Increasing Plunger Well Profitability Using Geomagnetic Sensing

EXTREME TELEMATICS CORP.

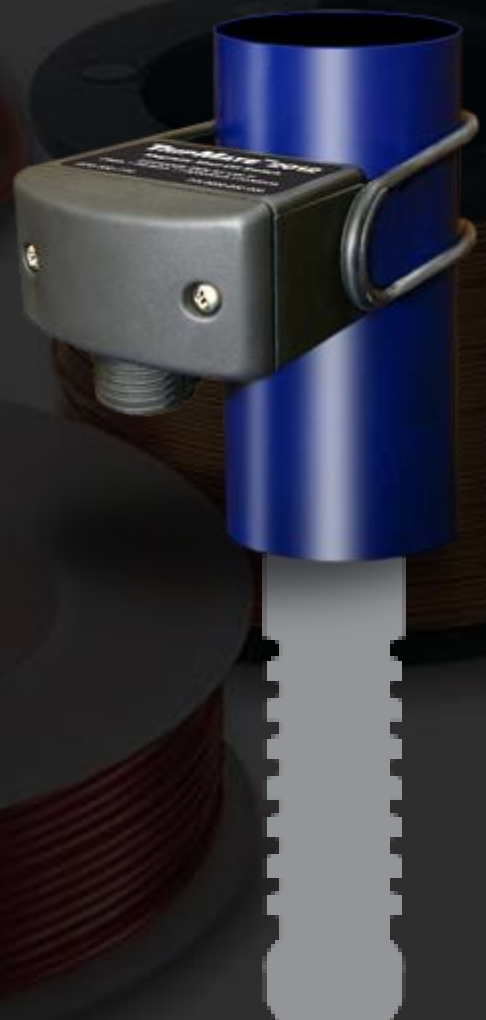
Cyclops™ PLUNGER ARRIVAL SENSOR

ETC EXTREME TELEMATICS CORP.

Sasquatch™ PLUNGER VELOCITY SENSOR

Historical Plunger Sensor Technology

- Electromagnetic Coils
  - Used in most cheap plunger sensors
  - Moving metal creates a current in the coil
  - Current causes switch to close
  - Different coil required for each voltage
- Issues
  - Slow moving or stalled plungers don't create enough current
  - Radios and other systems can trip sensor
  - Susceptible to lightning and cathodic protection
  - Noisy and short switch closures cause issues with controls
  - Easy to burn out

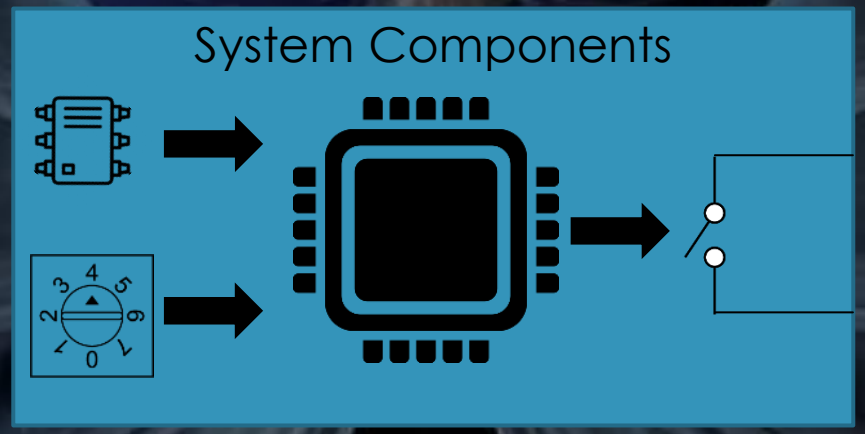


The Cost of Cheap Sensors

- Maintenance Costs
  - Most sensors need replacing every 12 – 18 months
  - Time and money to procure and replace
- Lost Production
  - Most controllers shut in well if the plunger sensor fails
  - False arrivals also cause shut ins
  - Non-arrivals cause increase in close time, leads to fast plungers
  - Improper optimization adjustments
- Hassle
  - Having to always diagnose problems
  - Focus being taken away from more pressing issues

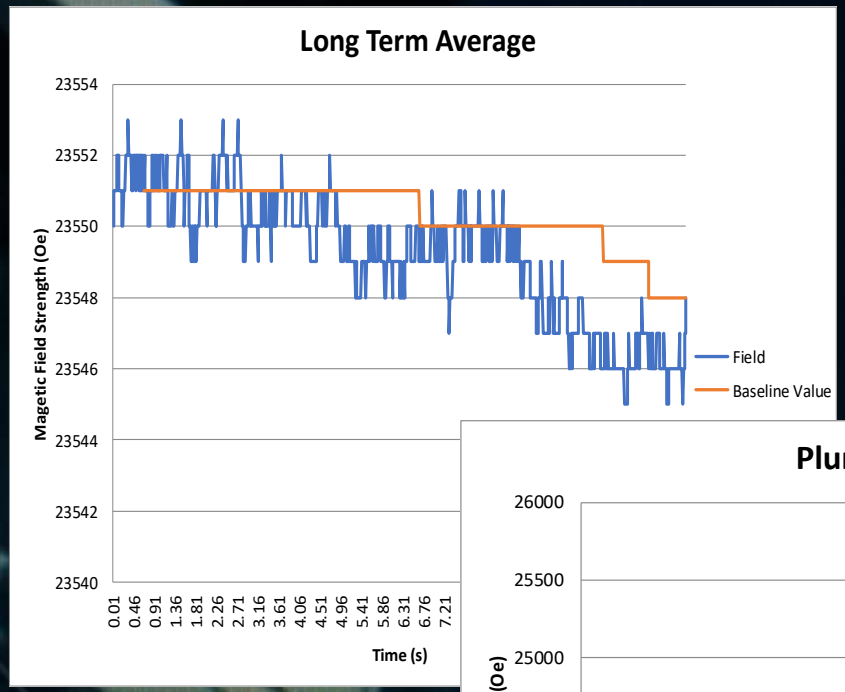
Geomagnetic Sensing Technology

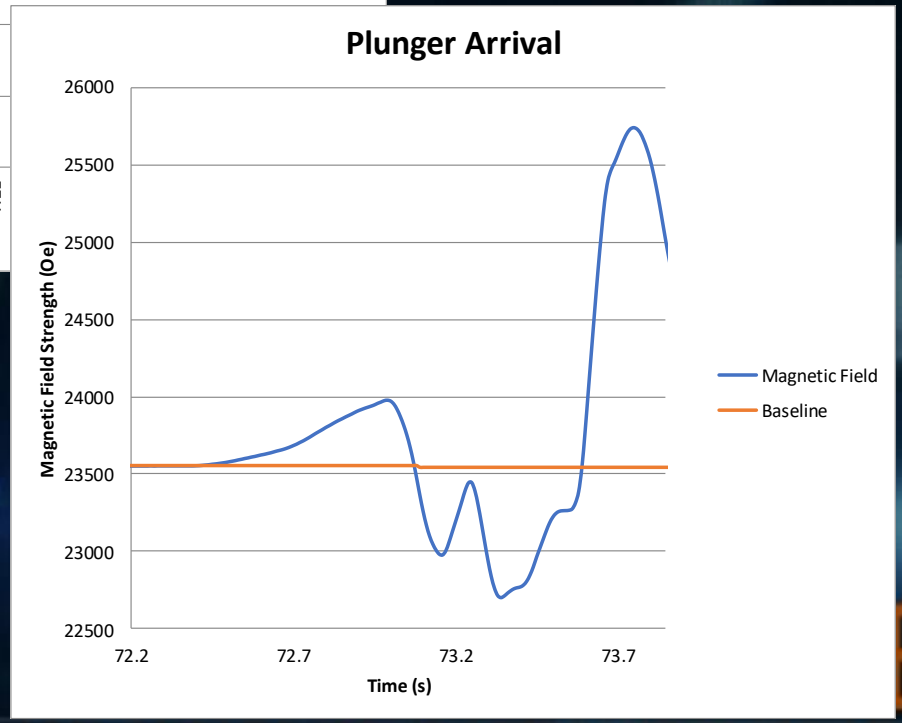
- Looks for warping of the Earth's magnetic field
- Main components
  - Magnetometer - Senses the earth's magnetic field
  - Sensitivity Dial – Adjust the amount of change required to trip
  - Microprocessor – Record the readings, filter noise, identify trips
  - Digital Switch – Signal the arrival with a clean, timed pulse



Geomagnetic Sensing Technology

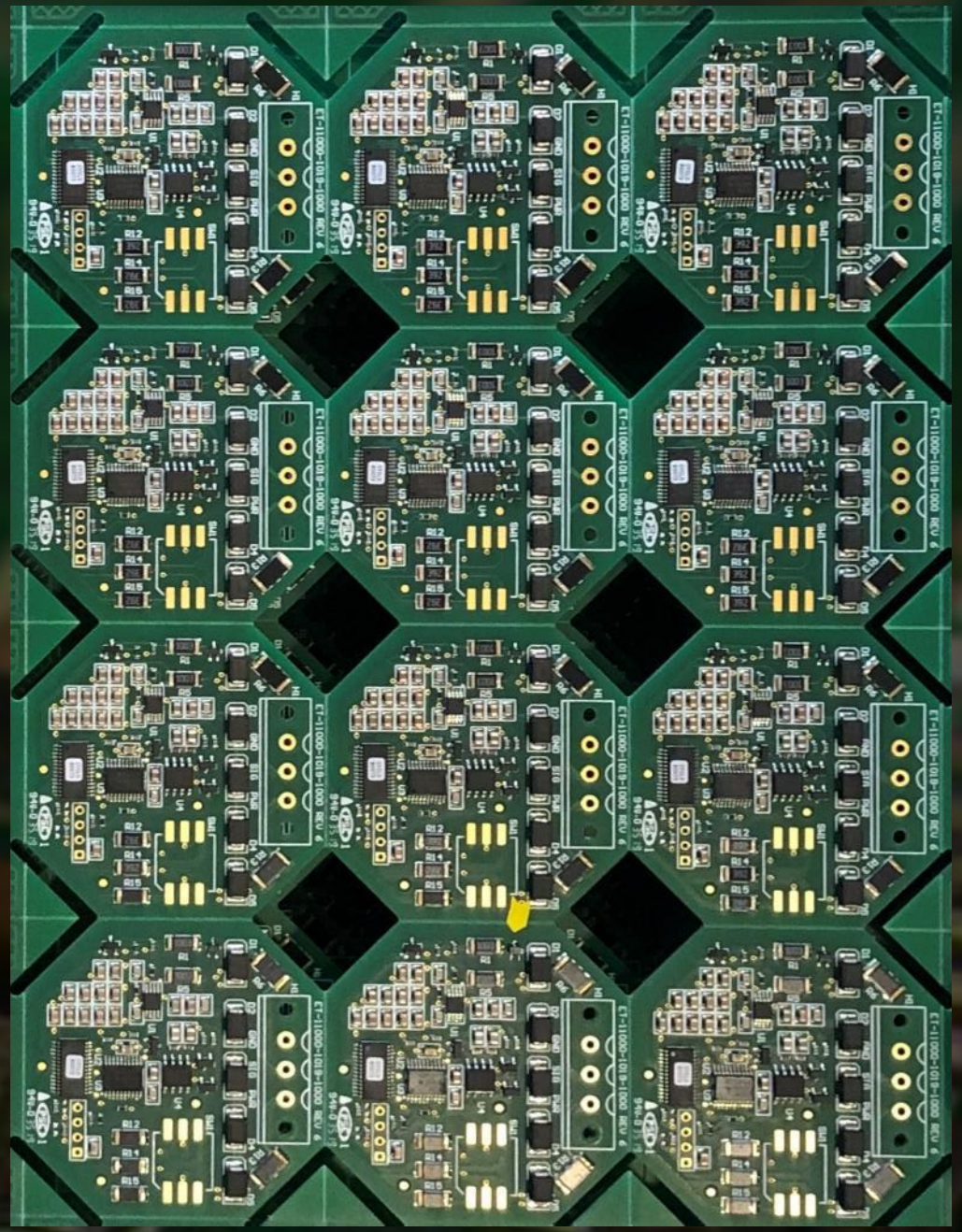
- Operation
  - Take samples and filter noise
  - Establish baseline (No Plunger)
  - Compare samples to baseline
  - Set and hold switch





Digital Sensor Benefits

- Long Term Reliability
  - Printed circuit board
  - No moving parts
- Multiple voltage capable
  - Built in voltage regulator accepts 5V to 24V
- Immunity to noise – Eliminate false trips
  - Nearby equipment
  - Lightning
  - Cathodic Protection
- Speed/location independent – Accurate arrival Detection
  - Detect slow moving plungers
  - Detect plungers that stall before lubricator



Digital Sensor Benefits

- Adjustable sensitivity
  - Reduce false trips due to noise
  - Increase visibility of anvil, stalled plungers, and through casing
- Real time data visibility
  - Connect sensor to a PC
  - Watch arrivals in real time
- Upgradable software
  - Sensor has replaceable software
  - Refresh sensitivity upgrade
  - Magnetic lubricator upgrade

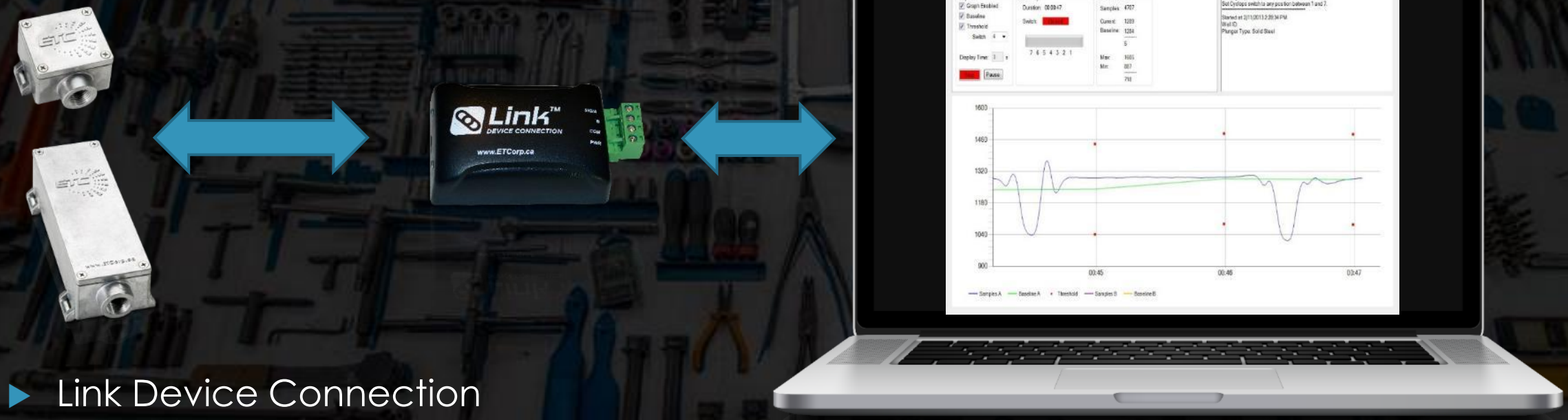
Cyclops™ PLUNGER ARRIVAL SENSOR

Safe and Rugged

- Hazardous Locations Approved
  - Cyclops IS - Class 1 Zone 0 (Div 1) and Class I Zone 2 (Div 2)
  - Cyclops ExP – Class 1 Zone 1 (Div 1)
- Wide Temperature Range
  - -40 °C to +70 °C
  - -40 F° to +160 °F
- Rugged Aluminum Enclosure
  - Mounting Legs
  - Watertight lid with captive screws
  - ½" NPT Cable Port

Cyclops™
PLUNGER ARRIVAL SENSOR

Tools



- Link Device Connection
  - Connect ETC Sensors to a PC
- Vision Device Management
  - Update internal sensor software
  - Interact with sensors in real time to diagnose problems

Fast Plunger Issues

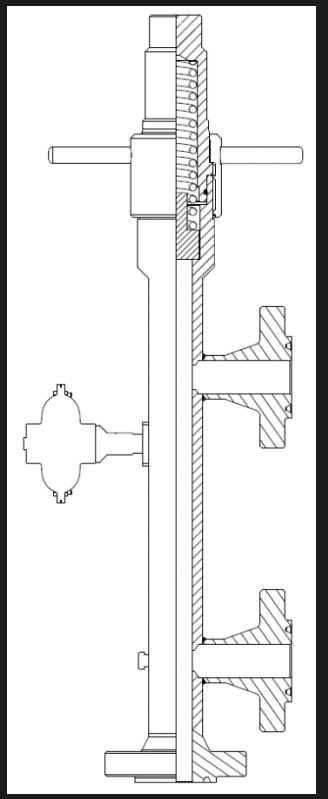
- Average Velocity Issue
  - Well depth divided by rise time
  - Assumes plunger at bottom
  - Ignores any acceleration
- Fast Plunger Causes
  - Inconsistent fluid loads
  - Plunger does not make it to bottom
  - Hole in the tubing
  - Low line pressure/flow to tank
  - Change in chokes

Safety and Maintenance

- Maintenance programs often use
  - Number of trips
  - Time (i.e. 6 months)
- Not all arrivals are equal
  - Different mass of plunger
  - Different impact velocity
- Kinetic Energy = ½ mv^2
- Repetitive fast plungers can lead to lubricator breaches

API 11 PL

- Lead by Conoco with several other majors
- Participation from most quality plunger manufacturers
- Sets standards for surface equipment
  - Design
  - Manufacturing
  - Testing
- All API 11 PL compliant lubricator and spring assemblies must have a Kinetic Energy (KE) rating
- How do you know if your arrivals are within spec?



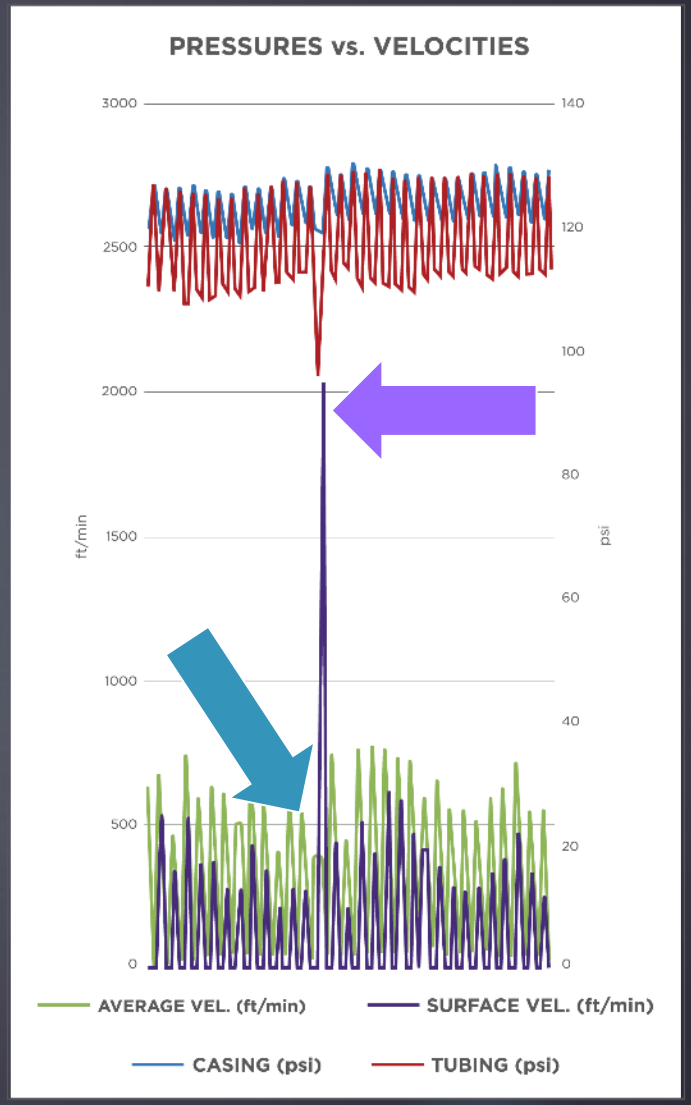
Surface Velocity Sensor

- Two sensors in one
  - Fixed distance
  - Single processor/clock
  - Eliminate as much error as possible
- Same rugged and reliable design of Cyclops
- Other advanced features
  - Kinetic Energy Calculations
  - Alarm on fast/hard and dangerous arrivals
  - Alarm on cumulative Kinetic Energy

Sasquatch™ PLUNGER VELOCITY SENSOR

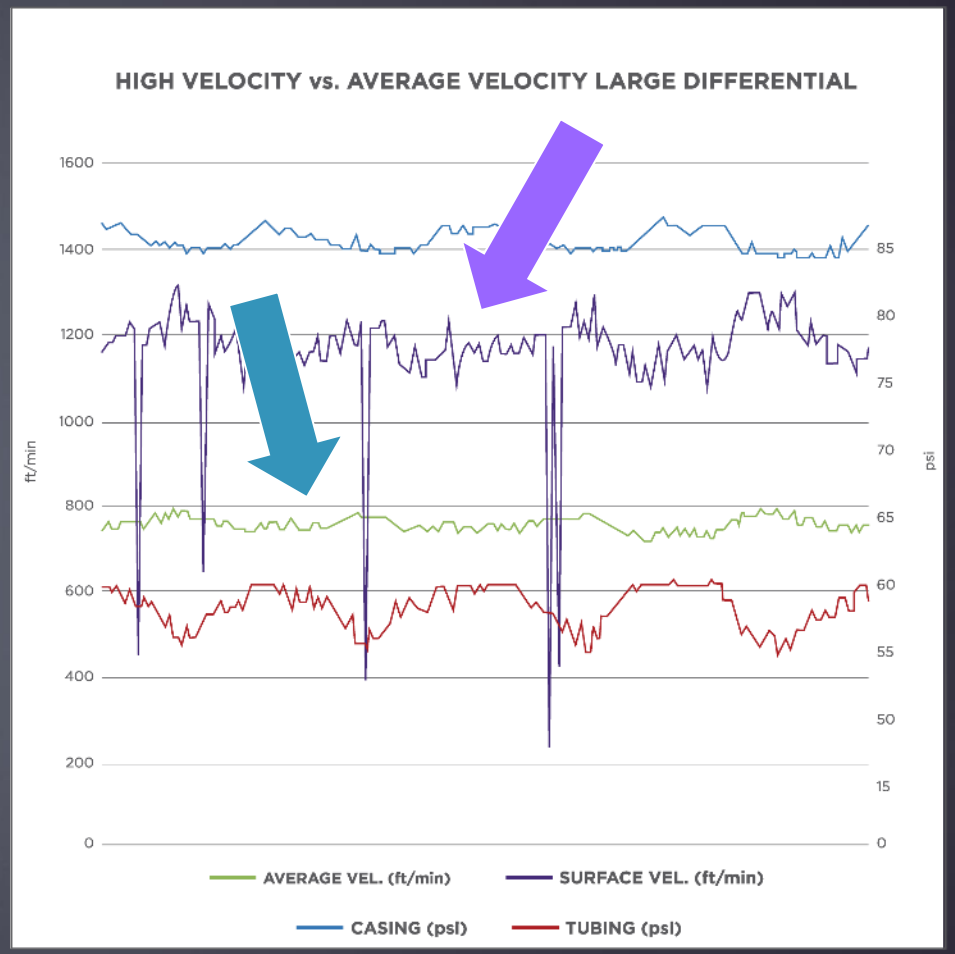
Kinetic Energy on Venting

- 7.5 lb (3.4 kg) Plunger
- Average Velocity calculated at 400 ft/min (122 m/min)
  - Estimated KE = 7.02J
- Surface Velocity recorded as 2025 ft/min (617 m/min)
  - Actual KE = 180 J
- Over 25x more energy than expected
- Was occurring once every few hours



Consistent High Kinetic Energy

- 9 lb (4.1 kg) Plunger
- Average Velocity of 750 ft/min (229 m/min)
  - Estimated KE = 29.76 J
- Surface Velocity regularly 1200 ft/min (366 m/min)
  - Actual KE = 76.18 J
- Over 6 months (4300 arrivals) spring has absorbed 200 kJ more than anticipated



Dangerous Hit

- 10 lb (4.54 kg) Plunger
- Average Velocity of 250 m/min (820 ft/min)
  - Estimated KE = 39.4 J
- Surface Velocity peaks 1714 m/min (5623 ft/min)
  - Actual KE = 1853 J
- Single arrival may be enough to collapse spring completely