Beyond Fracking, Can We Increase EUR?

An Enhanced Oil Recovery Proposal for Shale Oil Scenarios

Prepared for the Unconventional Resource Development
Enhanced Recovery and Environmental Stewardship, Oct 13th 2016, Austin Tx

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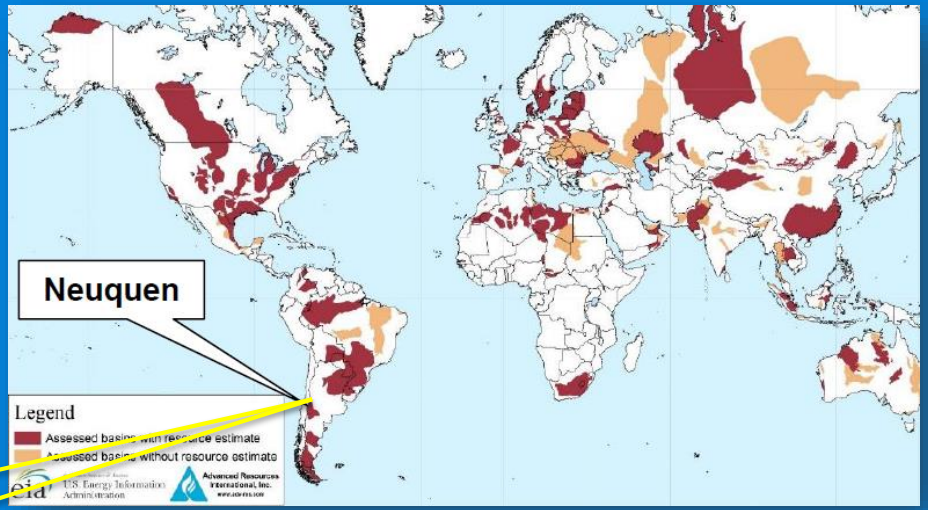
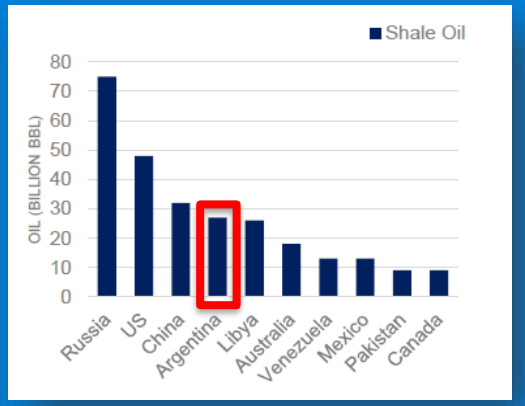
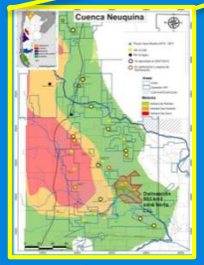


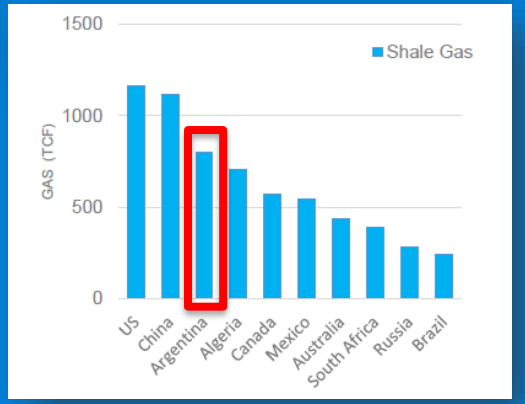




Area
7,400 k.acre

Argentina's Technically Recoverable Resources

Shale Oil	27 B bbl	Shale Gas	802 Tcf



SOURCE: *"EIA Report" Aug-2016*

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VACA MUERTA AT A GLANCE

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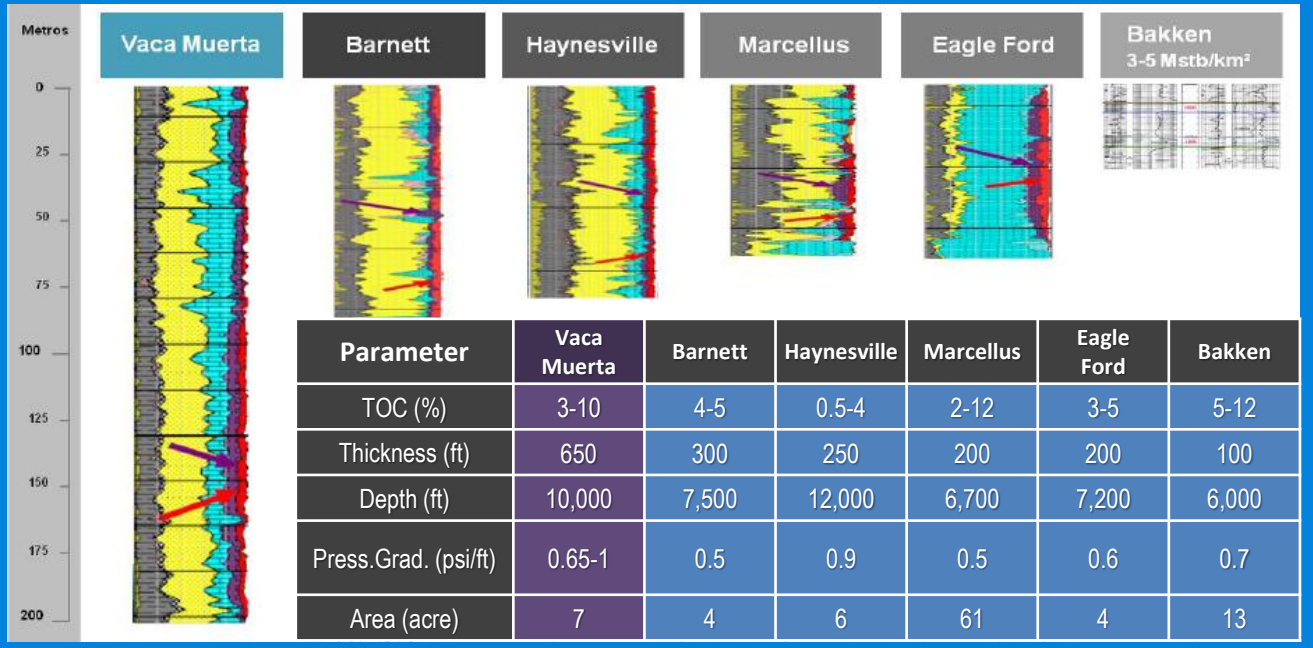
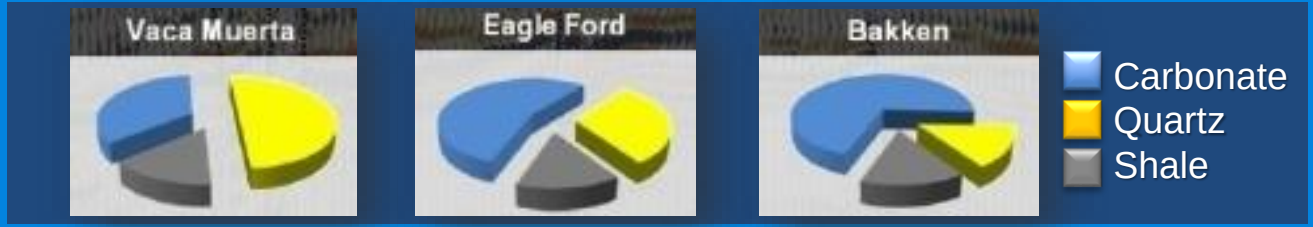
Vaca Muerta…
A World Class Resource

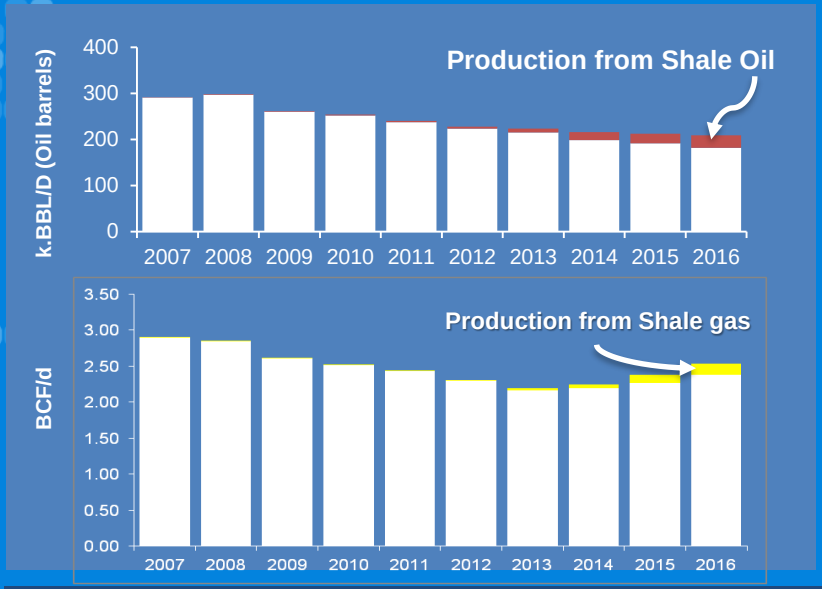


Parameter	Vaca Muerta	Barnett	Haynesville	Marcellus	Eagle Ford	Bakken
TOC (%)	3-10	4-5	0.5-4	2-12	3-5	5-12
Thickness (ft)	650	300	250	200	200	100
Depth (ft)	10,000	7,500	12,000	6,700	7,200	6,000
Press.Grad. (psi/ft)	0.65-1	0.5	0.9	0.5	0.6	0.7
Area (acre)	7	4	6	61	4	13



VACA MUERTA AT A GLANCE

Shale Production in NQN Basin



Vaca Muerta (Shale) Drilled Wells @Aug-2016

550+ oil wells

50+ gas wells

Well Architecture

30% horizontal wells

70% vertical wells

Key Players

YPF, Chevron, Total, Shell, Pan American Energy, Wintershall, Pluspetrol, Petronas, ExxonMobil, Dow

VACA MUERTA AT A GLANCE

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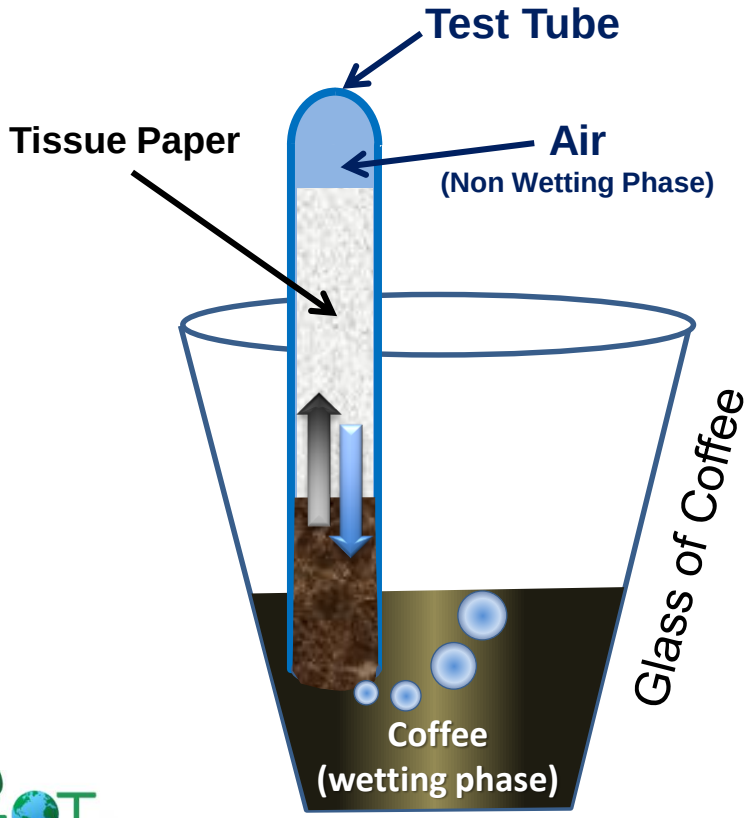
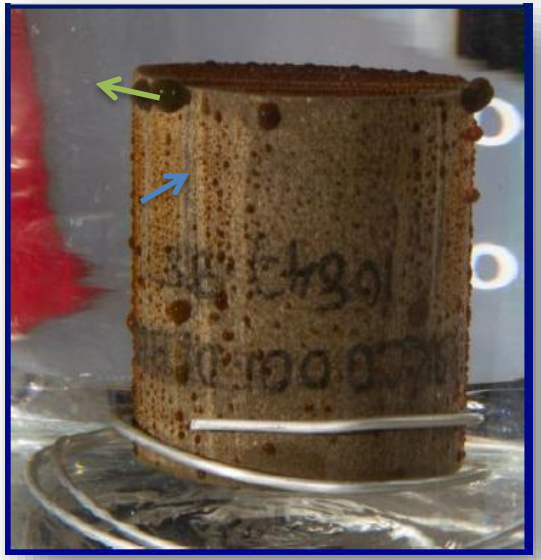
MAIN IDEA

Increase EUR in unconventional reservoirs (Shale Oil Scenarios) by means of a ***modification*** of current operation practices, based on ***strong capillary*** forces and cyclic ***water injection***

Countercurrent Imbibition



Bakken Low Salinity



SOURCE: "*Creating a Worldwide Unconventional Revolution Through Technically Justifiable Strategies"* Kurtoglu, B; SPE Distinguished Lecturer Presentation held in Buenos Aires, Sep-2016

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MAIN Uncertainty

Will it work in real wells?

1. ***Could we inject water without damaging the current frac system?***
2. ***Will it produce the effect of spontaneous imbibition?***
3. ***Will it recover enough incremental oil? → How much is enough?***

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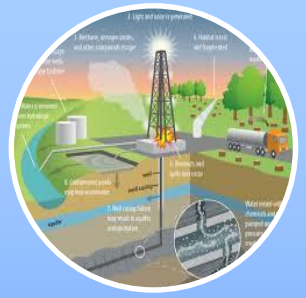

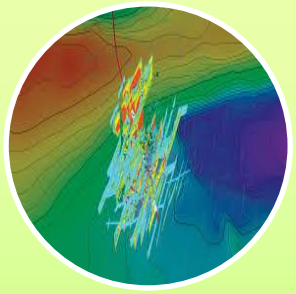

Conceptual

Theoretical

Experimental

PROPOSAL DE-RISKING

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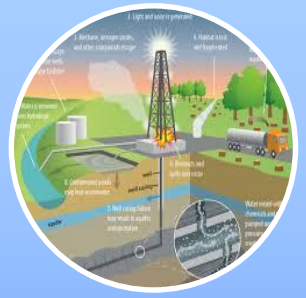

Conceptual

Theoretical

Experimental

PROPOSAL DE-RISKING

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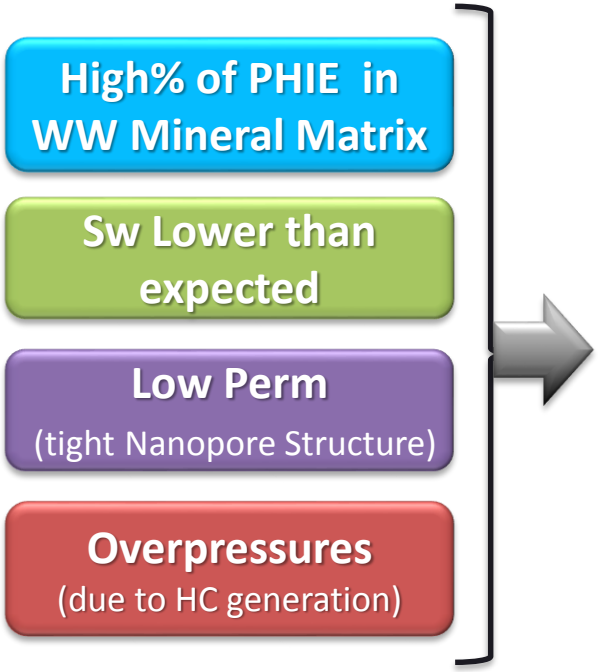
SUMMARY of CONCEPTUAL MODEL



- Imbibition will occur if exposed to high press. water
- Speed will be relate to exposed surface (complexity)
- Imbibition of water will expel the oil increasing EUR

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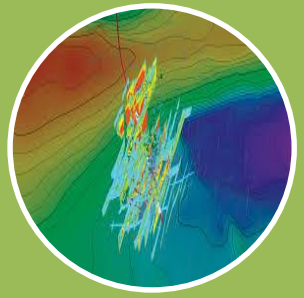
Conceptual



Theoretical

Experimental

PROPOSAL DE-RISKING

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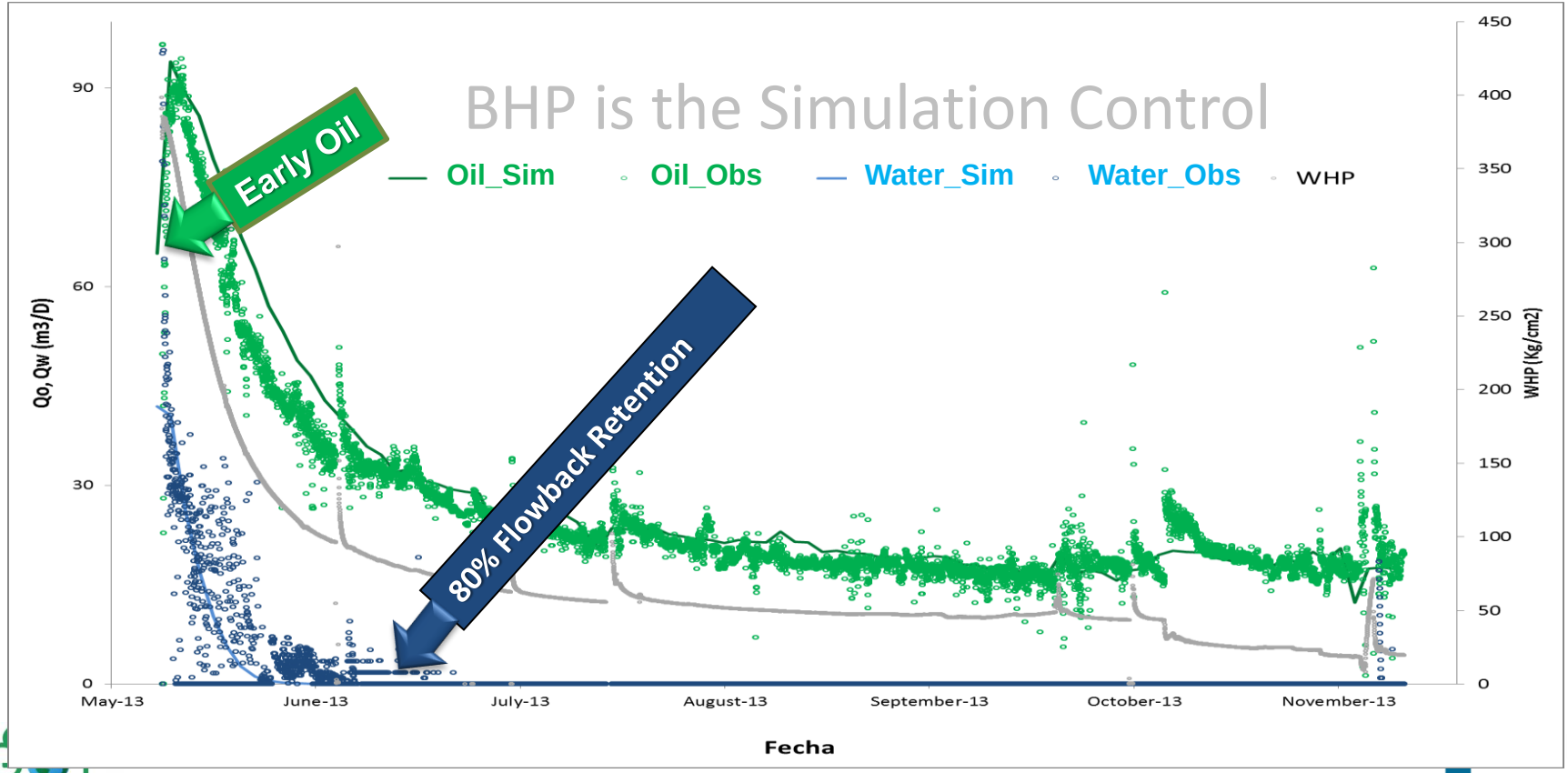
FLOWBACK SINGLE HISTORY MATCH – NUMERICAL MODEL



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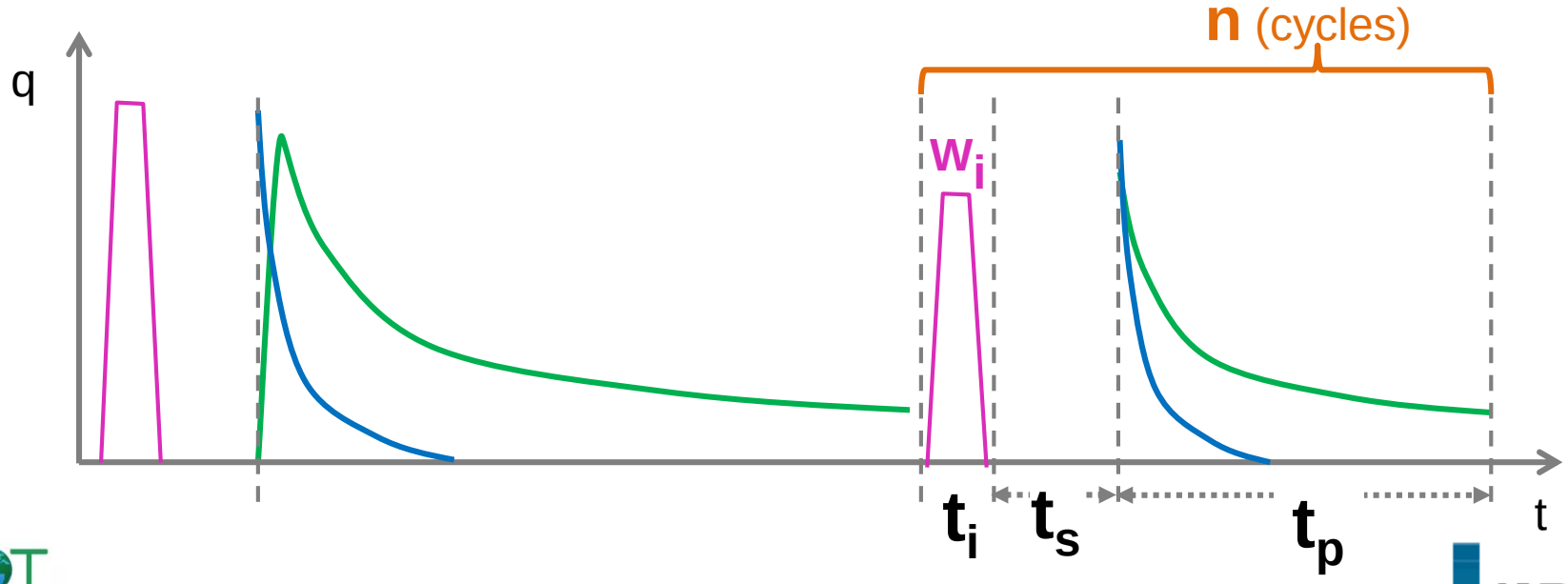
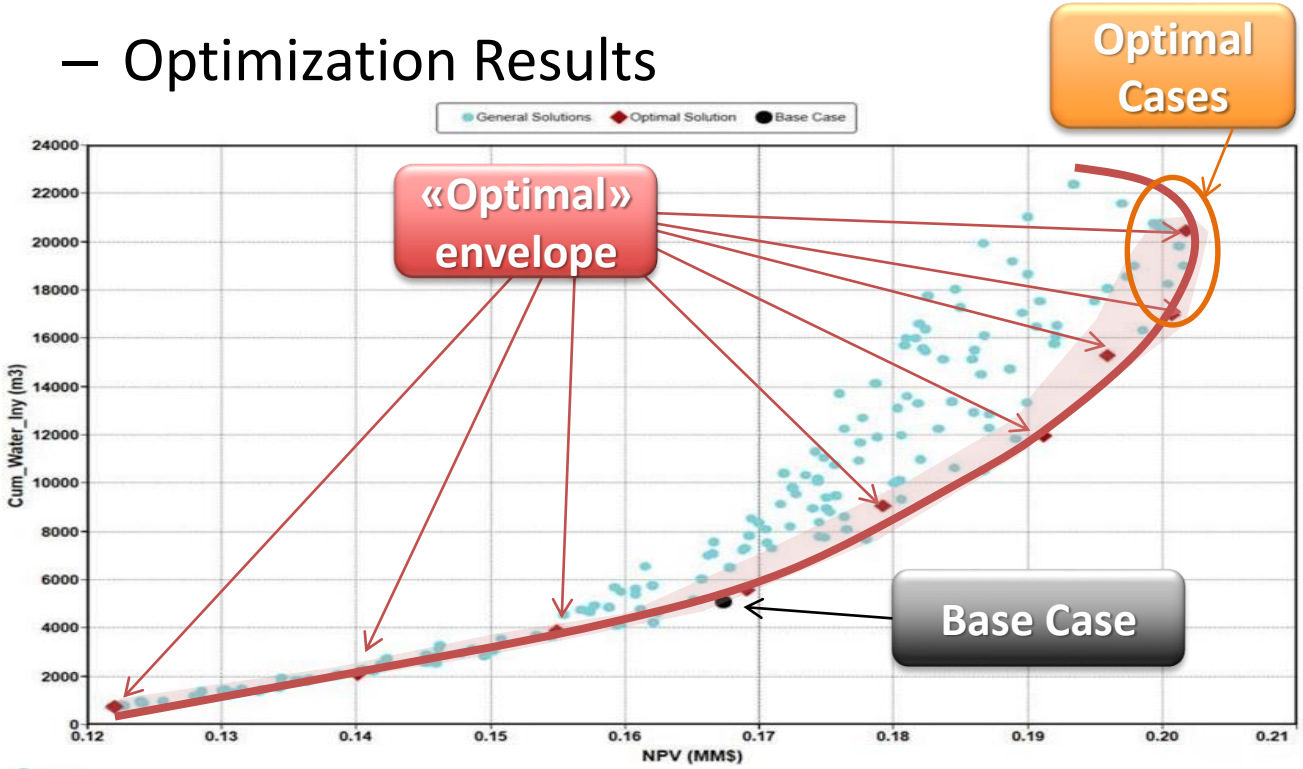
PROPOSAL – DESIGN AND OPTIMIZATION

- Optimize Treatment Parameters to improve Field Test
- Quantify Expected Incremental Oil (Incremental EUR vs Base Case)



PROPOSAL – DESIGN AND OPTIMIZATION

– Optimization Results



Average Optimal Parameters

$N = 15$ cycles

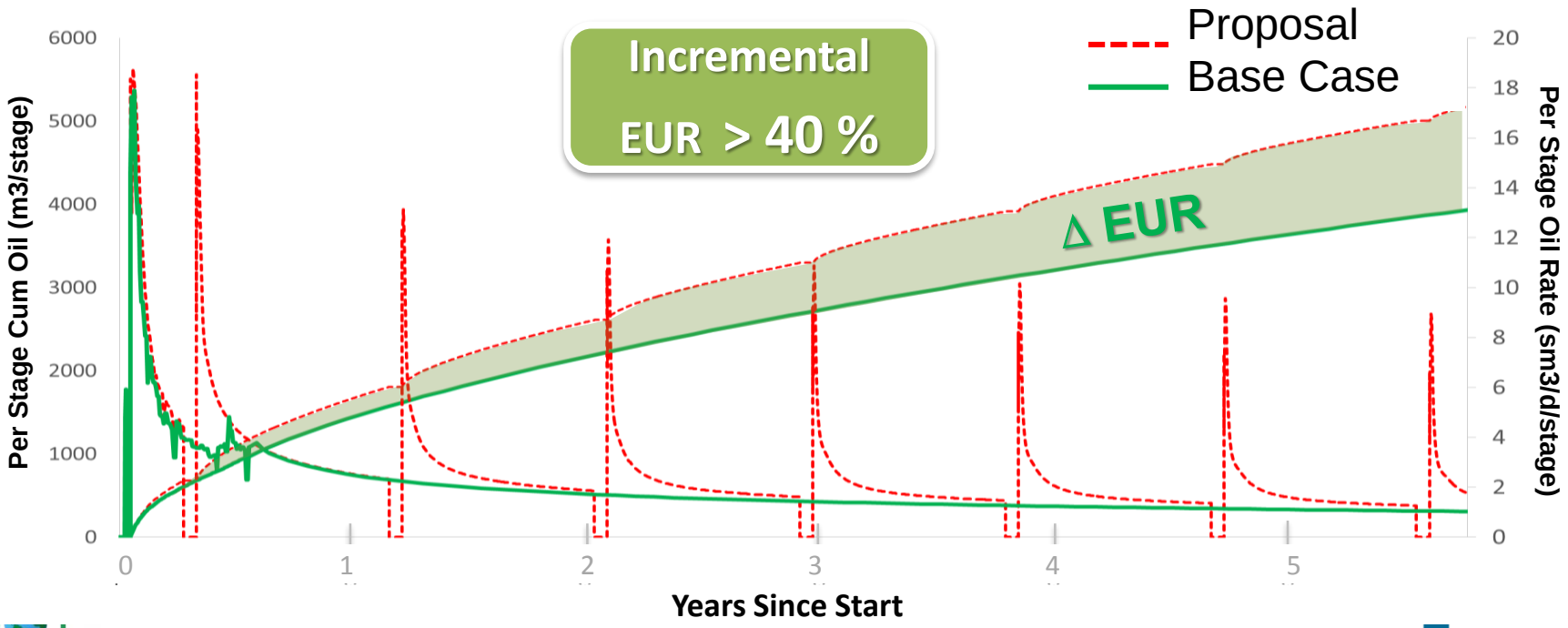
$Q_{iny} = 63$ m3/d

$T_p = 210$ days

$T_{iny+soak} = 33$ days

PROPOSAL – RESULTS

– Substantial Incremental Recoveries Expected



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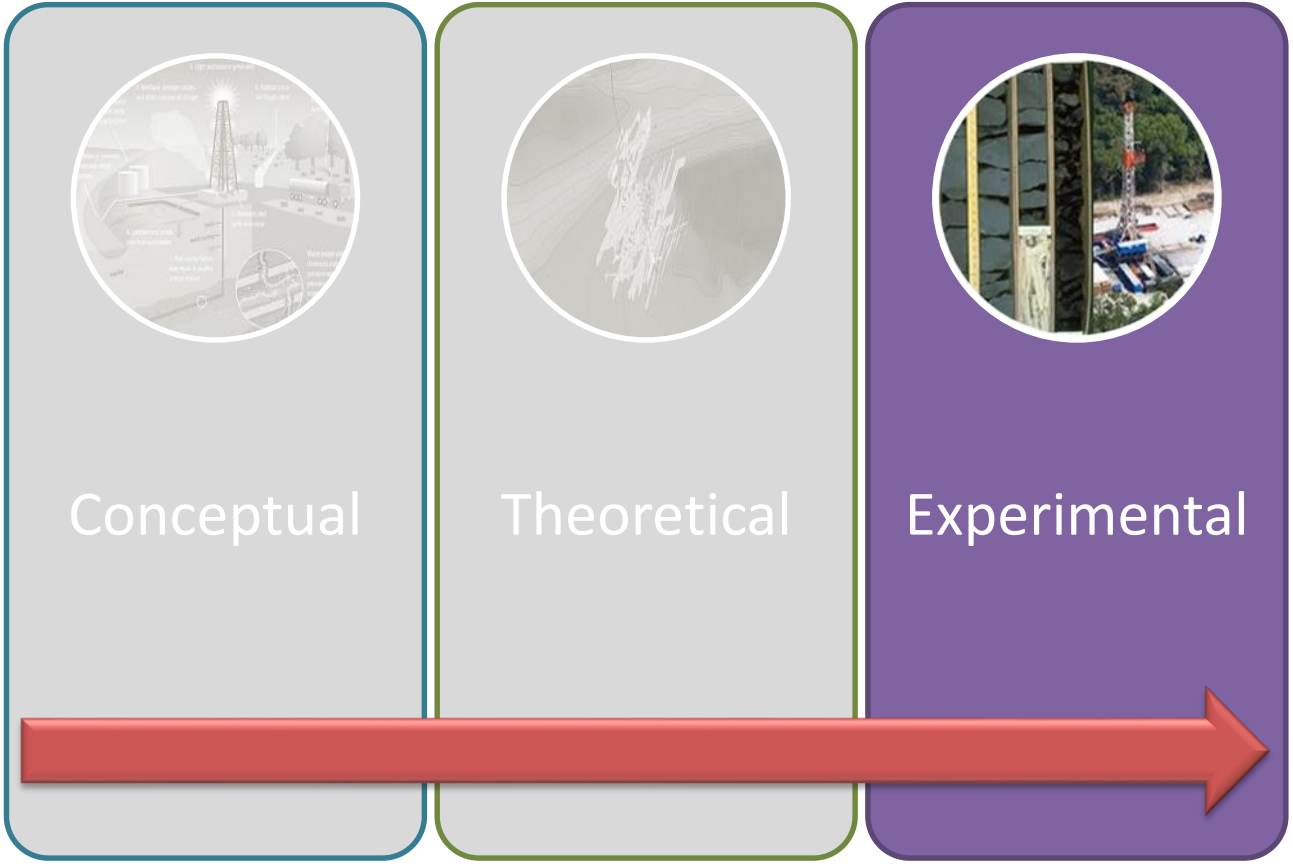
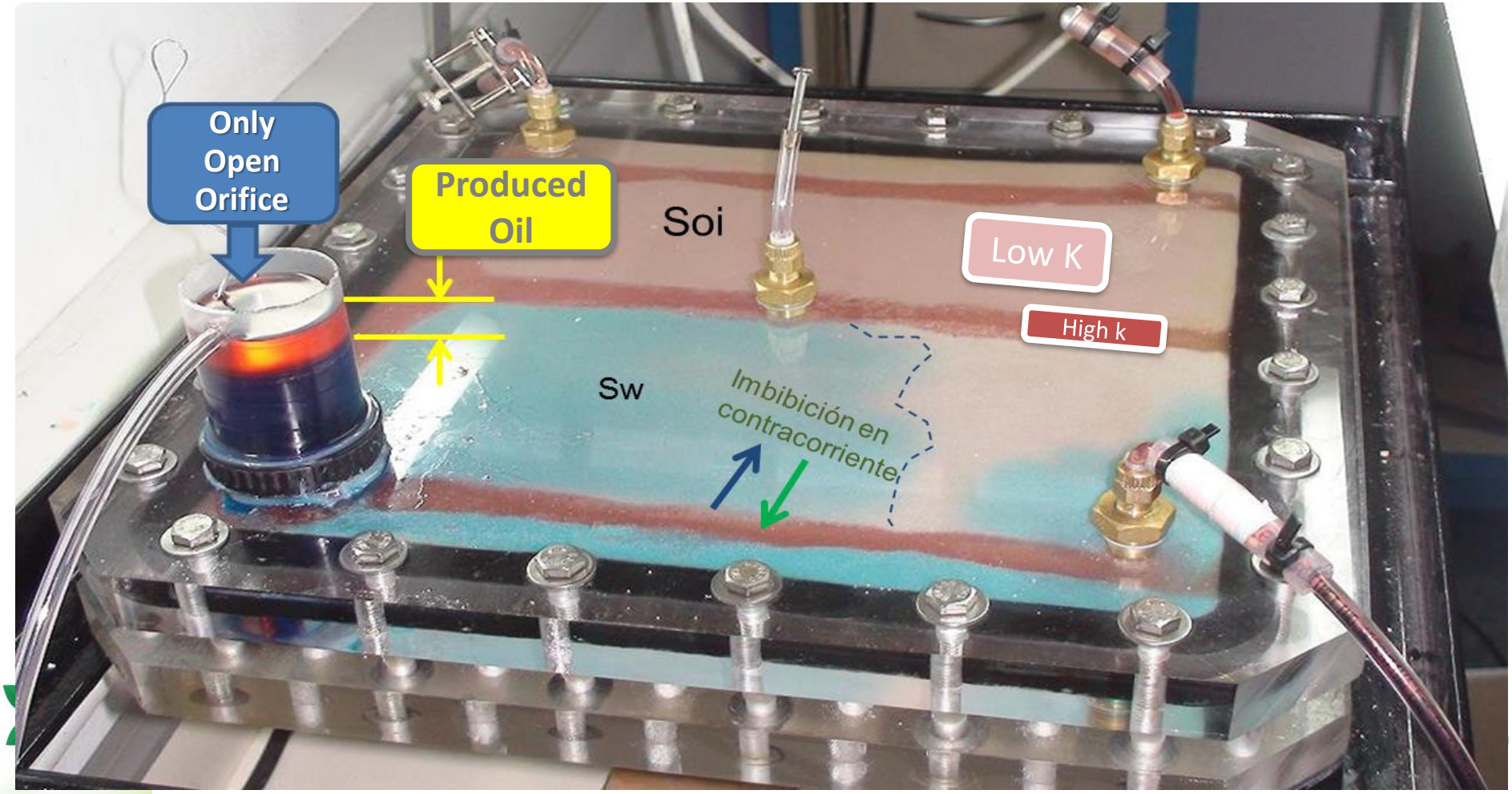
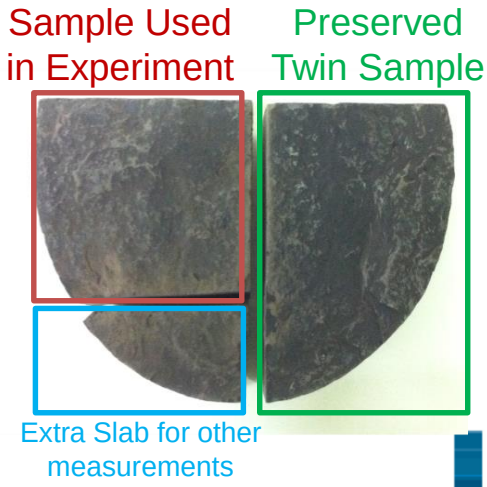

Conceptual
Theoretical
Experimental

Conceptual Model Tested in Glass Beads Cell



EXPERIMENTAL MODEL (LAB)

- **Core Analysis Procedure**
  - An experimental methodology was designed to test spontaneous imbibition in 3 full diameter Vaca Muerta core samples



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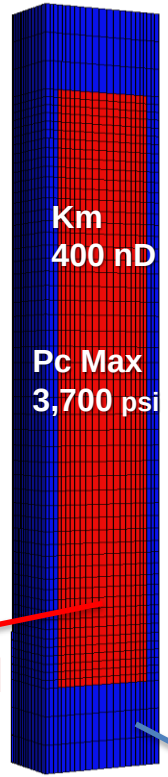
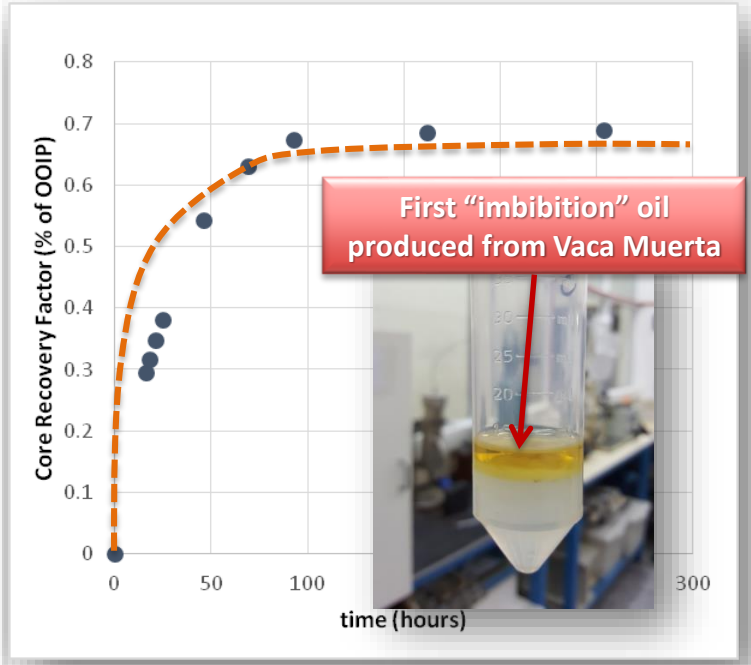
EXPERIMENTAL MODEL (LAB)

- **Core Analysis Results**
  - Recovered exceeded 60% of OOIP in less than 120 hours
  - Core 3D Model using the same rock-fluid parameters as the ones used in the field numerical model (Pc, Km and Rel Perms) produced a satisfactory match



Core Model



Core Holder Model

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EXPERIMENTAL MODEL

- **Field Tests**
  - Undocumented experiences in Vaca Muerta (one well)
  - Poorly documented EOR experiences in the Bakken, US

"…Too few data exist for the six injection tests performed in the Bakken to perform thorough engineering and geologic analysis, nor are the designs or test objectives fully understood…"

Source: "Enhanced Oil Recovery (EOR) in Tight Oil: Lessons Learned from Pilot Tests in the Bakken", Sorensen J. EERC, 2015.

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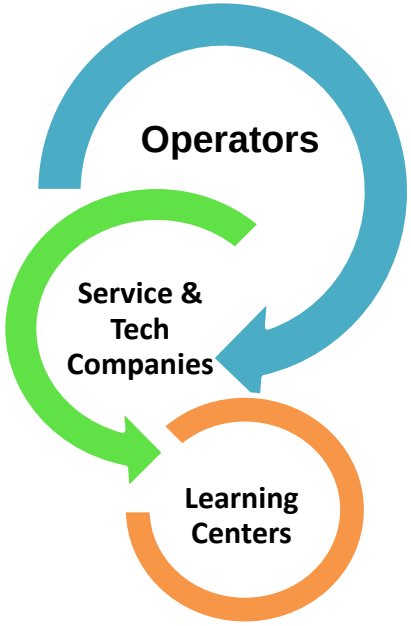
EXPERIMENTAL MODEL

- **Field Tests → NEXT STEPS**
- We are on the verge of producing a properly desigend field test in Vaca Muerta (oil window)
- These results will provide invaluable insight to pursue this potential ***"game changing"*** task…

WHO will take the challenge?



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Questions?
(too many…perhaps?)