MECACHROME

Air Valve Spring

For Road Engines

Mecachrome International specializes in the development and manufacture of advanced technologies in the aerospace and automotive sectors since 1937.

The Commitment: to provide efficient, effective solutions to satisfy and exceed customers' expectations.

Introduction

- **With regards to the huge progress made by the AIR VALVE SPRING systems during the last 15 years, it is now realistic to imagine applications for road engines.**

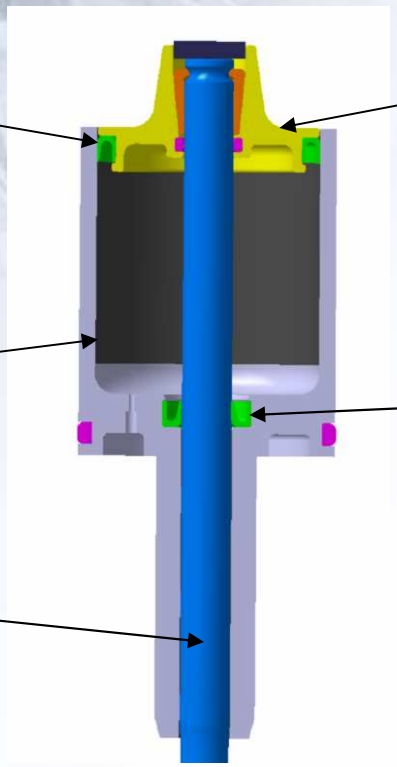
- **Aim of this presentation is to explain WHY and HOW this can be possible.**

- **MECACHROME is developing an AVS system suitable for road engines. Technical choices are based on RELIABILITY and COST aspects.**

SUMMARY

- ***Description / Vocabulary***
- ***AVS : From Formula 1 to the street:***
  - AVS in F1
  - AVS in other applications
  - Durability aspects
  - Cost aspects
- ***Potential Benefits:***
  - Reduced reciprocating mass
  - Enhanced cam profiles
  - Reduced friction / loads / noise
- ***AVS Development:***
  - Current situation
  - Partnerships
- ***Study Proposal***

DESCRIPTION / VOCABULARY



FROM FORMULA 1 TO THE STREET
AVS in F1

- ***Real start in F1 in the early 90^{ies}***
  - Engine life less than 500km (average RPM ~ 13000RPM)
  - High air consumption (re-filling during GPs)
  - Lack of understanding of the most important parameters
  - Lack of consistency in seals production
- ***Reliability achieved in the late 90^{ies}***
  - Engine life still ~500km
- ***Nowadays in F1***
  - Engine life ~2000km (average RMP ~16000RPM)
  - Valve lift > 18mm
  - Air spring is not a concern anymore

FROM FORMULA 1 TO THE STREET
AVS in other applications

- ***Introduction in Moto GP***
  - Almost un-noticed
  - Smaller budgets than F1
- ***Small series production engines (leisure vehicles)***
  - Engine life > 250 hours
- ***Mass production road applications***
  - Engine life > 3000 hours (currently in development)

FROM FORMULA 1 TO THE STREET
Durability

- ***As far as durability is concerned, the key element is the reciprocating seal***

- ***AVS seal must be considered as a ''NORMAL SEAL''***

- ***Seal wear is a function of:***
  - sliding velocity = f(cam profile, RPM)
  - internal AVS pressure = f(seal diameter)
  - contact surface between seal and liner = f(seal diameter, lip height)
  - materials, surface finish
  - …

FROM FORMULA 1 TO THE STREET
Durability

- ***Formula 1 design constrains:***
  - Extreme compacity (cylinder head size and weight)
    - Seal OD < 20mm
    - Seal height < 2mm
    - Seal radial thickness < 2mm
  - Ultra lightweight components
    - Air piston / seal OD < 20mm
  - Very aggressive cam profiles
    - High sliding velocity between seal and air liner
    - High valve acceleration
  - Use of an air reservoir (no compressor)
    - No air leakage admissible

- ***Road engine design constrains:***
  - Use of a compressor
    - Low pressure available
  - Ability for the system to work in various temperature conditions

FROM FORMULA 1 TO THE STREET
Durability

In F1, needs for compacity (diameter, height), for ultralight weight components and for zero air leakages lead to high pressures and small contact surface between seal and liner => HIGH WEAR RATE

Reducing pressure and simultaneously increasing contact surfaces means LOW WEAR RATE IS ACHIEVABLE

	Valve velocity (mm/rad)	Average RPM	Av. Sliding velocity (m/s)	Pressure (bars)	Contact surface (mm^2)	Total Cycles (10^E6)	Cycles / km	Total Km
F1	22	16000	18.4	70	28	9.1	4500	2 000
Road	14	3000	2.1	23	78	676	3000	**225 000**

FROM FORMULA 1 TO THE STREET
Cost

- ***What makes AVS expensive in F1:***
  - Use of non-return and relief valves for each AVS (no tolerance to oil intrusion)
  - Seal / Expander technology (to achieve zero air leakage in all operating conditions)
  - Seal production / control costs
  - Pressure regulation system (sometimes electronic solenoïd valves)
  - Liner design

- ***What makes MECACHROME's system affordable:***
  - Simplistic design
  - Seal development (exclusive partnership with SAINT GOBAIN)
  - Suppression of coil spring

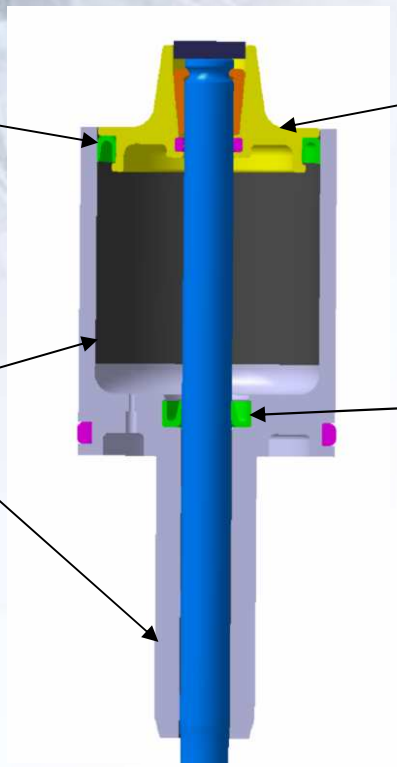
FROM FORMULA 1 TO THE STREET

- ***Typical Cost Breakdown***

  Estimation based on 100’000 sets

Air piston seal
1.75 €

Air piston
0.50 €



Liner + valve guide
1.75 €

Valve stem seal
1.00 €

TOTAL 5.00 €

POTENTIAL BENEFITS

POTENTIAL BENEFITS

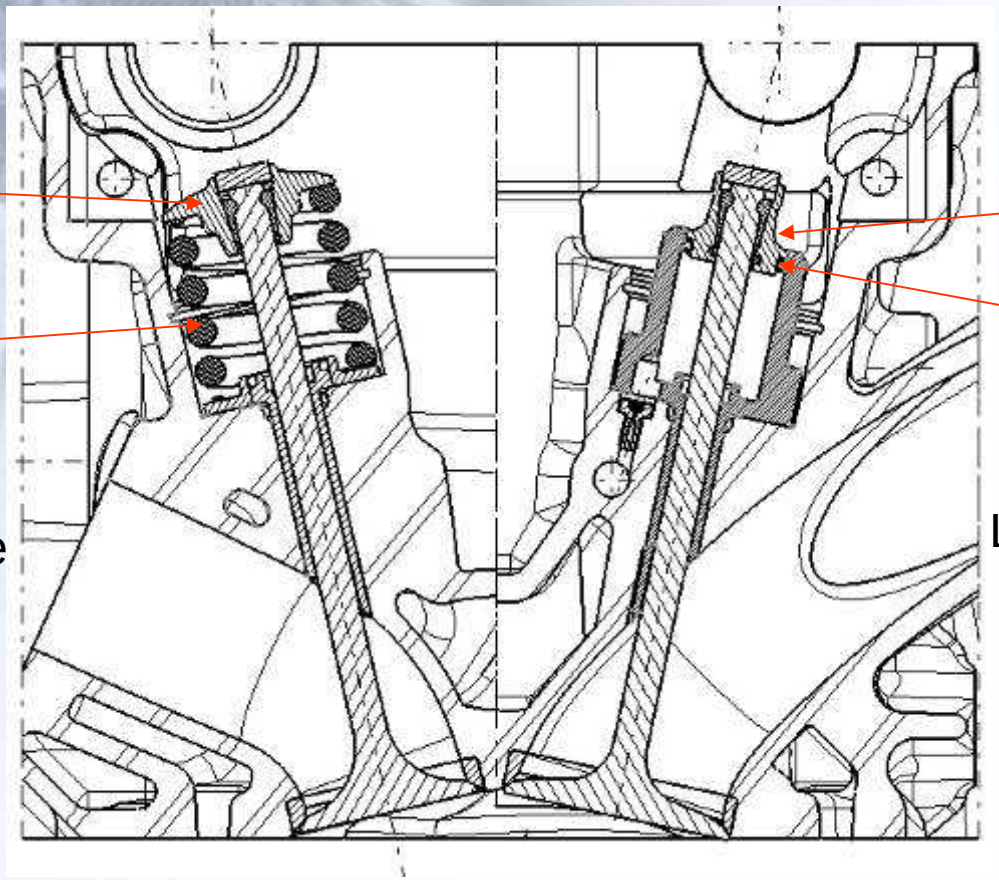
Reduced Reciprocating Mass

Retainer
12 g

Double Wire spring
~15 g recip.

Lifter + Inlet valve
96 g

TOTAL **123 g**



Air piston
6 g

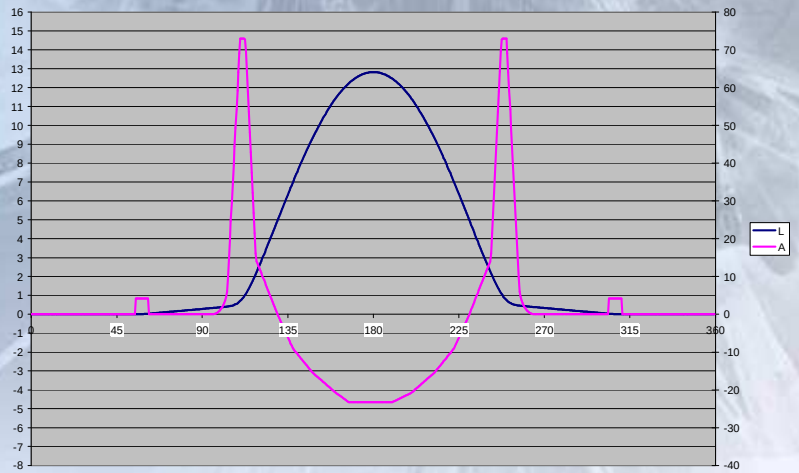
Seal
1.5 g

Lifter + Inlet valve
96 g

TOTAL **104 g**

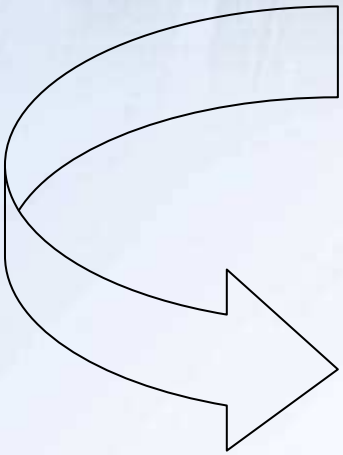
POTENTIAL BENEFITS

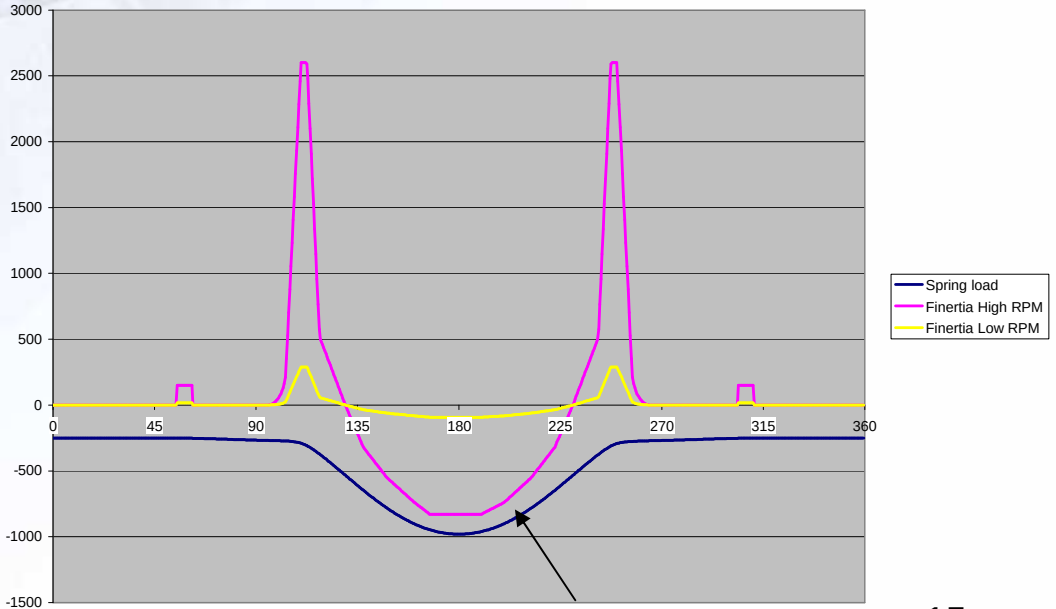
Cam Profiles



Finertia = mass * acceleration

Fspring = K * Po * $(Vo/V)^{\gamma}$

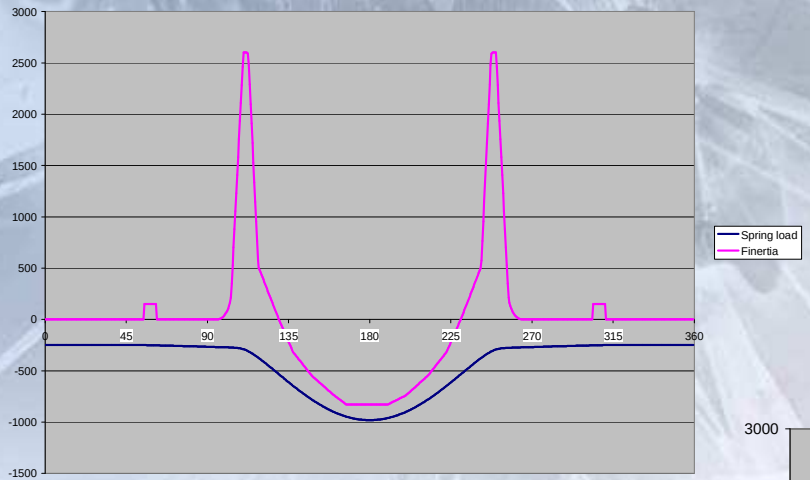




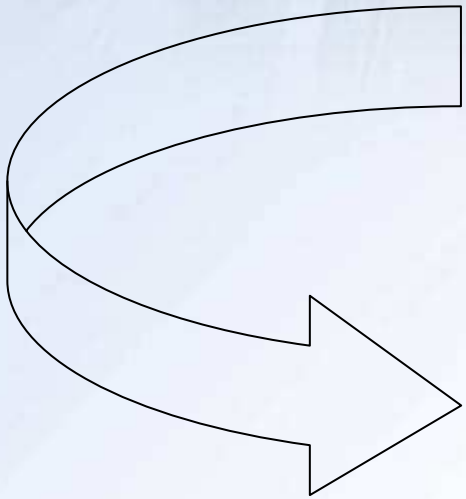
Minimum contact load at Max speed

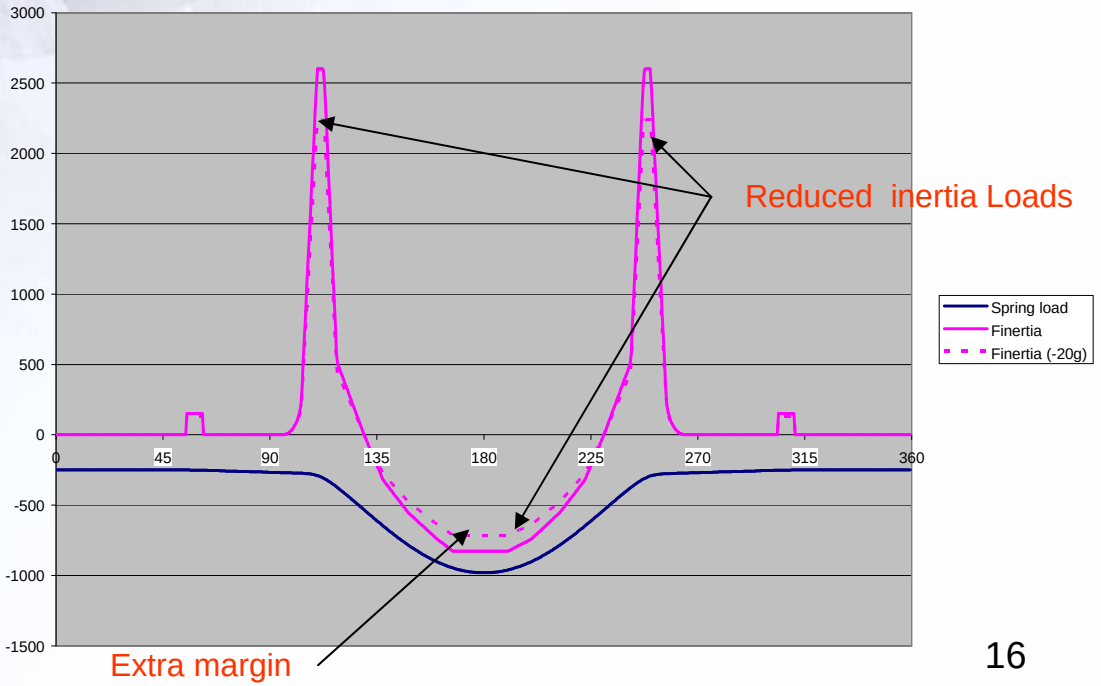
POTENTIAL BENEFITS

Cam Profiles



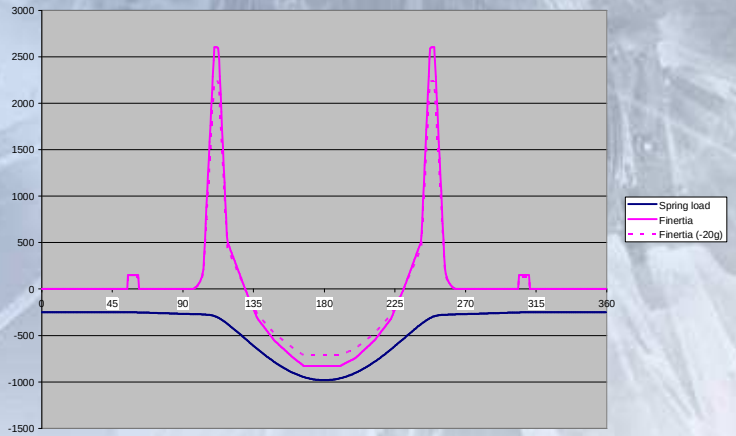
Finertia = **mass** * acceleration





POTENTIAL BENEFITS

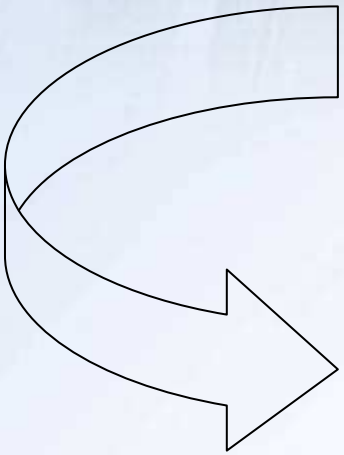
Enhanced Cam Profiles 1

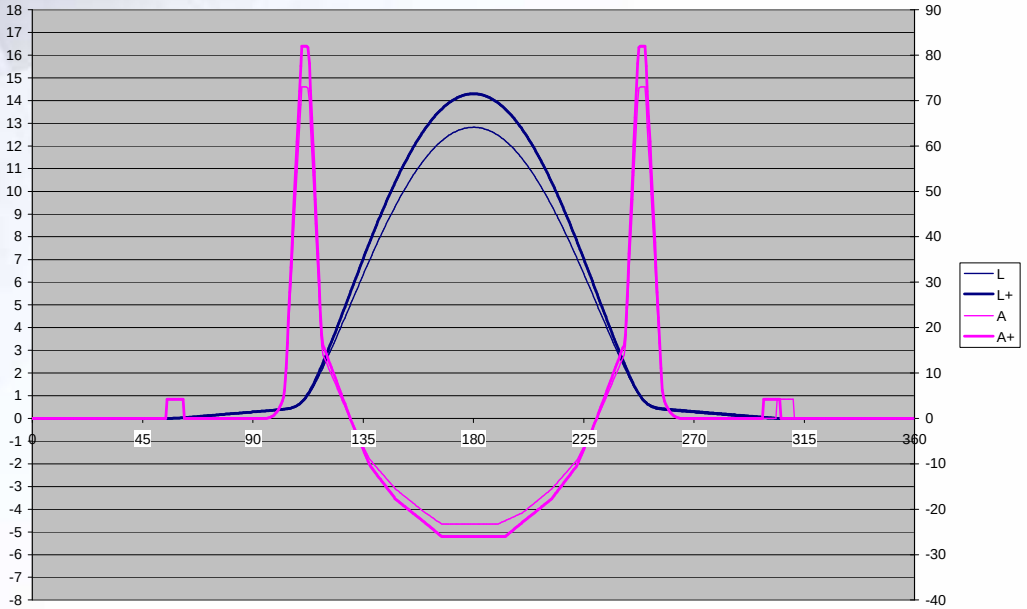


Increase valve accelerations:

-Increased valve lift

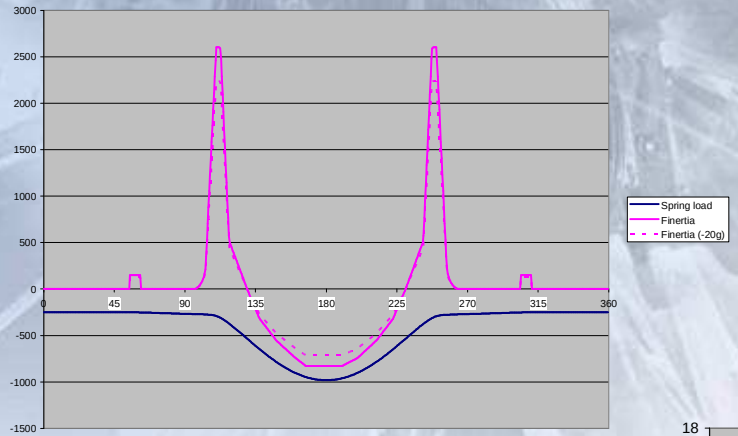
-Improved power





POTENTIAL BENEFITS

Enhanced Cam Profiles 2



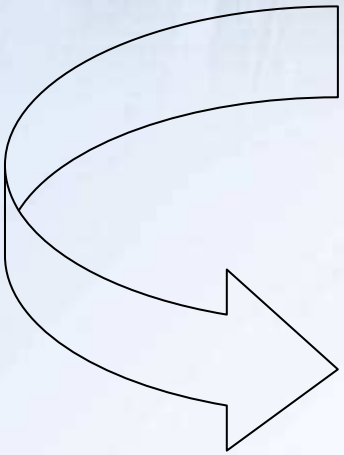
Reduce opening duration:

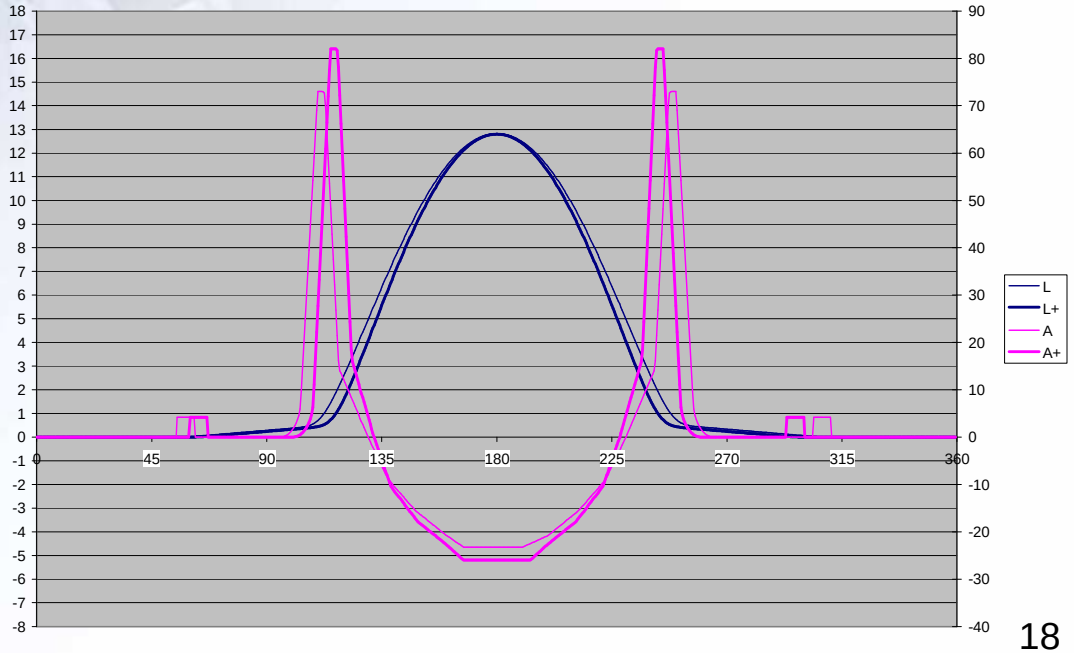
-Reduced overlap (pollution)

-Increased engine torque

-Particularly suited for VVT

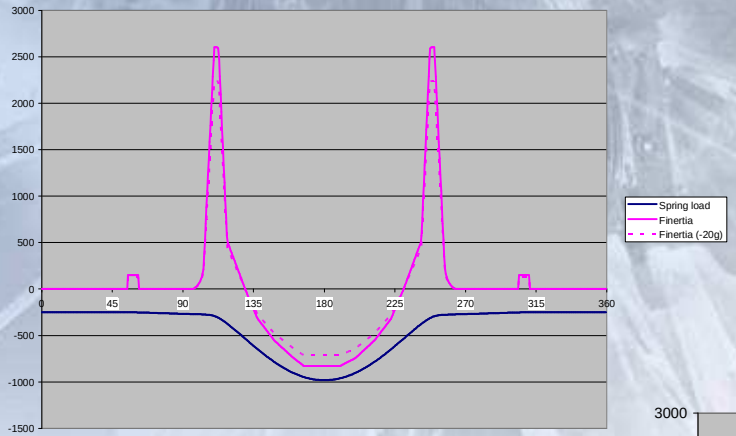
- …





POTENTIAL BENEFITS

Reduced Friction / Loads / Noise



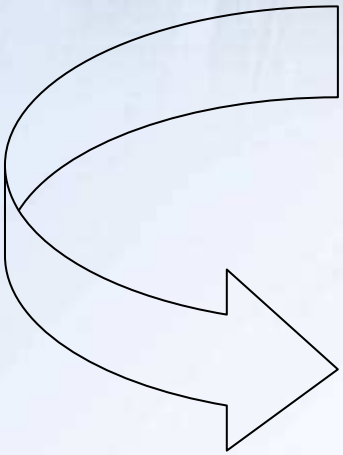
Reduce spring load (AVS pressure):

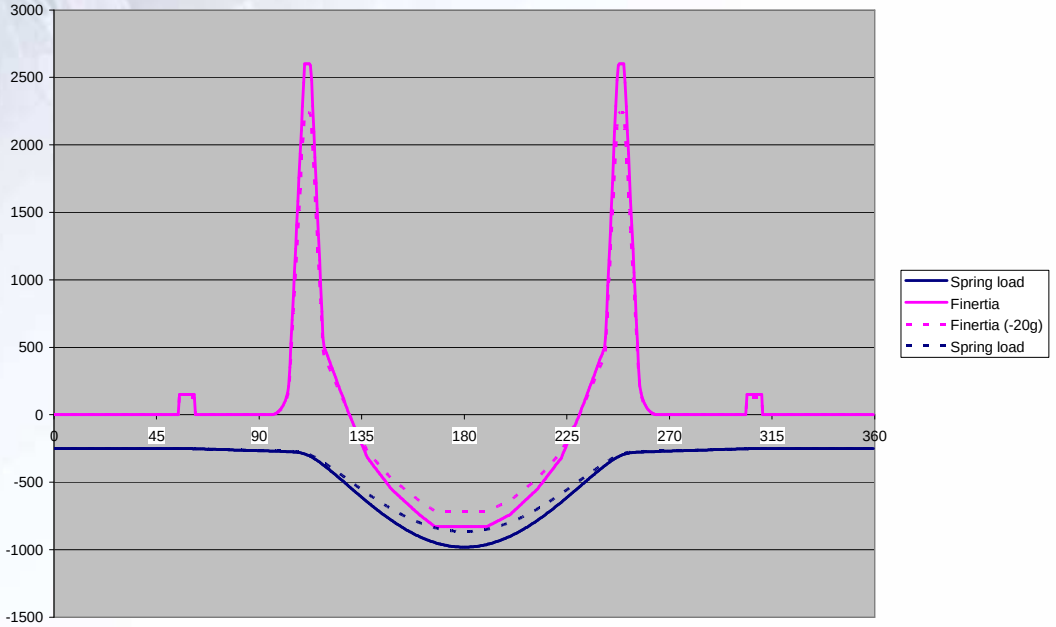
-Reduced cam/follower contact load

-Reduced stab torque

-Reduced friction

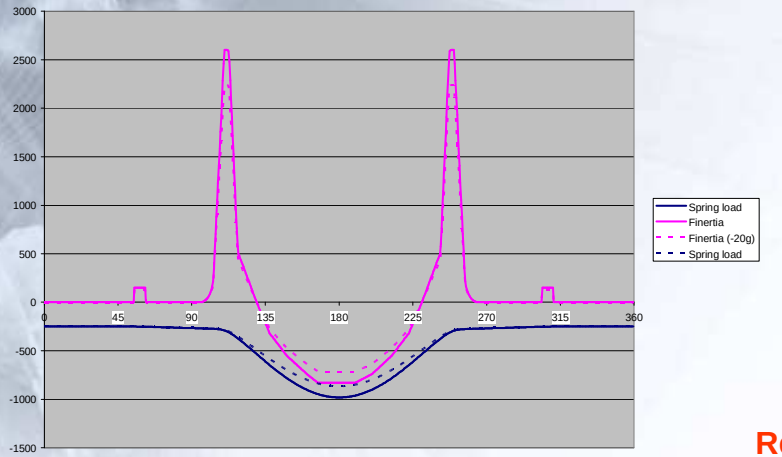
- …

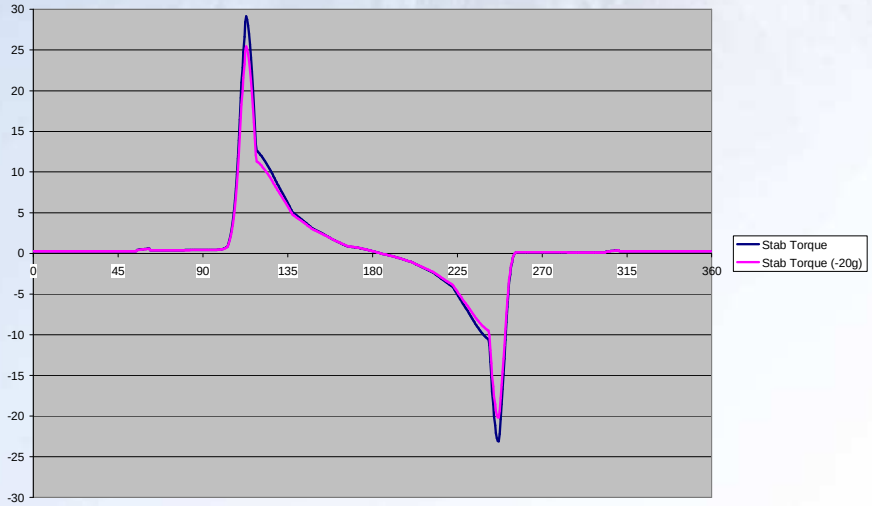




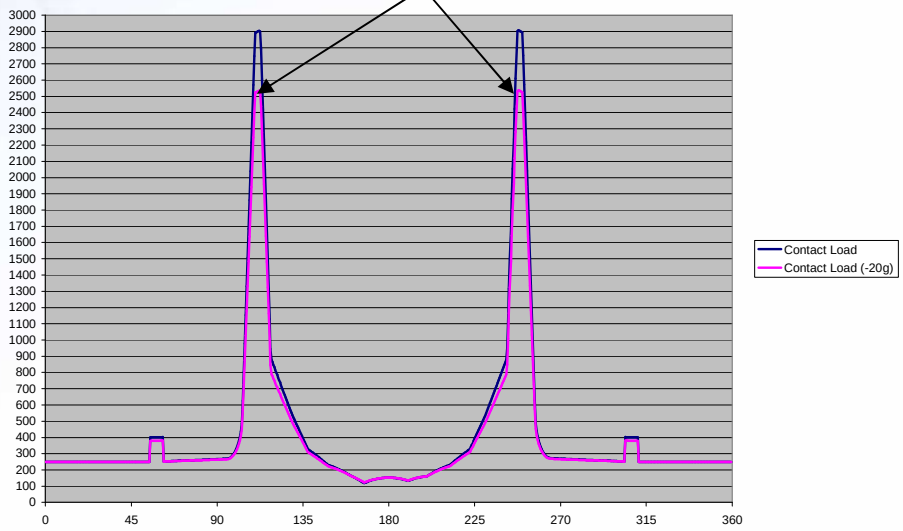
POTENTIAL BENEFITS

Reduced Friction / Loads / Noise





Reduced contact Loads



AVS DEVELOPMENT
Current Situation

- ***MECACHROME has developed its own system***

- ***The system is in its final validation stage***
  - Cylinder head rig test
  - Fired engine test
  - Vehicle test

- ***Running system on the road by end 2008***

AVS DEVELOPMENT
Partnership

- ***MECACHROME has concluded an exclusive partnership with an internationally renowned OEM seal supplier for seal development***

MECACHROME'S STUDY PROPOSAL

- **The CUSTOMER sets out and agrees in collaboration with MECACHROME to the design targets and system performances that must be achieved with the AVS.**

  → ***Technical Specification Sign Off.***

- **MECACHROME designs the first AVS System prototype in accordance with the set out Technical Specifications.**

  → ***AVS Prototype Design.***
  → ***MECACHROME modifies & adapts the CUSTOMER'S chosen cylinder head.***
  → ***MECACHROME manufactures & assembles all prototype parts.***

- **MECACHROME tests a fully assembled cylinder head on a special bench.**
- **MECACHROME modifies a complete CUSTOMER engine to fit the new AVS Cylinder Head.**
- **MECAHROME or the CUSTOMER carry out all the engine dyno tests to validate and sign off the final design.**
- **MECACHROME carries out the complete Industrialisation of the AVS system for its entry into high volume serial productions.**

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