



LT1

[media.gm.com/newcorvetteengine](http://media.gm.com/newcorvetteengine)



**SMALL BLOCK**  
*GEN 5*

**Tadge Juechter**

*Executive Chief Engineer*

*Corvette*

# The Small Block...

- Made high-performance attainable to a whole new generation of customers
- Ushered in a new age of engine design and manufacturing
- Helped make Chevrolet a formidable force in motorsports



SMALL BLOCK  
SERIES

# Corvette and Small Block

## *Corvette Production Cars*

- Corvette powered by Small Block for 57 years
- Small Block power and performance are synonymous with Corvette

## *Corvette Racing*

- Corvette won its first race at LeMans with a Small Block in 1960
- Corvette won its seventh championship at LeMans in 2011 by more than two minutes
- In 2012 Corvette Racing swept drivers, team and manufacturers championships
- Most successful team in ALMS history: 77 class wins, 8 drivers championships, 9 manufacturer/team championships



# All-new Corvette Engine

Started by Asking What Do We Want in a Performance Car Engine

- Compact
- Lightweight
- Powerful
- Efficient
- Durable
- Best solution had all of these attributes



SMALL BLOCK  
CORVETTE

# Corvette Frequently Asked Questions

- Will it be a 5.5L?
- Will it be a Twin Turbo V6?



SMALL BLOCK  
CORVETTE

# All-new Corvette LT1

## *6.2L V8 with Next-gen Technologies*

- **Corvette is lightweight, aerodynamic... makes it a great candidate for fuel-saving technologies**
- **LT1 is more powerful, more responsive, and more efficient than smaller displacement V8**
- **LT1 is faster, more responsive, and more efficient than a twin-turbo V6**



# All-new Corvette LT1

*New LT1 is a Perfect Choice  
for Corvette*

- LT1 engine is 99.9% new,  
engineered to deliver
  - Tons of power and torque
  - Compact size
  - Lightweight
  - Fuel efficient





# The New Corvette LT1 Objective:

*Improve performance, with 0-60  
in under 4 seconds*

*Improve efficiency, to make  
one of the most fuel efficient  
450 hp vehicles you can buy*



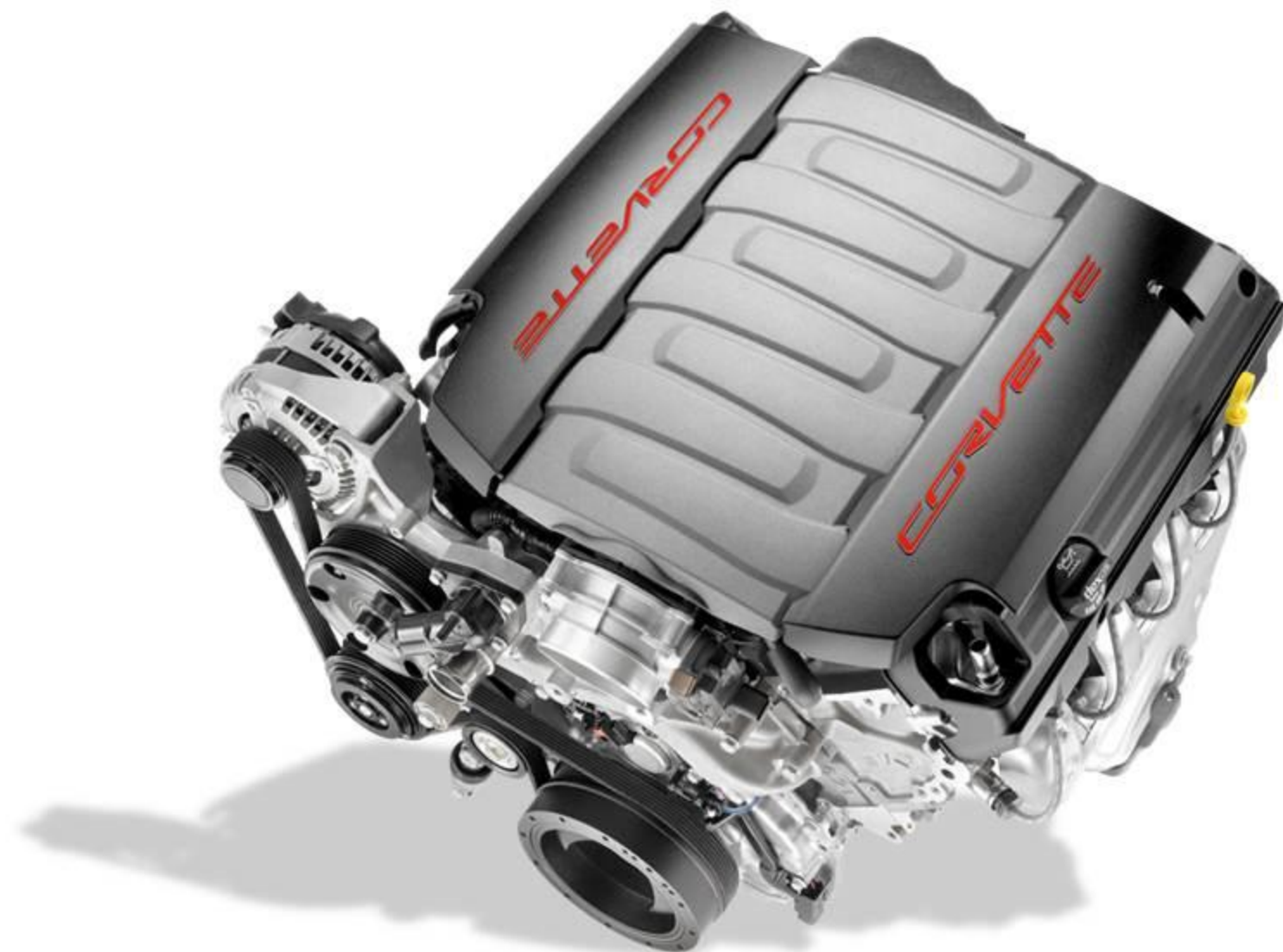


LT1

**Jordan Lee**

*Chief Engineer and  
Program Manager*

*Small Block Engines*



# LT1 6.2L V8 Engine Program Objectives

*Take a Great Engine and Make it Better*

High performance engine for Corvette

Optimize performance and efficiency

Extremely compact engine size –  
low mass, low hoodline, better driver visibility

LT1 is a purpose-built high performance engine

- All new Gen 5 engine design



# LT1 6.2L V8 Engine Program Objectives

*Take a Great Engine and Make it Better*

The LT1 was engineered to be best in class in many categories

- Incorporate Next-Gen technologies that improve performance and efficiency
- A very high performance and fuel efficient engine
- Maintain an extremely compact and power dense package
- Track capable engine performance  
(not an easy task with Corvette capability)



# LT1

## *Unprecedented Technology Combination*

- Direct injection
- Active Fuel Management
- Continuously variable valve timing
- ***Radically new combustion system with 11.5:1 compression ratio***
- ***Resulting in greater performance, efficiency and refinement in an extremely compact engine size***



# LT1 Overall Results

*Best Power, Torque, Acceleration and  
Fuel Economy Ever for Standard Corvette*

Preliminary 450 horsepower

Preliminary 450 lb-ft torque

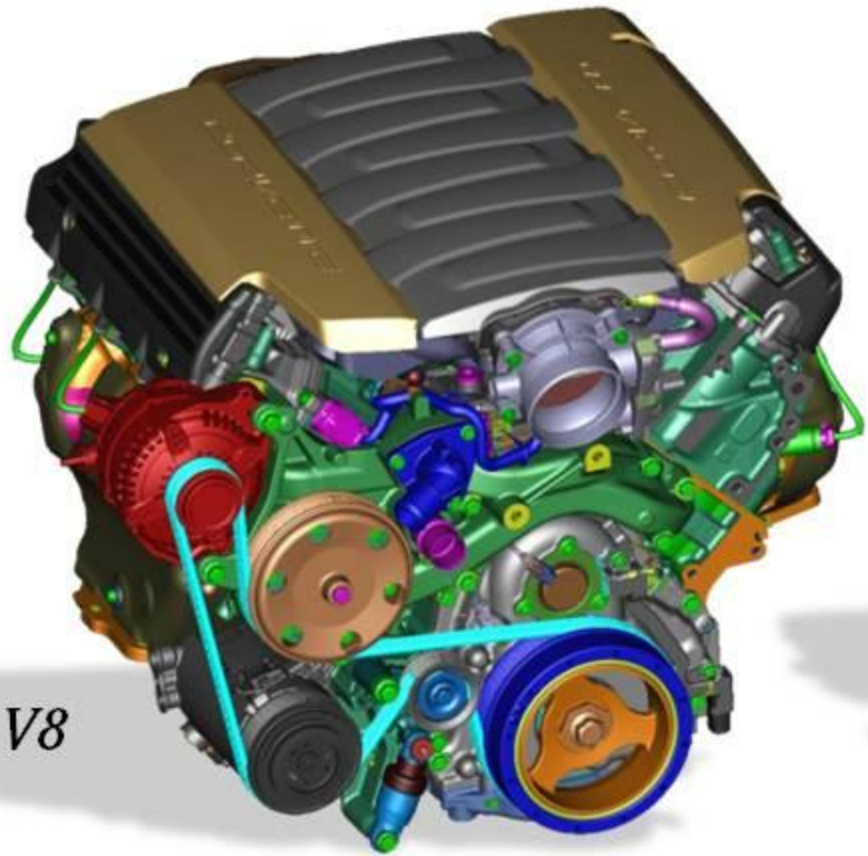
0-60 in under 4.0 seconds

More than 26 mpg



# LT1 vs. BMW

## Power Density



*LT1 6.2L V8*

*preliminary 450 hp / preliminary 450 lb-ft torque*

*mass = 465 pounds (211 kg)*



*BMW 4.4L Twin Turbo  
(5 Series, base V8 engine)*

*mass = 503 pounds (228 kg)*

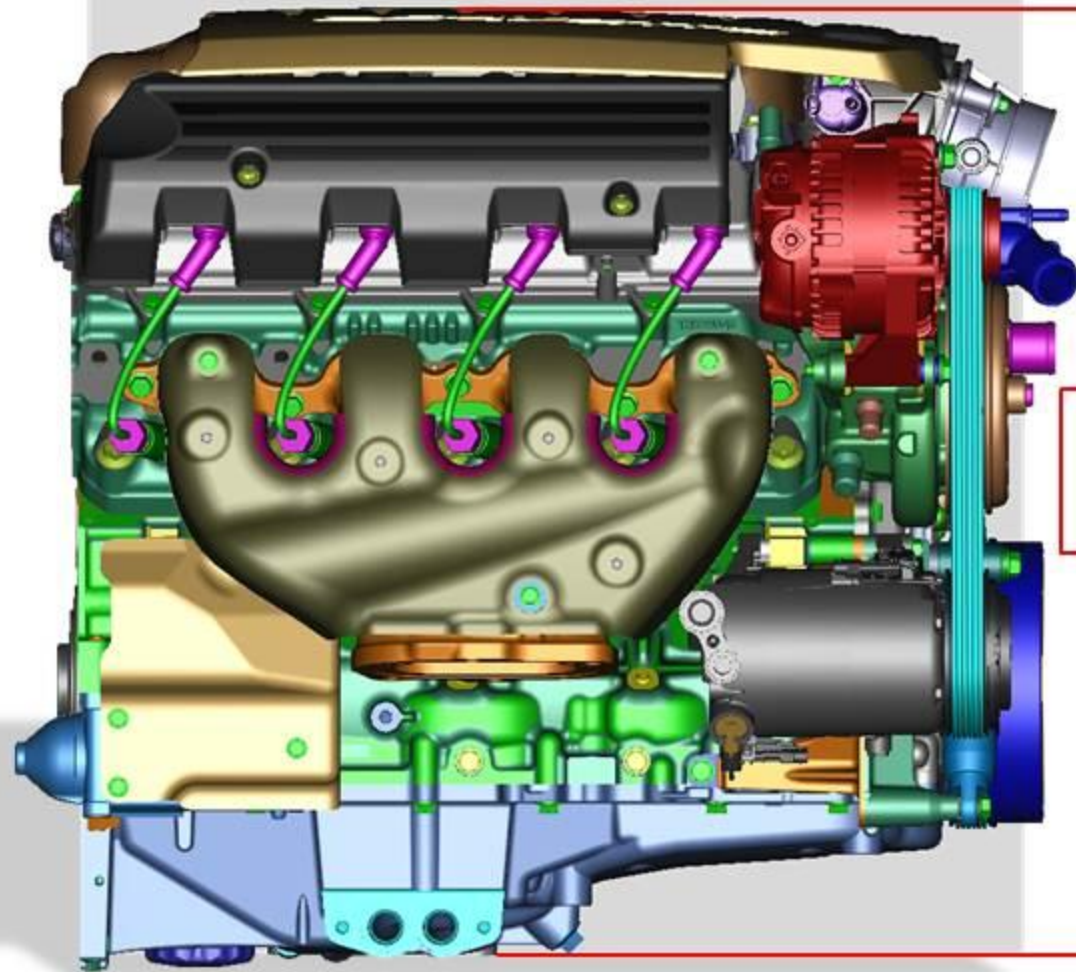
*(source: BMW technical paper)*



# LT1 vs. BMW

## Packaging Efficiency

*Base Engine Comparison*



29.6 inches  
(753 mm)

25.3 inches  
(642 mm)

**GRAY IS THE  
SIZE OF BMW  
ENGINE**

*(BMW dimensional data  
from BMW technical  
design paper published in  
MTZ 11/2008 Volume 69)*








# Corvette LT1

## Efficient Output

*One of the most fuel efficient sports cars on the market*

Model	HP	Torque (lb-ft)	0-60 (seconds)	MPG (highway)
Corvette Coupe 	Est. 450	Est. 450	Under 4.0	More than 26
Porsche 911 	350	287	4.6	27
BMW M3 Coupe 	414	295	4.8	20



# LT1 6.2L V8

*Unique Solution Set: Next-Gen Technologies*

## SMALL BLOCK — GEN 5

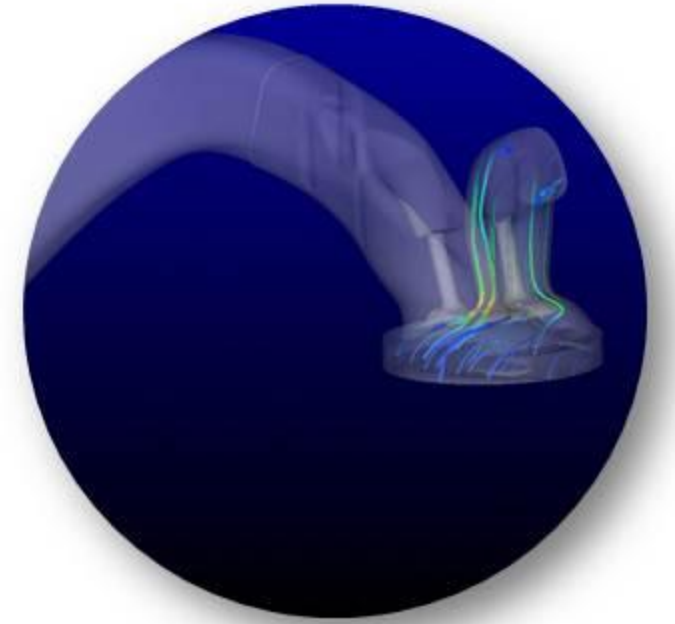


# The Most Beautiful Part Of The Corvette: *That Customers Will Never See*



# LT1 Advanced Combustion System

*Most Intensely Analyzed, Developed and Optimized System in GM's History*



- Hundreds of iterations of combustion systems analyzed
- Over 6 million hours of CPU time dedicated to combustion system optimization
  - Over 10 million hours of CPU time dedicated to all Gen 5 analysis (combustion, structural, cooling system, lube system, vent system)
- So advanced that an SAE paper is being written to explain the Gen 5's combustion system development process



# **LT1 Advanced Combustion System**

## ***Leading Edge Design Process***

Parametric design tools

Steady-state airflow assessment

- Three-dimensional Computational Fluid Dynamics (CFD) analysis
- Airflow bench testing

One-dimensional engine cycle simulation

Geometric flame propagation analysis

Three-dimensional mixing and combustion analysis

Single- and multi-cylinder combustion testing

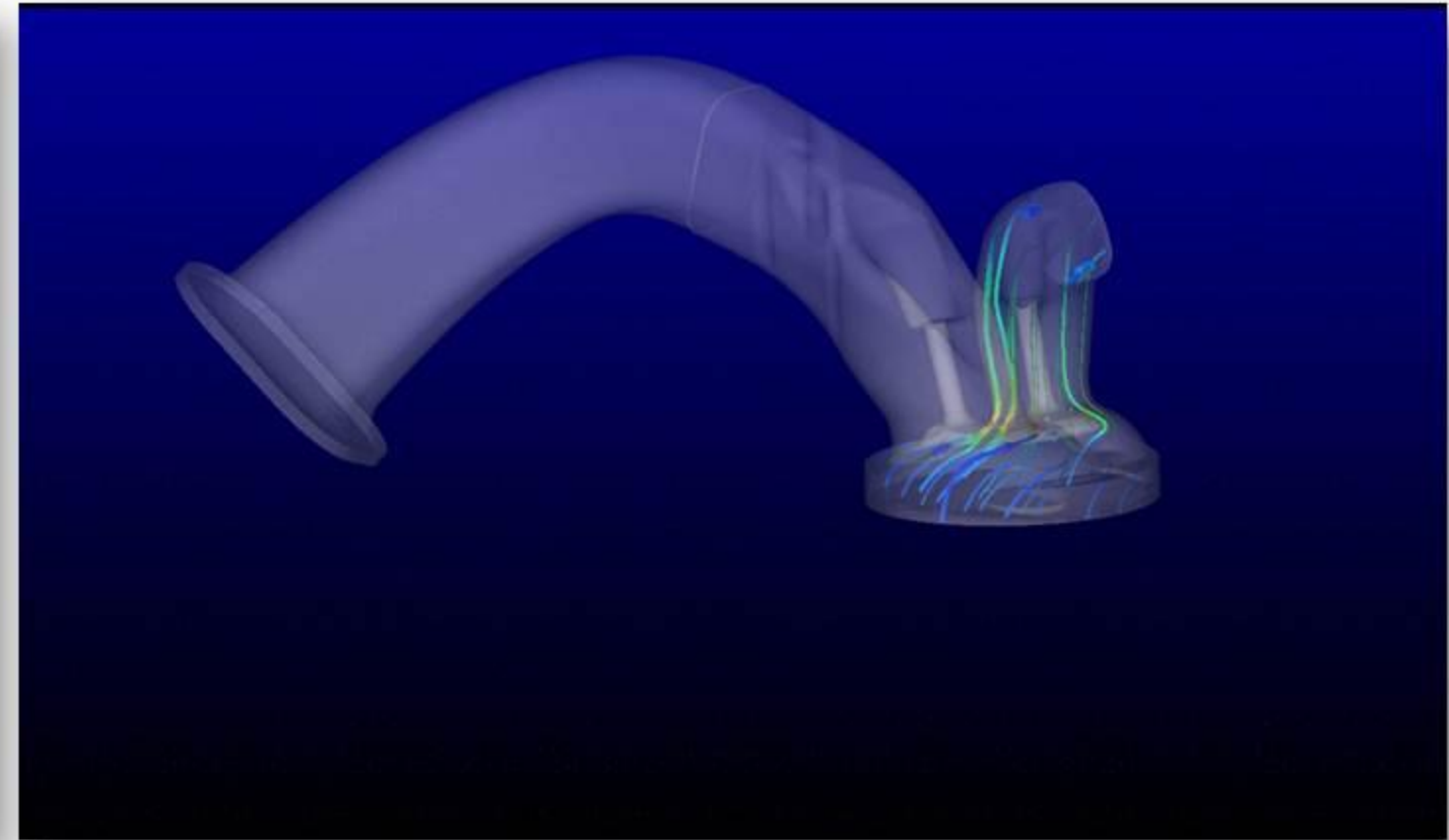
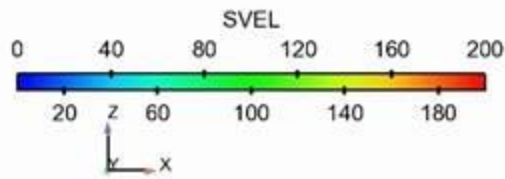
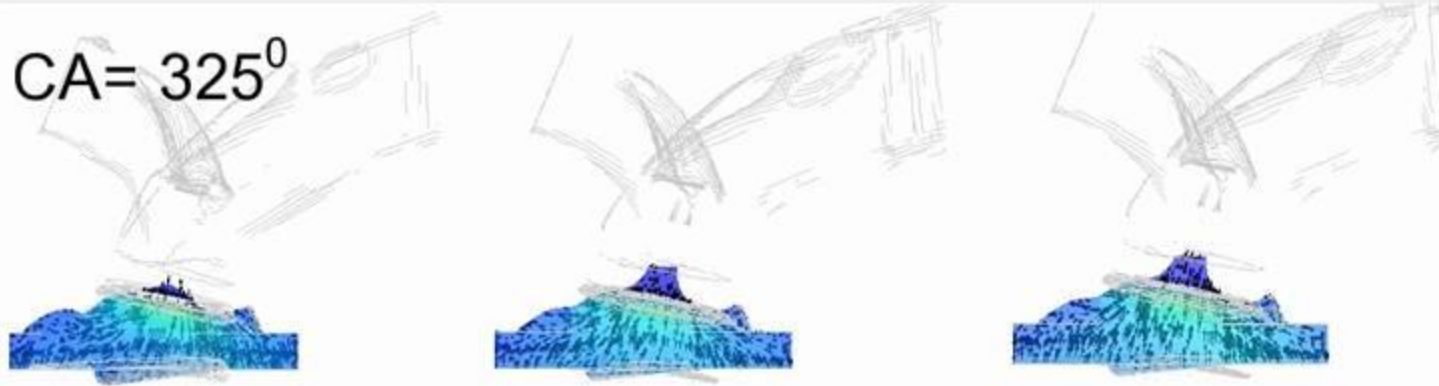
Vehicle level performance and fuel economy analysis



# LT1 Advanced Combustion System

## *Analysis of Airflow and Combustion*

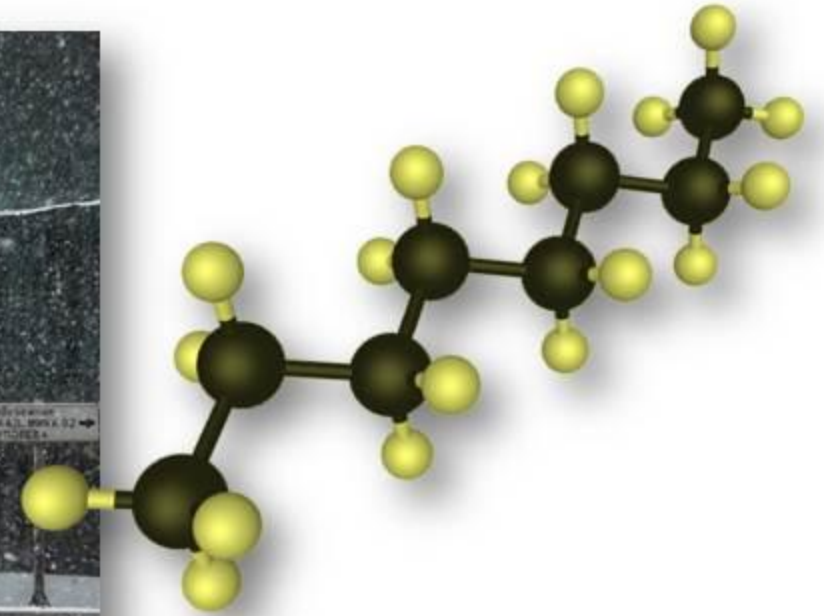
CA= 325<sup>0</sup>



# LT1 Advanced Combustion System

*The Gen 5's Advanced Combustion System assures every drop of fuel is converted to energy to maximize fuel efficiency, reduce emissions and reduce knock sensitivity*

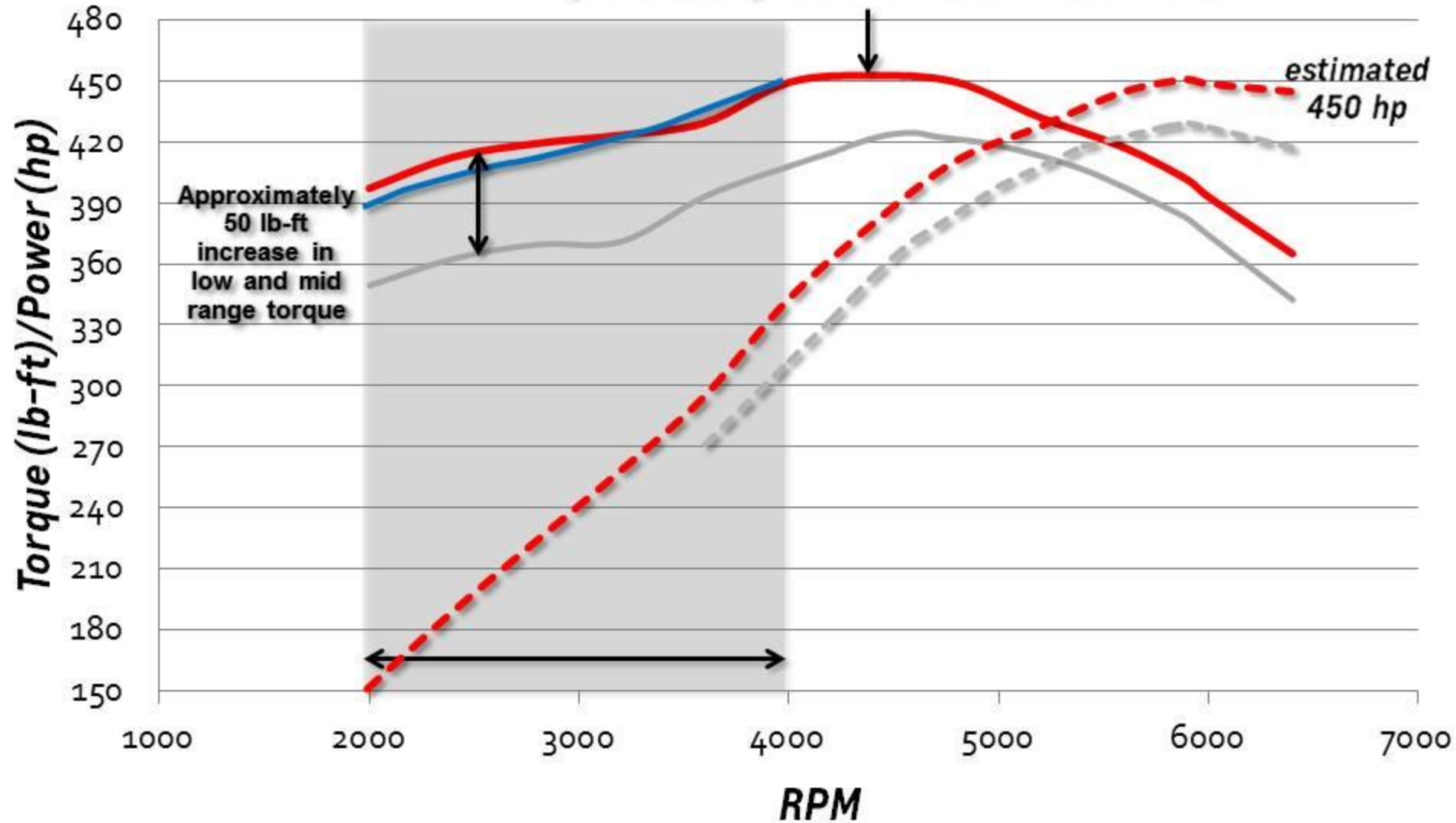
*Even in the most extreme climatic conditions*



# LT1 Torque Analysis

## Powerful & Efficient

preliminary 450 lb-ft (1236 kPa BMEP)



Better  
horsepower/liter  
than LS7

- 2014 Corvette 6.2L LT1 lb-ft
- 2013 Corvette 6.2L LS3 lb-ft
- 2013 Corvette Z06 7.0L LS7 lb-ft
- - - LT1 hp
- - - LS3 hp





# Legendary Durability



The Gen 5 LT1 has been pushed further than any of its predecessors with dyno testing. We are now using a more aggressive and advanced high speed, high load durability test based on extremely aggressive driving conditions.



# Legendary Durability

Each hour of durability testing is the equivalent distance of 40 laps around the Nürburgring's Nordschleife (12.9 mile length)



Each test has over 20,000 "0-60" mph passes at extreme oil and coolant temperatures



# Legendary Durability

*The Gen 5 LT1 6.2L engine will have accumulated an equivalent of over 1.5 million miles of validation testing*

- 60 times around the world



# Legendary Durability

Extensive thermal cycling performed to simulate over 10 years of extreme operating conditions

Repeated cycling between approximately  $-4^{\circ}\text{F}$  ( $-20^{\circ}\text{C}$ ) to  $239^{\circ}\text{F}$  ( $115^{\circ}\text{C}$ ) coolant temperature while running the engine under max power conditions



# Tonawanda Engine Plant

***Engine Manufacturing Experience for Almost 75 Years***

Built in 1937

Original 1955 Small Block built here

Designed by Albert Khan (famous industrial architect)

Holds world record single day engine production (8,832 engines)

Converted to make aircraft engines during World War II



# Tonawanda Engine Plant

## *State of the Art Manufacturing Facility*

*Technology didn't end with the engine design:*

- Block machining: 25 CNC machines per module capable of fully machining over 400 features including bores.
- Cylinder head machining: 11 CNC machines per module use 15 spindles and 44 unique cutting tools to machine all 6 planes of the head.
- Blocks and heads are loaded and unloaded to the machining modules as part of a visual quality inspection and transferred between modules using agile robotics.
- State of the art advanced torque monitoring of nearly 250 fasteners.





LT1



**LT1**

# John Rydzewski

*Assistant Chief Engineer  
Small Block Engines*



*fuel economy*



*emissions*



*torque/ power*



*refinement*



*mass*



*durability*







# Direct Injection Fuel System

- Direct injection
- Compact fuel system hidden under intake manifold, injectors under intake ports
- Single high output fuel pump
- Injector spray and droplet design integrated to mixture dynamics
- Fuel rail isolation features suspend injectors for enhanced refinement
- Fuel pump control logic to minimize mechanical impact
- Acoustic encapsulation

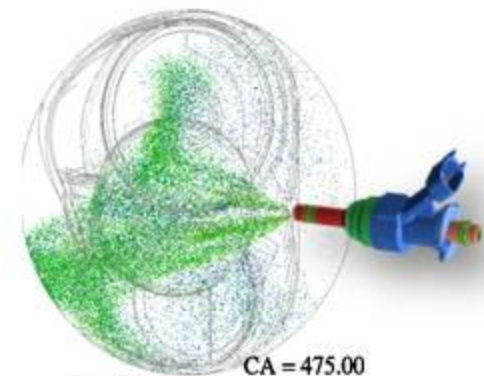


Fuel Charging Assembly



Fuel Pump

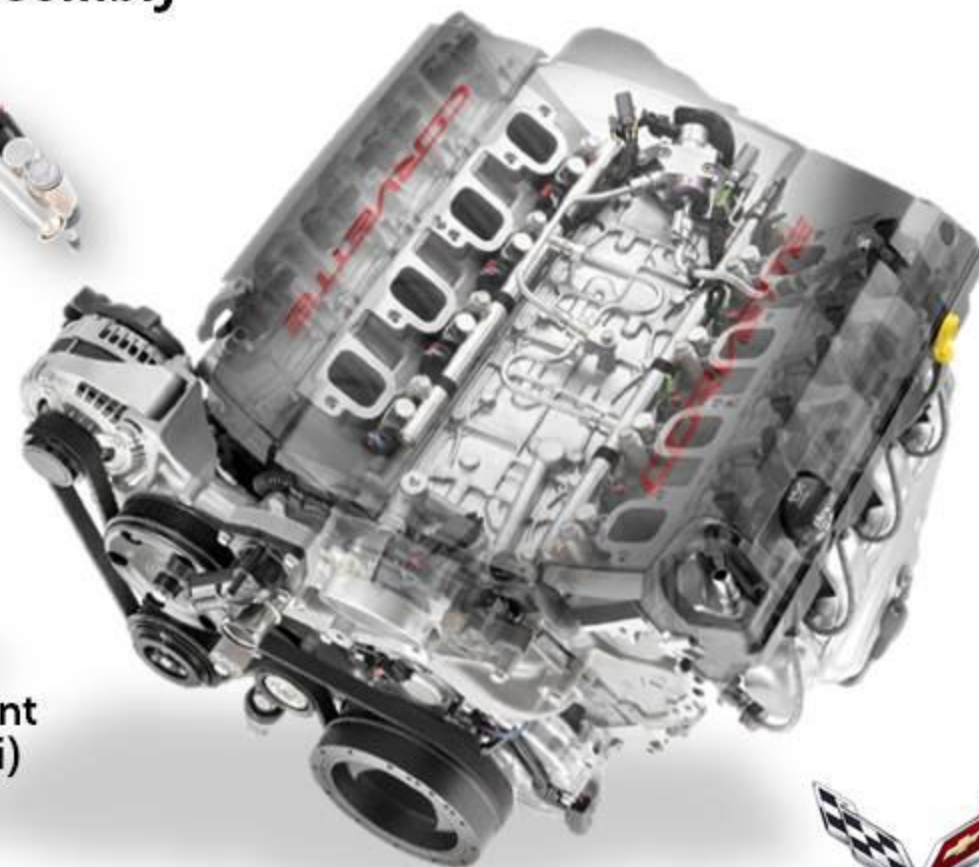
1.48 cc/rev geometric displacement  
15 MPa system operation (2,175 psi)  
3 Lobe 5.7mm lift cam interface



CA = 475.00

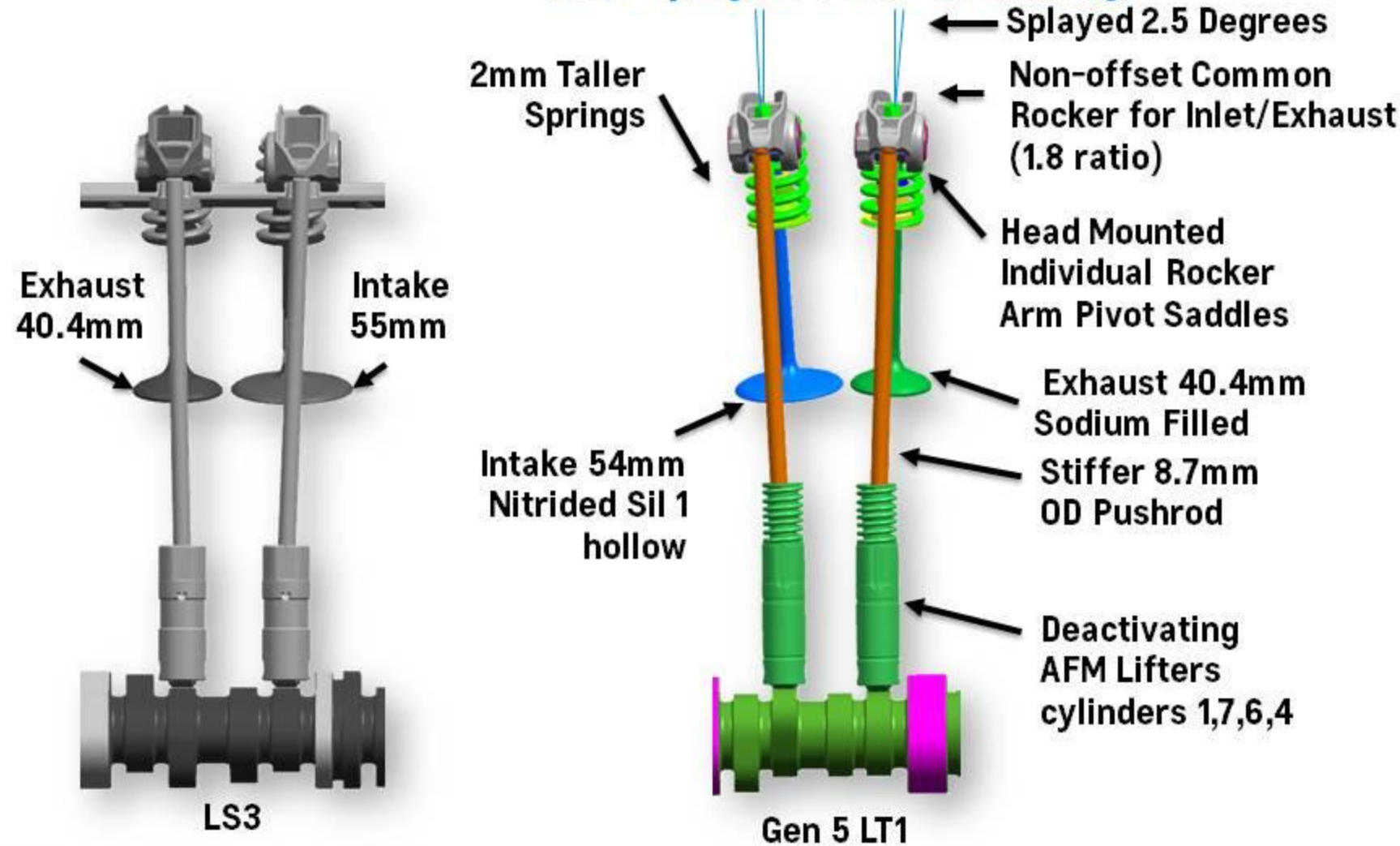
Injectors

Flow rate: 22.0 cc/s @ 10MPa

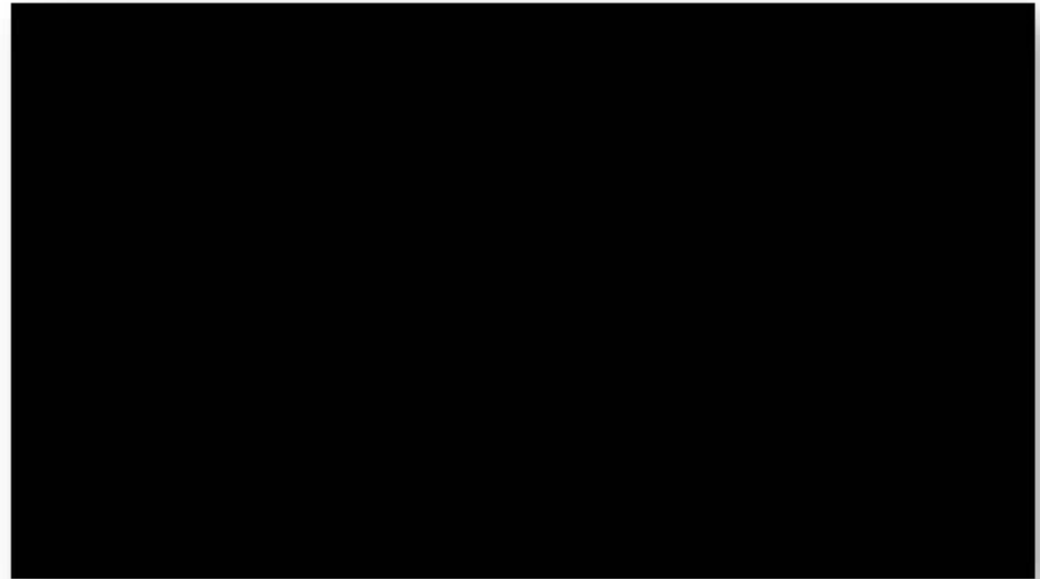


# LT1 Valvetrain and AFM

## New Splayed Valve Geometry



6600 rpm engine speed fuel cut-off



## Active Fuel Management

Electrical/hydraulic deactivation/reactivation

V8 Firing Order: 1 8 7 2 6 5 4 3

V4 Firing Order: 8 2 5 3



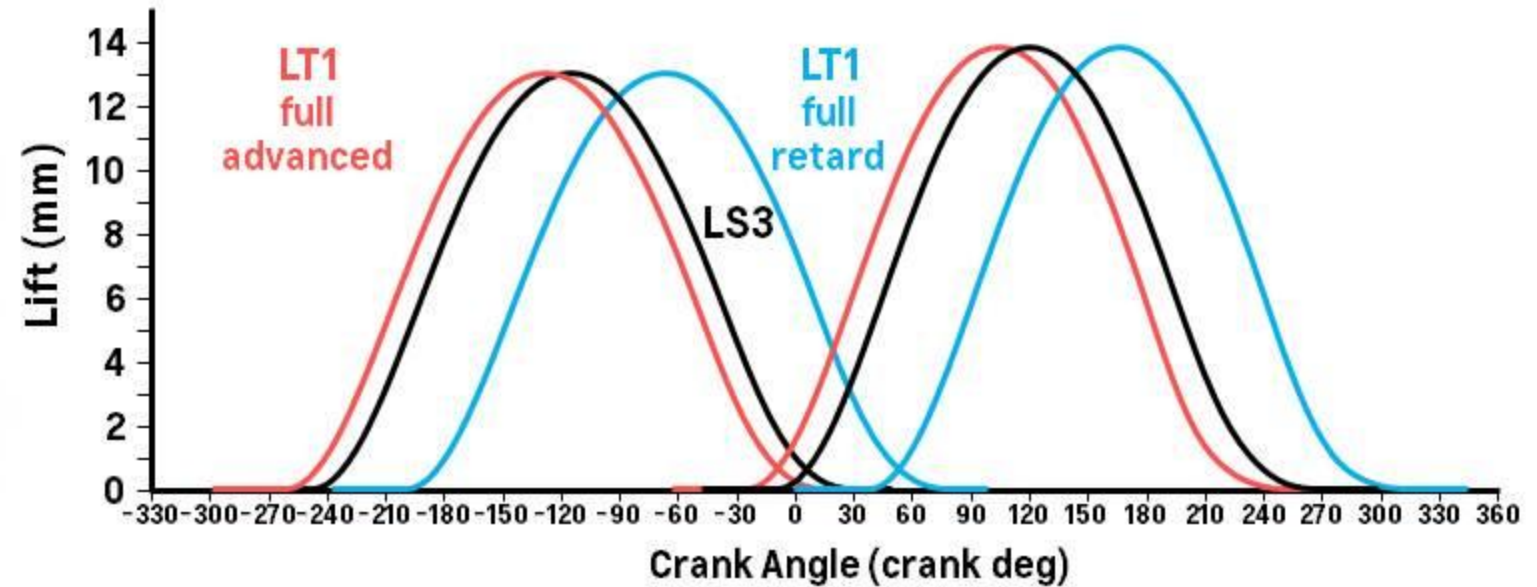
# Valvetrain

## Camshaft and Continuously Variable Valve Timing

- LT1 camshaft design based on LS3's cam tuning (14mm gross intake lift)
- Variable valve timing / capability (62 crank degrees of cam phasing authority)
- LT1 lift events were optimized to incorporate the new high rocker ratio and splayed valve geometry
- Cam (opening and closing ramps) profiles accommodate AFM and provide refined low speed operation
- Tri-lobe for direct injection pump

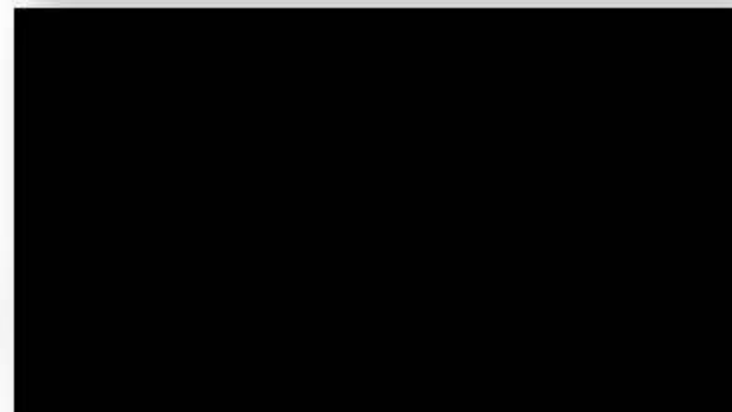
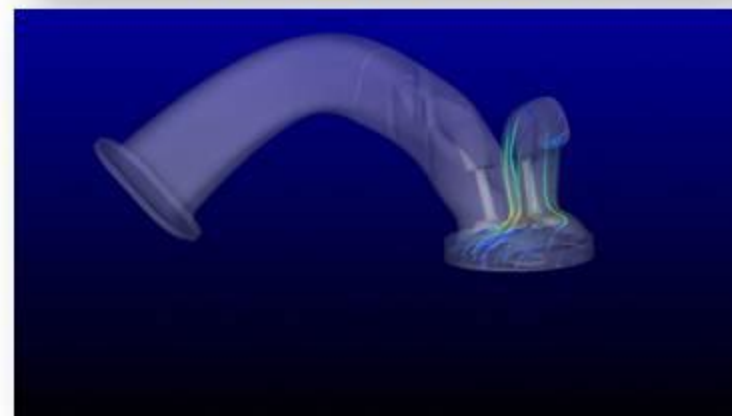
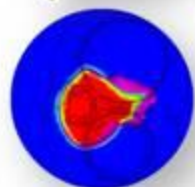


Lash Adjusted Valve Lift vs. Crank Angle



# Gen 5 Combustion

- Every mm of every design feature carefully developed to support the most ideal combination of direct injection, AFM and continuously variable valve timing
- Twisted shaped high flowing intake and exhaust ports
- Splayed intake and exhaust valve
- Compact combustion chamber
- Precise piston topography
- Strong focused mixture motion
- Swapped intake and exhaust
- Centralized spark plug and center of ignition
- Optimized interaction of cam duration / overlap, injector spray, air flow vectors, bores size and 92mm stroke
- Very efficient 11.5:1 compression (premium fuel recommended, not required)



# LT1 Cylinder Head

Combustion chambers sized for higher C.R.

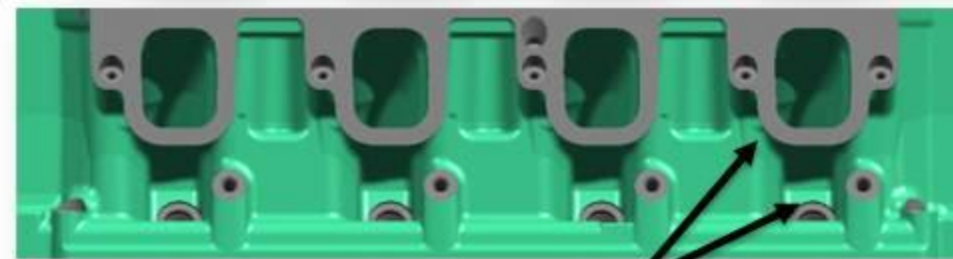
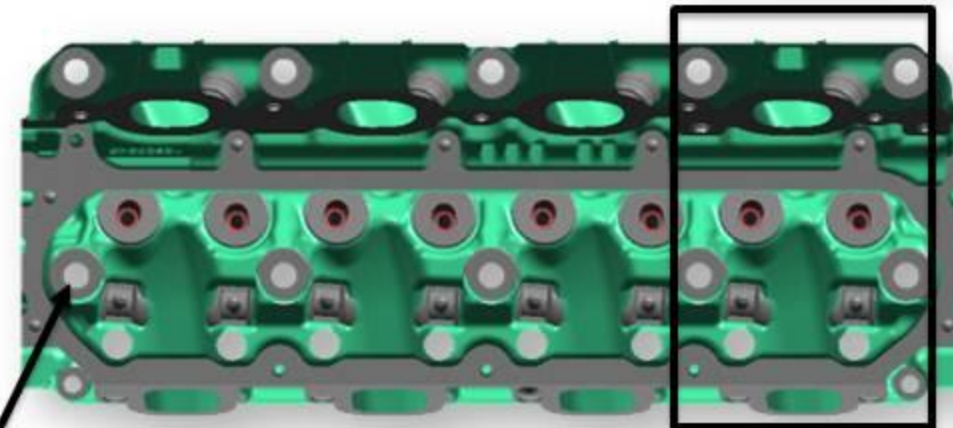
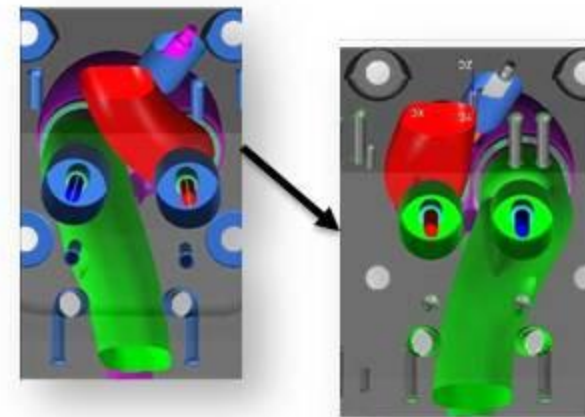
Spark plugs moved closer to center for optimal ignition, reduce knock

Intake and exhaust valves reversed in cylinders

Gen 5



Gen 4



All head bolts now M12 (vs. M11 in Gen 4)

Intake ports raised for fuel



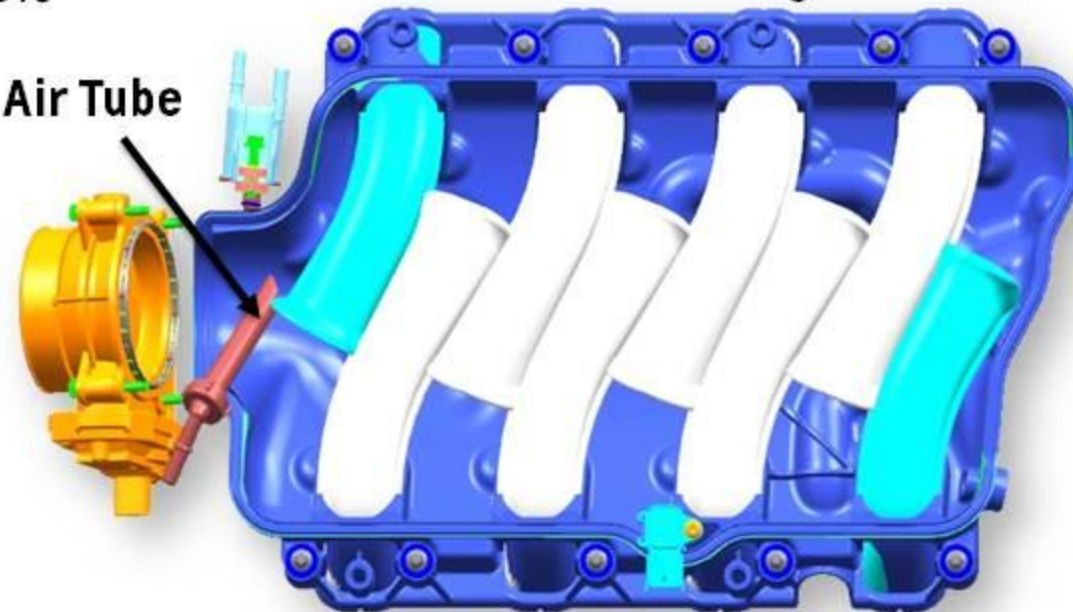
# Intake Manifold Features

- “Runners in a Box” architecture
- 4-piece molded and welded composite intake manifold; lightweight and thermally efficient design
- Integral manifold cover with copolymer filled acoustic barrier
- 87mm digital throttle body with low restriction
- Dynamic Air flow improved 3.6%
- Air flow imbalance reduced 50%



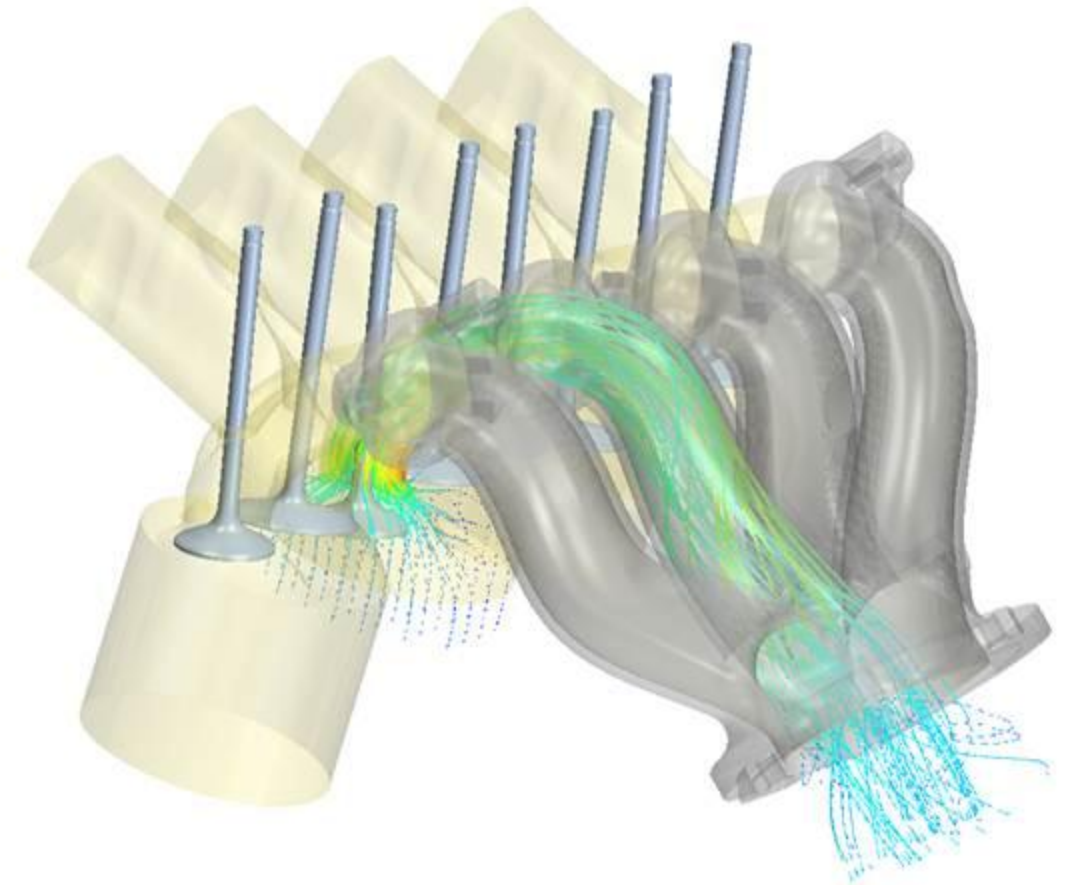
“Runners in a Box” Design

PCV Foul Air Tube



# LT1 Tuned Exhaust

- LT1 uses a similar yet cast version of the “four-into-one” short-header exhaust manifold used on the LS7 and LS9
- Runner geometry was further optimized using the latest analysis software to develop cross sections which minimize restriction and maximize volumetric efficiency tuning of exhaust gas flow
- Nearly equal length runners to ensure all cylinders have consistent flow of exhaust gases
- Cast header passages enable consistent exhaust flow into the “wide mouth” collector
- Radiated noise reduction



# LT1 Piston / Rod Features



High Compression  
'Pop-up'  
(11.5 : 1 C.R.)

Direct Injection Fuel 'Bowl'

Valve Relief  
for Cam  
Phasing

Tapered / Wide Pin End  
(Supercharged Type)

High Strength  
PM Forging  
(Supercharged Material)

LS3 Style  
Ring Pack

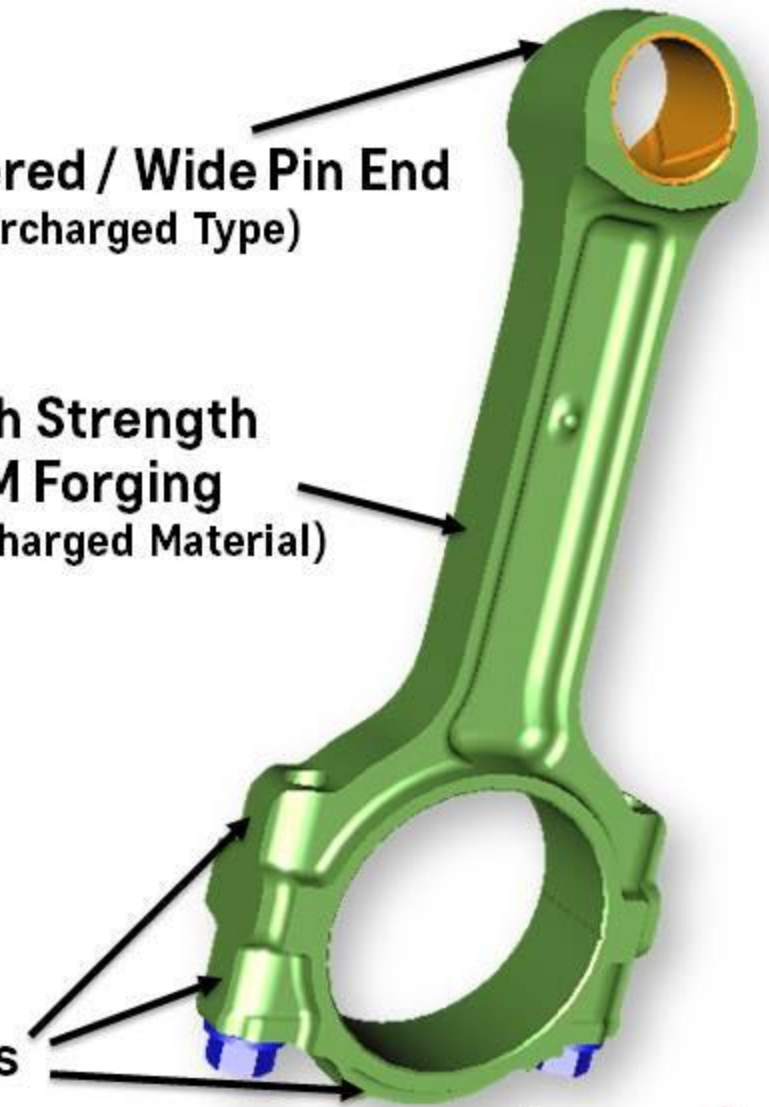
High Strength Al  
(Supercharged Material)

Skirt Notch for Oil Jet

Piston Cooling  
Oil Jet

LS3 Style Cast and Drilled Oil  
Drains

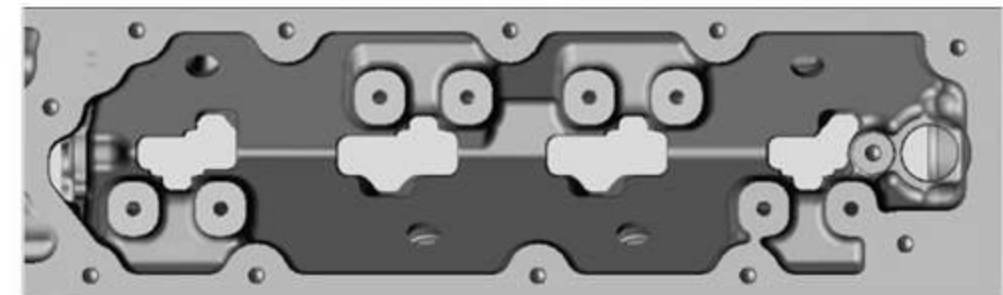
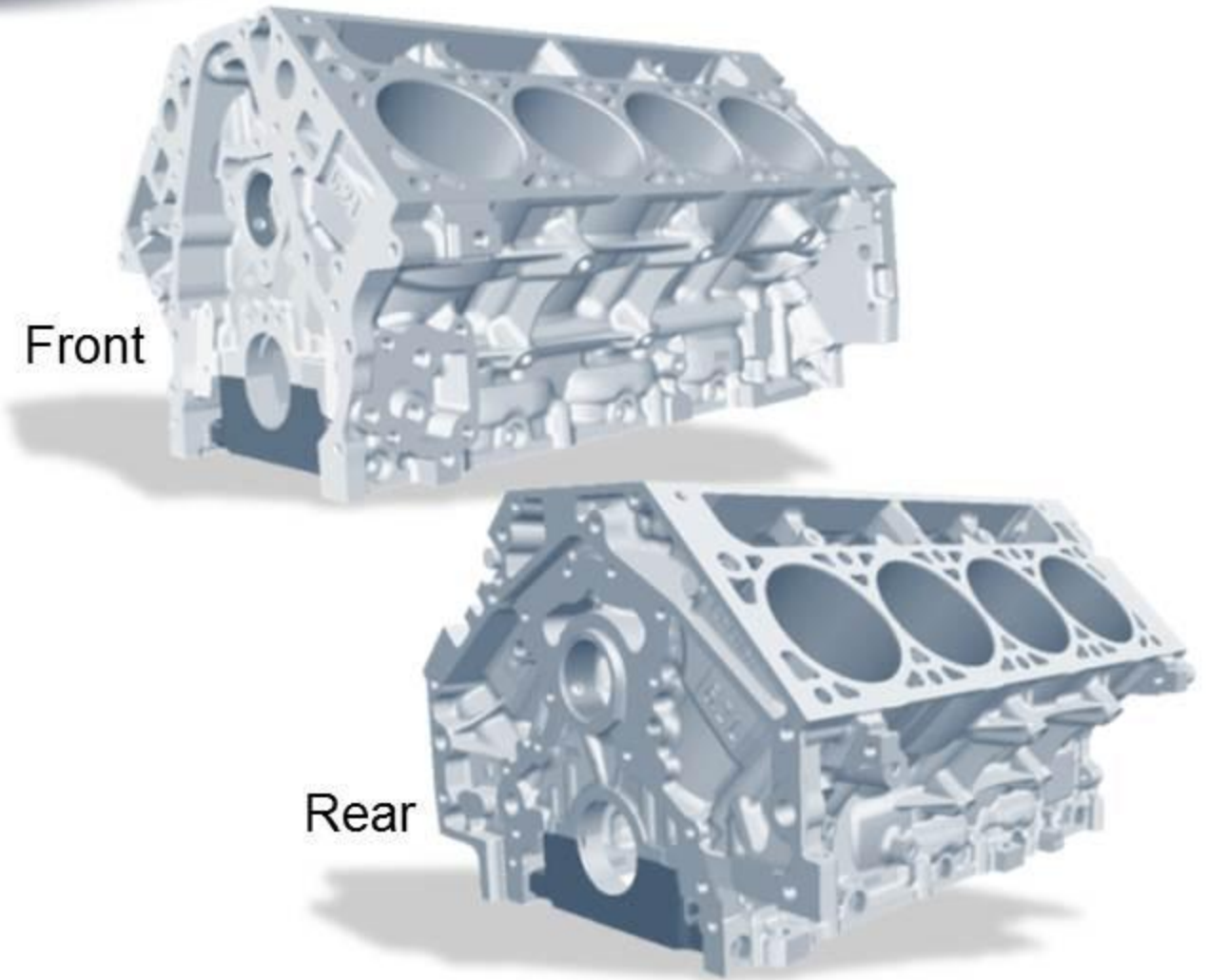
Lightweight Features





# LT1 Block

- Aluminum – 319 Precision Cast
- 103.25mm Bores with cast-in-place liners; induction liner heating for dimensional control
- All aluminum deck face (cast over liners)
- Nodular iron main caps (were powder metal)
- SIDI Pump mounting features in valley (new rear cam bearing)
- Crankcase optimization for windage
- New Water Jackets (M12 new length head bolts, optimized for structure)
- New engine mount bosses and rear cover mounting provisions



# LT1 Crankshaft & Bearings

- Steel forged crankshaft
- Polymer main and rod bearings



## Crankshaft:

- 1538MV Steel Forging (twisted)
- Induction hardened journals
- Intermediate pin drills



## Main Bearings:

- Polymer Coated Bi-metal eccentric
- Upper groove narrower than Gen 4 for increase bearing area/oil films



Gen 5  
4.0mm

Gen 4  
5.5mm

## Rod Bearings:

- Polymer Coated Bi-metal eccentric

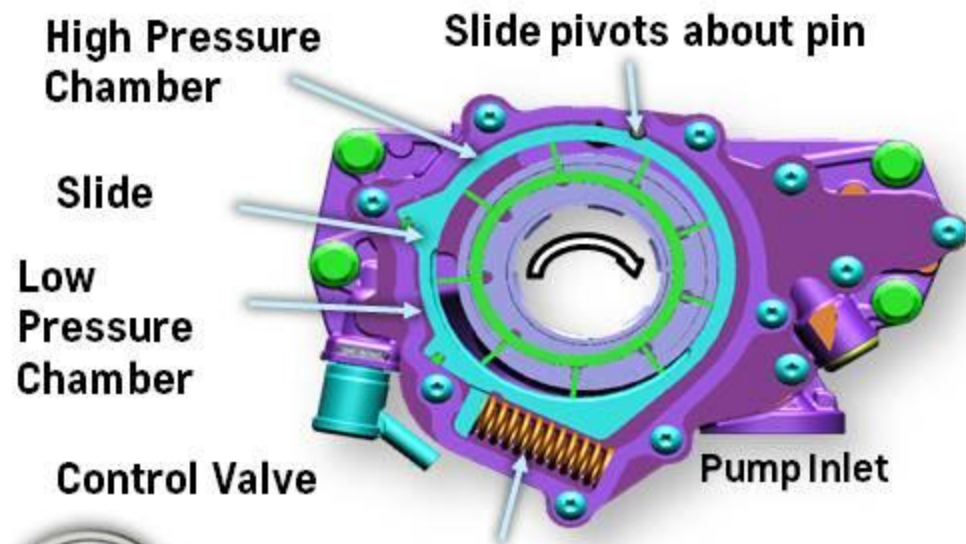
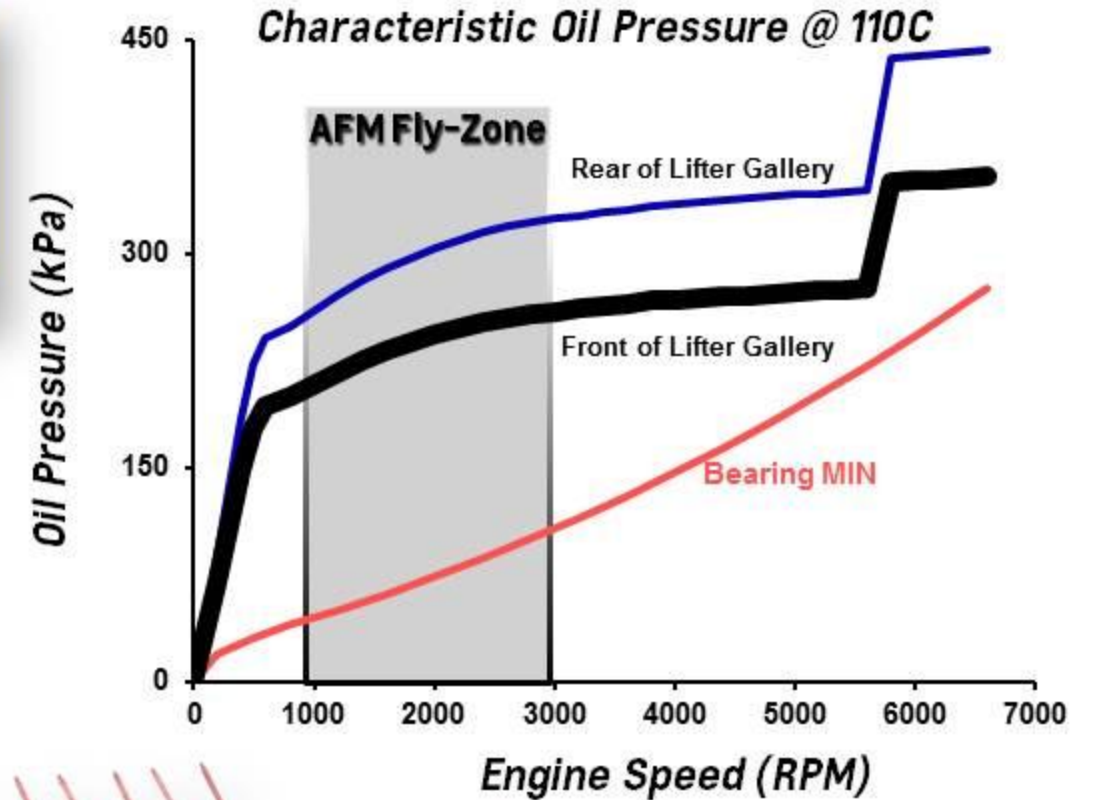
## Upper Thrust Bearings:

- 3 Piece / 180deg washer design
- Polymer Coated eccentric flat bearing / Aluminum-Tin thrust washers
- Laser welded assembly



# LT1 Lube Circuit

- Variable-displacement oil pump continuously adjust oil flows to maintain proper oil pressure at bearings
- Dual-pressure capability
  - Very efficient oil pressure at lower rpm coordinated with AFM
  - Higher pressure at higher rpm for aggressive engine operation
- New oil pressure sensing location



Spring calibrated for desired oil flow & pressure



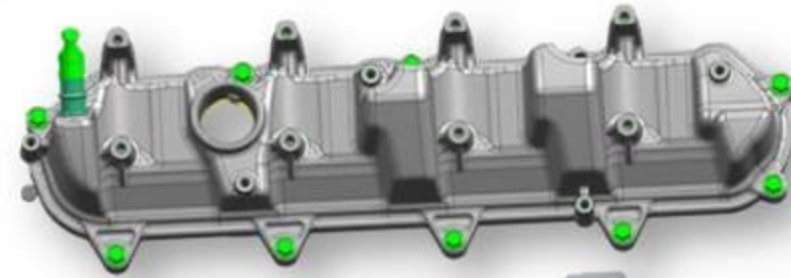
Pressure sensor relocated from rear to front

Gen 5 oil pressure gauge measurements are 50-75kpa lower than LS engines

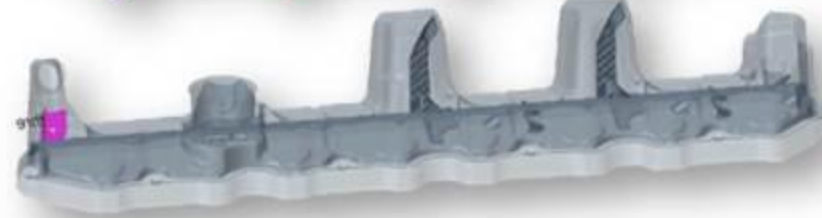


# Lube and Vent System

- Rocker cover dome features between direct-mount ignition coils; domes contain baffles (impactors) which separate oil and air from the crankcase gases
- 3 times enhancement in oil/air separation capability
- Patent-pending integrated positive crankcase ventilation (PCV) system that enhances oil economy and oil life, while reducing oil consumption and contributing to low emissions
- Revised foul air separator wrapped around the AFM solenoids
- New oil pan with performance windage tray
- 6 quart oil capacity



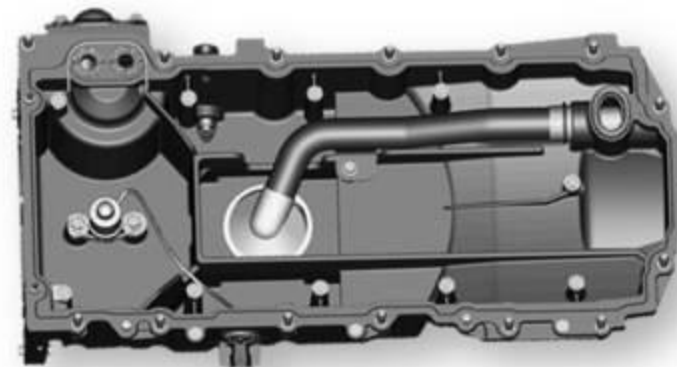
Rocker Cover with integral fresh air separator



LOMA with integral foul separator

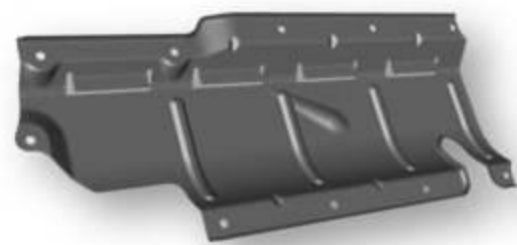


Oil Pan and Windage Tray



# LT1 Dry Sump System

- New variable vane oil pump coupled to a new higher output gerotor scavenge pump
- New Scavenge pump with capacity increase from 20.9 to 26 cc/rev
- Higher output oil cooler (coolant-to-oil) mounted on oil pan
- Enhanced pan and windage tray
- Enhanced oil pickup in dry sump tank
- 11.5 quart capacity

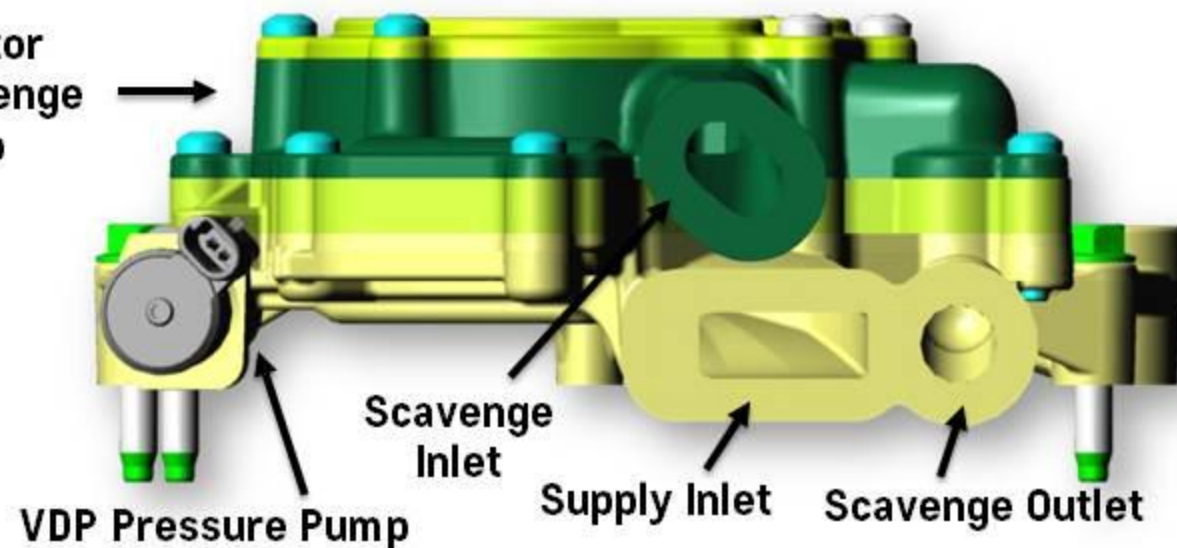


Windage Tray



Dry Sump Tank

Gerotor  
Scavenge  
Pump



# Lube and Vent System

- Wet or dry sump systems available within compact design
- Track capable in the hands of the most capable drivers
- Lube designed thru extensive “Tilt Rig” and “MRC” development



## GM “MRC” Milford

...one of the most challenging collection of race course elements



## GM “Tilt Rig” Pontiac

...rapidly tilts the engine during extreme operation to simulate the loads experienced during high-speed cornering; braking and acceleration on a racetrack; capability of tilting is 53 degrees which simulates lateral acceleration of up to 1.3g



# Summary

## *One Of The Most Technologically Advanced Engines In The World*

All new high performance engine designed for Corvette

Next-Gen technologies featuring a radically new combustion system

One of the most compact, power dense engines in the world

Highest standard power, torque and fuel economy ever for Corvette





**Dave Mooty**

*Lab Manager*

*Powertrain Development Center*

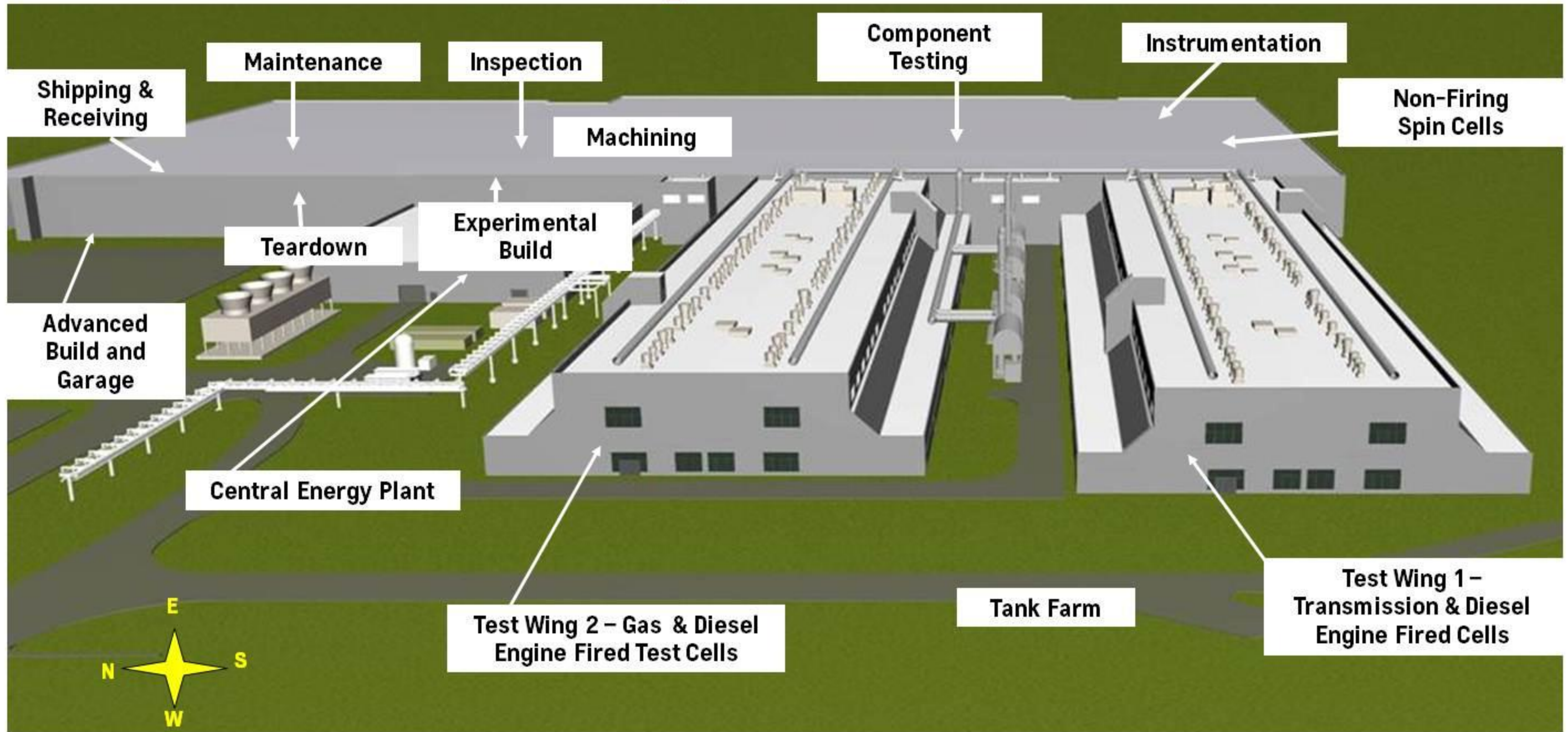


# Powertrain Development Center

- Largest and most technically advanced powertrain development center in the world
- 450,000-square-foot facility
- Two test wings with 120 flexible dynamometer test cells
- More than 100 powertrain component test stands
- 250,000 gallon fuel capacity
- 34 different fuel types
- Regenerative Thermal Oxidizers (RTOs) allow us to destroy at least 96% carbon monoxide emissions
- 15% of the power for this facility is recycled energy generated in house



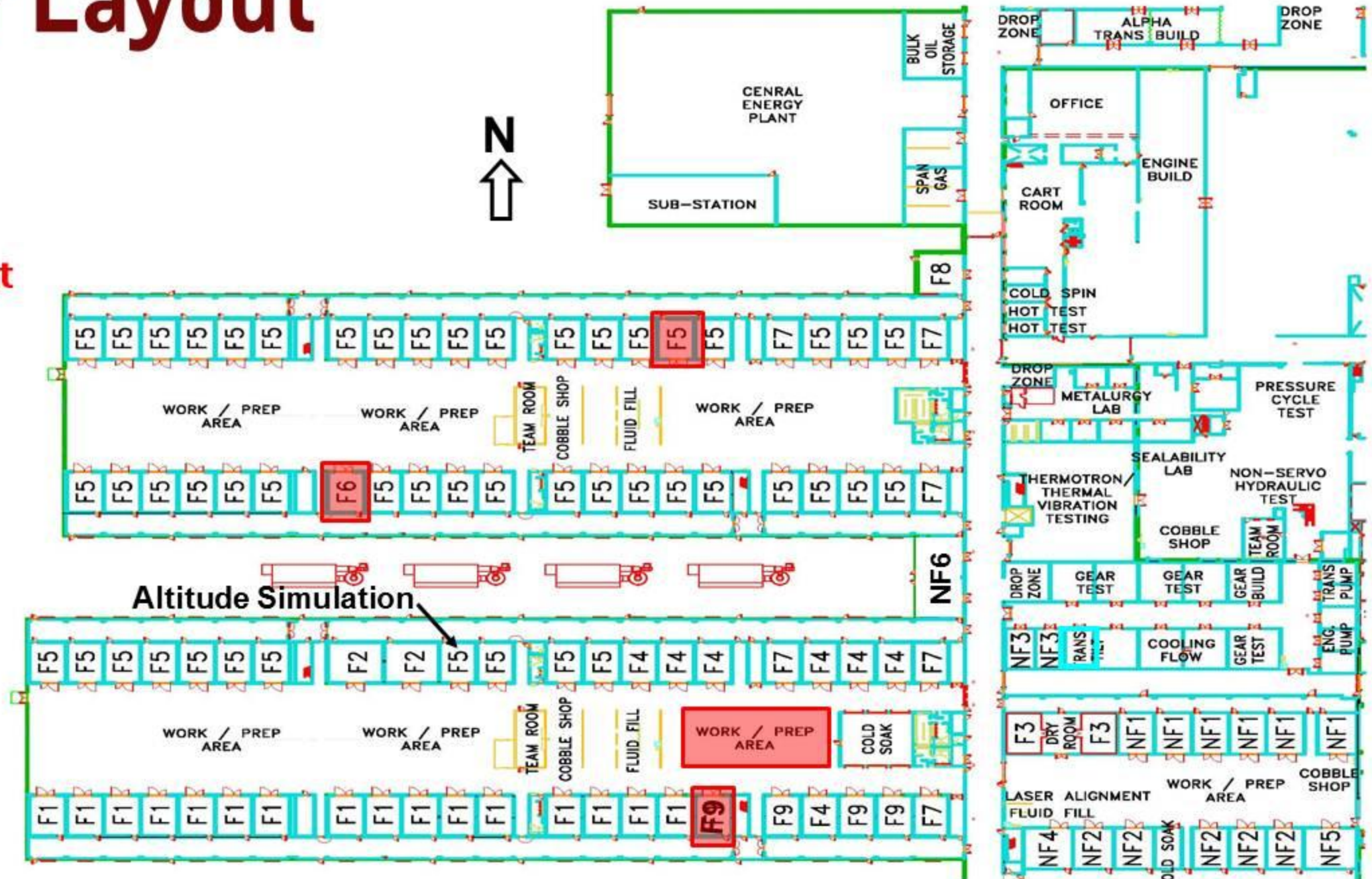
# Powertrain Development Center



# First Floor Layout

## Test Cell Key

- F1 – PT FWD/RWD
- F2 – PT AWD
- F3 – Cold Room
- F4 – Calibration Engine
- F5 – Engine Development**
- F6 – Engine Tilt**
- F7 – Certification
- F8 – Specialty Tests
- F9 – PT Calibration**
- NF1 – Unloaded Spin
- NF2 – Loaded Spin
- NF3 – Torque Converter
- NF4 – Dynamic Trans Tilt
- NF5 – AWD Loaded Spin
- NF6 – Hybrid Development
- NF7 – Hybrid Durability
- NF8 – Aux Pump Development
- NF9 – Aux Pump Durability
- 85 Fueled Test Cells
- 35 Non Fueled Test Cells
- Vehicle simulation capability





LT1