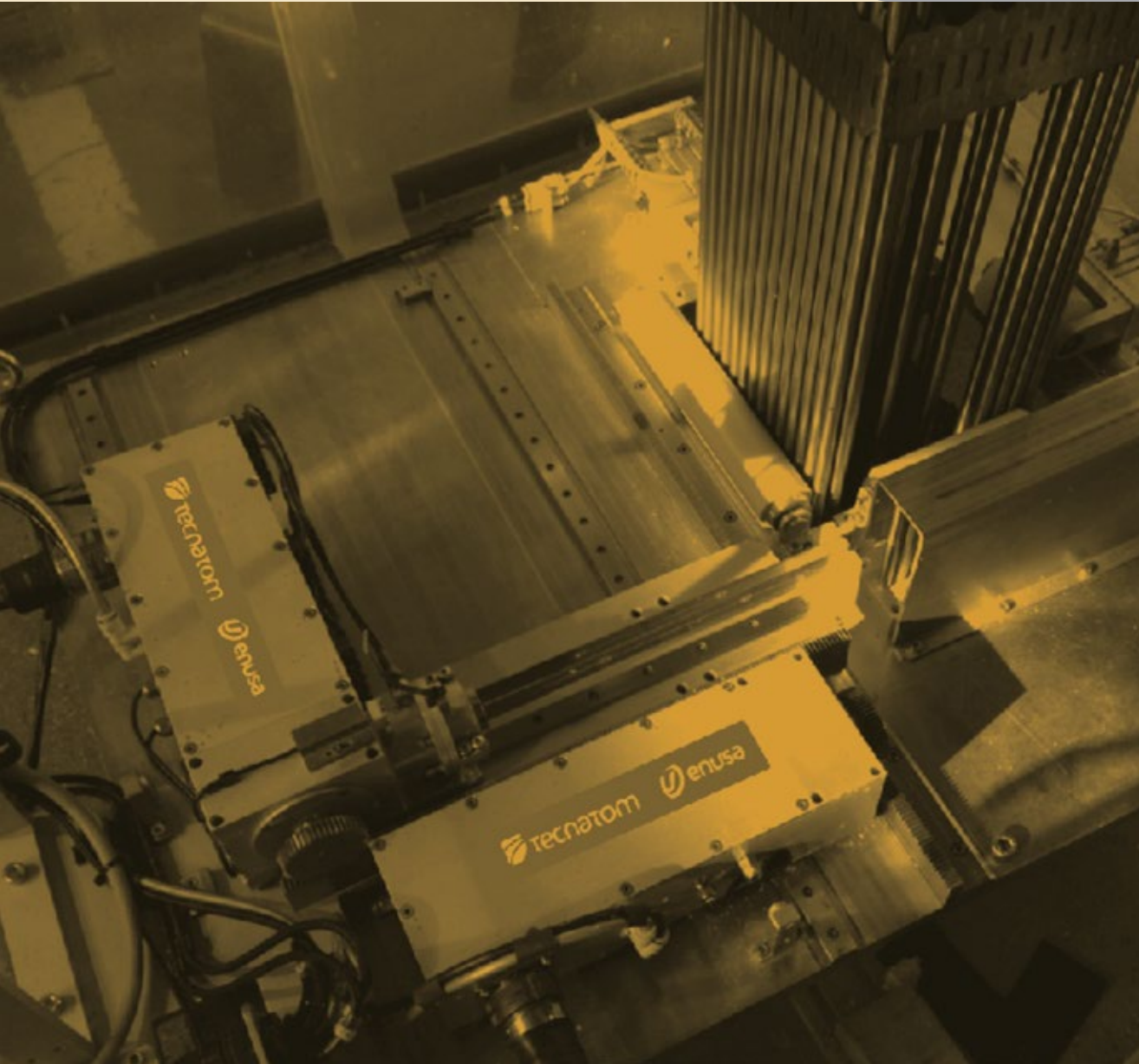


Ready for the future,
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NUCLEAR FUEL INSPECTION

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NUCLEAR FUEL INSPECTION

NEED OF FUEL INSPECTION

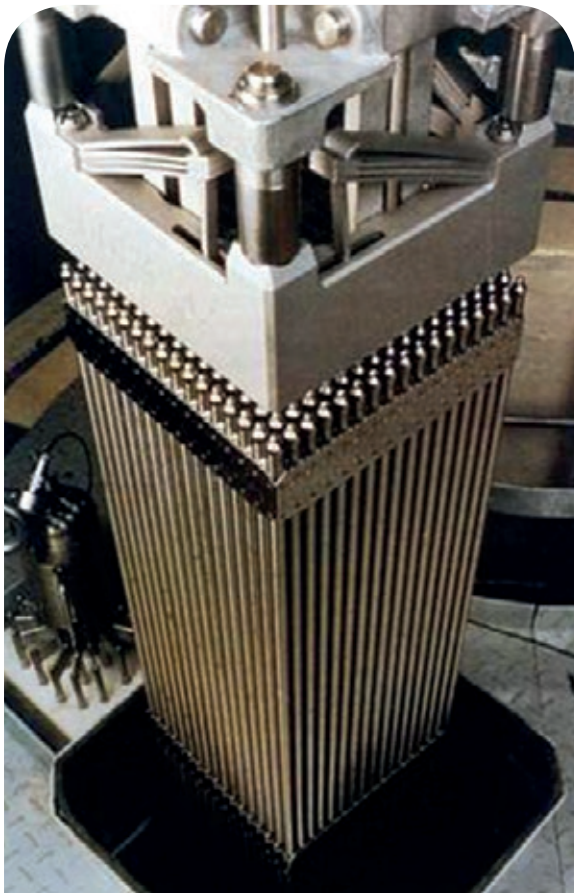
Do you need to know the behavior of the nuclear fuel in your plant?

Are you concerned with regard the ability to detect, characterize and accurately sizing potential degradations in the fuel?

Are you in need of engineering services such as monitoring, degradation & operational assessment and acceptance criteria?

Do you have issues with nuclear failed fuel and are you interested in knowing the root cause?

Did you know Tecnatom and ENUSA have the capabilities to help you answering those questions?



We can offer you the best cost effective solution with a highly improved qualified systems, and an experienced and qualified inspection team providing inspection services and recommendations for your nuclear fuel.

Since the mid 90's Tecnatom and ENUSA have been cooperating in the development and use of SICOM inspection systems for spent fuel assemblies characterization at PWR and BWR nuclear power plants. ENUSA engineering department is responsible for the assessment of the inspection results.

We have developed dedicated systems to cover different needs of the nuclear power plants, providing the best performance quality. Most systems are fully designed, and manufactured by ourselves and validated by the customers under strict specifications in order to increase the reliability and accuracy of the systems with regard the following objectives:

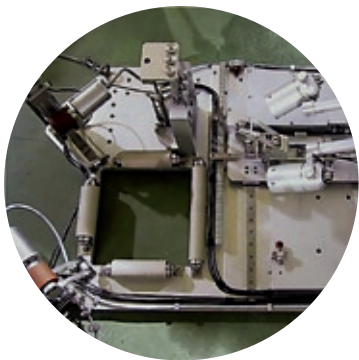
- Guarantee a safe operation.
- Optimize the economic performance of the fuel cycle.
- Locate and characterize flaws on failed fuel.
- Determine root cause of failed fuel.
- Redefine/Confirm fuel behavior models.

SICOM INSPECTION SYSTEMS

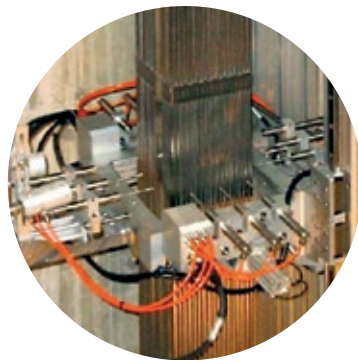
SICOM equipments are perfectly integrated to ensure effective, safe and quick nuclear fuel assembly inspections.

SICOM family is a technologically advanced solution that allows to characterize a wide range of fuel assembly components and evaluate integrity of the fuel assembly.

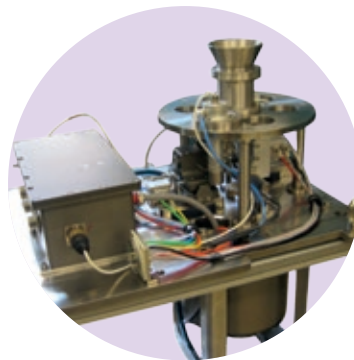
SICOM-COR



SICOM-DIM



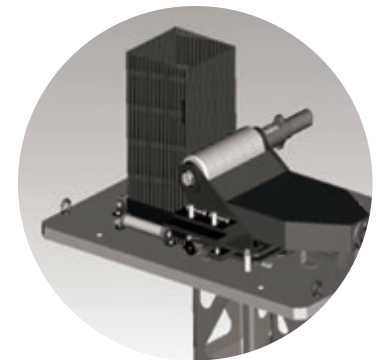
SICOM-ROD



SICOM-LEN



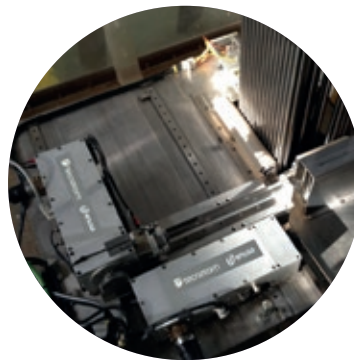
SICOM-LIM



SICOM-G-FR



SICOM-NG-FA



SICOM-UT



SICOM ON-LINE SIPPING



SICOM IN-CAN SIPPING

NUCLEAR FUEL INSPECTION

SICOM INSPECTION SYSTEMS

The SICOM family is comprised by the following inspection systems:



■ SICOM-COR

System for peripheral fuel rod oxide layer measurements and visual inspection.



■ SICOM-DIM

System for dimensional characterization of the fuel assemblies.



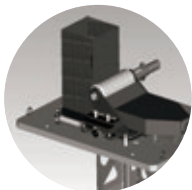
■ SICOM-ROD

System designed for inspection and characterization of fuel rod (Corrosion, profilometry, thickness loss, section loss, crack detection and its length).



■ SICOM-LEN

Designed for fuel rod length measurement with artificial vision technique.



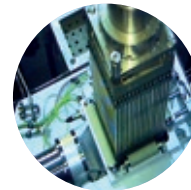
■ SICOM-LIM

Designed for cleaning crud deposits in peripheral rods in a PWR fuel assembly.



■ SICOM-G-FR

System for fuel rod radiometric characterization. Measurements on pellet stack length for burnup verification and on plenum area for Kr-85 concentration.



■ SICOM-NG-FA

System for fuel assembly radiometric characterization. Gamma and neutron detectors for burnup verification.



■ SICOM-UT

Detection of failed fuel rods.



■ SICOM ON-LINE SIPPING

Detection of leaking fuel assembly during refueling activities.

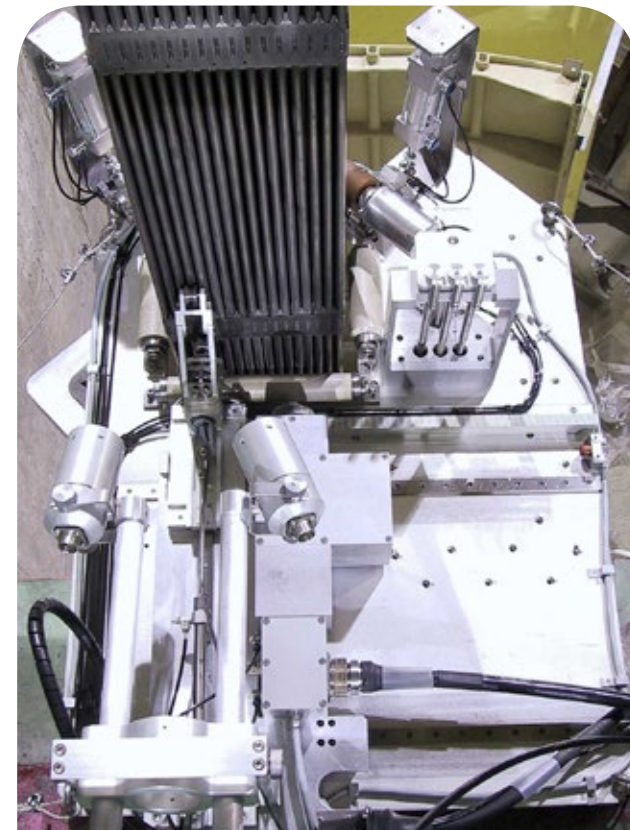


■ SICOM IN-CAN SIPPING

Detection of leaking fuel assembly at spent fuel pool.

SICOM-COR

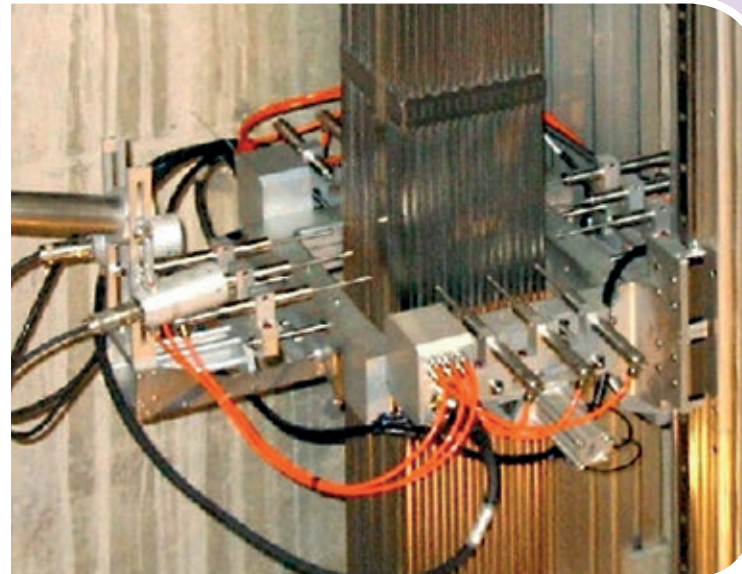
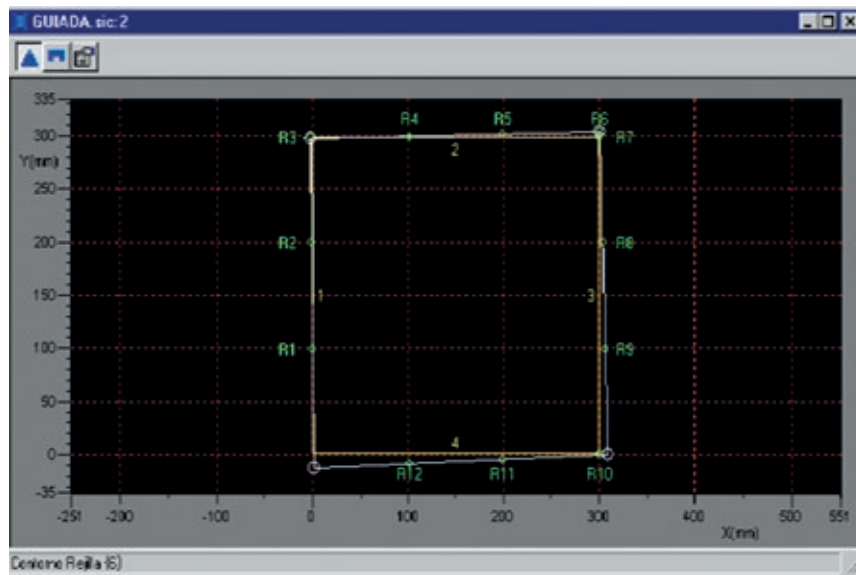
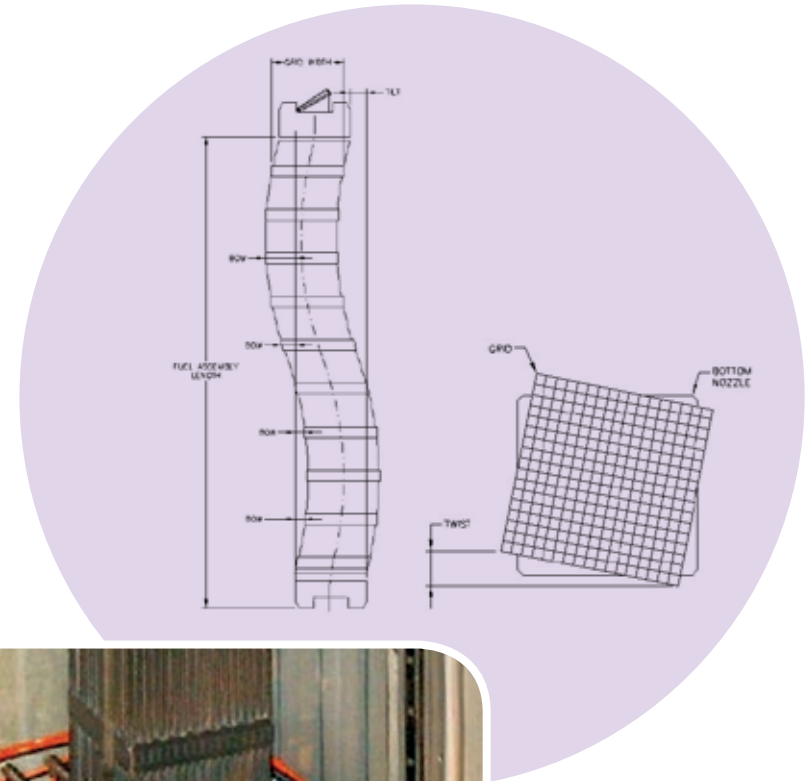
- Performs Oxide Layer measurements on peripheral fuel rods of a fuel assembly by means of Eddy current Testing (ET). Dimensional characterization (fuel rod to top nozzle gap, spacing between rods) can also be carried out by Visual Testing (VT).
- Light inspection system. Installation on racks of the spent fuel pool.
- Scan of entire length of fuel assembly by means of the manipulating fuel crane (axial position information is acquired on each scan).
- Integrity Visual inspection, focusing on:
 - Upper / Lower nozzles and springs.
 - Rods, Grids and plugs.
 - Spacing between rods.
 - Rods displacements.



NUCLEAR FUEL INSPECTION

SICOM-DIM

- Full length measurement of fuel assembly.
- Dimensional characterization of fuel assembly by LVDT's devices
 - Grid width measurements.
 - Deviations from vertical axis on every grid (Bow).
 - Fuel assembly twist determination with respect to the lower nozzle.
 - Upper nozzle inclination with respect the lower nozzle (Tilt).
 - Length of fuel assembly.



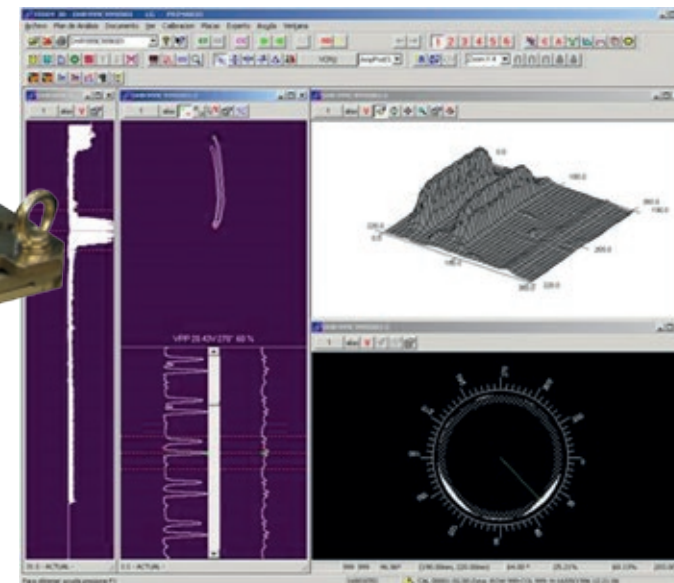
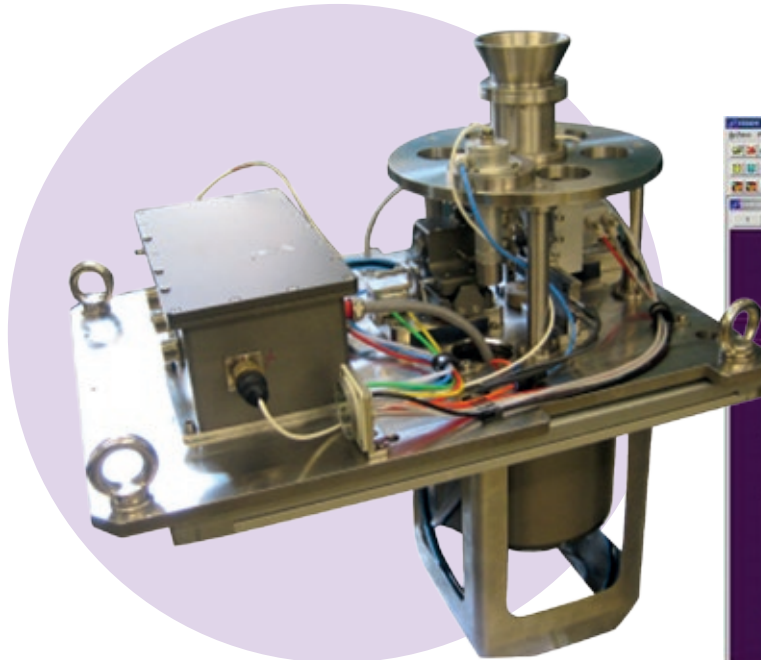
SICOM-ROD

System designed for inspection and characterization of fuel rods in PWR and BWR fuel type.

Capabilities:

- Profilometry by LVDT's devices.
- Oxide Layer measurement by ET.
- Rod integrity inspection by ET.

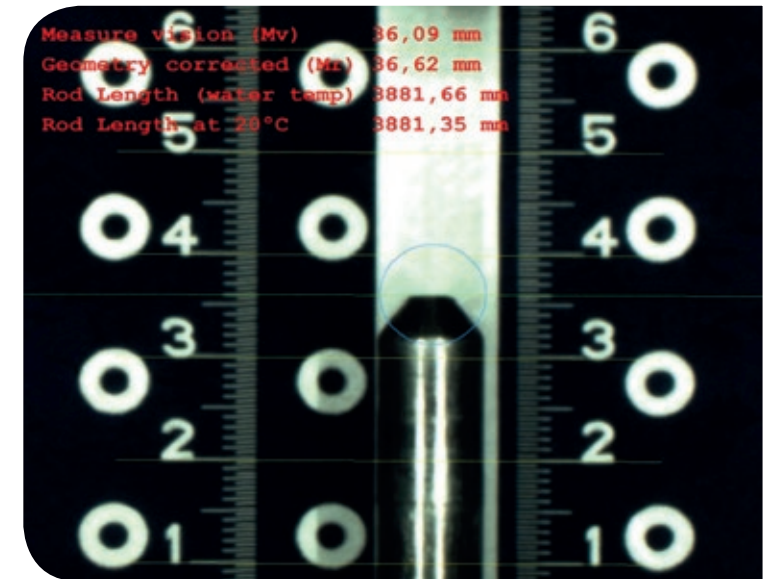
MEASURE	TECHNIQUE
OD diameter	LVDT
Oxide layer thickness	ET (pancake)
Cross section loss	ET (bobbin coil)
Local loss of wall thickness	ET (rotating pancake coil)
Crack length	ET (rotating pancake coil)



NUCLEAR FUEL INSPECTION

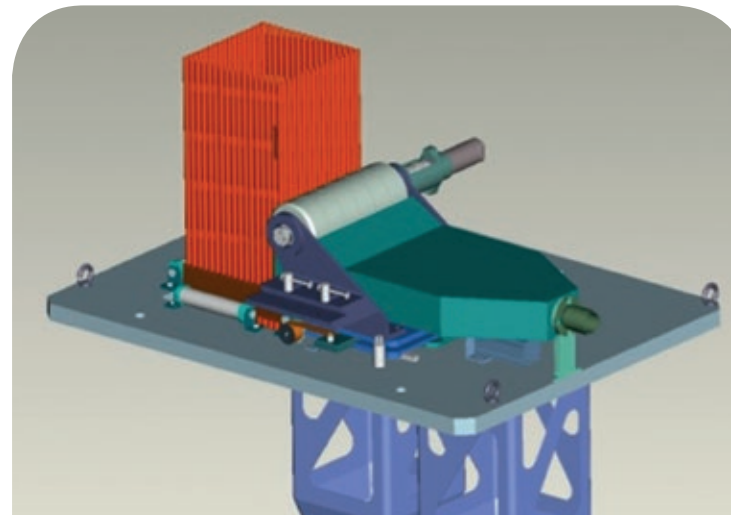
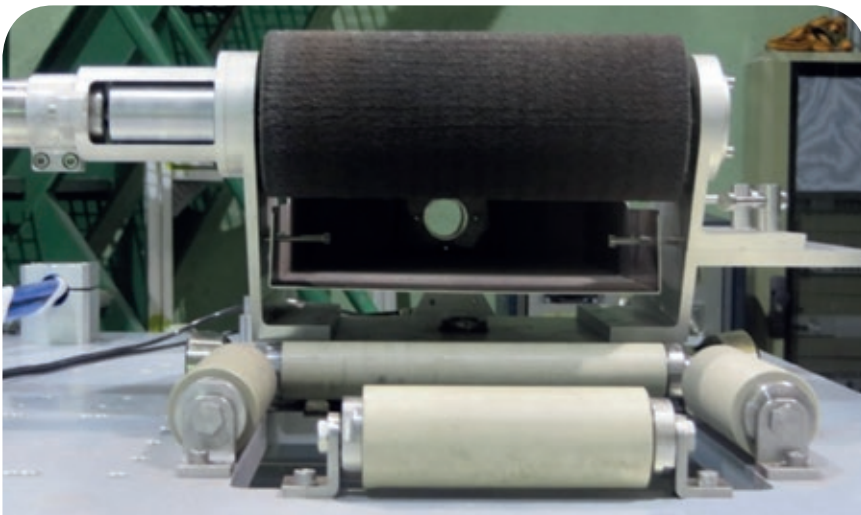
SICOM-LEN

- Fuel rod length measurement with artificial vision technique.
- System applicable to measurement of fuel rods PWR and BWR.
- Automatic generation of reports and inspection records.



SICOM-LIM

- System designed for cleaning crud deposits in peripheral rods in PWR fuel assembly.
- Cleaning of fuel assemblies performed before SICOM COR inspection to get more reliable oxide thickness measurement.

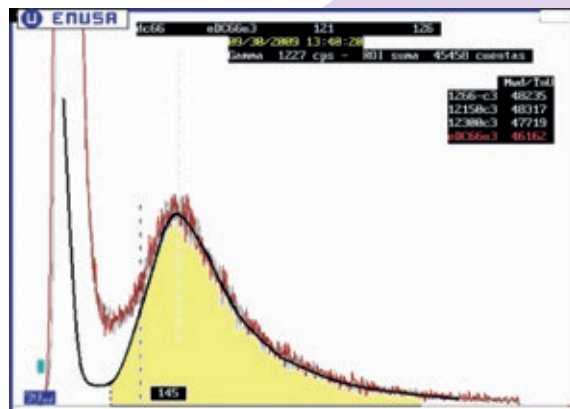
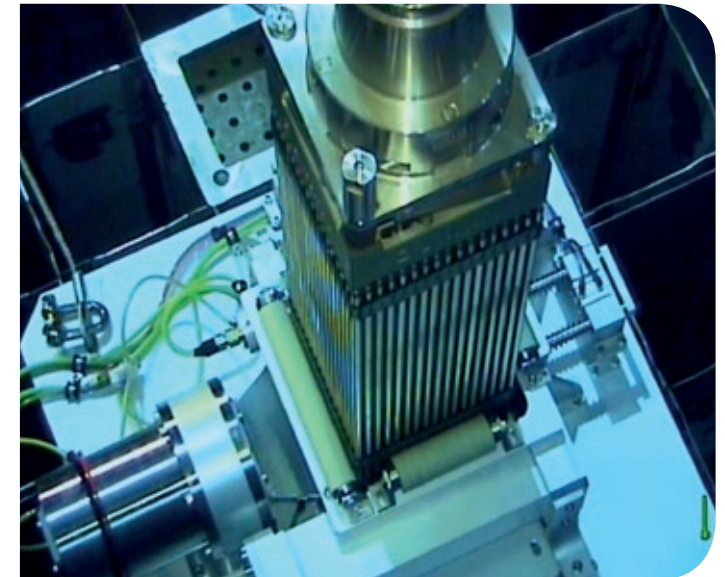


SICOM NG-FA

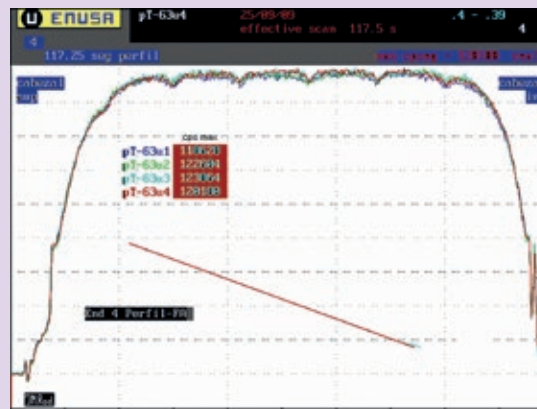
Radiological characterization of the spent fuel assembly by means of gamma and neutron detectors. System validated with real fuel assembly.

Measurements:

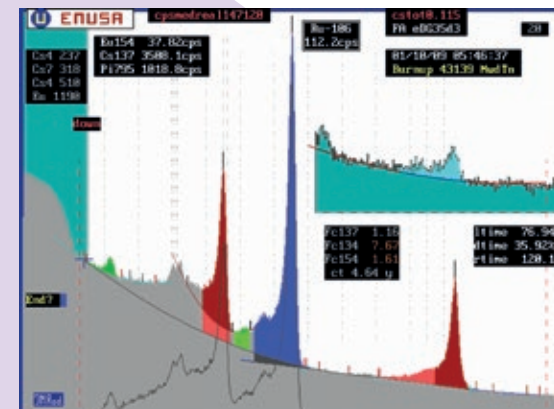
- Burnup.
- Gamma and neutron profiles.
- Great axial spatial resolution.



Neutron spectrum on the 4 faces
of the fuel assembly.



Gamma profile of the fuel
assembly.



Gamma spectrum on the 4 faces
of the fuel assembly.

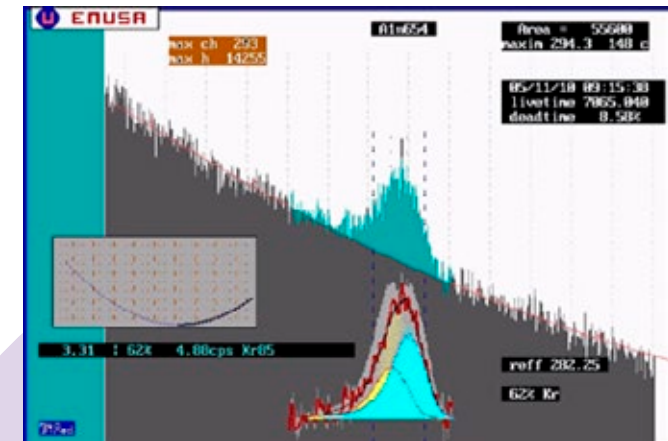
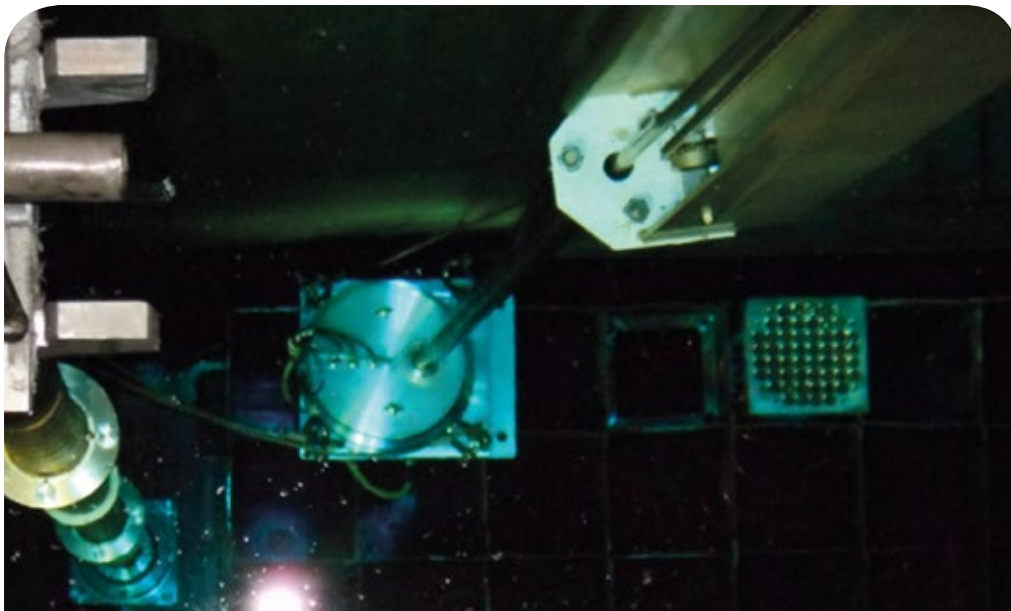
NUCLEAR FUEL INSPECTION

SICOM G-FR

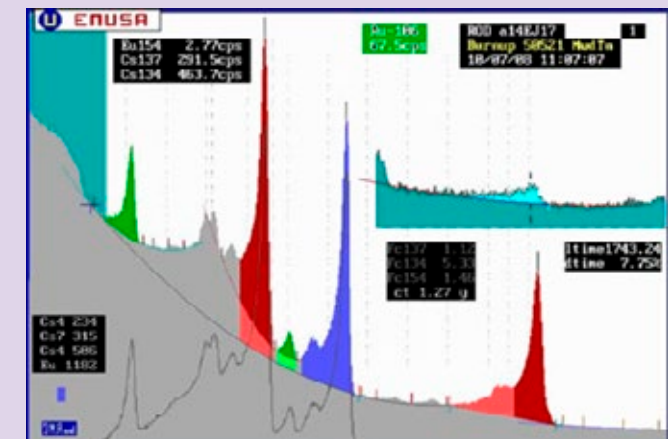
Radiological characterization of the spent fuel rods. System validated with real fuel rods.

Measurements:

- Great axial spatial resolution.
- On pellet stack length: axial burnup profile and average burnup.
- On plenum area: Kr-85 concentration.



Kr 85 Spectrum in the plenum area



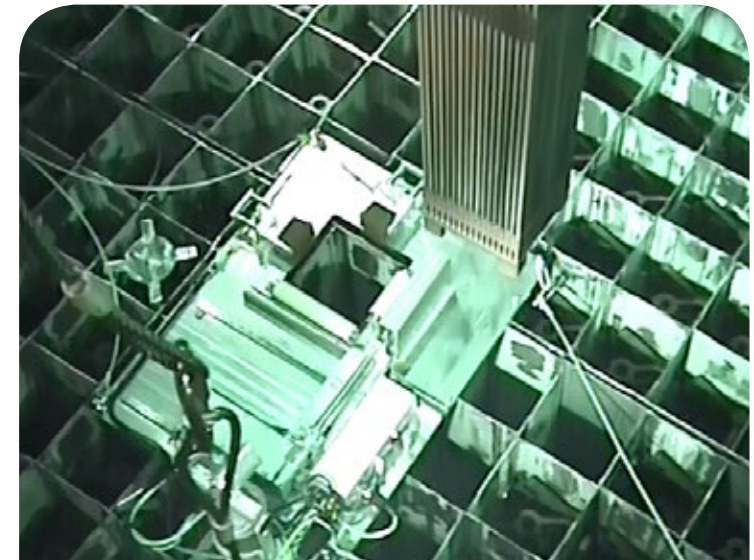
Gamma Spectrum

SICOM-UT

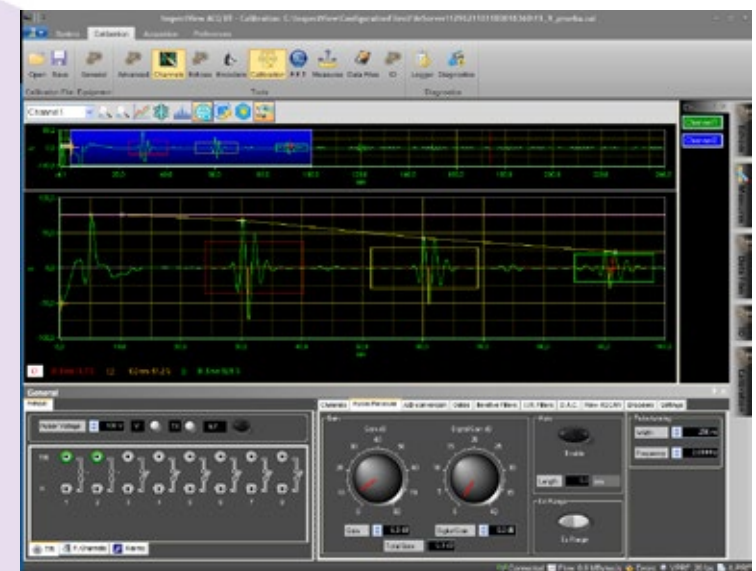
Detection of failed fuel rods by UT method. Validated system with real fuel assembly.
Acquisition system with digital automatic data evaluation and reporting.
Post-inspection re-edition and re-evaluation, without repeating data acquisition.

System features:

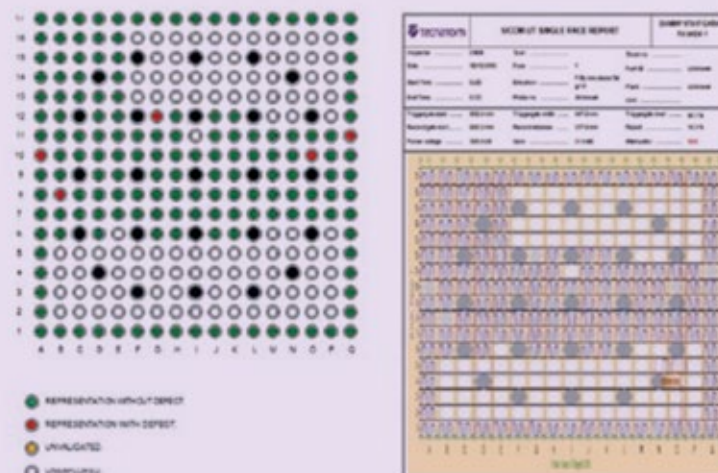
- X-Y movement system of a emitter/receiver UT probe.
- UMAC technology interface with Ethernet.
- Specific software (InspectView).



Automatic analysis report



Easy analysis representation map



NUCLEAR FUEL INSPECTION

SICOM ON-LINE SIPPING

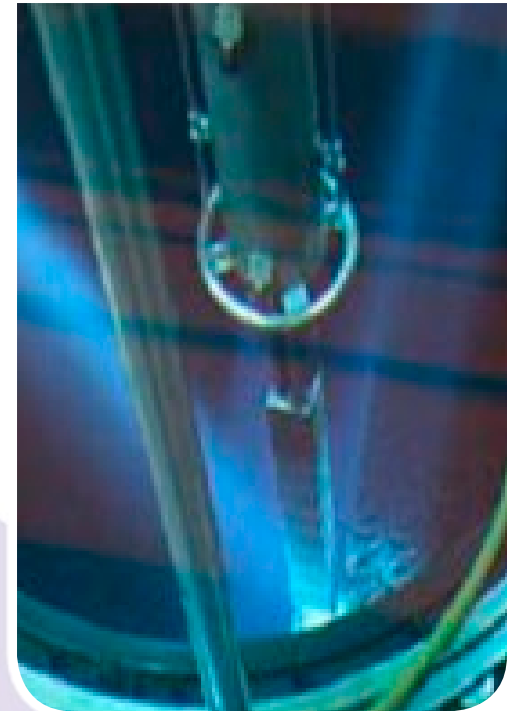
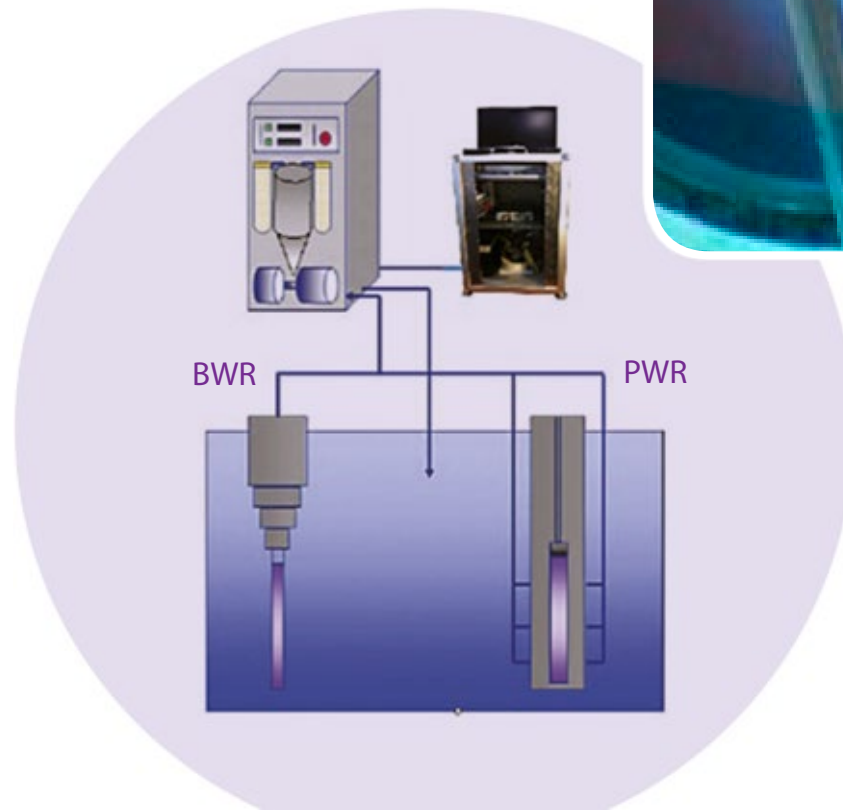
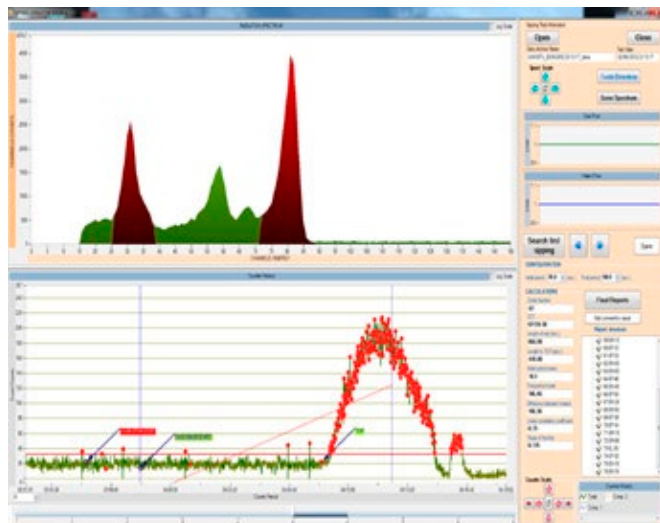
On-line sipping is performed during the normal fuel handling during core download to detect leaking fuel assemblies.

No time consuming on critical path.

The system consists of three main components: Suction unit, Process unit and Digital unit.

The dedicated software platform is based on outstanding spectrometry applications.

Several Regions of interest can be followed graphically at the same time as well as the spectra appears in real time on the display.



SICOM IN-CAN SIPPING

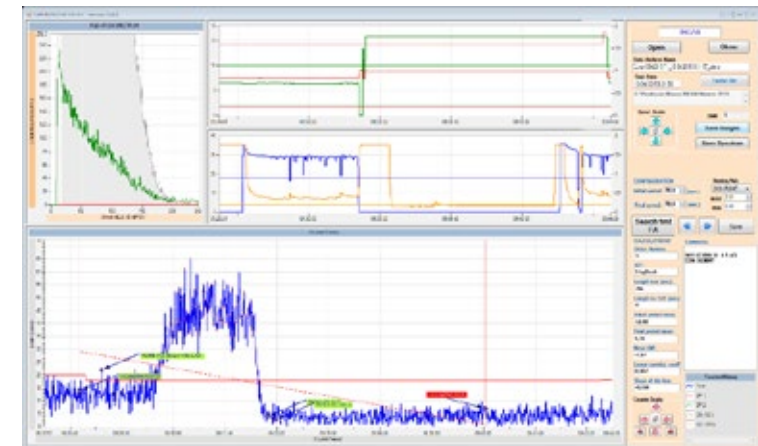
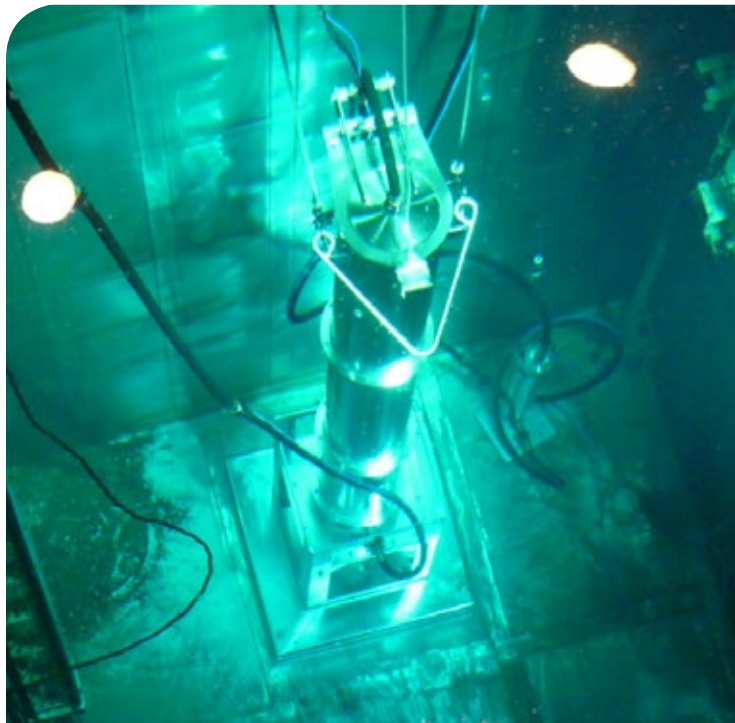
Detection of leaking fuel assembly at spent fuel pool.

The system produces a release of fission products by vacuum.

Liquid sampling system, separation process for gas phase.

Beta detector for gas Kr-85.

System validated with real failed fuel assemblies.



Specific software to record and check
operation parameters



NUCLEAR FUEL INSPECTION

Ready for the future,
caring for the customer

REFERENCES AND CERTIFICATIONS

Tecnatom and ENUSA have wide experience in performing nuclear fuel inspection campaigns in numerous European nuclear power plants (NPP). In all of them, inspections have already successfully been performed.

Several systems and inspection procedures have been qualified in a real components for both national and abroad customers.

Our main references are:

- Almaraz NPP.
- Ascó NPP.
- Belleville NPP.
- Forsmark NPP.
- Garoña NPP.
- Olkiluoto NPP.
- Tihange NPP.
- Trillo NPP.
- Vandellos NPP.



Inspection Team:

- Wide expertise from Team Leaders.
- Well experienced and trained inspection technicians.
- High qualified engineering department for the assessment of inspection results.



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