

# J-PARC Accelerator Issue

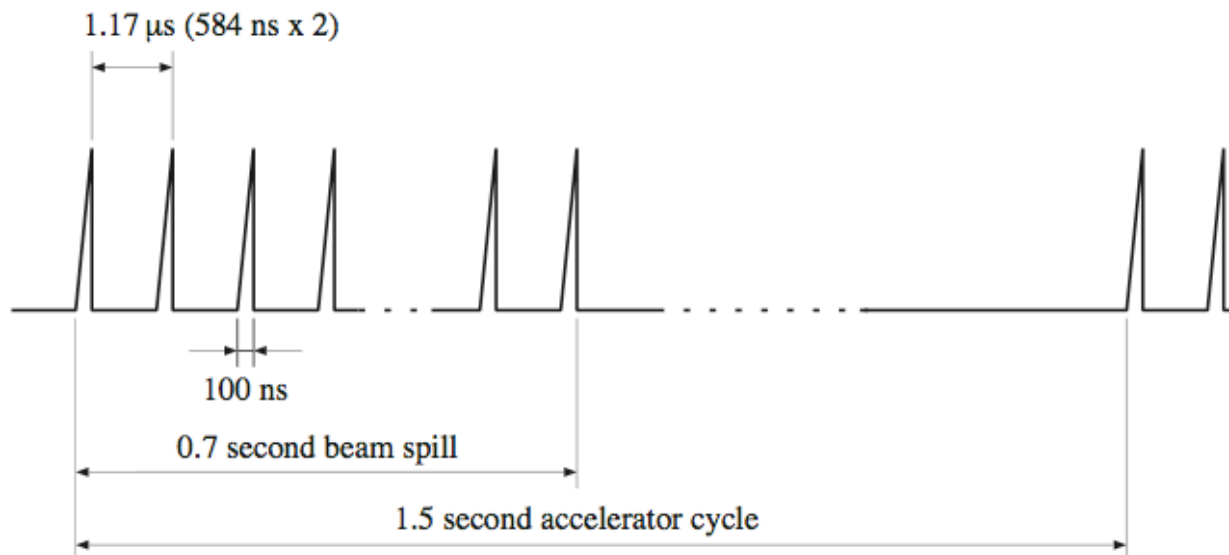
NP08, March 6, 2008

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KEK Acc. Lab

- COMET Requirements for accelerator
- COMET Accelerator Issues and Solutions
- g-2/PRISM

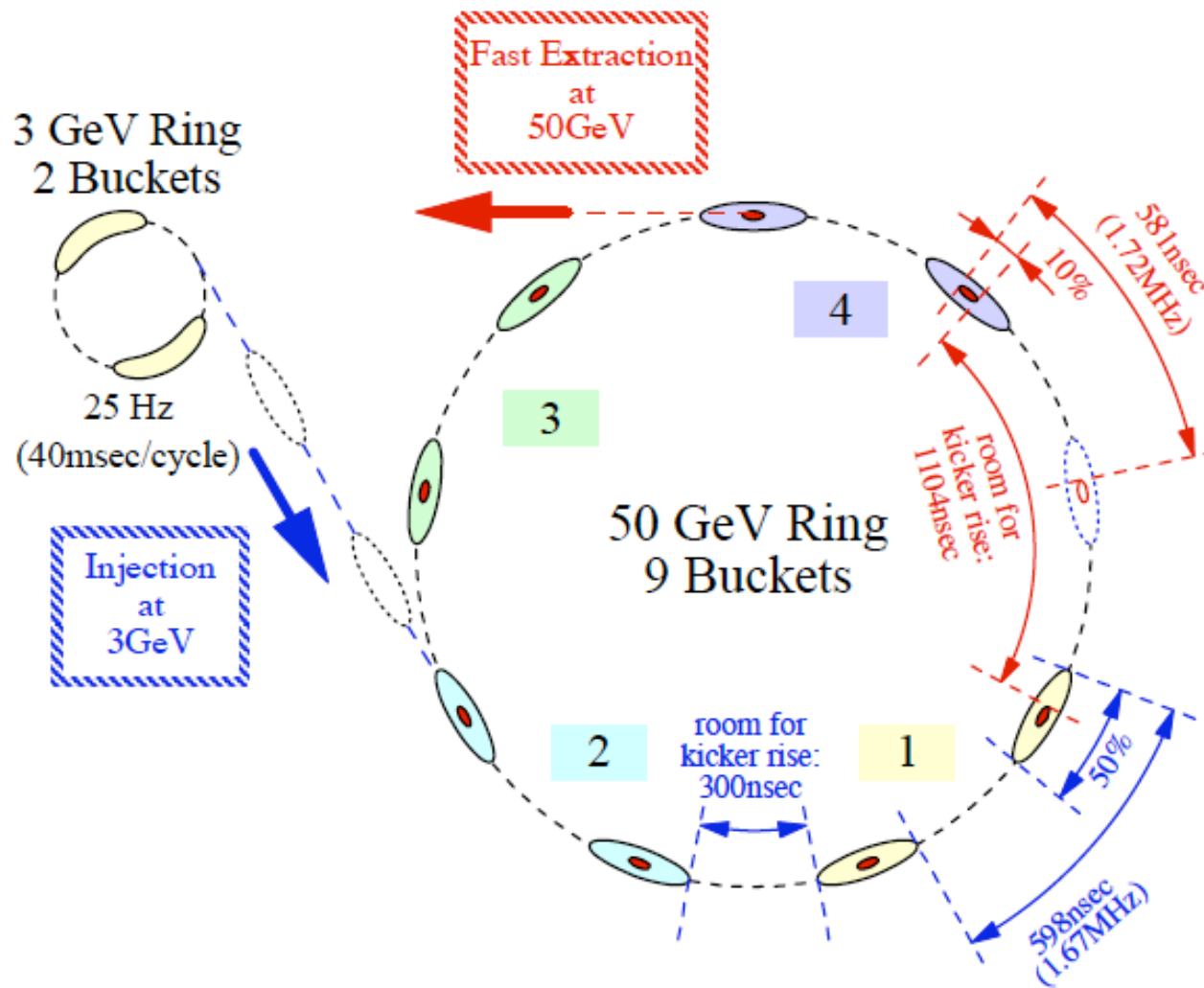
# Accelerator Requirements

- Energy: 8GeV
- Beam Intensity:  $7\mu\text{A}$ , 56kW
- Extraction method: Slow Extraction  
short spill
- bunch width and bunch-bunch spacing
- extinction  $10^{-9}$

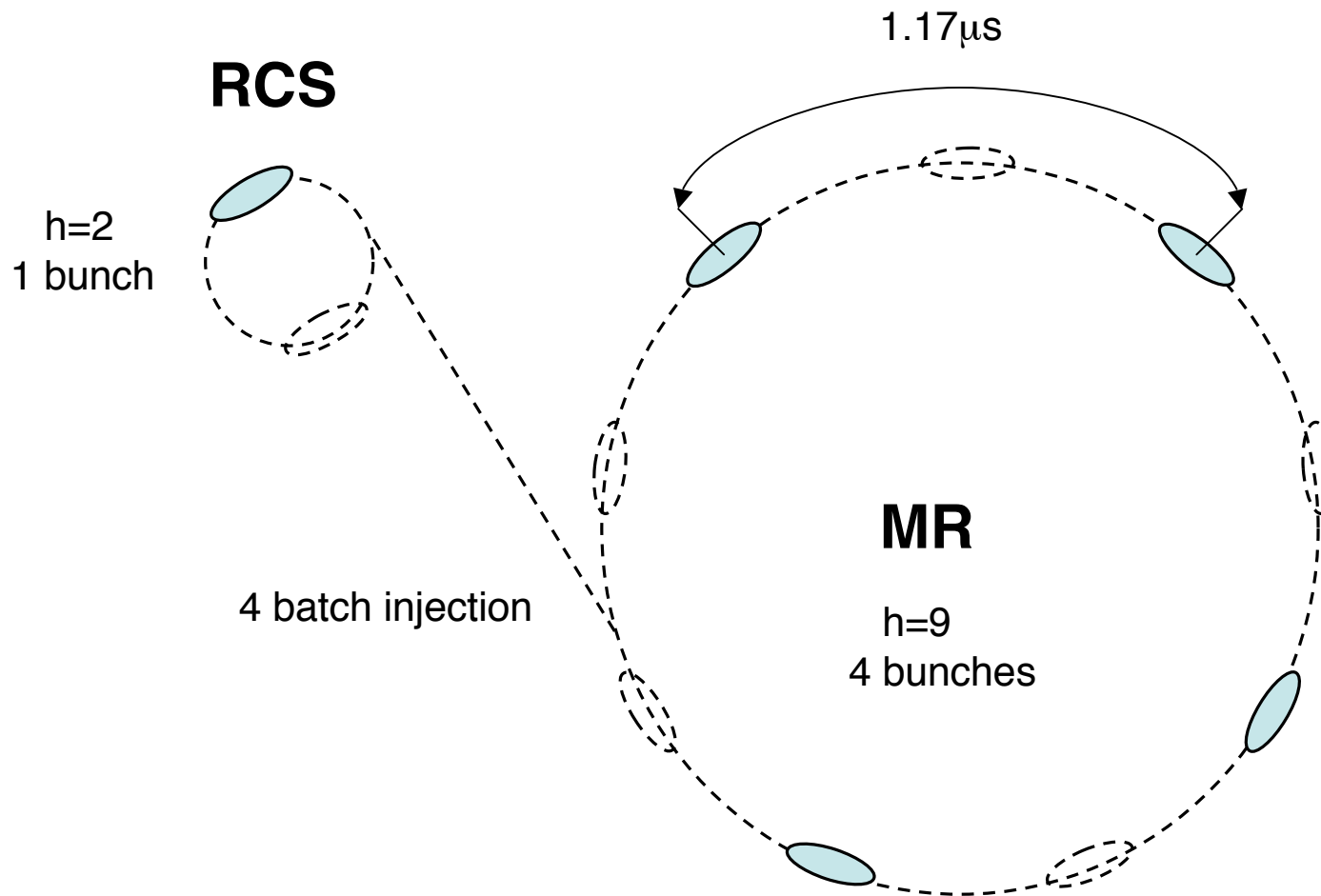


# Bunch to bunch spacing issue

## Nominal Scheme

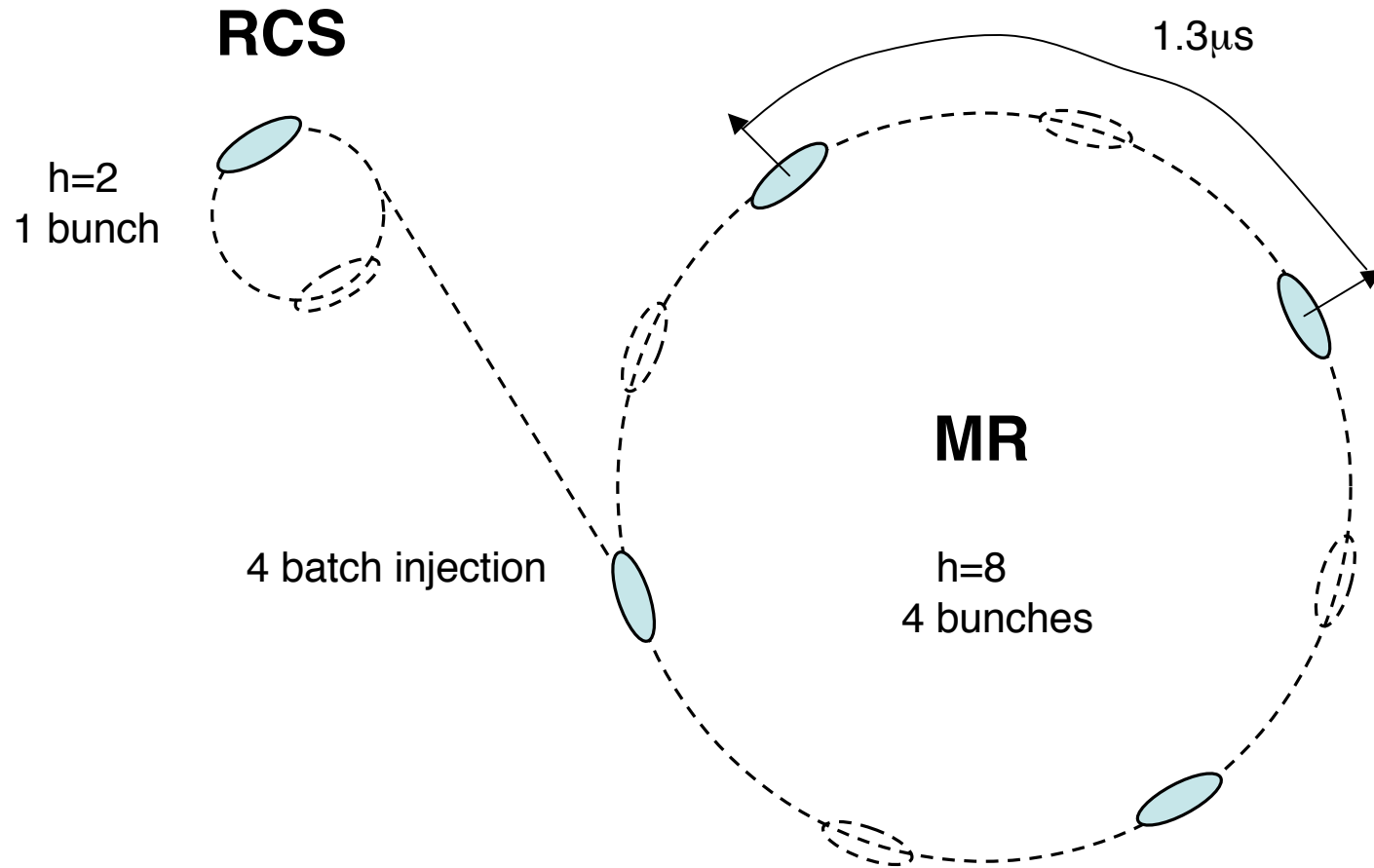


# Injection Scheme (1)

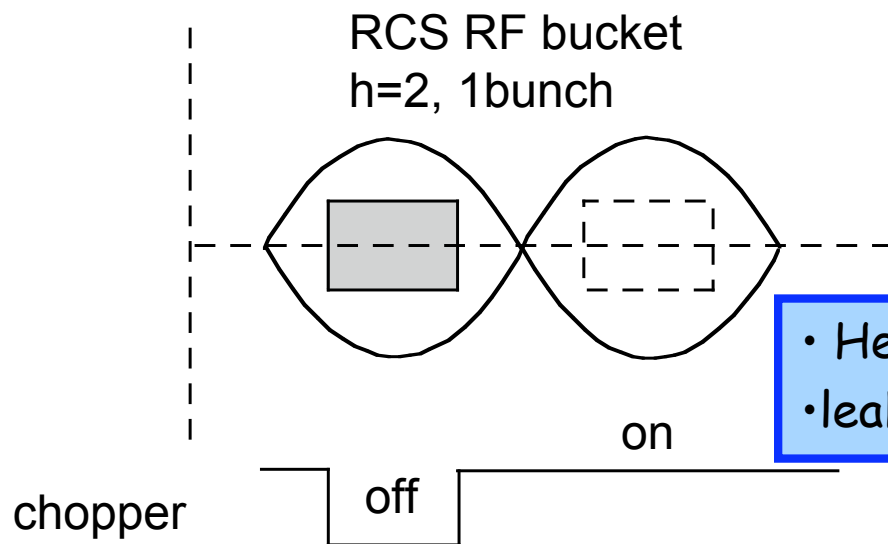
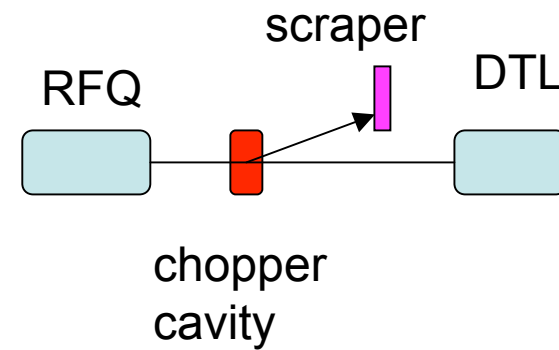
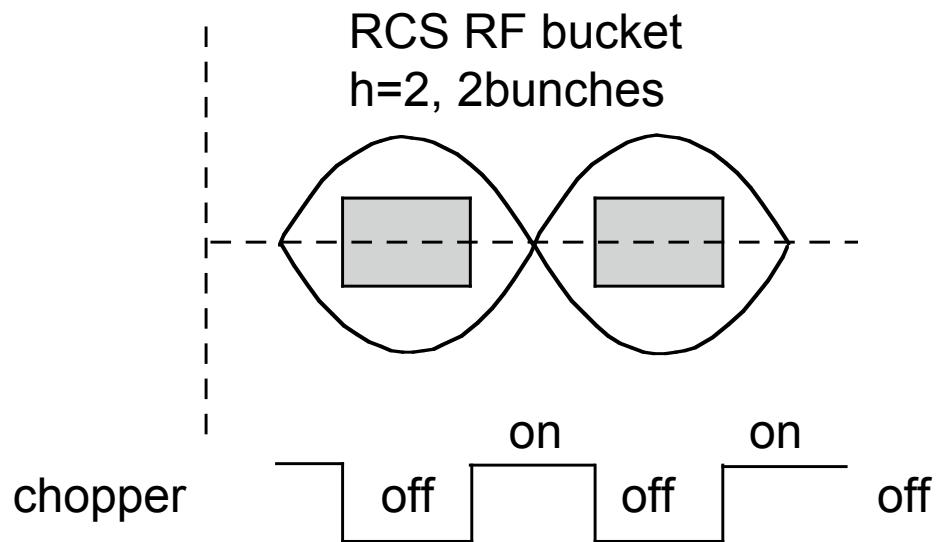


empty bucket in RCS and MR

• Injection Scheme (1)

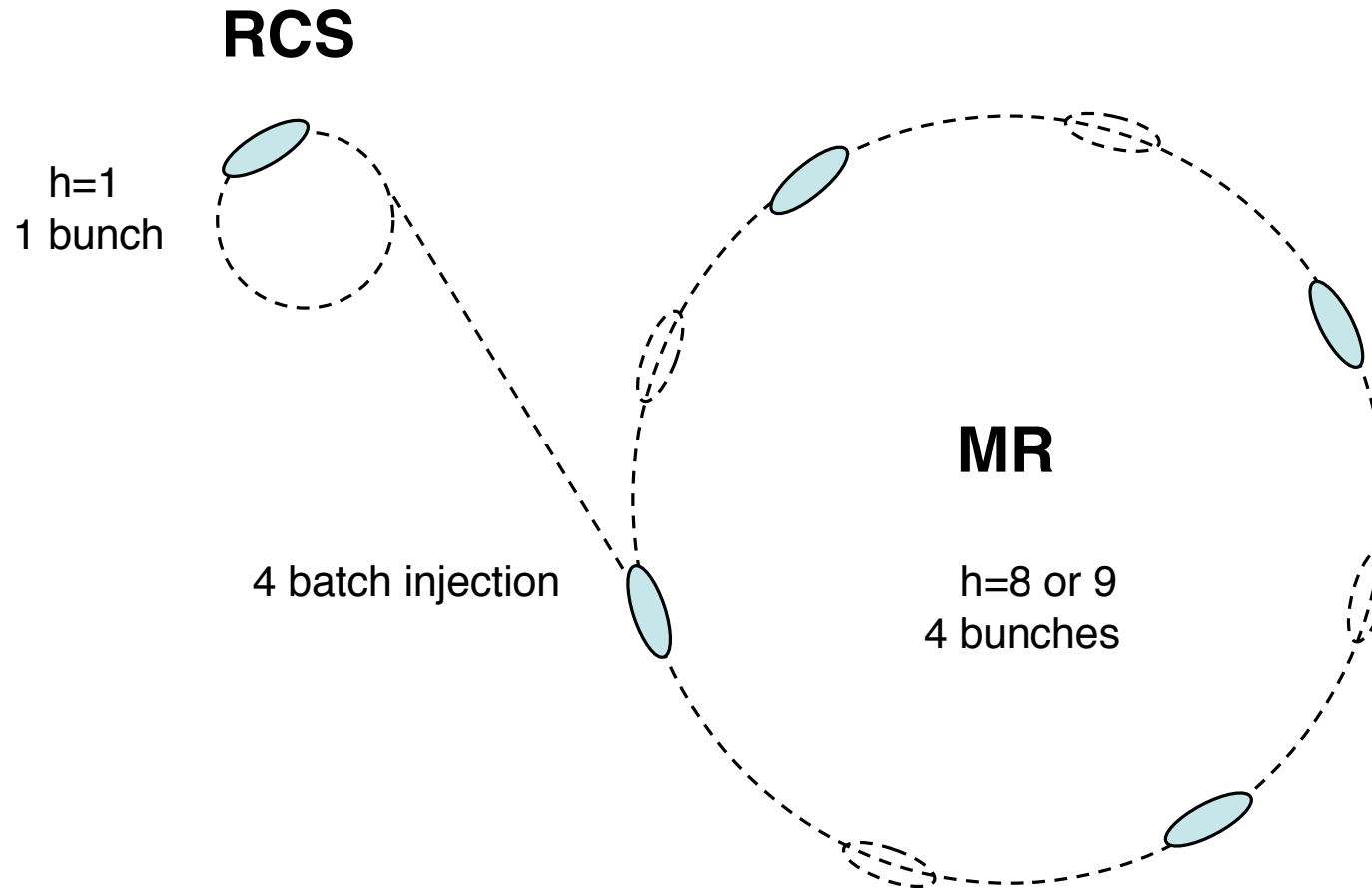


• Chopper (RCS one bunch operation with  $h=2$ )



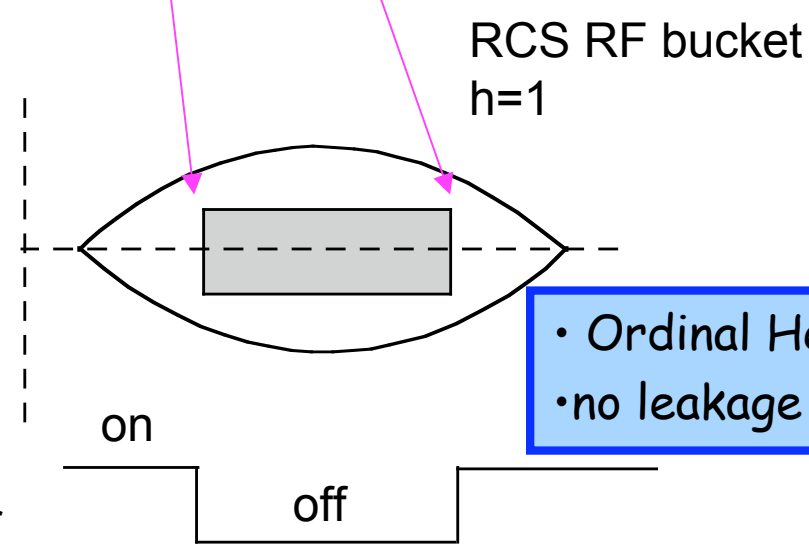
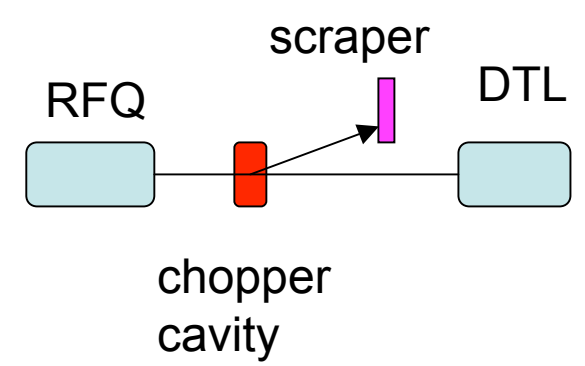
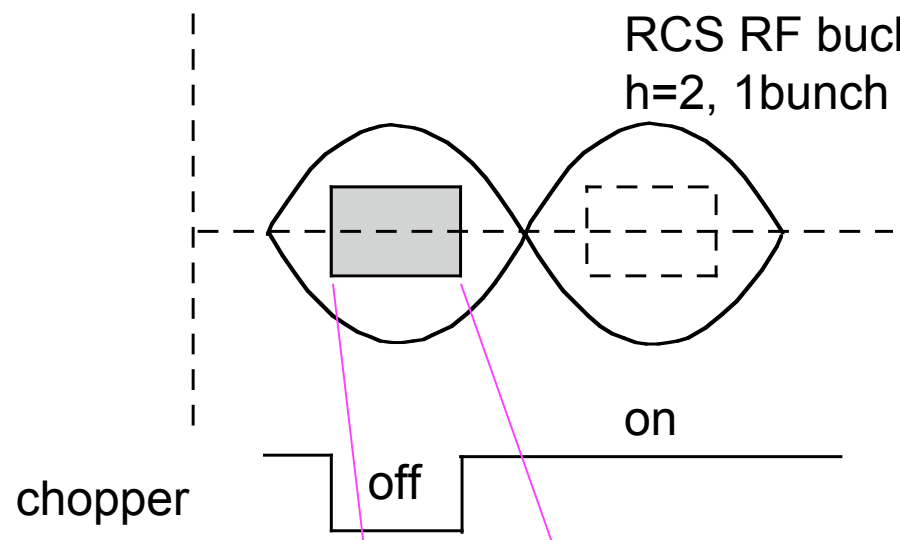
- Heavy Heat load in Beam dump
- leakage of chopped beam in empty bucket

## Injection Scheme (2)



- space charge tune shift is half of (1)
- longitudinal emittance is twice of (1)
- no empty bucket in RCS
- RCS rf system minor modification

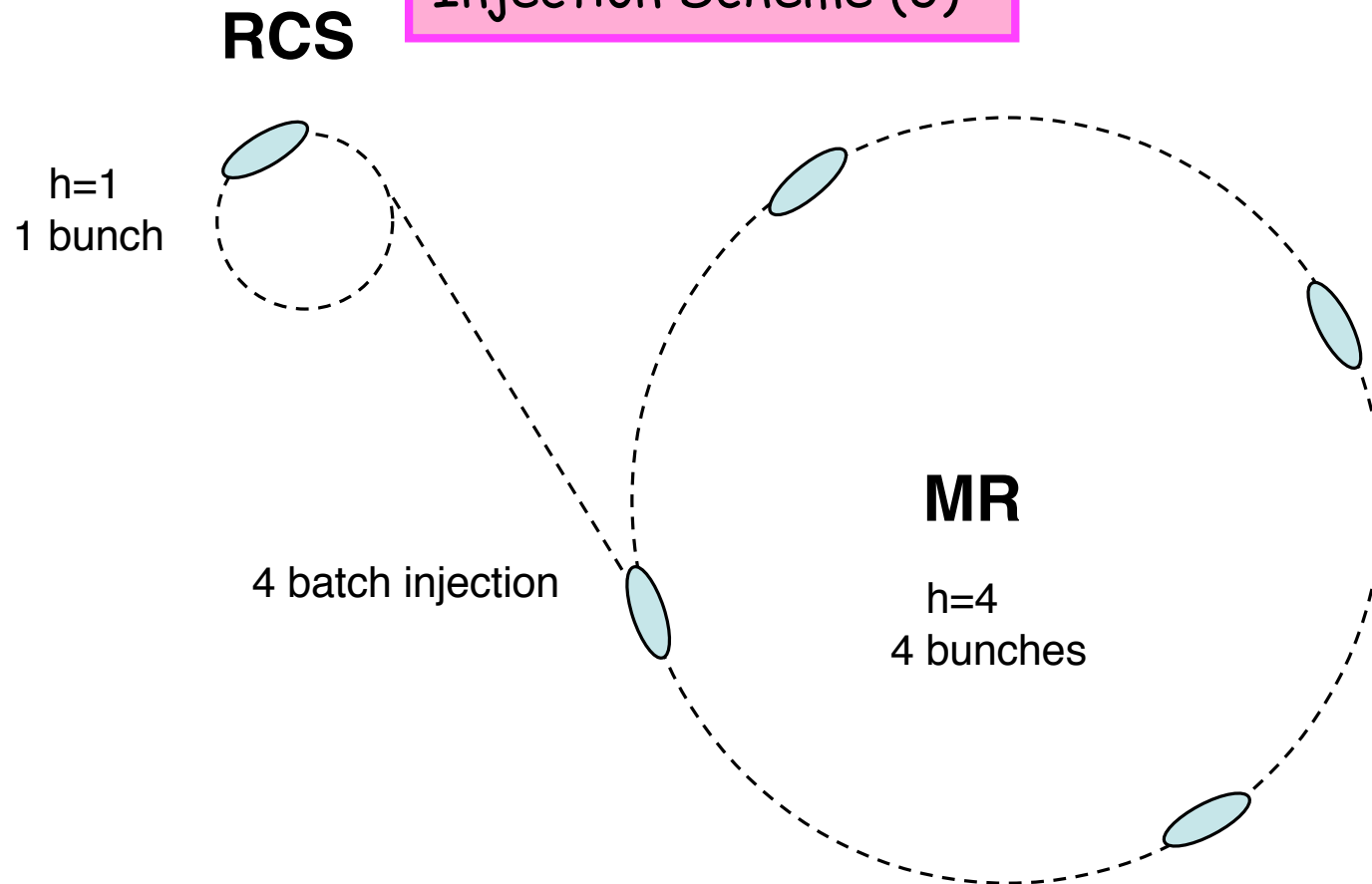
• Chopper (RCS one bunch operation with  $h=1$ )



- Ordinal Heat load in Beam dump
- no leakage of chopped beam in empty bucket



## Injection Scheme (3)

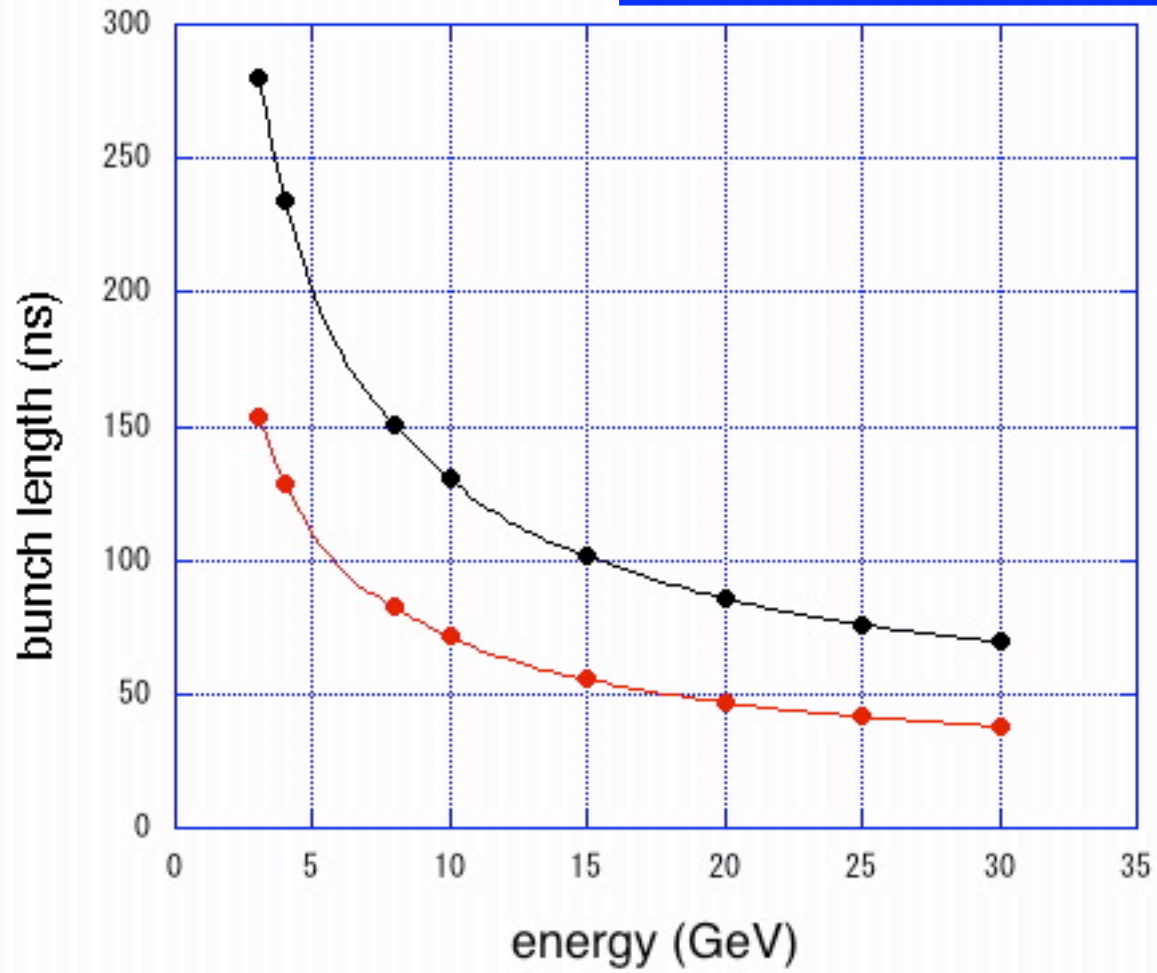


- no empty bucket both RCS and MR  
→ advantageous for extinction
- space charge tune shift for MR is half
- longitudinal matching is same as RCS h=2, MR h=8
- Large modification of RF system may be needed
- long bunch

# Bunch Width



- RF Voltage 210kV
- Condition matched in h=9 RF Bucket



## Extracted Beam Size Issues

- Acceptance at MR slow extraction line and hadron transport line is  $25\pi$  mmmad
- 3→8 GeV acceleration: Beam size shrink by adiabatic damping is small

### Nominal scenario

space charge tune shift: -0.24 (RCS), -0.2 (MR)

- $144\pi$  (0.4GeV) →  $54\pi$  (3GeV) →  $35\pi$  (8GeV)  
1.5 times            1.5times

### Strategy

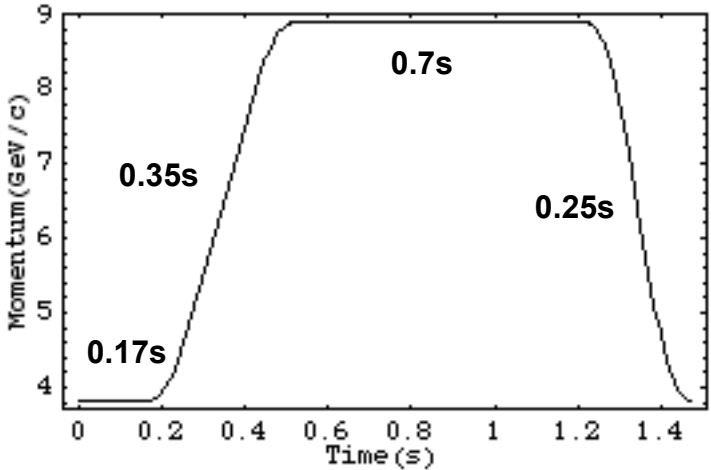
- MR rep. rate as high as possible  
  reduce particle number in the bunch  
  suppress space charge effect
- accelerate beam with emittance smaller than nominal  
  achieved by  
    reducing painting area in RCS  
    narrowing transport line and MR collimator apertures

# Probable RCS painting and MR pattern

8GeV extraction  
7μA, 56kW  
RCS: h=1 (1batch)  
MR: h=9, 4batch, 4batch

dB/dt same as 40GeV pattern

total time(s)=1.47

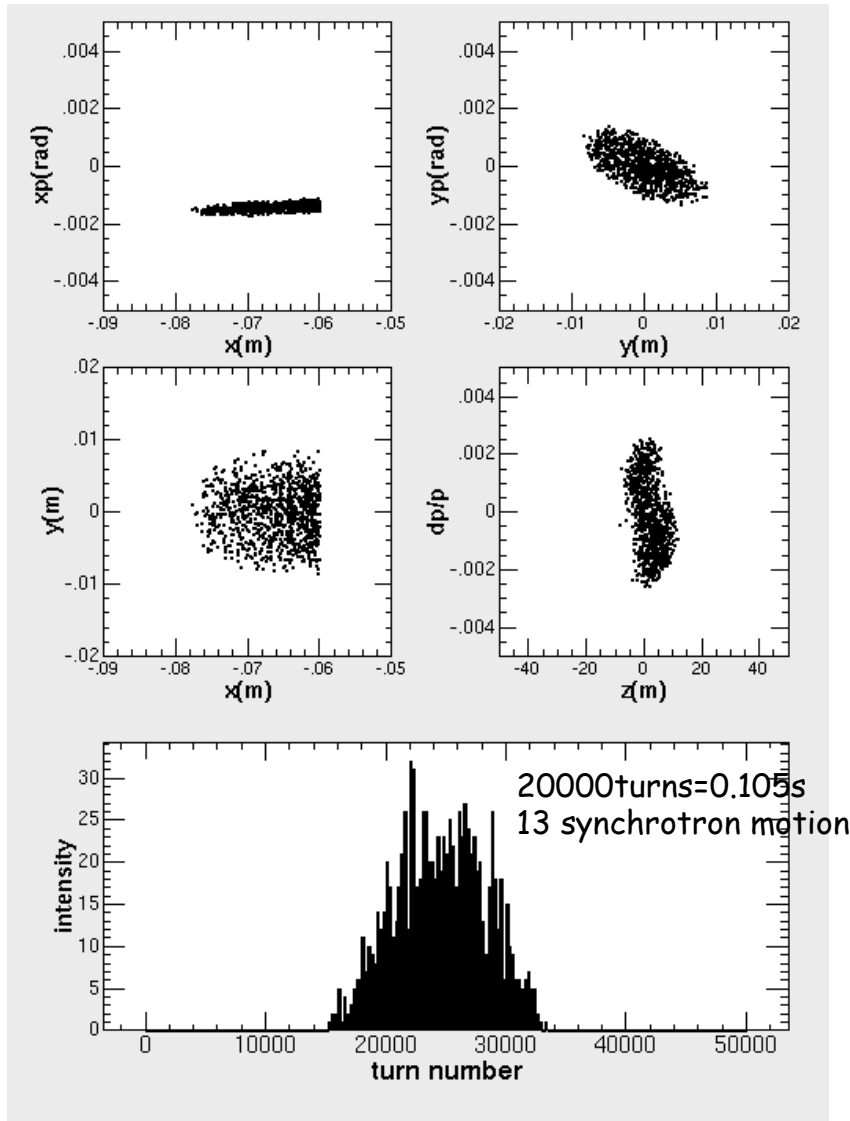


$0.16 \times 10^{14}$  ppb (1/2.6 of designed  $0.4125 \times 10^{14}$  ppb)

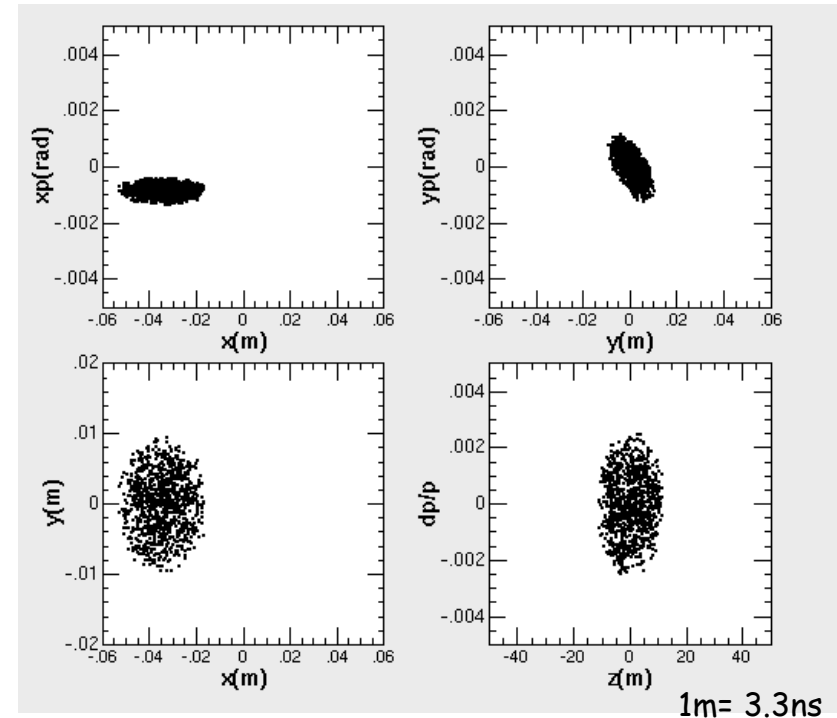
- $144\pi$  (0.4GeV) →  $36\pi$  (3GeV) →  $15\pi$  (8GeV)  
RCS tune shift -0.046
- $93\pi$  (0.4GeV) →  $23\pi$  (3GeV) →  $10\pi$  (8GeV)  
RCS tune shift -0.072

# Bunch kept during slow extraction process?

extracted beam at ESS



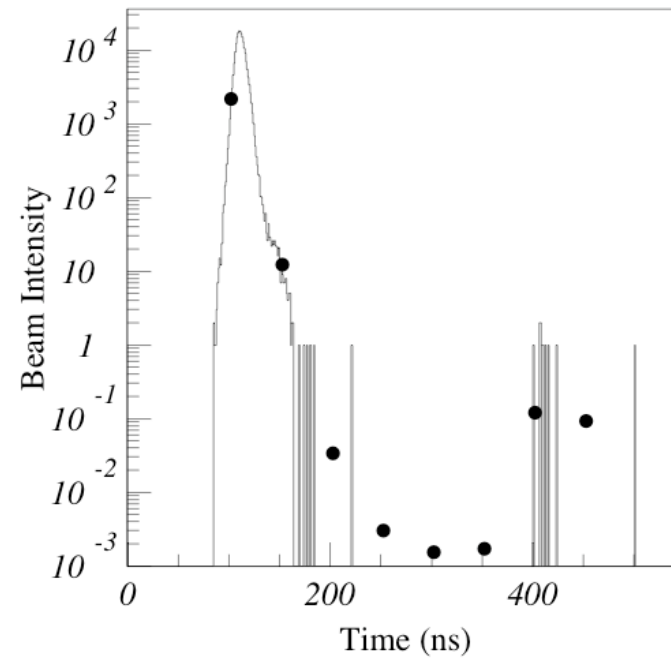
before extraction at ESS



- 8 GeV energy
- $h=9$ , RF cavity ON, 210 kV
- $E_L = 3\text{eVs}$ , matched ellipse

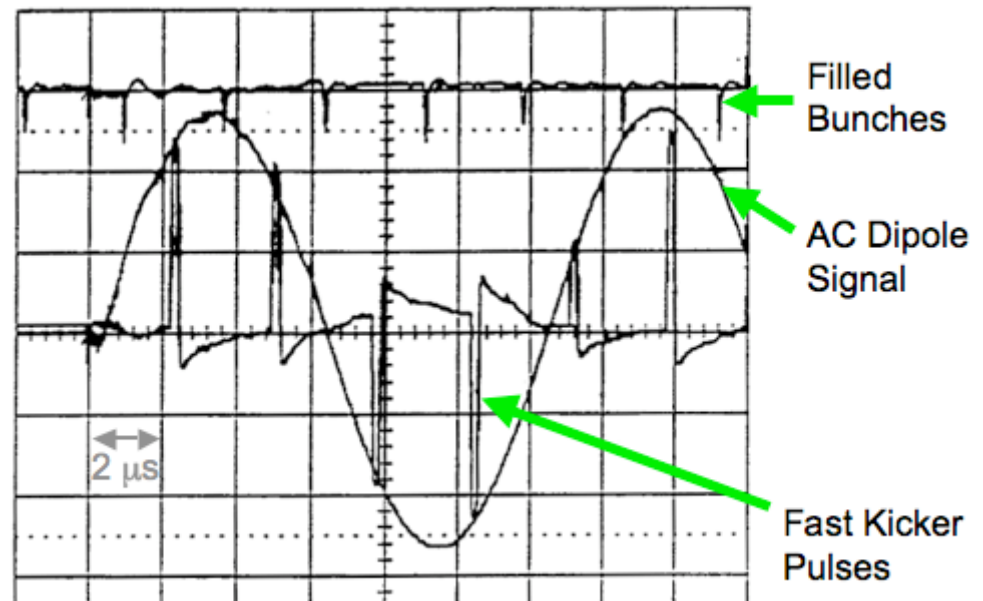
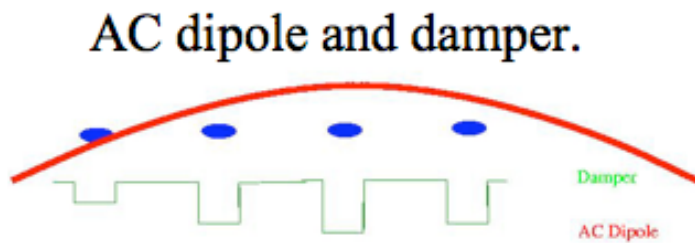
# Extinction Issue Gap Cleaning

AGS internal extinction test  
(from K. Brown slide)



## AGS internal extinction test (from K. Brown slide)

- Stripline AC dipole at 80 kHz excites coherent vertical betatron resonance
- Fast (100 ns) kickers cancel AC dipole at the bunches
- Kicker duty factor is low  $100 \text{ ns} / 2.7 \mu\text{s} = 4\%$
- Concept tested in FY98 using existing AC dipole and kickers



## Summary (COMET)

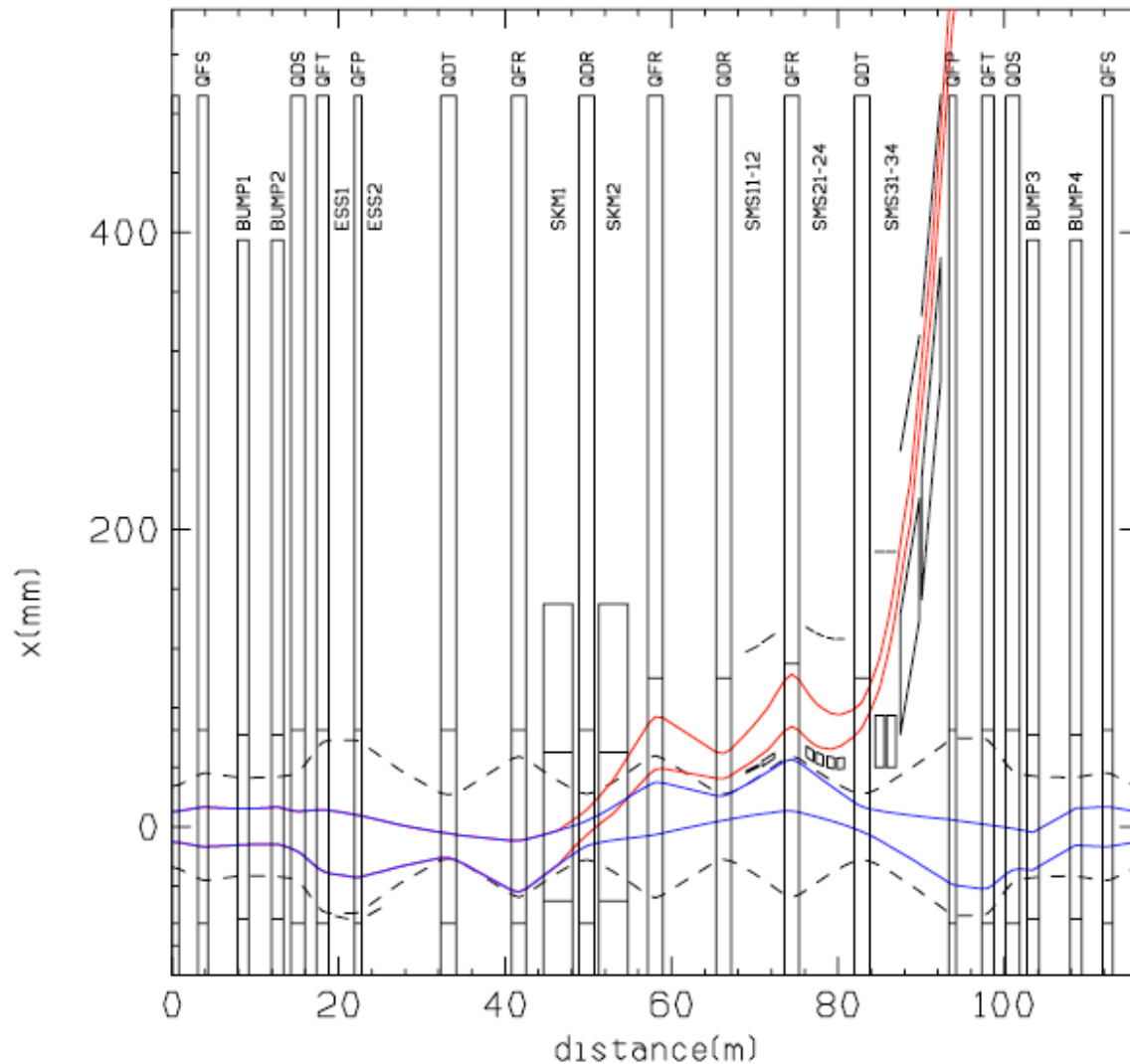
- 1 $\mu$ s bunch to bunch gap
  - > 1 bunch-RCS(h=1,2), 4-bunches MR(h=9,8,4)
- extracted beam size
  - increase MR rep. rate and reduce the particle number in the bunch
  - Transverse painting in smaller area in RCS
  - to match in extraction acceptance
- Simulation shows bunch structure is kept after slow extraction
  - Bunch width may be acceptable, depending on  $E_L$
- AGS gap cleaning method

### Issues investigated

- High RF duty is acceptable?
  - If not, add RF cavities and reduce rf voltage per cavity
- Behavior particles scattered at electrostatic septum ribbons?
- Space charge effect for 8GeV slow extraction?
- More promising gap cleaning method?



# Fast extraction for g-2 and PRISM at hadron hall



- 30GeV energy
- $h=9$  ( $f_{rf}=1.72\text{MHz}$ )  
 ->debunched  
 ->rebunched at  $h=90$   
 (17.2MHz rf cavities)
- fast extraction every bunch
- two 3.5m long kicker sections  
 2 x 2.1mrad  
 short rise time  
 high rep. (100-1000Hz)