

Nordic and Baltic Neutron Scattering Communities, 2006-2016

- a bibliometric study

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0. Perspective and scope of the investigation

In this document, we present and discuss basic information needed to elucidate the present situation in the Nordic and Baltic scientific environment within neutron scattering science. The investigation is a part of a larger effort to prepare the ground for the Nordic/Baltic involvement in the scientific part of the European Spallation Source, ESS. The investigation is hosted by the Nordic Neutron Science Program, NNSP.

We perform a bibliometric investigation of the publications in the five Nordic countries: Denmark, Norway, Sweden, Finland, and Iceland – as well as the three Baltic countries: Estonia, Latvia, Lithuania. We consider publications dealing with neutron scattering, including instrumentation, data taking, and data analysis. In addition, theoretical work is included if it lies close to the experiments, i.e. prediction or modelling of experimental data. However, we exclude use of neutrons for fusion, nuclear and particle physics, and for element analysis by nuclear activation (known as PGAA). In addition, we exclude the use of “ultra-cold” neutrons for e.g. fundamental studies of quantum mechanics.

The present report is an update of a series of similar reports, latest from August 2016. The present work cover the full 11 year time span 2006 to 2016, both inclusive.

We show that there is in general a strongly increasing tendency in the publication rate and in the scientific communities in Denmark and Sweden; the Swedish increase is concentrated to staff at ESS. The community size in Norway seems constant. The communities in the other Nordic countries are much smaller and show no increasing tendencies. In the Baltic countries the communities are small, but Estonia has achieved a remarkable increase in activity over the last few years.

1. Neutron Scattering articles

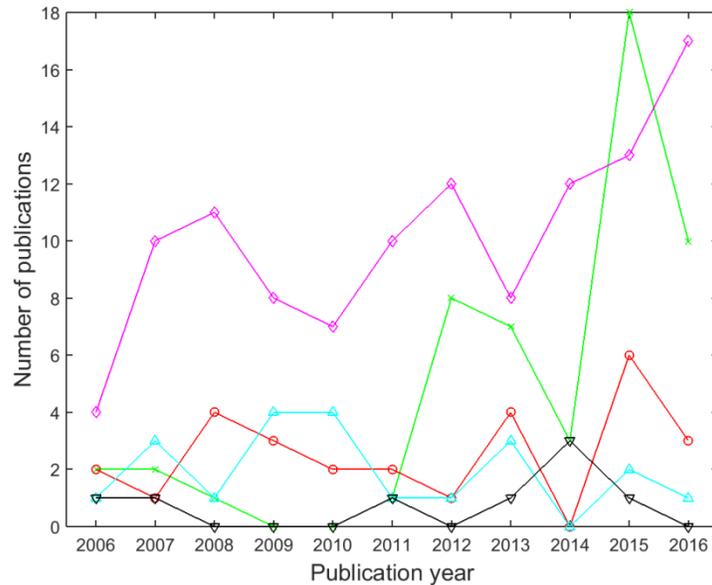
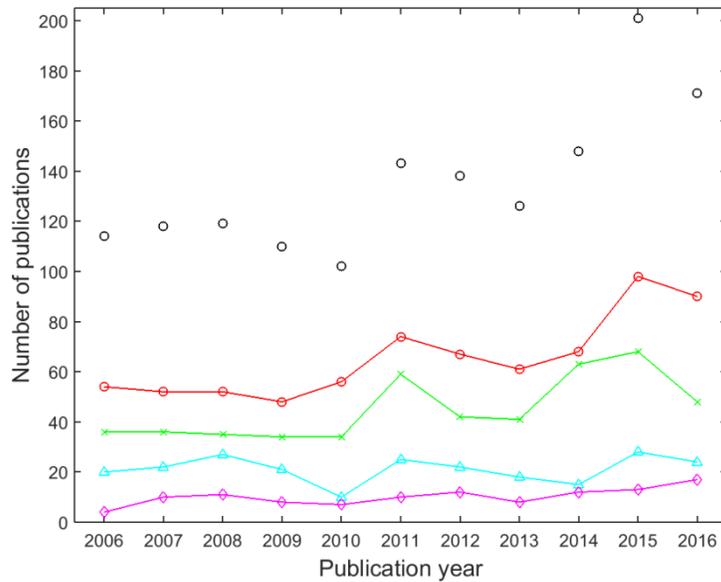
We here present an analysis of the neutron scattering publications published 1/1-2006 to 31/12-2016. We have counted all peer-reviewed articles for each of the Nordic/Baltic countries within each year, and we have further counted how many of these are published in “top 20% high-profile” journals, defined by the Danish official “authority lists” from 2010 and 2015 (we use the 2015 list for the 2015/2016 publications; the 2010 list otherwise). The number of high profile papers is everywhere listed in parentheses.

Most data has been found using ISI Web of Science using a selection of neutron-related keywords. Abstracts were read to remove false searches, and potential articles were studied to be classified according to the type of neutron science, and for the use of neutron sources. In addition, the Journal of Neutron Research has been searched manually, since this journal does not appear in ISI Web of Science.

It should be noted that the ISI Web of Science has in early 2017 included a number of conference proceedings for the last around 10 years. Hence, the number of publications has increased since the last report. Therefore, the data cannot be compared directly with the previous reports. This has prompted us to redo the time series analysis to include the newly available publications.

The table below contains all 1488 publications found in our analysis, divided into country and publication year. In the sum, publications with authors from more than one Nordic/Baltic country is counted only once. This “double count” correction is shown explicitly. Nordic/Baltic collaborations and “double counts” are discussed more in section 3.

| Year/ country | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | SUM |
|------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-------------------|
| DK | 36 (18) | 36 (23) | 35 (15) | 34 (28) | 34 (21) | 59 (30) | 42 (23) | 41 (20) | 63 (21) | 68 (35) | 48 (15) | 496 (249) |
| N | 20 (6) | 22 (7) | 27 (3) | 21 (6) | 10 (4) | 25 (10) | 22 (6) | 18 (8) | 15 (9) | 28 (8) | 24 (9) | 232 (76) |
| S | 54 (14) | 52 (16) | 51 (23) | 48 (24) | 56 (30) | 74 (22) | 66 (30) | 61 (31) | 68 (29) | 98 (30) | 91 (36) | 719 (285) |
| FI | 4 (2) | 10 (5) | 11 (2) | 8 (1) | 7 (5) | 10 (5) | 12 (4) | 8 (3) | 12 (6) | 13 (3) | 17 (8) | 112 (44) |
| IS | 1 (0) | 1 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0) | 0 (0) | 1 (1) | 3 (2) | 1 (0) | 0 (0) | 8 (3) |
| ES | 2 (0) | 2 (1) | 1 (0) | 0 (0) | 0 (0) | 1 (0) | 8 (3) | 7 (7) | 3 (2) | 18 (11) | 10 (3) | 52 (27) |
| LV | 2 (0) | 1 (0) | 4 (0) | 3 (0) | 2 (1) | 2 (0) | 1 (0) | 4 (1) | 0 (0) | 6 (0) | 3 (1) | 28 (3) |
| LI | 1 (0) | 3 (0) | 1 (0) | 4 (0) | 4 (1) | 1 (0) | 1 (0) | 3 (2) | 0 (0) | 2 (0) | 1 (0) | 21 (3) |
| double count | 6 (3) | 9 (3) | 12 (2) | 8 (5) | 11 (6) | 30 (11) | 15 (5) | 17 (8) | 16 (5) | 33 (12) | 23 (7) | 180 (67) |
| SUM | 114 (37) | 118 (49) | 118 (41) | 110 (54) | 102 (56) | 143 (56) | 137 (61) | 126 (65) | 148 (64) | 201 (75) | 171 (65) | 1488 (623) |



The data from the table are presented in the two figures above. In the top figure, black represents the sum of all eight Nordic/Baltic countries, red Sweden, green Denmark, cyan Norway, and Finland magenta. In the bottom figure, Finland is magenta, while Estonia, Latvia, and Lithuania are green, red, and cyan, respectively. Black symbols represent Iceland.

We see that Sweden has the largest publication number with Denmark being on average at 69% of this value. Norway reaches 32% of the Swedish value, Finland at 16% with an increasing tendency. Estonia is on average at 7% of the Swedish value, but has shown an increase over the last few years, where it equals Denmark and Sweden in publications per capita. Latvia, Lithuania, and Iceland have few neutron publications and are comparable to Finland in publications per capita. There is a slightly increasing trend in the total publication number over the time span, with the 2015 number being clearly the highest, 49% higher than the period average, followed by 2016.

Many publications, 42% on average, are in the top-20% journals. This confirms earlier observations that neutron scattering results are likely to lead to important scientific results. We speculate that this is due to the limited number of neutron sources and the competitive nature of access to experimental time at the international facilities.

2. Neutron community, time development, and present location

We here list the approximate size of the neutron scattering communities in the respective countries. We have here defined the neutron community to consist of authors with at least two neutron-related publication within a 5-year counting period. We divide the authors into three categories:

- **Infrequent users** with 2-4 publications. This would typically cover casual users among staff, scientists new to the field, as well as Ph.D. students close to the end of their studies.
- **Frequent users** with 5-9 publications. This would typically be staff scientists working with neutrons as one of several research techniques, post docs within the field, or very talented Ph.D. students.
- **Expert users** with 10+ publications. This would typically be permanent staff with particular neutron expertise or senior post docs specializing in neutron scattering and with a strong scientific potential.

The list below covers the 5-year period 2012 - 2016. We have separated staff at ESS from the rest of the Swedish scientists to highlight the direct effect of this facility.

| Author type | Infrequent (2-4) | Frequent (5-9) | Expert (10+) | SUM |
|-------------------|------------------|----------------|--------------|------------|
| Denmark | 92 | 28 | 12 | 132 |
| Norway | 45 | 3 | 6 | 54 |
| Sweden, excl. ESS | 84 | 16 | 9 | 109 |
| Sweden, ESS only | 69 | 12 | 7 | 88 |
| Finland | 13 | 5 | 1 | 19 |
| Iceland | 1 | 0 | 0 | 1 |
| Estonia | 7 | 2 | 1 | 10 |
| Latvia | 12 | 0 | 0 | 12 |
| Lithuania | 3 | 0 | 0 | 3 |
| SUM | 263 | 61 | 27 | 351 |

The sizes of the national communities are roughly proportional to the number of publications. The core of the Nordic/Baltic communities (defined as the frequent and expert users) presently counts 88 scientists.

The tables below covers the distribution of the communities in Denmark, Sweden, and Norway into their (most recent) affiliation. 11 institutions are found to have more than 10 researchers in the community; exactly the ones that have at least one expert (10+ papers).

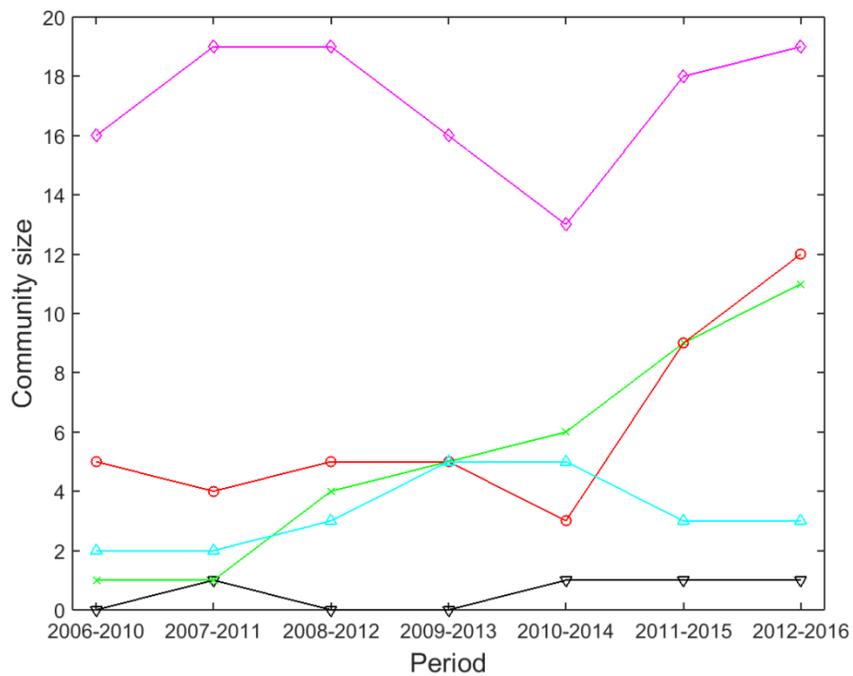
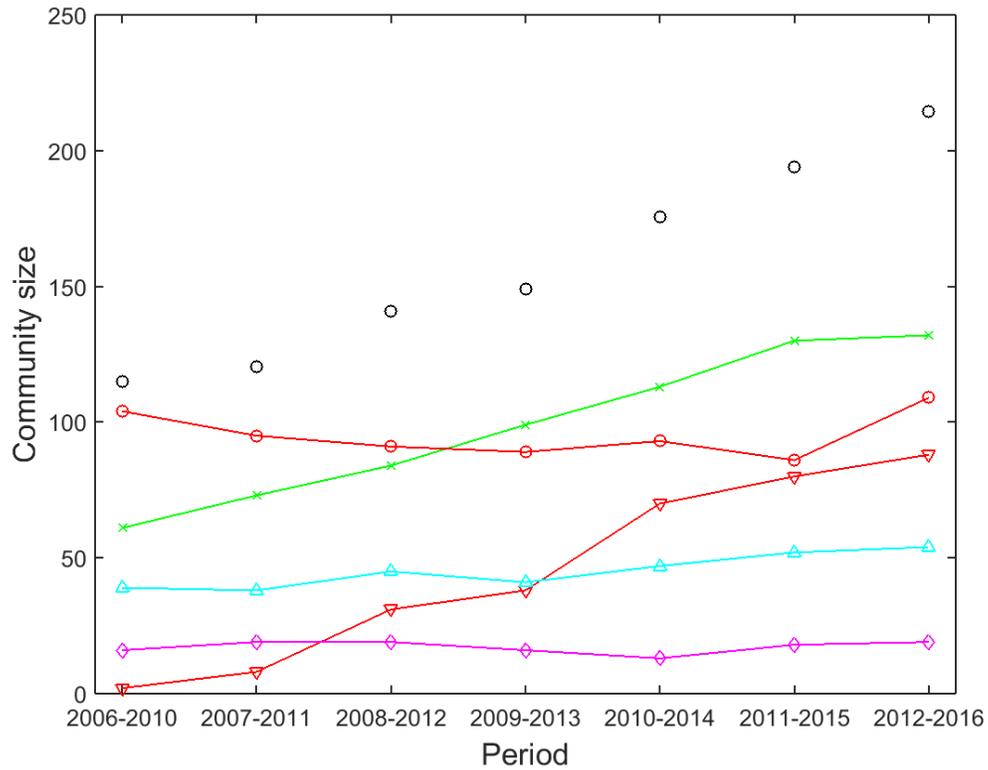
| Affiliation | Infrequent (2-4) | Frequent (5-9) | Expert (10+) | SUM |
|----------------------|-------------------------|-----------------------|---------------------|------------|
| DENMARK | | | | |
| Univ. Aalborg | 1 | | | 1 |
| Univ. Aarhus | 12 | 4 | 1 | 17 |
| Univ. Copenhagen | 42 | 19 | 8 | 69 |
| DTU, Lyngby | 30 | 5 | 3 | 38 |
| ESS-Data Managem. | 2 | | | 2 |
| Roskilde Univ. | 2 | | | 2 |
| Univ. Southern DK | 2 | | | 2 |
| XNOVO (private) | 1 | | | 1 |
| NORWAY | | | | |
| Inst. Energy Res. | 16 | 1 | 4 | 21 |
| NTNU, Trondheim | 4 | | | 4 |
| SINTEF, Trondheim | 2 | | | 2 |
| Univ. Bergen | 1 | | | 1 |
| Univ. Oslo | 22 | 2 | 2 | 26 |
| SWEDEN | | | | |
| Chalmers Tech. Univ. | 12 | 1 | 3 | 16 |
| ESS | 69 | 12 | 7 | 84 |
| Gothenburg Univ. | 2 | | | 2 |
| KTH, Stockholm | 5 | 1 | | 6 |
| Linköping Univ. | 8 | 1 | 1 | 10 |
| Lund Univ. | 14 | 2 | 1 | 17 |
| Malmö Univ. | 4 | 1 | | 5 |
| Stockholm Univ. | 10 | 3 | 1 | 14 |
| Swedish Museum | 1 | | | 1 |
| Uppsala Univ. | 27 | 7 | 3 | 37 |
| Univ. West | 1 | | | 1 |

| Affiliation | Infrequent (2-4) | Frequent (5-9) | Expert (10+) | SUM |
|------------------------|-------------------------|-----------------------|---------------------|------------|
| FINLAND | | | | |
| Aalto Univ. Techn. | 8 | 2 | | 10 |
| Finnish Res. Engin. | | 2 | | 2 |
| Lappeenranta Univ. T | 1 | | | 1 |
| Tampere Univ. Techn. | 2 | | 1 | 3 |
| Oulu Univ. | 1 | 1 | | 2 |
| Univ. Eastern Finland | 1 | | | 1 |
| ICELAND | | | | |
| Univ. Iceland | 1 | | | 1 |
| ESTONIA | | | | |
| NICPB, Tallinn | 5 | 1 | 1 | 7 |
| Univ. Tartu | 2 | 1 | | 3 |
| LATVIA | | | | |
| Inst. Phys. Energetics | 3 | | | 3 |
| Riga Techn. Univ. | 1 | | | 1 |
| Univ. Latvia | 8 | | | 8 |
| LITUANIA | | | | |
| Vilnius State Univ. | 3 | | | 3 |

The table above covers Finland, Iceland, and the three Baltic countries. Here are one institutions with a community of at least 10 researchers.

To follow the development of the scientific communities, we have recorded the sizes of the Nordic countries, starting from the 5-year period 2006-2010. The numbers represent the total community, while the number in parentheses denote the sum of frequent and expert users.

| Community size | 2006-2010 | 2007-2011 | 2008-2012 | 2009-2013 | 2010-2014 | 2011-2015 | 2012-2016 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|
| Denmark | 61 (22) | 73 (23) | 84 (28) | 99 (29) | 113 (32) | 130 (38) | 132 (40) |
| Norway | 39 (14) | 38 (12) | 45 (15) | 41 (14) | 47 (12) | 52 (14) | 54 (9) |
| Sweden, not ESS | 104 (32) | 95 (27) | 91 (25) | 89 (24) | 93 (26) | 86 (27) | 109 (25) |
| Sweden, ESS | 2 (1) | 8 (2) | 31 (7) | 38 (14) | 70 (16) | 80 (18) | 88 (19) |
| Finland | 16 (1) | 19 (1) | 19 (0) | 16 (1) | 13 (2) | 18 (4) | 19 (6) |
| Iceland | 0 (0) | 1 (0) | 0 (0) | 0 (0) | 1 (0) | 1 (0) | 1 (0) |
| Estonia | 1 (0) | 1 (0) | 4 (0) | 5 (1) | 6 (1) | 9 (3) | 11 (3) |
| Latvia | 5 (1) | 4 (0) | 5 (0) | 5 (0) | 3 (0) | 9 (0) | 12 (0) |
| Lithuania | 2 (1) | 2 (0) | 3 (0) | 5 (0) | 5 (0) | 3 (0) | 3 (0) |
| SUM | 230 (72) | 241 (65) | 282 (75) | 298 (83) | 351 (89) | 388 (104) | 429 (102) |



The data from the table is presented graphically in the two figures above. In the first plot, the black circles represents the sum of the Nordic and Baltic countries (divided by two), red circles Sweden excl. ESS, red triangles ESS, green crosses Denmark, cyan triangles Norway, and Finland magenta. At the

second plot, Finland is again magenta, black triangles represent Iceland, cyan triangles Lithuania, green crosses are Estonia, while red circles are Latvia. The data show a clearly increasing tendency in the Nordic/Baltic communities, a 50% total increase over the last 5 years. The general increase is caused by two clear tendencies: 1) the community size for Denmark has doubled, and 2) the number for ESS has increased from basically 0 to 88. Also Estonia shows an increase, although the absolute numbers are small. “Sweden not ESS” and Finland both show a decrease with a recovery within the latest year or two, while the other countries are fairly constant in time.

By studying the numbers closer, the significant Danish increase is seen to be caused equally by additional Ph.D. students and post docs, and attraction of new permanent staff (around 20 in each category). The decrease of “Sweden not ESS” is found to be related to the close-down of the Studsvik reactor in 2005, with a recovery after around 10 years – same time scale as was seen for the close-down of the Danish reactor at Risø in 2000. The strong increase of the ESS community naturally follows the hiring of personnel at ESS, combined with the fact that this personnel needs a few years from the hiring until they have collected sufficient publications with a Nordic address.

3. Nordic-Baltic collaborations

We here list the number of articles that feature authors from at least two Nordic/Baltic countries. This number is also used to correct the article sum in the overall count, shown in section 1, and in the following sections. As before, high-impact articles are listed in parentheses.

| Year | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | SUM |
|--------------------------|--------------|--------------|---------------|--------------|--------------|---------------|---------------|---------------|---------------|---------------|---------------|-----------------|
| Denmark - Norway-Sweden | | | 1 (0) | | | 2 (1) | 1 (0) | 2 (1) | | | | 6 (2) |
| Denmark - Norway | | 2 (1) | 1 (0) | | 1 (0) | 4 (2) | | 1 (0) | 2 (2) | | 1 (0) | 12 (5) |
| Denmark-Sweden-Lithuania | | | | | 2 (1) | | | | | | | 2 (1) |
| Denmark - Sweden | 1 (0) | 3 (2) | 3 (2) | 2 (2) | 4 (4) | 17 (5) | 8 (2) | 6 (1) | 11 (1) | 23 (11) | 13 (4) | 91 (34) |
| Denmark - Finland | | | | 1 (0) | 1 (0) | | | | | | 2 (0) | 4 (0) |
| Norway-Sweden-Finland | | | | | | | | | | 2 (0) | | 2 (0) |
| Norway - Sweden | 3 (1) | 3 (0) | 3 (0) | 5 (3) | | 2 (1) | 3 (1) | 4 (3) | 1 (1) | 2 (1) | 4 (2) | 30 (13) |
| Norway - Finland | 1 (1) | | 1 (0) | | | 1 (0) | | | 1 (0) | | | 4 (1) |
| Sweden - Finland | 1 (1) | | | | 1 (1) | 2 (1) | 2 (2) | | | | 1 (1) | 7 (6) |
| Sweden - Iceland | | | | | | | | 1 (1) | 1 (1) | | | 2 (2) |
| Sweden - Estonia | | | | | | | | | | | 1 (0) | 1 (0) |
| Sweden - Lithuania | | 1 (0) | 1 (0) | | | | | | | 1 (0) | | 3 (0) |
| Estonia - Latvia | | | 1 (0) | | | | | 1 (1) | | 3 (0) | 1 (0) | 6 (1) |
| SUM | 6 (3) | 9 (3) | 11 (2) | 8 (5) | 9 (6) | 28(10) | 14 (5) | 15 (7) | 16 (5) | 31(12) | 23 (7) | 170 (65) |
| Double count correct. | 6 (3) | 9 (3) | 12 (2) | 8 (5) | 11(6) | 30(11) | 15 (5) | 17 (8) | 16 (5) | 33(12) | 23 (7) | 180 (67) |

We see that there is much collaboration between the countries. 12% of all publications in the investigations are of collaborative nature, with a clearly increasing trend over the last 5 years.

The largest number of collaborative work is on the axis Denmark-Sweden, but also the Norway-Sweden combination is often seen. The large number of Denmark-Sweden collaborations in 2011 is partly explained by the ESS collaboration, where Danish scientists working on ESS project to their affiliation added “ESS, Sweden”. This procedure was changed from 2012, where the additional affiliation would be “ESS, Denmark”. Discarding 2011, the Danish-Swedish collaboration seems to show a steady increase over the whole time span, with no less than 21 common publications in 2015.

Analysing the collaborations further, the Danish-Swedish collaboration has a main UCPH/DTU-Lund/ESS axis, both with respect to ESS instrumentation and research in magnetism, as well as soft matter and biological systems, using instruments at ILL and the Danish instruments at PSI. Some collaboration is seen also between Lund/Chalmers and Århus. The Swedish-Norwegian collaboration is concentrated in a Chalmers-Oslo/Kjeller axis with common use of the powder diffractometers at Kjeller and the Swedish diffractometer Polaris at ISIS. The Norwegian-Danish collaboration is mainly along an Århus-Oslo/Kjeller axis and is concentrated on the use of the Kjeller powder diffractometers.

4. Scientific themes

We here present the distribution of the articles on different scientific themes, as given by the ILL categorizing into “colleges”. The categorizing is performed by our own judgement after browsing each article. We have merged the ILL college 6: “glass and liquid dynamics” with college 7: “materials dynamics”, and split the ILL college 1 into two: “Engineering/Geology” and “Instrumentation”. ILL colleges 2 and 3 deal with “Theory” and “Nuclear Physics”, respectively. Theory is in this investigation not a separate field, but distributed on to the corresponding scientific themes, whereas we do not include Nuclear Physics in this report.

| Category | Hardmatter Structure | Materials Dynamics | Magnetic structure | Magnetic dynamics | Soft matter | Geology, engineering | Biological sciences | Instrumen-tation | SUM |
|------------------|----------------------|--------------------|--------------------|-------------------|------------------|----------------------|---------------------|---------------------|-------------------|
| ILL coll. | 5a | 6+7 | 5b | 4 | 9 | 1 (1st part) | 8 | 1 (2nd part) | - |
| Denmark | 75 (29) | 39 (18) | 79 (61) | 85 (62) | 78 (40) | 5 (2) | 56 (21) | 79 (16) | 496 (249) |
| Norway | 119 (36) | 18 (3) | 19 (9) | 5 (4) | 51 (16) | 4 (2) | 9 (3) | 7 (3) | 232 (76) |
| Sweden | 196 (68) | 64 (39) | 88 (45) | 28 (22) | 147 (58) | 36 (8) | 72 (26) | 88 (19) | 719 (285) |
| Finland | 33 (15) | 14 (9) | 18 (5) | 3 (0) | 23 (10) | 6 (3) | 14 (1) | 1 (1) | 112 (44) |
| Iceland | | 4 (3) | 2 (0) | | 2 (0) | | | | 8 (3) |
| Estonia | 12 (7) | 5 (2) | 13 (8) | 16 (10) | 4 (0) | | 2 (0) | | 52 (27) |
| Latvia | 4 (0) | 3 (2) | 9 (1) | | 2 (0) | 4 (0) | | 6 (0) | 28 (3) |
| Lithuania | 3 (0) | 2 (0) | 1 (0) | 1 (0) | 8 (2) | 1 (0) | 5 (1) | | 21 (3) |
| - double count | 39 (17) | 17 (9) | 16 (9) | 8 (4) | 32 (7) | 4 (3) | 24 (9) | 40 (7) | 180 (67) |
| SUM | 403 (138) | 132 (67) | 213 (120) | 130 (94) | 283 (119) | 52 (12) | 134 (43) | 141 (32) | 1488 (623) |

We see that the Danish activities are evenly spread over the topics – except Geology/Engineering – and that there are a large fraction of high-profile publications, in particular in magnetism and soft matter. Sweden has a similar spread as Denmark, however with more emphasis on materials structure/soft

matter and less on magnetic dynamics. Here, high profile publications are abundant also in hard matter dynamics. Norway has a clear strong point in structure of hard materials, and some activities in soft matter. Finland has some activity in hard matter structure, magnetism, and soft matter. Estonia has a relatively large activity in magnetism and a very large fraction of high-impact articles.

Over the Nordic/Baltic countries as a whole, there is an emphasis on hard matter structure, soft matter, and magnetism. Geology/Engineering is largely absent. Biosciences are well represented with 9% of the total publication volume, comparable to the international level (which is 7-8%). However, given the tradition of this field in the Nordic countries, there would be potential for more volume here.

The high-impact (top 20%) publications are frequently found in most categories, the highest fractions are found in magnetism (62%), while hard matter dynamics and soft matter have very respectable high-impact rates of around 50%. Instrumentation has the lowest fraction of high-profile publications (23%).

5. Neutron scattering methods

We here present the distribution of the articles on different neutron scattering methods. This division is mostly based upon instrument classes. However, triple axis machines are grouped after their use: inelastic or single crystal diffraction. When data for a publication has been taken by more than one technique, we chose the one where most time has been used (own judgement).

| Category | Powder diffract. | Single crystal diffract. | Stress-strain diffract | SANS | Reflectometry | Inelastic scattering | Imaging | Review, book, old data | Instrumentation | Theory | SUM |
|----------------|------------------|--------------------------|------------------------|-----------------|-----------------|----------------------|---------------|------------------------|-----------------|------------------|-------------------|
| Denmark | 53 (17) | 45 (36) | 1 (0) | 91 (47) | 22 (13) | 106 (56) | 9 (6) | 34 (11) | 57 (7) | 78 (56) | 496 (249) |
| Norway | 106 (31) | 7 (3) | 3 (1) | 52 (16) | 5 (4) | 15 (3) | 1 (0) | 18 (5) | 5 (2) | 20 (11) | 232 (76) |
| Sweden | 197 (62) | 23 (10) | 24 (5) | 111(45) | 93 (41) | 78 (40) | 13 (7) | 50 (17) | 61 (8) | 69 (50) | 719 (285) |
| Finland | 31 (10) | 11 (3) | 1 (1) | 17 (8) | 2 (0) | 9 (4) | 1 (1) | 11 (3) | 1 (1) | 28 (13) | 112 (44) |
| Iceland | 2 (0) | | | 1 (0) | | | | | | 5 (3) | 8 (3) |
| Estonia | 24 (14) | 4 (3) | | 1 (0) | | 10 (4) | | 2 (1) | | 11 (5) | 52 (27) |
| Latvia | 7 (0) | | | 3 (0) | 1 (0) | 4 (1) | 2 (0) | 4 (1) | 6 (0) | 1 (1) | 28 (3) |
| Lithuania | 4 (0) | | 1 (0) | 3 (1) | 9 (2) | 1 (0) | | 1 (0) | | 2 (0) | 21 (3) |
| - double count | 38 (12) | 11 (5) | 1 (1) | 27 (11) | 15 (6) | 30 (7) | 7 (5) | 8 (3) | 29 (3) | 14 (11) | 180 (67) |
| SUM | 386 (114) | 79 (48) | 29 (5) | 252 (99) | 117 (47) | 193 (95) | 19 (7) | 112 (32) | 101 (15) | 200 (121) | 1488 (623) |

We see that Norway has a relatively very high activity in powder diffraction, and some in SANS, reflecting the instrumentation in Kjeller. Denmark has high publication volume within SANS and inelastic scattering, reflecting the two Danish instruments at PSI. Furthermore, Denmark and Sweden have much work within instrumentation, related to ESS and the McStas software, and within theory. Sweden has also significant activities within reflectometry, SANS, powder diffraction, and inelastic

scattering. Estonia has a relatively high activity within powder diffraction and theory, while the Finnish activities are rather evenly distributed.

The fraction of high profile publications is very high (50% to 60%) within single crystal diffraction, inelastic scattering, and theory. The overall volume of publications in powder diffraction and SANS is very high, but the fraction of high-profile publications is here lower (30% and 40%, respectively).

6. Neutron sources

We here analyse the actual neutron sources used for the 2006-2016 publications. We have included direct experimental work, as well as site-specific instrumentation work,. Some neutron publications use data from more than one source, in that case both/all sources are counted. Some publications do not use original data and are thus not counted here. Hence, the sums do not agree with the sums in the previous sections. Sources in parentheses are permanently closed.

| Source | | DK | N | S | FI | IS | ES | LV | LI | Double count | SUM |
|-------------|------|------------|------------|------------|-----------|----------|-----------|-----------|-----------|--------------|-------------|
| ESS | S | 21 | 2 | 24 | | | | 2 | | 15 | 34 |
| Kjeller | N | 8 | 91 | 5 | 2 | | | | | 15 | 91 |
| ILL | F | 120 | 22 | 173 | 19 | | 11 | 1 | 2 | 43 | 305 |
| ISIS | UK | 41 | 23 | 139 | 9 | 2 | 3 | | 3 | 23 | 197 |
| PSI | CH | 114 | 17 | 32 | 2 | | 14 | 4 | 1 | 25 | 159 |
| FRM2 | D | 22 | 7 | 24 | 3 | | | | 3 | 7 | 52 |
| HZB | D | 20 | 4 | 24 | 2 | | 4 | 8 | | 9 | 53 |
| LLB | F | 4 | 4 | 16 | 9 | | 1 | 3 | 1 | 2 | 36 |
| BNC | H | 5 | 2 | 2 | 3 | | | | | | 12 |
| Delft | NL | 4 | | 8 | | | | | | 4 | 8 |
| Rez | CZ | 1 | 1 | 7 | 1 | | | | | 1 | 9 |
| Dubna | RUS | | 5 | 3 | 2 | | 4 | 5 | | 2 | 17 |
| Zarechnyi | RUS | | | 3 | | | | | | | 3 |
| PNPI | RUS | | | | 1 | | | | | | 1 |
| (GKSS) | (D) | 8 | 7 | 17 | 1 | | | | 1 | 6 | 28 |
| (Studsvik) | (S) | 3 | 5 | 66 | | | | | | 7 | 67 |
| (Jülich) | (D) | 3 | 1 | 7 | 3 | | | | | | 14 |
| (DR3) | (DK) | 3 | | 1 | | | | | | 1 | 3 |
| SNS | US | 15 | 2 | 16 | 1 | | 2 | | | 4 | 32 |
| NIST | US | 18 | 6 | 24 | | 1 | 1 | | 6 | 1 | 55 |
| HFIR | US | 7 | | 4 | 1 | | | | | | 12 |
| LANL | US | 6 | 4 | 12 | 7 | | | | | 2 | 27 |
| MURR | US | 2 | | | | | | | | | 2 |
| Chalk River | CAN | 2 | | 1 | | | | | | | 3 |
| (IPNS) | (US) | 4 | | 1 | 2 | | | | | | 7 |
| J-PARC | JAP | | | 2 | 1 | | | | | | 3 |
| KEK | JAP | 2 | | | 1 | | | | | | 3 |
| ANSTO | AUS | 8 | 2 | 12 | 1 | | 1 | | | 1 | 23 |
| Dhruva | IND | | | 3 | | | | | | | 3 |
| IRR-1 | ISR | | | 2 | | | | | | | 2 |
| SUM | - | 441 | 205 | 628 | 71 | 3 | 41 | 23 | 17 | 168 | 1261 |

The Nordic/Baltic countries have very different choice of sources. Danish activities are much focused on PSI with the Danish instruments, Norway has a strong focus on their own source in Kjeller, while Sweden has a strong activity at ISIS with the Swedish instrument there. All Nordic countries, as well as Estonia, benefit strongly from ILL, with Denmark and Sweden as clearly the largest users (and the only members).

The world leading sources SNS and (in particular) J-PARC show low numbers, even though they began user operation already around the beginning of the counting period. This is partly because the time from data taking to publication is typically 2-3 years, partly because both sources started with a limited selection of instruments, and partly because the distance to these sources will hardly allow them be first choice of source for any European experimental group, unless for unique experiments. On the other hand, the ILL-like reactor facility NIST, near Washington DC, has a large Nordic/Baltic use, which equals that of the geographically much closer sources HZB and FRM-2. The reason for this fact cannot be revealed by our data.

7. Conclusions

The Nordic/Baltic neutron scattering community counts 429 scientists, who have in total published 1488 neutron-related articles over the last 11 years. There is a clear increasing tendency in the annual publication rate over the period of investigation; this increase comes mainly from staff at ESS and from Danish universities. 11% of the publications are made in collaboration between two or more Nordic/Baltic countries, with an increasing tendency.

42% of the publications appear in the 20% highest ranked journals, and are spread over most of the “usual” scientific topics for neutrons. This means that the research is broad and generally on a high international standard.

Notable potential for improvement is found within the topics Geology and Engineering, where the publication volume is virtually non-existing. In addition, there is a potential for development within the Biological sciences, given the Nordic/Baltic countries' general high level in this these research areas.

The main neutron source used for obtaining the results is the ILL, which accounts for 24% of the (source-related) publications. In addition, Norway has a strong use of Kjeller, Sweden of ISIS, and Denmark of PSI. This reflects the places with which the countries have particular collaboration due to investment in and operation of neutron instruments. These instrument operations are clearly linked to the scientific strong points of each country.

When deciding upon particular means for stimulating neutron scattering science in the Nordic and Baltic countries it will be prudent to consider both strong points and fields with potential for development, including the large differences in experience and competence between the countries.