



# Tracers for remaining oil saturation determination

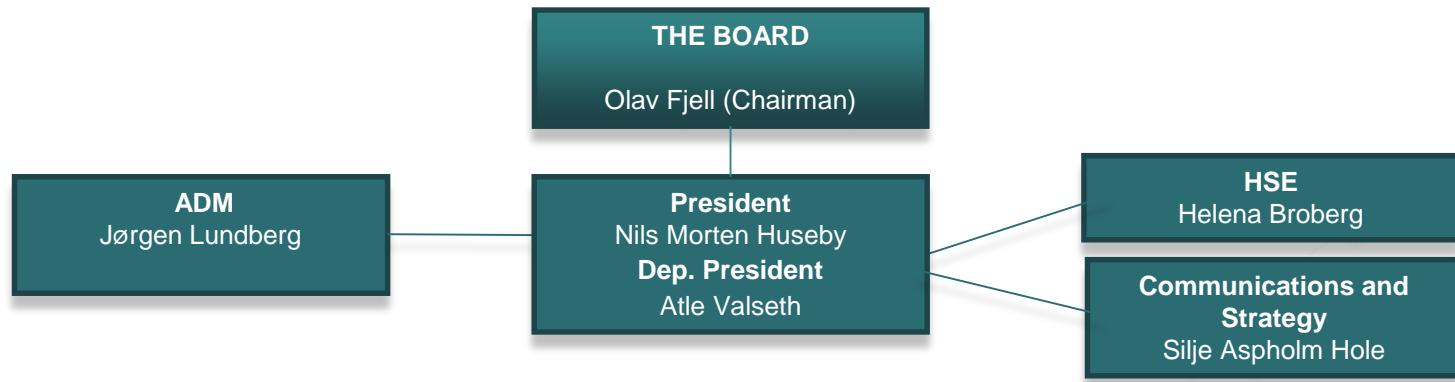


Reservoir Surveillance and Monitoring  
FORCE seminar 13.09.2017

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# Outline

- Who are we?
- Different tracer types
- How can tracers be used to gain information about the reservoir
- New possibilities



**Nuclear Technology, Physics and Safety**  
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**Energy and Environmental Technology**  
Arve Holt



**Petroleum Technology**  
Martin Foss



**Safety Man-Technology-Organisation**  
Jon Kvalem



**Isotope Laboratories**  
Bente Tange Harbø



**Nuclear Waste Management**  
Henning Refshauge Vahr



# Tracer timeline at IFE

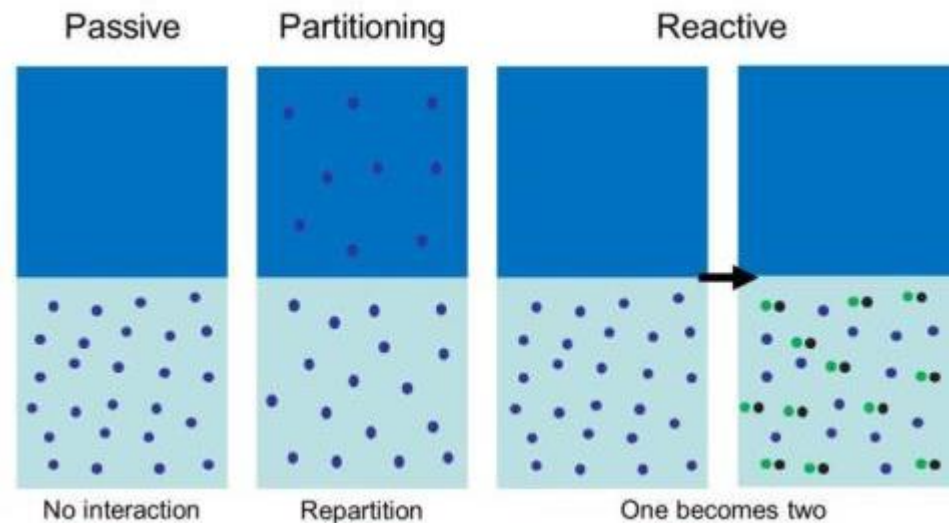
- 1950ies Ground water, process equipment and different assignments for local authorities
- 1983 Tracers for oil field applications
- 1986 First interwell tracer study at Ekofisk
- 1991 Development of chemical tracers for reservoir studies (Tracer Club)
- 2001 Tracer studies of offshore process equipment
- 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
- 2016 Qualified tracers for Single Well Chemical Tracer Test (SWCTT)

# A tracer gives information about a system

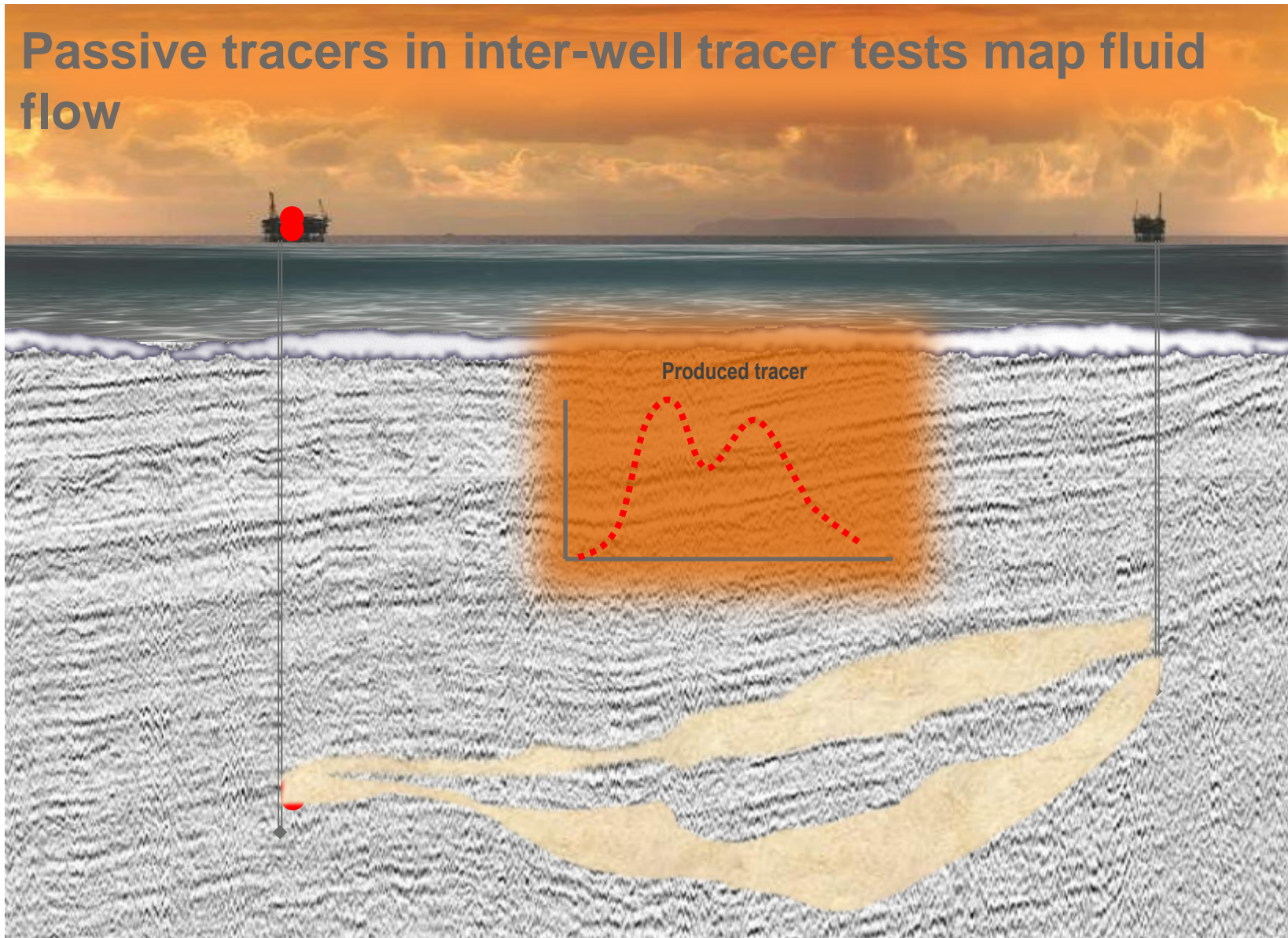
- A tracer is injected into a system and can be followed through this system and give information about it.

Different tracer categories:

- Passive tracers
- Partitioning tracers
- Reactive tracers



# Passive tracers in inter-well tracer tests map fluid flow

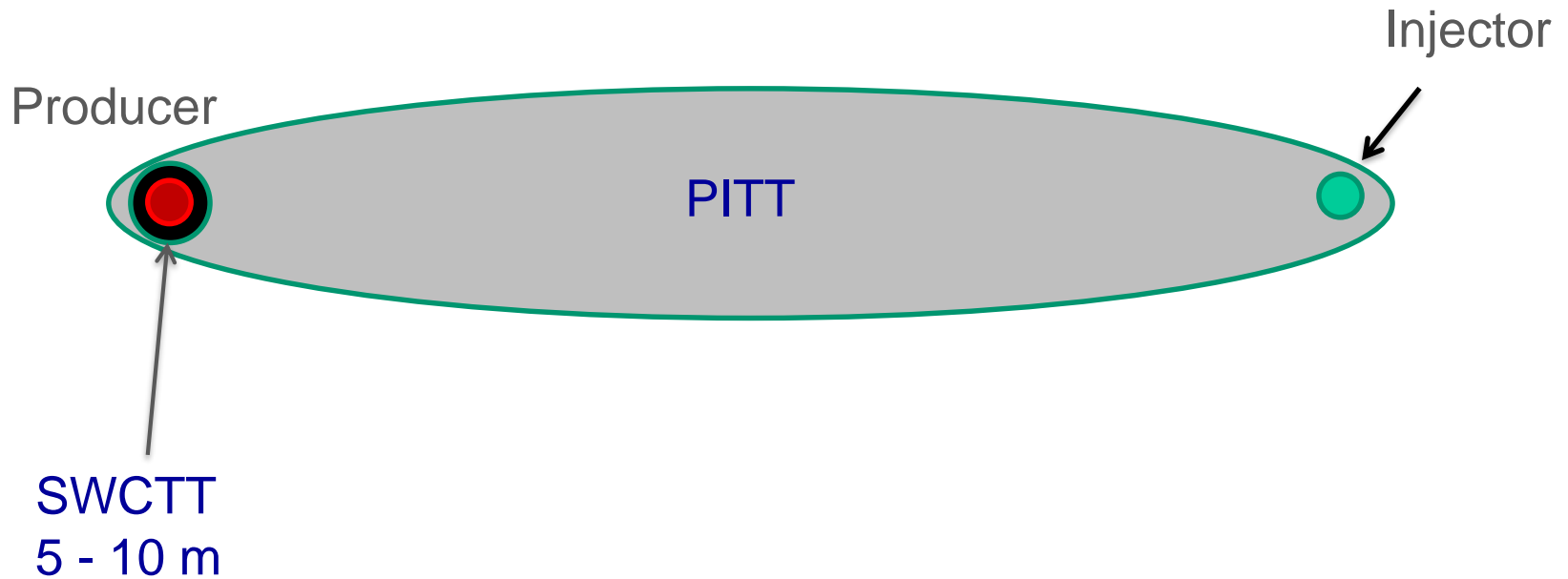


# Inter-well tracer tests (IWTT)



- Interwell tracer studies provides information about dynamic properties of the reservoir:
  - Preferential flow directions
  - Horizontal and vertical communication between wells
  - Permeability
  - Sweep volumes
  - Large-scale heterogeneities

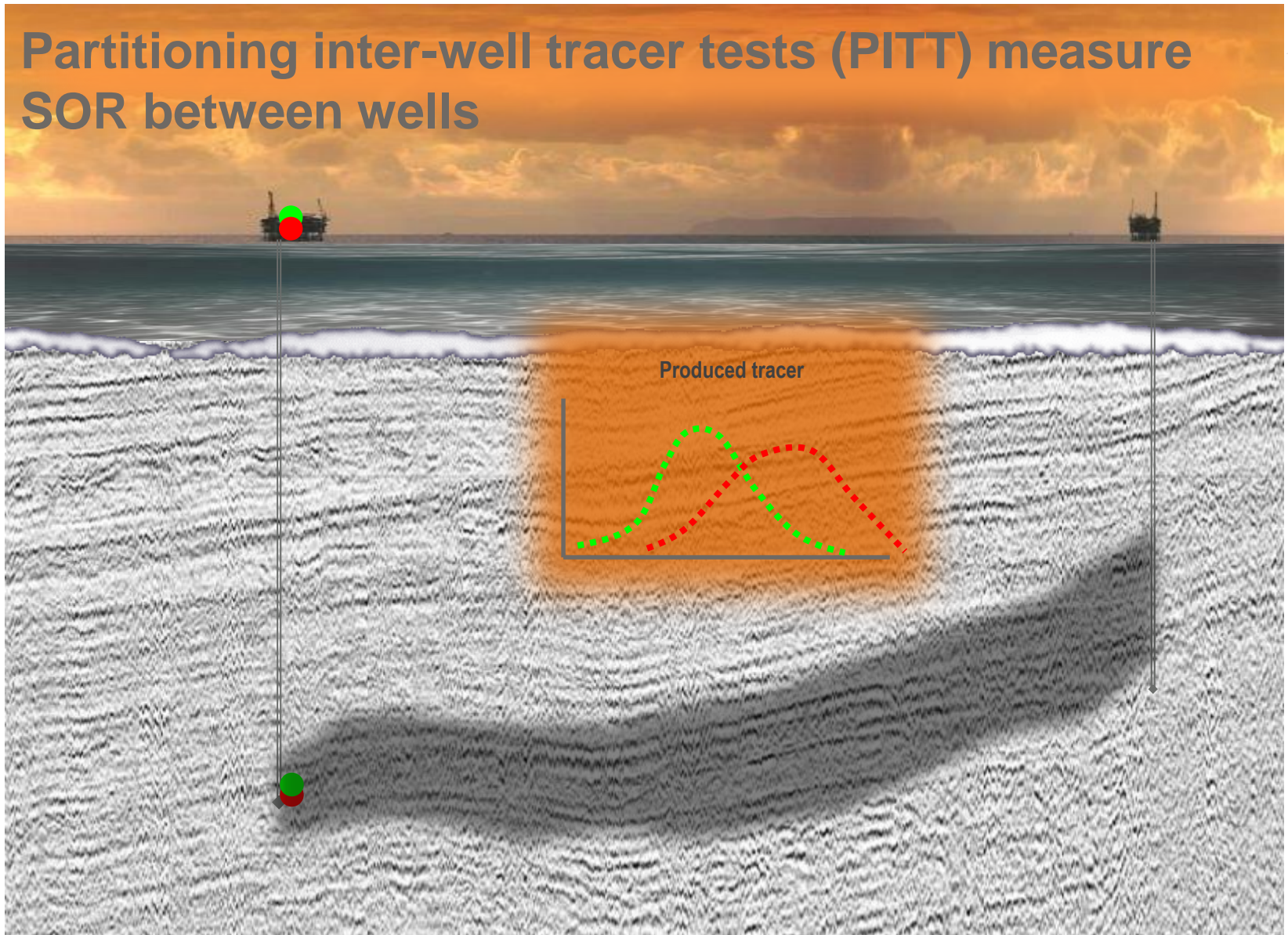
# Partitioning tracers are used in two different field operations



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



# Partitioning inter-well tracer tests (PITT) measure SOR between wells



# PITT tracers

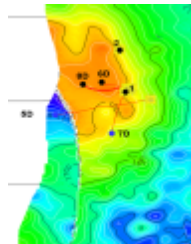


- Identification of IOR/EOR targets
- Evaluation IOR/EOR operations/performance.

# PITT tracer development at IFE

- 2013: Qualification of new group of PITT tracers

Viig et al, 2013; «Application of a New Class of Chemical Tracers to Measure Oil Saturation in Partitioning Interwell Tracer Tests”, SPE 164059.



PITT results:

- LAV-1:  $S_o = 24\%$
- LAV-2:  $S_o = 22\%$
- LAV-6:  $S_o = 11\%$



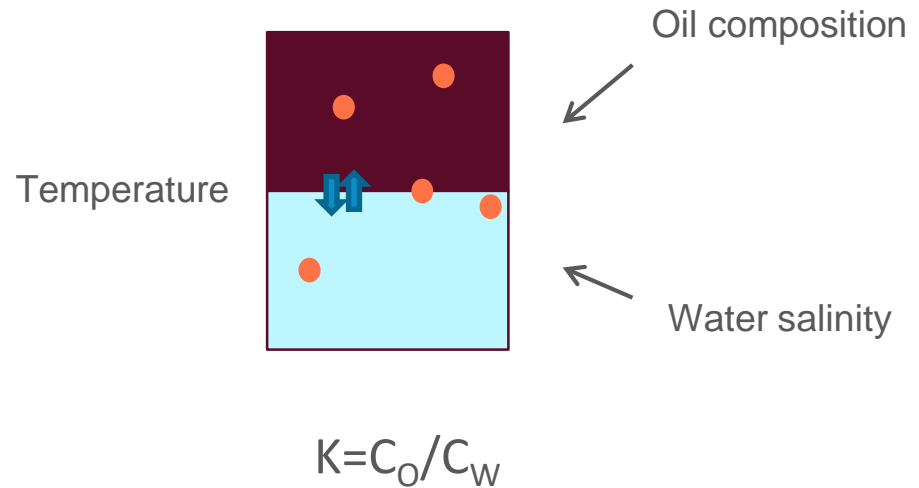
Core measurements LAV-1

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

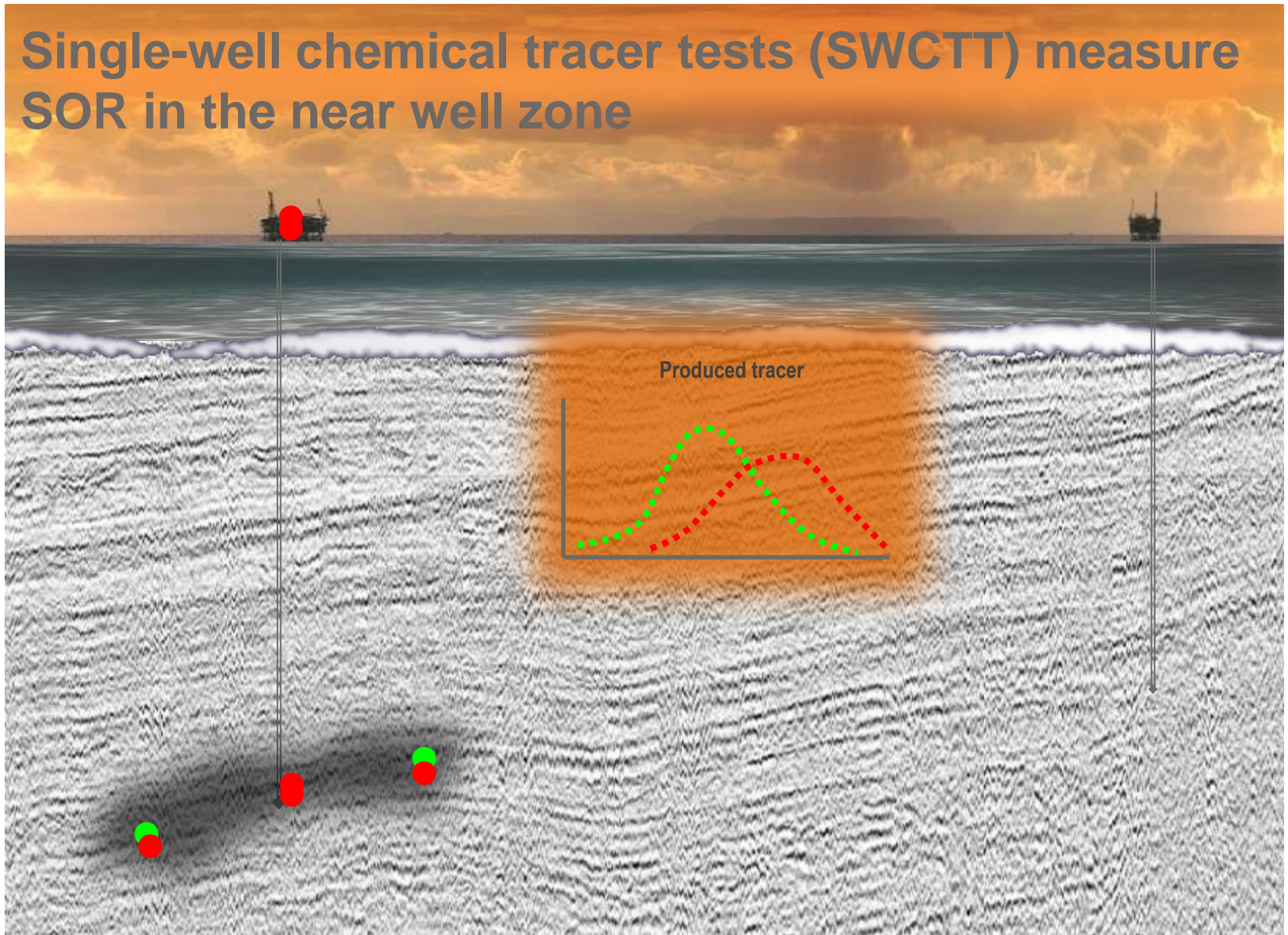
# PITT tracer development at IFE

- Work continues:

The National  
IOR Centre  
of Norway



# Single-well chemical tracer tests (SWCTT) measure SOR in the near well zone



# Single-well chemical tracer tests (SWCTT)



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

# SWCTT tracer development at IFE

- 2016: Qualification of new group of SWCTT tracers

Al-Abbad M., Sanni, M., Kokal, S., Krivokapic, A., Dye, C., Dugstad, Ø., Hartvig, S., Huseby, O., (2016) A Step-Change for Single Well Chemical Tracer Tests (SWCTT): Field Pilot Testing of New Sets of Novel Tracers Field Pilot Testing of New Sets of Novel Tracers, SPE-181408-MS.

What is new??

# SWCTT tracer development at IFE

Original method:



- 100-500 kg EtAc injected
- 100- 500 kg of IPA and NPA injected
- Injection time 1 day
- HSE



# SWCTT tracer development at IFE

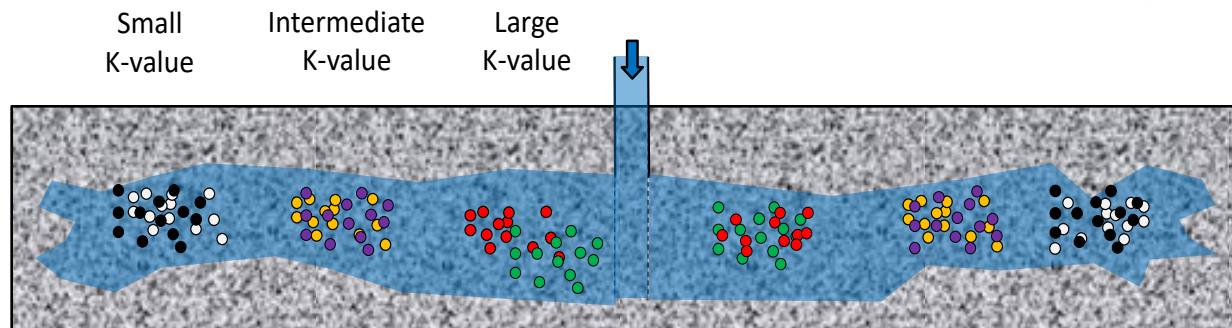
New method:



Status 2016:

- Four new tracer families (12 tracers)
- Injection amount 80g
- Pulse injection possible

# New SWCTT tracers give new possibilities



- Investigation depth depend on K-value. This gives saturation estimate specific for each zone.

SPE 7076

USING CHEMICAL TRACERS TO MEASURE  
FRACTIONAL FLOW AND SATURATION IN-SITU

by H.A. Deans, Member SPE-AIME, Exxon Production  
Research Company and Rice University

If «yes»



Cost-efficient data access

1. SoR
2. Fractional flow
3. Relative permeability

# Summing up

- Studies have proved that tracers are a reliable tool to measure remaining oil saturation.
- New tracers give new possibilities!



Thank you!