# Condensed Matter Nuclear Science

# Status Report Germany

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This memo reports historical and present, experimental and theoretical research being done in Germany of relevance to *Condensed Matter Nuclear Science* (CMNS), describing "cold fusion" or *Low Energy Nuclear Reactions* (LENR).

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## Historical

The first who reported [1-3] Palladium catalysed fusion of hydrogen nuclei to Helium at room temperature were German researchers Paneth and Peters in 1926. They retracted their work for unknown reasons. Lochte-Holtgreven studied LENR in the 1970s and reported [4-5] neutrons when electrically exploding deuterated liquids. He was director of the institute for experimental physics at the *Christian Albrechts University* at Kiel.

After the initial announcement by Fleischmann and Pons [6] and Jones et al. [7] in 1989, electrochemical Palladium runs at the *Free University of Berlin* resulted in the observation of the phenomena reported in [6], but results were explained without assuming nuclear reactions [8]. Electrochemical Titanium runs by a team at *Kernforschungszentrum Karlsruhe* did not lead to unexpected neutron measurements [9]. Both groups jointly published their results in 1990 [10]. A joint physicist/chemist group at *Max-Planck-Institute for Plasma Physics* tried to reproduce the claim. They did not observe neutrons above background [11]. Helium was not looked for. Excess heat was not seen. The longest test run lasted three weeks. An experienced physicists group at *Hahn-Meitner-Institut* in Berlin tried to replicate the Jones experiment but could not find neutrons [12].

Having attended the second *International Conference on Cold Fusion* (ICCF2) in Como, Italy, in 1991, Europe's leading physical electrochemist Gerischer wrote in a memo [13]:

> In spite of my earlier conclusions that the phenomena reported by Fleischmann and Pons in 1989 either depend on measurement errors or were of chemical origin, there is now undoubtedly overwhelming indications that nuclear processes take place in metal alloys. (…) I consider it absolutely necessary that these phenomena are systematically researched. (…) The fact that, in the Republic of Germany, this work has been inhibited is no more justified. It could later on be regarded as a very unfortunate gap in German research when compared with the activity in other countries and particularly in Japan.

In the conference proceedings Gerischer presented his "impressions of a critical observer" [14].

**Present experiments**

The nuclear physics group at the *Technical University of Berlin* presented [15] a measurement of an n/p asymmetry for d+d fusion reactions by accelerating deuterons in the 5 to 60 keV energy range onto Sr, Li and some other deuterated metallic lattices for the first time in 1997. A second report [16] and the first publication in English [17] in 1998 was devoted to the enhanced electron screening effect in the d+d reactions in metals. After a 2-year-debate with referees of *Phys. Rev. Let.* the paper was finally published in *Europhysics Letters* [18]. Huke's PhD thesis [19] includes screening measurements, investigation of disturbing target-surface effects, and observation of an n/p asymmetry for Sr, Na, Li and some other metals. Huke performed a quantum mechanical "ab-initio" simulation as an attempt to describe the observed screening energy values.

The paper [20] discussed the "channelling effect" and other solid-state effects in a competition to the electron screening effect. On the EPS symposium in Hungary 2002 the group presented [21] a theory of the electron screening effect based on the dielectric function approach, leading to the screening energies larger by a factor of two than the previous estimations. In recent experiments, the screening effects of C, Al, Zr, Pd, and Ta lattices in the d+d reactions have been tested. The results [22-23] obtained for Pd are close to those of Kasagi et al. [24]. The paper [22] presented an improved theory of the electron screening effect in nuclear reactions for metallic environments and compared experimental data obtained by means of the accelerator technique at higher deuteron energies with those observed in the heavy water electrolysis at room temperature. Under an assumption of quasi-free moving deuterons in the lattice, the theory enables the authors to explain neutron production rates of Jones et al. [7], although not the energy production rate of Fleischmann and Pons [6].

The first German group to test for LENR by deuteron acceleration was from the *Max-Planck-Institute for Plasma Physics*. They could not detect, however, fusion products above expected gas target rates [25]. According to the Berlin group this could be a consequence of neglecting surface contamination due to insufficient vacuum and inhomogeneous deuterium distribution. An adjusted analytical method which is sensitive to such disturbing effects is presented in [18, 26]. This surface effects can considerably alter the measured screening energies or even vanish them. Thus, the values of the Berlin group are a lower limit of the "real" screening energies. The findings of the two other groups [24, 27-31] should therefore only be taken qualitatively with a limited predictability.

The second group at the *Ruhr University Bochum* in Germany confirmed [28] the Berlin findings, first studying the near noble metal Ta which is less vulnerable to oxidation by O radicals. The following Bochum paper [29] presents results for more elements. However, the results obtained for some metals were affected by a significant oxygen contamination. In the papers [30-31] Bochum presents screening energies for 35 different target materials applying cleaning of target surfaces by Kr sputtering prior the deuteron irradiation. Additionally, the authors report about a correlation between the Hall constant and measured screening energies. A paper with a detailed discussion of the whole subject is in preparation by the Berlin group.

The eleventh *International Conference on Condensed Matter Nuclear Science* (ICCF11) in Marseille, France, saw the biggest contingent of German researchers ever. The Berlin group presented for the first time experimental and theoretical results [32-34] to the CMNS community. Their theory to explain LENR using standard physics was welcomed as an "orthodox" approach.

*Comments or additions to this memo welcome, as this is a continuing endeavour. The report may contain errors as the author is no physicist.*

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