

# PRODUCTION LOGGING TOOL (PLT)

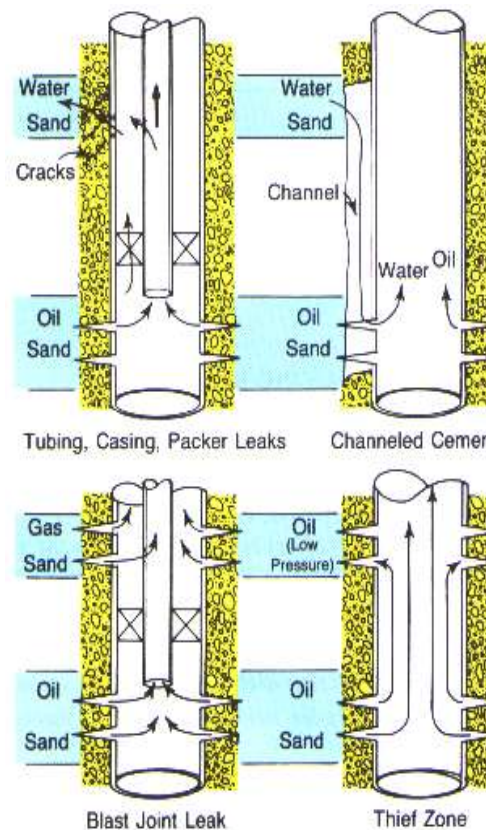
By Fletcher Entika Anak Jaya

# Production Logging Tool (PLT)



# PL Applications

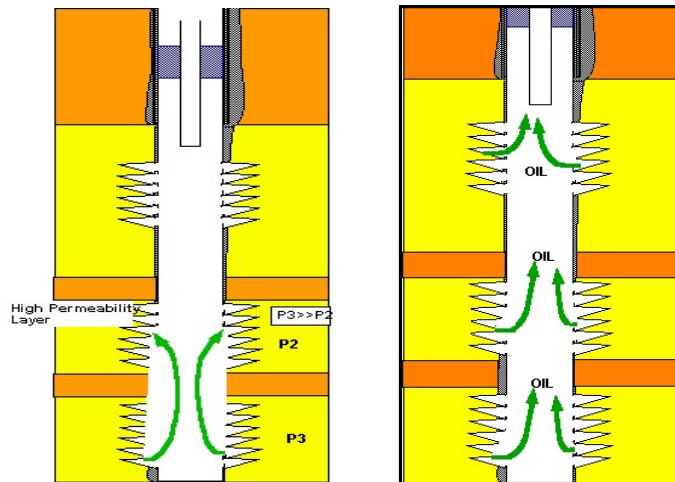
- Evaluation
  1. Production profile distribution
  2. Zonal productivity
- Monitoring
  1. Production profile changes
  2. Fluid type changes: Water or Gas breakthrough
- Diagnosis
  1. Source of high GOR or Water Cut
  2. Detection of leaks and crossflow
- Production Enhancement
  1. Data for workover planning
  2. Completion and treatment effectiveness



# Typical PL program

## 1. Shut-In conditions

- Perform passes at different speeds across the interval of interest
- Perform spinner calibration
- Determine fluid levels
- Detect Cross-flows (if any)



## 2. Flowing conditions

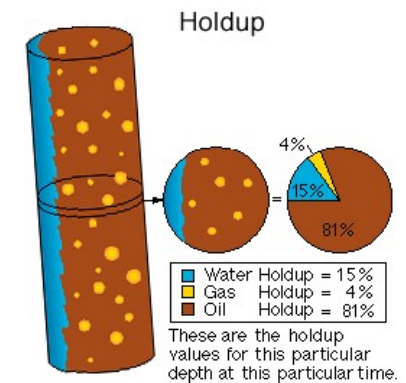
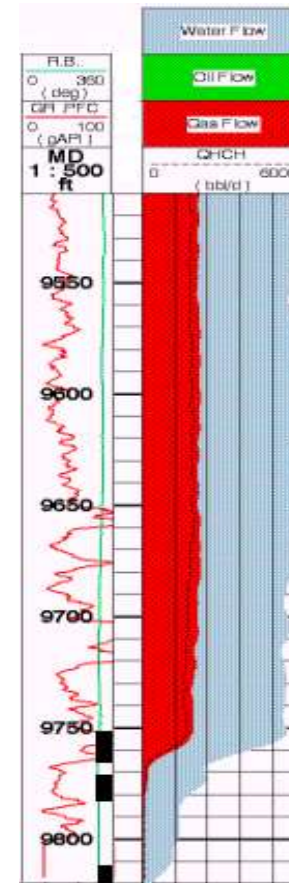
- Wait for stable flow
- **pressure, spinner, density ?**
- Log interval of interest (passes up and down at different speeds)
- Perform spinner calibration
- Identify flowing profile & cross-flow
- Identify fluid entries
- Log stations if requested

Shut-In the well  
before POOH in  
the Tubing !

# Production Logging Interpretation

## FACTS

1. Single phase: determination of downhole profile and interpretation of downhole data is straight forward.
2. Multiphase flow : phenomena like holdup, slippage velocity and phase segregation complicates the flow behavior.
3. For the interpretation of production logs under multiphase flow conditions, **Holdup is of major importance**.
4. Water Hold Up vs Water Cut



# PLT Toolstring

The standard tool for PLT can be divided into several section which are:

- Telemetry/communication section (XTU)
- Pressure section (QPS)
- Temperature section (PRT)
- Depth correlation section (PGR, CCL)
- Fluid ID section (CWH, FDR) – **Water Hold Up & Density**
- Flowmeter section (ILS, CFBE ,CFSM) – **Phase Speed**
- Deployment section (PRC, PKJ, weight bar)

$$Q_w = V_w \times A \times H_w$$

$$Q_o = V_o \times A \times H_o$$

$$Q_G = V_G \times A \times H_G$$



15K Psi & 170 degC rating

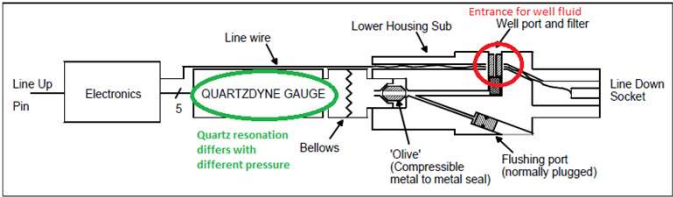
# Quartz Pressure Sensor (QPS) & Platinum Resistance Thermometer (PRT)

## Quartz Pressure Sensor, QPS

Measures changes in flowing and shut-in pressures.

### Measurement Principal

- Pressure from well fluid will enter through the well port, and will then be measured by the quartzdyne gauge which is protected by the bellow
- Since the resonation of the quartz is effected by both temperature and pressure, another quartz was incorporated in the circuit to solely measure the resonation effected by temperature.
- This second quartz is not subjected to well pressure at all. It will then act as the “corrector” for the first quartz to get a more precise data.



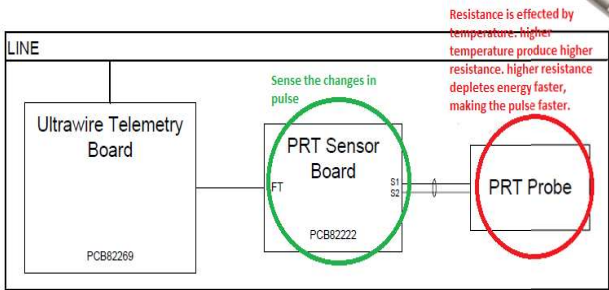
## Platinum Resistance Thermometer, PRT

The temperature sensor responds to small temperature changes - indicating fluid movement inside and/or outside of the completion.

### Measurement Principal

- A fast-sensing platinum is used as a resistor in the sensor system (RLC circuit), where the temperature effects the resistance of the platinum, and at the same time effecting the frequency produced by the circuit.
- Higher temperature creates higher resistance in platinum, which depletes energy faster in the circuit, thus creating faster pulse

BLOCK DIAGRAM



# Production Gamma Ray (PGR) & Casing Collar Locator (CCL)

## Production Gamma Ray, PGR

Measures natural gamma ray radiation levels in the wellbore.  
Used, for depth correlation, lithology and radioactive scale identification which is associated with water production.

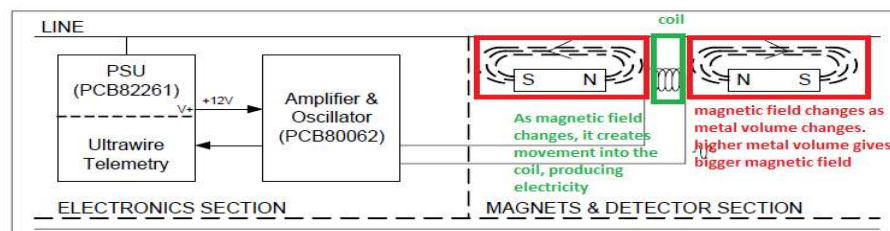


## Casing Collar Locator, CCL

The **CCL** sensor responds to changes in metal volume such as at casing joints, completion items or perforations. It is mainly used for depth correlation though can be used to detect holes and perforations.



### BLOCK DIAGRAM



## Capacitance Water Hold-Up (CWH) & Fluid Density Radioactive (FDR)

### Capacitance Water Hold-Up, CWH

Oil, water and gas have different dielectric responses, the capacitance tool has different frequencies in gas, oil and water but it is principally used to measure the water fraction in the mixture.

#### Measurement Principal

Using concept of dielectric to identify fluid, thus knowing the fraction volume of water.

Dielectric is an insulator that can be polarized by electrical field.

Dielectric constant for **water = 80, air = 1, and oil = 10.**

### Fluid Density Radioactive, FDR

Oil, water and gas have different densities. By measuring the overall density of the wellbore fluid the fraction or holdup of each phase can be calculated

#### Measurement Principal

- The lower section of the tool has a radiation source, that will travel through a slot filled with well fluid, and a detector above the slot to count the value of radiation that arrives.
- Higher density fluids absorb more gamma rays from gamma rays source, hence the low number of arrival at detector vice versa.
- The logarithm of tool response to density is linear for liquid with 0.0 to 0.9 g/cc density.



# Flowmeter

## Flowmeters

The flowmeter measures well fluid velocity using a turbine (spinner) impeller, the higher the fluid velocity, the faster the spinner rotates. Knowing fluid velocity and tubing size, volumetric flow rate can be calculated. Spinner mechanical sections should be selected to suit completion size and fluid velocity. However in general, the largest spinner impeller that can be used will give the best results.

### 1. Continuous Flowmeter Spinner:

This spinner rotates continuously. It is typically used in tubing and in casing for high rate gas wells. It has roller bearings.



### 2. Caged Fullbore Flowmeter:

The spinner impeller is closed in tubing and opens up in casing to present a large diameter impeller, giving high sensitivity. It is protected by a springbow cage.

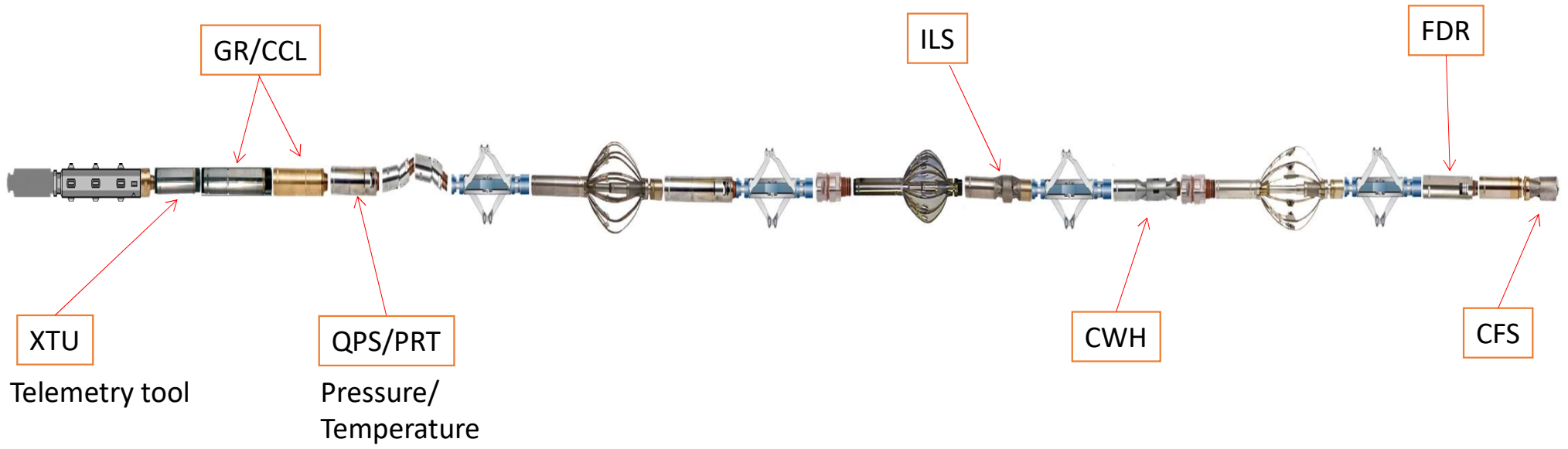


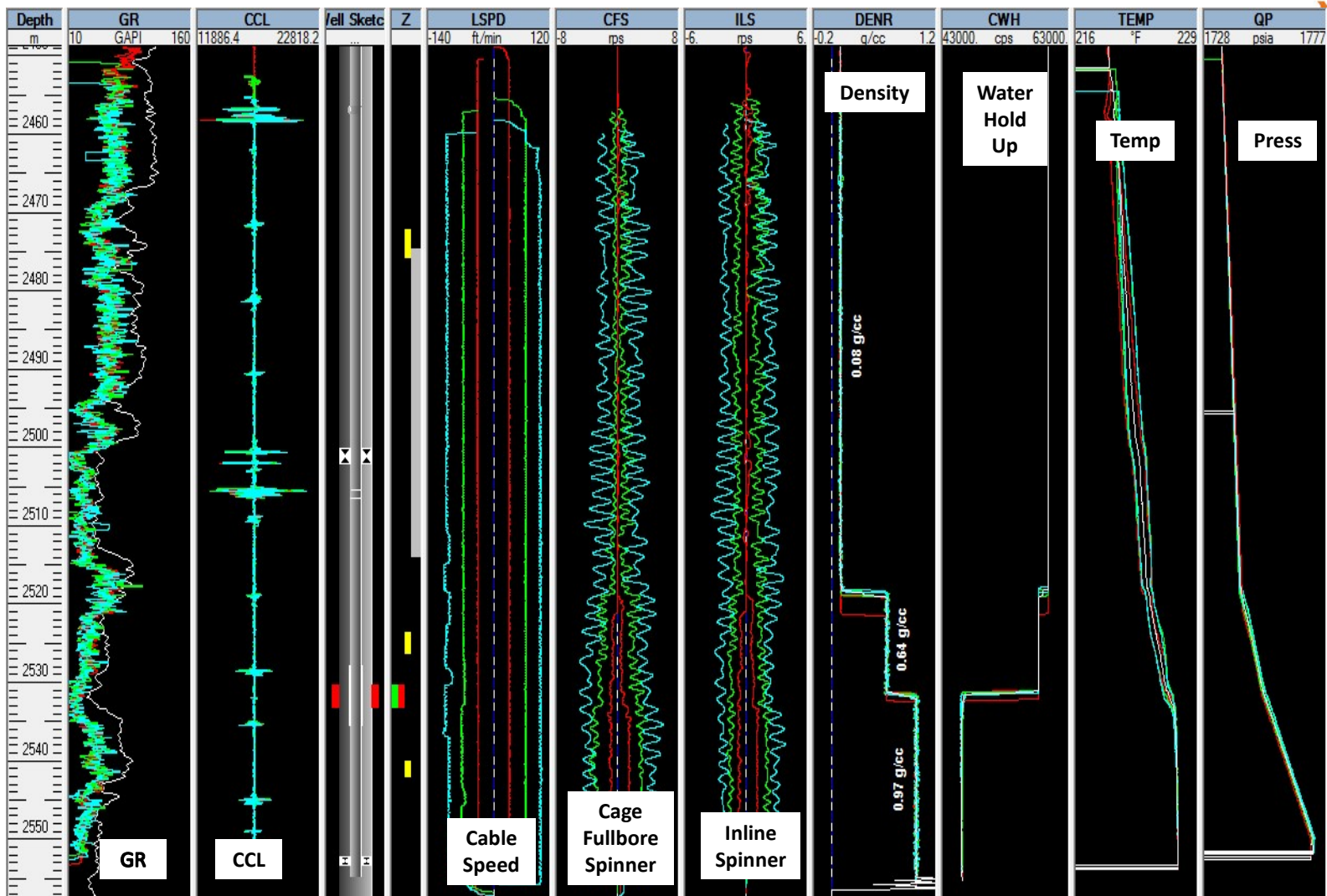
### 3. In Line Spinner:

The back up spinner. Positioned at the middle of toolstring.



# Standard E-Line Production Logging Toolstring Configuration





# Multi Array Production Suite (MAPS)

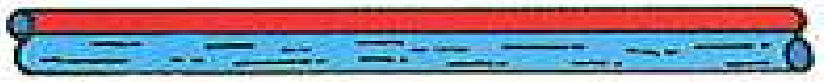


# MAPS Function & Applications

- **MAPS Function:** Identify oil & gas production and locate water entry points in all types of well conditions. (Vertical to horizontal) *{PLT string use in well with phase segregation due too deviated well}*
- Specifically required for wells where phase separation occur normally in high deviation well
- MAPS combines the **Spinner Array Tool (SAT)**, **Capacitance Array Tool (CAT)** and **Resistance Array Tool (RAT)** to measure phase hold-ups and velocities
- CAT is used for fluid ID, RAT for water hold up, and SAT as flowmeter.
- Since the flowmeter, fluid ID and water hold up sensor gives individual data, it is very important to line up the sensors in the same plane as the tools are usually in cylindrical shape and can rotate 360 degree. To make sure of this, Production Inclinometer Accelerometer can be used.

# Flow Regime

In c  
reg  
Eve  
pha  
side



Stratified  
Smooth Flow

Stratified



Stratified  
Wavy Flow



Elongated  
Bubble Flow

Intermittent



Slug Flow



Annular  
Flow

Annular



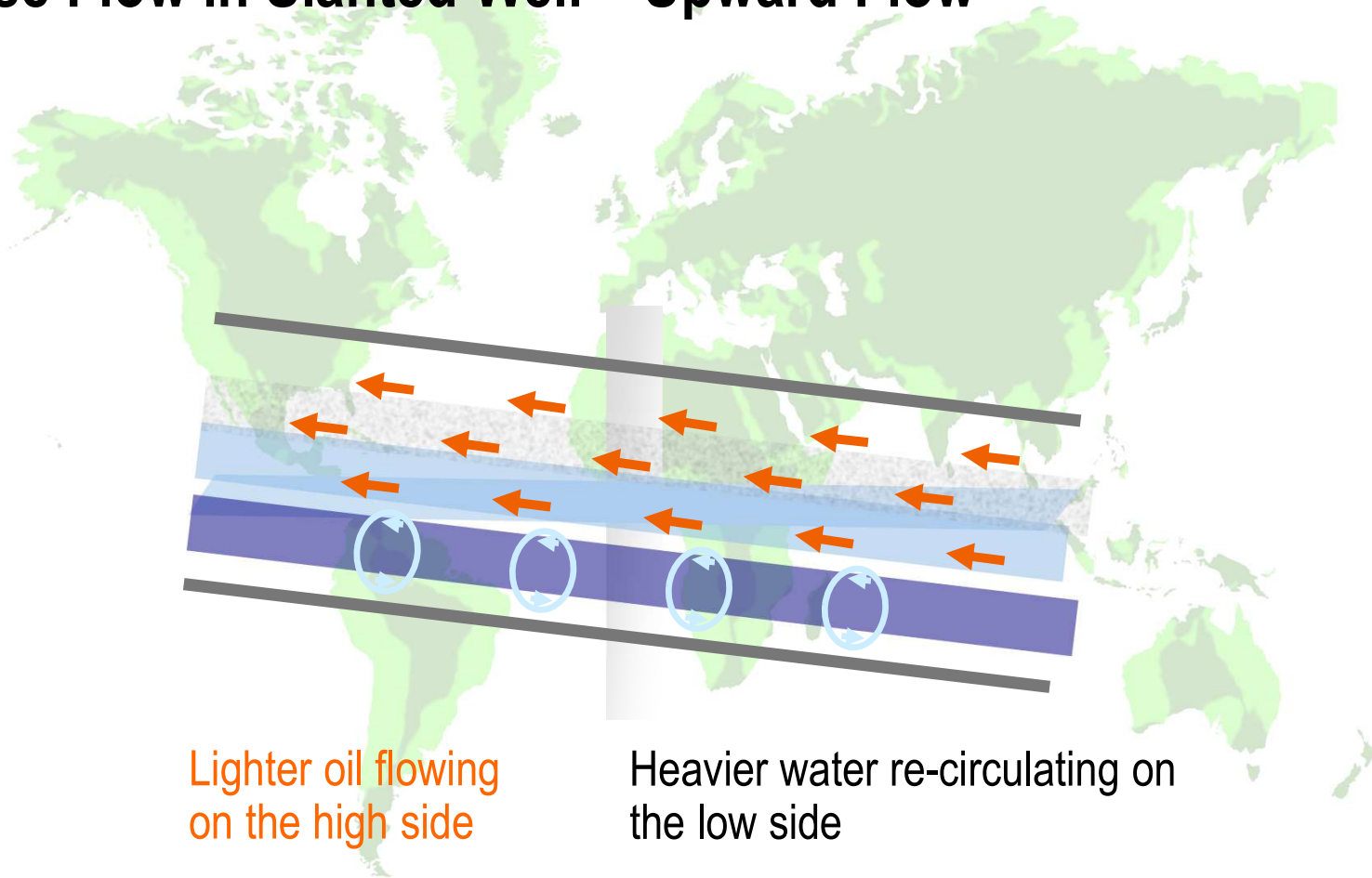
Wavy Annular  
Flow



Dispersed  
Bubble Flow

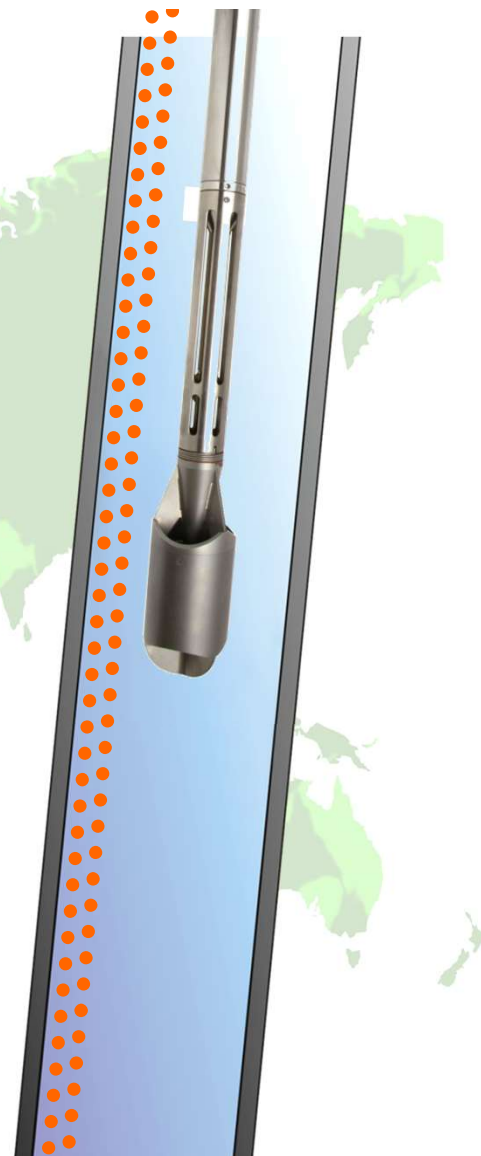


## Multiphase Flow in Slanted Well – Upward Flow



# Standard Tool

Tools positioned in the centre of a well may miss oil, or gas flowing on the high side, or water on the low side of the pipe



# MAPS Tool Design

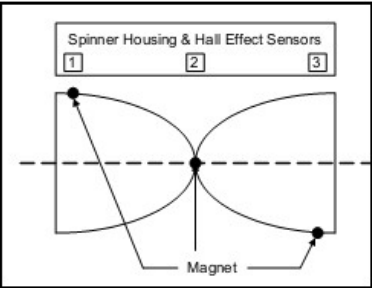
Bowspring style tools deploy sensors to intercept minority flows at the perimeter of a pipe



# Spinner Array Tool (SAT)

6 miniature flowmeters mounted on bowsprings  
Measure the velocity of surrounding fluid

Spinner OD	Minimum Tool OD
0.6in	2.125in
0.4in	1.90in



# Capacitance Array Tool (CAT)

- 12 miniature sensors mounted on bowsprings
- Specially developed to measure the capacitance of surrounding fluid
- Dielectric constant for **water = 80, air = 1, and oil = 10.**

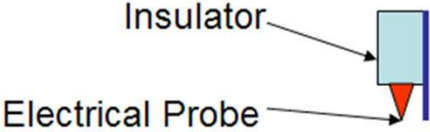


# Resistivity Array Tool (RAT)

12 miniature sensors mounted on bowsprings  
Specially developed to measure the electrical resistance of surrounding fluid



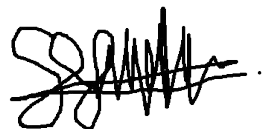
RAT Typical Value  
Gas: 1  
Oil: 0.8  
Water: 0.4



# Thank you !

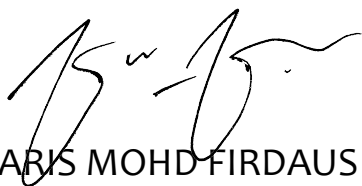
Questions and Answering Session

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