Photon Flux Control

Liping Gan
UNCW

Outline

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- Sensitivity of beam position stability
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PrimEx-η Requirement

The number of tagged photons on the physics target must be known at 1% precision

Tagged Photon

A tagged photon should satisfy following conditions:

- A good scattering electron in the tagger that has good reconstructed energy and timing information from the tagger spectrometer.
- A Photon reaches the physics target that must be in coincidence with a good tagged scattering electron in the tagger.

Number of tagged photons on the target is not equal to the number of hits recorded by the tagger due to following reasons:

- A event in which a bremsstrahlung photon is produced but it does not reach the physics target due to the collimation or absorption along the photon beam line.

- Moller scattering in the radiator which produces an electron in the photon tagger without an accompanying photon.

- Extra hits registered in the tagger due to accidental background.

Procedure to obtain number of tagged photons

- In a special calibration run (TAC run) , replace the physics target with a lead-glass total absorption counter (TAC) directly in a low intensity photon beam so that TAC is able to withstand. The absolute tagging ratio is obtained by:

$$\mathrm{R}_{absolute} = \frac{N_{\gamma \bullet e}^{TAC}}{N_e^{Cal}}$$

Where $N_{\gamma \bullet e}^{TAC}$ is the number of photons registered by TAC which are in coincidence with tagged electrons in the tagger, and N_e^{Cal} is the number of electrons registered in the tagger.

Conditions for TAC run: (1) TAC is 100% efficient (by assumption). (2) the radiator thickness should be similar to the radiator used in the production runs so that the scattering electrons will experience similar multiple scattering and absorption in the radiator for both TAC run and production runs; (3) Photon beam must low enough for TAC to withstand. For a 10^{-5} R.L. Radiator, the electron beam current should be $\leq$ 1nA.

- For a physics production run (normal beam intensity), the number of tagged photon on the target is calculated by: $N_\gamma^{tagged} = N_e^{\exp} \times R_{absolute}$

Where $N_e^{\exp}$ is the number of electron registered in the photon tagger during the production run .

High order corrections to tagged photon flux

The number of tagged photon described in the previous slide must be corrected by measuring the relative tagging ratio due to following reasons:

1. Since the absolute tagging ratio is measured at orders of magnitude lower beam intensity than the production runs, the beam current effects, such as non-linearity of the tagger counters at higher beam current, should be corrected.

1. The TAC calibration runs can only be performed at intervals between the production runs. One needs monitor the long term stability of the absolute tagging ratio over the time.

Relative Tagging Ratio

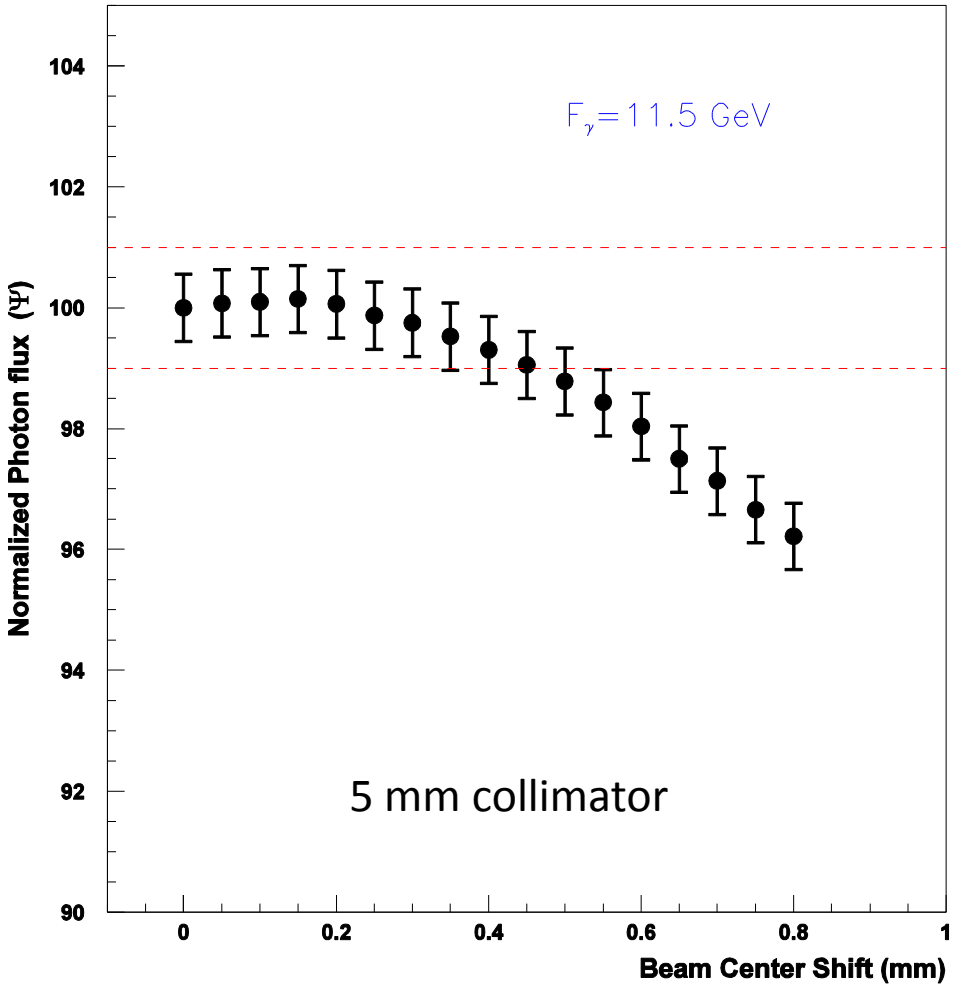
- Take the e^+e^- pair-production data continuously in both TAC calibration runs and physics production runs.
- Relative Tagging Ratio is calculated by:

$$R_{relative} = \frac{N^{PS}_{e^+e^-\bullet e}}{N_e}$$

Where $N^{PS}_{e^+e^-\bullet e}$ is the number of the e^+e^- pairs registered by the PS spectrometer which are in coincident with tagged electrons in the tagger, N_e is the number of electrons registered in the tagger.

- Any changes in the relative tagging ratio will be used to correct the tagged photon flux.

Sensitivity to beam position stability



To control the tagged photon flux within 1%, the center of photon beam position should be maintain within ±200 μm at primary collimator location

Summary

- To control the absolute tagged photon flux at 1% level, special TAC calibration runs must be performed periodically with a reduced electron beam current ($\leq$1 nA).

- In order to correct the effects due to beam non-stability, the tagged photon flux should be monitored and corrected by measuring the relative tagging ratio with the e^+e^- pair-production measurement in parallel to both TAC calibration runs at lower beam intensity and physics production runs at higher beam intensity.

- The beam requirements for TAC calibration runs: (1) capability of $\leq$1 nA electron beam current, and (2) photon beam center position should be stable within $\pm$200 μm at primary collimator location