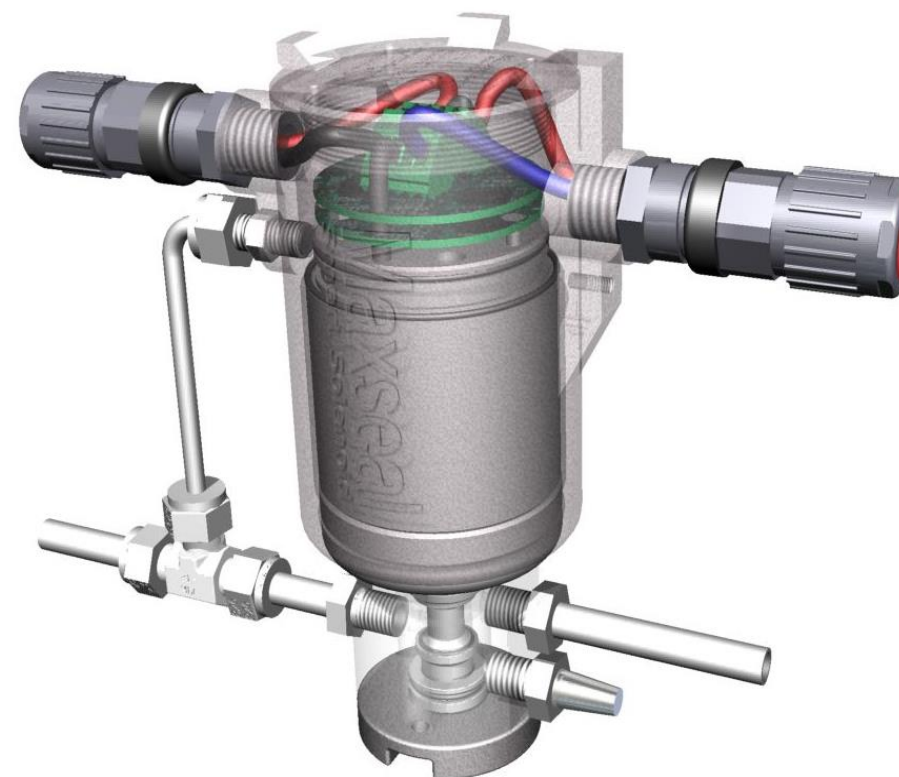


# THE SMART SOLENOID – Reliable Condition Monitoring in Process Industry

Dr.-Ing. Maik Fiedler, Engineering Director Europe & IA  
April 26<sup>th</sup> 2017, MDA Forum, Hannover



*Engineering  
GREAT  
Solutions*

 IMI NORGREN®

 IMI BUSCHJOST®

 IMI FAS®

 IMI HERION®

 IMI MAXSEAL®

# IMI Group

*Three divisions – One company – One purpose*



- ▶ World leader in the precise fluid control and movement
- ▶ £1.6 billion turnover (2016) and 11,000+ employees worldwide
- ▶ Listed on the London Stock Exchange



One IMI → "We deliver **GREAT** solutions for our customers tackling the world's most demanding engineering challenges."

- ▶ **FOCUS:** *Motion and fluid control*  
technologies wherever precision, speed and reliability are essential
- ▶ **MARKETS:** Industrial Automation, Rail, Commercial Vehicles, Life Sciences, Oil & Gas
- ▶ **R&D:** USA, China, Germany, UK, Switzerland
- ▶ **MANUFACTURING:** USA, Germany, China, UK, Switzerland, Czech Republic, Mexico and Brazil



IMI  
Precision Engineering

*We deliver integrated solutions that improve the performance, productivity and safety of customers' equipment.*



# IMI Precision Engineering

*Product brands for dedicated markets*

## **IMI NORGREN®**

- ▶ Actuators, air preparation, pressure switches, fittings, valves



## **IMI HERION®**

- ▶ Solenoid valves, NAMUR valves and Hydraulic solutions



## **IMI BUSCHJOST®**

- ▶ Process and multimedia solenoid valves and system solutions



## **IMI MAXSEAL®**

- ▶ Stainless steel solenoid valves for harsh environments



## **IMI FAS®**

- ▶ Comprehensive portfolio of miniature fluid control solutions



*Over 310  
years of brand  
experience*

# A Challenge in Process, Oil & Gas Industry

## *Safety/Reliability and Operating Time/Profit*





# Automated Process Control Valves

*The reliable „Heart“ of every plant*



- ▶ **Control production processes**
- ▶ **Bypass pipework for maintenance**
- ▶ **Emergency shutdown**
- ▶ **In short: *Operate on Demand***

# High reliability, safety and life time requirements

## *Need for Data capturing (CM, PdM) and functional testing*



- ▶ **Must be reliable at staying on as well as turning off**
- ▶ **Must Work in hot and cold places**
- ▶ **Product quality is essential**
- ▶ **Product must be easy to use**



# Typical failures in real life applications

## *A SMART System has to detect and predict*

### ▶ Solenoid valve

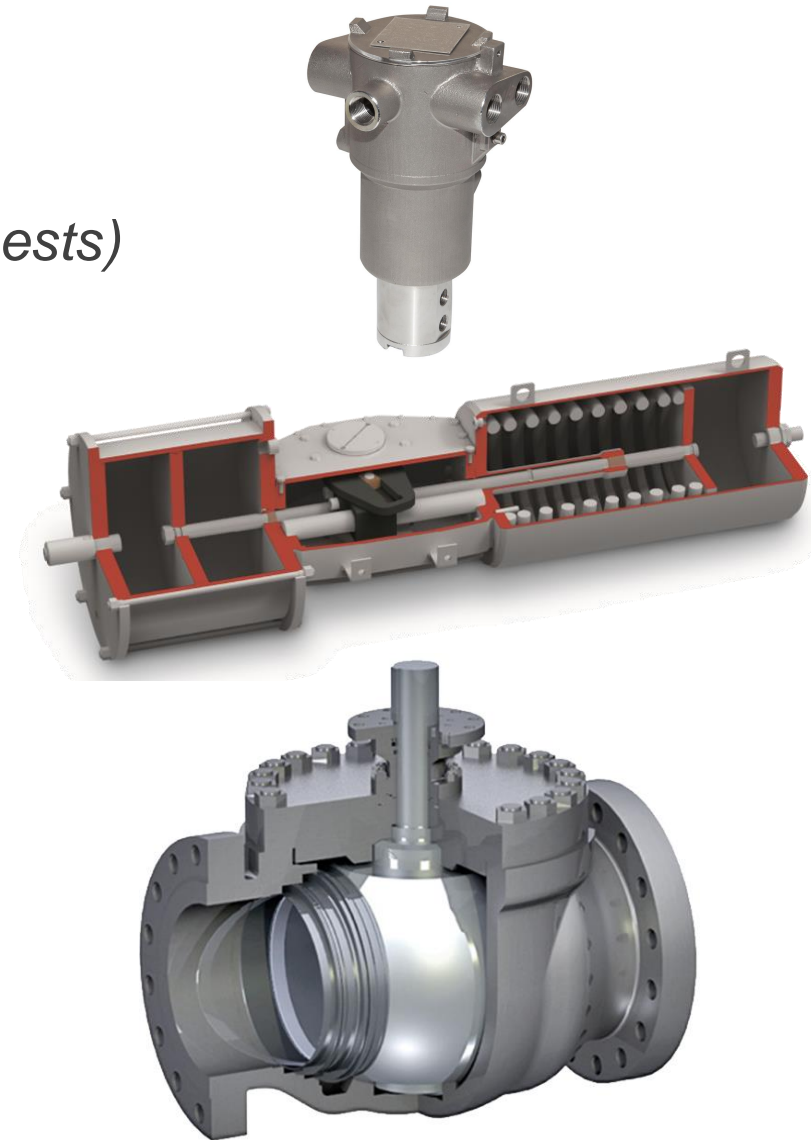
- ▶ *Blocked inlet or exhaust port*
- ▶ *Restricted exhaust flow (Dust build-up, Salt encrustation, Icing, Insect nests)*
- ▶ *Damaged piping*

### ▶ Actuator

- ▶ *Loss of spring force or Spring broken*
- ▶ *Drop in output torque (Lost lubrication, Seal degradation, Icing)*

### ▶ Process Valve

- ▶ *Increased valve breakout torque (Build-up of debris on valve seat)*
- ▶ *Increased valve dynamic torque (Valve packing stiffness over time)*
- ▶ *Stem Shear*





# The SMART Solenoid Valve with PST

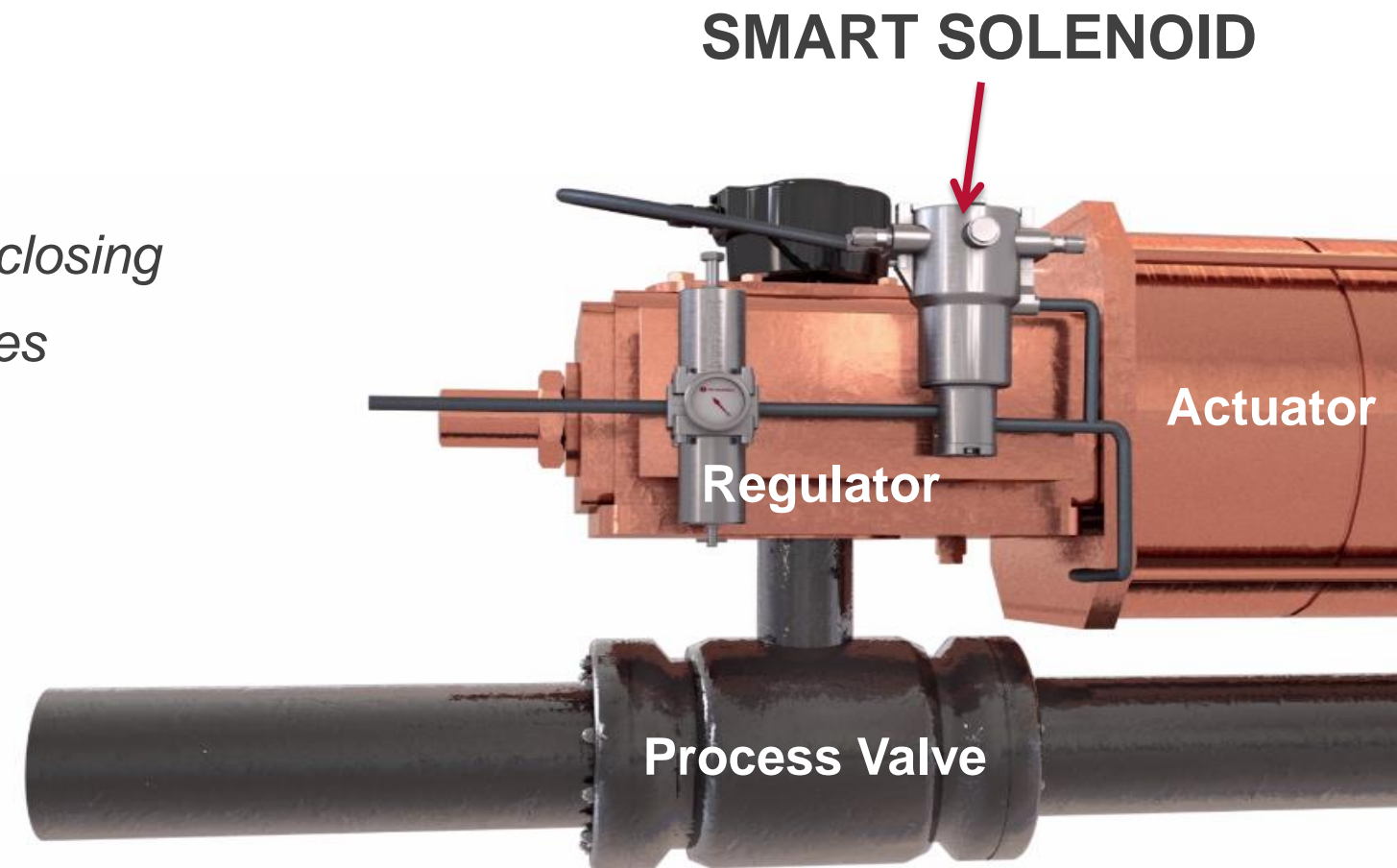
A valve that bring peace of mind to plant operators

The diagram features a central hand-drawn sketch of a solenoid valve. Surrounding this sketch are various handwritten notes and labels in black and red ink. At the top, 'INTEGRATED PARTIAL STROKE TESTING' is written in red. Other labels include 'SIL3', 'SIMPLE INSTALLATION', 'Fast commissioning', 'SIMPLE RETROFIT', 'PFD', '100% COMPATIBLE', 'Reduced downtime', 'PNEUMATIC & HYDRAULIC', 'Simple reporting', 'Internal pre-testing', 'Fewer spurious trips', 'HIPPS', 'Improved shutdown intervals', 'PREDICTIVE MAINTENANCE', 'Increased safety', 'CV UP TO 4.5', 'MAXIMUM DIAGNOSTIC COVERAGE', 'Safety function', 'HIGH MTTFs', 'IEC 61508', 'IEC 61511', 'FFR', 'ESD', and 'INTRODUCING ICO4-PST THE SMART SOLENOID' written in red along a curved arrow at the bottom. A small schematic diagram of a valve is also present. To the right of the diagram is a photograph of the IMI MAXSEAL solenoid valve, a cylindrical metal component with multiple ports and a top-mounted solenoid coil. The IMI MAXSEAL logo is at the bottom right of the photograph.

# The SMART Solenoid Valve with PST

*A reliable solenoid valve combined with testing capability*

- ▶ **SMART Solenoid Valve**
  - ▶ *Monitoring functionality integrated*
  - ▶ *Automatic & manual full stroke monitoring*
- ▶ **Partial Stroke Testing (PST)**
  - ▶ *Tests valve functionality online without valve closing*
  - ▶ *Allows increase of time between maintenances*





# PST methodology and sequence

*Ensure no unintended process interruption occurs*

## ▸ **Accidental trip protection** *(Dual redundant switching circuit & Software protection)*

### 1. **System self test**

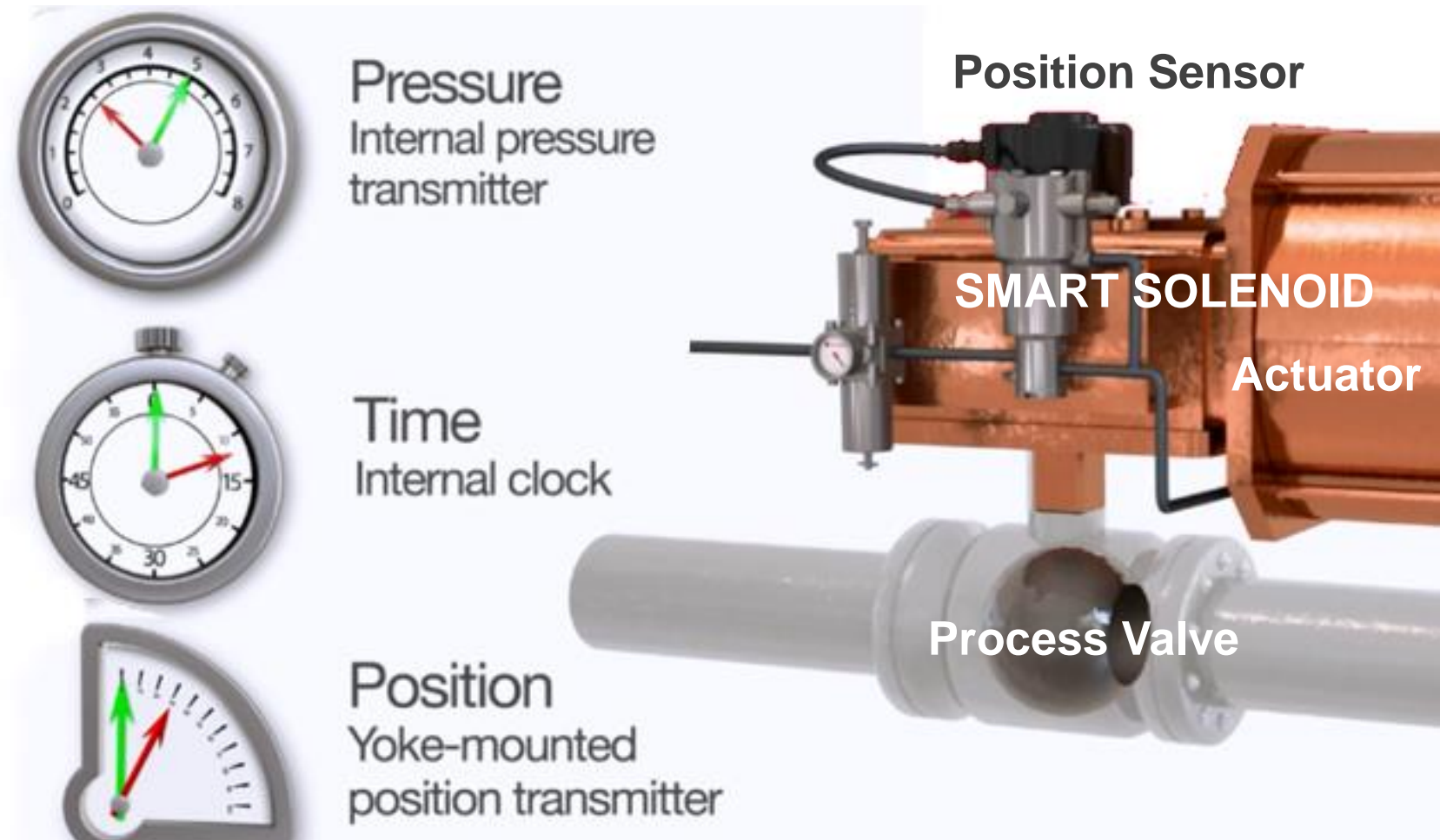
- *Minimum coil voltage*
- *Minimum instrument pressure*
- *Switching circuit functional*
- *Pressure transmitter functional*
- *Air inlet blockage test*

### 2. **De-energise solenoid valve**

### 3. **Monitor pressure, position and time**

### 4. **Re-energise at required position**

### 5. **Analyse results**



# Configuration software & GUI

*Easy to use with every PDM system*

The image displays four overlapping windows from the IMI configuration software:

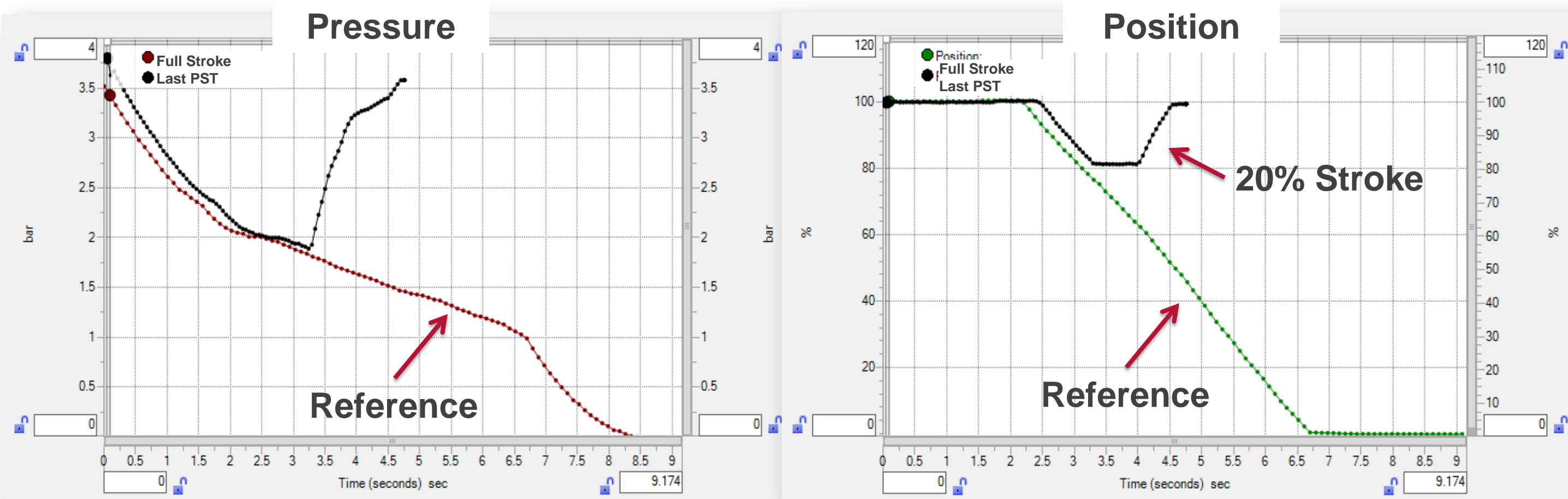
- Device setup (Basic setup):** Shows fields for Date (01/15/2016), Write protect (None), Descriptor (NC HP PRD HIPPSA), Message, and Final assembly num (0). It includes a photo of a valve and a 'Revision #'s' button.
- Parameter list:** A table showing device parameters for 'ICO4-PST DevRev3'.
- Align position sensor - (Online):** Features an 'Alignment gauge' with a raw position value of 1341. The gauge scale ranges from 0 to 4000. Below the gauge, it shows 'Raw Pos' as 1341 counts, with a range from 0 to 4096.
- ICO4-PST DevRev3 - PST options - (Online):** Contains test configuration settings such as Overstroke limit (5.0 %), HIPPS valve mode (Off, record both de- and re-pressurisation), and adjust PST commissioning parameters like Minimum test pressure (4.58174 bar), Maximum test pressure (6.87261 bar), PST pressure limit (2.49 bar), PST position target (25.0 %), PST pass threshold (50.0 %), PST solenoid off time (2.372 sec), Valve de-press. time (1.9 sec), Valve re-press. time (0.77 sec), Zero-stroke time limit (0.358 sec), and Full-stroke record time (5.20833 sec).

**DEVICE SETUP | BASIC SETUP**



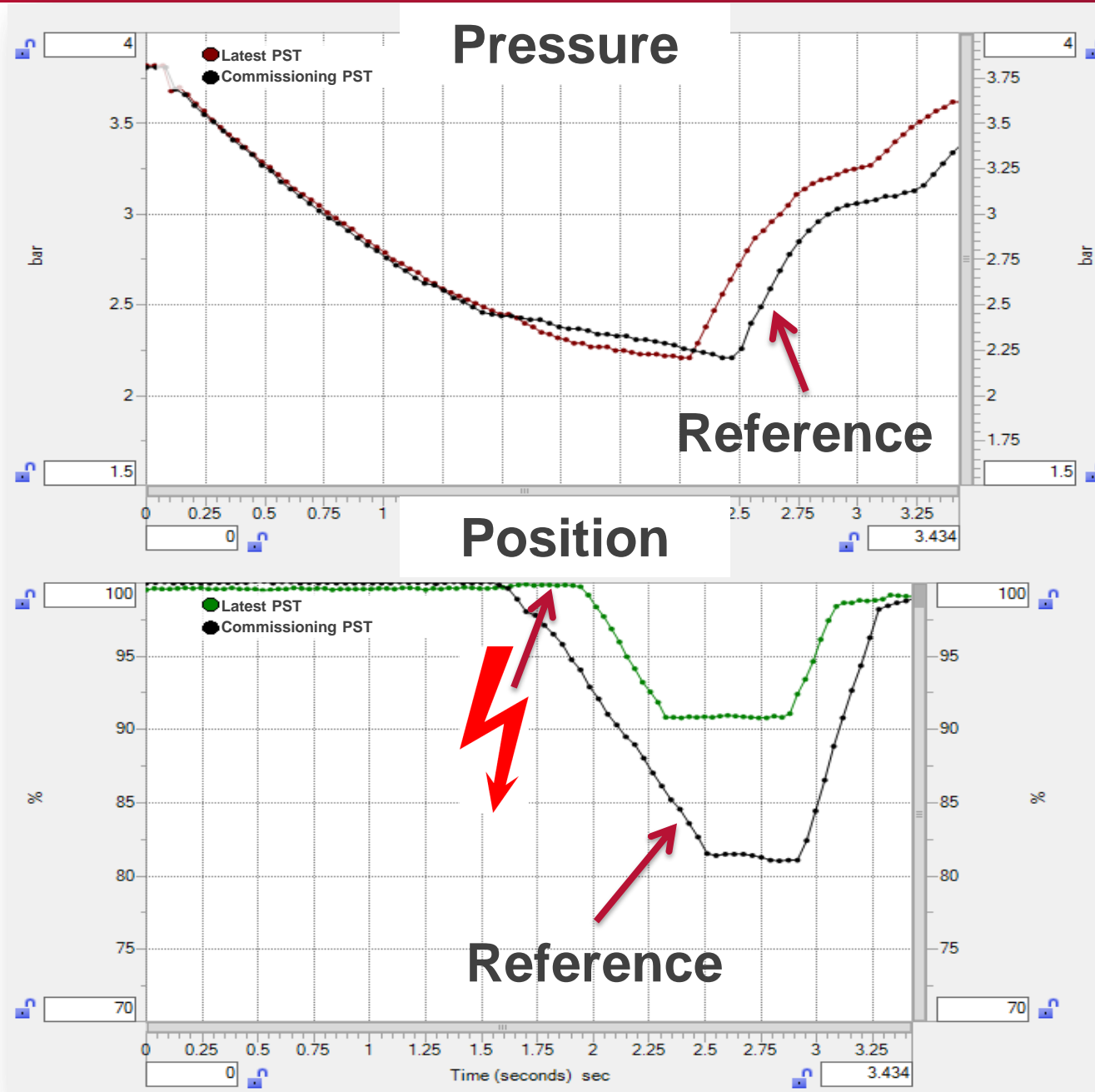
# Measurement data in as-new condition


Reference curve and 20% PST



# Measurement data in used condition

## Reference curve and increased breakout torque

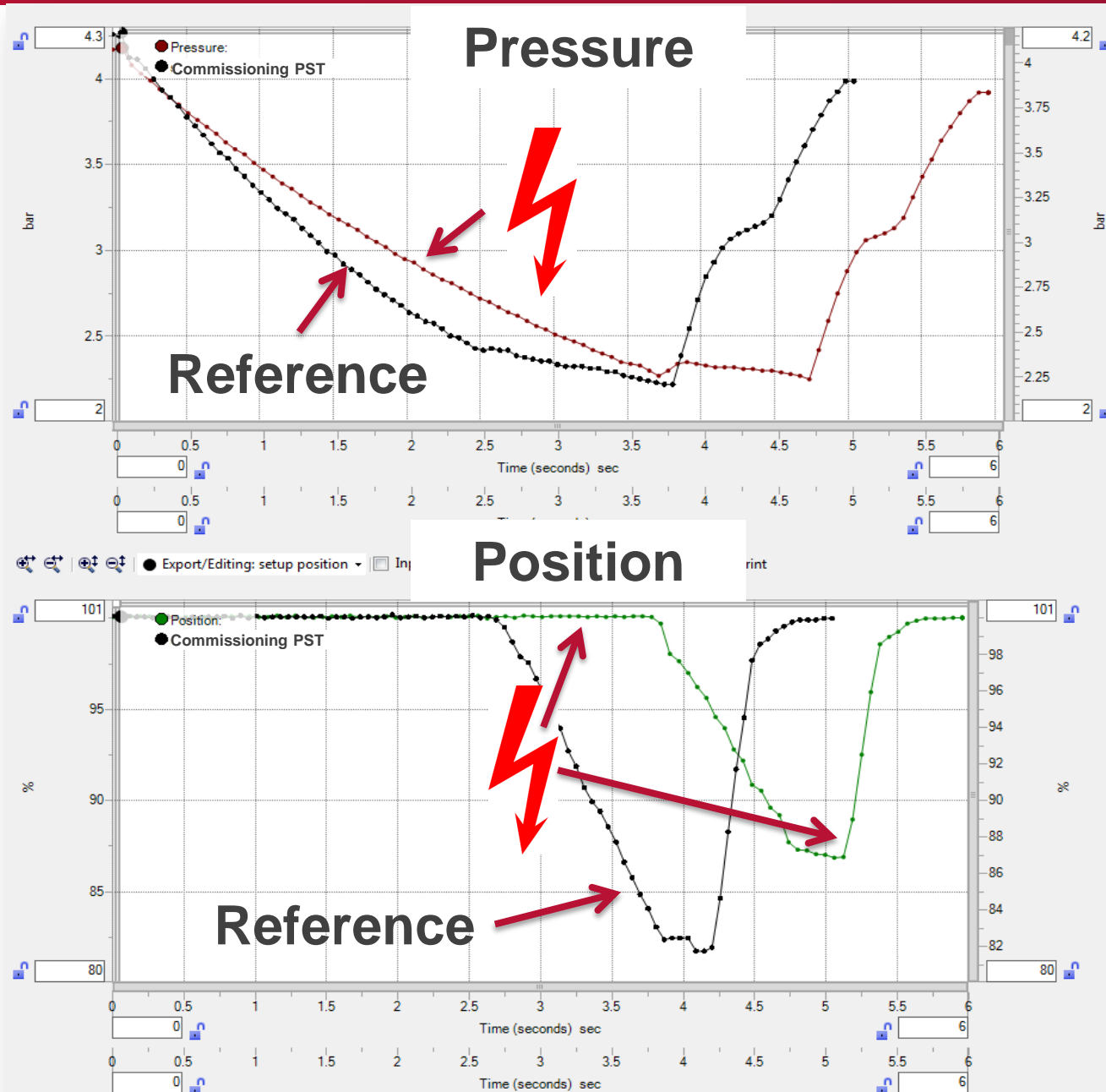


- ▶ Same de-pressurisation curves
- ▶ Extended time to breakout 
- ▶ Test failed
  - ▶ *Indicates sticking valve*
- ▶ Maintenance recommended



# Measurement data in used condition

## Reference curve and restricted SOV exhaust



- ▶ Different de-pressurisation curves
  - ▶ Extended time to breakout
  - ▶ Time override engaged / Position not reached
- ▶ **Test failed**
- ▶ *Indicates exhaust restricted*
- ▶ **Maintenance recommended**

# Diagnostic data analysis and trending

*Use data frequently to generate new information*

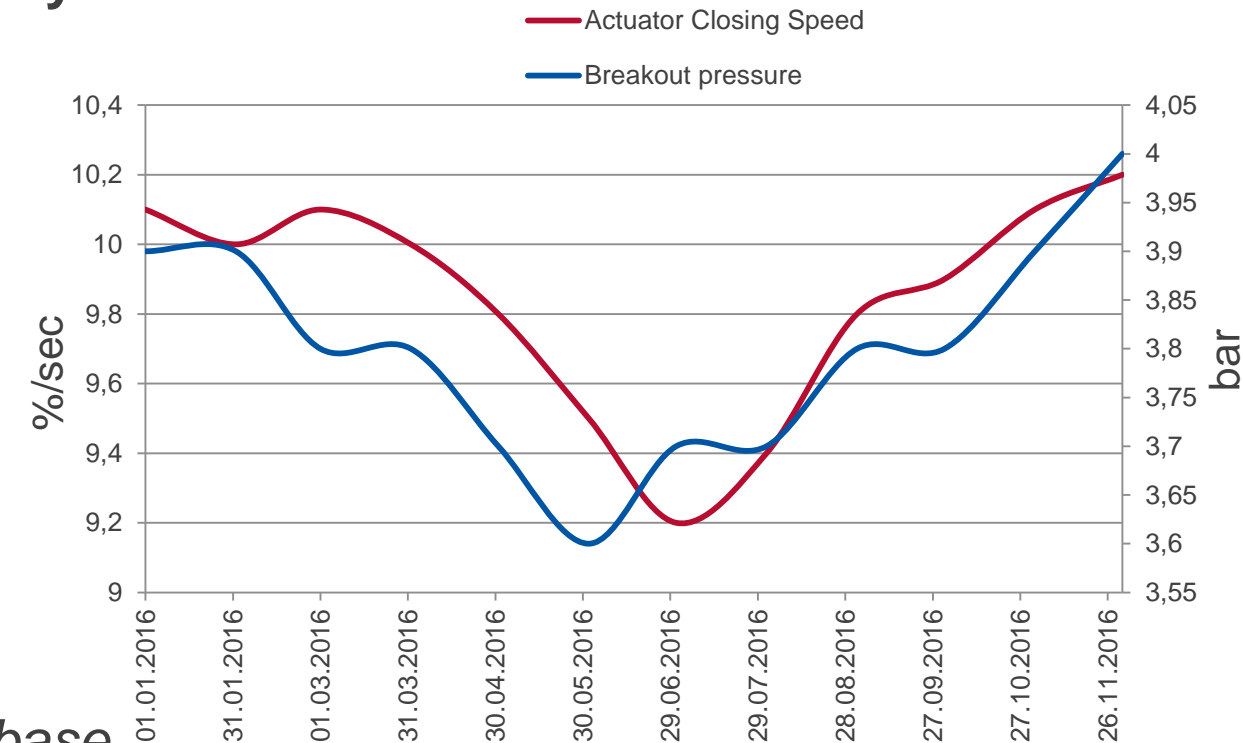
- ▶ **The following data points are measured & stored for every test**

- ▶ *Valve movement percentage*
- ▶ *Internal temperature*
- ▶ *Starting pressure*
- ▶ *Valve closing speed (%/sec)*
- ▶ *Process valve breakout pressure*
- ▶ *Solenoid valve reaction time*

- ▶ **Parameter export and analysis over time**

- ▶ *Facilitates capability to create custom diagnostic database*

- ▶ **Condition Monitoring (CM) and Predictive Maintenance (PdM)**





# Summary

*CM and PdM bring value to our customers!*

- ▶ **Originally developed for the Oil & Gas industry**
- ▶ **Easily adaptable for Industrial Automation, Life Science and other markets**
- ▶ **Improving**
  - ▶ *Safety performance & Reliability*
  - ▶ *Production performance & TCO*
- ▶ **Easy to**
  - ▶ *Engineer & Install*
  - ▶ *Commission & Service*
  - ▶ *Operate*
- ▶ **Intelligent system able to provide CM and PdM capability to process valves**



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