INFN-LNF experiments with Nickel-Copper Alloys (01 December 2020).

INFN-LNF (Istituto Nazionale di Fisica Nucleare-Laboratori Nazionali di Frascati) has been engaged in Cold Fusion-LENR studies since March 1989.

In the last decade the work transitioned from the initial study of **Palladium-Deuterium** based **systems** (e.g. Pd-B compounds, Pd-Y alloys), in electrolytic and gaseous high temperature environment (up to 800 °C), to **Nickel and its alloys.** In fact, hot **Constantan** ($Cu_{55}Ni_{44}Mn_1$) wires became the focus of a long series of experiments that leveraged on the unique set of properties of this alloy, notably a moderate cost, a remarkable capability to absorb hydrogen and the durability in various experimental conditions.

Heated Constantan shows indeed the occurrence of anomalous heat if a series of conditions are met, remarkably a sufficiently high temperature and the presence of a **flux** of atomic deuterium or hydrogen. Both the magnitude and reproducibility of these anomalous heat effects are mainly dependent on the surface properties of the wires and the presence of ***non-equilibrium conditions*** such as thermal gradients, electric fields and/or the emission of electrons. INFN participates in CleanHME project aiming to increase anomalous heat effects thanks to the use, mainly, of an innovative voltage-current pulses technique. Pulses will be applied longitudinally along the wires and, in a second phase, among the Constantan and a counter-electrode (Fig. 1) to induce:

- **the impulsive heating of the wires,** with pulses of 2-10 microseconds and peak power up to about 10000 V*A (negative polarity);
- **a sudden emission of electrons**, due to the localized increasing of temperatures of Low-Working-Function sub-micrometric coating;
- **the ionization of the gas** (H_2, D_2 or mixtures Ar-H_2, Ar-D_2, Xe-H_2, Xe-D_2) via a Dielectric Barrier Discharge (DBD) or Paschen breakdown: phase 2 of the experiment. These conditions are deemed effective at inducing a flux of active species through the surface of the wires.

The current work is focusing on:

- **the development the "pulser" circuitry**. The pulsing approach was published already by INFN group in 1996 on Physics Letters A and Fusion Technology. The original pulser was instrumental for a series of highly successful experiments with Pd based materials (typically straight wires, 50-100 μm diameter, pulses duration 500-2000 ns). On the base of the original concept, a new circuitry is being developed for an optimized pulse duration, peak voltage, in-phase characteristics, to meet the requirements of Constantan wires of larger diameter (350 μm instead of the previous 100-200 μm) and constrains of the innovative *compact coaxial coiled geometry* (160 cm wire length). The peculiarity of the coiled coaxial geometry is the occurrence of, self-generated, fast voltage pulses sent directly to the counter-electrode *in situ*. This approach avoids limitations due to the long cable (and related impedance mismatch) that connects the pulser with the active coil.
- **the replacement of the present glass reactor with a stainless-steel vessel**; to prevent recurring issue of leakages that have affected various past experiments.

- **the implementation of a modified/optimized Residual Gas Analyzer** to monitor the species present during the experiments with a view at distinguishing ^4He from D_2 (should it be produced).

Further supports will be given to the Univ. Uppsala's Group (Bo Hoistad) for the replication of selected experiments with Constantan wires, while in a second phase (Q2-Q3 2021) a wire prepared at INFN and a simplified/dedicated "pulser" circuit could be shared to carry out tests in presence of impulsive excitations and DBD (or Paschen discharges).

References

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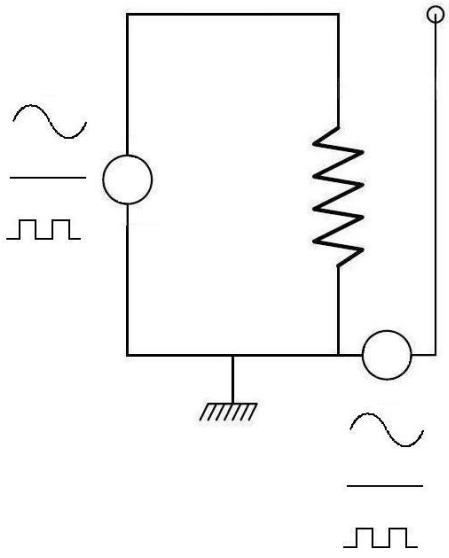

Fig 1. Wire arrangement

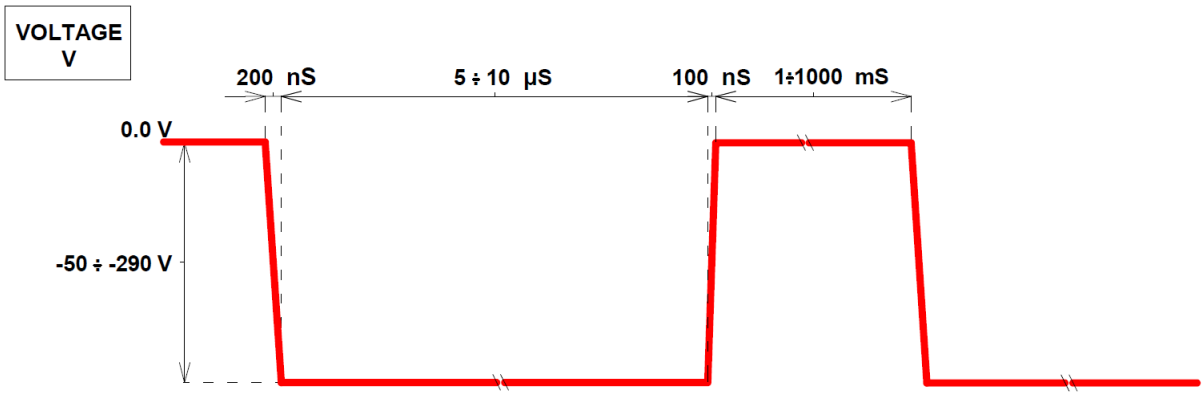

Fig 2. Typical Voltage Curve of the pulses that will be used in upcoming experiments. Next step will be pulse duration reduction down to 2 µs, while increasing the peak voltage (up to -700 V).