Damper Fundamentals

Basic Damper Principles

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Damper Fundamentals

Types of shocks

- Gas-pressurized with internal or external Accumulators
- “Hydraulic” twin tube - zero or low pressure gas

Types of adjustments

- Needle valve bleed adjusters
- Spring preload / blow-off adjusters
- Canister bump bleed adjusters
- Canister bump blow-off adjusters
- Canister pressure

Damper Fundamentals (2)

Piston Style

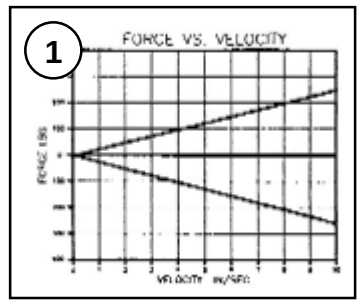
- Linear
- High-flow linear
- Digressive / linear
- Digressive / digressive
- Velocity-dependent (VDP)
- Digressive blow-off
- Bleed holes &/or bleed shims

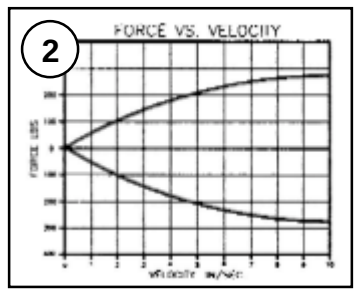
Adjustment Ranges

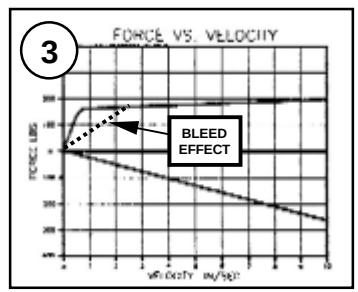
- Low-speed – piston or needle bleeds
- Mid-range
- High-speed

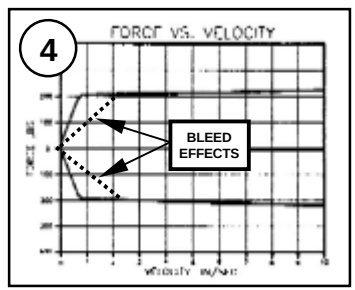
“Critical Damping”

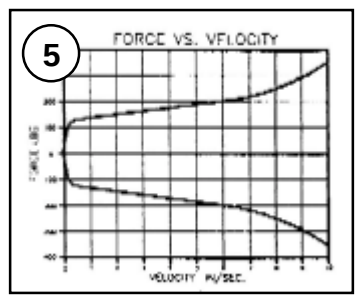
- Fastest response, minimum footprint load variation

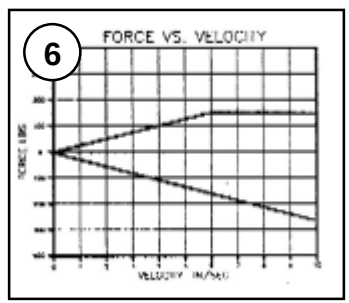












Shock Tuning (1)

Basic adjustments

Adjustment ⇨	More Compression		More Rebound		More Canister Pressure	Larger Bleed Area
Location ⇩	High-speed	Low-speed	High-speed	Low-speed		
Front	More front un-sprung mass control, possible excess suspension loads over bumps or curbs, possible loss of grip over bumps	Less front chassis drop, less trailing-throttle oversteer, possible loss of grip	Better front un-sprung mass control, possible loss of front grip over bumps	Less front chassis rise, less power-on understeer, possible loss of grip	More front height control, possibly less front grip	Shallower nose angle, more front grip, possible loss of low-speed front chassis control
Rear	More rear un-sprung mass control, possible excess suspension loads over bumps or curbs, possible loss of grip over bumps	Less rear chassis drop, less power-on understeer, possible loss of grip	Better rear un-sprung mass control, possible loss of rear grip over bumps	Less rear chassis rise, less trailing-throttle oversteer, possible loss of grip	More rear height control, possibly less rear grip	Shallower nose angle, more rear grip, possible loss of low-speed rear chassis control

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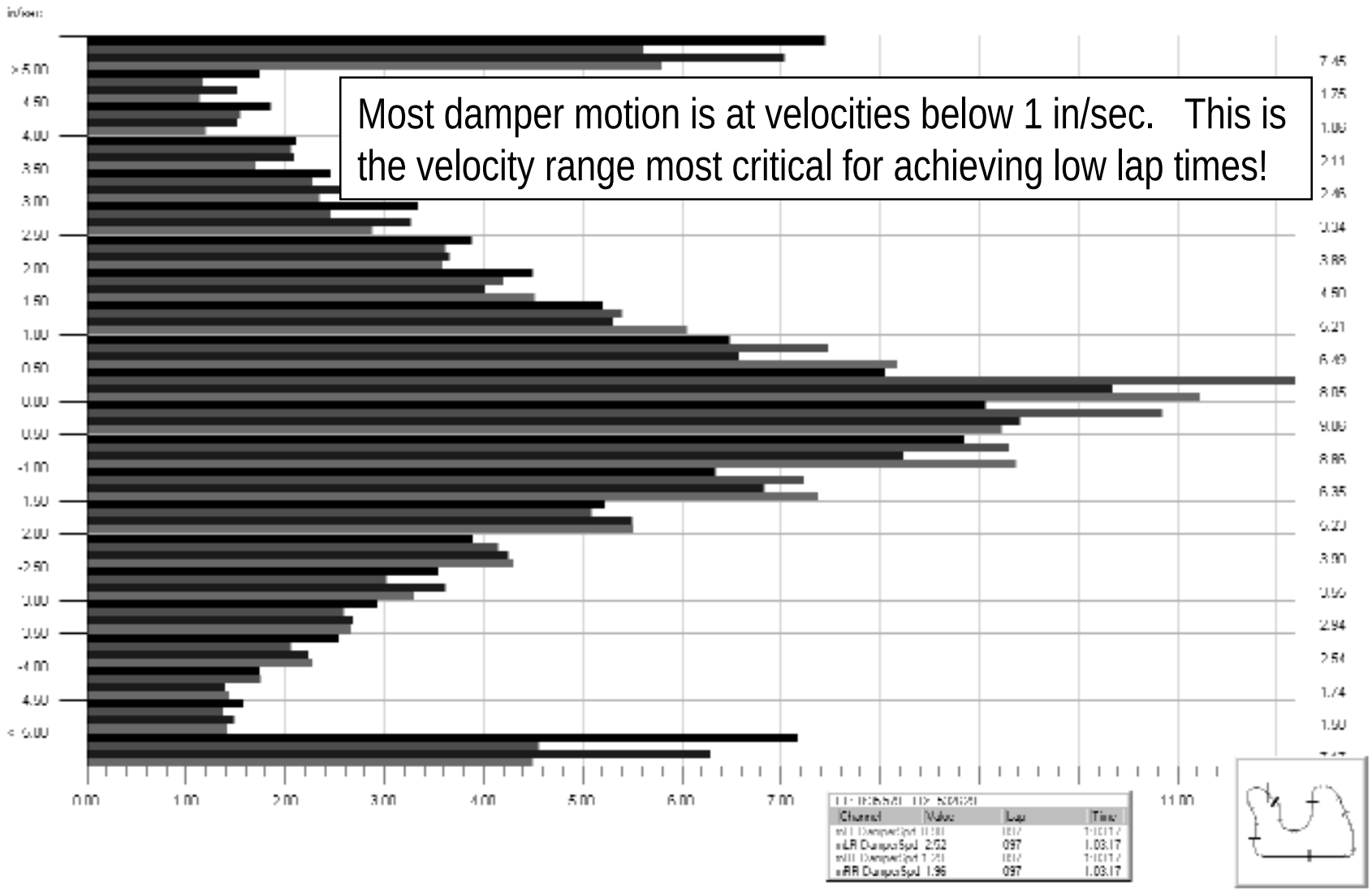
Shock Tuning (2)

What other symptoms do you look for?

- Try to achieve "critical damping" to optimize response and grip ("chassis shock dyno" is useful approximation). Deviation from "critical damping" ⇒ less grip : i.e., suspension friction, too much damping, too little damping ⇒ less grip
- Low speed bump (bleed) – optimizes platform control and grip.
  - Too much bleed makes the car feel unresponsive and mushy.
  - Too little bleed reduces grip and tire life, and causes the tire to alternate between grip and slip.
- Low speed rebound (bleed) – controls trailing-throttle oversteer and power understeer.
  - More bleed allows increased dynamic ride (roll-center) height.
  - Too little bleed reduces grip and tire life.
- High speed (canister) bump – "support" vs. too harsh on bumps
- Low speed (canister) bump – "support" vs. too harsh on bumps
- Rebound – use the least amount of rebound possible while maintaining needed platform control – too much reduces grip.
- After car balance has been attained, adjust low-speed bump and low-speed rebound together, both stiffer or softer, to optimize damping for track conditions.
- Higher canister pressure acts similar to reduced bleed.
- For rain – use more bleed and/or lower canister pressure (less low speed control)

Shock Histogram (Data Acquisition)

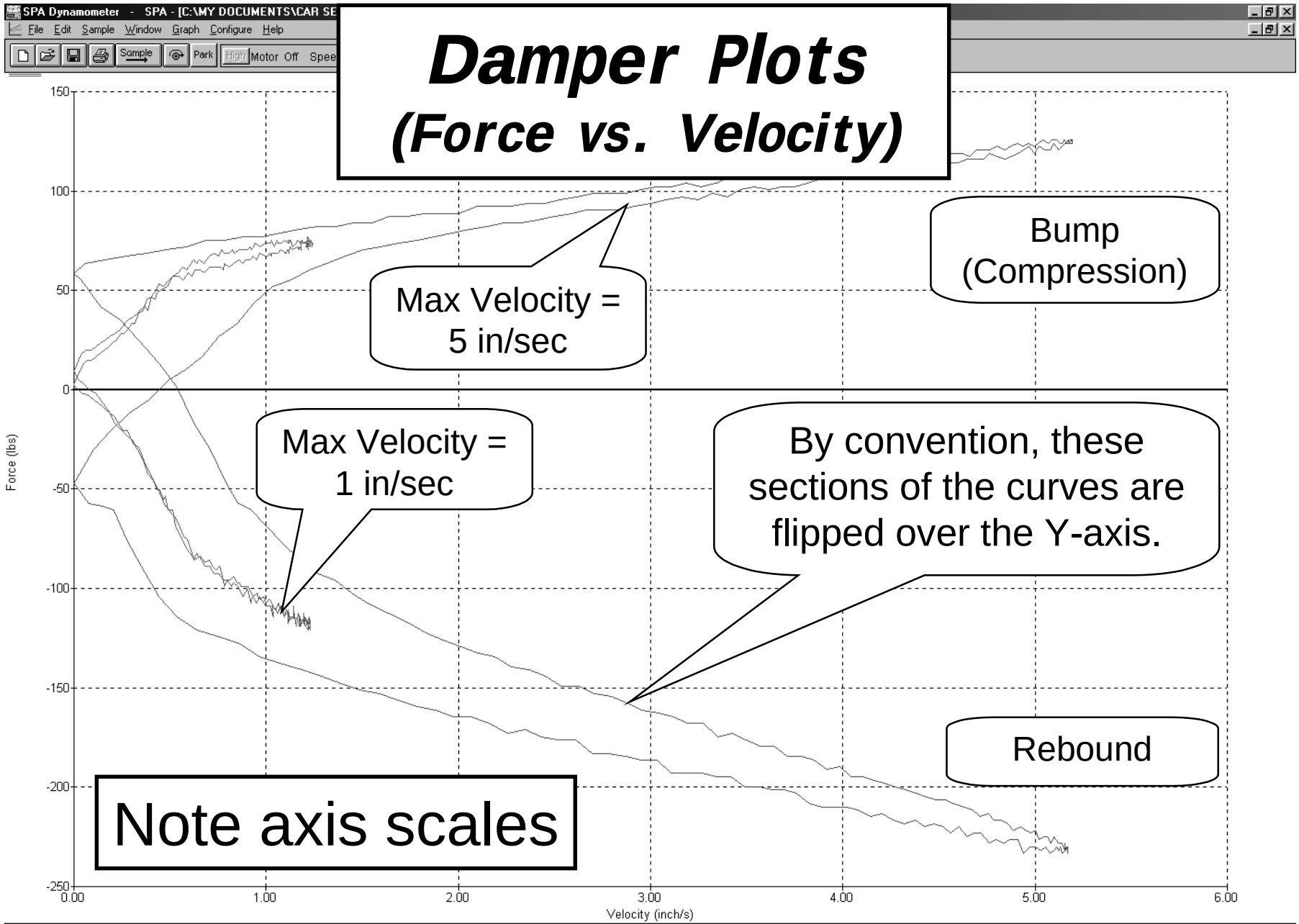


Bump Rubber Characteristics

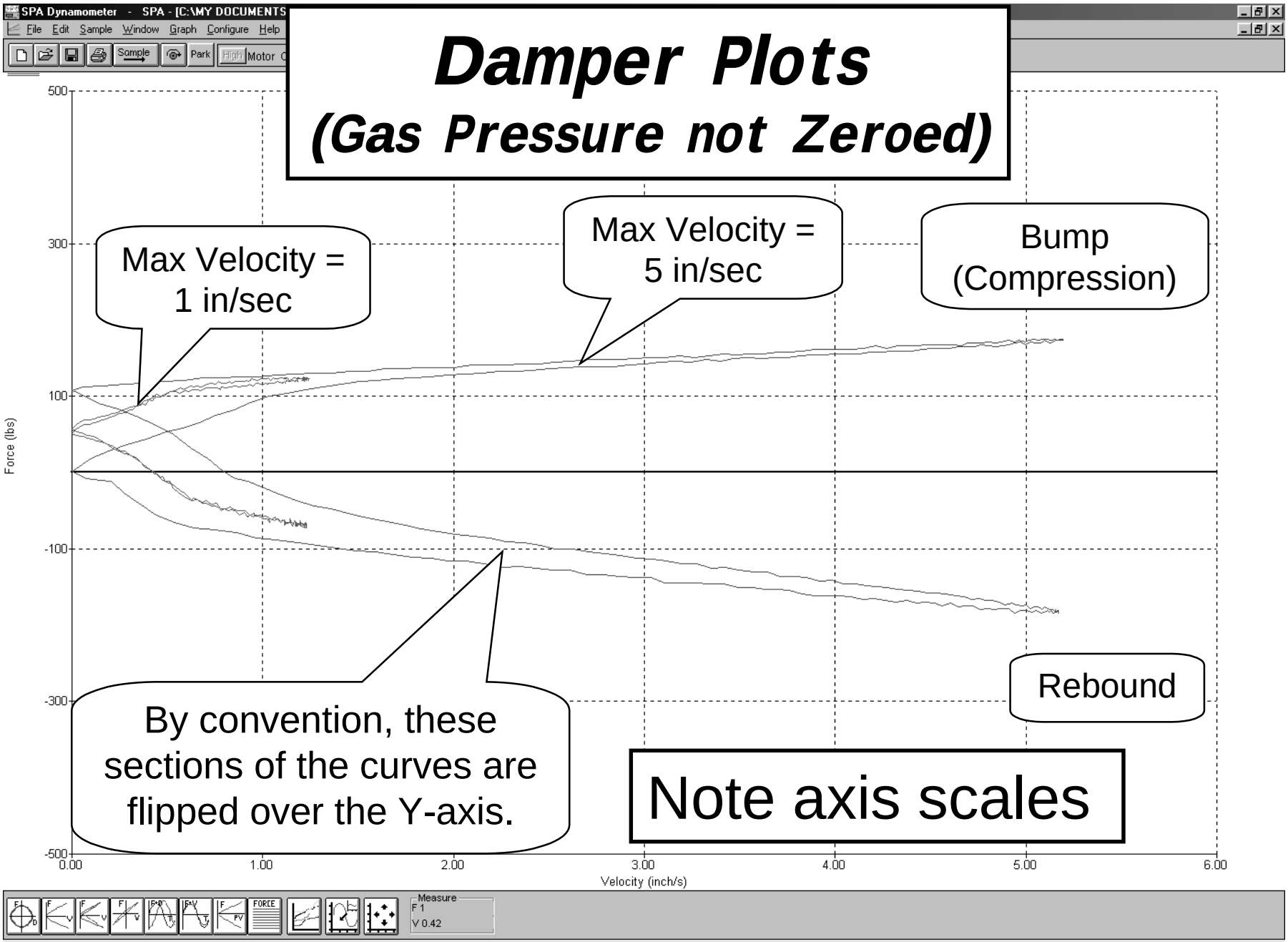
Disp. (in)	Load (lb)	Rate (lb/in)	Load (lb)	Rate (lb/in)	Load (lb)	Rate (lb/in)
0.04	2	56	10	254	11	251
0.08	17	363	32	559	20	197
0.12	32	397	50	457	27	157
0.16	59	682	63	330	33	131
0.20	92	833	80	432	38	120
0.24	149	1442	96	406	42	123
0.28	248	2515			48	141
	Dynamics		Ohlins		Penske	

Notice that even for small motions and loads, the added rate is ***very*** large!

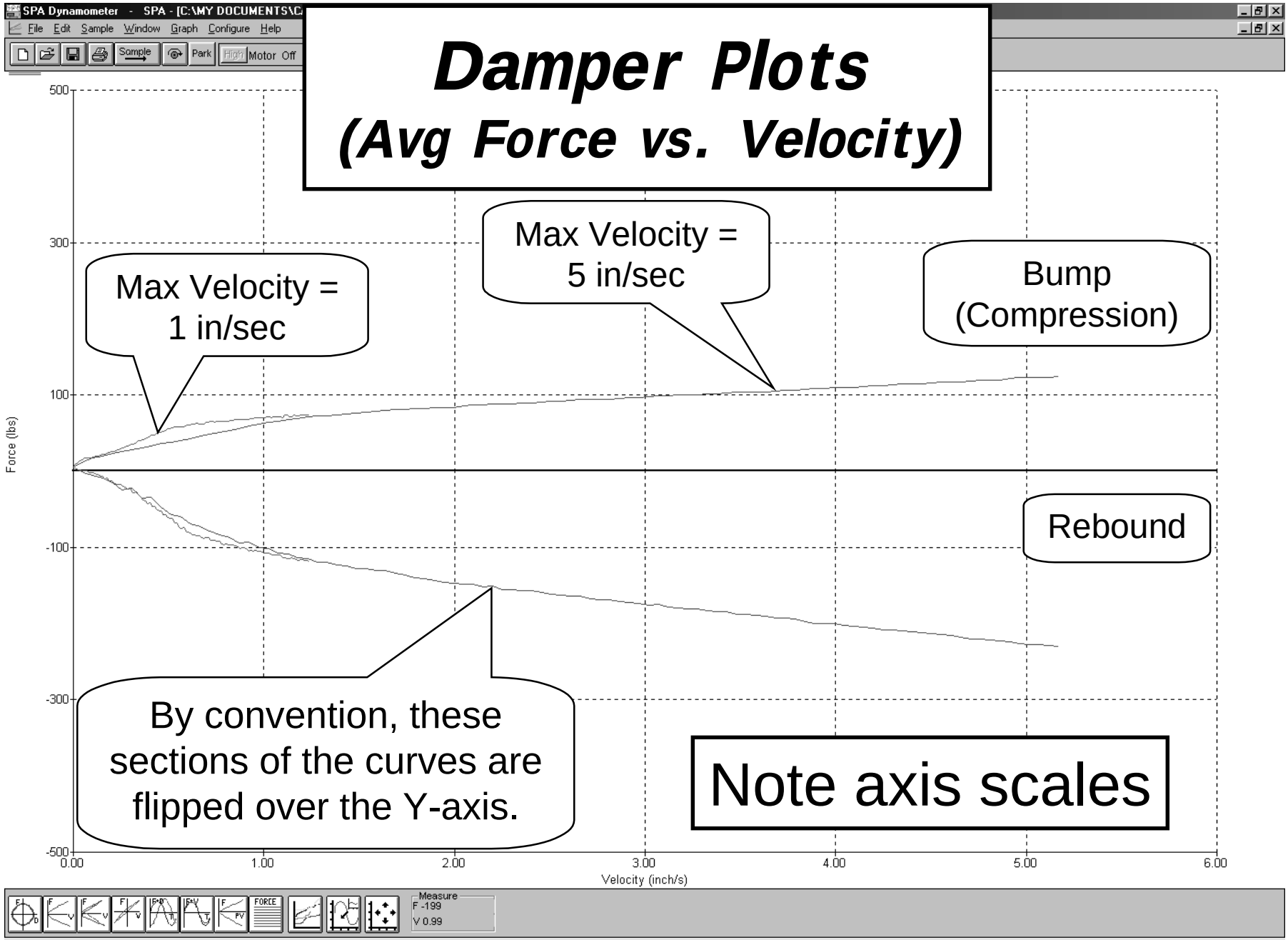
Damper Plots
(Force vs. Velocity)



Damper Plots
(Gas Pressure not Zeroed)



Damper Plots
(Avg Force vs. Velocity)



Damper Plots
Force vs. Displacement