



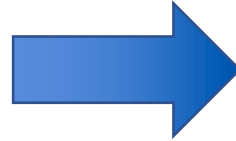
Decision-Making Technology for Oil and Gas

Using the industry's only genuinely coupled hydraulic fracturing, wellbore, and reservoir simulator

August 9, 2022

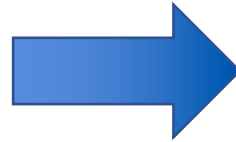
Quantitative Optimization

Market conditions, company objectives, and operational constraints are constantly evolving



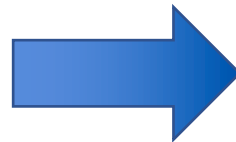
Optimization must be multifaceted

Drilling inventory is a finite resource



Trial and error is an inefficient optimization method

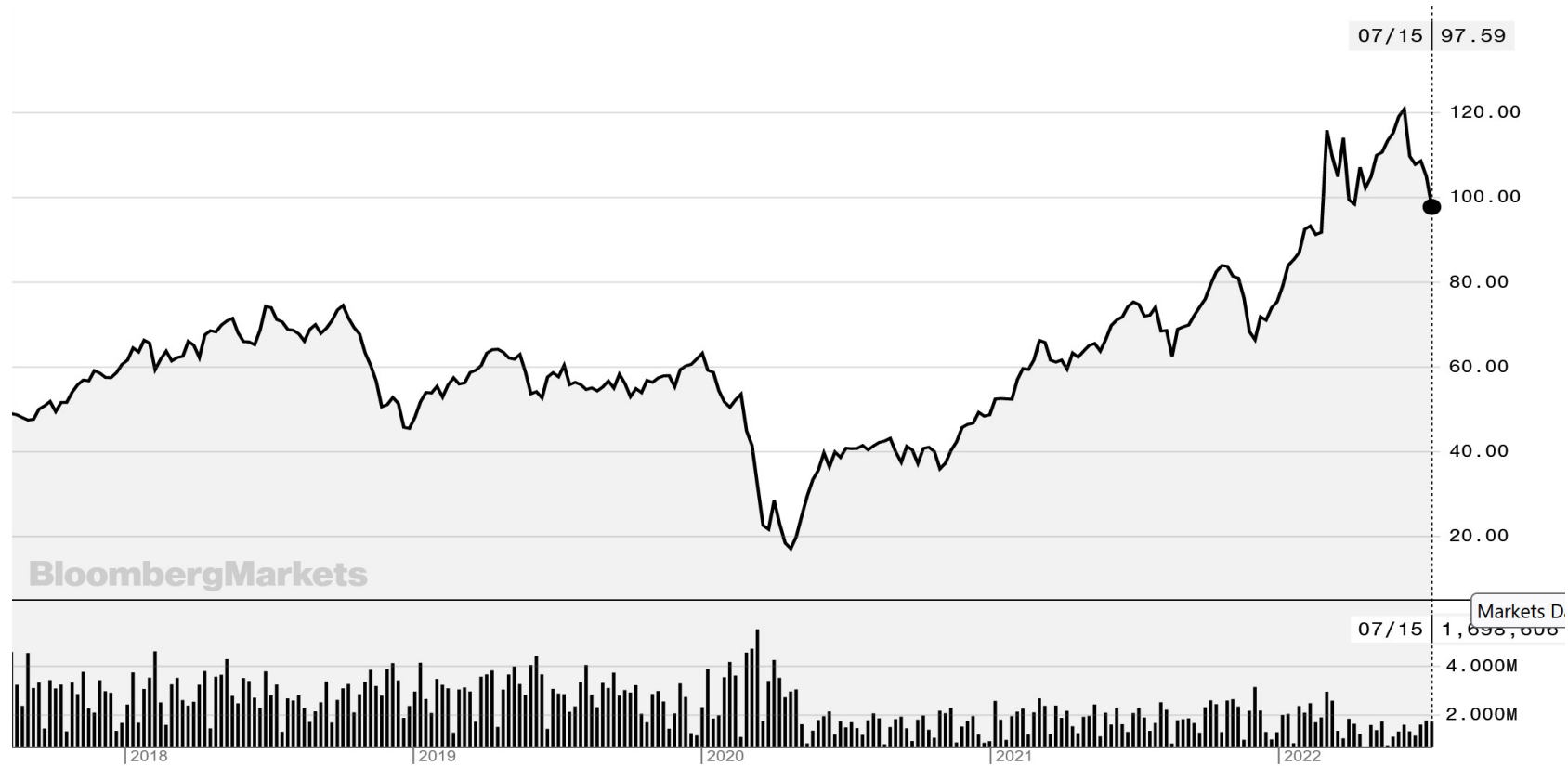
The subsurface is complex and hard to predict



Computational models are now highly predictive

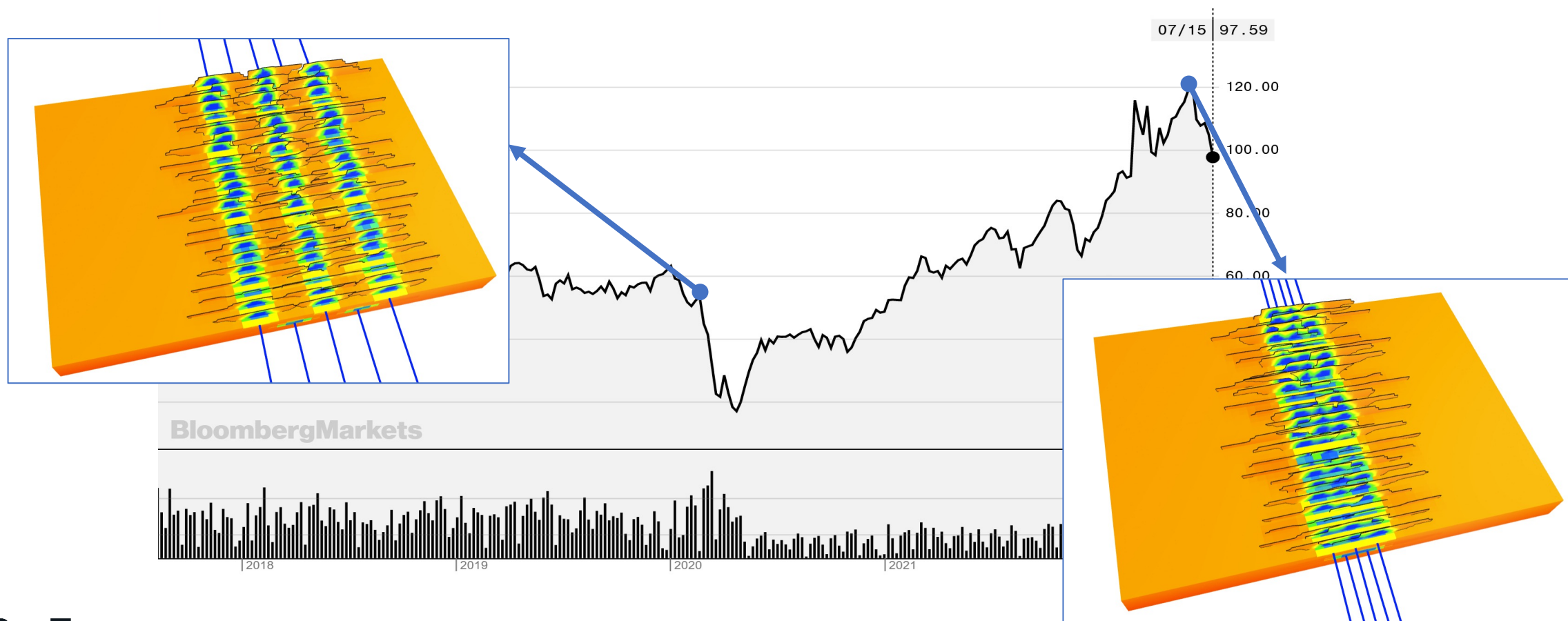
Dynamic Pricing Environment

Death, taxes, and volatility are constant



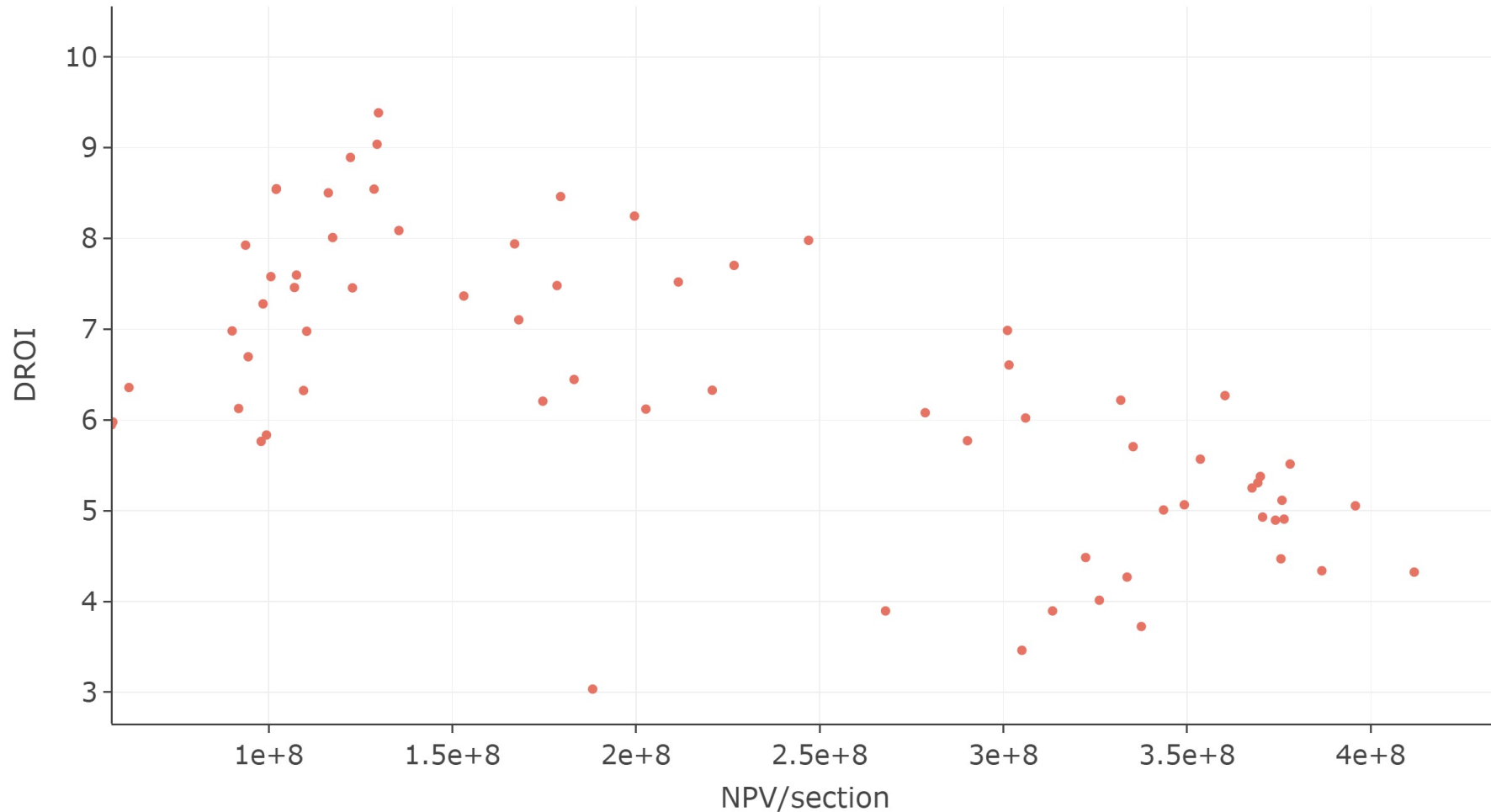
Optimal Design is a Function of Oil Price

At higher commodity pricing, tighter spacing prevails as greater interference is tolerated



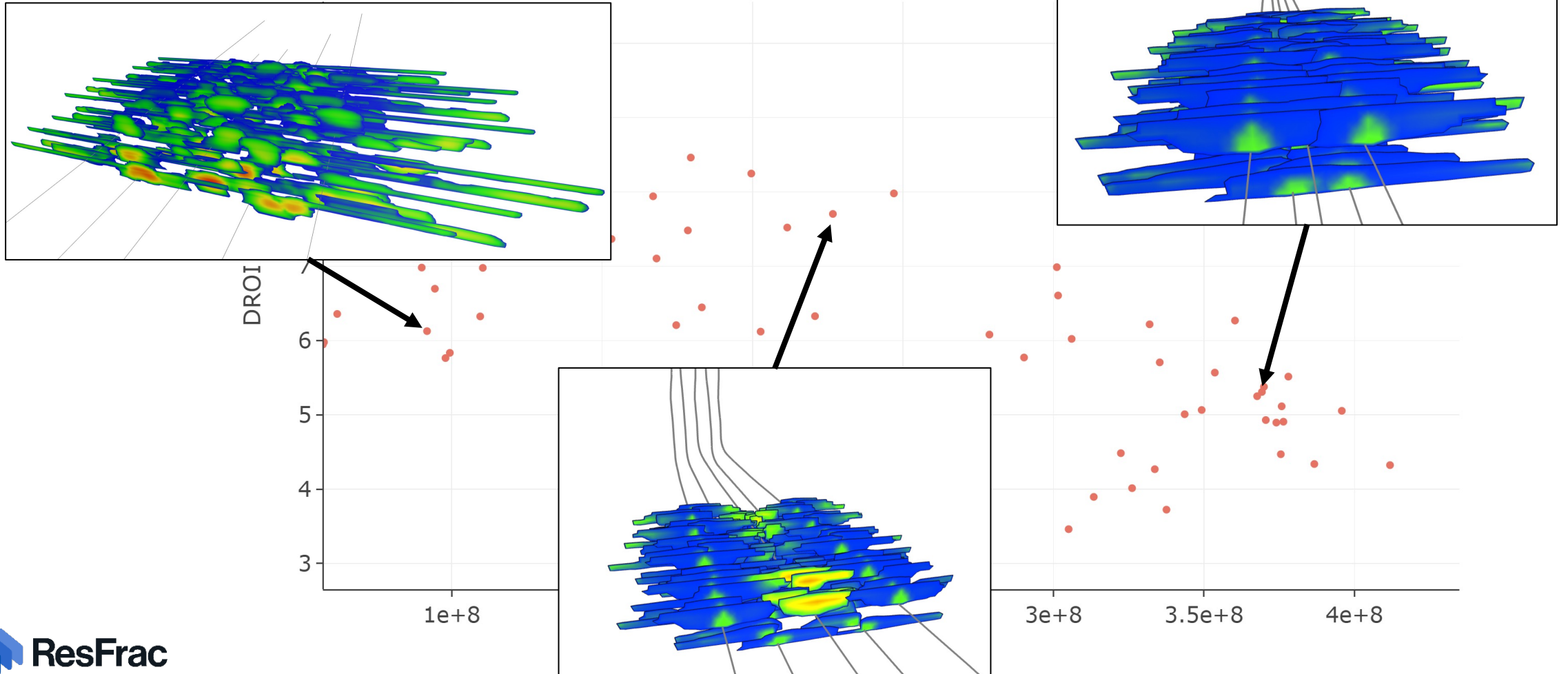
Nuanced and changing objectives

- Each point is a specific design scenario



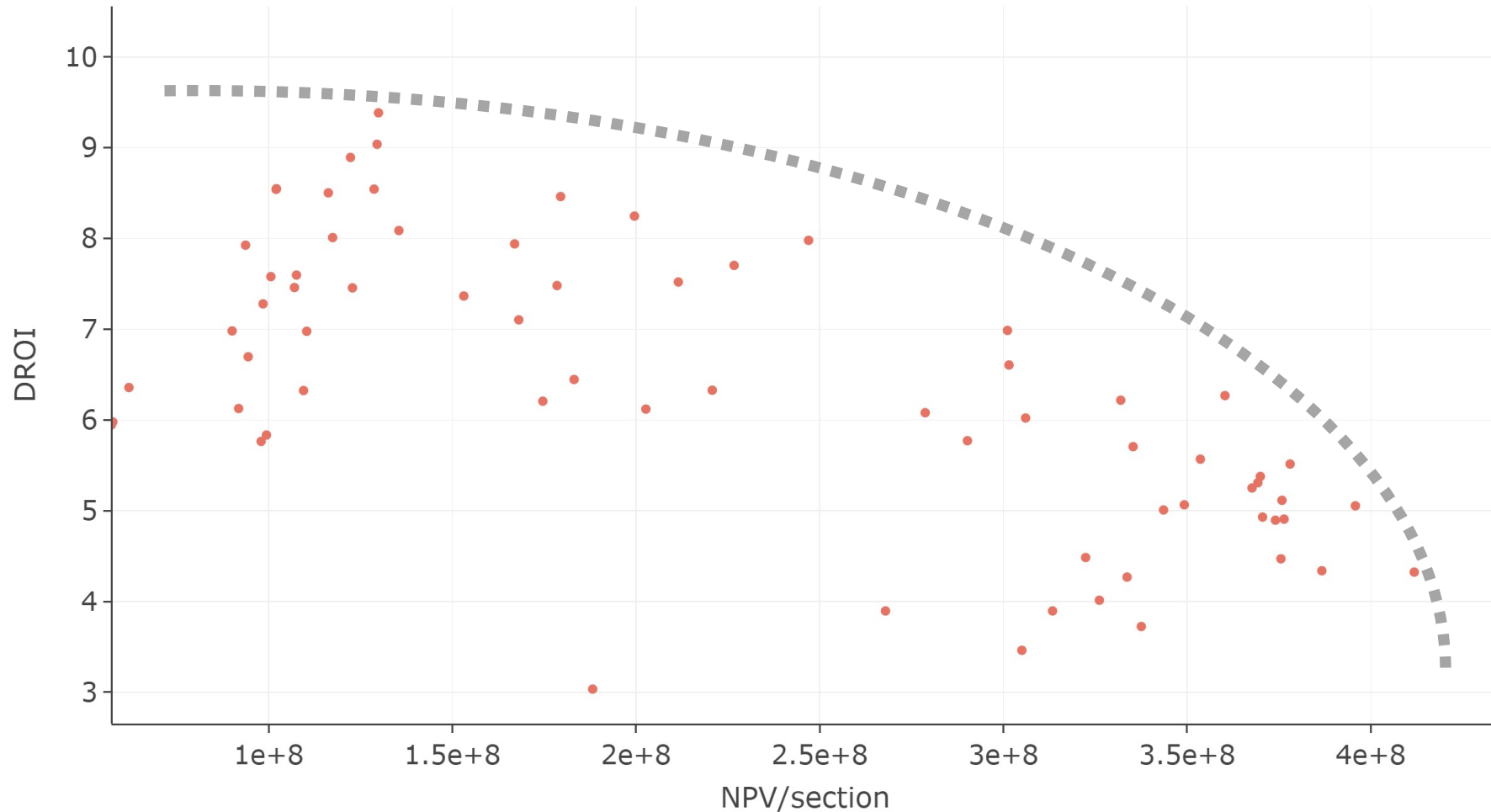
Nuanced and changing objectives

- Each point is a specific design scenario

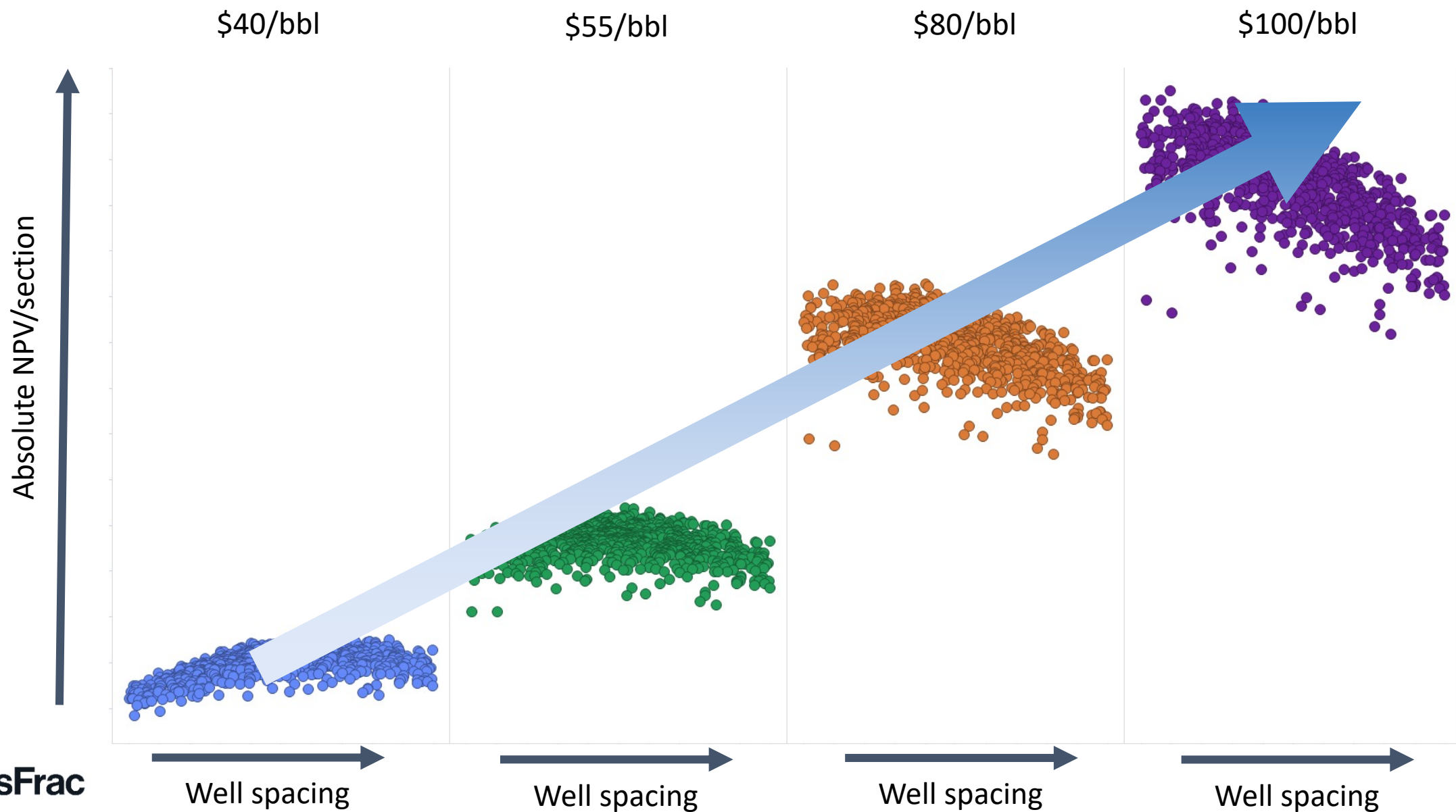


Nuanced and changing objectives

- NPV is not the only performance objective
- NPV is in competition with other metrics, like ROI



Rising Oil Price Lifts All Scenarios



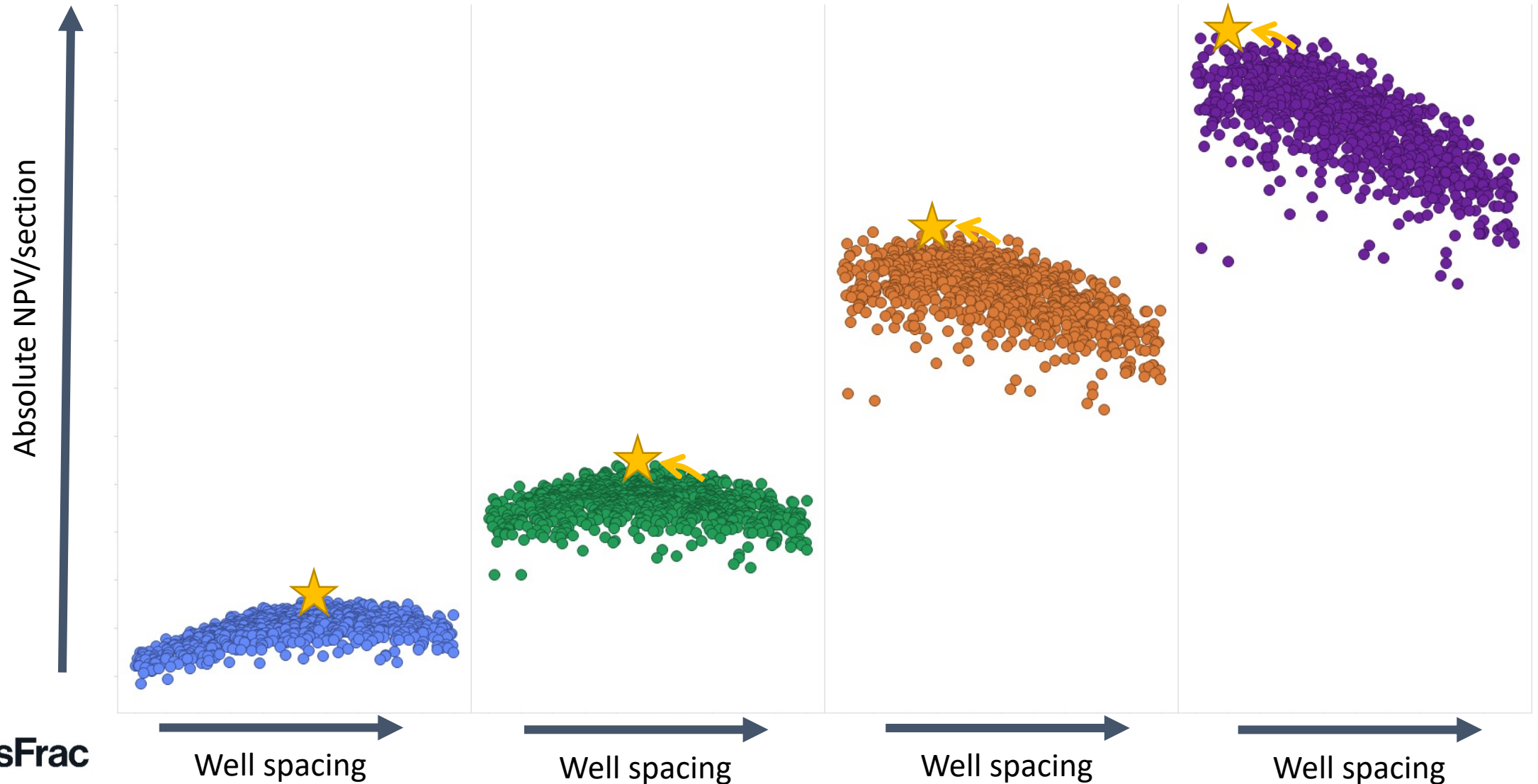
Optimal Design is a Function of Oil Price

\$40/bbl

\$55/bbl

\$80/bbl

\$100/bbl



Why Optimal Design Matters

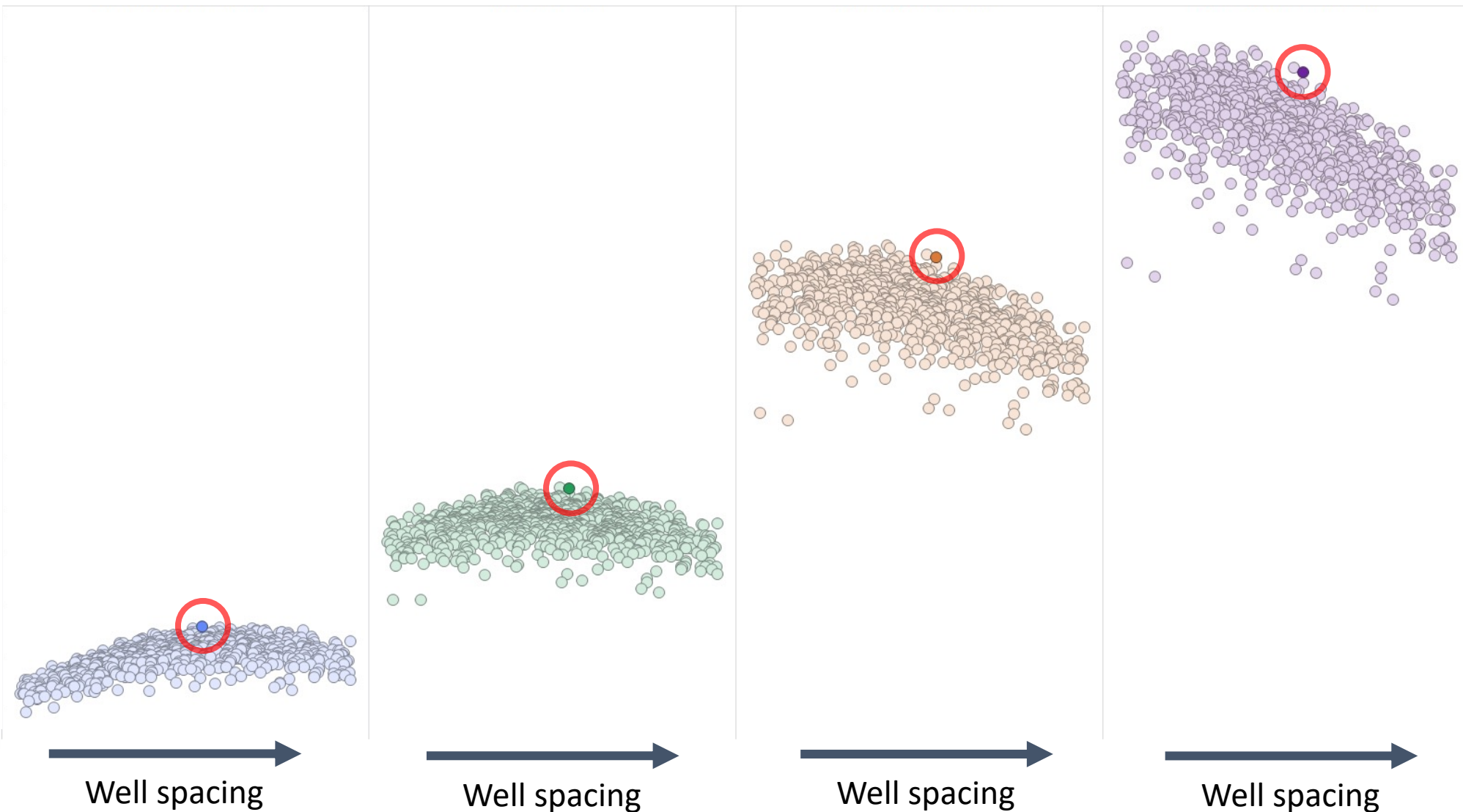
\$40/bbl

\$55/bbl

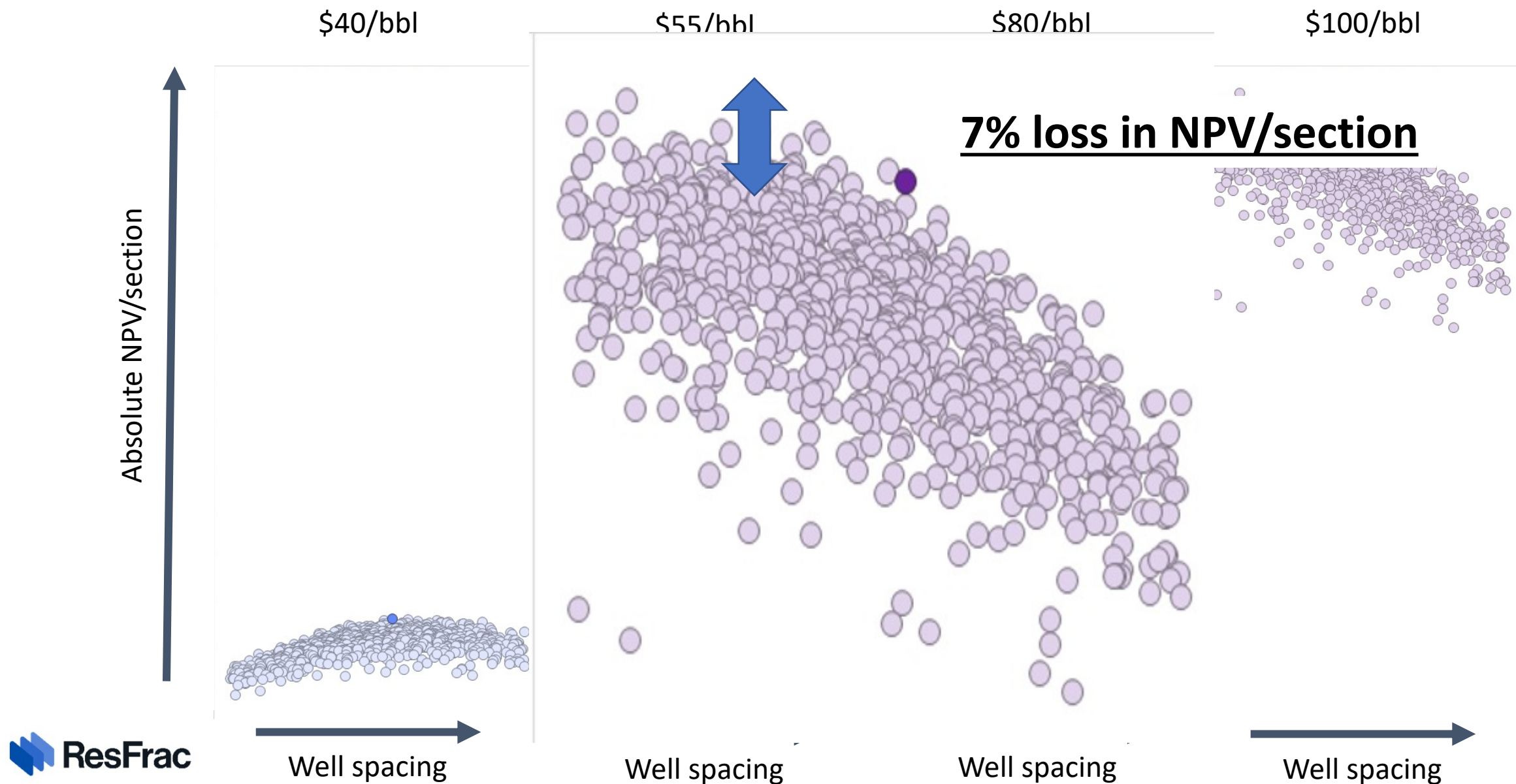
\$80/bbl

\$100/bbl

Absolute NPV/section

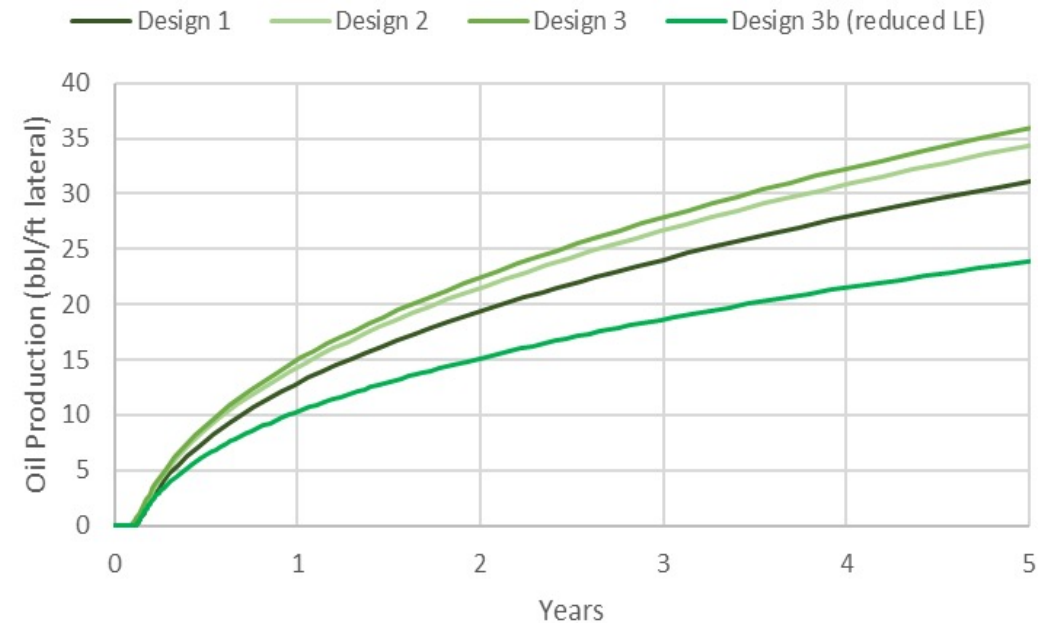
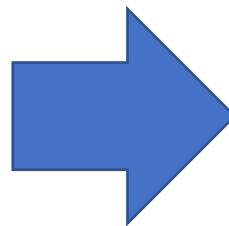


Why Optimal Design Matters



Need the Ability to Forecast Performance From Inputs

depletion petrophysics
geology
geomechanics
well-landing



Kaufman et al., 2019

Who is ResFrac?

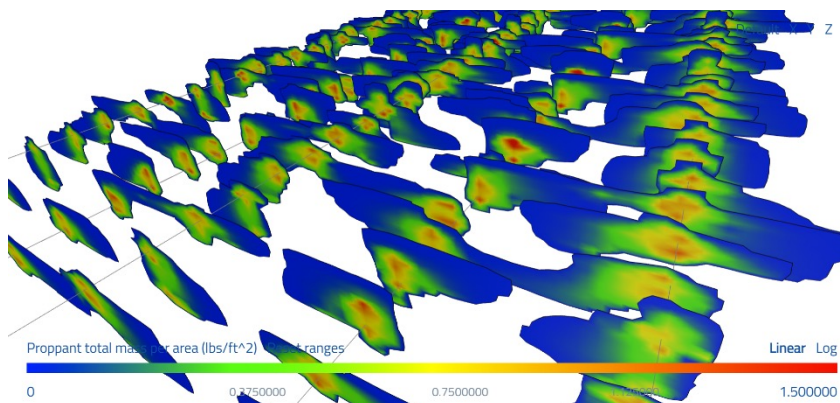
- ResFrac was founded in 2015 to support science-based decision making
- Leveraged years of research of co-founder Dr. Mark McClure at Stanford and UT at Austin
- Rapid adoption across the shale patch with 80%+ YoY growth since inception
- Only commercial modeling software that fully couples fracture, reservoir, and geomechanics dynamics



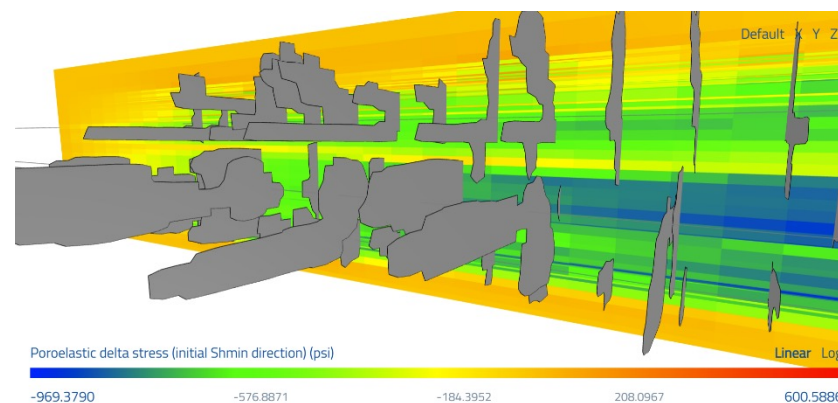
Case studies in every major basin co-authored with operators

ResFrac Provides a Holistic Modeling Software

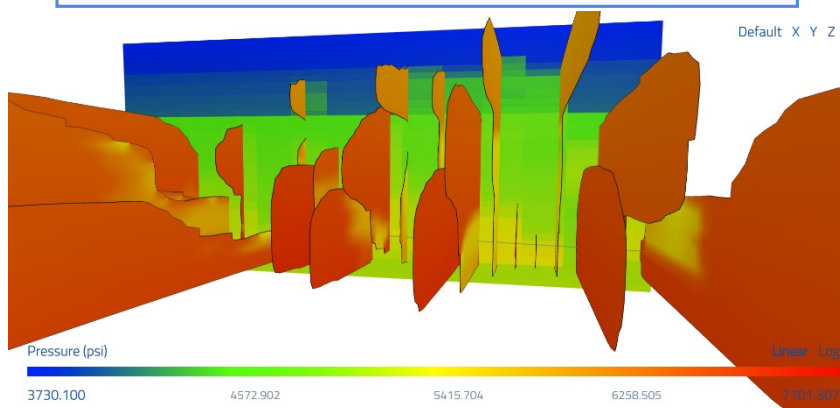
Fracture Propagation



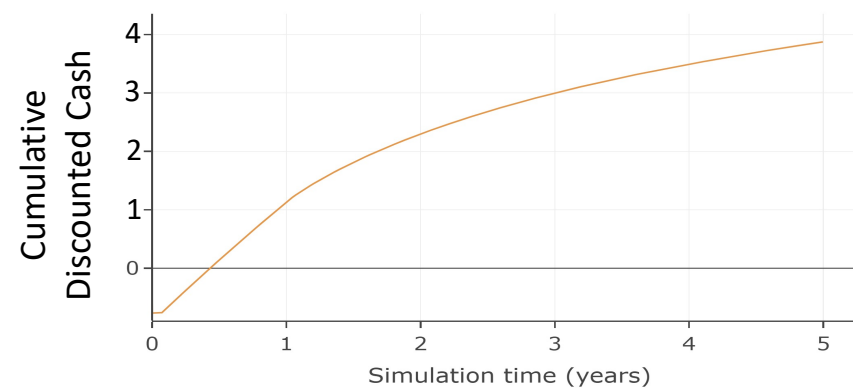
Geomechanics



Reservoir Flow



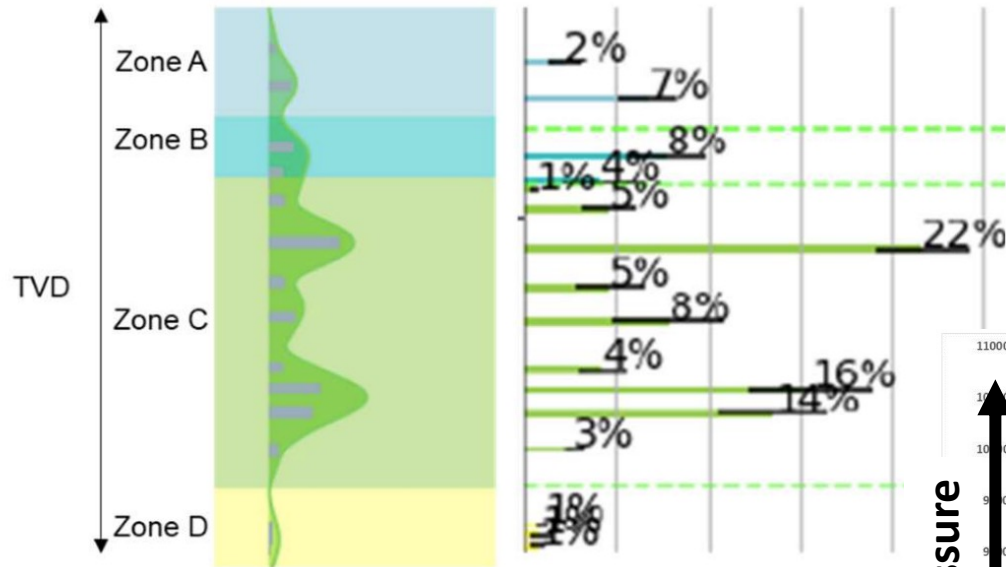
Economics



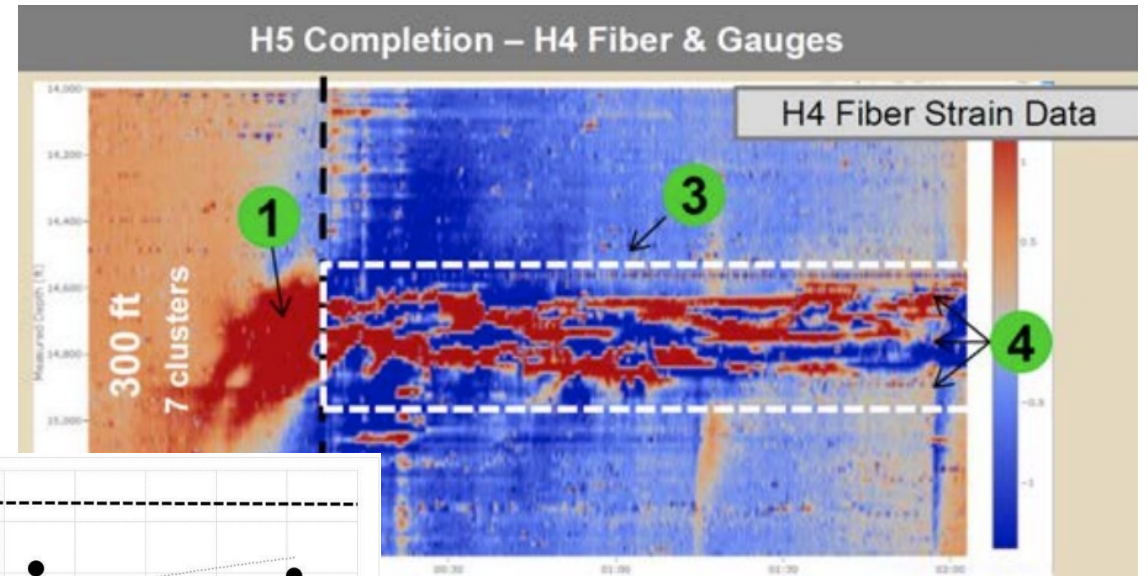
Why is Now Different?

The last five years have yielded unprecedentedly detailed, in-situ measurements of hydraulic fractures

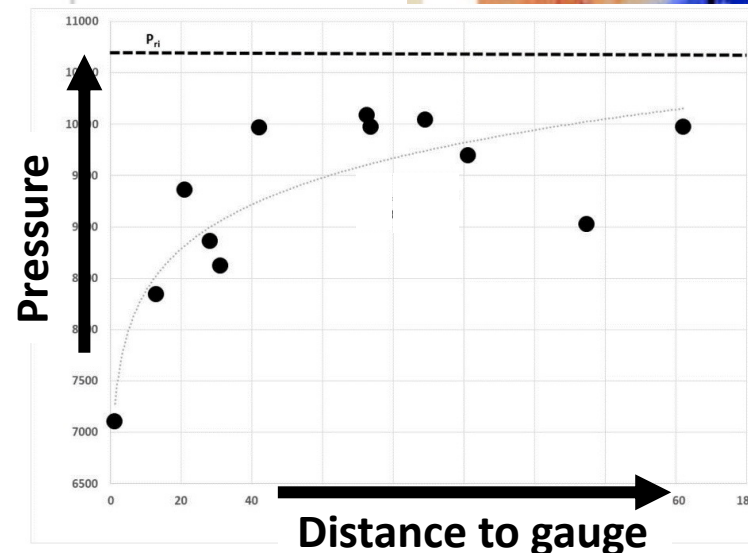
Well S Contribution by Layer vs. Depth



Albrecht et al., 2022



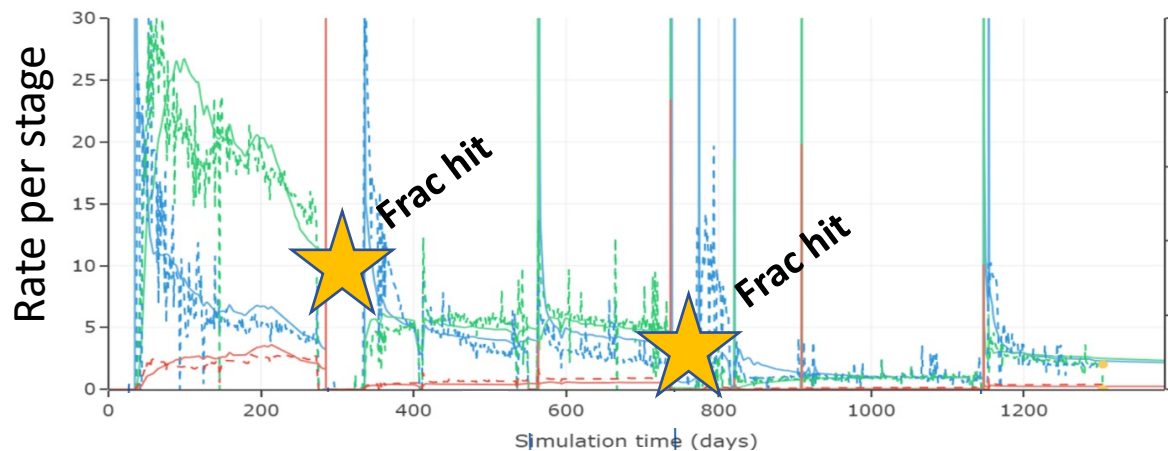
Cipolla et al., 2022



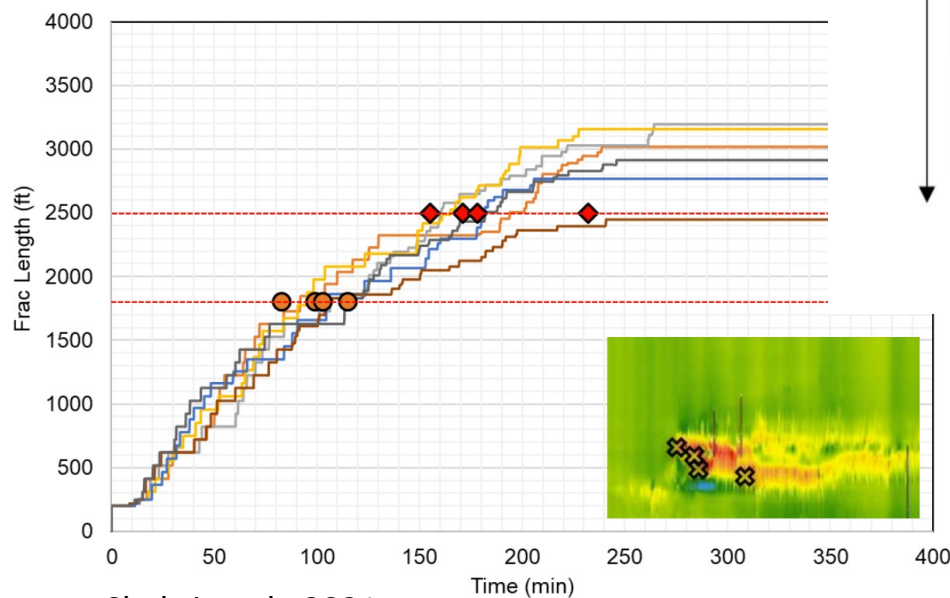
Rateman et al., 2019

Why ResFrac?

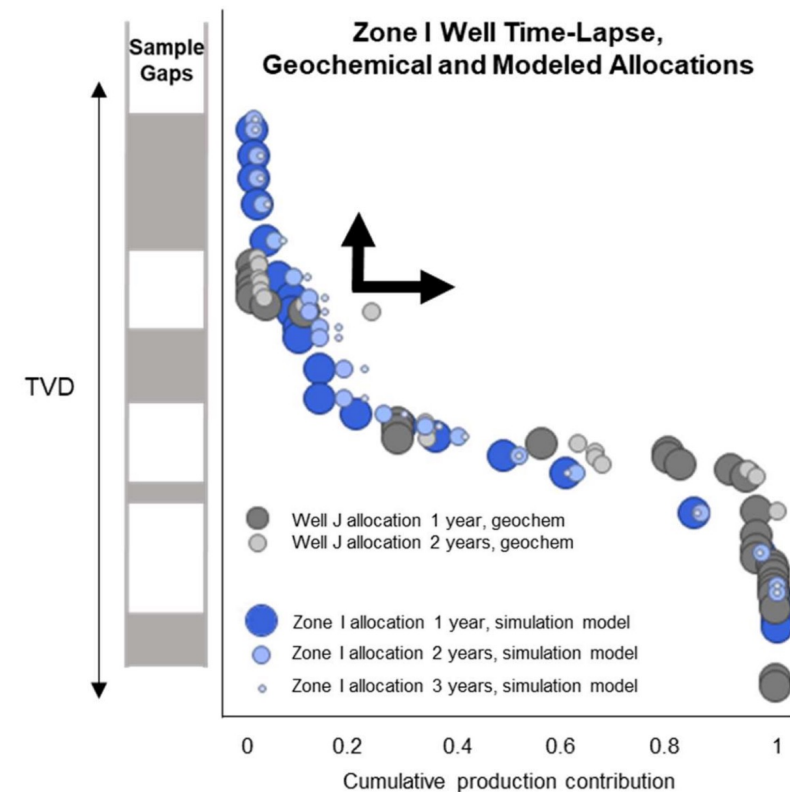
Numerical models can replicate and predict these behaviors



Ratcliff et al., 2022



Shahri et al., 2021



Albrecht et al., 2022

Collaborative Study Demonstrated Results Driven by Physics

7 Operators

10 High-fidelity
data sets

4 Basins



Software

Services ▾

About ▾

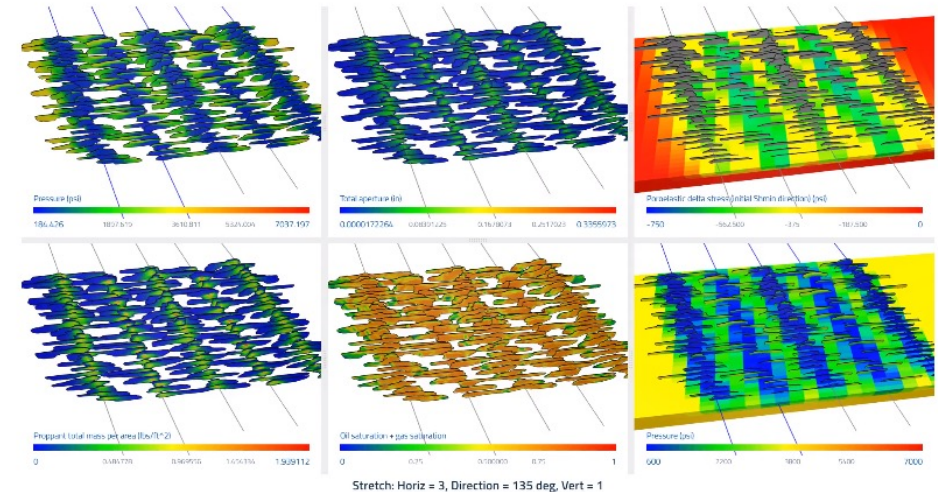
News

Library ▾

Contact

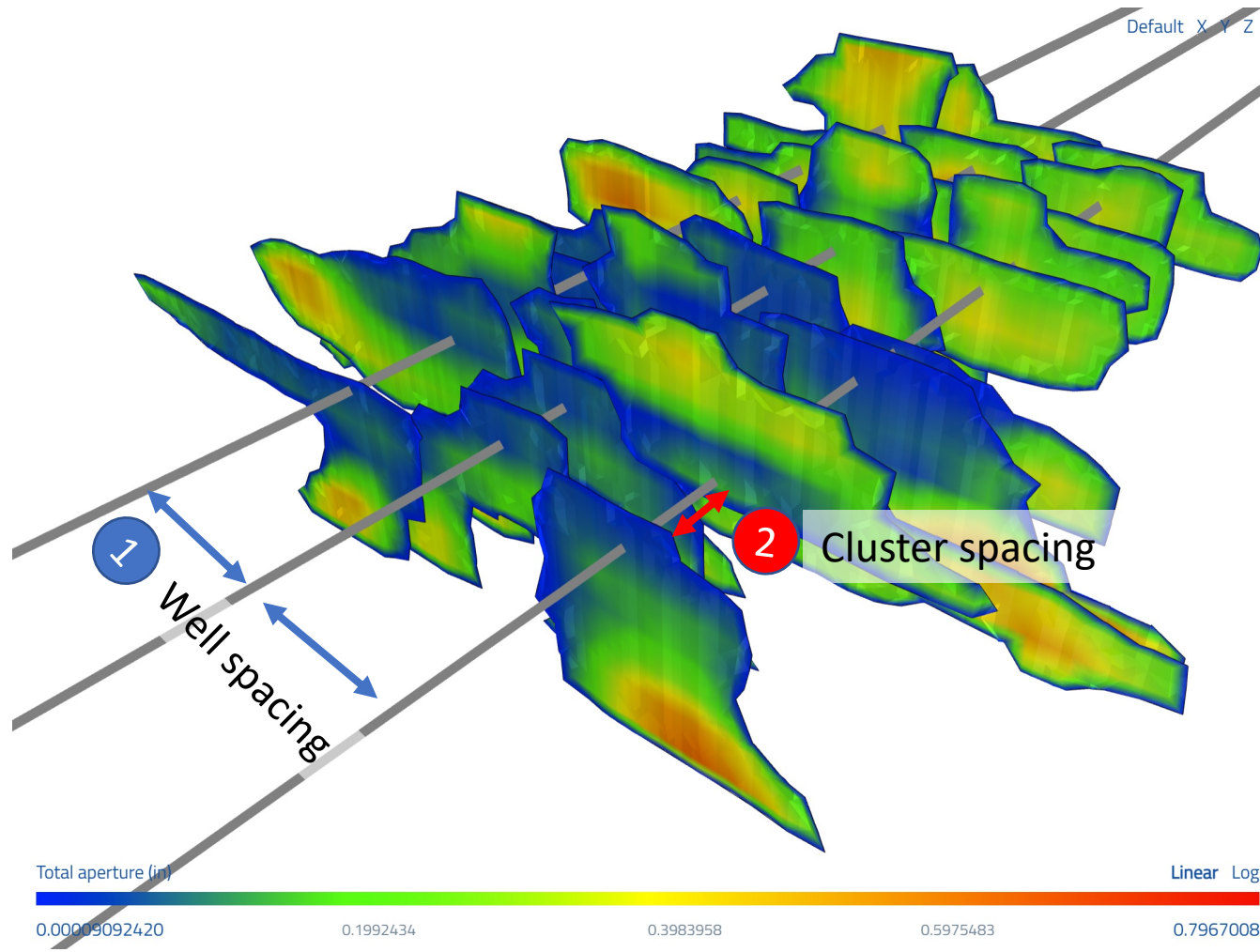
The Parent/Child Industry Study

Integrating world-class field datasets with cutting edge modeling to deliver measurable improvements in frac design and well performance



Results and behaviors consistent within basins, different by basin

Coupled-Physics Unveils Parameter Dependencies

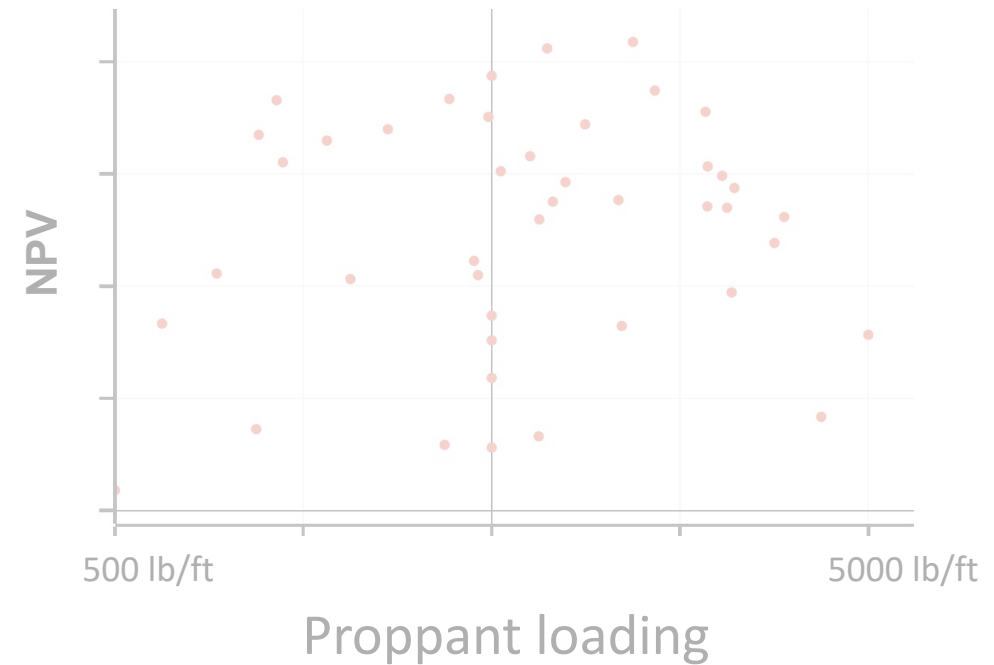
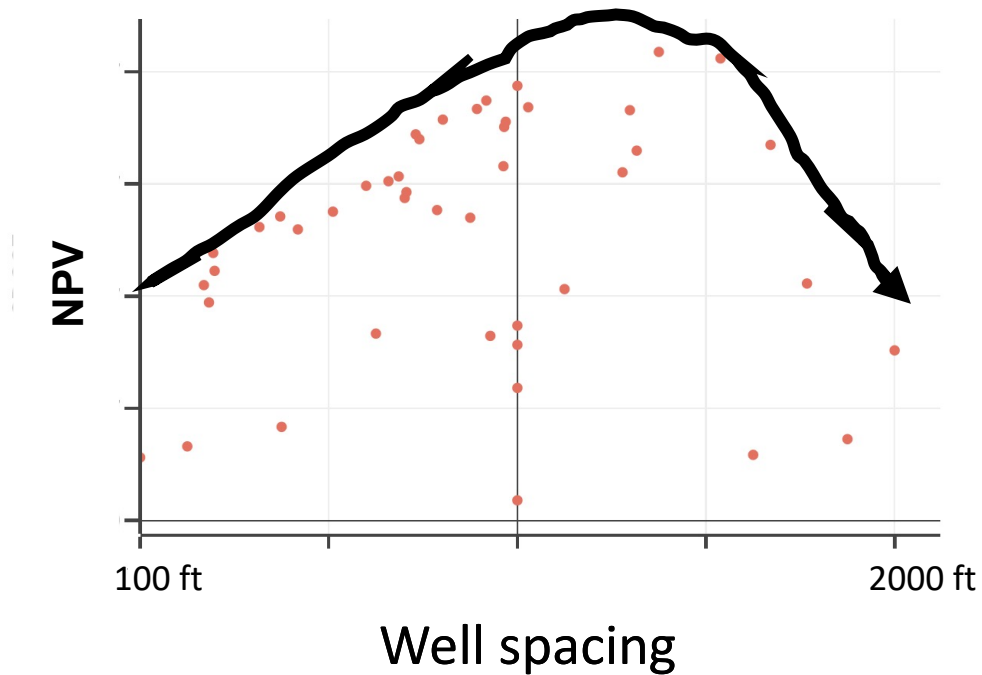


3 Proppant loading



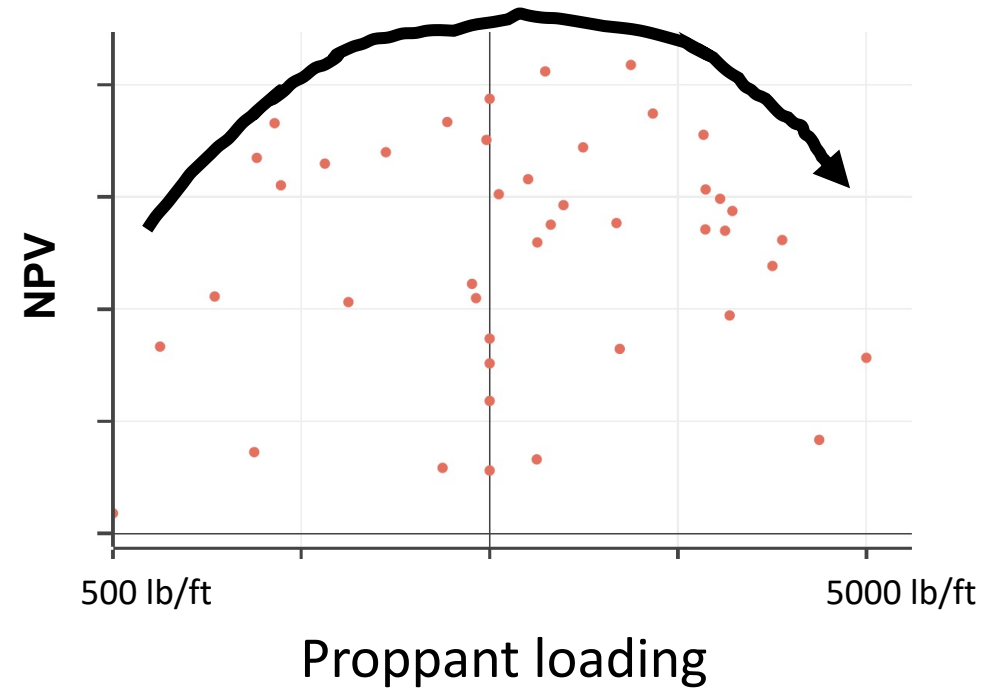
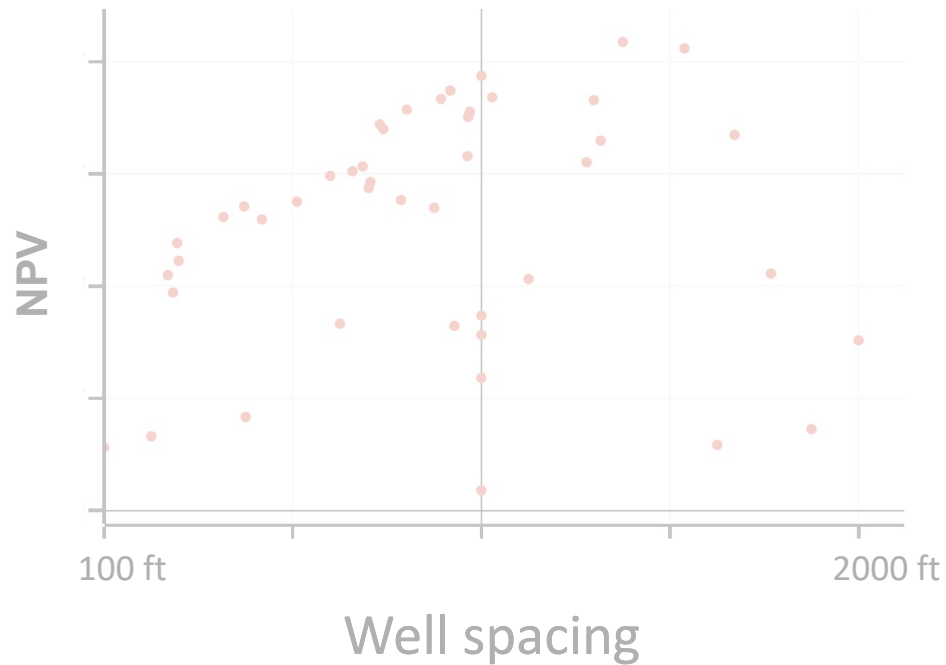
Negative Returns to Increased Well Spacing

- Wells too close suffer from adverse interference
- Wells too far apart leave unexploited resource behind



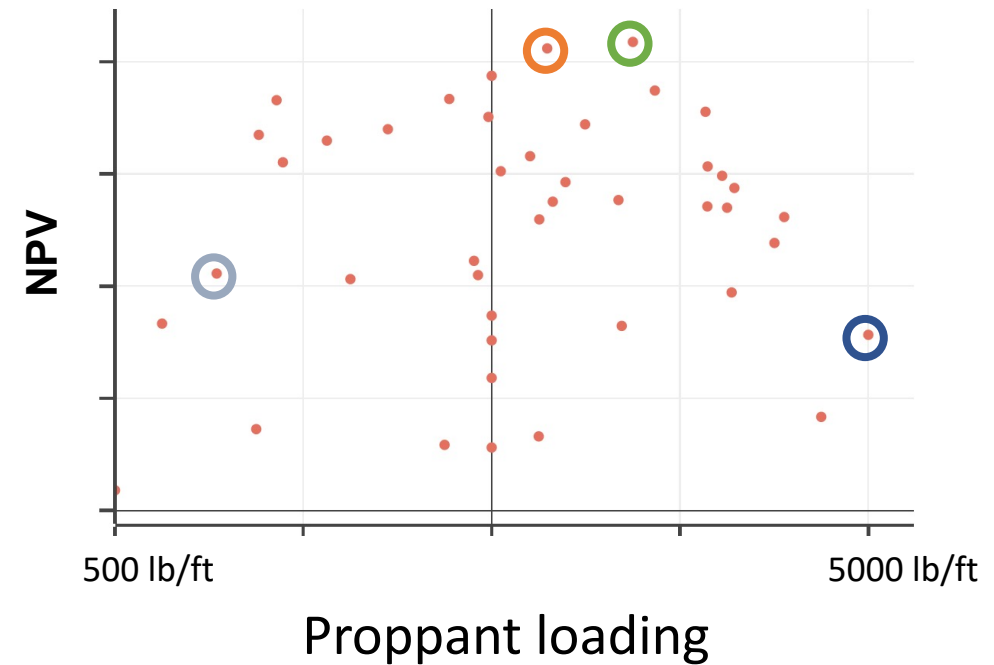
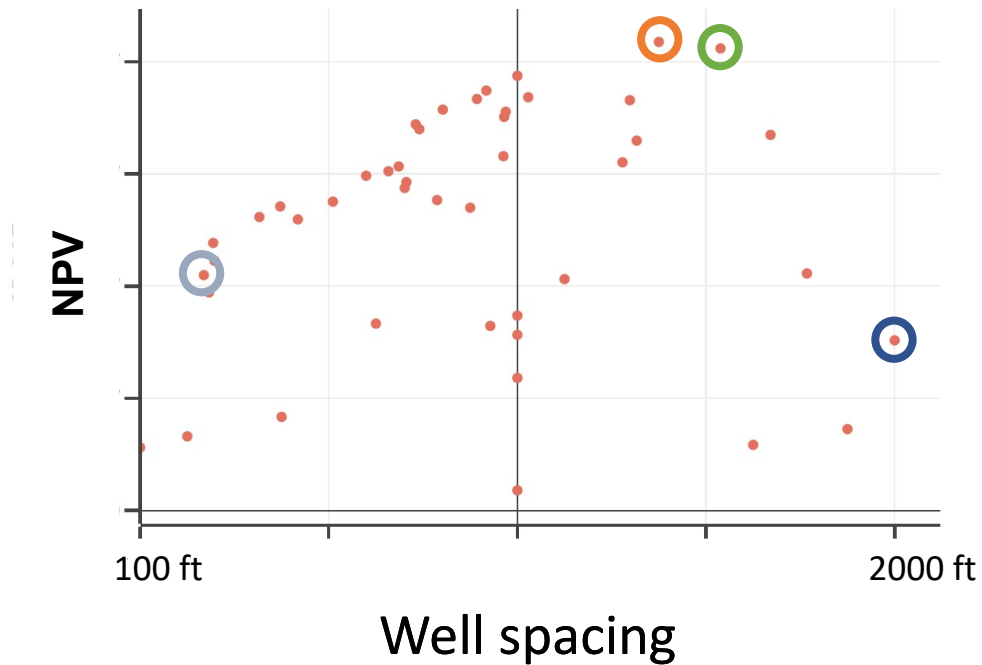
Diminishing Returns to Increase Proppant

- Too little proppant and wells are under-stimulated
- Too much proppant and additional cost does not recover incremental



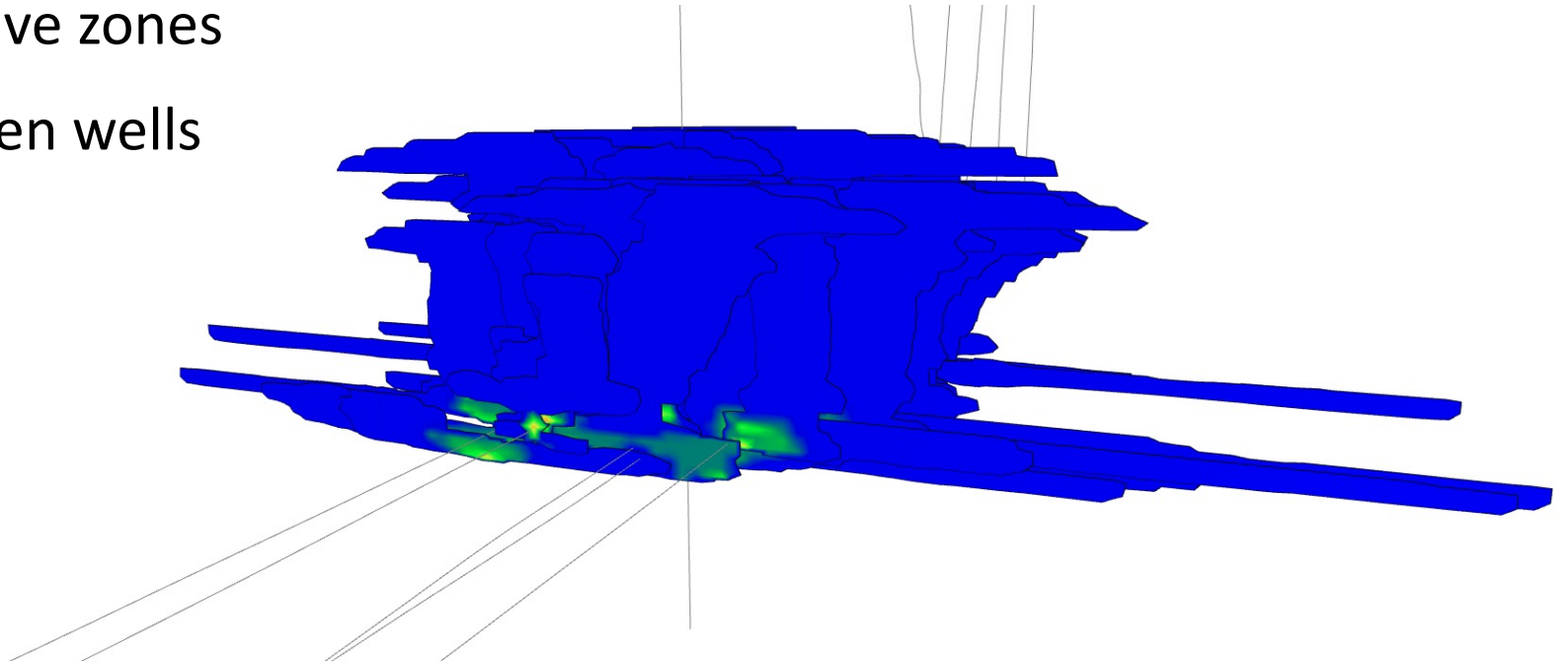
Coupled Model Reveals Symbiotic Relations

- Colored circles identify corresponding cases
- As well spacing is increased, optimizer tries to compensate by pumping more proppant



Applied Optimizations – HFTS 2

- Consortia of 16 operators and DOE funded most detailed analysis of subsurface to-date
- Detailed characterization and modeling of
 - Fracture propagation
 - Depletion and productive zones
 - Communication between wells



Optimization Identified 60% Uplift in NPV/Section

- Optimized: landing zone, well spacing, cluster spacing, proppant loading
- Cluster spacing shows plateau then decreasing NPV/section
- Proppant loading shows returns to higher volumes until plateauing

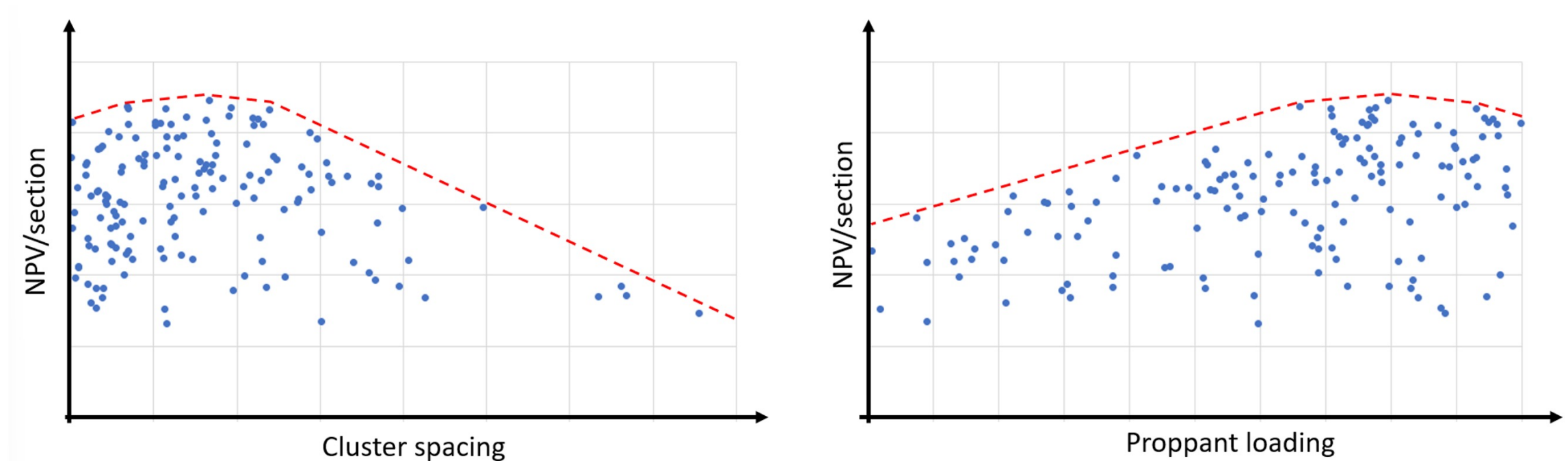
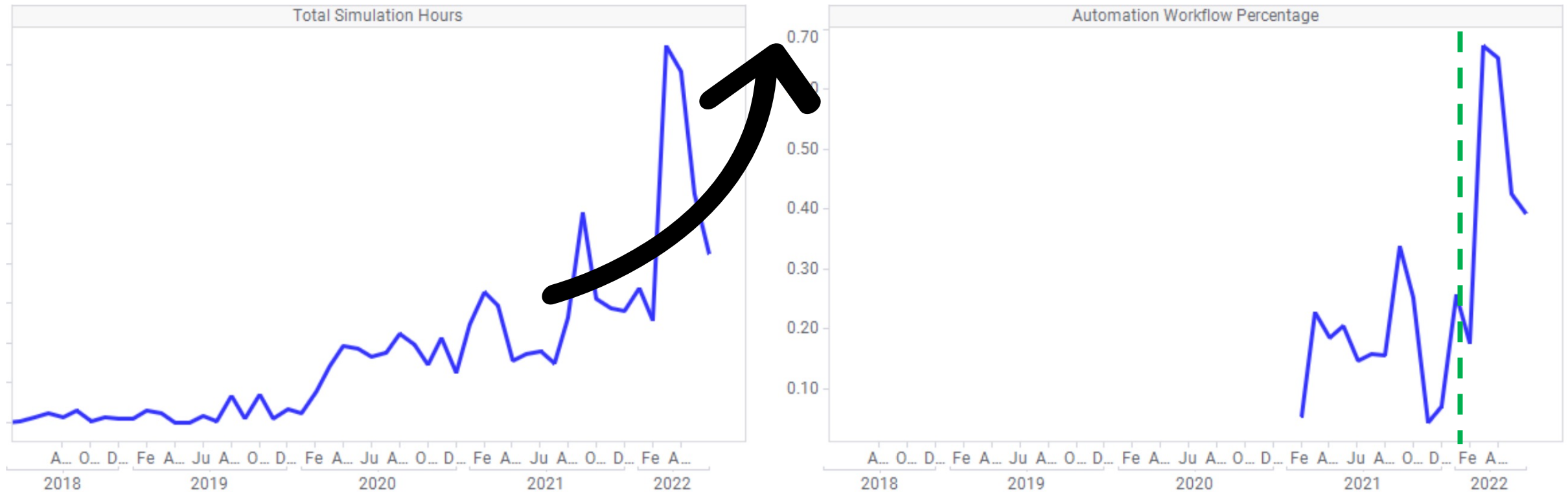


Figure 19 Proxy model results - NPV/section vs Cluster spacing and Proppant loading at the optimal Well spacing

Chart showing point at which optimization released

- Steady growth across the all markets
- Optimization and automation workflows now make up more than half the usage



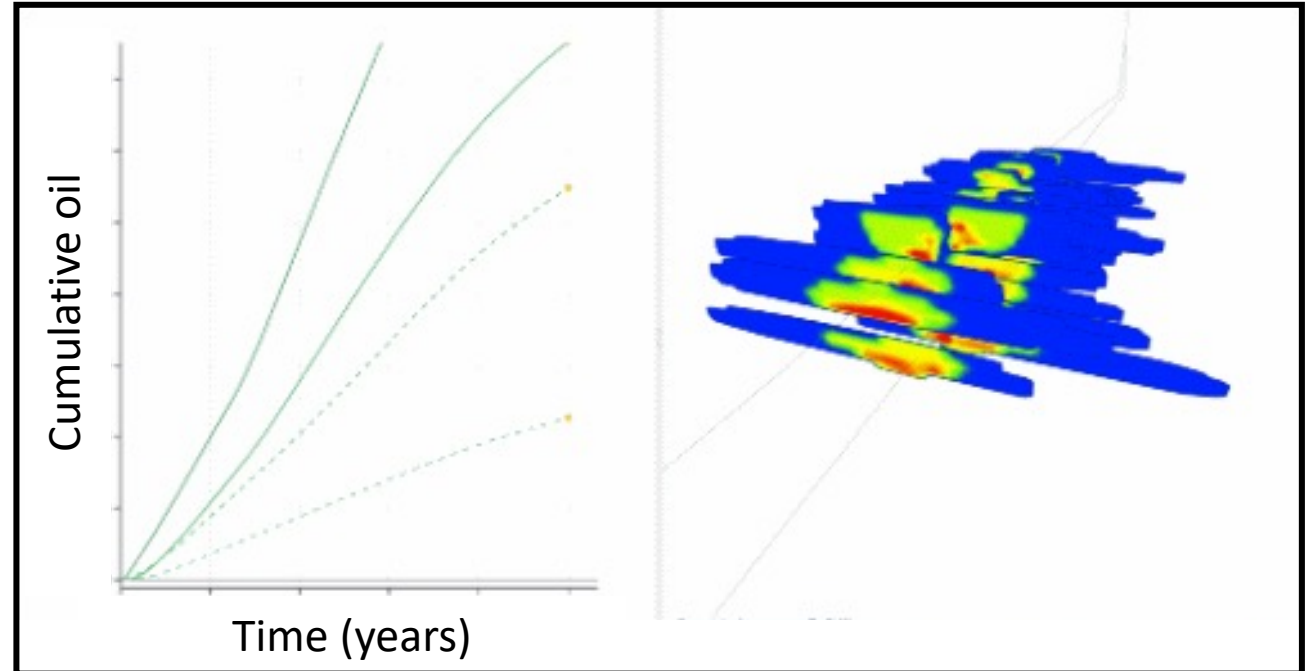
Optimization capabilities released

Quantitative Optimization

Computational models are now highly predictive

Optimal design is a function of fracturing, reservoir, operational, and economic considerations

Modeling workflows empower operators to accelerate their innovation cycle





Thank you!

garrett@resfrac.com



Appendix

ResFrac was Founded in 2015 to Support Science-Based Decision Making



Dr. Mark McClure
CEO and Co-founder

Stanford PhD
UT at Austin Professor
Fracture and geothermal
expert
Harts 40 Under 40



Dr. Charles Kang
CTO and Co-founder

Stanford PhD
Hank Ramey Award
Optimization and hydraulic
fracturing expert



Garrett Fowler
COO

Stanford MS
Operator/service
company background
SPE Regional
Technical Award



Joe Frantz
Sr. Executive
Advisor

Previous executive
roles at Range
Resources and CEO of
Unbridled Resources



Dr. Mark Zoback
Sr. Executive
Advisor

Stanford Professor
World-renowned
geomechanics expert
Countless awards