Kicker Differential Decay
E821 vs E989

David Rubin

Cornell University

November 30, 2022

Differential Decay

$$\Delta\omega_a = \frac{d\langle\phi_a\rangle}{d\gamma}\frac{d\langle\gamma\rangle}{dt}$$

Kicker Differential Decay:

- Muons begin to precess when they exit the inflector.
- The difference in the ω_a phase of muons that exit the inflector with time difference Δt is

$$\Delta\phi_a = \omega_a \Delta t$$

$$\frac{d\langle\phi_a\rangle}{d\gamma} = \omega_a \frac{d\langle t\rangle}{d\gamma} = \omega_a \frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}$$

$$\Delta\omega_a = \frac{d\langle\phi_a\rangle}{d\gamma}\frac{d\langle\gamma\rangle}{dt} = \frac{d\langle\phi_a\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt} = \omega_a \frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt}$$

$$\frac{\Delta\omega_a}{\omega_a} = \frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt}$$

Track a distribution through the inflector and into the ring

Note momentum and injection time of all particles that survive 4 us and generate the 2D histogram

$$\boxed{\rho(\delta, t)}$$

(t is the time the particle exits the inflector)

$\langle t(\delta)\rangle$ is the average time of particles with momentum δ

$$\langle t(\delta)\rangle = \frac{\int \rho(\delta, t) t dt}{\int \rho(\delta, t) dt}$$

The slope is $\dfrac{d\langle t(\delta)\rangle}{d\delta}$

PHYSICAL REVIEW D **73,** 072003 (2006)

E821 kicker
and muon pulse

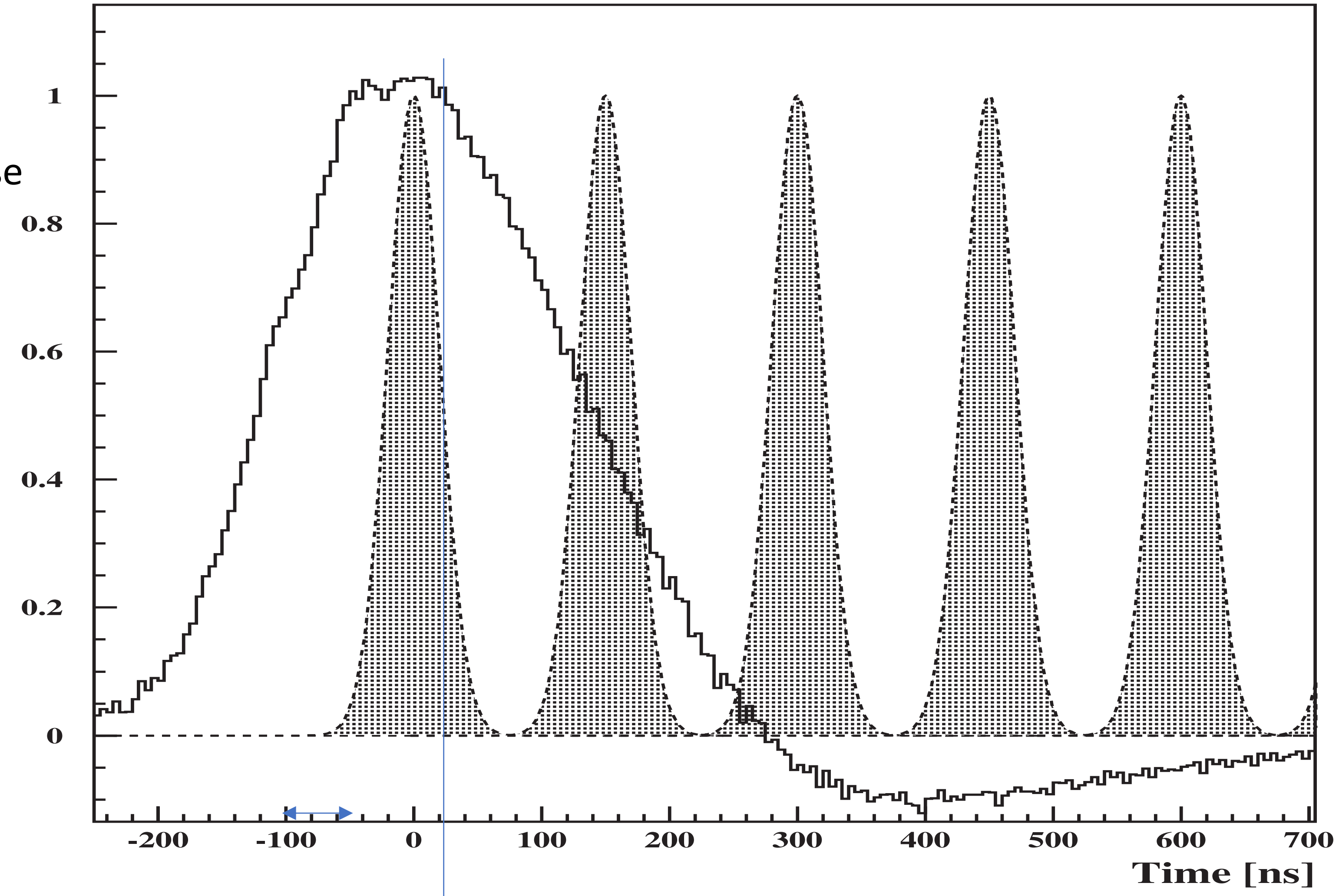
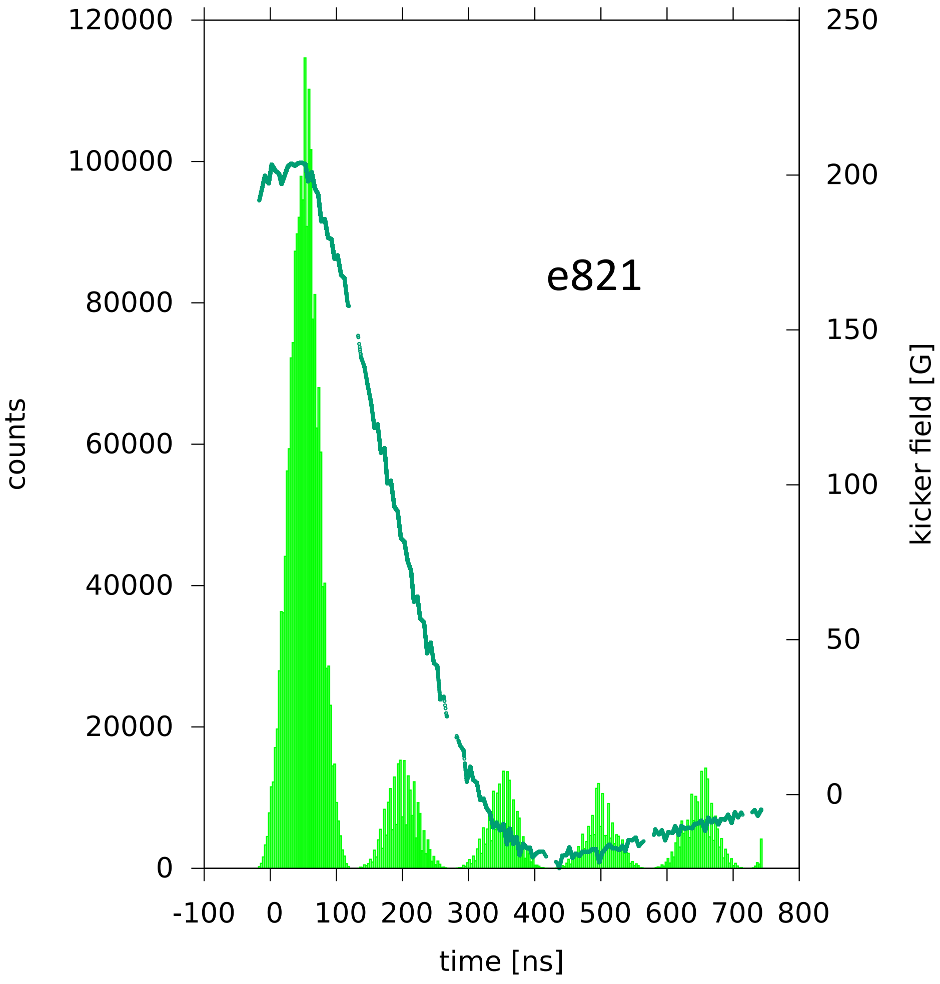
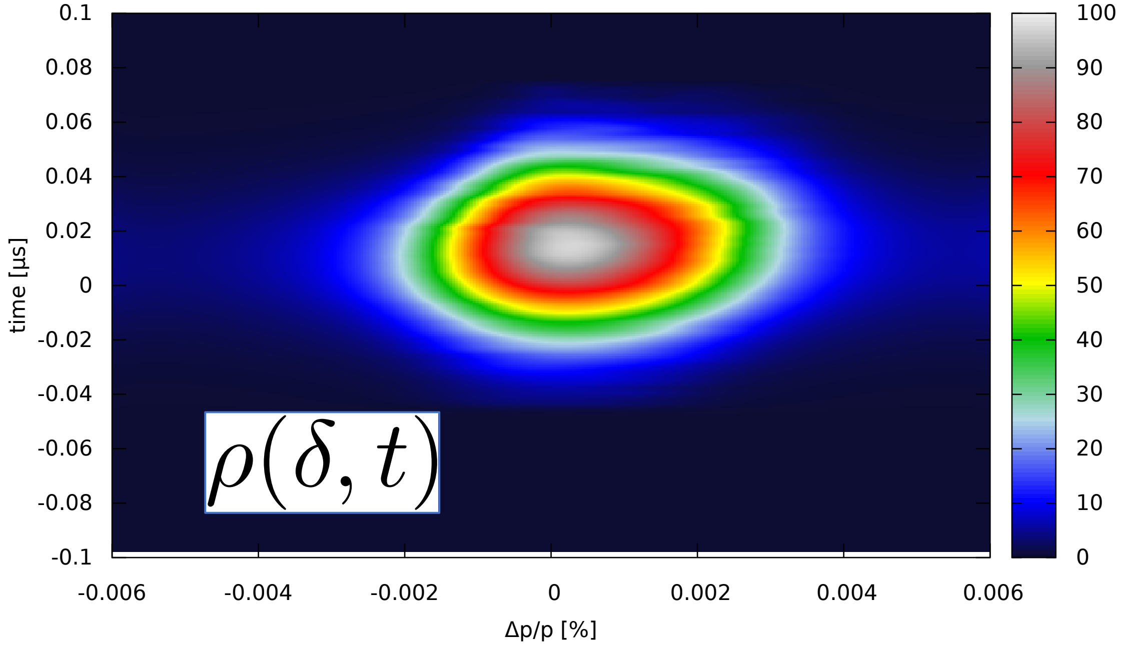


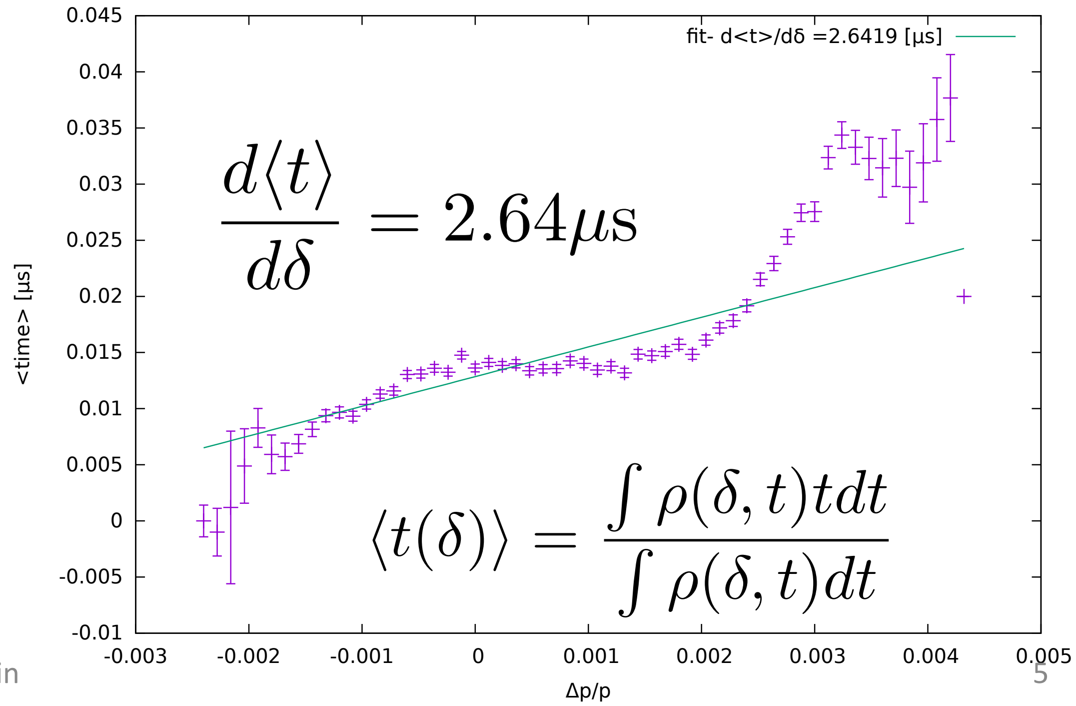
FIG. 10. The trace is a sample kicker current pulse from one of the three kicker circuits. The periodic pulses provide a schematic representation of the unmodified muon bunch intensity during the first few turns. The vertical axis is in arbitrary units.



$n=0.137$

$\langle r_e \rangle \sim 4.5$mm





config_023

E821

B_k = 204 G

$$\Delta\phi_a = \omega_a \Delta t$$

$$\Delta\omega_a = \frac{d\langle\phi_a\rangle}{d\gamma}\frac{d\langle\gamma\rangle}{dt} = \frac{d\langle\phi_a\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt} = \omega_a\frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt}$$

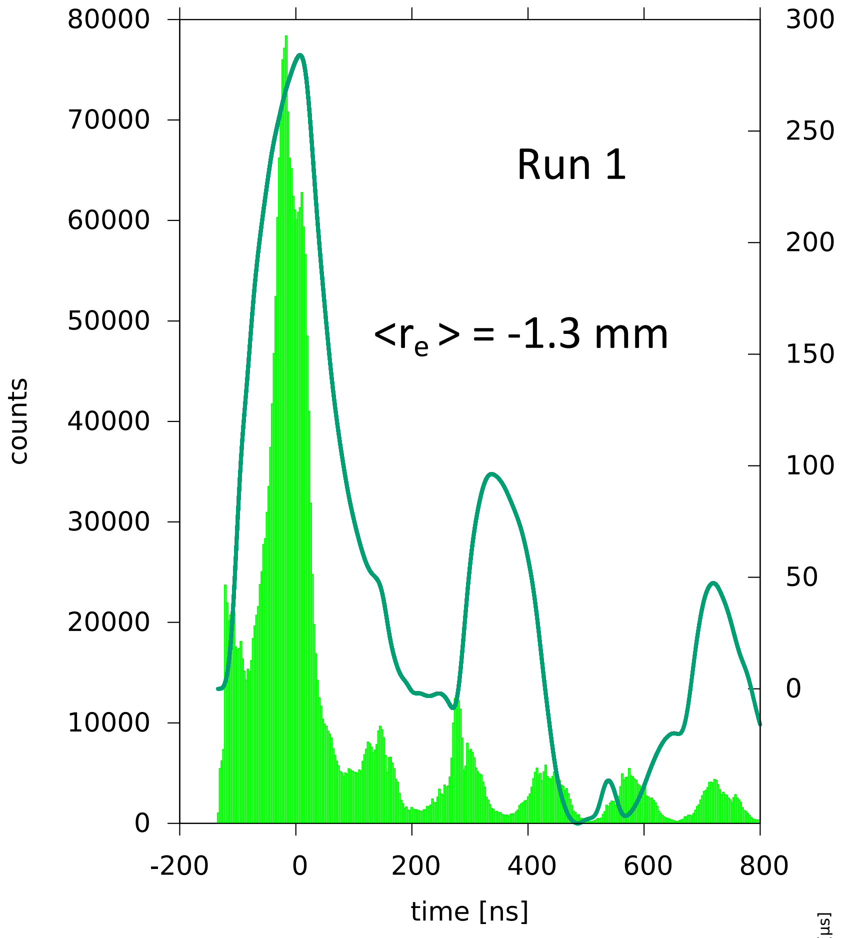
$$\frac{\Delta\omega_a}{\omega_a} = \frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt}$$

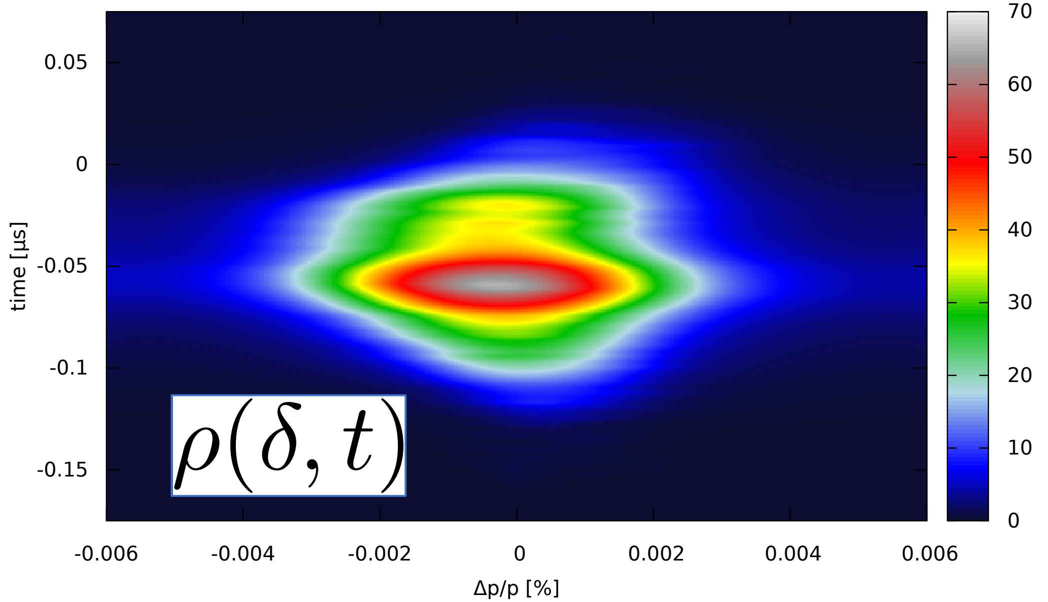
$$\frac{d\langle\gamma\rangle}{dt} \sim \frac{\sigma^2}{\mu^2\tau} \sim 5.6\times10^{-7}\frac{1}{\mu\mathrm{s}}$$

Crnkovic et al. doc-db 3477

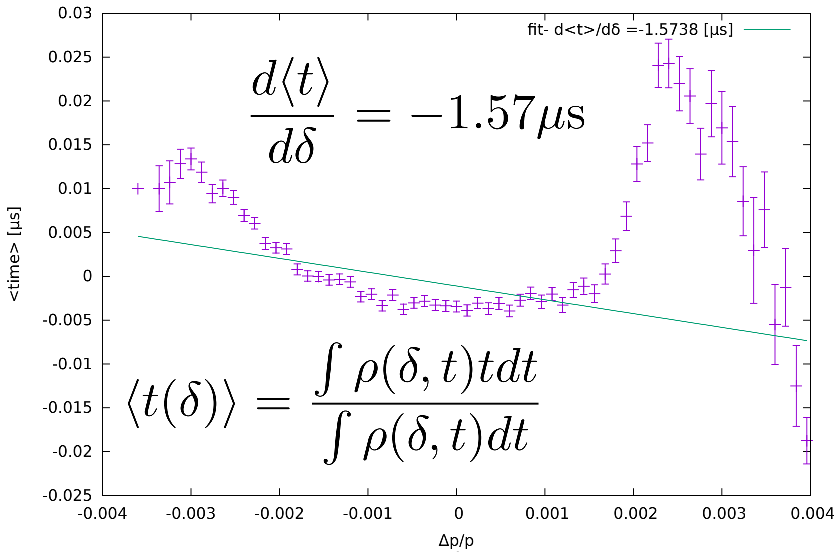
$$\frac{d\langle t\rangle}{d\delta} = 2.64\mu\mathrm{s}$$

$$\frac{\Delta\omega_a}{\omega_a} = 50\ \mathrm{ppb}$$

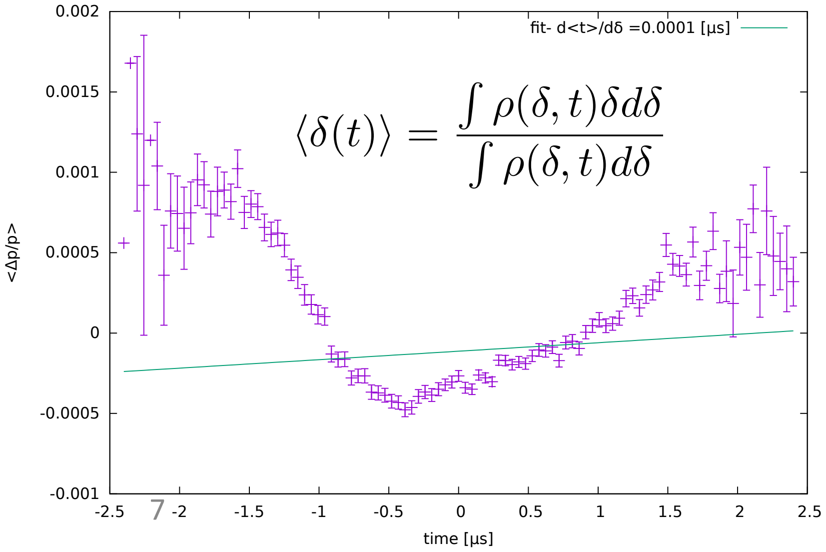




<t(δ)>



<δ(t)>



config_025

E989

B_k = 284 G

$$\Delta\phi_a = \omega_a \Delta t$$

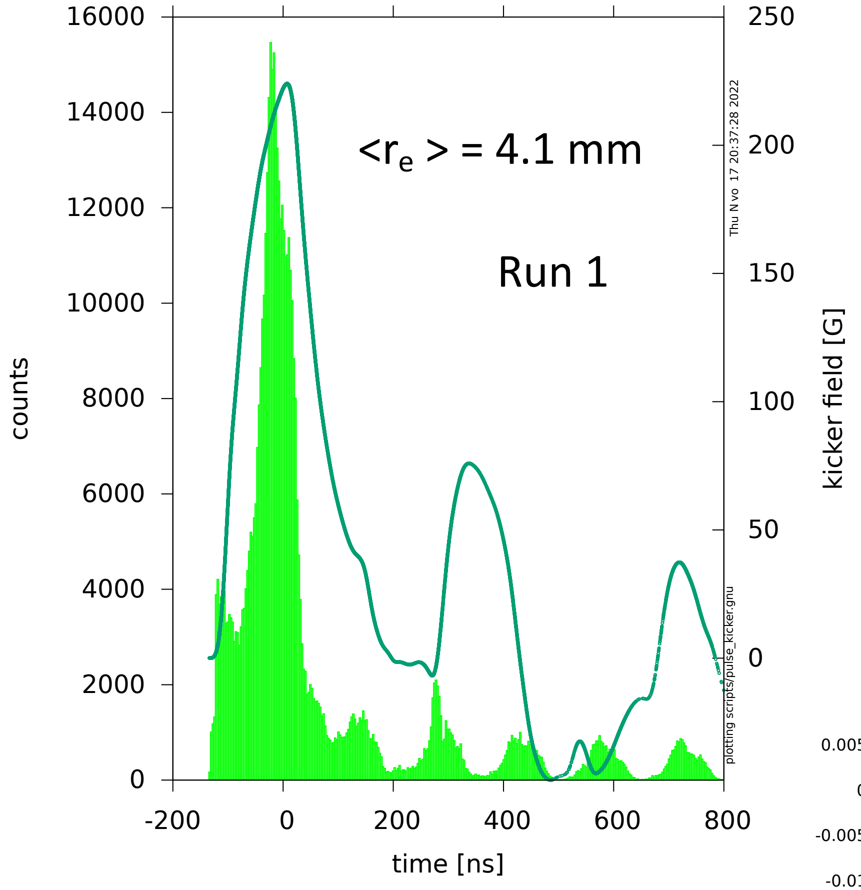
$$\Delta\omega_a \quad = \quad \frac{d\langle\phi_a\rangle}{d\gamma}\frac{d\langle\gamma\rangle}{dt} = \frac{d\langle\phi_a\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt} = \omega_a\frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt}$$

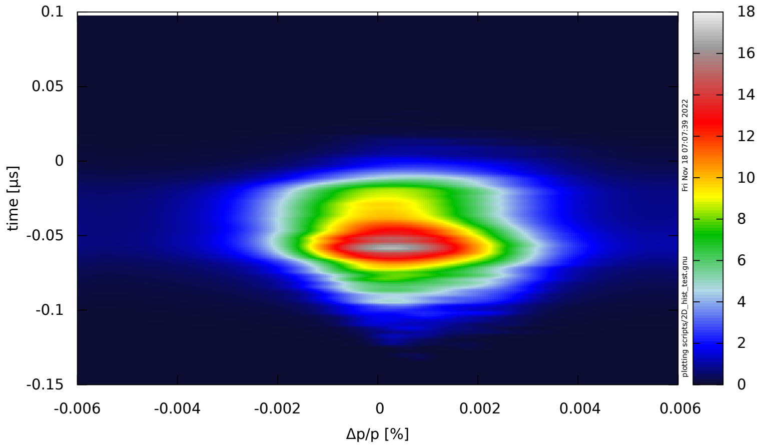
$$\frac{\Delta\omega_a}{\omega_a} = \frac{d\langle t\rangle}{d\delta}\frac{1}{\gamma}\frac{d\langle\gamma\rangle}{dt}$$

$$\frac{d\langle\gamma\rangle}{dt} \sim \frac{\sigma^2}{\mu^2\tau} \sim 5.6\times 10^{-7}\frac{1}{\mu\mathrm{s}}$$

$$\frac{d\langle t\rangle}{d\delta} = -1.57\mu\mathrm{s}$$

=> $$\frac{\Delta\omega_a}{\omega_a} = -30 \text{ ppb}$$

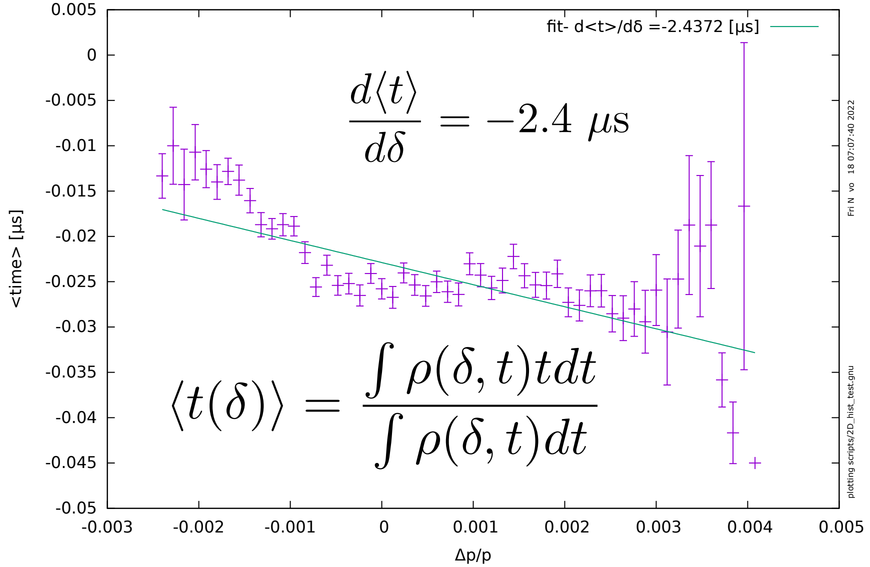




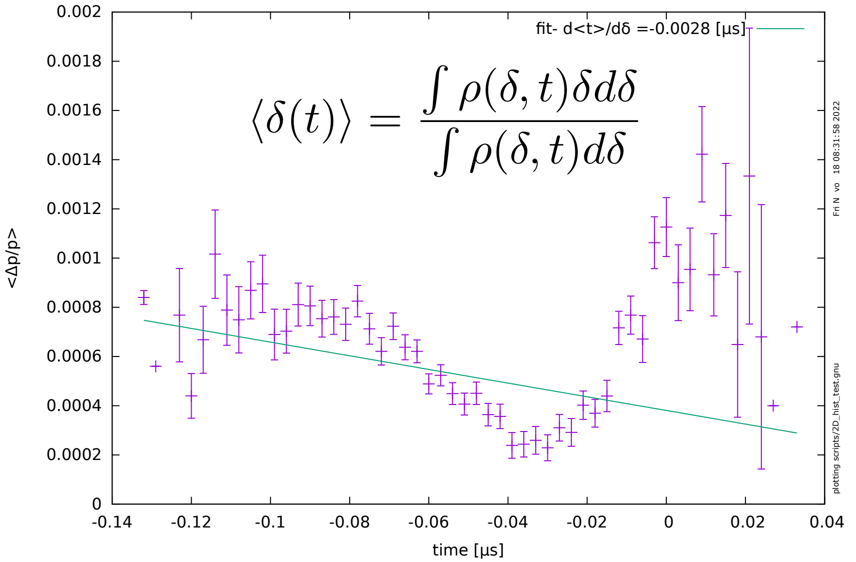
$$\frac{\Delta\omega_a}{\omega_a} = -46 \text{ ppb}$$

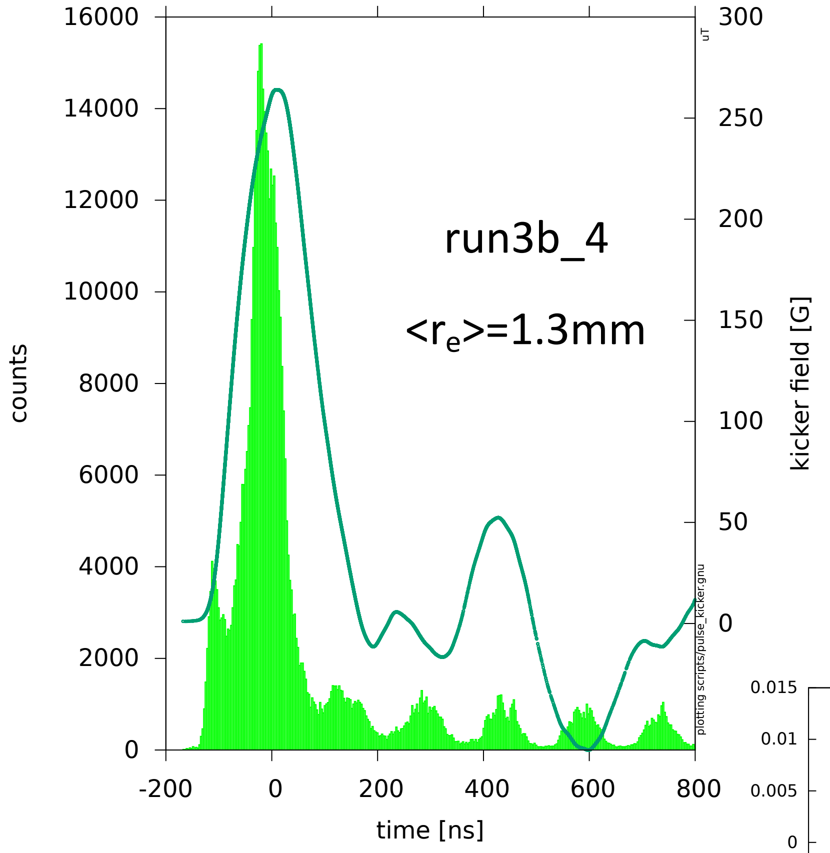
config_027

<t(δ)>



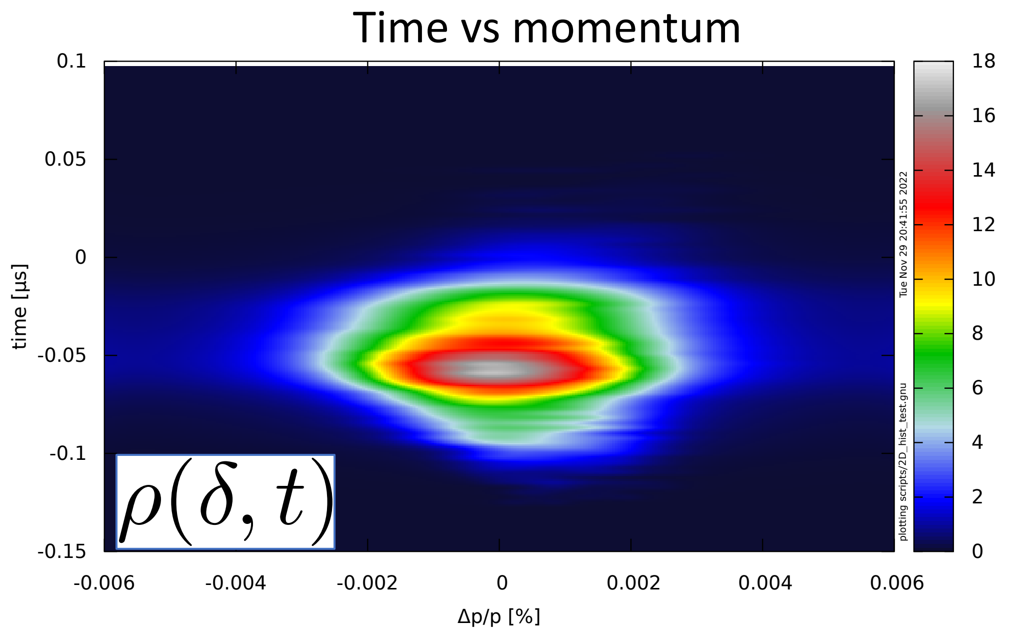
<δ(t)>





$$\frac{\Delta\omega_a}{\omega_a} = -10.3 \text{ ppb}$$

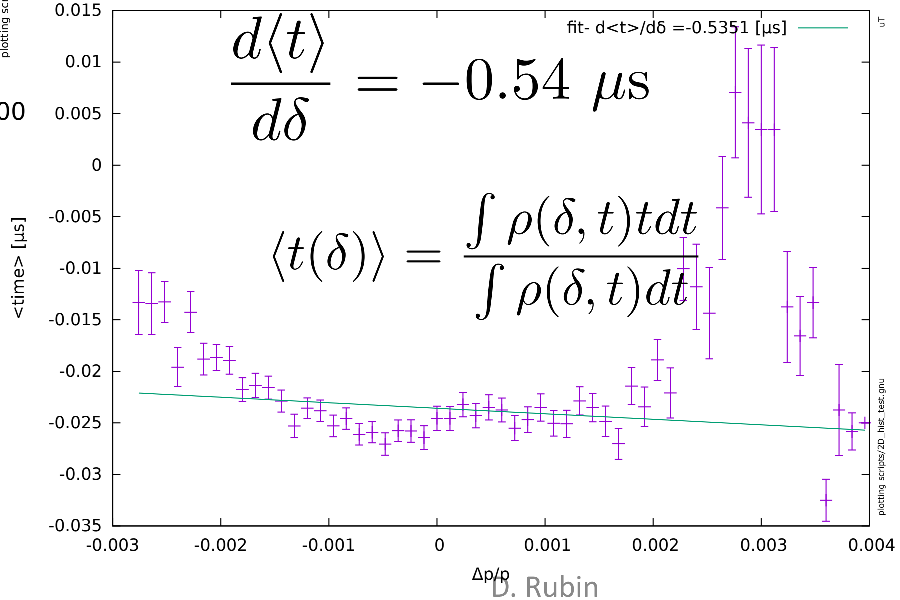
config_032



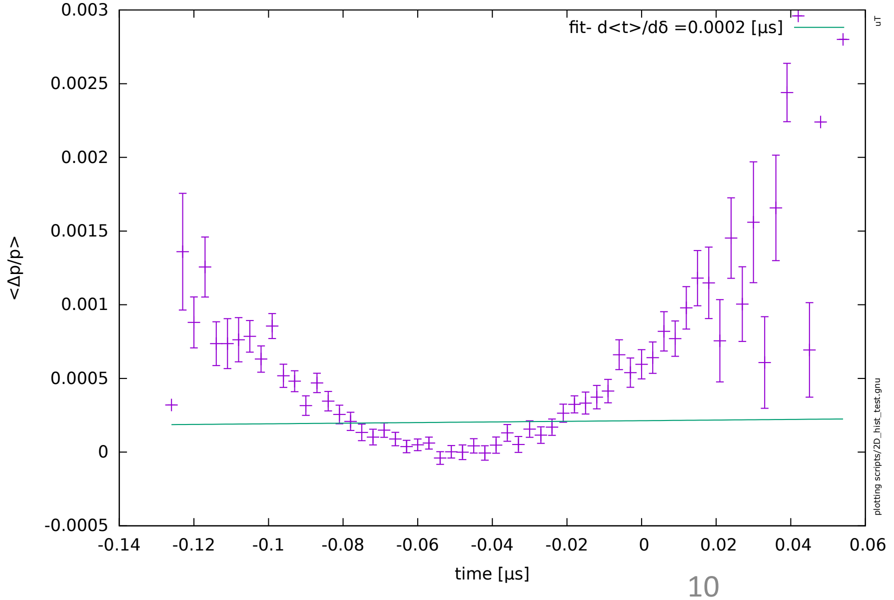
<t(δ)>

$$\frac{d\langle t\rangle}{d\delta} = -0.54 \ \mu s$$

$$\langle t(\delta)\rangle = \frac{\int \rho(\delta,t)\,t\,dt}{\int \rho(\delta,t)\,dt}$$



<δ(t)>



Kicker differential decay is sensitive to

- Kicker pulse shape and amplitude
- Muon pulse shape

END