## Parallel implementation of Time-Domain airborne SAR focusing

## J. Euillades1, P. Berardino1, I. Catapano1, C. Esposito1, R. Lanari1, A. Natale1, S. Perna1,2

### 1Istituto per il Rilevamento Elettromagnetico dell’Ambiente (IREA) Consiglio Nazionale delle Ricerche (CNR), Via Diocleziano 328, Napoli, Italy, 2Dipartimento di Ingegneria (DI) Università degli Studi di Napoli “Parthenope”, Centro Direzionale Isola C4, Napoli, Italy.

### euillades.j@irea.cnr.it, berardino.p@irea.cnr.it, catapano.i@irea.cnr.it, esposito.c@irea.cnr.it, lanari.r@irea.cnr.it, natale.a@irea.cnr.it, stefano.perna@uniparthenope.it

Airborne Synthetic Aperture Radar (SAR) systems offer high-resolution imaging, rapid deployment, and operational flexibility, making them particularly suitable for time-critical applications such as environmental monitoring and emergency response. Compared to satellite-based systems, their lower flight altitudes enable improved azimuth resolution and shorter revisit times. However, accurate focusing of airborne SAR data must account for motion errors resulting from attitude instabilities and deviations from the planned linear trajectory. Airborne SAR data focusing can be carried out in the Frequency-Domain (FD) or in the Time-Domain (TD). While Frequency-Domain algorithms are computationally efficient, Time-Domain focusing achieves higher accuracy in producing Single Look Complex (SLC) images, at the cost of higher computational demand.

In this work, we present a performance assessment of two Time-Domain SAR focusing strategies—pixel-wise and matrix-wise—implemented using the airborne SAR infrastructure operated by IREA-CNR (Naples, Italy), which includes a SAR sensor named MIPS and a multi-node, multi-thread Information Technology (IT) platform for storage and processing. To leverage these parallel computing capabilities, both strategies are further extended to parallel execution frameworks.

Experimental results indicate that the pixel-wise strategy outperforms the matrix-wise approach in terms of computing time. Moreover, parallel processing significantly accelerates computation, which is critical for scenarios requiring prompt data turnaround such as emergency response and environmental monitoring.

Current developments are focused on migrating the parallel implementation to GPU-based architectures. This aligns with the ITINERIS project’s mission, as the IT platform was recently enhanced with GPU-equipped servers to fully exploit their parallel processing power. Implementing the presented TD focusing strategies on GPUs is expected to further improve processing time efficiency, enabling faster generation of high-quality SAR imagery. Such advancements will support near real-time monitoring capabilities, enhancing rapid decision-making in environmental management and emergency scenarios, and thereby reinforcing ITINERIS’s objective to strengthen Italy’s research infrastructure through cutting-edge technological innovation.

**Keywords:** **Airborne Synthetic Aperture Radar (SAR), airborne infrastructure, parallel Time-Domain SAR focusing.**