Performance evaluation of a versatile and low-jitter WR board designed for radio-telescopes

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Among the wide panel of time and frequency transfer solutions over fiber networks, White Rabbit (WR) represents a significant technology by providing a standardized solution while offerings precision and reliability in synchronizing distributed systems, such as telecommunications, finance, and scientific research[1]. White Rabbit introduces fresh opportunities for networked systems and research infrastructures due to their reduced operational cost, and paves the way for future innovations built on precise timekeeping. White Rabbit is at the same time a technology under active R&D to improve further its performance. The drive to enhance White Rabbit hardware and software stems from the need for ultra-precise timing capabilities and arbitrary in-phase frequency generation, particularly in research fields like radio astronomy (e.g. to synchronize multiple dishes and accurately tag events for capturing celestial phenomena), physics detector systems that require synchronization across multiple detectors and precise time tagging for triggerless systems, and accelerator synchronization interested by a seamless distribution of master oscillator signals to improve the overall accelerator efficiency and its reliability.

Our primary focus for this work lies in developing a radio telescope demonstrator tailored for 3D mapping of the universe's atomic hydrogen distribution[2]. Here we report on our progresses on the development of a high performance low-jitter electronic board based on WR core, so-called IDROGEN. We will report on the evaluation of timing and frequency signals versus the active H-masers operated at SYRTE and show timing stability at 1-ps within 1 day of integration, and control of time offset below 10 ps. We will focus on the capability of IDROGEN to rephase accurately RF signals up to 500 MHz (see fig. 1). We believe this technology demonstrates great potential for addressing the rigorous demands of high-precision timing applications and could be applied to the link SYRTE to the radio-telescope in Nançay in a near future.

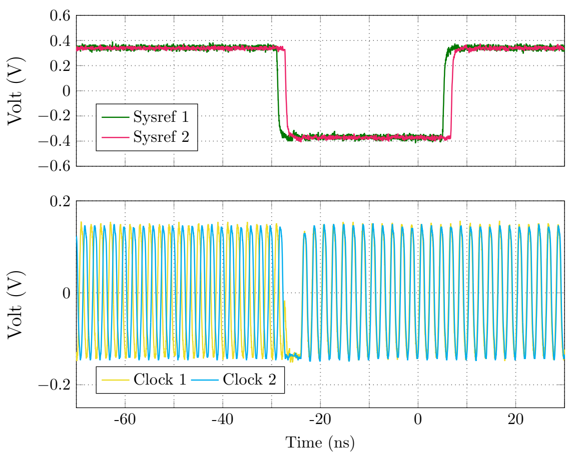

Fig. 1: Example of a sine wave generation at 500 MHz by two IDROGENs boards (bottom plot), phase-locked by WR on a common WR switch. On the plot one sees the two waves resynchronized after the falling edge a following a resynchronisation pulse derived from the WR process (upper plot).

[1] « IEEE 1588-2019 see. https://standards.ieee.org/standard/1588-2019.html

[2] R. Ansari *et al.* (2020) doi: 10.1093/mnras/staa345.