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Memo

DATE: *November 4, 2005*

TO: RHIC E-Coolers

FROM: *Ady Hershcovitch*

SUBJECT: **Minutes of the November 4, 2005 Meeting**

Present: Ilan Ben-Zvi, Andrew Burrill, Wolfram Fischer, Alexei Fedotov, Lee Hammons, Ady Hershcovitch, Vladimir Litvinenko, William Mackay, Thomas Roser, Dejan Trbojevic, Gang Wang (SUNY Stony Brook).

Topics discussed: VORPAL Simulations and BETACOOL Computations in Wiggler Field, IBS Studies in RHIC

VORPAL Simulations and BETACOOL Computations for Non-magnetized Cooling in Wiggler Field: The meeting consisted of two presentations by Alexei. In the first presentation, Alexei showed a comparison between VORPAL simulation of the effect on an electron bunch cooling force in wiggler field and numerical integration using the BETACOOL code. There is a good agreement between the codes. Both show a reduction of about 30% of the cooling force due to the presence of the wiggler at the parameters chosen for that example.
Present electron beam cooling scenario is based on 2.5nC per bunch. To first order in this case a wiggler is not needed. However, for complete cooling of the whole ion beam, it may be desirable to increase the total electron bunch charge to 5nC per bunch. In that case recombinations might become an issue. The purpose of the wiggler is to increase transverse electron velocity components and reduce recombinations to negligible levels. Given the gain in overall cooling obtained by doubling the charge per electron bunch, 30% reduction in cooling force is a small price to pay.
Below is Alexei's presentation.

IBS Studies in RHIC: in the second presentation Alexei showed experimental IBS studies in RHIC and their preliminary comparison to theory. Experimental studies were performed with both gold and copper ion beams in both the blue and the yellow rings. Comparison to calculations was made utilizing the BETACOOL code using Martini's IBS formalism with 1). "exact" with RHIC-5 MAD lattice and 2). "model" with RHIC-5 lattice with higher dispersion. The experiments were set up in such a way that IBS is manifested solely in growth of emittance and ion bunch length. Experimental IBS measurements in gold were in agreement with the "model" that showed a factor of 2 higher growth than the "exact" calculations. In the case of copper there was good agreement between the "exact" calculations and the measurements.

Comparison between VORPAL simulation in wiggler field (D. Bruhwiler, G. Bell) and numerical integration using BETACOOL – November 1, 2005

Simulation parameters:

Electron beam:

ne=2.0e14 m^{-3}

tau=1.56e-9sec

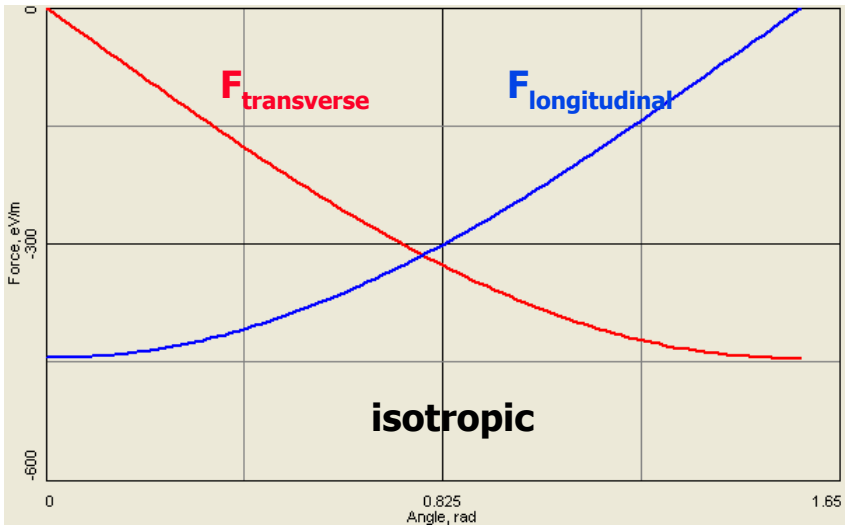
rms velocities V_e_x,y=3e5 m/s, V_e_z=1e5 m/s

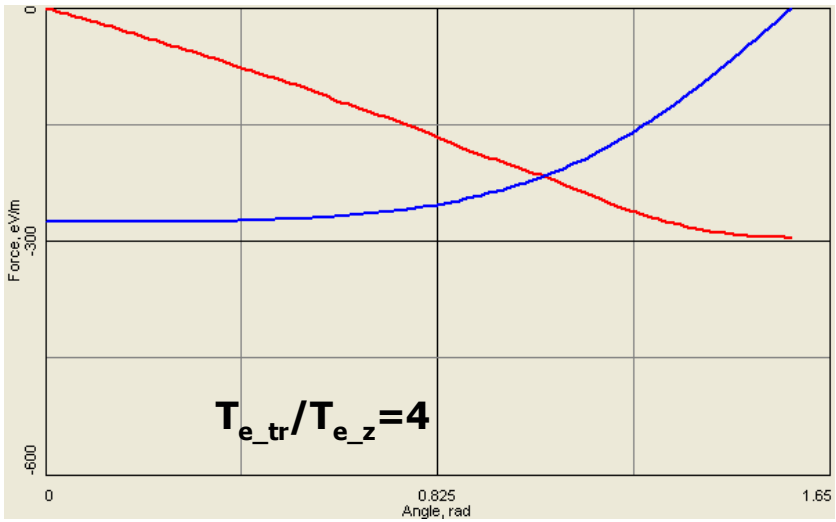
Wiggler:

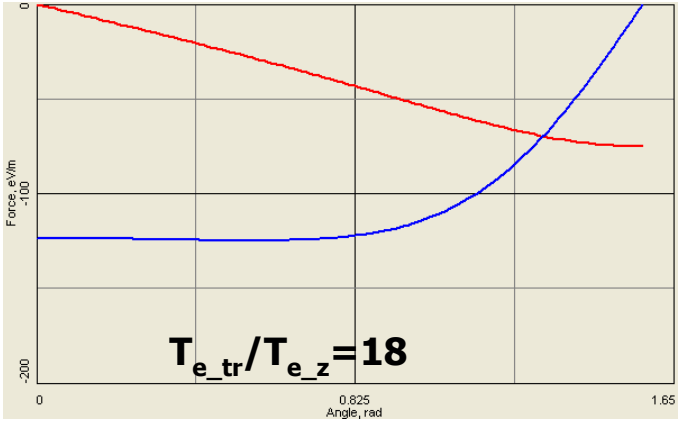
B=10G

λ=10cm

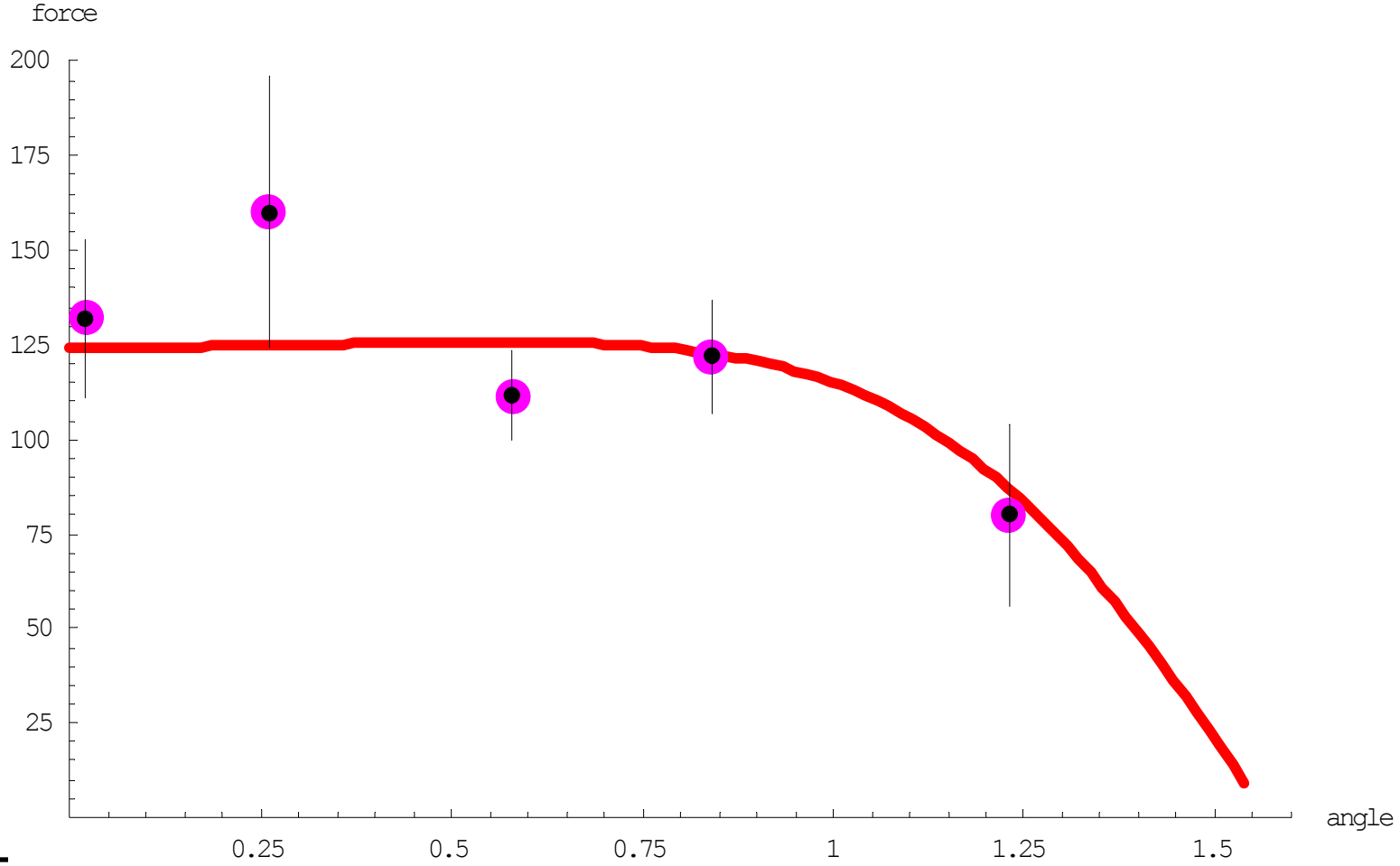
Effect of anisotropy in Unmagnetized force



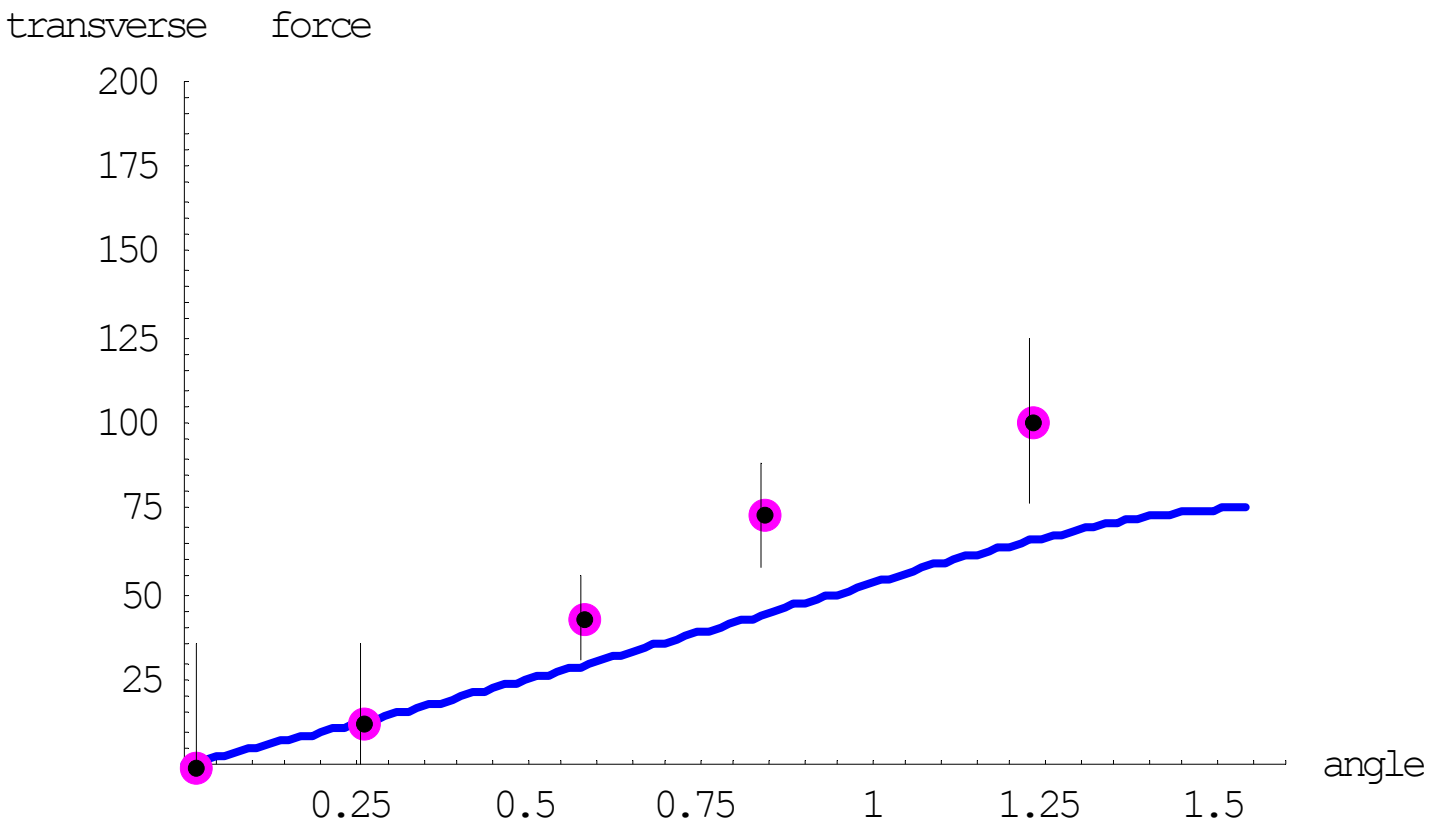




Angular dependence (for V_ion=3e5 m/s) of Longitudinal component – without wigglers



Angular dependence (for V_ion=3e5m/s) of Transverse component – without wigglers



Non-magnetized cooling and recombination

Possible problem of Non-Magnetized cooling is recombination because now we have very small electron transverse temperatures of the order of 0.5-1 eV.

This can be controlled by helical undulators which introduce coherent azimuthal angle:

$$\theta = \frac{eB\lambda}{2\pi pc}$$

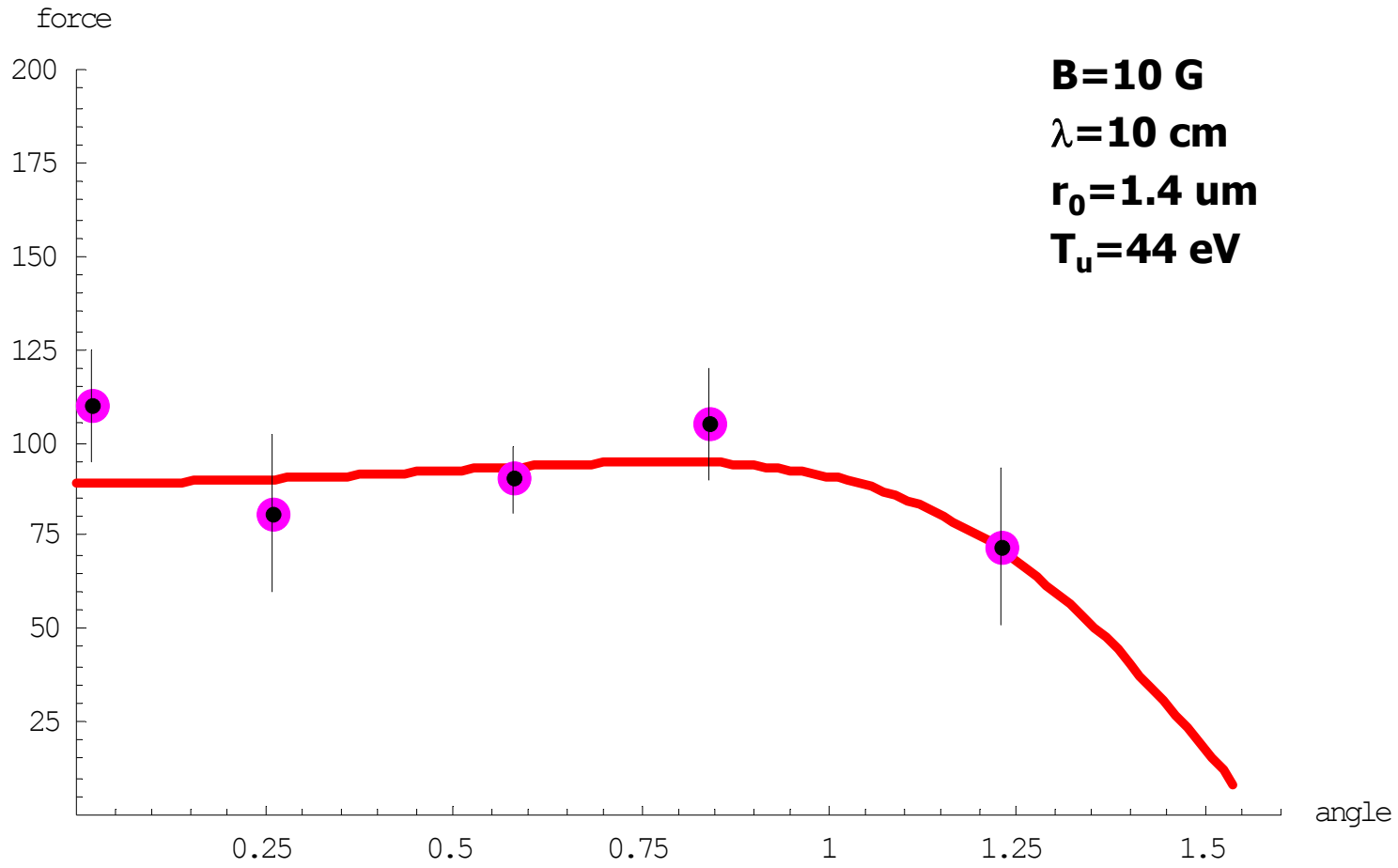
which can produce large T_u to suppress recombination

However, this may lead to some reduction in the cooling force by a factor

$$\ln\frac{\rho_{\max}}{\rho_{\min}} / \ln\frac{\rho_{\max}}{r_0}$$

where $r_0 = \frac{\theta\lambda}{2\pi}$

Angular dependence (for V_ion=3e5m/s) of Longitudinal component – with wigglers



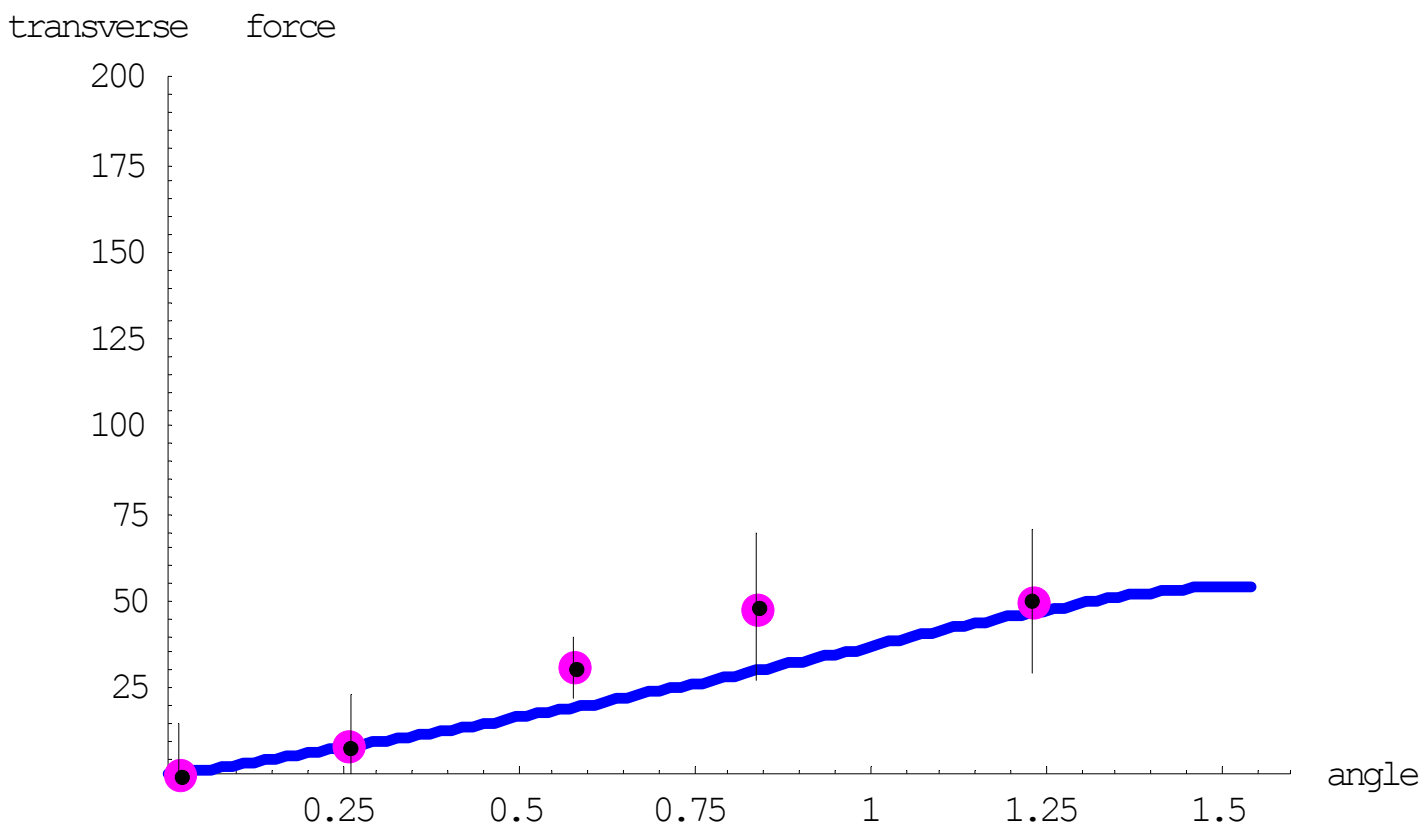
B=10 G

λ=10 cm

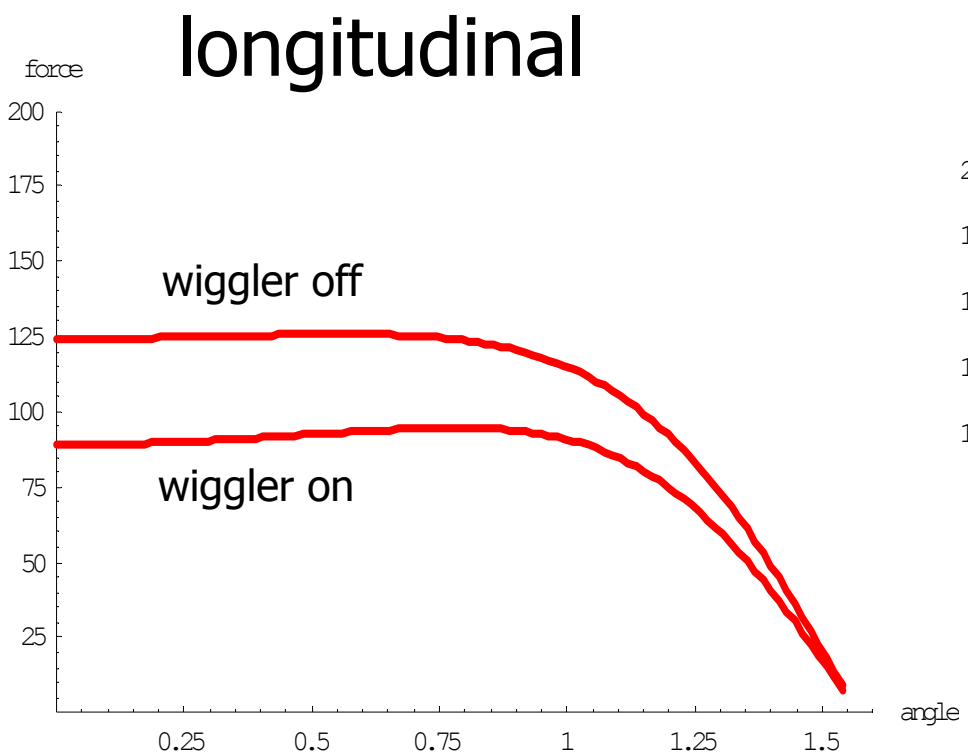
r_0=1.4 um

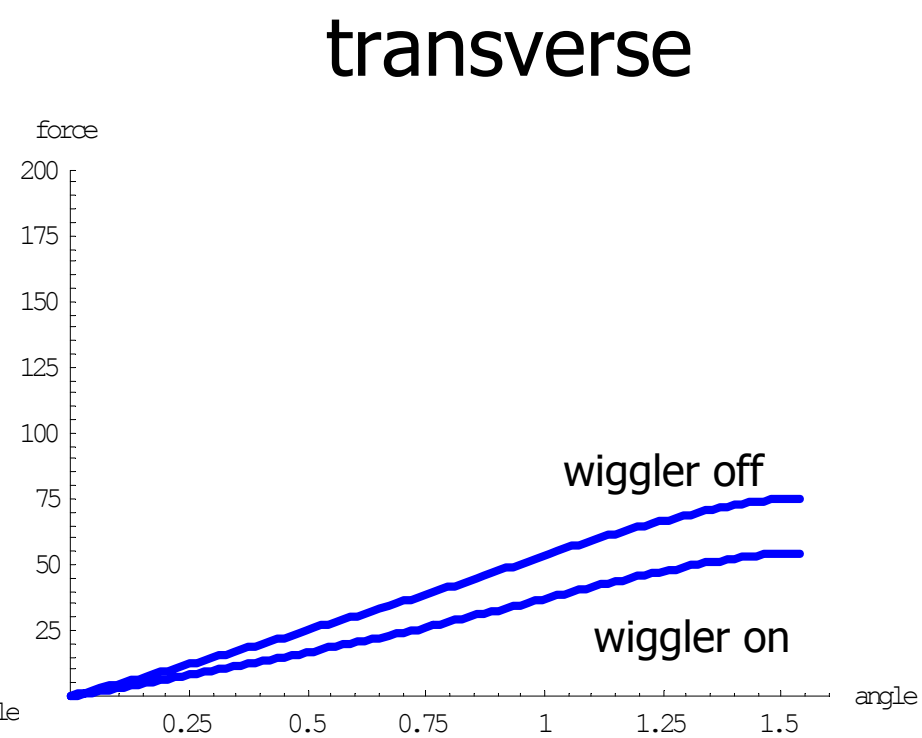
T_u=44 eV

Angular dependence (for V_ion=3e5m/s) of Transverse component – with wigglers



Longitudinal and Transverse components (at V_ion=3e5m/s) – with and without wigglers (only BETACOOL numerical integration is shown)





reduction in force as expected from logarithm