An Overview of Progress with the Study of a Structured Laser Beam (SLB) for Alignment

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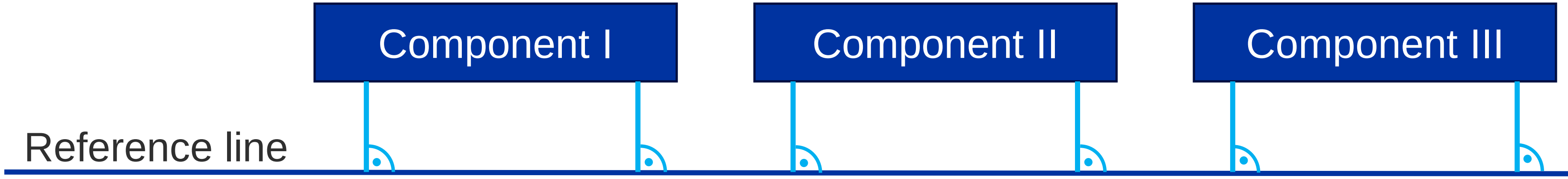
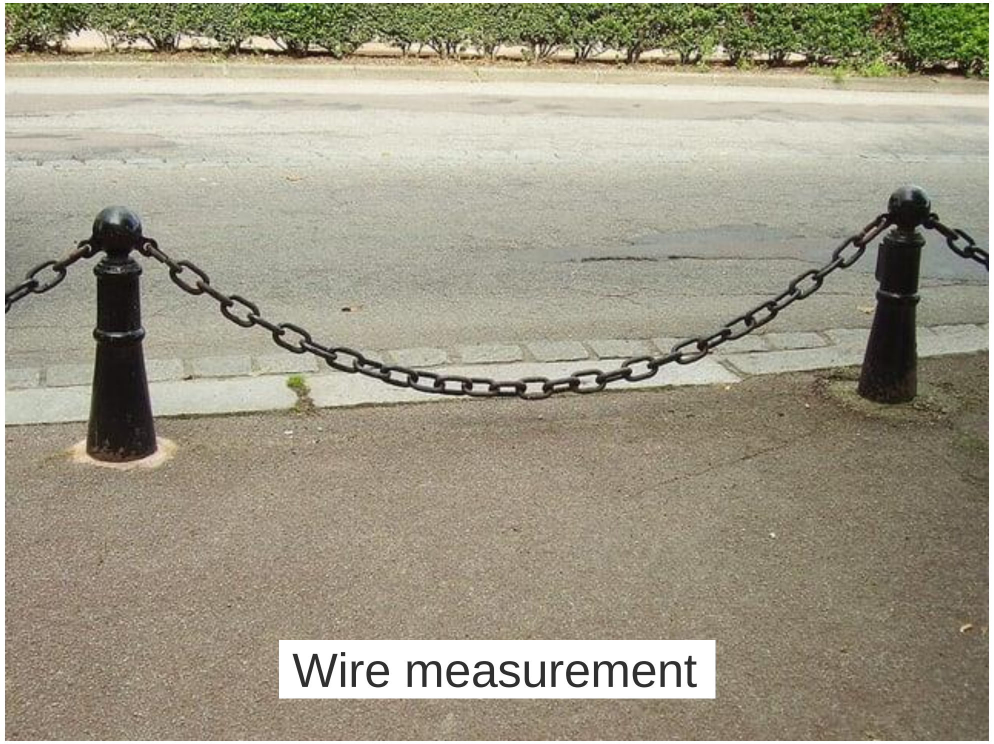
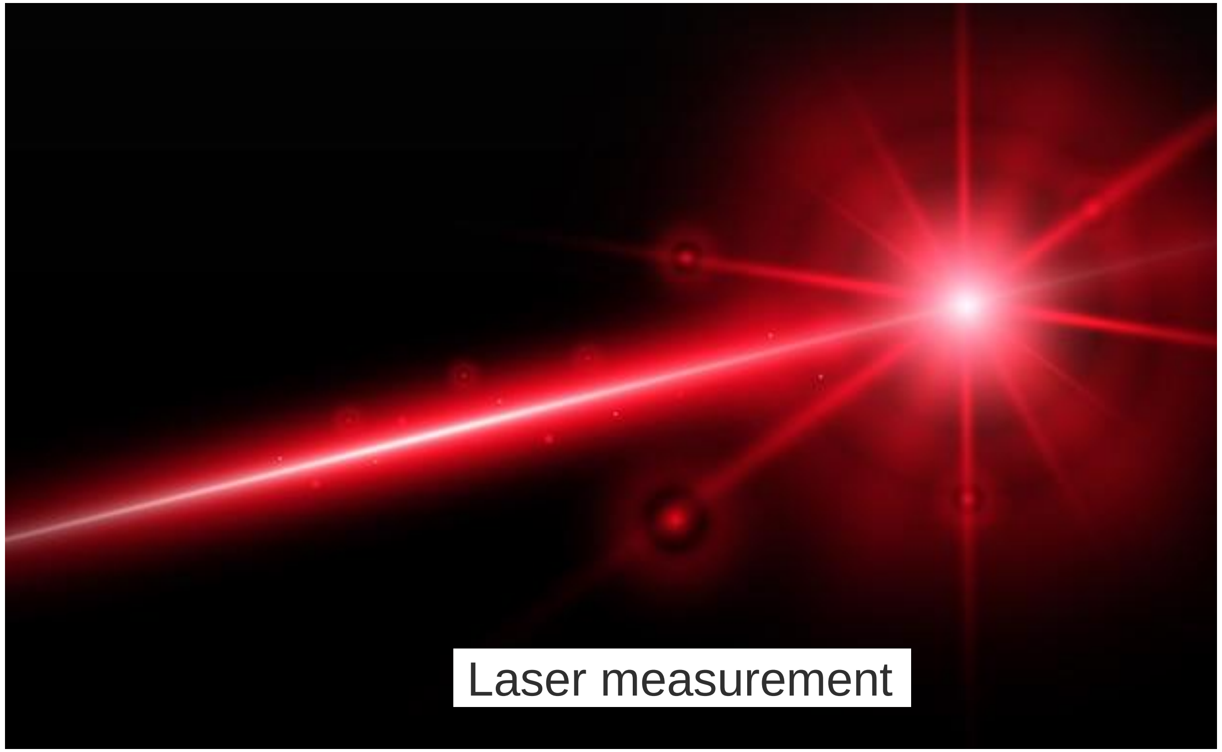
Straight line for alignment



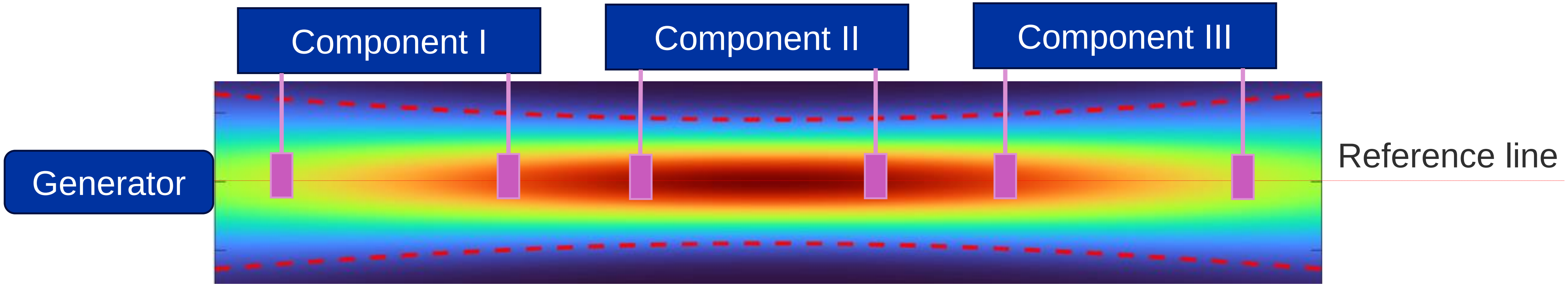
Assumptions:

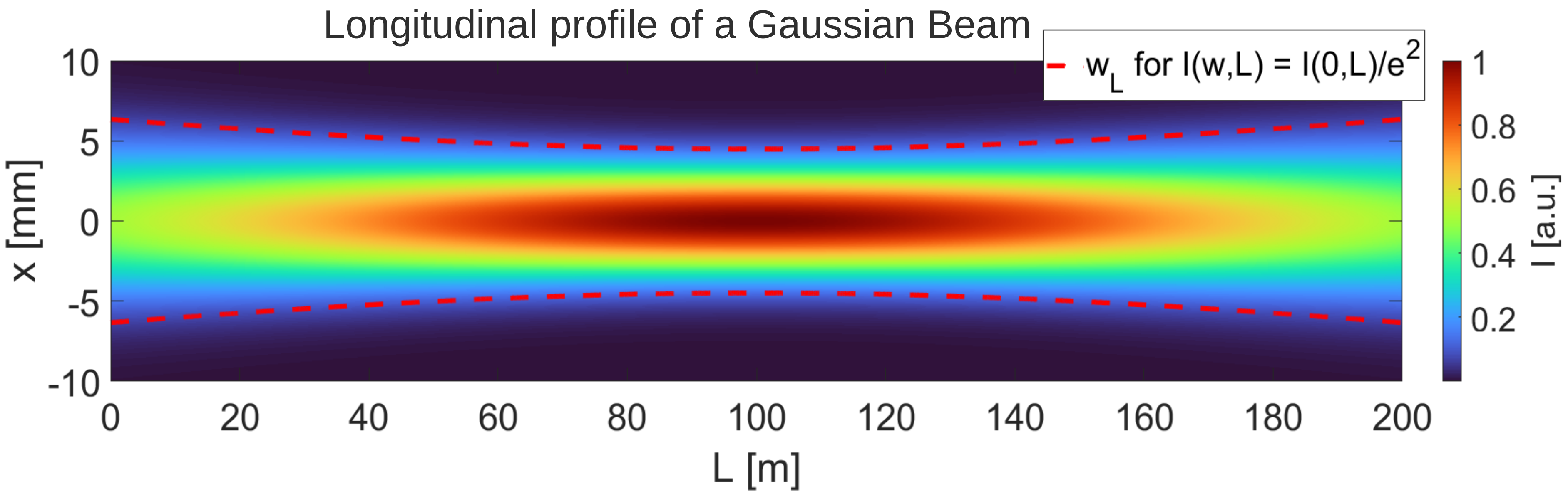
- Line is straight
- Offsets are perpendicular

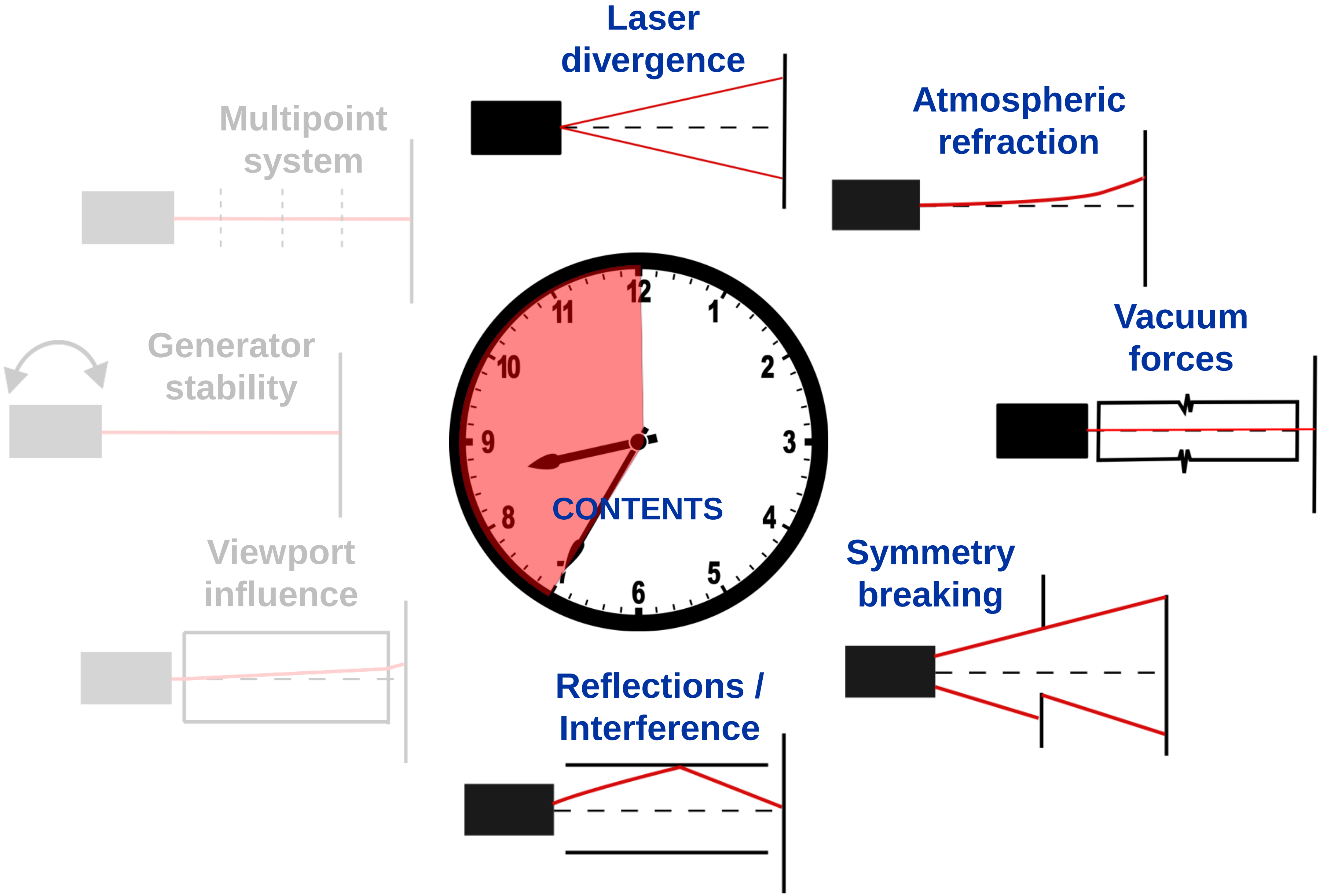




Alignment – beam width – Gaussian beam






Laser divergence
Atmospheric refraction
Multipoint system
Generator stability
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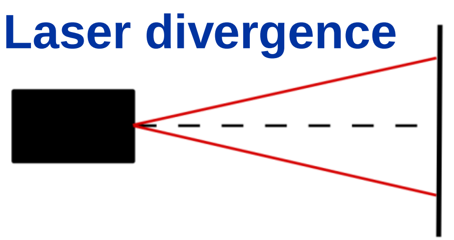
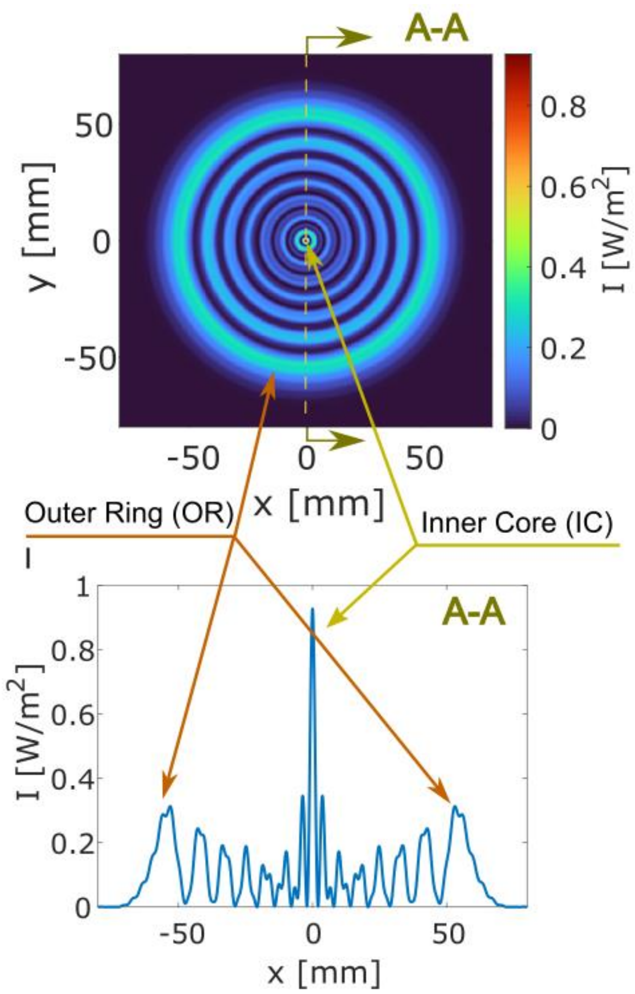
Reflections / Interference

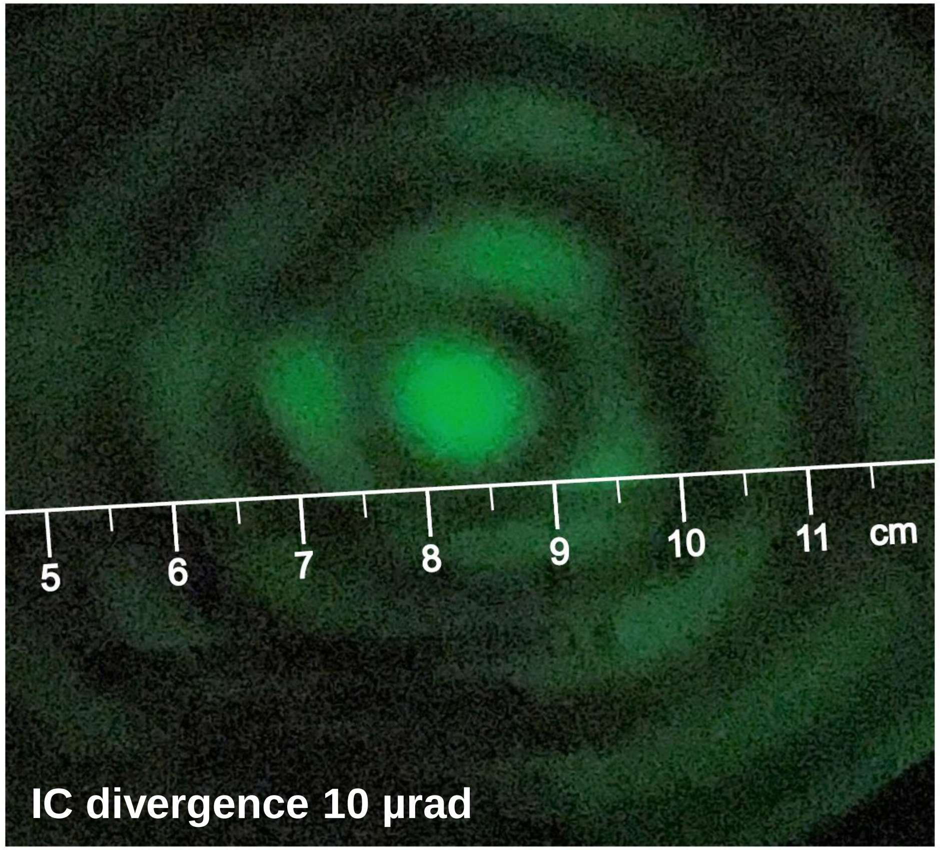
Low divergence of Inner Core (IC)



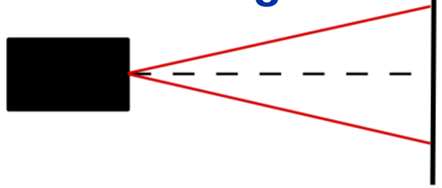
Theoretical transverse profile of an SLB at 225 m

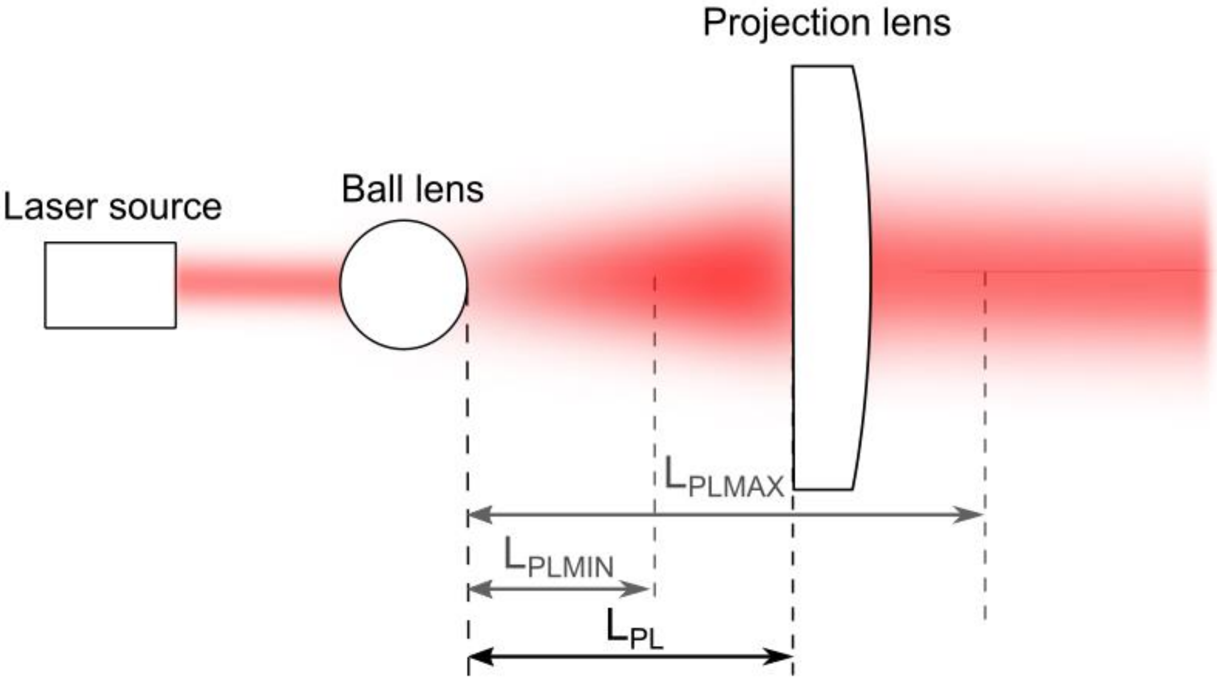


Acquired transverse profile at 900 m

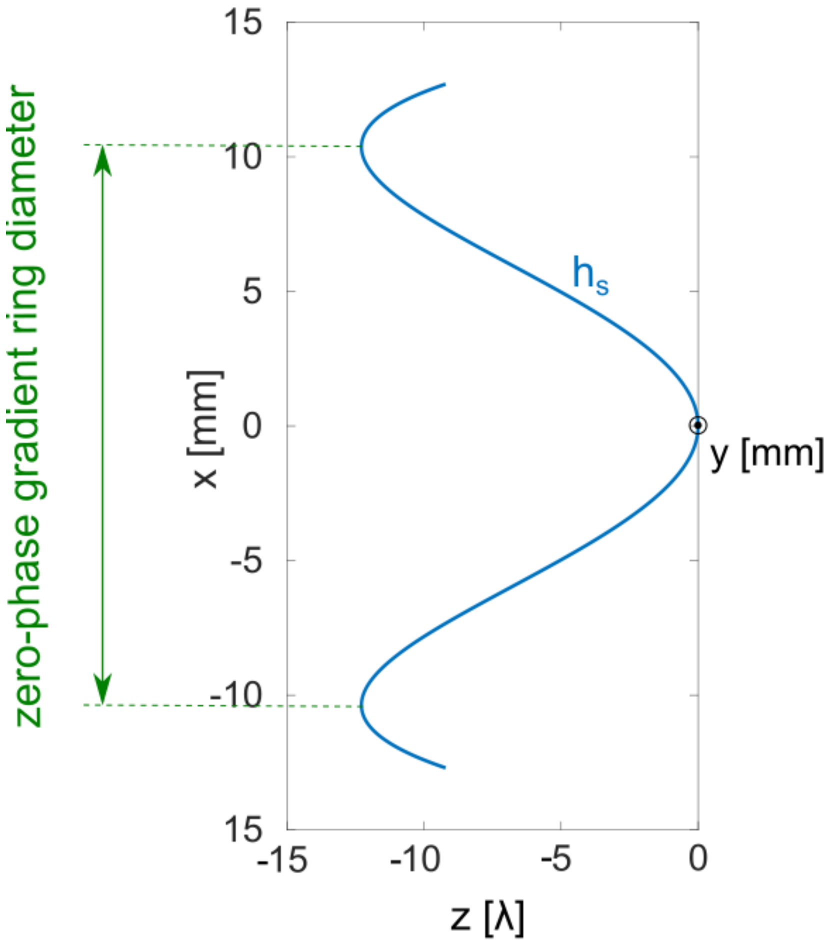


Generator and wavefront



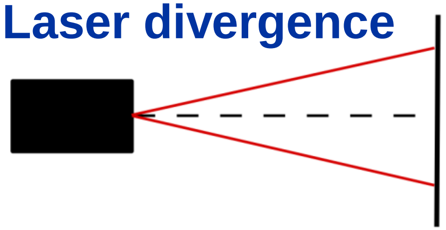


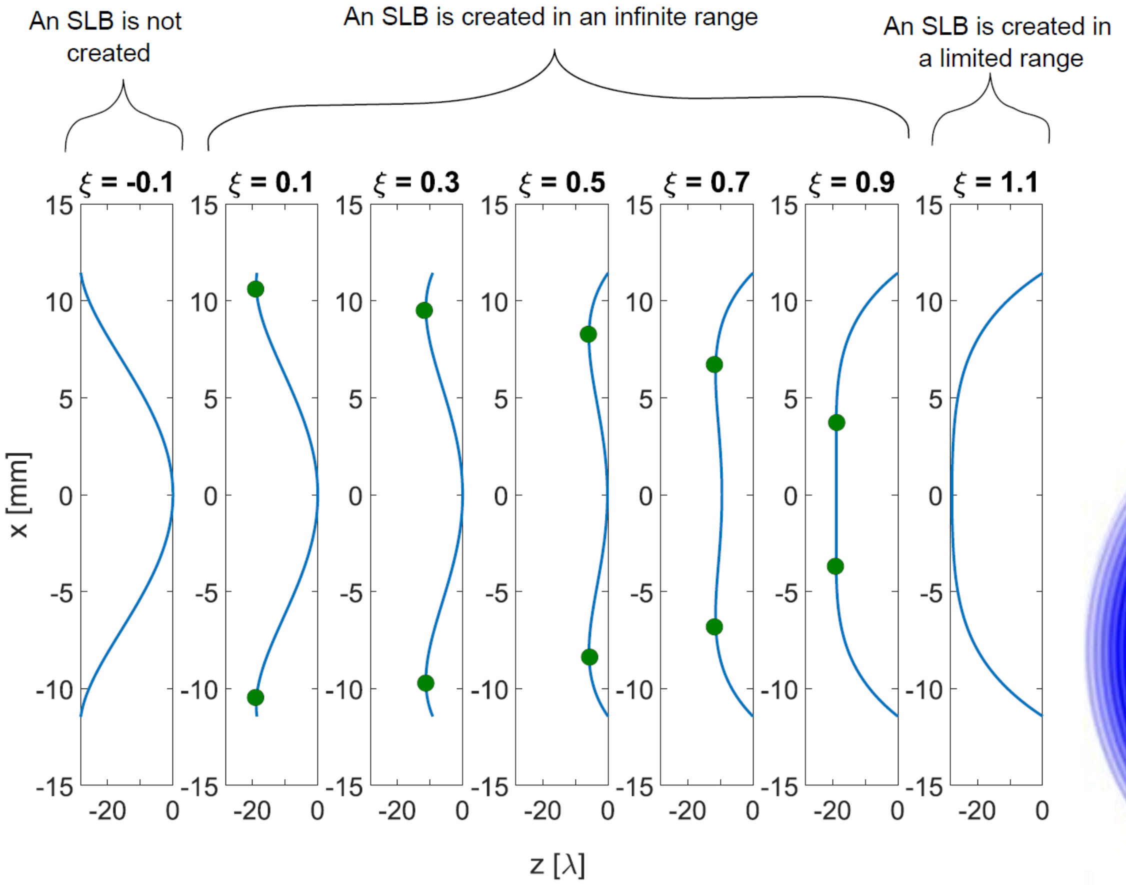
$$L_{PL} = L_{PLmin} + \boxed{\xi}(L_{PLmax} - L_{PLmin})$$



Wavefront and profile

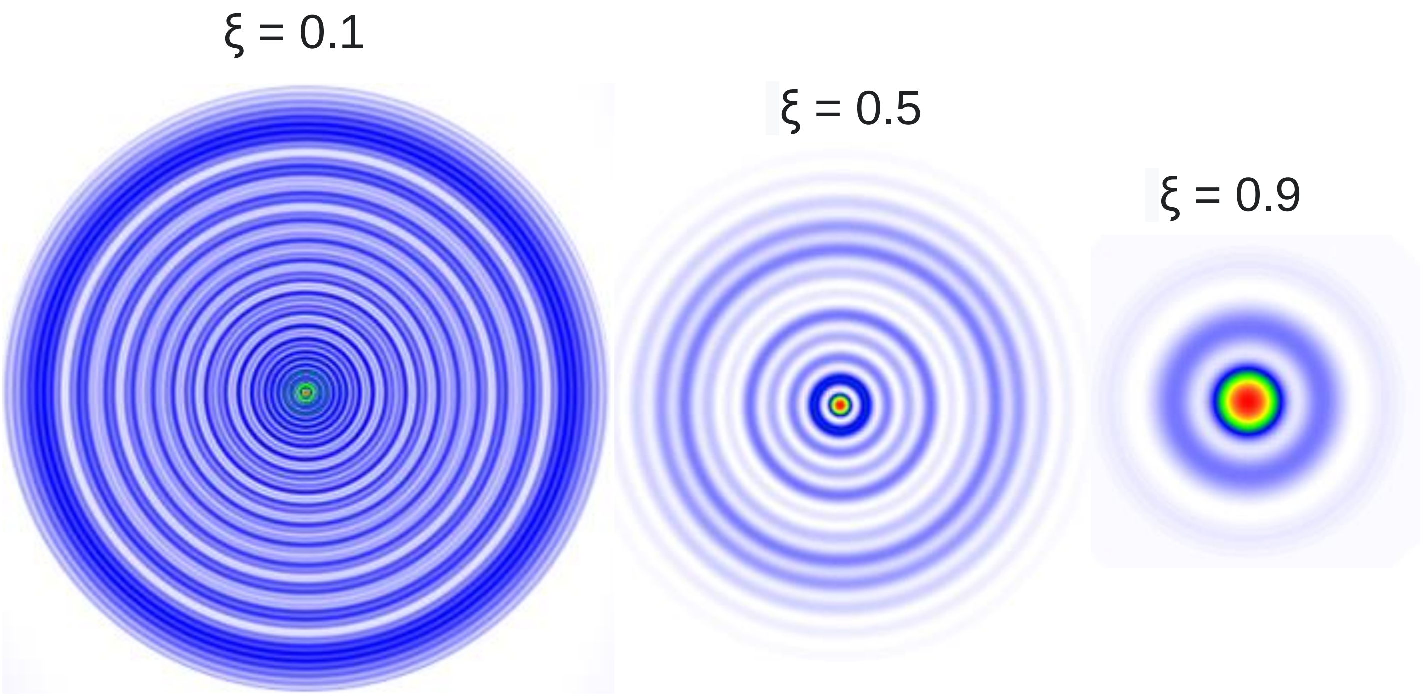
Laser divergence





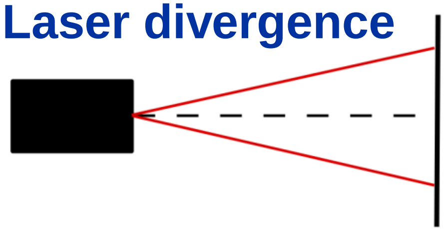
Large zero-phase gradient ring:

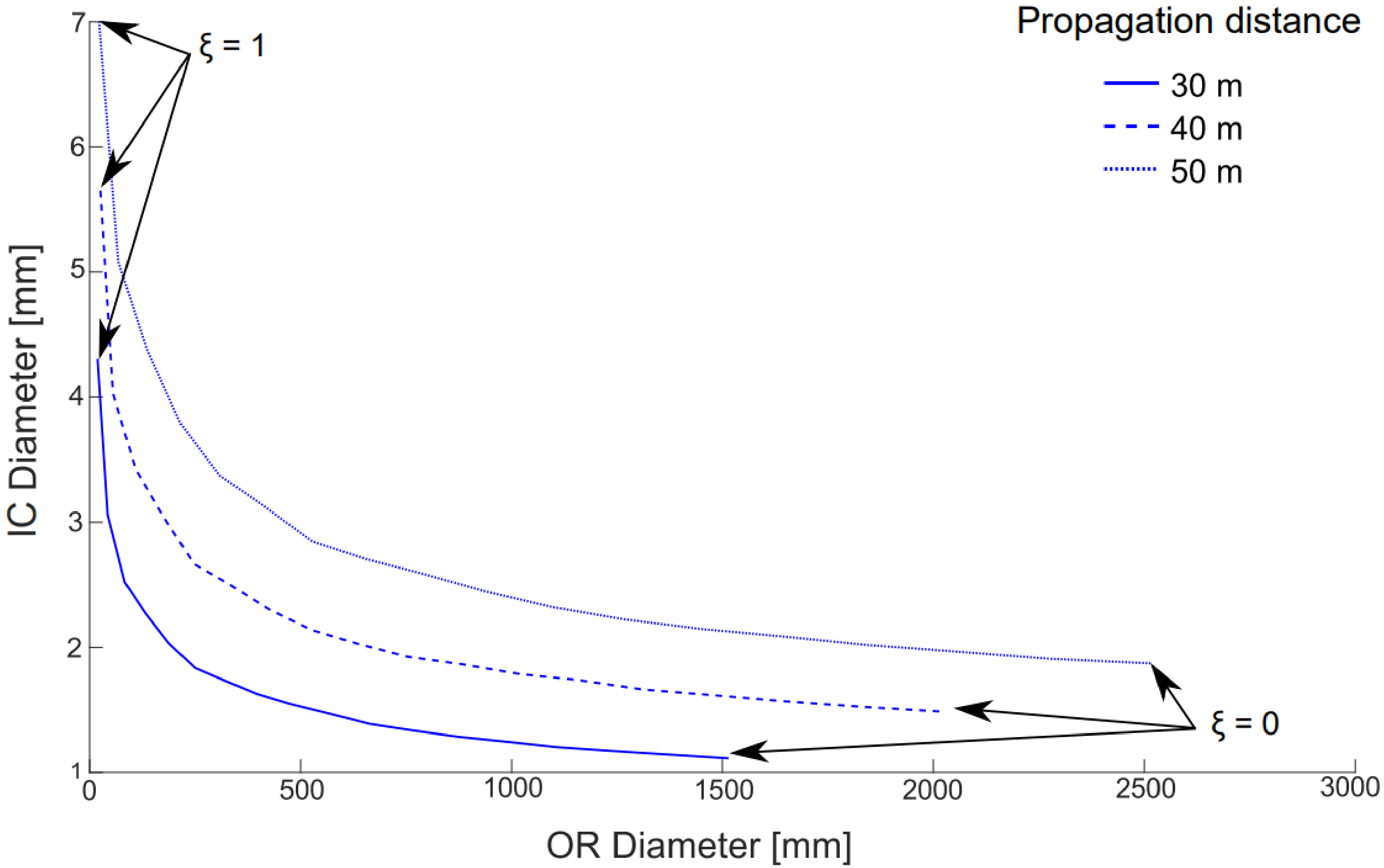
- Small IC
- Large OR



Inner Core and Outer Ring diameters

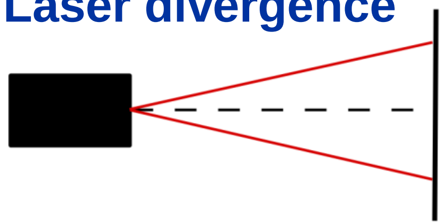
Laser divergence

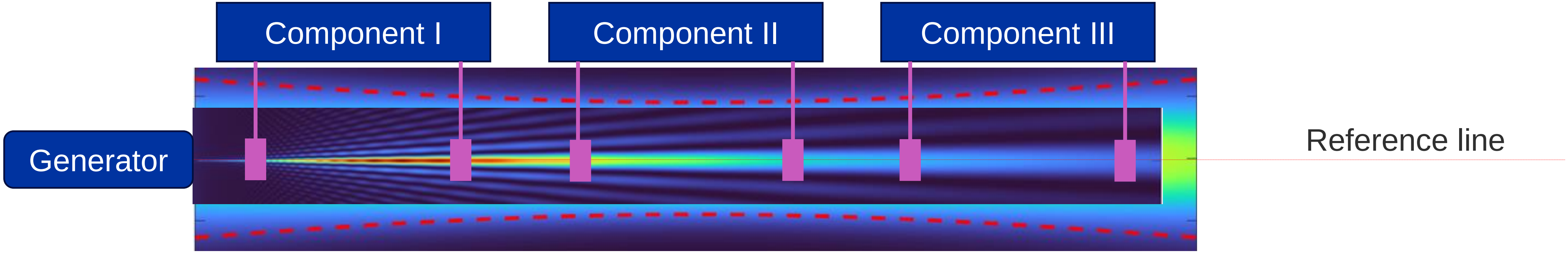


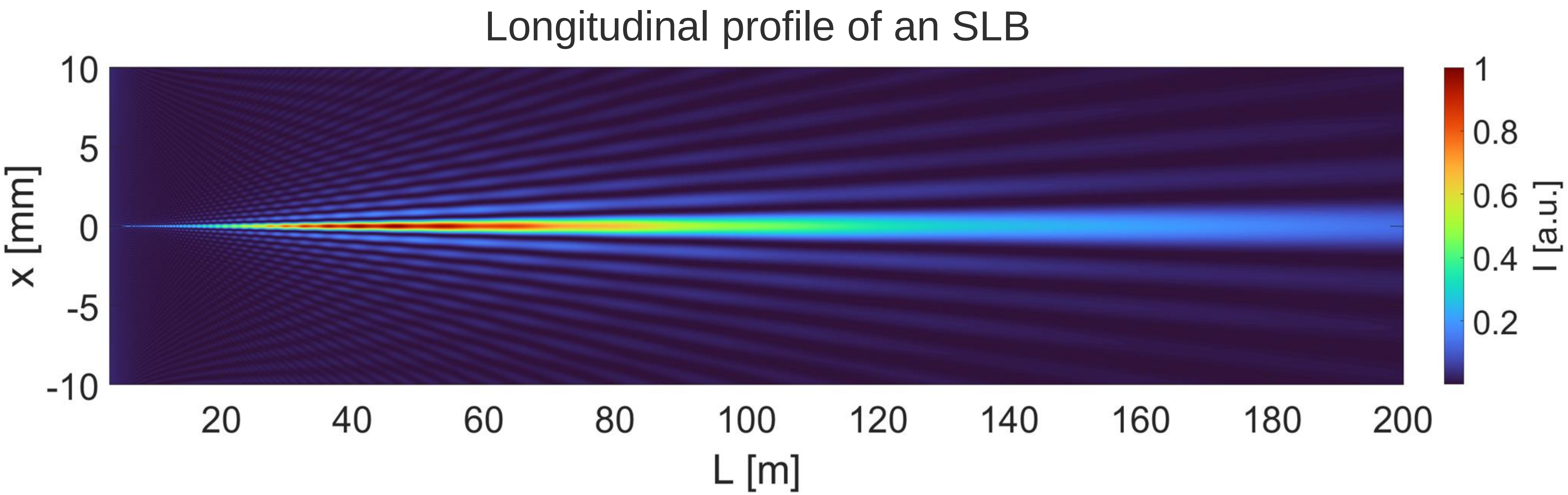


Alignment – beam width – SLB

Laser divergence

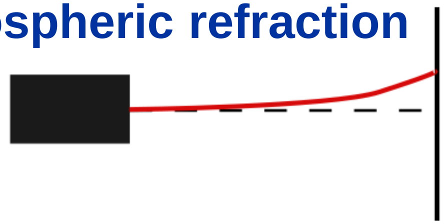


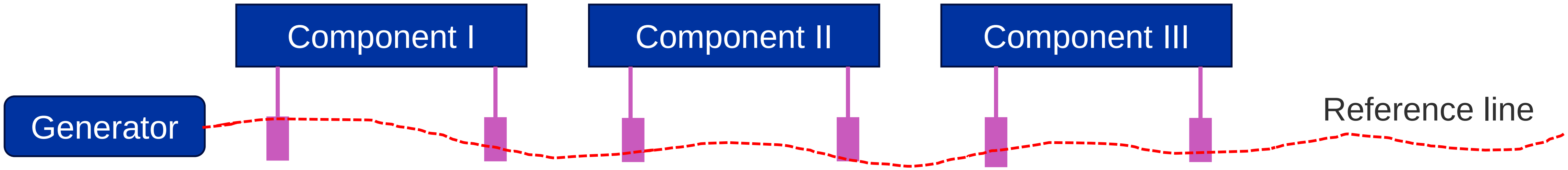


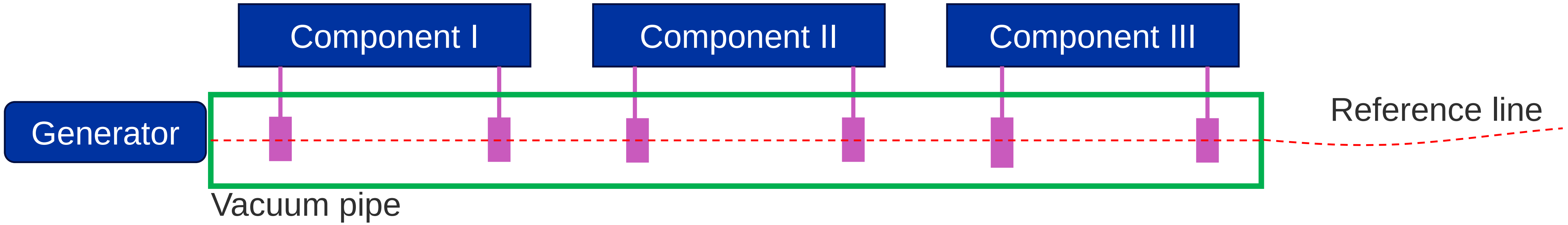


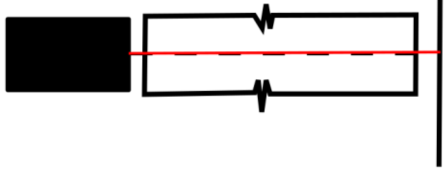
Refraction and Vacuum

Atmospheric refraction



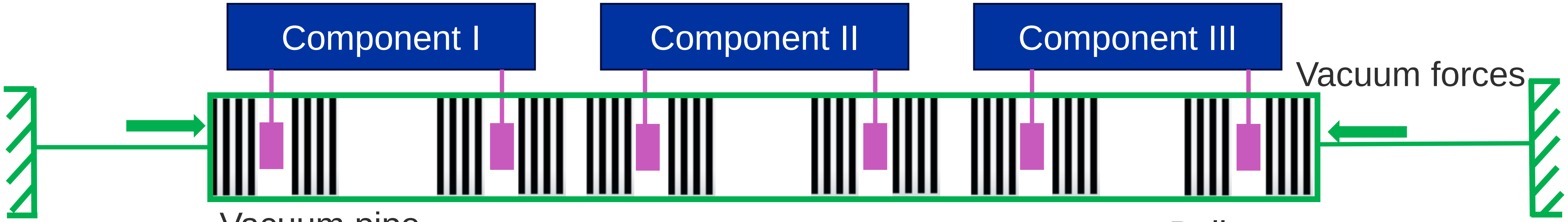


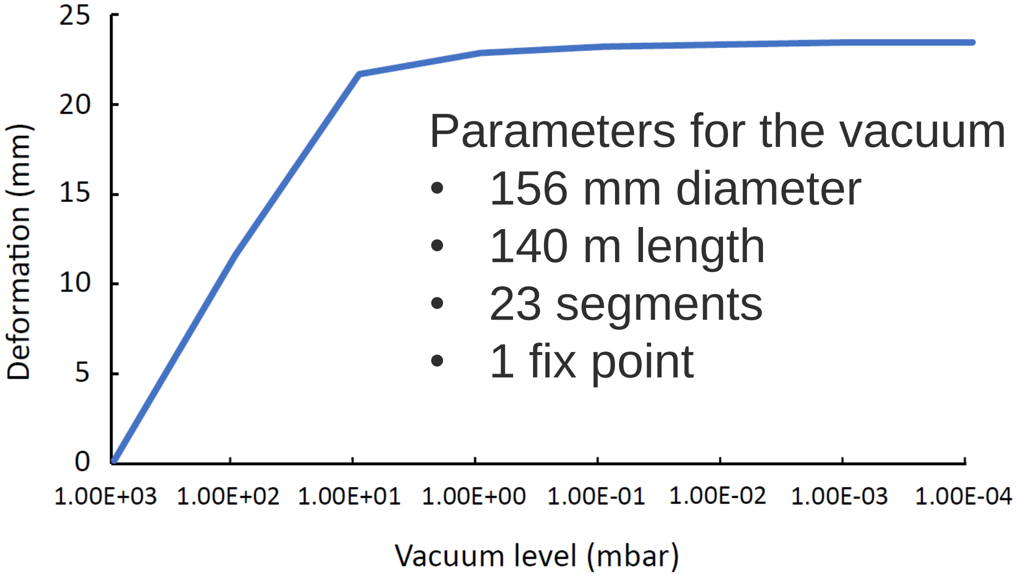




Vacuum forces

Constraint on the mechanical link between the vacuum system and measured components



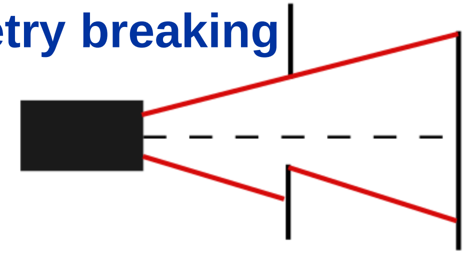


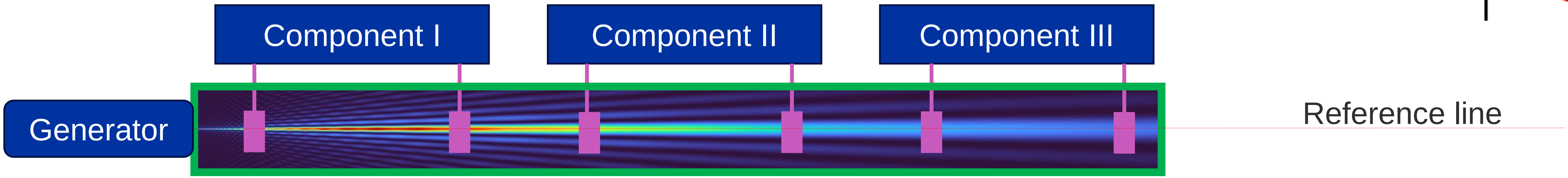
Parameters for the vacuum system:

- 156 mm diameter
- 140 m length
- 23 segments
- 1 fix point

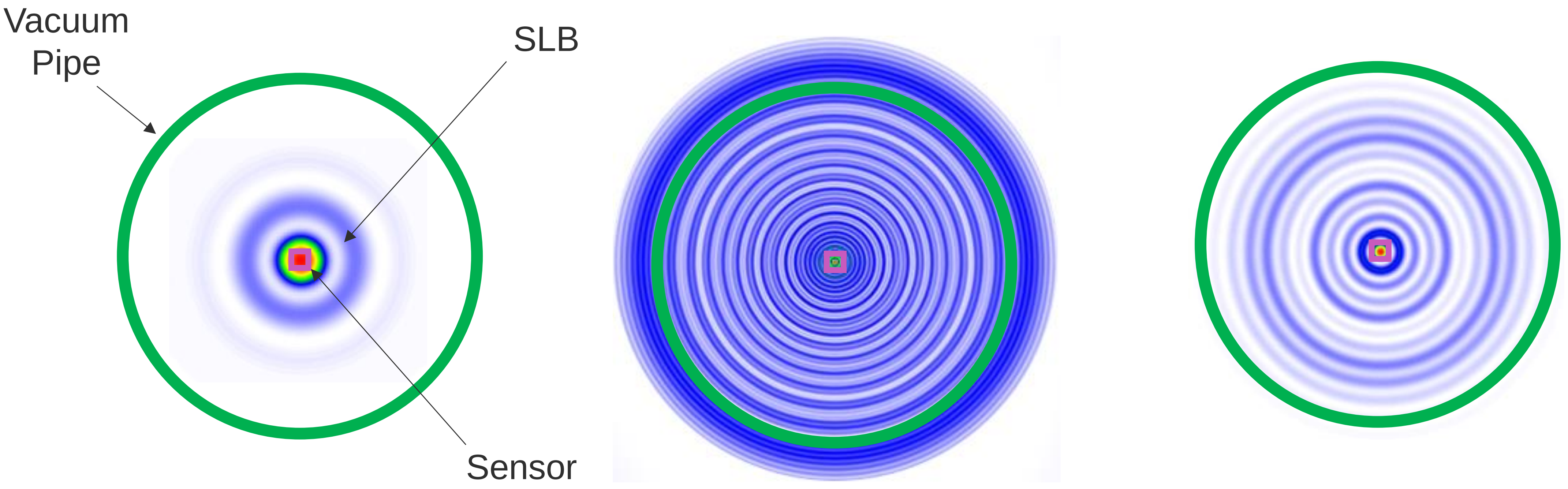
Symmetry breaking – Vacuum pipe

Symmetry breaking

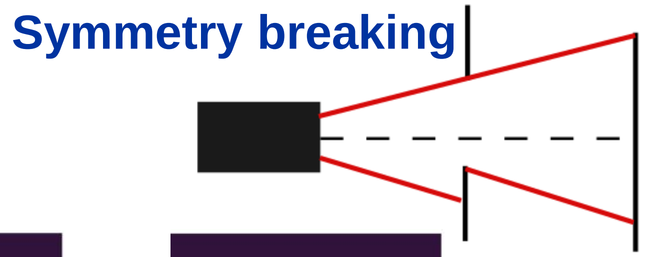




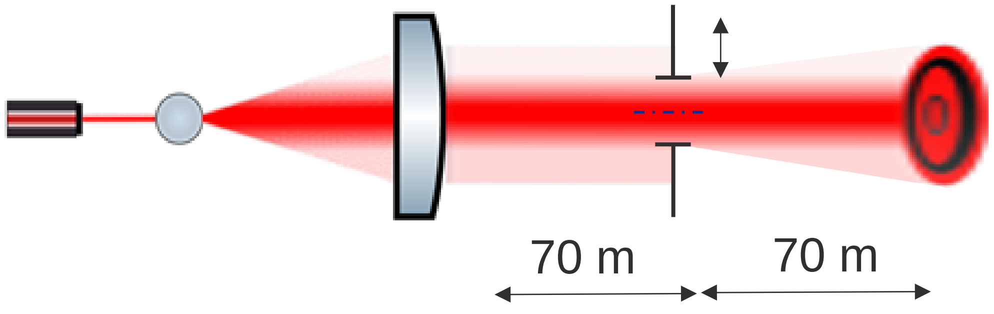
Inner Core and Outer ring vs Vacuum Pipe and Sensor size

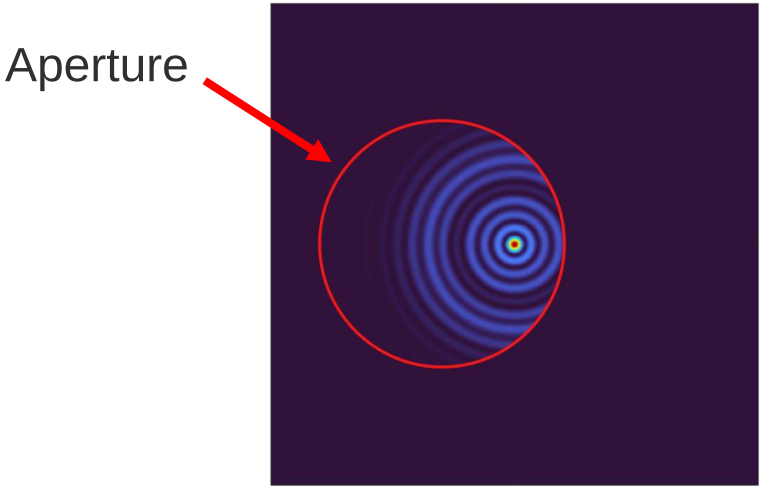


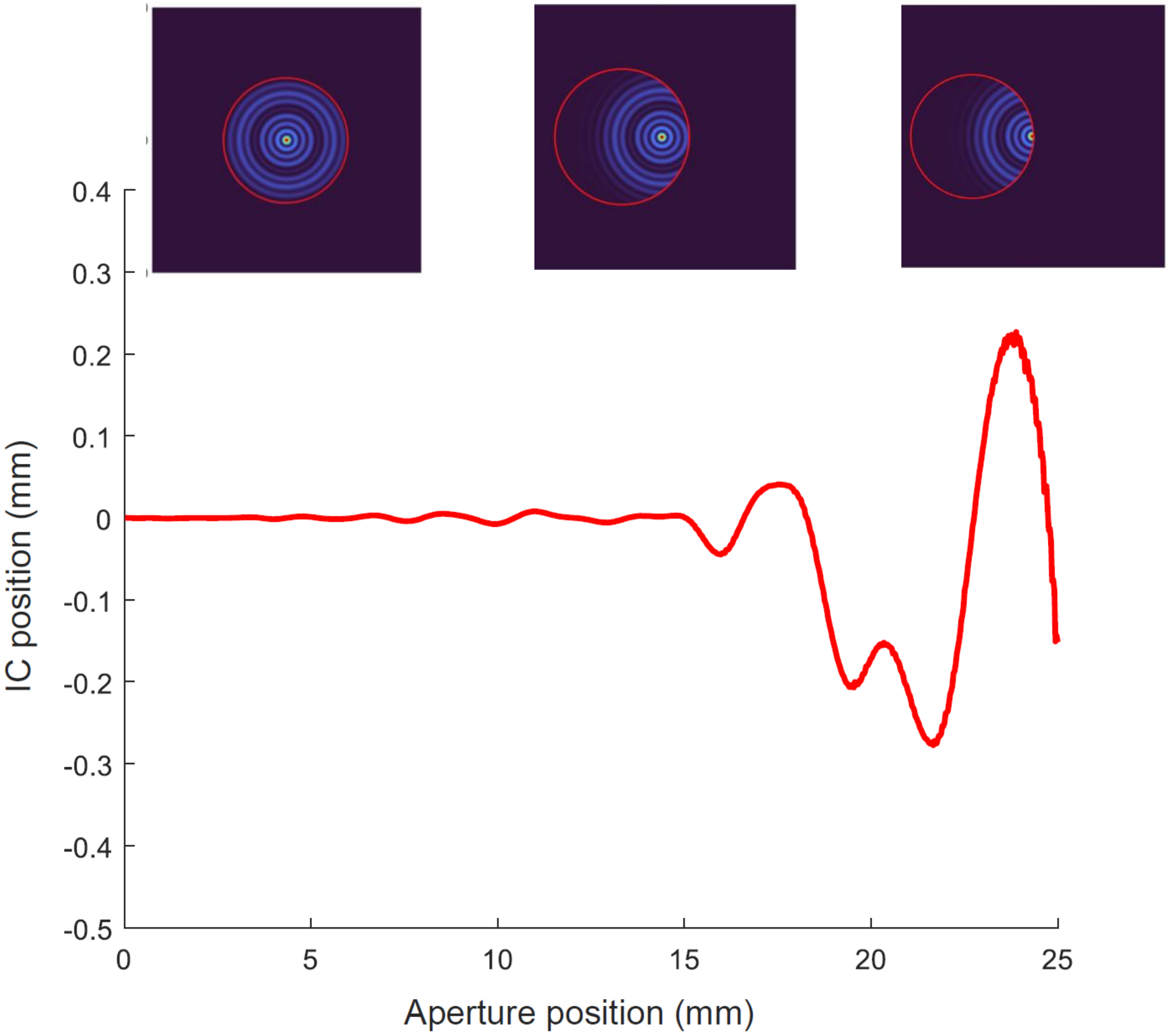
Symmetry breaking – Single aperture

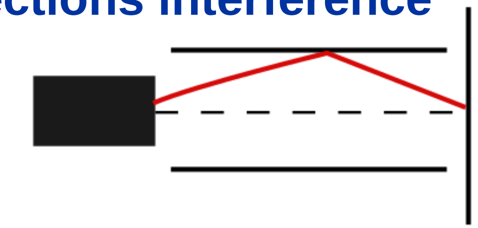


The size of the OR and the aperture
at the 70 m is equal 50 mm

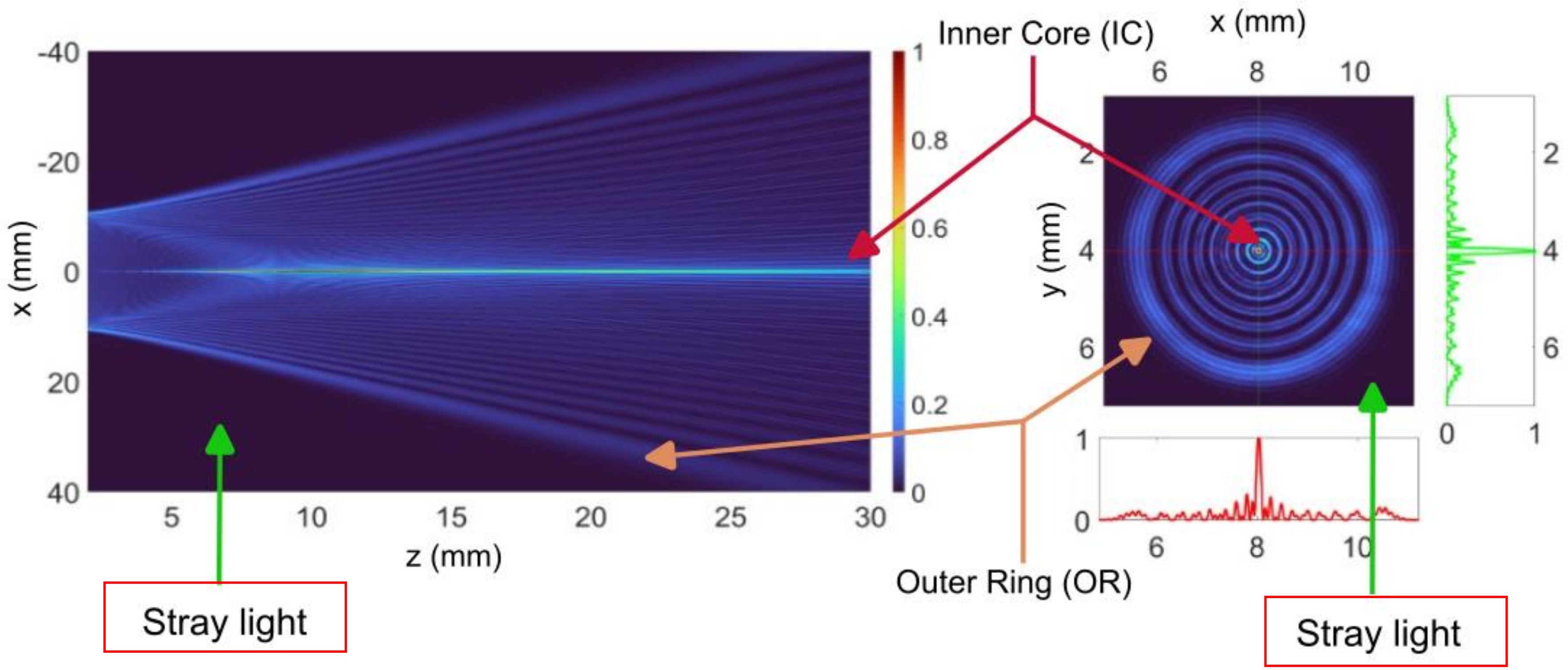




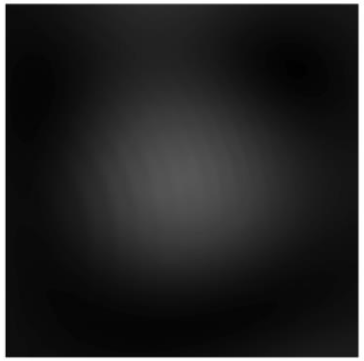


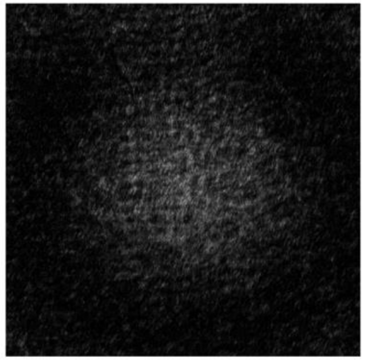


Source of reflection



Propagation in free air 140 m

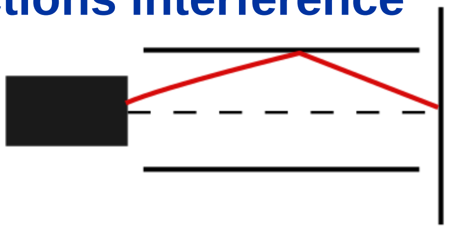




Propagation in vacuum pipe 140m

Reflection reduction - Methods

Reflections interference

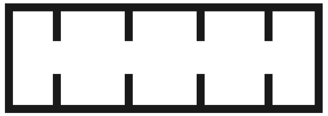


Pipe | Laser

Color

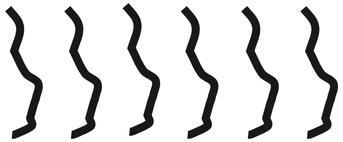
Black

Structure



Rough
Baffles

Temporal coherence



Wavefront (t)

Spatial coherence

Wavefront (t)

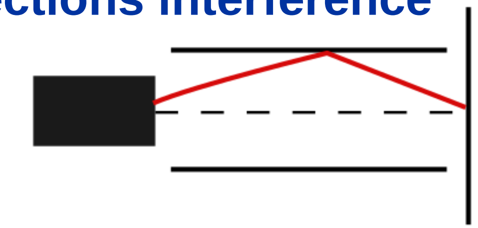
Black undulated

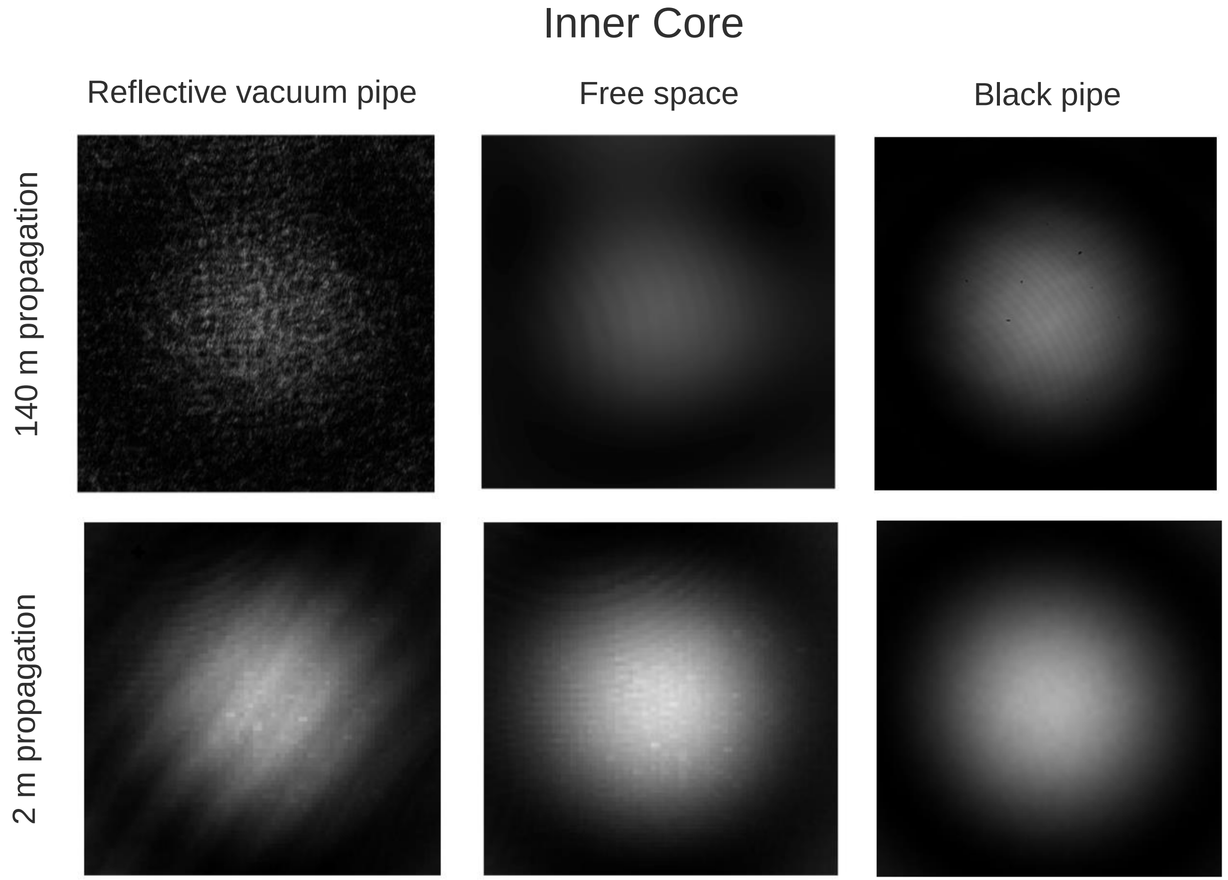
He Ne laser

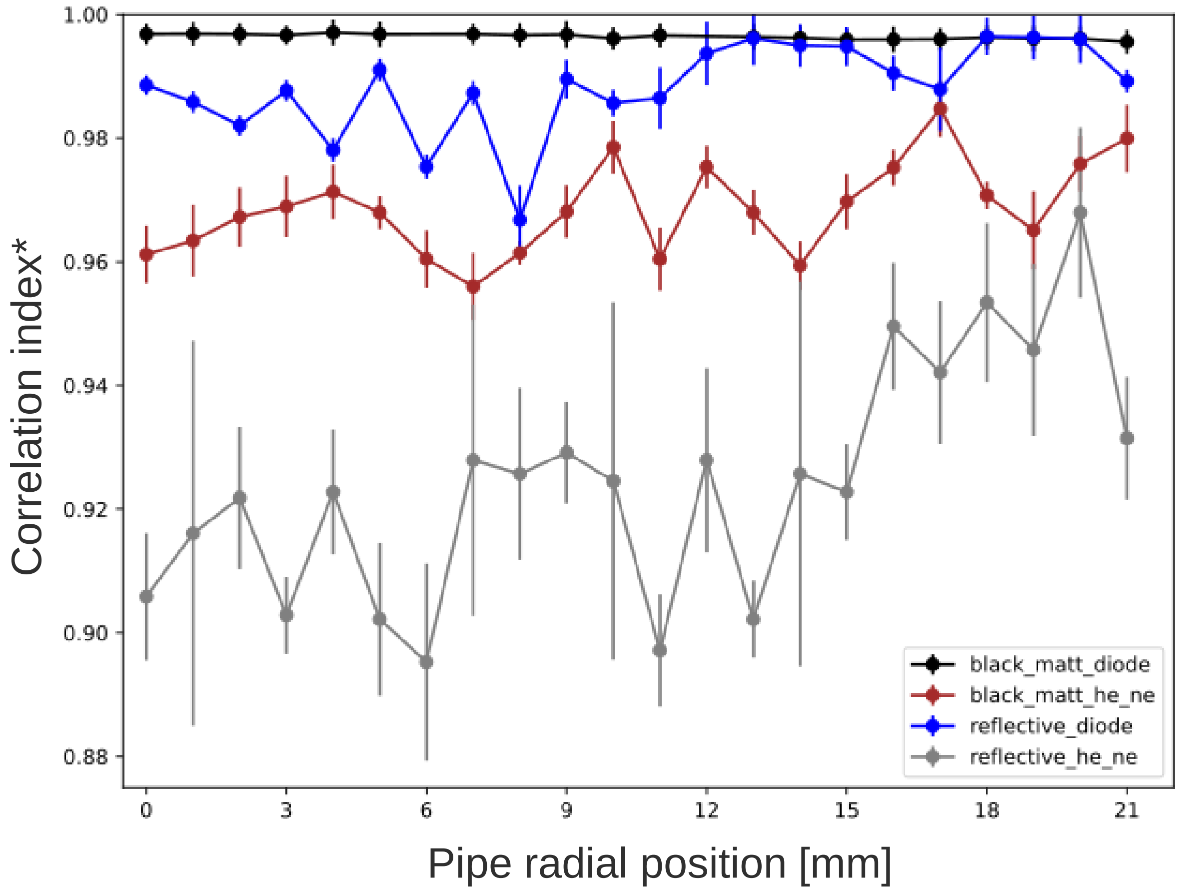
Laser Diode

Reflection reduction - Results

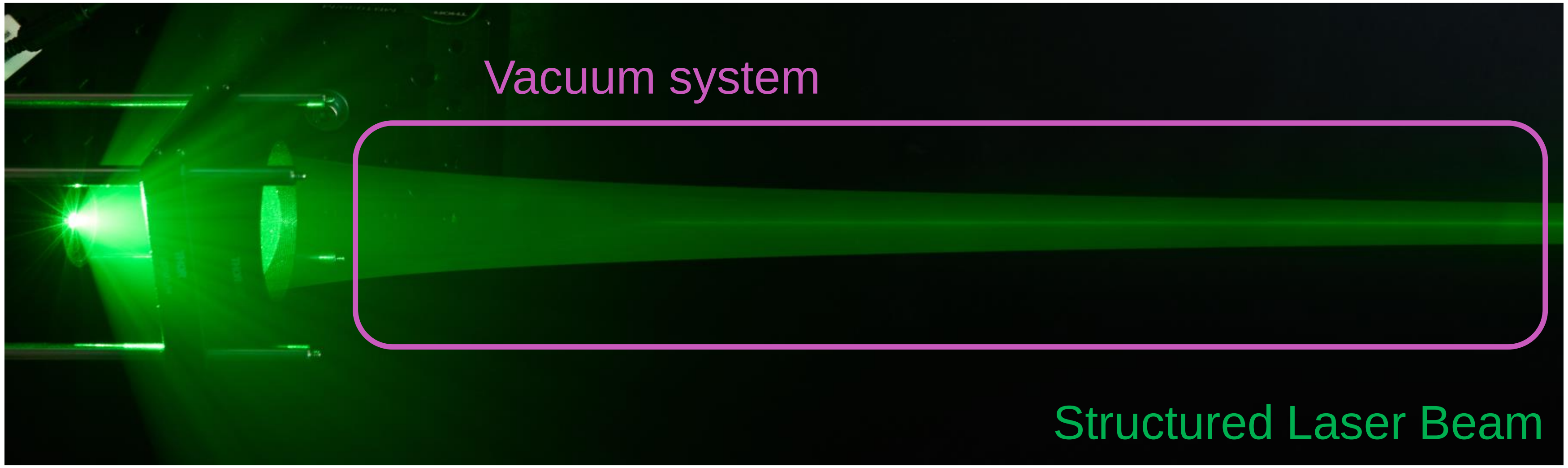
Reflections interference

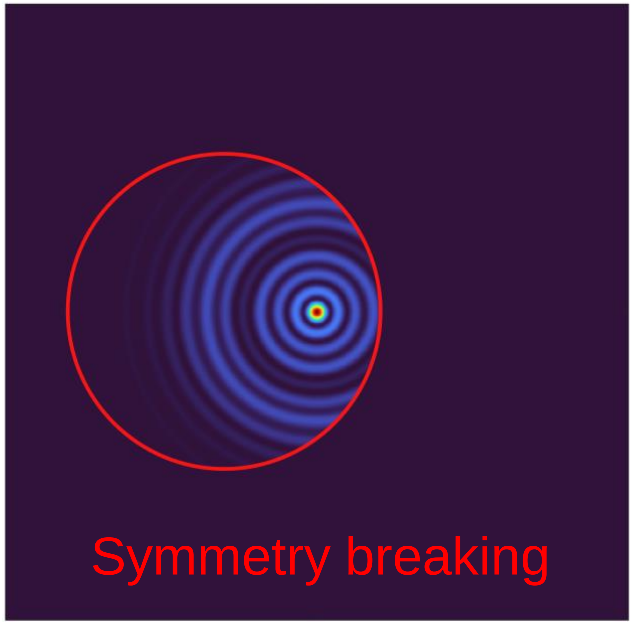


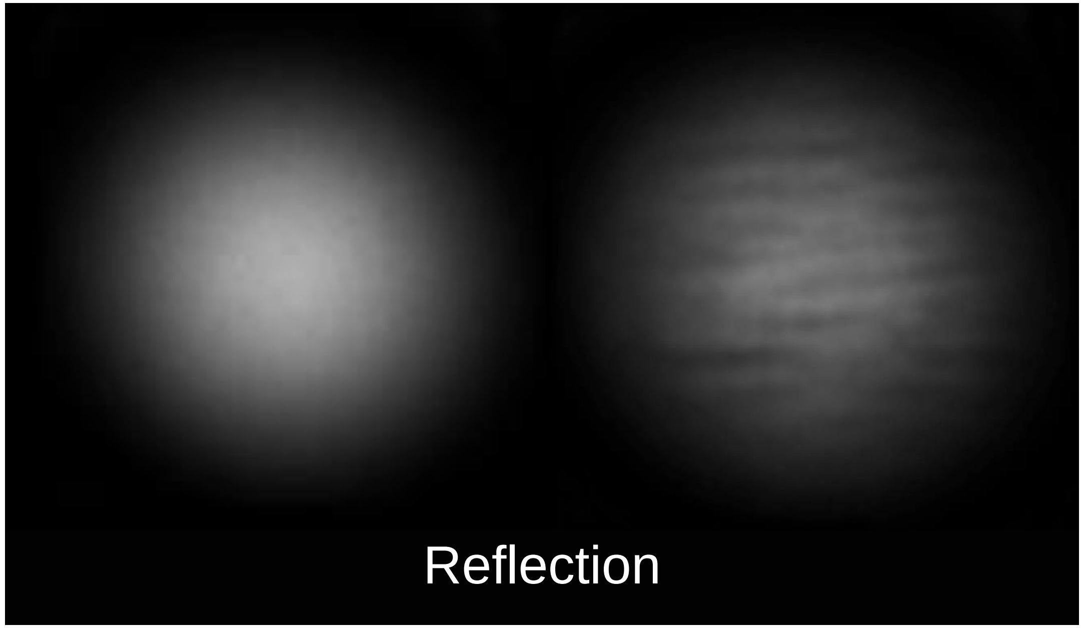




Correlation index* - Structure Similarity Index Measure (SSIM) between photos in free space and in the pipes (test at 2 m)


Vacuum system
Structured Laser Beam


Symmetry breaking


Reflection

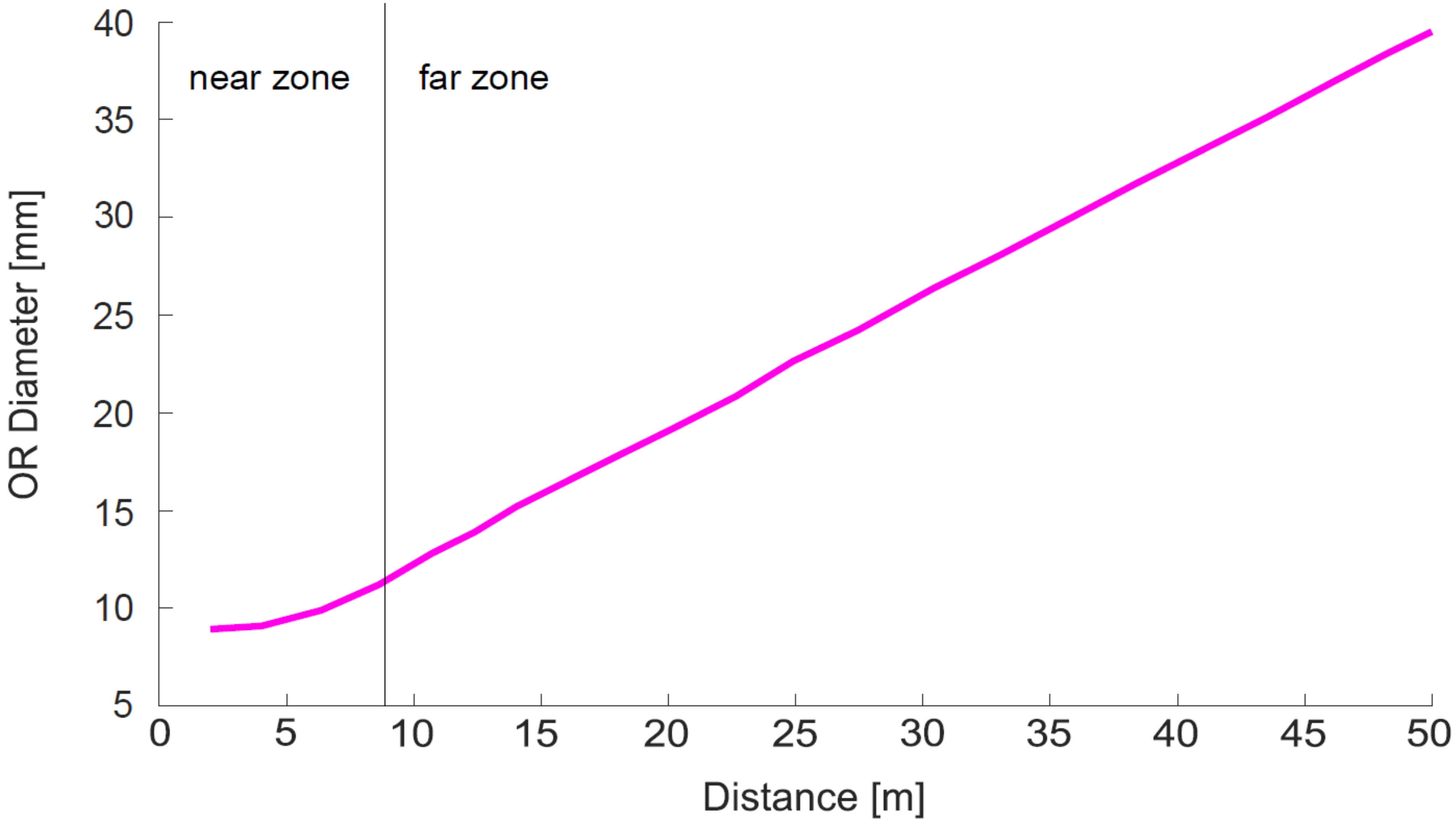
ETH zürich

Witold Niewiem

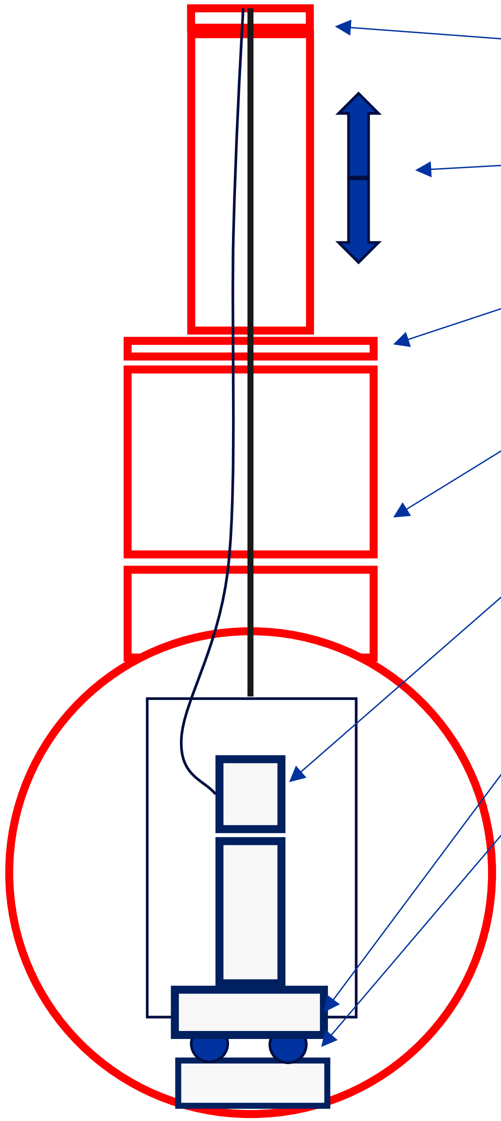
CERN

home.cern

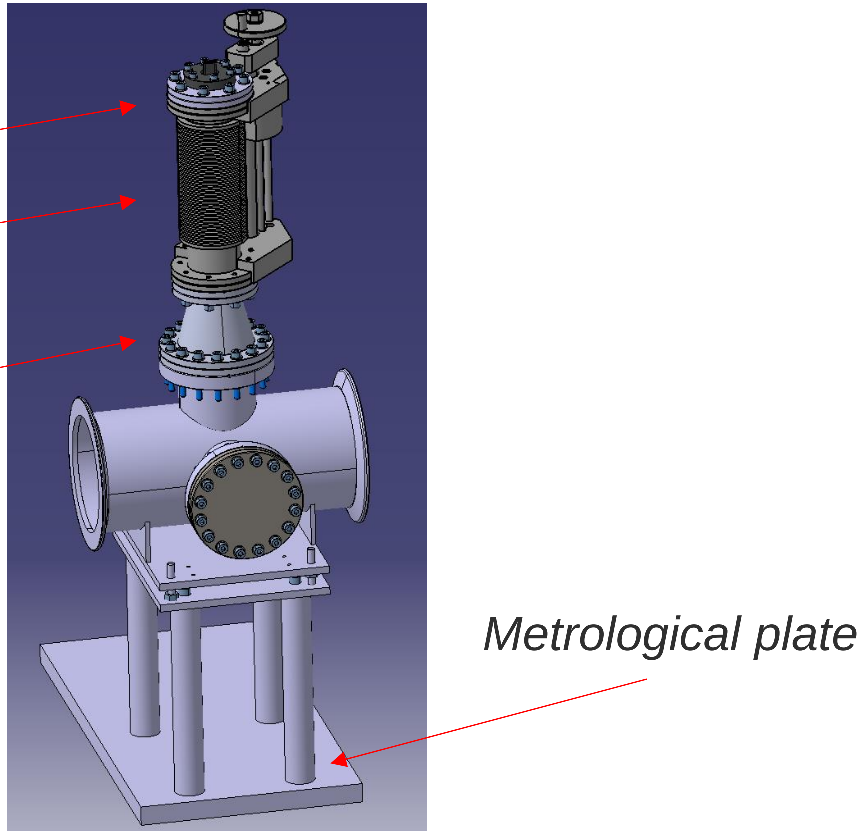
Near and far optical zones

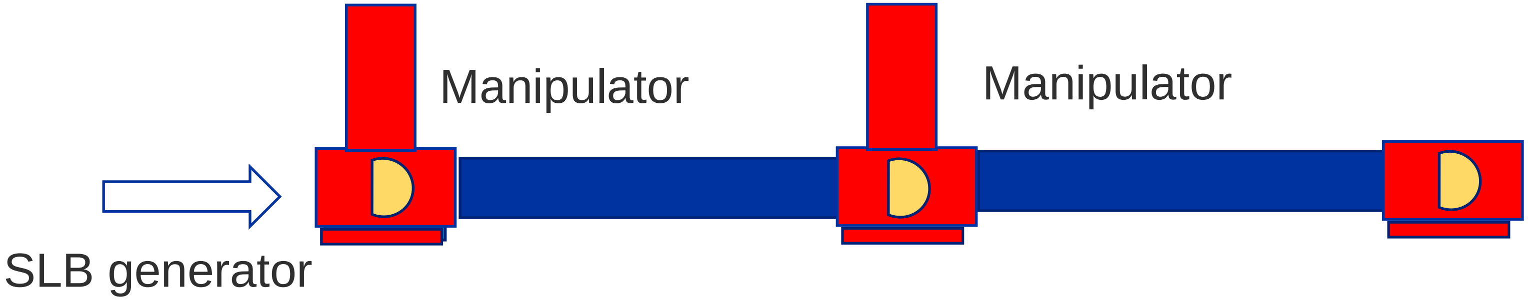


Shutter system principle



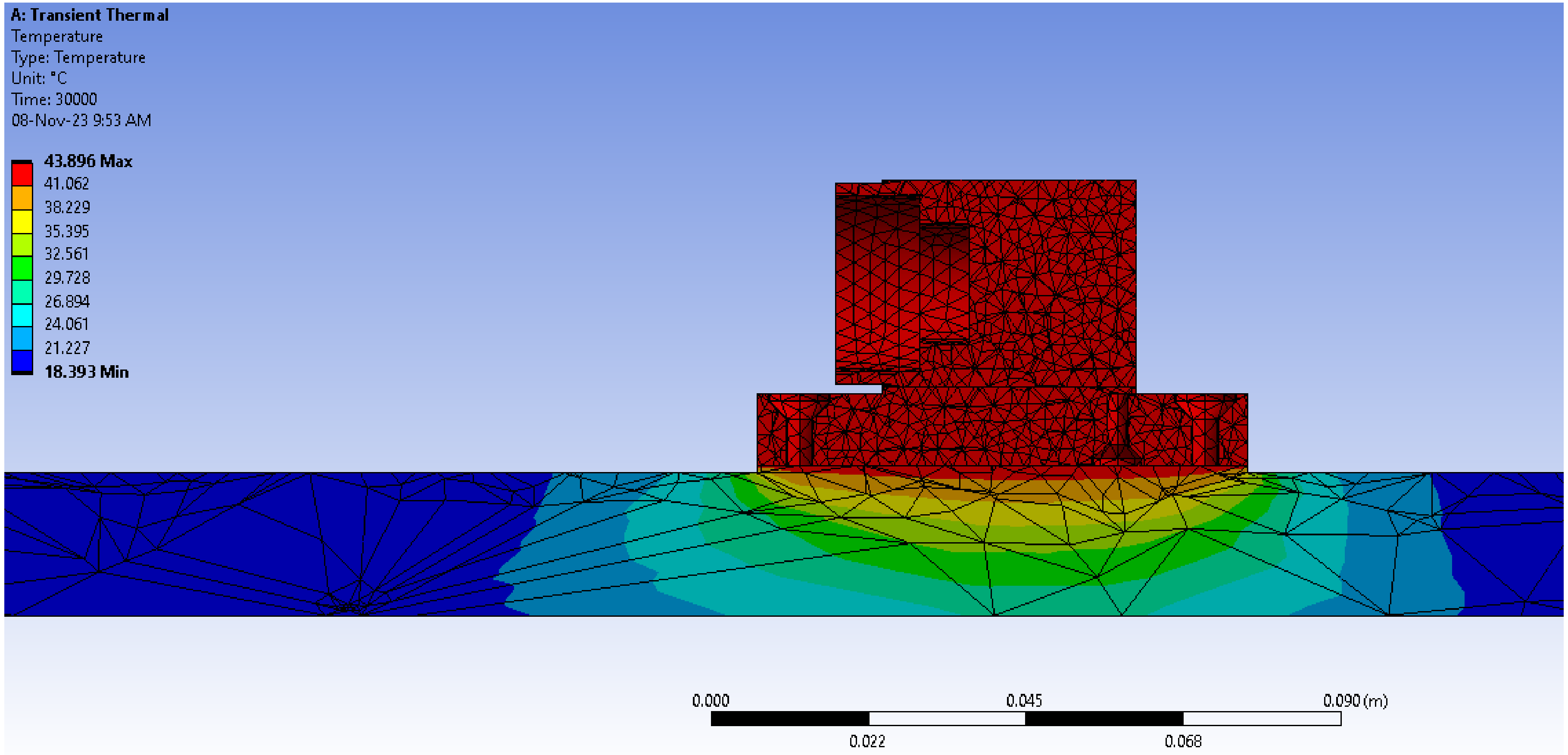
- Feedthrough
- Manipulator
- Adapter flanges
- Extension
- Camera
- Groove
- Kinematic mount





Setup side view

Heat dissipation



Optical beams GB and Bessel Beam

Forms of light waves propagating with small divergence

Gaussian beam
- small focus
- significantly diverges

Bessel beam
- long longitudinal focus
- limited range
- zero divergence