RADIOTRACING TOOLS FOR ON-LINE MEASUREMENT

KEY PRODUCTS:

RNT/TLA FOR WEAR INVESTIGATIONS

D-LUBE FOR FUEL DILUTION

C-LUBE FOR ENGINE OIL CONSUMPTION

AIR-X FOR LUBRICANT AERATION

FLUID CONDITIONING AND TEST RIGS

BENEFITS OF RADIOTRACING TECHNIQUES:

- Real-time results
- Very high sensitivity
- Non intrusive
- No dismantling
- Reduced test durations

KEY PRODUCT N° 4: LUBRICANT AERATION AERATION MONITORING

WHAT IS OIL AERATION ?

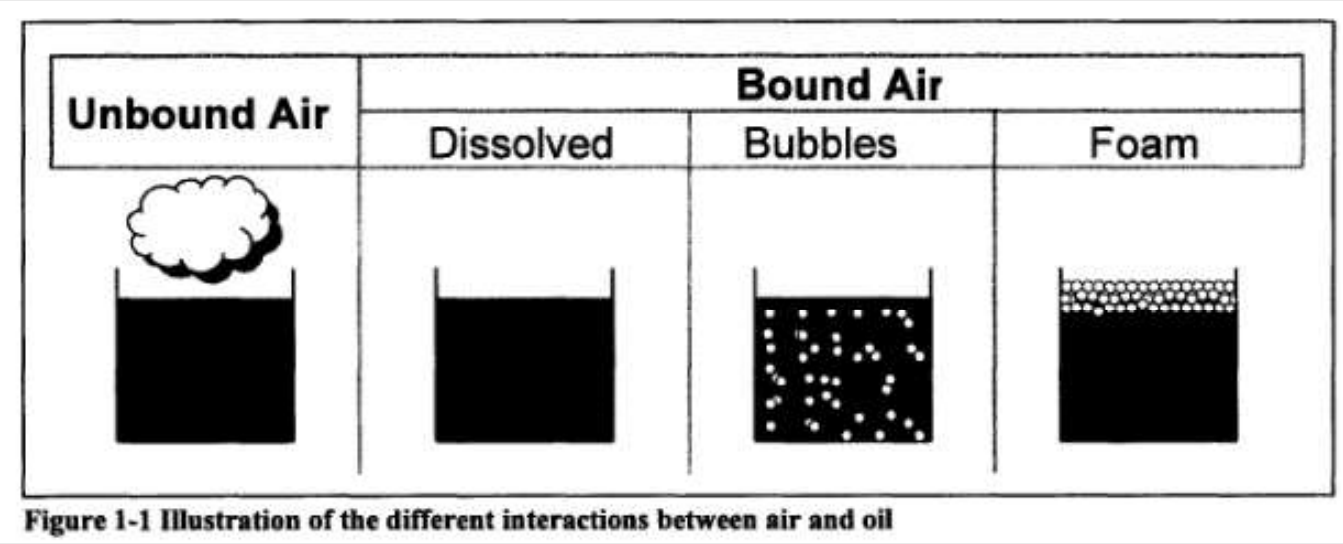
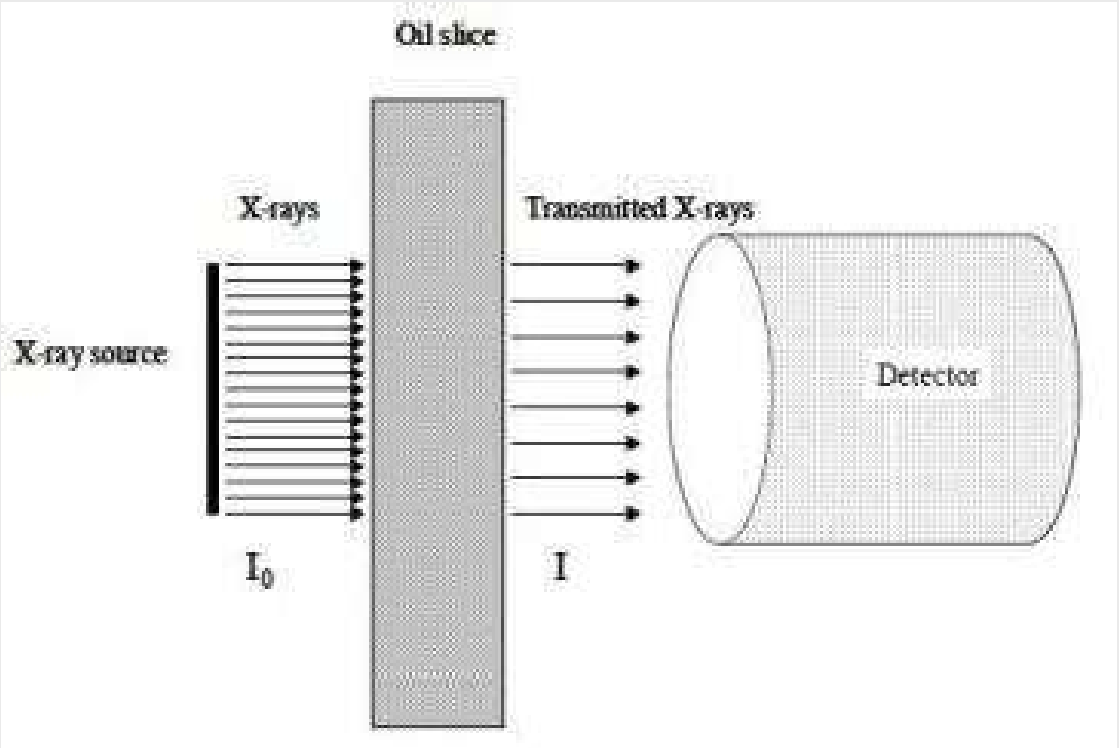


Figure 1-1 Illustration of the different interactions between air and oil

GAS CONTENT ISSUES:

- Increased oil temperature and thermal breakdown of the oil
- Reduction of cooling effect due to inefficient heat transfer
- Reduced lubricants viscosity and retarded oil supply -> higher wear rates
- Cavitation in oil pumps and bearings (main and conrod bearings)
- Accelerated oil oxidation
- Lower bulk modulus -> erratic hydraulic operation (critical to lash adjusters, belt tensioners,…) -> loss of load and power, **valvetrain failure**, air-lock, etc.

BASED ON A DENSITY MEASUREMENT (2)



NaI(Tl) scintillators

The loss of intensity of an X-ray beam is given by the law:

$$I = I_0 \, e^{-\mu r x}$$

I is the intensity of the transmitted beam (number of X-rays/s)

I_0 is the intensity of the source beam (number of X-rays/s)

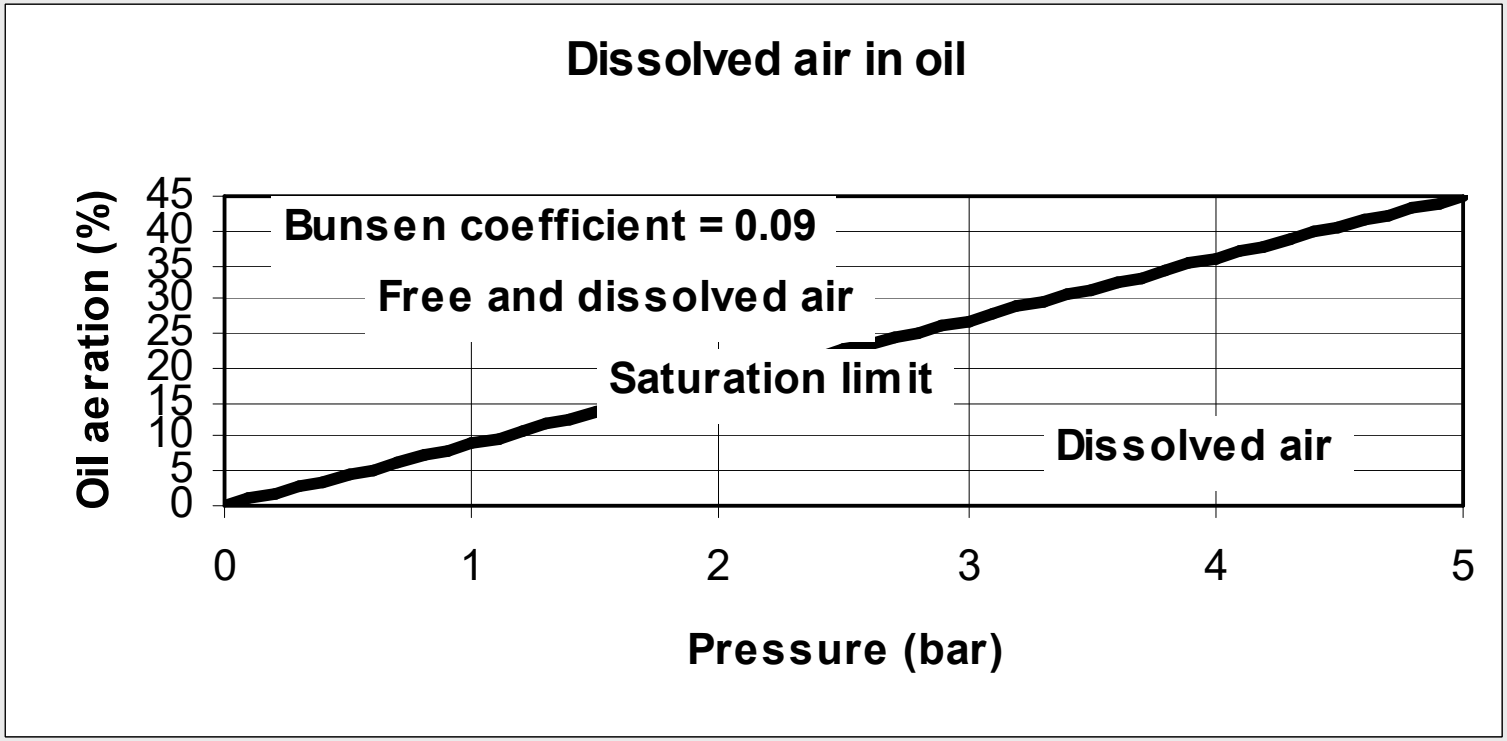
μ is the absorption coefficient depending on X-ray energy and material (cm^2/g)

r is the mass density (g/cm^3)

x is the thickness of crossed material (cm)

DISSOLVED AIR FRACTION (3)

Dissolved Air - Henry-Dalton's Law



Volume of disolved gas in a liquid is given <u>at equilibrium</u> by:

$$V_{gas} = c\, V_{liq}\, (P + P_{atm}) / P_{atm}$$

V_{gas} = dissolved volume of gas under normal conditions (20° C, 101.3 kPa)

V_{liq} = volume of liquid under normal conditions

P = relative pressure

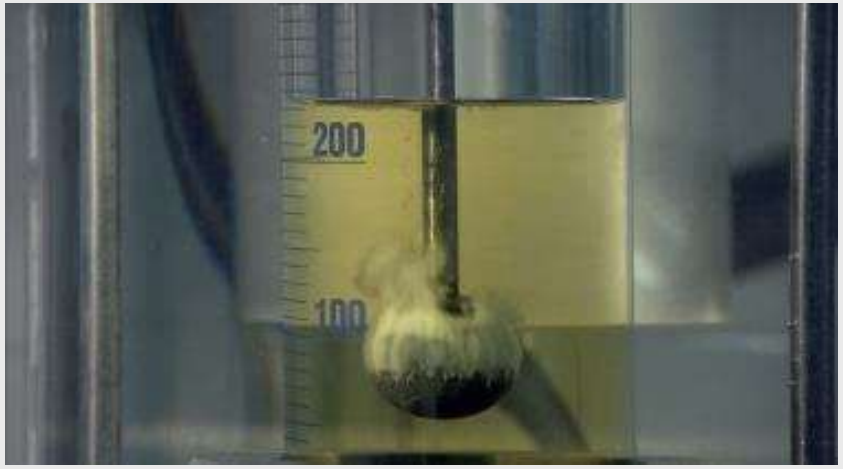
P_{atm} = normal atmospheric pressure

c = Bunsen coefficient (typically 0,08 to 0,1 for lubs in engine) at given T°

OIL AERATION MEASUREMENT WITH AIR-X (4)

AIR- X : A REFERENCE TOOL FOR MONITORING OIL AERATION

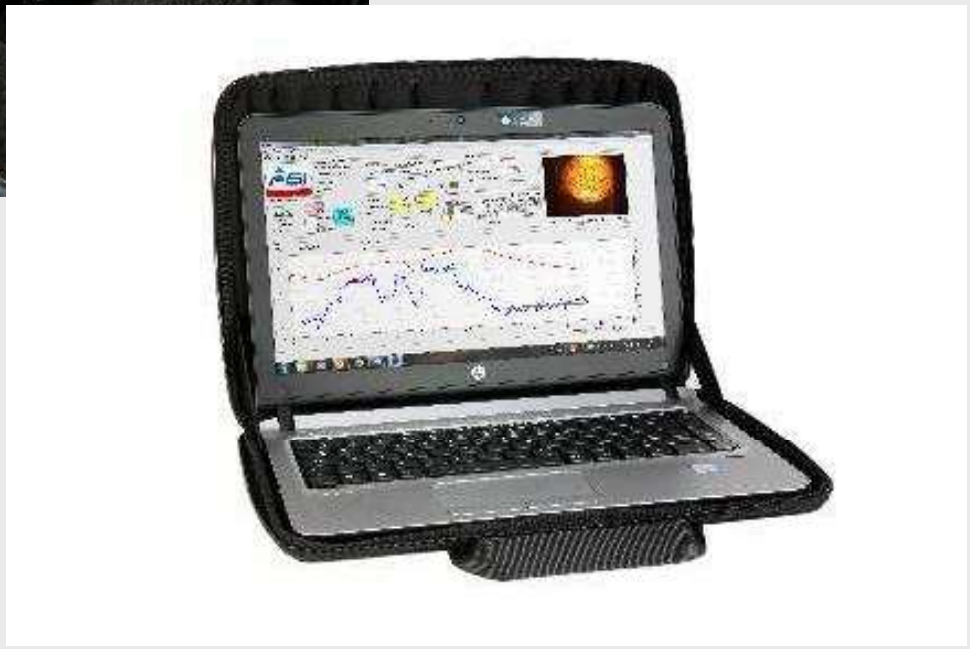
- On-line results with **response time from 1 sec to several minutes**
- **Measuring range**: 0-100% in term of gas content
- **Accuracy** :
  - ± 0,5 % for 10s acquisition time
  - ± 0,1 % for 60s acquisition time
- **Easy** calibration
- User **friendly** and **quick** set up
- Suitable to use with **any lubricant**
- No need to label the oil



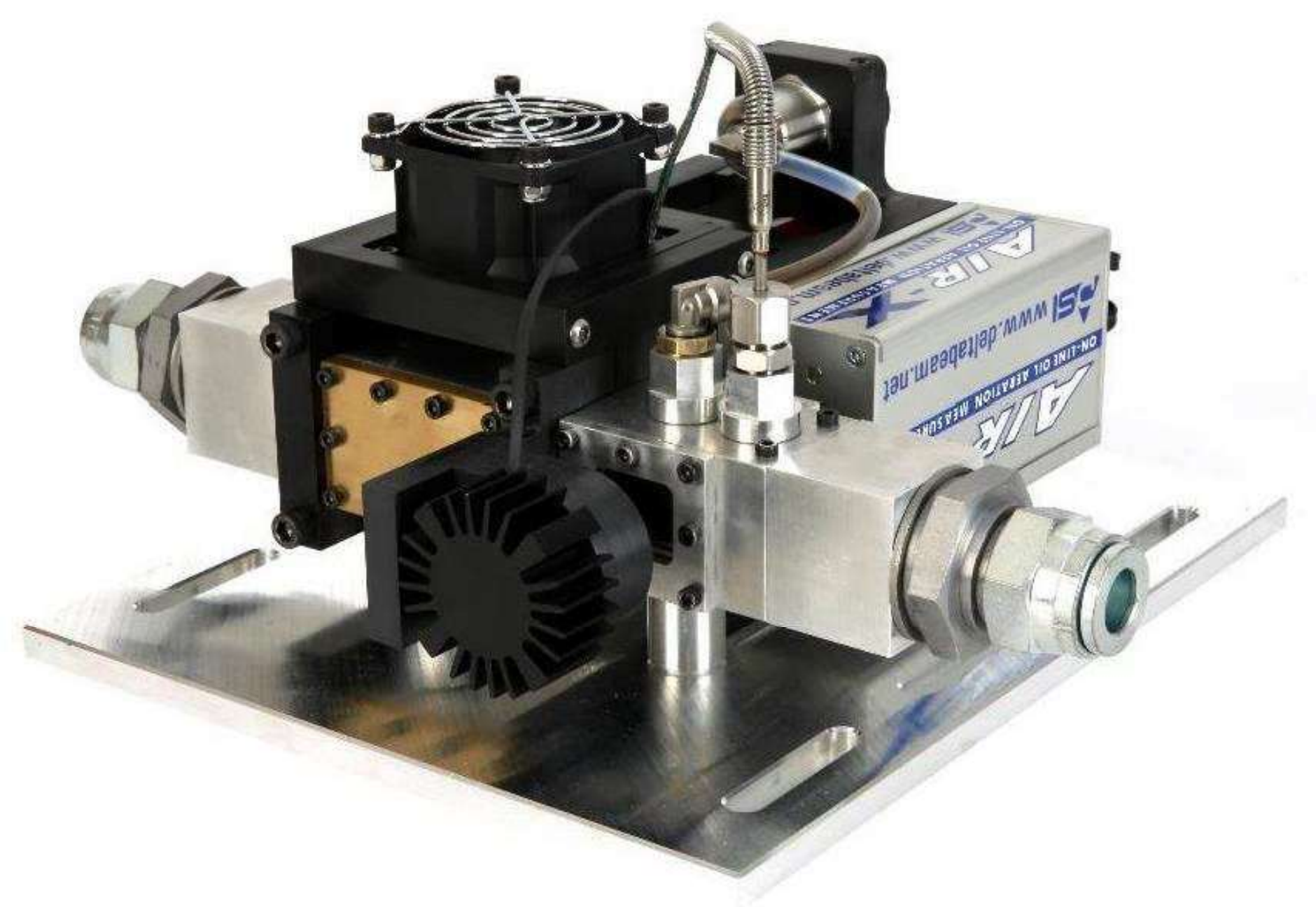
- Sample point from any mechanical system (engine gallery, oil pan, gear boxes, pressurized pipes, oil tank…)
- Use of an exempted X-Ray source
- Real-time visualization of oil flow in the measuring chamber
- Not a black box: access to measurement parameters for in-depth analysis

AIR-X SENSOR CLOSE VIEW (5)

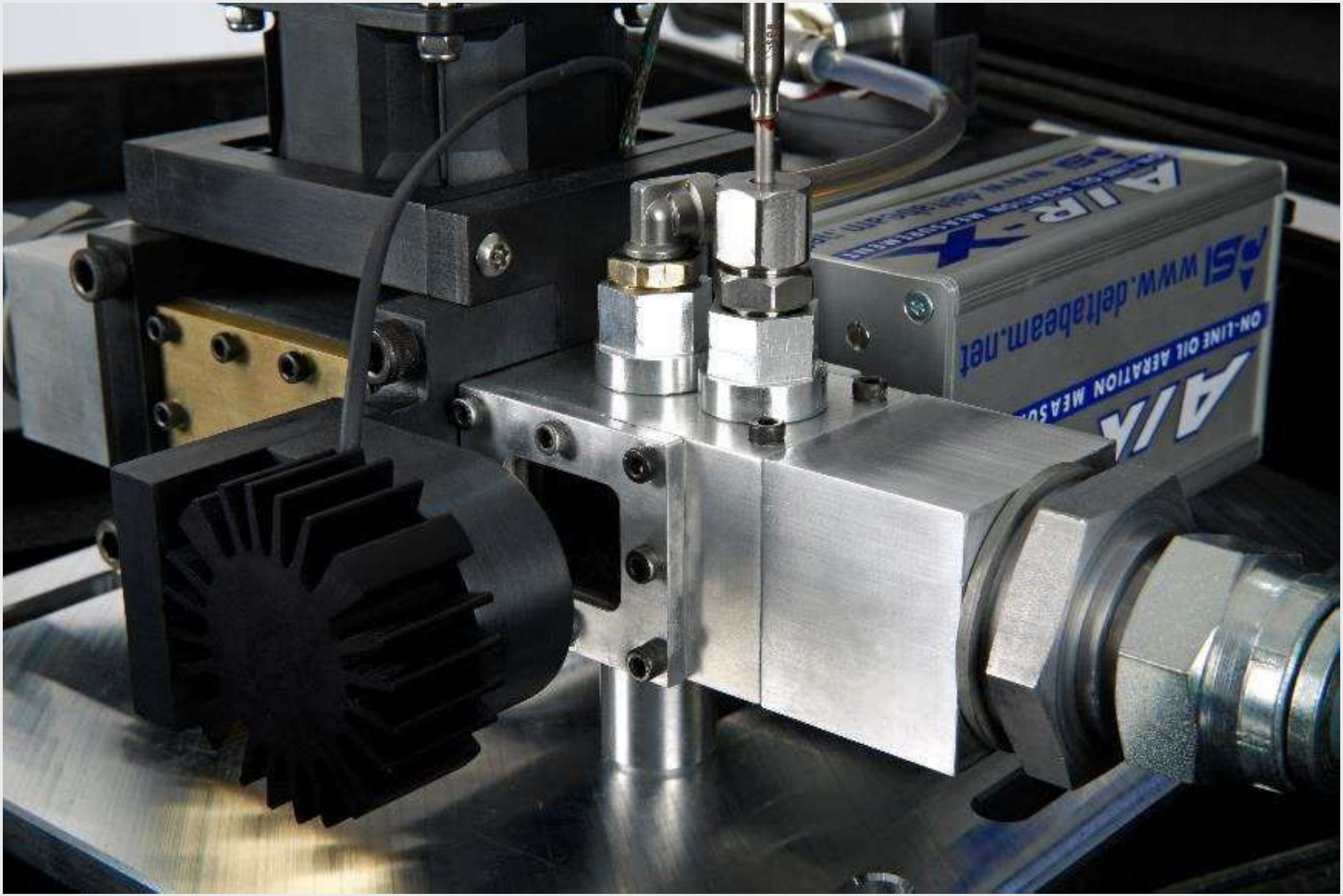
- X-ray source
- Detector
- MCA
- Analog I/O
- Dedicated software
- Live flow visualization



AIR-X SENSOR CLOSE VIEW (6)



AIR-X SENSOR CLOSER VIEW (7)



AIR-X SENSOR CLOSE VIEW (8)

STANDARD AIR-X AND COMPACT AIR-X (9)

TWO VERSIONS AVAILABLE:

Standard Air-X

- With internal pump to sample fluid from oil tank or oil pan

Compact Air-X

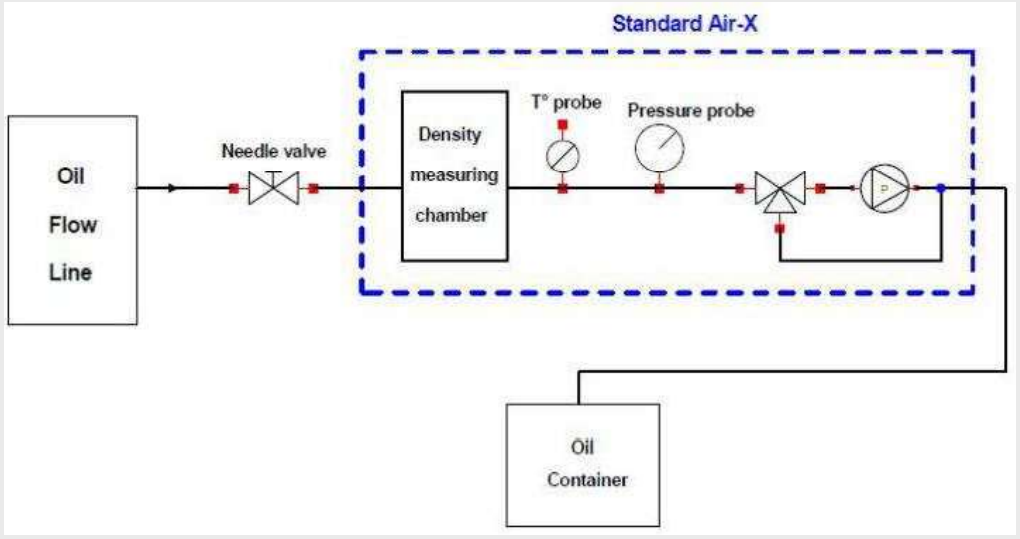
- Lightweight and portable version for dyno, on-board, dry sump and tilt rig application

Similar sensor, electronic, software and computer -> same performances

STANDARD AIR-X AND COMPACT AIR-X (10)

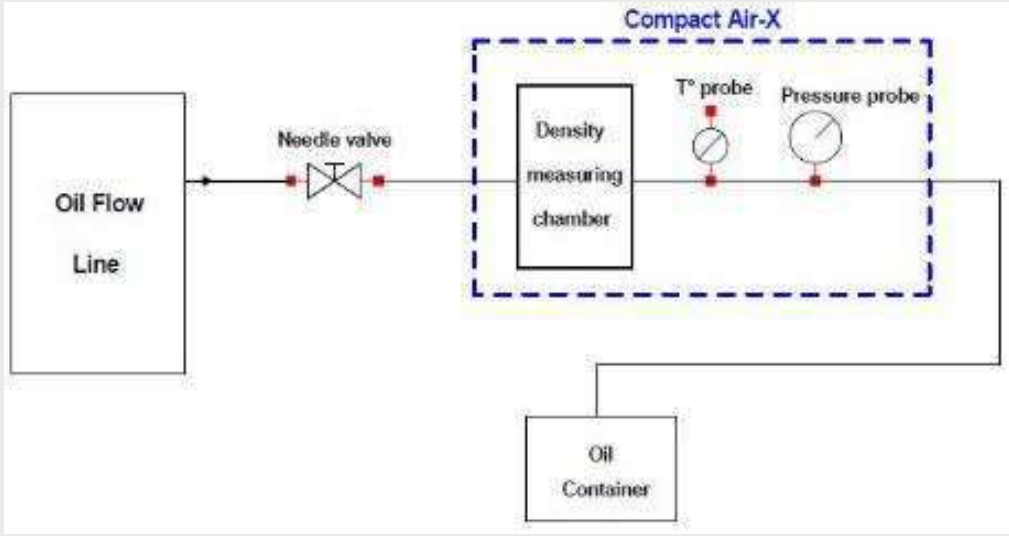
TWO VERSIONS AVAILABLE:

Standard Air-X



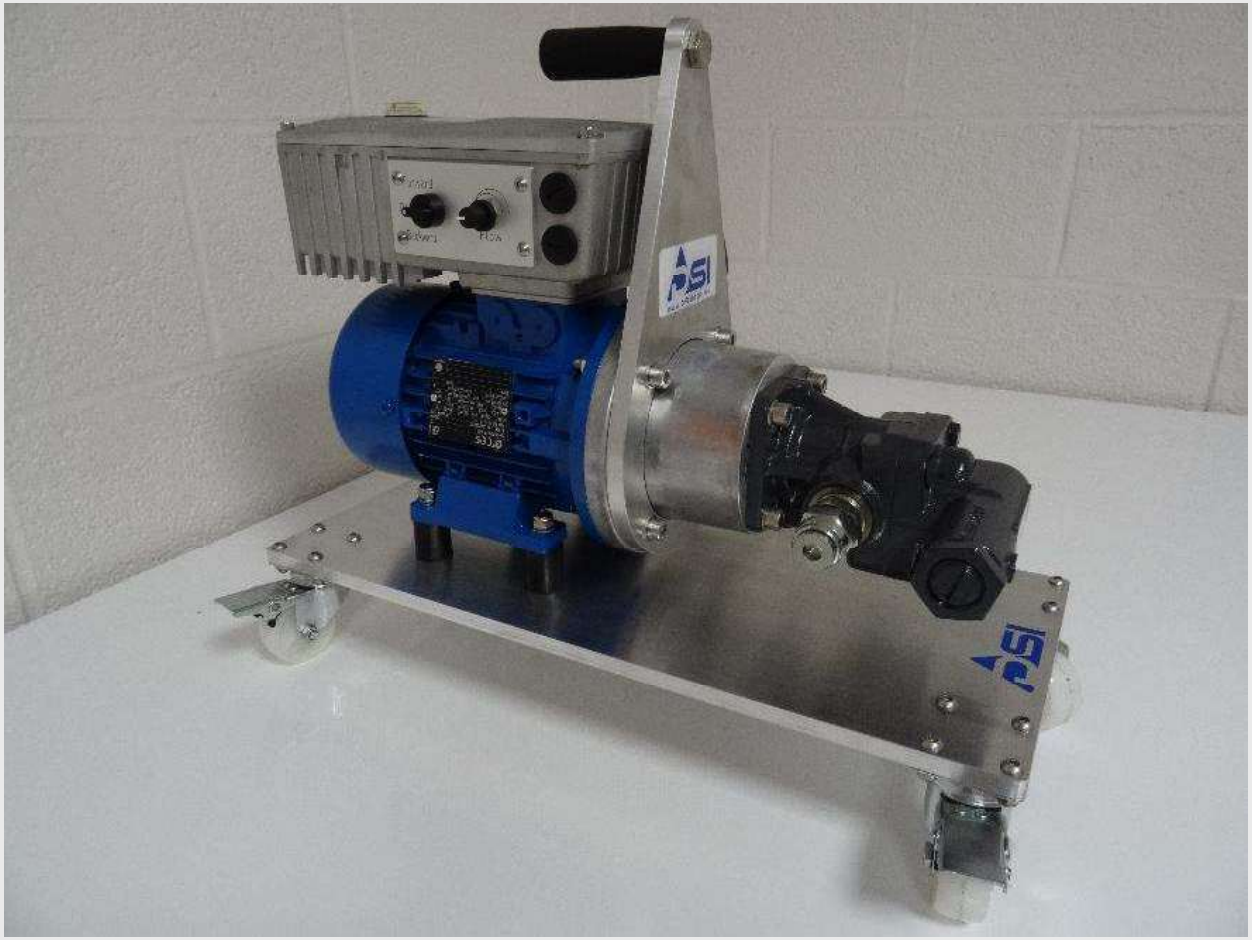
- By-pass for the pump
- Possibility to measure the dissolved air fraction by dropping down the pressure

Compact Air-X



- Suitable for higher oil flow measurement
- Can be placed inline in lubrication system

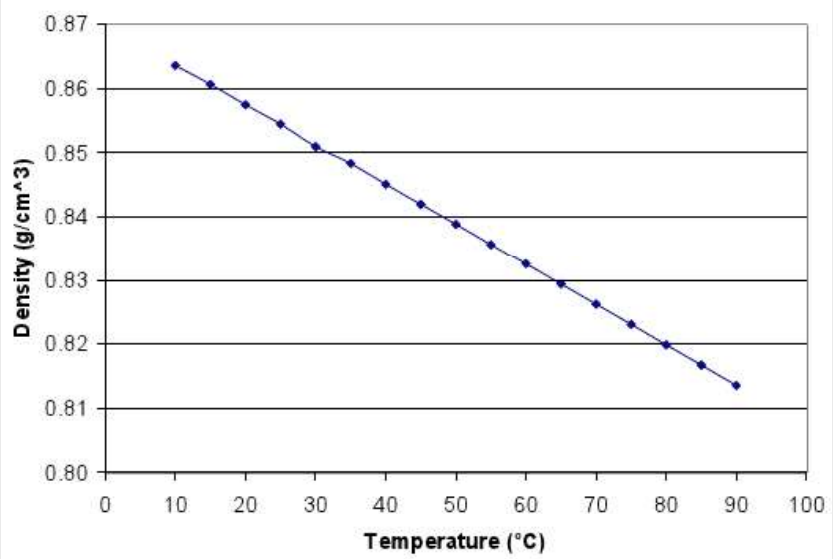
SAMPLING SYSTEM FOR COMPACT AIR-X



HOW TO CALIBRATE AIR-X (II)

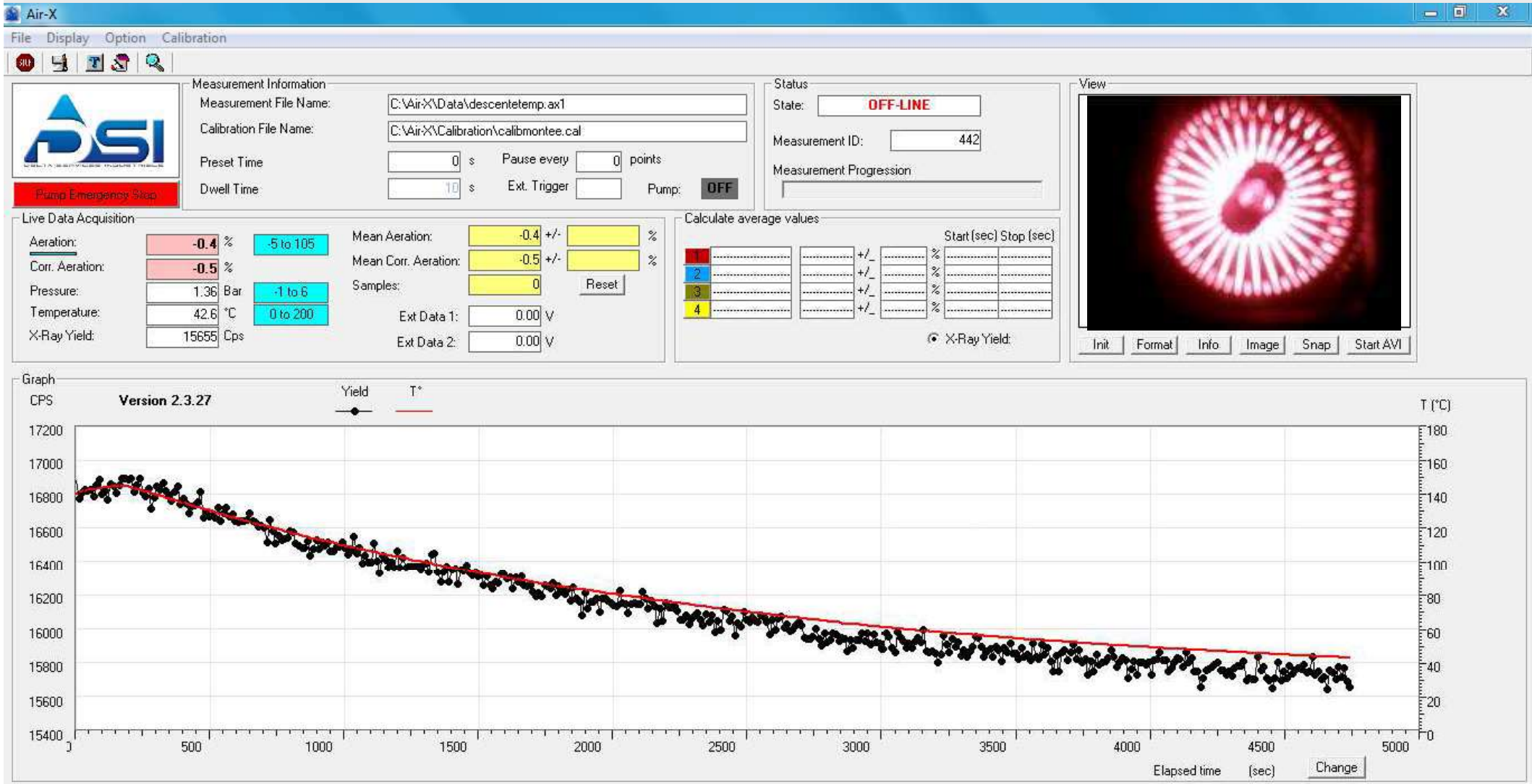
CALIBRATION:

- 100% air: empty measurement chamber (1 minute)
- 0 % air: “temperature calibration”
  - Oil density decreases when oil temperature increases
  - Depends on oil formulation
  - Calibration routine (1.5 hr)
  - Has to be done once per oil
- 0% air: re-calibration (1 minute)
  - To compensate for oil aging and contamination



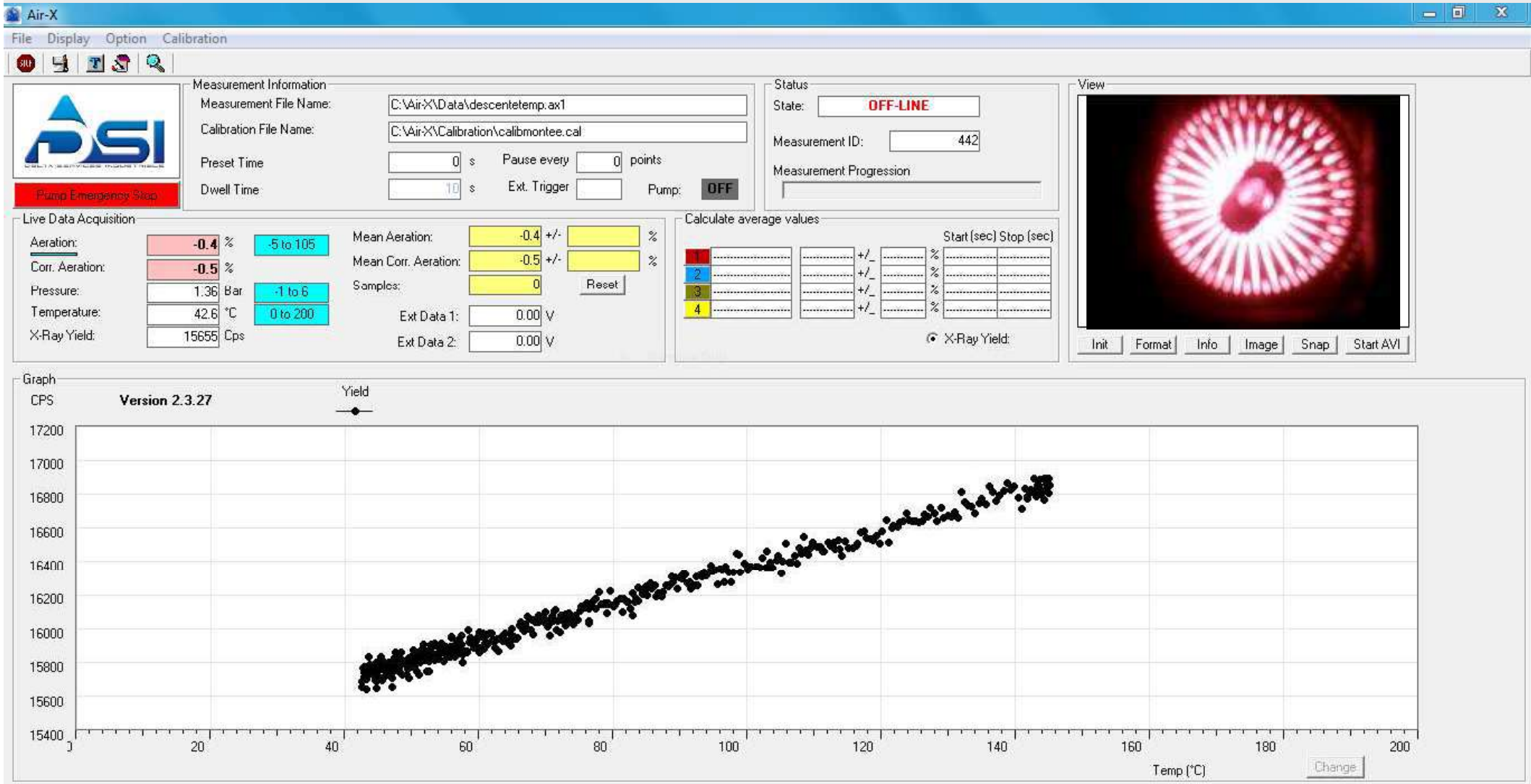
OIL AERATION MEASUREMENT WITH AIR-X (12)

CALIBRATION: 0% TO BE PERFORMED FOR EACH OIL REFERENCE



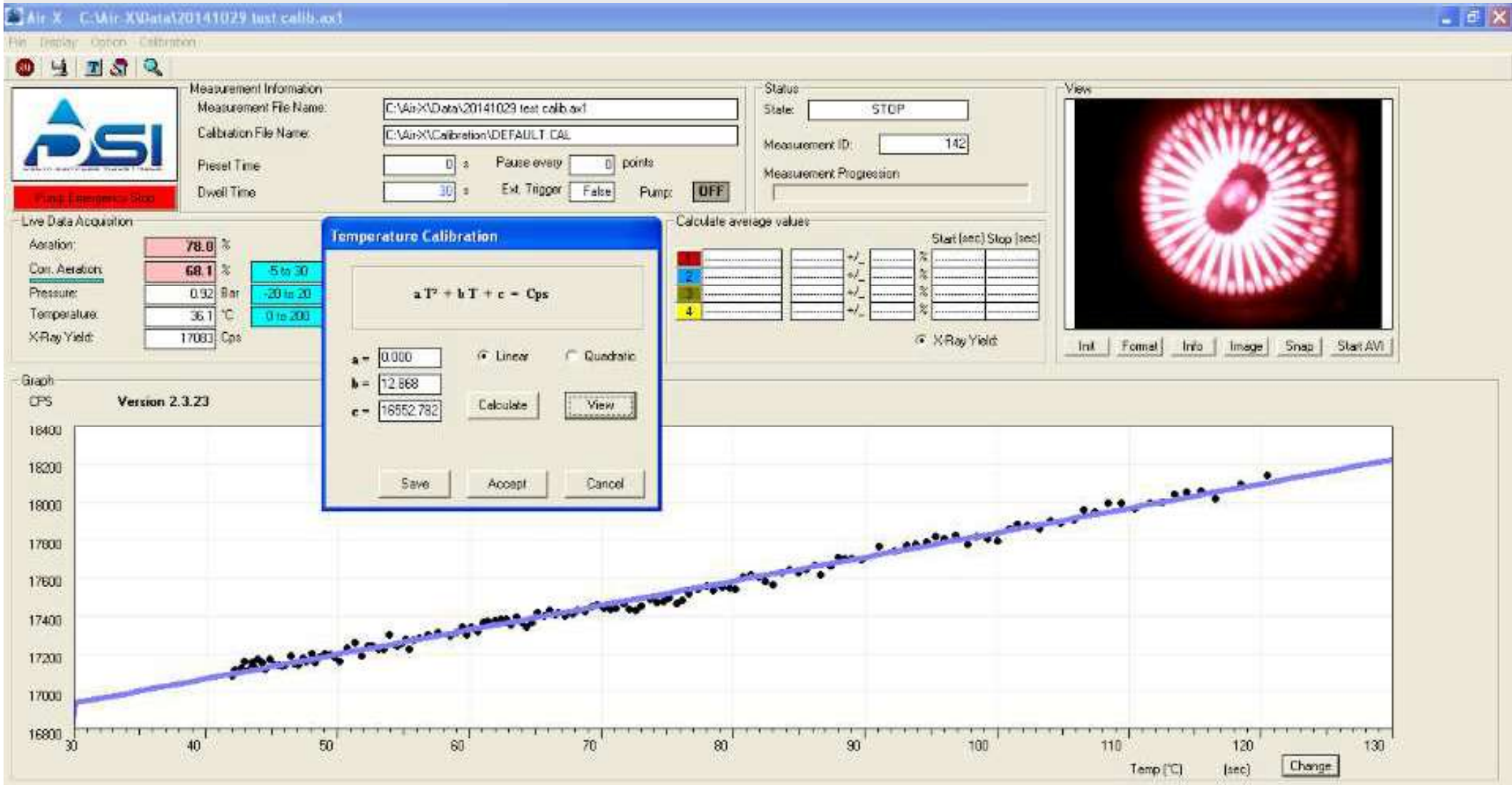
OIL AERATION MEASUREMENT WITH AIR-X (13)

CALIBRATION: 0% TO BE PERFORMED FOR EACH OIL REFERENCE



OIL AERATION MEASUREMENT WITH AIR-X (14)

CALIBRATION: 0% TO BE PERFORMED FOR EACH OIL REFERENCE



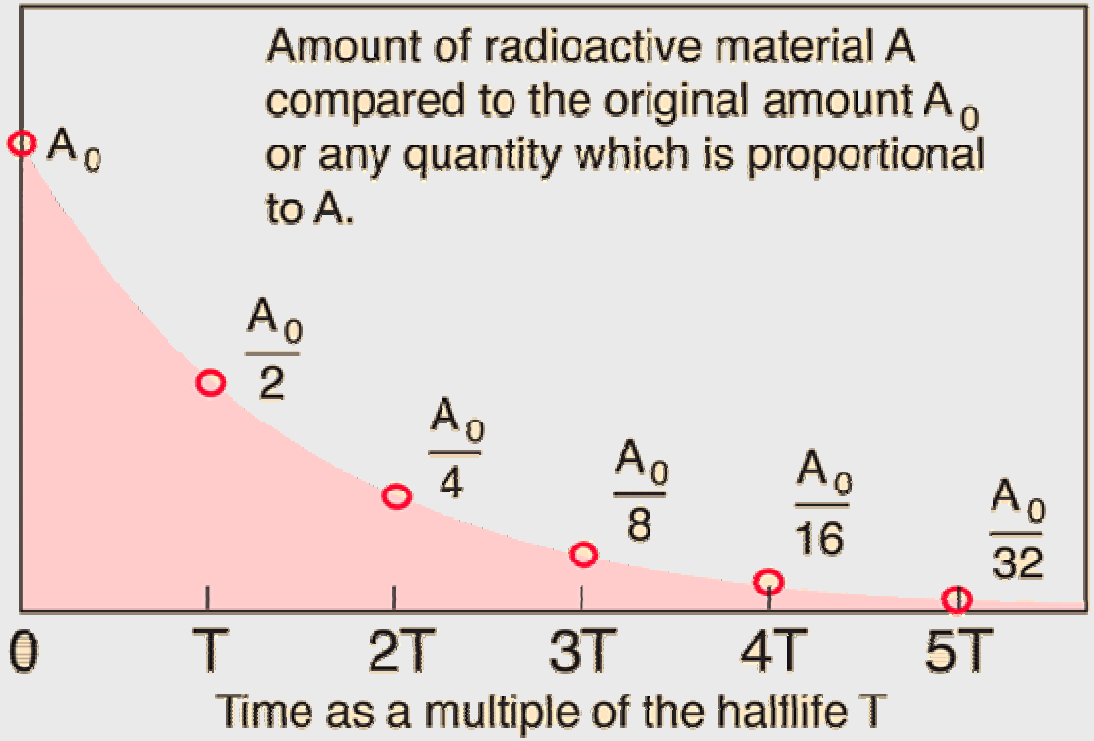
AIR-X MAINTENANCE (15)

- Sealed X-ray source of Cd-109
- Half-life = 462 days
- To maintain accuracy and short response time:

  -> Source replacement every 2 years

  -> Supply of a new X-ray source (incl. disposal of the old source) + source certificate + holder

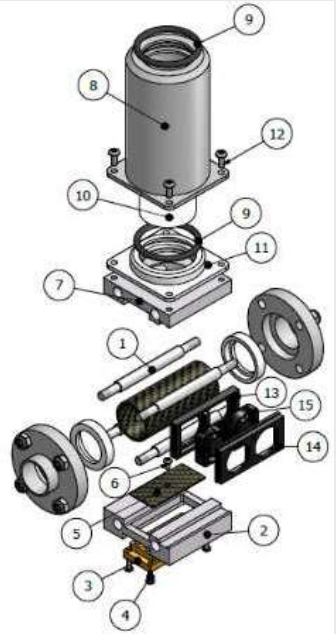
  = downtime of approx. 2 weeks



OIL AERATION MEASUREMENT WITH AIR-X (16)

Custom-made sensors:

- Compact measurement probe for complete integration in vehicule for on-road or on-track measurement
- Dual Air-X system for on-line measurement oil separator system efficiency



OIL AERATION MEASUREMENT WITH AIR-X (18)

Origin of entrained gas

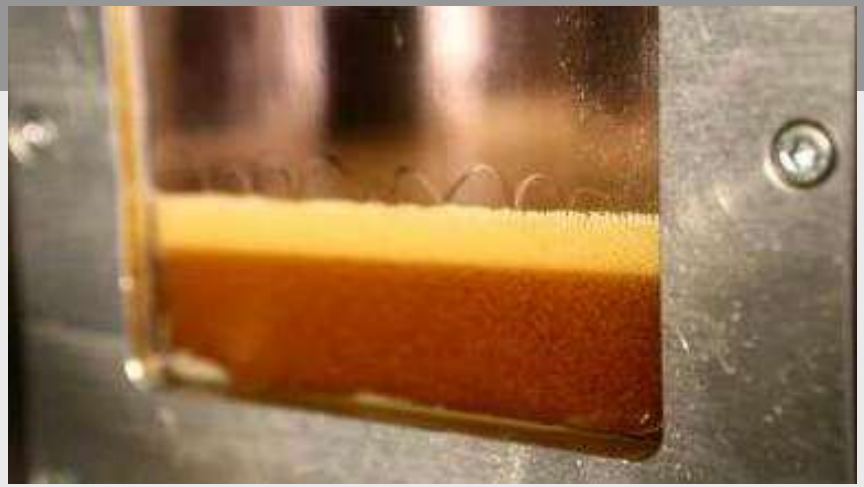
- Underfilling or overfilling of oil pans
- Insufficient blow-by oil mist separation
- Ineffective design and positioning of oil intake and wash plate within oil pan
- Ineffective oil injection nozzles design
- Shorter rest time of lubricant within oil pan due to high flow rate / low oil level
- Acceleration and inclination of the mechanical system (driving in bends at high speed)
- Inappropriate oil formulation
- Outside air sucked into the system after inlet

OIL AERATION MEASUREMENT WITH AIR-X (19)

Air- X usages:

- Investigation of the root cause of foam and air entrainment problems
- Test of antifoam additives and lubricants properties
- Definition of maximum and minimum level of oil stick
- Optimization of lubrication circuit
- Incorporation of aeration data into analytical model
- Easy mapping of air content versus inclination or acceleration
- Monitoring entrained air in hydraulics installation

KEY PRODUCT N° 5A: FLUID CONDITIONING SYSTEMS WITH OIL AERATION GENERATOR

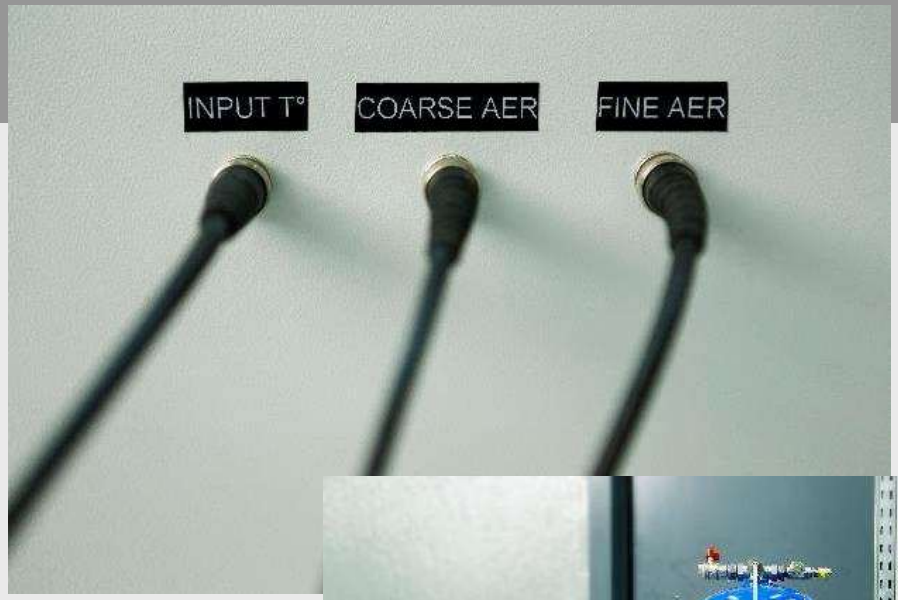


Fine bubbles and foams (mayonnaise)
up to 20 % of aeration
"Big" bubbles up to 80 % of aeration

Adjustable oil flow, pressure, temperature and **aeration**

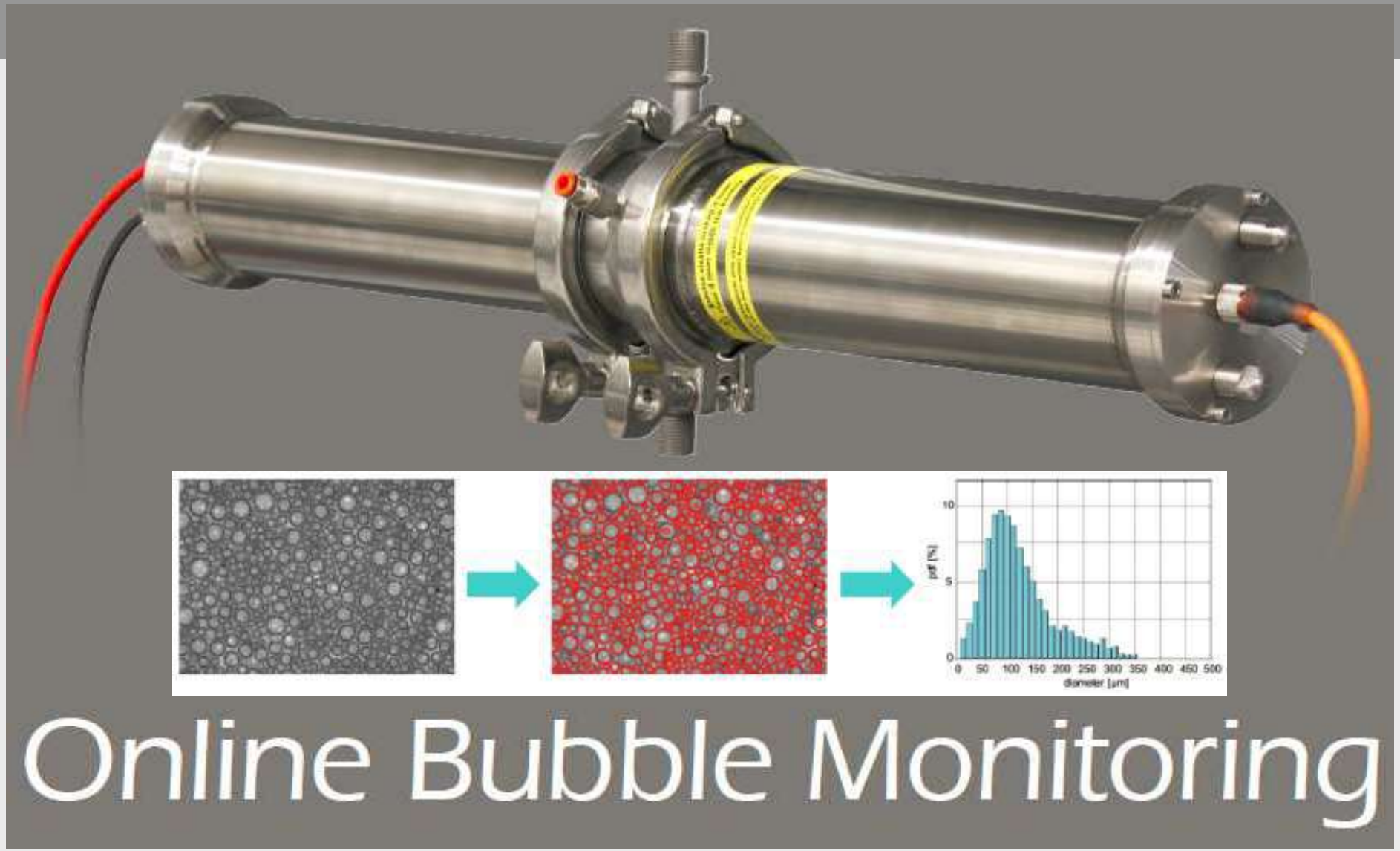
→ Laboratory rigs to measure de-aeration efficiency of lubricants

KEY PRODUCT N° 5A: FLUID CONDITIONING SYSTEMS WITH OIL AERATION GENERATOR



KEY PRODUCT N° 5A: AIR-MIX SYSTEM FOR DEAERATION OIL TANK EFFICIENCY MONITORING (USED IN FORMULA 1)

REFERENCE : BUBBLE SIZE DISTRIBUTION MEASUREMENT



Equipment manufactured by the company Pixact based in Finland