Artificial Lift R&D Council

2021 International Sucker Rod Pumping Virtual Workshop

February 8-12, 2021

Rod pump monitoring and optimization:
New physics for today's problems

Acoustic Wells

Dr. Sebastien Mannai
Dr. Charles-Henri Clerget

info@acoustic-wells.com

Agenda

- Goals
- System presentation
- New technologies and approaches
- Case studies
  - Well setpoint optimization
  - Gas locking
  - Efficacy of chemical treatments
- Future work and next steps
- Conclusion

Goals

- Show the benefits of field-wide monitoring, control and optimization
- Streamlining SCADA through widespread IoT
- Augment traditional dynacard approach with novel sensing
- Deploy real-time AI for analysing large streams of high resolution sensor feeds

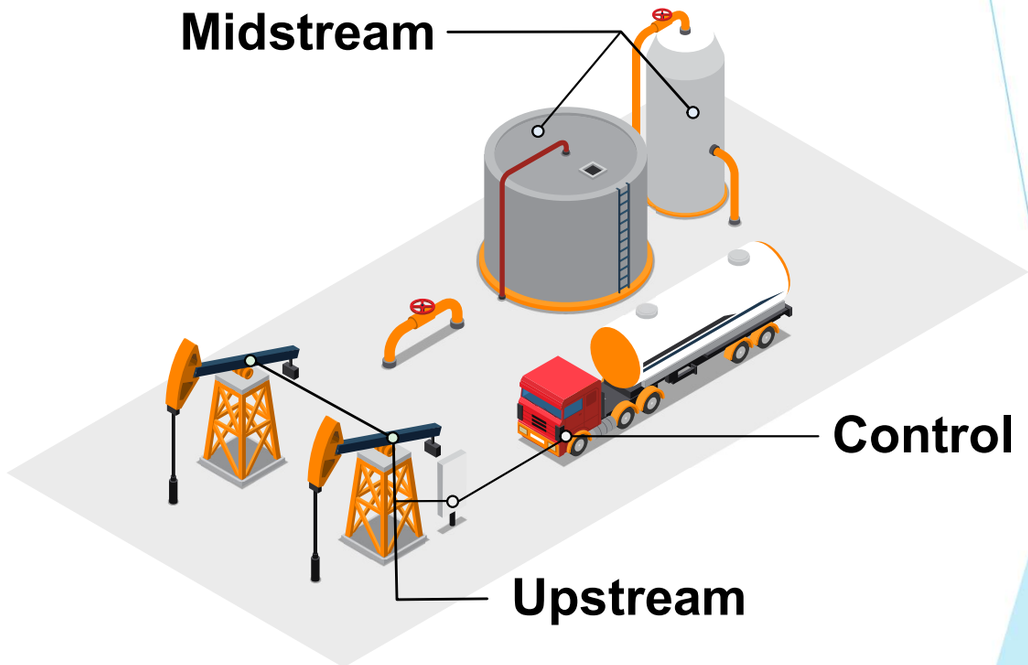
Initial target: large, uninstrumented stripper fields

Market conditions accelerating adoption of automation

- **Lower oil prices** mean lower margins and producers **focused on running leaner operations**
- **Tighter regulations** tend to enforce new monitoring requirements and better practices
- With a stronger focus on ESG topics than ever before, **the industry's environmental footprint has to be continuously reduced**, especially gas emissions and liquid leaks

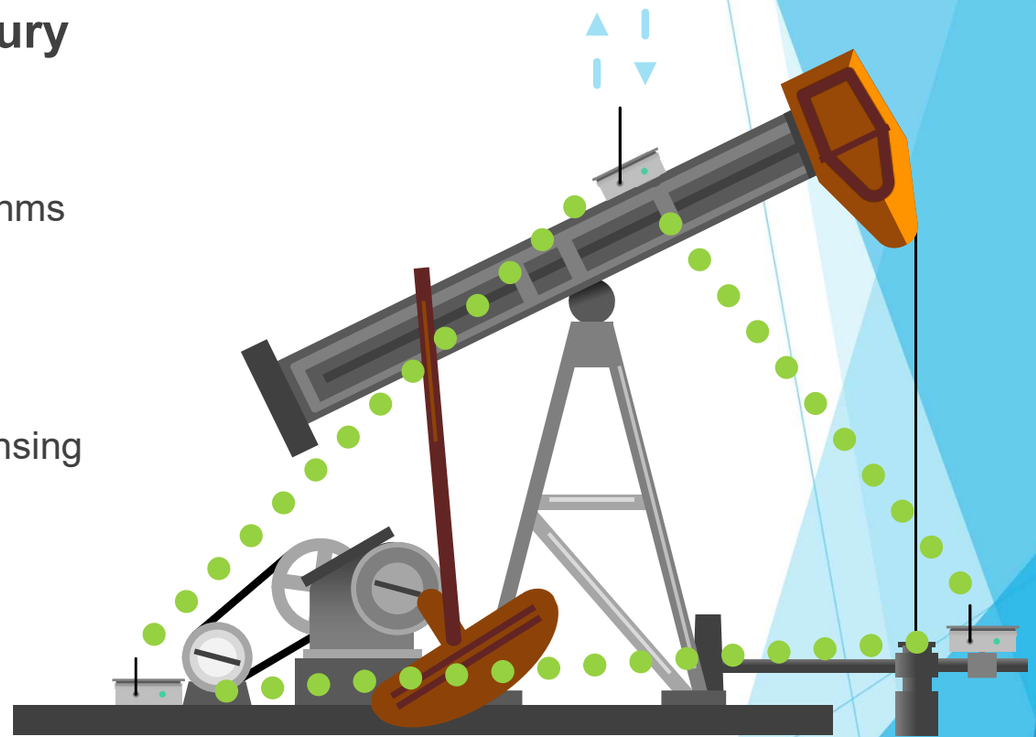
Our approach: A field wide solution

- **Upstream**
  - Underground pump monitoring and real-time pump optimization
  - Pumpjack surface issue detection & diagnosis
- **Midstream**
  - Tank monitoring and leak detection
  - Production allocation and virtual flow metering
- **Control**
  - Well runtime adjustments and automatic fail-safes
  - Routing and workflow optimization

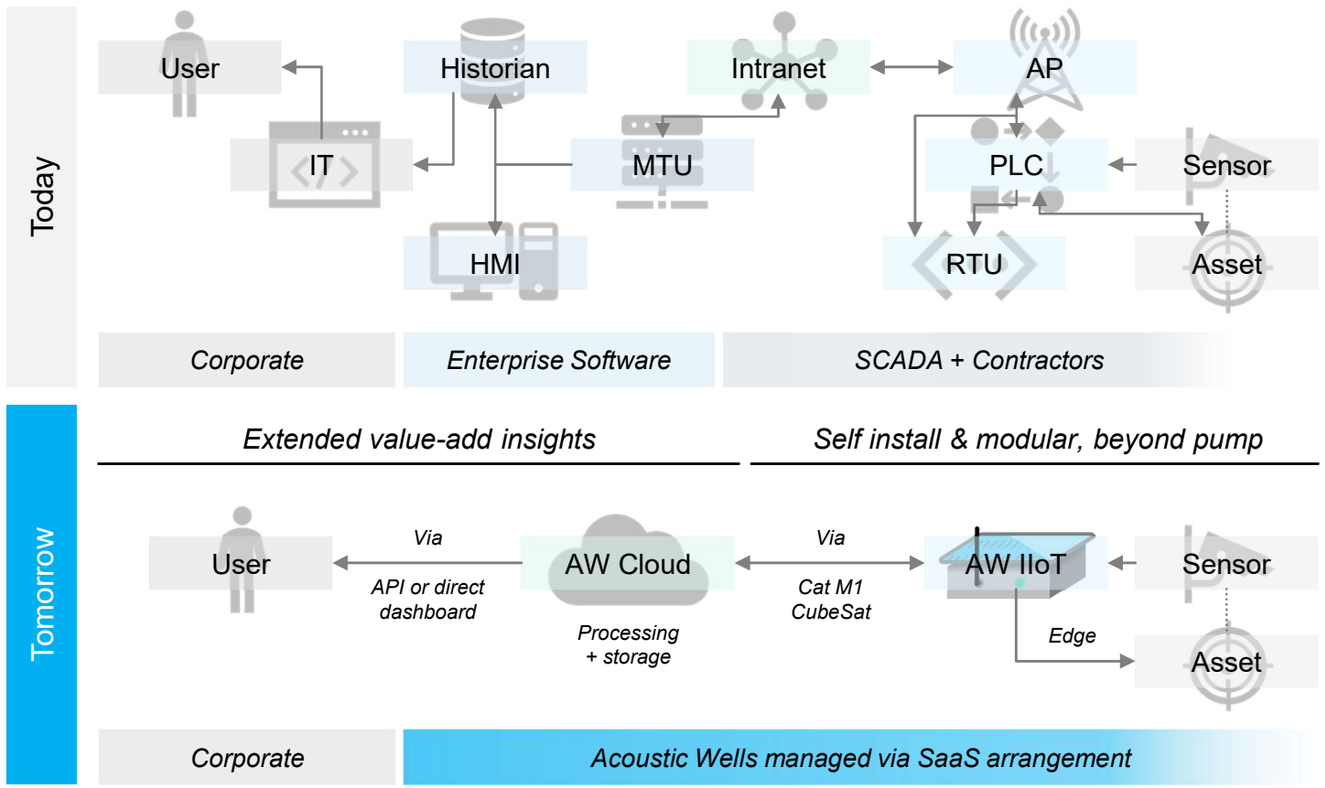


System presentation: IoT for all

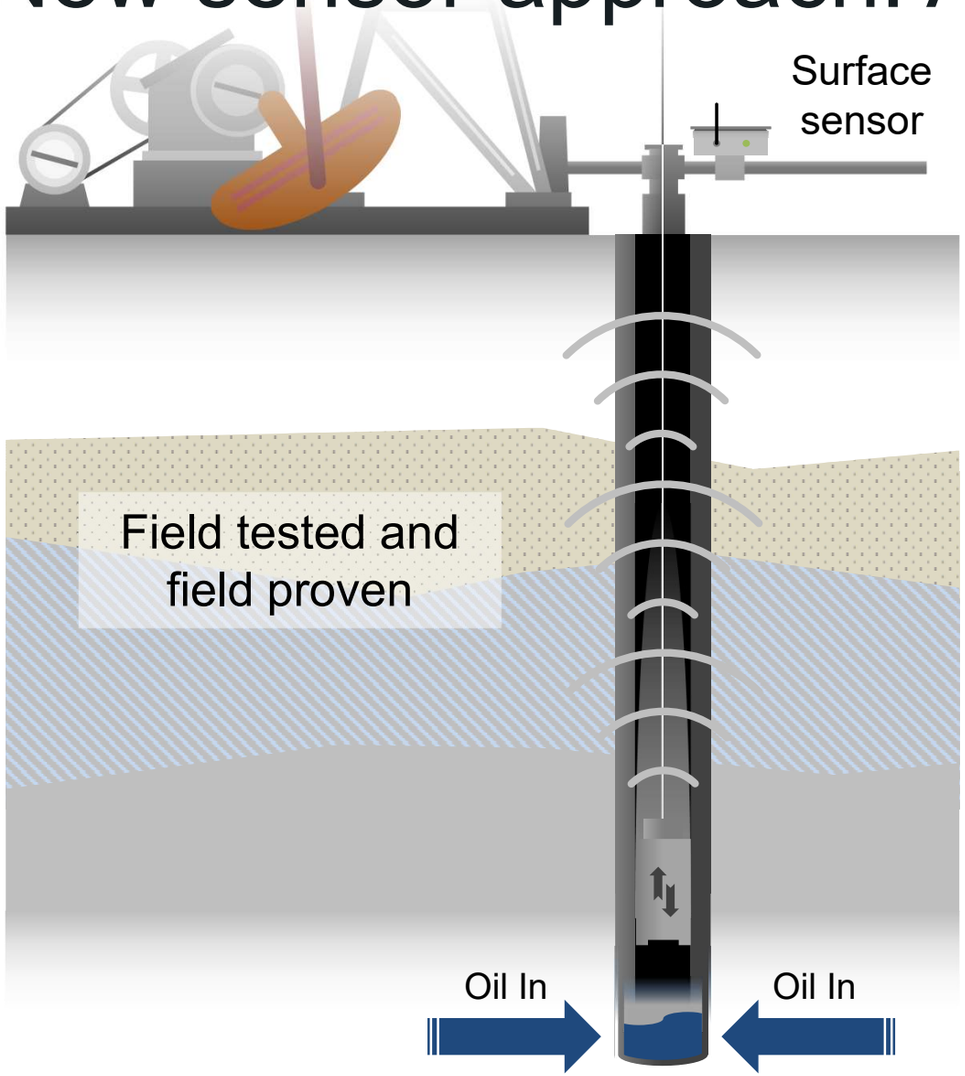
- **Bringing stripper fields into the 21st century**
- **No infrastructure required for telemetry**
  - New long range 5G network + compression algorithms
  - High resolution data 24/7
- **Lowering sensor and automation cost**
  - New, affordable load cell technology + acoustic sensing
  - No RTU/PLC, bare metal microcontrollers + cloud computing
  - Fully wireless with years of battery life
- **Everything is recorded simultaneously**
  - Rod loading, current, vibration, acoustics, pressures
- **AI in the cloud and on the edge**



High quality data collection, made simple

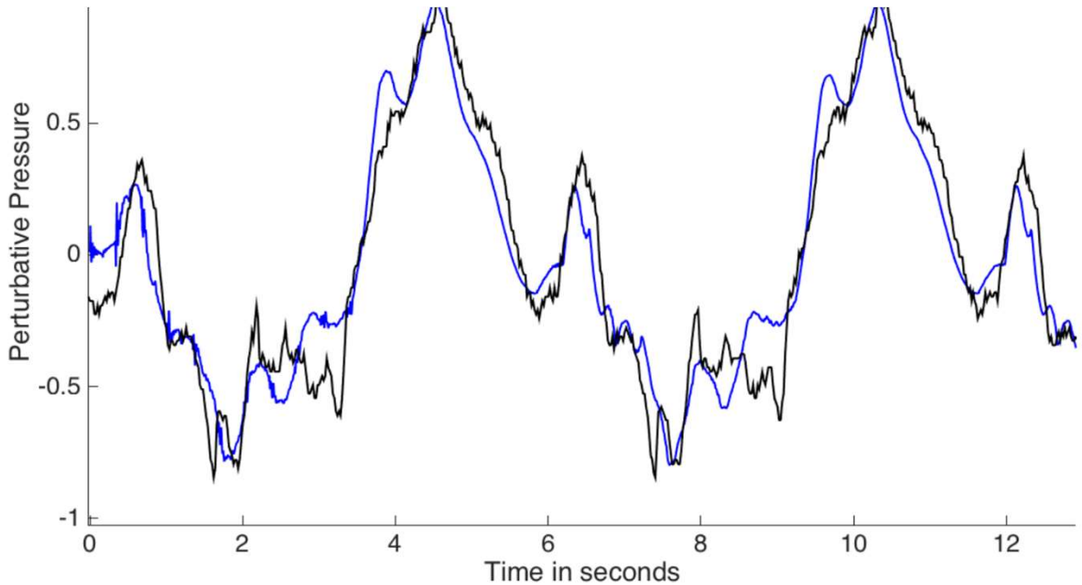


New sensor approach: Acoustics



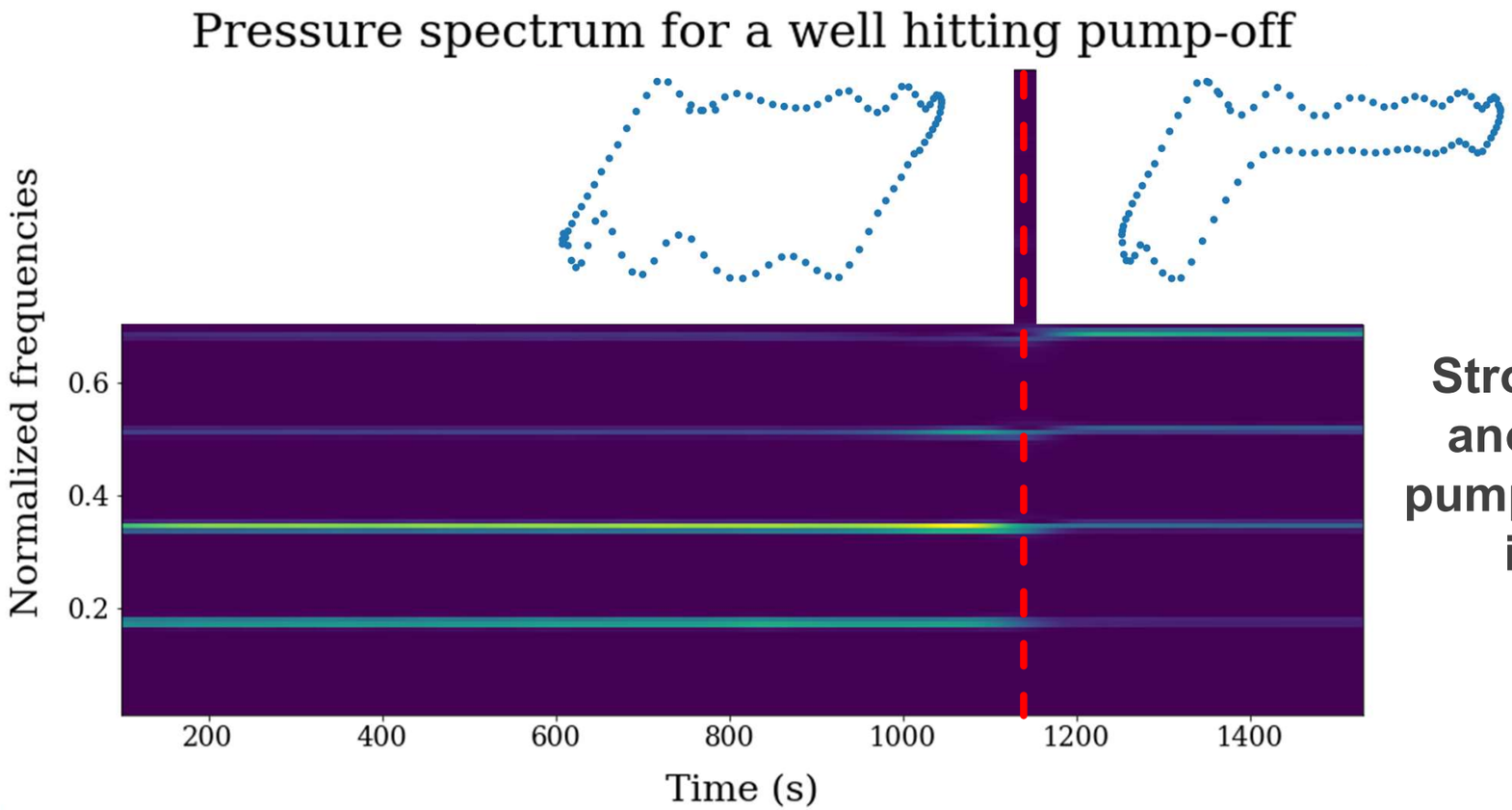
- Pump acts as a speaker
- Tubing carries the sound waves to the surface
- Wellhead sensors pick up the signal

New sensor approach: Acoustics



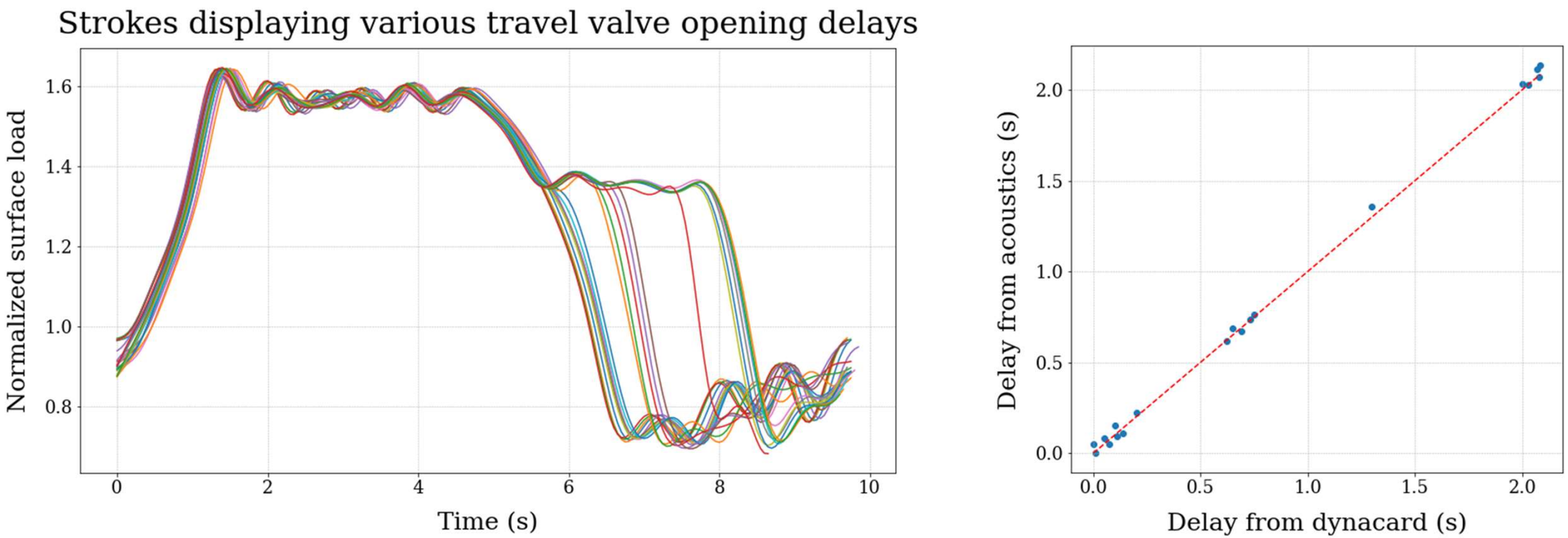
- **Pros**
  - Insensitive to well deviation
  - Good for surface piping monitoring & flow pattern anomaly detection
  - Very cost effective
- **Cons**
  - Must disentangle signals when several wells are connected on the same flowline
  - Challenging signal to noise ratio when pressure is low (e.g. no backpressure valve)
  - Newer and high data rate

Sensitivity of the acoustic signal to changing downhole conditions



Strong acoustic anomaly when pump gas fraction increases

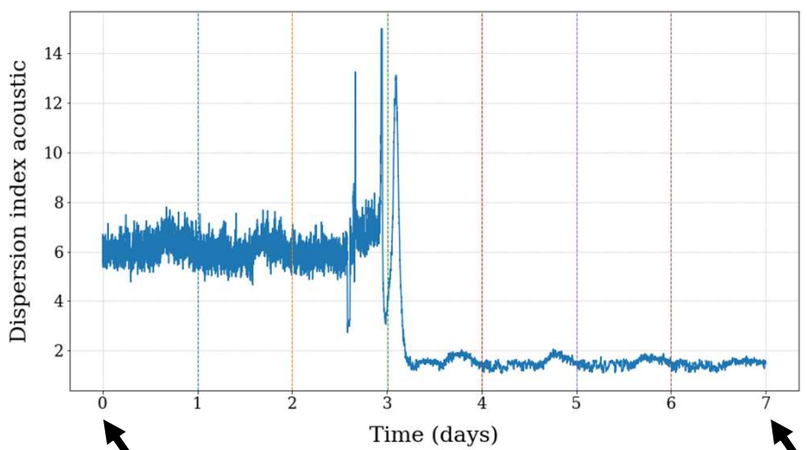
Acoustic analysis gives precise underground pump information



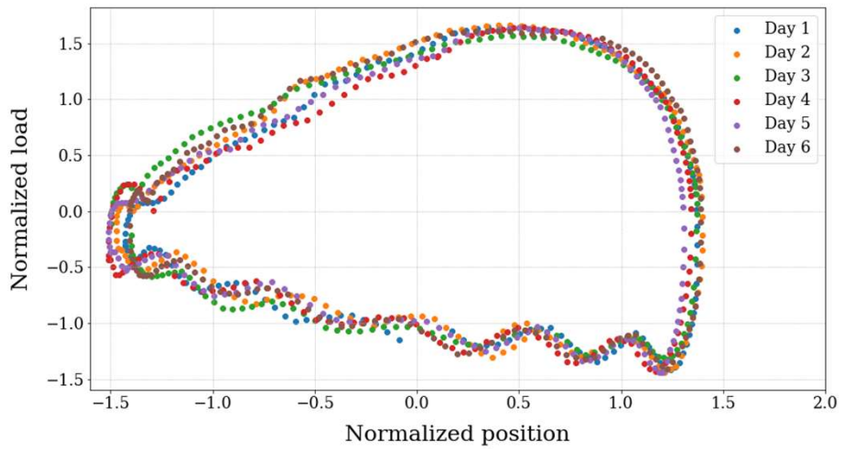
Traveling valve opening timing obtained using acoustics exactly matches dynacard measurements as pump gas fraction increases

Complementing pump cards to detect flow anomalies

- Surface tubing leak stopped well production despite constant downhole conditions: obvious with frequency analysis of tubing acoustic (cards and pressure not enough)



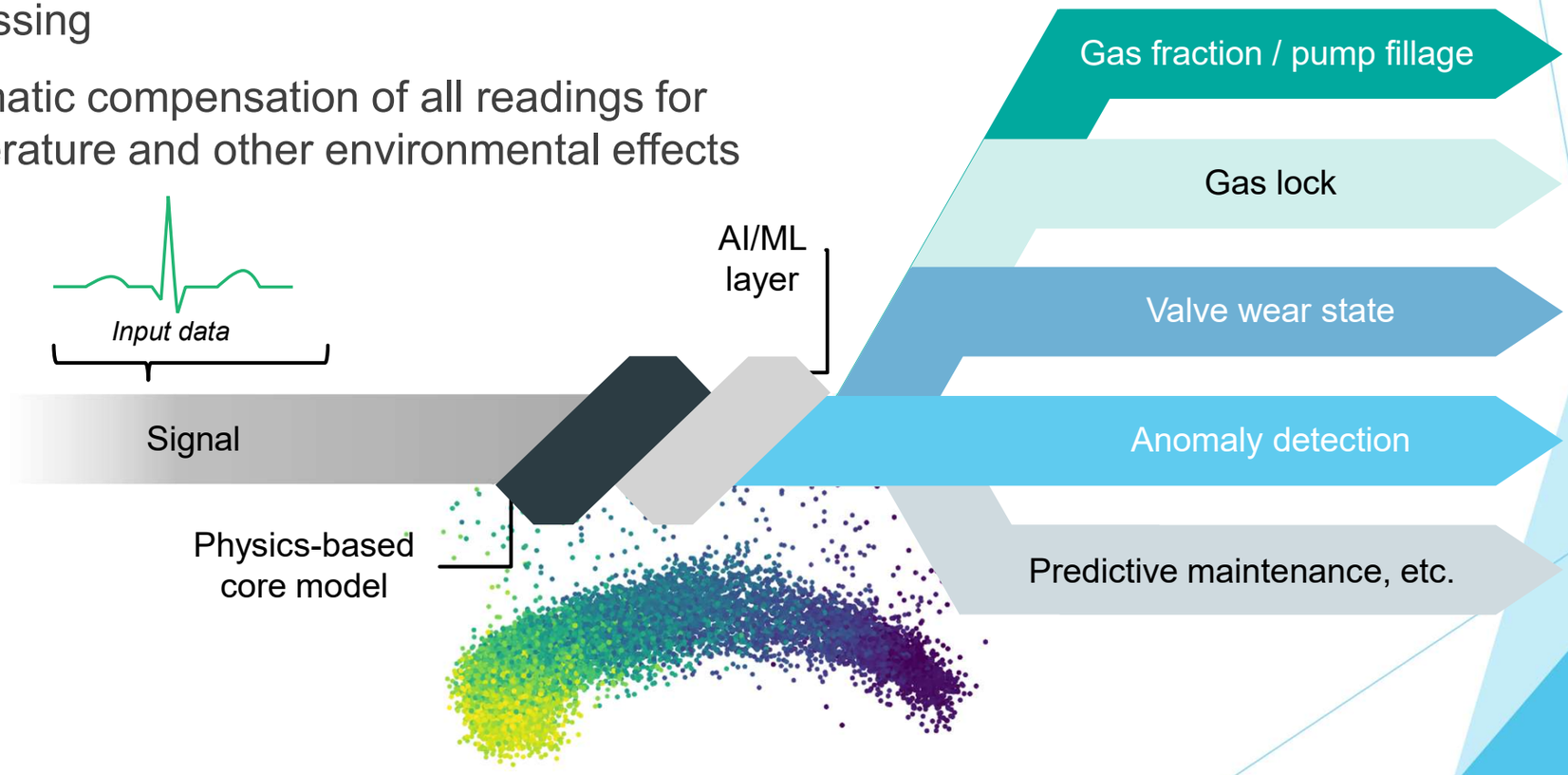
Well test: producing



Well test: no longer producing

Advanced signal processing of sensor feeds

- Acoustic signal is data intensive and requires significant processing
- Automatic compensation of all readings for temperature and other environmental effects



Case study 1: Haynesville-Bossier operator

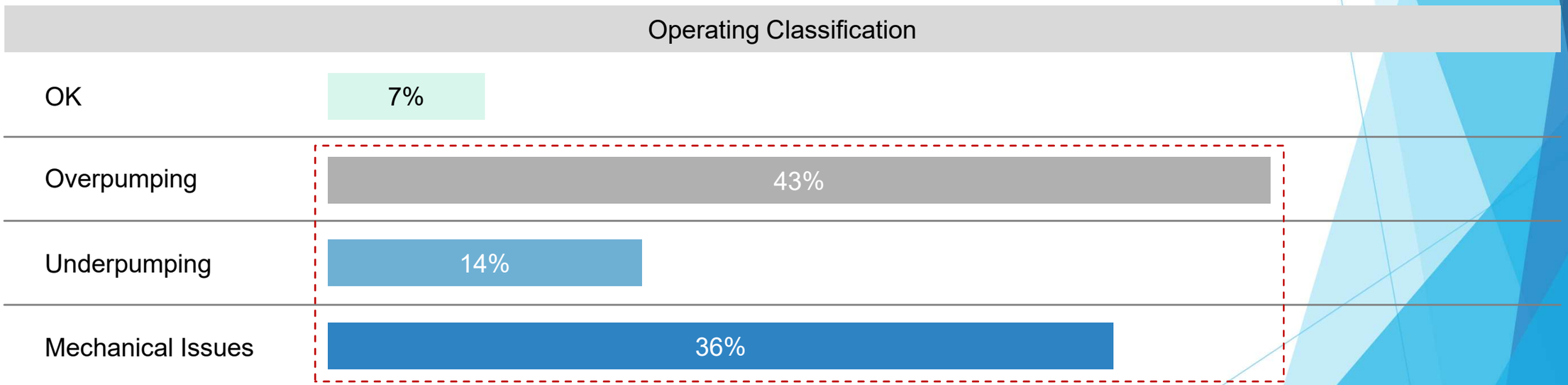
Private operator with ~600 wells

Examining assets across 5 leases

Wells + tanks installed

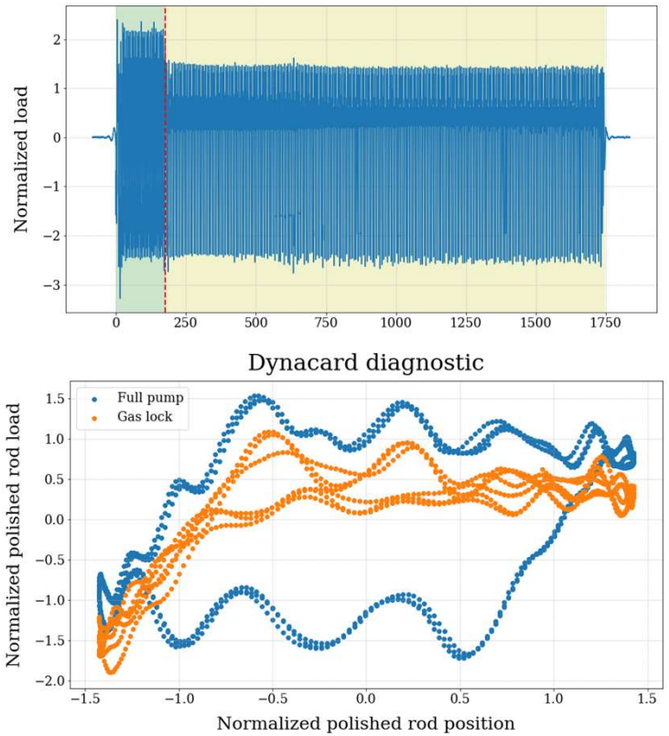
Chemical treatment impact monitoring

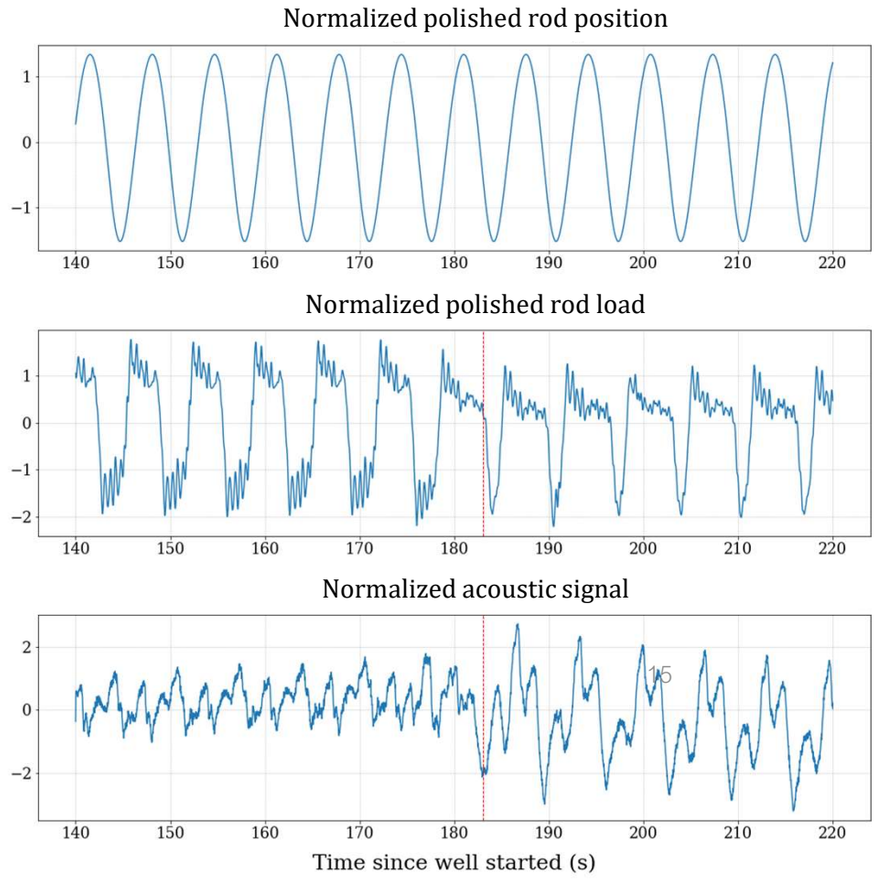
Control + leak detection coming



>90% of assets capable of significant improvement;
excludes impact of chemical & workflow optimization + leak detection

Case study 1:
Setpoint adjustments of timer wells

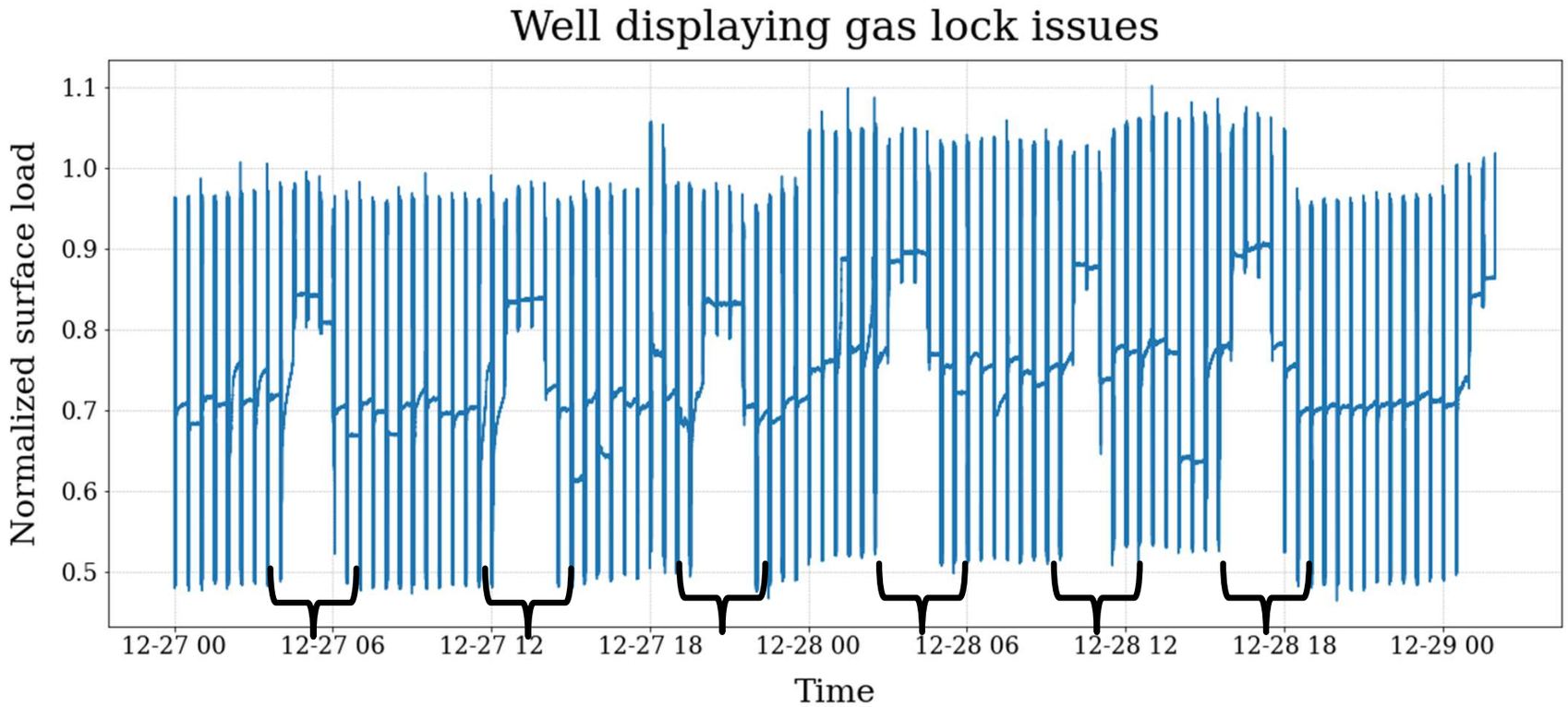




Case study 1: Setpoint adjustments of timer wells

- For a subset of 14 wells
  - 4 wells under-pumping (typical **10-20% increase in production**)
  - 6 wells over-pumping (typical **~50% reduction in power usage**)
  - 2 cases of severe gas lock (~20% and 50% of time spent pumping empty strokes)
  - 1 stuck traveling valve, 2 eroded traveling valves
  - Additional issues like motor shorting, sheave failure, and fuse failures detected

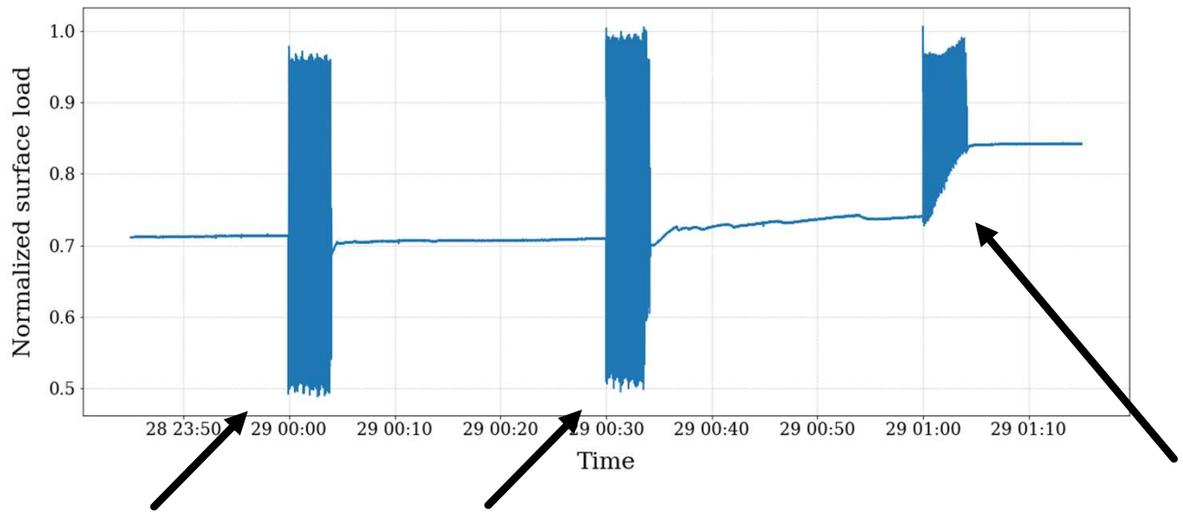
Case study 2: Gas lock and reduced pump action

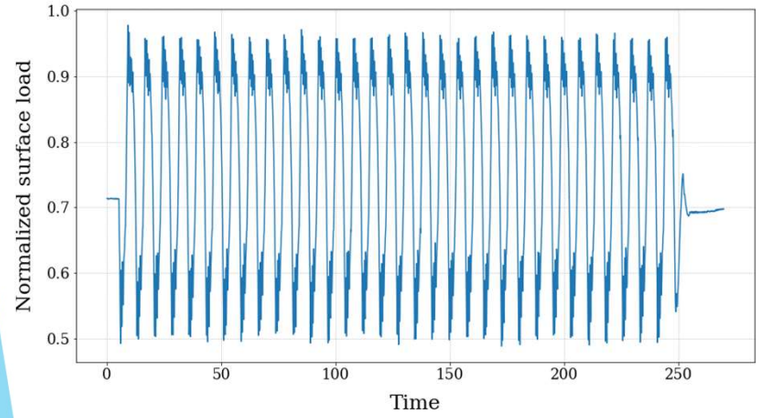


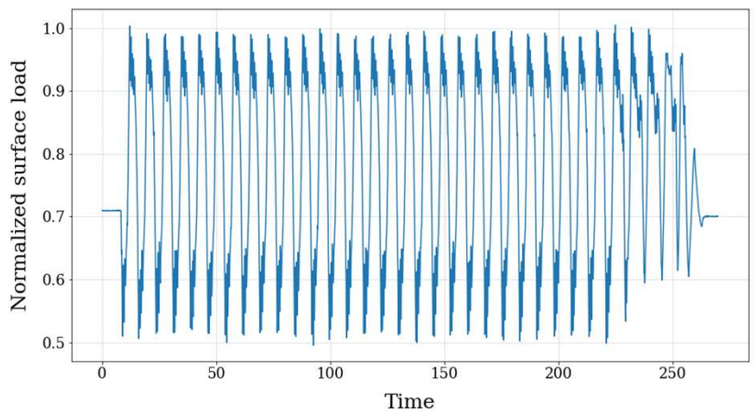
Load cell indicates periods of gas locking leading to stuck standing valve (SV), increasing wear and significantly reducing production

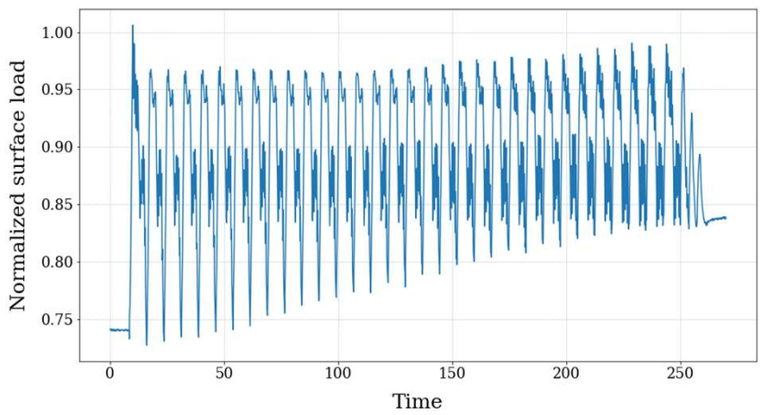
Case study 2: Reasonably good settings still lead to issues

3 partially gas locked strokes are enough and unseat the standing valve and block the pump for a couple hours

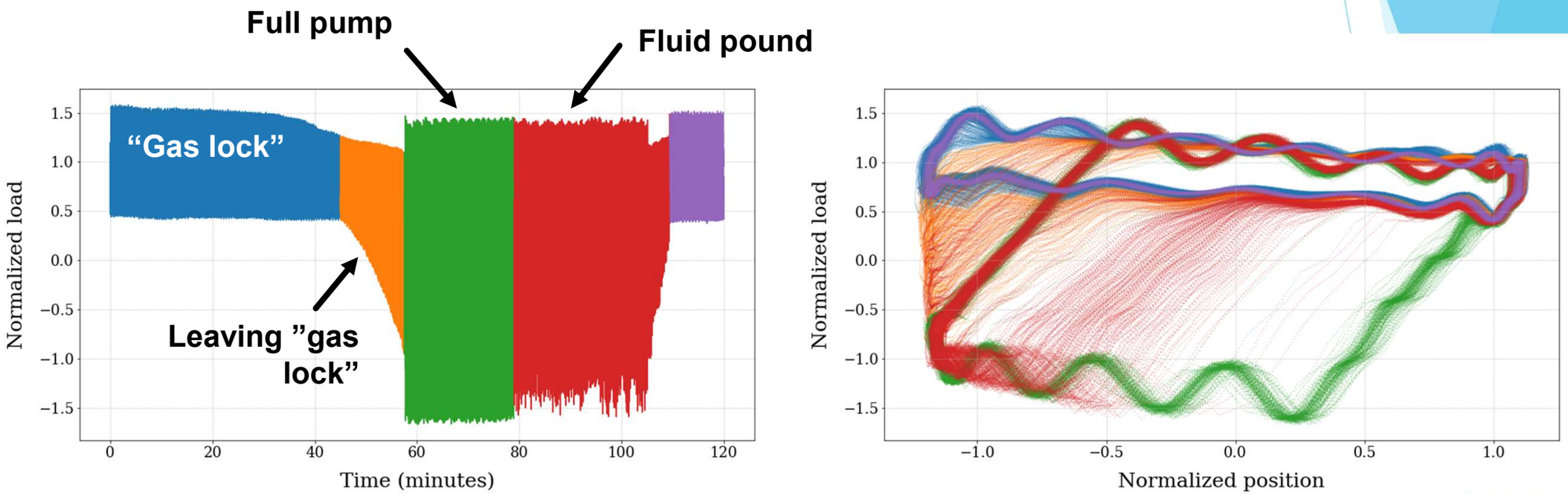






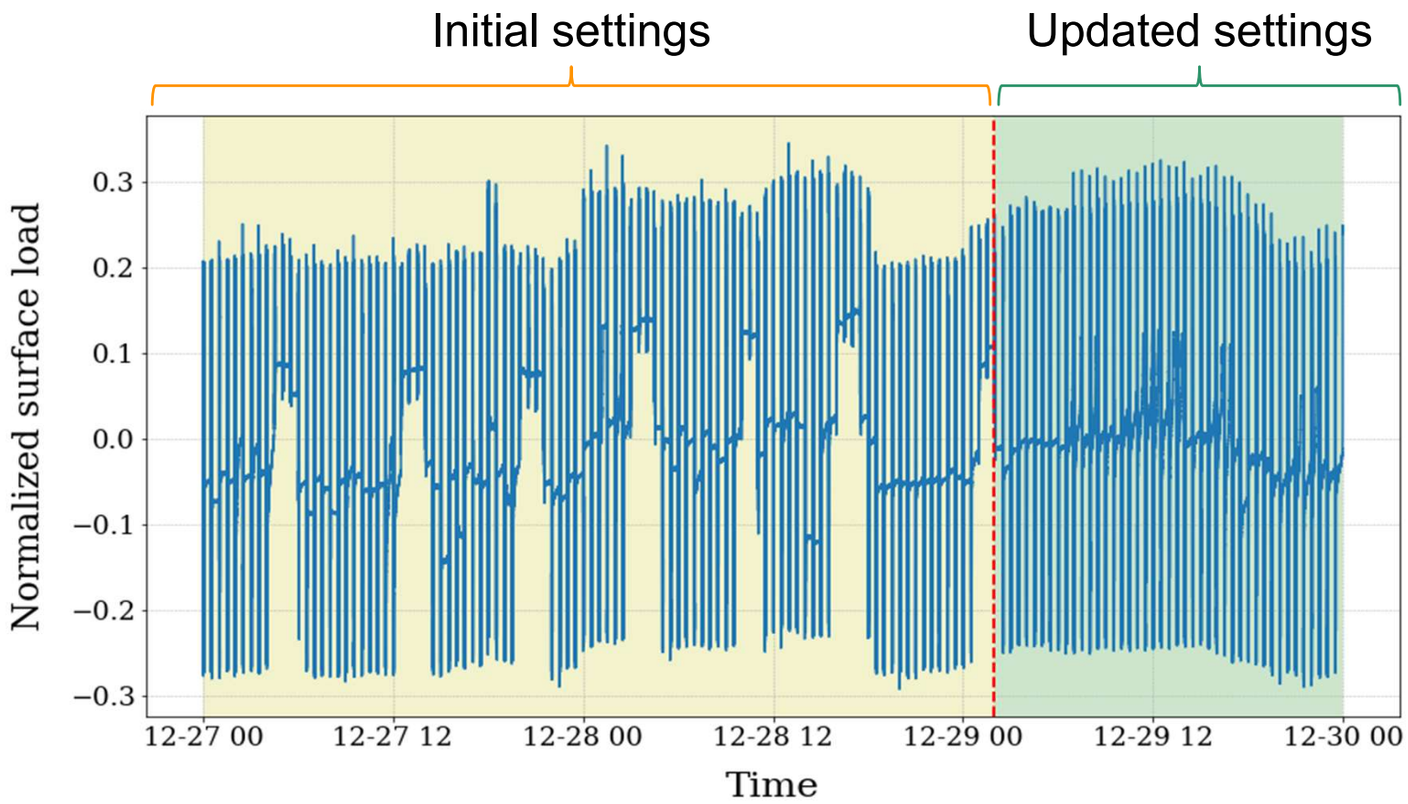


Case study 2: Stroke by stroke analysis



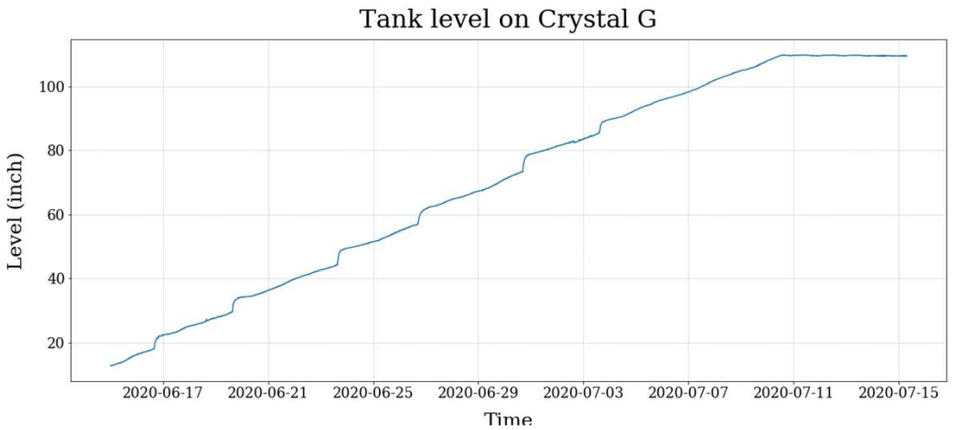
Advanced control schemes running 24/7 are able to avoid "gas locking"/SV issues and instantly increase production

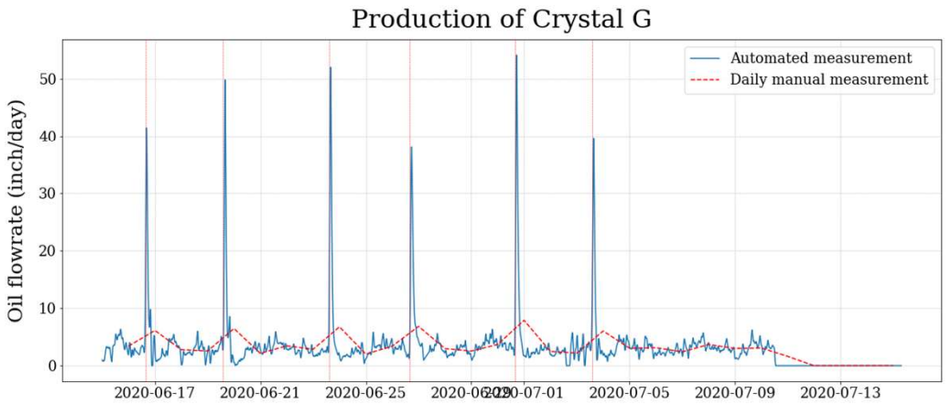
Case study 2: Solving the problem using control

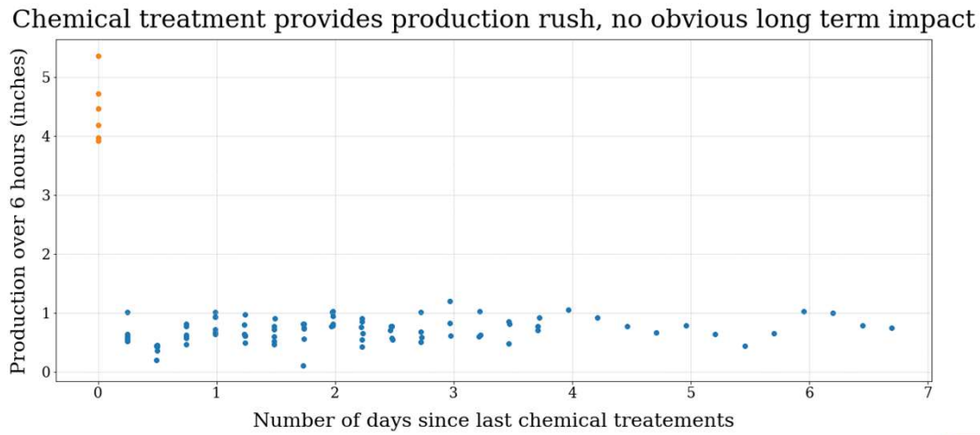


- Control algorithm leads to:
  - Higher production, **+20% full strokes**
  - Lower lifting costs per bbl
  - Longer mean time between well failure, i.e. longer well life

Case study 3: Efficacy of chemical treatments







- Chemical treatments do not seem to cannibalize later baseline production
- Production uplift not significantly influenced by time interval between injections

Next steps

- Advanced control using variable speed drives
- Virtual flowmeter with production allocation and automated well testing
- Acoustically augmented control of deviated/horizontal wells

Conclusions

- With 5+ high resolution sensor streams per well, we are able to get a complete picture of well & pump conditions
- Acoustics nicely complement load cell approach
- Advanced algorithms are necessary to process this amount of data 24/7
- By developing a product at a low enough cost with high enough efficacy across all conditions, even stripper fields can finally be automated at the highest level

Thank you

The authors are thankful for their insightful discussions with Dr. Victoria Pons, and to Echometer for sharing and creating amazing online educational content.

Copyright

Artificial Lift R&D Council

Rights to this presentation are owned by the company(ies) and/or author(s) listed on the title page. By submitting this presentation to the International Sucker Rod Pumping Workshop Workshop, they grant to the Workshop, and the Artificial Lift Research and Development Council (ALRDC) rights to:

- **Display the presentation at the Workshop.**
- **Place the presentation on the www.alrdc.com web site, with access to the site to be as directed by the Workshop Steering Committee.**
- **Place the presentation on a CD for distribution and/or sale as directed by the Workshop Steering Committee.**

Other uses of this presentation are prohibited without the expressed written permission of the company(ies) and/or author(s).

Disclaimer

The following disclaimer shall be included as the last page of a Technical Presentation or Continuing Education Course. A similar disclaimer is included on the front page of the International Sucker Rod Pumping Workshop Web Site.

The Artificial Lift Research and Development Council and its officers and trustees, and the International Sucker Rod Pumping Workshop Workshop Steering Committee members, and their supporting organizations and companies (here-in-after referred to as the Sponsoring Organizations), and the author(s) of this Technical Presentation or Continuing Education Training Course and their company(ies), provide this presentation and/or training material at the International Sucker Rod Pumping Workshop "as is" without any warranty of any kind, express or implied, as to the accuracy of the information or the products or services referred to by any presenter (in so far as such warranties may be excluded under any relevant law) and these members and their companies will not be liable for unlawful actions and any losses or damage that may result from use of any presentation as a consequence of any inaccuracies in, or any omission from, the information which therein may be contained.

The views, opinions, and conclusions expressed in these presentations and/or training materials are those of the author and not necessarily those of the Sponsoring Organizations. The author is solely responsible for the content of the materials.

The Sponsoring Organizations cannot and do not warrant the accuracy of these documents beyond the source documents, although we do make every attempt to work from authoritative sources. The Sponsoring Organizations provide these presentations and/or training materials as a service. The Sponsoring Organizations make no representations or warranties, express or implied, with respect to the presentations and/or training materials, or any part thereof, including any warrantees of title, non-infringement of copyright or patent rights of others, merchantability, or fitness or suitability for any purpose.