Today's Outline - January 27, 2015

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- Undulator coherence

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Reading Assignment: Chapter 3.1–3.3

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Homework Assignment #01:
Chapter Chapter 2: 2,3,5,6,8
due Thursday, January 29, 2015

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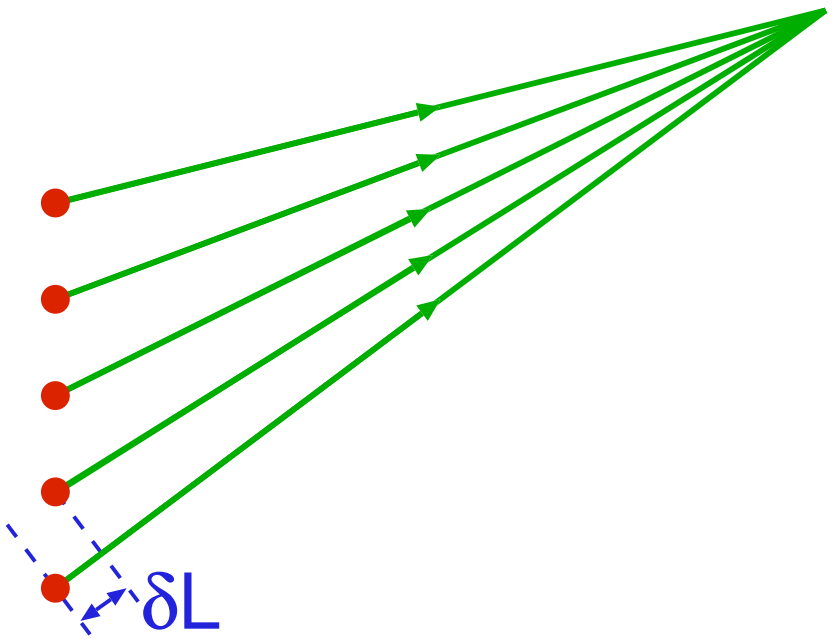

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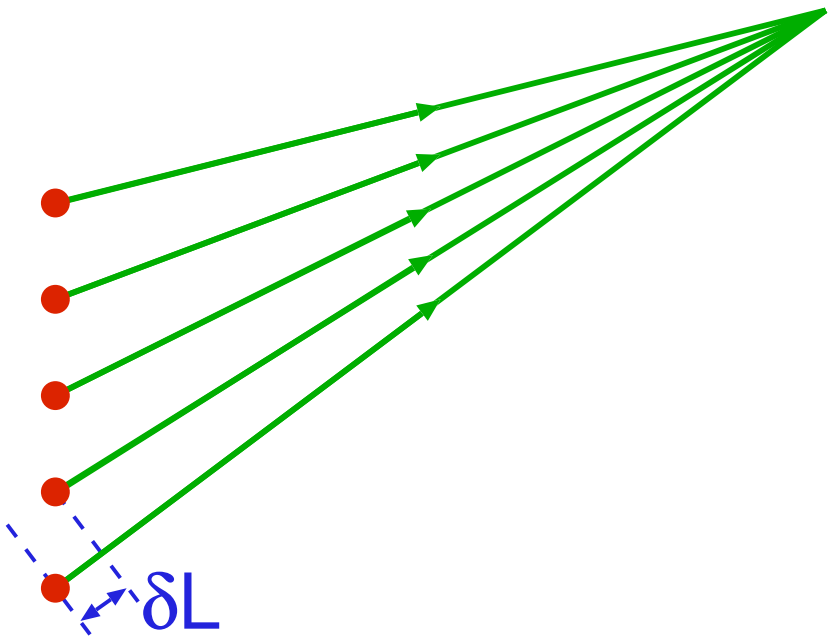

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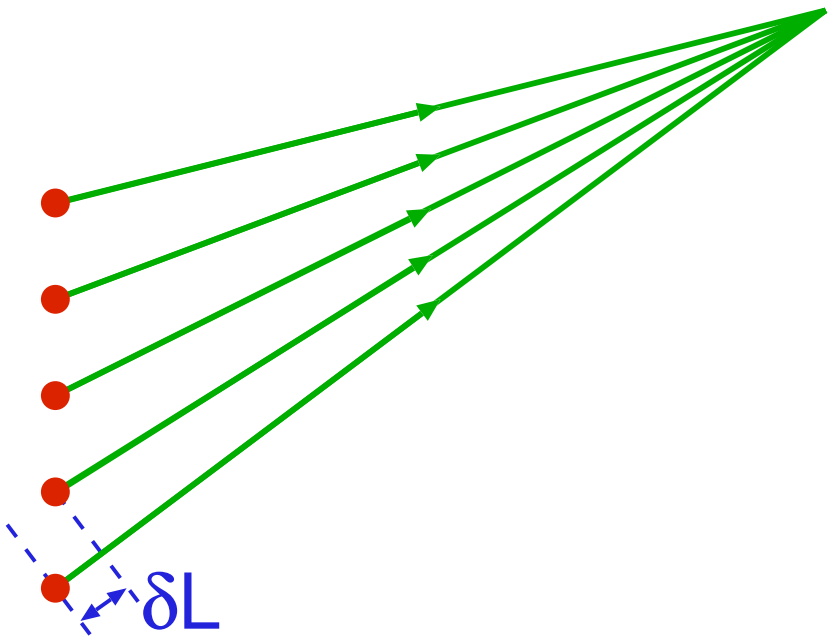

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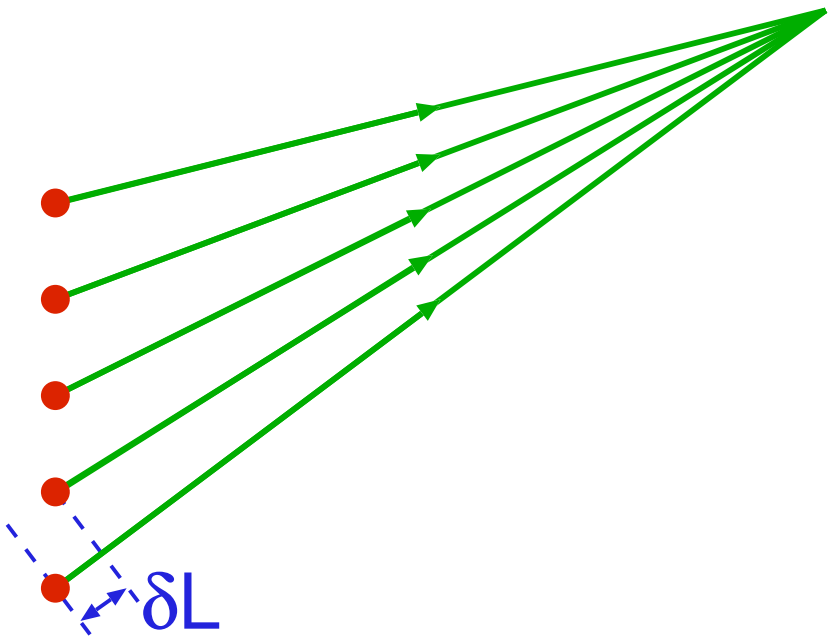

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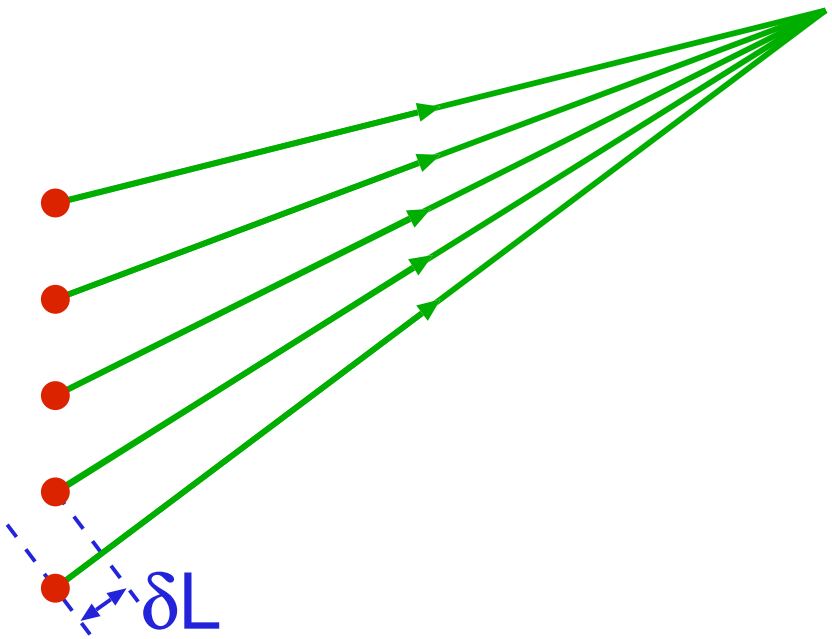

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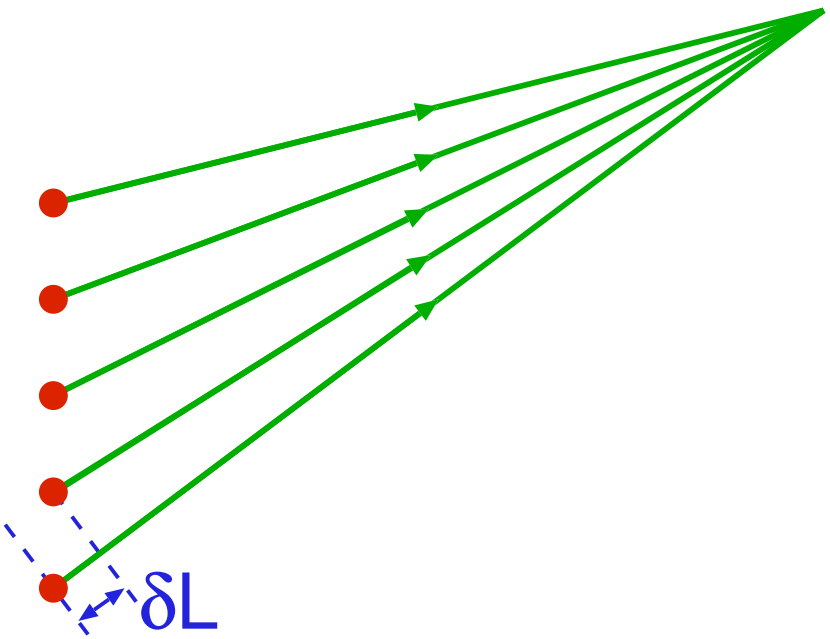

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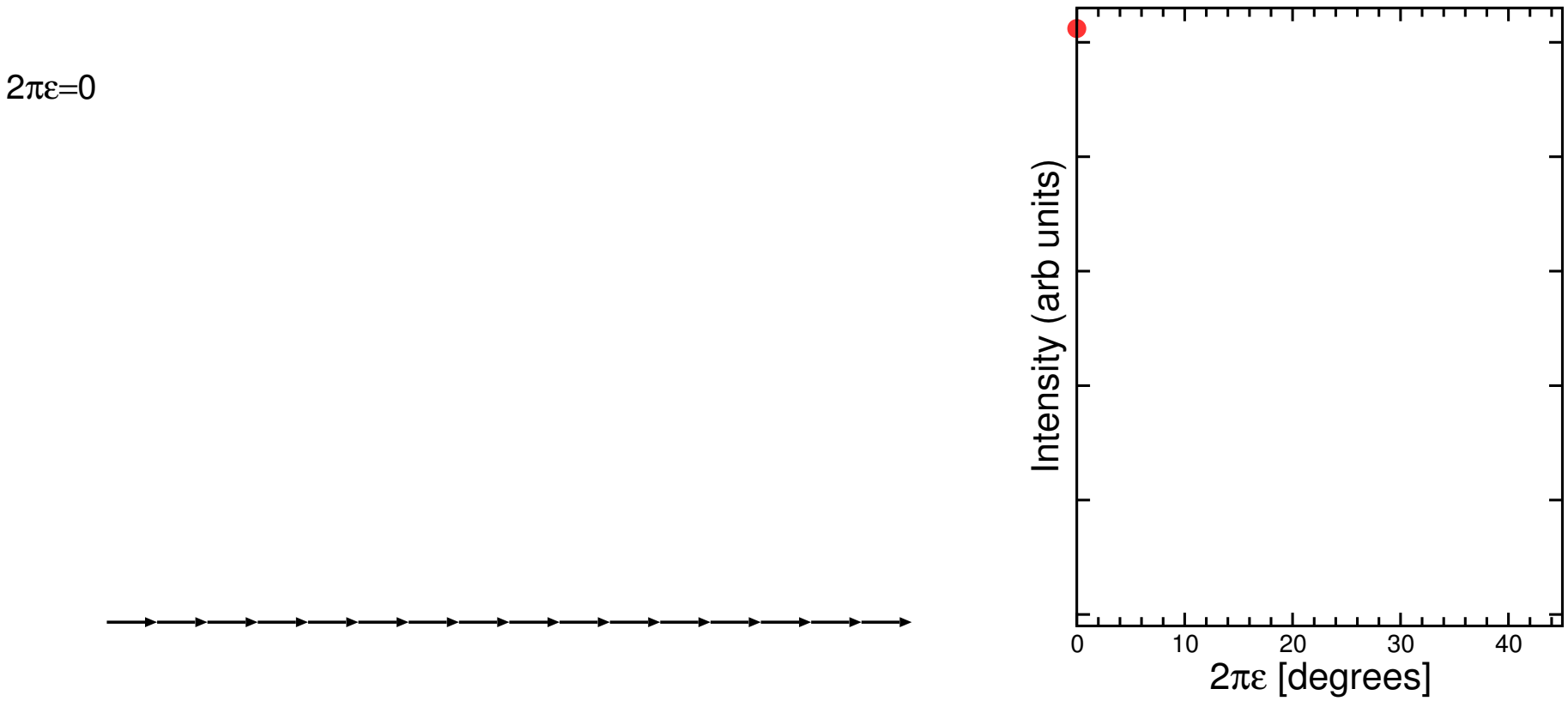

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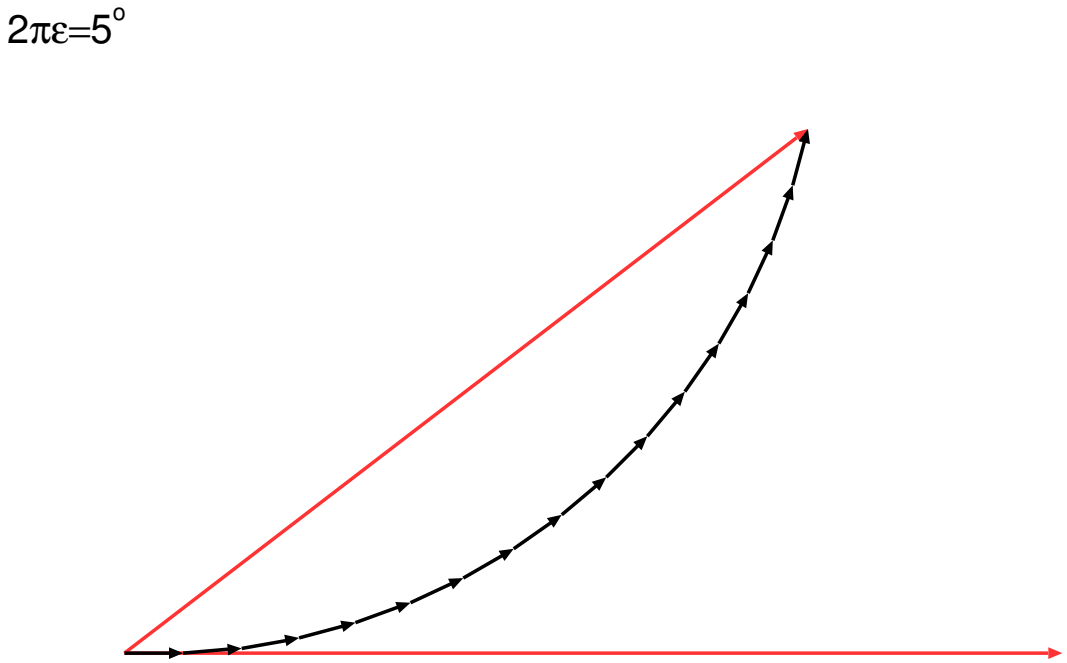

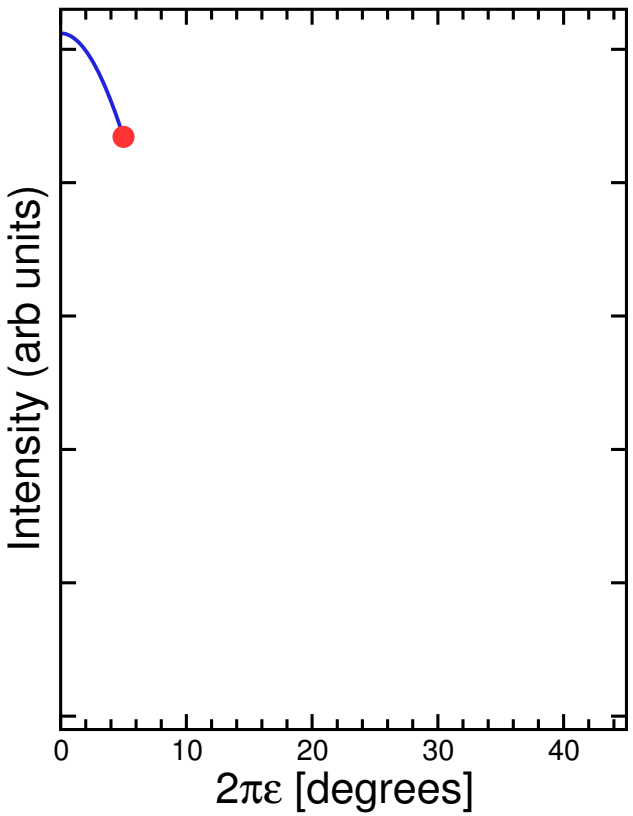

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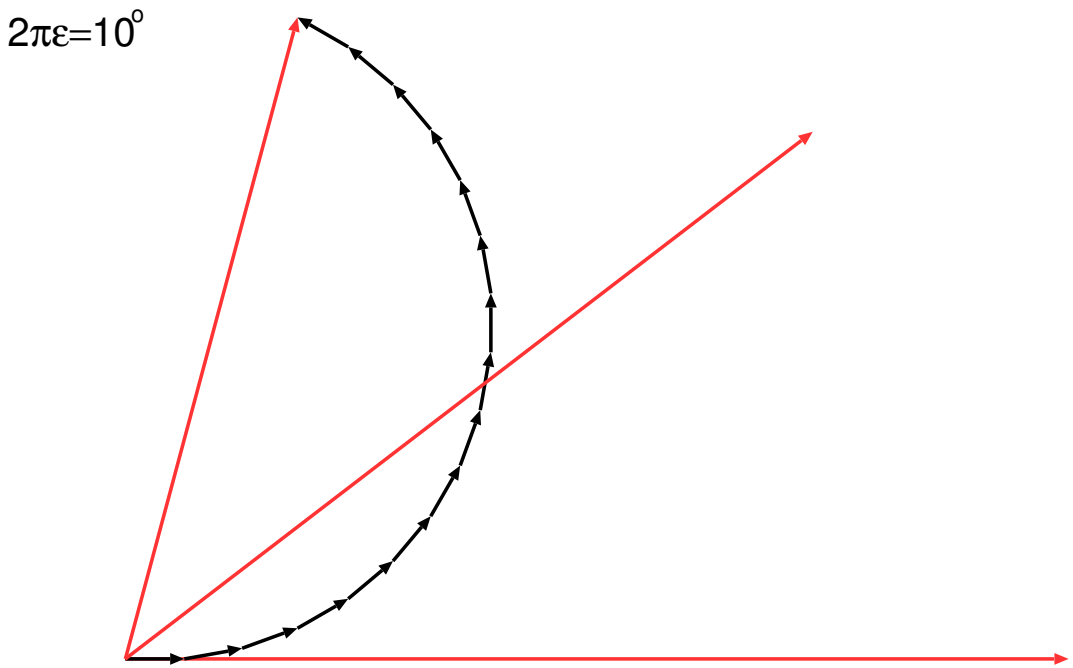

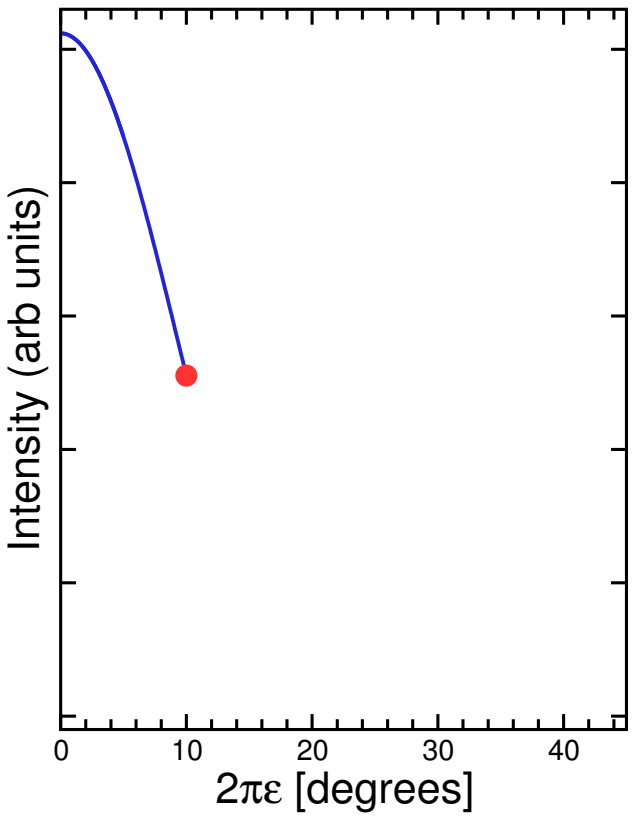

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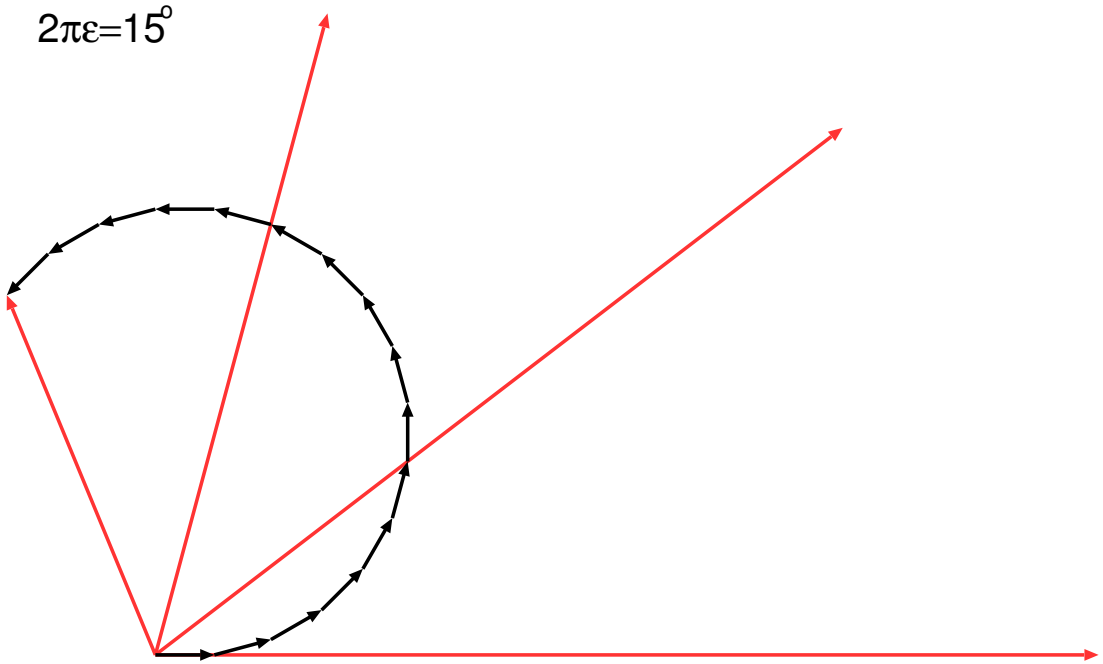

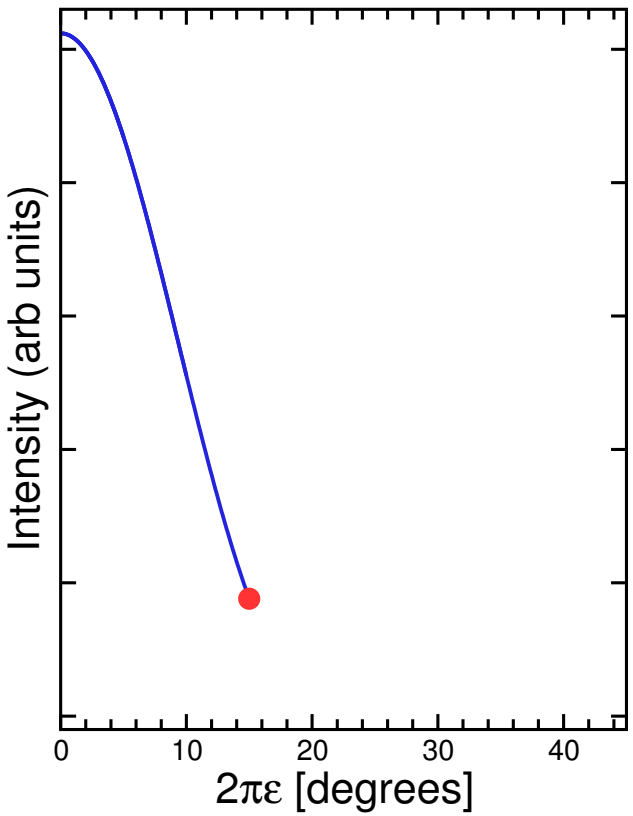

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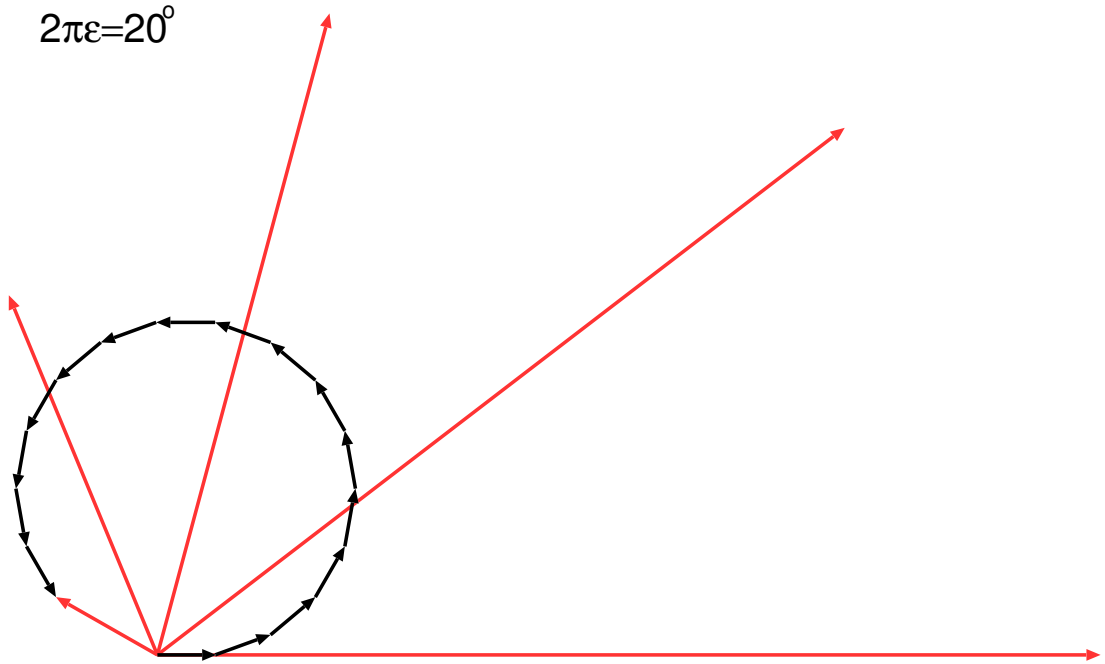

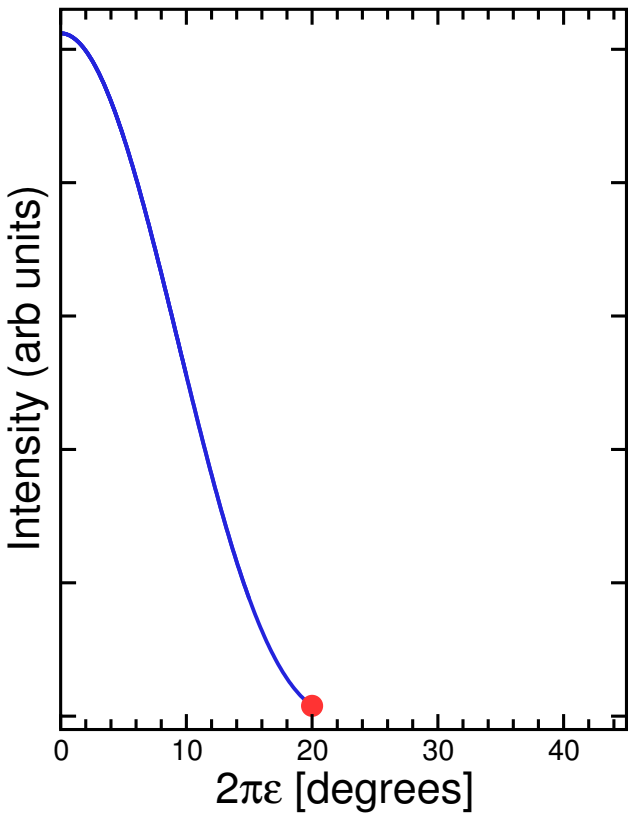

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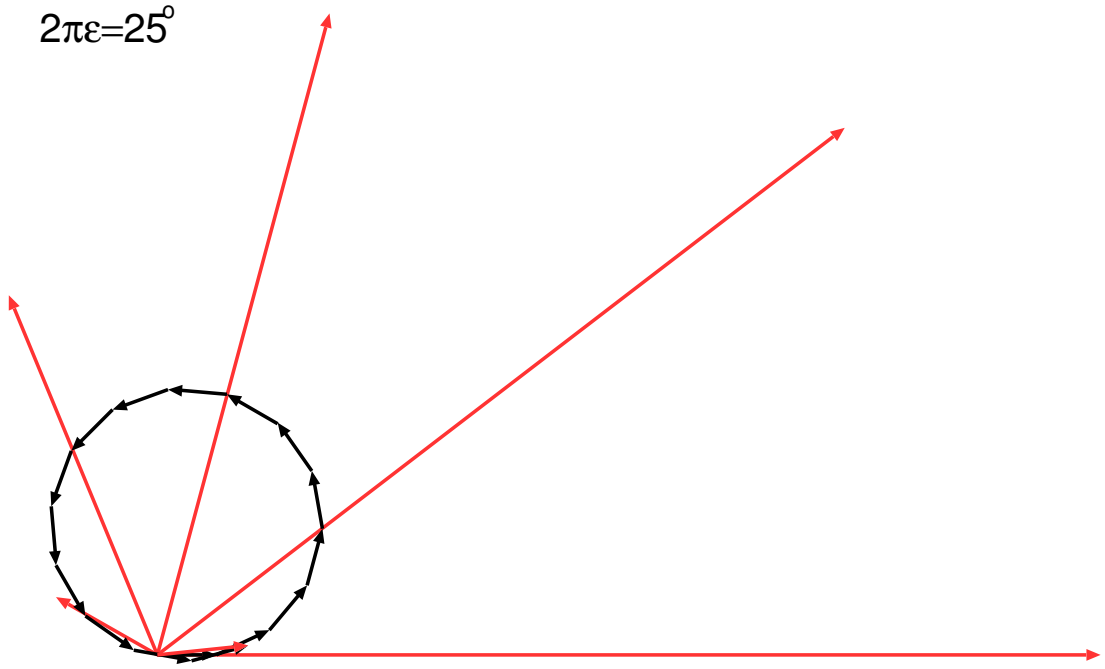

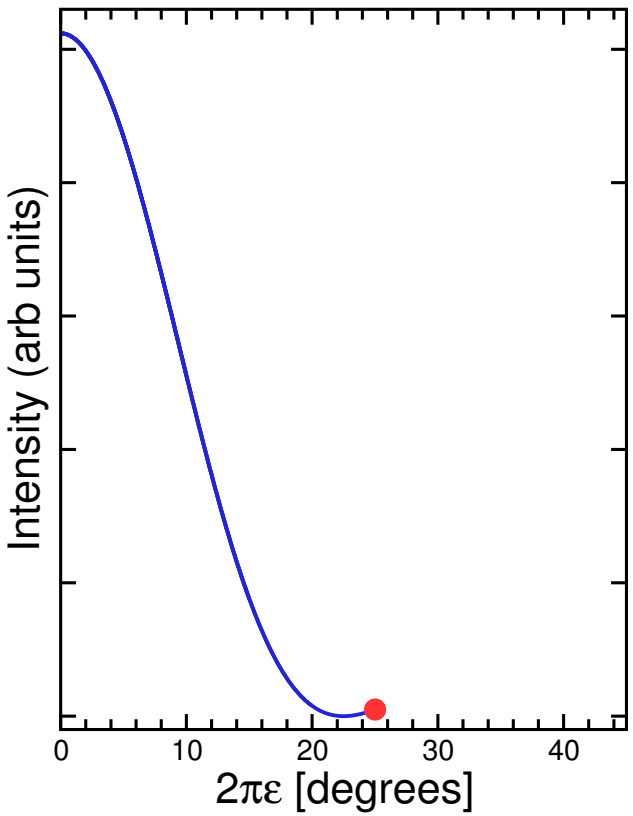

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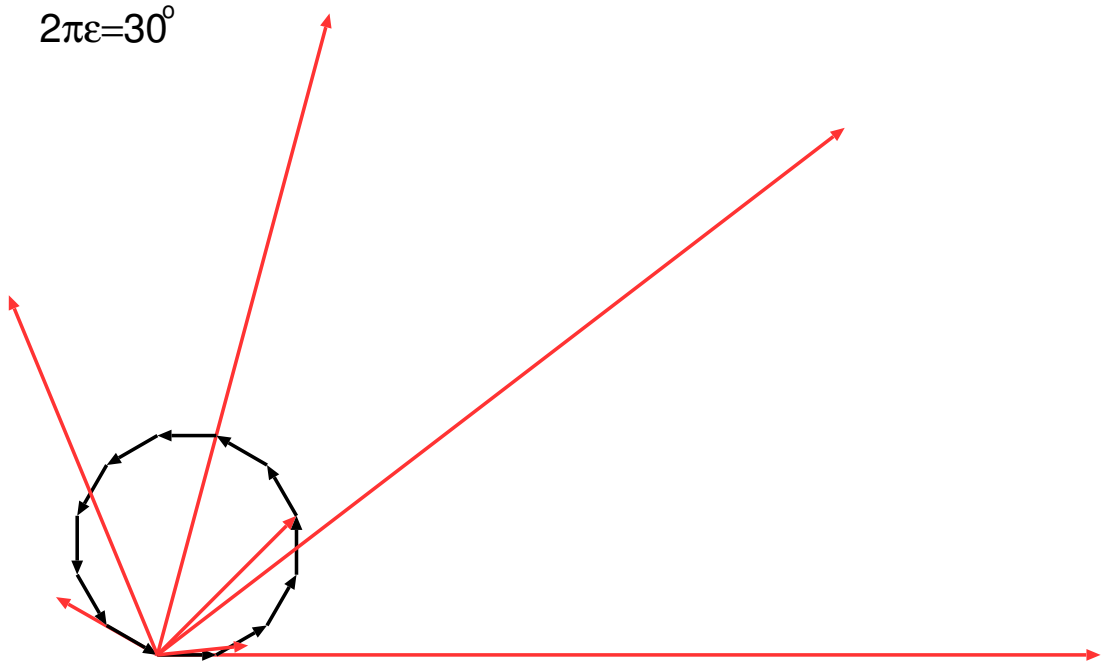

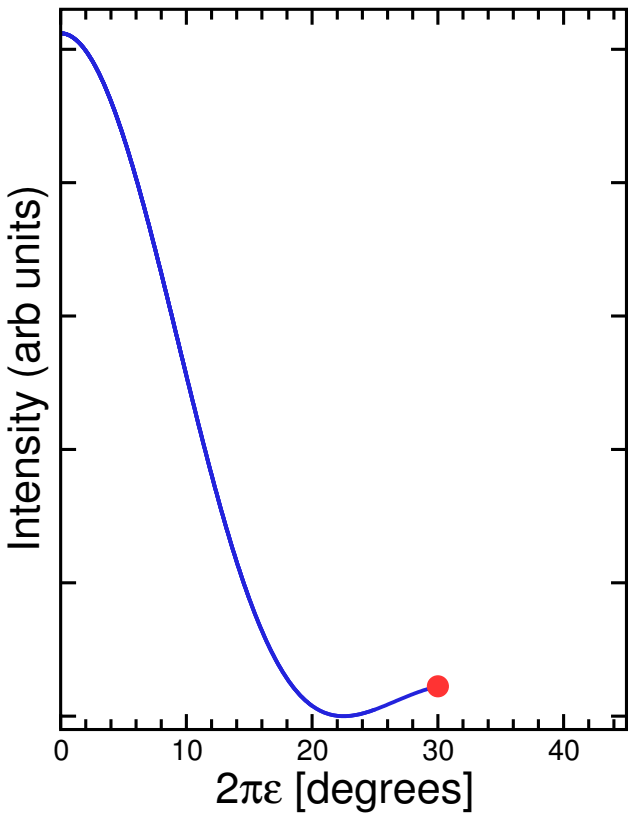

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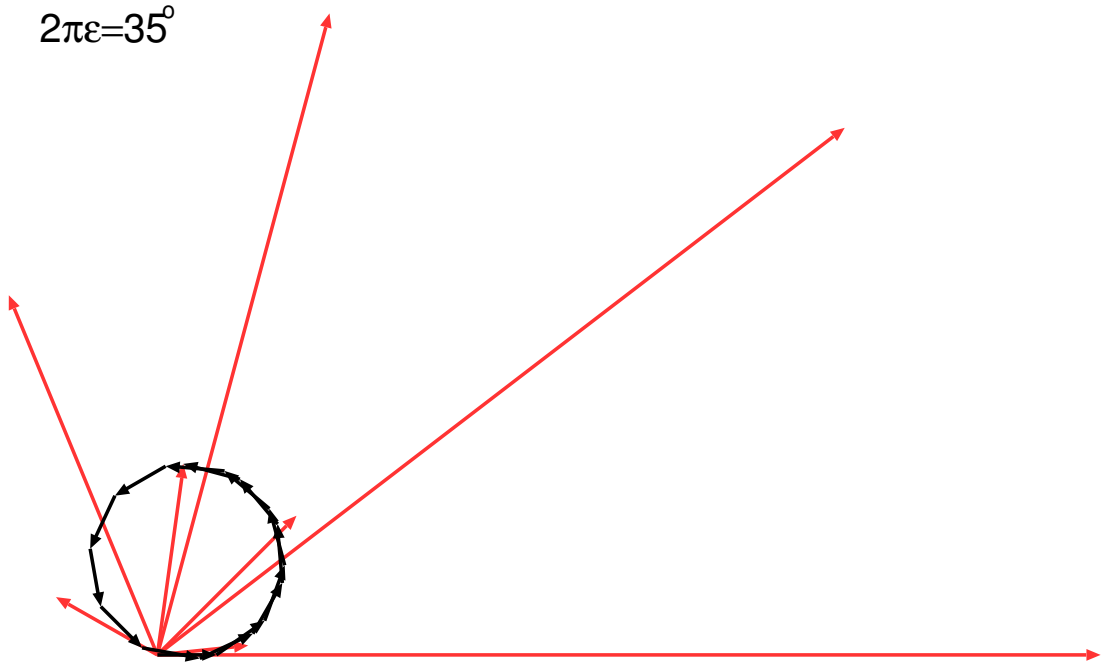

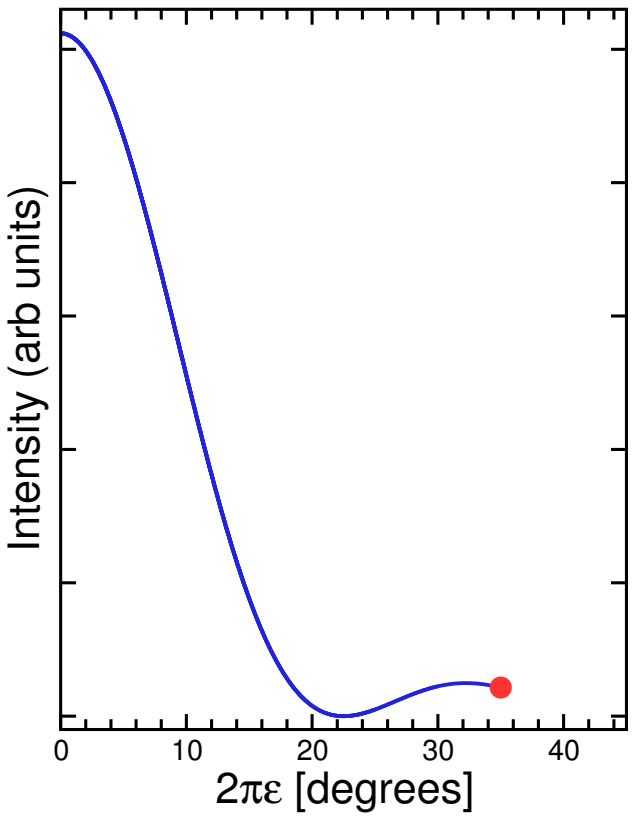

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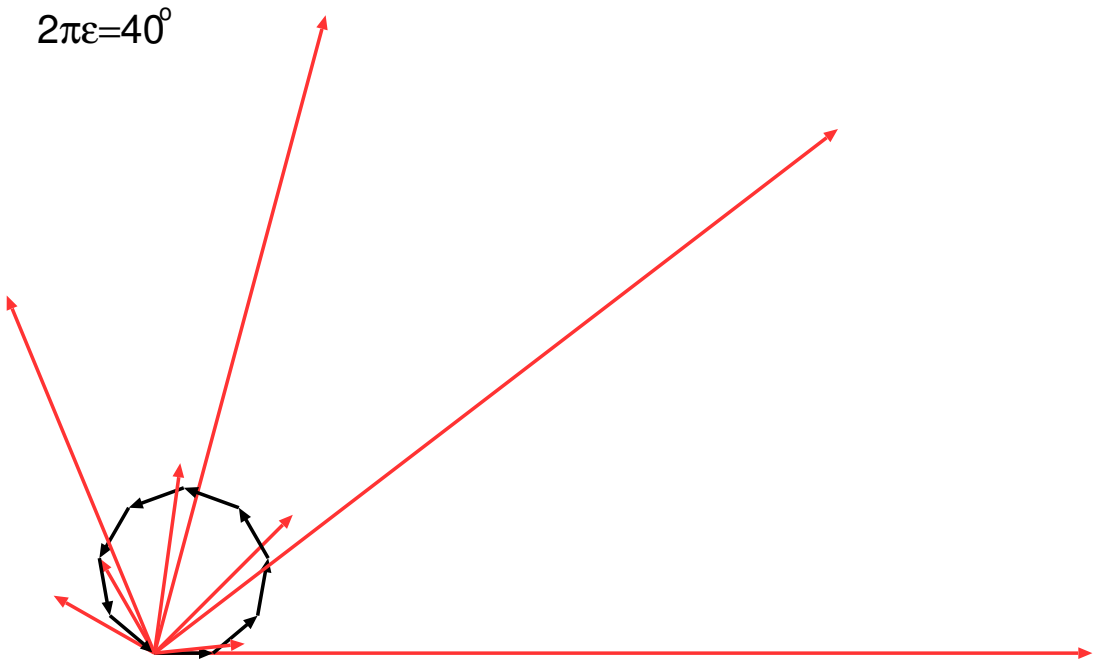

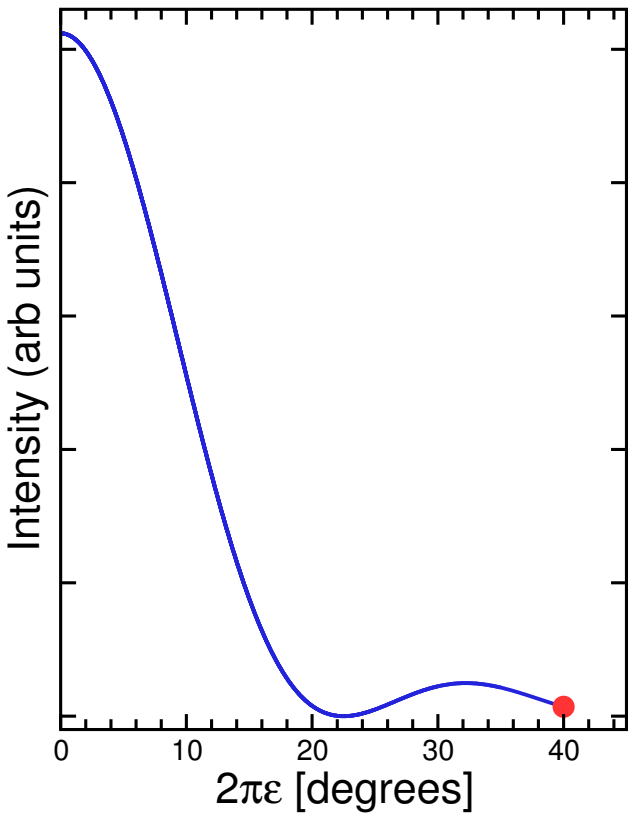

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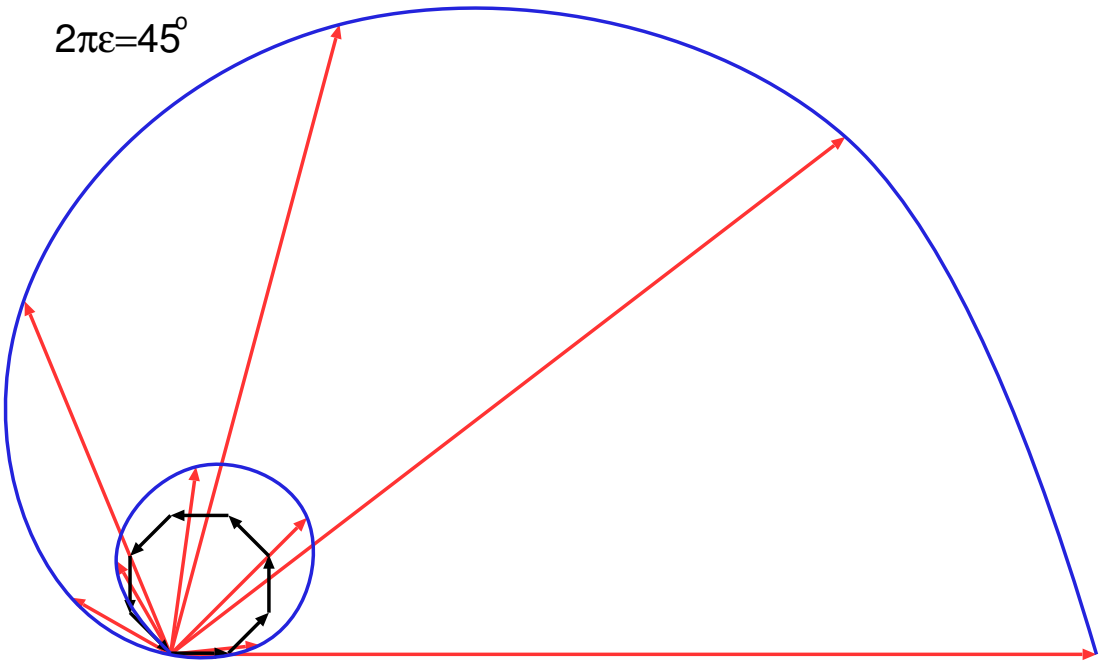

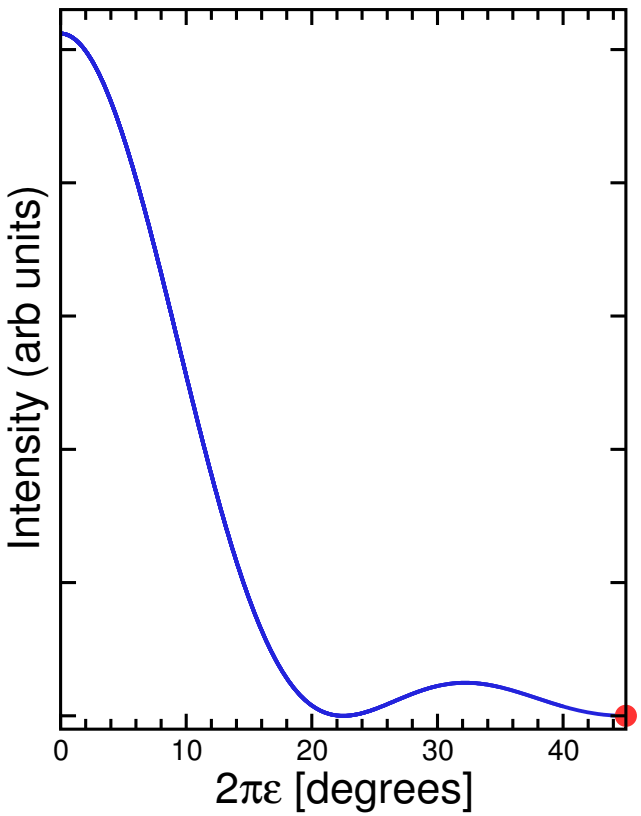

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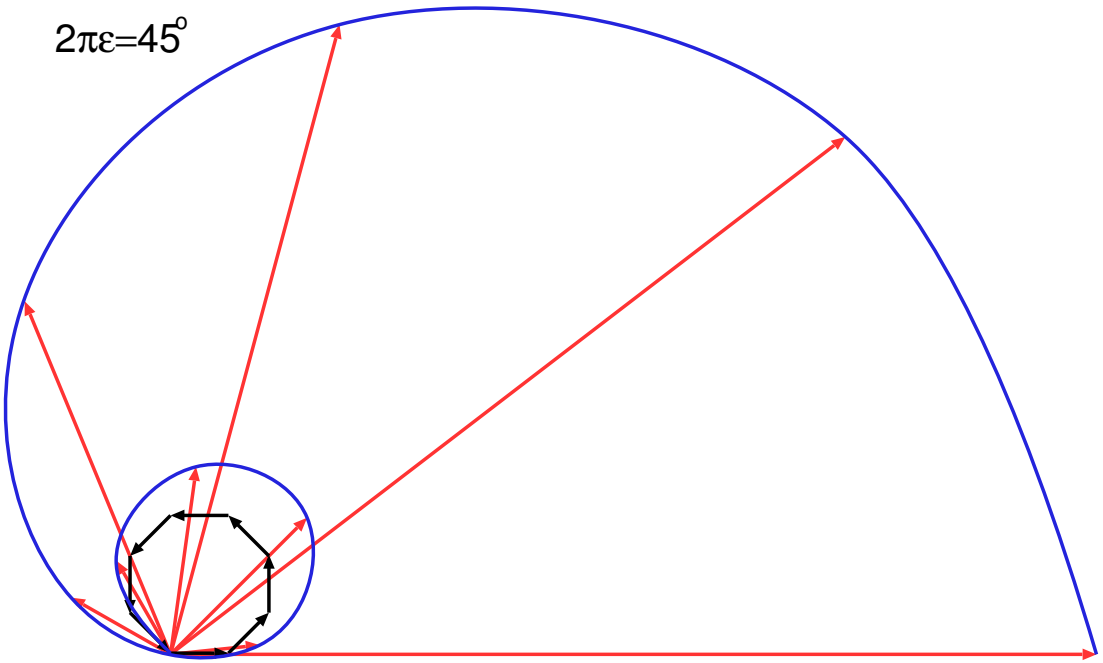
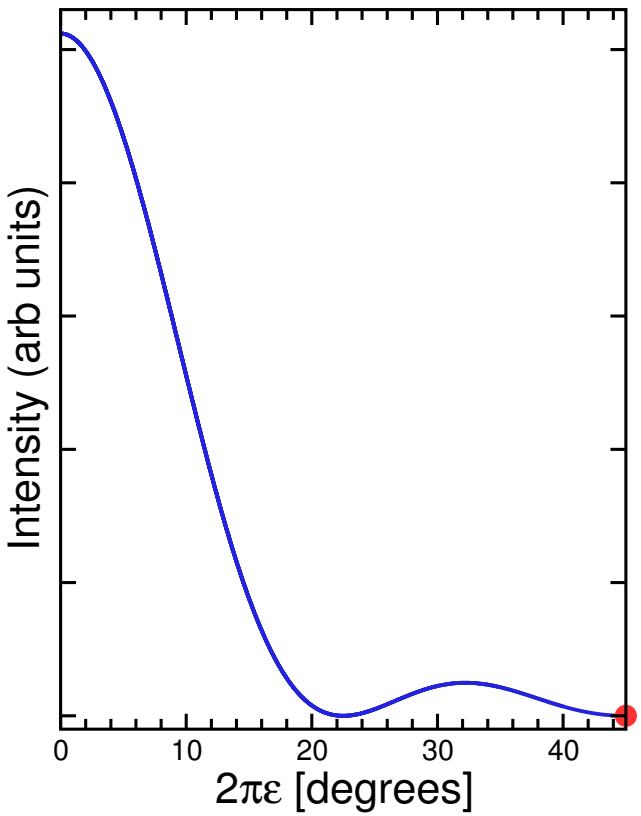
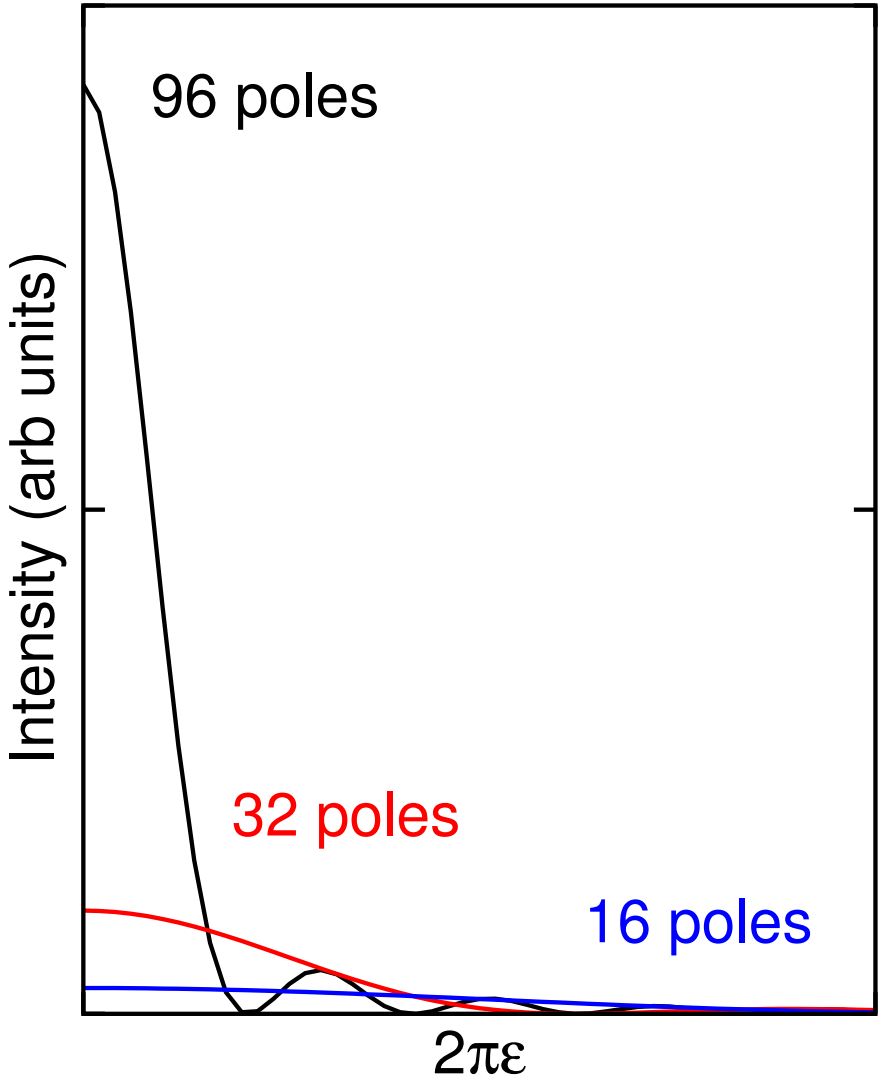




With the height and width of the peak dependent on the number of poles.

Undulator coherence



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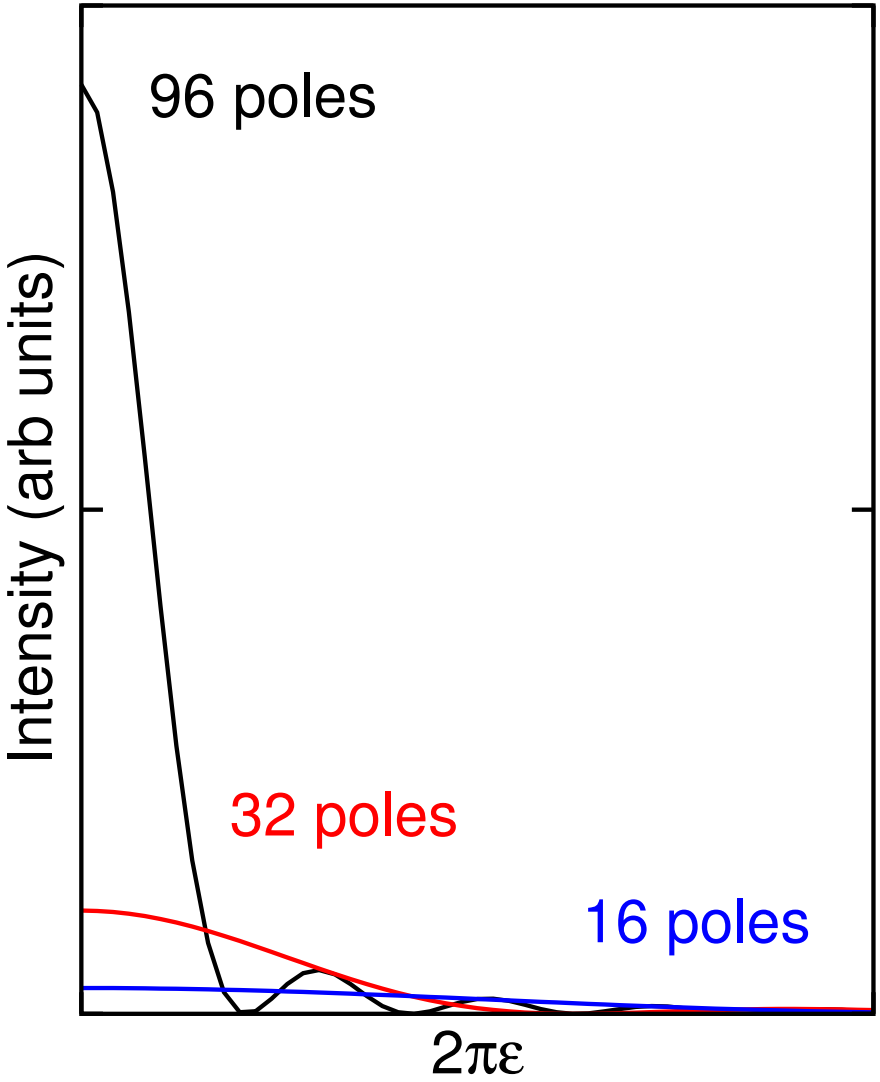
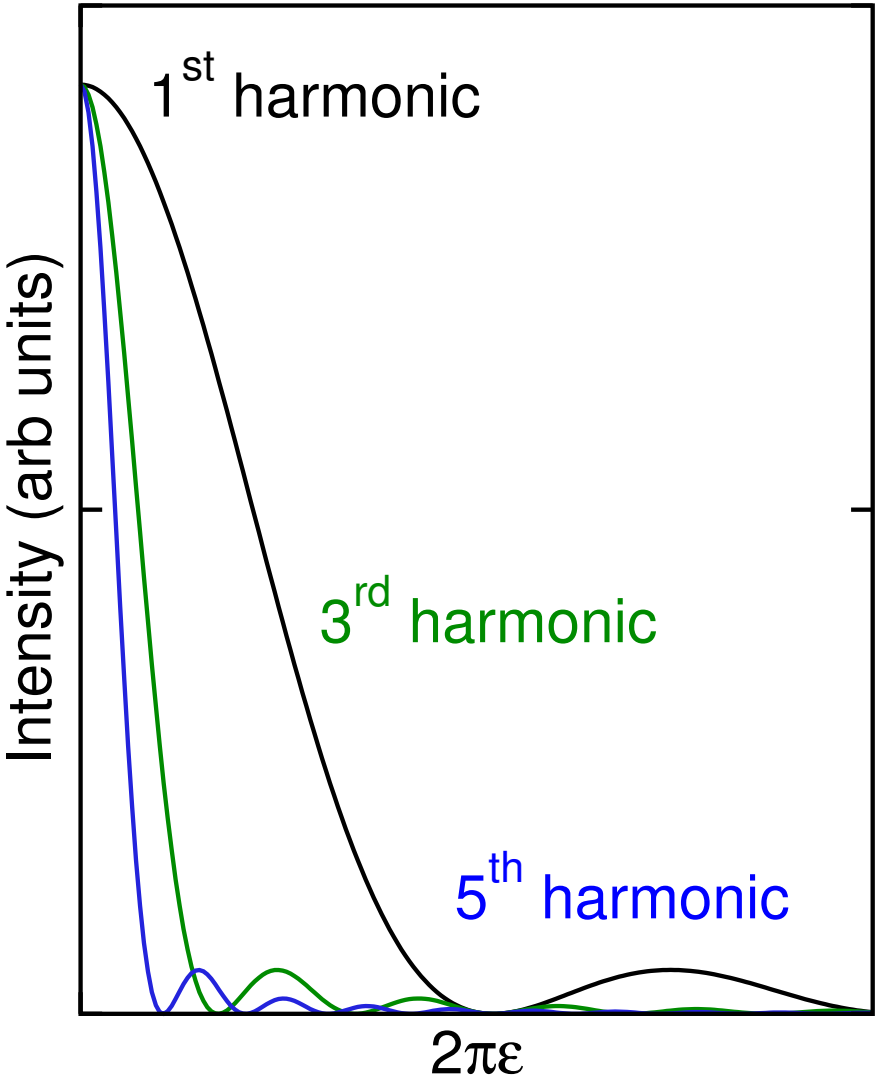
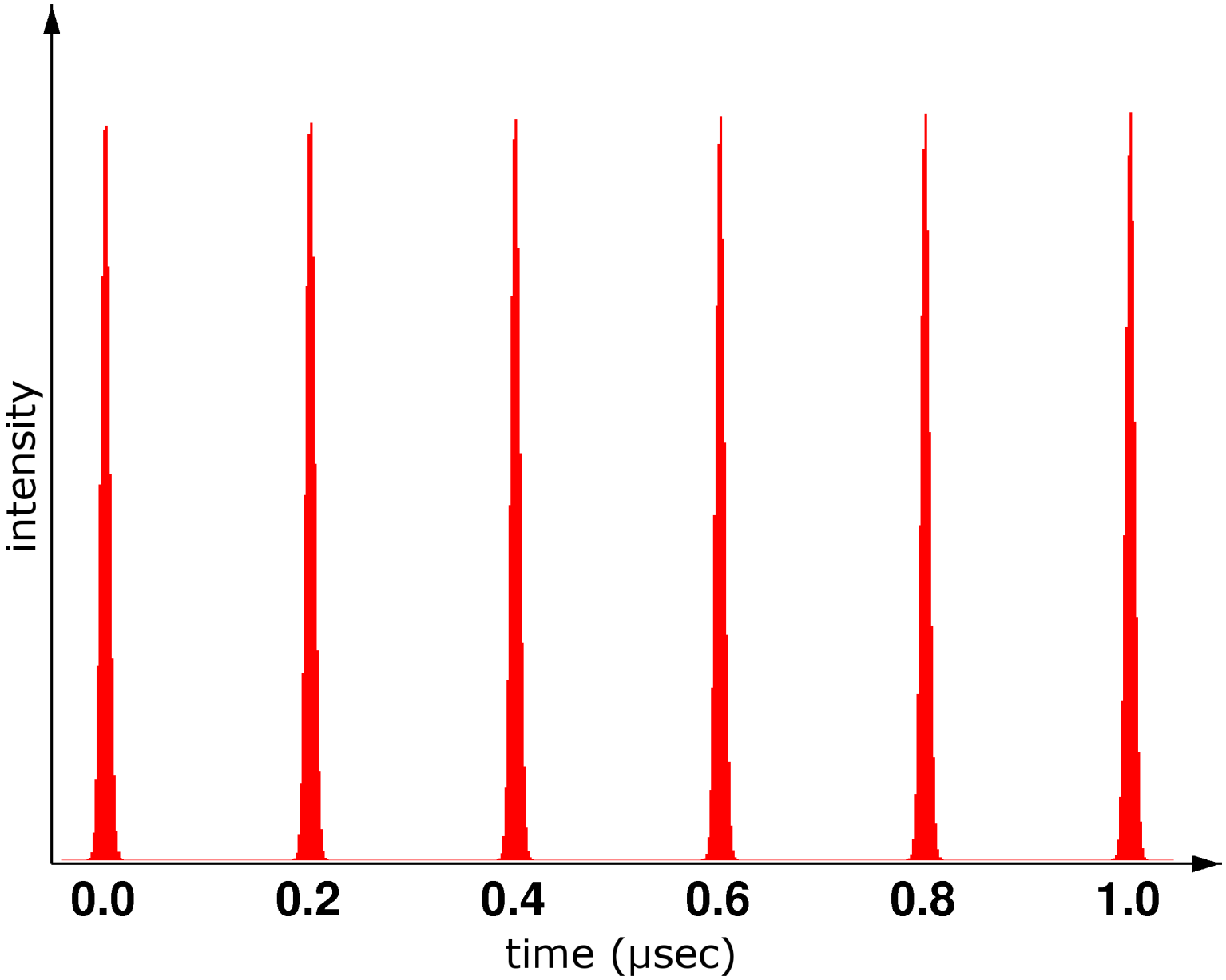




Synchrotron time structure



Energy recovery linacs

Undulators have limited peak brilliance

Energy recovery linacs

Undulators have limited peak brilliance but the use of an energy recovery linac can overcome this limitation and enhance peak brilliance by up to three orders of magnitude

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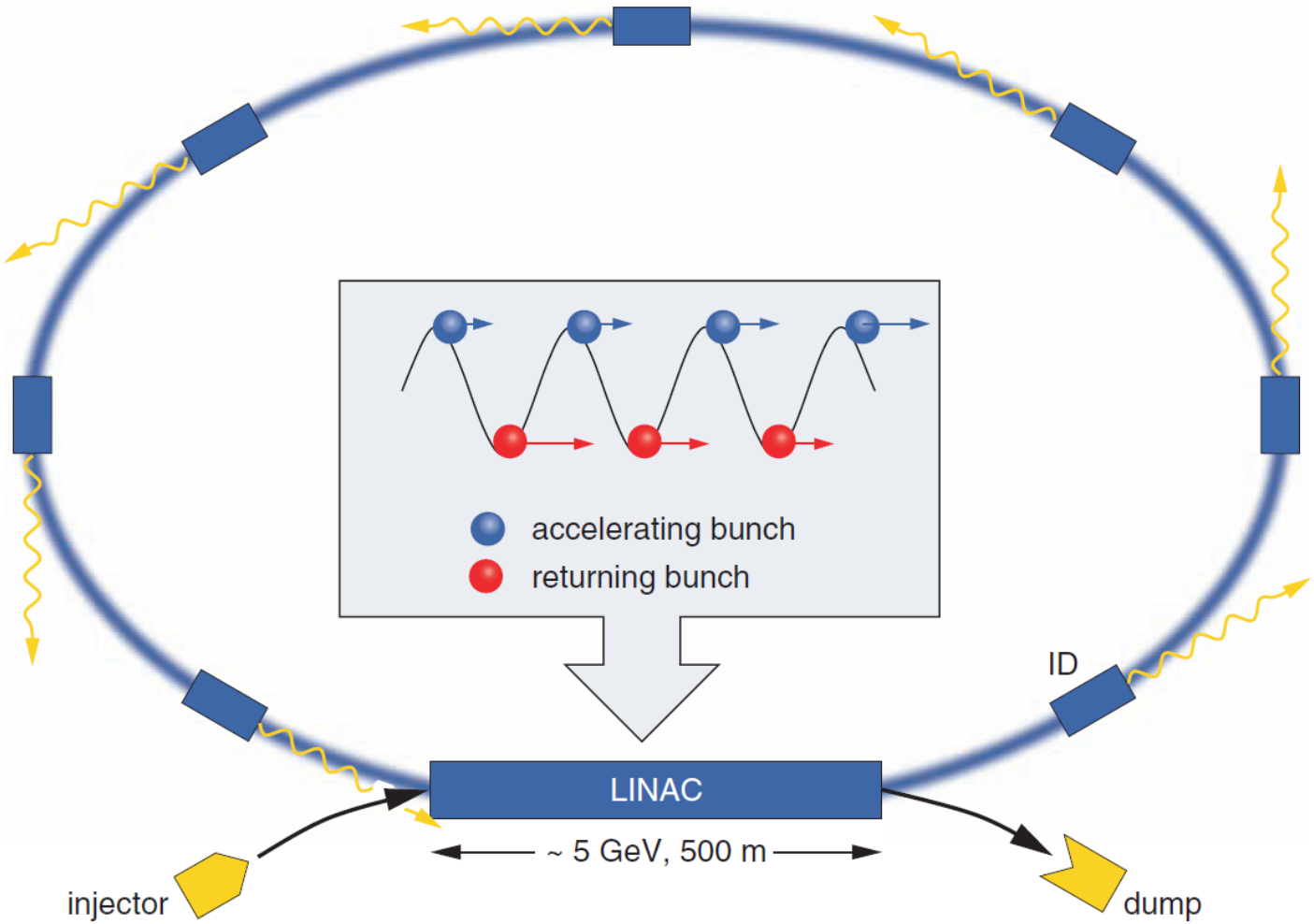
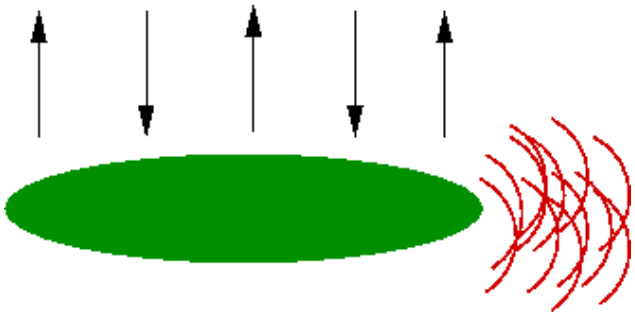


Free electron laser



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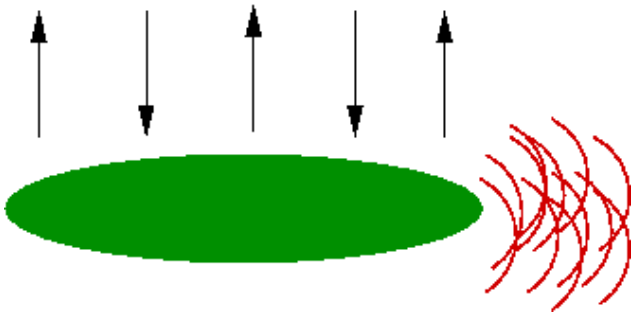
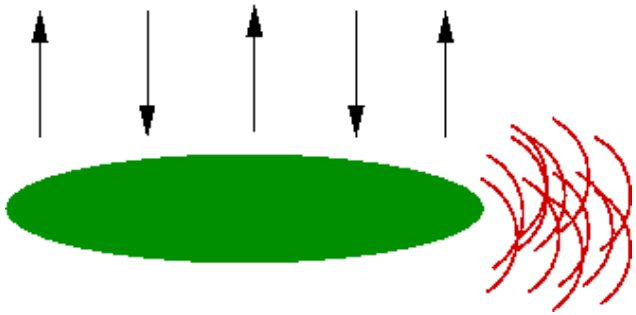


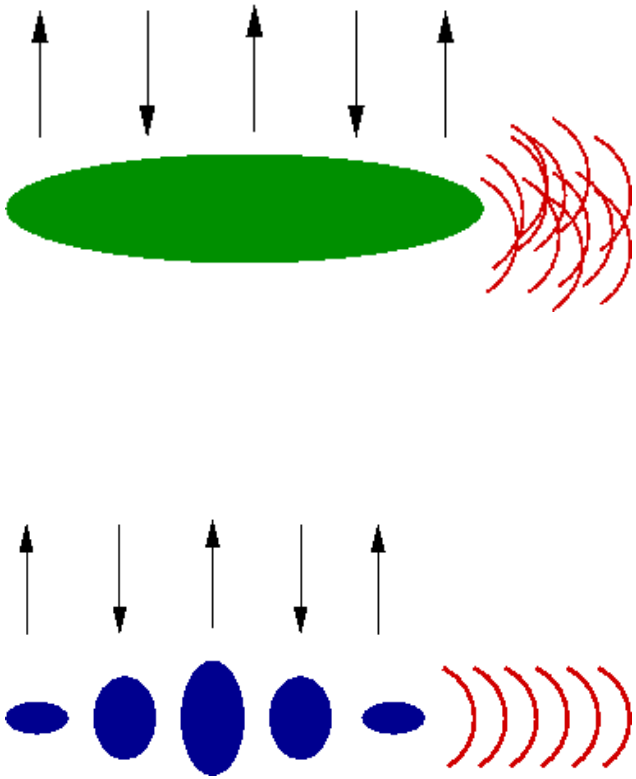
- Initial electron cloud, each electron emits coherently but independently

Free electron laser



- Initial electron cloud, each electron emits coherently but independently
- Over course of 100 m, electric field of photons, feeds back on electron bunch

Free electron laser



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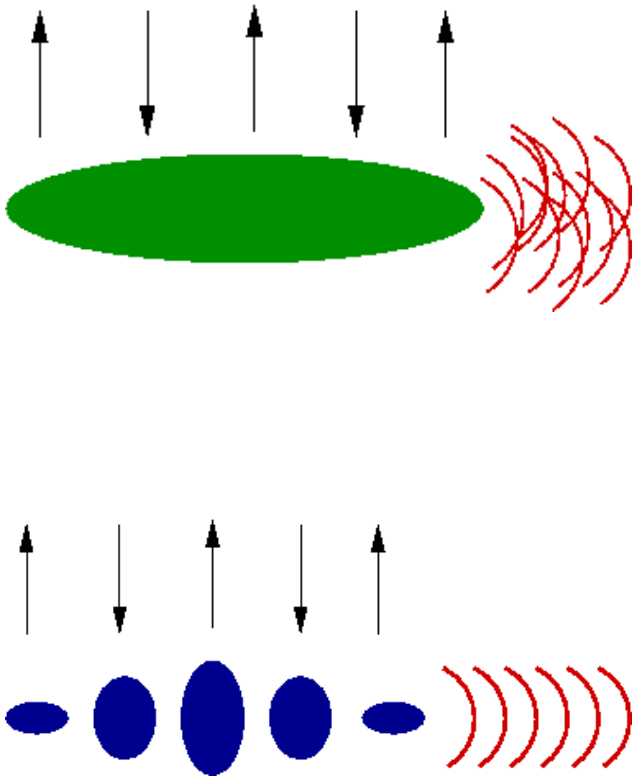

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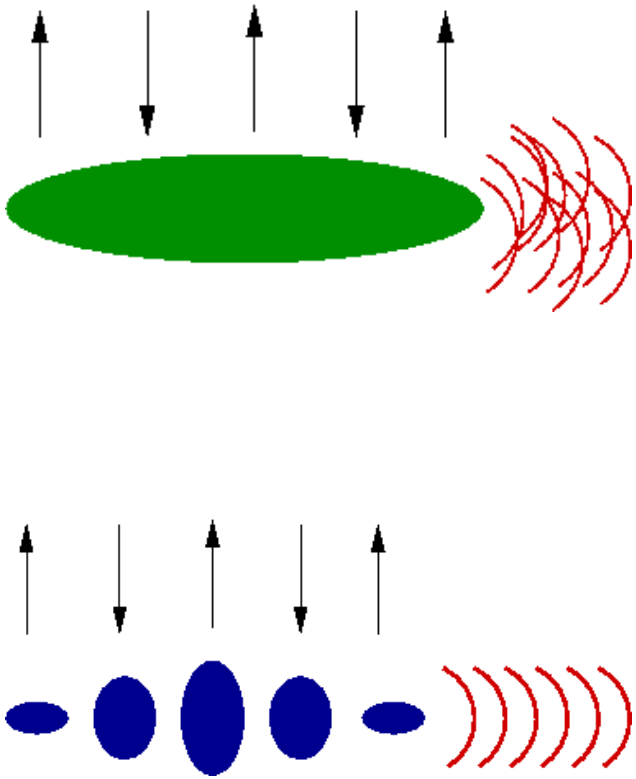
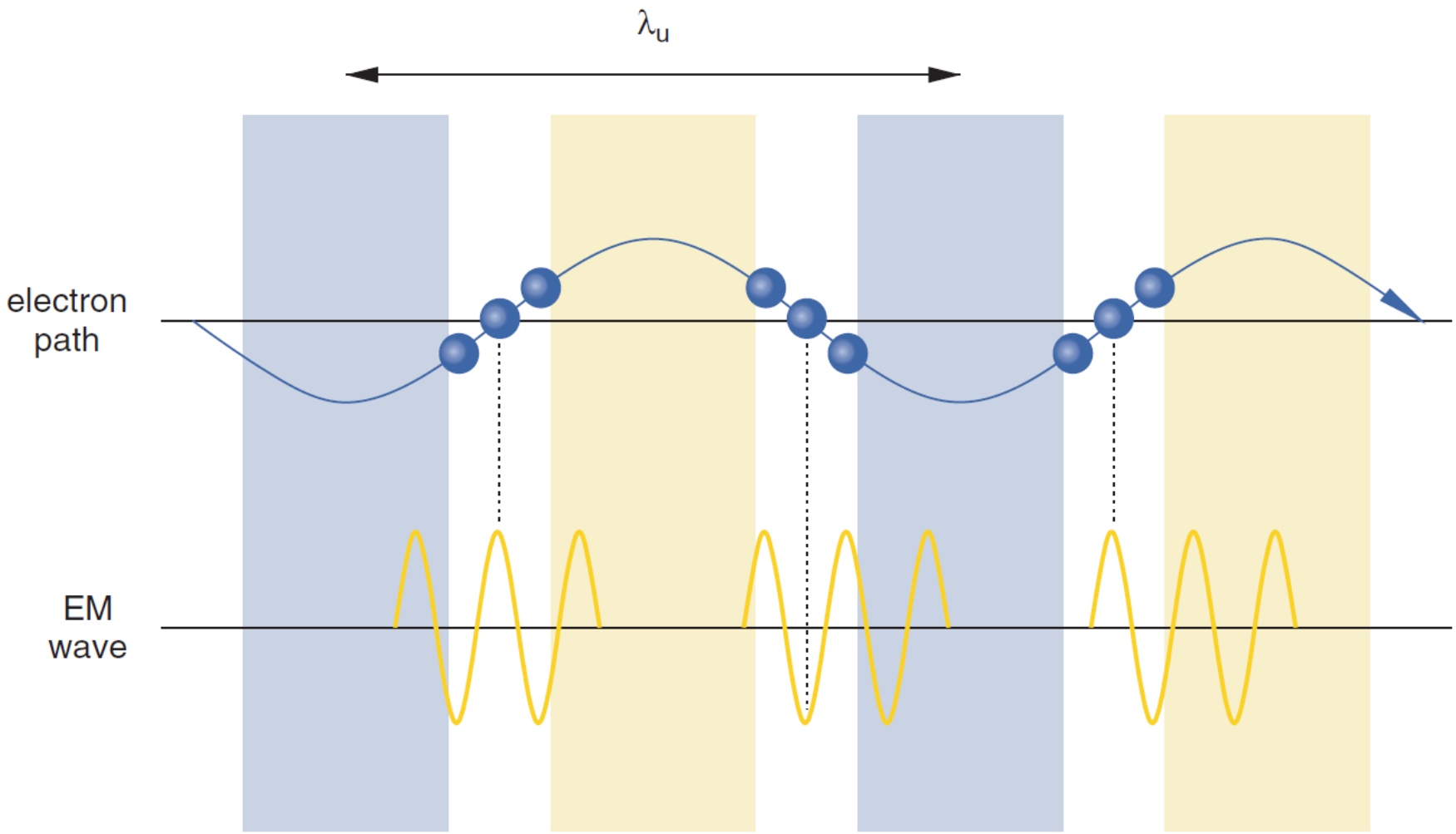
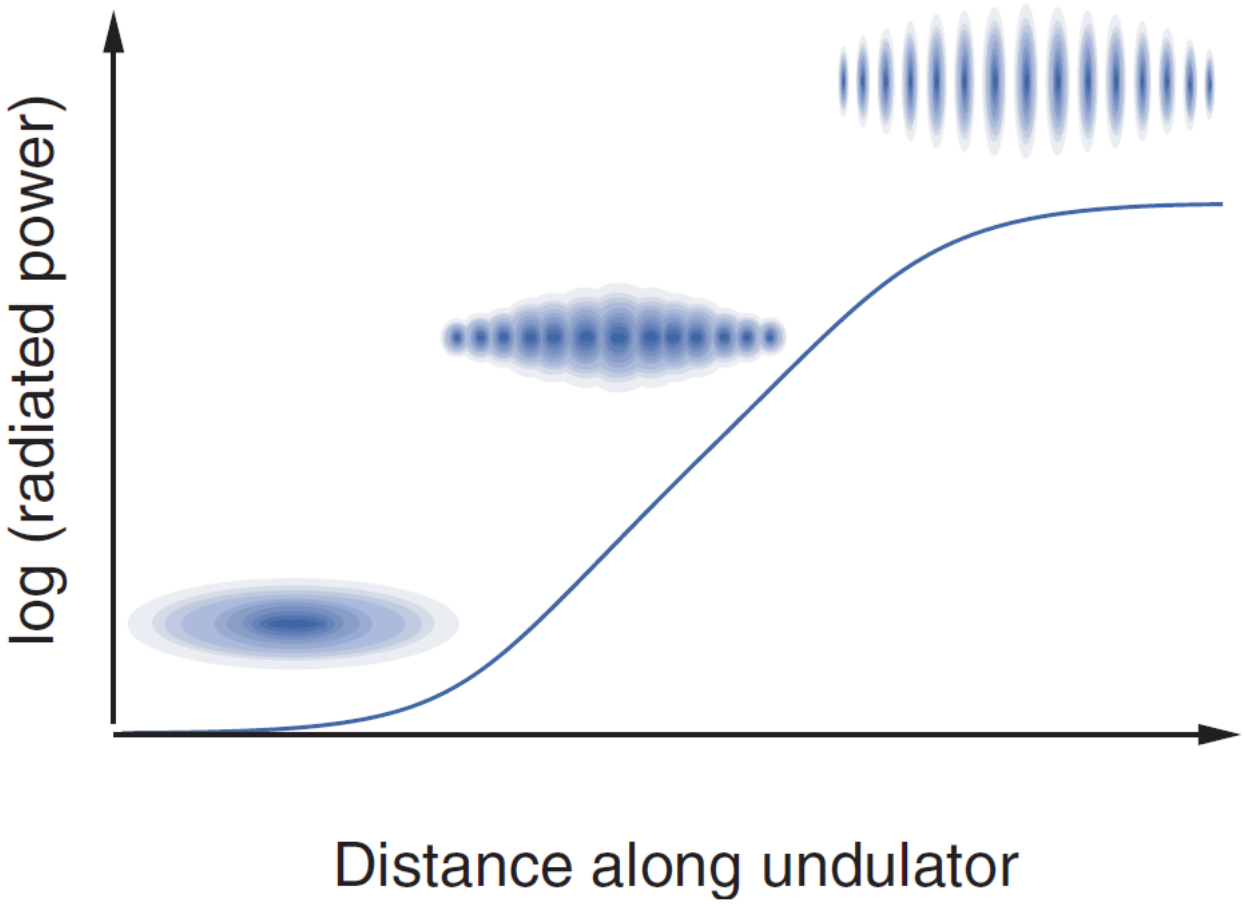


- Initial electron cloud, each electron emits coherently but independently
- Over course of 100 m, electric field of photons, feeds back on electron bunch
- Microbunches form with period of FEL (and radiation in electron frame)
- Each microbunch emits coherently with neighboring ones

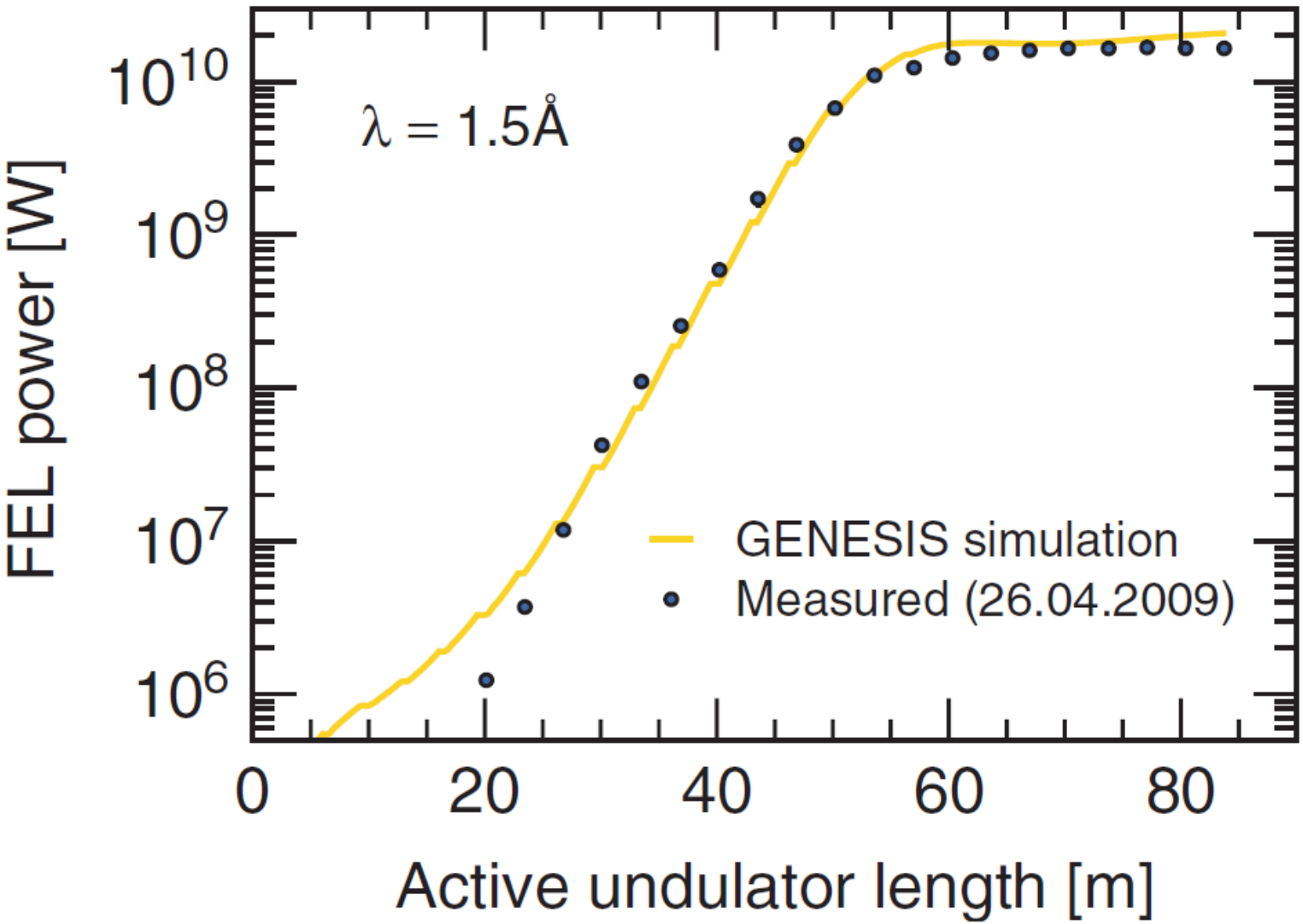
Self-amplified spontaneous emission



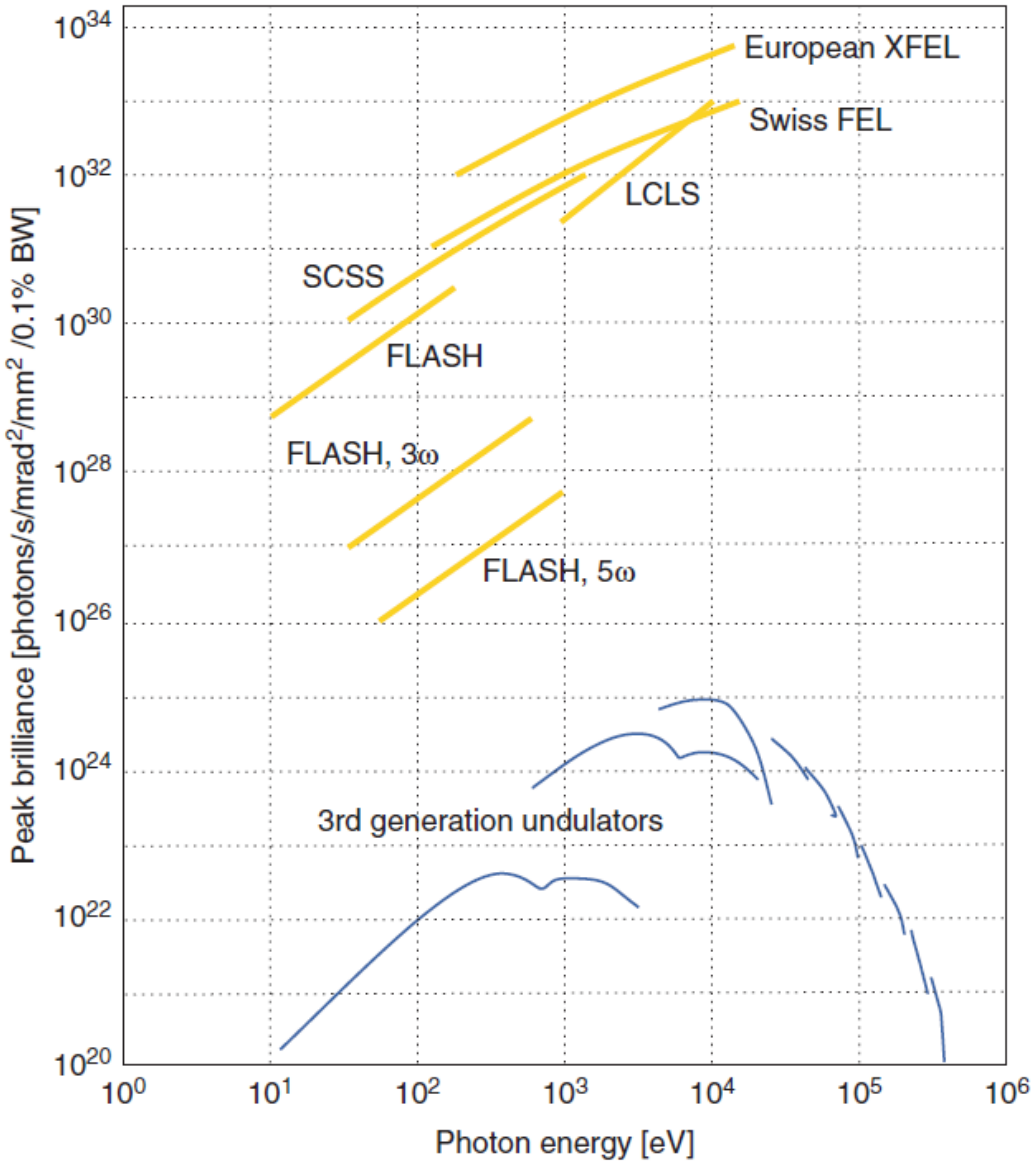
FEL emission



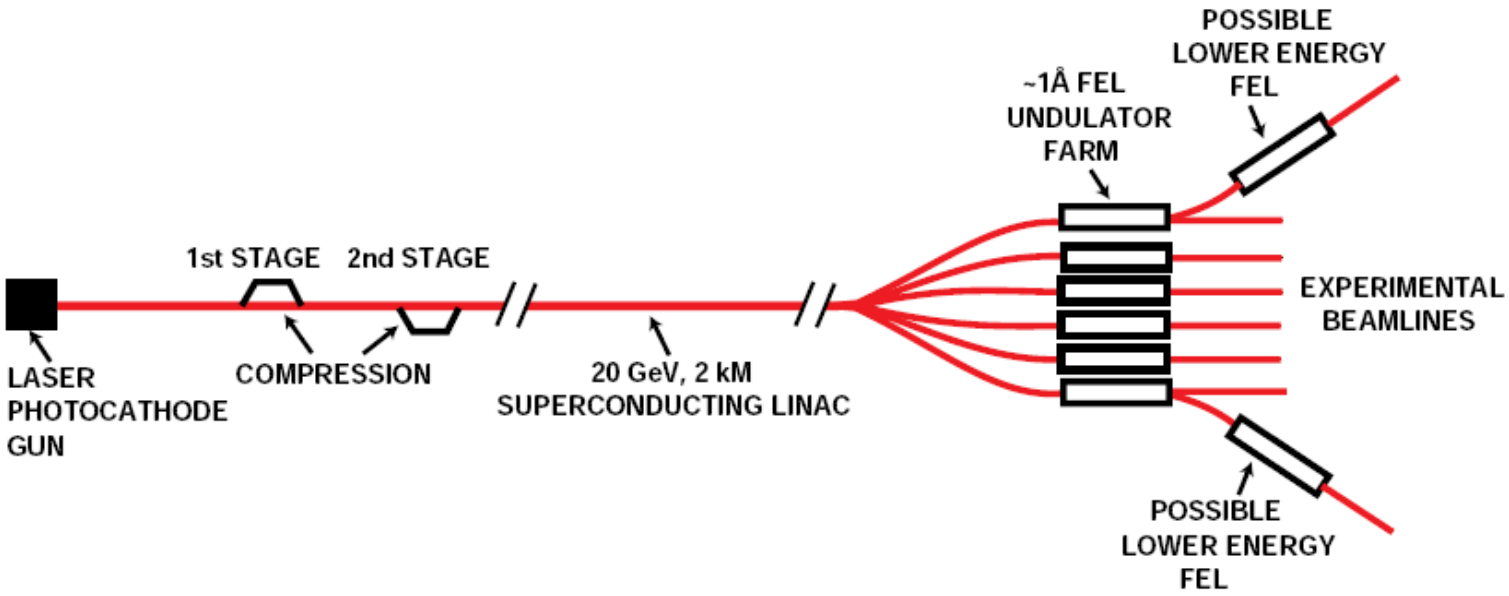
FEL emission



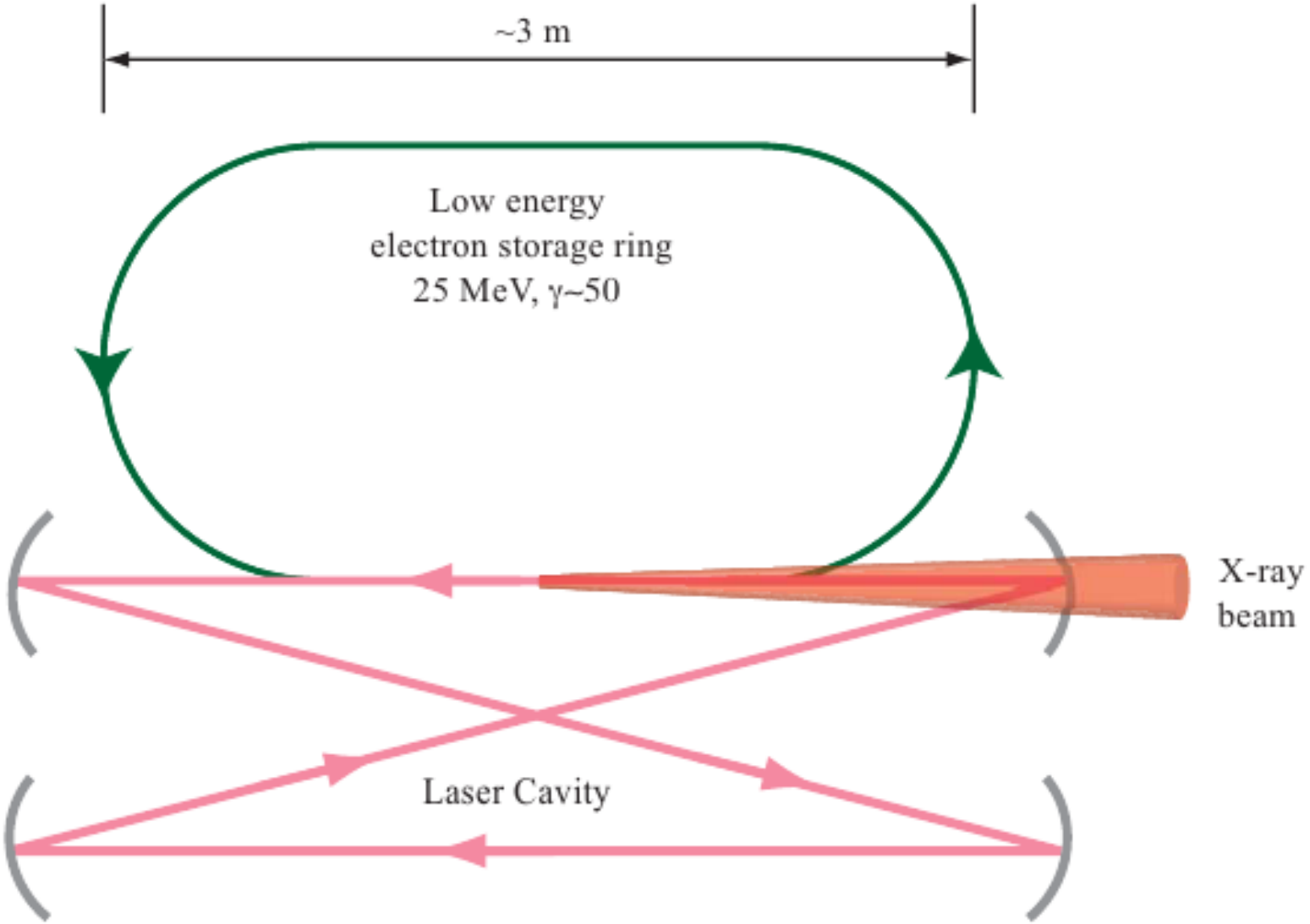
FEL emission



FEL layout


POSSIBLE
LOWER ENERGY
FEL
~1Å FEL
UNDULATOR
FARM
1st STAGE
2nd STAGE
EXPERIMENTAL
BEAMLINES
LASER
PHOTOCATHODE
GUN
COMPRESSION
20 GeV, 2 kM
SUPERCONDUCTING LINAC
POSSIBLE
LOWER ENERGY
FEL

Compact sources



Types of X-ray Detectors

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Gas detectors

Types of X-ray Detectors

Gas detectors

Scintillation counters

Types of X-ray Detectors

Gas detectors

Scintillation counters
Solid state detectors

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Solid state detectors

Charge coupled device detectors

Types of X-ray Detectors

Gas detectors

- Ionization chamber

Scintillation counters
Solid state detectors

Charge coupled device detectors

Types of X-ray Detectors

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Scintillation counters
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Solid state detectors

- Intrinsic semiconductor

Charge coupled device detectors

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Scintillation counters

Solid state detectors

- Intrinsic semiconductor
- P-I-N junction

Charge coupled device detectors

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- Ionization chamber
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Solid state detectors

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Charge coupled device detectors

- Indirect

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Scintillation counters

Solid state detectors

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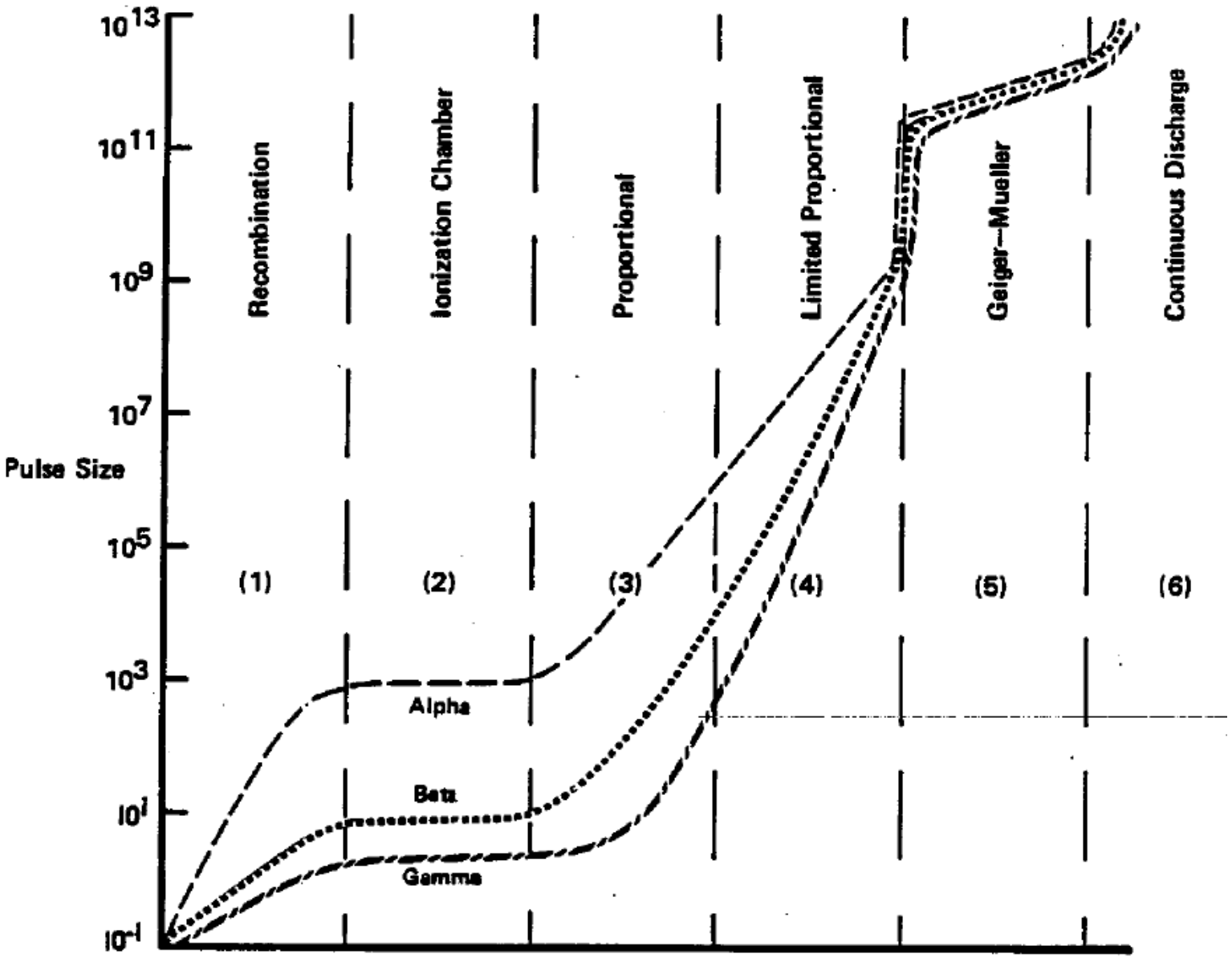
Charge coupled device detectors

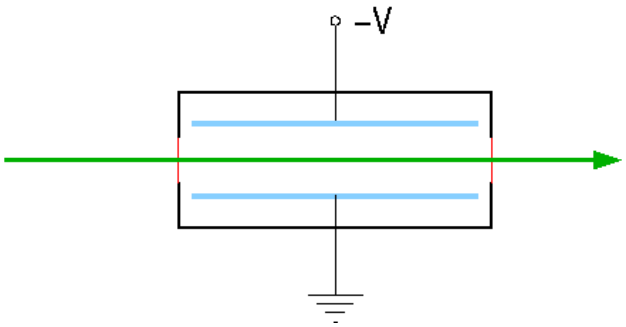
- Indirect
- Direct coupled

Gas Detector Curve



Ionization Chamber

Useful for beam monitoring, flux measurement, fluorescence measurement, spectroscopy.



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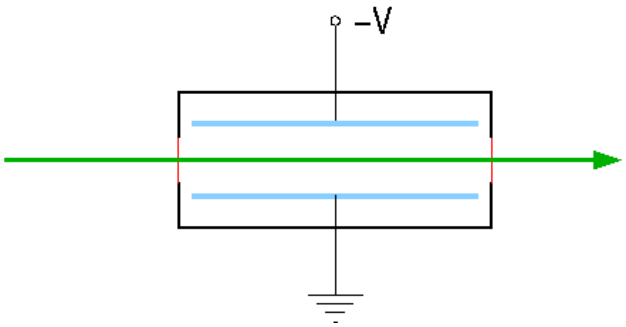

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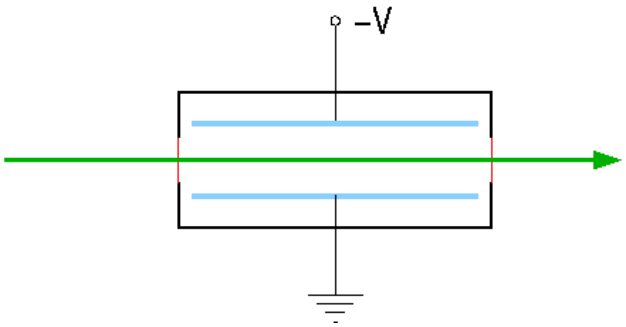

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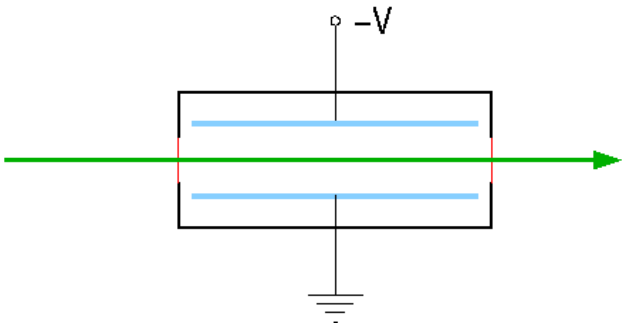

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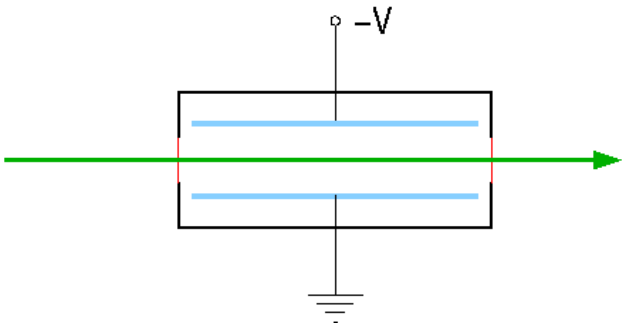

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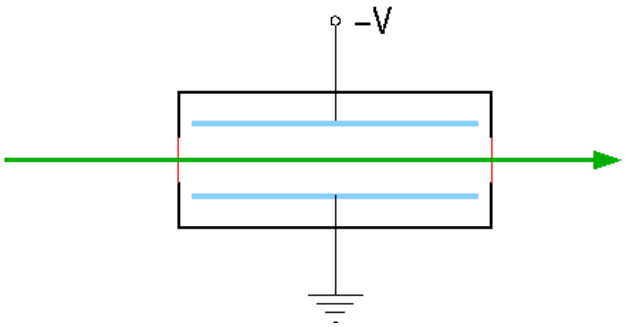

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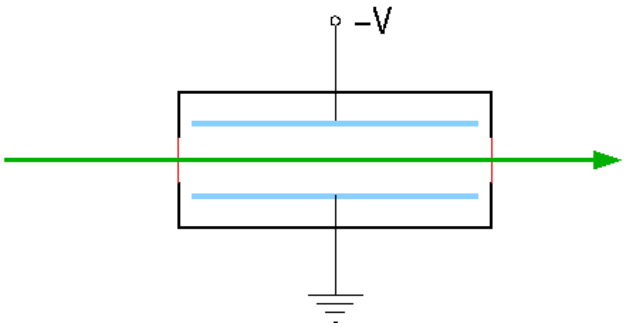

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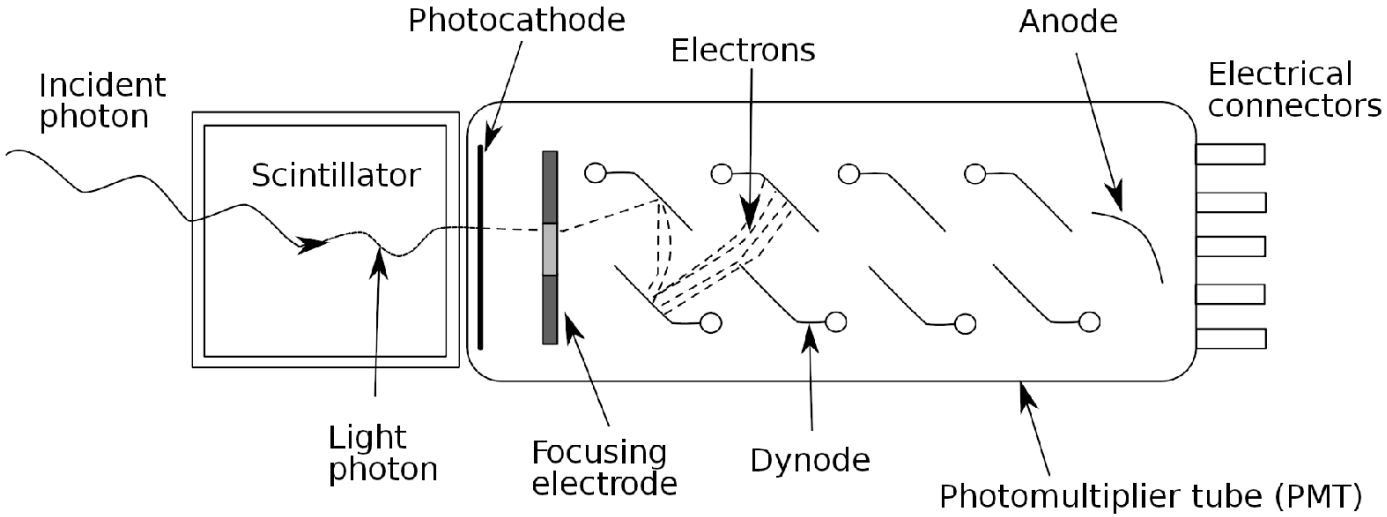
- 22-41 eV per electron-hole pair (depending on the gas) makes this useful for quantitative measurements.

Scintillation Counter

Useful for photon counting experiments



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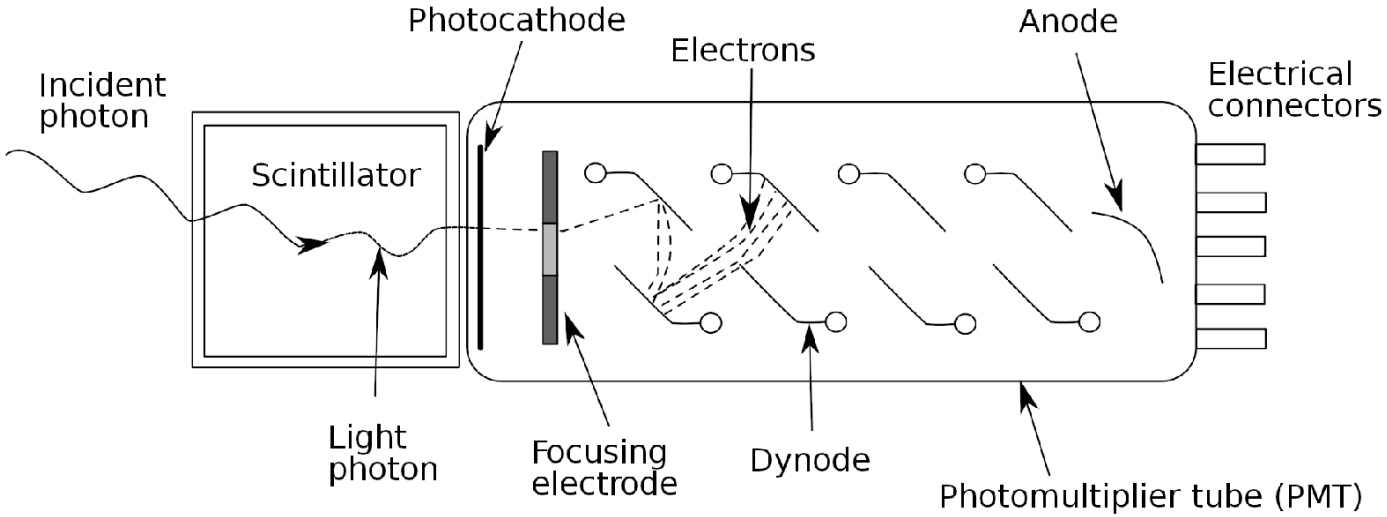

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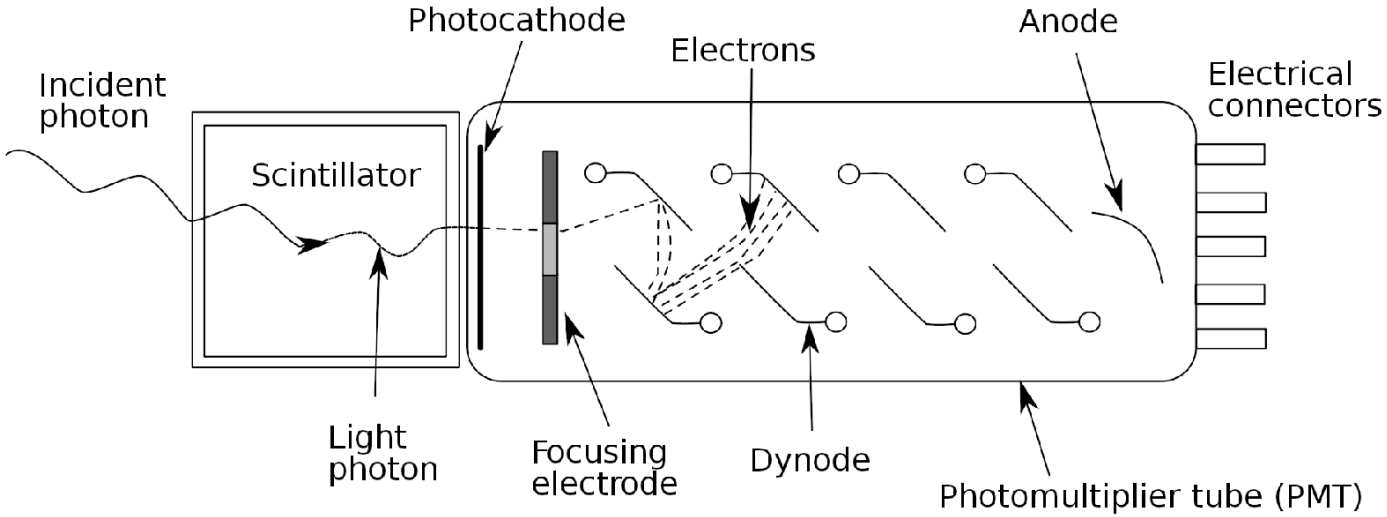

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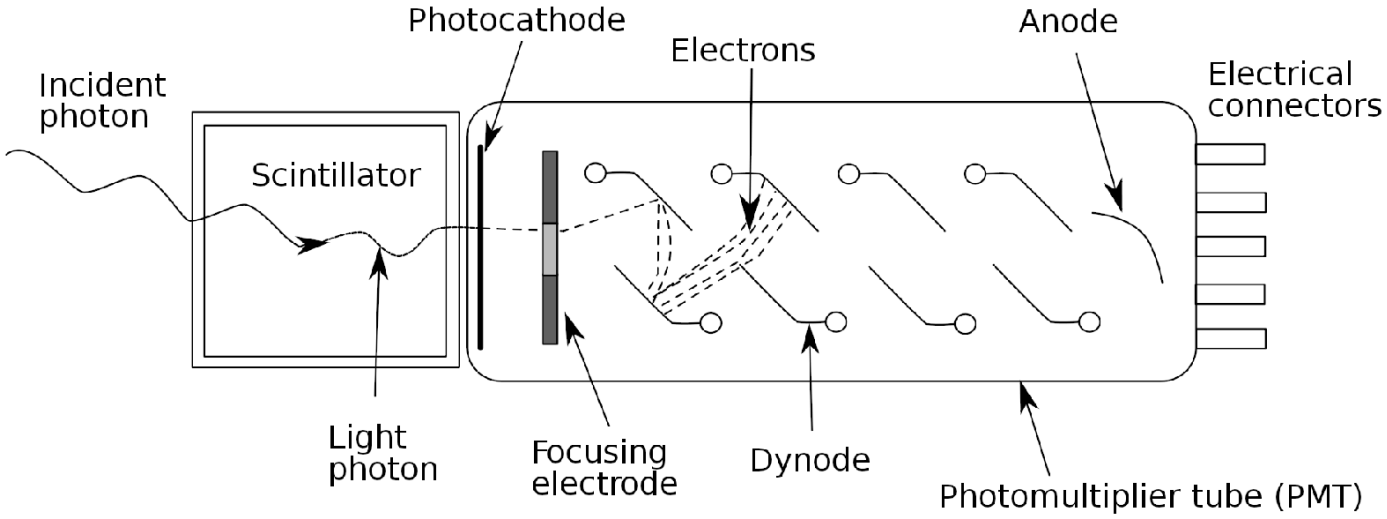

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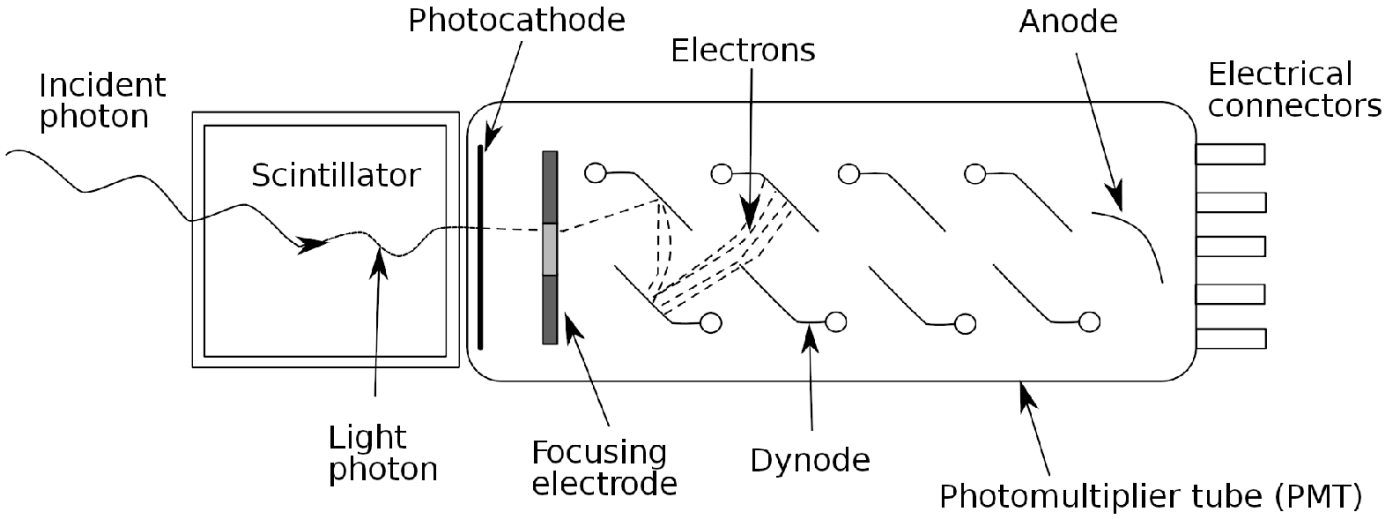

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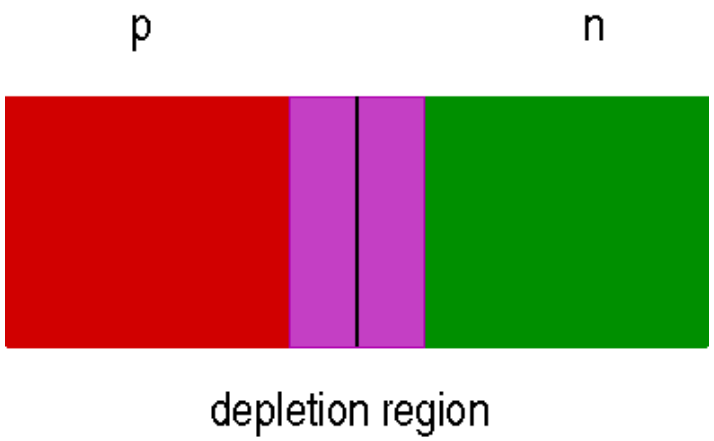
- Output voltage pulse is proportional to initial x-ray energy.

Solid State Detectors

Open circuit p-n junction has a natural depletion region



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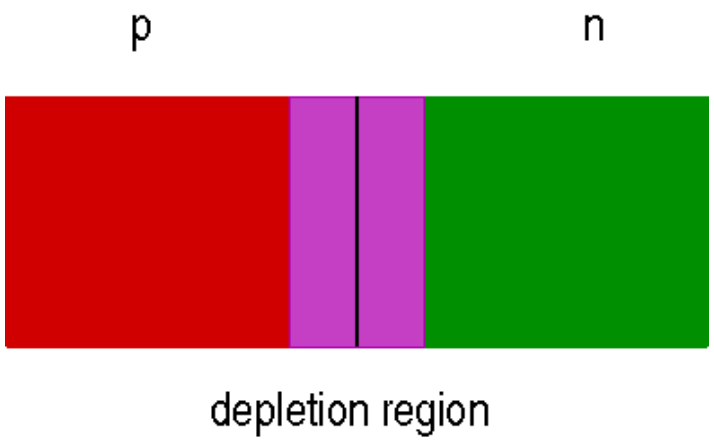

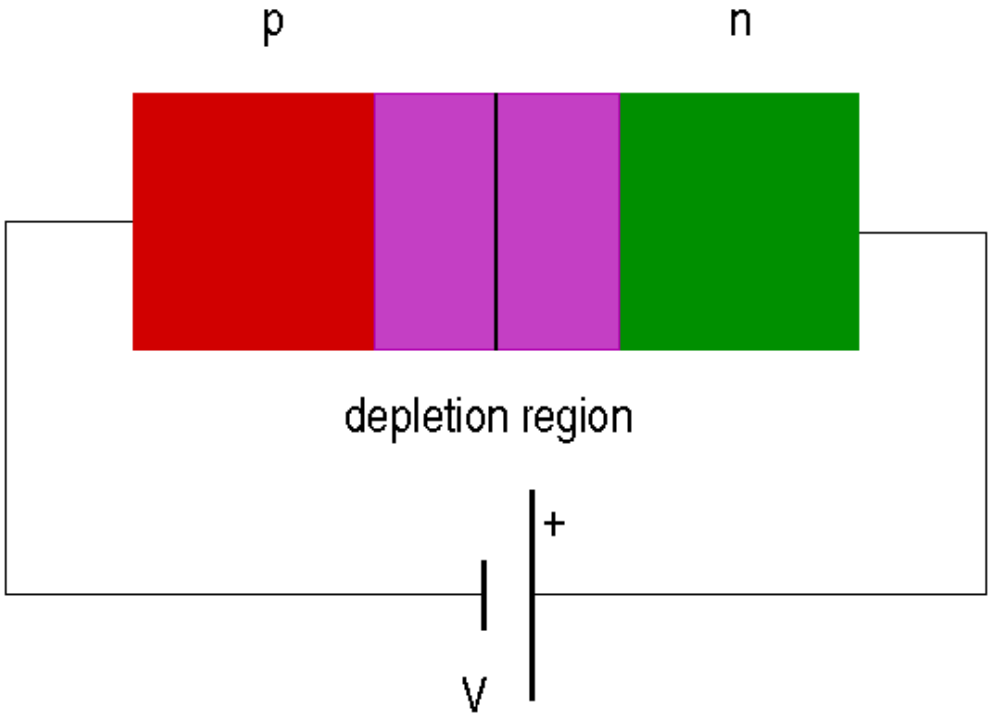

When reverse biased, the depletion region grows

Solid State Detectors

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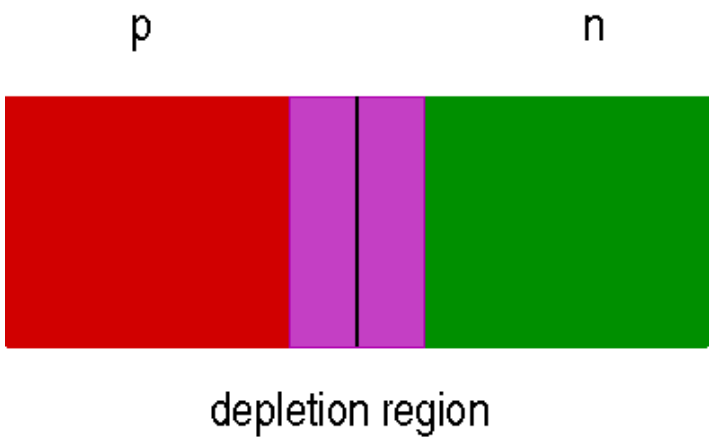
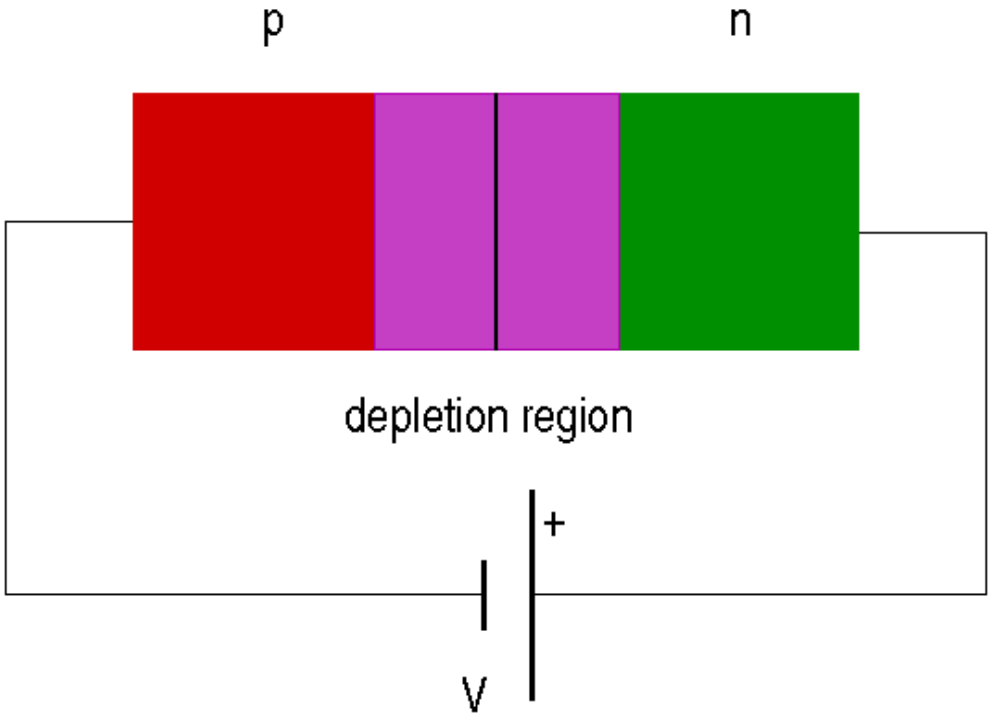
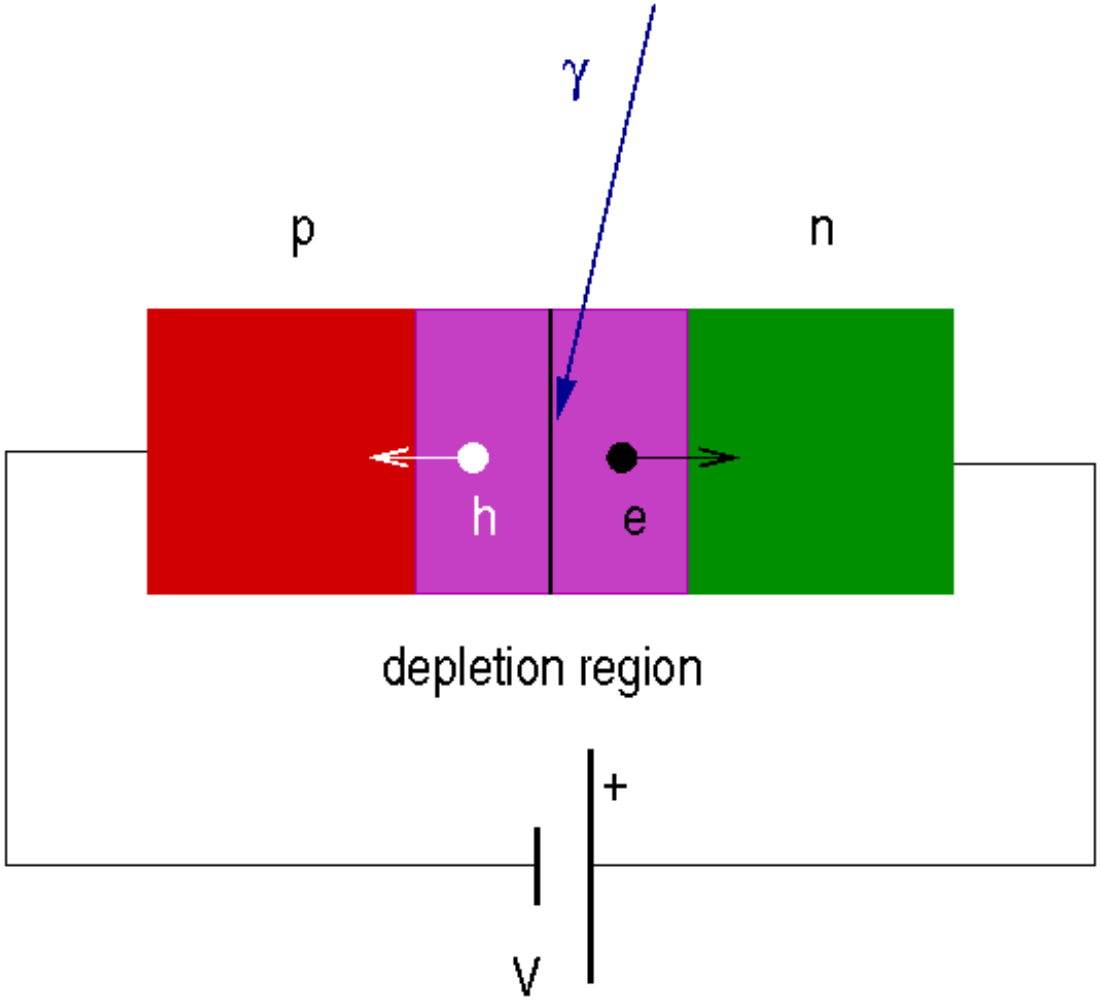




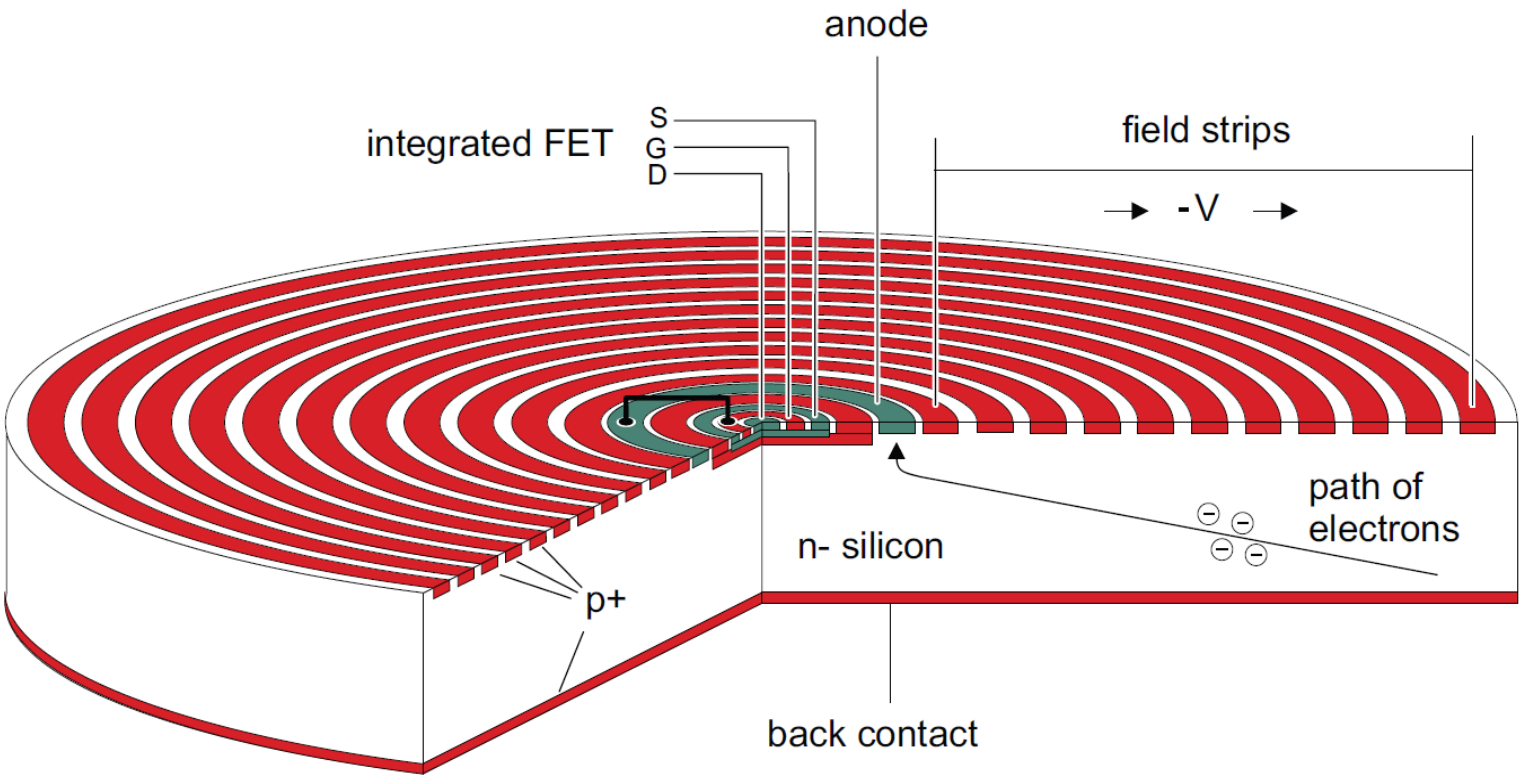
When reverse biased, the depletion region grows creating a higher electric field near the junction

Ge Detector Operation



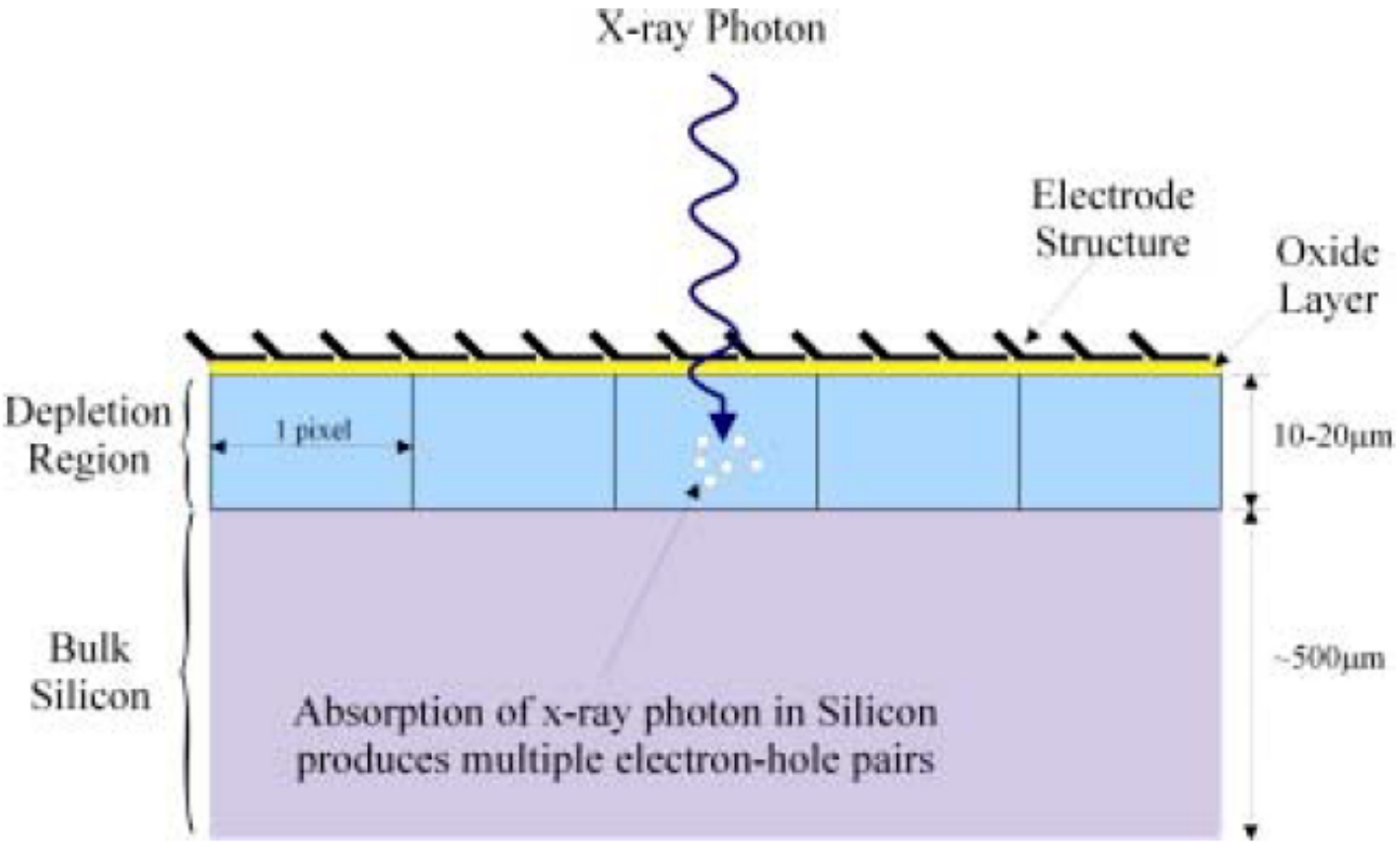
Silicon Drift Detector

Same principle as intrinsic or p-i-n detector but much more compact and operates at higher temperatures

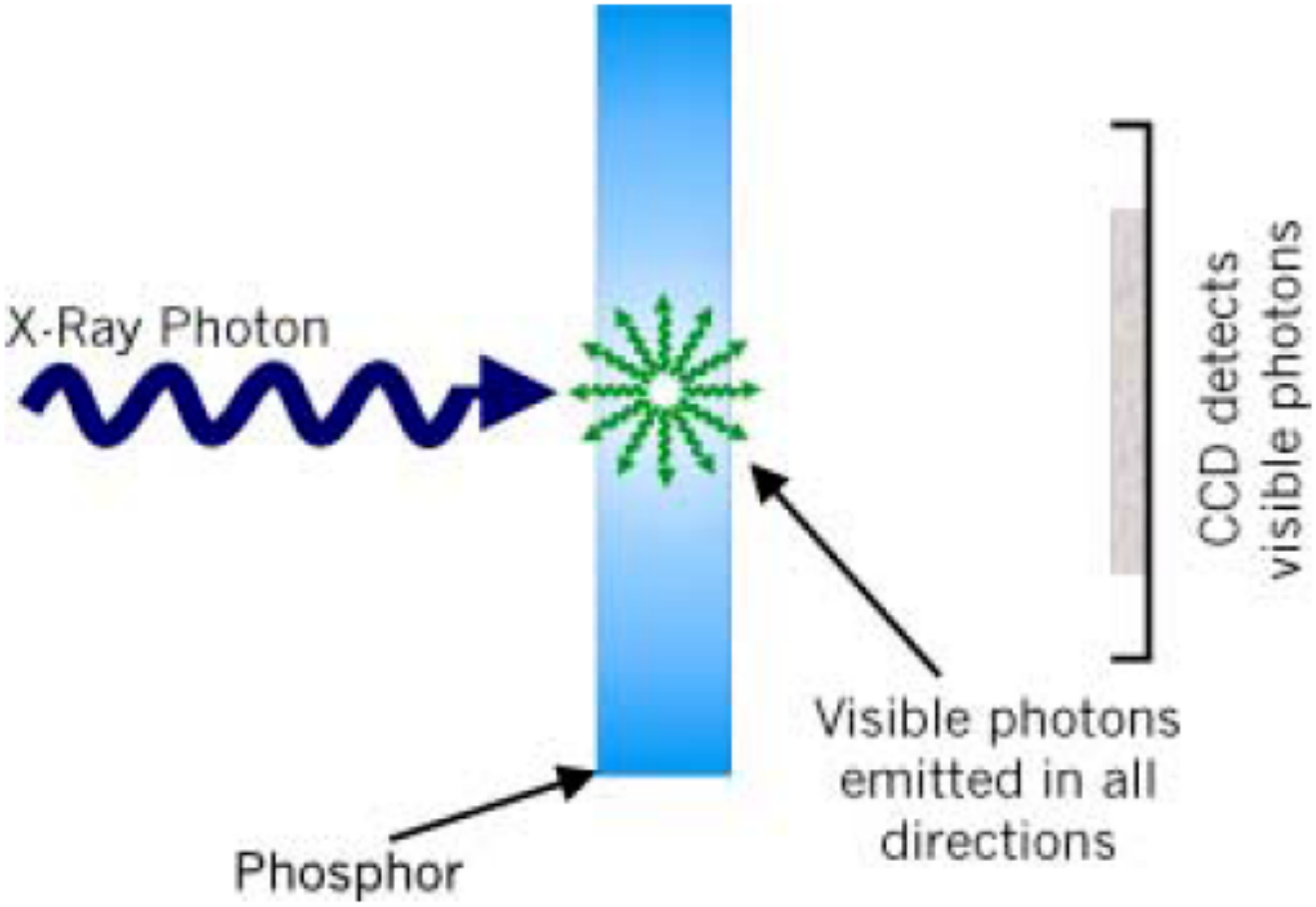


Relatively low stopping power is a drawback

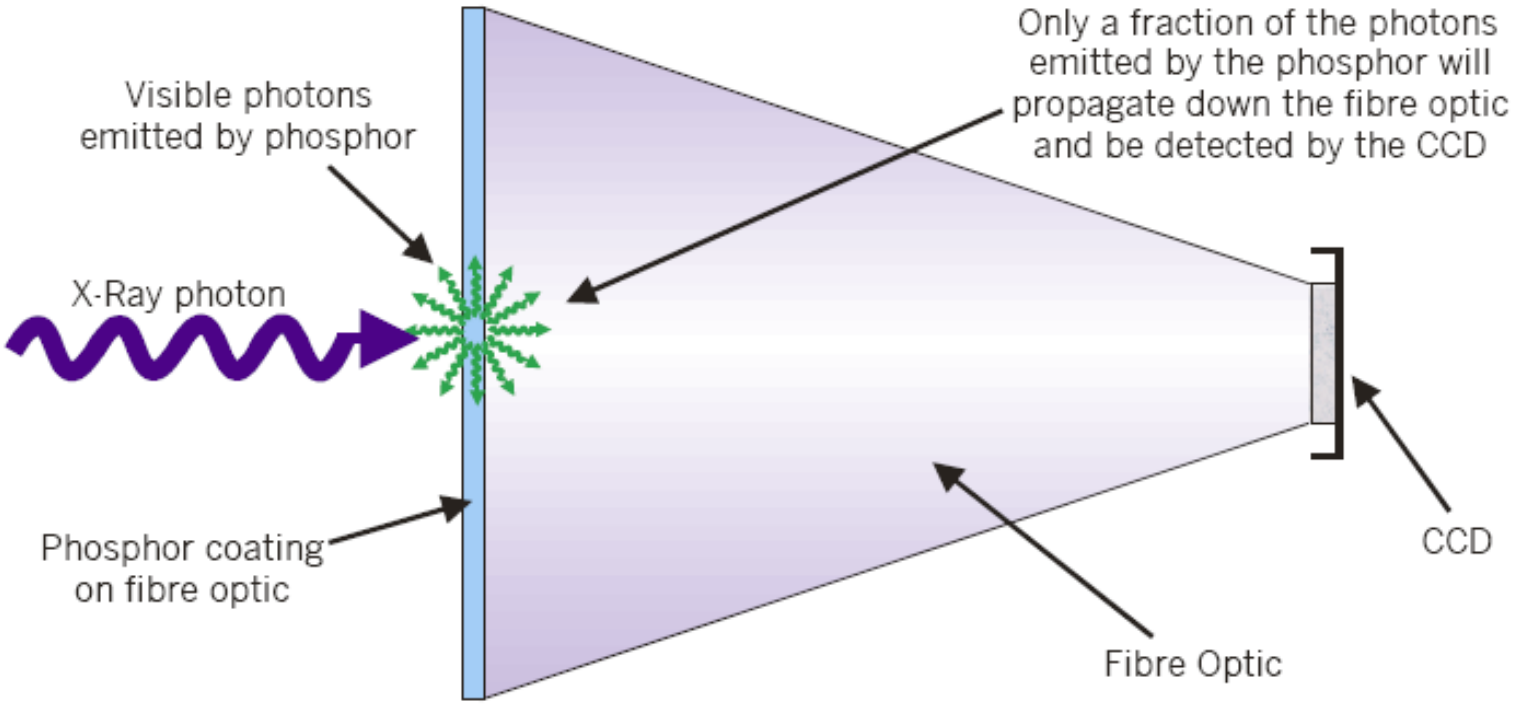
CCD detectors - direct



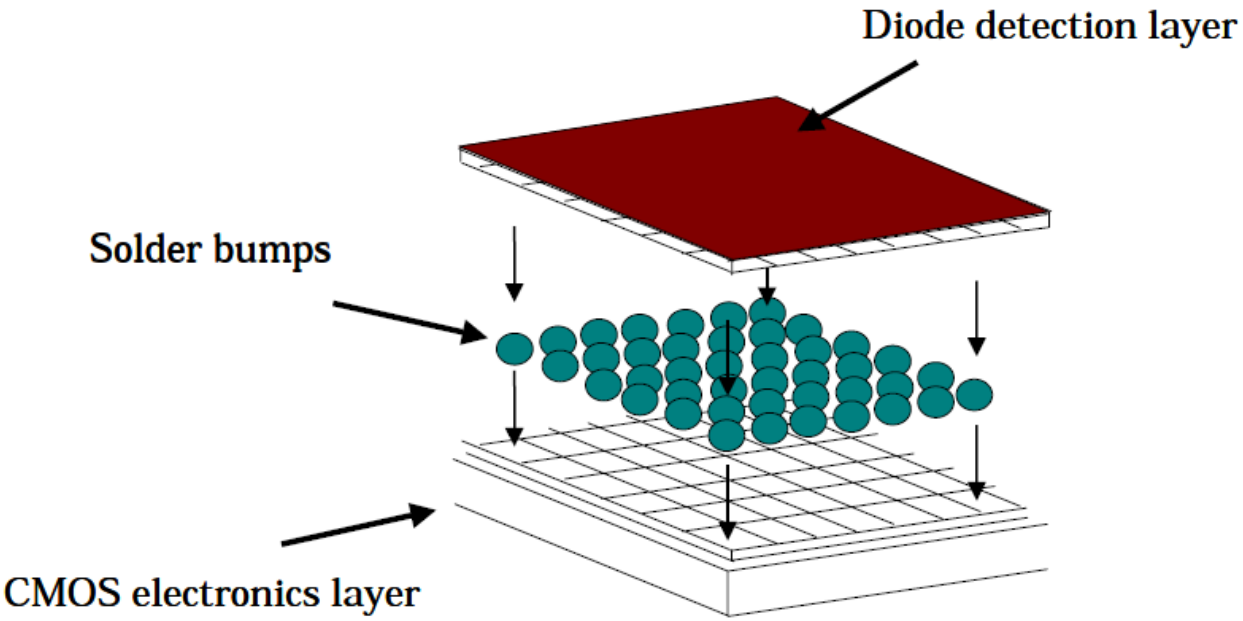
CCD detectors - indirect



CCD detectors - lightpipe taper



Pixel Array Detectors - schematic



Pixel Array Detectors - Pilatus

Pixel array detector with 1,000,000 pixels.

Each pixel has energy resolving capabilities & high speed readout.

Silicon sensor limits energy range of operation.

from Swiss Light Source

Pixel Array Detectors - high energy solutions