Round Table: Novel Opportunities for Cooperation between France and Germany in Neutron Science

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Attendance: ~65 participants in the audience

Short summary

The main message of this round table discussion directed towards the young audience of the condensed matter conference of the German Physical Society (DPG) is that there is a **world of opportunities** for them for either performing neutron scattering nowadays, in getting appropriate training, or in working in top-level international neutron facilities with strong scientific and technological positions in Europe, and **in particular in France and Germany**. Job opportunities not only include current positions for research and instrument development, but also participation in the design and building of future large-scale facilities, be they located in Sweden (ESS, Lund), or at the upcoming compact sources, ICONE in Saclay/FRA, and the High Brilliance Source (HBS-1) in Jülich/GER. The highest possible level of participation with the directors of French and German facilities (MLZ, JCNS, LLB, and ILL) was an asset. The neutron user community was represented by SFN and KFN. Important issues were access to beam time, international careers, and scientific collaborations between France and Germany.

The round table discussion

The round table discussion was opened by a short presentation about the **possibilities offered by neutron scattering** in condensed matter physics and chemistry as well as biophysics by Frank Schreiber. Different aspects had been chosen for their pedagogic value, covering a broad field: crystal and polymer structure, diffusion and dynamics (phonons, magnons, …), contrast matching and deuteration, magnetism and skyrmions, with relevance for batteries or quantum and information technology. Complementarity with X-ray scattering was underlined. This part has been carefully prepared in order to show that the discussion was not intended to be an expert discussion, but a general discussion directed towards in particular young and potentially interested scientists.

A second presentation was given by Julian Oberdisse, introducing the “nuts and bolts” of neutron scattering in terms of the **instruments operated by JCNS, MLZ, ILL, and LLB**, **presenting their directors**, who were all in the room. These facilities offer a variety of French-German research and instrument collaborations, as shown explicitly. Moreover, the European perspective offered by the facilities in Sweden, Switzerland, UK, or Spain, was described. As

a starting point, many societal challenges which can be tackled with neutrons were discussed in detail: energy, climate and environment, health and food, mobility, cultural heritage, and innovation. This highlighted the broad range of scientific opportunities for young researchers trained in neutron science to make a significant contribution to such topics, as well as to the associated economic sectors. Also, the opportunity to get a job in neutron scattering, now or within the next ten years, was emphasized by all facility directors.

The strong user base in France and Germany was explicitly mentioned in the presentation of **KFN and SFN** to the public. KFN has identified a user base of ca. 1300 persons from 230 scientific institutions. SFN is a learned society with ca. 500 members, representing a user base which is typically evaluated to be 1500 people, from 300 institutes.

The round table discussion was organized around **two main topics**. The **first** one concerned "**access to neutron beams**", which triggered considerable interest in the public, posing a number of questions. Through the questions from the audience, it emerged that the (possibly psychological) difficulty to contact a large-scale facility is non-negligible. In their response, all facility managers stated that on the contrary, **newcomers are extremely welcome**, because they bring in fresh ideas and allow further widening of the user base. The representatives of KFN and SFN underlined that there were a variety of **courses offered to train people**, from a three-day practical school on international instruments at ILL (Collaborative Research Group, CRG), to a one- or two-week school (as organized by ILL/Montpellier or JCNS), or the five-week-Hercules school at ILL. Some of these schools such as the thematic schools organized by SFN publish freely downloadable textbooks. SFN and KFN also run annual meetings, originally focused on either the French (JDN) or German (DN, SNIB) user community, but with nowadays a strong international focus.

Several questions concerned the **technical aspects of access** to neutron beam time. As a first answer given by the directors, the mechanism of beamtime distribution which is currently implemented in virtually all facilities worldwide was outlined, namely the proposal system with regular calls, typically twice a year, and expert committees deciding on beamtime allocation. The drawbacks of this system were not hidden: the system is rather slow (about 6 months from request to experiment), and decisions may come late and can even be negative, in particular when instruments are strongly requested – the overbooking is typically a factor of 2 in most "normal" cases, which usually allows all promising experiments to receive beamtime, but this number may nevertheless discourage new users.

The **recommendations** outlined by the facility directors can be summarized as follows: In general, they estimate that 2 or 3 months from the proposal to the experiment can be reached. It was strongly suggested to new users to either team up with experienced users, or to contact directly the instrument responsibles for advice. It was pointed out that in all facilities, a faster way to beamtime for either very urgent projects (**fast, or easy access**), or for **test measurements** on in-house beamtime, or director's discretion time is already available. Such test measurements allow checking some scientific hypothesis before submitting a full proposal. Along the same lines of reasoning, virtual instruments ("**digital twins**") will be increasingly available to estimate measurement times and statistics for given types of samples. Concerning the upcoming compact neutrons sources ICONE and HBS-1, the facility managements are currently rethinking the way to allocate beamtime, taking into account different ways of doing research. The multiple possibilities to receive training on instruments or in schools was again underlined, providing further contact with instrument scientists or experts.

Another important aspect addressed in the discussion with the audience was the question of the sometimes lengthy **data acquisition times**, in particular in comparison with X-ray scattering. Indeed, due to the underlying physics, incoming neutron fluxes are orders of

magnitude weaker. It was emphasized by the participants that some measurements, in particular those sensitive to hydrogen atoms or magnetic moments, can *only* be done with neutrons. Moreover, modern sources aim at higher and higher brilliance – there is "plenty of space at the top", **creating many opportunities for young scientists**. Given the increasing data production rates, the question of the management of **big data** is becoming increasingly relevant. The participants of the round table reminded that experiments which are feasible with X-rays should be done with X-rays, leaving the most important neutron applications to this rarer resource. In some specific cases, the complementarity of different probes, X-rays or neutrons, may also be beneficial for experiments, as they may highlight different aspects of the same structure, e.g. exact positions of heavy vs. light elements.

An additional aspect of the discussion concerned **data analysis**. Data analysis is part of the workflow of scattering experiments, where conclusions are usually inferred in an indirect manner, due to the nature of the scattering process. Again, it was emphasized that seeking help and teaming up with expert groups is highly recommended, beside receiving personal training in schools. Moreover, powerful data analysis programs are available, and considerable efforts are pursued in the sources to implement more efficient data reduction and processing. Users should leave with pre-treated data, enabling them to work on the science of the problem, rather than having to solve technical issues. Artificial intelligence is expected to become increasingly helpful, which is why it is also actively pushed by the scattering facilities, and software packages are already available. Given the increase in computing power, "on the fly" data analysis may become feasible in specific applications. Finally, **dedicated workshop and schools** for data analysis are regularly held in the French-German research landscape.

The **second topic** on both "**international jobs** in neutron facilities, now and in the future", and "**scientific and instrumental collaboration** between France and Germany", could only be discussed briefly, due to lack of time. In the initial presentations by the chairpersons, the collaborations in instrument development and science between the different large-scale facilities had been explicitly shown, and were commented on during the round table discussion. The explicit question to be answered by the panel was "**Could there be a job for me in neutron scattering?**". Therefore, the final part of the discussion was centered around the international nature of such jobs and their environment, such as a PhD in one country, post-doc in another, until obtaining a permanent position in yet another neutron facility, possibly the future French (ICONE) and German (HBS-1) compact sources. It was mentioned that this concerns not only **scientific careers**, but includes technicians, engineers, and obviously instrument scientists, who are also carry out in-house research. In this context, it was underlined that the French-German partnership is also active at ESS where common beamlines exist. Moreover, emerging **scientific opportunities** could be identified, for instance in rapidly developing neutron imaging, as evident from the rising number of proposals.

Concerning strictly scientific projects, two aspects were mentioned. First of all, the science strategy developed by ILL. Besides leveraging on recent and very powerful instrument upgrades, this science strategy proposes to concentrate forces on **specific topics of societal relevance** (battery research, health, quantum information, …), using different types of project organization, like hubs or showcases. Secondly, the well-known **ANR-DFG joint research program** has allowed the funding of ca. 60 projects per year over the past ten years, between (at least) one French and one German institution each, over the past 10 years, for a total budget which can be estimated to ca. 200 M€ in each country.

The final message appears to be clear: **there are strong opportunities in neutron science for young researchers**, in scientific projects of their choice, but also in instrument development, in France and Germany, in existing facilities, for ESS beamlines with French/German participation, and facilities yet to come, like ICONE and HBS-1.