Guides and gravity in McStas

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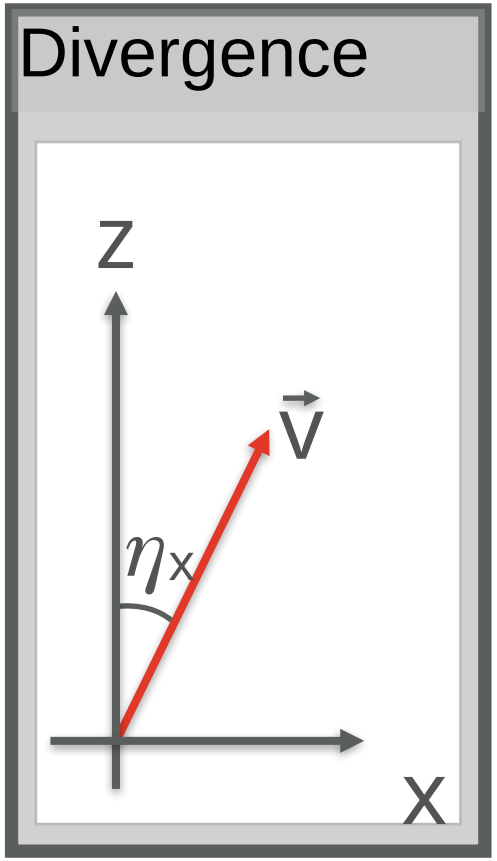
Works at ESS DMSC on McStas development

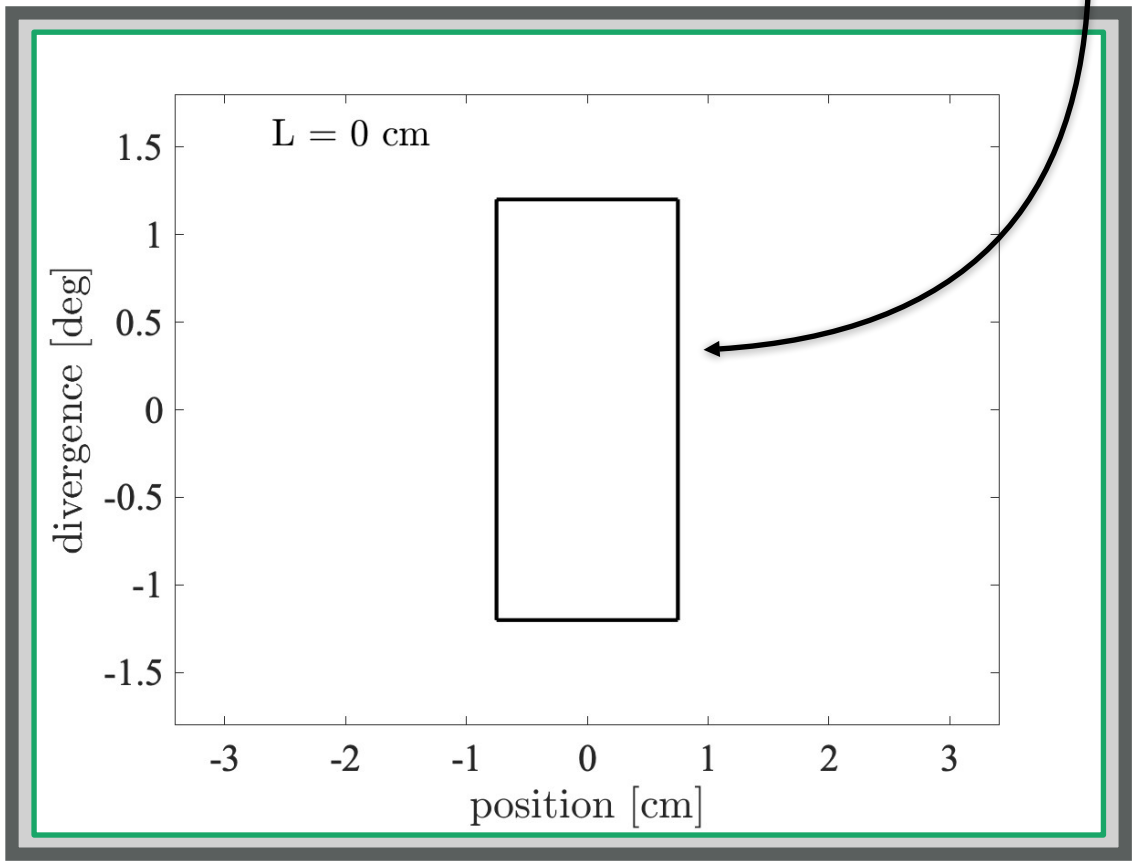
Overview

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

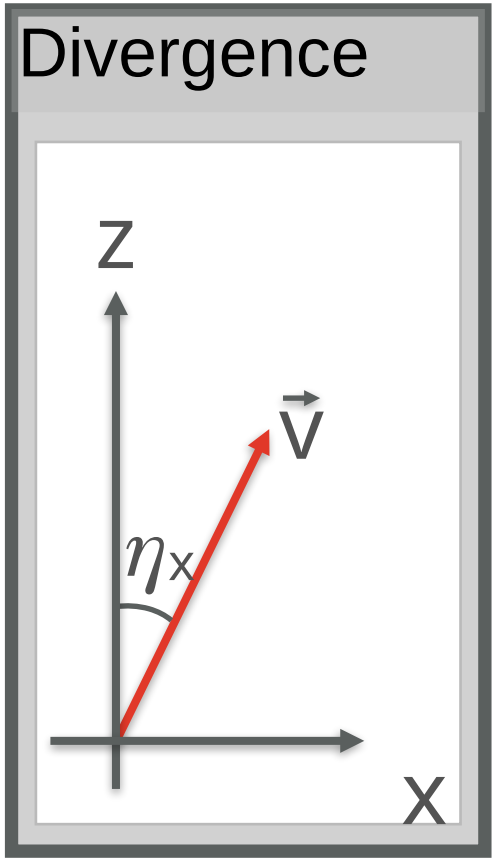
Beam propagation in free space



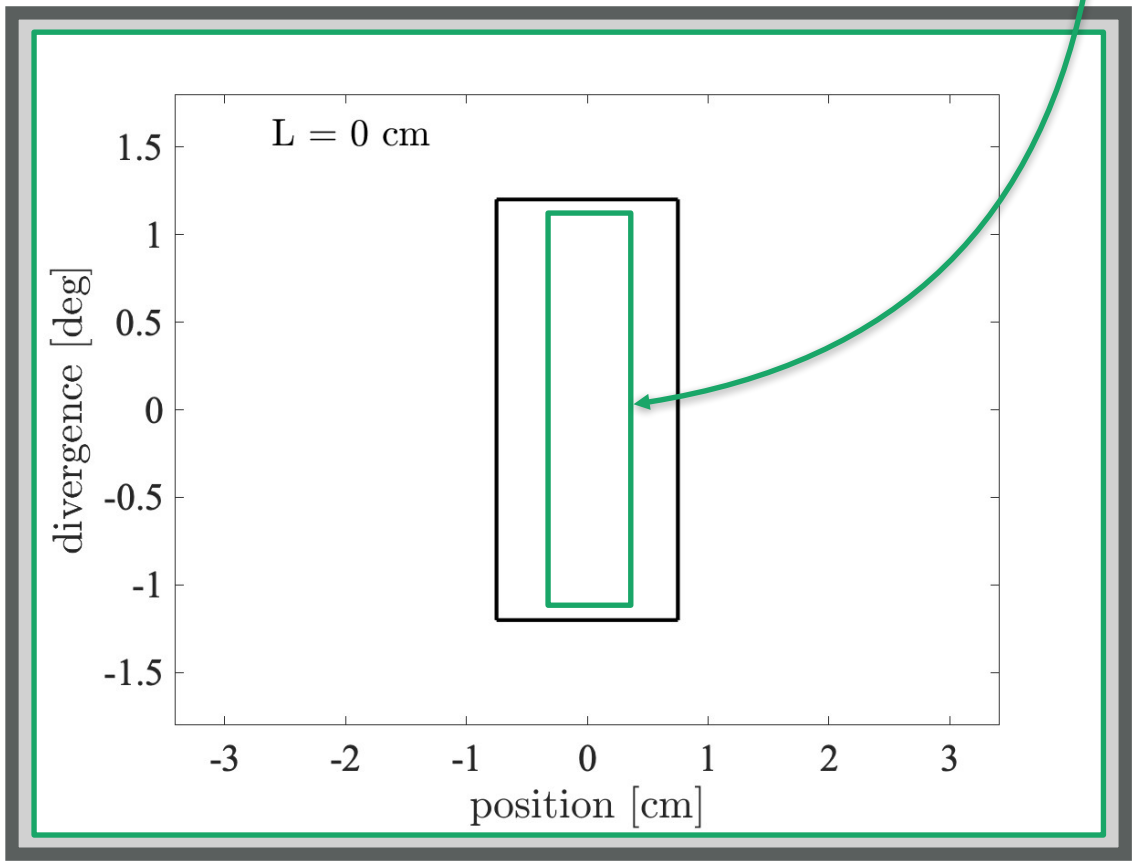
“Phase-space” at source



Beam propagation in free space



Wanted “phase-space” at sample



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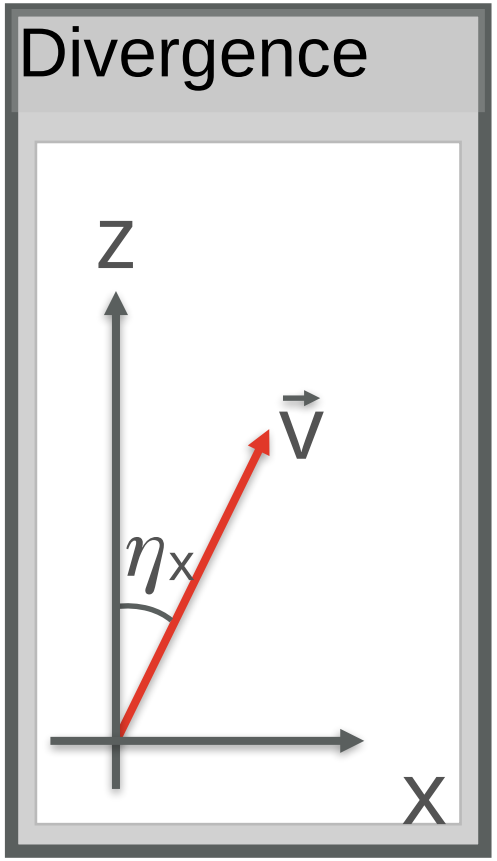

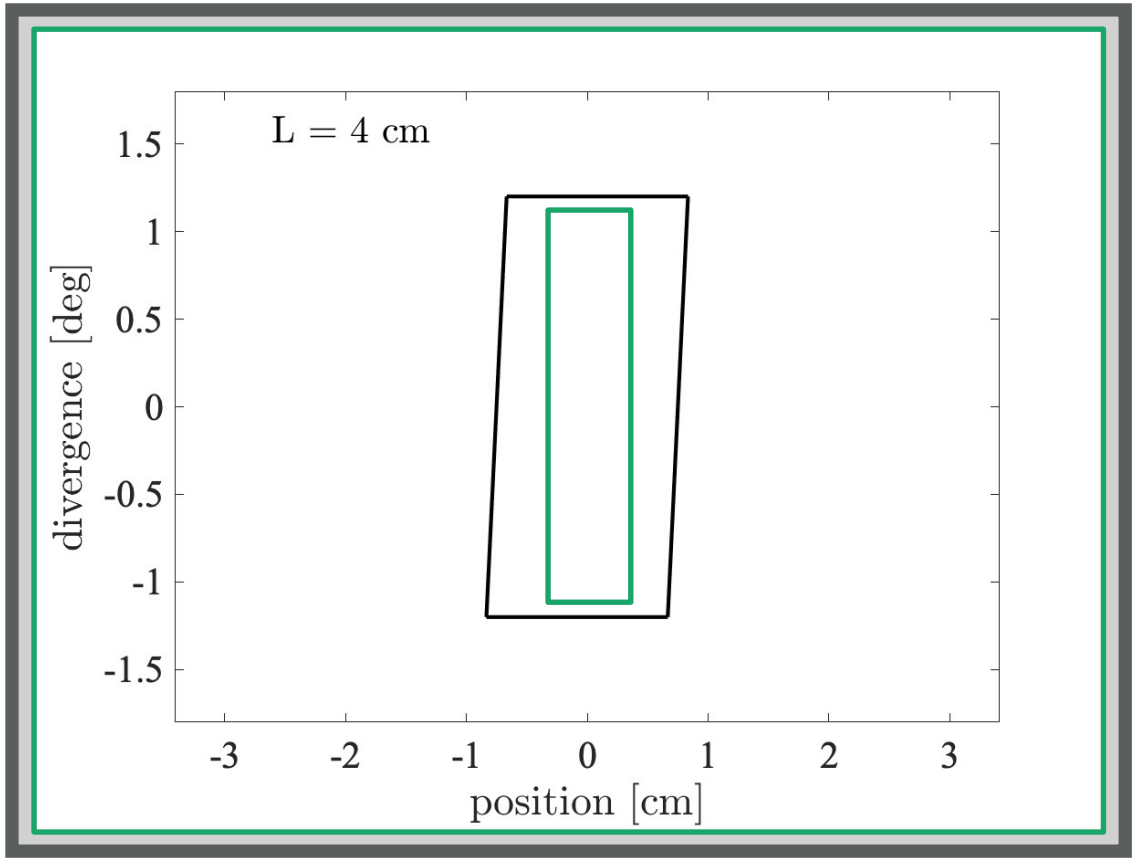

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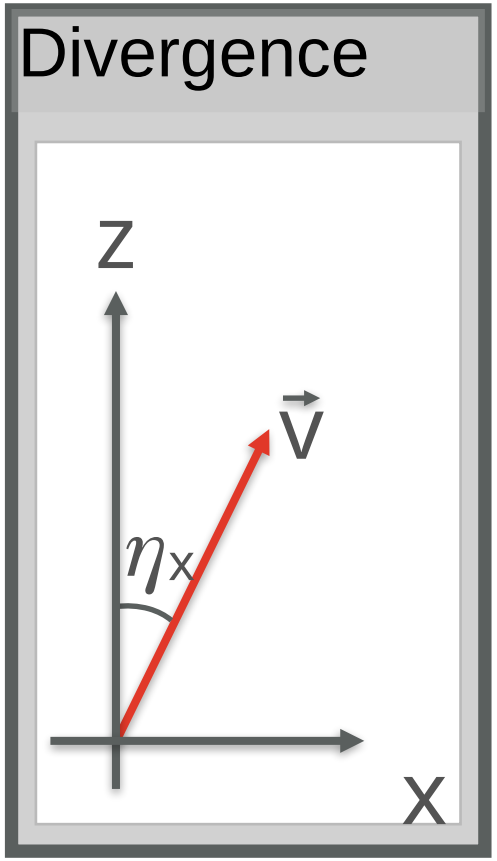

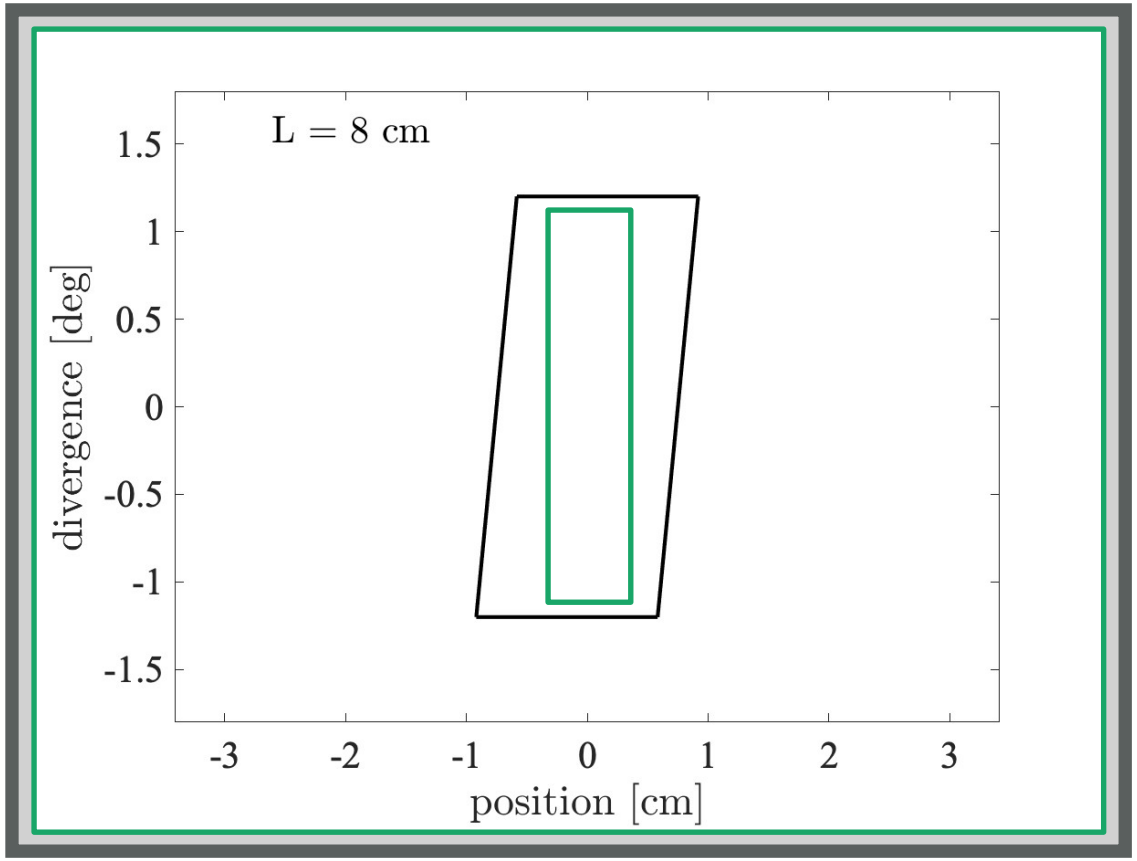

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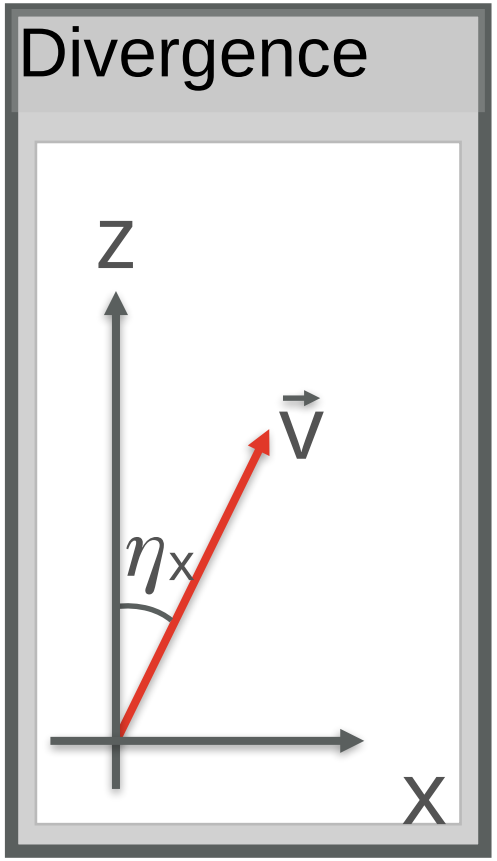

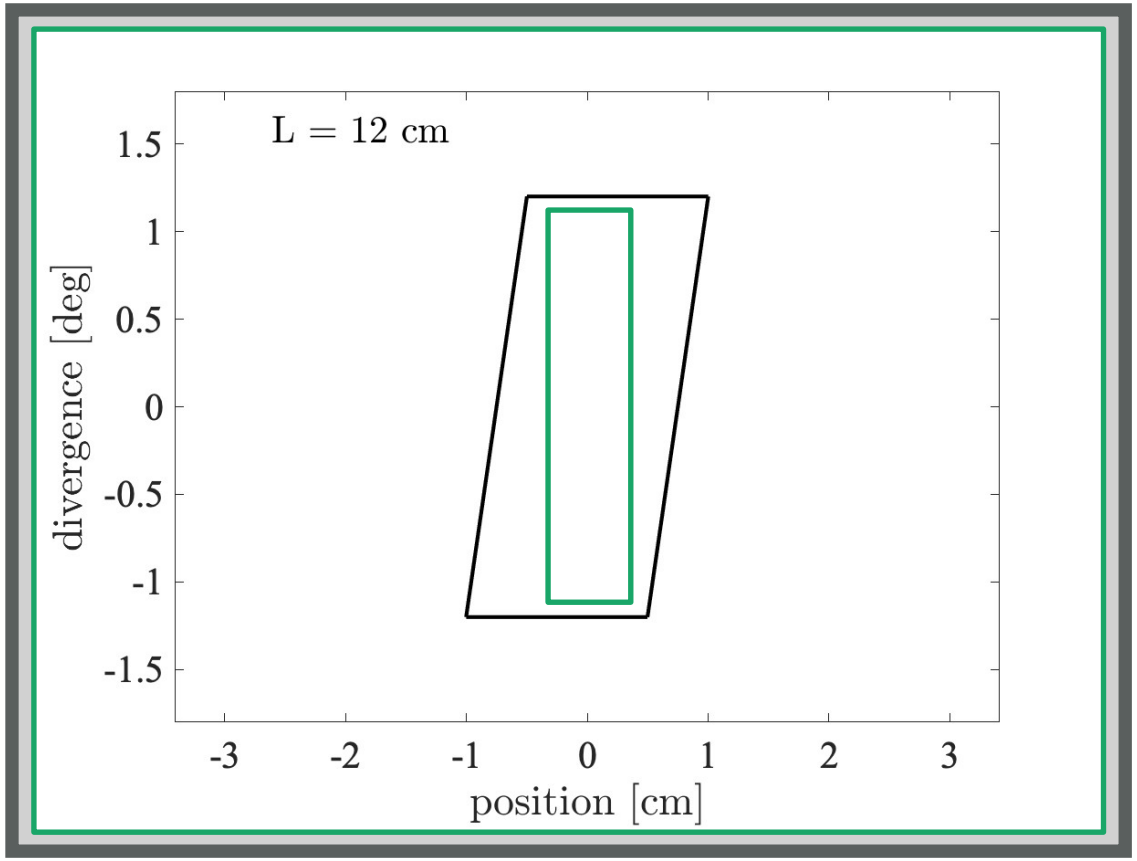

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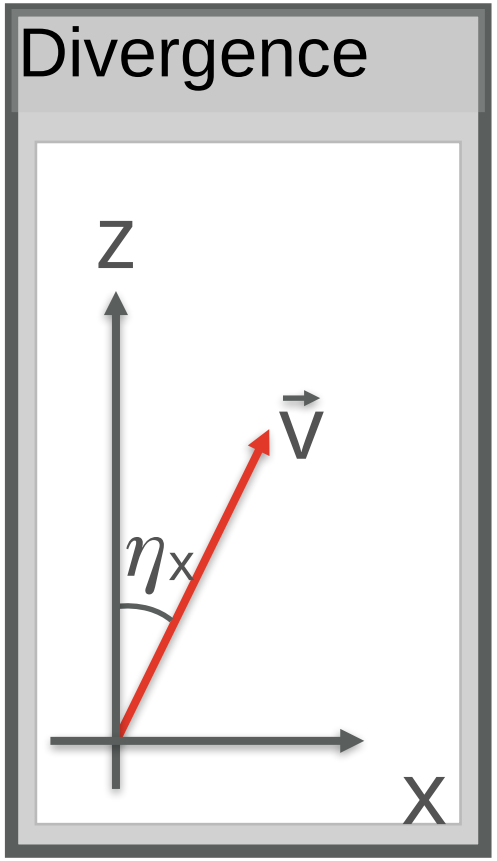

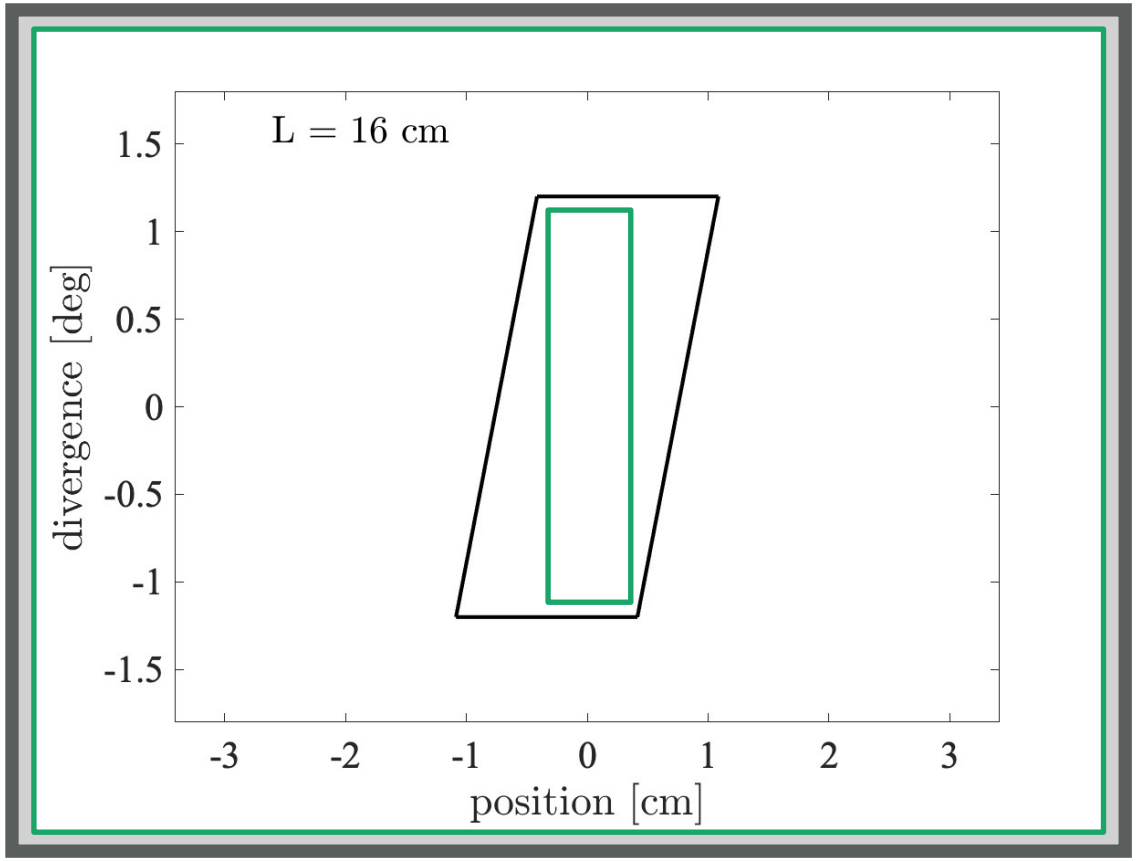

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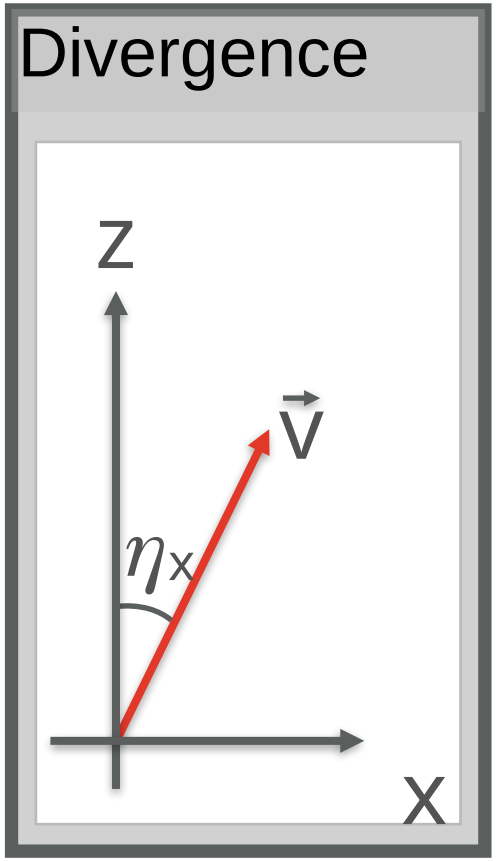

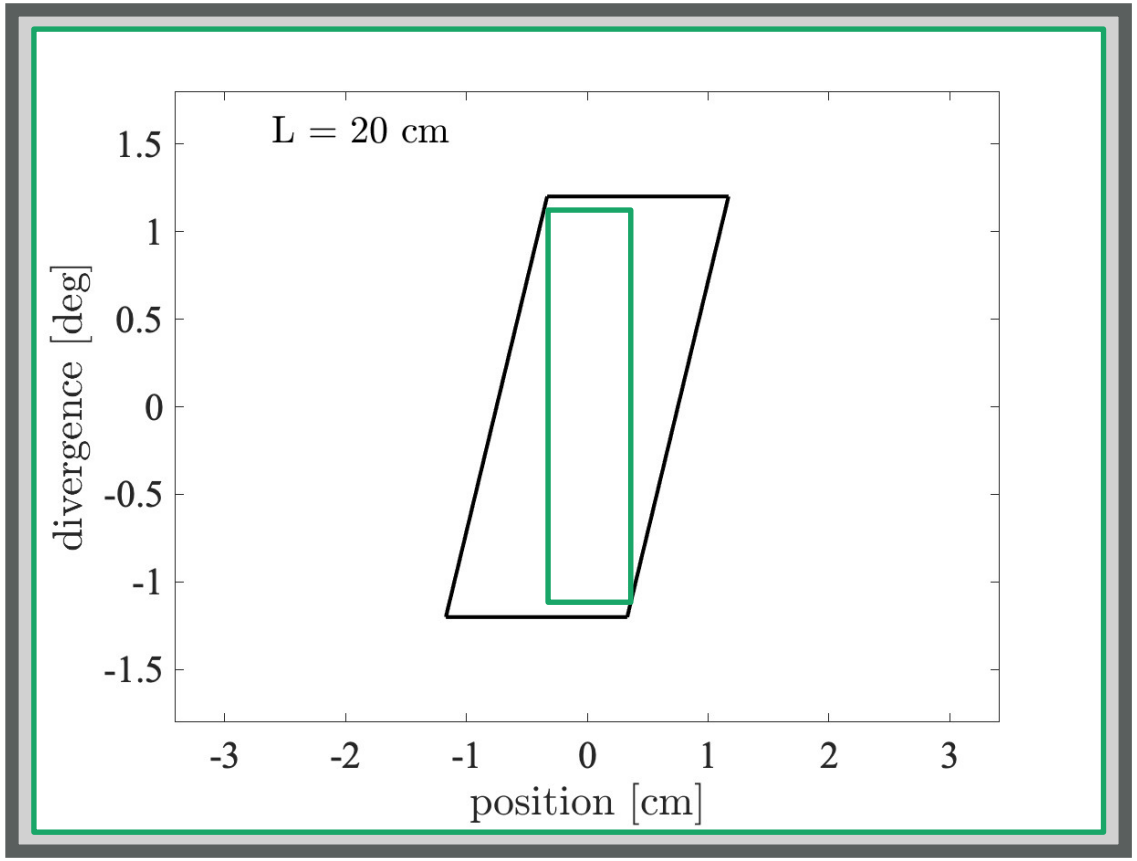

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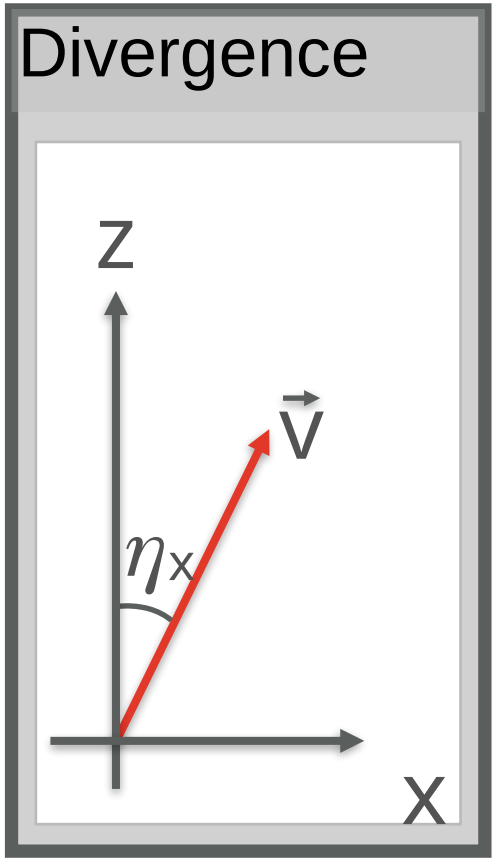

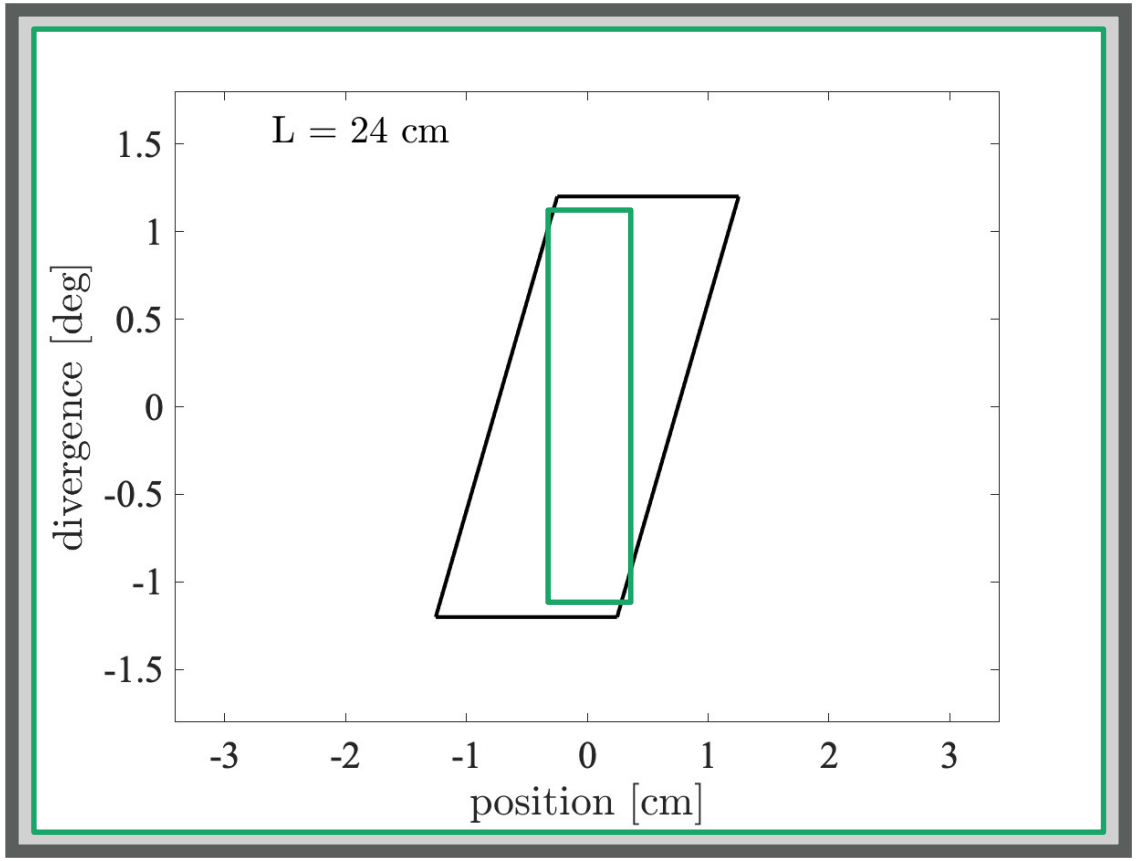

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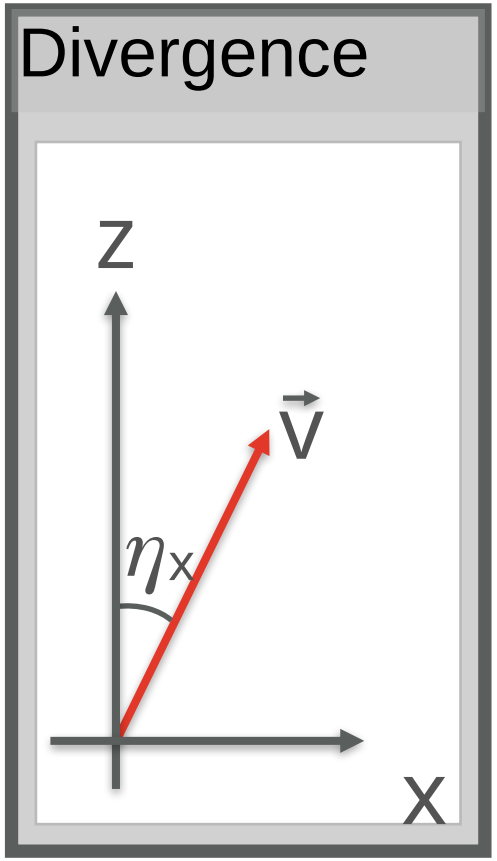

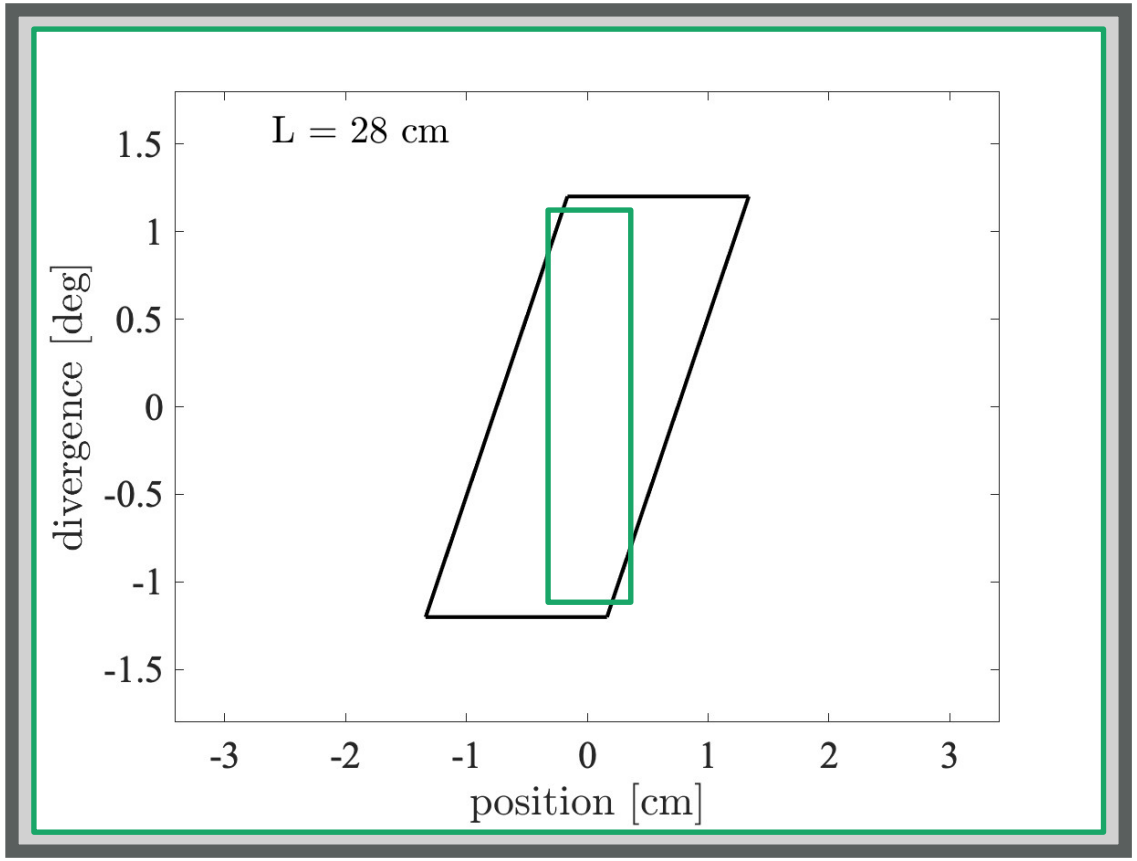

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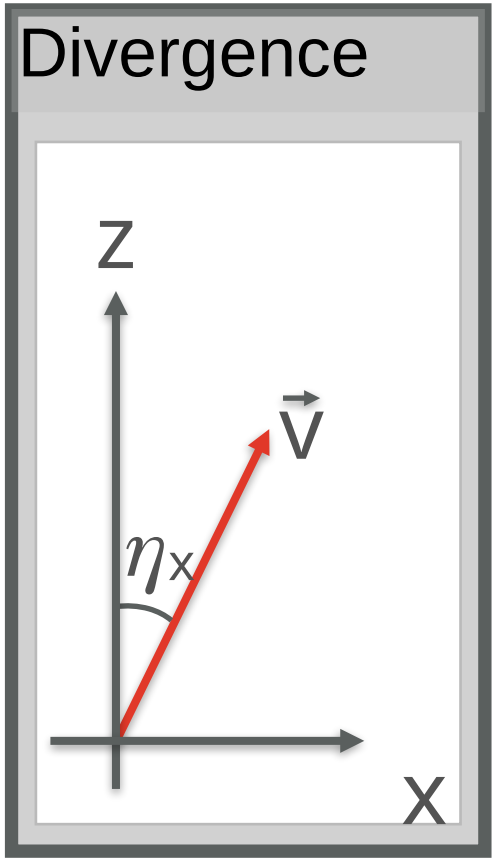

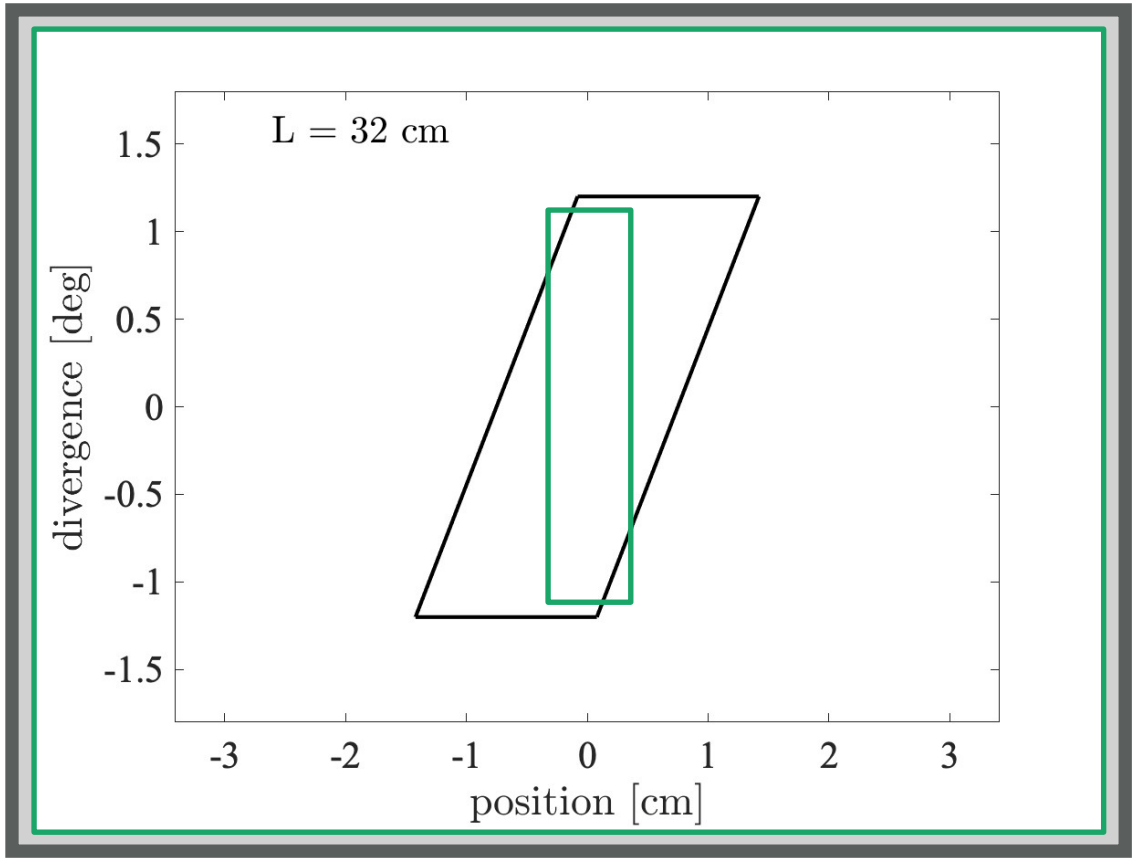

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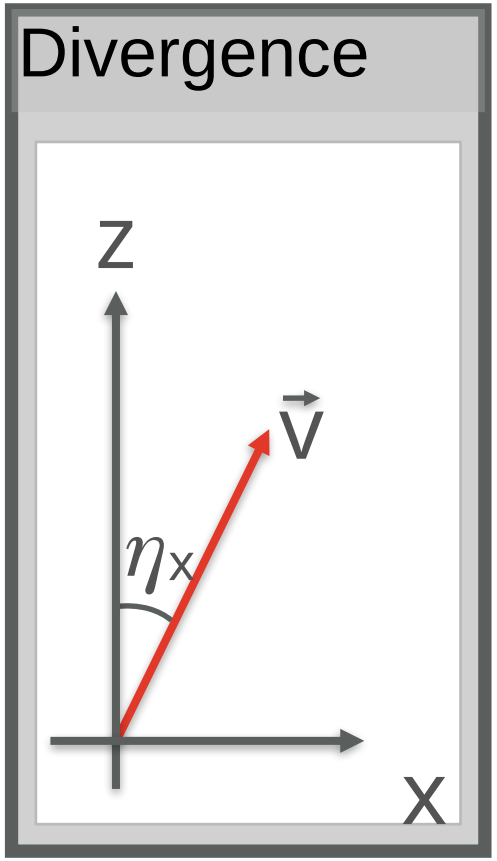

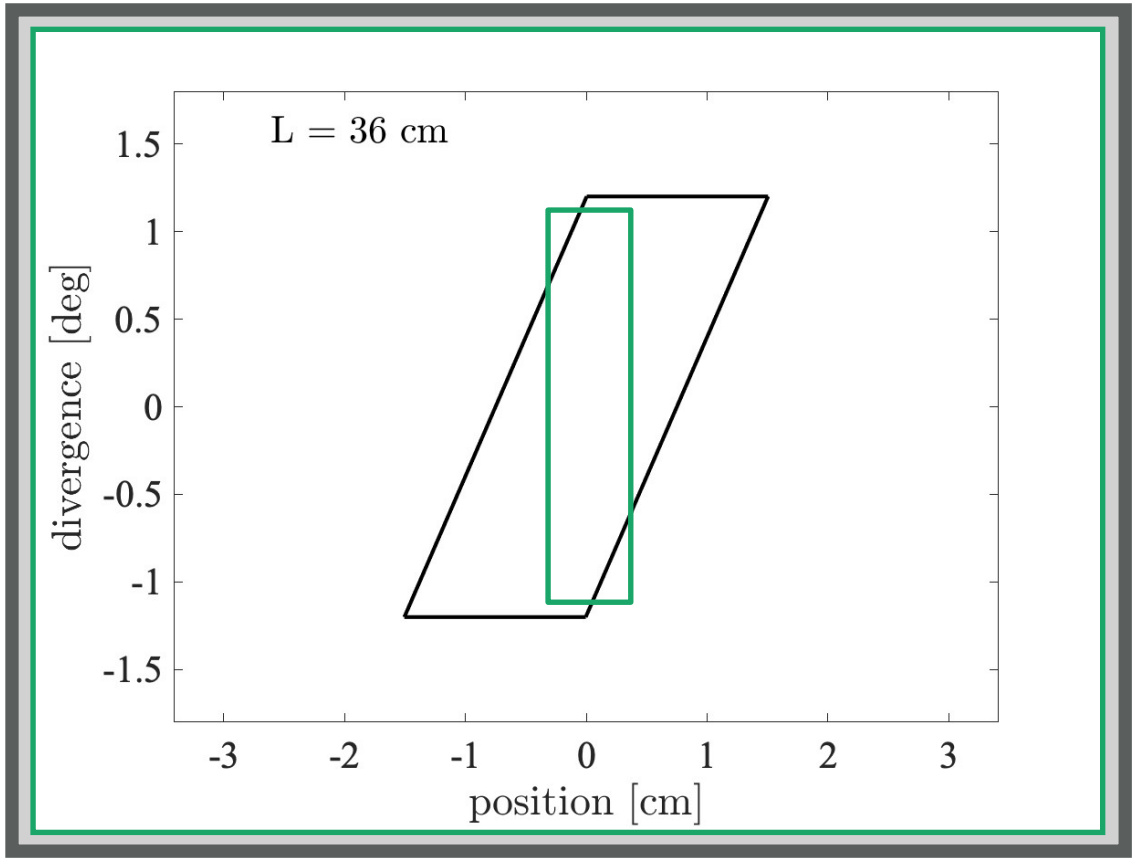

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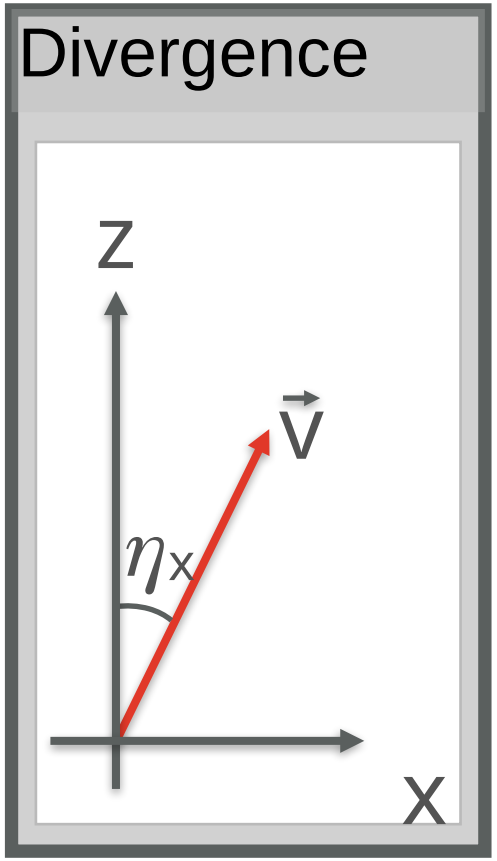

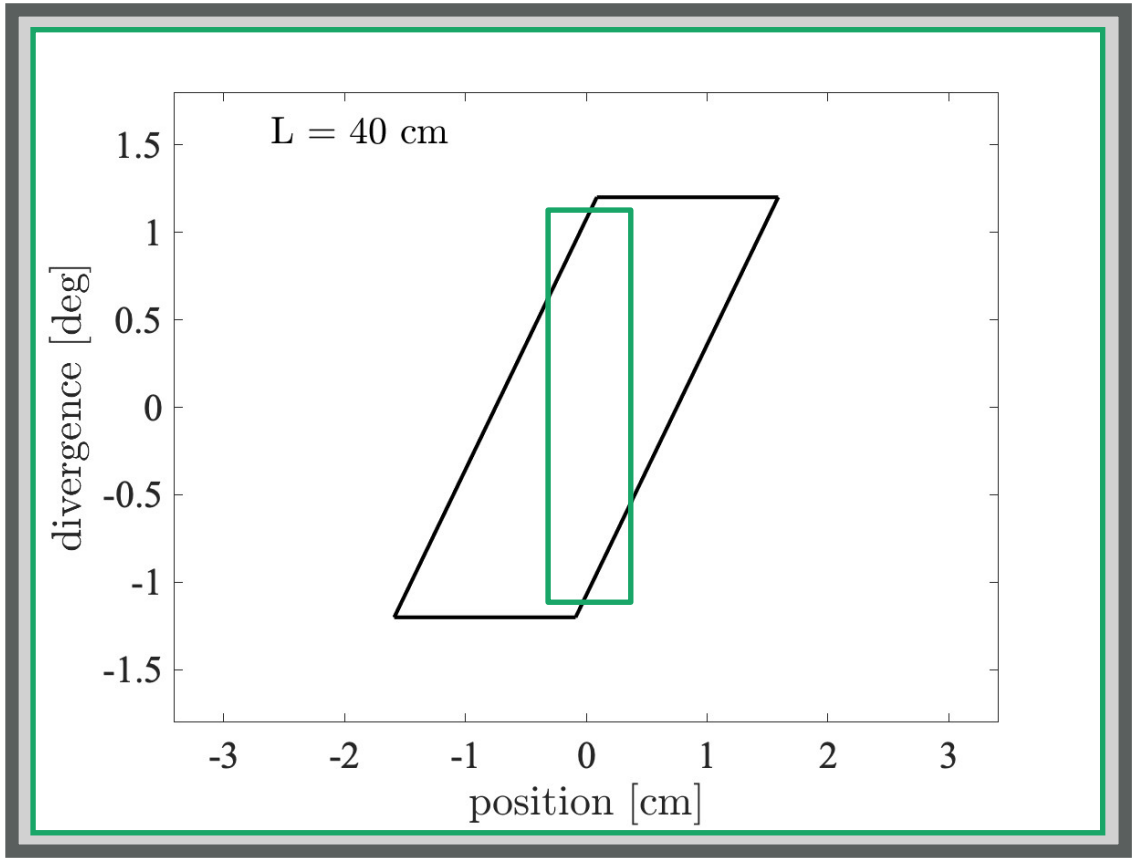

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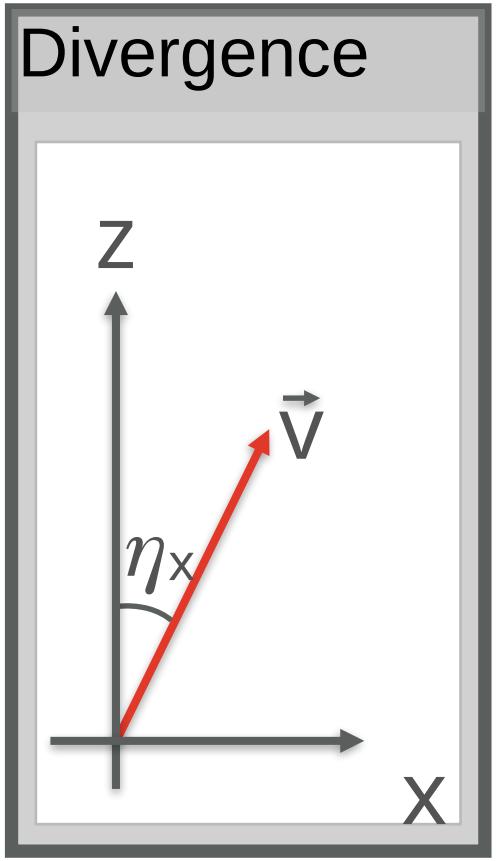

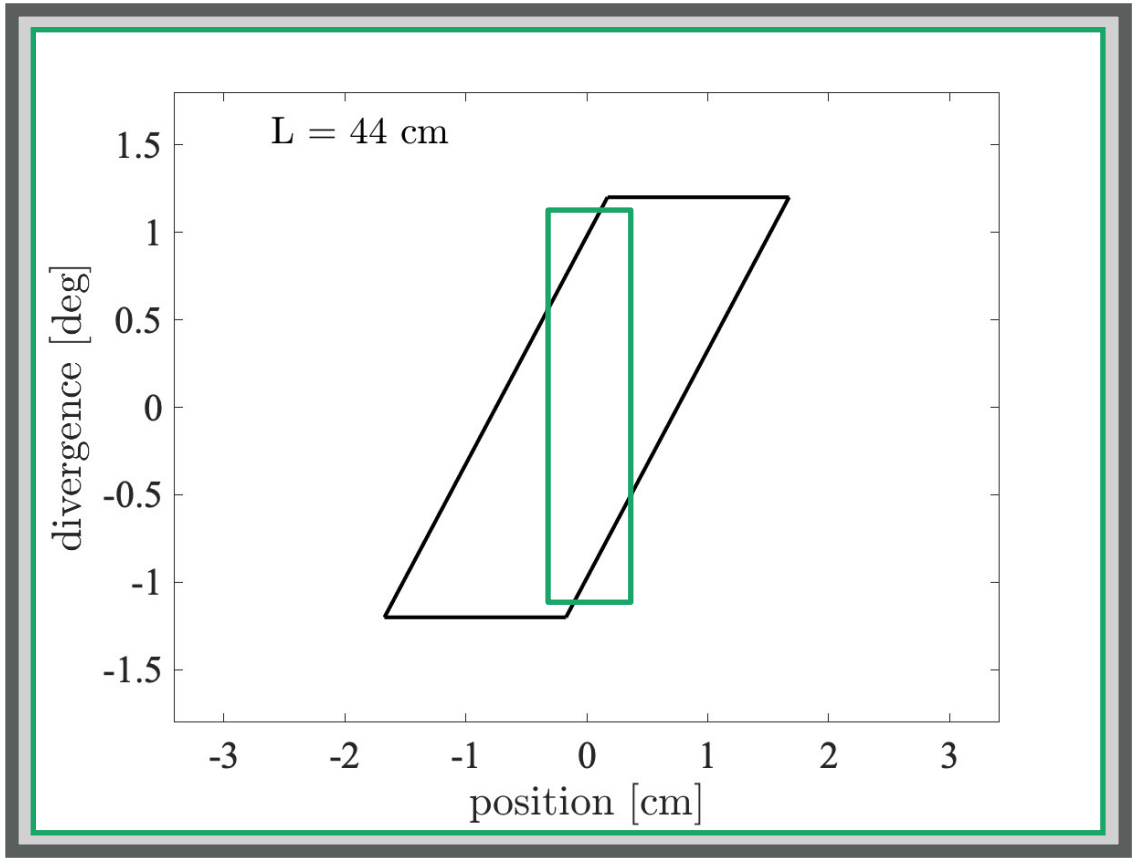

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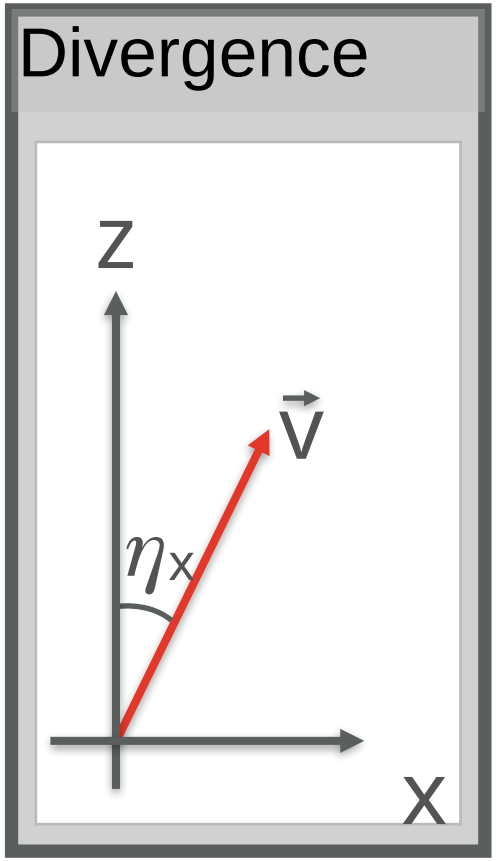

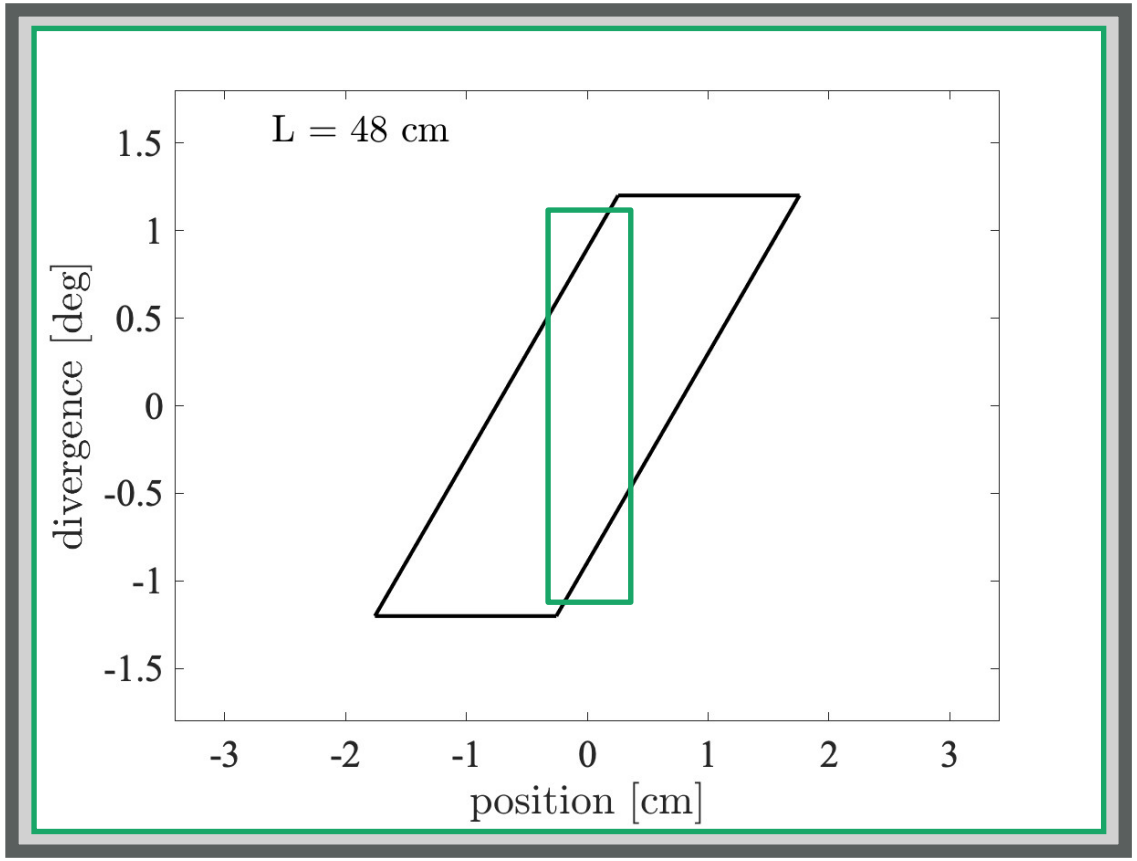

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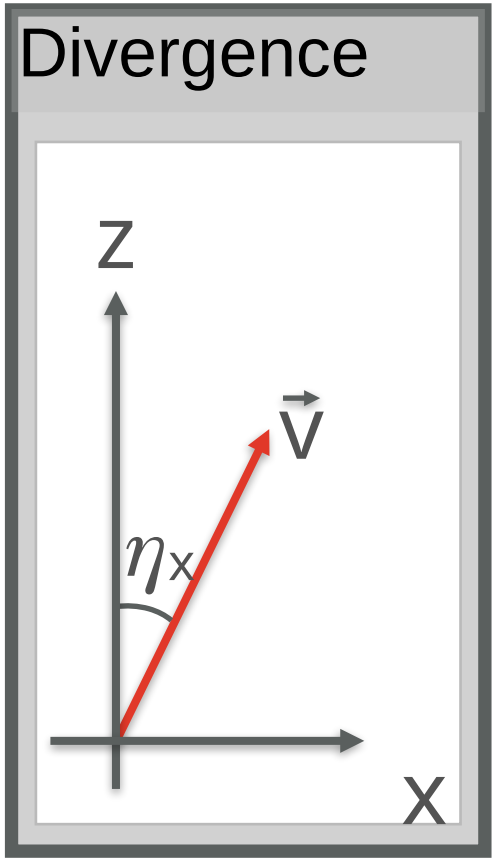

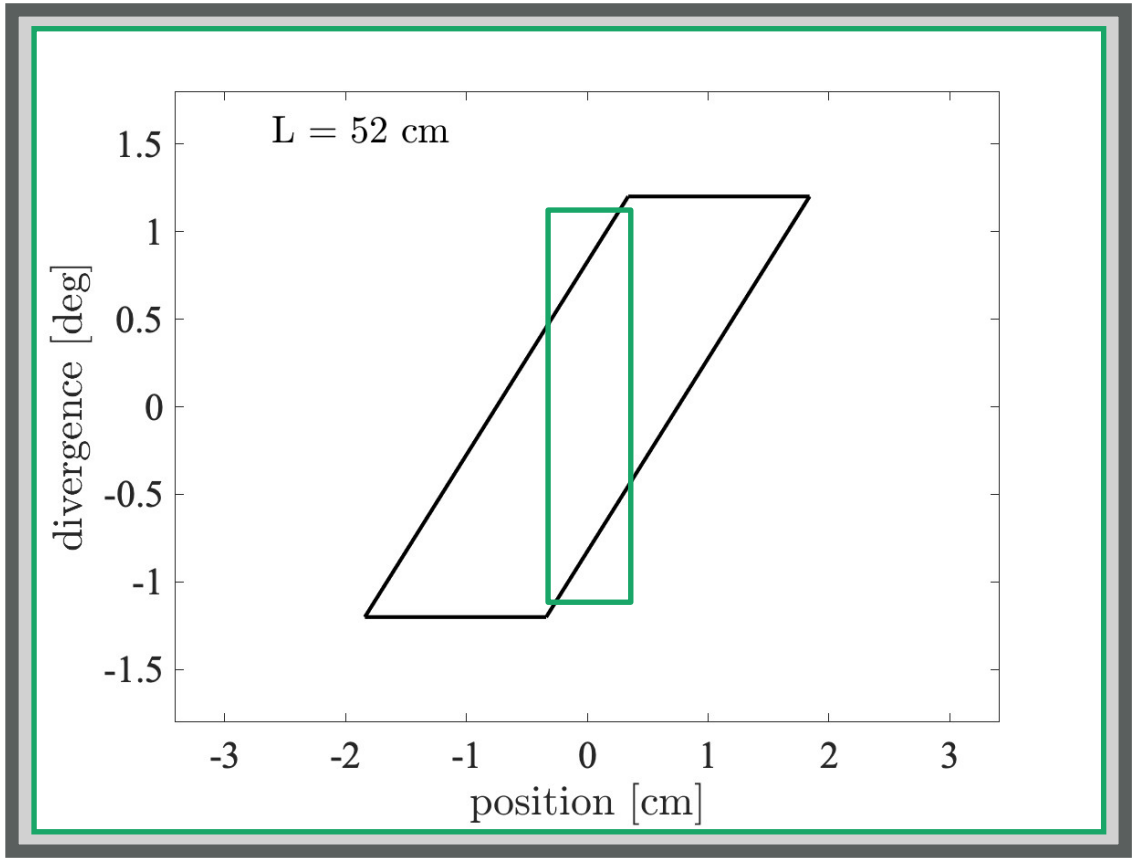

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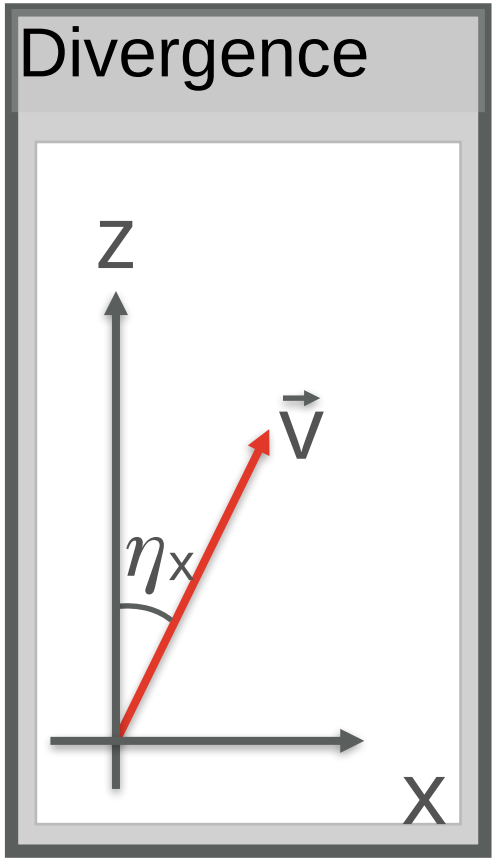
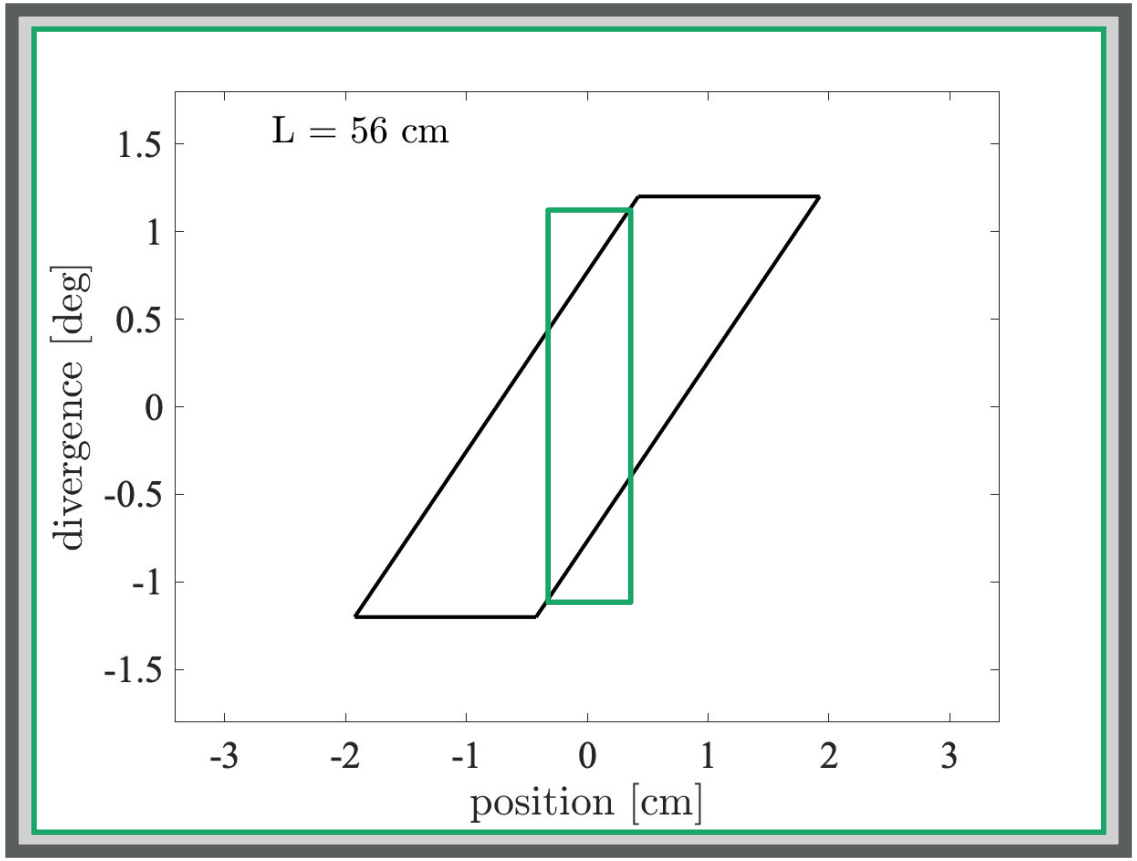
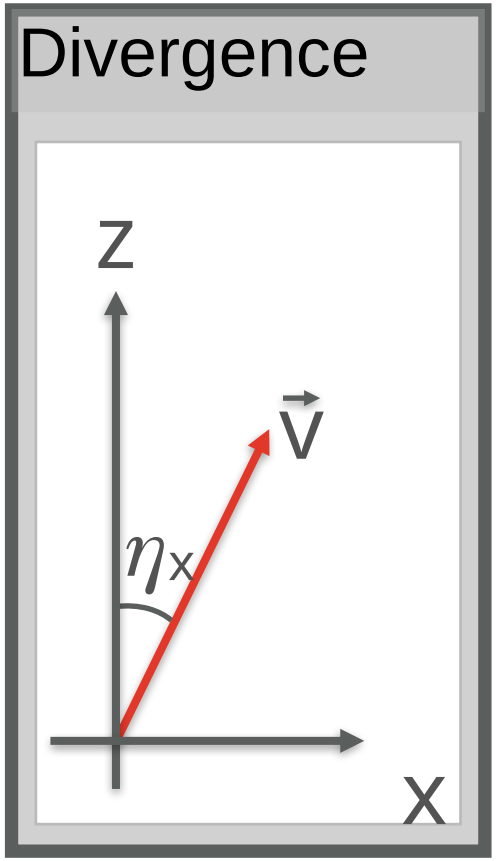
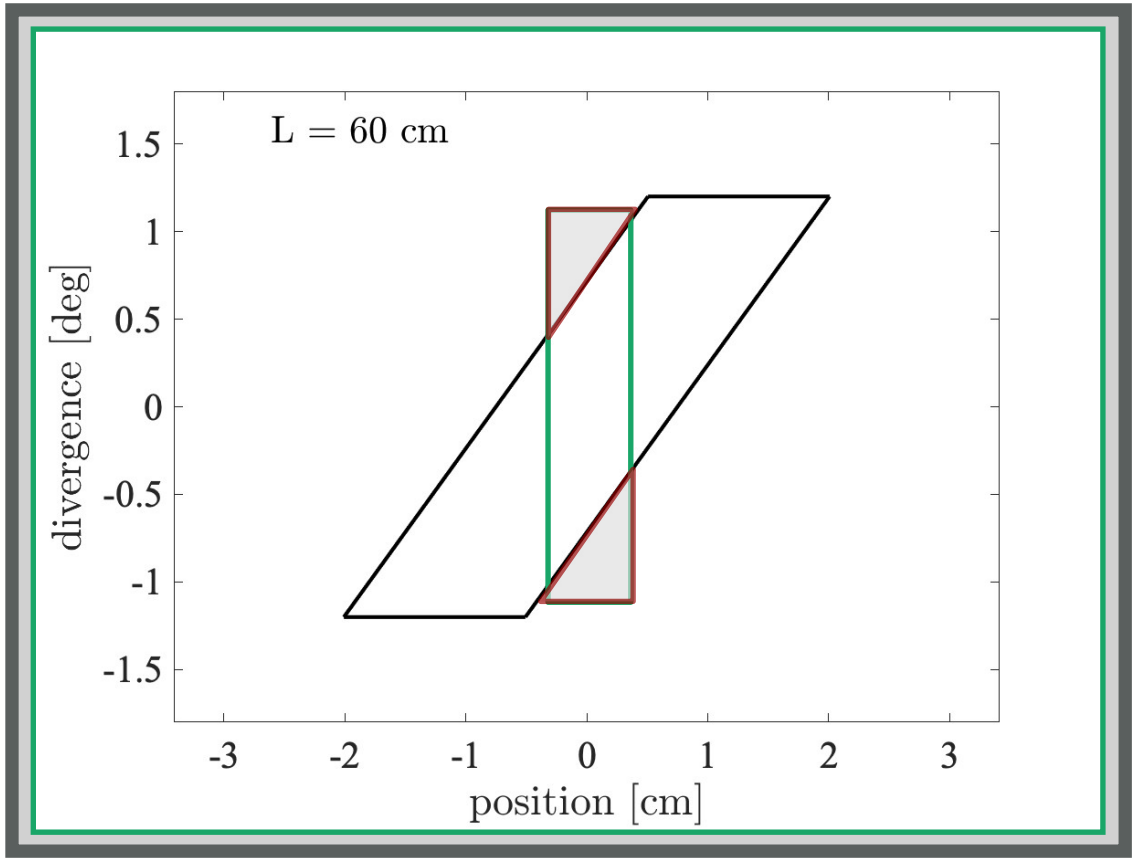




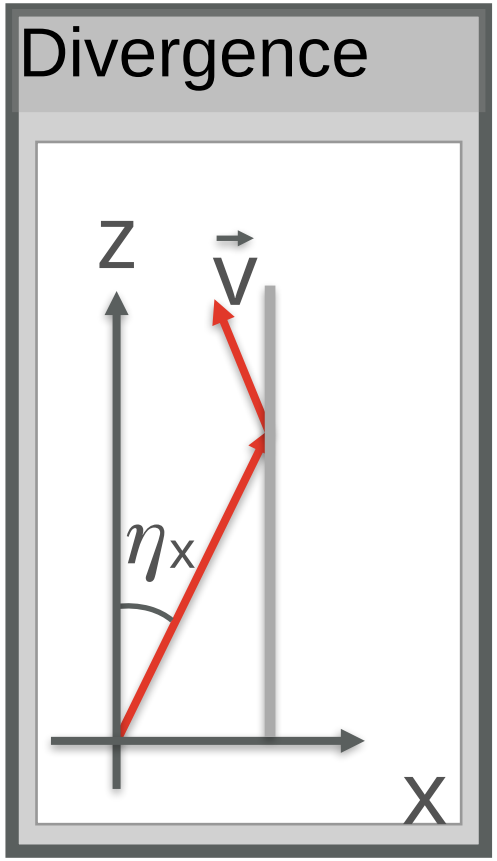
Beam propagation in free space

- We lost some phase-space to propagation

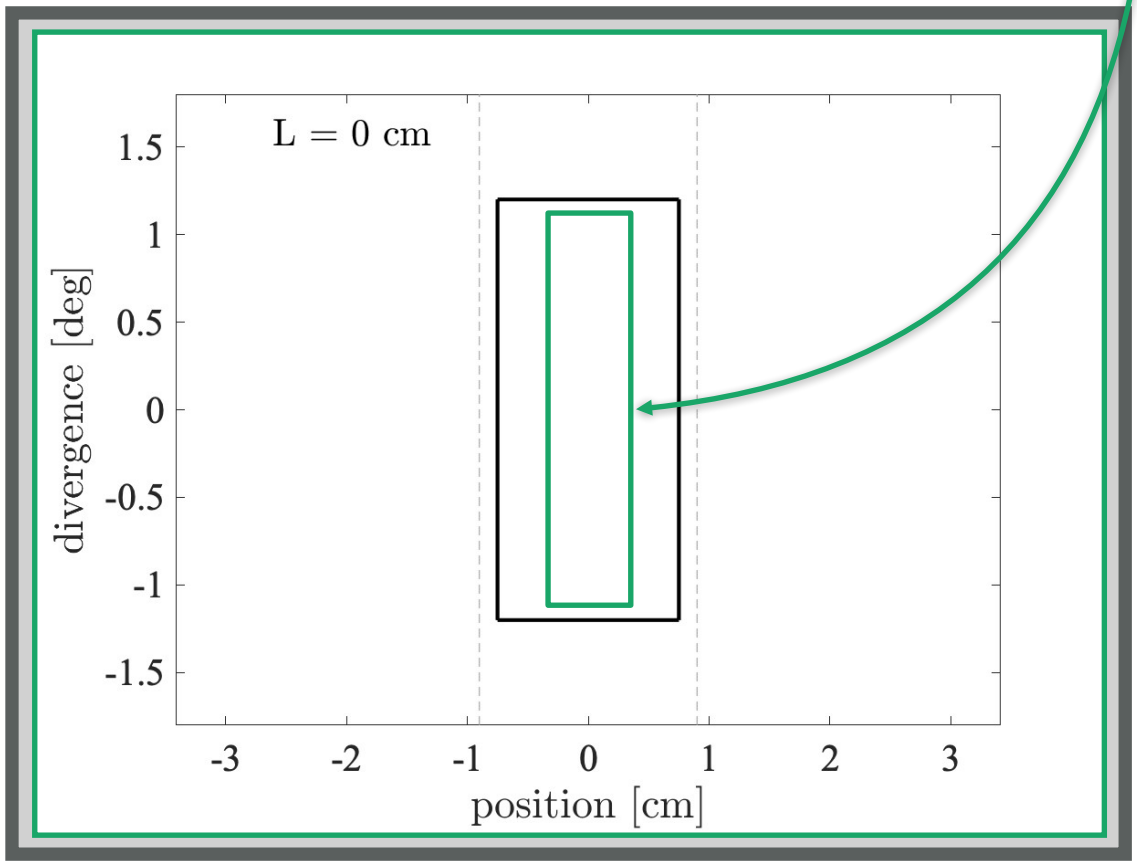




Beam propagation in guide



Wanted “phase-space” at sample



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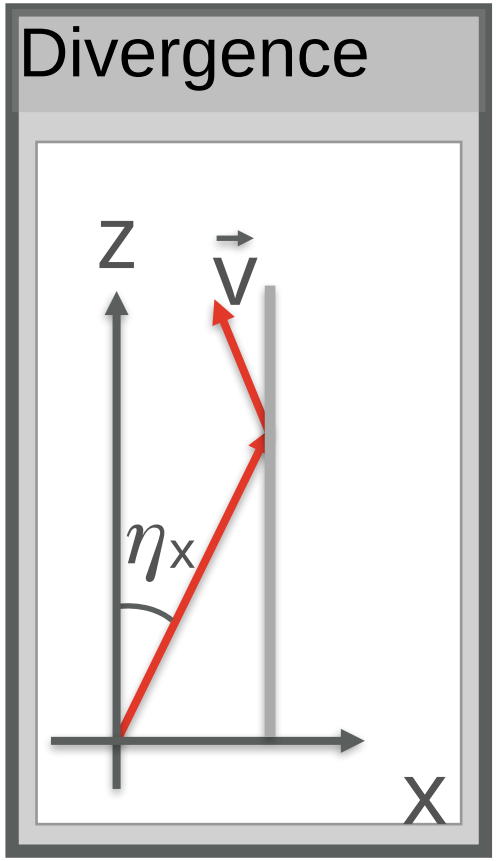

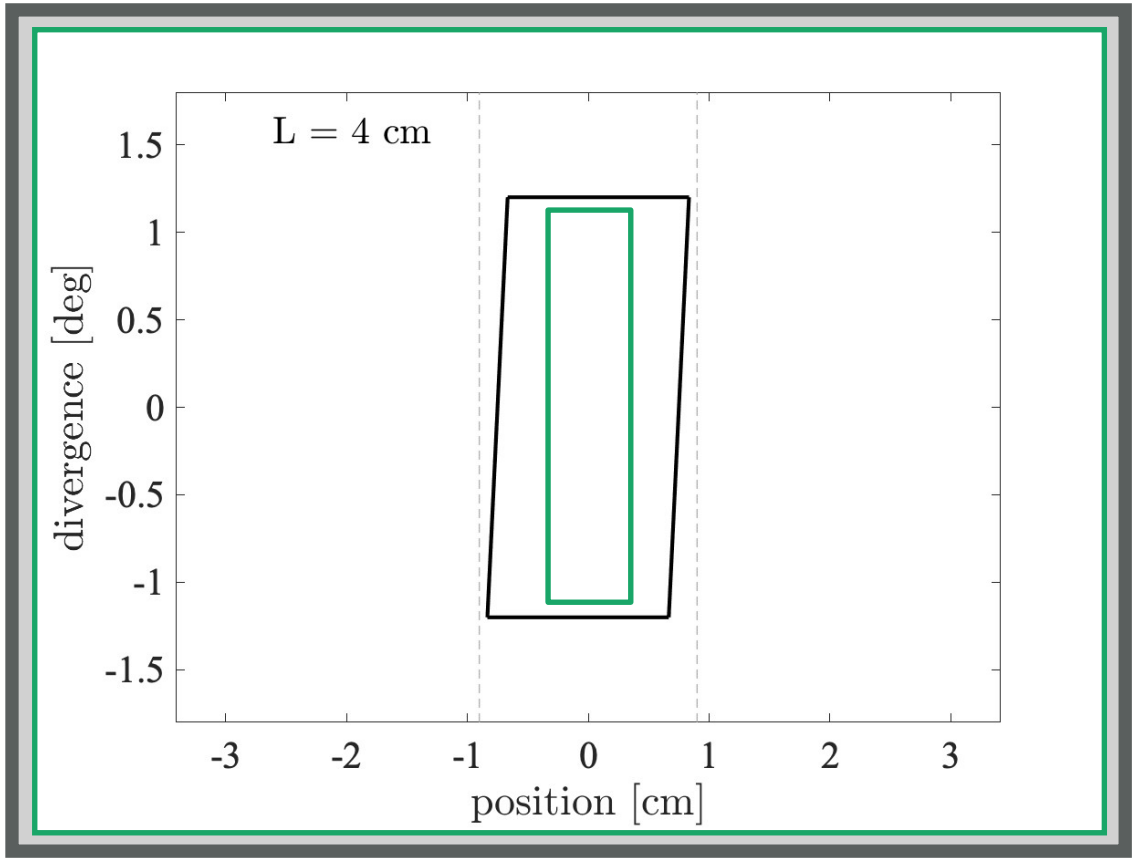

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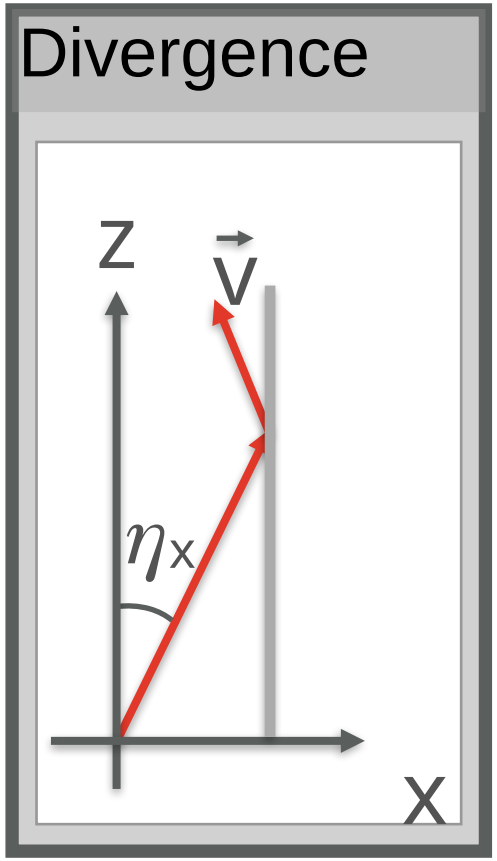

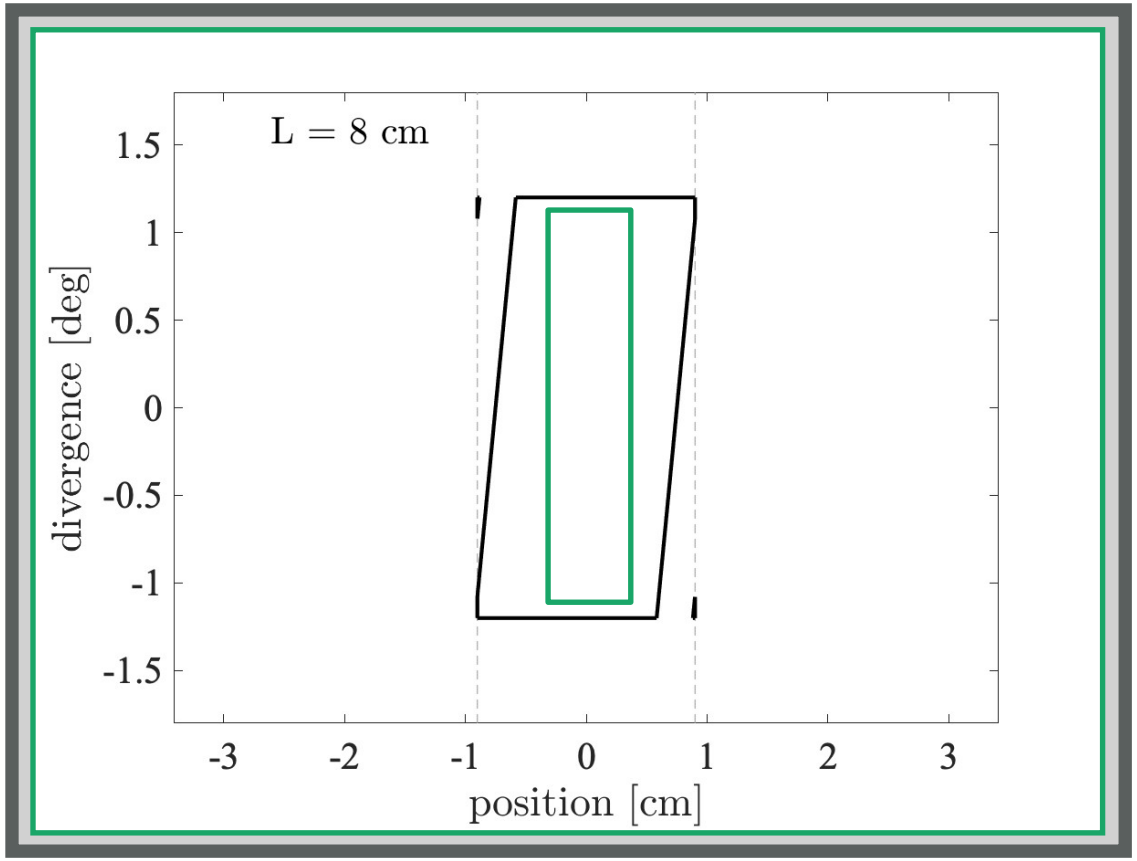

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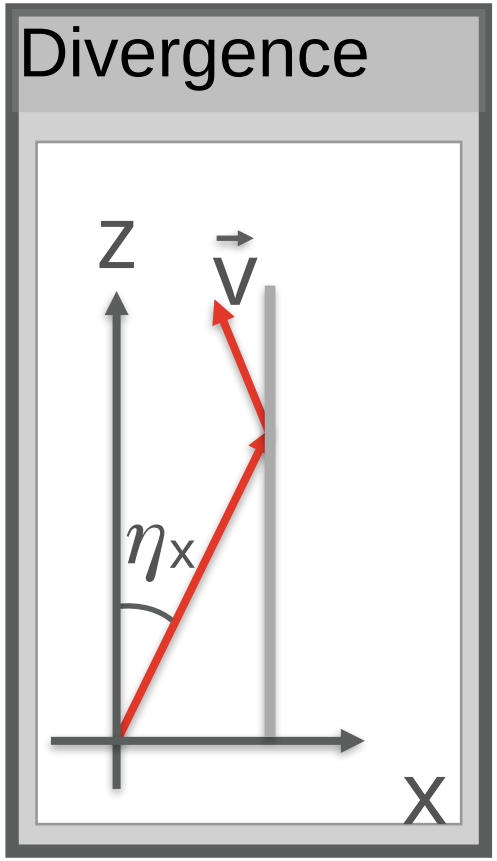

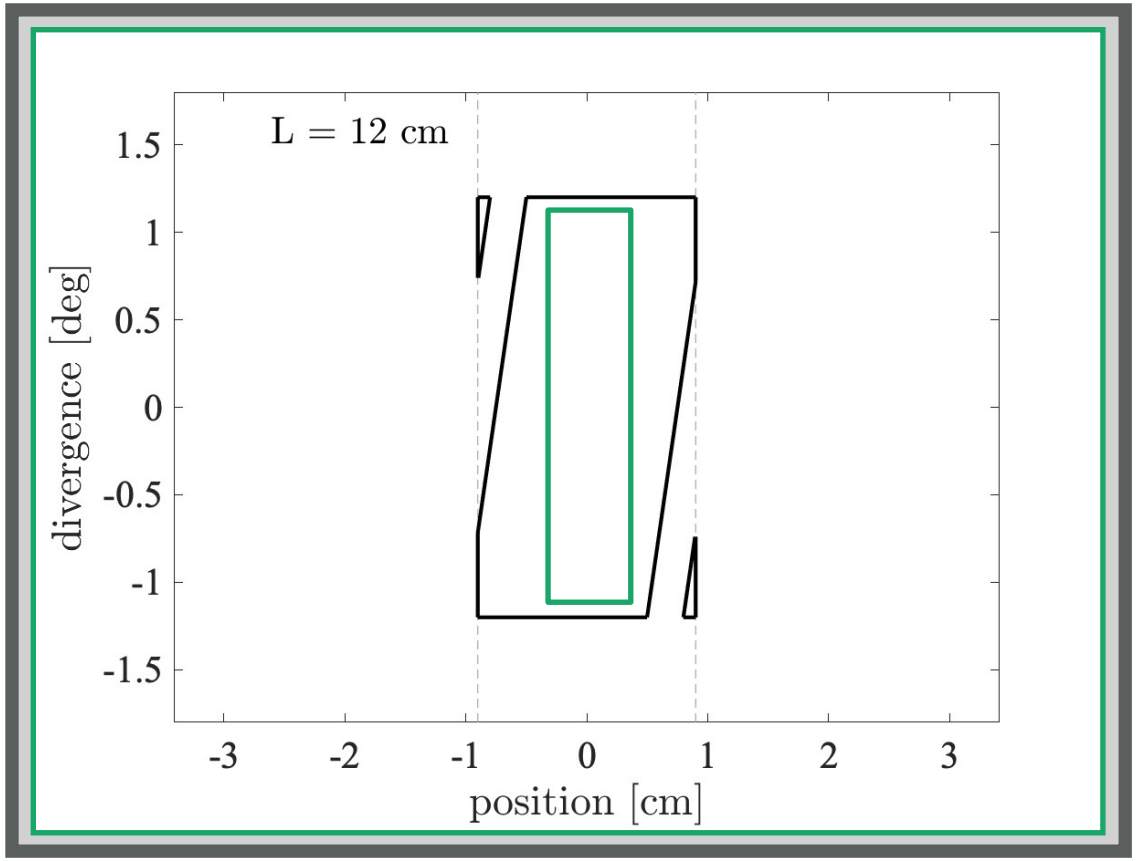

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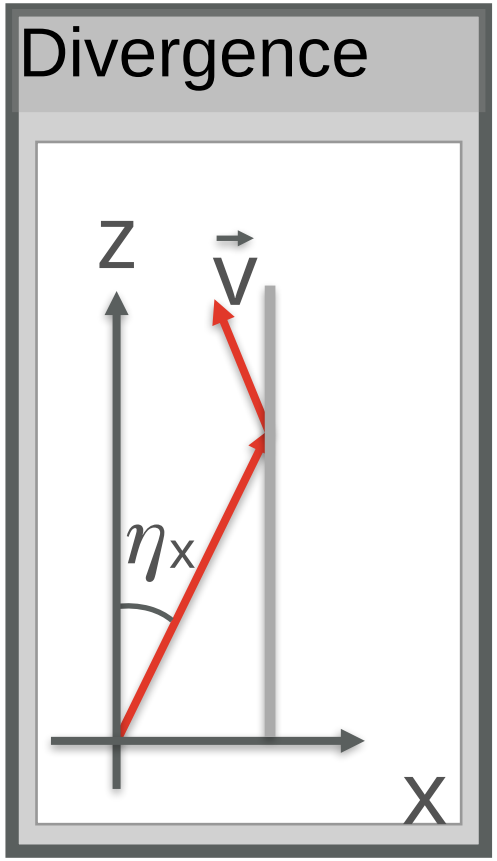

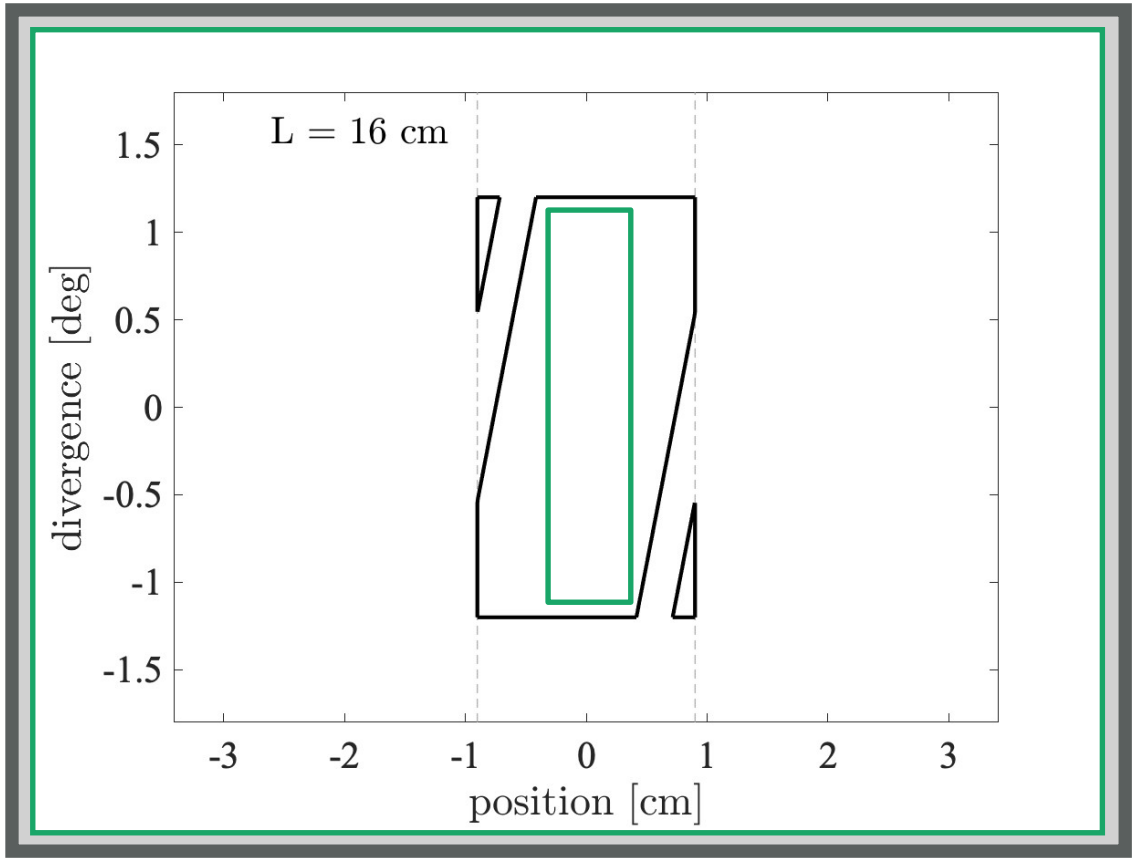

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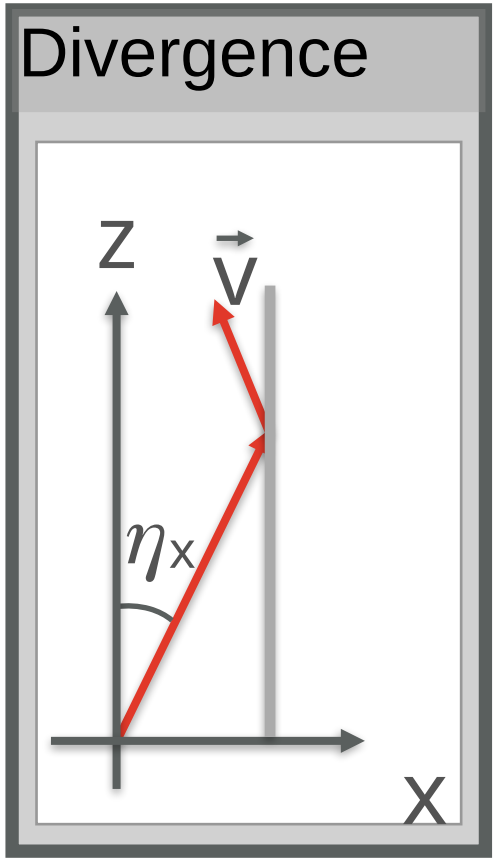

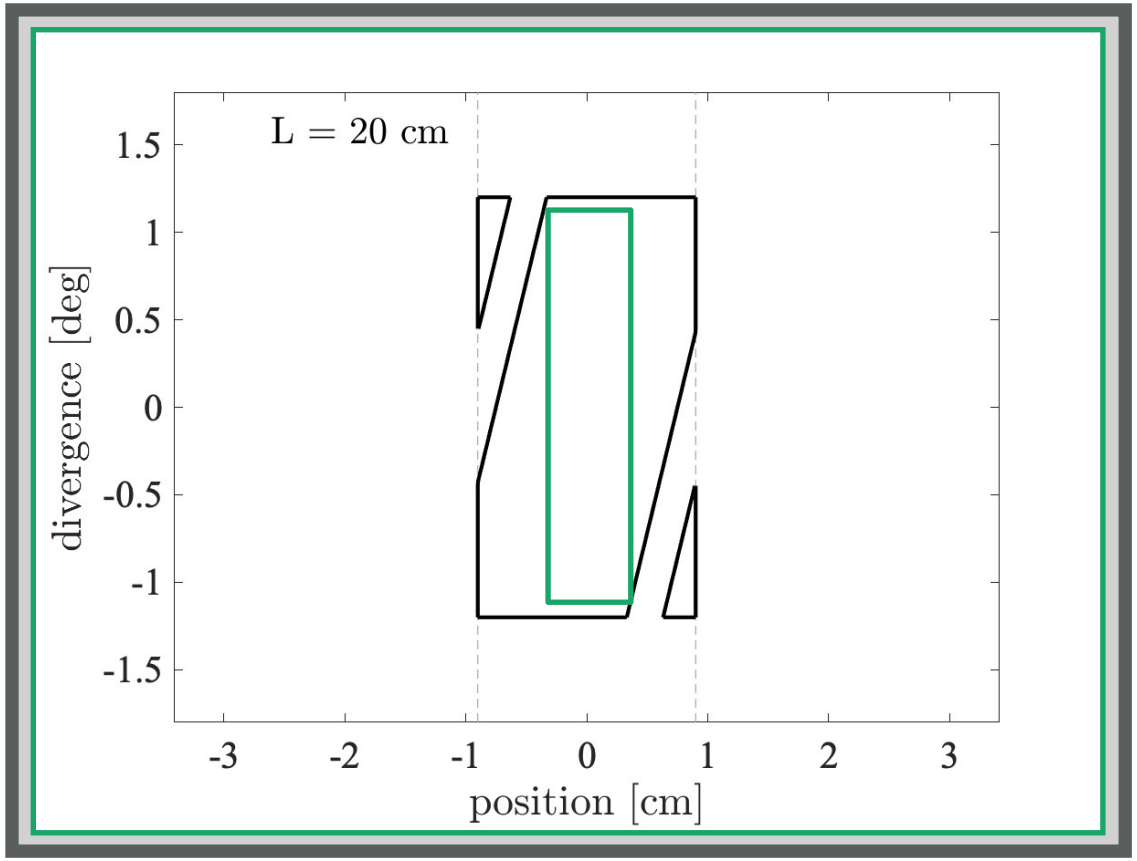

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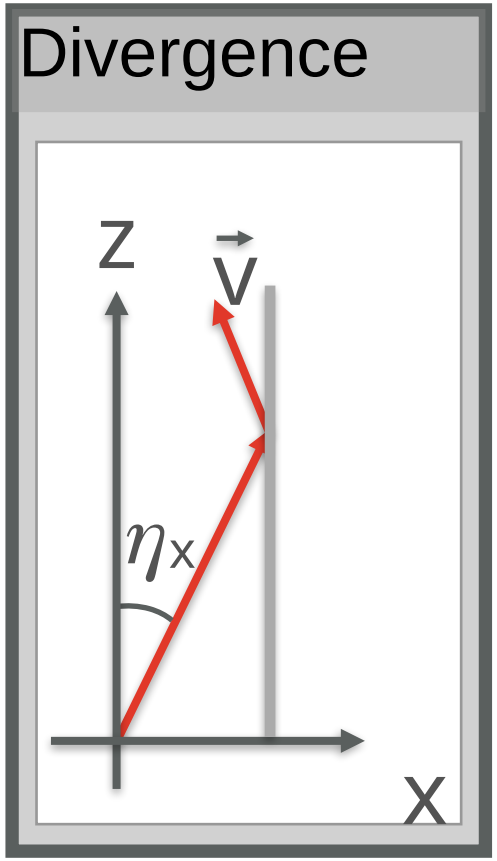

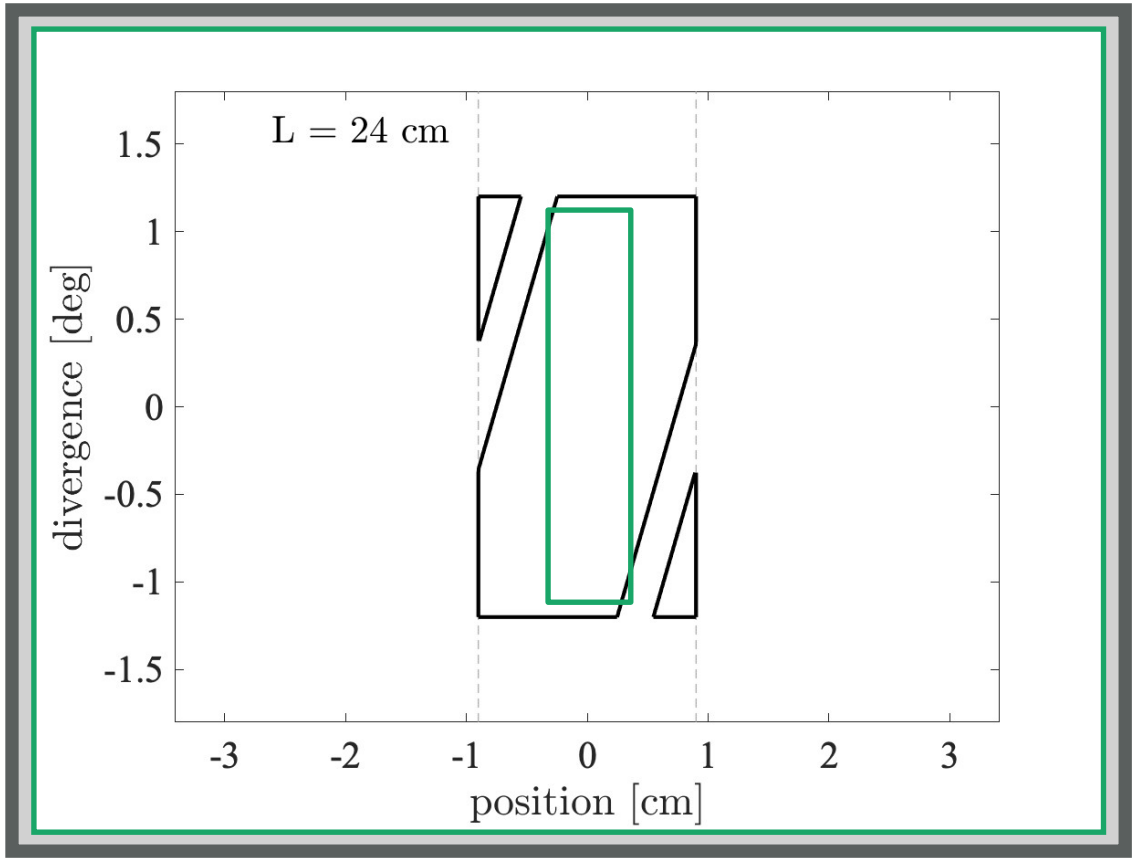

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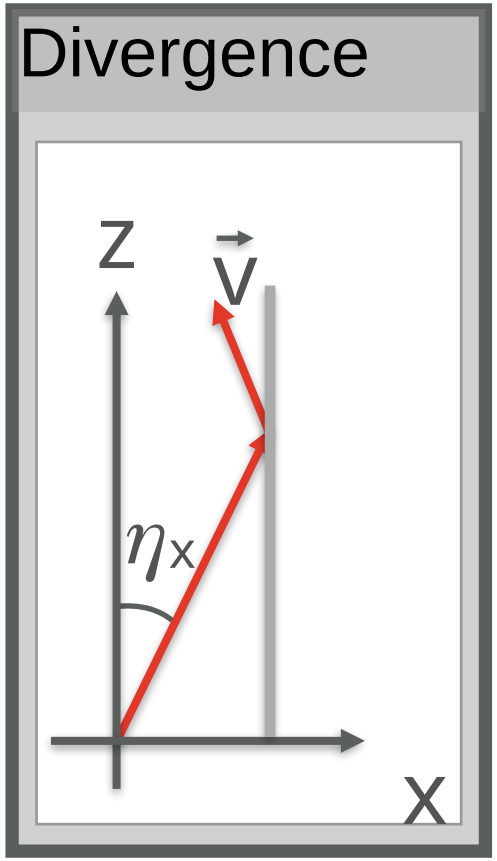

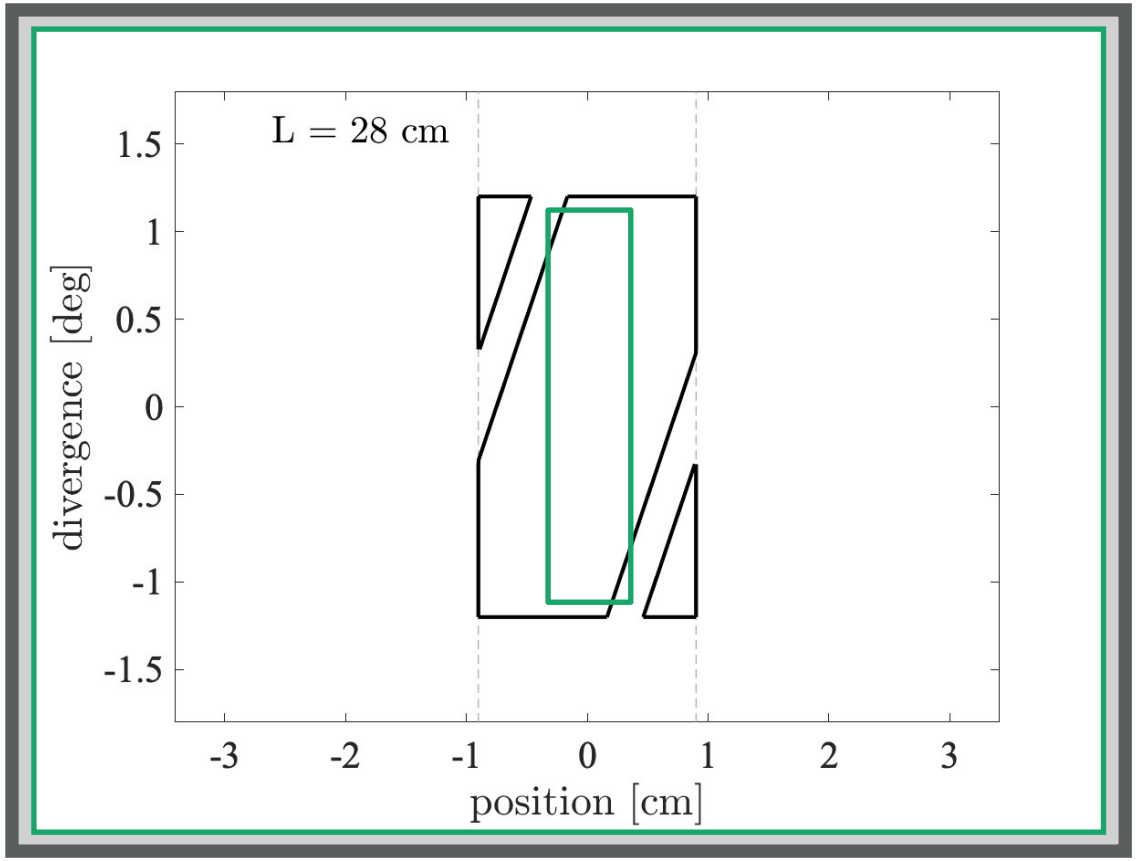

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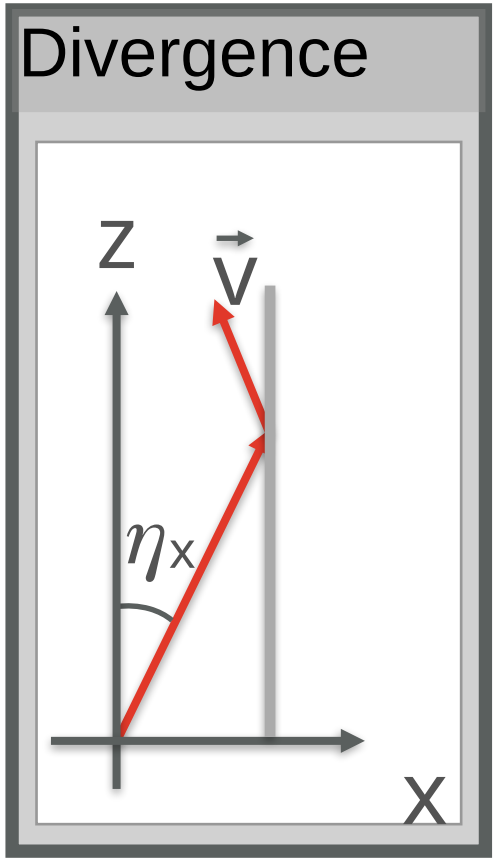

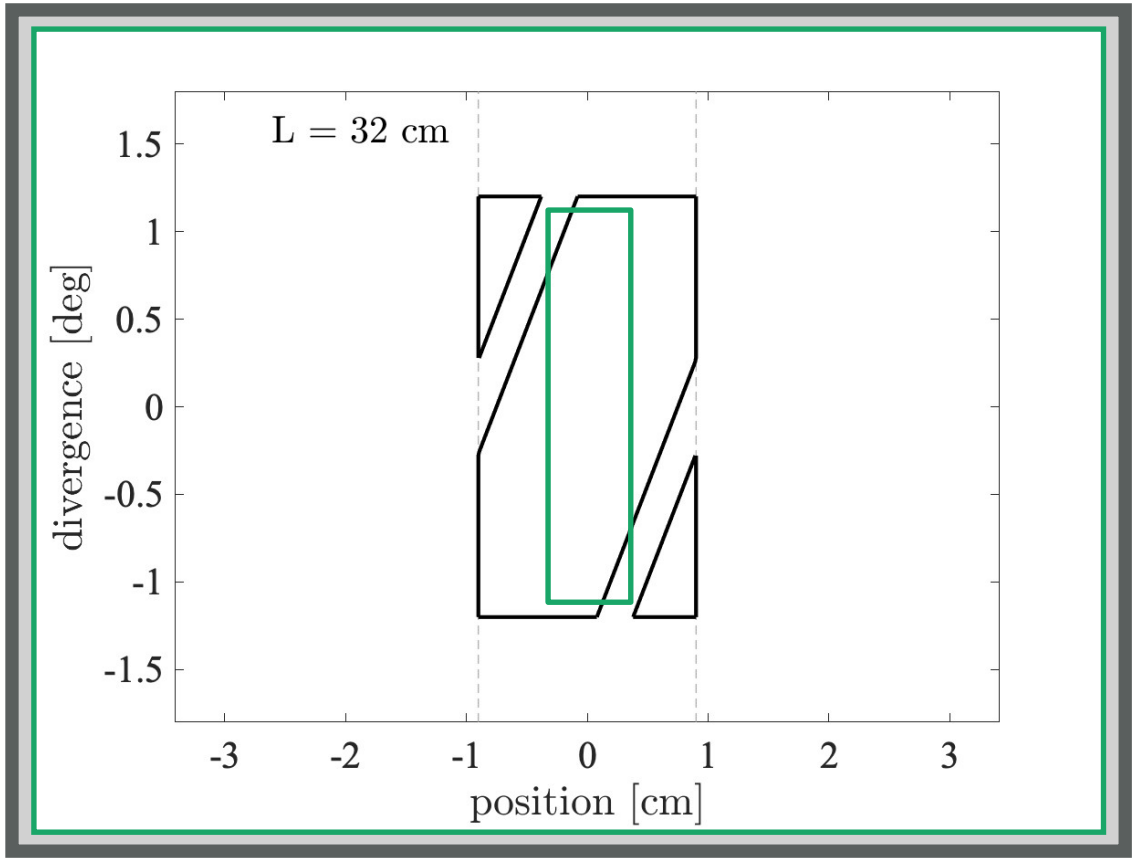

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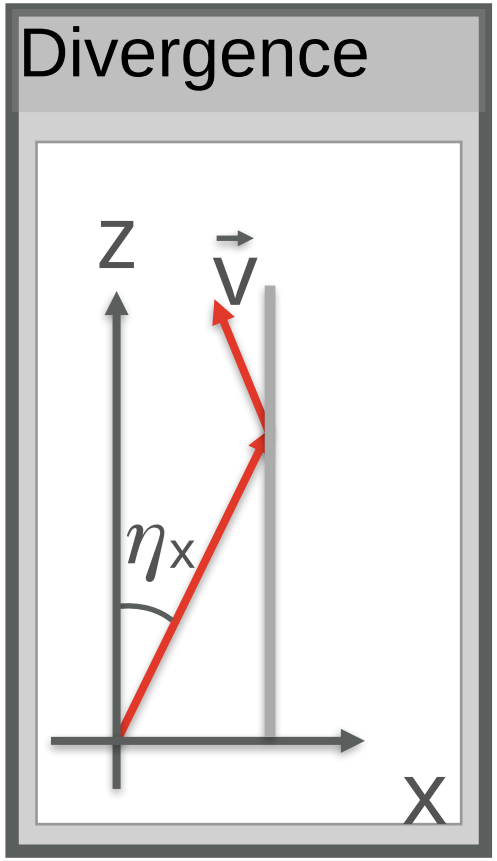

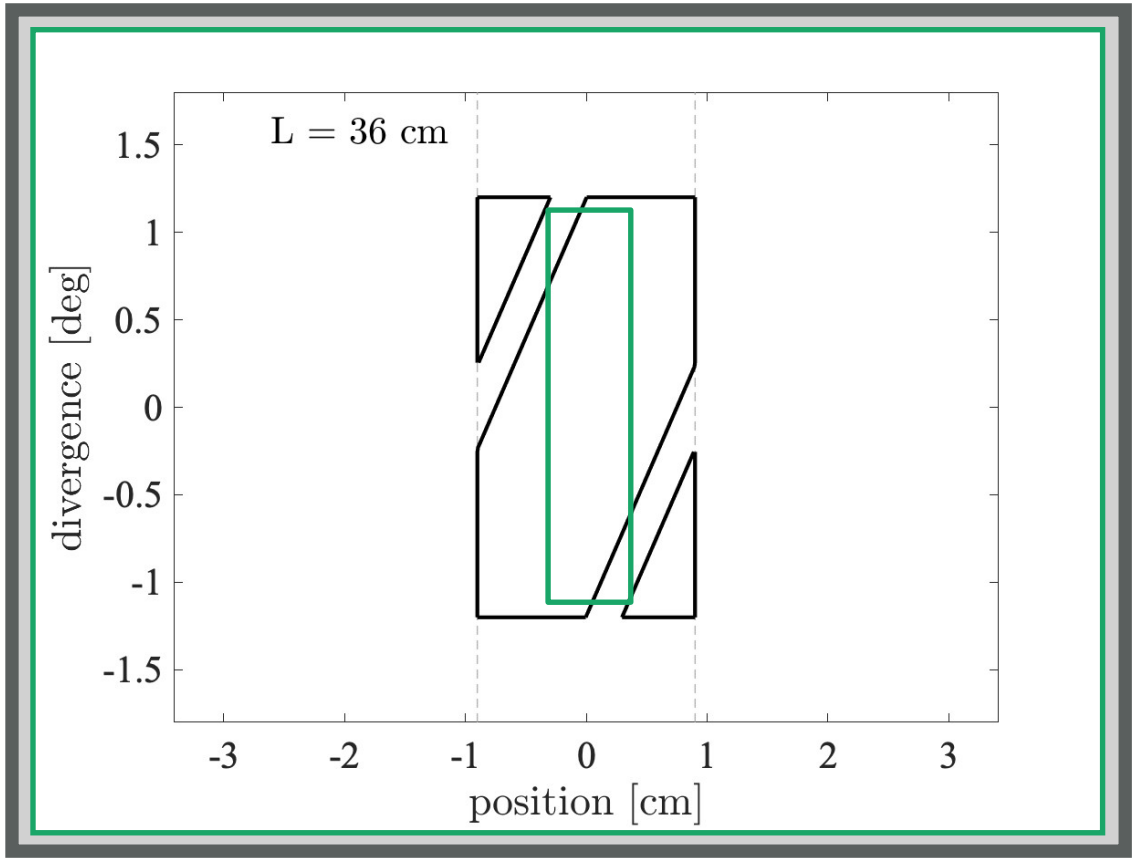

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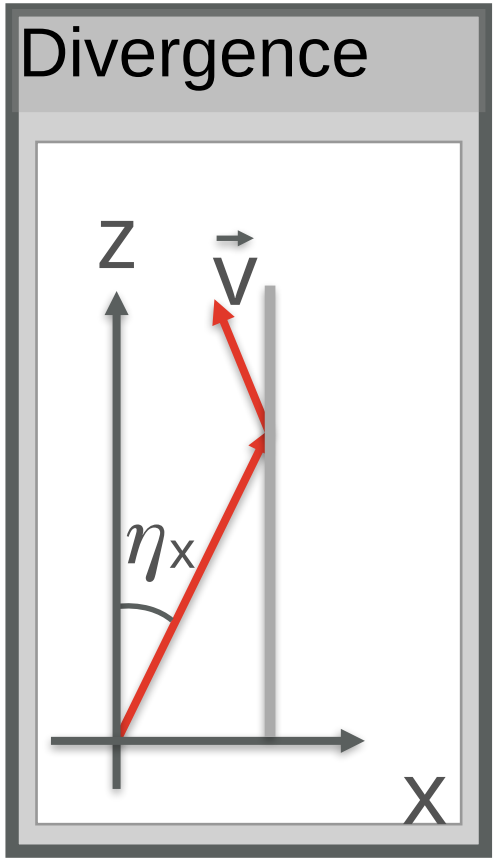
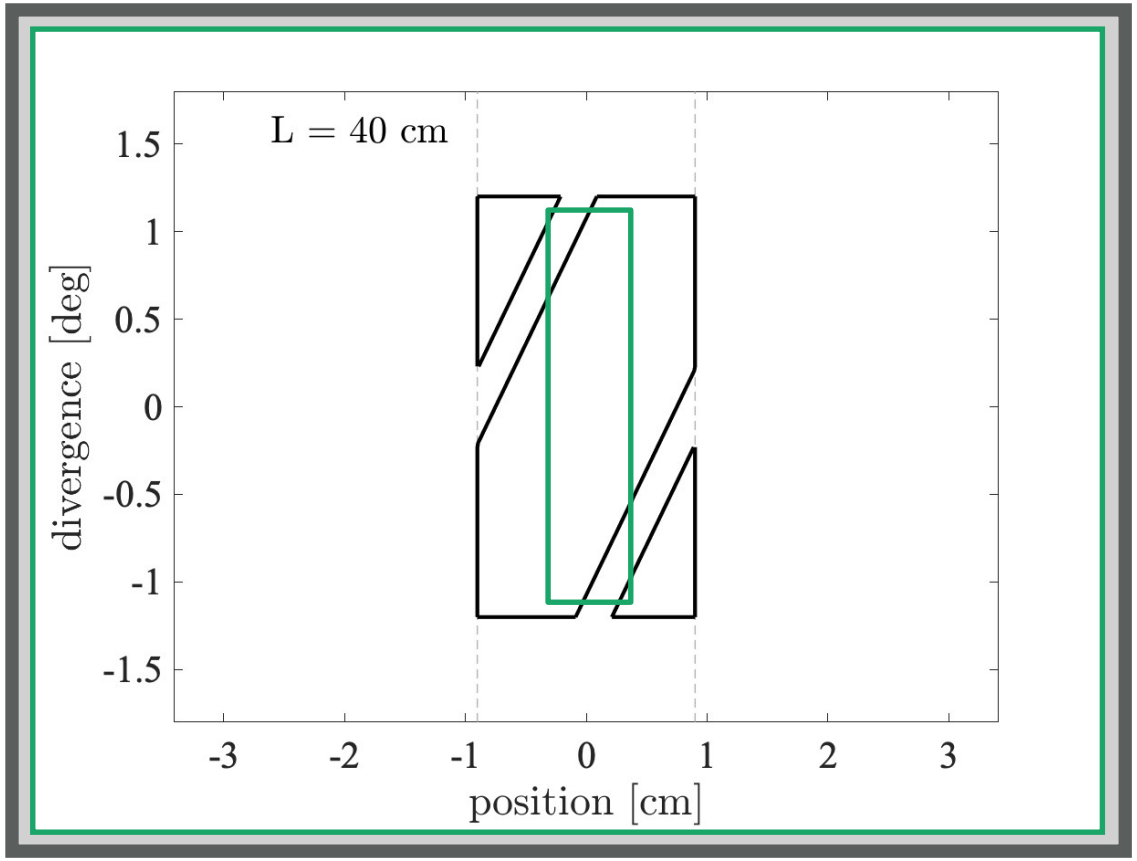
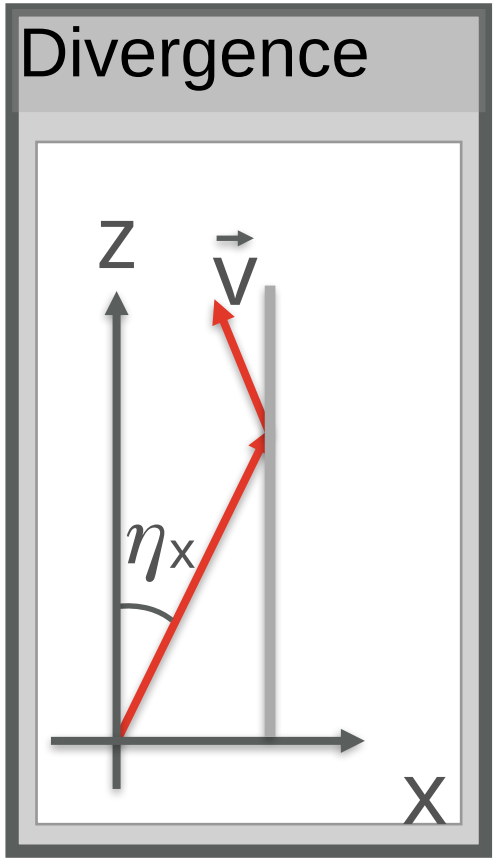
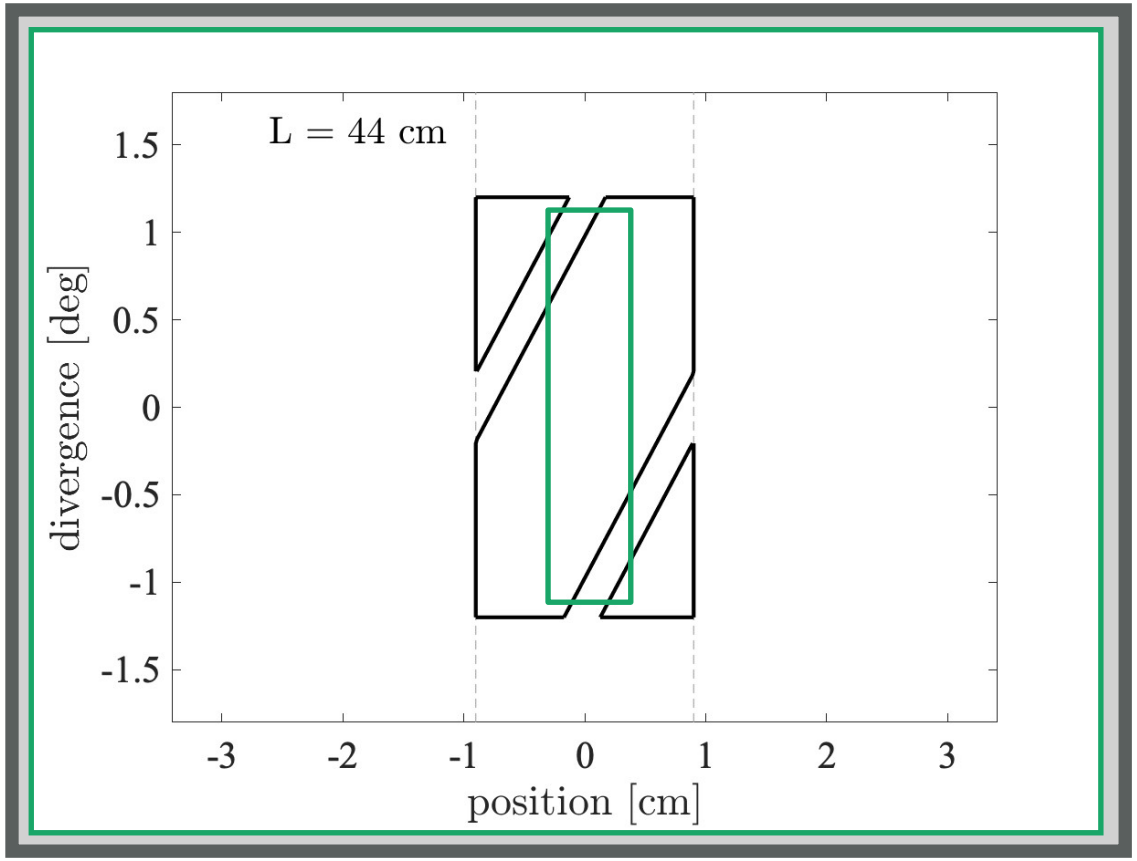


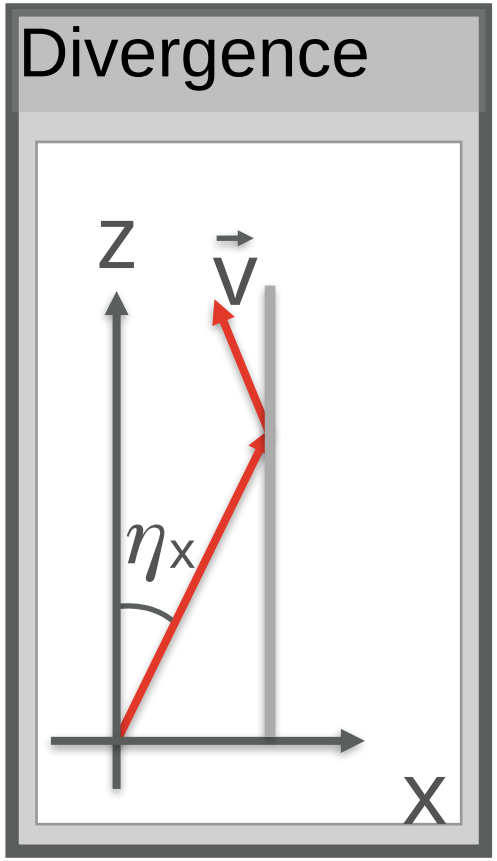


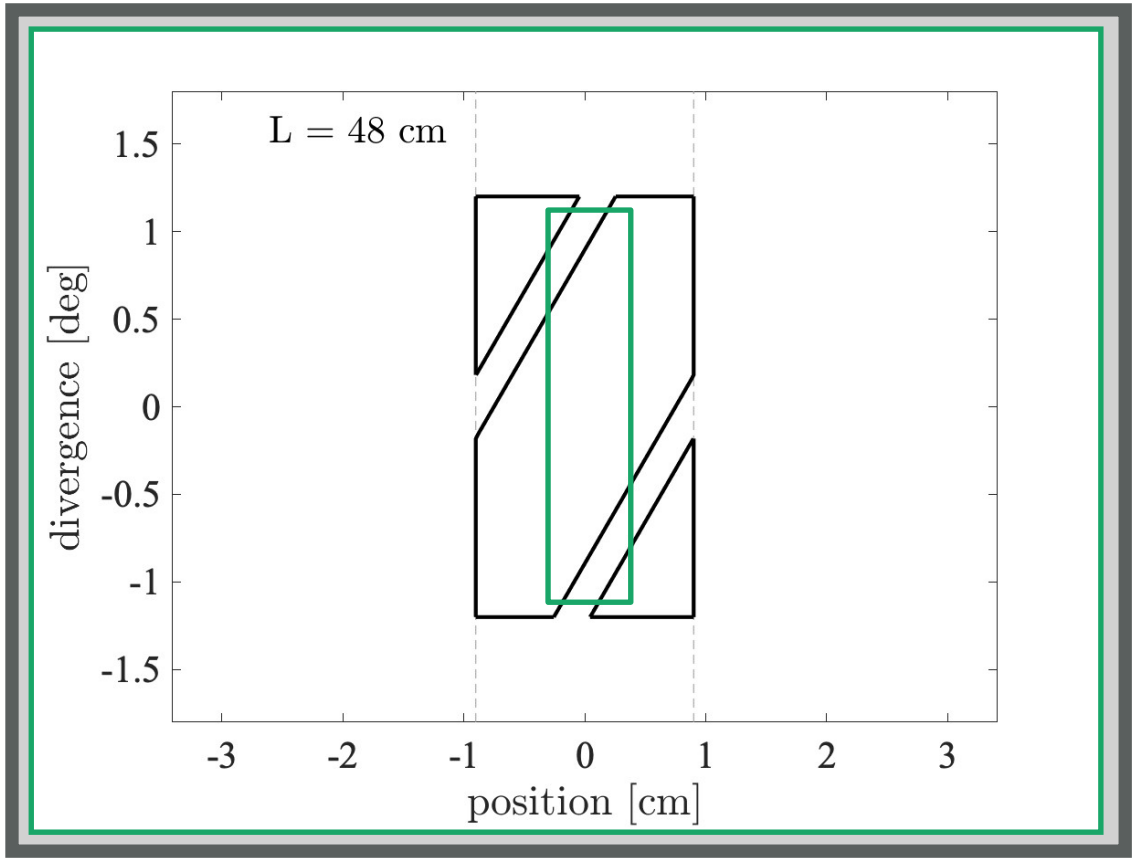
Beam propagation in guide



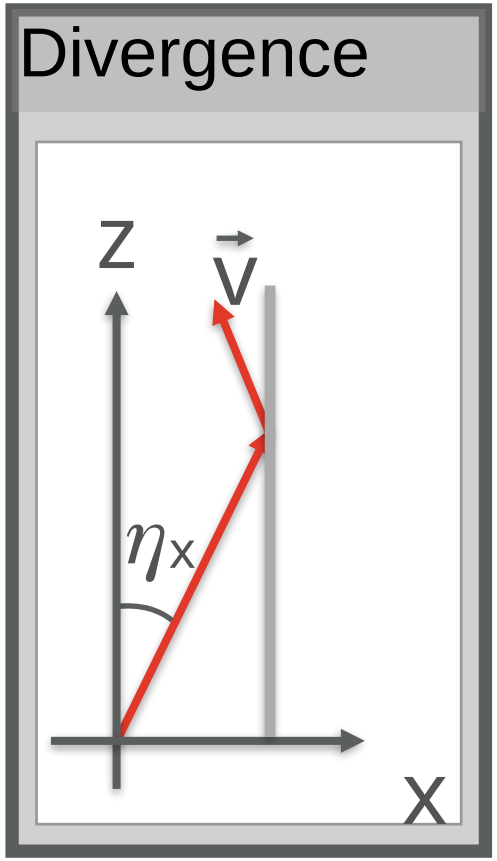


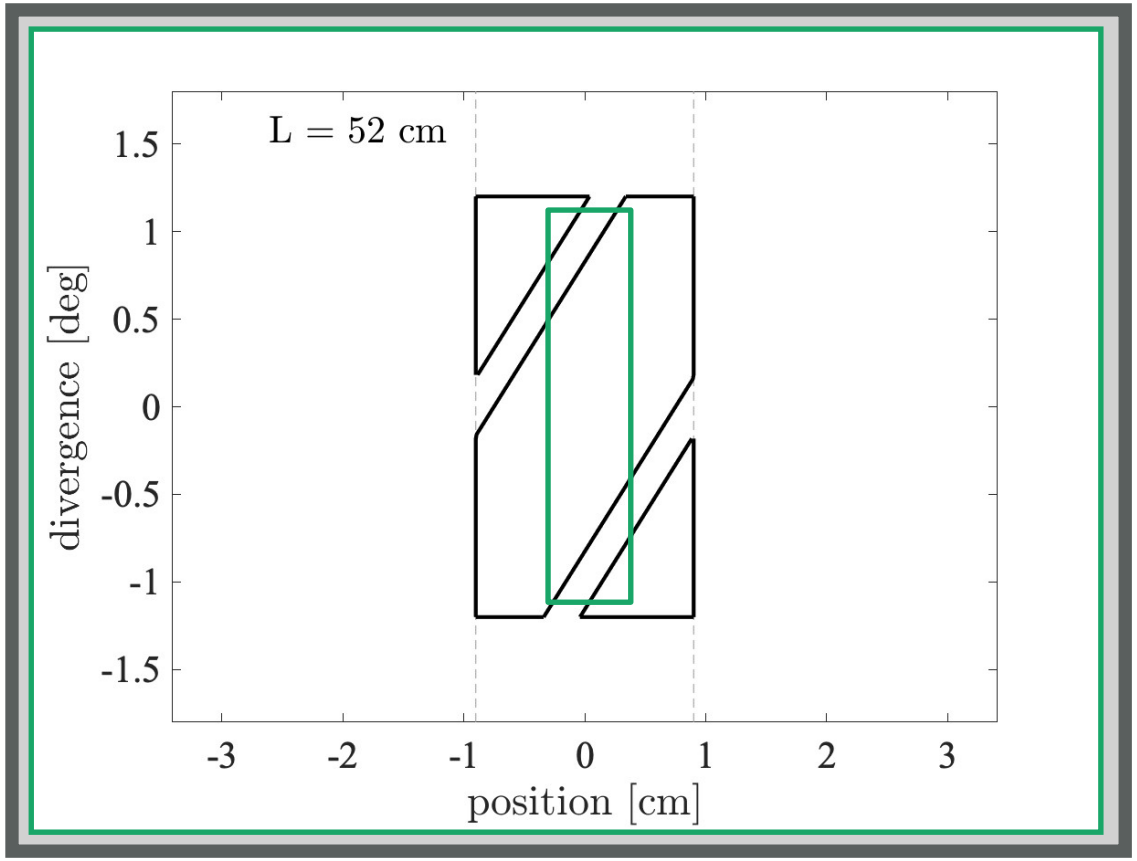
Beam propagation in guide



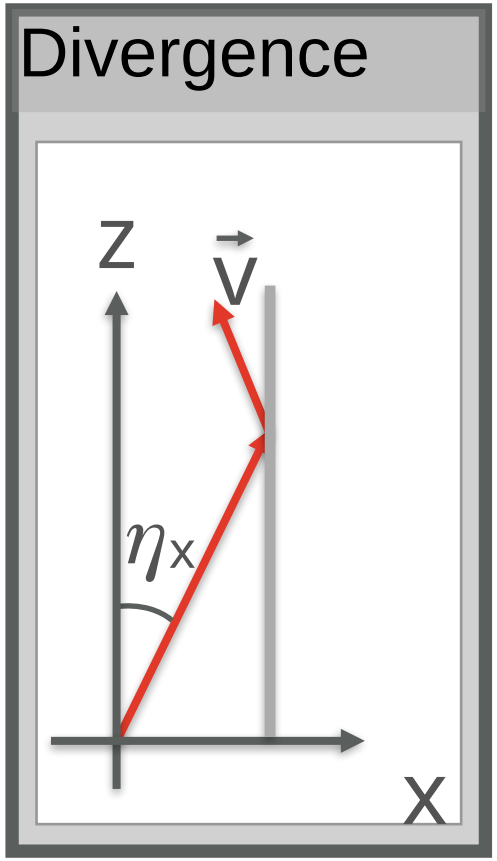


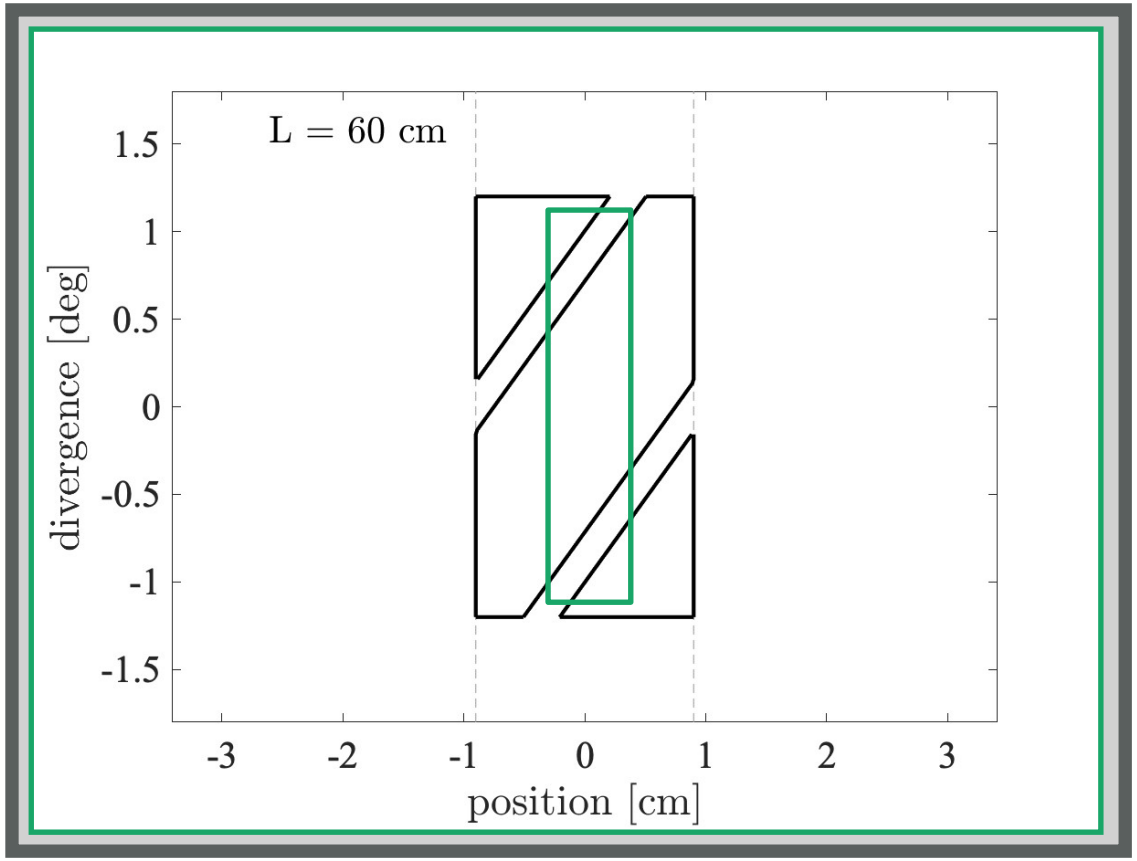
Beam propagation in guide





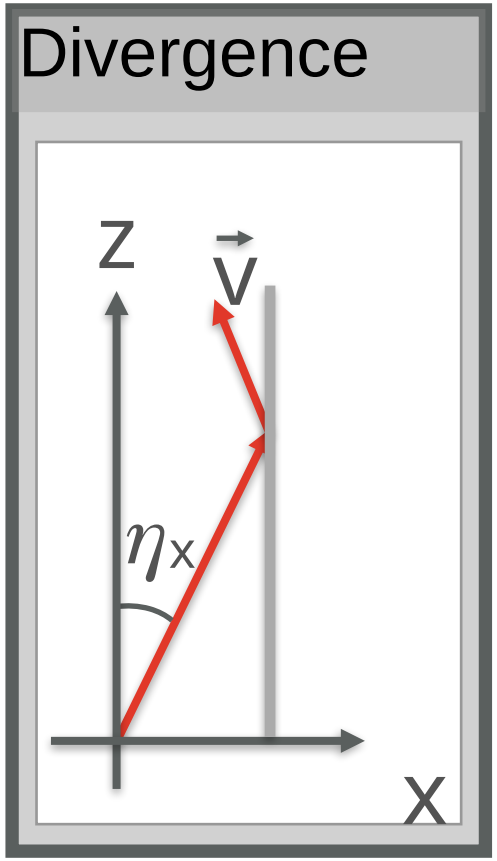
Beam propagation in guide

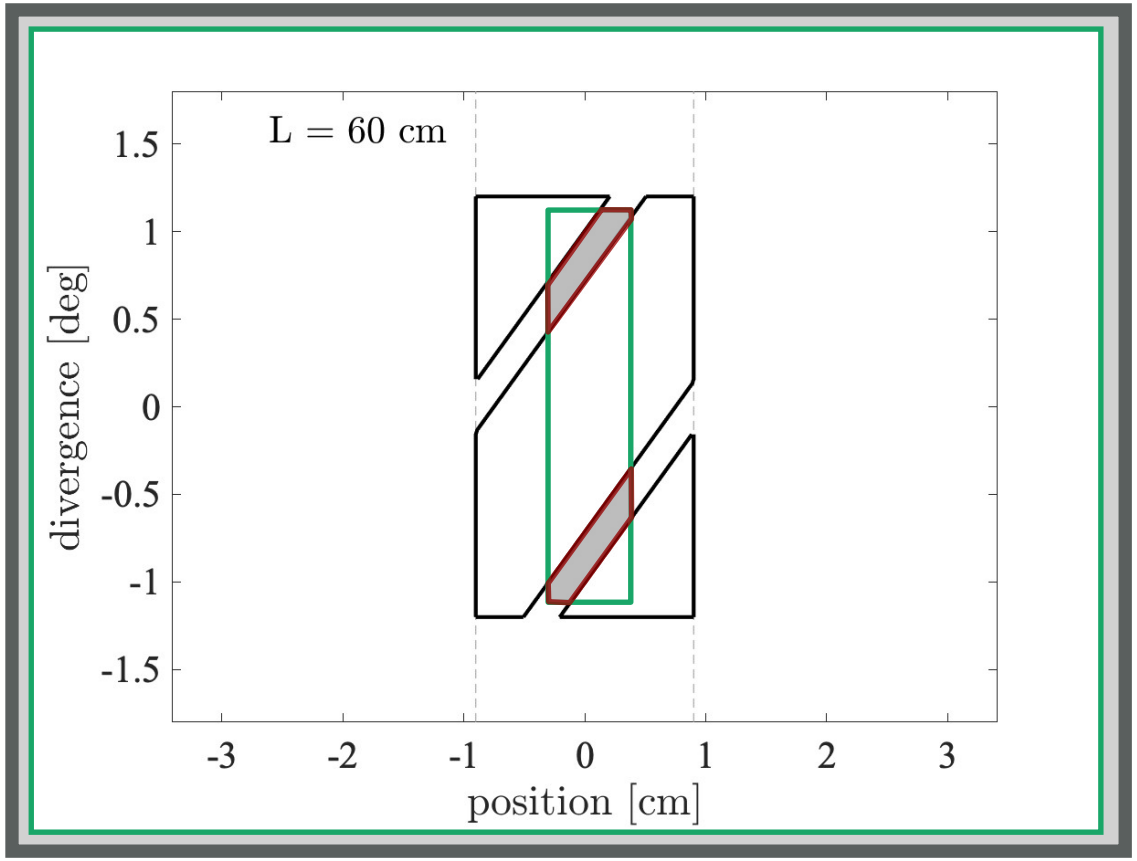




Beam propagation in guide

With a guide we lost less phase-space area!

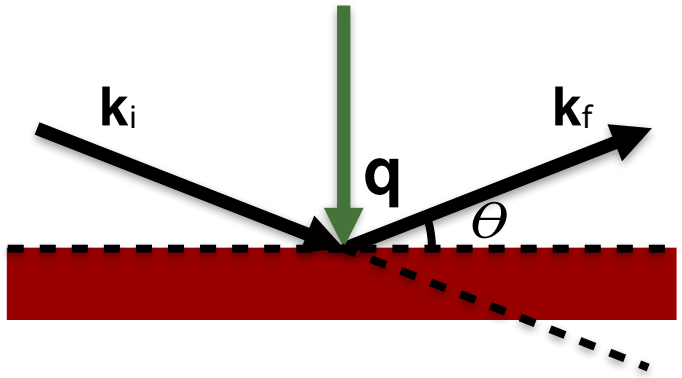


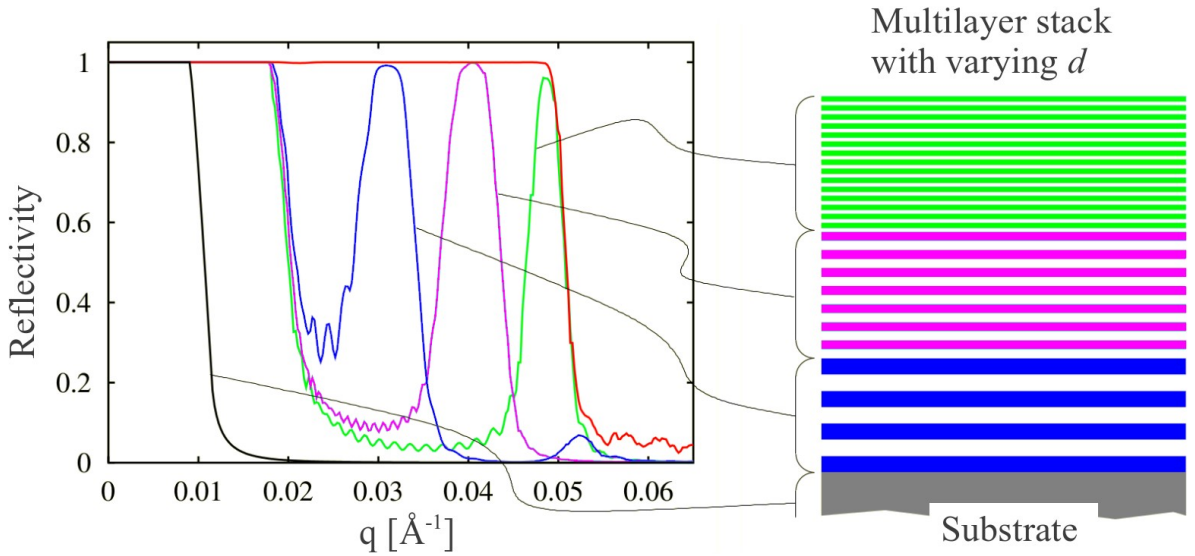


Reflectivity curves

- Reflectivity, super mirror, reflectivity curve

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

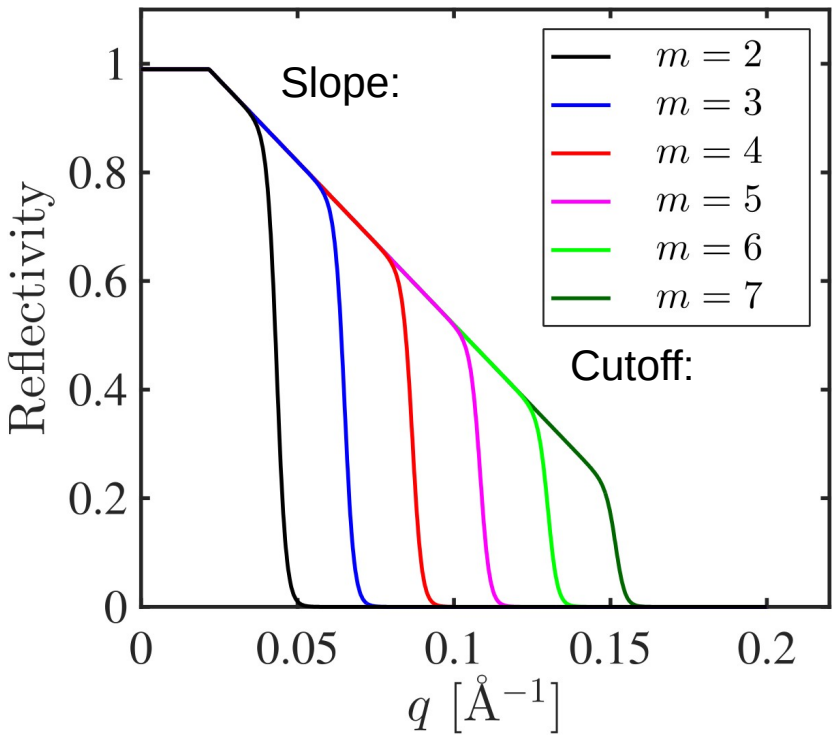




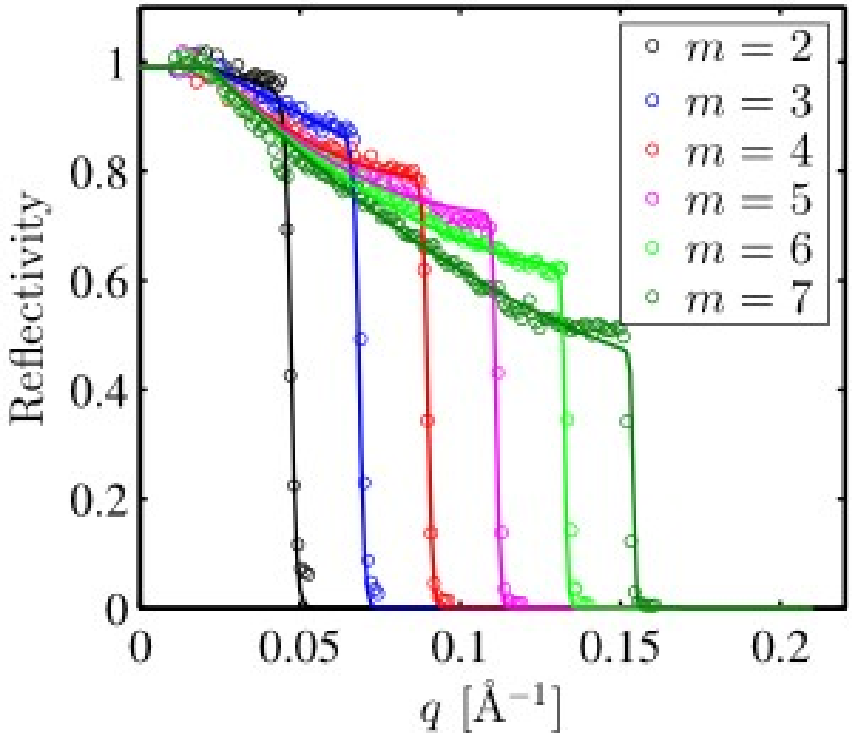
Reflectivity curves in McStas

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

McStas standard model



McStas fitted model



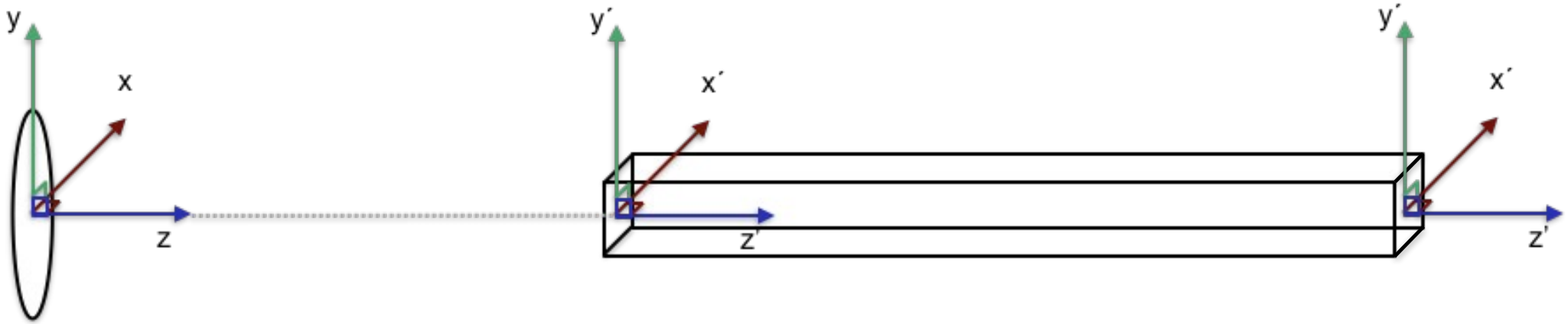
= 0
W = 0

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

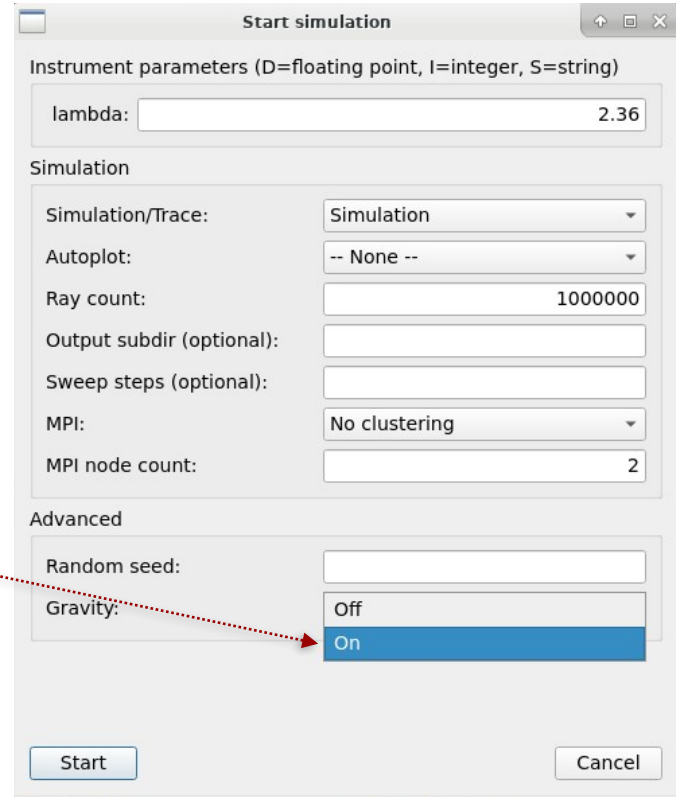
Gravitation in McStas

- 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 *v direction.)*



- As you will see in the practical, implications are greatest with long wavelengths and at long distances

- *“How about e.g. elliptic mirror optic X that does not support gravity?”*

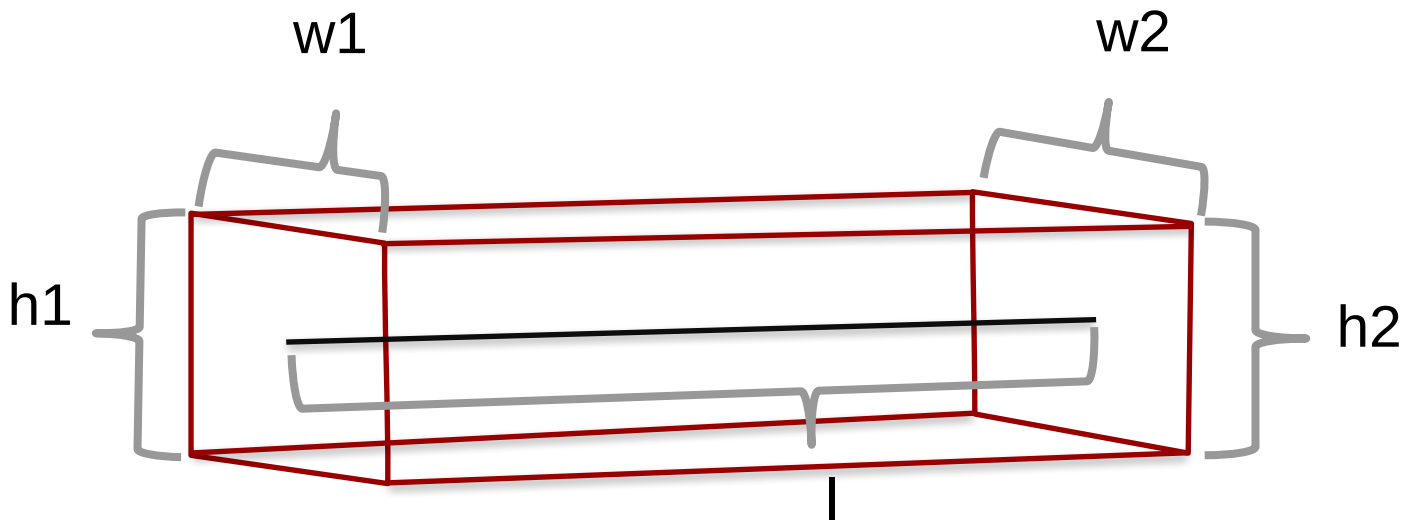
  - often a good workaround is to add a monitor close to the surface of object X, this takes care that propagation up to the monitor includes gravitation:

  - 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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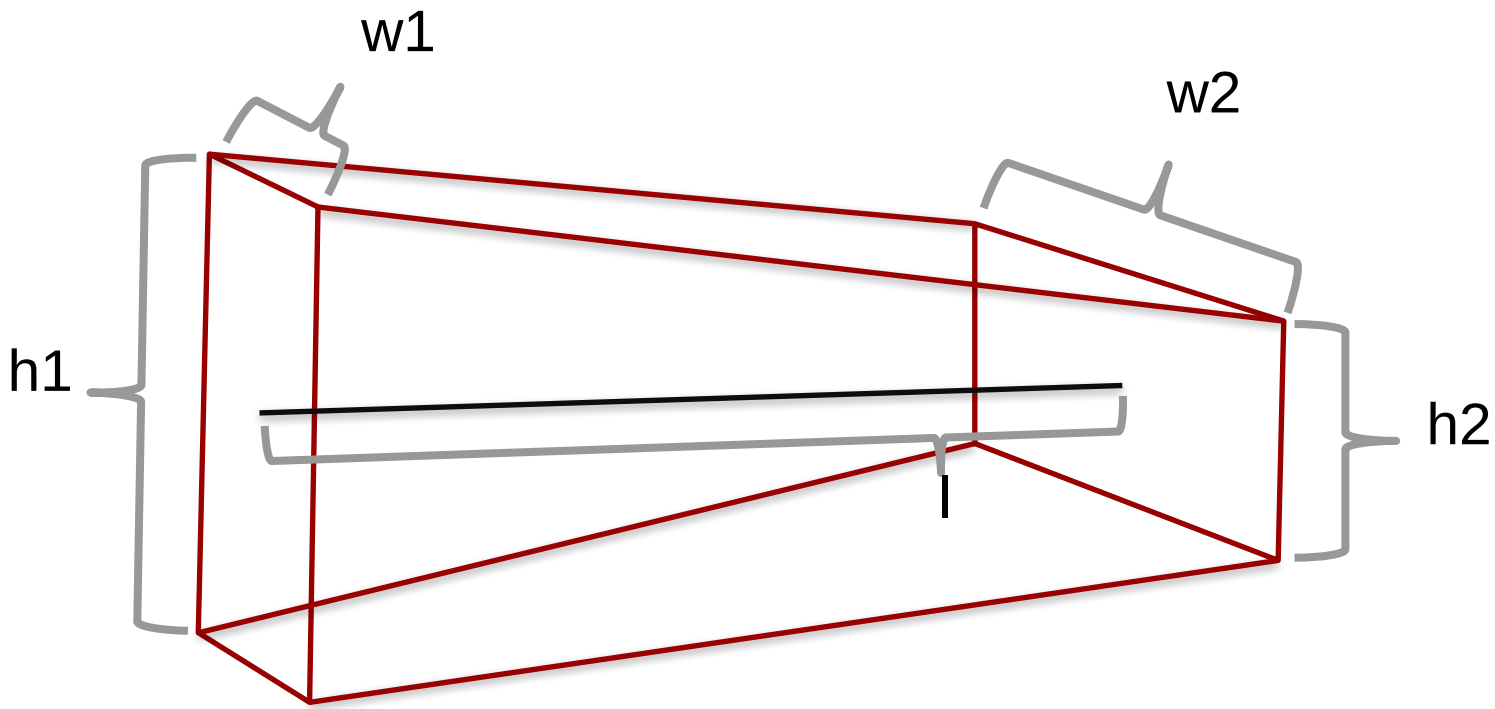

Popular guide components: Guide_gravity

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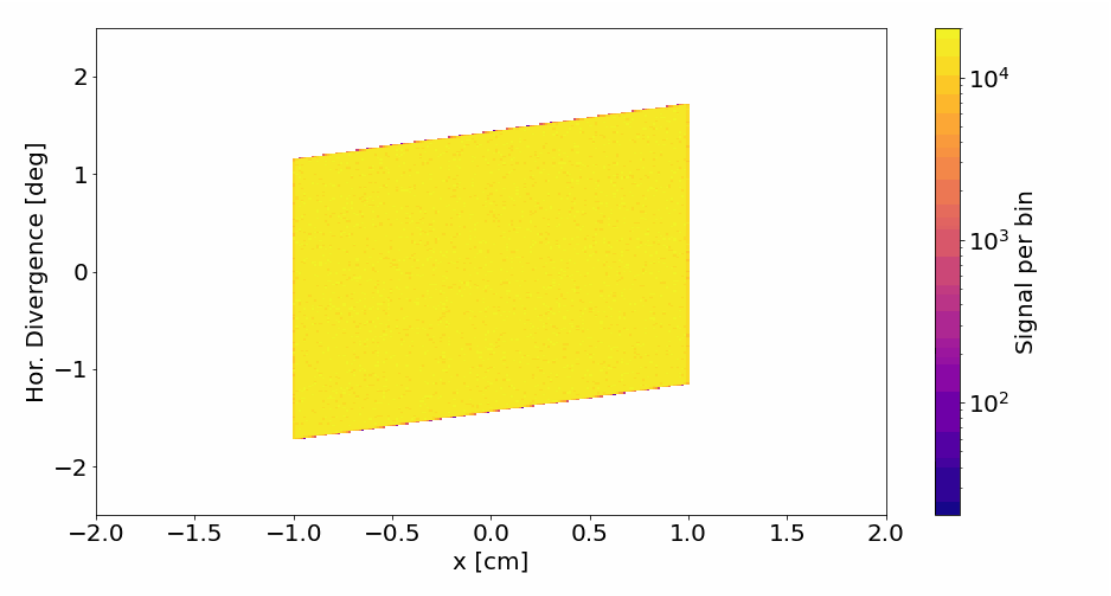
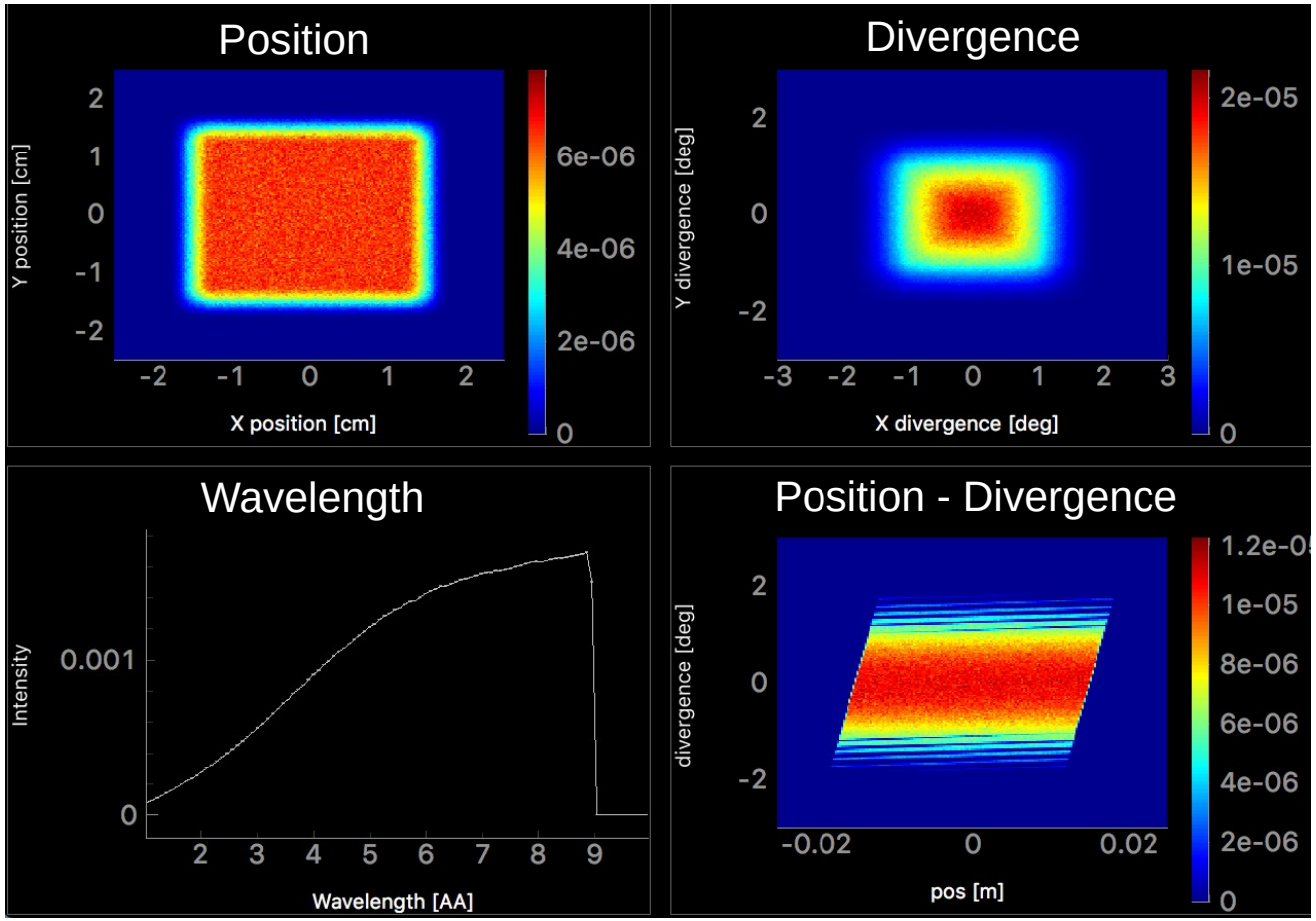
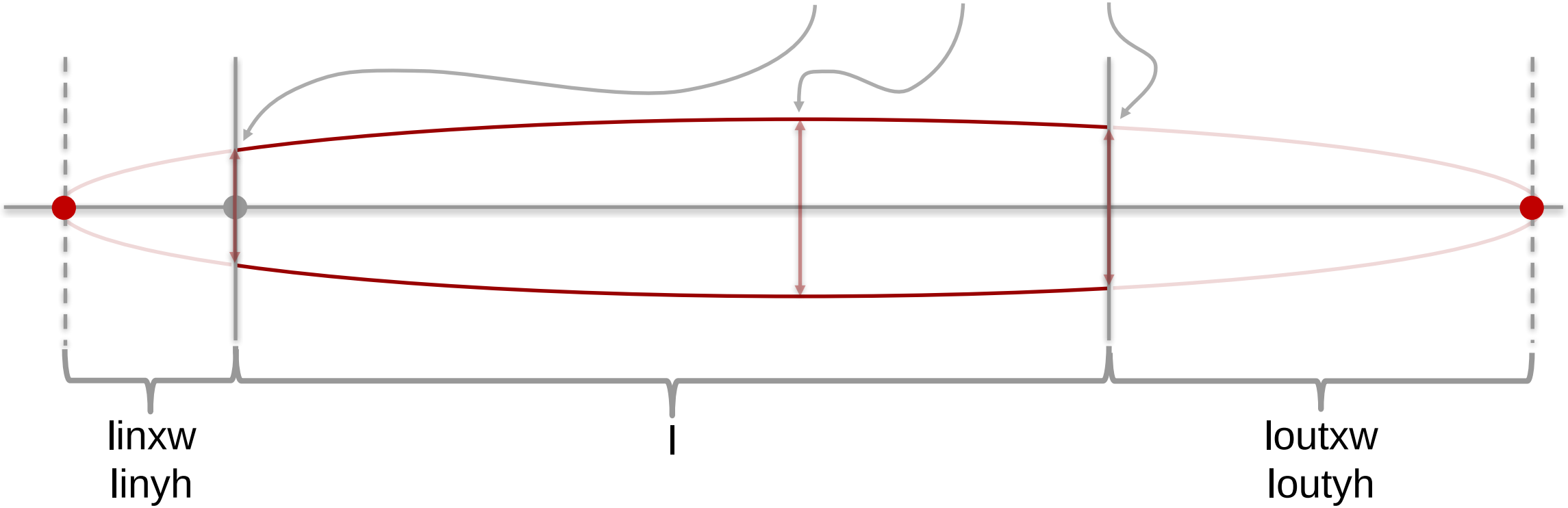




Popular guide components: Elliptical_guide_gravity

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

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



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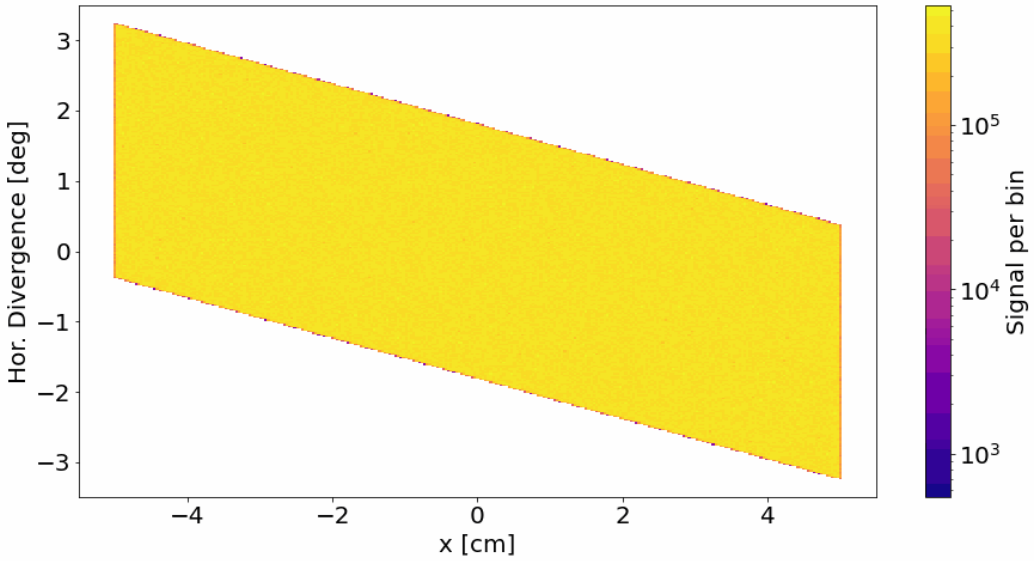
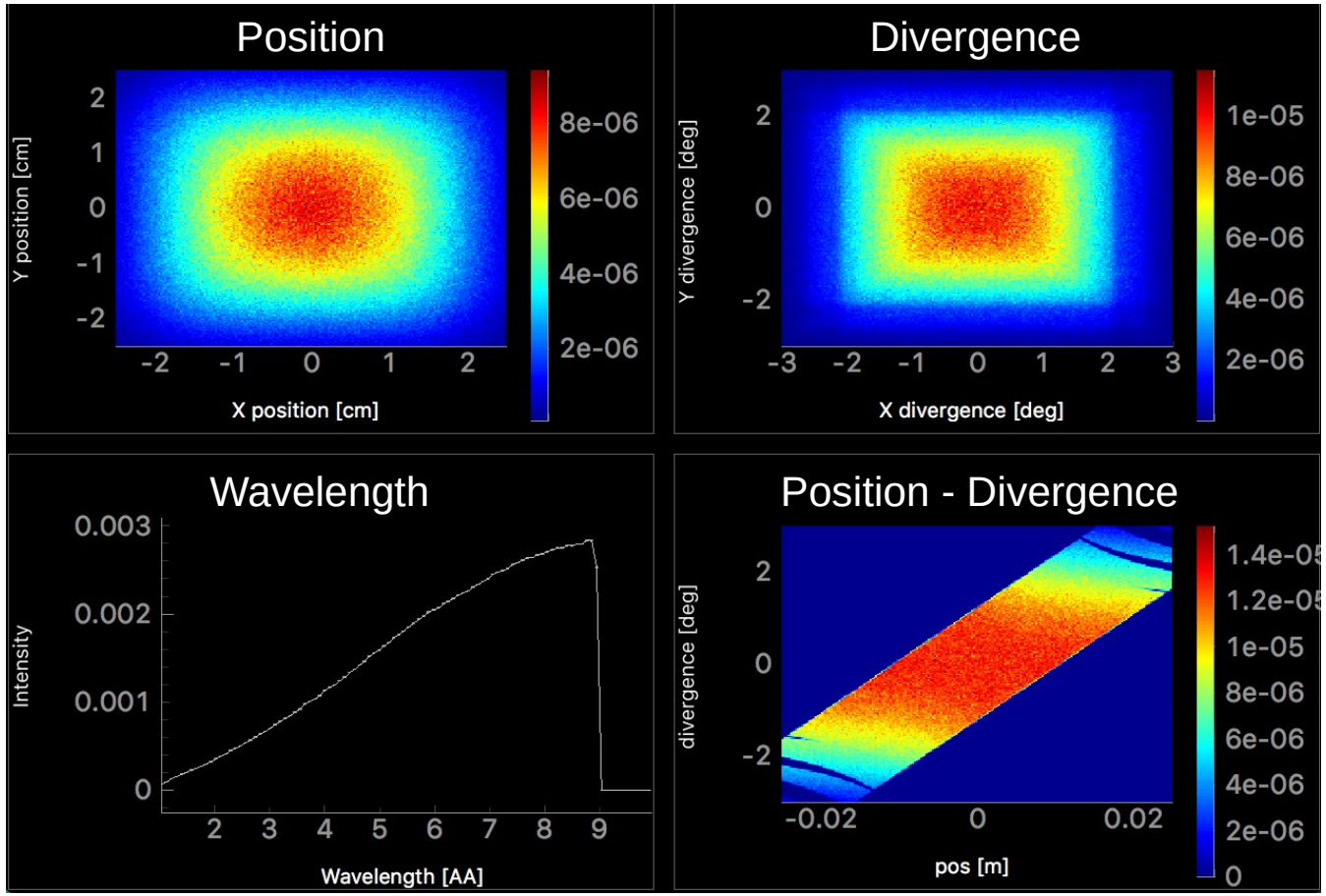
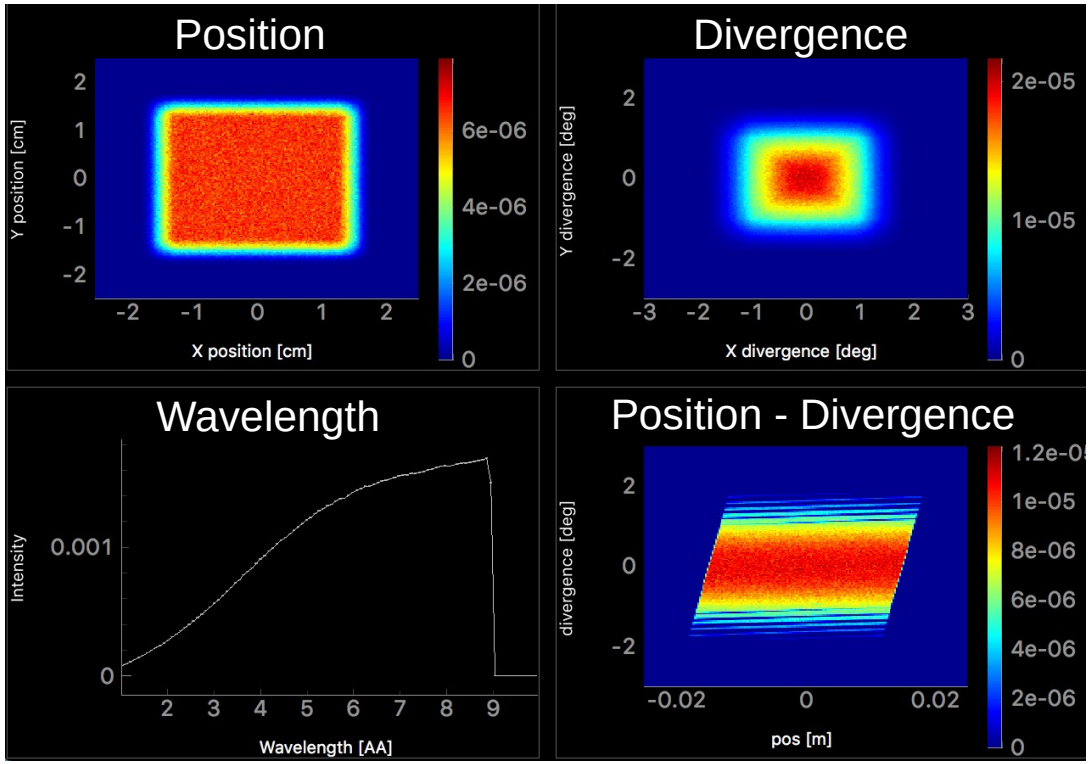


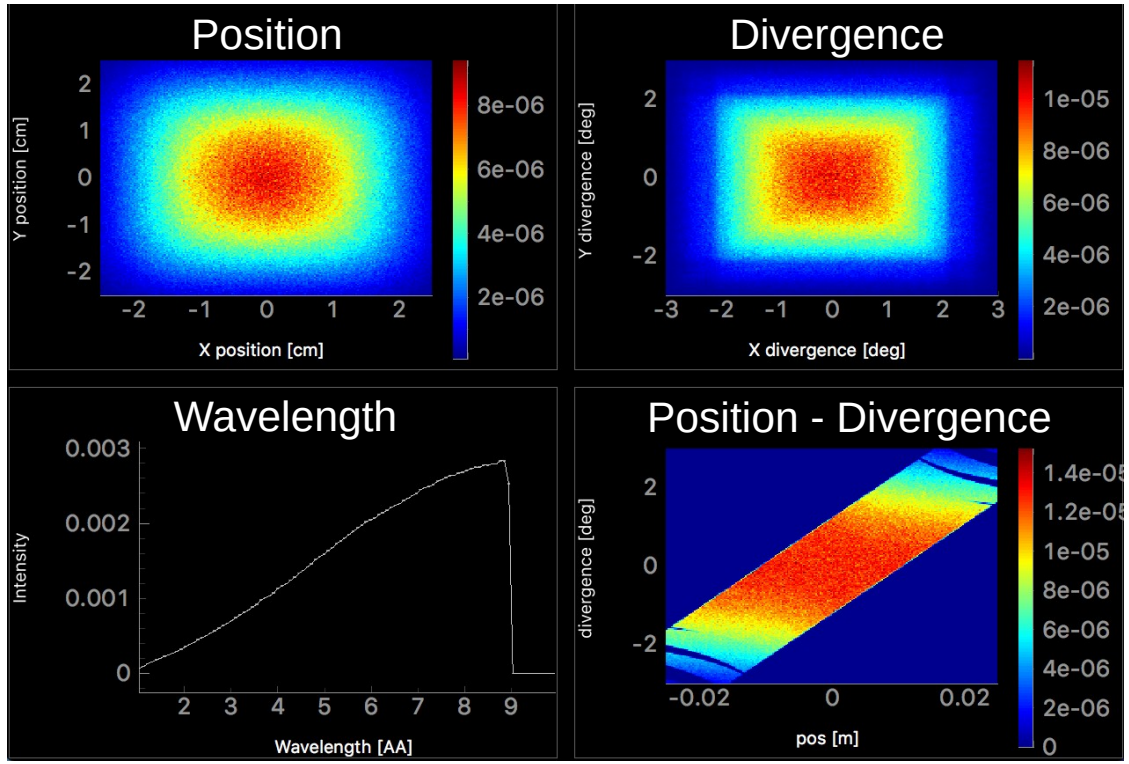


Comparison: Guide_gravity and Elliptic_guide_gravity

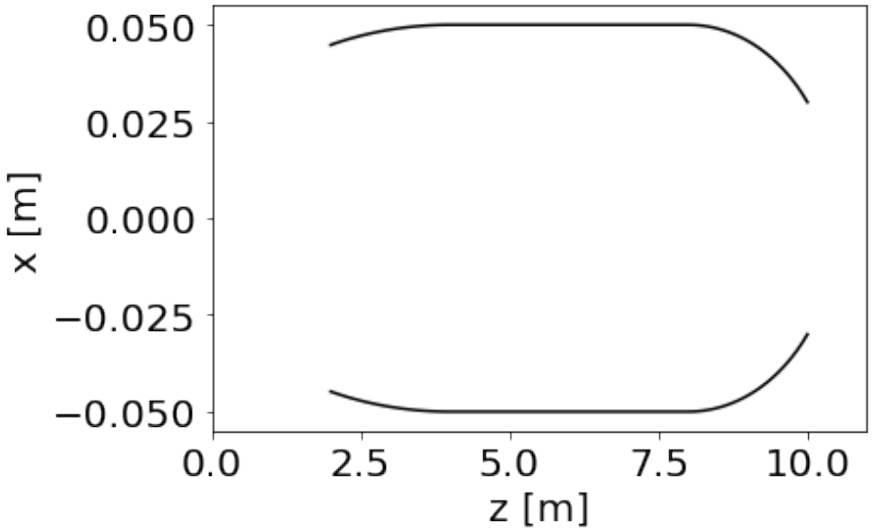
Guide_gravity

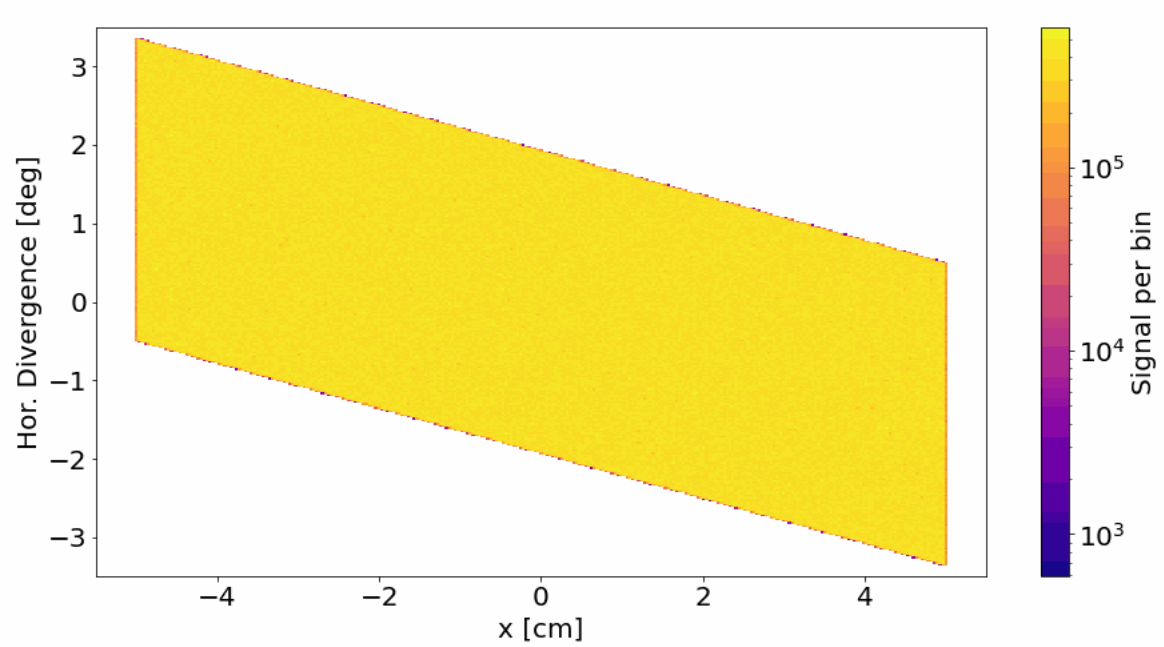


Elliptic_guide_gravity

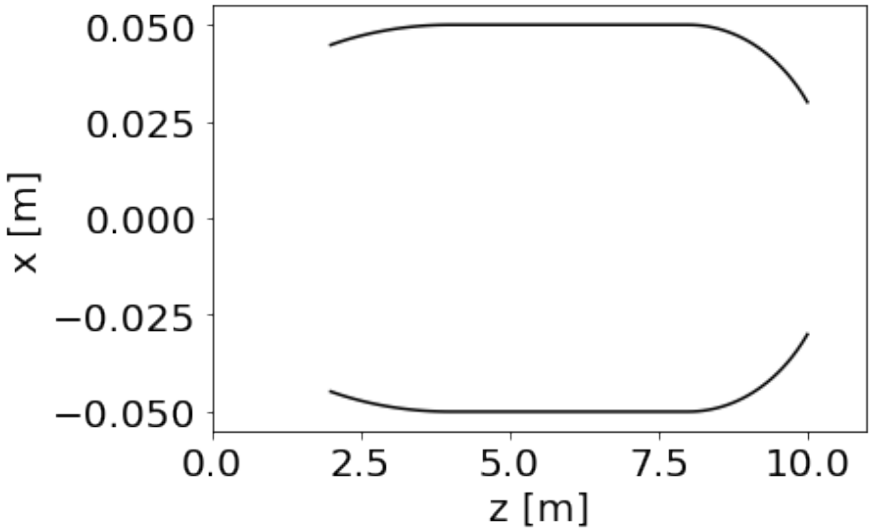


Balistic guide

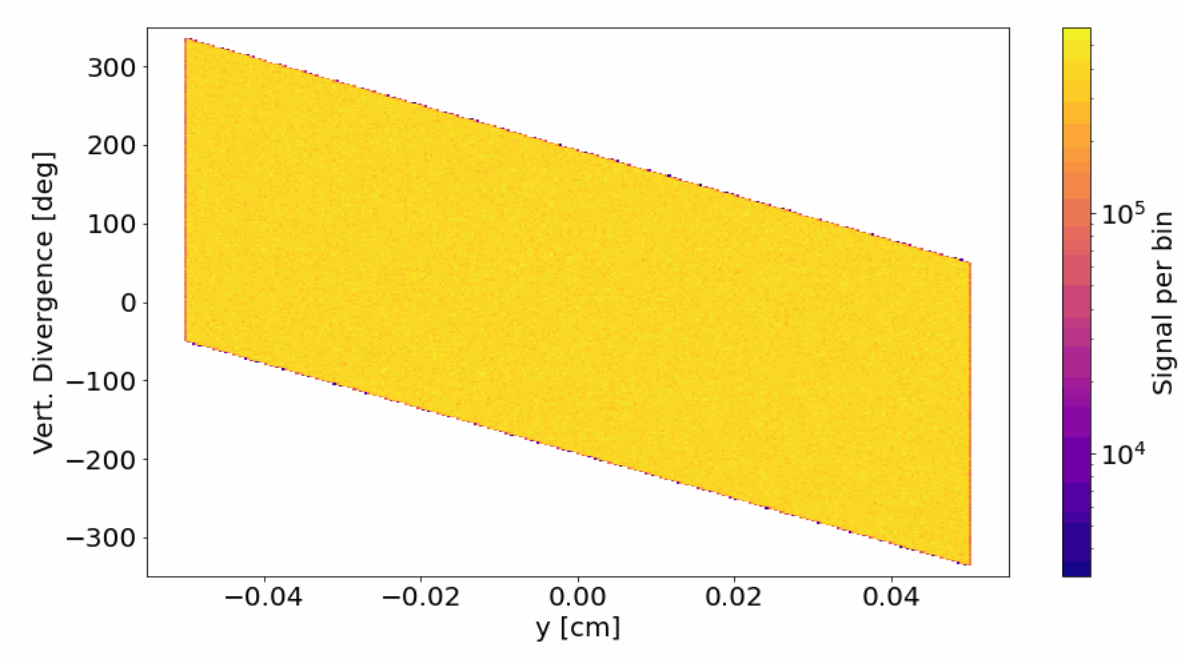




Balistic guide with gravity

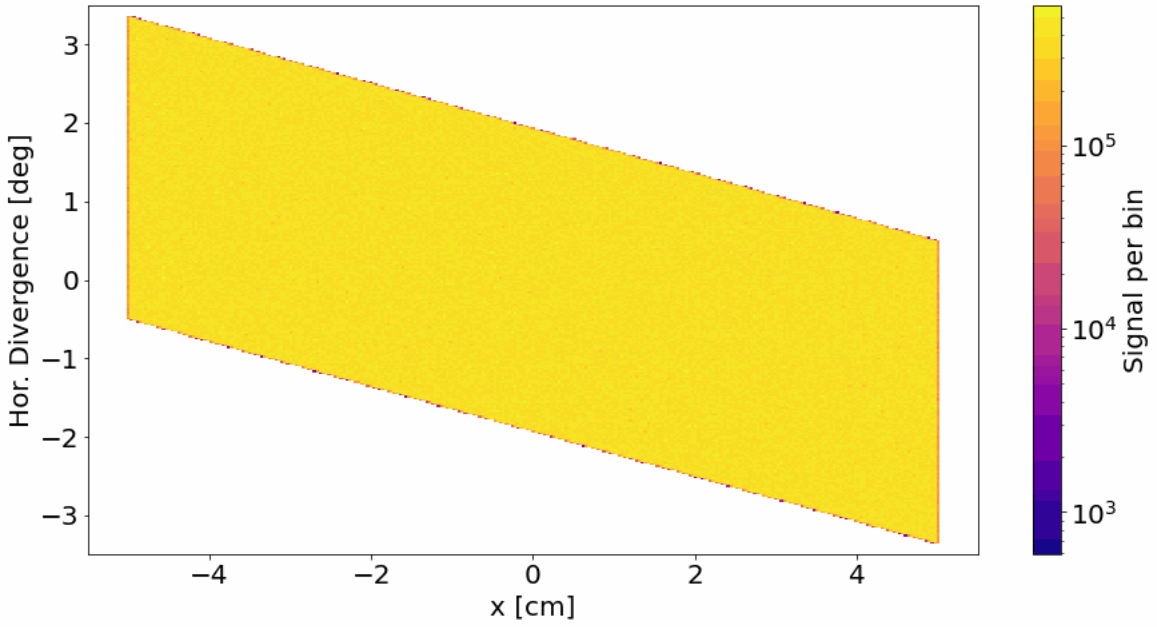


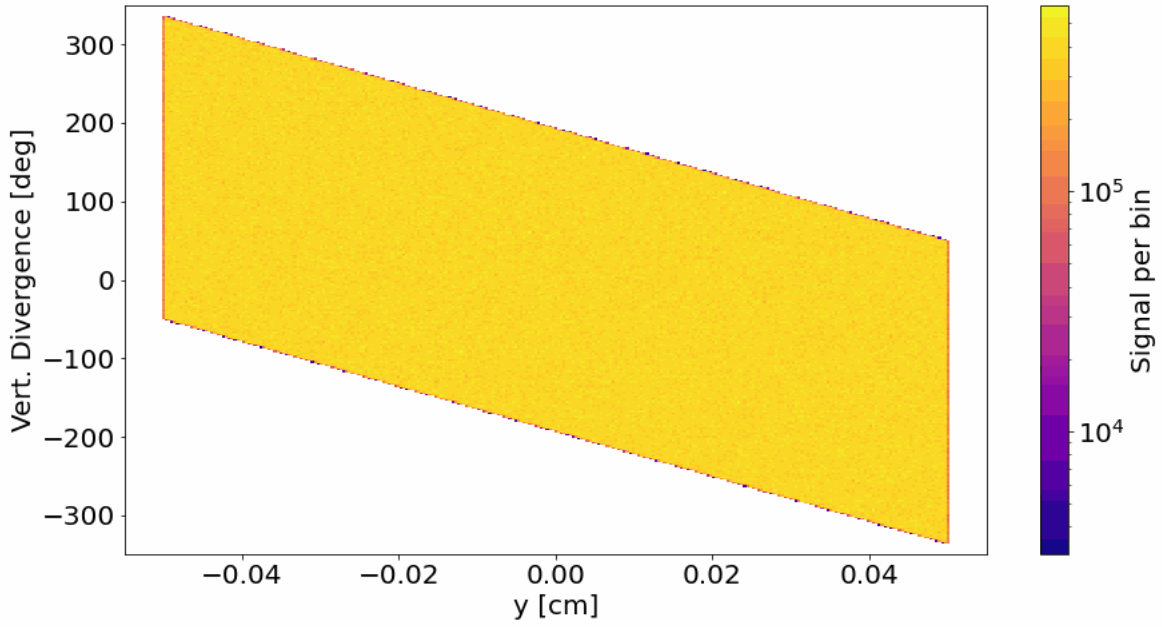
With gravity



Balistic guide with and without gravity

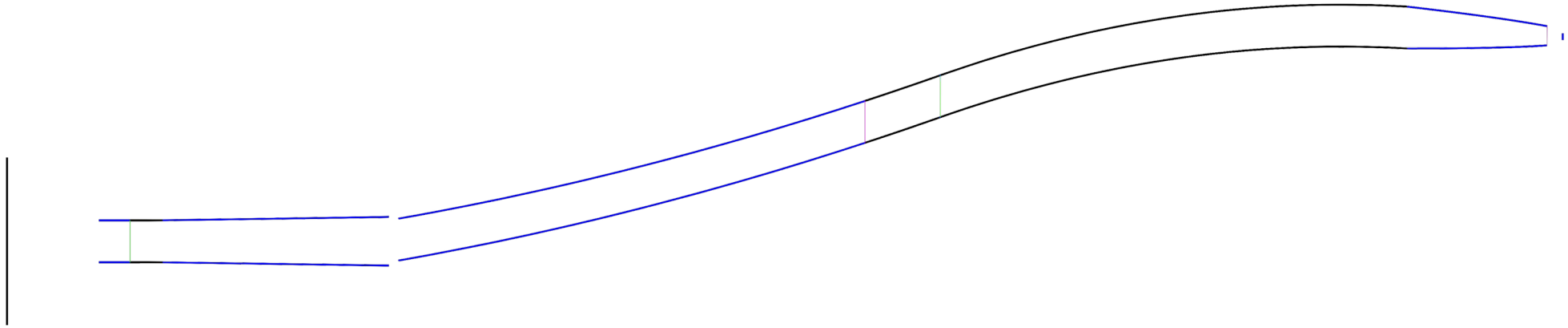
With gravity





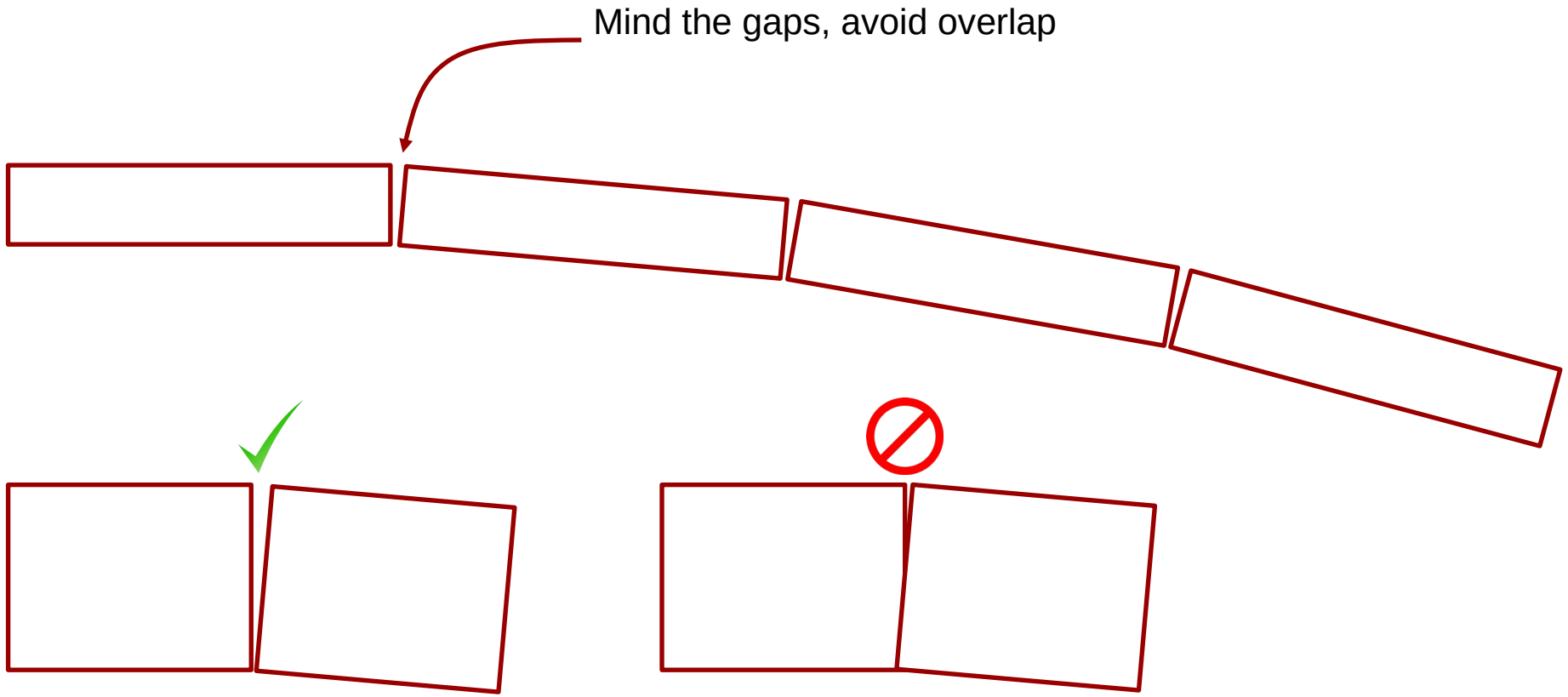
Breaking line of sight

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



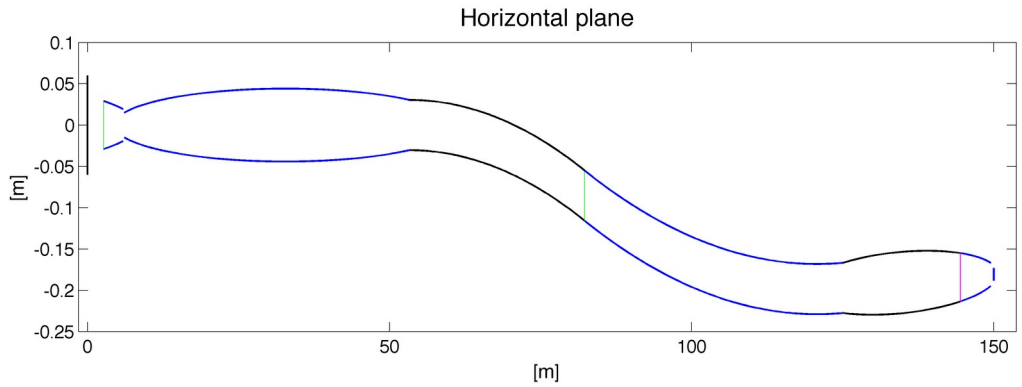
Breaking line of sight

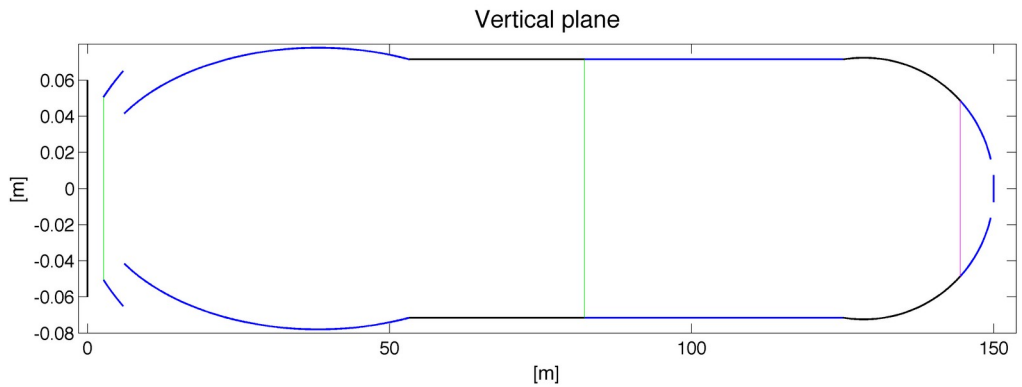
- Bender / Guide_curved component or many straight sections

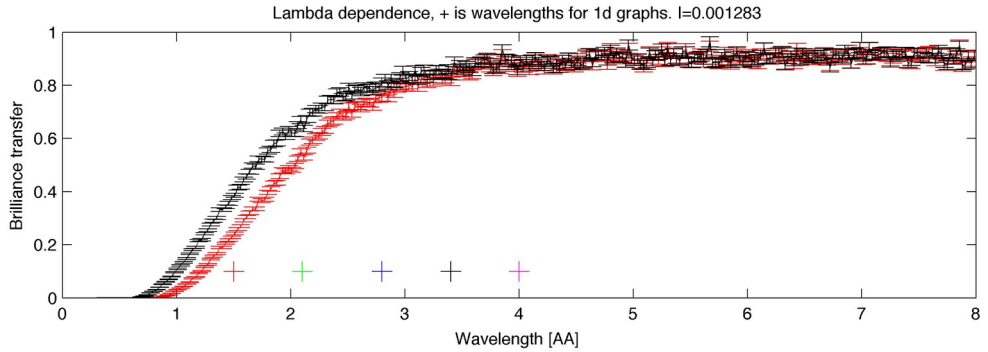


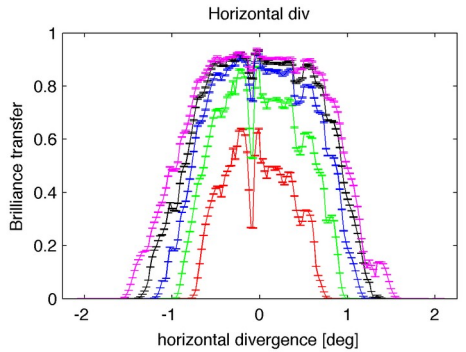
Guide optimization

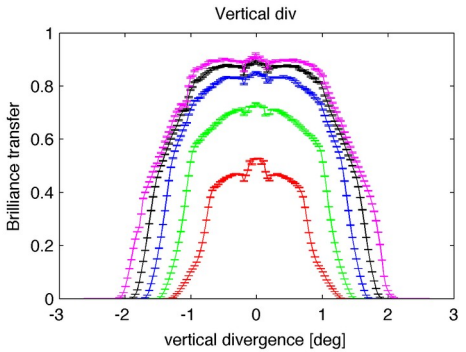
- Optimization result from MATLAB guide_bot
- Python guide_bot available

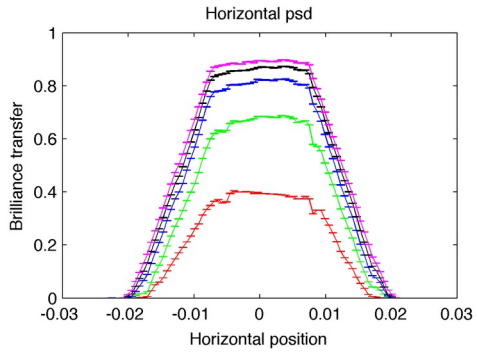


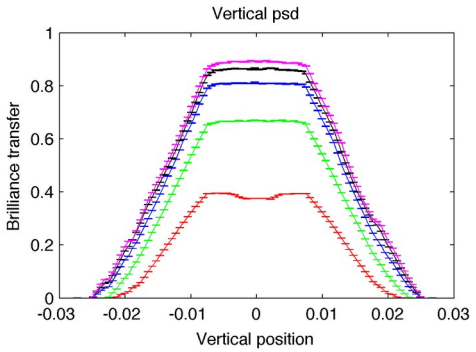








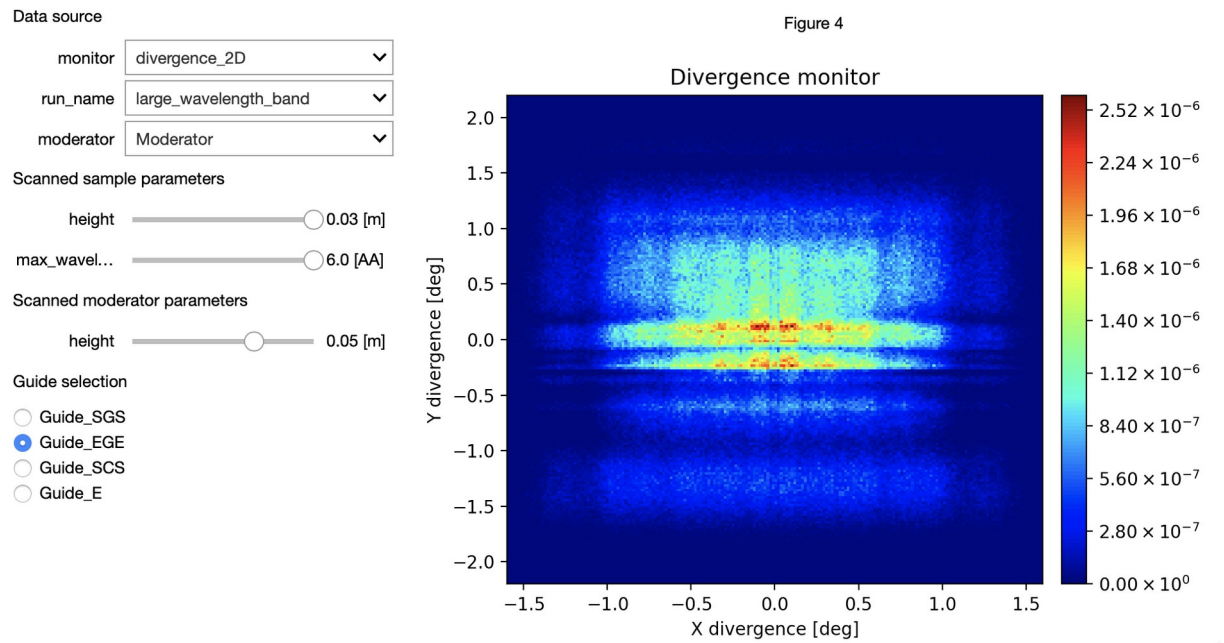




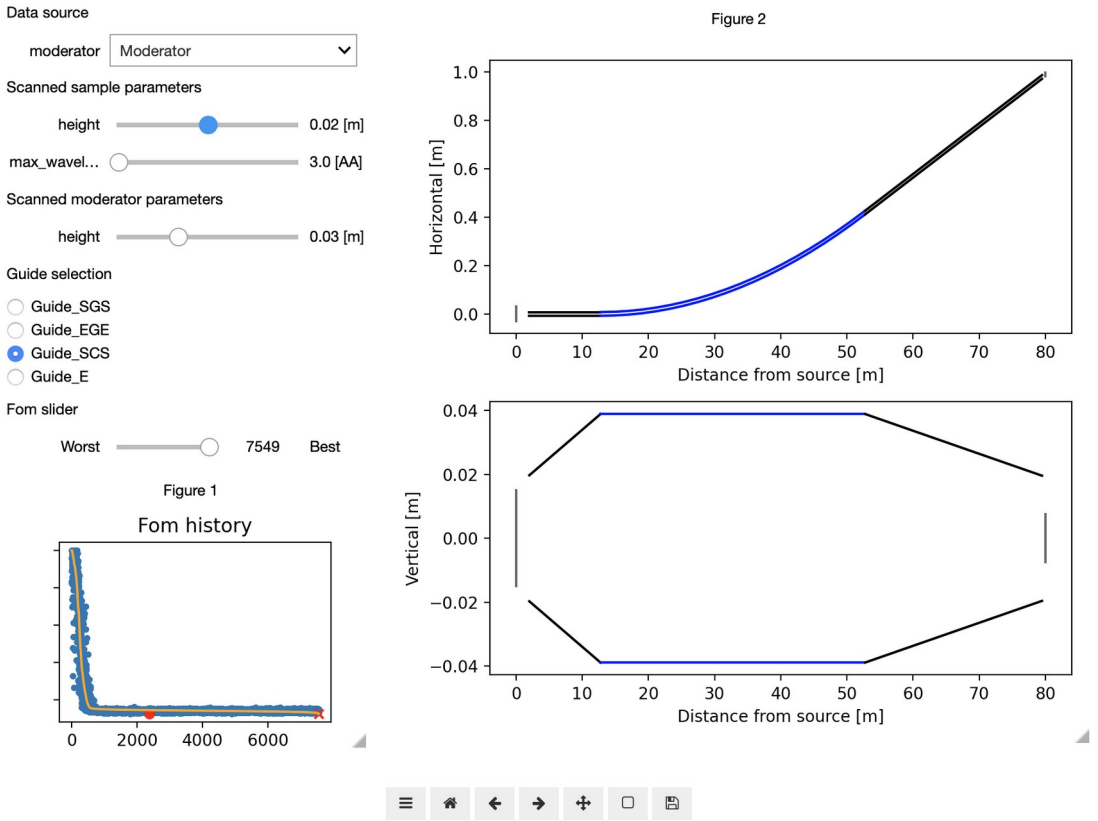
Guide optimization

- Optimization results from python guide_bot
- pip install guide_bot --upgrade

```
In [13]: results.plot_any_monitor()
```




```
In [11]: results.plot_guide()
```



Solution on github, use if you are stuck

Guide exercise

- Start with instrument file provided on github

- **Task 1)**
  - Compare output for two different guide lengths
- **Task 2)**
  - Introduce a parameter that control width of the guide
  - Compare two runs with different guide widths
- **Task 3)**
  - Check how much gravity impacts the output
- **Task 4)**
  - Exchange the last 20% of the guide with an elliptic nose.
  - See the geometry with mcdisplay
  - Identify how the resulting beam have changed