# Status of ANKA

E.Huttel for the Machine and THz Group

**ANKA (Status) Report:**

- **New e-gun**
- **Single Bunch Measurements**
- **Low-α Experiments**
- **Bunch by Bunch Feedback**
- **New Timing System**
- **Coupling**
- **Insertions**
- **T-Bone-Project**

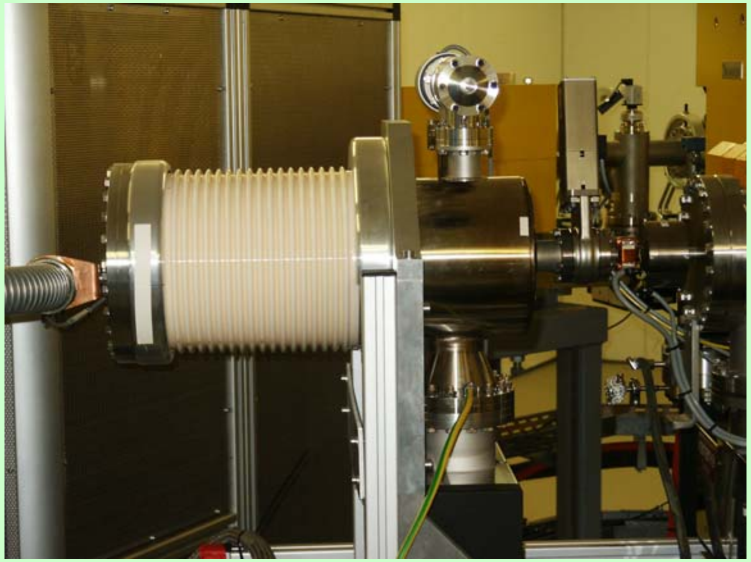
# New Single Bunch e-Gun

| | |
|---|---|
| Delivery + On-Site-Tests: | Januar 2009 |
| Operation at Injector: | April 2009 |
| Operation with Single Bunch: | June 2009 |

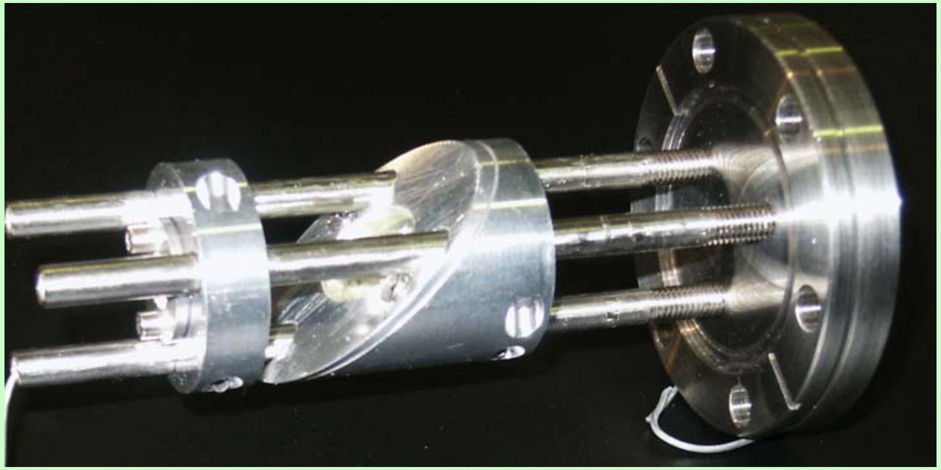
New HV-Pulse Transformer for Microtron-Linac necessary.

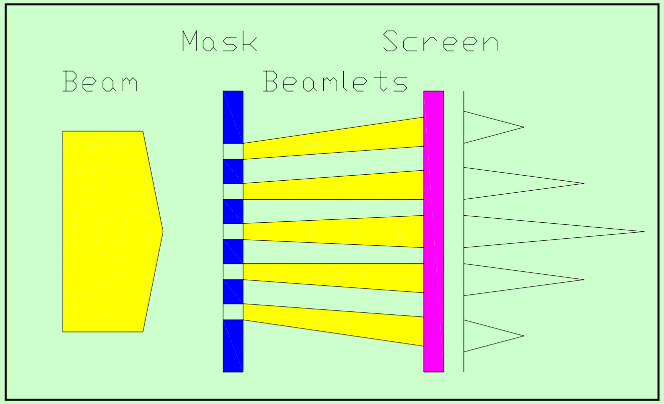
**Specification:**

| | |
|---|---|
| Single Bunch Charge: | 2 pC |
| Peak Width (FWHM): | 1 ns |
| Long Bunch current: | 0.2 A |
| Gun Voltage: | 90 kV |
| Norm.Emittance (2 σ): | 20 µm |
| Repetition Rate: | 1 Hz |



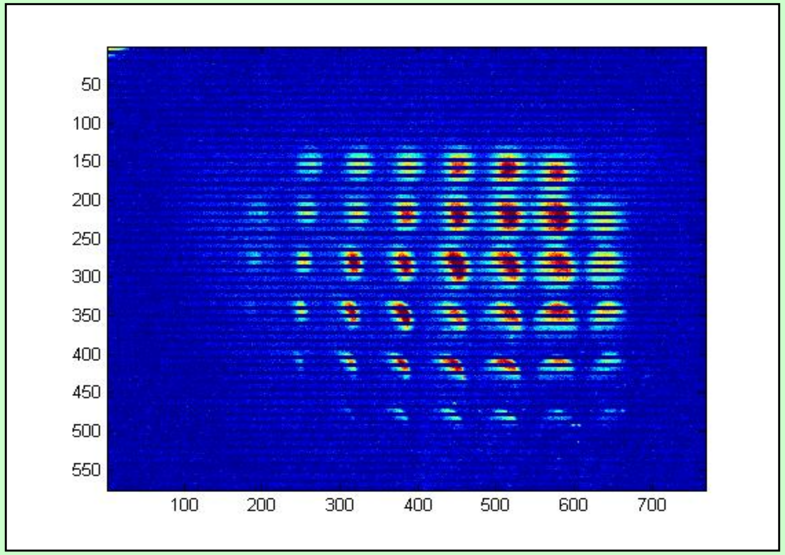
# Emittance Measurement Set Up

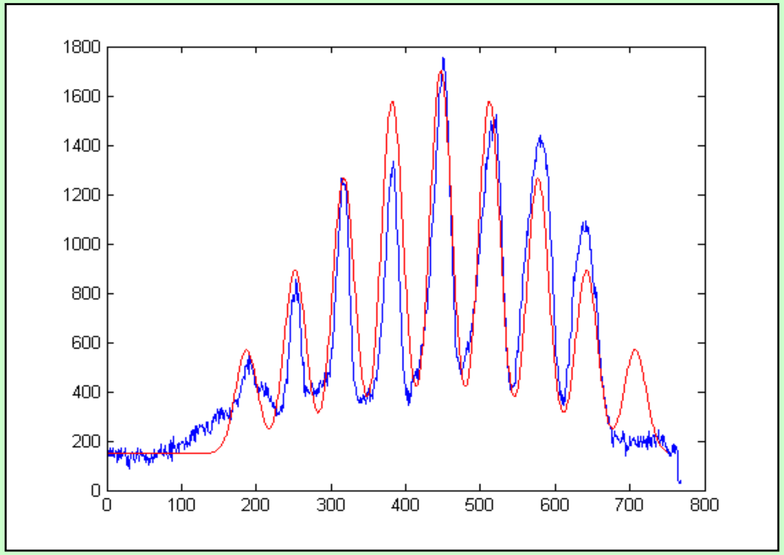


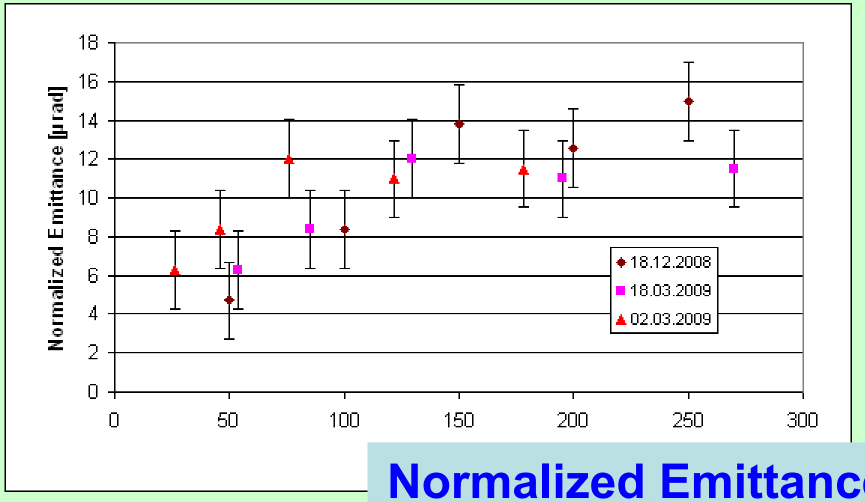



| | | |
|---|---|---|
| **Mask:** | **10 x 10 holes** | |
| | **Hole-hole-distance:** | **0.75 mm** |
| | **Hole-diameter:** | **0.05 mm** |
| | **Hole-screen distance:** | **35 mm** |
| **Screen:** | **YAG-Ce (Crytur)** | |
| | **Diameter:** | **20 mm** |
| | **Thickness:** | **0.05 mm** |

# Emittance Measurement Results

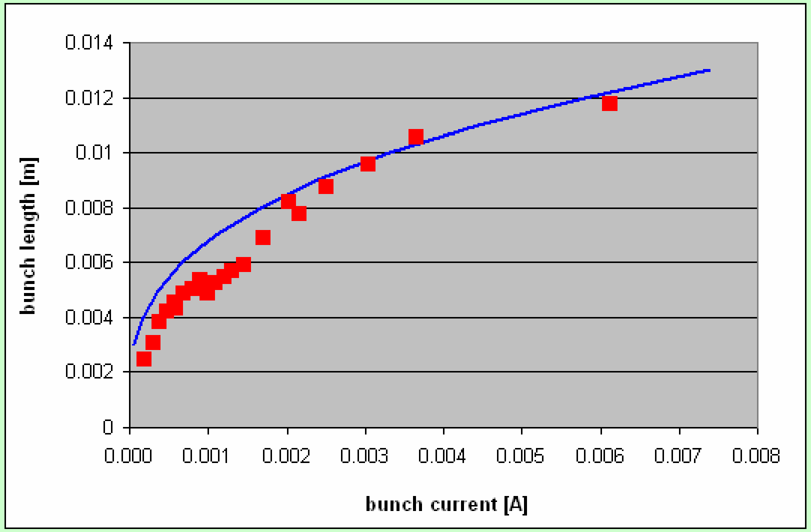


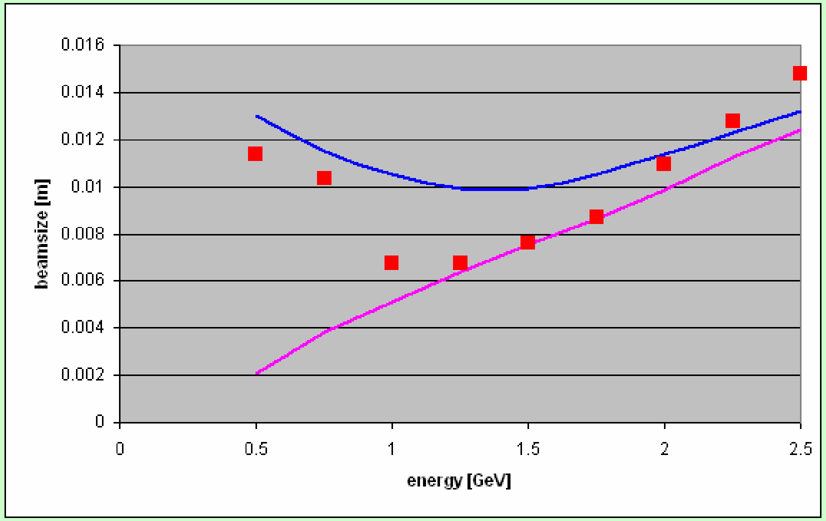




**Normalized Emittance (σ) ~ 10 µ rad**

# Longitudinal Impedance




## Potential Well Distortion

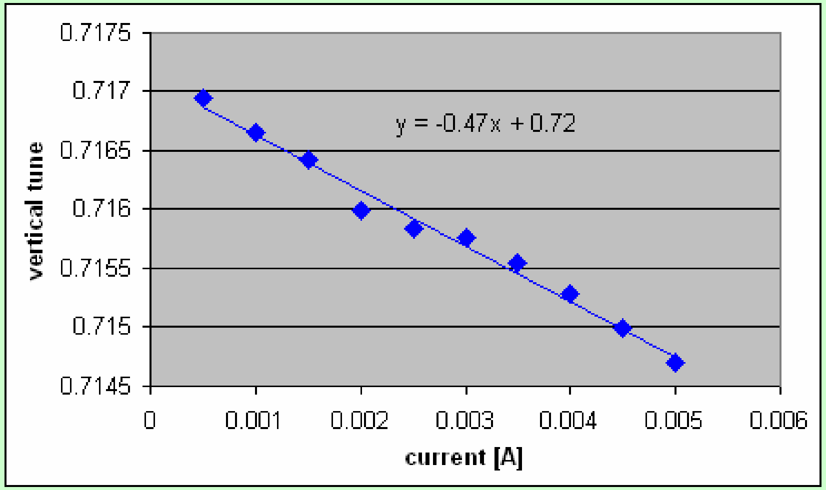
$$\left(\frac{\sigma}{\sigma_0}\right)^3 - \left(\frac{\sigma}{\sigma_0}\right) = \frac{\alpha I}{\sqrt{2\pi} q_S^2 E}\left(\frac{r}{\sigma_0}\right)^3\left(\frac{Z}{n}\right)$$

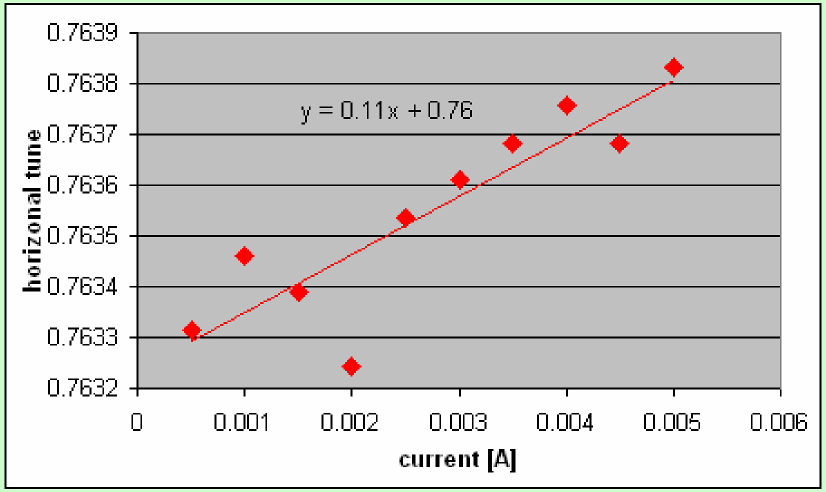
$$\sigma_0 = \frac{\alpha\sigma_E}{2\pi f_S}$$

**Z/n = 0.3 Ω**

| | |
|---|---|
| $\sigma_0$ = 0.002 m | Zero current bunch length |
| α = 0.009 | Momentum compaction |
| r = 29 m | Average radius |
| I | Bunch current |
| σ | Bunch length |
| fs = 37 kHz | Synchrotron frequency |
| σE = 1.8 10-4 | Energy spread at 0.5 GeV |
| qs = fs / fr | Synchrotron tune |
| fr = 2.715 | Revolution frequency |

# Transverse Impedance



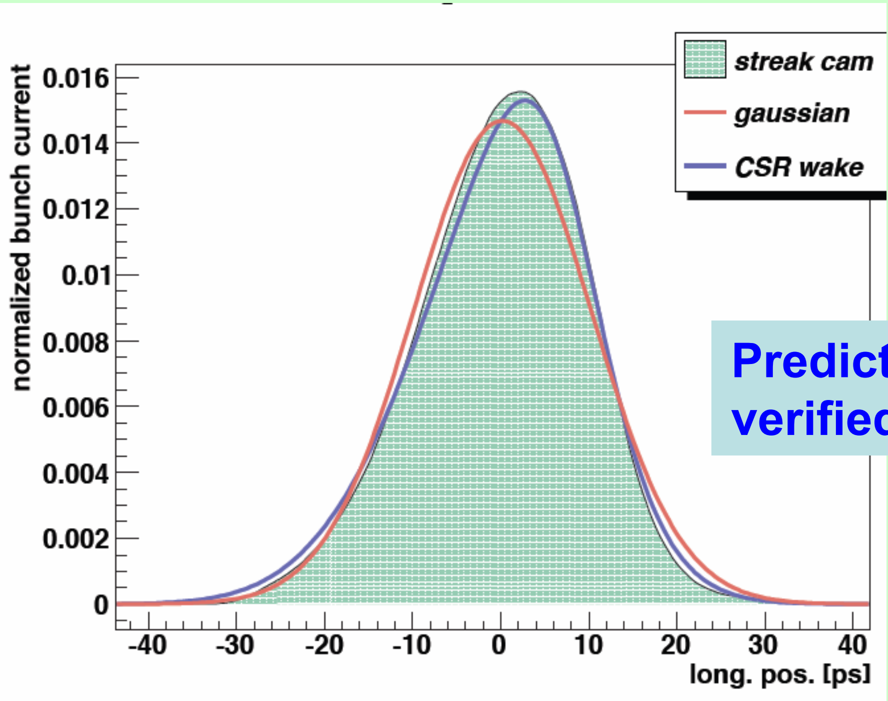




$$\frac{dq_y}{dI} = \frac{I\beta_{av} r_{av}}{4\sqrt{\pi} E \sigma_0} \mathrm{Im}(Z_y)$$

$r_{av}$ = 29 m
$\beta_{av}$ = 8 m
E = $0.5\ 10^9$ V
$dq_y$ / dI = 0.5 1/A
$\sigma_0$ = 0.01 m ???

**$Z_y$ = 0.1 MΩ/m**

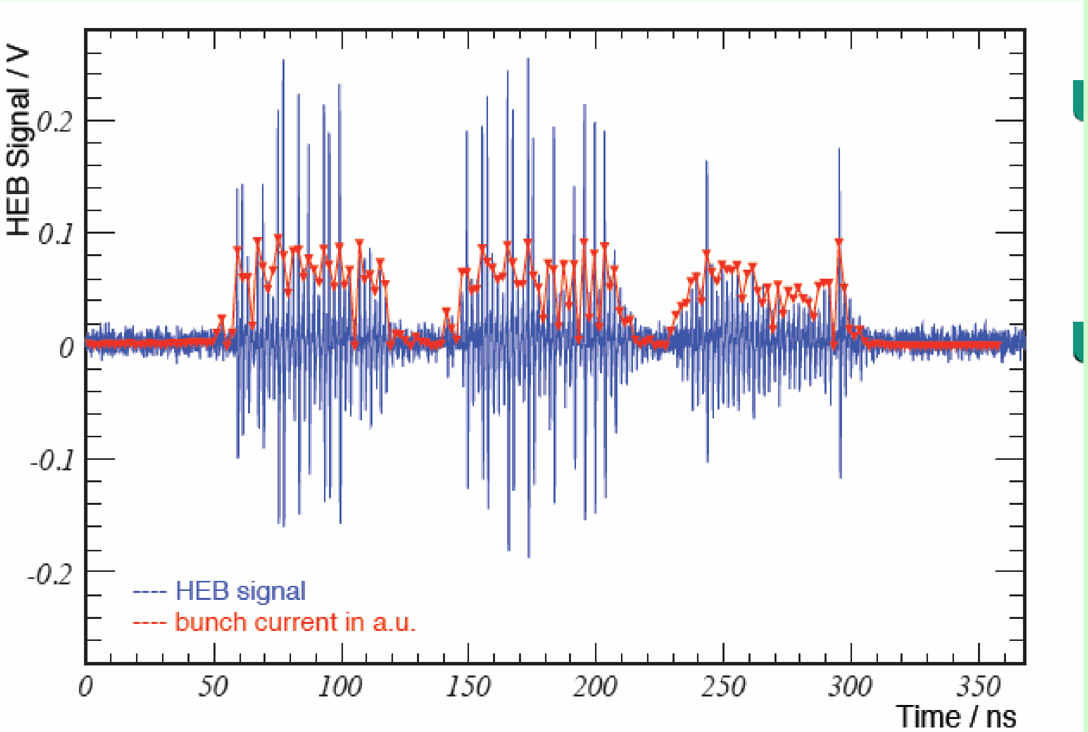
# Low Alpha Mode Bunch Size

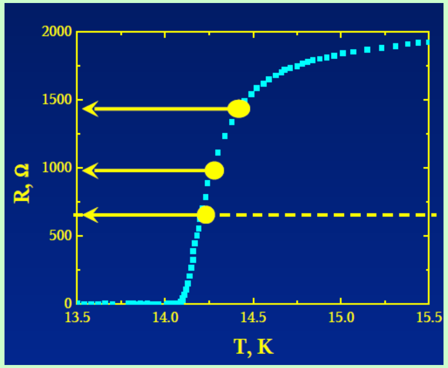


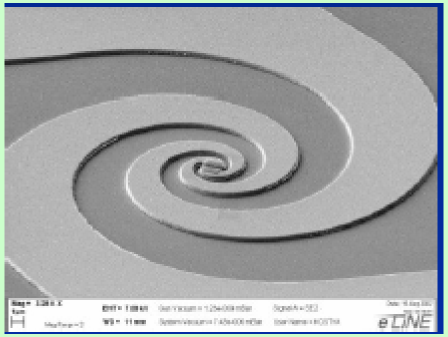

M.Klein: Work Shop Non Linear Beam Dynamic, Diamond 2009

**Predicted Bunch deformation (CSR wake) verified by Streak camera measurement**

# THz Detection by Hot Electron Bolometer (NbN)



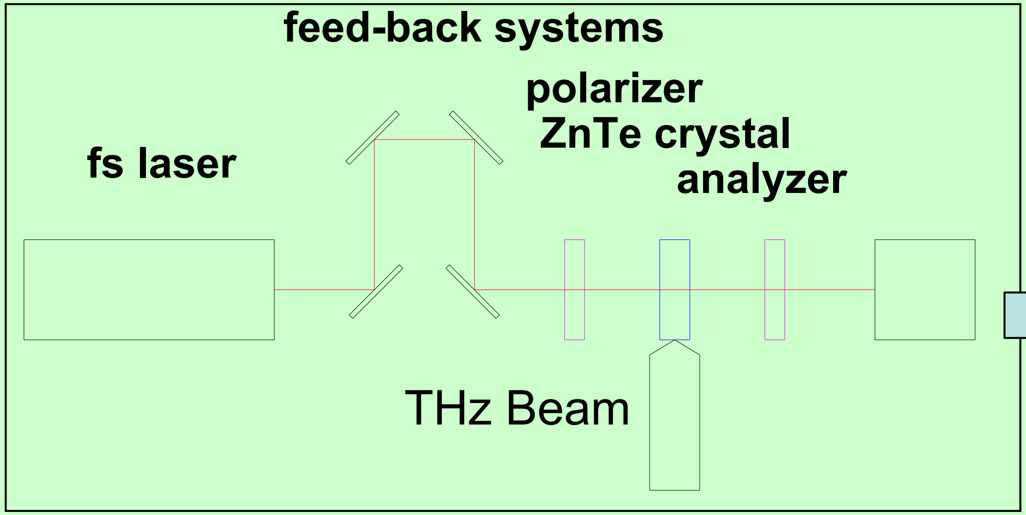



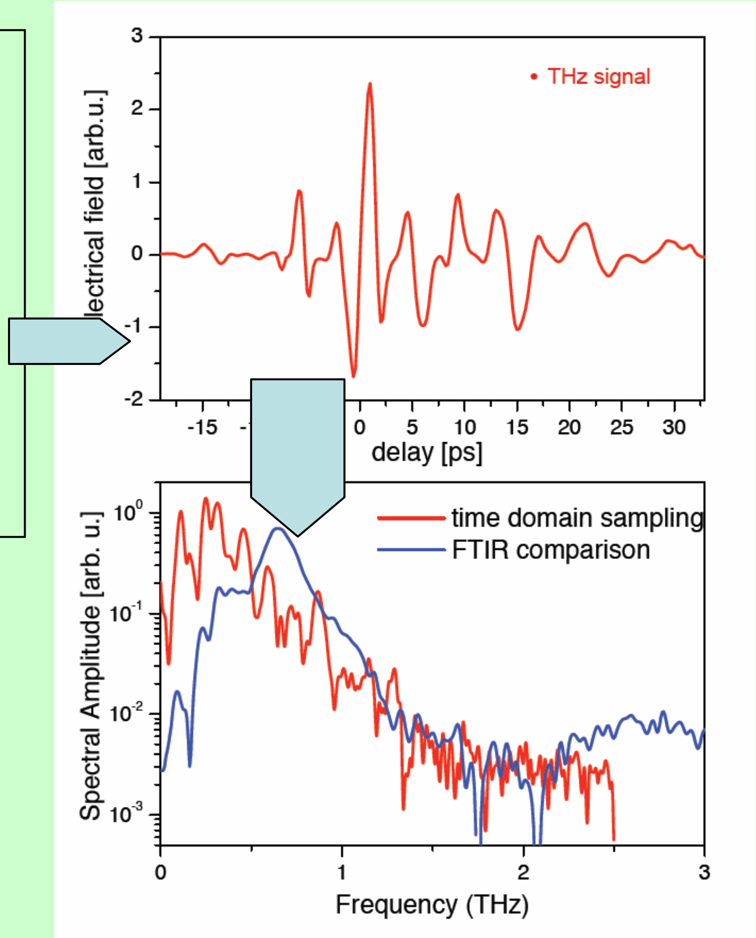
| | Sensitivity | Response time |
|---|---|---|
| Si Bolometer: | $10^{-14}$ W/Hz | 15 µs |
| NbN Bolometer: | $10^{-12}$ W /Hz | 0.1 ns |

**High Charge (wake) of leading bunch increases (bursting) Radiation**

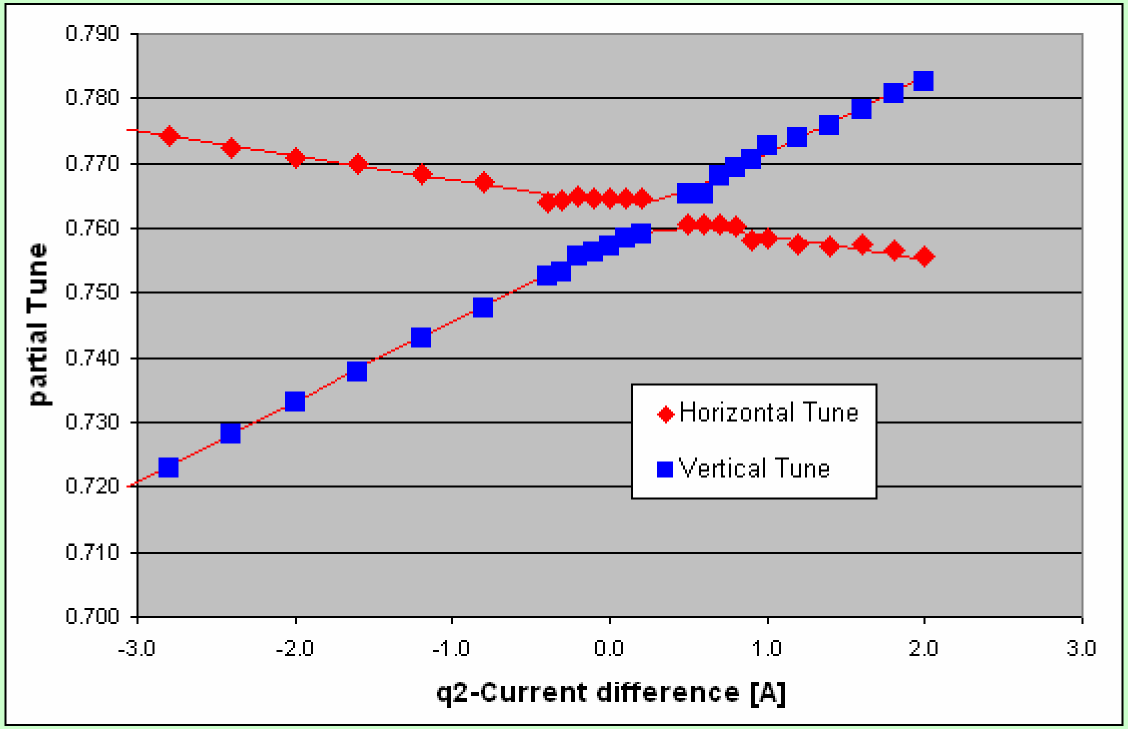
# Electro Optical Sampling

Anton Plech et al., PAC09
(Prepare pump probe experiments)



# Coupling



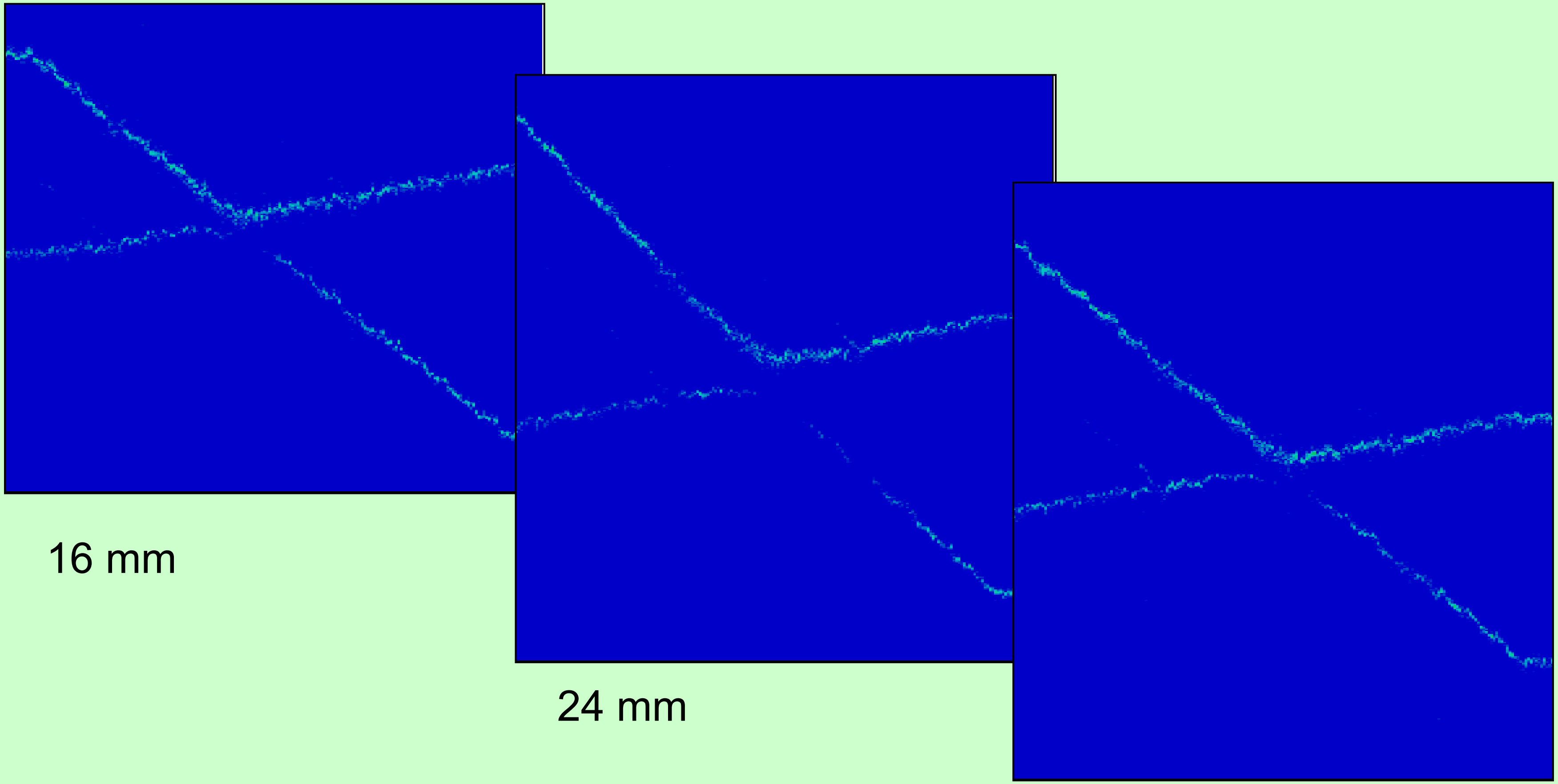

$$\left|q_y - q_x\right| = \frac{\Delta + \sqrt{\Delta^2 + c^2}}{2}$$

$$\frac{\varepsilon_y}{\varepsilon_x} = \frac{c^2}{2\Delta^2 + c^2}$$

Λ: linear tune approach difference
c: closed tune approach

**No scew quads**
**Tune approach: 0.005**
**Emittance Coupling: 0.010**

# Coupling and Wiggler Gap



16 mm

24 mm

100 mm

# Bunch by Bunch Feedback

**Dimitry Teytelman (DINTEL-INC)**

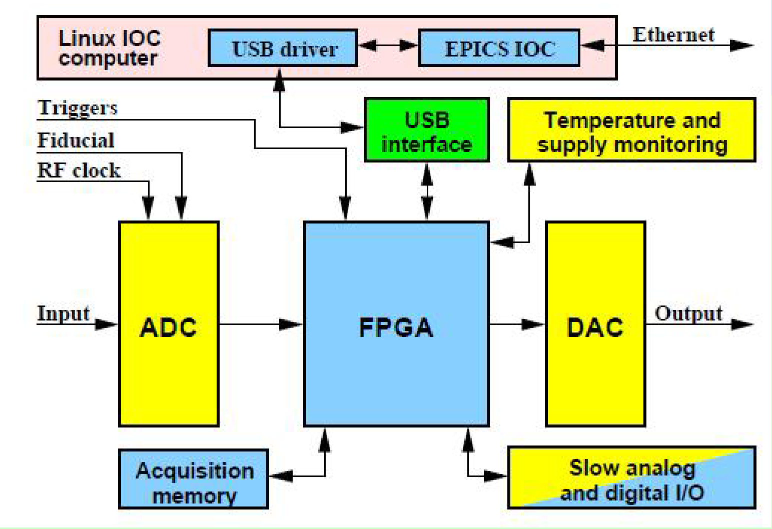
**Bunch by Bunch Feedback**

**Complete Package:** RF Frontend

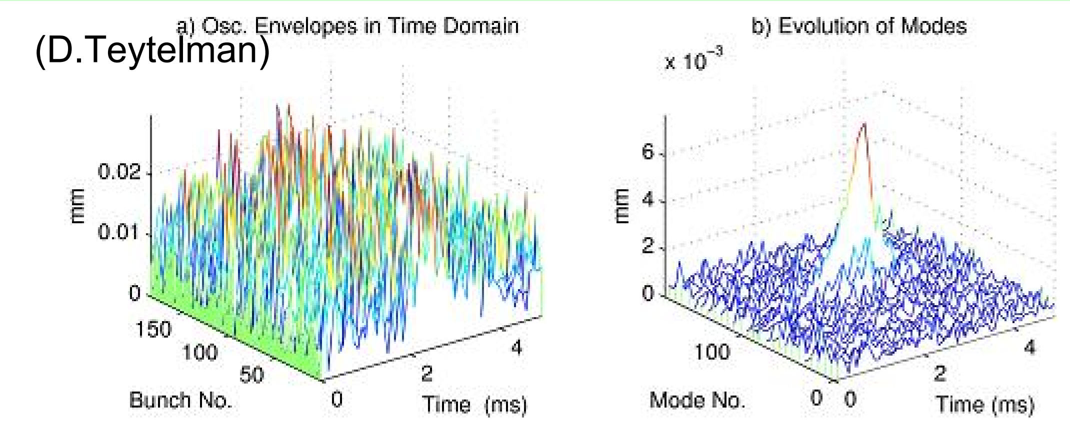
Bunch by Bunch Feedback

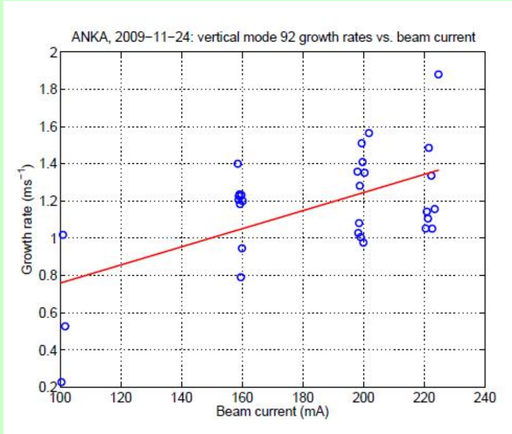
Diagnostics

Commisioning




# Grow-Damping Vertical




| | | | |
|---|---|---|---|
| **Normal filling:** | **30% gap,** | **up to 200 mA** | **vertical stable** |
| **Bunch by Bunch:** | **15% gap** | **up to 240 mA** | **vertical stable** |
| | | **lost on ramp** | |

**Assumed we need large gap to clear Ions. Should be visible at low mode.**

**But critical mode is 92 (250 MHz)! Cavity mode?**

**Does the gap also damp vertical instabilities,**

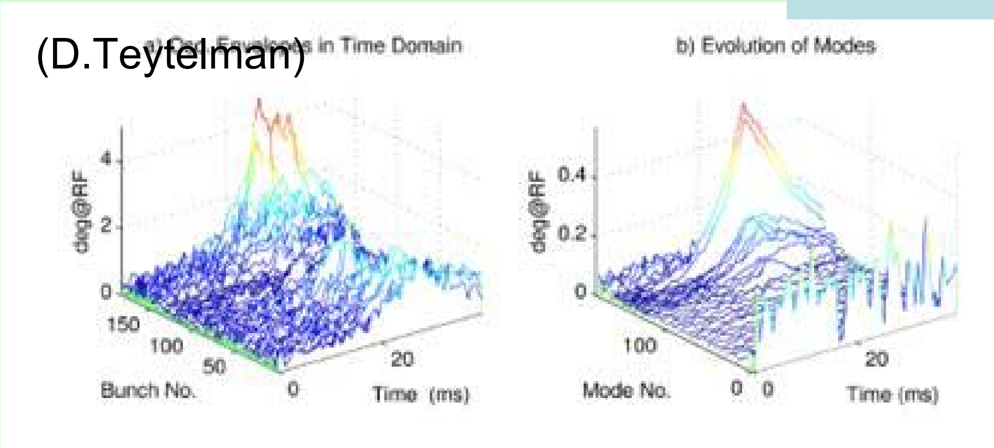
**as longitudinal instability damp vertical instabilities,**

**as positive chromaticity (+4) damp vertical instabilities.**

# Grow/Damping Longitudinal

**Vertical kicker used for longitudinal kick**

(D.Teytelman)




**Mode 134 Cavity L5/L9**
**Mode 156 L3**

**At Injection:**

**Normal operation:** Longitudinal unstable at any current

**With Feedback:** Longitudinal stable up to 10 mA

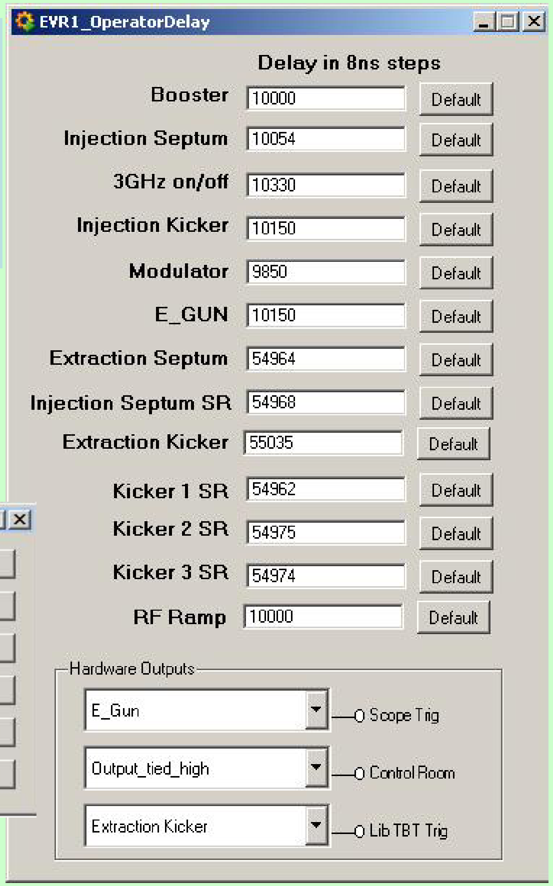
But then vertical unstable

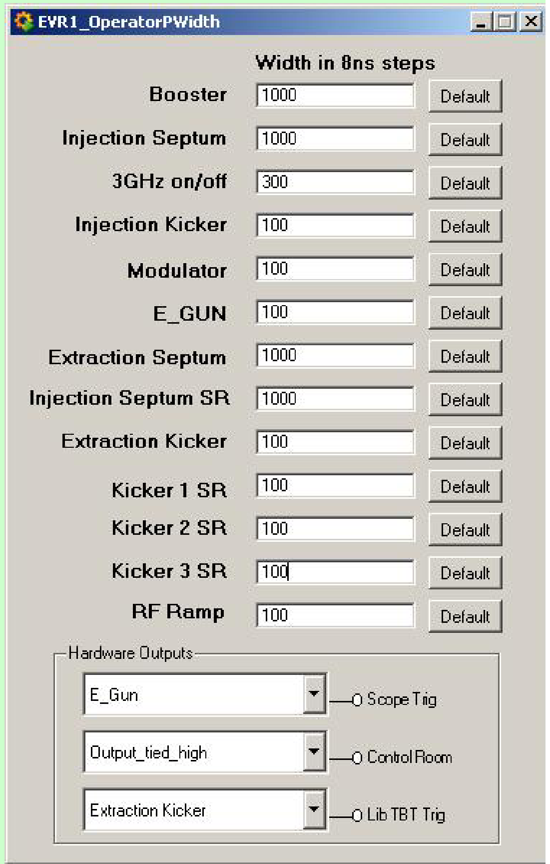
# New Timing System

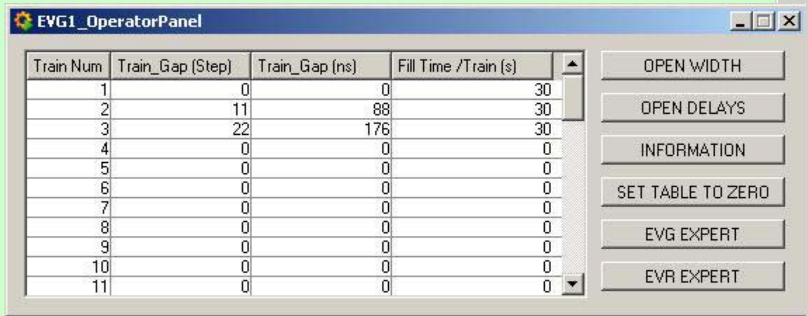
**Micro Research (Finland) Firm ware: 1 Generator, 1 Receiver**
**Replacing 4 Stanford Delay Generator plus homemade Electronics**

**Advantage:**
**More reliable,**
**More flexible,**
**Better for time depending Exp.**

**Visualization with PVSS**



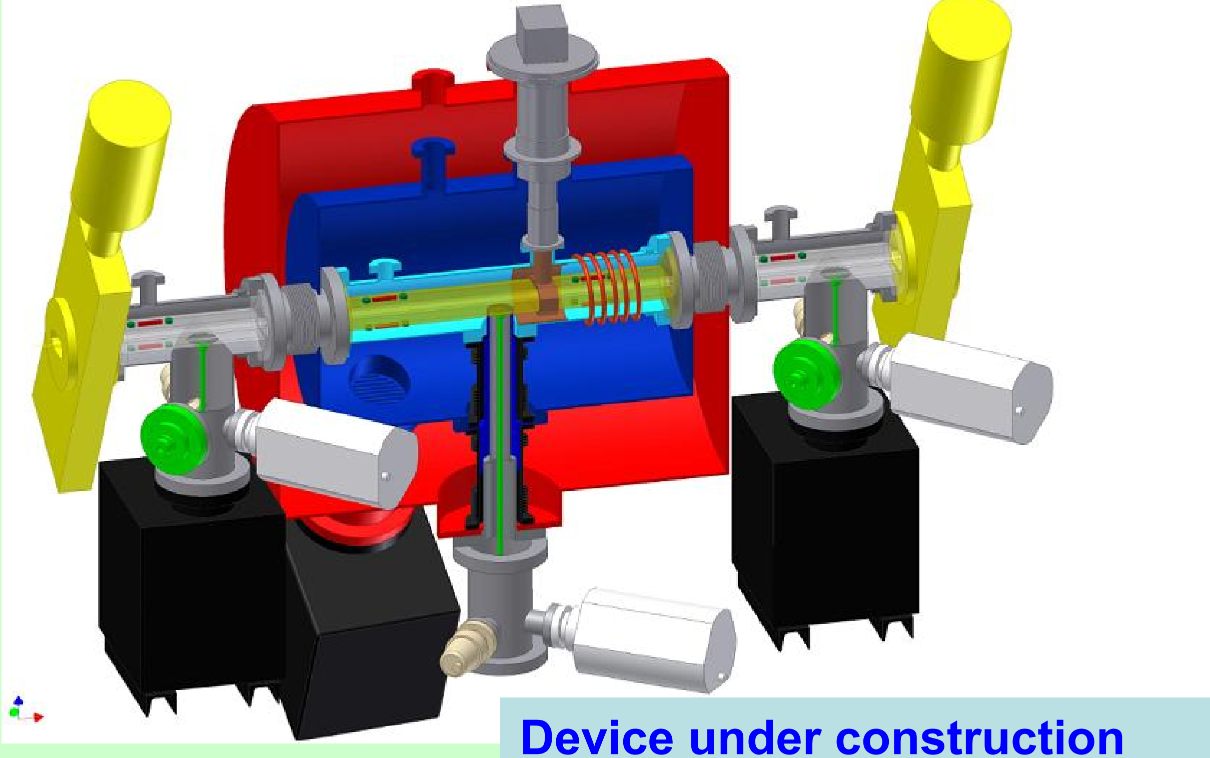



# COLD-DIAG

S.Casualboni, et al

**Heat load in super conducting Insertions not fully understand.**
**Caused by electron clouds?**

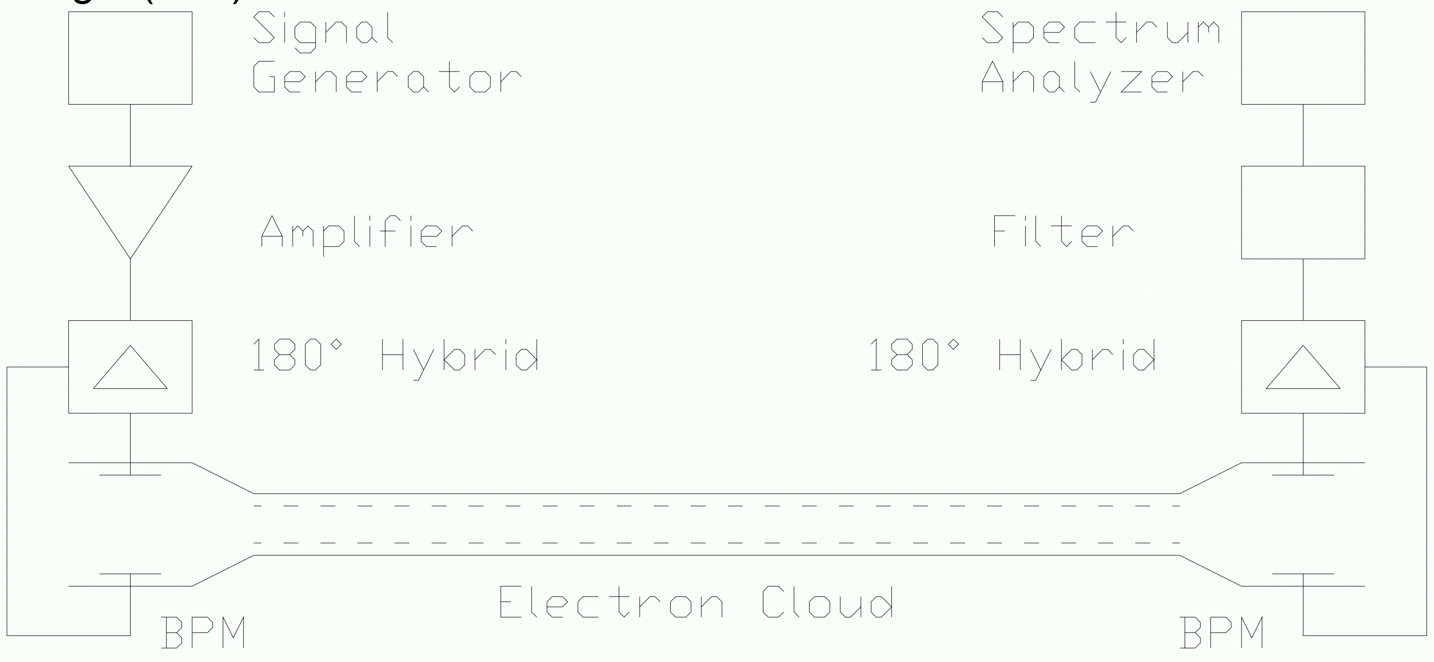


**Device under construction**
**Equipment rented from SRS Daresbury.**
**Installation at DIAMOND under discussion.**

# Electron Clouds

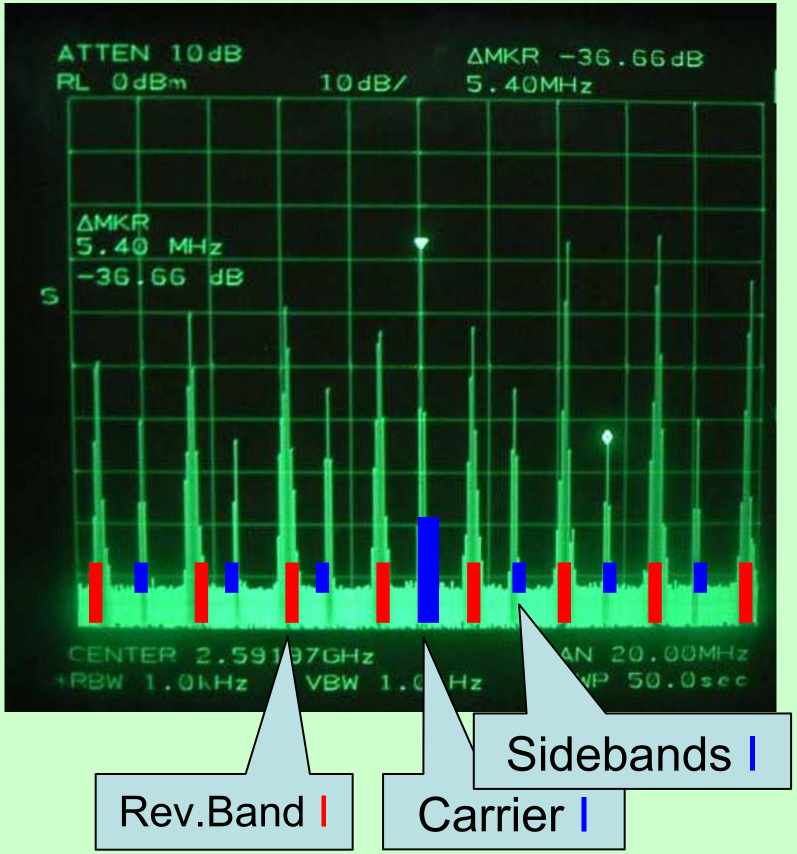
Initiated by F.Caspers (CERN)

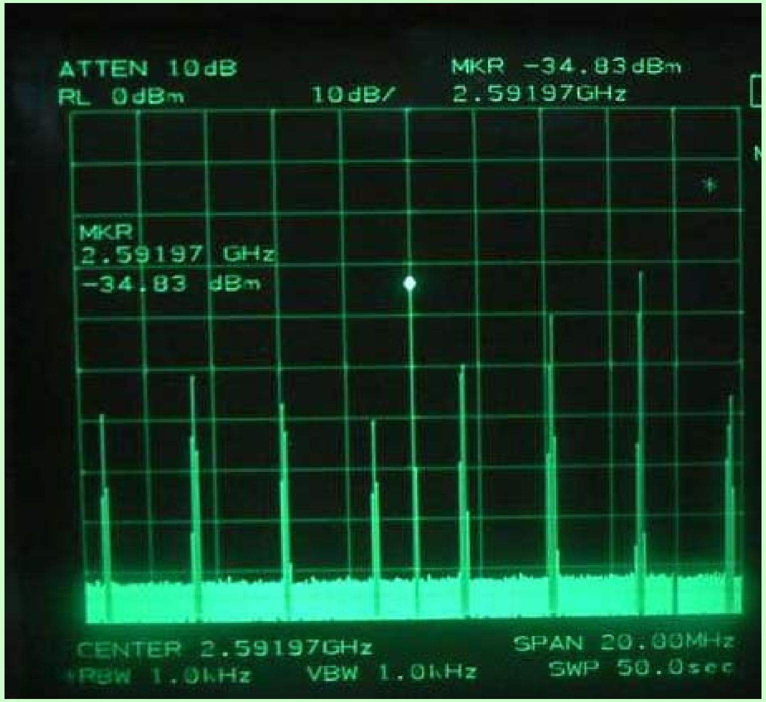
R.Weigel (MPI)




**Microwave transmission through beam tube.**
**Presents of e-clouds cause change in phase.**
**Gap in beam will cause phase modulation (side bands).**

# Microwave Transmission Results




**Symmetric Sidebands indicate amplitude modulation, not phase modulation**

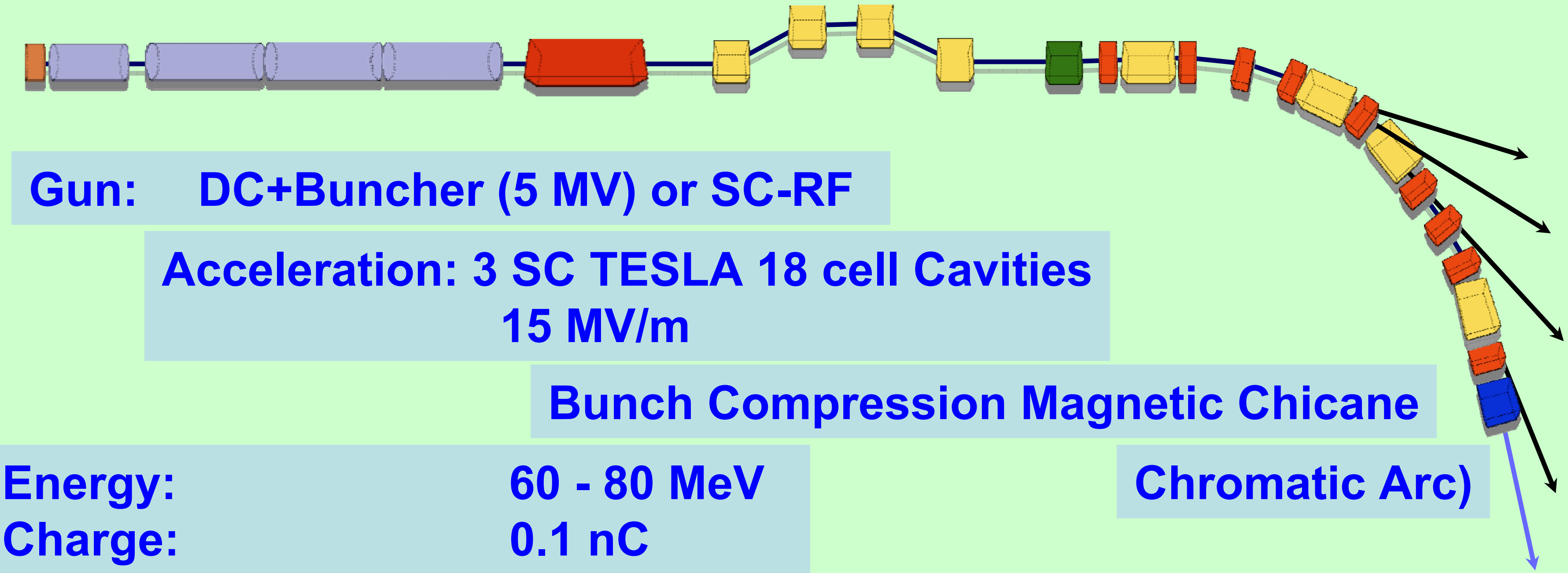
**With Band pass filter no sidebands**

**No Indication of Electron clouds!**
**Upper limit for e-clouds?**

# Beyond ANKA: TBONE

**TBONE** THz Beam Optics New Experiments

Superconducting Linac for short bunches as THz Source



Gun: DC+Buncher (5 MV) or SC-RF

Acceleration: 3 SC TESLA 18 cell Cavities
15 MV/m

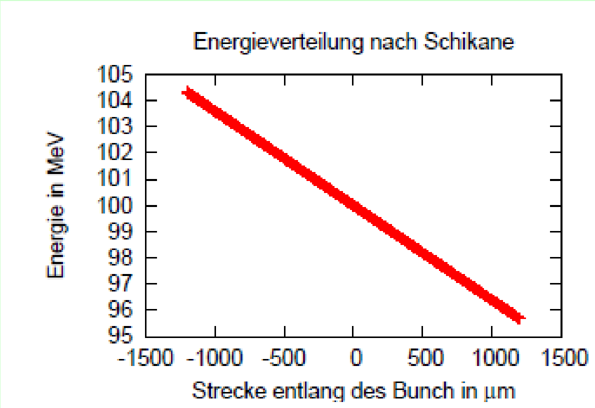
Bunch Compression Magnetic Chicane

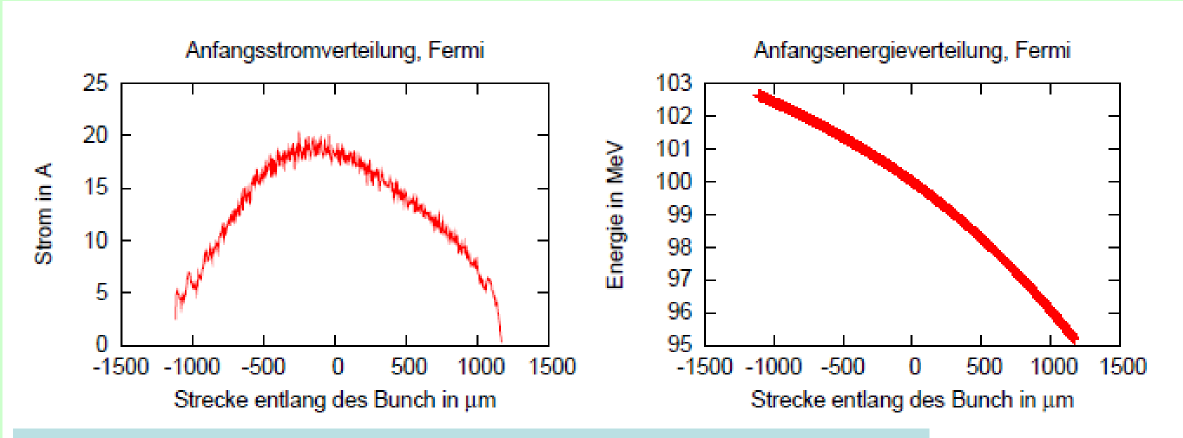
Chromatic Arc)

| | |
|---|---|
| Energy: | 60 - 80 MeV |
| Charge: | 0.1 nC |
| Repetition Rate: | 10 MHz |
| Average Current. | 1 mA |
| Pulse Width: | 5 fs |
| Emittance (nor.): | 2 µrad |

# Bunch Compressor

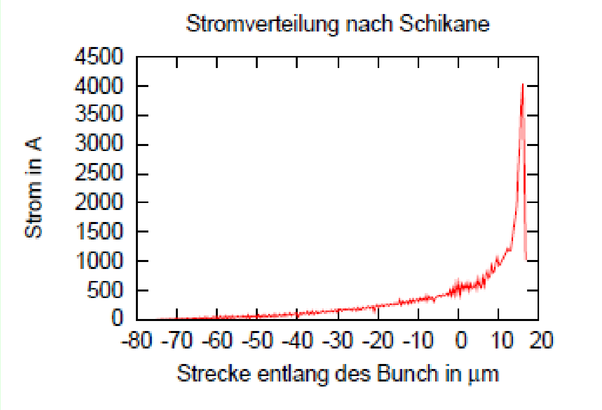
Diploma-theses S.Hillenbrand: Simulation of bunch compressor (CSR, AT)

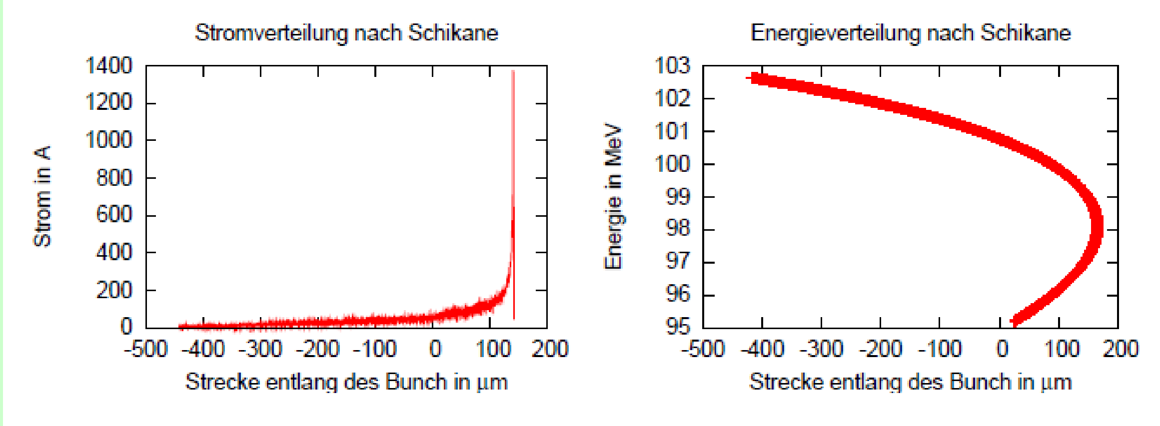


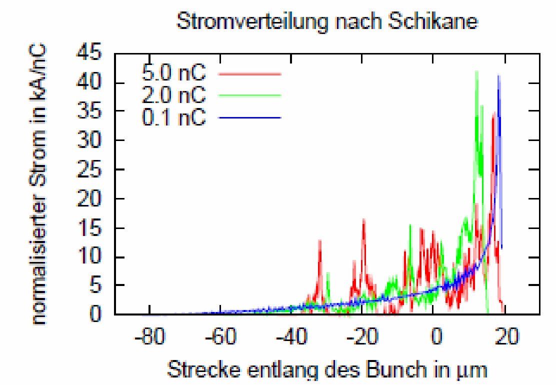

Ideal starting conditions

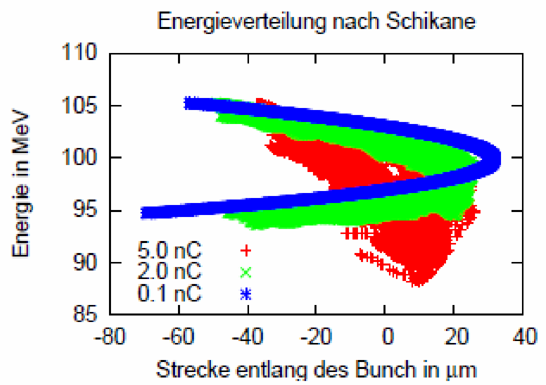
More realistic conditions: reduced current



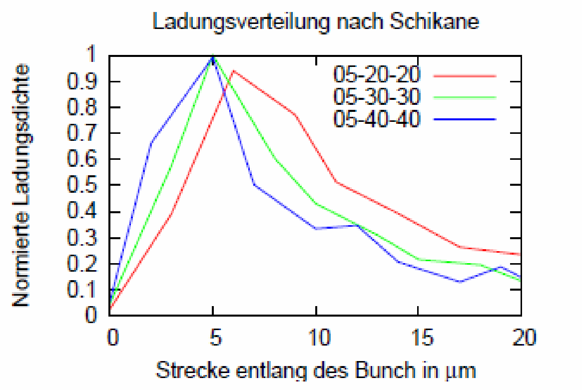



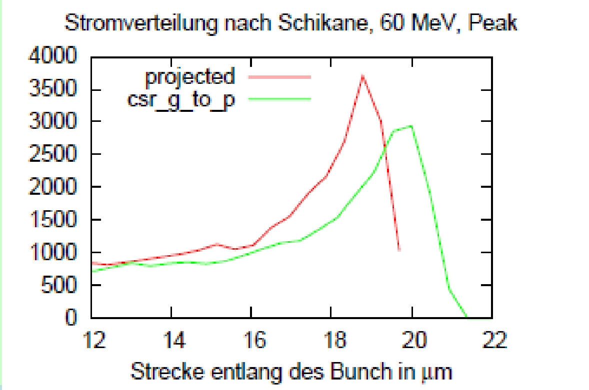
# Bunch Compressor




**Max Current limited to 0.1 nA before CSR is effecting the bunch**




**Dependence on linac phase and energy (66,70,74 GeV)**

**Dependence on space charge: uncritical up to 5 m**

# Next Steps for TBONE

Conceptional Design Report to be done.
Cooperation with Research Centre Dresden (THz Diagnostics, Simulation.

# Thank You For Your Attention

Machine group:
**E.Huttel**, I.Birkel, N.Smale

Young Investigators group (THz):
**A.S.Müller**, M.Fitterer, S.Hillenbrand, N.Hiller, A.Hofmann, V.Judin, M.Klein, S.Marsching, K.Sonnad

Undulate group:
**S.Caslbuoni**, A.Grau, S.Gerstl, E.Mashkina, D.Saez de Jaurgui,

Sabbatical:
P.Tavares (LNLS)

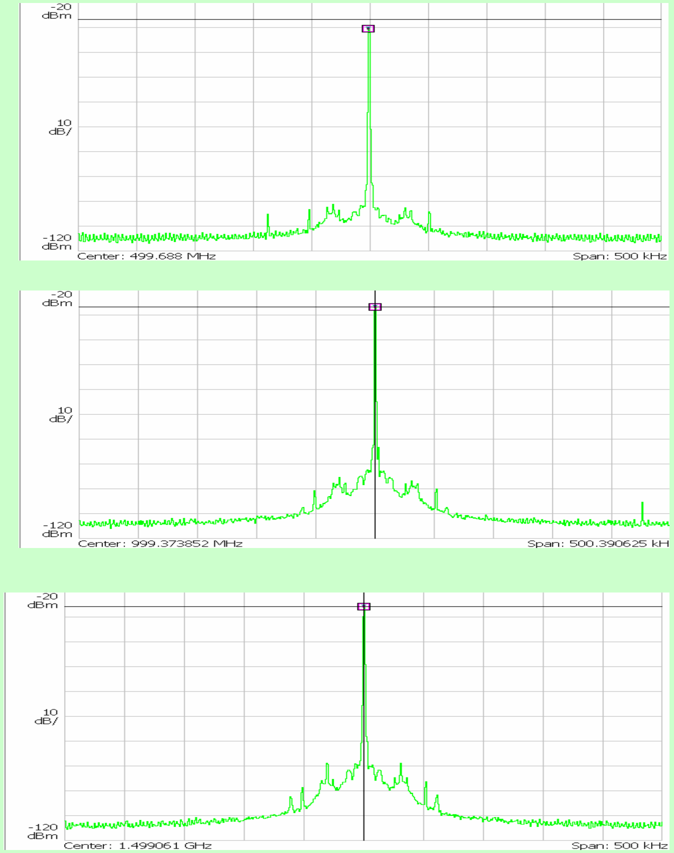
Guest:
F.Caspers (CERN)
D.Teytelman (DIMITEL)

Beamlines:
Y.L.Mathis (IR)
R.Weigel (MPI)
A.Plech (EOS)

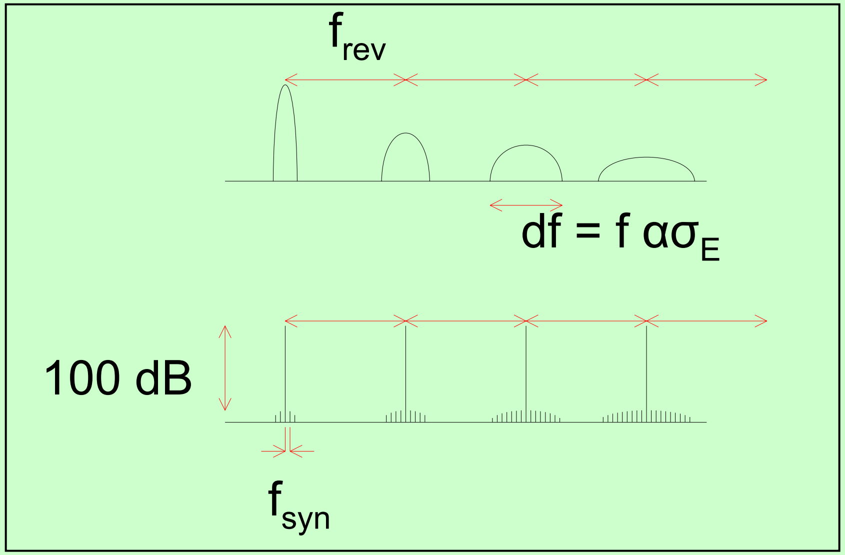
# Schottky-Noise

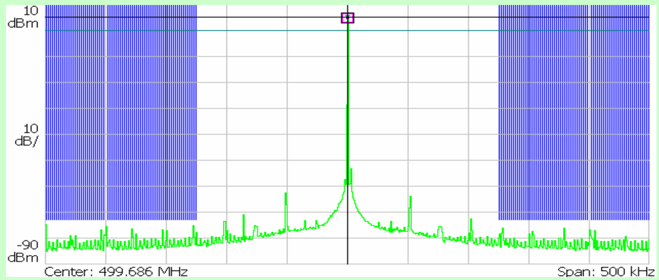
Initiated by F.Caspers (CERN)

**Diagnostics tool for unbunched beam**
**Difficult for bunched beam**




**Stripline-pick-up, Schottky?**




**RF pick-up, Phase noise?**