Описание двигателя

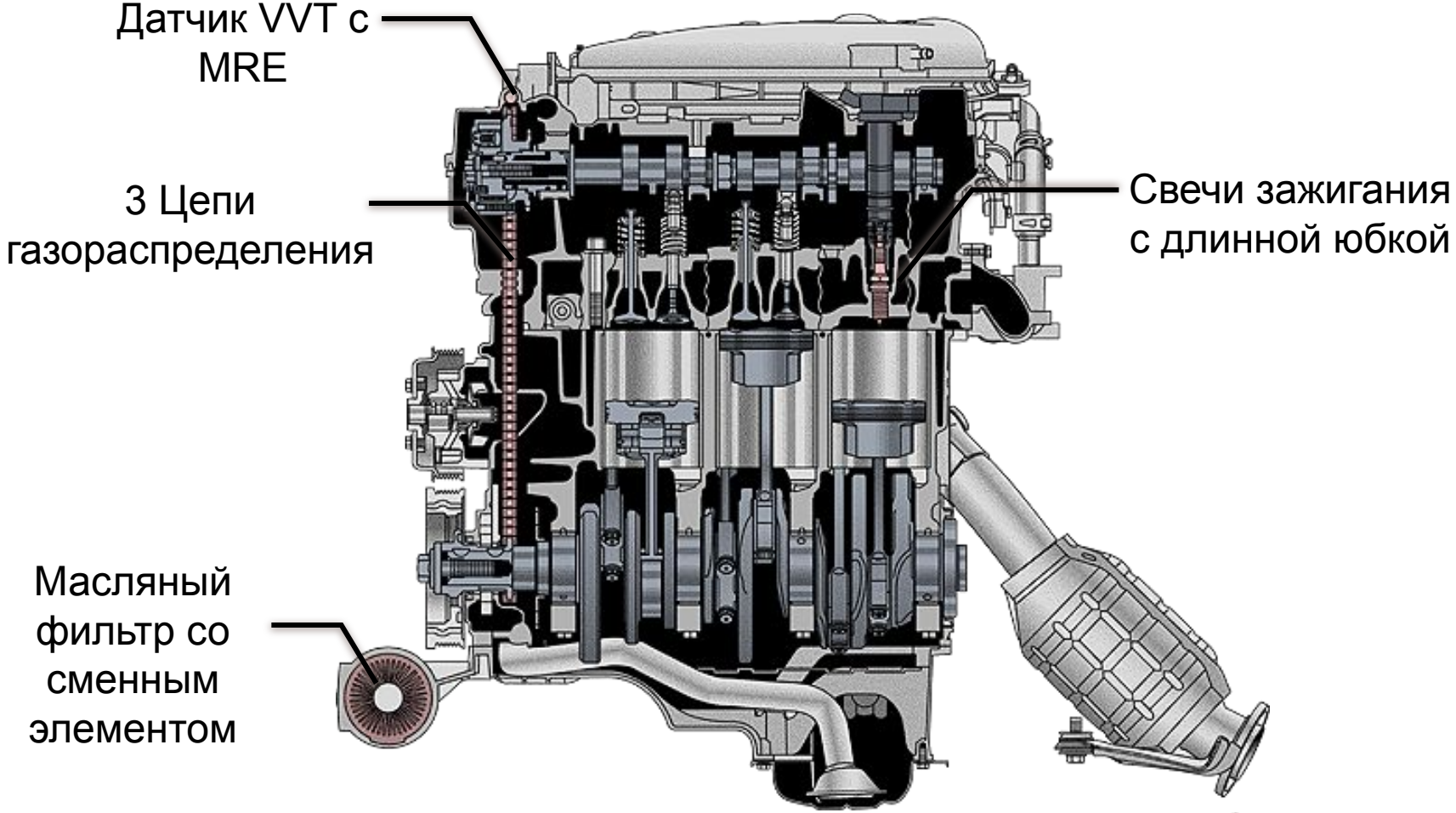
- Общие сведения
  - V-образный 6-ти цилиндровый, угол развала блока 60^0, рабочий объём 2.5 л, 24-клапана, система газораспределения DOHC с механизмом VVT-i, на впуске и выпуске, система ACIS электронный дроссель (система ETCS-i)

4GR-FSE

Система D-4 [Непосредственное впрыскивание]

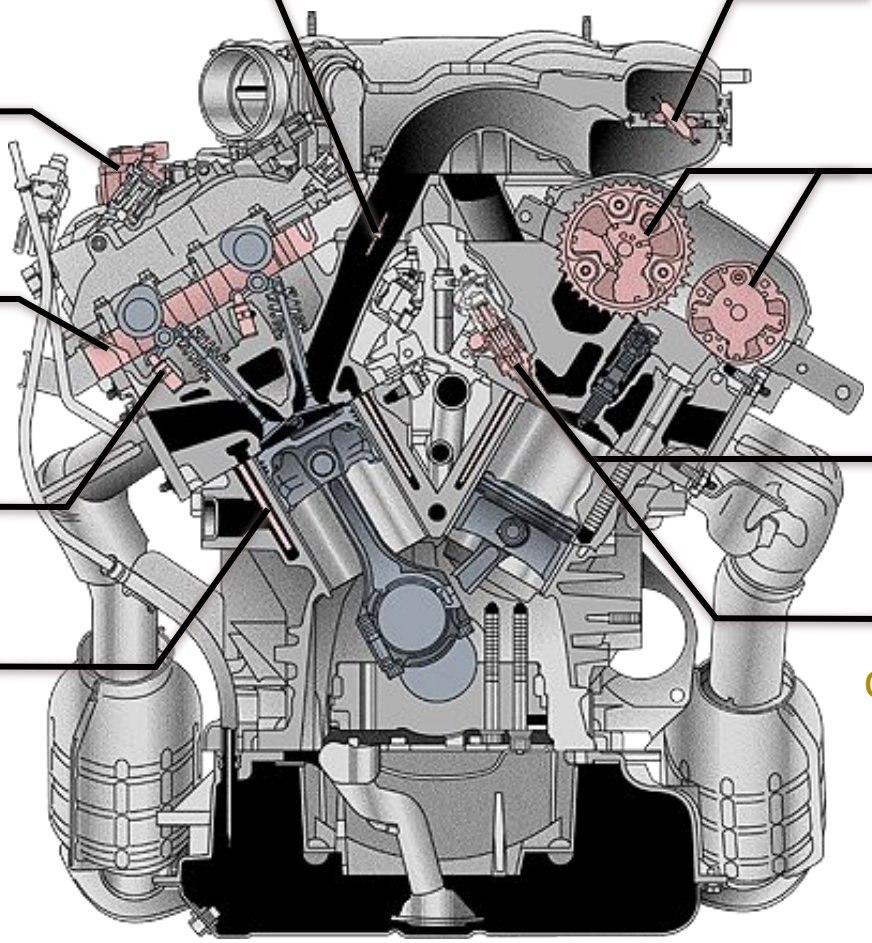
Описание двигателя

- Характеристики **4GR-FSE**



Описание двигателя

- Характеристики **4GR-FSE**



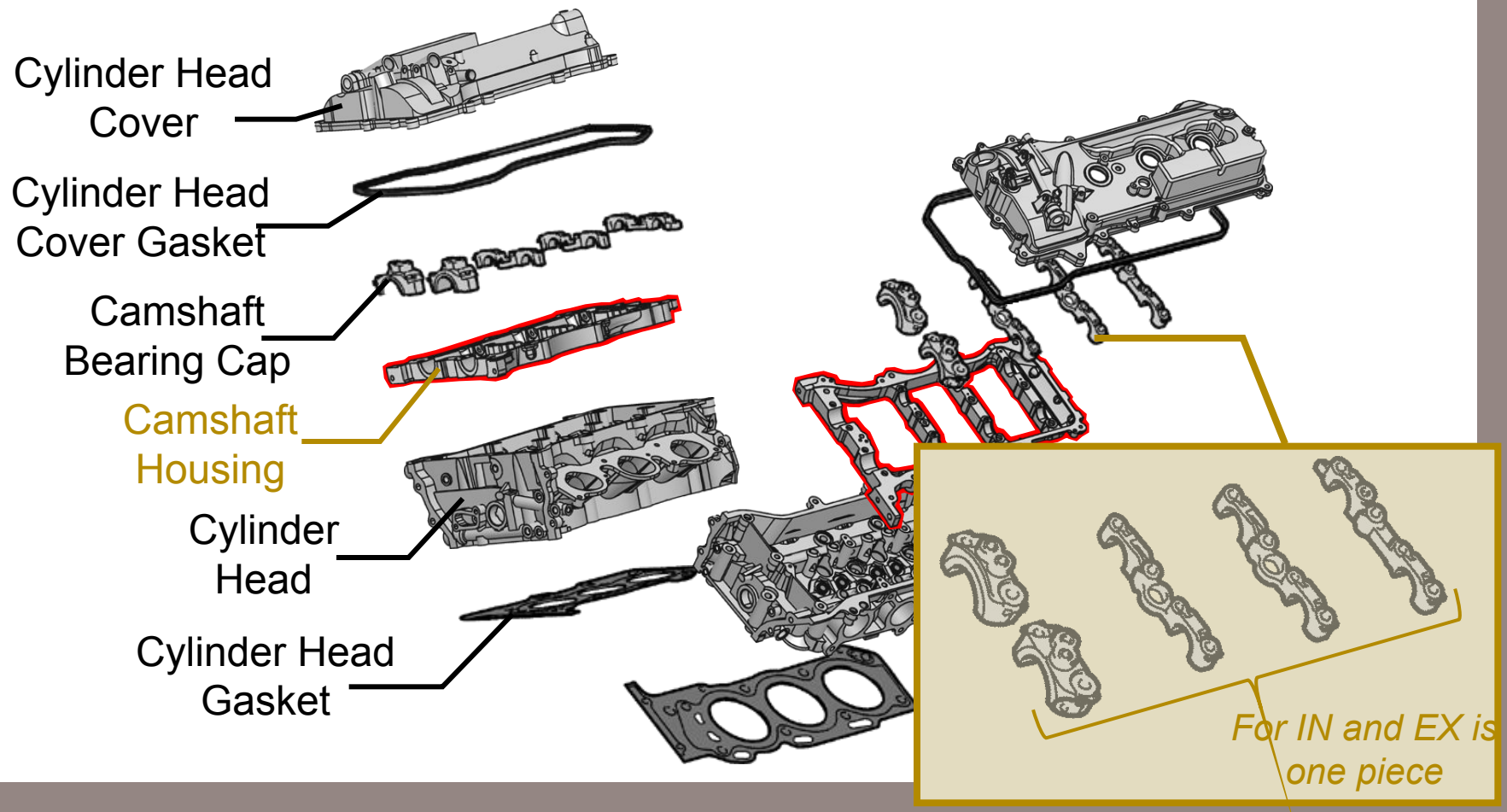
Описание двигателя

- Основные характеристики

	4GR-FSE
Число и расположение цилиндров	6, V-образно
Механизм газораспределения	24-клапана, DOHC, цепной привод, два VVT-i
Тип камеры сгорания	Шатровая
Раб. Объём, cm^3	2499
Диаметр цилиндра x ход поршня mm	83.0 x 77.0
Степень сжатия	12.0
Макс. мощность кВт @ обор. (л.с. @ обор.)	152 @ 6,400 (204 @ 6,400)
Макс. кр. момент N·m @ обор.	250 @ 4,800

Engine Proper

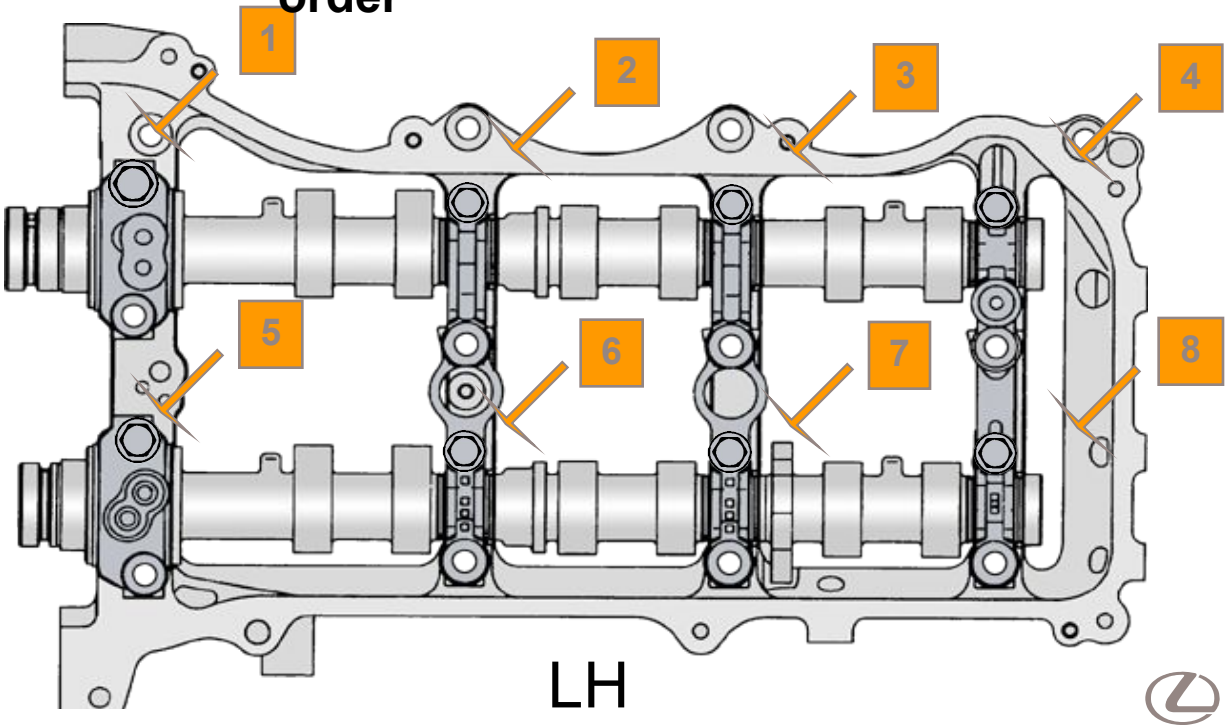
- Cylinder Head
  - Camshaft housing to simply the cylinder head structure
  - Camshaft bearing cap for IN and EX is one piece



Service Point (Engine Proper)

- Cylinder Head
  - Camshaft and camshaft housing installation

Step 1	X	**: Temporary tighten (Torque: 10N·m [102kgf·cm])** **: Tightening order**

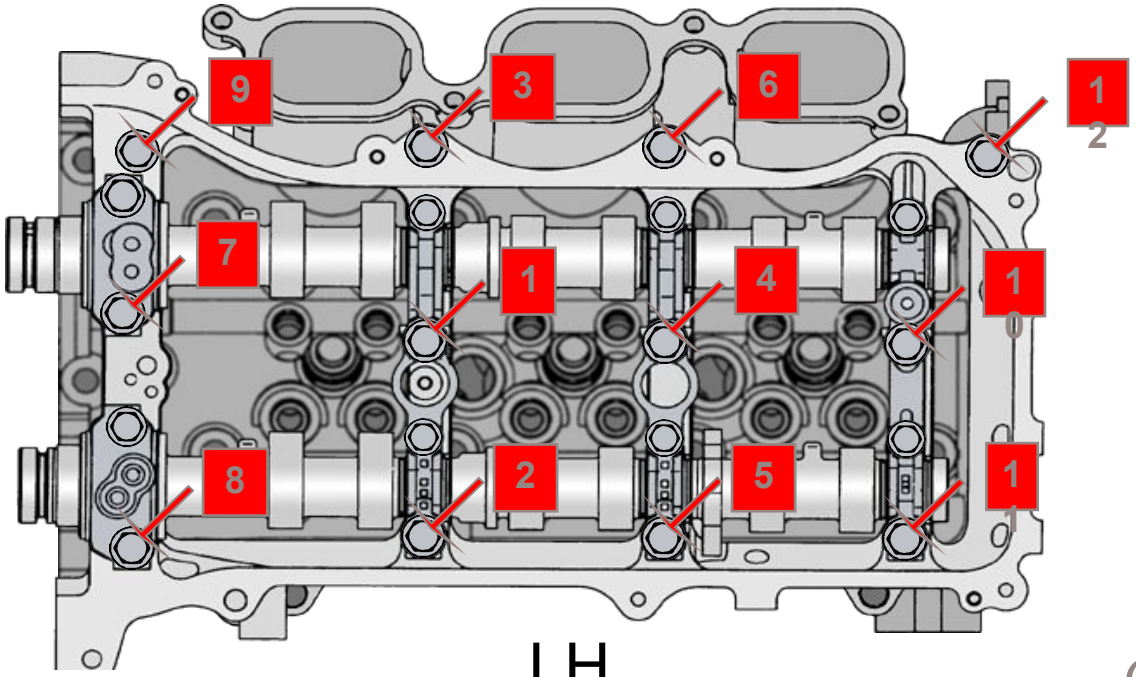


LH Bank

Service Point (Engine Proper)

- Cylinder Head
  - Camshaft and camshaft housing installation

Step 2	✓	**: Tighten (Torque: 28N·m [286kgf·cm])**
	X	**: Tightening order**

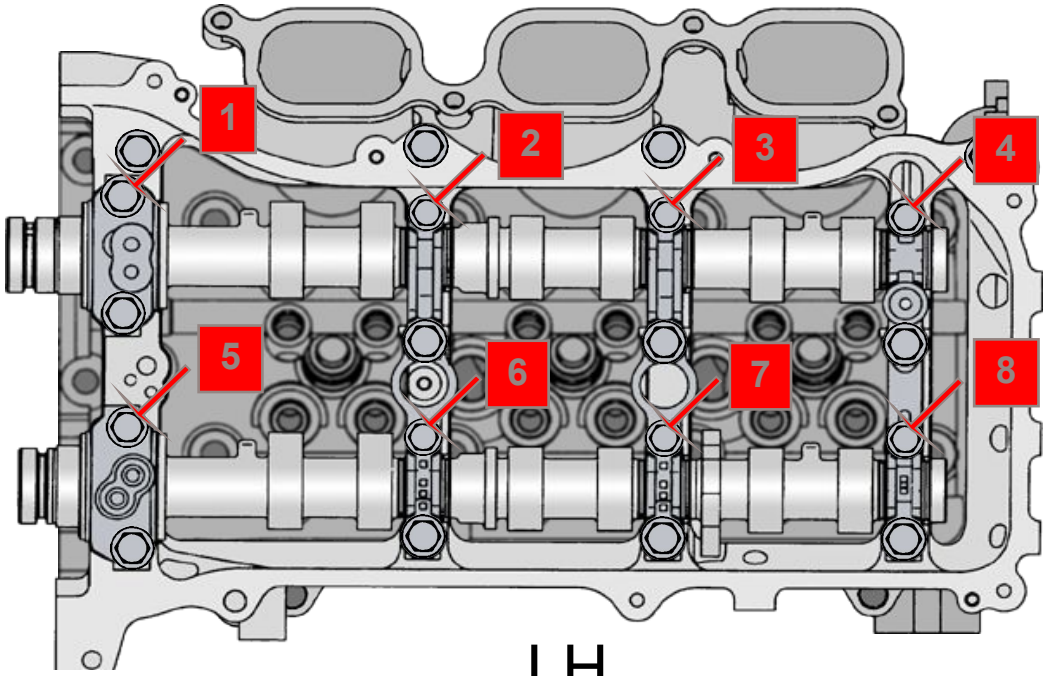


LH Bank

Service Point (Engine Proper)

- Cylinder Head
  - Camshaft and camshaft housing installation

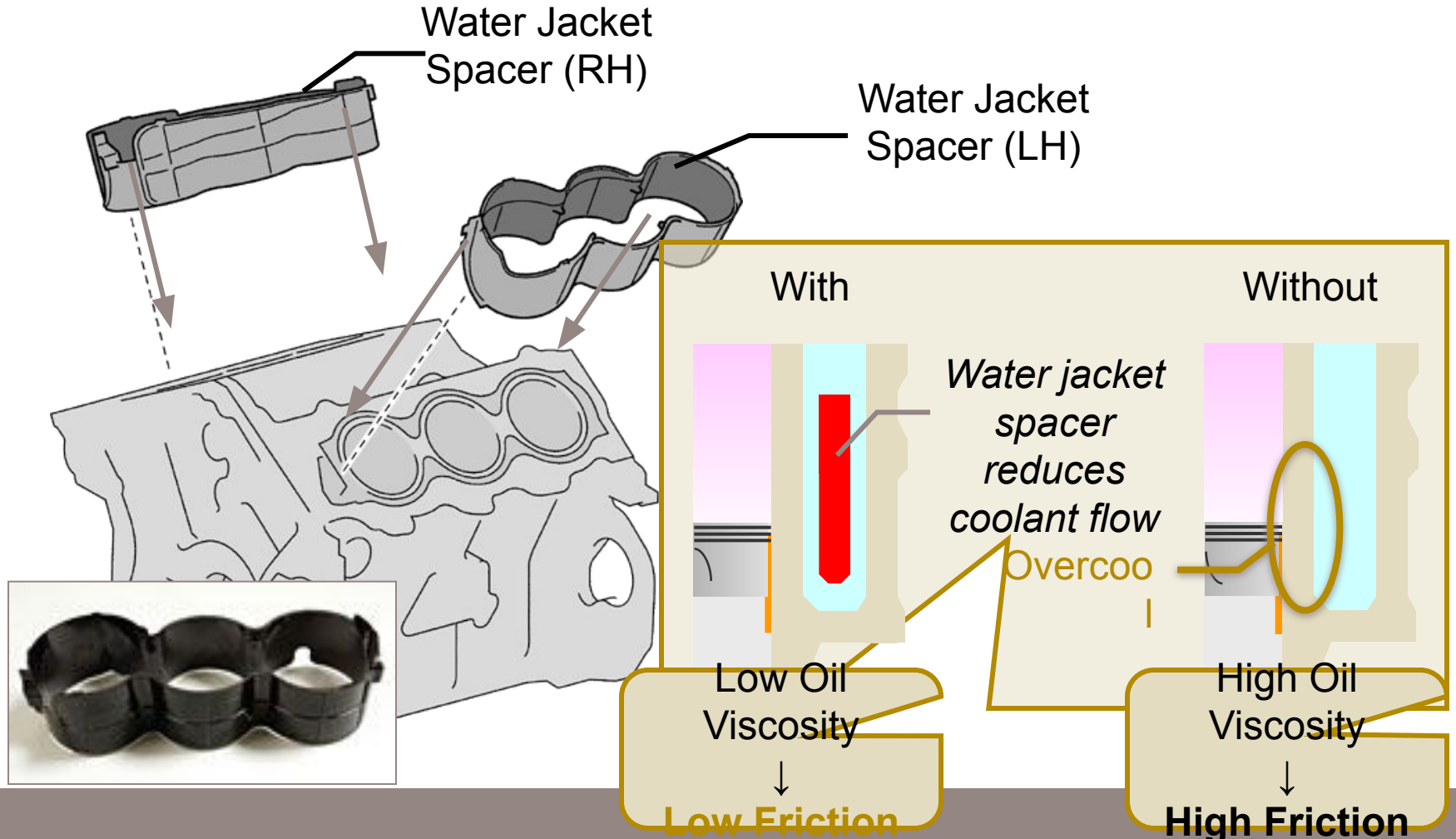
Step 3	✓	**: Tighten (Torque: 16N·m [163kgf·cm])**
	X	**: Tightening order**



LH Bank

Engine Proper

- Cylinder Block
  - Water jacket spacer optimizes the cylinder bore temp. to reduce friction

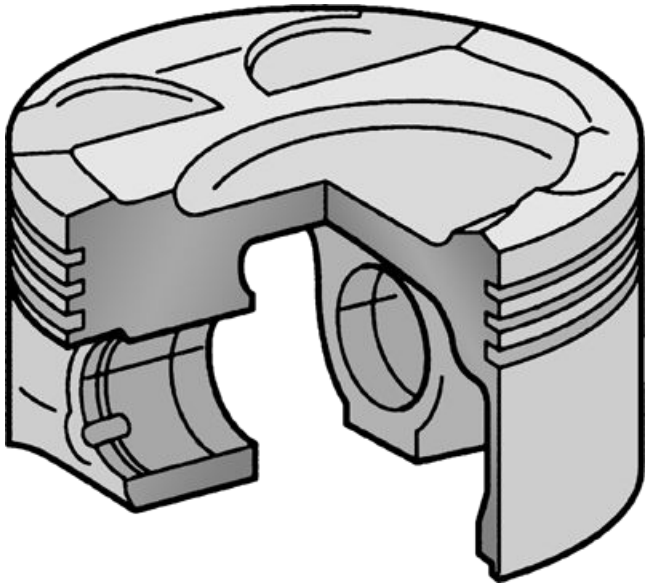


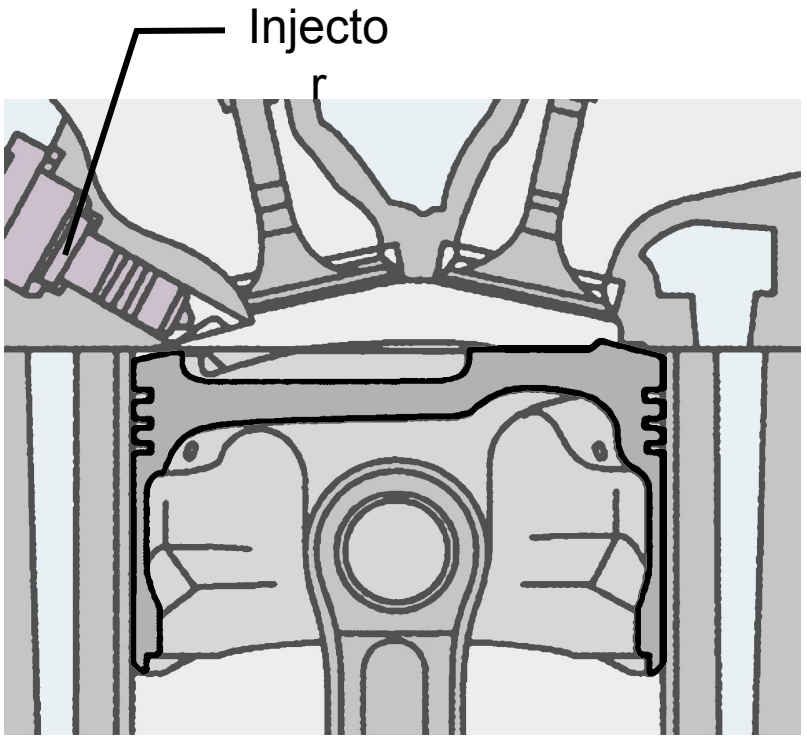
Engine Proper

- Cylinder Block
  - Spiny liner is used to increase cooling performance

Engine Proper

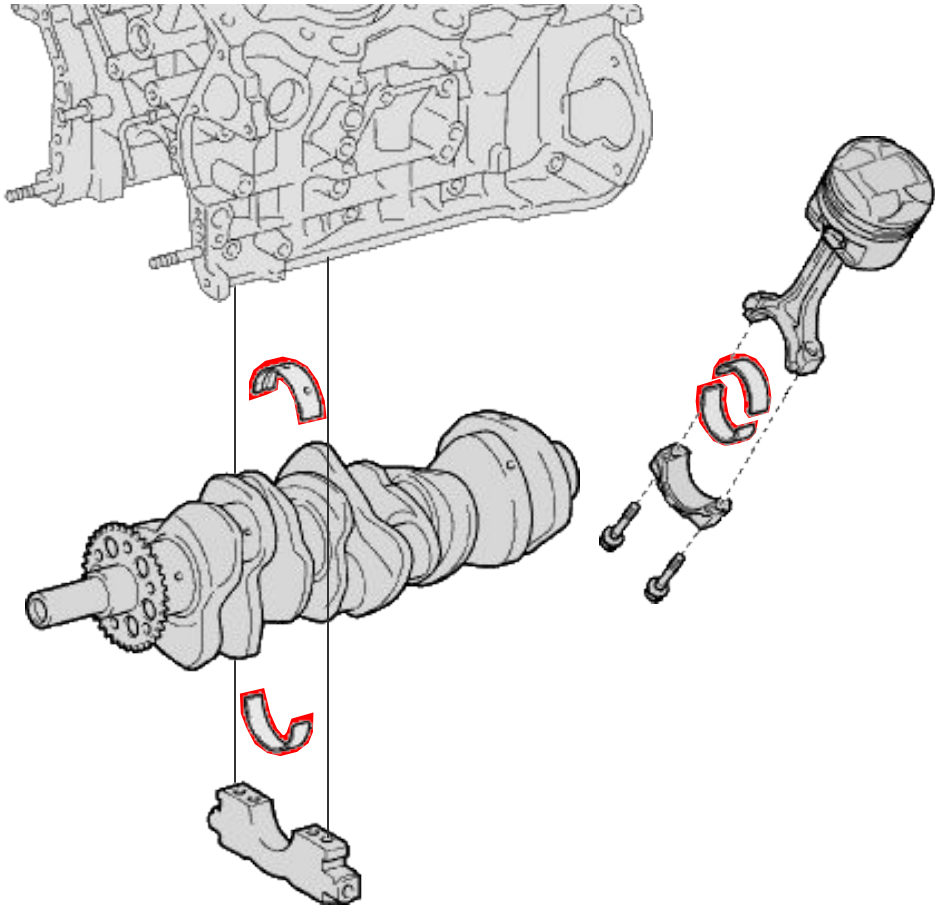
- Piston
  - Optimal piston head shape to promote the mixture of fuel and air





Engine Proper

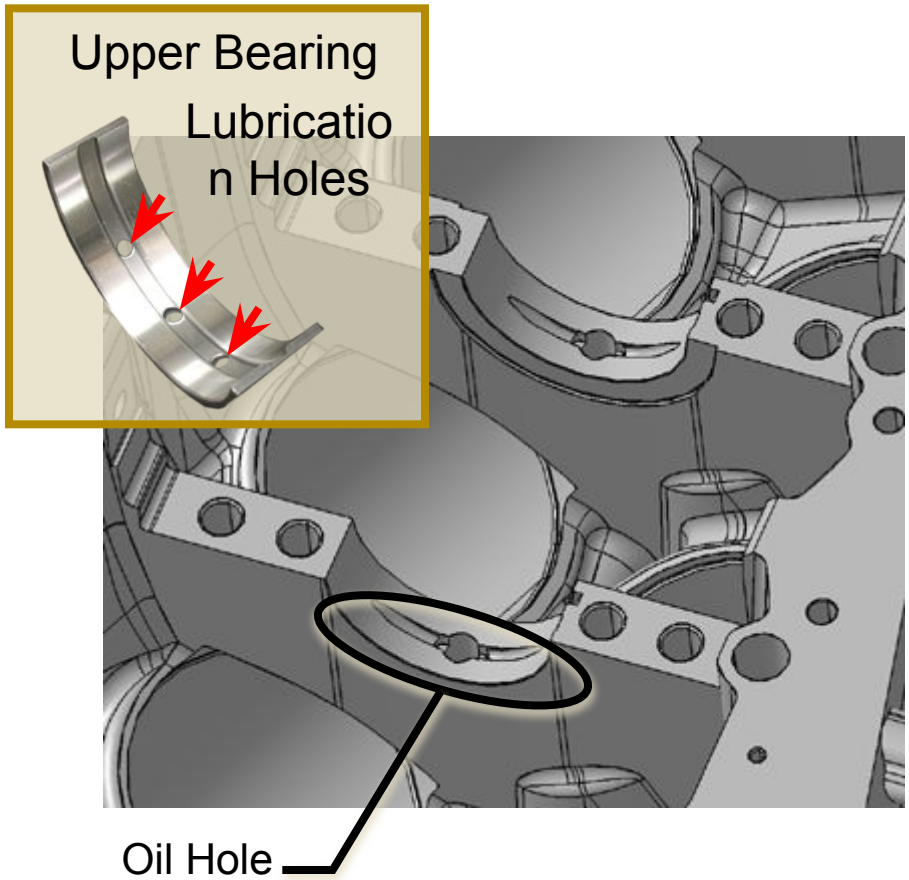
- Bearing
  - Bearing without bearing claw is used for crankshaft bearings and connecting rod bearings

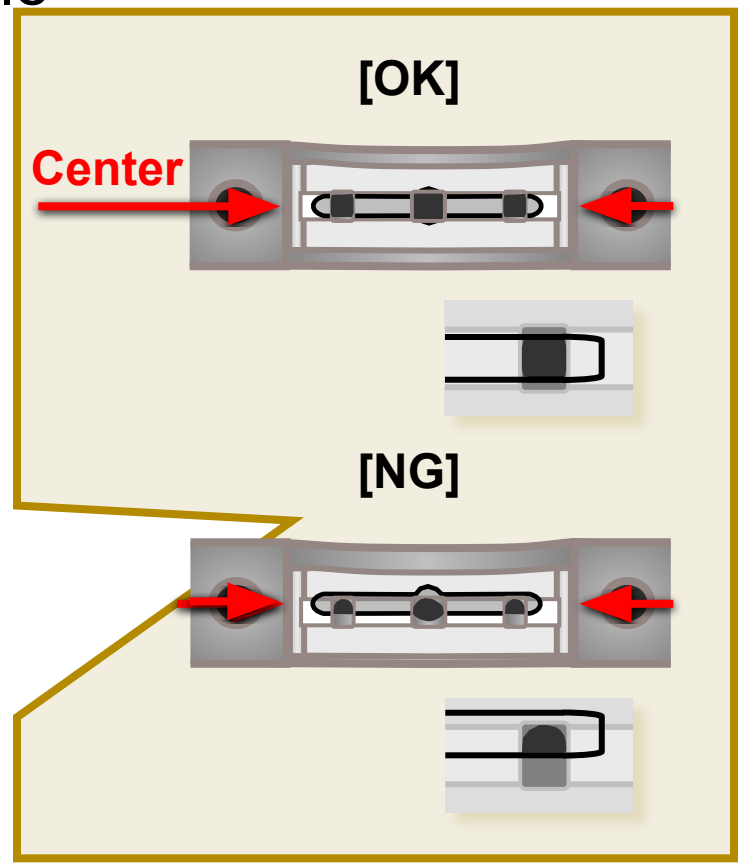


Without bearing claw

Service Point (Engine Proper)

- Installation of Crankshaft Upper Bearing
  - Bearing position should be centered to the cylinder block journal to align the oil hole

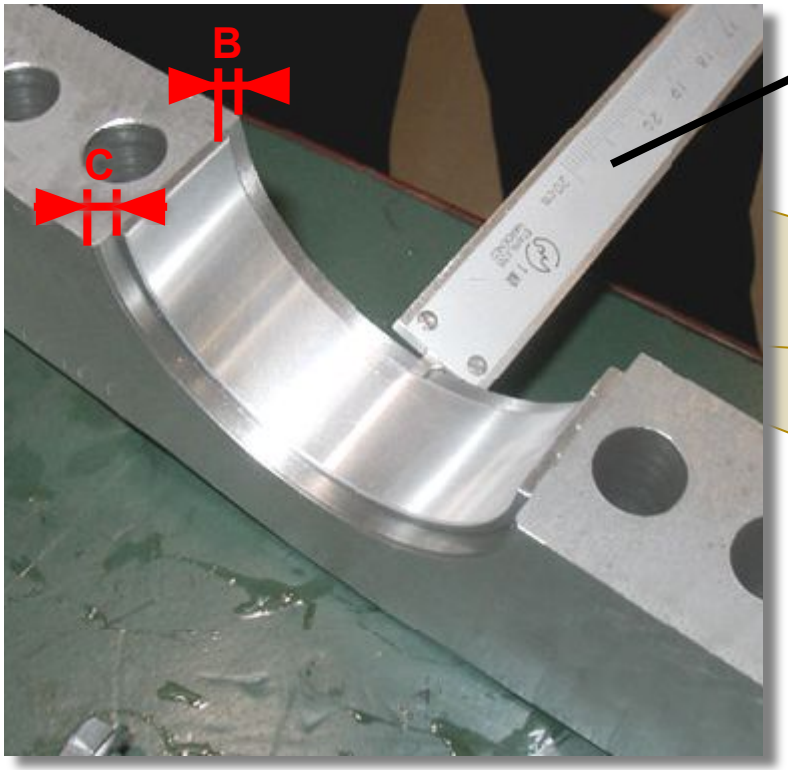




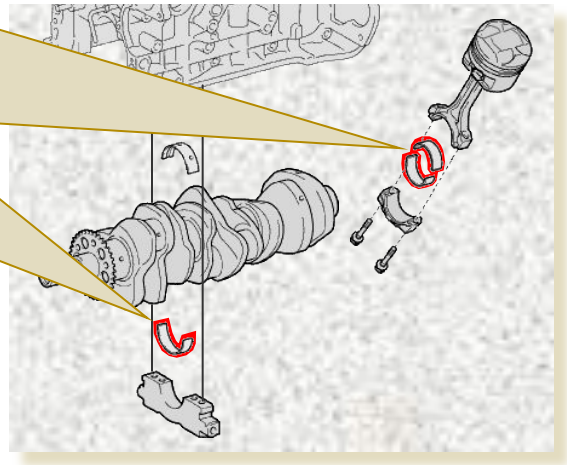
Service Point (Engine Proper)

- Installation of Crankshaft Lower Bearing, Connecting Rod Upper and Lower Bearings
  - Bearing should be positioned in center and measure the position

    Difference Between “B” and “C”: 0.7 mm (0.028 in.) or less

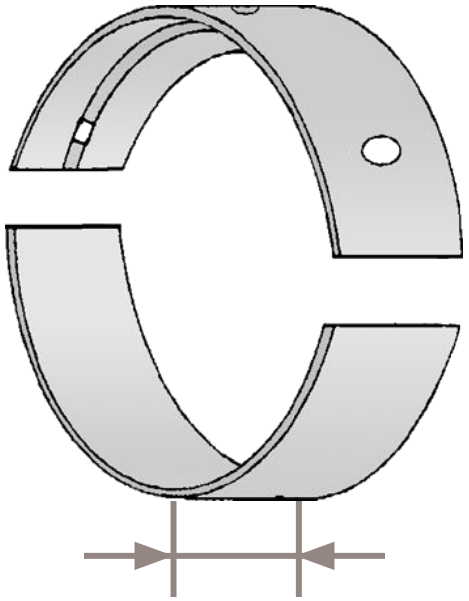


Vernier Caliper



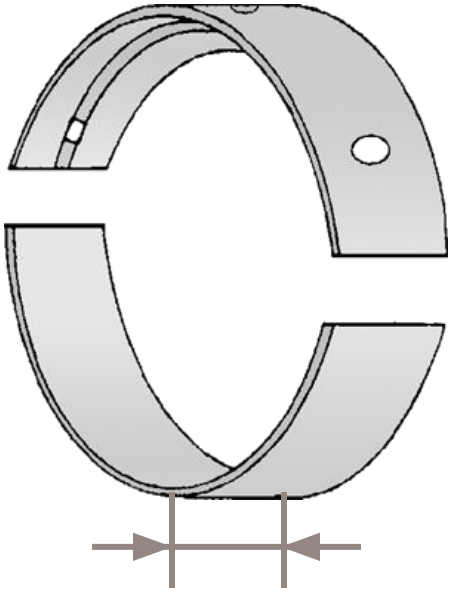
Service Point (Engine Proper)

- Crankshaft Bearing (upper and lower)
  - Combination of different width of the Bearings



21.0 mm
(0.827 in.)

No.1 and No.4 Journals

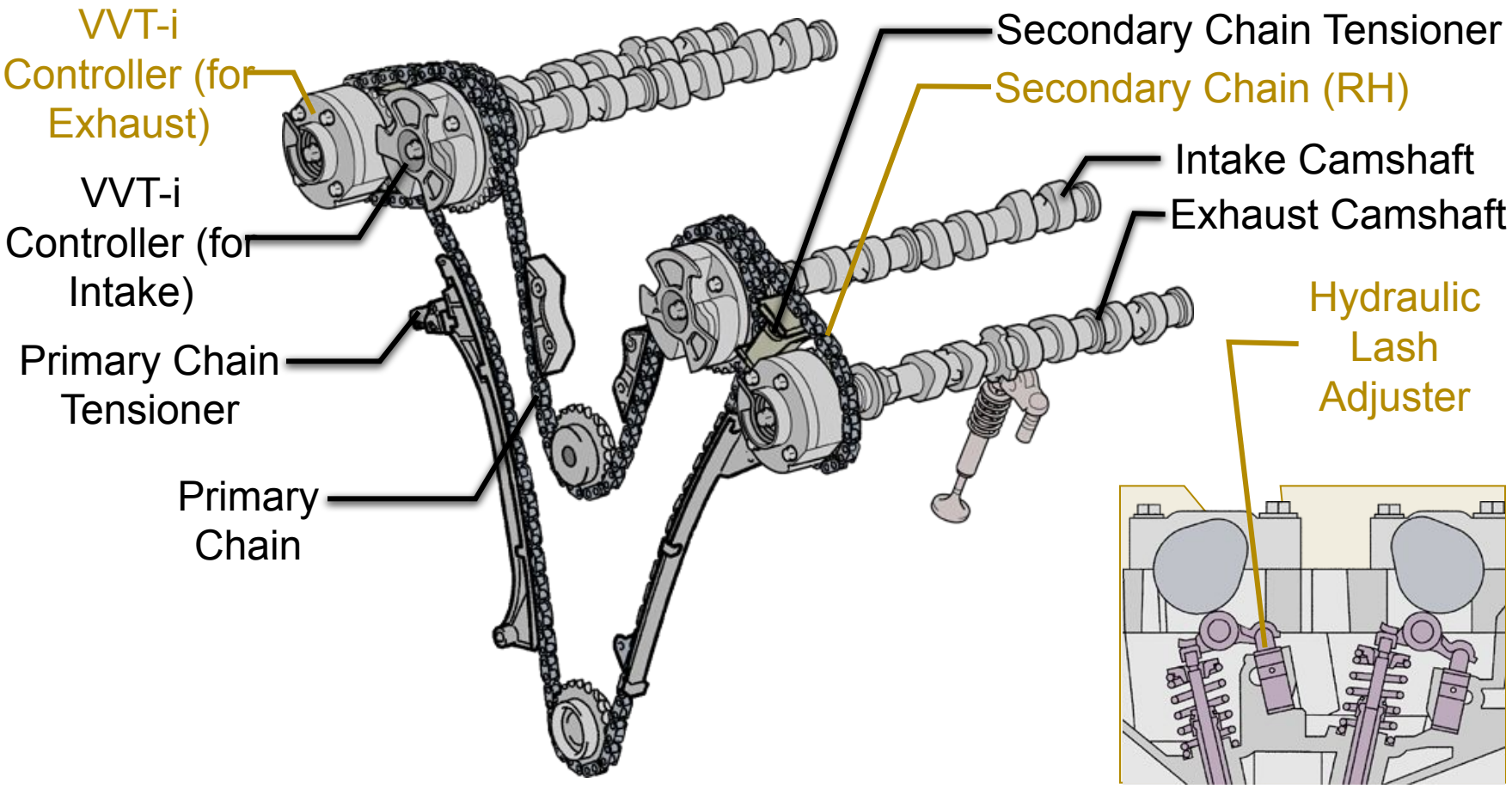


18.0 mm
(0.709
in.)

No.2 and No.3 Journals

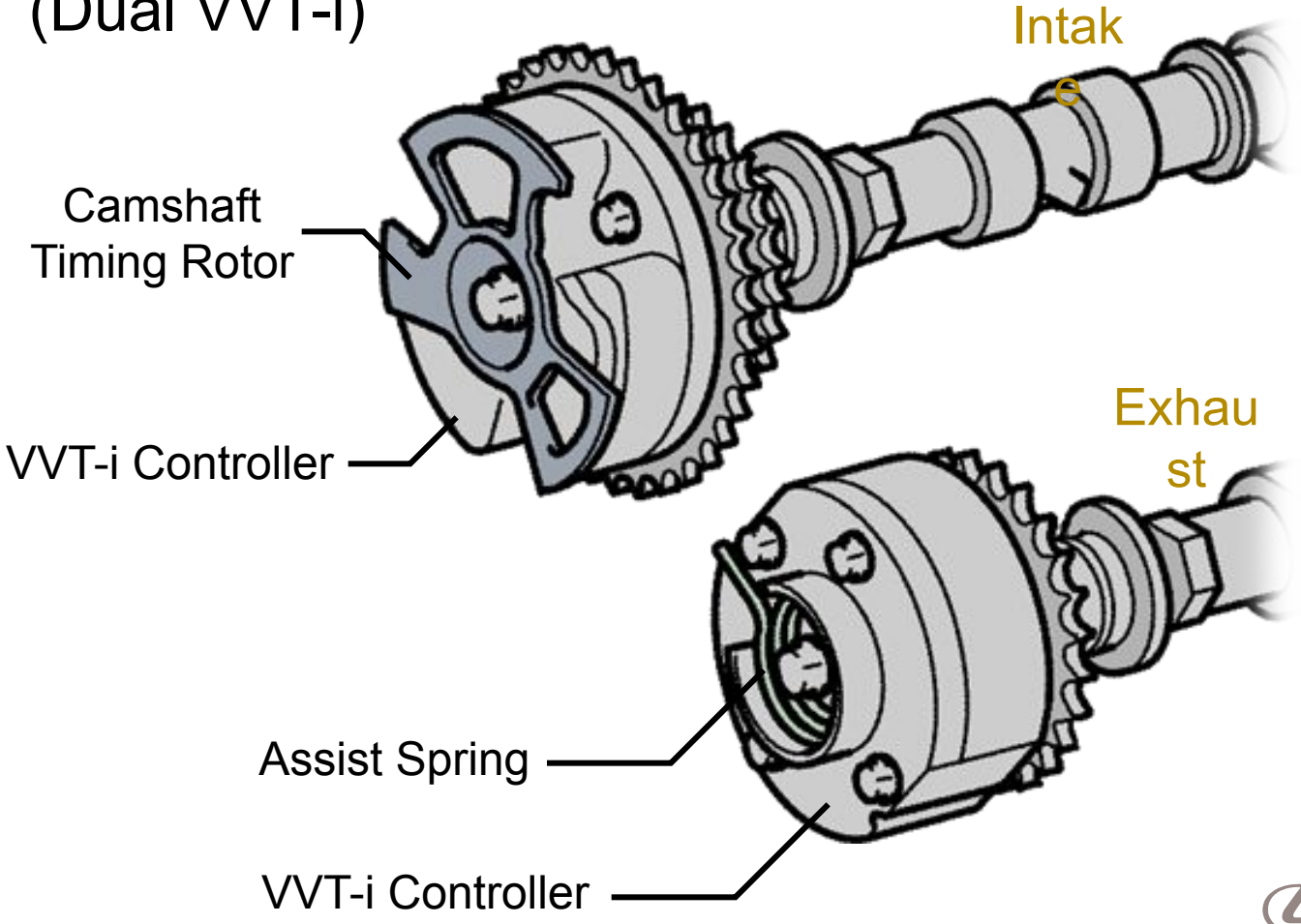
Valve Mechanism

- General
  - Three timing chains to drive intake and exhaust camshafts of each bank



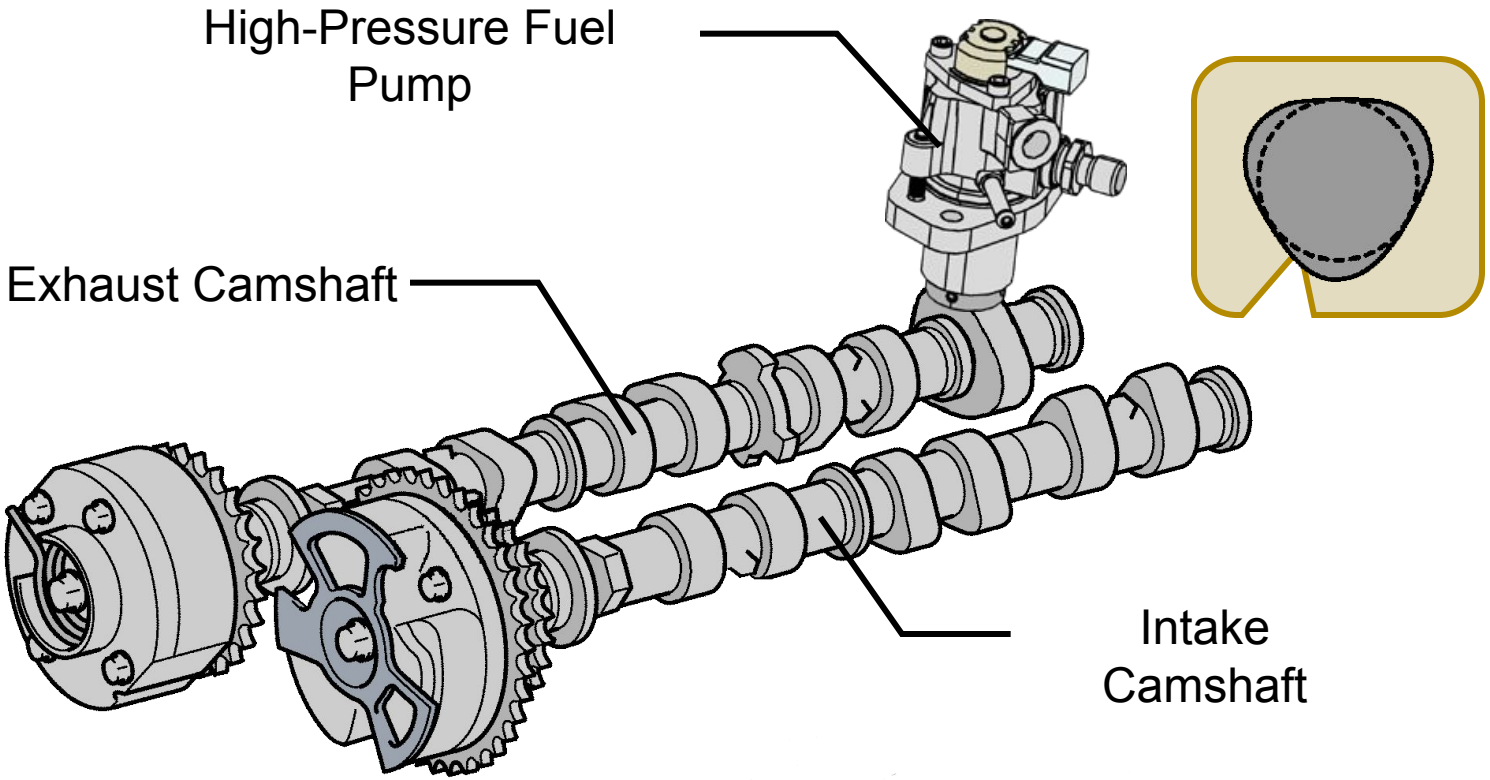
Valve Mechanism

- Camshaft
  - VVT-i system is used for intake & exhaust camshafts (Dual VVT-i)



Valve Mechanism

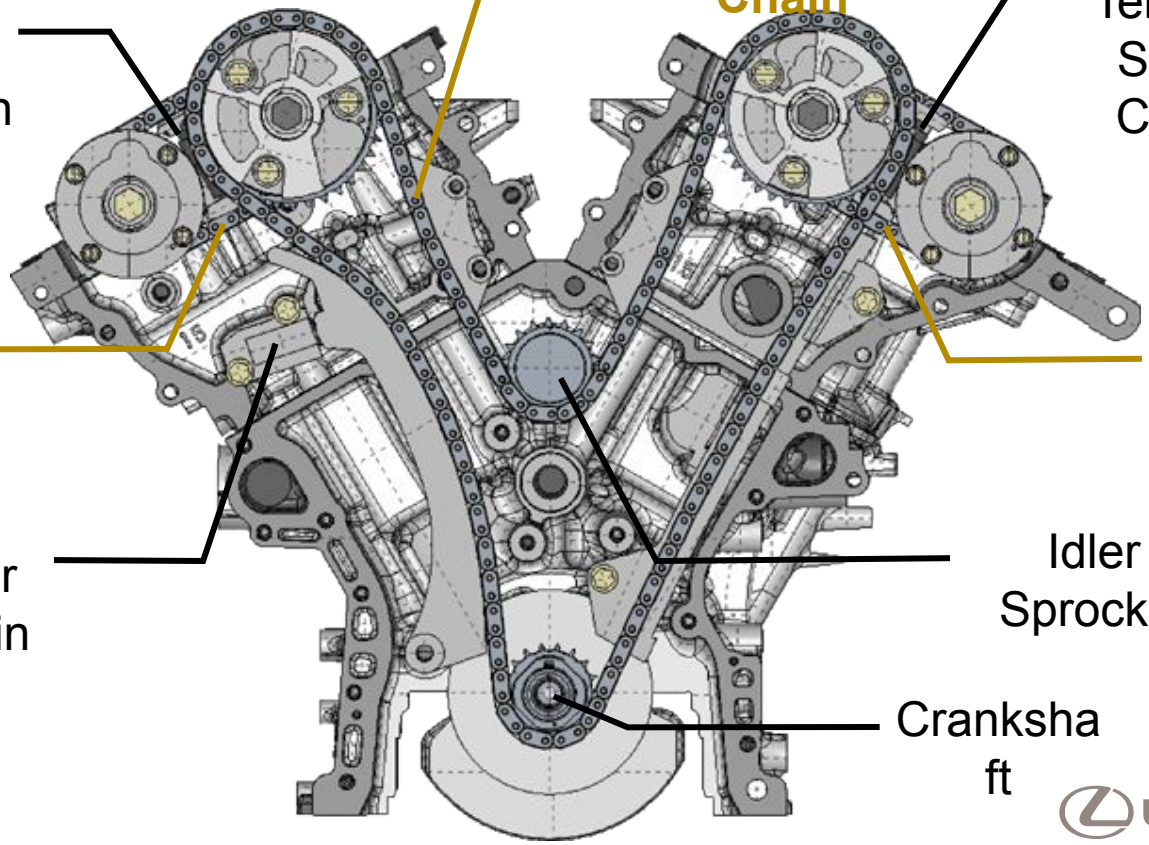
- Camshaft
  - RH bank exhaust camshaft is provided with the cam to drive the high-pressure fuel pump



RH Bank

Valve Mechanism

- Timing Chain
  - Three timing chains to drive intake and exhaust camshafts of each bank



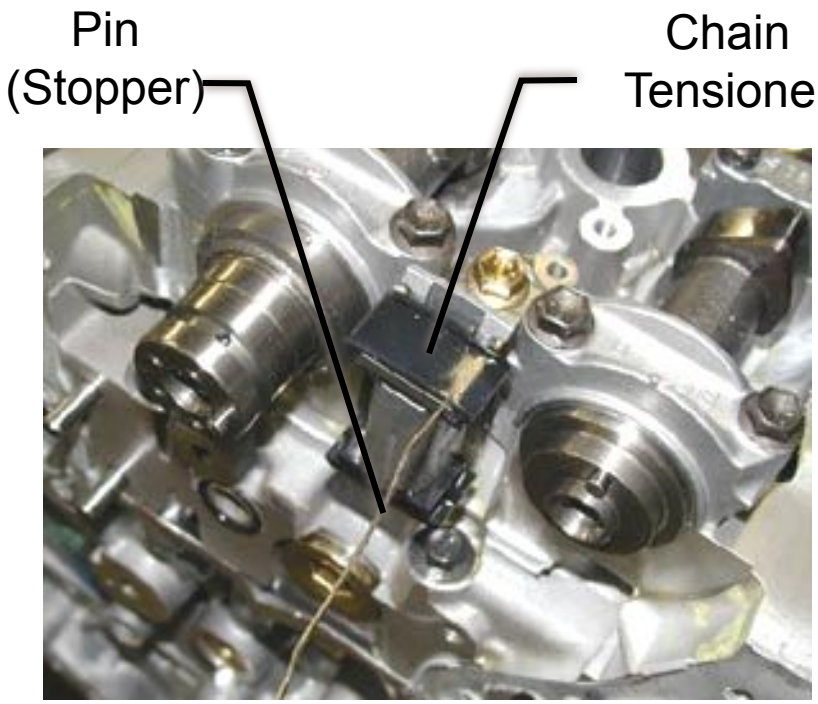
Valve Mechanism

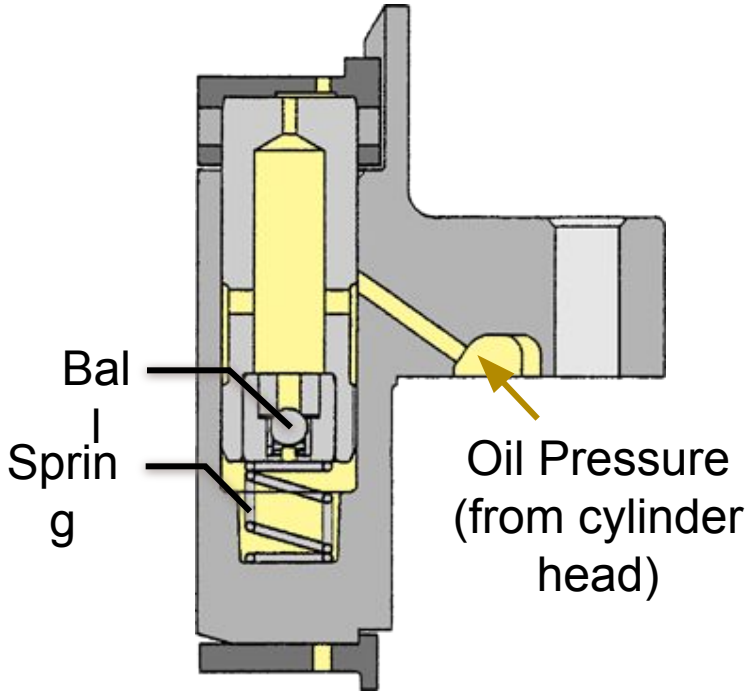
- Chain Tensioner
  - Primary chain tensioner
    - Ratchet type non-return mechanism

Service hall for
remove and replace

Valve Mechanism

- Chain Tensioner
  - 2 secondary chain tensioners are used for left and right bank

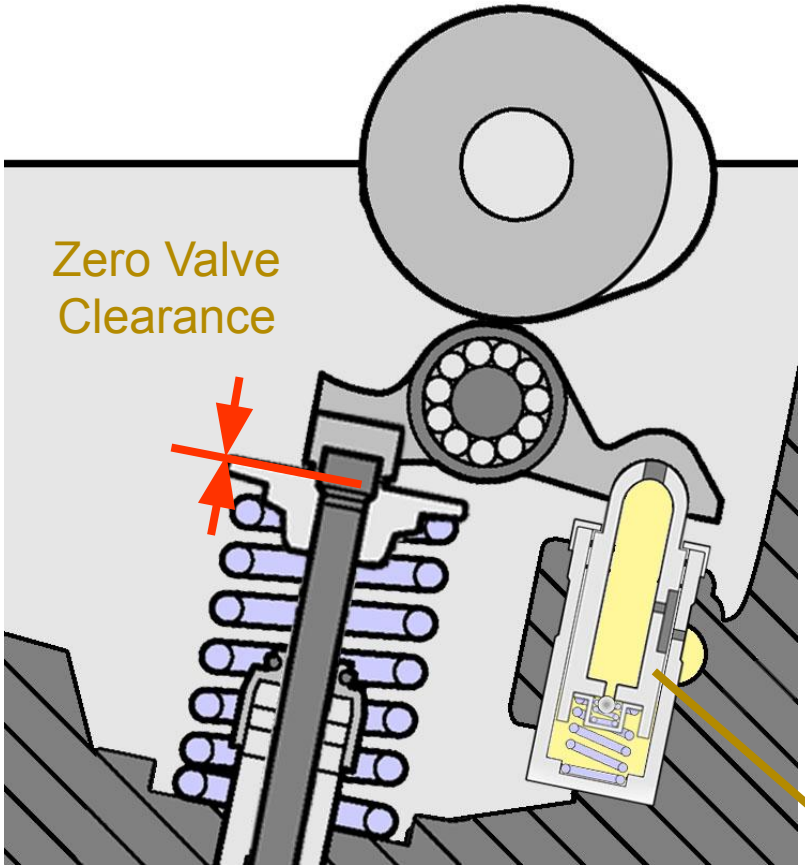


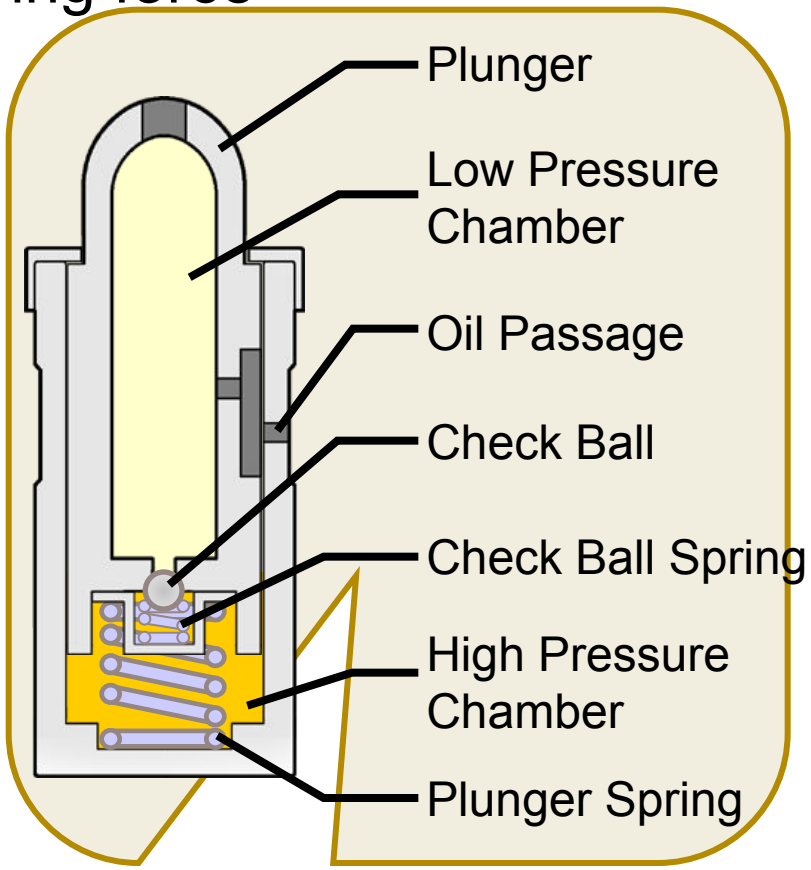


Left Bank

Reference (Valve Mechanism)

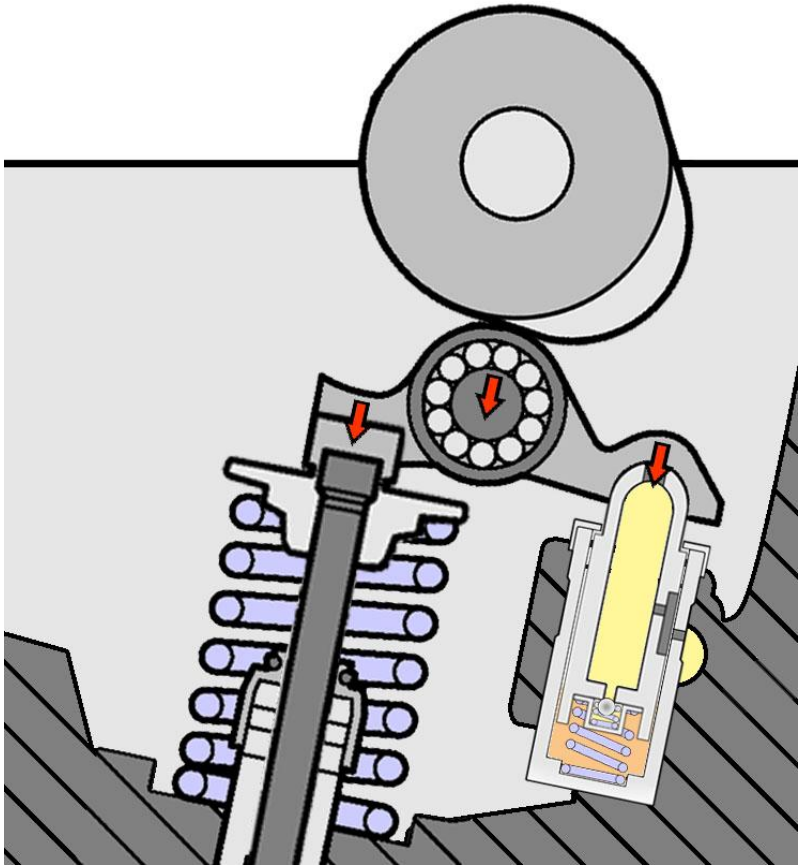
- Hydraulic Lash Adjuster
  - Maintaining a constant zero valve clearance through use of oil pressure and spring force

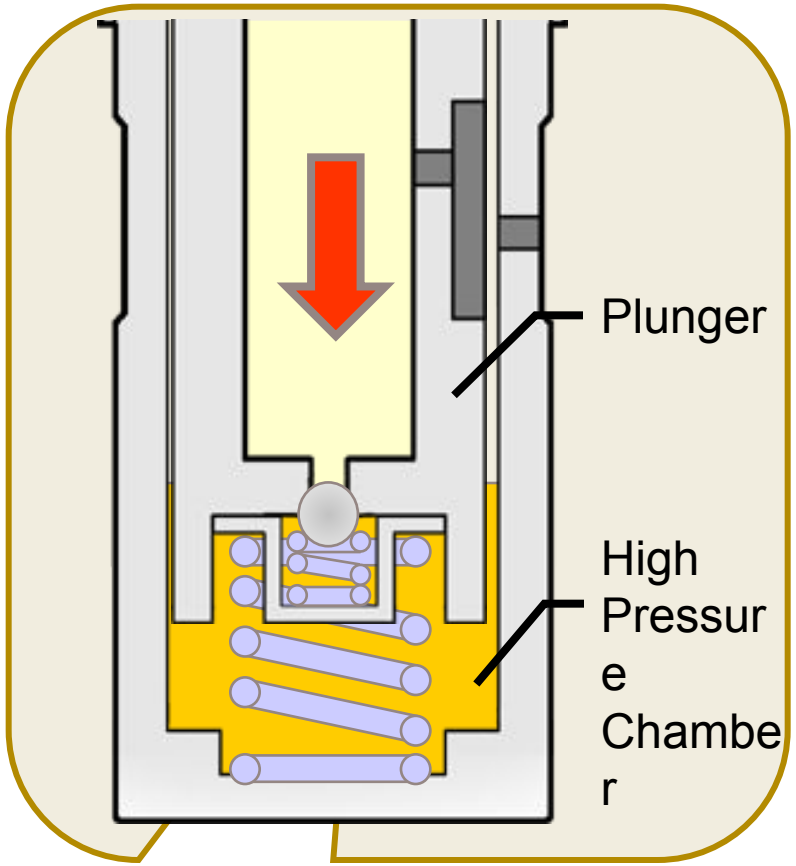




Reference (Valve Mechanism)

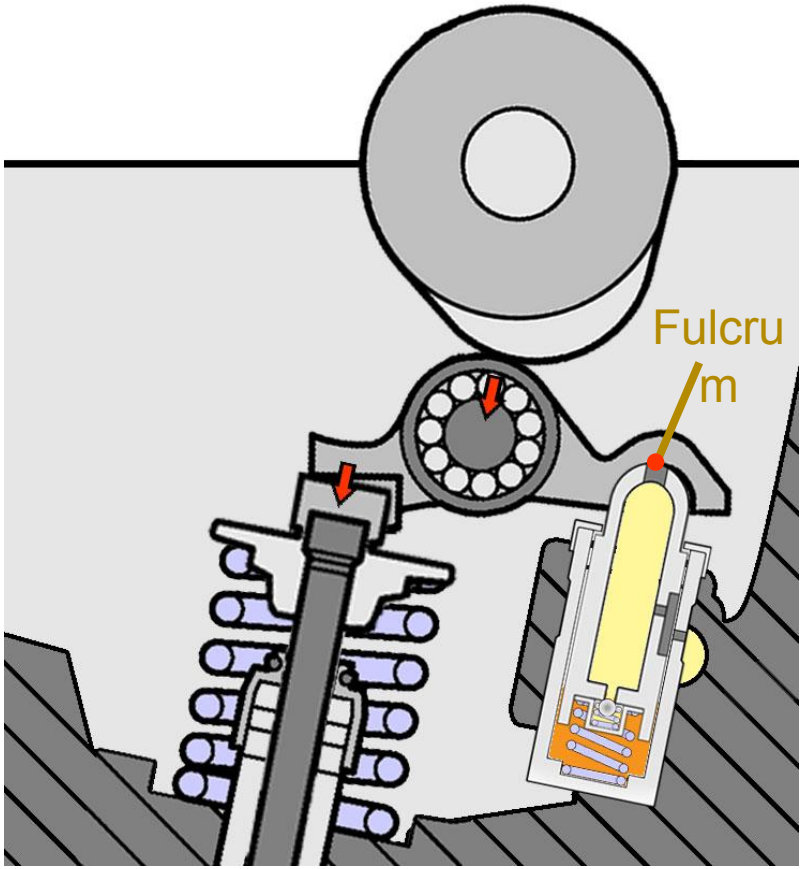
- Hydraulic Lash Adjuster
  - Start cam lift, plunger is pressed and oil in high pressure chamber is kept

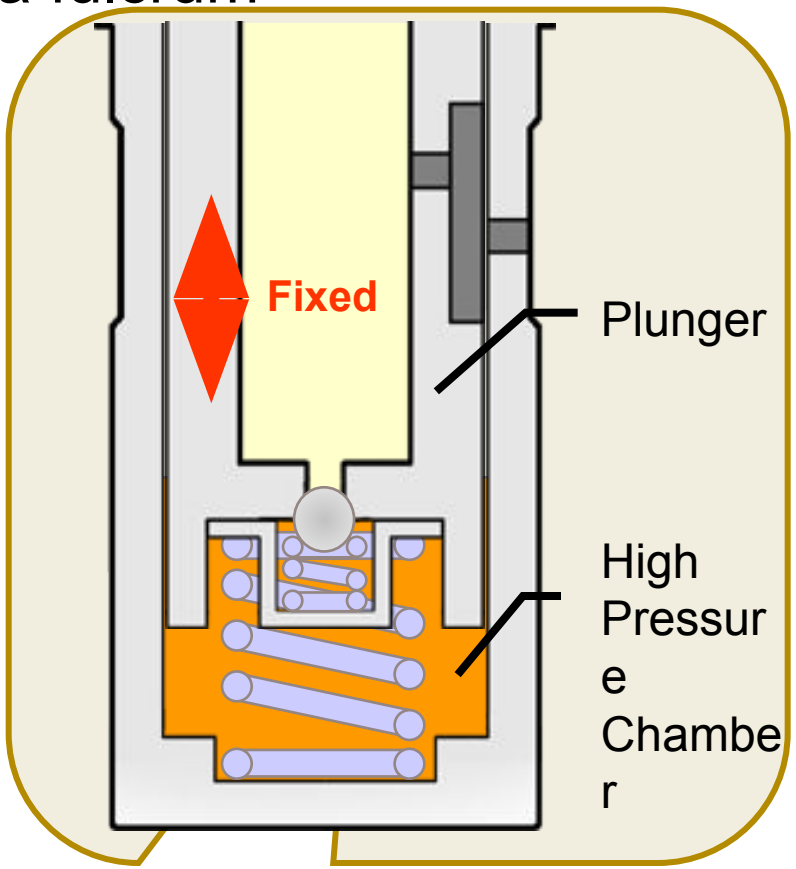




Reference (Valve Mechanism)

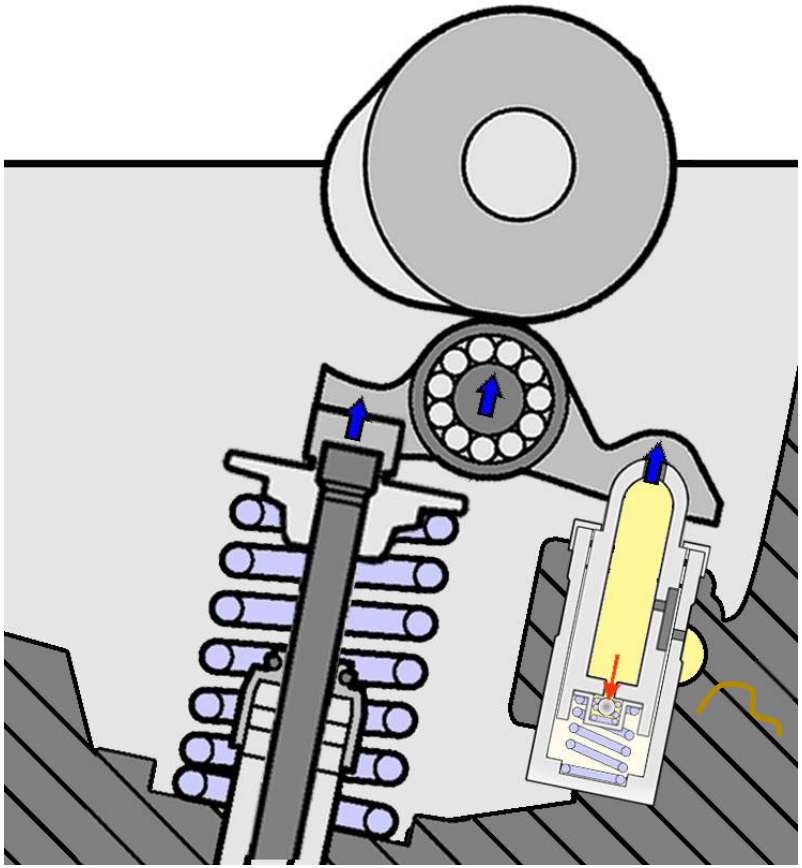
- Hydraulic Lash Adjuster
  - Then the rocker arm pushes the valve by using hydraulic lash adjuster as a fulcrum

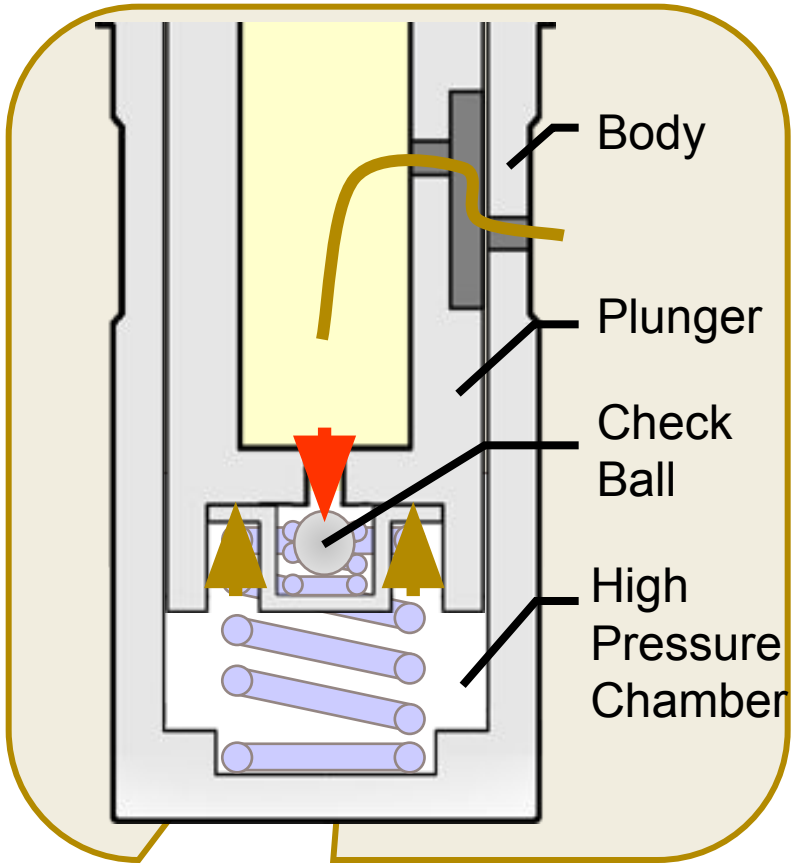




Reference (Valve Mechanism)

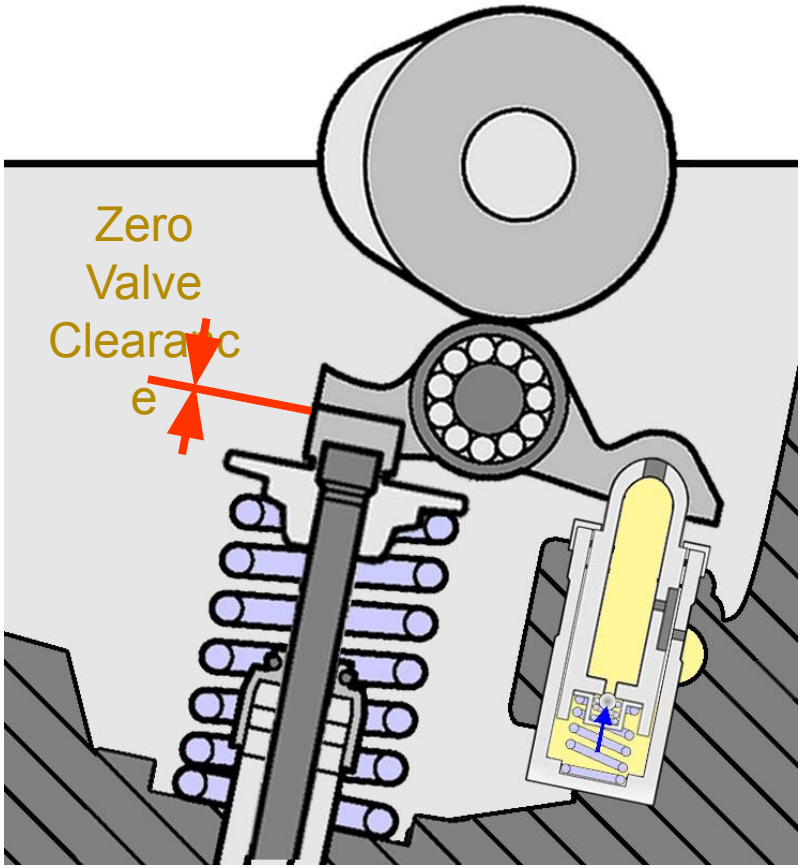
- Hydraulic Lash Adjuster
  - Plunger pushes back, check valve is opened and fills up oil

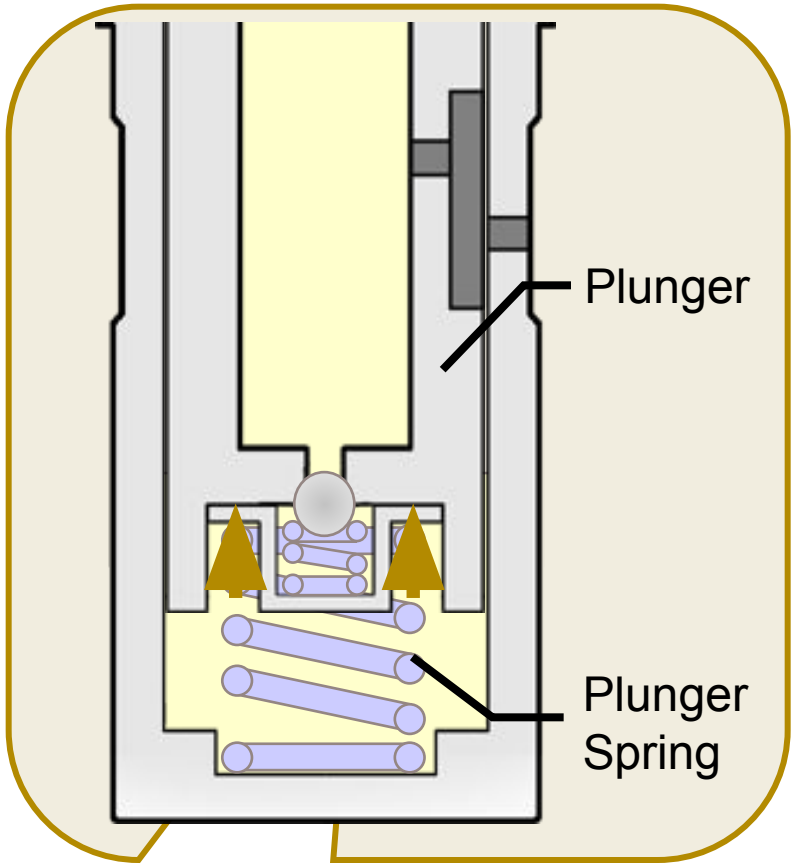




Reference (Valve Mechanism)

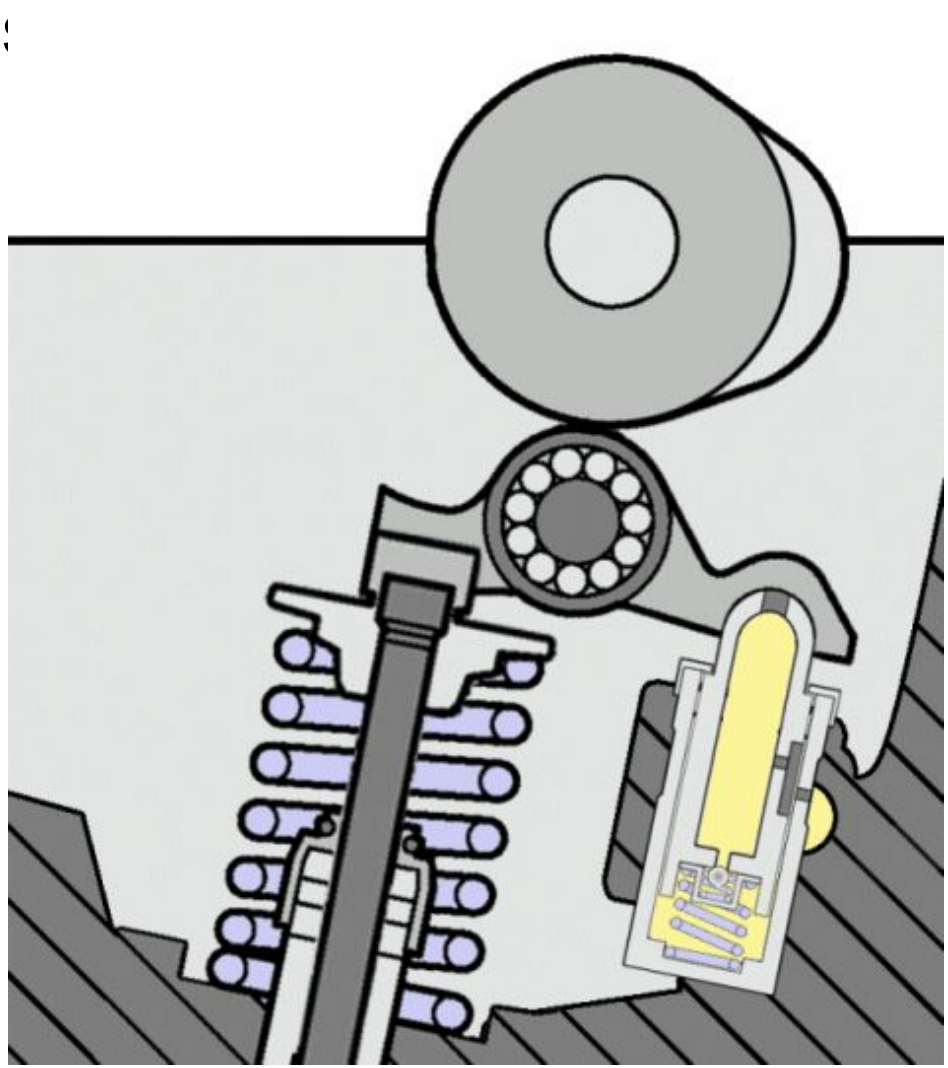
- Hydraulic Lash Adjuster
  - Plunger is pushed up, then, valve clearance is maintained at zero





Reference (Valve Mechanism)

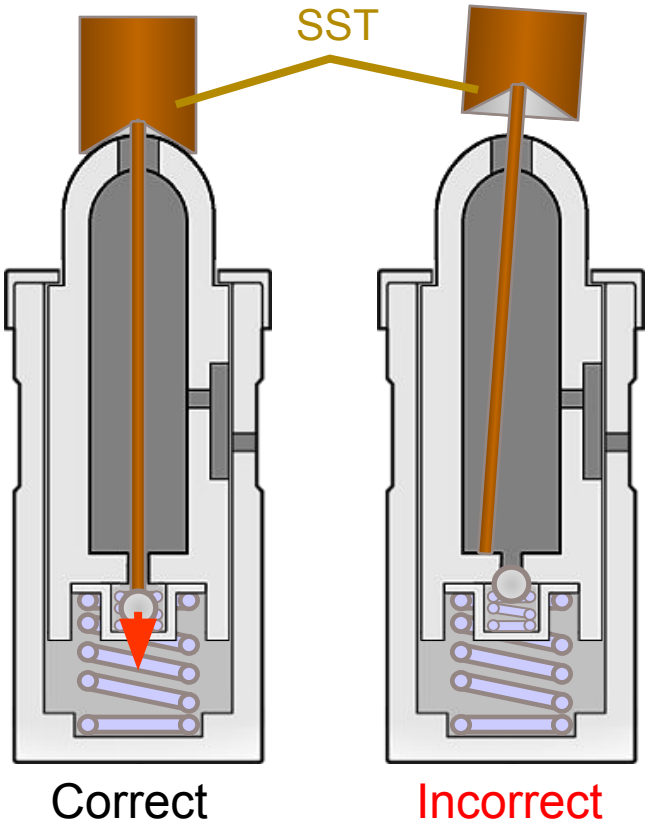
- Hydraulic La
  - Operation



Service Point (Valve Mechanism)

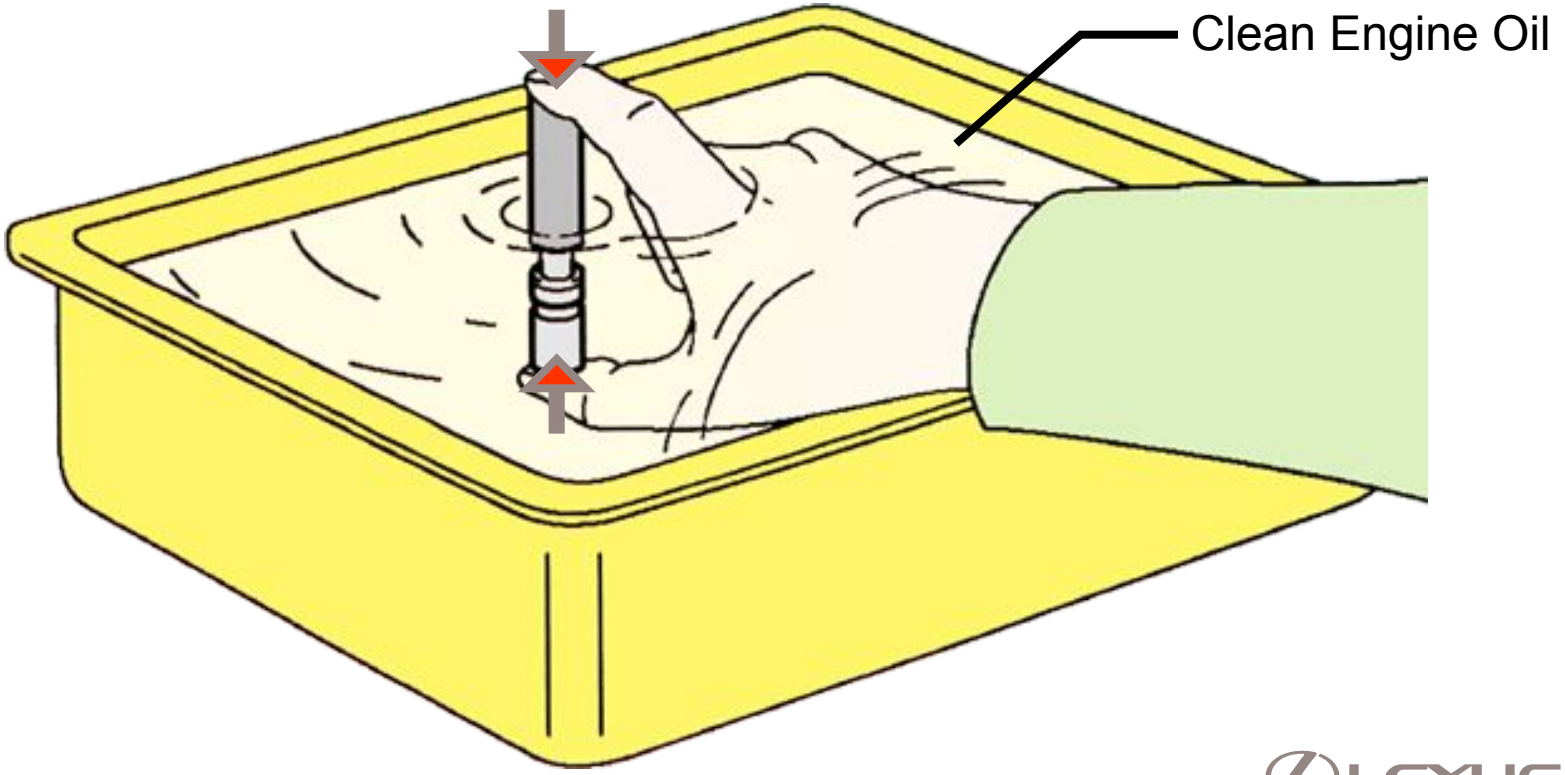
- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - 1. Pushing check ball down by using SST

Hydraulic Lash Adjuster



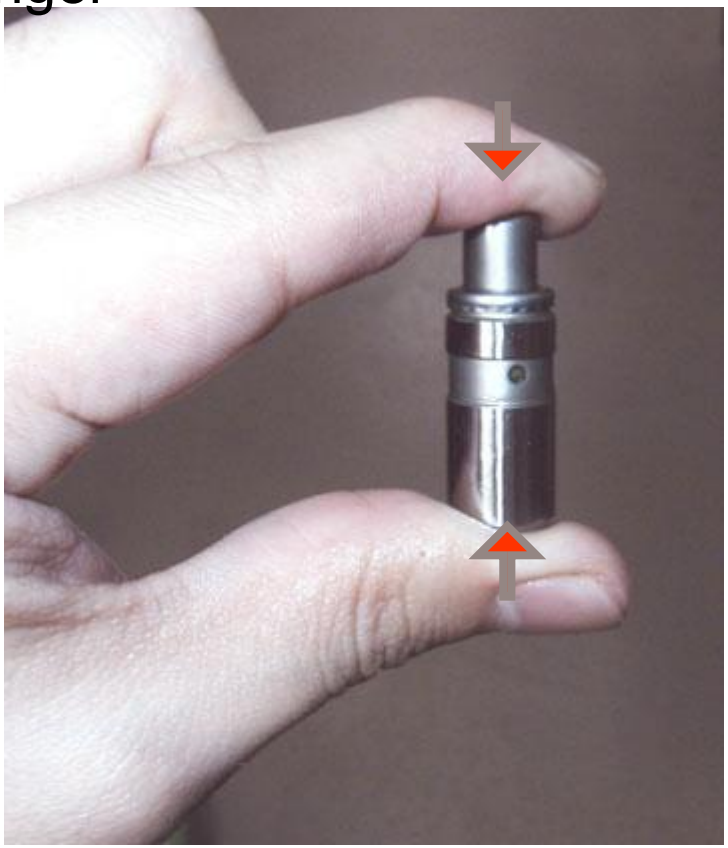
Service Point (Valve Mechanism)

- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - 2. Immerse hydraulic lash adjuster in clean engine oil, then compress and return the plunger with SST 5 to 6 times



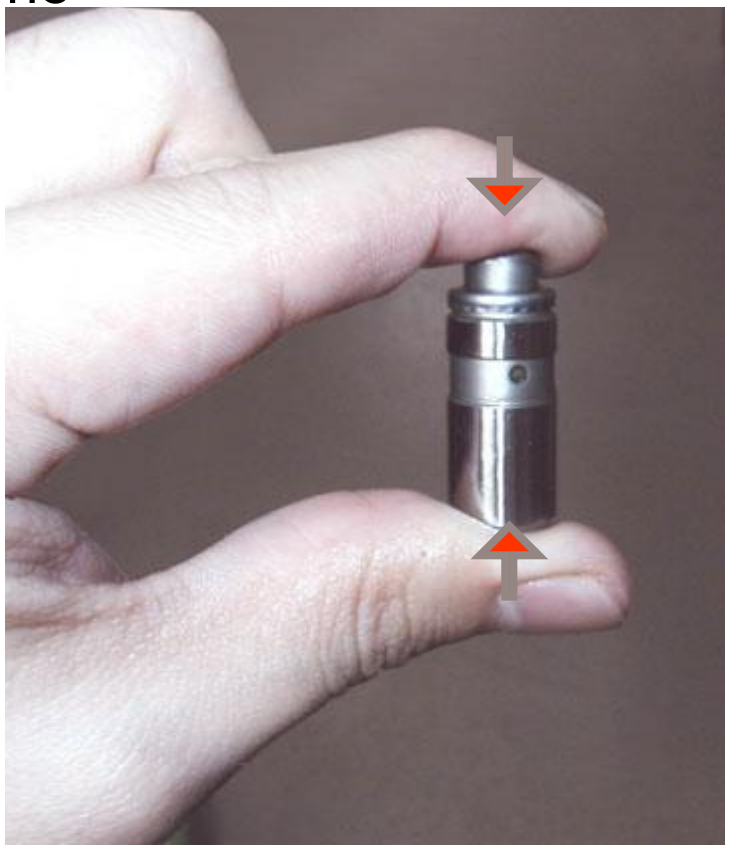
Service Point (Valve Mechanism)

- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - 3. Press the plunger by finger and check the blockage of plunger



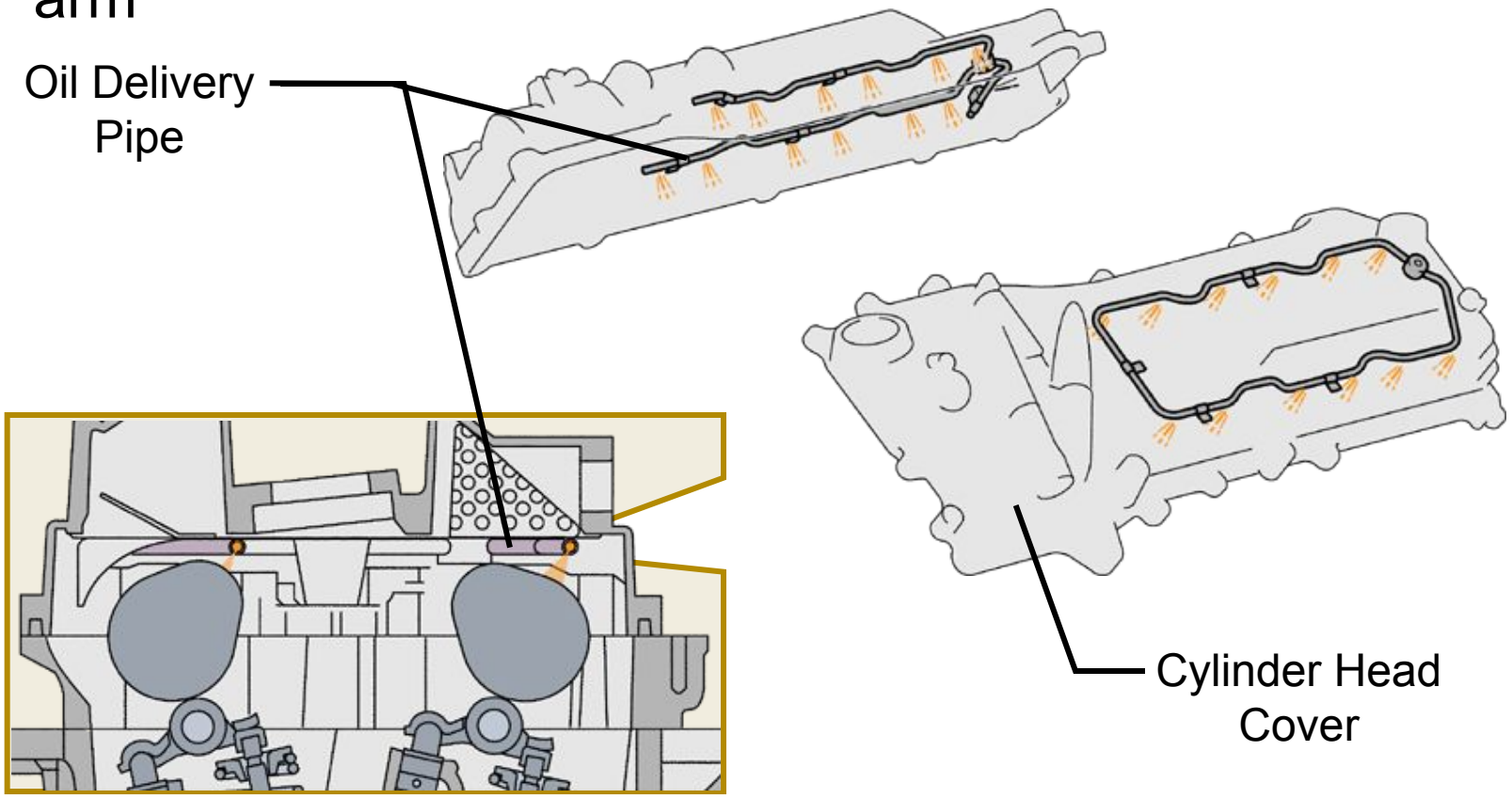
Service Point (Valve Mechanism)

- Hydraulic Lash Adjuster
  - Engine oil changing procedure
    - If plunger is compressed after 3 times trial, replace to new one



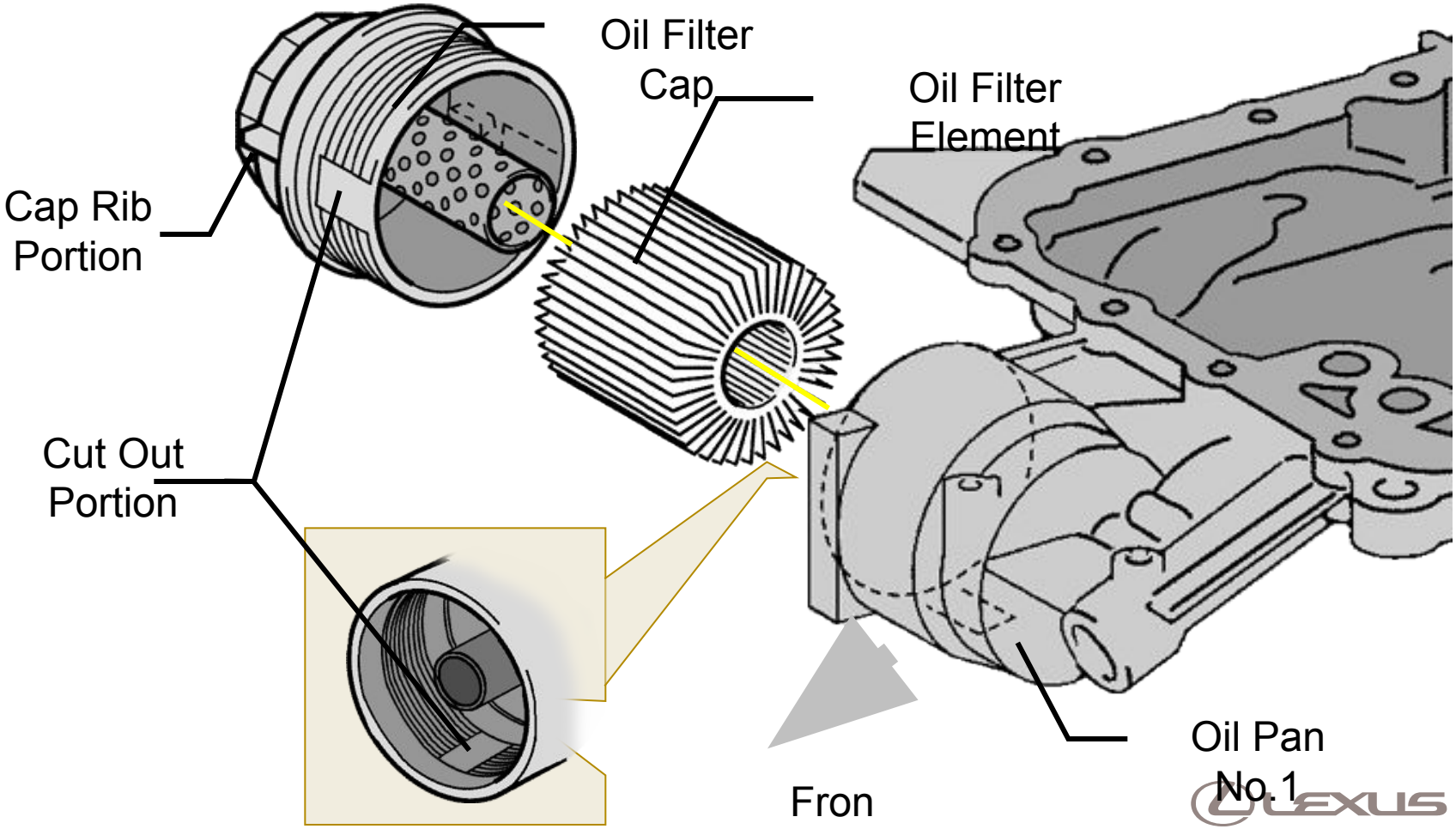
Lubrication System

- Oil Delivery Pipe
  - Oil delivery pipe is used to lubricate cam and rocker arm



Lubrication System

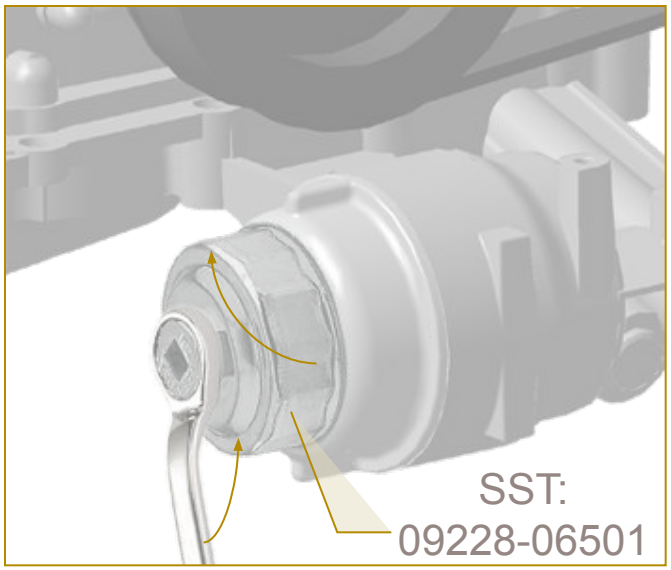
- Oil Filter (2WD)
  - Element replacing type oil filter is used



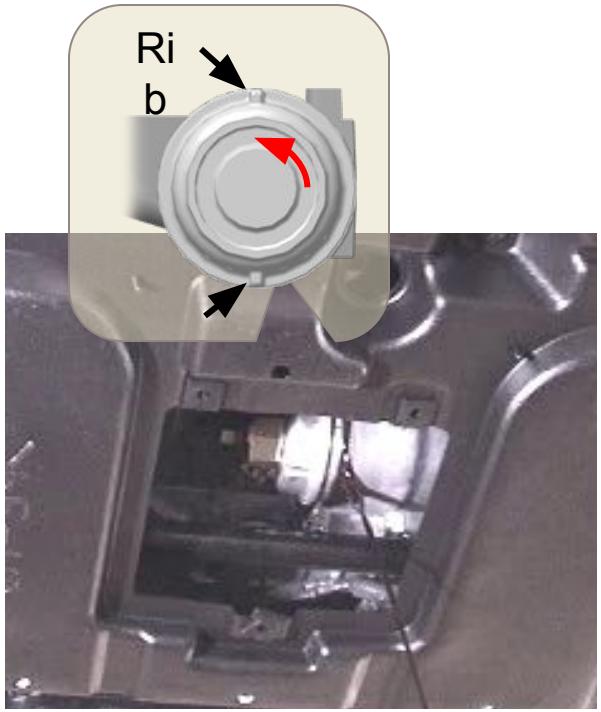
Service Point (Lubrication System)

- Oil filter (4WD)
  - Oil filter replacement
    - Removal

Remove filter element



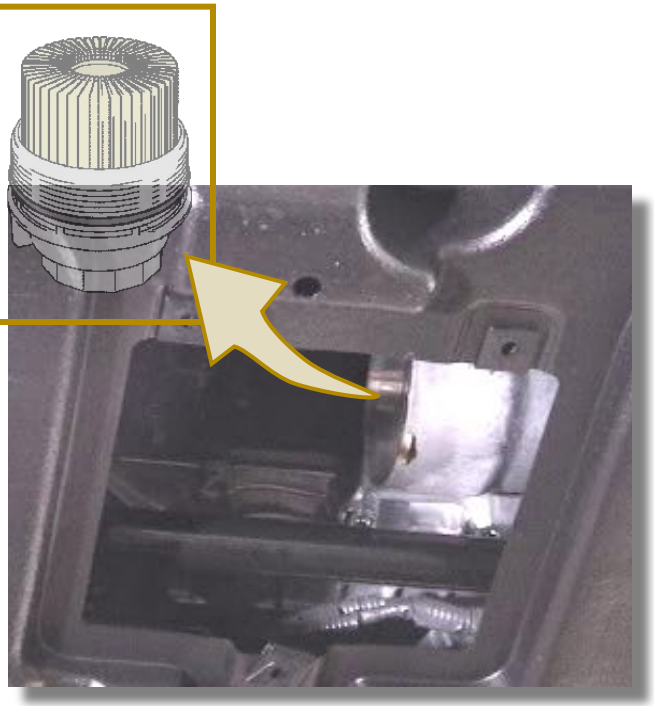
Loosen the filter cap for approx. 4 rev.



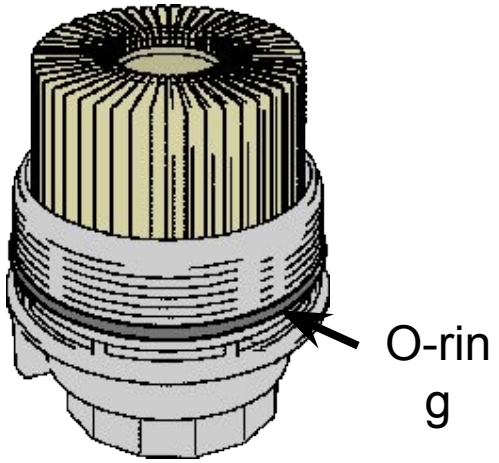
Align the cap rib vertically and drain oil

Service Point (Lubrication System)

- 3UR-FE (4WD)
  - Oil filter replacement
    - Removal



Remove oil filter cap and filter element

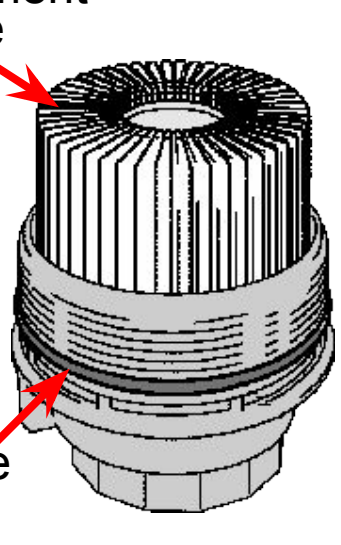


Remove filter element and O-ring from filter cap

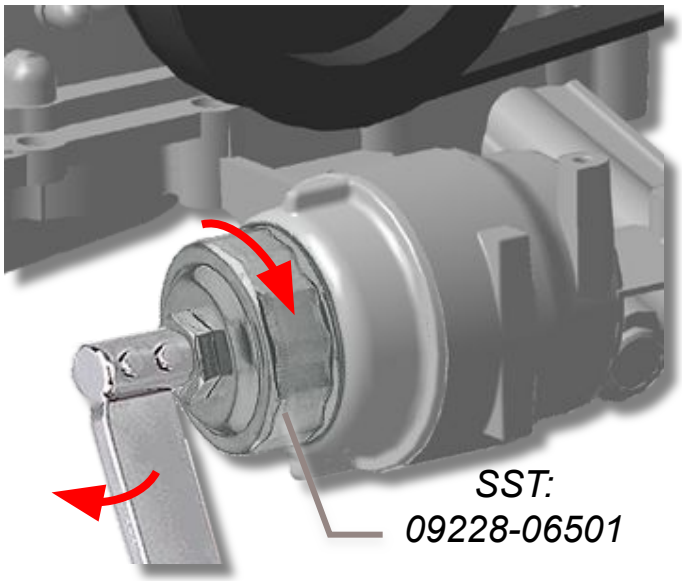
Service Point (Lubrication System)

- Oil filter (4WD)
  - Oil filter replacement
    - Installation

Install filter element



Set new filter element and O-ring

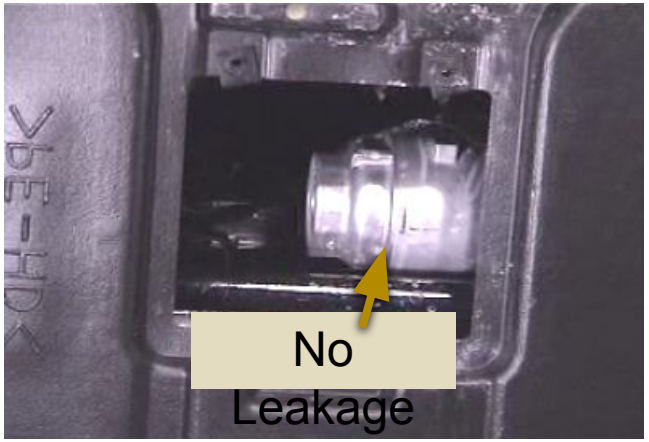


Install filter cap using SST

Service Point (Lubrication System)

- Oil filter (4WD)
  - Oil filter replacement
    - Installation

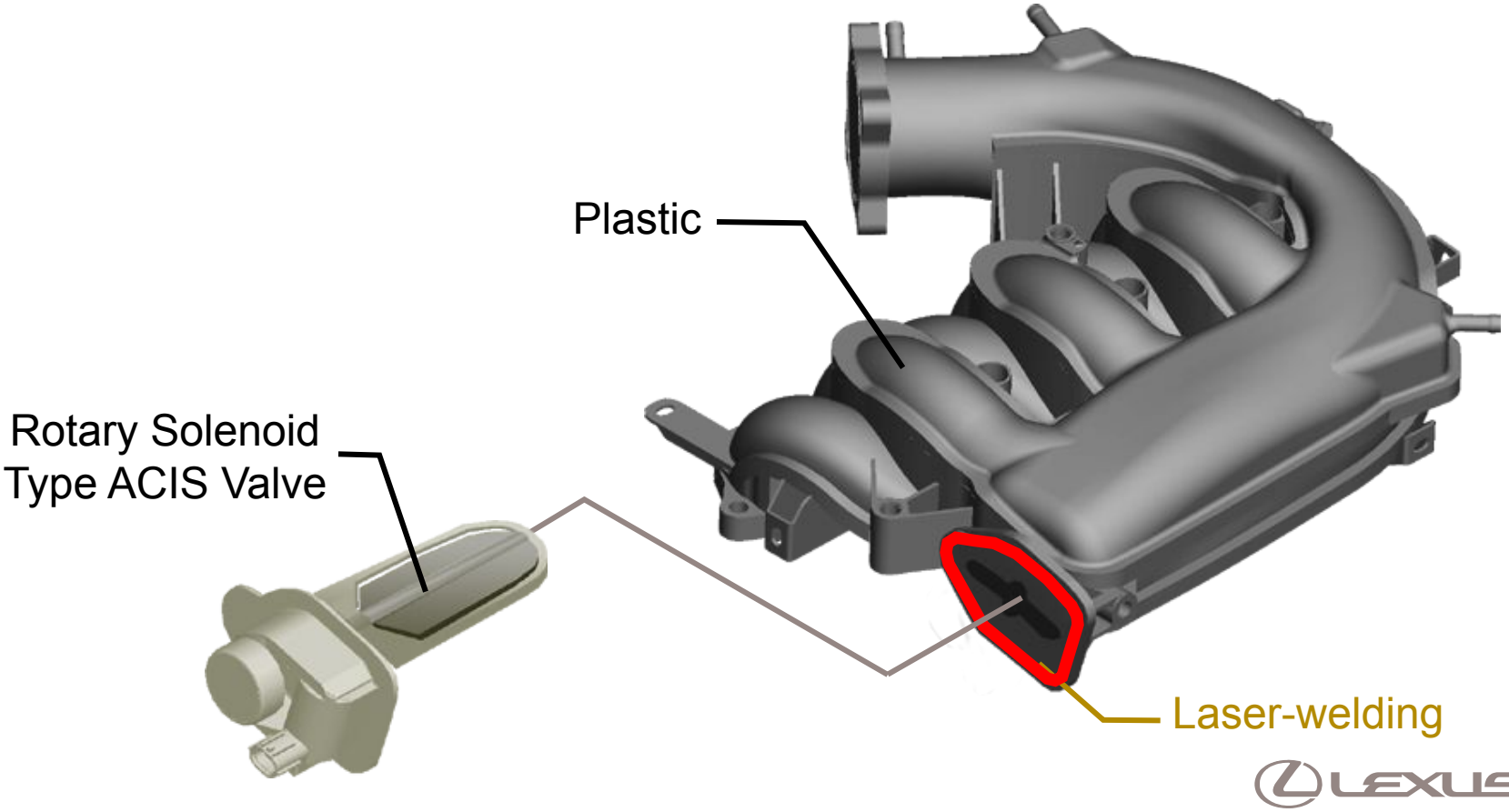
Refill engine oil



Run the engine and check oil leakage

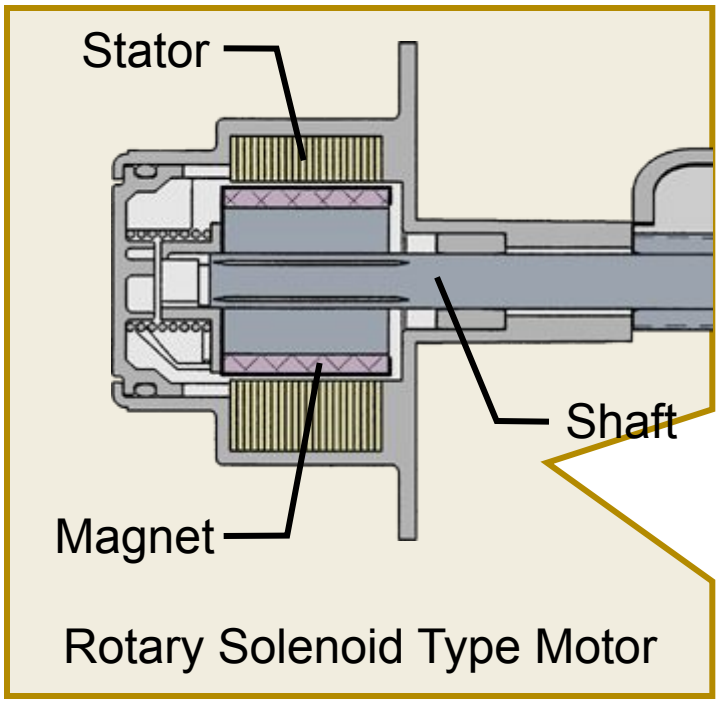
Intake and Exhaust System

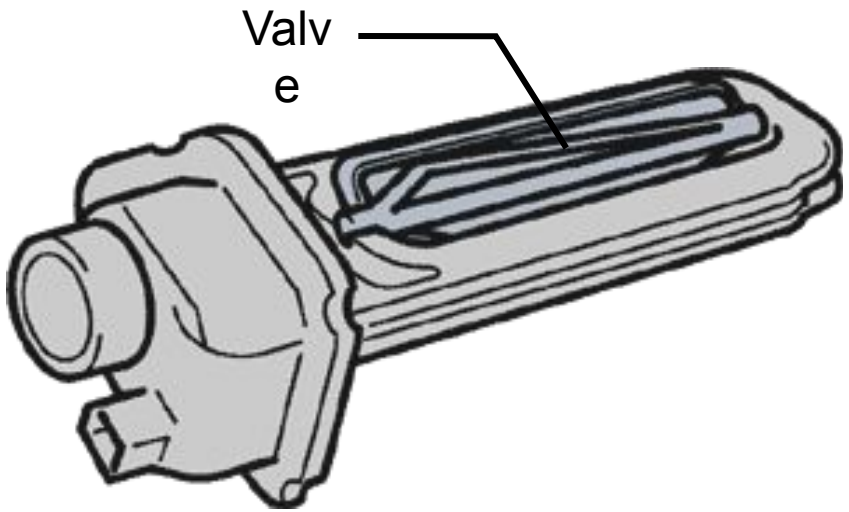
- ACIS Valve
  - Rotary solenoid type ACIS valve is used
  - ACIS valve is unified by laser-welding



Reference (Intake & Exhaust System)

- ACIS Valve
  - Rotary solenoid type ACIS valve is used



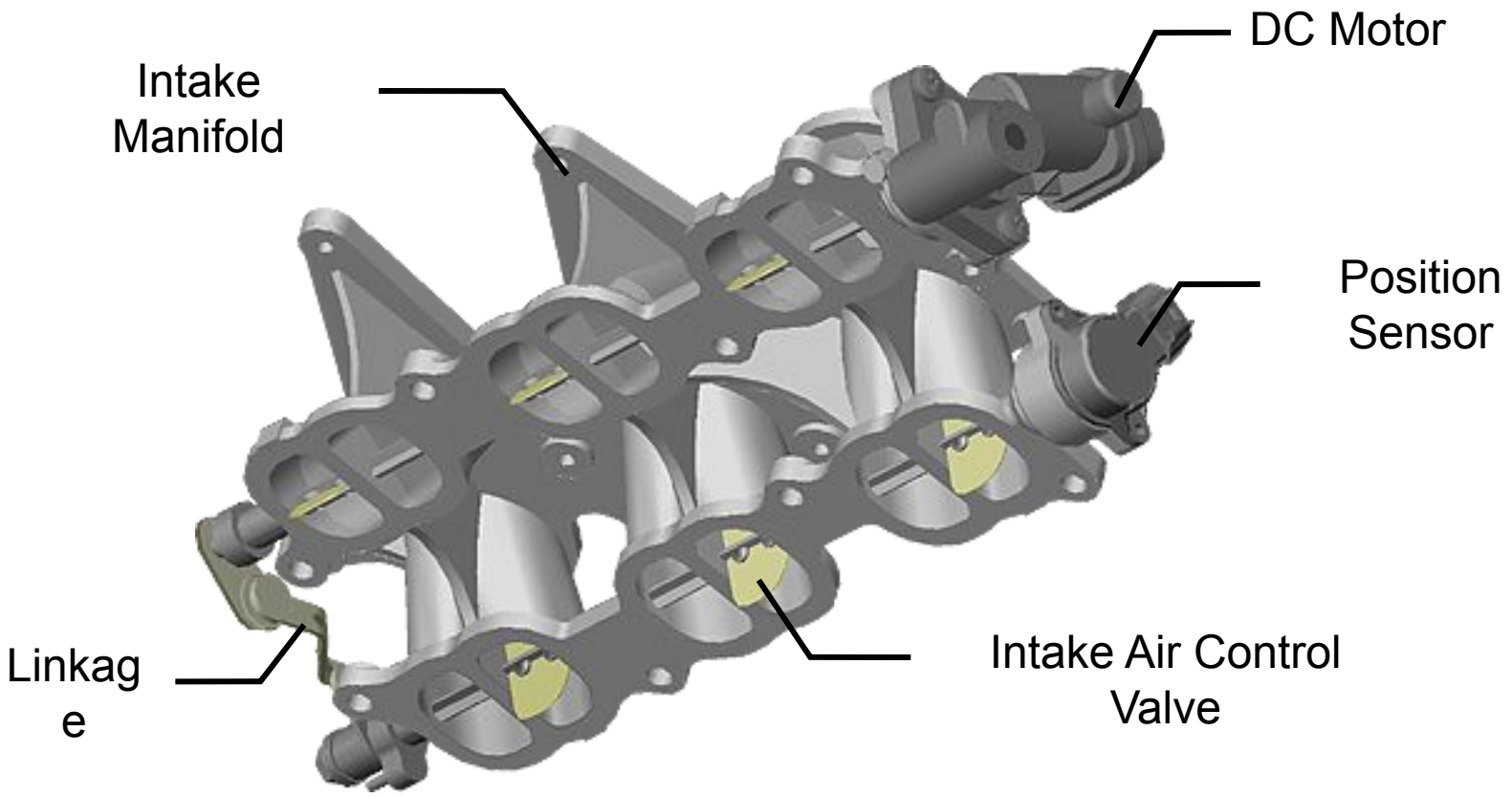


ACIS Valve

LEXUS

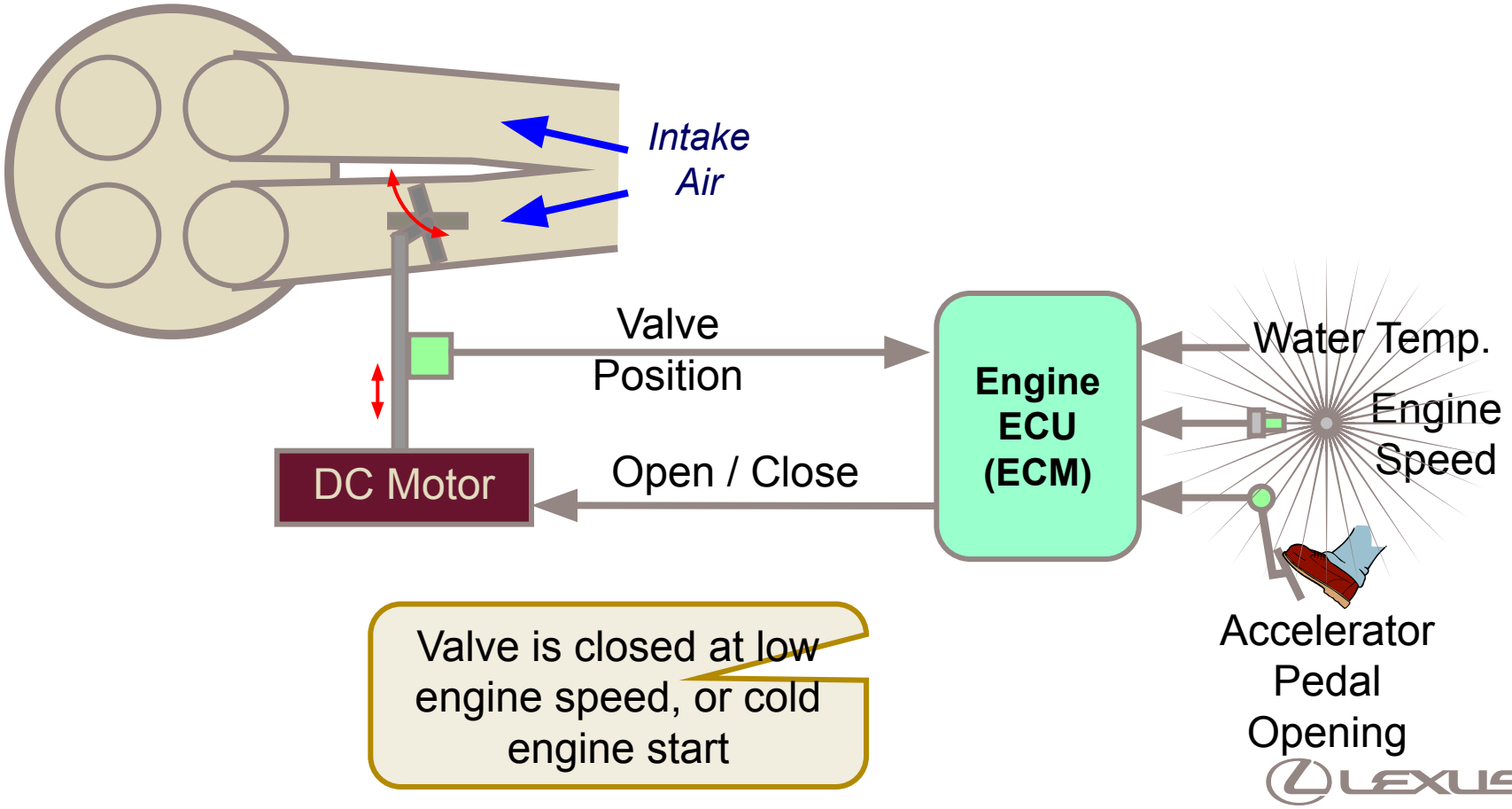
Intake and Exhaust System

- Intake Air Control Valve
  - Intake air control valve is operated by DC motor



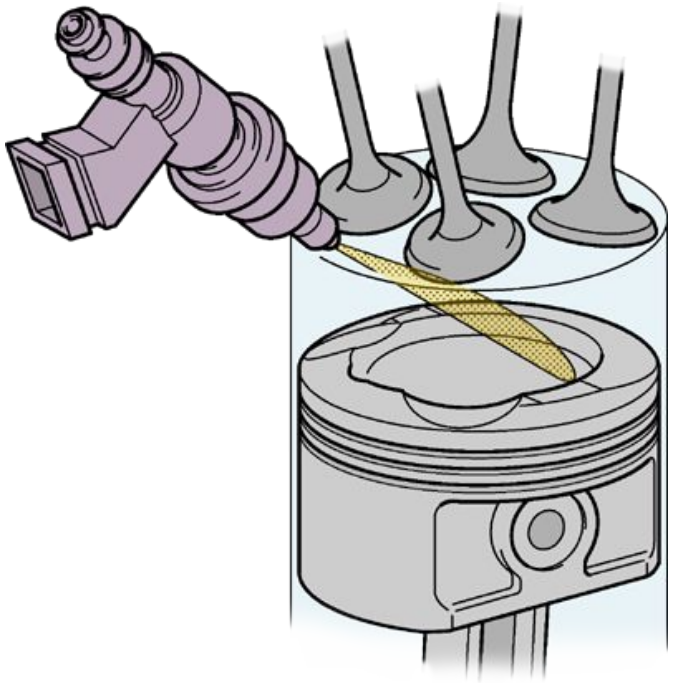
Intake and Exhaust System

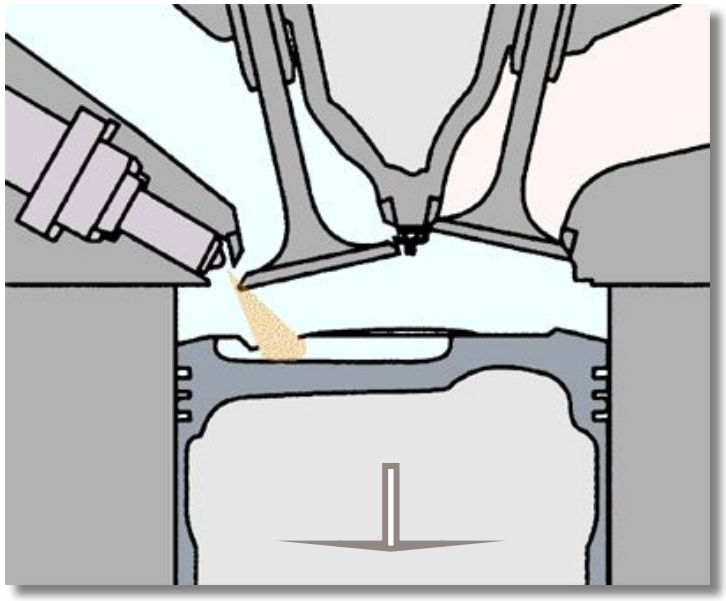
- Intake Air Control Valve
  - Operation



D-4 System

- General
  - 4GR-FSE engine uses D-4 System

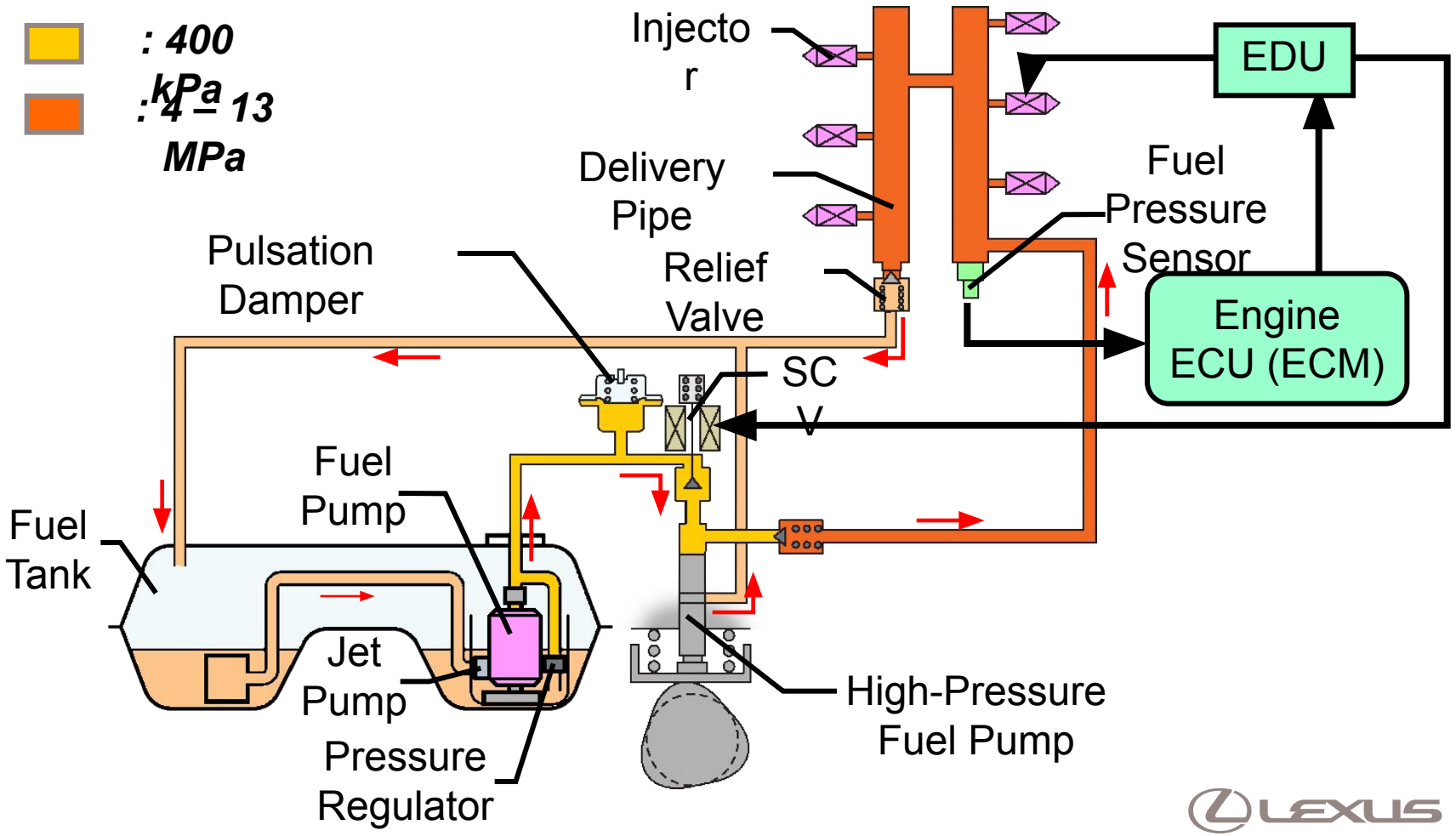




D-4 (Direct injection 4-stroke gasoline engine)

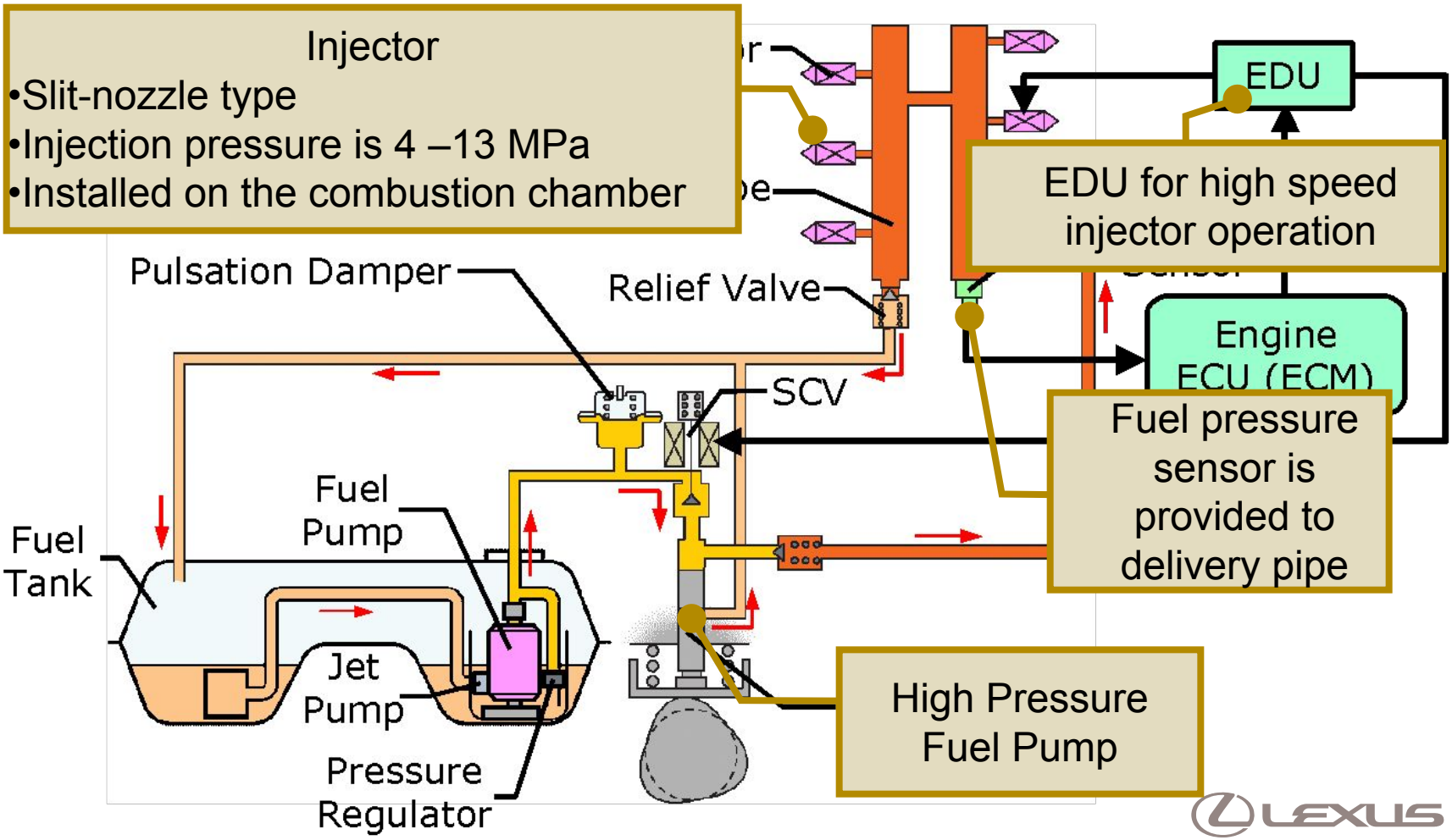
D-4 System

- System Diagram



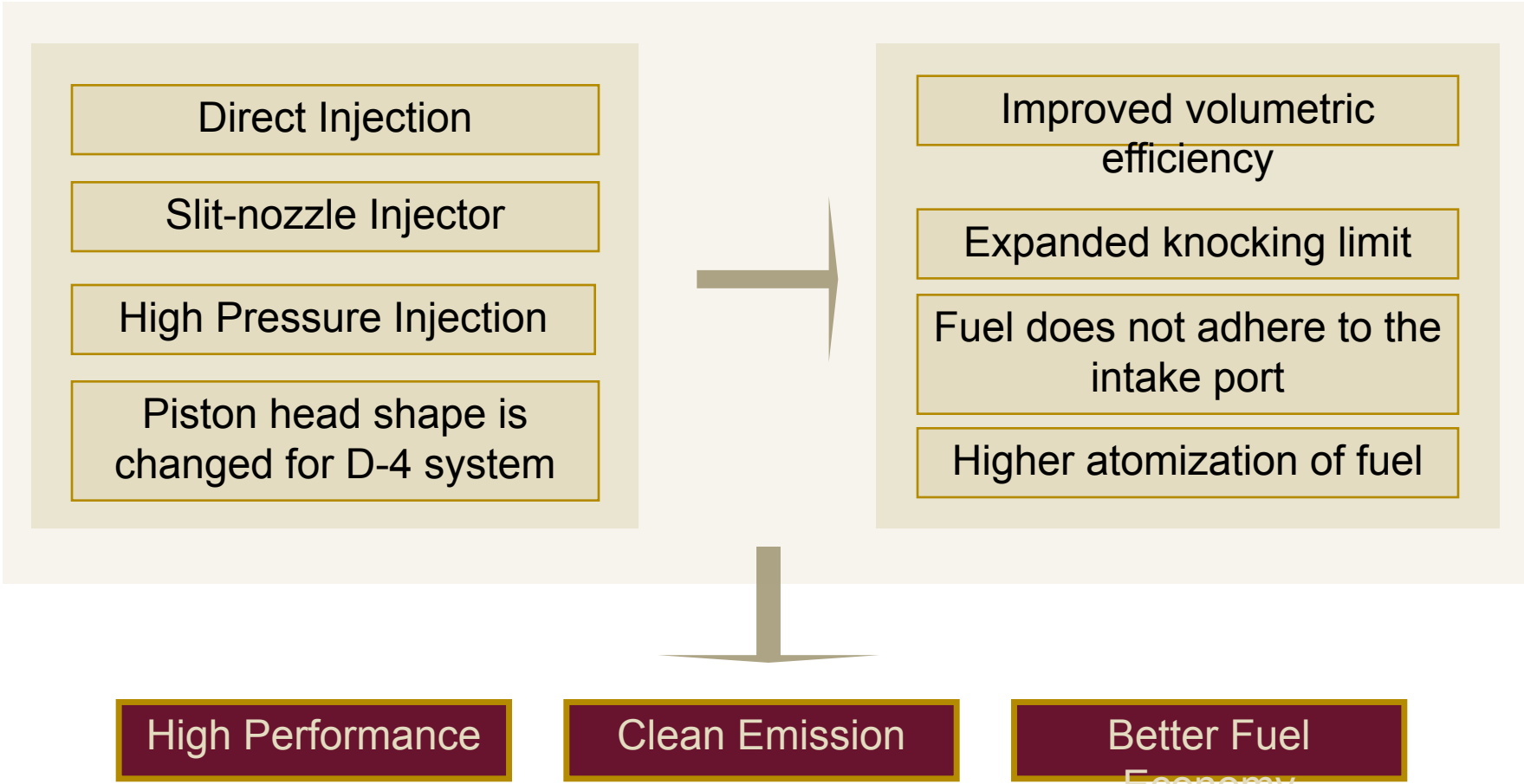
D-4 System

- Difference from usual gasoline EFI



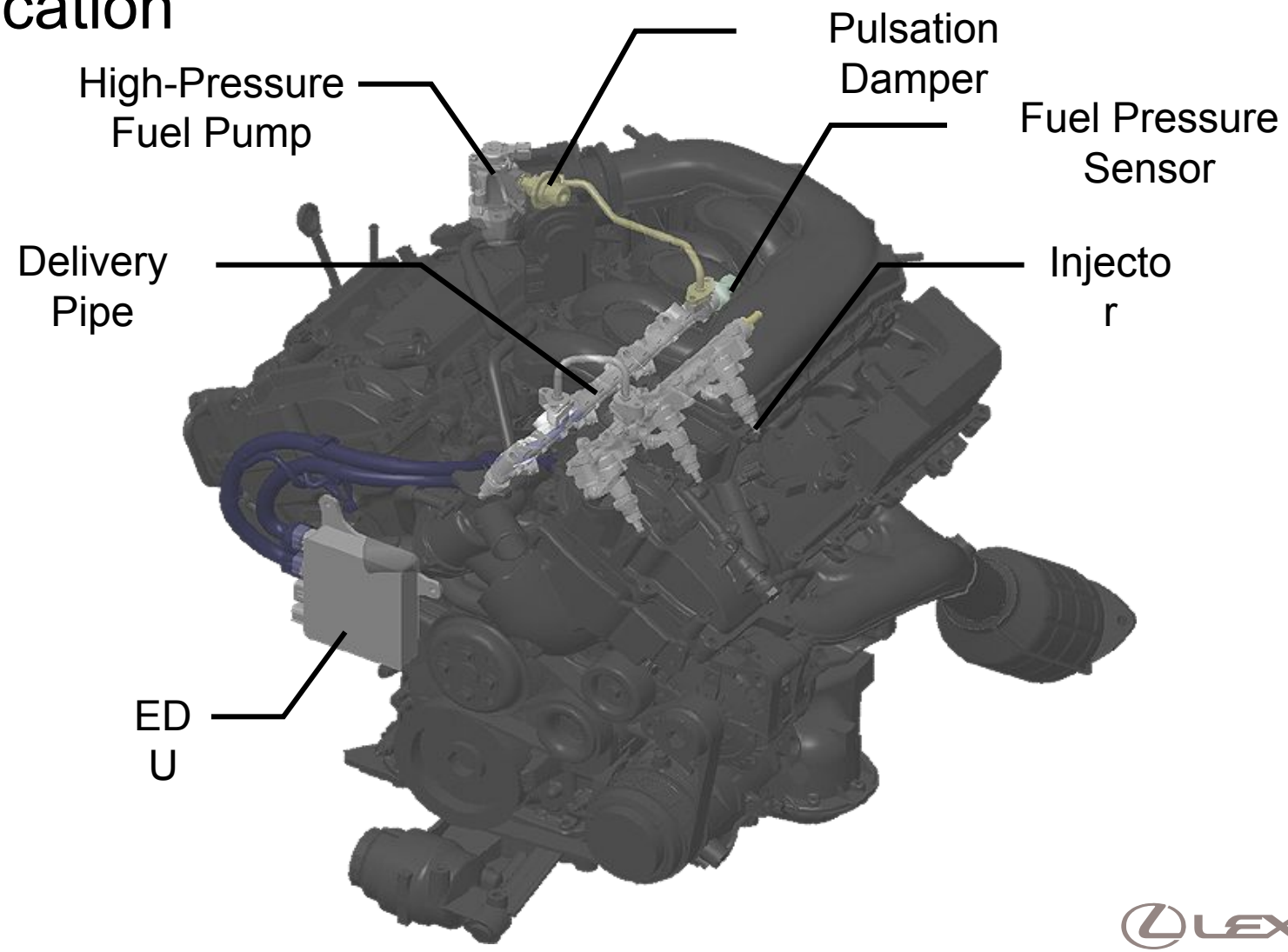
Reference

- Features of D-4 System



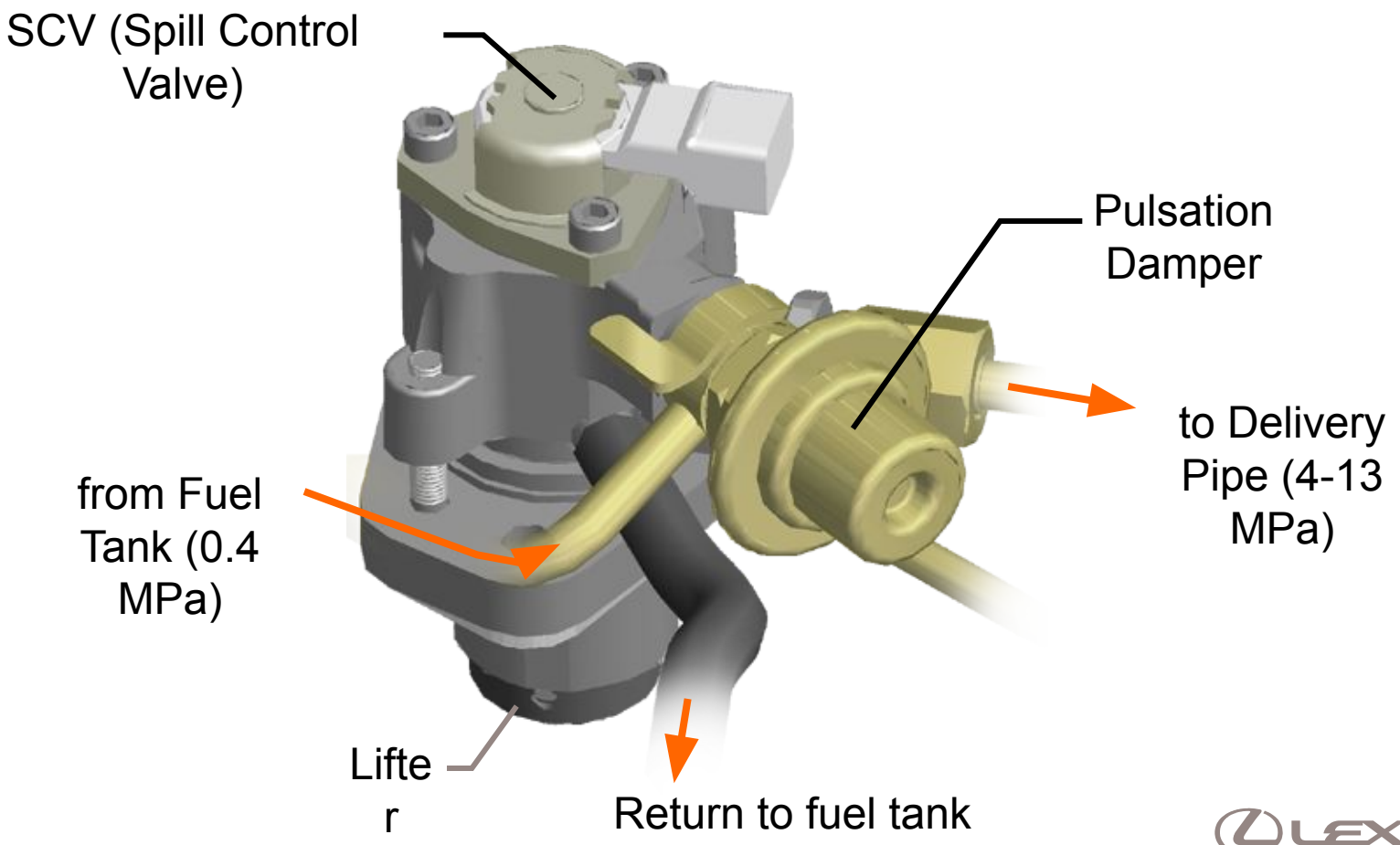
D-4 System

- Location



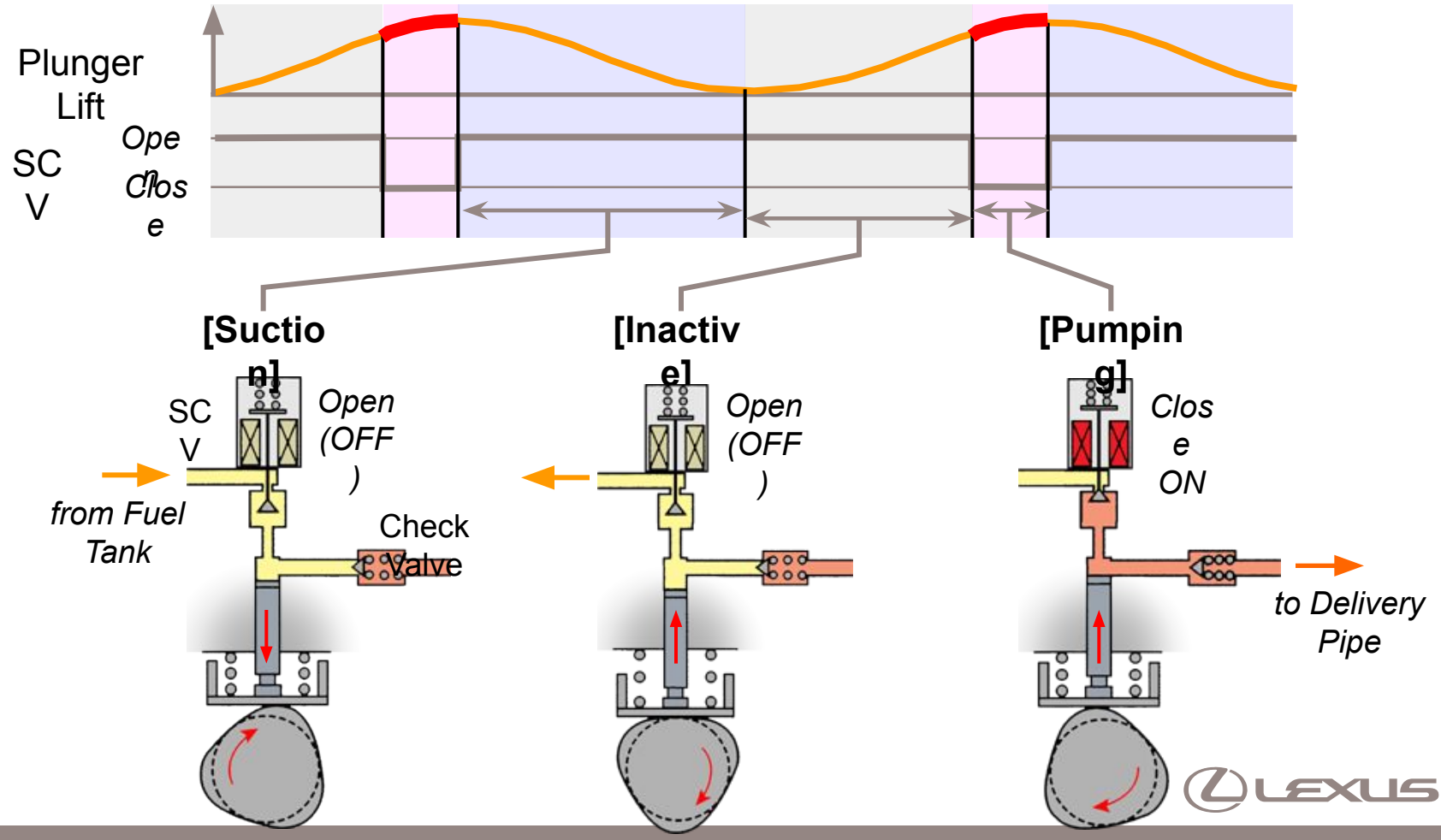
D-4 System

- High-Pressure Fuel Pump
  - Supplies the high pressure fuel to the delivery pipe



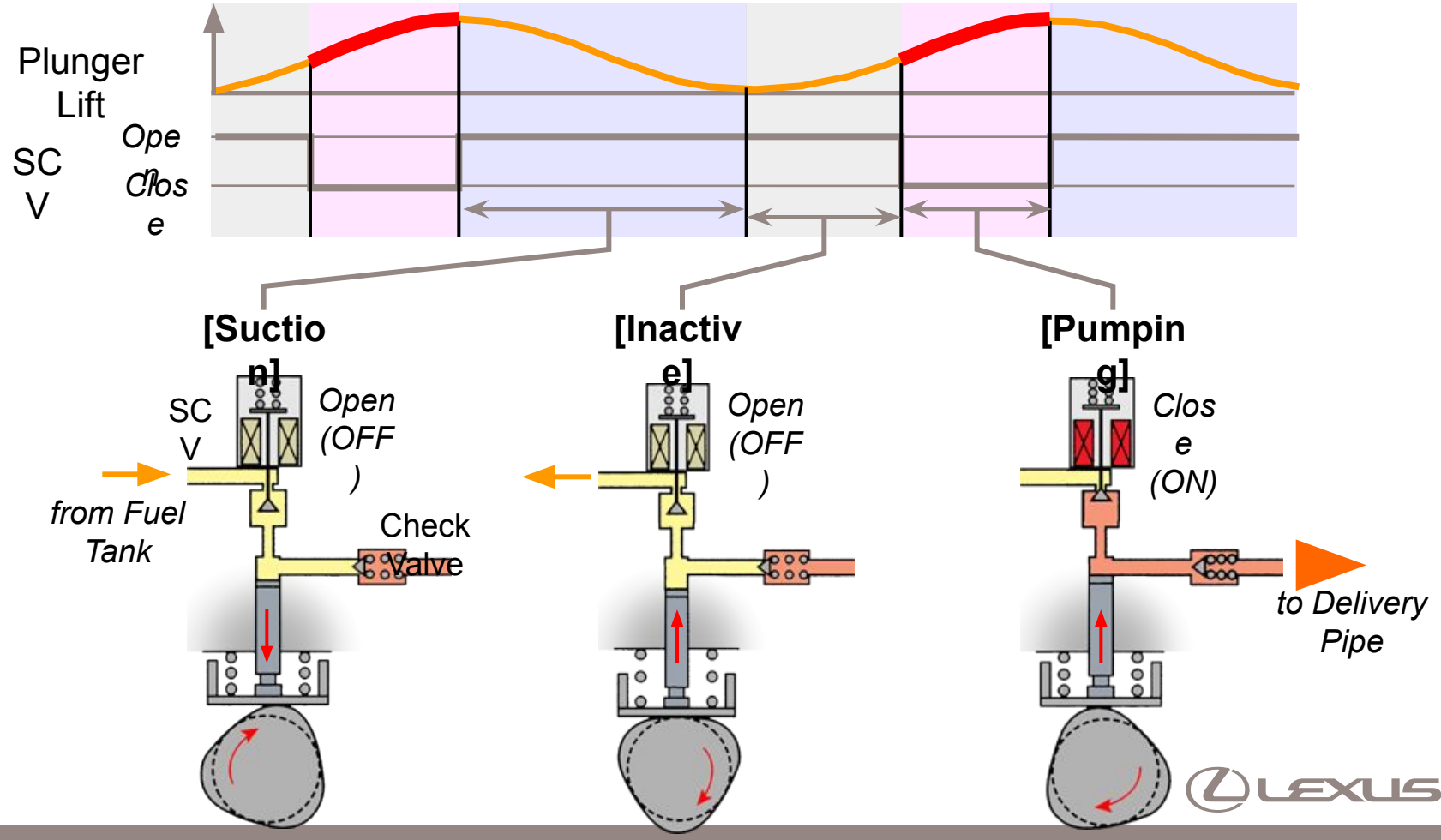
D-4 System

- High-Pressure Fuel Pump
  - Fuel control operation (SCV close timing is **late**)



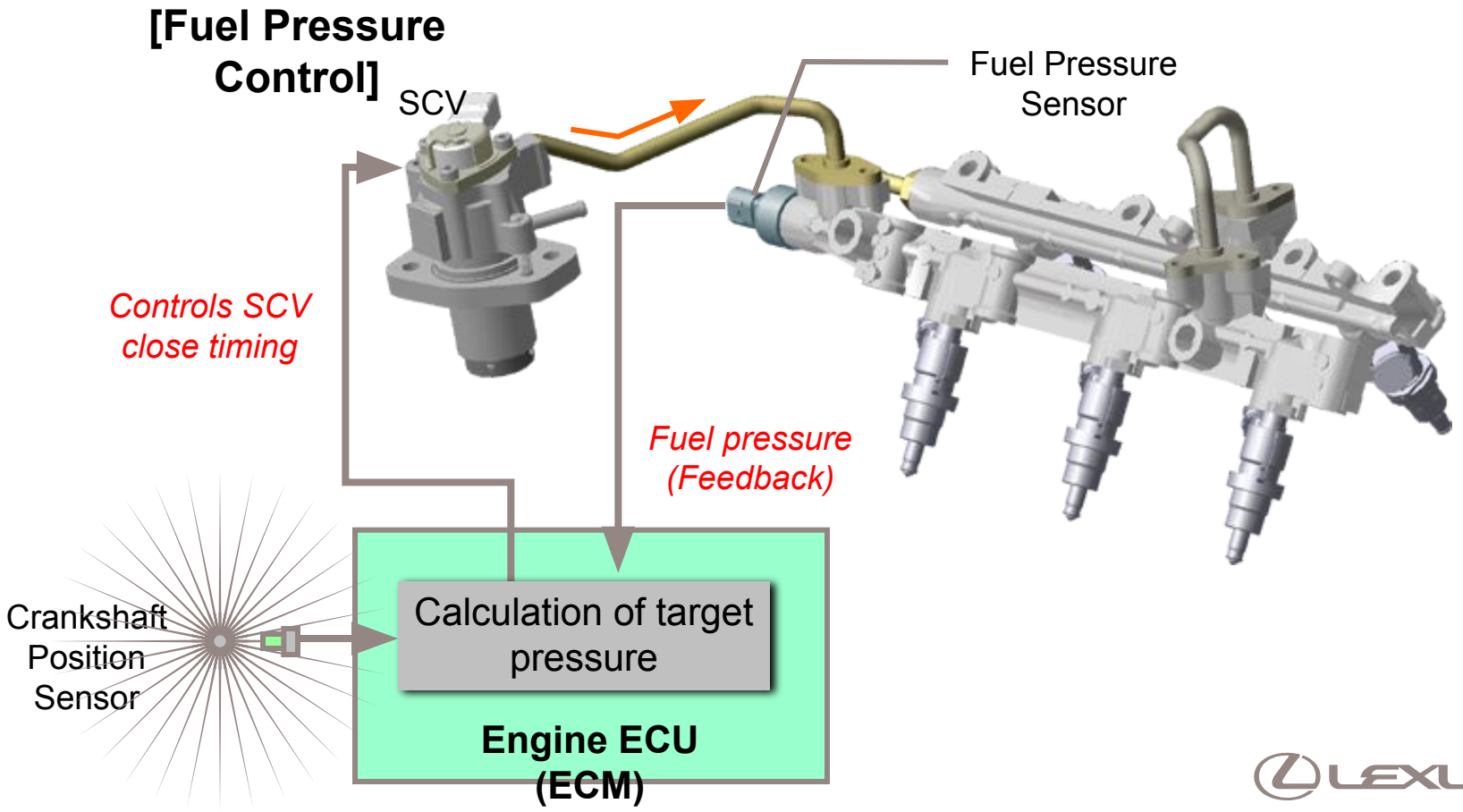
D-4 System

- High-Pressure Fuel Pump
  - Fuel control operation (SCV close timing is **early**)



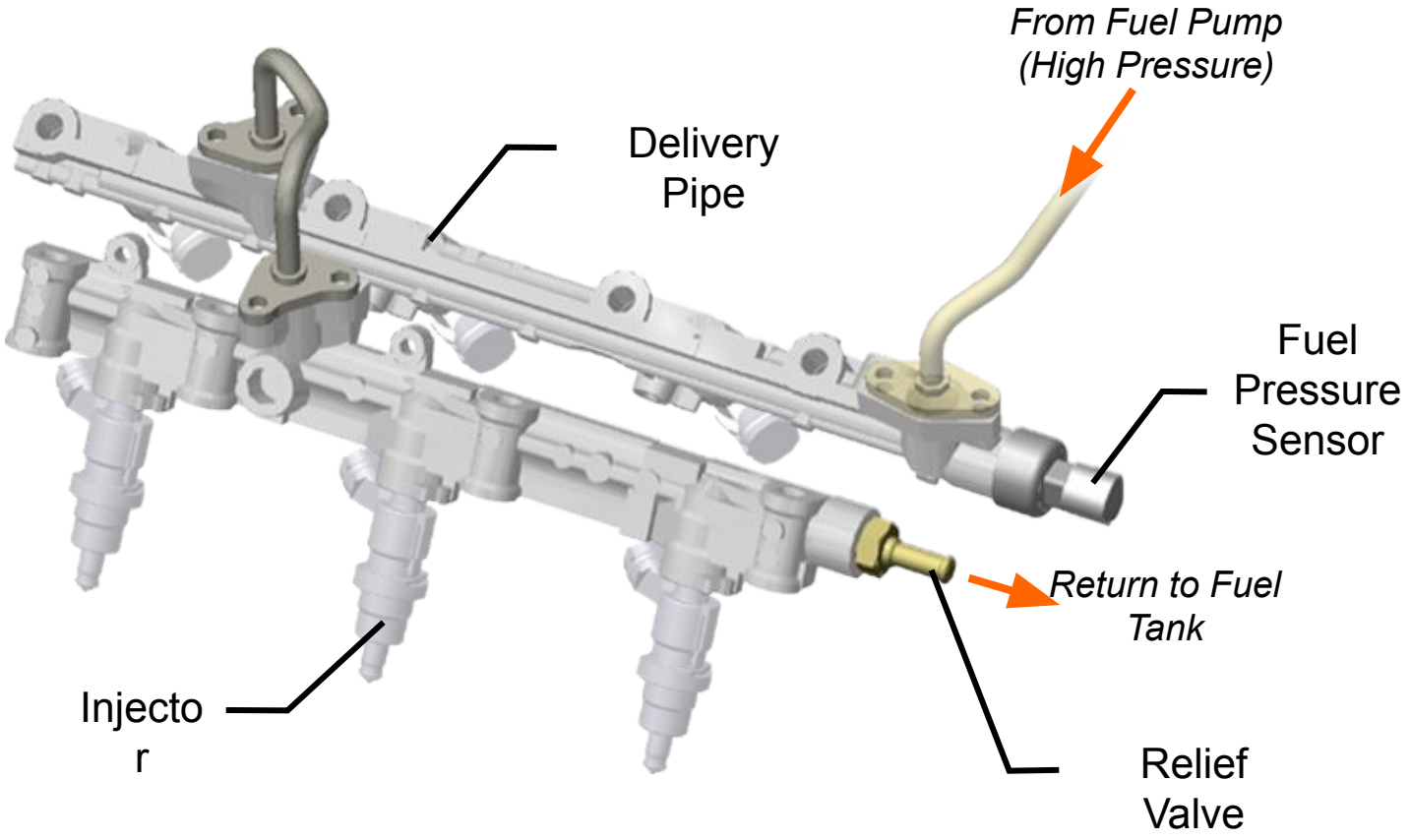
D-4 System

- High-Pressure Fuel Pump
  - The SCV close timing regulates the pumping volume to control fuel pressure



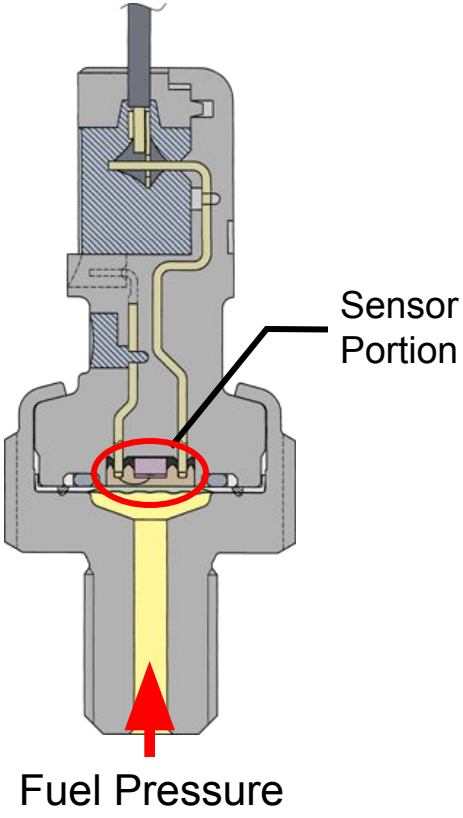
D-4 System

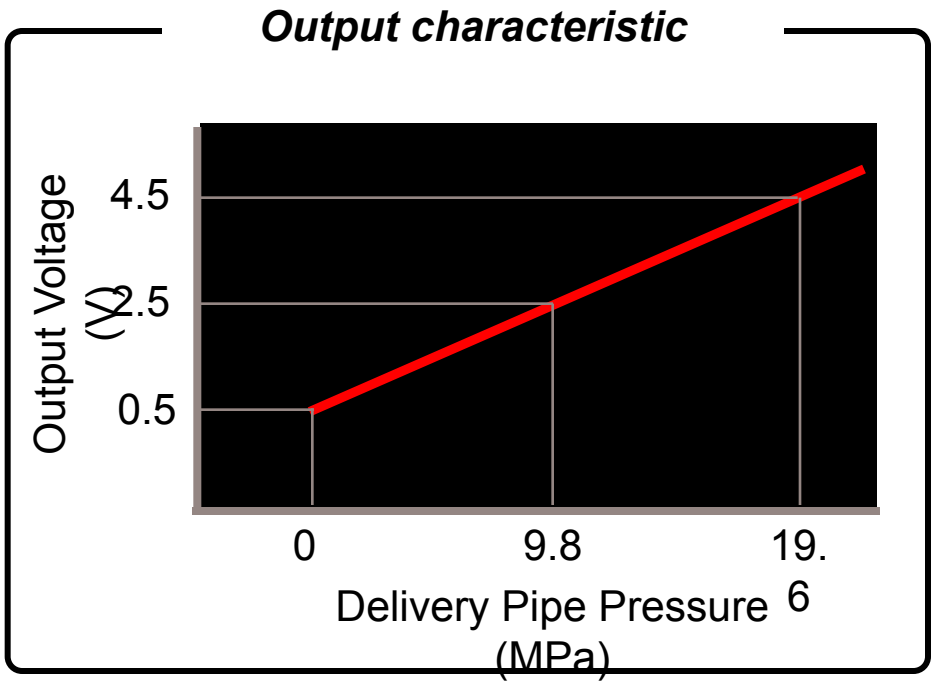
- Delivery Pipe
  - Stores high-pressure fuel (4 – 13 MPa) produced by high-pressure fuel pump



D-4 System

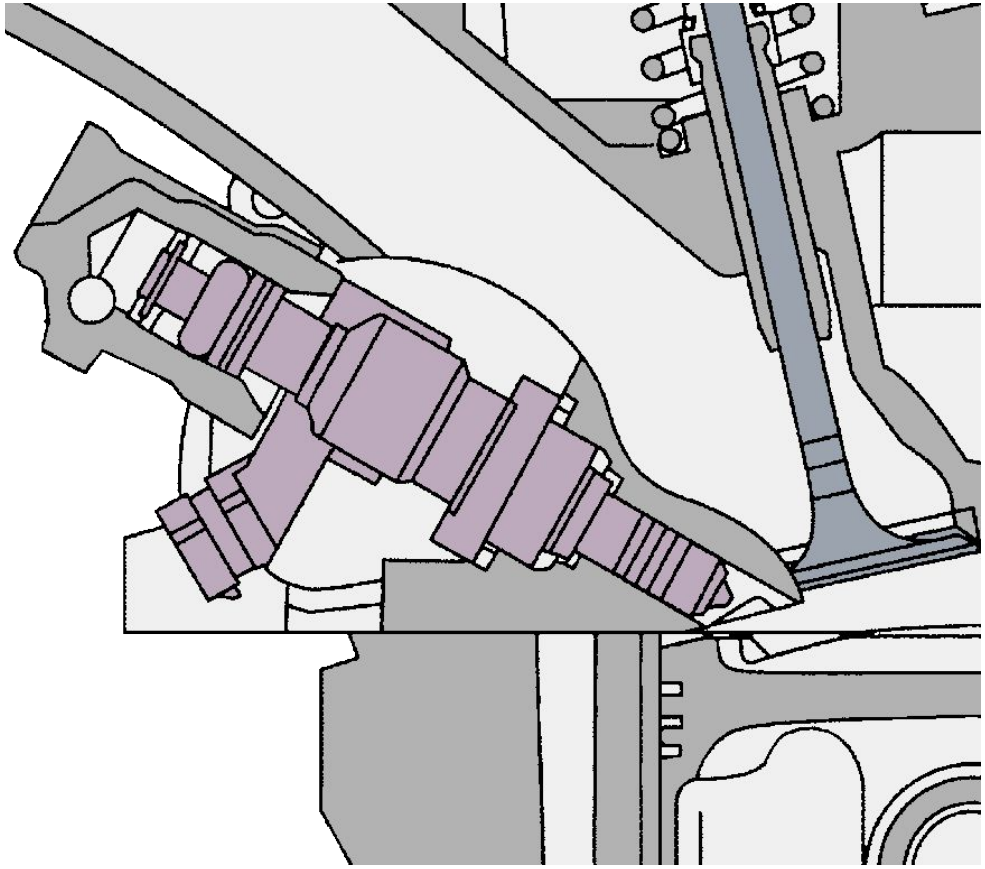
- Delivery Pipe
  - Fuel pressure sensor

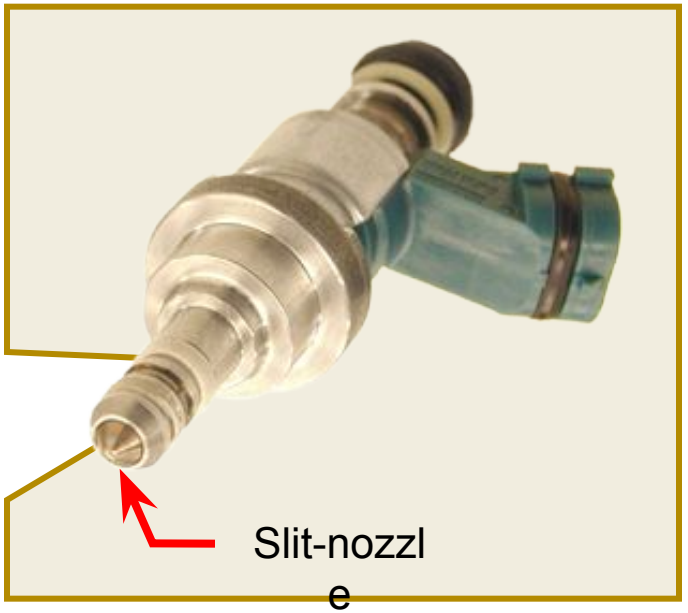




D-4 System

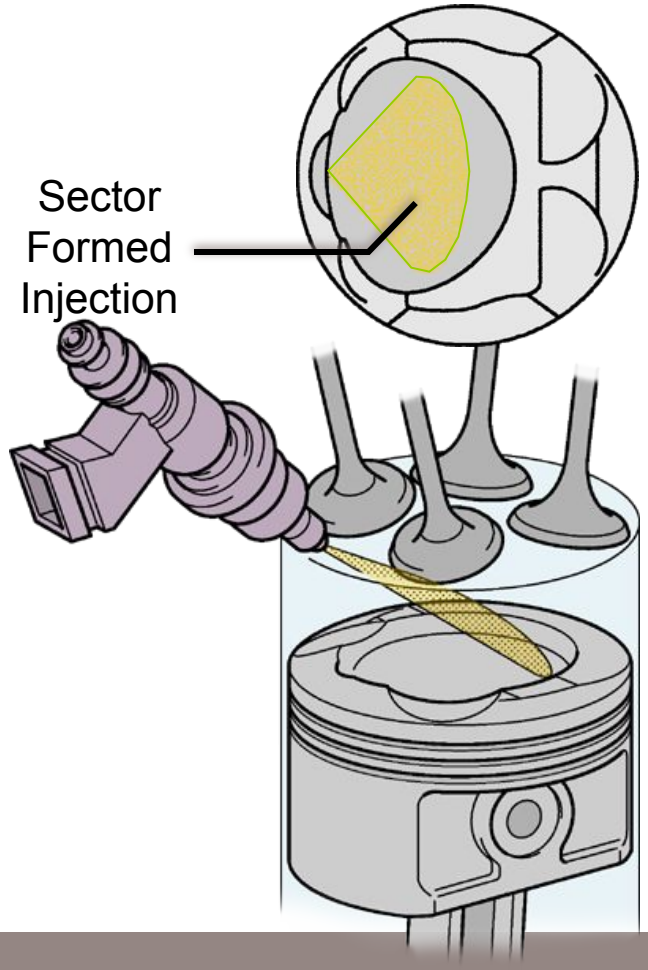
- Injector
  - High pressure, slit-nozzle type injector

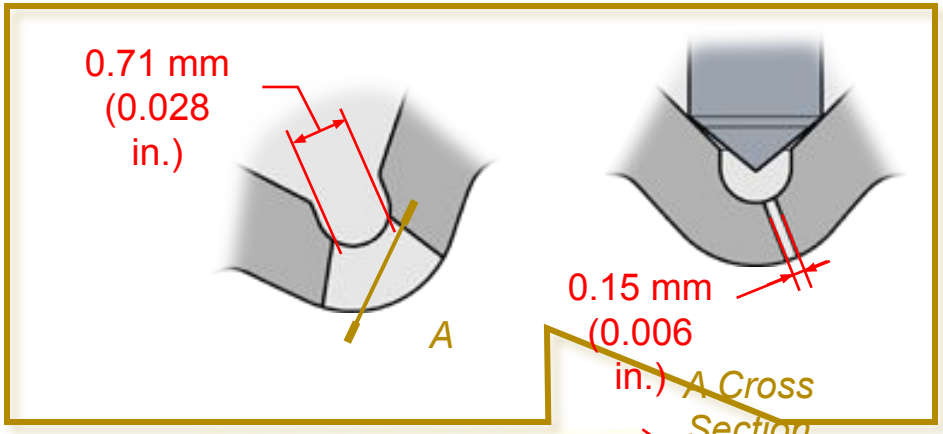




D-4 System

- Injector
  - Slit-nozzle makes sector formed injection

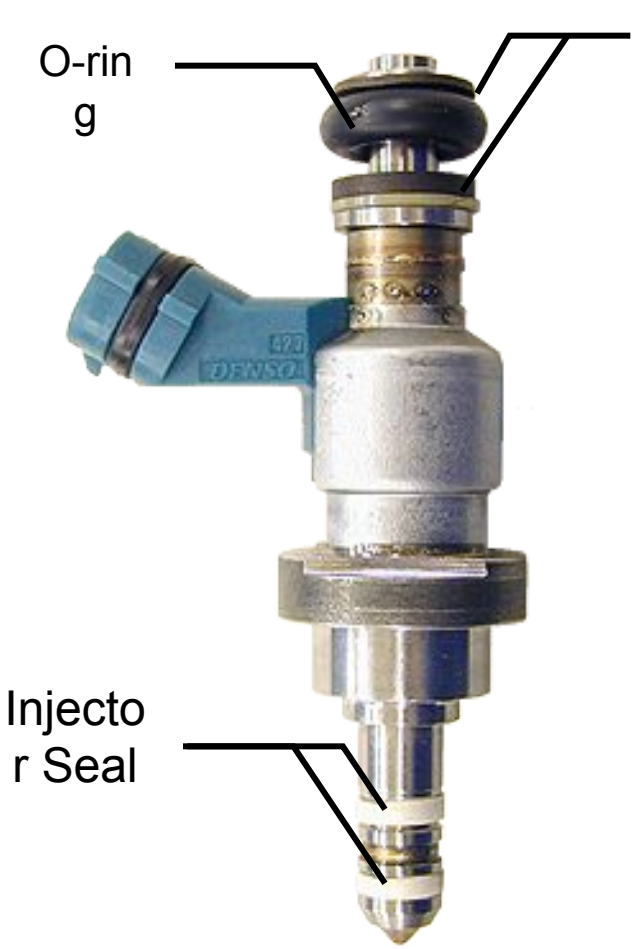


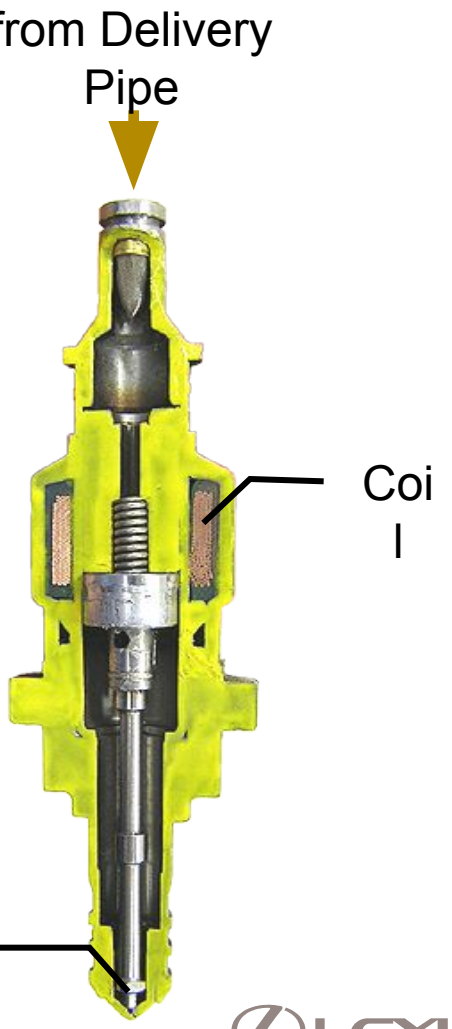


Slit-nozzl
e

D-4 System

- Injector
  - Construction





Service Point (D-4 System)

- Injector
  - When remove the injector from cylinder head, replace the injector seal using new SST

Injector Seal

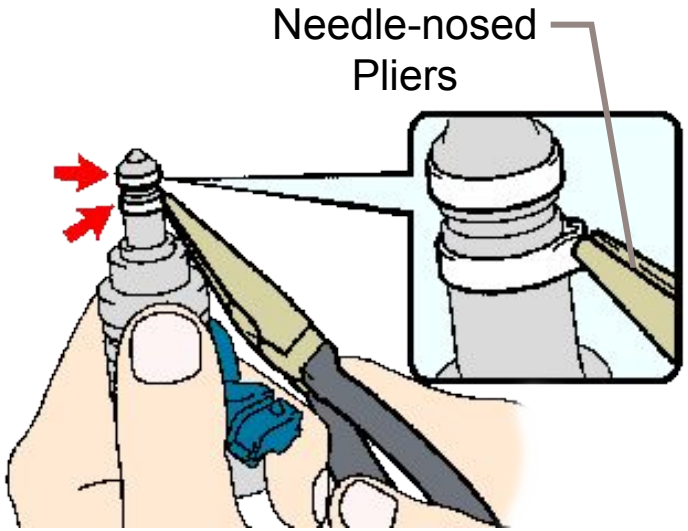
Injector Seal Guide (09268-03020)

Injector Seal Holder (09268-03010)

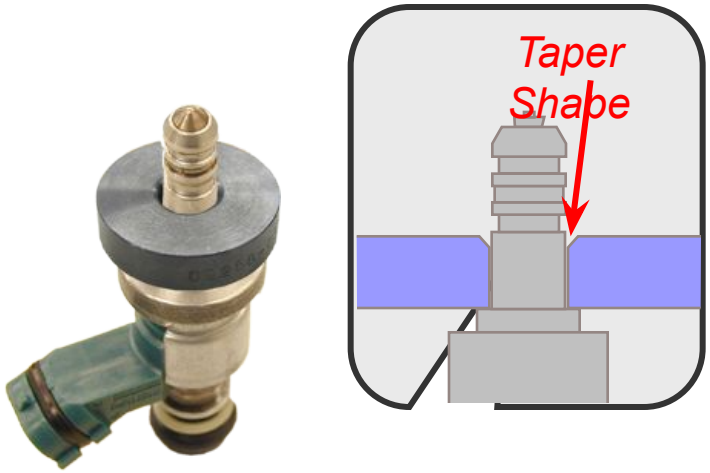
SST
09260-39015

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



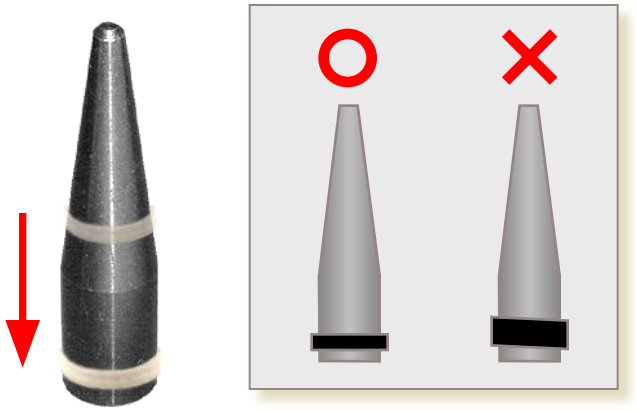
1. Remove injector seals



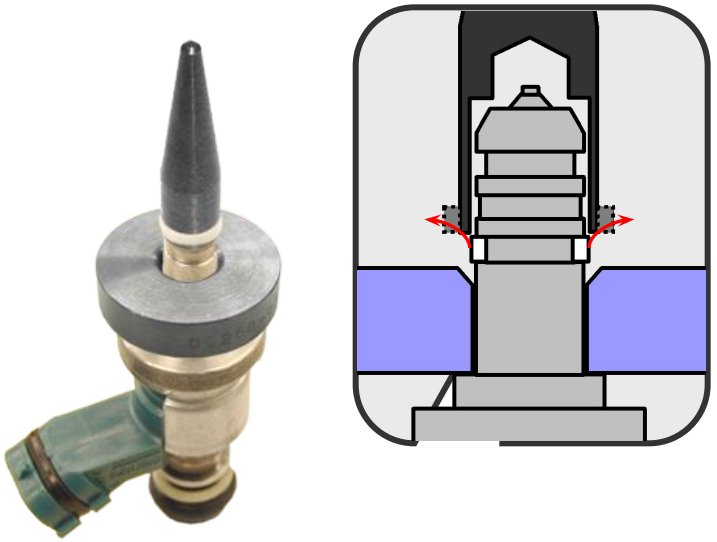
2. Attach the guide (SST)

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



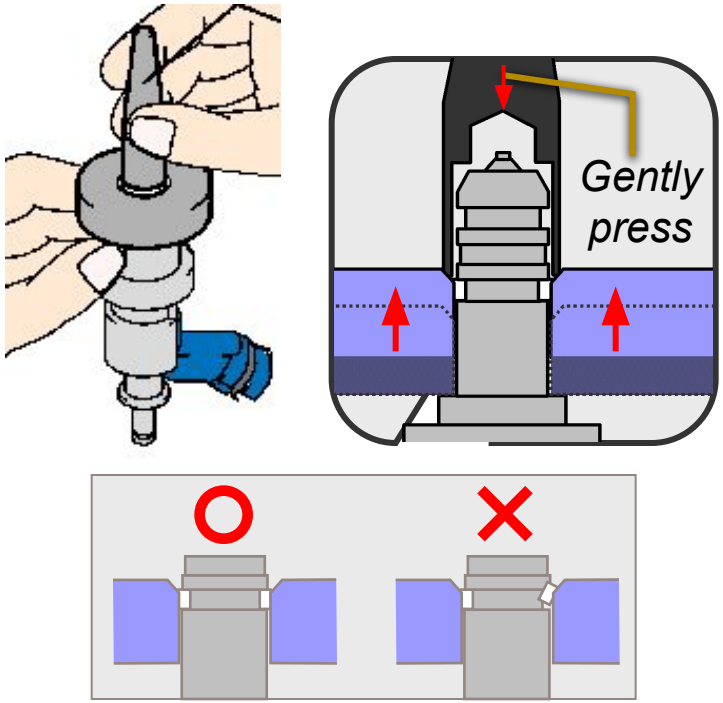
3. Install a new injector



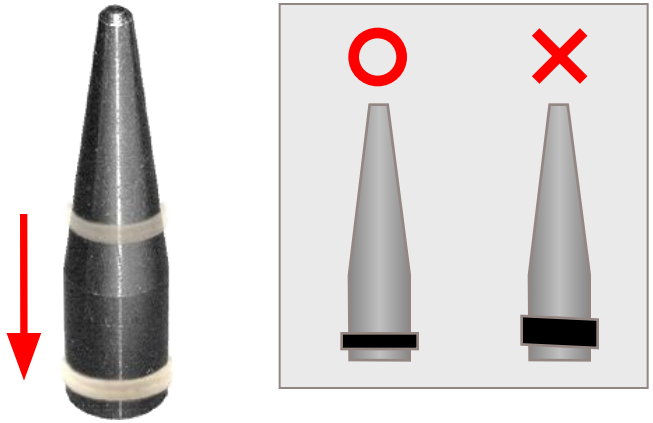
4. Slide the the injector seal into the injector groove

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



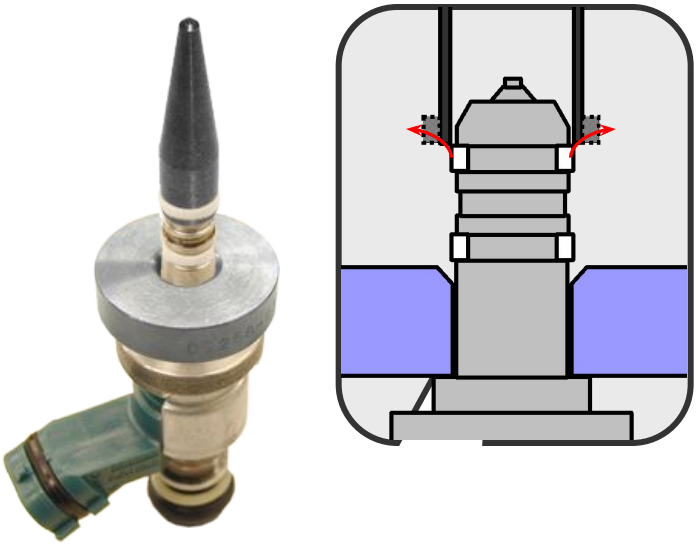
5. Settle the injector seal



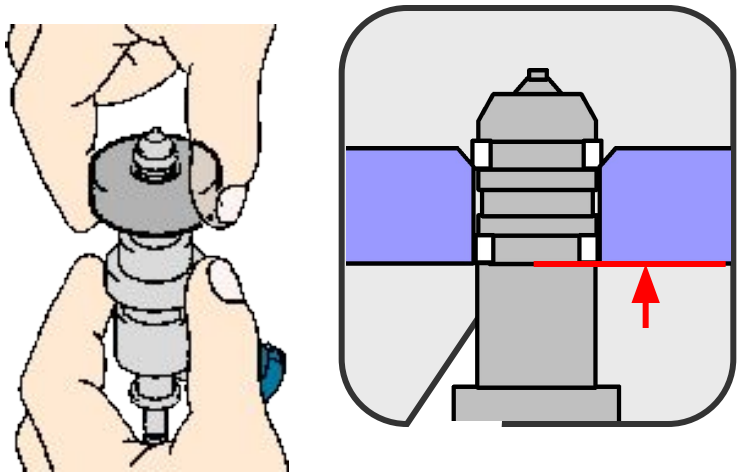
6. Install a new injector seal

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



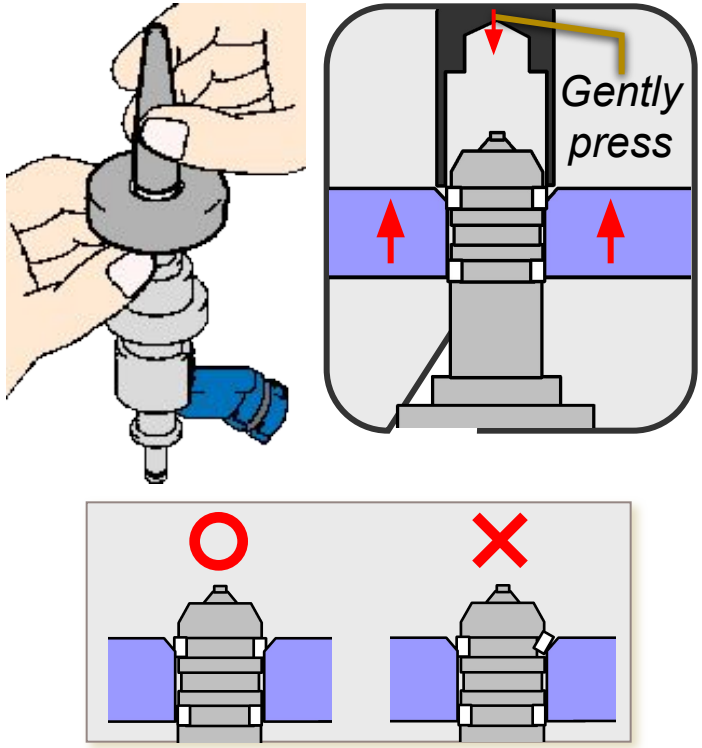
7. Slide the injector seal into the injector groove



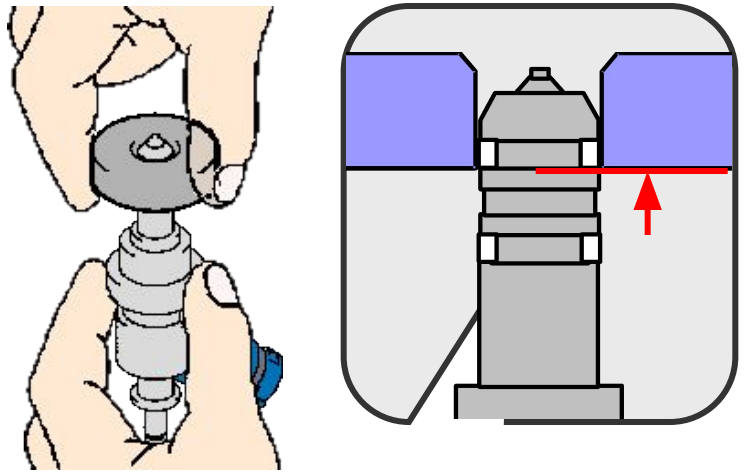
8. Fully align the injector seal

Service Point (D-4 System)

- Injector
  - Replacement of injector seals (using SST)



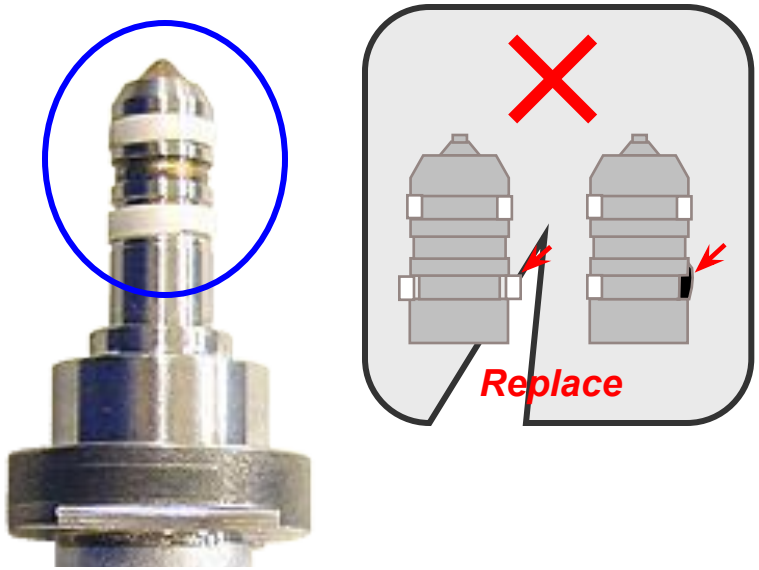
9. Settle the injector seal



10. Fully align the injector seal

Service Point (D-4 System)

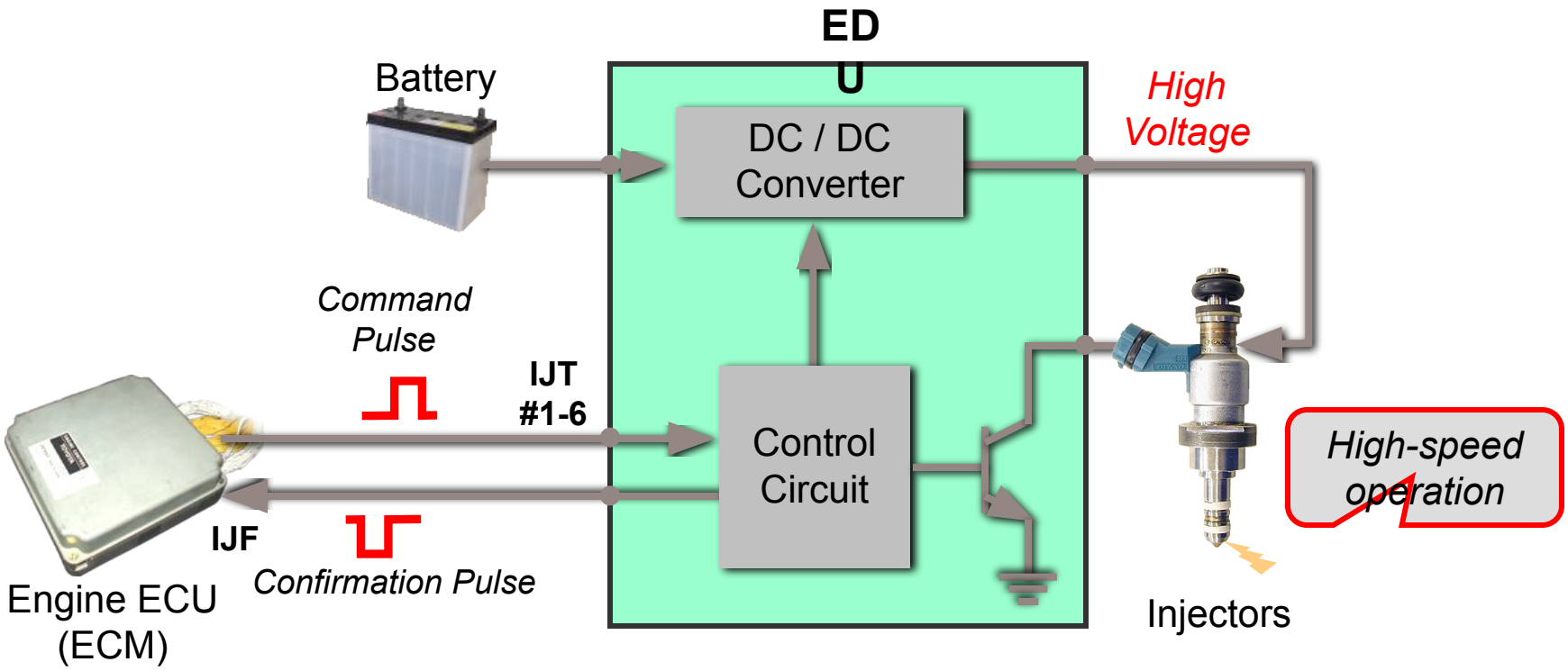
- Injector
  - Replacement of injector seals (using SST)



11. Check the injector seals

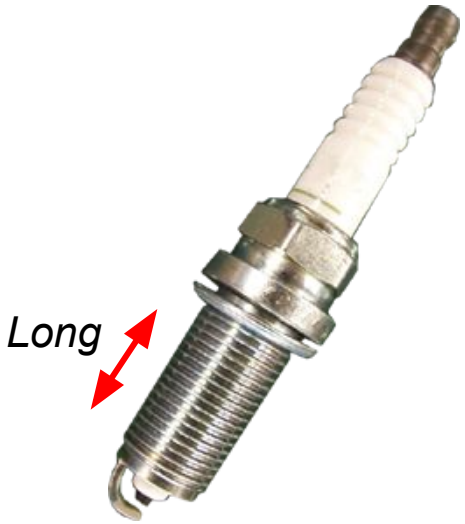
D-4 System

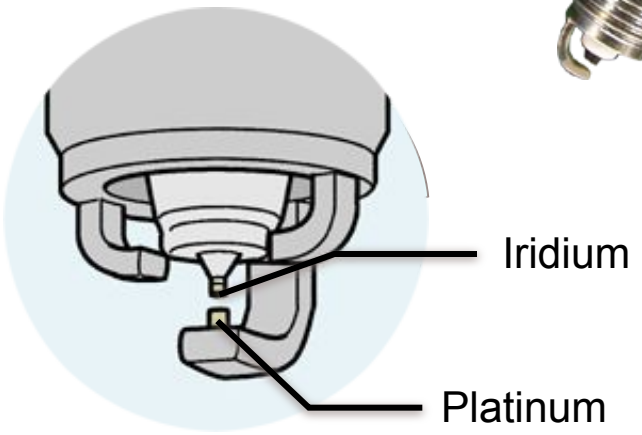
- EDU (Electronic Driver Unit)
  - Drives the injectors at high speed

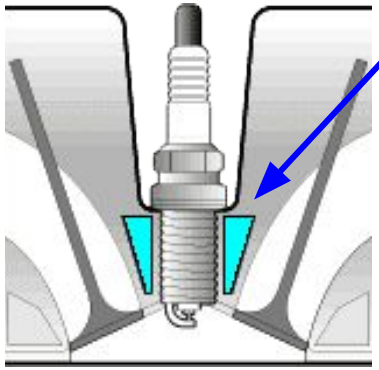


Ignition System

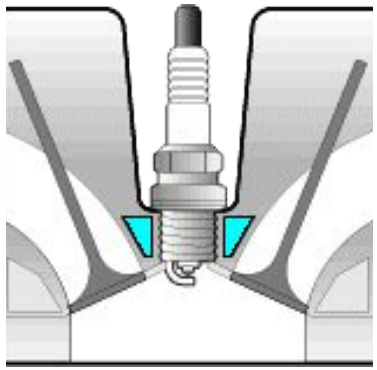
- Spark Plug
  - Long-reach type spark plug to improve cooling performance on cylinder head







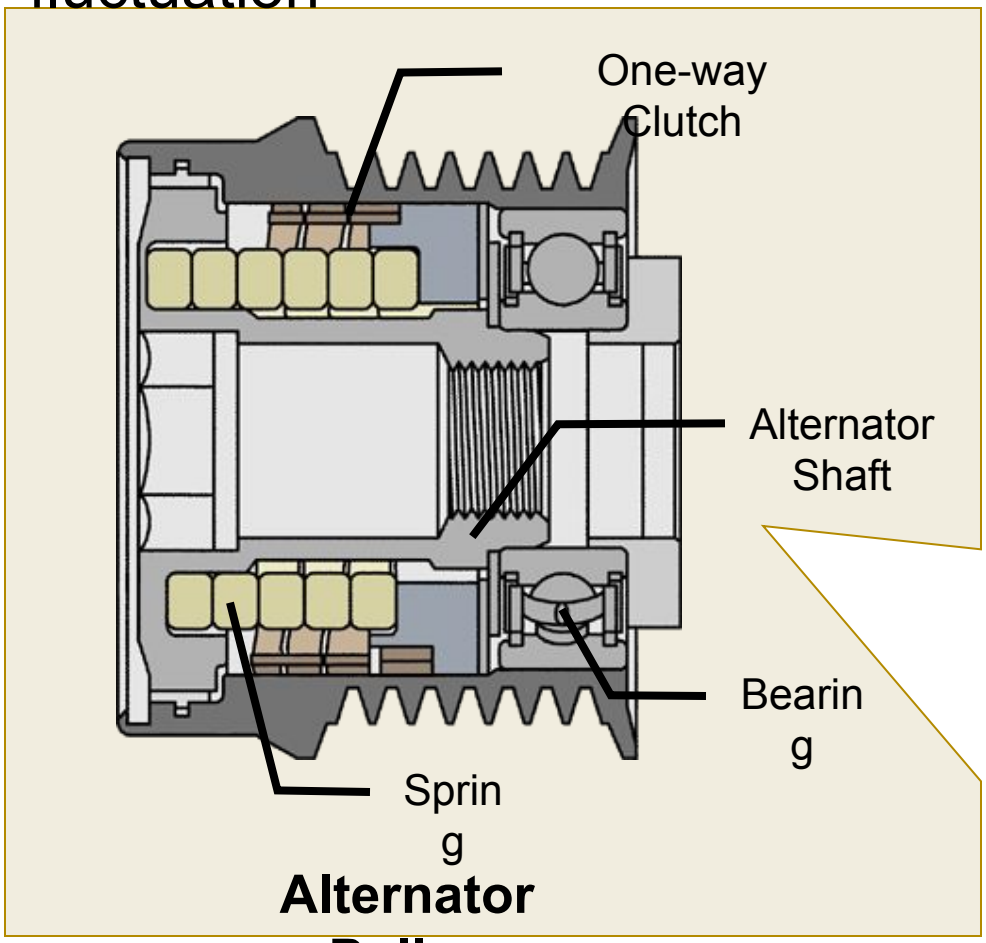
Long-reach Type

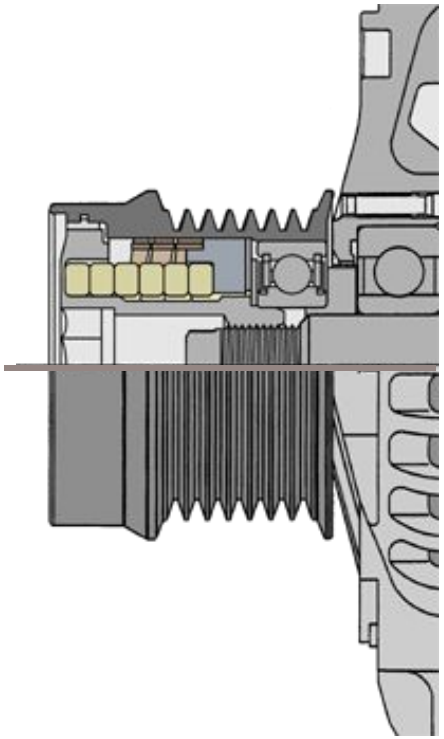


Normal Type

Charging System

- Alternator Pulley
  - One-way clutch is used in the pulley to absorb engine fluctuation

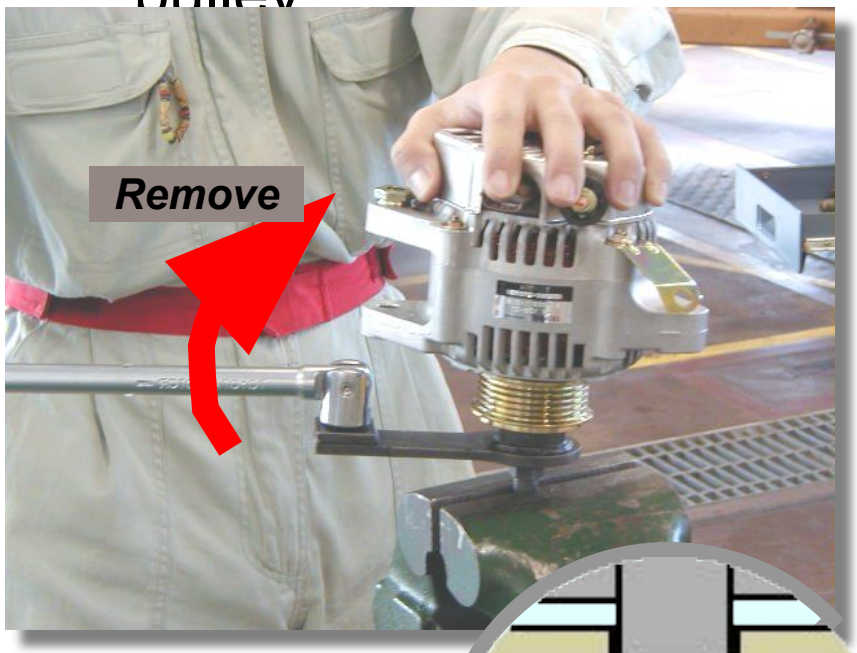


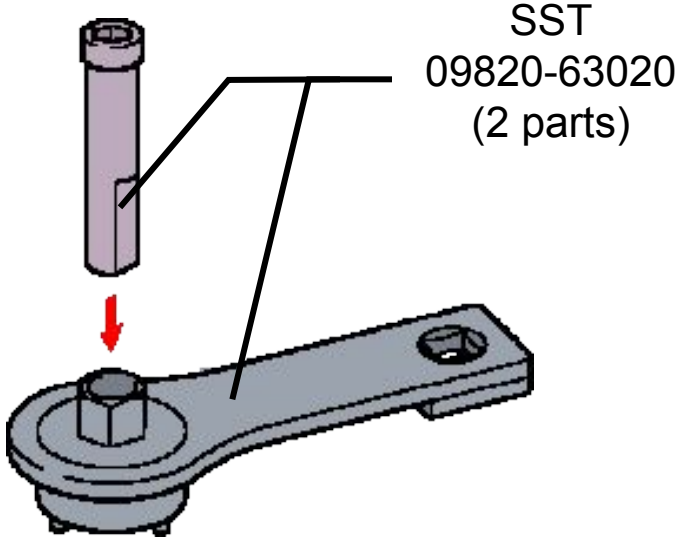


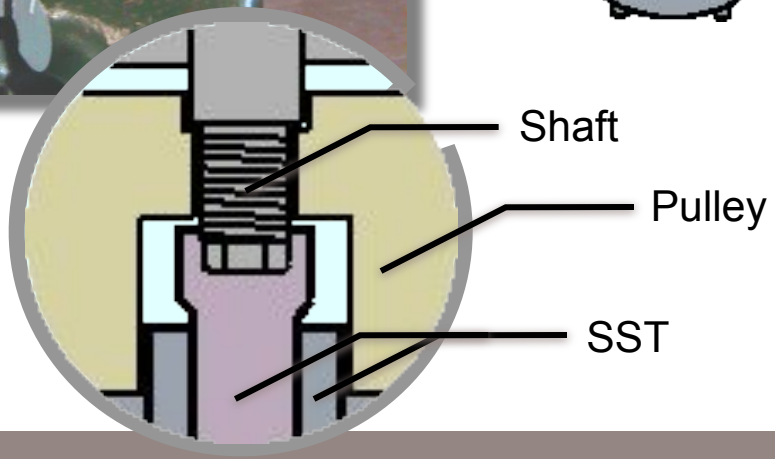
Alternator

Service Point (Charging System)

- Alternator Pulley
  - Using a SST, when remove or install the alternator pulley

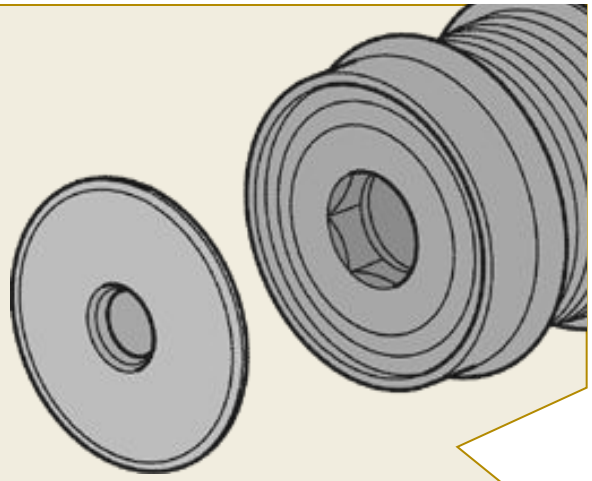






Service Point (Charging System)

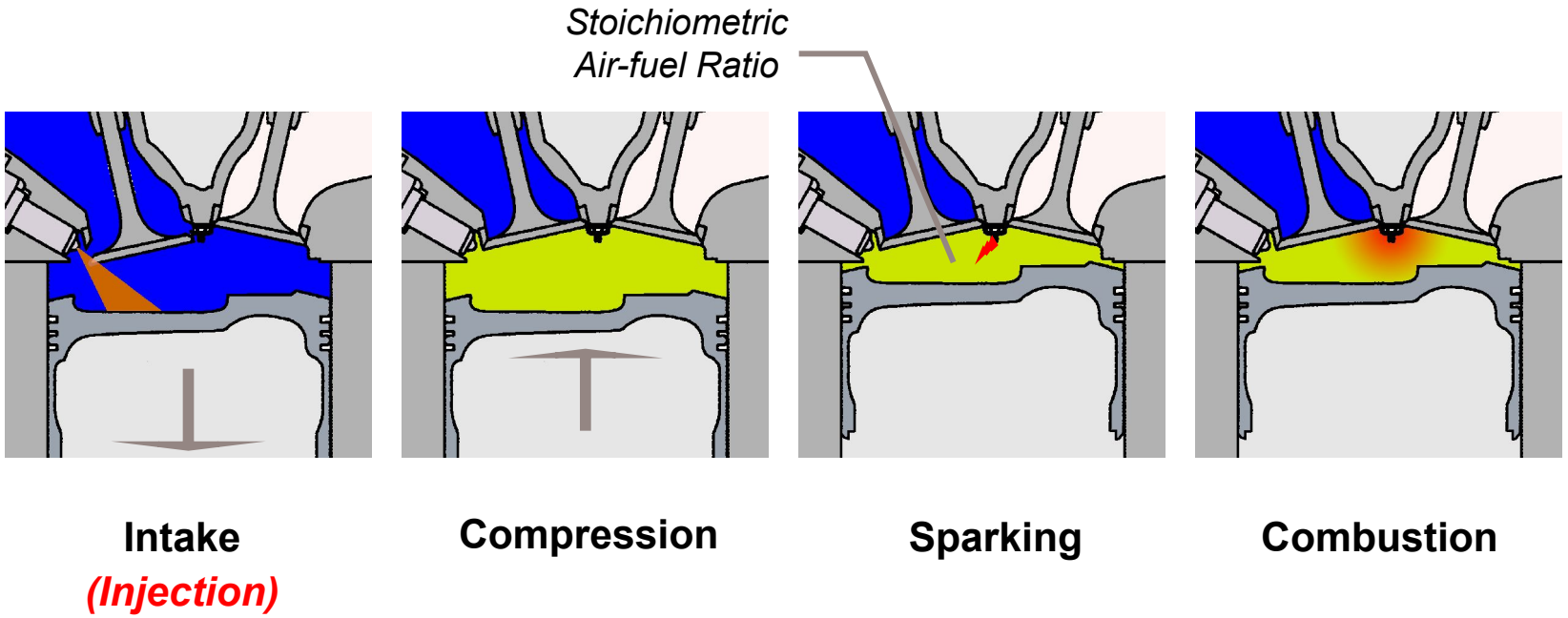
- Alternator Pulley
  - Alternator pulley cap is non-reusable part



Alternator Pulley Cap
(Non-reusable Part)

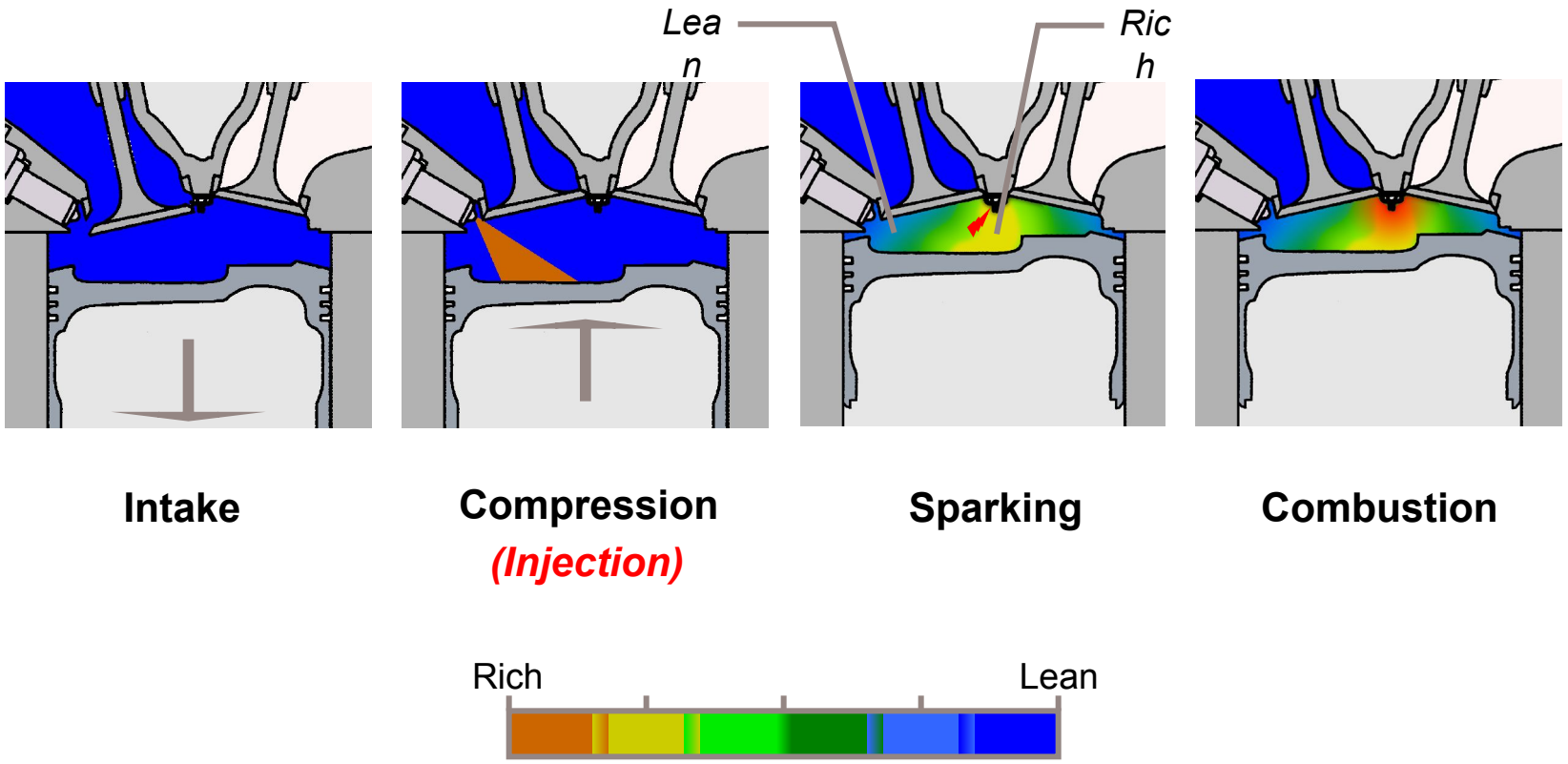
Engine Control System

- D-4 EFI Control (for 4GR-FSE)
  - D-4 EFI conducts the injection volume control and injection timing control simultaneously



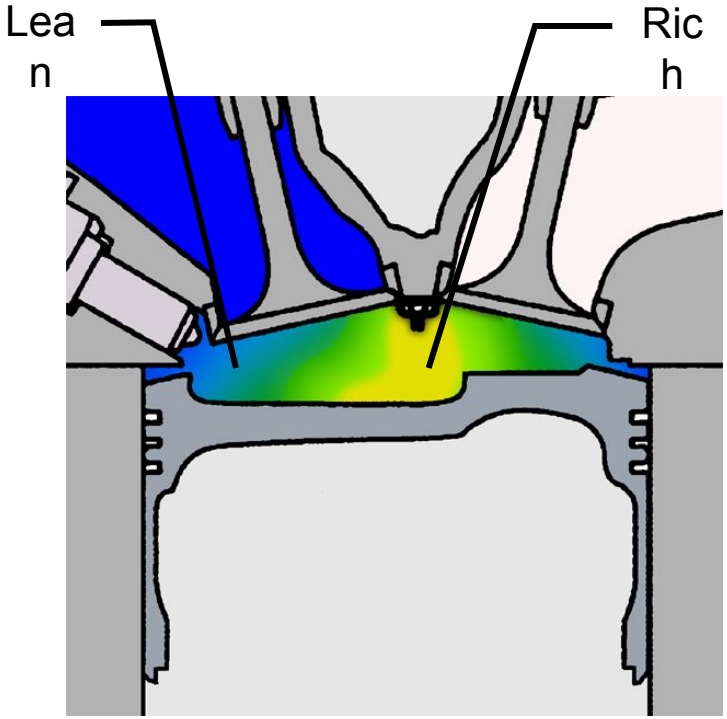
Engine Control System

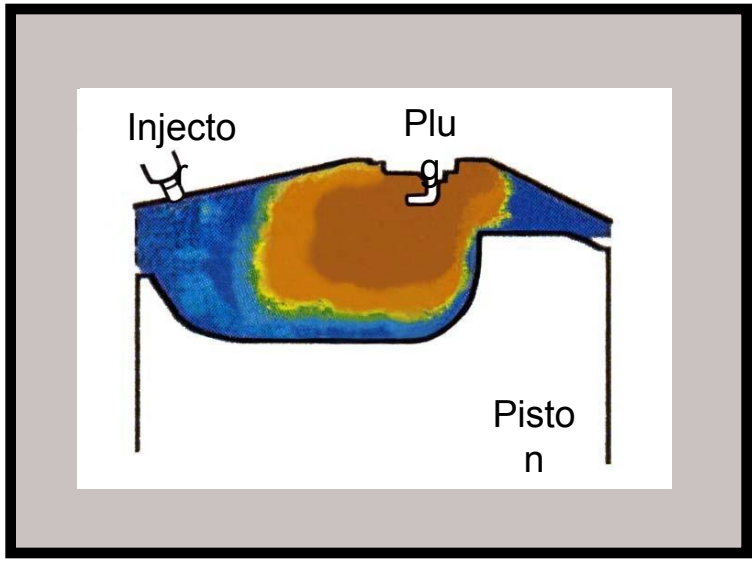
- D-4 EFI Control (for 4GR-FSE)
  - At cold start, weak stratification combustion to improve TWC worm-up performance



Reference (Engine Control System)

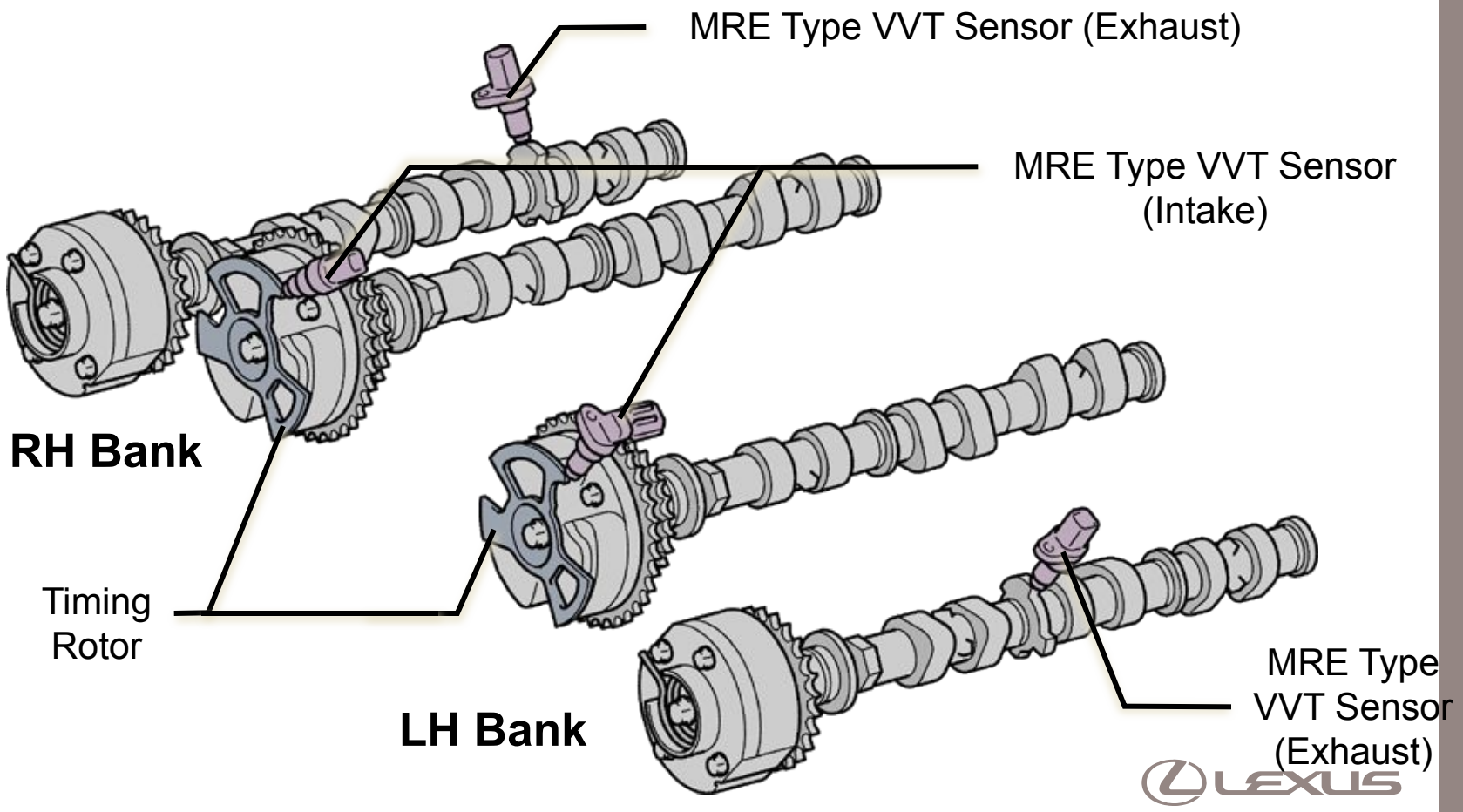
- D-4S fuel control (for 4GR-FSE)
  - Weak stratification combustion
    - Creates rich and lean portions of air-fuel mixture within the combustion chamber





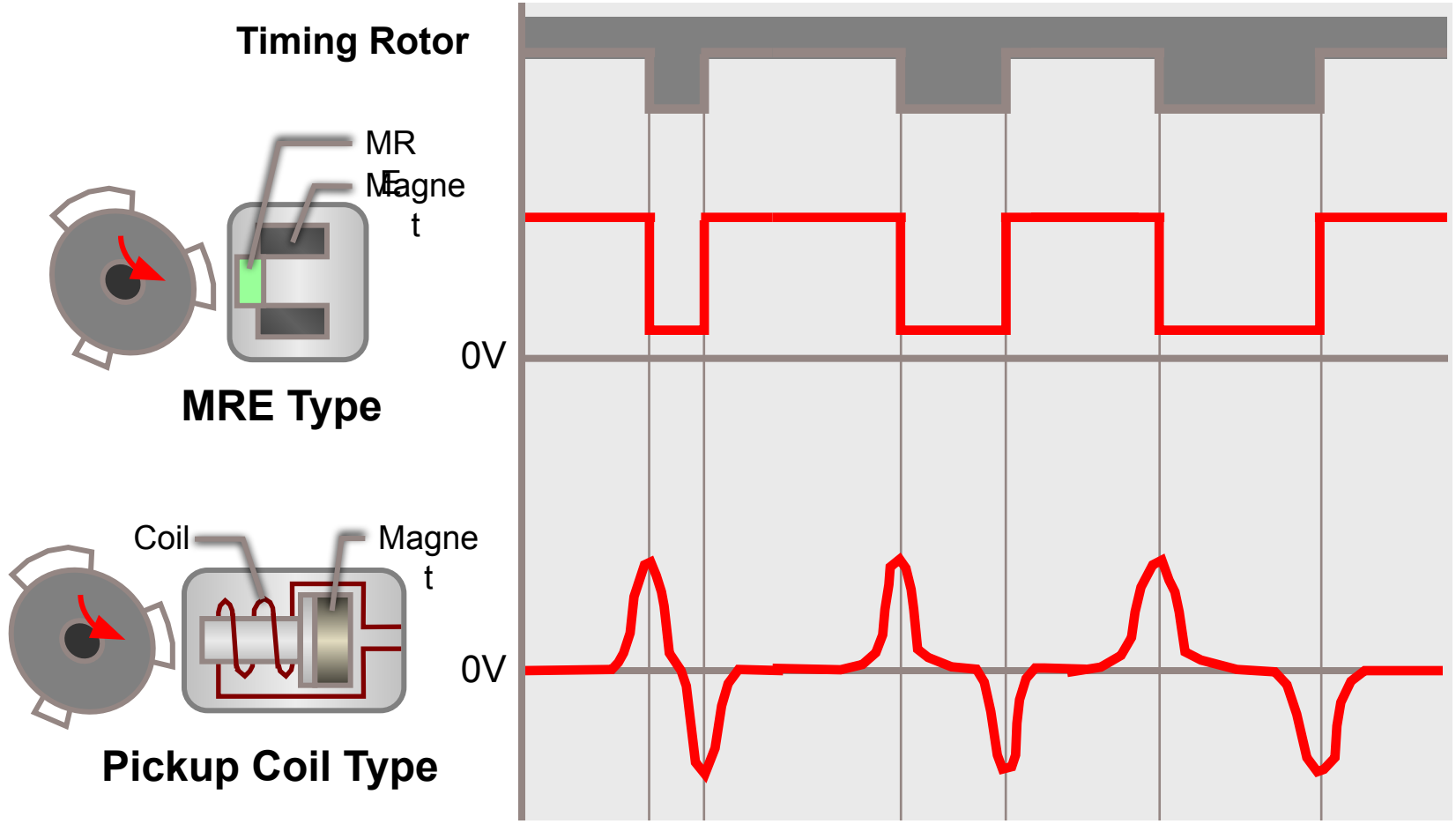
Engine Control System

- VVT Sensor
  - 4 MRE type VVT sensors are used for intake and exhaust camshaft of each bank



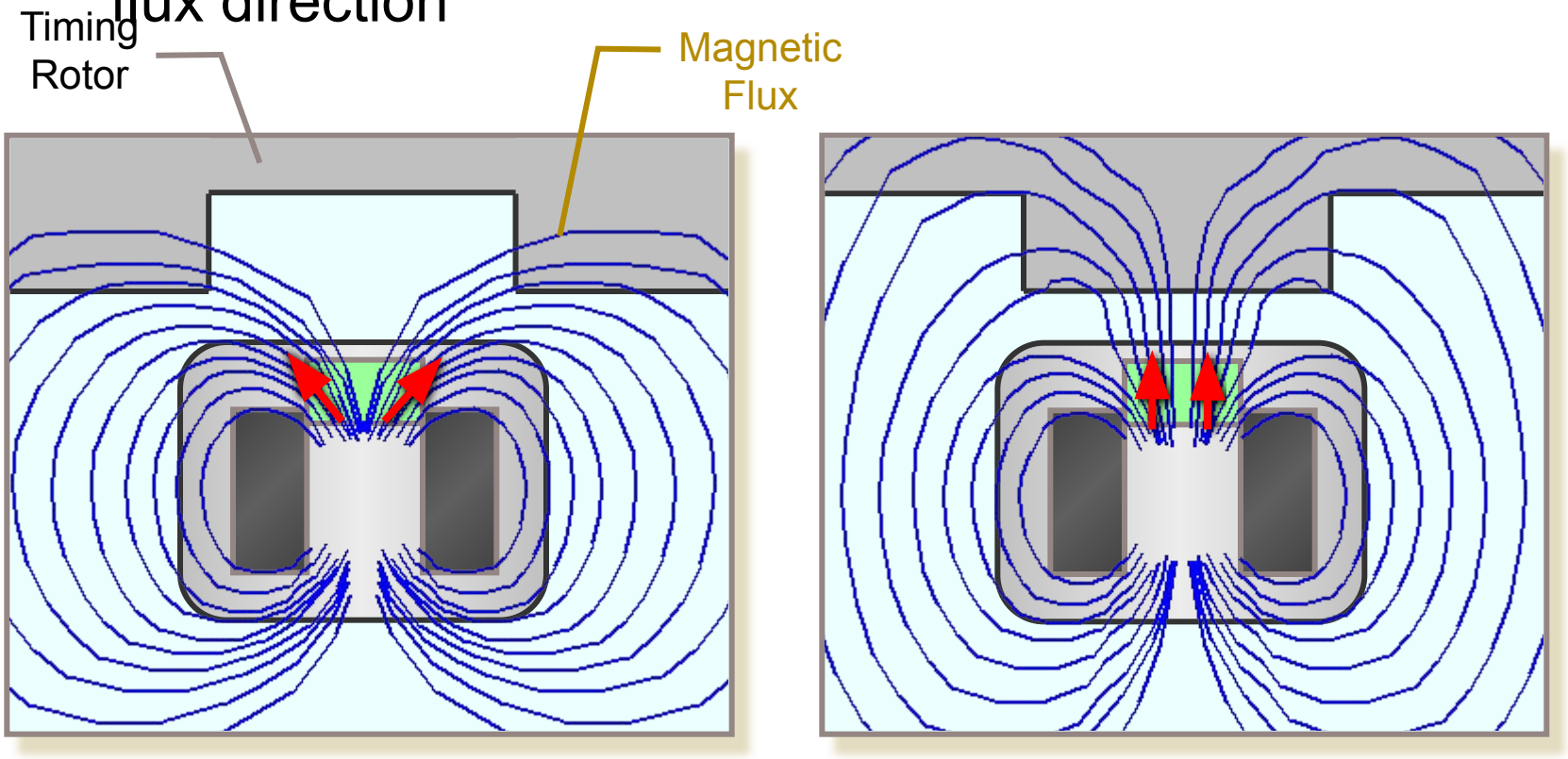
Reference (Engine Control System)

- Wheel sensor
  - Output signal is digital waveform



Reference (Engine Control System)

- MRE Sensor
  - The resistance of MRE is changed by the magnetic flux direction



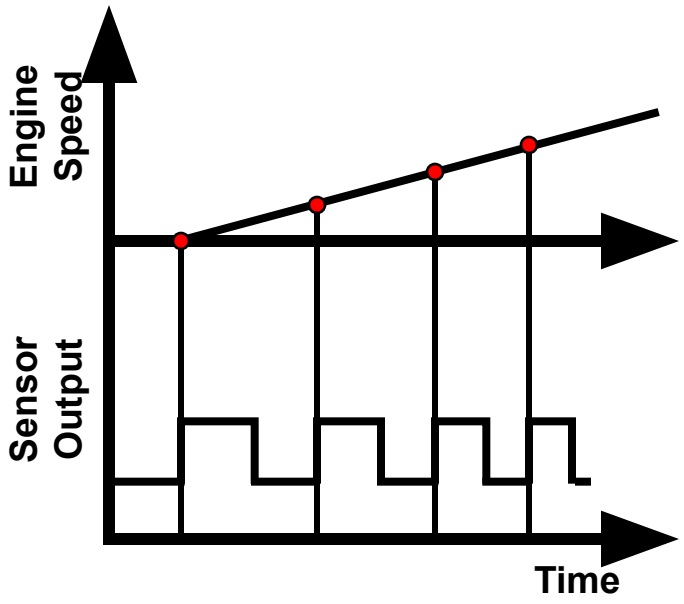
Sensor Output "High"

Sensor Output "Low"

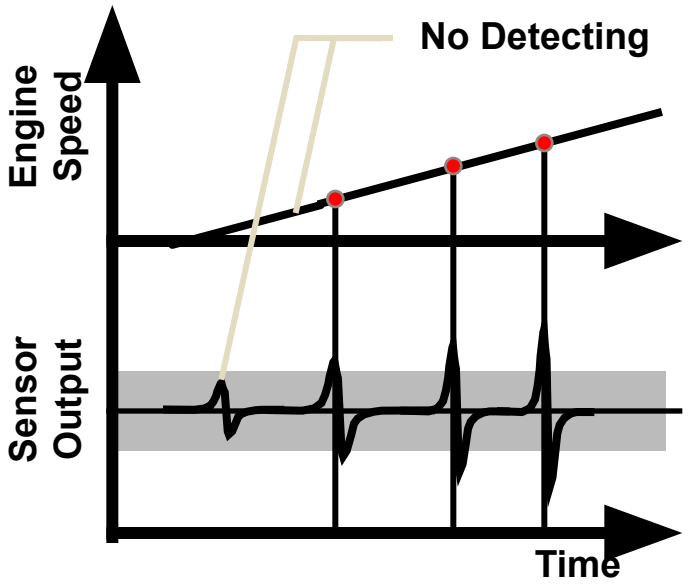
Reference (Engine Control System)

- MRE sensor
  - Signal output at extremely low speed rotation can be ensured

MRE Type

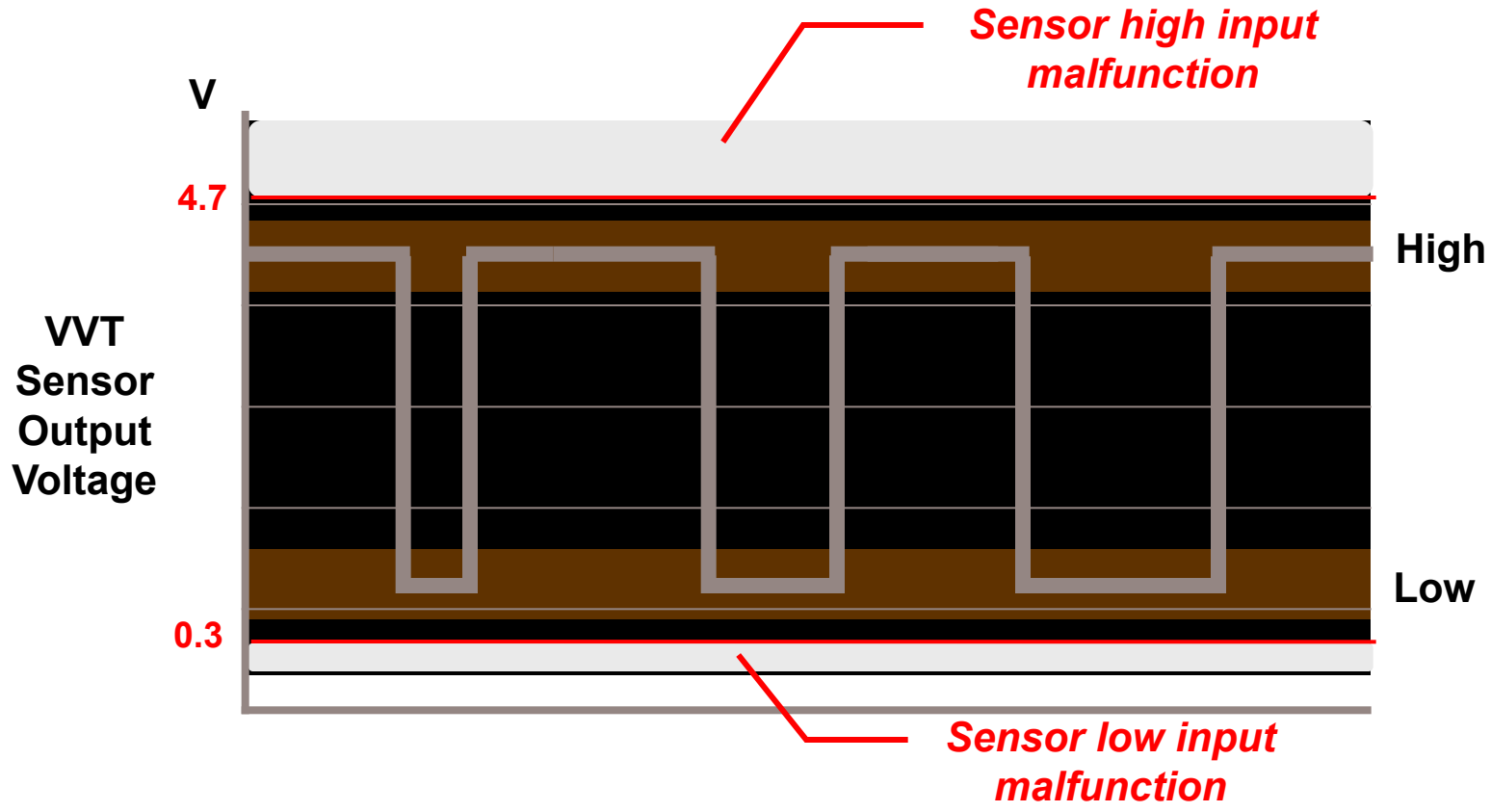


Pickup Coil Type



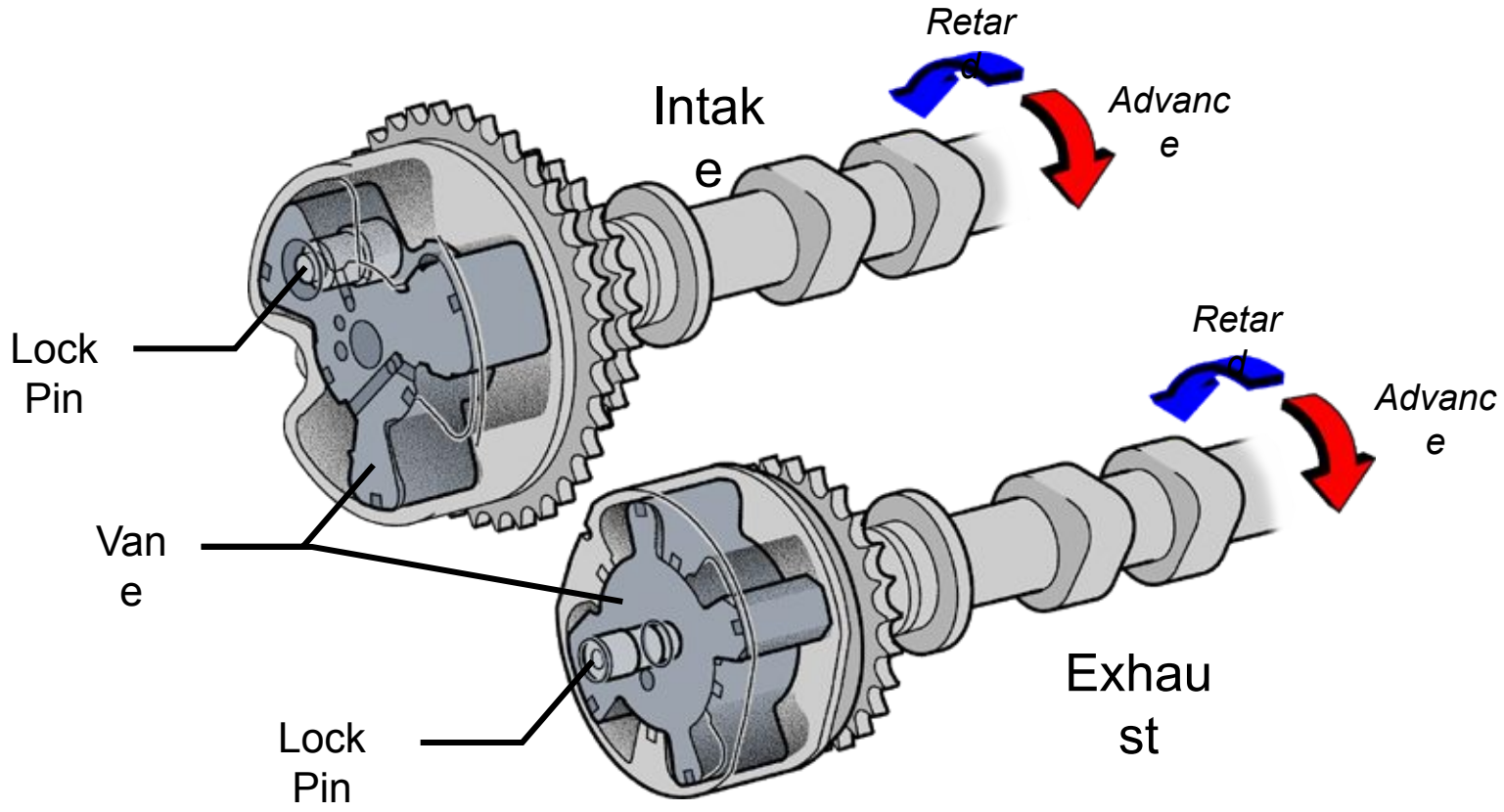
Reference (Engine Control System)

- System Sensor
  - By the adoption of MRE type VVT sensor, ECM can detects the sensor low input or high input malfunction



Engine Control System

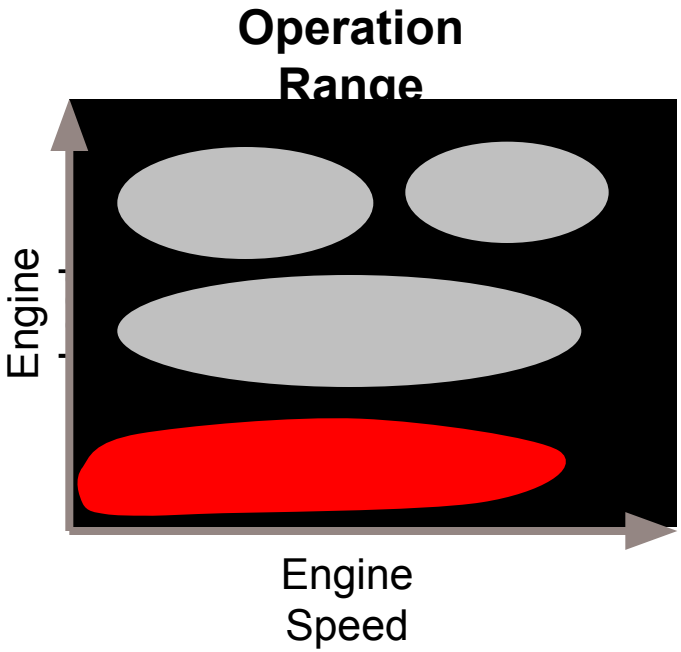
- Dual VVT-i (Variable Valve Timing – intelligent)
  - VVT-i is used for intake and exhaust camshafts



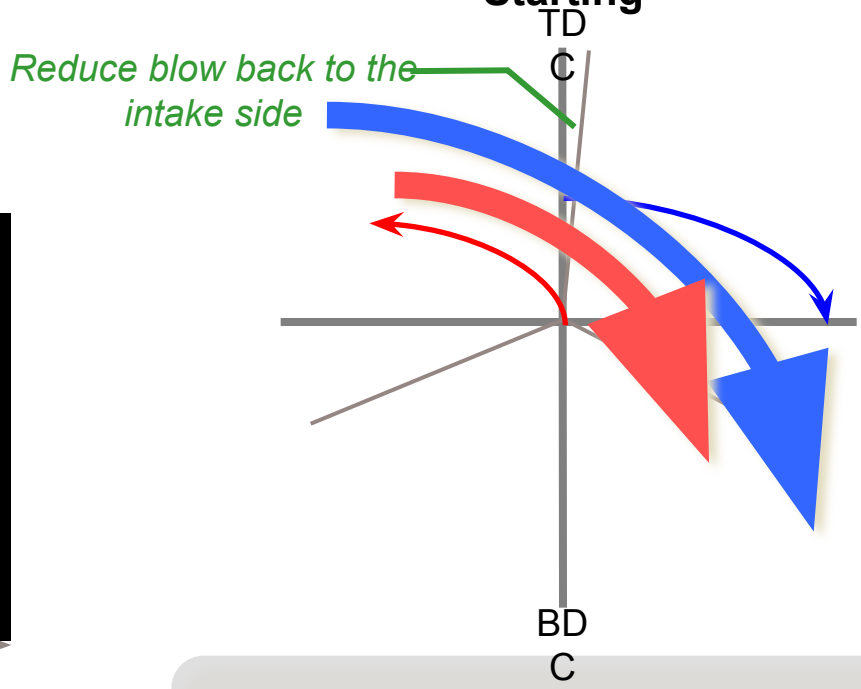
Dual VVT-i for LH Bank

Reference (Engine Control System)

- Dual VVT-i
  - Operation



At Idle, Light Load, Low Temp. and Starting

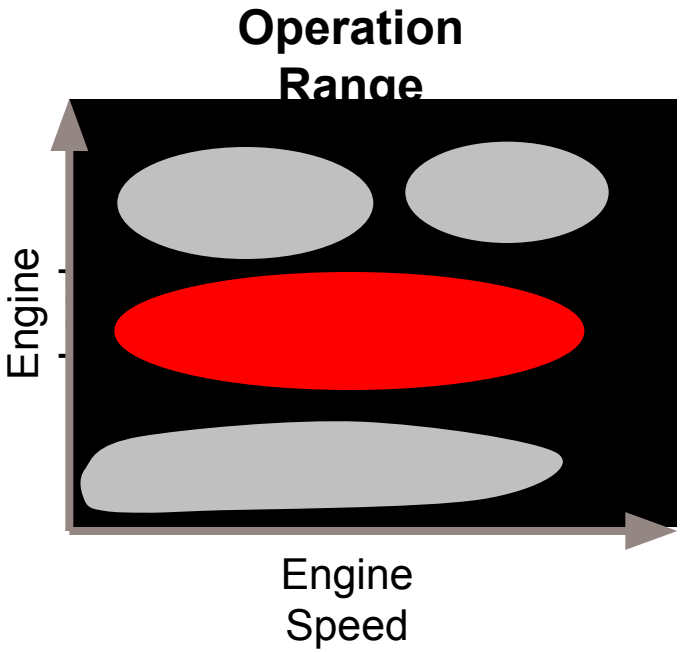


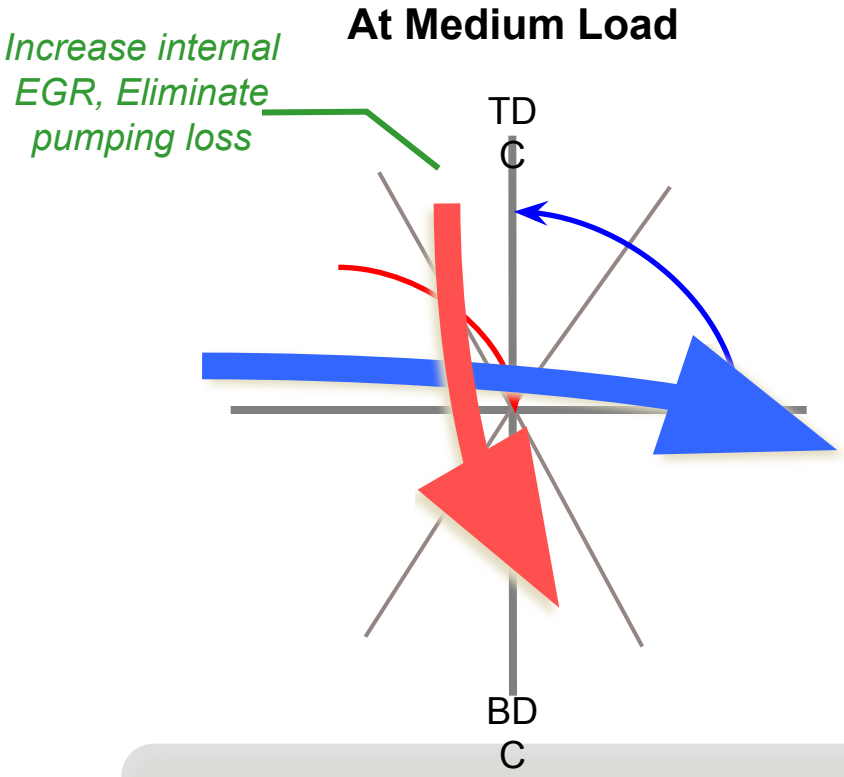
Effect

- Stable combustion for fuel economy

Reference (Engine Control System)

- System
  - Operation

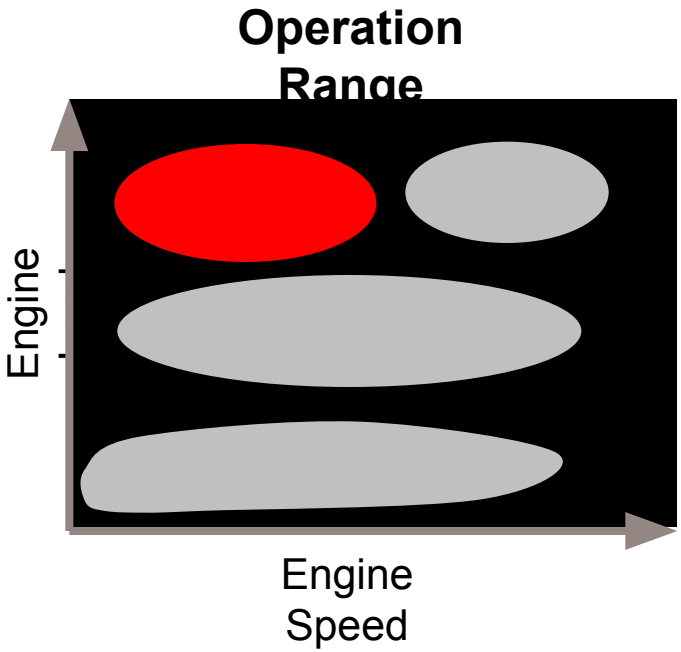


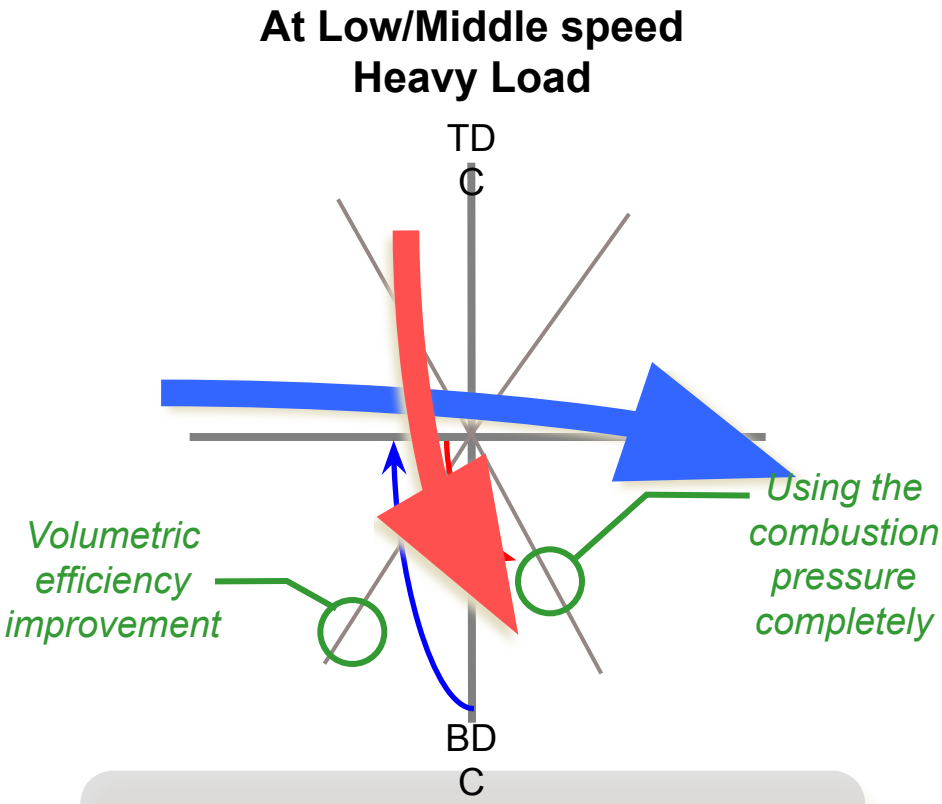


- Effect
  - Improved emission control
  - Better fuel economy

Reference (Engine Control System)

- System
  - Operation



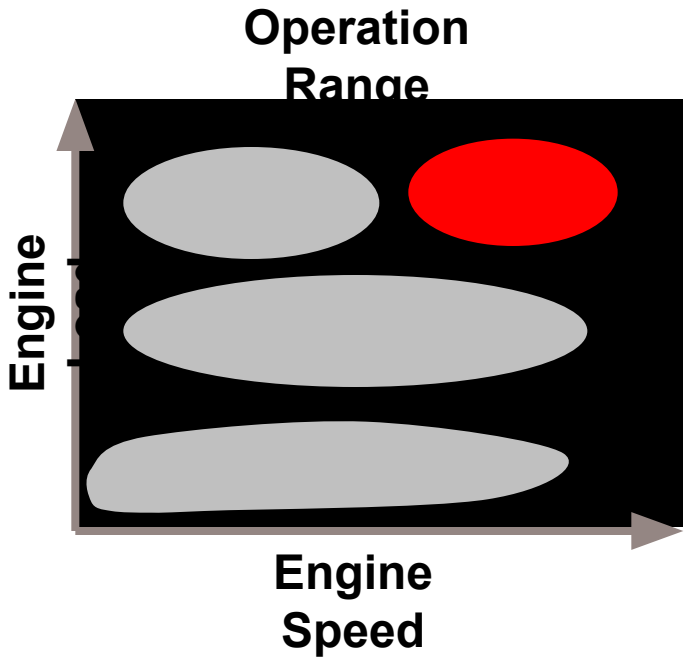


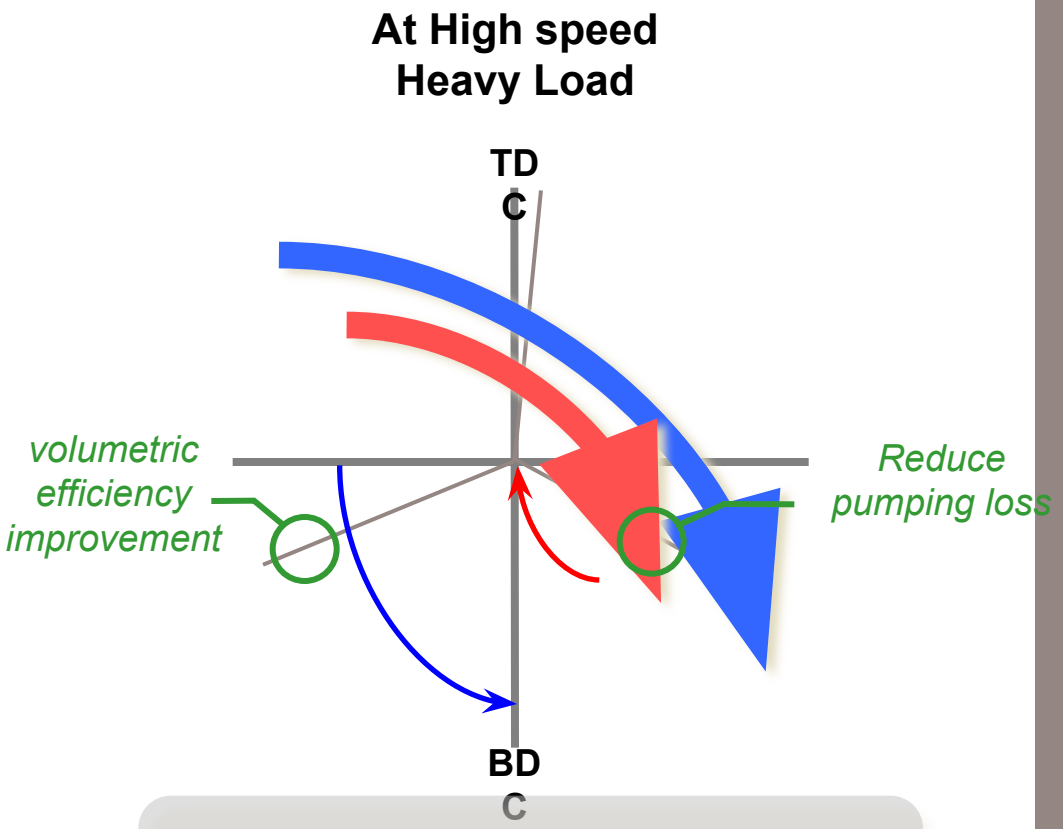
Effect

- Improved torque/output

Reference (Engine Control System)

- System
  - Operation





- Effect
  - Improved output

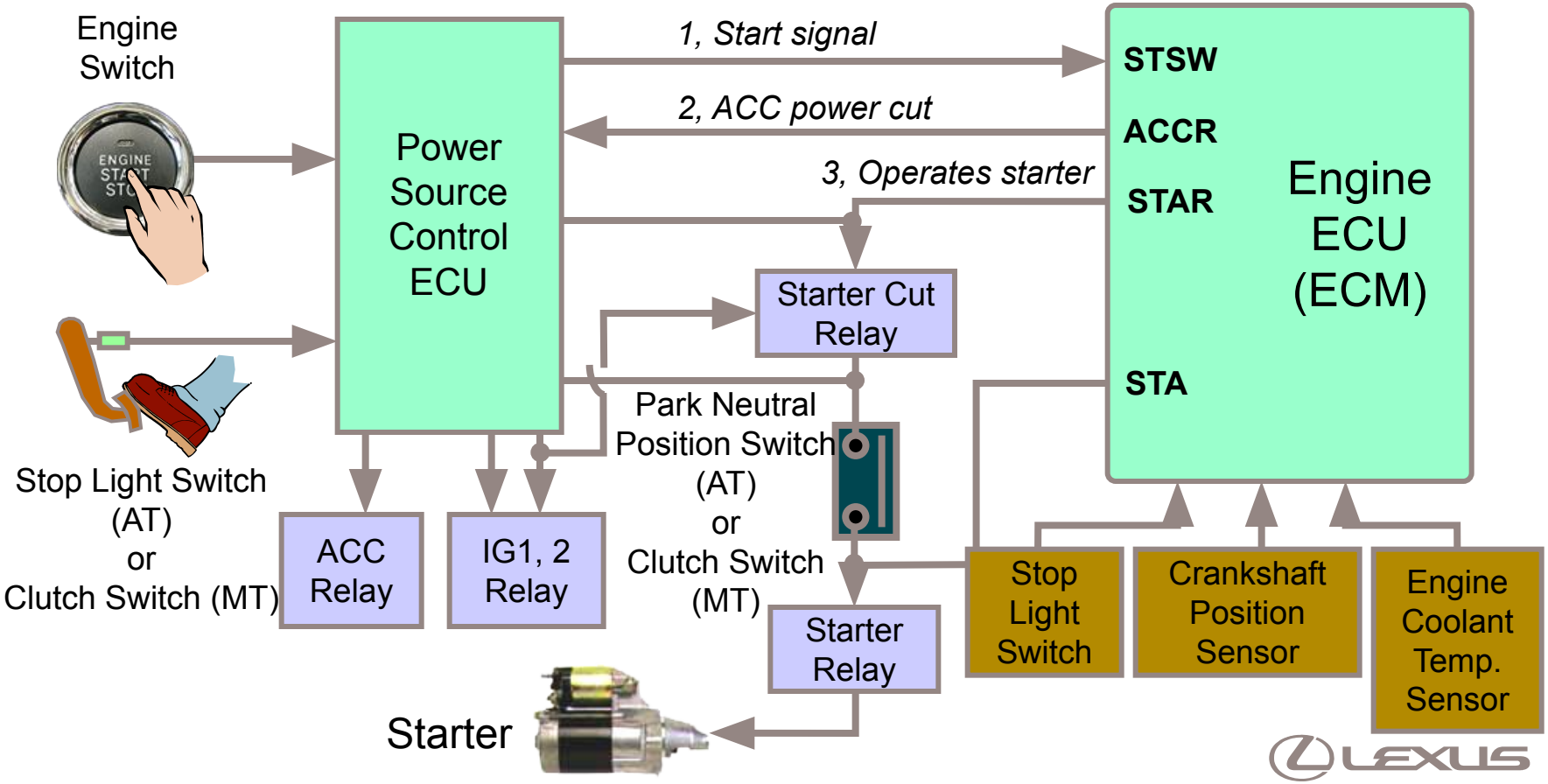
Service Point (Engine Control System)

- Dual VVT-i
  - Following 14 DTCs are added by adoption of exhaust VVT-i

DTC No.	Detection Item	DTC No.	Detection Item
P0013	Camshaft Position "B" Actuator Circuit (Bank 1)	**P0025**	Camshaft Position "B" - Timing Over-Retarded (Bank 2)
P0014	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 1)	**P0365**	Camshaft Position Sensor "B" Circuit (Bank 1)
P0015	Camshaft Position "B" - Timing Over-Retarded (Bank 1)	**P0367**	Camshaft Position Sensor "B" Circuit Low Input (Bank 1)
P0017	Crankshaft Position - Camshaft Position Correlation (Bank 1 Sensor B)	**P0368**	Camshaft Position Sensor "B" Circuit High Input (Bank 1)
P0019	Crankshaft Position - Camshaft Position Correlation (Bank 2 Sensor B)	**P0390**	Camshaft Position Sensor "B" Circuit (Bank 2)
P0023	Camshaft Position "B" Actuator Circuit (Bank 2)	**P0392**	Camshaft Position Sensor "B" Circuit Low Input (Bank 2)
P0024	Camshaft Position "B" - Timing Over-Advanced or System Performance (Bank 2)	**P0393**	Camshaft Position Sensor "B" Circuit High Input (Bank 2)

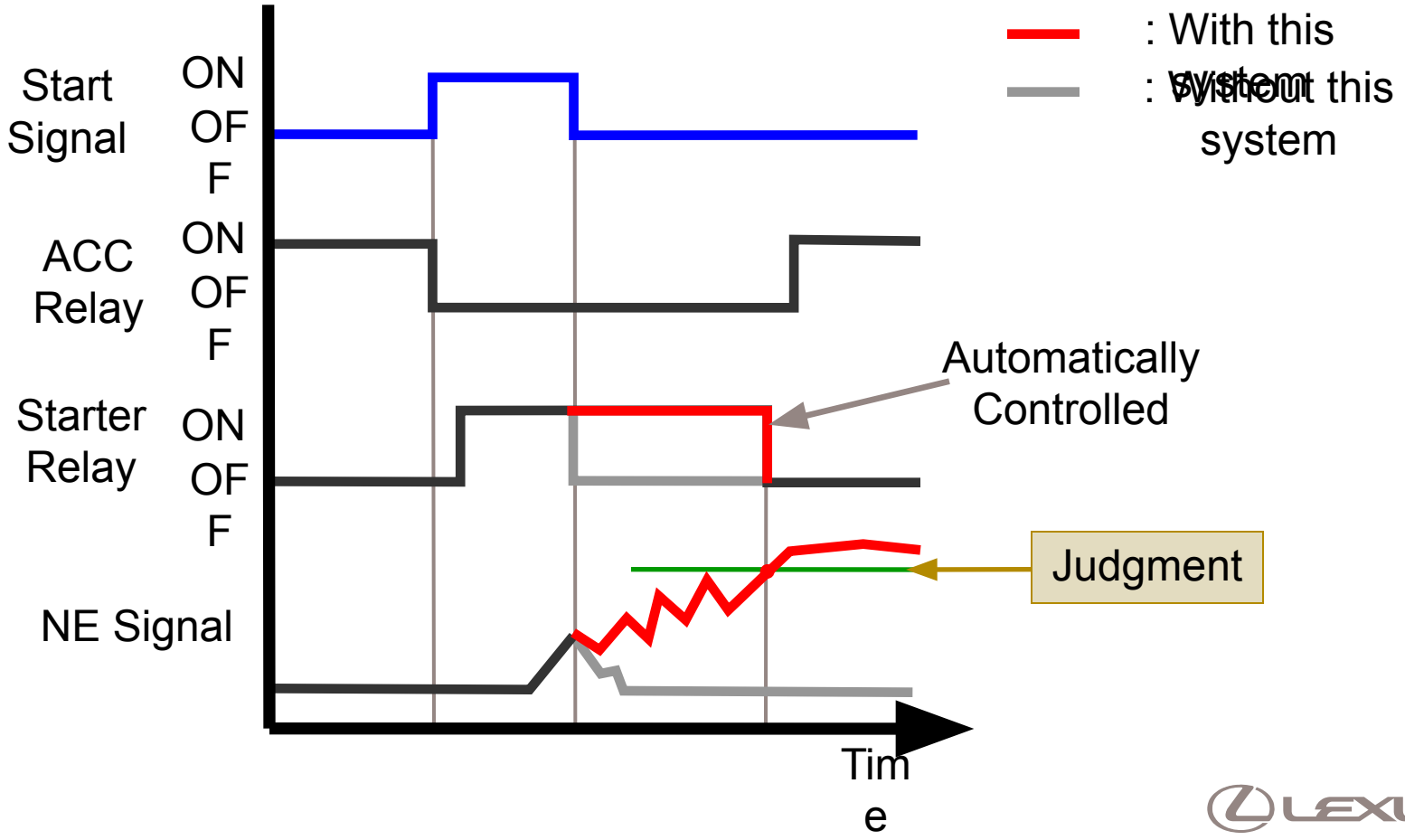
Engine Control System

- Cranking Hold Function
  - Once the power mode is turned to “Engine Starting”, starter operates until engine starting



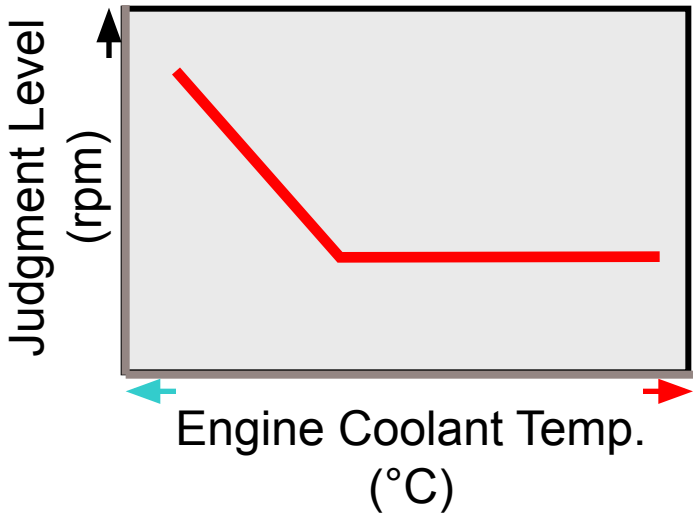
Reference (Engine Control System)

- Cranking Hold Function
  - Operation

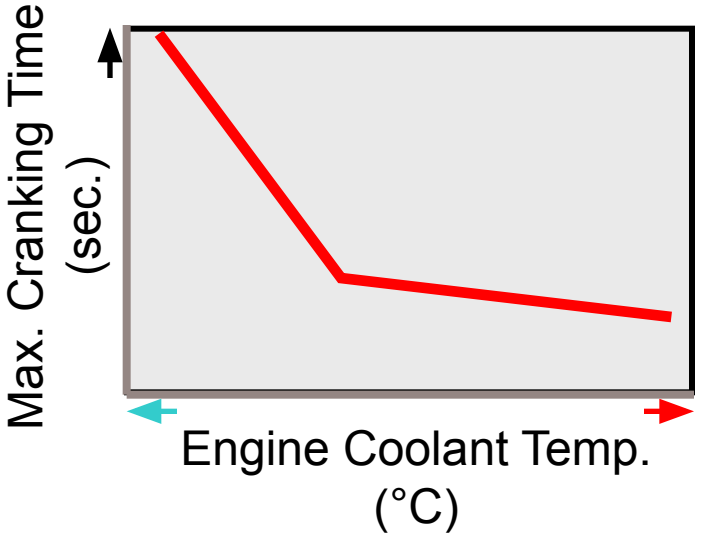


Reference (Engine Control System)

- Cranking Hold Function
  - Judgment of the engine firing
  - Maximum cranking time



Judgment of the engine firing



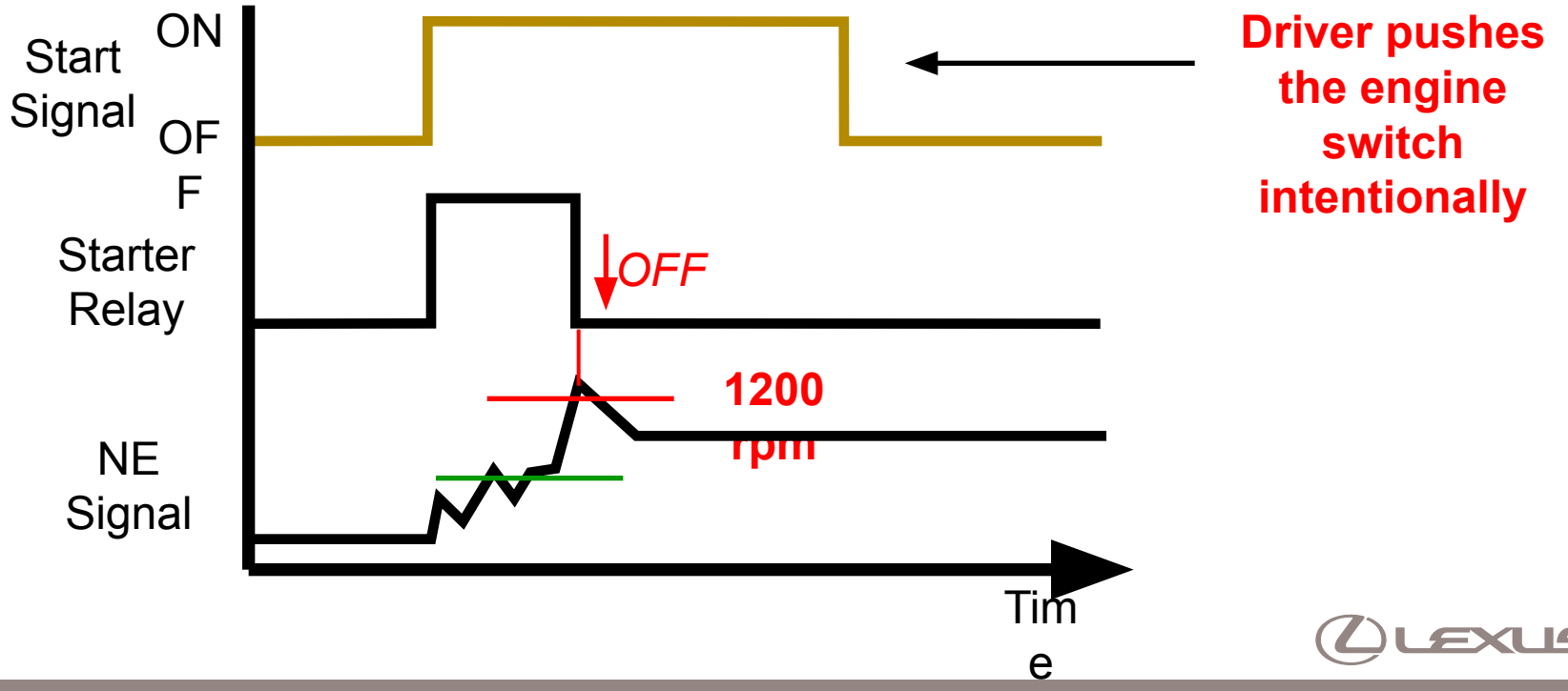
Maximum cranking time

(When engine does not start by some abnormalities)

Reference (Engine Control System)

- Cranking Hold Function
  - Protection during engine starting

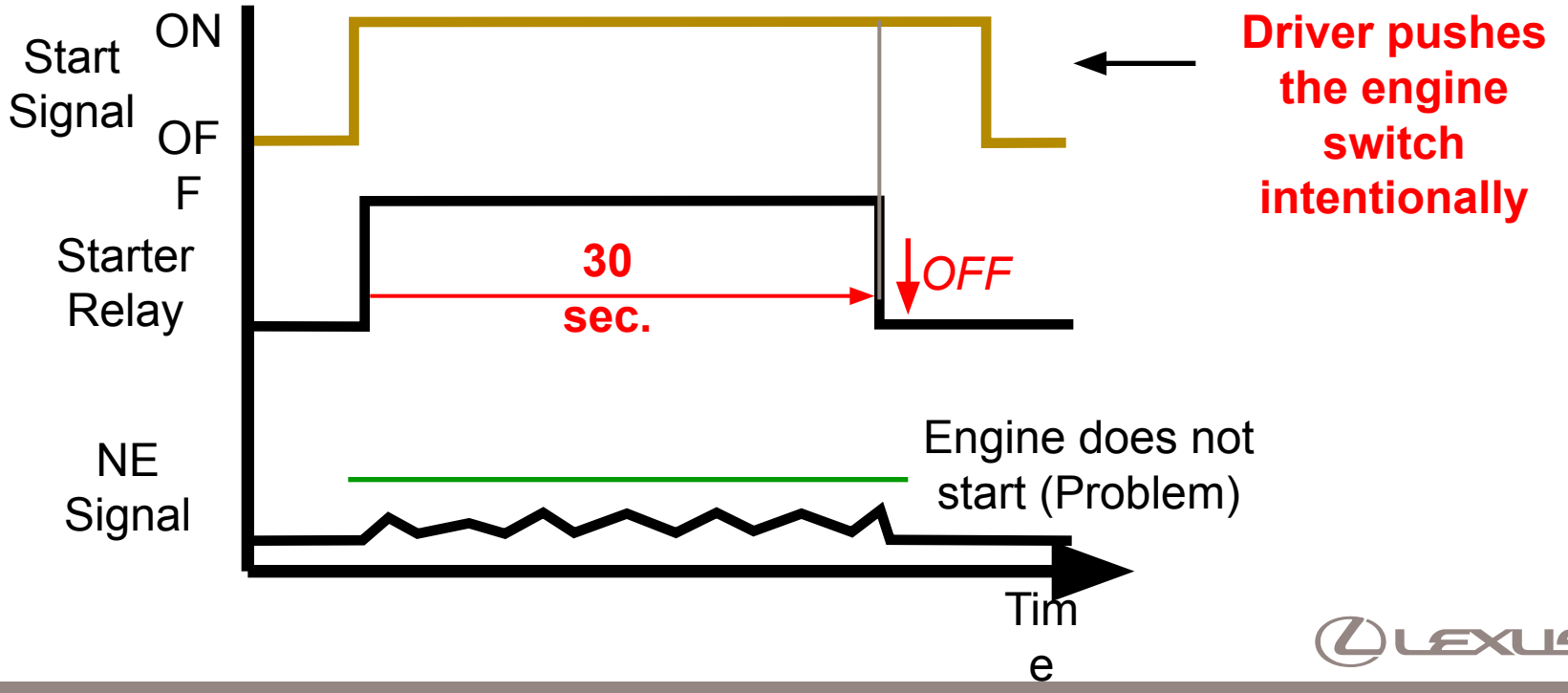
If the engine speed becomes 1200 rpm or more while cranking, engine ECU (ECM) stops starter to prevent starter overrun



Reference (Engine Control System)

- Cranking Hold Function
  - Protection during engine starting

Starter overheating protection operates starter max.30 sec.
with intentional starter operation



Engine Control System

- Communication
  - CAN (Controller Area Network) communication for DLC3 and other ECUs