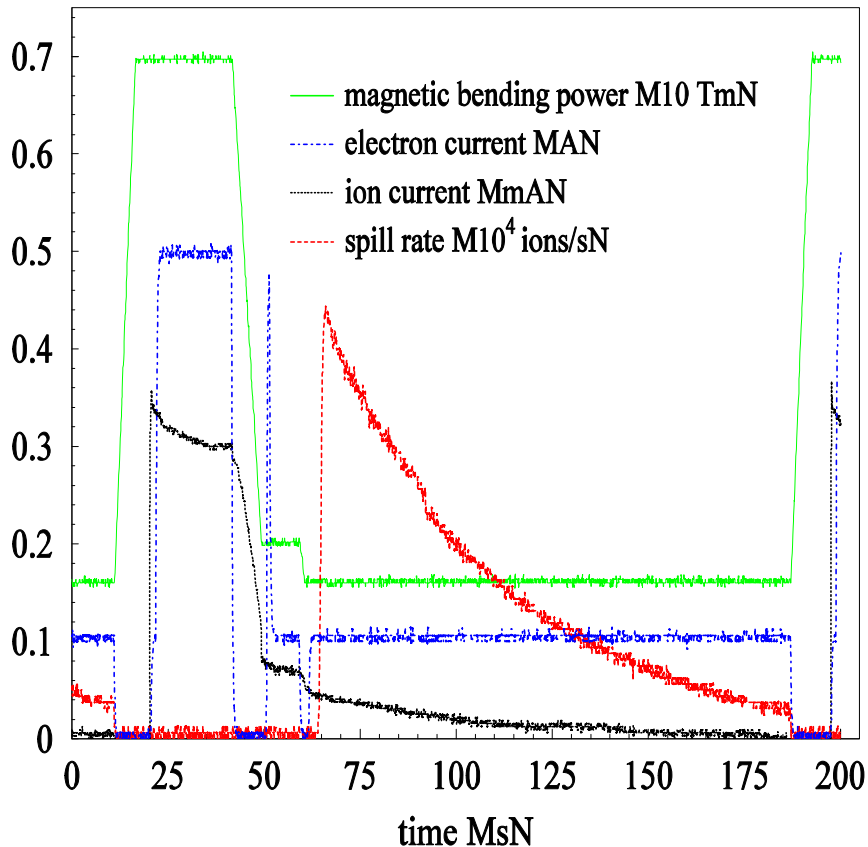


Beam Deceleration

cycle with ultraslow (charge changing $U^{92+} \rightarrow U^{91+}$)
extraction for external experiments



standard deceleration cycle

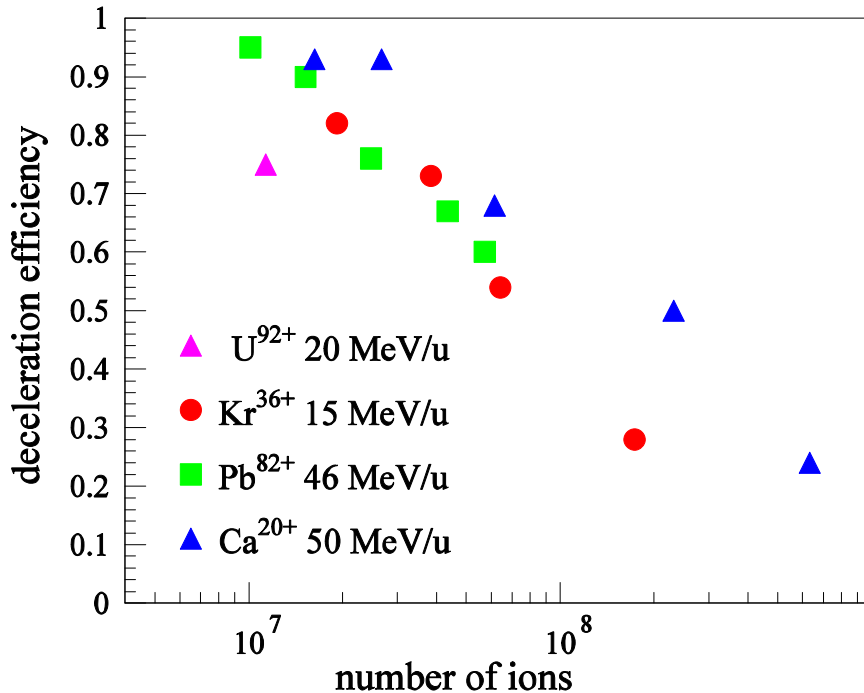
cooling before deceleration (~ 10 s)

slow ramping (< 0.1 T/s)

cooling at intermediate energy (~ 30 MeV/u)

ultraslow extraction (option)

Deceleration Efficiency



increase of losses with beam intensity

possible causes:

growth of phase space volume

(adiabatic increase, intrabeam scattering)

longitudinal compression due to bunching

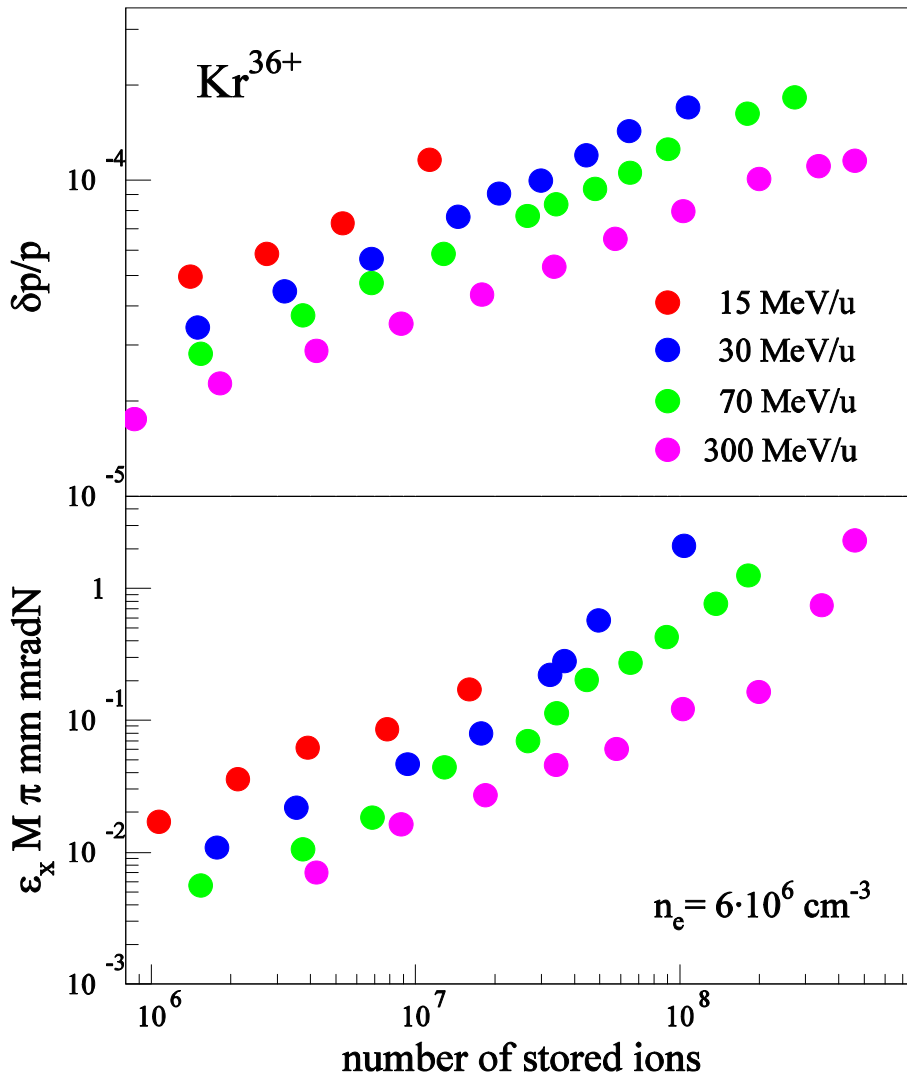
eddy current effects

closed orbit distortions due to imperfections

maximum intensity after deceleration: 1×10^8

instabilities, space charge limit ?

Beam Parameters of Cooled Stored Heavy Ions after Deceleration

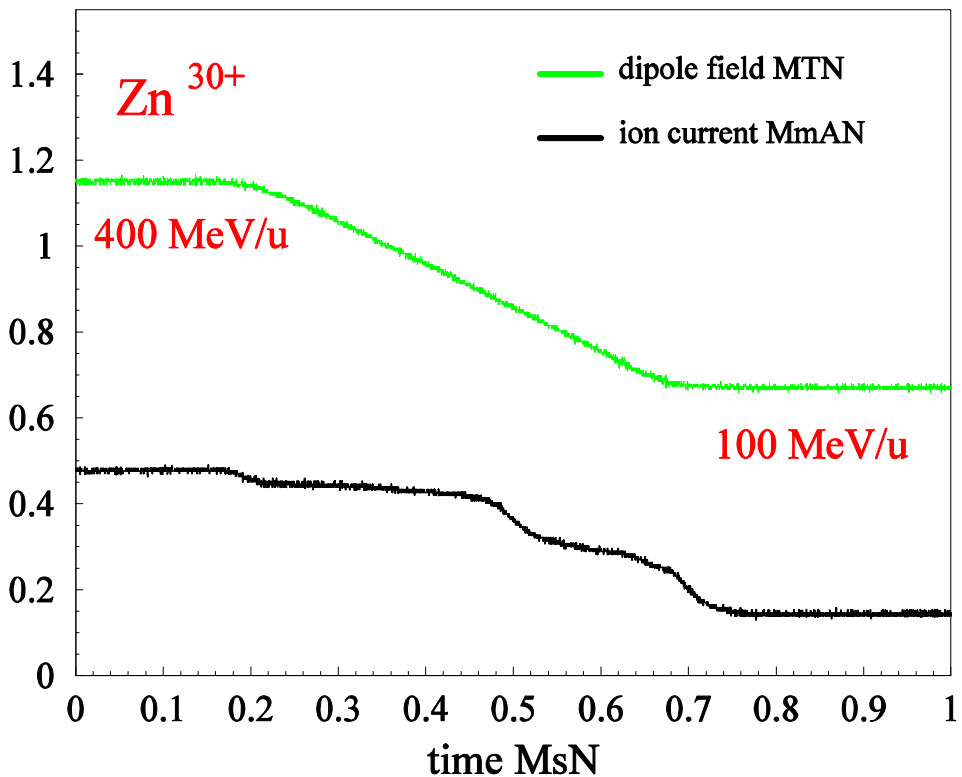


**emittance and momentum spread
determined by intrabeam scattering
energy dependence from experiments:**

$$\epsilon \propto (\beta\gamma)^{-4/3}, \quad \delta p/p \propto (\beta\gamma)^{-2/3}$$

First Test of Fast Deceleration

ramping of the ring at a rate of 1 T/s



not available for experiments

improve deceleration efficiency

modifications of cooling concept/hardware

Recent Improvements

filling the ESR with one single SIS pulse

full ramping capability for all power supplies

average vacuum: 3×10^{-11} mbar

improved diagnostics:

beam position during ramp

fast (online) tune measurement

fast detector drives for experiments with stored ion

event control of target and detectors drives

Future Improvements

software

ramping of electron cooler magnetic field

more flexibility in ramping parameters

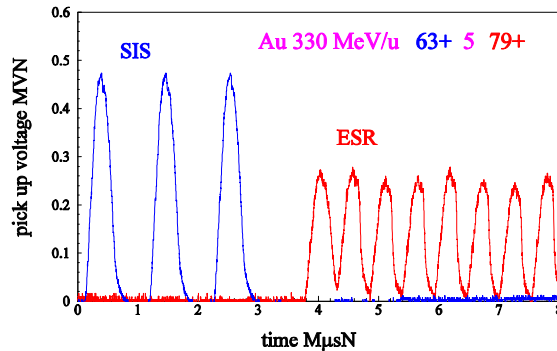
further vacuum improvement

fast extraction after deceleration

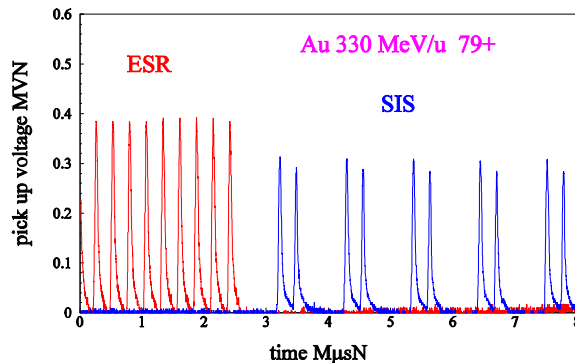
detection of very slow ions

Fast Extraction from the ESR in the reinjection mode

injection of one bunch from SIS to ESR



reinjection of two bunches from ESR to SIS



high efficiency due to cooled beam

extraction at lower energy needs to be studied, kicker pulse limited to 3 µs

Status of Deceleration at the ESR

with uranium beam

typical injection energy : 300- 400 MeV/u

for physics experiments:

**deceleration to various energies in the range
20- 120 MeV/u**

**experiments with stored and slowly extracted
highly charged ions (charge changing
extraction)**

**fast extraction at injection energy in
reinjection mode**

during machine development:

**deceleration to 15 MeV/u: up to 10^6 U^{92+} ions
debunching/rebunching $h=2$ to $h=4$**

**deceleration to 9 MeV/u:
cooling at two intermediate energies
detectable, but unmeasurable beam intensity**