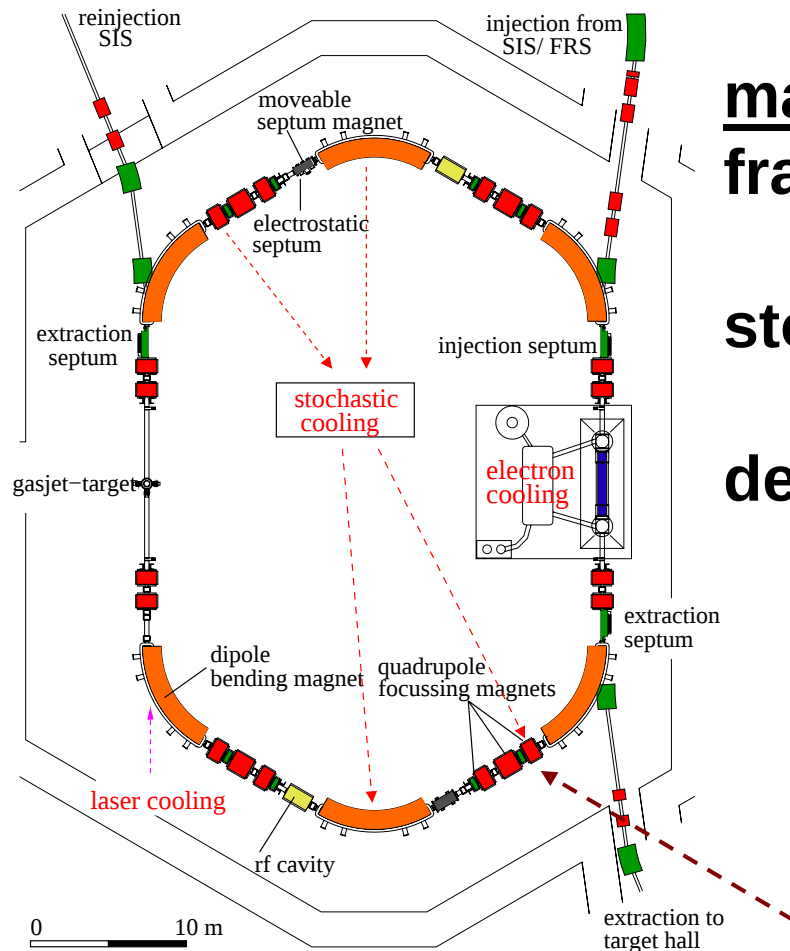


ESR Operation



main operation modes (in 2007):
fragment beam storage (SMS) and
isochronous mode
storage of incompletely stripped ions
(U^{28+} , Li^{1+})
deceleration of highly charged ions
fast (HITRAP commissioning)
and slow extraction
stored decelerated ions

main problem: poor vacuum (10^{-10} mbar)
remaining: leak in quad vacuum chamber
repair: beginning of 2008

ESR operation

**C. Dimopoulou, F. Nolden,
M. Steck, U. Popp (target)**

M. Steck, FRS user meeting, November 5, 2007

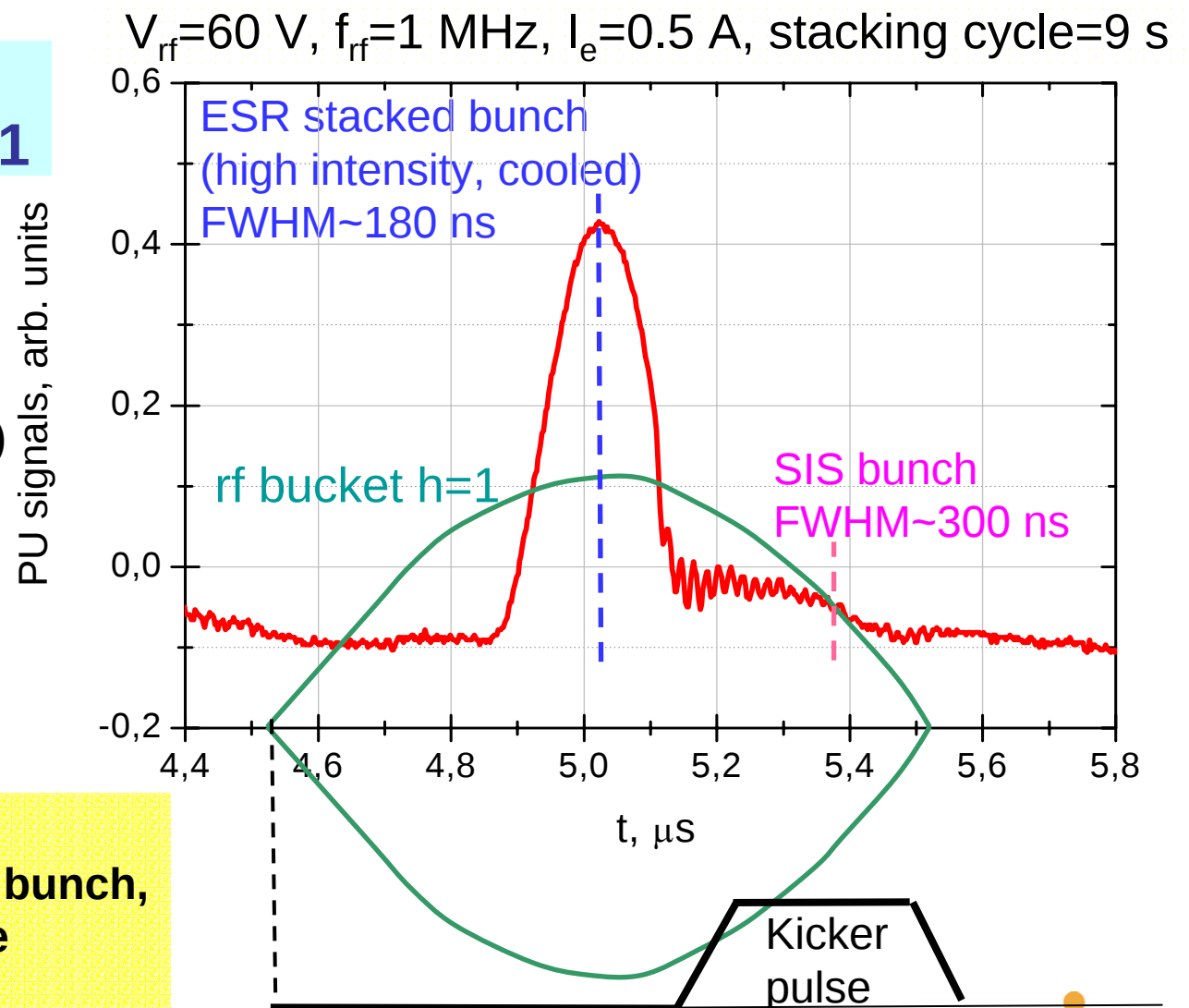
Accumulation Studies

Stacking with sinusoidal rf at $h=1$

Ar¹⁸⁺ 65 MeV/u

rf on during injection,
fast debunching (~ 1 ms)
after injection

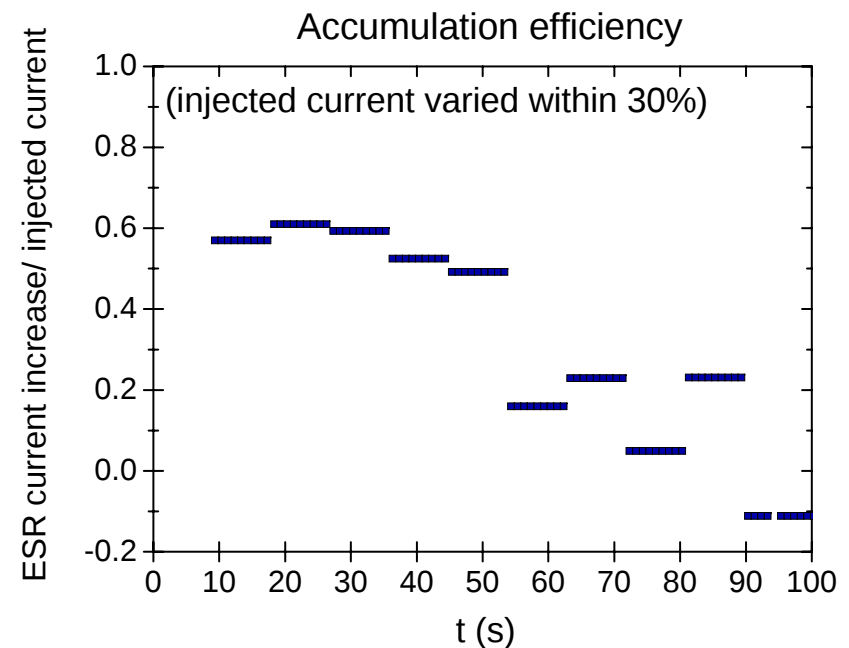
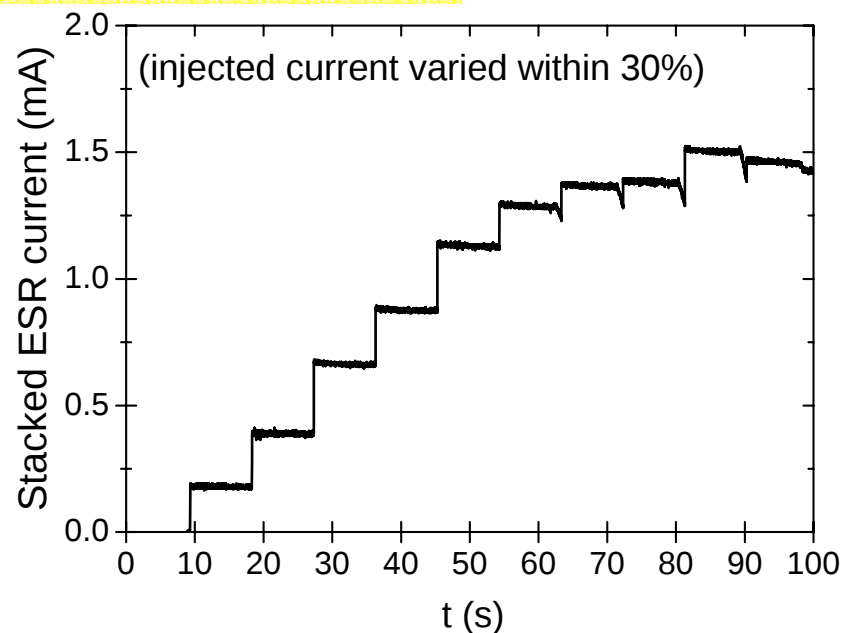
Qualitative information:
relative phase of stacked bunch,
new bunch & kicker pulse
w.r.t. separatrix



Stacking with sinusoidal rf at $h=1$

Current transformer measurement of beam current

stacking cycle=9 s $V_{RF}=120$ V, $f_{rf}=1$ MHz, $I_e=0.1$ A



Problems:

- Imperfect synchronization RF-kicker, varying kicker pulse length
 - Adiabatic bunching (~ 0.25 s) fast w.r.t. e-cooling
- ➔ Stack losses after every injection

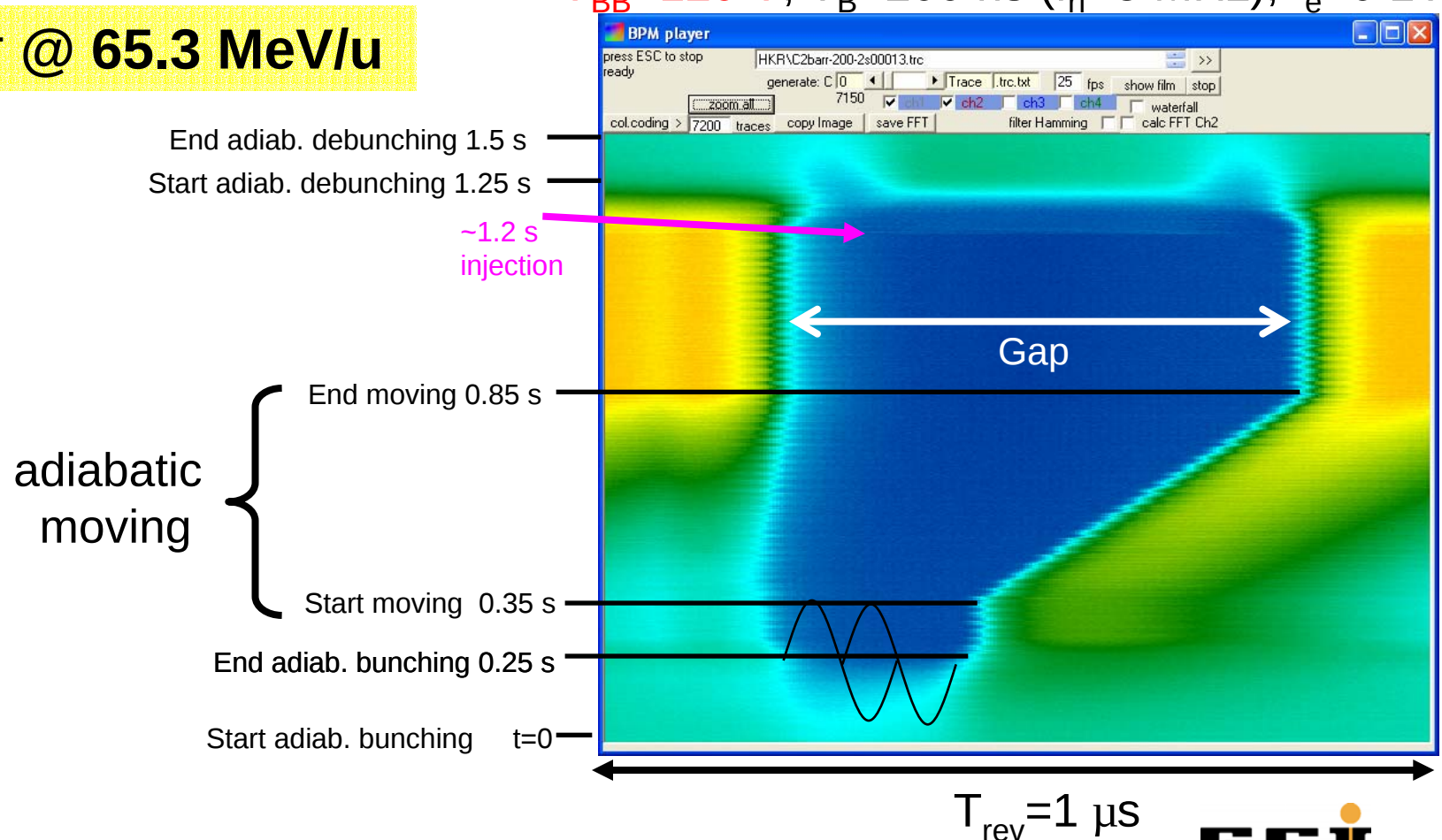
Stacking with Barrier Buckets

Beam signal in ESR pick-up

(1 frame/ 200 revolutions for a total time of 1.46 s)

$^{40}\text{Ar}^{18+}$ @ 65.3 MeV/u

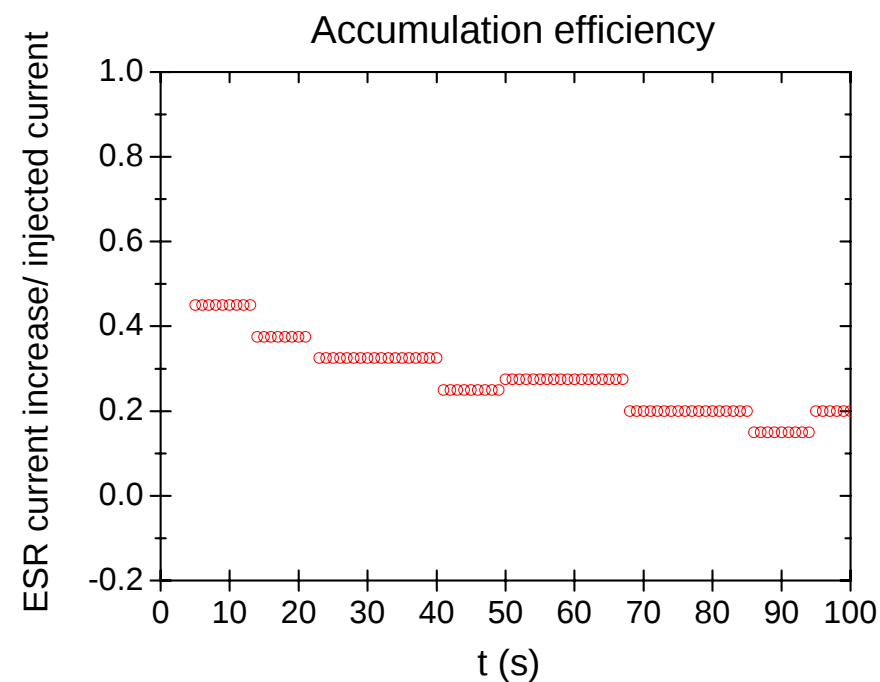
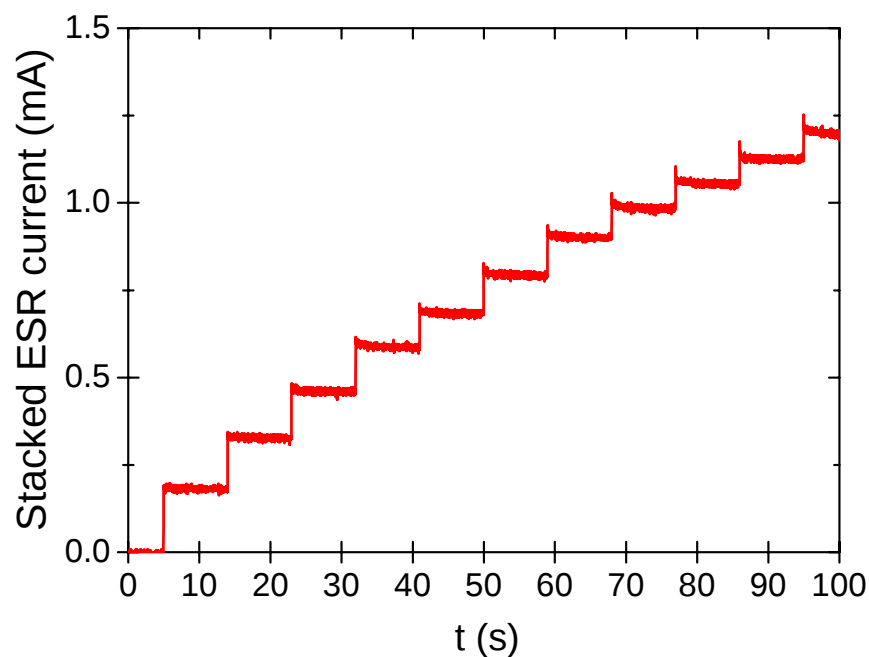
$V_{BB}=120\text{ V}$, $T_B=200\text{ ns}$ ($f_{rf}=5\text{ MHz}$), $I_e=0.1\text{ A}$



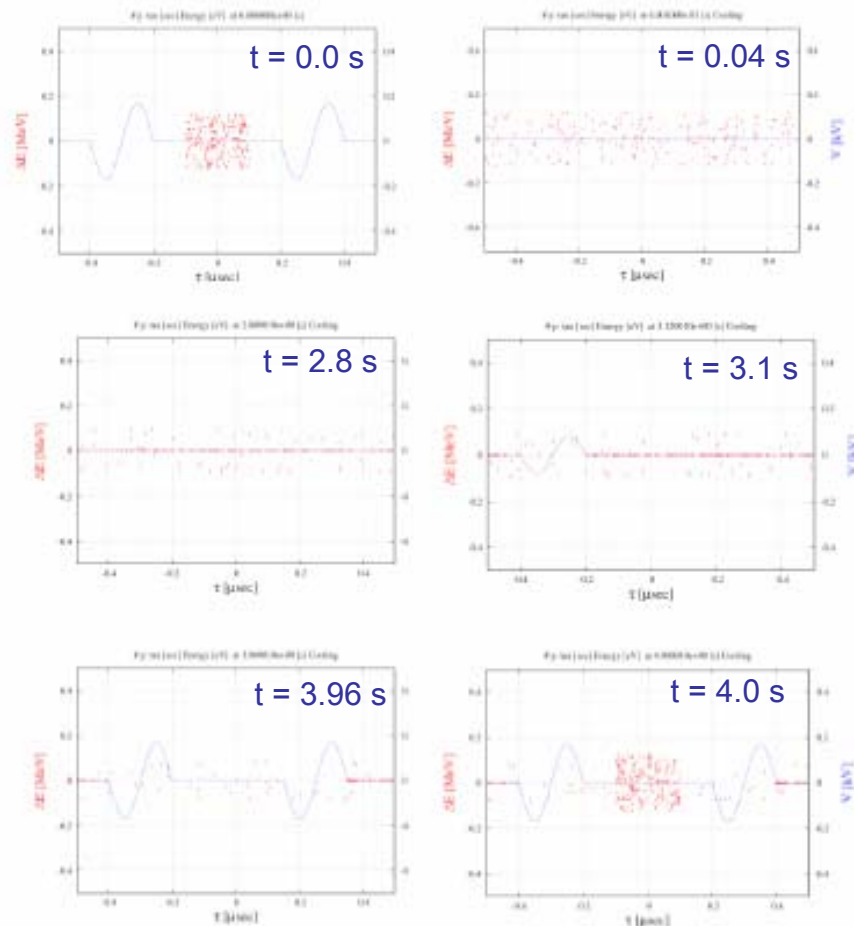
Stacking with Barrier Buckets

Beam accumulation measured by the ESR current transformer

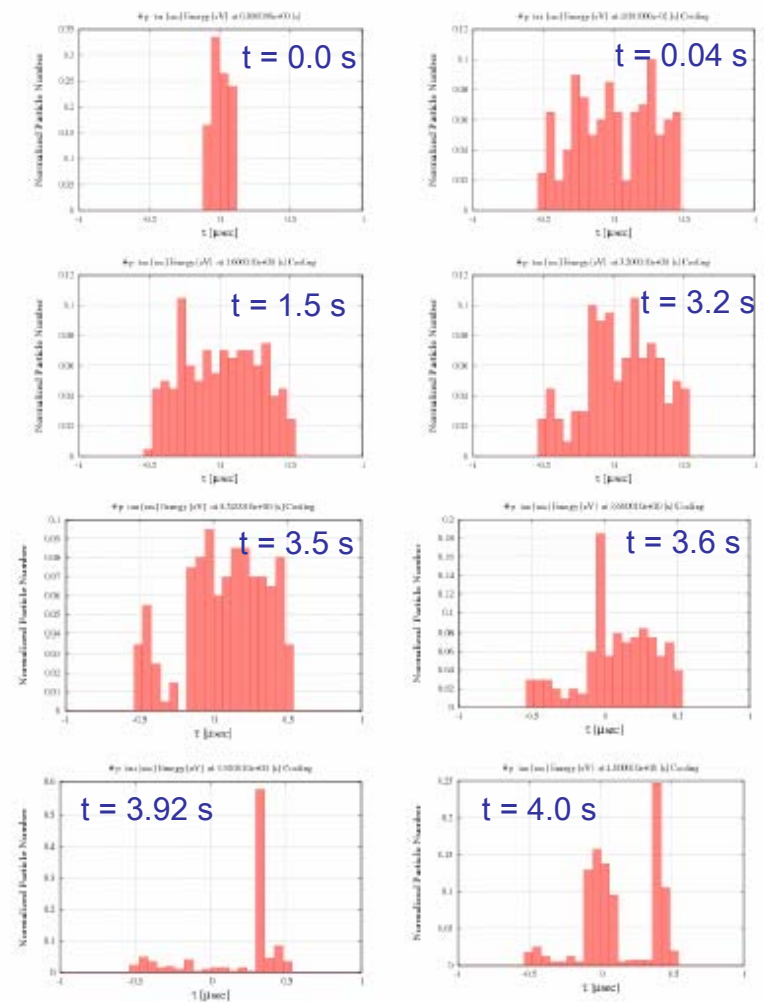
$V_{BB}=120$ V, $T_B=200$ ns ($f_{rf}=5$ MHz), $I_e=0.1$ A, stacking cycle=9 s



Simulation of Barrier Bucket Accumulation in the ESR



← ring circumference →



simulation by T. Katayama

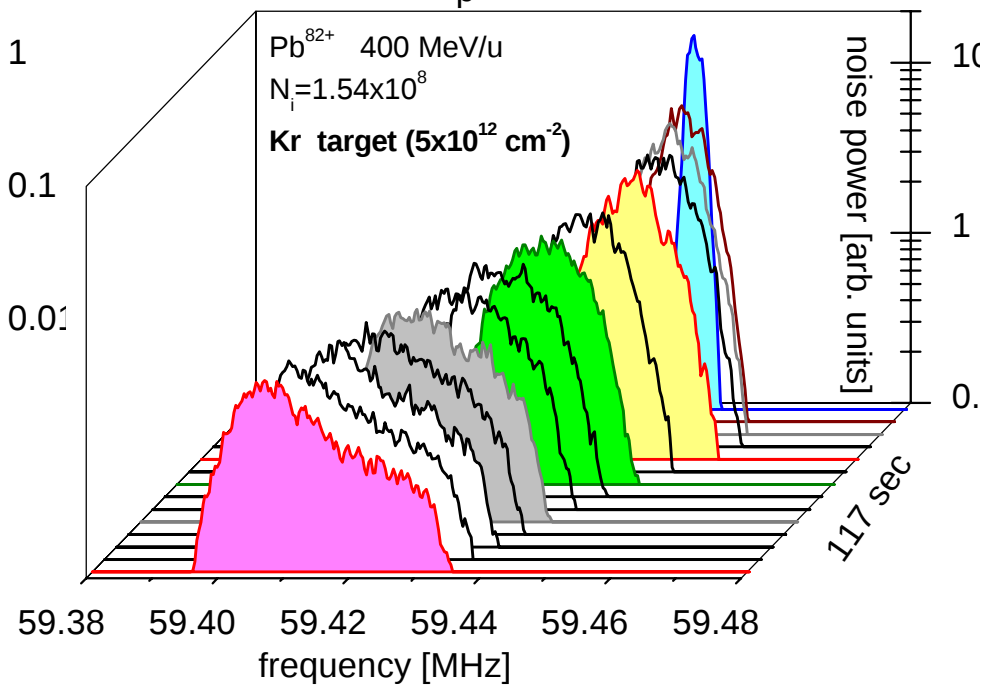
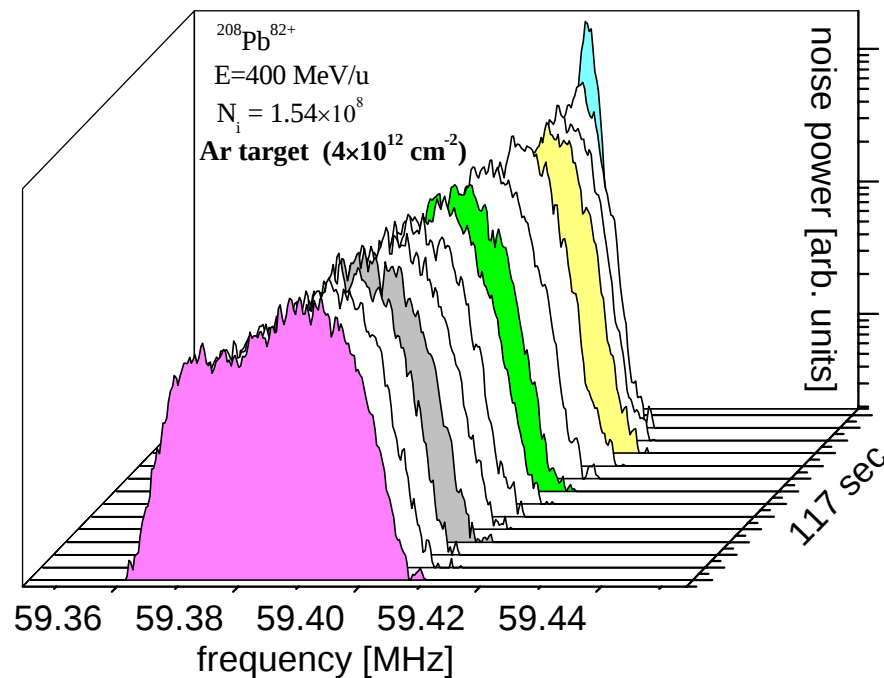
Blow-Up Measurements

Ion beam: $^{208}\text{Pb}^{82+}$

$E = 400 \text{ MeV/u}$;

$$N_p = 1.8 \times 10^8$$

$$N_p = 1.54 \times 10^8$$



Ar target ($4 \times 10^{12} \text{ atoms/cm}^2$)

Kr target ($5 \times 10^{12} \text{ atoms/cm}^2$)

observation: heating (spread) and energy loss (shift)

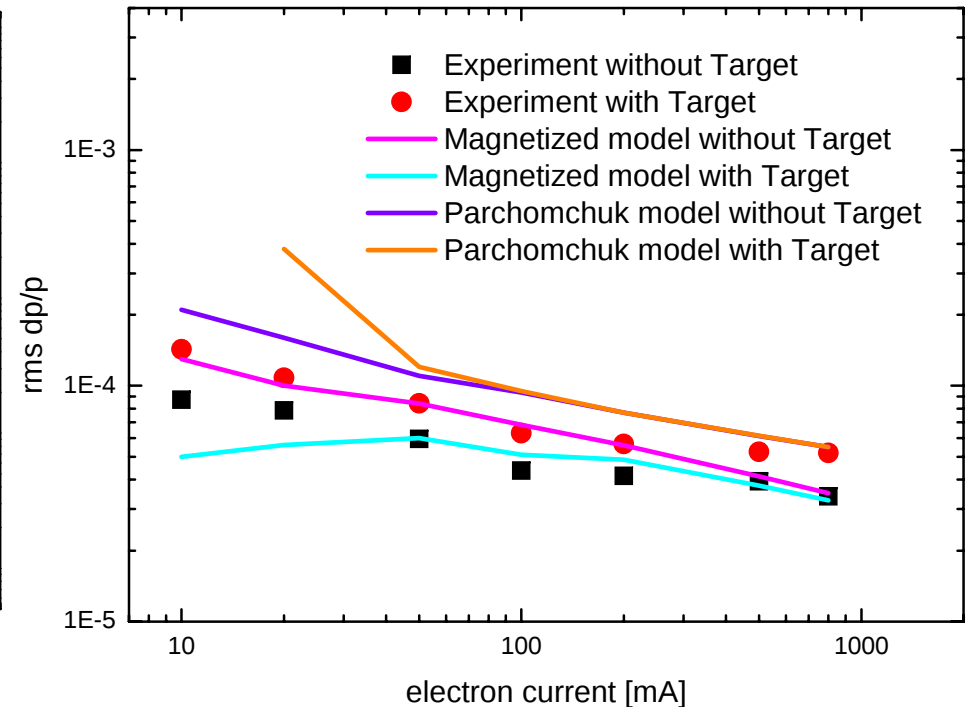
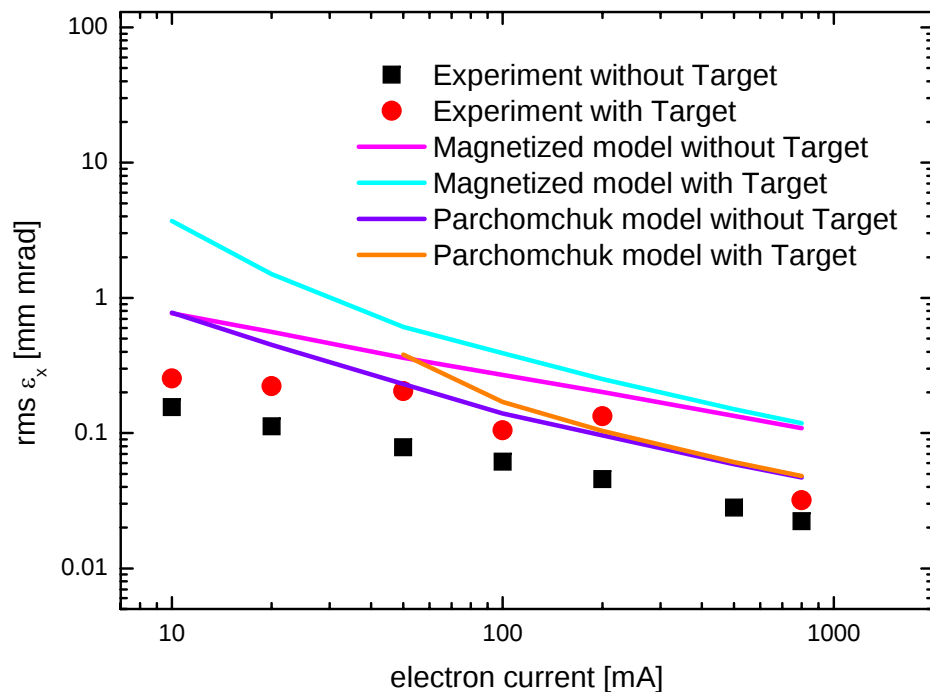
goal: reliable predictions for NESR

Equilibrium Beam Parameters with Target

$^{208}\text{Pb}^{82+}$ 400 MeV/u

number of stored ions $N_i = 1.5 \times 10^8$

jet target Xe $2.5 \times 10^{12} \text{ cm}^{-2}$

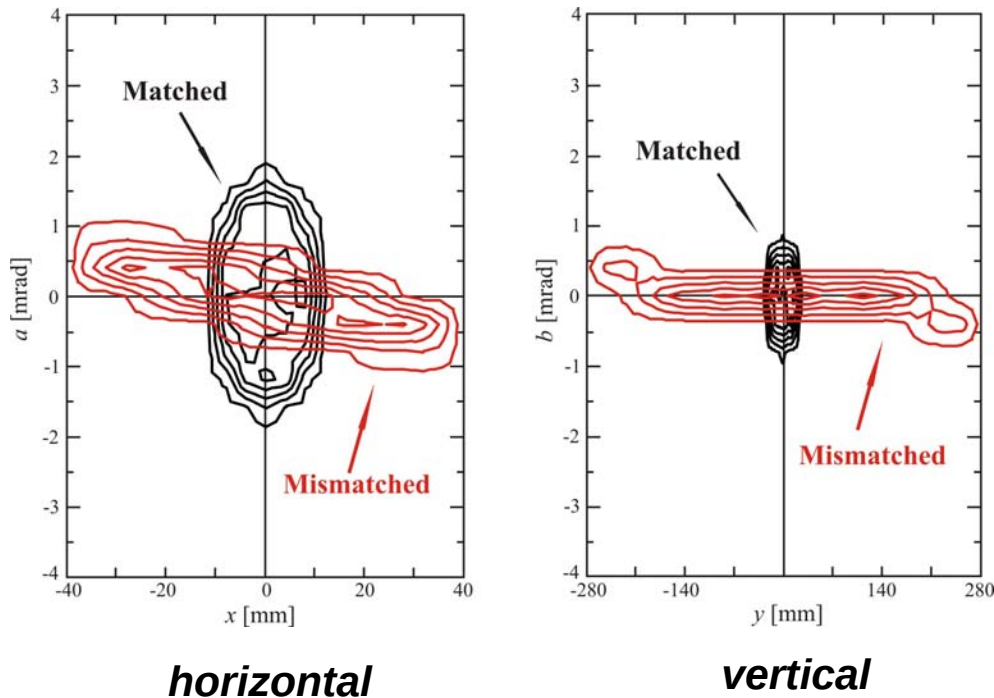


Simulation with BETACOOOL code (Dubna)

Transmission Optimization in Isochronous Mode

S. Litvinov, PhD thesis

ion optical calculation



experimental result
momentum acceptance

