

Engine Downsizing – A Kaizen Approach

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22nd Jun 2010



1. Maruti Suzuki India Ltd & Indian market Scenario

2. Engine downsizing concepts & Market Trends

3. Key Challenges

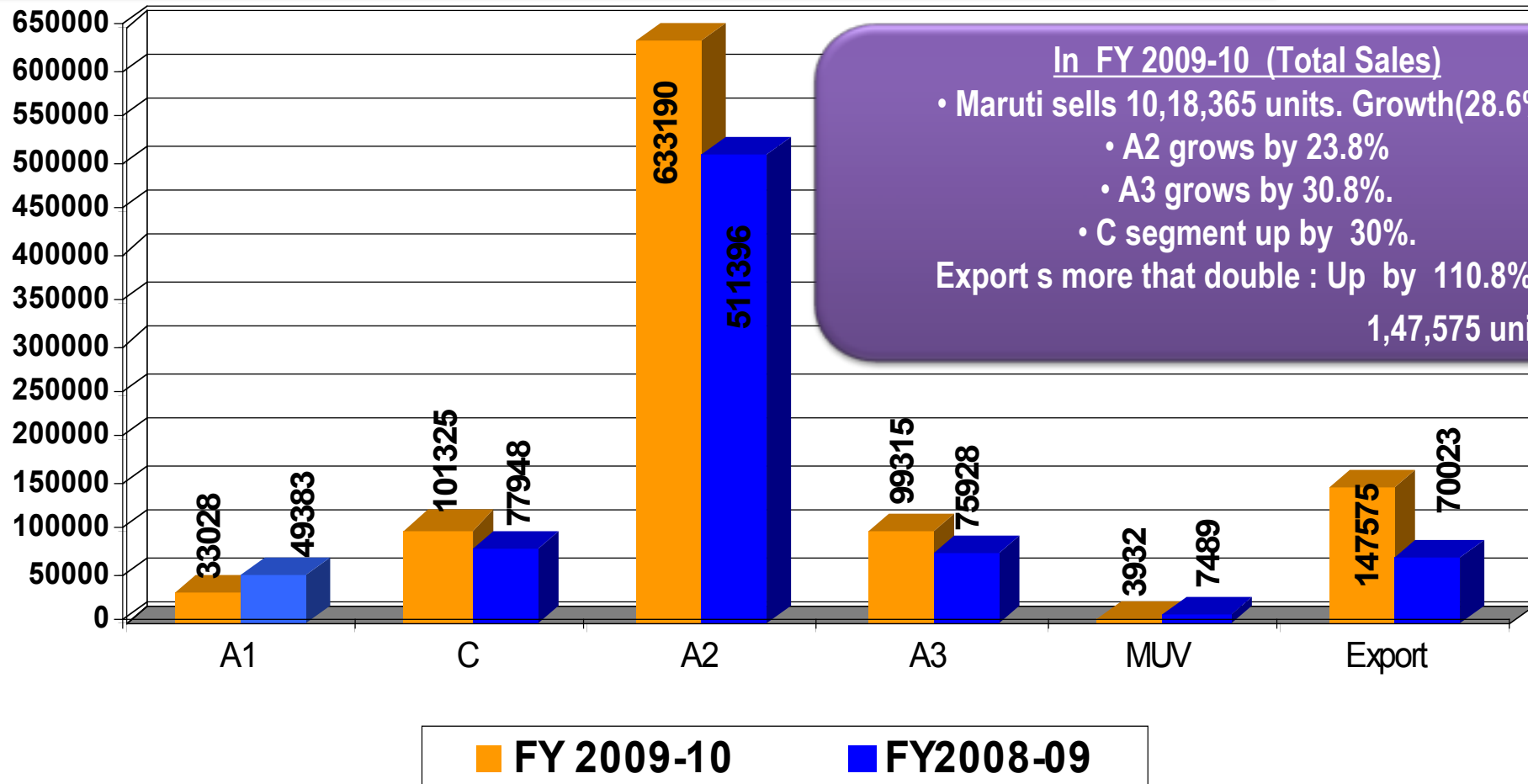
4. Exploration of Options

5. The evolution of new engine

6. Summary

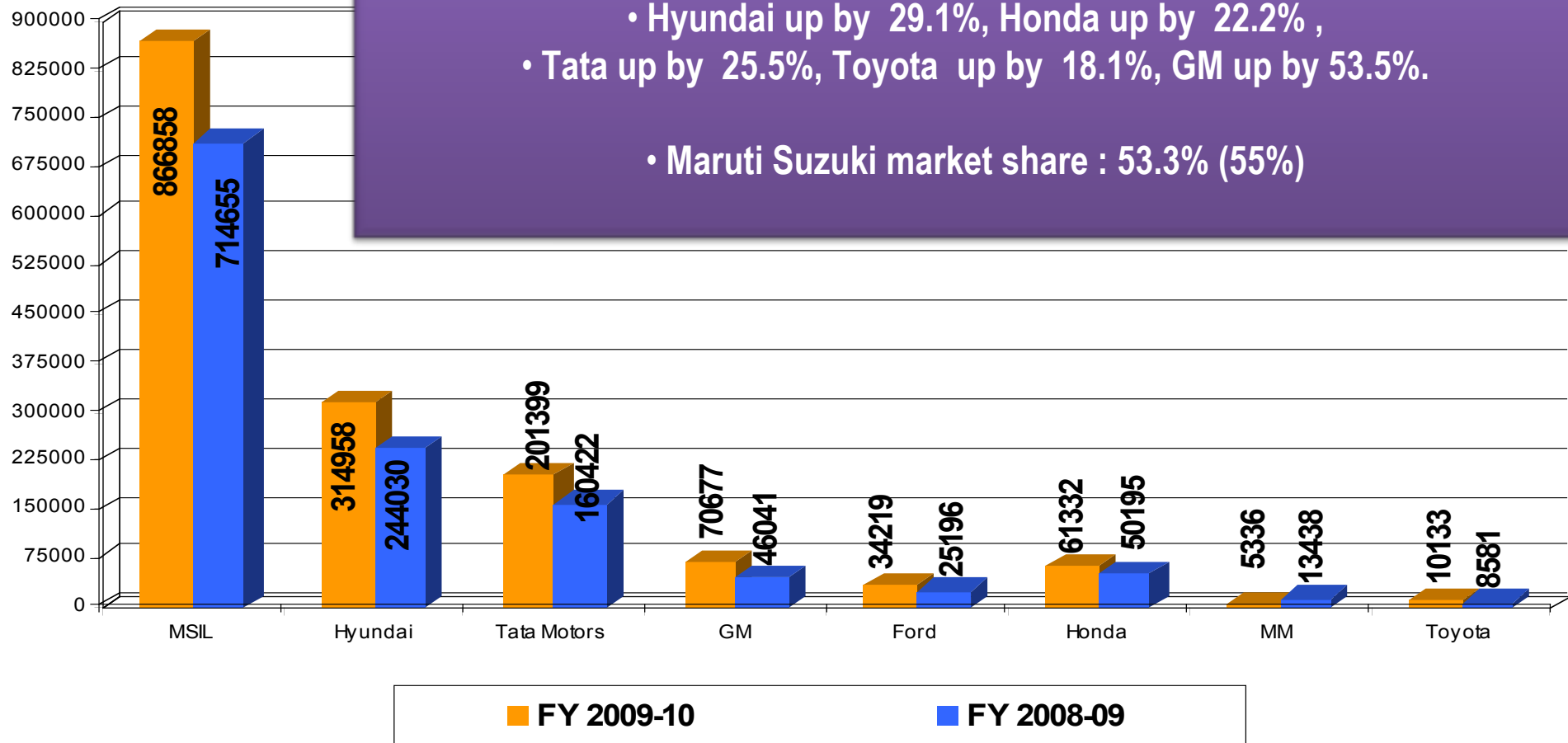
- Maruti Suzuki India Limited (MSIL, formerly Maruti Udyog Limited), a subsidiary of Suzuki Motor Corporation of Japan, is India's largest passenger car company
 - Market leader in Indian Automotive industry since last 26 years.
 - Largest Engg, Research, Design & Development centre of Suzuki Motor Corp outside Japan
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Our Achievements this fiscal
One Million sales :Highest ever Annual sales
Highest ever exports sales

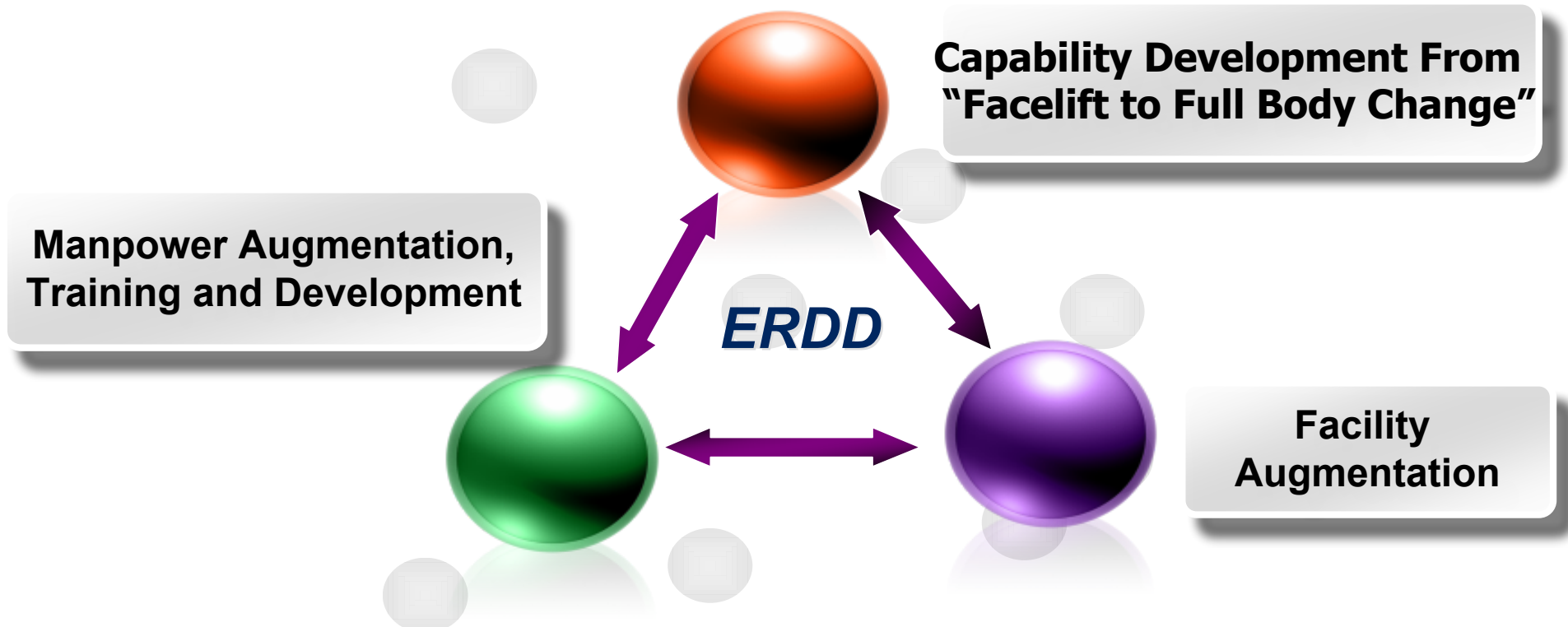


During FY 2009-10 (Domestic Passenger cars)

- Maruti Suzuki up by 21.3%. Industry up by 25.2%. Others up by 30%
- Hyundai up by 29.1%, Honda up by 22.2% ,
- Tata up by 25.5%, Toyota up by 18.1%, GM up by 53.5%.
- Maruti Suzuki market share : 53.3% (55%)



“Build our engineering capability to Conceive, Design and Develop Cars to delight the Indian Consumer and establish Maruti as a Design Hub of SMC”





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World wide Trends

Turbo Charging

Super Charging

Hybrid Vehicles

Engine Capacity Reduction

Constraints

Turbo Charging



•Cost Up

Super Charging



•High Cost
•Parts Availability

Hybrid Vehicles



•Cost Up
•Nascent Technology

**Engine Capacity
Reduction**



•New parts
•Limited options

Driving Forces

- **Legislation Driven**
 - ✓ Reduction in Tax Duty for vehicles <1200cc
24% → 16%
- **Customer Driven**
 - ✓ Engine Downsizing
 - ✓ Price Reduction of Vehicle
 - ✓ Fuel Economy

Indian Perspective

Based on the Driving forces and prevailing Indian conditions, The Downsizing in terms of **Capacity Reduction** works out to be the most feasible solution

Concepts

“Whatever the case, downsizing results in an increased engines’ power and/or torque density, which serves one main objective: Fuel Consumption reduction”

“Engine Downsizing is the technique used to achieve the similar performance with enhanced fuel economy and reduction in emissions”

Concepts

- **Downsizing permits**
 - ✓ Increasing engines power and torque (to respond to new market demands or to compensate for vehicle weight increase) without increasing cylinder capacity.
 - ✓ Reducing engines' capacity at same power.
- **Reducing capacity at same power permits reducing Fuel Consumption**
 - ✓ Pumping losses reduction
 - ✓ Gases-to-wall heat transfer reduction
 - ✓ Friction losses reduction



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Major factors

- **Economical**
 - ✓ Minimum investment in the existing facilities
 - ✓ Cost down vis a vis current engine
- **Technical**
 - ✓ Maximum Fuel Economy with the given engine
 - ✓ Same Torque compare to existing engine



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Available & Probable Options

Detail	Available Options		Probable Options	
	G-X	G-Y	G-A	G-B
Bore (mm)	72	74	71	72
Stroke (mm)	61	75.5	75.5	73.5
Displacement (cc)	993	1298	1195	1196

Major affected parts

Option G-A

- Cylinder Block
- Piston
- Piston Rings

Option G-B

- Crank Shaft
 - Conn ROD
-

Detail Option G-A

Bore	71mm
Stroke	75.5mm
Disp. Volume	1195 cc

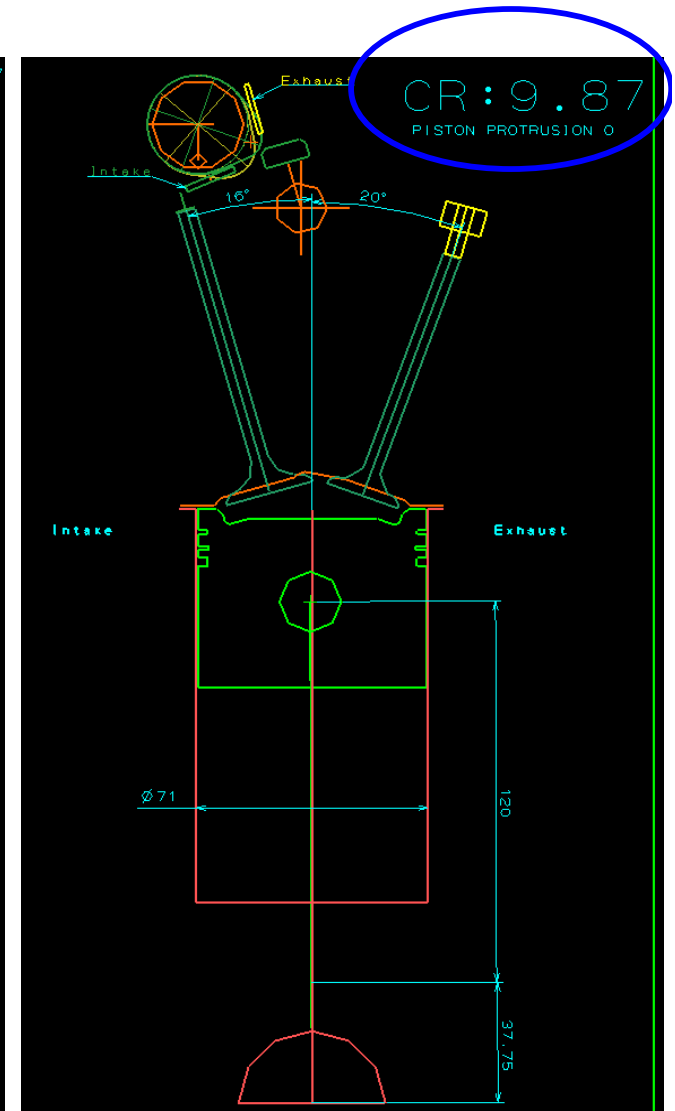
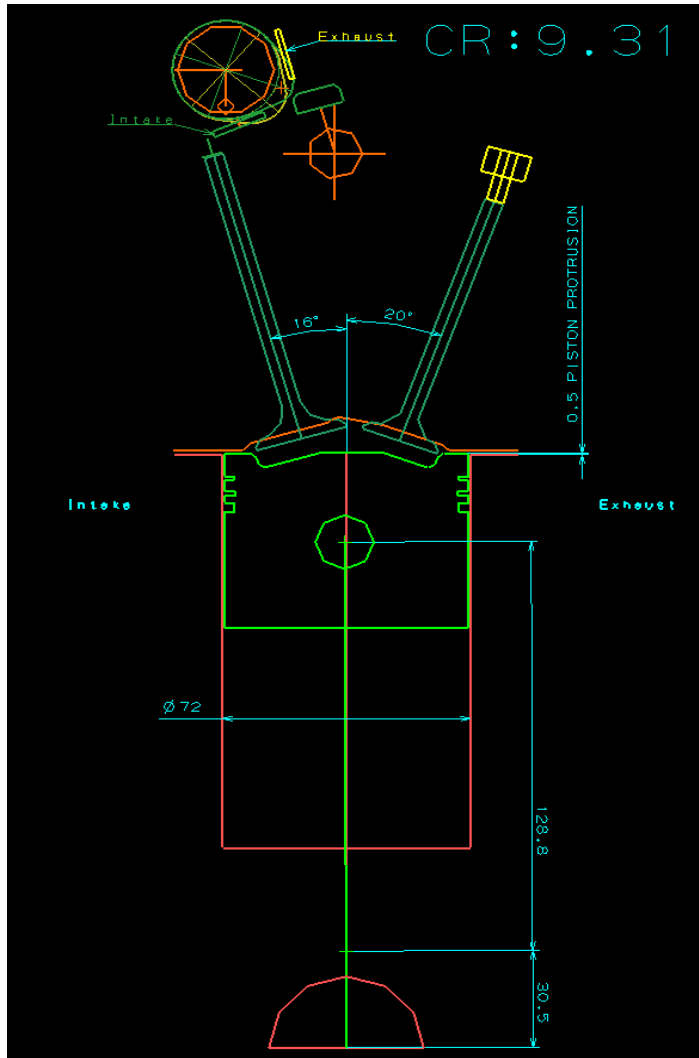
Components	Detail
Cylinder block	New
Cylinder head	G-X(22.5cc)/G-Y(25.5cc)
Piston / Piston Rings	New
Crankshaft	G-Y
Connecting Rod	G-Y

Detail Option G-B

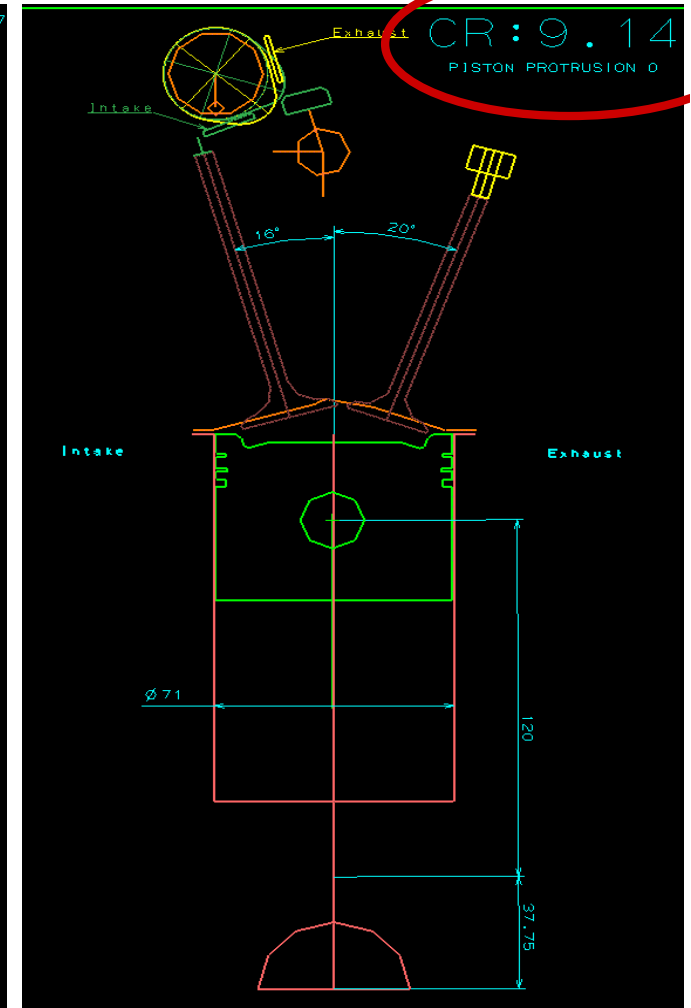
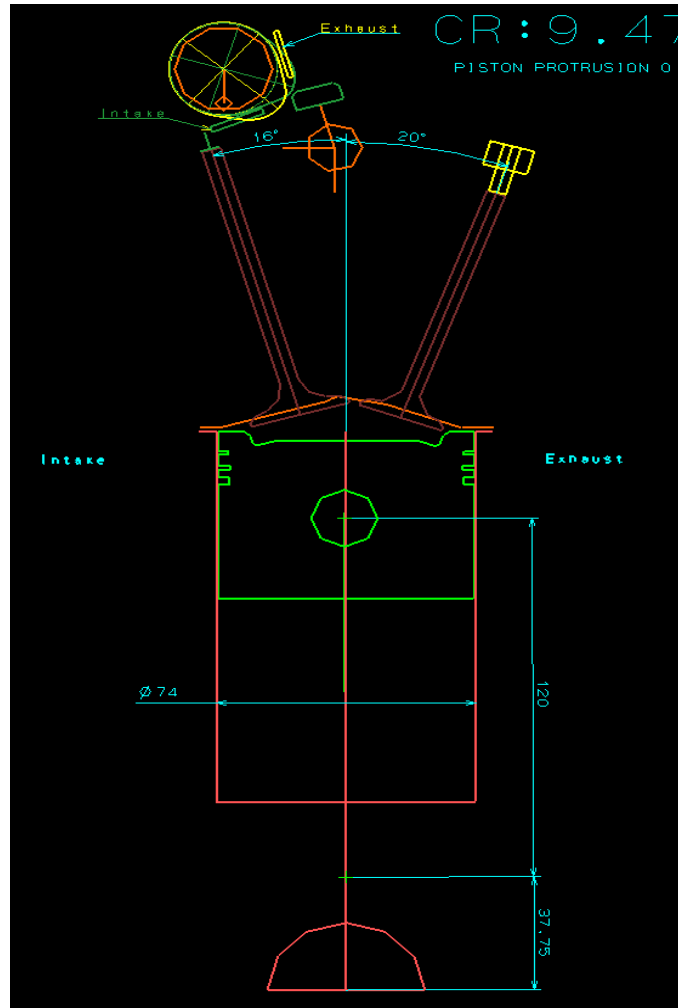
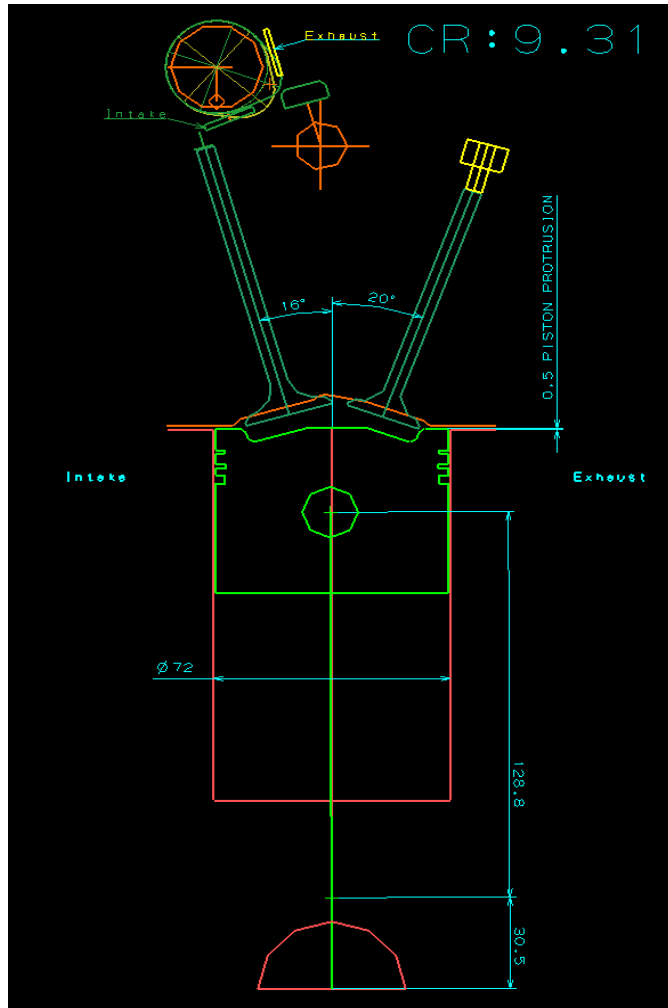
Bore	72mm
Stroke	73.5mm
Disp Volume	1196 cc
Crank throw	36.75 mm (Existing 37.75 mm G-Y)
Conrod length	121.55mm (Existing 120mm G-Y)

Components	Detail
Cylinder block	G-X
Cylinder head	G-X
Piston / Piston Rings	G-X
Crankshaft	New (G-Y Base)
Connecting Rod	New (G-Y base)

Layout of Option G-A (G-X Head)

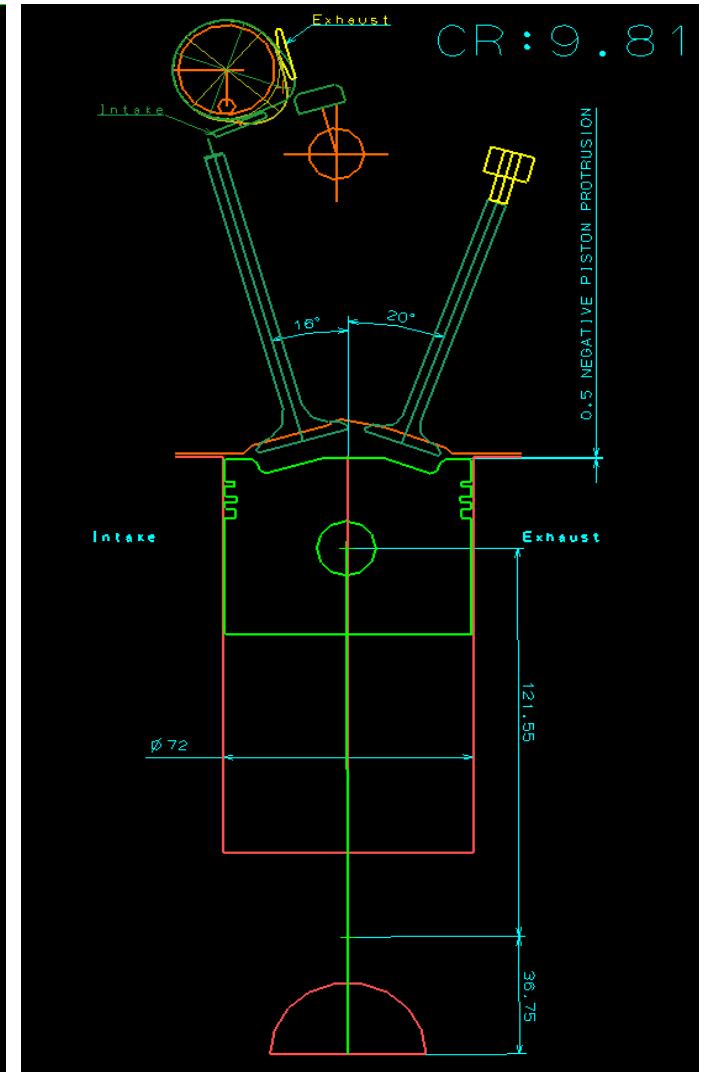
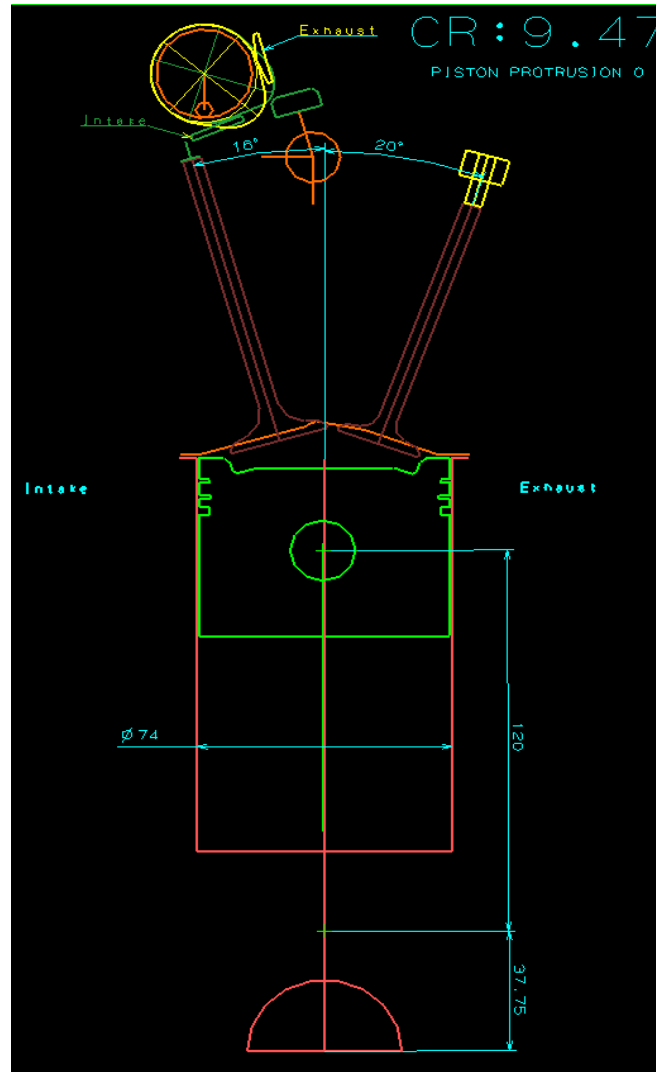
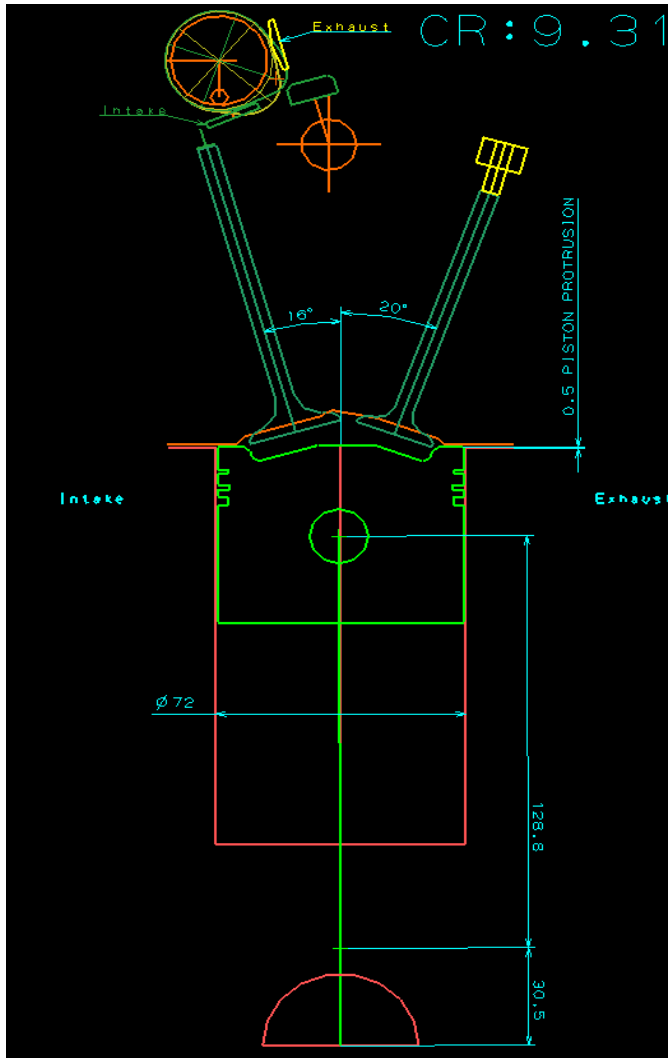


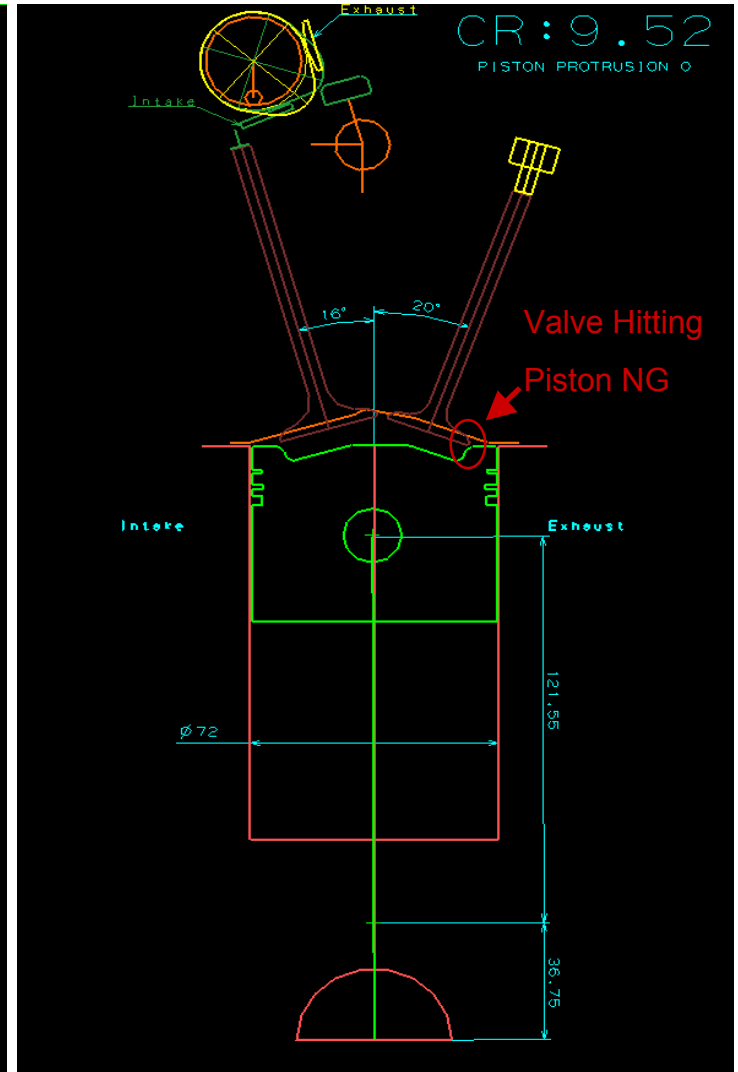
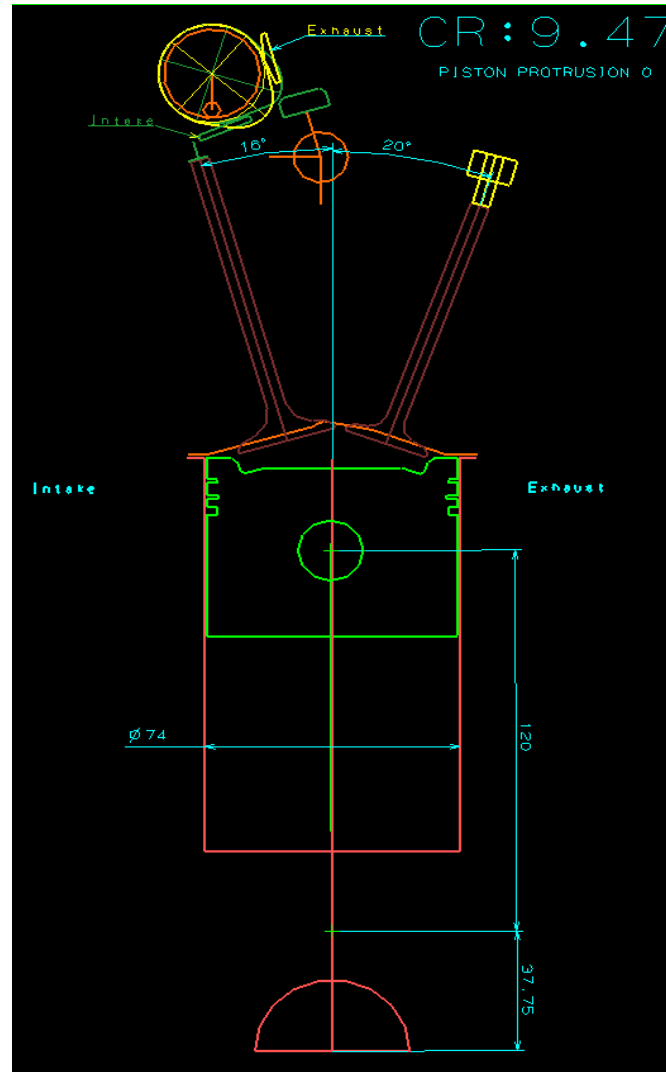
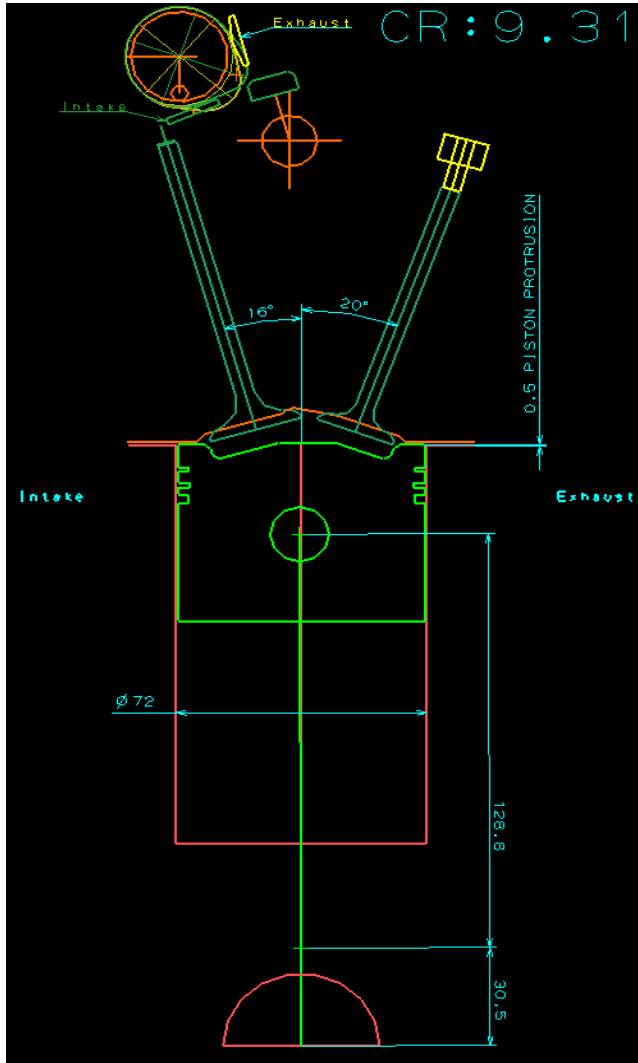
Max CR with G-X Head



CR Less With G-Y Head

Layout of Option G-B (G-X Head)





Valve hitting



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Kaizen Approach

The Definition → Kaizen is the Japanese term means Continuous improvement, taken from words Kai means Continuous and Zen means improvement.

- Some term it as Change for betterment
 - Small change for continuous improvement
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Final Option selected

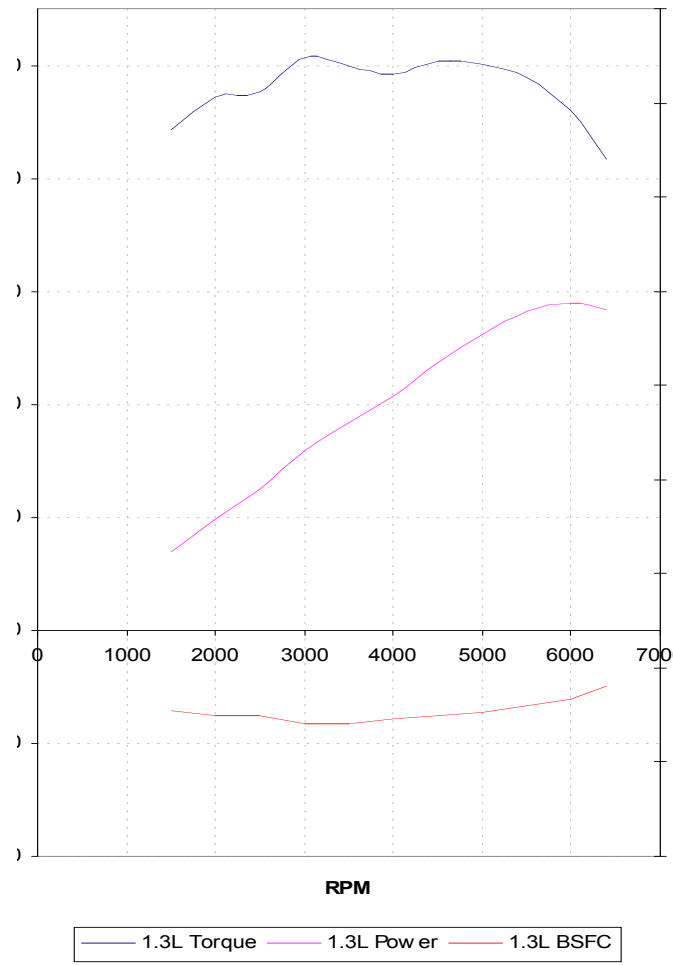
GA with G-X Head

Bore	71mm
Stroke	75.5mm
Disp. Volume	1195 cc
CR	9.87

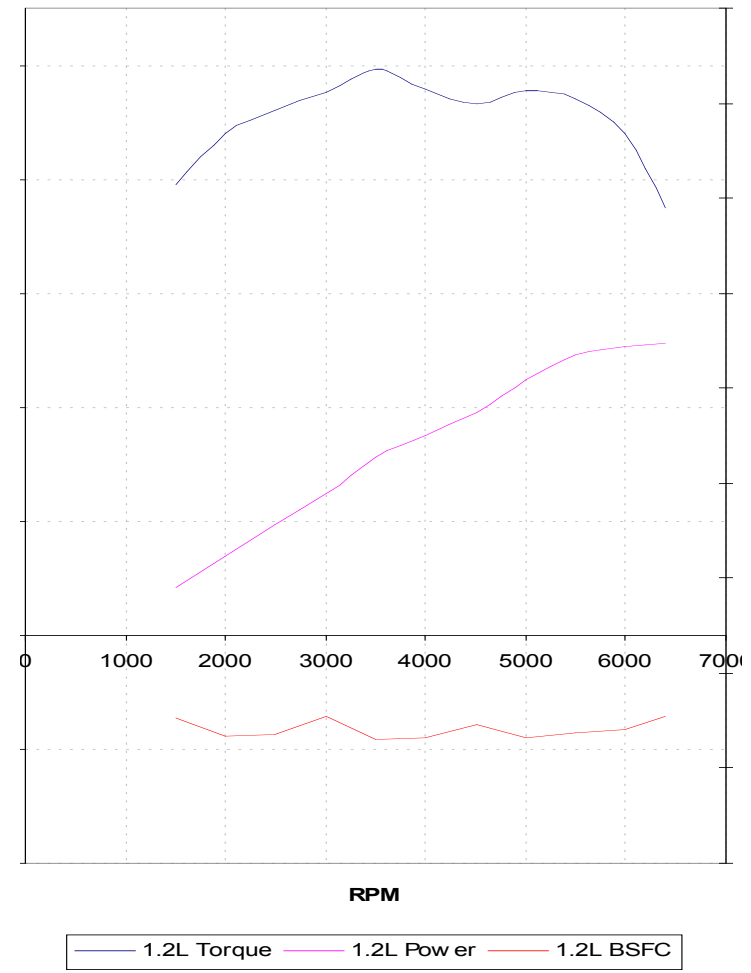
- ✓ To have max CR for FE improvement
- ✓ New Cylinder block with change on Sleeve only
- ✓ Design of new Piston and rings
- ✓ Minimal changes in the machine shop
- ✓ No change in cylinder head, Crank Shaft

o Performance Curve (Existing & New)

Perf 1.3 L



Perf 1.2 L





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Summary

- ✓ Increase in FE → 11.5%
- ✓ No changes in the In house machine shop
- ✓ Max Torque achieved with reduced capacity
- ✓ Tax Duty benefit 24% → 16%
- ✓ Cost Down to the company
- ✓ End benefit to customer

Thank You
