

# Guides and gravity in McStas

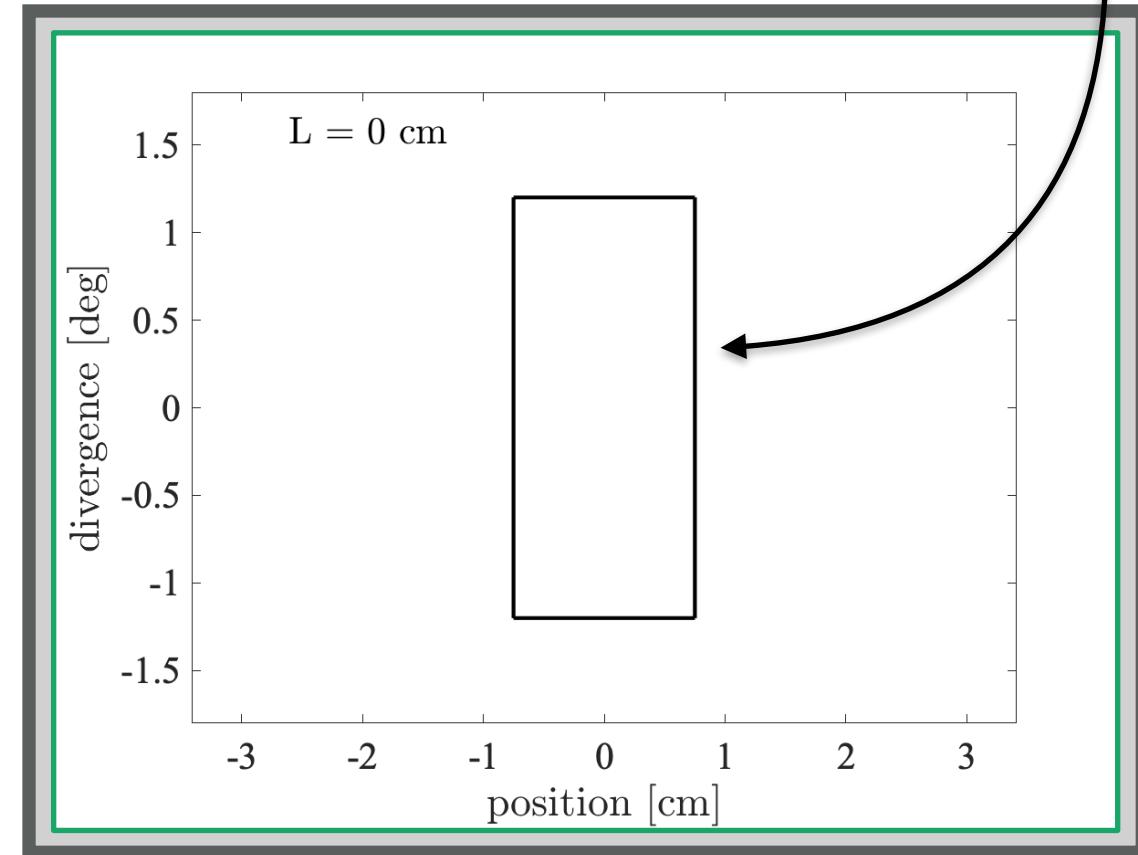
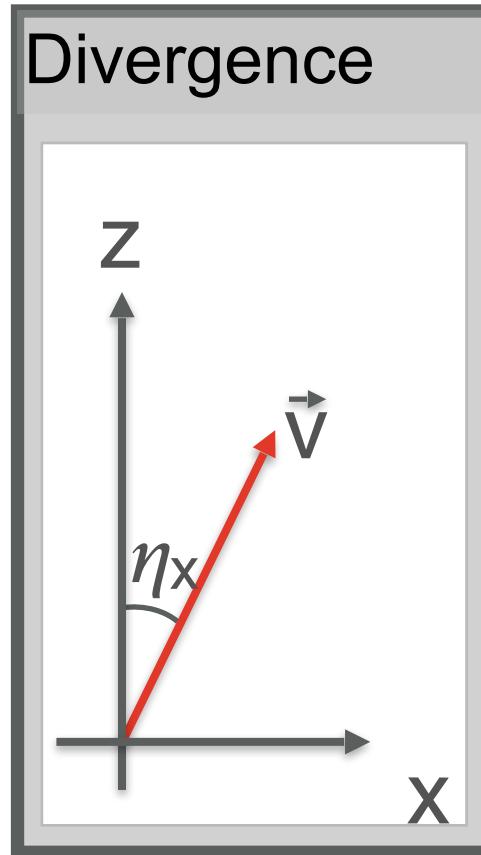
Mads Bertelsen

# 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
- Examples from guide\_bot
- Exercise

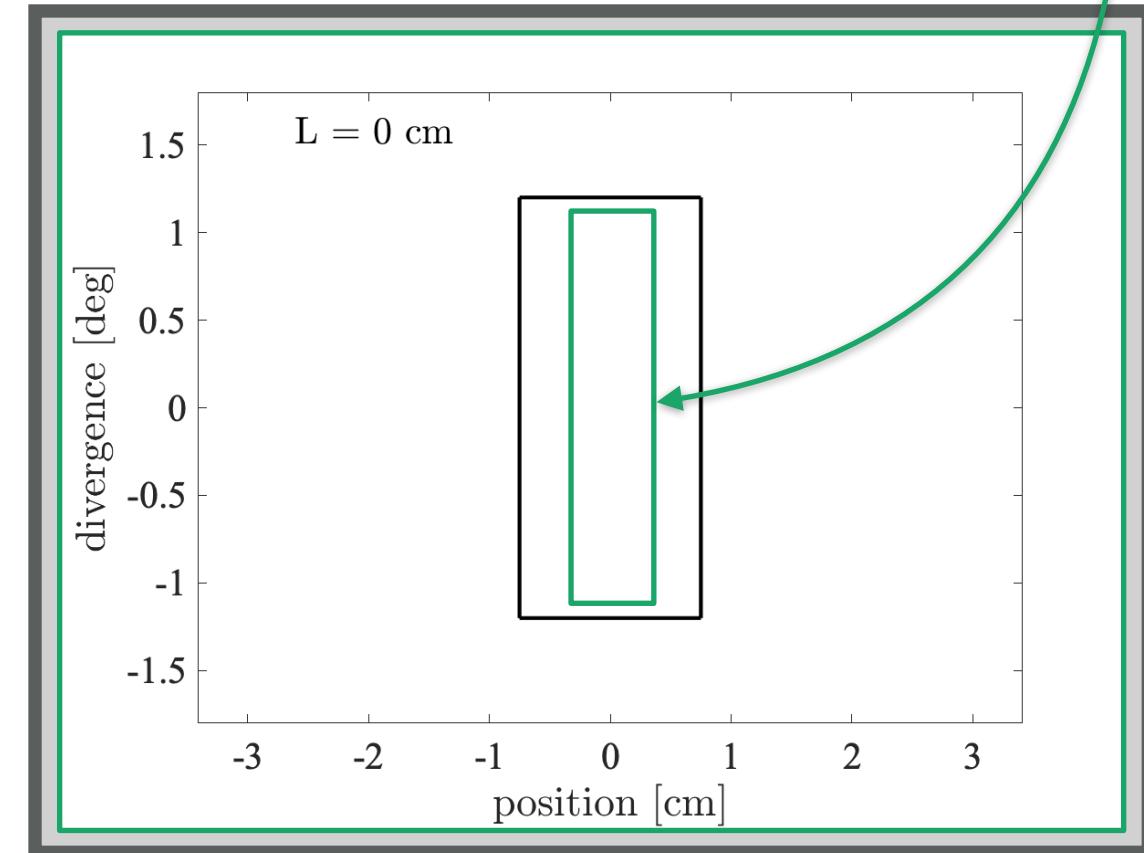
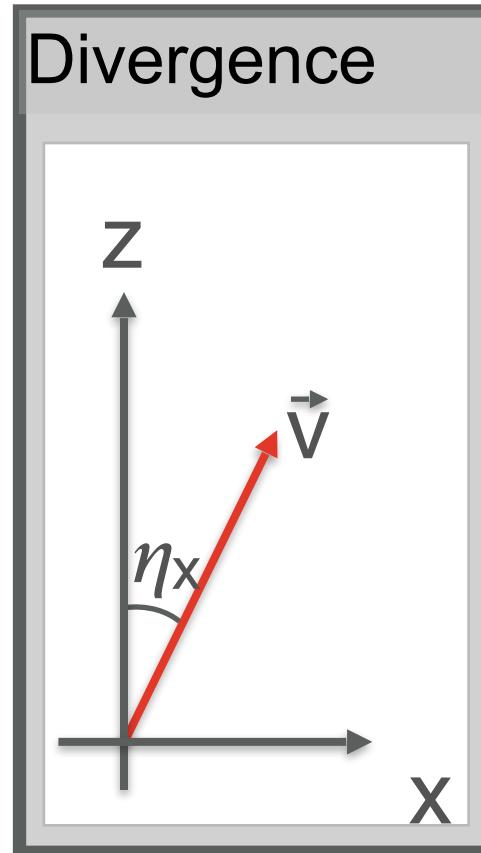
# Beam propagation in free space

“Phase-space” at source

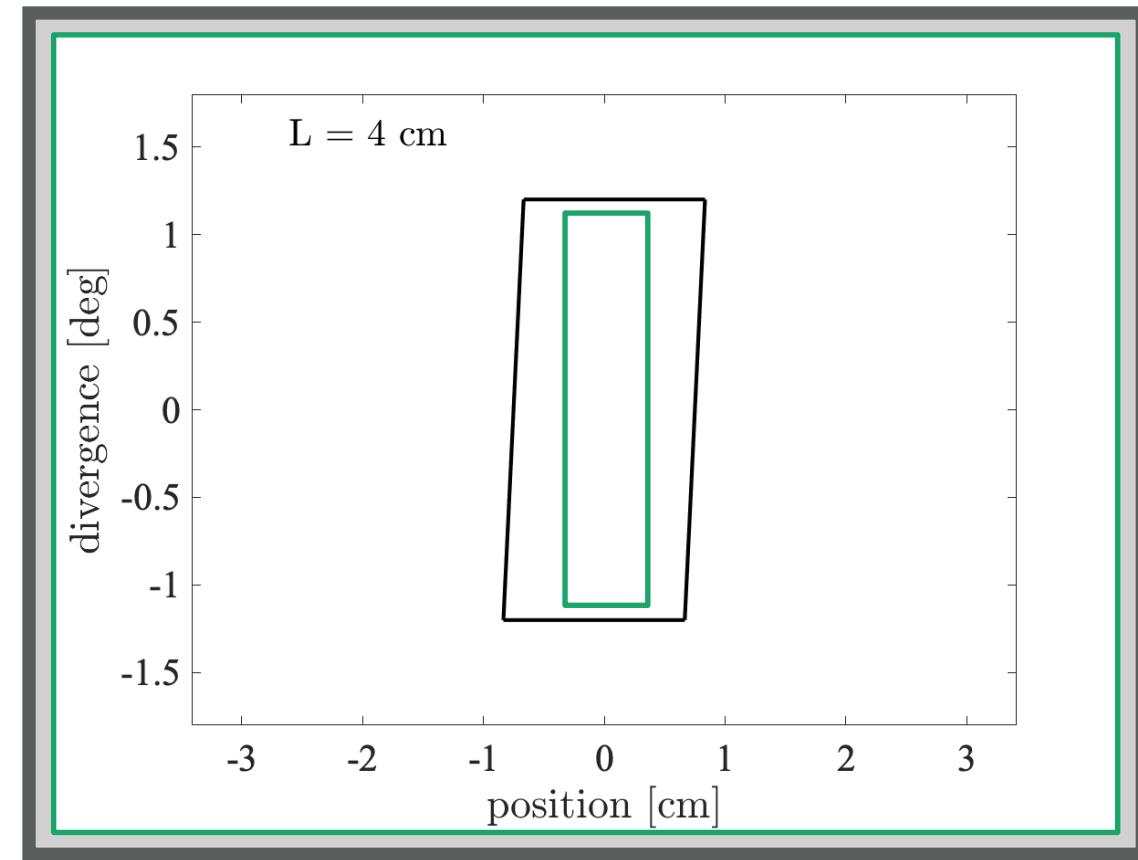
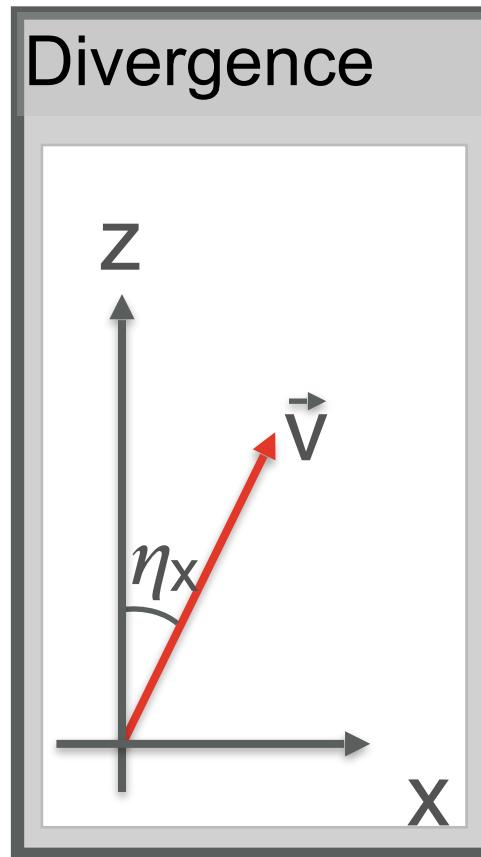


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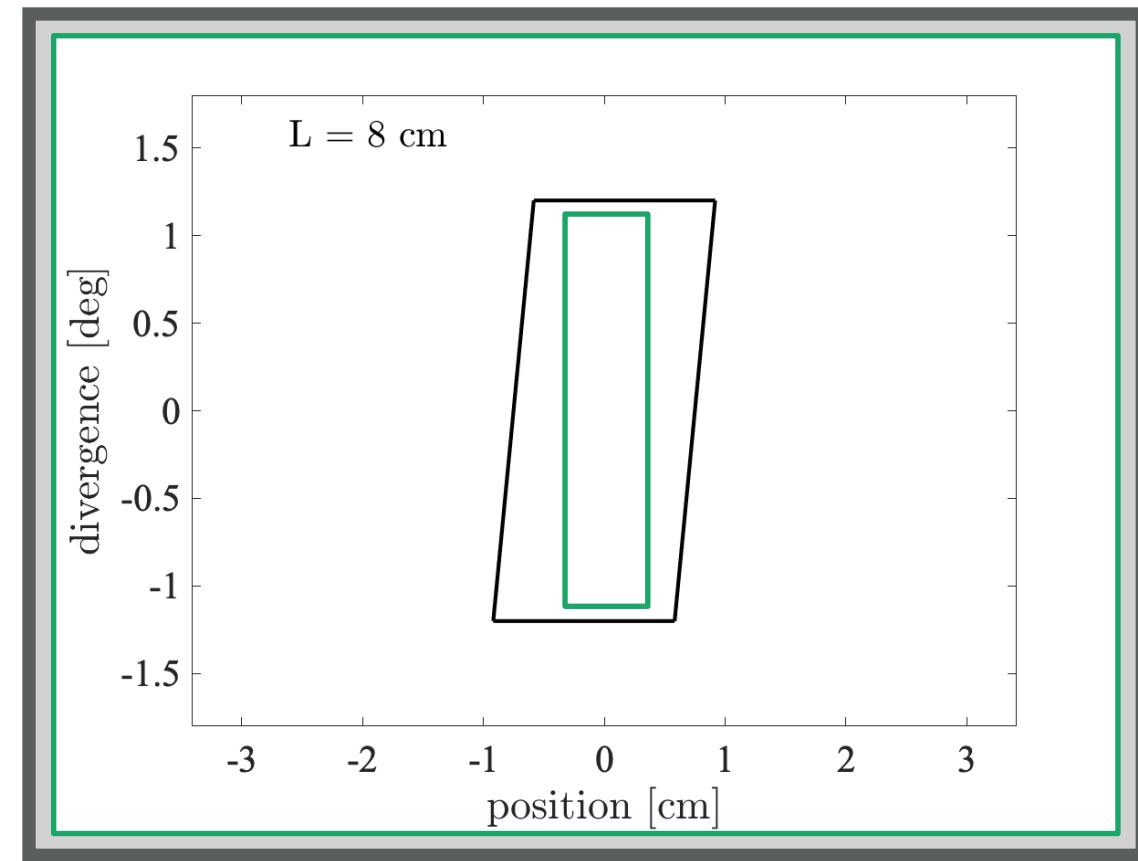
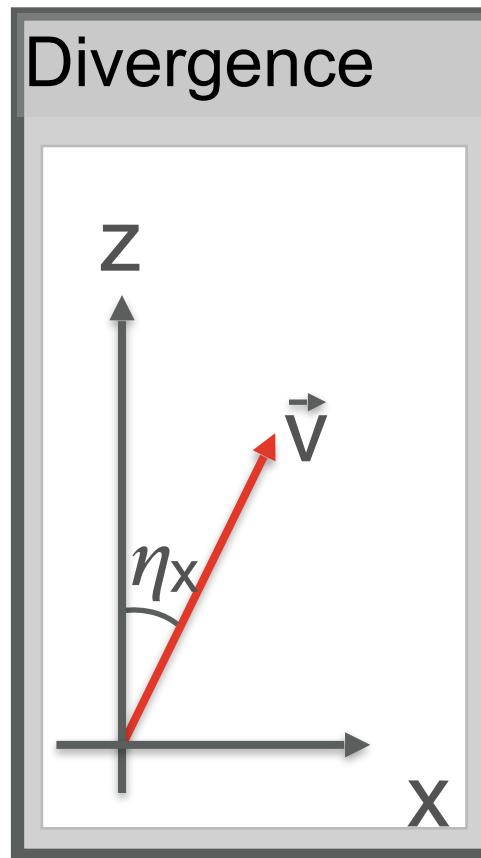
Wanted “phase-space” at sample



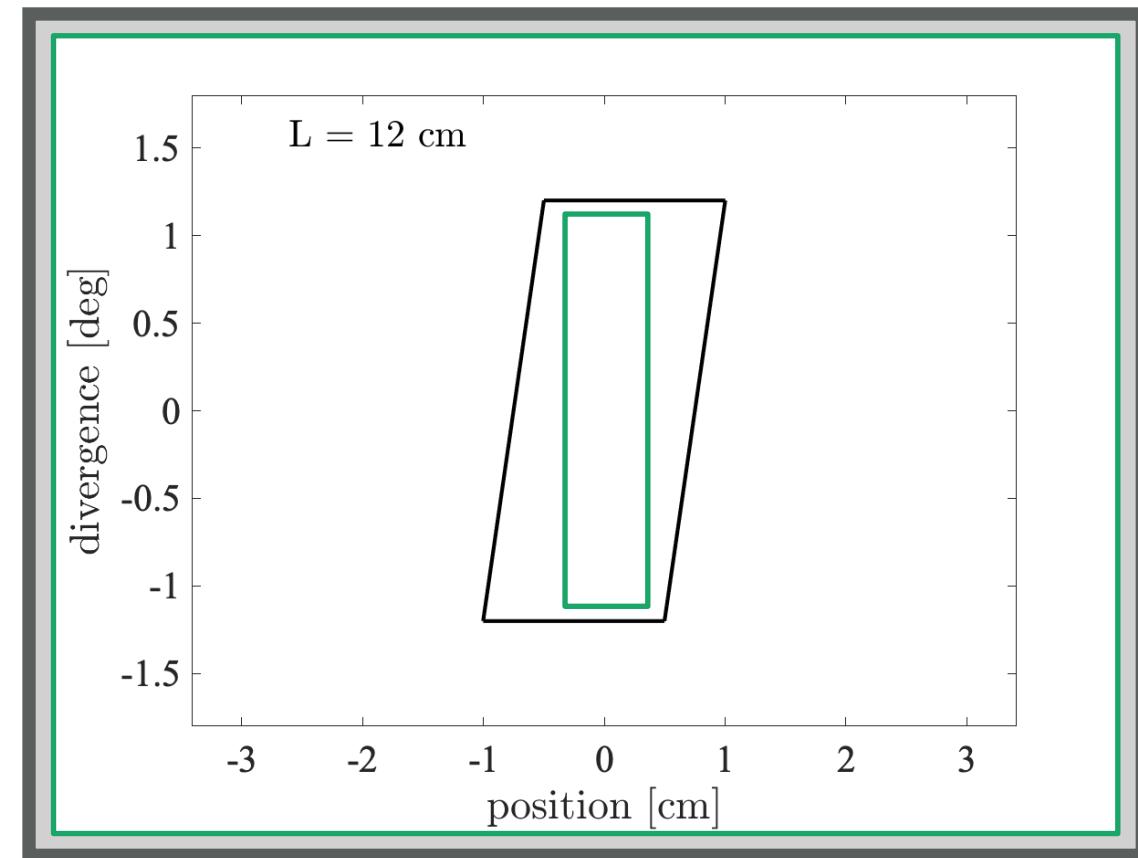
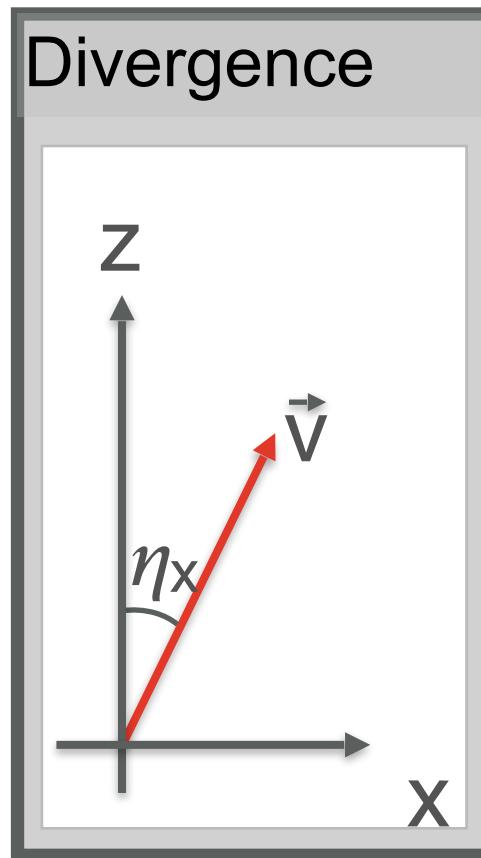
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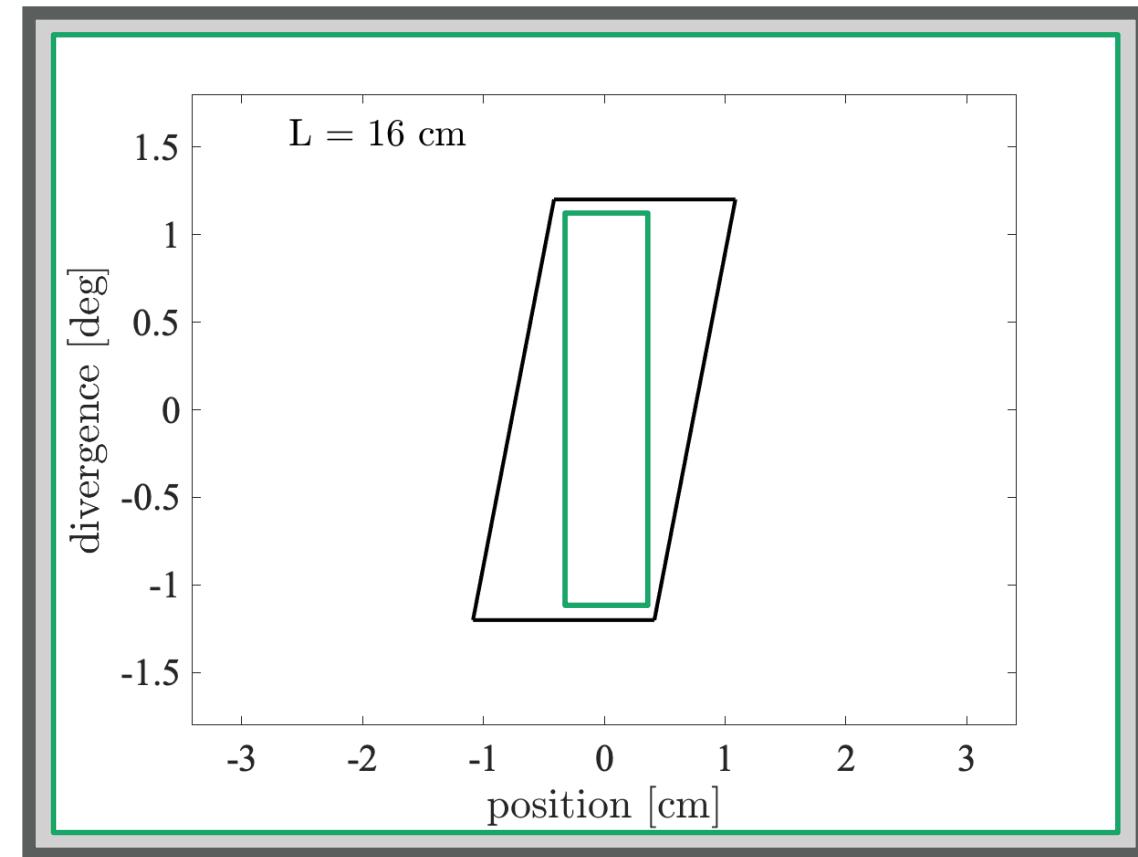
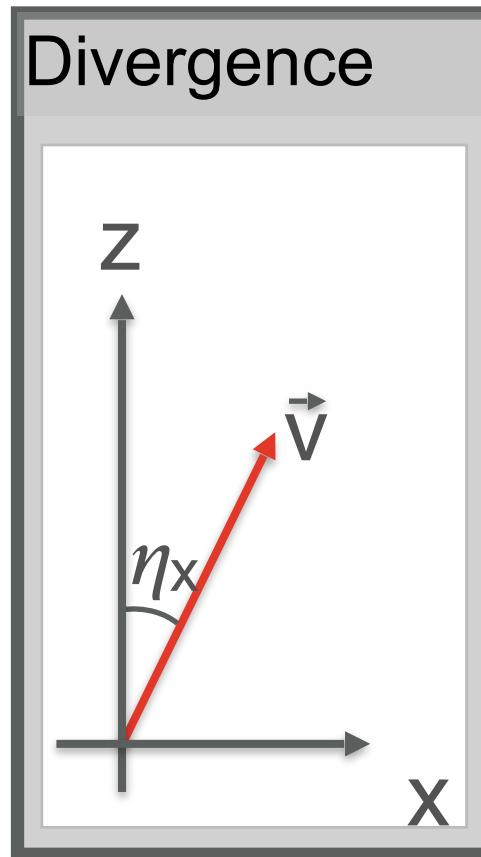
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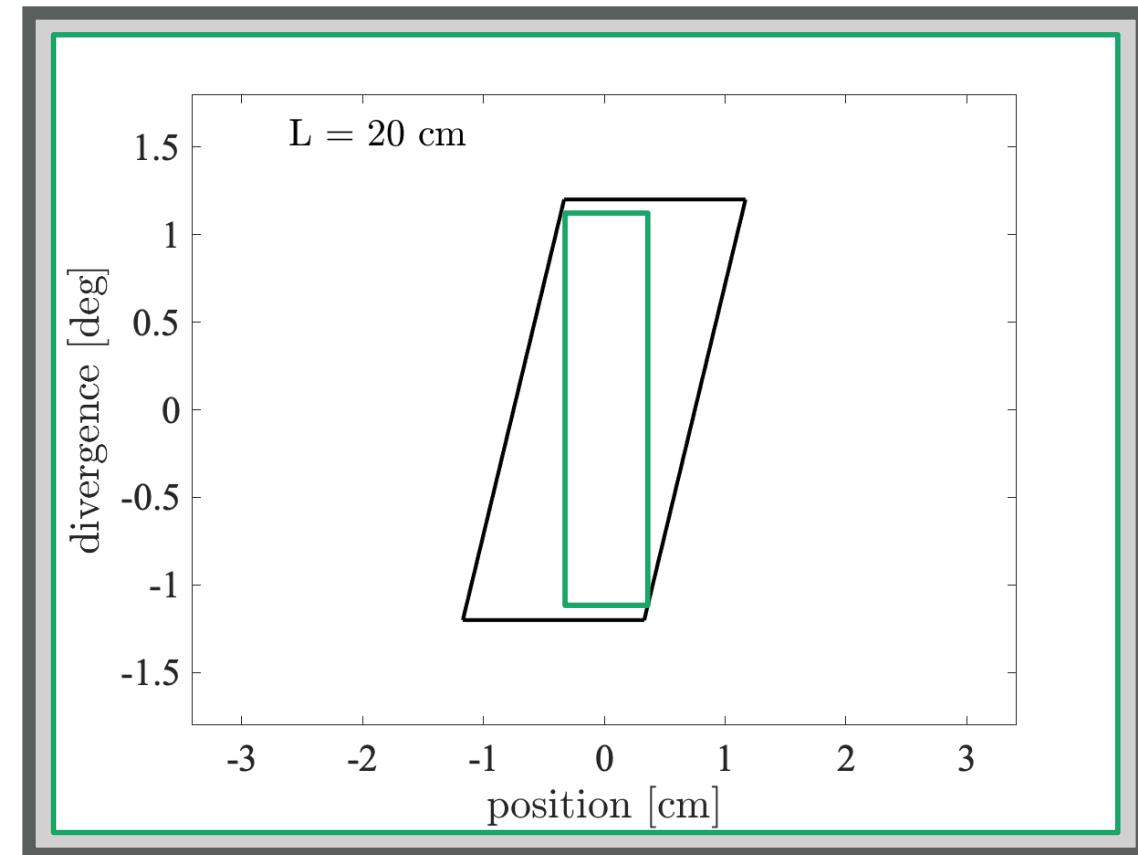
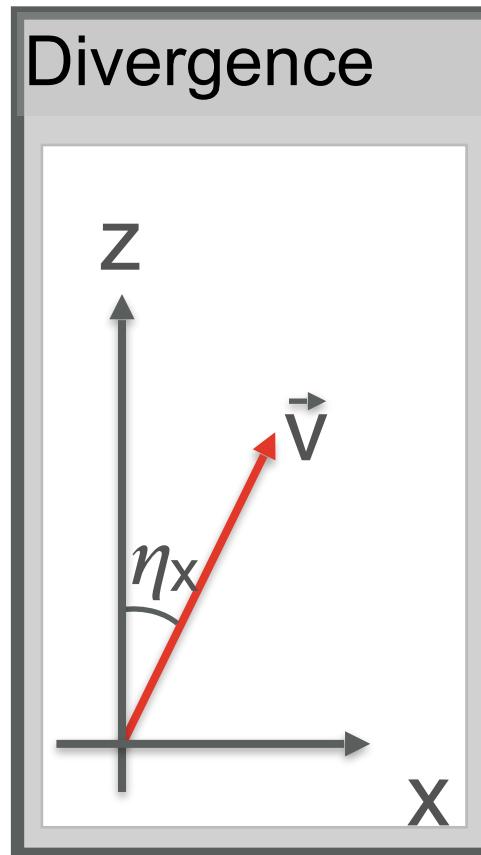
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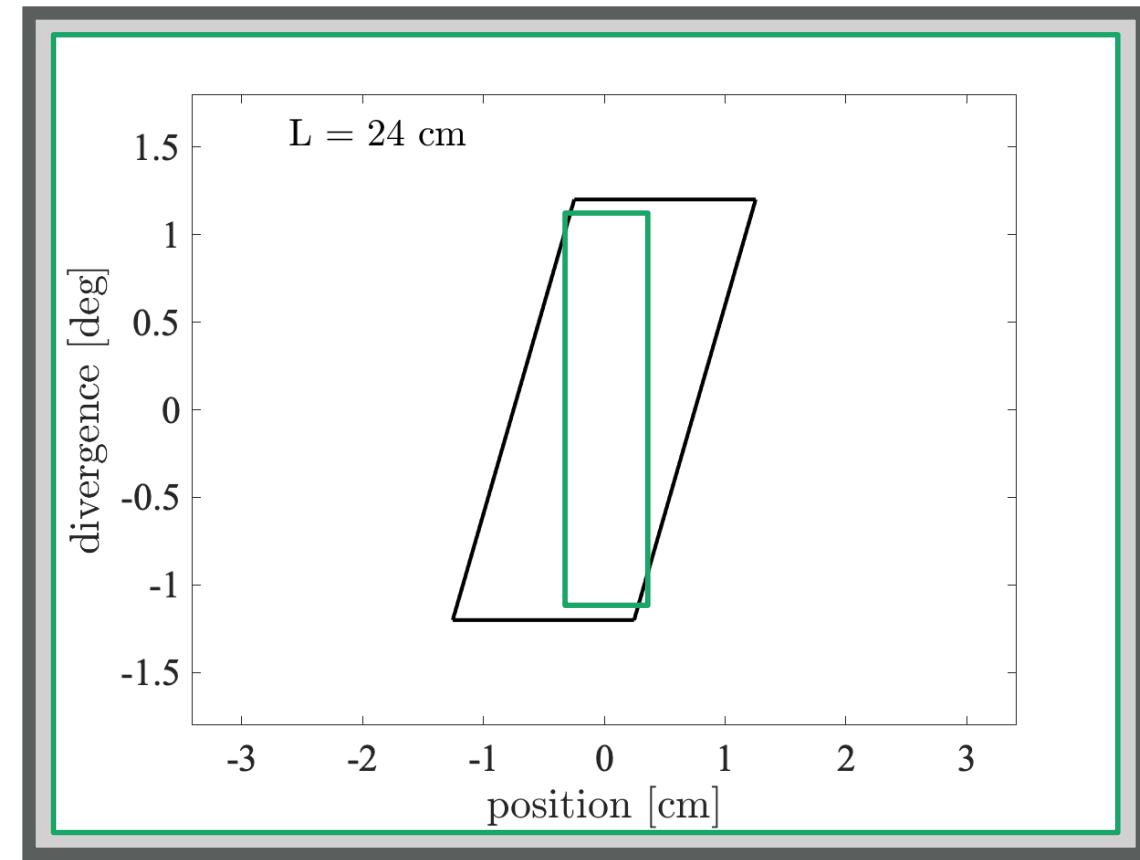
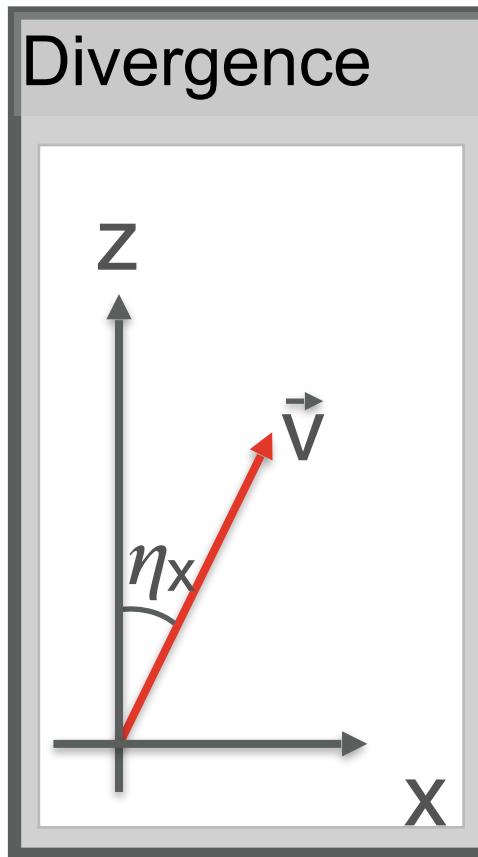
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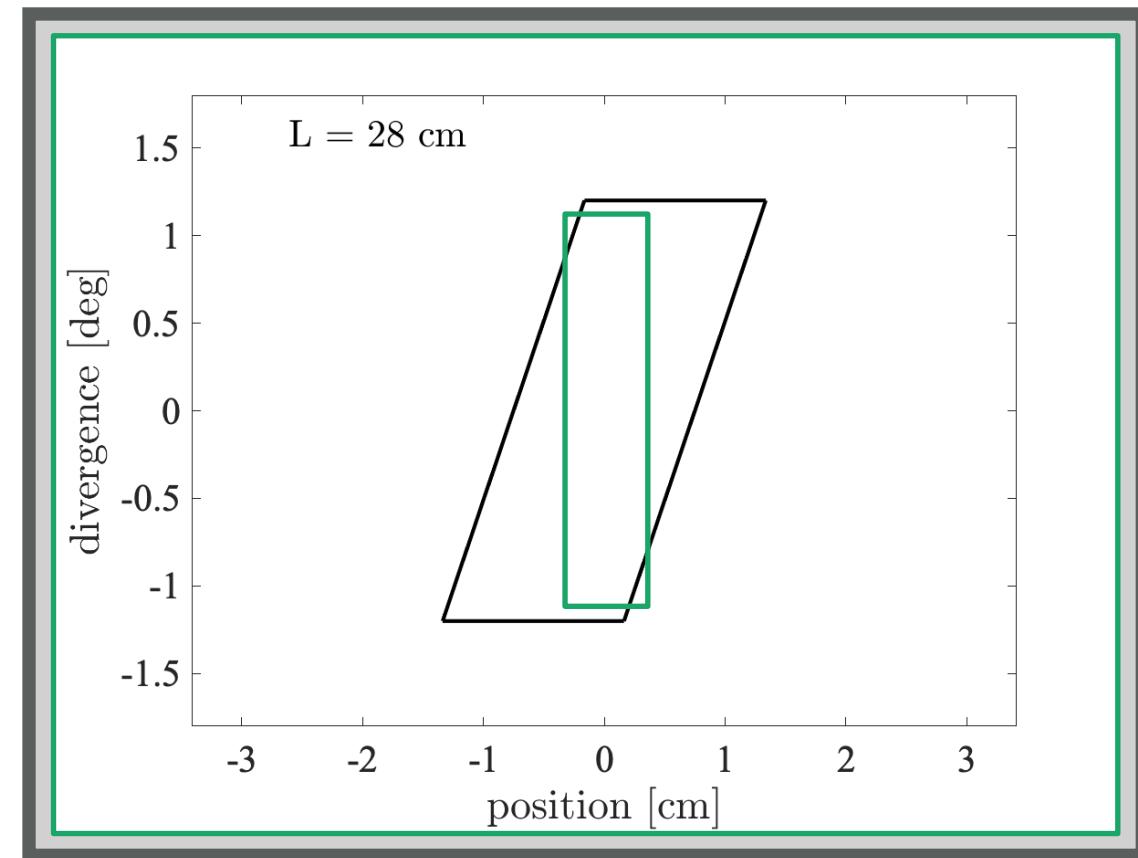
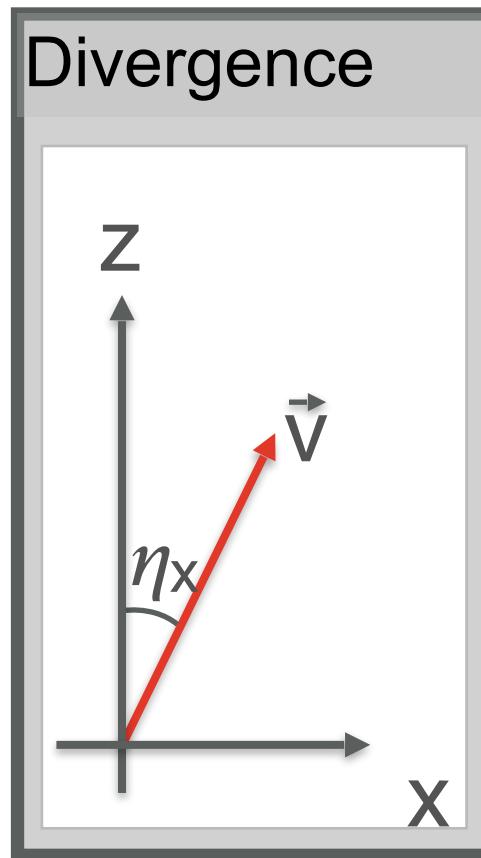
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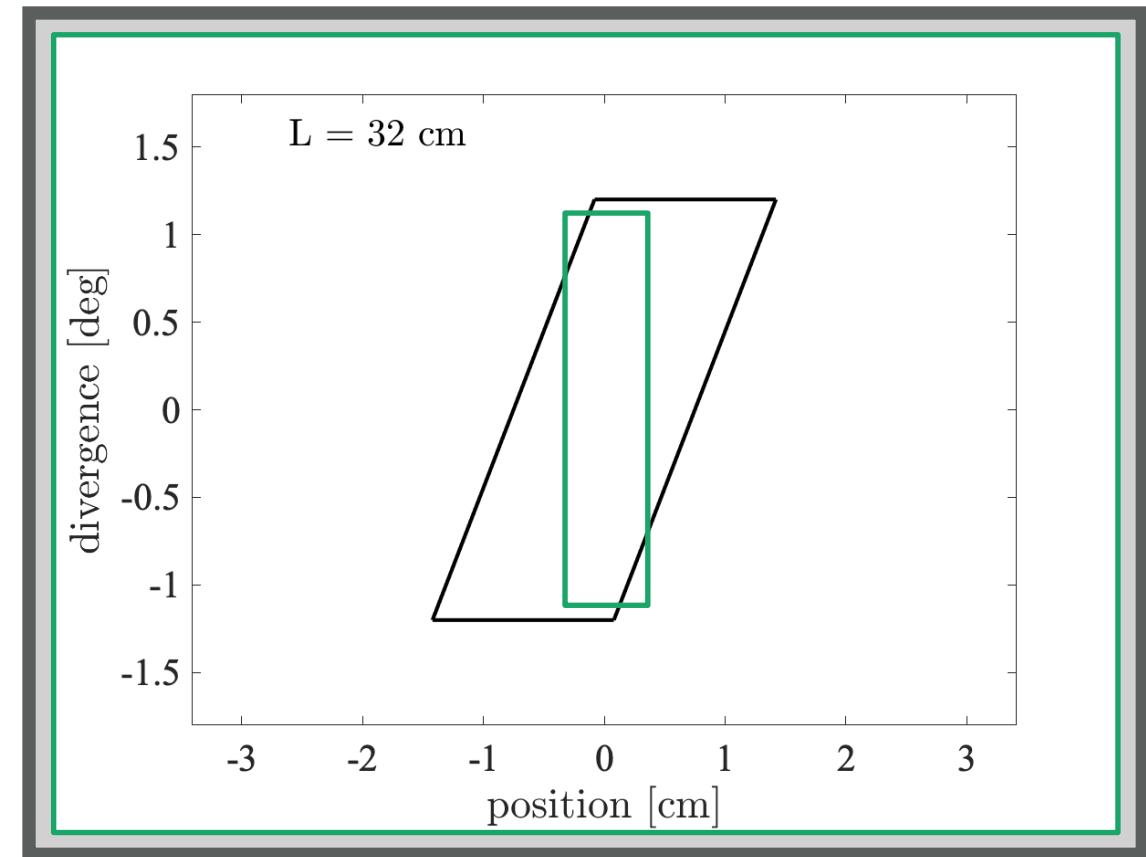
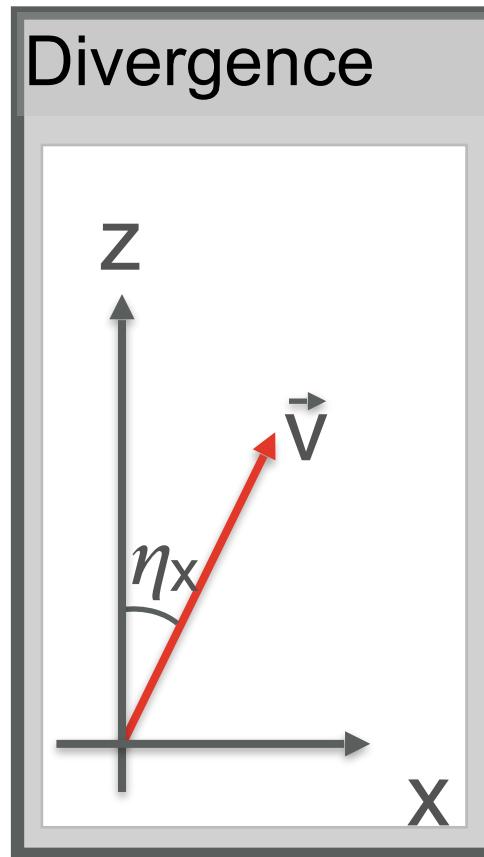
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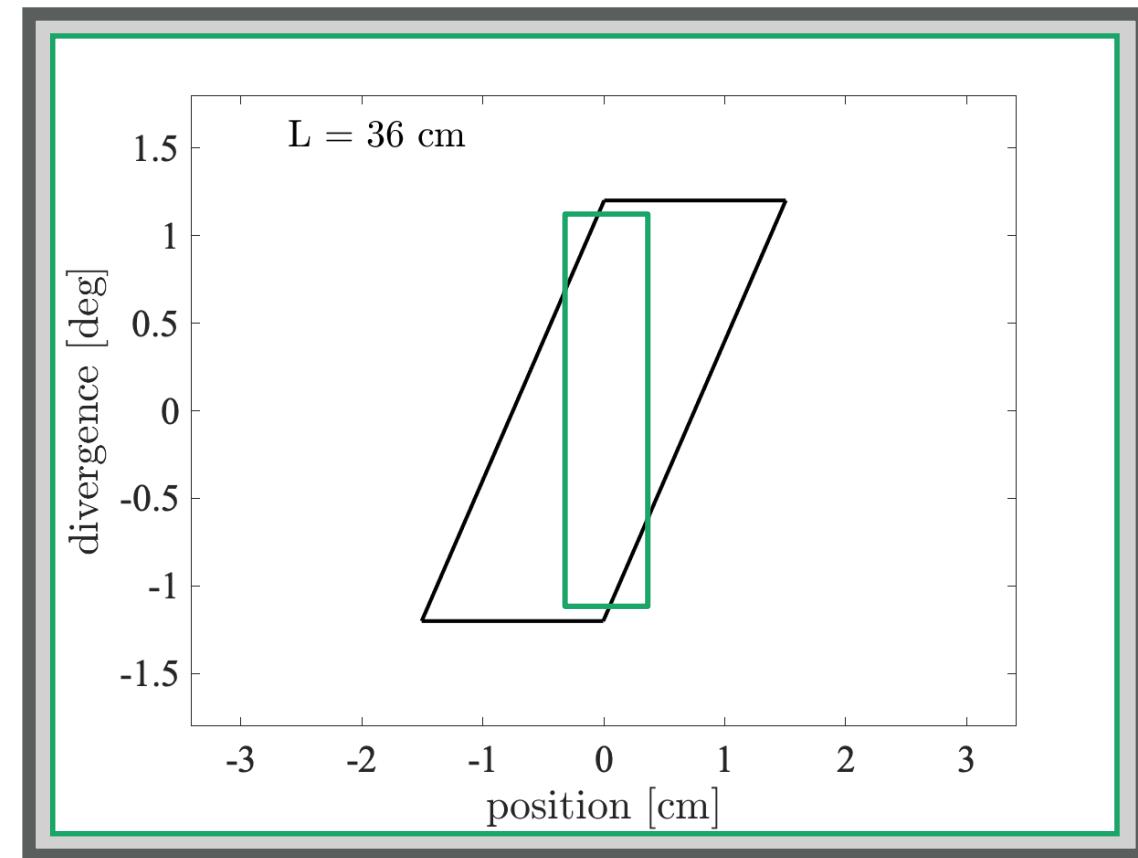
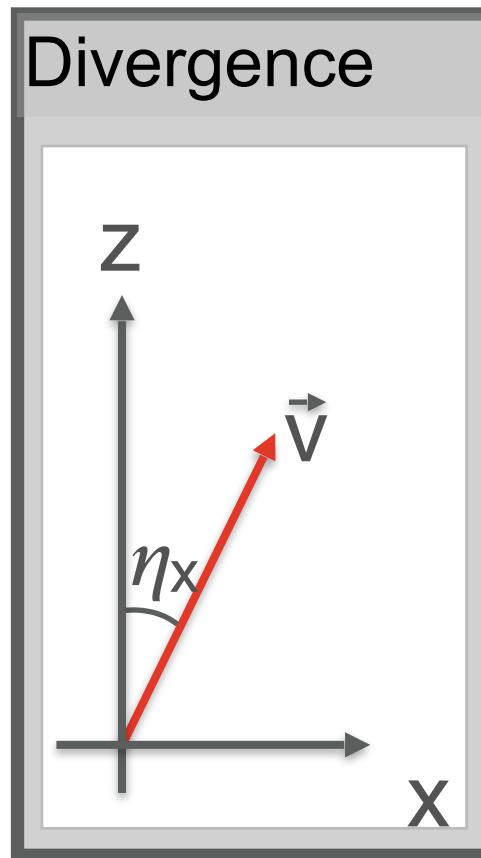
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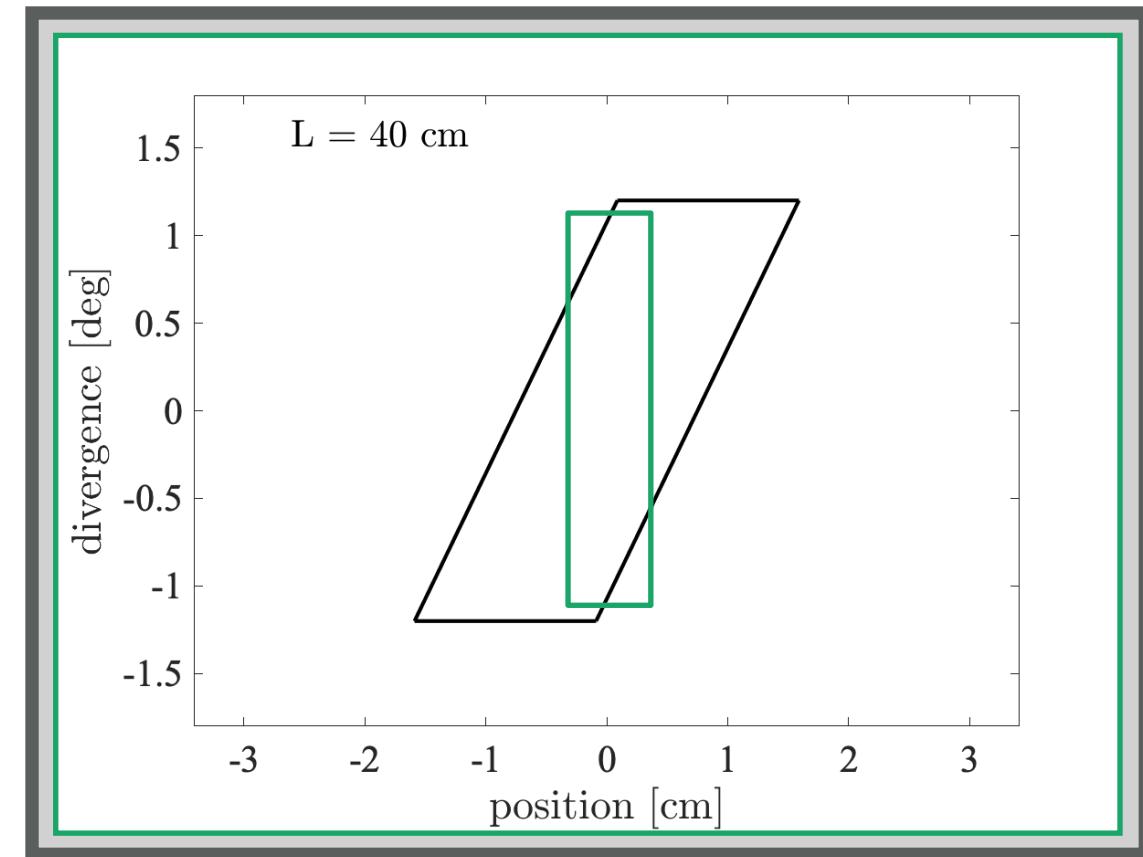
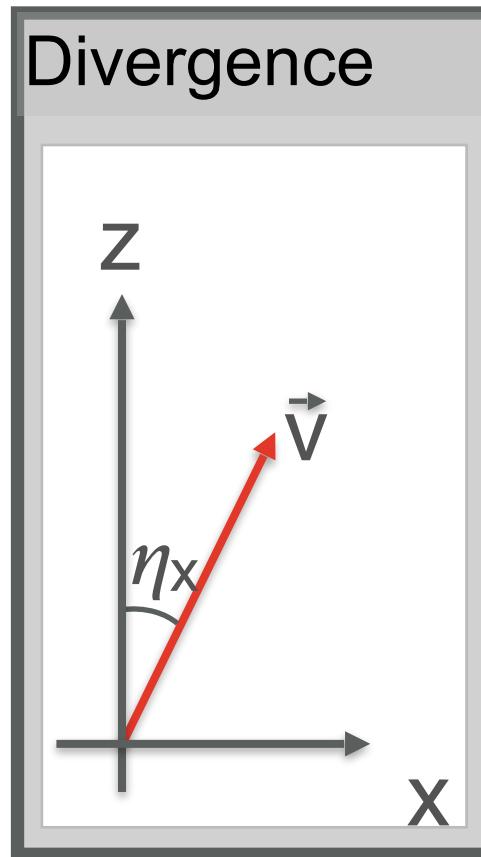
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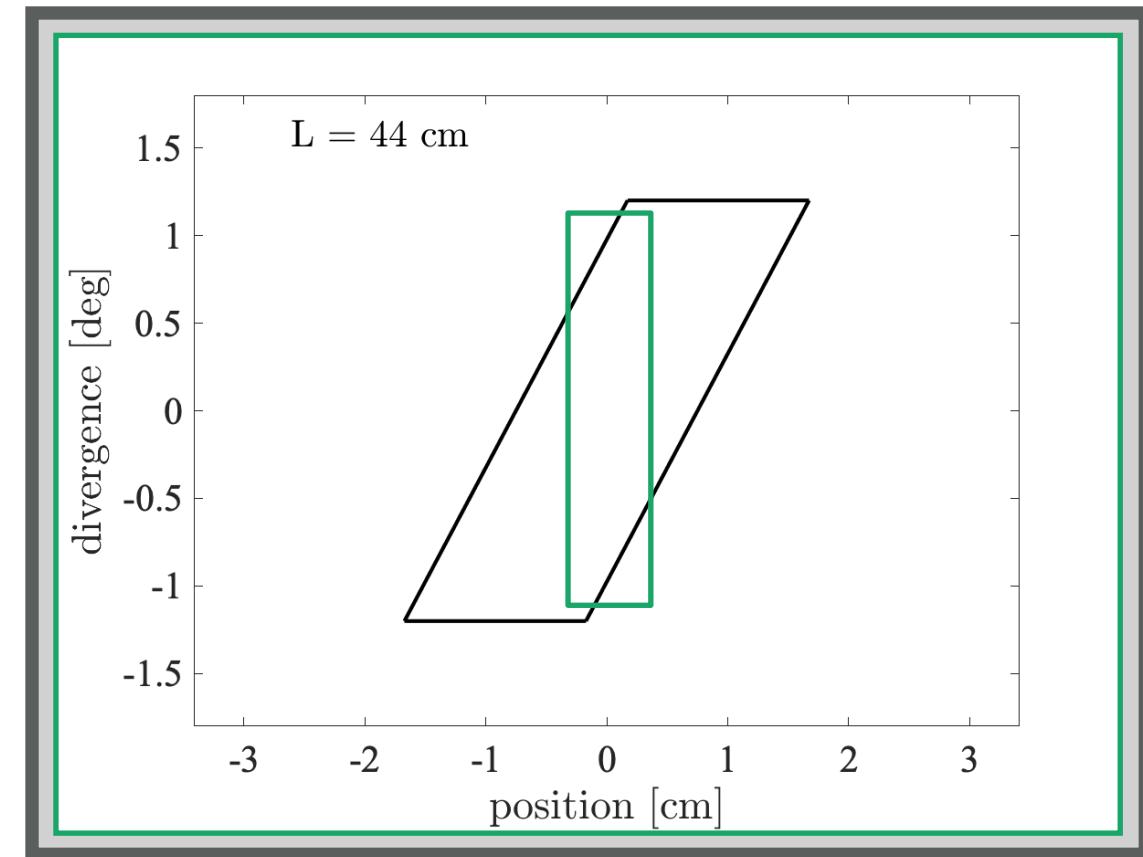
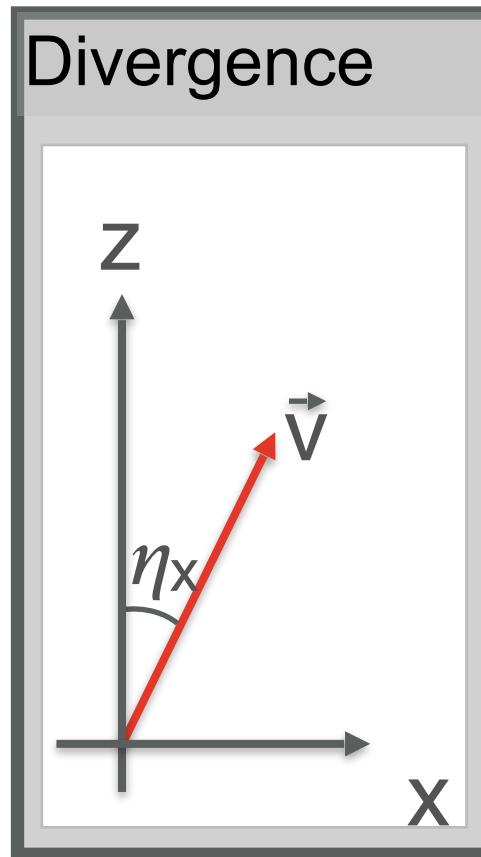
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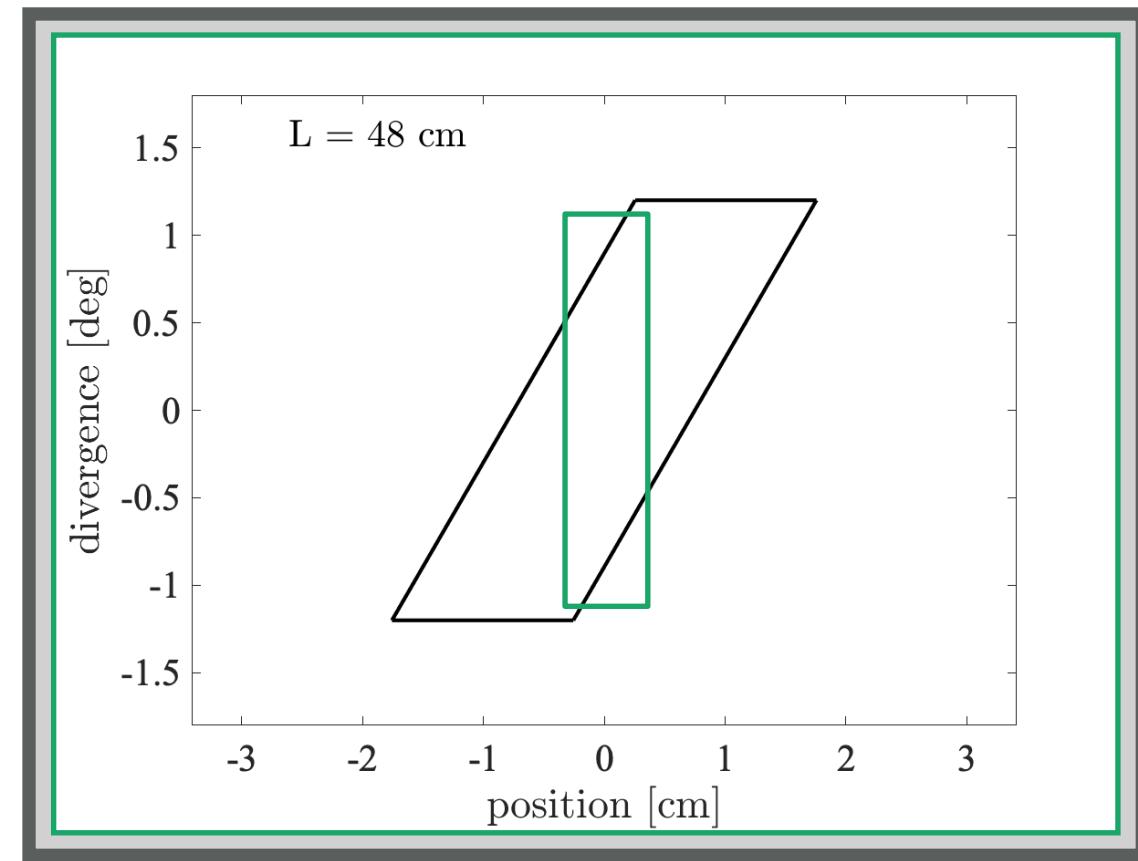
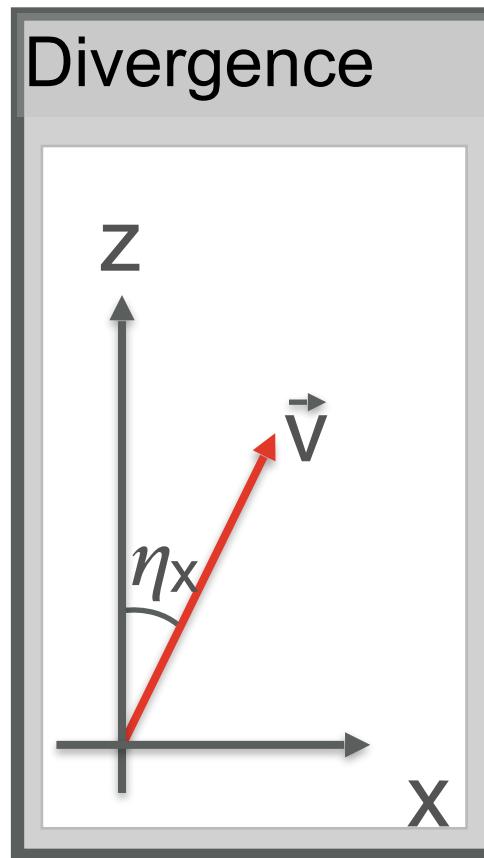
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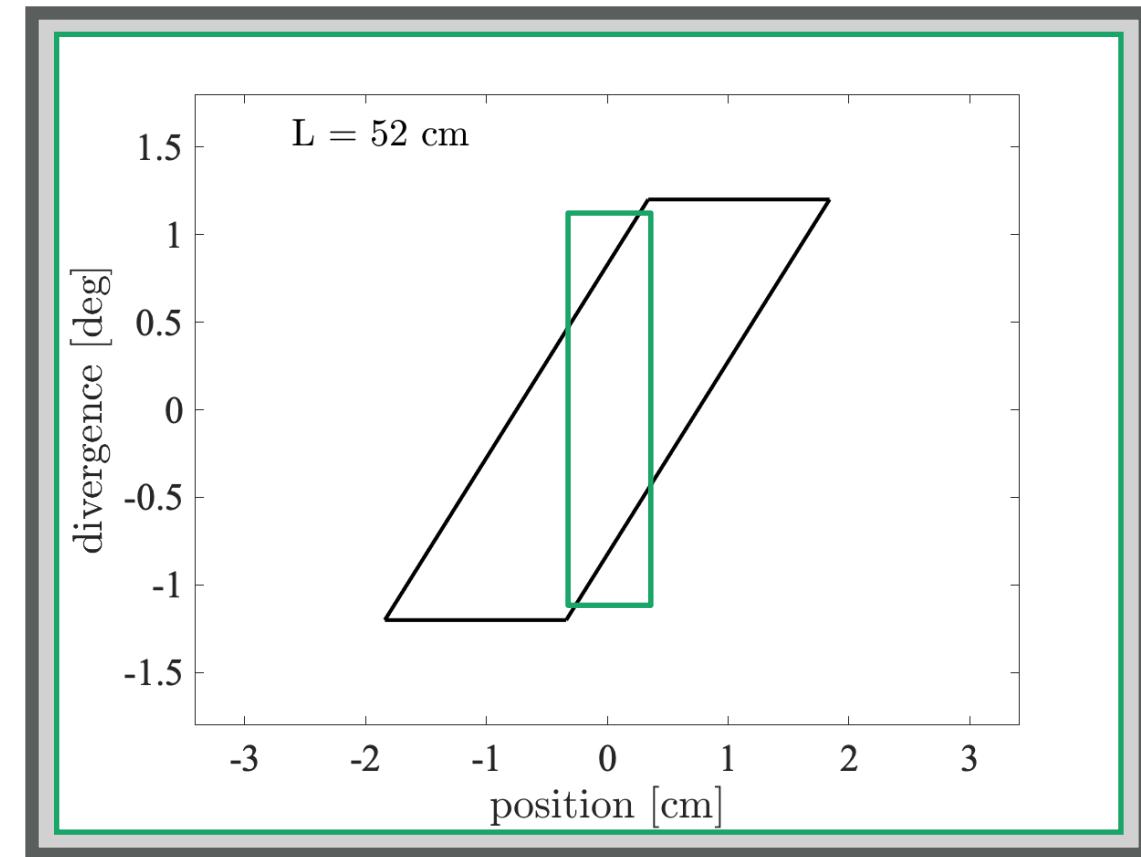
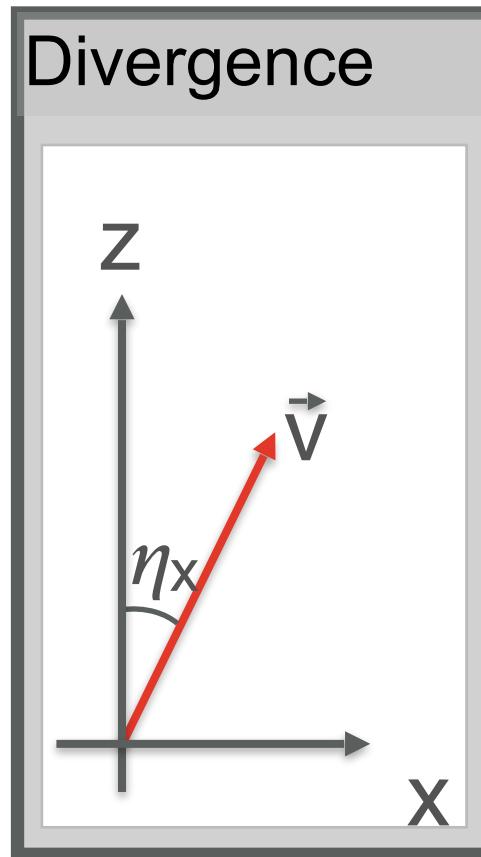
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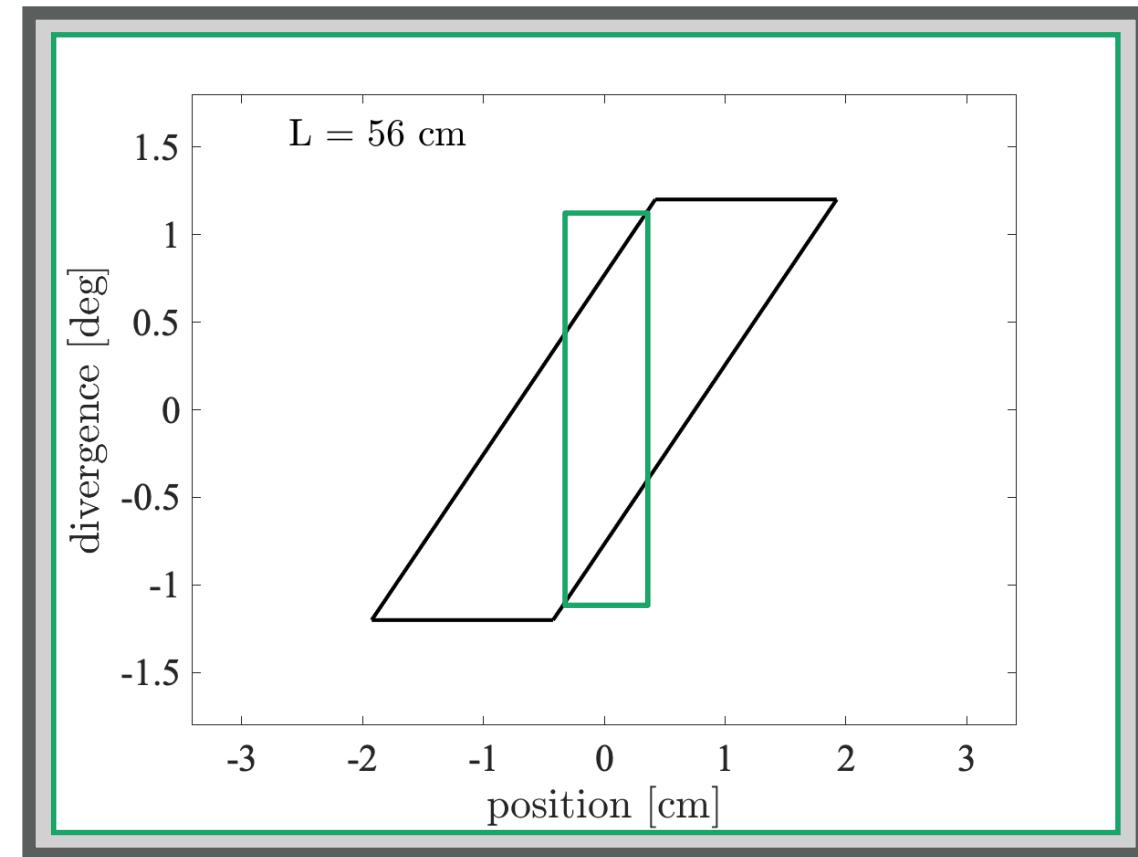
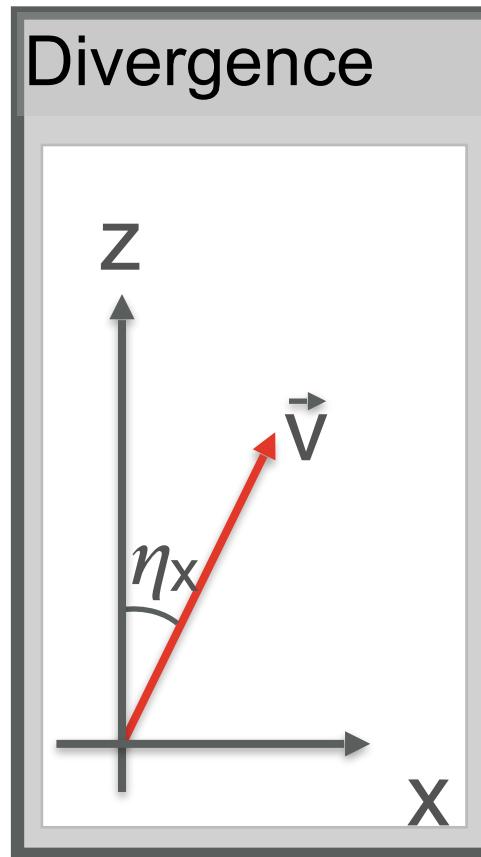
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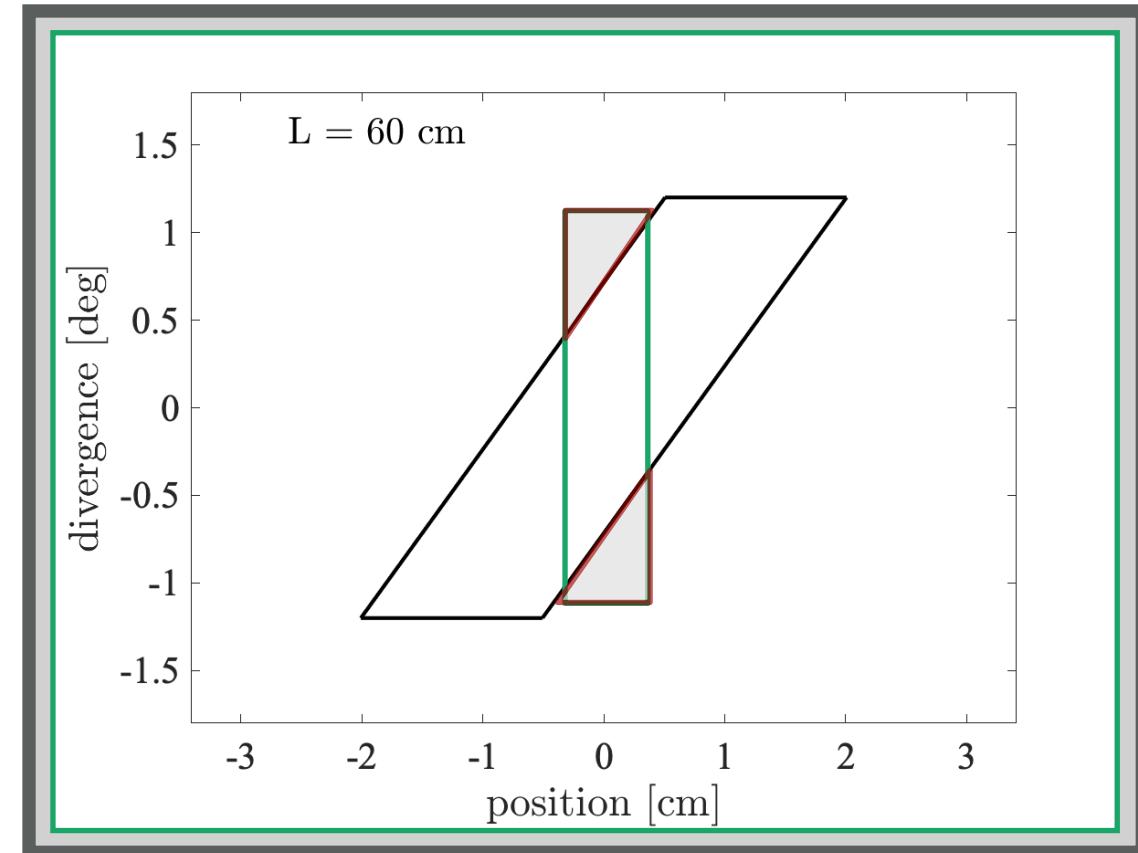
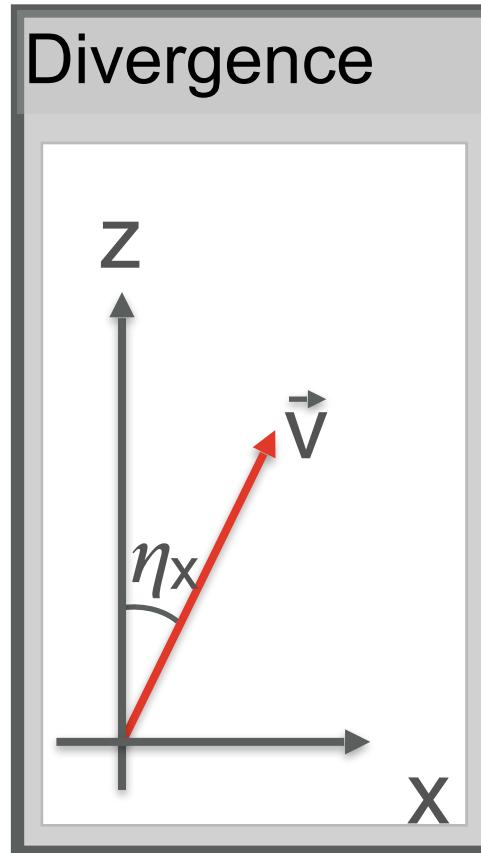


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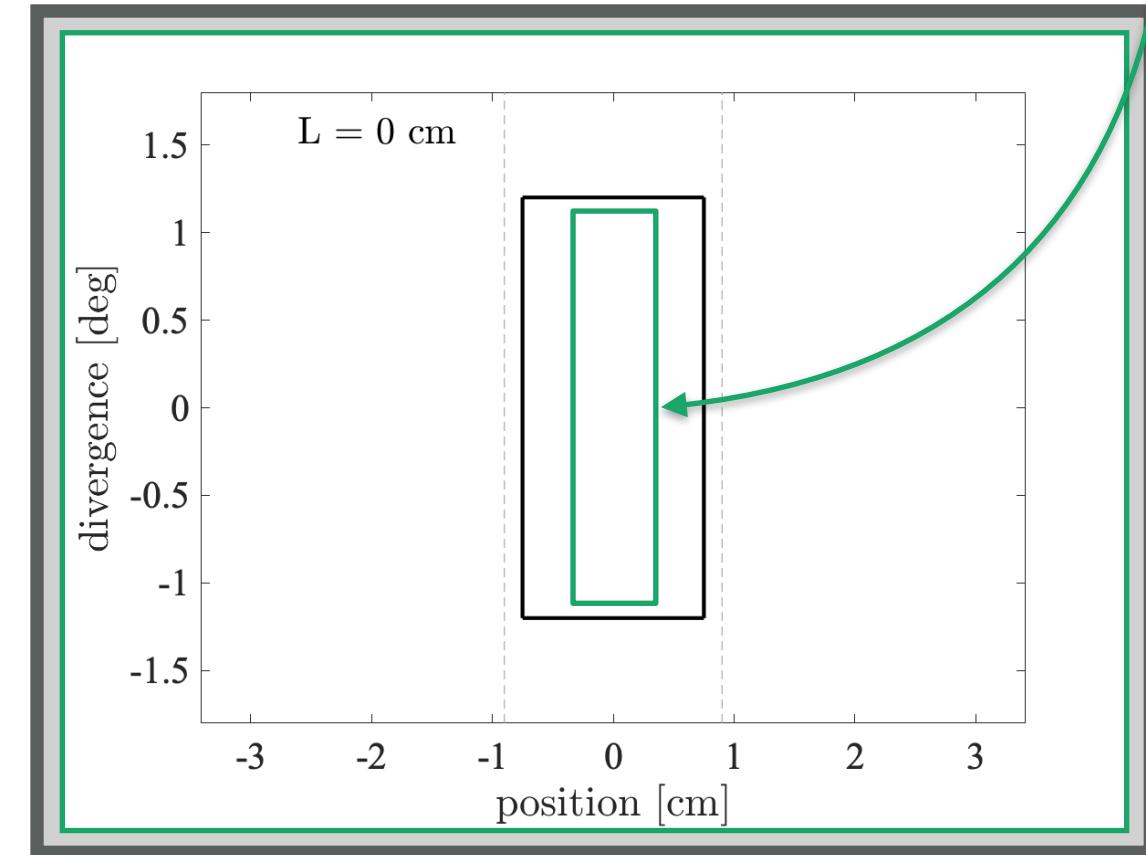
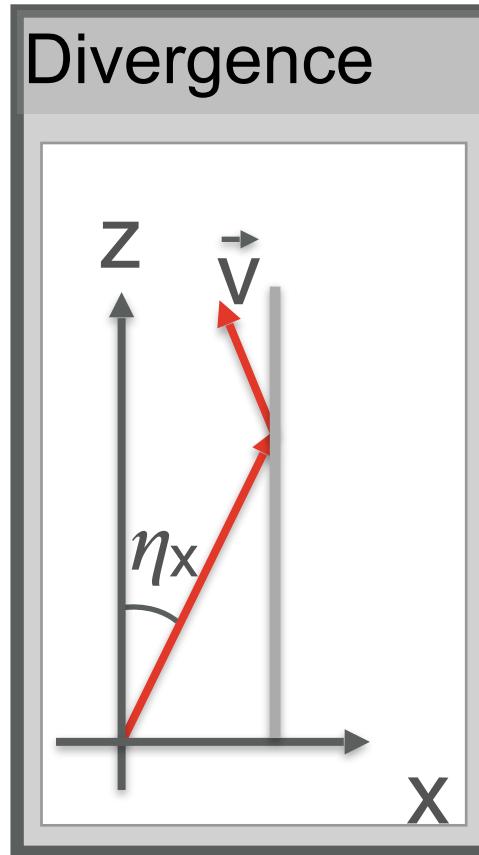


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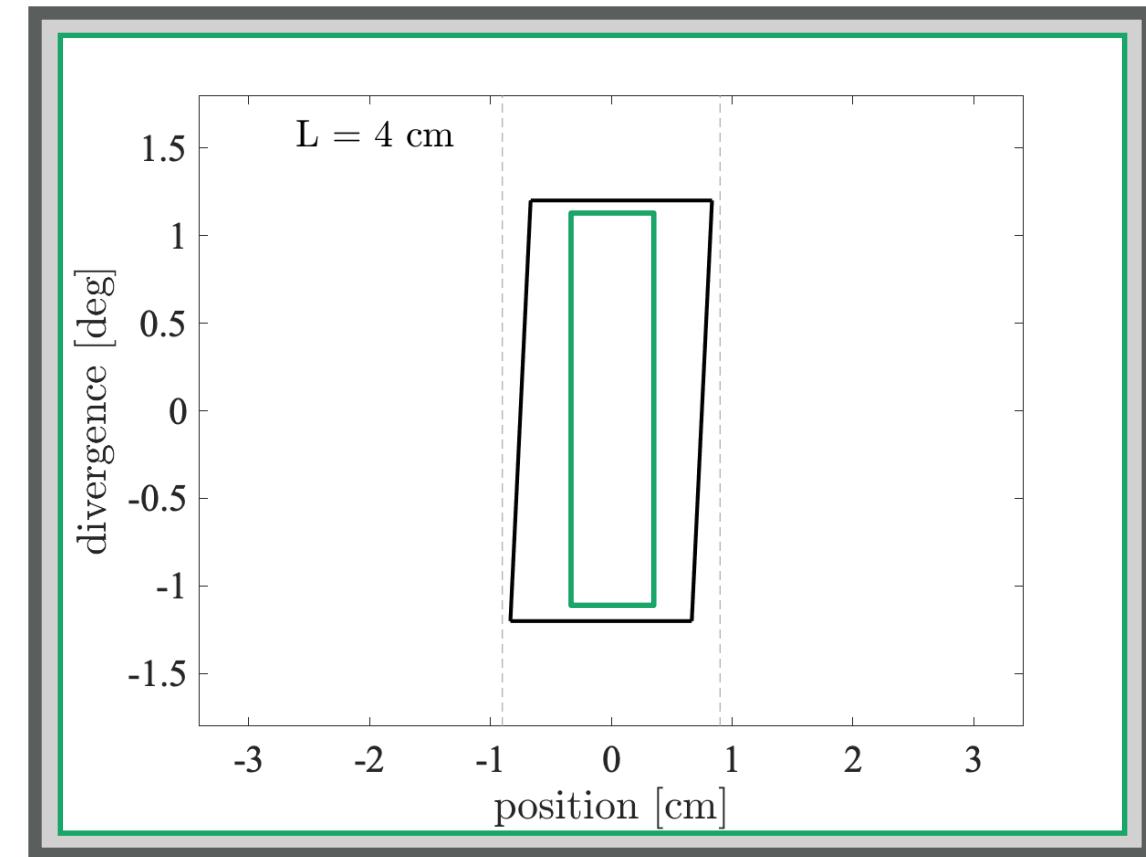
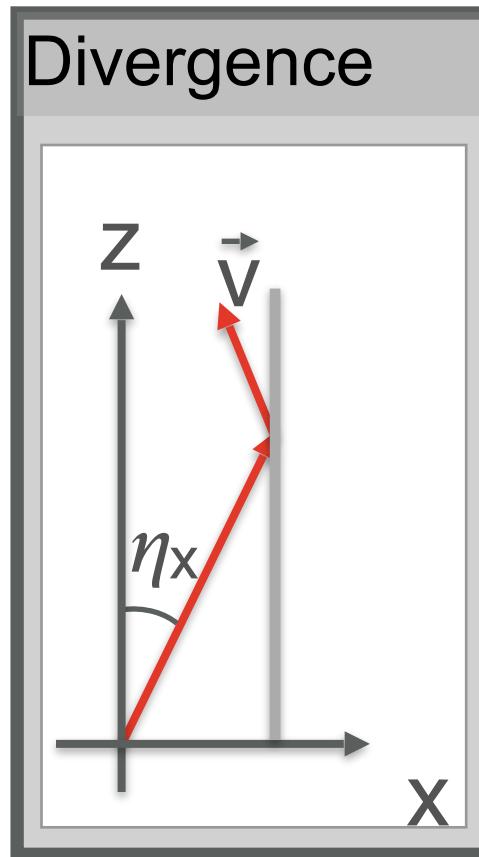
- We lost some phase-space to propagation



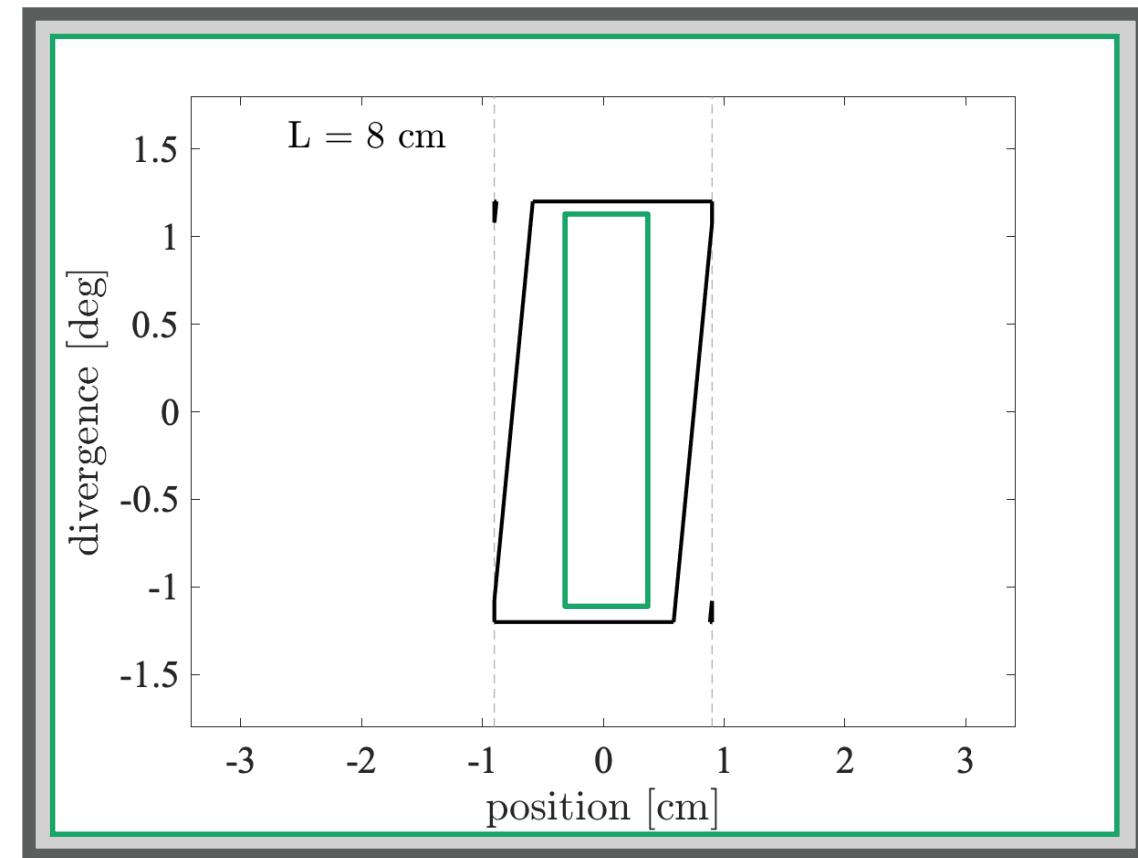
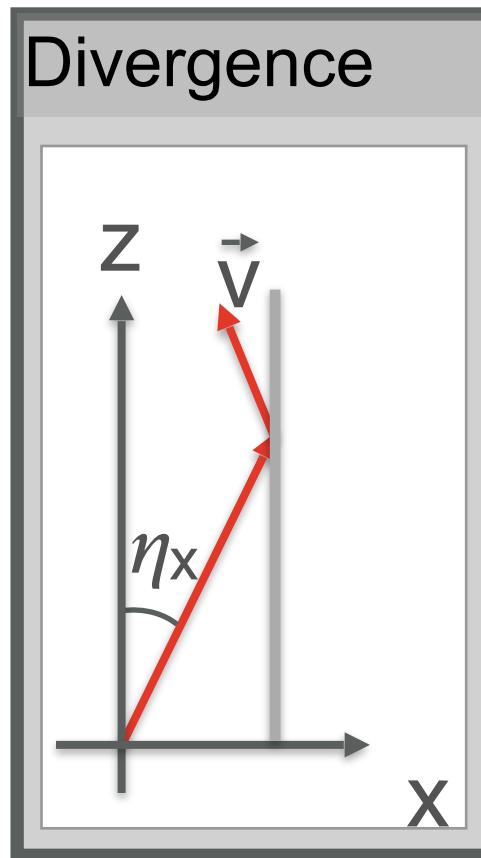
# Beam propagation in guide



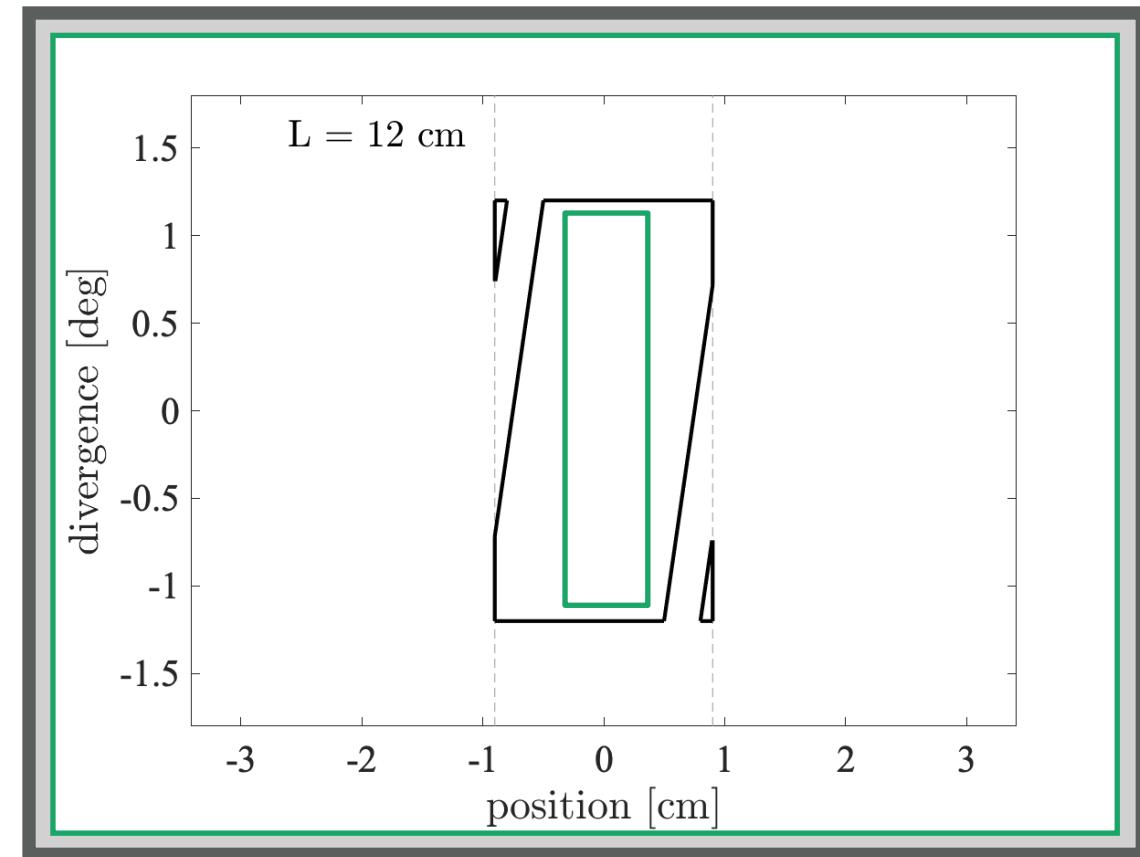
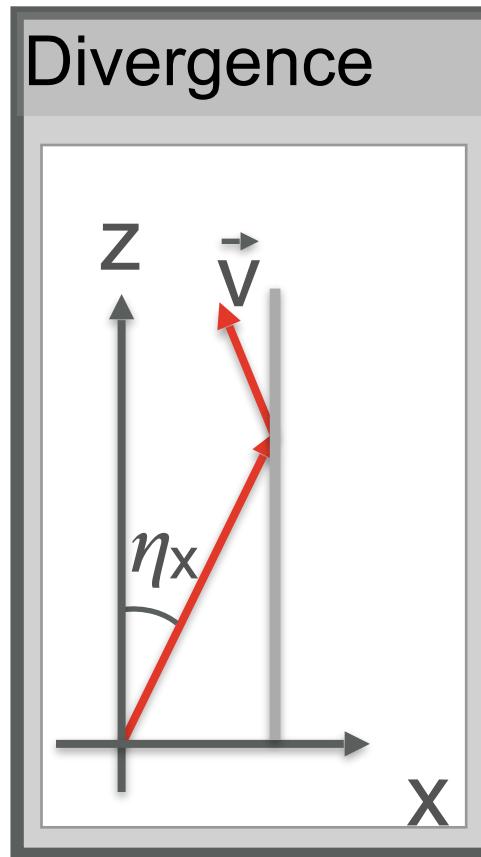
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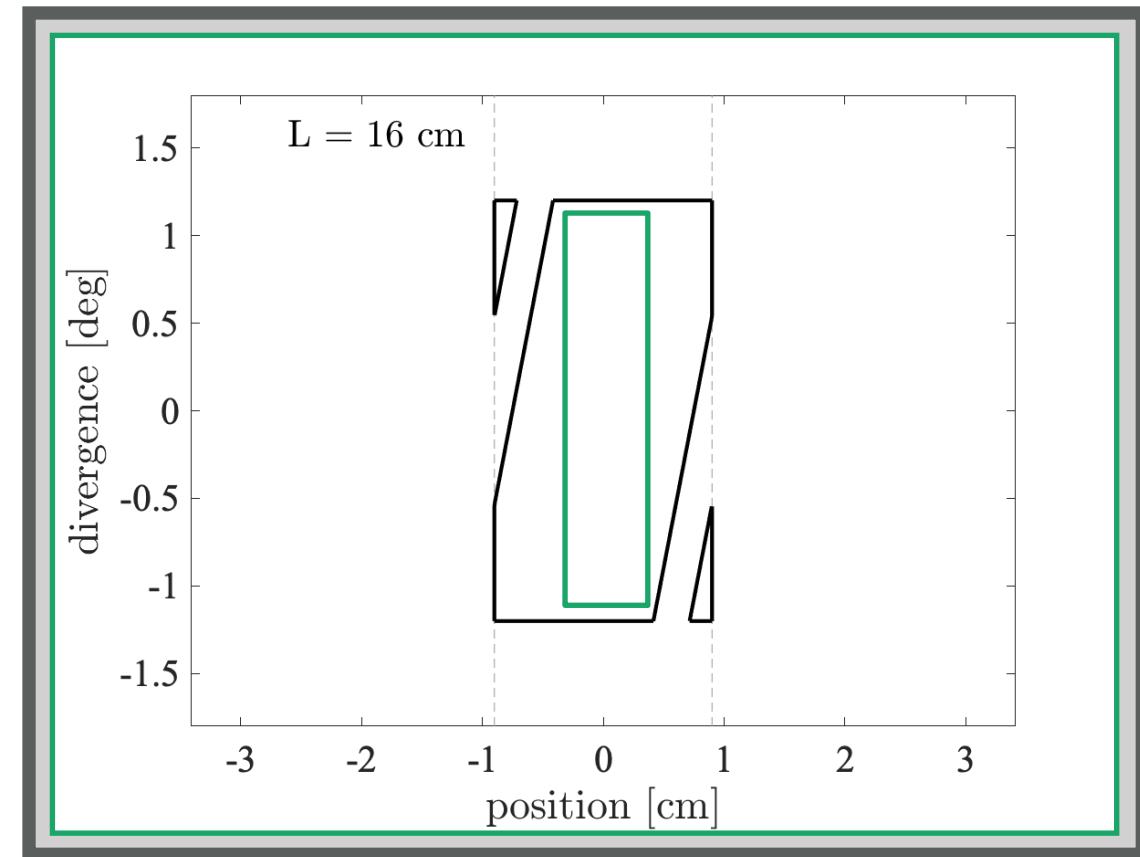
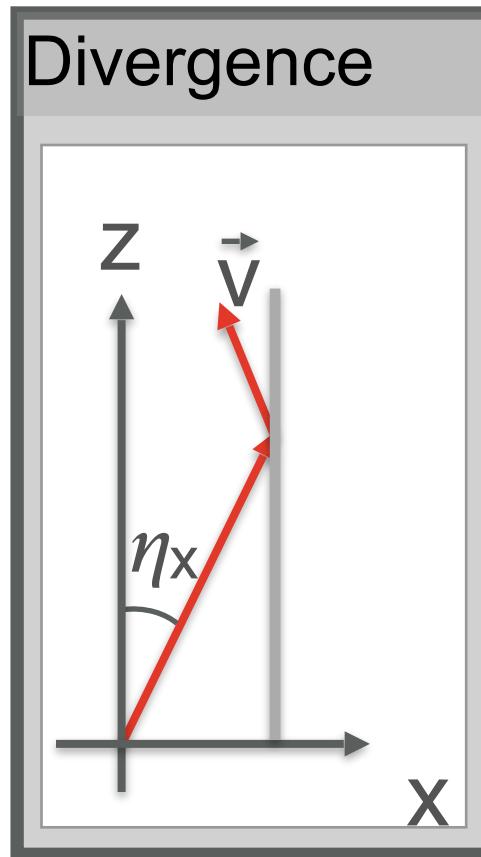
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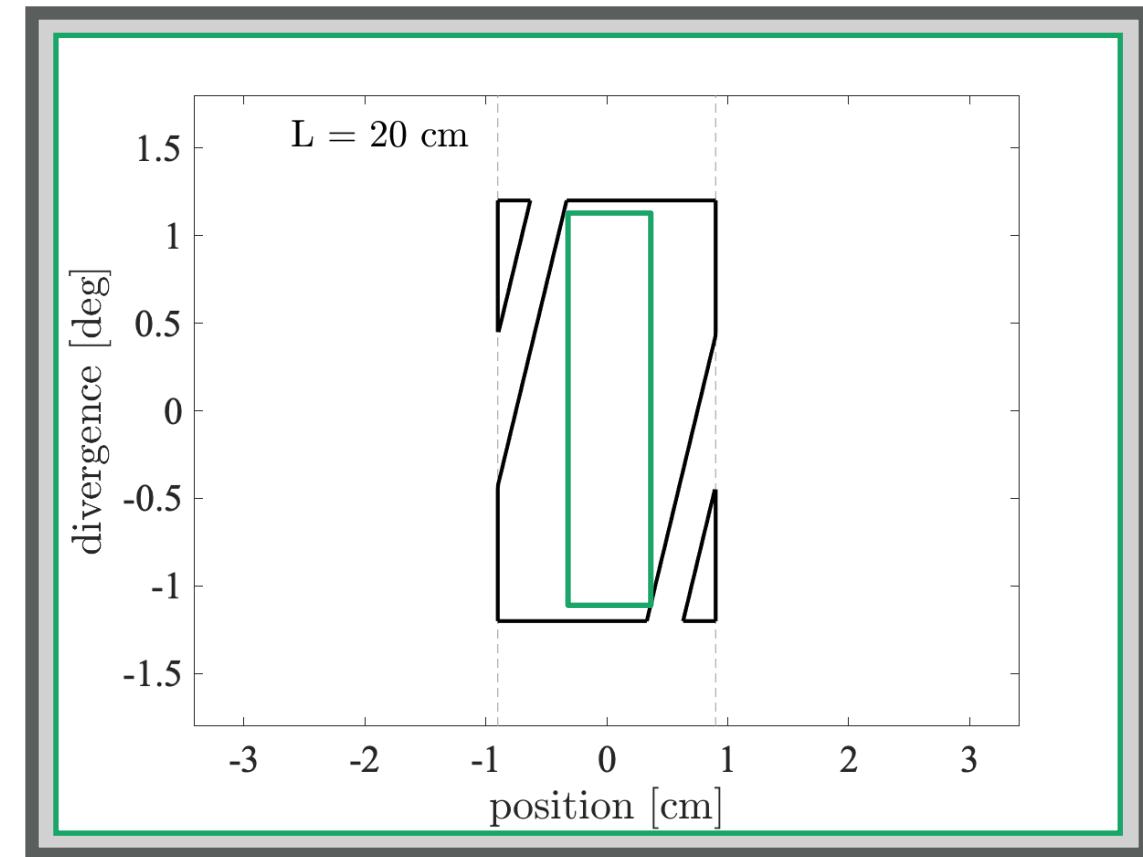
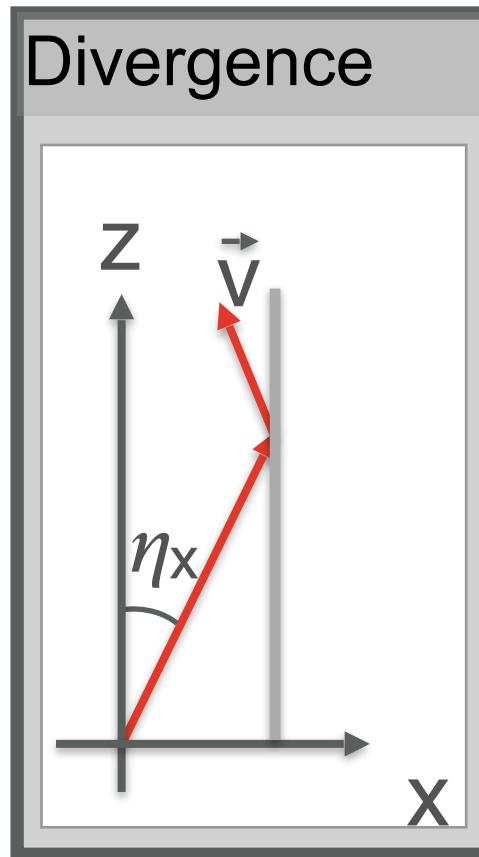
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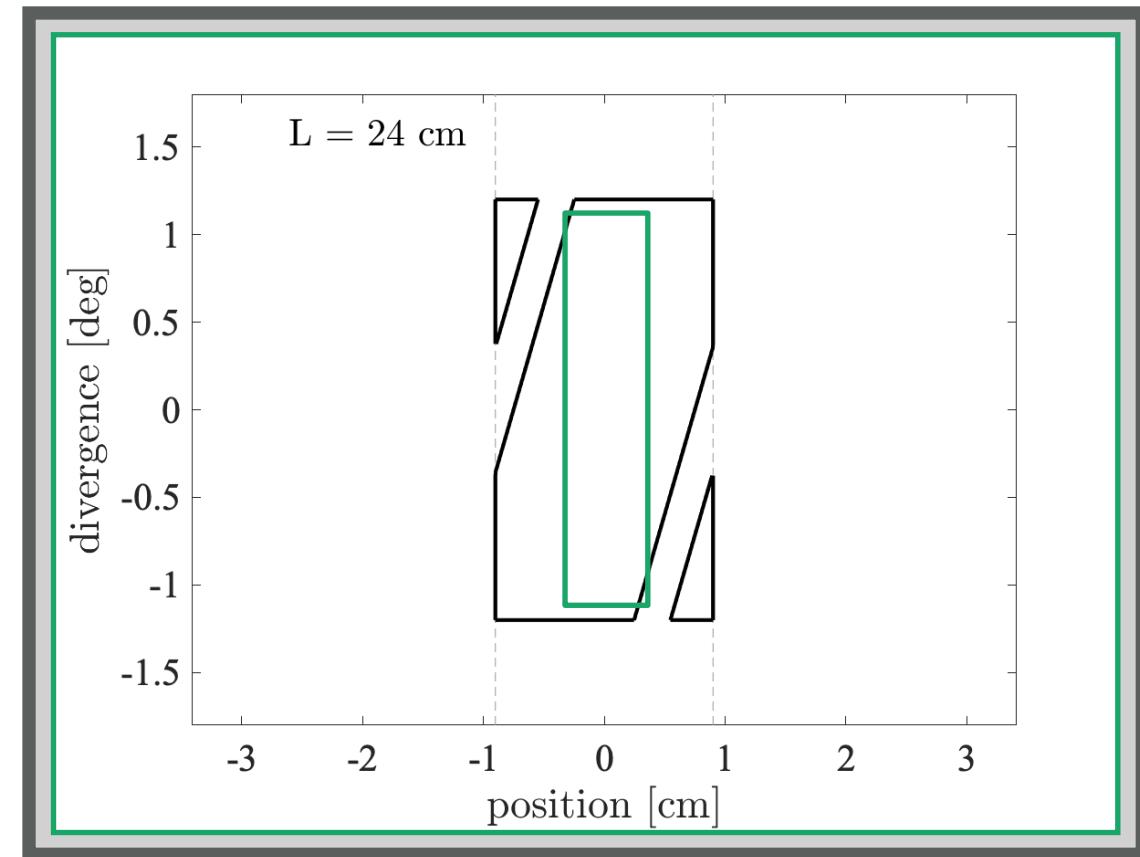
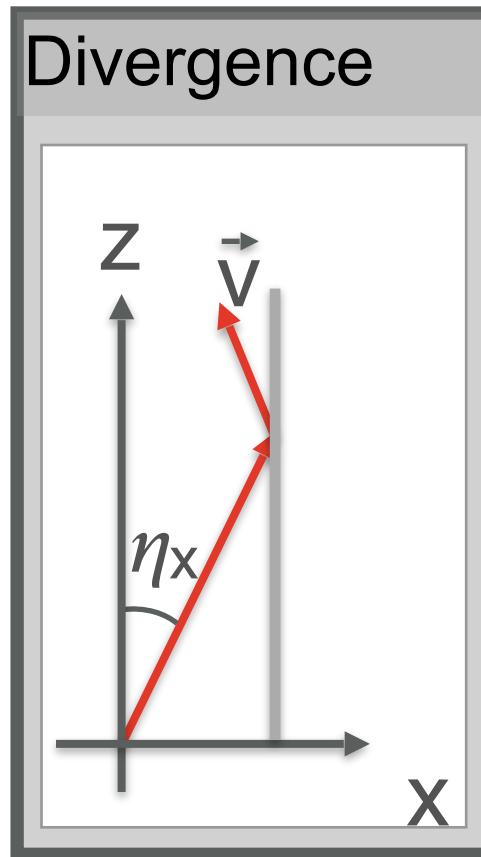
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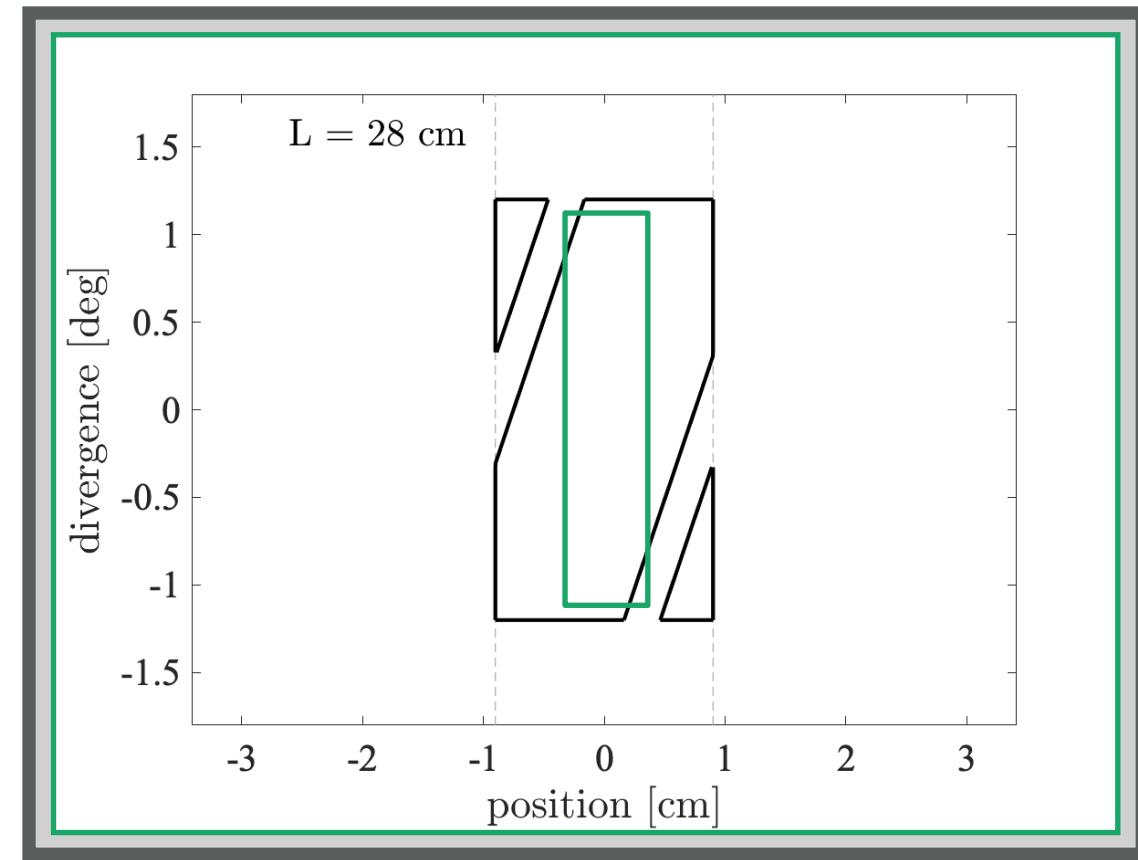
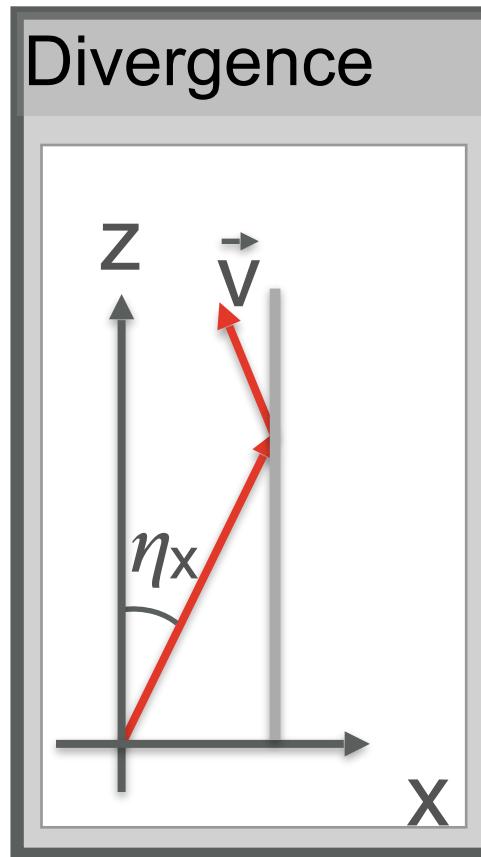
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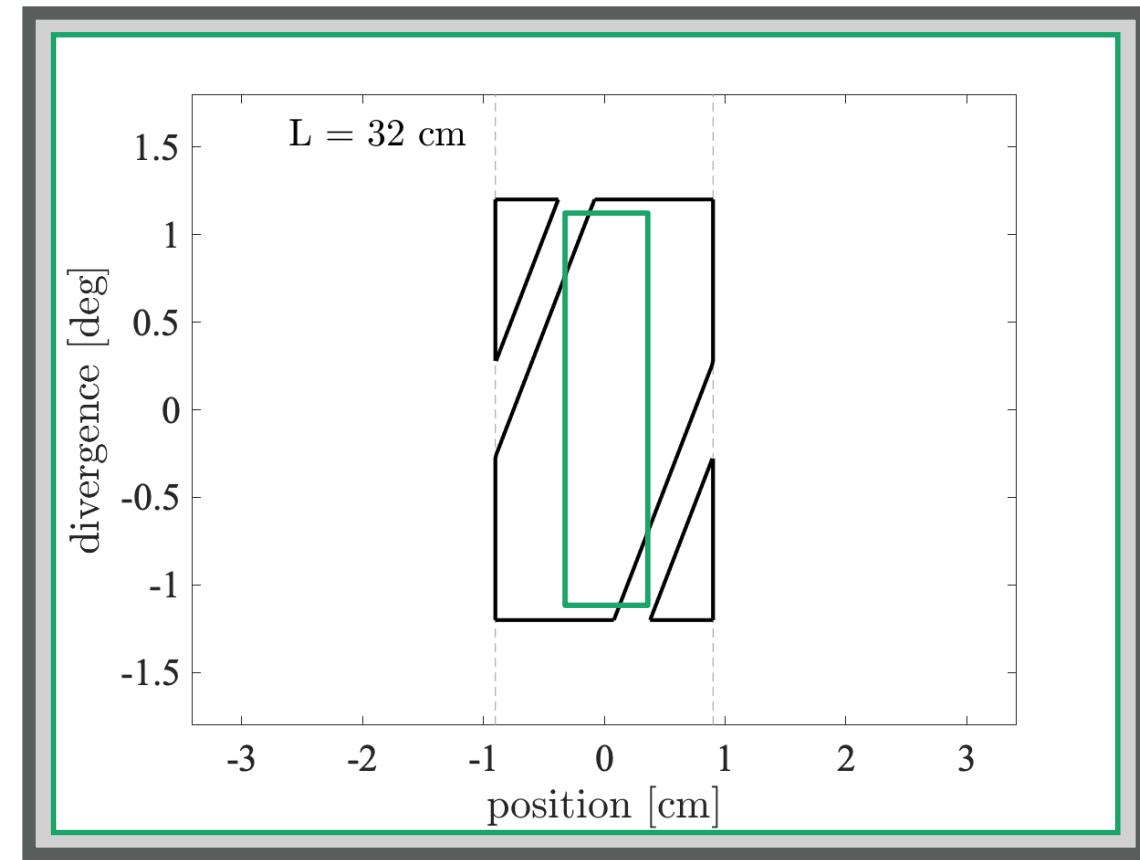
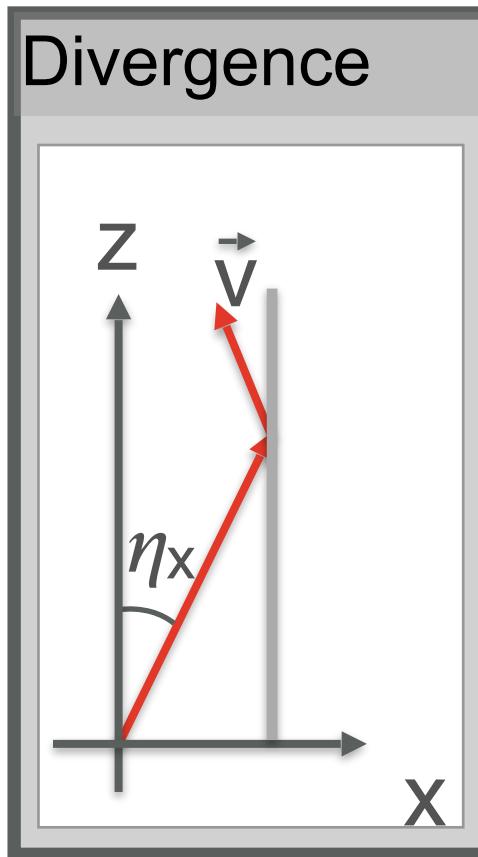
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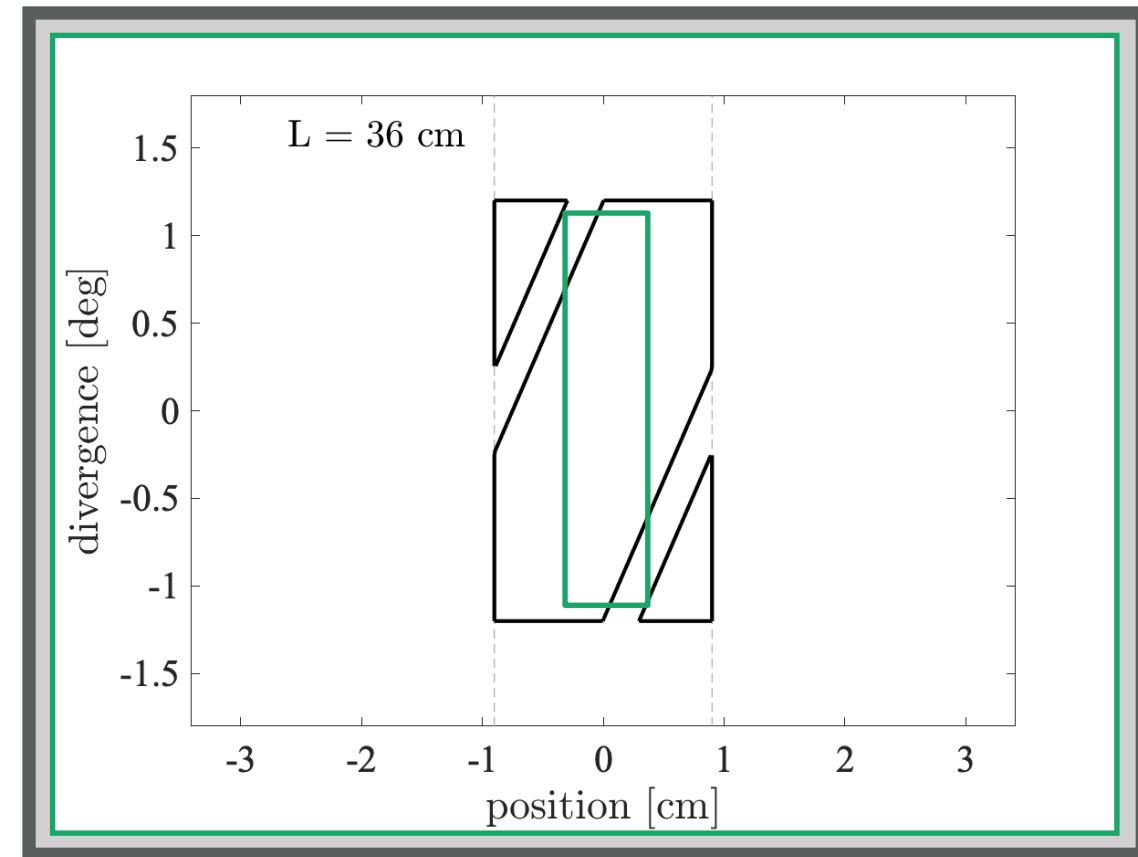
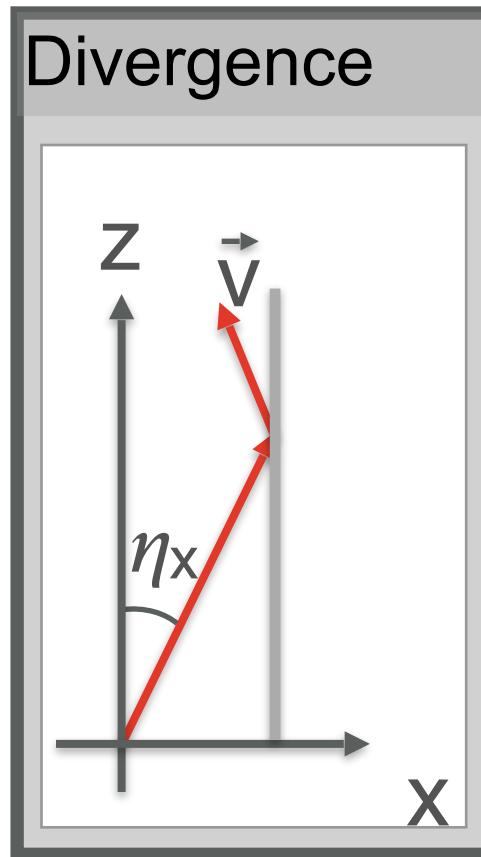
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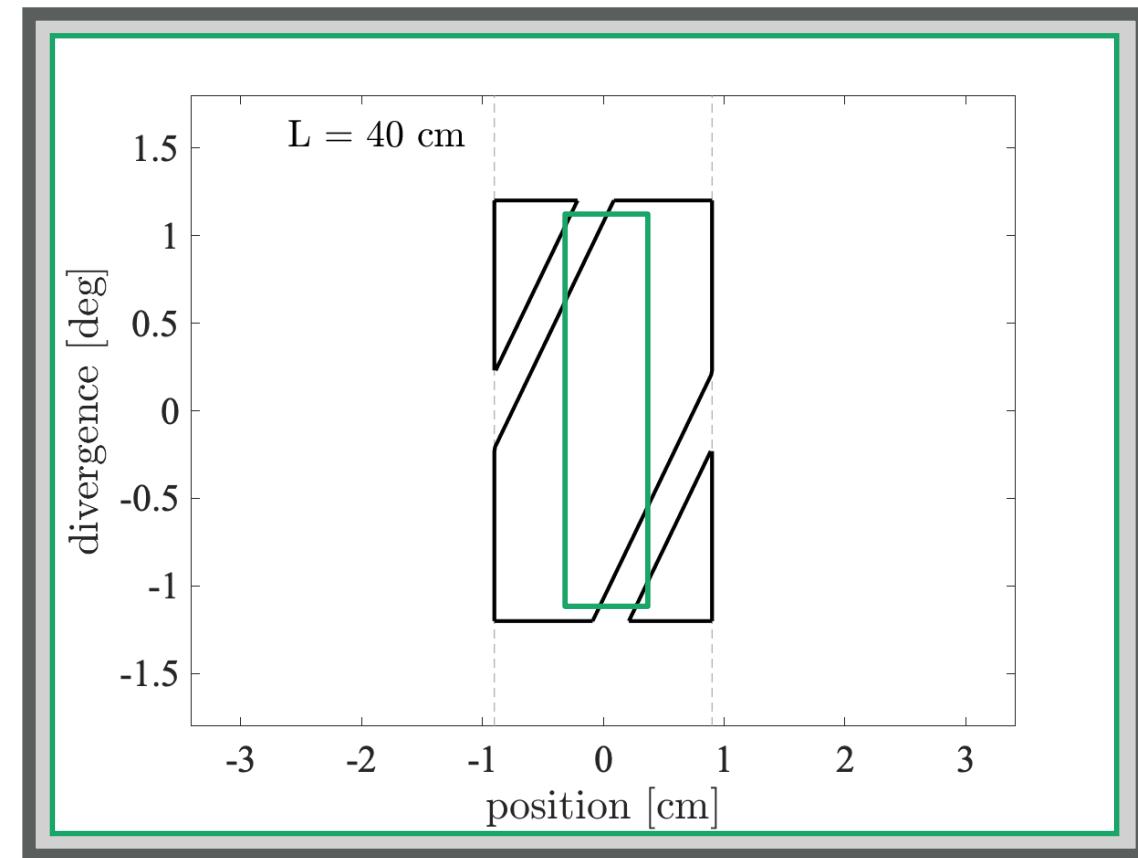
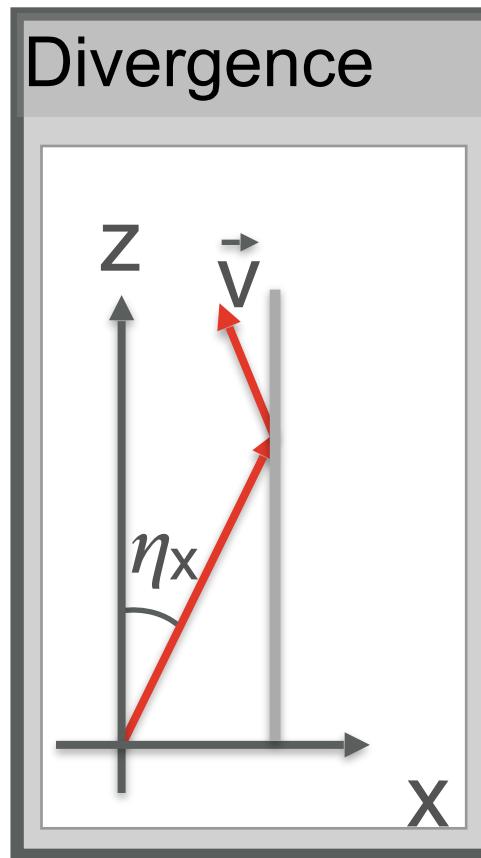
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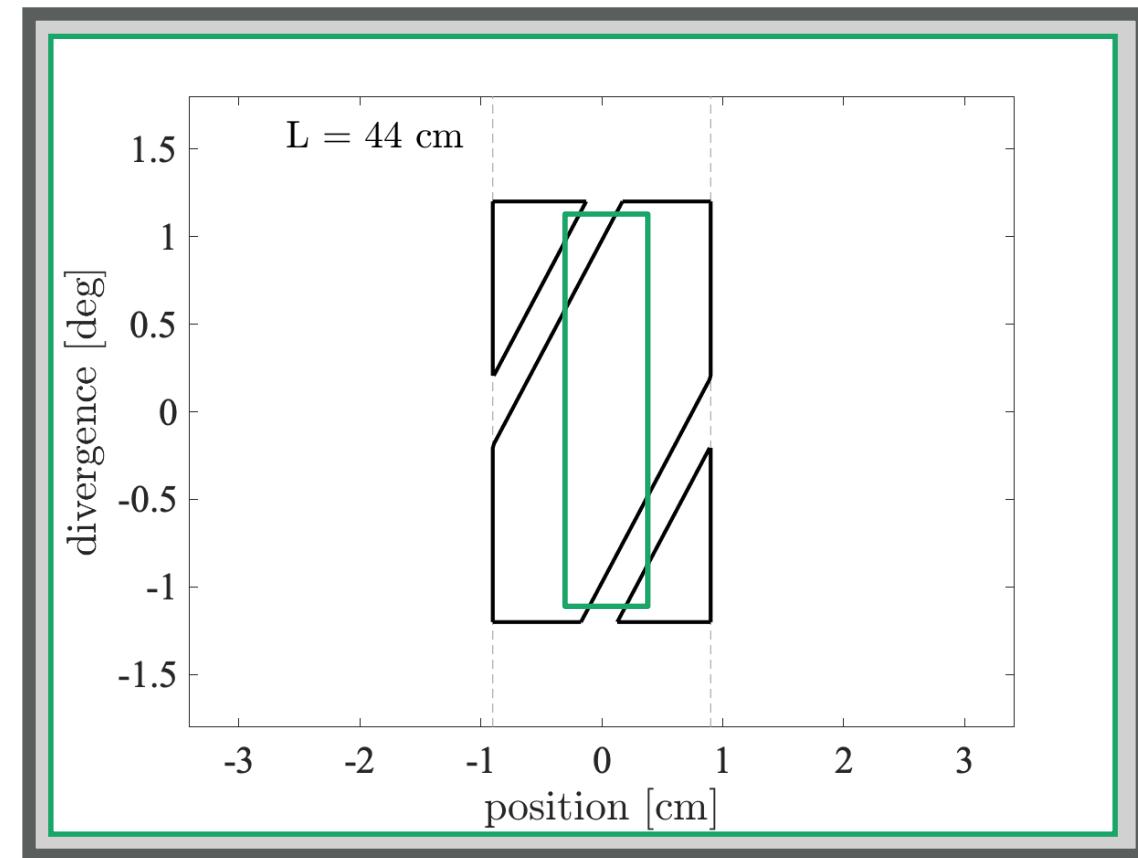
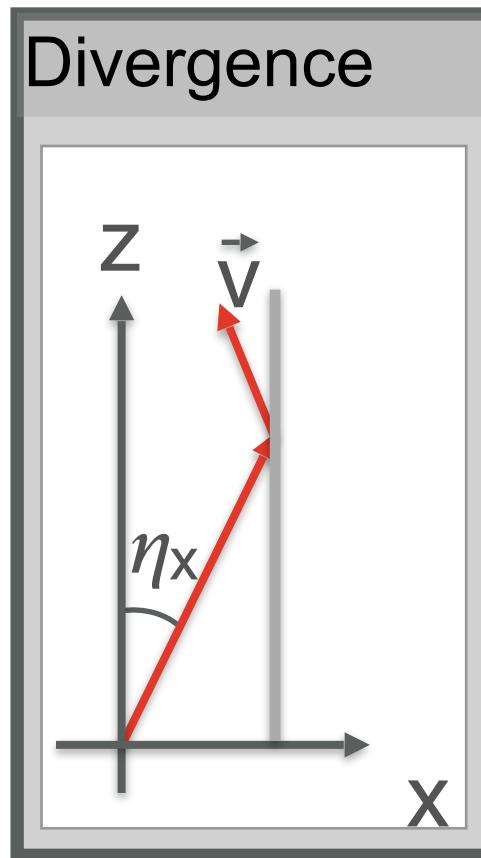
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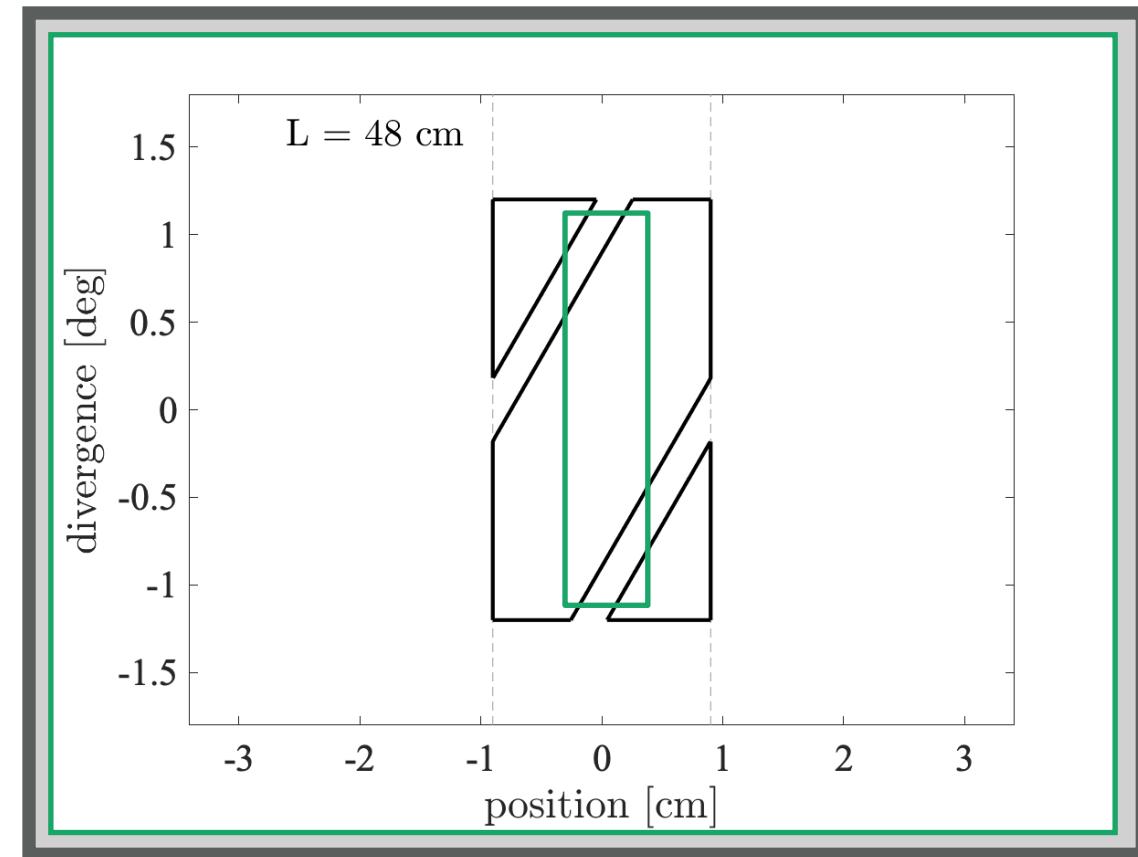
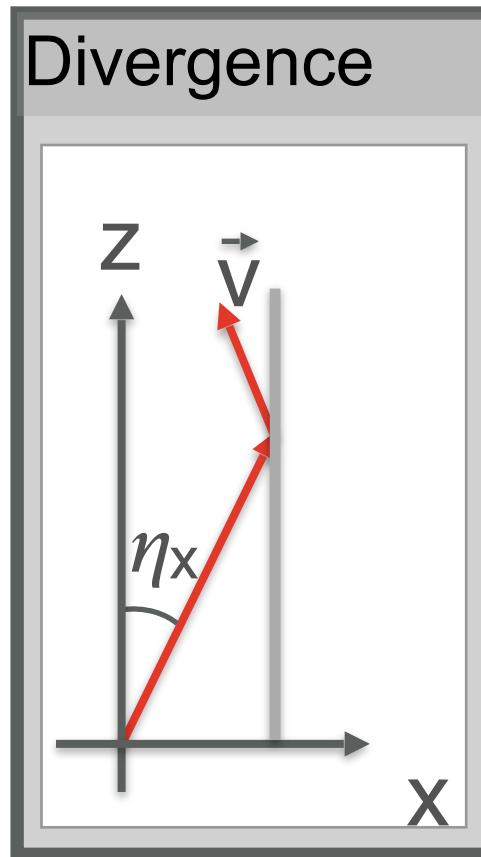
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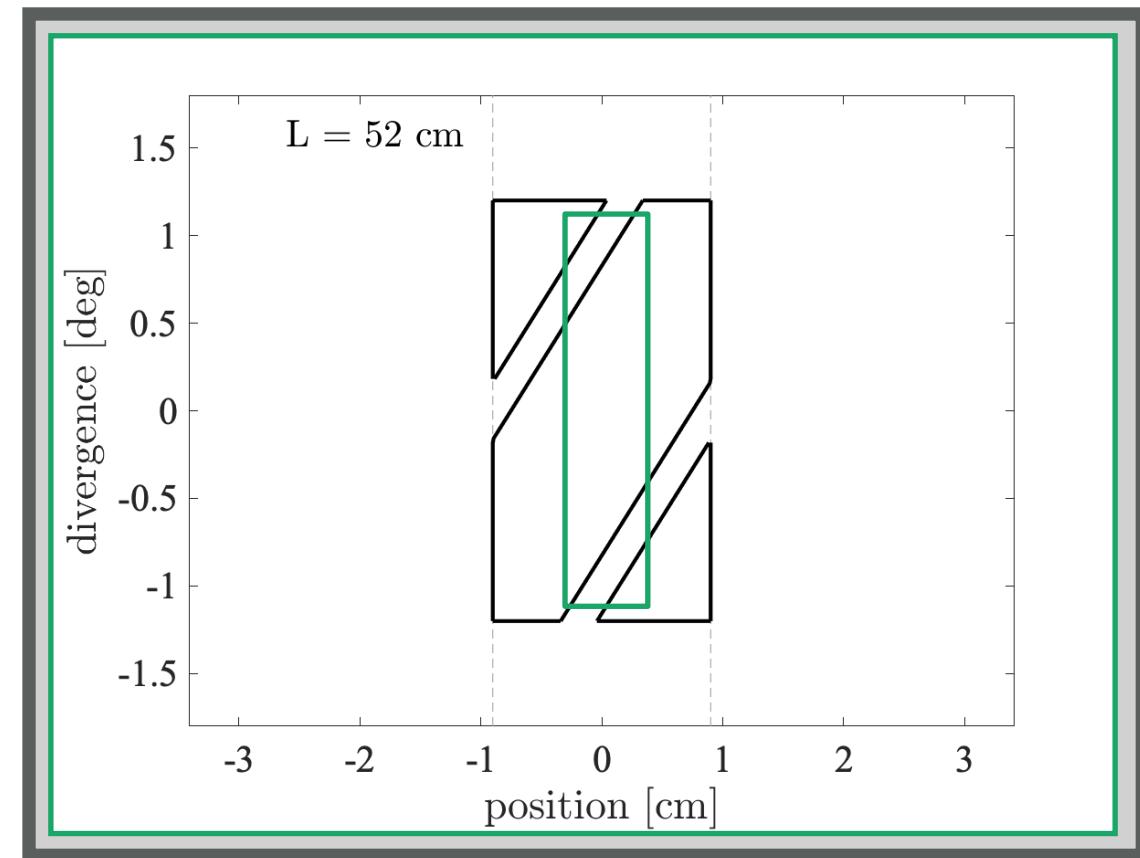
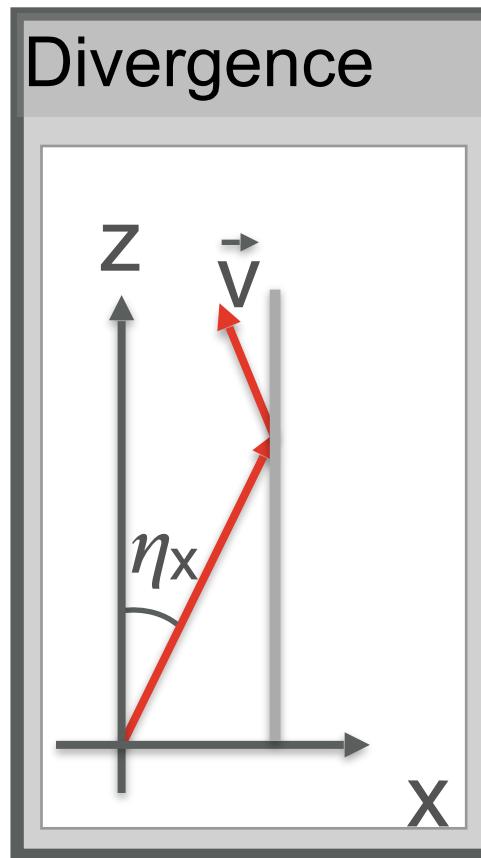
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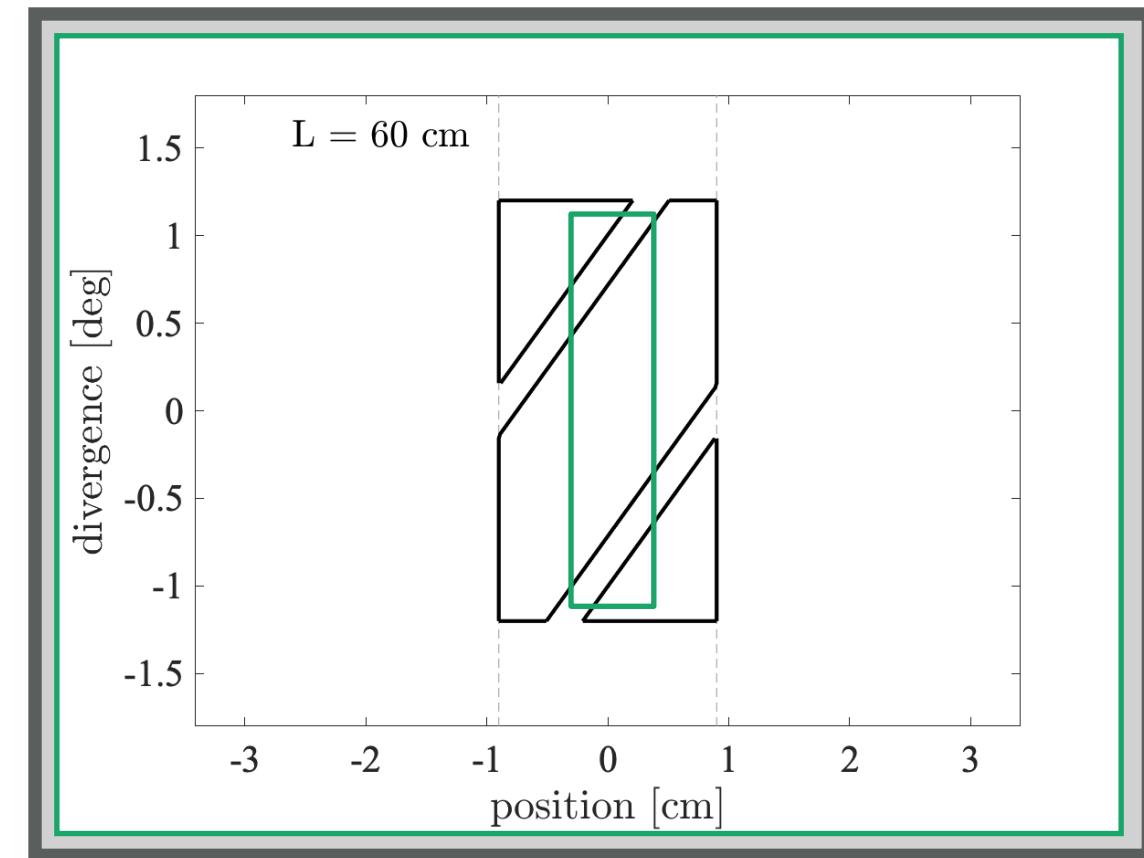
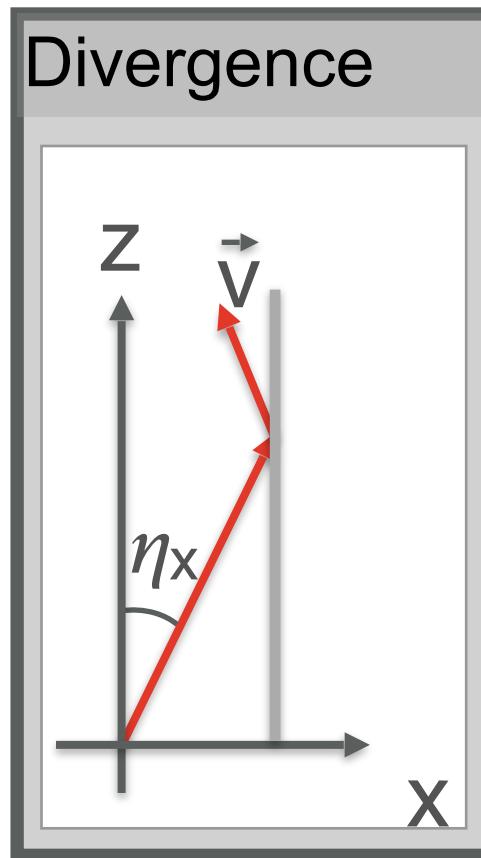
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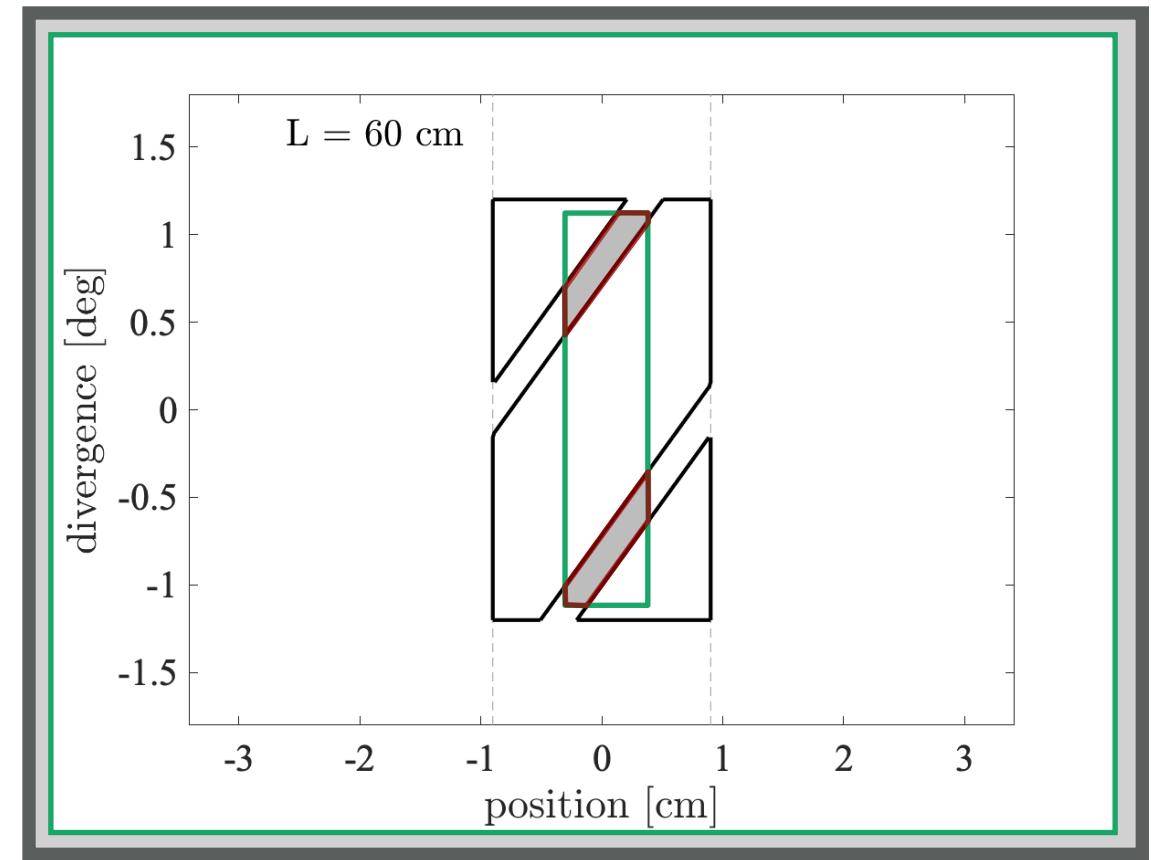
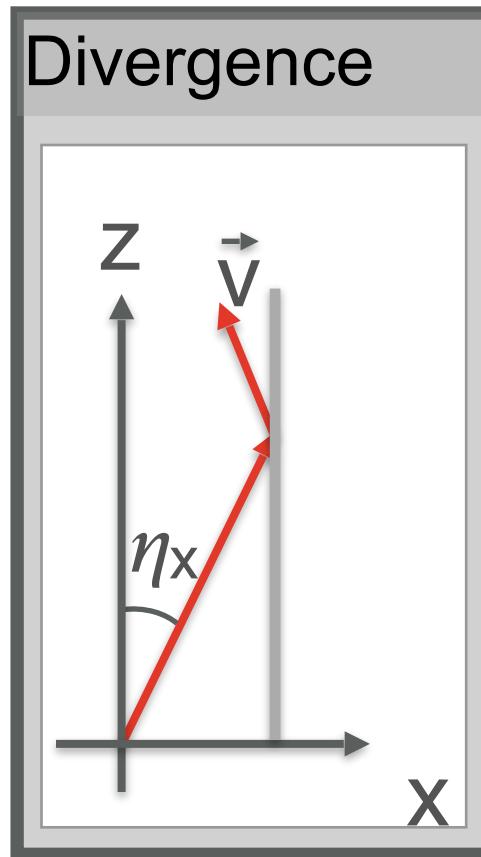


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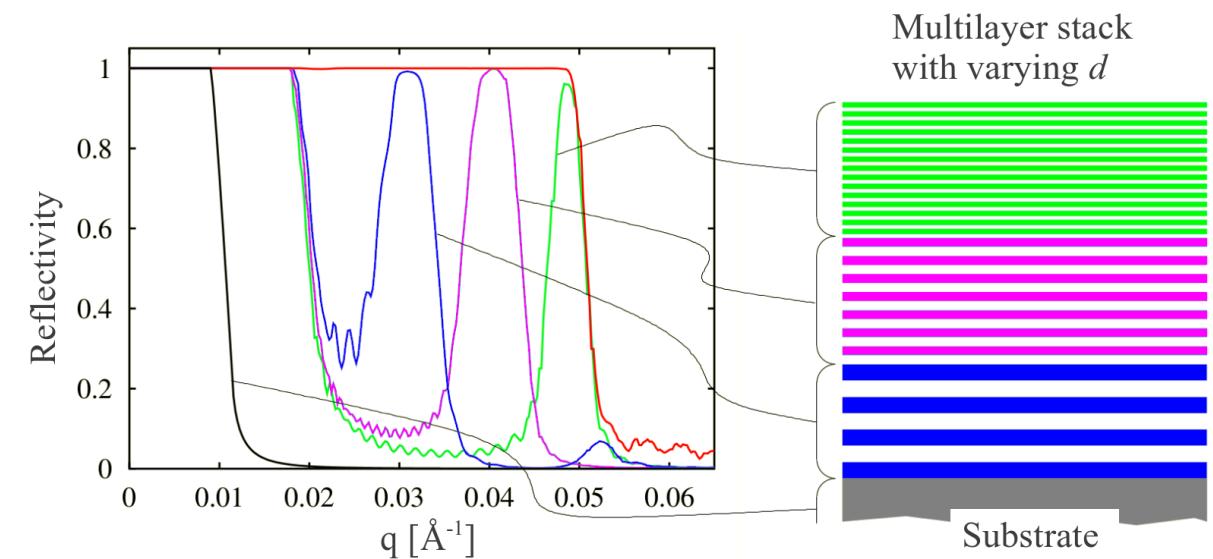
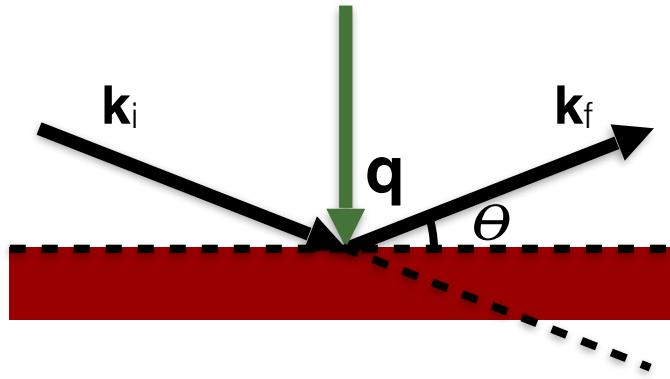
We got some phase-space back from guide reflection!



# Reflectivity curves

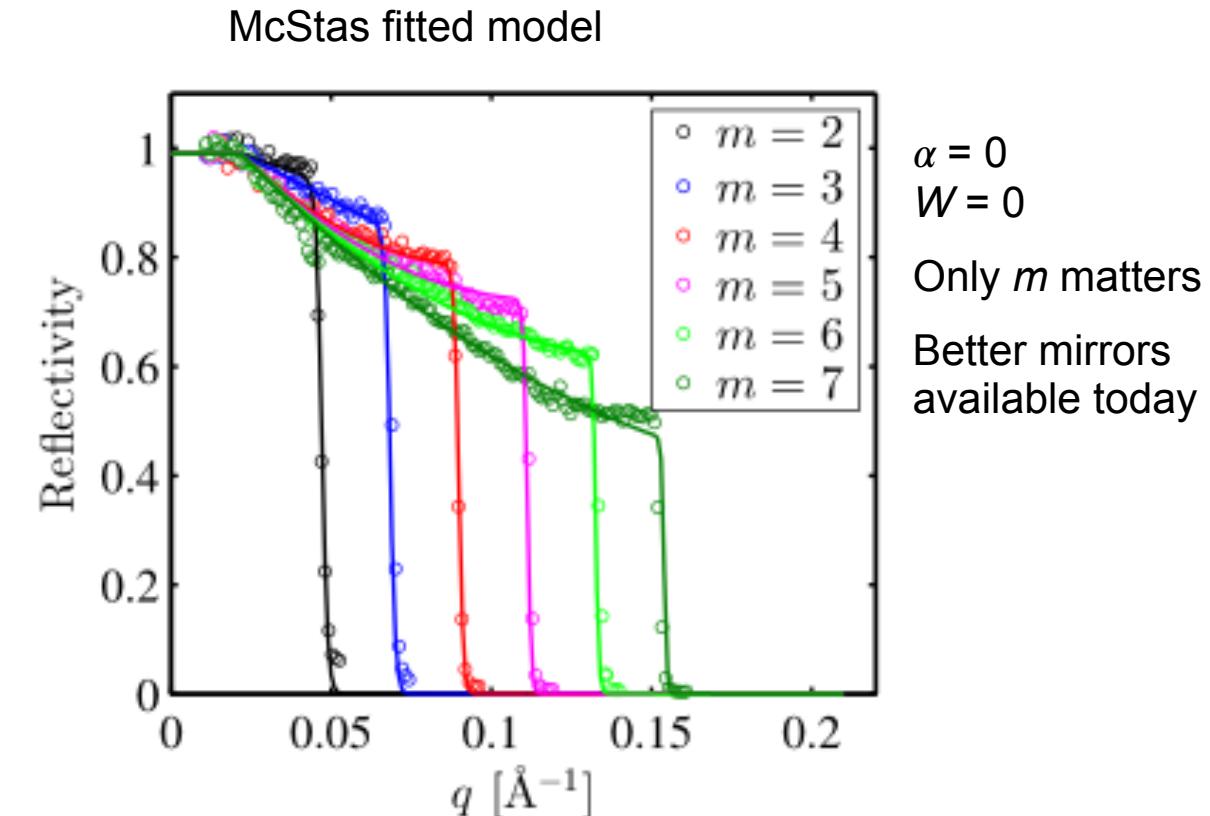
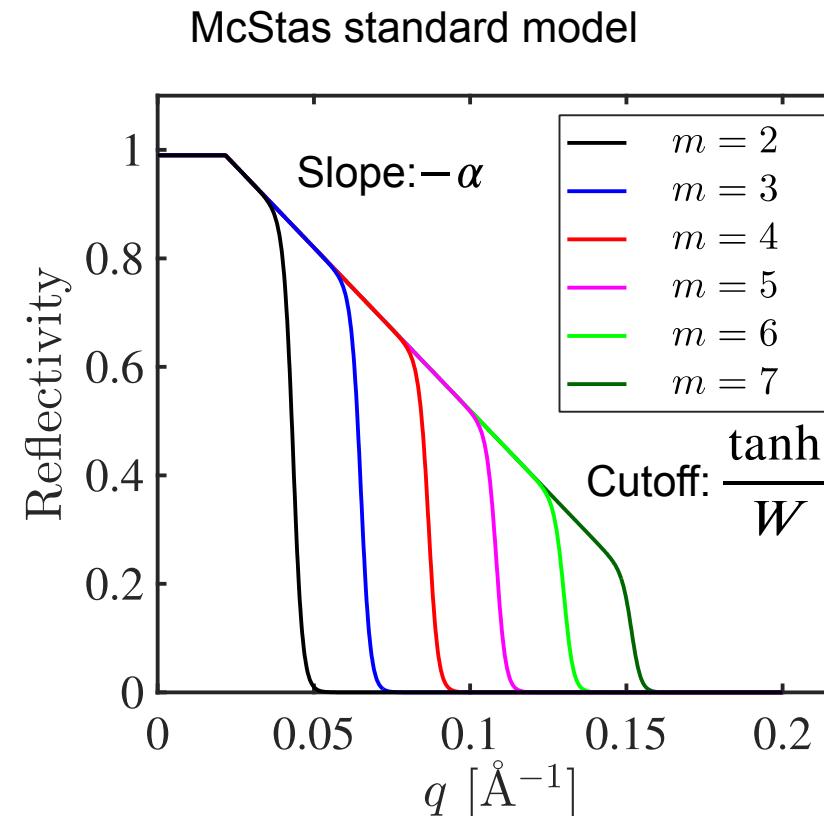
- Reflectivity, super mirror, reflectivity curve

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



# Reflectivity curves in McStas

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

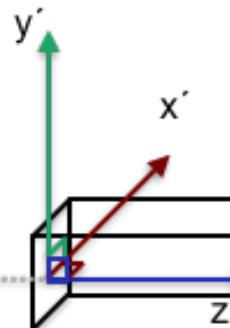


# Guide placement in McStas

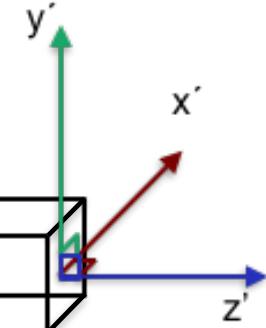
- The center is the front of the guide element
- Tip: Insert a guide at the end of the guide



COMPONENT Source  
AT (0,0,0) ABSOLUTE



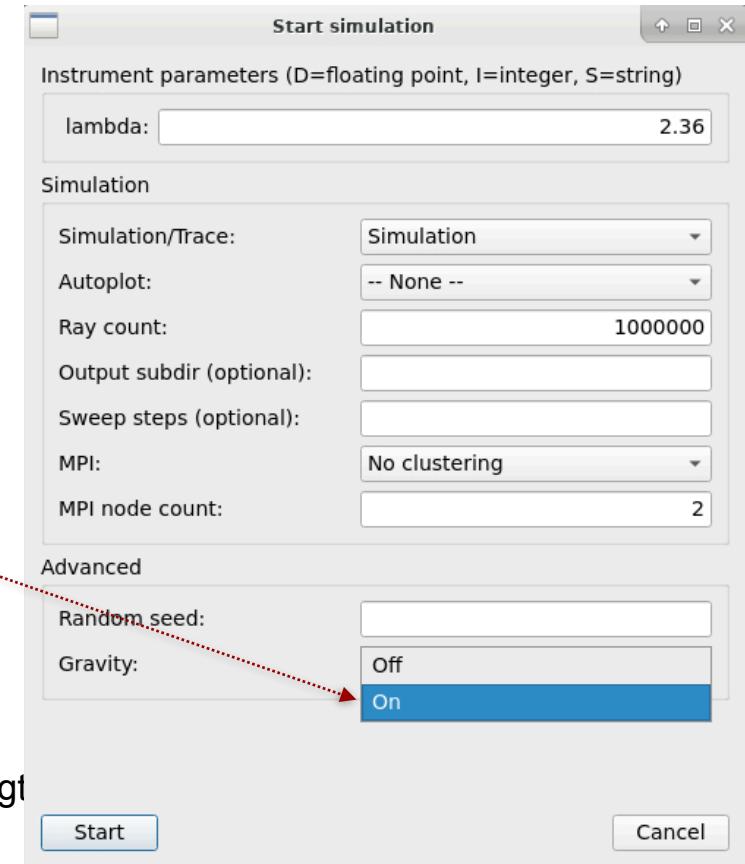
COMPONENT Guide(length=A)  
AT (0,0,2) RELATIVE Source



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

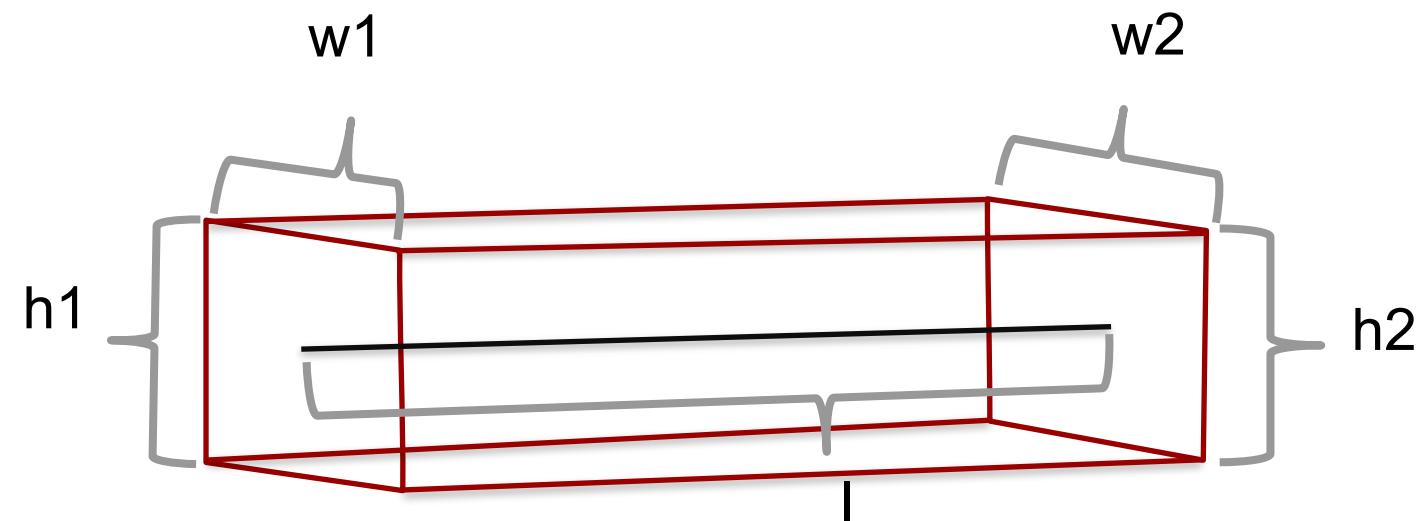
# Gravitation in McStas

- 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 wavelength
- “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



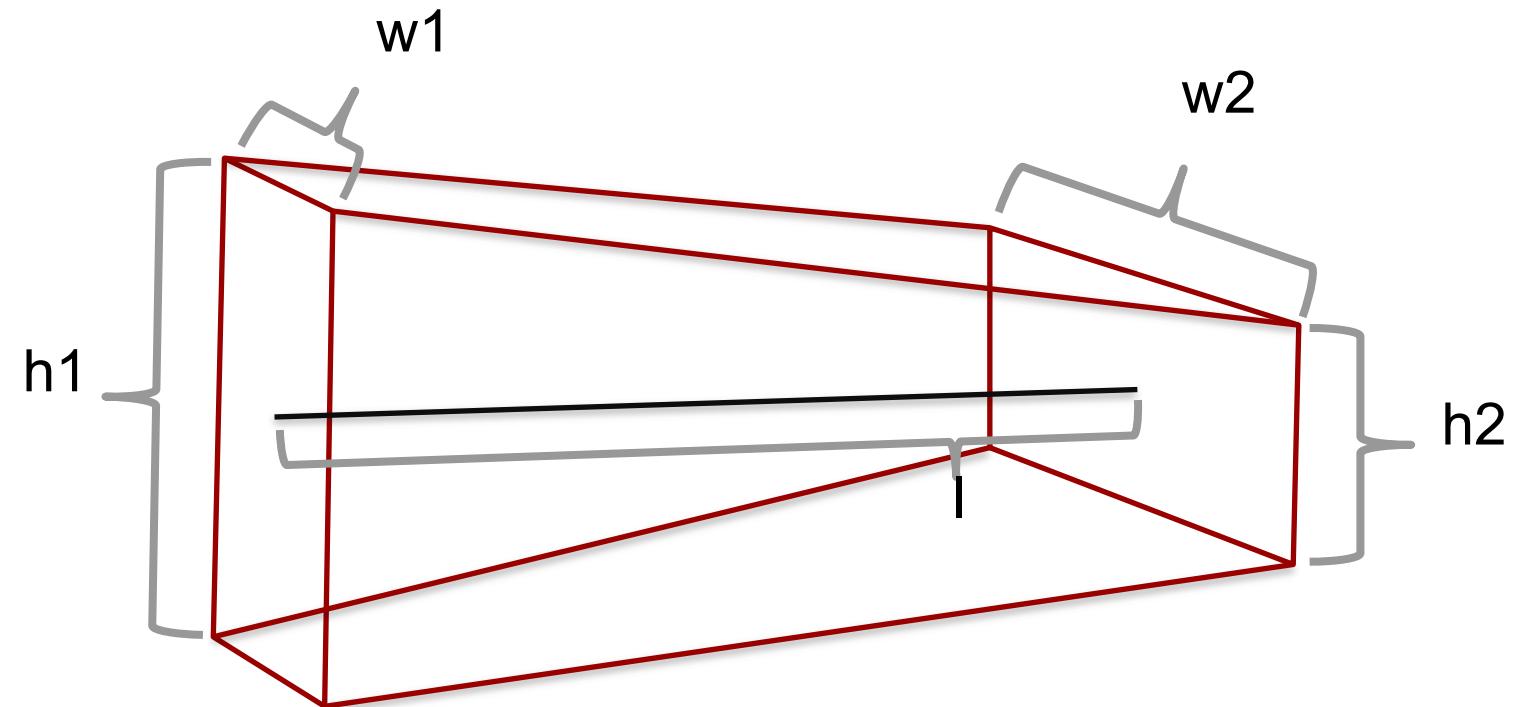
# Popular guide components: Guide\_gravity

- 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)



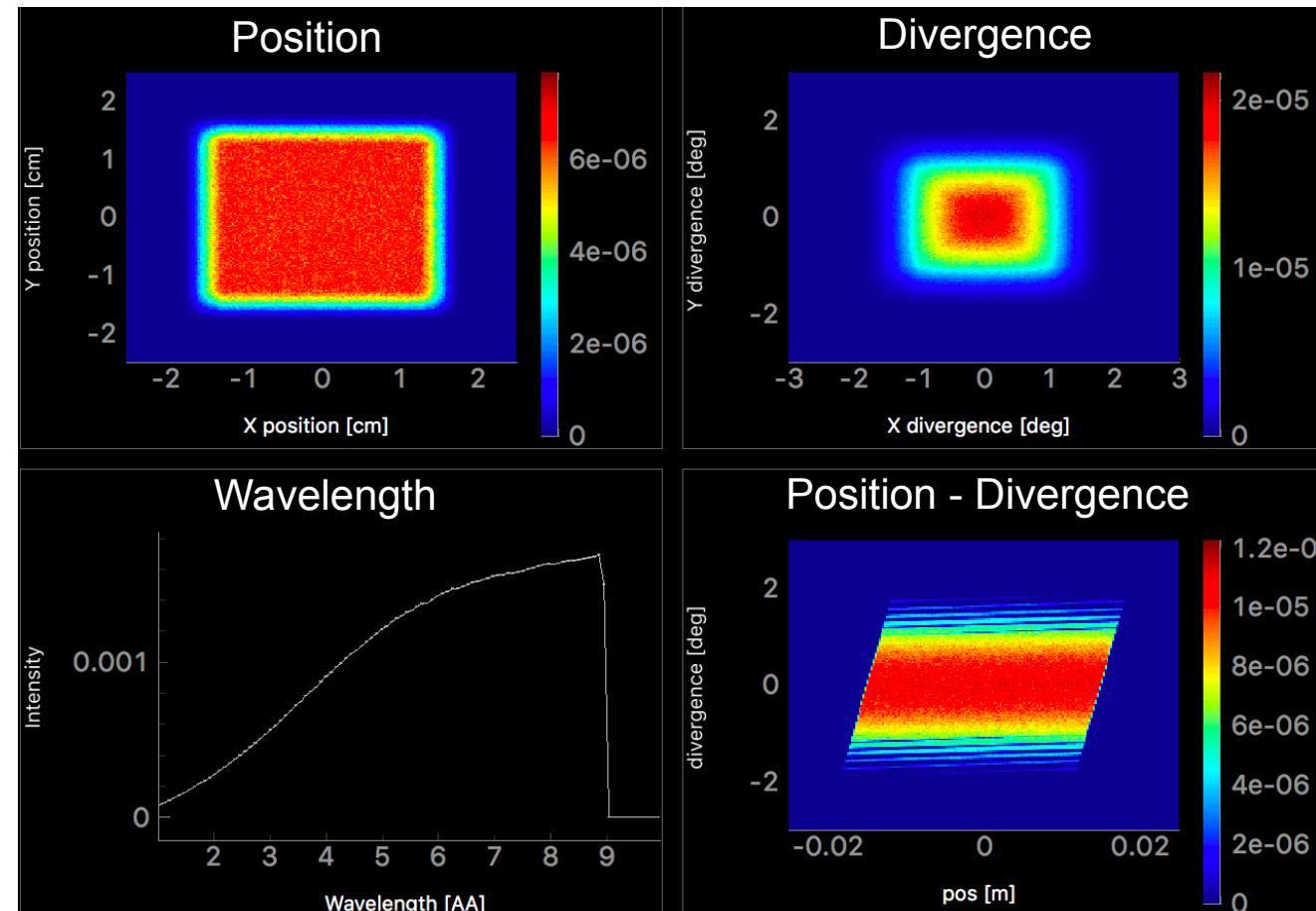
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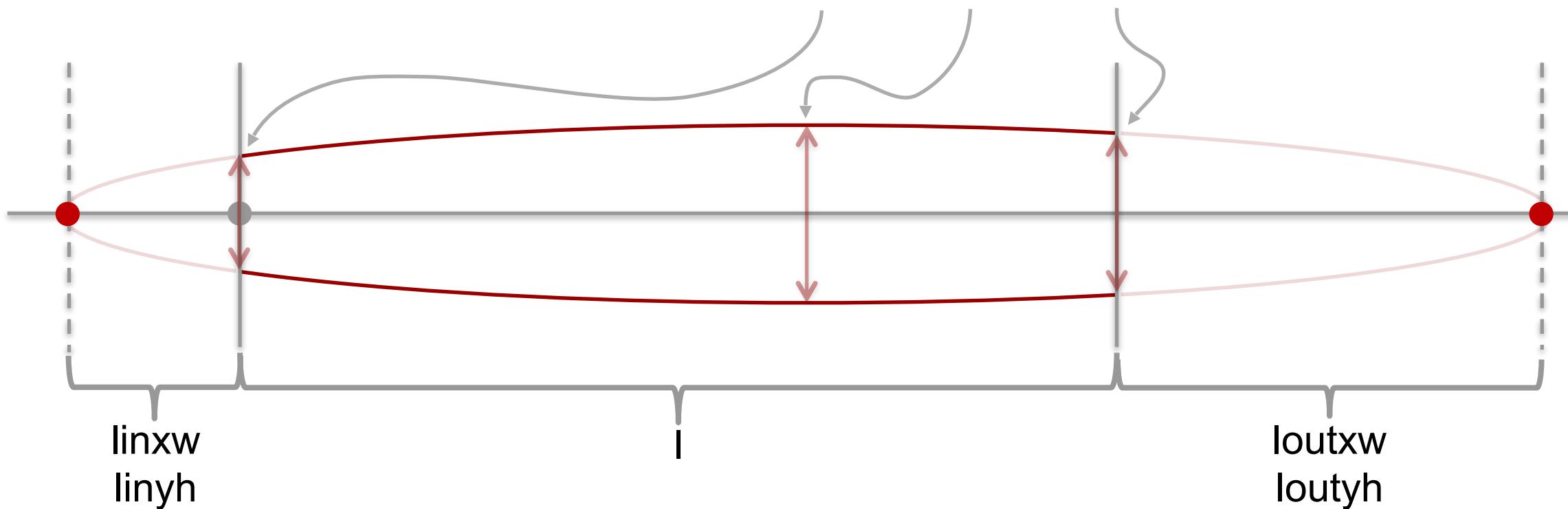
- Typical guide component with gravity



# Popular guide components: Elliptical\_guide\_gravity

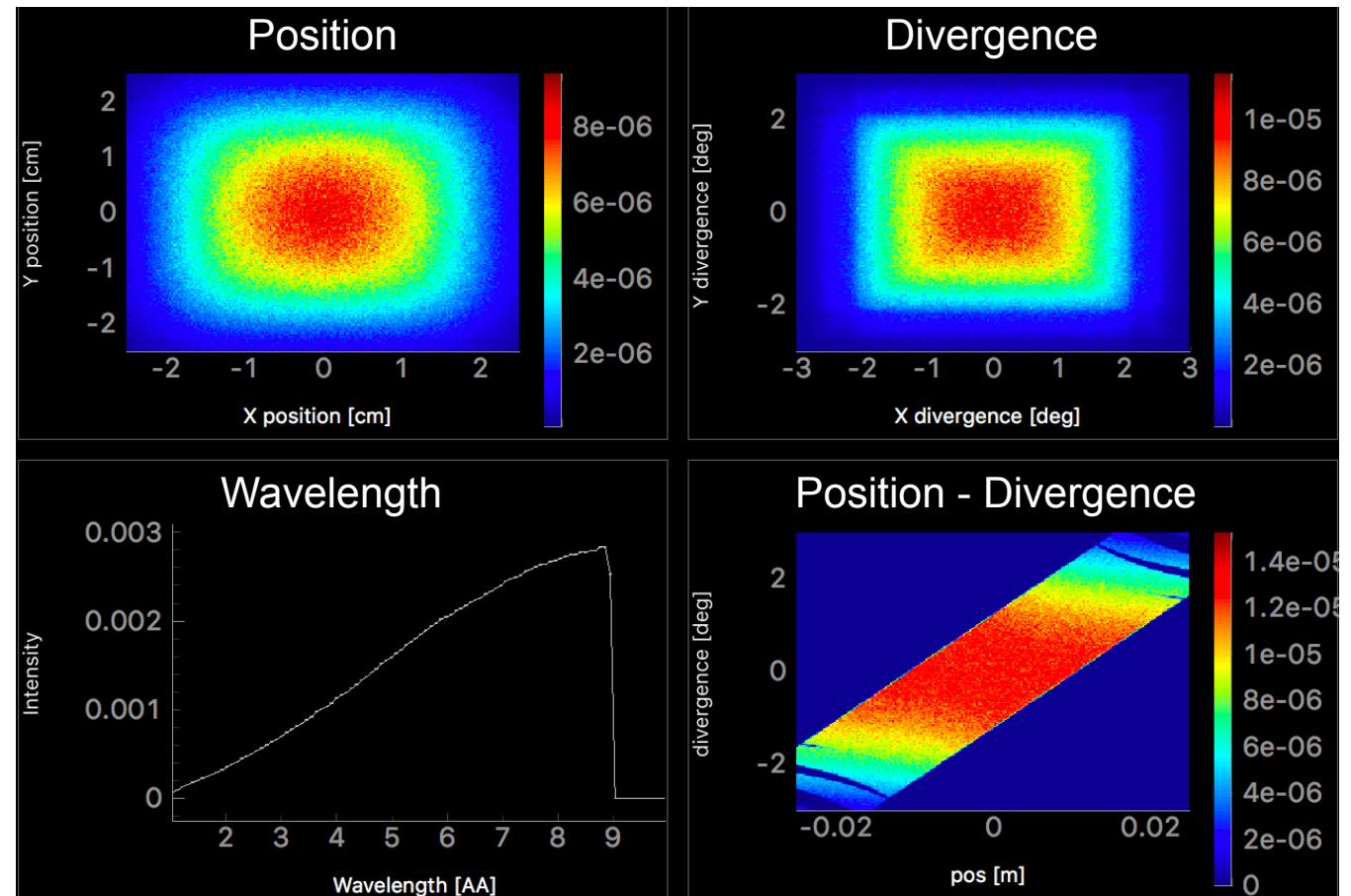
- Useful for elliptic and parabolic guide geometries, focusing, ballistic, coating distribution, ...

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



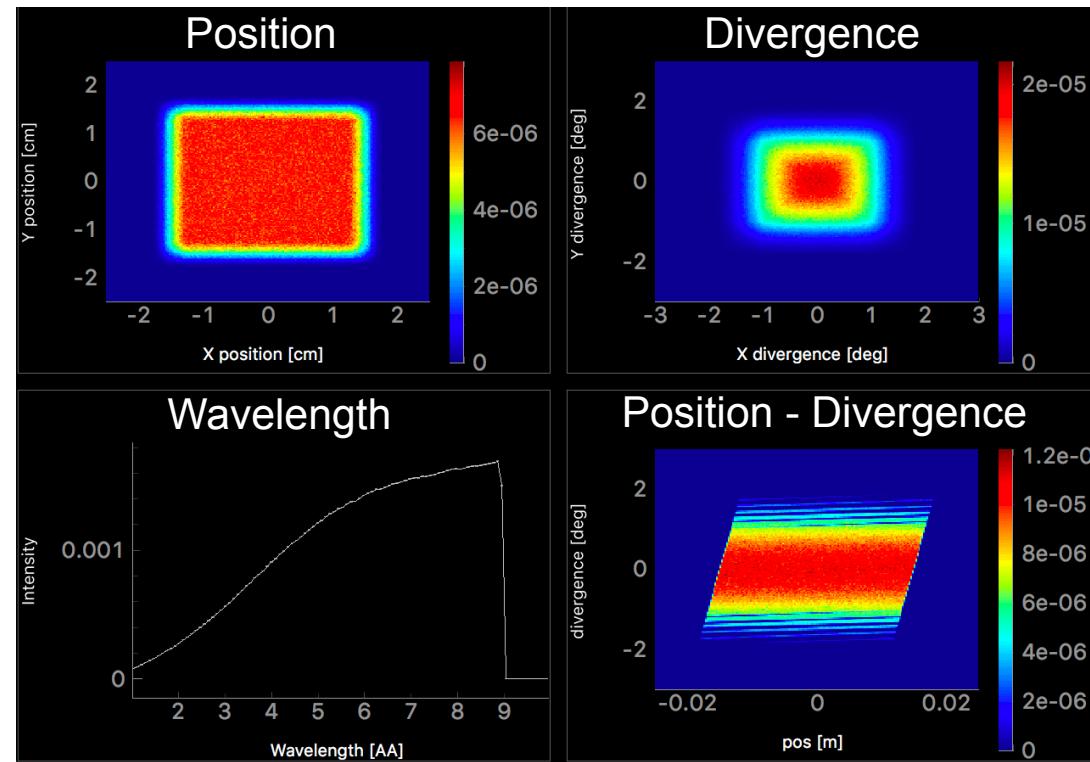
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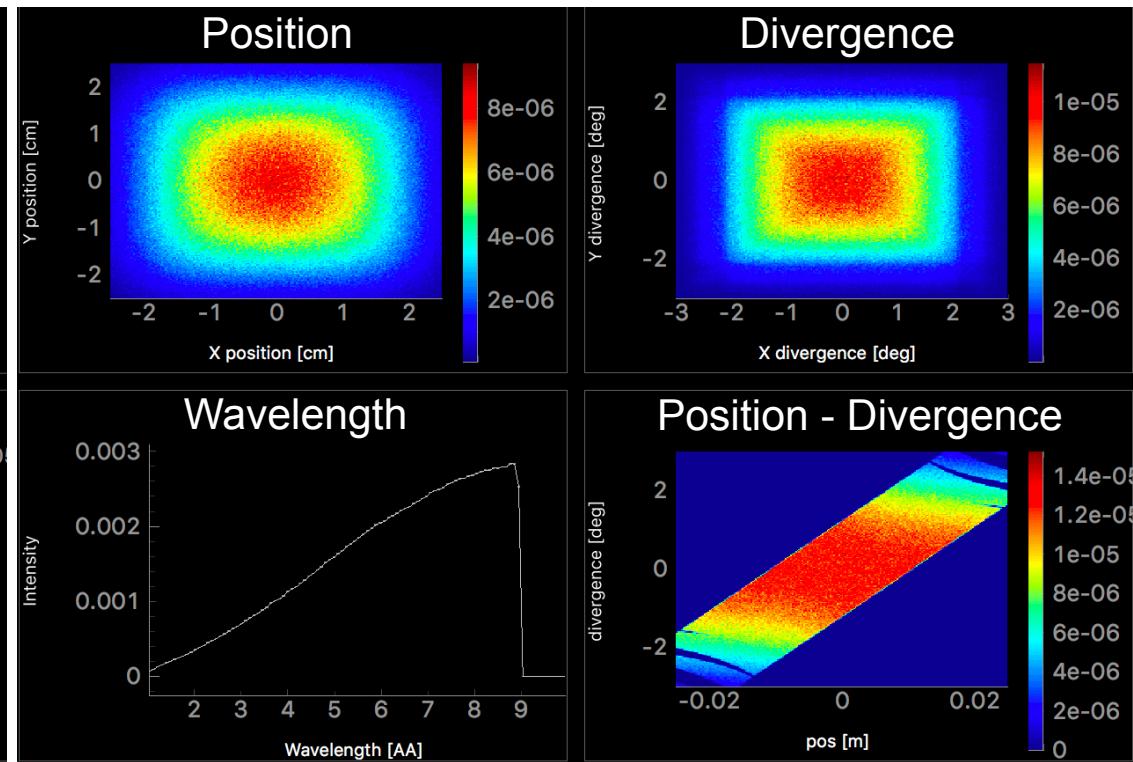


# Comparison: Guide\_gravity and Elliptic\_guide\_gravity

Guide\_gravity

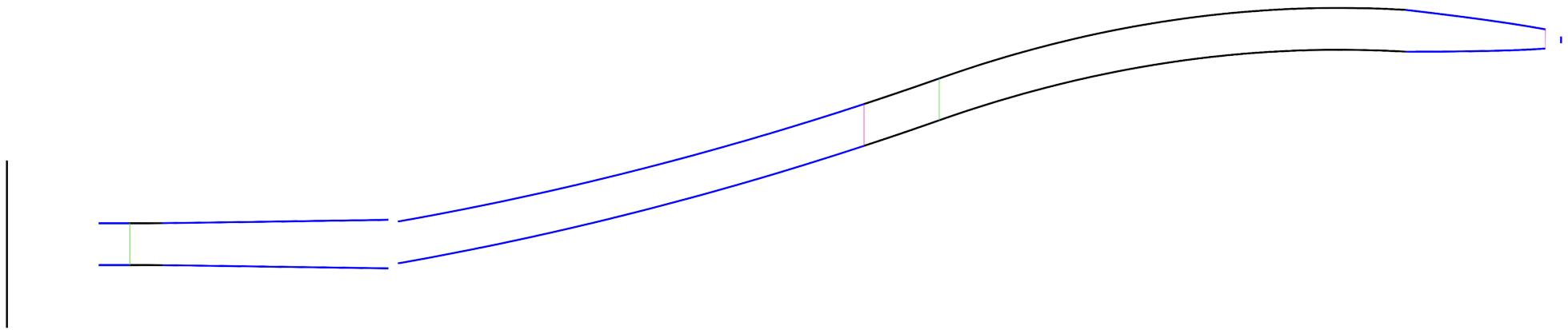


Elliptic\_guide\_gravity



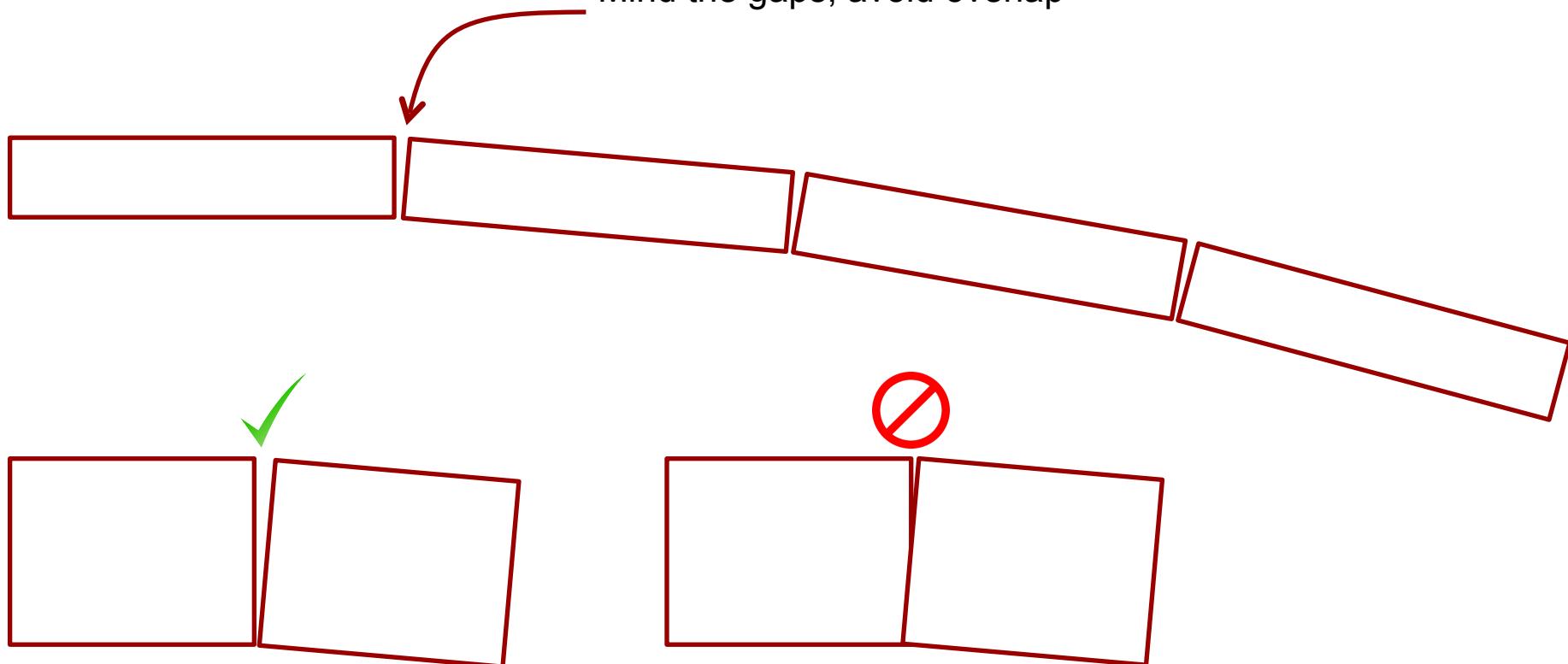
# Breaking line of sight

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



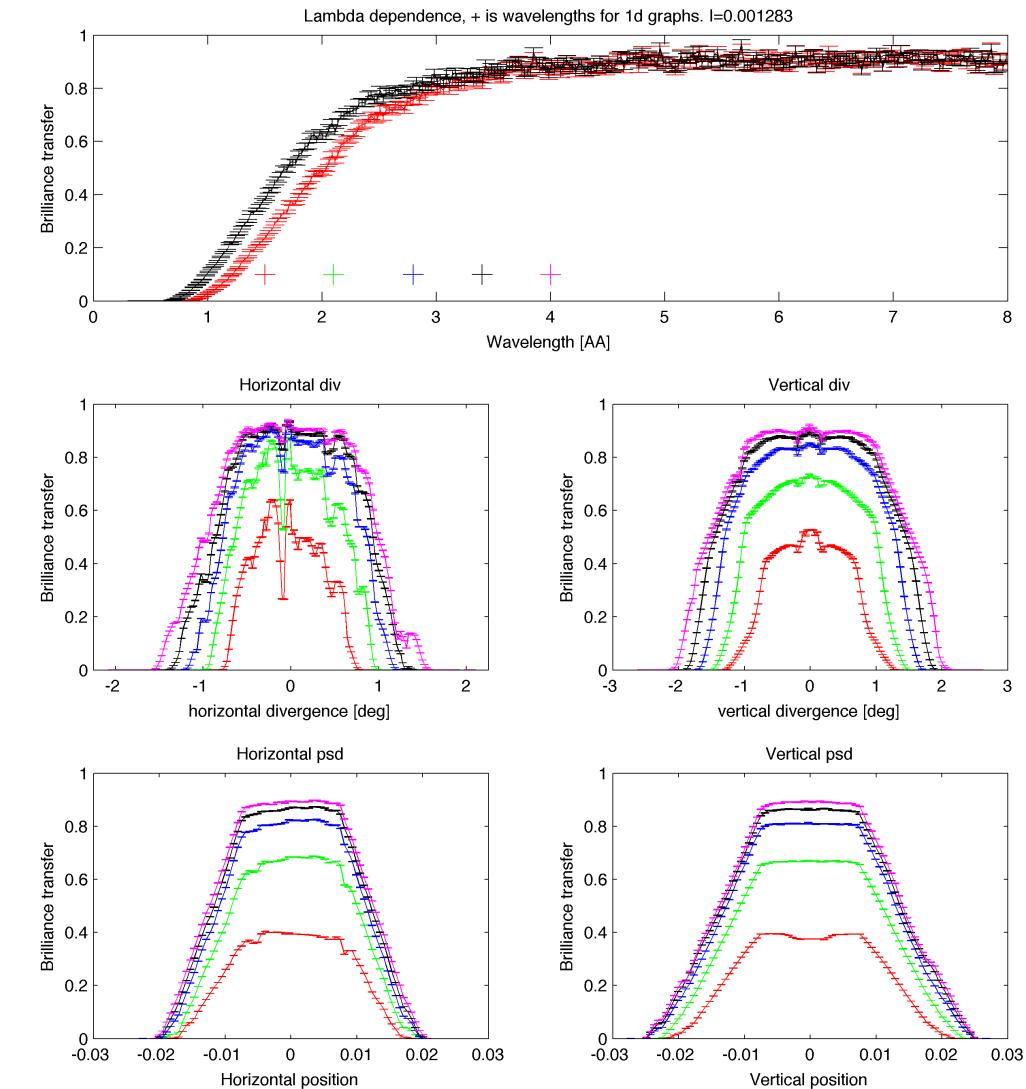
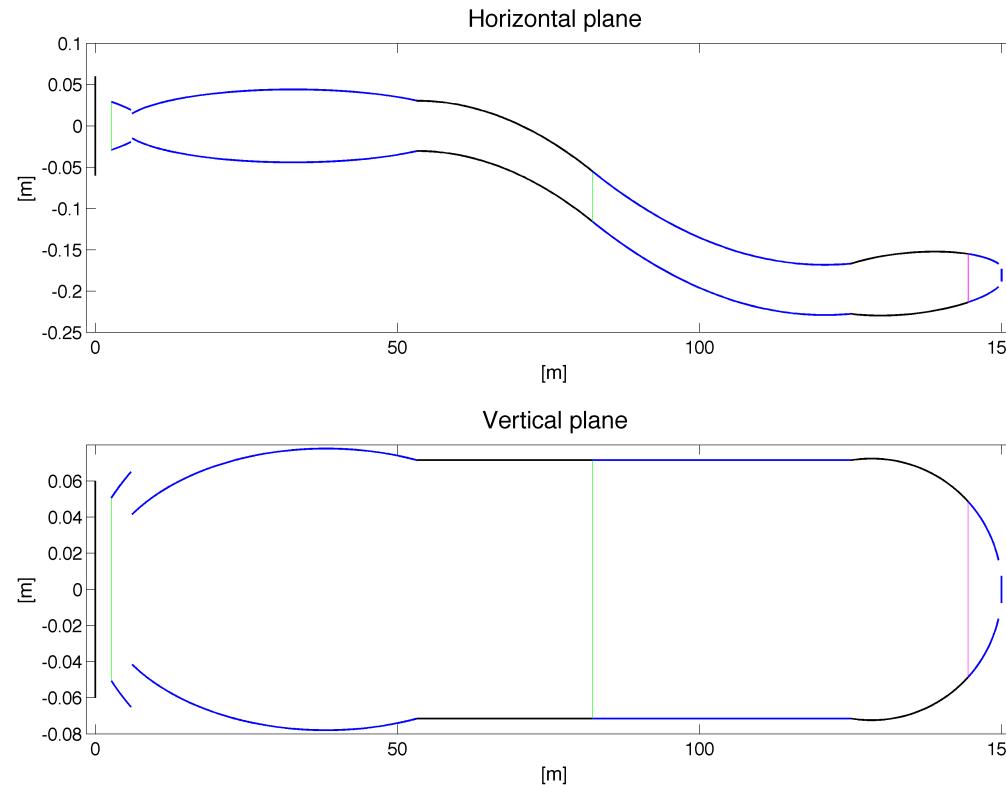
# Breaking line of sight

- Bender / Guide\_curved component or many straight sections  
Mind the gaps, avoid overlap



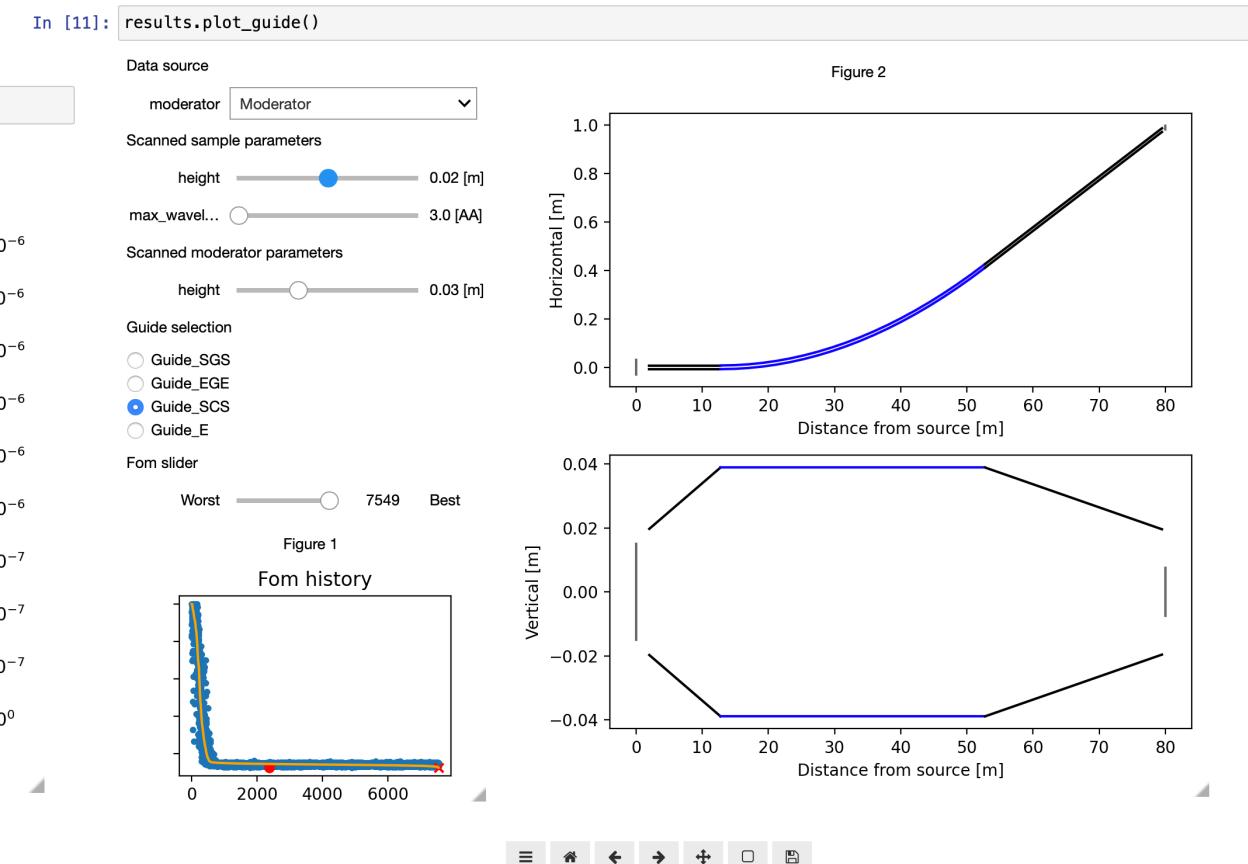
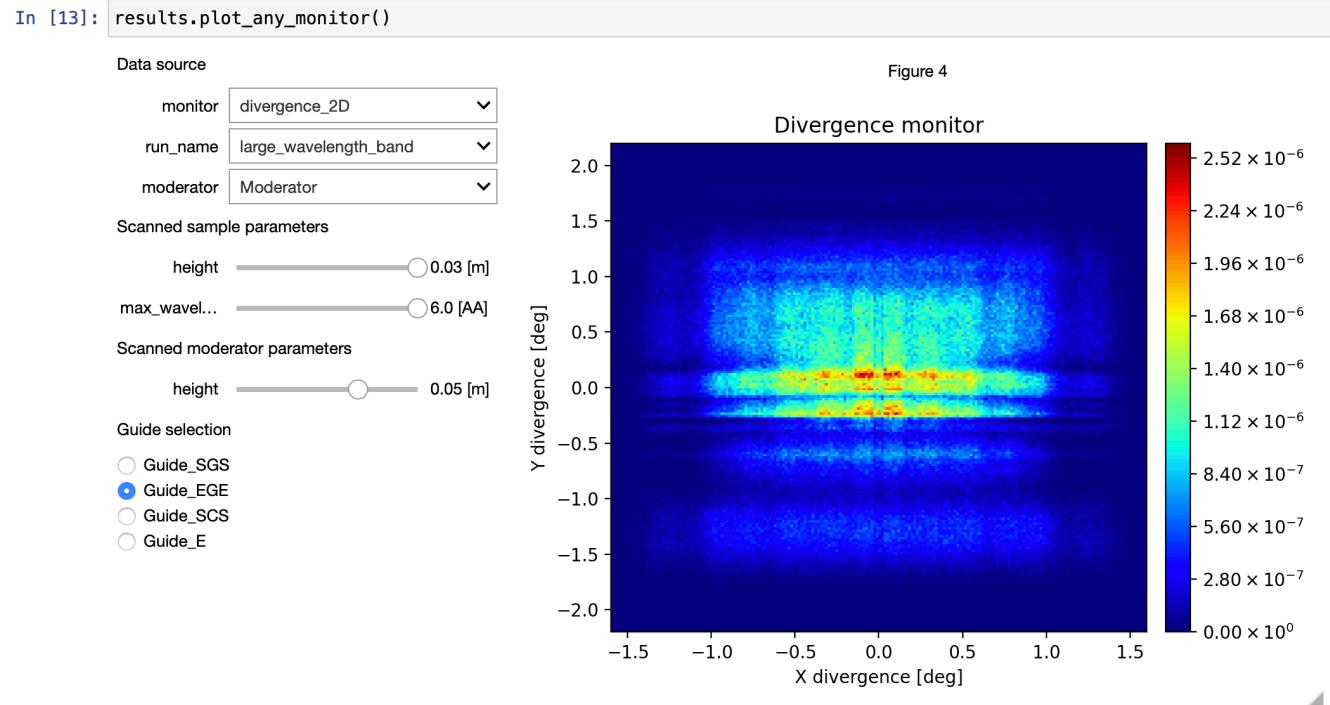
# Guide optimization

- Optimization result from MATLAB guide\_bot
- Python guide\_bot available



# Guide optimization

- Optimization results from python guide\_bot
- pip install guide\_bot --upgrade



Solution on [github](#), use if you are stuck

## Guide exercise

- 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