Design of the neutron guide system for the PIK reactor

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PIK reactor
Main parameters

Main parameters

- Thermal power 100 MWt
- Fuel HEU
- Reflector D$_2$O
- Max flux (central channel) $5 \times 10^{15}$ n/s/cm$^2$
- Max flux (reflector) $1.3 \times 10^{15}$ n/s/cm$^2$
- 10 horizontal beamtubes
- 2 CNS and 1 HNS planned

Reactor starts in late 2018!
**Cold neutron source**

**Configuration**

- **Core**
- **CNS Beamtube N3**
- **Shutter Guides** (not precise)

Dimensions:
- **780 mm**
- **220 mm**
- **967 mm**
- **1820 mm**

**Beamtube N3**

120x200 -> 320x200 mm$^2$
Cold neutron source
Comparable to the ILL VCS

Brilliance

Flux

2nd CNS of HCS-type is planned
Our task
Neutron guide system

Design features

- Extensive use of modern optics
- One guide — one instrument

Restrictions

- Only one beamtube!
- Beam requirements not frozen
- Narrow space in the bunker (25 m)
- $11.5^0$ between beamtube axis and guide hall axis
- Time and budget constraints

Instrumentation
14 cold instruments in the guide hall

I stage 2014–2018 (Modernization)
- 2× SANS
- 2× reflectometers
- SESANS
- DCD

PIK-GGBase collaboration

II stage 2017–2021 (New instruments)
- Powder diffractometer
- 2× SANS
- 2× reflectometers (1 replacement)
- TAS
- Direct TOF spectrometer
- NSE spectrometer
- DEDM (fundamental physics line)

Additional thermal instruments from the reactor hall
General approach for the design

1. Define the beam requirements for each of the instruments and optics needed
   - Some are known from the previous experience
   - Some need additional study
2. Group the instruments according to the defined requirements
3. Fill the guide hall with instruments
4. Optimize horizontal shape of each guide
   - Curvature radii
   - Bender length
   - Focusing noses
5. Optimize vertical shape of each guide
6. Check the effect of the shutter optics (∼970 mm from the CNS)
Monochromatic instruments optics

Constant cross-section is preferable

Elliptic guides performance

Ellipse

Constrained ellipse

Nosed guides are preferable
Tilting the beam

Divergence = ±0.5°, lambda = 5

\[ \text{L}_{\text{cen}} \% \]

\[ \text{L}_{\text{tot}} \text{[m]} \]
<table>
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<tr>
<th>Guide</th>
<th>Instruments</th>
<th>Main features</th>
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<td>DEDM (f.physics)</td>
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<td></td>
<td>ColdTAS</td>
<td>straight, h-focusing nose</td>
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<td>H1</td>
<td>PD, cm-Ref</td>
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<td>h-Ref, v-Ref</td>
<td>v-nosed, 2 branches</td>
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<td>H4</td>
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<td>H5</td>
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Hall plan
Saving space for the future

High instrument density!

- put some instruments outside of the guide hall
- classify instruments into «lateral» and «straight» beamlines
- special cases of NSE and TOF
## Loss factors

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<th>$S$</th>
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<th>$A_v$</th>
<th>$A_h$</th>
<th>$A_{rot}$</th>
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Summary

- PIK reactor will start by the end of 2018
- The general approach to design guide system is presented
- The current system design is presented
- Acknowledgment to NSAC members
Thank you for attention!