AGS Polarized Proton Developments 2013

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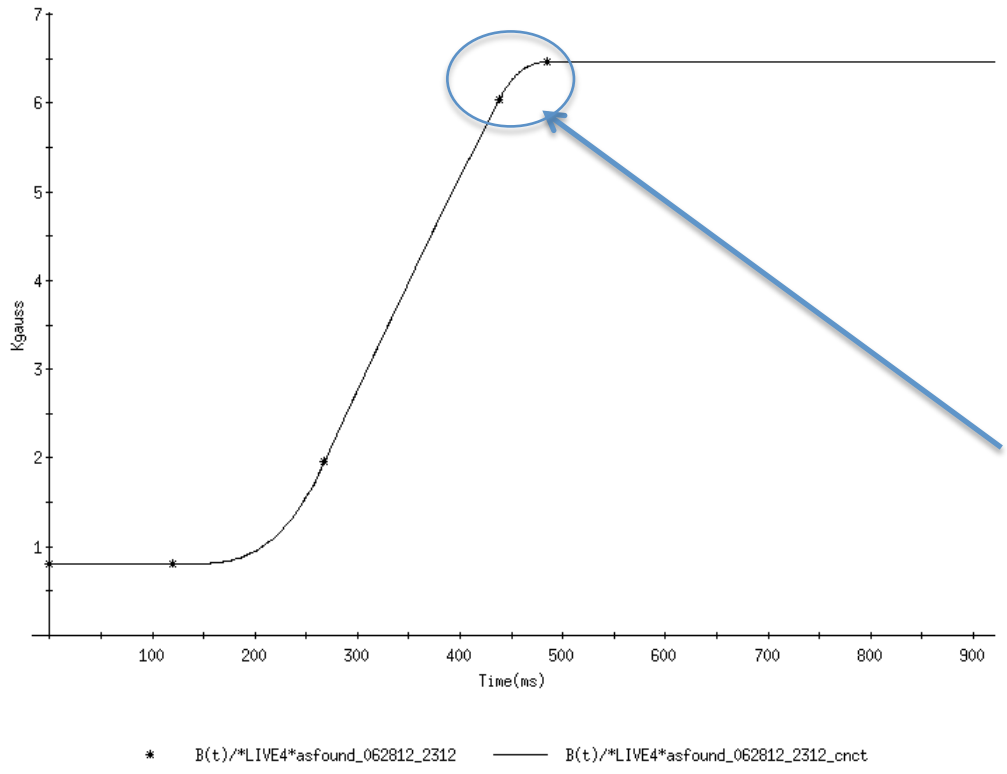
(for many: Injectors, Spin, Instrumentation, Pulsed Power, RF, Controls, Survey…)

Overview

- Improve polarization loss at high energy
  - Extraction on the fly
  - Radial jump
  - Spin tune calculation
- Instrumentation and measurement
- Orbit
  - AGS orbit stability problem
  - Survey and absolute orbit

Depolarization Near Top Energy



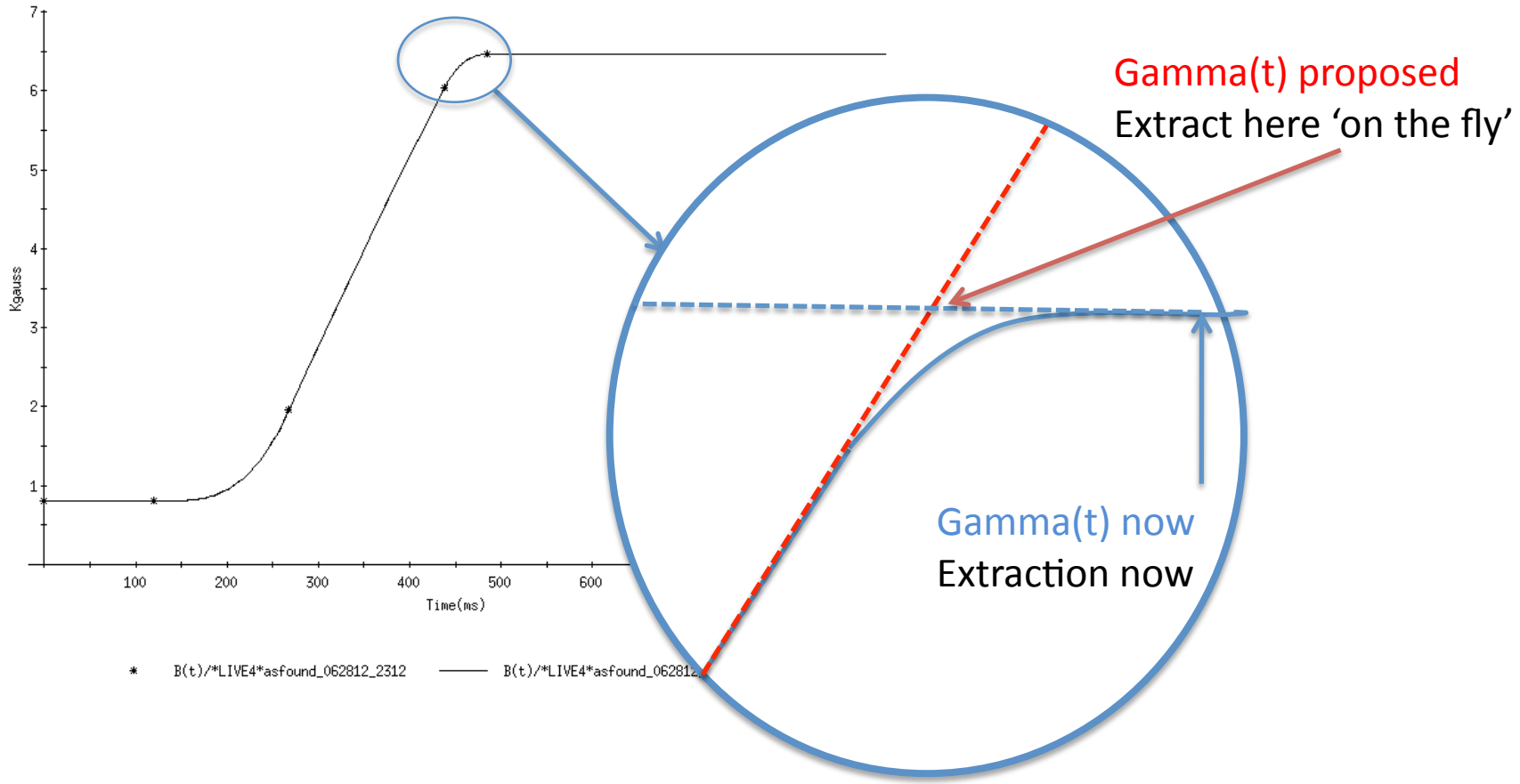
- Intrinsic resonance strength increases as γ INCREASES
- Depolarization gets worse as ramp rate DECREASES

Rollover to flattop is a problem

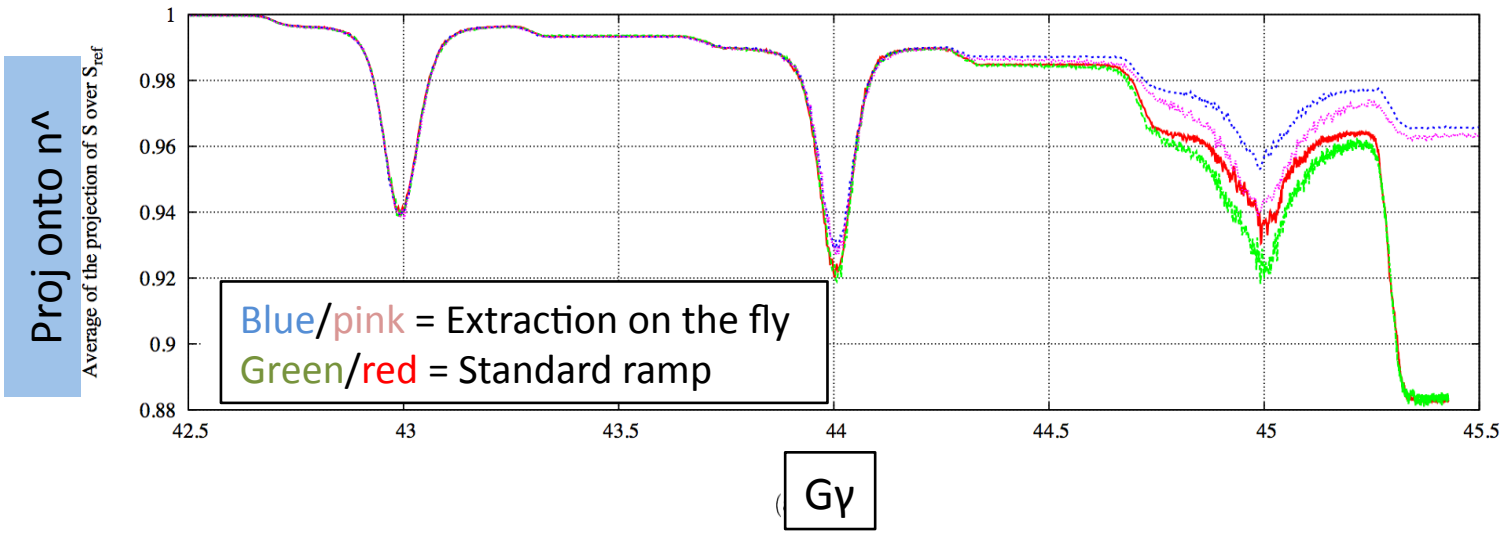
γ is high
dγ/dt is low

Extraction on the fly

Principle: Don't roll over and extract during the acceleration ramp



JUMP QUADS *OFF*



JUMP QUADS *ON*

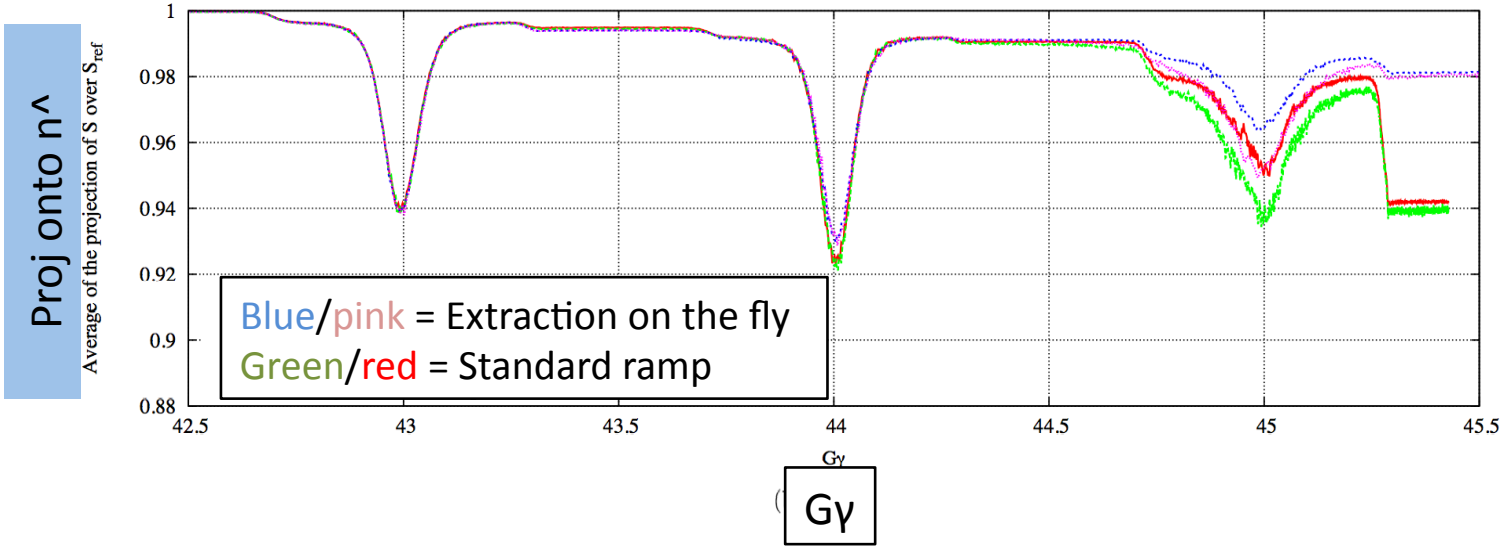


Figure 1: Comparison of the effect of a constant acceleration rate. The two plots show the evolution of the average projection of the spin vector over the $\vec{n_0}$ vector as a function of the energy. these trackings were made using the same Gaussian distributions of in the horizontal plane $\epsilon_x^{N,95\%} = 13.5\,\pi$ and either no vertical distribution or using a Gaussian distributions of $\epsilon_x^{N,95\%} = 14\,\pi$.
(a) shows the evolution of the polarization without the jump quads
(b) shows the evolution of the polarization with the jump quads

Extraction on the fly: Effort

- LLRF reconfigured for df/dt != 0
  - Fast change in momentum as the pulsed bumps come on (2-4 ms prior to extraction)
  - Already commissioning the new AGS LLRF system this year
- Present 'DC' extraction bumps cannot ramp during acceleration (back-leg windings, have net back-emf)
  - Pulsed bumps
  - Upgraded DC bumps

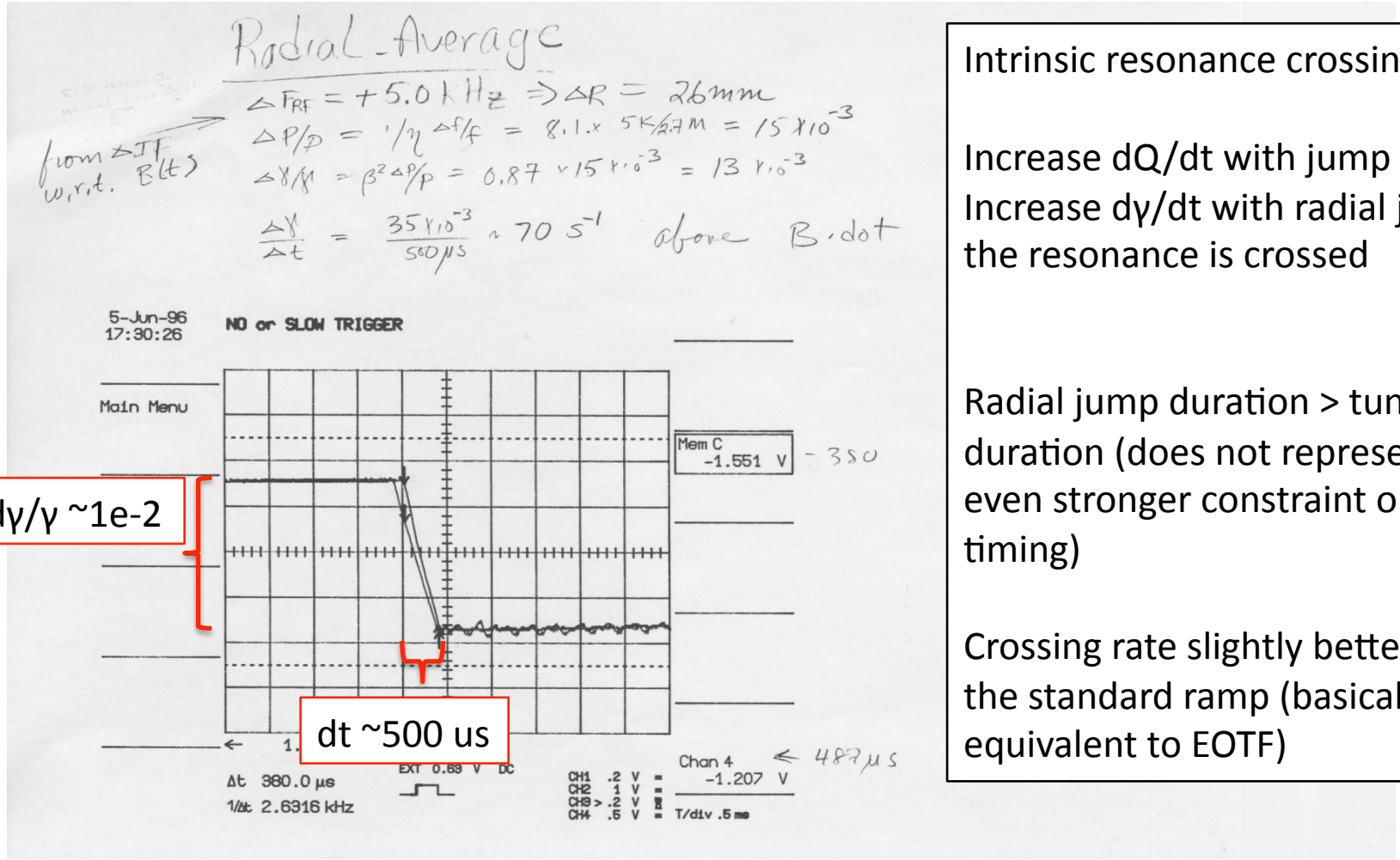
EOTF: Drawbacks

- Large effort: LLRF and pulsed power
- Turnaround time for initial test
  - 1-2 shifts to switch to pulsed bumps
  - 1 shift to go back
- Extracted energy jitter from MMPS within 9 MHz tolerance, transverse jitter has to be measured.
- Not compatible with extraction of two p^ bunches (might not be doable for other reasons)
- Pulsed bump spec not compatible with multibunch extraction of ions

EOTF: Sketch of a plan

- 1-2 shifts: In-ring hookup of pulsed bumps
- ~3 shifts
  - Set up pulsed bump extraction on the flattop
    - Could conceivably gain enough confidence to operate like this, but probably not
  - Move extraction to the ramp
  - 'Easy' polarization measurement of EOTF beam requires RHIC to be at injection. Alternative is long ramp polarization measurement
- 1 shift: return to operation

Radial Jump Test Done with Ion Beam in 1996



Intrinsic resonance crossing rate:

Increase dQ/dt with jump quads
Increase dγ/dt with radial jump as the resonance is crossed

Radial jump duration > tune jump duration (does not represent an even stronger constraint on the timing)

Crossing rate slightly better than the standard ramp (basically equivalent to EOTF)

The test was done at injection with gold beam and we got $d\gamma/dt=70\ s^{-1}$.
$d\gamma/dt=60\ s^{-1}$ for regular ramp.

(Test done by M. Brennan)

(Slide from H. Huang)

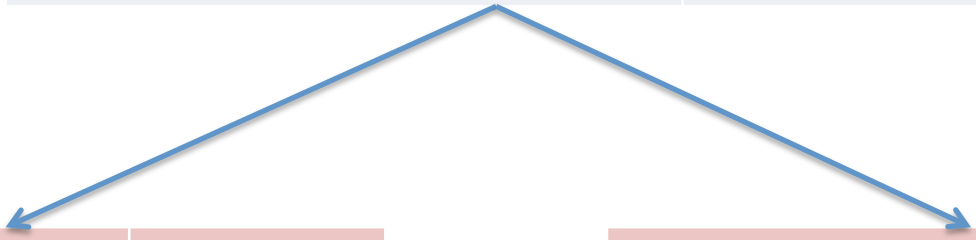
Radial Jump: Effort

- Less LLRF work, but no change to extraction scheme
  - Same competition with commissioning efforts
- Compatible with multi-bunch extraction
- No dedicated RHIC time to reconfigure bumps/measure polarization
- Possibility for longitudinal emittance growth
- Have to jump once per resonance (maybe three times)

Crossing Rates for Final Resonance

Max acceleration rate on the ramp is 60 Gγ/s

Machine Condition	Crossing Rate (Gγ/s)
Standard ramp (no JQ)	15
Standard + JQs	415



EOTF + JQs	**515**
Radial Jump + JQs	**525**

EOFT and radial jump are not mutually exclusive (in the FOT)

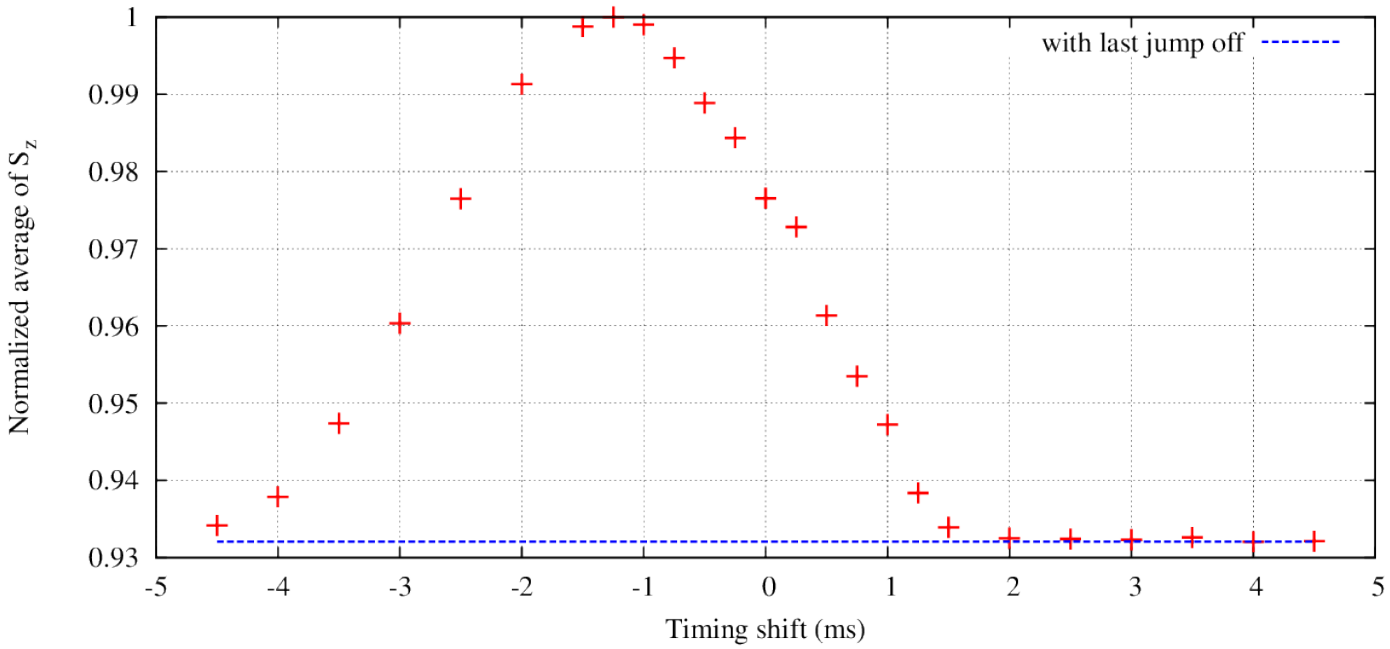
(data from Y. Dutheil)

Tune jump timing: Improvement of spin tune calculation

Assuming spin tune = Gγ at horizontal resonance is not accurate for last (slow) resonances

Precise calculation improves jump timing and our interpretation of the measurements

(simulation done by Yann)



AGS Orbit Studies

- Effort to understand intermittent AGS orbit dipole kicks
  - Analysis of prior run data
  - Installation of power supply diagnostics for orbit correctors
  - Thinking about improved diagnostic effort for Run 12 operation
- Another round of AGS magnet realignments, continue work toward understanding of bare AGS orbit

Instrumentation and Measurement

- Much covered in previous talk (Michiko)
  - IPM beta function measurement
  - AGS BBQ tune meter development
  - RHIC-style IPM work
  - (the list continues)

- SY leading a data analysis effort to understand the evolution of emittance/intensity through the injectors

- Improved polarization profile measurement method in Run 12
  - Will help with the single horizontal resonance measurements

Summary

- Polarization development in the AGS to focus mostly on the last horizontal resonance
  - Extraction on the fly
  - Radial jump
- Only extraction on the fly requires dedicated RHIC time (both require RF time)
- Some time will have to be spent quantifying the effects of the new source
  - Same intensity in half the longitudinal emittance may prompt APEX studies (transition, space charge, instability….)