National Institute of
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AIST

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Progress report

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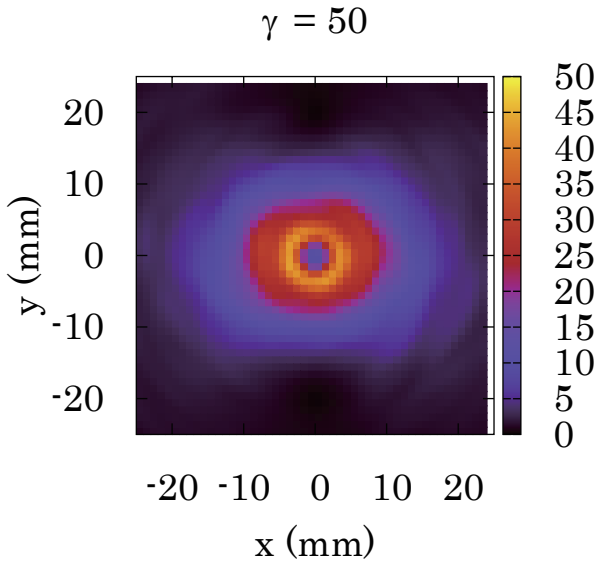
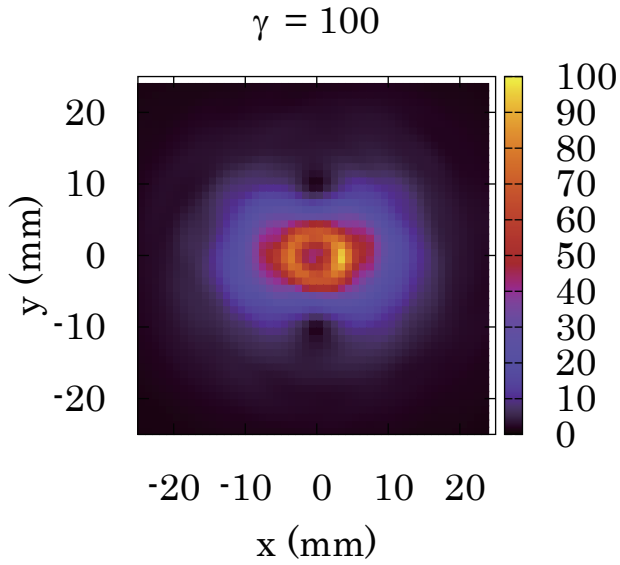
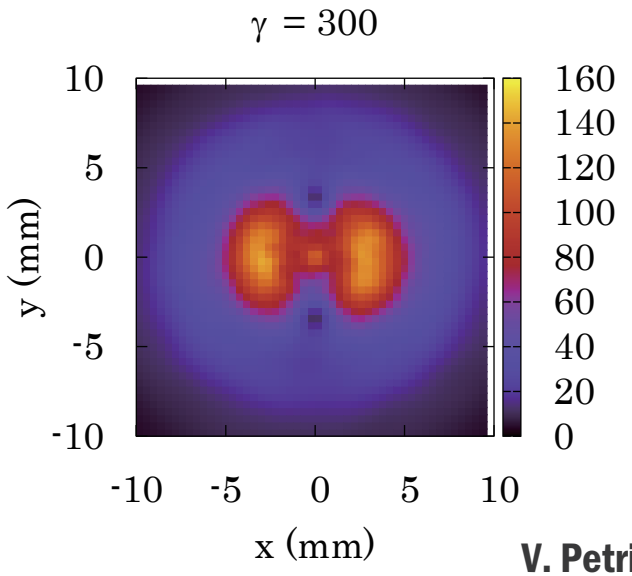
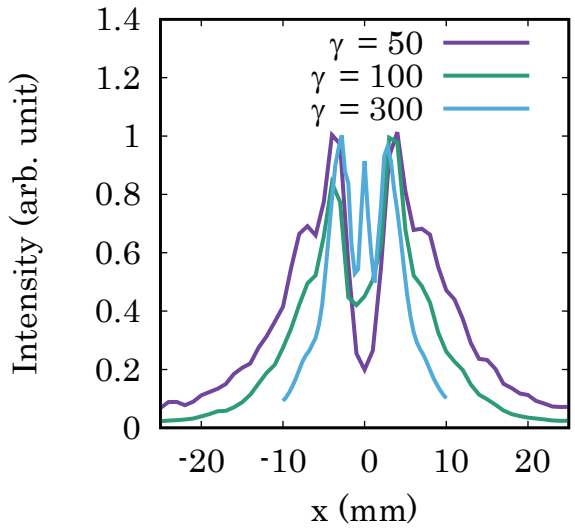
Calculation of $|E|^2$ of gamma-ray vortex









Laser

Linearly polarized (y direction).
OAM = 1ħ

The diameter of the ring does not depend on the electron energy?

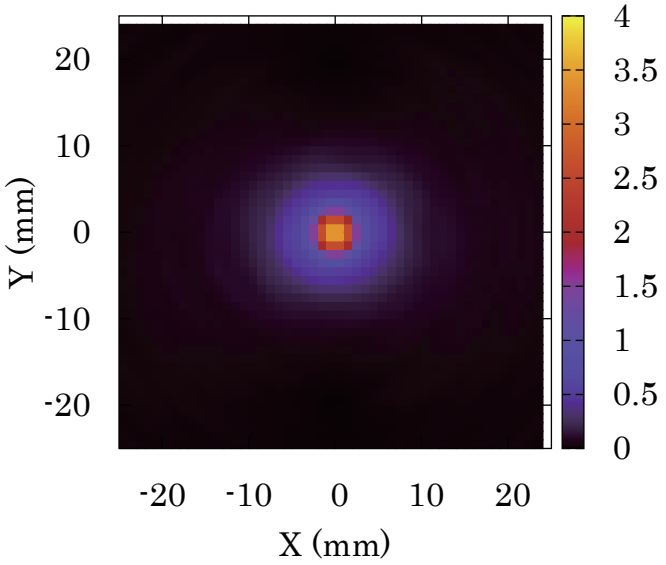
Further calculation is needed.

V. Petrillo et al., PRL 117 (2016) 123903. Her calculation code was used.

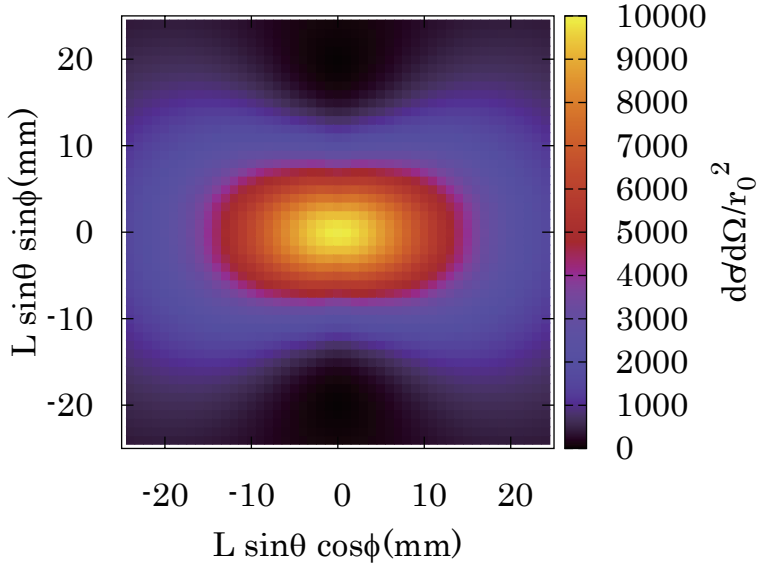
To calculate the real spatial distribution

In the case of Gaussian beam (OAM = 0)

Simulated $|E|^2$ distribution



Cross section, $d\sigma/d\Omega$



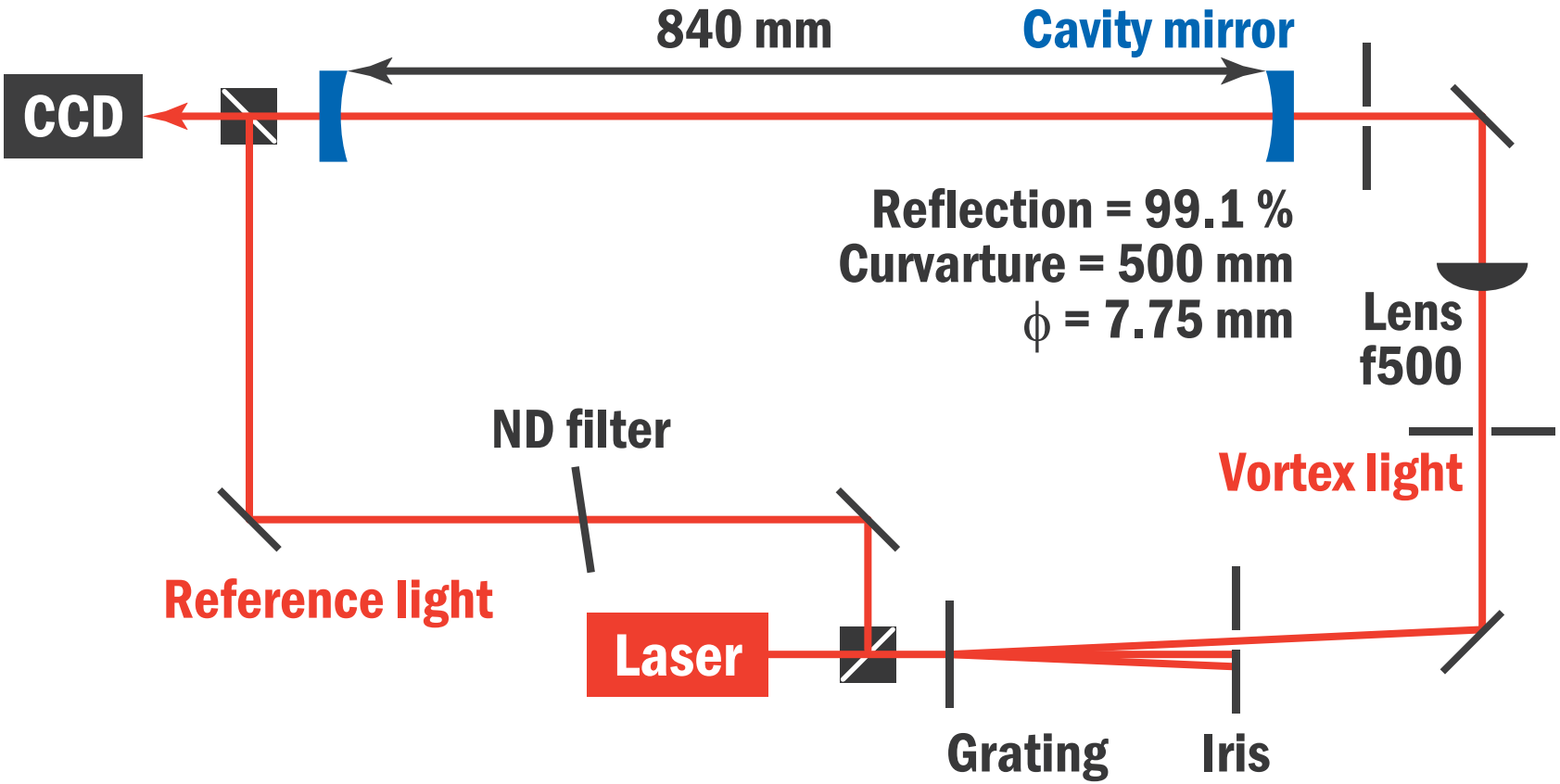
This should be measured in the experiment.

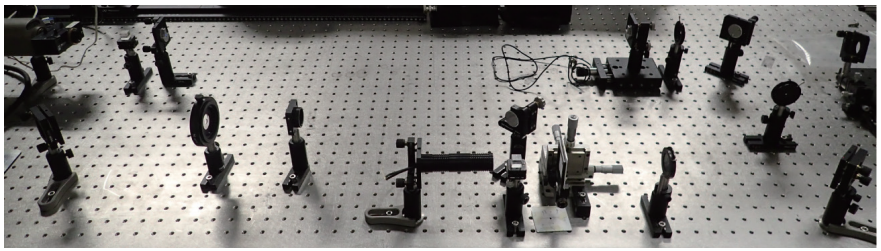
$$\frac{d\sigma}{d\Omega} = \left\langle \frac{dP}{d\Omega} \right\rangle / \left\langle \left| \vec{S} \right| \right\rangle = \left\langle \frac{dP}{d\Omega} \right\rangle / \frac{c}{8\pi} |E_0|^2$$

$$\left\langle \frac{dP}{d\Omega} \right\rangle = \frac{c}{8\pi} r_0^2 |E_0|^2 \left| \vec{\varepsilon}^* \cdot \vec{\varepsilon}_0 \right|^2$$

To calculate the real spatial distribution of the gamma ray vortex, $|E|^2$ should be divided by the averaged Poynting vector?

Cavity test of vortex laser

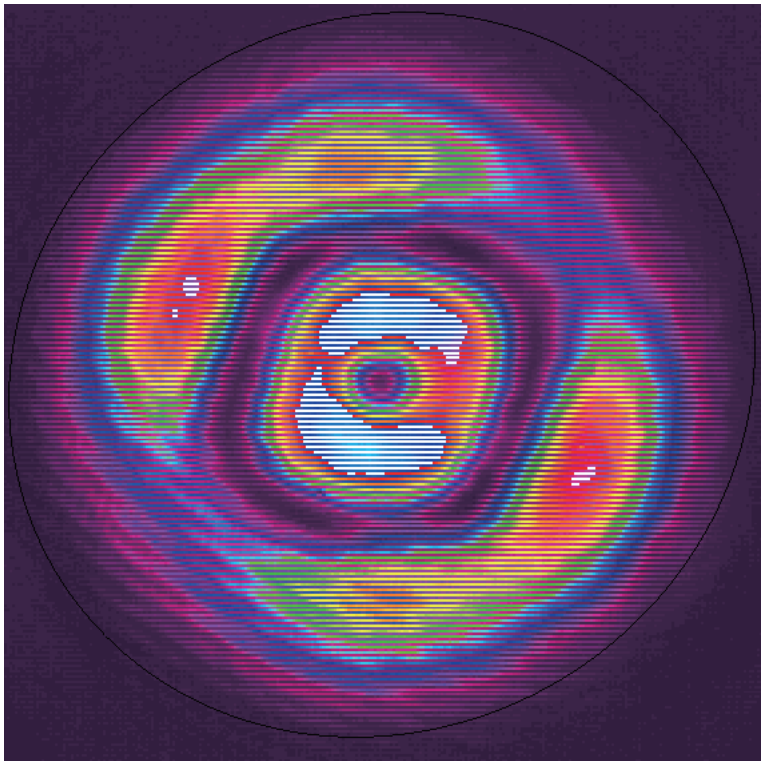




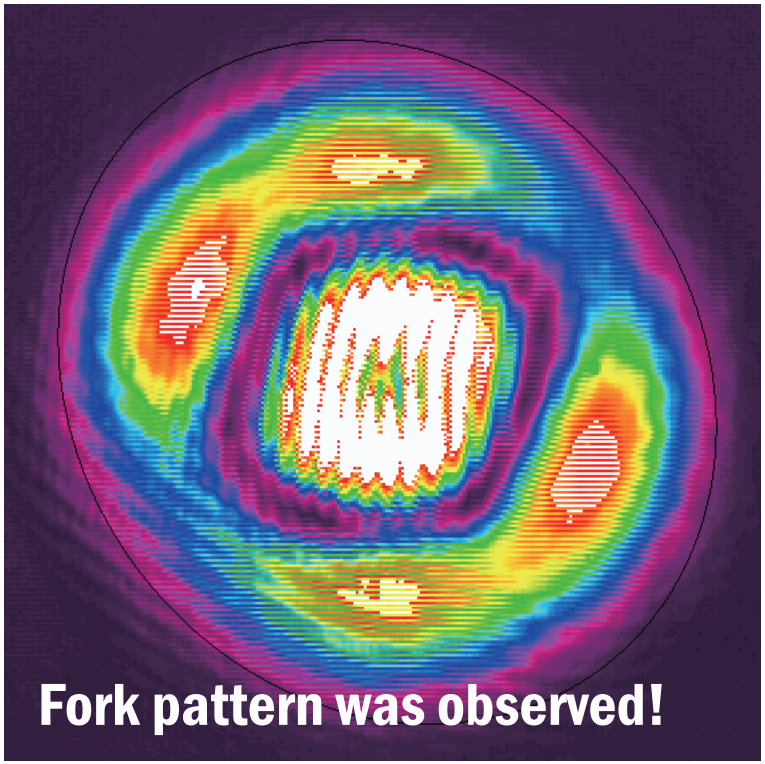
Note: two cavity mirrors are not controlled by any feedback system.

Fork interference pattern was observed

Spatial distribution after cavity



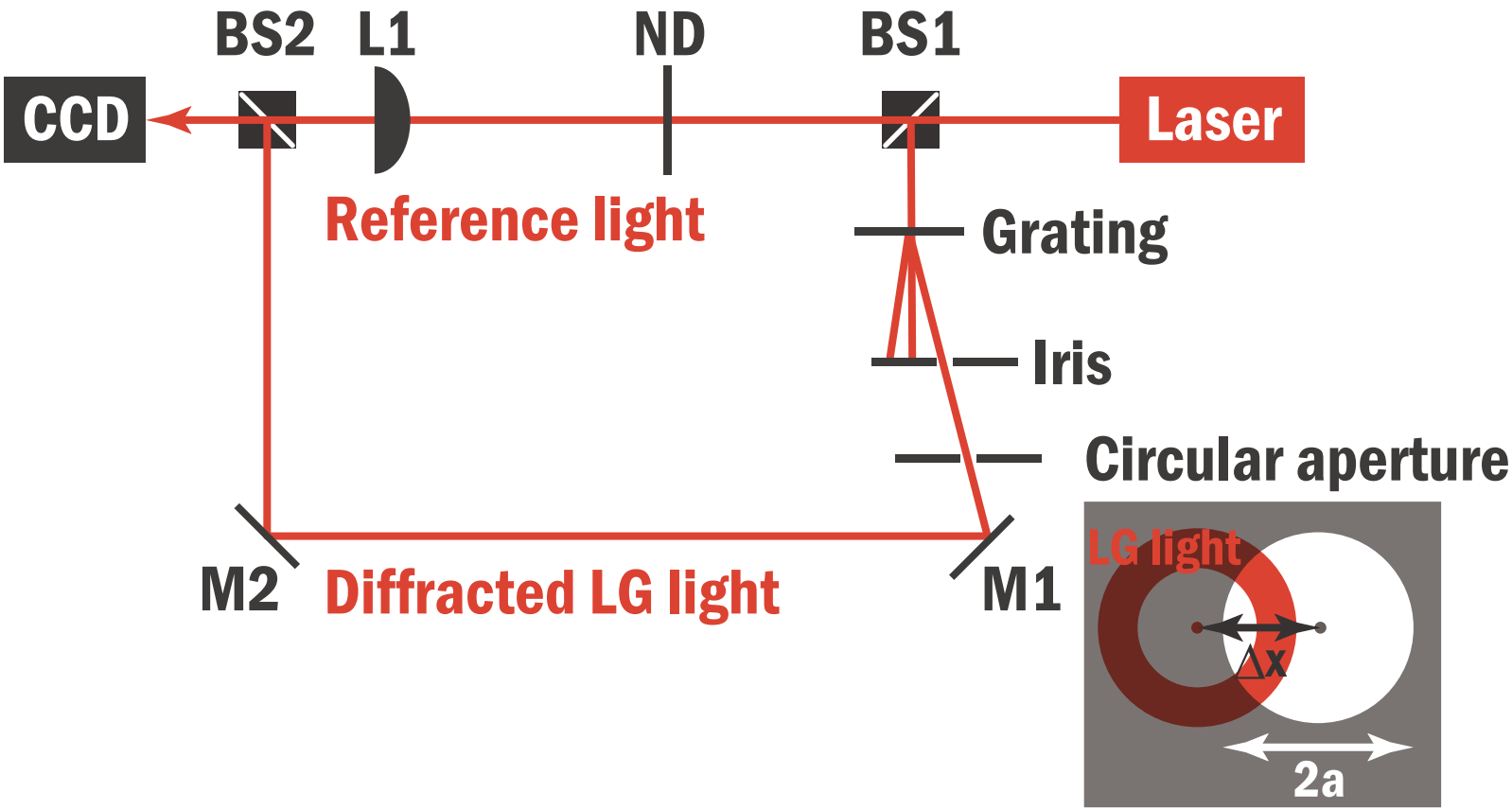
Interference pattern (ℓ =1)



Not the whole time, sometime no fork pattern.

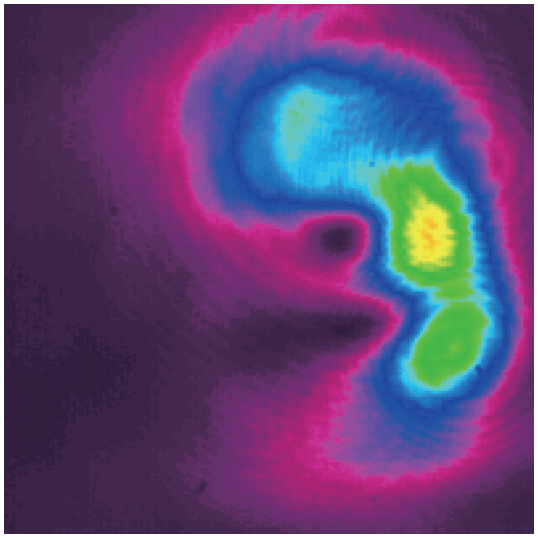
Next step:
Mode locking, estimation of storing power, etc..

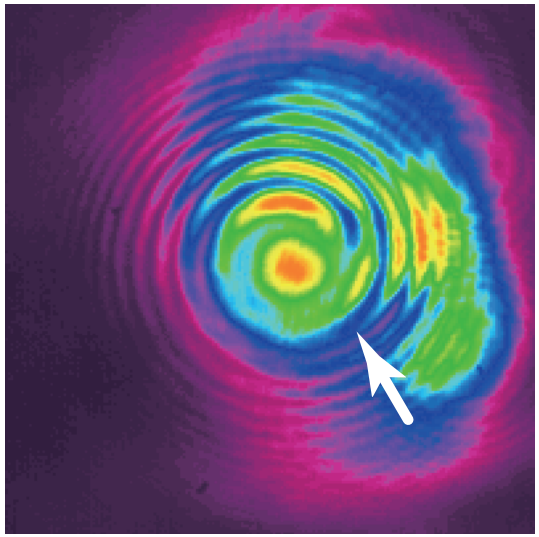
Diffraction measurement

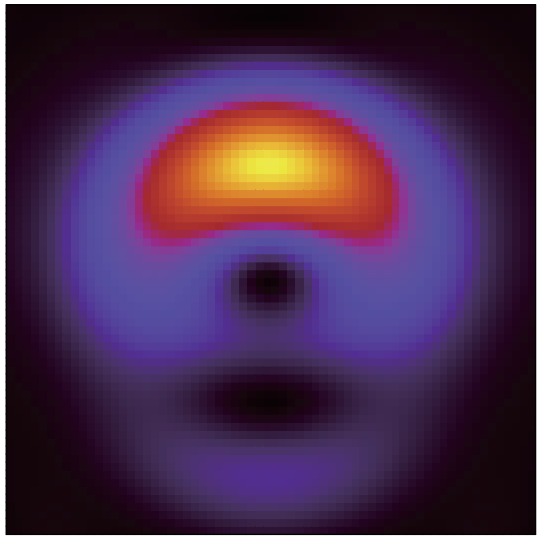


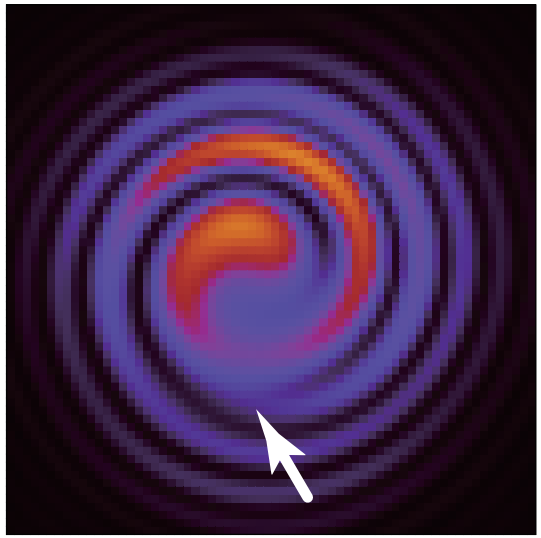
Diffracted LG beam and interference m=2

dx = 0.3 mm

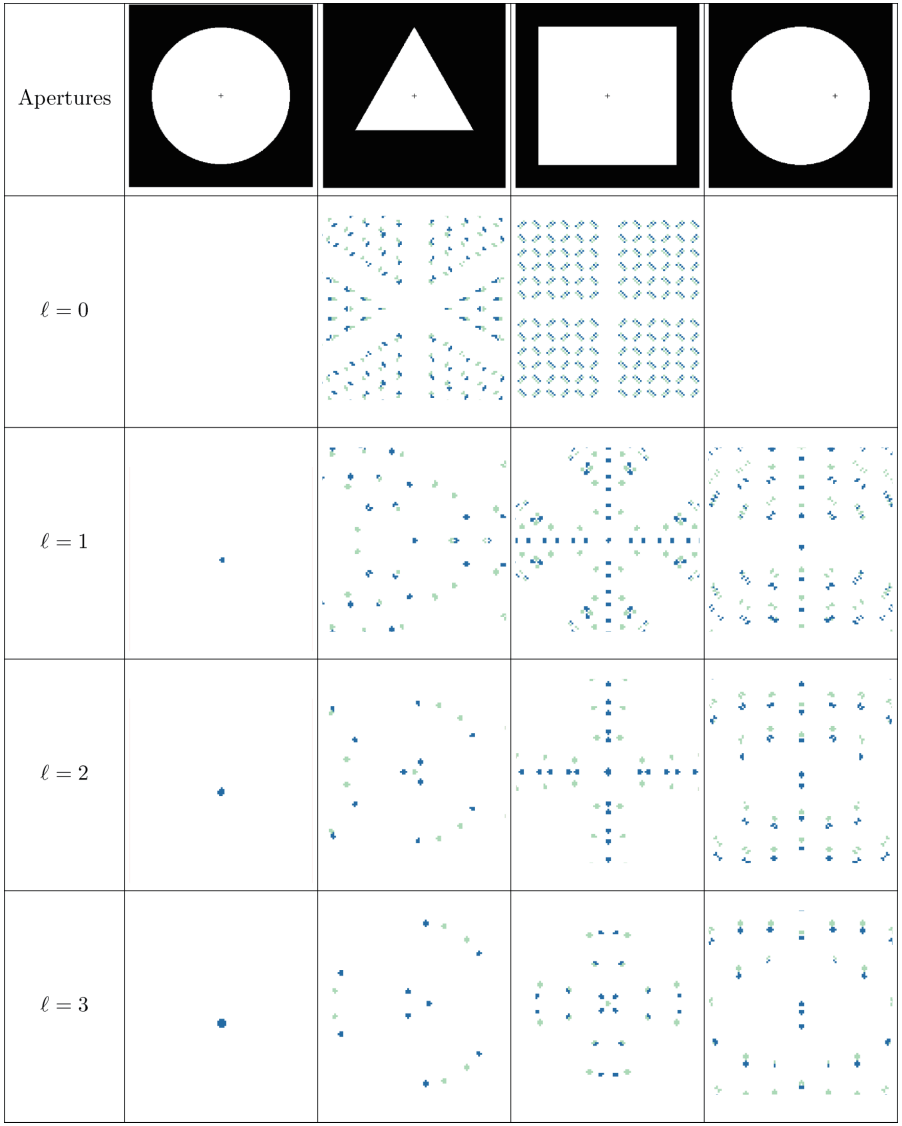








Previous work -diffraction of electron vortex-



Simulated apertures and far-field vortex patterns resulting from vortex beams of different orders. The + marker in each aperture highlights the center of the incoming vortex beam. Blue symbols correspond to a positive (right-handed) vortex core, while green symbols correspond to a negative (left-handed) vortex core.

L. Clark et al., Phys. Rev. A 93 063840 (2016).

Tasks

About gamma-ray vortex:

Calculation of spatial distribution and number of photons of gamma ray to design a detector system.
How to detect the OAM of gamma-rays? - Detection of the change of the spatial distribution is one of the method.

About vortex laser:

Mode-locking, estimate the storing laser power.
Where can we do the experiment?

About diffraction of vortex laser:

I have not seen the experimental results of off axis diffraction through a circular aperture. Can we write a paper?