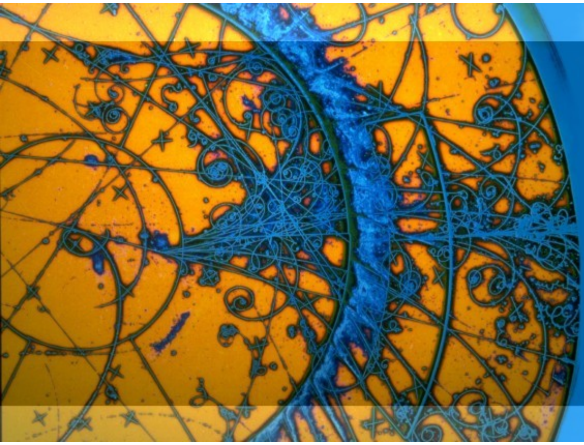
HUGS 2006 Presentation



GlueX Photon Beam Preparation

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Topics

1. Motivations for GlueX and use of photons as probes
2. Photon beam requirements (selections)
3. Review of the photon beam line
4. Details on Coherent Bremsstrahlung (CB)
    i. CB Process
    ii. Resulting spectral, angular and polarization distributions
    iii. Isolation of desired photons, consequences and compromises

Photon Beam Requirements

Parameter	Motivation	Design Decision
Energy	enough to efficiently create and detect mesons up to 3 GeV	~9 GeV
Linear Polarization	• eigenstate of parity (conserved in strong int.) • prepares a definite state	~40%

Photon as Probe

Review of Experimental Goals

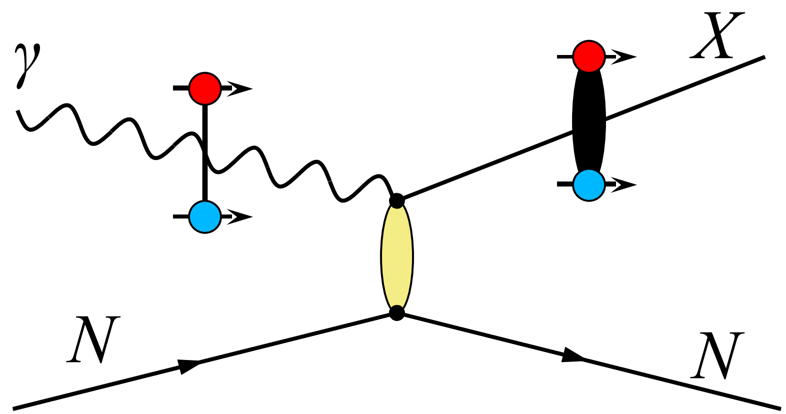
- GlueX is searching for exotic quantum numbers J^{PC} – evidence of contribution from gluon flux tube excitations.
- working out the quantum numbers: exotic states occur for S=1
- photon can be thought of as [producing] a meson with spin-aligned quarks
- other probes, e.g. pion would require a spin flip of one of the quarks leading to suppression exotic states!

Review of Notation:

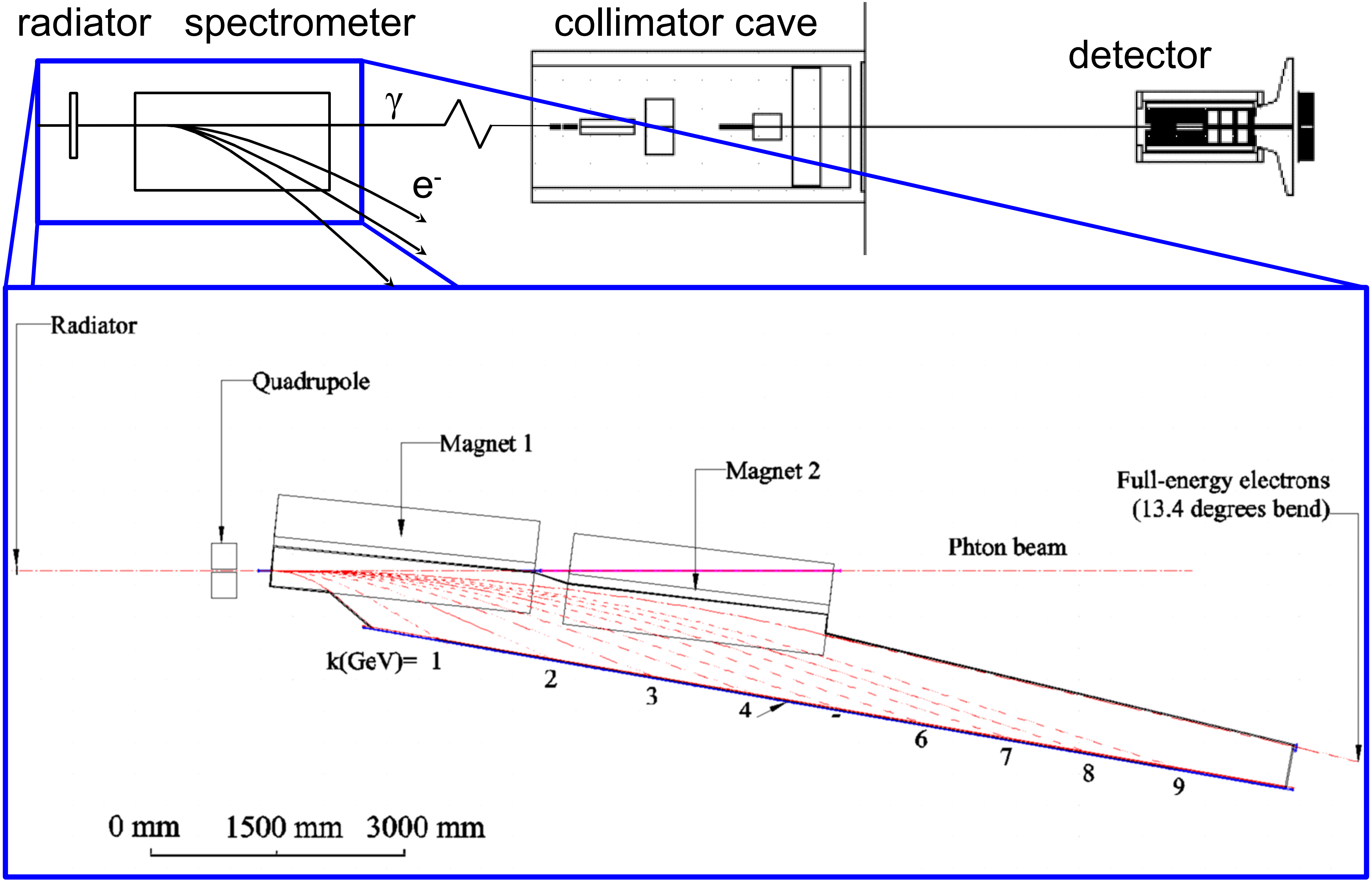
$$\vec{J} = \vec{L} + \vec{S}$$

$$P = (-1)^{L+1}$$

$$C = (-1)^{L+S}$$



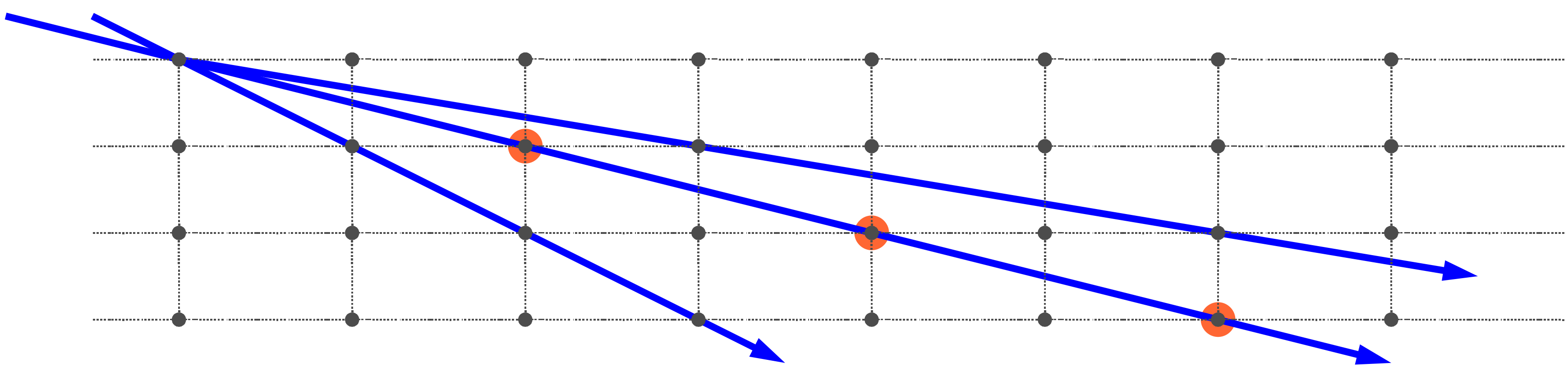
Photon Beam Line



Coherent Bremsstrahlung (CB)

An electron beam is sent through a thin wafer of a nearly ideal diamond crystal (“radiator”)

Goal: Arrange the electron energy and the spacial frequency of lattice sites along its path such that the radiated photons superpose coherently.

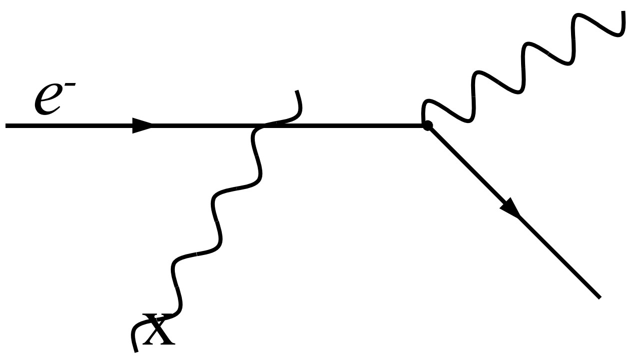


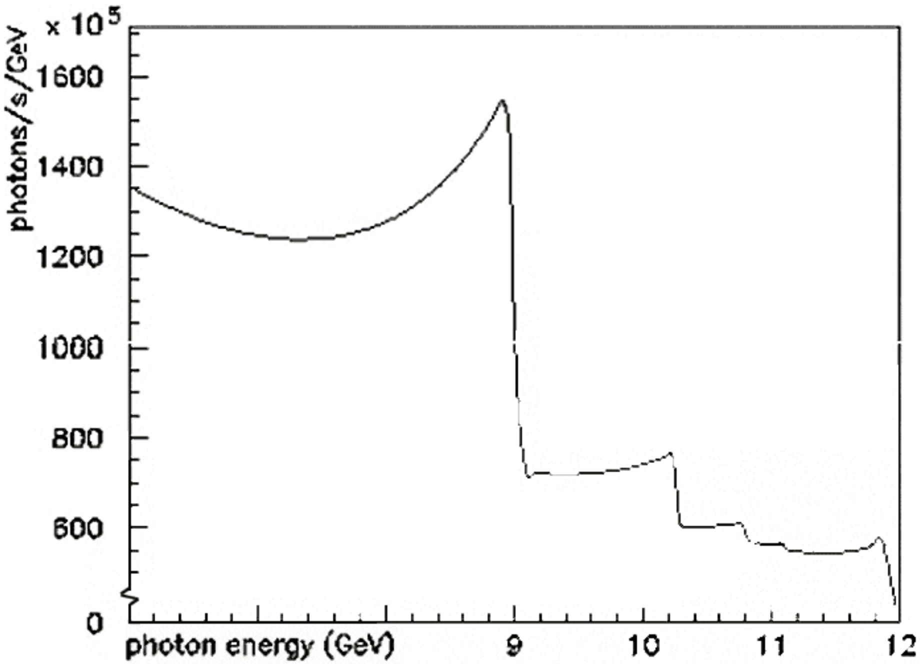
Coherent Bremsstrahlung (CB)

In Particle Physics Language:

We can think of CB as Compton scattering from *virtual* photons.
The points (frequencies) of the inverse lattice → modes of the photons

By appropriately orienting the crystal, we select a set of modes accessible to the electron from which to Compton-scatter.





CB: Maintaining Polarization

Polarization

$E_\gamma / E_{e^-} \to 1 \quad \Rightarrow \quad \psi \to 0 \quad \Rightarrow$ no distinct polarization plane is defined.

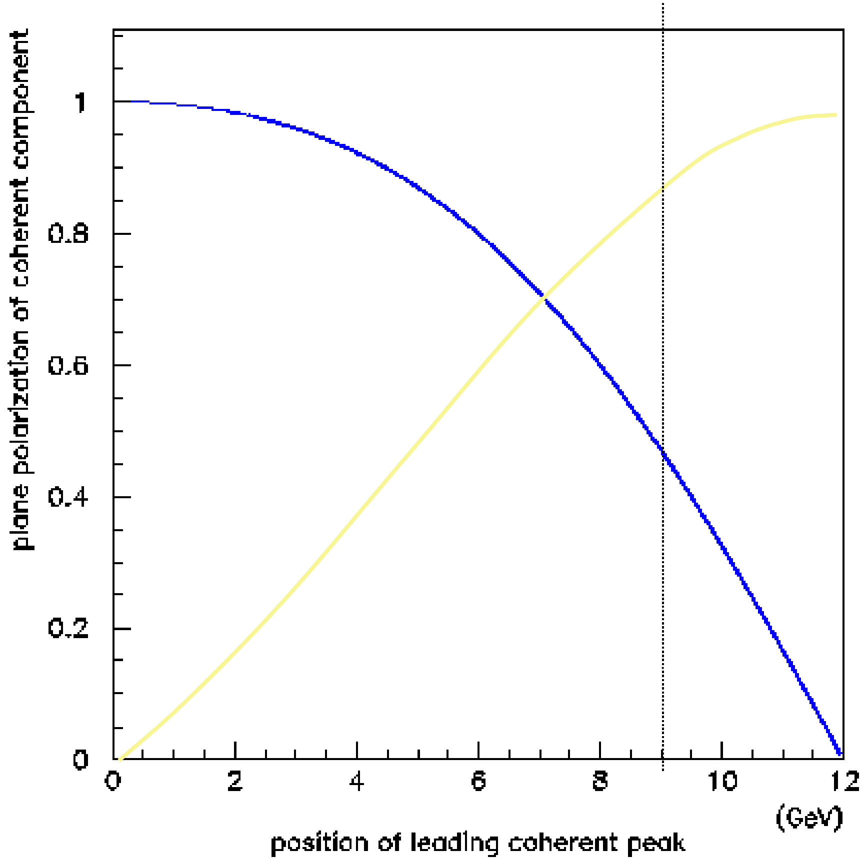
Full 12GeV photons cannot be used!

↓

Use the next most optimal peak in the spectrum

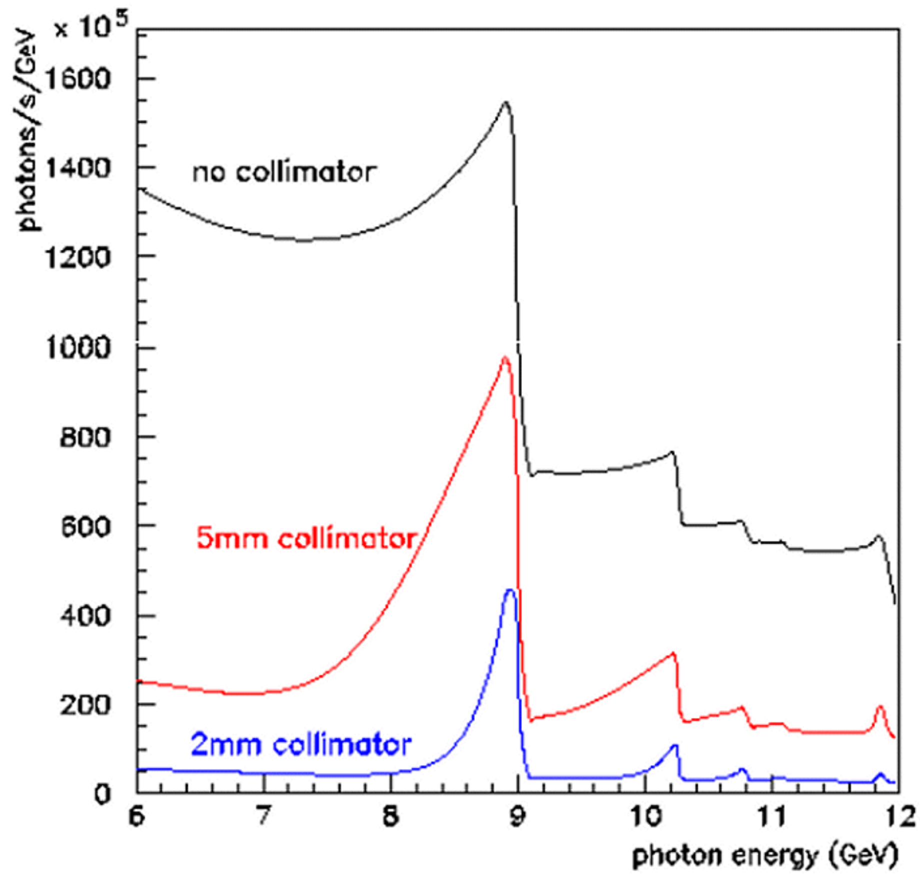
↓

Our choice: peak in range 8.4 - 9 GeV



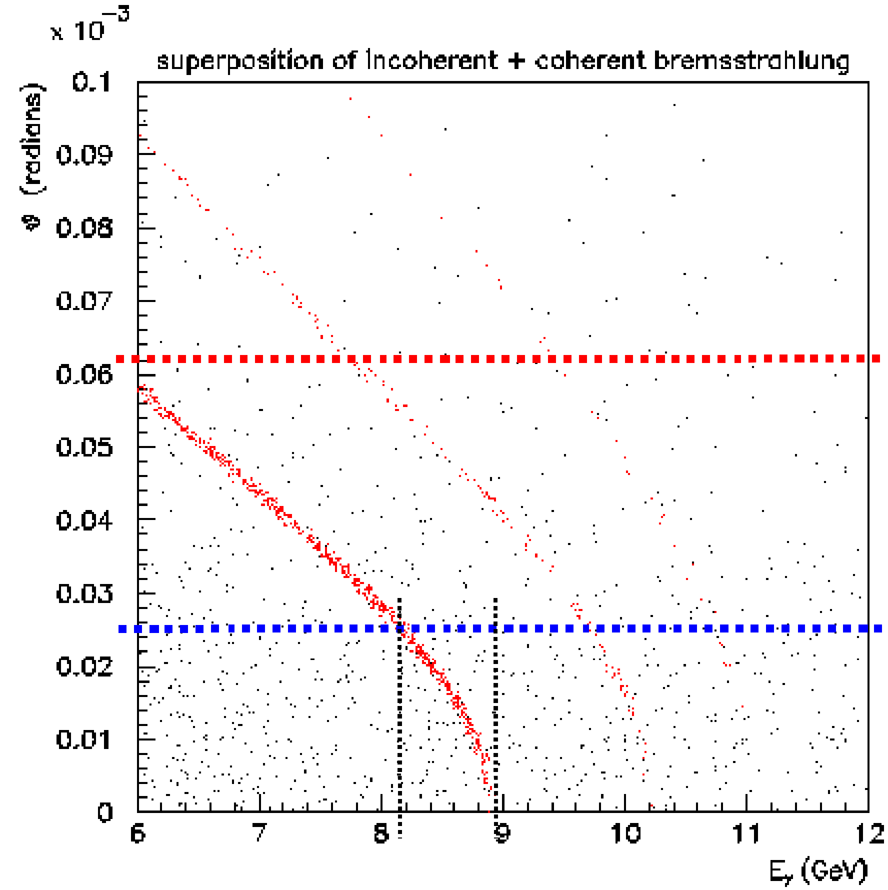
Bremsstrahlung Filtering

Among the beam frequencies ω_n with intensity enhancements, we find a pronounced peak ~9 GeV



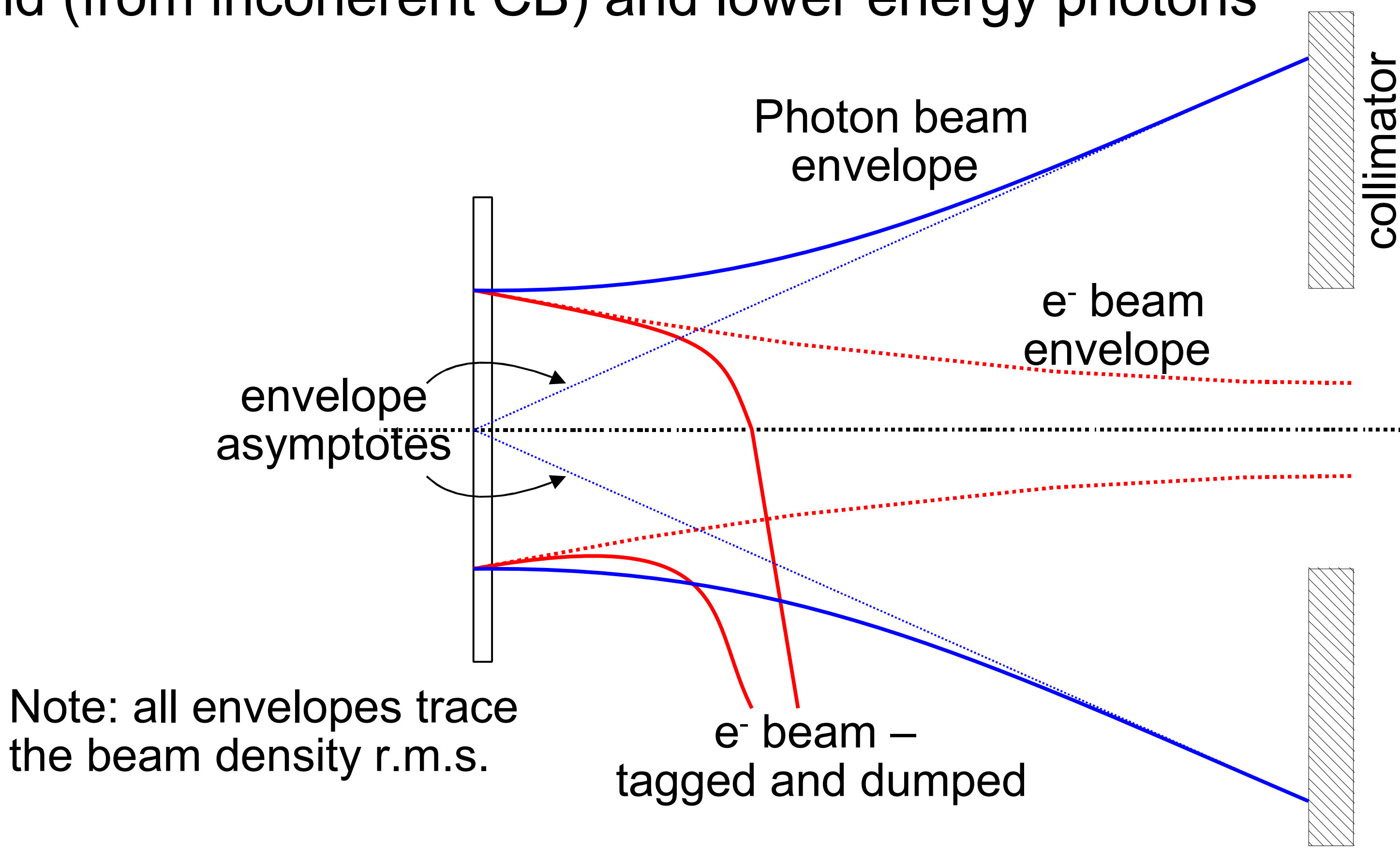
Sources of angular distribution of CB photons:

- Coherent – function of angle
- Incoherent – ~evenly distributed



Photon Beam Collimation

- (virtual) waist of the *e*$^-$ beam on collimator plane to focus photon beam
- actual *e*$^-$ beam is cleared away and spectrally analyzed ("tagging") by dipole magnets
- photon beam expands along ~80m path due to CB angular distribution
- spectral background (from incoherent CB) and lower energy photons are collimated out



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