



# **VIVID**<sup>TM</sup>

Acoustic Listening Platform

# **Archer**

- Patented ultra-high sensitivity acoustic technology
- Broadest frequency bandwidth and amplitude of acoustic energy with industry-leading sensitivity
- Detects, investigates and describes leaks that negatively affect the performance of oil and gas wells
- Accurately locates even the lowest energy leaks, verifying cement barrier seals and characterizing downhole events with unparalleled precision
- **VIVID™** acoustic listening platform detects leaks that were previously undetectable and provides you with the clearest answers where other technologies fail

# If it's there, we'll detect it

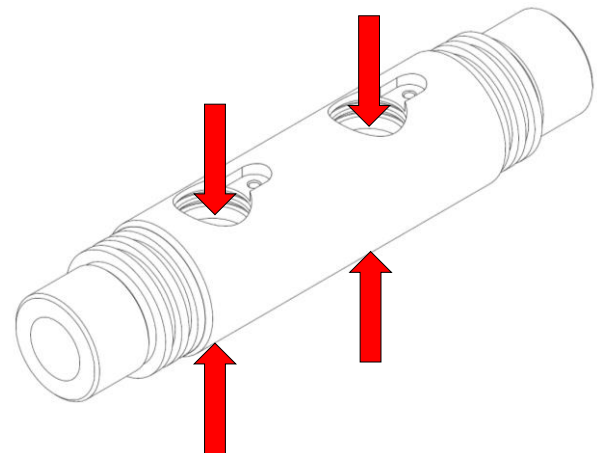
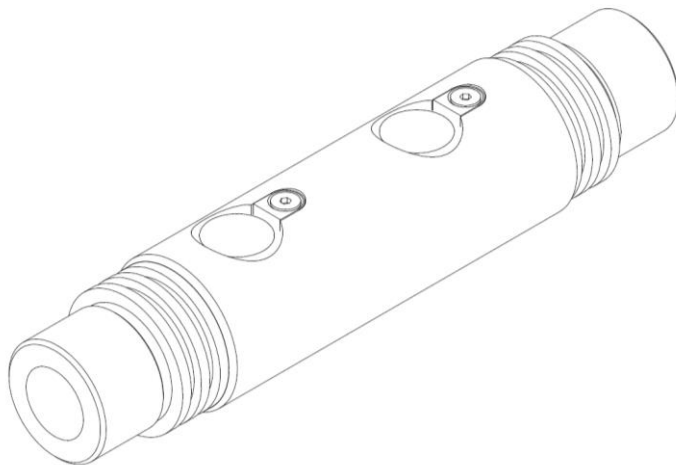
# **VIVID™ – Tool specifications**

## Tool specifications

- Sensors:
  - 2 passive acoustic sensors
  - <1 – 656 kHz frequency range
- Operational:
  - Dynamic and stationary logging
  - Real-time and memory
- Physical
  - 1 11/16" OD
  - 29" length
  - 4.9 kg weight
- Environmental
  - 177 degC / 350 degF max temperature
  - 15000 psi max pressure

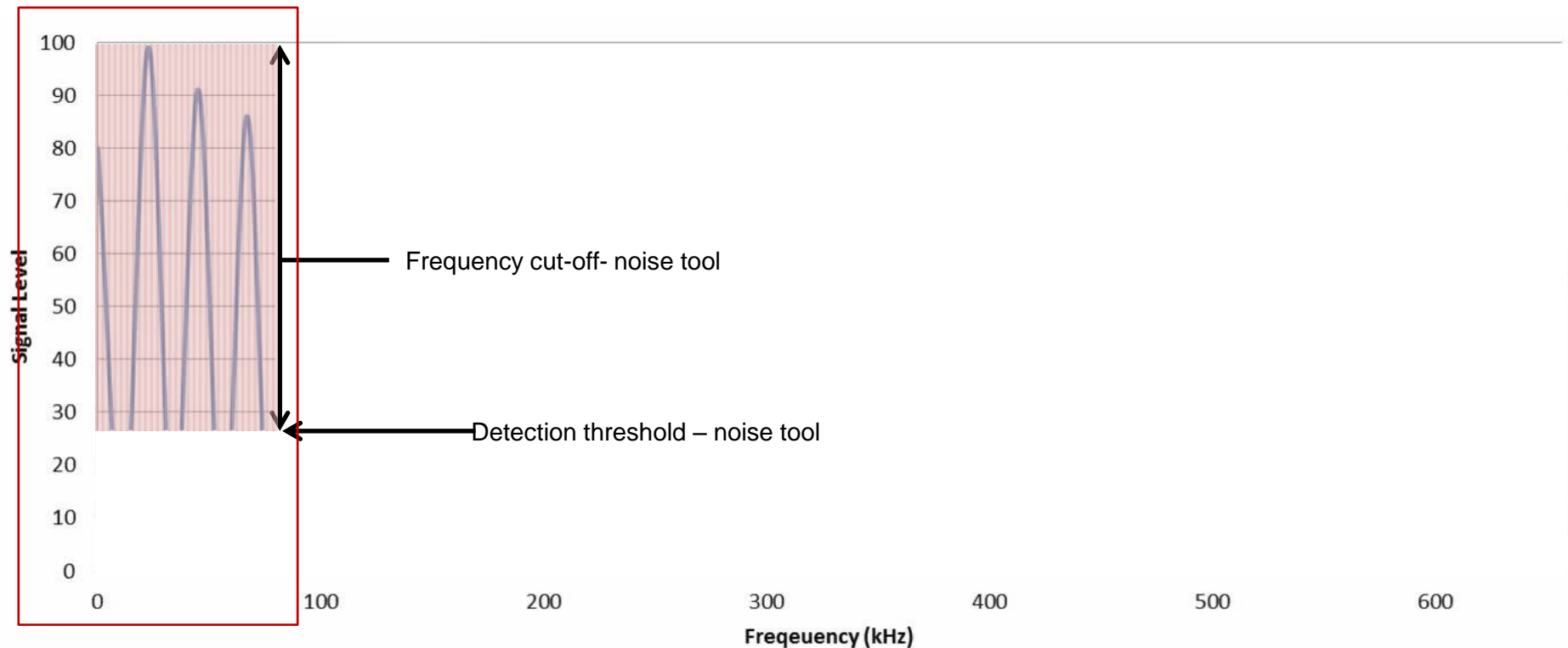


- Two sensors give optimum response across the entire frequency spectrum
- The sensors are integrated with the tool housing by means of a patented pressure-balanced insertion assembly.
- Removing the need for an oil filled pressure compensation system means the acoustic window is in direct contact with well fluid, giving proven industry leading sensitivity



# VIVID™ – Unparalleled sensitivity

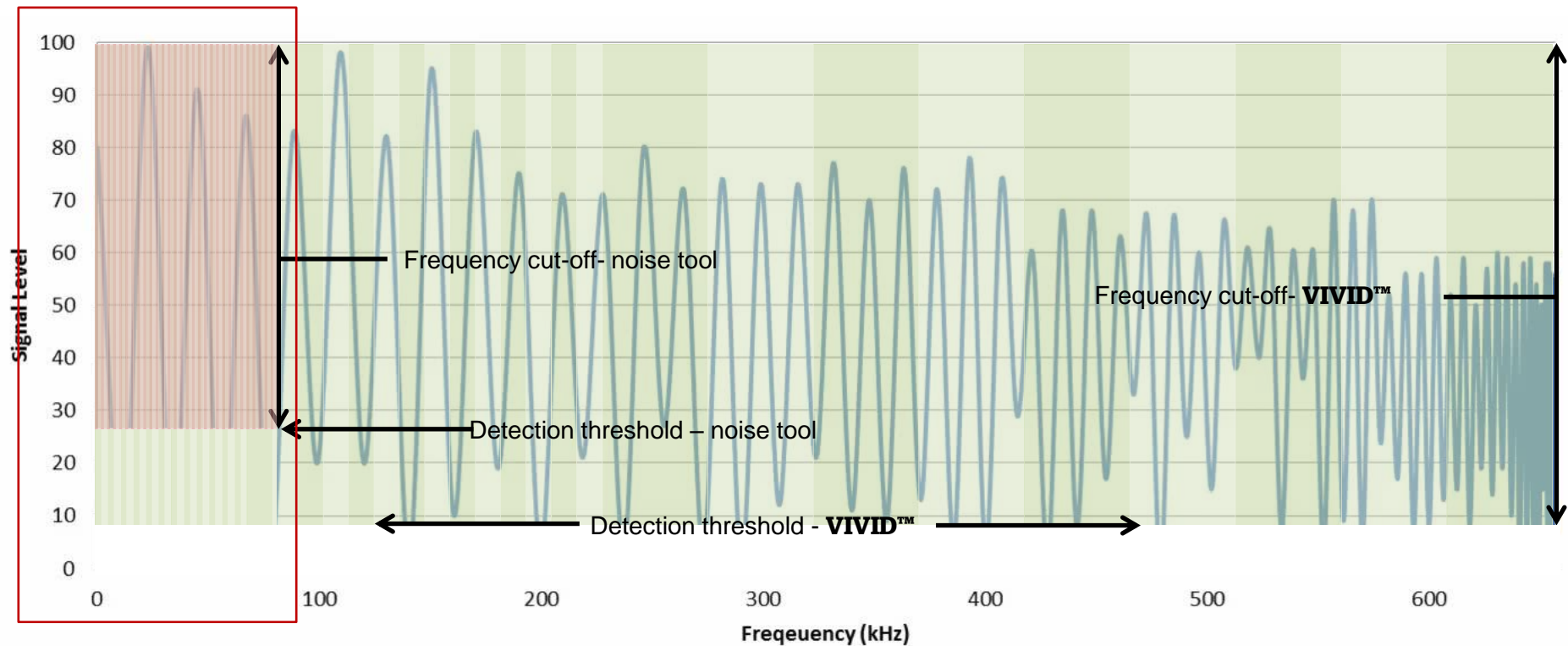
- Full spectrum acoustic signal from low frequency to ultrasonic levels
- Conventional tools are sensitive to only part of the spectrum
- Much of the information is missed



# VIVID™ – Unparalleled sensitivity

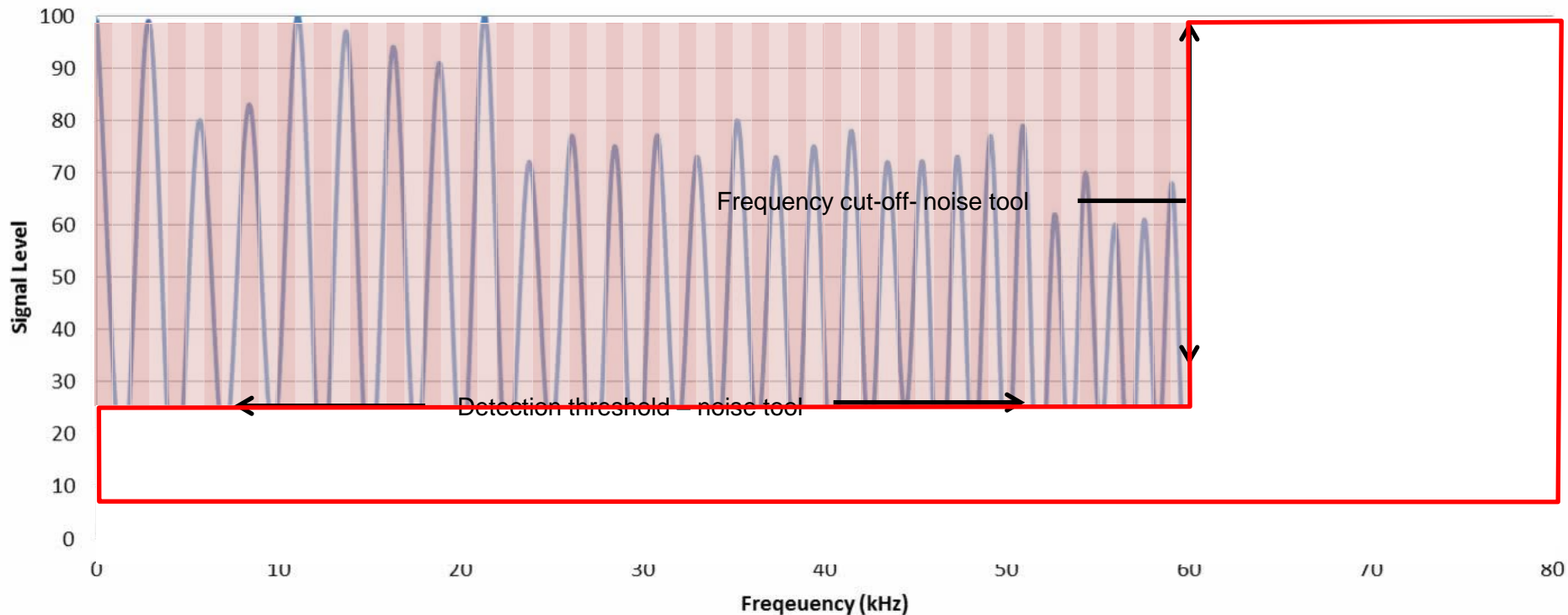
Archer

- Extremely low detection threshold and broadband response from **VIVID™** gives the full picture



# VIVID™ – Unparalleled sensitivity

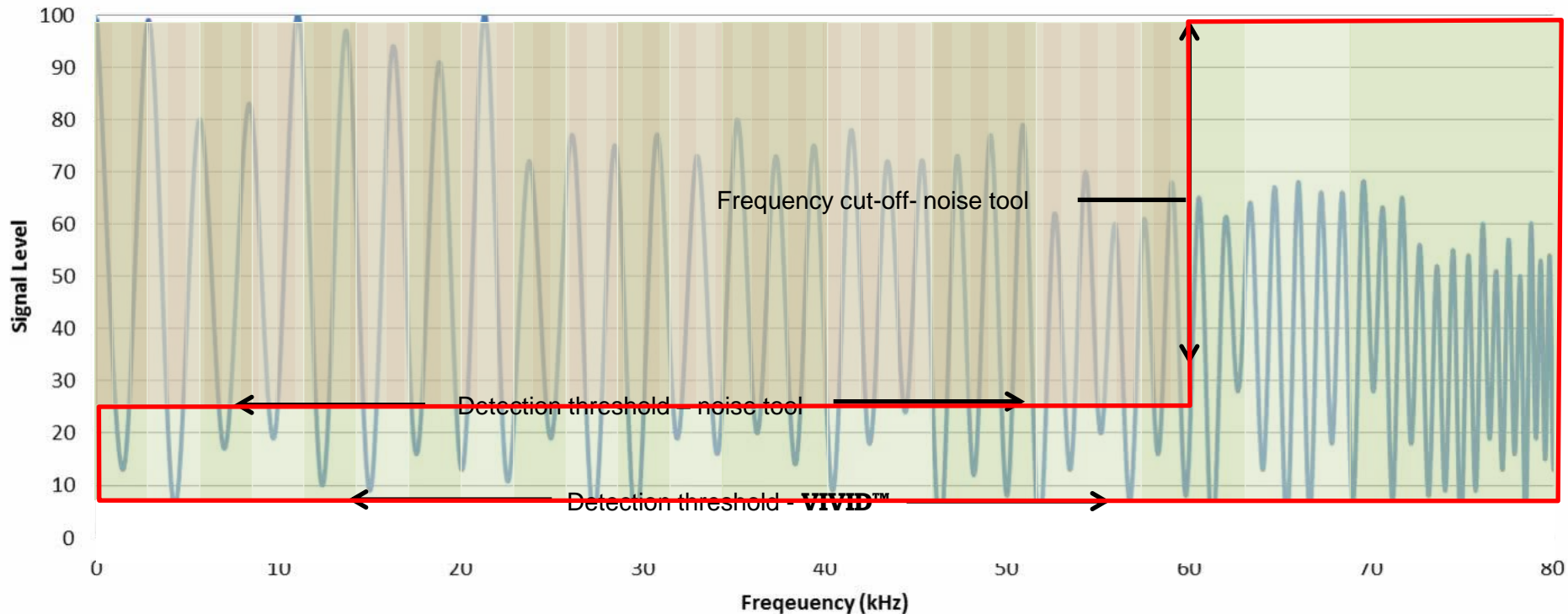
- Limited spectrum up to around 80 kHz
- Conventional tool response – overlooking low energy signals





# VIVID™ – Unparalleled sensitivity

- Limited spectrum up to around 80 kHz
- **VIVID™** response
- Previously hidden information now revealed by **VIVID™** regardless of the number of channels recorded



- **Casing and completion evaluation**
- **Cement performance evaluation**
- **Turbulent flow analysis**
- **Sand control evaluation**

## Section 1

### **VIVID™ – Casing and completion evaluation**

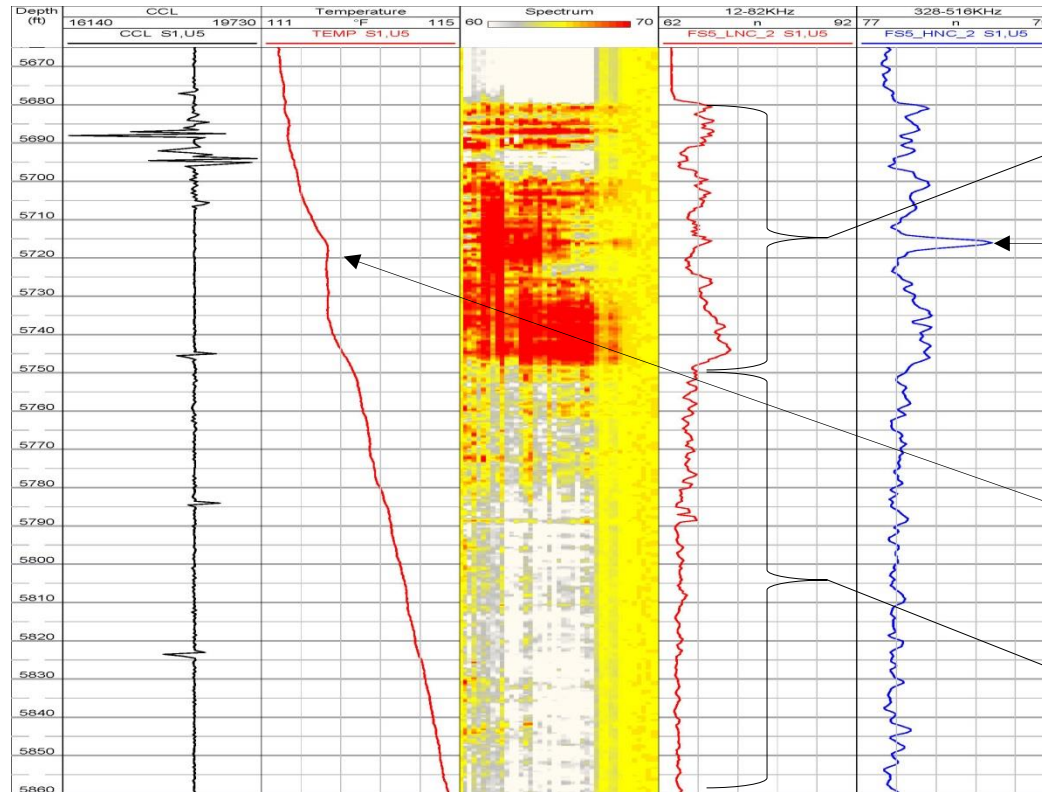
1. Road noise suppression
2. Shallow leak location in presence of surface noise
3. Characterised leak responses in gas and water
4. Gas bubble flow characterisation
5. Gas migration behind multiple casing strings
6. Identification of cross flow between perforations

## Road noise suppression

A log is run dynamically inside tubing to locate a leak in the production casing

Road noise significantly increased while approaching an SPM

Selectively filtering the VIVID™ response rejects road noise and reveals the casing leak location



Elevated road noise just below SPM assembly

Leak in casing behind tubing revealed in high frequency spectrum

Change in temperature gradient at leak site

Baseline road noise

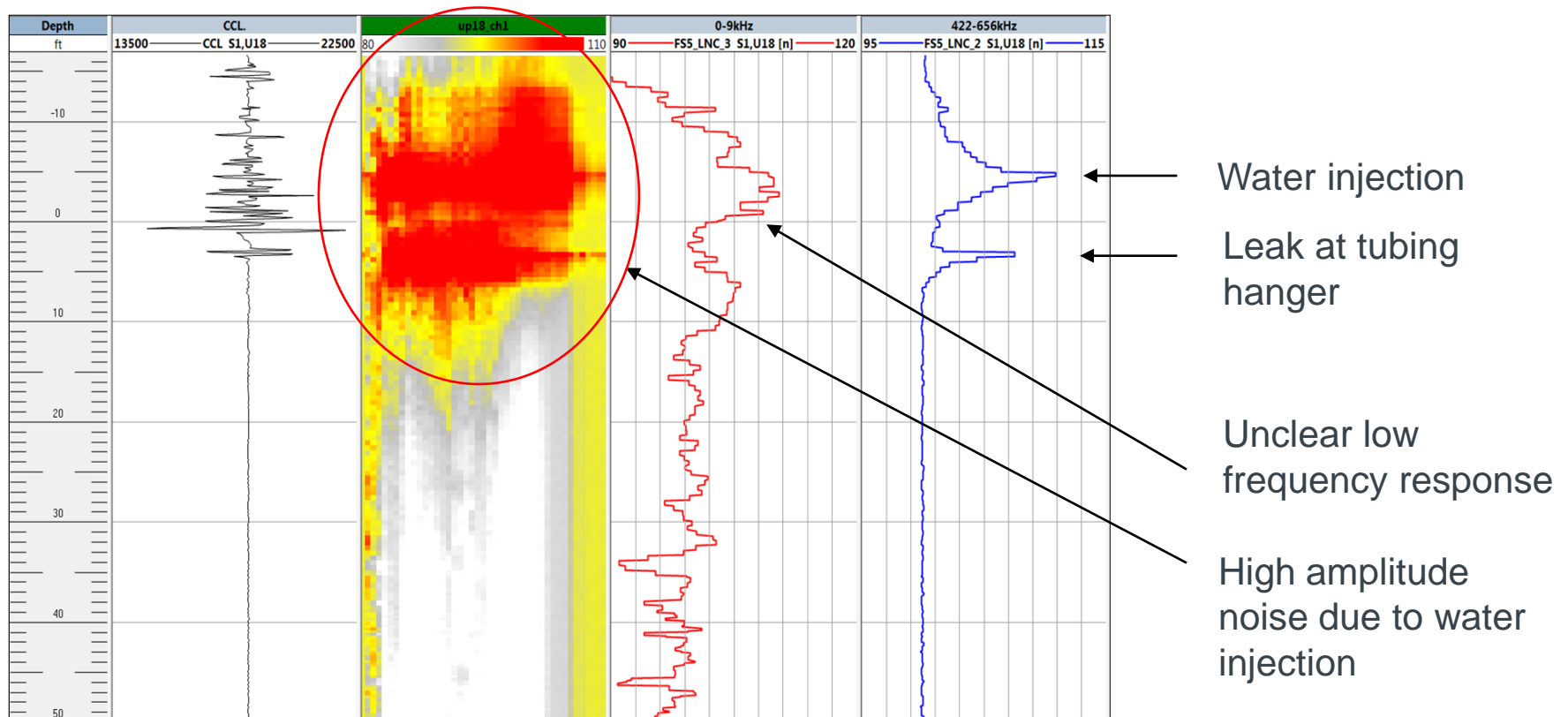
## Shallow leak pinpointed despite the presence of surface noise

Consider a well which only leaks under sustained fluid injection

The flow noise caused by injection at surface is extensive and broad spectrum

Low to mid frequency response is unclear, flow noise masking any leak signature

High frequency ultrasound reveals the exact location of the leak, and the injection point



## Sharp vertical resolution regardless of well fluid

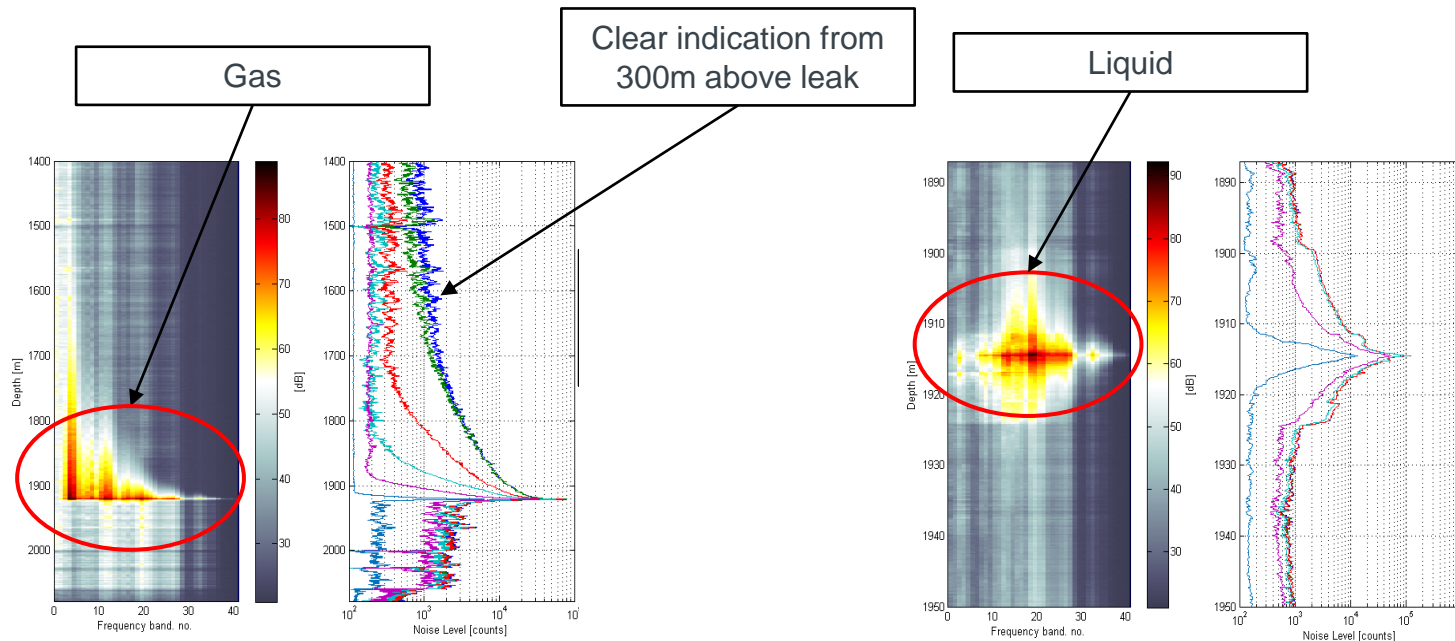
Broadband sampling of data allows full characterisation of leaks

Logging down in gas at 40m/min past a leak

After filling the tubing with water, the leak is still active

**VIVID™** broadband frequency reveals characteristic signatures to allow fluid typing

Ultrasound allows very precise depth location



Gas filled tubing

Liquid filled tubing

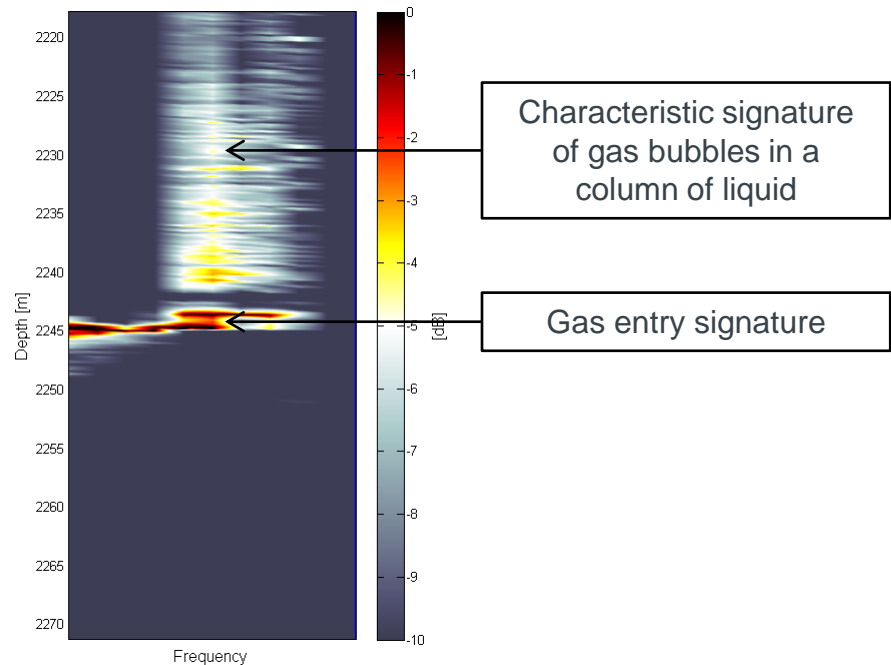
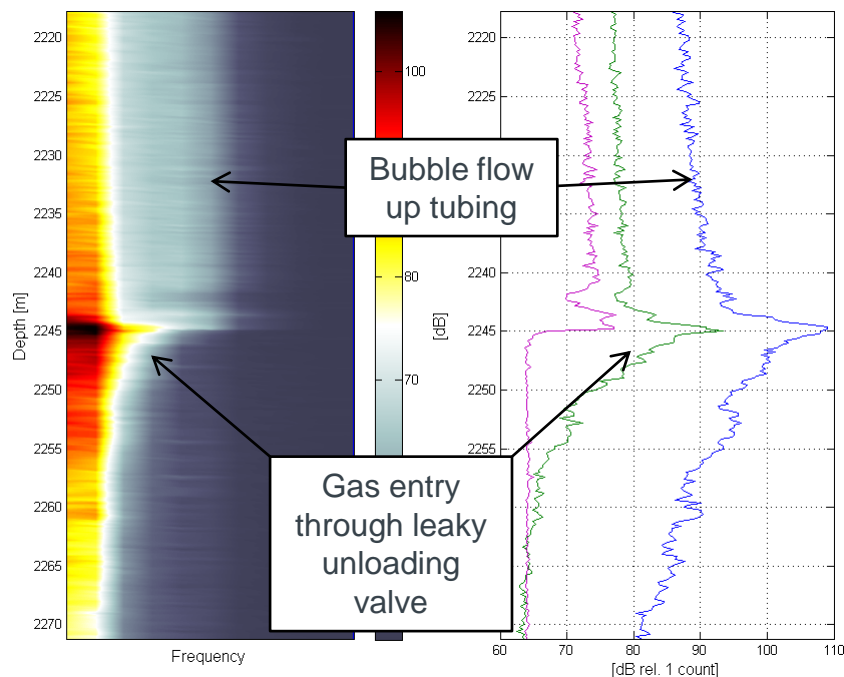
## Gas movement characterisation

**VIVID™** detects characteristic 'fizz' of gas bubbles moving through liquid

The broadband response captures not only the gas entry point...

...but also the subsequent movement

Applying simple bandwidth equalization reveals the signature of gas entry into liquid filled tubing



Equalized view

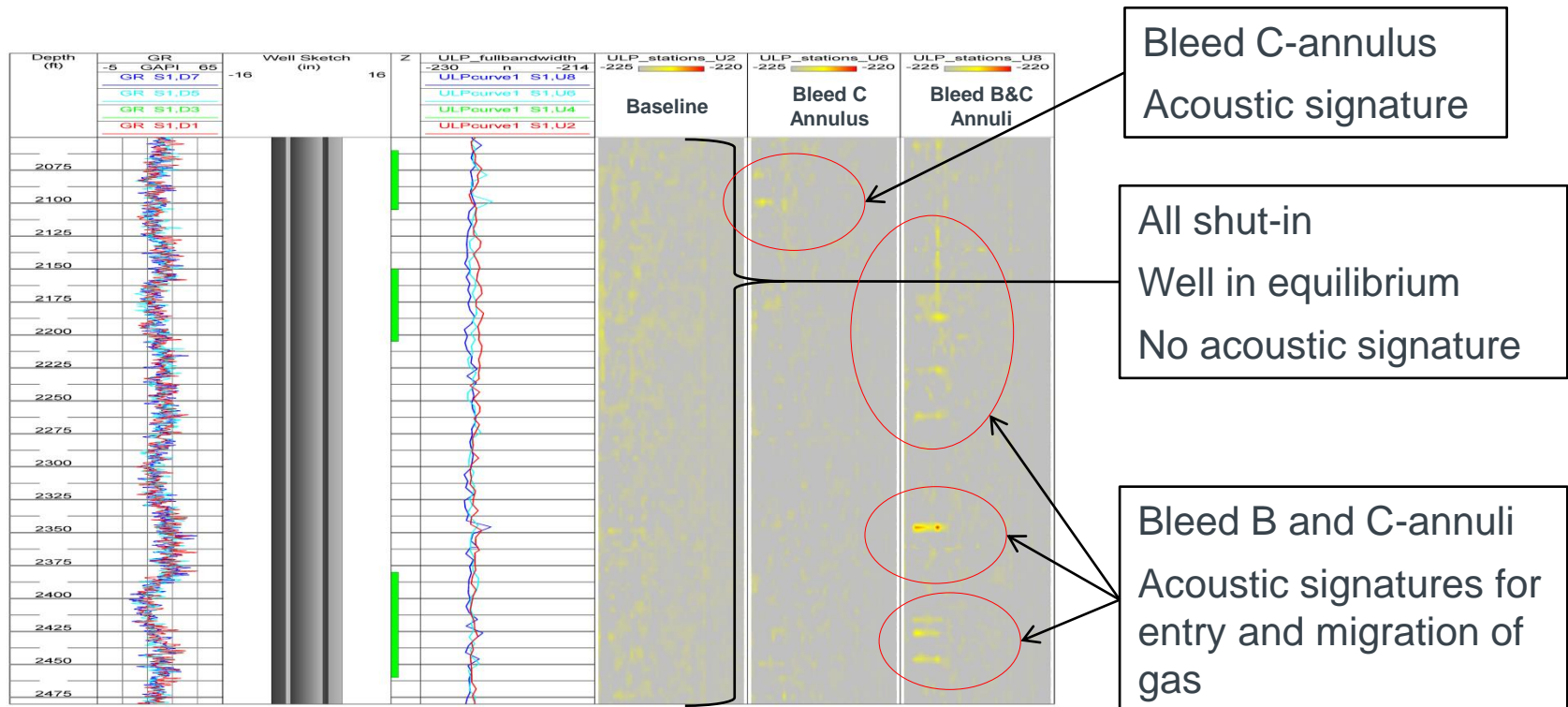
## Gas migration behind multiple casing strings

Slowly building C-annulus pressure, conventional technology cannot identify the source

High sensitivity **VIVID™** technology deployed in a carefully planned intervention

Energy comparison between different well states enables mapping of the gas migration

Previously undetectable SAP flowpath and charging source revealed



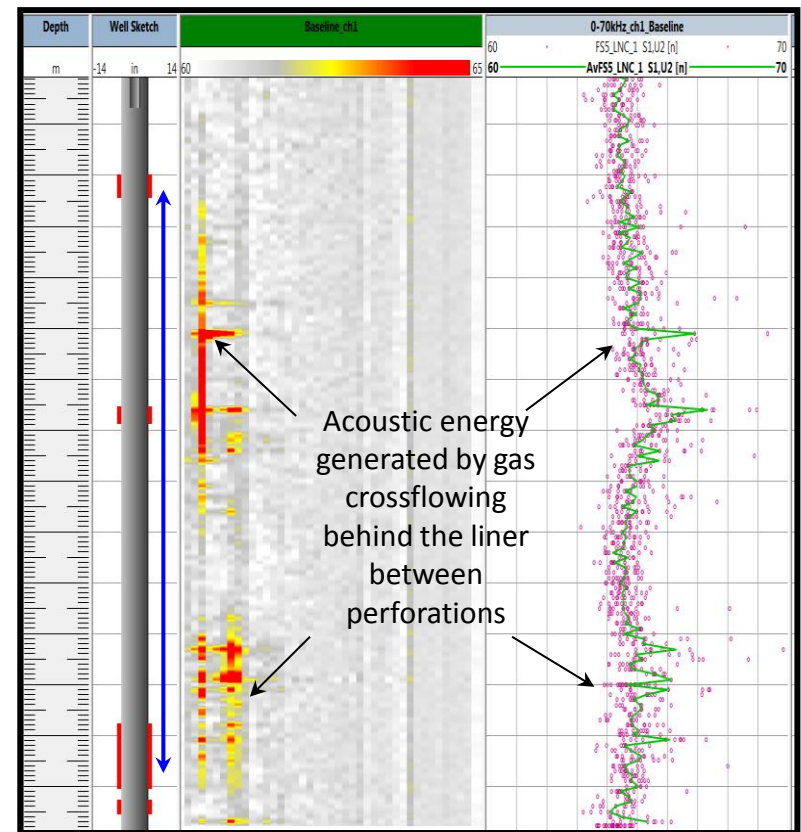
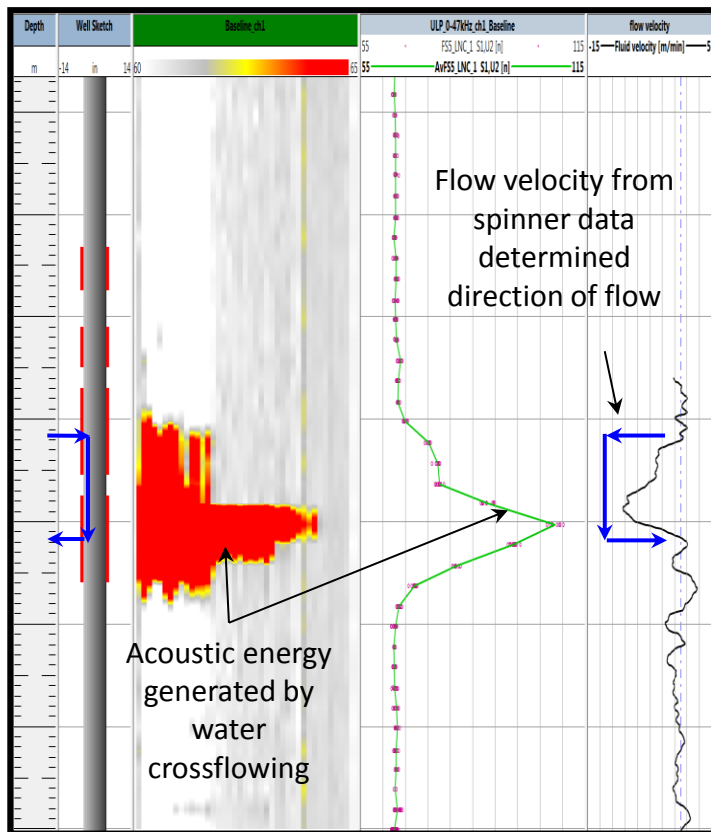


## Cross flow identification between perforations

With the well shut in, a survey can identify crossflow in the wellbore

Where there is crossflow behind a liner or casing, there is no indication in the wellbore

**VIVID™** detects acoustic energy generated by fluid movement behind the liner



## **Section 2**

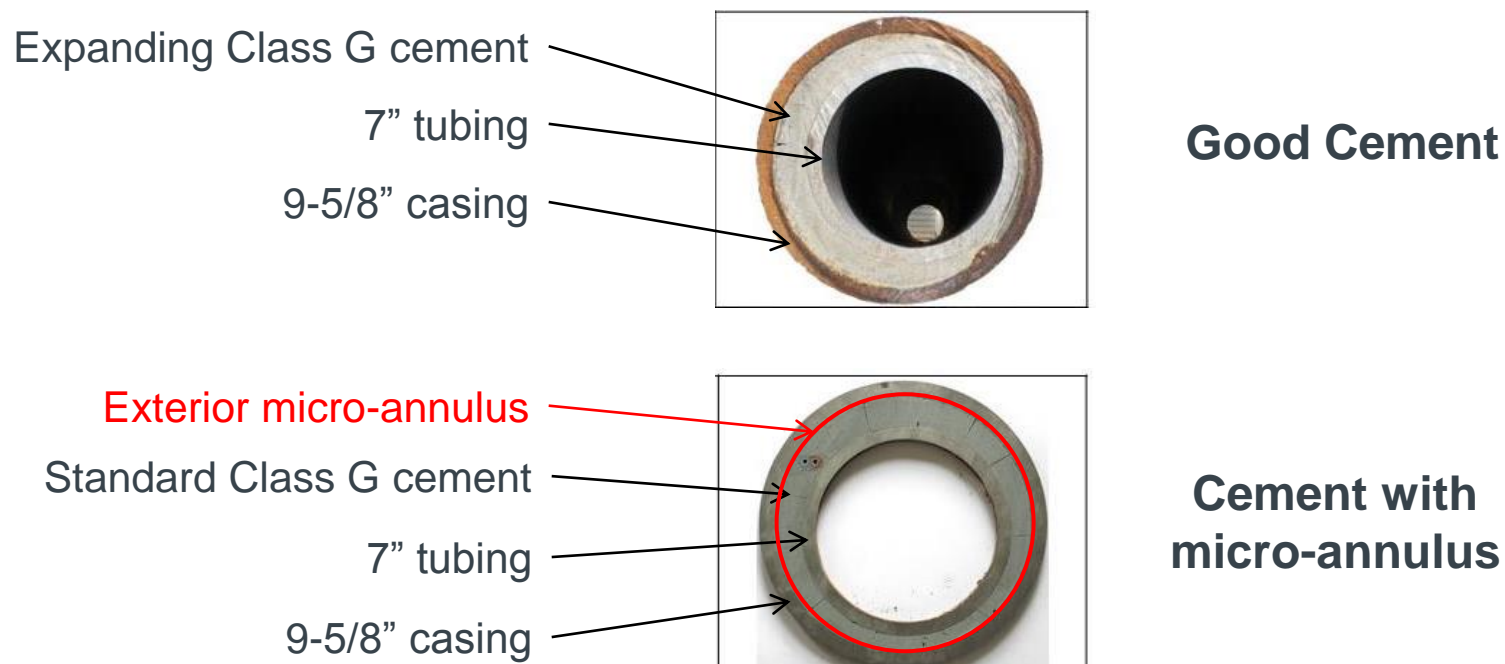
### **VIVID™ – Cement performance evaluation**

- 1. Fluid flow through a cemented annulus**
- 2. Water flow through “Good” cement**
- 3. Water flow in a micro-annulus**
- 4. Minimum flow verification - gas**

## Fluid flow in a cemented annulus

Conventional bond tools evaluate only cement condition, not cement performance

Test cells made up from 7" tubing cemented inside 9-5/8" casing to test response



The expanding cement test cell shows as good cement with any conventional bond tool

But the micro-annulus case will also show as good cement

**VIVID™** detects flow through the cement, even at very low rates, regardless of the bond

## Flow through “good” cement

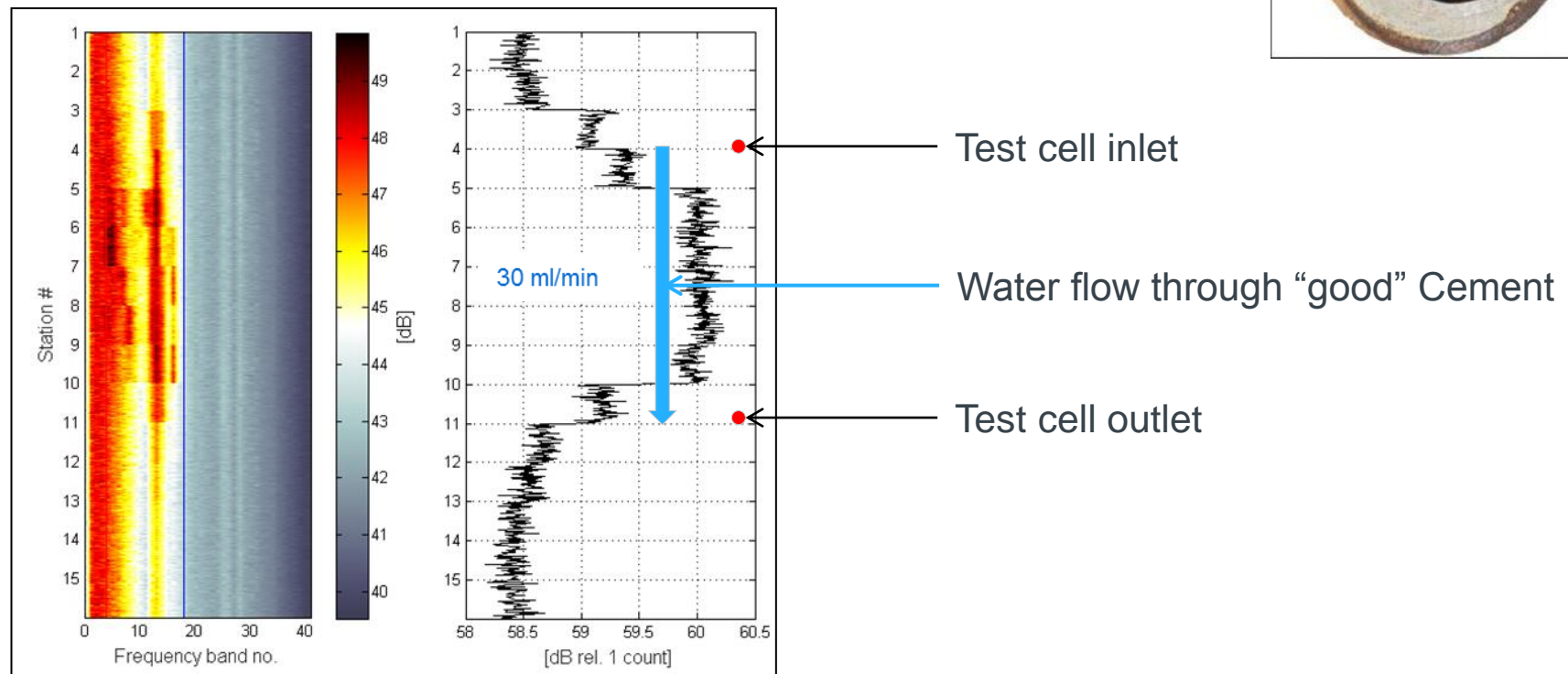
Test cell cemented and cured under controlled conditions - “as good as it gets”

Water pumped into the cemented annulus

A series of stationary measurements 25cm apart recorded

Water flow as low as 30 ml/min detected, even in “good” cement

Fully transparent data and processing – evident in real-time



# VIVID™ – Cement performance evaluation

## Flow through “good” cement

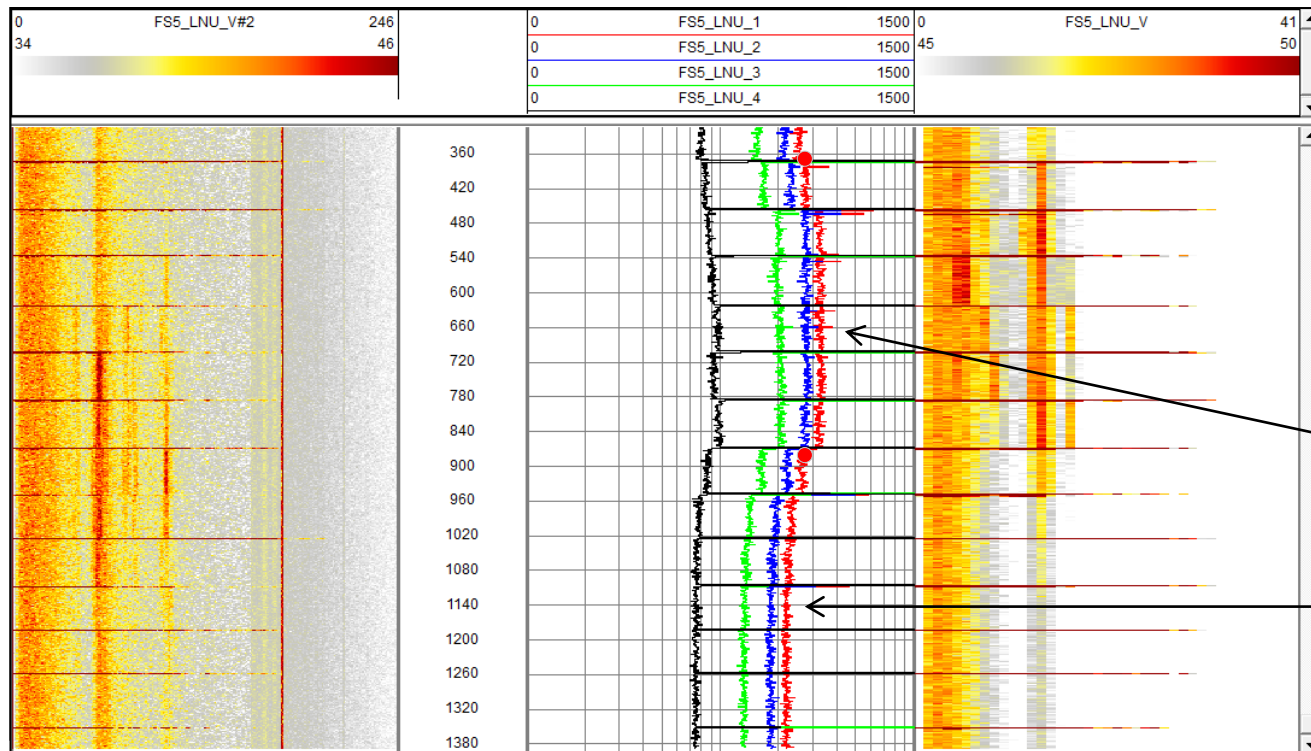
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Flow noise

Baseline

# VIVID™ – Cement performance evaluation

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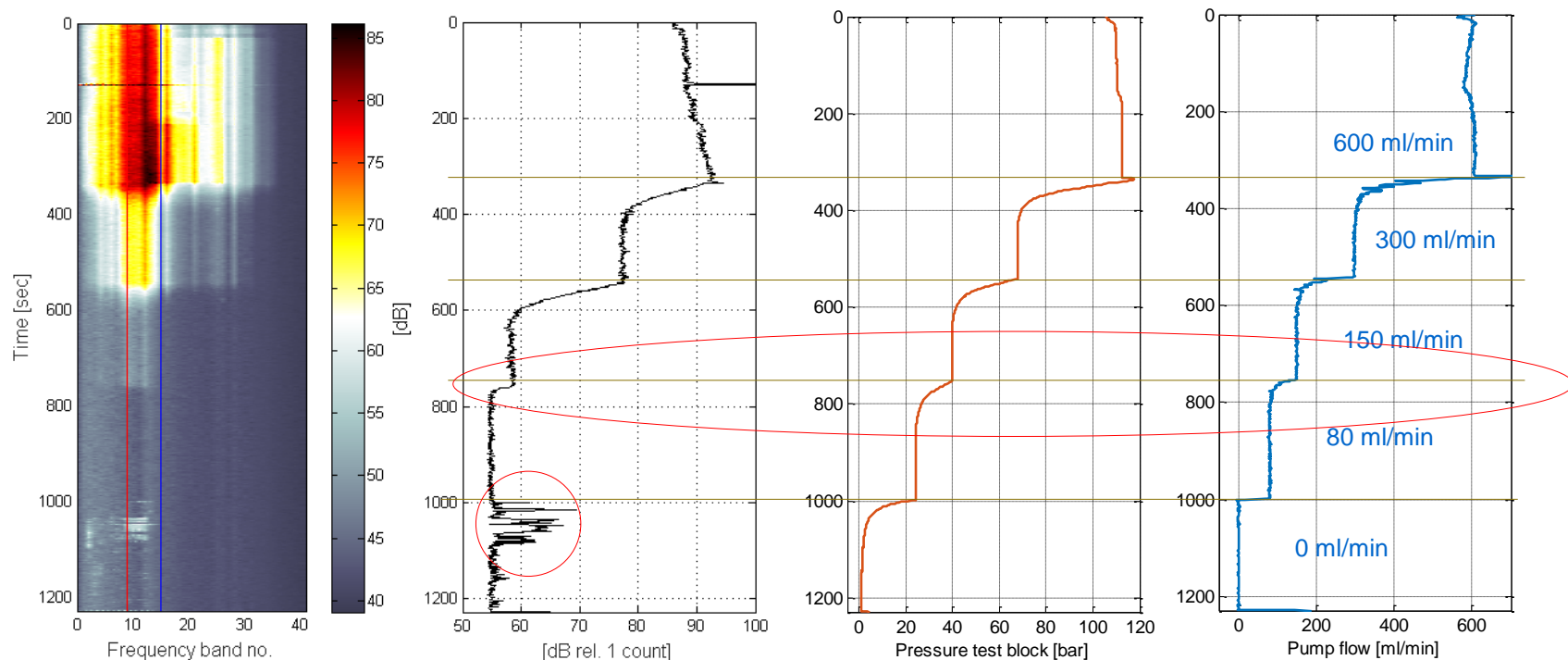
## Flow through micro-annulus

Test cell cemented, with an effective micro-annulus of 56µm

Water flow-rate reduced in stages from 620ml/min

Flow still detected down to 80ml/min

**VIVID™** detects transient noise behaviour as pressure reduces after pumps stopped





### Minimum flow verification - Gas

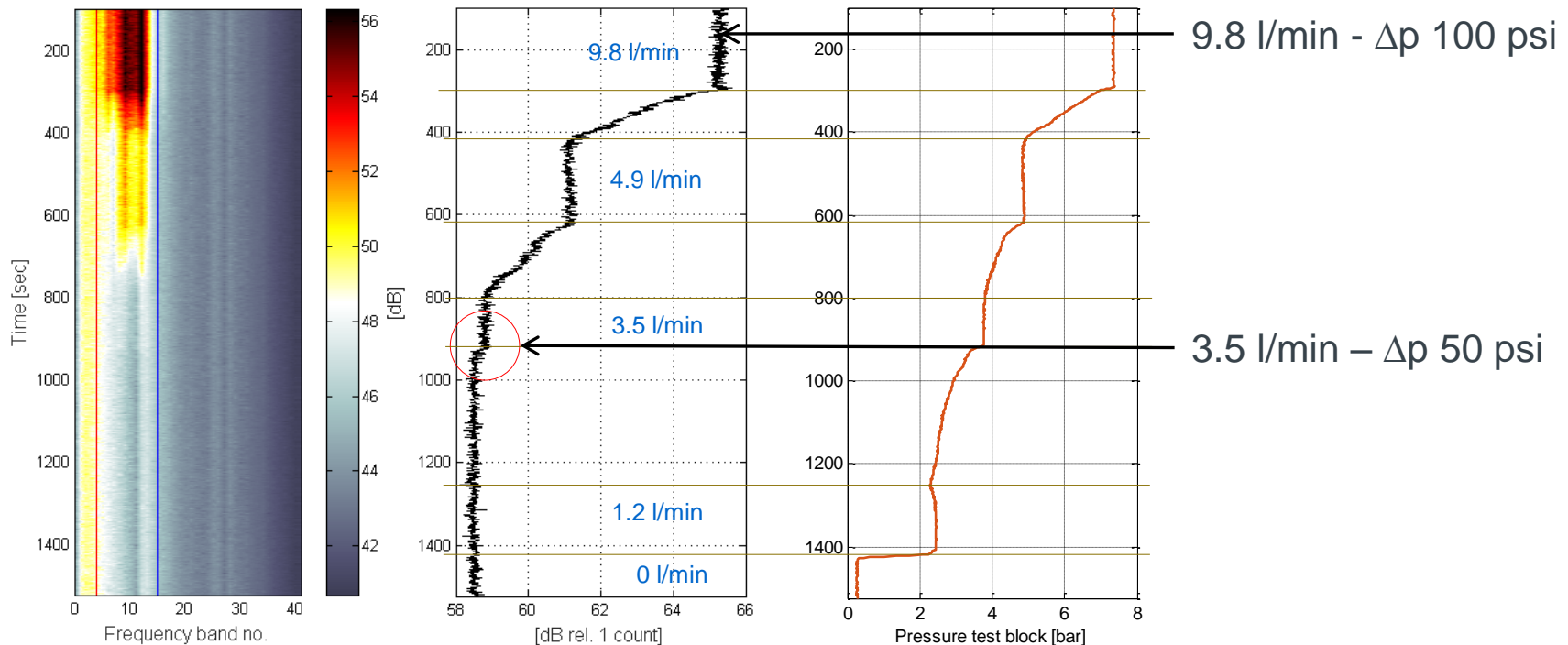
Test cell cemented, with an effective micro-annulus of 56 $\mu$ m

Gas pumped into annulus at low pressure – maximum  $\Delta p$  100 psi

Gas flow-rate reduced in stages from 9.8 l/min

Flow detected down to less than 3.5 l/min at a differential of only 50 psi

**VIVID™** can detect and map even very low rate gas migration



# Section 3

## **VIVID™** – Turbulent flow analysis

### 1. Turbulence mapping

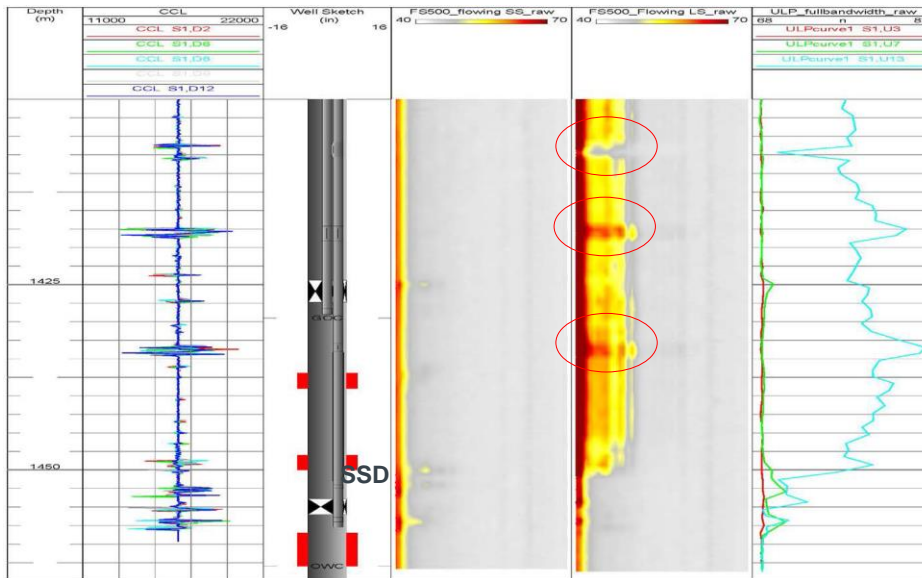


Turbulence through well completion may be mapped by logging while flowing. Turbulence log supplements PLT data, supports differentiation from leaks and may have applications in high rate wells with erosion

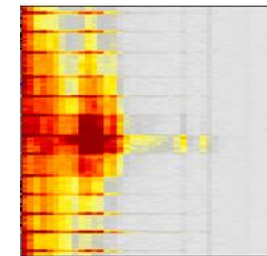
Full broadband spectrum and sensitivity support production flow characterization

Example of turbulence mapping while flowing the long string in a dual completion well.

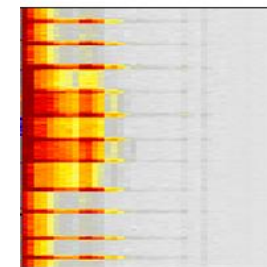
Turbulence in flowing Long String



High rate injection well. Same  $\Delta P$  between tubing and casing



Leak sound spectrum



Safety valve sound spectrum

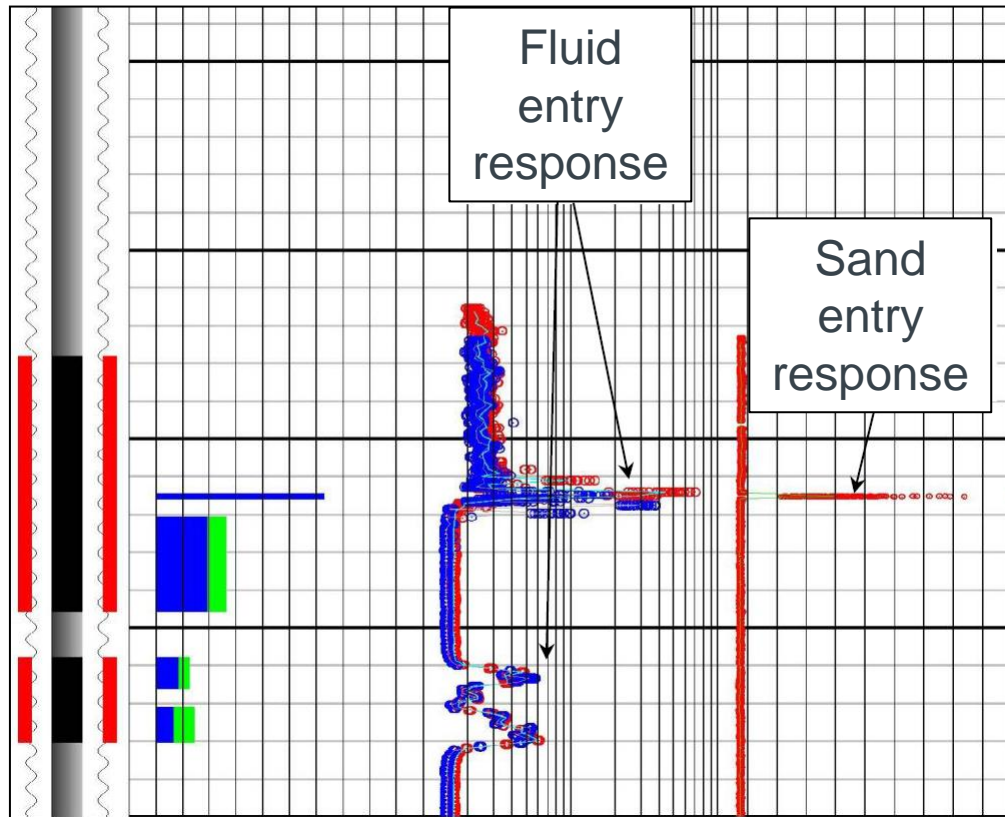
## **Section 4**

### **VIVID™ – Sand control evaluation**

#### **1. Sand control evaluation**

We are working on several application for the **VIVID™** - Acoustic logging platform within the sand control evaluation arena.

The **VIVID™** broadband response enables signal discrimination and characterization



Our ultra-high sensitivity sensors and patented integration enable us to characterize downhole events and provide you with clear, documented evidence that you are addressing safety and regulatory requirements in both the operational and P&A phases of your well's lifecycle.

**If it's there, we'll detect it.**

**archerwell.com**