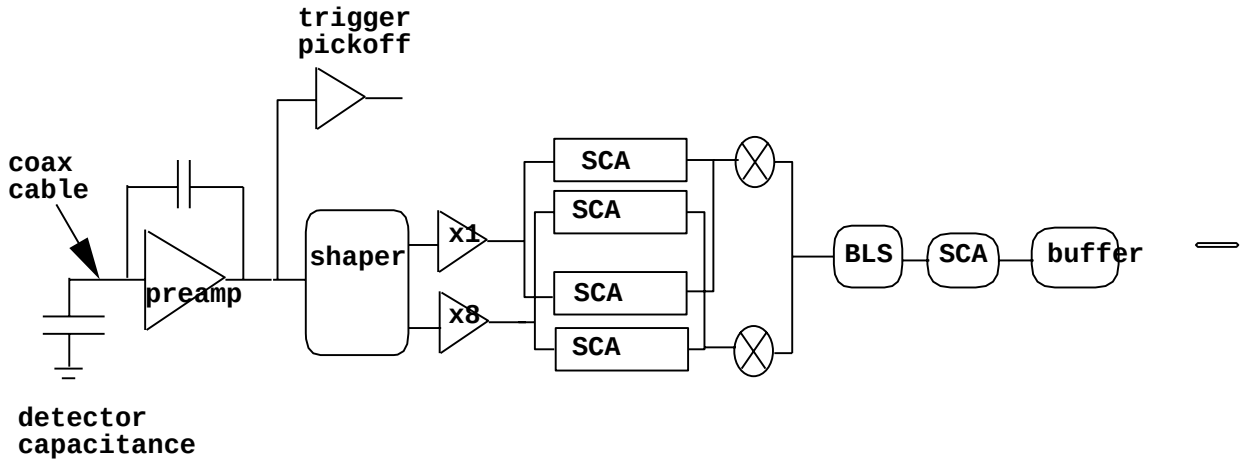
Calorimeter Preamplifier System



Outline

- Cables
- Preamplifier
- Preamplifier Motherboard
- Preamplifier Power Supply
- Pileup effects on resolution
- Status

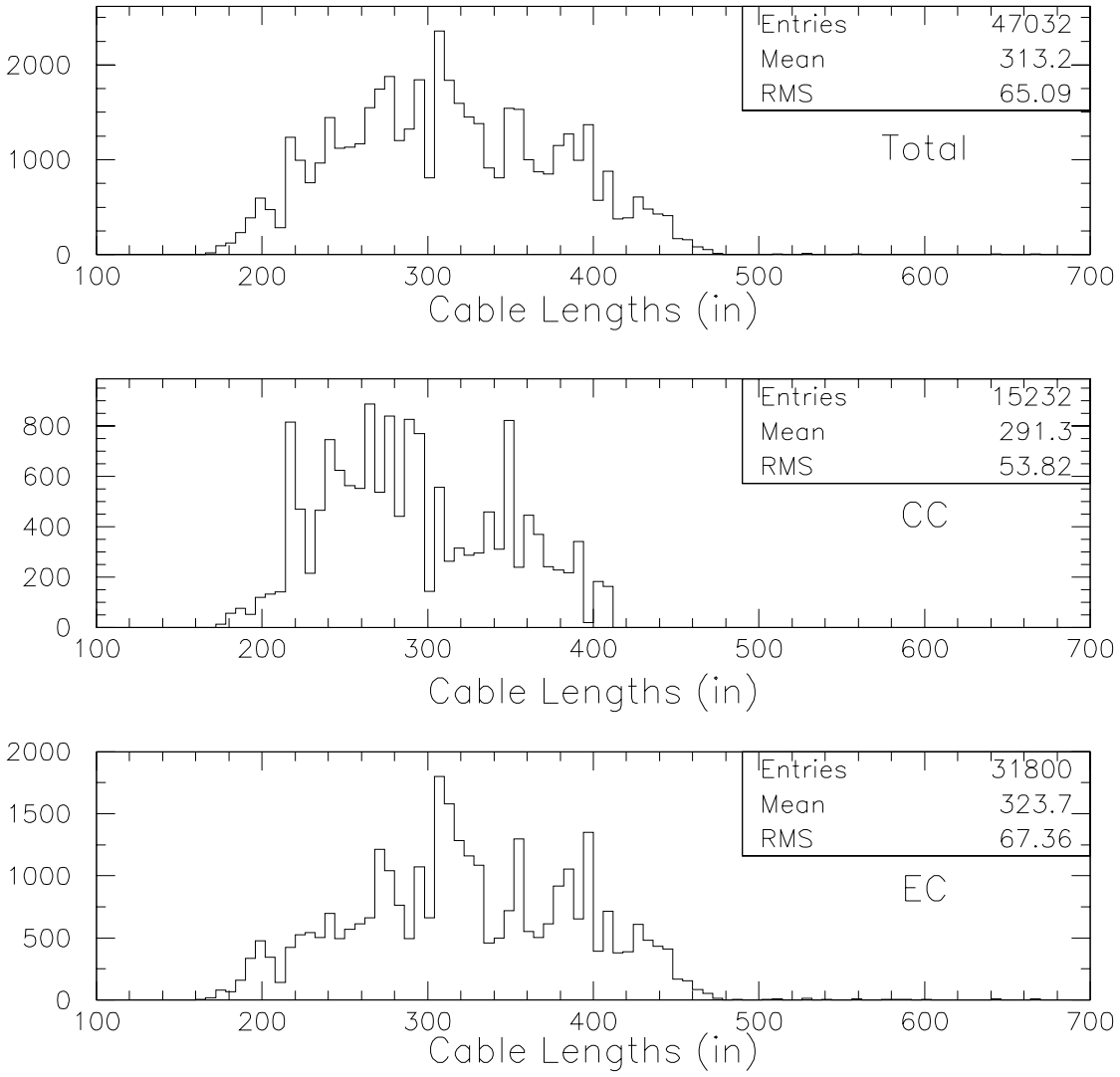
Input Cables

Run I: 30 Ω coax cable inside calorimeter, 115 Ω outside

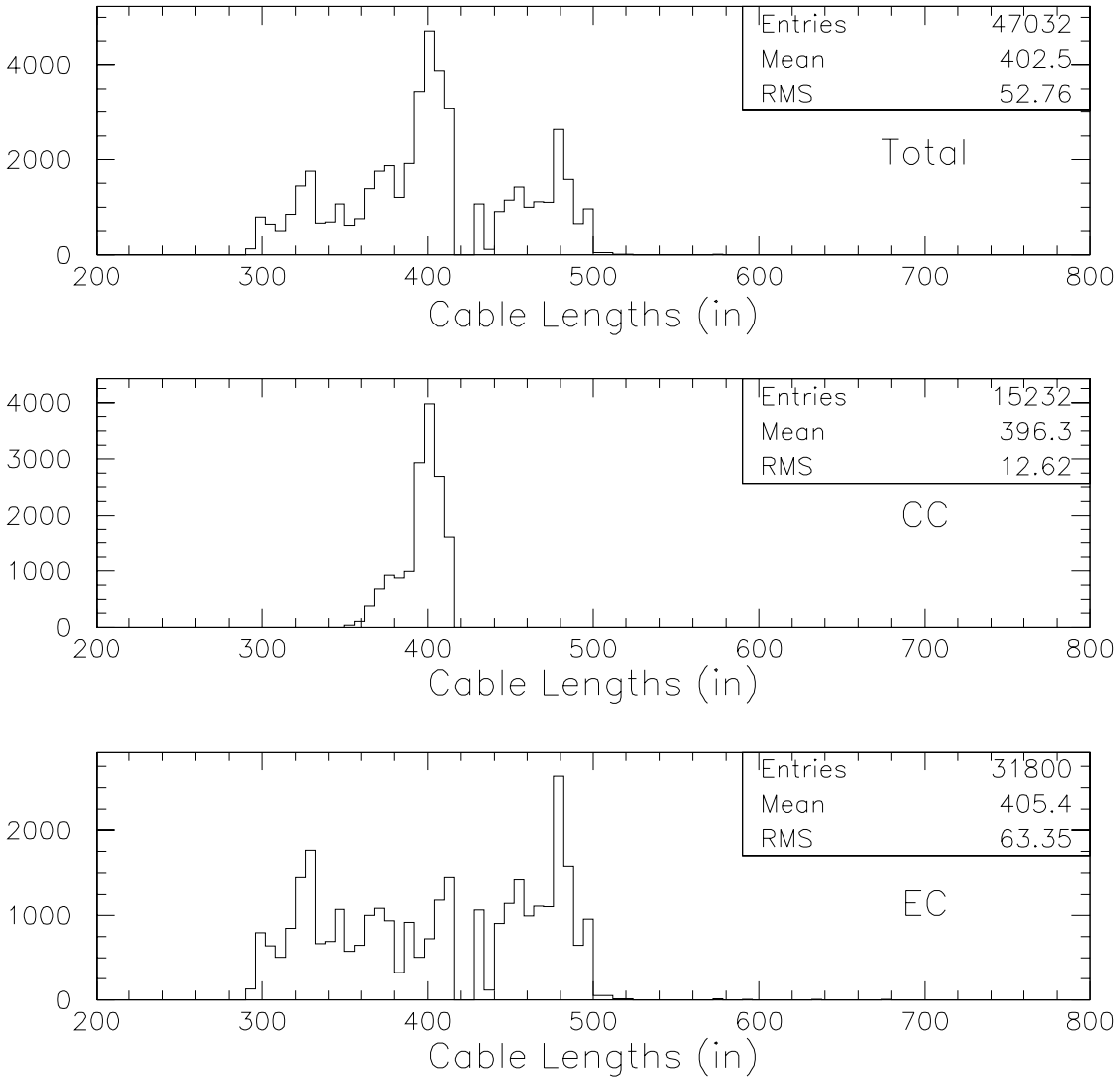
Run II: Replaced 115 Ω cable with 30 Ω coax to

- prevent reflections
- spread in cell-preamp total cable lengths minimized by tuning the lengths of the replacement cables ⇒ reduced error in signal timing

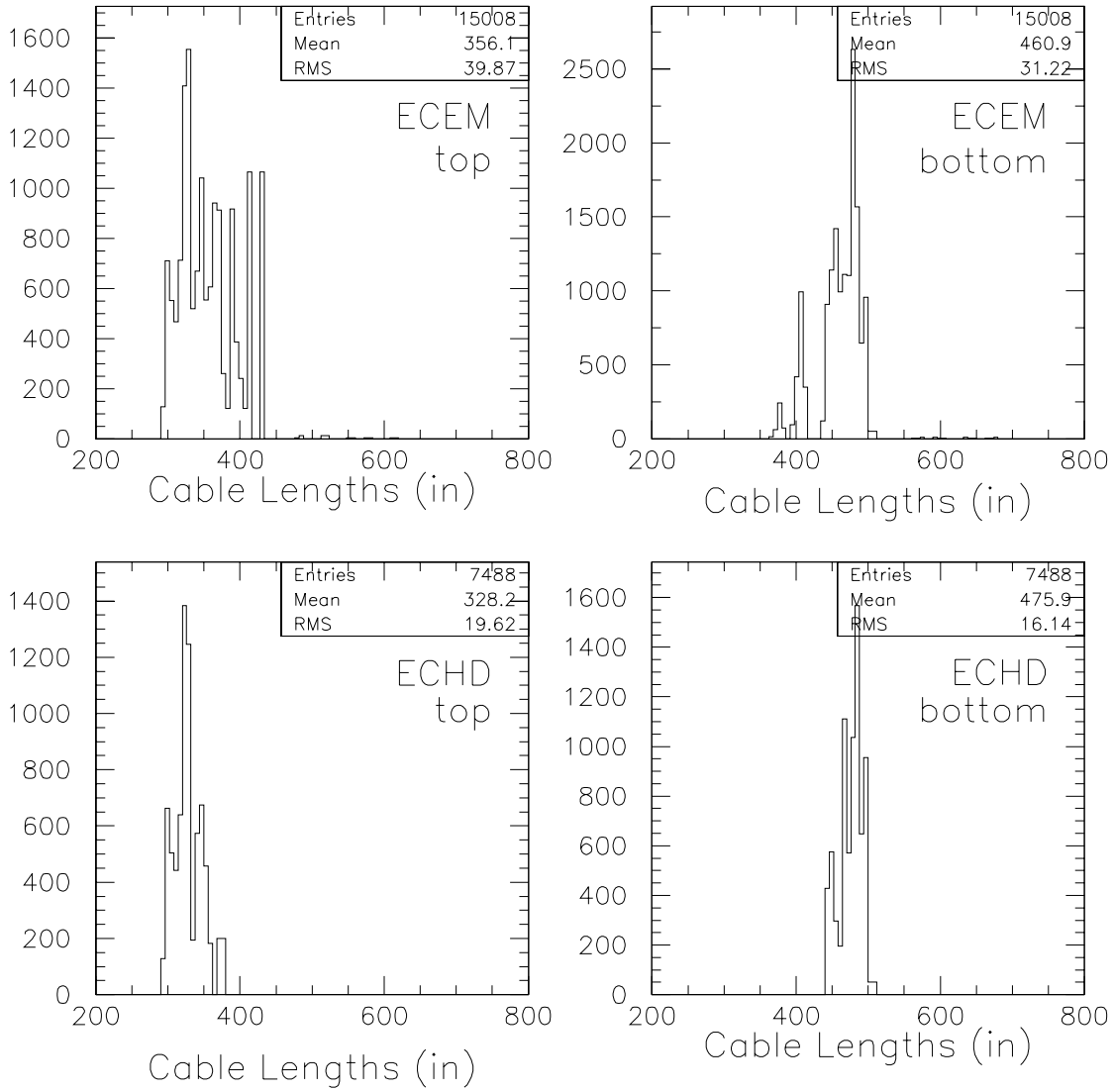
Run I Calorimeter-Preamp Cable Lengths



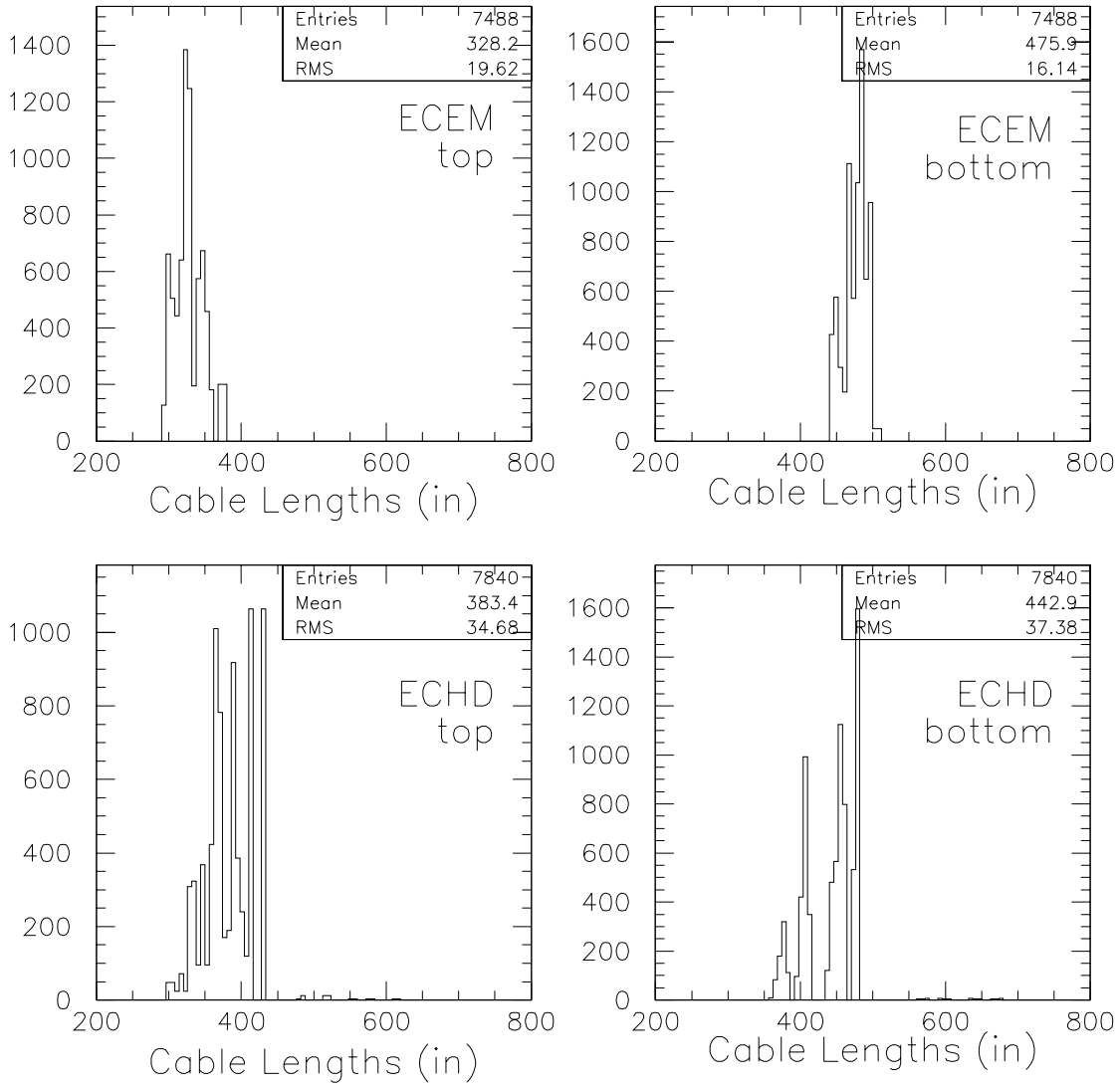
Run II Calorimeter-Preamp Cable Lengths



Run I EC Calorimeter-Preamp Cable Lengths



Run II EC Calorimeter-Preamp Cable Lengths



Preamplifier

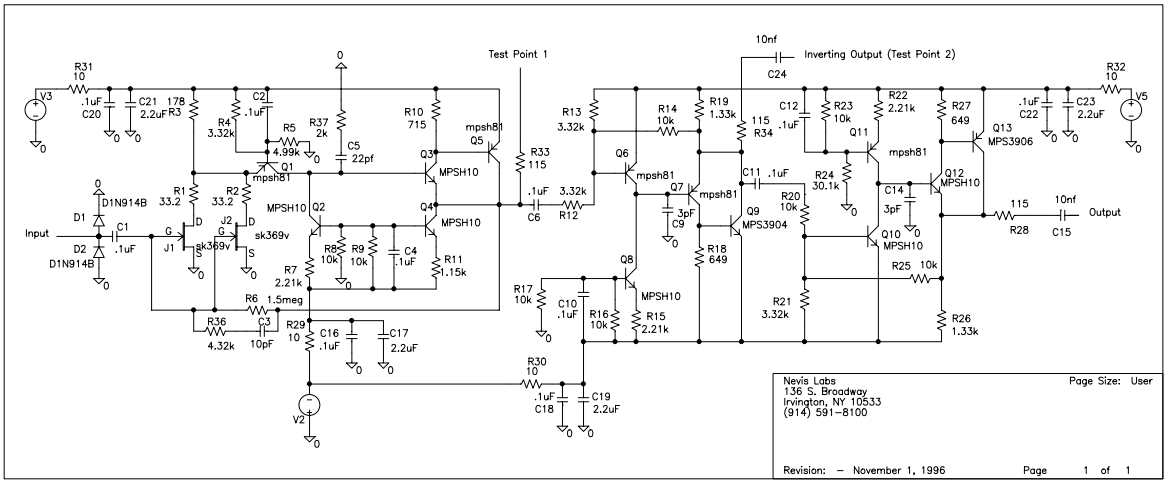
Charge-integrating preamplifier

- high DC open-loop gain
- high DC input impedance
- low input bias current
- low noise
- high linearity

Additional Run II requirements due to faster shaping:

- increased electronic noise ⇒ compensate with two input jFETs instead of one
- sensitive to reflections at BLS input ⇒ preamp output terminated and back-terminated. Driver stages added for
  - ▷ gain to compensate for termination
  - ▷ current drive capability
  - ▷ differential output capability
- sensitive to RC time constant introduced by detector capacitance and cable impedance ⇒ cancel the effect with appropriate peaking circuit in preamp first stage
- sensitive to reflections at preamp input ⇒ tune preamp open loop gain to maintain 30 Ω input impedance

Preamplifier Schematic



Preamplifier Species

Species label	Raw Cap (pF)	w/ Offset (pF)	RMS (pF)	R3 (Ω)	R36 (Ω)	R37 (Ω)	R6 (MΩ)	C3 (pF)	C5 (pF)
A	416	16	150	238	0	0	3	5	10
B	1265	865	218	218	5190	2600	3	5	10
C	2182	1782	420	195	10690	5350	3	5	10
D	4028	3628	594	120	21770	6590	3	5	10
E	403	3	43	239	0	0	1.5	10	22
F	881	481	159	227	1440	660	1.5	10	22
G	1458	1058	176	213	3170	1440	1.5	10	22
Ha	1974	1574	26	200	4720	2150	1.5	10	22
Hb	2296	1896	39	193	5690	2590	1.5	10	22
Hc	2597	2197	143	185	6590	3000	1.5	10	22
Hd	2837	2437	43	179	7310	3320	1.5	10	22
He	3185	2785	77	171	8360	3800	1.5	10	22
Hf	3604	3204	48	161	9610	4370	1.5	10	22
Hg	4088	3688	85	149	11060	5030	1.5	10	22
I (ICD)	0	N/A	0	178	0	0	0.682	22	22

Preamplifier Motherboard Map

Preamp Motherboard Maps 1-4 (384 boards)

CC

Board 1 (192)		Board 2 (64)		Board 3 (64)		Board 4 (64)	
Channel	Species	Channel	Species	Channel	Species	Channel	Species
0	A	0	A	0	A	0	A
1	A	1	A	1	A	1	A
2	E	2	E	2	E	2	E
3	E	3	E	3	E	3	E
4	E	4	E	4	E	4	E
5	E	5	E	5	E	5	E
6	G	6	G	6	G	6	G
7	D	7	D	7	D	7	**A**
8	D	8	D	8	**B**	8	D
9	D	9	D	9	**B**	9	D
10	D	10	D	10	D	10	D
11	A	11	A	11	A	11	A
12	A	12	A	12	A	12	A
13	A	13	A	13	A	13	A
14	E	14	E	14	E	14	E
15	E	15	E	15	E	15	E
16	E	16	E	16	E	16	E
17	E	17	E	17	E	17	E
18	G	18	G	18	G	18	G
19	D	19	D	19	D	19	**A**
20	D	20	D	20	**B**	20	D
21	D	21	D	21	**B**	21	D
22	D	22	D	22	D	22	D
23	A	23	A	23	A	23	A
24	A	24	A	24	A	24	A
25	A	25	A	25	A	25	A
26	E	26	E	26	E	26	E
27	E	27	E	27	E	27	E
28	E	28	E	28	E	28	E
29	E	29	E	29	E	29	E
30	G	30	G	30	G	30	G
31	D	31	D	31	**C**	31	D
32	D	32	D	32	**A**	32	D
33	D	33	**C**	33	D	33	D
34	D	34	**A**	34	D	34	D
35	A	35	A	35	A	35	A
36	A	36	A	36	A	36	A
37	A	37	A	37	A	37	A
38	E	38	E	38	E	38	E
39	E	39	E	39	E	39	E
40	E	40	E	40	E	40	E
41	E	41	E	41	E	41	E
42	G	42	G	42	G	42	G
43	D	43	D	43	**C**	43	D
44	D	44	D	44	**A**	44	D
45	D	45	**C**	45	D	45	D
46	D	46	**A**	46	D	46	D
47	A	47	A	47	A	47	A

Preamplifier Box Map

Preamp Box Map 1

CC

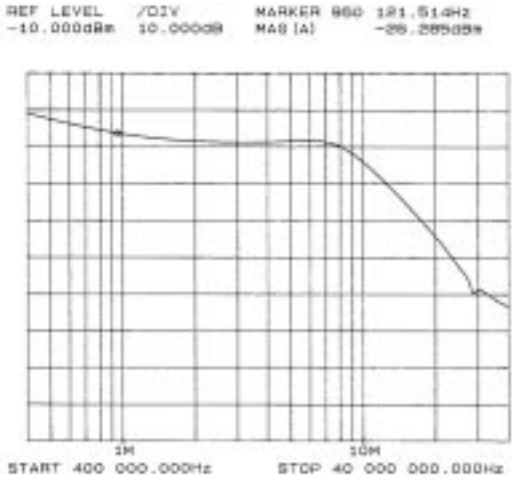
Boxes 2,3,8,9

Location	Board
0	1
1	1
2	1
3	2
4	3
5	4
6	1
7	1
8	1
9	2
10	3
11	4
12	1
13	1
14	1
15	2
16	3
17	4
18	1
19	1
20	1
21	2
22	3
23	4
24	1
25	1
26	1
27	2
28	3
29	4
30	1
31	1
32	1
33	2
34	3
35	4
36	1
37	1
38	1
39	2
40	3
41	4
42	1
43	1
44	1
45	2
46	3
47	4

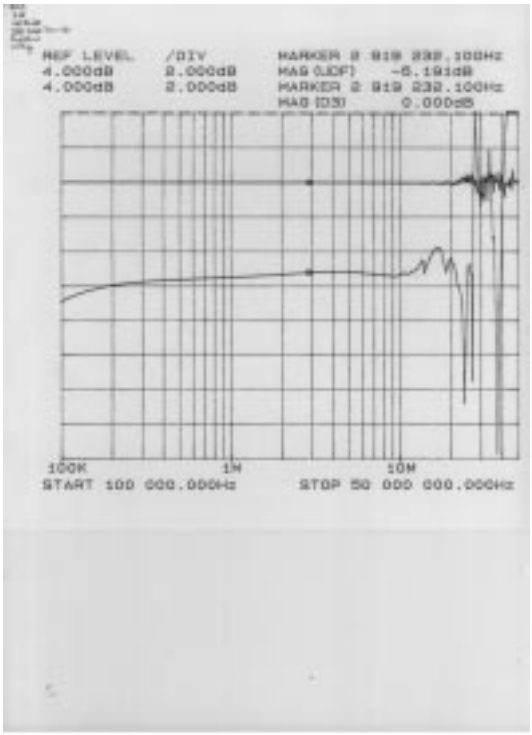
Location	Board
48	1
49	1
50	1
51	2
52	3
53	4
54	1
55	1
56	1
57	2
58	3
59	4
60	1
61	1
62	1
63	2
64	3
65	4
66	1
67	1
68	1
69	2
70	3
71	4
72	1
73	1
74	1
75	2
76	3
77	4
78	1
79	1
80	1
81	2
82	3
83	4
84	1
85	1
86	1
87	2
88	3
89	4
90	1
91	1
92	1
93	2
94	3
95	4

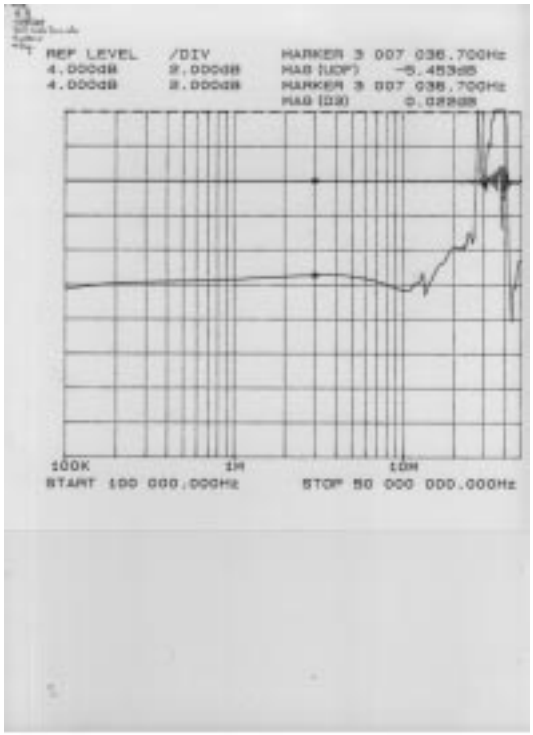
Preamplifier Response Measurements

Gain *vs* Frequency



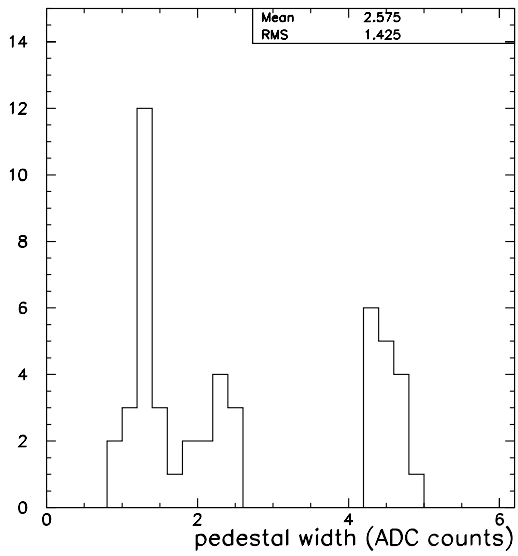
Input Impedance *vs* Frequency

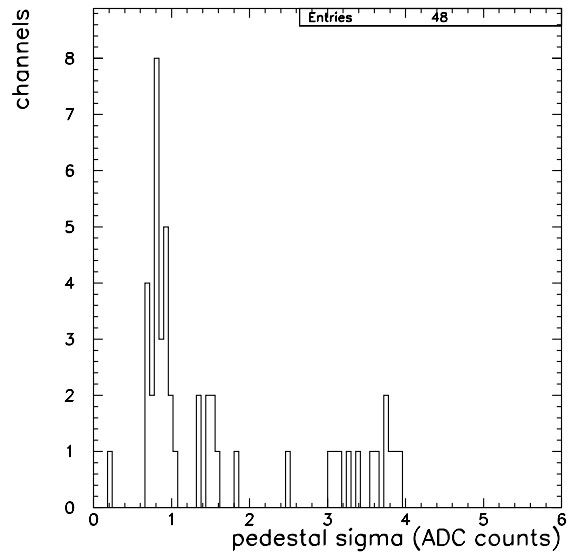




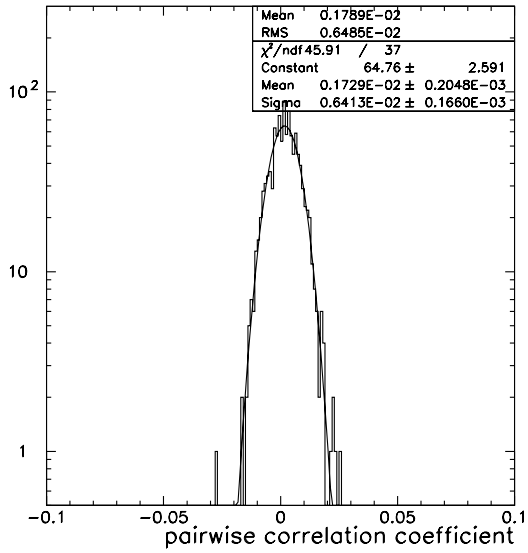
Comparative Noise Measurements

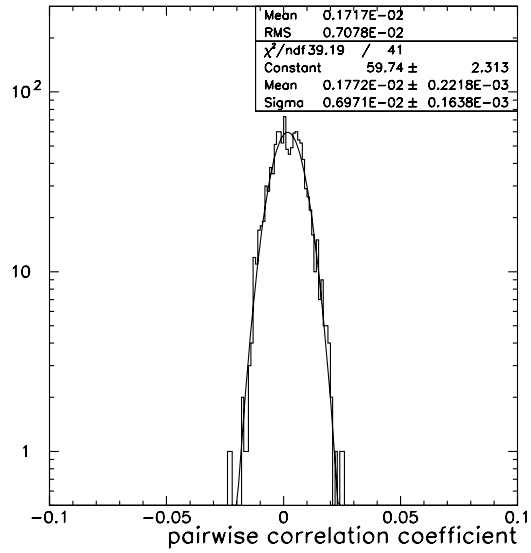
Uncorrelated Noise



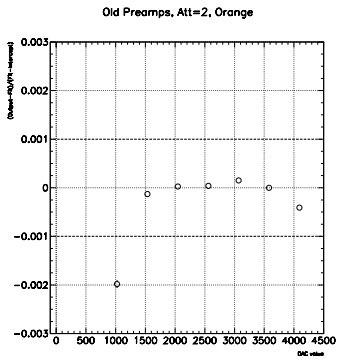


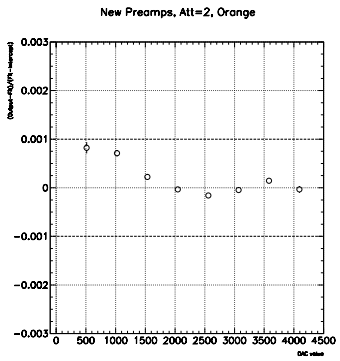
Correlated Noise

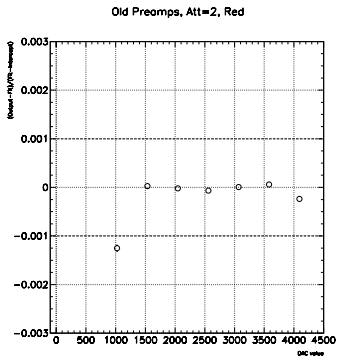


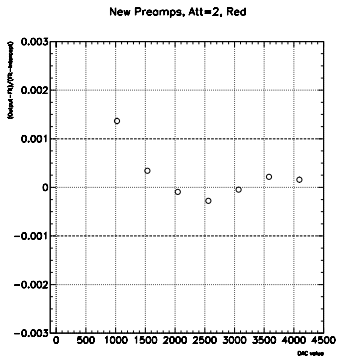


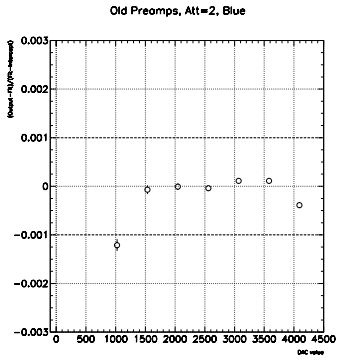
Comparative Linearity Measurements

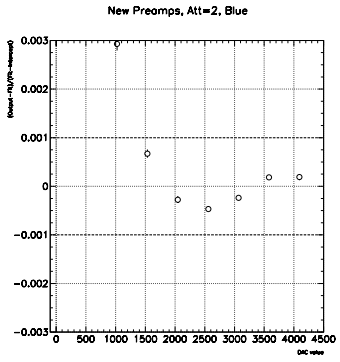












Preamplifier Motherboard

8-layer printed circuit board : noise and cross-talk minimized with

- ground or power planes of solid copper separating buried signal planes
- grounded copper pour around signal traces
- RC filter on power lines with 1/4 Ω resistors and three capacitors (150 μF, 4.7 μF and 0.1 μF) to attenuate high and low frequency ripple (high frequency capacitors on both ends of board)
- all components surface-mounted to prevent high frequency radiation and pickup from lead ends

Capacitance of all calibration pulser signal traces equalized

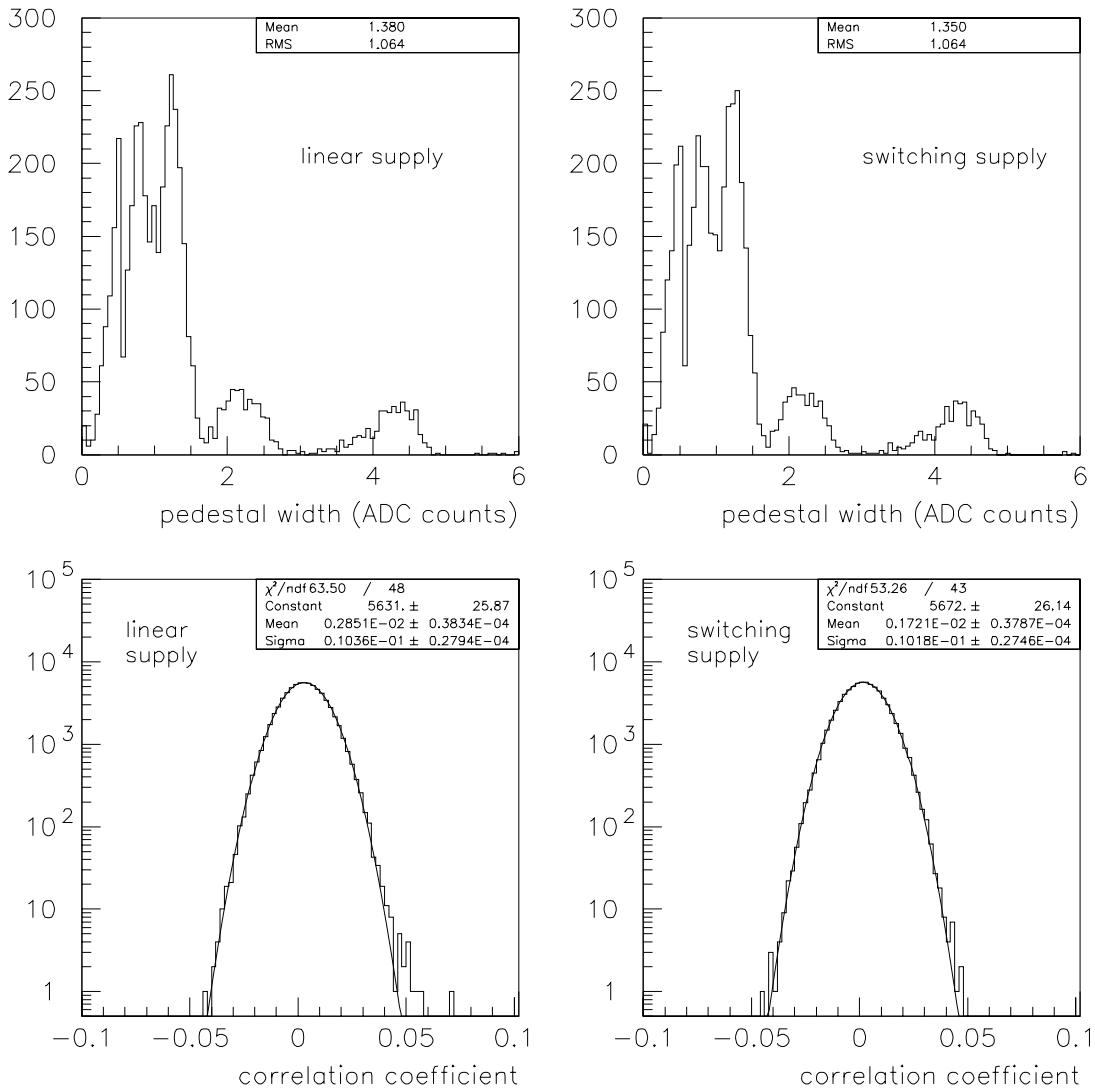
Dual-row of pins on preamplifier connectors for better mechanical stability

Keying pins to ensure preamplifiers are correctedly mounted

Preamplifier Power Supply

preamplifier power dissipation 80 mW (Run I) ⇒ 280 mW (Run II)

more efficient switching supplies to be used, noise performance good



magnetic shielding required

Preamplifier System Status

120 ceramic hybrid engineering samples built and tested, performance satisfactory

preamp and motherboard design finalized

5000 channel pre-production run to start soon

preamp power supply tested, noise performance satisfactory

magnetic shielding for power supply in design