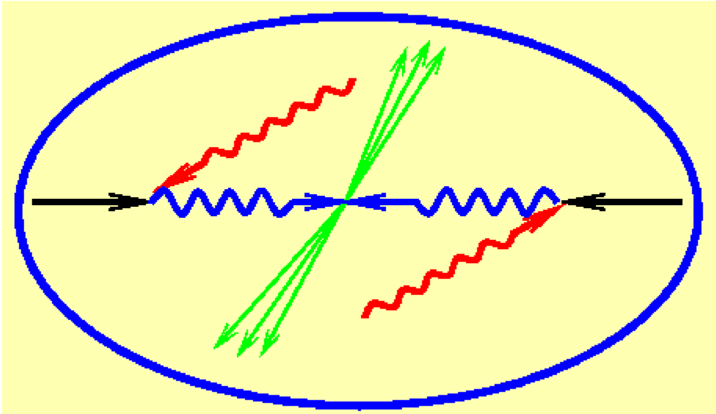

# $\gamma\gamma$-collider on $W_{\gamma\gamma} \leq 12$ GeV

(talk at the panel discussion)


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(page from my overview talk)

A new proposal !!!

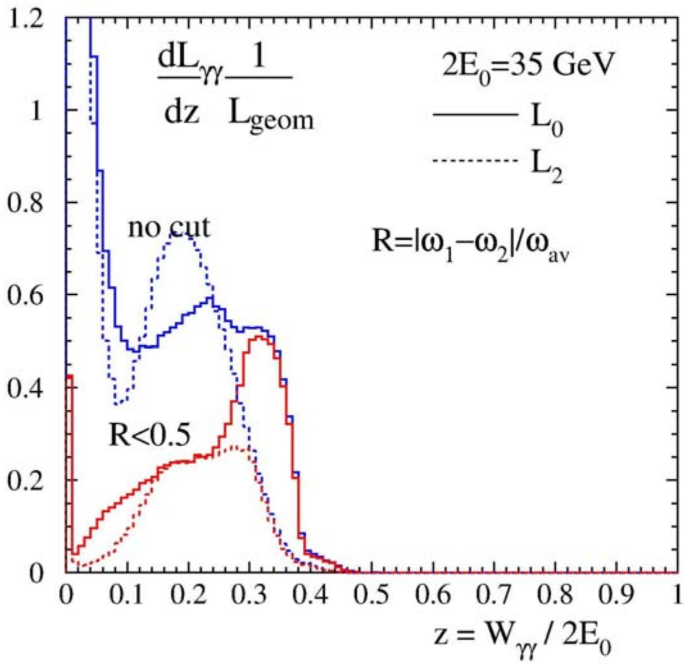
# The Photon collider based on European XFEL with $E_0 \approx 17.5$ GeV (or a new one)

for study $\gamma\gamma$ physics in c, b quark energy region $W_{\gamma\gamma}$=3-12 GeV

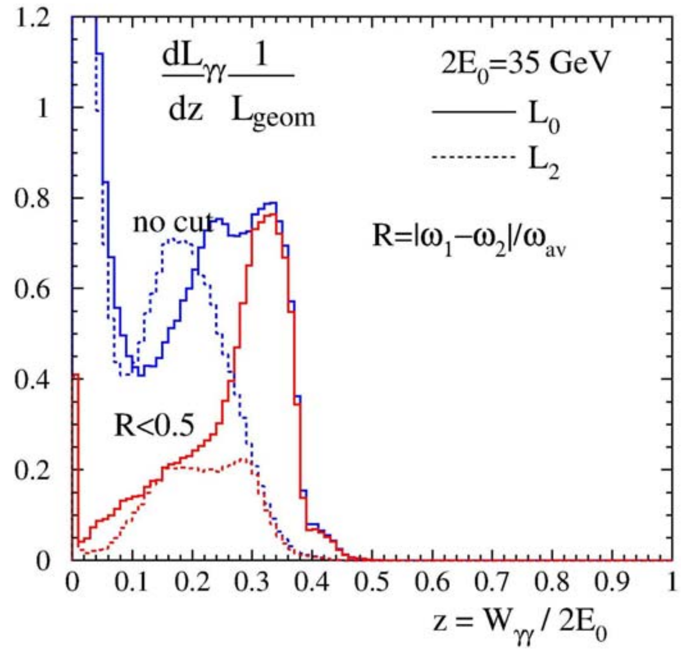
European Superconducting XFEL start operation in 2017. Its electron beam parameters: $E_0$=17.5 GeV, $N=0.62\cdot10^{10}$ (1 nQ), $\sigma_z$=25 μm, $\varepsilon_n$=1.4 mm mrad, f≈30 kHz

Using arcs with R~100-200 m we can get a photon collider with f=15 kHz. Other parameters for γγ collider: $\beta^*$=100 μm, $\sigma_z$=25 μm→70 μm (to reduce disruption angles), laser wavelength λ=0.5 μm, we get the following γγ luminosity spectra:

Unpolarized electrons, $P_c$=-1




Polarized electrons, $2\lambda_e P_c$=-0.85




$L_{geom}=1.1\cdot10^{33}$

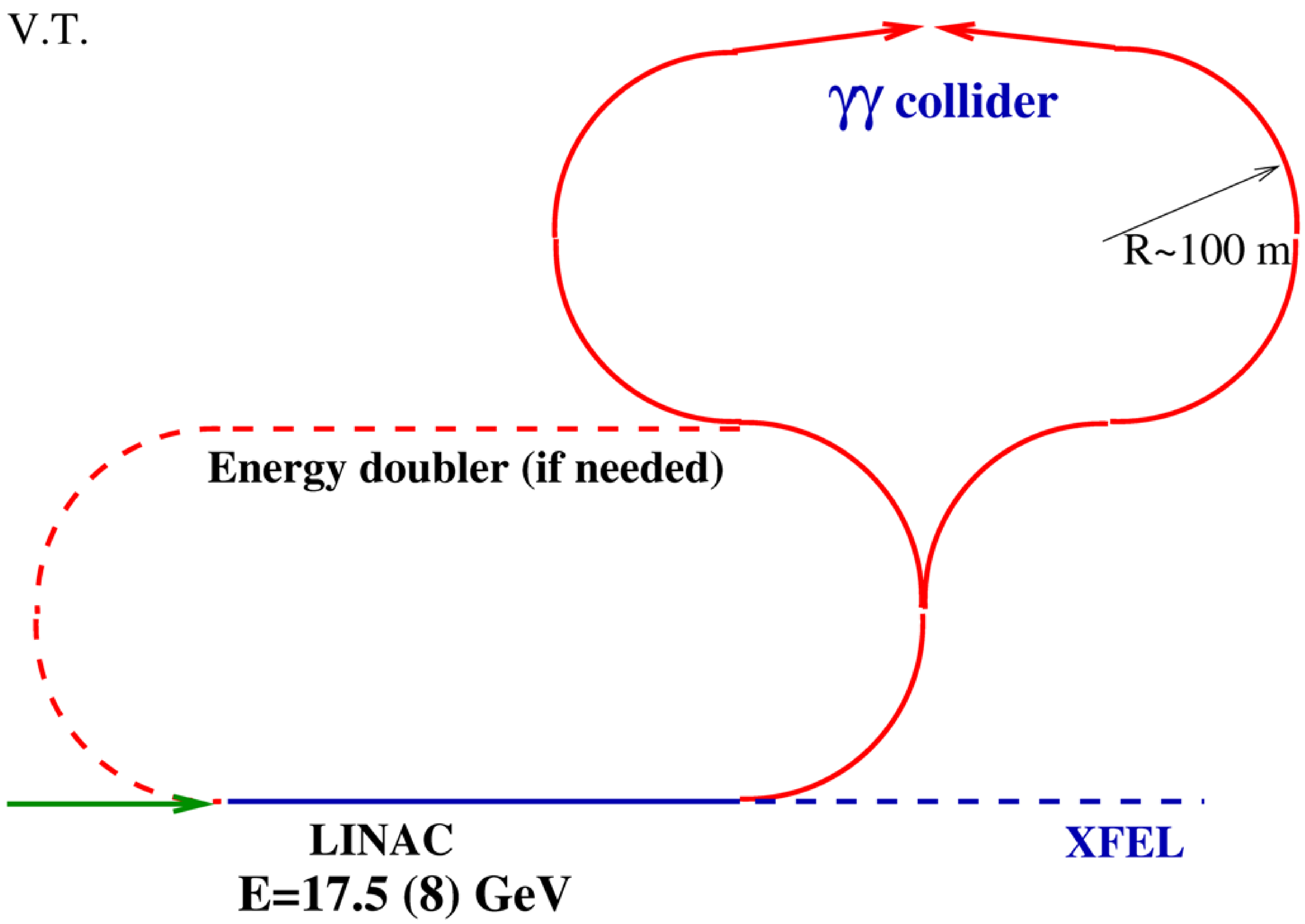
↓

$L_{geom}=2.3\cdot10^{34}$

(with low emittance plasma source and β=100→70 μm)

γγ peak at 12 GeV, covers all bb-meson region. Electron polarization is desirable, but not mandatory (improvement <1.5 times). Easy to go to lower energies by reducing the electron beam energy.

# Scheme of the collider



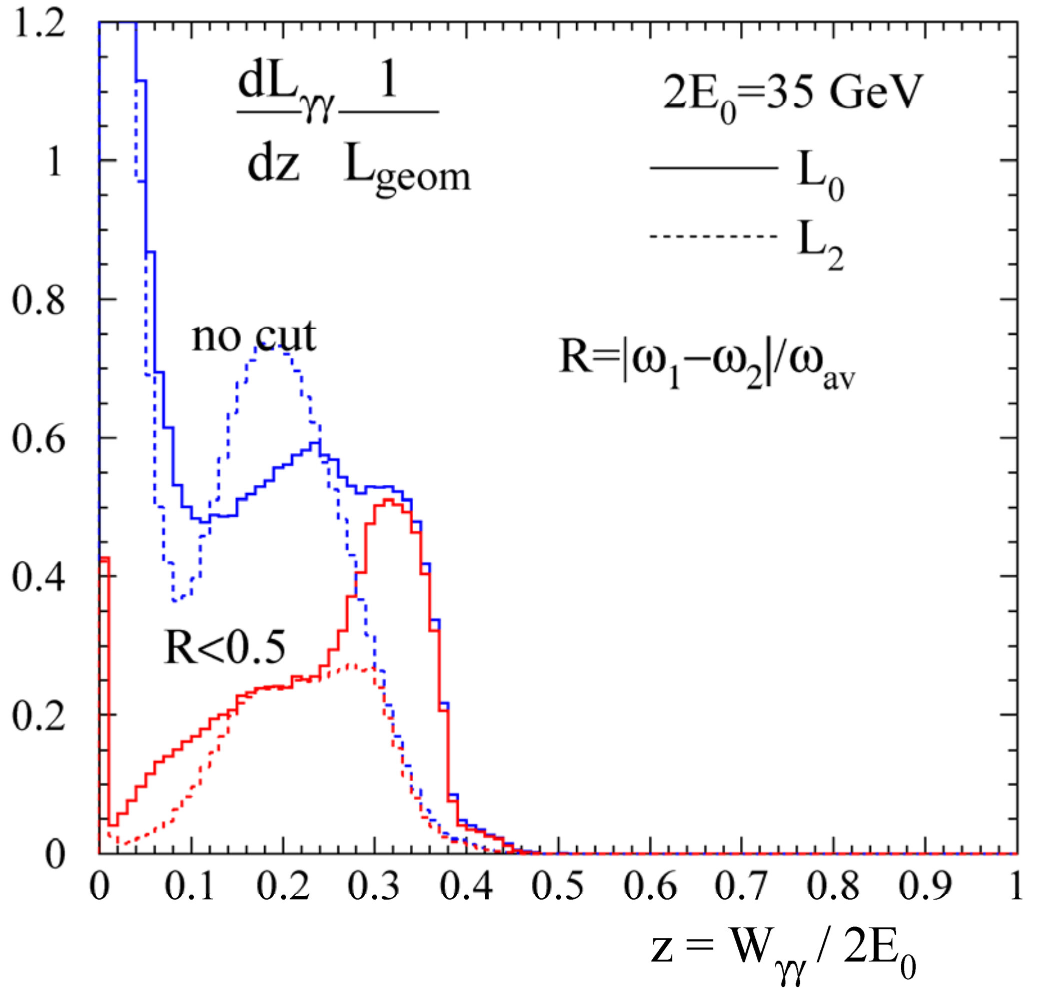

Linac not in scale

# Parameters of photon collider for bb-energy region ($W_{\gamma\gamma}$<12 GeV)

V. Telnov

| | |
|---|---|
| $E_0$, GeV | 17.5 |
| $N/10^{10}$ | 0.62 |
| f, kHz | 15 |
| $\sigma_z$, μm | 70 |
| $\varepsilon_{nx}/\varepsilon_{ny}$, mm mrad (unpolar. plasma gun) | 0.1/0.1 |
| $\beta_x/\beta_y$, μm | 70/70 |
| $\sigma_x/\sigma_y$, nm | 14/14 |
| laser λ, μm | 0.5 |
| b, (CP-IP dist.), mm | 0.5 |
| crossing angle, mrad | ~30 |
| $L_{ee}$, $10^{34}$ | 2.3 |
| $L_{\gamma\gamma}(z>0.5z_m)$, $10^{34}$ | 0.3 |
| $W_{\gamma\gamma}$(peak), GeV | 12 |

Unpolarized electrons, $P_c$=-1




In Table a low emittance plasma gun is assumed. With the XFEL gun the luminosity is smaller 14 times.

# Resonance formation from two real photon collisions

$Q = 0$ , $C = +$, $J^P = 0^+, 0^-, 2^+, 2^-, 3^+, 4^+, 4^-, 5^+ \ldots (\text{even})^{\pm}, (\text{odd} \neq 1)^+$

Example: $\gamma\gamma \to \eta_b$.

There was attempt to detect this process at LEP-2 (2E=200 GeV, L=$10^{32}$, but only upper limit was set.

$$N = \frac{dL_{\gamma\gamma}}{dW_{\gamma\gamma}} \frac{4\pi^2 \Gamma_{\gamma\gamma}(1+\lambda_1\lambda_2)}{M_x^2} \left(\frac{\hbar}{c}\right)^2 t$$

For our collider $\frac{dL_{\gamma\gamma}}{dW_{\gamma\gamma}} \frac{2E_0}{L_{ee}} \simeq 0.5$ , so

$$N \sim \frac{\pi^2 \Gamma_{\gamma\gamma}(1+\lambda_1\lambda_2)}{E_0 M_x^2} \left(\frac{\hbar}{c}\right)^2 (L_{ee}t) \sim 8 \cdot 10^{-27} \frac{\Gamma_{\gamma\gamma}}{E_0 M_x^2 [\text{GeV}^2]} (L_{ee}t)$$

For $\Gamma_{\gamma\gamma}(\eta_b) = 0.5 \text{ keV}, E_0 = 17.5 \text{ GeV}, \text{M}(\eta_b) = 9.4 \text{ GeV}, \lambda_{1,2} = 1, L_{ee} = 1.1 \cdot 10^{33} - \underline{2.2 \cdot 10^{34}},$

$t = 3 \cdot 10^7 s$ we get $N(\eta_b) \approx 10^5 - 2 \cdot 10^6$ and measure its $\Gamma_{\gamma\gamma}$

Production rate is higher than was at LEP-2 (in central region) ~ 500 - $10^4$ times!

Such photon collider has very rich physics, incl. 4-quark (or molecular) states. Many such states with unclear nature have been discovered recently.

Just for information. $\eta_b$ is detected in radiative decays of Υ(nS). Babar has detected ~ 30000 $\eta_b$, this was not sufficient to detect its decay to γγ, because Br~$7 \cdot 10^{-5}$. Such decay can be observed at Super-B. LHC with 300 $fb^{-1}$ will produce $5 \cdot 10^9$ $\eta_b$.

# Conclusion

Photon collider needs high rep. rate electron linacs and powerful high rep. laser, both technology already exist. All aspects of photon collider are understood at good level. It has sense, for beginning, to consider construction of the photon collider on the energy $W_{\gamma\gamma} \leq 12$ GeV (bb regions). Physics here in γγ is very rich and unexplored.

Part of this facility (SC linac) can be used simultaneously for XFEL. So, such project has a strong motivation. This can be done on the base of existing European XFEL or (may be easier) to construct a new one in other place.