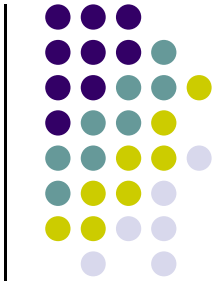
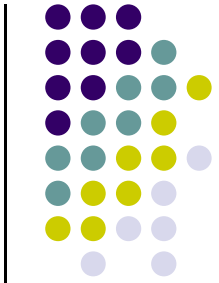


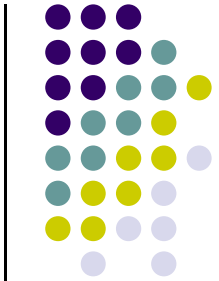
Studies on the resolution of different beam size readout systems at PITZ

Outline



- Sources of uncertainties during the beam size measurements
- Calculating the optical parameters of a single lens system
- Next steps
- Conclusion

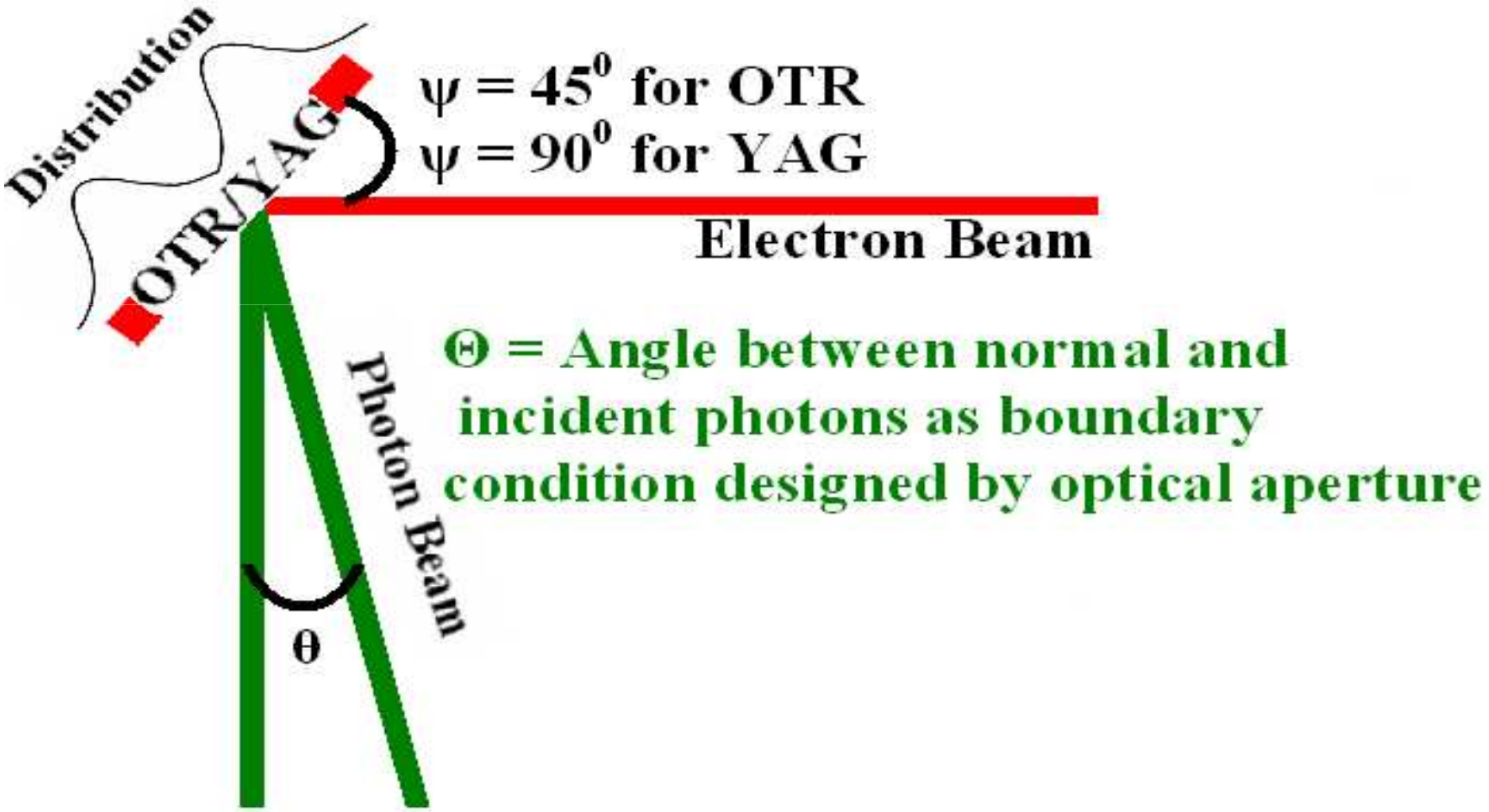
Sources of uncertainties during measurements

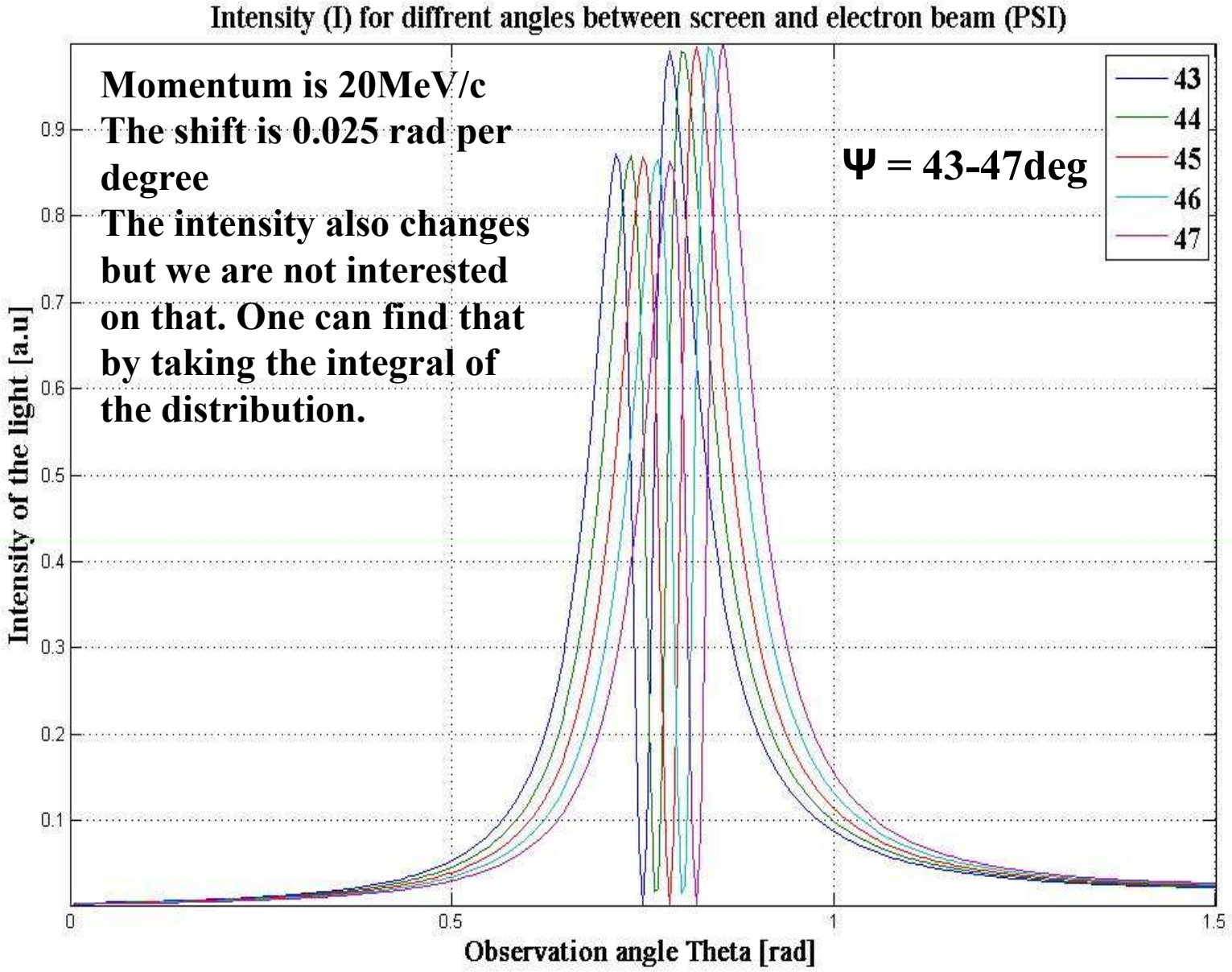


- **Screen, lens or camera misalignments**
- **This misalignment can only occur in Z direction which changes the angle between x and z axis(45 for OTR and 90 for YAG).**
- **Absorption coefficient of the transmission window**
- **In order to have the right beam profile less photon must be absorbed by transmission window.**
- **"$\acute{\alpha}=4\pi n/\lambda$"(Beer–Lambert law). Where $\acute{\alpha}$ is absorption coefficient, n is the refraction index of the window and λ is the wave length of the photon**
- **Magnification, Optical aperture**
- **The magnification will make easy to visualize small beam sizes.**
- **" m=f/f-S or m=I/O" where m is magnification ,f is the focal length of the lens and S is the distance between lens and mirror, I is the image diameter and O is the object diameter.**
- **θ=f/D or θ =1/γ where θ shows the Optical aperture γ is the photon energy γ =Etot/Eo, f is the focal length and D shows diameter of the lens.**

Study of angular distribution from OTR

1. **Incident angle (ψ)**




Intensity (I) for diffrent angles between screen and electron beam (PSI)
Momentum is 20MeV/c
The shift is 0.025 rad per degree
The intensity also changes but we are not interested on that. One can find that by taking the integral of the distribution.
Ψ = 43-47deg
43
44
45
46
47
Intensity of the light [a.u]
Observation angle Theta [rad]
0
0.5
1
1.5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9

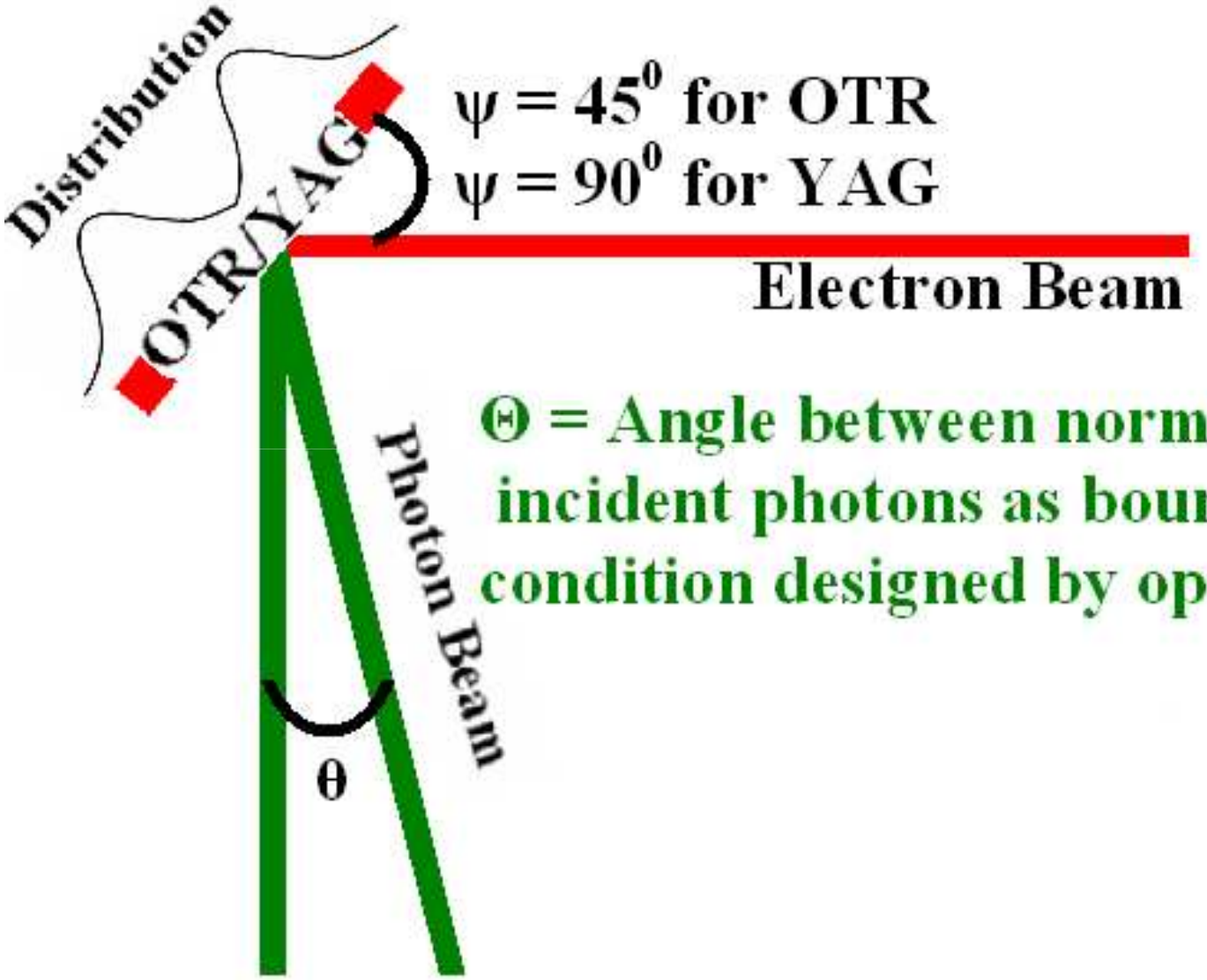
Study of angular distribution from OTR

- **The plot shows that changing the Ψ from 43 up 48 (momentum is kept fixed) in step of 1 deg almost does not affect the angular distribution.**

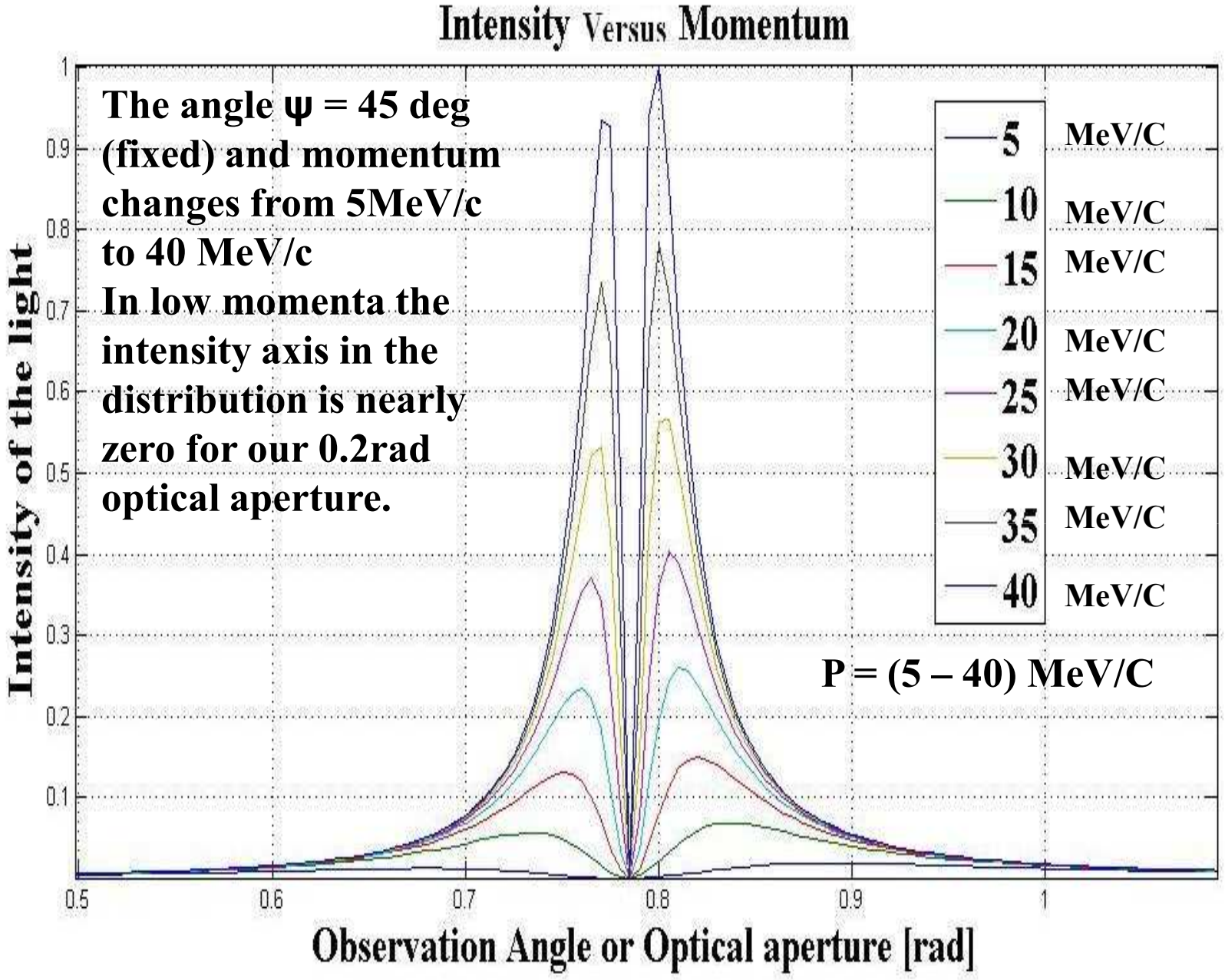
- **Changes in distribution by changing the most probable incident angle 44 to 46 in step of 0.2deg is almost constant and has nearly no effect on distribution.**

- **Only the distribution is shifted 0.025rad per deg which affects the optics.**

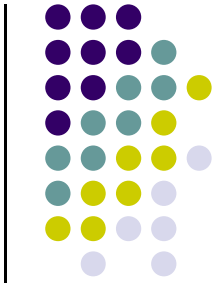
Momentum as variable



Θ = Angle between normal and incident photons as boundary condition designed by optical aperture


Intensity Versus Momentum
The angle ψ = 45 deg (fixed) and momentum changes from 5MeV/c to 40 MeV/c
In low momenta the intensity axis in the distribution is nearly zero for our 0.2rad optical aperture.
5 MeV/C
10 MeV/C
15 MeV/C
20 MeV/C
25 MeV/C
30 MeV/C
35 MeV/C
40 MeV/C
P = (5 – 40) MeV/C
Intensity of the light
Observation Angle or Optical aperture [rad]
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.5
0.6
0.7
0.8
0.9
1

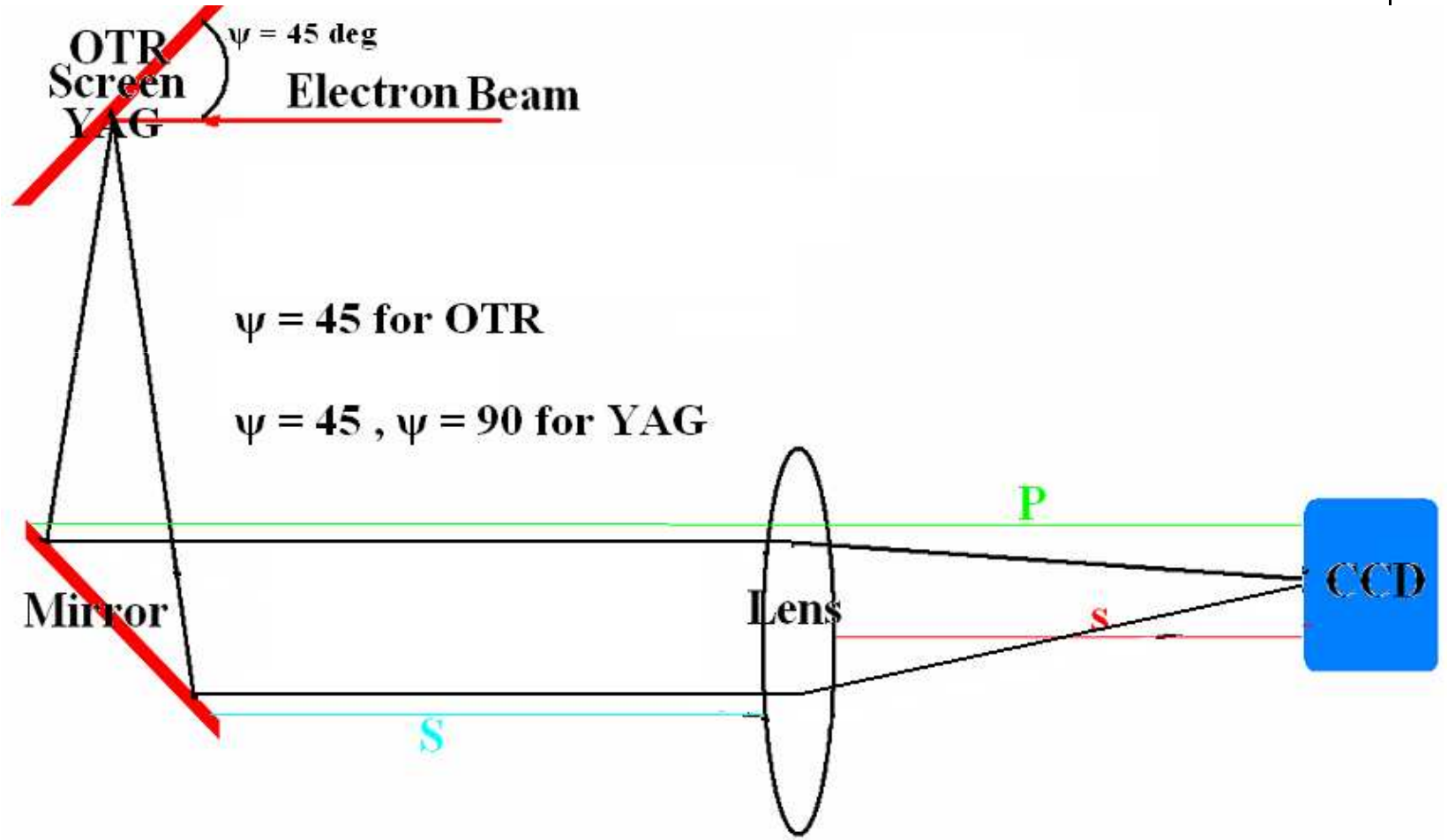
Momentum as variable



- **The plot shows changing the Momentum from 5 MeV/c up to 40 MeV/c (keeping Ψ fixed) will cause changes in shape (height and width) of the distribution for every momentum.**

- **Finally we conclude that in momenta equal or less than 5MeV/c we are losing the photon beam in this aperture of 0.2rad.**

Calculating the optical parameters of a single lens system

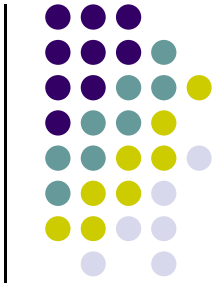


Optical system

In this simple optical system the following parameters were discussed and calculated by some small programs in MATLAB:

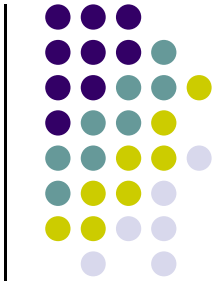
1. **Magnification (By design):** **The purposed magnification is already given to us, we have to calculate rest of the parameters like lens diameter, focal length and so on accordingly.**
2. **Aperture (By design):** **We have a fixed optical aperture so for different energies we need to use different screens (photon yield must be calculated first) in order not to lose the photons and have better image on the camera.**
3. **Lens positioning for different magnifications:** **For a given magnification we need to fix the distance between lens and screen (Mirror) which refer to the positioning of the lens in a fixed distance between screen and camera.**

Next steps

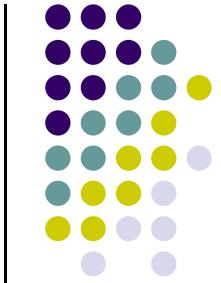


- **Optical system resolution (screen, lenses and camera resolution, aberrations on the lenses and calculating these parameters for optical systems of several lenses)**
- **Comparing and studying the papers written in DESY and other institutes on YAG saturation.**
- **Choosing the screens OTR or YAG ? By studying their physical properties(photon yield or Quantum efficiency), mounting, electron beam density, number of pulses and so on.**
- **Experimental work in Optic lab with different lenses and cameras.**
- **Study of the existing data i.e. thermal emittance results.**

Conclusion



- **OTR screens are a better choice for momenta more than or equal to 5MeV/c for our present aperture of 0.2rad, but is still not compared to YAG.**
- **The smaller the momentum (energy) the larger the aperture of the lens (in order to collect more light) is required.**
- **Studies on the different properties of both screens should be done in details.**
- **Data from different screens should be worked out and compared in order to make sure the above statement.**



Many thanks for your attention and patience