SNO-STR-91-021

ACCIDENTAL TRIGGER RATES - II
LIQUID SCINTILLATOR

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I. Introduction

The results presented in SNO-STR-90-36 are extended to cases where the PMT singles rates are of the order of 100K/sec. These are the singles rates anticipated from tritium decays if liquid scintillator were placed in the detector. Here one would expect about 86 PMT's to fire for 1 MeV events.

II RESULTS

Fig 1a is similar to Fig 1 in SNO-STR-90-36 with the abscissa now extending up to 500 PMT's firing within a 100 ns time window. The ordinate is $NR\tau$ where N is the total number of PMT's in the detector, R is the singles rates in a single PMT, and τ is the width of the timing window (fixed at 100 ns). Each of the five lines is for a constant accidental rate ranging from 0.01/sec t0 100.0/sec. Fig 1b is a similar set of curves for accidental rates ranging from 1.0×10^{-2}/sec to 1.0×10^{-6}/sec. The numerical results are presented in Table I. It is noted that the accidental rate is extremely sensitive to the number of PMT's required by the trigger. This is better seen in Fig 2a which plots the $\log_{10}$ of the accidental rate (sec^{-1}) vs the number of PMT's required by the trigger, for R = 100K/sec, N = 10,000 τ = 100ns. The accidental rate changes from $\approx$ 1/sec to $\approx$ 1/day, when the number of PMT's changes from 165 to 183. The numerical results are listed in TABLE 2a. The plots and numerical summaries for R=150K and 200K are shown in Figs 2b,2c, and TABLES 2b,2c. With the PMT singles rate equal to 200K/sec,the accidental rate can be kept below 1/day by requiring 320 PMT's to fire. Should the electronic threshold have a jitter of 10% (as in Kamioka), then a threshold of 350 PMT's would be required, which is about 4 MeV. To get down to a 2 MeV threshold the singles rates would have to be kept below 100K/sec.

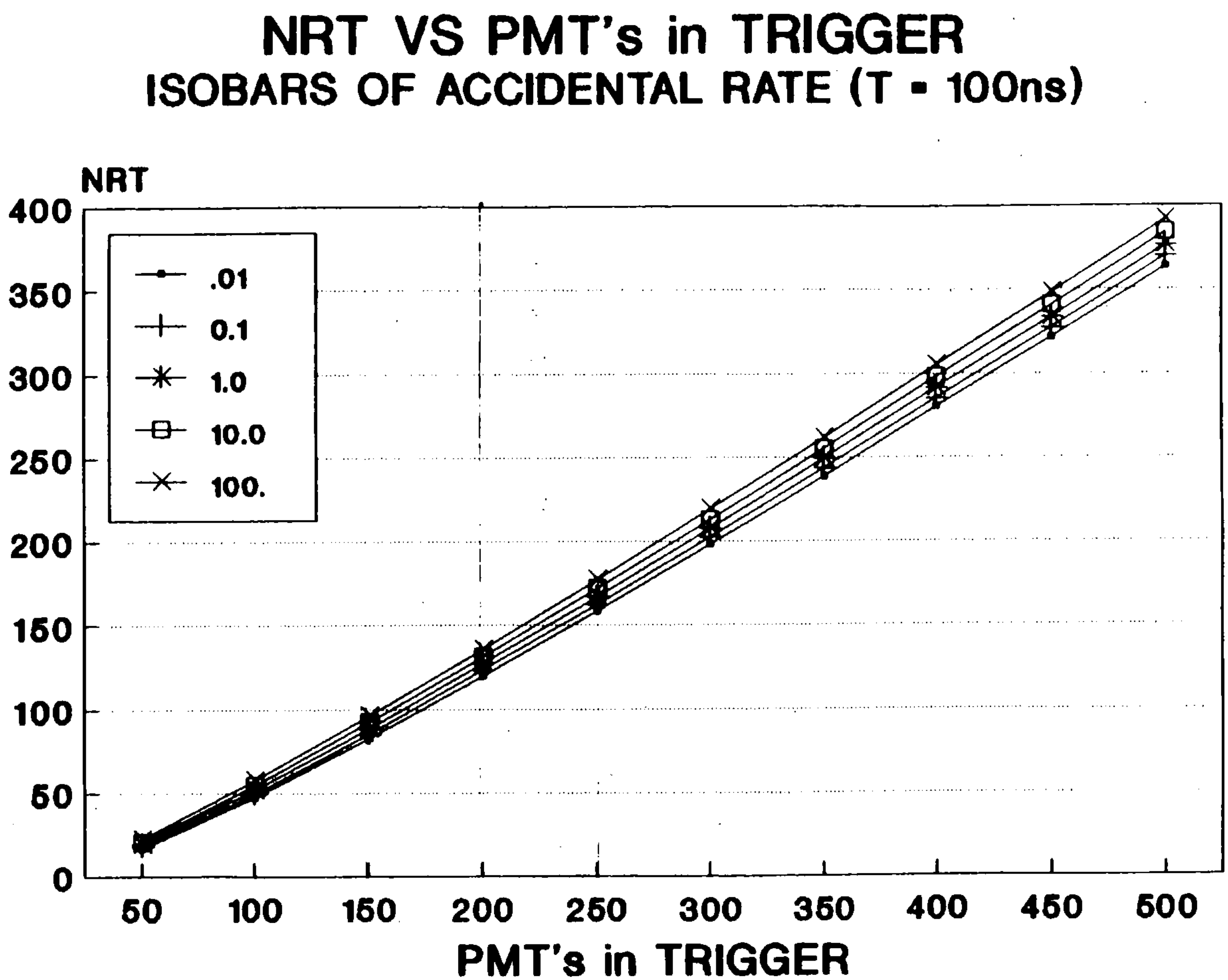

NRT VS PMT's in TRIGGER
ISOBARS OF ACCIDENTAL RATE (T = 100ns)
NRT
400
350
300
250
200
150
100
50
0
.01
0.1
1.0
10.0
100.
50
100
150
200
250
300
350
400
450
500
PMT's in TRIGGER

Fig. 1a

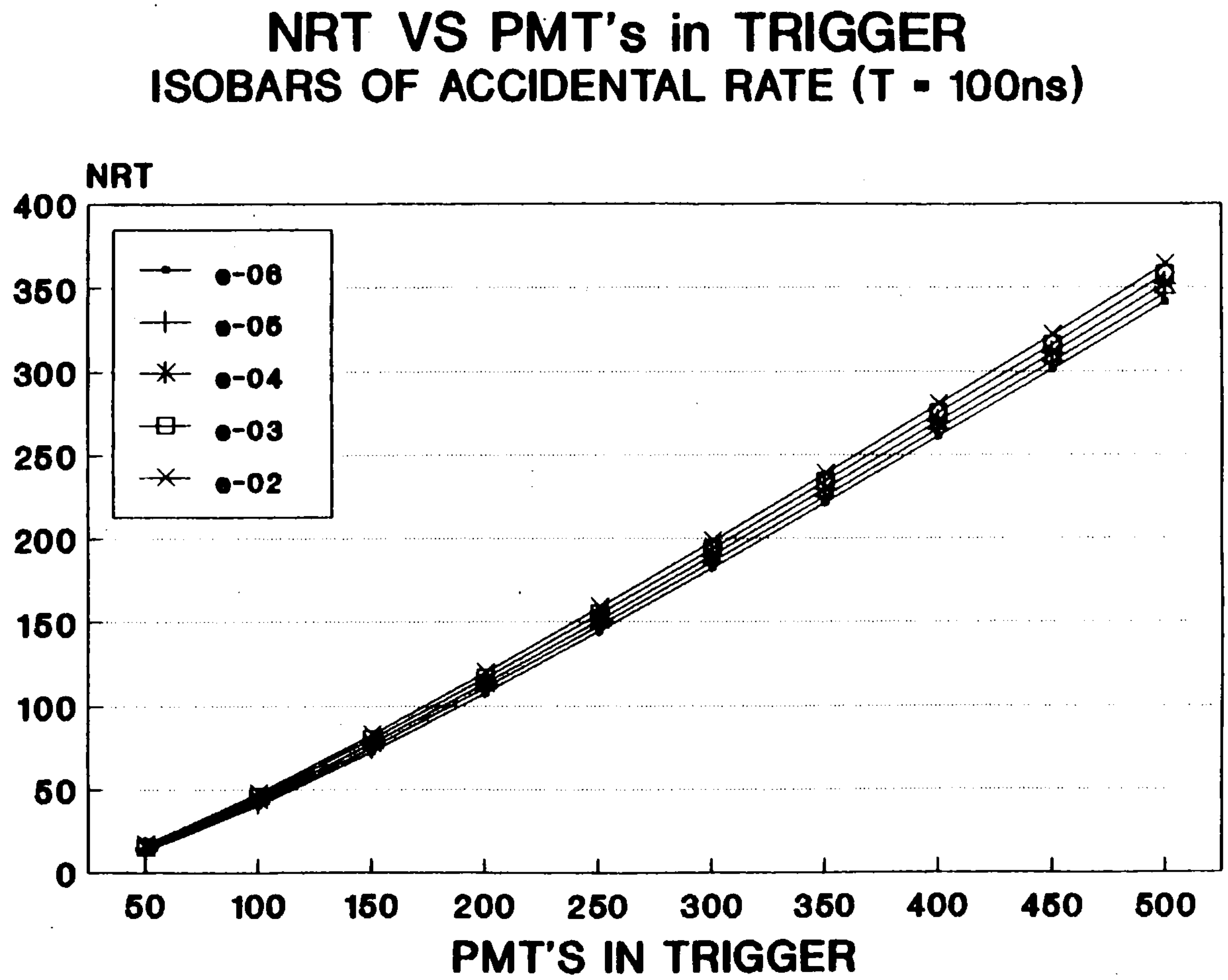
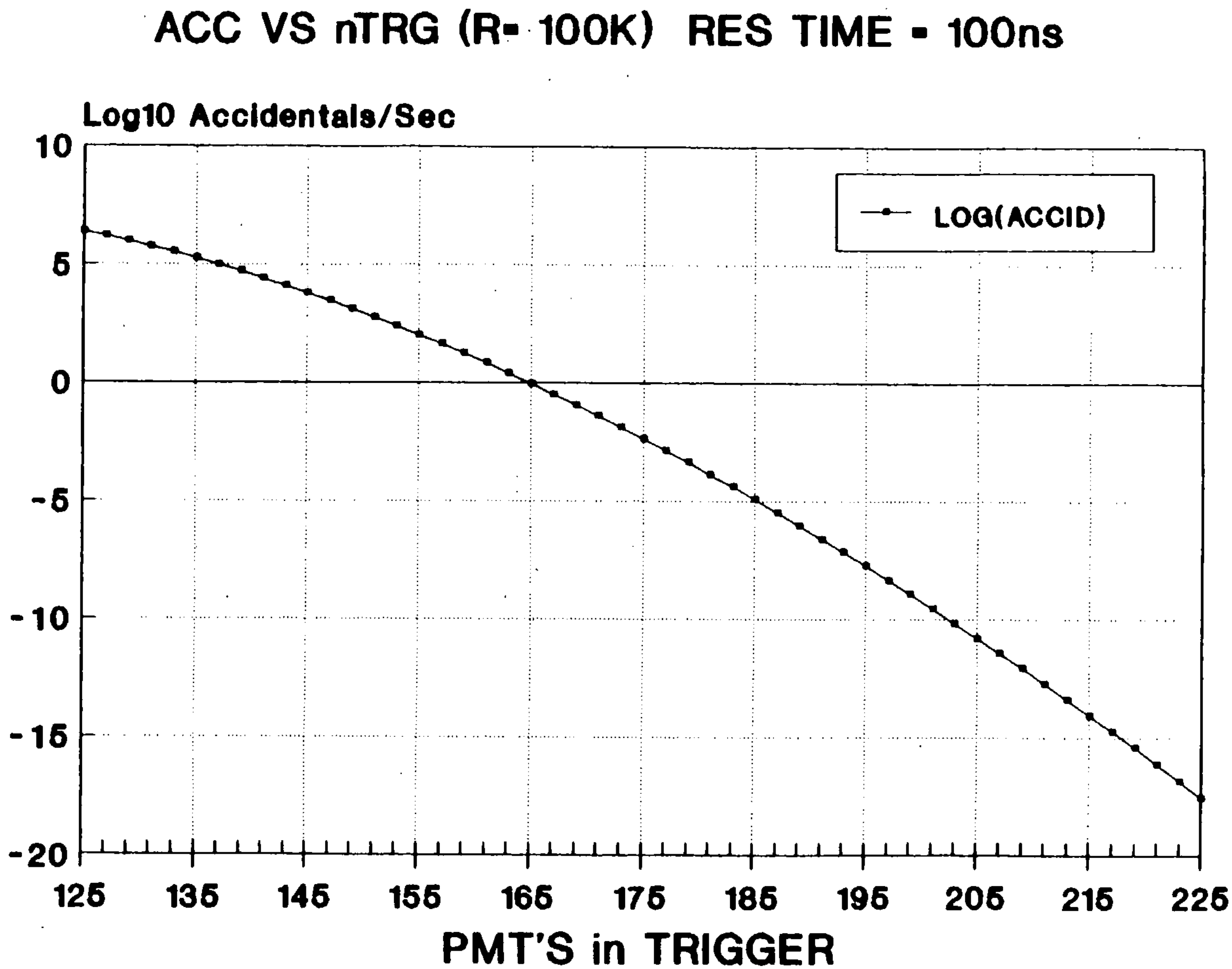

NRT VS PMT's in TRIGGER
ISOBARS OF ACCIDENTAL RATE (T = 100ns)
NRT
400
350
300
250
200
150
100
50
0
e-06
e-05
e-04
e-03
e-02
50
100
150
200
250
300
350
400
450
500
PMT'S IN TRIGGER

Fig. 1b



ACC VS nTRG (R= 100K) RES TIME = 100ns
Log10 Accidentals/Sec
10
5
0
-5
-10
-15
-20
LOG(ACCID)
125
135
145
155
165
175
185
195
205
215
225
PMT'S in TRIGGER

Fig. 2a

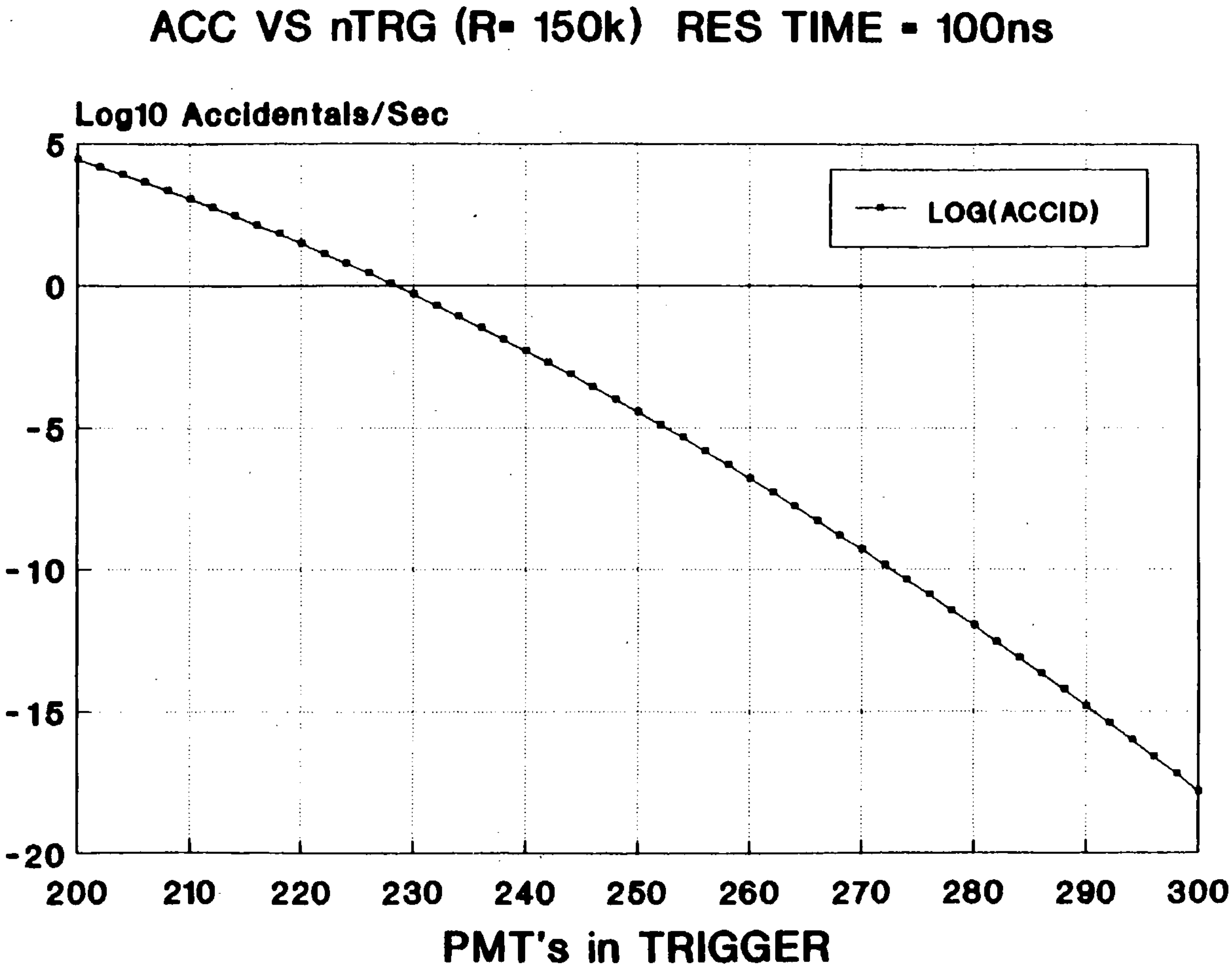

ACC VS nTRG (R= 150k) RES TIME = 100ns
Log10 Accidentals/Sec
LOG(ACCID)
5
0
-5
-10
-15
-20
200
210
220
230
240
250
260
270
280
290
300
PMT's in TRIGGER

Fig. 2b

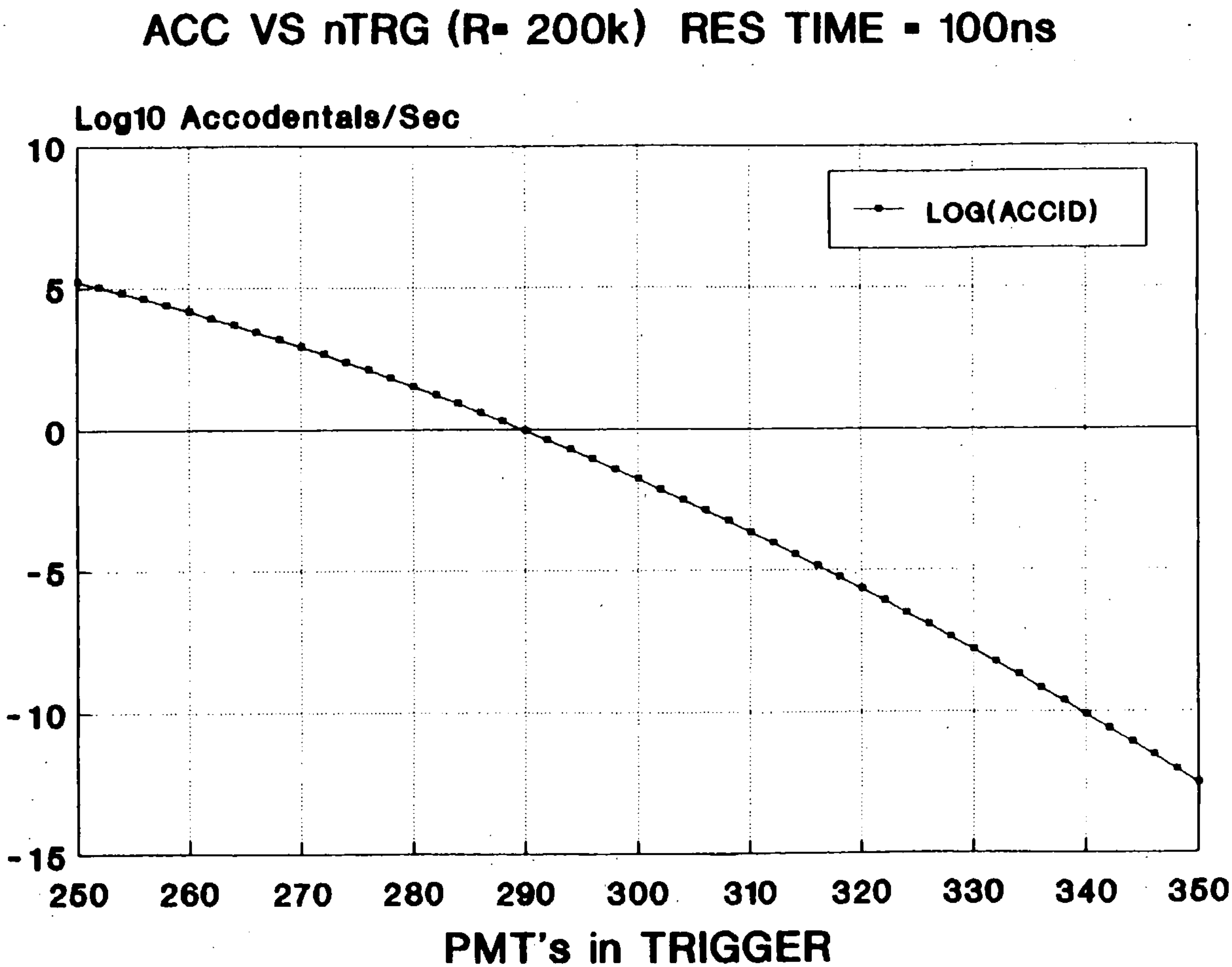

ACC VS nTRG (R= 200k) RES TIME = 100ns
Log10 Accodentals/Sec
LOG(ACCID)
10
5
0
-5
-10
-15
250
260
270
280
290
300
310
320
330
340
350
PMT's in TRIGGER

Fig. 2c

TABLE I

NRT VS ACCIDENTAL RATE RES TIME = 100.00 NS

NTRG	.01	0.1	1.0	10.0	100.
50	16.586	17.792	19.139	20.660	22.400
100	47.354	49.516	51.883	54.498	57.423
150	82.337	85.251	88.415	91.882	95.724
200	119.570	123.122	126.962	131.150	135.766
250	158.261	162.377	166.814	171.637	176.936
300	197.997	202.623	207.600	212.997	218.912
350	238.531	243.626	249.100	255.024	261.506
400	279.697	285.231	291.166	297.581	304.589
450	321.384	327.328	333.696	340.574	348.074
500	363.508	369.840	376.618	383.931	391.899

NRT VS ACCIDENTAL RATE RES TIME = 100.00 NS

NTRG	-06	-05	-04	-03	-02
50	12.786	13.612	14.512	15.499	16.586
100	40.209	41.810	43.523	45.364	47.354
150	72.535	74.756	77.116	79.636	82.337
200	107.502	110.253	113.166	116.263	119.570
250	144.186	147.408	150.810	154.418	158.261
300	182.102	185.751	189.597	193.669	197.997
350	220.959	225.001	229.257	233.755	238.531
400	260.565	264.973	269.610	274.507	279.697
450	300.783	305.537	310.533	315.802	321.384
500	341.519	346.598	351.934	357.556	363.508

TABLE 2a

ACC VS nTRG (R= 100000.00) RES TIME = 100.00 NS

NTRG	LOG(ACCID)
125	.6382E+01
127	.6182E+01
129	.5969E+01
131	.5742E+01
133	.5501E+01
135	.5247E+01
137	.4980E+01
139	.4700E+01
141	.4408E+01
143	.4102E+01
145	.3785E+01
147	.3455E+01
149	.3114E+01
151	.2760E+01
153	.2395E+01
155	.2018E+01
157	.1629E+01
159	.1230E+01
161	.8188E+00
163	.3973E+00
165	-.3550E-01
167	-.4789E+00
169	-.9328E+00
171	-.1397E+01
173	-.1872E+01
175	-.2357E+01
177	-.2852E+01
179	-.3358E+01
181	-.3873E+01
183	-.4398E+01
185	-.4932E+01
187	-.5476E+01
189	-.6030E+01
191	-.6593E+01
193	-.7166E+01
195	-.7747E+01
197	-.8338E+01
199	-.8938E+01
201	-.9547E+01
203	-.1016E+02
205	-.1079E+02
207	-.1142E+02
209	-.1207E+02
211	-.1272E+02
213	-.1338E+02
215	-.1405E+02
217	-.1473E+02
219	-.1541E+02
221	-.1611E+02
223	-.1681E+02
225	-.1752E+02

TABLE 2 b

ACC VS nTRG (R= 150000.00) RES TIME = 100.00 NS

NTRG	LOG(ACCID)
200	.4427E+01
202	.4171E+01
204	.3906E+01
206	.3632E+01
208	.3349E+01
210	.3058E+01
212	.2758E+01
214	.2450E+01
216	.2134E+01
218	.1809E+01
220	.1476E+01
222	.1135E+01
224	.7865E+00
226	.4297E+00
228	.6497E-01
230	-.3075E+00
232	-.6879E+00
234	-.1076E+01
236	-.1471E+01
238	-.1875E+01
240	-.2285E+01
242	-.2703E+01
244	-.3129E+01
246	-.3561E+01
248	-.4001E+01
250	-.4449E+01
252	-.4903E+01
254	-.5365E+01
256	-.5833E+01
258	-.6308E+01
260	-.6791E+01
262	-.7280E+01
264	-.7776E+01
266	-.8279E+01
268	-.8788E+01
270	-.9304E+01
272	-.9827E+01
274	-.1036E+02
276	-.1089E+02
278	-.1144E+02
280	-.1198E+02
282	-.1254E+02
284	-.1310E+02
286	-.1367E+02
288	-.1424E+02
290	-.1482E+02
292	-.1541E+02
294	-.1600E+02
296	-.1660E+02
298	-.1721E+02
300	-.1782E+02

TABLE 2c

ACC VS nTRG (R= 200000.00) RES TIME = 100.00 NS

NTRG	LOG(ACCID)
250	.5237E+01
252	.5037E+01
254	.4830E+01
256	.4616E+01
258	.4394E+01
260	.4167E+01
262	.3931E+01
264	.3690E+01
266	.3441E+01
268	.3186E+01
270	.2924E+01
272	.2656E+01
274	.2381E+01
276	.2099E+01
278	.1810E+01
280	.1516E+01
282	.1215E+01
284	.9078E+00
286	.5941E+00
288	.2745E+00
290	-.5183E-01
292	-.3839E+00
294	-.7224E+00
296	-.1067E+01
298	-.1418E+01
300	-.1774E+01
302	-.2137E+01
304	-.2505E+01
306	-.2880E+01
308	-.3260E+01
310	-.3646E+01
312	-.4038E+01
314	-.4436E+01
316	-.4839E+01
318	-.5248E+01
320	-.5663E+01
322	-.6084E+01
324	-.6509E+01
326	-.6941E+01
328	-.7378E+01
330	-.7820E+01
332	-.8268E+01
334	-.8721E+01
336	-.9180E+01
338	-.9644E+01
340	-.1011E+02
342	-.1059E+02
344	-.1107E+02
346	-.1155E+02
348	-.1204E+02
350	-.1254E+02

SNO-STR-91-022

Wavelength Shifter or Liquid Scintillator in SNO: First Pass

Dave Wark

April 2, 1991

1 Introduction

At the Vancouver workshop on neutral current detection Art MacDonald suggested that the addition of wavelength shifter or a water-based liquid scintillator to the D_2O might improve the overall performance of SNO, particularly for neutral current detection. Several difficulties were identified with such schemes which may render them unworkable, however the possible benefits are sufficient that it may be a good idea to consider them further. I am writing this note to bring those who were not present at the workshop up to date on this idea in the hope that they may identify either problems or advantages that we have missed up to now. I also hope that people in the collaboration who have experience with these materials, or know where information on them can be found in the literature, will send me a note and let me know.

The purpose of these additives is to increase the light output of electrons in the D_2O . In a previous D_2O CC experiment carried out at LAMPF [1] the addition of 1.0 mg/l of the wavelength shifter 4-methyl-umbelliferone was found to increase the light output of the D_2O by a factor of 3 (summed over their photocathode response function) by shifting light of wavelength too short to be detected by their PMT's (~360 nm) to a detectable wavelength (~450 nm). Another [2] group looked into the use of a water-based liquid scintillator consisting of 2% Triton X-100 (a commercial surfactant used to render scintillators water soluble for use in tritium assay), 0.25 g/l PPO (a primary scintillator) and 0.00625 g/l POPOP (a wavelength shifter matched to PPO) and found light yields which would correspond to an enhancement in the light yield in SNO of about a factor of ten. If this were the only effect it would be hard to argue against such a scheme, as this additional light has several beneficial effects in SNO. First, by increasing the light output of electrons in the D_2O relative to electrons created outside the acrylic vessel it should eliminate any backgrounds caused by light created outside the acrylic vessel (such as the PMT beta-gammas). Second, even a small admixture of isotropic light greatly improves the vertex resolution, in the absence of additional scattering we might get vertex resolution $\leq$10 cm. The added light would improve