Gamma rays production via intracavity Compton back-scattering with FEL photons

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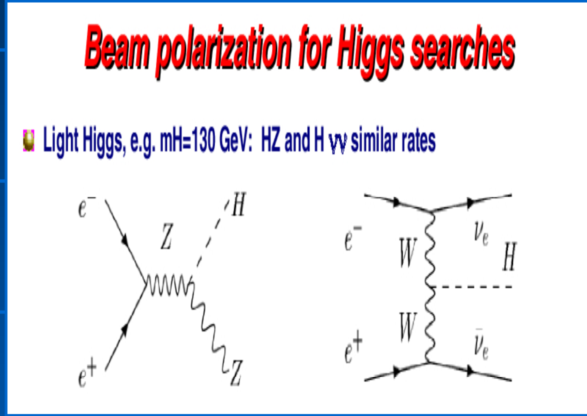
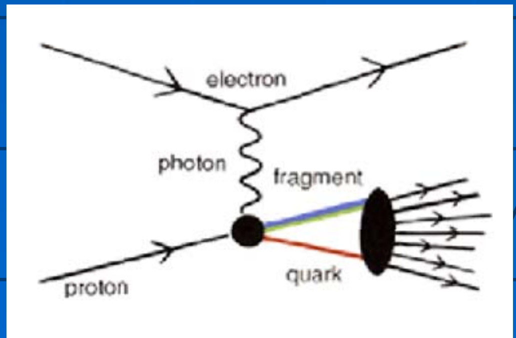
Applications

- Non conventional source of positron for future colliders.
  - Production of polarized e+ beams

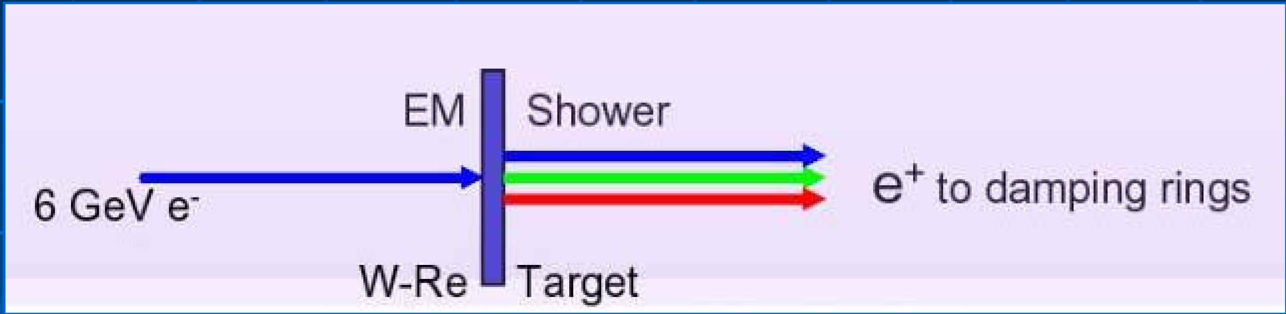


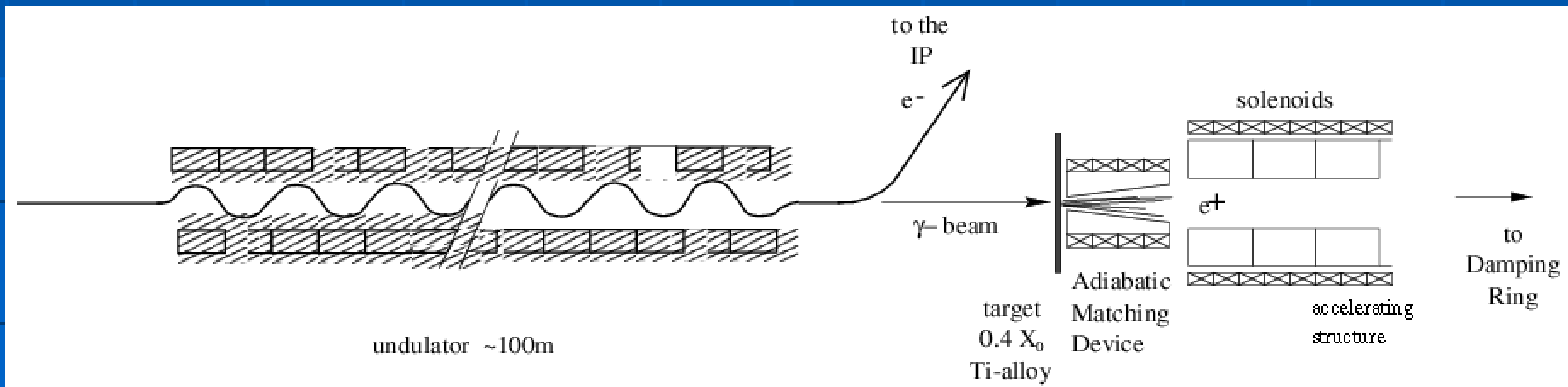
- Nuclear Physics,
  – Non perturbative QCD:
  - Proton polarizability



Hadron EM polarizabilities
G. Dattoli - Lett. N. Cim. (1977)

Positron source:

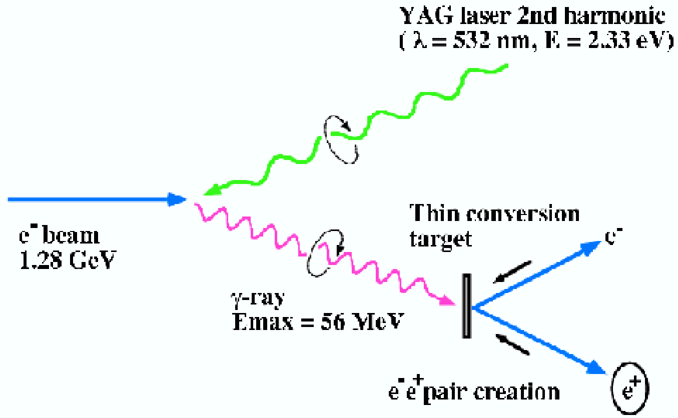




Compton back-scattering

- *Proof of principle*

ATF-Compton Experiment@KEK



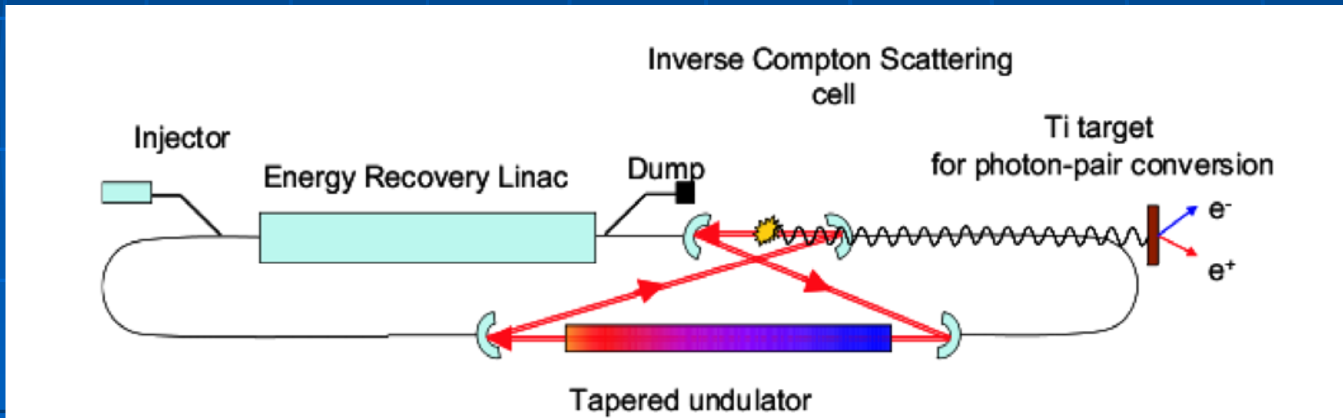
i) proof-of-principle demonstration

ii) accumulate technical informations: polarimetry, beam diagnosis, …

No Optical Cavity at Collision Point

ICS+FEL idea is not new…

- C. Pagani, E.L Saldin, E.A. Schneidmiller and M.V. Yurkov NIM A 429 (1999) 476-480.
- V.N. Litvinenko and J.M.J. Madey, NIM A 375 (1996) 580-583

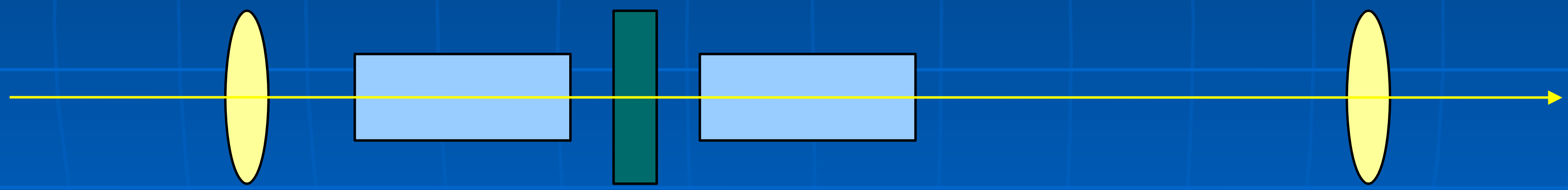


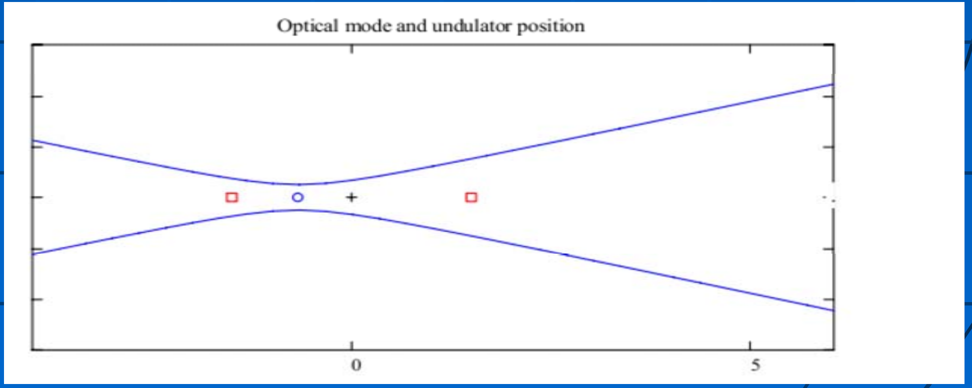
- P. Musumeci http://www.astec.ac.uk/id mag/ID-Mag Helical ILC_Positron Production_ Workshop.htm (broken link?)

Lack an estimation of the γ yield.

Proposed scheme

- FEL oscillator, Optical Klystron @ λ ~ 260nm
- Intracavity back-scattering, yielding γ @ +70 MeV
- E ~ 1 GeV





Beam parameters

- $Q = 300\ pC$
- $I_{peak} = 80\ A$ $\sigma_T = 1.5\ ps$
- $\varepsilon_n = 10\mu m$
- $E = 1\ GeV$ $\Delta E = 20\ KeV$

- $\nu_b = 2.986\ GHz$ (Rep rate in macropulse)
- $rr = 100\ Hz$
- $\Delta T = 5\mu s$ (Macropulse)
- $n_b = \Delta T \cdot \nu_b = 1.5 \cdot 10^4$ (bunches in macrop.)

Undulator

N_p	60
$L_u = N_p \cdot \lambda_u$	3m

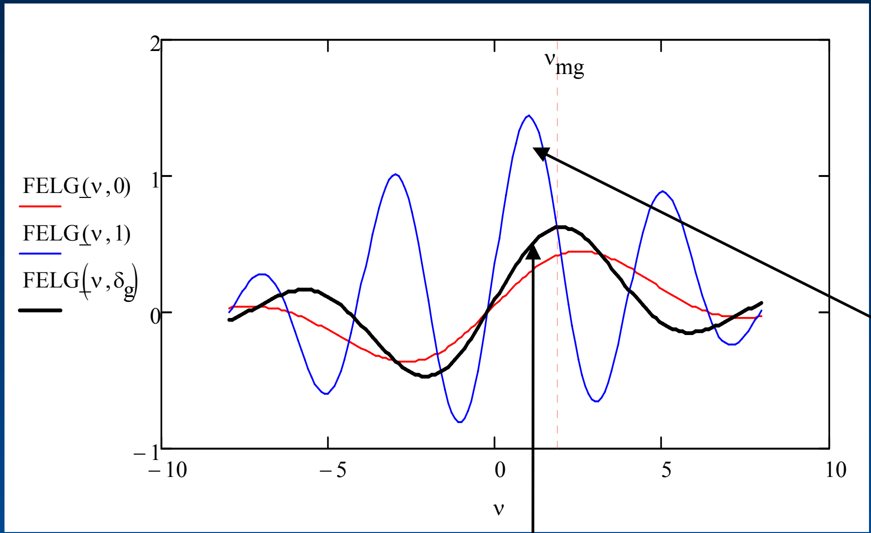
Optical Cavity

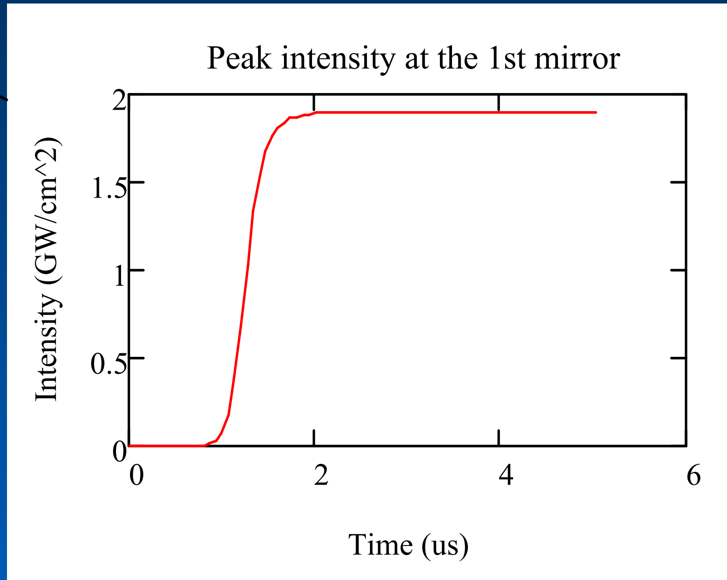
- $N_{br} = 200$
- $L_c = N_{br} \cdot c/2 \cdot v_b = 10.04$ m
- $R_1 = 3.5$m $R_2 = 6.8$m

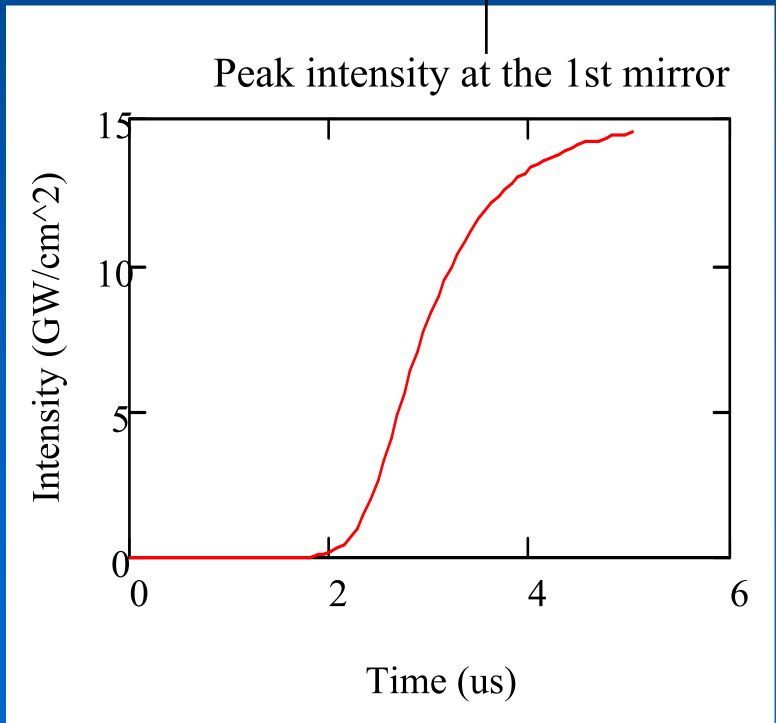
$w_1 = 1.126$mm $w_2 = 2.229$mm

- $w_0 = 250$ μm $z_r = 761$μm
- Reflectivity=99% $\eta = 1 - R^2 = 2\%$

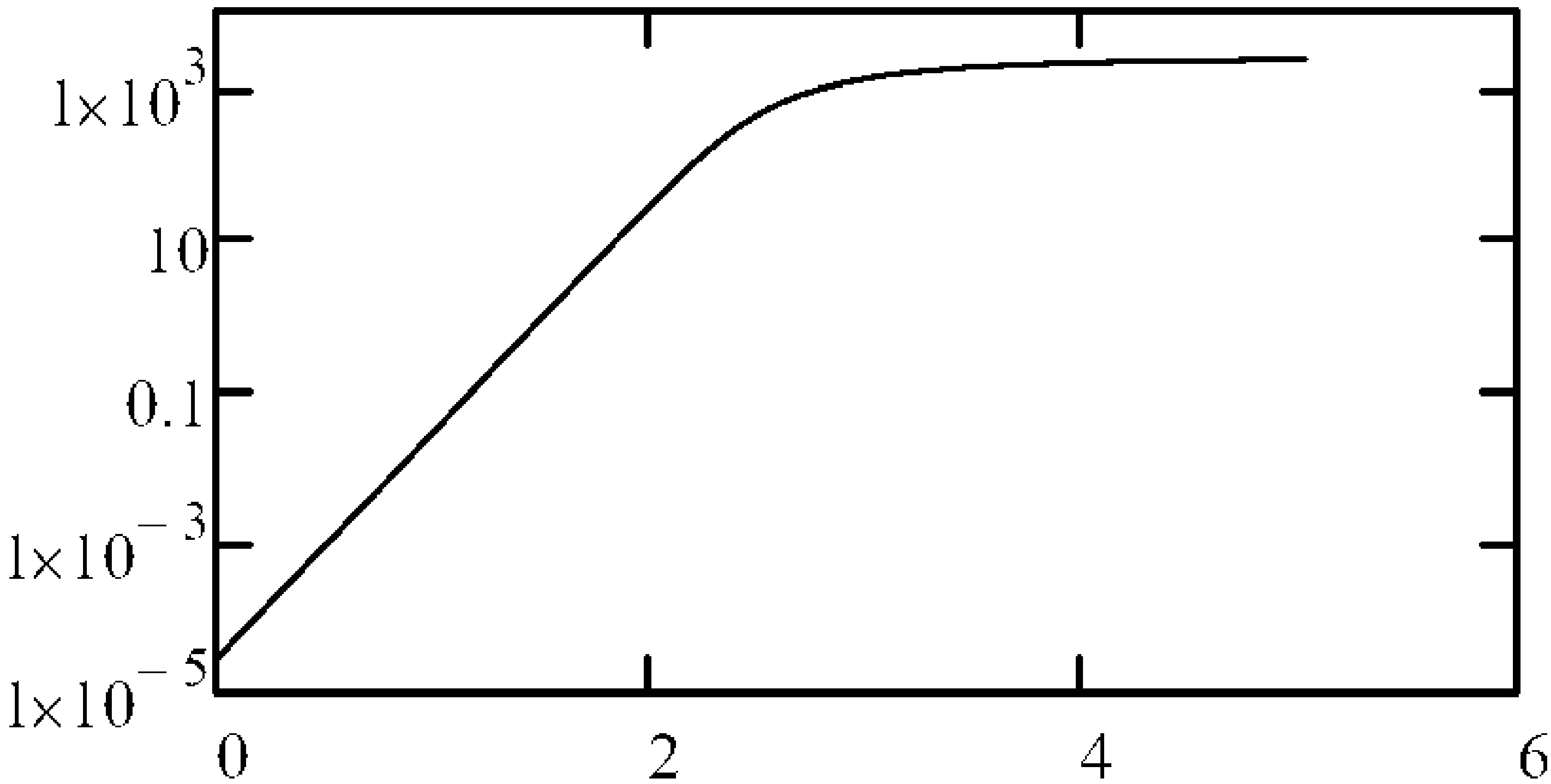
Gain optimization



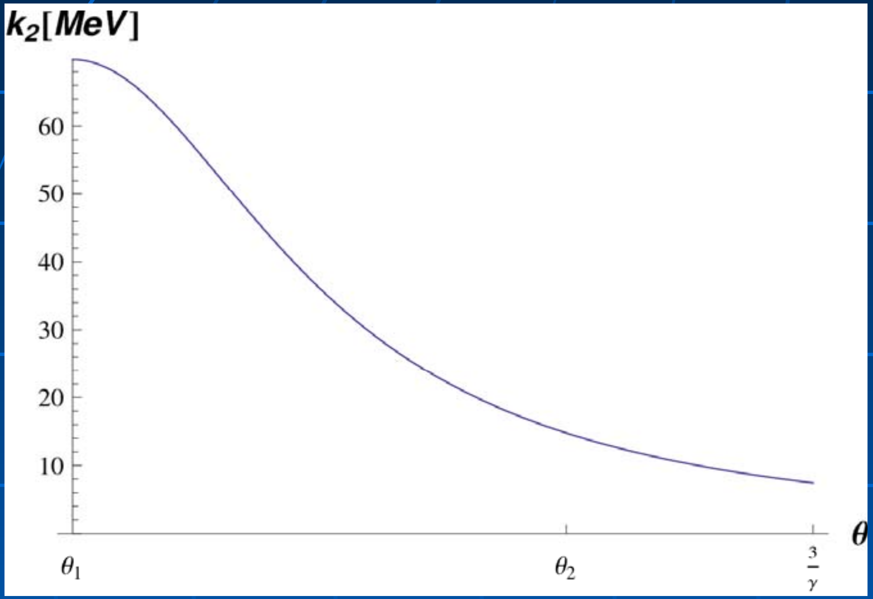




Intracavity peak power

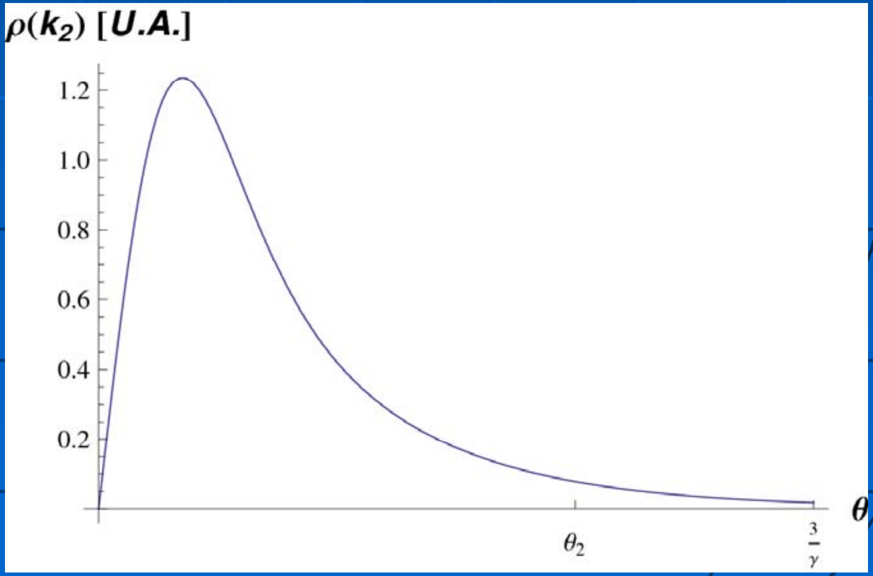


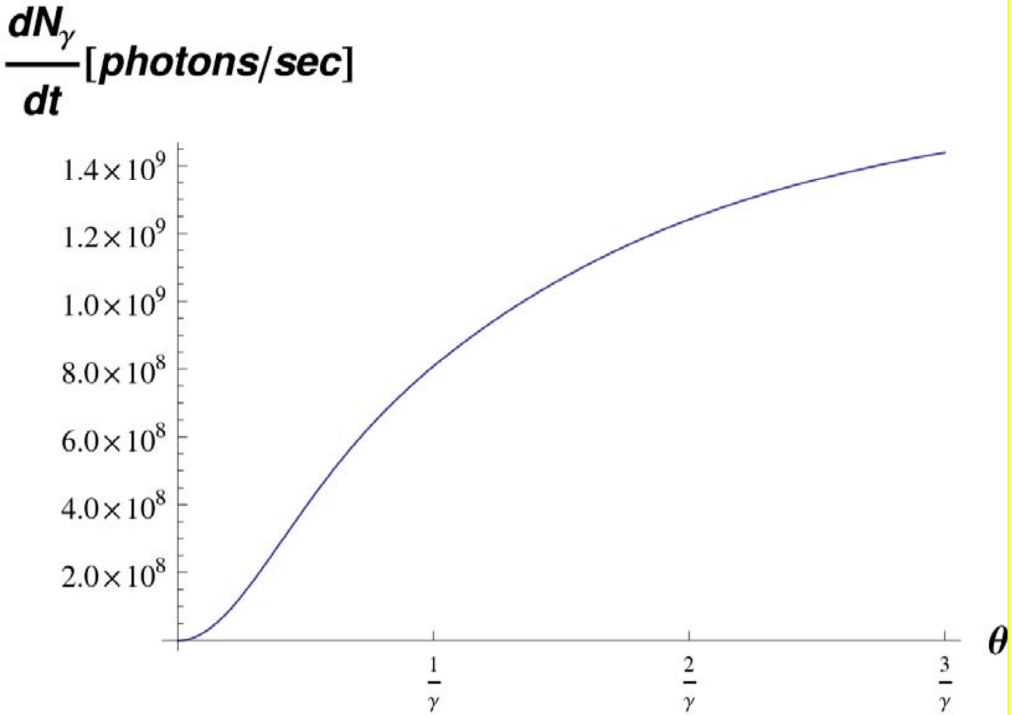
$$2^{nd}\ mirror \rightarrow 3.311 \frac{J}{cm^2}$$



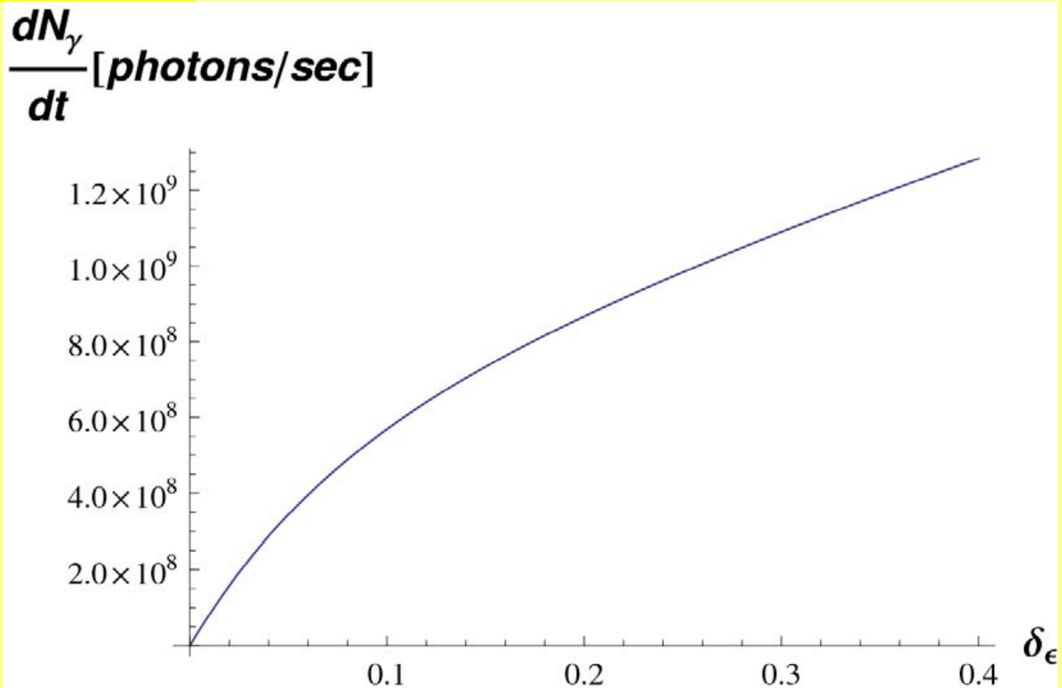
$k_2(\theta)$

$\rho_{k_2}(\theta)$





$$\frac{dN_\gamma}{d\Omega} = rrN_{br}\,\frac{1}{2\pi}\frac{d\sigma}{d\Omega}\frac{N_{FEL}N_e}{\sigma_{ph}^2+\sigma_e^2}$$



Conclusions

- The hard γ yield from a practical Optical Klystron FEL has been estimated in terms of collection angle and energy spread;

- Monte Carlo simulations of electromagnetic showers are needed to characterize the interaction with target for e+ production to assess achievable polarization;