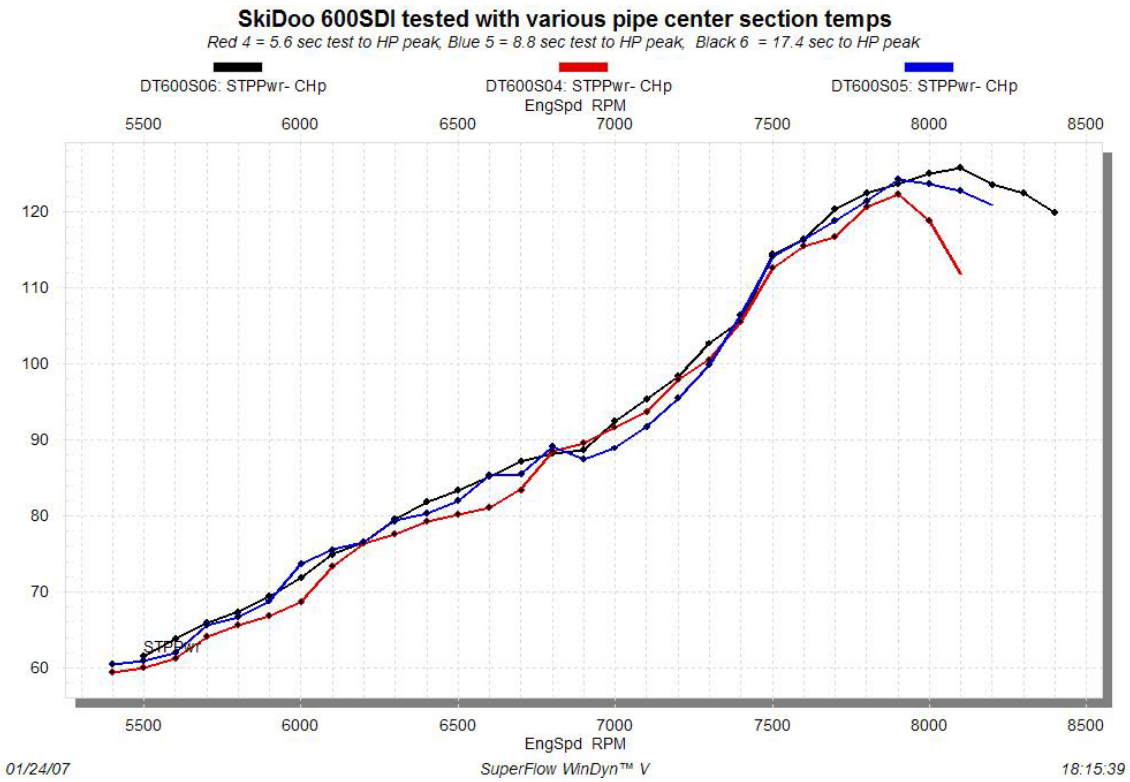
SkiDoo 600 SDI pipe comparison/ head mod

Jim Cooper of Cooper Sales and Service in Waterport NY put this test session together with pipes he collected to test on his mom's sled (which had several thousand trail miles from last year) which he had recently freshened up with new rings and pistons. Jim also had a head modified with .010" tighter squish band, and combustion chamber enlarged to net one point lower compression, similar to what Sean Ray has been doing here with two cylinder pump gas engines [tighter squish, lower compression, and advancing ignition timing].

Our first baseline bone stock testing was done at three different acceleration rates to show the effects of pipe center section gas temp on HP curves and where HP peak occurs. For the comparison with the aftermarket pipes we used the slower rate, the same rate as used in all other tests that follow.

The reason for this graph is for us to understand that on our two-stroke sleds, the HP peak RPM continuously rises and falls with the average temperature of the exhaust gas inside the pipe (since the speed of sound increases I think in direct proportion to the absolute temperature of the gas). So people who haven't followed our early testing in DynoTech (all posted here in the archives for your perusal) may mistakenly think they have to clutch their sleds to immediately climb to the HP peak shown in our 20 second dyno runs. As you can see in the following graph, clutching to our 20 second dyno run can cost you 20-30 HP during the first five or more seconds. Since the gas temp inside the center section of the pipe is about the average of the varying temps throughout the pipe (usually hottest at the header pipe, coolest at the outlet pipe) so measuring the gas in the middle of the center section makes most sense for accurate clutch tuning. The most savvy dyno tuners today measure their pipe(s) center section temps to determine what RPM their clutches should shift to during any situation. I've begun carrying Digatron instruments with fast acting open element probes for datalogging that information on the sled after determining the pipe CS temp/ HP peak RPM curve on the dyno.



The following dyno test data was obtained first with the stock single pipe and muffler, then with three aftermarket single pipes with the stock muffler:

1) BMP (Bikeman Performance) modified stock pipe—this is where a customer mails in his stock pipe, which is modified by BMP with some internal modification and a lengthening of the center section (still accommodates the stock heat shields).
2) Straightline single pipe and stock muffler. This one is shaped like the stock (and BMP pipe) so the stock heat shields should fit well enough to fool the trail Gestapo who might write summonses for even quiet as stock aftermarket pipes using stock mufflers.
3) DynoPort single pipe. We also tested a DynoPort can which added a few dB but matched the stock muffler's airflow and HP close enough with each pipe as to not be discernable.

Here are the four pipes tested on the stock 600SDI engine, with stock muffler.

stock single pipe EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	Fuel A lb/hr	BSFC lb/hph	AirTmp degF	Air1+2 scfm	TsTim2 second	A/FA-B Ratio
5500	58.7	61.5	34.1	0.585	60	98	0	13.24
5600	59.9	63.8	35.2	0.584	61	102	0.6	13.25
5700	60.8	66.1	35.7	0.574	62	106	1.5	13.64
5800	61.1	67.4	35.9	0.565	62	109	1.8	13.87
5900	61.8	69.4	37.3	0.571	61	114	2.5	13.99
6000	62.8	71.8	38.3	0.565	61	117	3.2	13.99

6100	64.5	74.9	41.3	0.584	61	121	3.9	13.47
6200	64.8	76.6	42.1	0.581	61	124	4.4	13.49
6300	66.3	79.5	46.1	0.614	62	129	5.3	12.81
6400	67.1	81.8	48.6	0.631	62	133	6.1	12.51
6500	67.4	83.4	48.9	0.622	62	135	6.5	12.61
6600	67.8	85.1	49.8	0.621	63	138	7.1	12.71
6700	68.4	87.2	51.8	0.632	64	142	8.1	12.53
6800	68.1	88.1	52.5	0.633	63	143	8.4	12.48
6900	67.5	88.6	56.4	0.676	63	146	9.2	11.82
7000	69.4	92.4	56.9	0.654	63	149	9.6	11.99
7100	70.5	95.3	57.1	0.637	64	151	9.8	12.12
7200	71.8	98.4	58.2	0.629	64	155	10.4	12.18
7300	73.9	102.7	61.6	0.638	64	161	11.3	11.94
7400	74.9	105.6	63.3	0.637	64	165	11.5	11.91
7500	80.1	114.4	67.9	0.631	64	175	12.8	11.81
7600	80.4	116.4	68.2	0.623	64	176	13.6	11.84
7700	82.1	120.4	72.1	0.636	64	180	14.5	11.45
7800	82.5	122.5	73.7	0.638	62	183	14.9	11.34
7900	82.2	123.7	75.7	0.649	62	185	15.7	11.16
8000	82.1	125.1	76.7	0.651	63	186	16.3	11.09
8100	81.6	125.9	77.5	0.653	62	187	17.4	11.07
8200	79.2	123.6	76.8	0.661	63	188	18.5	11.18
8300	77.5	122.5	77.1	0.668	63	187	18.7	11.12
8400	75.1	119.9	77.5	0.687	63	187	18.8	11.05

BMP modified stock pipe

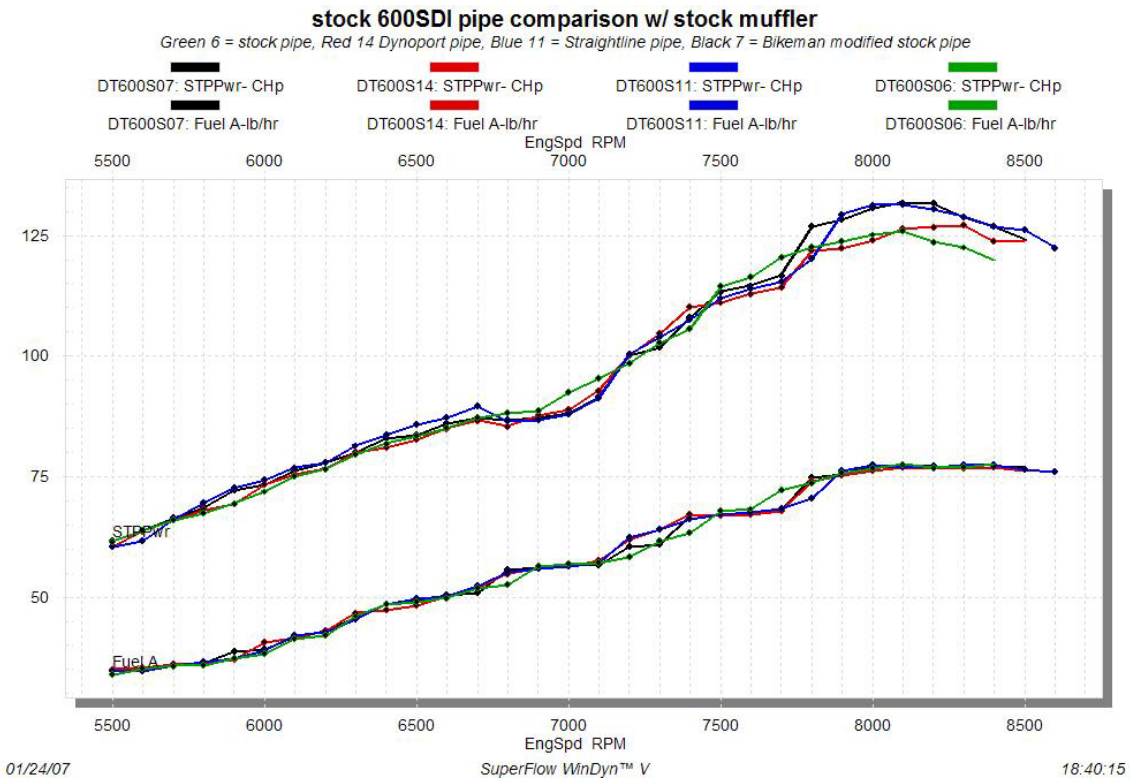
EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	Fuel A lb/hr	BSFC lb/hph	AirTmp degF	Air1+2 scfm	TsTim2 second	A/FA-B Ratio
5500	58.8	61.5	34.6	0.595	60	96	0	12.77
5600	59.8	63.8	35.1	0.583	60	100	0.6	12.99
5700	61.3	66.5	35.7	0.569	61	104	1.4	13.31
5800	62.1	68.5	36.2	0.559	60	108	1.9	13.61
5900	64.3	72.2	38.7	0.568	60	114	2.9	13.44
6000	64.3	73.4	39.2	0.565	60	116	3.3	13.52
6100	65.6	76.2	41.9	0.582	60	120	4.1	13.11
6200	66.1	77.9	43.1	0.586	62	122	4.6	12.08
6300	66.8	80.1	45.9	0.607	61	126	5.2	12.62
6400	67.9	82.8	48.5	0.621	61	131	6.2	12.34
6500	67.5	83.6	49.3	0.625	61	132	6.5	12.31
6600	68.4	86.1	50.4	0.621	60	137	7.4	12.46
6700	68.3	87.1	50.8	0.617	60	138	7.7	12.47
6800	66.9	86.7	55.7	0.681	60	141	9.1	11.61
6900	66.4	87.3	56.1	0.681	60	142	9.2	11.56
7000	66.2	88.2	56.6	0.679	60	143	9.4	11.54
7100	67.7	91.5	56.6	0.656	61	145	9.5	11.74
7200	73.1	100.2	60.5	0.641	60	156	10.9	11.78
7300	73.3	101.8	60.8	0.632	60	157	11.5	11.84
7400	76.6	108.1	66.8	0.656	61	167	12.4	11.42
7500	79.4	113.3	66.8	0.625	61	170	13.2	11.68
7600	79.2	114.6	67.4	0.624	61	171	13.6	11.65

7700	79.6	116.7	68.1	0.618	61	172	13.7	11.59
7800	85.4	126.9	74.7	0.622	58	180	14.8	11.02
7900	85.3	128.3	75.5	0.623	60	180	15.9	10.93
8000	85.8	130.8	77.3	0.626	60	183	16.5	10.81
8100	85.4	131.7	77.2	0.621	60	184	17.2	10.93
8200	84.3	131.6	77.2	0.621	60	186	18.2	11.01
8300	81.5	128.7	76.6	0.629	59	186	19.3	11.09
8400	79.3	126.8	76.9	0.642	59	186	19.7	11.12
8500	76.7	124.2	76.9	0.655	59	186	19.8	11.11

Straightline single pipe EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	Fuel A lb/hr	BSFC lb/hph	AirTmp degF	Air1+2 scfm	TsTim2 second	A/FA-B Ratio
5500	57.6	60.4	34.6	0.607	60	94	0	12.46
5600	57.7	61.6	34.6	0.595	60	95	0.2	12.61
5700	60.9	66.1	35.7	0.572	60	103	1.3	13.21
5800	62.9	69.5	36.5	0.556	60	108	2.1	13.55
5900	64.7	72.7	37.3	0.543	60	113	2.8	13.82
6000	65.1	74.3	38.8	0.553	60	116	3.2	13.66
6100	66.1	76.8	42.1	0.581	59	121	4.3	13.16
6200	65.9	77.8	42.7	0.581	59	122	4.5	13.08
6300	67.8	81.3	45.3	0.589	59	127	5.1	12.79
6400	68.7	83.7	48.5	0.613	59	131	6.1	12.38
6500	69.3	85.8	49.6	0.612	59	135	6.8	12.42
6600	69.4	87.2	50.1	0.608	59	137	7.2	12.54
6700	70.2	89.6	52.4	0.621	60	142	8.1	12.38
6800	66.8	86.4	55.2	0.677	60	142	9.1	11.82
6900	66.1	86.7	56.1	0.684	60	143	9.3	11.72
7000	65.9	87.9	56.4	0.681	60	145	9.5	11.75
7100	67.5	91.3	57.1	0.663	60	148	9.6	11.89
7200	73.1	100.3	62.3	0.657	58	159	10.9	11.71
7300	74.7	103.9	64.1	0.652	58	162	11.1	11.61
7400	76.3	107.5	66.1	0.651	59	167	12.1	11.55
7500	78.4	111.9	67.2	0.635	59	171	12.9	11.68
7600	78.7	113.9	67.7	0.629	59	173	13.8	11.71
7700	78.7	115.4	68.3	0.626	59	174	14.1	11.65
7800	80.9	120.2	70.5	0.621	59	176	14.7	11.46
7900	86.1	129.3	76.3	0.624	59	182	15.9	10.93
8000	86.2	131.3	77.3	0.624	61	183	16.6	10.86
8100	85.2	131.5	77.1	0.621	61	184	17.7	10.95
8200	83.6	130.5	76.9	0.625	61	186	18.3	11.05
8300	81.6	128.9	77.3	0.636	61	186	19.4	11.02
8400	79.3	126.8	77.3	0.647	61	186	19.6	11.02
8500	77.9	126.1	76.4	0.643	61	186	19.8	11.16
8600	74.8	122.4	75.9	0.657	60	186	19.9	11.25

DynoPort single pipe EngSpd	STPTrq	STPPwr	Fuel A	BSFC	AirTmp	Air1+2	TsTim2	A/FA-B

RPM	Clb-ft	CHp	lb/hr	lb/hph	degF	scfm	second	Ratio
5500	57.7	60.4	35.1	0.614	60	95	0	12.45
5600	59.7	63.6	35.3	0.588	60	100	0.9	13.02
5700	60.7	65.9	36.1	0.579	60	104	1.5	13.24
5800	61.7	68.2	36.4	0.565	59	109	2.3	13.75
5900	61.7	69.4	37.1	0.566	59	111	2.7	13.75
6000	64.2	73.3	40.6	0.587	61	117	3.5	13.16
6100	64.9	75.3	41.6	0.585	60	120	4.2	13.24
6200	64.9	76.6	42.9	0.594	60	123	4.6	13.08
6300	66.7	80.1	46.7	0.618	59	129	5.7	12.65
6400	66.4	80.9	47.2	0.618	59	130	6.1	12.61
6500	66.7	82.6	48.2	0.618	59	133	6.4	12.61
6600	67.6	84.9	50.2	0.626	59	138	7.3	12.57
6700	67.9	86.6	51.8	0.634	60	141	8.1	12.43
6800	66.1	85.4	54.8	0.681	60	141	8.8	11.79
6900	66.7	87.6	55.9	0.676	60	143	9.2	11.72
7000	66.6	88.8	56.4	0.673	59	144	9.4	11.69
7100	68.6	92.8	57.5	0.656	59	148	9.6	11.75
7200	73.1	100.2	61.9	0.655	59	154	11.1	11.41
7300	75.3	104.6	63.9	0.648	60	159	11.5	11.41
7400	78.1	110.1	67.1	0.646	60	166	12.7	11.36
7500	77.7	111.1	66.8	0.637	59	168	13.2	11.53
7600	78.1	112.9	67.1	0.629	59	170	13.8	11.59
7700	77.9	114.2	67.8	0.628	59	171	13.9	11.53
7800	82.1	121.7	74.1	0.645	61	178	15.1	10.97
7900	81.4	122.4	75.2	0.652	61	179	15.7	10.92
8000	81.4	123.9	76.1	0.651	61	181	16.4	10.88
8100	82.1	126.5	76.9	0.645	61	184	17.4	10.94
8200	81.2	126.7	76.6	0.641	61	184	18.2	11.03
8300	80.4	127.1	76.7	0.639	59	186	18.7	11.08
8400	77.4	123.8	77.1	0.659	59	186	19.4	11.08
8500	76.6	124.1	76.3	0.652	59	186	19.7	11.18



Finally, with the Straightline pipe fitted to the stock muffler, Jim installed a custom head that had a .010" tighter squish band and had the combustion chamber opened up enough to reduce uncorrected compression ratio one full point.

Assuming the tighter squish increased turbulence enough so that the mixture burned more quickly, the engine appeared to achieve peak combustion chamber pressure in a more ideal area ATC. The shape of the top end HP curve appears like one with added ignition lead—higher peak HP then tailing off sooner. With his SkiDoo computer, Jim Cooper tried increasing timing further than stock and HP was unchanged, meaning that with this combustion chamber we couldn't improve HP with ignition advanced more than stock.

Other stock 600SDI's we've tweaked on have benefited from advanced timing, but this one appeared to be maxed out.

Straight line single pipe, lower compression tight squish head								
EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	Fuel A lb/hr	BSFC lb/hph	AirTmp degF	Air1+2 scfm	TsTim2 second	A/FA-B Ratio
5400	56.9	58.5	34.6	0.627	60	93	0	12.33
5500	57.4	60.1	35.1	0.621	61	94	0.8	12.25

5600	58.8	62.7	35.1	0.593	60	98	1.3	12.73
5700	60.2	65.3	35.7	0.579	60	101	1.9	12.95
5800	62.4	68.9	37.6	0.579	61	106	2.6	12.86
5900	64.1	71.9	38.2	0.564	61	109	3.2	13.05
6000	65.7	75.1	40.1	0.566	61	114	3.9	13.09
6100	65.8	76.4	41.3	0.574	61	116	4.6	12.85
6200	66.1	77.9	43.4	0.591	61	118	5.1	12.51
6300	67.4	80.8	47.1	0.617	61	123	5.8	12.01
6400	67.9	82.7	48.1	0.617	61	126	6.5	12.01
6500	67.9	84.1	48.9	0.617	61	129	6.8	12.05
6600	69.3	87.1	50.3	0.613	61	134	7.9	12.19
6700	69.3	88.4	51.1	0.613	61	136	8.4	12.19
6800	65.6	84.9	55.5	0.693	59	140	9.4	11.51
6900	64.8	85.2	56.1	0.696	59	141	9.9	11.53
7000	65.1	86.7	56.2	0.687	59	142	10.1	11.57
7100	65.6	88.6	56.4	0.674	59	144	10.2	11.68
7200	66.6	91.3	57.1	0.661	59	146	10.3	11.76
7300	75.8	105.3	65.4	0.658	60	161	12.1	11.28
7400	76.1	107.1	66.3	0.655	59	163	12.2	11.29
7500	78.7	112.4	67.2	0.633	60	169	13.8	11.53
7600	79.9	115.6	68.7	0.631	60	171	14.3	11.39
7700	80.4	117.9	69.1	0.621	60	172	14.6	11.43
7800	80.7	119.9	69.3	0.612	60	173	14.7	11.45
7900	86.8	130.6	75.7	0.614	61	180	16.3	10.87
8000	86.7	132.1	76.6	0.616	62	181	17.1	10.84
8100	86.2	133.1	77.1	0.615	61	184	17.9	10.98
8200	85.2	133.1	76.6	0.611	61	185	18.4	11.03
8300	82.1	129.6	77.1	0.631	61	185	19.6	11.01