enhanced the pulse height with napthalene (and anthracene). At liquid nitrogen temperature napthalene was superior to anthracene, thus reversing the room temperature relation. It was suggested that lowering the temperature might change the emission (fluorescence) range of the phosphors.

Mr. Bell reported NaI activated with 1% thallium responded with pulses larger than anthracene by a factor of about 2 but was of seemingly longer decay time. He estimated the decay time as about 0.4 - 0.5 μsec. Cooling to dry ice

temperature decreased pulse size and increased decay time to ~ 1 μsec. Use of NaI with 10% Tl impurity showed noticeably decreased pulse size and increased decay time compared to 1% Tl activated NaI.

It was remarked that anthracene responded several times better to 1.3 Mev β's (Co^{60}) than it did to 5.3 Mev α's (Po). The ratio was even larger with naphthalene. Low energy electrons did not behave as well in naphthalene.

Mr. Bell reported that Harshaw Chemical Co. was engaged on a Bureau of Ships contract to crystallize anthracene in large quantities; it is unknown whether large crystals can be secured from them commercially.

Dr. Hofstadter (Princeton) discussed the thallium-activated alkali halides. Absorption curves of the various halides were reproduced (see bibliography note). The curves showed sharp absorption peaks in the ultraviolet region. It was suggested that both KI and NaI are transparent to their own emission in the longer wavelength ultraviolet region.

In preparing samples of the alkali halides for research Dr. Hofstadter first places the powdered NaI (for instance) in a quartz tube sealed at one end and with a necked extension on the other. With vacuum pumping applied, the tube is heated by torch until the powder melts. Additional amounts of powder may be put in upon cooling the tube. After the correct amount of a halide is melted down and solidified, the required amount of thallium compound is inserted (in this case TlI). The tube is heated (while pumping) until fusion of the enclosed mass results, the neck is sealed and the tube cooled slowly. The fluorescence (excited by Tesla coil) was pinkish at high temperatures; at low temperatures it was blue.

By leaving the crystal mass in the sealed tube, possible hygroscopic damage to the crystal was avoided. At less than 30% relative humidity no damage was reported to exposed crystals over a long period. The possibility of using polystyrene dope to protect the crystal was suggested. "Vycor" tubing might also be used in place of quartz tubing. Boric acid seemed to act as a flux, and larger crystals were produced by its use, although the effectiveness of this boric acid in neutron detection is unknown.

An estimate of the decay time of NaI was 0.3 - 0.5 μsec. NaI gave larger pulses than anthracene (~2x) but it seemed to be slower than anthracene.

Dr. Hofstadter agreed that the 25% "efficiency" in counting incident γ-ray quanta reached by most experimenters could not be reconciled with theory using the Compton effect alone. In discussion, the 25% figure was called high

by factors of 2 to 4. The possibilities of false pulses within the tube, secondary emission, secondary electrons from shields, etc., or multiple counts from the amplifier with very strong pulses were mentioned.

To show the possibilities of differentiating between particles of different energies the scintillation counter was subjected to radiation from several sources with this resulting curve.

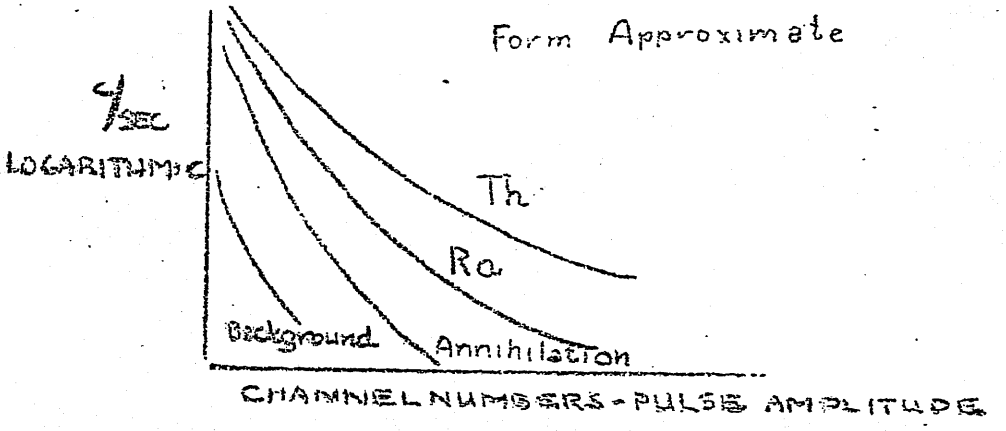

Fig. 2

By use of a spectroscope and photographic plate, the regions of fluorescence of NaI, KI and napthalene were found as each was bombarded by suitable radiations (Ra). NaI and KI had wide bands of emission in the range 4000-4800 A° with a peak ~ 4200 A°. Napthalene fluoresced chiefly in the region 3300-3400 A°. It was suggested that this method of detection might be used to advantage (especially with strong sources of radiation where the averaging effect of the photographic film might be useful).

Dr. Hofstadter used voltages on the 1P21 tube in the range 400-600 volts.

The advantages of the ten-channel discriminator in ease of securing data was mentioned.

In summary: KI gave even smaller pulses than napthalene, while NaI gave larger (2x) pulses than anthracene. (Anthracene is estimated at 3-5 times napthalene) The alkali halides have the advantage of comparatively high density (~ 3.5) compared to the organic phosphors (~ 1.2) but the alkali halides seemingly have longer decay times than the organic phosphors (0.3-0.5 μsec. compared to 10^{-7} - 10^{-8} sec. for anthracene). All decay times are estimated.

Dr. Baker (Cornell) reported that a group at Cornell had undertaken to get a value of the absolute efficiency of anthracene. A model 501 amplifier was used with a 1P21 tube at liquid air temperature. The excitation was a semi-collimated beam of 4 Mev α-particles.

By stimulating with light, a value for the mean pulse height corresponding to single electrons from the cathode was obtained for comparison with pulses from the α-particles. A value of 20 photoelectrons per α-particle for the absolute efficiency of anthracene was obtained. By use of a clipping circuit only electrons emitted in the same 0.1 μsec. were counted.

Dr. Baker stated that in looking for a phosphor to count neutrons he had taken a mixture of ZnO and $NaBO_4$ with a trace of Mn salt and heated the mixture just under the melting point of $ZnBO_4$. A dirty powder resulted. This powder glowed under radium irradiation. The absolute efficiency was about the same as that of anthracene; its efficiency as a neutron counter and its speed were not known.

Dr. Condit (Naval Radiation Defense Laboratory, San Francisco) reported that he had investigated the temperature dependence of several phosphors.

Zinc sulfide showed no appreciable temperature variation from liquid air temperature to 50°C. The temperature variation was greater with the thinner films of ZnS. Bombardment was with α-particles.

The counting rate vs. temperature curve for napthalene is as follows:

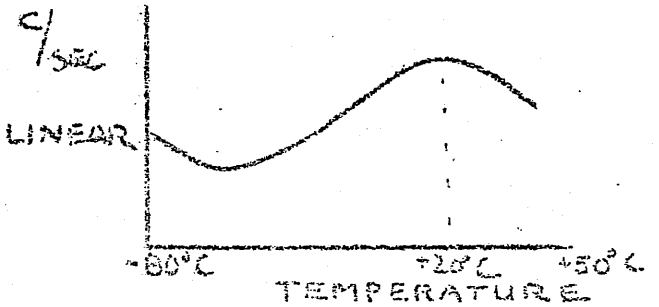

Fig. 3

Maximum variation in counting rates was about 2 to 1 over the graph.

A corresponding curve for anthracene showed a peak of maximum response occurring at about room temperature.

It is important to note that the curves were taken at a fixed discriminator setting. The discriminator was set at room temperature to exclude all pulses less than about 2 times noise. The curves were all reproducible as to form. A 931A tube at 900 volts was used. The whole assembly, tube and phosphor, was cooled. Radiation was from a radium γ source for naphthalene and anthracene.

Photomultipliers

Dr. Glover (R.C.A.) opened the discussion of photomultiplier tubes by remarking that the 931-A, which had a gain of about 12000 when introduced ten years ago, now consistently has a gain, at 100 volts per stage, of 10^5 to 10^7. There is, however, still a variation in gain among 931-A's of as much as 100 to 1. The best 10% of the 931-A's are selected and offered for sale as 1P21's. The criteria used in this selection are cathode emission, dc dark current, which must be less than 0.1μa for an anode-cathode potential difference of 1000 volts, signal-to-noise ratio, which should be about 10-1, and freedom from residual gas. Dr. Glover pointed out that while gas may lower the signal-to-noise ratio of a tube at high voltages, a gassy tube may, at lower voltage, actually have a larger ratio than one free from gas. This behavior is shown in the accompanying graph (Fig. 4).

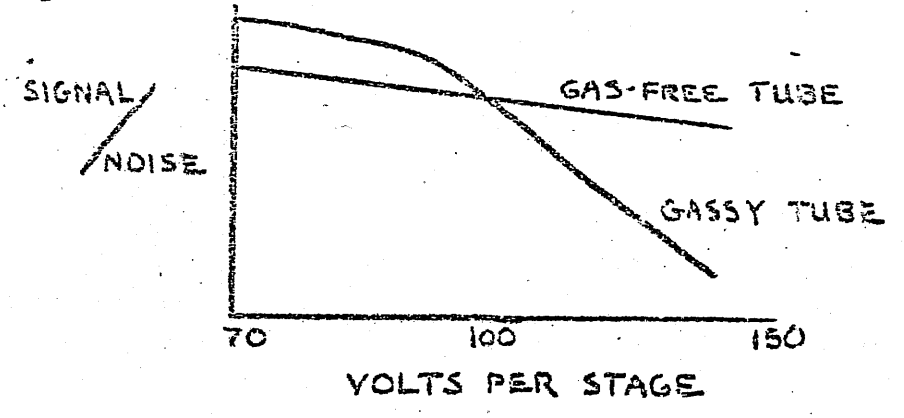

Fig. 4

The signal-to-noise ratio is also strongly temperature dependent, as is well known. A change in temperature from +80°C to -180°C may lower the signal output less than 2 db, while increasing the signal-to-noise ratio as much as 40 db.

Since the Brookhaven conference last year, the following changes have been made in the design of the 931-A: The mica sheets which support the tube elements have been replaced by unlaminated ceramic discs; this makes the tube free from random pulses due to caesium vapor occluded in the mica. The black bakelite base has been replaced by a low-leakage, non-hygroscopic micanol base.

colored other than black to date the tubes since January, 1948. A new cathode surface, two or three times as sensitive as the old, has been provided.

The best photosensitive surfaces known, according to Dr. Glover, have efficiencies of 120 μa/lumen, at 2870°K, (i.e. about one electron for every three quanta), and peak response between 3700 and 4500 A°. The highest efficiency available in commercial tubes is 90 μa/l in the 929. The best 1P21's give about 50 μa/l, with the average about 20.

It was suggested by P. R. Bell and others that the solid angle subtended by the cathode at the phosphor could be made larger if the tube had a plane window placed close to the grid. It was also suggested that a reflecting cylinder surrounding the cathode would direct some of the divergent light from sources outside the envelope back on to the cathode.

There is currently available an experimental tube, the C7132, which has a 2" transparent window in the end of the tube. Behind this is an electron focussing ring and ten amplifying stages. The cathode efficiency is 10-20 μa/l. While this tube satisfies somewhat the requirements of larger solid angle, it necessarily has a larger thermal ion current than the 931-A.

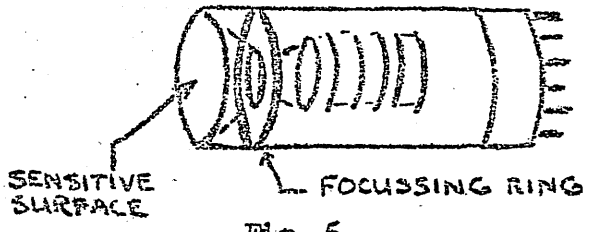

Fig. 5

Dr. Glover pointed out that the noise of a mediocre tube could often be greatly reduced by placing about the tube a metallic shield in intimate contact with the envelope and several hundred volts negative with respect to the anode. The best tubes are not much affected by this procedure. The improvement is thought to be due to a decrease in secondary electron emission from the envelope.

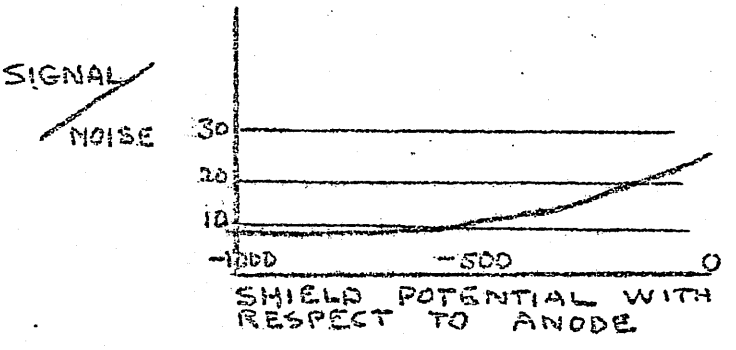

Fig. 6

It was pointed out by Dr. Deutsch and Mr. Bell that photomultiplier tubes may be operated at voltages well above the rated voltage if cooled to liquid air temperatures.

Proportionality

Dr. Rozalie Hoyt (University of Rochester) discussed the possibilities of phosphors as proportional counters, and presented an analysis in which the effects of the phosphor and those of the photomultiplier on pulse height distribution were separated as far as possible.

If α is the gain of the photomultiplier, β the number of photoelectrons released at the cathode per primary particle incident on the crystal, and Y the number of electrons arriving at the anode per primary particle, then

$$\bar{y} = \bar{\alpha}.\bar{\beta}$$

Further, the fractional mean square deviation is given by:

$$\frac{\overline{\gamma^2} - \bar{\gamma}^2}{\bar{\gamma}^2} = \frac{\overline{\beta^2} - \bar{\beta}^2}{\bar{\beta}^2} + \frac{1}{\beta}\,\frac{\overline{\alpha^2} - \bar{\alpha}^2}{\bar{\alpha}^2}$$

or,

$$\sigma_\gamma^2 = \sigma_\beta^2 + \frac{1}{\beta}\sigma_\alpha^2$$

$\sigma_\gamma^2, \sigma_\alpha^2$ are observed, and σ_β^2 calculated by using the above formula. Measuring the distribution in pulse height for Polonium α's bombarding ZnS, Dr. Hoyt found $\sigma_\alpha^2 = 0.11$, or about 33%, $\sigma_\gamma^2 = 0.08$, or about 30%. For $\beta = 30$, this gives $\sigma_\beta^2 = 30\%$. This results in the observed distribution in pulse height shown in the graph (Fig. 7). It is evident that if β can be made fairly large, fluctuations in the gain of the photomultiplier become unimportant, and the distribution in pulse height is due almost entirely to the phosphor.

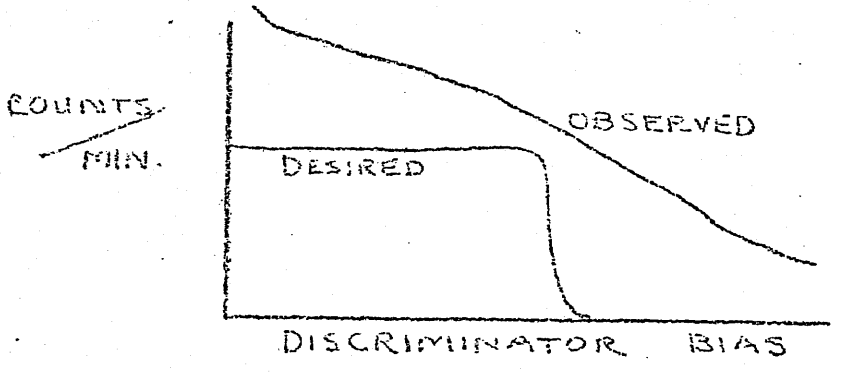

Fig. 7

Dr. Martin Deutsch remarked that σ_p^2 has been reduced in some cases by irradiating smaller areas of the crystal, indicating that the crystal may be less regular than it appears.

Bibliography

Phosphors:

P. R. Bell, Phys. Rev. 73, 1405 (1948)

M. Deutsch, Nucleonics 2, No.3, 58 (1948)

R. Hofstadter, Phys. Rev. 74, 100 (1948)

R. J. Moon, Phys. Rev. 73, 1210 (1948)

Photomultipliers:

R. Engstrom, J. Opt. Soc. Amer. 37, 420 (1947)

Parallel-Plate Geiger Counter

The parallel-plate Geiger counter as a high resolution counter was covered in the report of Drs. R. W. Pidd and L. Madansky (Brookhaven). By applying a potential to fixed parallel plates and then passing an ionizing particle between the plates it was possible to get sparks to drive a delay line and give 1000 volt pulses to a scope for direct observation.

The rise time of the pulse was less than they could measure; the resolution time seemed less than 10^{-8} second and it was felt that lifetimes of 10^{-9}-10^{-10} second might be measured. Unfortunately the dead time is large. With Au, Al, and Pt electrodes the dead time was ~ 0.1 second; with Pb the dead time in several instances was about 0.001 second, and in one instance, with a Pb-Sn mixture, a dead time of 0.0004 second was observed.

The spacing between plates was about 1mm. Operating potentials were 1000-3000 volts. Typical operating conditions were a potential of 2000 volts and a pressure of 3 atmospheres of argon. An electronic quench circuit and a quench gas (butane) were used. Variation of the spacing and pressure in the counter did not greatly affect the characteristics.

The avalanche region in the parallel plate Geiger counter is the whole counter and the efficiency is of course limited by the probability of getting sufficient ion pairs to initiate a spark.

CRYSTAL COUNTERS

Summary of Present Status

Dr. Platt (University of Rochester) summarized the present status of crystal counters as follows: A number of insulating crystals have been discovered which show pulses of conductivity when bombarded by ionizing radiations. Such crystals can therefore be used as solid ionization chambers with techniques analogous to those developed for gas ionization chambers. A typical block diagram of a counting setup is shown (Fig. 8):

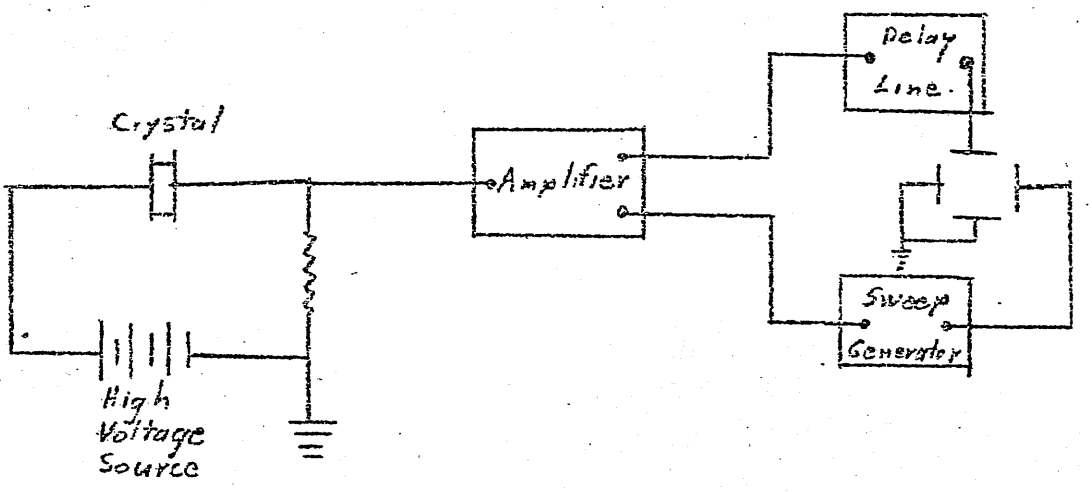

Fig. 8

A representative chain of events might involve a charged particle losing 1 Mev in the crystal, giving rise to 10^5 electrons free to move in the conduction band. If these electrons all move completely through the crystal and the capacity of the crystal and input circuit is 20 mmf., the input voltage pulse is of the order of a millivolt. The linear amplifier should then have a voltage gain of 10^4 to 10^5, in order to have an output signal of the order of tens of volts for display on the oscilloscope screen or for accurate amplitude discrimination.

One might hope for the following desirable qualities in a crystal counter:

1. Large stopping power. Since the crystal is a solid which may be of fairly high atomic number, the energy absorbed per unit volume from a beam of ionizing radiation is larger than can be obtained with devices using gas.

2. Fast response and fast rise time of the voltage pulse. For accurate coincidence or timing measurements, many experiments require the voltage pulse to rise within 0.5 microseconds of the ionizing event, and 10^{-9} seconds is an enticing goal.

3. Fast recovery time, to make possible high counting rates.

4. Proportionality - the amplitude of the voltage pulse should be proportional to the energy lost in the crystal.

5. Long lifetime, or reproducibility - the response to identical events should not change with the number of counts or the time of day.

6. Simplicity.

The following crystals have been reported to count:

1. Silver chloride
2. Silver bromide (added to list by Dr. Hofstadter of Princeton)
3. Thallium bromide
4. Thallium bromide-thallium iodide mixture
5. Diamond
6. Zinc sulphide
7. Cadmium sulphide

Of these, the first four are ionic conductors at room temperature and have therefore been used at liquid nitrogen temperature. The remaining three have been used at room temperature.

Silver Chloride Counters

Mr. Whittemore (Harvard University) reported on experiments done by Mr. Voorhees and himself, working with Dr. Street. The silver chloride crystals were obtained from Harshaw Chemical Company, and were used in pieces 5 mm thick and perhaps an inch in diameter. These crystals were carefully annealed, and electrodes were applied by painting the sides with glyptal, developing silver

surfaces on the faces with photographic developer, and then removing the glyptal with glyptal solvent. It was found essential to clean all traces of grease from the crystals to avoid arcing. The crystals thus prepared were satisfactory with voltage gradients up to 4500 volts/cm.

Mr. Whittemore investigated the proportionality of a silver chloride counter, using cosmic ray mesons. An array of Geiger tubes and absorbers was used in conjunction with the crystal counter, such that pulses were recorded when a cosmic ray meson passed through the crystal and then through a known thickness of absorber. The absorber thickness was first adjusted to record mesons passing through the crystal with the velocity of minimum ionization. One can calculate for such mesons the probability of a given energy loss in the crystal (there is considerable spread because of the small number of ionizing collisions involving large energy transfer). The observed number of pulses at each amplitude were compared with this calculated curve. The agreement was within statistical error except for a small low energy tail in the observed results. The absorber thickness was increased to record mesons 15% above minimum ionization, and the agreement with the predicted curve was again excellent. The experimental results for the two meson energies were clearly resolved.

Mr. Whittemore calculated from his data the energy required to free one electron in silver chloride, and obtained the figure 7.8 electron volts/electron. This is in excellent agreement with the value found by Dr. van Heerden in his original work on silver chloride. The amplifier used in Mr. Whittemore's work is the Los Alamos Model 100, with a rise time of 0.5 microsecond. When the voltage across the crystal was reduced to 750 volts, some pulses were observed having rise times slower than that of the amplifier. From this one calculates an electron mobility of around 1500 cm^2/volt-sec. The uniformity of the crystal was investigated by using Geiger counters of area smaller than the crystal to limit the area of the crystal used. Some 15% of the crystal was found to give poor response. This inferior area may explain the low energy tail mentioned above.

Mr. Voorhees' experiment measured the lifetime of the μ-meson. A coincidence-anticoincidence array of Geiger tubes was used to trigger an oscilloscope sweep when a meson was stopped in the crystal. The delayed amplifier output from the crystal was displayed on the sweep, which was of 6 microseconds duration. Scope photographs show both the pulse due to the meson and the pulse from the decay electron; the rise times (Los Alamos Model 500 amplifier) are about 0.2 microseconds. The meson lifetime obtained is 2.3 ± 0.5 microseconds.

The Harvard group finds that the performance of some silver chloride crystals can be improved by gamma irradiation at liquid air temperature, with no applied voltage. One crystal showed an improvement of some 15% in counting rate at a given discriminator setting after 3 hours exposure to a radium gamma source at 11 milliroentgens/hr. After warming to room temperature and recooling the

improvement disappeared but no deterioration was observed. Gamma irradiation at room temperature definitely does damage the crystal. These results are consistent with the theory that at low temperatures irradiation fills up electron traps, while at room temperature silver centers are formed in the crystal.

Dr. R. Hofstadter (Princeton University) reported on work done by his group.

1. Growing of AgCl Crystals

Originally this group worked with AgCl crystals obtained commercially. However, it was found that there was very little reproducibility in results for these crystals, even after the most identical treatment possible. Consequently this group grew their own crystals. All the crystals so produced are really polycrystals, made of single crystals with dimensions of 1 to 2 mm on a side. (The crystal boundaries were quite visible in reflected light.)

The crystal growing is done in 1" diameter pyrex tubes which are turned or pulled down on one end to a cone with a 30 to 45 degree angle. The tube is filled with AgCl powder and lowered into a tubular furnace, the middle temperature of which is 450°C. When the AgCl powder melts it is greatly reduced in volume, consequently the tube is refilled two or three times.

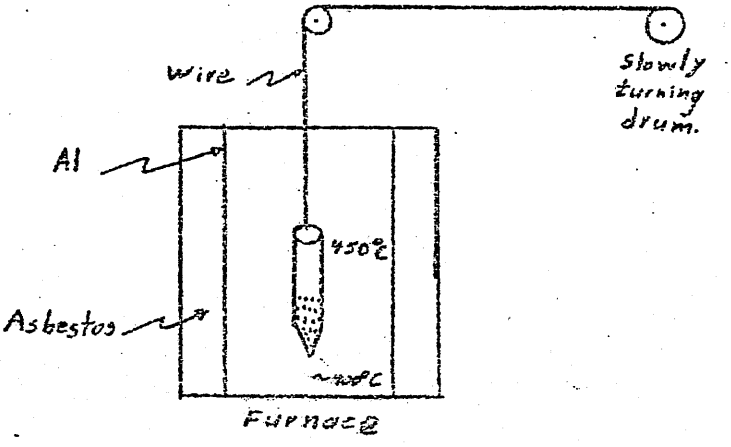

Fig. 9

The tube is lowered a few inches in 24 hours, or even more slowly. The best crystals were obtained if the cooling process lasted 5 days.

The crystallization process is a purification process also, and therefore pure AgCl powder is not necessary. The purer crystals are formed at the bottom—the impurities come to the top.

After the crystals are formed the tube is removed from the furnace and the crystals cut to the desired thickness with a glass saw. It is not necessary to remove the crystal from the tube before this. These crystals are necessarily 1" in diameter, but it is entirely possible to grow larger ones.

The crystals are then ground smooth and platinum electrodes are sputtered on two sides, using the method described in Strong's "Procedures in Experimental Physics". The crystal is then annealed at 400°C. The growing, cutting, and sputtering can be done in daylight, since the annealing process removes any darkening.

The Princeton group does its annealing in the crystal chamber itself, and therefore the crystal does not have to be touched or moved after annealing. It is also possible to view the crystal with crossed Nicols while the annealing is taking place. This is the best way to make sure the annealing process removes all the strains in the crystal.

Photographs had been obtained showing the strain patterns of several crystals. It was reported that the strain pattern did not change essentially with repeated warming and cooling of the AgCl crystal (from 77°K to room temperature).

2. Mobility

Rise times were measured as a function of applied field for several commercial AgCl crystals, and also for AgBr crystals. For the AgBr crystals, if the reciprocal rise time in microseconds^{-1} is plotted against the applied field, the graph has the following form:

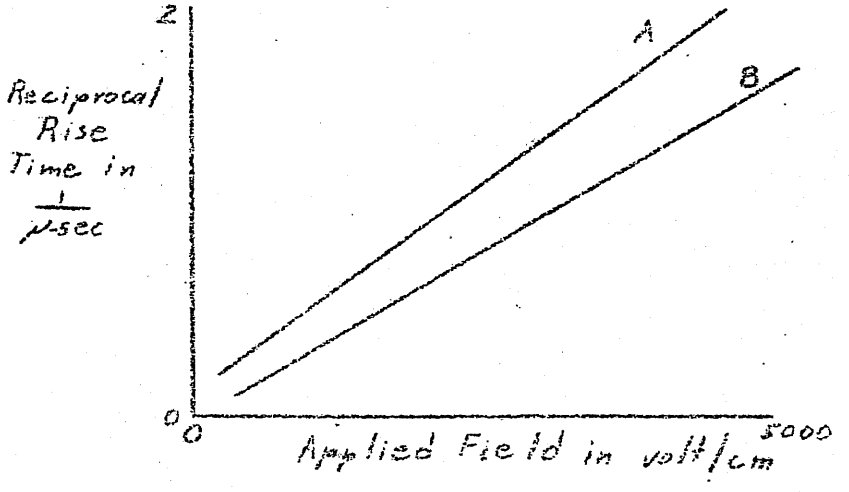

Fig. 10

The mobility is evaluated from these curves. Curve A is for a 0.55cm. AgBr crystal, and ν = 252 cm^2/sec-volt. Curve B is for a 0.8 cm AgBr crystal, and

ν = 223 cm^2/sec-volt. The calculated value for AgBr (from the Mott-Froelich theory) is about 240 cm^2/sec-volt. On the one experimental value of ν reported for AgCl, a value of 159 cm^2/sec-volt was obtained for a 0.4 cm crystal. There is no existing explanation of the discrepancy between the experimental and calculated values of ν for AgCl, since any imperfections in the crystal (trapping centers, etc.) would give a higher experimental value of ν.

In the measurement of the efficiency of the AgCl crystals, this group reported values varying between 7 and 8 ev per ion pair. The efficiency of AgBr was measured to be 7 ev per ion pair.

3. Polarization

Assume we have a crystal of thickness l and α-particles incident on the left face of this crystal, which has no trapping planes.

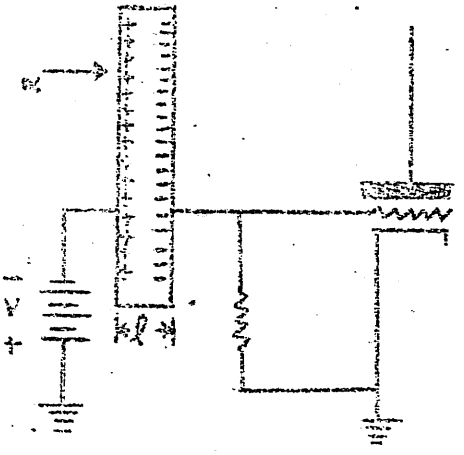

Fig. 11.

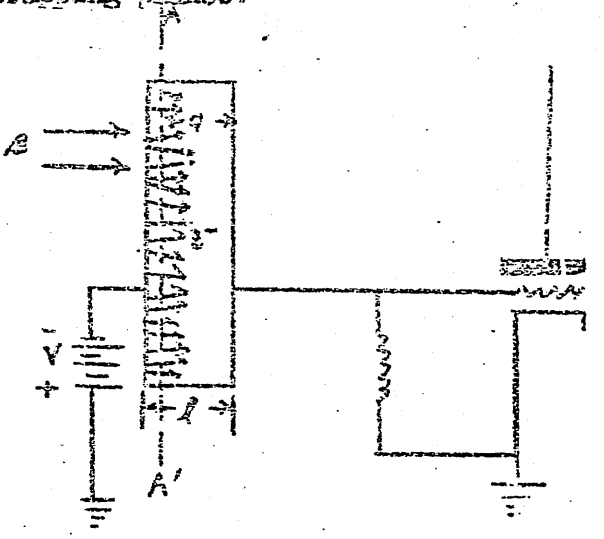

Fig. 12

Assume also that the α-particles penetrate only a very small distance into the crystal. Therefore the electrons are released in a thin sheet of the crystal on the left. The field these electrons experience inside the crystal is V/l. As the electrons produced by the α-particles leave the thin sheet on the left the battery compensates for any gradual change in potential. Hence one expects no polarization with α-particles. (See Fig. 11.)

Suppose now instead there are incident on the crystal 2 Mev β-particles. These penetrate 2 mm into the crystal (see Fig. 12). The positive charge left by the ejected electrons we shall assume to exist in a sheet AA', 1 mm from the left side. Since the positive charges do not move, the field inside the crystal changes,

the effective field now being:

$$E_{eff} = \frac{V}{t} - \frac{4\pi\sigma'}{K}\left(1 - \frac{x}{t}\right)$$, where

σ' = surface density of charge on the sheet

K = dielectric constant of the crystal

x = distance of plane AA' from right hand side of crystal

σ' is known if the number of charges incident on the crystal is known. For a crystal 1 cm, 0.5 cm thick, and with P^{32} β-particles incident, it takes 500,000 particles to reduce the pulse size to half its initial value.

Any vertical trapping plane would act just as the sheet AA' above.

4. Dr. Berry (Eastman Kodak Co.) reported that large single crystals (1 cm in diameter or larger) had been grown by the method of van Heerden. The method of determining the mosaic structure of these crystals is to etch slowly and polish at the same time by rubbing the crystal on filter paper soaked in a non-acid hypo. The surface is then examined in reflected light for crystal boundaries.

Thallium Halide Counters

Dr. Hofstadter remarked that he had observed counts with thallium halide crystals (particularly with a sample of a mixture of TlI and TlBr, prepared by Harshaw Chemical Co. and recrystallized at the Bureau of Standards) but that no extensive work had been done on these crystals.

Diamond Counters

Dr. McKay (Bell Telephone Laboratories) described work which he had been doing to investigate the conductivity in diamond under electron bombardment. He used a specimen of diamond transparent in the ultraviolet to around 2200 A°. Electrodes were applied to opposite faces of the diamond; one face was connected to the amplifier input and the other to a source of AC voltage. An electron gun was used to bombard the diamond with a beam of electrons of a fraction of a milliampere intensity, energy variable from zero to 20 Kev, in five microsecond pulses. These pulses were timed to occur at both the positive and the negative peak of the AC crystal voltage. In this way persisting polarization effects are avoided: on the positive half cycle electrons move through the crystal, building up negative space charge by trapping, and on the negative half cycle the same process occurs with the positive holes, which move in diamond, so that an

essentially space charge neutral crystal is obtained.

The amplitude and shape of the pulses were observed as a function of the crystal voltage and bombarding voltage, for both the positive and the negative half cycles. The amplifier and oscilloscope used had an overall rise time of about 3 x 10^{-8} seconds. Typical pulse shapes are shown

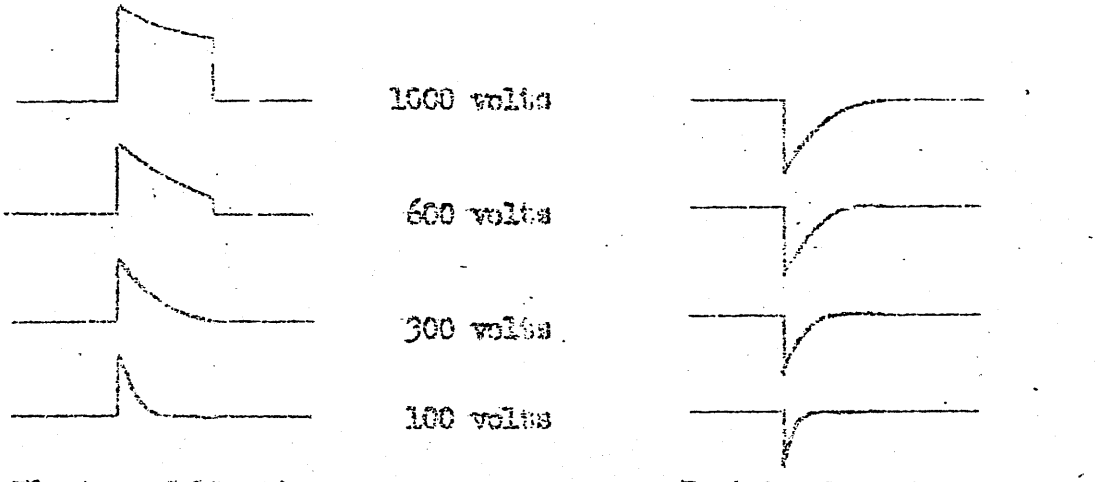

Fig. 13

The "droop" of the pulse should be expected because of the buildup of space charge during the pulse duration; from the shape of the pulses it appears that the positive holes have a much shorter mean range than the electrons. Assuming (1) a homogeneous distribution of trapping centers, (2) no saturation of traps, (3) no space charge due to trapped electrons, (4) no recombination, (5) a trapped electron stays trapped, (6) drift velocity less than thermal velocity, (7) the motion of positive holes can be neglected, then the amplitude of the leading edge of the pulse when collecting electrons should be proportional to the quantity

$$\Omega\left(1 - e^{-\Omega^{-1}}\right)$$

where $\Omega = \frac{w}{l}$

l = thickness of crystal
w = mean range = vFt
v = mobility
F = field strength
t = mean time before trapping

A plot of experimental values of this amplitude vs. field strength was in good agreement with the relation above except for small values of the field strength, where the discrepancy may be due to space charge building up in a time short compared to the rise time of the amplifier.

From this plot the mean range was evaluated as a function of field strength. Assuming Seitz' calculated value of 156 cm^2/volt-sec. for the electron mobility in diamond at room temperature, the mean time before trapping was found to be 3.8×10^{-8} seconds. This sets an upper limit to the rise time of the voltage pulse due to an ionizing event in diamond; 0.04 microseconds after the event the electrons are no longer in motion. Dr. McKay calculated from his data that it takes about 10 ev to release one electron to the conduction band in diamond. He also observed that after several months of intensive bombardment his diamond gave the same response that it initially did.

Dr. Ahearn (Bell Telephone Laboratories) reported on the use of diamonds as crystal counters for the detection of polonium α-particles. In his best diamonds he also obtains about 10 ev per electron released to the conduction band, or one half million electrons collected per polonium α-particle; this signal was about fifty times noise for his setup. He found wide variations between diamonds; the best counted most of the α-particles incident, 17% of those examined gave no detectable response under α-bombardment, and the majority of the diamonds were intermediate in performance.

Dr. Ahearn was unable to correlate the counting characteristics of these diamonds with price, color, fluorescence under ultraviolet irradiation, or transparency to ultraviolet light. Some diamonds which counted were examined for strain; they were strained. Some diamonds with flaws counted well.

One diamond which counted well was investigated using a collimated source of α-particles giving a beam about 0.2 mm^2 in area. Counting rates were obtained as a function of position on the diamond face, and were found to vary from 0 to 100% of the α-particles/sec. incident. The best counting area coincided with a flaw in the diamond; it was suggested in discussion that perhaps local strains had been relieved in this region.

He had also obtained a curve of counting rate vs. field strength in the diamond, counting pulses above a given amplitude. The fraction of α's counted rose smoothly from zero to around 70%. The conclusion is that the trap densities must vary widely; if this density were constant, when any α-particle gave rise to a given pulse amplitude all α's should give pulses of the same amplitude.

Mr. Gostrell (Bureau of Standards) reported on work done at the Bureau on diamonds as counters for gamma radiation. Diamonds were clamped between electrodes and irradiated with gamma rays from Cobalt 60 (1.1 and 1.3 Mev). Using the criterion that the signal to noise ratio must be greater than

three, two diamonds were observed to count per hundred examined. For a typical "good" diamond, the counting rate for a fixed discriminator setting had decreased by a factor of three after 24 hours, and showed no further decrease thereafter. Investigating the counting rate for gamma rays as a function of the intensity of the gamma radiation, the counting rate began to fall off at 30,000 counts/min. and had fallen off 10% at 100,000 counts/min.

Zinc Sulphide Counters

Dr. Ahearn (Bell Telephone Laboratories) reported that counts had been observed with both natural (sphalerite) and synthetic (wurtzite) crystal of zinc sulphide. Pulses were observed with both cleaved and polished surfaces of the natural crystals, and with natural faces on the synthetic ones. Polonium α-particles gave pulses 5 to 10% of the amplitude of those obtained with the best diamond; the synthetic crystals counted somewhat more poorly than the natural ones. Higher voltages were required than for diamond; diamonds showed no further increase in pulse amplitude above voltage gradients of 2,000 volts/cm, while zinc sulphide required 20,000 volts/cm. Only a limited number of zinc sulphide crystals have been investigated.

Cadmium Sulphide Counters

Dr. Platt (University of Rochester) pointed out that Frerichs had reported particle induced conductivity in cadmium sulphide. He had measured the increase of direct current through a cadmium sulphide crystal under β and α bombardment. For continued bombardment of the order of thousands of particles /sec., microamperes of steady current were obtained. The Rochester group had obtained one of Dr. Frerichs' crystals through the courtesy of Northwestern University and the Bureau of Ships, and had observed individual pulses for both β and α-particles. With a voltage of 150 volts applied across a 0.2 mm gap between electrodes, polonium α-particles gave pulses of two millivolts, and β-particles, estimated as transferring a maximum energy of 200 kev to the crystal, gave some pulses of 300 microvolt amplitude. The rise time of these pulses was 0.2 microsecond and limited by the amplifier used. Dr. Ahearn commented that the Bell Telephone Laboratories had also received a cadmium sulphide crystal and had obtained counts with it.

Partial List of Attendance at Conference, July 22 and 23, 1948
University of Rochester

C	Ahearn, A. J.	Bell Labs., Murray Hill, N. J.
	Aughey, H.	duPont Experimental Station, Wilmington, Del.
	Axel, P.	U. of Illinois, Urbana, Ill.
S	Baker, C.	Cornell Univ., Ithaca, N.Y.
S	Bell, P.R.	Oak Ridge National Lab., Oak Ridge, Tenn.
	Berry, C.	Eastman Kodak Co. Research Labs., Rochester NY.
	Bleuler, E.	Purdue Univ., Lafayette, Ind.
S	Condit, R.I.	Naval Radiological Defense Lab., San Francisco, Cal.
	Corson, D. R.	Cornell Univ., Ithaca, NY
C	Costrell, L.	National Bureau of Standards, Washington, DC
	Dana, L. I.	Union Carbide & Carbon Co., New York City
S	Deutsch, M.	M.I.T., Cambridge, Mass.
	Gilletts, R. H.	Linde Air Products Co., Tonawanda, NY
S	Glover, A.	R.C.A., Lancaster, Pa.
	Goodale, E. E.	General Electric Co., Schenectady NY
	Hanchett, G.	R.C.A., Harrison, N. J.
	Higginbotham, W.A.	Brookhaven National Lab., Upton, L.I., NY
S	Hofstadter, R.	Princeton Univ., Princeton N.J.
	Jordan, W. H.	Oak Ridge National Lab., Oak Ridge, Tenn.
	Kuper, J.B.H.	Brookhaven National Lab., Upton, L.I., NY
	Lawson, J. L.	General Electric Co., Schenectady, NY
	Liddel, U.	Office of Naval Research, Washington, DC
	Lyman, E.	Univ. of Illinois, Urbana, Ill.
	MacNeille, H. M.	A.E.C., Washington, D.C.
	Madansky, L.	Brookhaven National Lab., Upton, LI, NY
	McCandrish	Linde Air Products Co., Tonawanda, NY
C	McKay, K.G.	Bell Telephone Labs., Murray Hill, N.J.
	Minett, E. E.	R.C.A., Camden, N. J.
	Parkinson, W. C.	U. of Michigan, Ann Arbor, Mich.
	Pidd, R. W.	Brookhaven National Lab., Upton, L.I., NY
	Raboy	Carnegie Inst. of Tech., Pittsburgh Pa.
	Sevick, J.	Wayne Univ., Detroit, Mich.
	Sheer, C.	Columbia Univ., New York, NY
	Small, L.	Service Diamond Tool Co., Ferndale, Mich.
	van Heerden, P.J.	Harvard Univ., Cambridge, Mass.
	Wakefield, E. H.	Radiation Counter Lab., Chicago, Ill.
	White, A. H.	Bell Telephone Labs., Murray Hill, N.J.
C	Whittemore, W. L.	Harvard Univ., Cambridge, Mass.

Bibliography

R. Hofstadter, J.C.D. Milton, and S.L. Ridgway, Phys. Rev. 72, 977-8 (1947)

H. Froelich and N.F. Mott, Proc. Roy. Soc. (A), 171, 496 (1939)

Mott and Gurney, Electronic Processes in Ionic Crystals, p.107 (Oxford, 1946)

M. Czerny, Zeits. f. Physik 65, 600 (1930)

R.B. Barnes, Zeits. f. Physik 75, 732 (1932)

M. Blackman, Phil. Trans. Roy. Soc. (A), 236, 103 (1936)

L.F. Wouters and R.S. Christian, Phys. Rev. 72, 1127-8 (1947)

P.J. van Heerden, The Crystal Counter (dissertation, Utrecht, 1945)

R. Hofstadter, Phys. Rev. 73, 631 (1948)

A.J. Ahearn, Phys. Rev. 73, 1113 (1948)

R. Frerichs, Phys. Rev. 72, 594 (1947)

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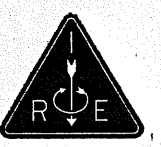
S	Bell, P.R.	Oak Ridge National Lab., Oak Ridge, Tenn.
	Berry, C.	Eastman Kodak Co. Research Labs., Rochester NY.
	Bleuler, E.	Purdue Univ., Lafayette, Ind.
S	Condit, R.I.	Naval Radiological Defense Lab., San Francisco, Cal.
	Corson, D. R.	Cornell Univ., Ithaca, NY
C	Costrell, L.	National Bureau of Standards, Washington, DC
	Dana, L. I.	Union Carbide & Carbon Co., New York City
S	Deutsch, M.	M.I.T., Cambridge, Mass.
	Gillette, R. H.	Linde Air Products Co., Tonawanda, NY
S	Glover, A.	R.C.A., Lancaster, Pa.
	Goodale, E. E.	General Electric Co., Schenectady NY
	Hanchett, G.	R.C.A., Harrison, N. J.
	Higginbotham, W.A.	Brookhaven National Lab., Upton, L.I., NY
S	Hofstadter, R.	Princeton Univ., Princeton N.J.
	Jordan, W. H.	Oak Ridge National Lab., Oak Ridge, Tenn.
	Kuper, J.B.H.	Brookhaven National Lab., Upton, L.I., NY
	Lawson, J. L.	General Electric Co., Schenectady, NY
	Liddel, U.	Office of Naval Research, Washington, DC
	Lyman, E.	Univ. of Illinois, Urbana, Ill.
	MacNeille, H. M.	A.E.C., Washington, D.C.
	Madansky, L.	Brookhaven National Lab., Upton, LI, NY
	McCandrish	Linde Air Products Co., Tonawanda, NY
C	McKay, K.G.	Bell Telephone Labs., Murray Hill, N.J.
	Minett, E. E.	R.C.A., Camden, N. J.
	Parkinson, W. C.	U. of Michigan, Ann Arbor, Mich.
	Pidd, R. W.	Brookhaven National Lab., Upton, L.I., NY
	Raboy	Carnegie Inst. of Tech., Pittsburgh Pa.
	Sevick, J.	Wayne Univ., Detroit, Mich.
	Sheer, C.	Columbia Univ., New York, NY
	Small, L.	Service Diamond Tool Co., Ferndale, Mich.
	van Heerden, P.J.	Harvard Univ., Cambridge, Mass.
	Wakefield, E. H.	Radiation Counter Lab., Chicago, Ill.
	White, A. H.	Bell Telephone Labs., Murray Hill, N.J.
C	Whittemore, W. L.	Harvard Univ., Cambridge, Mass.



Second National Annual Meeting of the PROFESSIONAL GROUP ON NUCLEAR SCIENCE

●

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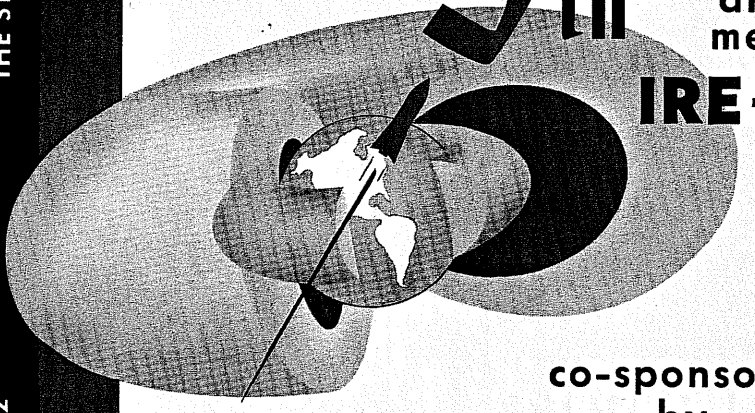

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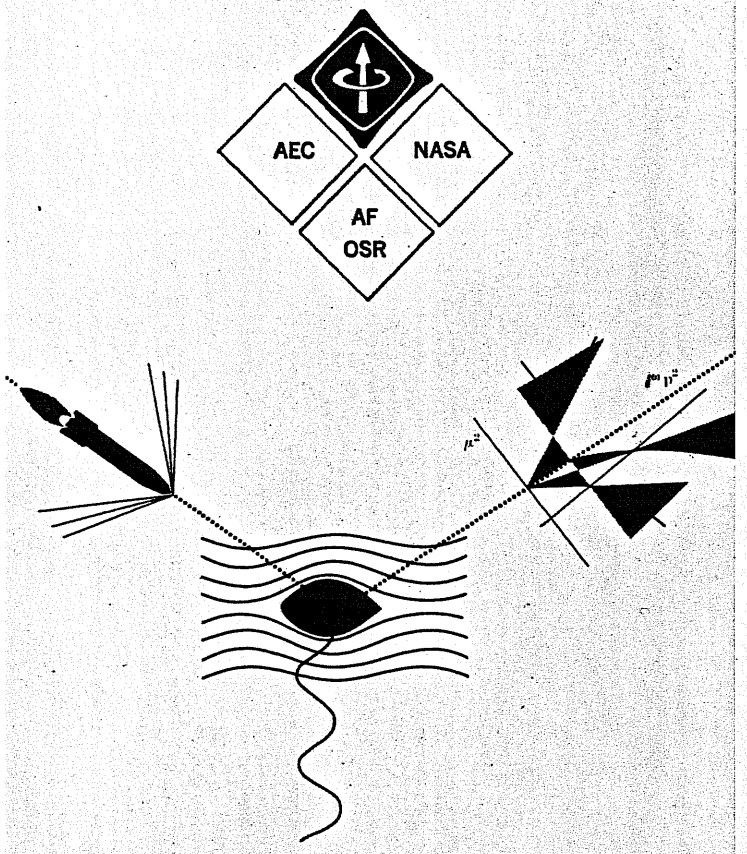

INTERNATIONAL SYMPOSIUM ON PLASMA PHENOMENA AND MEASUREMENT

TENTH ANNIVERSARY MEETING — IEEE-PTGNS

THE EL CORTEZ HOTEL
San Diego, California
October 29-November 1, 1963

The IEEE Professional Technical Group on Nuclear Science presents, as its Tenth Anniversary Meeting, an International Symposium on Plasma Phenomena and Measurement. This Symposium is co-sponsored by the Institute of Electrical and Electronic Engineers, the National Aeronautic and Space Administration, the U.S. Atomic Energy Commission, and the Air Force Office of Scientific Research. The Symposium will emphasize, but will not be limited to, discussions on plasma physics applications and measurements. As is customary, nuclear instrumentation and controls will also be an important part of the program.

In addition to contributed papers, several invited tutorial papers on related topics will be given by authorities in their field. Papers will be published in the January 1964 issue of the Transactions of the PTGNS.

In addition to the technical sessions, a tour of General Atomic research facilities including the pulsing reactor, linear accelerator, and several experimental facilities for plasma physics will be available.

Technical exhibits by manufacturers and organizations in the nuclear and plasma physics instrumentation fields are planned.

Registration

Registration information facilities will be provided in the Main Lobby of the El Cortez Hotel as follows:

Monday, October 28 — 3 p.m.-9 p.m.
Tuesday, October 29 — 8:30 a.m.-5 p.m.
Wednesday, October 30 — 8:30 a.m.-5 p.m.
Thursday, October 31 — 8:30 a.m.-12:30 p.m.

All those attending the technical sessions must register and receive badges. The registration fee for IEEE members is $12, for non-members $16, and for students $5. However, if advance registration is received by October 1st, these fees are reduced to $10, $14, and $4, respectively. The fees include admission to the technical sessions, exhibit area and to the special luncheon on Tuesday. Non-members applying for IEEE membership at the time of the meeting will be registered at the member fee. Information concerning the IEEE, and membership application forms will be available at the registration desk.

Exhibits

The Don Room of the El Cortez Hotel will be used as a display area for commercial and technical exhibits. The exhibition area will be open from 9 a.m. to 5:30 p.m. Tuesday and Wednesday, and from 9 a.m. to 12 noon on Thursday.

Special Luncheon, Tuesday, October 29

A special luncheon will be served in the International Room of the El Cortez Hotel from 12:30 to 2:30 p.m. on Tuesday, October 29. Dr. Norris E. Bradbury, Director of Los Alamos Scientific Laboratory, will be the guest speaker. Cost of the luncheon is included in the registration fee.

Institute of Electrical & Electronic Engineers

Nuclear Science Group

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L. Costrell, Gen. Chairman

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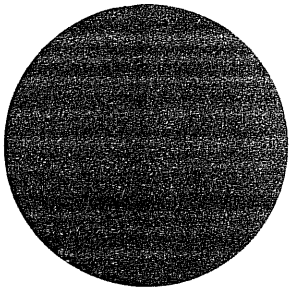

For Further Info Contact
Mr. John Kilpatrick
Exhibits Chairman
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P.O. Box 8555
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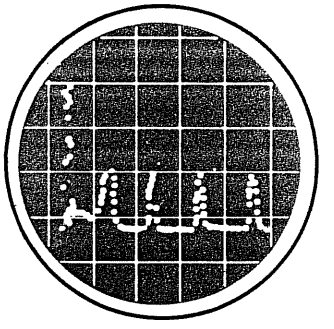
11th NUCLEAR SCIENCE SYMPOSIUM

Instrumentation In Space And Laboratory



Institute of Electrical & Electronic Engineers
Phila. Sheraton Hotel
Oct. 28, 29, 30, 1964

Sponsored by

IEEE Nuclear Science Group
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Each year the IEEE holds a Symposium on Nuclear Science in order to provide scientists and engineers engaged in one of the many scientific and industrial aspects of nuclear energy a means for communication with their colleagues.

Past symposia have included a broad spectrum of topics in the nuclear field: nuclear propulsion—space phenomena —plasma physics. This year our emphasis is on nuclear instrumentation in space and in the laboratory.

A diversity of topics includes geomagnetically trapped radiation and other space phenomena, radiation detectors and high speed circuitry, radiation effects, space nuclear propulsion, and reactor control and instrumentation.

In addition to contributed papers, several invited tutorial papers on related topics will be given by authorities in their field. Symposium papers will be published in the January 1965 issue of the Transactions of the PTGNS.

In addition to the technical sessions, tours of the Space Sciences Laboratory at the General Electric Valley Forge Space Technology Center and the Philadelphia Electric high temperature gas cooled reactor generating plant at Peachbottom, Pa. will be available.

Technical exhibits by manufacturers and organizations in fields associated with the Symposium topics are planned.

Registration

Registration information facilities will be provided at the 2nd floor registration desk of the Philadelphia Sheraton Hotel as follows:

Tuesday, October 27—3 p.m.-9 p.m.
Wednesday, October 28—8 a.m.-6 p.m.
Thursday, October 29—8 a.m.-6 p.m.
Friday, October 30—8 a.m.-12 p.m.

All those attending the technical sessions must register and receive badges. The registration fee for IEEE members is $12, for non-members $16. However, if advance registration is received by October 1st, these fees are reduced to $10 and $14, respectively. The fees include admission to the technical sessions, exhibit area and to the special luncheon on Wednesday. Non-members applying for IEEE membership at the time of the meeting will be registered at the member fee. Information concerning the IEEE, and membership application forms will be available at the registration desk.

Exhibits

The Tiered Balcony, North Balcony and the Delaware Valley Suite of the Philadelphia Sheraton Hotel will be used as a display area for commercial and technical exhibits. The exhibition area will be open from 8:00 a.m. to 8:00 p.m. Wednesday (exhibitors' night) and from 8:00 a.m. to 6:00 p.m. on Thursday and Friday.

Special Luncheon, Wednesday, October 28, 1964

A special luncheon will be served in the Pennsylvania Room of the Philadelphia Sheraton Hotel from 12:00 to 2:00 p.m. on Wednesday, October 28, 1964. During the luncheon Dr. Homer E. Newell, Director of the Office of Space Sciences, NASA, will give the Symposium keynote address. Cost of the luncheon is included in the registration fee.

Tours

Tours are planned to visit the Space Sciences Laboratory at the General Electric Company's Missile and Space Division facility at Valley Forge, Pa., and the Philadelphia Electric Company's Nuclear Plant at Peachbottom, Pa. Tours are planned to start immediately after the last paper on the opening day and will return to the hotel before 8:00 p.m. There is no charge for any of these tours if advance registration is made.

Social Activities

Despite all of the independent pursuits possible in Philadelphia — shopping at Wanamakers or a concert at the Academy of Music, Theatre at the Forrest or a film at the Stanley, Saturday afternoon at Franklin Field for Navy-Notre Dame football or a weekend at the World's Fair if you're fortunate enough to be able to delay your departure; the Committee believes it important to continue the very successful social program of earlier meetings. Accordingly, arrangements are being made for a membership dinner on Thursday, October 29, at one of Philadelphia's most popular clubs. Details will be available at registration.

Accommodations

The Philadelphia Sheraton Hotel is setting aside an appropriate block of rooms with free parking for conference attendees. A special Government rate will be available to ½ the planned attendance. A registration card is enclosed. For those desiring other accommodations other hotels and motels are, of course, available. Reservations for rooms should be made directly with the hotel.

Ladies' Activities

Attendance with wives has been increasing and the committee has accordingly prepared an informal program for their entertainment and included in this program are a tour of the Artist Colony and Antique Shops of New Hope, Pennsylvania and a tour of the historic sights of Colonial Philadelphia. There will be no charge for the tour other than luncheons, if advance registration is made.

TECHNICAL SESSIONS

Wednesday, October 28, 1964

Opening Remarks: 9:00 a.m., Main Ballroom (A), Sheraton Hotel
J. B. Trice, *Chairman,* IEEE—GROUP ON NUCLEAR SCIENCE

Session I-A. Invited Papers on Investigations of Space Phenomenon—I
9:10 a.m. Main Balcony (A)
Chairman: George H. Ludwig, *Goddard Space Flight Center*
RESEARCH WITHIN THE IONOSPHERE; Robert E. Bourdeau, *Goddard Space Flight Center*
RECENT OBSERVATIONS ON THE GEOMAGNETIC TRAPPED RADIATION; James A. Van Allen, *University of Iowa*
THE CISLUNAR MAGNETIC FIELD; Norman F. Ness, *Goddard Space Flight Center*
RECENT RESULTS CONCERNING INTERPLANETARY PLASMA STUDIES; Bruno B. Rossi, *Massachusetts Institute of Technology*

Session II-A. Invited Papers on Investigations of Space Phenomenon—II
2:10 p.m. Main Ballroom (A)
Chairman: John E. Naugle, *NASA Headquarters*
GALACTIC AND SOLAR COSMIC RAYS; Frank B. McDonald, *Goddard Space Flight Center*
CORONAL EXPANSION AND PARTICLE PROPAGATION THROUGH INTERPLANETARY SPACE; Eugene M. Parker, *University of Chicago*
THE NEAR ENVIRONMENT OF THE MOON AND INNER PLANETS; Gordon J. F. MacDonald, *University of California, Los Angeles, California*
X-RAY ASTRONOMY; Herbert T. Friedman, *United States Naval Research Laboratory*

Thursday, October 29, 1964

Session III-A. Scintillators and Tubes
9:00 a.m. Main Ballroom (A)
Chairman: George A. Morton
BACKGROUND IN LIQUID SCINTILLATION COUNTING SYSTEMS; C. F. G. Delaney and A. J. MacGovern, *University of Dublin*
GAIN VS. TEMPERATURE EFFECTS IN NaI(Tl) PHOTO-MULTIPLIER SCINTILLATION DETECTORS USING 10 AND 14 STAGE TUBES; R. Erling Rohde, *Argonne National Laboratory*
SCINTILLATION TIME-CONSTANT DETERMINATION IN NANOSECOND RANGE USING SINGLE TRACES; Milton Furst and Hartmut P. Kallmann, *New York University*
APPARATUS FOR PRECISE MEASUREMENT OF SCINTILLATOR DECAY TIMES; R. L. McGuire, E. C. Yates, D. G. Crandall and C. R. Hatcher, *Edgerton, Germeshausen & Grier, Santa Barbara*
EVALUATION OF ORGANOMETALLIC COMPOUNDS FOR GAMMA DETECTION IN PLASTIC SCINTILLATORS; K. C. Tsou, *University of Pennsylvania*
LOW ENERGY CHARGED PARTICLE DETECTION USING THE CONTINUOUS CHANNEL ELECTRON MULTIPLIER; D. S. Evans, *Goddard Space Flight Center*
EVALUATION OF NEW PHOTOMULTIPLIERS FOR SCINTILLATION COUNTING; H. R. Krall, *RCA, Lancaster*
FIBER BETA COUNTER; G. Hardie, J. J. Ezop and C. C. Preston, *I.I.T. Research Institute*

Session III-B. Satellite Instrumentation—I

9:00 a.m. Main Ballroom (B)

Chairman: A. W. Schardt

REVIEW OF TECHNIQUES IN SPACE INSTRUMENTION; George Pieper, *Goddard Space Flight Center*

LOW POWER FAST PULSE CIRCUIT TECHNIQUES IN THE MIT GAMMA-RAY TELESCOPE; F. Williams Sarles, Jr. and James K. Roberge, *M.I.T. Lincoln Laboratory*

X-RAY TELESCOPE FOR AN ORBITING SOLAR OBSERVATORY; D. B. Hicks and L. R. Reid, Jr., *Ball Brothers Research Corp.*, and L. E. Peterson, *University of California, La Jolla*

PULSE HEIGHT ANALYZER WITH INTERNAL STORAGE FOR SPACE USE; R. M. Rodrigues, *University of California, Livermore*

MULTICHANNEL SPECTROMETER FOR THE MEASUREMENT OF TRAPPED PARTICLES; J. B. Reagan, J. C. Bakke, W. L. Imhof and R. V. Smith, *Lockheed, Palo Alto*

AIRBORNE SCAN-CONVERTER SYSTEM; Stanley W. Thomas, *University of California, Livermore*

CYCLOTRON TESTS TO DETERMINE THE RESPONSE OF SOLID STATE DETECTORS TO PROTONS OF ENERGIES 50-160 MeV FOR USE IN A PROTON SPECTROMETER; G. W. Grew, *NASA—Langley*

Session IV-A. Semiconductor Radiation Detectors

1:30 p.m. Main Ballroom (A)

Chairman: G. L. Miller

ENERGY LOSS BY CHARGED PARTICLES IN SILICON AS A FUNCTION OF TRACK ORIENTATION; Harvey E. Wegner, *Brookhaven National Lab.*

UTILIZATION OF WEB SILICON FOR POSITION SENSITIVE DETECTORS; E. J. Ludwig, *Rutgers University*, W. M. Gibson, *Bell Telephone Labs.*, J. Hood, *Dow Corning*

LARGE GERMANIUM LITHIUM-DRIFT P-I-N DIODES FOR GAMMA-RAY SPECTROSCOPY; A. J. Tavendale, *Chalk River*

A LITHIUM DRIFTED GERMANIUM SURFACE BARRIER DETECTOR; H. DeLyser and F. P. Ziemba, *Solid State Radiations, Inc.*, and W. R. Van Antwerp, *Edgewood Arsenal*

INTERNAL PULSE AMPLIFICATIONS IN HIGH FIELD SILICON RADIATION DETECTORS; G. C. Huth, J. B. Trice, J. A. Shannon and R. A. McKinney

USE OF THE Si^{A} (n α) Mg^{A-3} AND Si^{A} (n, p) Al^{A-1} REACTIONS IN A SEMICONDUCTOR DIODE FOR MEASURING NEUTRON SPECTRA; J. B. Trice, J. A. Shannon and G. C. Huth, *General Electric, Valley Forge*

NEW RESULTS CONCERNING THE RECTIFYING PROCESS IN SURFACE BARRIER COUNTERS; P. Siffert and A. Coche, *C.E.N., Strasbourg, France*

PREPARATION, CHARACTERISTICS AND APPLICATIONS OF HIGH-VOLTAGE SILICON SURFACE-BARRIER DETECTORS; Ernest D. Klema, *Northwestern University*

PREPARATION AND PERFORMANCE OF A MINIMUM IONIZING PARTICLE DETECTOR; H. Blumenfeld and F. P. Pandolfi, *Princeton University*

ANOMALOUS RESPONSE OF SEMICONDUCTOR RADIATION DETECTORS AT LOW TEMPERATURES; W. R. Dodge, S. R. Domen, A. T. Hirshfeld and D. D. Hoppes, *National Bureau of Standards*

TRANSIENT RESPONSE OF SOLID STATE DETECTORS; A. Hemmendinger, M. G. Silbert and A. Moat, *Los Alamos Scientific Lab.*

Session IV-B. Radiation Effects

1:30 p.m. Ballroom (B)

Chairman: L. Kornblith, Jr.

SURFACE EFFECTS OF GASEOUS IONS AND ELECTRONS ON SEMICONDUCTOR DEVICES; Peder J. Estrup, *Bell Telephone Labs.*

THE SELECTION OF TRANSISTORS FOR USE IN HIGH IONIZING RADIATION FIELDS; Charles W. Bostian and Edward G. Manning, *University of North* Carolina

A PRAGMATIC TECHNIQUE FOR PRESELECTING RADIATION RESISTANT SEMICONDUCTOR DEVICES; M. L. Rossi and G. H. Bolles, *Grumman Aircraft Corp.*

THE EFFECTS OF STEADY-STATE REACTOR RADIATION ON THIN MAGNETIC FILMS; W. D. Miller and D. I. Norman, *Univac, Sperry Rand, Saint Paul*

TRANSIENT RADIATION EFFECTS ON SEMICONDUCTOR DIFFUSED INTEGRATED CIRCUITS; A. S. Hoffman and T. C. Getten, *Autonetics, Anaheim, California*

RADIATION EFFECTS IN METAL-OXIDE-SEMICONDUCTOR TRANSISTORS; W. Chang, E. Steele and J. Raymond, *Northrop Ventura*

RADIATION DAMAGE IN SILICON P-I-N LITHIUM-DRIFT SOLAR CELLS; Norman J. Gri, *Avco Corp., Norman, Okla.*

THE USE OF BULK SEMICONDUCTOR MATERIAL FOR ABSORBED-DOSE MEASUREMENTS; R. F. Bass and O. L. Curtis, Jr., *Northrop, Ventura*

RADIATION INDUCED OUTGASSING IN AN ALUMINUM SYSTEM; C. O. Muehlhause, M. Ganoczy and C. Kupiec, *National Bureau of Standards*

Session IV-C. Space Nuclear Propulsion—I

1:30 p.m. Pennsylvania Room

Chairman: H. O. Ruppe

SOLID CORE ENGINES—GRAPHITE AND OTHERS; Carl Schwenk, *NPO*

LIQUID GAS CORE; Dave Knapp, *Douglas Aircraft*

NUCLEAR PULSE PROPULSION—VARIOUS APPROACHES; Jim Nance, *GD/Atomic*

ISOTOPE HEATED ENGINES; James Heyer, *MSFC*

MISSIONS: HAZARDS, FLIGHT/RANGE, SAFETY

TEST MISSIONS, ORBITAL/LUNAR/PLANETARY, APPLICATIONS; Herbert Rad, *Lockheed*

Friday, October 30, 1964

Session V-A. Circuits

9:00 a.m. Main Ballroom (A)

Chairman: R. L. Chase

HIGH STABILITY NUCLEAR PULSE AMPLIFIER ANALYSIS; Kenneth F. Hatch, *Univ. of California, Livermore*

ONE-MICROSECOND ADC USES GATED 55-MEGACYCLE OSCILLATOR; G. F. Comiskey, R. A. Karlin and R. D. Carlson, *Linear Alpha, Inc., Evanston, Ill.*

A FAST ADC FOR PULSE HEIGHT ANALYSIS; T. L. Emmer, *RIDL Div., Nuclear-Chicago Corp.*

SEMI LOGARITHMIC AMPLIFIER SYSTEM; W. W. Goldsworthy, *Univ. of Cal., Berkeley*

A WIDE RANGE LOGARITHMIC AMPLIFIER FOR NERVA; G. A. Gilmour, C. E. Hardies and J. H. Wilson, *Westinghouse Astronuclear Lab., Pittsburgh*

GENERATION AND MEASUREMENT OF UV PULSES IN THE SUB-NANOSECOND REGION; J. T. D'Allesio and P. K. Ludwig, *Univ. of Notre Dame*

MONITORING OF SILICON DETECTOR SYSTEMS WITH PULSED GaAs; Robert W. Kuckuck and J. Chong Lee, *Univ. of California, Livermore Electro-Nuclear Labs.*

A HIGH TEMPERATURE REMOTE PULSE PREAMPLIFIER SYSTEM FOR REACTOR STARTUP CHANNELS; R. E. McLain and L. S. Beller, *Atomics International*

DIGITAL PERIOD METER UTILIZING MAGNETIC CORE; Y. Sakurai and Seiji Inokuchi, *Osaka Univ.*

HIGH SPEED PULSE CIRCUITRY FOR SURFACE MASS SPECTROMETER; Fred H. Sawada, *Gen. Electric, Knolls Atomic Power Lab.*

Session V-B. Space Nuclear Propulsion—II

9:00 a.m. Main Ballroom (B)

Chairman: H. E. De Bolt

INTERNAL POWER: REQUIREMENTS IN SPACE FOR EXTRATERRESTRIAL BASES / FOR ELECTRIC PROPULSION; Robert Seitz, R. Vachon and L. H. Wood, *MSFC*

SNAP SYSTEMS: ISOTOPES AND REACTORS; Fred Schulman, *OART, NASA HQ*

LOW ACCELERATION THRUSTERS: ARC, IONIC, MHD HYBRIDS; John Teem, *Electro-Optical Systems*

LOW ACCELERATION MISSIONS: INTERORBITAL / LUNAR / PLANETARY FROM ORBIT, MIXED ACCELERATION; Ted Edelbaum, *UA/Research*

UNCONVENTIONAL APPROACHES: RADIATORS, CONTROLLED FUSION, POWER TRANSMITTED FROM A BASE, BLUE SKY POWER GENERATION, OTHERS; Voya Gradecak, *MSFC*

Session VI-A. Laboratory Instrumentation

1:30 p.m. Main Ballroom (A)

Chairman: John Gilroy

WIRE CHAMBER FOR MULTIPLE EVENTS; Michael Neumann, *Univ. of Chicago*

IMPROVEMENT OF SPATIAL RESOLUTION OF SPARK CHAMBERS; Michael Neumann, *Univ. of Chicago*

DIGITAL READOUT CIRCUITS FOR WIRE SPARK CHAMBERS; W. A. Higinbotham, J. F. Jacobs and H. R. Pate, *Brookhaven National Lab.*

SPARK-GAP TRIGGER AMPLIFIER; Quentin Kerns and Harold W. Miller, *Univ. of California, Berkeley*

DESIGN AND CALIBRATION OF A BROAD RANGE MAGNETIC NEUTRON SPECTROMETER; Carmen Cialella, *Aberdeen Proving Ground*

INJECTOR PULSER FOR LINAC PICOSECOND OPERATION; N. J. Norris, R. K. Hanst, K. F. Bailey and E. J. Johnson, *Edgerton, Germeshausen & Grier, Santa Barbara*

THE DESIGN OF A GENERAL PURPOSE RADIOACTIVE ISOTOPE SCANNER WITH DIGITAL READOUT FOR MEDICAL DIAGNOSTIC PURPOSES; Arvid Lundy and Michael Trump, *Memorial Hospital, New York City*

CONTINUOUS TRITIUM-IN-AIR MONITOR; B. Banville and F. Sannes, *Chalk River*

REACTOR GASEOUS ACTIVITY MONITORING; N. M. Sutherland and A. MacKenzie, *Nuclear Enterprises, Edinburgh*

Session VI-B. Satellite Instrumentation and Accelerators—II

1:30 p.m. Main Ballroom (BB)

Chairman: O. L. Tiffany

THE MASS ANALYSIS OF THE LUNAR ATMOSPHERE; R. W. Fredericks, J. L. Vogl, R. A. Abramson, W. Bernstein and W. A. Fowler, *TRW Space Tech. Labs., Cal. Inst. of Tech.*

A DETECTOR FOR THE ARGON ABUNDANCE IN THE MARTIAN ATMOSPHERE; F. B. Harrison, W. Bernstein and J. L. Vogl, *TRW Space Tech. Labs.*

ANALYSIS OF THE MARTIAN ATMOSPHERE BY ALPHA PARTICLE BOMBARDMENT — THE RUTHERFORD EXPERIMENT; E. J. Franzgrote and J. H. Marshall, *Jet Propulsion Lab., Cal., Inst. of Tech.*

A METHOD FOR ANALYZING THE SURFACES OF EXTRATERRESTRIAL BODIES; Troy C. Martin, *Texas Nuclear Corp.*

TWO-PHASE HYDROGEN DENSITY MEASUREMENTS BY NEUTRON ATTENUATION; Donald Shook, *NASA—Lewis Research*

SECOND DERIVATIVE OF FLUX DIGITAL CONTROL OF A SPACE REACTOR FROM SOURCE LEVEL TO CRITICAL; W. A. Dempler, *Westinghouse Astronuclear Lab., Pittsburgh*

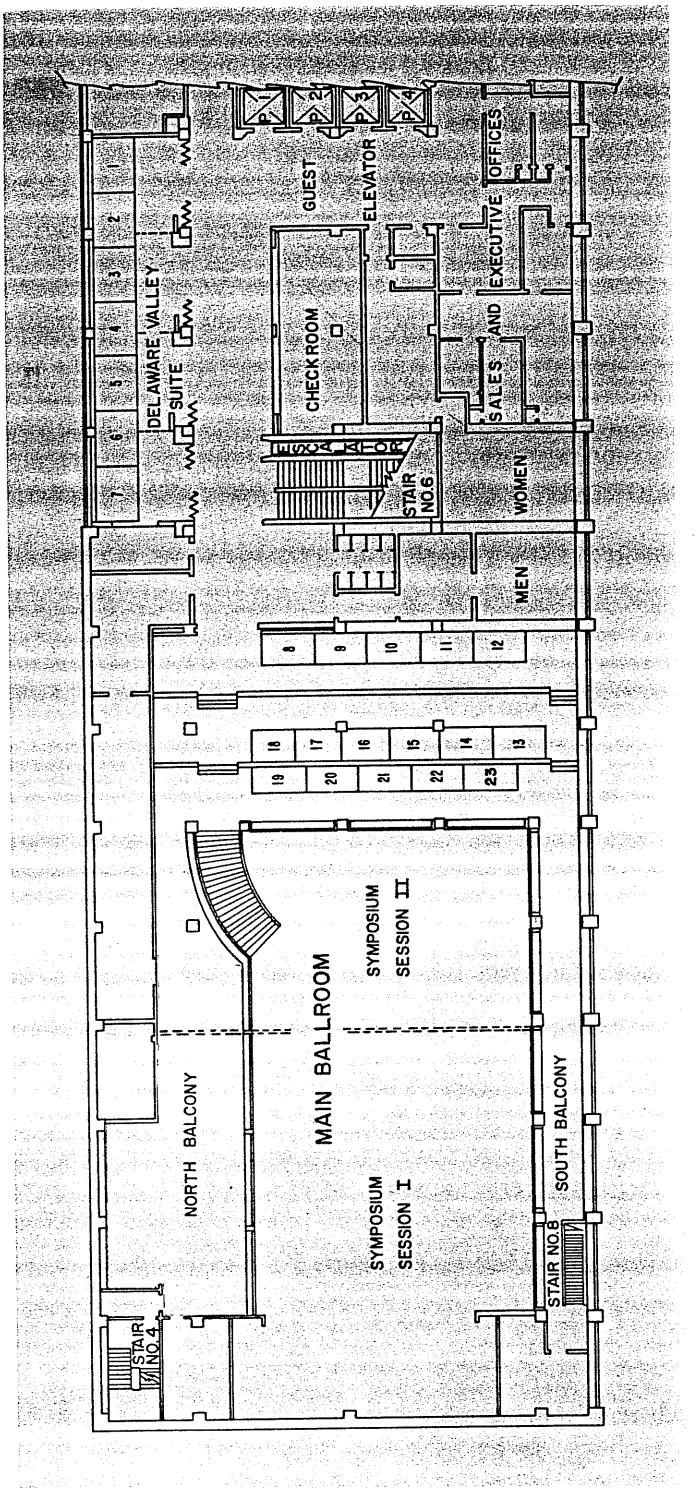
RADIATION TOLERANT STARTUP CONTROLLER FOR SNAP 10A; R. H. Wagner, *Bendix Research Lab.*

THE DEVELOPMENT OF CONTROL DRUM DRIVES FOR COMPACT REACTORS; I. Rowe, *Atomics International*

PRECISION MAGNETIC MEASUREMENTS USED FOR THE DESIGN OF THE STANFORD TWO-MILE LINEAR ACCELERATOR TRANSPORT SYSTEMS; J. K. Cobb and J. J. Muray, *Stanford Univ.*

THE BEAM SWITCHING MAGNET SYSTEM FOR THE STANFORD TWO-MILE ACCELERATOR; J. L. Cole, J. J. Muray, *Stanford Univ.*

BOOTH	EXHIBIT
1 & 2	Technical Measurement Corp.—North Haven, Conn. solid state detector, pulse height and activation analysis systems
3	Linear Alpha, Inc.—Evanston, Ill. fast multichannel analyzer system, Syntec/150
4	Edgerton, Germeshausen & Grier, Inc.—Boston, Mass. M100 modular high speed counting system
5 & 6	Harshaw Chemical Co.—Cleveland, O. crystals, radiation detectors, solar cells, TLD reader
7	Nanosecond Systems, Inc.—Fairfield, Conn. modular logic with 200 mc pre-scalar & associated equipment
8	ORTEC—Oak Ridge, Tenn. semiconductor detectors, associated electronics, ion sources
9	Encyclopedia Britannica, Inc.—Chicago, Ill. Encyclopedia Britannica publications
10	Franklin Institute Laboratories—Philadelphia, Pa. nuclear & space research & development
11	The Pennsylvania State University—University Park, Pa. nuclear & space research, educational program
12	Chronetics, Inc.—Yonkers, N.Y. nanologic high speed systems & 100 mc nuclear scalar
13	RCA Electronic Components & Devices—Harrison, N.J. photo multipliers, image intensifiers, gamma detectors
14	RCA Victor Co., Ltd.—Montreal, Canada P diffused Li, Li-drifted Si & Ge nuclear detectors
15	Nuclear Data, Inc.—Palantine, Ill. multichannel analyzers, signal averaging computer
16	LND, Inc.—Oceanside, L.I., N.Y. logic circuits & tubes—proportional, GM, BF_3, fission chambers
17	Hamner Electronics Co., Inc.—Princeton, N.J. nuclear instruments and detectors
18	Tennelec Instrument Co. Inc.—Oak Ridge, Tenn. TC 200 linear amp., 100 C & TC 110 preamp for cooled Ge detectors
19	Simtec, Ltd.—Montreal, Canada silicon Li-drift detectors, charge sensitive preamps & amplifiers
20	Packard Instrument Co.—Downers Grove, Ill. 4096 multiparameter & 400 channel analyzers, data center
21	Solid State Radiation, Inc.—Los Angeles, Calif. semiconductor detectors, preamps & associated equipment
22	RIDL Div., Nuclear-Chicago Corp.—Des Plaines, Ill. multichannel analyzers, modular nuclear instruments
23	Bell Telephone Company of Pa. information & message center



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NOVEMBER 14, 15, 16, 1973

1973 NSS

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REGISTRATION FEES	Before Nov. 7	At Symposium
*IEEE members	$15	$20
*Non-members	20	25
*Students	6	6
One-day special	------	12
Luncheon (Nov. 14)	5	6
Unemployed IEEE members	------	No Charge
Exhibits only	------	No Charge

*Will receive copy of Symposium Proceedings.

Advance registration is urged to minimize delays and upon request full refunds will be made on unused advance registrations if request is received by November 23. Information about group registration on request from Arrangements Chairman listed below. Note savings available by advance registration. Mail registration and remittances to:

S. D. Winter, L-43
Lawrence Livermore Laboratory
Box 808
Livermore, California 94550
(415) 447-1100, Ext. 8582

Make all remittances payable to "IEEE 1973 NSS." Extra registration forms and programs may be obtained by writing to the above address.

Registration and information facilities will be available in the Main Lobby of the Sheraton-Palace Hotel during the following hours:

Tuesday, November 13	6:00 p.m. – 9:00 p.m.
Wednesday, November 14	8:00 a.m. – 6:00 p.m.
Thursday, November 15	9:00 a.m. – 5:00 p.m
Friday, November 16	9:00 a.m. – 12:00 noon

All those attending the technical sessions must register and receive badges. The basic registration fee applies to technical sessions and the luncheon session has a separate fee. Non-members applying for IEEE membership at the time of the meeting will be registered at the member fee. Information concerning the IEEE and membership application forms will be available at the registration desk.

Unemployed IEEE members will be admitted without charge. Please apply at the registration desk.

HOTEL RESERVATIONS

The "Palace" is known widely by discriminating travelers and has reserved rooms appropriate to the expected attendance. The hotel is located right in the business/shopping area and is only a few minutes on foot from principal stores, theaters, and other downtown hotels. Because of the popularity of the hotel and the number of visitors to the city, particularly in November, advance registration is imperative and a hotel registration card is enclosed. All reservations for rooms should be made with

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

Date: April 10, 1972

To:

R. K. Abele, ORNL
J. L. Blankenship, ORNL
W. L. Brown, BTL
R. L. Butenhoff, AEC/DID
J. A. Coleman, NBS
D. C. Cook, NRL
F. S. Goulding, LRL/B
T. R. Kohler, Philips
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J. L. Palms, Emory U.
S. J. Rudnick, ANL
F. A. Kirsten, LBL
H. W. Van Ness, LLL

Subject: Scintillation and Semiconductor Counter Symposium and Nuclear Science Symposium

1. My letter of March 7 (copy attached) stated that I think the time has come to merge the Scintillation Counter Symposium with the Nuclear Science Symposium. The purpose of this letter is to expand on that subject while taking advantage of the feedback received. This letter is addressed to all members of the NSG Instruments and Detectors Committee and to selected individuals whose views I feel will be useful.

2. SCINTILLATION AND SEMICONDUCTOR COUNTER SYMPOSIA

Given below are attendance and exhibit booth figures for the SSCS. This data are also plotted on the attached graph.

SSCS	Attendance	Exhibit Booths
1962	733	28
1964	811	36
1966	751	44
1968	558	46
1970	459	42
1972	330	34

Though it is undoubtly true that the 1972 attendance was hurt by late mailing of programs, the drastic decrease in submitted papers as compared to previous years is a clear indication of decreased activity. With current travel restrictions one could expect an increase in submitted papers with constant activity since an accepted paper helps a guy get to the meeting. I attribute the continuing drop in attendance primarily to decreased activity and funding and travel restrictions. As would be expected, exhibitor participation is delayed with respect to attendance.

3. NUCLEAR SCIENCE SYMPOSIA

Here are the figures for the attendance and exhibit booths for the Nuclear Science Symposia:

NSS	Location	Attendance	Exhibit Booths
1964	Philadelphia	400	22
1965	San Francisco	est 470	23
1966	Boston	460	32
1967	Los Angeles	294	40
1968	Montreal	214	est 30
1969*	San Francisco	582 (+ 143**)	40
1970*	New York	454	30
1971*	San Francisco	669	35

* 1969, 1970, 1971 includes also Nuclear Power Symposium.
** 143 "exhibits only" registrants.

The above date are plotted on the attached graph. As compared to the SSCS, one would expect these figures to bounce around because they include variables such as location and "add-on" meetings. Points are shown for the Los Angeles meeting of 1967, the year the travel ax fell, and the Montreal meeting that followed Los Angeles and carried the additional burden of foreign travel. San Francisco has the advantage of a large attendance and magnetism for non-Californians. Therefore, we've stuck with San Francisco for our western NSS for 1969, 1971, and 1973. The eastern NSS has been in various locations (giving an added variable) but, except for Montreal in 1968 and our southern venture (Miami Beach) in 1972, we've stuck with the northeast corrider in recent years to attract a large local attendance.

In 1969, 1970 and 1971 the Nuclear Power Symposia were appended to the Nuclear Science Symposia. The attendees due to the NPS seemed to be about 30% of the total (NSS+NPS) in 1970 and 1971. This was a basis for the "estimated" portions of the NSS and (NSS+NPS) curves on the attached graphs.

4. TECHNICAL SESSIONS

Early SSCS's had lots of circuit and instrumentation papers. When detector papers began crowding the program, the circuit and instrumentation papers were shoved to the NSS. Lately, as detector papers eased, more circuit and instrumentation papers have been accepted by the SSCS. Though the NSS technical coverage has been broader than that of the SSCS, to a great extent they've covered the same ground. Both have detector sessions, both have circuit and instrumentation sessions, both have had space instrumentation and application sessions, and lately both have had paper and sessions dealing with biomedical and environmental applications. As funding and travel have tightened, many potential authors, attendees and exhibitors have been compelled to choose between the NSS and the SSCS.

5. COMBINATIONS

The NSS has in recent years had the advantage of the Nuclear Power Symposium being added to it but there is some feeling that every year is too often for the NPS. That would mean having the NSS fly on its own in the east (or in the west). What seems to me to be a logical and viable arrangement is the SSCS and the NSS conducted as a single meeting in even years in the east. I'm talking of an integration of the SSCS and the NSS - not of the SSCS into the NSS. I'm talking of a common time, hotel, and arrangements with an SSCS Program Committee and an NSS Program Committee coordinated by the meetings chairman. I'm talking of SSCS sessions that would not compete with each other, though there would be competing NSS sessions. The SSCS chauvinist therefore need not lose out on any SSCS sessions. though he would be exposed to the temptation of competing NSS sessions.

I'm talking of holding the 1974 SSCS in Washington (as usual) but delayed till fall and held together with the 1974 NSS, with the whole thing billed as the

1974 NSS and 1974 SSCS	East

I'm also talking about the west coast meetings (odd years) continuing as combined NSS and NPS

NSS and NPS	West

If the nuclear power people want a yearly NPS, that's no sweat. We'd have the

1974 NSS 1974 SSCS 1974 NPS	East

all as one big package. However, as mentioned above, there's been some grumbling about yearly NPS's. There are all kinds of possible arrangements that would be vaible.

The combination I'm talking about here (without prejudice to other combinations are:

Even Years East	NSS SSCS
Odd Years West	NSS NPS

6. SSCS and NSS PROGRAM

Here are the 1971 NSS and 1972 SSCS programs:

SSCS

PMT's and Scints	PMT's and Scints	Medical Dets and Imaging	Medical Dets and Imaging	Semicond Dets	Circuits and Systems

NSS

Plenary	Nuclear Instr.	Nuclear Instr.	Radiation Detectors	Radiation Detectors	
	Biomedical Instr.	Environomental Radionuclide Analysis Systems	Enivron. Radionuclide Analysis Systems	Nuclear Tech in Environ. Research	Nuclear Tech in Environ. Research
	Space Instr.	Radiation Damage		Data Acquisition	Data Acquisition
			Plasma Instr. and Fusion Power		Reactor Instr and Test

Every item in the SSCS has been covered to some extend in the NSS. Only the plasma and the reactor instrumentation sessions of the NSS have never been dealt with in any of the SSCS.

7. ESTIMATES OF ATTENDANCE AND EXHIBIT BOOTHS pour BEAUCOUP COMBINAISON

For my estimates of attendance and exhibit booths for various meeting arrangements see the attached "Estimated 1973 and 1974 Attendance and Exhibit Booths, NSS, NPS, SSCS." Of course everyone is free to make their own estimates.

8. PROCEEDINGS

Details would have to be worked out. Publication of Proceedings, combined or separate? when published? if separate volumes does a registrant get both or does he choose one with the other available at extra cost? These questions need consideration but they're not that tough.

9. COMMENTS, PLEASE

I would appreciate receiving comments from each of you to assist in making a decision to whether changes should be made and, if so, as to what changes should be made. Please let me hear from you promptly - it's later than you think.

Sincerely,

Louis Costrell
IEEE/NSG Meetings Chairman

Enclosures:
(A) L. Costrell ltr of March 7, 1972
(B) Attendance & Exhibit Booths, Actural & Estimated 1962 - 1972, NSS, NPS, SSCS 30 March 1972
(C) Estimated 1973 & 1974 Attendance and Exhibit Booths, NSS, NPS, SSCS 30 March 1972

March 7, 1972

241.02

A. W. Snyder
G. L. Miller
R. F. Shea
J. A. Martin
D. C. Cook

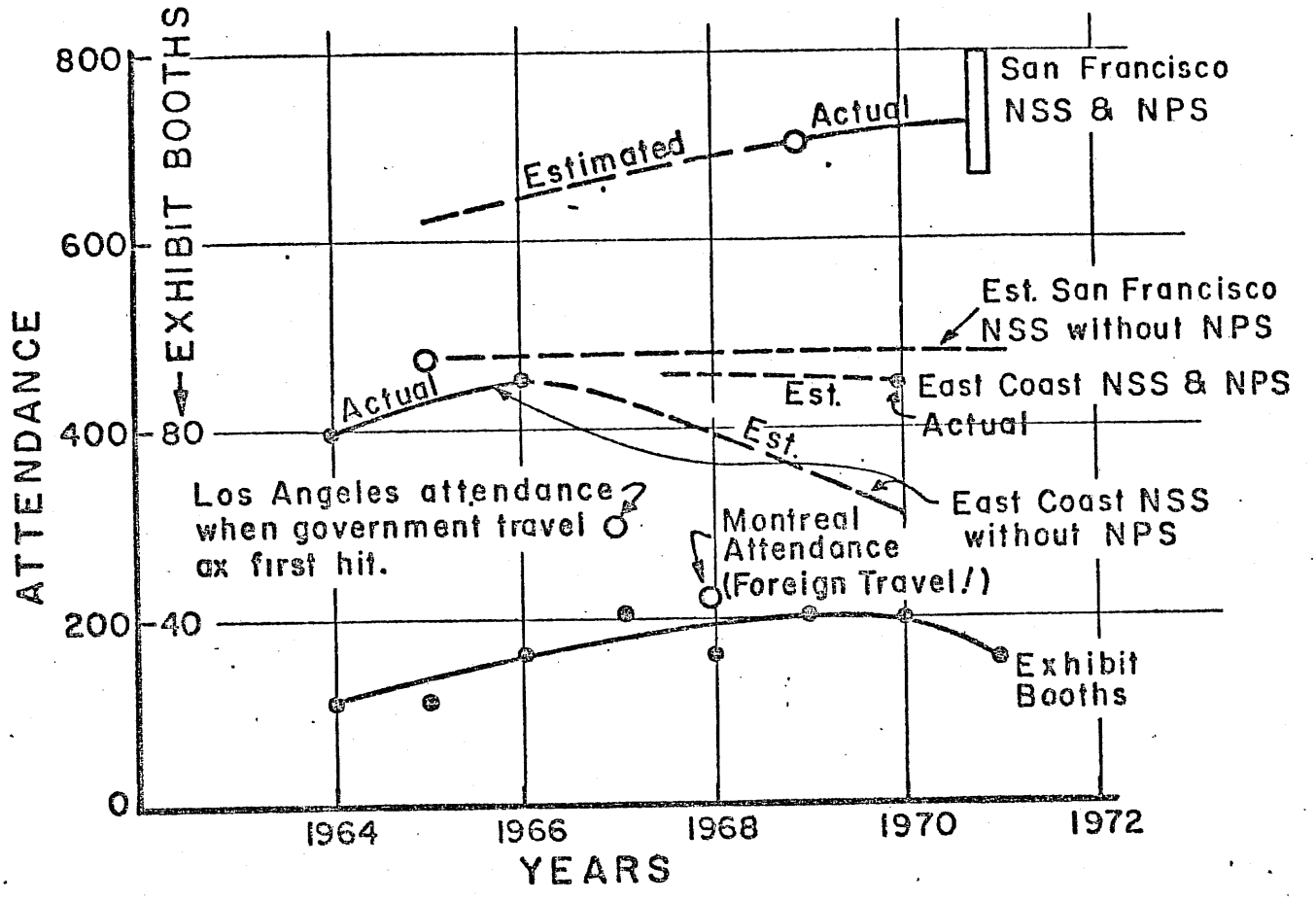
I think the time has come to merge the Scintillation and Semiconductor Counter Symposia with the Nuclear Science Symposia. This integration could be smoothly accomplished by having the 1974 NSS in Washington. There is urgency to this matter since we have hotel reservations for the 1974 and 1976 SSCS and these should be cancelled early enough not to inconvenience the hotel. There are a number of problems that will need resolution and some of us should get together to deal with them. I'm listing below some of the items that have to be looked into and we should do this very soon to accomplish the integration before we fall on our collective faces.

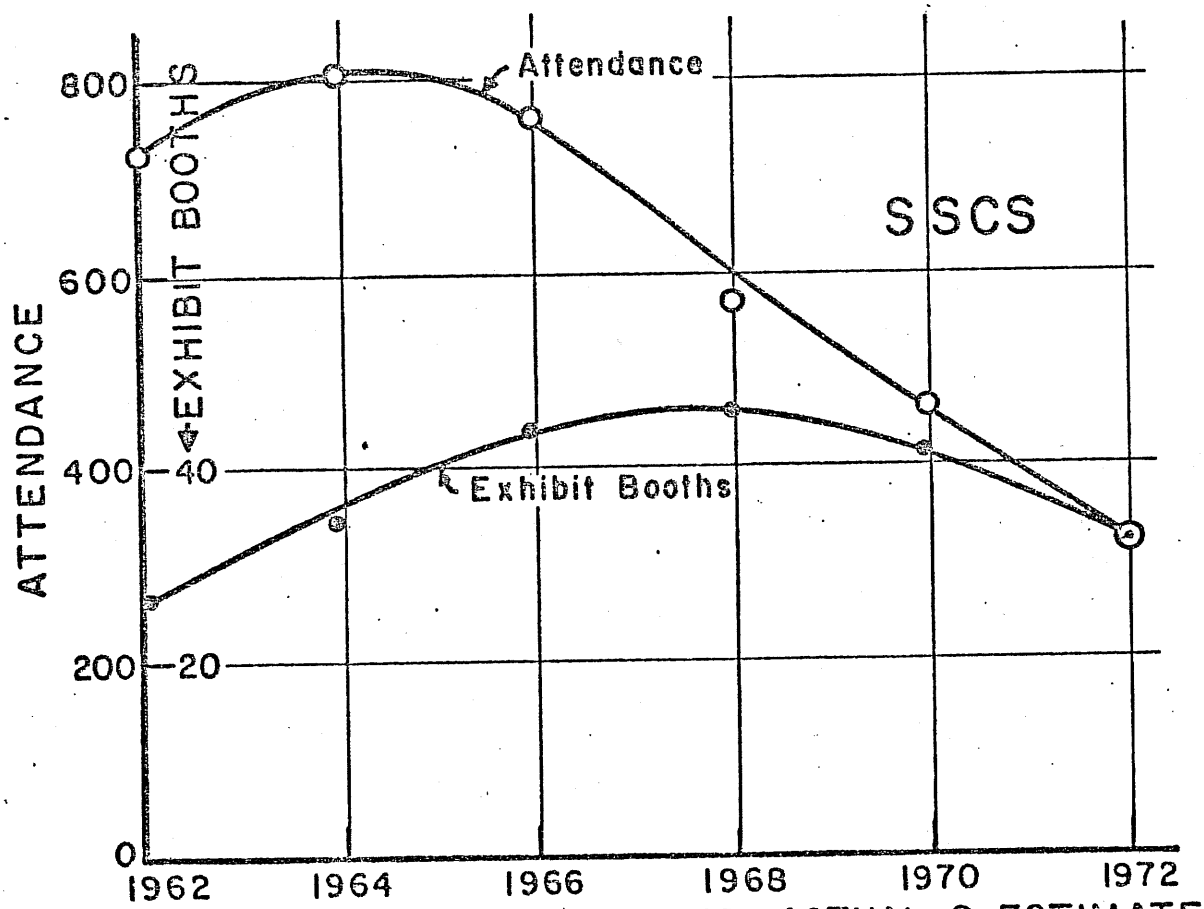
Items requiring consideration

(a) Conference sessions
(b) Conference Proceedings
(c) Proceedings volume (cubic ft.)
(d) Publication schedules
(e) Proceedings distribution
(f) Publication cost
(g) Conference scheduling
(h) Conference attendence
(i) Conference registration income
(j) Conference exhibits
(k) Conference exhibits income

Sincerely,

Louis Costrell





ATTENDANCE & EXHIBIT BOOTHS, ACTUAL & ESTIMATED
1962-1972, NSS, NPS, SSCS 30 MARCH 1972

ESTIMATED 1973 & 1974 ATTENDANCE AND EXHIBIT BOOTHS, NSS, NPS, SSCS

30 MARCH 1972