Systematic Errors

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1999-2001 Systematic Errors on $< \omega_a >$

Source	(ppm)		
	1999	2000	2001
Pile-Up	0.13	0.13	0.08
AGS Background	0.10	0.01	0.01
Lost Muons	0.10	0.10	0.09
Timing Shifts	0.10	0.02	0.02
E-field and vertical β-motion	0.08	0.03	0.06
Fitting Method / Binning	0.07	0.06	0.06
Coherent Betatron Oscillation	0.05	0.21	0.07
Beam debunching	0.04	0.04	0.04
Detector Gain Changes	0.02	0.13	0.12
Total systematic error on ω_a	0.3	0.31	0.21

New in 2000

Sweeper magnet to eliminate AGS background

Improve Control of Pileup

$\sigma_a = 0.08$ ppm in 2001- mostly scales linearly with rate

- Pileup efficiency 0.036
- Pileup phase 0.038
- Unseen PU 0.026- make correction

Things to do

- Increase segmentation in detector/PMT/WFD
- reduce flash- reduced background leads to more reliable

pulse separation

- Study Q method
- Need better control of gains and pulse shapes of individual detector elements (crucial to the modeling process)

'Q' Method

How is this best implemented?

Need a simulation in order to identify at least the most obvious issues...

Study effects of

- Effect of Background (Eliminate w/ ratio method?
- Effect of non-linear energy response

Future run: Plans to reduce $\sigma_{\omega_a}(CBO)$

Currently: $\sigma_a(CBO) = 0.07$ ppm

- Choose n: CBO resonance frequencies far from f_a
- Improve orbit kick- need to finish simulations and correlate to data
- Active RF to reduce CBO amplitude
- Sextupole E or B field to damp out CBO
- Increase inflector aperture to reduce narrow waist
- increase symmetry of detectors around ring, fix det 20

- increase vertical size of detectors

Muon Losses

Contribution to $\sigma_{\omega_a} = 0.10$ ppm Reduce by x2

- Lost muons monitored by scintillator elements at 11 detector stations.
- Losses ≈1% per τ_μ at 50 μs, 0.1% late times
- Distortion of $N(t)$ has minimal effect on value of ω_a
- Possibility: lose more muons with phase which differs from average

Ways to Reduce Error

- Main way: minimize losses by heavier 'scraping' beam at early times, $\approx 0 - 10\mu s$
  - New scraping scheme with RF?
- Increase ring coverage of muon loss monitors
- Increase instrumentation of muon loss monitors
  - Better estimate of shape of curve of losses vs. time- get better fit to spectrum without mop term? thereby getting a better estimate of the absolute loss rate.
- Go to dedicated muon detector(s) e.g. scintillator slabs shielded by lead

- Backward muons- will it reduce the range of stored muon phases?

Detector Gain Stability

- Calibration from average positron energy vs. time

  Affected by background levels, rates, PMT gate-on time (more severe near injection point)

  Stable $\approx 0.2\%$ over 10 muon lifetimes.

- $\sigma_{\omega_a}(gain) =$ 0.13 ppm (1999), 0.12 ppm (2000)-CBO, 0.12 ppm (2001)- g-2 in island length

  – Island length problem scales like PU. Solve problem in next analysis.

Future improvements

- Improved monitoring of gains- laser/LED
- Instrumentation of all detector channels
- Reduction of the 'flash' associated with particle injection
  - PMT can be gated on sooner, gain settles sooner
  - reduced background: calibration fits more reliable
- Improve stability of shape of pulses