Komitee
Forschung mit
Neutronen

Research with neutrons – current challenges and actual strategies

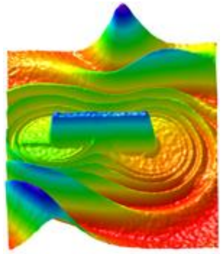
Komitee
Forschung mit
Neutronen

Astrid Schneidewind, JCNS at MLZ Garching

Exciting properties of neutrons

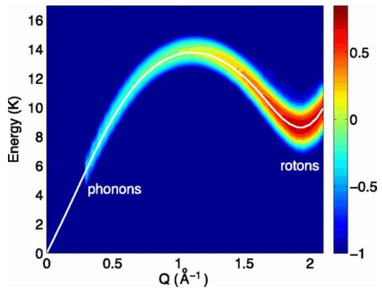
Komitee Forschung mit Neutronen

No charge!



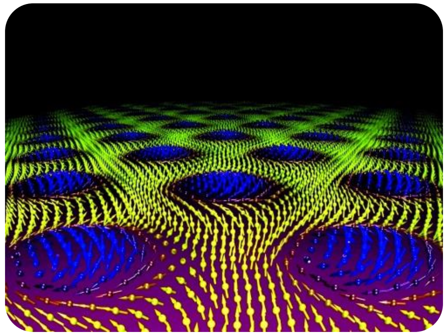
N. Kardjilov et al., Nature Physics **4** (2008) 399

Energy and momentum suited for simultanious study in time and space



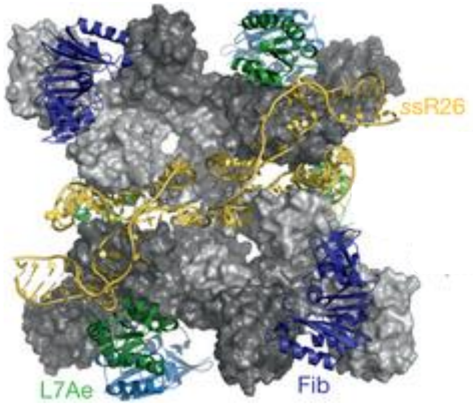
B. Fåk et al., PRL **109** (2012) 155305

Magnetic moment



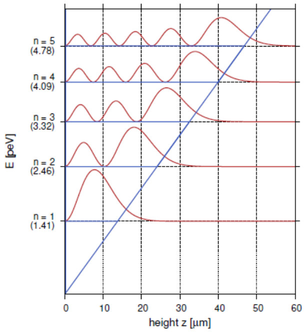
S. Mühlbauer et al., Science **323** (2009) 915

Interaction with light elements



A. Lapinaite et al., Nature **502** (2013) 519

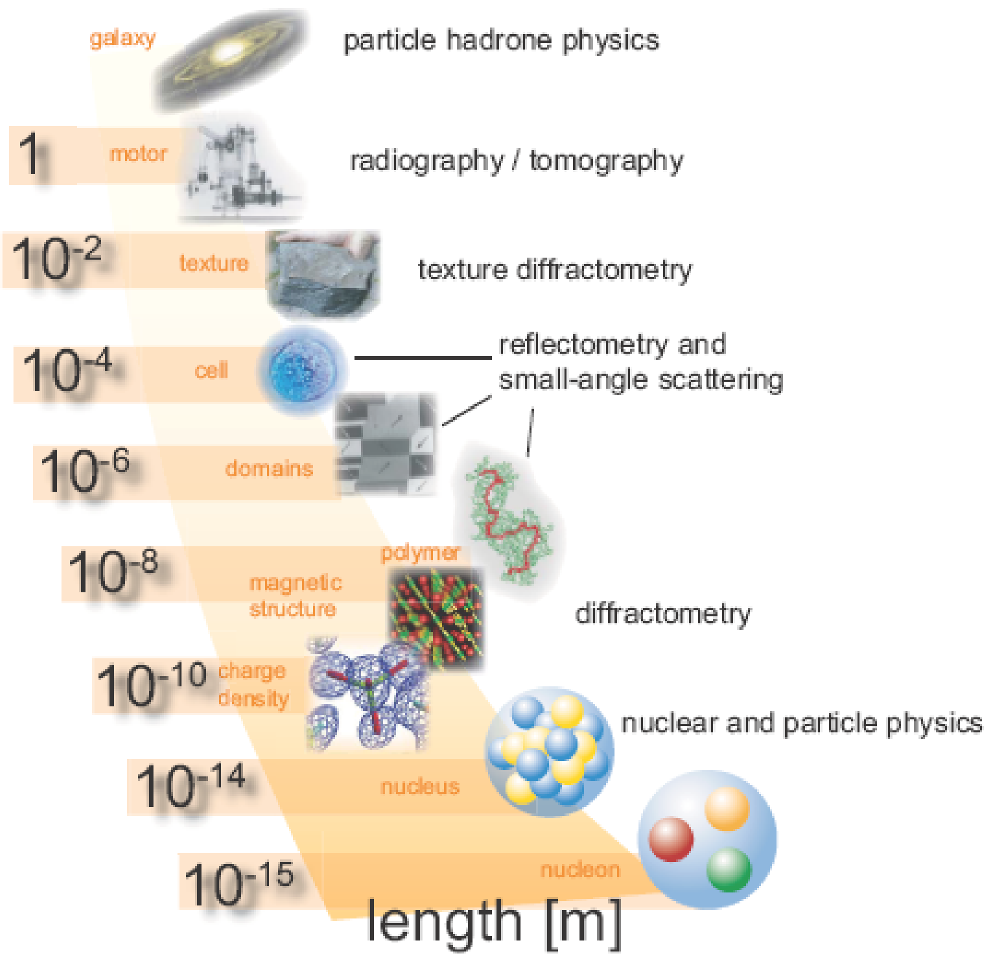
Neutron as particle

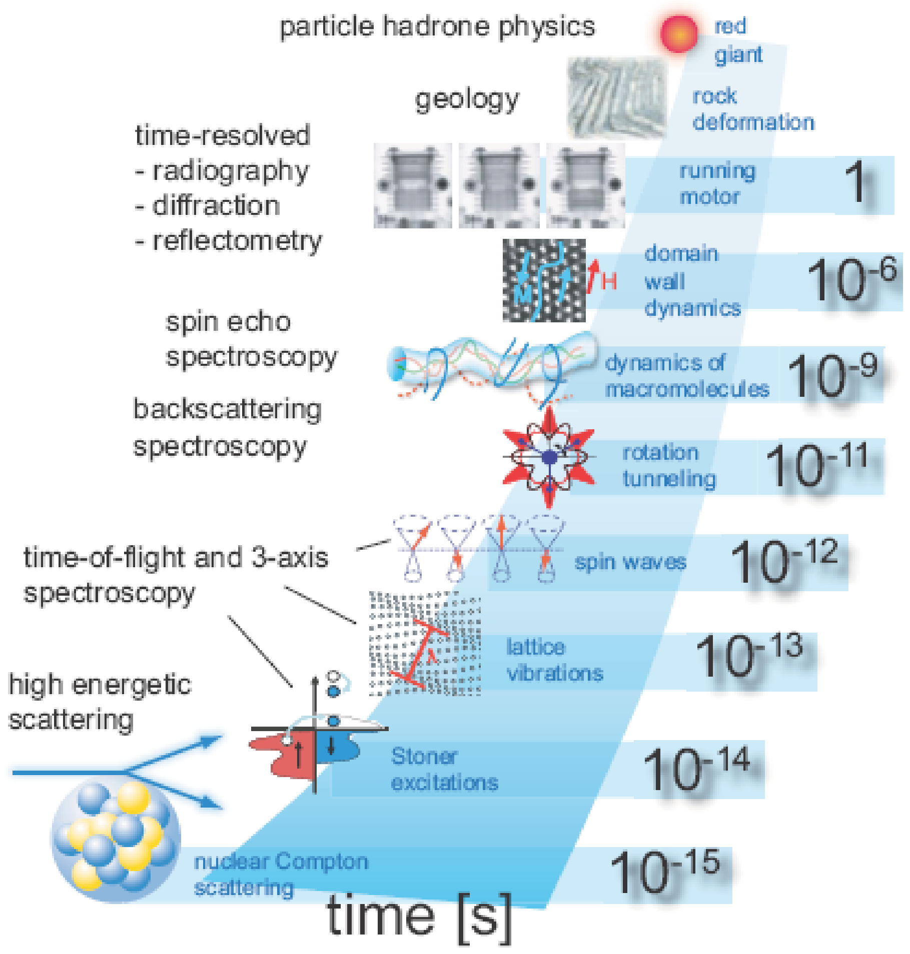


T. Jenke et al.., PRL **112** (2014) 151105

[T. Unruh]

Length and time scales accessible with neutrons.





How neutrons contribute to society

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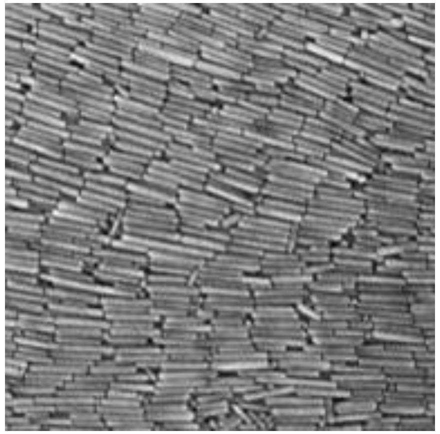


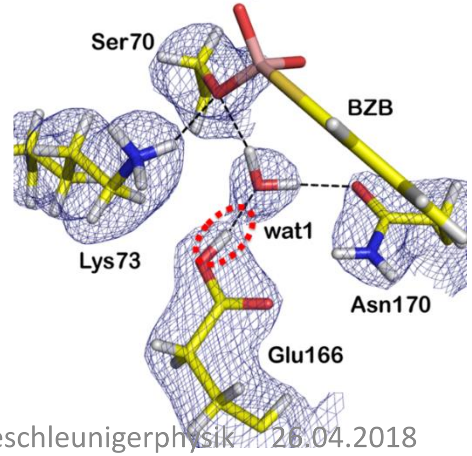
Energy

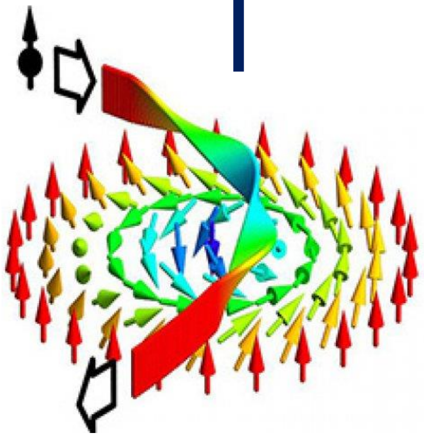
Health

Mobility

Information technology

innovative (nano-)materials





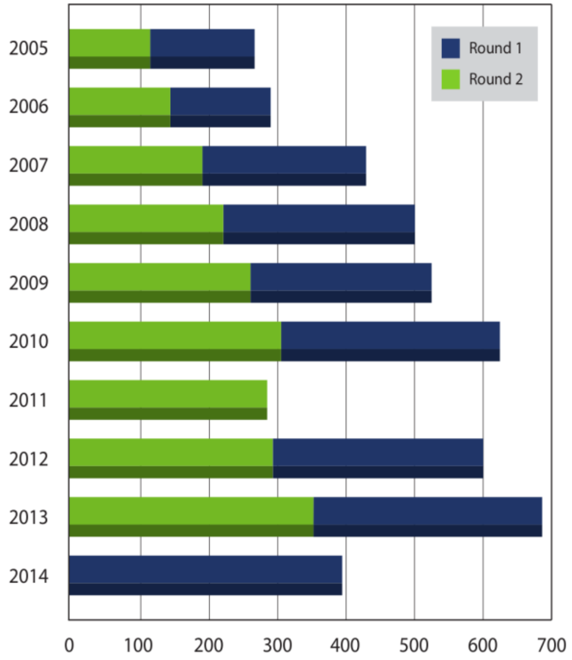
Who knows?

[T. Unruh]

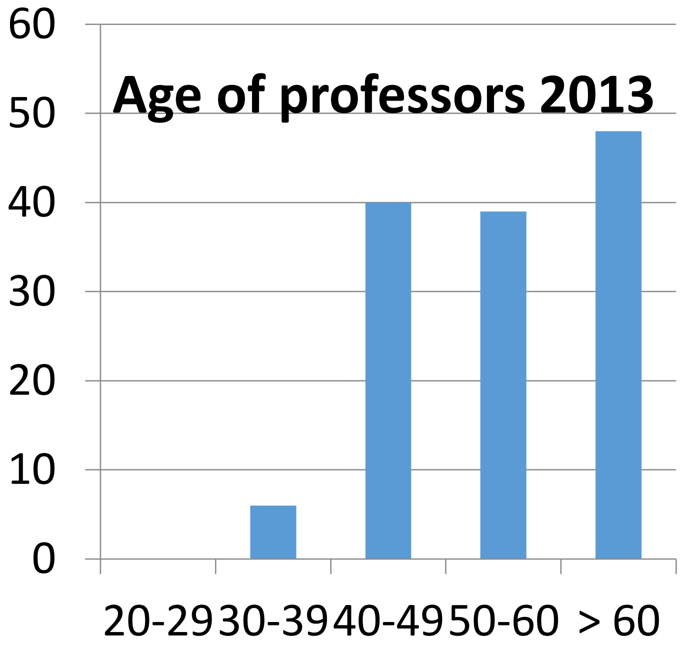
The German user community

2013	Registered users	1119	answering survey	563
2017	Registered users	≈ 1500	voting	>500

MLZ: 50% German users



- Healthy
- Active
- changing



Changes and challenges for neutron scattering

Komitee Forschung mit Neutronen

Users

- Change from methodical oriented to science oriented users
- Less interested in technique
- Faster success expected
- Less basic education (scatt.)

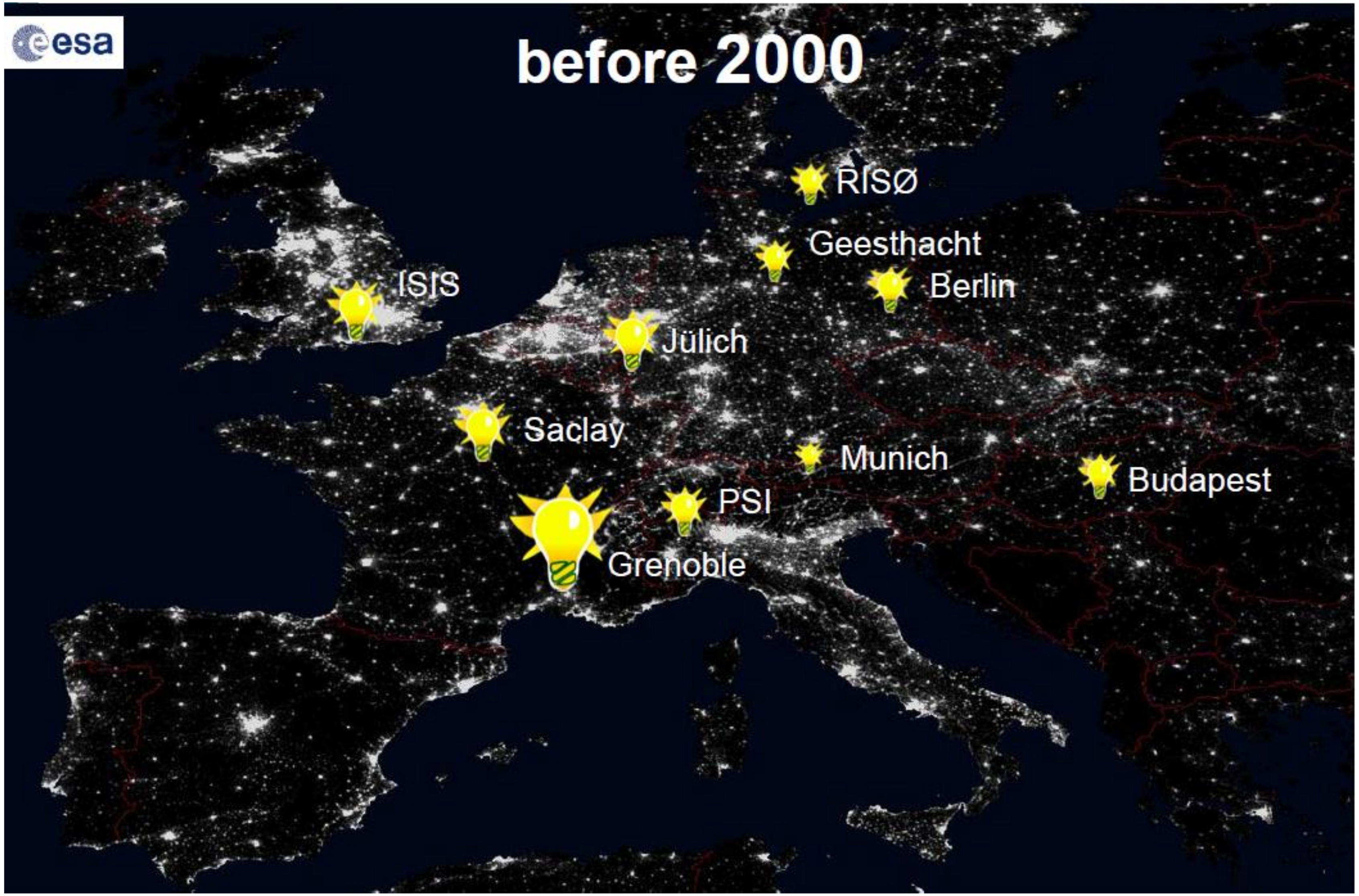
Facilities

- Less beamdays
- Less facilities (experience?)

- More and better support needed
- Software, robotics, virtual experiments
- Rapid excess, send-in-experiments
- Proposal system

- Efficient use of neutrons
- Training and education in blocks / virtual instruments
- New types of sources?

Possible European landscape of neutron LSF



[T. Brückel]

ESFRI-Report 2016

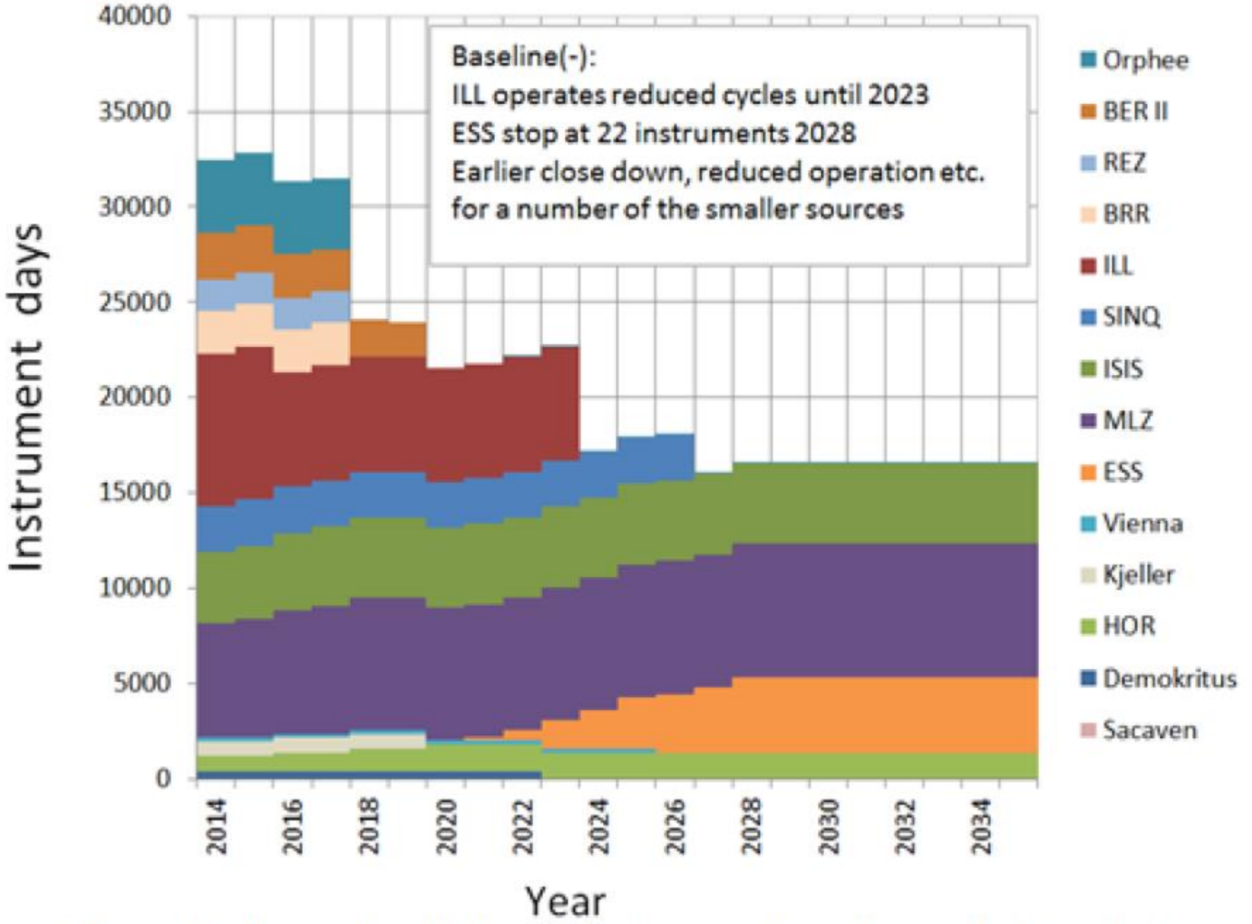


Figure 11. The predicted delivery of instrument beam-days in the Degraded Baseline Scenario.

Changes and challenges for neutron scattering

Komitee Forschung mit Neutronen

Users

- Less methodical oriented
- Less interested in technique
- Faster success expected
- Less basic scat. education

- More and better support needed
- Software, robotics, virtual experiments
- Rapid excess, send-in-experiments
- Proposal system

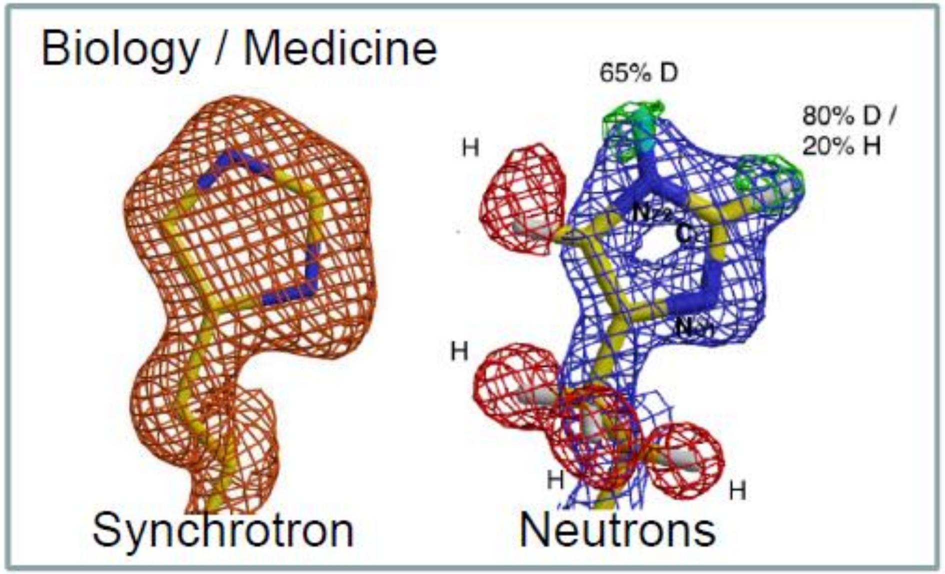
Facilities

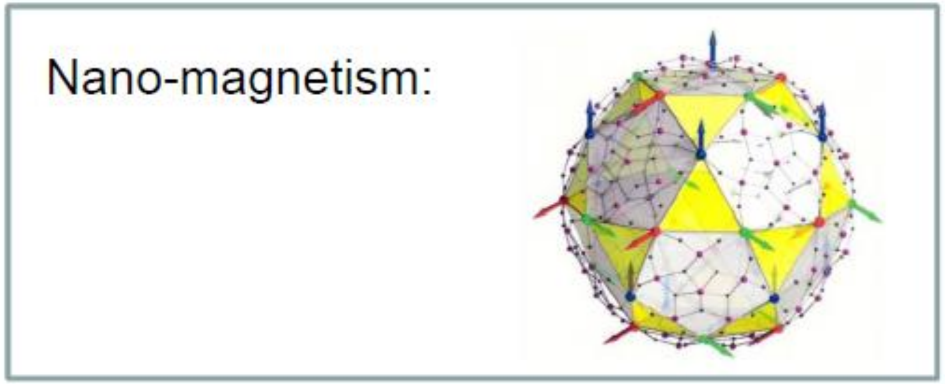
- Less beamdays
- Less facilities (experience?)
- High-end facilities and instruments

- Efficient use of neutrons
- Training and education in blocks / virtual instruments
- **New types of sources?**

High brilliance compact neutron sources (HBS)

T. Brückel: Forum Beschleunigerphysik Darmstadt 16. Februar 2017





Novel sources:

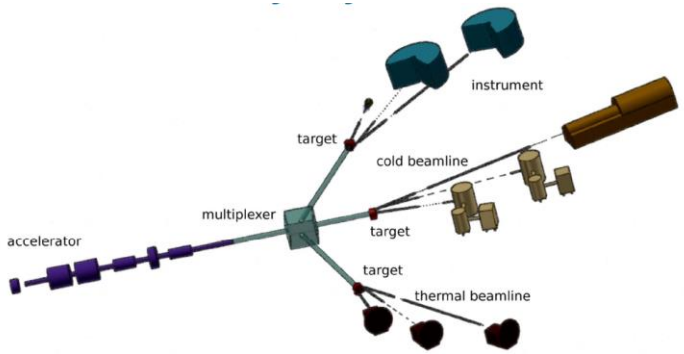
- high brilliance for small samples
- easy access for universities and industry
- education, user recruitment

⇒ project of a scalable,
high brilliant neutron source HBS
with realistic budget

[T. Brückel]

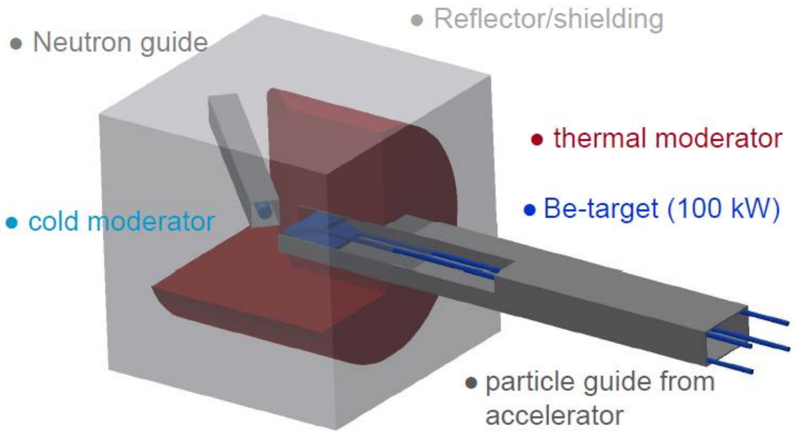
High brilliance compact neutron sources (HBS)

Komitee Forschung mit Neutronen



Bring neutrons to users
Scalable – from university budget to ISIS
Adapt to dedicated use – less neutrons (costs)
with high brilliance (more used neutrons)

No losses due to
solid angle coverage



[T. Brückel]

High brilliance compact neutron sources (HBS)

Komitee Forschung mit Neutronen

HBS - novel concept:

optimize the accelerator driven source from ion source to detector for every single instrument:

- ✓ adapted pulse time structure
- ✓ dedicated moderator
- ✓ dedicated optics

“every instrument has its own adapted neutron source!”

[T. Brückel]

Challenges for accelerator development

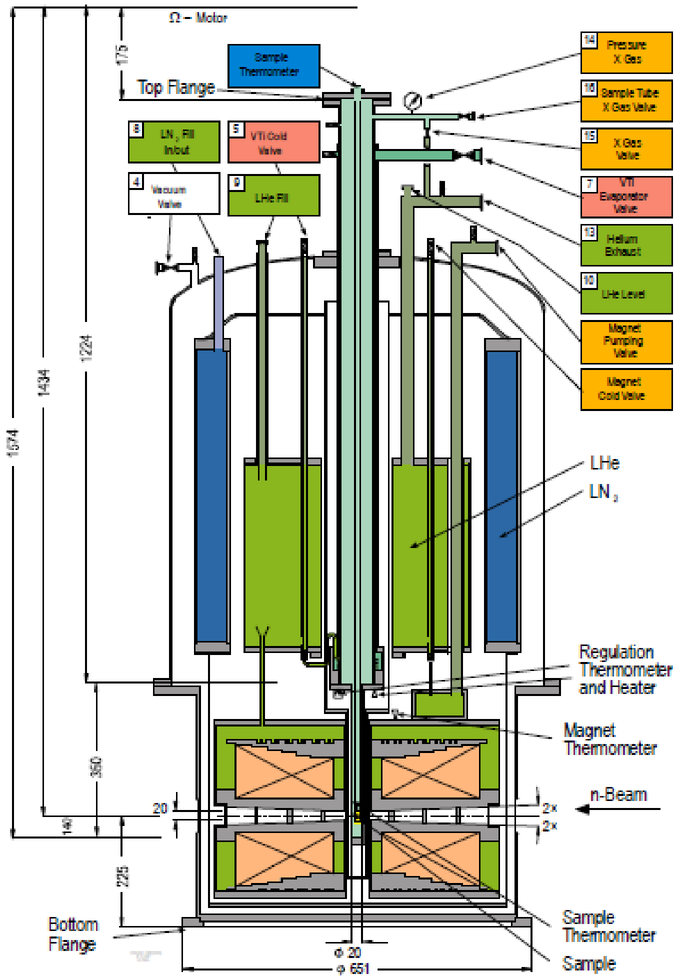
- Small version: NovaEra will use commercial accelerators – due to cost and maintenance reasons
- Medium size?
- For sources comparable to ISIS (UK) or HZB (Berlin) (medium neutron flux today) one needs accelerators to be developed
  - ➢ High current proton accelerators – like ESS (Sweden), but different properties
  - ➢ Proton current 100mA
  - ➢ Power 70-80MeV
  - ➢ optimized for high neutron flux
  - ➢ Pulse length 100 μs (50-300Hz) – well suited for neutron research
  - ➢ Highest reliability (>> 90%)

Challenges for next period

- Variable accelerator cavities
- Compact and loss-free
- Not superconducting (it seems to be less expensive also in operation without sc also in long-term operation)
- Reliability above 90%

- Spallation – needs GeV – much more expensive
- Development of low-energy accelerators gives option to built limited, scalable alternatives up to ISIS-size
- nuclear process: 1p → Be → n

Another idea – what about magnets?



- 15T – success story
- 25T HZB with very limited access
- Horizontal magnets or SANS (17T Birmingham)

- Fast development
- Movable magnet …25T with large opening
- Best would be shielded

- Synergies available?

[HZB handbook]

Another idea – what about magnets?

Komitee Forschung mit Neutronen

- 25T HZB with very limited access
- Huge effort to calculate what is possible
- Many things are not possible

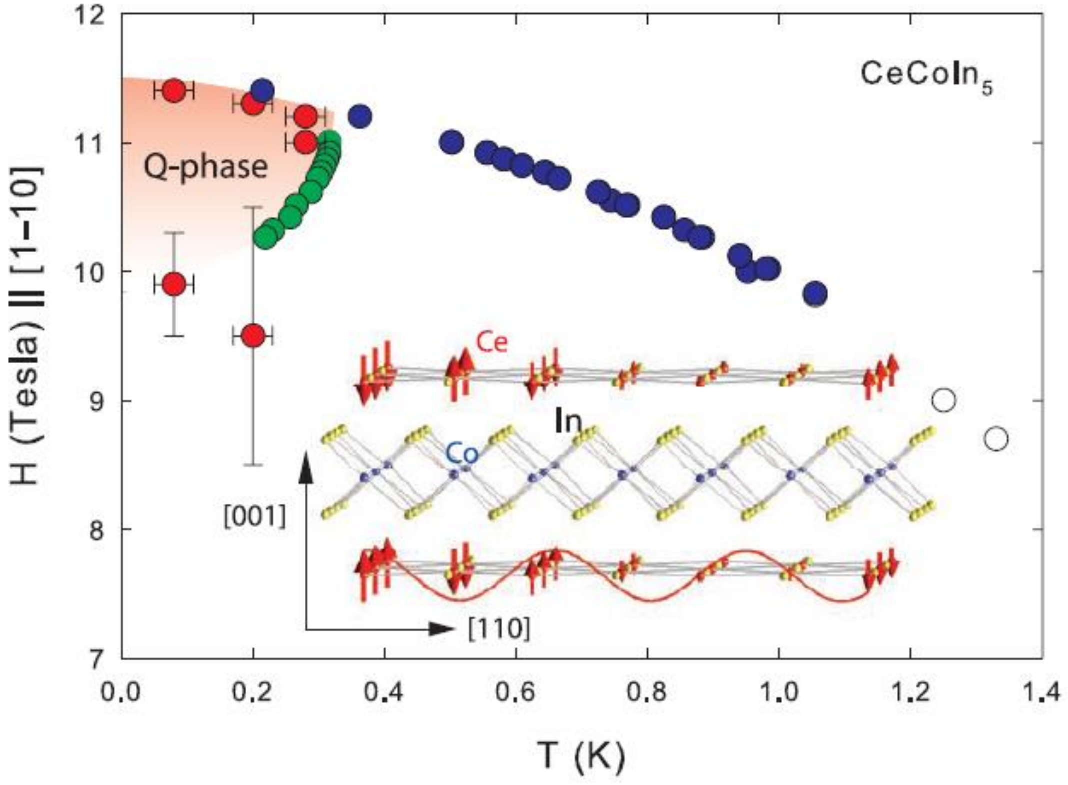
- Movable magnet 20…25T with large opening
- Best would be shielded

- Synergies available?

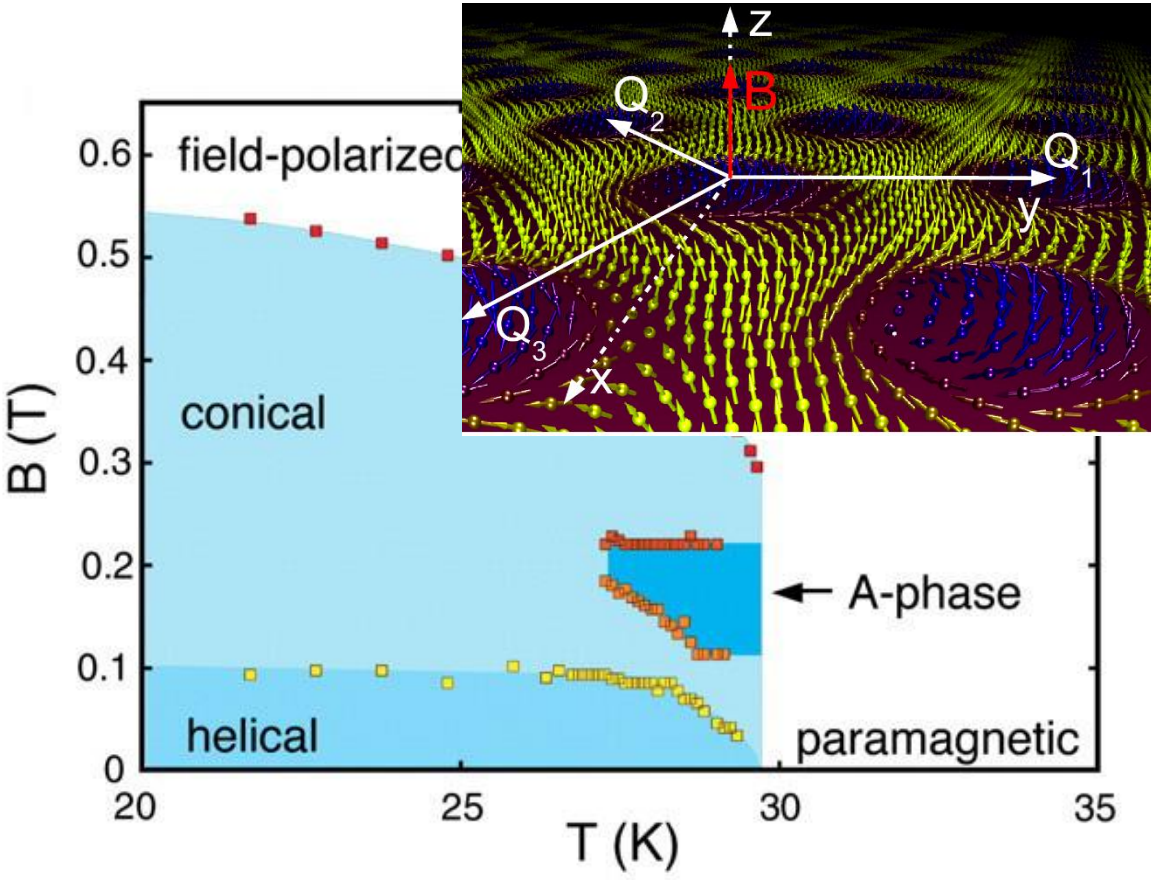
[HZB handbook]

Vielen Dank für die Einladung,
Aufmerksamkeit und spannende Diskusion!

Why higher magnetic fields – new ground states?



[Science 321 (2008)]



[PRL102, 186602 and Science 323 (2009)]

Overview from 2017

Accelerator	
particles	deuterons
particle energies	5 – 50 MeV
peak current	100 mA
pulse length	50 μs – 2.5 ms
frequency	24, 96, 384 Hz / (quasi continuous ? variable 20-400)
Target	
Be slap	1.4 cm thickness
cooling	water (gallium)
max. power	100 kW per target station
number of target stations	3
number of beamlines	3 - 5 per target station
Moderator & Reflector	
thermal moderator	polyethylene slap
cold moderator	para-/ortho hydrogen & solid methane
reflector	beryllium / graphite

[T. Brückel]