

Electro-hydraulic Servo Actuation For Well Completions

SPE-210069-MS

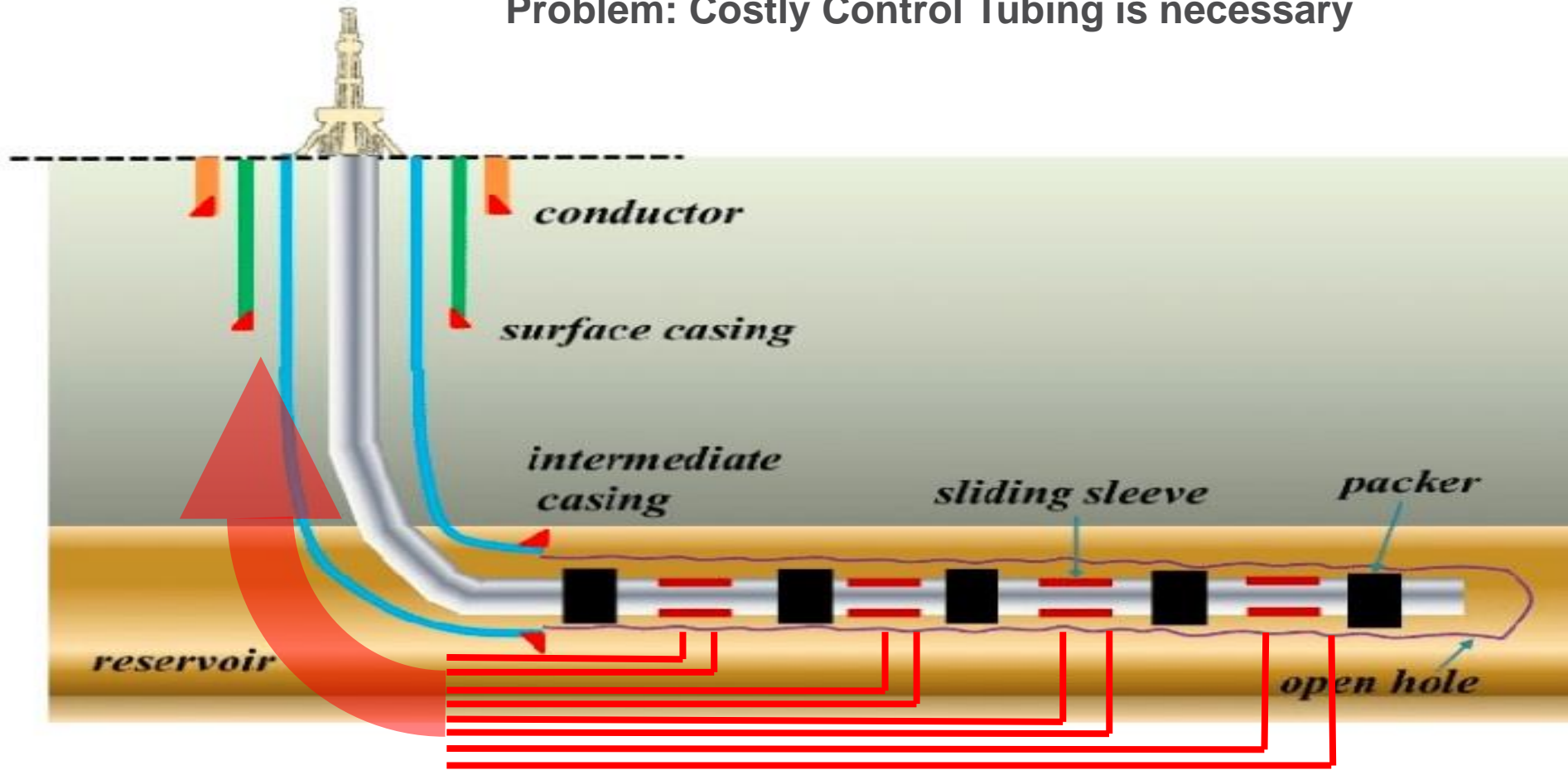
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Hydraulically controlled Multi-zone Well Completions

Problem: Costly Control Tubing is necessary



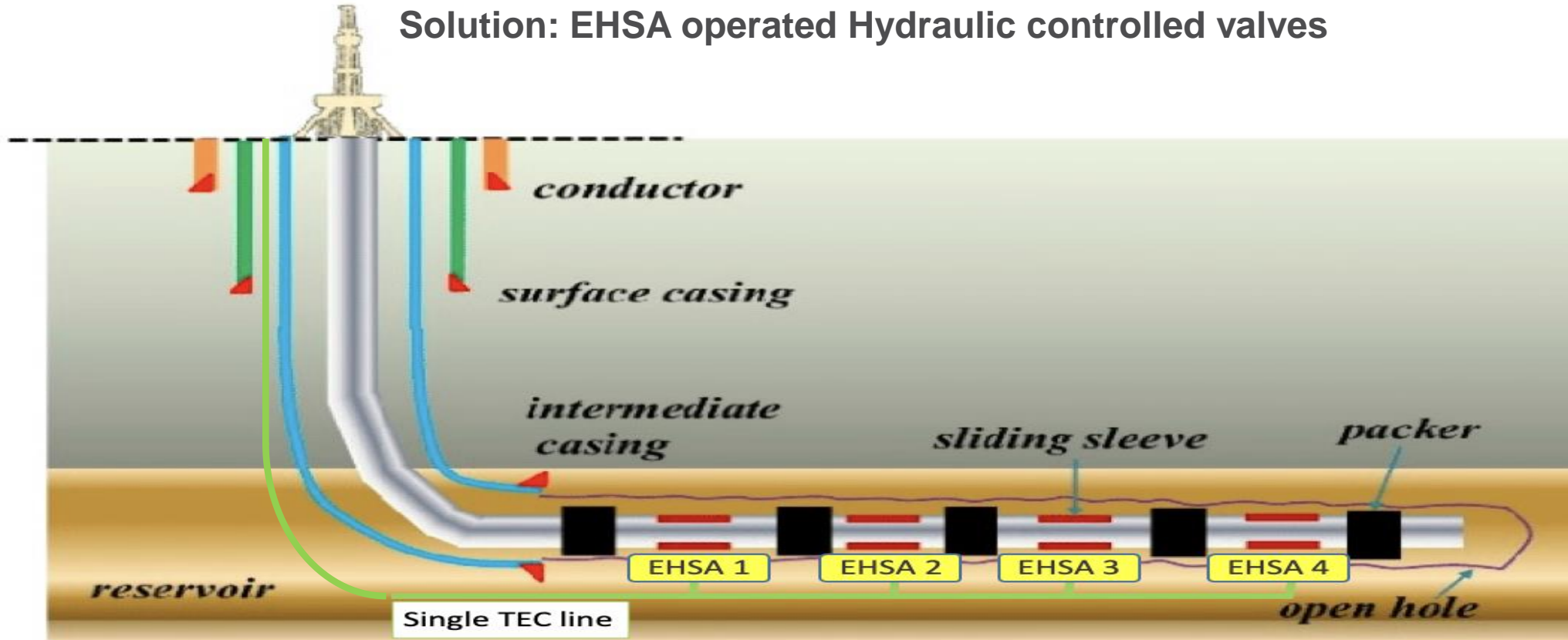
A typical hydraulically controlled 4 zone well completion requires **8 hydraulic control tubing lines**.

Advanced
Oilfield
Innovations



Electro-Hydraulic Servo Actuators (EHSA) – The Natural Progression

Solution: EHSA operated Hydraulic controlled valves



Single TEC line

- Connects all EHSA to the surface
- Power ALL EHSA
- Control each EHSA independently
- Expandable to large number of control valves



**LOWER COST
UNLIMITED VALVES
PRECISION CONTROL
EXISTING CERTIFIED VALVES**



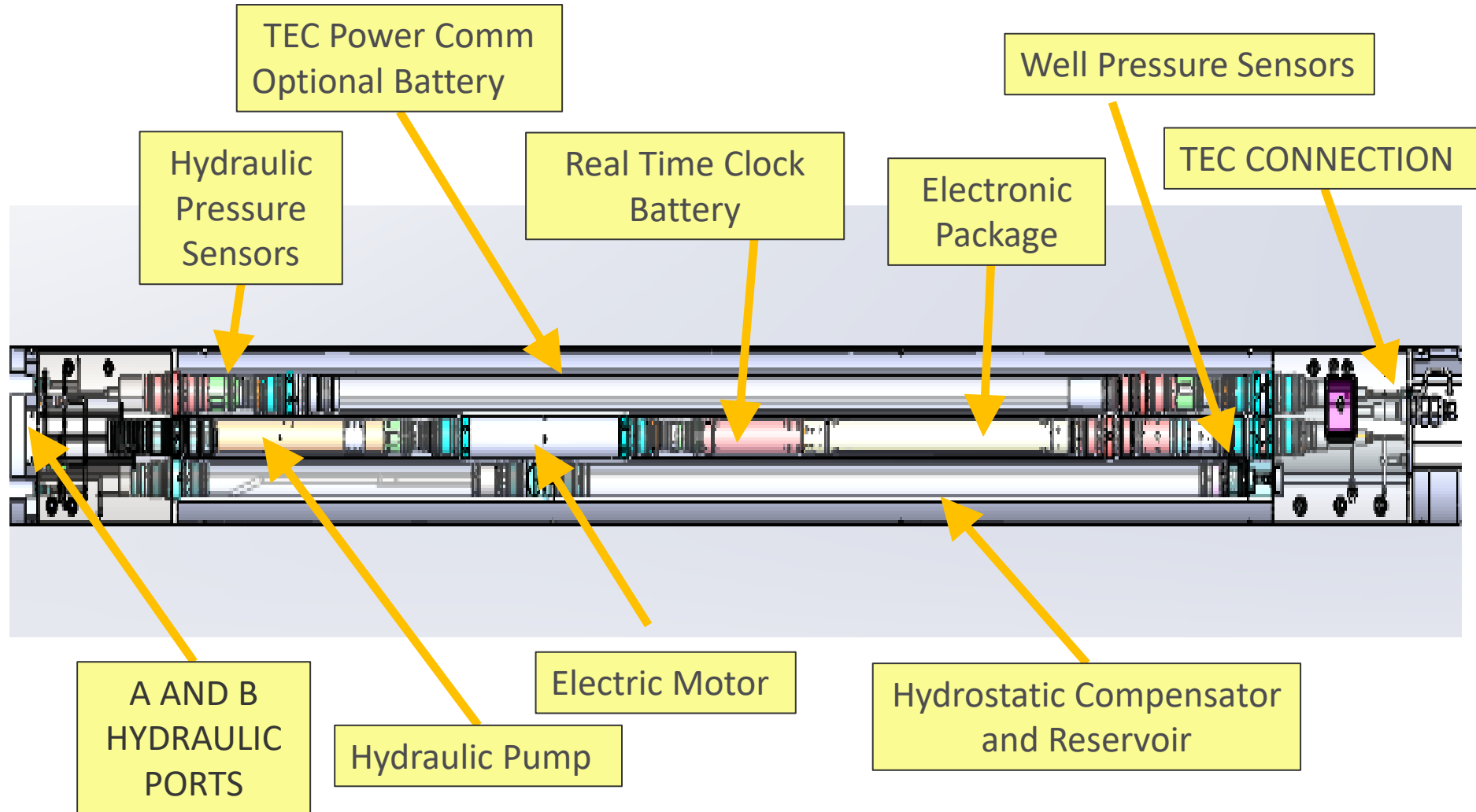
Core of Electro-Hydraulic Servo Actuator

EHSA Program Started in 2014

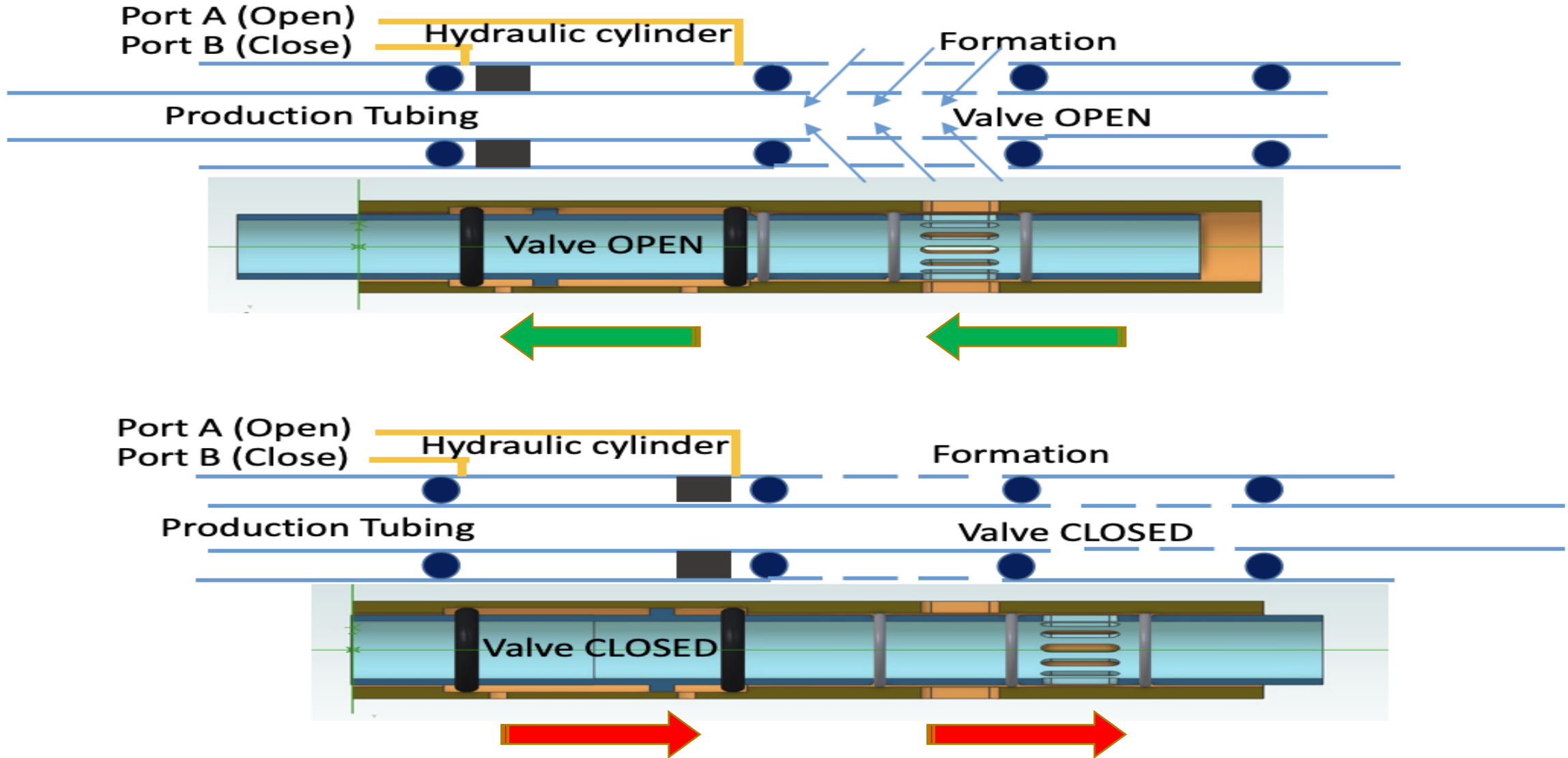
FEATURE SET REQUIREMENTS

- ✓ Bi-Directional flow
- ✓ No solenoid needed to reverse flow
- ✓ Positive Displacement Pump (volumetric)
- ✓ No check valves
- ✓ Releases Pressure when power is off or lost
- ✓ By design guarantees NOT to hydraulically lock
- ✓ Operates unbalanced and single ended pistons
- ✓ Remedial capabilities
- ✓ Simplicity Achieves Reliability
- ✓ Debris tolerant
- ✓ Requires NO priming
- ✓ Pump Diameter 23 mm (< 1 inch)

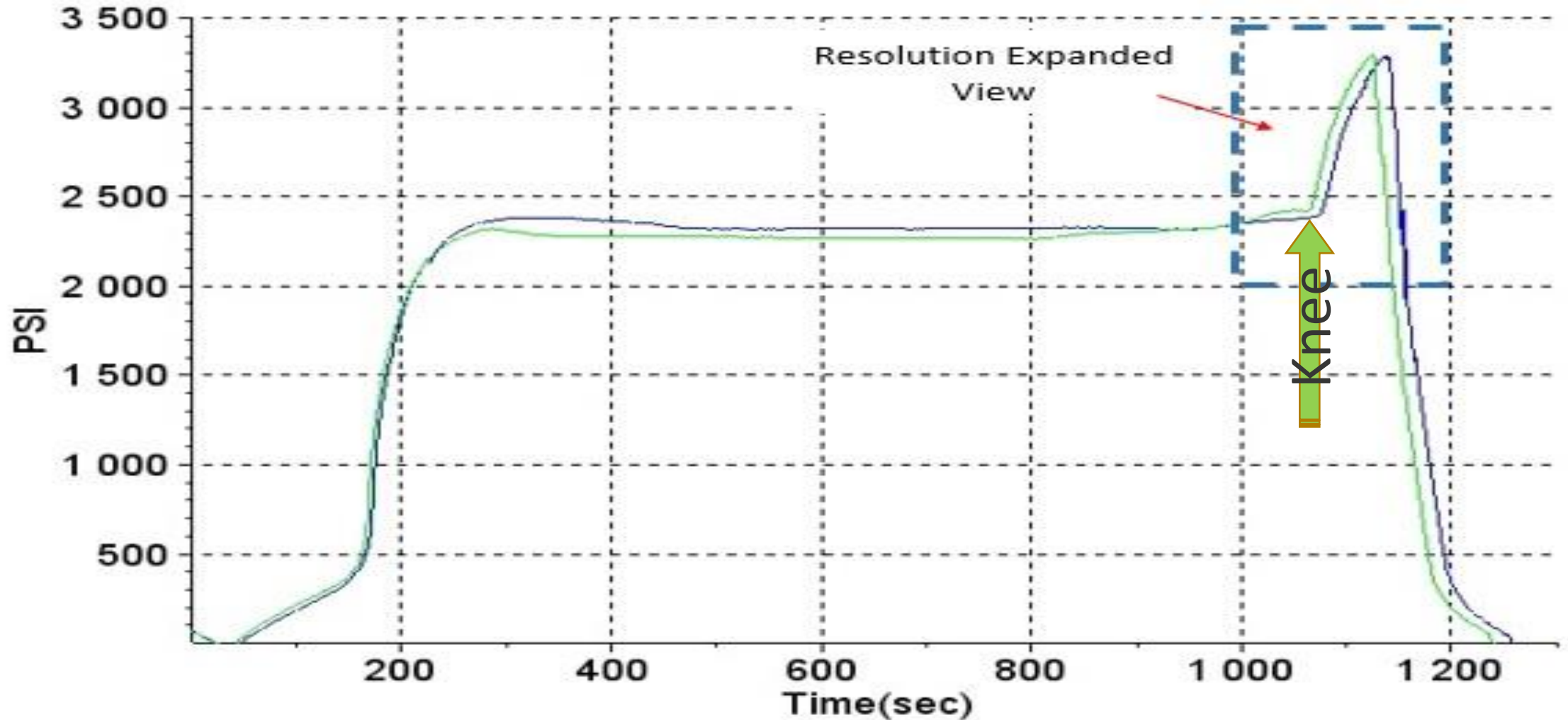
EHSA Example Embodiment



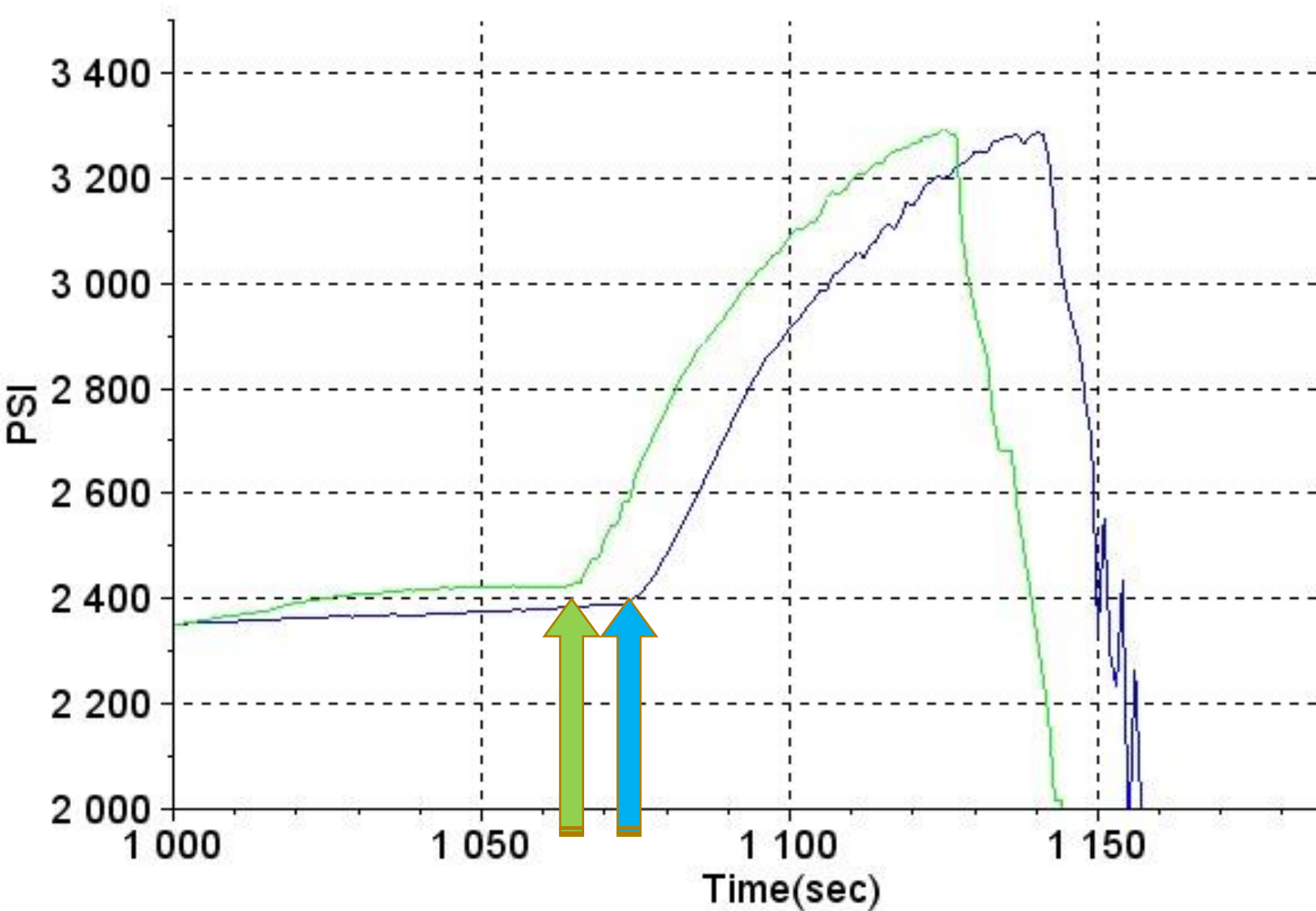
Hydraulic Valve OPEN CLOSE



Bi-Directional Shift OPEN CLOSE



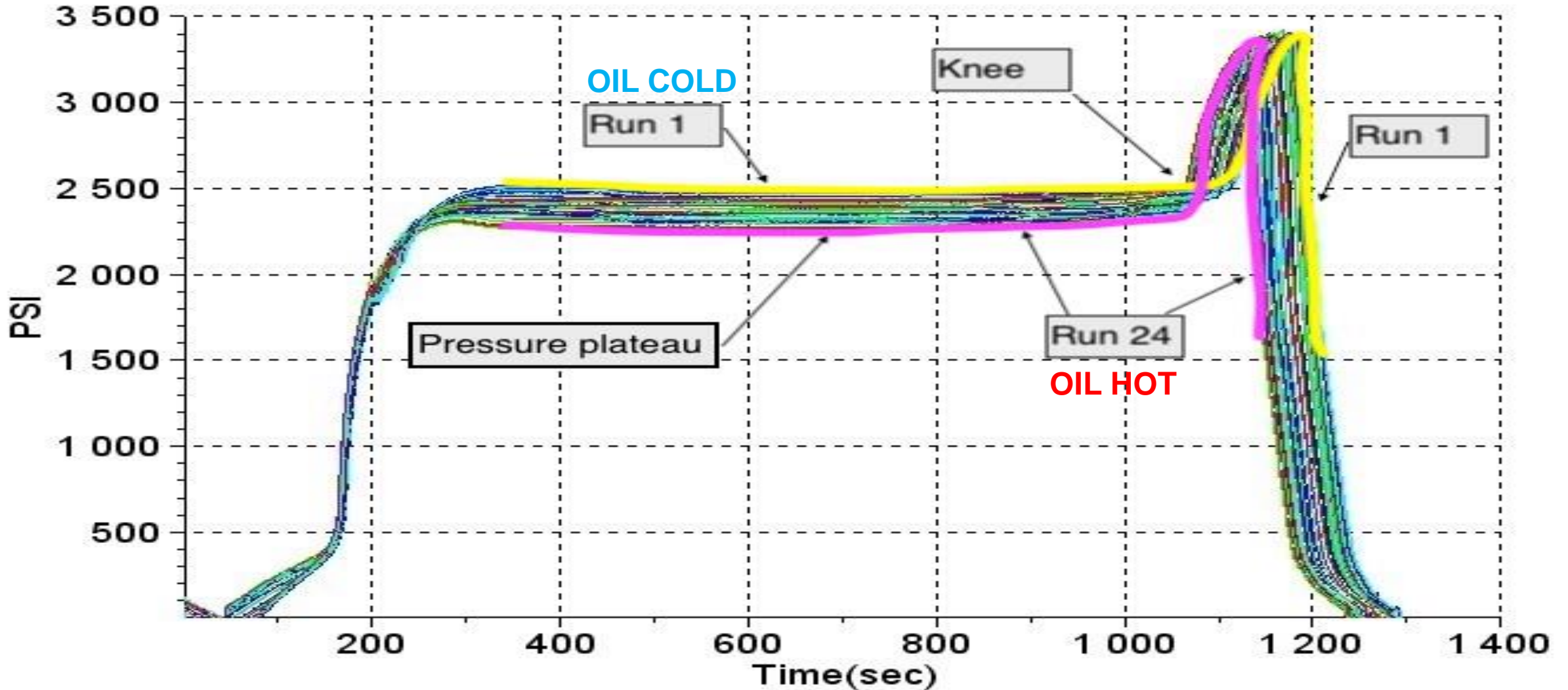
Bi-Directional Shift OPEN CLOSE Expanded View



- Expanded view of open/close shifts
- Pressure increase Knee at the hydraulic cylinder End of Travel
- OPEN End of Travel at 1065 seconds
- CLOSE End of Travel at 1075 seconds
- Accuracy is $\pm 1\%$
- Demonstrates the accuracy of the volumetric displacement pump

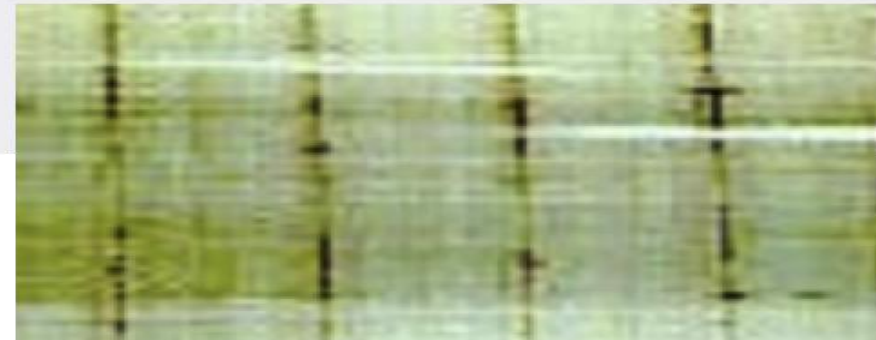
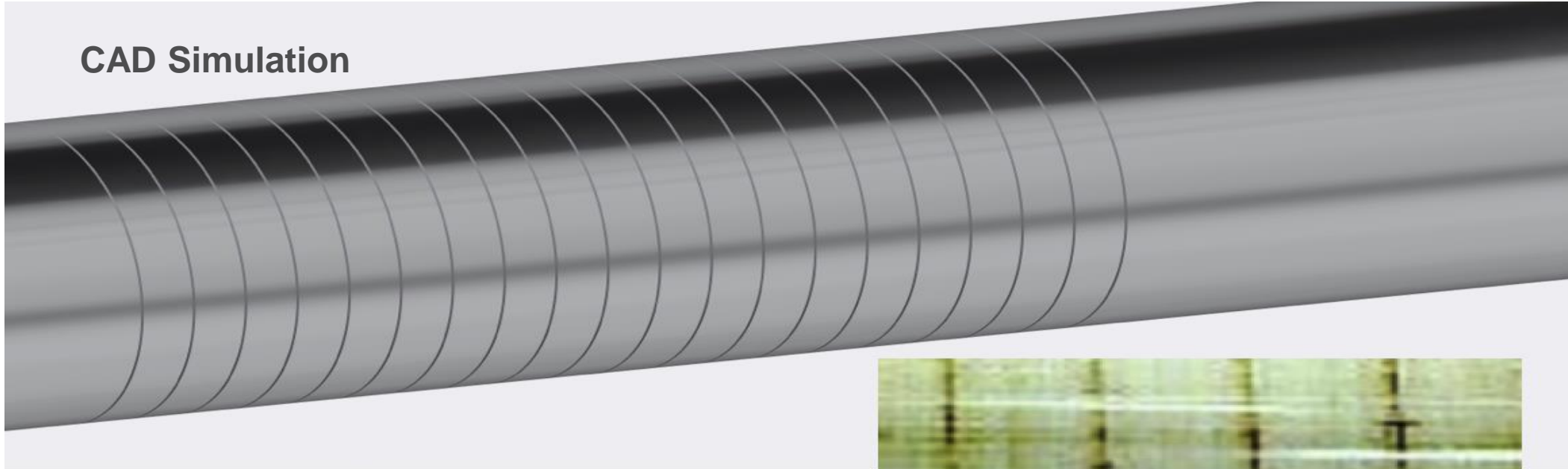
Envelope Plots of Bi-Directional Shifts

24 OPEN 24 CLOSE



Zebra Pattern on Hydraulic Cylinder

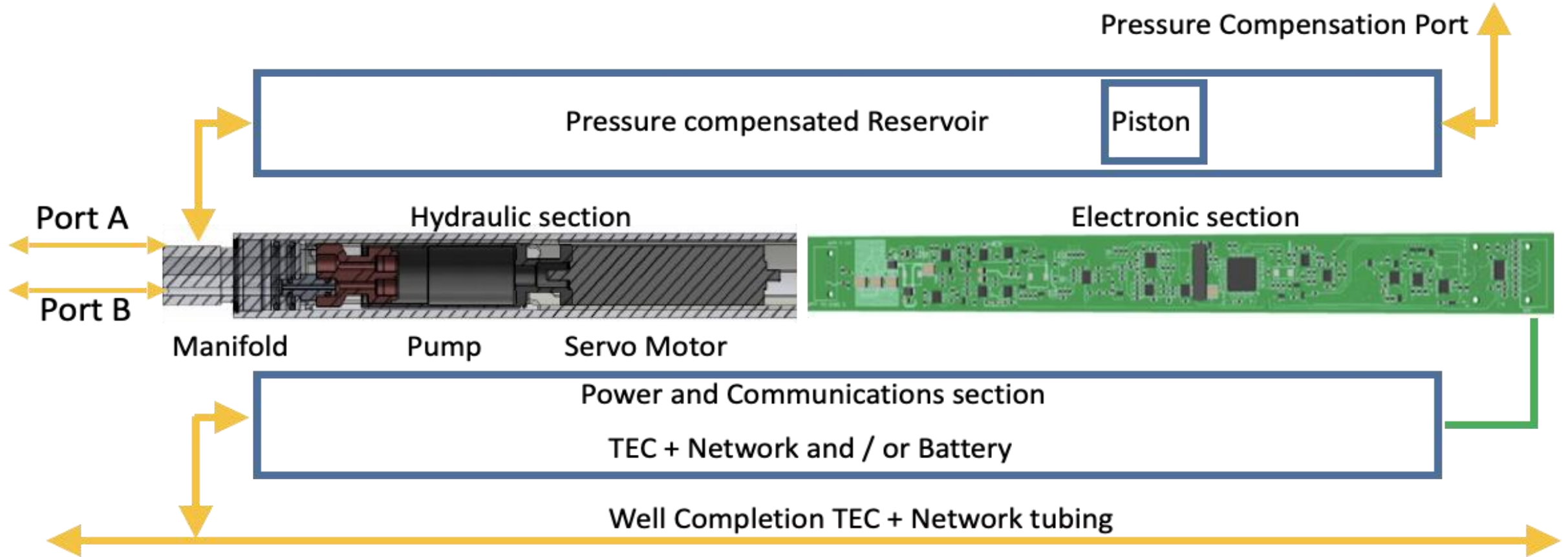
CAD Simulation



Micro-photograph

- EHSA operating hydraulic cylinder
- Same volume steps each direction
- Many identical steps form rings

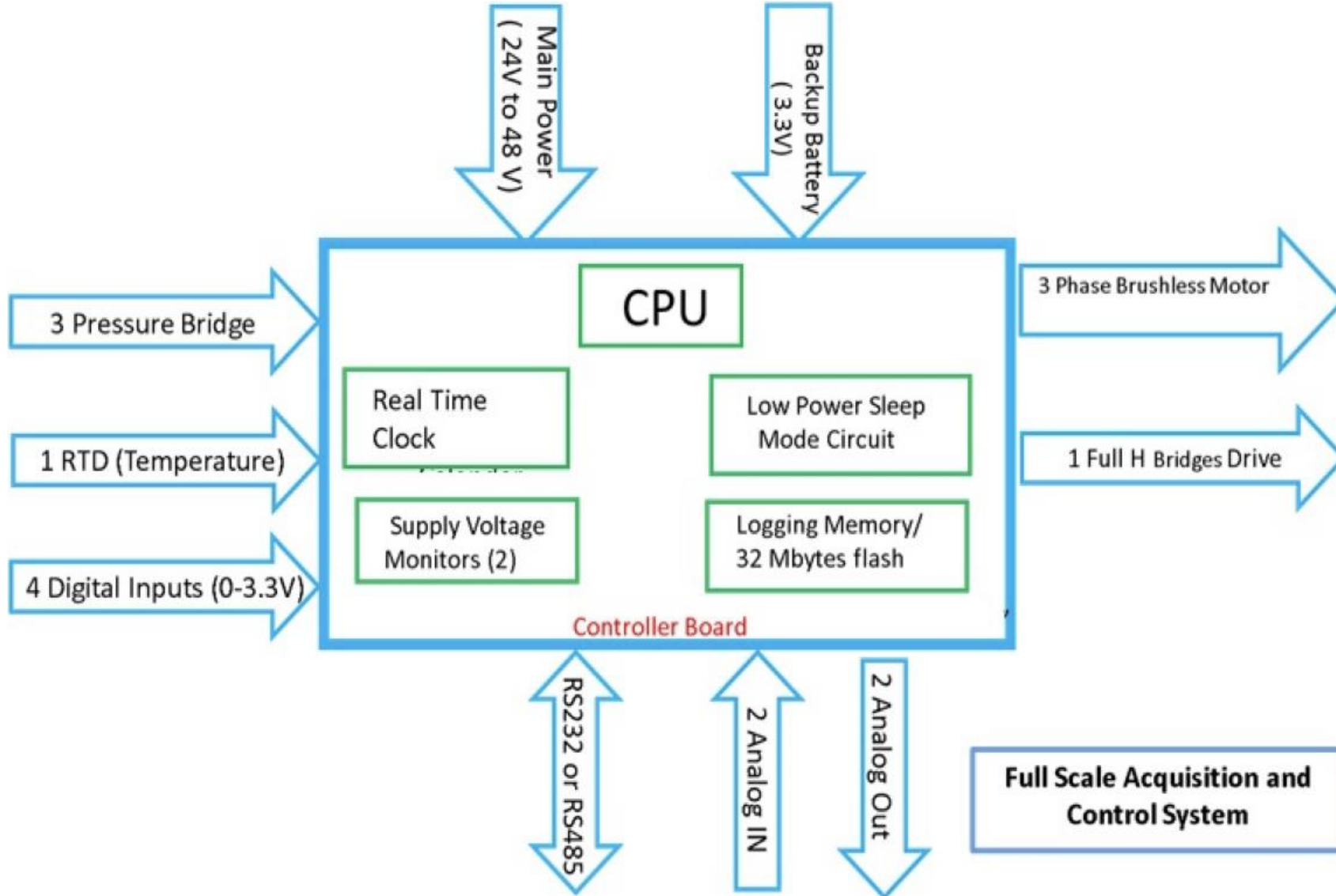
EHSA Device Block Diagram



EHSA Device major sections:

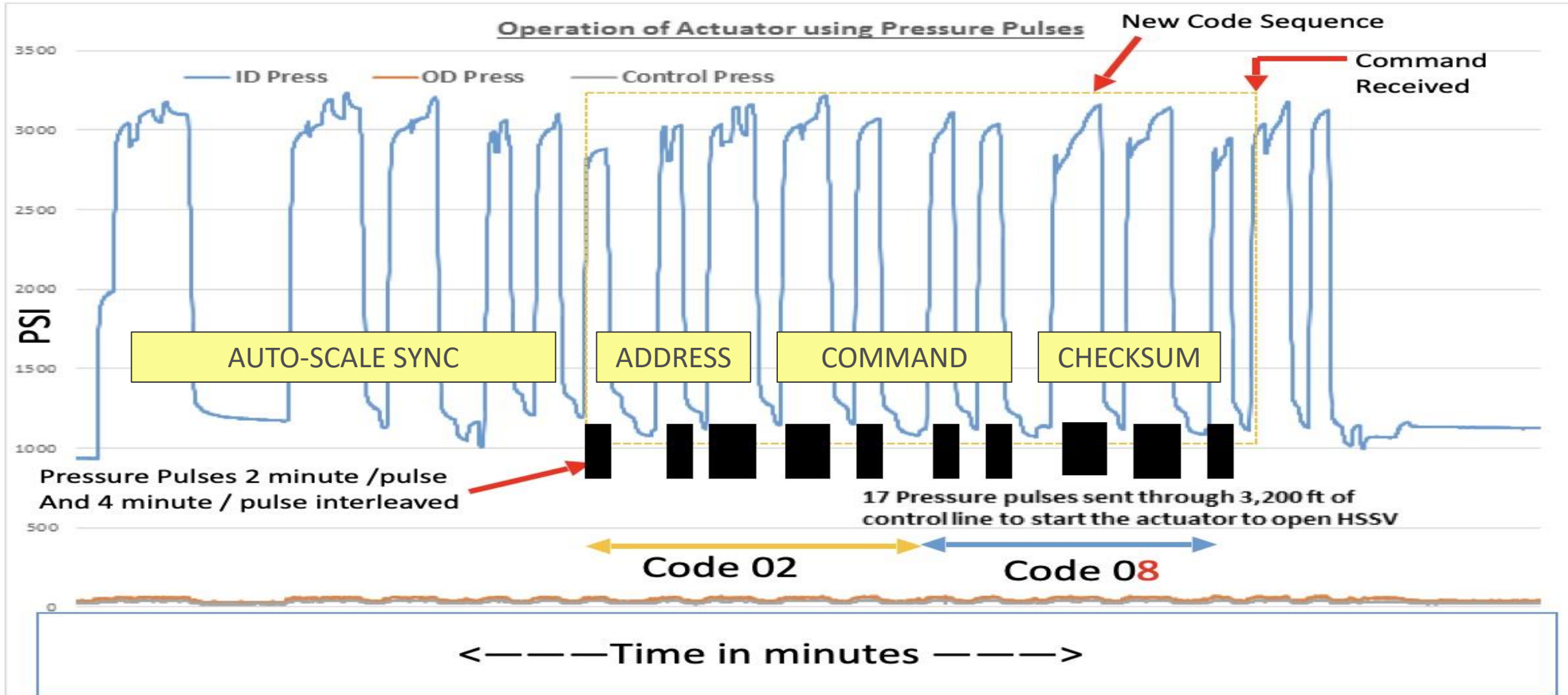
- Hydraulic Pump and motor
- Pressure compensated reservoir
- Electronics
- Power and communications

Electronic Section Block Diagram



- Custom Well Completion firmware
- Broad range of parameters
- Sensors:
 - Pressure
 - Temperature
 - Hydraulic Pressure
 - Power Use
- Communications
 - TEC network
 - Pressure Pulse Command
- Power
 - TEC network
 - Battery
- Autonomously act on a real time clock trigger and alarms

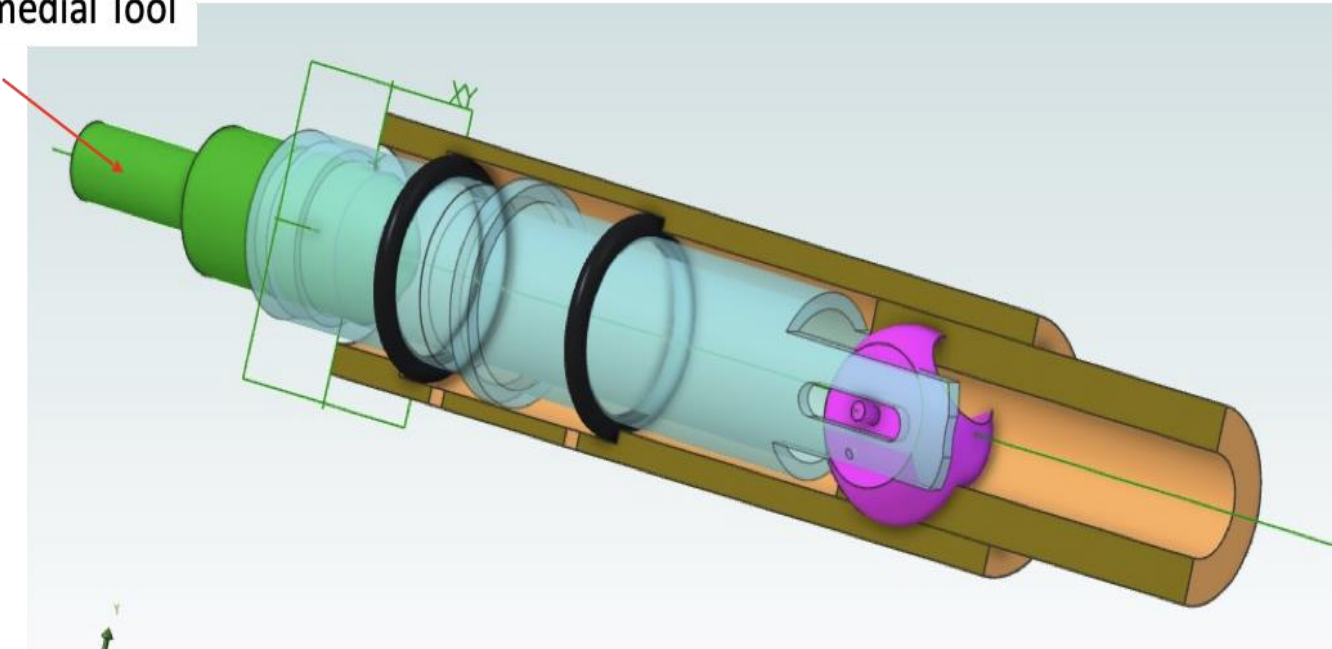
High Reliability Pressure Pulse Command – NO FALSE TRIGGERS



Remedial Shifting

Integral Valveless Mechanical Override

Remedial Tool



- Integral Remedial Valveless Hydraulics
- Shifting tool non-destructive intervention
- Vital capability designed into EHSA
- Multi-Zone Completions long term success
- Non-Locking Hydraulics
- Passive Electronics Protection Built-In
- EHSA operates after Intervention

- Remedial Shifting (non destructive) requires a none locking hydraulic System
- No check valves in Electro-Hydraulic System Actuator
- No hydraulic lock , allowing manual shifting

Remedial shifting Ball Valve shows a shifting tool mechanical intervention

Custom System Components



Thank you for your interest. Our patents information are available.

