



# **Simultaneous Intrusive & Acoustic Real Time (I-ART) Solids Monitoring**

**Technology for Well Service Challenges**

**Frac Stimulation, CT Clean Out & Well Testing**



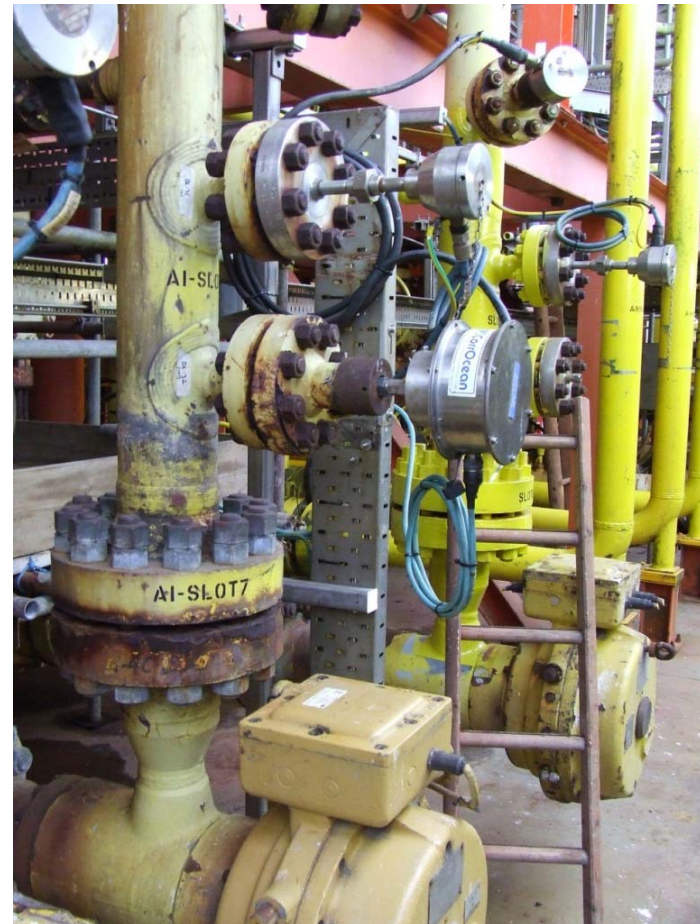


# Sand Monitoring Technology

## Past Lessons Part 1

### Intrusive Sand Monitoring

- **1992 First commercially available Topside Intrusive Sand Monitoring System – CorrOcean ASA**
- **Based on Corrosion Monitoring ER probe technology**
- **Non – Corrosive Alloys selected to isolate erosion from corrosion effects**
- **1994 Subsea systems trialled in Norwegian sector of North Sea**





# Sand Monitoring Technology

## Past Lessons Part 2

### Acoustic Sand Monitoring

- **1990 Topside Acoustic Sand Monitoring System pioneered by Fluenta AS**
- **Based on recognition & isolation of sand sound wave frequency**
- **Lack of IP protection led to proliferation of competitors:**
  - **Simrad**
  - **Stresswave**
  - **ClampOn**





# Sand Monitoring Technology Present

## Sand & Solids Monitoring Technology

- Acoustic Monitoring
- Intrusive Monitoring

### Case Studies

- Frac Ops
- Well Test
- Production Test
- Milling / Sand Bridge Clean Out





# Sand Monitoring Technology Well Service Real Time Acoustic System

- Acoustic Sand Sensors
- Passive Microphone Transducers
- Filters to isolate Sand Noise from Mechanical
- Rapid Response to Sand Production

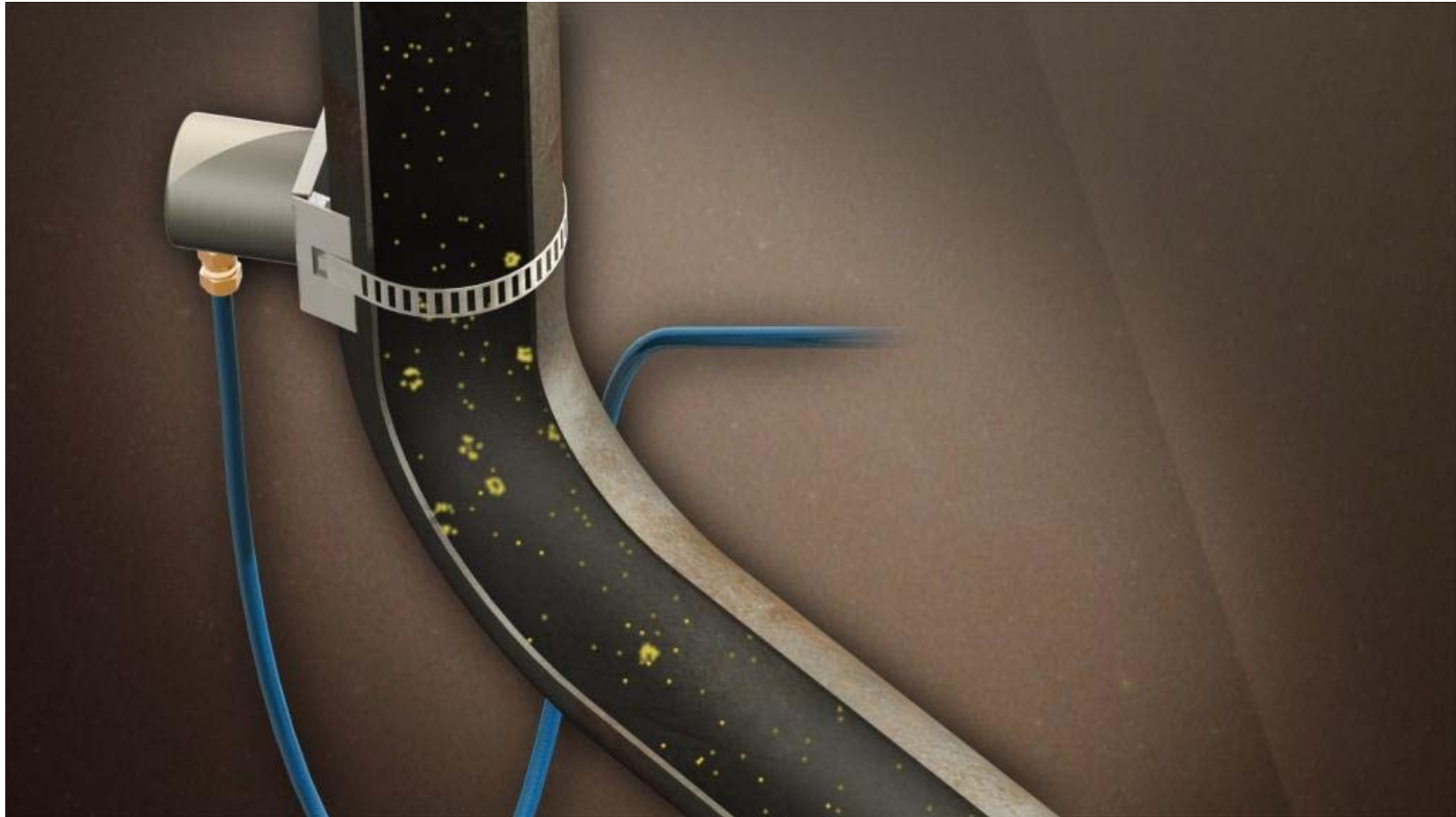




# Sand Monitoring Technology

## Video Clips - Acoustic

### Acoustic Sand Monitoring





# Sand Monitoring Technology

## Acoustic Systems

### The Good & The Bad

#### Pros

- High Sensitivity to sand production.
- Instantaneous response to sand production.
- Low power consumption.
- Ease of Installation.
- No Temperature Dependency Effects.
- Reduced risk and cost.
- Ideal solution for HP/HT wells.
- No pressure bearing seal failure risk.
- Reduced manual handling.
- No inherent component design problems.
- Can be installed as Pig Detectors

#### Cons

- Signal interpretation –chokes, slug flow or sand?
- Calibration required for accurate sand production.
- Sand impingement on pipe wall in low velocity, high viscous flow?



## Sand Monitoring Technology Intrusive ER Systems

- Intrusive Electrical Resistance Probes
- Non Corrosive Elements
- Variety of Element Materials
- Variety of Probe Styles





# Sand Monitoring Technology Well Service High Resolution ER System

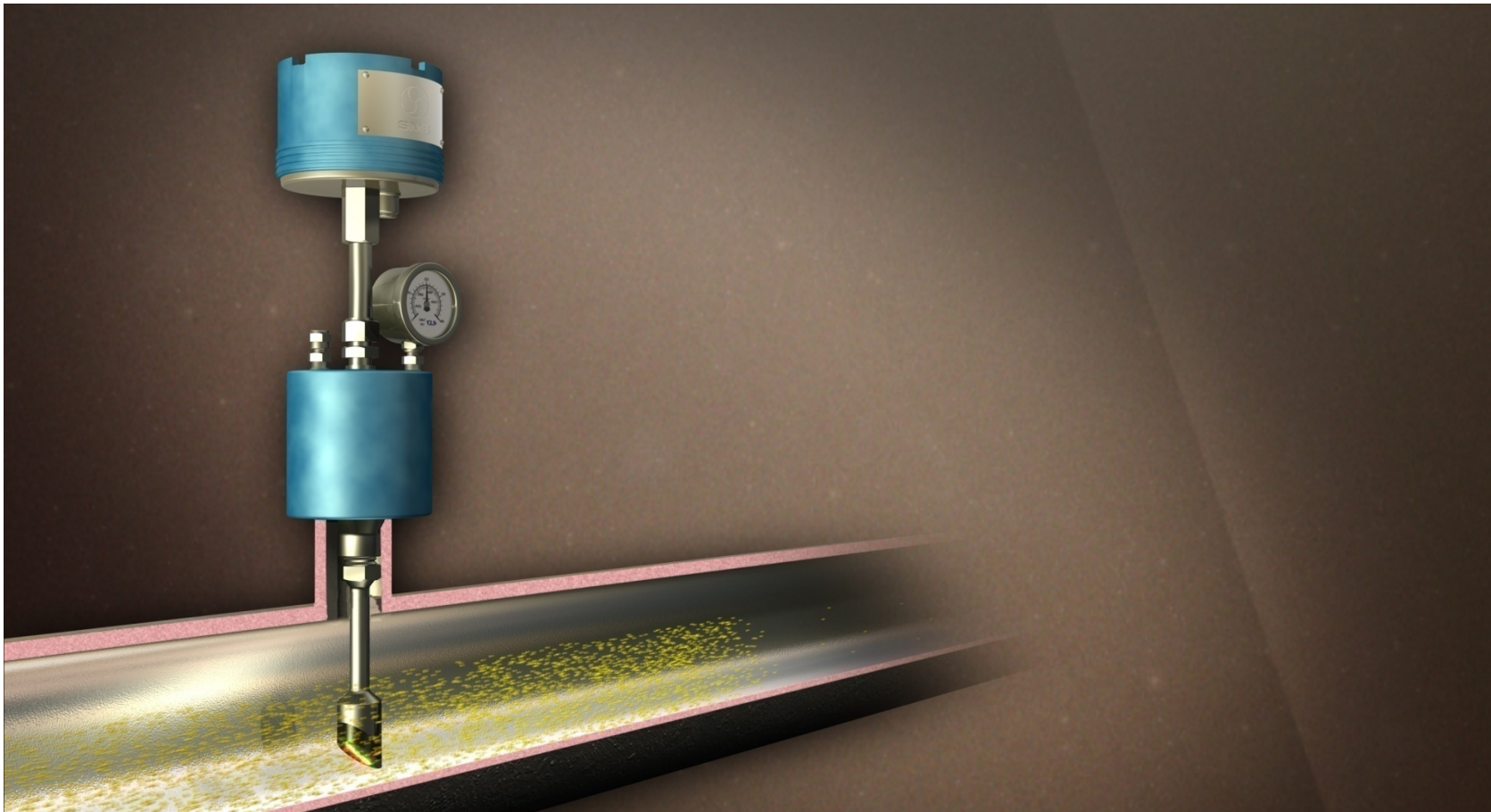
- Elbow Spool – 3” 1502
- High Temp ER Probes - Angle Head Probe
- Pressure Retaining Cap
- High Res Transmitter
- Interface Unit / PC





# Sand Monitoring Technology Video Clips - Intrusive

## Intrusive Sand Monitoring





# Sand Monitoring Technology

## Intrusive Systems

### The Good & The Bad

#### Pros

- **Direct measurement of solids.**
- **Not affected by noise from chokes.**
- **No calibration required.\***

#### Cons

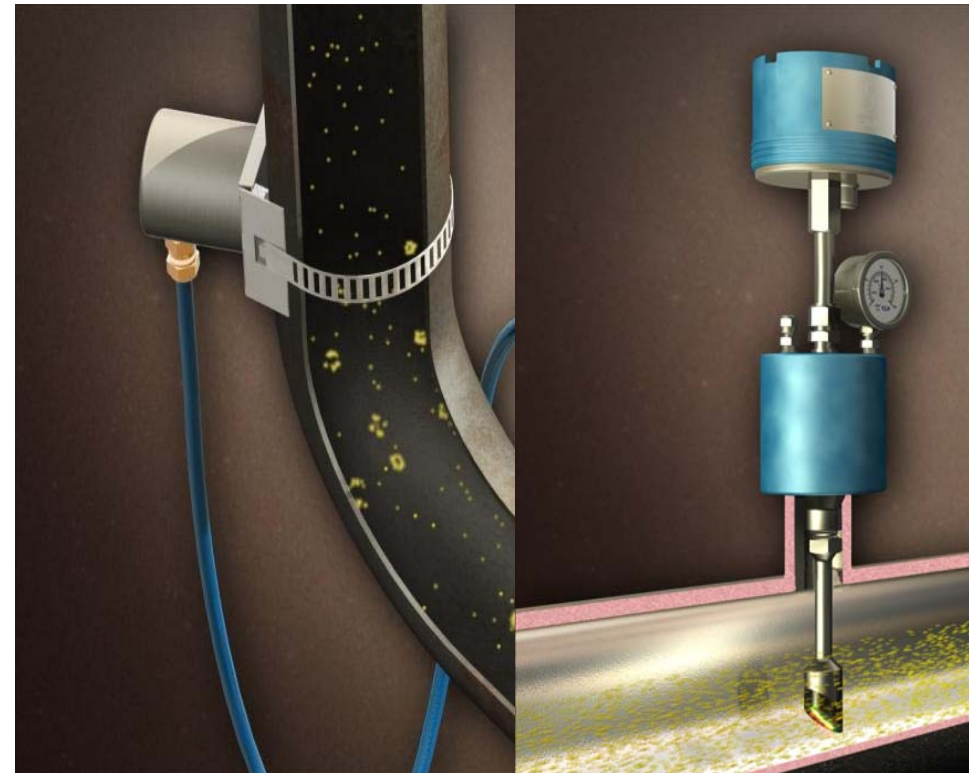
- **Temperature compensation.**
- **Data not instantaneous.**
- **High level of operator skill required.**
- **Probe length and placement critical.**
- **Potting compound degradation.**
- **Seal failure in access fitting assembly.**
- **Probe with cable feed through a safety issue.**
- **Cost of ongoing maintenance.**
- **Subsea application suitability?**
- **Wax formation on elements.**
- **Erosion of elements in low velocity, high viscosity flows?**



# Sand Monitoring Technology Intrusive & Acoustic Real Time (I-ART)

## I-ART

- **Combines the advantages of both monitoring technologies.**
- **Highly responsive and direct measurement of solids.**
- **Acts as a self check on data form each system.**
- **Cost effective for additional data during test conditions**





# Field Services

## Sand & Solids Monitoring Applications

### SMS Field Services

Unique Real Time Monitoring :

- Acoustic
- High Res. ER Intrusive

Applications:

- Frac Ops
- Well Test
- Production Tests
- CT Work Over
- UBD





**Well Service**  
**Case Studies**  
**Sand & Solids Monitoring Applications**





# Sand Monitoring Technology

## Case Study 1 – Frac Operations

### Workscope

- **Completion Programme**
- **Wireline Conveyed Perforation**
- **Fracture Stimulation**
- **Pre –WT Clean Up**
- **CT Operations**
- **WT Clean UP**

### Solids Monitoring Equipment

- **Acoustic – Upstream Sand Trap**
- **Acoustic – Downstream Choke**
- **Intrusive – Downstream Choke, Inlet to Heat Exchanger**

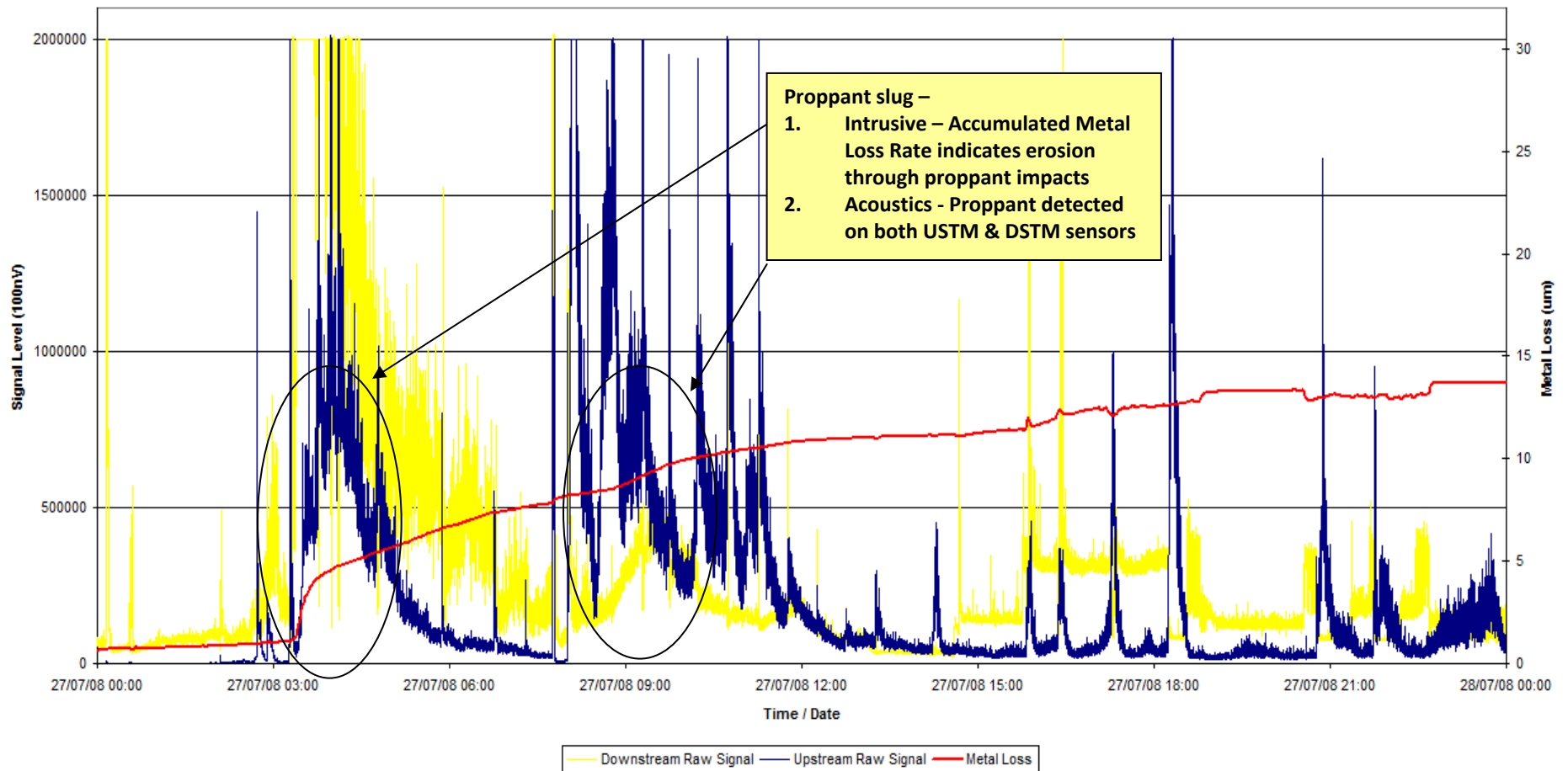
### Objective for Use

- **Confirm well clean of proppant / sand**
- **Identify solids trends during highly erosive service**
- **Prove sand filter integrity**



# Intrusive / Acoustic Detector Data Frac Proppant Clean Up

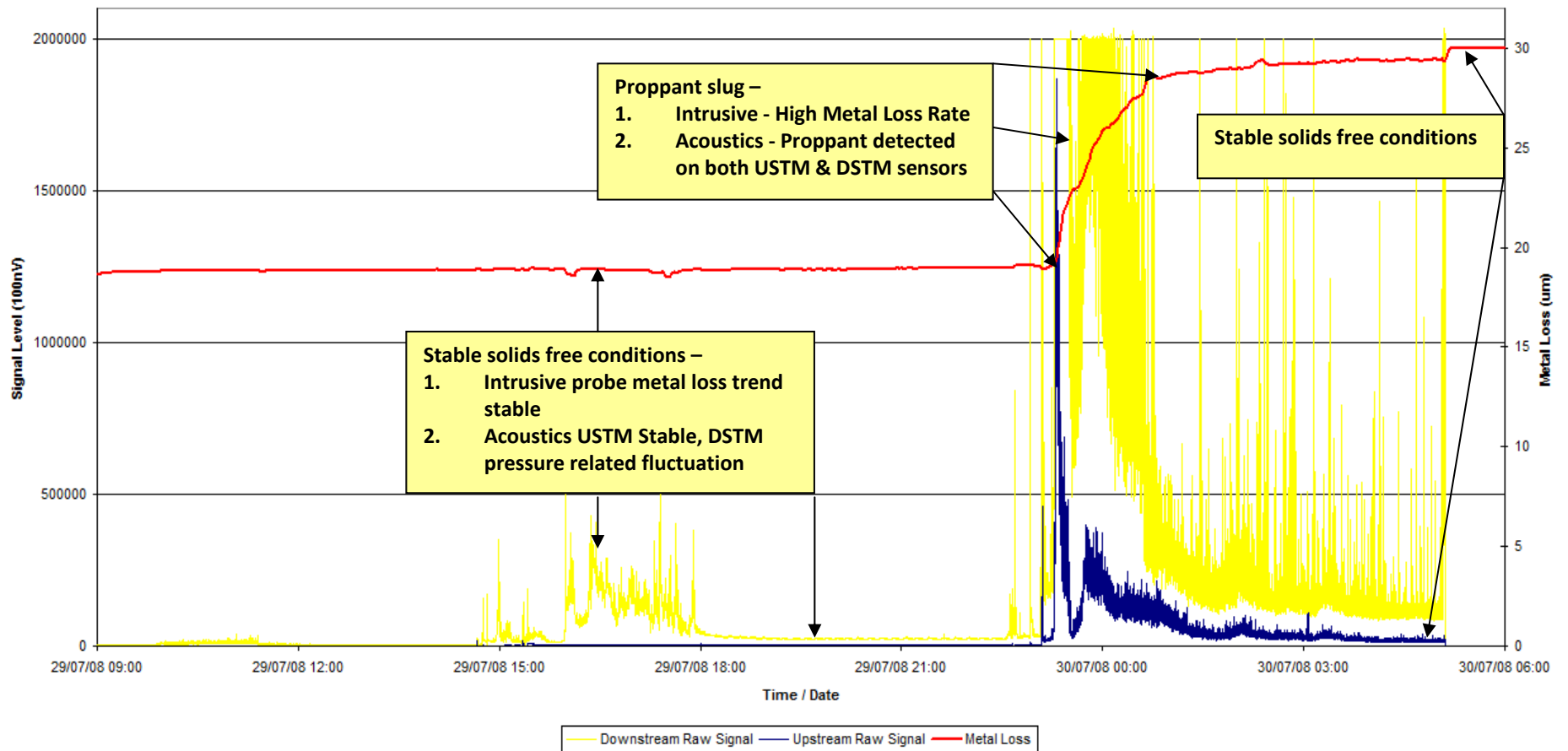
Upstream & Downstream Raw Signal & Metal Loss Vs Time





# Intrusive / Acoustic Detector Data Frac Proppant Main Flow

Upstream & Downstream Raw Signal & Metal Loss Vs Time





# Sand Monitoring Technology

## Case Study 2 – Well Test

### Workscope

- **Completion Programme**
- **CT Operations**
- **WT Clean UP**

### Solids Monitoring Equipment

- **Acoustic – Upstream Sand Trap**
- **Acoustic – Downstream Choke**

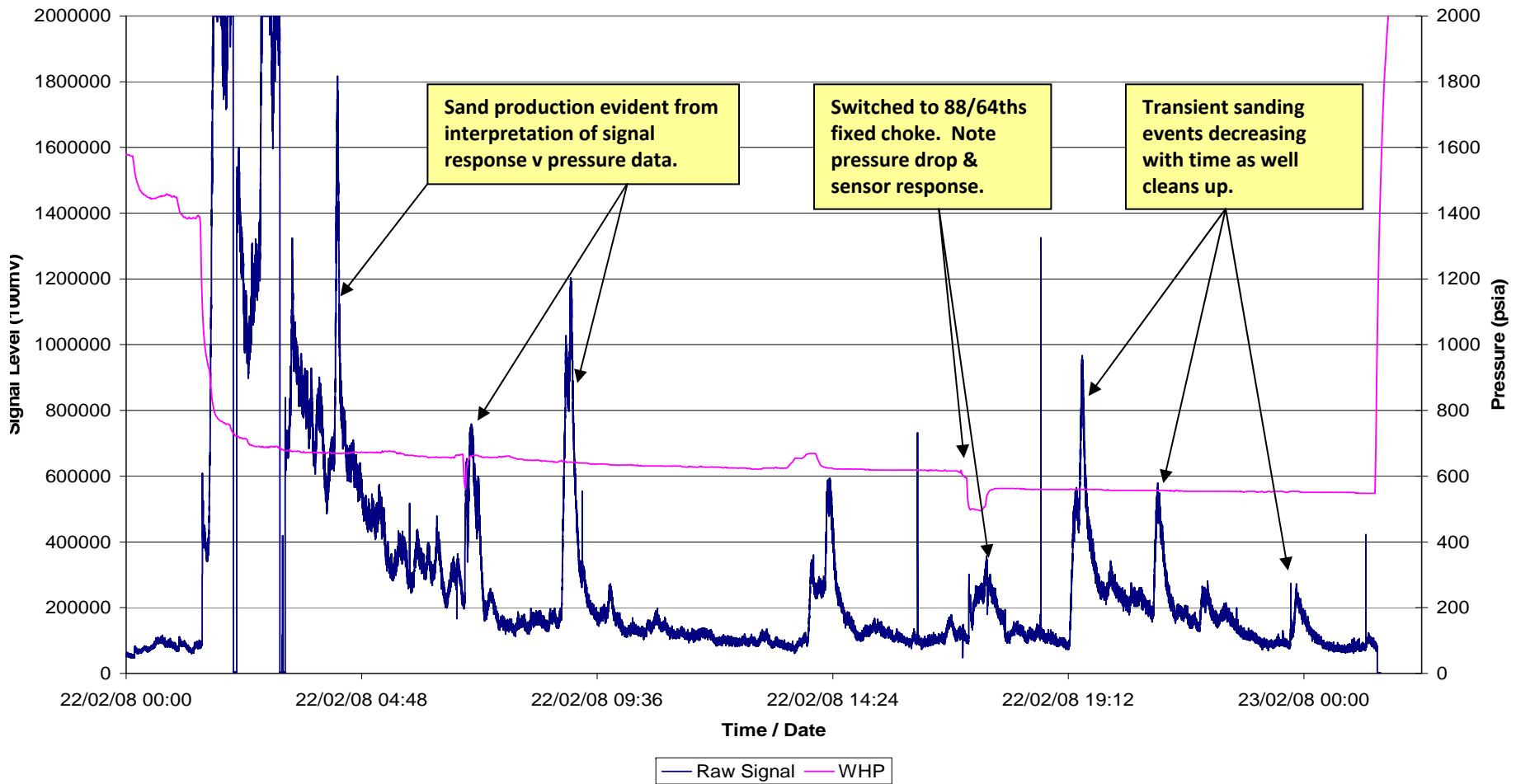
### Objective for Use

- **Confirm well clean of sand / solids**
- **Confirm completion screen integrity - identify transient solids trends**
- **Prove sand filter integrity**



# Acoustic Detector Data Well Test - Completion Clean Up

Raw Signal vs WHP





# Sand Monitoring Technology

## Case Study 3 – Production Test

### Workscope

#### Workover Programme

- Wireline Conveyed Perforation
- Clean Up

### Solids Monitoring Equipment

- Single Acoustic – Flowline monitoring

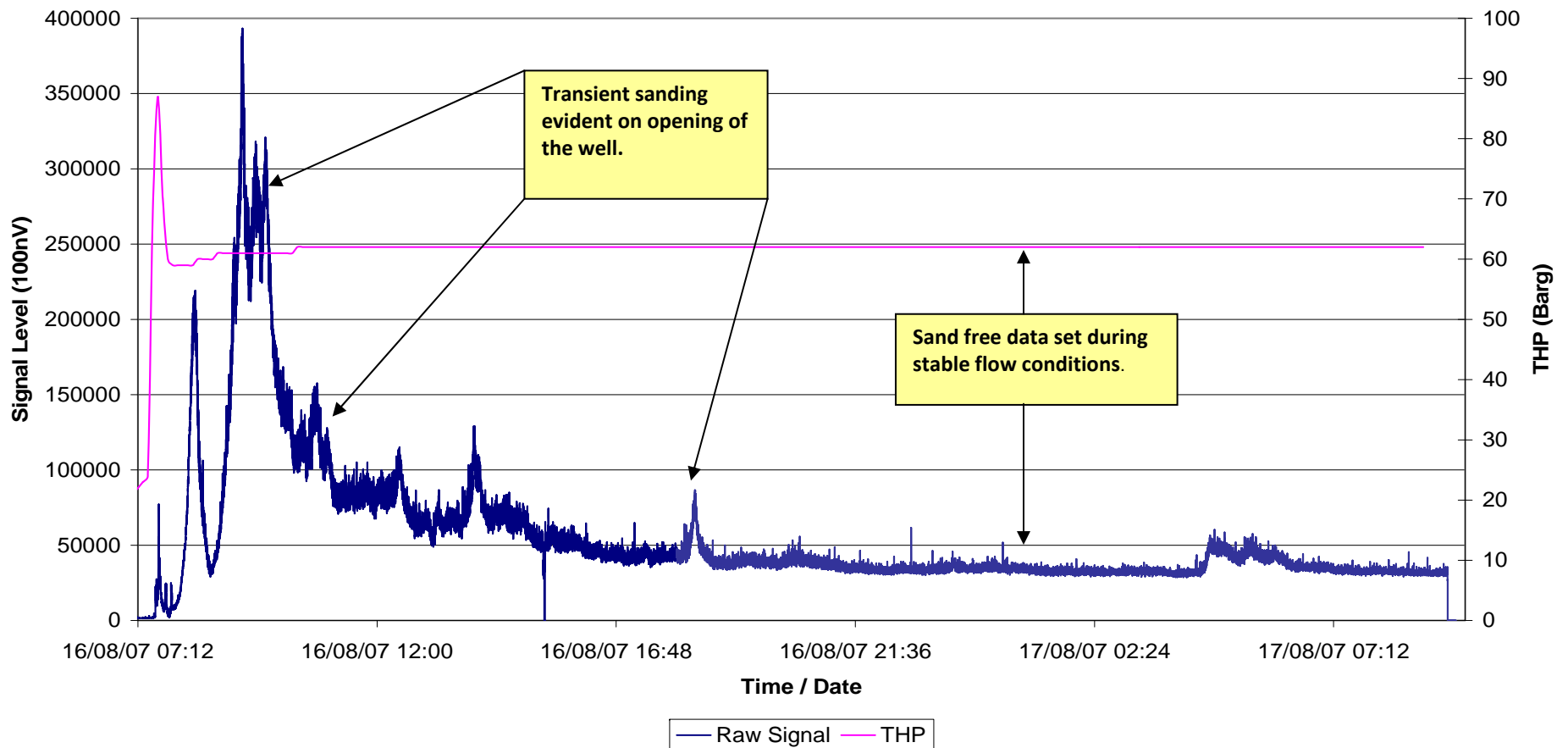
#### Objective for Use

- Identify solids trends post perforation during increased flow rates
- Confirm 'sand free' operating conditions



# Acoustic Detector Data Production Test – Perforation Clean Up

Raw Signal Vs THP





# Sand Monitoring Technology

## Case Study 4 – CT Scale Milling / Sand Bridge

### Workscope

#### Workover Programme

- CT Operations
- Scale Milling
- Sand Bridge clean out

### Solids Monitoring Equipment

- Acoustic – Downstream Choke

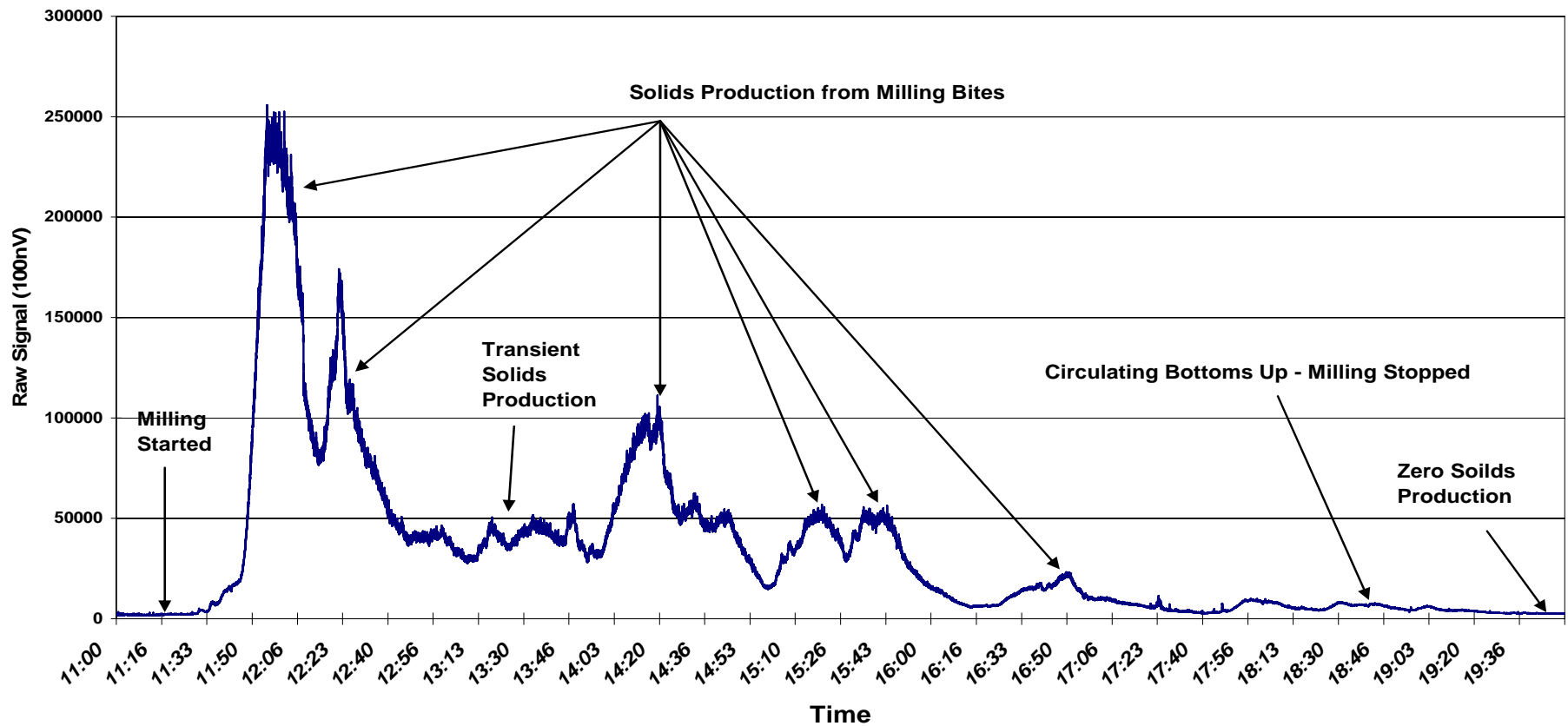
#### Objective for Use

- Identify & confirm solids returns at surface
- Confirm effective hole cleaning to prevent stuck pipe
- Identify solids trends - Well clean of solids at increased flow rates



# Acoustic Detector Data CT Scale Milling / Sand Bridge Clean Out

Scale Milling Ops -08092005





# Summary Well Services Sand & Solids Monitoring Technology

## Workscope Applications

Variety of Well Service activities where real time identification of solids adds value:

- Well Test
- Frac Ops
- Production Tests
- CT Work Over
- UBD

## Solids Monitoring Equipment

Field Proven Options for Real Time Solids Monitoring:

- External Acoustic Sensors
- Intrusive High Res. ER probes
- Combined intrusive – acoustic packages for complete coverage



# Sand Monitoring Technology Future Developments

## Sand & Solids Monitoring Technology

### Wish List

- Software for combined acoustic / intrusive and erosion calculations
- Combined Sand & Flow Rate measurement
- Reliable sand quantification in any flow regime

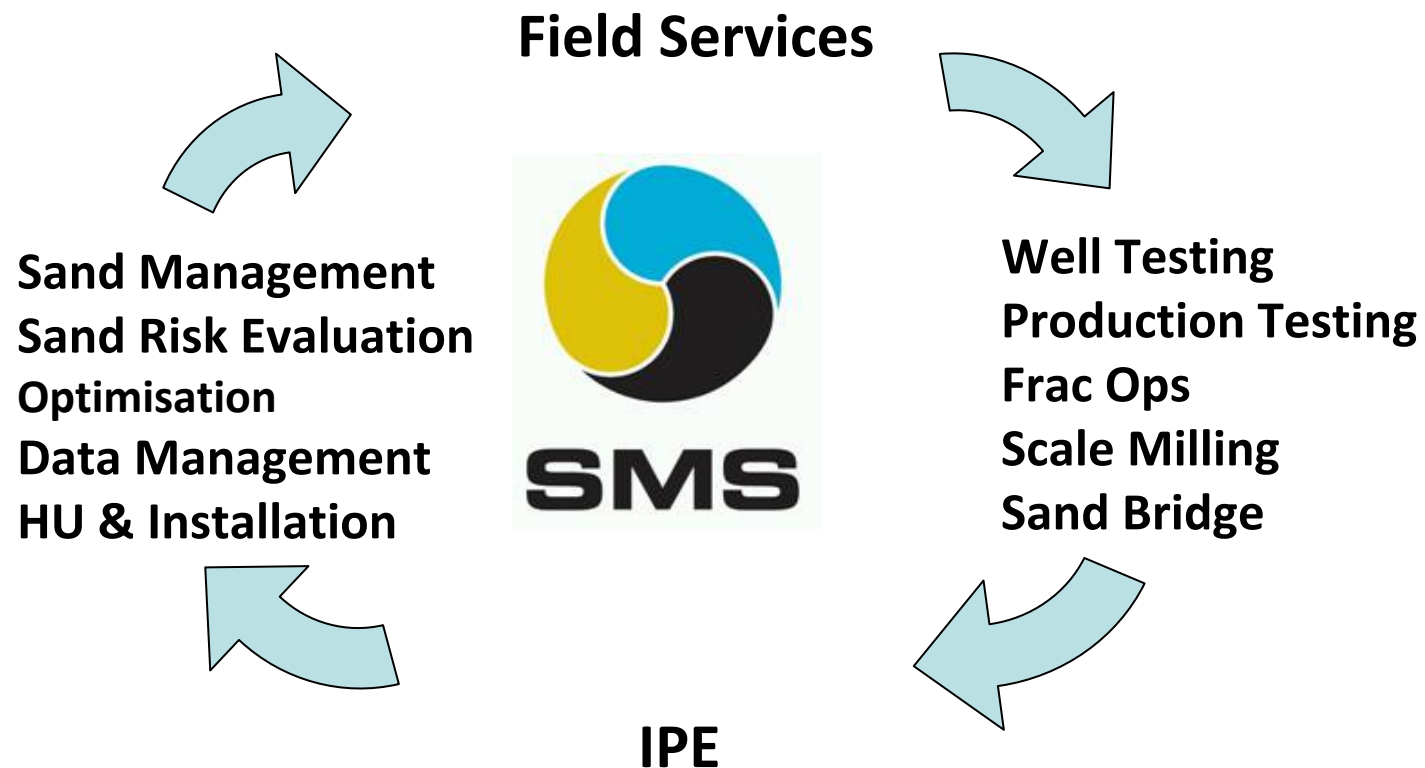
### Reality

- In development
- One system available, however resolution on flow measurement poor.
- Not yet but in development





## Where SMS Add Value Single Source Sand Solution



- **Unique Independent Knowledge of Acoustic & Intrusive Systems**