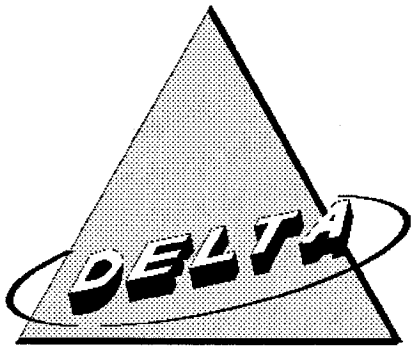
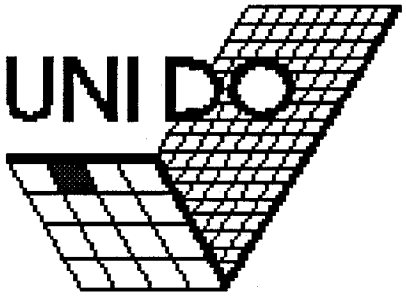




Workshop on Future Light Sources, Argonne
April 6-9, 1999

Impedance Characterization and Correlated Longitudinal Beam Studies at DELTA

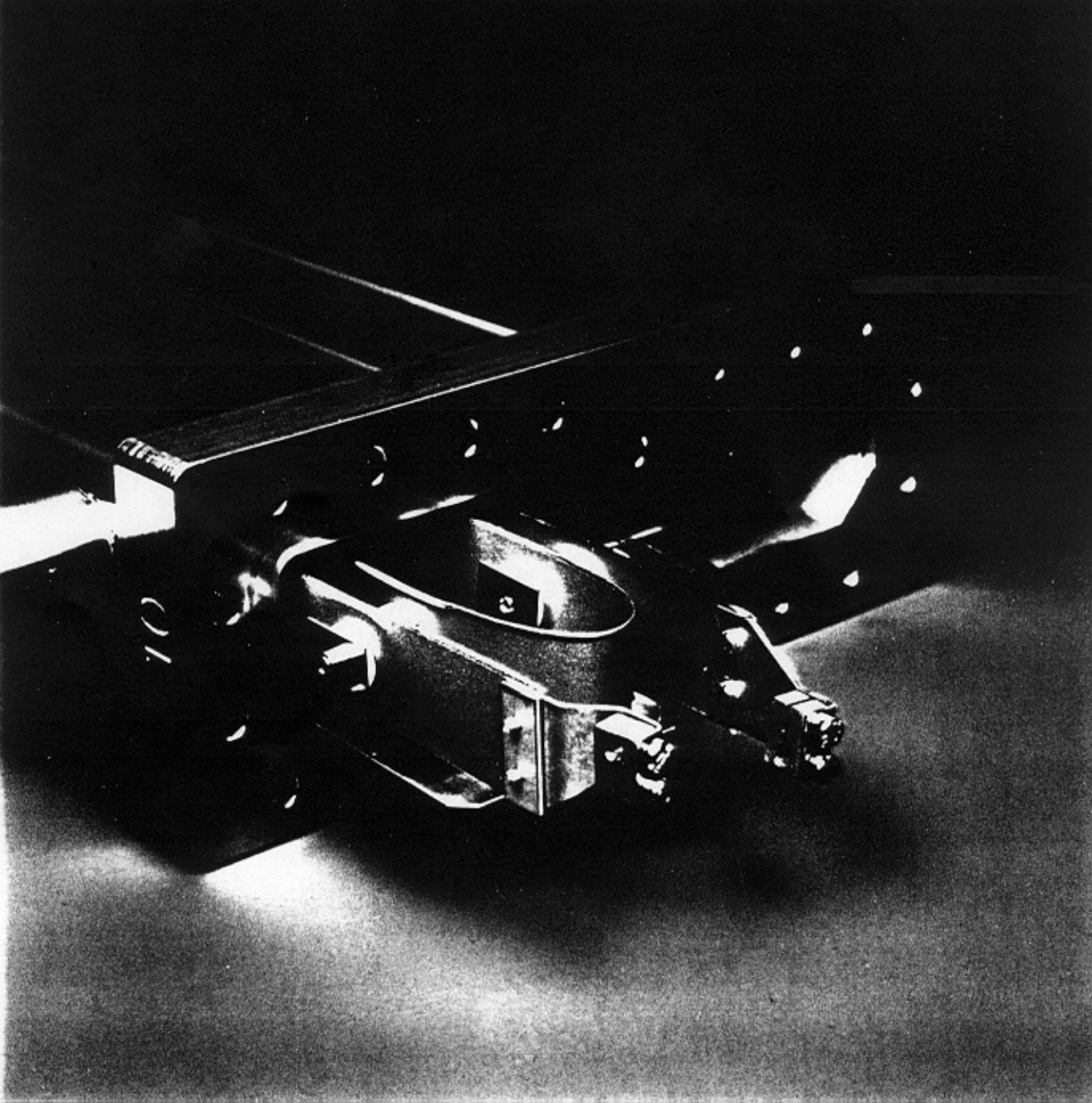
Thomas Weis

Institute for Accelerator Physics and Synchrotron Radiation
Department of Physics
University of Dortmund, Germany

Beam and Impedance Characterization at DELTA

Investigations on Microwave Instability and Bunch Lengthening Effects

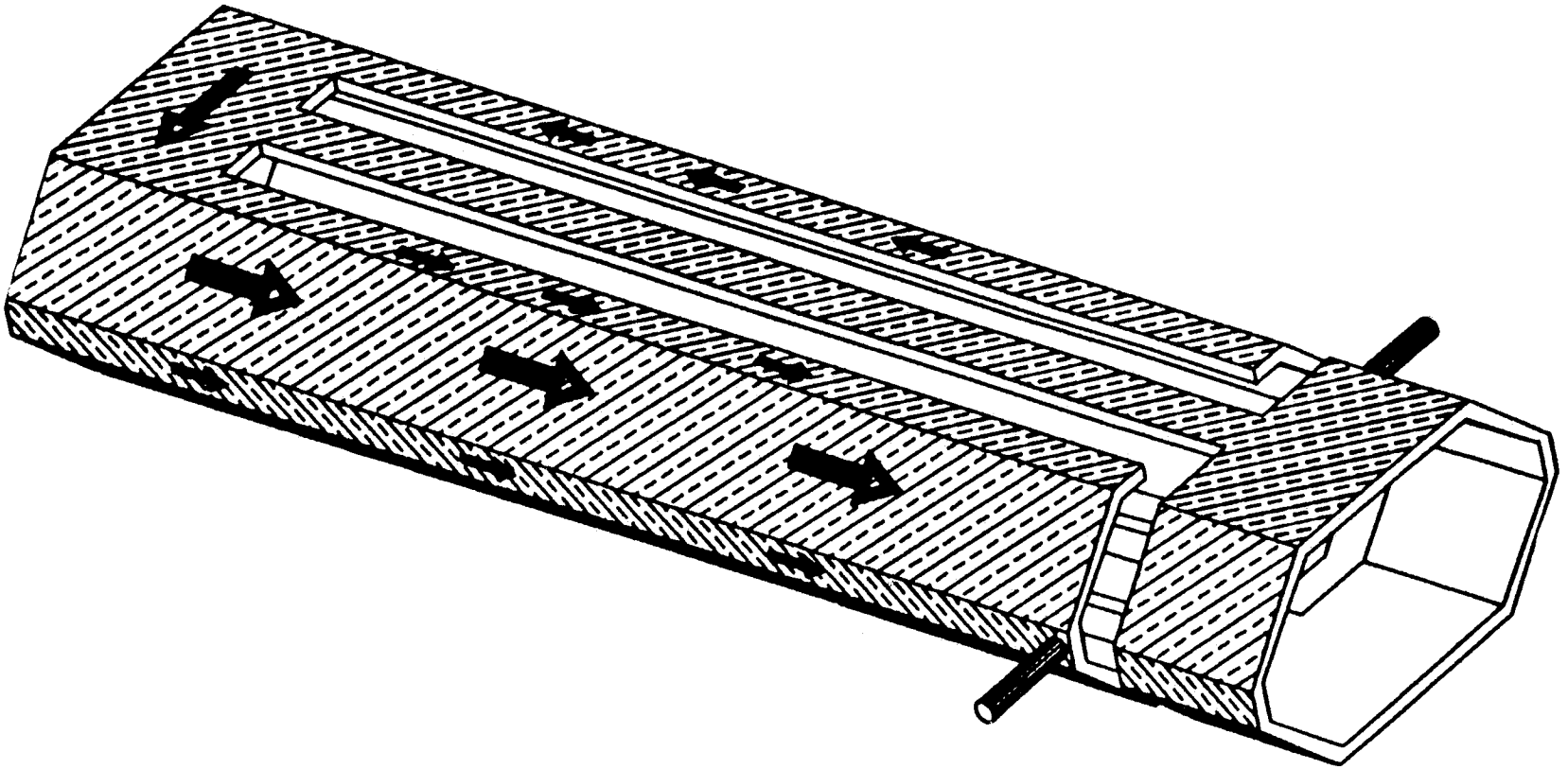
- Interested institutions: ENEA (Frascati), CLRC (Daresbury), DELTA
- Modeling of machine impedance together with beam studies
- DELTA offers ideal situation (impedance optimized vacuum chamber design, low basic impedance of $Z/n = 0.37\ \Omega$)
- All presently installed components have been characterized at least by lossfactors
- Wide range of possible energies (400 - 1500 MeV) and RF-bucket height available
- Single bunch currents of at least 20 mA are or should be available for all energies
- The turbulent bunch lengthening regime is easily accessible for all energies
- Bunchlength measurement possible via undulator SR emission with streak camera (not continuously available yet)
- First promising results at 450 MeV



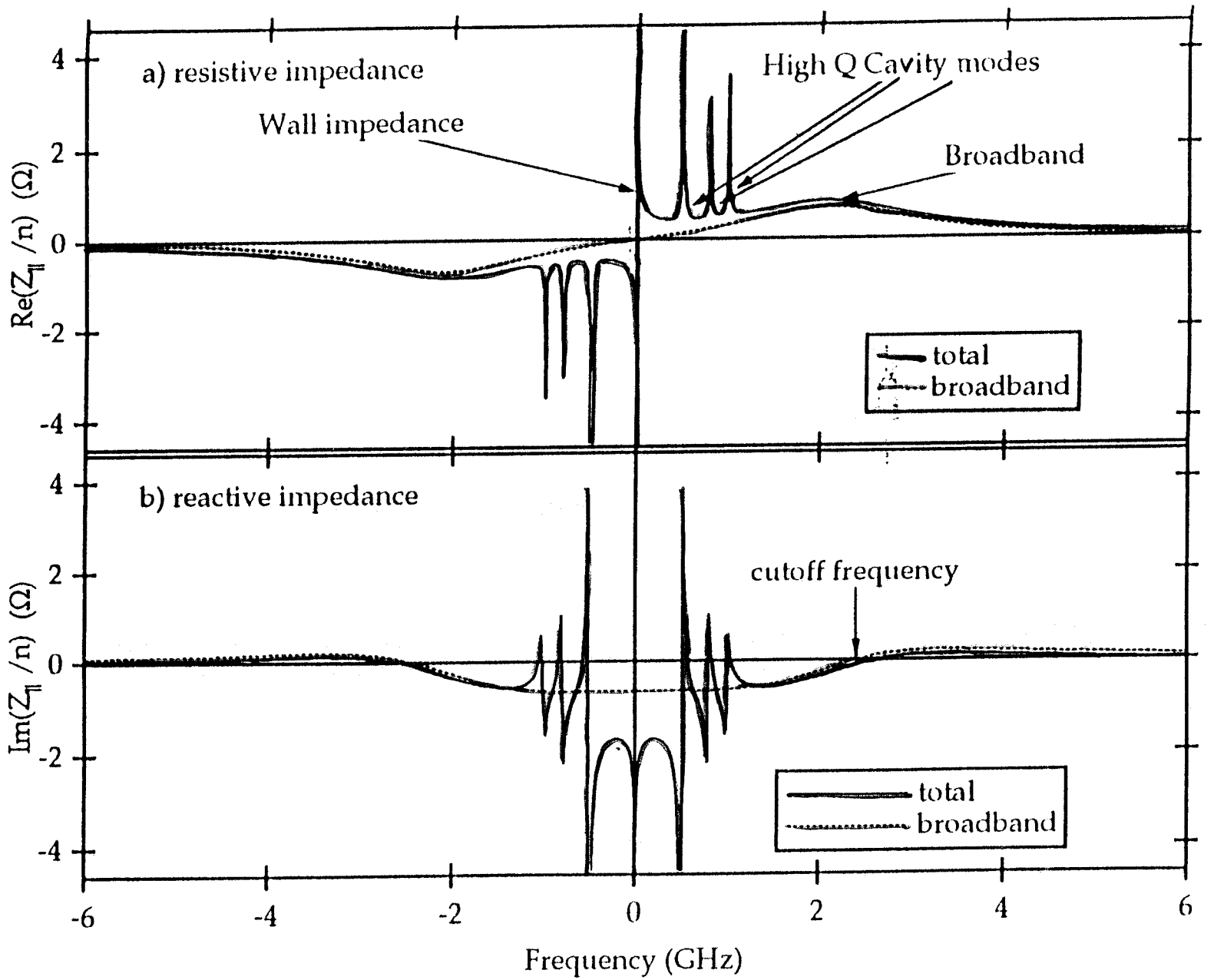
Minimizing the Impedance

The DELTA-Kicker-Design

The kicker as continuation of the vacuum chamber



$Z_{\parallel}$ typical storage ring



Furman et al.
LBL

Longitudinal Impedance of DELTA

component	number	total lossfactor (V/C)
cavity	1	$5.4*10^{11}$
kicker	3	$8.6*10^{10}$
feedb. kicker	1	$8.6*10^{9}$
septum	1	$9.5*10^{10}$
bellows	28	$1.3*10^{11}$
pumping	6	$5.9*10^{7}$
monitor	1	$1.4*10^{9}$
scraper	1	$3.5*10^{7}$
valves	6	$1.0*10^{10}$
welding joints	10	$2.5*10^{8}$

DELTA lossfactors for bunchlength $\sigma = 1$ cm

Calculation of DELTA-lossfactors for bunchlength $\sigma = 0.5, 1, 2, 3, 4, 5$ cm were performed leading to a broadband resonator model of:

DELTA-Broadband-Resonator-Model:

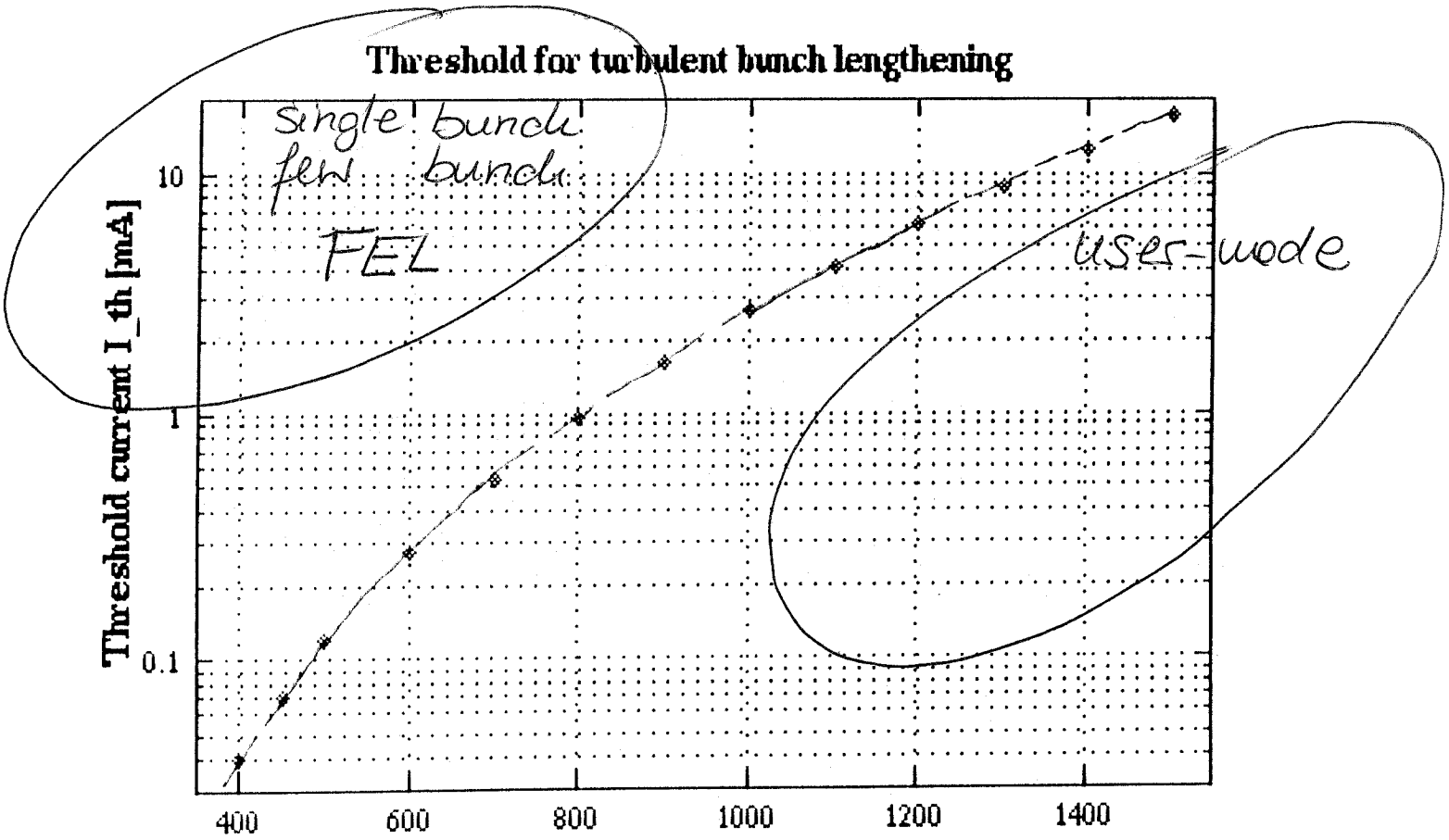
$R_s = 110\ \Omega$

$f_r = 17$ GHz

$Q = 0.046$

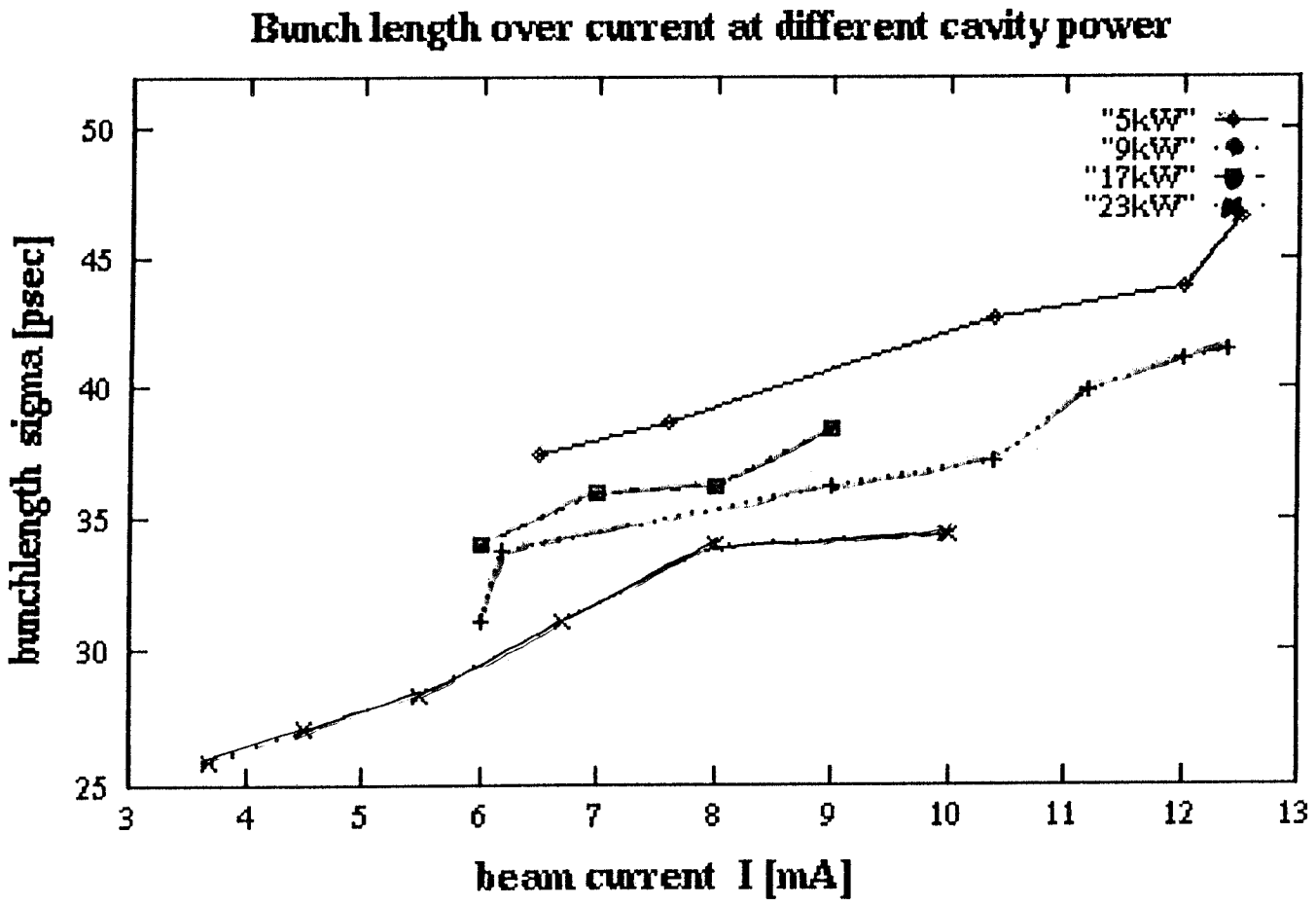
$Z/n = 0.37\ \Omega$

Threshold Currents for Microwave Instability at DELTA



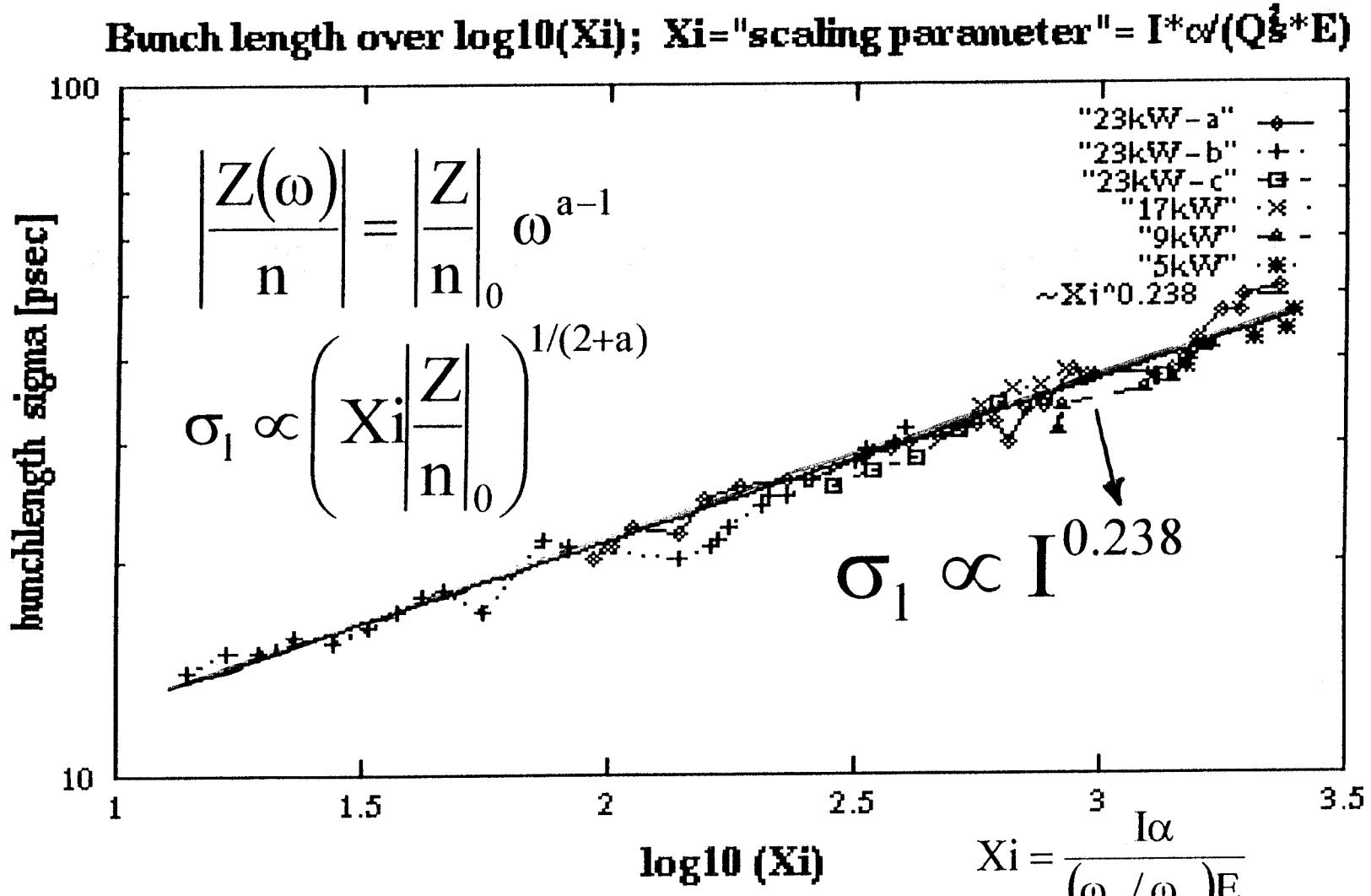
Source: K. Dunkel

First Results at 450 MeV



Source: K. Dunkel

Scaling of Impedance



Source: K. Dunkel

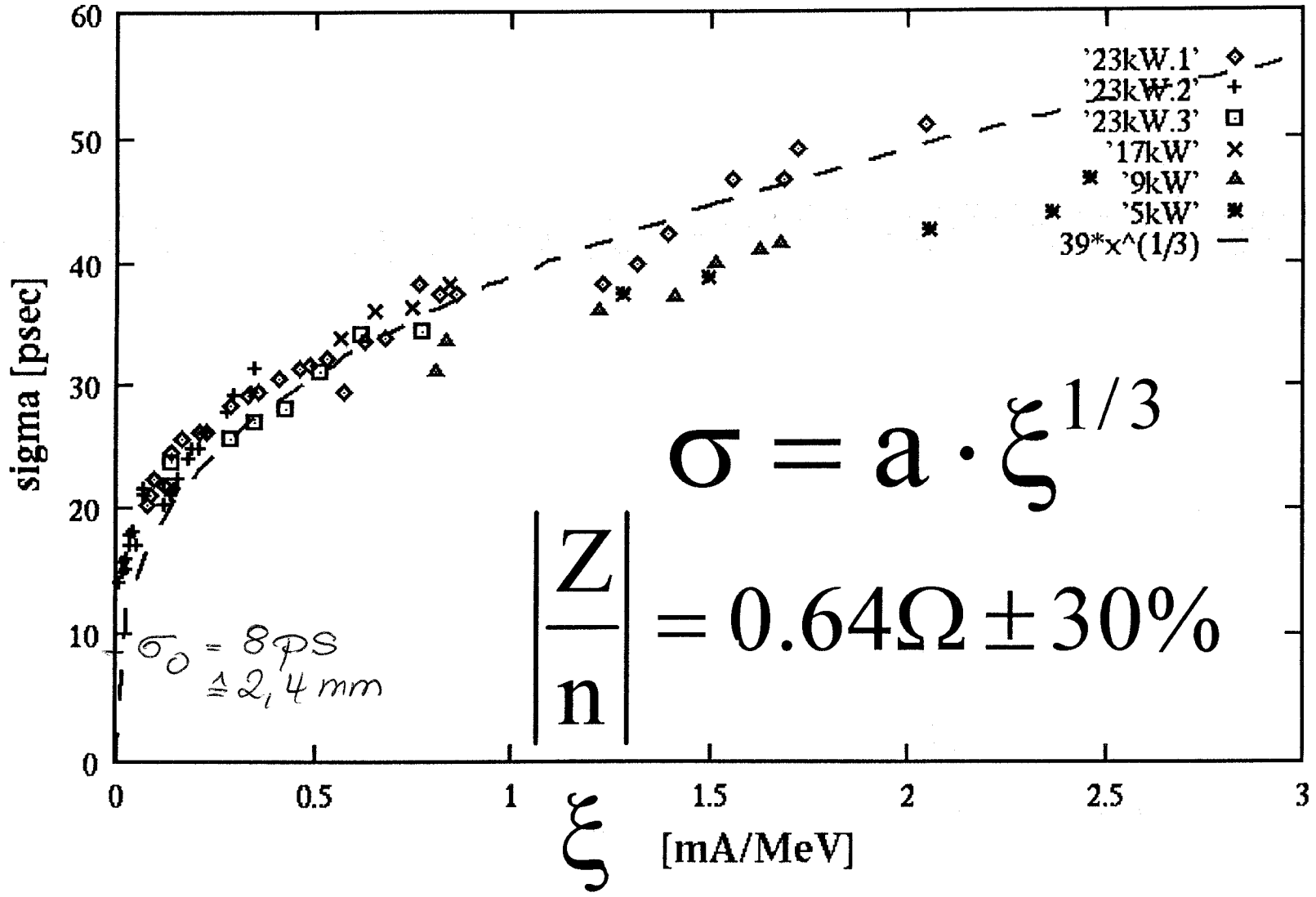
Calculating the Impedance

A Simple Model

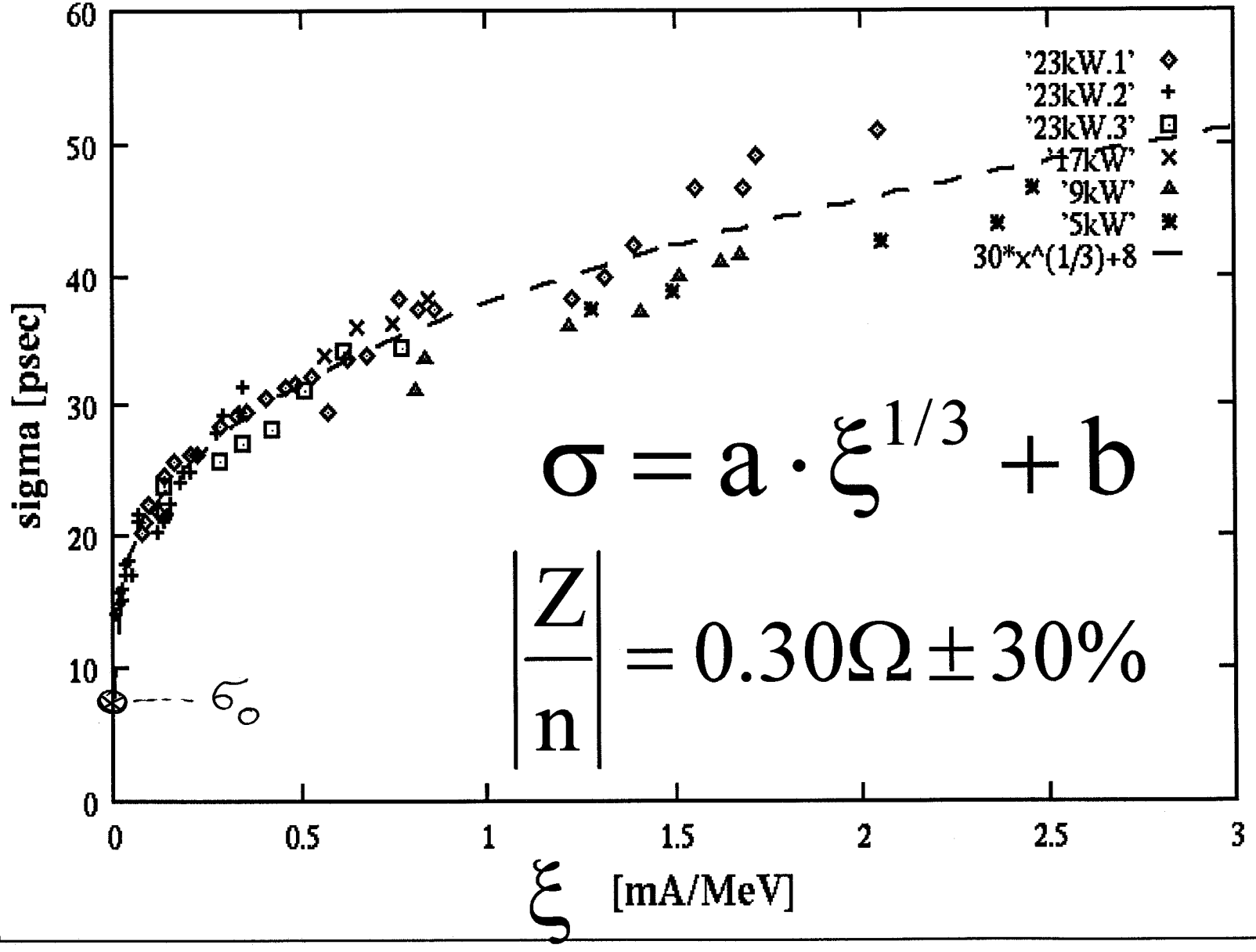
$$\sigma_t = \left(\frac{|Z/n| \cdot L^3 \alpha I}{(2\pi)^{7/2} c^3 Q_s{}^2 E} \right)^{1/3} = \left(\frac{|Z/n| \cdot L^3 \xi}{(2\pi)^{7/2} c^3} \right)^{1/3}$$

with $$\xi = \frac{\alpha I}{Q_s{}^2 E}$$

Measurements at 450 MeV



Measurements at 450 MeV



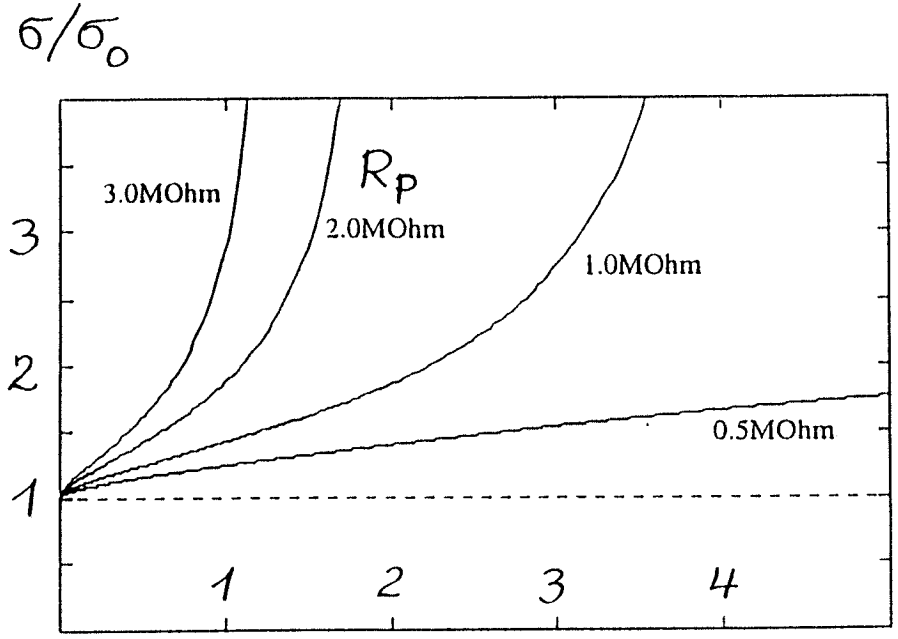
Bunchlength Control and Manipulation

Passive 3rd Harmonic Cavity

- Installation of one single cell standard pillbox 1.5 GHz cavity in fall 1999
- Cavity under inhouse fabrication
- Investigations on beam lifetime and stability for multibunch operation @ 1.5 GeV
- Investigations on bunch lengthening effect (factor of 2 under reasonable conditions)
- How does this cavity (even if tuned off resonance) influence impedance and bunchlength at single bunch operation?
- calculation show increase of Z/n from 0.37 Ω to 0.53 Ω (+50%) and should have only a minor influence on the bunchlength at 450 MeV and 20 mA
- Middle of 2000 decision possible whether more than one cavity should be installed or the actual cavity removed from the ring.
- Time schedule: 10/1999 - 6/2000 total 200 h beamtime shared between single bunch and user mode for different energies
- Personnel and Resources: PHD-student (K. Dunkel starting 4/98); available

Bunchlength Manipulation

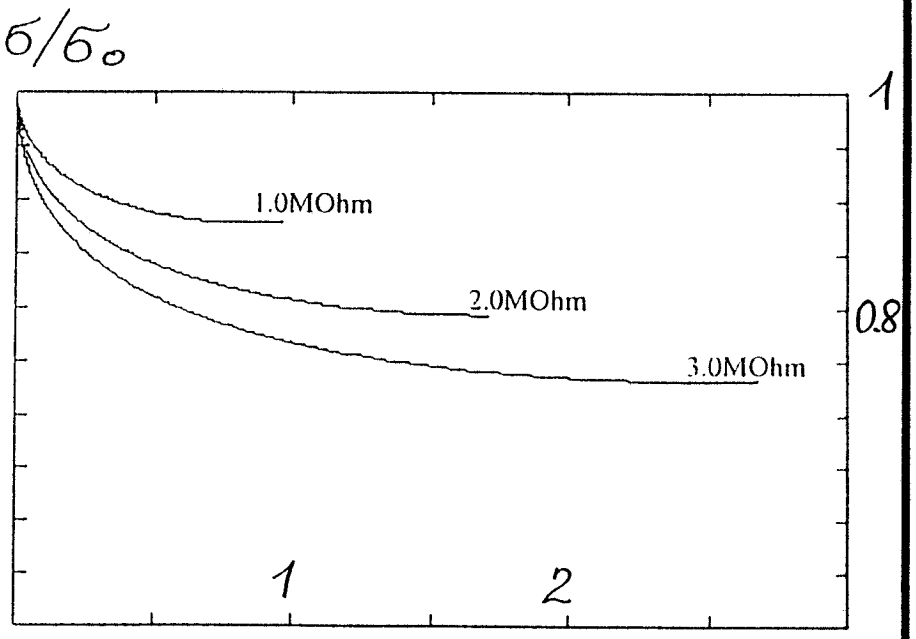
Bunchlengthening



P [kW]

@ 1.5 GeV, 100 mA, multibunch

Bunchshortening



P [kW]

@ 450 MeV, 30 mA, s. bunch

Source: K. Dunkel

Summary and Outlook

- First bunchlength measurements at low energy (450 MeV) confirm low impedance of appr. $Z/n = 0.4\ \Omega$ at the „pure“ machine
- Until end of 4/99 bunchlength measurements at 1 GeV are planned
- Necessary installation of a superconducting wiggler (4/99 -6/99, vertical gap 10 mm) will change impedance drastically
- Bunchlength measurements at different energies and RF-settings are forseen 7/99-12/99 for comparison and better characterization
- Installation of one 3rd harmonic passive Landau-cavity will allow for determination of bunchlength variation, beam life time investigations and investigations concerning the influence on impedance
- DELTA as a testbed needs support and collaboration on the theoretical side (modeling of impedance) as well as on the more practical side concerning the importance of machine detoriations (small gaps of insertions etc.)
- DELTA is open for external use, collaboration, tests or what ever you think...