DØ Note 3393
version 2

Preamp Species Summary

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1 Introduction

In the absence of any detector capacitance, all cells will produced identical triangular output shapes. However, variations in detector capacitance produce some intrinsic deviations in shape. The preamps are divided into fourteen species as a means to counteract these deviations. In this note, I present relevant information describing the characteristics of the fourteen species. I also list the quantities required for the species (I) to be used in the intercryostat detector (ICD).

2 Preamp Design

A complete discussion of the preamp design can be found in the Technical Design Report for the Calorimeter Electronics Upgrade [1, section 4.2].

The division of the preamps into species is required to achieve equal compensation. Compensation works as follows: The integrating feedback capacitor is replaced with an RC circuit, which partially differentiates the output. This counteracts the partial integration performed by the detector RC network (detector capacitance plus cable impedence), giving the desired output of the original charge deposited in the detector. The different parts of the detector have different capacitances, so one needs to adjust the RC compensation circuit for the different detector regions.

In addition, there is an open loop gain adjusting RC circuit which helps to pull out the charge from the detector faster than the RC detector network would otherwise allow. This is required due to the run II bunch spacings of 396 and 132 ns.

Ideally, these features would produce a uniform output waveform and uniform input impedence for all channels. However, because we are not building 47,032 different preamps, there are some deviations in waveform.

3 Species

At the initial level of preamp subdivisions, there are two sets of four species. One set corresponds to the EM3 and EM4 layers which tend to produce more charge than the other layers, and thus have a higher feedback capacitance (10 pF). The EM1, EM2, and hadronic layers comprise the other set and all have 5 pF feedback capacitance.

The four species within a set correspond to increasing detector capacitance. The small capacitance associated with the EM1 and EM2 layers puts these layers all in species A, the uncompensated species. A complete breakdown of species with layer is given in figures 1 through 15 where the x-axis labels layer in the following manner:

- 1: CC EM1,EM2
- 2: CC EM3
- 3: CC EM4
- 4: CC Hadronic
- 6: EC EM1,EM2
- 7: EC EM3
- 8: EC EM4
- 9: EC Hadronic

There are several points to note from these plots. First, and most obvious, the last 10 pF feedback species (H) has been subdivided into six different species. The motivation for this can be seen from figure 24, which shows six or seven individual peaks within this last species (in this figure the x-axis is detector capacitance). These peaks correspond to EM3 and EM4 layers in the EC and these layers are valuable enough to have their own species, where necessary. It should be noted that the H plots in this note correspond to the sum of all the H subdivisions, and *not* to a separate species.

Another important point is that species B, C, and D are purely hadronic. These species tend to correspond to a wide range of capacitances since the hadronic layer tends to come in a wide range of shapes. These species spill over into other species' ranges (figures 18 to 20) because of an attempt to minimize specialization of installation.

Finally, only the CC EM3 layer is placed in species E to narrow the capacitance peak (figure 21). Species F, G, and H contain EC EM3 and EM4 layers. All of the CC EM4 channels are in species G.

Each histogram of capacitance for a given species determines the RC feedback and open-loop-gain circuits for that species. Figure 32 shows the detector capacitances as well as the values for the RC feedback and gain circuits (R36, R37, C3, and C5). There is a column 'w/ Offset,' which is the capacitance actually used in compensation. Since this offset is -400 pF, there is an overall undercompensation in the RC circuit; however, the waveform still appears uniform throughout the detector. The product of R36 and C3 is equal to the product of the detector capacitance (w/ offset) and the cable impedence. This is how R36 is determined. The same method is used to determine R37, where C5 is the fixed gain capacitance. The species A and E are set as the uncompensated species against which all other species are compared. This is how the offset is determined. The ICD preamp type I is included in this figure.

A final, and perhaps most useful, set of plots (figures 34 to 49) show the detector capacitance vs. eta for the different species. The x-axis is eta times ten and the y-axis is detector capacitance. For species A, the 'CC only' portion is also shown (figure 35). Comparison of this with the complete species A capacitance vs. eta plot shows the creeping of hadronic layers into species A (high capacitance values) and the EM layers of the EC (high eta values). These plots also demonstrate that species E is CC only and species F and H are EC only.

4 Species Maps

In order to facilitate the placement of preamp species in the correct channels corresponding to the correct parts of the detector, there is a set of nineteen motherboard board maps corresponding to the total number of different arrangements of preamps on the motherboards. For the CC, only four motherboards are needed due to the simplicity in detector design. These motherboard layouts are shown in figure 50. The EC motherboard layouts are shown in figures 51 to 54. In the CC maps, differences from board one are noted in boldface type. In the EC maps, the differences between sets of phi for a given eta are noted in bold. Finally, all channels which do not have a corresponding detector input are marked with a *.

The placement of the motherboards in the boxes also requires a set of maps, shown in figures 55 and 56. Every sixth board on one side of each EC box is a hadronic board, corresponding to board five. Aside from that, the EC has a pattern which alternates every six boards. This corresponds to a detector pattern of switching capacitances for every fourth phi. The basis for these switching capacitances is believed to be the copper wires running on the edges of every other detector piece.

References

[1] O. Abdrashitov et al, *Calorimeter Electronics Upgrade for Run 2 (Technical Design Report, Version 1.7)*

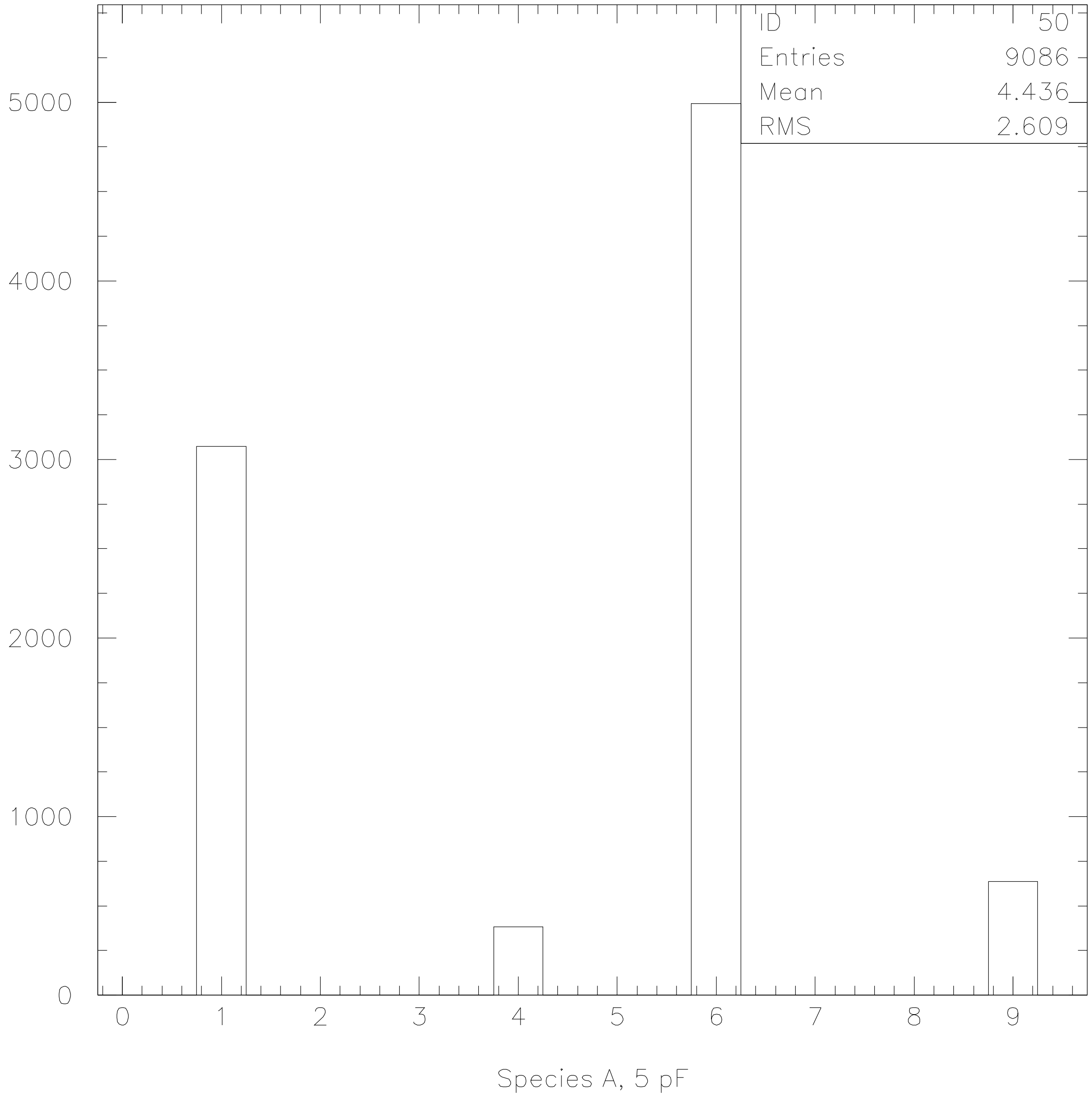

Figure 1: Number of A species vs. layer.

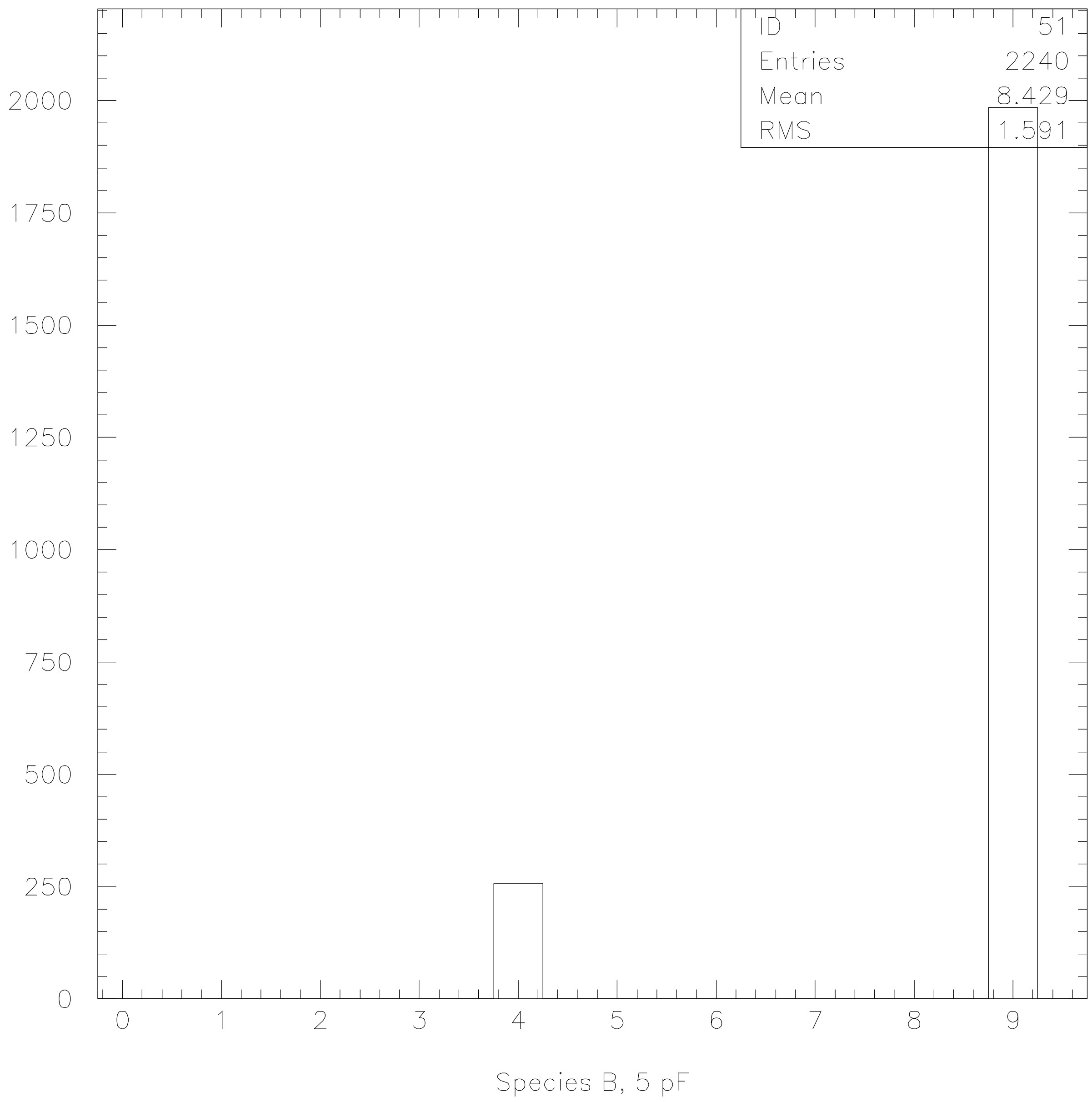

Figure 2: Number of B species vs. layer.

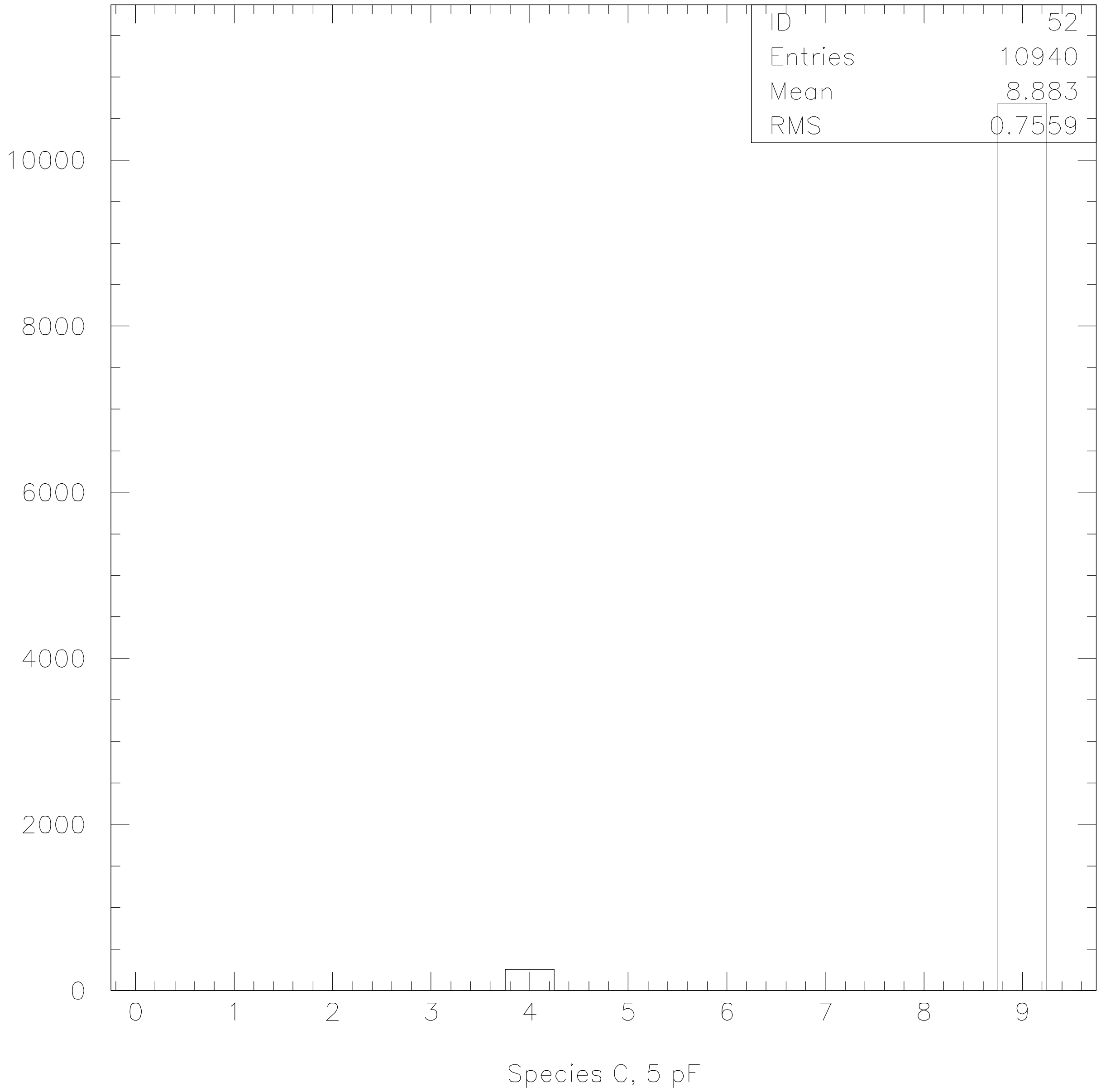

Figure 3: Number of C species vs. layer.

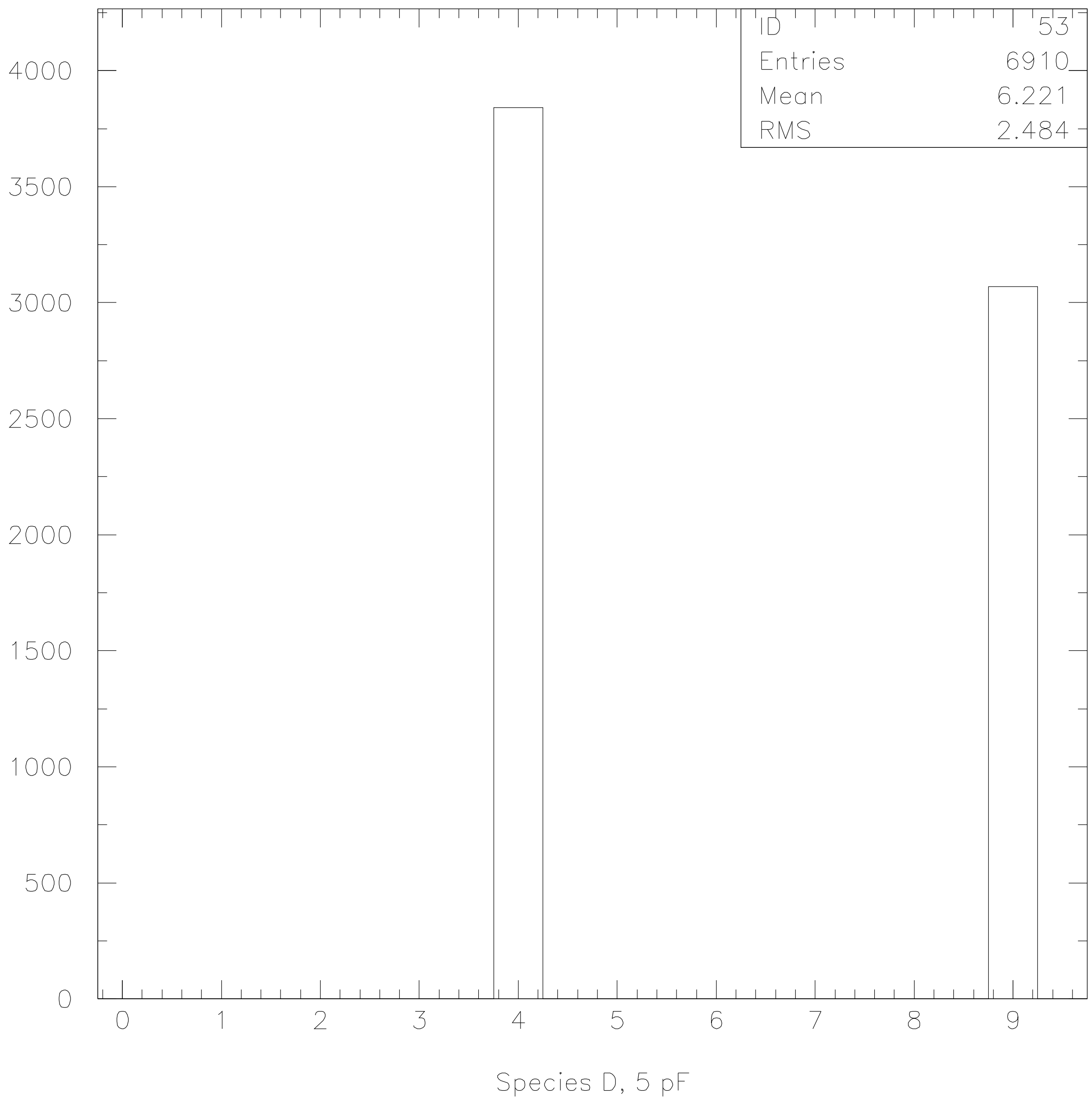

Figure 4: Number of D species vs. layer.

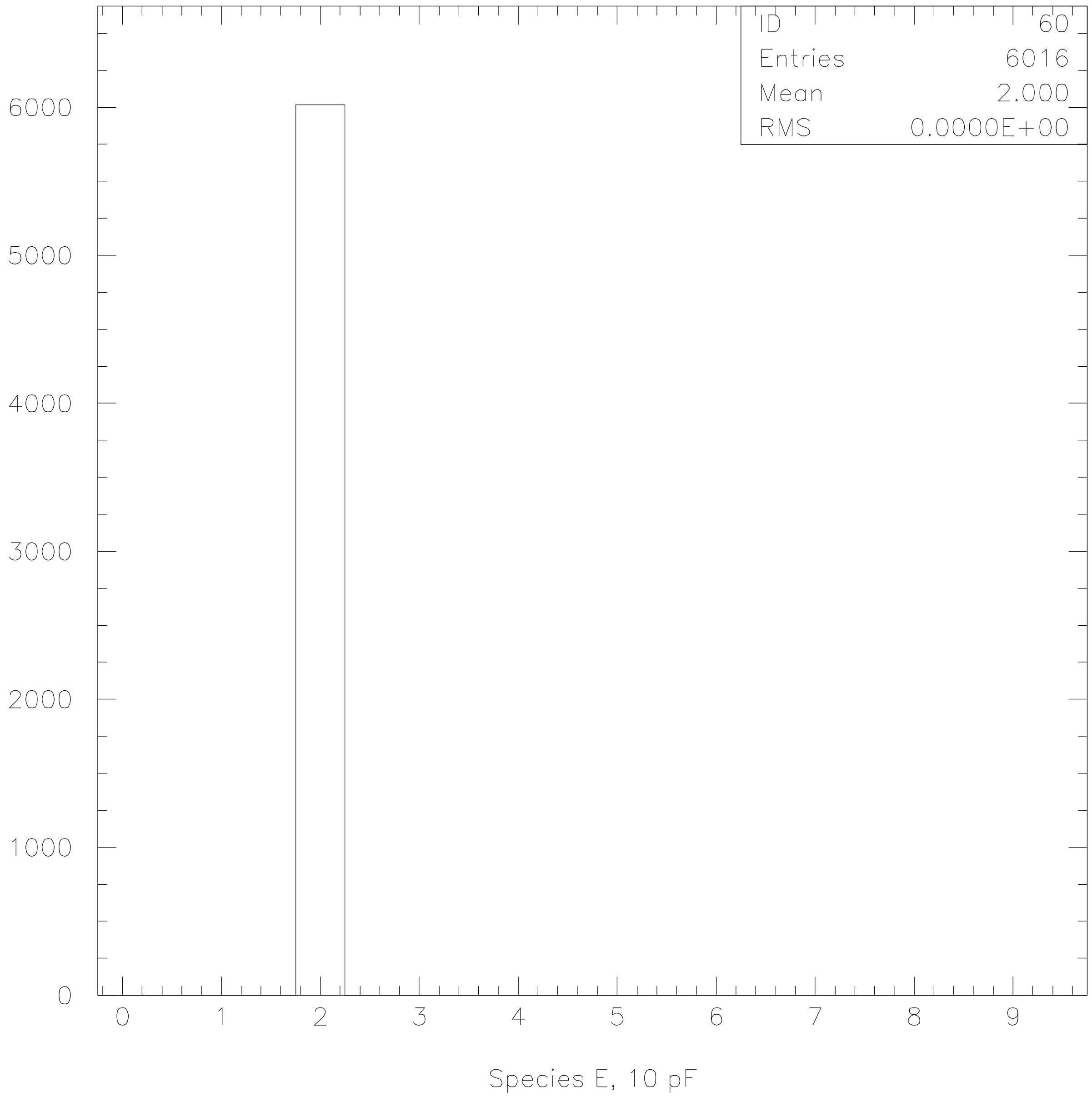

Figure 5: Number of E species vs. layer.

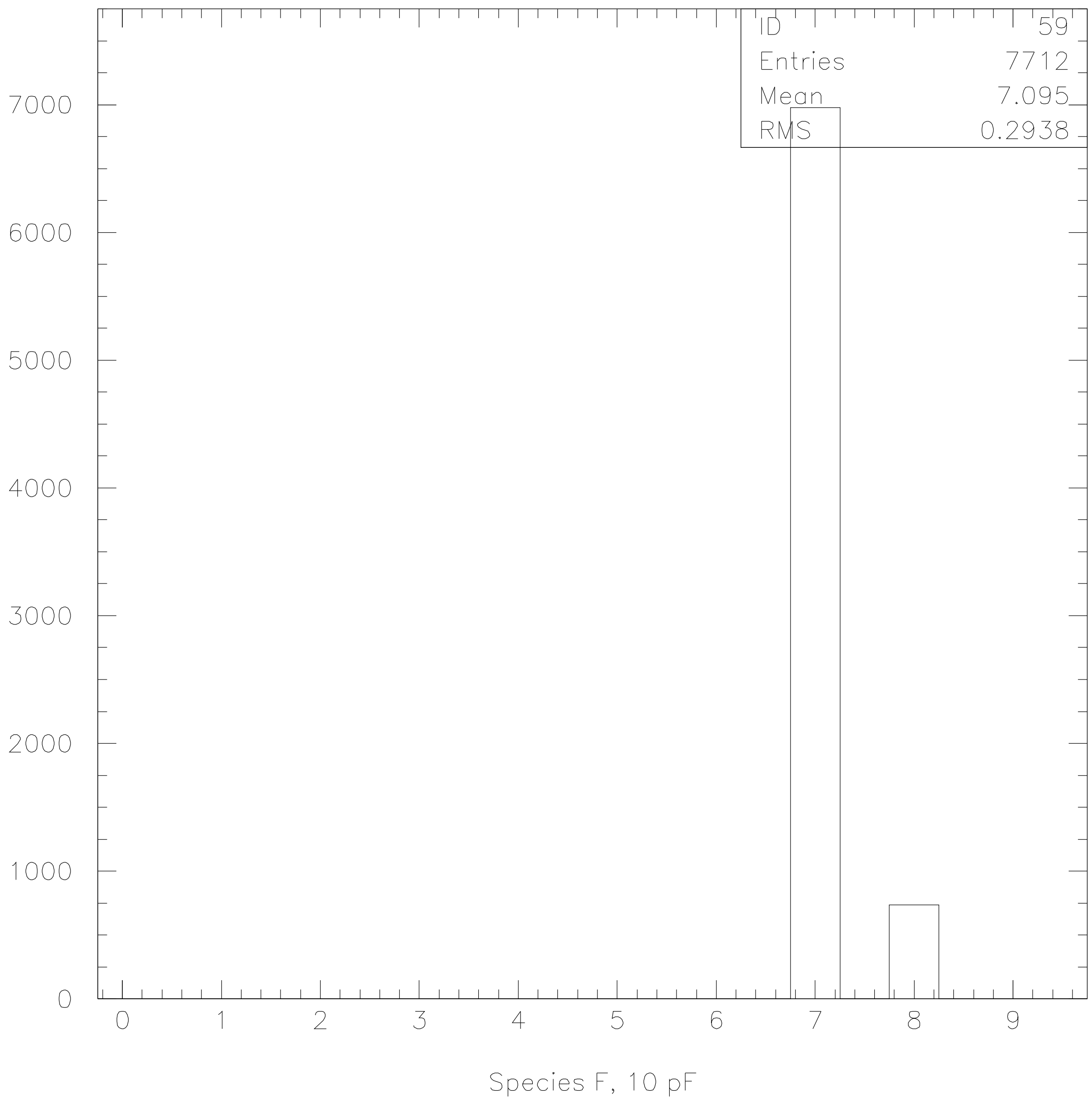

Figure 6: Number of F species vs. layer.

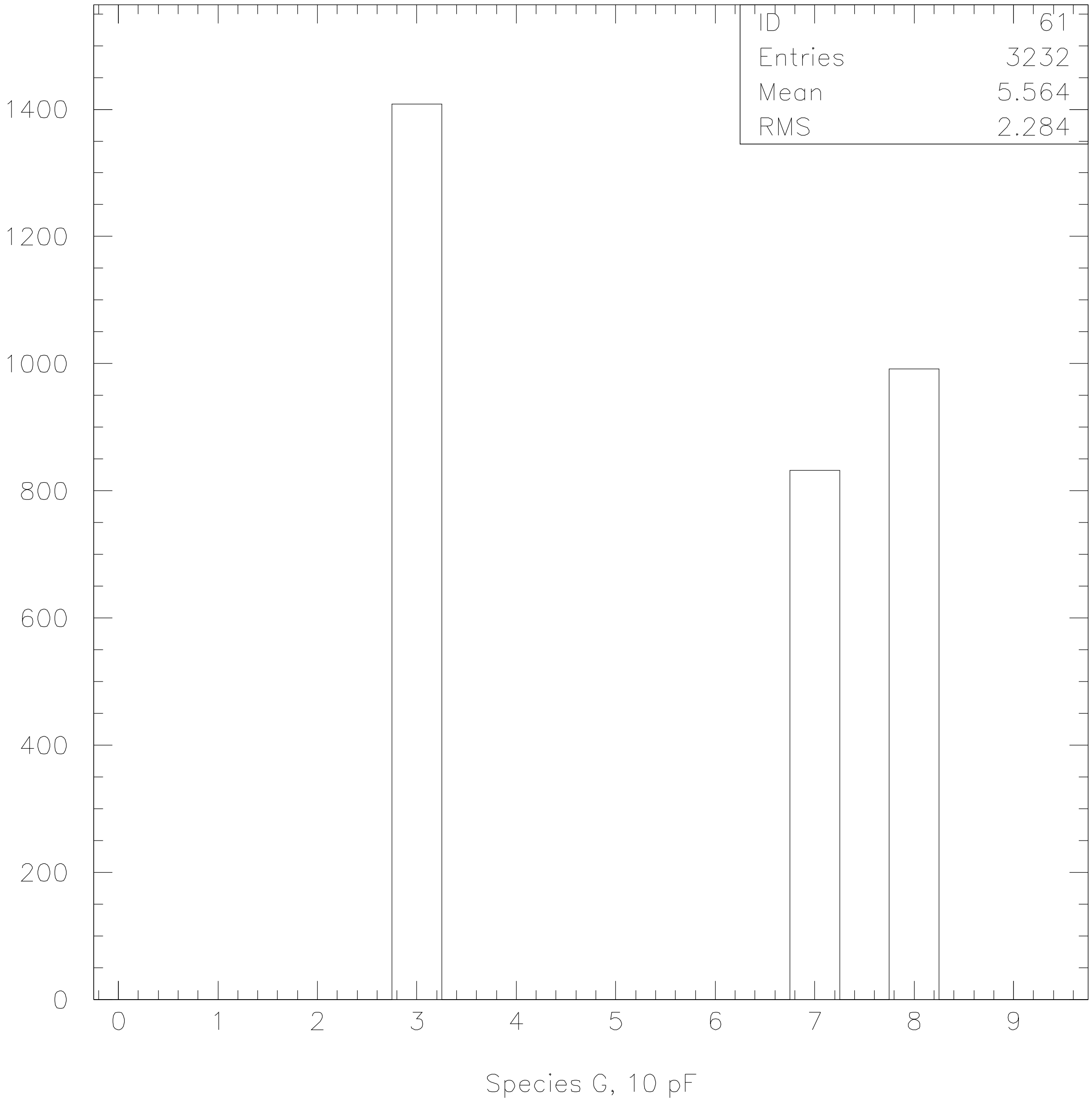

Figure 7: Number of G species vs. layer.

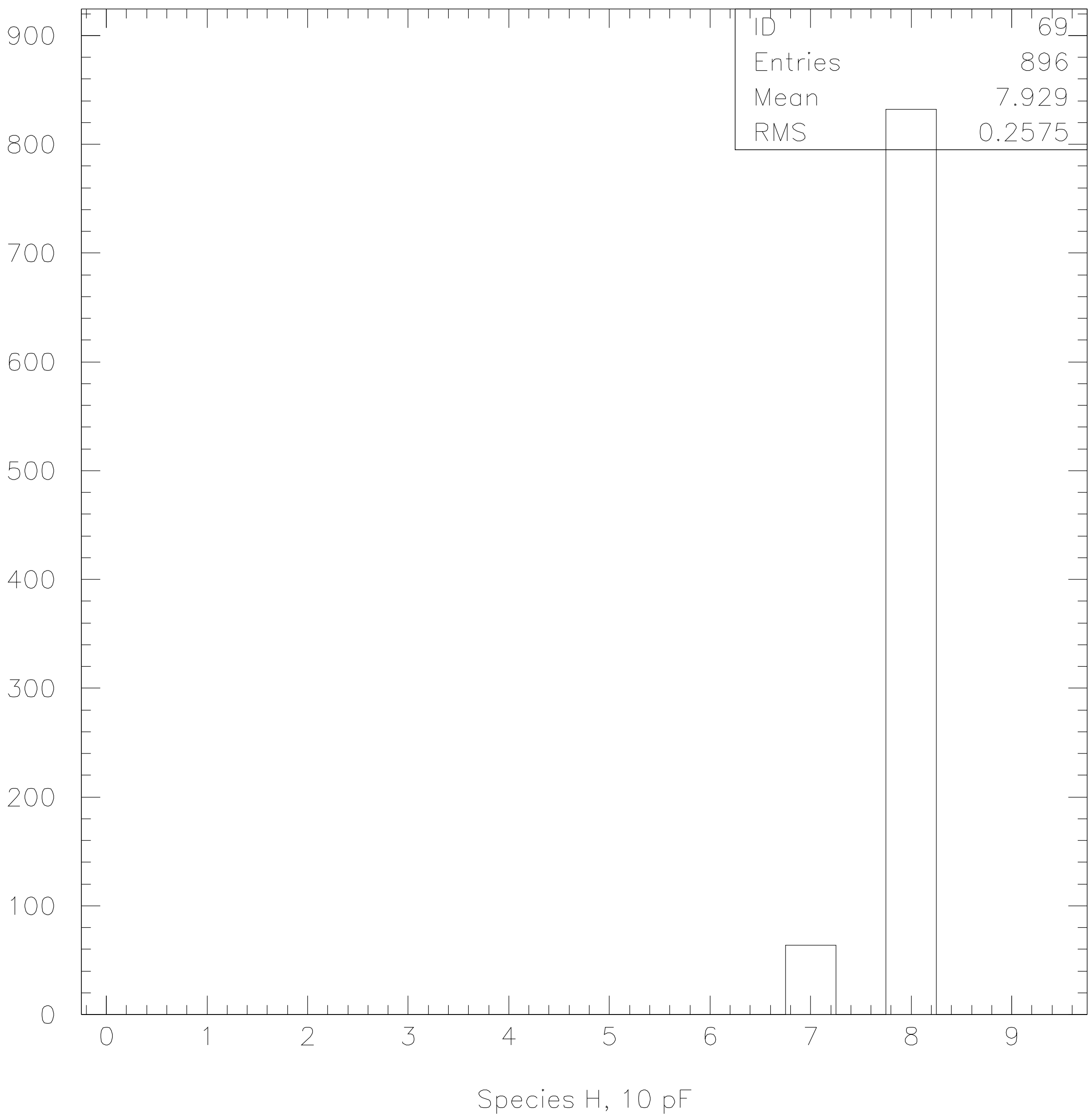

Figure 8: Number of H species vs. layer.

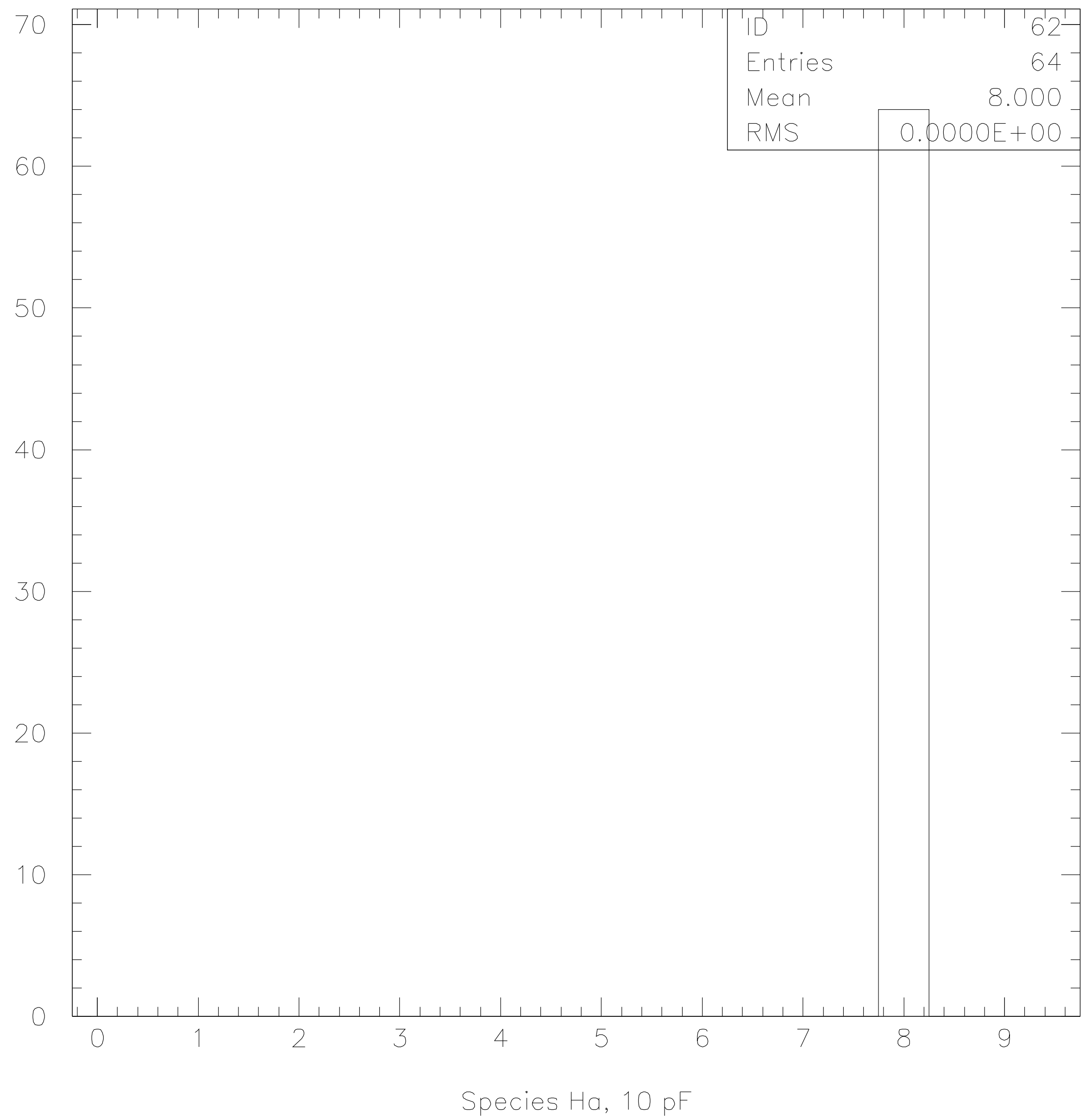

Figure 9: Number of Ha species vs. layer.

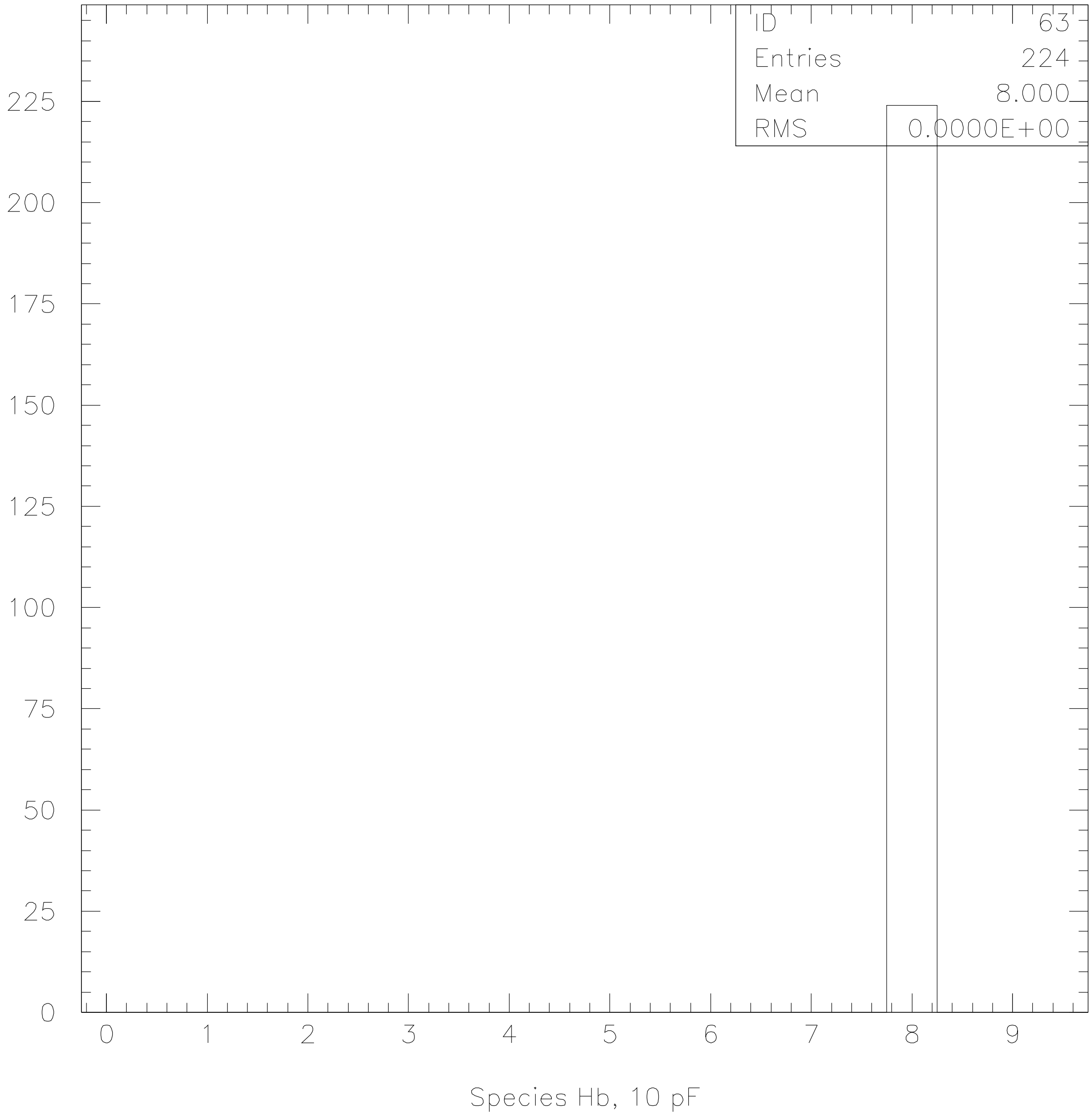

Figure 10: Number of Hb species vs. layer.

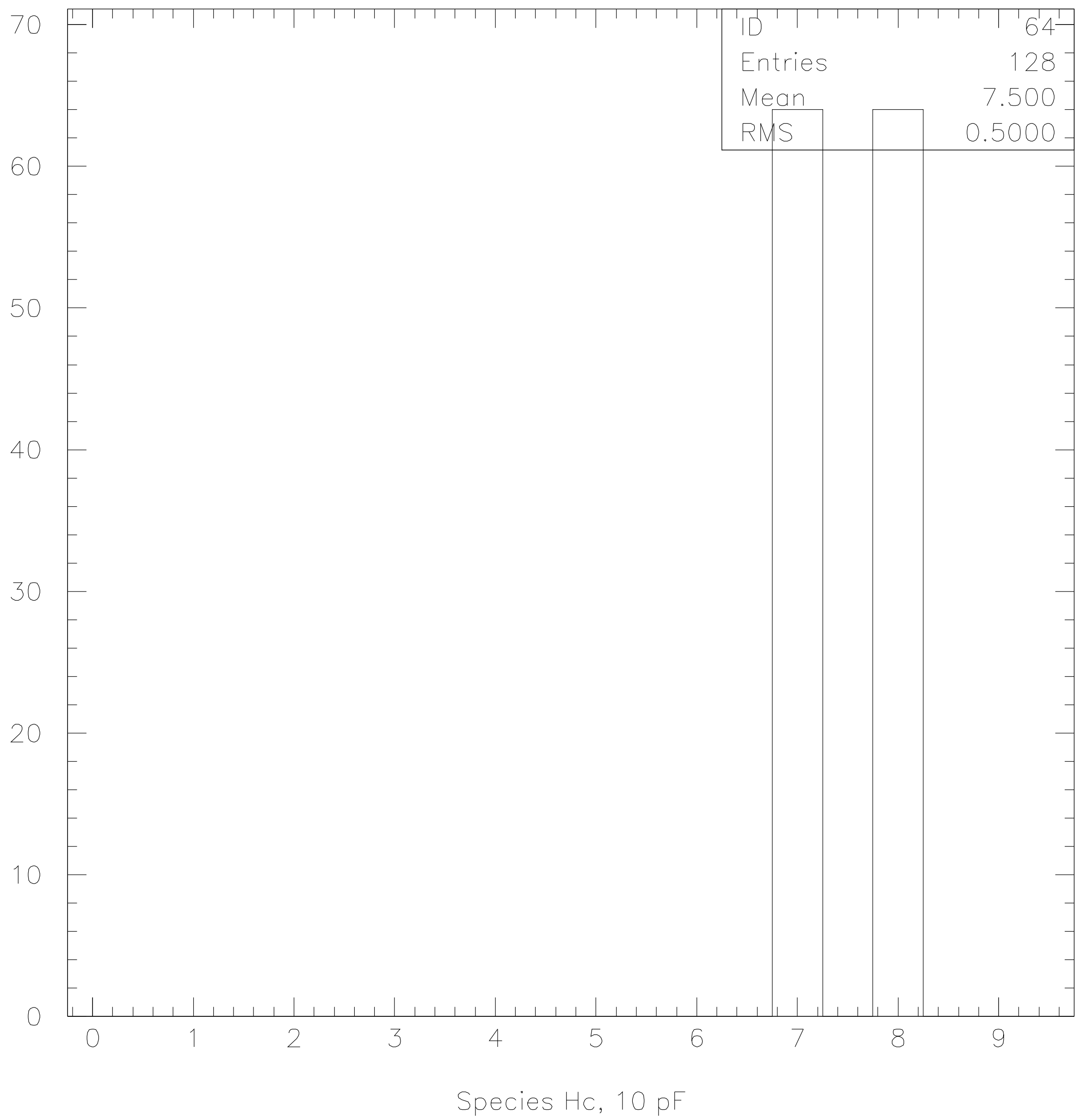

Figure 11: Number of Hc species vs. layer.

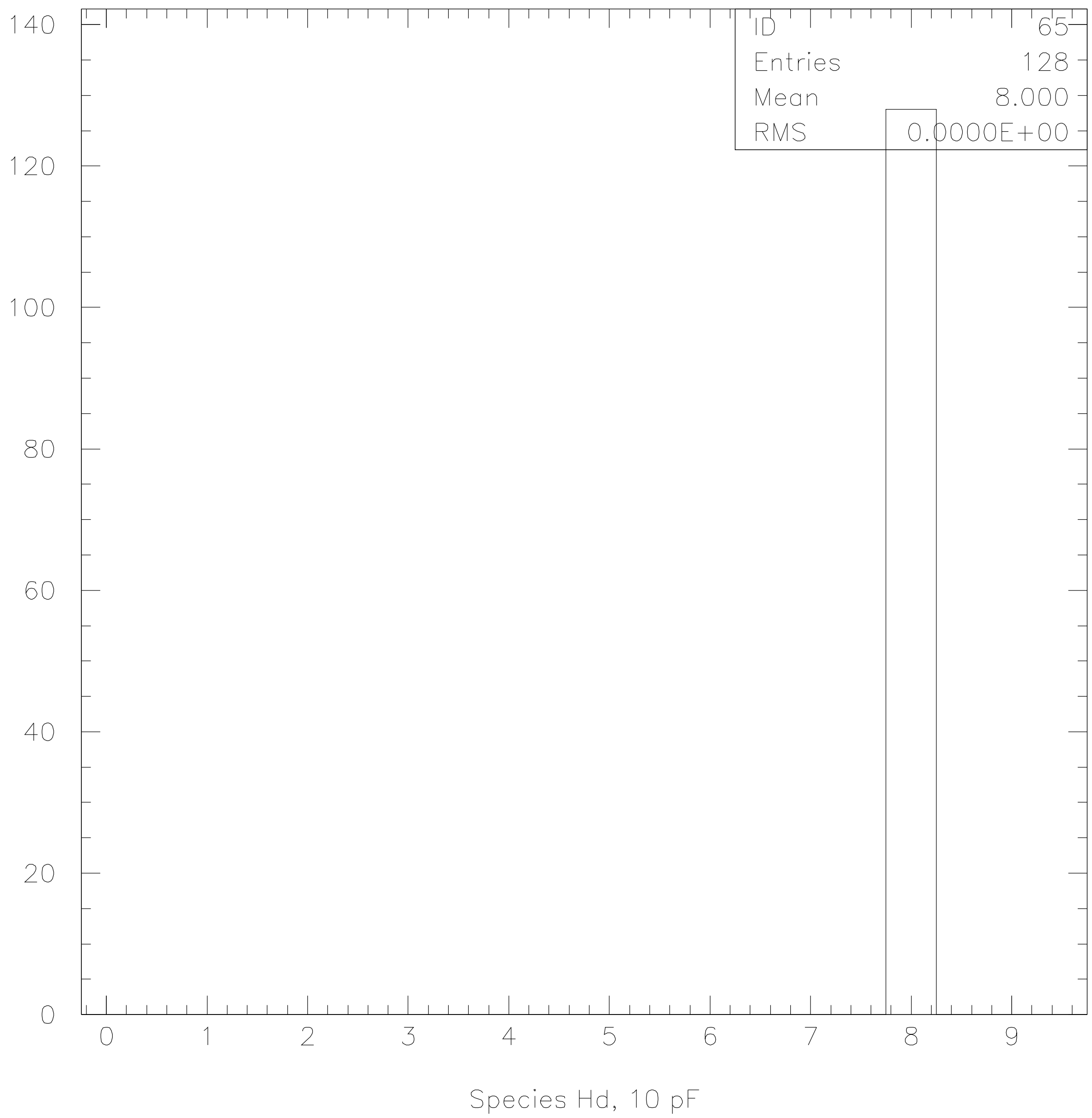

Figure 12: Number of Hd species vs. layer.

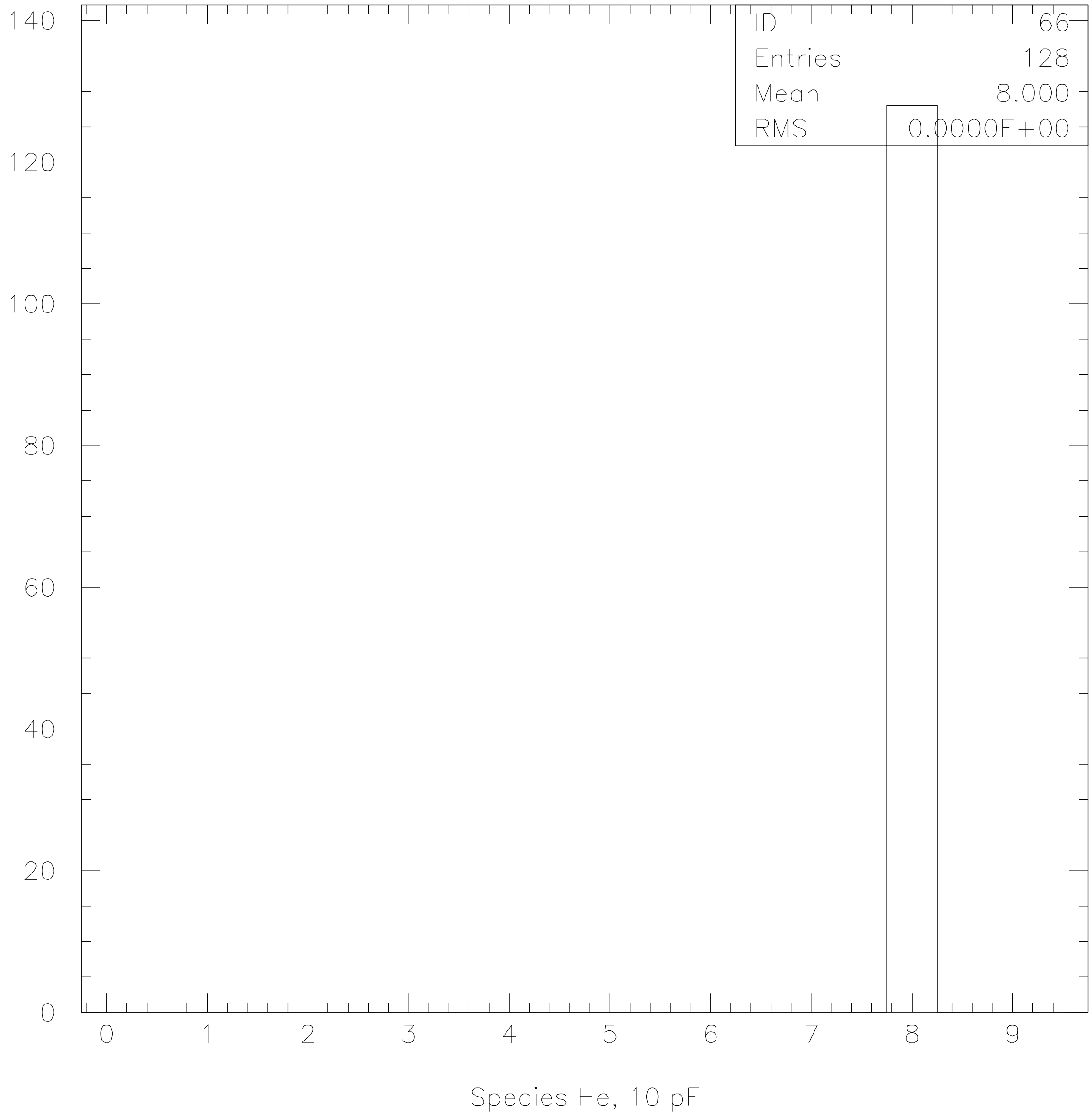

Figure 13: Number of He species vs. layer.

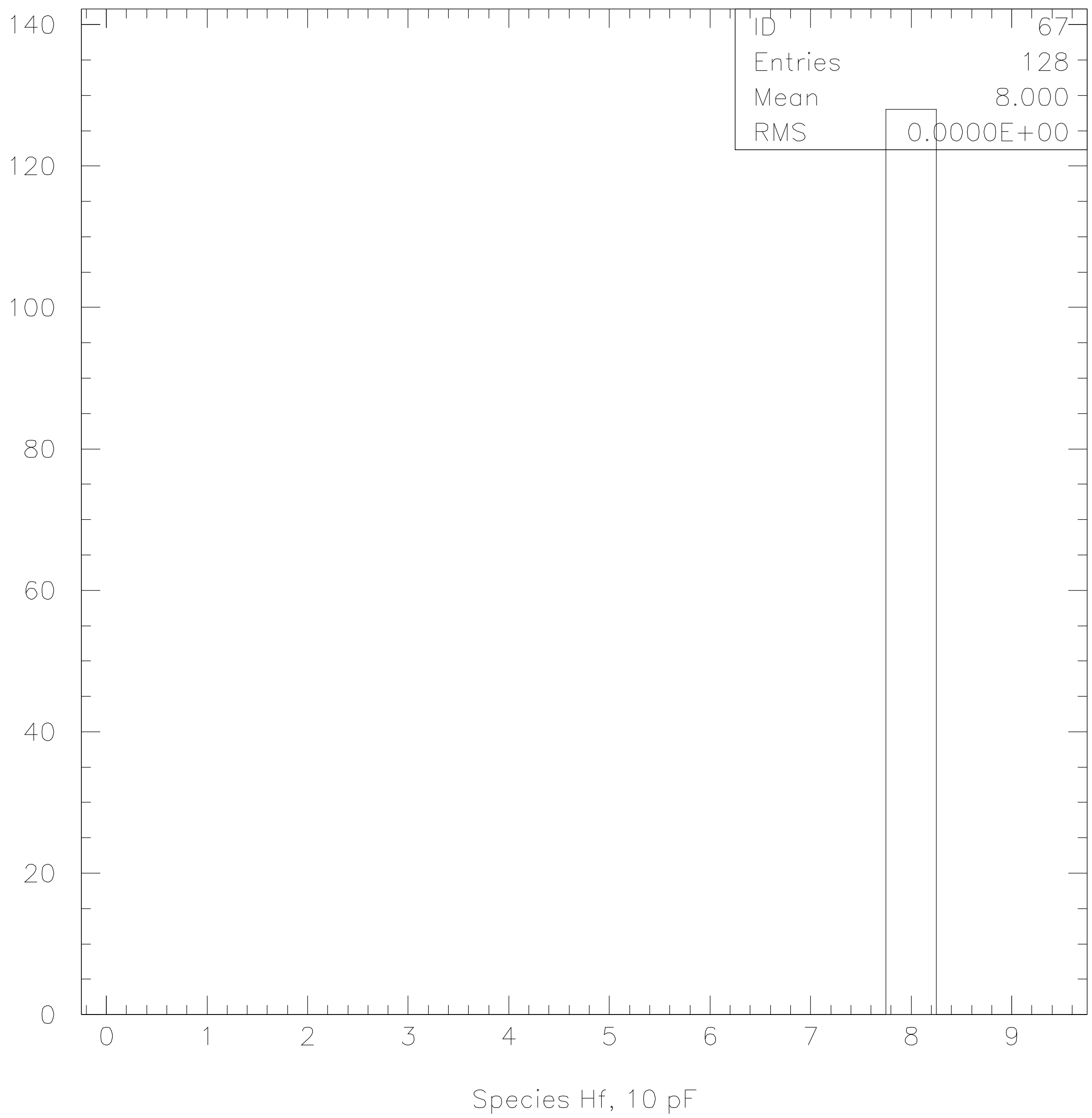

Figure 14: Number of Hf species vs. layer.

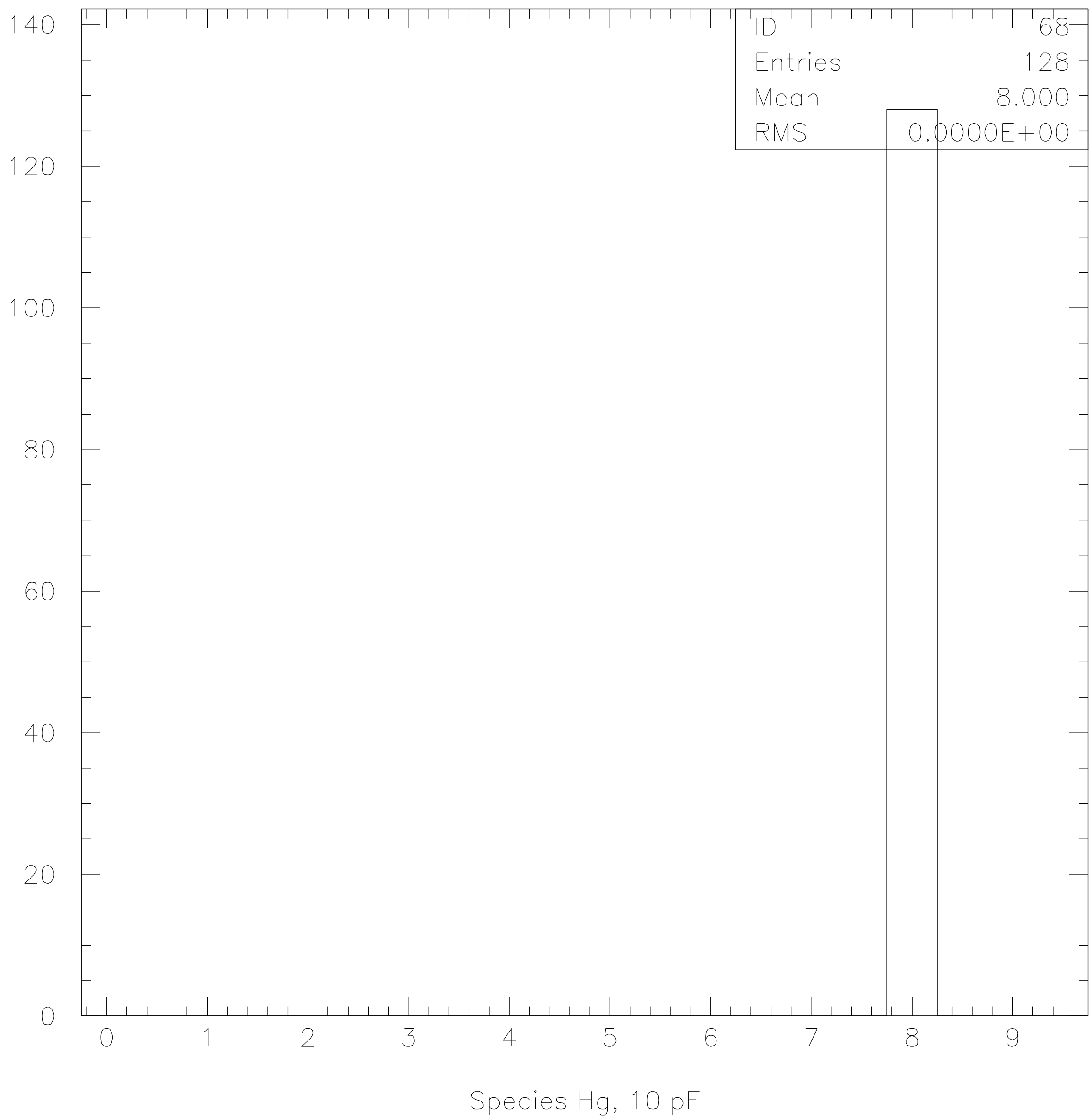

Figure 15: Number of Hg species vs. layer.

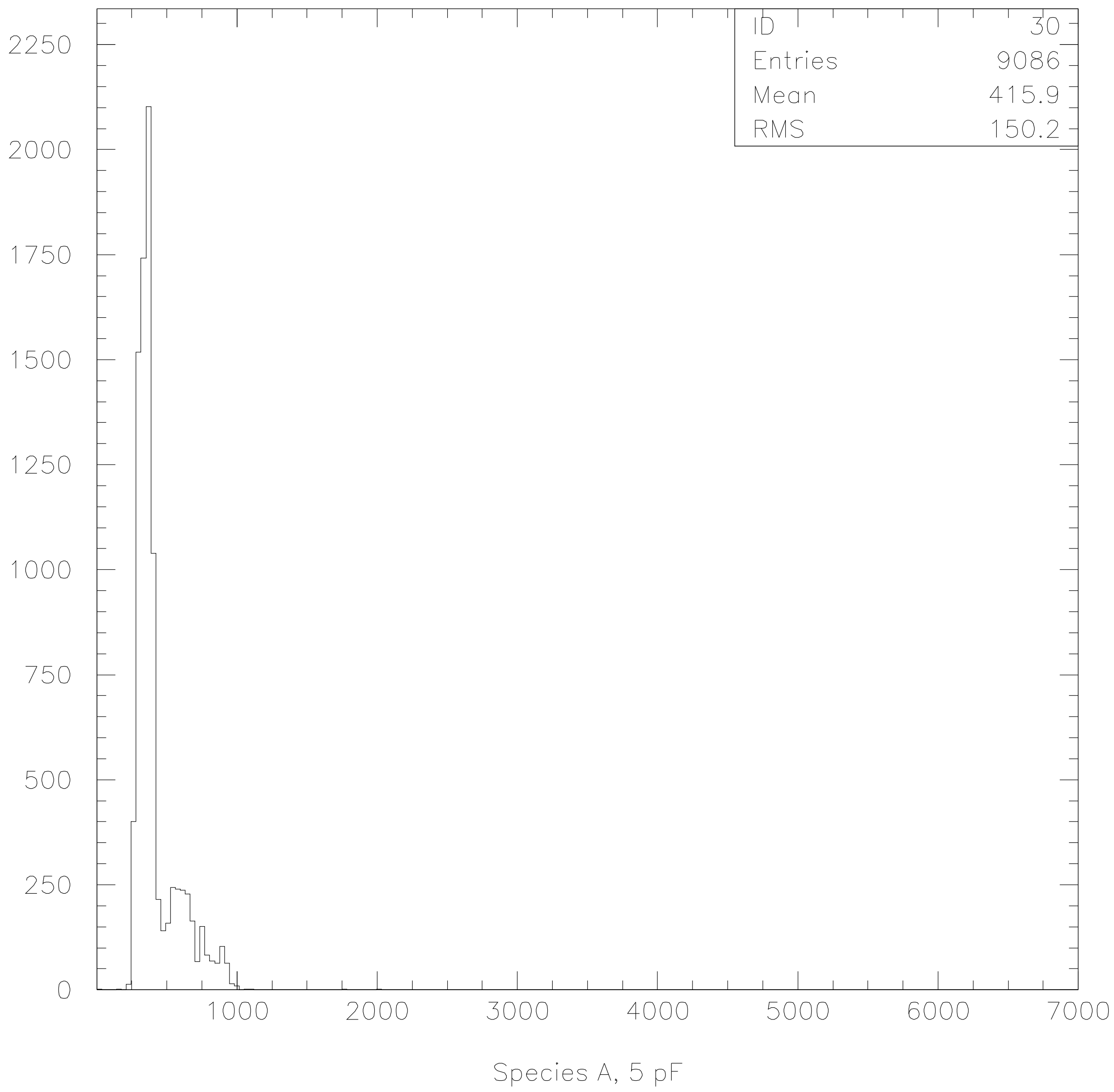

Figure 16: Number of A species vs. capacitance.

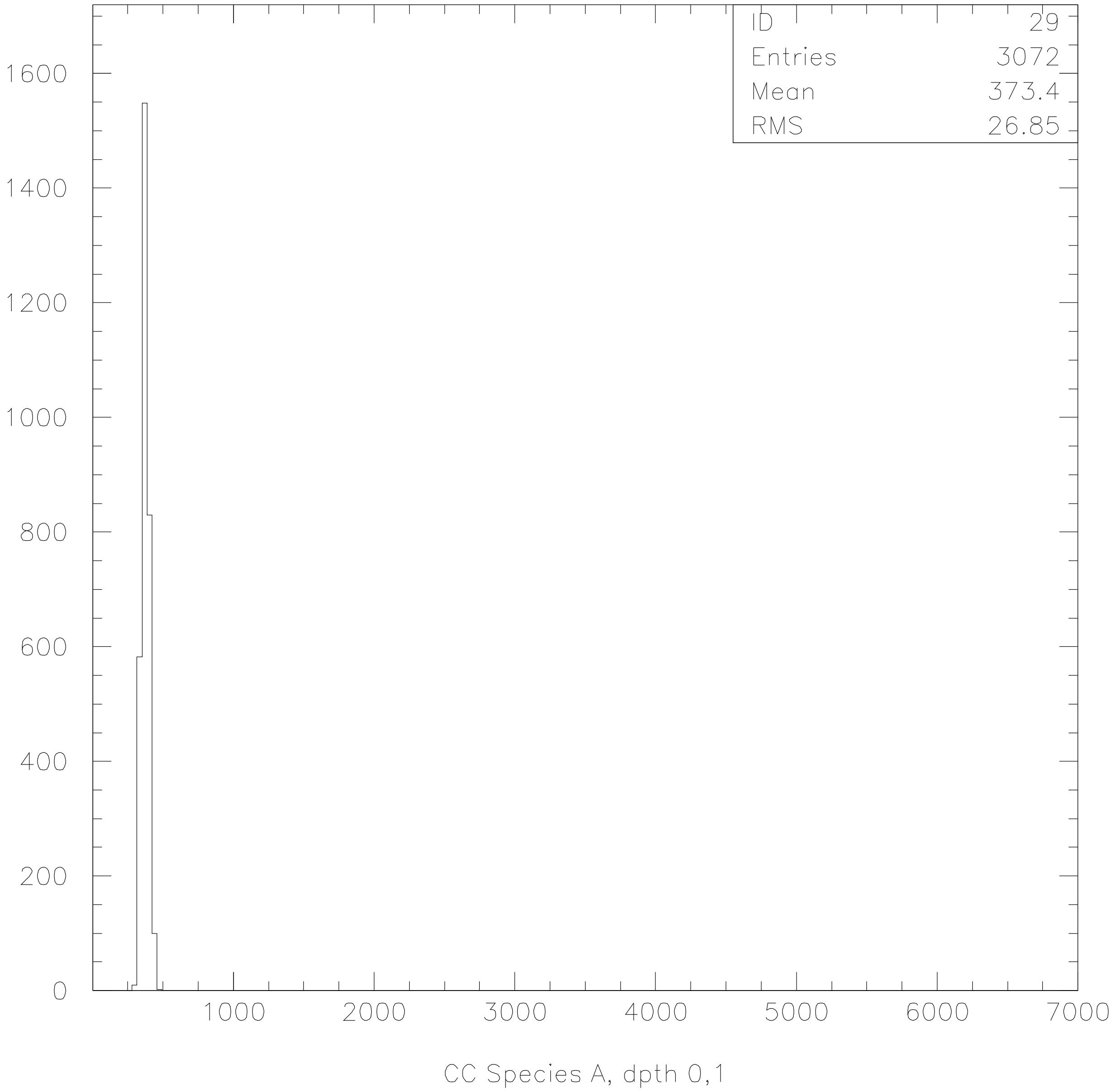

Figure 17: Number of CC A species vs. capacitance.

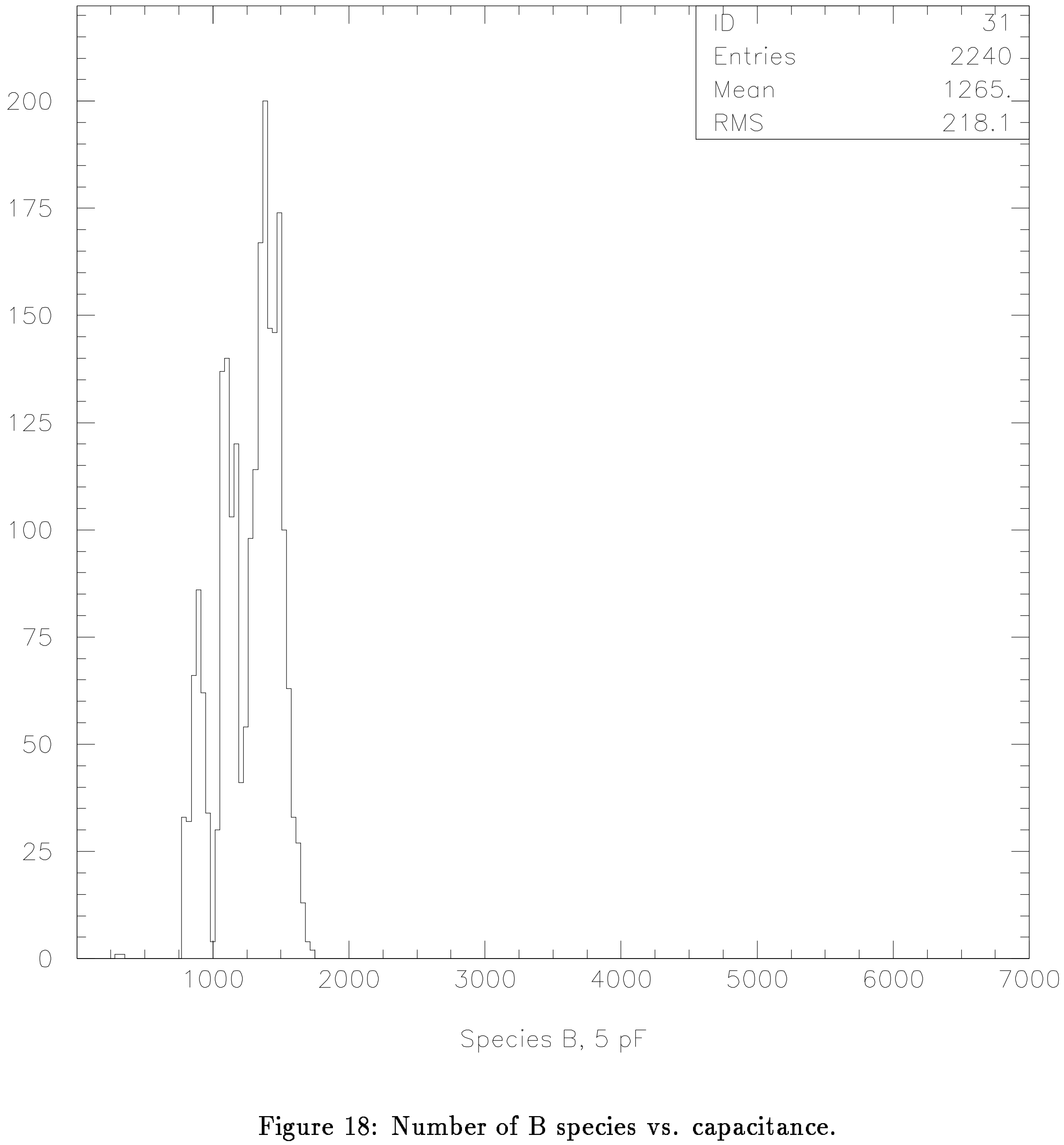

Figure 18: Number of B species vs. capacitance.

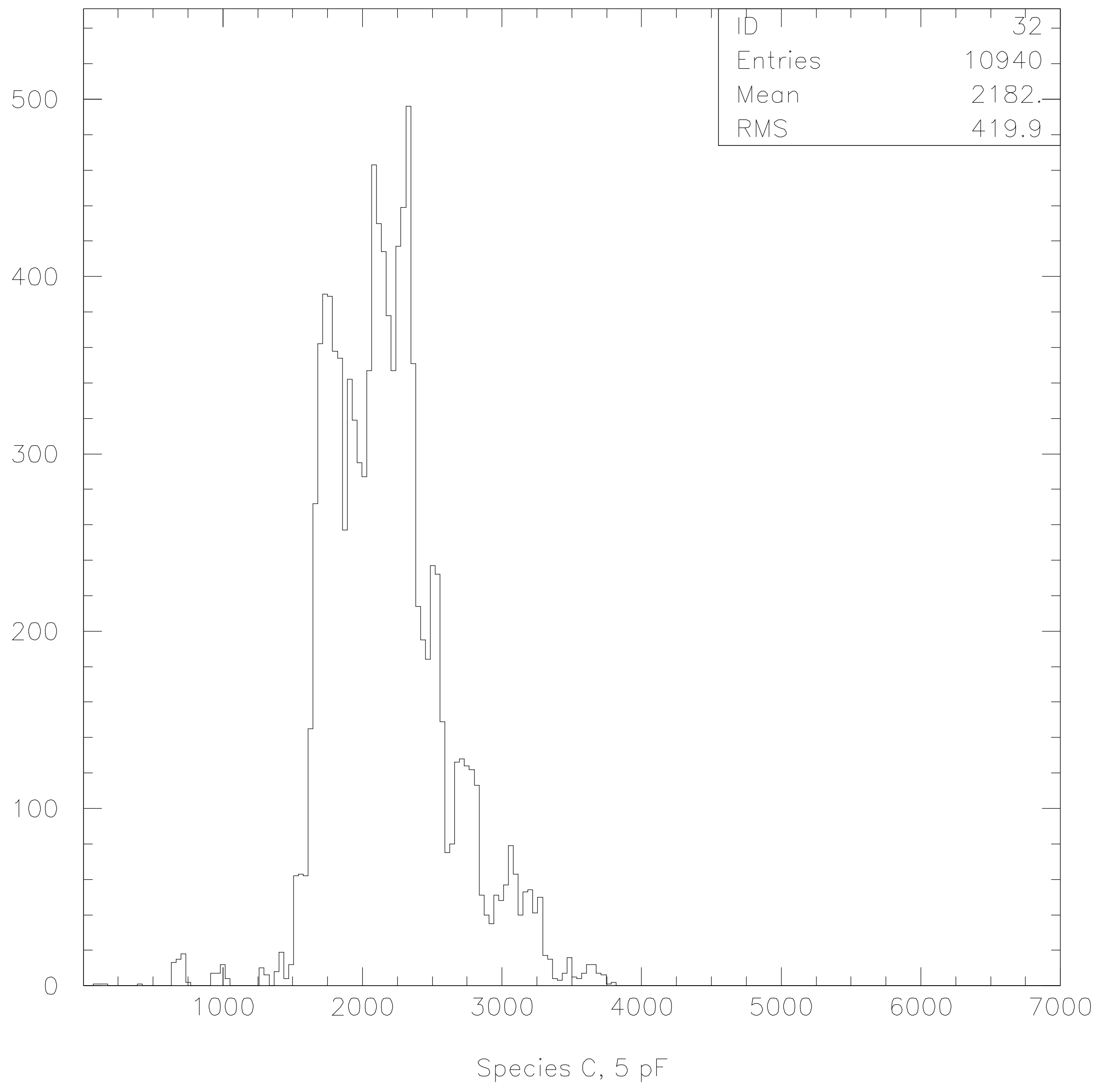

Figure 19: Number of C species vs. capacitance.

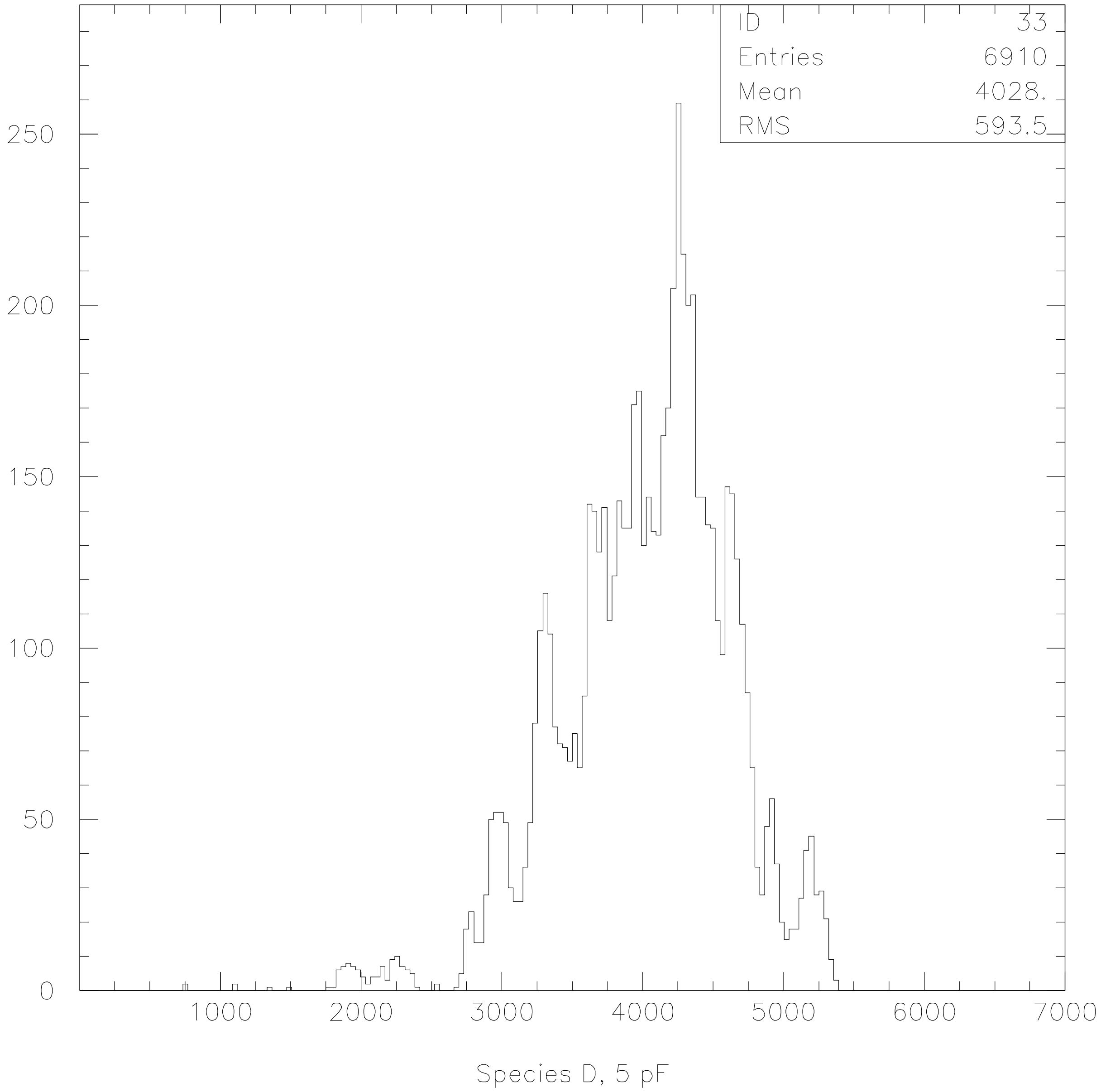

Figure 20: Number of D species vs. capacitance.

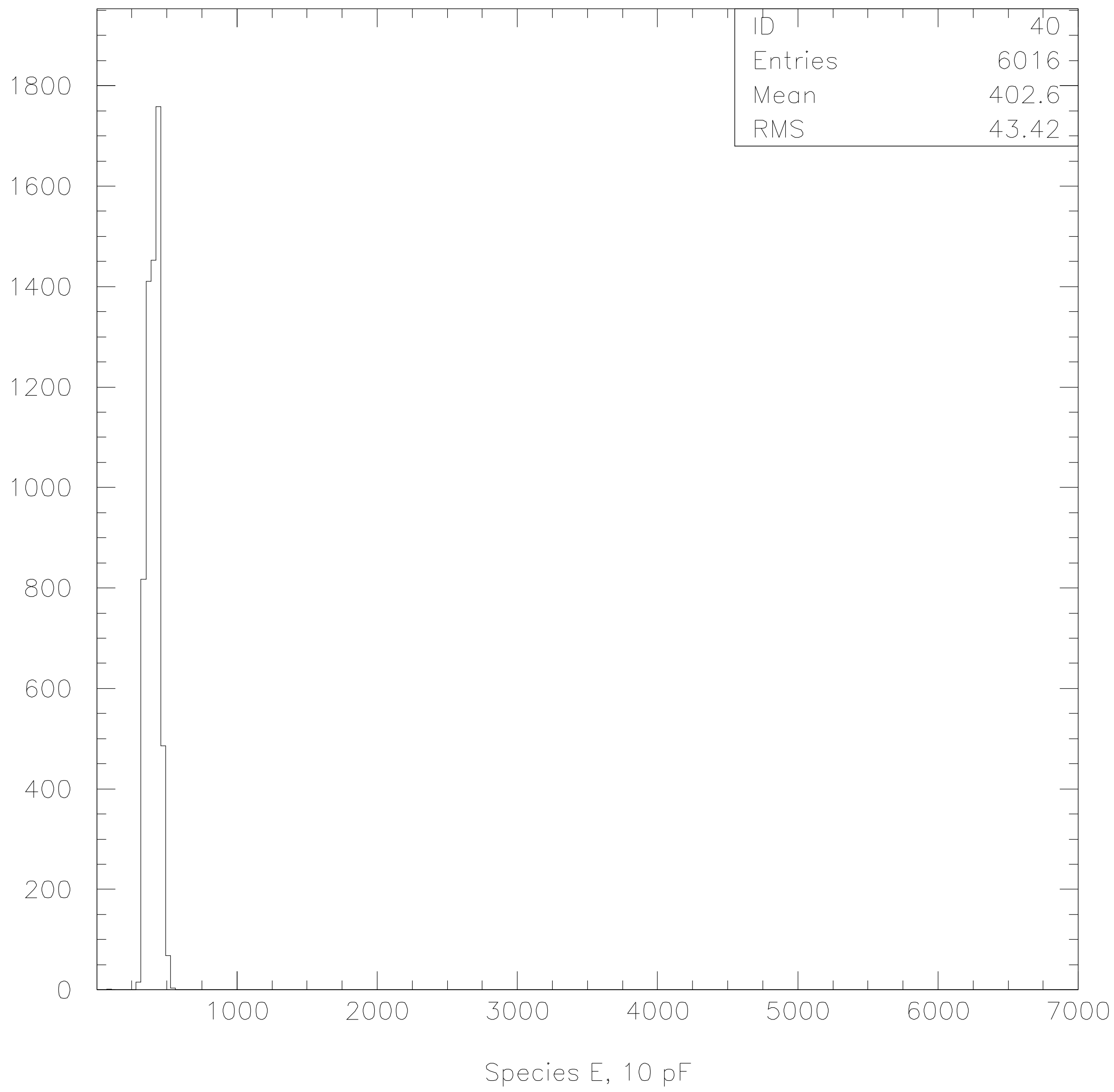

Figure 21: Number of E species vs. capacitance.

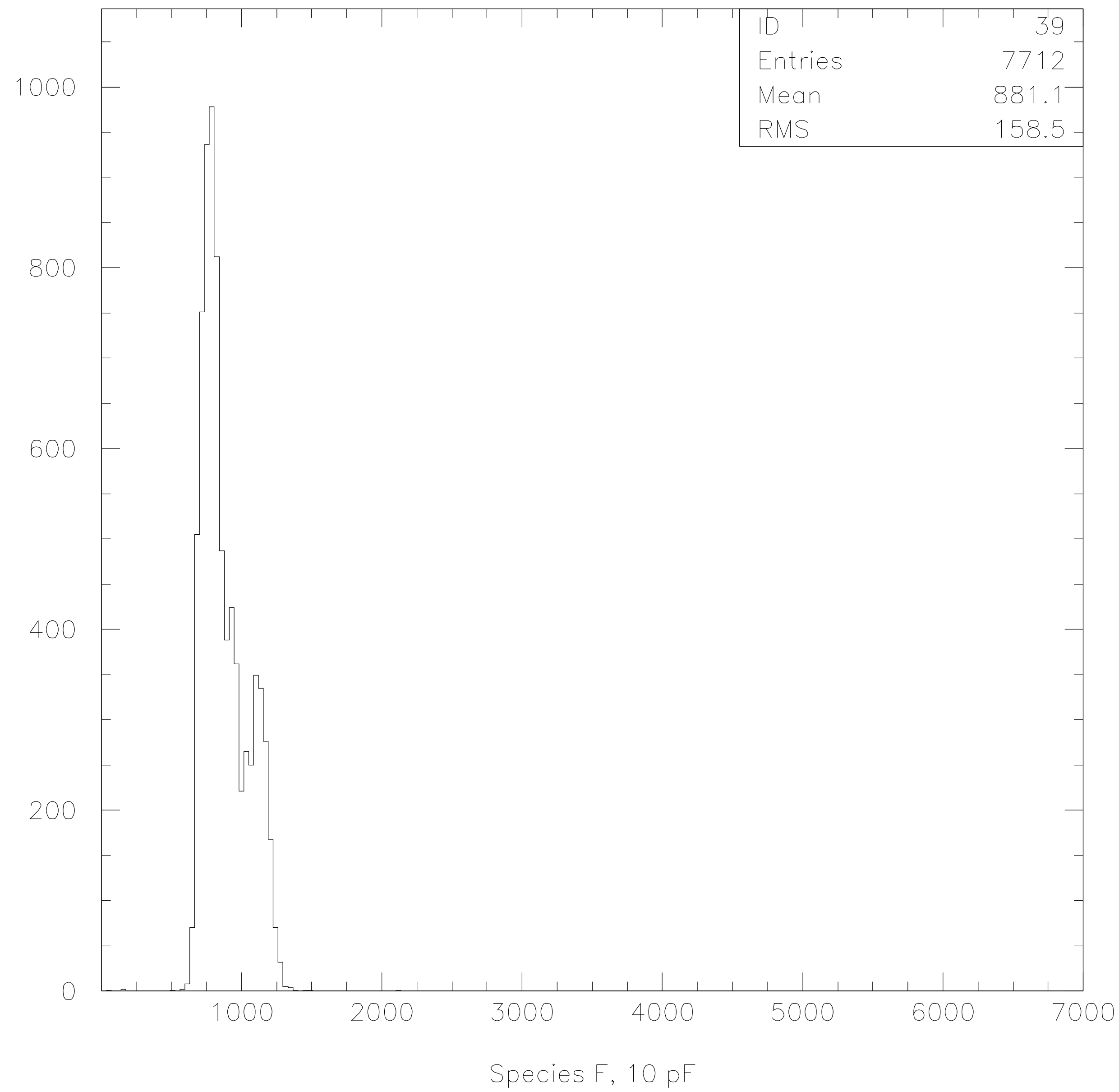

Figure 22: Number of F species vs. capacitance.

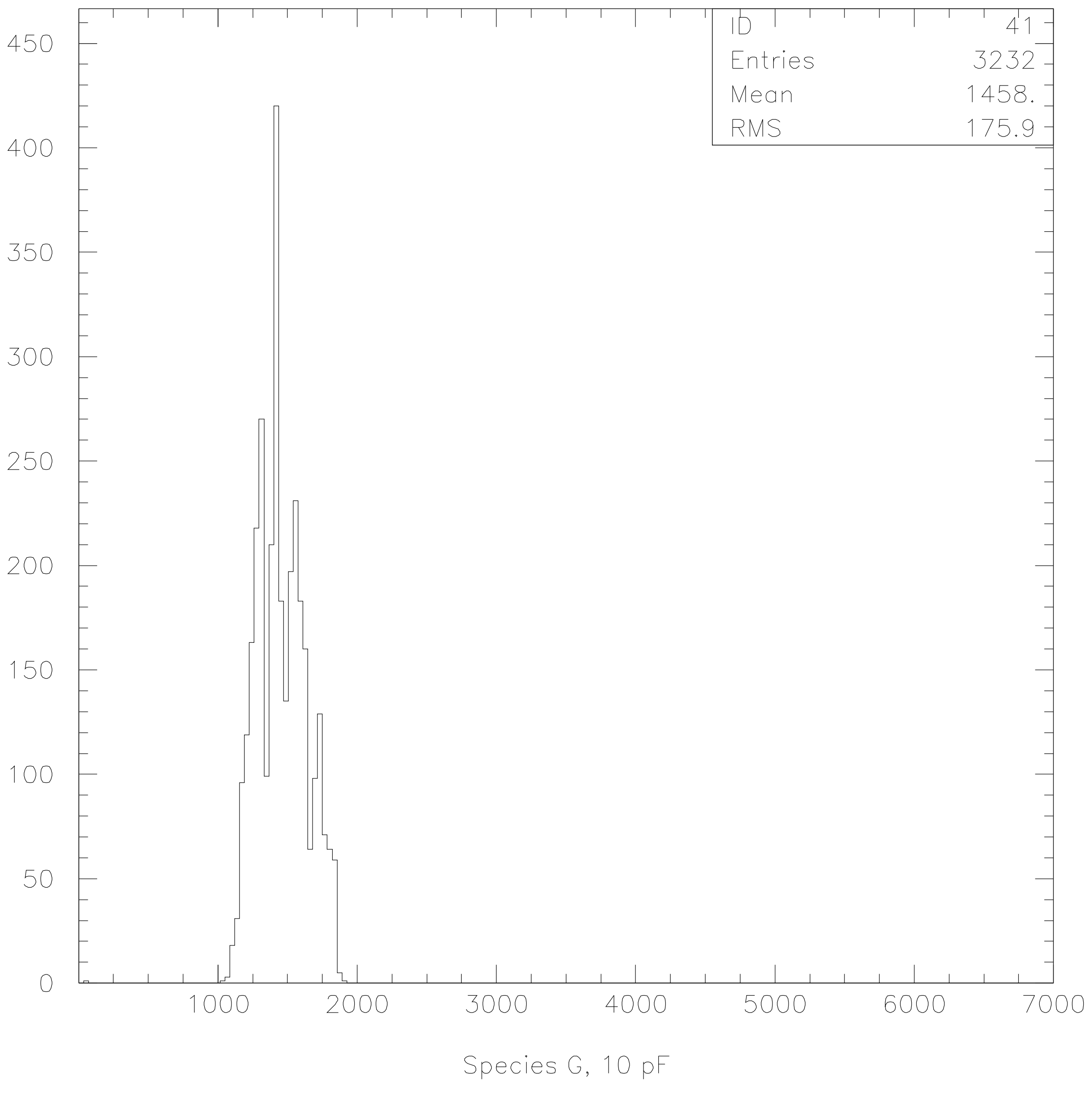

Figure 23: Number of G species vs. capacitance.

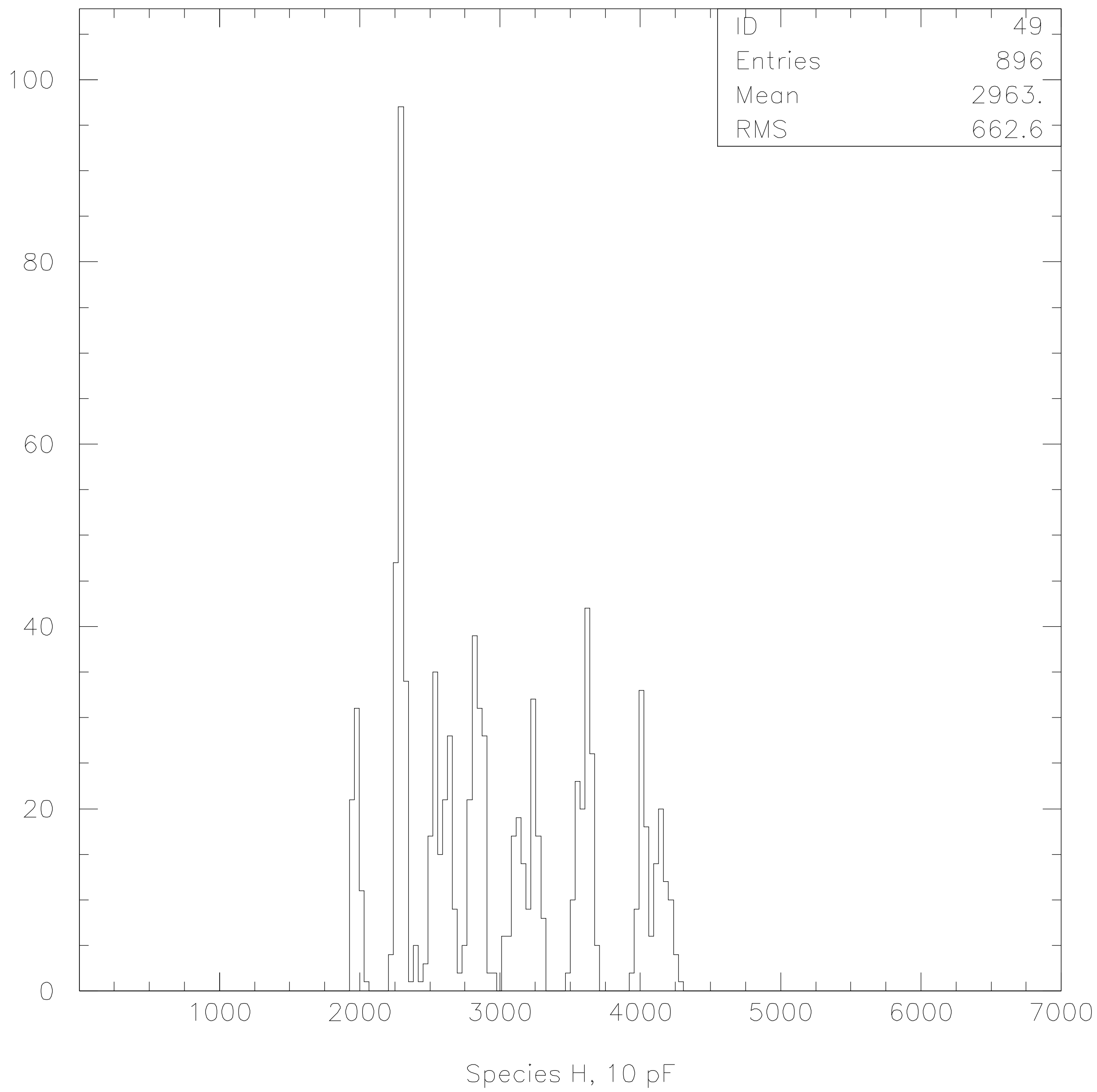

Figure 24: Number of H species vs. capacitance.

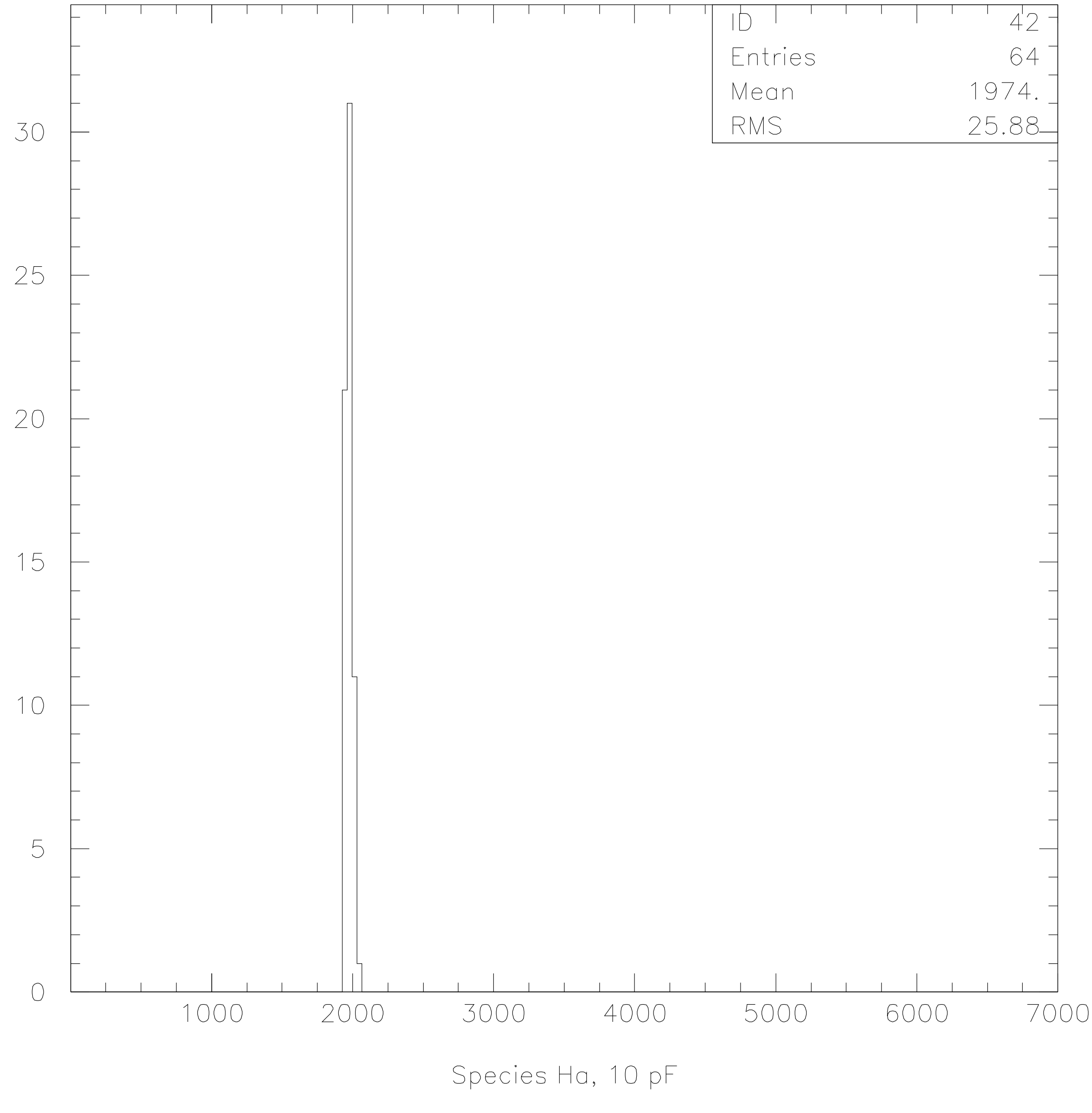

Figure 25: Number of Ha species vs. capacitance.

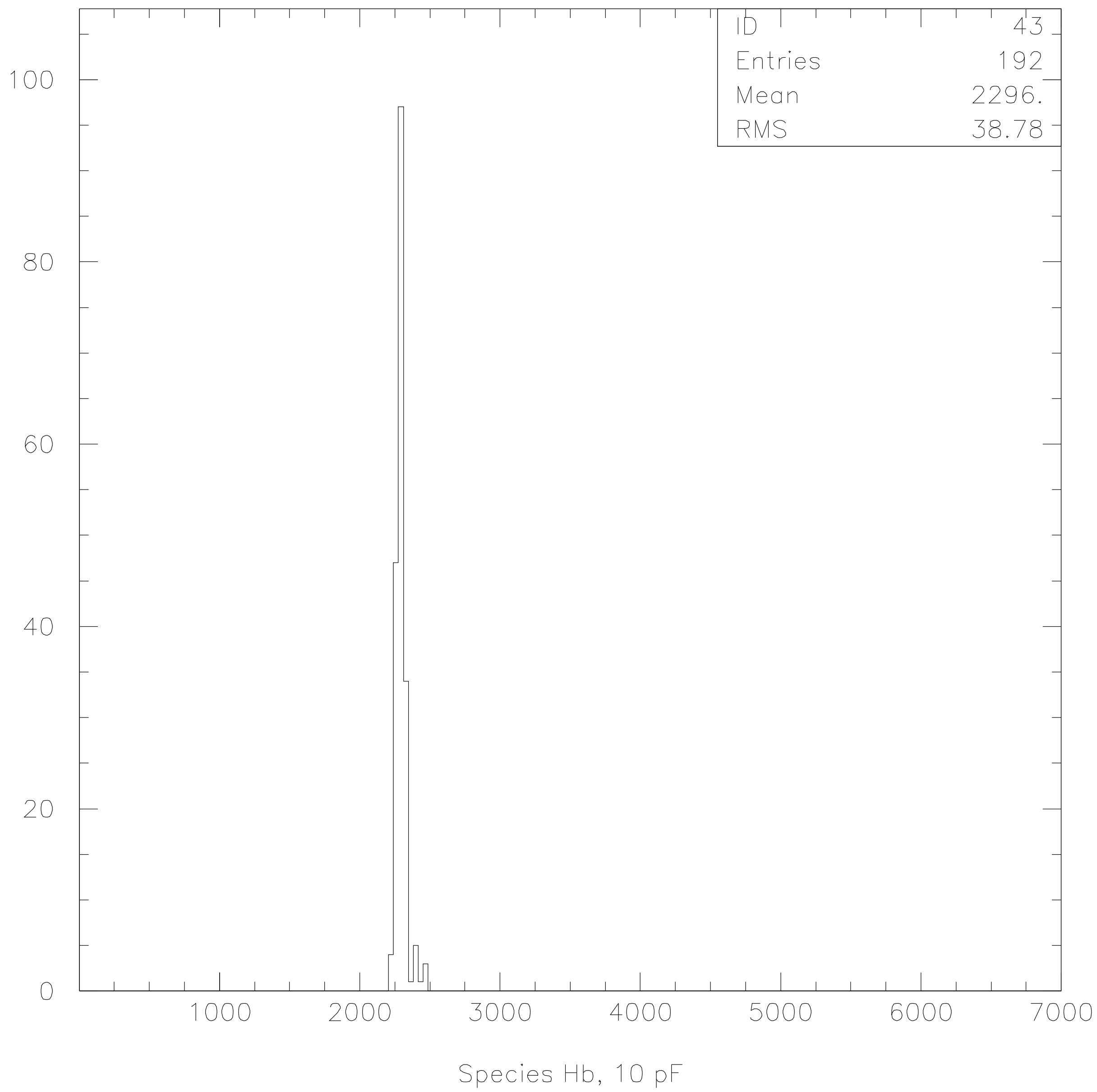

Figure 26: Number of Hb species vs. capacitance.

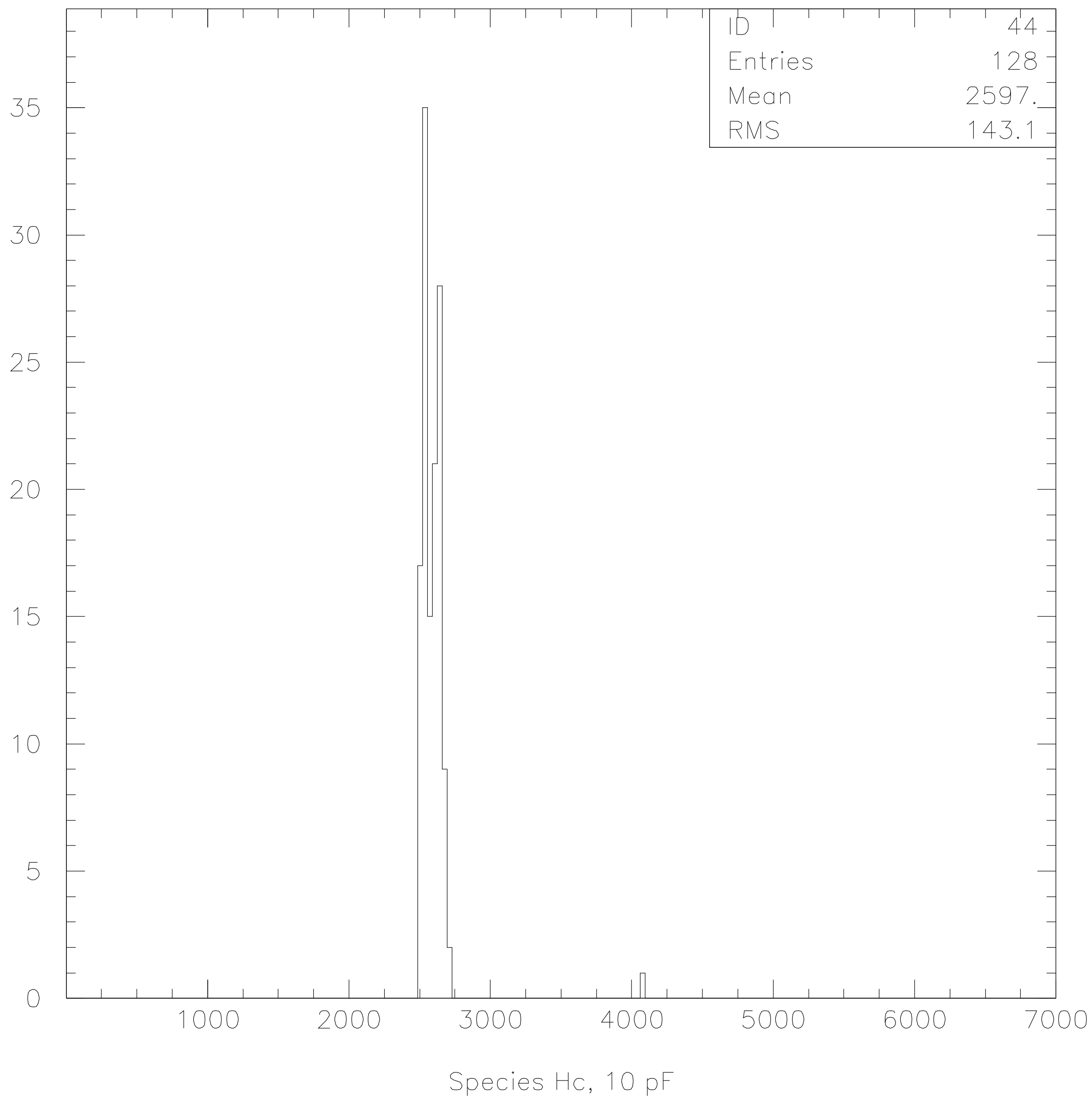

Figure 27: Number of Hc species vs. capacitance.

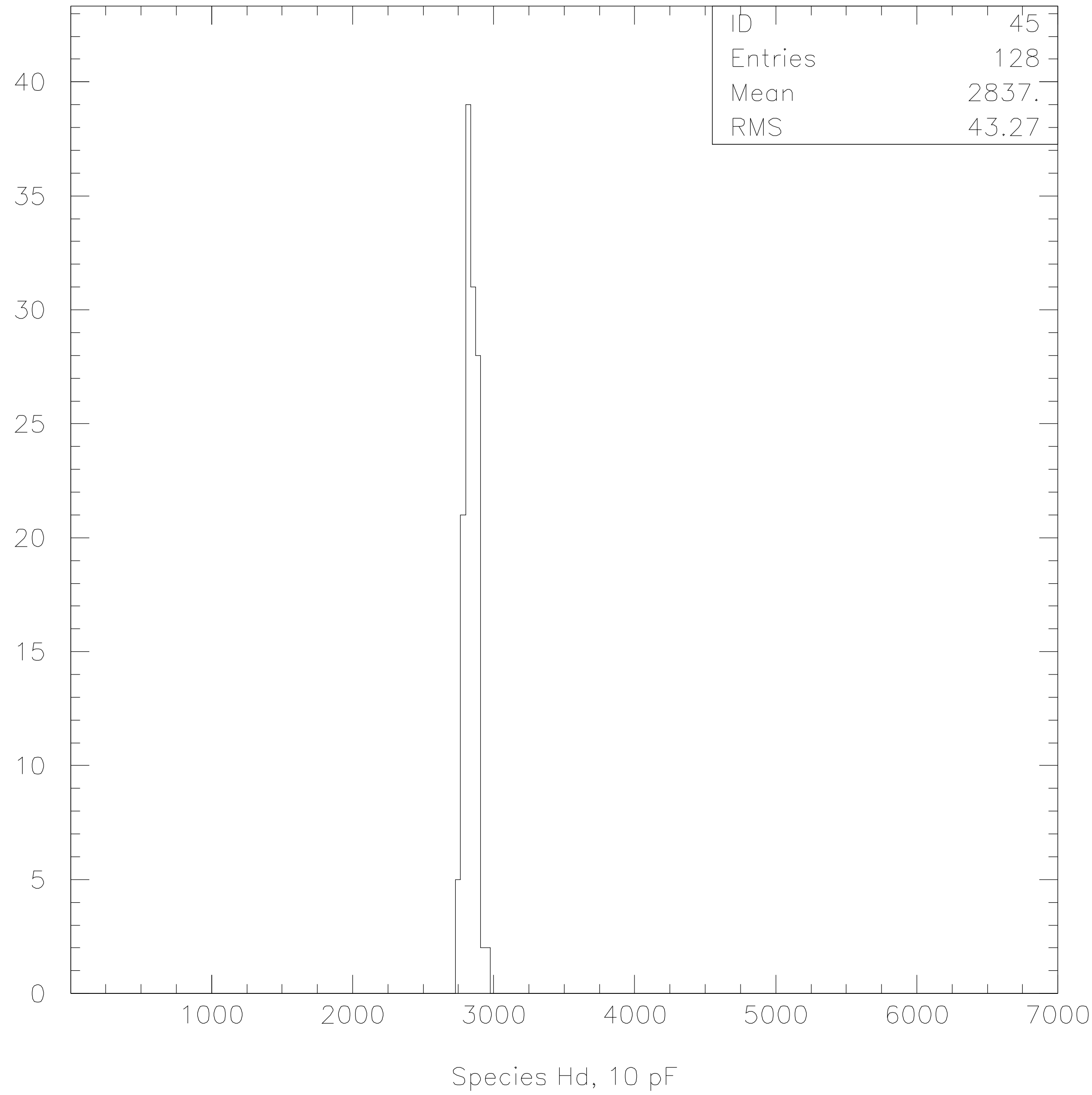

Figure 28: Number of Hd species vs. capacitance.

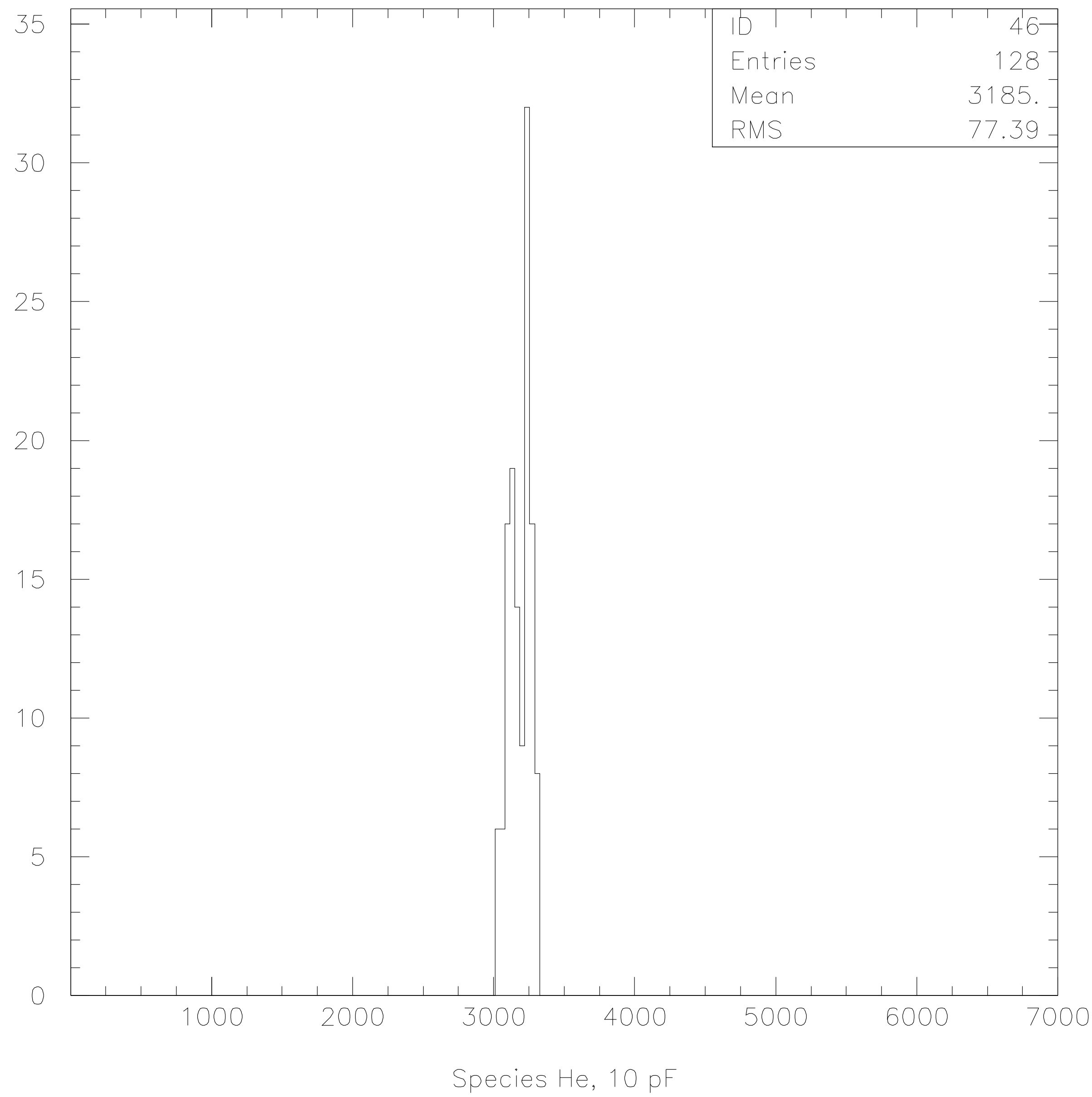

Figure 29: Number of He species vs. capacitance.

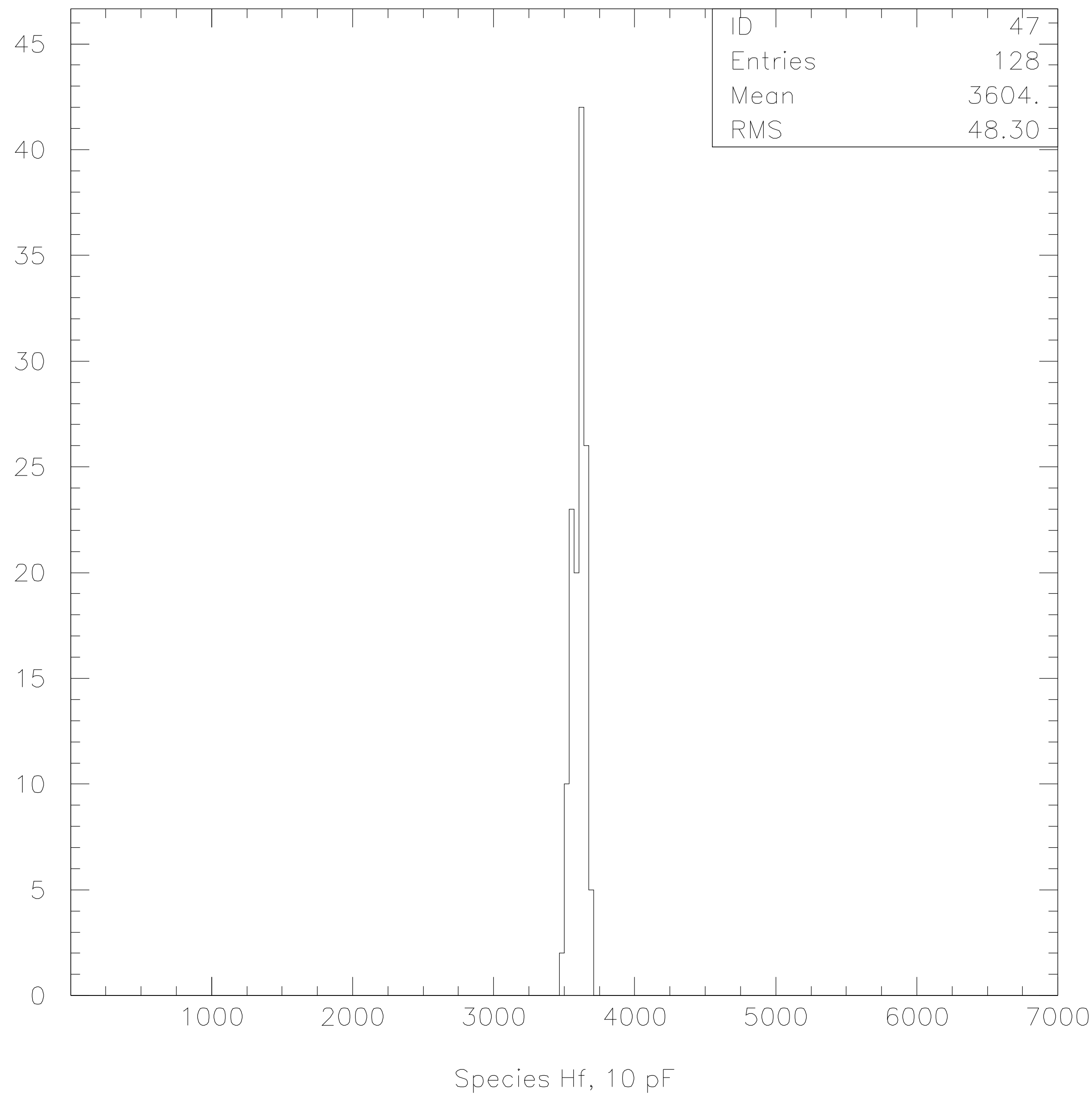

Figure 30: Number of Hf species vs. capacitance.

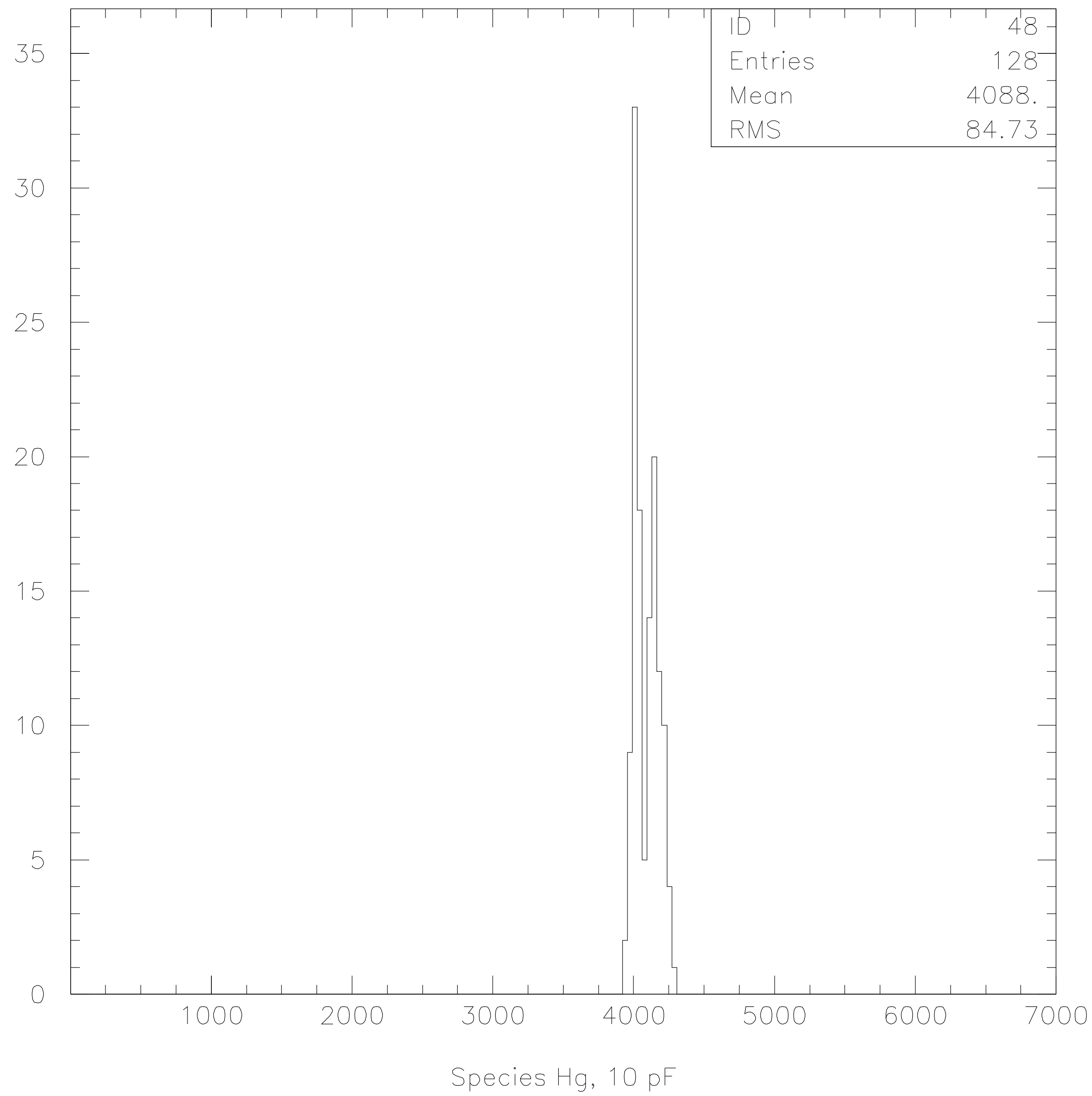

Figure 31: Number of Hg species vs. capacitance.

1/14/98

Preamp Species Capacitances and Resistor Values

				Feedback		Open loop gain	
Species	Raw Cap.	w/ Offset	RMS	R36	C3	R37	C5
A	416	16	150	0	5	0	10
B	1265	865	218	5190	5	2595	10
C	2182	1782	420	10692	5	5346	10
D	4028	3628	594	21768	5	10884	10
E	403	3	43	0	10	0	22
F	881	481	159	1443	10	656	22
G	1458	1058	176	3174	10	1443	22
Ha	1974	1574	26	4722	10	2146	22
Hb	2296	1896	39	5688	10	2585	22
Hc	2597	2197	143	6591	10	2996	22
Hd	2837	2437	43	7311	10	3323	22
He	3185	2785	77	8355	10	3798	22
Hf	3604	3204	48	9612	10	4369	22
Hg	4088	3688	85	11064	10	5029	22
I	0	N/A	0	0	22	0	22

All capacitances in pF. All resistances in Ohms.
Offset is -400 pF for A-Hg. No offset for I.

Cable Impedence: 30.0

Figure 32: Species Capacitances and Resistances

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Preamp Species Quantities

Species	Quantity	w/spares
A	13376	14514
B	2240	2431
C	11008	11944
D	6912	7500
E	9920	10764
F	7712	8368
G	3232	3507
Ha	64	102
Hb	192	259
Hc	128	182
Hd	128	182
He	128	182
Hf	128	182
Hg	128	182
I	384	500

Number of Preamps used:	55680
Number of Spares:	5120
Total Number of Preamps:	60800

Figure 33: Species Quantities

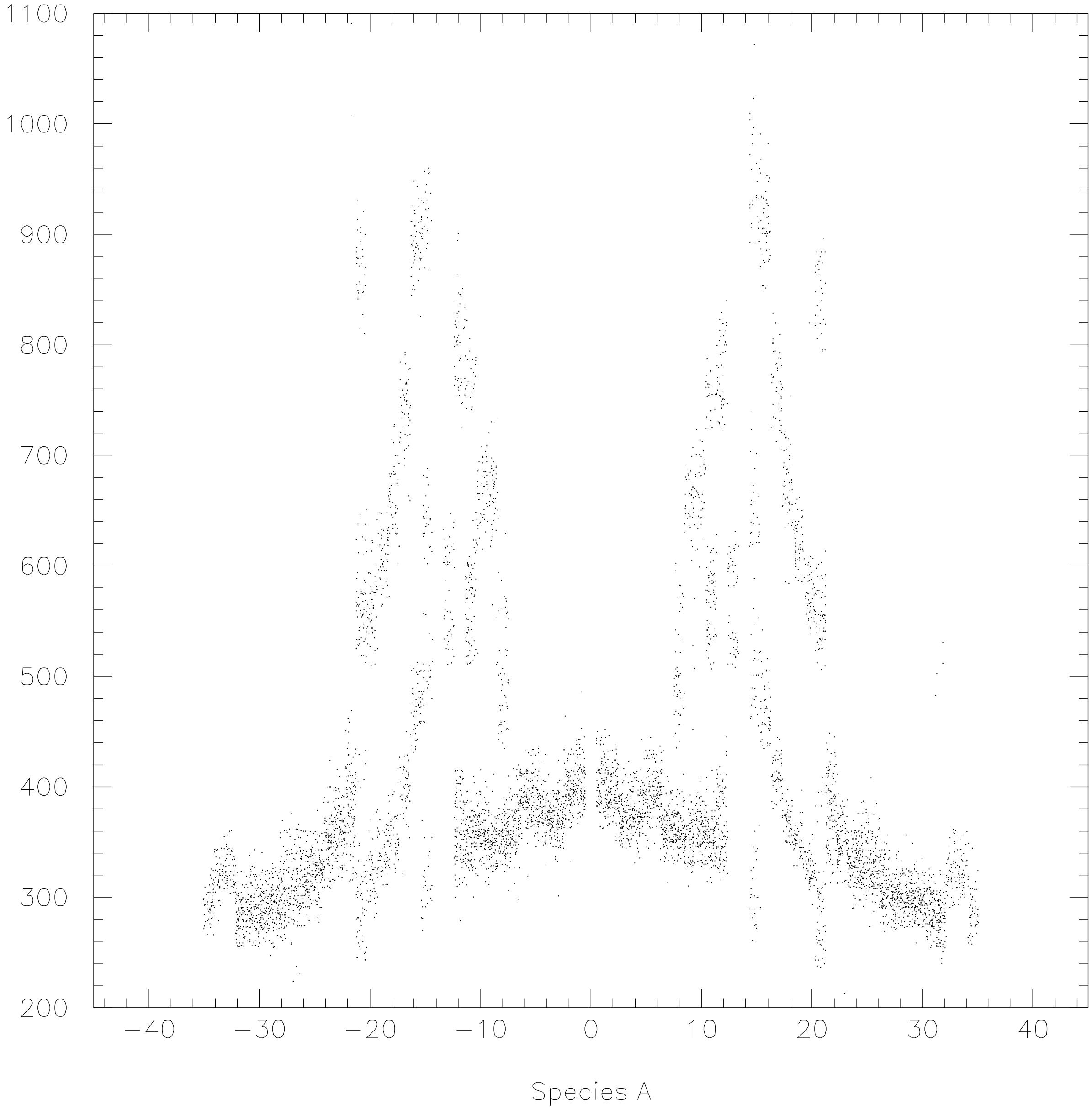

Figure 34: Species A: Capacitance vs. eta

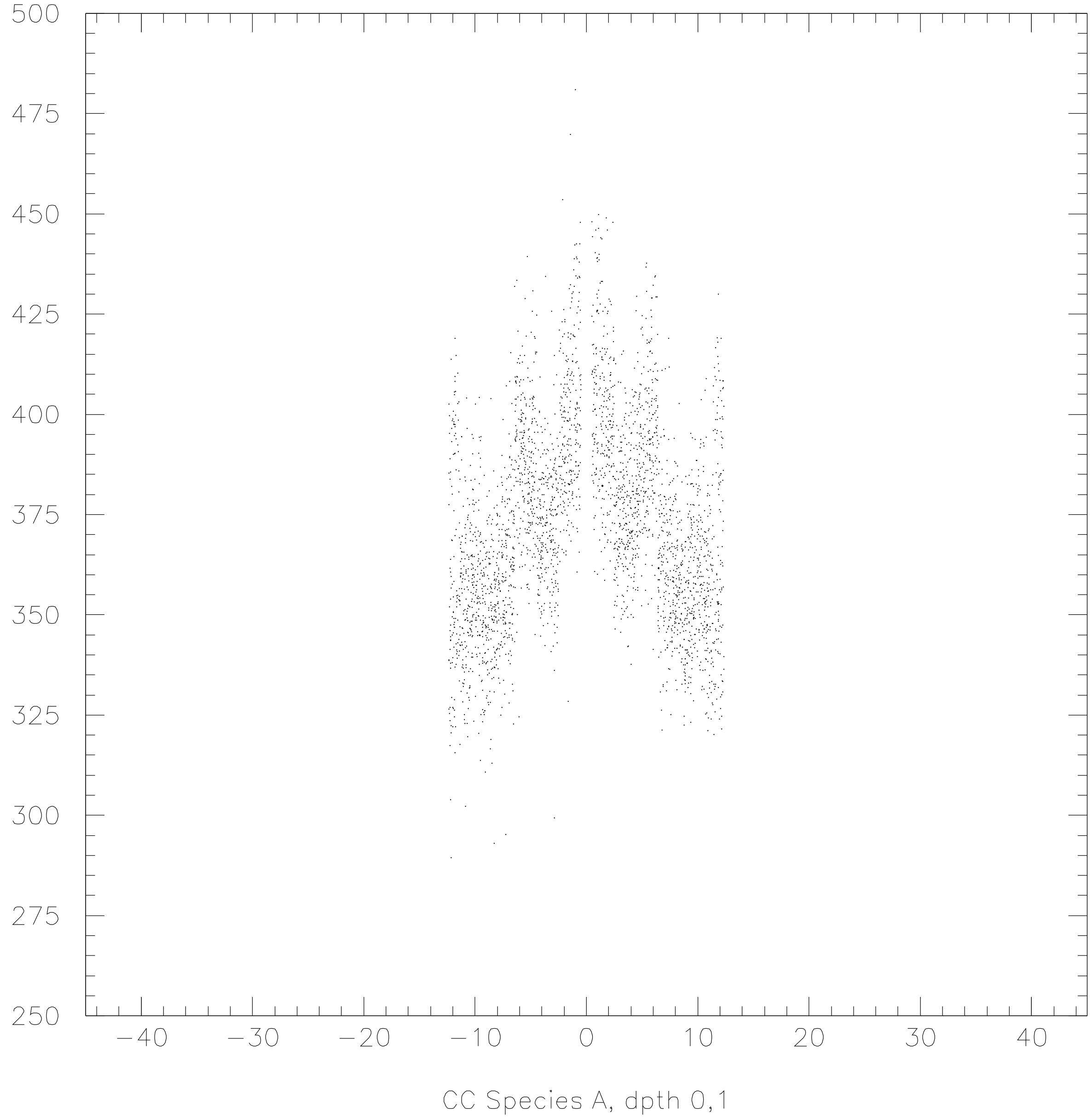

Figure 35: Species A: Capacitance vs. eta (CC)

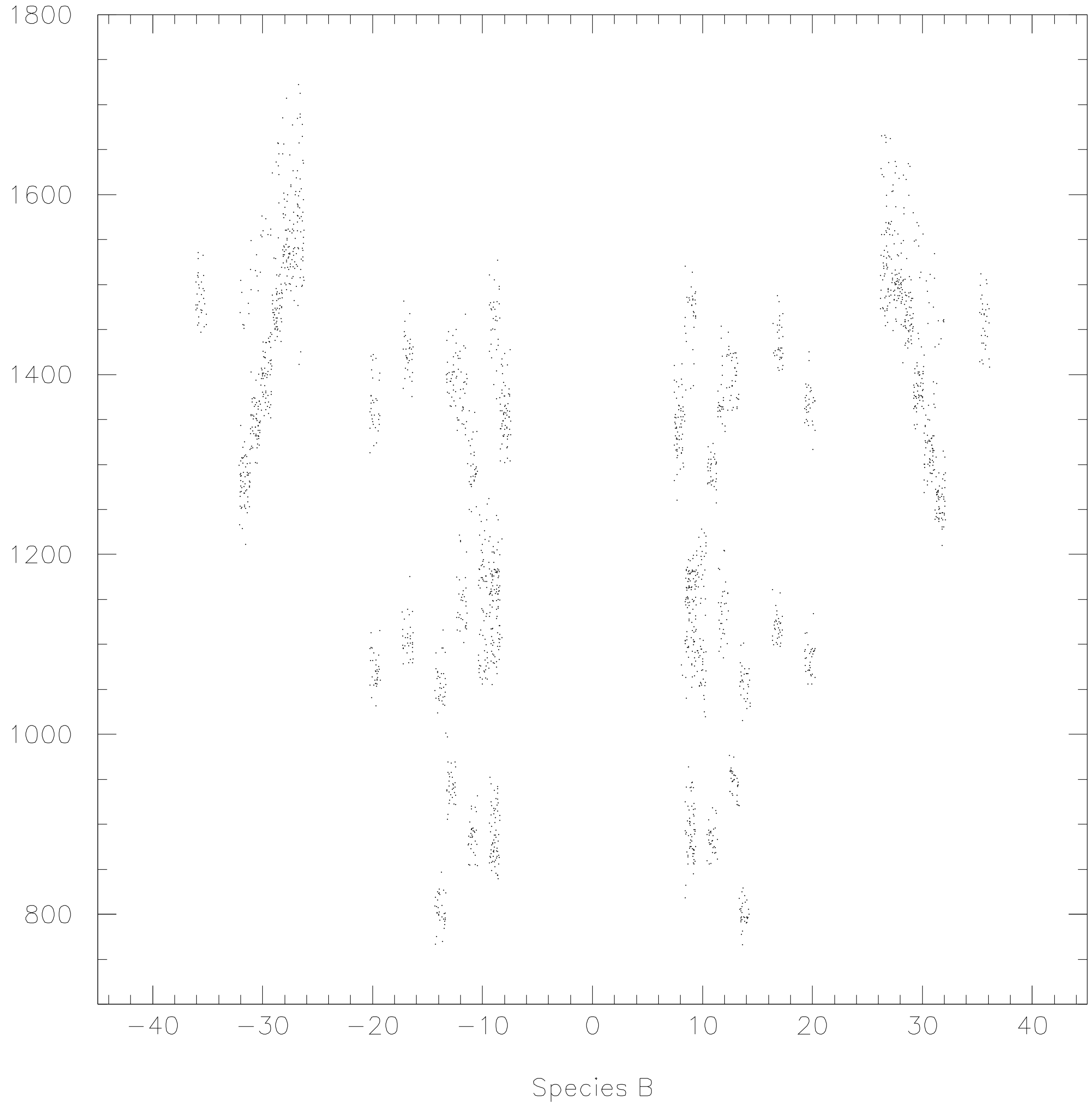

Figure 36: Species B: Capacitance vs. eta

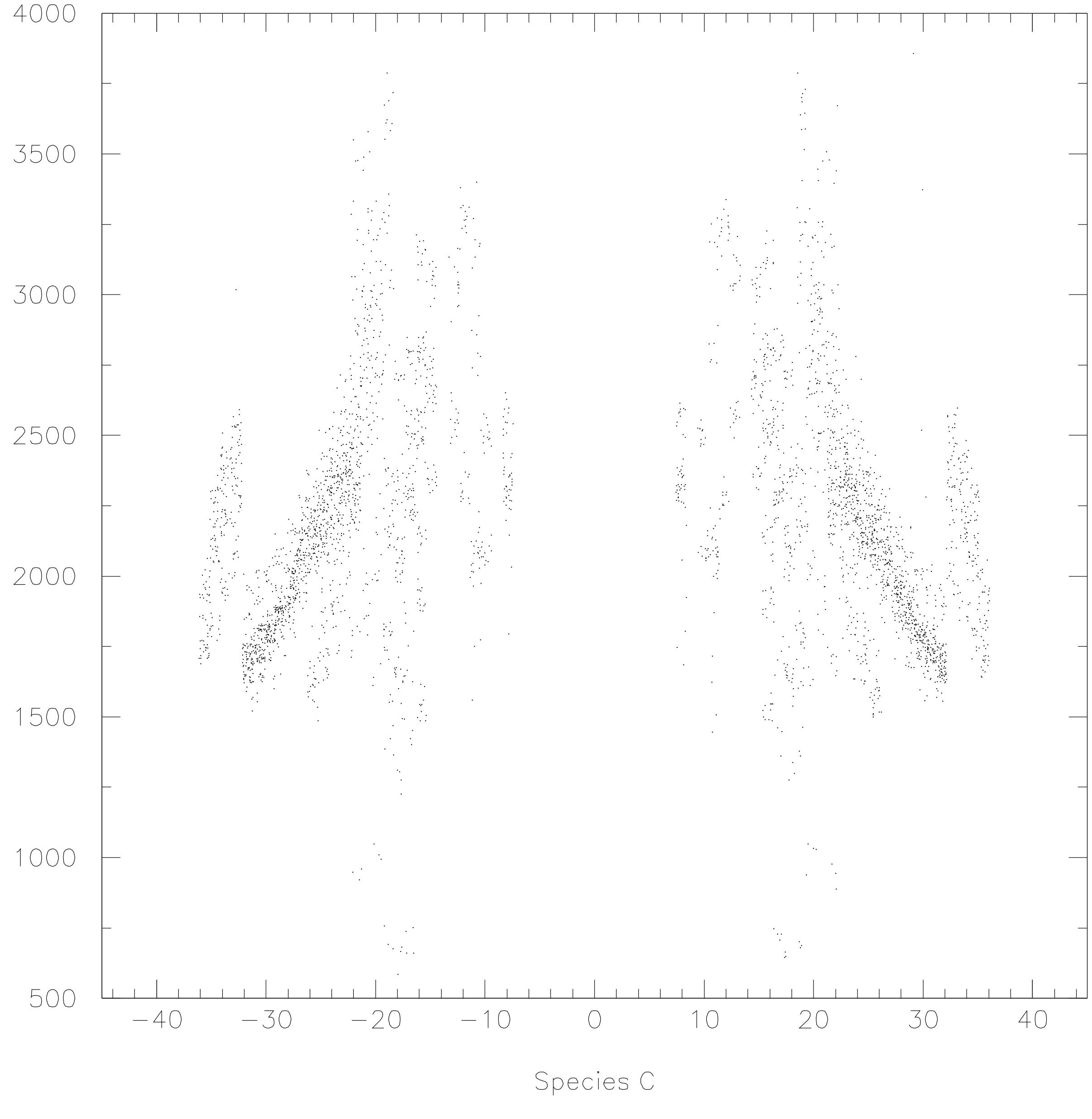

Figure 37: Species C: Capacitance vs. eta

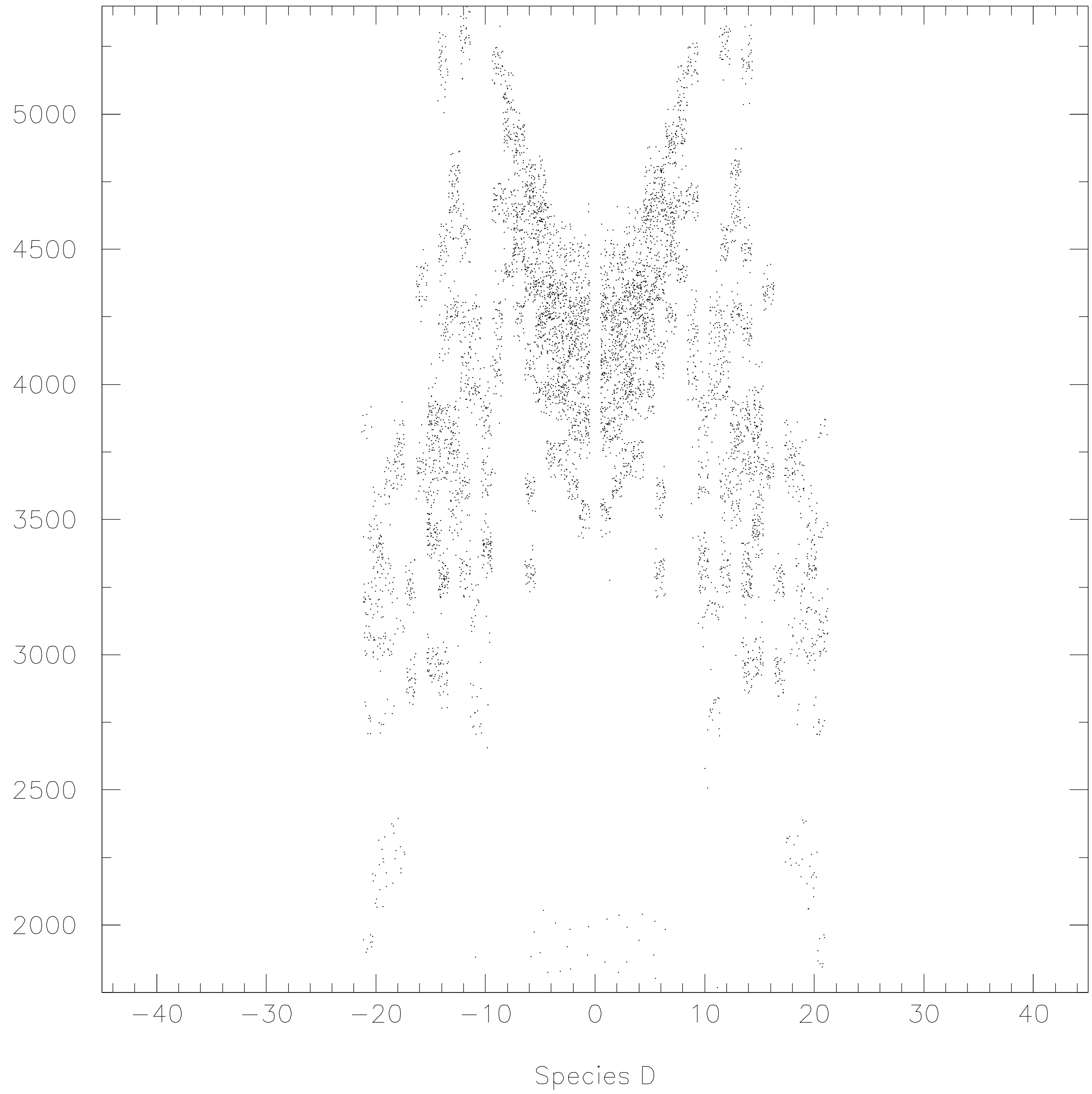

Figure 38: Species D: Capacitance vs. eta

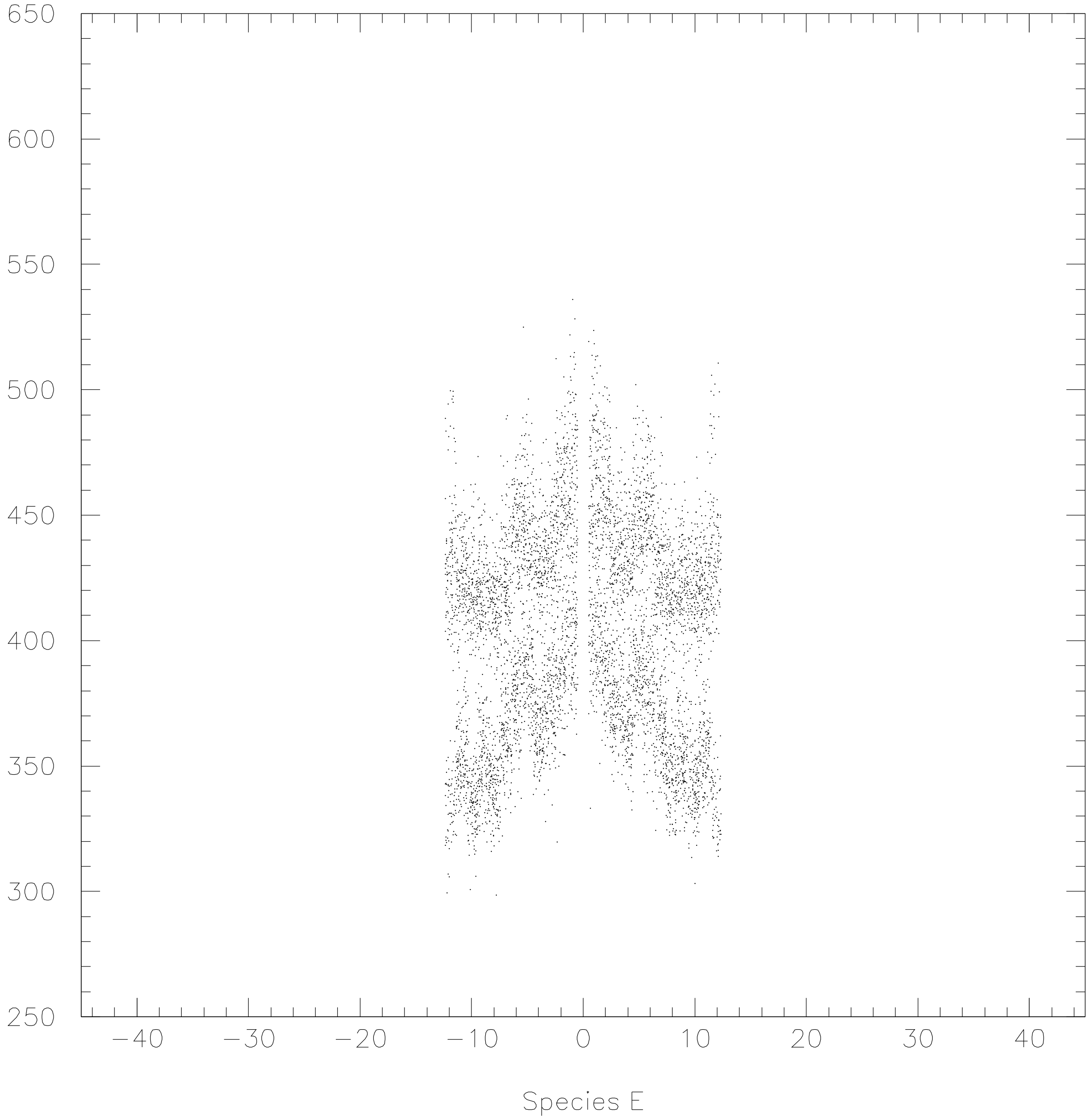

Figure 39: Species E: Capacitance vs. eta

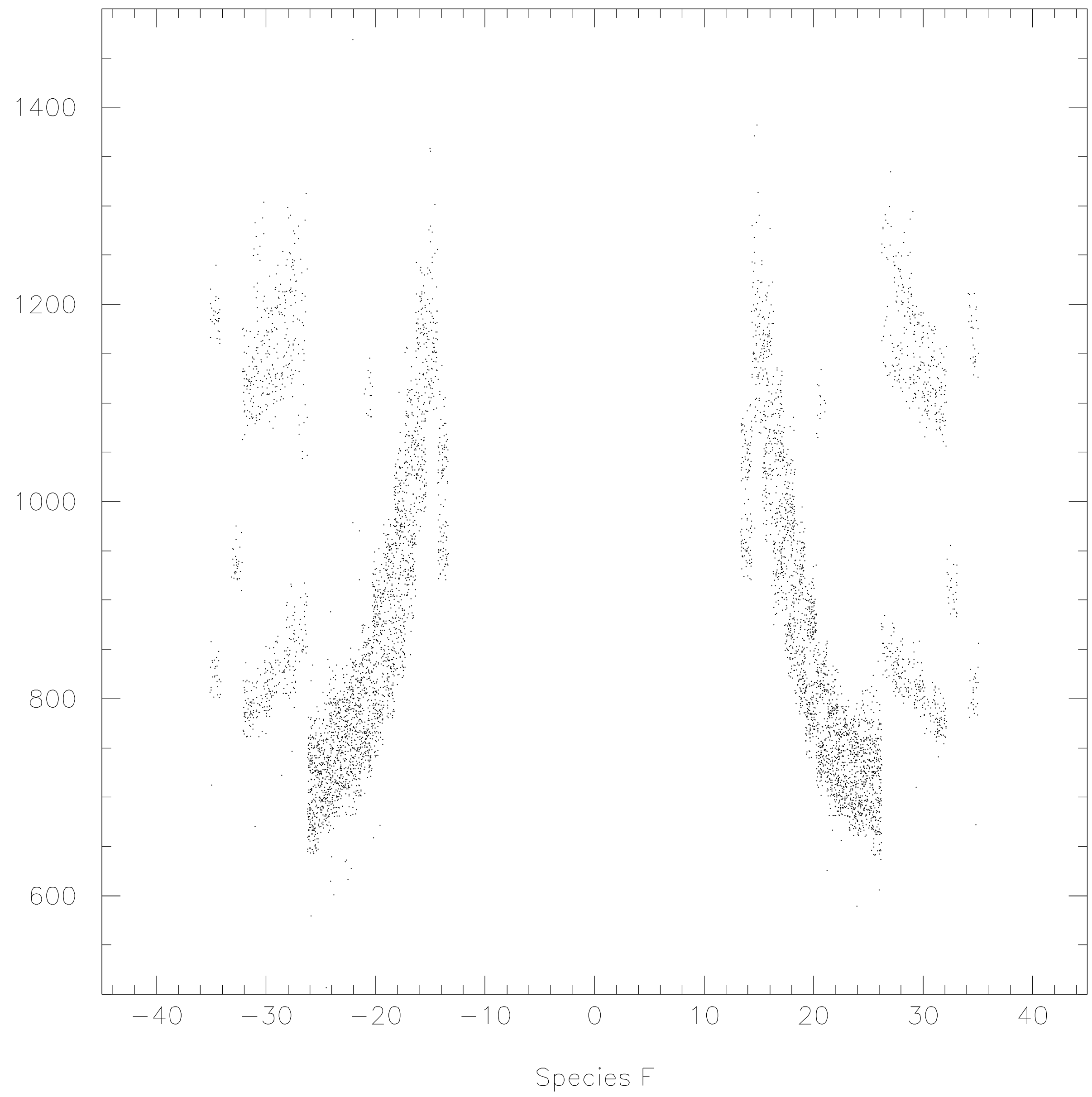

Figure 40: Species F: Capacitance vs. eta

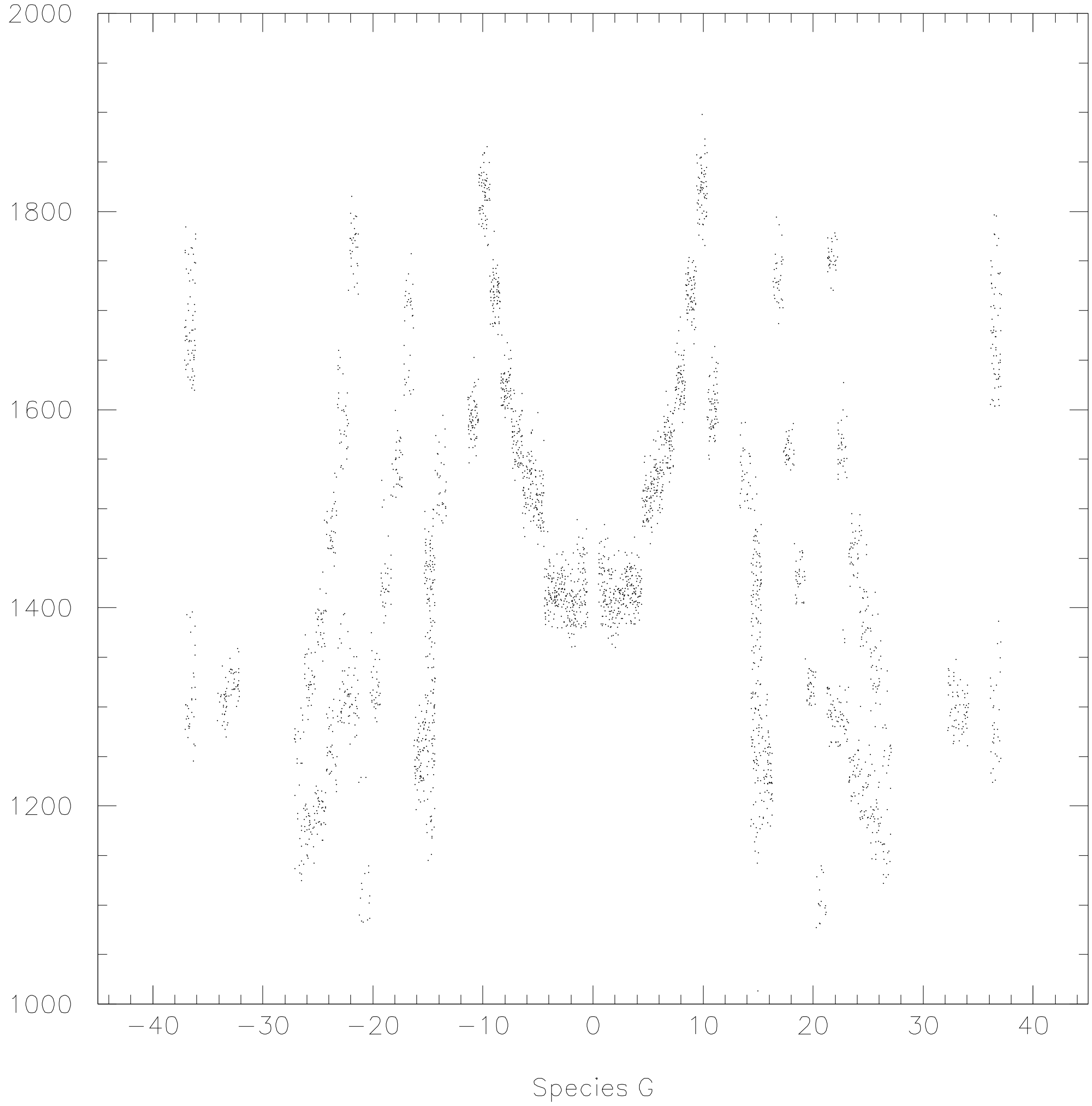

Figure 41: Species G: Capacitance vs. eta

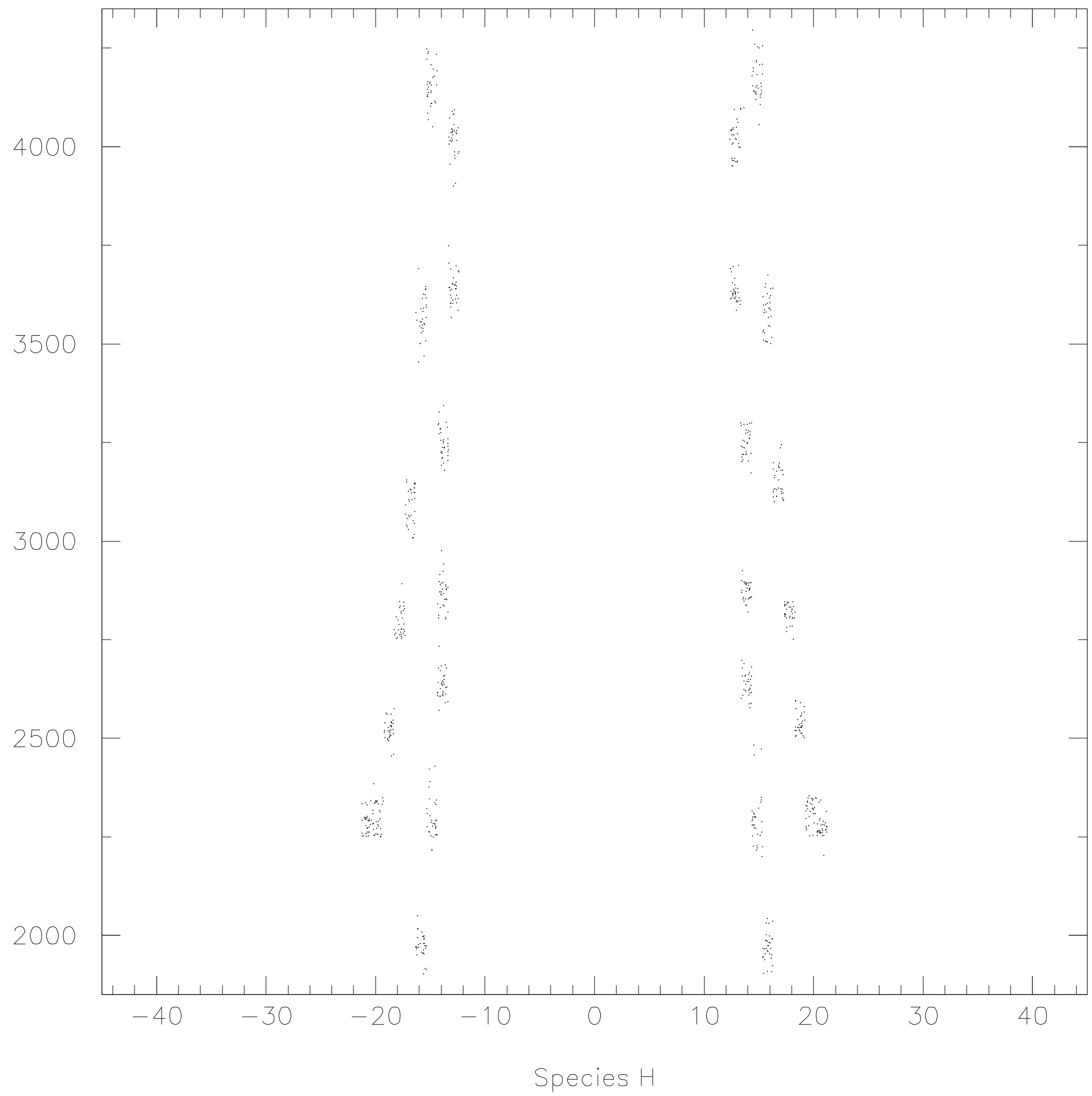

Figure 42: Species H: Capacitance vs. eta

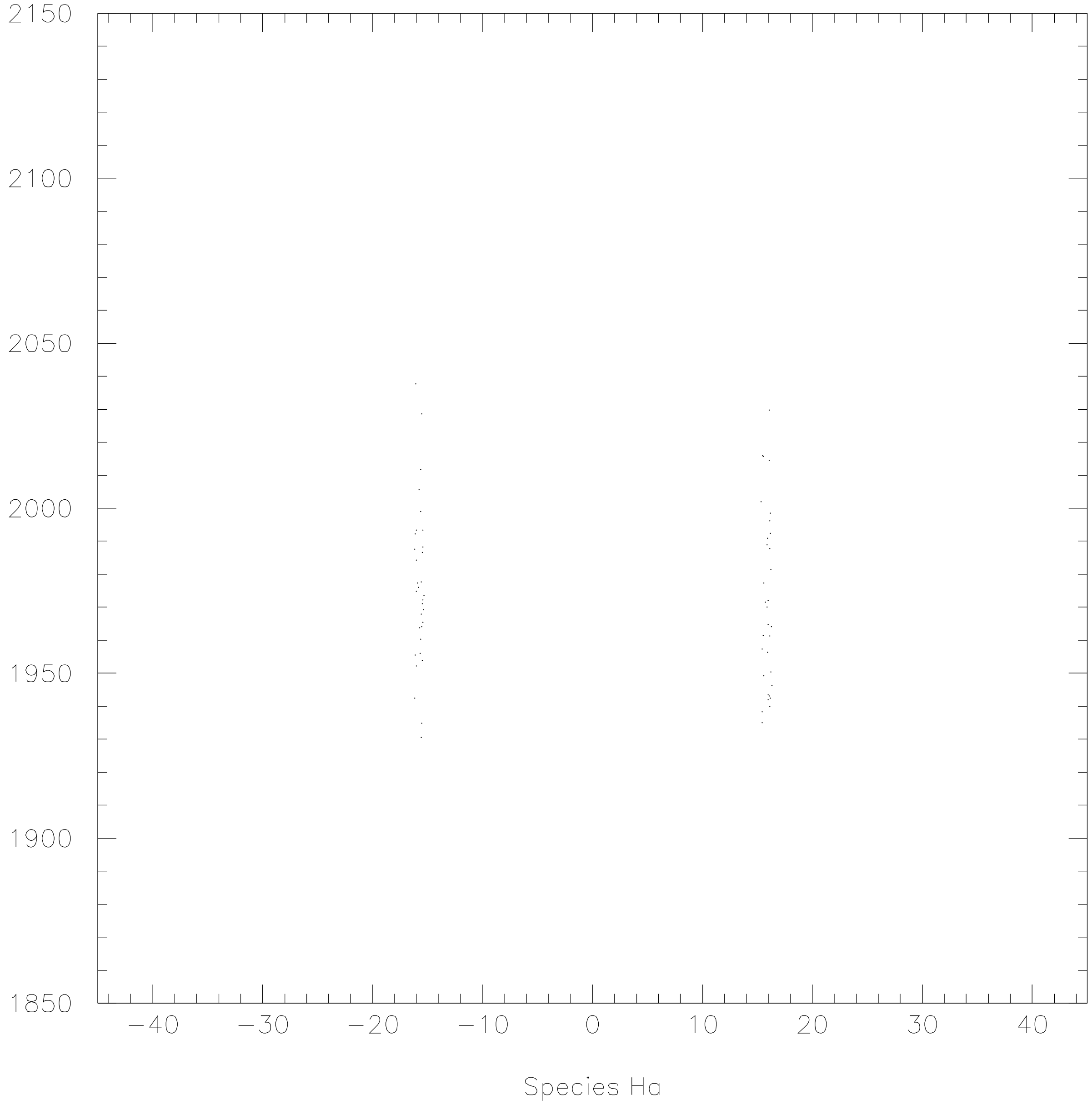

Figure 43: Species Ha: Capacitance vs. eta

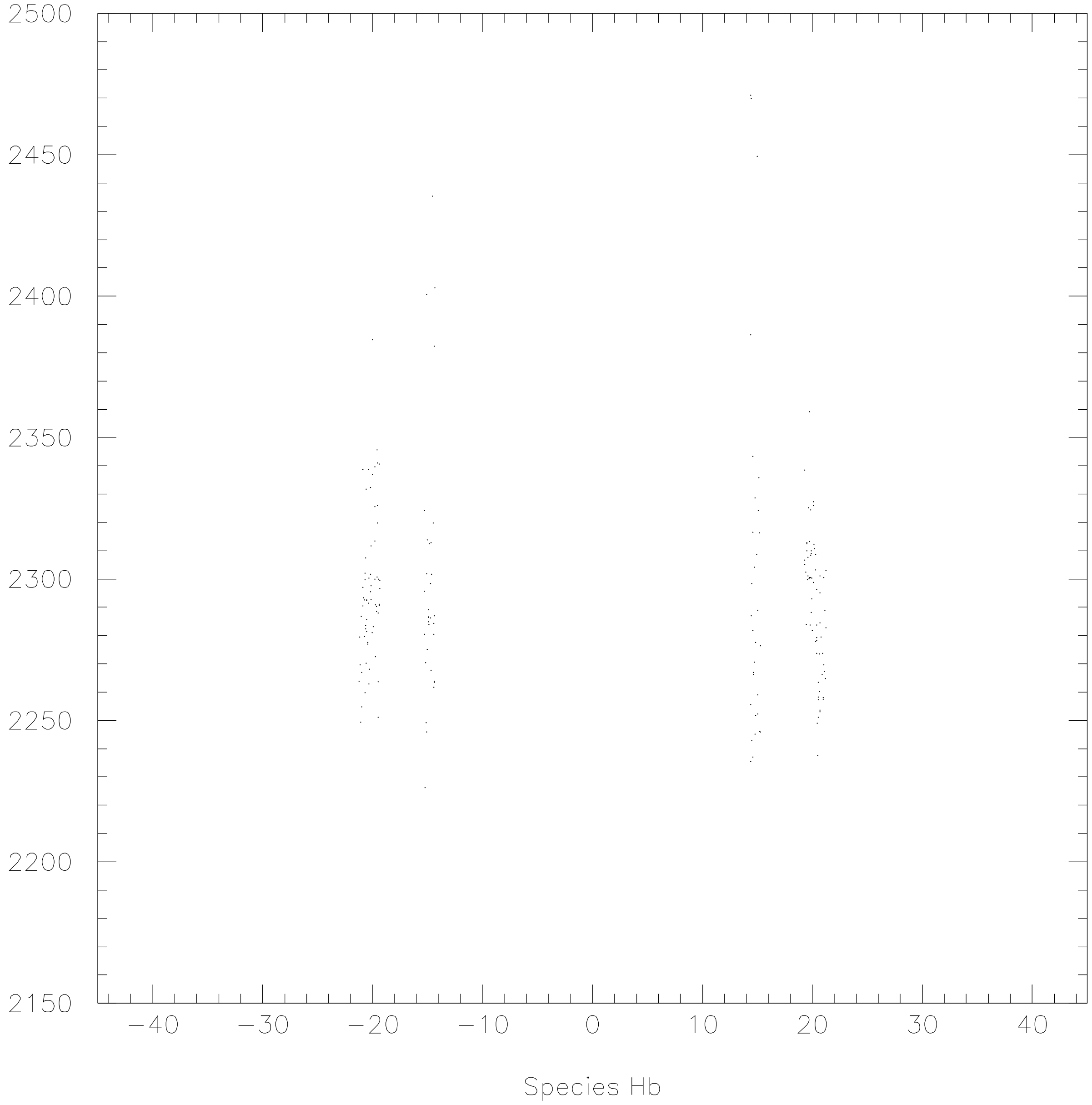

Figure 44: Species Hb: Capacitance vs. eta

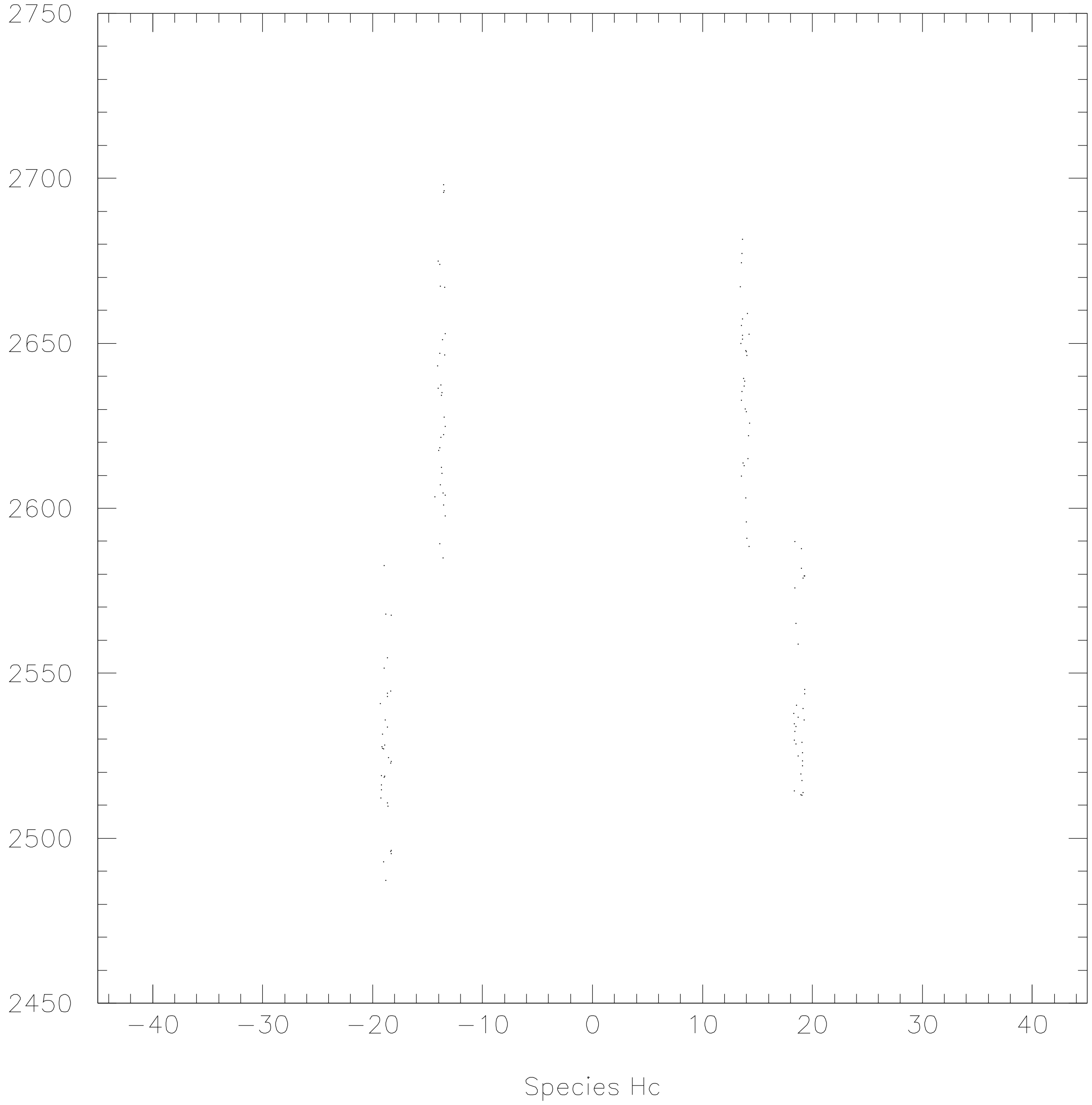

Figure 45: Species Hc: Capacitance vs. eta

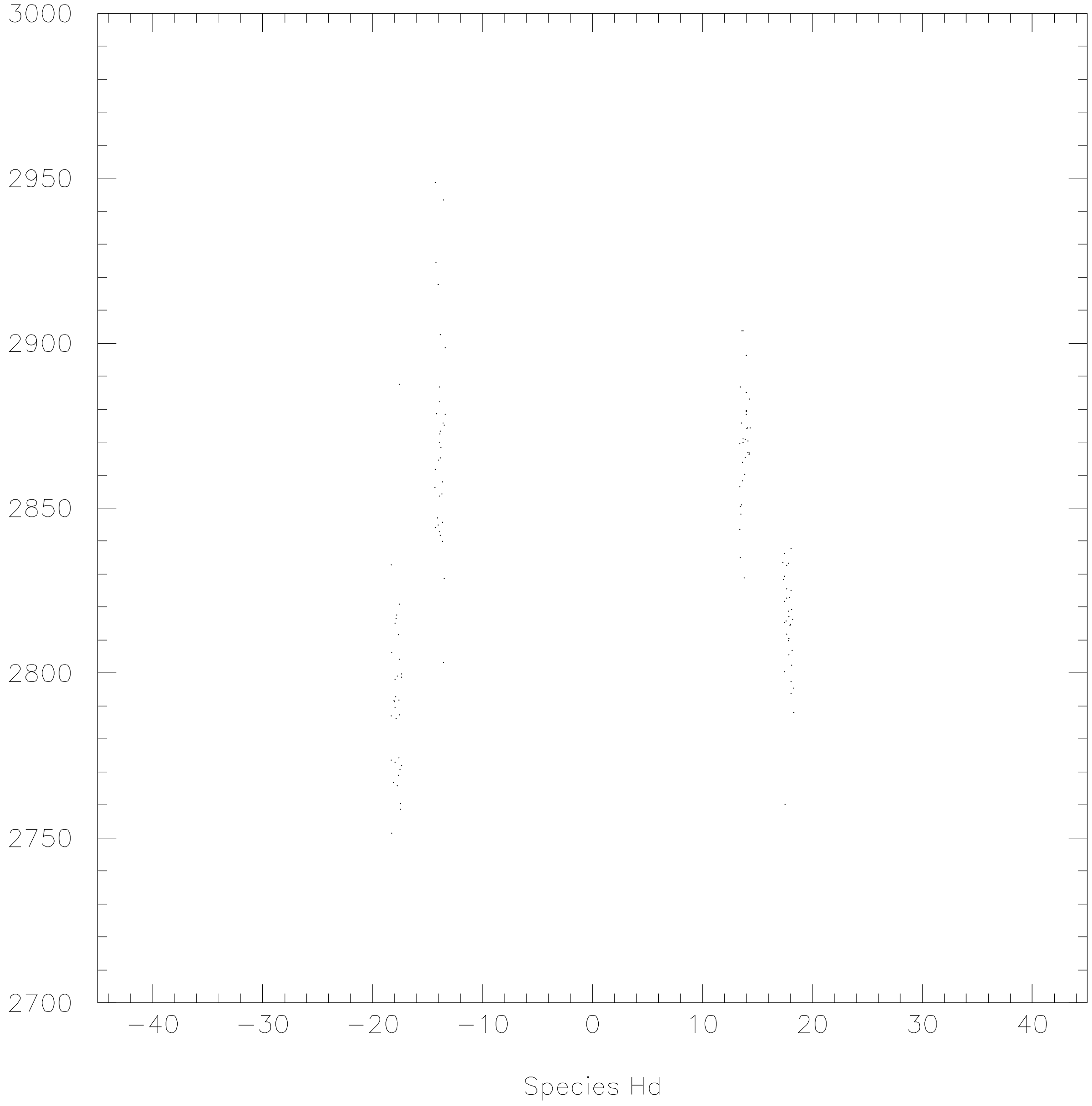

Figure 46: Species Hd: Capacitance vs. eta

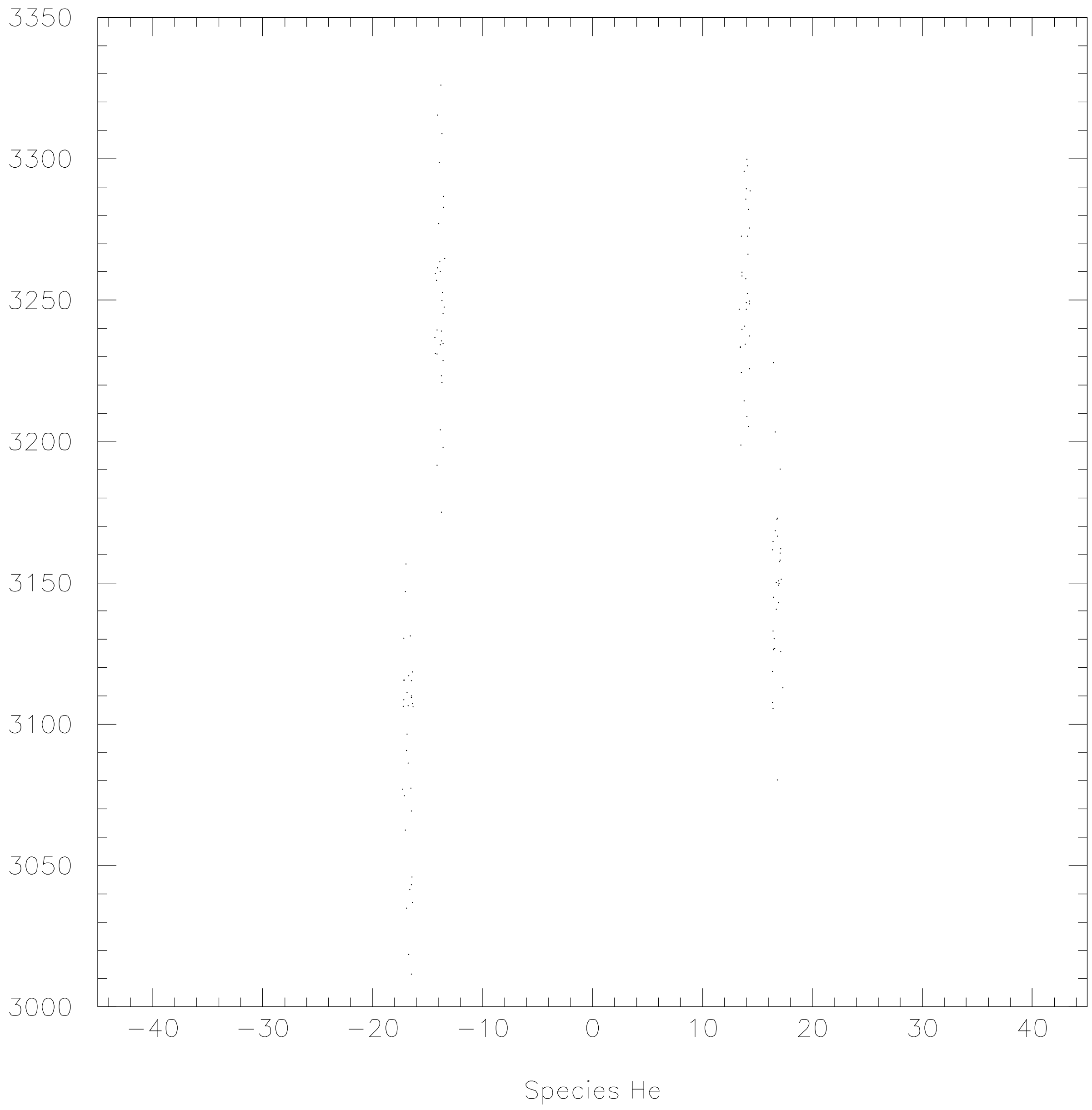

Figure 47: Species He: Capacitance vs. eta

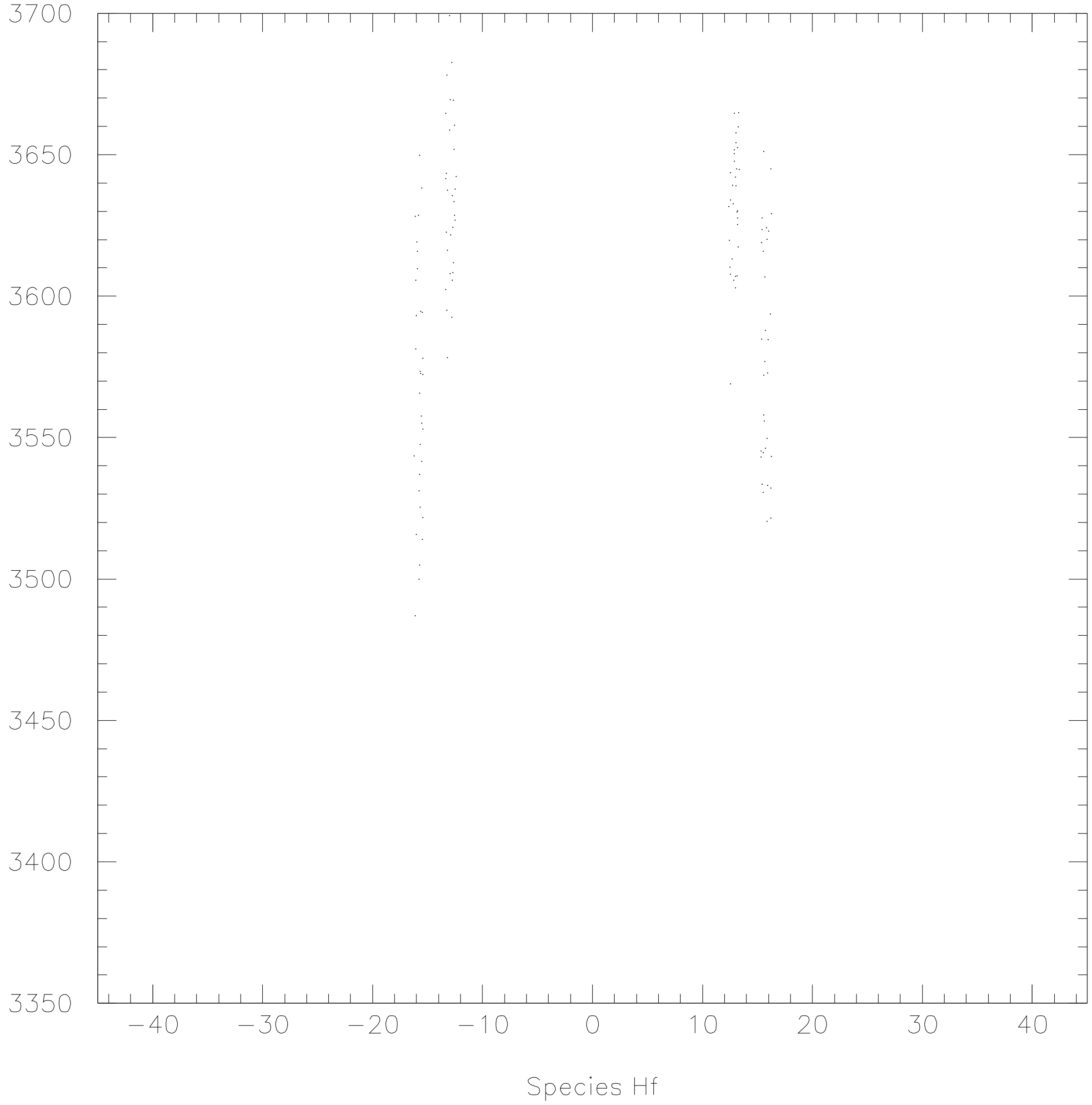

Figure 48: Species Hf: Capacitance vs. eta

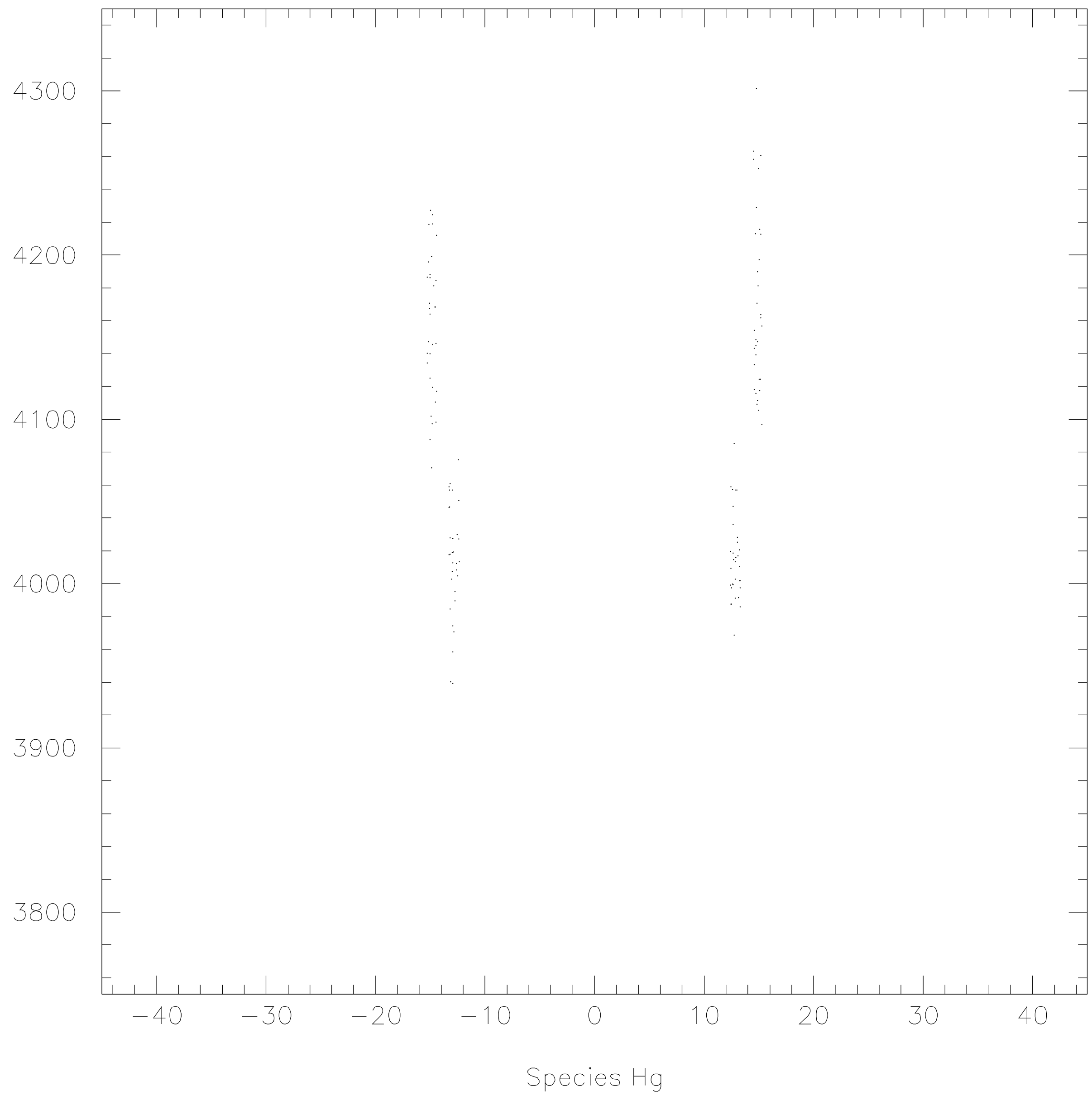

Figure 49: Species Hg: Capacitance vs. eta

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	**A***
9	D	9	D	9	**B**	9	**A***
10	D	10	**A***	10	**A***	10	**A***
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	**A***
21	D	21	D	21	**B**	21	**A***
22	D	22	**A***	22	**A***	22	**A***
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	**E***
31	D	31	D	31	**C**	31	**A***
32	D	32	D	32	**A**	32	**A***
33	D	33	**C**	33	**A***	33	**A***
34	D	34	**A**	34	**A***	34	**A***
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	**E***
43	D	43	D	43	**C**	43	**A***
44	D	44	D	44	**A**	44	**A***
45	D	45	**C**	45	**A***	45	**A***
46	D	46	**A**	46	**A***	46	**A***
47	A*	47	A*	47	A*	47	A*

* indicates no detector channel

Figure 50: CC Motherboard Maps

Preamp Motherboard Maps 5-7 (128 boards)

EC

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

Board 5 is a special board with all 5 pF feedback capacitance. All channels correspond to hadronic channels.

* indicates no detector channel

Figure 51: EC Motherboard Maps (5-7)

Preamp Motherboard Maps 8-11 (128 boards)

EC

Board 8 (32)		Board 9 (32)		Board 10 (32)		Board 11 (32)	
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	F	2	F	2	F	2	F
3	G	3	G	3	F	3	F
4	F	4	F	4	F	4	F
5	G	5	G	5	F	5	F
6	Hb	6	**Hg**	6	G	6	**He**
7	C	7	C	7	C	7	C
8	C	8	C	8	B	8	B
9	D	9	D	9	C	9	C
10	D	10	D	10	C	10	C
11	D	11	D	11	D	11	D
12	A	12	A	12	A	12	A
13	A	13	A	13	A	13	A
14	G	14	G	14	F	14	F
15	G	15	G	15	F	15	F
16	G	16	G	16	F	16	F
17	F	17	F	17	F	17	F
18	Hg	18	**Hb**	18	He	18	**G**
19	C	19	C	19	C	19	C
20	C	20	C	20	B	20	B
21	D	21	D	21	C	21	C
22	D	22	D	22	C	22	C
23	D	23	D	23	D	23	D
24	A	24	A	24	A	24	A
25	A	25	A	25	A	25	A
26	F	26	F	26	F	26	F
27	G	27	G	27	F	27	F
28	F	28	F	28	F	28	F
29	F	29	F	29	F	29	F
30	Ha	30	**Hf**	30	G	30	**Hd**
31	C	31	C	31	D	31	D
32	C	32	C	32	C	32	C
33	C	33	C	33	A*	33	A*
34	C	34	C	34	C	34	C
35	D	35	D	35	C	35	C
36	A	36	A	36	A	36	A
37	A	37	A	37	A	37	A
38	G	38	G	38	F	38	F
39	F	39	F	39	F	39	F
40	F	40	F	40	F	40	F
41	F	41	F	41	F	41	F
42	Hf	42	**Ha**	42	Hd	42	**G**
43	C	43	C	43	D	43	D
44	C	44	C	44	C	44	C
45	C	45	C	45	A*	45	A*
46	C	46	C	46	C	46	C
47	D	47	D	47	C	47	C

* indicates no detector channel

Figure 52: EC Motherboard Maps (8-11)

Preamp Motherboard Maps 12-15 (128 boards)

EC

Board 12 (32)		Board 13 (32)		Board 14 (32)		Board 15 (32)	
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	F	2	F	2	F	2	F
3	F	3	F	3	F	3	F
4	F	4	F	4	F	4	F
5	F	5	F	5	F	5	F
6	G	6	**Hc**	6	G	6	**Hb**
7	C	7	C	7	C	7	C
8	C	8	C	8	C	8	C
9	C	9	C	9	C	9	C
10	A*	10	A*	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	F	14	F	14	F	14	F
15	F	15	F	15	F	15	F
16	F	16	F	16	F	16	F
17	F	17	F	17	F	17	F
18	Hc	18	**G**	18	Hb	18	**F**
19	D	19	D	19	C	19	C
20	D	20	D	20	C	20	C
21	C	21	C	21	C	21	C
22	A*	22	A*	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	F	26	F	26	F	26	F
27	F	27	F	27	F	27	F
28	F	28	F	28	F	28	F
29	F	29	F	29	F	29	F
30	G	30	**Hb**	30	G	30	G
31	C	31	C	31	C	31	C
32	D	32	D	32	C	32	C
33	D	33	D	33	C	33	C
34	C	34	C	34	C	34	C
35	B	35	B	35	C	35	C
36	A	36	A	36	A	36	A
37	A	37	A	37	A	37	A
38	F	38	F	38	F	38	F
39	F	39	F	39	F	39	F
40	F	40	F	40	F	40	F
41	F	41	F	41	F	41	F
42	Hb	42	**G**	42	G	42	G
43	C	43	C	43	C	43	C
44	C	44	C	44	C	44	C
45	D	45	D	45	C	45	C
46	C	46	C	46	C	46	C
47	B	47	B	47	C	47	C

* indicates no detector channel

Figure 53: EC Motherboard Maps (12-15)

Preamp Motherboard Maps 16-19 (384 boards)

EC

Board 16 (128)		Board 17 (64)		Board 18 (128)		Board 19 (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	F	2	F	2	F	2	F
3	F	3	E*	3	E*	3	**G**
4	F	4	E*	4	E*	4	E*
5	F	5	E*	5	E*	5	E*
6	G	6	F	6	F	6	E*
7	C	7	C	7	C	7	C
8	C	8	C	8	C	8	C
9	C	9	C	9	C	9	C
10	C	10	C	10	C	10	C
11	C	11	**B**	11	**B**	11	C
12	A	12	A	12	A	12	A
13	A	13	A	13	A	13	A
14	F	14	F	14	F	14	F
15	F	15	E*	15	E*	15	**G**
16	F	16	E*	16	E*	16	E*
17	F	17	E*	17	E*	17	E*
18	G	18	G	18	**F**	18	E*
19	C	19	C	19	C	19	C
20	C	20	C	20	C	20	C
21	C	21	C	21	C	21	C
22	C	22	C	22	C	22	C
23	C	23	**B**	23	**B**	23	C
24	A	24	A	24	A	24	A
25	A	25	A	25	A	25	A
26	F	26	F	26	F	26	F
27	F	27	E*	27	E*	27	F
28	F	28	E*	28	E*	28	E*
29	F	29	E*	29	E*	29	E*
30	G	30	**F**	30	**F**	30	E*
31	C	31	C	31	C	31	C
32	C	32	C	32	C	32	C
33	C	33	C	33	C	33	C
34	C	34	C	34	C	34	C
35	C	35	**B**	35	**B**	35	C
36	A	36	A	36	A	36	A*
37	A	37	A	37	A	37	A*
38	F	38	F	38	F	38	**G**
39	F	39	E*	39	E*	39	**G**
40	F	40	E*	40	E*	40	**G**
41	F	41	E*	41	E*	41	E*
42	G	42	**F**	42	**F**	42	E*
43	C	43	C	43	C	43	C
44	C	44	C	44	C	44	C
45	C	45	C	45	C	45	C
46	C	46	C	46	C	46	C
47	C	47	**B**	47	**B**	47	**B**

* indicates no corresponding detector channel

Figure 54: EC Motherboard Maps (16-19)

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

Figure 55: Box Map (CC)

Preamp Box Maps 2,3

EC

Map 2: Boxes 0,1,6,7

Location	Board	Location	Board
0	5	48	16
1	6	49	16
2	8	50	17
3	10	51	18
4	12	52	18
5	14	53	19
6	5	54	16
7	7	55	16
8	9	56	17
9	11	57	18
10	13	58	18
11	15	59	19
12	5	60	16
13	6	61	16
14	8	62	17
15	10	63	18
16	12	64	18
17	14	65	19
18	5	66	16
19	7	67	16
20	9	68	17
21	11	69	18
22	13	70	18
23	15	71	19
24	5	72	16
25	6	73	16
26	8	74	17
27	10	75	18
28	12	76	18
29	14	77	19
30	5	78	16
31	7	79	16
32	9	80	17
33	11	81	18
34	13	82	18
35	15	83	19
36	5	84	16
37	6	85	16
38	8	86	17
39	10	87	18
40	12	88	18
41	14	89	19
42	5	90	16
43	7	91	16
44	9	92	17
45	11	93	18
46	13	94	18
47	15	95	19

Map 3: Boxes 4,5,10,11

Location	Board	Location	Board
0	5	48	16
1	7	49	16
2	9	50	17
3	11	51	18
4	13	52	18
5	15	53	19
6	5	54	16
7	6	55	16
8	8	56	17
9	10	57	18
10	12	58	18
11	14	59	19
12	5	60	16
13	7	61	16
14	9	62	17
15	11	63	18
16	13	64	18
17	15	65	19
18	5	66	16
19	6	67	16
20	8	68	17
21	10	69	18
22	12	70	18
23	14	71	19
24	5	72	16
25	7	73	16
26	9	74	17
27	11	75	18
28	13	76	18
29	15	77	19
30	5	78	16
31	6	79	16
32	8	80	17
33	10	81	18
34	12	82	18
35	14	83	19
36	5	84	16
37	7	85	16
38	9	86	17
39	11	87	18
40	13	88	18
41	15	89	19
42	5	90	16
43	6	91	16
44	8	92	17
45	10	93	18
46	12	94	18
47	14	95	19

Figure 56: Box Maps (EC)