International Workshop on Applications of Advanced MC Simulations

Paul Scherrer Institut, 2 - 4 October, 2006

Simulations for the HYSPEC polarization options

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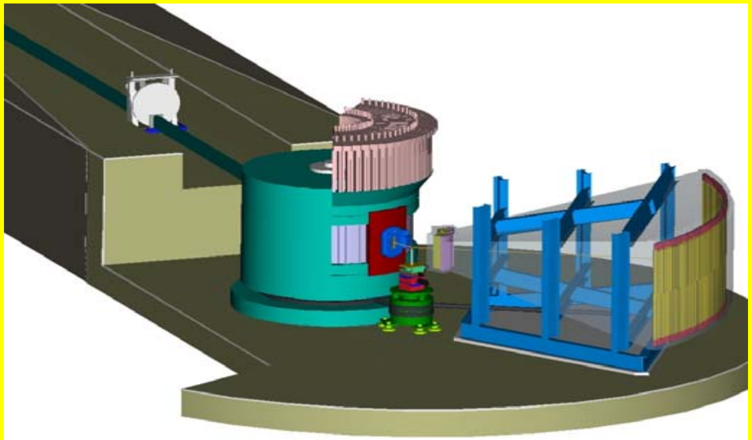
Introduction

- collaboration between PSI and SNS to design/produce a supermirror polarization analyzer for HYSPEC

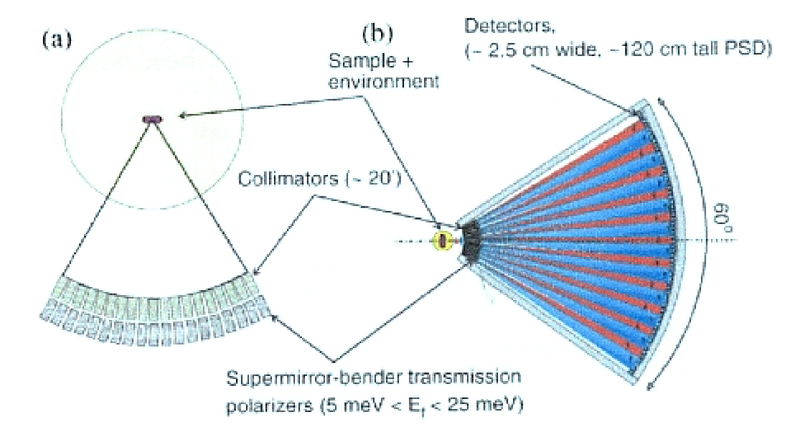


HYSPEC – Time-of Fligth Hybrid Spectrometer

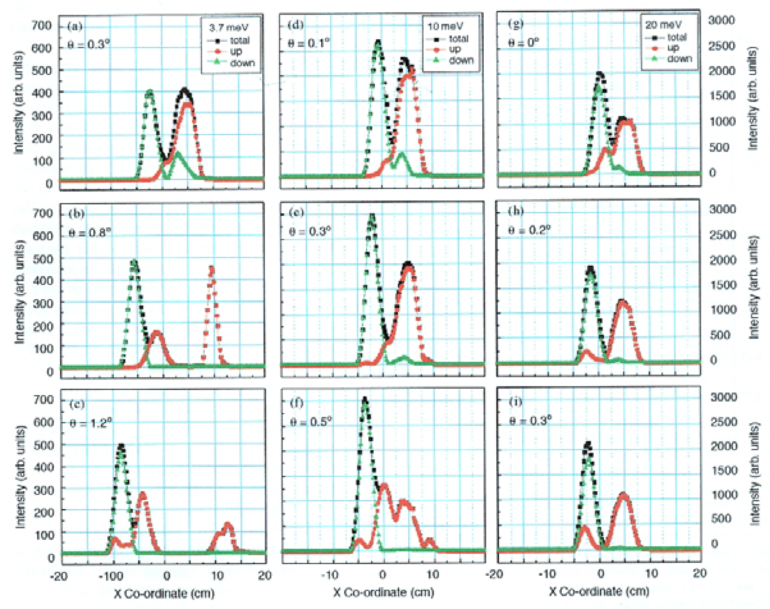
- content of presentation
  - cross-check/intercomparison (between VITESS and NISP) to an existing proposal of a HYSPEC supermirror polarizer
  - (double) S- bender polarizer configuration for the reflected neutron beam
  - borated-glas single bender (polarizer) configuration for the reflected neutron beam

HYSPEC - Supermirror-bender Transmission Polarizer

- starting point was a cross-check/intercomparison between the NISP and VITESS packages



setup of the transmission polarizer



horizontal profiles of the neutron intensity at the detector for 3.7, 10 and 20 meV

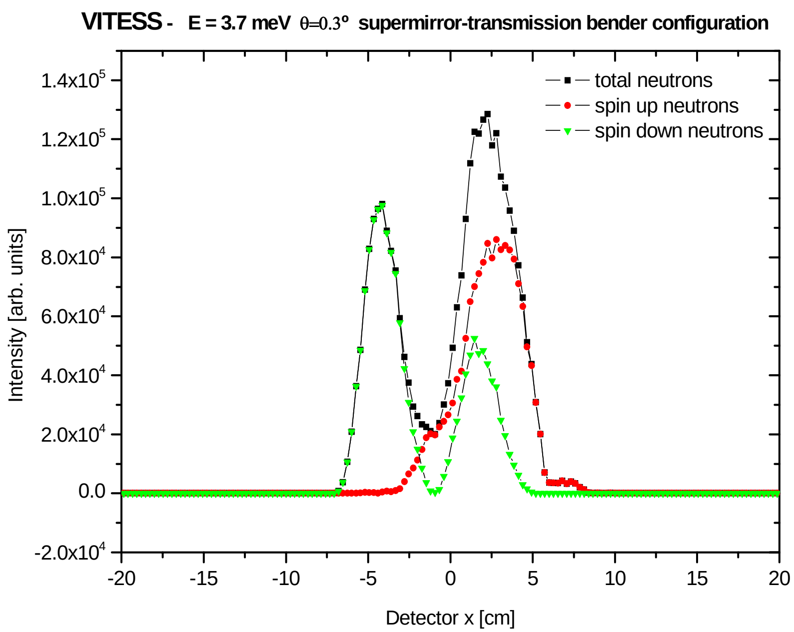
I.Zaliznyak et al. Physica B 356 (2005) 150-155

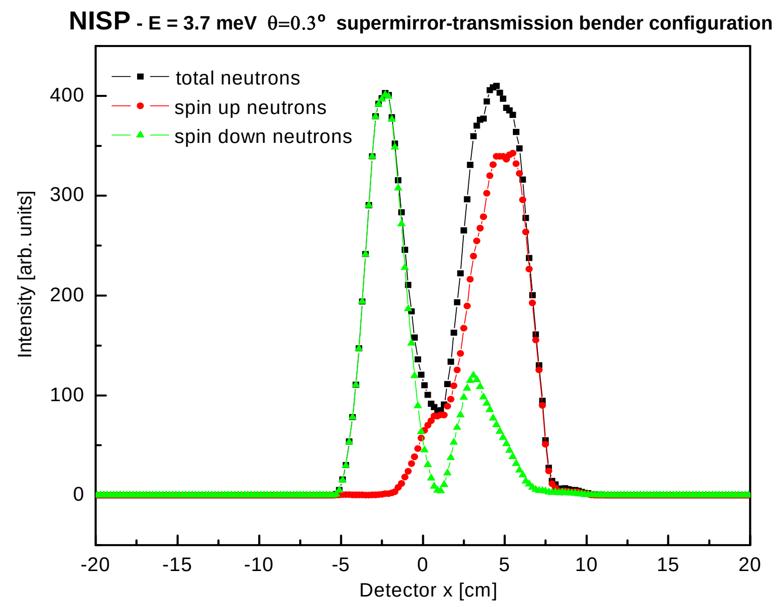
Main values of BNL-Bender Configuration

- source size 2x2 cm; $\Delta\lambda/\lambda$ = 1 %
- distance source – upstream collimator: 40 cm
- upstream collimator: 20 minutes; dimension: 2x12x15 cm (WxHxL)
- distance source – bender: 55 cm
- bender configuration: dimension 2x12x5 cm (WxHxL); r=500cm; 80 Si-blades coated with m=3 ⇨ R=77% (spin up) and m=1 (spin down);
- distance source – detector: 450 cm

Energy 3.7 meV with θ=0.3°

- theta θ – tilt angle between collimator and bender axes





- differences: absorption in Si-wavers ; using different reflectivity curves

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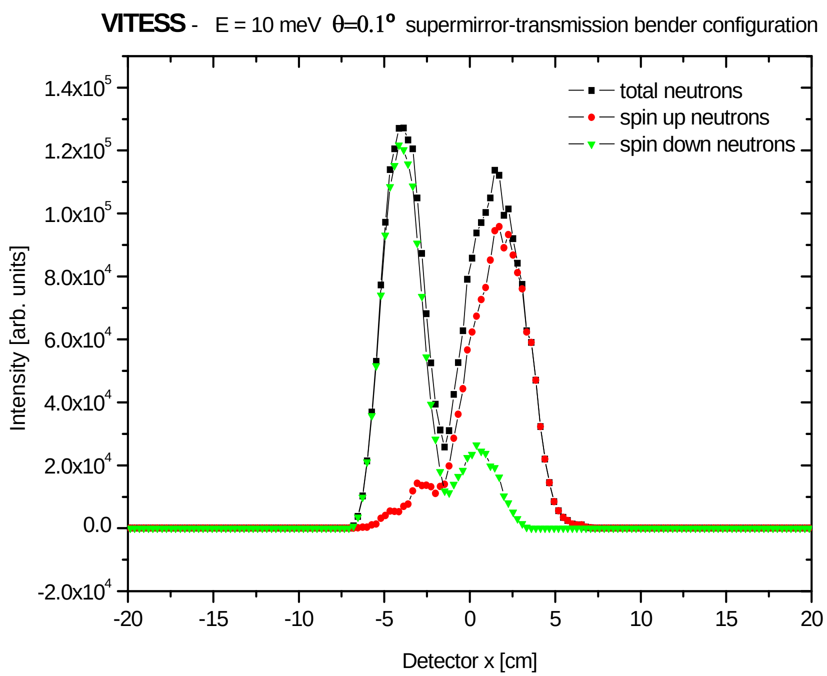
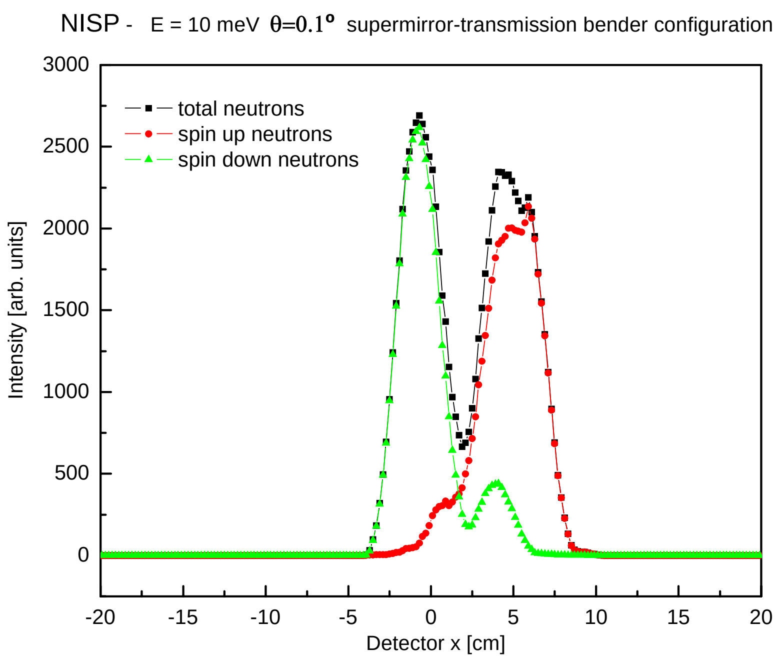
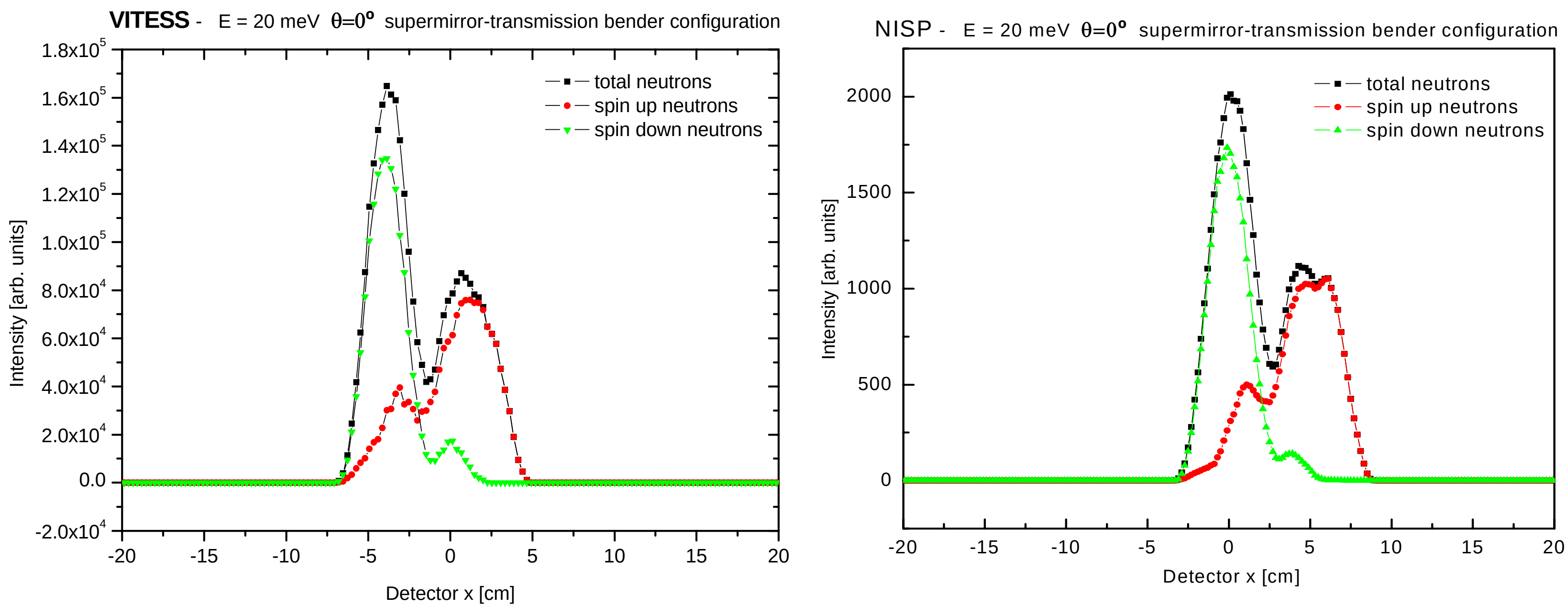
Energy 10 meV with θ=0.1º





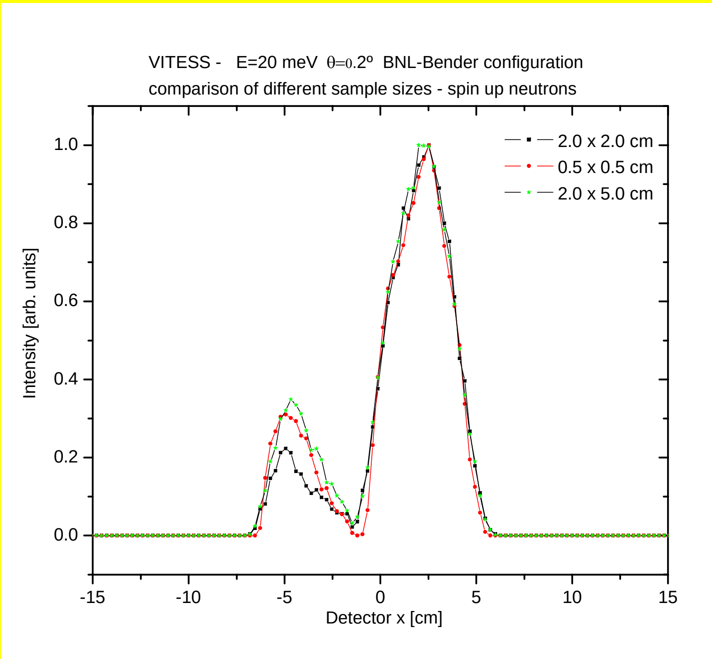
- very small differences in the shape of the reflected beam

Energy 20 meV with θ=0º



- small differences in the shape and scaling factor for the transmitted beam

Dependency of the Detector Profile from the Sample Size



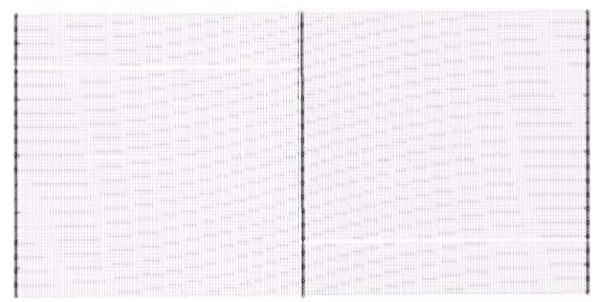
comparison of spin up neutron beam for different sample sizes

Conclusion

- cross-check shows a very good agreement
- separation of spin up and spin down neutrons over a big energy range is very complicated
- presently defuse scattering and waviness of supermirrors are not included

S-shaped Supermirror Bender

- spin up and spin down neutrons will be measured subsequently
- each useful neutron makes two reflections
- transmitted neutron beam will be absorbed in a gadolinium layer (approx 50 µm) behind supermirror layer

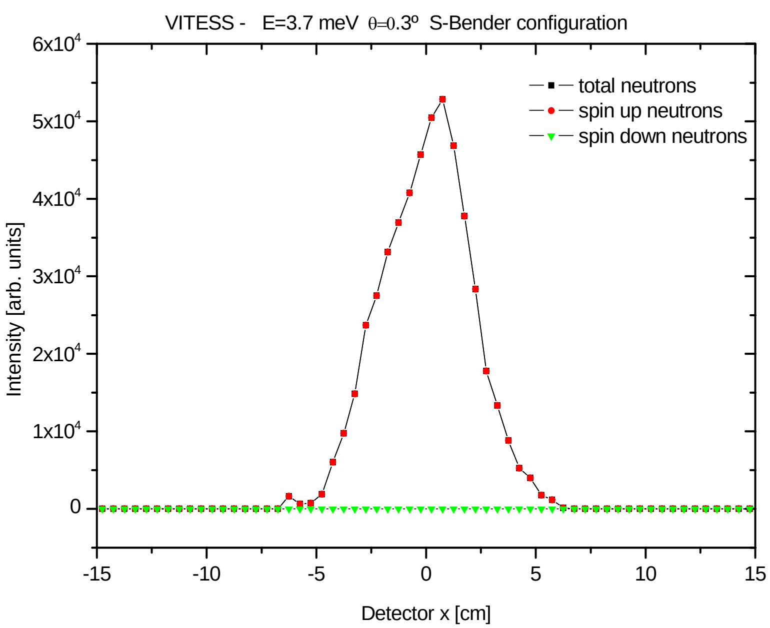


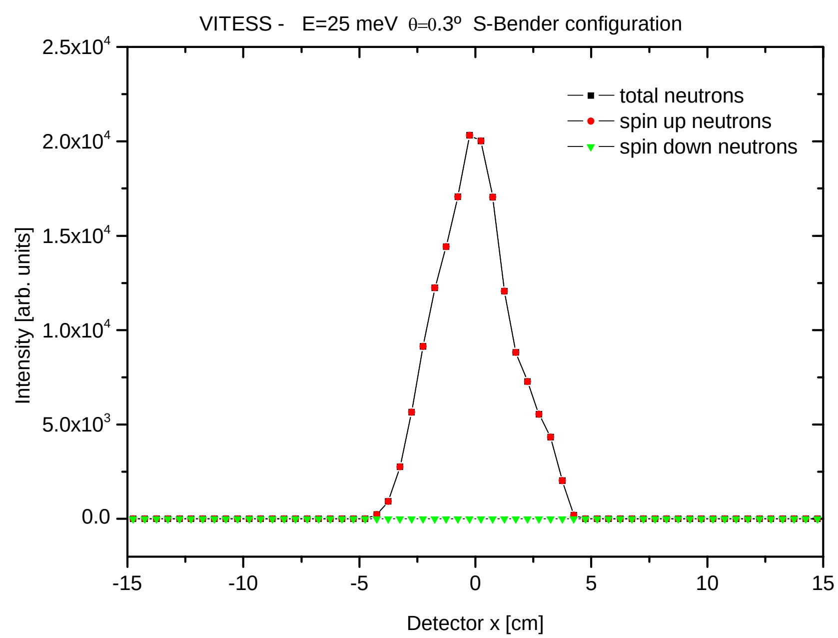
right-curved supermirror bender | left-curved supermirror bender

Main values of S-Bender Configuration

- source size 2x2 cm; $\Delta\lambda/\lambda$ = 1 %
- no upstream collimator necessary
- distance source – bender: 55 cm
- bender configuration: dimension 2x12x10 cm; r_1=500 cm; r_2=-500 cm; 80 Si-blades coated with m=3 ⇨ R=77% (spin up) and m=0.1 (spin down);
- distance source – detector: 450 cm

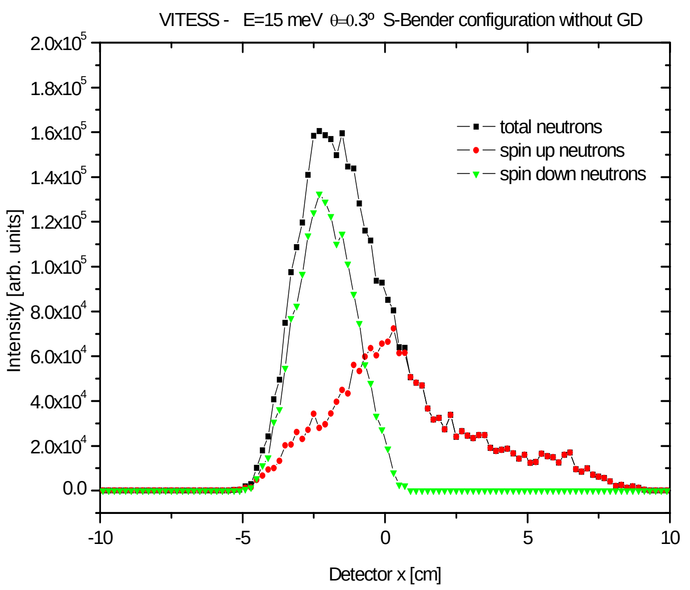
Detector Profiles for 3.7 and 25 meV





- S-bender has been tilted with 0.3° in both cases

Detector Profile without Gadolinium

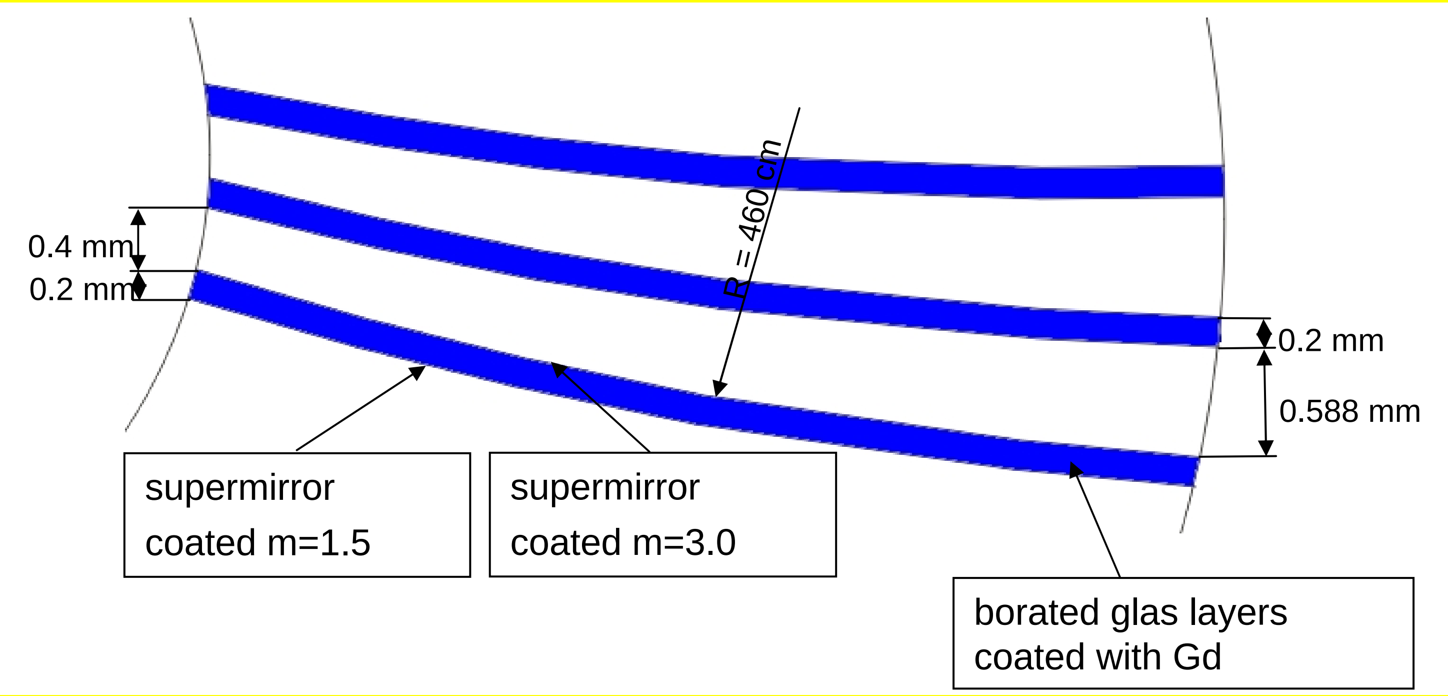


Conclusion

- very high polarization (no contamination)
- fixed tilt angle θ for the full energy range from 3.7 to 25 meV
- disadvantage: polarization efficiency; some loss in intensity; factor 2-4

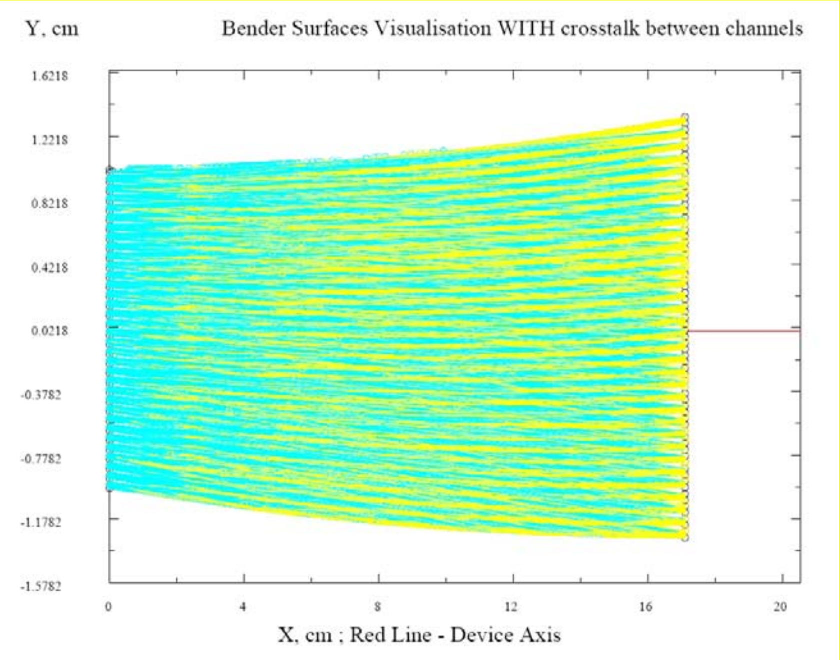
Borated-glas Supermirror Bender
Configuration

- source size 2x2 cm; $\Delta\lambda/\lambda$ = 1 %
- distance source – bender: 55 cm
- bender dimensions: 2x19x17.1 cm (WxHxL)
- distance source – detector: 450 cm



Borated-glas Supermirror Bender

- spin up and spin down neutrons will be measured subsequently
- increasing critical angle through opening channel shape
- reflected neutron beam will be measured, transmitted neutrons will be absorbed in Gd-layer



bender is working in reflection (yellow – reflected neutrons; blue – not reflected neutron)

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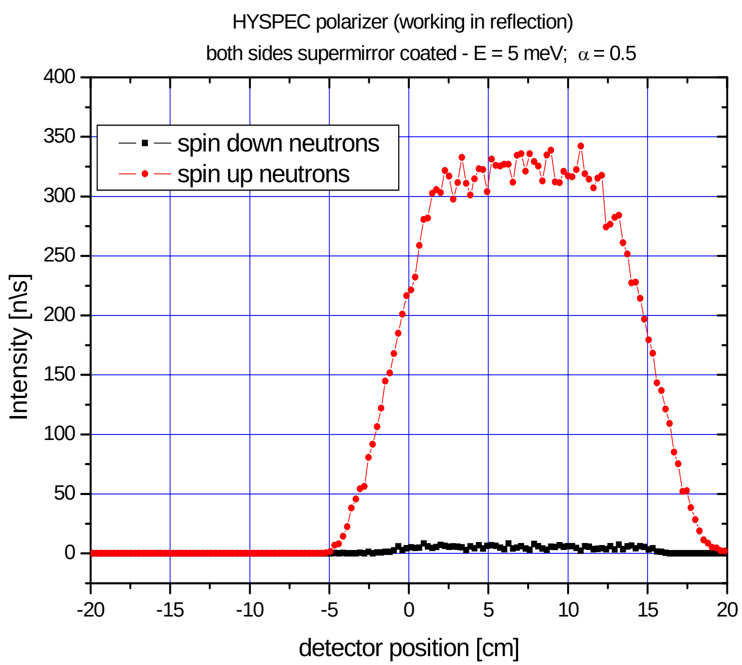
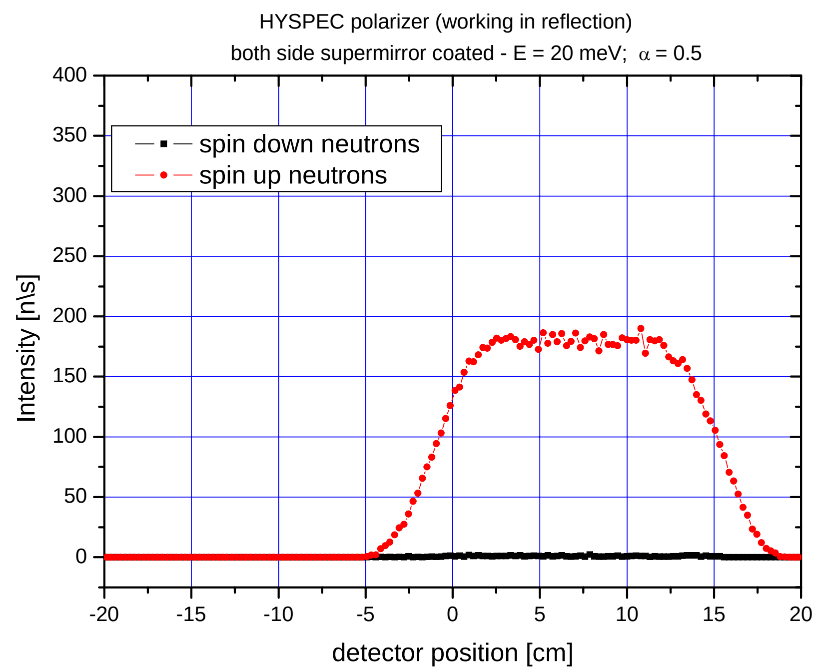
Detector Profiles for 5 and 20 meV





- bender has been tilted with 0.5° in both cases

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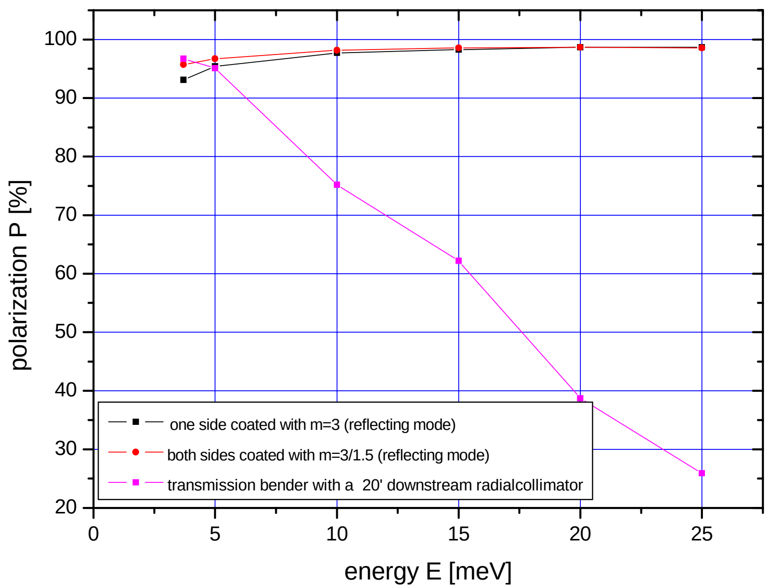
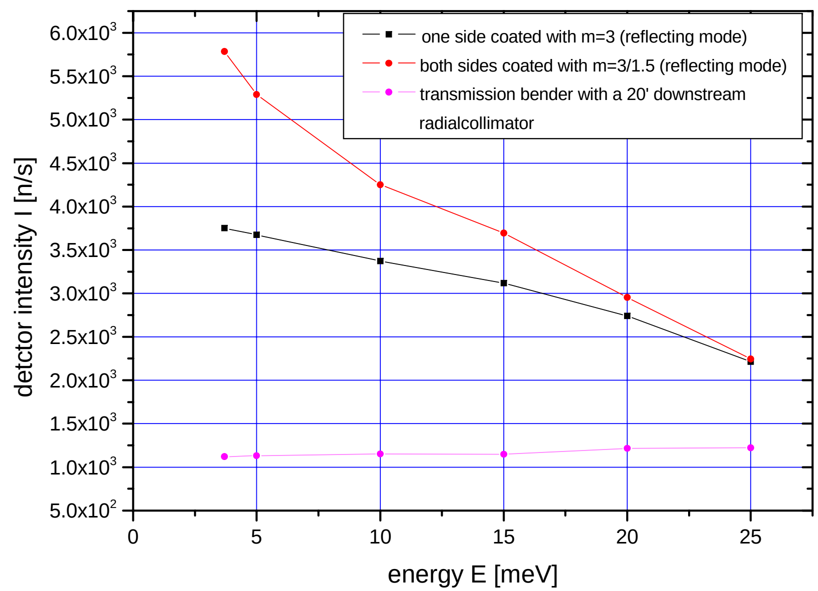
Performance of the Borated-glase Supermirror Bender





- to improve energy resolution an additional collimator can be used

Conclusions to the Borated-glas Supermirror Bender

- very high polarization over the full energy range (3.7 to 25 meV)
- also fixed tilt angle θ for the full energy range
- polarization efficiency higher as S-bender and BNL configurations

Summary

- intercomparison shows a good agreement between the MC-packages NISP and VITESS
- analysis of simultaneously measured spin up/spin down data can be sophisticated
- subsequent measurement of the spin states covers a big energy range with very good polarization
- the borated-glas supermirror bender covers a very good performance and cost-effective design