The increasing demand on structural heath monitoring of the civil and mechanical structures and the continuous progress in miniaturization of electrical devices force the search for new sources of electrical power. Such sources were identified in the ambient conditions as sun light, thermal conditions, wind, see waves and also vibrations of natural and technical systems. In contrary to large installations we are interested in small portions of energy which can be used to power small portable devices and/or load batteries to extend their lifetime. As far as vibration energy transformation is concerned, one needs to catch vibration energy to the mechanical resonator and later transform it via a transducer sensitive to physical multi-fields. One of the best transduces possible to miniaturize is a piezoelectric material component (usually a layer) responding to deformations of the mechanical resonator in changes of its electrical polarization. Such variable polarization produces an electromotive force in the electrical circuit (it is place between the electrodes of the capacitor). In the beginning linear systems were investigated. However, it was difficult to adjust them to variable sources of kinetic energy because such a system should work in the resonance conditions with to guarantee larger enough power output. The studies performed in the recent years show that nonlinear resonators can overcome this deficiency. Namely they can transduce the energy in the broader frequency range. In this case the nonlinear effects should be modelled. In Fig. 1 they are modeled by distribution of additional magnets which leads to multistable system.

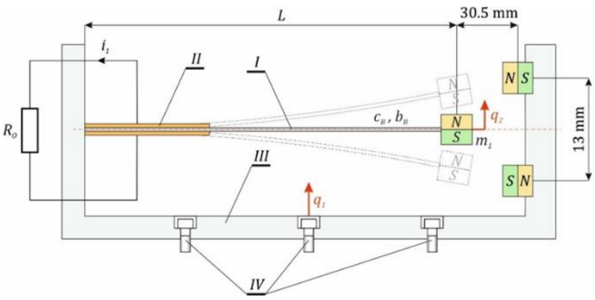

Fig. 1 The multistabe resonator after [1]. A piezoelectric transducer II is glued onto the beam, which generates an electric charge as a result of the elastic deformation of the beam. Frame III, via mounting screws IV, creates a fixed connection with the vibrating mechanical system. In addition, in the frame III, permanent magnets are fixed, which are arranged symmetrically with respect to the axis of the vibrating beam.

Another development is related to coupled resonators, Such resonators can provide more power if they move in the synchonized way (after [2]). One should remember that in the nonlinear systems synchronization is improved. Note that multiple solutions can be simultaneosly disadvantage and advantage in the system in that sens that various solutions in the motion of resonators would correspond to different power outputs. It is still a question how to get the optimum solution from the existing ones. One of the indication to clarify that is to study the stabilty of particular solutions. The advantage of existing multiple solutions is that they are changing and optimizing with the freqency changes and can effectively broaden the frequency rage of the energy transduction.

Finally, our present projet is devoted to the nonlinear resonators but the source would be wind flow. Such systems were investigated before by us (see [3]). Interestingly, our results show that that system changes the power output depending the bluff bodies profile crosssection. Namely, for a cisrular crossection the power outpu is garanteed by vortex induced vibrations (VIV) appering in the small wind speed while for a rectangular crossection power output maximize at large wind speeds thanks to galloping vibrations. In the paper [3] we studied the the hybrid approach using the complex crossections of bluff bodies posessing features of circular and rectangular ones. Our results [3] proved that it was a succeful solution. The present proposal is more advanced as it combines all three elements discussed above. We are going to study energy harvesting with (a) nonlinear resonators, (b) coupled resonators, (c) resonators excited by air flow. Additionally, the frequency lock-in effect will be investigated under conditions of misstuned oscillators. The research will include theoretical modeling, numerical simulations and an experimental part. The results obtained in the Polish-Chinese cooperation will be published in major scientific journals.

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