
# SSEGAI

## Technology for Advanced Material Characterisation

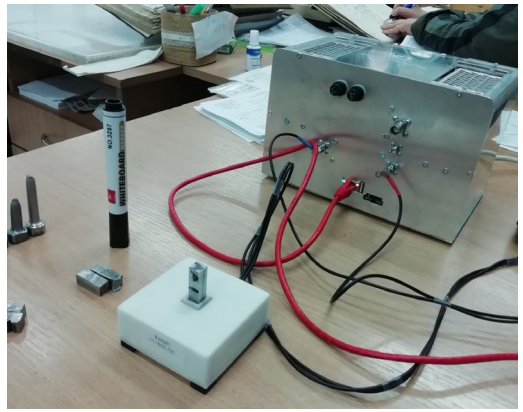
**Complete technology and adaptable components for industrial and R&D applications**

ETGR-TECH | Technology & Expertise Offer

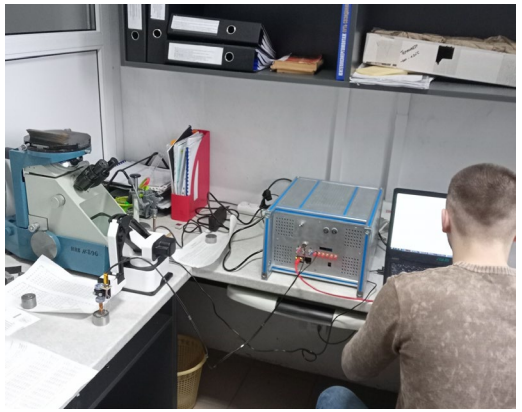
# SSEGAI TECHNOLOGY

## Non-destructive material characterisation through electromagnetic interaction

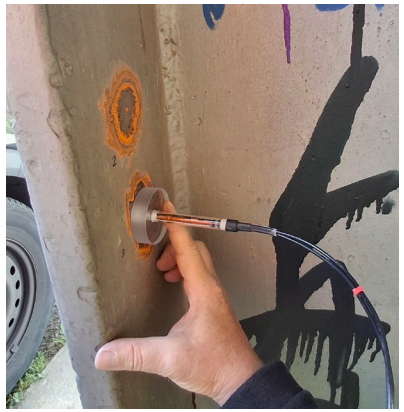
**One technology platform → multiple material properties, structures and operating environments**



**Industrial specimen**
Mechanical-property assessment



**Production environment**
Material-property assessment



**Infrastructure object**
Residual stress / strain field

Controlled EM field → Material interaction → Resulting EM field → Measurement → Signal analysis → Material characterisation

The complete SSEGAI technology can be adapted to a specific industrial task; its hardware and software components can also be integrated independently.

# QU-SCOPE MEASUREMENT PLATFORM

## Adaptable to Partner Applications

**A configurable measurement platform currently implemented for electromagnetic transducers and complex electromagnetic measurements**

CURRENTLY IMPLEMENTED

### Electromagnetic measurement systems

Partner transducers and electromagnetic devices can be integrated by adapting interfaces, excitation and acquisition parameters.

POTENTIAL EXTENSION OF THE PLATFORM PRINCIPLES

### The same configurable architecture may be adapted to other physical-field detection systems

**ACOUSTIC**

Excitation / detection with acoustic transducers

**OPTICAL**

Optical sources, detectors and acquisition

**IONISING RADIATION**

Detector interfacing and signal acquisition

**PARTNER-SPECIFIC**

Other sensing systems requiring tailored I/O

These non-electromagnetic configurations are potential adaptations of Qu-Scope principles; they have not yet been implemented or experimentally validated.

Collaboration can start from an existing electromagnetic configuration or from engineering adaptation of the platform to a partner's measurement task.

# SENSOR TECHNOLOGY

## From Material Characterisation to Embedded Sensing

**Existing electromagnetic sensor technology can be adapted in geometry, field configuration and integration method for a partner's specific measurement task**

### CURRENTLY IMPLEMENTED

**Electromagnetic material sensor**

Sensor geometry and excitation can be tailored to the object, surface and required measurement zone.

Non-destructive interaction with industrial materials and structures for acquisition of material-response signals.

### POTENTIAL PARTNER-SPECIFIC SENSOR CONFIGURATIONS

**The sensing principle can be engineered as part of the partner's machine, tool or monitored component**

#### ROBOTIC GRIPPER / FINGER

Embedded sensing for material-aware handling, object differentiation and additional feedback beyond machine vision

#### PROCESS-INTEGRATED SENSOR

Sensor geometry integrated directly into production equipment for continuous or in-process material monitoring.

#### ELECTRODE / COMPONENT MONITORING

Coils or sensing elements incorporated around a functional component to track changes associated with degradation

#### SENSOR ARRAYS

Multiple sensing elements arranged around an industrial object for spatially distributed measurements and reconstruction tasks

These configurations illustrate engineering directions for adaptation. They should be treated as application concepts unless validated in a specific partner setup.

The sensor can therefore be supplied as part of SSEGAI or developed as a standalone sensing element for integration into a partner application.

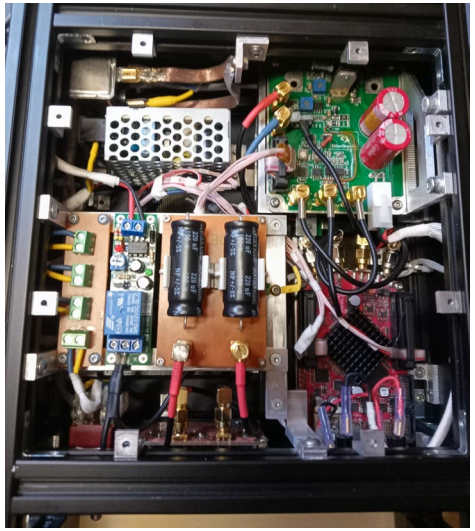
# MEASUREMENT ELECTRONICS AND FPGA DEVELOPMENT

From configurable excitation and acquisition to partner-specific measurement hardware

**A working Qu-Scope electronics architecture provides a practical basis for adaptation to new sensors, interfaces and measurement tasks**

## CURRENTLY IMPLEMENTED

### Qu-Scope measurement electronics



Integrated excitation, amplification, signal acquisition, control and computing hardware implemented in the Qu-Scope system.

## ENGINEERING CAPABILITIES FOR PARTNER SYSTEMS

### Individual electronics and FPGA functions can be adapted or developed around a partner's sensor and measurement architecture

**FPGA / DIGITAL SIGNAL PROCESSING**

Waveform generation, timing, synchronisation and deterministic control of measurement cycles.

**ANALOG & POWER ELECTRONICS**

Excitation stages, amplification and signal conditioning matched to sensor and load requirements.

**DATA ACQUISITION & INTERFACES**

Acquisition paths and hardware interfaces adapted to partner transducers, devices and control systems.

**CUSTOM MEASUREMENT HARDWARE**

Development or modification of electronics for a specific industrial or research measurement task.

Partner-specific configurations are engineering adaptations: their scope and validation depend on the target hardware and measurement task.

The electronics and FPGA layer can therefore be contributed as part of SSEGAI or as a standalone development for integration into a partner application.

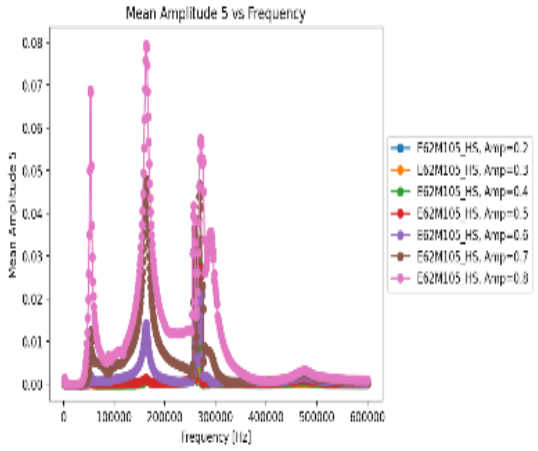
# DATA ANALYSIS AND HARMONIC ENERGY SIGNATURE

## Extracting material-related information from measured electromagnetic-field data

**Measured data are analysed to identify reproducible changes in frequency response and harmonic structure associated with material properties, structure and condition**

### CURRENTLY IMPLEMENTED

**Analysis of SSEGAI measurement data**




Frequency-dependent data and harmonic components are compared across specimens, material states and measurement conditions. Their amplitudes, positions and changes form the basis for material-related interpretation.

### DATA-ANALYSIS CAPABILITIES

**The analysis methods can be applied within SSEGAI or adapted to compatible experimental datasets provided by a partner.**

#### FREQUENCY-RESPONSE ANALYSIS

Analysis of measured quantities as functions of excitation frequency and measurement conditions.

#### HARMONIC-STRUCTURE ANALYSIS

Analysis of the fundamental and higher-harmonic components contained in the measured data.

#### FEATURE EXTRACTION

Identification of quantitative data features whose changes correlate with material properties, structure or condition.

#### PARTNER DATA ANALYSIS

Adaptation of the analysis methods to compatible experimental datasets obtained with a partner's measurement system.

Harmonic Energy Signature characterises the harmonic structure of the measured resulting electromagnetic field formed by interaction between the sensor field and the material's induced electromagnetic field.

Data-analysis methods can therefore be contributed as part of SSEGAI or used independently for a partner's experimental data and material-characterisation task.

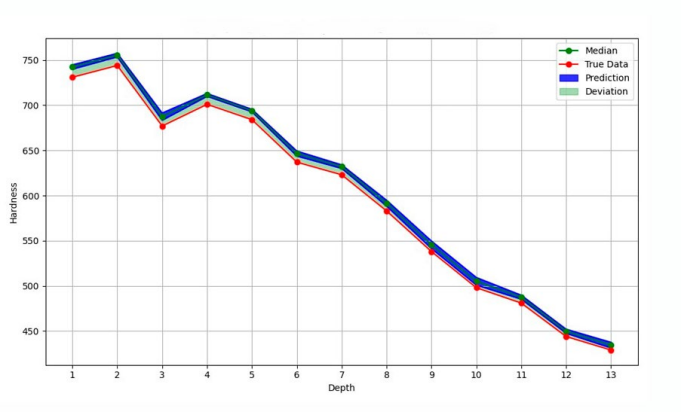
# AI AND MACHINE-LEARNING METHODS

## From analysed measurement data to material-property and condition models

**Neural-network and machine-learning models use analysed measurement data and extracted features to establish quantitative relationships with material properties and condition**

### CURRENTLY IMPLEMENTED

**Models trained on SSEGAI measurement data**




Trained models map measurement-derived data to target material characteristics using reference-labelled datasets. Model performance is verified against known or independently measured values.

### AI / ML CAPABILITIES FOR PARTNER APPLICATIONS

**The modelling layer can be adapted to a partner's own measurement data, target variables and industrial decision task.**

#### NEURAL-NETWORK MODELS

Training and adaptation of neural networks for nonlinear relationships between measurement-derived inputs and target material parameters.

#### REGRESSION & CLASSIFICATION

Quantitative property estimation, state classification and condition assessment from labelled experimental datasets.

#### MODEL TRAINING ON PARTNER DATA

Development of application-specific models using a partner's measurement data and available reference or ground-truth values.

#### MODEL VALIDATION & ADAPTATION

Performance evaluation, retraining and adaptation when materials, sensors, operating conditions or target tasks change.

AI/ML is not tied to SSEGAI hardware: where suitable labelled data exist, the modelling methods can be developed around a partner's own measurement system and application.

The AI/ML layer can therefore be contributed as part of SSEGAI or developed independently as a data-driven modelling component for a partner application.

# THANK YOU

Thank you for your attention

**SSEGAI • Material Intelligence**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