



IFE tracer innovation- a step change in oil saturation measurements

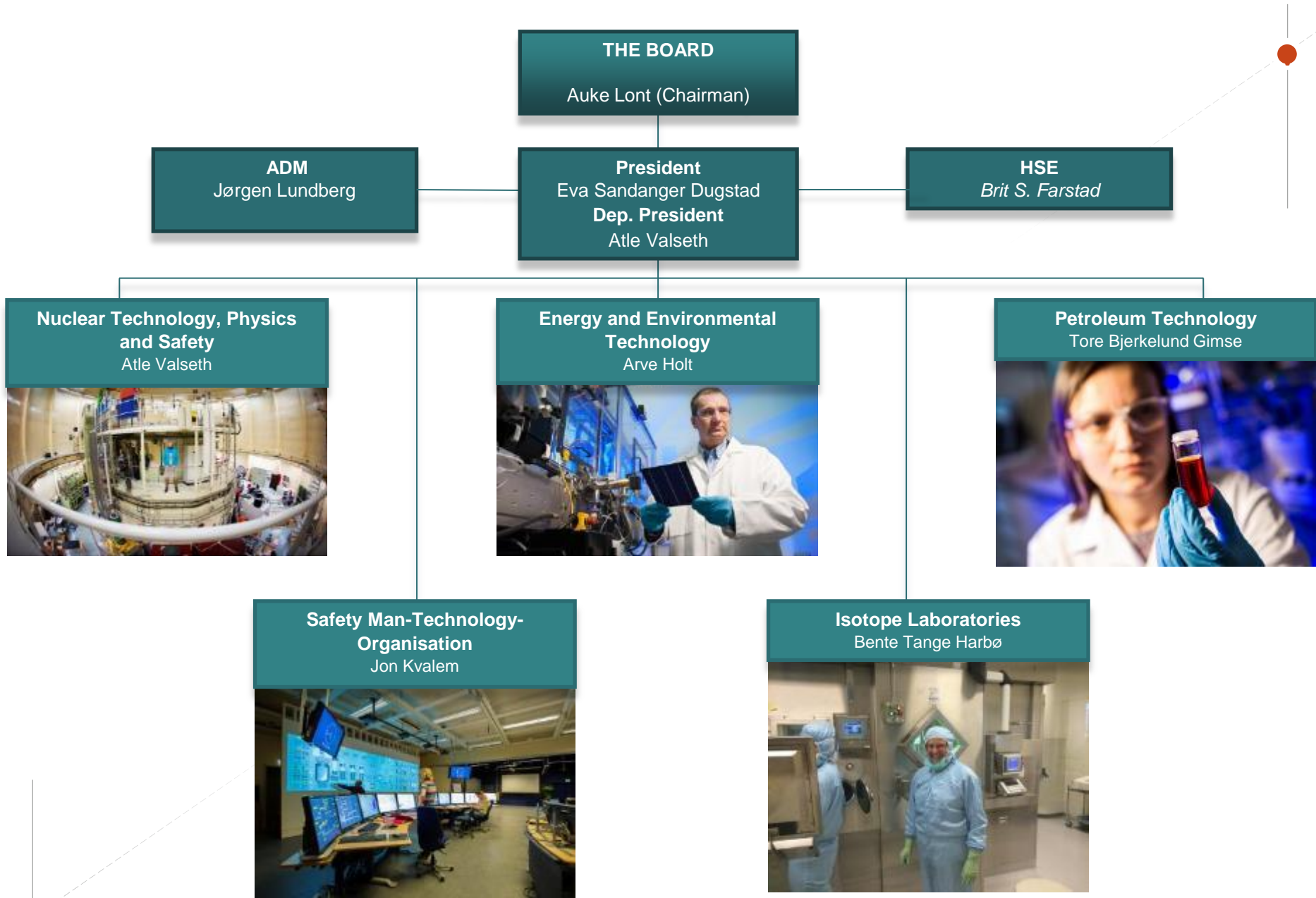
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Outline

- IFE tracer history
- Oil saturation measurements
- Two cases
 - PITT
 - SWCTT
- Future activities



Tracer timeline at IFE

- 1950ies Ground water, process equipment and different assignments for local authorities
- 1983 Tracers for oil field applications
- 1986 First interwell tracer study at Ekofisk
- 1991 Development of chemical tracers for reservoir studies (Tracer Club)
- 2001 Tracer studies of offshore process equipment
- 2005 Resman was established, partly based on IFE technology
- 2009 SPE award: For distinguished contribution to petroleum engineering in the area of reservoir description and dynamics
- 2012 Qualified tracers for Partitioning Interwell Tracer Test (PITT)
- 2013 Restrack was established, based on IFE technology

The Tracer Club

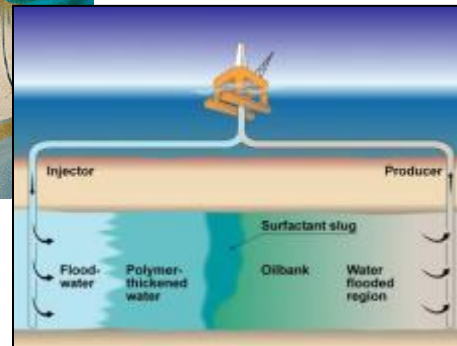
Long term research project, 7 oil companies

TracIntel
2013-2017



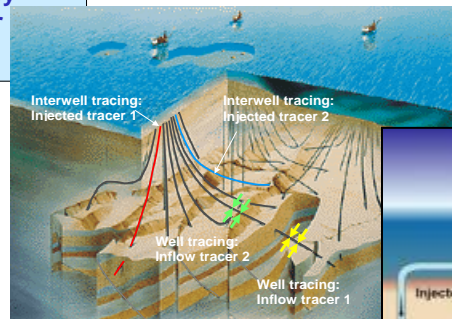
Development of Intelligent Tracer Technology

TracEOR
2008-2012



Tracer Technology for monitoring of secondary and tertiary oil recovery processes

ResTrac
2003-2007



Tracer Technology in Advanced Reservoir Exploitation Programs

Advisor
1998-2002

Detection and Quantification of Remaining and Unswept Oil by Innovative Tracer Technology

ITRC
1992-1997

Identification of new non radioactive tracers for water and gas monitoring

Experience in field applications



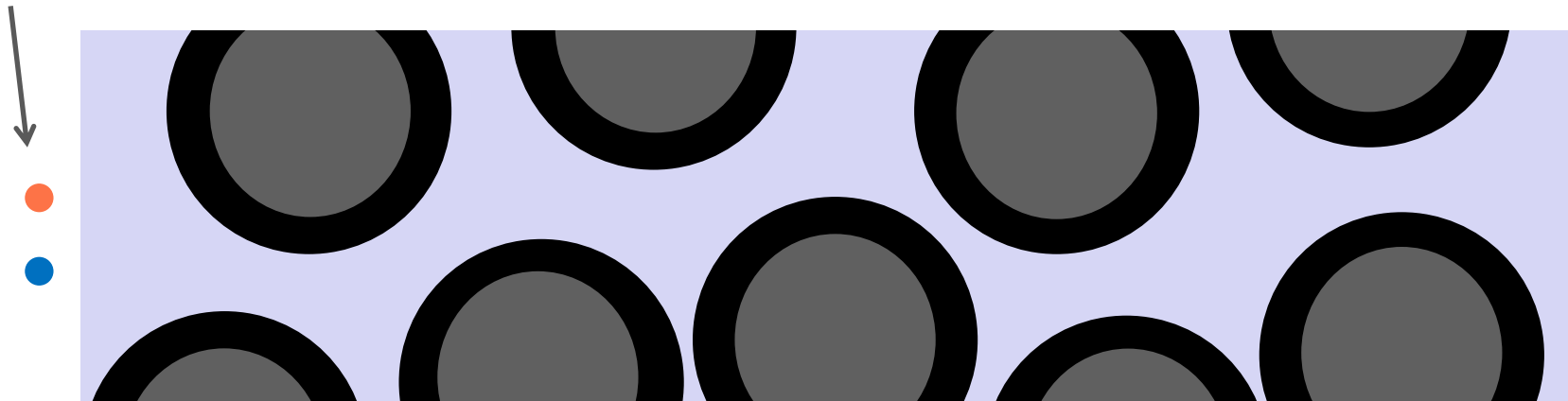


Oil saturation measurements using tracer technology

Tracers can be used for measuring oil saturation in the water swept well.

Simultaneously
injection

$$S_o = \frac{T_R - T_W}{T_R + T_W(K - 1)}$$

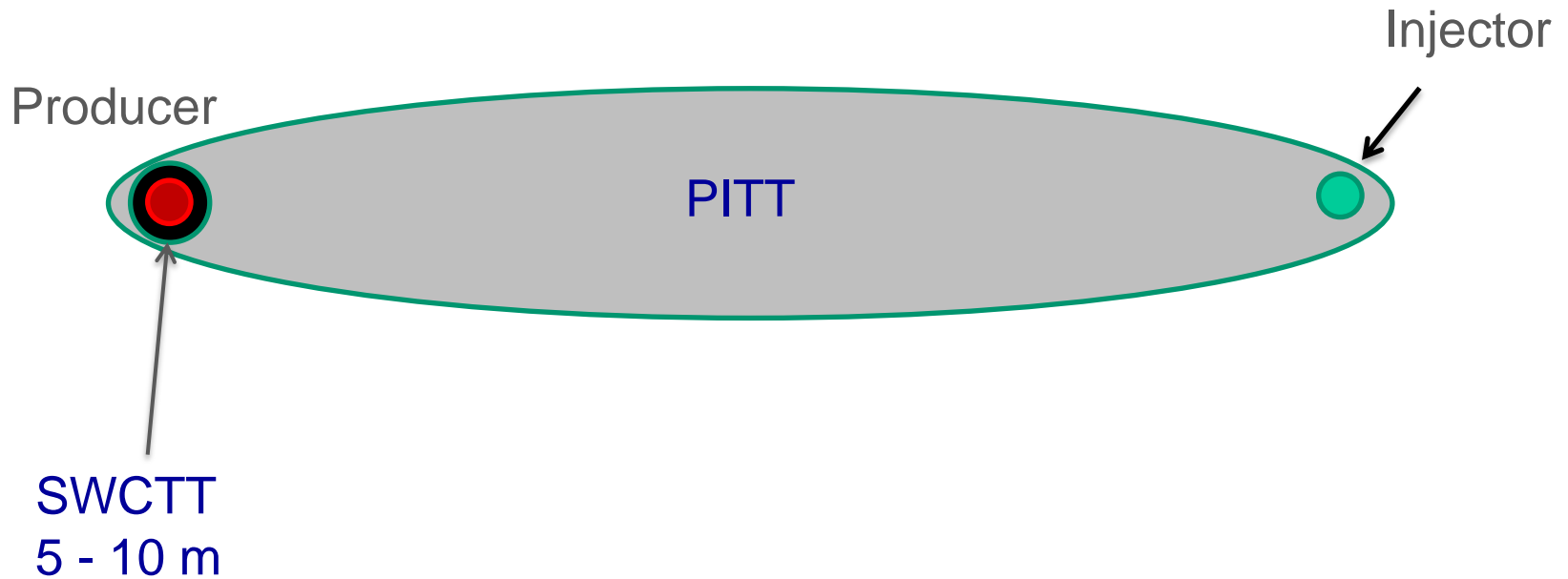


- Partitioning tracer
- Passive tracer

How can such measurements be used?

- Identification of IOR/EOR targets
- Evaluation IOR/EOR operations/performance.

Oil saturation is measured in two different field operations

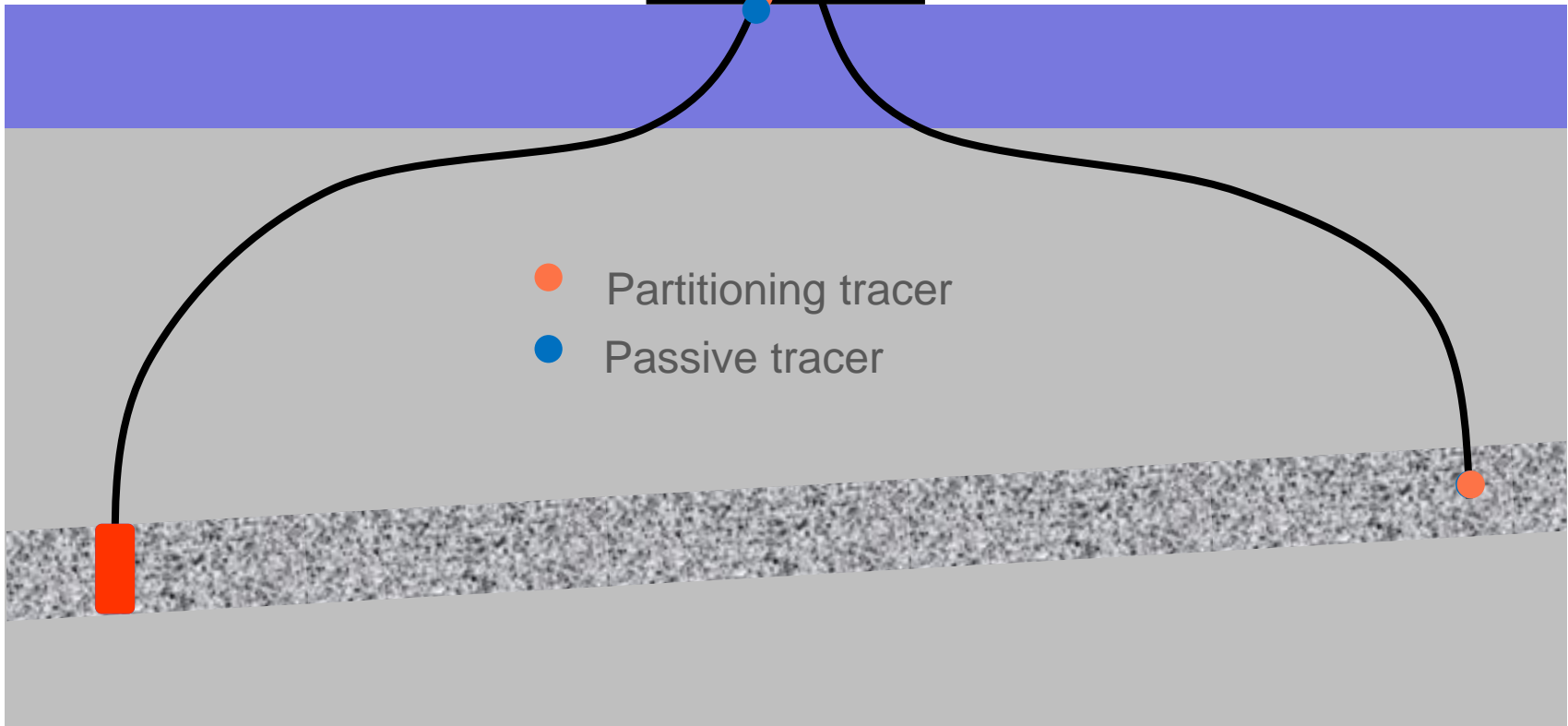
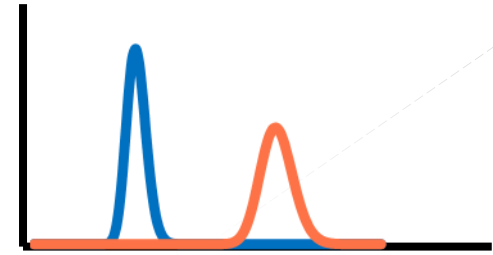
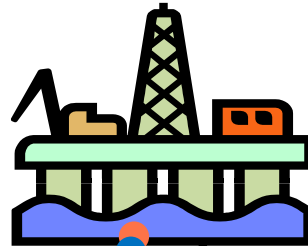


Single Well Chemical Tracer Test – SWCTT
Partitioning Interwell Tracer Test - PITT

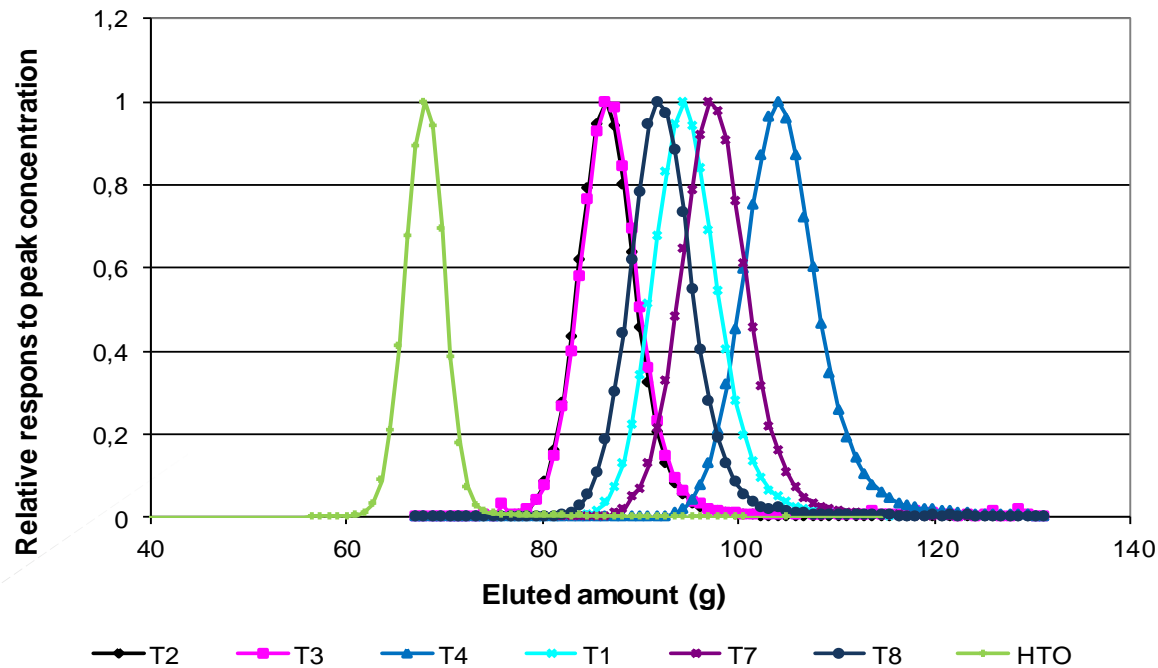
Partitioning Interwell Tracer Test

Lagrange pilot (SPE 164059)

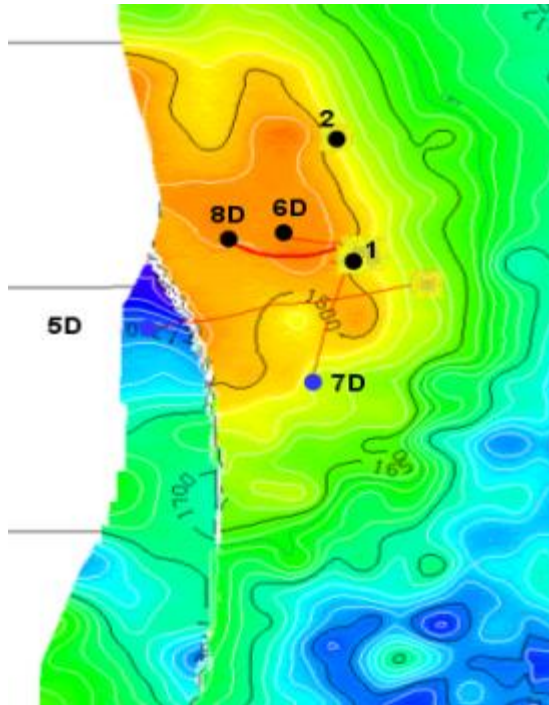
$$\text{SOR} = \frac{T_p - T_w}{T_p + T_w (K-1)}$$



Research status prior to the Lagrave pilot: 6 Partitioning tracers qualified and ready for pilot field experiments



Pilot selection: Lagrave field reservoir data

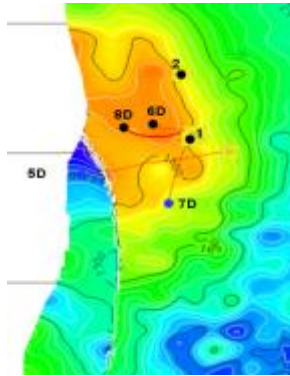


- According to production profiles and history, reservoir was at Sor.
- Sor had been measured from cores in producer LAV-1
- Excellent lateral reservoir continuity => Sor values for LAV-1 can be extended to other regions of the reservoir.

Calculated oil saturation in the area between injector and LAV-1

Tracer	β	K	\overline{S}_o [%]
T8	0.60	1.9	24
T7	0.75	2.4	24
T3	0.50	1.5	25
T2	0.50	1.5	25
T1	0.70	2.1	25
T4	0.80	2.9	22

Comparing oil saturation from field test and core measurements



PITT results:

- LAV-1: $S_o = 24\%$

Core measurements LAV-1

- Zone A: 25%
- Zone B top: 28%
- Zone B base: 23%

Conclusion from Lagrave pilot

Six tracers have been qualified in laboratory and field test.

Field pilot confirms the applicability of the tracers

Partitioning tracers can be used to estimate oil saturation in the interwell region



PITT service by



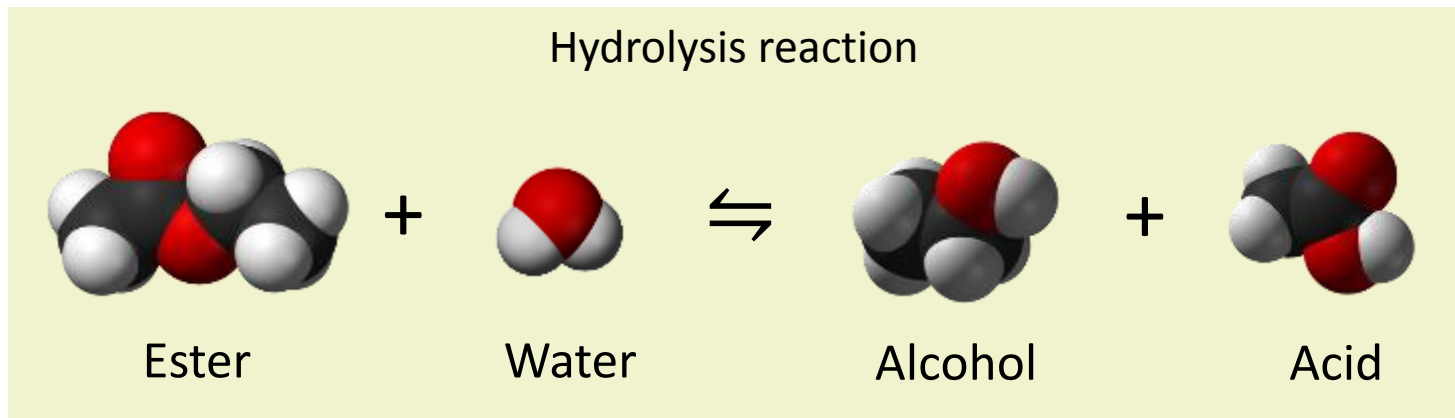


Single Well Chemical Tracer Test

“New tracers and methods for SWCTT”

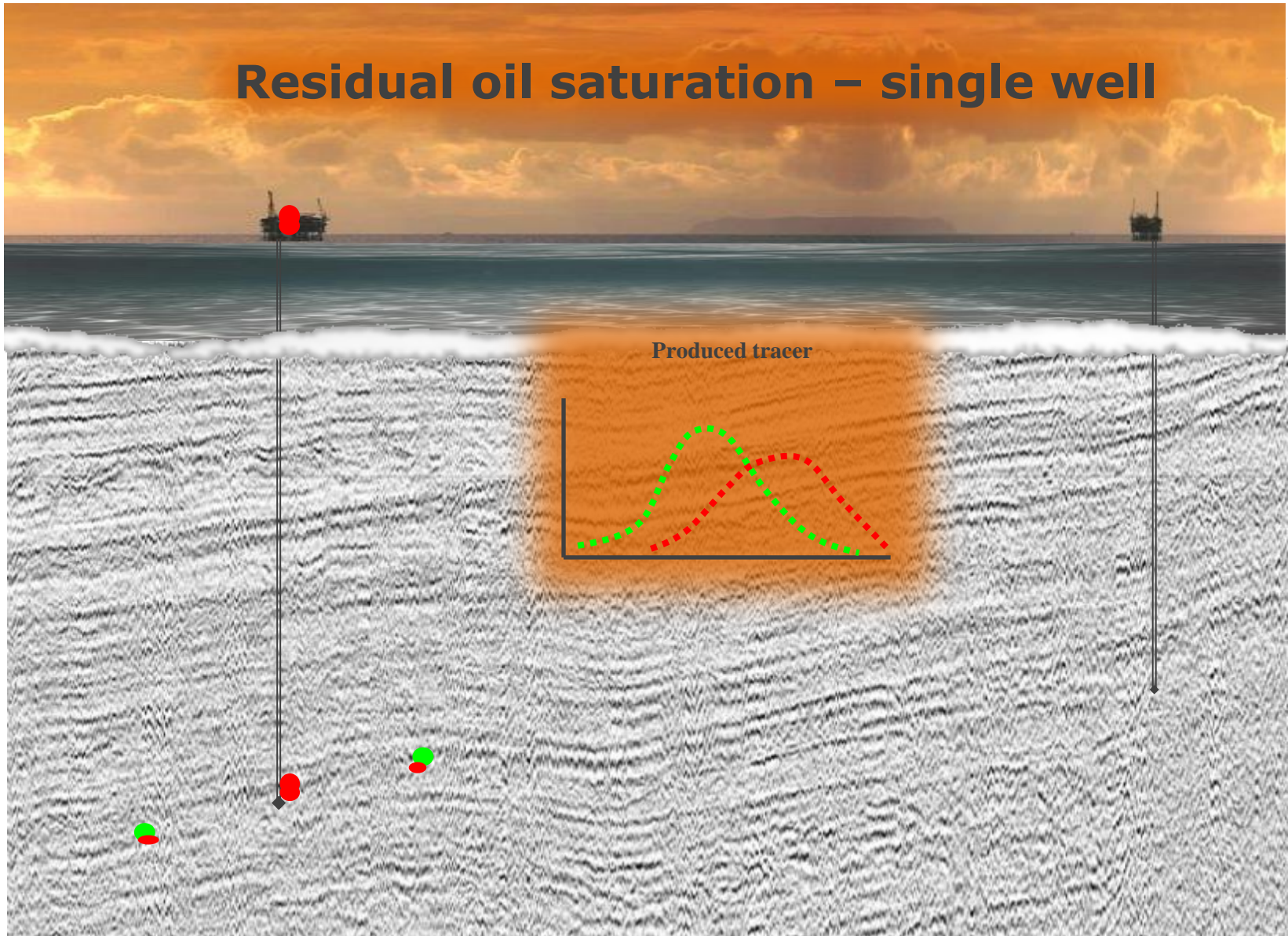
Single Well Chemical Tracer Test

Reactive tracers:



EOR verification - Measuring remaining oil

Residual oil saturation – single well



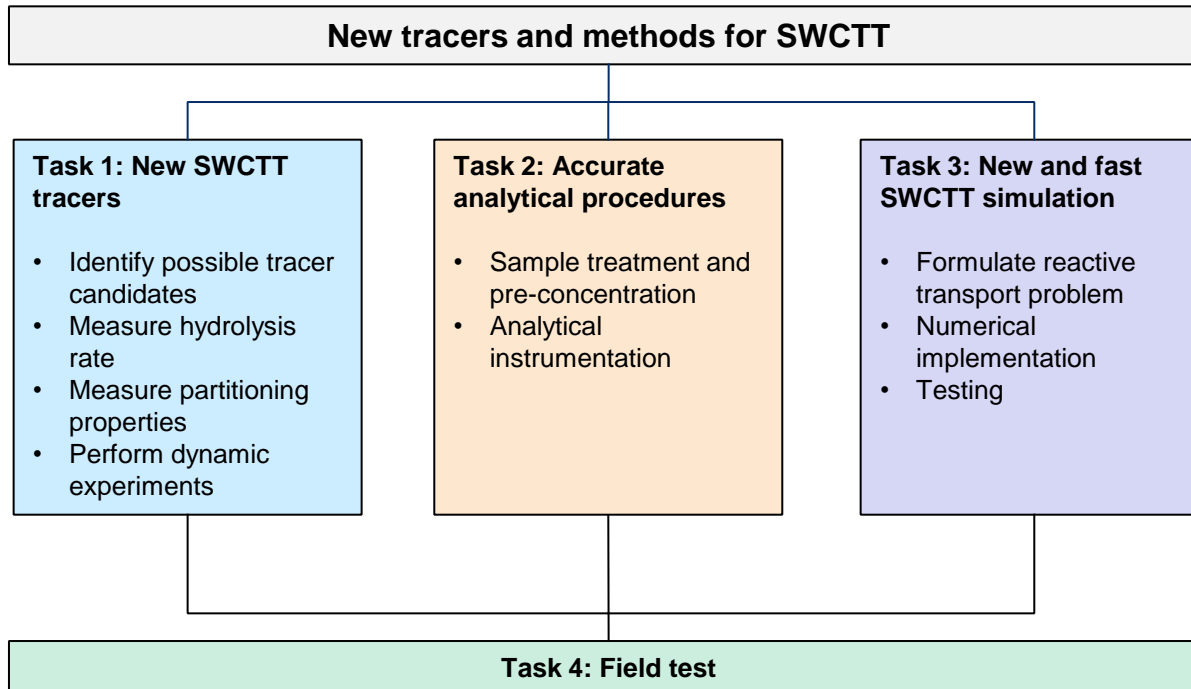
SWCTT field operation

Typical test parameters

- 100-500 kg EtAc injected
- 100- 500 kg of IPA and NPA injected
- Injection time 1 day
- HSE
- Shut in time 2-3 days
- Back-production 2 days
- Sampling each 15 minute



RCN-KMB project



Participants: 8 companies

RCN-KMB results

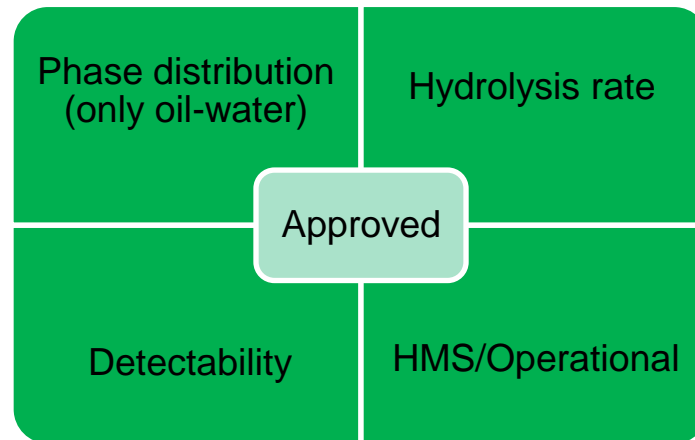
- Task 1
 - Four new tracer families identified, synthesized and tested.
- Task 2
 - A new sample treatment and analytical method has been developed suited for low ppb level tracer analysis.
- Task 4
 - A SWCTT field pilot using three selected tracers has been successfully completed in Middle East in June 2015.

Preparation of injection solutions



Pilot summary

- Operational and technical success



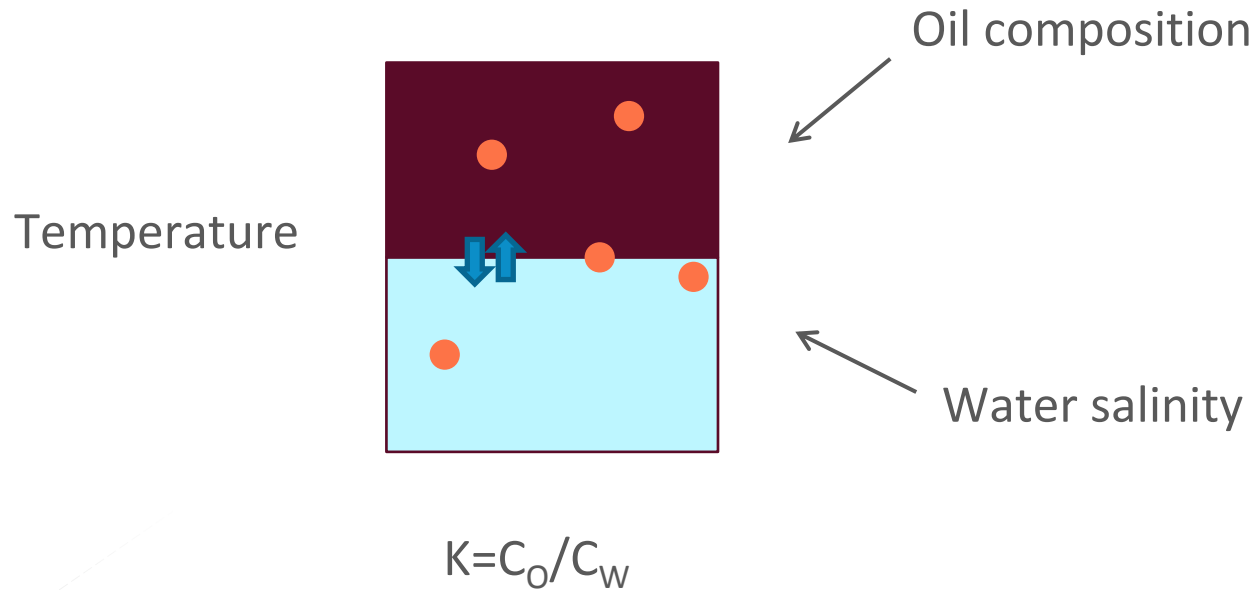
Conclusions

- New tracers work !
 - Same So from new and old tracers
 - Mass balance OK
 - Arrive as cover tracers
- The tracers may be injected in short time interval.

SWCTT service by  RESTRACK™

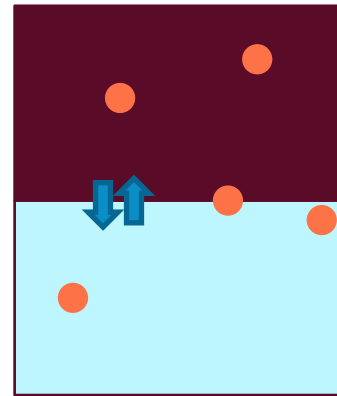
Future activities

Partitioning between oil and water is highly dependent of several factors



It is a need for tracers covering different conditions

- Tracers qualified for different conditions.
- A task included in The National IOR centre of Norway.



**The National
IOR Centre
of Norway**

Thank you!