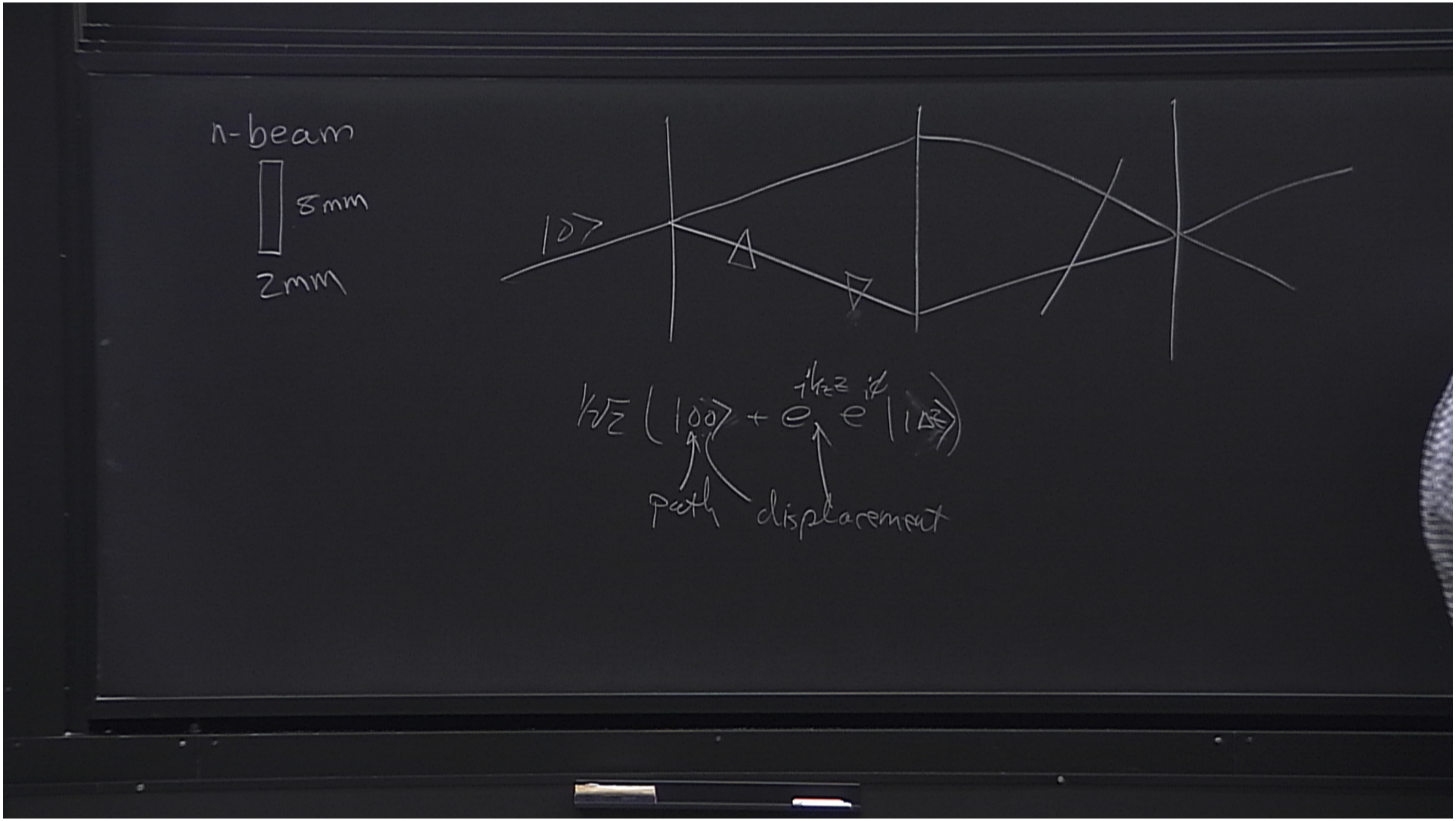
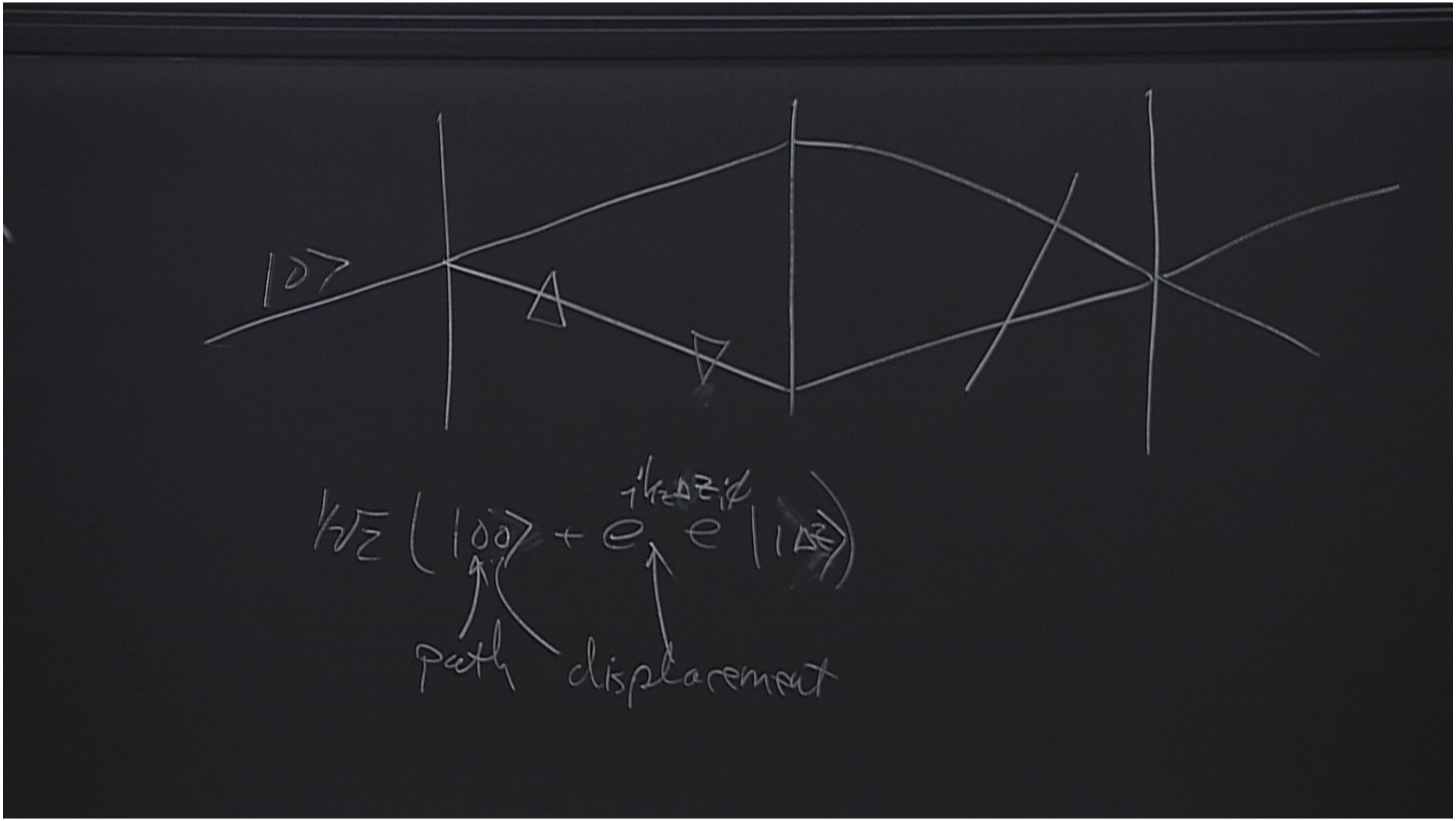
Title: Explorations in Quantum Information-6

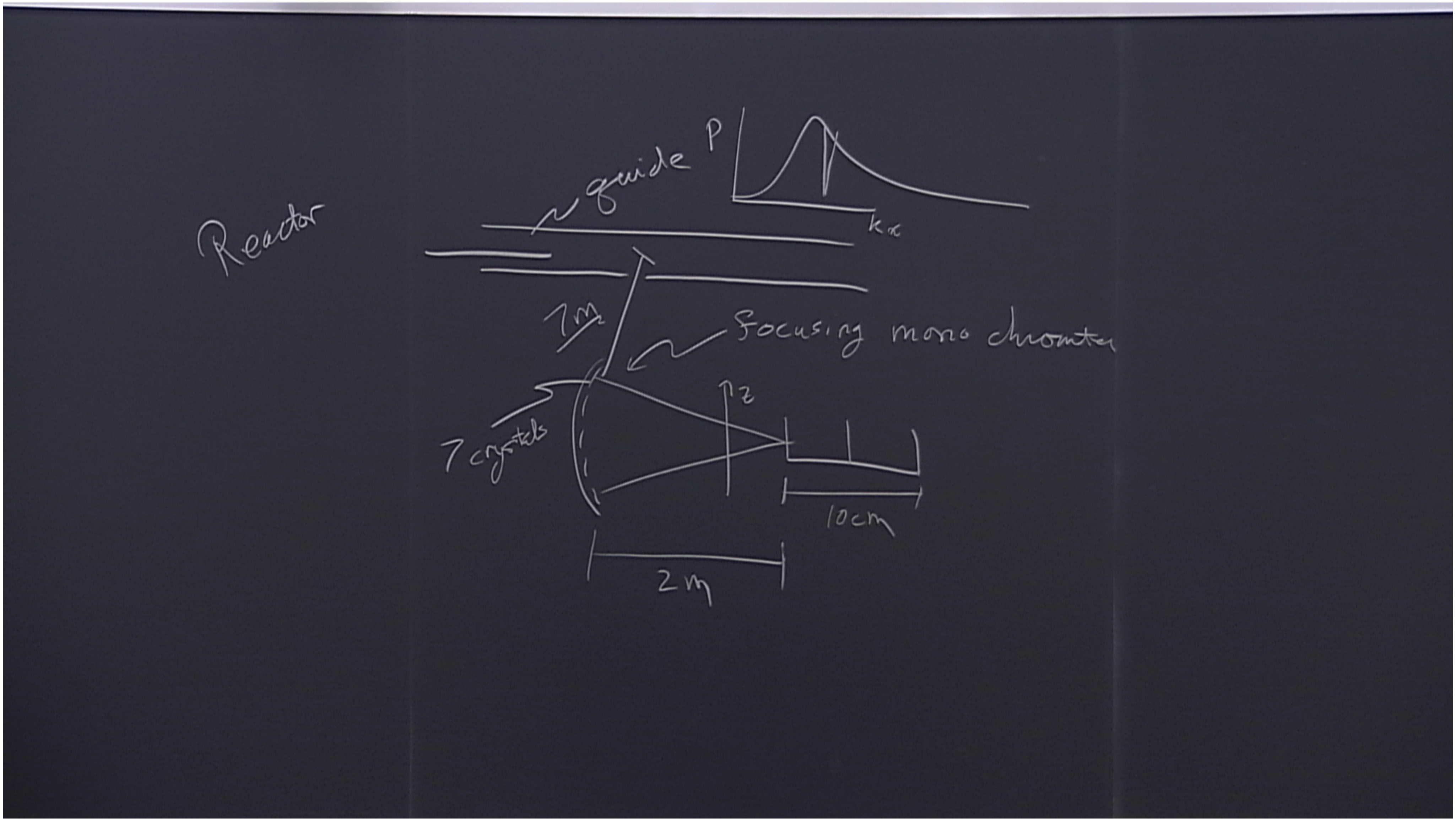
Date: Mar 23, 2015 09:00 AM

URL: http://pirsa.org/15030025

Abstract:


n-beam
8mm
2mm
|0⟩
path
displacement


|0>
1/√2 (|00> + e^{ik_zΔz} e^{iφ} |1Δz>)
path
displacement



Reactor
guide
P
focusing monochromator
1m
7 crystals
z
10cm
2m

$$|0\rangle\langle 0| : \frac{1}{2} \frac{|0\rangle - e^{-ik_z \Delta z} e^{-i\phi} |\Delta z\rangle}{\sqrt{2}}$$

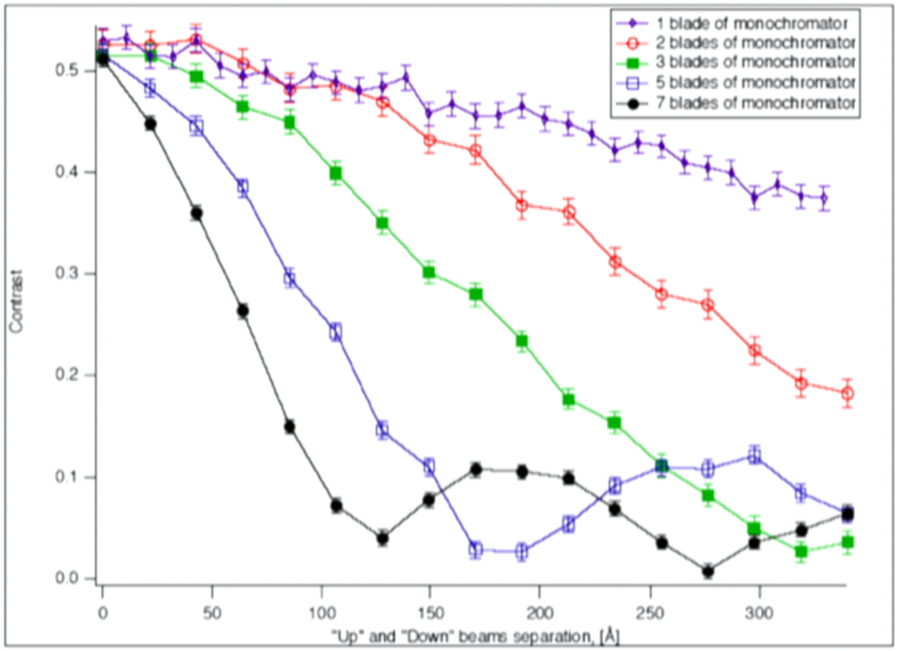
$$I_0(\Delta z) = \frac{1}{2}\left(1 - \cos(\phi + k_z \Delta z)\right)$$

$$I_0(\Delta z) = \frac{1}{2} - \int P(k_z) \cos(\phi + k_z \Delta z)\, dz$$

Wolfram CDF Player File Edit Window Help Mon 9:17 AM dcory

QE Lec 5.cdf

The experiments show the expected bahavior.



Note that the beats in the above data are predicted since the momentum spread has features. The Coheence curve is just the Fourier transform of the momemtum distribution.

9 blades of 2nd focusing monochromator

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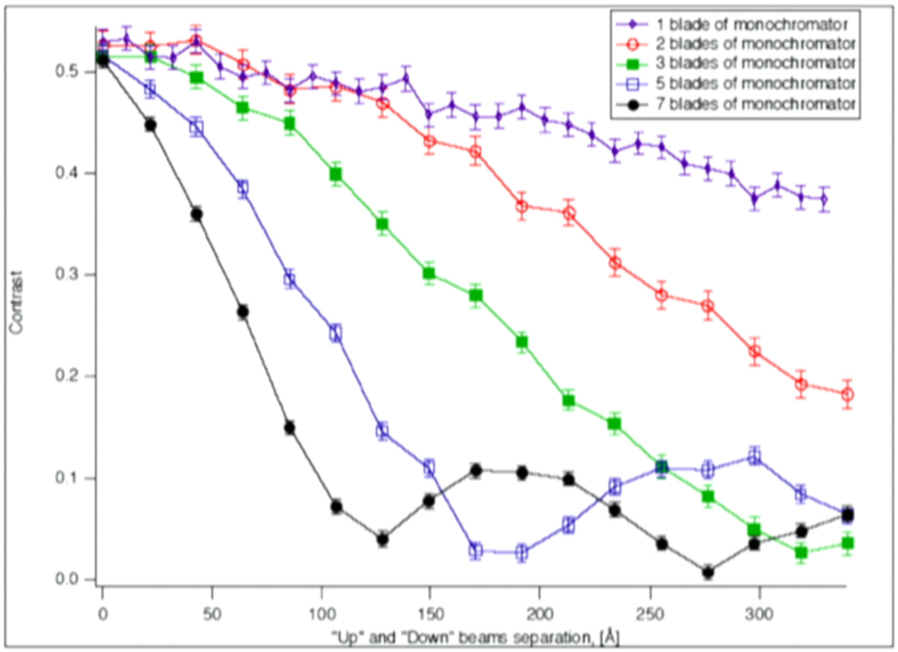

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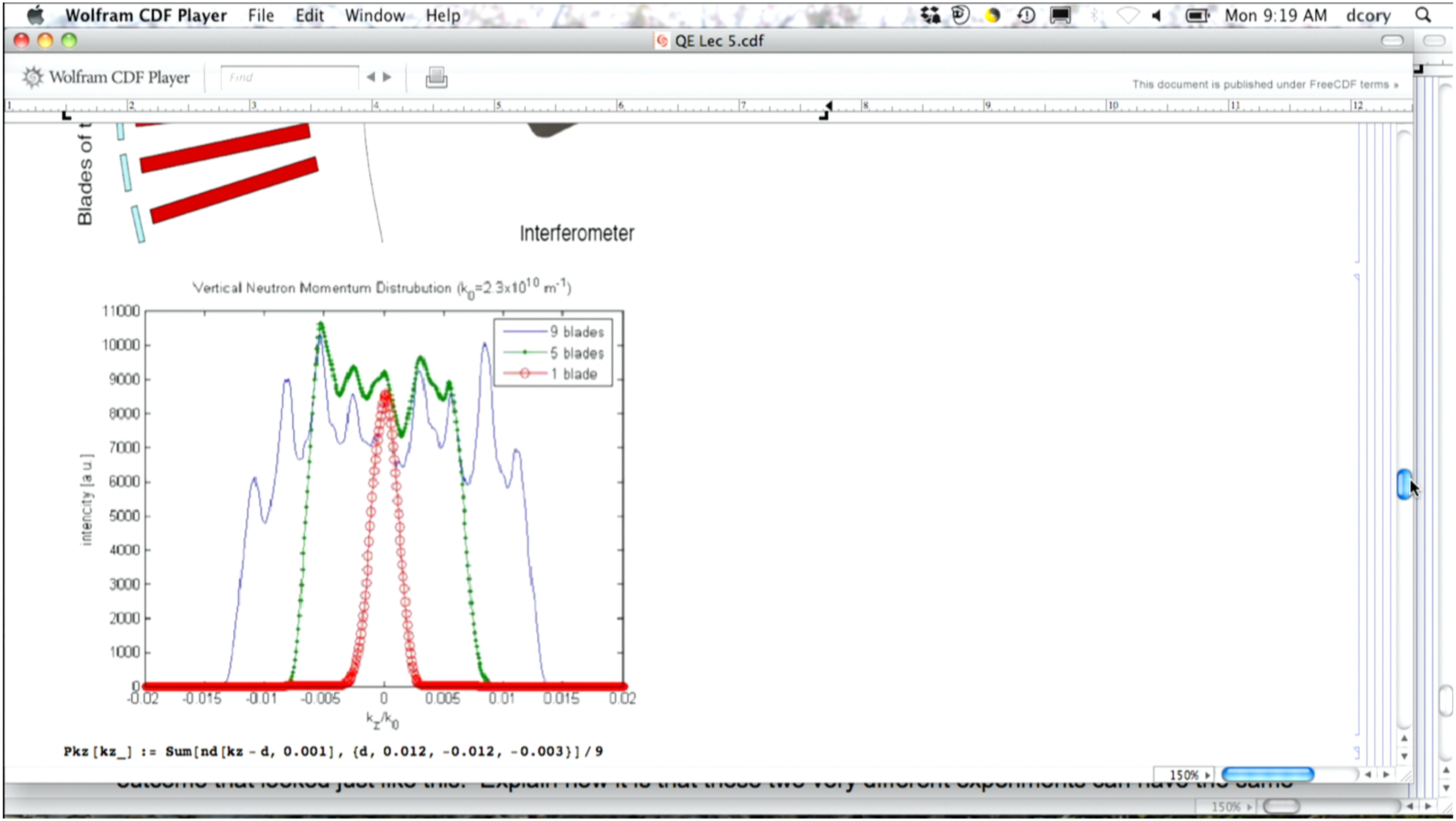
9 blades of 2^{nd} focusing monochromator

150%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Mon 9:19 AM dcory
QE Lec 5.cdf
Wolfram CDF Player
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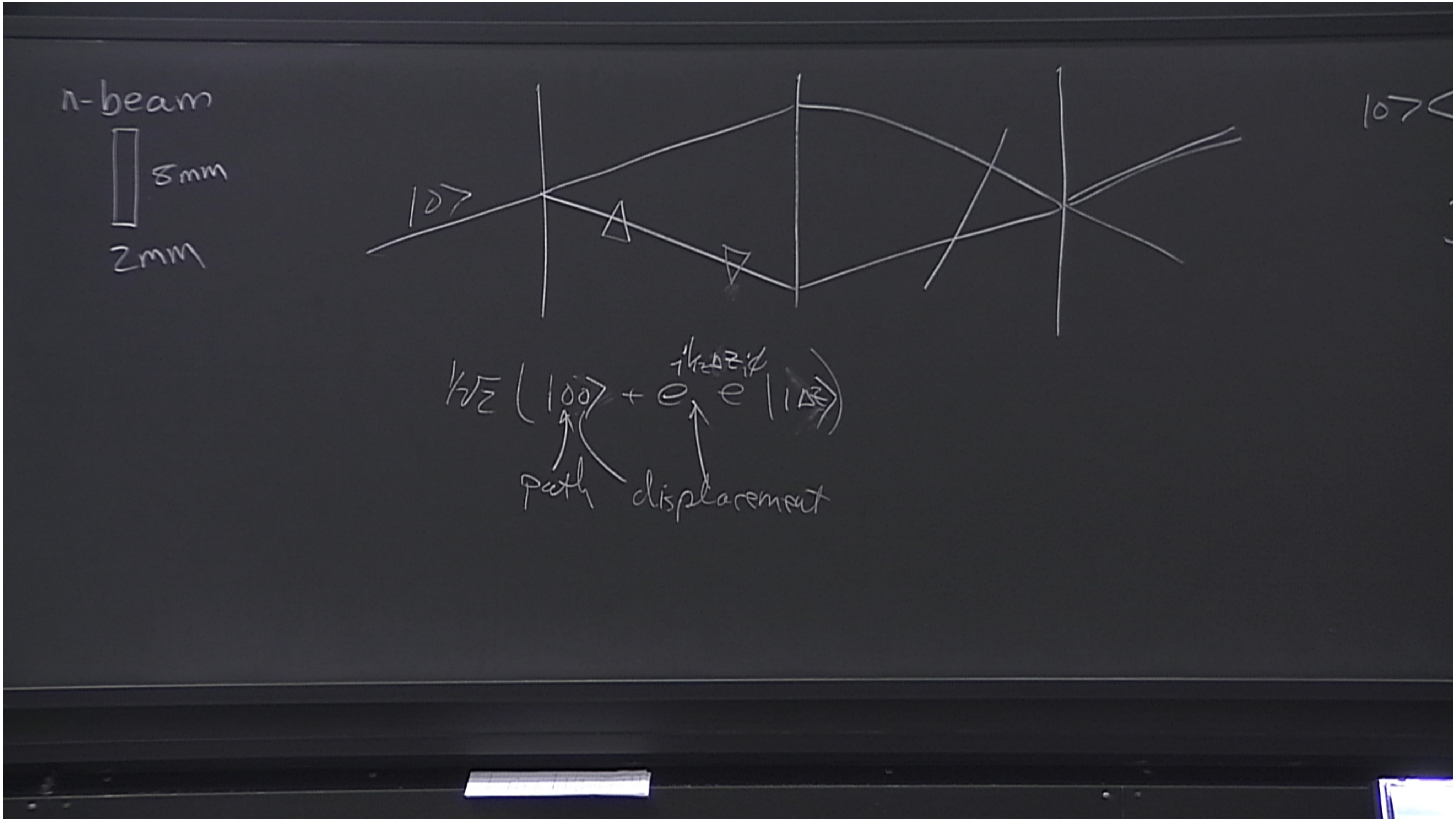
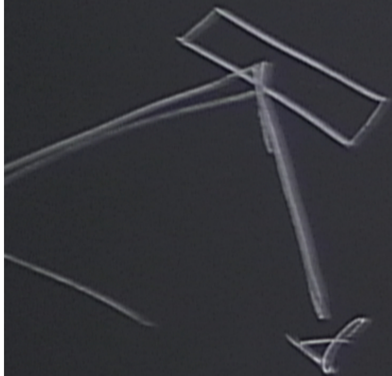
Blades of t
Interferometer
Vertical Neutron Momentum Distrubution (k_0=2.3x10^10 m^-1)
9 blades
5 blades
1 blade
intencity [a.u.]
k_z/k_0
Pkz[kz_] := Sum[nd[kz - d, 0.001], {d, 0.012, -0.012, -0.003}] / 9
150%

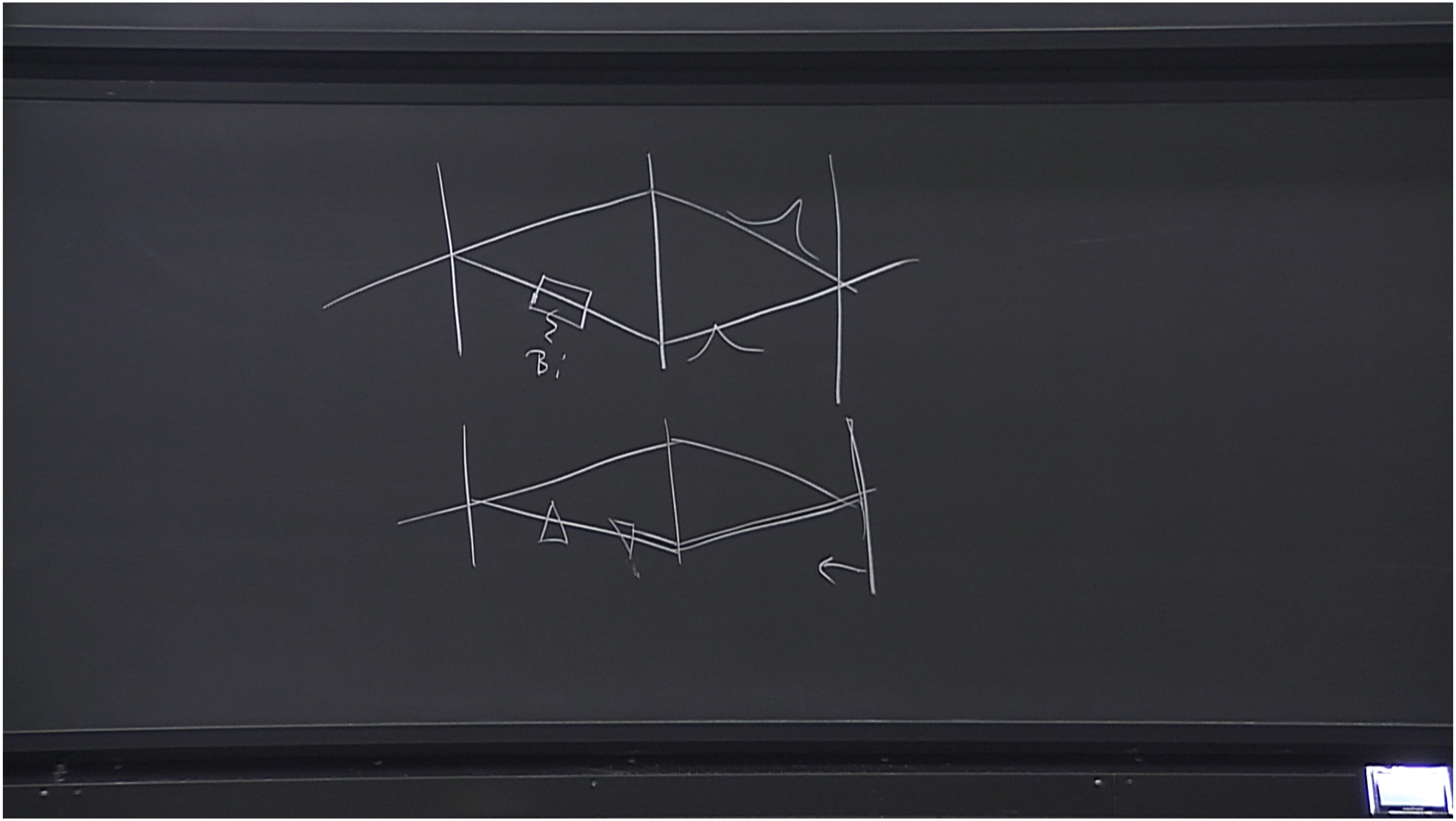

n-beam
8mm
2mm
|0>
path
displacement

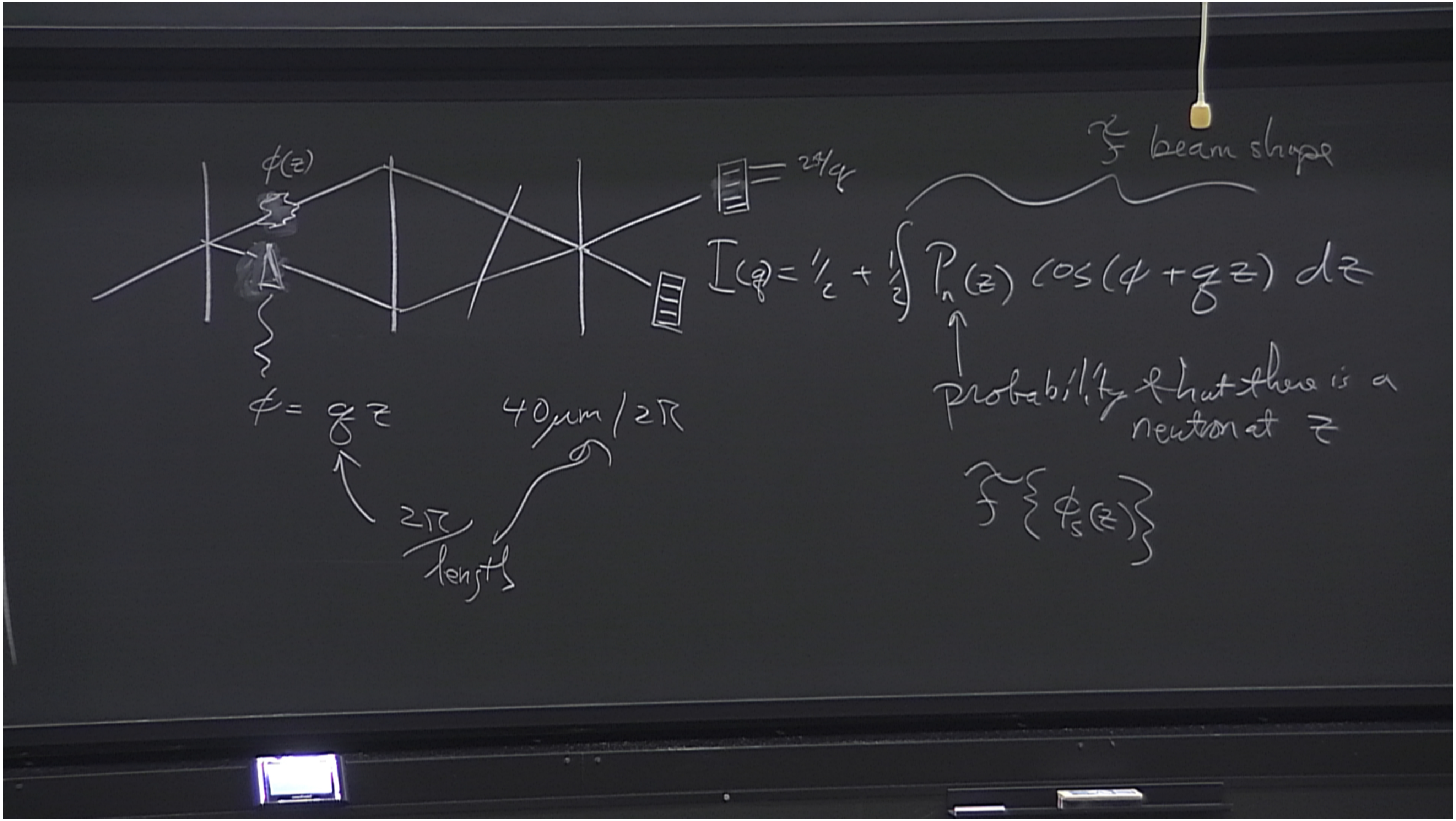


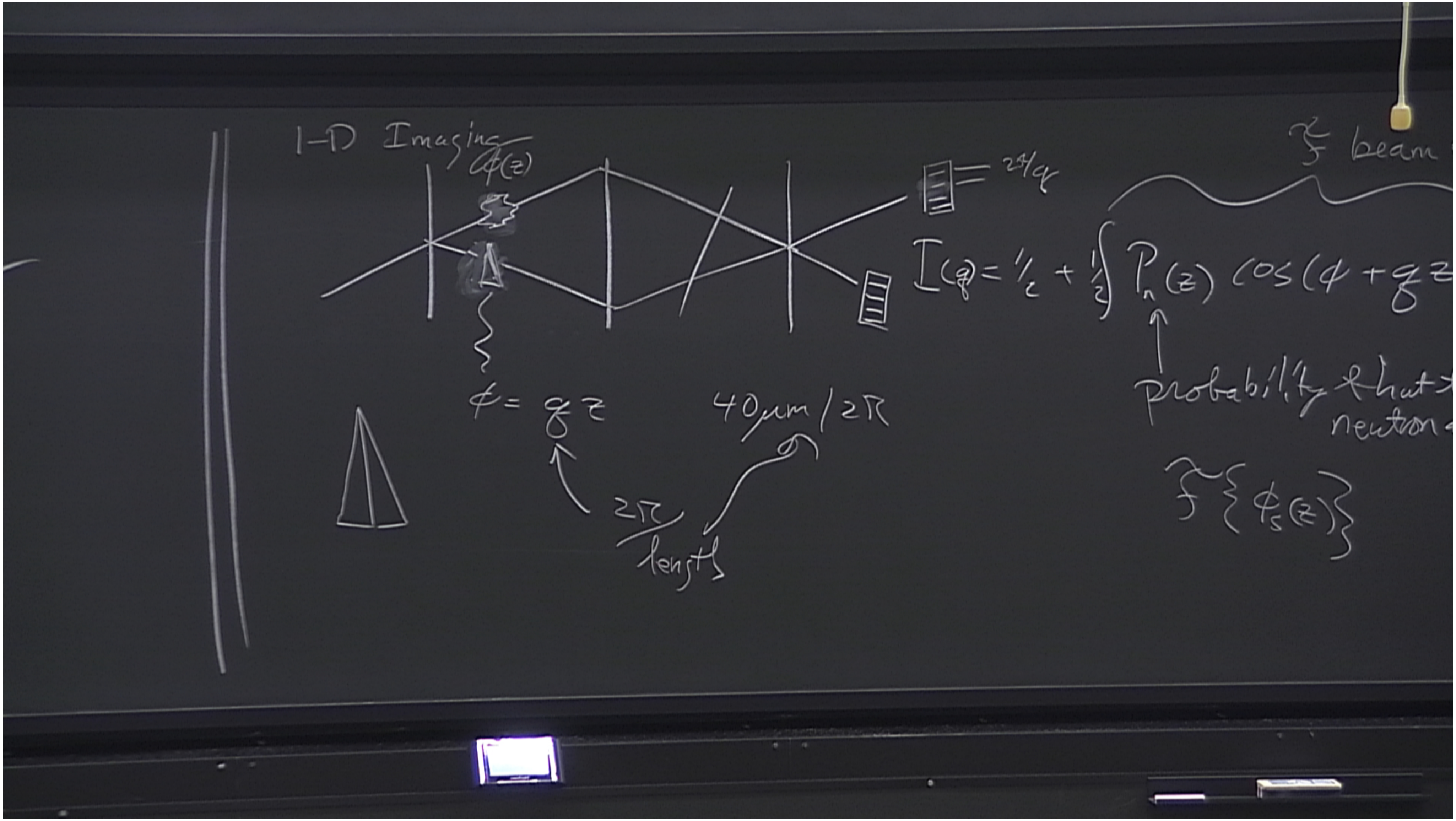
$$|0\rangle\langle 0| : \quad \frac{1}{2}\,\frac{|0\rangle - e^{-ik_z\Delta z}e^{-i\phi}|\Delta z\rangle}{\sqrt{2}}$$

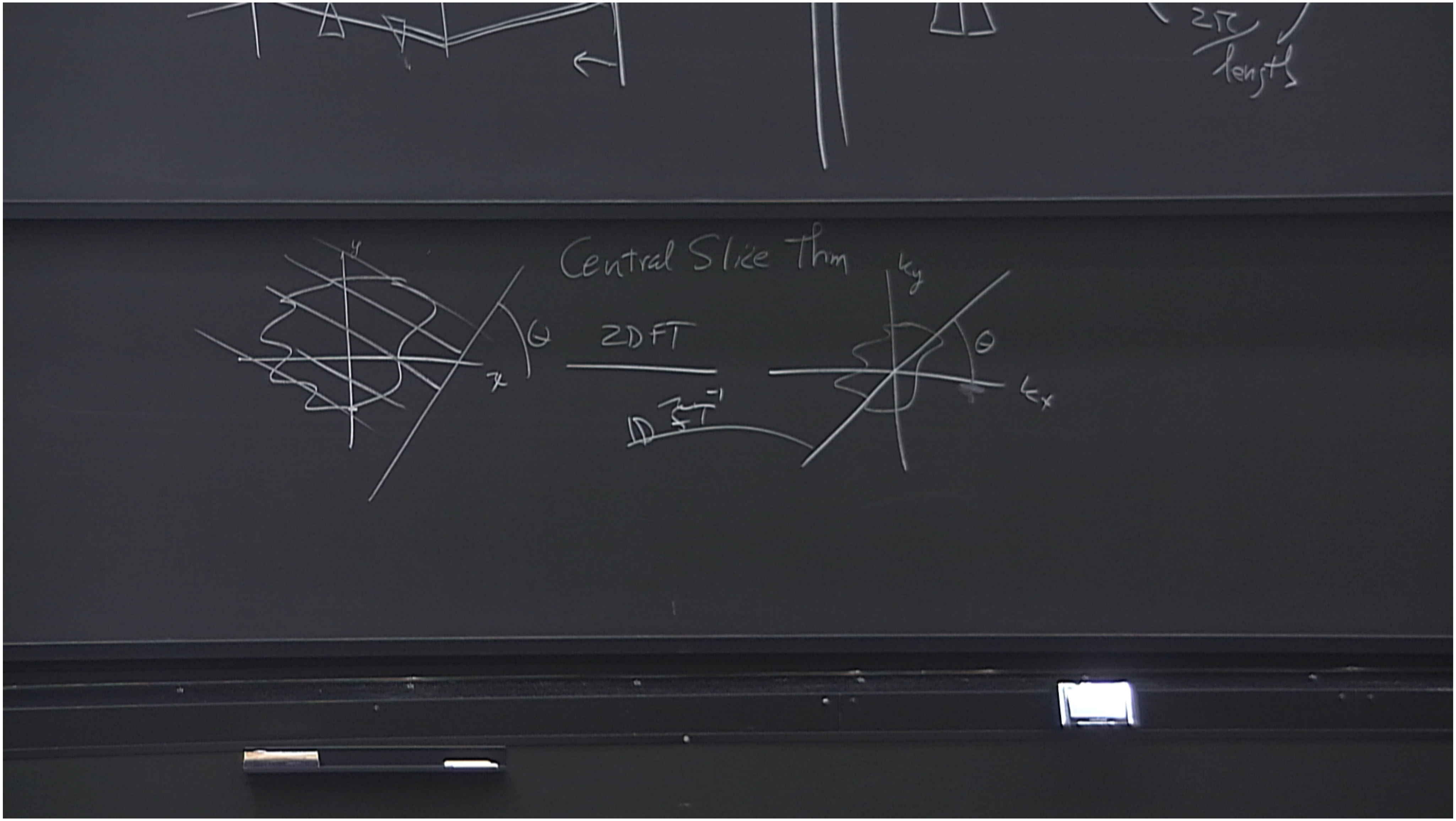
$$I_0(\Delta z) = \frac{1}{2}\left(1 - \cos(\phi + k_z\Delta z)\right)$$

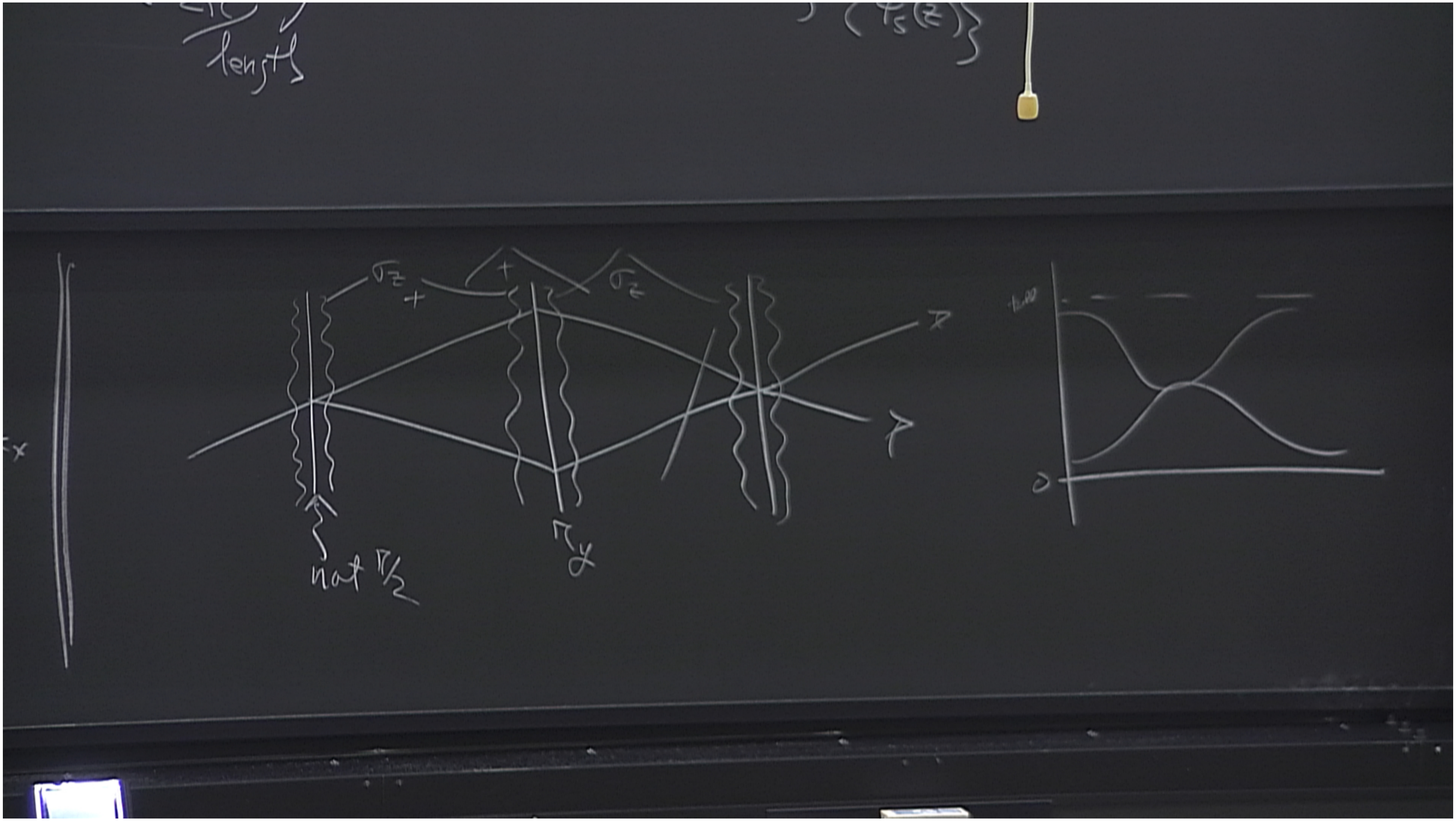
$$I_0(\Delta z) = \frac{1}{2} - \int P(k_z)\cos(\phi + k_z\Delta z)\,dz$$


B_i


φ(z)
2π/q
beam shape
I(q) = 1/2 + 1/2 ∫ P_n(z) cos(φ + qz) dz
probability that there is a
neutron at z
φ = qz
40μm / 2π
2π / length
F{φ_s(z)}


1-D Imaging
φ(z)
2π/q
beam
I(q) = 1/2 + 1/2 ∫ P_n(z) cos(φ + qz
probability that
neutron
φ = qz
40μm / 2π
2π / length
{φ_s(z)}


Central Slice Thm
2D FT
1D FT^-1
θ
x
y
k_y
k_x
θ
2π
length


length
nat π/2

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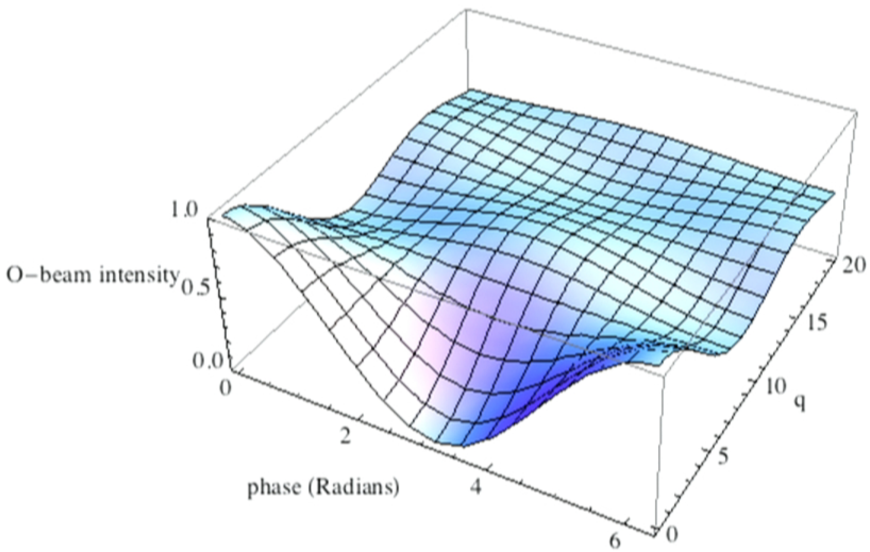
QE Lec 3.nb

$$0.5 + \frac{-\mathrm{Sin}[a - 0.5\,q] + \mathrm{Sin}[a + 0.5\,q]}{2\,q}$$

Note that the *q* dependence is a sinc function (the Fourier transform of a top-hat function).

```
Plot3D[M6O[q, a], {a, 0, 2 π}, {q, 0, 20},
 {AxesLabel → { "phase (Radians)", "q", "O-beam intensity"}, PlotRange → {0, 1}}]
```




```
M6H[q_,  a_] := Integrate[Tr[Ezm . res6[q,z,a]],{z,-0.5,0.5}]
```

150%

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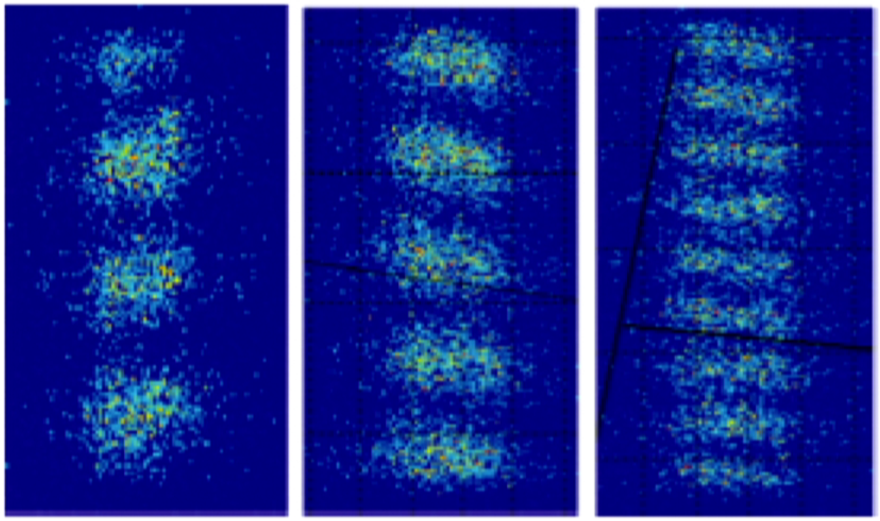
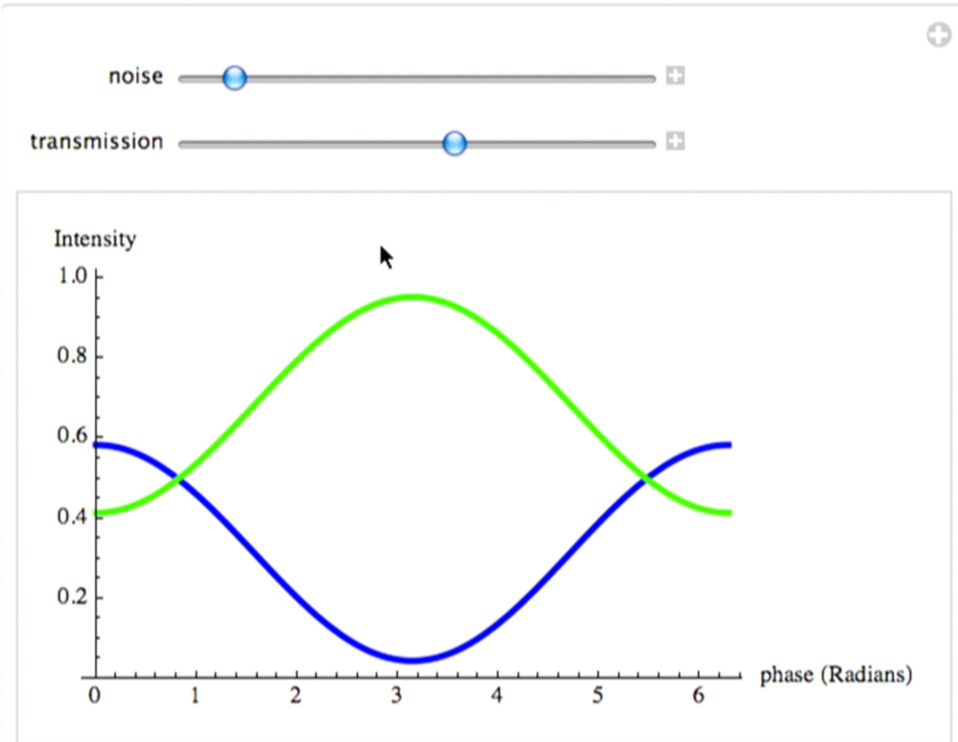
QE Lec 3.nb

Clearly, the interferometer actually retains the desired contrast, it is just that the contrast curves from the various spatial locations are shifted in phase and add incoherently. For larger wave-numbers, this results in the integrated contrast vanishing even though at each spatial location the contrast is preserved.

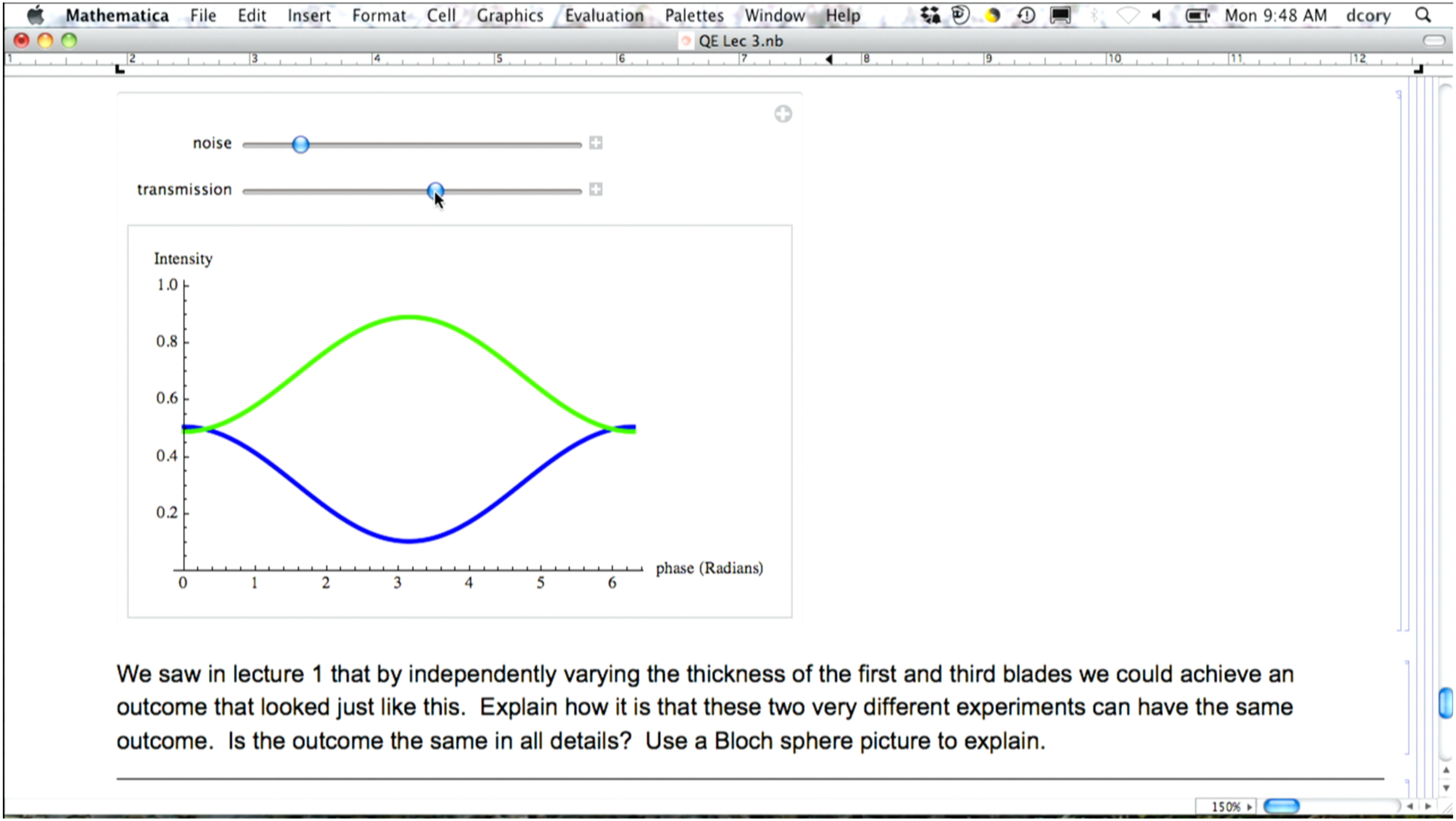


Measurements from a position sensitive detector showing the fringes and the beam profile. Note that the position sensitive detector has low quantum efficiency. The neutron is converted to light in a scintillator which is then collected in a CCD. If the scintillator is thick, then the quantum efficiency is increased but at a cost of resolution. The scintillation event acts as a point source for photons.

150%



We saw in lecture 1 that by independently varying the thickness of the first and third blades we could achieve an outcome that looked just like this. Explain how it is that these two very different experiments can have the same outcome. Is the outcome the same in all details? Use a Bloch sphere picture to explain.



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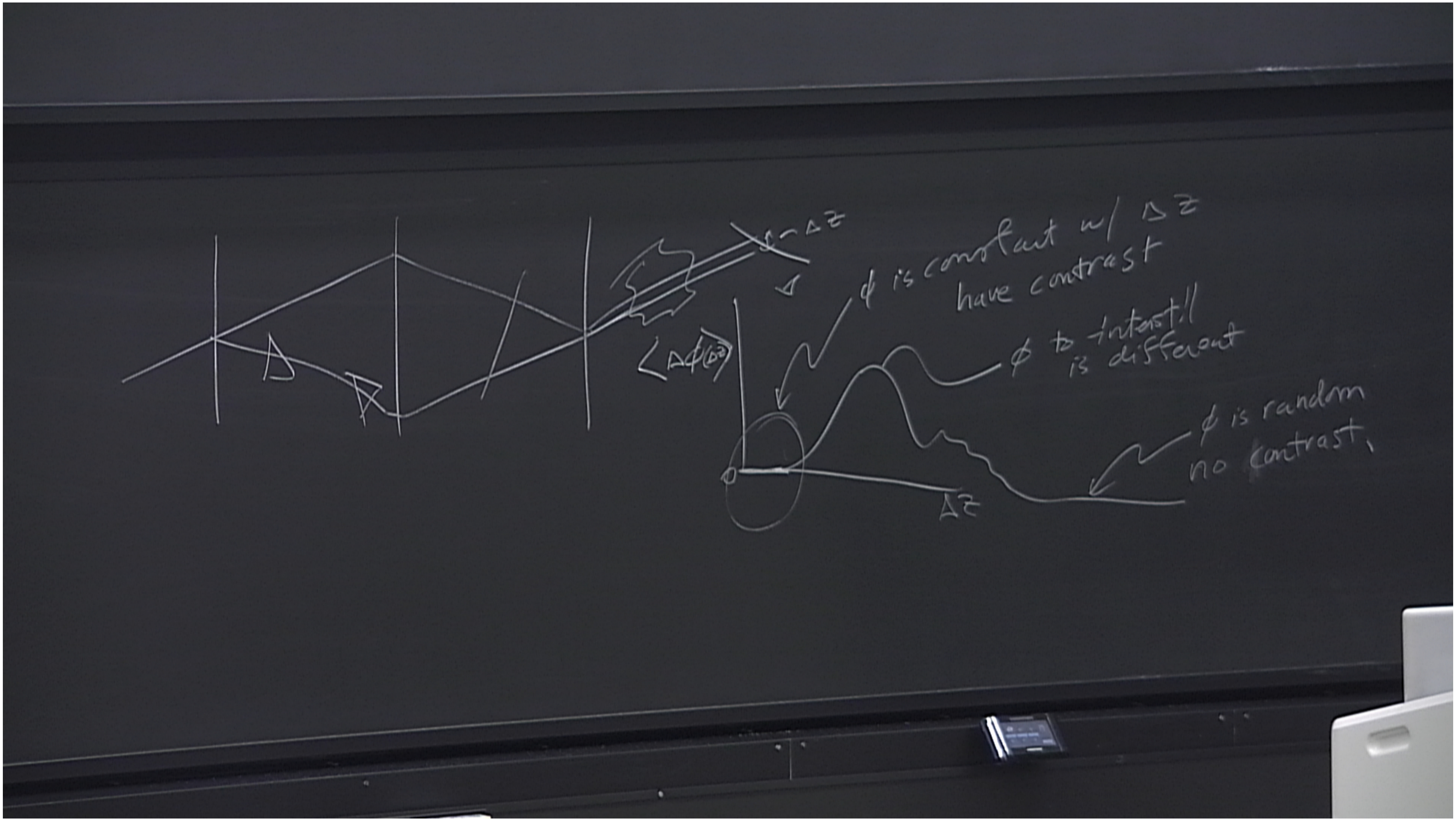
φ is constant w/ Δz
have contrast
φ is random
no contrast,
Δz