

# Online Testing of ERW-Welded Tubes with PAUT

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## 1 Abstract

A new testing system has been developed by KARL DEUTSCH to facilitate the online inspection of ERW-welded tubes to detect material flaws caused by the welding or descaling process. With the ECHOGRAPH SNHF PAUT, a robot arm is positioned beside the customer's inspection line. This arm carries a probe holder into which various phased array probes can be inserted depending on the required diameter range. The concave-shaped probes cover a large area on both sides of the weld seam. During testing, the phased array probe is positioned concentrically to the tube which moves under the probe holder. The tubes are tested in endless mode. The advantage of using phased array technology in this application is the large scanning area, making seam tracking obsolete even if the weld seam is slightly out of position. The system is regularly calibrated with reference defects located parallel to the test line. Typical reference defects are longitudinal notches N5 and N10 and FBH 3.2 mm.

**Keywords:** ERW-welded tubes, PAUT, online testing, robotic automation

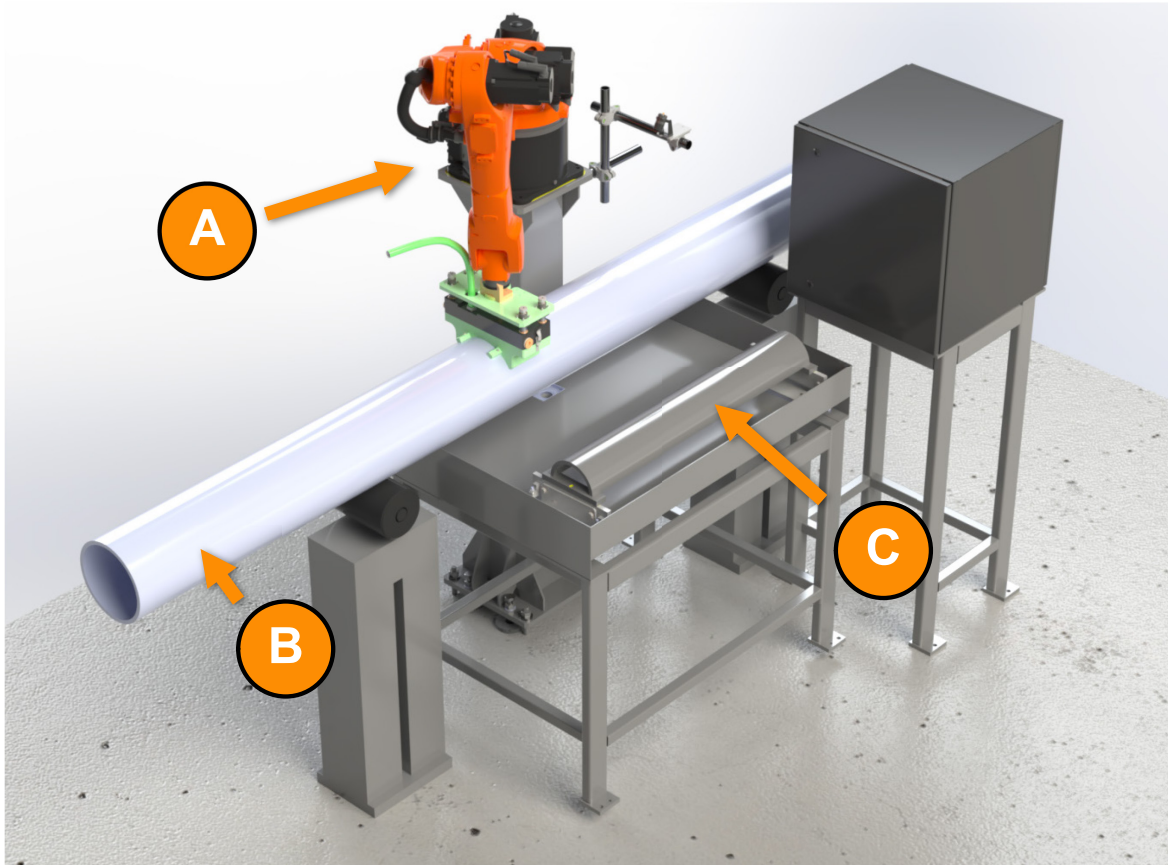
## 2 Introduction

In this project, a testing system for ERW-welded tubes manufactured at MARCEGAGLIA was required that is automatic, quick and flexible in its application. Compliance with the standards ISO 10893-11, API 5L 46<sup>th</sup> edition (Line Pipe) and ASTM E273.15 were mandatory. The ECHOGRAPH SNHF PAUT system developed by KARL DEUTSCH and KARL DEUTSCH ITALY employs phased array technology. The probes are applied to the test piece with an automated robot that checks endless pipes online and utilises its own parallel calibration station for consistent test quality. The objective is to find weld seam defects that can occur during the descaling or welding process.

## 3 System Concept

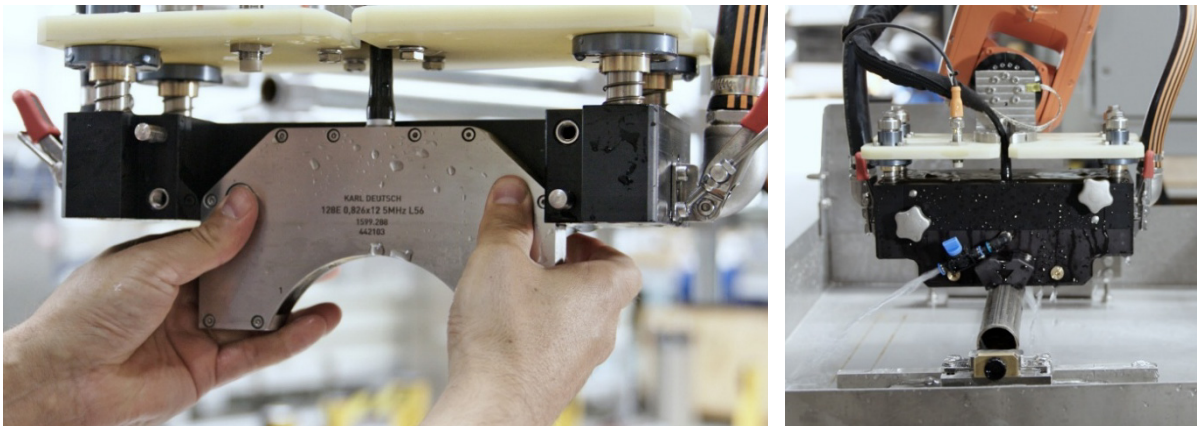
The system is designed for online inspection and is positioned next to the production line. Its central component is a robot arm (Fig. 1, A) carrying the probe holder. Various phased array probes can be inserted depending on the required diameter range. The production line (Fig. 1, B) is tested in endless mode. During testing, the phased array probe is positioned concentrically to the tube with the tube passing beneath the probe holder. A calibration station (Fig. 1, C) is mounted next to the test line, into which tube half-shells are inserted, providing different diameters with reference flaws (typically longitudinal notches N5 and N10 and FBH 3.2 mm).

To verify the test settings, reference measurements must be carried out at regular intervals. During calibration, the robot moves the probe holder over the reference tube with the same test speed as the test line.



**Fig. 1.** Test setup: Robot arm (A), inspection line (B), calibration station (C)

The probe holder allows for different PAUT probes to be inserted depending on the required diameter range of the tube (see Fig. 2).



**Fig. 2.** Mounting of a PAUT probe for a different pipe diameter

## 4 Ultrasonic Testing Configuration

Phased array technology offers a major advantage in weld seam inspection, as the linear scan covers a wide area around the weld seam. Compared to conventional ultrasonic testing, the overlapping ultrasonic waves of PAUT probes deliver more reliable results with a better resolution (see Fig. 3).

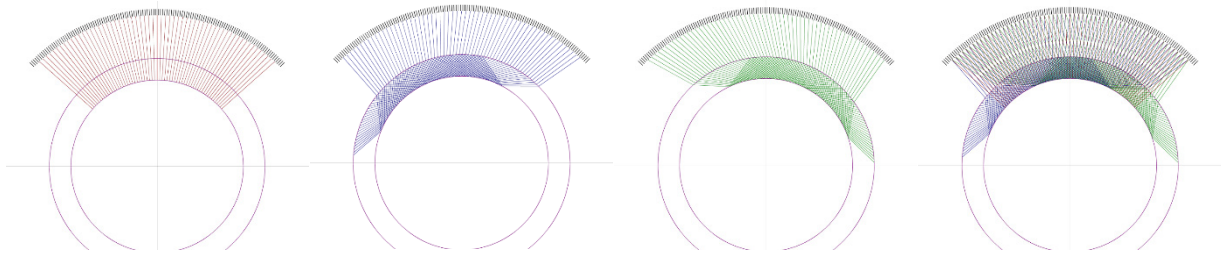


Fig. 3. Ultrasonic sound waves in the tube

The operator does thus not have to move the inspection system radially if the weld seam deviates from the ideal position. Seam tracking technology is not required with this approach. Should an operator detect excessive deviation of the weld seam from the ideal position through the installed camera (see Fig. 4), the probe holder can be adjusted online using a joystick. The system could also be operated automatically. In this case, the probe and calibration tube would be selected by the robot.

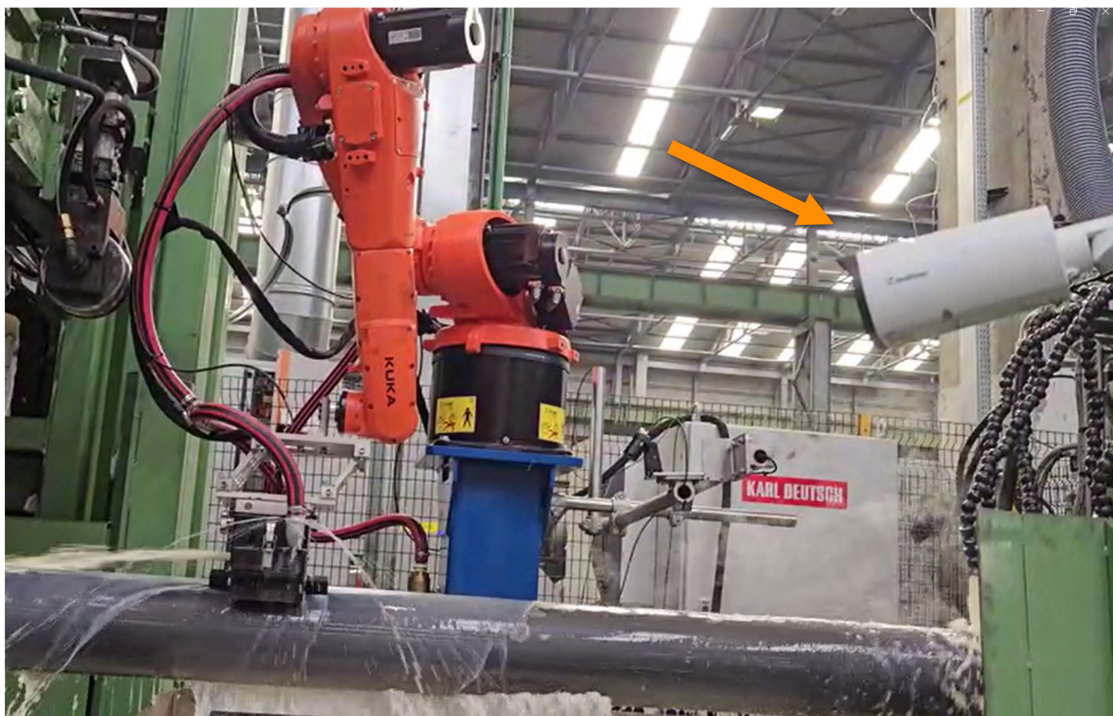
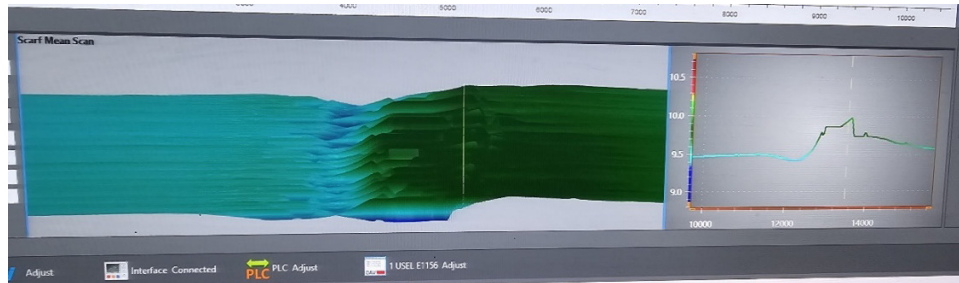


Fig. 4. Production line at MARCEGAGLIA with camera

Beside the inspection of the weld for flaws, PAUT allows for the simultaneous verification of the thickness of the weld bead (see Fig. 5). As a result, the proper function of the deburring tools can be monitored, as their malfunction results in a change of weld thickness.



**Fig. 5.** Scarf Mean Scan in evaluation software ECHOVIEW

The phased array probes for this project are a compromise for detection of longitudinal and lamination defects; they could also be used for wall thickness measurements. Diameter-specific skids allow improved guidance of the probe holder on the surface and therefore reproducible transmission of the ultrasound into the material. Coupling takes place by means of a water gap (see Fig. 6).



**Fig. 6.** Water gap coupling of PAUT probe

## 5 Conclusion

The ECHOGRAPH SNHF PAUT is a new system for online testing of ERW-tubes. Compared to conventional systems for this use case, this development utilises a single PAUT probe whose scanning area eliminates the need for seam tracking technology. This probe can furthermore be exchanged to allow for testing of different pipe diameters. The system can thus be adapted to different testing tasks, increasing its flexibility. A robot arm has been used to mount the probe and apply it to the inspection line, making this solution more space-efficient than conventional systems for online testing.

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