

DARIA



compact neutron sources



Russian compact neutron source initiative DARIA

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Motivation

Concept and design features

Current status

Conclusion



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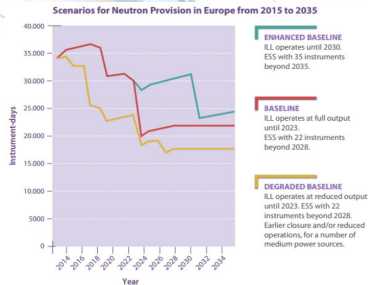
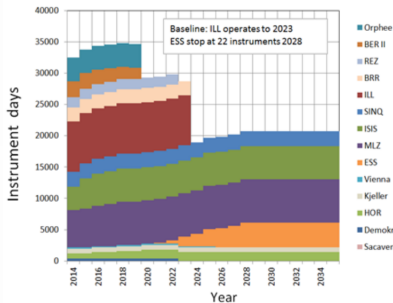


Рис.: From ESFRI 2016 "Neutron scattering facilities in Europe. Present status and future perspectives"



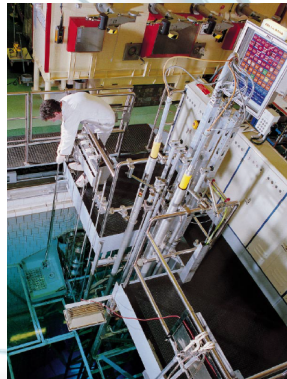
Features to point

- ▶ Huge cost
- ▶ Common use (user program)
- ▶ Extreme concentration of opportunities

Network of smaller sources



- ▶ WWR reactors (USSR and Warsaw Pact countries)
- ▶ TRIGA





Medium- and small-power reactors are a driver for neutron scattering techniques and instrumentation development

- ▶ Virtual sources for TAS
- ▶ Multiple analyzer systems for TAS
- ▶ SESANS
- ▶ Optically blind chopper pair
- ▶ Bispectral beam extraction

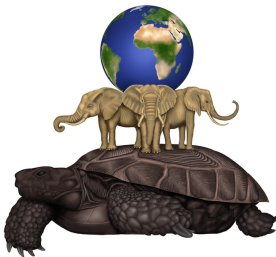
- ▶ Flagship sources are alive (ILL, FRM-II, IBR-2M in operation; ESS, PIK under construction, Neptun in design phase)
- ▶ Most of medium- and small-power sources closed (Juelich, Geesthacht, Risoe, Saclay, Berlin, Oslo, Moscow, Ekaterinburg, majority of WWRs and german zero-power reactors)



How it should look like



- ▶ One «flagship» source for a country or a number of countries — for Nobel prizes
- ▶ Several medium–power sources — workhorses for routine experiments, training, testing, etc



Examples

- ▶ LENS (USA)
- ▶ CPHS (China)
- ▶ RANS и др. (Japan)
- ▶ HBS, SONATE и др. (Europe)

Features

- ▶ Relatively cheap
- ▶ Compact target and small overall area
- ▶ Easy safety certification





- ▶ **Compact sources are to replace medium–power sources**
 - ▶ **The aim of a compact neutron source project — to design a source ready to «mass» production**
1. Ensuring the wide availability of neutrons for (not) users and the associated increase of the quality of experiments on flagship sources;
 2. Ensuring close cooperation with industry and commercialization of neutron scattering;
 3. Giving new impetus to the evolution of the neutron experiment techniques.



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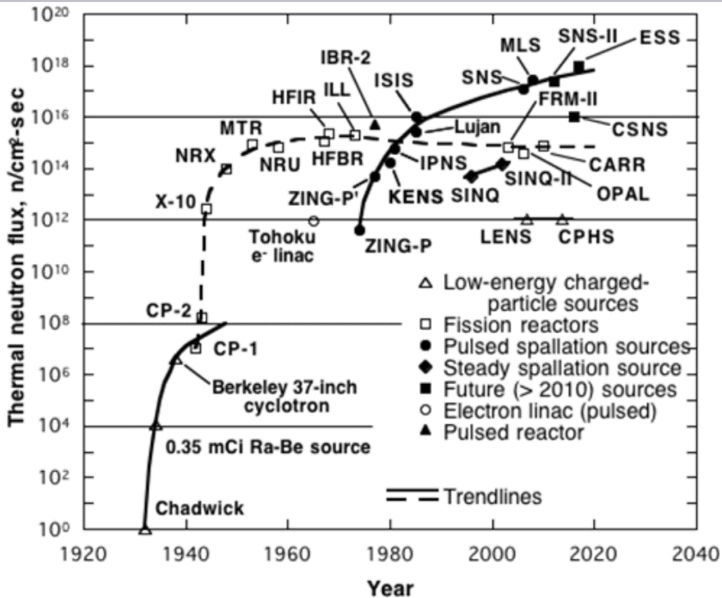
Conclusion

Compact sources

Where are they in the food chain?



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The key problem



- ▶ Compact source concede 6 orders of flux to modern mega-facilities — is it possible to make a neutron experiment in principle?
- ▶ Deep optimization required!

Key features

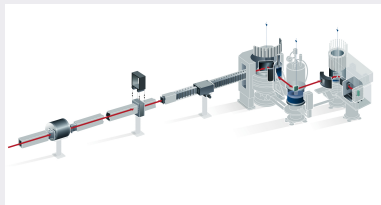
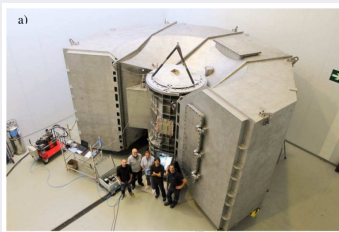
1. High current low energy proton accelerator with Be target



Рис.: CPHS TMR, Beijing, China

Key features

1. High current low energy proton accelerator with Be target
2. Medium reactors as a reference





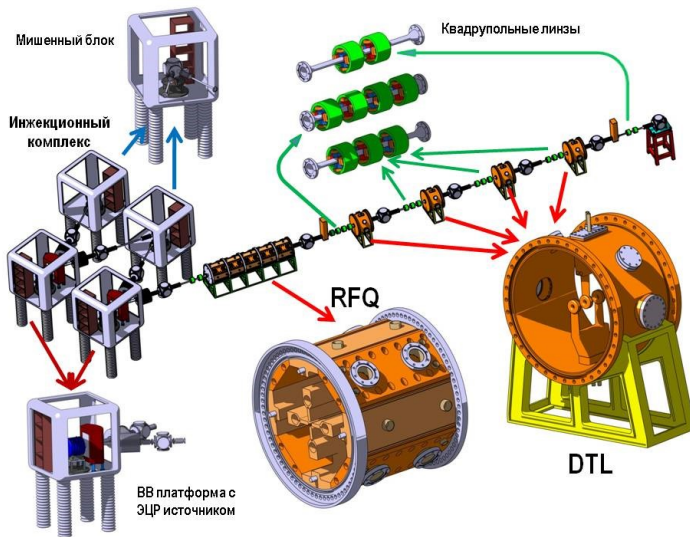
Key features

1. High current low energy proton accelerator with Be target
2. Medium reactors as a reference
3. Integrative design from sample to source
 - ▶ Individual moderators
 - ▶ Matching the moderation time and pulse duration
 - ▶ Accelerator operation adapted to each experiment

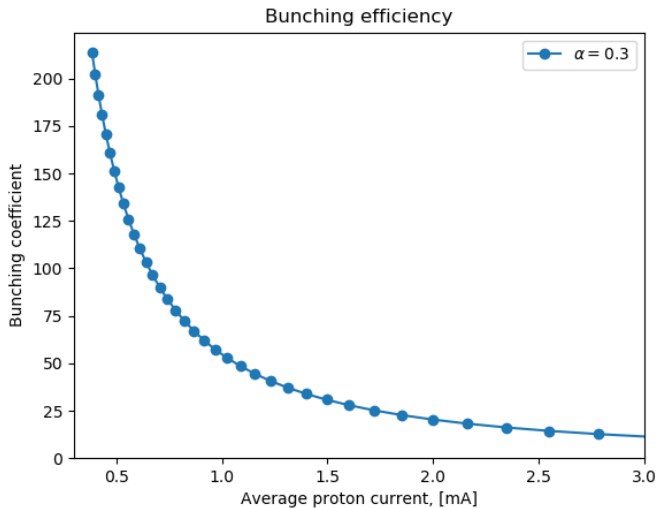


BELA — ITEP linac project

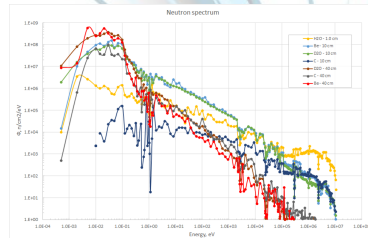
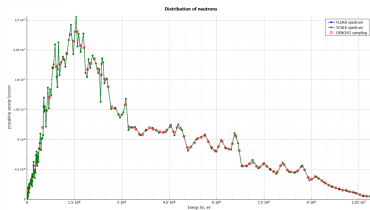
Seems to be the most suitable for DARIA



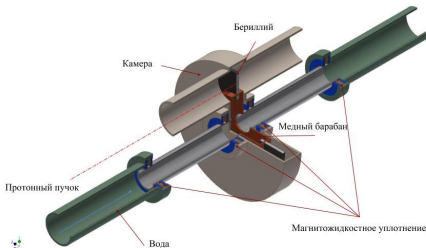
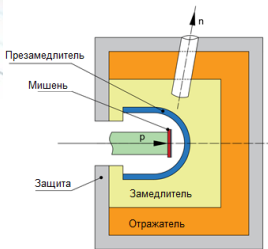
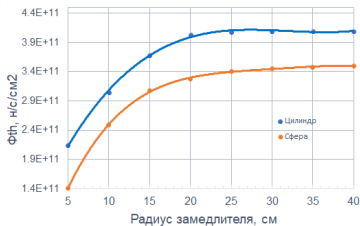
Possible way to get high peak current with modern technologies



MCNP simulations to increase an efficiency of neutron thermalization



The real restriction — target cooling, too low heat conductivity in Be



- ▶ General purpose diffractometer
- ▶ SANS
- ▶ Reflectometer

Future options:

- ▶ Inverted geometry spectrometer
- ▶ Multi-mode spin echo instrument



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- ▶ PNPI/SPbSU: K. Pavlov, P. Konik, N. Kovalenko, A. Petrova, G. Dovzhenko, S. Grigoriev
- ▶ JINR: S. Kulikov, M. Bulavin
- ▶ ITEP: T. Kulevov, G. Kropachev, A. Sitnikov, A. Kozlov, A. Seleznev
- ▶ IKBFU: A. Goikhman, A. Sinitsyn, E. Klementiev





- ▶ RSF grant for making CDR (18 M rub for 3 years)
- ▶ RFBR grant for instrumentation design (0.8 M rub for 2 years)



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- ▶ Compact neutron sources are strictly demanded as a network of facilities for training, adjusting, instrument science and industrial applications
- ▶ DARIA — the project of high current compact accelerator-driven neutron source with beryllium target servicing 2–4 instruments. CDR is expected by the end of 2021
- ▶ DARIA — the way to reshape Russian neutron landscape in the era of PIK and DNS-IV



Thank you for your attention!