Guides and gravity in McStas

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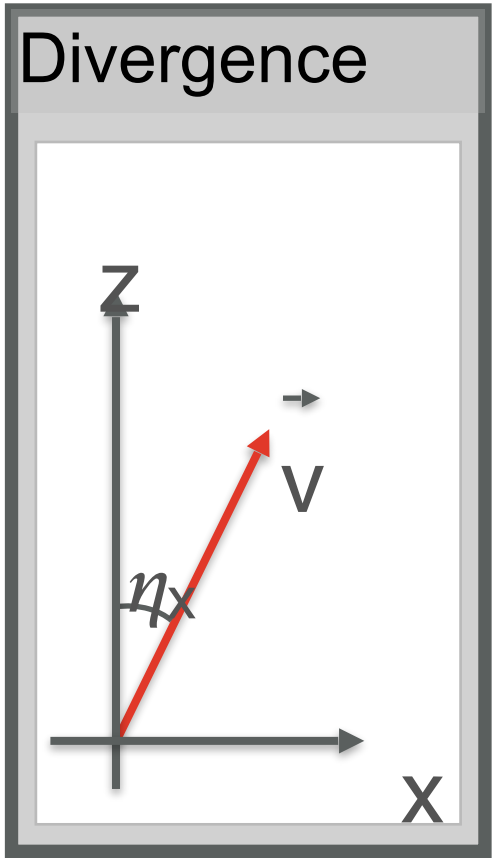
Adapted from slides by Mads Bertelsen, ESS

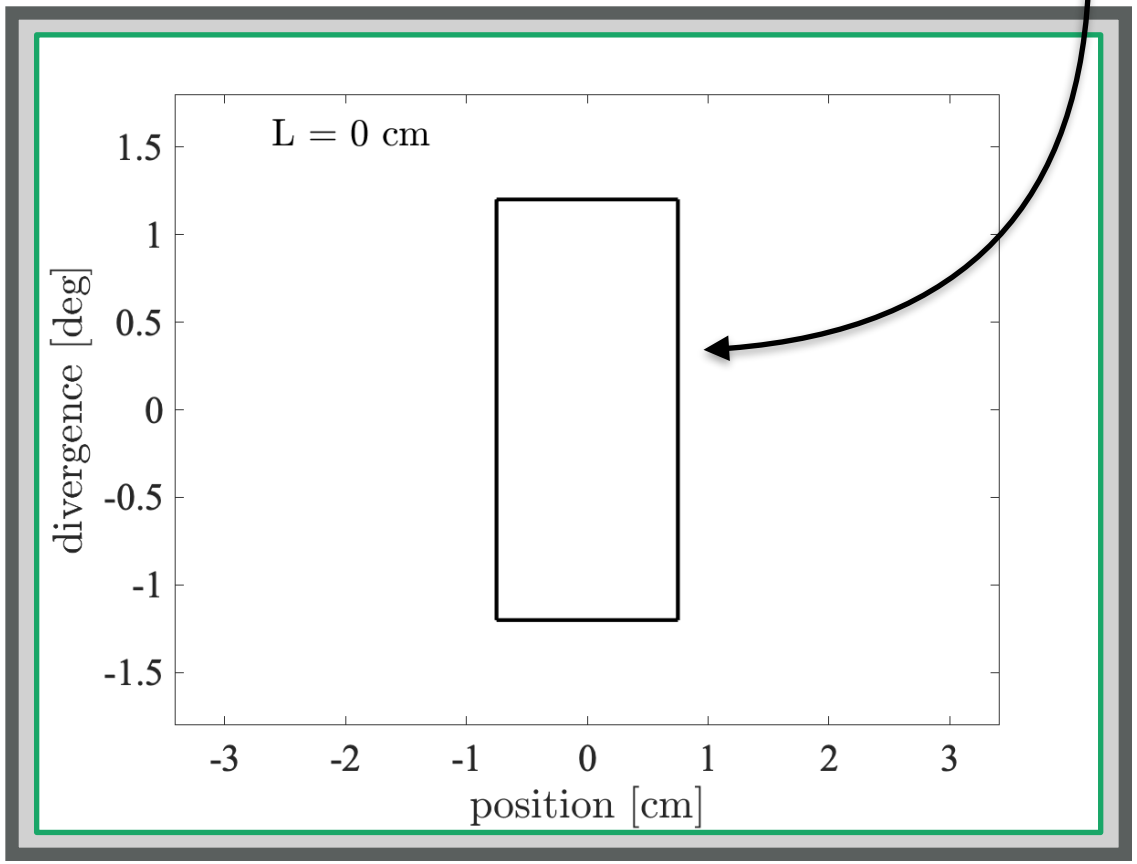
Overview

- Description of phase-space and propagation
- Reflectivity
- McStas coordinate system
- Gravitation in McStas
- Guide components with support for gravity
  - Guide_gravity
  - Elliptic_guide_gravity
- Breaking line of sight
- Example
- Exercise

Beam propagation in free space



“Phase-space” at source



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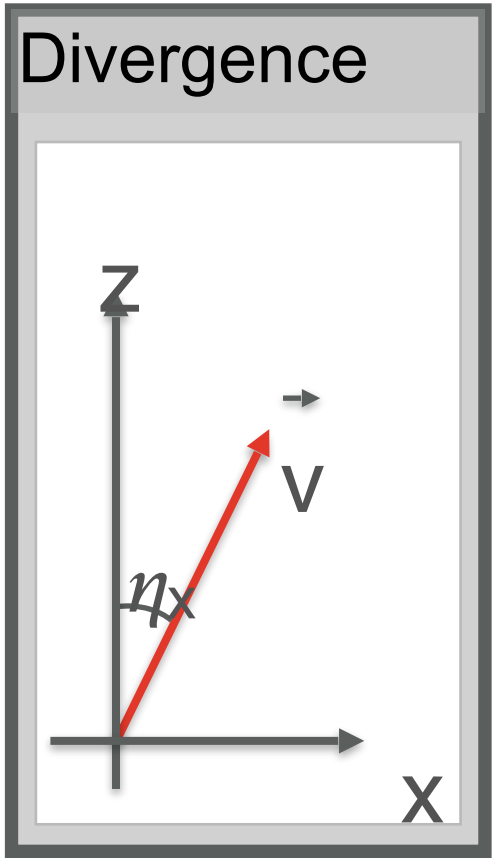
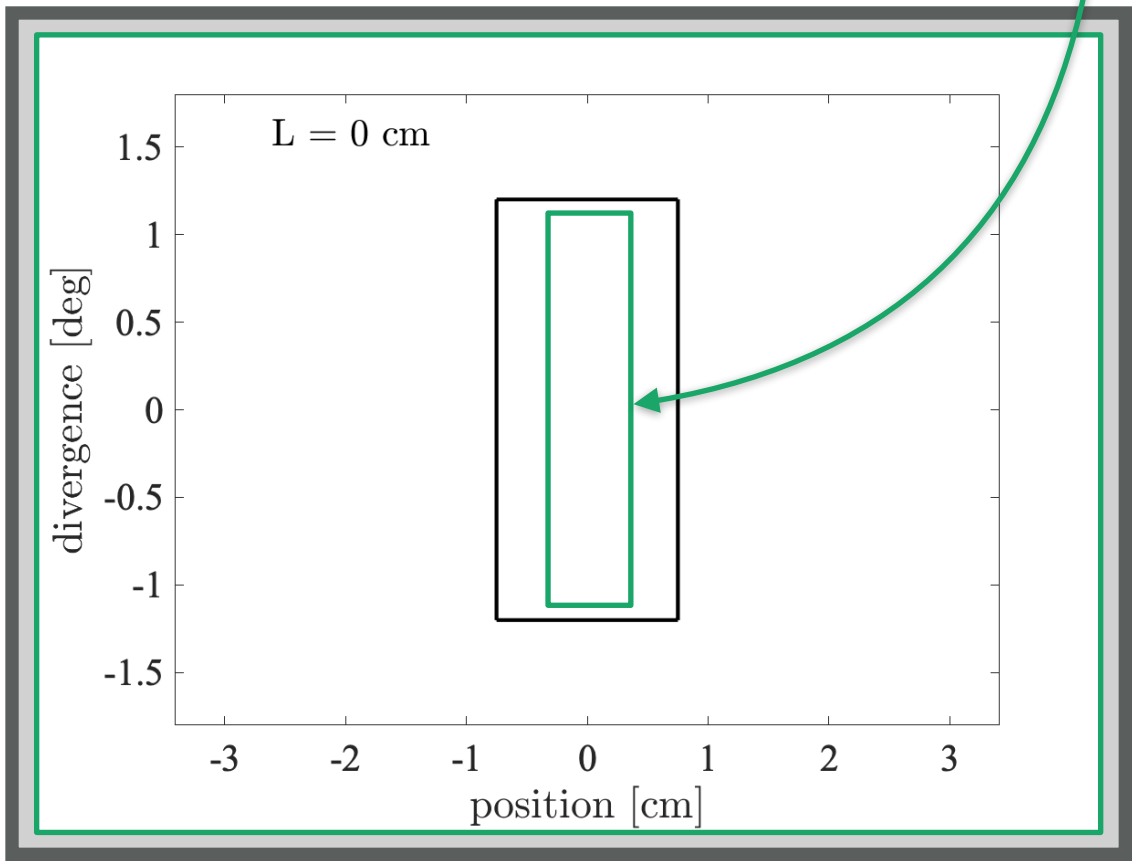


Wanted “phase-space” at sample



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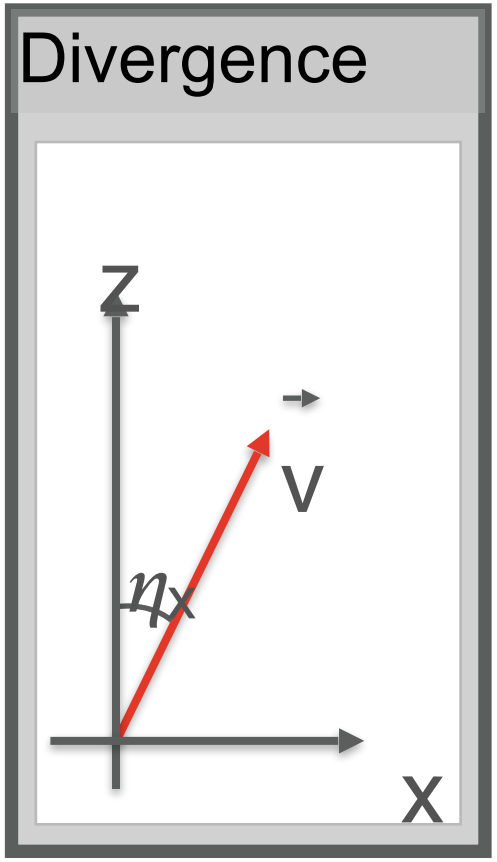

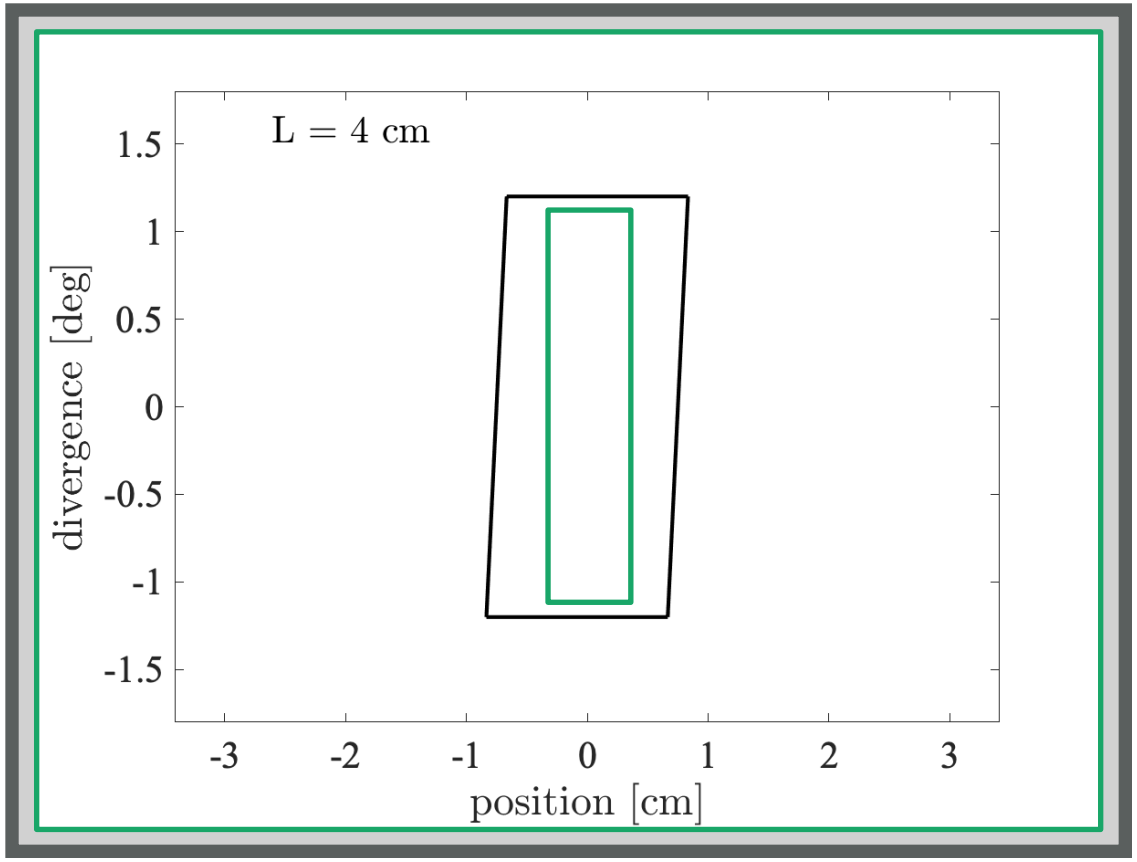

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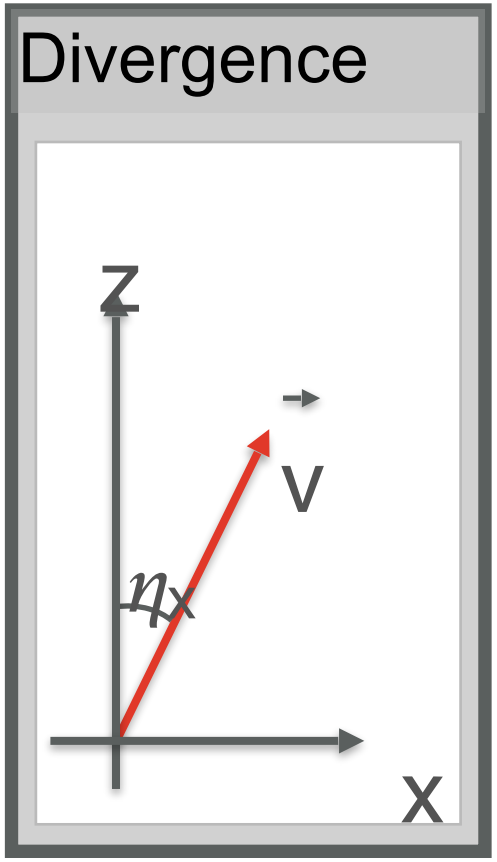

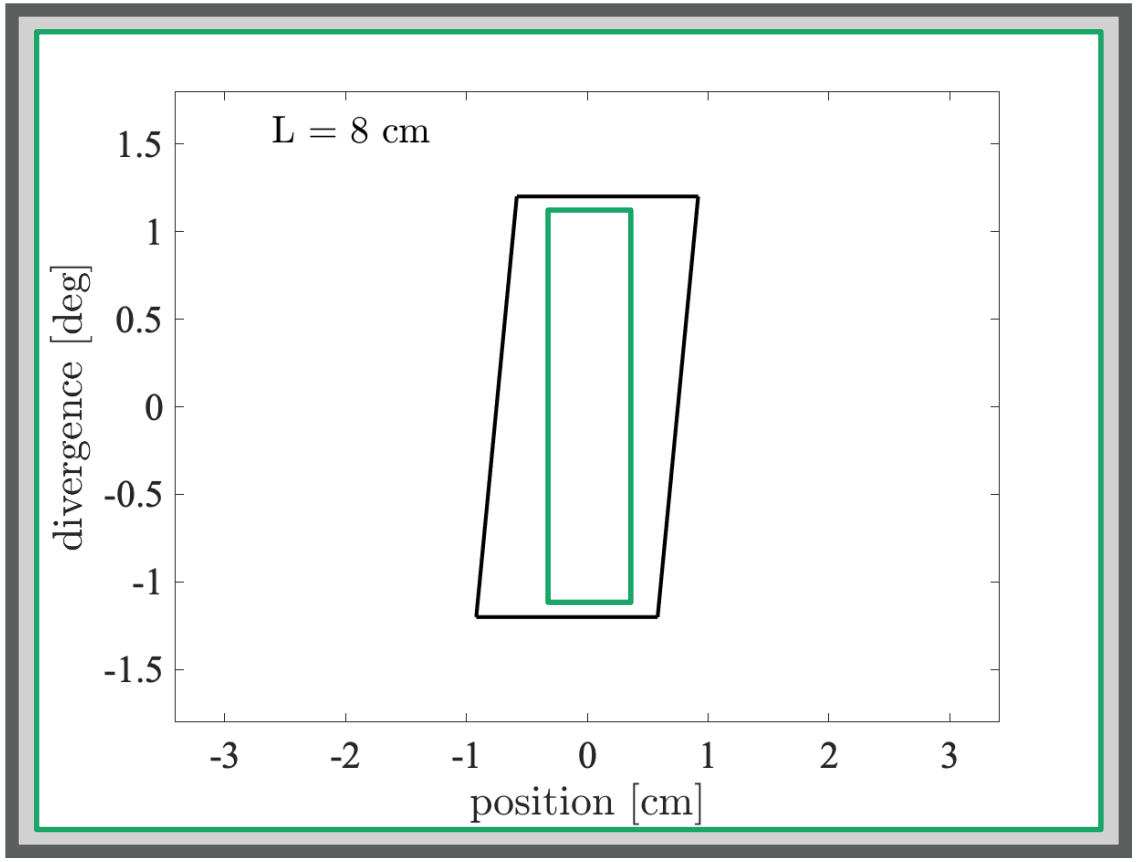

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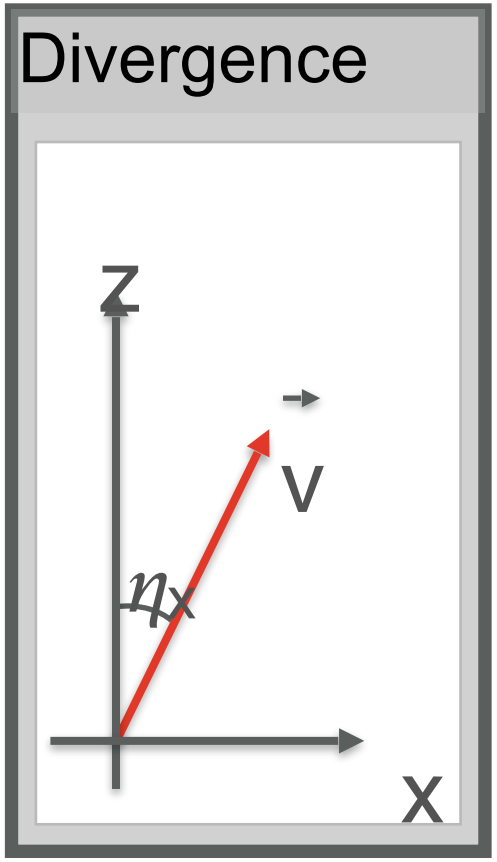

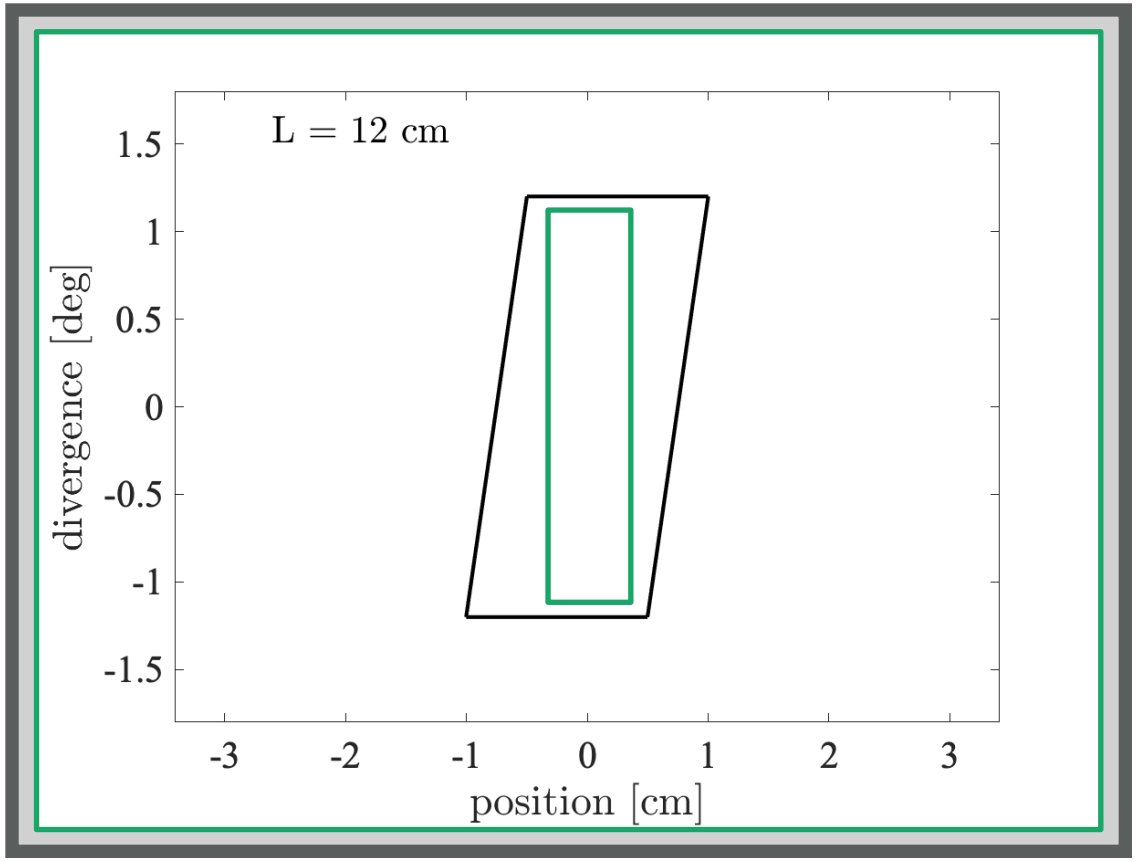

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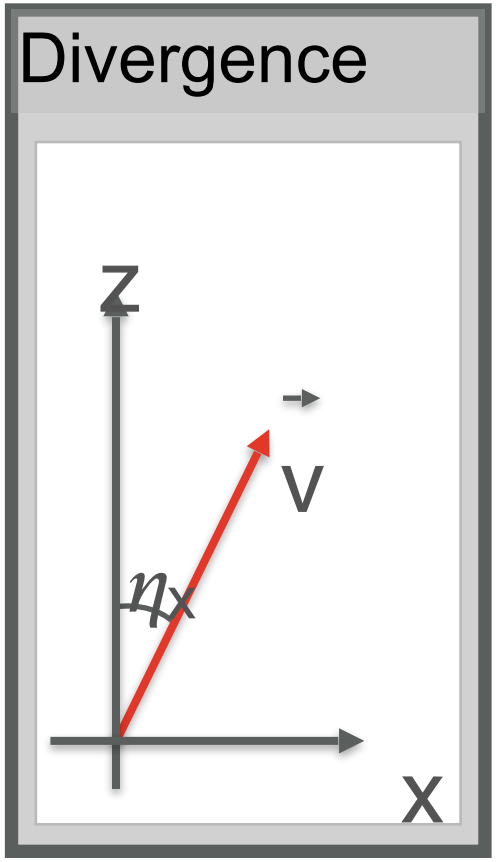

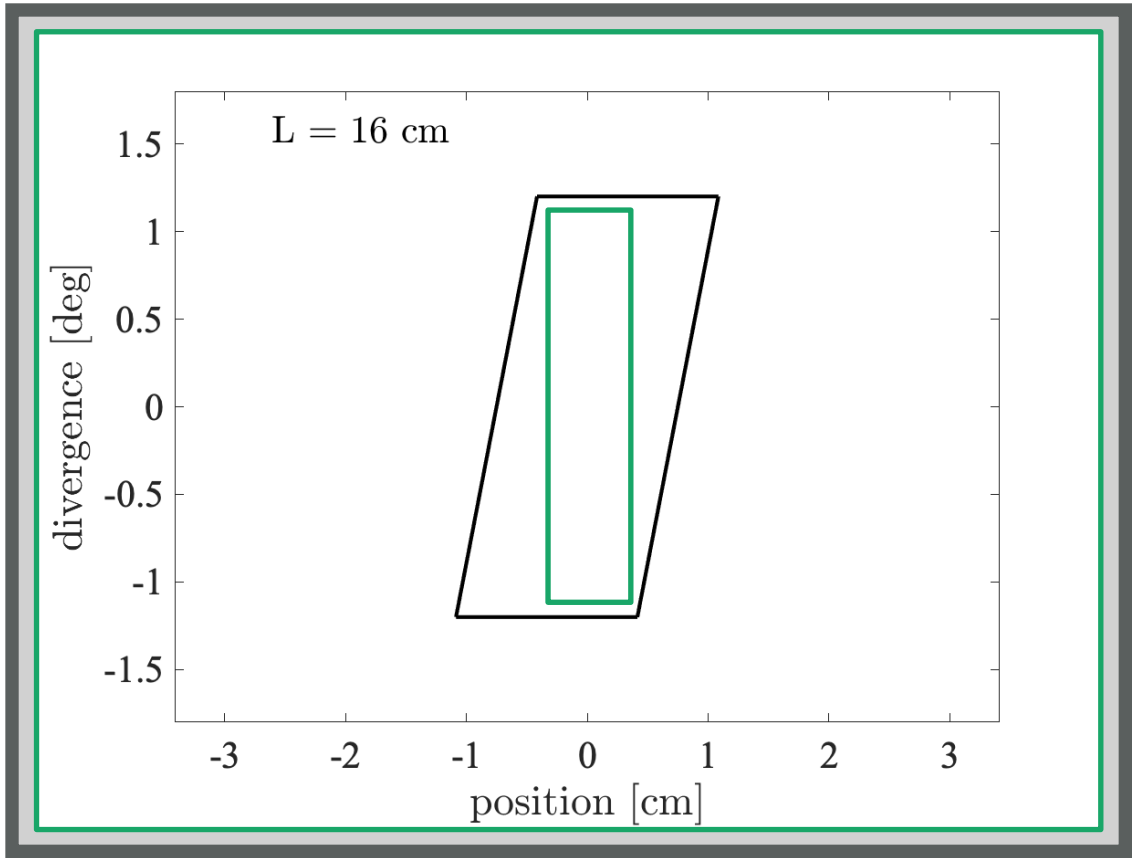

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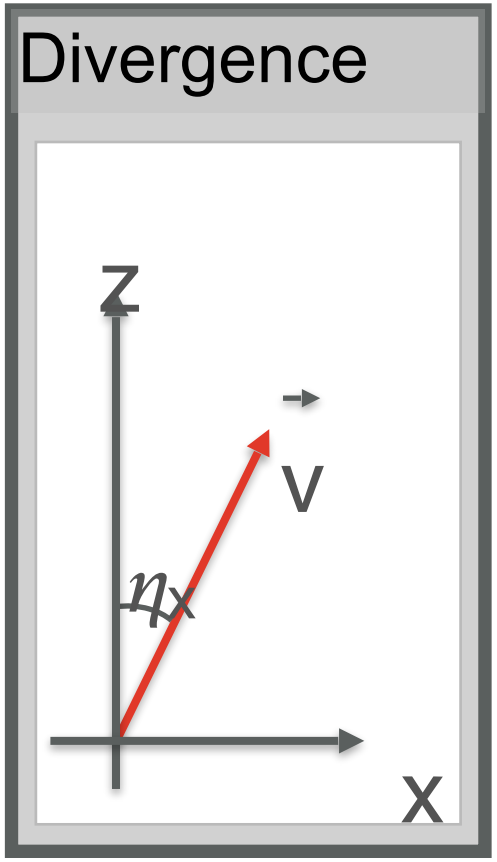

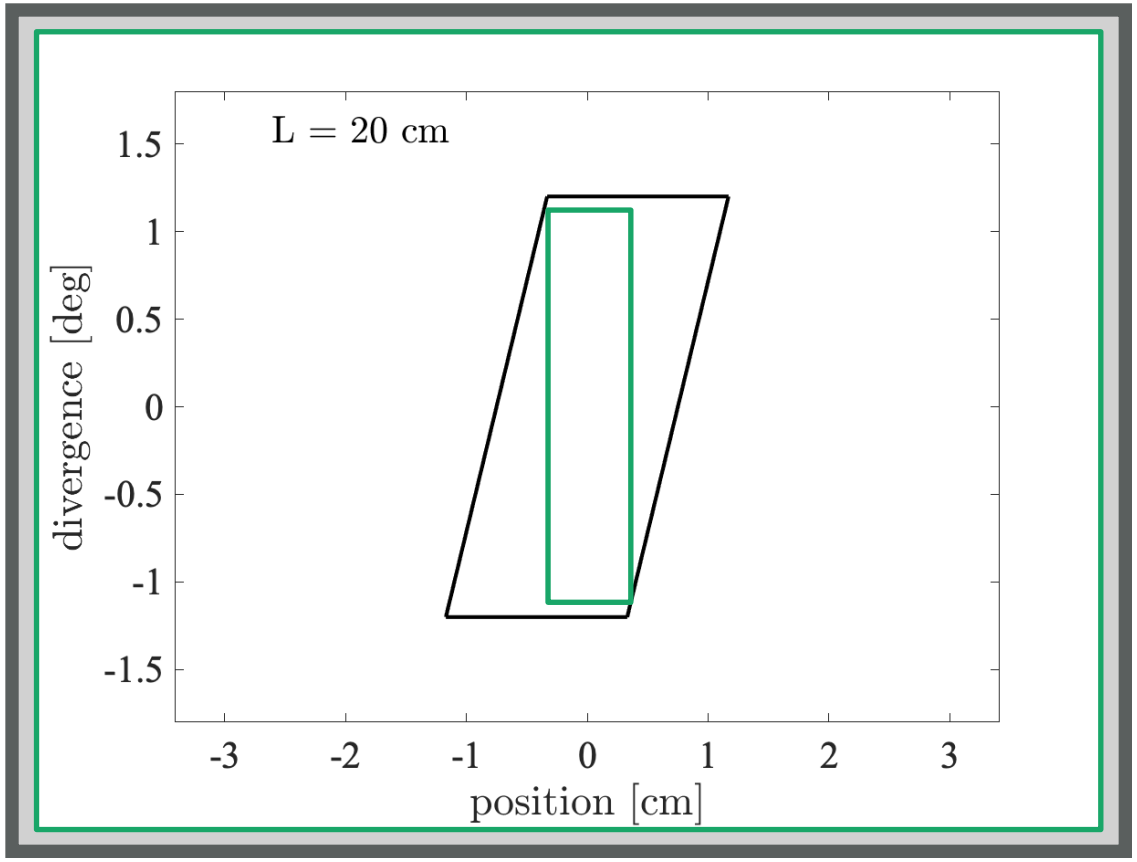

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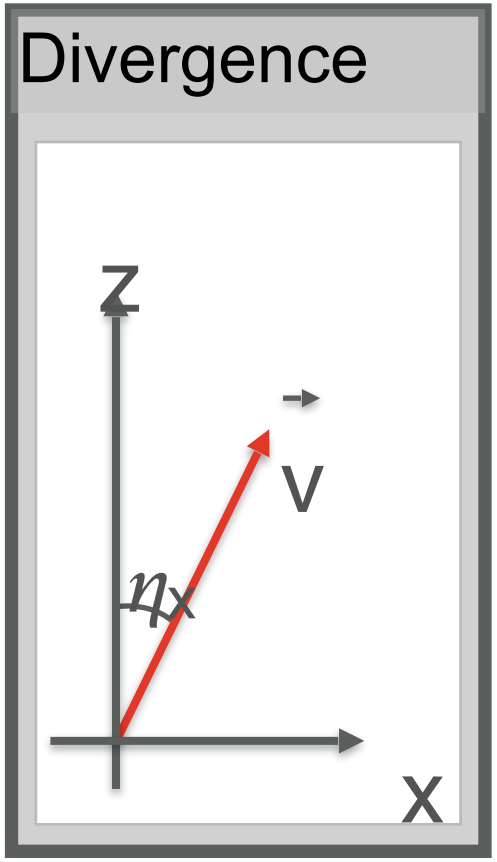

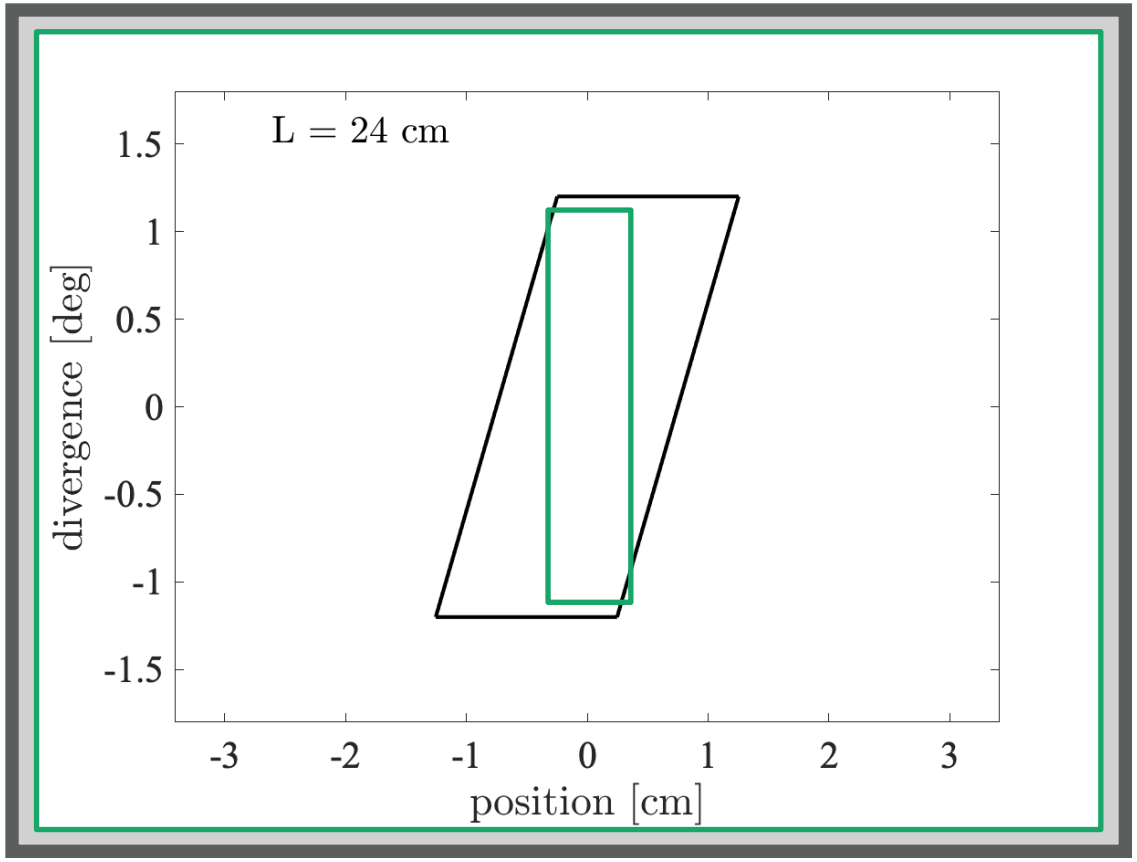

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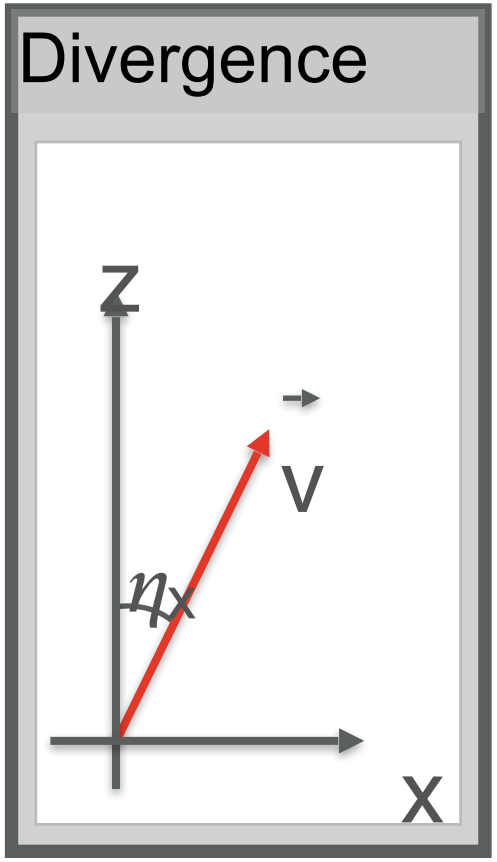

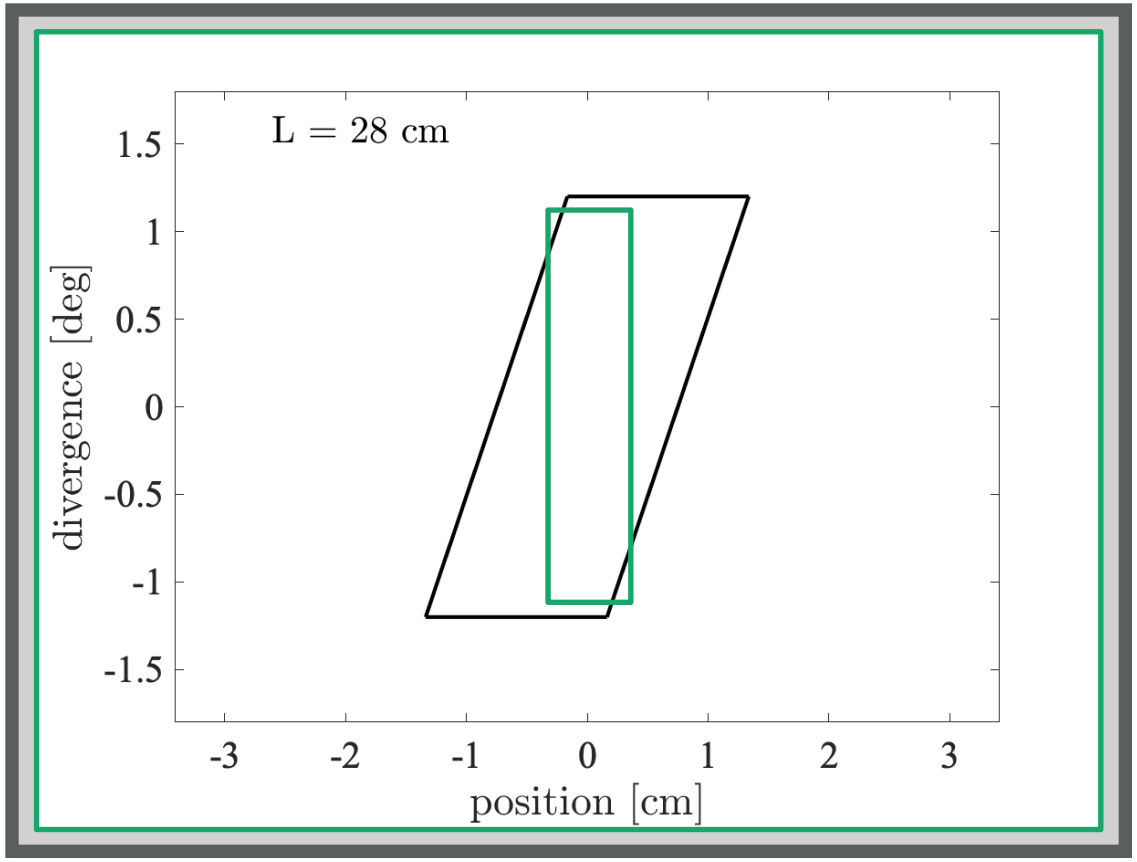

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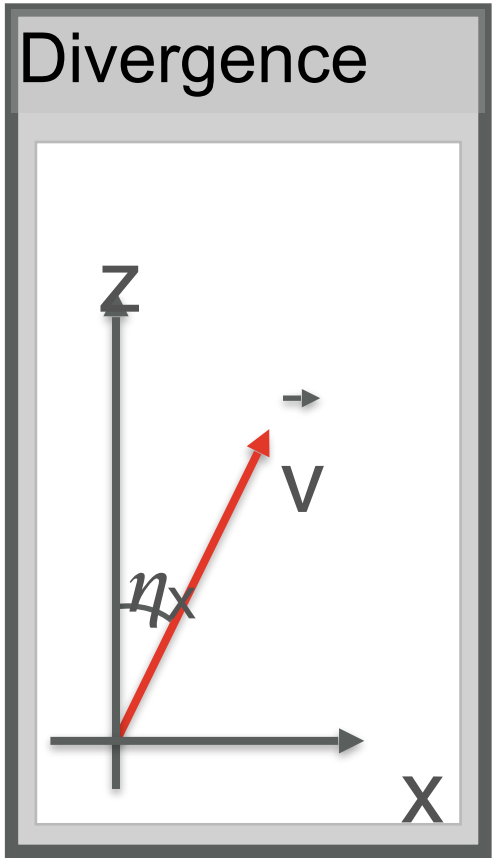

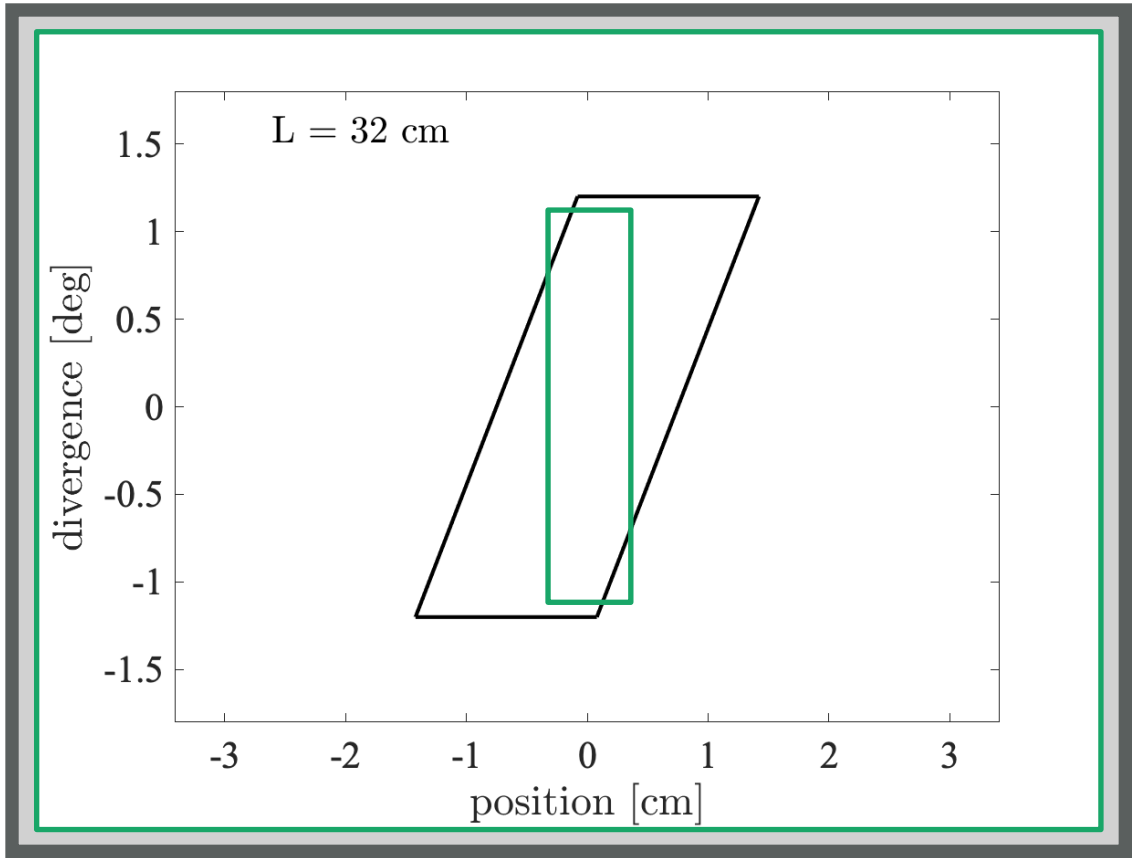

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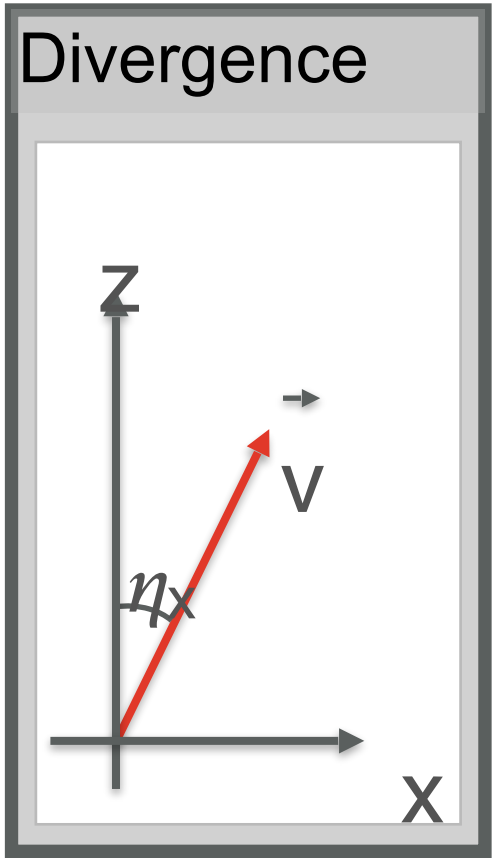

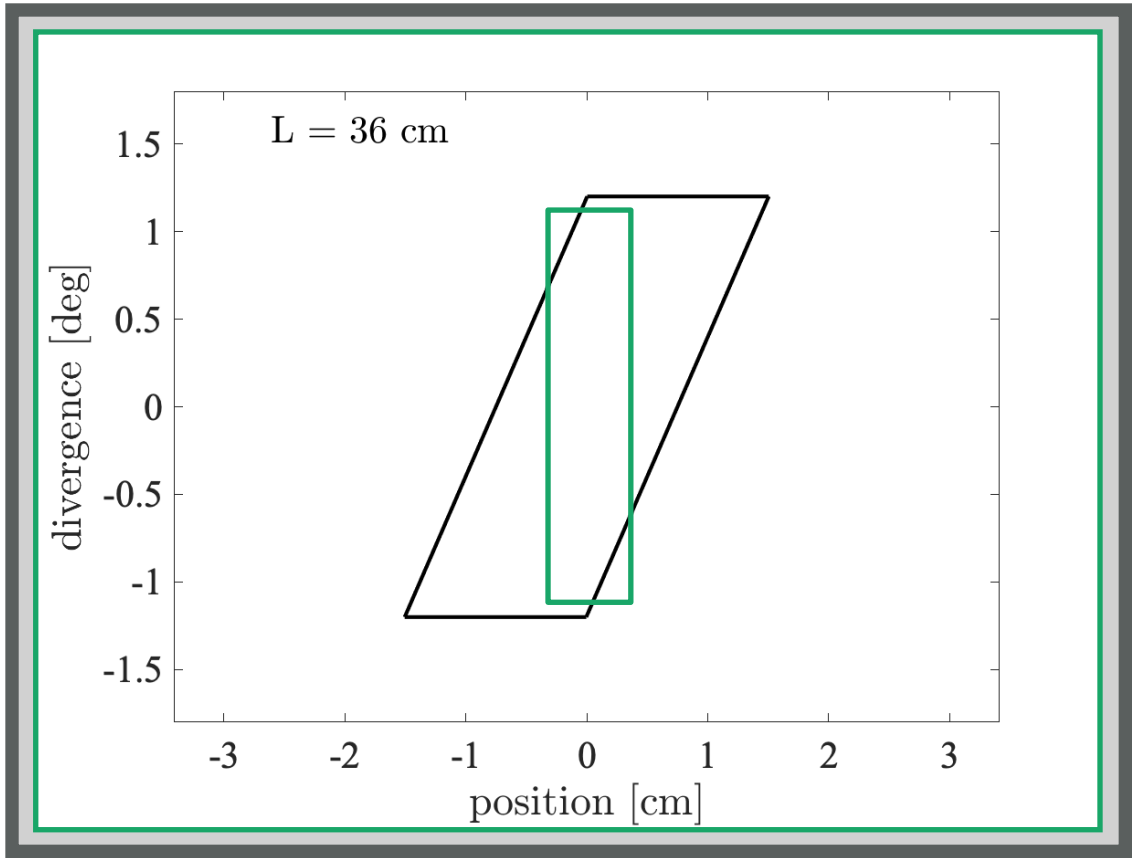

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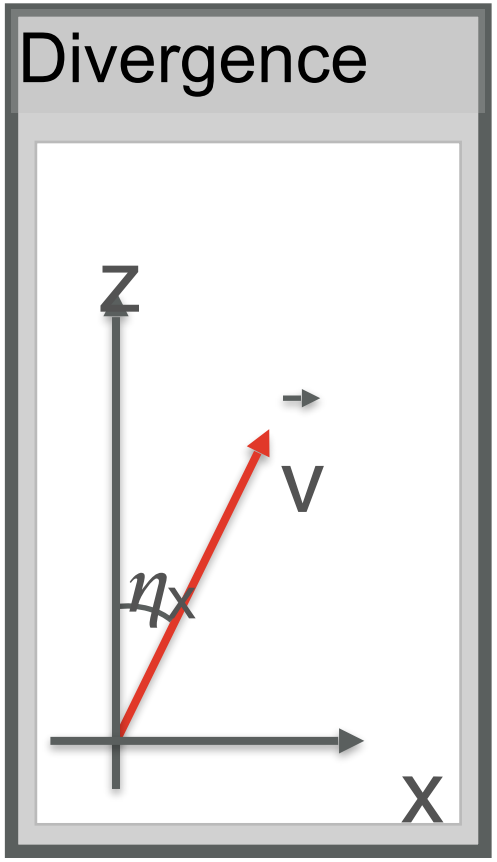

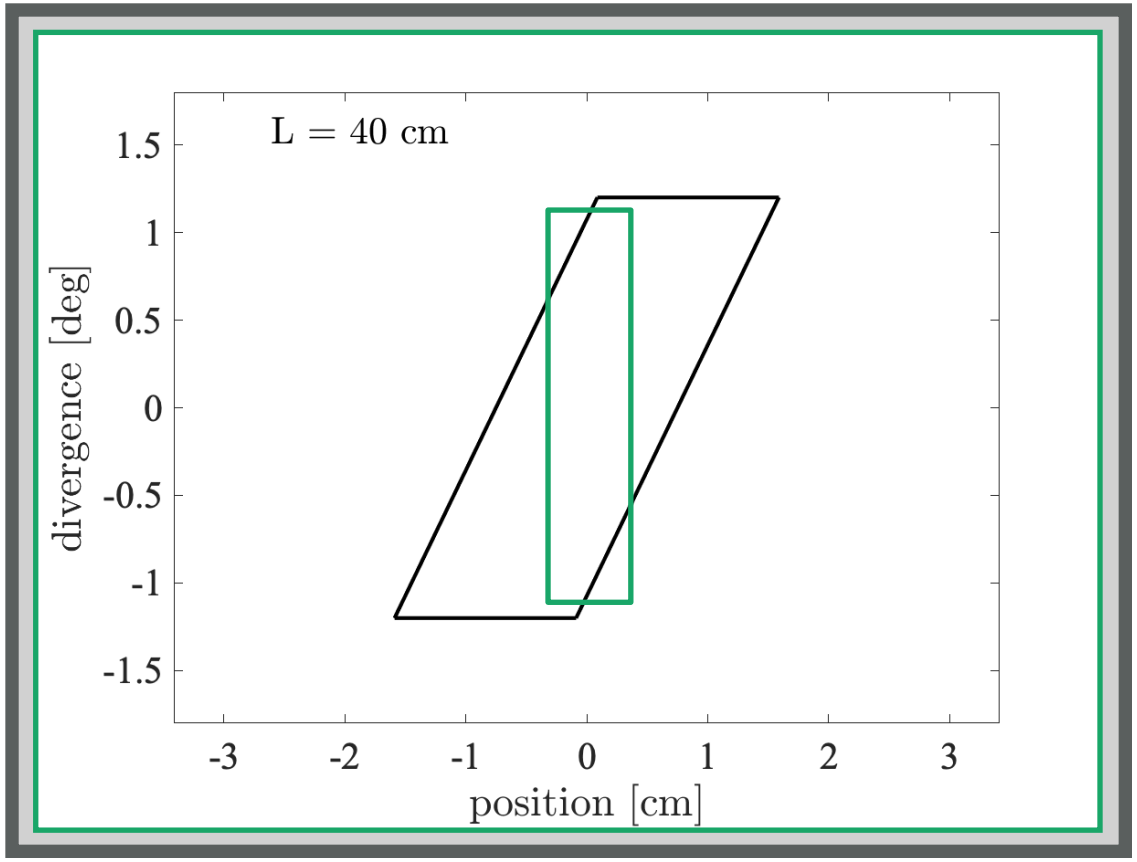

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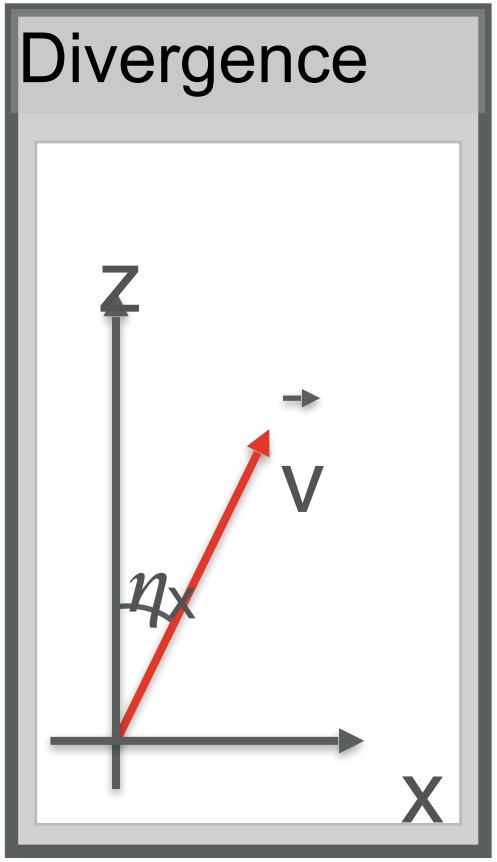

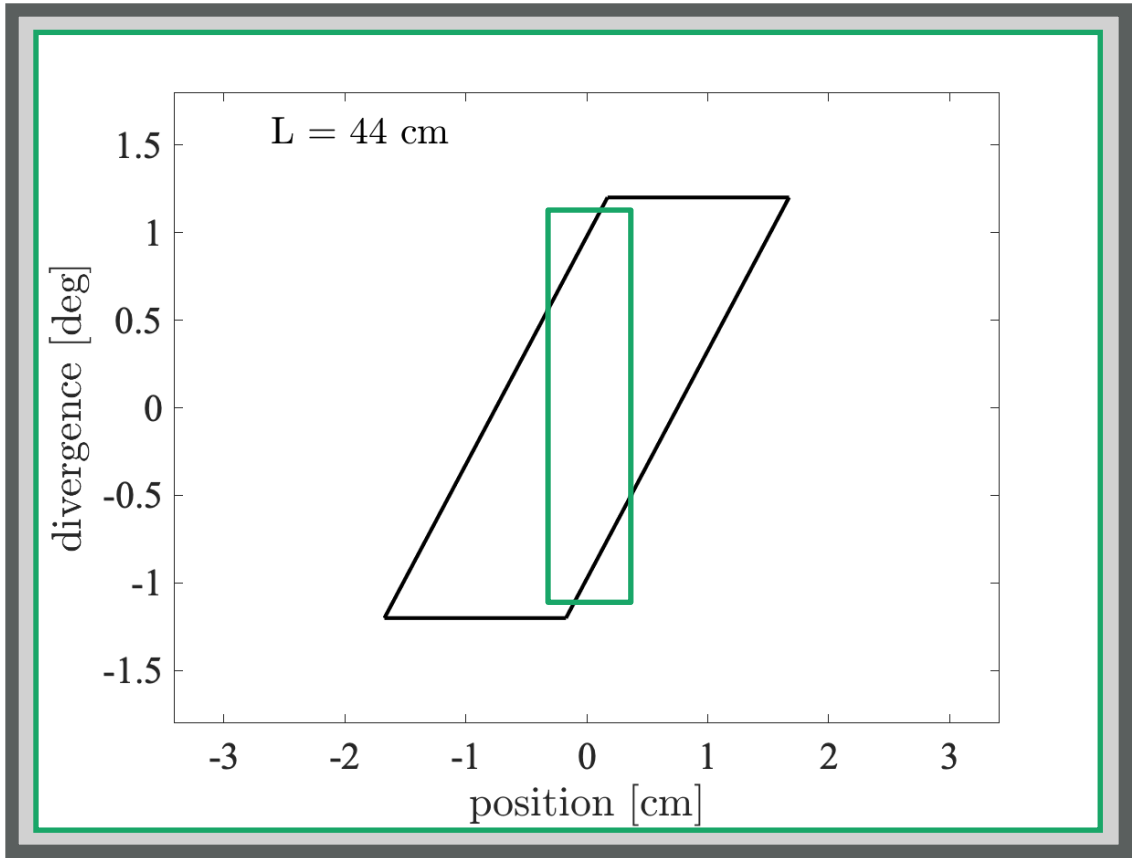

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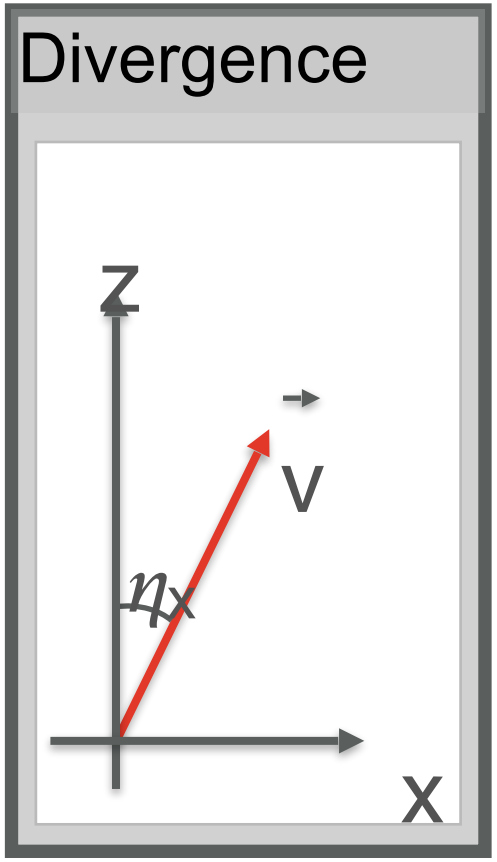

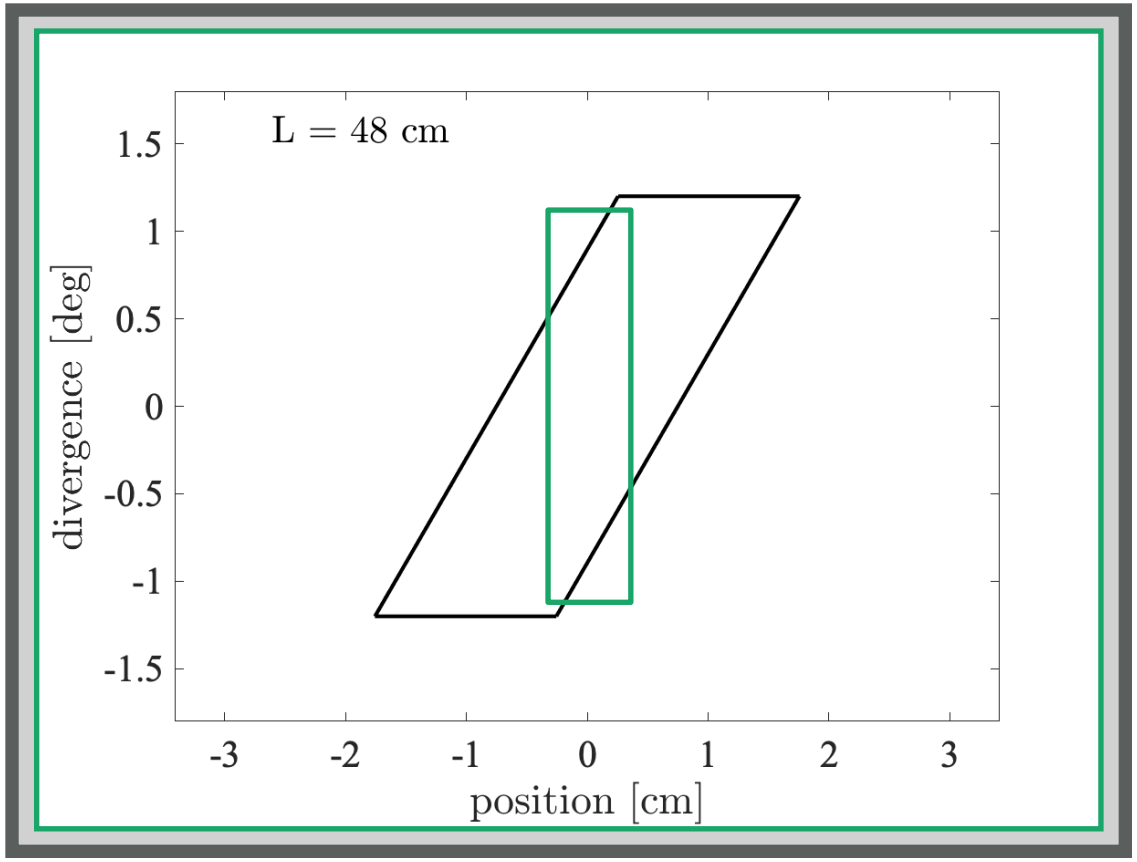

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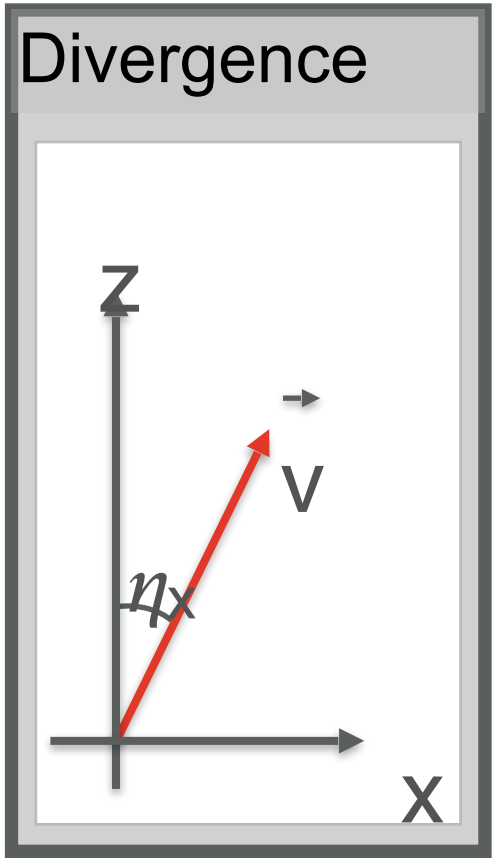

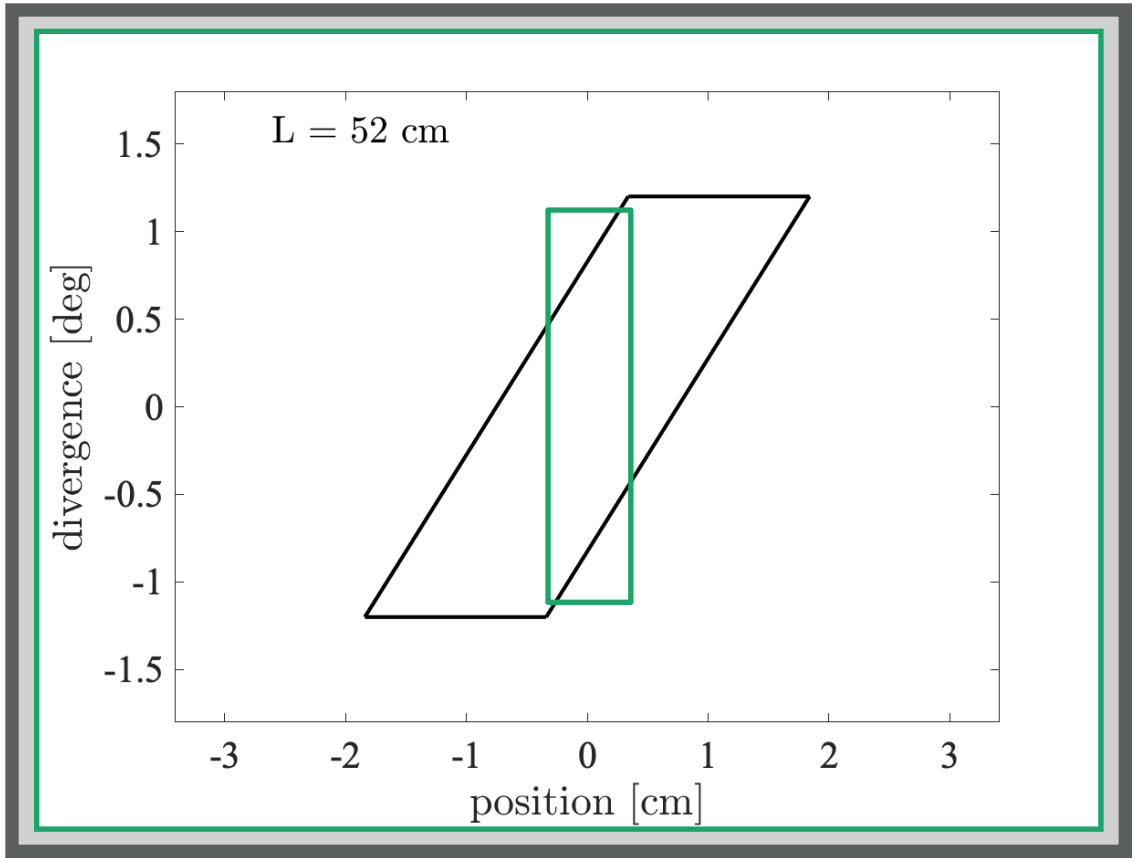

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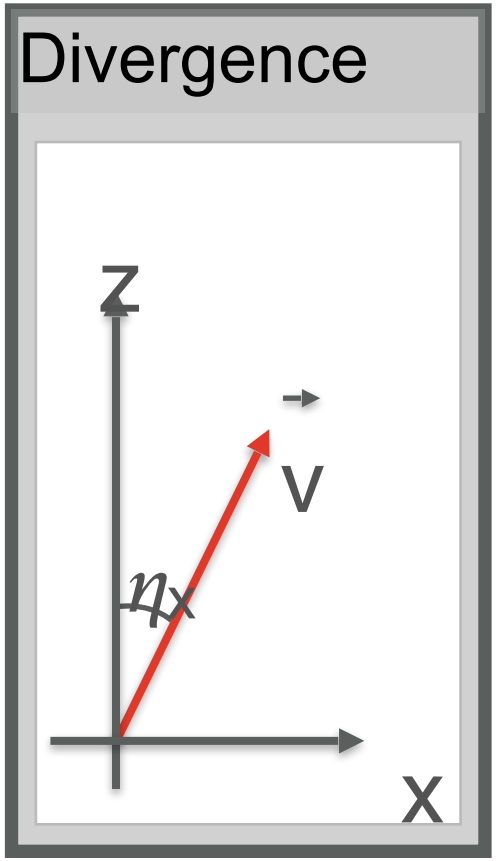
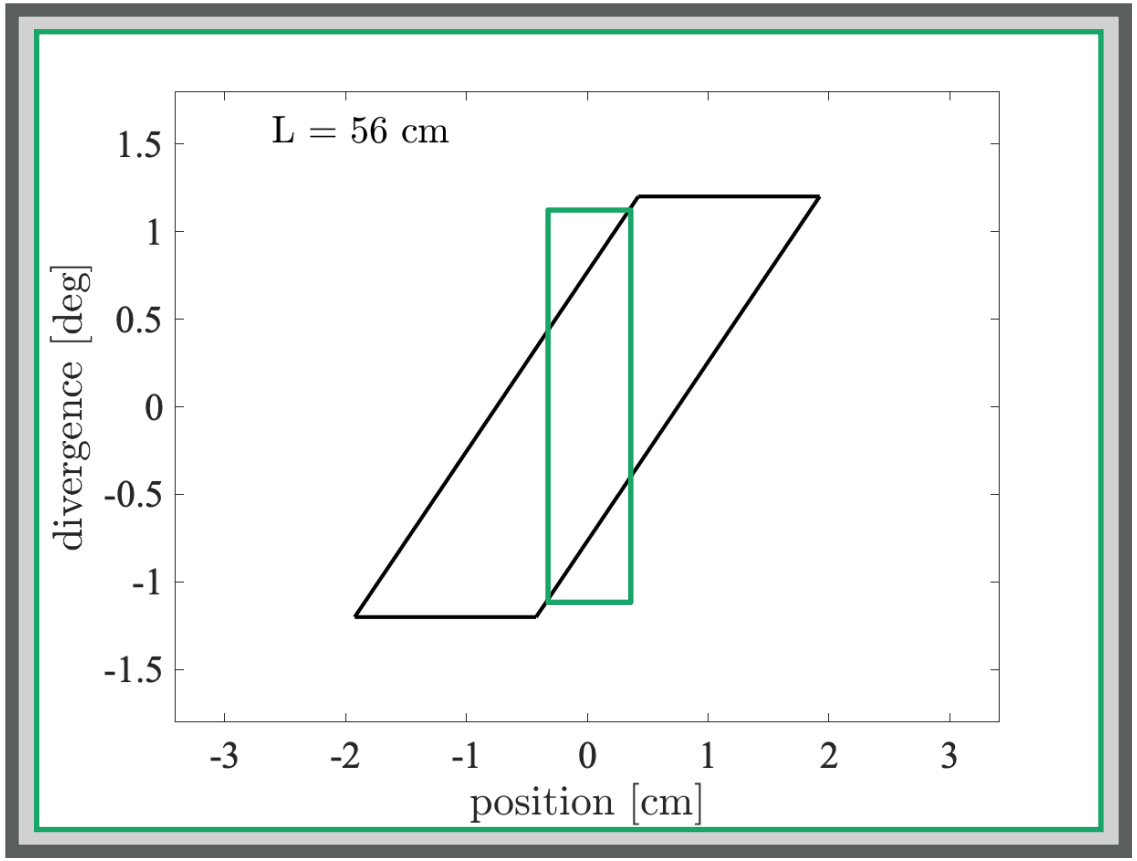
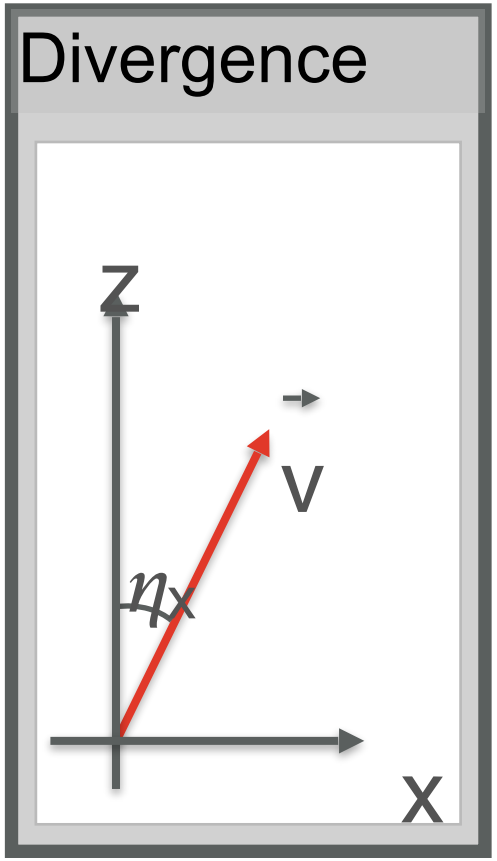
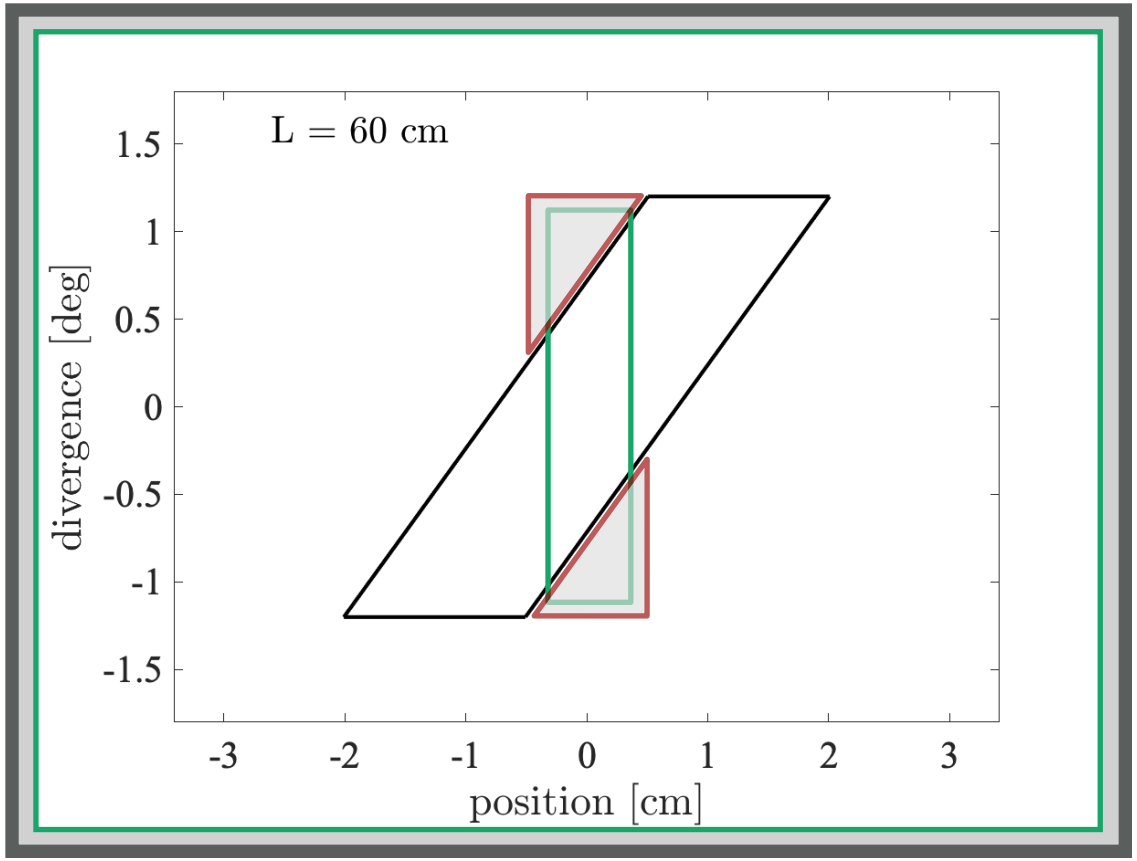




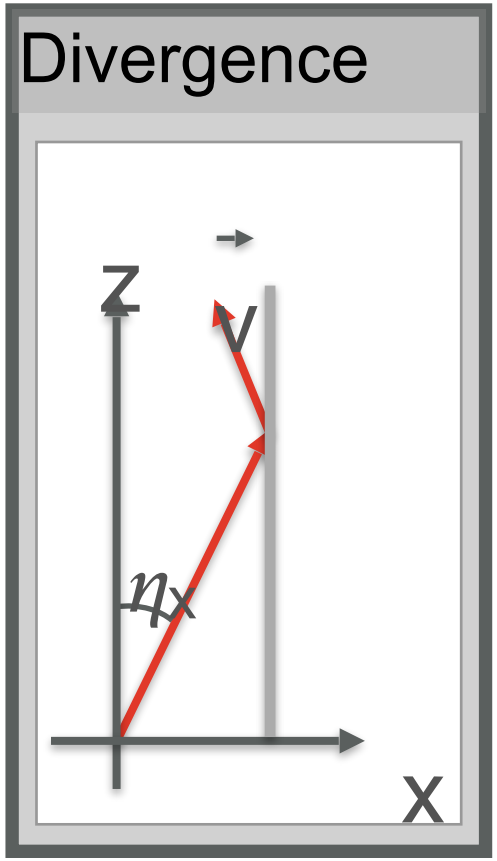
Beam propagation in free space

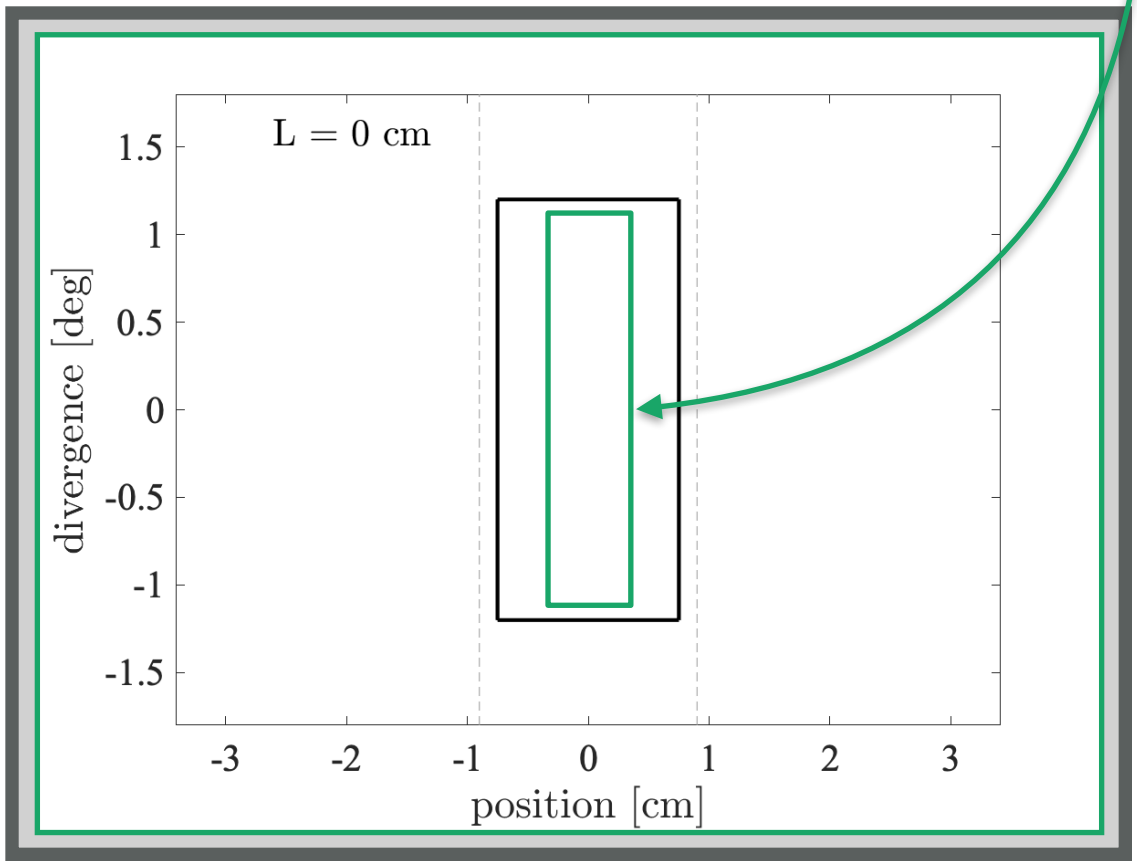
- We lost some phase-space to propagation





Beam propagation in guide





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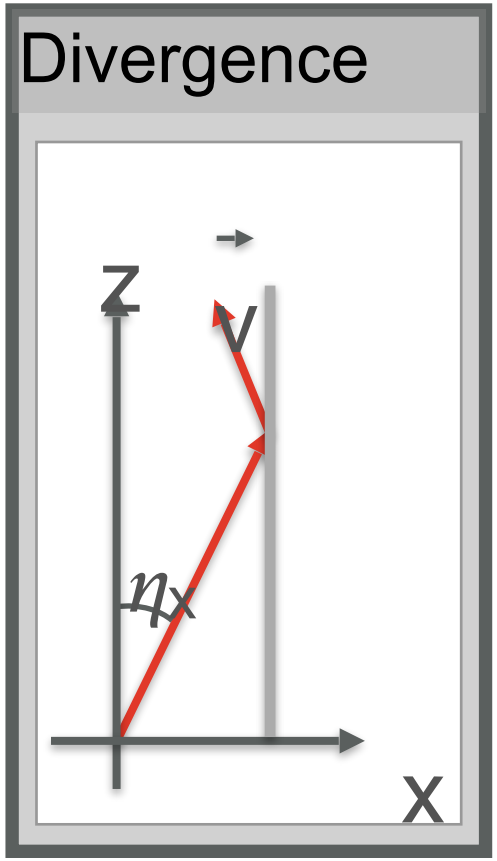

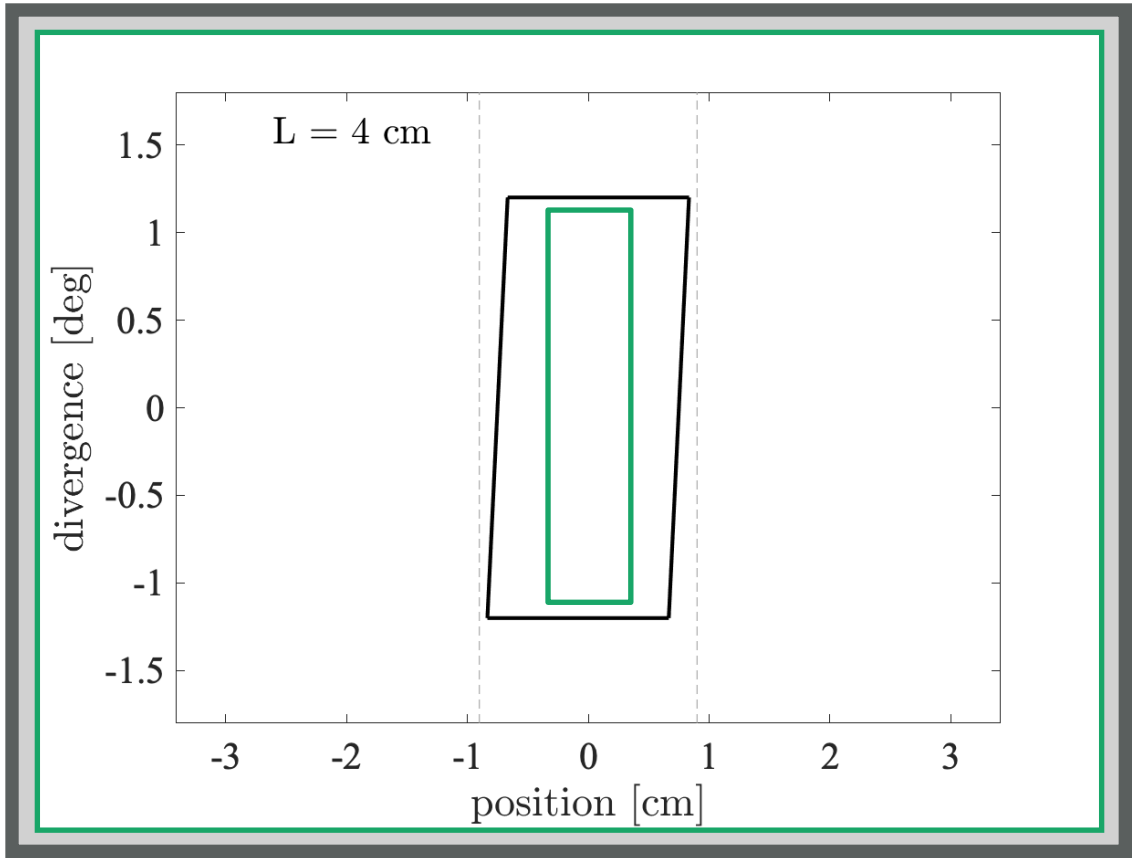

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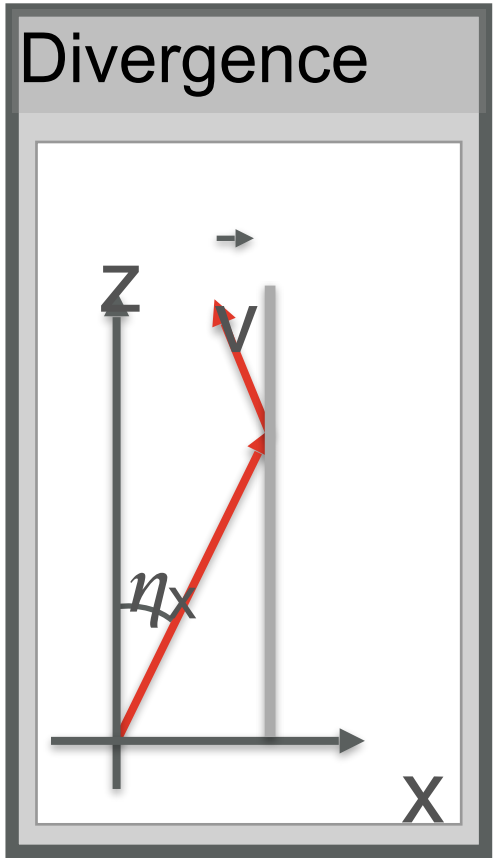

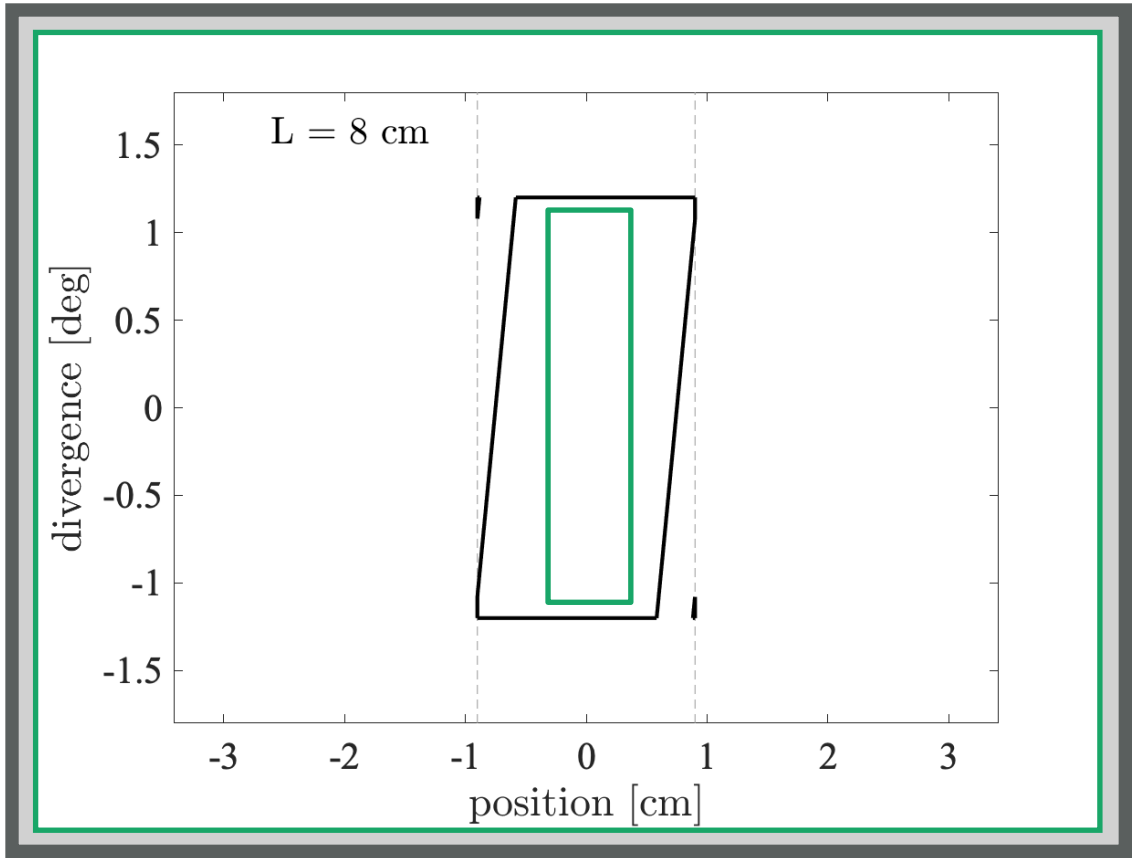

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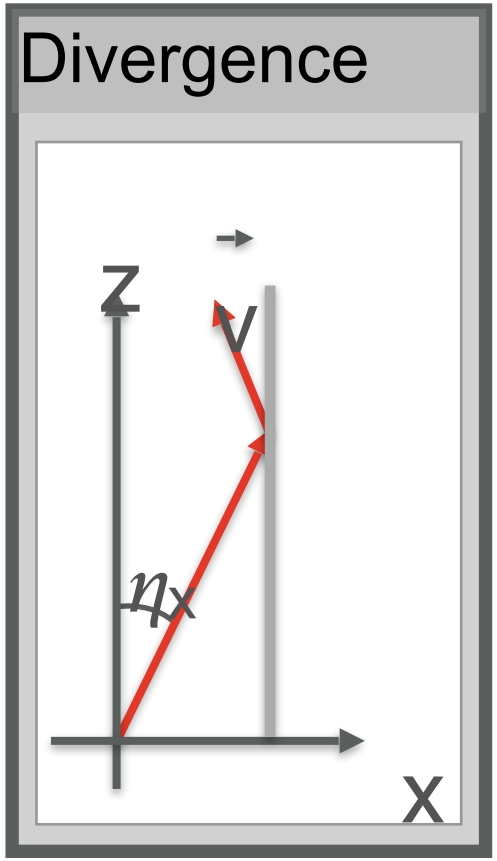

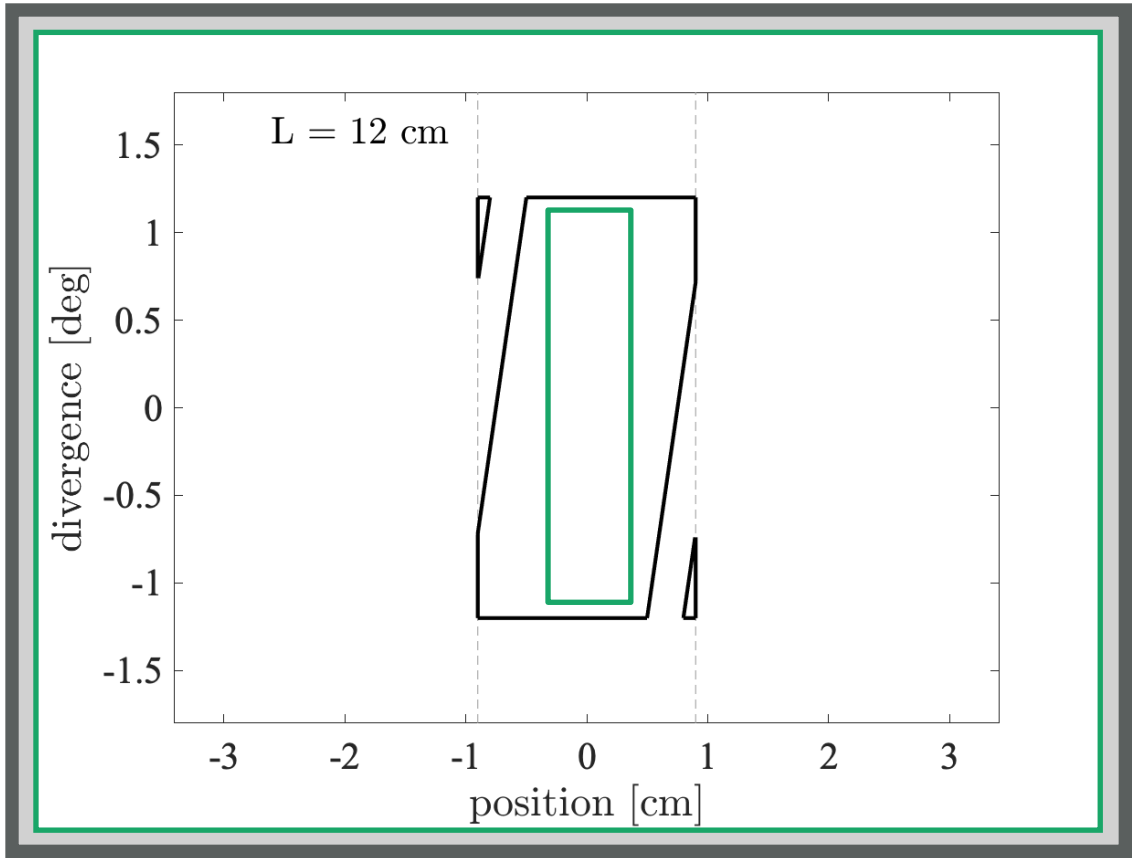

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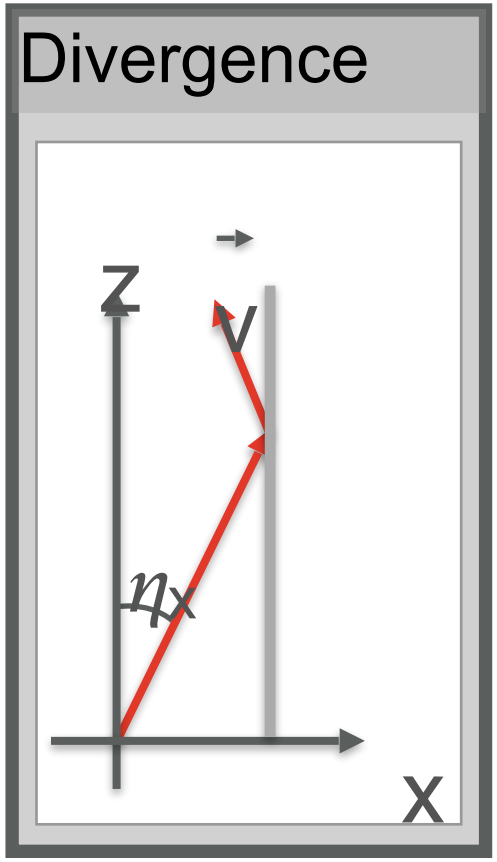

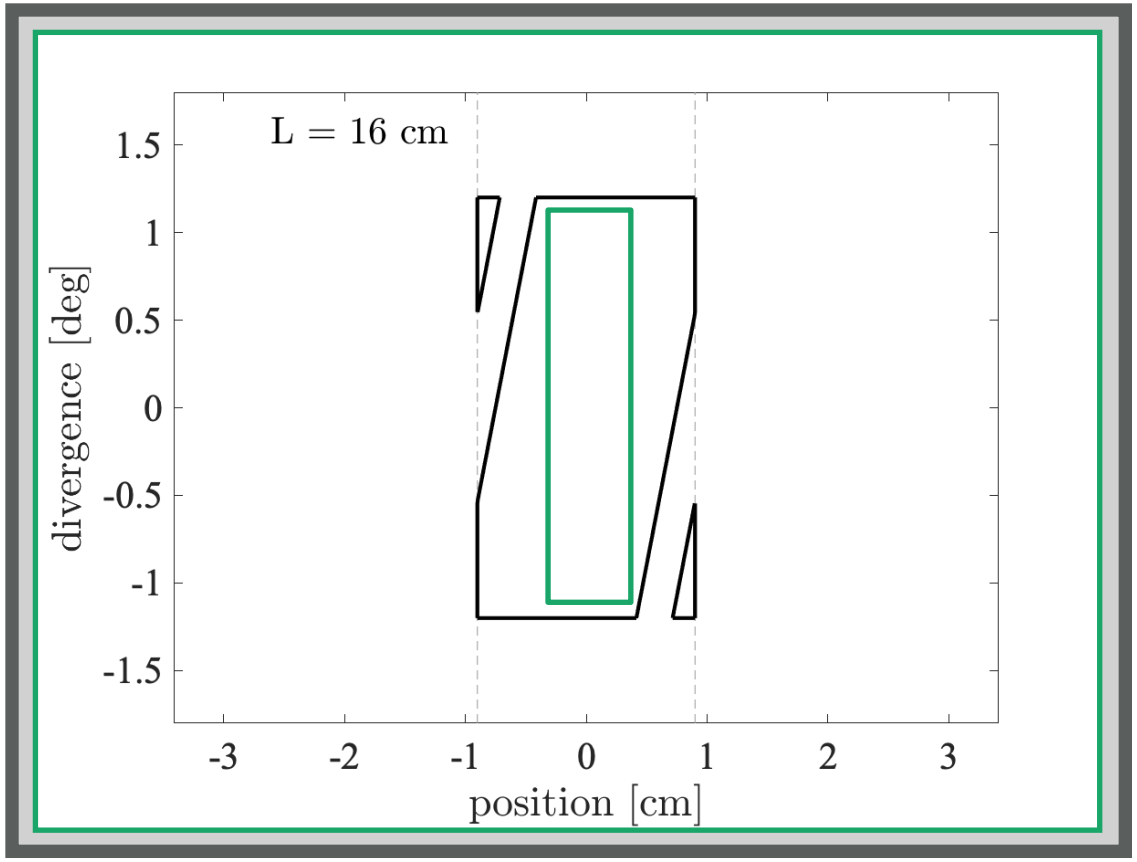

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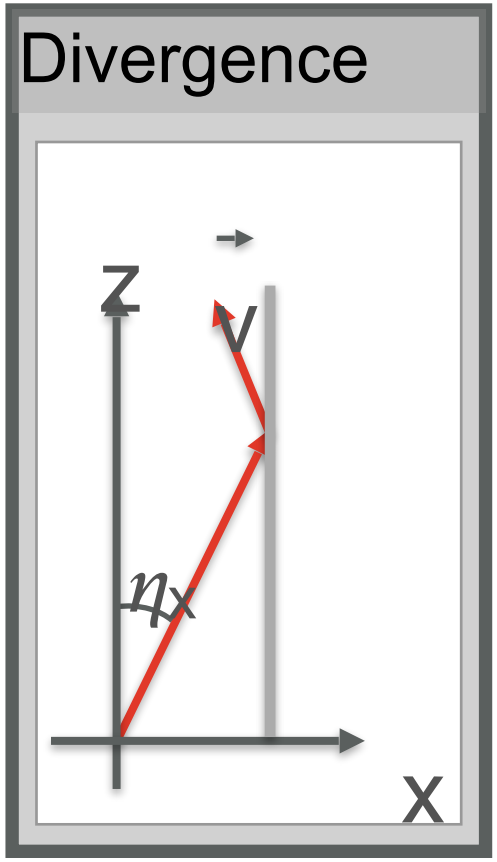

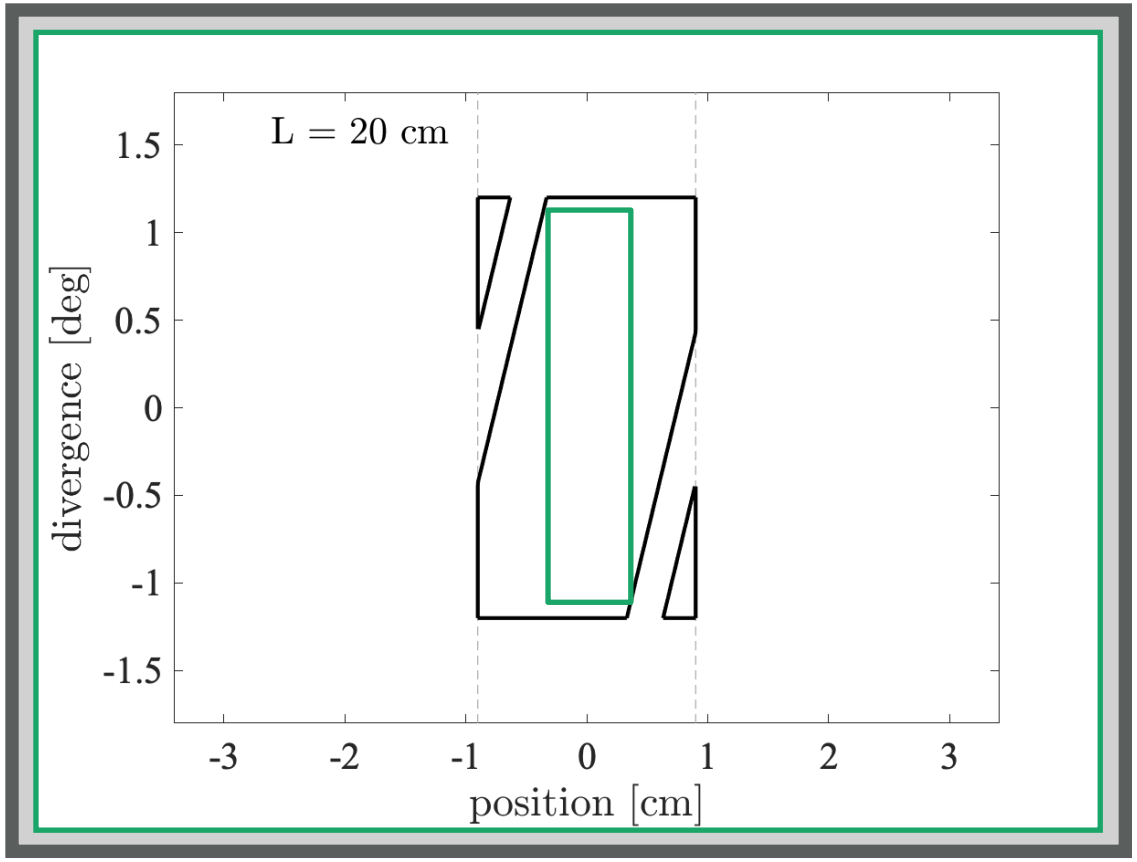

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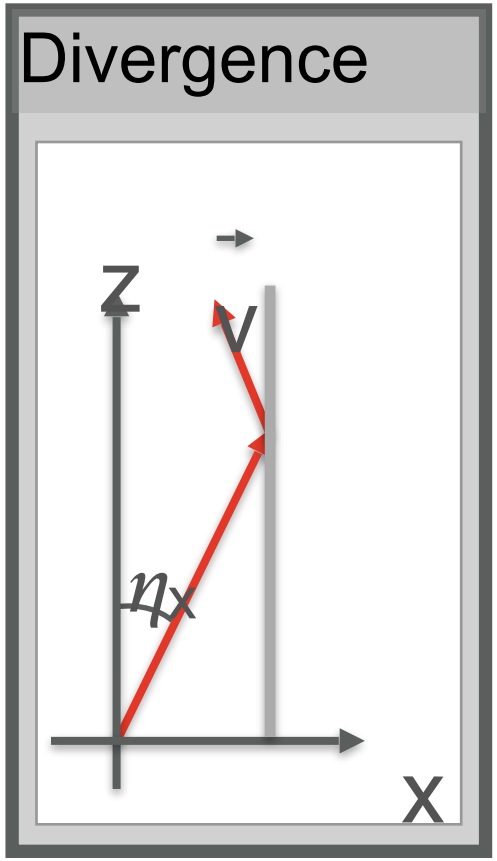

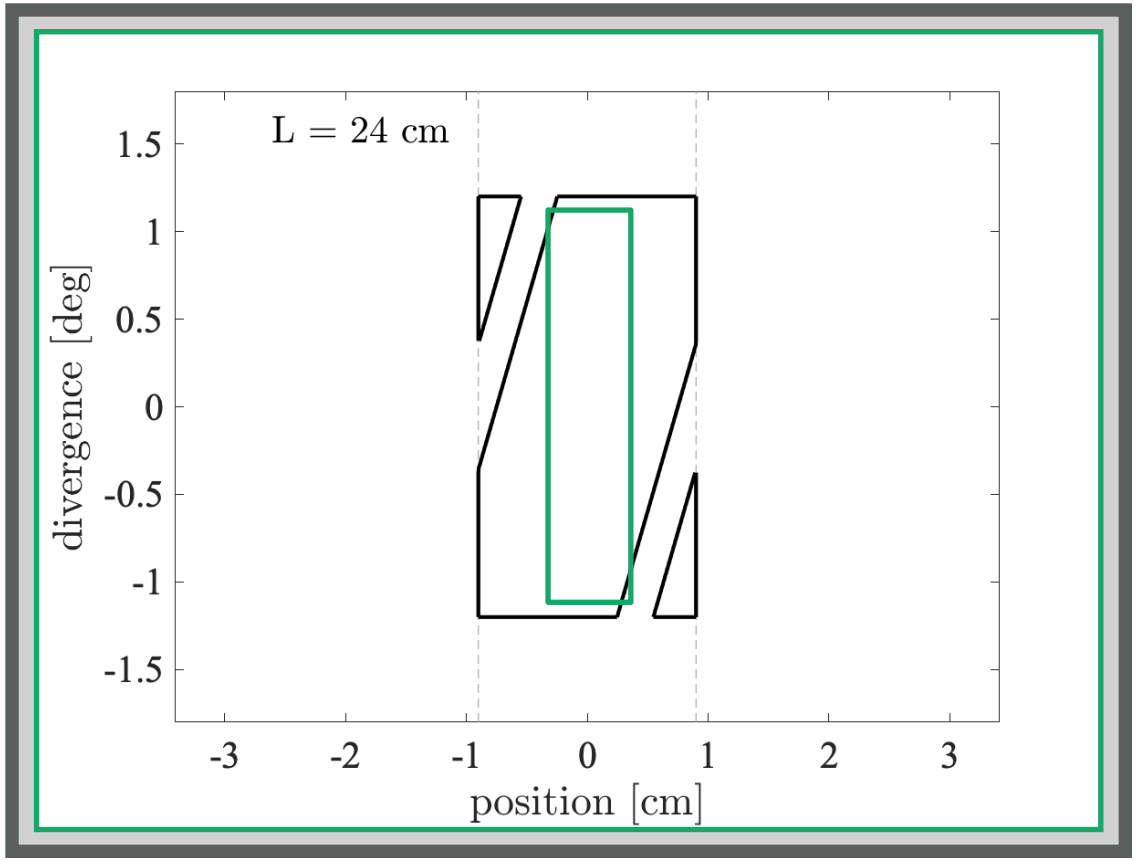

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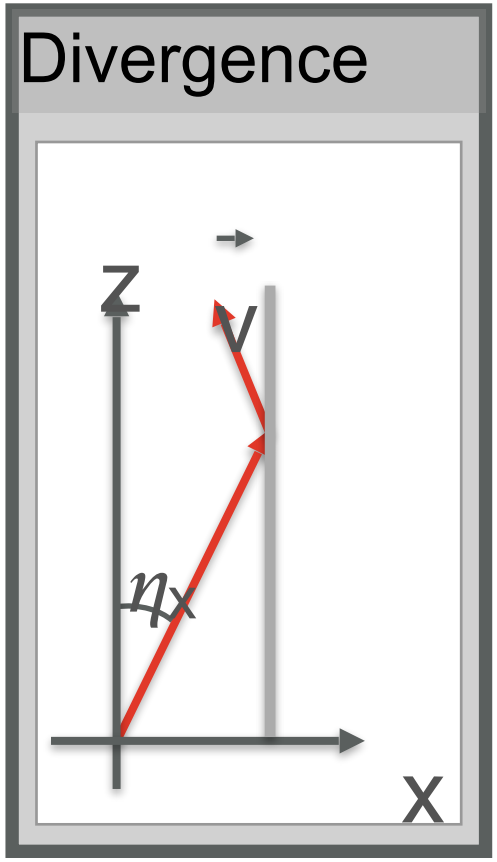

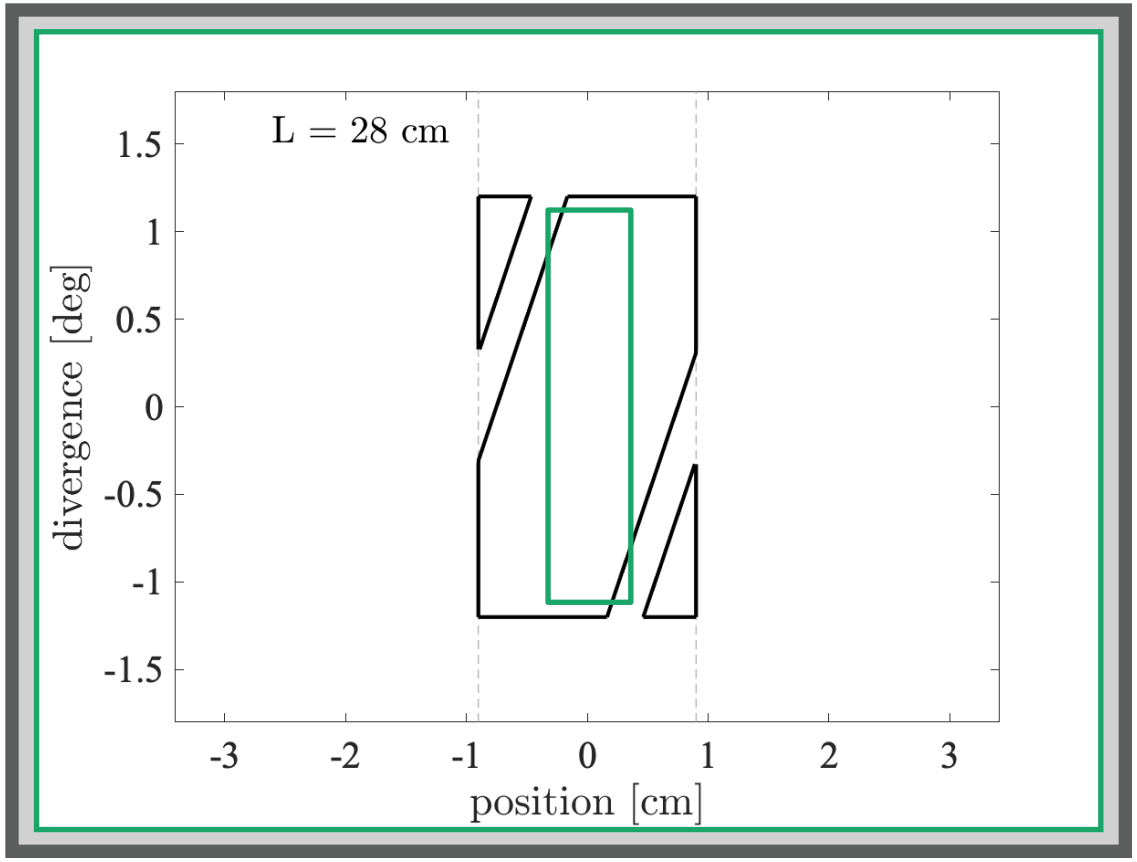

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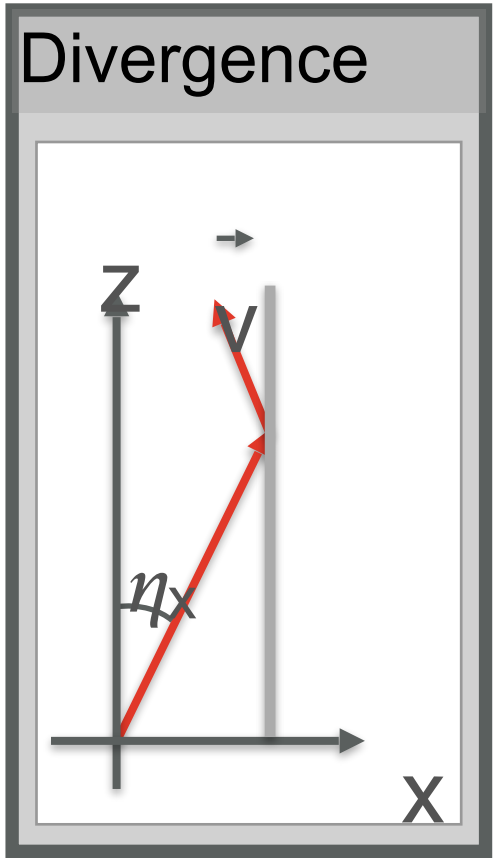

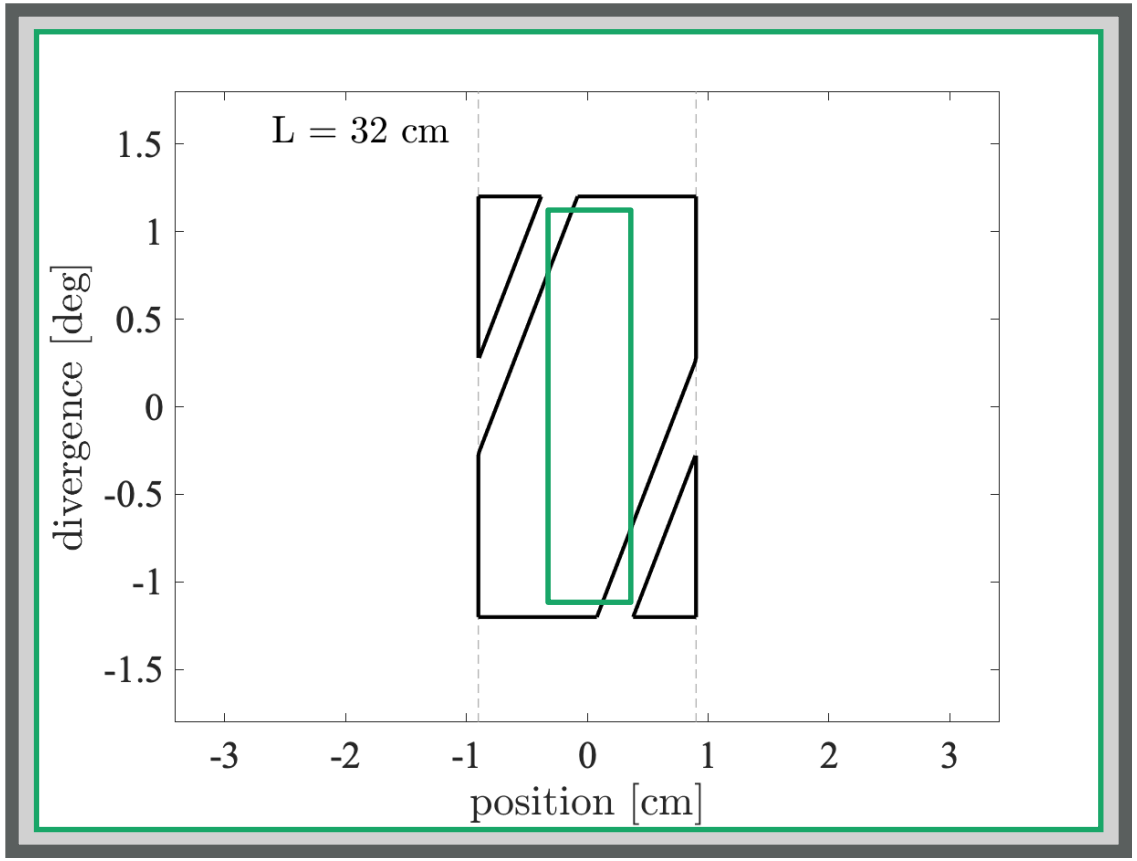

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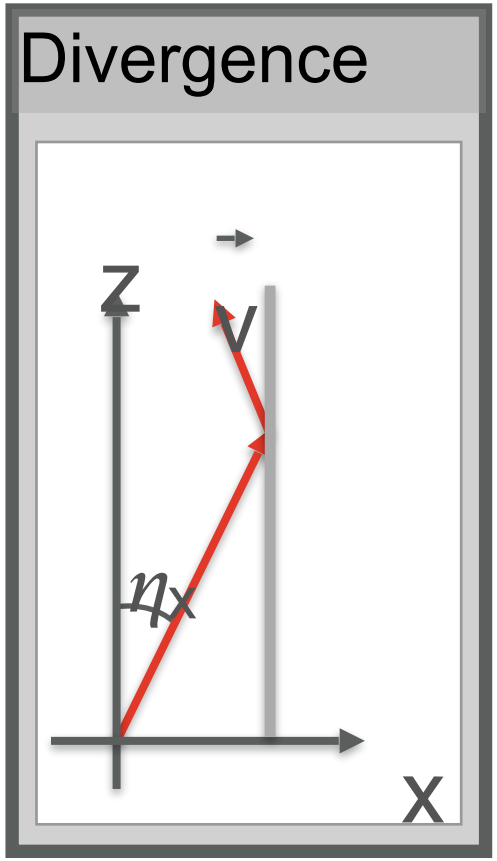

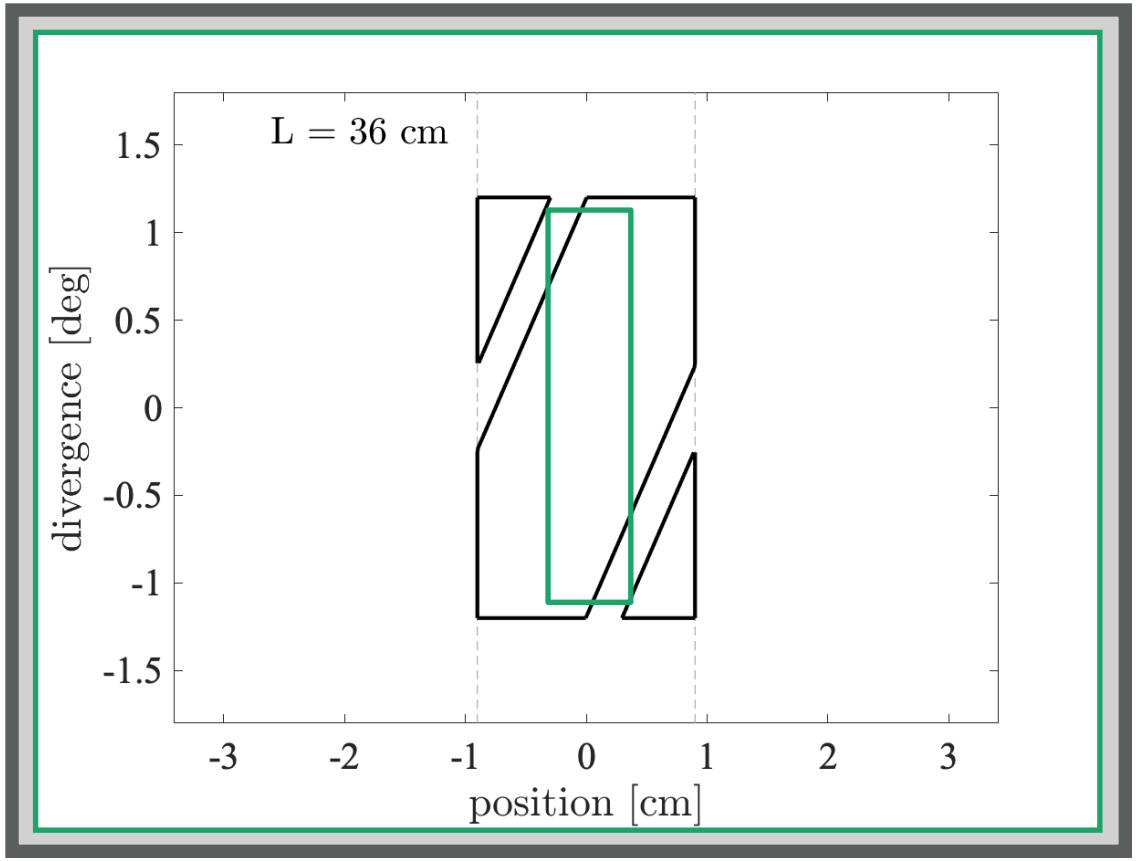

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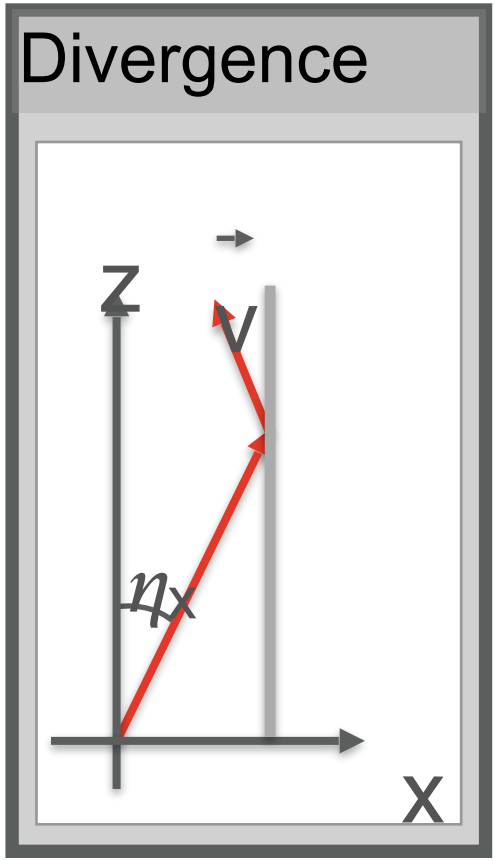

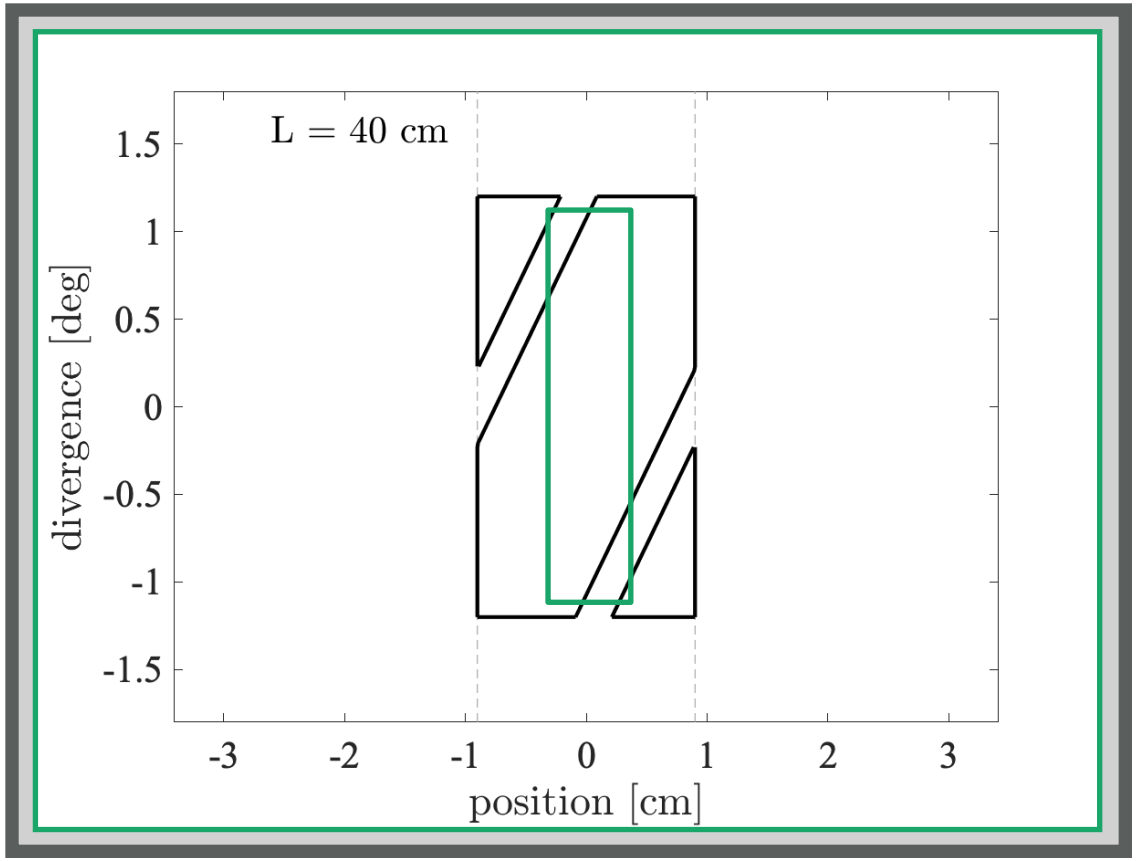

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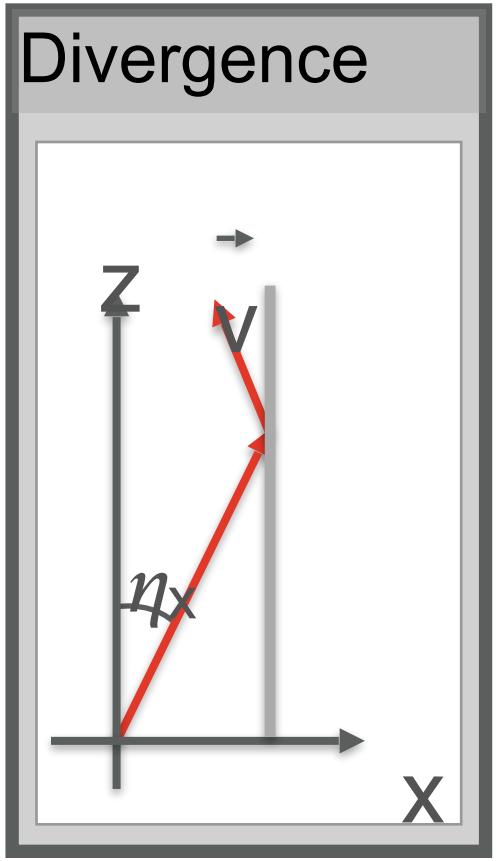

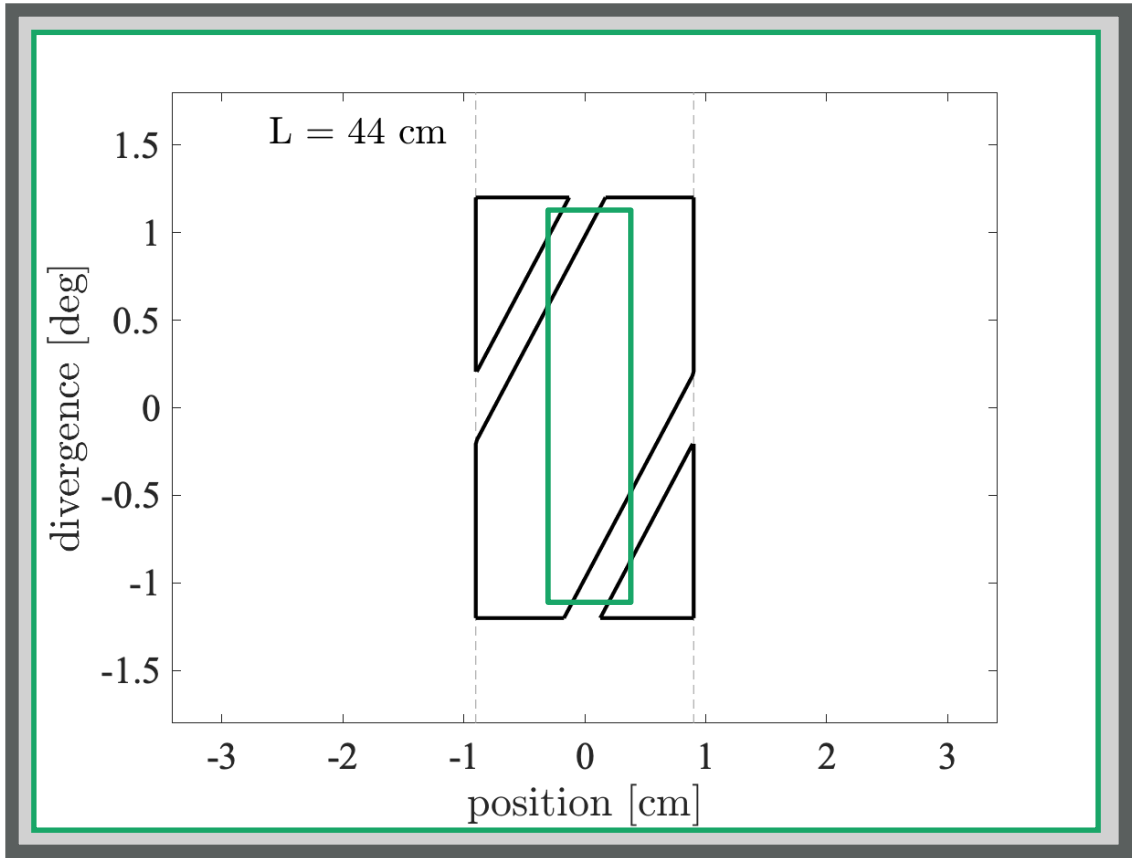

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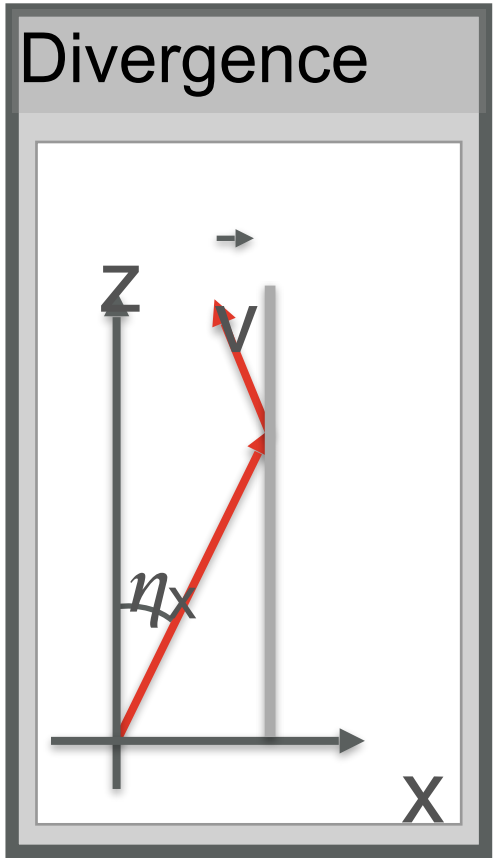
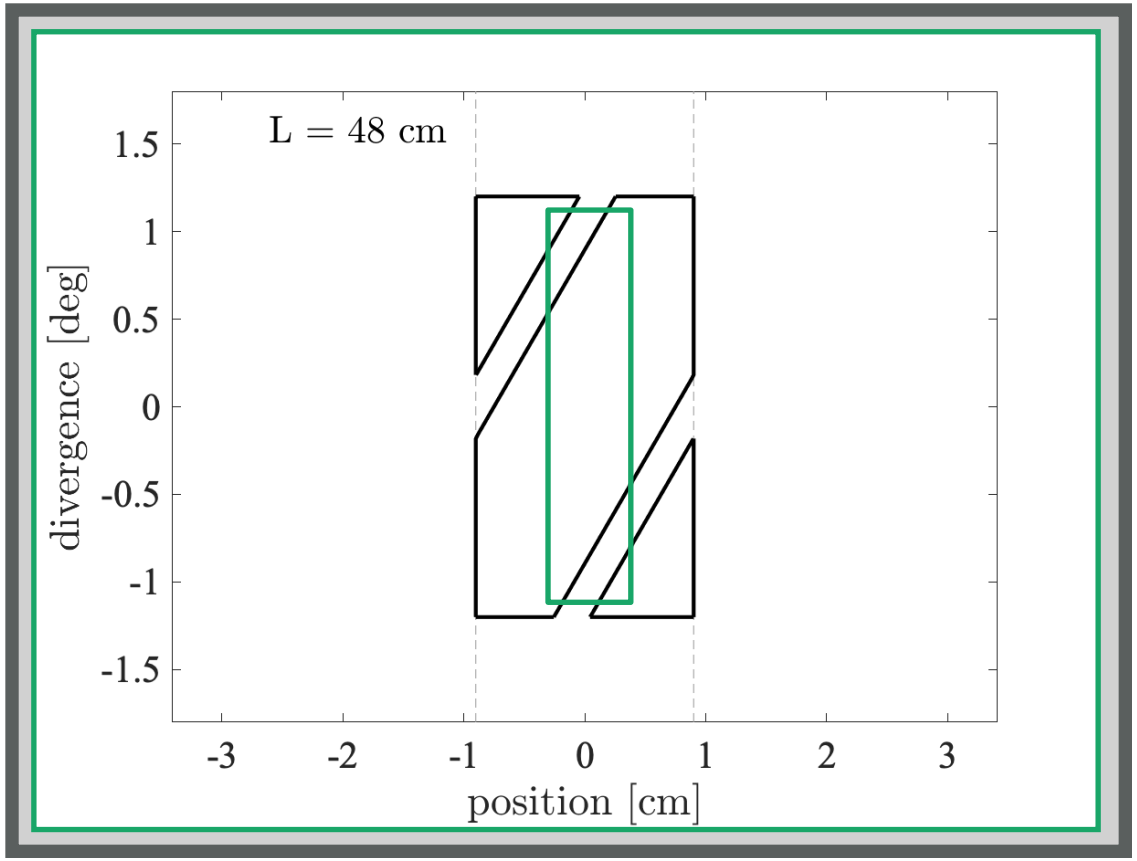
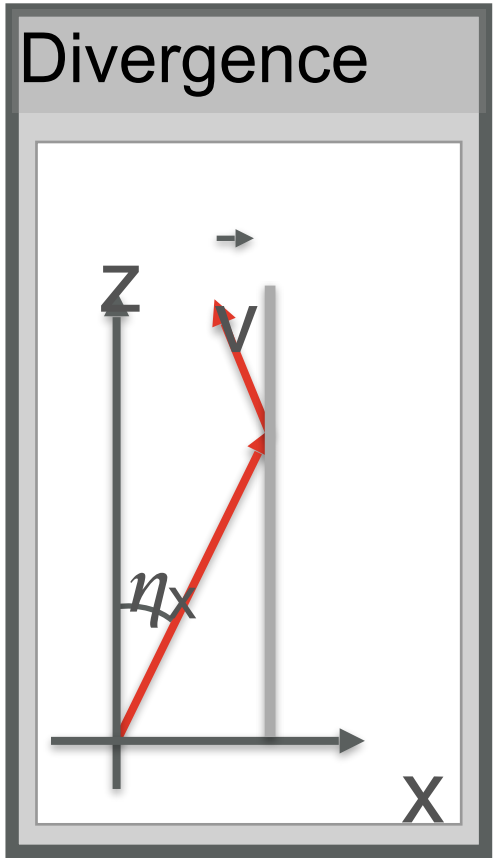
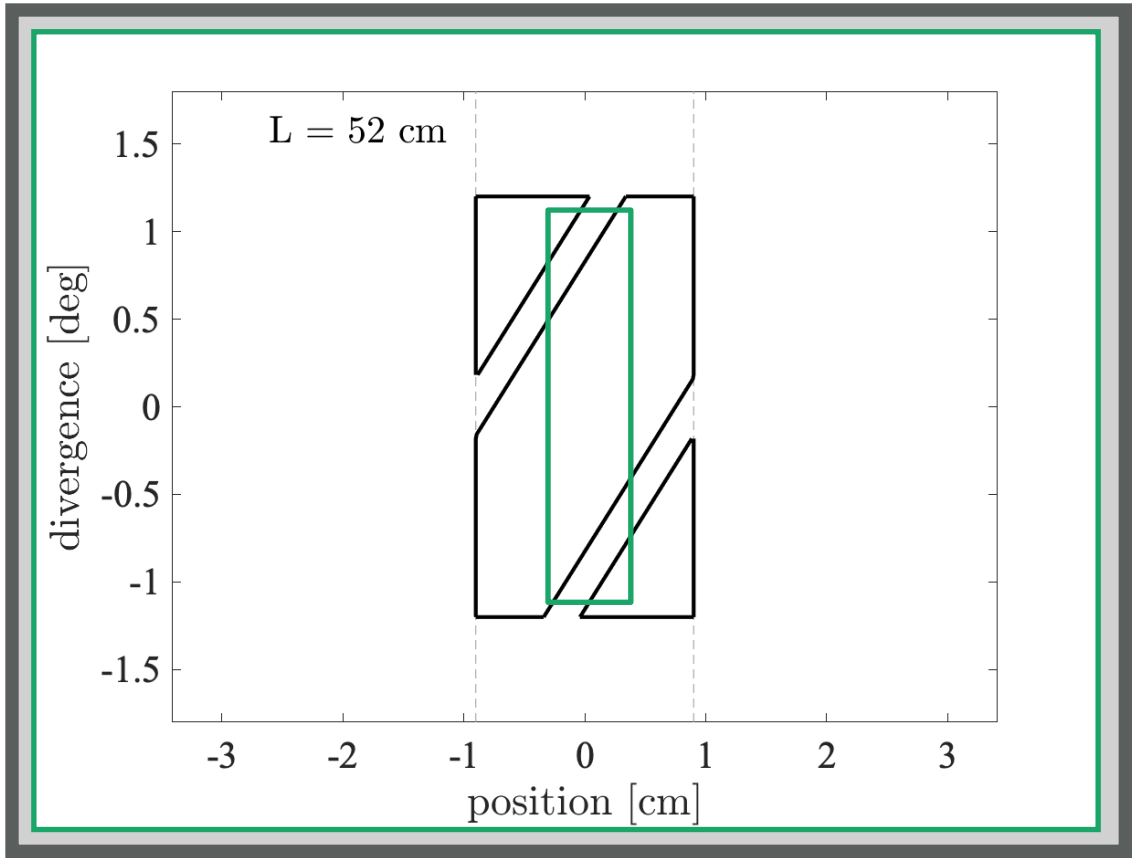


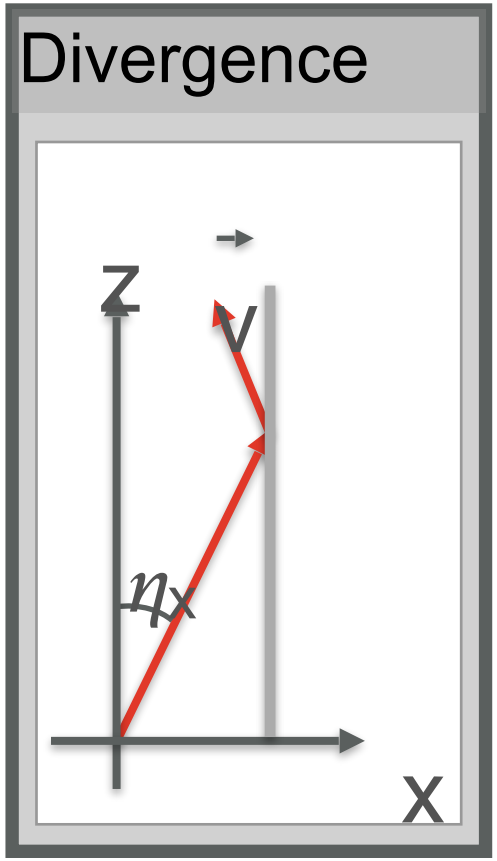


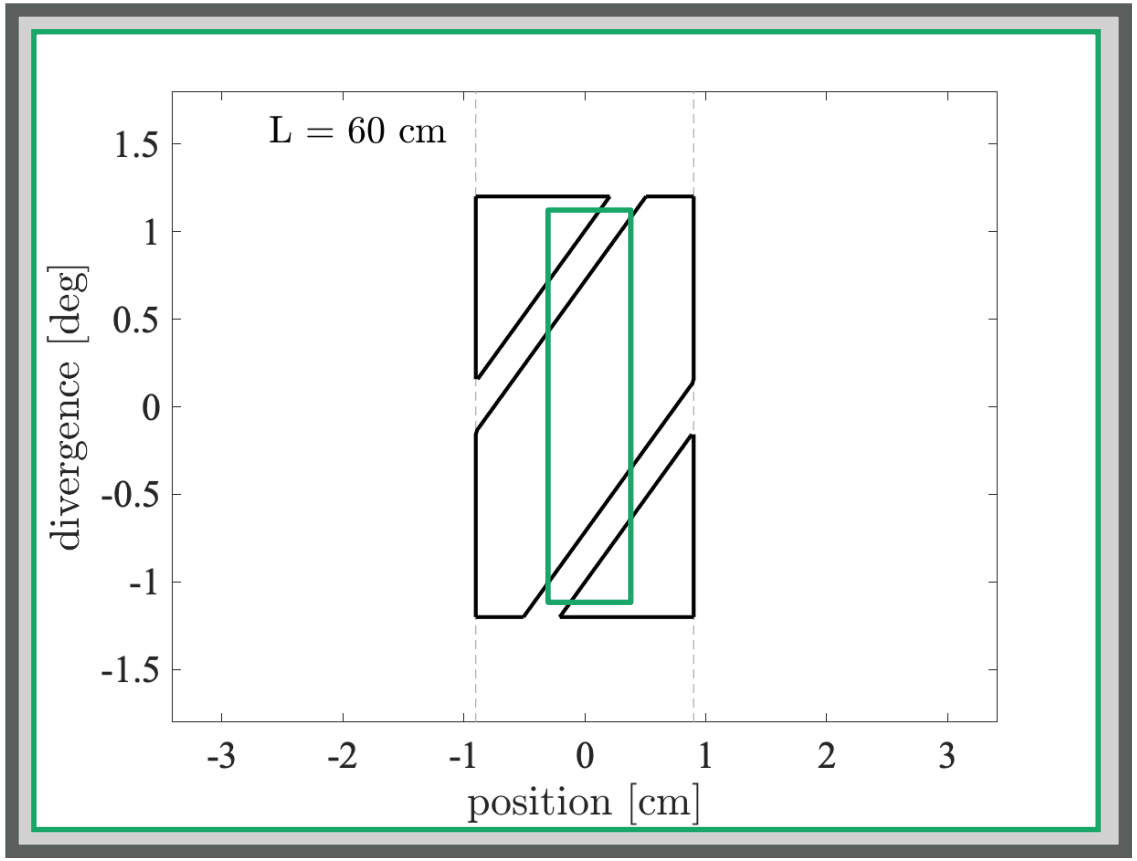
Beam propagation in guide





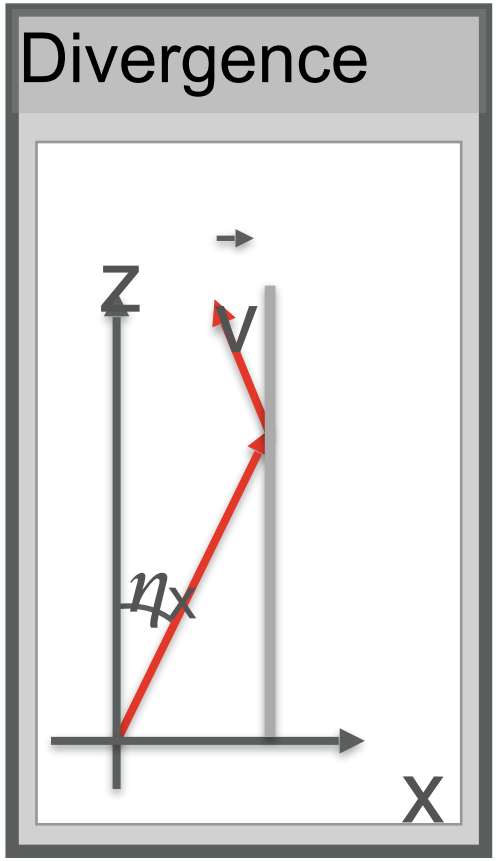
Beam propagation in guide

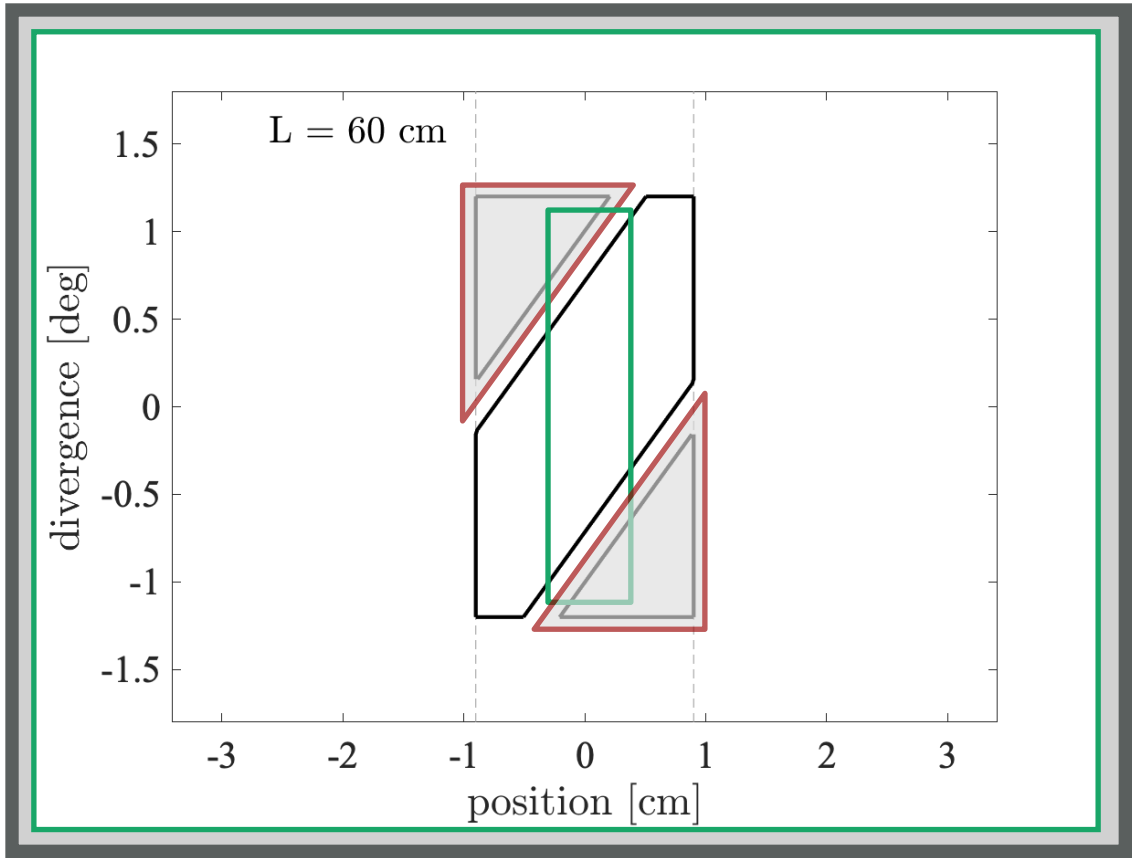




Beam propagation in guide

We got some phase-space back from guide reflection!

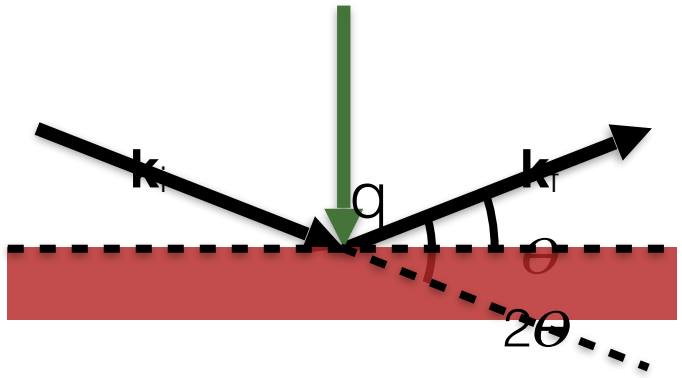


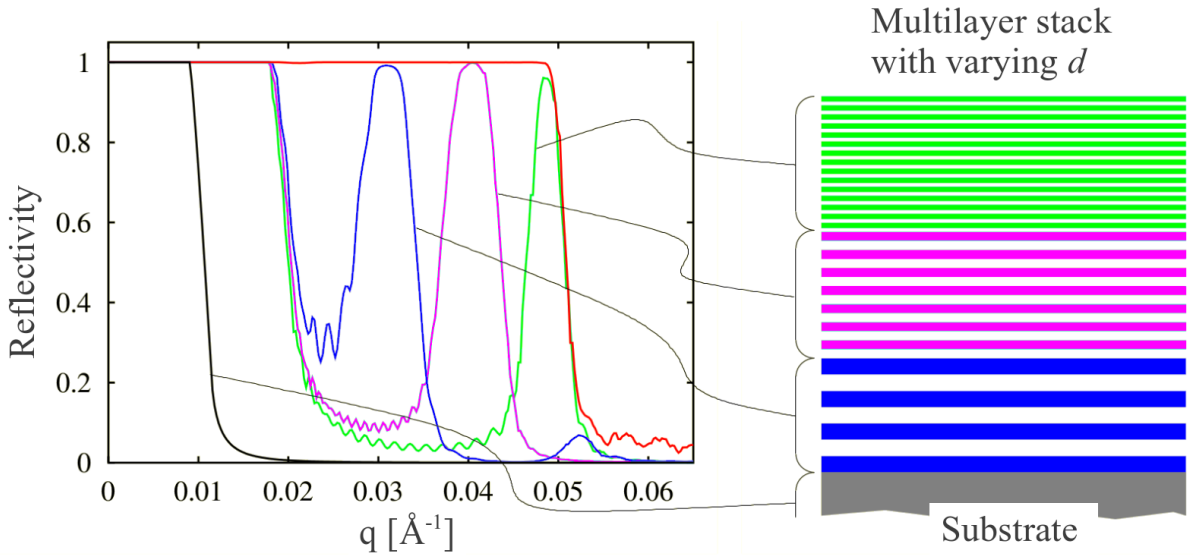


Reflectivity curves

- Reflectivity, super mirror, reflectivity curve

$$m = \frac{\theta_{mirror}}{\theta_{Ni}}$$

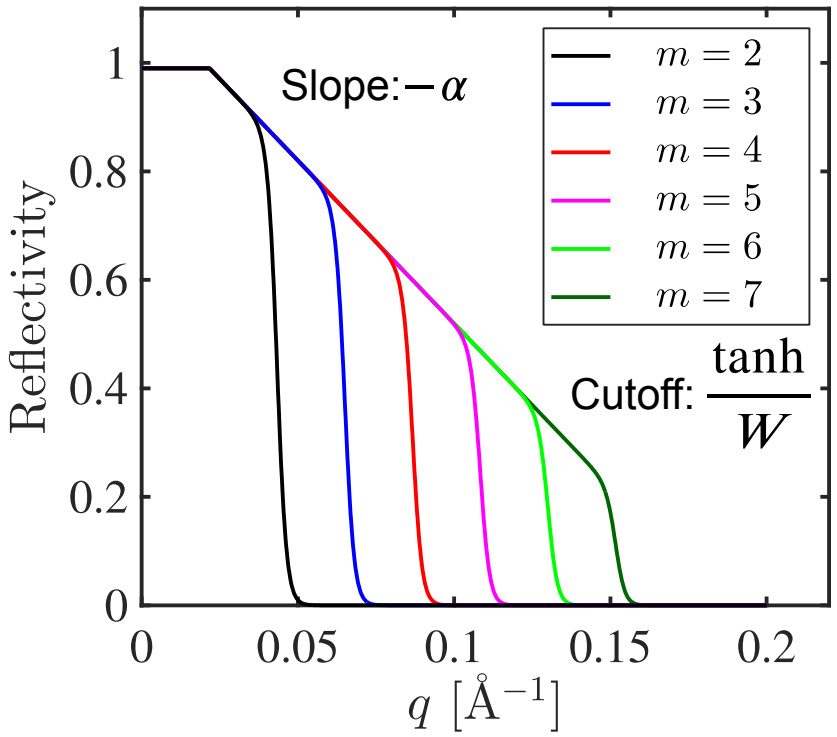




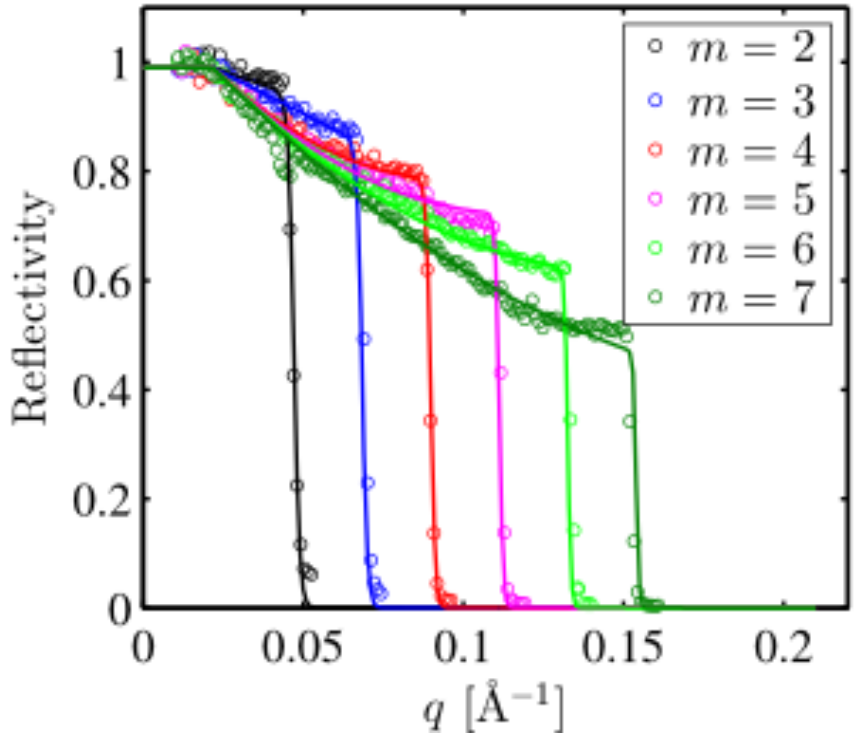
Reflectivity curves in McStas

$$R(q) = \begin{cases} R_0 & \text{if } q < q_c \\ R_0(1 - \tanh((q - mq_c)/W))(1 - \alpha(q - q_c))/2 & \text{otherwise} \end{cases}$$

McStas standard model



McStas fitted model



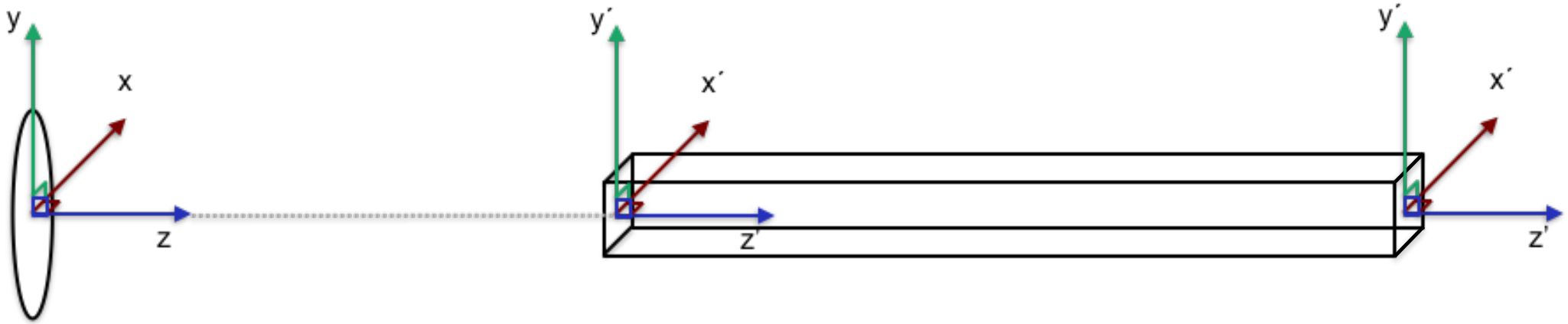
α= 0
W = 0

Only m matters

Better mirrors available today

Guide placement in McStas

- The center is the front of the guide element
- Tip: Insert a guide at the end of the guide



COMPONENT Source
AT (0,0,0) ABSOLUTE

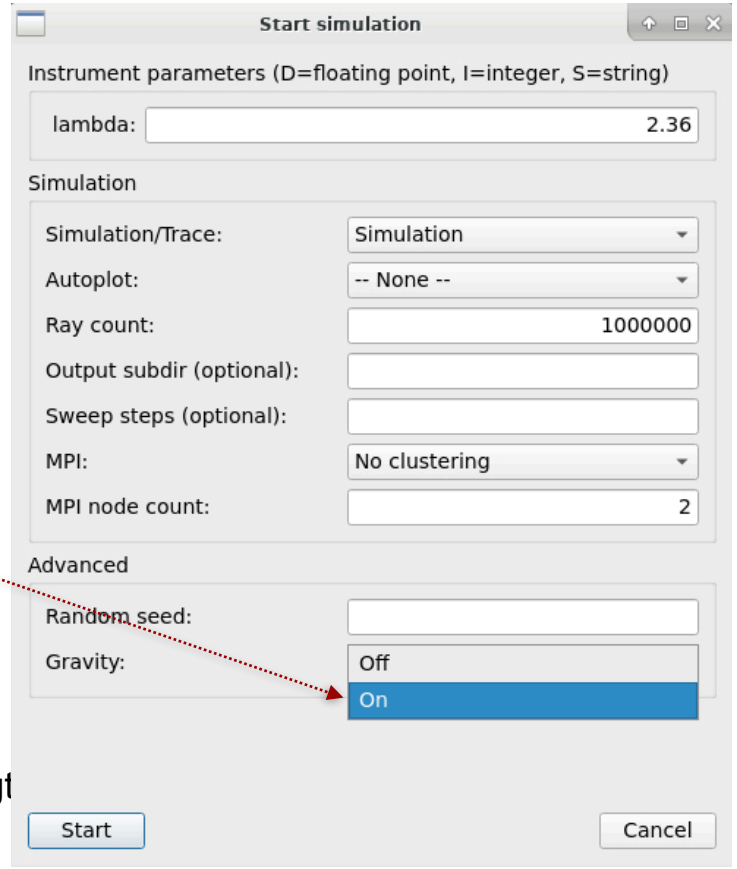
COMPONENT Guide(length=A)
AT (0,0,2) RELATIVE Source

COMPONENT Arm
AT (0,0,A) RELATIVE Guide

Gravitation in McStas

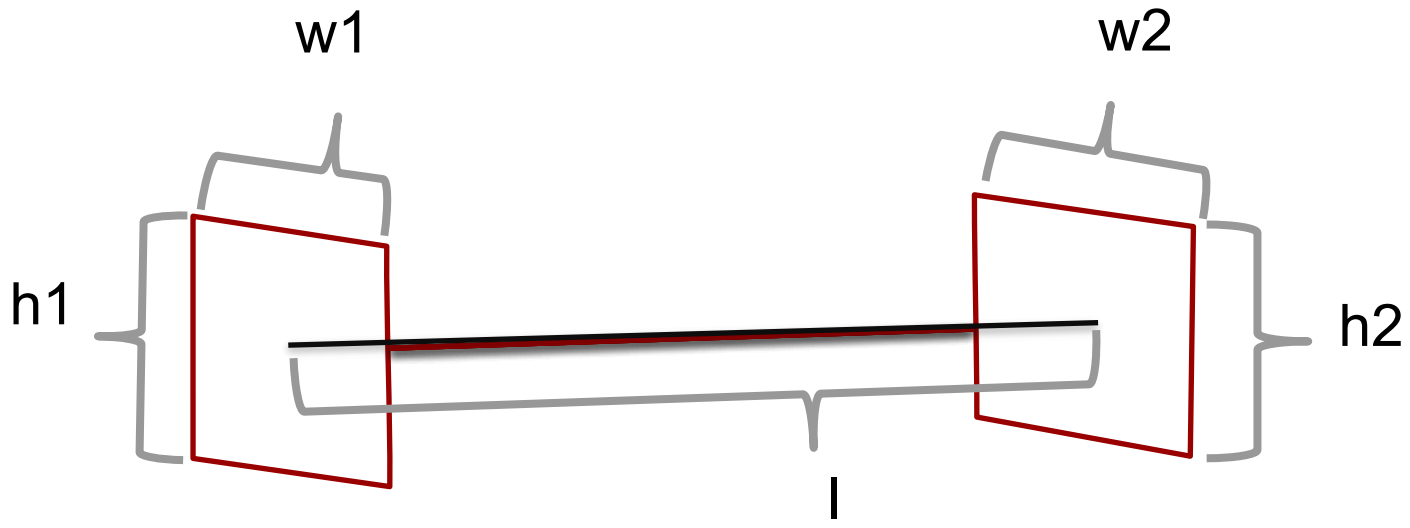
- Enabled by adding -g / --gravitation on command line or by selecting “Gravity On” in mcgui
- Default ~ gravity on earth
  #define GRAVITY 9.81 /* [m/s^2] gravitational acceleration */

  (If on the moon, use -DGRAVITY=1.62 ;-))
- For guides, only Guide_gravity and Elliptic_guide_gravity support parabolic propagation. (Many others propagate linearly in $\vec{v}$ *direction.)*
- As you will see in the practical, implications are greatest with long wavelengt
- *“How about e.g. elliptic mirror optic X that does not support gravity?”*
  - often a good workaround is to add a monitor close to the surface of object X, this takes care that propagation up to the monitor includes gravitation:
  - Gravity is enabled in any call to PROP_DT, PROP_Z0 etc., but not in intersect_* routines (most monitors use PROP_Z0 directly, no intersect_ call first
  - OK to propagate without gravitation e.g. within sample, through velocity selector etc. / range of ~cm’s



Popular guide components: Guide_gravity

- Typical guide component with gravity, parameter-interface similar to e.g. Guide.comp
- Many additional features, channels, fermi chopper, … (see mcdoc pages for more info)



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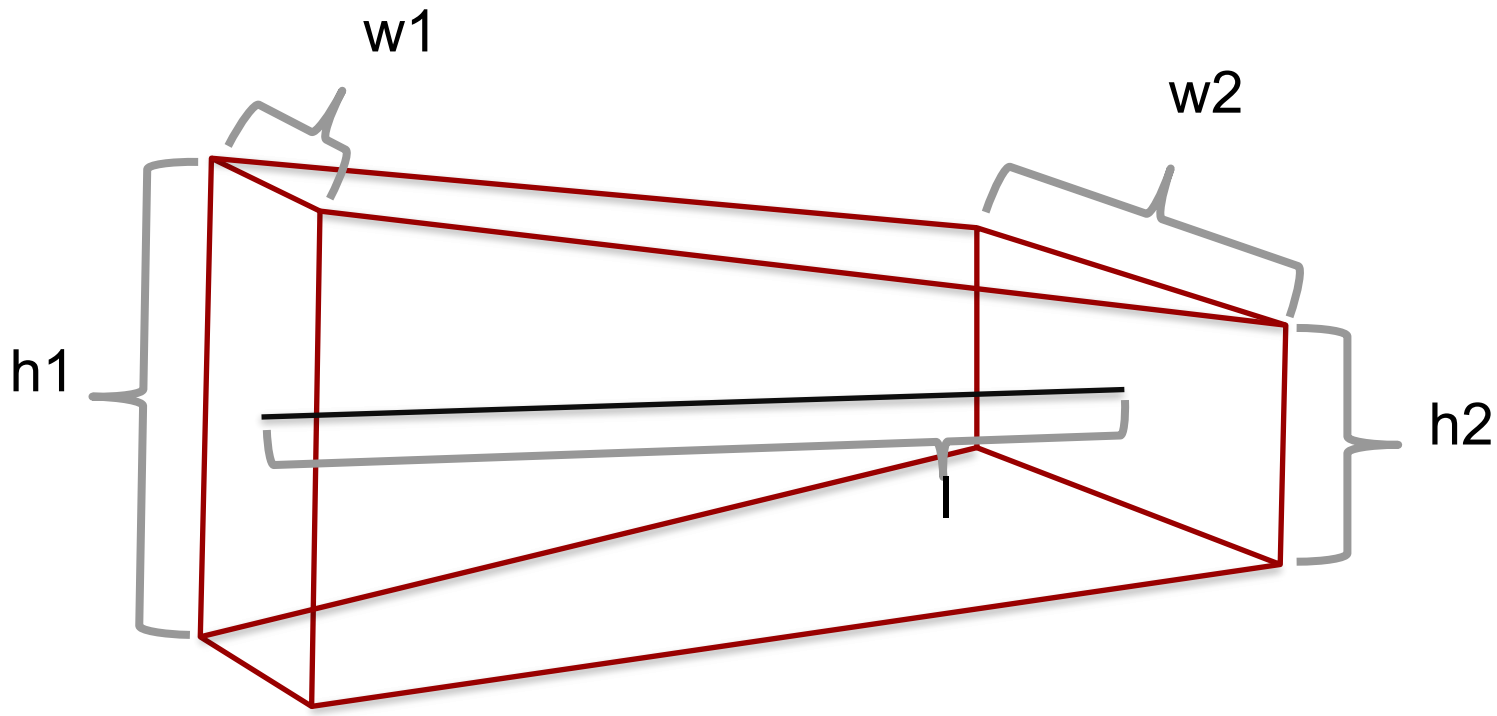

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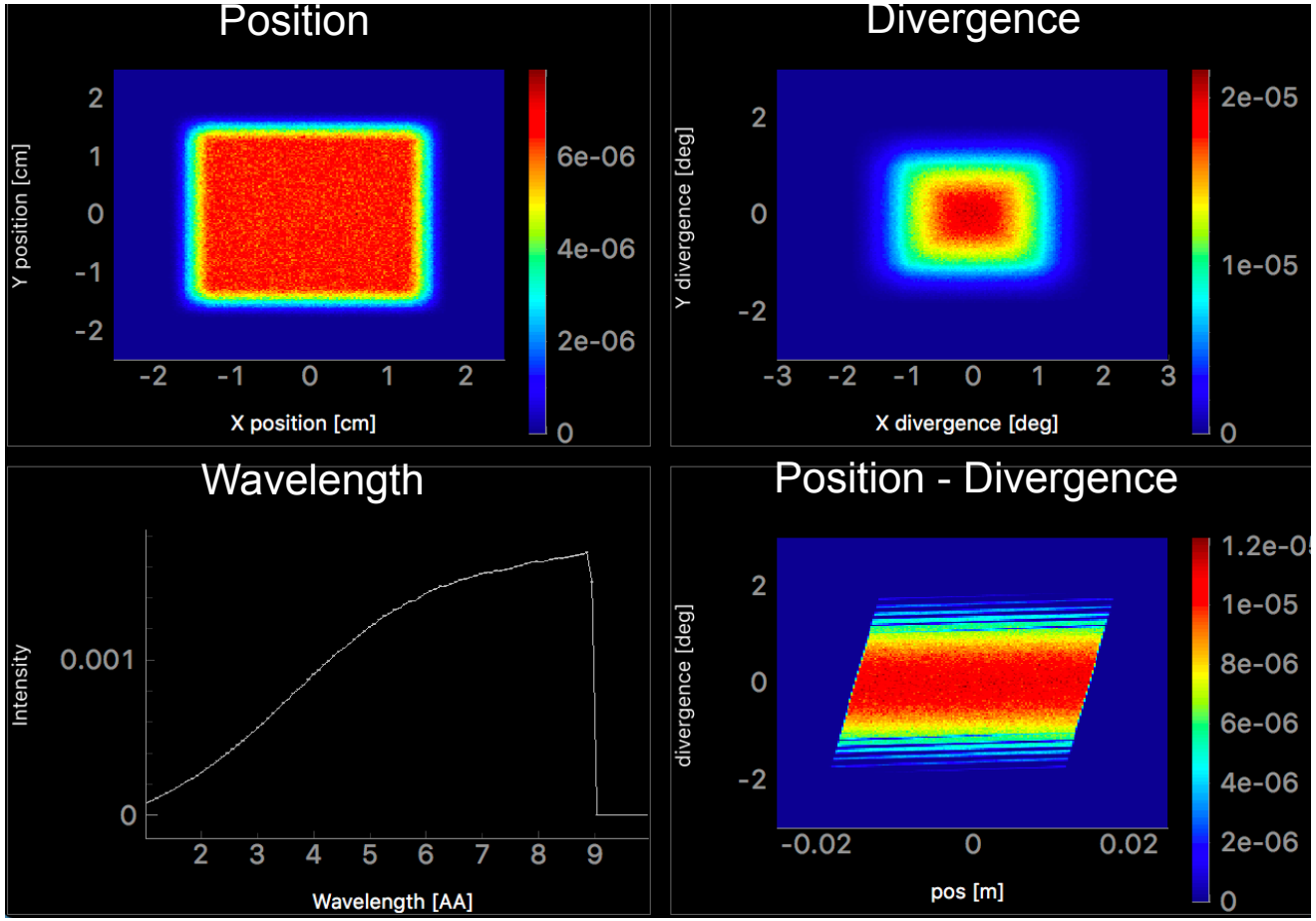
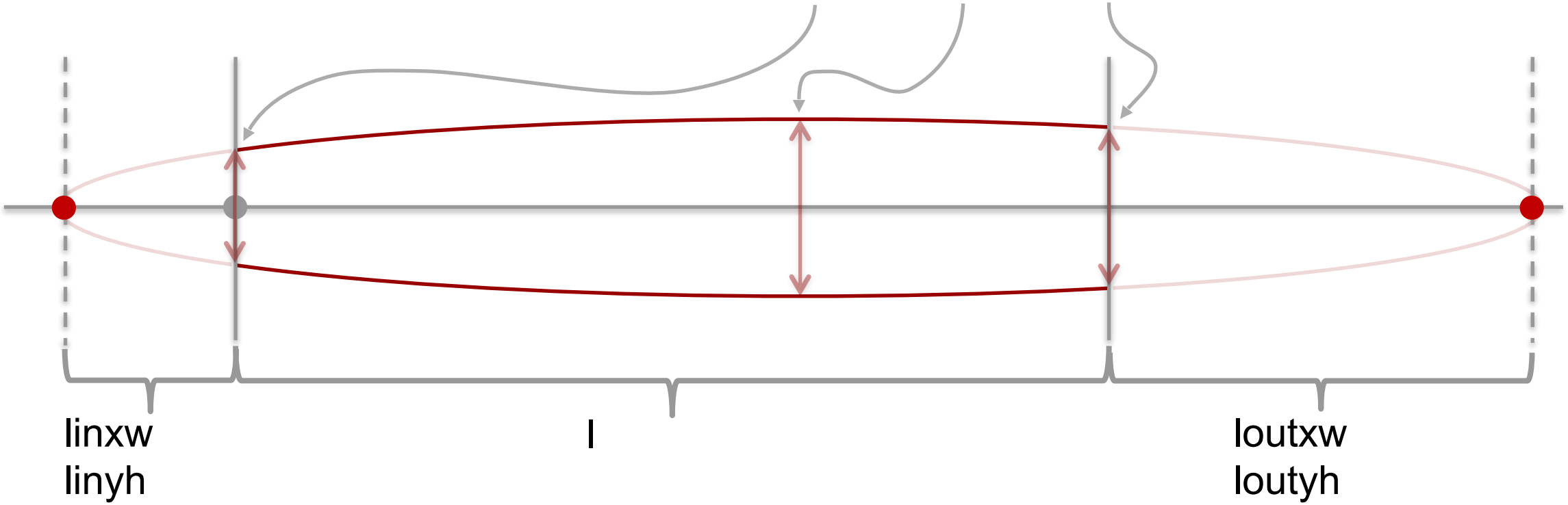
- Typical guide component with gravity



Popular guide components: Elliptical_guide_gravity

- Useful for elliptic and parabolic guide geometries, focusing, ballistic, coating distribution,

xwidth and yheight at DimensionsAt = ”entrace” , ”mid” or ”exit”



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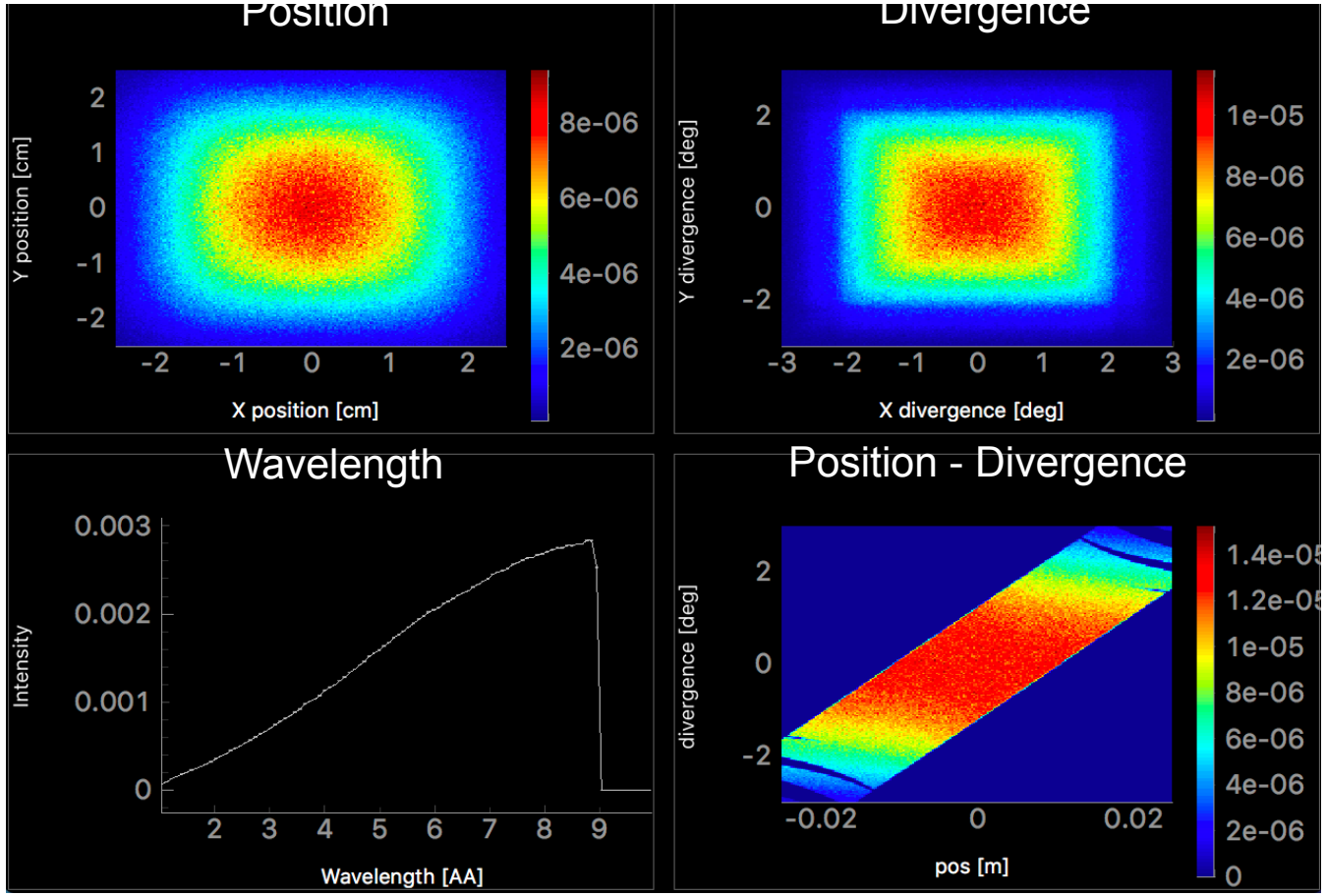
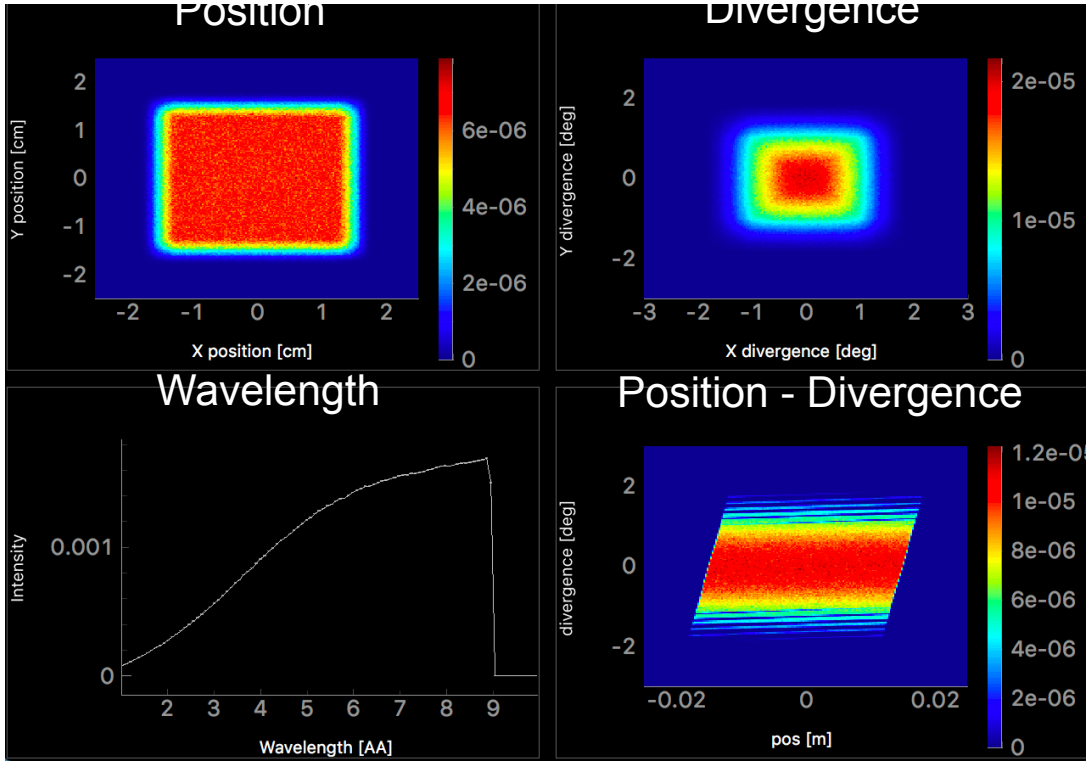
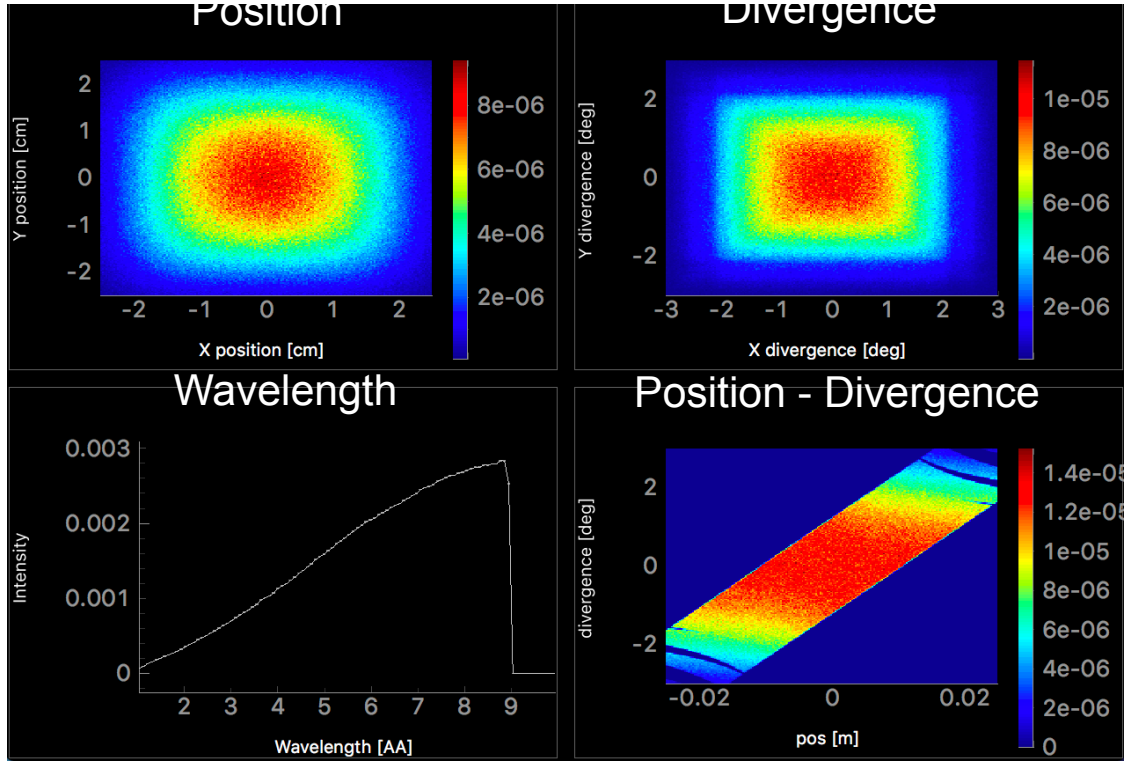


Comparison: Guide_gravity and Elliptic_guide_gravity

Guide_gravity

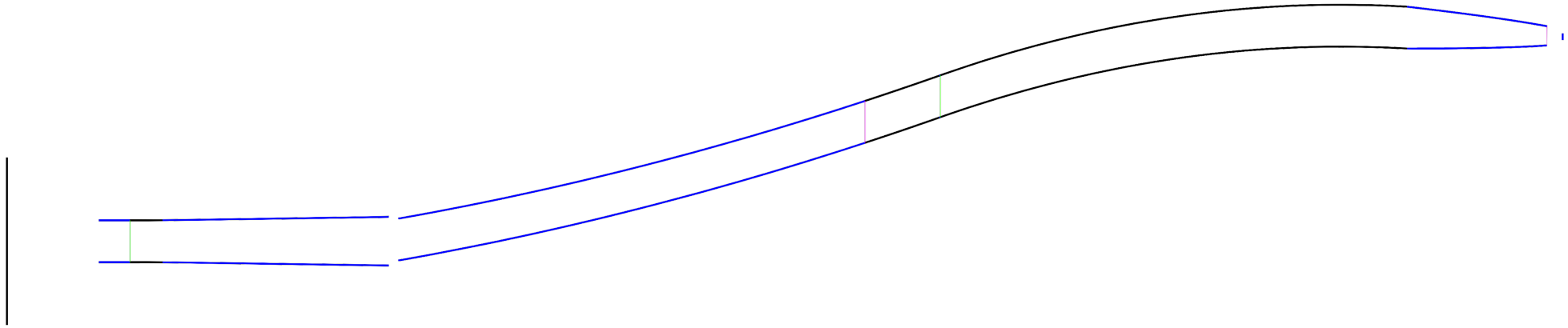


Elliptic_guide_gravity



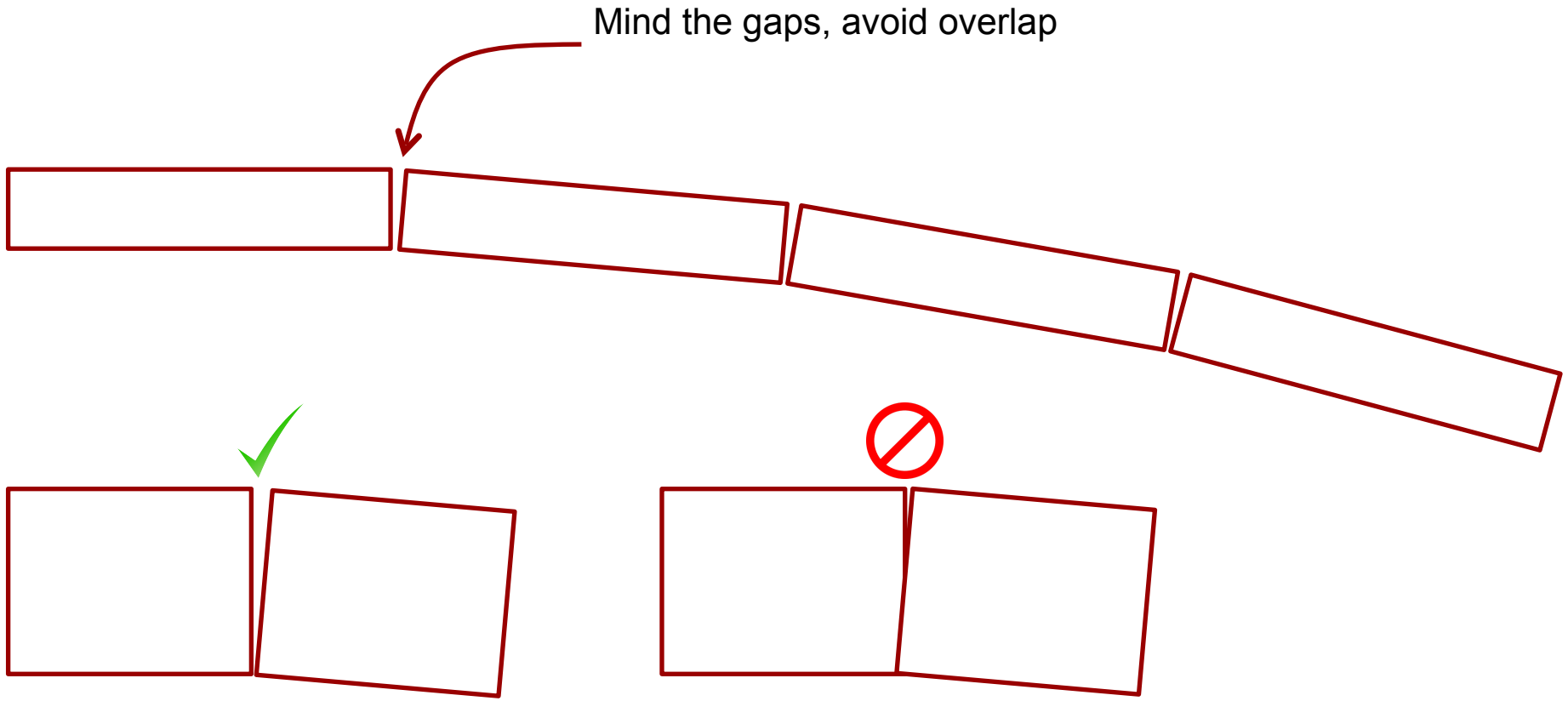
Breaking line of sight

- Importance of breaking line of sight, ways of doing so, …



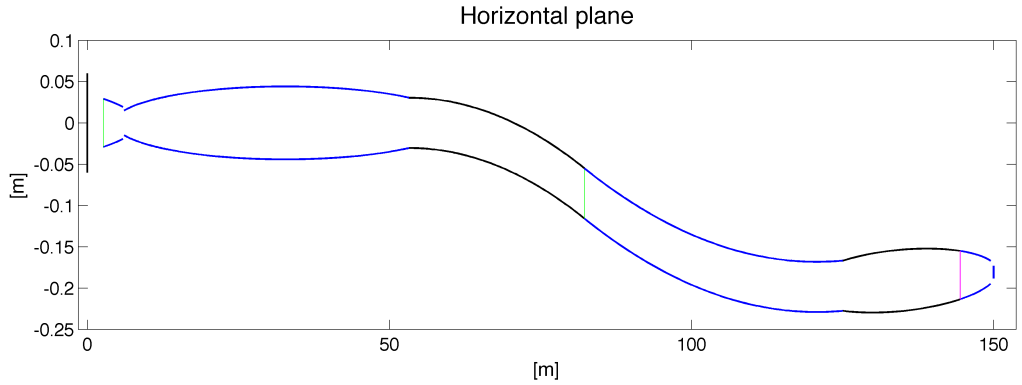
Breaking line of sight

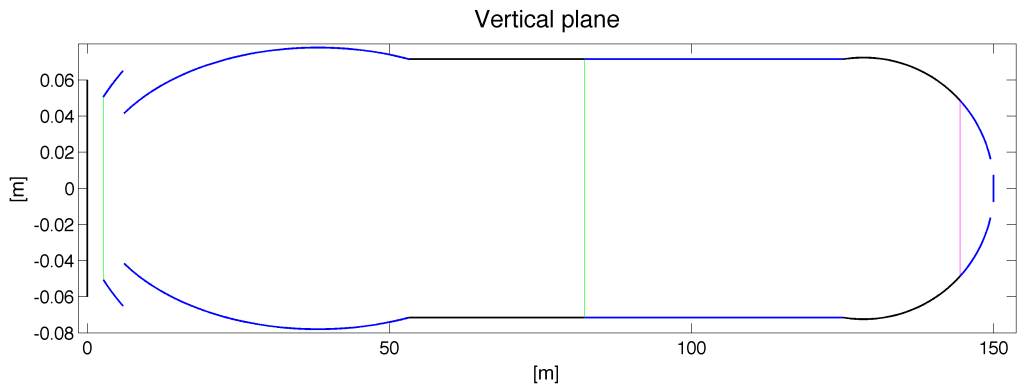
- Bender / Guide_curved component or many straight sections

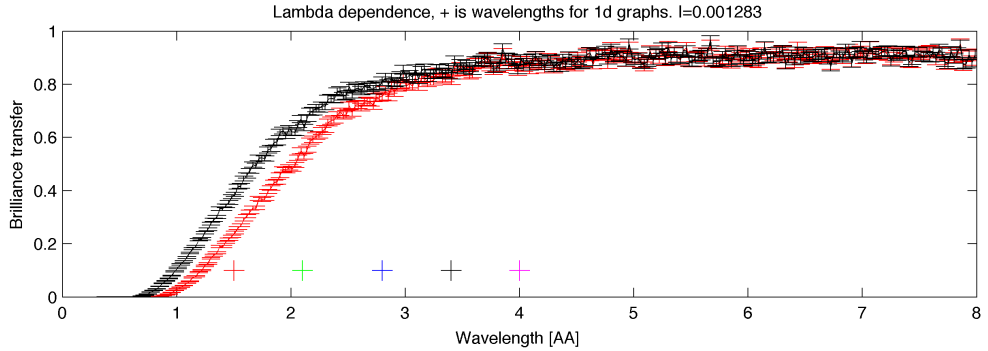


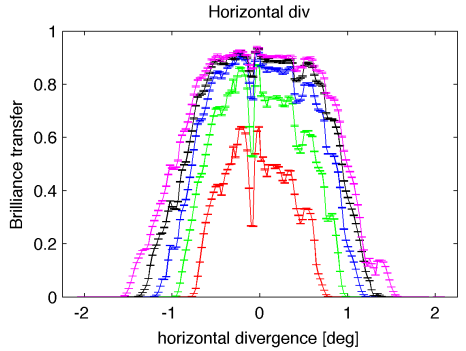
A guide design

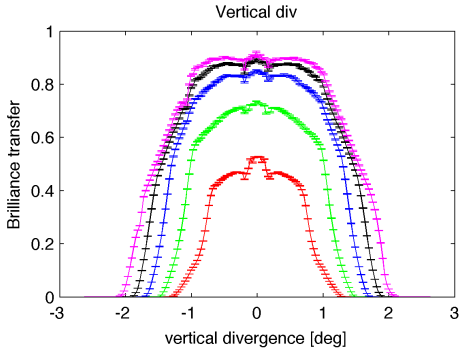
- To be continued in Thursday guidebot talk by Mads Bertelsen

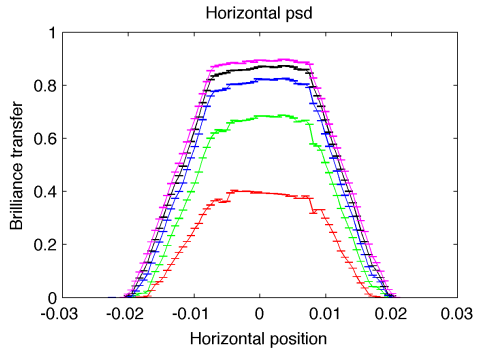


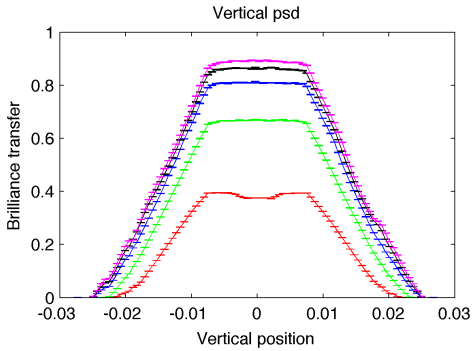












Guide exercise

Solution on github, use if you are stuck

- Insert a guide and use an instrument input parameter to set the length
- Use monitors to see the resulting beam
  - PSD_monitor (spatial distribution)
  - Divergence_monitor (divergence distribution)
  - L_monitor (wavelength distribution)
  - Posdiv_monitor (acceptance diagram)

- Extra tasks:
  - Scan guide length
  - Introduce a gap by using two guide components
  - Use Guide_gravity and extend to 100 m length
  - Investigate the effect of gravity on the transport of long-wavelength neutrons