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Advanced geometries for ballistic neutron guides

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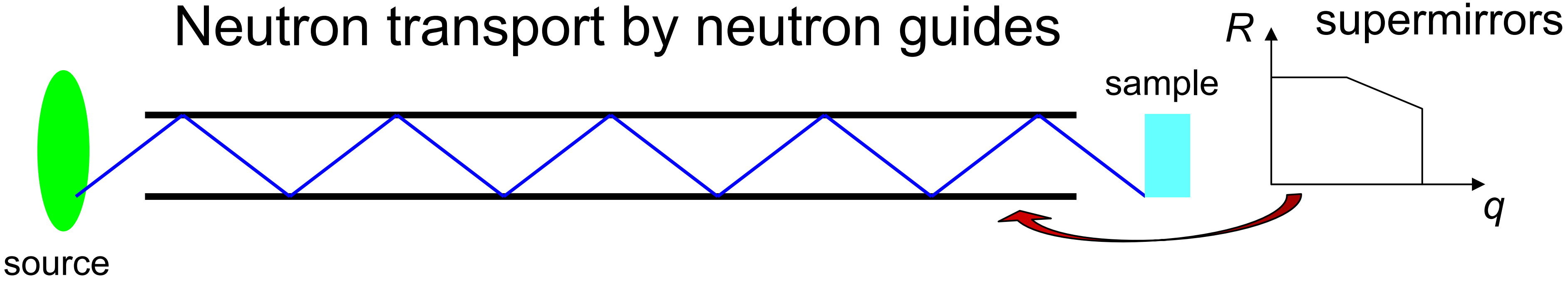
Content

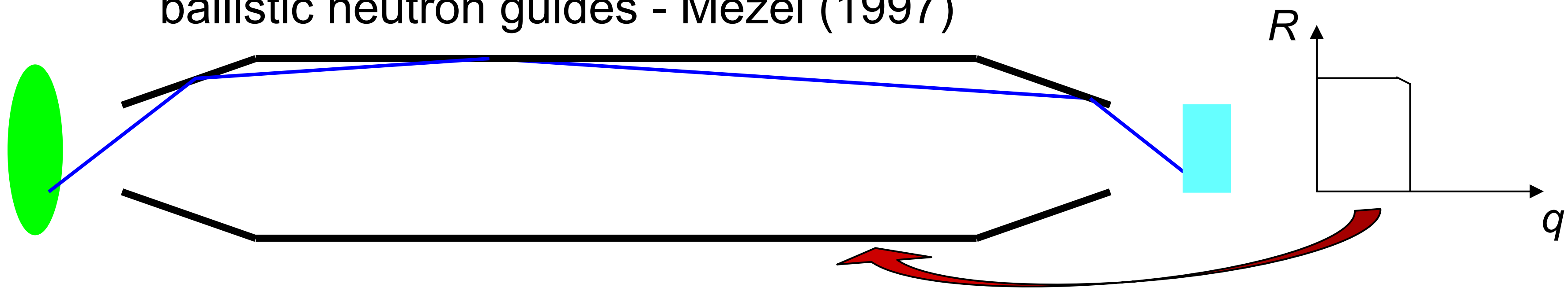
- Introduction
- Perfomance of ballistic guides with linear and non-linear tapering
- Phase space distribution of transmitted beam
- Technical aspects of elliptical guides
- Conclusions

Introduction

Neutron transport by neutron guides

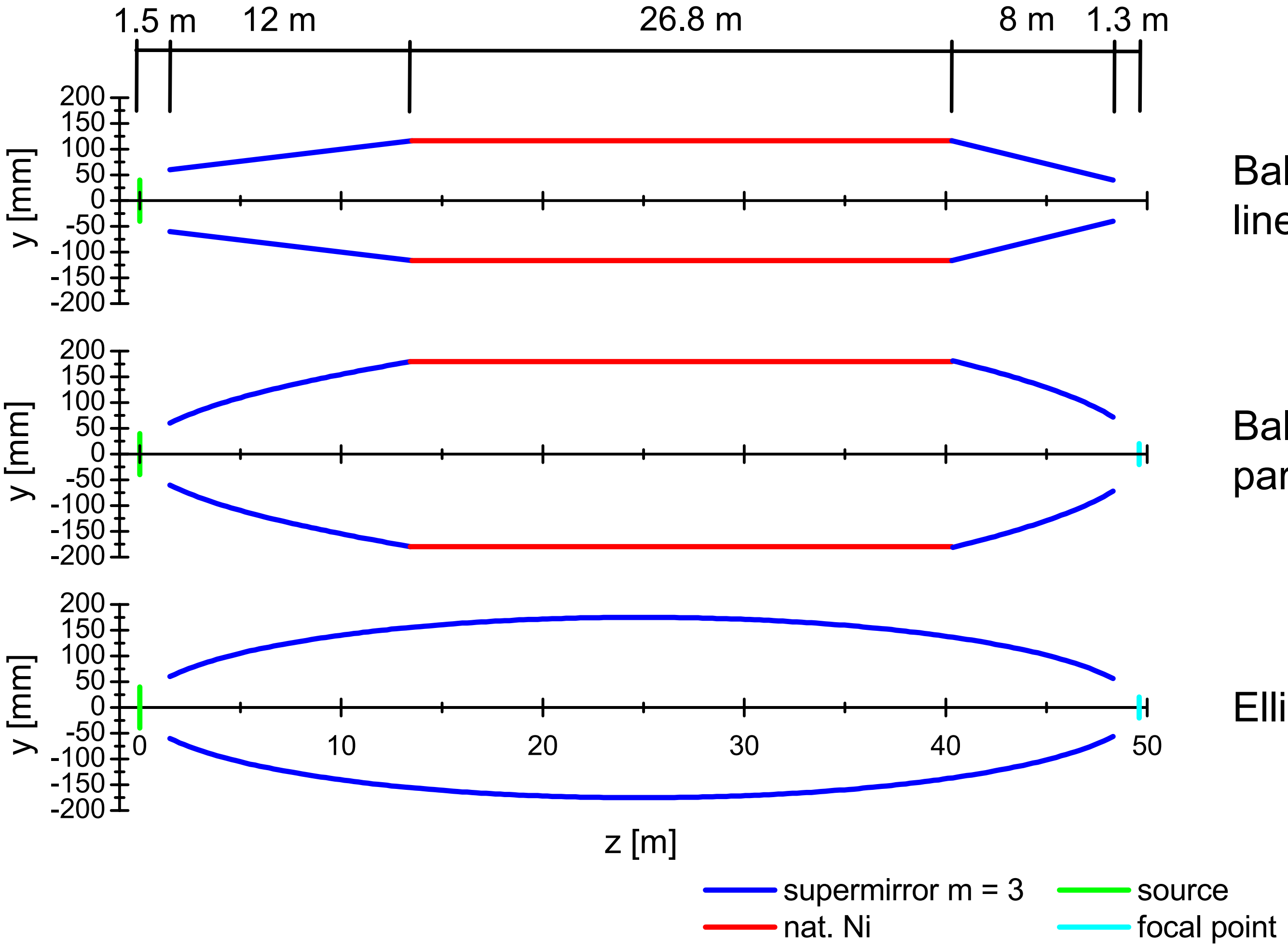


ballistic neutron guides - Mezei (1997)



- ⇒ inhomogeneous phase space distribution
  ⇒ decreasing intensity with increasing distance from guide exit
- Parabolic and elliptic geometries to improve perfomance and phase space
- New guide component for McStas simulation program

Various geometries for ballistic guides



Ballistic neutron guide with linearly tapered div./conv. sections

Ballistic neutron guide with parabolic div./conv. sections

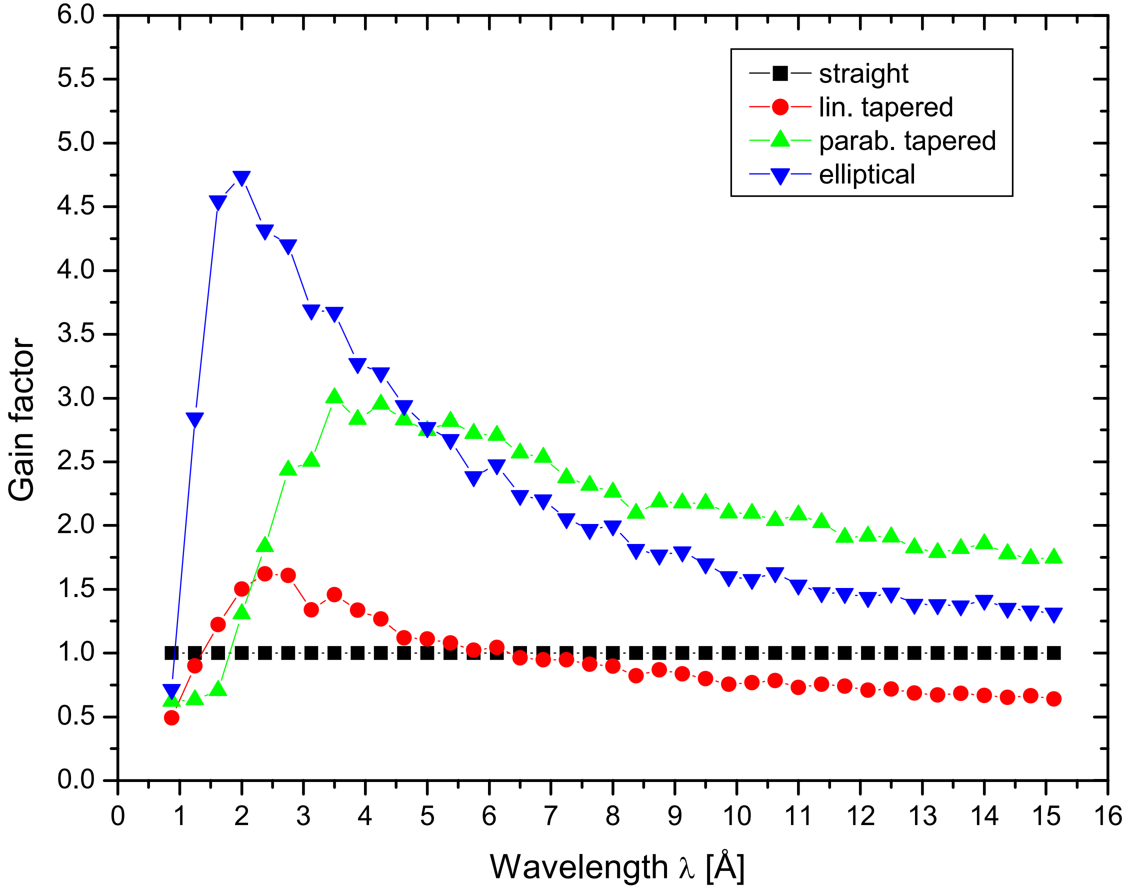
Elliptical guide

Geometrical details of the simulated neutron guides

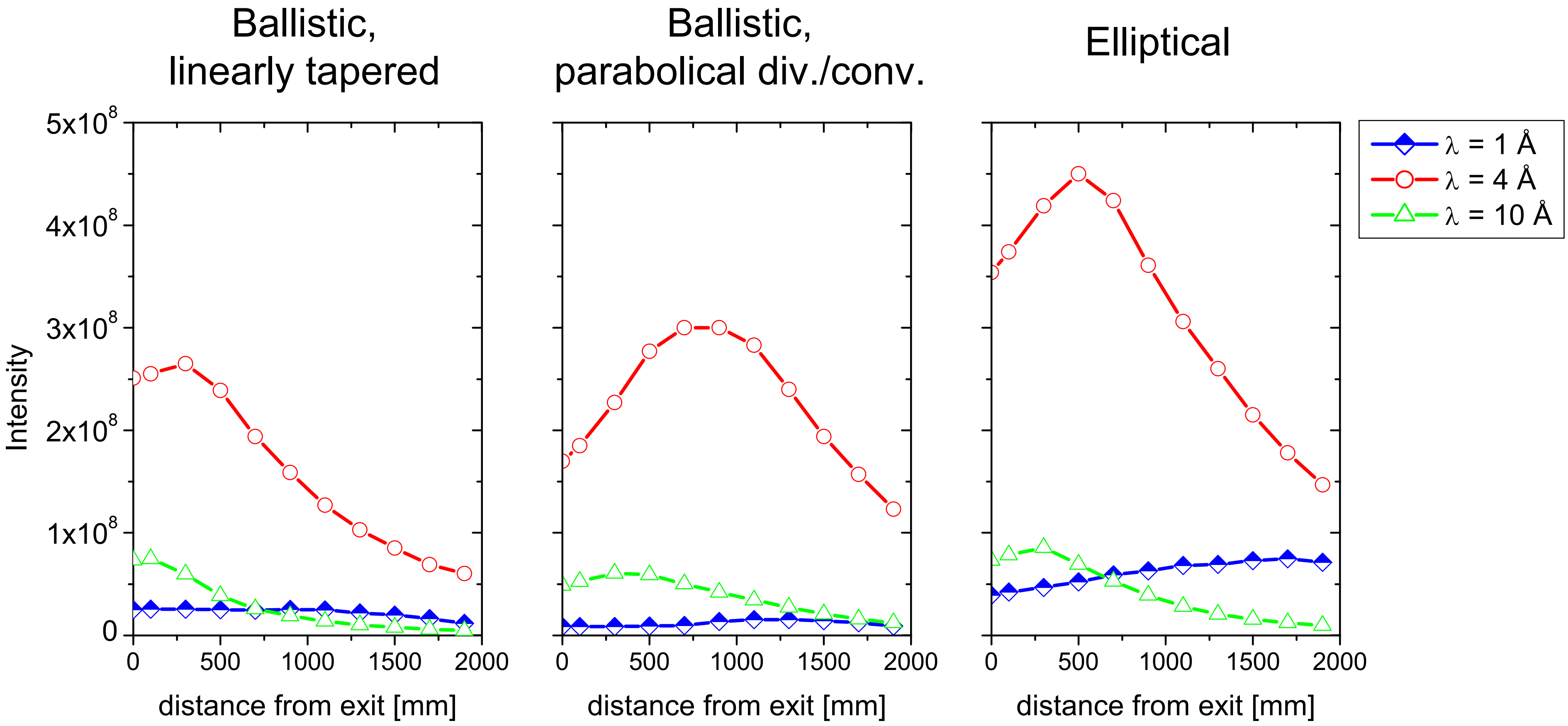
<table>
<tr><th></th><th>Straight</th><th>Ballistic, linearly tapered</th><th>Ballistic, parabolically tapered</th><th>Elliptical</th></tr>
<tr><td>Cross section at entrance</td><td colspan="4">35 x 120 mm²</td></tr>
<tr><td>Cross section at exit</td><td>35 x 120 mm²</td><td>23 x 80 mm²</td><td>39 x 135 mm²</td><td>33 x 112 mm²</td></tr>
<tr><td>Largest cross section</td><td></td><td>76 x 233 mm²</td><td>105 x 360 mm²</td><td>102 x 250 mm²</td></tr>
<tr><td>Guide length</td><td colspan="4">46.8 m</td></tr>
<tr><td>Length of divergent section</td><td colspan="4">12 m</td></tr>
<tr><td>Length of convergent section</td><td colspan="4">8 m</td></tr>
<tr><td>Coating (at all sides)</td><td>SM, m = 2</td><td>SM, m = 3 / 1 / 3 [a]</td><td>SM, m = 3 / 1 / 3 [a]</td><td>SM, m = 3</td></tr>
<tr><td>Distance focal point to guide entrance</td><td></td><td></td><td colspan="2">1.5 m</td></tr>
<tr><td>Distance focal point from guide exit</td><td></td><td></td><td colspan="2">1.3 m</td></tr>
<tr><td>Distance source to guide entrance</td><td colspan="4">1.5 m</td></tr>
</table>

[a] Reflectivity range of super mirror (SM) in units of neutron critical angle of natural nickel for divergent / straight / convergent sections, respectively.

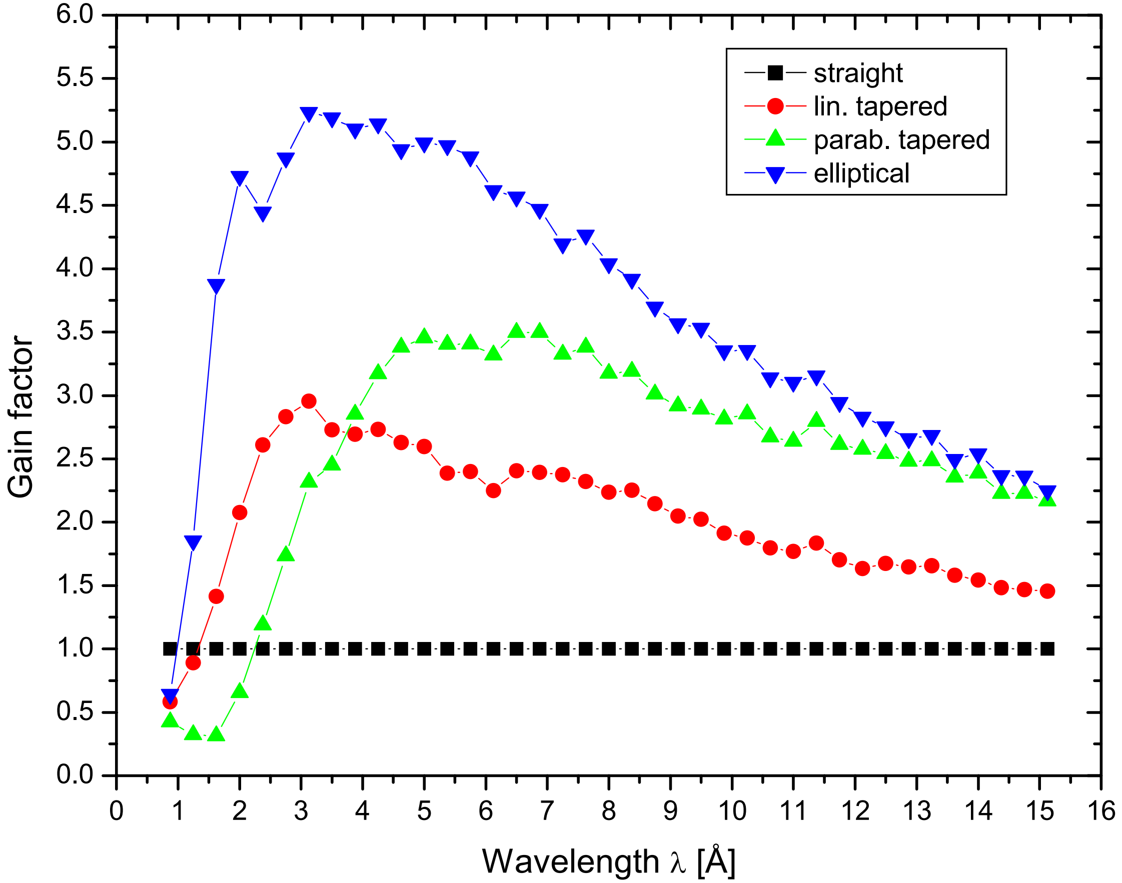
Gain factors @ 1.3 m from guide exit (focal point)



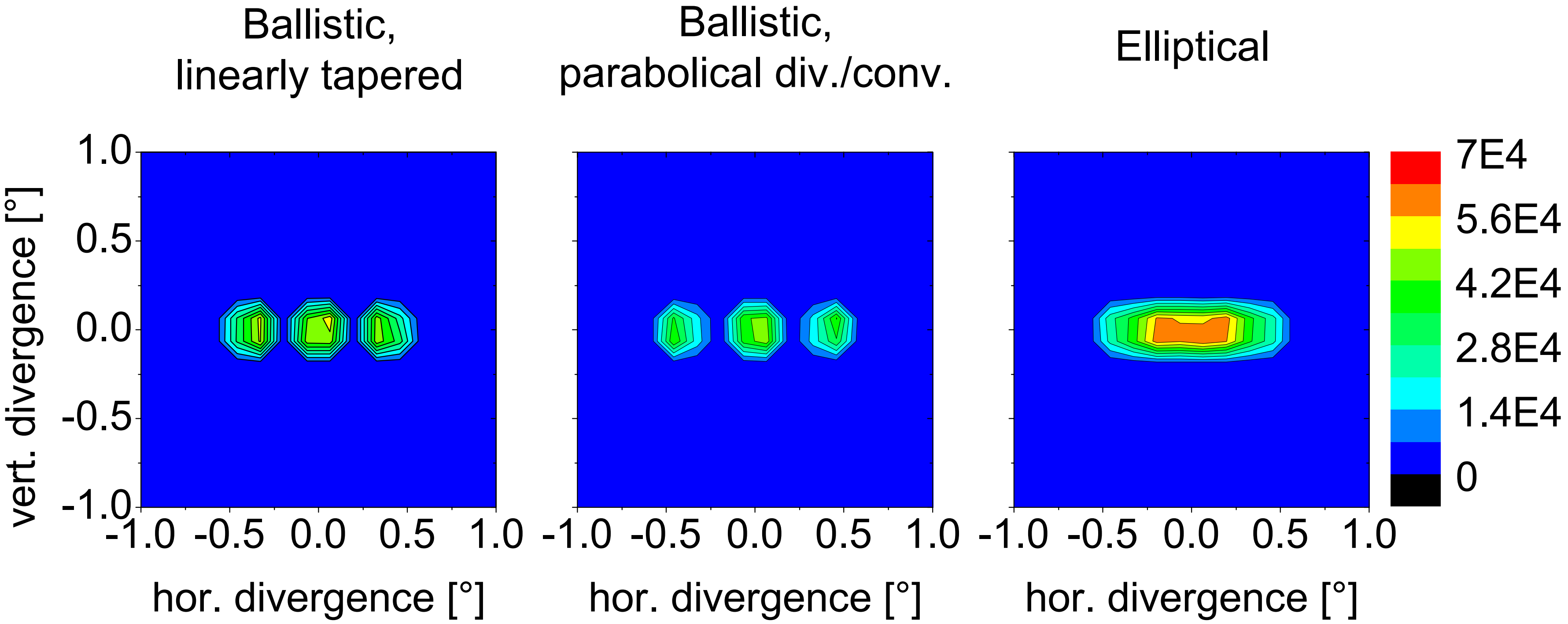
Intensity dependence on distance from exit



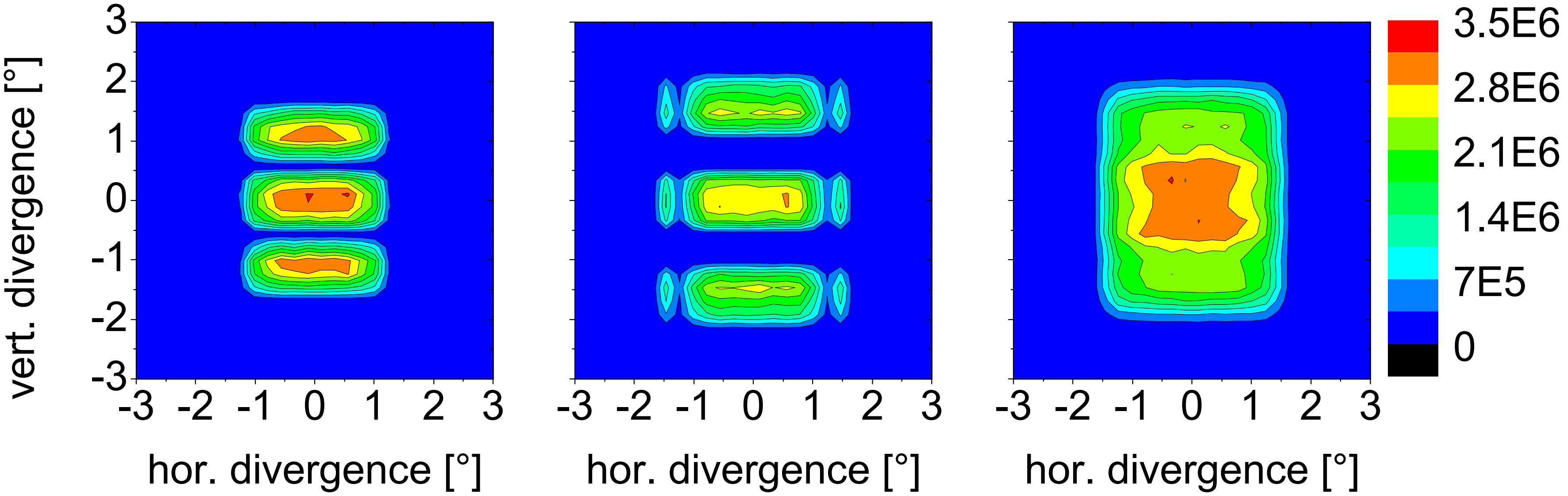
Gain factors @ 0.5 m from guide exit



Divergence distribution @ l = 1 Å



Divergence distribution @ l = 4 Å

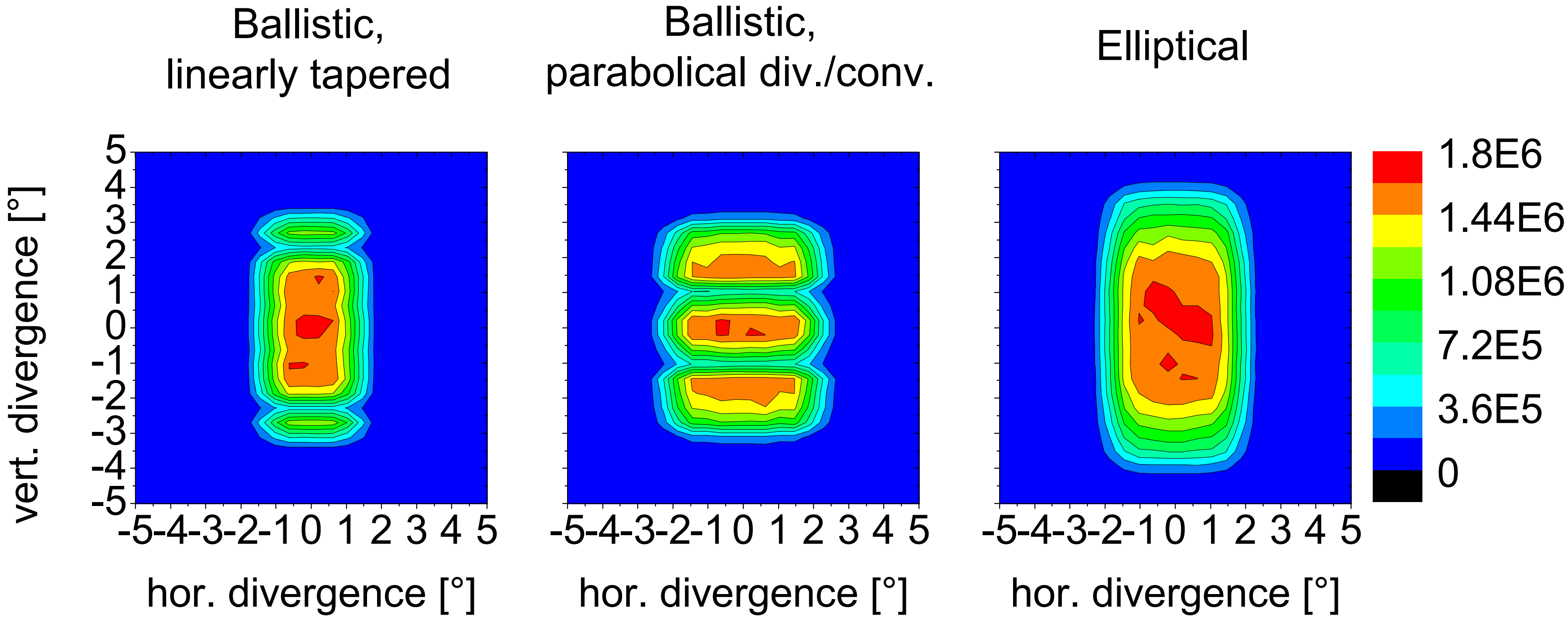


Ballistic, linearly tapered

Ballistic, parabolical div./conv.

Elliptical

Divergence distribution @ l = 10 Å

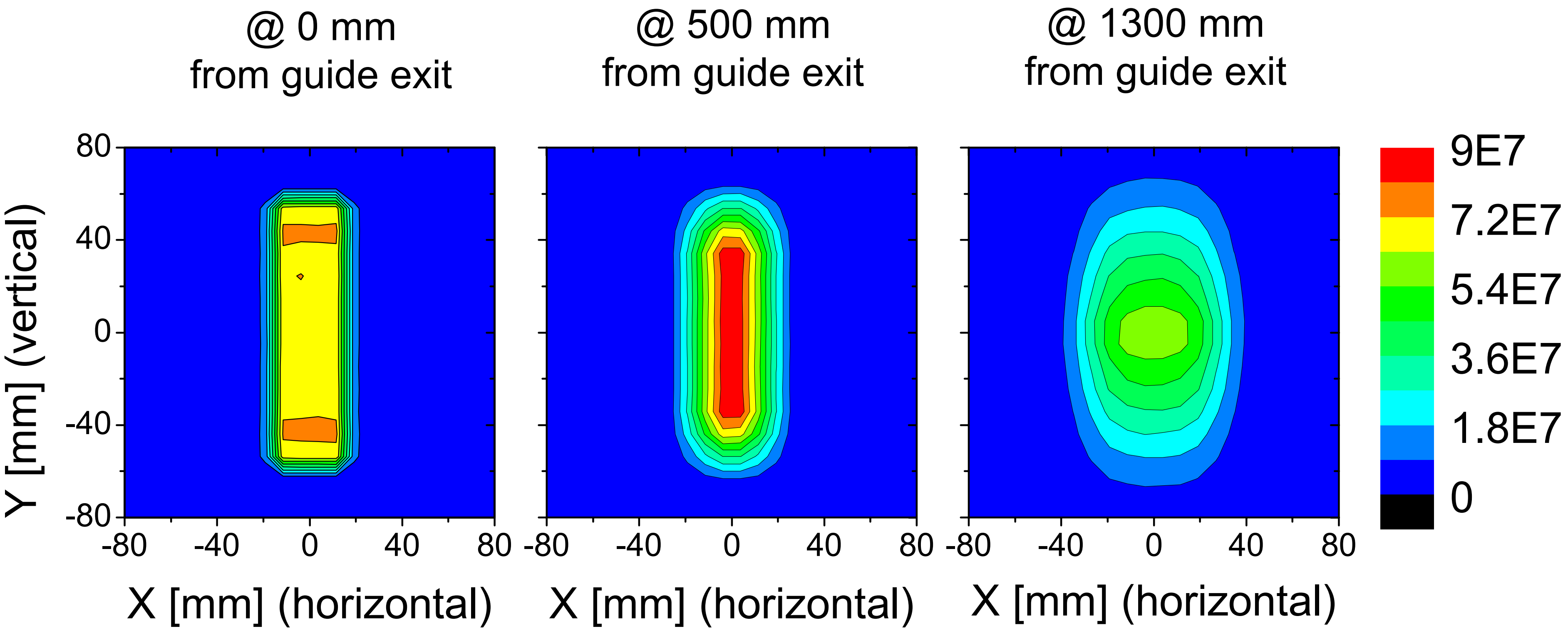


Ballistic,
linearly tapered

Ballistic,
parabolical div./conv.

Elliptical

Elliptical guide: spatial distribution @ l = 4 Ǻ

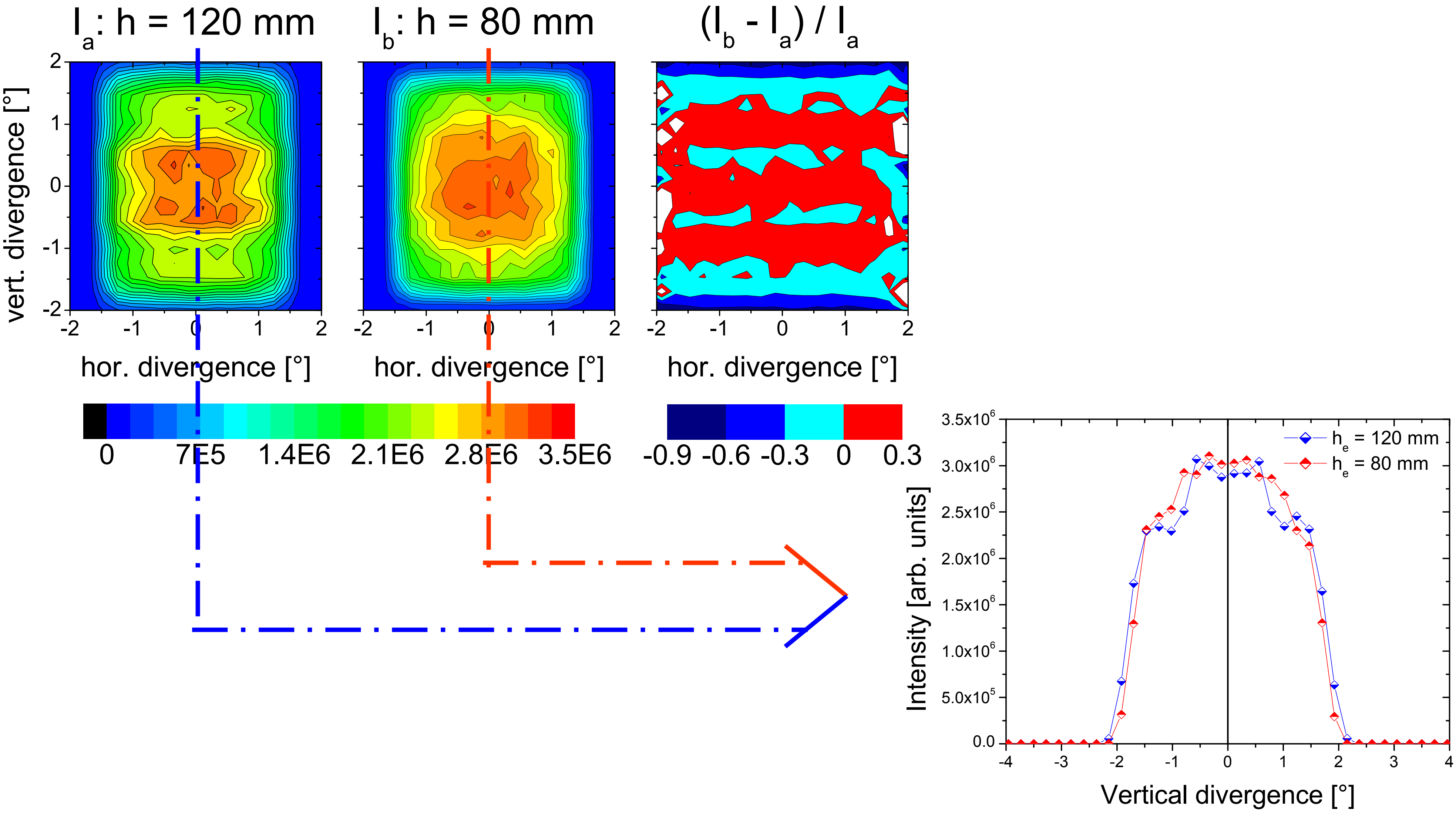


@ 0 mm
from guide exit

@ 500 mm
from guide exit

@ 1300 mm
from guide exit

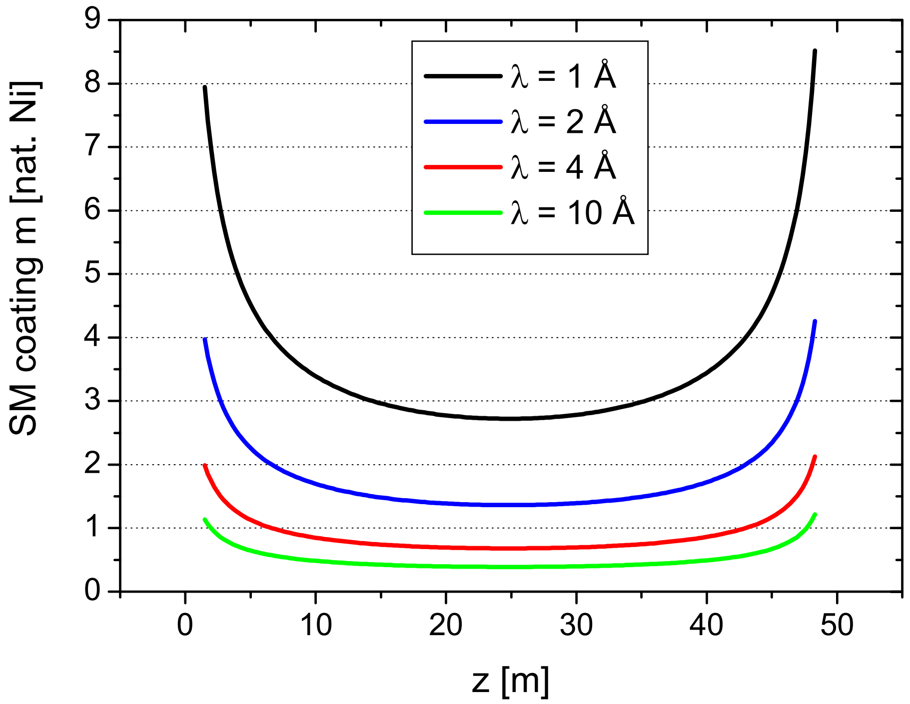
Elliptical guide: variation of entrance height



Technical aspects of elliptical guides

- modern grinding machines ⇒ non-linear shapes
- dimensions: typically twice of straight guide ⇒ 102 x 250 mm²
- value for money: more glass, cheaper coatings

SM coating for top/bottom walls, h = 80 mm



Conclusions: Non-linear ballistic guides

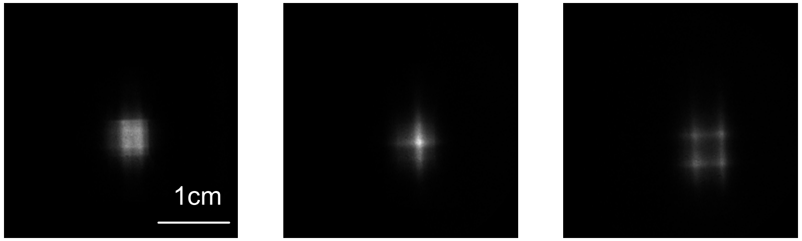
- large intensity gains
- homogenous phase space
- broad bandpass

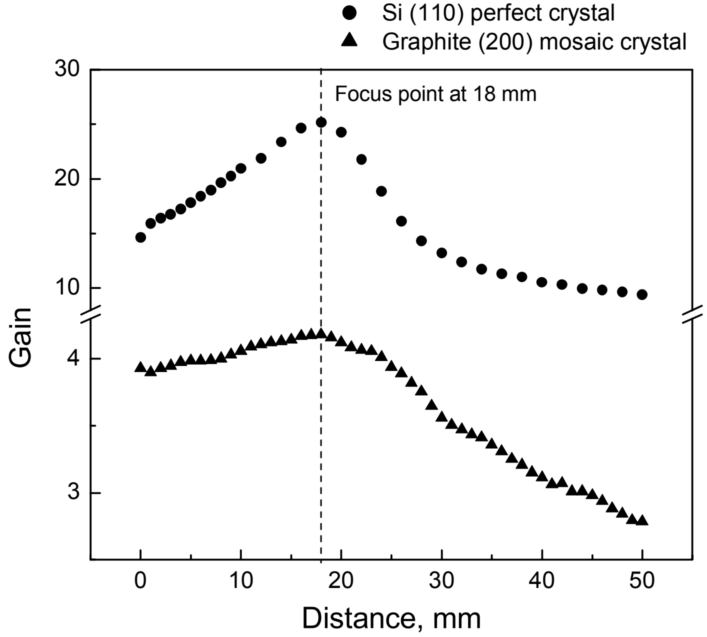
- technically feasable
- easy to design

- future: - polarization options
  - reduction of size of moderator
  - micro-focusing

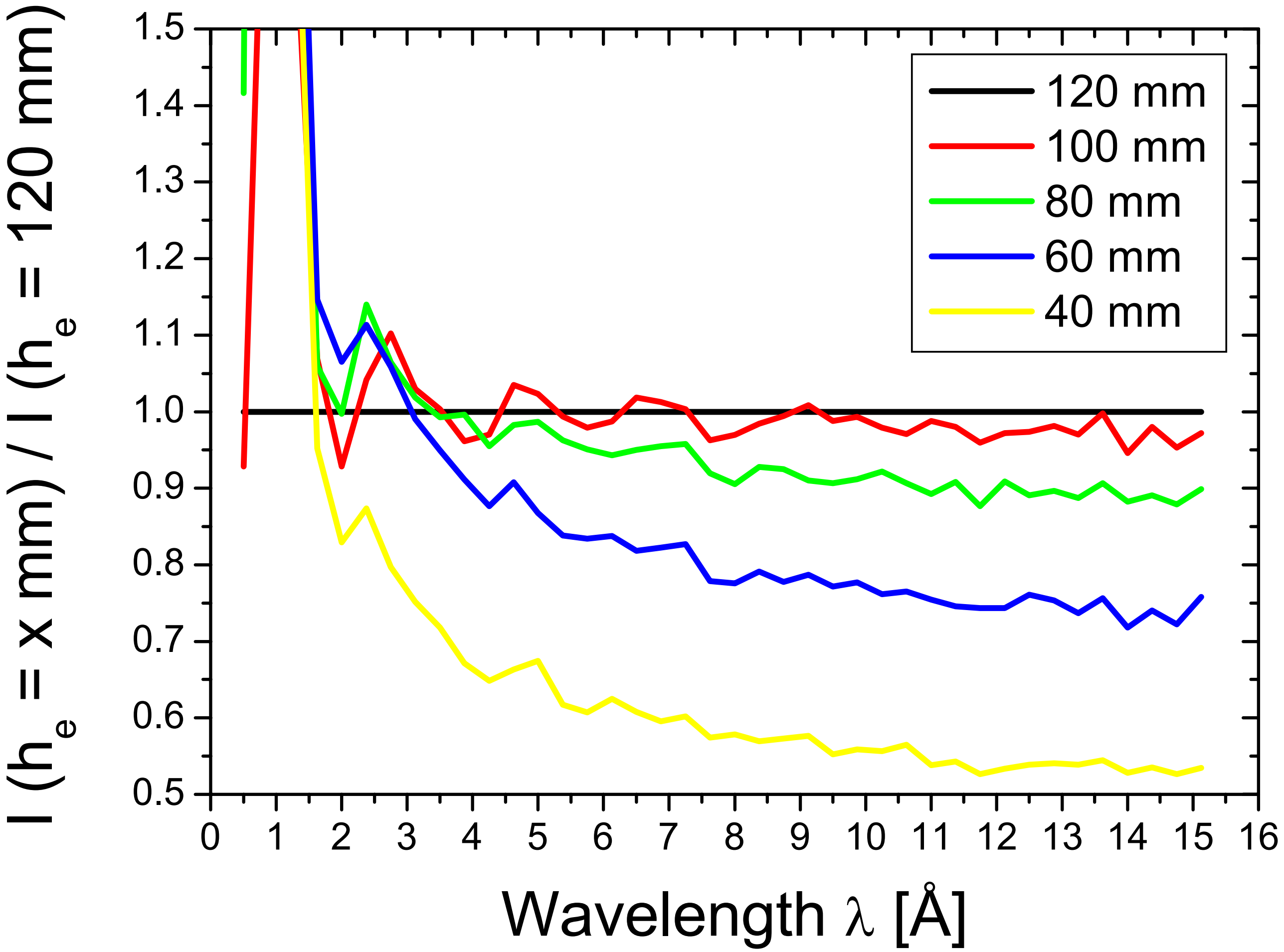
Experimental test, Kardjilov et al.

@ guide exit @ focal point @ large dist.

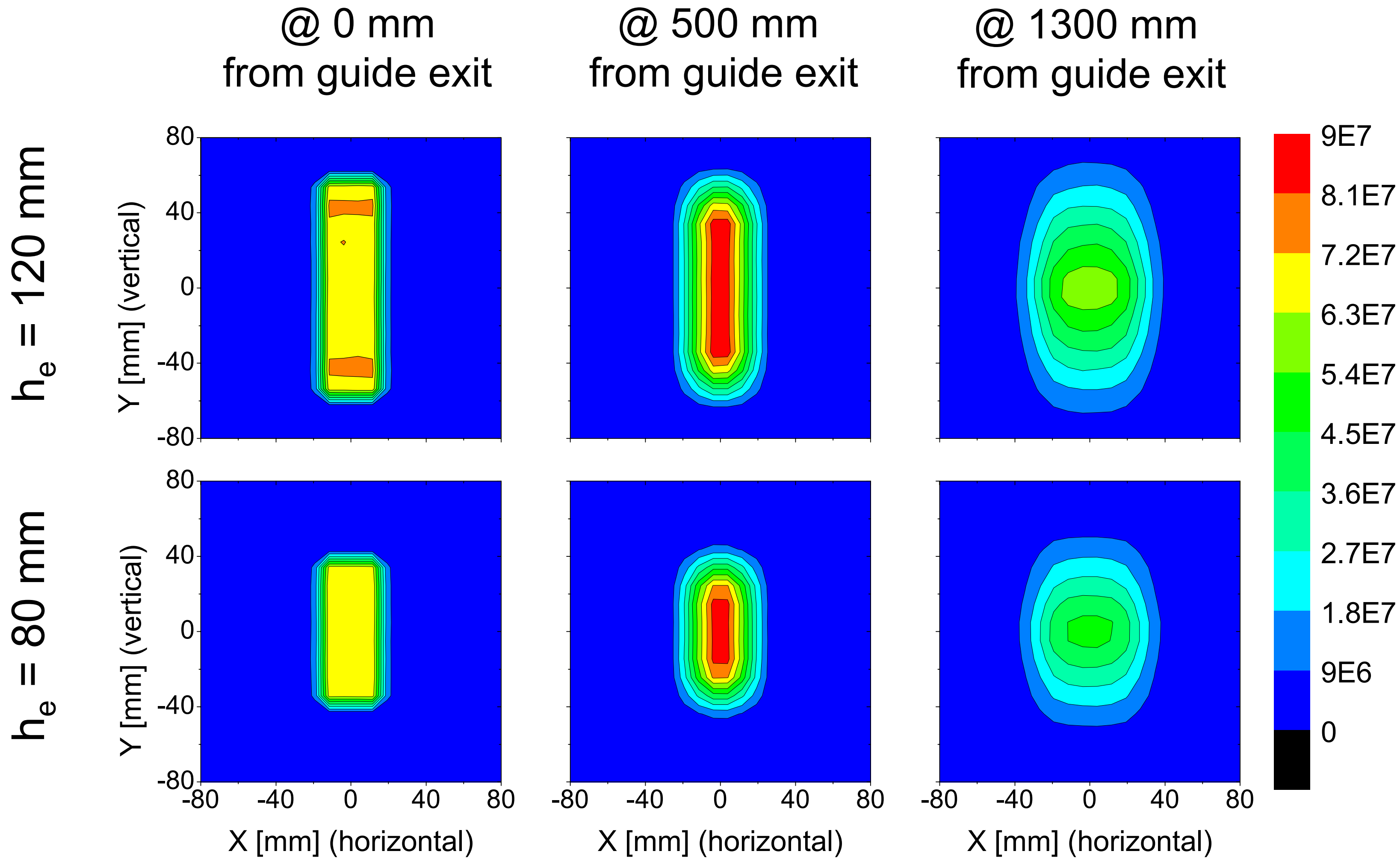




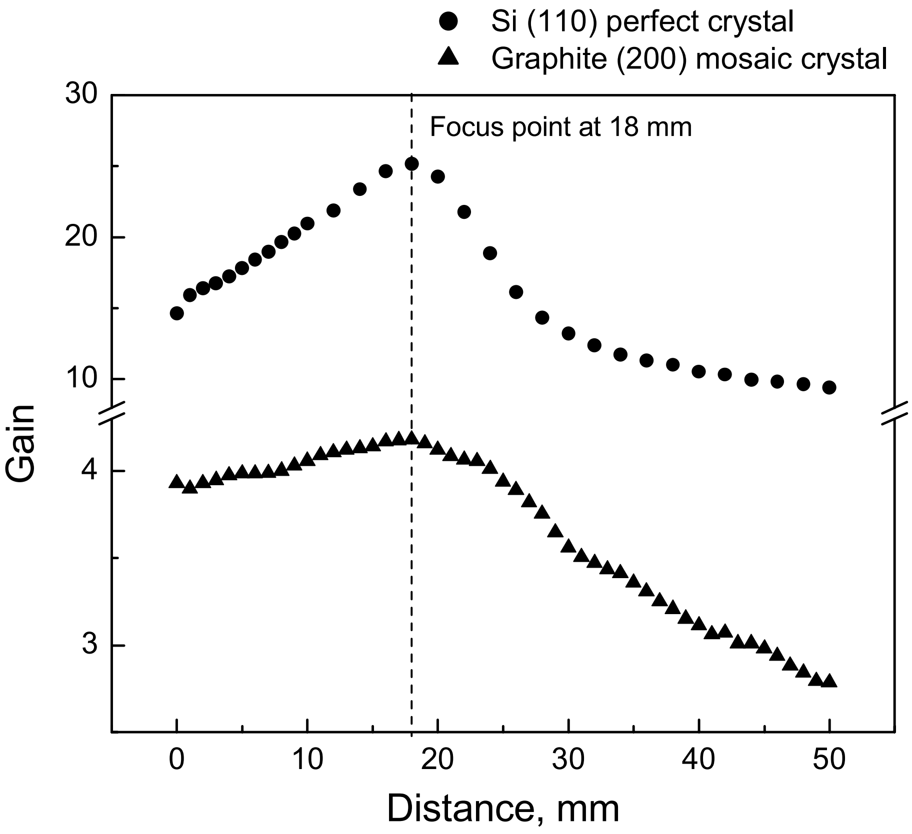
Elliptical guide: transmission behaviour for different entrance heights

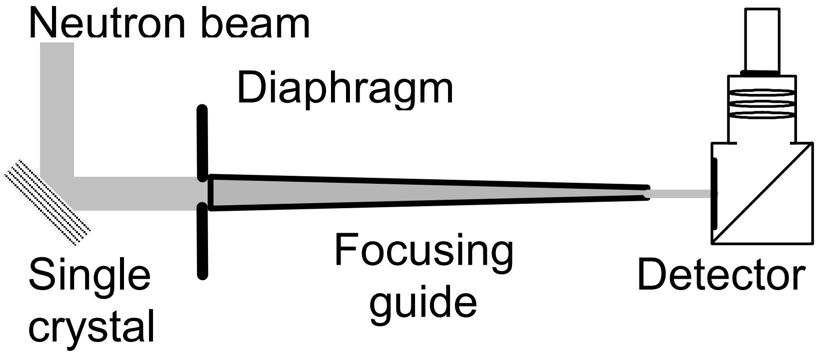


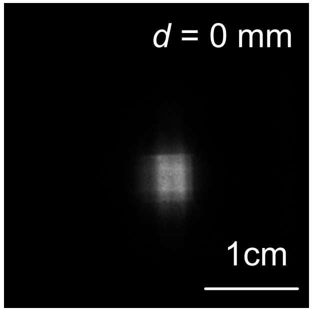
Elliptical guide: Spatial distribution for different entrance heights



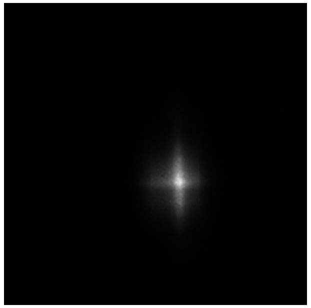
Micro-focusing with a parabolic flight tube



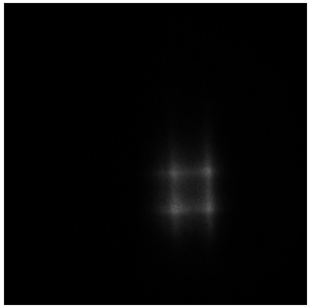




@ guide exit



@ focal point



@ large dist.