INTEGRADDE. Quality control strategy for early detection of defects in AM building process. In line monitoring using uncooled high speed infrared cameras sensitive in the MWIR spectral range.

INTEGRADDE will rely on the use of a multimodal infrared and visible imaging to acquire geometrical and thermal information of the molten pool. The use of high speed (up to 2 kHz) uncooled imaging sensor technology sensitive in the MWIR spectral range (1-5 microns) from NIT combined with CMOS industrial cameras is being explored in the frame of the project activities. The final goal is to develop common monitoring principles for direct energy deposition (DED) processes.

The advantage of using high speed cameras sensitive in the MWIR spectral range for monitoring DED processes is associated to the combination of two main facts: 1) MWIR spectral band provides optimum thermal contrast of melt pool, much better than the provided by shorter wavelengths sensors, and 2) the capability of detecting processes fluctuations in a very dynamic scenario. In INTEGRADDE real time monitor and control of both, WAAM and LMD-w processes, are under studied. Different optical arrangements are being developed and implemented. So, Irepa laser and NIT have developed, by the first time, a coaxial optical arrangement for LMD-w processes. Figure 1 shows a picture of the coaxial arrangement of NIT camera in the LMD-w head of Irepa Laser. Figure 2 shows images of the melt pool captured during the deposition process. In parallel, activities related with in line monitoring and controlling WAAM processes are being carried out in the frame of INTEGRADDE project. Figure 3 shows the set up used in the test trials done at West university. Figure 4 shows melt pool image obtained with NIT camera during metal deposition with WAAM during test trials done at West University. Figure 5 shows the dynamics of the melt pool during the deposition of a layer. The information captured by NIT camera will be used for extracting key features for real time control of the processes.

Real-Time (RT) control is being implemented based on the different features of the melt pool. In INTEGRADDE they will be built on an embedded control architecture (FPGA/ARM SoC) endowed with hardware and software programmability. FPGAs offer unique performance for RT process control, whilst ARM allows parallel processing capabilities. This control architecture has been implemented previously by project partners for RT embedded control, because offers processing intensive capabilities for machine vision and signal processing applications.

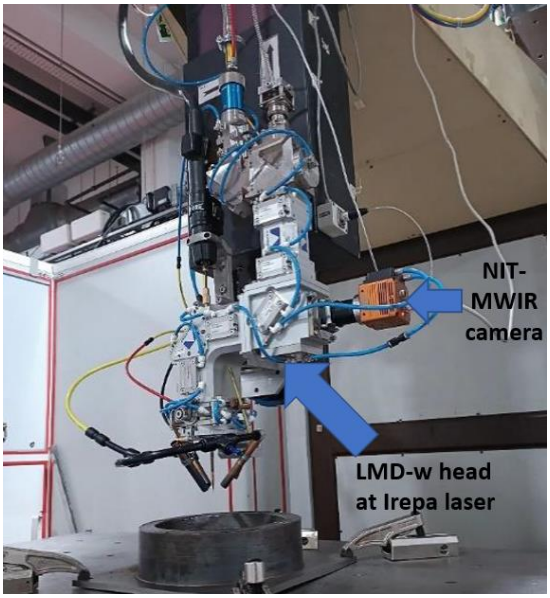

Figure 1.- NIT camera coaxially installed at Irepa Laser LMD-w system

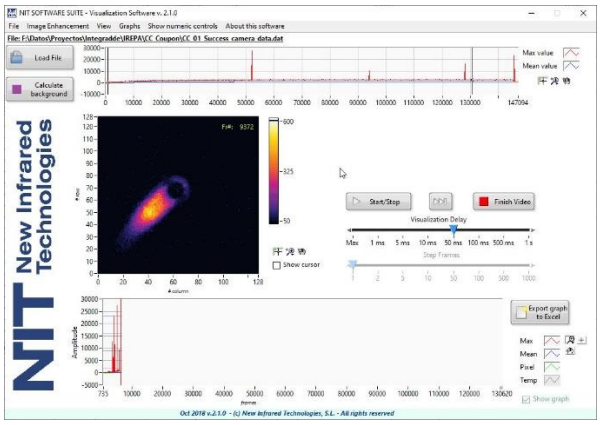

Figure 2.- Melt pool image obtained coaxially during LMD-w deposition process at Irepa Laser premises.

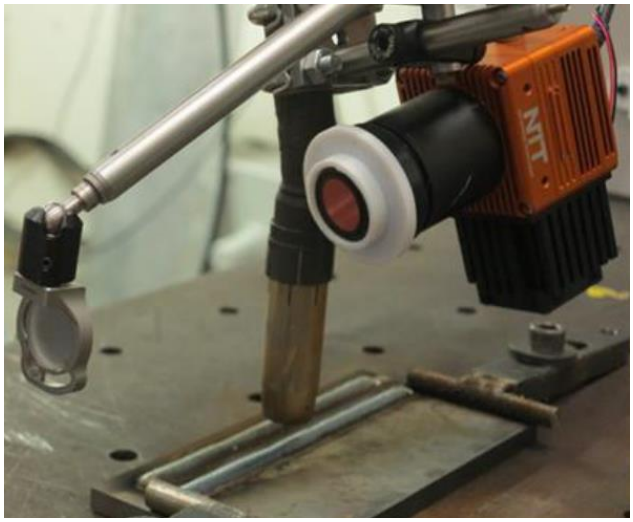

Figure 3.- Set up used at West University for monitoring WAAM processes

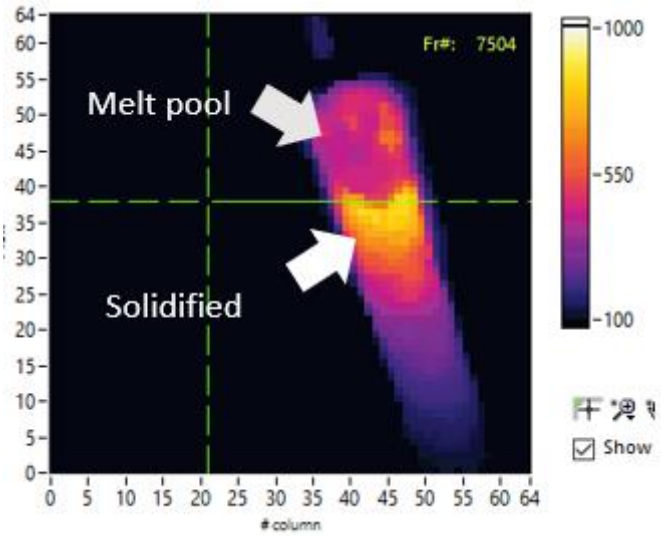

Figure 4.- Melt pool image captured during a WAAM deposition process. The lower emissivity of melted material makes the apparent temperature of melt pool lower than the solidified material.

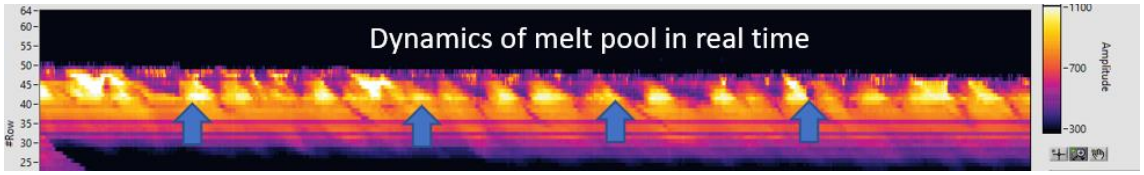

Figure 5.- Melt pool dynamics recorded during the deposition of a metal bed. It is possible to see the dynamics of the melt pool in real time