# Photon-Photon collisions at LUXE

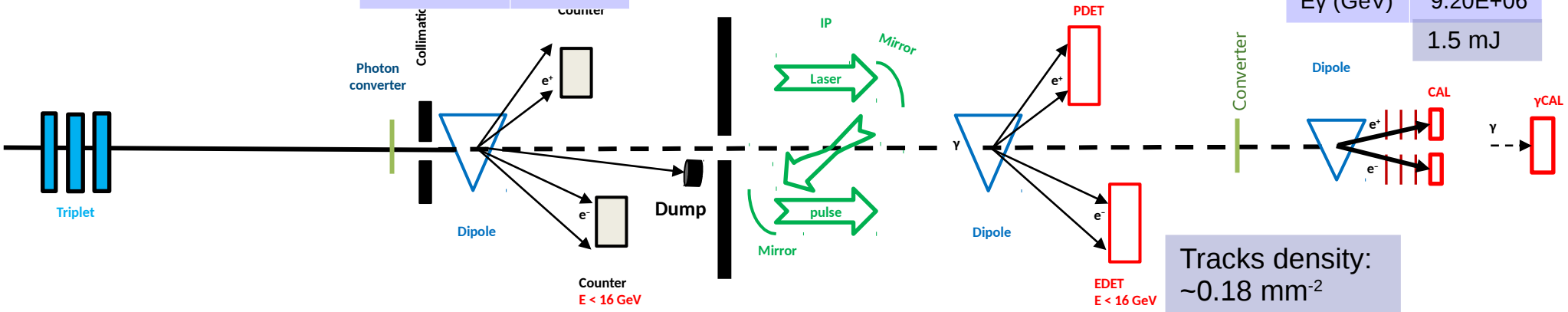
| | |
|---|---|
| e- | 6.25E+09 |

| | |
|---|---|
| e- | 6.26E+09 |
| e-, < 16 GeV | 1.80E+08 |
| e+ | 1.62E+06 |
| γ | 5.60E+08 |

| | |
|---|---|
| γ | 4.91E+06 |
| γ, E >7GeV | 4.66E+05 |

| | Stage 0 | Stage 0.5 |
|---|---|---|
| e- | 1.32 | 24.5 |
| e+ | 1.32 | 24.5 |

| | |
|---|---|
| γ | 4.80E+06 |
| Eγ (GeV) | 9.20E+06 |
| | 1.5 mJ |



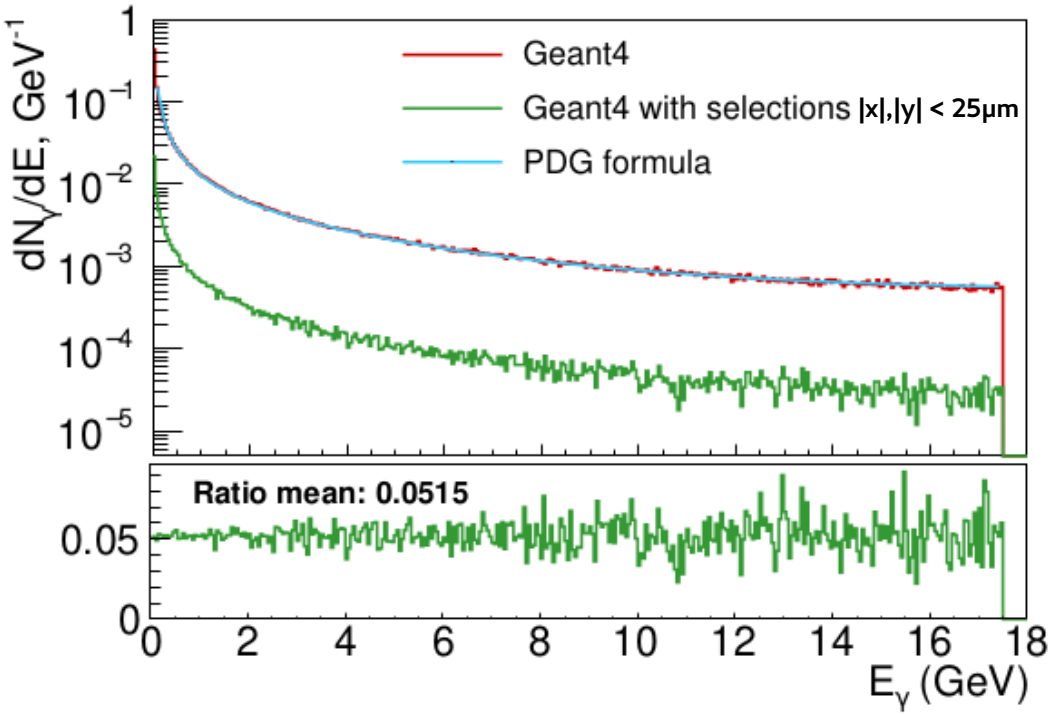

| Area | Description | e- | e+ | γ | Notes |
|---|---|---|---|---|---|
| A | Incident beam | 6.25E+09 | | | XFEL beam sigma_xy = 5μm, emittance: 1.4e-3 mm mrad |
| B | Target | 6.26E+09 | 1.62E+06 | 5.60E+08 | Tungsten 35 μm, (1%X0), 5 m upstream of IP |
| | | | | | |
| C | IP | | | 4.91E+06 | Geometrical cut \|x\|<25μm && \|y\|<25μm is applied to match laser transverse size |
| | E > 7 GeV | | | 4.66E+05 | |
| | E > 12 GeV | | | 1.92E+05 | |
| | | | | | |
| D | Detectable | | | | |
| | Stage 0 | 1.32 | 1.32 | | Laser: 1.0e19 W/cm², (0.35J, 100μm², 35 fs) |
| | Stage 0.5 | 24.5 | 24.5 | | Laser: 2.6e19 W/cm², (1.0J, 100μm², 35 fs); Track density up to 0.18 mm-2 |
| | | | | | |
| E | γ detector | | | 4.80E+06 | Total energy: 9.2e6 GeV = 1.5mJ |
| | Wire target | ~100 | ~100 | | Tungsten wire converter target, D=10 μm |

# Bremsstrahlung production Gent4 vs PDG formula

PDG formula for bremsstrahlung production:

$$\omega_i \frac{\mathrm{d}N_\gamma}{\mathrm{d}\omega_i} \approx \left[\frac{4}{3} - \frac{4}{3}\left(\frac{\omega_i}{E_e}\right) + \left(\frac{\omega_i}{E_e}\right)^2\right] \frac{X}{X_0}$$

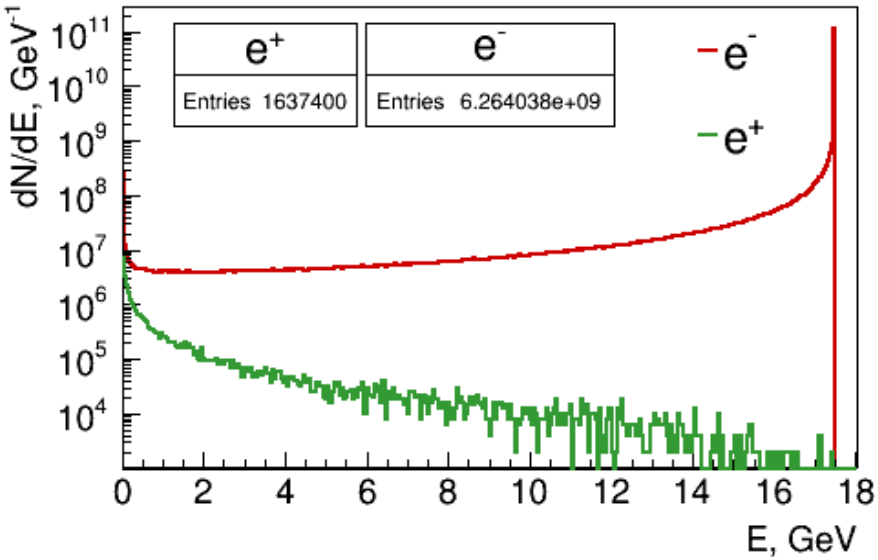
- Gaussian beam;
- Tungsten target 1%X0 (35μm), 2m from
- Two histograms are compered:
  - |x| < 1mm and |y| < 1mm (read);
  - |x| < 25μm and |y| < 25μm (green).




| | |
|---|---|
| Nγ | 4.91E+06 |
| Nγ, E >7GeV | 4.66E+05 |

- Electrons and positrons observed after the target (θ<17°).
- Spectra and table data correspond to one BX.

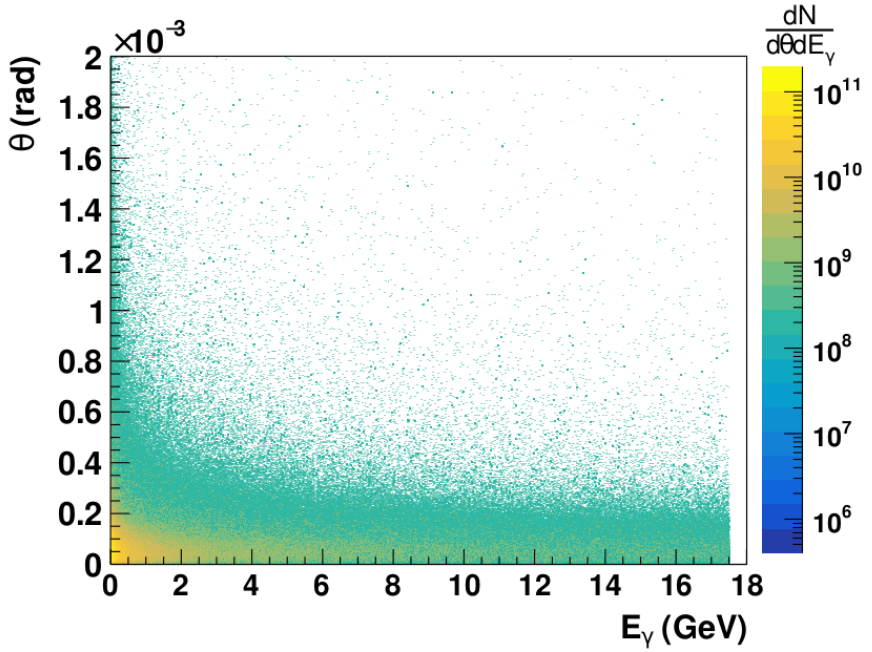
| | |
|---|---|
| **N e-** | 6.26E+09 |
| **N e-, <** 16 GeV | 1.80E+08 |
| **N e+** | 1.62E+06 |

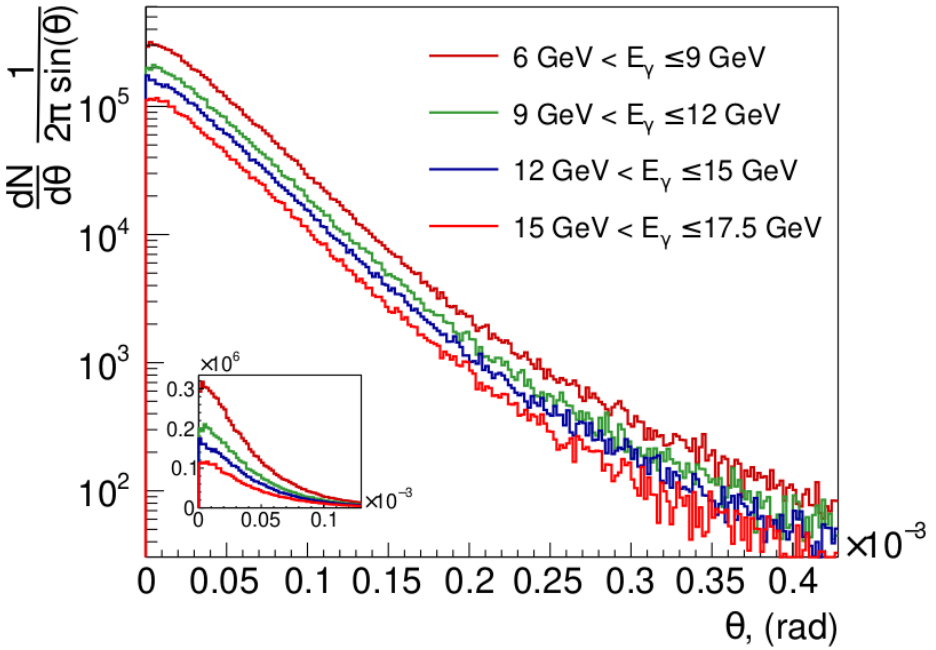


# Polar angle distribution of bremsstrahlung photons

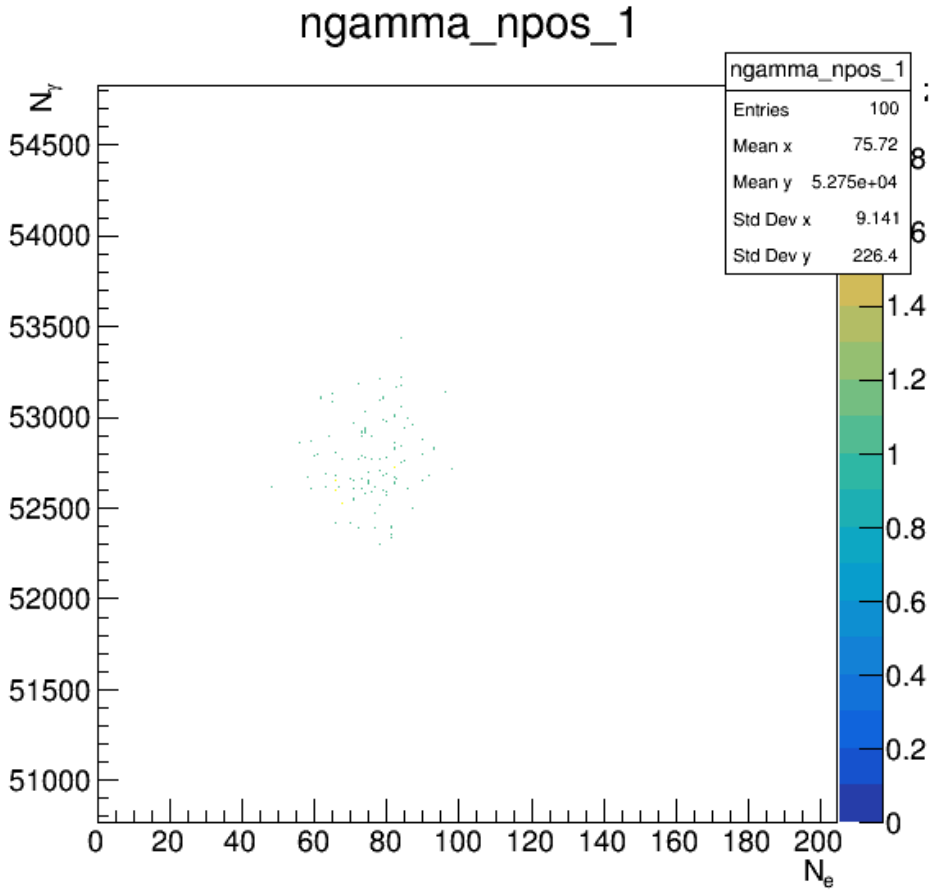
The normalized emittance of European XFEL LINAC is 1.4 mrad mm [3]. Considering the Lorentz factor $E_{beam}/m_e \approx 3.5e4$ and relationship between emittance and normalized emittance $\varepsilon = \varepsilon_n/\gamma$ the standard deviation of Gaussian distribution for $x'$ is $\sqrt{\frac{\varepsilon}{\beta^*}} \approx 8\ \mu$rad.

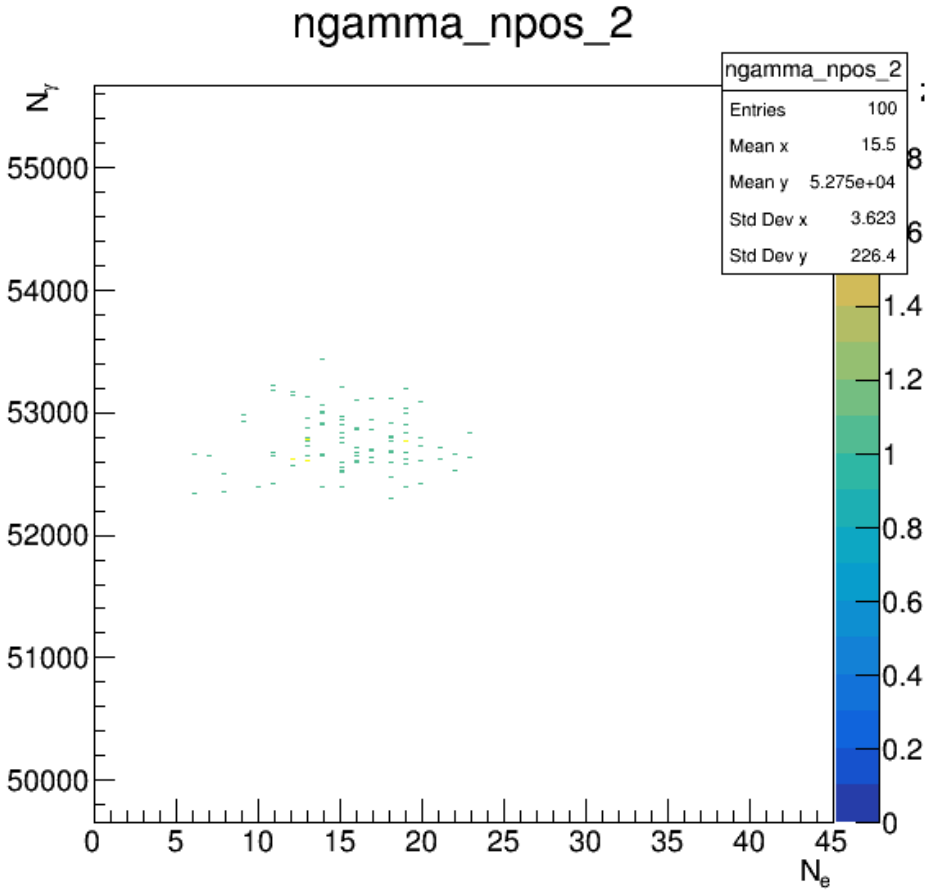
- For bremsstrahlung photons the shape of the polar angle distribution for different energy ranges is similar.
- The angular spread is mainly influenced by production and less by initial electron beam.



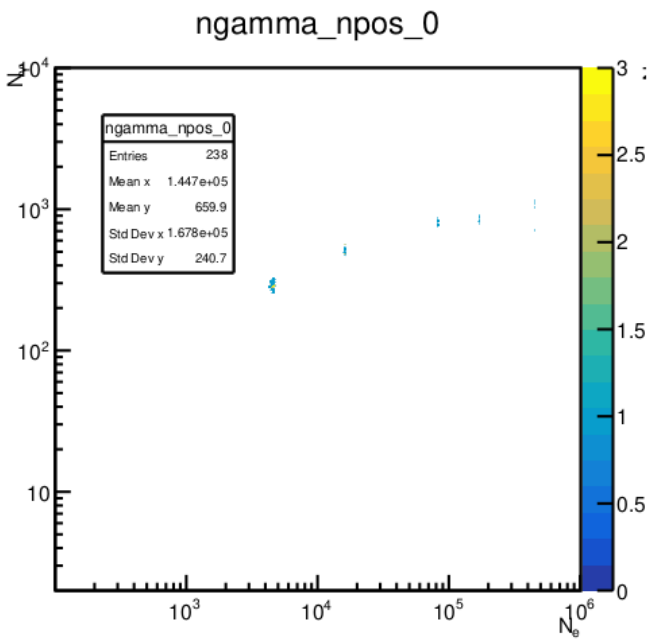



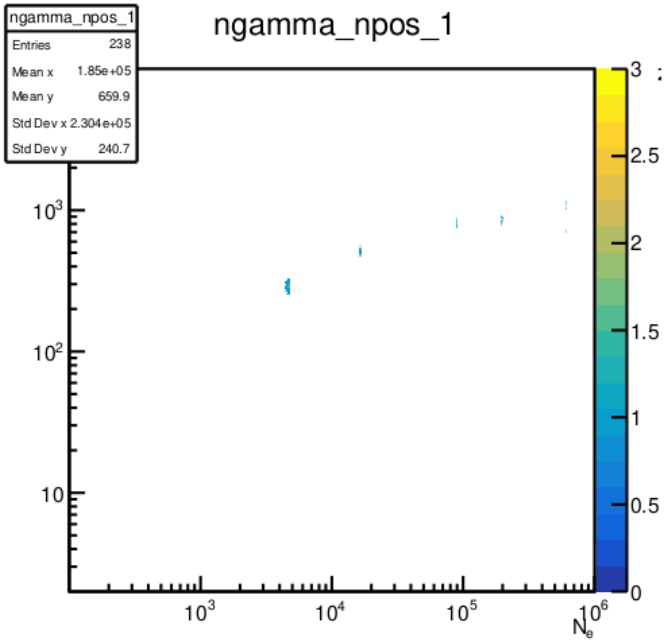
# Estimation of photon production by measuring positrons

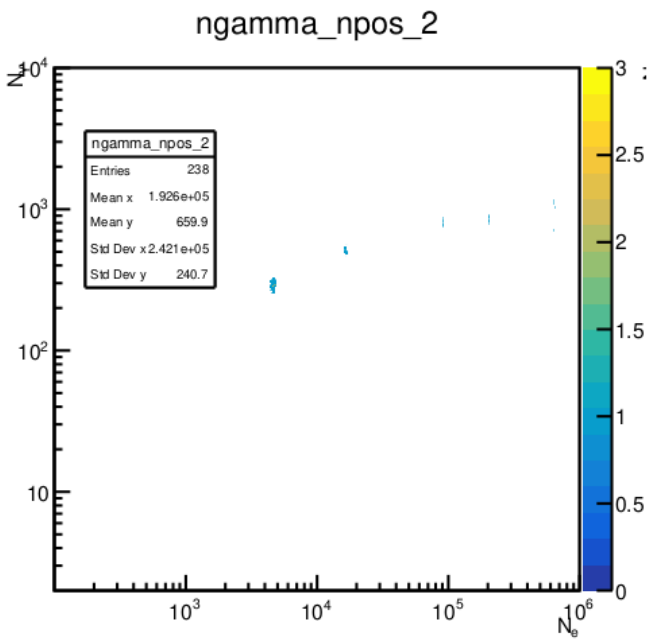


# 3 E bins


ngamma_npos_0
ngamma_npos_0
Entries 238
Mean x 1.447e+05
Mean y 659.9
Std Dev x 1.678e+05
Std Dev y 240.7
$N_\gamma$
$N_e$


ngamma_npos_1
ngamma_npos_1
Entries 238
Mean x 1.85e+05
Mean y 659.9
Std Dev x 2.304e+05
Std Dev y 240.7
$N_e$


ngamma_npos_2
ngamma_npos_2
Entries 238
Mean x 1.926e+05
Mean y 659.9
Std Dev x 2.421e+05
Std Dev y 240.7
$N_\gamma$
$N_e$

# Estimation of photon production by measuring positrons

$$\text{ArcTan}\left[\frac{R\left(\text{Cos}[t]-\sqrt{1-\left(\frac{d}{R}+\text{Sin}[t]\right)^2}\right)}{d}\right]$$

```
ff[t_, R_] = D[f[t, R], t]
```

```
ffe0[R_] = ff[t, R] /. {d -> 1, t → 0}
```

```
ffe1[R_] = ff[t, R] /. {d -> 1, t → 0.5}
```

```
Plot[{ffe0[R], ffe1[R]}, {R, 1.2, 10.0}]
```