

## SILOSCAPE—Flexure-based Escapements for Mechanical Watches

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*Combining its expertise in the domains of micro-manufacturing techniques and precision mechanisms, CSEM has been a pioneer in the design and production of centimeter scale silicon parts featuring fine mechanical functions, opening up new opportunities for the design and production of novel and innovative watch mechanisms. In the frame of the SILOSCAPE MIP, CSEM is focusing on the design and production of novel high-performance watch oscillators and escapements.*

Silicon is an interesting material for the design of precise mechanical parts such as the ones encountered in watch mechanisms: it is amagnetic, corrosion free, and characterized by an ideal elastic behavior, a high fracture strength and a low density. Using microfabrication techniques inherited from the microelectronic industry (DRIE), it can be batch processed with a micrometric precision for the production of large quantities of centimeter scale mechanical parts that can comprise several levels with fine mechanical functions such as flexure blades. Thanks to all these interesting properties, Silicon offers new opportunities for the design and production of novel and innovative watch mechanisms. In the late 90's CSEM was a precursor in this field [1], paving the way for a new trend that is now followed by several key players in the Swiss watch industry. Since then, CSEM has kept carrying on its pioneering work by pushing back the frontiers of the micromechanical structuration of silicon and by improving its mastery of the production of such delicate parts [2,3].

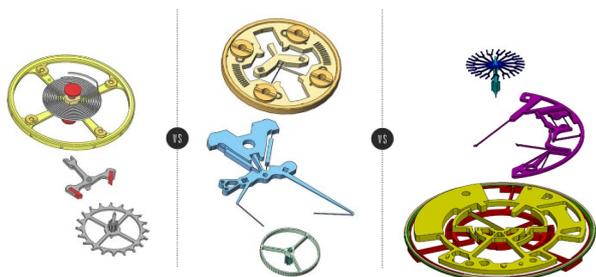


Figure 1: The Swiss anchor escapement (left), The Genequand escapement (middle), the Siloscape escapement (right).

The oscillator and the escapement, are the most delicate and high added-value technical parts of a mechanical watch; for the past ten years, CSEM has proposed several original designs of mechanical watch oscillators [4] and, in a close partnership with Vaucher Manufacture Fleurier, integrated at the watch level, the very original FlexTech and Silicon based Genequand [5] escapement, the first flexure based watch regulator (escapement + oscillator) ever designed and implemented at the watch scale. With the use of silicon as a base material for the design of a watch regulator, the conventional ruby pivots can be replaced by

flexure blade pivots, allowing a very precise and frictionless oscillations of the guided components.

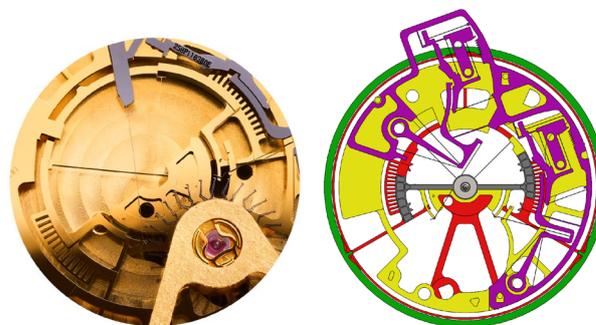


Figure 2: The Siloscape escapement integrated in a watch (left) and its latest updated design (right).

The Siloscape escapement [6], the latest escapement invented at CSEM, is also FlexTech based and paired with a Wittrick oscillator. This innovative escapement is characterized by a power reserve three times better than a conventional system, a good precision performance and is auto-starting by nature, which means that a large accidental shock cannot stop it. Besides, unlike the Swiss anchor and the Genequand escapements, the anchor of the Siloscape escapement is not made of a single part: the impulse planes are implemented on the oscillator itself, while the resting planes are implemented on two detents integrated together in a specific monolithic part which also plays a second function by allowing a fine tuning of the system's isochronism.

Pursuing its pioneering role, CSEM is now working on the design of two novel escapements adapted to flexure-based oscillators and targeting a very precise time keeping (typ. +/- 2s/d) rather than a large increase of the power reserve. The first escapement concept under investigation at CSEM aims at keeping the oscillator amplitude as constant as possible during operation to improve the time keeping precision of the watch. The second escapement concept under investigation at CSEM aims at simplicity and precise time keeping when paired with a flexure based oscillator such as the CR4 [4] oscillator. With these two novel escapements, a regular power reserve is targeted, the goal being to address a market segment complementary to the ones targeted by the Genequand and the Siloscape escapement.

- External key contributors: "Olivier Laesser" and "Winiger Horloger"

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[2] O. Dubochet, *et al.*, "L'hybridation du silicium : vers une simplification de l'intégration de composants silicium dans les mouvements horlogers", SSC, 2015.

[3] M. Despont, *et al.*, "Tic-Tac" made in Silicon", SSC, 2019.

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[5] F. Barrot, *et al.*, "Un nouveau régulateur mécanique pour une réserve de marche exceptionnelle", SSC, 2014.

[6] F. Barrot, *et al.*, "SILSOCAPE—a novel silicon-based flextech watch escapement", CSEM Scientific and Technical Report (2019) 20.