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A Second Study to Determine the Effect of High Initial Flares in Corner Horns

No drivers are considered for the majority of this study

Horn Theoretical Parameters

- Throat compression ratios start at 1.75:1 and extend to 3.50:1
- The length of the initial flares range from 20 to 60 cm in length
- The angle of the initial flare is conical in nature, but runs from an effective exponential expansion f_c of 30 to 220 Hz

The graphic below represents a portion of the high initial horn flares studied, and the column data will now be elaborated.

A - Driver Sd (2)-12 inch drivers in parallel

B - Sd/S1 throat ratio

C - S1 area at throat

D - S2 area at end of initial conical flare

E - L1 length of initial flare

A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S
					Effective Exponential Flare1	S3	Exp	Flare2	fc	Ripple	Eff	Record	fc Rank (%)	Ripple Rank (%)	Eff Rank (%)	Total (2) Rank	Total (3) Rank
Sd	Ratio	S1	S2	L1													
1040	2.5	416	599.4	20	50	4056.1	152.4	34.35	53.67	6.987	117.7	13	16.6	86.4	84.9	51.6	71.4
1040	2.5	416	719.5	20	75	4056.1	152.4	31.07	51.5	7.648	116.9	14	26.9	77.0	75.6	74.7	91.9
1040	2.5	416	802.8	20	90	4056.1	152.4	29.1	50.22	8.032	116.4	60	33.0	71.5	69.8	85.1	96.7
1040	2.5	416	863.6	20	99.99	4056.1	152.4	27.79	49.35	8.305	116.1	15	37.2	67.6	66.3	90.6	97.8
1040	2.5	416	929.11	20	110	4056.1	152.4	26.48	48.49	8.58	115.7	77	41.3	63.7	61.6	94.8	95.1
1040	2.5	416	999.5	20	120	4056.1	152.4	25.16	47.62	8.861	115.4	78	45.4	59.7	58.1	97.7	92.5
1040	2.5	416	1075.3	20	130	4056.1	152.4	23.85	46.76	9.144	115	79	49.5	55.7	53.5	99.4	86.6
1040	2.5	416	1156.8	20	140	4056.1	152.4	22.54	45.9	9.429	114.6	84	53.6	51.6	48.8	99.8	79.3
1040	2.5	416	1244.4	20	150	4056.1	152.4	21.23	45.05	9.717	114.3	98	57.6	47.5	45.3	98.8	73.0

F - effective exponential flare rate in Hz, actual flare is conical

G - S3 mouth area

H - Exp length of exponential section

I - effective exponential flare rate in Hz

J - calculated fc based on SPL average by summing from initial peak to 300 Hz

K - maximum ripple based on the max-min

A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S
					Effective Exponential Flare1	S3	Exp	Flare2	fc	Ripple	Eff	Record	fc Rank (%)	Ripple Rank (%)	Eff Rank (%)	Total (2) Rank	Total (3) Rank
Sd	Ratio	S1	S2	L1													
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M - SPL efficiency based on summing from first peak to 300Hz

N - Hornresp file number

O - The entire group of fc data is grouped for min/max. The min value of fc is assigned a value of 100% and the max value of fc is given 0%.

P - Ripple is assigned a value of 100% for the lowest value and 0% for the highest

Q - The highest efficiency value is assigned 100% and the lowest, 0%

A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S	
					Effective									fc	Ripple	Eff	Total (2)	Total (3)
					Exponential									Rank	Rank	Rank	Rank	Rank
Sd	Ratio	S1	S2	L1	Flare1	S3	Exp	Flare2	fc	Ripple	Eff	Record	(%)	(%)	(%)			
1040	2.5	416	599.4	20	50	4056.1	152.4	34.35	53.67	6.987	117.7	13	16.6	86.4	84.9	51.6	71.4	
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1040	2.5	416	1244.4	20	150	4056.1	152.4	21.23	45.05	9.717	114.3	98	57.6	47.5	45.3	98.8	73.0	

R - The ranking for fc and Ripple are multiplied together and then divided by a constant, such that the highest value is 100%

S - Is similar to R, except that fc, Ripple, and Eff rank values are multiplied together and divided by a constant so that the highest value is equal to 100%.

In the example below, the highest S value is highlighted in yellow. The fc is the lowest possible, the Ripple is the lowest, and the Eff is the highest.

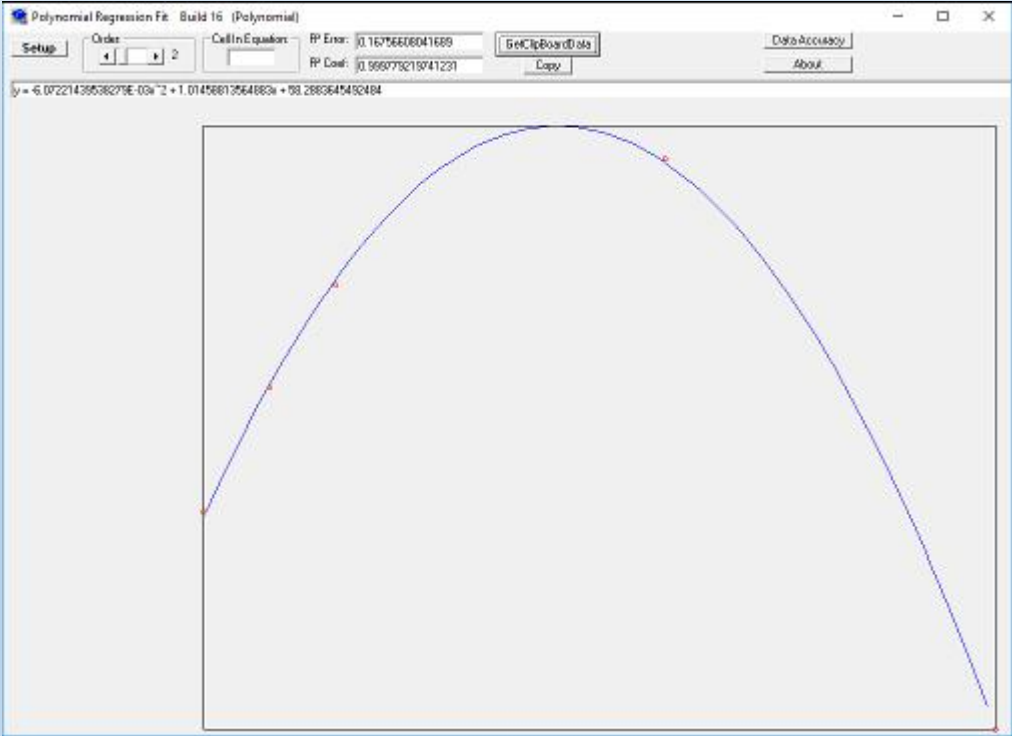
A	B	C	D	E	F	G	H	I	J	K	M	N	O	P	Q	R	S
					Effective								fc	Ripple	Eff	Total (2)	Total (3)
					Exponential								Rank	Rank	Rank	Rank	Rank
Sd	Ratio	S1	S2	L1	Flare1	S3	Exp	Flare2	fc	Ripple	Eff	Record	(%)	(%)	(%)		
1040	2.5	416	599.4	20	50	4056.1	152.4	34.35	53.67	6.987	117.7	13	16.6	86.4	84.9	51.6	71.4
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1040	2.5	416	1244.4	20	150	4056.1	152.4	21.23	45.05	9.717	114.3	98	57.6	47.5	45.3	98.8	73.0

When using the f_c , Ripple, and Eff, to pick the optimum high initial flare rate, the optimum f_c value invariably ends up being very close to an $f_c = 50\text{Hz}$.

When using the f_c and Ripple to find the optimum combination, the initial flare rate is higher than above and the f_c is typically closer to 46Hz .

To allow more precise calculation of relation between Effective Expo Flare and Total Rank (2) (fc * Ripple), a second order polynomial is generated based on the X-Y data in the two columns shown. A program to the right generates the coefficients.

Effective	Total (2)
Exponential	Rank
Flare1	
29.98	83.5
40	89.0
49.95	93.6
99.99	99.2
150	73.8
30	70.5



The polynomial data is inserted into the various columns and more X-data is inserted to allow more granular calculations.

X-Data is the effective flare rate, Y data, the $fc \cdot \text{Ripple}$ ranking in %.

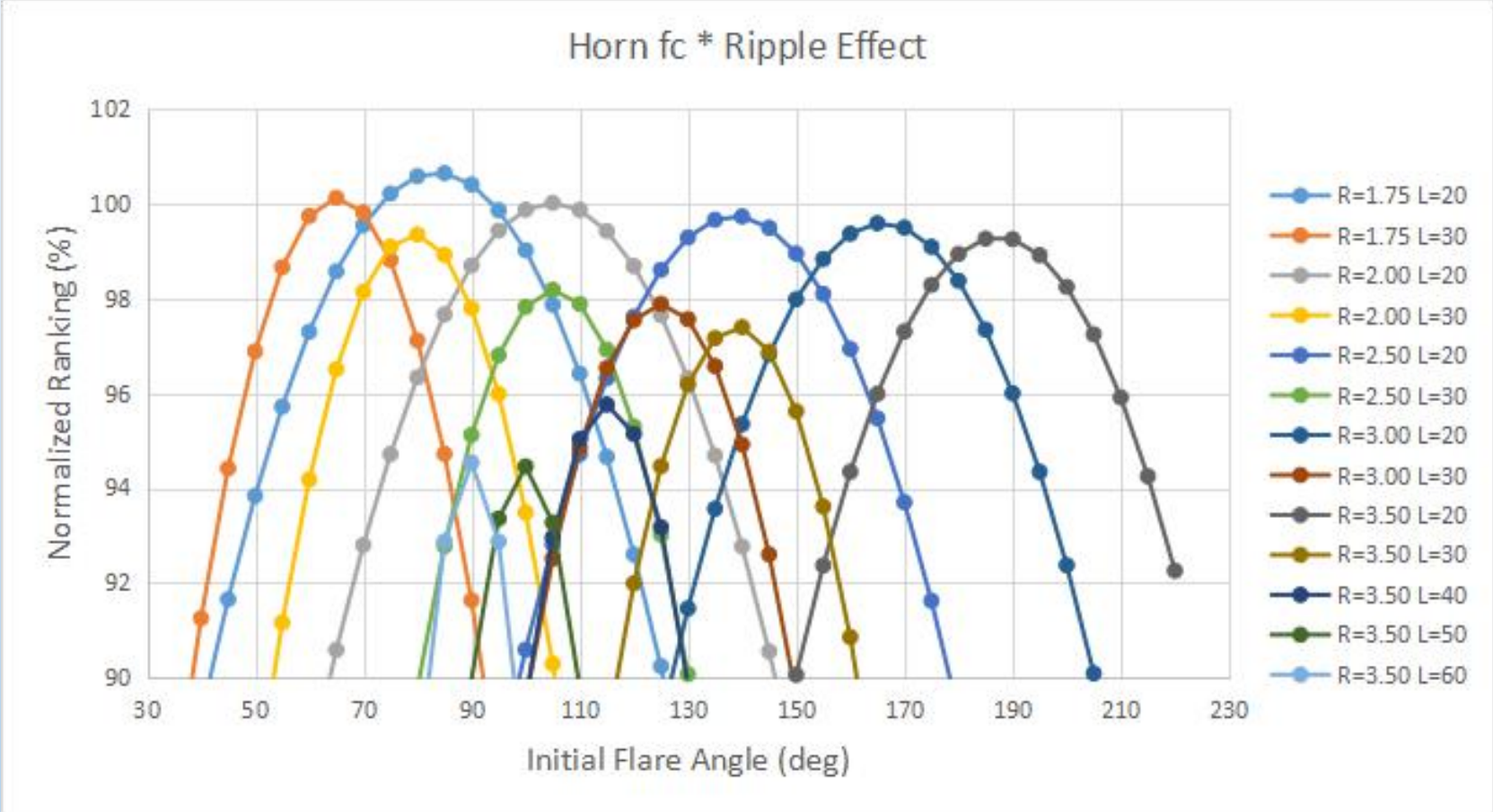
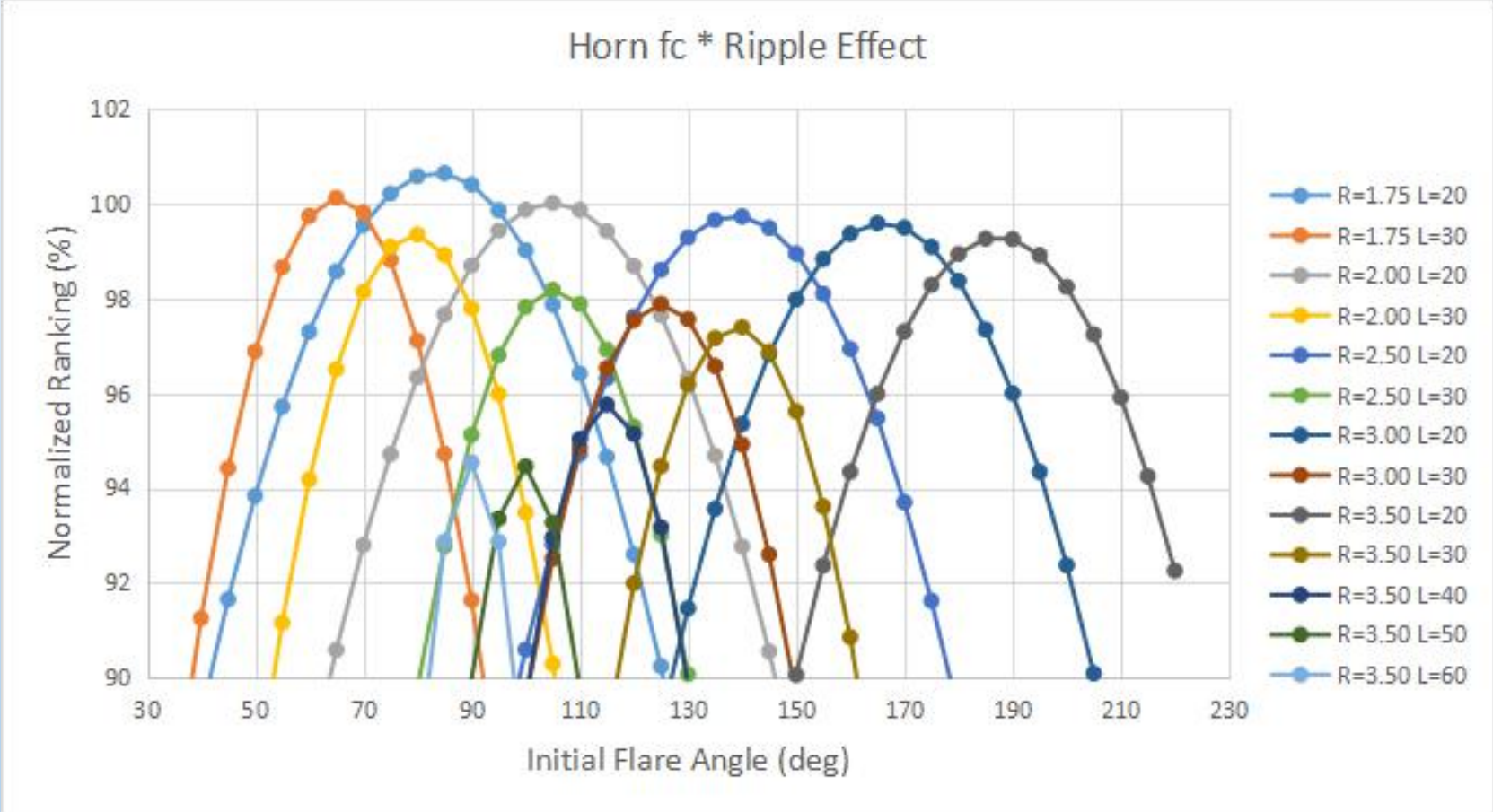
						fc * Ripple Poly Data		
Ratio	1.75	1.75	2	2	2.5	2.5	3	3
L1	20	30	20	30	20	30	20	30
30	83.26102	82.82102						
35	86.36049	87.38219						
40	89.15635	91.24751						
45	91.6486	94.41699		83.03752				
50	93.83724	96.89063	82.1555	87.44268				
55	95.72226	98.66843	85.25953	91.15673				
60	97.30368	99.75038	88.06774	94.17967				
65	98.58149	100.1365	90.58011	96.5115				
70	99.55568	99.82675	92.79666	98.15223		81.76635		
75	100.2263	98.82117	94.71738	99.10184		86.09871		
80	100.5932	97.11975	96.34228	99.36035		89.76913		
85	100.6566	94.72248	97.67134	98.92775	82.08222	92.77759		
90	100.4164	91.62937	98.70458	97.80404	85.22399	95.12411		81.46
95	99.8725	87.84042	99.44199	95.98922	88.05848	96.80868		85.81
100	99.02503	83.35563	99.88358	93.48329	90.58567	97.8313		89.49
105	97.87396	78.17499	100.0293	90.28626	92.80557	98.19197		92.5
110	96.41927		99.87926	86.39812	94.71818	97.89069	79.90649	94.85

And the acoustic efficiency is also calculated using linear regression (a poly with two coefficients). Again this allows finer resolution in estimating efficiency for various high initial flare rates.

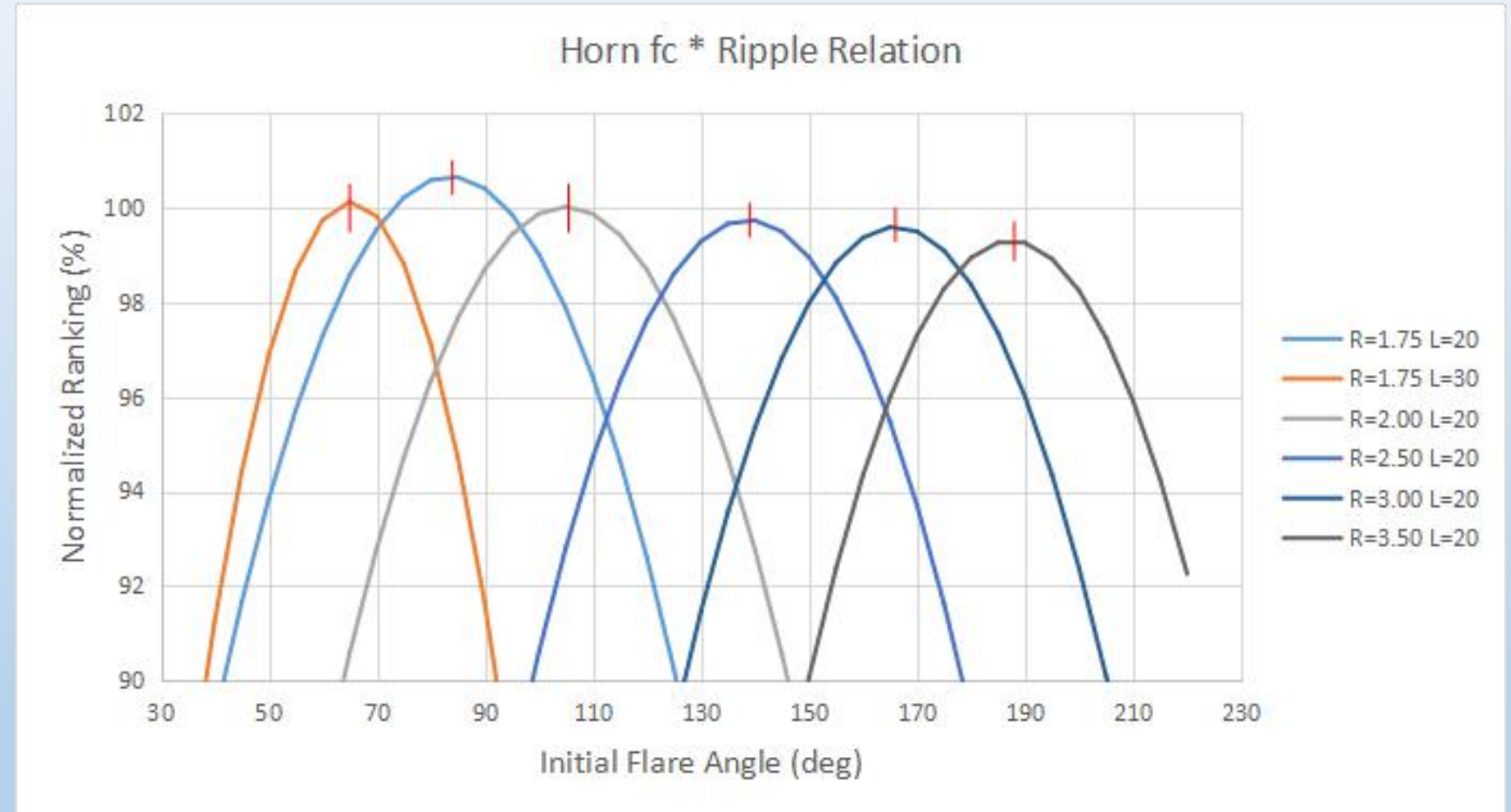
Effective	
Exponential	
Flare1	Eff
29.98	116.6
40	116.3
49.95	115.9
99.99	114.2
150	112.5

		Efficiency Poly Data			
1.75	1.75	2	2.5	3	3.5
20	30	20	20	20	20
116.6079	116.7116	117.2712	118.4433	119.4232	120.2773
116.4365	116.4522	117.1017	118.2714	119.247	120.0985
116.265	116.1928	116.9323	118.0995	119.0709	119.9197
116.0936	115.9334	116.7629	117.9277	118.8948	119.7408
115.9222	115.674	116.5935	117.7558	118.7186	119.562
115.7508	115.4146	116.424	117.5839	118.5425	119.3832
115.5794	115.1552	116.2546	117.4121	118.3664	119.2043
115.408	114.8958	116.0852	117.2402	118.1902	119.0255
115.2366	114.6364	115.9158	117.0683	118.0141	118.8467

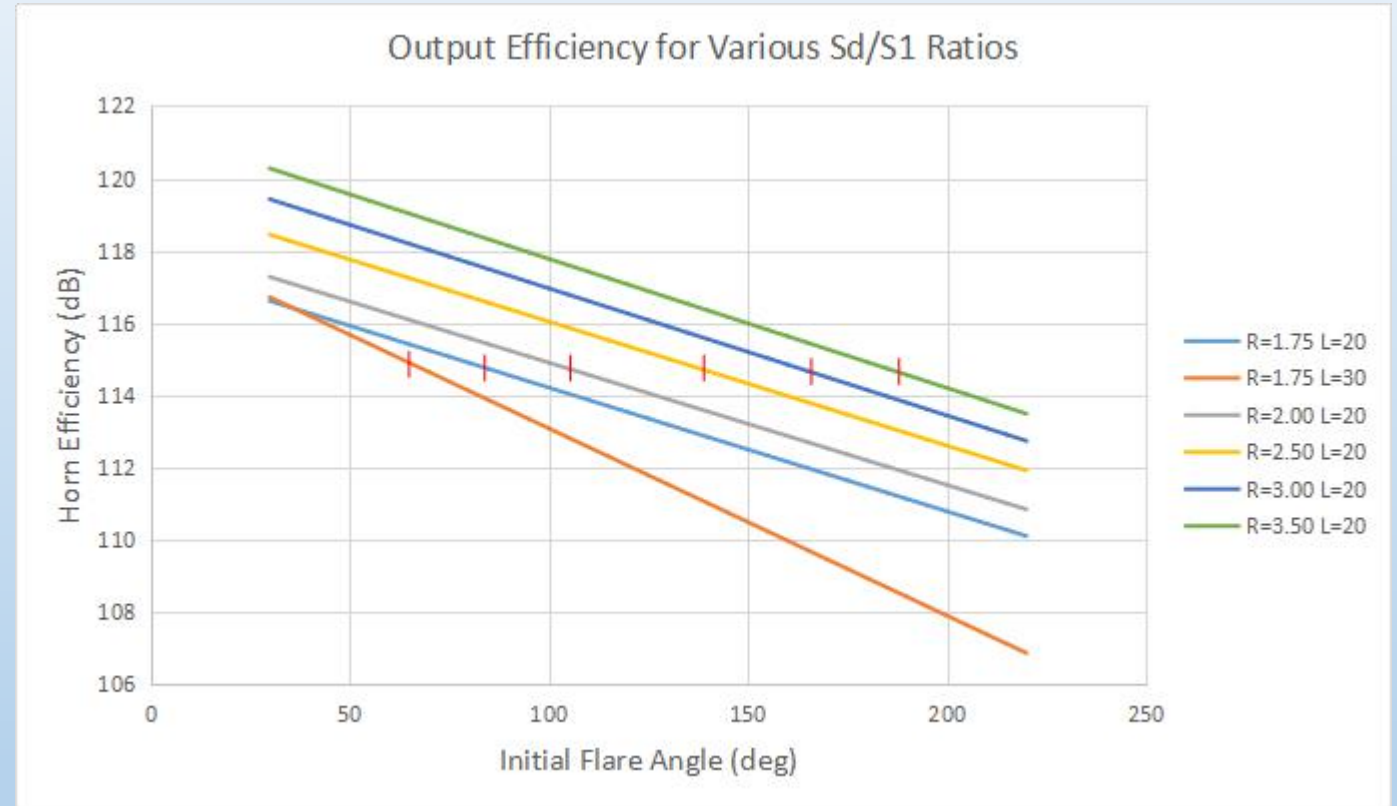
The lowest possible f_c is found by multiplying f_c^* by Ripple, and graphing that data according to the high initial flare rate.



This graph is similar to above, except that only the highest performing horn flares are maintained.



This graph above has red markers that show the ideal initial flare rate for each modeled horn shape. These markers are shown in the same position here. Note that the efficiencies of these various shaped horns are almost identical.



Also interesting, is that all the modeled horn shapes each have almost exactly the same fc, with several examples shown to the right.

	Determine	fc	Ripple	27.73 (see Q67)	
	Min	Rank	Rank		
	fc	poly	poly		
	(Hz)	(%)	(%)		
3	46	53.09747	51.89333	99.36547	R=1.75 L=20
5	46.1	52.62125	52.37481	99.38795	
7	46.2	52.14502	52.85629	99.39389	
3	46.3	51.66879	53.33778	99.38329	
2	46.4	51.19257	53.81926	99.35615	
2	47.4	46.43031	58.63408	98.17521	
3	46.5	50.74221	53.74881	98.35318	R=1.75 L=30
5	46.6	50.26587	54.26048	98.35737	
7	46.7	49.78952	54.77214	98.34399	
3	46.8	49.31317	55.28381	98.31302	
9	46.9	48.83682	55.79548	98.26448	
2	47	48.36048	56.30715	98.19836	
3	45.8	54.09976	50.99348	99.48558	R=2.00 L=20
5	45.9	53.6231	51.46241	99.51583	
7	46	53.14645	51.93134	99.52997	
3	46.1	52.66979	52.40026	99.52798	

At right are the parameters put into Hornresp to generate SPL curves with an actual driver.

Hornresp - Input Parameters

File Tools Window Help

Ang	0.5 x Pi	Eg	2.83	Rg	0.00	Cir	0.31
S1	297.50	S2	553.50	Con	20.00	F12	0.00
S2	553.50	S3	2028.05	Exp	152.40	F23	23.33
S3	0.00	S4	0.00	L34	0.00	F34	0.00
S4	0.00	S5	0.00	L45	0.00	F45	0.00

Sd	507.00	Cms	1.74E-04	Mmd	47.28	Re	3.20
Bl	10.90	Rms	2.14	Le	0.94	Nd	1
Vrc	50.00	Fr	100.00	Vtc	520.00		
Lrc	16.00	Tal	4.00	Atc	520.00		

Comment R=1.75 L=20 F=85 Eminence Delta 12LFC - 52Hz

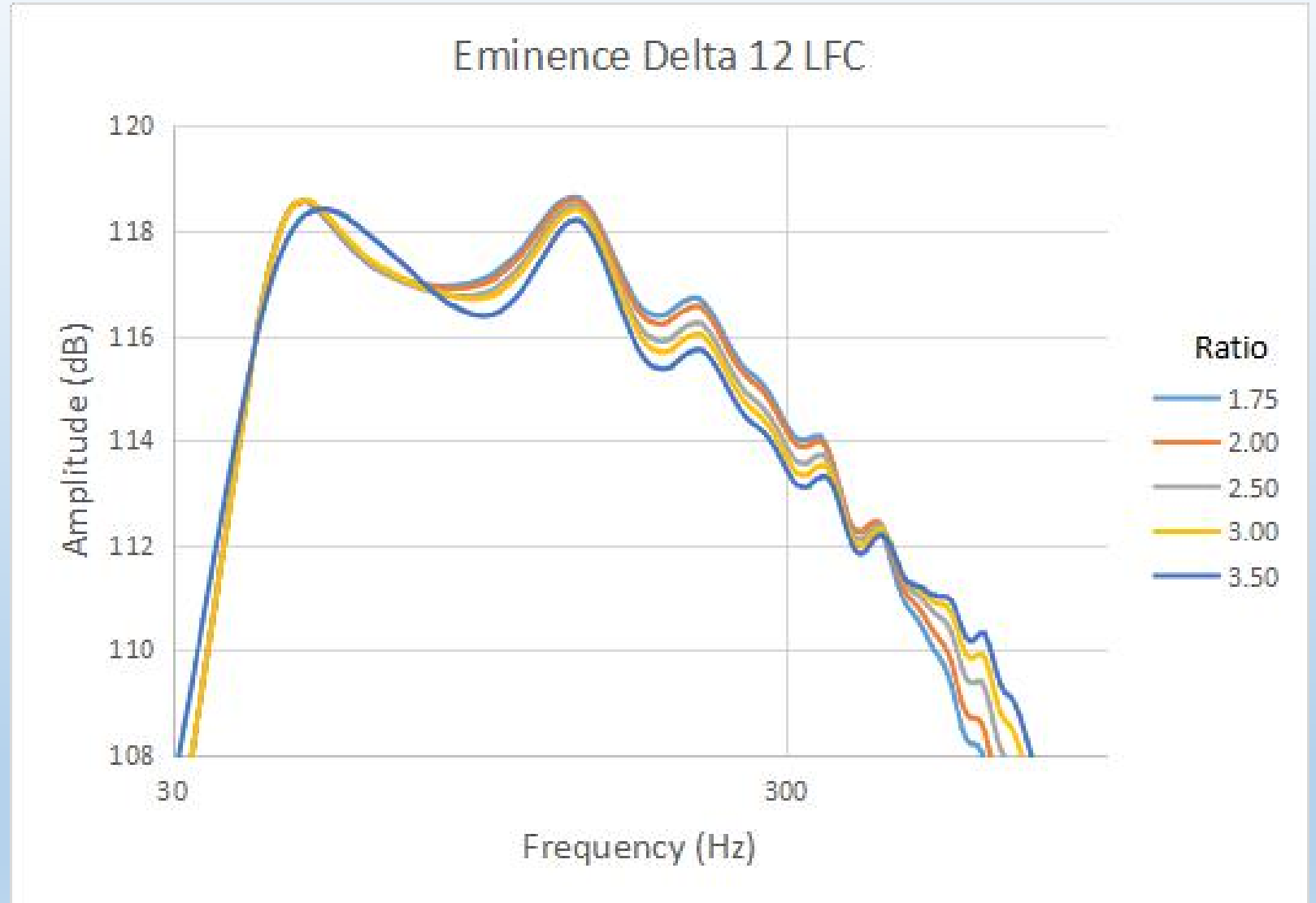
Previous Next Edit Add Delete Record 10 of 14 Calculate

Show previous record

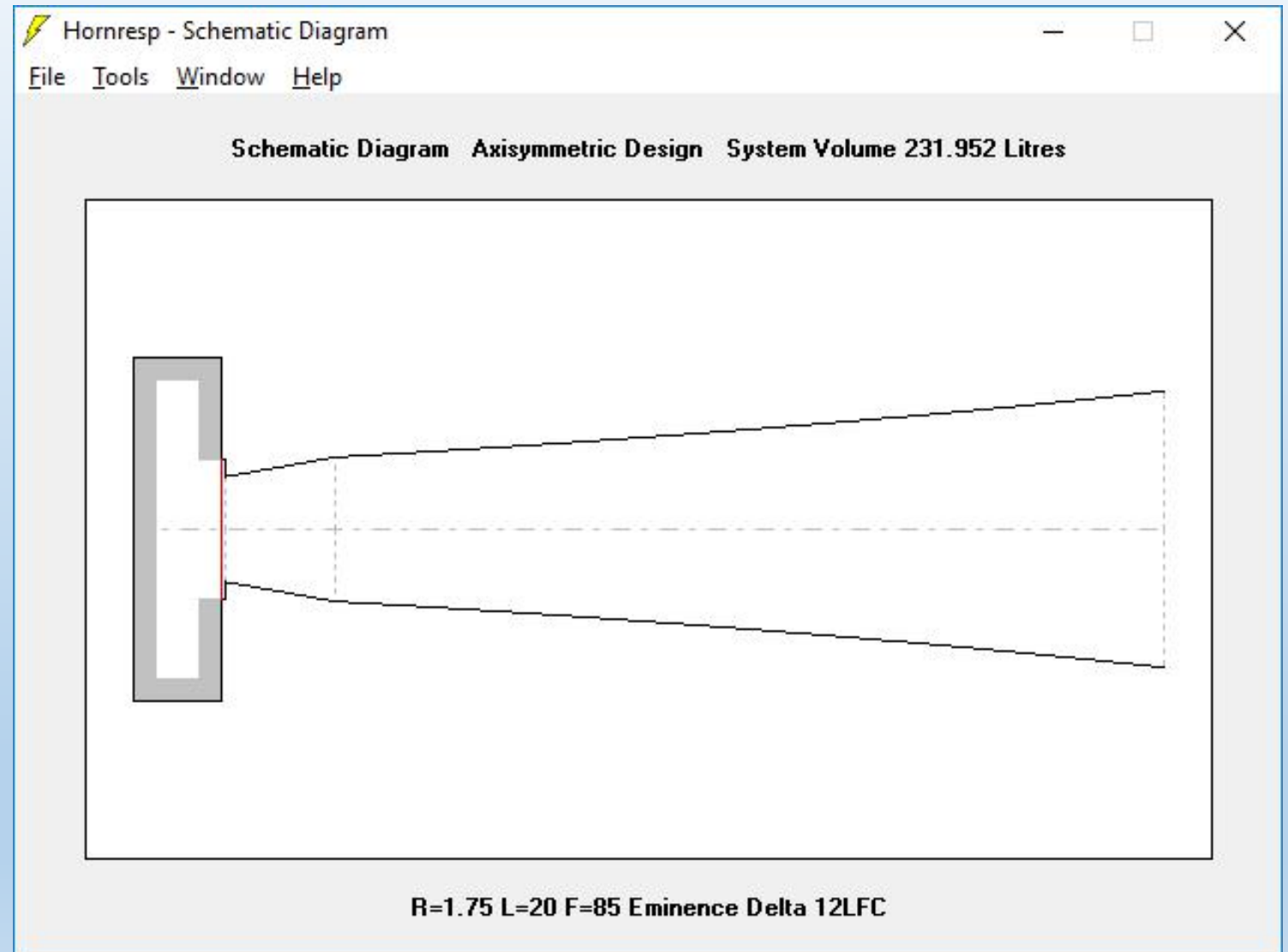
Now horns with the optimum high initial flare rate are modeled using a real driver. The data to right are the output files from Hornresp.

		Eminence Delta 12LFC				
Ratio	1.75	2	2.5	3	3.5	
Freq (hertz)	SPL (dB)	SPL (dB)	SPL (dB)	SPL (dB)	SPL (dB)	
10	81.6336	81.63421	81.63667	81.638671	83.67378	
10.14405	81.89846	81.89909	81.90162	81.903675	83.93827	
10.29017	82.16381	82.16446	82.16706	82.169171	84.20323	
10.43839	82.42967	82.43033	82.43301	82.435175	84.46868	
10.58875	82.69604	82.69672	82.69948	82.701702	84.73463	
10.74128	82.96295	82.96365	82.96648	82.968769	85.00109	
10.896	83.23042	83.23113	83.23405	83.236391	85.26808	
11.05295	83.49845	83.49918	83.50218	83.504586	85.53562	
11.21216	83.76706	83.76781	83.7709	83.773372	85.80373	
11.37367	84.03628	84.03705	84.04023	84.042767	86.07241	
11.5375	84.30613	84.30692	84.31018	84.312788	86.34169	
11.7037	84.57662	84.57742	84.58078	84.583457	86.61159	
11.87228	84.84777	84.84850	84.85205	84.854702	86.88212	

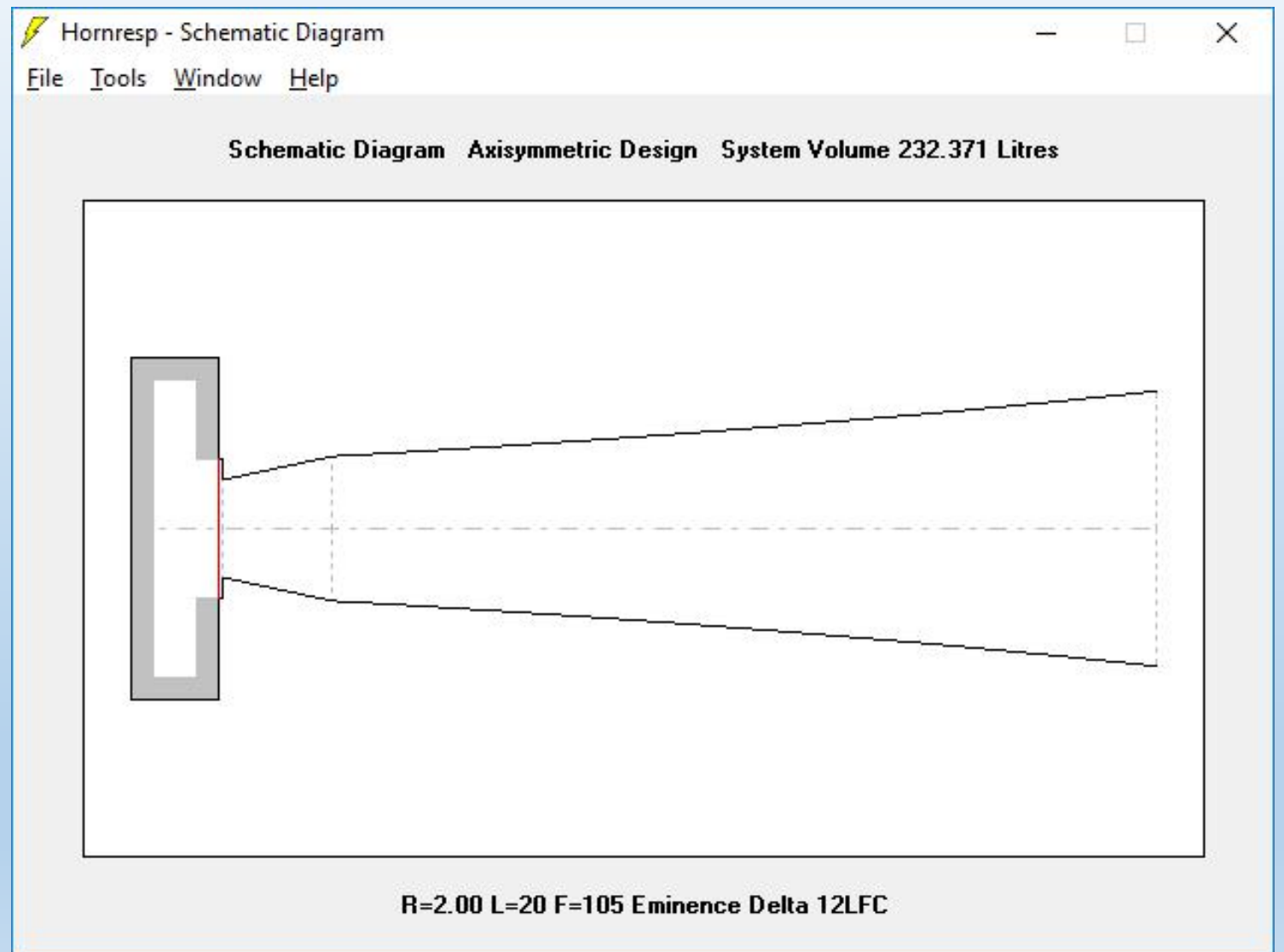
It is striking how similar the SPL curves are to each other, even though the horn initial taper shape is vastly different.



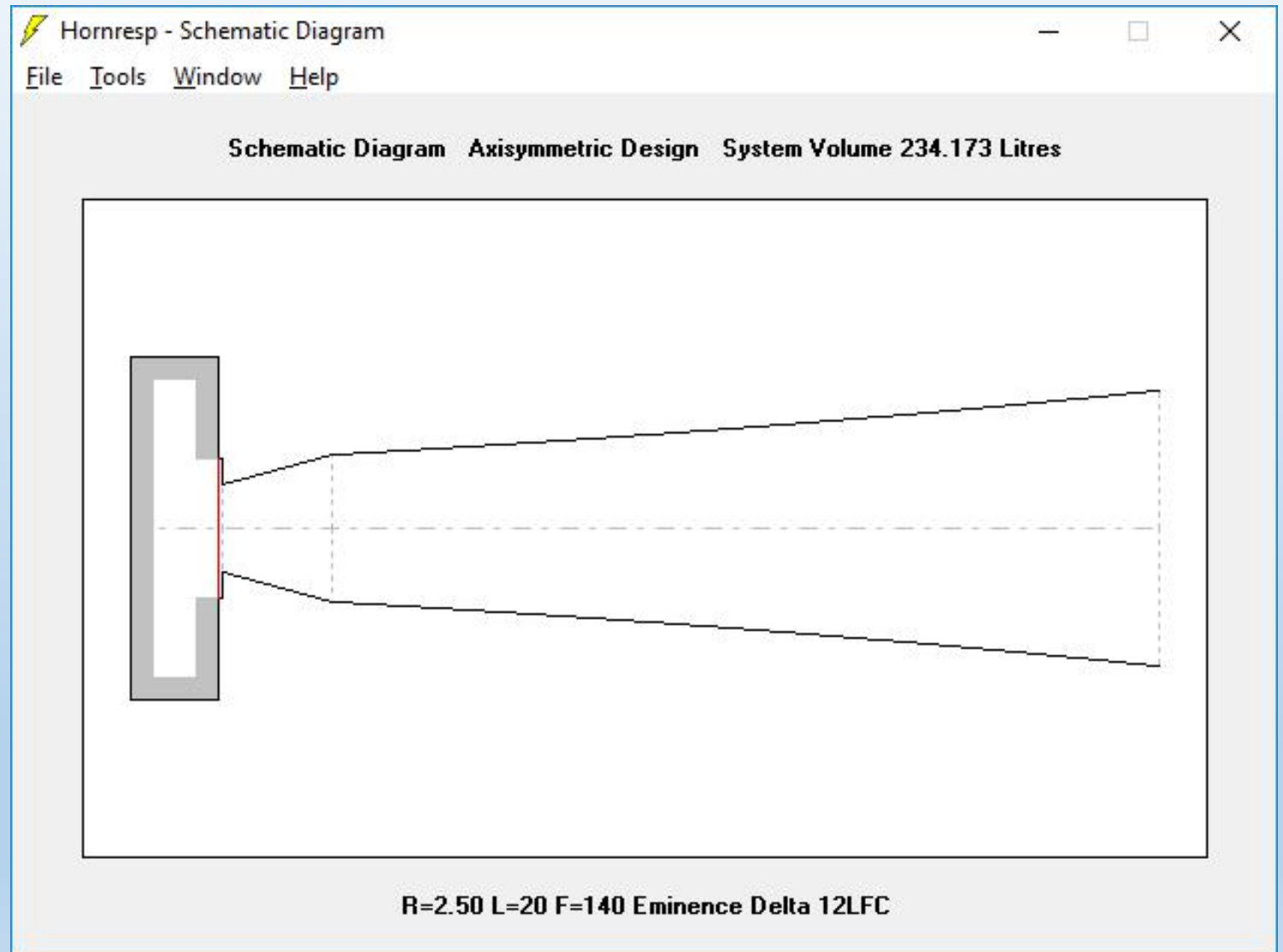
R=1.75 L=20 F=85



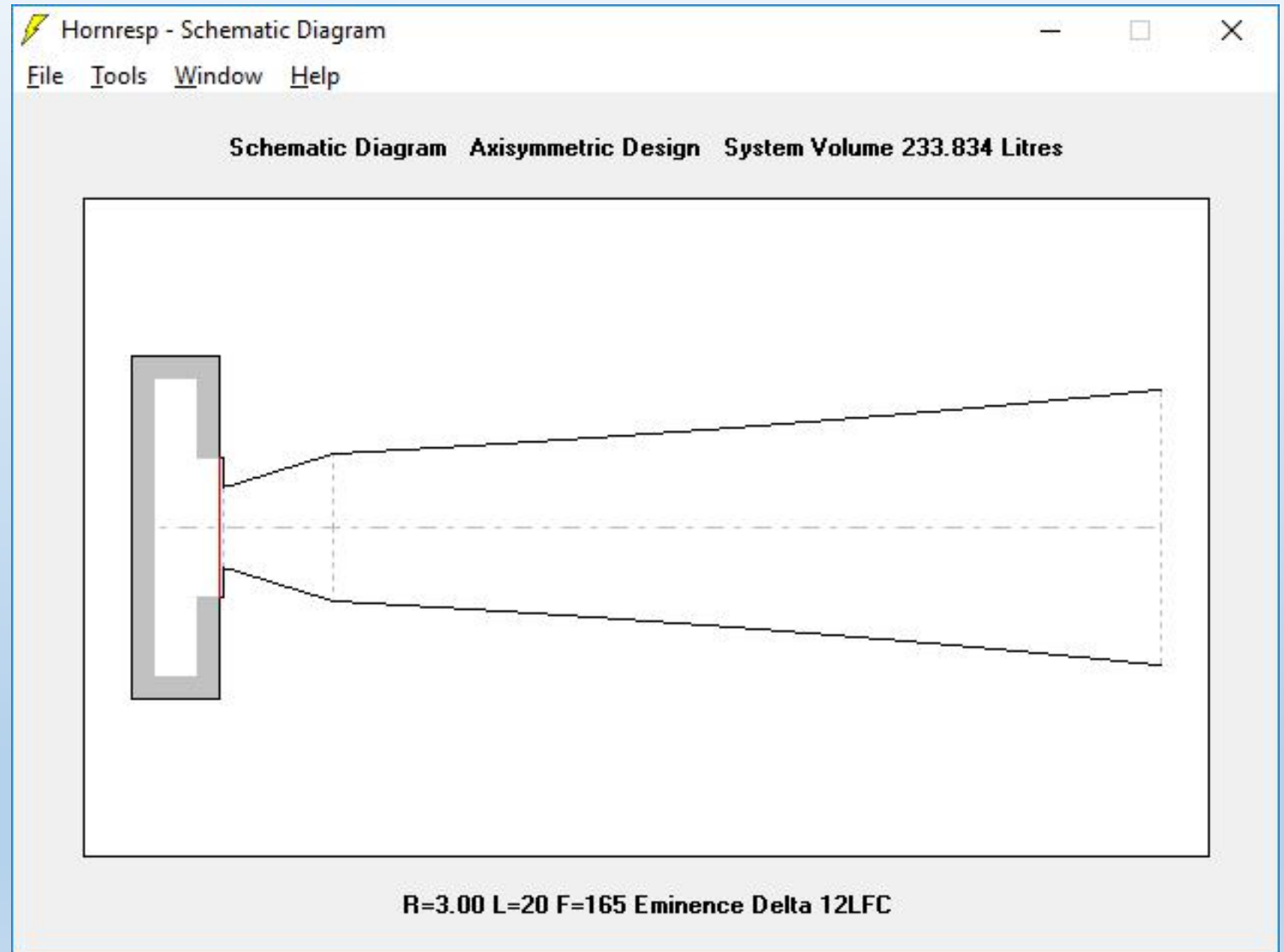
R=2.00 L=20 F=105



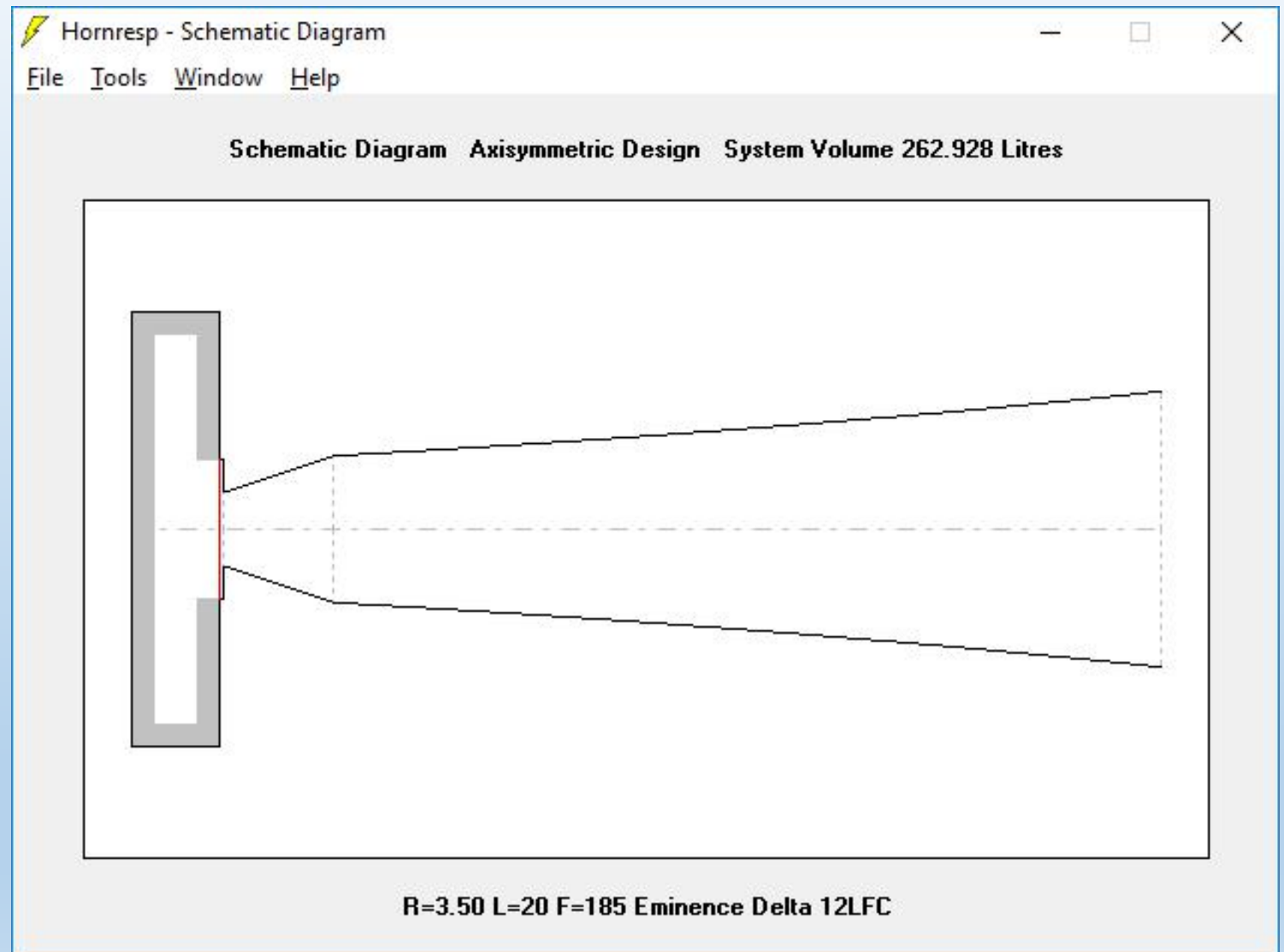
R=2.50 L=20 F=140



R=3.00 L=20 F=165



R=3.50 L=20 F=185



Summary

- Horn shapes which utilize f_c , Ripple, and Efficiency have been compared.
- A mathematical method to optimize the inter-relation between the three variables has been developed.
- When optimizing the three primary values, there seems to be little acoustic advantage over a pure exponential flare.
- When optimizing f_c and Ripple, the Hornresp model shows an 8% drop in f_c (50 to 46Hz). This f_c drop is also accompanied by a similar increase in Ripple over a pure exponential horn.
- There seems to be no “free-lunch” regarding getting a corner horn to perform at a slightly lower f_c than a pure exponential horn.
- Adding an actual driver to the modeling equation results in some surprises, which will be discussed in a later slide show.