COHERENT EFFECTS IN THE IONIZATION LOSS OF HIGH-ENERGY ULTRASHORT ELECTRON BUNCHES

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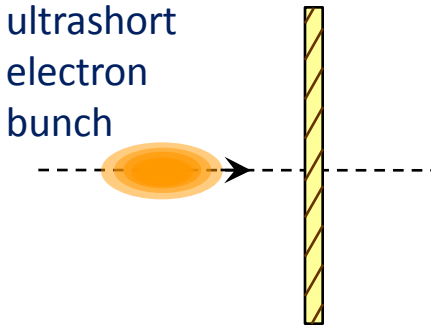
COHERENT EFFECT IN IONIZATION LOSS OF ULTRASHORT ELECTRON BUNCHES

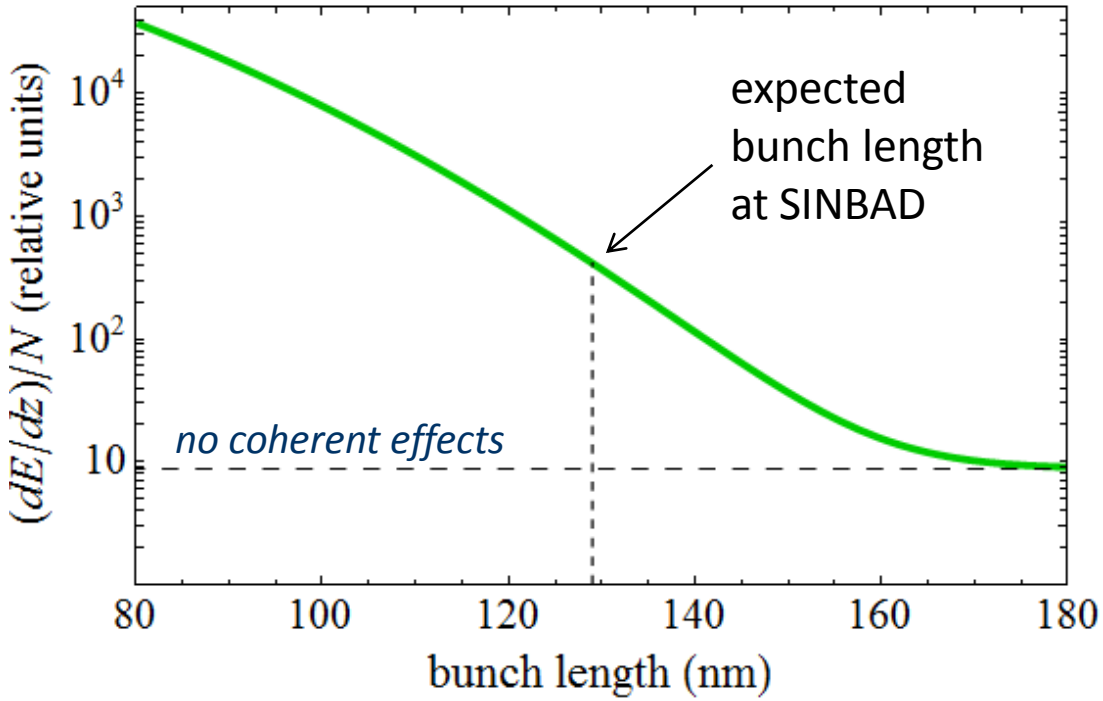
S.V. Trofymenko, N.F. Shul'ga // Phys. Lett. A, 383 (2019) 2561



Applicable for **European XFEL** and **SINBAD** at DESY

Possibility of enhancement of the ionization loss of ultrashort electron bunches by several orders of magnitude compared to the value from the Bethe-Bloch formula. Analogous enhancement is expected for characteristic radiation yield

Dependence of the ionization loss on the bunch length per single electron:



estimation for **SINBAD facility at DESY** (thin solid targets or gaseous targets)

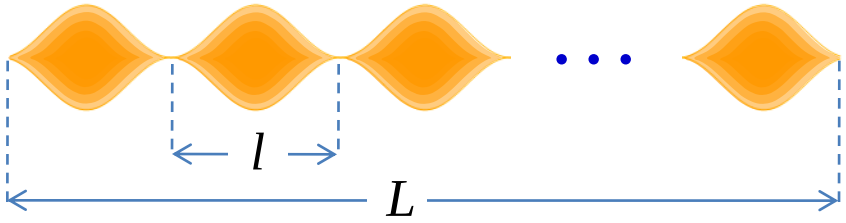
possibility of longitudinal and transversal bunch size diagnostics

RESONANCE EFFECT IN THE IONIZATION LOSS OF A MICROBUNCHED BEAM

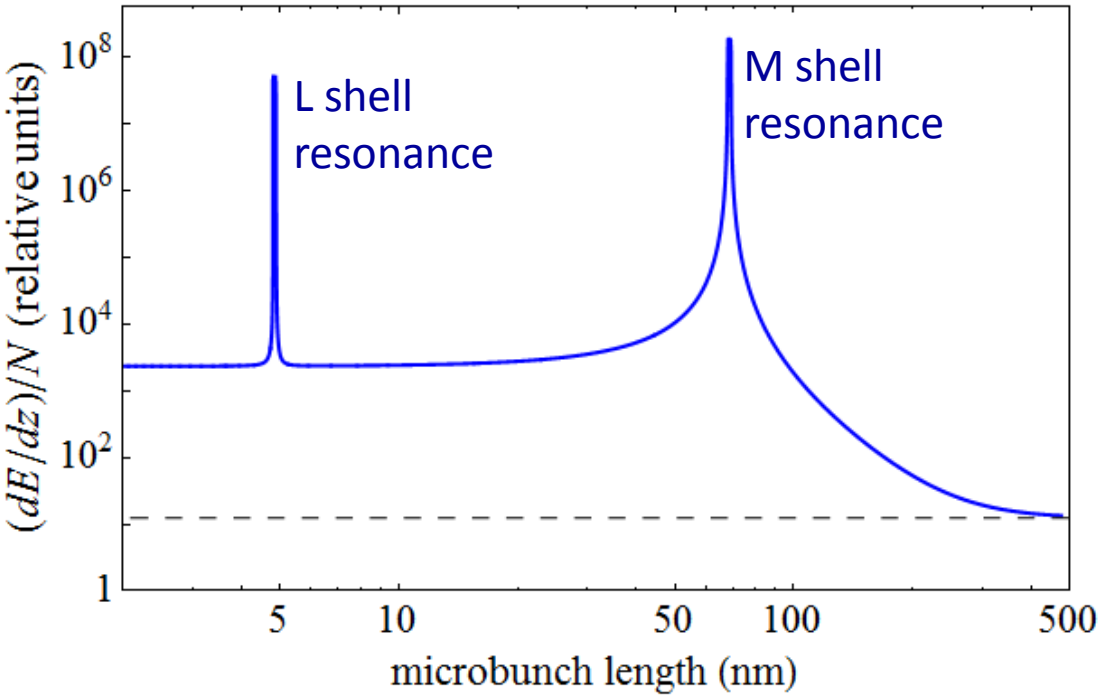
S.V. Trofymenko, N.F. Shul'ga // Phys. Rev. Accel. Beams, 23 (2020) 084501

L – beam length

l – microbunch length



Dependence of the ionization loss on the microbunch length in thin Si target:



Estimation for **European XFEL** (L =24 μm, Q $\approx$ 1 nCl, E= 17.5 GeV)

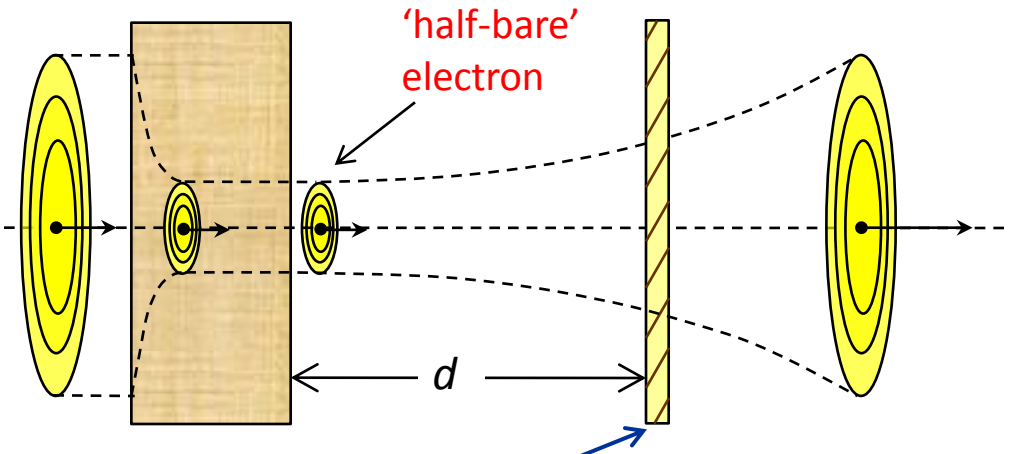
possibility of studying the microbunching process and controlling the microbunching quality

IONIZATION LOSS OF 'HALF-BARE' ELECTRONS IN THIN TARGET

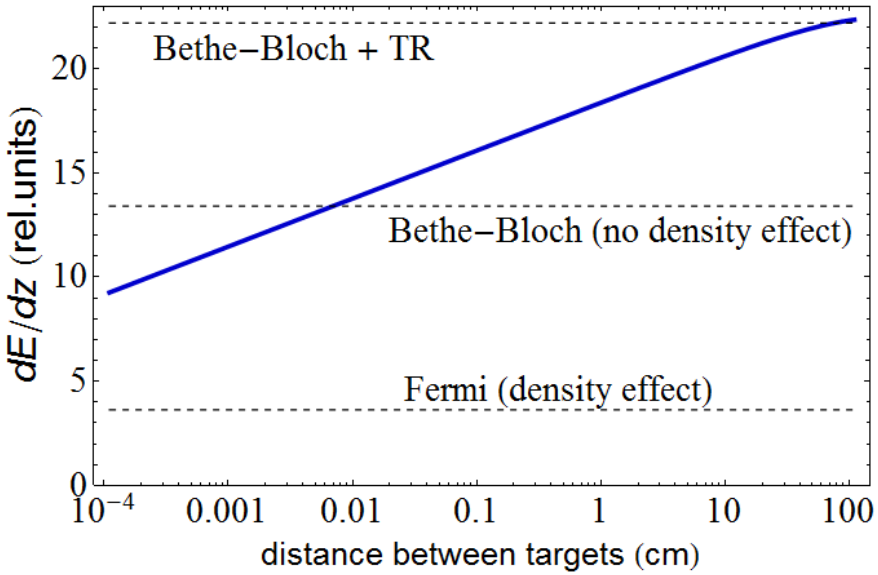
N.F. Shul'ga, S.V. Trofymenko // Phys. Lett. A, 376 (2012) 3572
S.V. Trofymenko, N.F. Shul'ga // Phys. Rev. Accel. Beams 19 (2016) 112801

Previous studies on 'half-bare' electrons in NSC KIPT (for bremsstrahlung):
N.F. Shul'ga, S.P. Fomin, *JETP Lett.* (1978)
N.F. Shul'ga, S.P. Fomin, *Phys. Lett. A* (1986)
N.F. Shul'ga, S.P. Fomin, *JETP* (1998)

Experimental evidence (CERN NA63):
H.D. Thomsen et. al. *Phys. Lett. B* (2009)

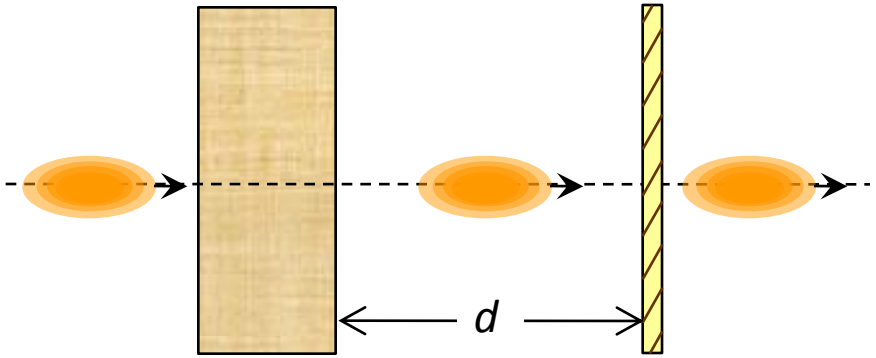


Electron ionization loss in thin target as a function of *d* (for 5 GeV electrons):

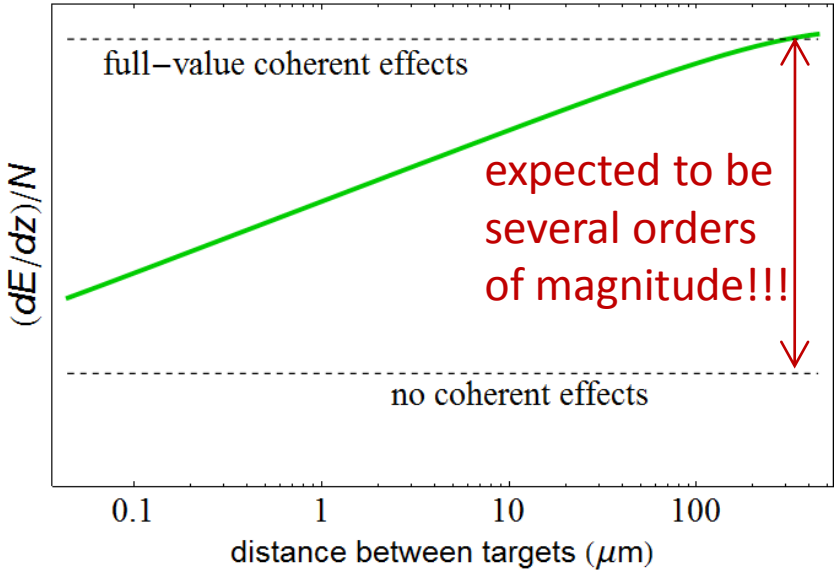


IONIZATION LOSS OF 'HALF-BARE' ELECTRON BUNCHES IN THIN TARGET

Effects, associated with 'half-bare' electrons are expected to be considerably enhanced for ultrashort bunches due to coherent effects in the ionization loss



ultrashort electron bunch (for 100 MeV, as at SINBAD):

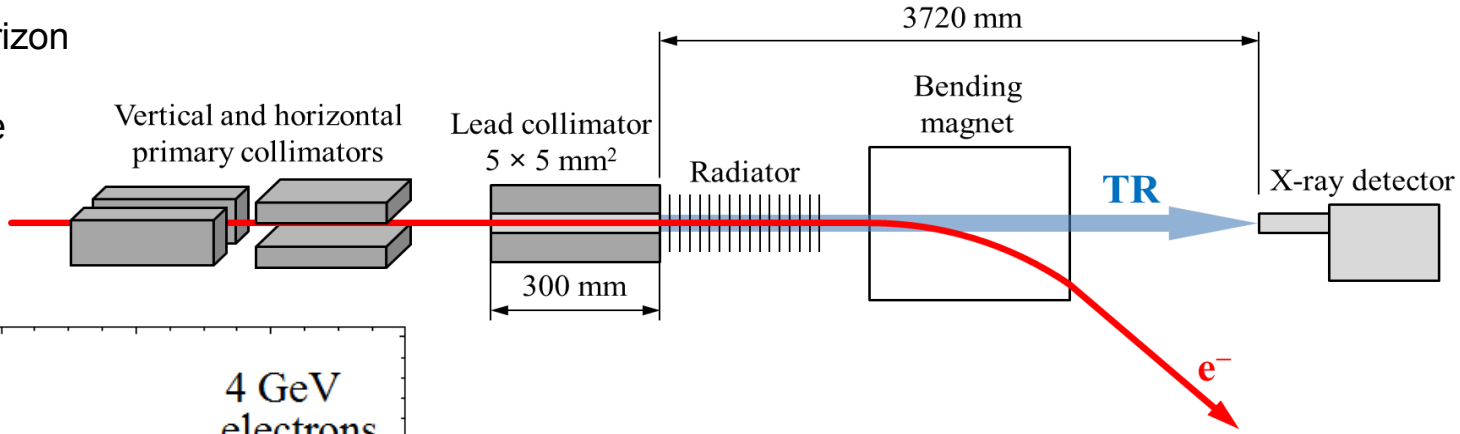


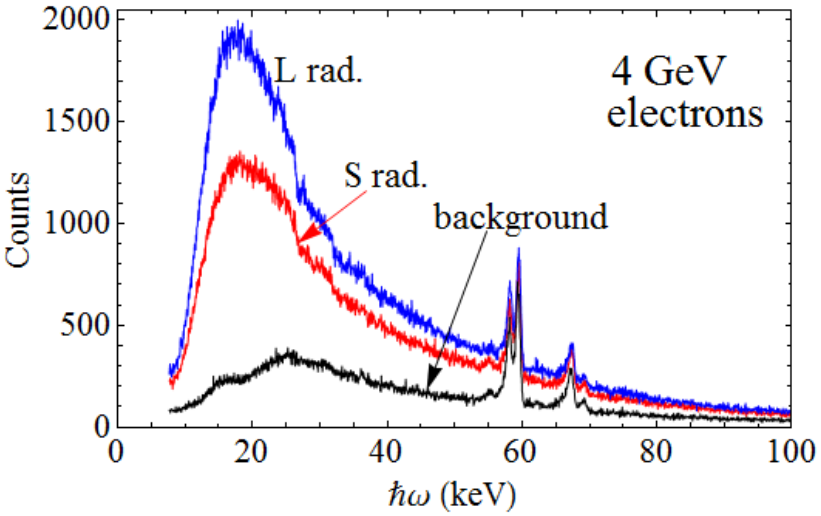
for small distance *d* – no coherent effects;
for large *d* – full-value coherent effects ⟶
huge difference between the ionization loss values

X-RAY TRANSITION RADIATION BY 'HALF-BARE' ELECTRONS. EXPERIMENT AT DESY II TEST BEAM (TB21)

S.V. Trofymenko, R.M. Nazhmudinov, A.V. Shchagin, A.S. Kubankin, A.P. Potylitsyn, A.S. Gogolev, N.A. Filatov, G. Kube, N.A. Potylitsina-Kube, M. Stanitzki, R. Diener, A. Novokshonov,
Nucl. Instrum. Meth. B, 476 (2020) 44

European Union's Horizon 2020 research and innovation programme (grant agreement No 654168)





L radiator ⟶ period is 3 mm ('dressed' electrons)

S radiator ⟶ period is 0.3 mm ('half-bare' electrons)

Experiment on characteristic radiation (DESY II TB21):

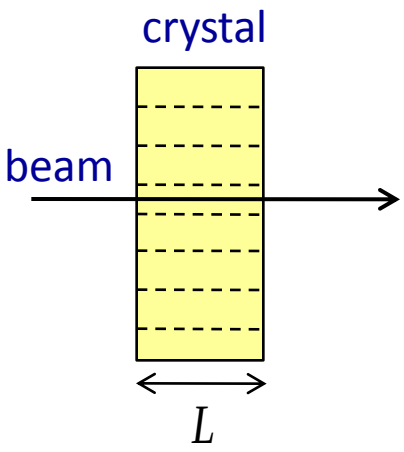
R.M. Nazhmudinov, A.V. Shchagin, S.V. Trofymenko, I.A. Kishin, A.S. Kubankin, A.P. Potylitsyn, A.S. Gogolev, N.A. Filatov, G. Kube, N.A. Potylitsina-Kube, M. Stanitzki, A. Novokshonov,
J. Phys. B: At. Mol. Opt. Phys., 54 (2021) 045201

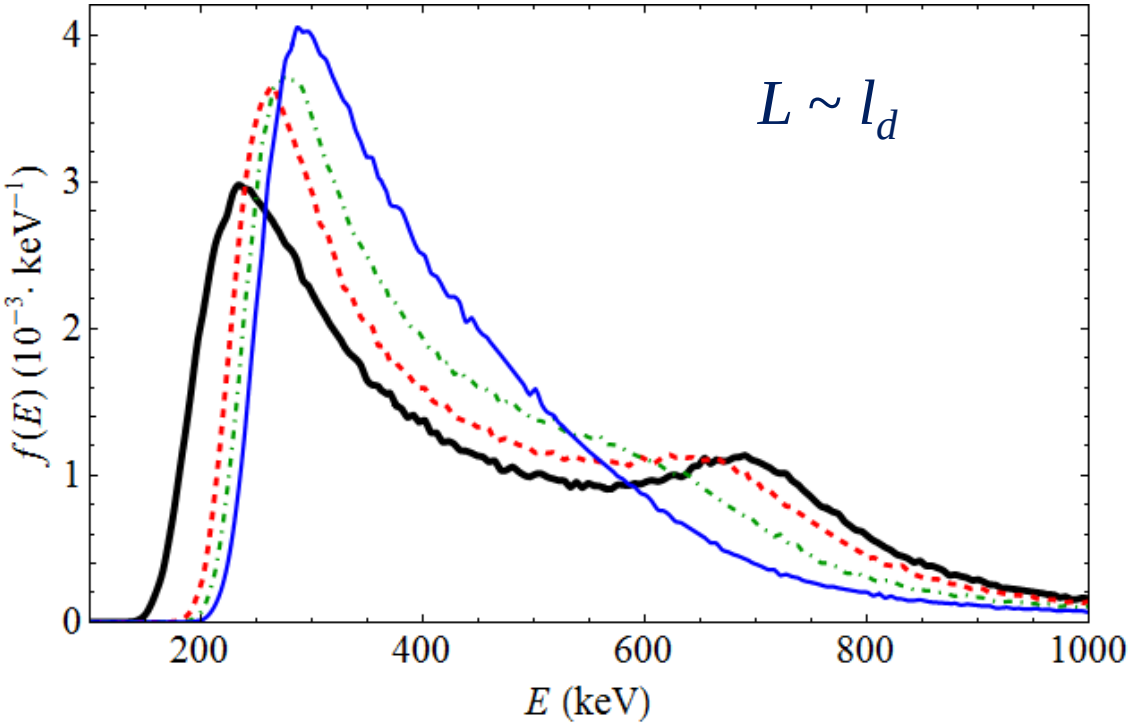
IONIZATION LOSS SPECTRUM OF NEGATIVE CHANNELED PARTICLES

S.V. Trofymenko , I.V. Kyryllin, Eur. Phys. J. C, 80 (2020) 689

S.V. Trofymenko, I.V. Kyryllin, O.P. Shchus, East. Eur. J. Phys. 4, 68 (2021)

Ionization loss distribution for different dechanneling lengths:





Possibility of the dechanneling length measurement on the basis of registration of the channeled particles ionization loss spectra

CONCLUSIONS

- Possibility for the study of coherent effects in the ionization loss or characteristic radiation for electron bunch parameters achievable at SINBAD and European XFEL

- Possibility for the study of effects associated with ‘half-bare’ electrons due to their significant enhancement by the coherent effects

- Applicability for diagnostics of transversal and longitudinal bunch size and study of the microbunching process

- Dechanneling length measurement on the basis of registration of the channeled particles ionization loss spectra