

360 Bunches in RHIC

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1. Introduction
2. Option 1: Very fast injection kickers
3. Option 2: Barrier rf stacking
4. Option 3: Long flattop injection kickers
5. Summary

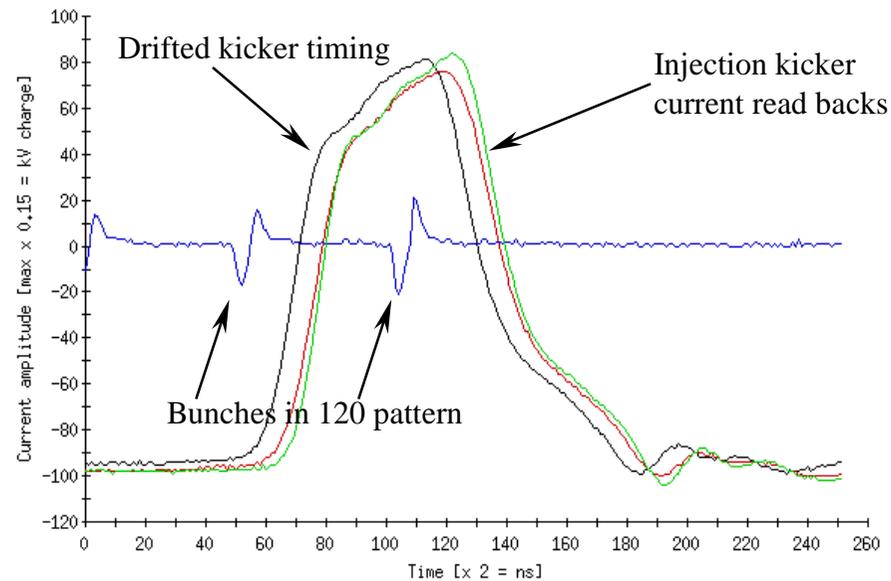
- Need abort gap in RHIC
 - Probably not more than 330 bunches possible
- Assume that 330 bunches can be accelerated
 - Need to take out common storage cavities
 - Upgrade fundamental mode damper for storage cavities
 - Probably need new power amplifier for acceleration system
- Assume that there is no pressure rise with high intensity beams (currently not the case)
 - Installation of NEG coated pipes (+ solenoids?) in warm regions
- Assume that instabilities can be dealt with
 - Feedback system
- Assume that additional long-rang beam-beam interactions are not a problem
 - Possibly wire compensation

- 330 bunches becomes an injection problem
 → **No solution yet**
 (p acceleration in storage system not discussed)

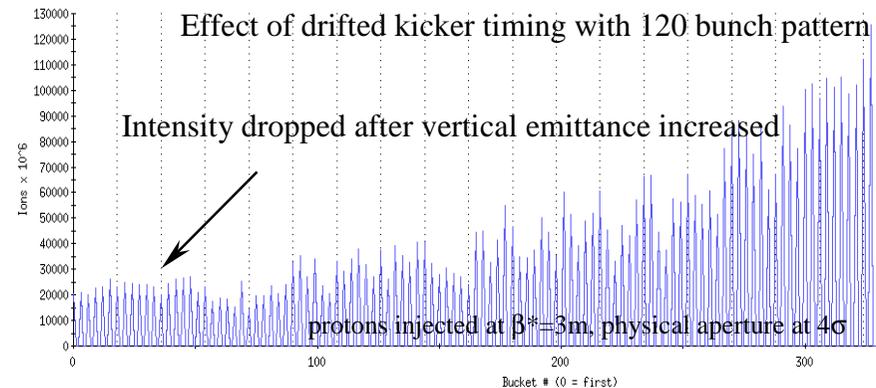
Current injection:

- Bunch-by-bunch (harmonic numbers in AGS and RHIC are independent)
- Injection kicker rise time limits number of bunches to 112

Thu Oct 4 13:43:14 2001, cycle 1002217388 Blue Injection Kicker



Wed Jan 16 13:40:28 2002, cycle 1011206424 Measured Fill Pattern



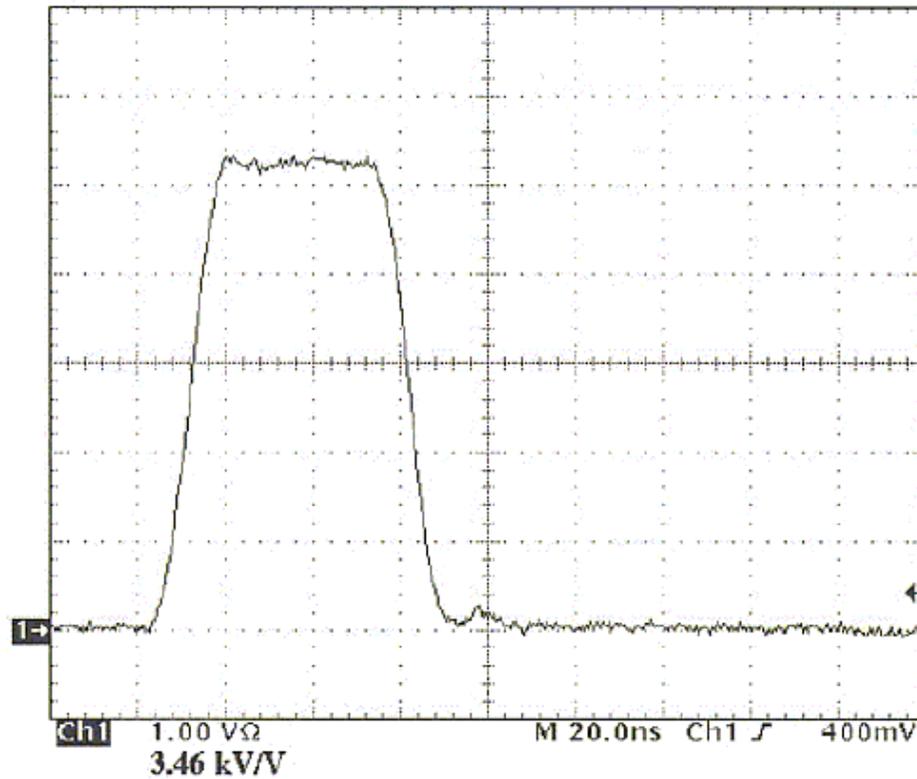
- Basic idea: kicker rises between bunches (bucket length 36ns, bunch length ≤ 20 ns)
→ rise time of ~ 15 ns required (currently 95ns)
- Ongoing R&D for solid-state based modulators at LLNL and in Japan
- Example LLNL:
20kV into 50Ω load, 10ns rise time
(H. Hahn is looking into usability)
- Need to design new injection kicker magnets
- May need to redesign injection area to have more space for kickers



Output Pulse - 30 ns, 18 kV into 50Ω

Tek Run: 2.50GS/s

Sample



C1 Rise
10.746ns
Unstable
histogram

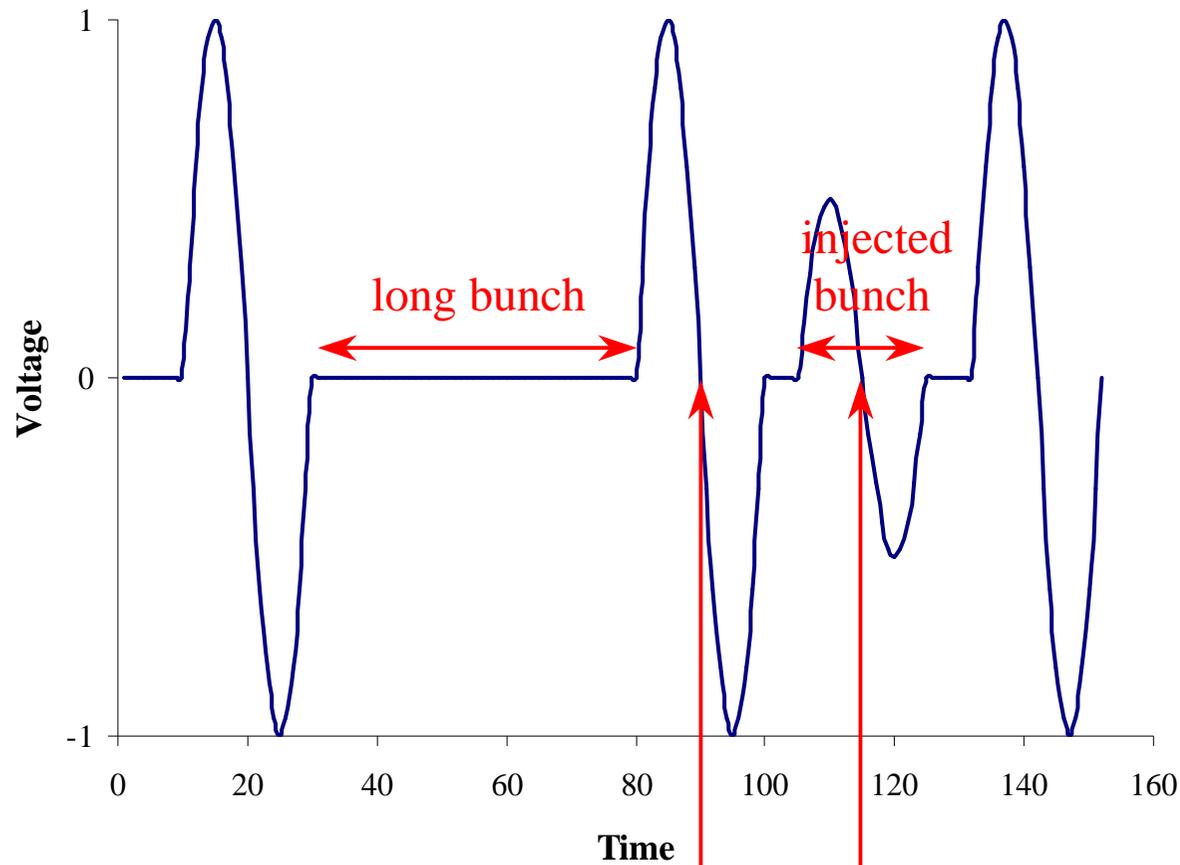
C1 Fall
10.239ns
Unstable
histogram

Rise time and flattop
length sufficient for
RHIC 330 bunches

E.G. Cook et al., “Solid State Modulator R&D at LLNL”, Workshop on Recent Progress in Induction Accelerators, RPIA2002, Tsukuba, Japan (2002).

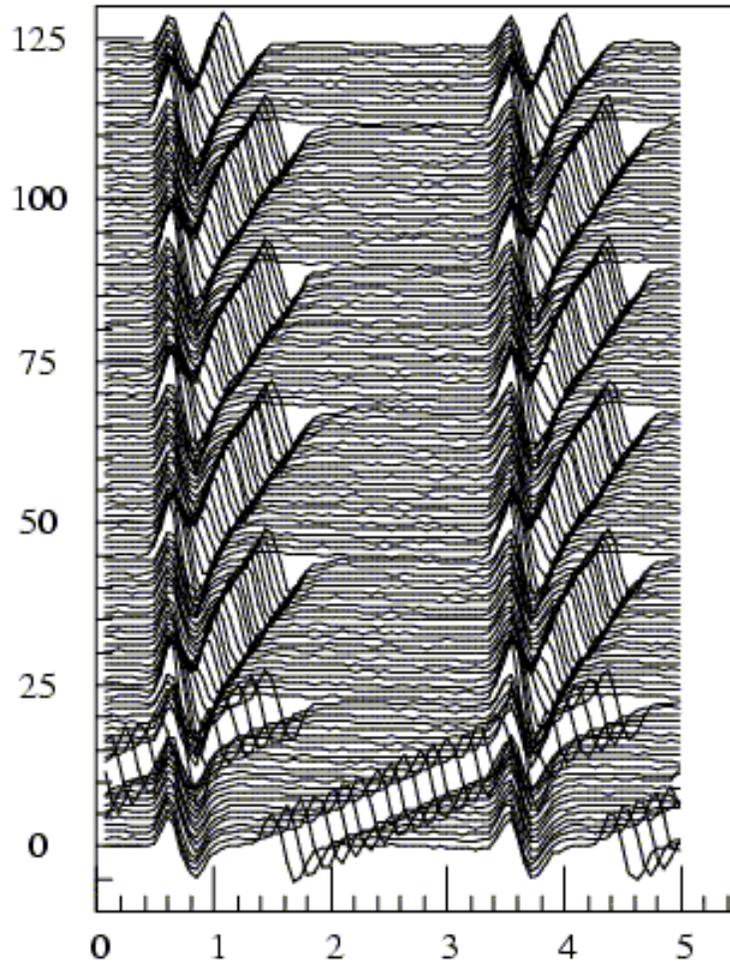
- Basic idea: use barrier buckets to maintain increasingly long bunch, inject into a bucket that is then merged with the long bunch
 - no new demands for injection kicker system
 - barrier rf system in RHIC needed
 - (AGS experience, but technology not widely used)
 - probably 2nd barrier rf system needed to match injected bunch
- Barrier buckets created by single (or few) sine waves, cavity otherwise off

Option 2: Barrier rf stacking



remove barrier to join new bunch with long bunch

match momentum to long bunch after injection



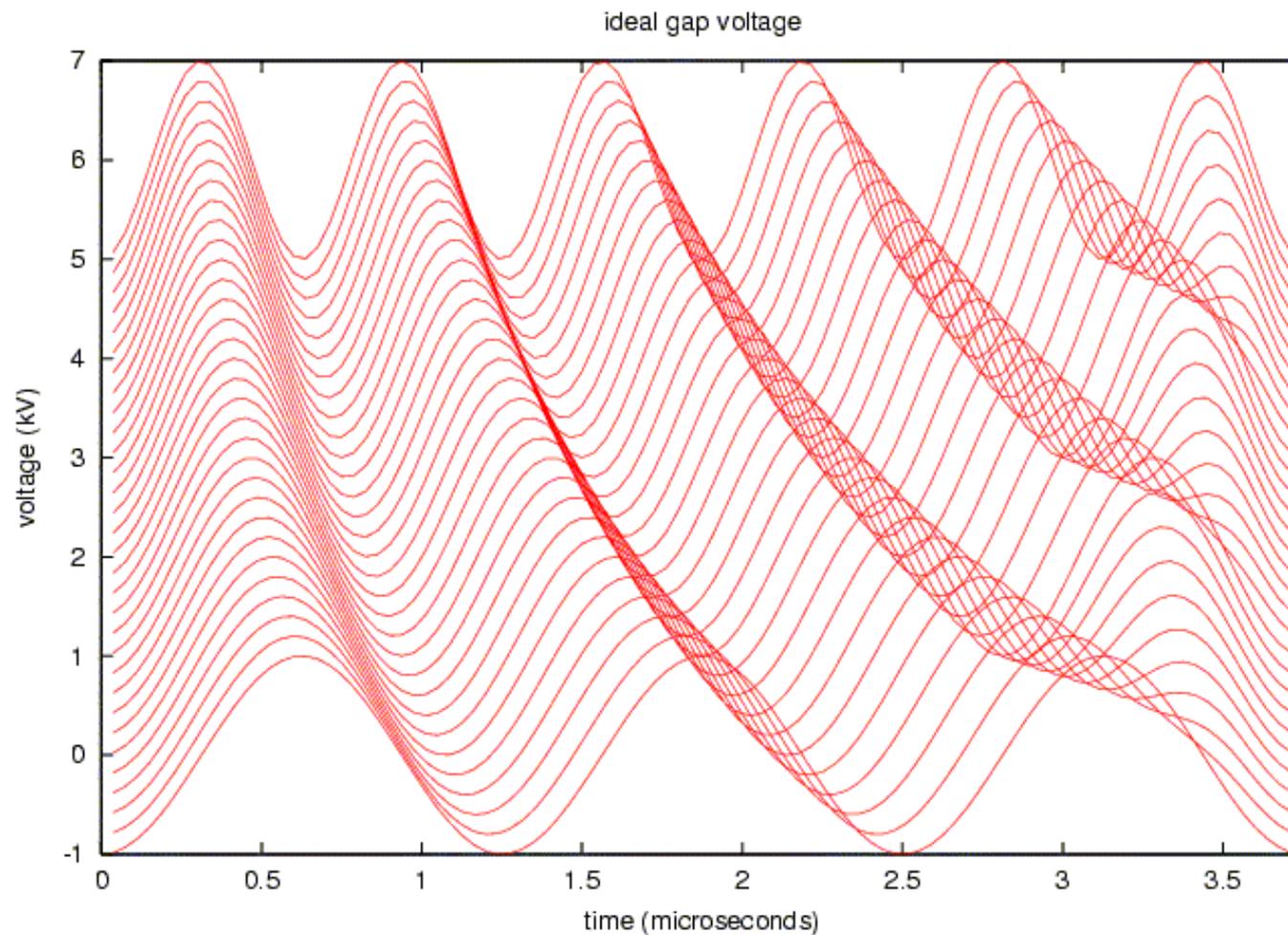
M. Blaskiewicz, M. Brennan, EPAC96
“A barrier bucket experiment for
accumulating de-bunched beam in
the AGS”

Need simulations to test viability for
RHIC

- cavity parameters
- longitudinal emittance growth

- Basic idea: transfer whole AGS fills (at least 5) into RHIC (considered during RHIC design)
- Bucket length at AGS extraction must be same as bucket length in RHIC
→ need 28 MHz rf system in AGS
- If RHIC-AGS ratio of harmonic numbers is not the same as circumference ($L_{\text{RHIC}}:L_{\text{AGS}}=19:4$), AGS at extraction needs to run at non-integer harmonic
- AGS fill unsolved: would need $\sim 10x$ more Booster cycles than now
→ may be too long at injection (IBS for Au, space charge)
→ possibly problems with LIPA (would currently be the case)
- Also need completely new injection system in RHIC
→ rise time less critical, but need up to $2.5\mu\text{sec}$ flat top

Example of change from integer to non-integer harmonic number in Booster, used for deuteron extra bunch merge (and Au in the future). — M. Blaskiewicz



- Large number of bunches (~ 330) requires solutions for the following problems:
 - Acceleration \rightarrow **probably possible**
 - Vacuum \rightarrow **probably possible**
 - Instabilities \rightarrow **probably possible**
 - Long-rang beam-beam interaction \rightarrow **probably possible**
 - Injection \rightarrow **unsolved**
- Possible injection schemes
 - Very fast injection kickers
 - Barrier rf stacking
 - Long flattop injection kickers
- No favorite injection scheme yet