



Perf Cluster Strategies

Liberty Engineering Solution



Rock Permeability Drives Optimized Frac Spacing

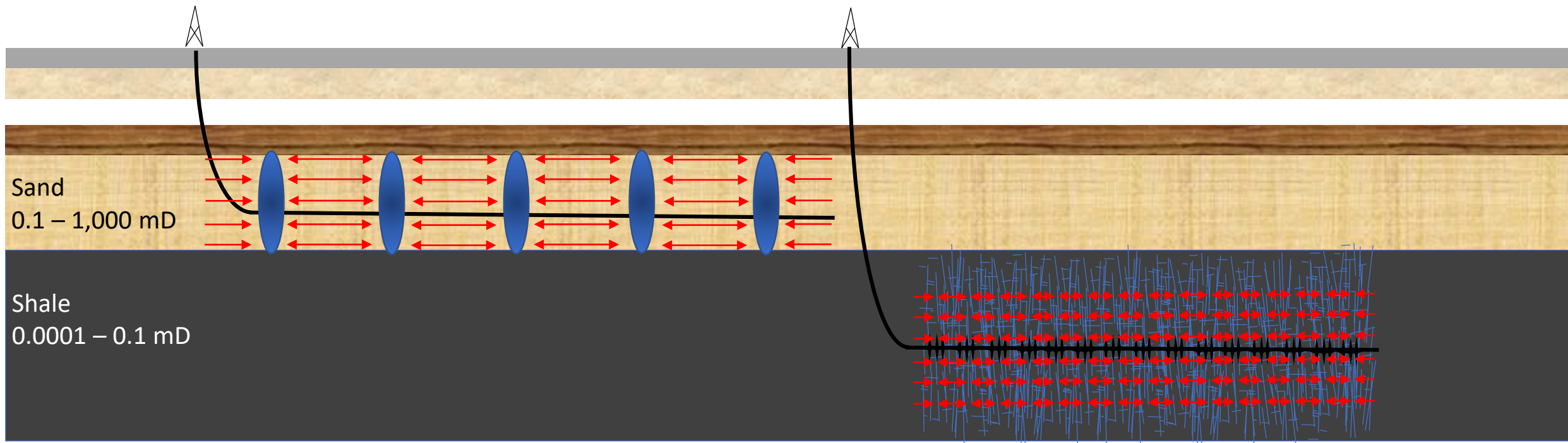
Impacts Stage Spacing and Perforation Clustering Decisions

Higher Permeability Rock

- Requires fewer fracs
- Too many clusters/stages cause “wasteful” production interference
- Need fracture conductivity

Lower Permeability Rock

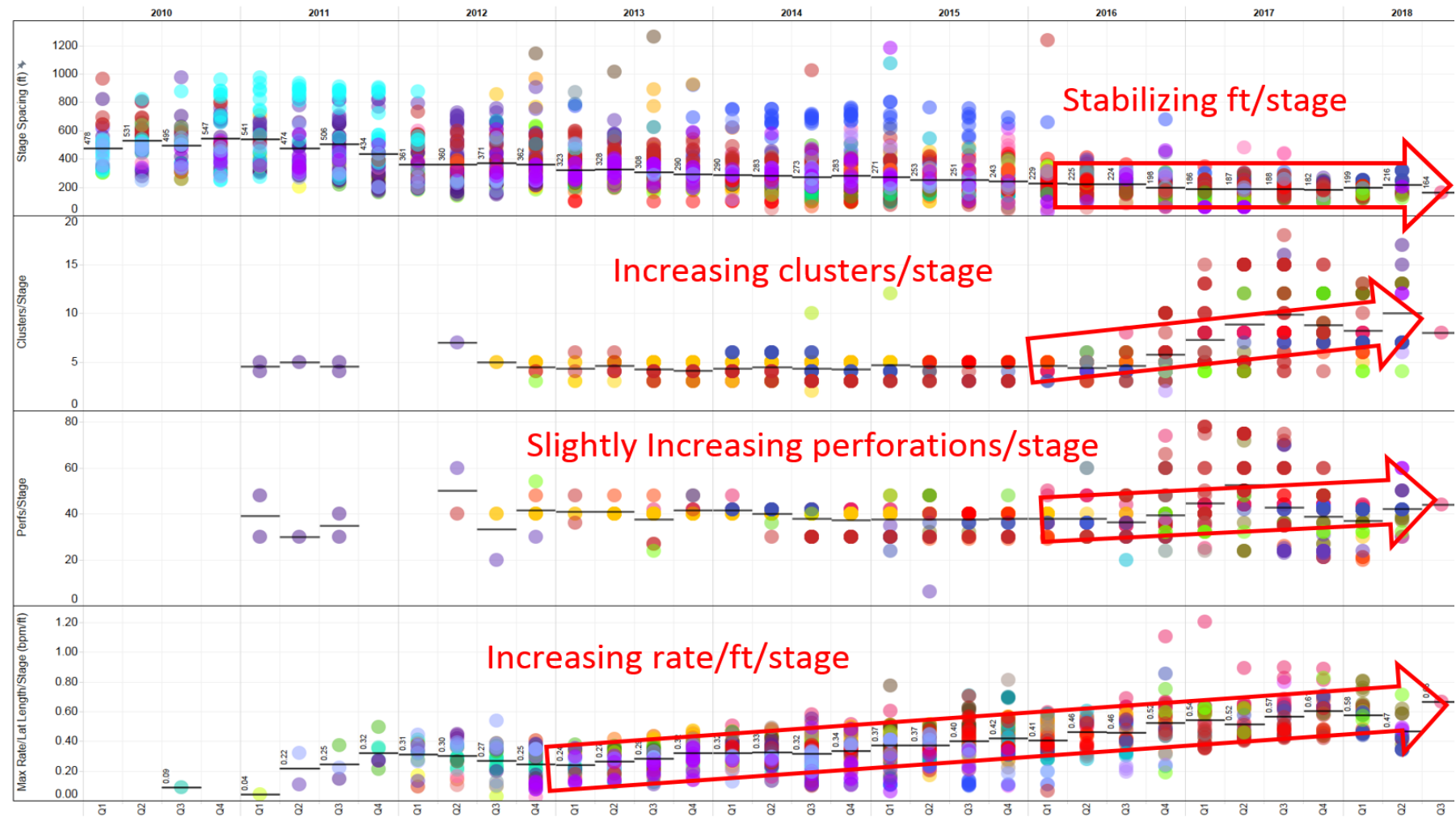
- Requires more fracs
- More effectively contributing clusters essential for economics
- Need fracture complexity



Shale Revolution Frac Trends

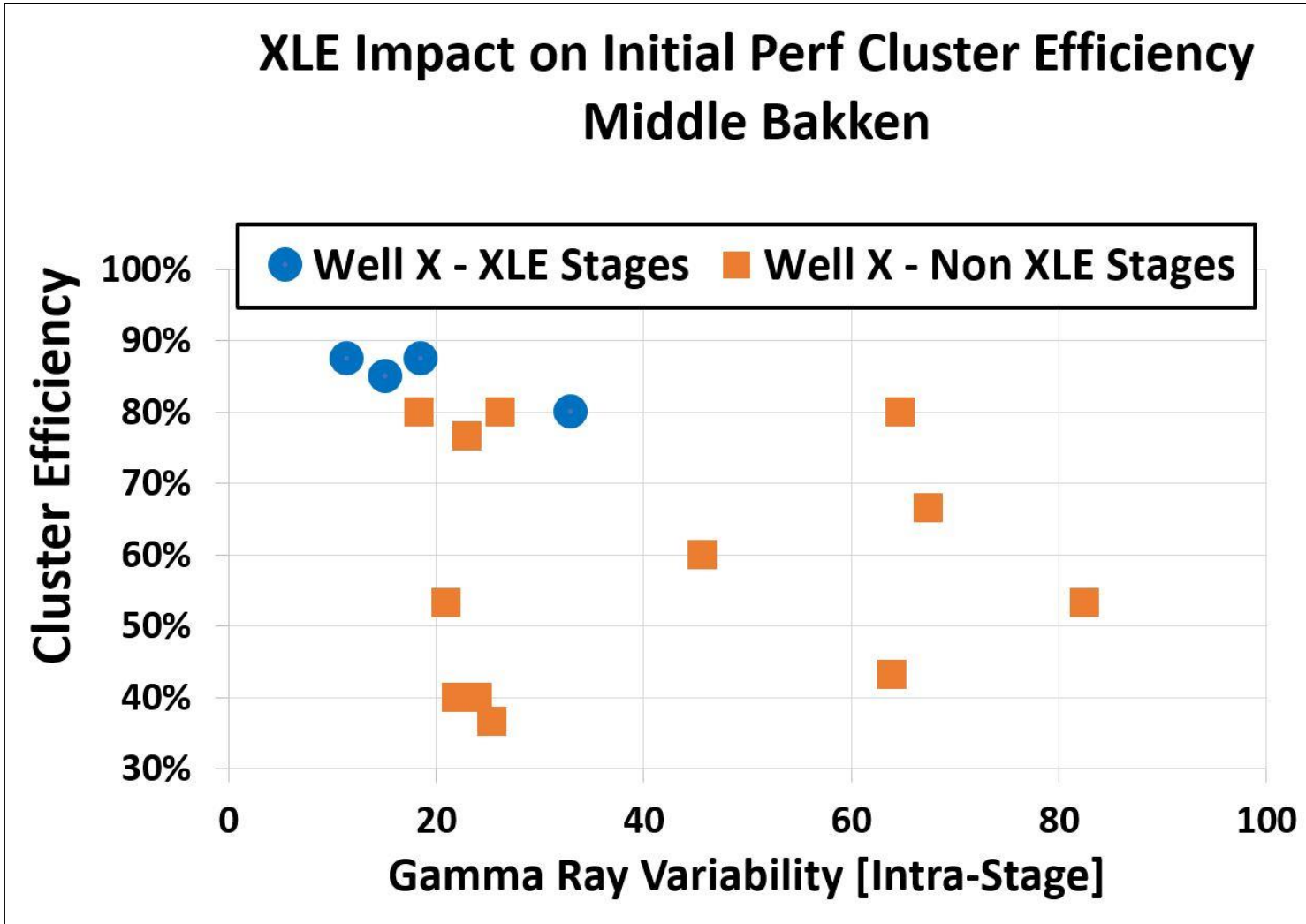
Creating Larger and Denser Fracture Networks


- Larger fracture network
 - Horizontal wells
 - Longer laterals
 - Increase in proppant mass
 - Increase in fluid volume
- Denser fracture distribution
 - Higher stage count
 - Higher pump rate
 - **Changes in perf clustering**
- Cost-sensitive
 - Fewer additives
 - Local proppant



Creating More Effective Perf Clusters

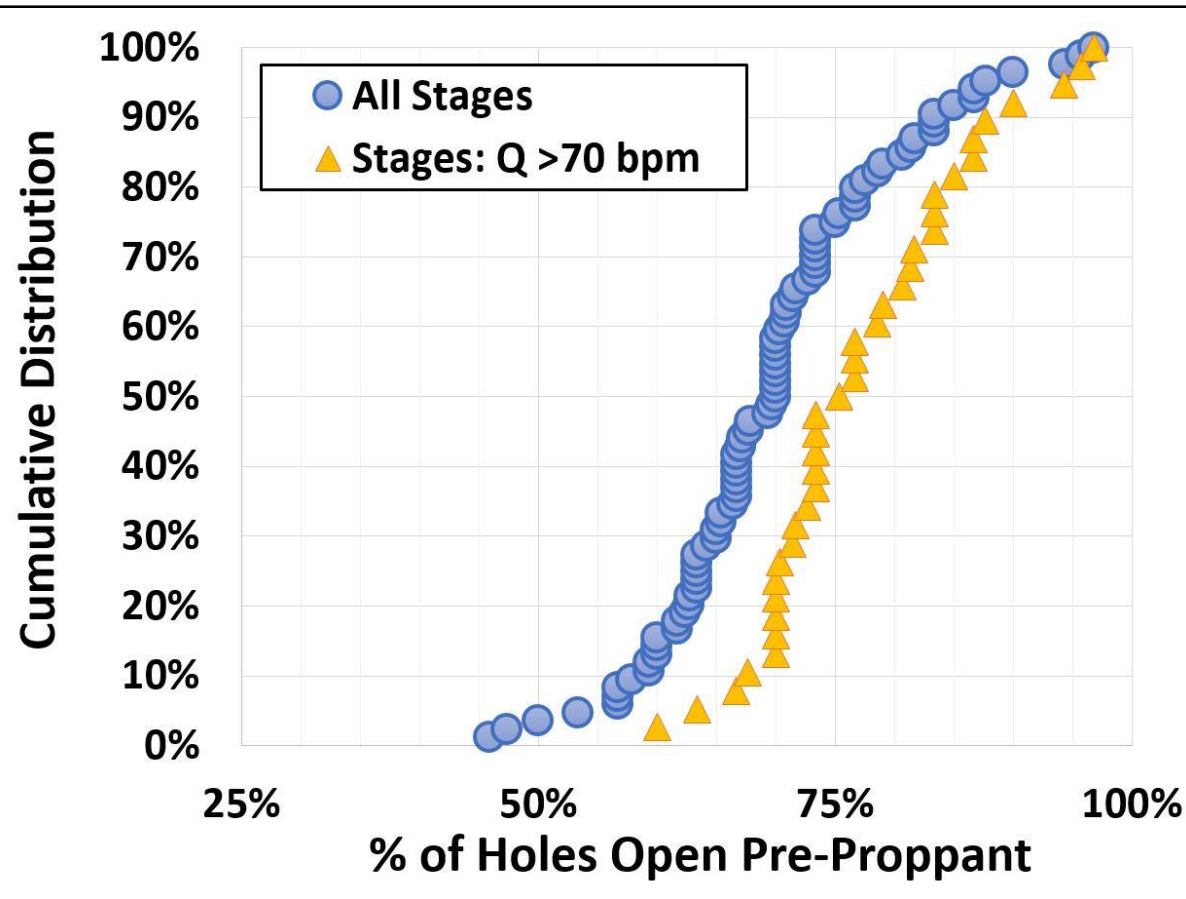
eXtreme Limited Entry (XLE) Design



Courtesy: SPE-189880 – Weddle et al 

Creating More Effective Perf Clusters

eXtreme Limited Entry (XLE) Design




Multi-well calibration has resulted in a 75% holes open design assumption:

- XLE strategy increased % perfs open by 5 – 10%
- Max rate before S/D Test impacts the number of holes initially open
- Intra-stage σ_{Hmin} variability impacts % of holes open

Step Down Analysis:

The Step Rate Test performed pre- & post-proppant

- SPE 62549 L. Weijers, C.A.Wright...et al)

Courtesy: SPE-189880 – Weddle et al 

Perf Cluster Strategies

The Liberty Difference Produces Better Wells

- Optimized perforation cluster design depends on reservoir characteristics
 - Liberty's DFIT evaluation provides vital input data
- Stepdown Tests provide real-time assessment of cluster efficiency
- An effective perforation cluster design
 - Can improve well performance
 - May help you save on frac stage count
- Before your frac job turns into a cluster frac, consider Liberty
 - Help with your perf cluster strategy
 - Pump your job effectively



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