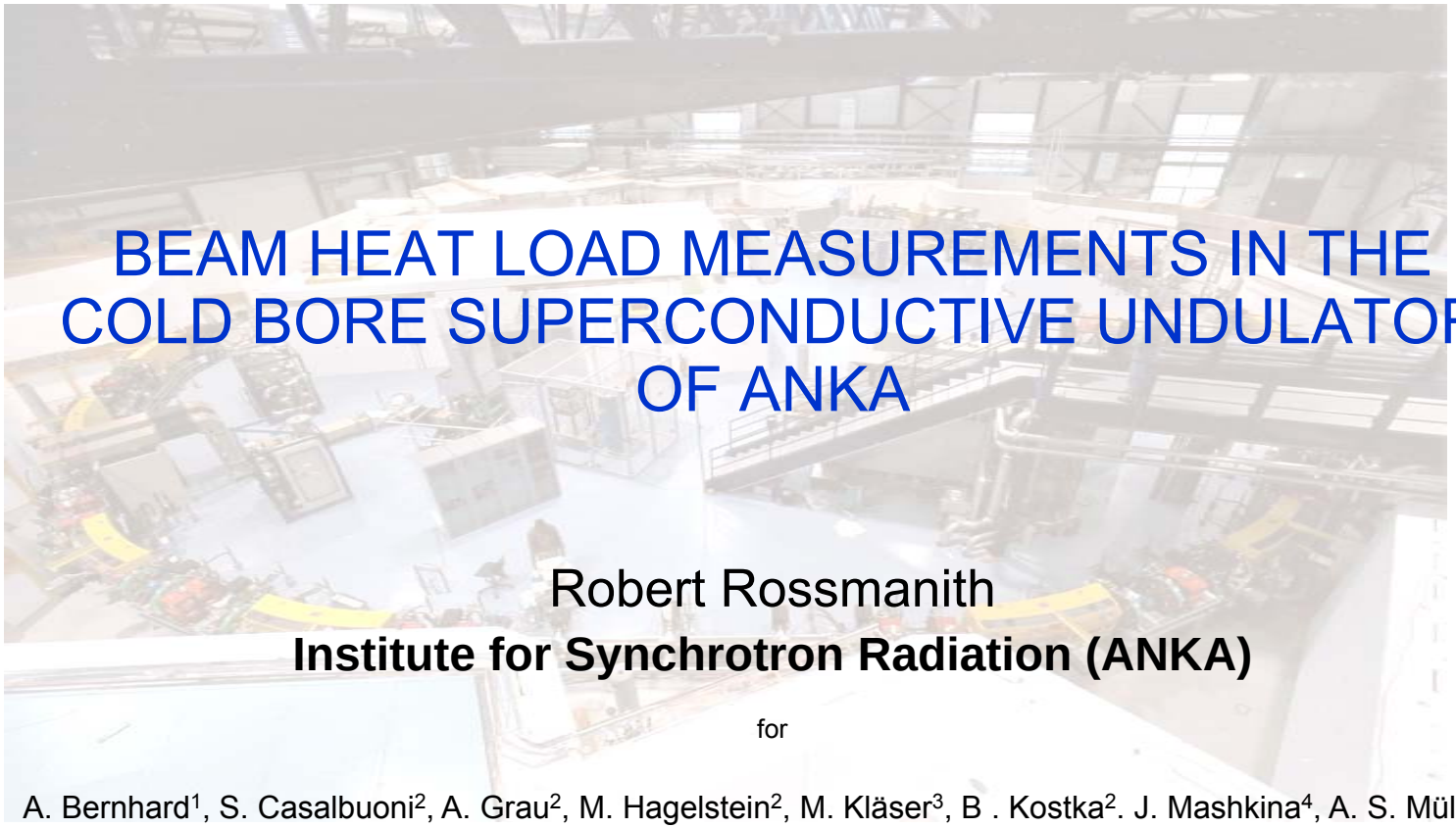


BEAM HEAT LOAD MEASUREMENTS IN THE COLD BORE SUPERCONDUCTIVE UNDULATOR OF ANKA

Robert Rossmanith

Institute for Synchrotron Radiation (ANKA)

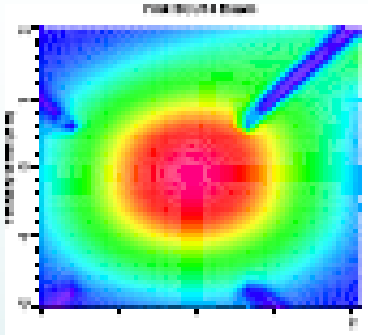
for

A. Bernhard[1], S. Casalbuoni[2], A. Grau[2], M. Hagelstein[2], M. Kläser[3], B . Kostka[2]. J. Mashkina[4], A. S. Müller[2], R. Rossmanith[2], Th. Schneider[3], E. Steffens[4], D. Wollmann[1], F. Zimmermann[5], T. Baumbach[1,2]

[1] Faculty of Physics, Univ. Karlsruhe, Germany
[2] Institute for Synchrotron Radiation (ANKA), Research Center Karlsruhe, Germany
[3] Institute for Technical Physics, Research Center Karlsruhe, Germany
[4] Physics Institute II, Univ. Erlangen-Nürnberg, Germany
[5]CERN, Geneva, Switzerland

NbTi SCU **Demonstrator**

Period length 14 mm, 100 periods, gap 8, 12, 16 mm

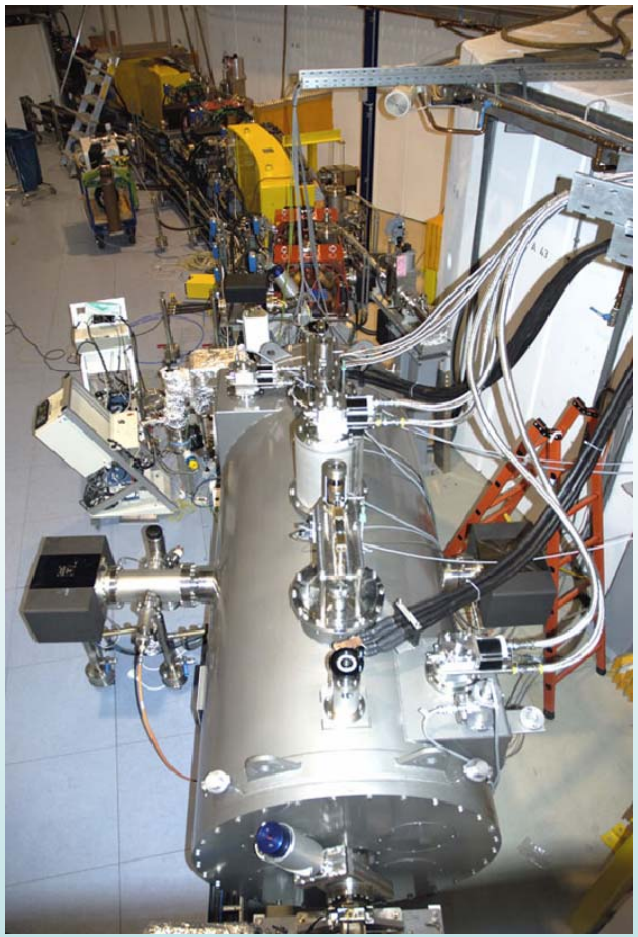


First beam March 29 2005

Since March 2005 cold in ANKA

(only routine maintenance of cryo-coolers)

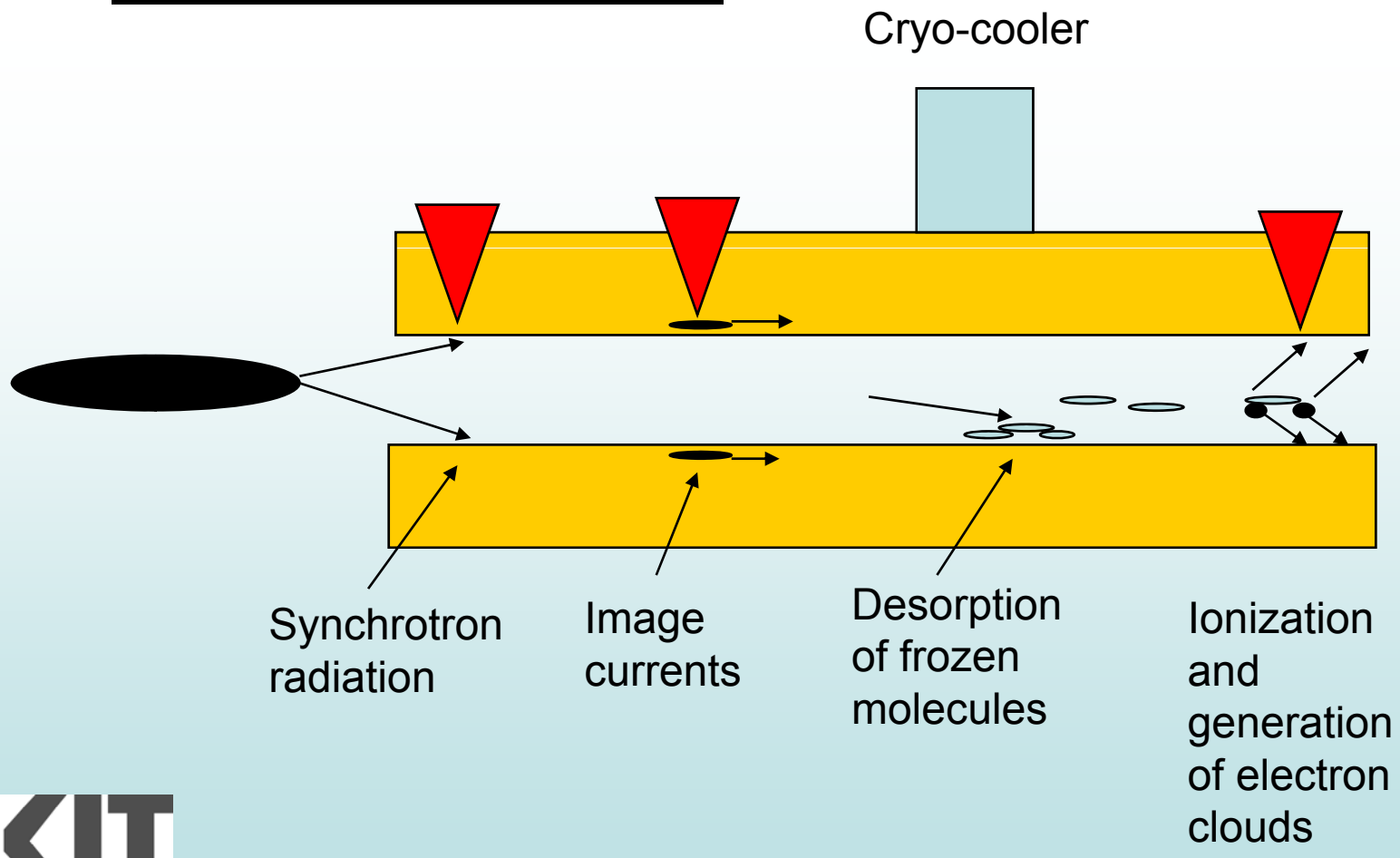
Compatible with normal user operation



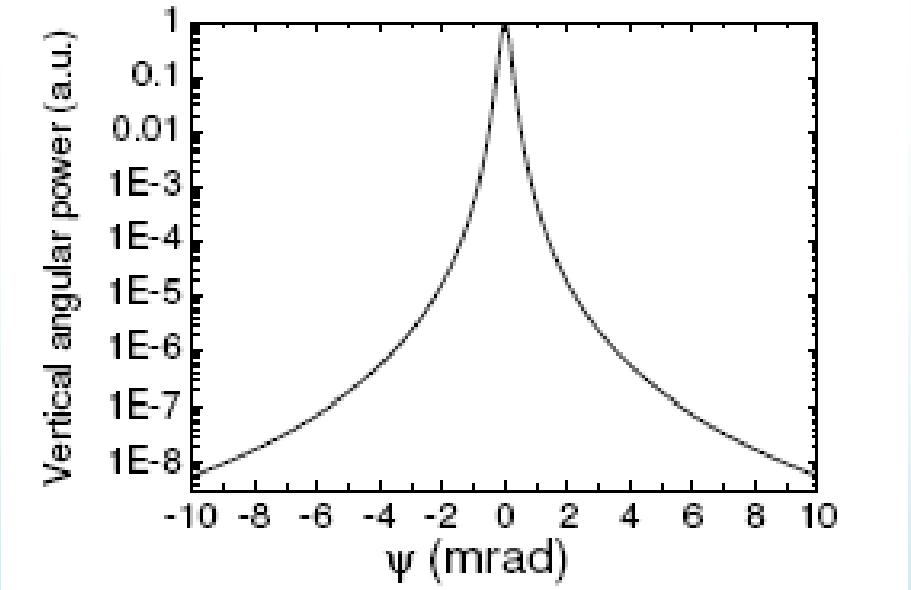
Built by ACCEL Instr. GmbH, Germany

Karlsruhe Institute of Technology

Heat mechanism by the beam



Synchrotron radiation scales with E^4 and I (E beam energy and I beam current



Vertical opening angle of synchrotron radiation vs. relative power (at 2.5 GeV)

(is a serious limitation to sc wigglers /undulators (10 m and longer) for damping rings for linear colliders

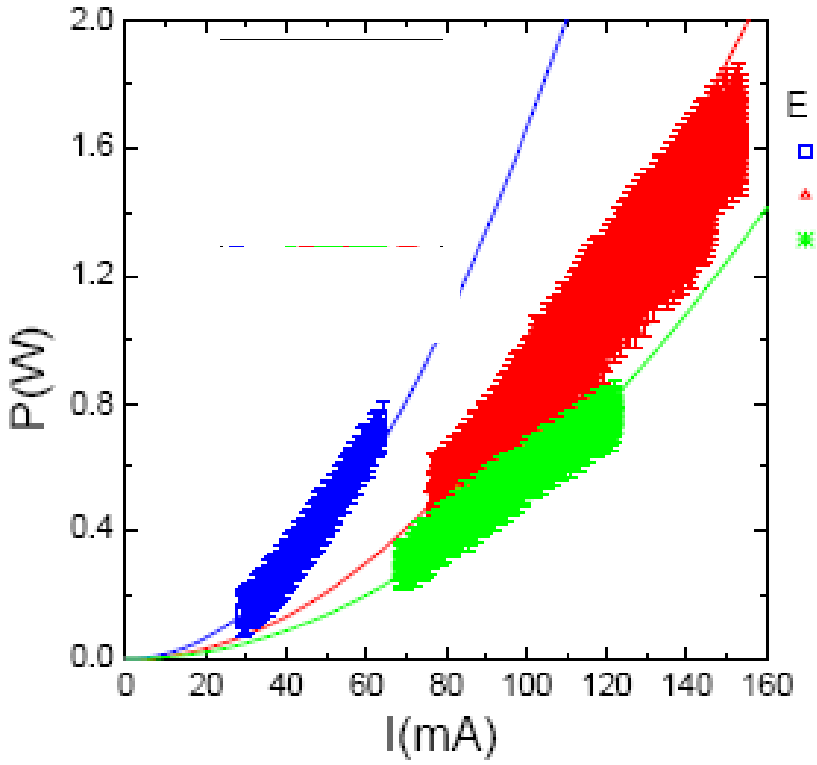
Resistive wall heating: modified Piwinski formula

$$P_{RW} = \frac{I^2}{M.f_0.\pi^2.g} \int_0^\infty S^2(\omega).R_{Surf}(\omega).d\omega \qquad \text{[W/m]}$$

I .....the average current
f_0....revolution frequency
g ....gap width
M.....number of bunches/ revolution
$S(\omega) = \exp(-\sigma_z^2\, \omega^2/2c^2)$
σ_z ...bunchlength
$R_{Surf(\omega)}$ the surface resistance.

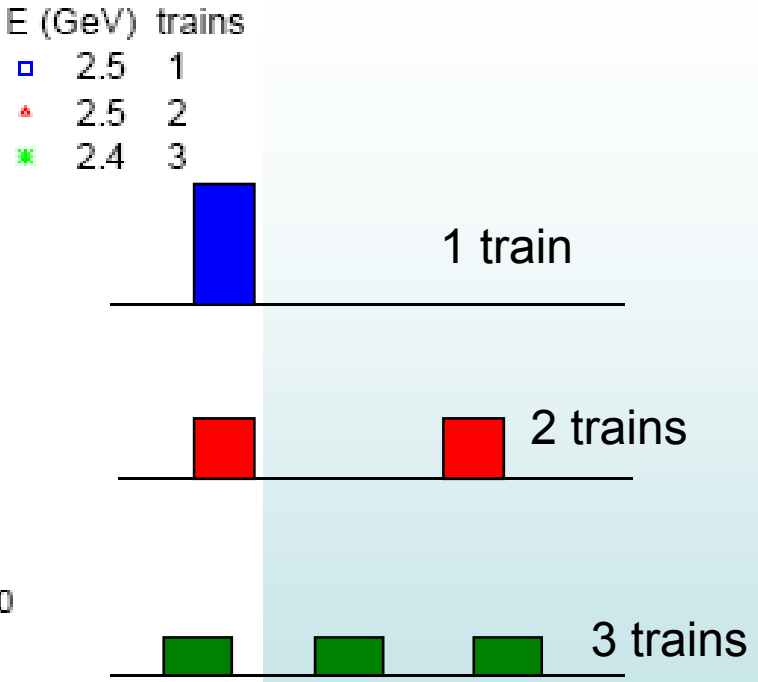
The deposited power scales with I^2 and the inverse of the gap width.

Measurement: heat load depends on average current **and** bunch current



Average current

gap 20 mm

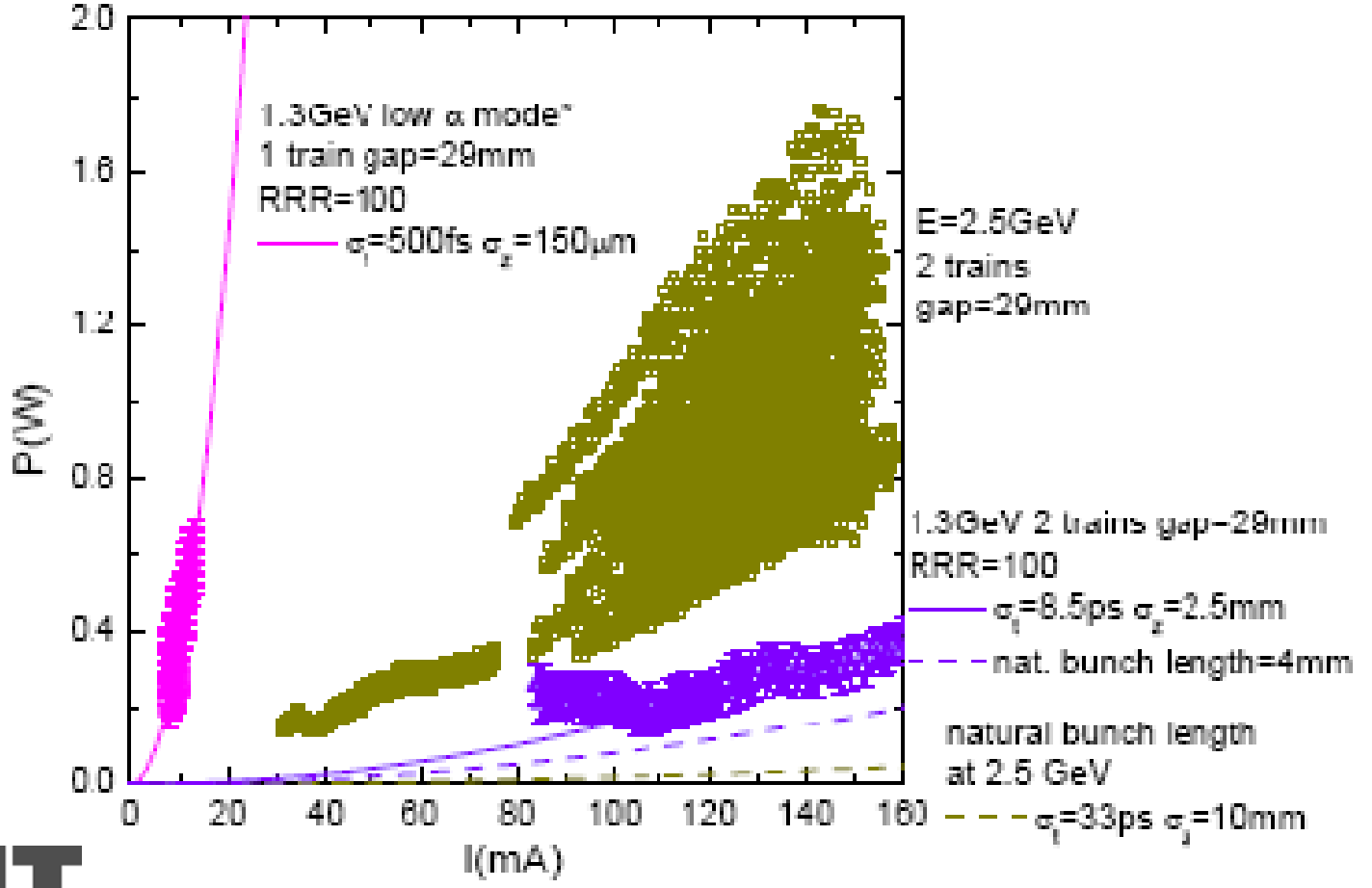


one revolution

Train = 32 bunches

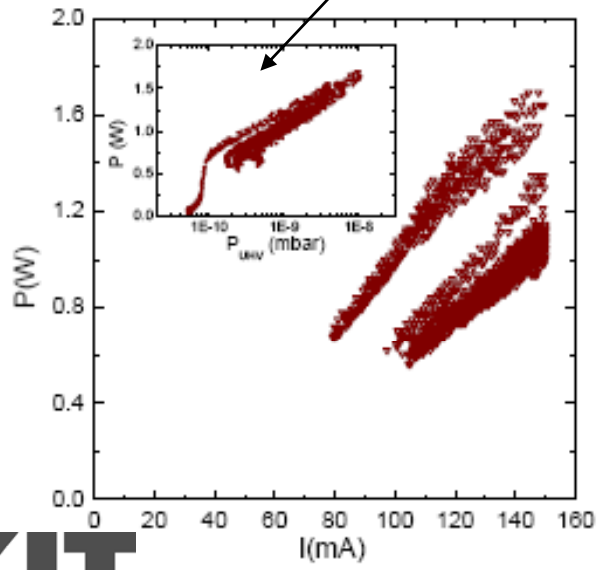
How does the heat load depend on the bunch length?

Solid and dotted lines: Piwinski formula

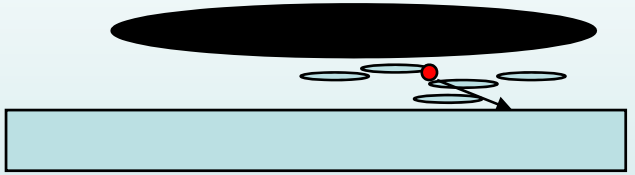


Beam heat with long bunches more than a factor of 10 higher than expected by resistive wall heating

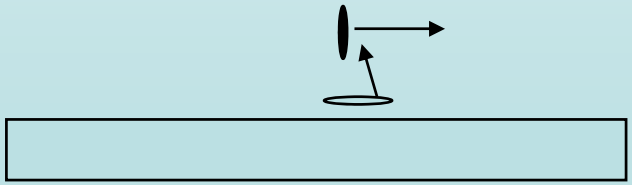
Vacuum pressure in undulator



Long bunches: desorption, ionization, electrons accelerated to surface by bunch field, more desorption etc.



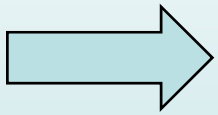
Short bunches: desorped molecules cannot be ionized again by beam



SUMMARY

Critical parameter A = bunch length /gap width

If A > 1, electron cloud heating is dominating



Modify cold bore for long bunches