CIRCOR
ENERGY

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Pipeline Engineering

ASSESSMENT OF THE EFFECTIVENESS OF CLEANING PROGRAMMES

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Why Cleanliness Inspection?

- **Why would an operator want to measure debris?**
  - ... because pipelines are found to be dirty when they are thought to have been clean

- **Why does this matter?**
  - Ensuring successful ILI surveys (first run success rate)
  - Ensuring effective chemical treatment programmes

- **The presence of internal debris can compromise these programmes**

Design Considerations

Two philosophies:

- **Direct measurement**

    – Local
    – No information on other (geometry) defects

- **(High Resolution) Calipering**

    – Mature technology
    – Dependent on accurate information on diameters

System Solution

- **Proximity measurement**
- **Arm-mounted magnetic sensing technology**
- **"Intelligent Caliper"**
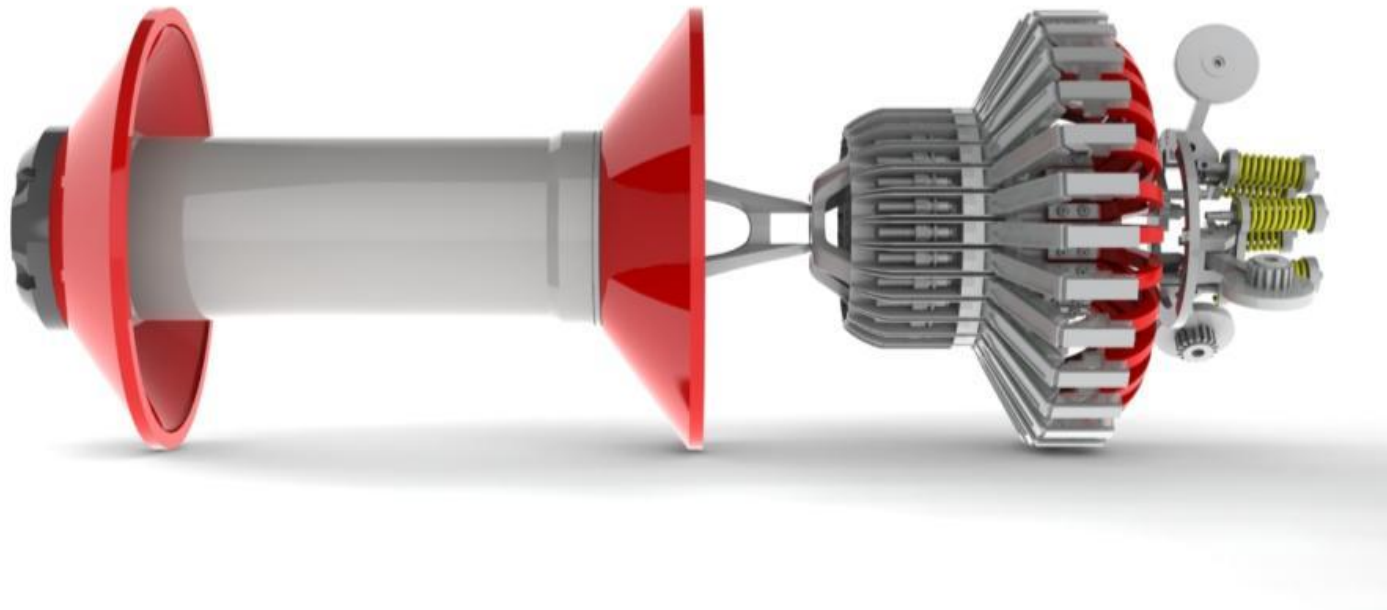
PECAT®

10"/12" Dual Module

18" Single Module

Measurement Capability

- Various scales – Calcium Carbonate, Barium Sulphate, Iron Sulphide, Calcium Sulphate, Sodium Sulphate

- Primarily in water injection lines and gas lines

- The deposits can be enhanced by bacteria (Iron Sulphide)

- NORM (Naturally Occurring Radioactive Material) and LSA (Low Specific Activity) Scale

- Waxes form in crude oil pipelines

- Temp. dependent (25 – 40°C)

- Drop out in zones depended on crude

- Melt when scraped off pipe wall

- Fluid flow also strips wax

Measurement Capability

- **Any inline non-ferrous debris present on the internal surface of a pipeline**

- **Hall effect sensors combined with small permanent magnets under Patent Pending**

- **Measure features which are in the range of 0 – 20mm**

- **Types of debris detected:**

    - Wax (hard and soft)
    - Scale
    - Sand/Sand in wax

- **Would not use this type of tool to detect hydrates as the risk of blockage is too great**

Loop Testing

- **Test Section**
- **4 flanged sections**
  - 1-off with 5 simulated dents, ranging from 2% to 25%
  - 2-off each with 2 PU liners, ranging in thickness from 5 to 20mm in 5mm steps
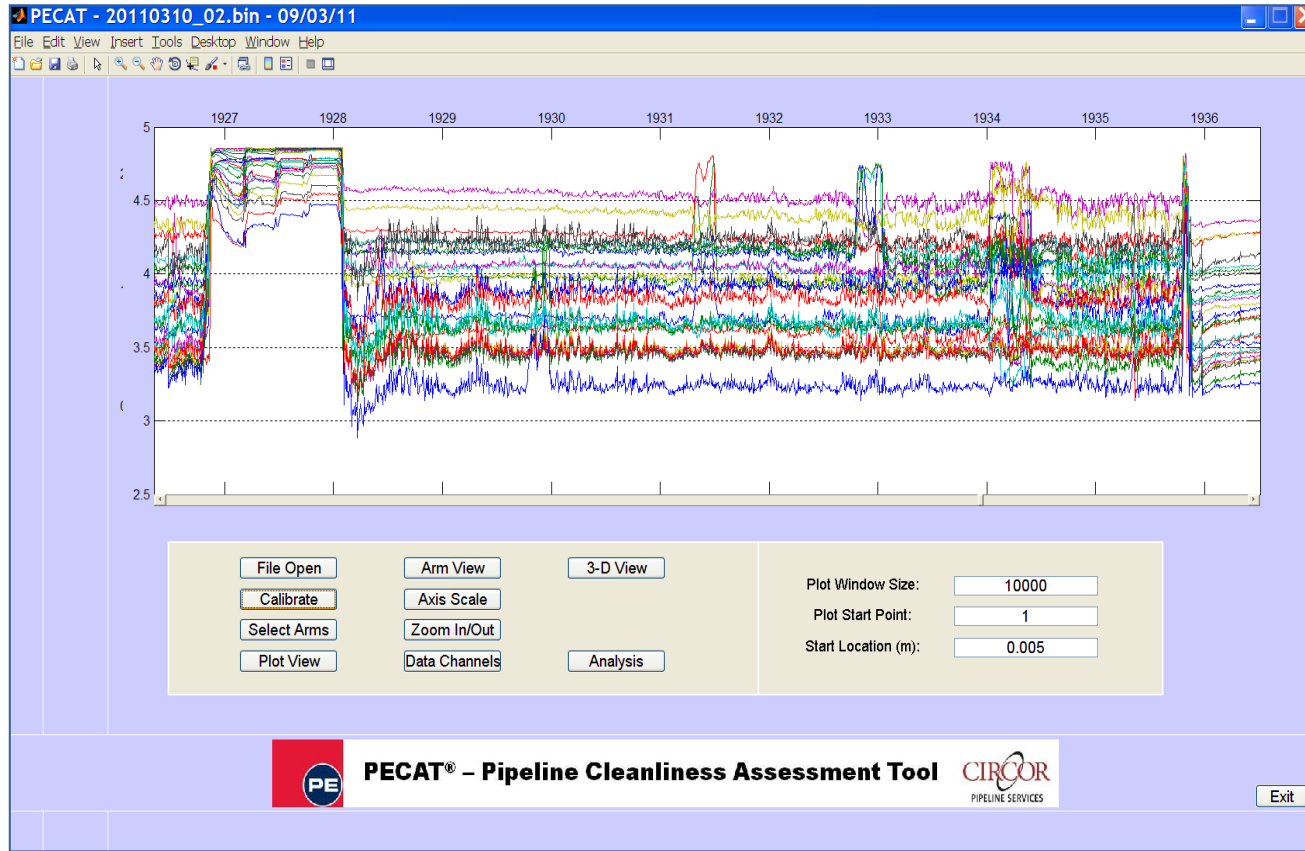 - 1-off make up spool to bring length up to 10m

Loop Testing

- **Petrofac Pipe-loop Facility, Montrose**

Parameter	Unit	10" Pipeline
OD	m	0.273
WT	m	0.0078
ID	m	0.2574
Length of Pipeline	m	1000
Unit Volume	m^3m^{-1}	0.052
Total Pipeline Volume	m^3	52.035

Loop Testing

Data Visualisation & Reporting

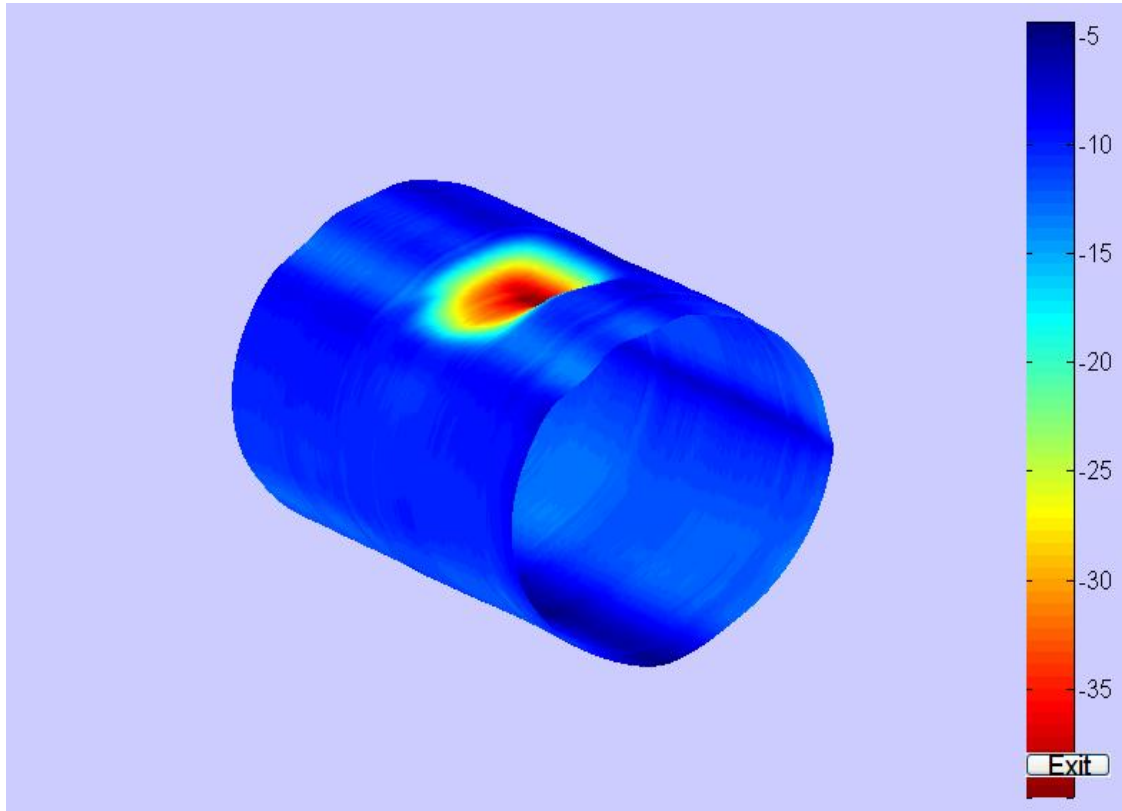**Debris Sensor Readings in Test Spool**

Loop Testing
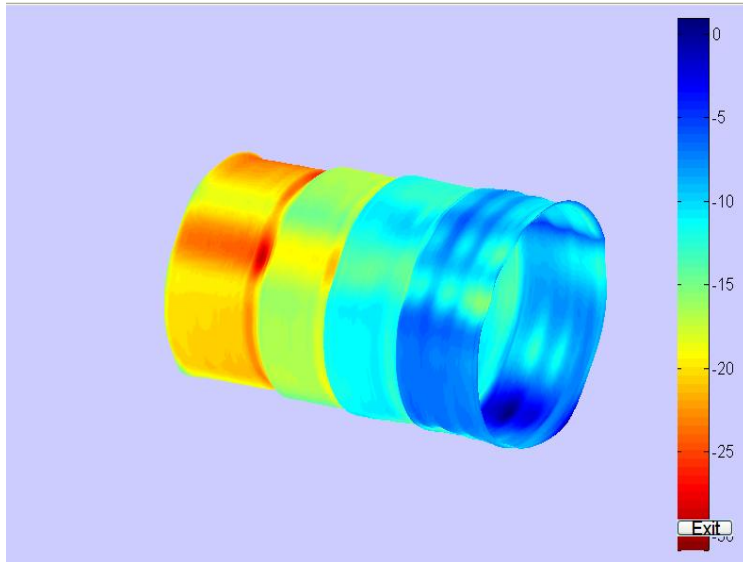
Test Spool
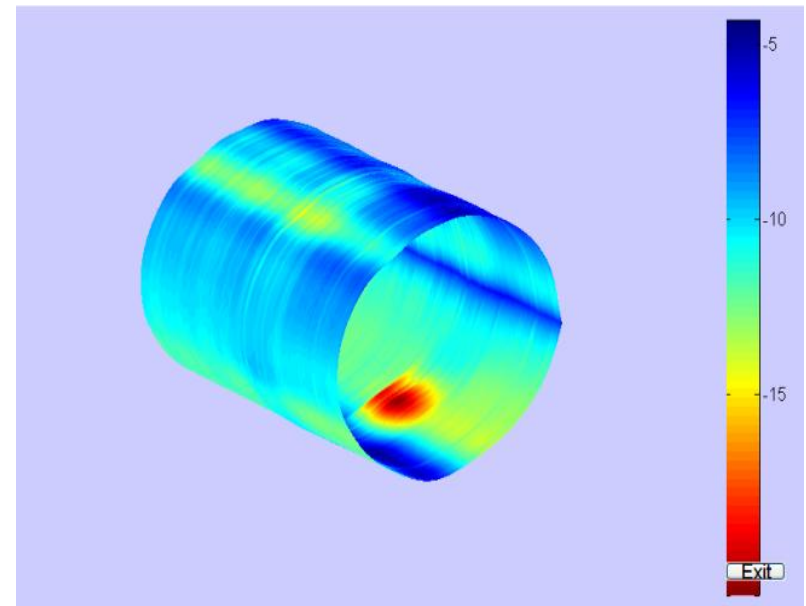
3% Dent

Test Spool Data


Pipeline 12% Dent Test Data

Loop Testing

- **15 test runs at various speeds**
- **Mechanical robustness of tool design tested**
- **Capability of measurement systems established**
- **Sub-millimetre accuracy achieved on artificial debris measurement**
- **Repeatability of measurement established**
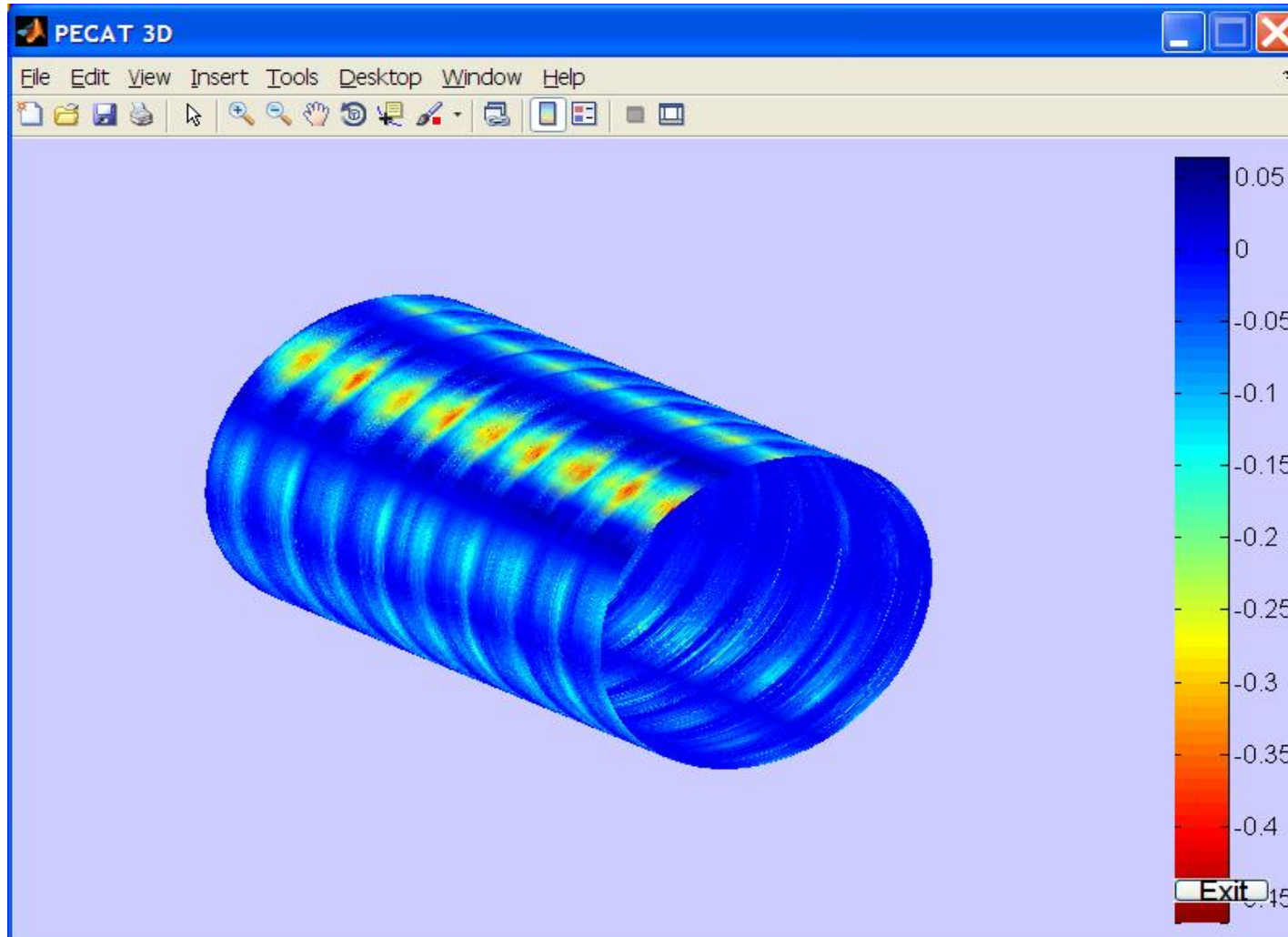- **Basic caliper functionality demonstrated**

Field Experience

- **North Sea Operator**

- **Medium length pipeline**

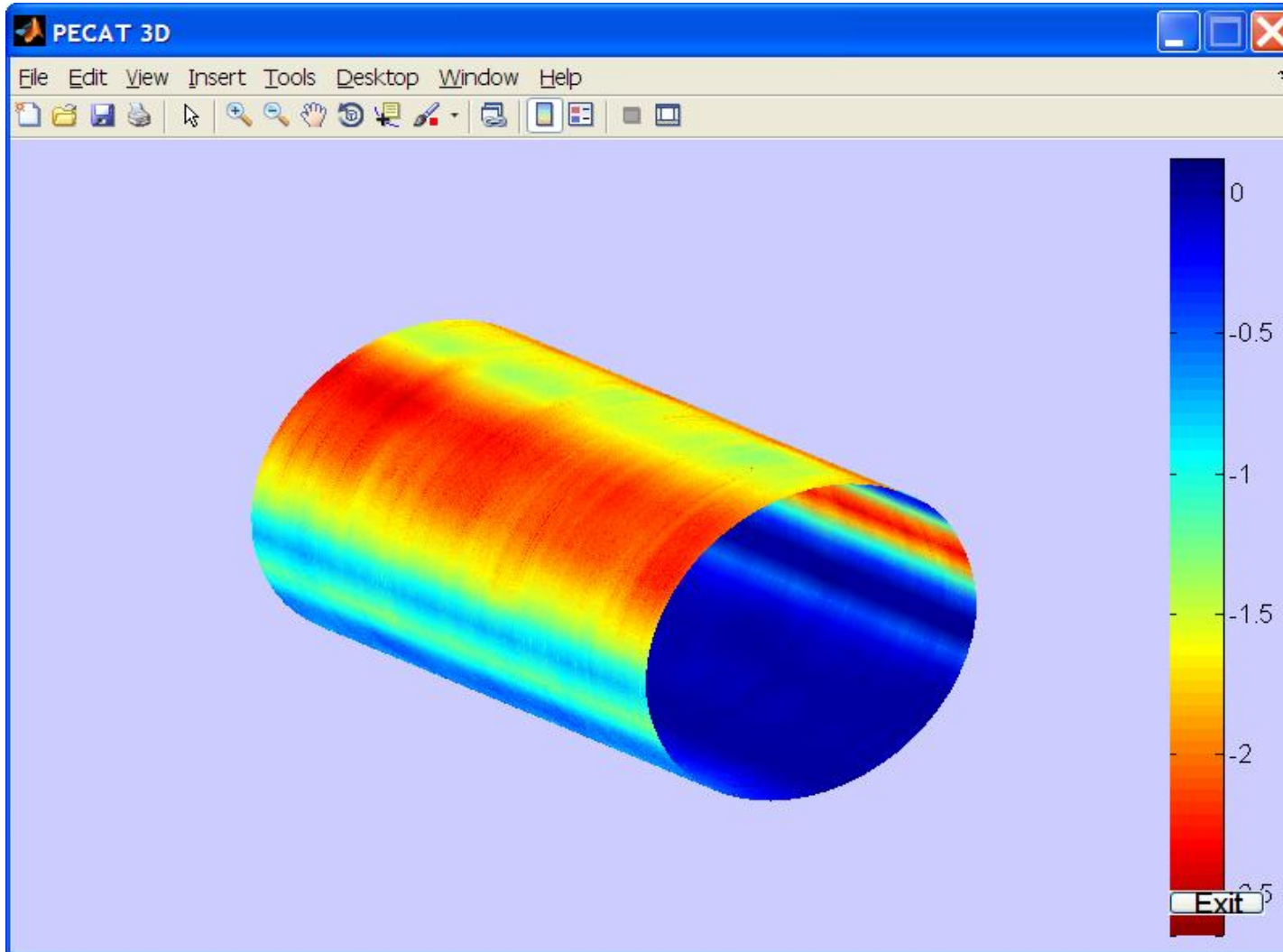- **Medium diameter pipeline**

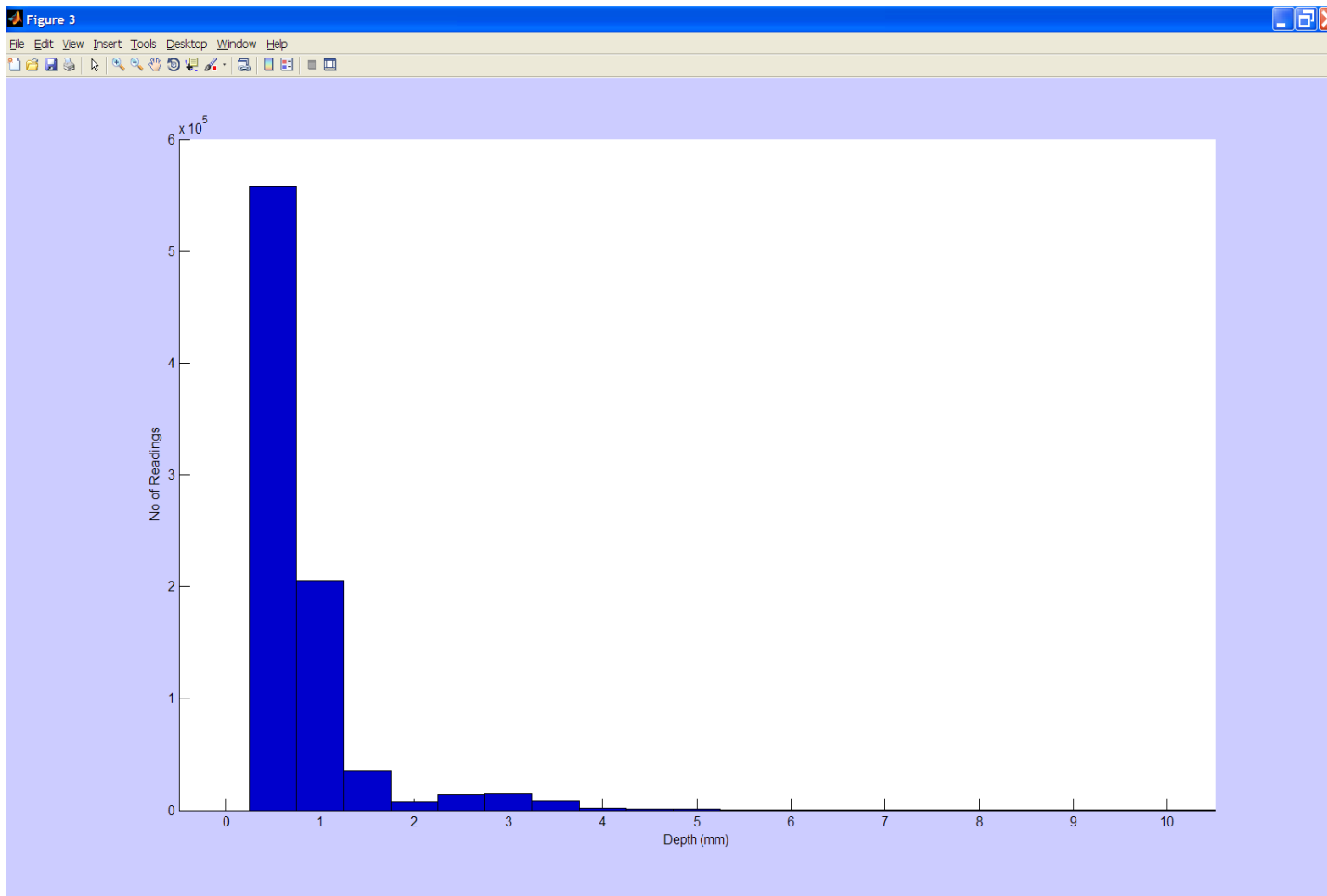- **Wax believed to be present**

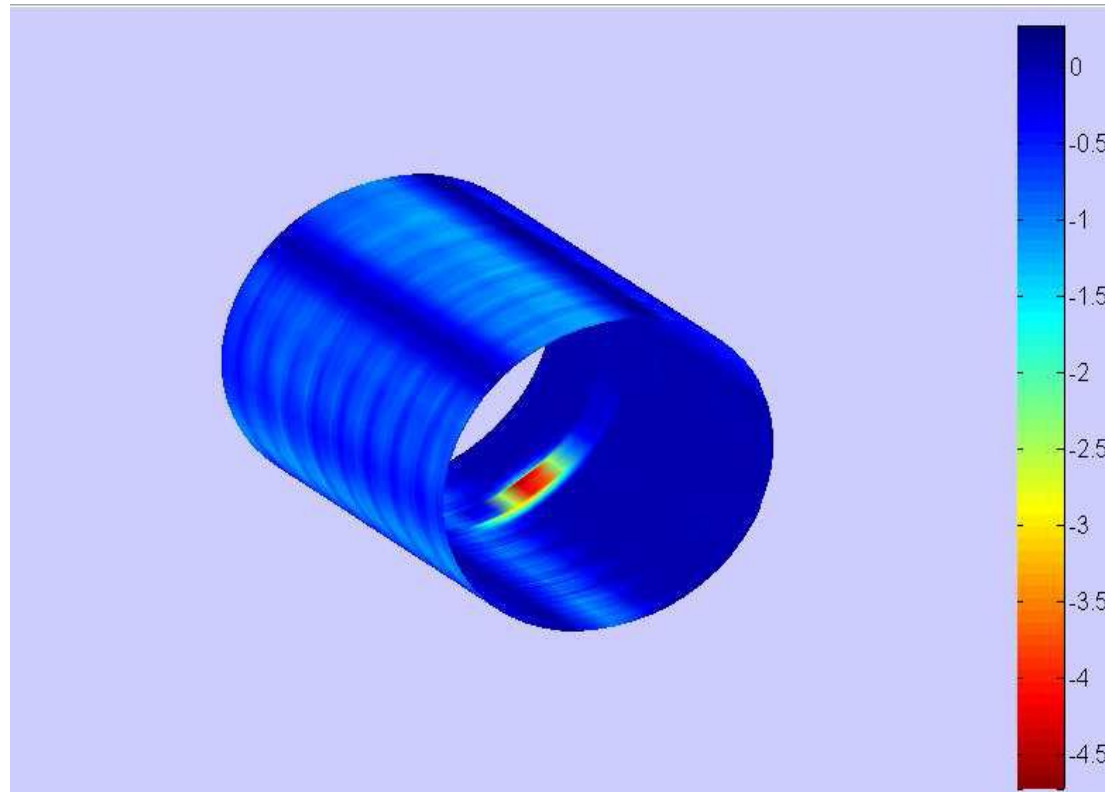# Clean Signal
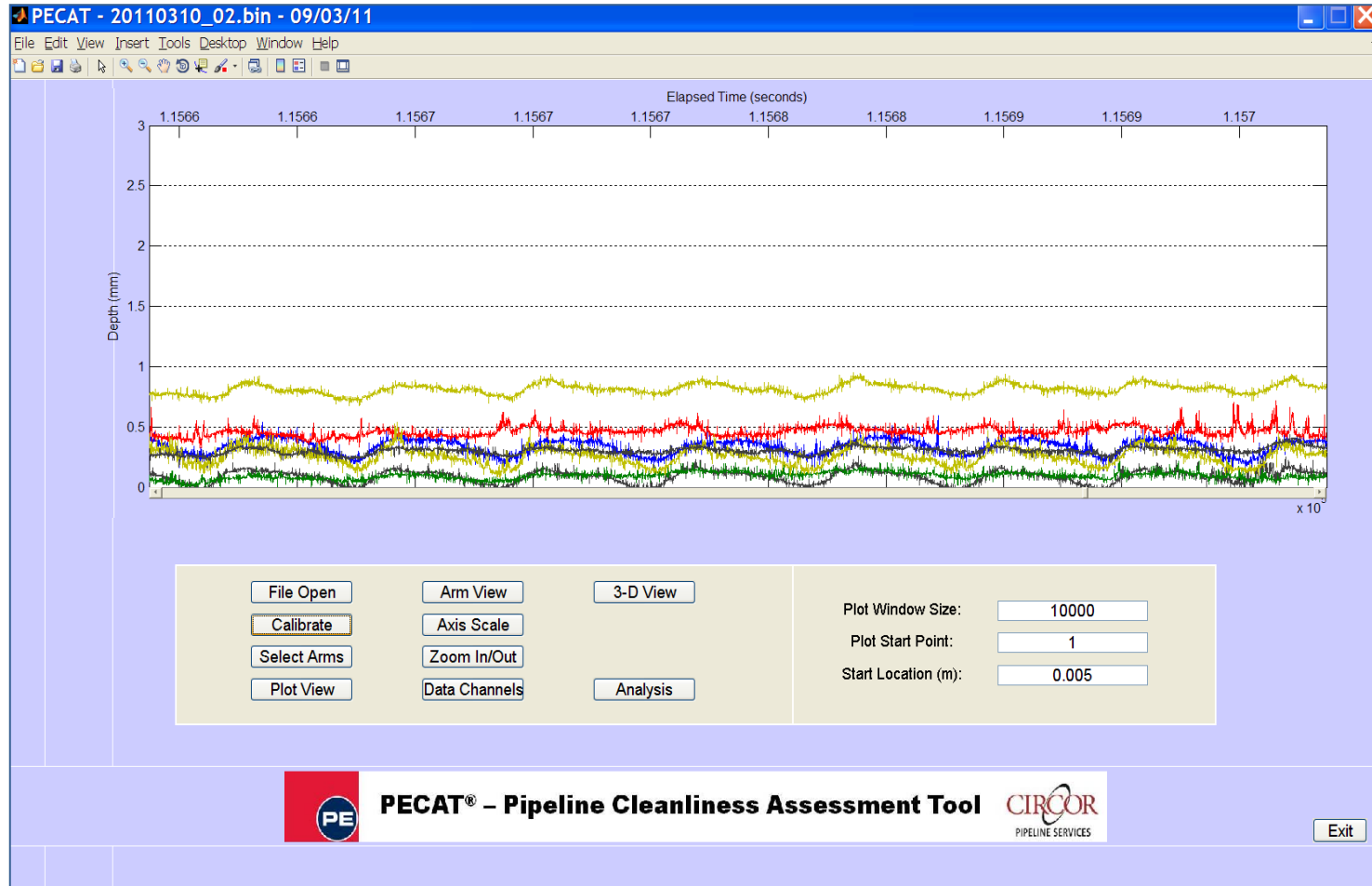
Clean Pipe – 3D View

Dirty Pipe – 3D View

Statistical Interpretation

(Zero Values Suppressed)

Localised Features

3D Anomaly Visualisation

In-line Features

Offtakes
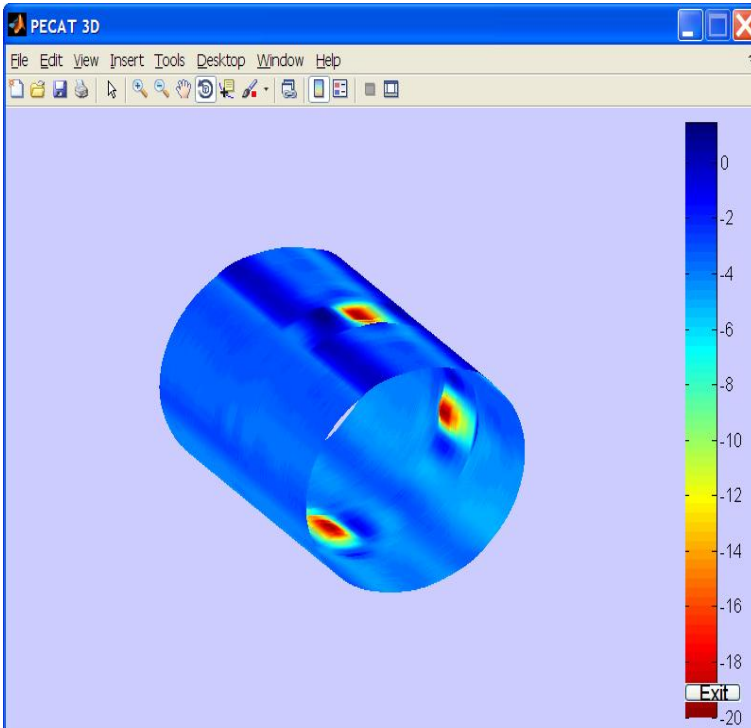
Drain
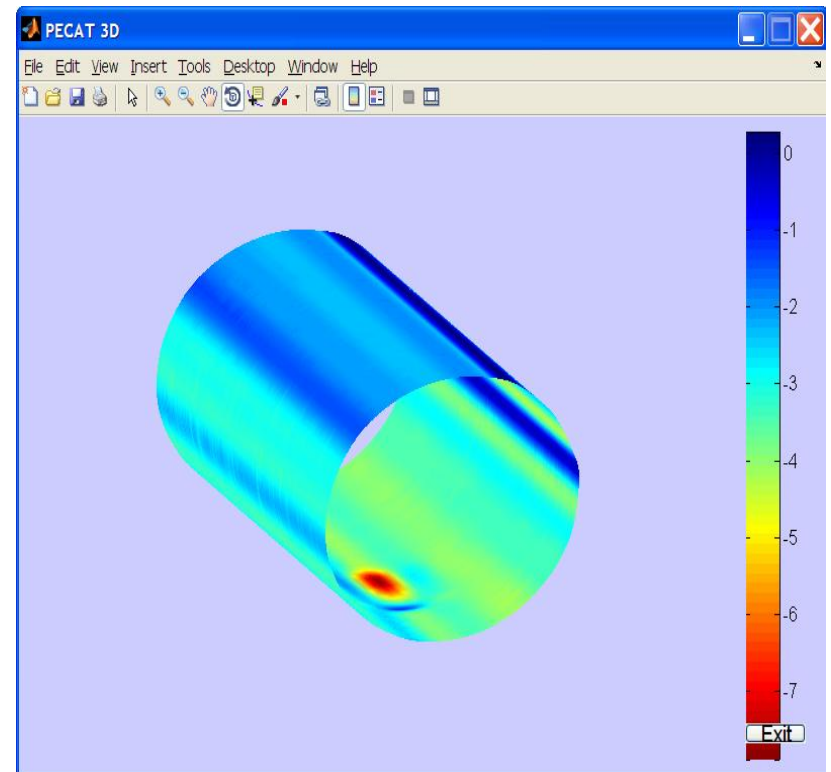
Data Interpretation

- **Positioning from odometry data**

- **Position benchmarked by reference to pipeline features (expansion spools, tee-pieces, etc)**

- **Regions with significant debris identified from overview plots**

- **Detailed examination performed**

Commercial Application

- **Debris measurement exercise early in programme**

- **Significant debris present throughout line**

- **Six week cleaning programme**

- **Re-survey measures reduced wax quantity**

- **Amounts removed consistent with survey**

- **Quantitative support for decision on cleanliness of line**

Summary

- **"Intelligent Caliper"**

- **Direct measurement using magnetic technique**

- **Integrating into pipeline cleaning process**

- **We have field validation of PECAT technique**

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