

# Recent and Future Cooling Experiments at COSY

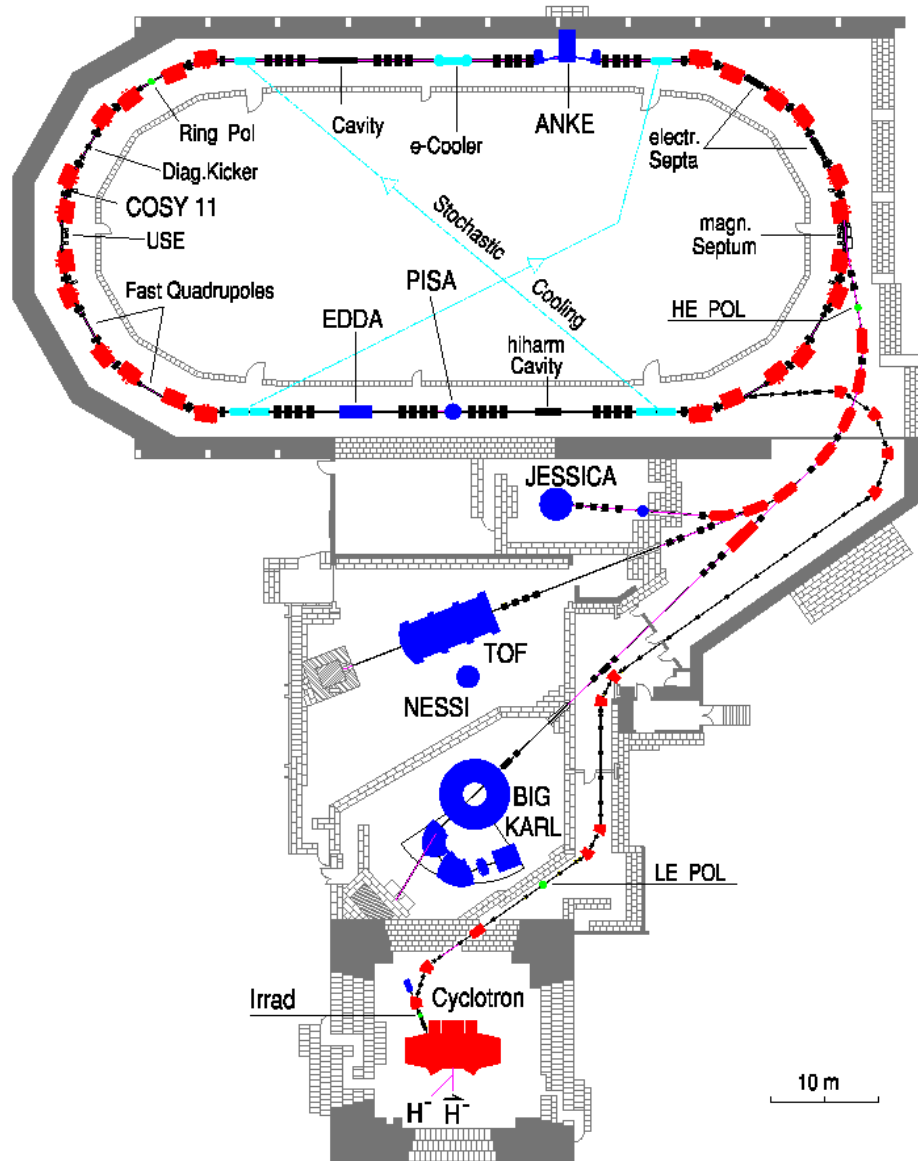
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# Outline

- The COSY accelerator facility
- Stochastic Cooling at COSY
- Electron Cooling
- Recent Cooling Experiments
- Future Experiments

# The Accelerator Facility



- COSY accelerates (polarized) protons and deuterons between 300 and 3700 MeV/c
- 4 internal and 3 external experimental areas
- Electron cooling at low energy
- Stochastic cooling at high energies

# Cooling at COSY

## Electron Cooling

Used at injection momentum

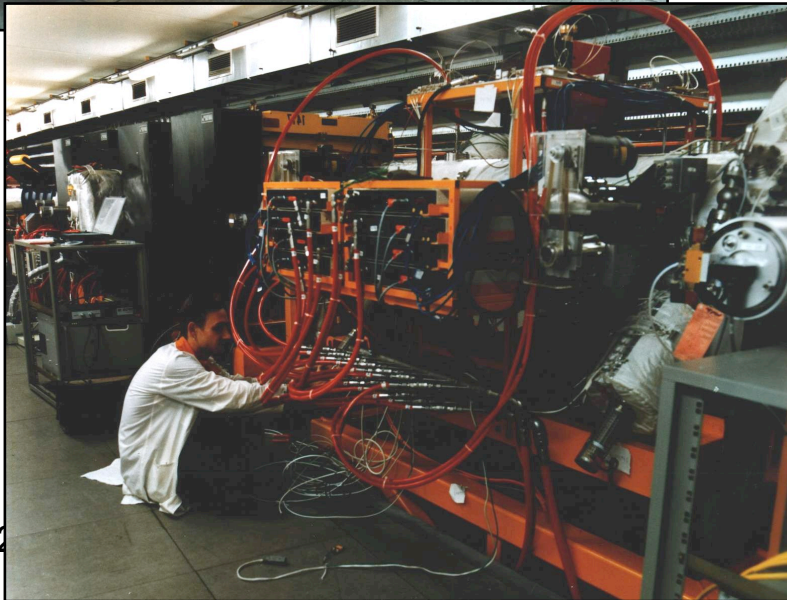
- For „halo-suppression“ of the extracted beams
- For intensity increase of low intensity beams (polarized beams)
- Cooling experiments

## Stochastic Cooling

Used at high momenta ( $>1.5$  GeV/c)

- Equilibrium beam conditions for internal experiments with thin gas cluster or atomic beam targets

# Stochastic Cooling

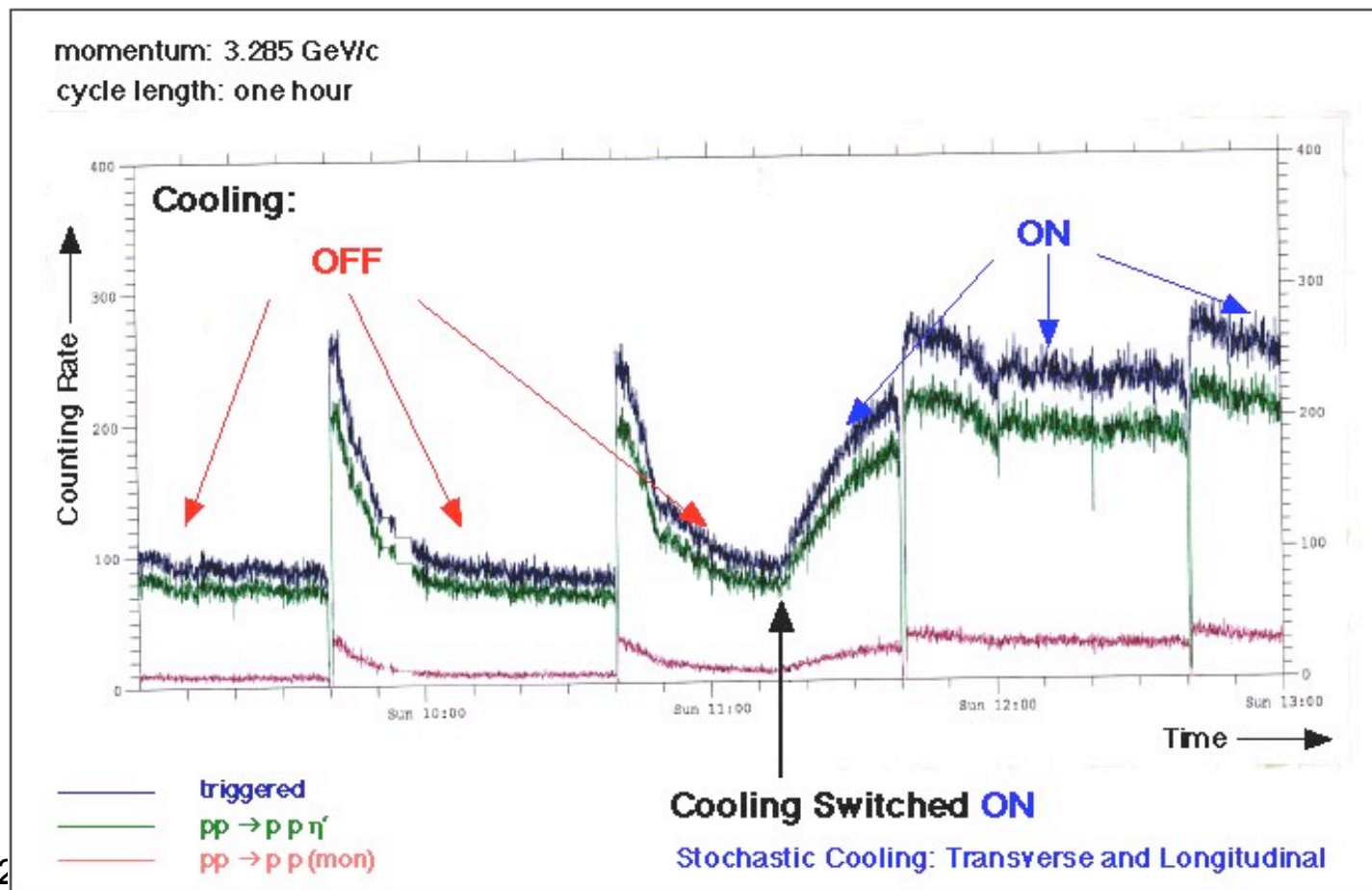


## Hardware

- 2 Pickup-Tanks, each of 4 m length, cooled to 20 K
- 2 Kicker-Tanks, each 2 m long
- Frequency range:
  - 1.0-1.8 GHz
  - 1.8-3.0 GHz
- Adjustable delays for different ion velocities
- Longitudinal Cooling with the vertical system in „Sum-Mode“

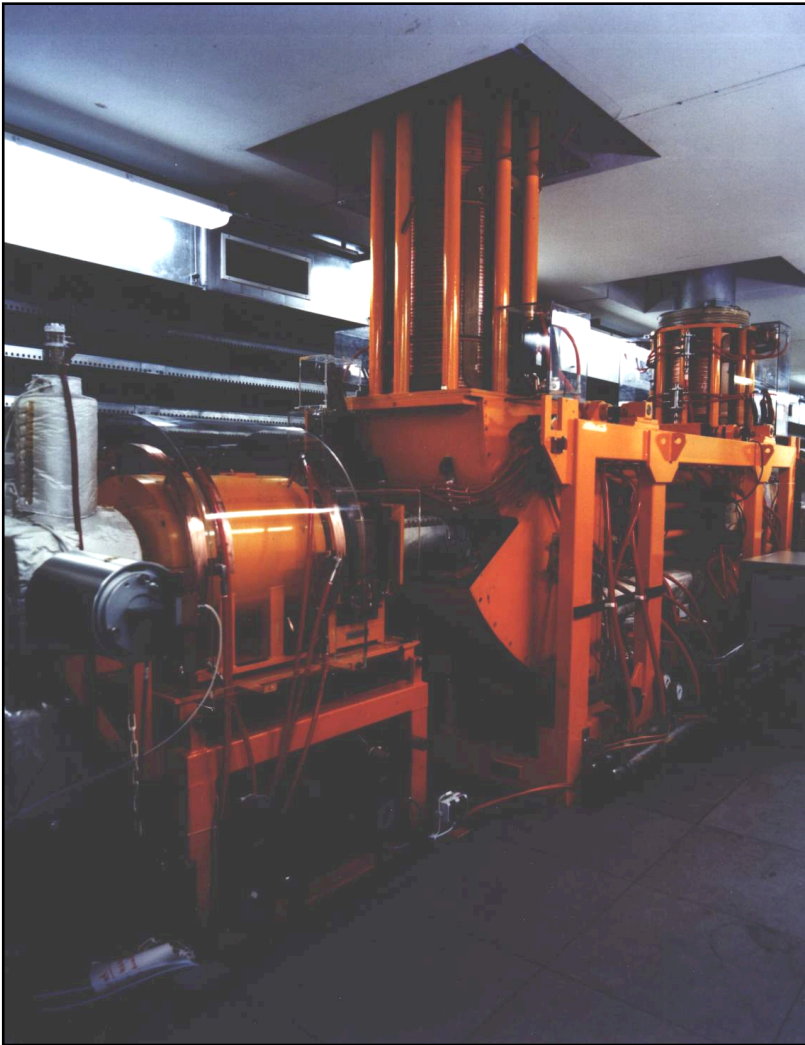
# The Main Goal for stochastic Cooling:

Constant Counting rate over a long flat top time with internal targets



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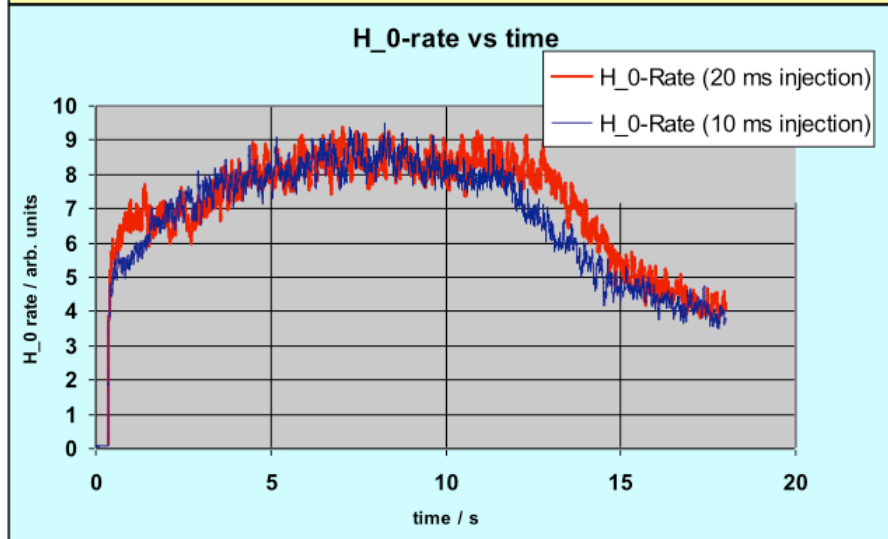
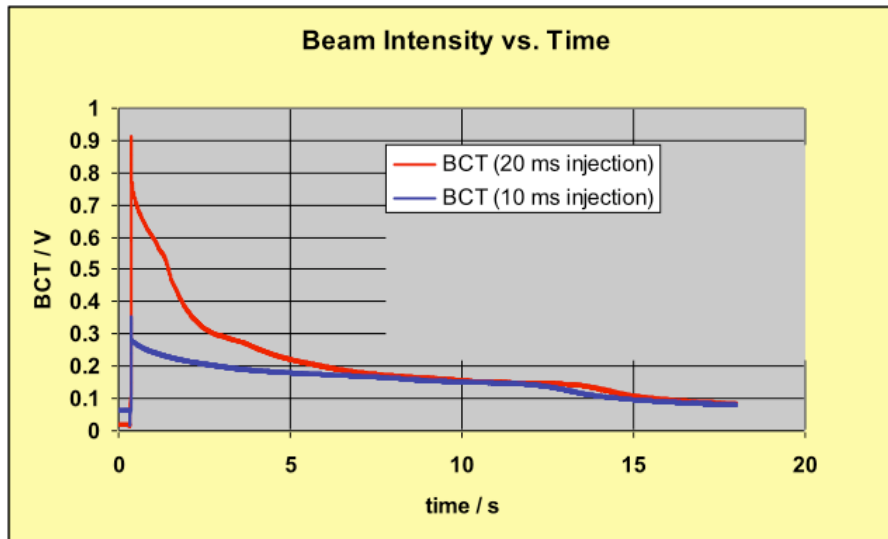
# The Electron Cooler



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- Electron energy up to 100 kV
- Electron current up to 3 A
- Normally used at 24 kV and 170 mA for injection energy

# Observation of initial losses



Initial losses disappear at smaller injected proton beam emittance

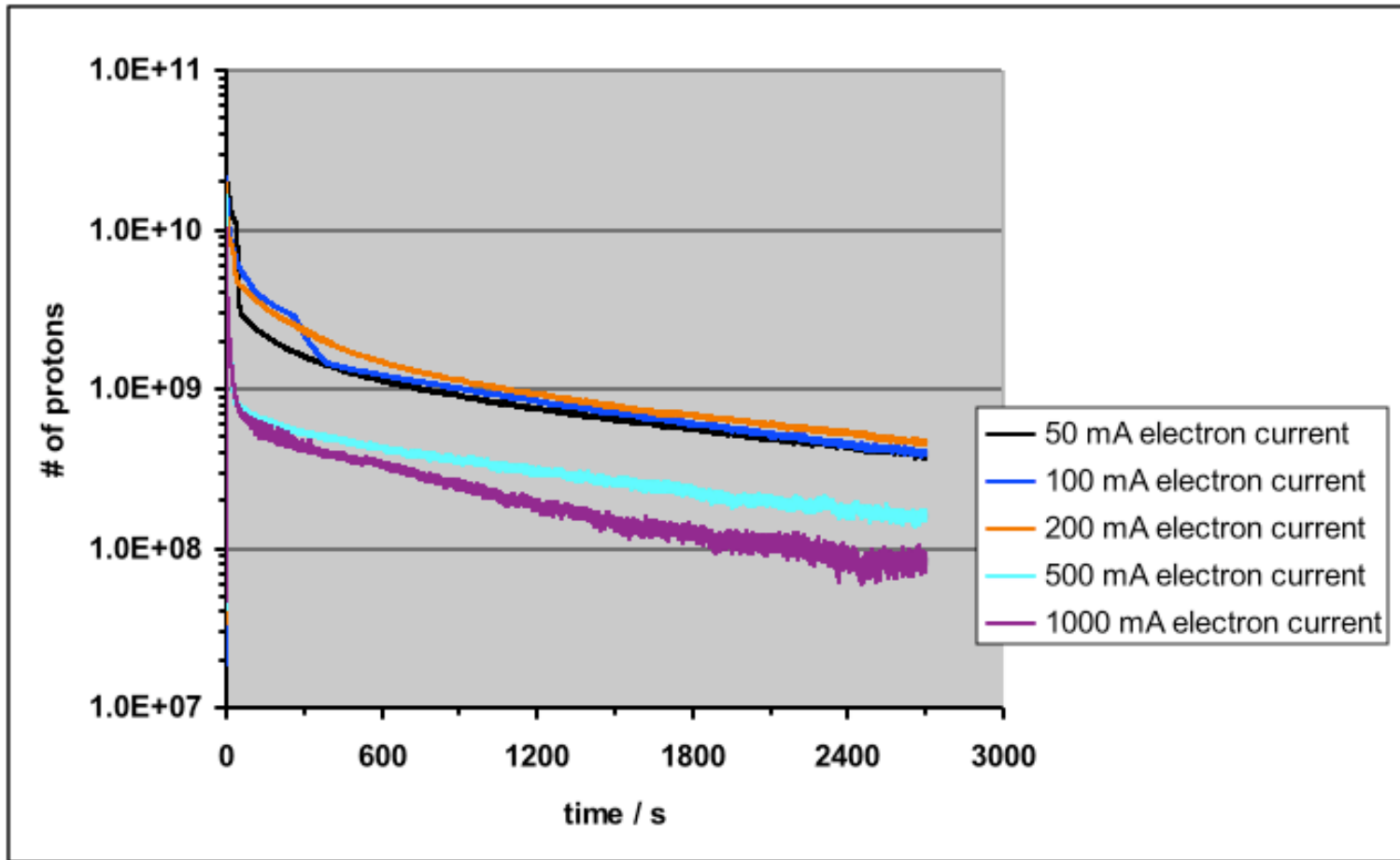
⇒ Protons outside the electron beam see a non-linear focussing by the electron beam



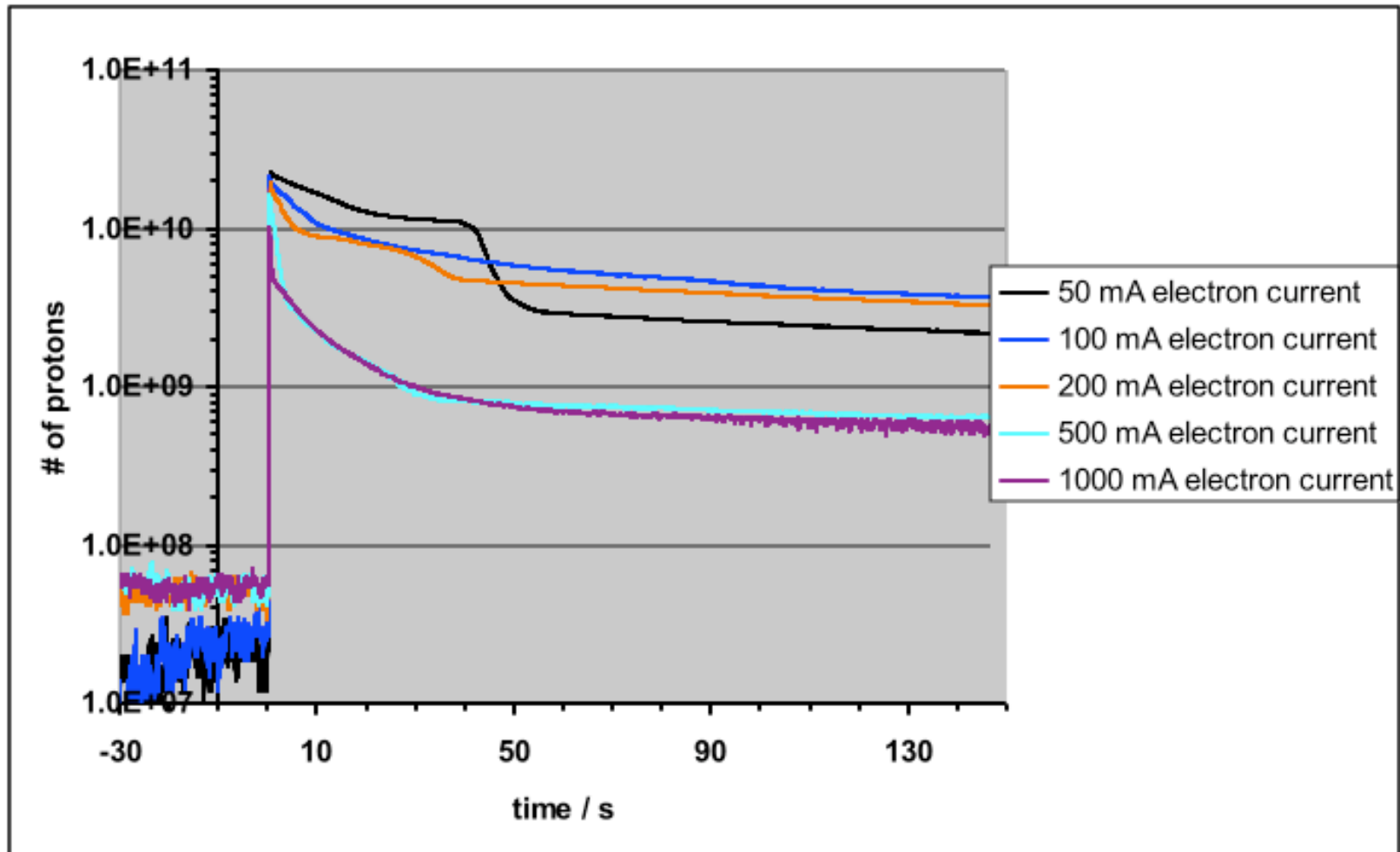
# Recent Electron Cooling Experiments

- Attempts towards crystallized beams  
⇒ A. Smirnov (today)
- Stability Limits of electron cooled beams  
⇒ Talk by Igor Meshkov (Thursday)
- Proton beam lifetime and phase space

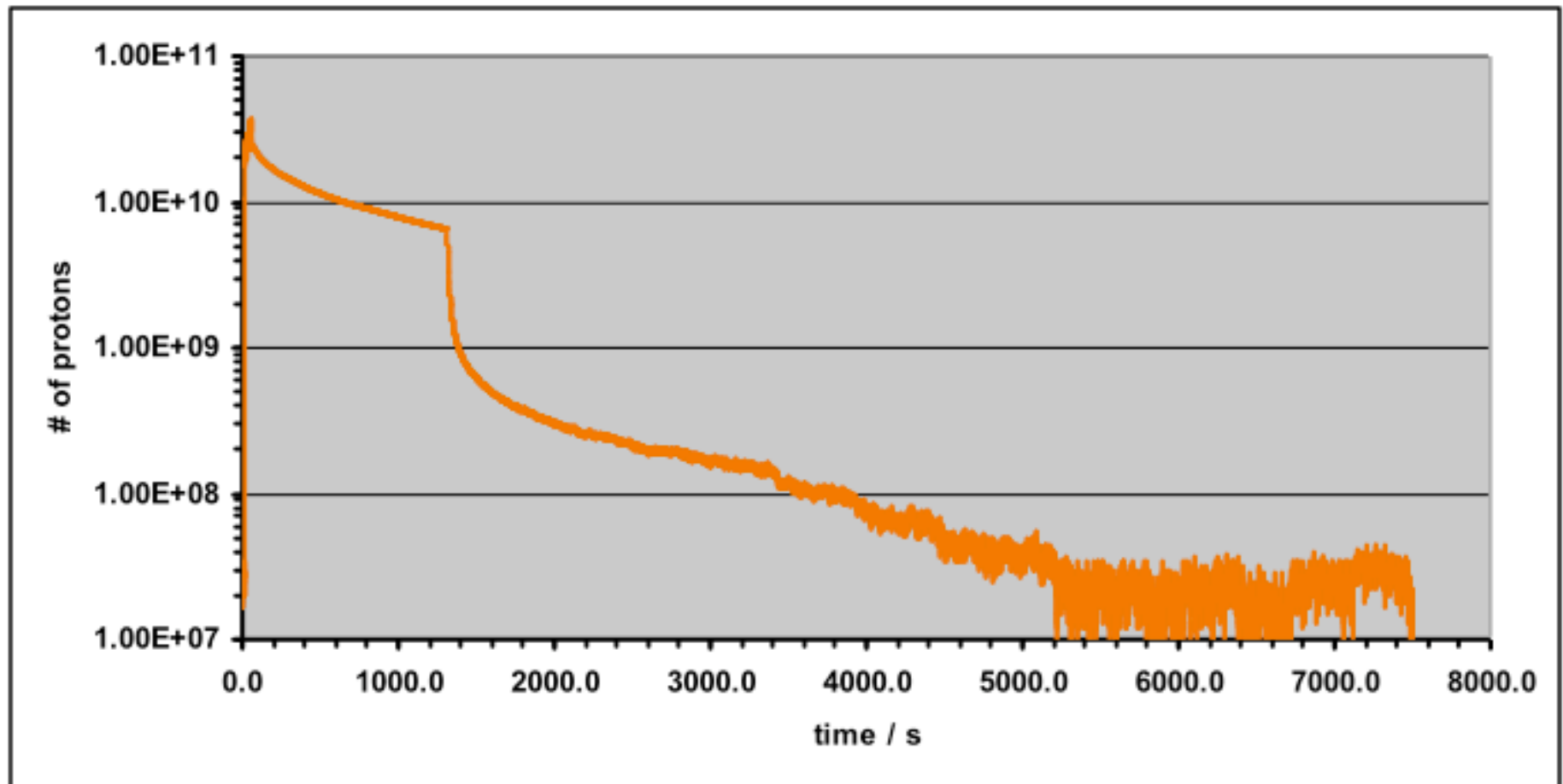
# Proton intensity as function of time and electron current



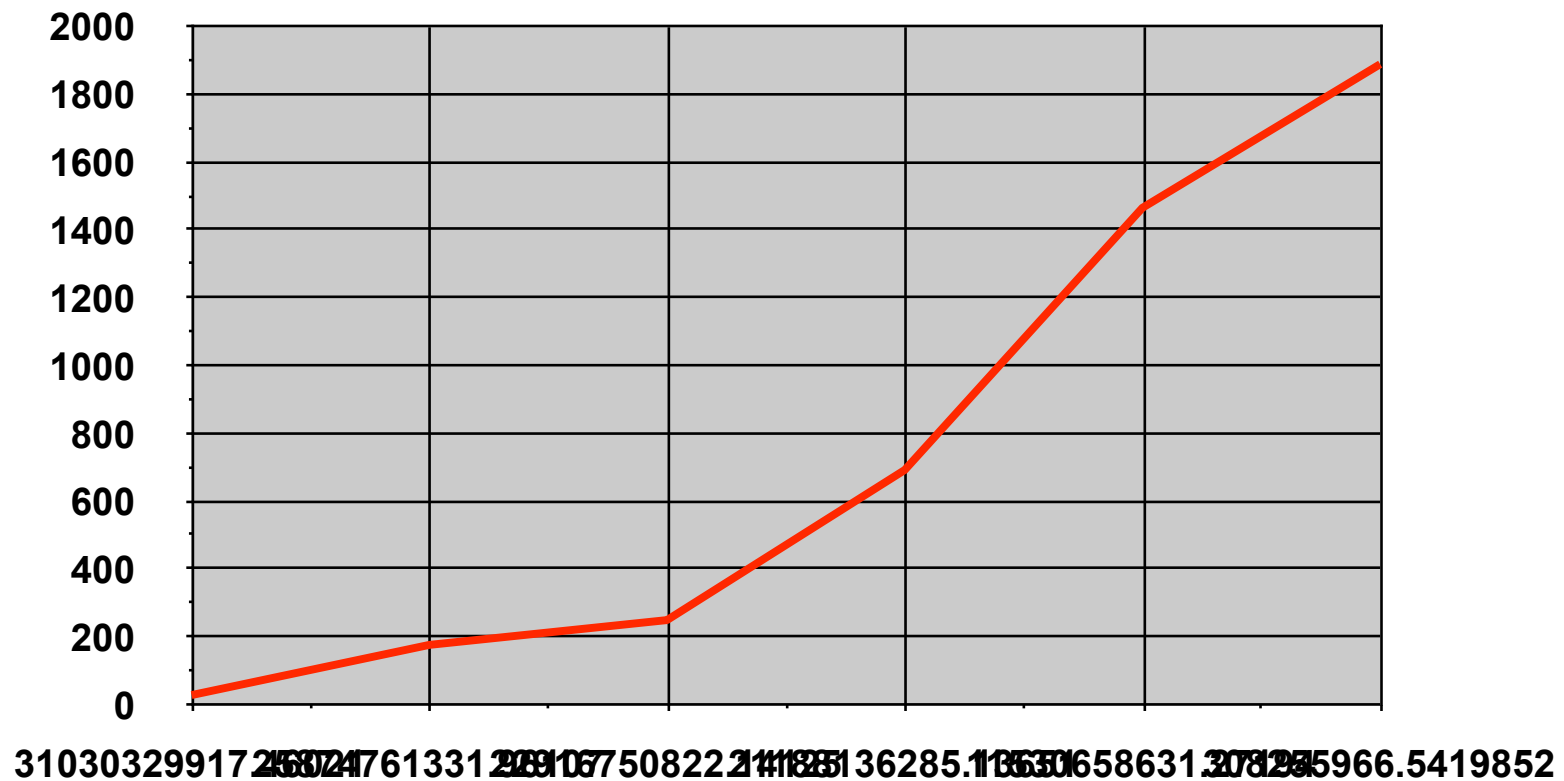
# Proton intensity as function of time and electron current



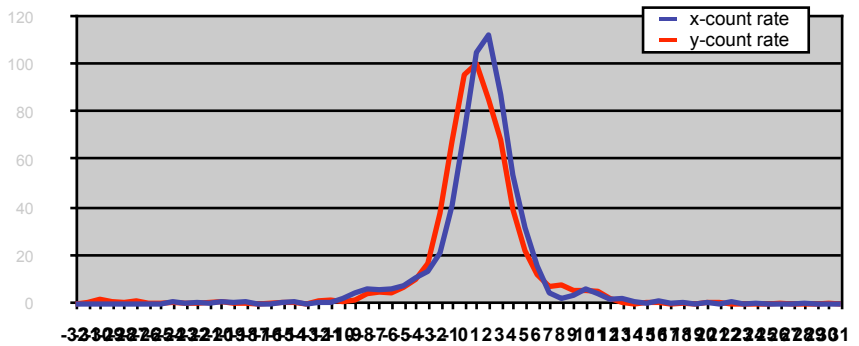
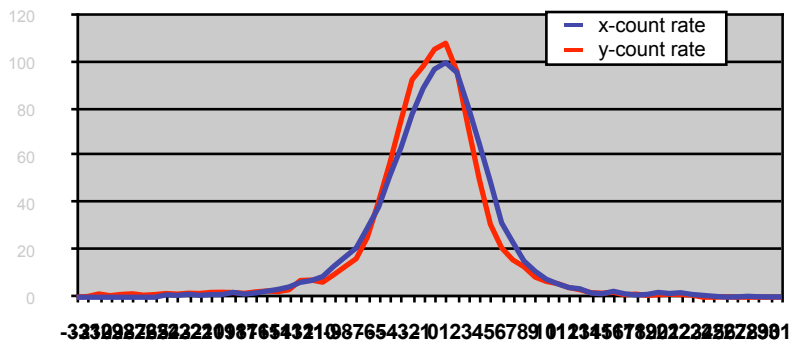
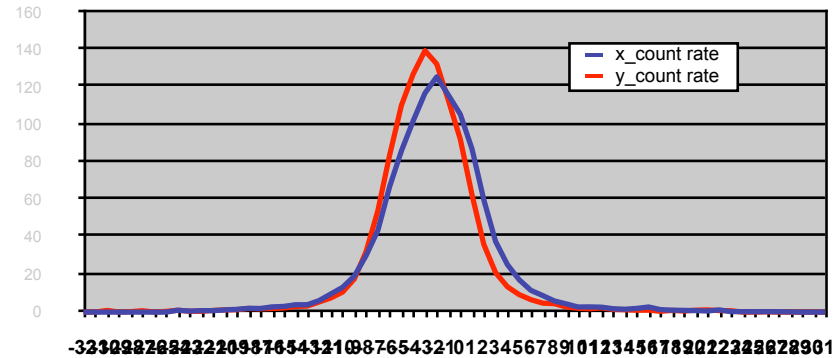
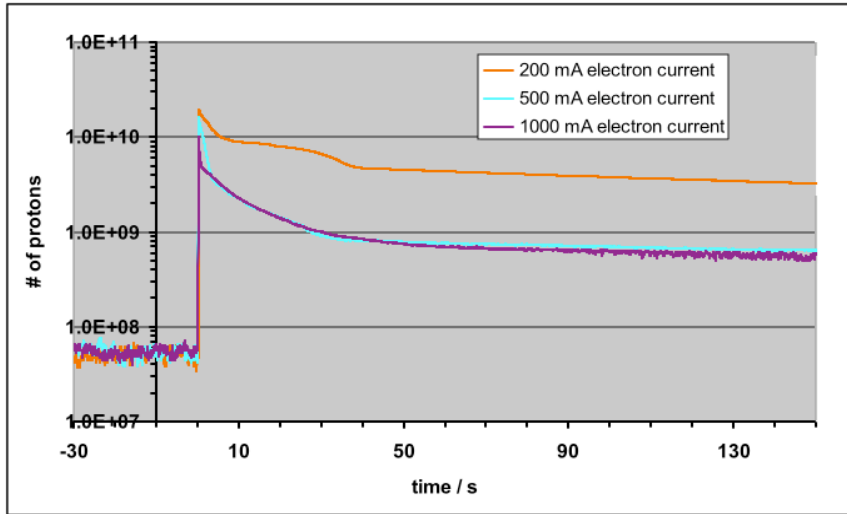
# Proton beam lifetime as function of beam intensity ( $I_{\text{electron}} = 150 \text{ mA}$ )



# Proton beam lifetime as function of beam intensity



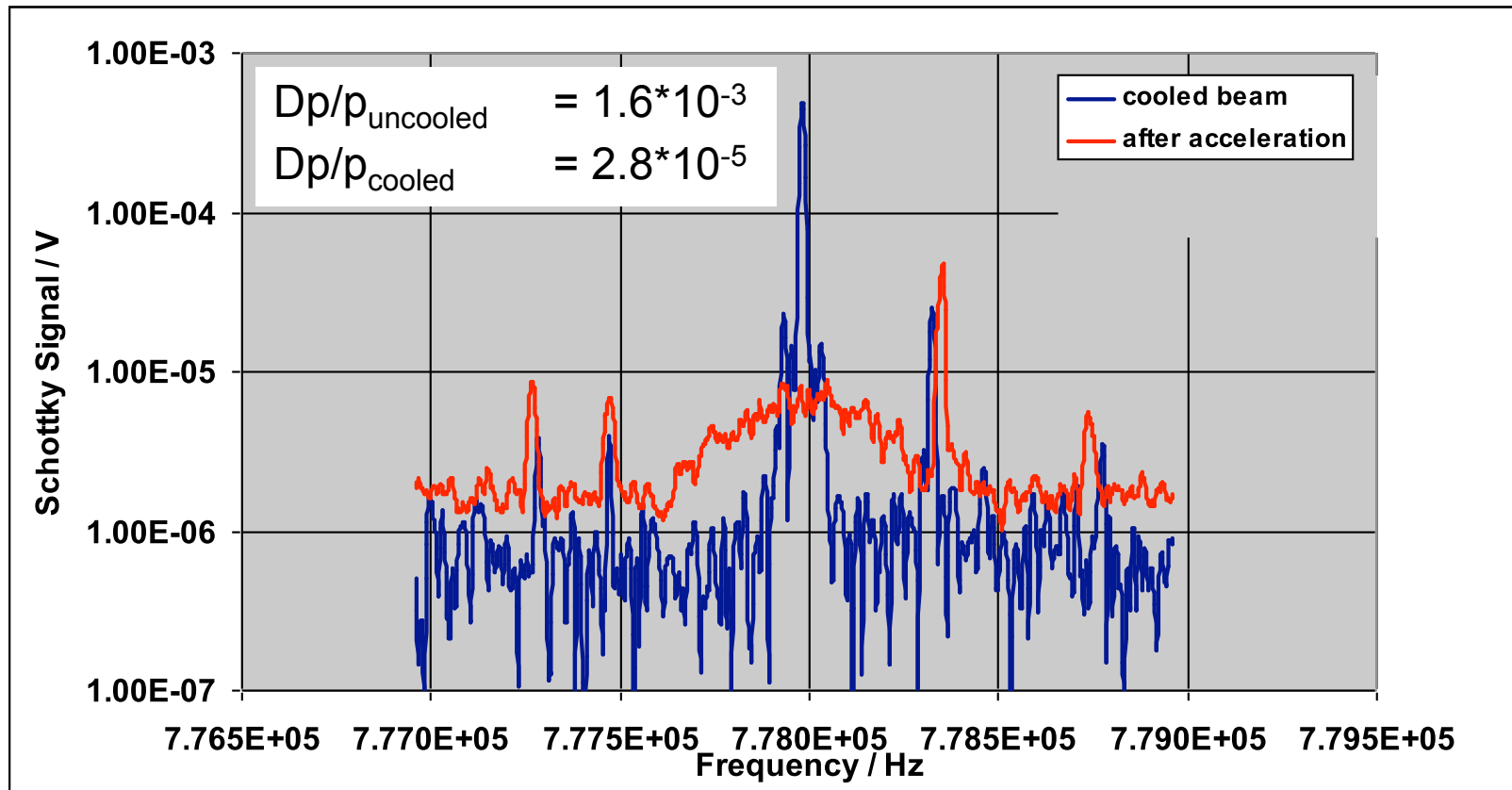
# Cooled emittances



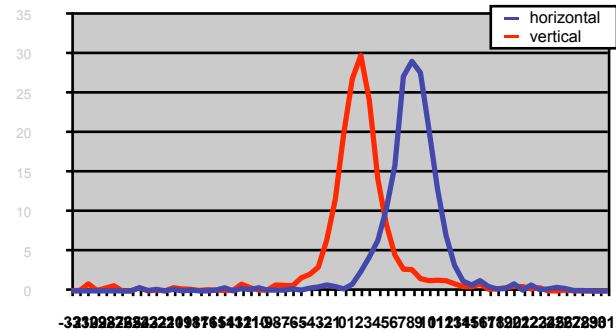
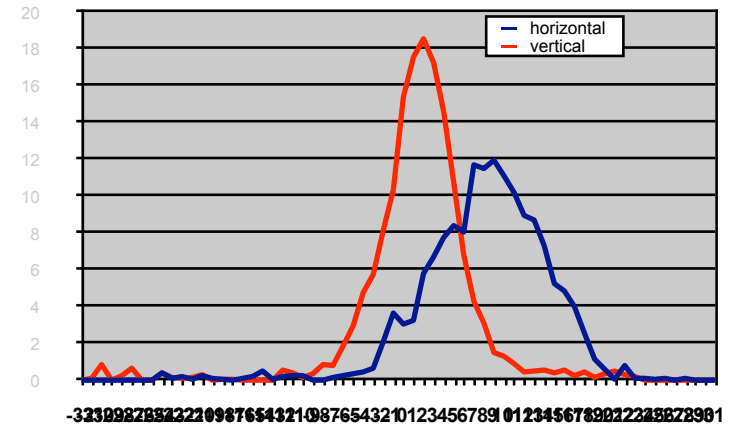
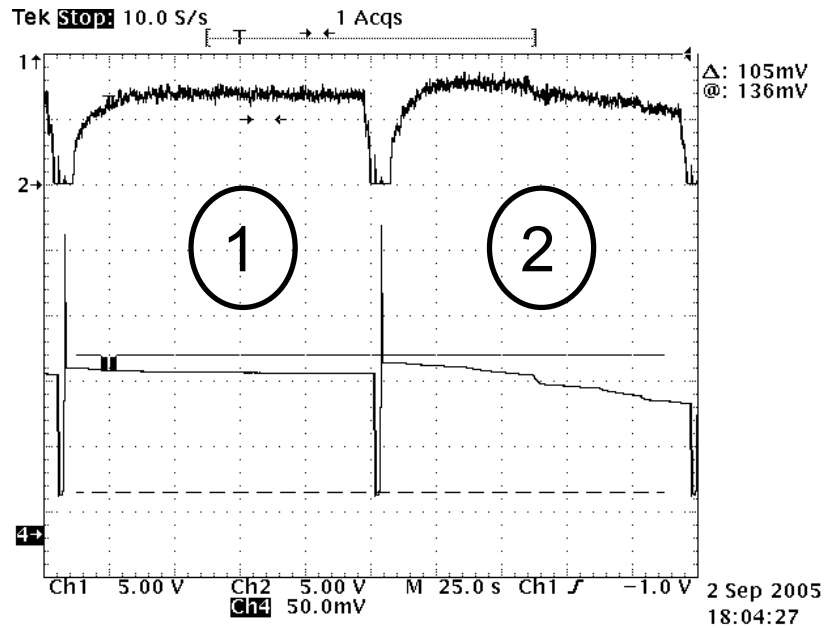
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# Cooling at 508 MeV/c ( $T_{\text{electron}} = 70 \text{ keV}$ )



# (Mis-)Alignment of the electron beam by 0.5 mrad



$\epsilon_{\text{misaligned}} = 1.0 \text{ mm mrad}$   
 $\epsilon_{\text{aligned}} = 0.4 \text{ mm mrad}$



# Summary

- In our electron cooler experiments at 45 MeV we observed
  - proton beam emittance depending initial losses
  - intensity dependant beam lifetimes
  - intensity dependant instabilities
- At 130 MeV we observed
  - No initial losses
  - Intensity dependant instabilities

# Future Experiments

In view of the necessary strong cooling in the FAIR-HESR we plan to investigate

- the dependence of cooling forces on ion beam optics
- Intensity limits
- Phase space density limits

Thank you for your attention