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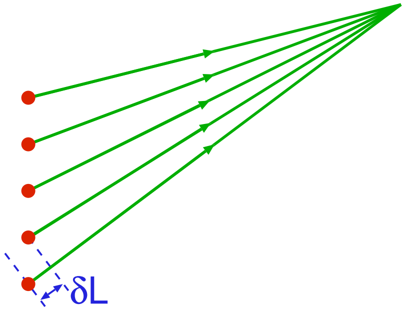

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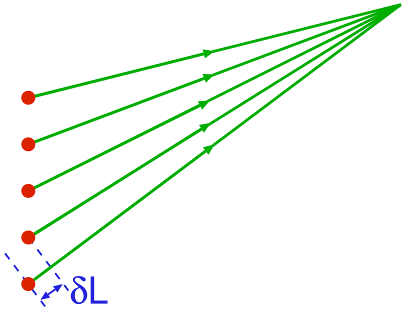

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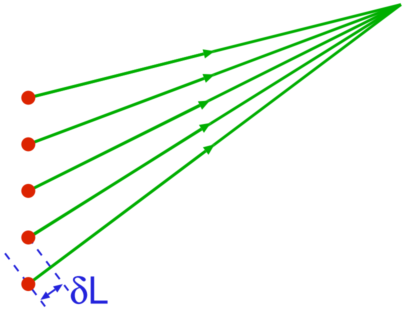

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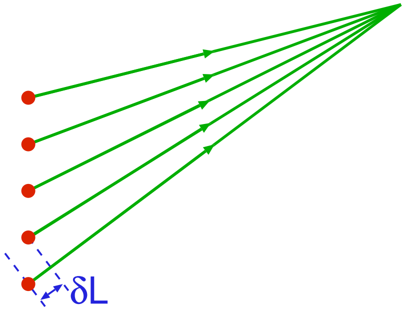

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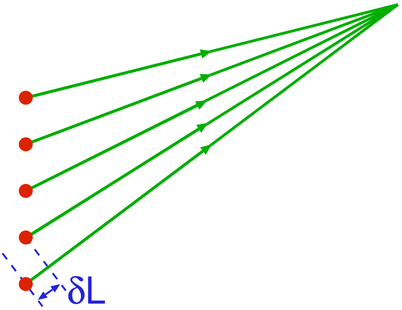

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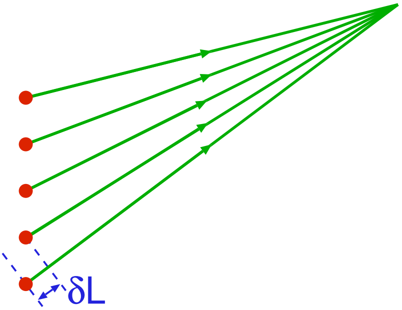

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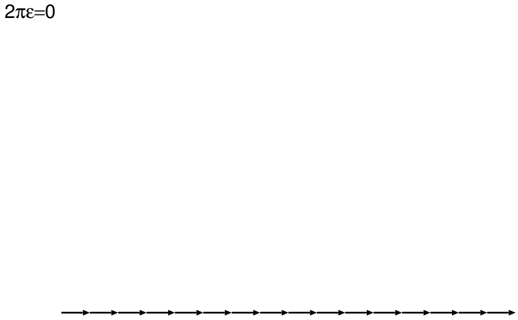

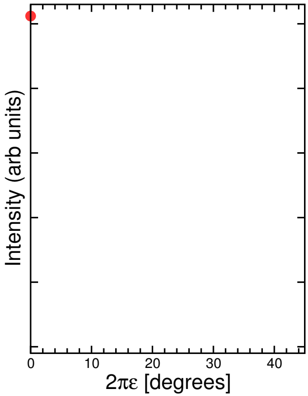

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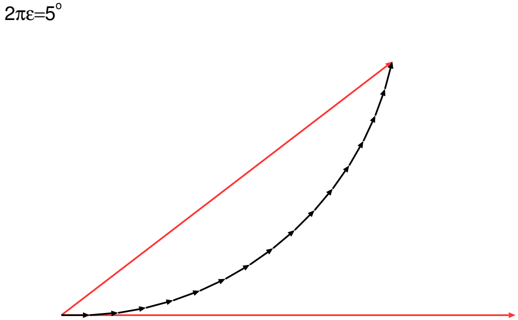

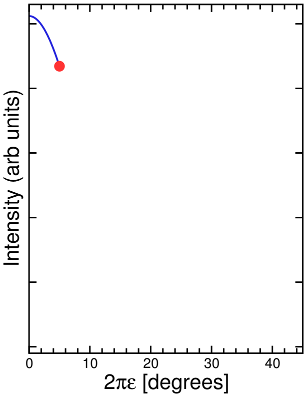

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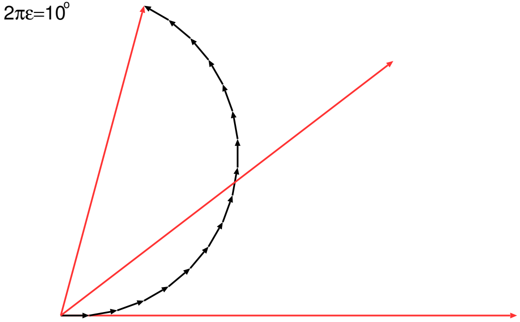

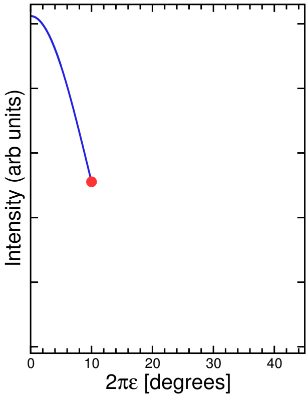

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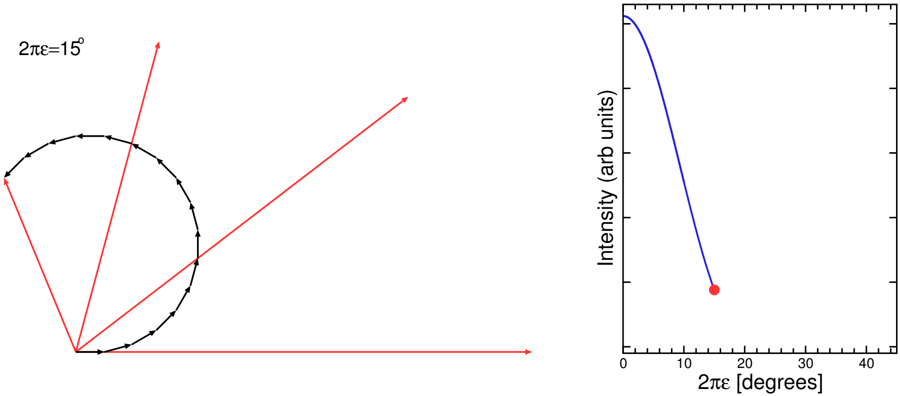

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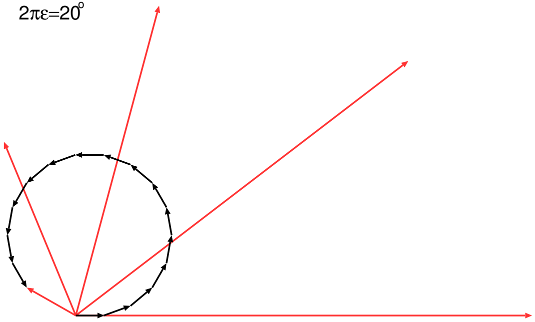

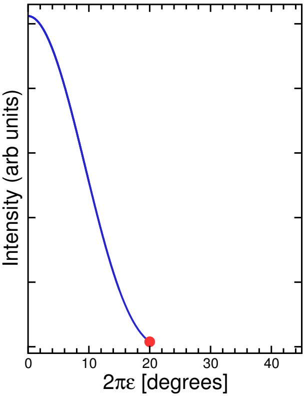

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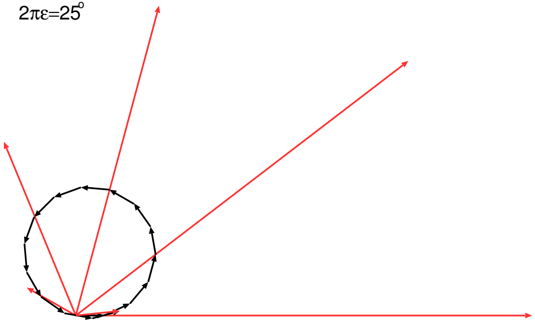

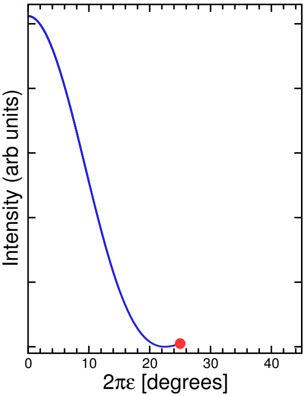

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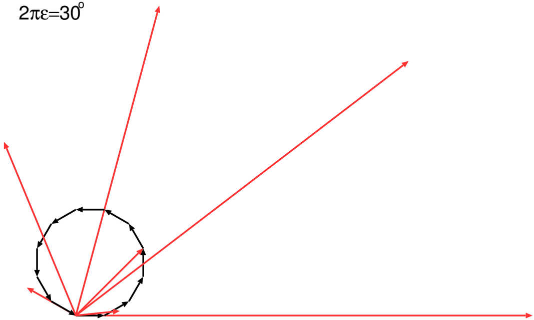

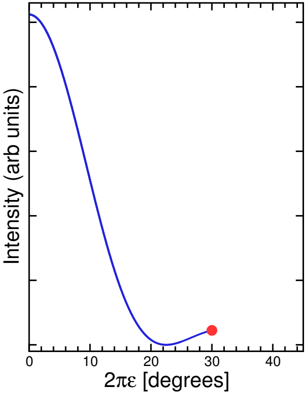

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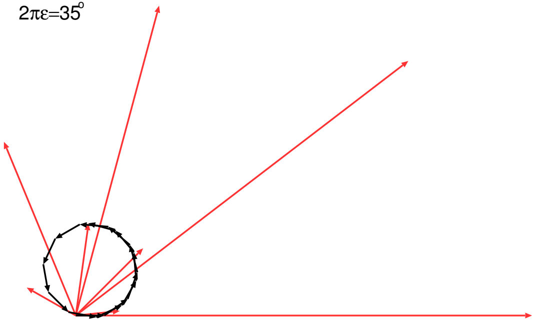

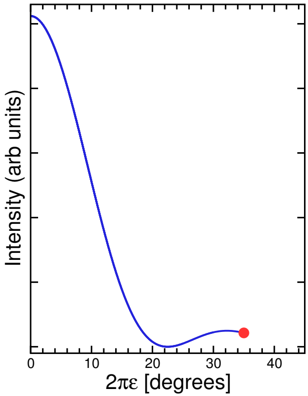

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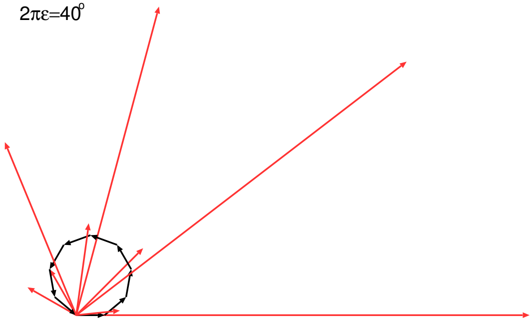

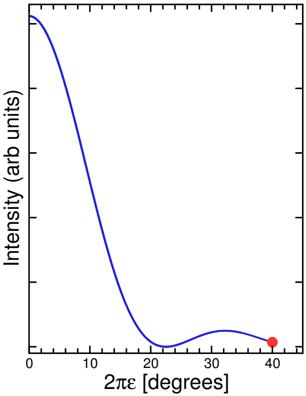

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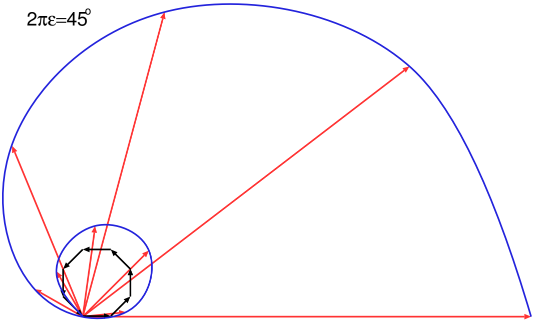

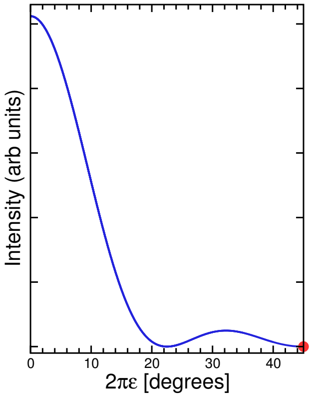

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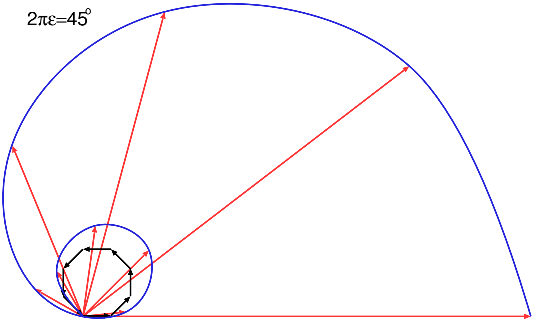
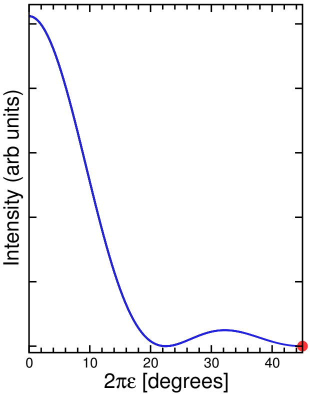
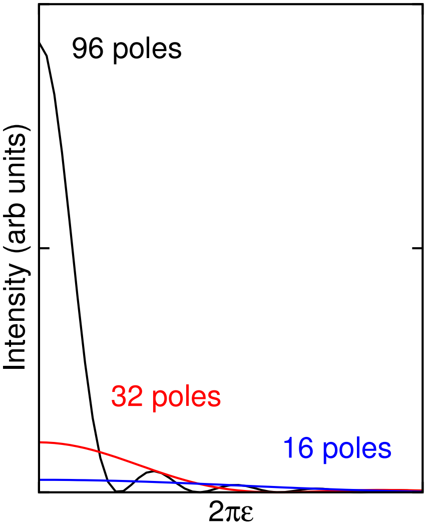




With the height and width of the peak dependent on the number of poles.

Undulator Coherence



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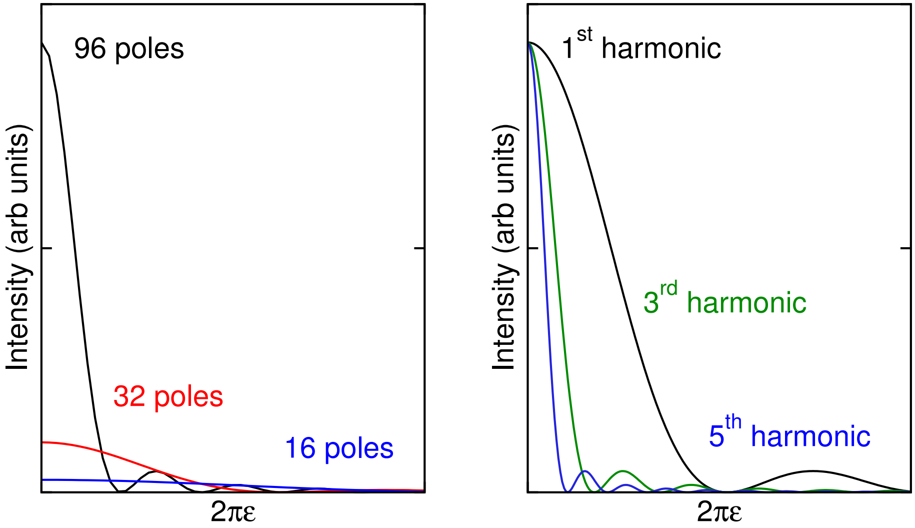

APS Parameters

Table 1: APS SR Beam Stability Requirement Evolution

Parameter	Units	RMS Beam Size and ***stability requirement*** (5 % of beam dimensions) at IDs in year 1995	2001	2005
σ_x ***x***	μm	334 ***16.7***	352 ***17.6***	280 ***14***
$\sigma_{x'}$ ***x'***	μrad	24 ***1.2***	22 ***1.1***	11.6 ***0.58***
σ_y ***y***	μm	89 ***4.45***	18.4 ***0.92***	9.1 ***0.45***
$\sigma_{y'}$ ***y'***	μrad	8.9 ***0.45***	4.2 ***0.21***	3.0 ***0.15***
ε_{eff}	nm-rad	8	7.7	3.2
Coupling	%	10.0	1.0	0.9

APS Emittance

For photon emission from a single electron in a 2m undulator at 1Å

$$\sigma_\gamma = \frac{\sqrt{L\lambda}}{4\pi} = 1.3\mu m \qquad \sigma'_\gamma = \sqrt{\frac{\lambda}{L}} = 7.1\mu rad$$

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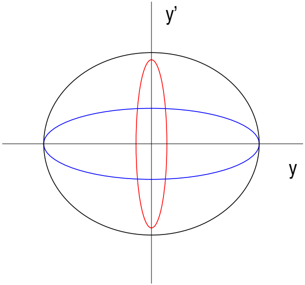

The current APS parameters are

$$\sigma_y = 9.1\mu m \qquad \sigma'_y = 3.0\mu rad$$

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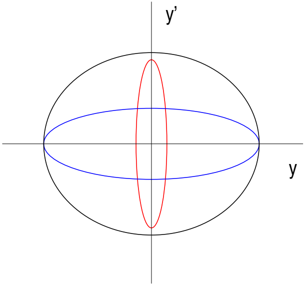

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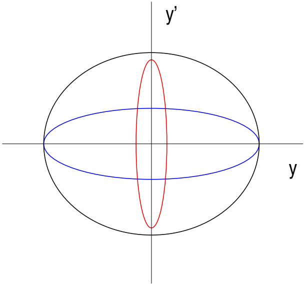

The current APS parameters are

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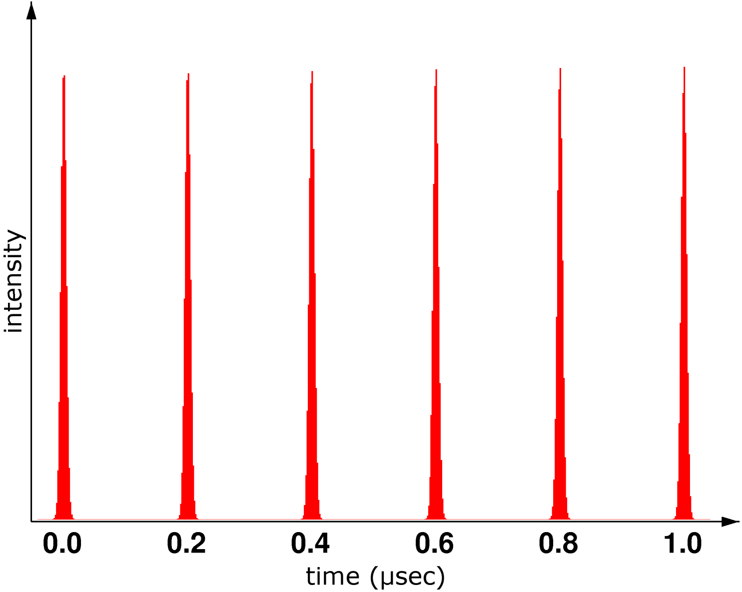
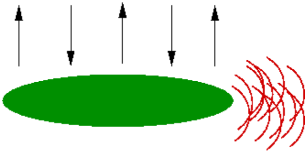
must convolute to get photon emission from entire beam (in vertical direction)

$$\sigma_{radiation} = 9.1\mu m \qquad \sigma'_{radiation} = 7.7\mu rad$$

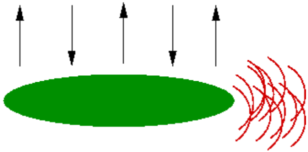
Synchrotron Time Structure



Free Electron Laser

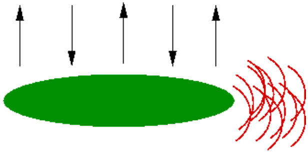


Free Electron Laser



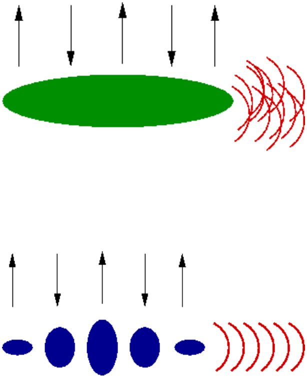
- Initial electron cloud, each electron emits coherently but independently

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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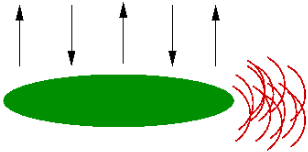

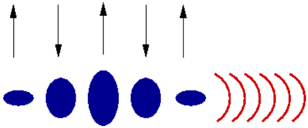

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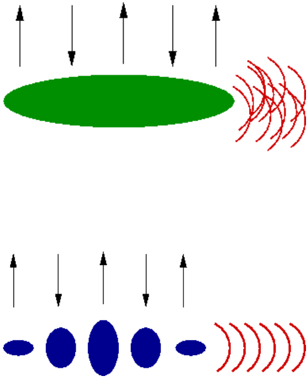
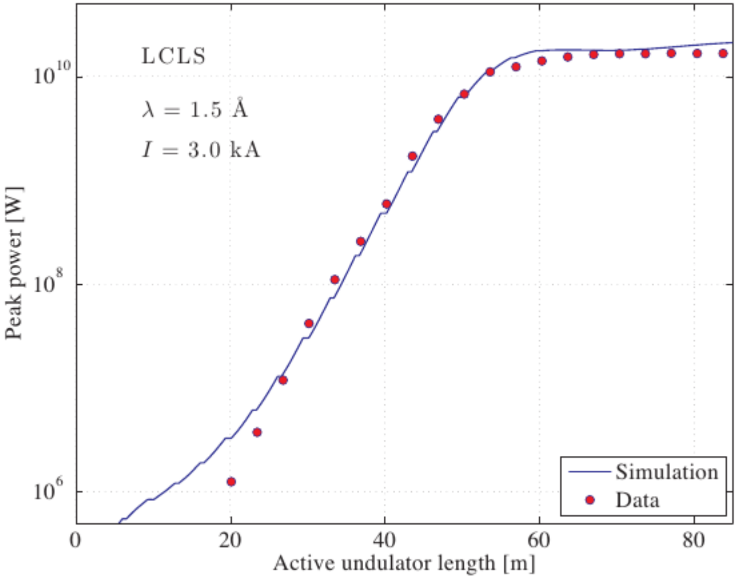
- Microbunches form with period of FEL (and radiation in electron frame)

Free Electron Laser

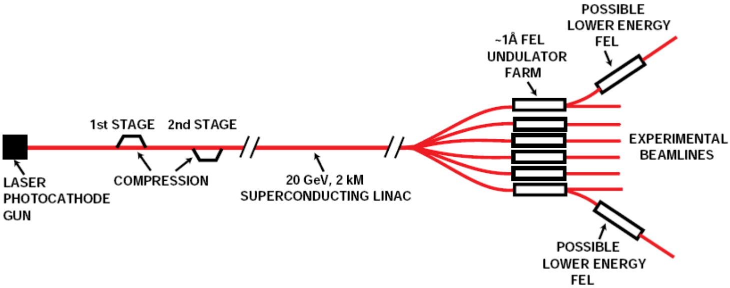


- Initial electron cloud, each electron emits coherently but independently
- Over course of 100 m, electric field of photons, feeds back on electron bunch
- Microbunches form with period of FEL (and radiation in electron frame)
- Each microbunch emits coherently with neighboring ones

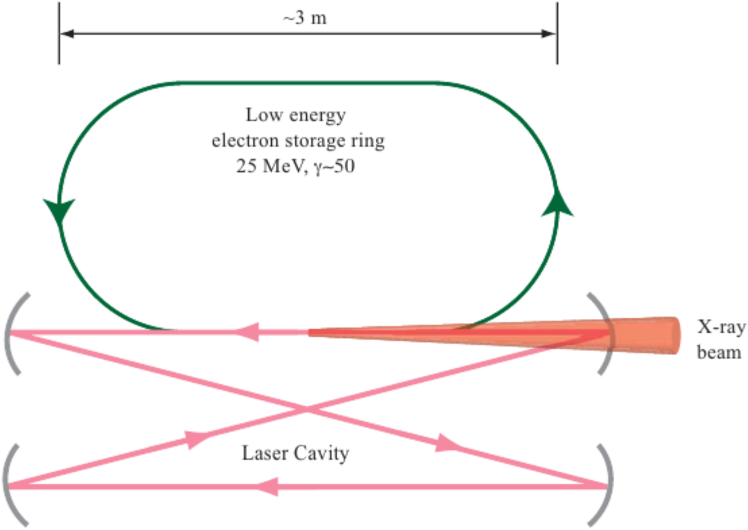
FEL Emission



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

Types of X-ray Detectors

Gas detectors

Scintillation counters
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

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Scintillation counters
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Charge coupled device detectors

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Scintillation counters
Solid state detectors

Charge coupled device detectors

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Scintillation counters

Solid state detectors

- Intrinsic semiconductor

Charge coupled device detectors

Types of X-ray Detectors

Gas detectors

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Scintillation counters

Solid state detectors

- Intrinsic semiconductor
- P-I-N junction

Charge coupled device detectors

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Gas detectors

- Ionization chamber
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Scintillation counters

Solid state detectors

- Intrinsic semiconductor
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Charge coupled device detectors

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Scintillation counters

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Charge coupled device detectors

- Indirect

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Scintillation counters

Solid state detectors

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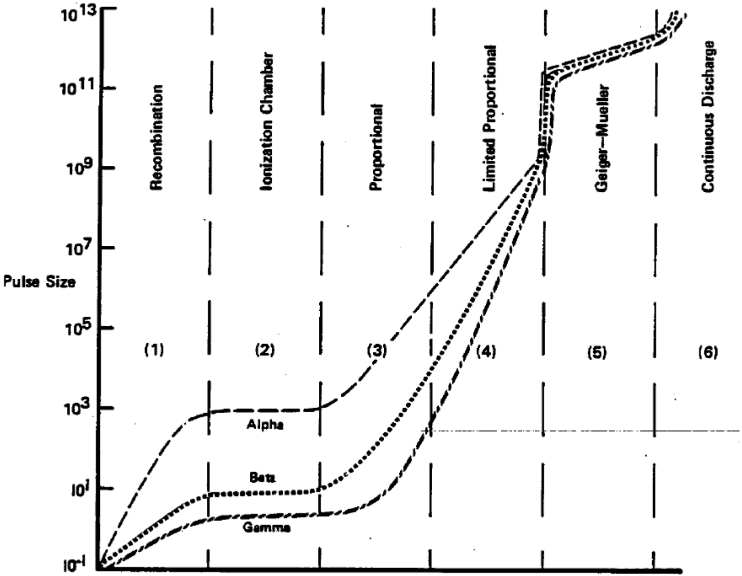
Charge coupled device detectors

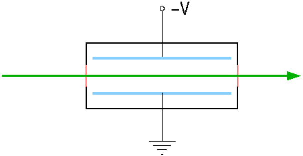
- Indirect
- Direct coupled

Gas Detector Curve



Ionization Chamber

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



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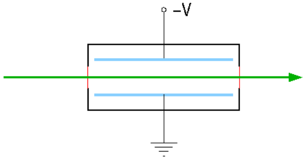

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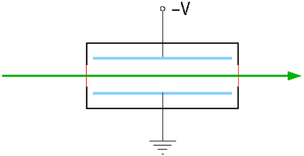

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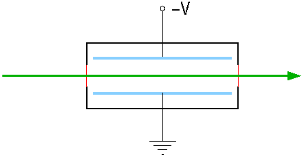

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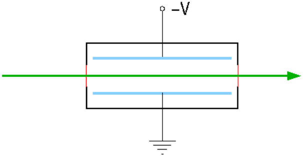

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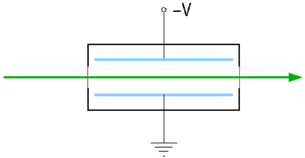

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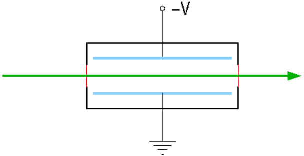

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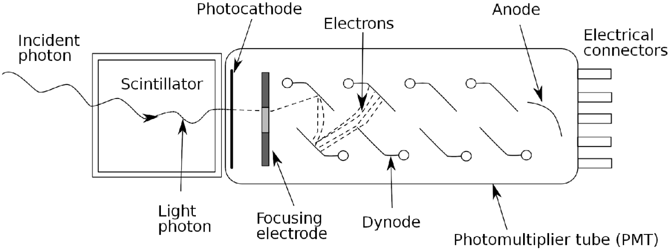
- Count rates up to 10^{11} photons/s/cm^3
- 22-41 eV per electron-hole pair (depending on the gas) makes this useful for quantitative measurements.

Scintillation Counter

Useful for photon counting experiments



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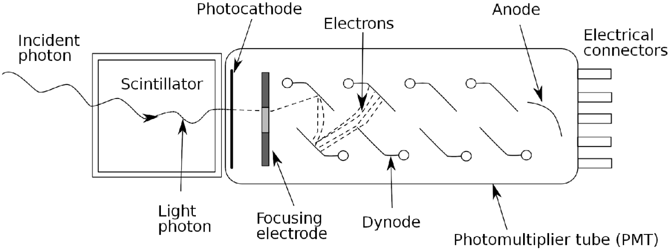

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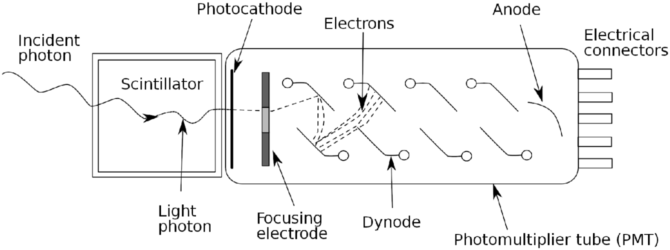

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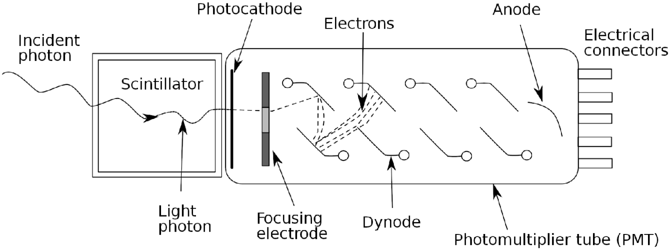

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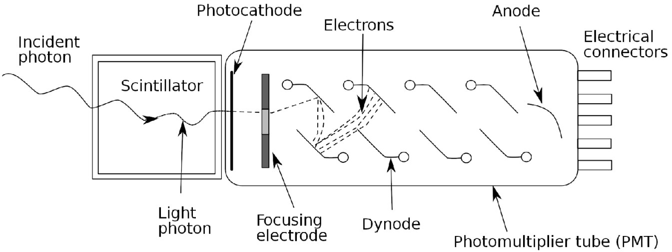

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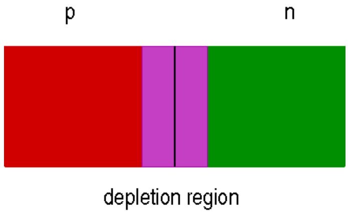
- Output voltage pulse is proportional to initial x-ray energy.

Solid State Detectors

Open circuit p-n junction has a natural depletion region



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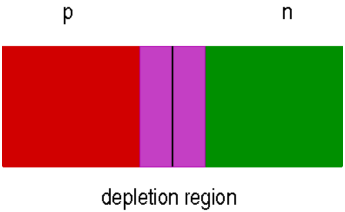

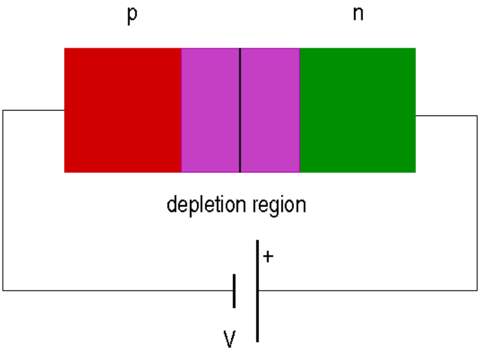

When reverse biased, the depletion region grows

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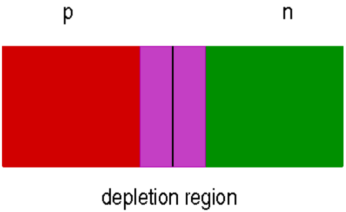
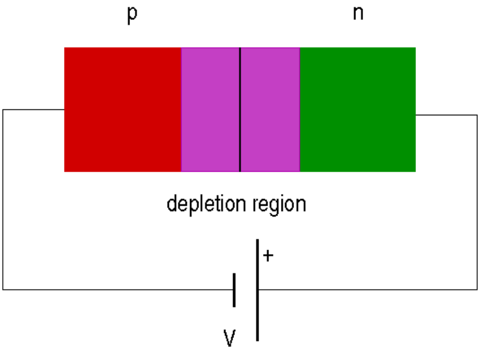
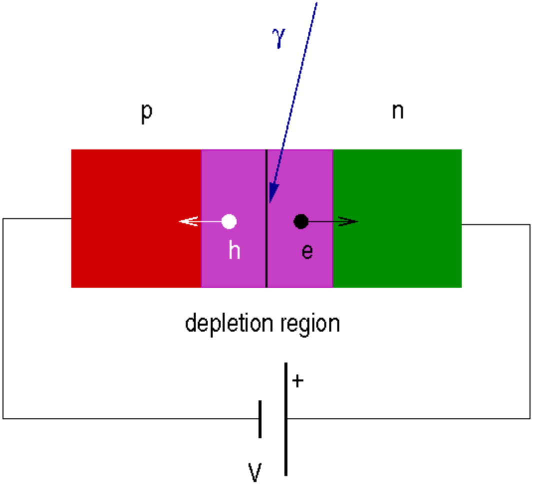




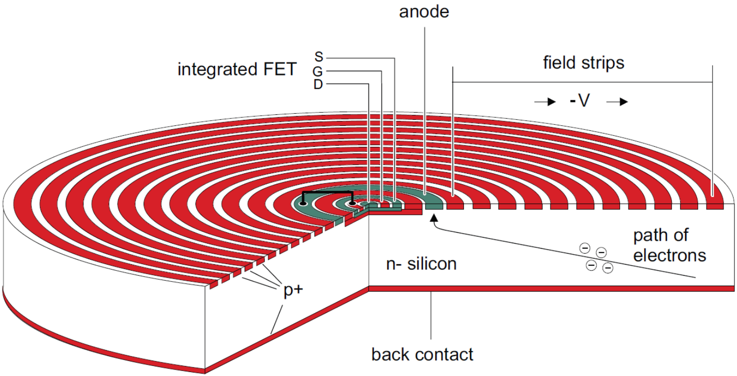
When reverse biased, the depletion region grows creating a higher electric field near the junction

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