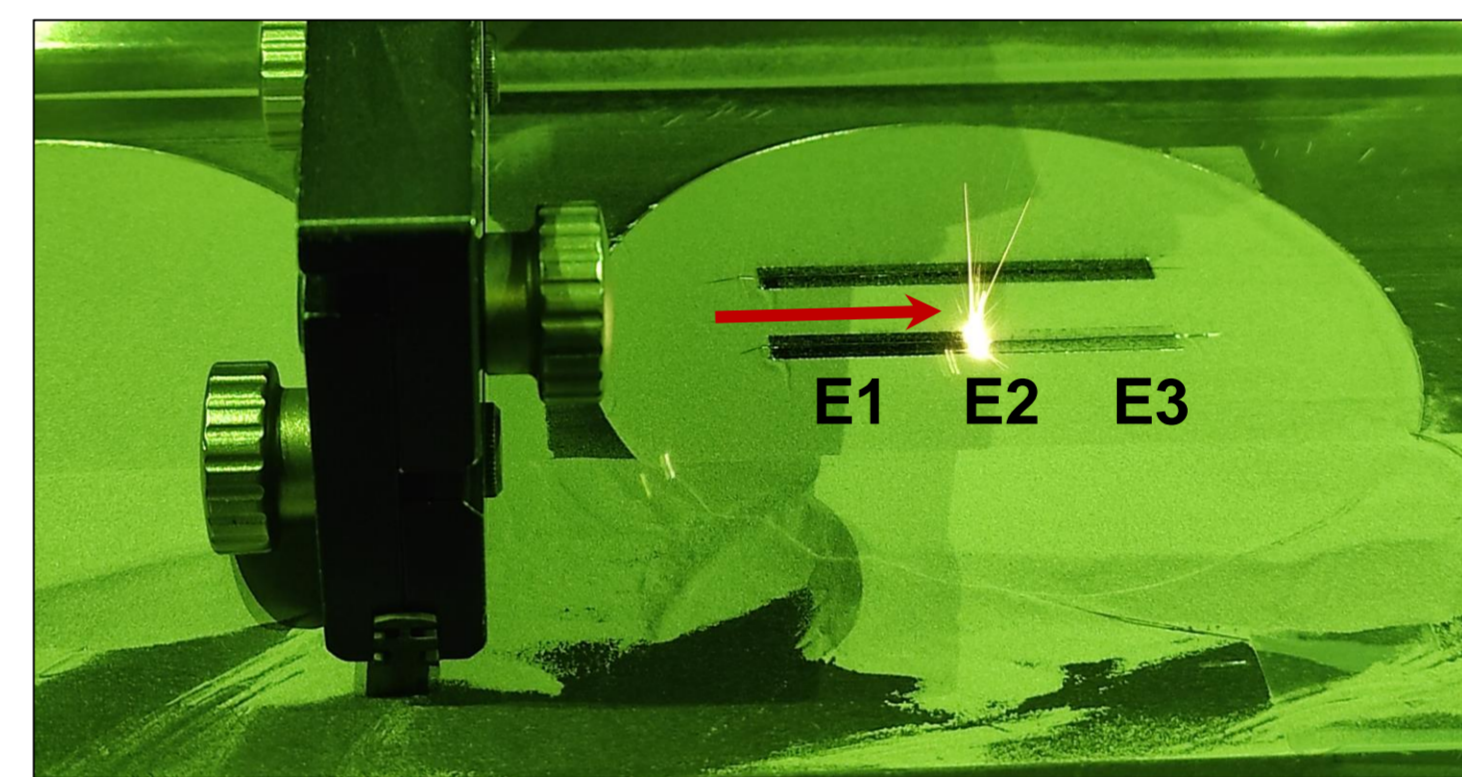
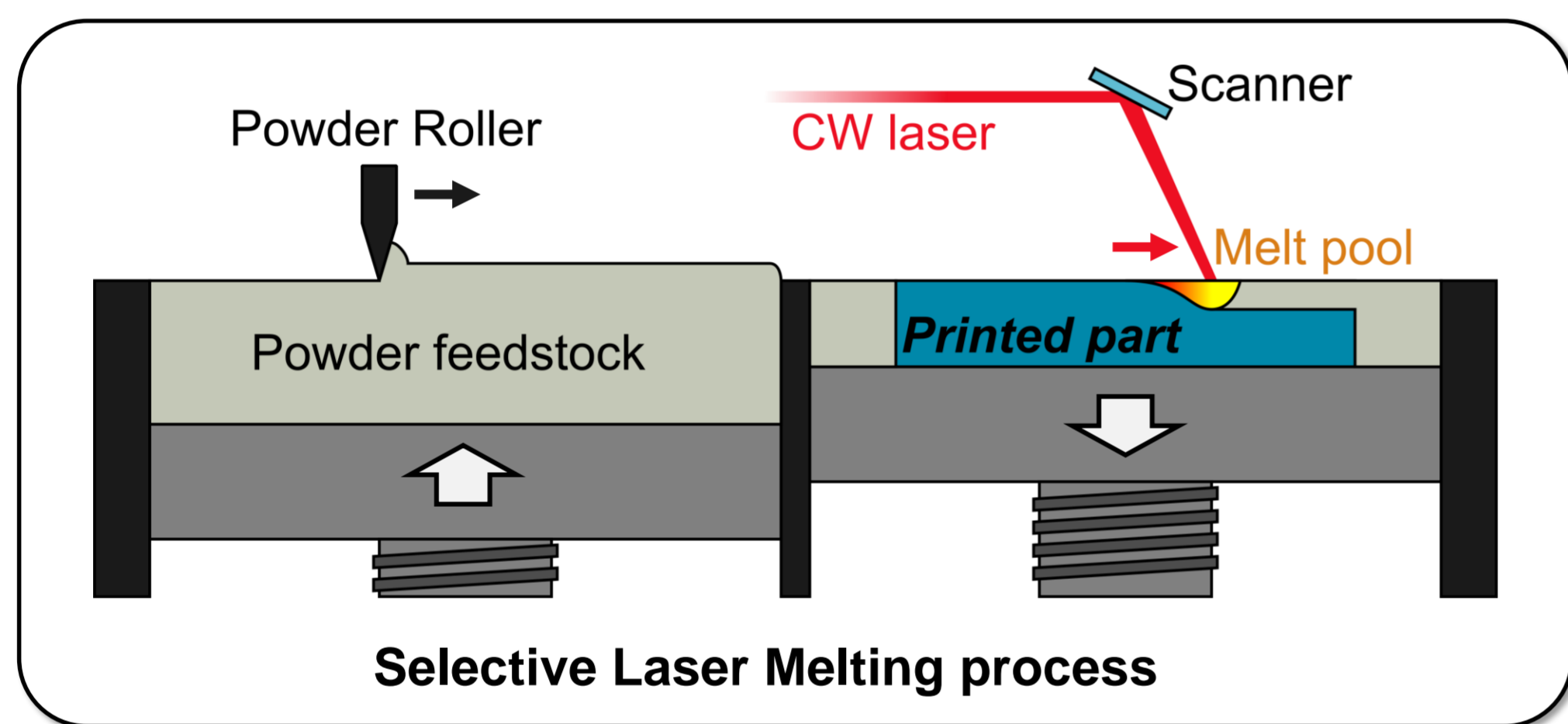
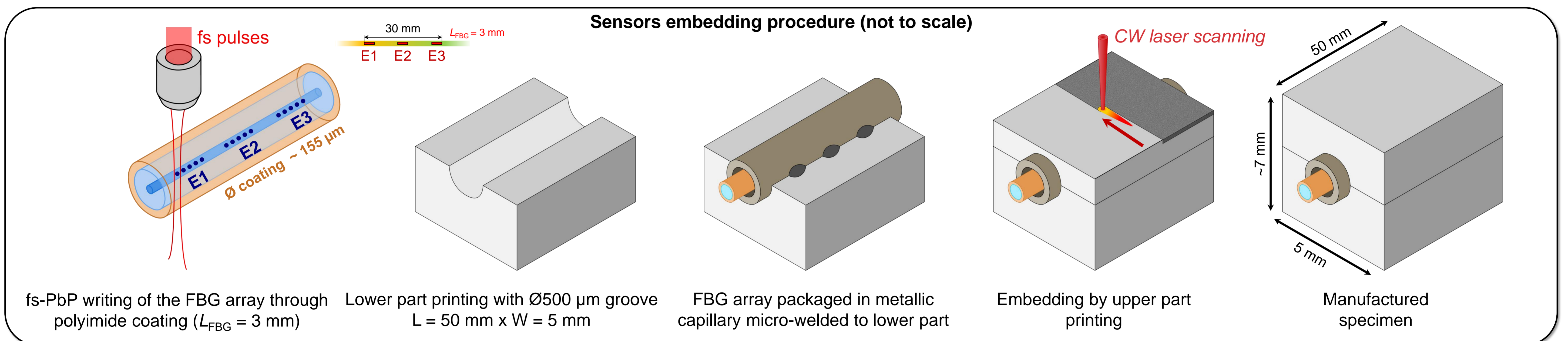


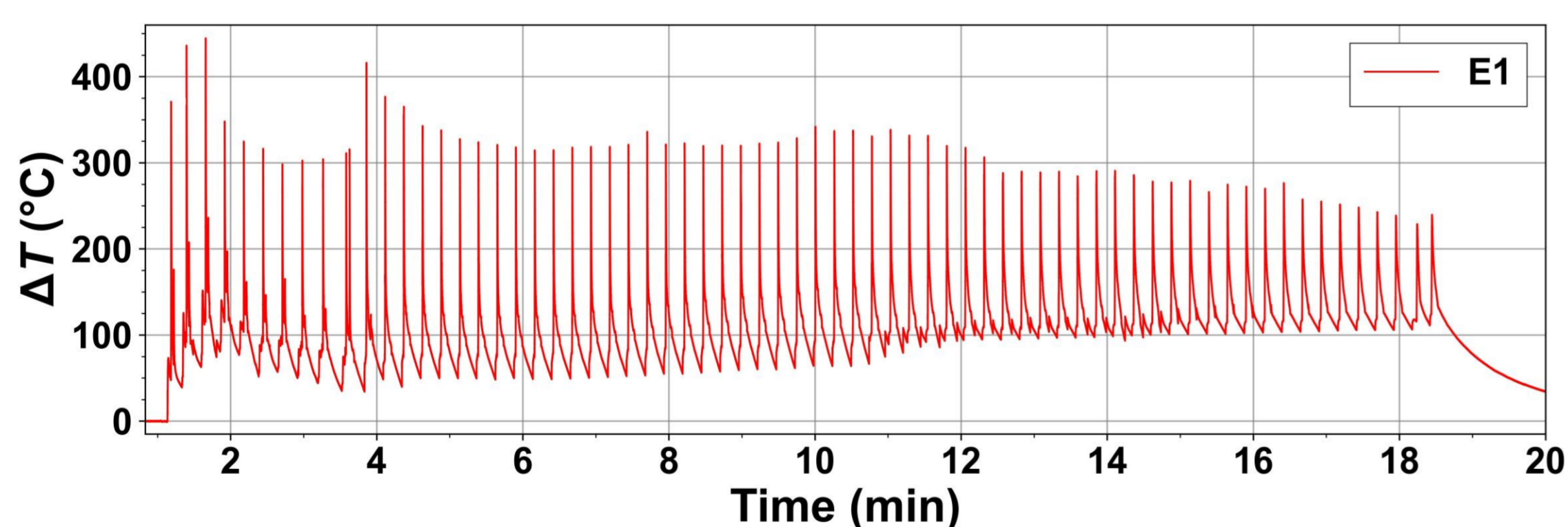
Abstract

Additive Manufacturing (AM) processes rely on the layer-by-layer production of parts with complex geometries. The embedding of sensors inside the printed materials allows to perform the *in-situ* monitoring of the AM process, as well as the monitoring of the parts during their usage in potentially harsh environments. We used an array of Fiber Bragg Gratings directly written in a polyimide-coated single mode fiber using the femtosecond point-by-point technique (fs-PbP FBGs) to monitor the temperature along a 316L stainless steel specimen additively manufactured by Selective Laser Melting (SLM). These gratings can withstand temperatures up to 1000°C. The FBG array was placed inside a steel capillary, hence it was sensitive to temperature only. Monitoring of the FBGs wavelengths at a scan rate of 5 kHz allowed multi-point temperature measurements and thermal dynamics monitoring throughout the process.

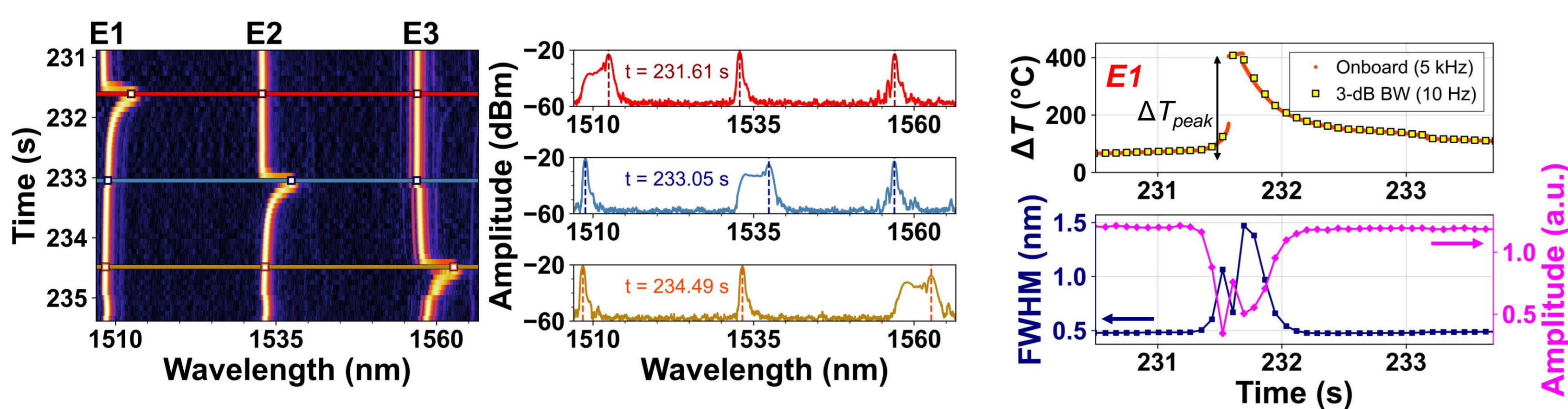
1 OPTICAL FIBER SENSORS ARRAY MANUFACTURING AND EMBEDDING BY SLM



2 SLM TEMPERATURE MONITORING USING FEMTOSECOND-WRITTEN FBGs



- ▶ Monitoring using si255 (Micron Optics) optical sensing instrument
 - 5 kHz on-board peak detection (based on zero-crossing of spectrum derivative)
 - 10 Hz spectral read out (3-dB bandwidth (BW) peak detection, FWHM and amplitude calculation)
- ▶ Each layer → ΔT induced by laser scanning
- ▶ $n_{\text{layers}} \uparrow \rightarrow$ decrease in ΔT due to thermal insulation by upper layers
- ▶ All FBG sensors show nearly identical ΔT
- ▶ Baseline increase → heat conduction into substrate plate



- ▶ Successive shift of spatially distributed FBGs
- ▶ Spectral chirp (FWHM increase) induced by thermal gradient

Conclusion and Perspectives

- ▶ Complete SLM process **temperature monitoring** of a 316L specimen performed
- ▶ **Thermal dynamics** successfully recorded at 5 kHz scan rate
- ▶ Measurements not severely impacted by **FBGs spectral distortions** due to thermal gradient induced chirp
- ▶ Peak temperature per layer dependent on material thickness
- ▶ **Transient process modeling** under investigation
- ▶ Coming next: *in situ* SLM monitoring **close to the melt pool** with high temperature FBGs **directly embedded** inside the part
- ▶ **Structural Health Monitoring (SHM)** of instrumented parts operational in harsh environments