ON THE COHERENT BREMSSTRAHLUNG (CB) BY RELATIVISTIC ELECTRONS AND POSITRONS IN CRYSTALS AT ULTRAHIGH ENERGIES (PROPOSAL FOR CERN)

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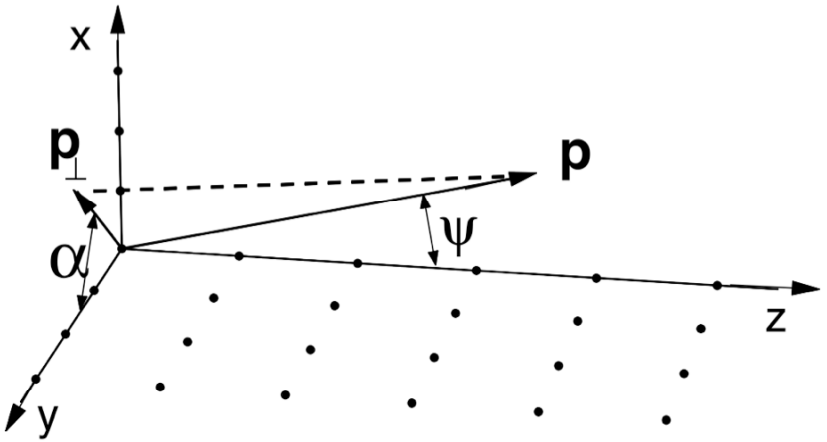


$$\psi >> \psi_c$$

$$\theta = \alpha\psi >> \theta_p$$

CB DO NOT INVESTIGATED PRACTICALLY AT ULTRA HIGH ENERGIES !

$$\psi >> \psi_c \qquad \theta >> \theta_p$$

- continuous plane potential = "point" effect in CB
- continuous string potential = "row" effect in CB
- random strings approximation in CB = dynamical chaos in CB (Überall's case)

The same is for $\gamma \to e^+ e^-$

CB AND DYNAMICAL CHAOS

(A.Akhiezer, N.Shul'ga, Sov. Phys. Usp. 25 (1982) 541)

Ter-Mikaelian's case (1953)

$$\omega\frac{d\sigma_{coh}}{d\omega}=\frac{2e^2\delta}{m^2\Delta}\frac{\varepsilon'}{\varepsilon}\sum_{\mathbf{g}}\frac{\mathbf{g}_\perp^2}{g_{II}^2}\left[1+\frac{\omega^2}{2\varepsilon\varepsilon'}-2\frac{\delta}{g_{II}}\left(1-\frac{\delta}{g_{II}}\right)\right]\left|U_{\mathbf{g}}\right|^2 e^{-\overline{u^2}\mathbf{g}^2}$$

$$g_{II}=g_z+\psi(g_y\cos\alpha+g_x\sin\alpha)\geq\delta,\quad \mathbf{g}_\perp^2=g_x^2+g_y^2,\quad \delta=\omega m^2/2\varepsilon\varepsilon'$$

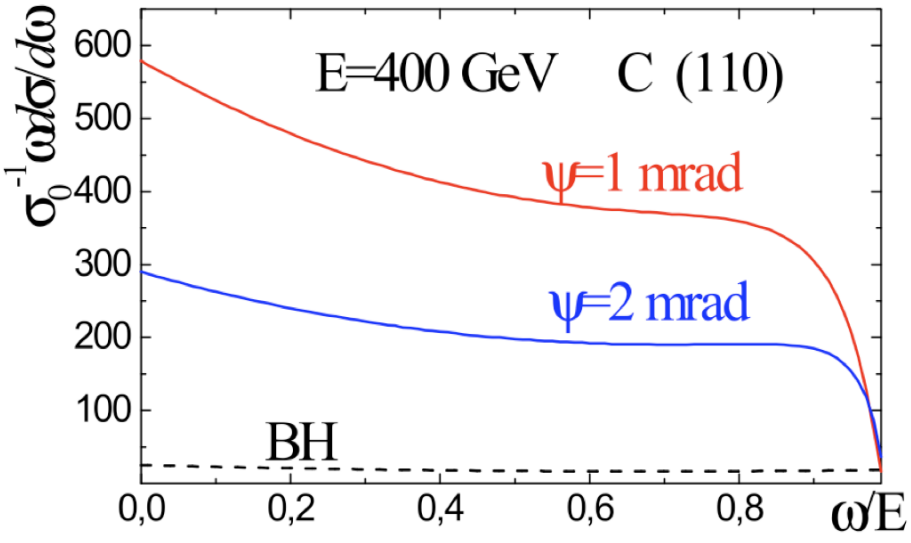
Überall's case (1956)

$$\omega\frac{d\sigma_{coh}}{d\omega}=\frac{2e^2\delta}{m^2 a_z}\frac{\varepsilon'}{\varepsilon}\sum_{\mathbf{g}_z}\int\frac{d^2g_\perp}{(2\pi)^2}\frac{\mathbf{g}_\perp^2}{g_{II}^2}\left[1+\frac{\omega^2}{2\varepsilon\varepsilon'}-2\frac{\delta}{g_{II}}\left(1-\frac{\delta}{g_{II}}\right)\right]\left|U_{\mathbf{g}}\right|^2 e^{-\overline{u^2}\mathbf{g}^2}$$

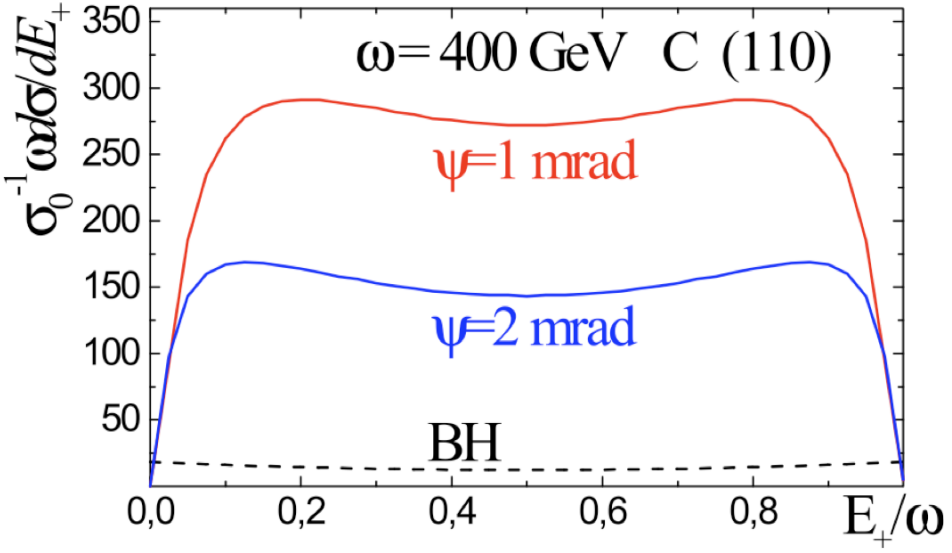
CB AND DYNAMICAL CHAOS

C <100> $\psi = 1\ mrad$ $E = 400\,GeV$

CB

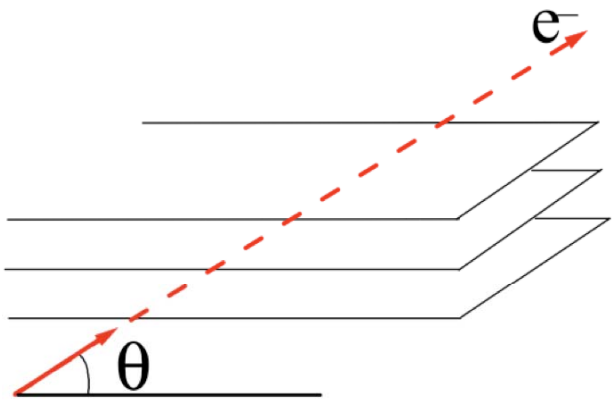


Pair production



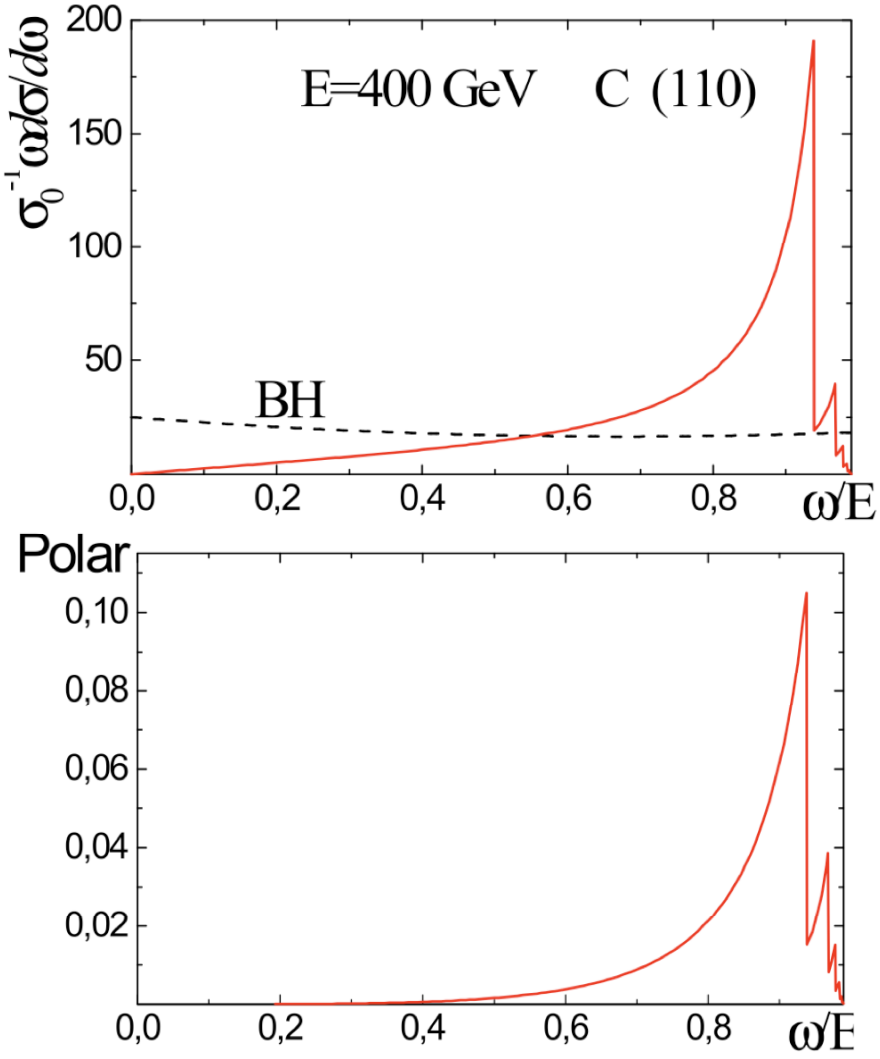
- Electromagnetic showers
- Analogies of LPM - effect

CB IN CONTINUOUS PLANE POTENTIAL ("POINT" - EFFECT)



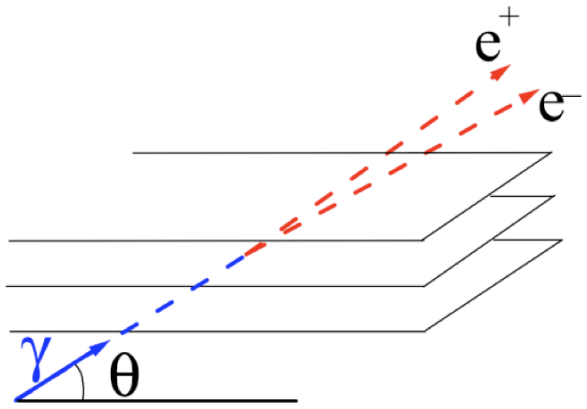
$$\theta \sim 5 \cdot 10^{-4} rad >> \theta_p$$

$$E = 400\,GeV$$

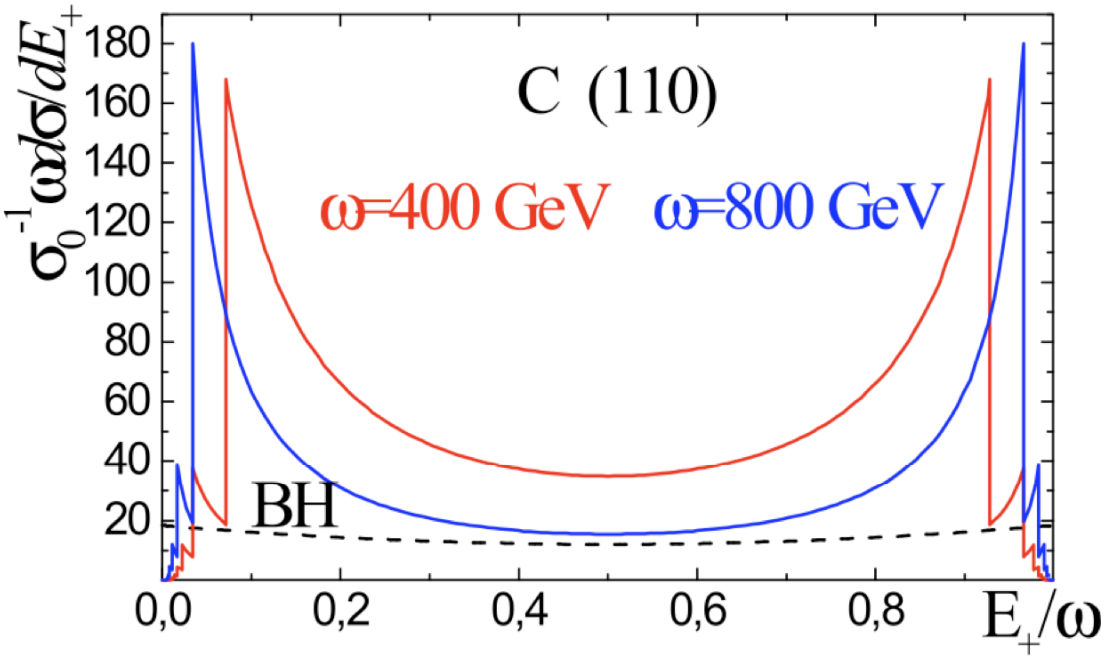


Transformation e^- in polarized γ - beam with $\hbar\omega \approx E\_$!!!

COHERENT e^+e^- PRODUCTION IN CONTINUOUS PLANE POTENTIAL



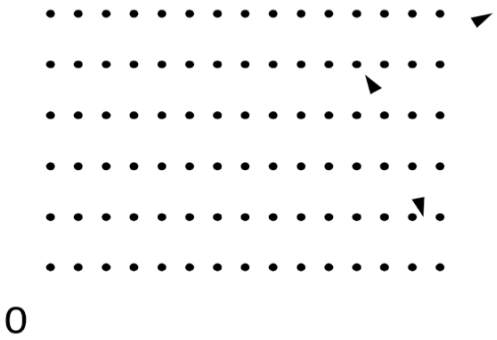
$$\theta = 5 \cdot 10^{-4}\, rad$$

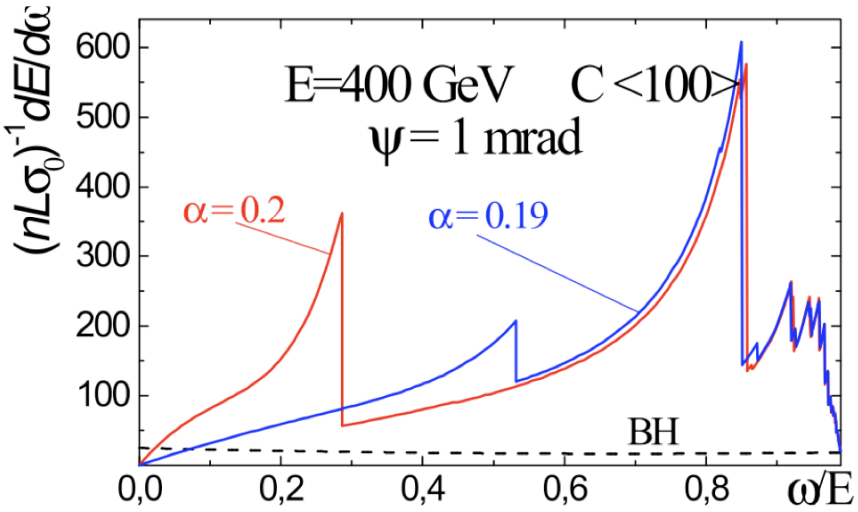


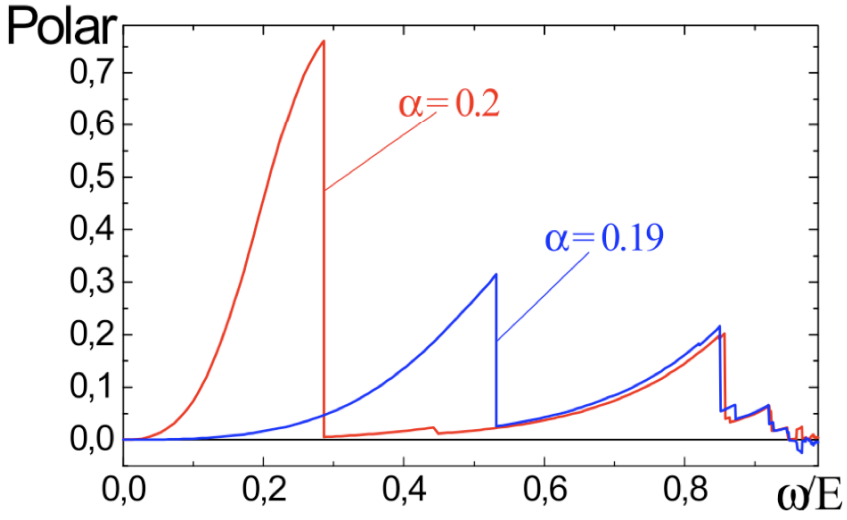
- positron source
- electromagnetic showers

CB IN STRING PLANE POTENTIAL (THIN STRUCTURE OF CB)

(N.Shul'ga, V.Truten', V.Syshchenko, Phys.Lett. B327 (1994) 306)



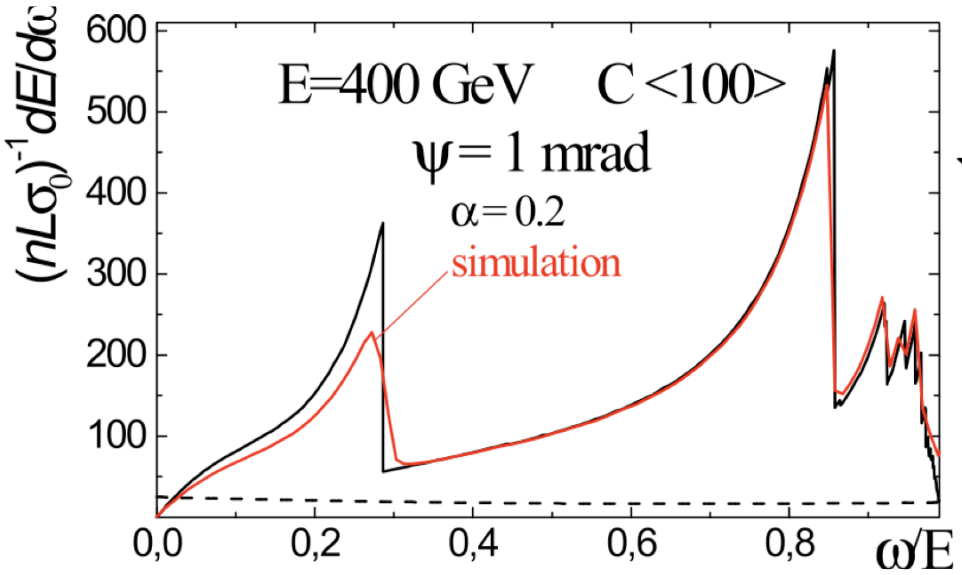


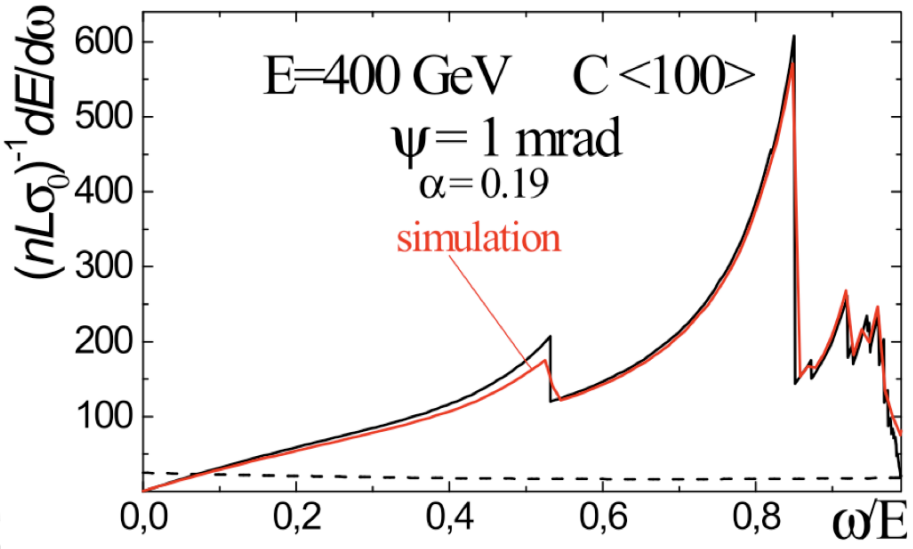


Simultaneously two planes work !!!

SIMULATION OF CB

(N.Shul'ga, V.Truten', V.Syshchenko, Nucl.Instr.Meth., B 119 (1996) 55)

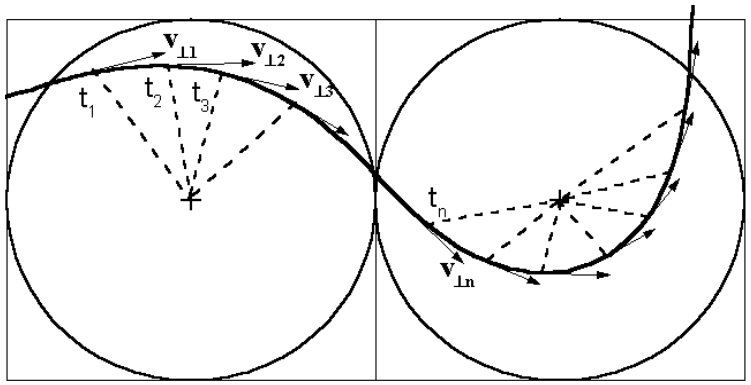




Simulation of the Coherent Radiation in Orinted Crystal

$$\frac{dE}{d\omega}=\frac{e^2\omega}{4\pi}\int_{\delta}^{\infty}\frac{dq}{q^2}\left[\frac{\varepsilon^2+\varepsilon'^2}{\varepsilon\varepsilon'}-4\frac{\delta}{q}\left(1-\frac{\delta}{q}\right)\right]\left|\mathbf{W}(q)\right|^2 \qquad \delta=\omega m^2/2\varepsilon\varepsilon'$$

$$\mathbf{W}(q)=\int_{-\infty}^{\infty}dt\,\dot{\mathbf{v}}_{\perp}(t,\ _0)e^{iqt} \qquad \mathbf{W}(q)=\sum_n e^{iqt_n}\Delta\ _n$$

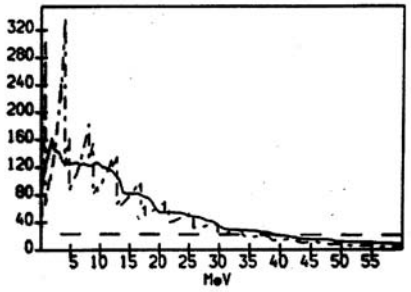


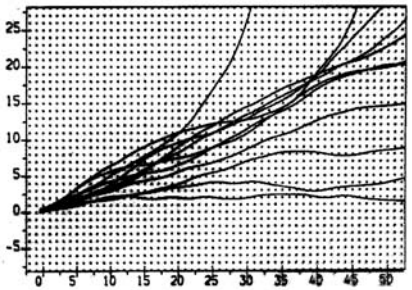
$$\Delta\dot{\mathbf{e}}_n=\Delta t\dot{\mathbf{v}}_{\perp n}=\mathbf{v}_{\perp n}-\mathbf{v}_{\perp n-1}$$

Coherent Radiation for real Electron and Positron trajectories in Crystals

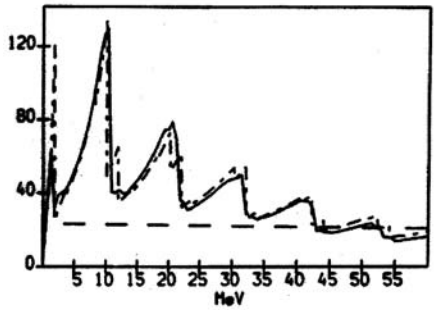
(Truten', N.Shul'ga, 1995 -…)

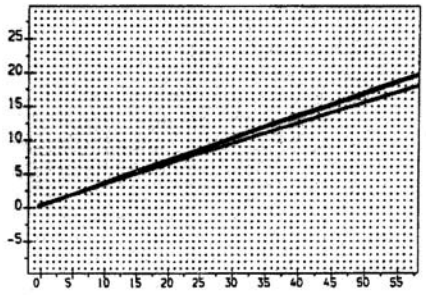
e^- $\psi = 2\psi_c$





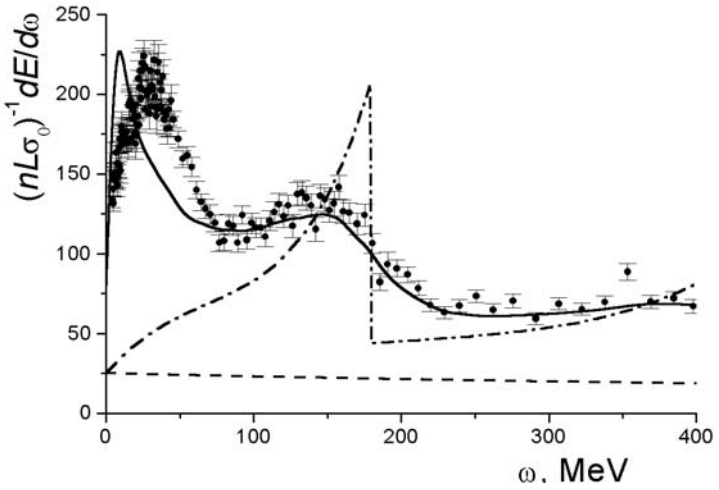
e^+ $\psi = 5\psi_c$



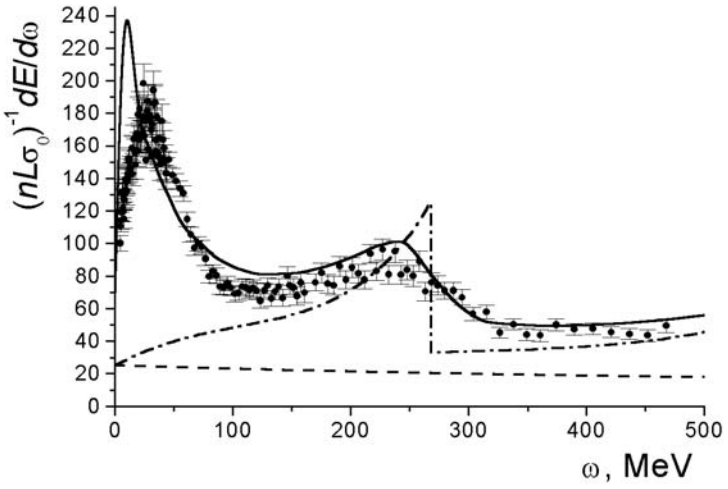


Theory (for real Crystal) – Experiment
Kharkov 1990 – …

Proc. of SPIE Vol. 5974 (2005), p. 59740D



$$ø = 5.5\,\text{mrad}\,(\sim 16 ø_c)$$



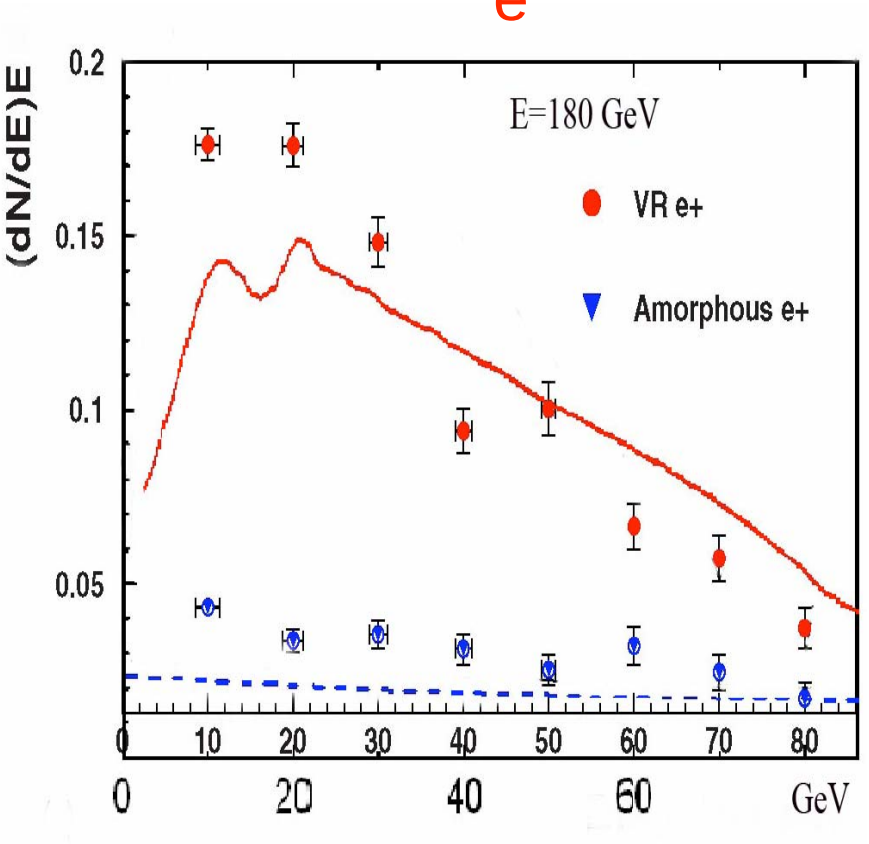
$$ø = 9\,\text{mrad}\,(\sim 27 ø_c)$$

$$E = 1.2\,GeV, \quad \text{diamond} \ \langle 110 \rangle \quad L = 300\mu$$

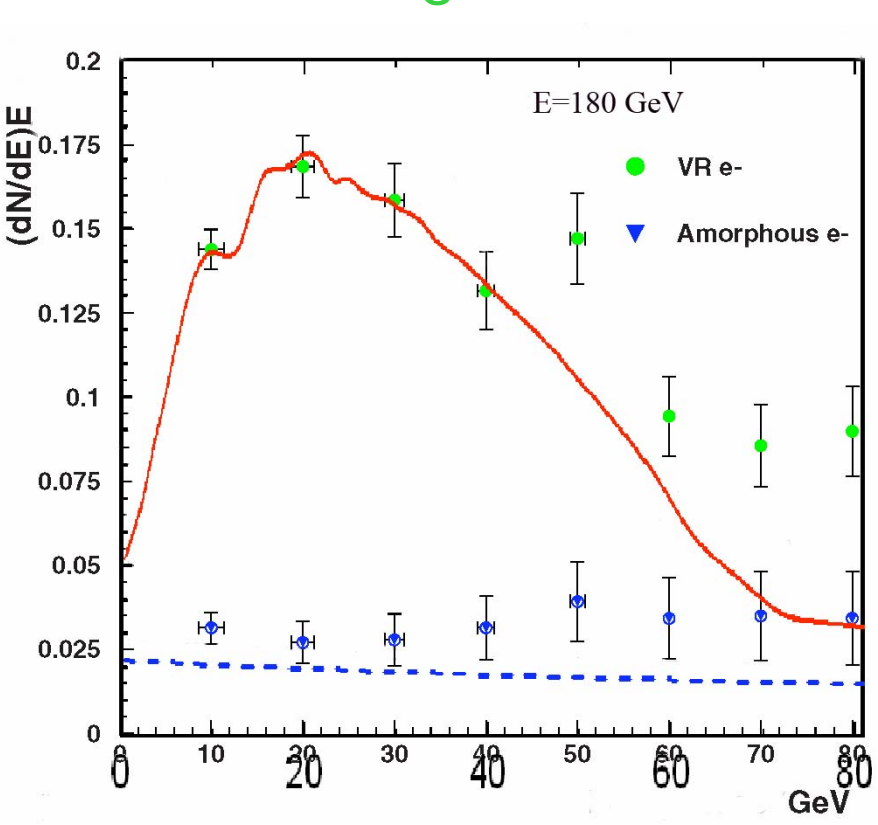
Simulation in Bent Crystal

CERN Experiment: W. Scandale at. al., Phys. Rev., A79, 2009

e^+



e^-



Theory

Thank You for Your Attention