

> **WHAT IS THE CHALLENGE WITH VEH?**

A simple battery will always be cheaper than an energy harvesting system BUT what if you cannot get to the battery to replace it? This situation occurs in industrial sectors including security, transportation, healthcare, consumer electronics, and others. VEH system is an emerging technique that promises to produce energy to run a low-power device such as IoT sensors.

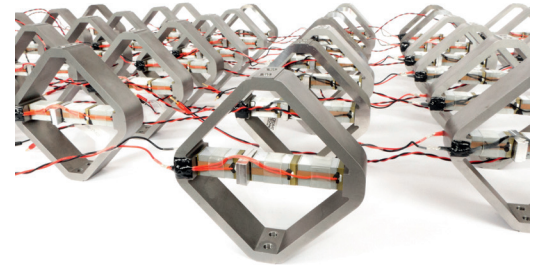


Fig. 1: APA® production batch

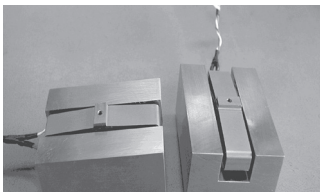
There are two challenges with energy harvester nowadays: The first one is to get a safe and durable VEH systems that need no maintenance. The second one is to power-efficient systems that harvest enough energy with real vibration profiles (random, chocs ...).The first challenge is tackled using spaced qualified piezo product such as APA®, The second is reached using patented bistable structure for wideband generator.

> **APA® BASED VEH FOR ROBUSTNESS**

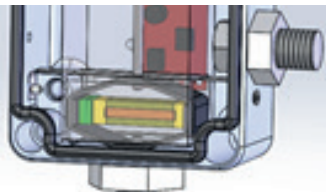
Although initially designed for actuation, APA® are particularly well suited for energy recovery, due to their robustness and good electromechanical characteristics. These piezo components have proved high technological maturity through aerospace qualifications: 10<sup>10</sup>cycles no failure, shock 500G, high thermal behaviour. In addition Cedrat Technologies covers a wide range of size and produces thousands of COTS APA® every year.

Four of them are presented hereafter.

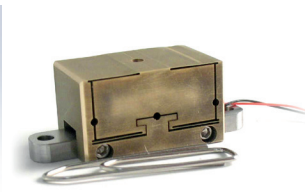
> **APA400M**



> **APA60SM**



> **APA50XS**



> **APA30UXS**



The performances of each APA® based VEH are raised in the following table:

APA® TYPE	POWER (MW)	PAYLOAD MASS (G)	FREQUENCY (HZ)	VIBRATION (G)	DIMENSIONS (MM)
APA400M	95	250	110	2.3	35x50 H25
APA60SM	20	50	1200	1.5	30x15 H45
APA50XS	4	30	450	1.2	20x15 H15
APA30μXS	0.014	3	18	0.1	10x6 H6

Table 1: APA® based VEH performances

As an example, the APA400M VEH performances are drawn below:

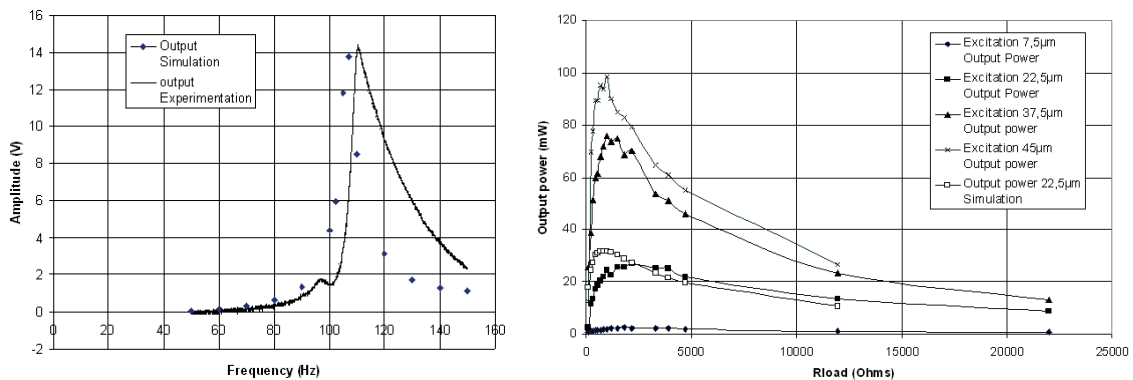


Fig. 2: Voltage and power generation with 2G excitation

### > WIDEBAND BISTABLE STRUCTURE FOR POWER EFFICIENCY

One important challenge is that the narrow frequency bandwidth of linear energy harvesting is inadequate to adapt the ambient vibrations, which are often random and broadband.

Therefore, CEDRAT TECHNOLOGIES exploits patented bistable structures to realize broadband energy harvesting and improve energy-harvesting efficiency.

These last two prototypes have the advantage of being particularly compact and robust.

Thanks to the patented bistable structure the harvester is able to generate an electrical power on a large bandwidth: from 20 to 70 Hz. With a volume of 5.46 cm<sup>3</sup>, a maximum power of 2.6 mW is obtained, corresponding to a power density of 0.483mW/cm<sup>3</sup>. The bandwidth is also improved by 812% compared with the linear equivalent generator

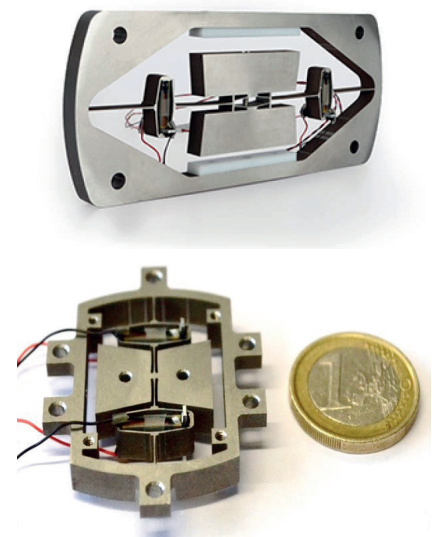


Fig. 3: Patented bistable structure for APA based VEH

### > ONGOING PROJECTS AND PARTNERS

- Wideband, nonlinear bistable structures for VEH are born in the University of Savoie Montblanc (USMB), more precisely in the Systems & Materials for Mechatronics Laboratory (SYMME). This technology has become mature through [PULSCE](#) maturation project. CEDRAT TECHNOLOGIES produces and commercially exploits SYMME's inventions through long terms partnership.
- CEDRAT TECHNOLOGIES is involved in [H2020 Fast Smart Project](#).
- In France, BPI granted RAILMON PSPC project in 2021.

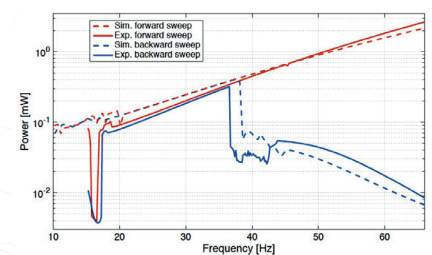


Fig. 4: measured and simulated power



Fig. 5: H2020 Fast Smart Project

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