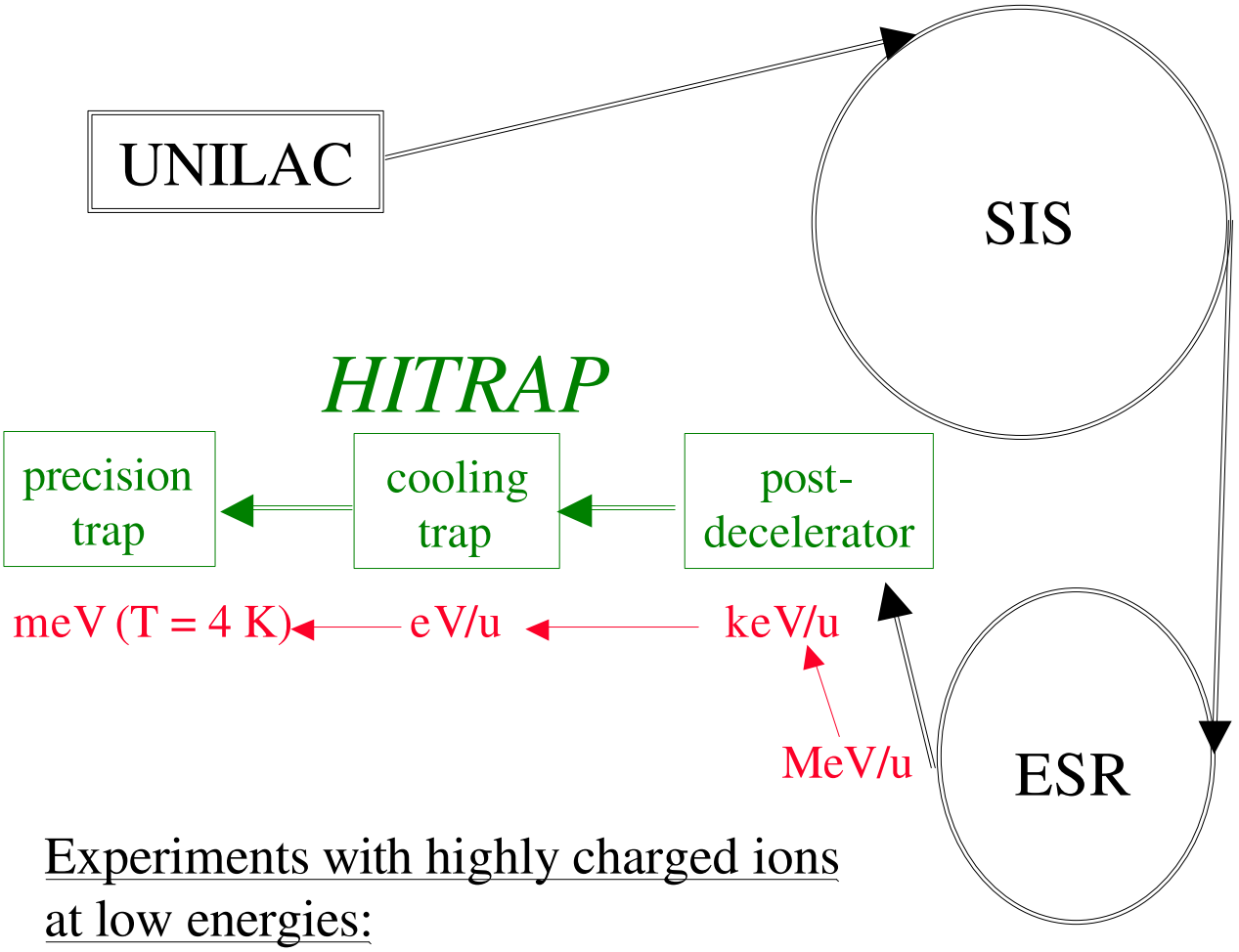
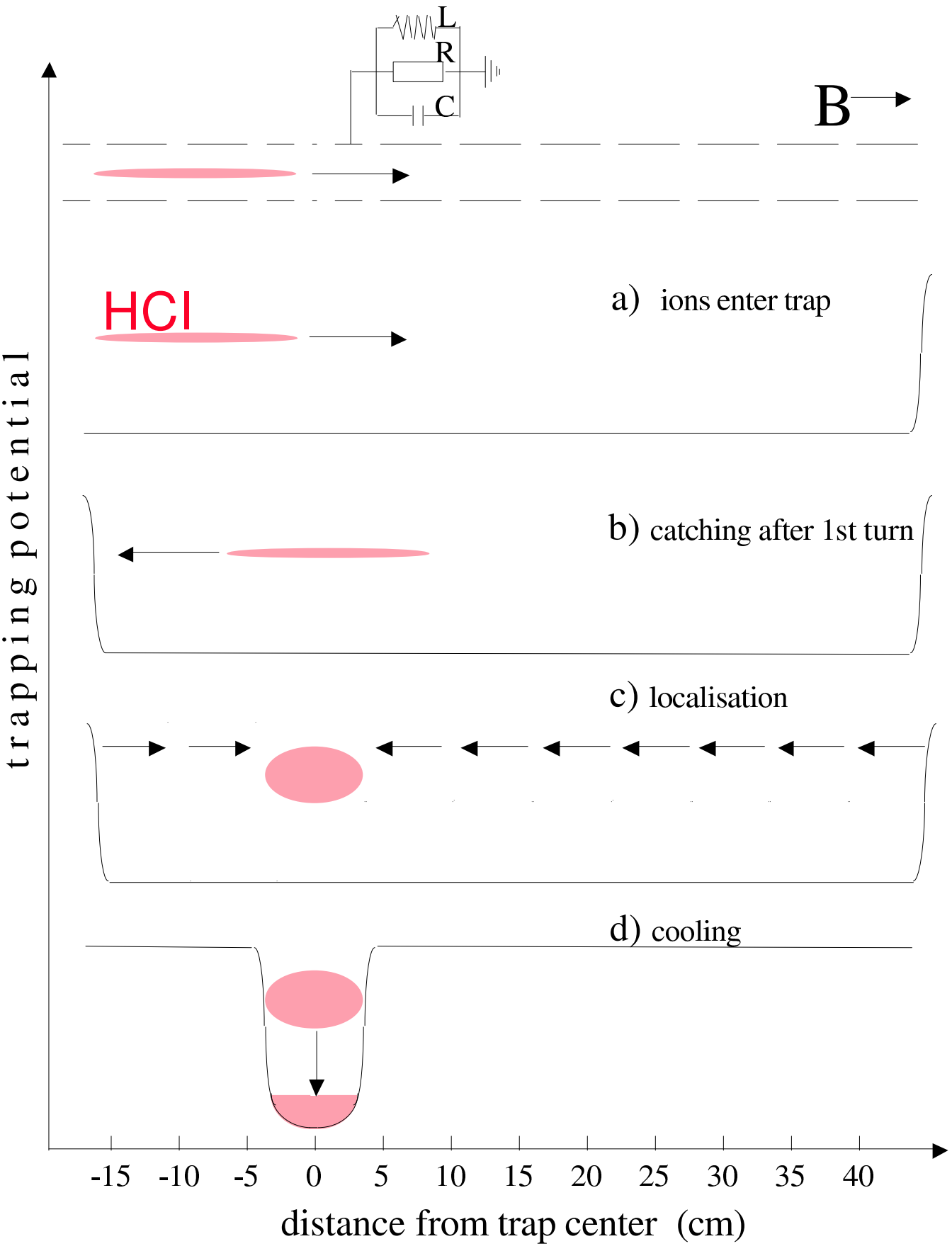
HITRAP Project at GSI



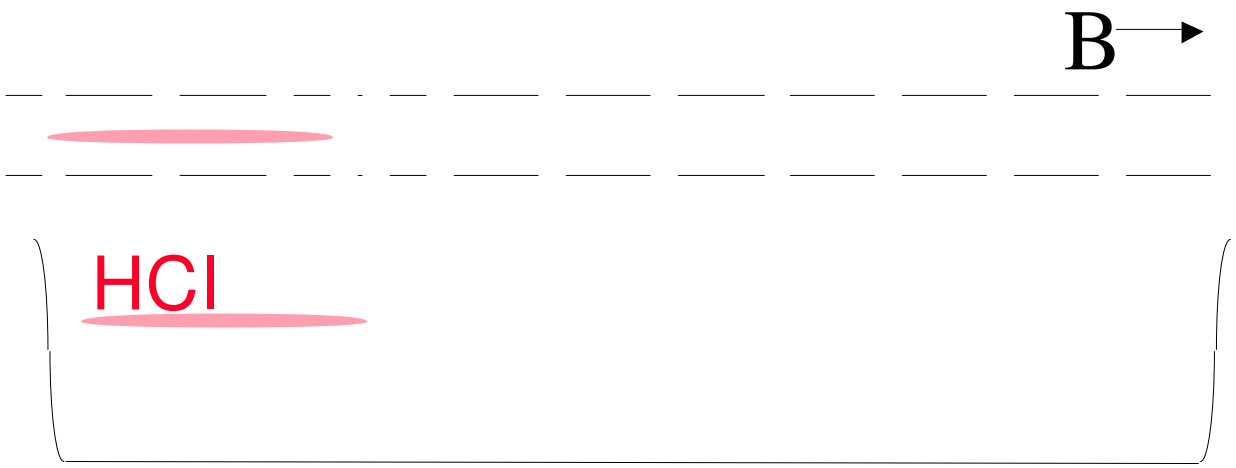
Experiments with highly charged ions at low energies:

- mass measurements (atomic binding energies)
- g-factor measurements (tests of QED)
- laser and X-ray spectroscopy with cold HCI
- surface and collision studies
- spectroscopy of exotic atomic systems (hollow atoms)

Capture and Cooling of HCI

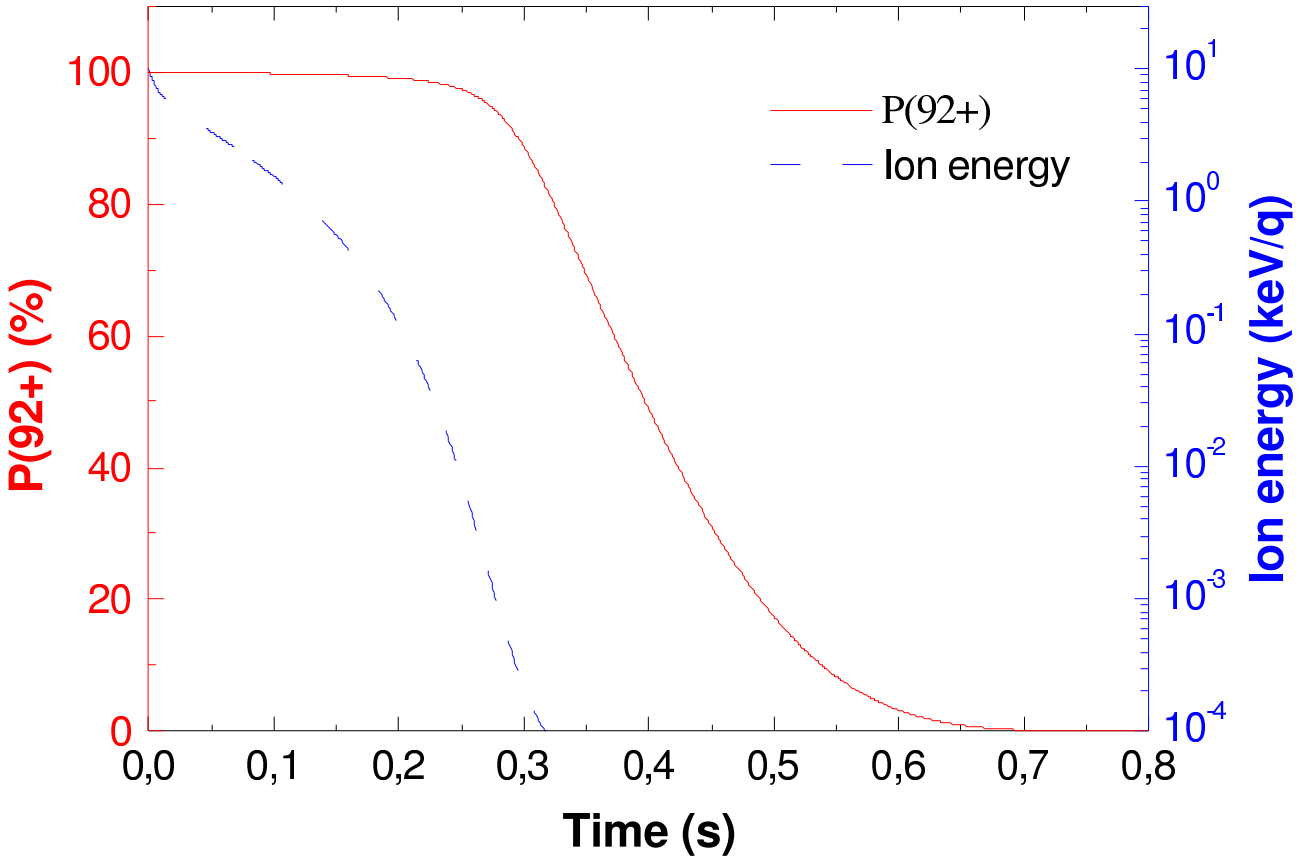


HITRAP: some design parameters of the Penning cooler trap:



length of trap:	0,5 m
inner diameter:	40 mm
potential depth:	30 kV
time of flight for one round trip: (for U^{92+} at E_{kin} = 10 keV / q)	t = 1,2 µs
electron cooling + resistive cooling	
magnetic field:	B = 6 Tesla
cyclotron frequency:	ν_c (U^{92+}) = 35 MHz

Electron Cooling in Penning Trap: Surviving Probability of U^{92+} Ions



The Magnetic Moment of the Electron

$$\frac{|\bar{m}|}{m_B} = g \cdot \frac{|\bar{s}|}{h}$$

μ: magnetic moment

g: g-factor

s: spin

$m_B = \frac{e\,h}{2\,m_e}$ (Bohr magneton)

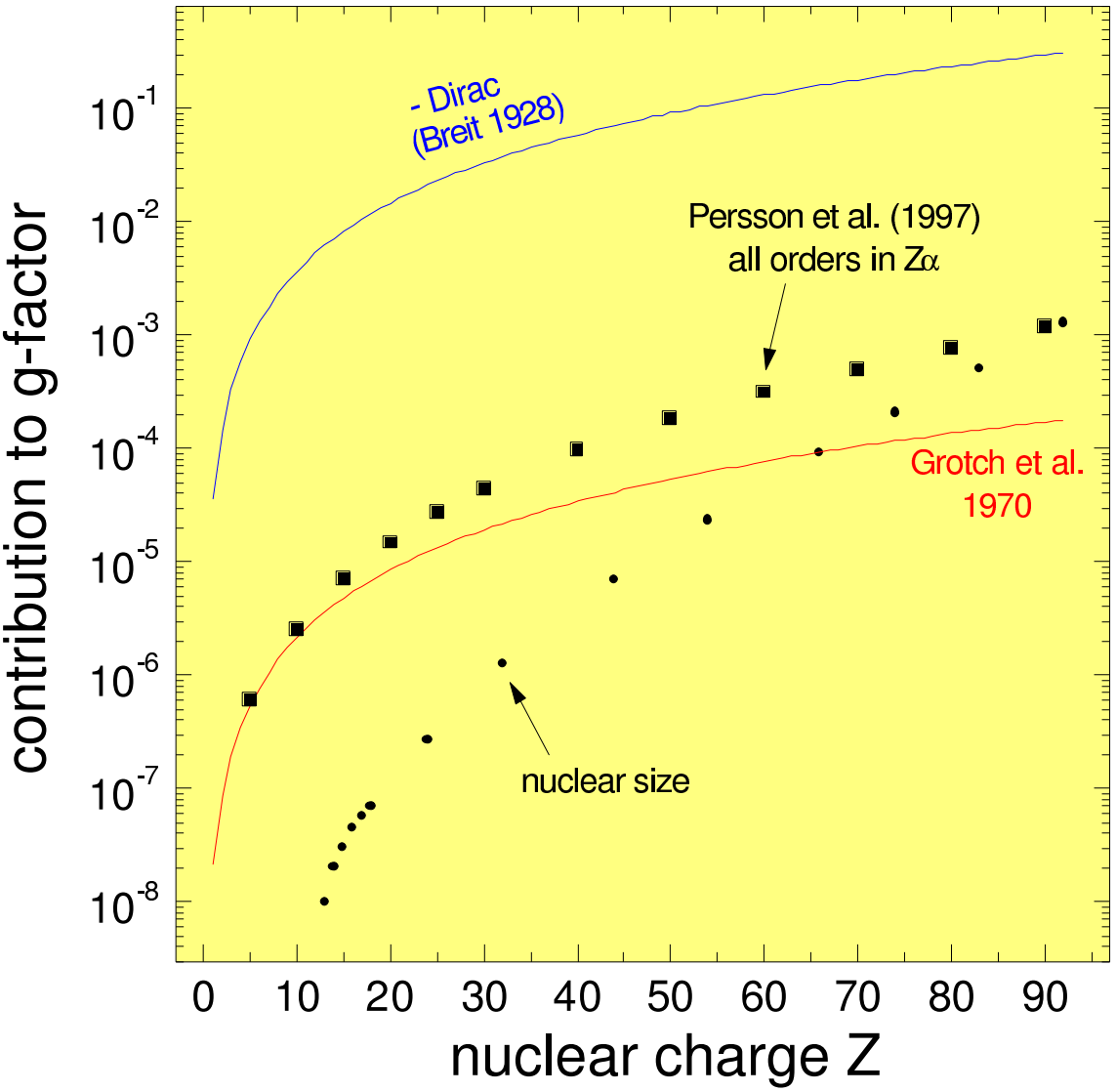
Dirac → g = 2

THEORY: CONTRIBUTIONS TO THE G-FACTOR OF THE BOUND ELECTRON

$$g_{bound}/g_{free} = 1 - (Z\alpha)^2/3 + \alpha(Z\alpha)^2/4\pi$$

relativistic correction (Dirac)

QED correction (Grotch et al.)



previous experiments: ^{1}H, ^{1}D and ^{4}He$^+$

How to Measure the g-Factor?

$$h\nu_L = g\mu_B B$$

ν_L : Larmor precession frequency

We also have to measure the B field!

$$\nu_c = \frac{q}{2\pi M_{ion}} B$$

ν_c : ion cyclotron frequency

$$g = 2 \cdot \left(\frac{\nu_L}{\nu_c^{ion}} \right) \cdot \frac{\left(m/e \right)^e}{\left(M/q \right)^{ion}}$$