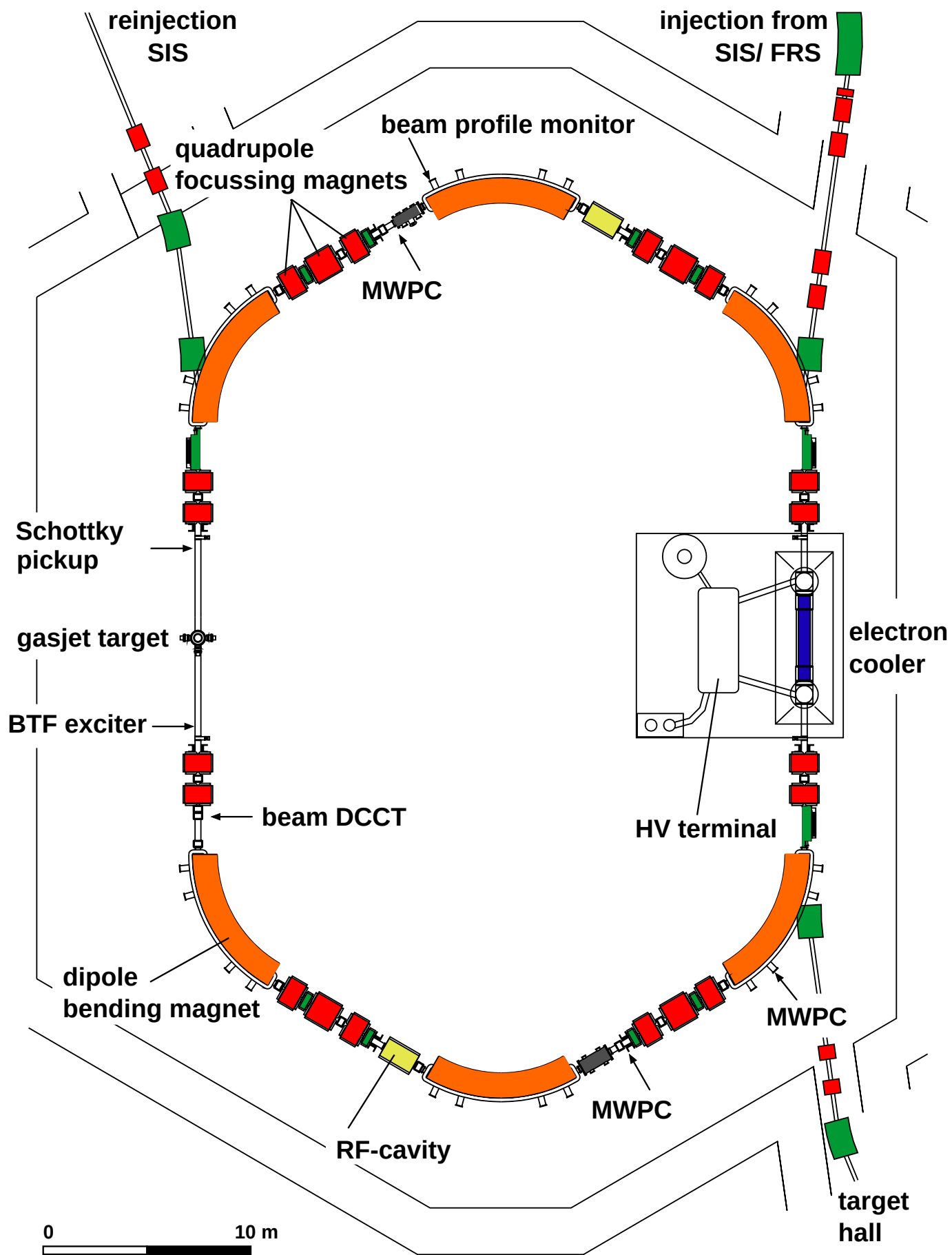


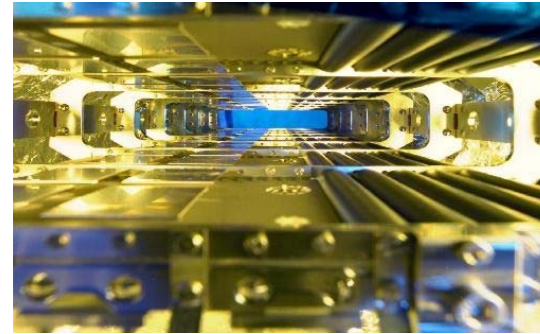
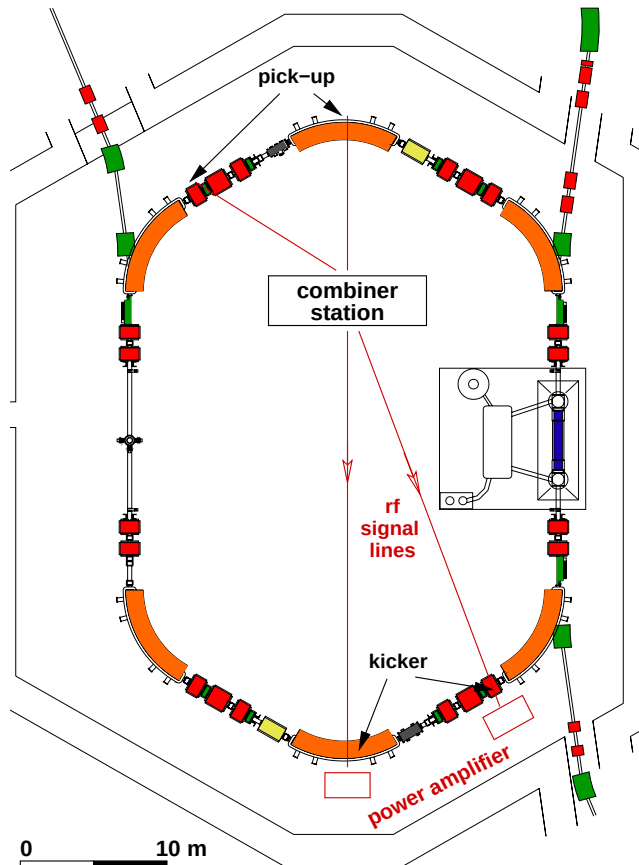


Stochastic Cooling at the ESR

Fast pre-cooling of hot fragment beams
in the energy range 400 – 550 MeV/u
bandwidth 0.9 – 1.7 GHz

$$\delta p/p = \pm 3.5 \text{ ‰} \rightarrow \delta p/p = \pm 0.1 \text{ ‰}$$

$$\epsilon = 1 \times 10^{-5} \text{ m} \rightarrow \epsilon = 2.5 \times 10^{-6} \text{ m}$$



Electrodes



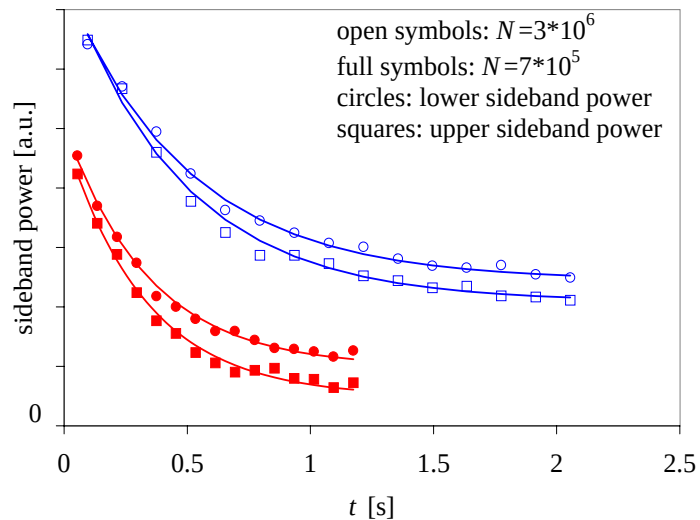
Combiner station



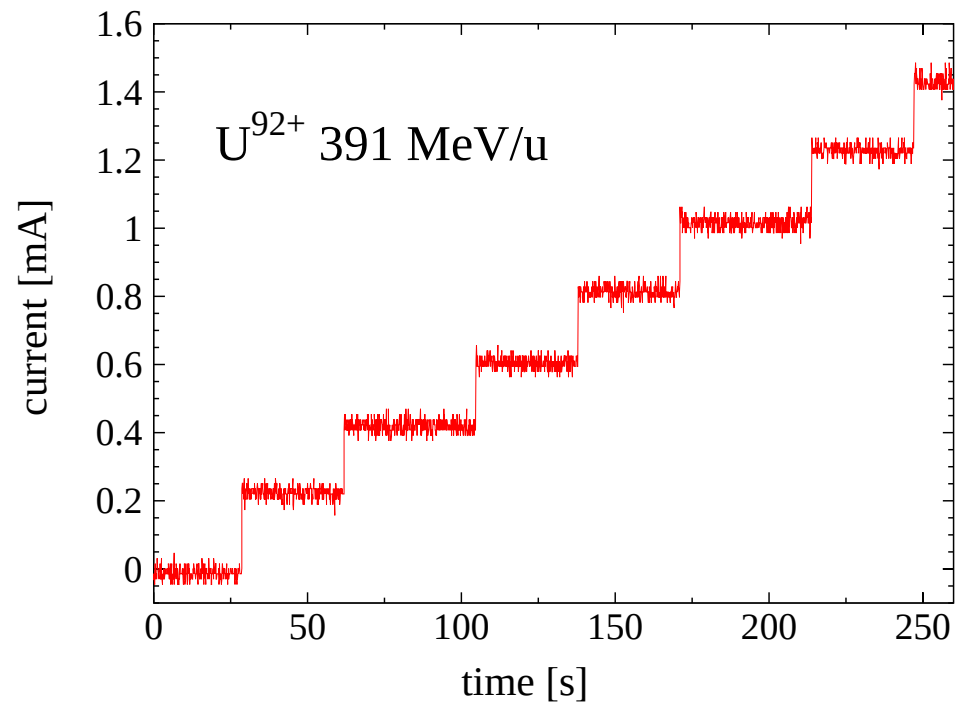
Power amplifiers

Stochastic Cooling of Uranium

Cooling times (for $N \sim 10^6$)
longit., vert.: 0.5 s
horiz. (not. optim.): 2.5 s

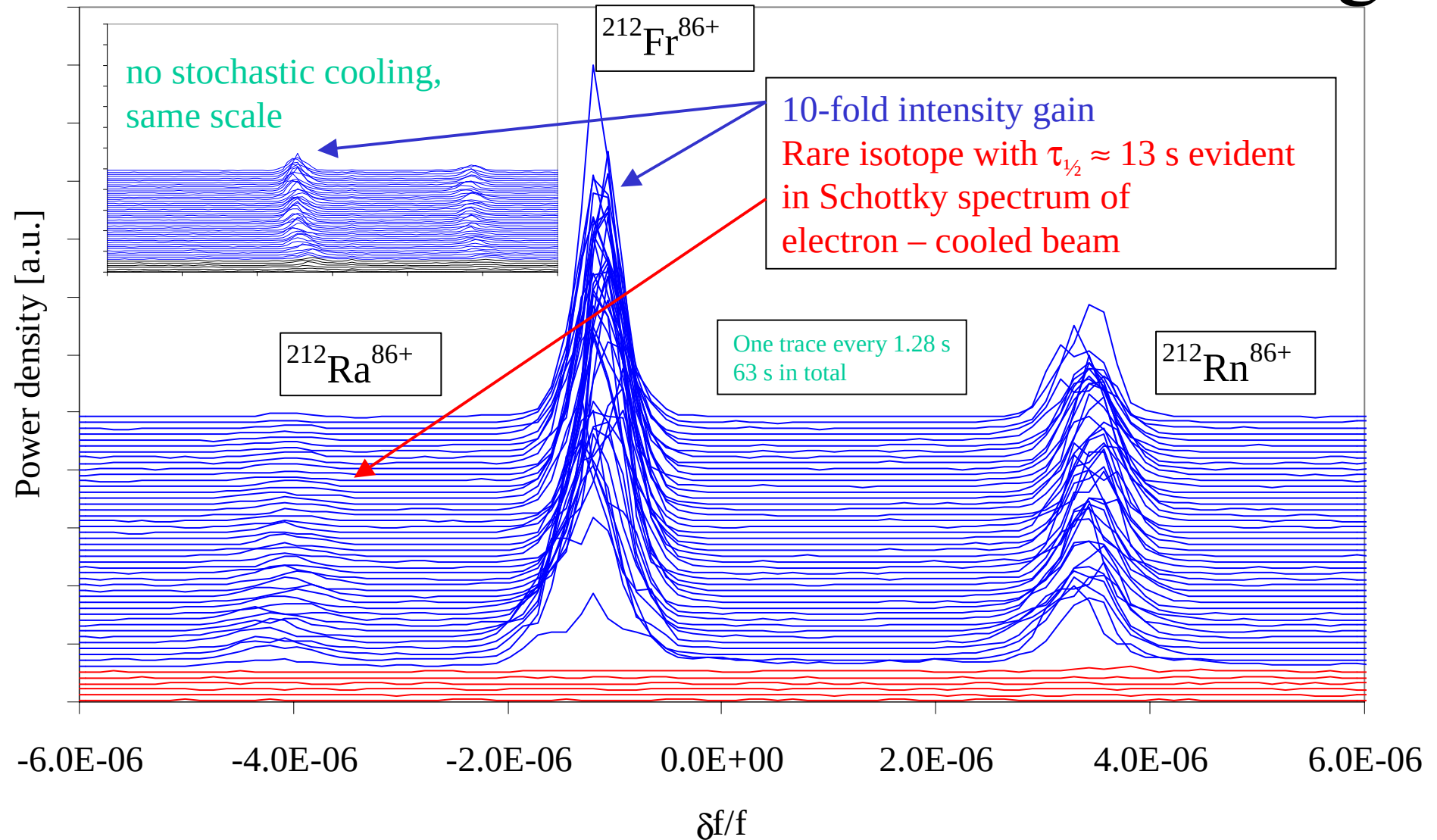


Accumulation by **combination of stochastic cooling, rf stacking and electron cooling** of the stack



Accumulation rate limited by synchrotron cycle

10-fold Intensity Gain of Rare Isotope Beams due to Stochastic Pre-Cooling



ESR Electron Cooler



electron beam parameters

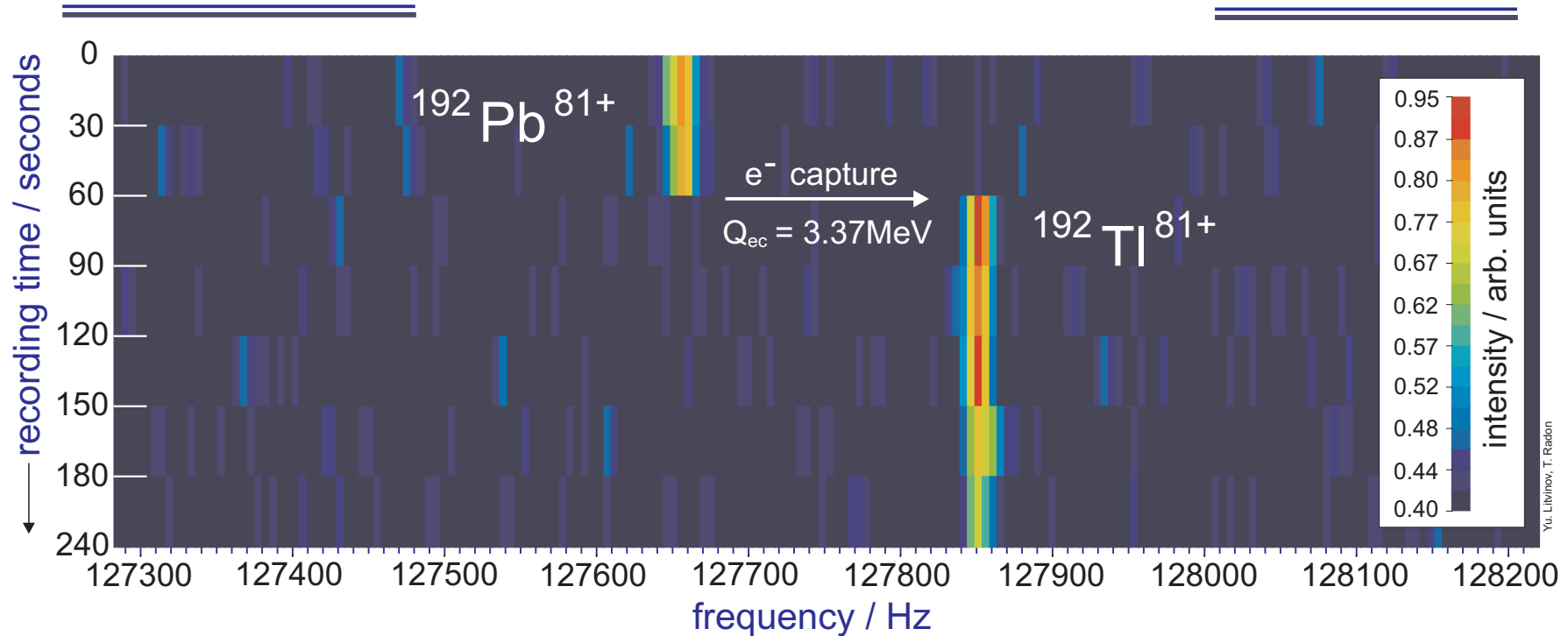
energy	5–250 keV
current	1 mA – 1 A
diameter	50.8 mm
gun perveance	1.95 μP
collection efficiency	>0.9998
temperature	
transverse	0.11 eV
longitudinal	~ 0.1 meV

magnetic field

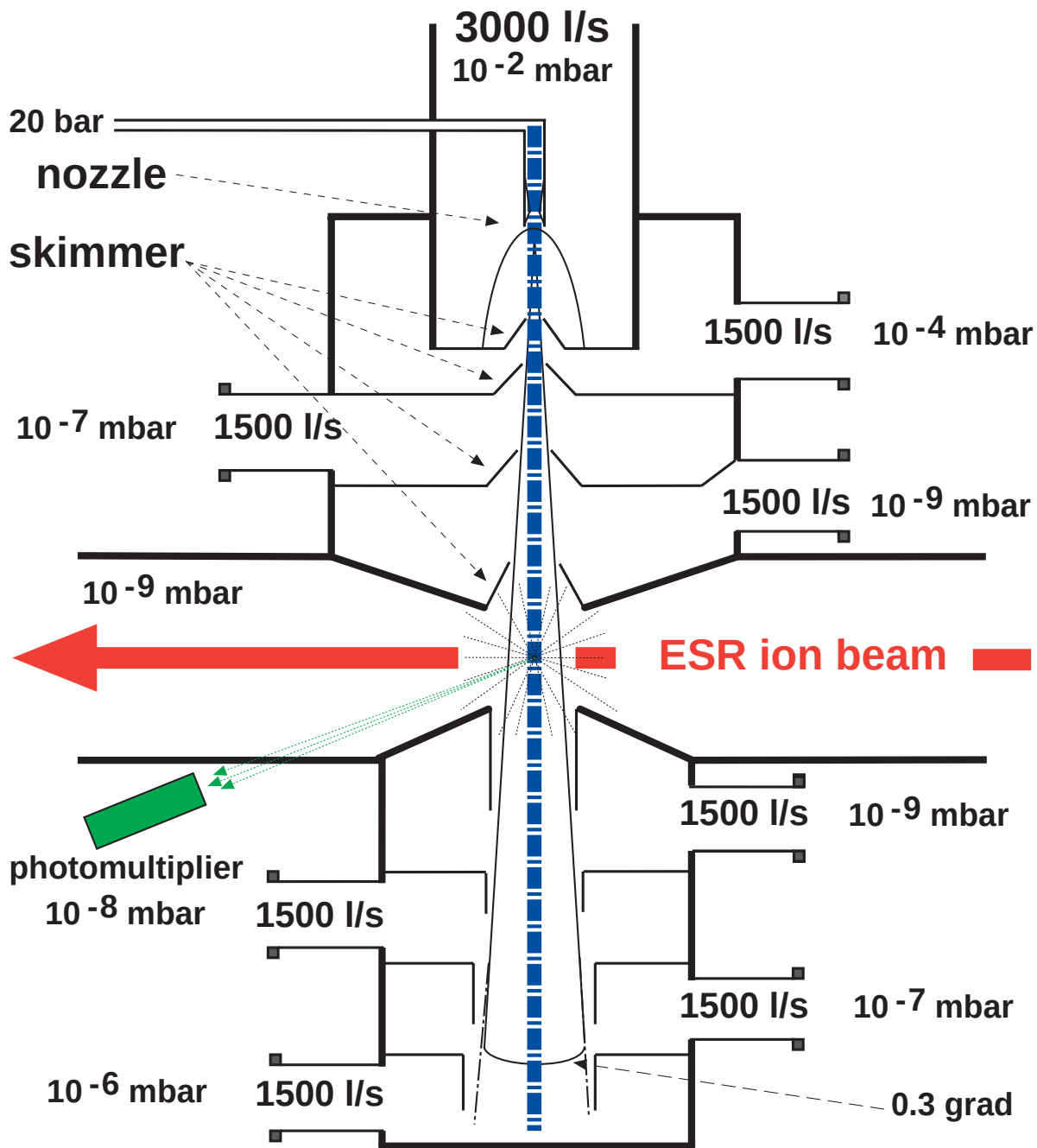
strength	0.05 – 0.2 T
straightness	1×10^{-4}

vacuum	2×10^{-11} mbar
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Detection of a Single Cooled Ion



**high sensitivity due to well defined revolution frequency
and high ion charge (Schottky noise $\propto q^2$)**



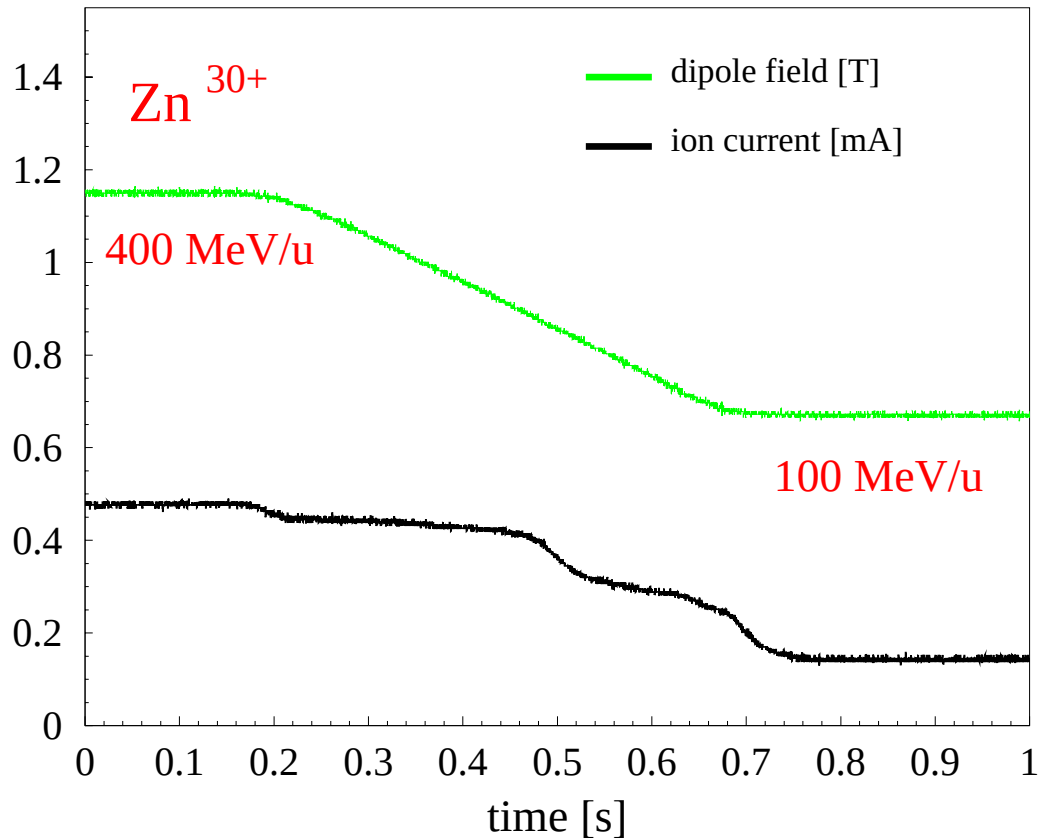
jet diameter in interaction point: 5 mm

target densities [atoms/cm²] for $p_t = 5 \times 10^{-9}$ mbar

gas	H ₂	N ₂	Ar	Kr	Xe
	1×10^{13}	7×10^{12}	7×10^{13}	2×10^{12}	5×10^{12}

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

stochastic pre-cooling and stacking

first test of fast ramping

fast detector drives for experiments with stored ions

event control of target and detectors drives

commissioning of electron spectrometer after gas jet

Future Improvements

improvement of isochronous mode

(better field flatness for variable magnetic rigidity)

improvements of deceleration

(faster ramp, lower energy, fast extraction)

increase of gas jet density (hydrogen)

further vacuum improvement