Differential Decay and Spin-Coordinate Correlation

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

$$= \left(\frac{d\langle \phi_a \rangle}{dx_{inf}}\frac{d\langle x_{inf} \rangle}{d\delta} + \frac{d\langle \phi_a \rangle}{dx'_{inf}}\frac{d\langle x'_{inf} \rangle}{d\delta} \right) \frac{1}{\gamma}\frac{d\langle \gamma \rangle}{dt}$$

$\frac{d\langle \phi_a \rangle}{dx_{inf}}$ & $\frac{d\langle \phi_a \rangle}{dx'_{inf}}$ Characteristic of injected beam at inflector exit

$\frac{d\langle x_{inf} \rangle}{d\delta}$ & $\frac{d\langle x'_{inf} \rangle}{d\delta}$ Determined by momentum acceptance of ring

$$\frac{d\langle \gamma \rangle}{dt} = \frac{\gamma^2 \sigma_e^2}{\gamma^2 (1 + \langle \delta \rangle)^2 \tau}$$ Crnkovic et al. doc-db 3477

$\frac{d\langle\phi_a\rangle}{dx_{inf}}$ & $\frac{d\langle\phi_a\rangle}{dx'_{inf}}$

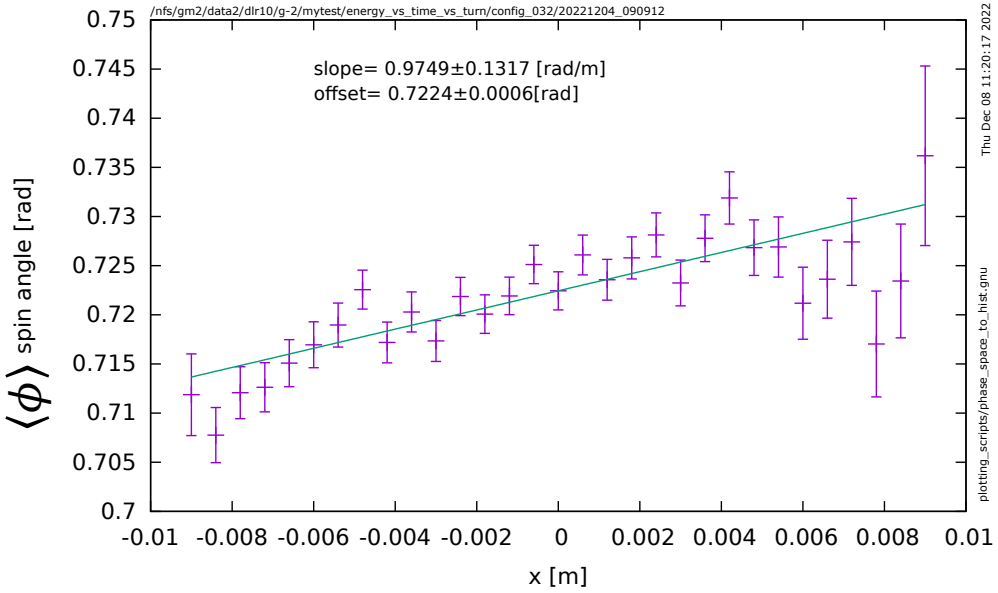
Characteristic of injected beam at inflector exit.
Correlations arise in pion decay channel

Propagate distributions generated by Diktys and Eremey to inflector exit.
Create 2 dimensonal arrays $N(\phi, x_{inf}), N(\phi, x'_{inf})$
Fit $\phi = a + bx_{inf}$ (for example) using

$$\chi^2 = \Sigma_i \left(\Sigma_j N_{ij} \left(\phi_j - (a + bx_i)\right)\right)^2 = \Sigma_i (\Sigma_j N_{ij})\left(\langle\phi\rangle_i - (a + bx_i)\right)^2$$

Minimize with respect to a,b to get

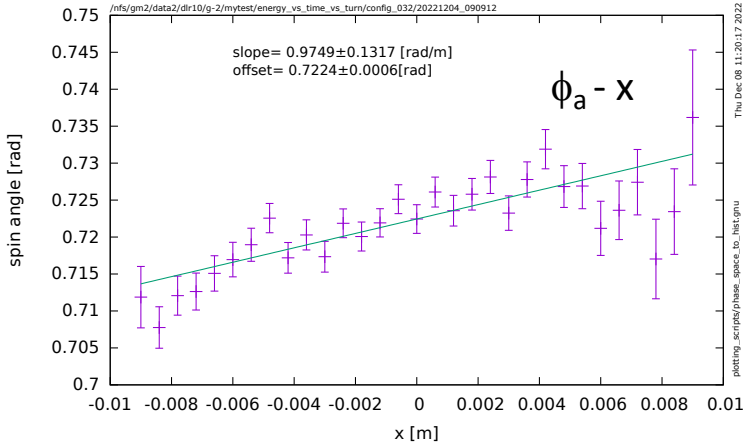
$$\frac{d\langle\phi\rangle}{dx_{inf}} = b$$

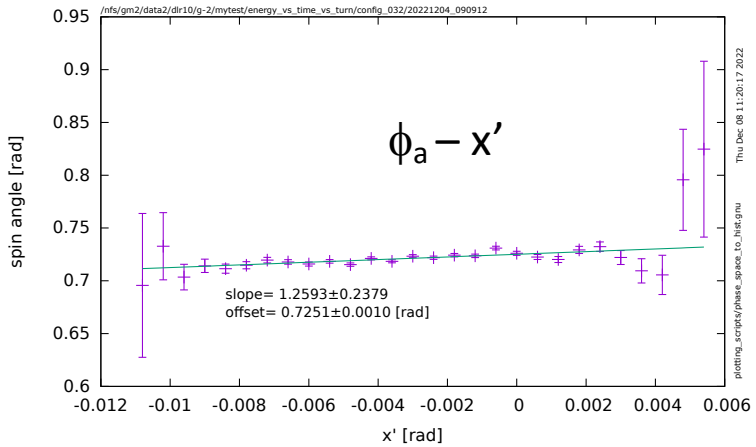


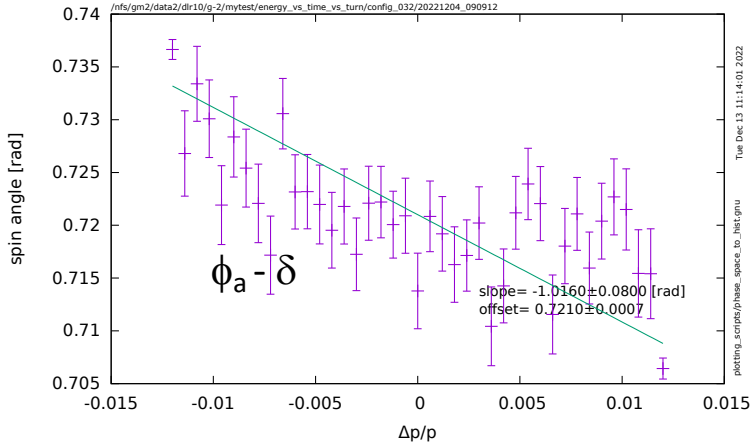
Propagate distribution through the injection channel to the inflector exit.

Correlations of $\phi_a = \cos^{-1}\left(\frac{\mathbf{s}\cdot\mathbf{p}}{|\mathbf{s}||\mathbf{p}|}\right)$ with x, x’ and δ

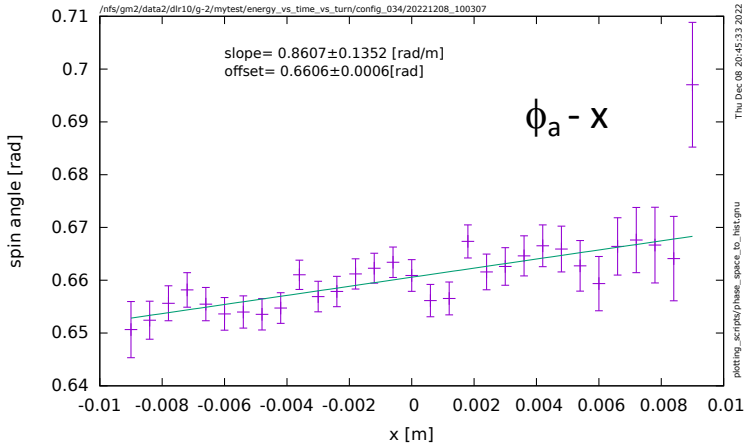
particles_M4M5End_400_mod.txt”(doc-db 16724 –Stratakis)

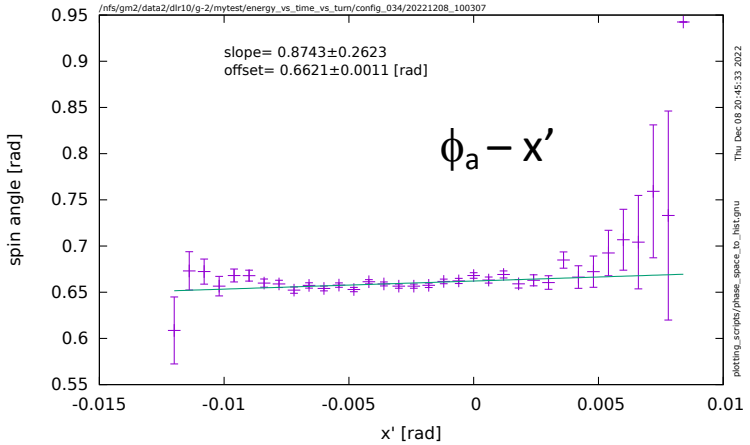


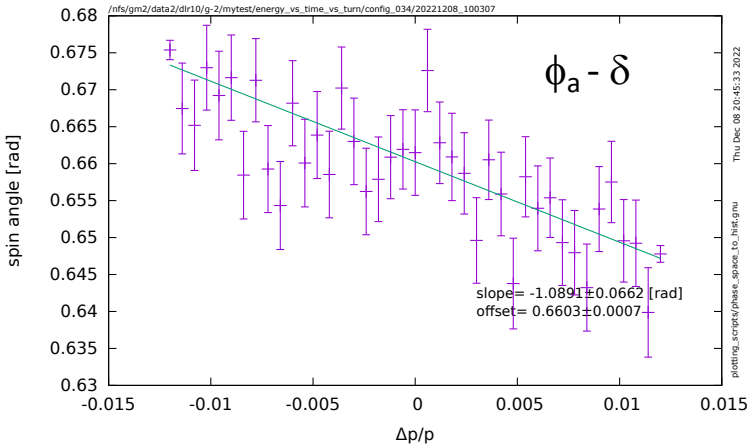




EndofM5_Valetov_withInit.dat doc-db 17800





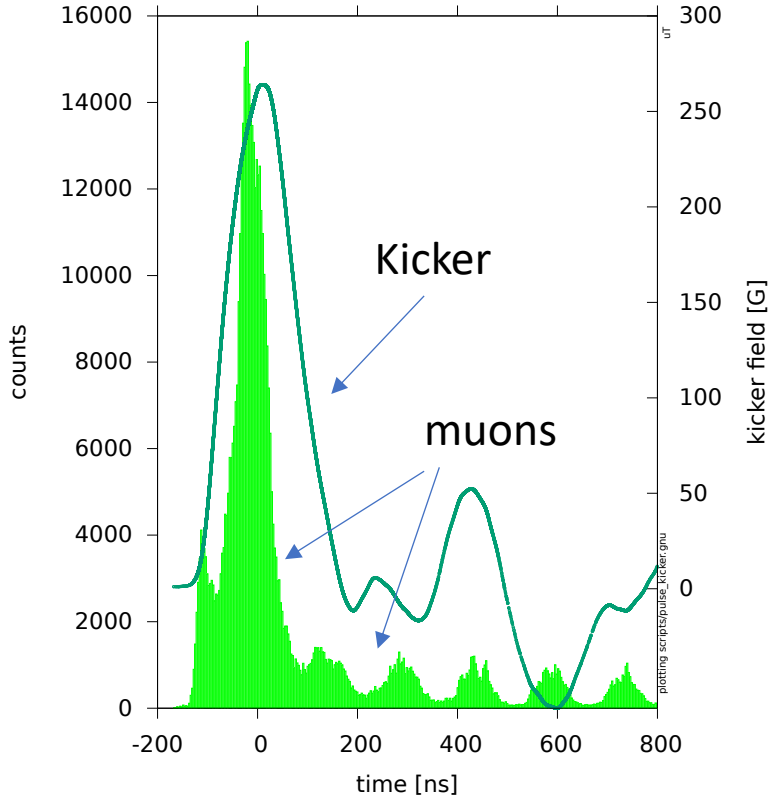


	$d\langle\phi\rangle/dx_{inf}$	$d\langle\phi\rangle/dx'_{inf}$	$d\langle\phi\rangle/d\delta$
Diktys	0.97 ± 0.13	1.26 ± 0.24	-1.02 ± 0.08
Eremey	0.86 ± 0.14	0.87 ± 0.26	-1.09 ± 0.07

Particle tracking to construct , $N(x_{inf}, \delta)$ and $N(x'_{inf}, \delta)$

Track particles with temporal distribution as per measured T0 through the injection channel and into the ring

- Peak kicker field is 264 G (Run3b-4)

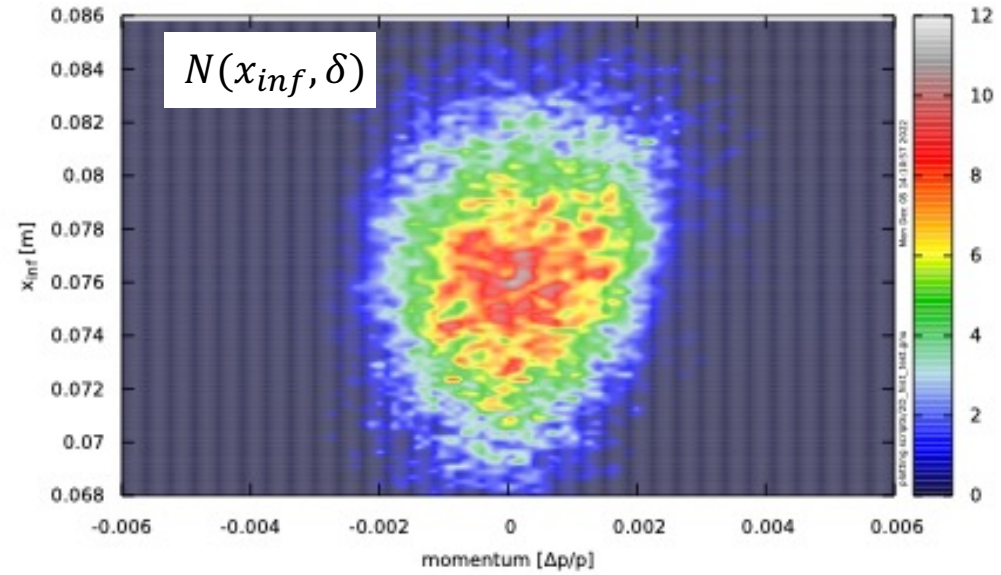


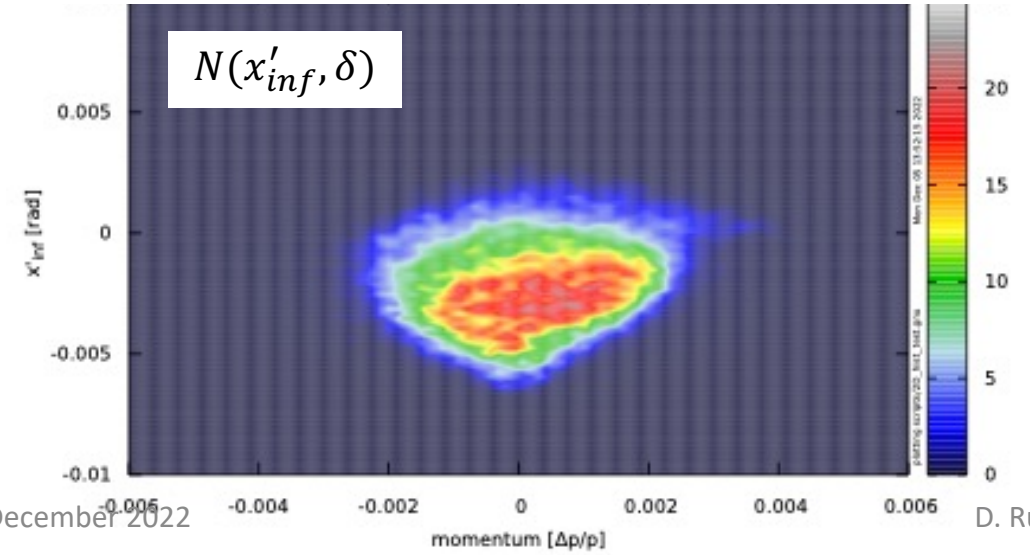
- Use measured kicker and muon pulses
- Assemble 2 dimensional arrays of particles that survive at least 4 us, $N(x_{inf}, \delta)$ and $N(x'_{inf}, \delta)$

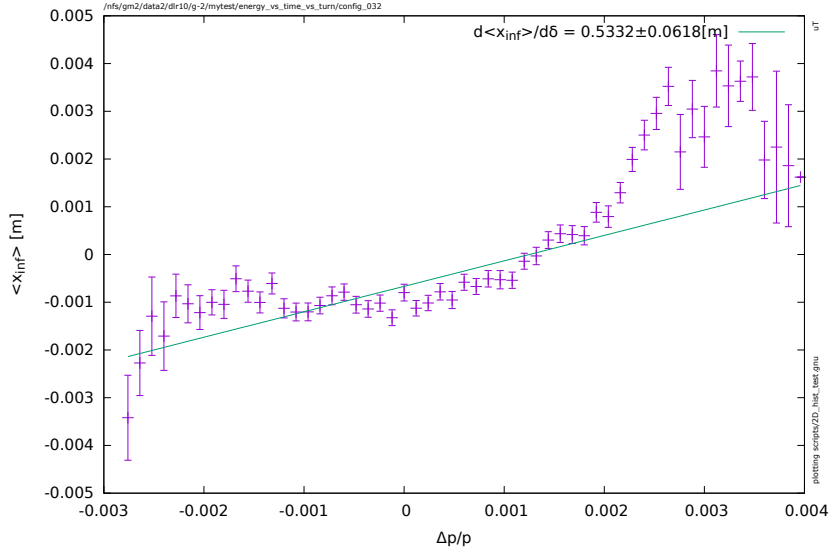
Track particles (Diktys distribution) through the injection channel and into the ring (created)

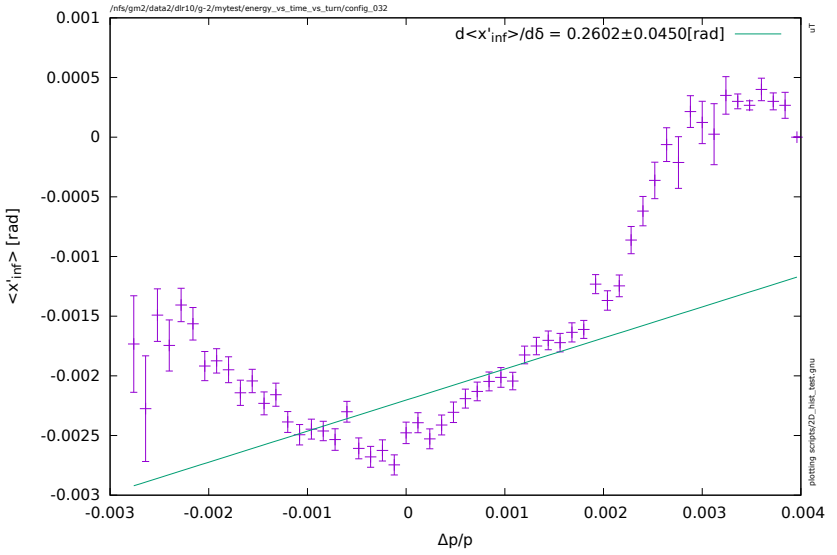
- Peak kicker field is 264 G (Run 3b-4), Measured kicker pulse shape.
- Compute offset and angle at inflector vs fractional momentum offset for particles that survive at least 4 us

config_032



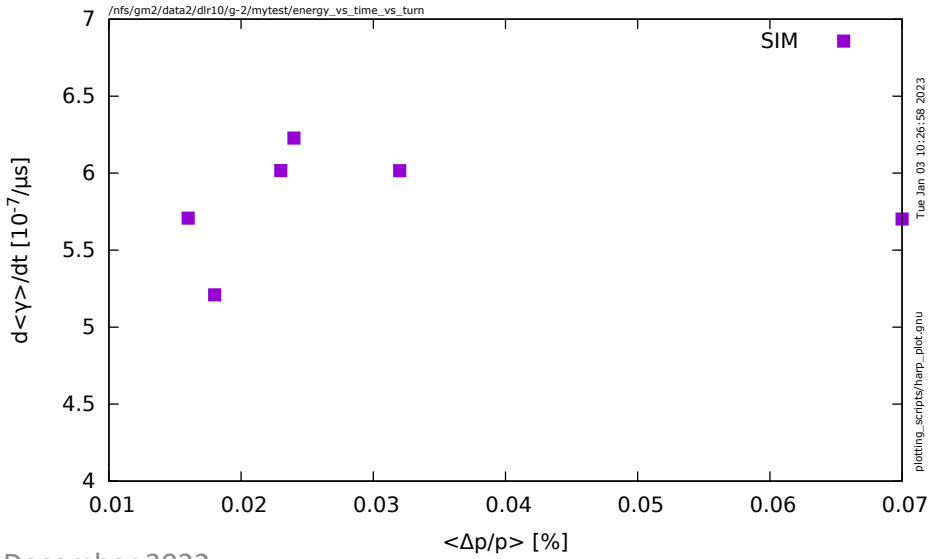


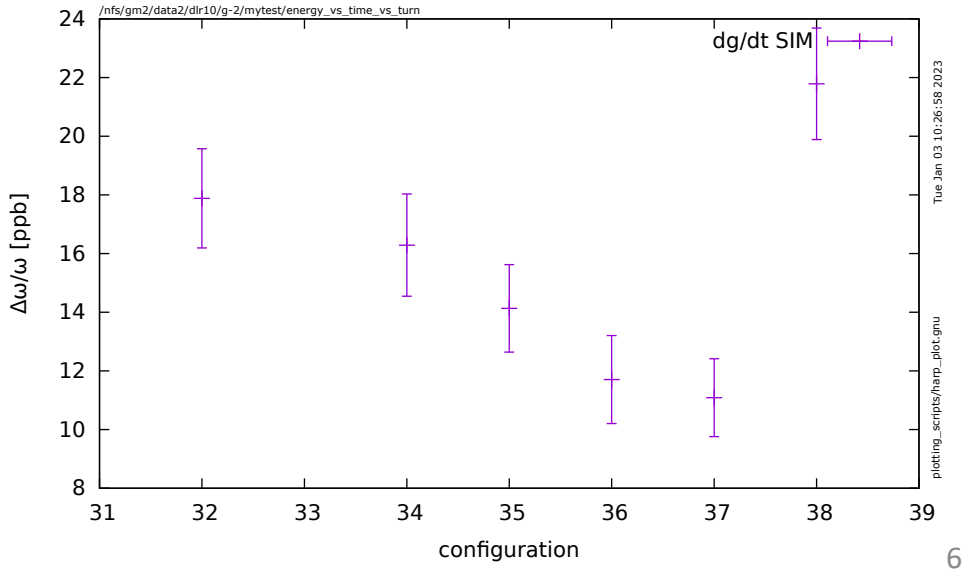


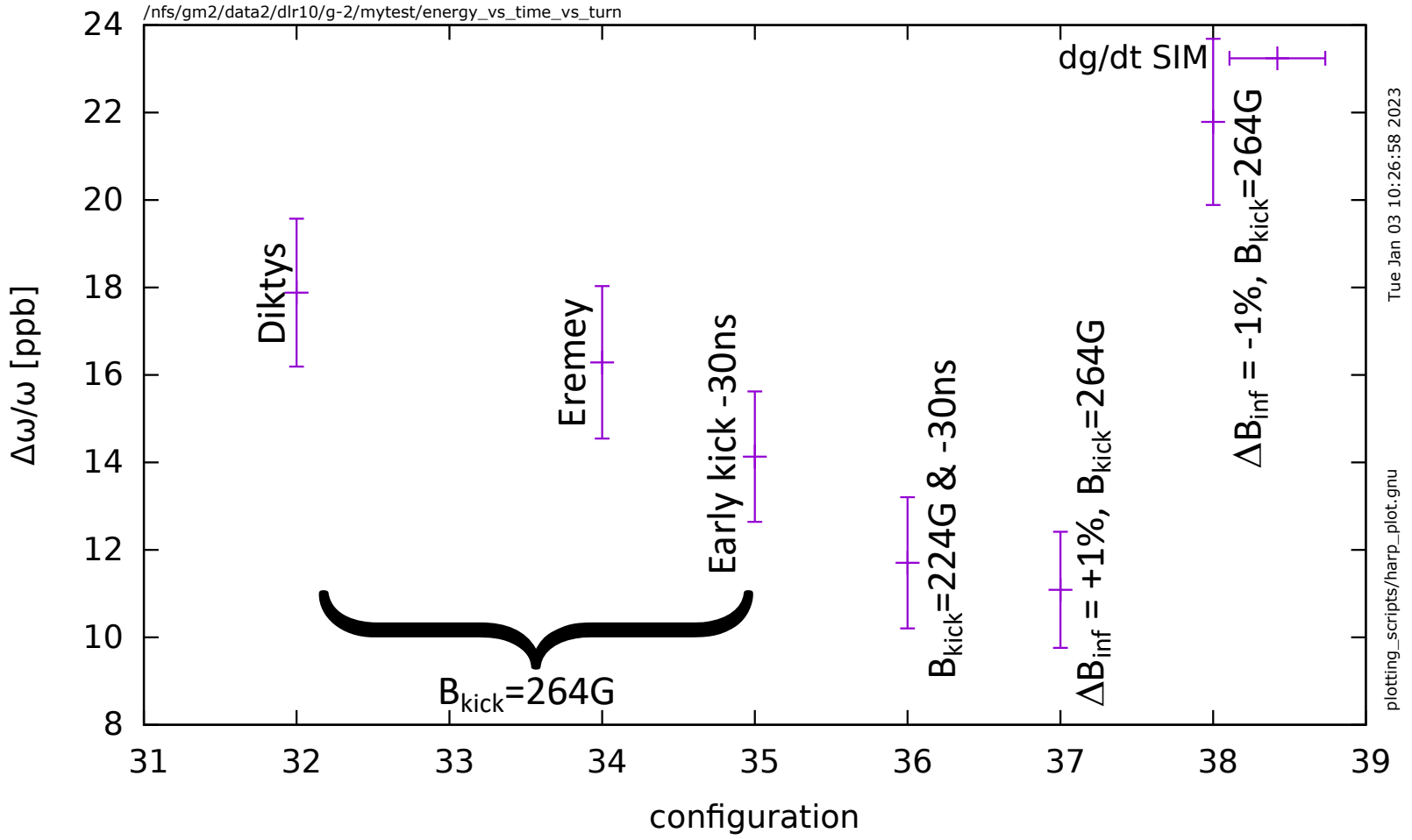


Dependence on kicker field,timing, inflector field, beam line distribution ?

$\frac{dx_{inf}}{d\delta}$[m]	$\frac{dx'_{inf}}{d\delta}$[rad]	$\frac{d\phi}{dx_{inf}}[\frac{\text{rad}}{\text{m}}]$	$\frac{d\phi}{dx'_{inf}}$	$\langle r_e \rangle$[mm]	σ_r [mm]	$\frac{d\langle\gamma\rangle}{dt} \times 10^{-7}/\mu s$	B_{kick} [G]	Kick delay [ns]	$\frac{\Delta B}{B_{inf}}$ [%]	Beamline Distribution
0.58 ± 0.04	0.26 ± 0.03	0.86 ± 0.14	0.87 ± 0.26	5.6	8.9	5.702	224	180	0	Eremey
0.55 ± 0.04	0.22 ± 0.03	0.86 ± 0.14	0.87 ± 0.26	2.6	9.1	6.016	264	180	0	Eremey
0.64 ± 0.06	0.25 ± 0.03	0.86 ± 0.14	0.87 ± 0.26	1.8	9.2	6.017	264	210	0	Eremey
0.53 ± 0.06	0.26 ± 0.05	0.97 ± 0.13	1.26 ± 0.24	1.3	8.9	5.708	264	210	0	Diktys
0.47 ± 0.05	0.17 ± 0.02	0.77 ± 0.14	0.93 ± 0.20	2.6	9.3	6.228	264	210	+1	Eremey
0.73 ± 0.08	0.30 ± 0.06	0.97 ± 0.11	1.09 ± 0.30	1.4	8.5	5.209	264	210	-1	Eremey



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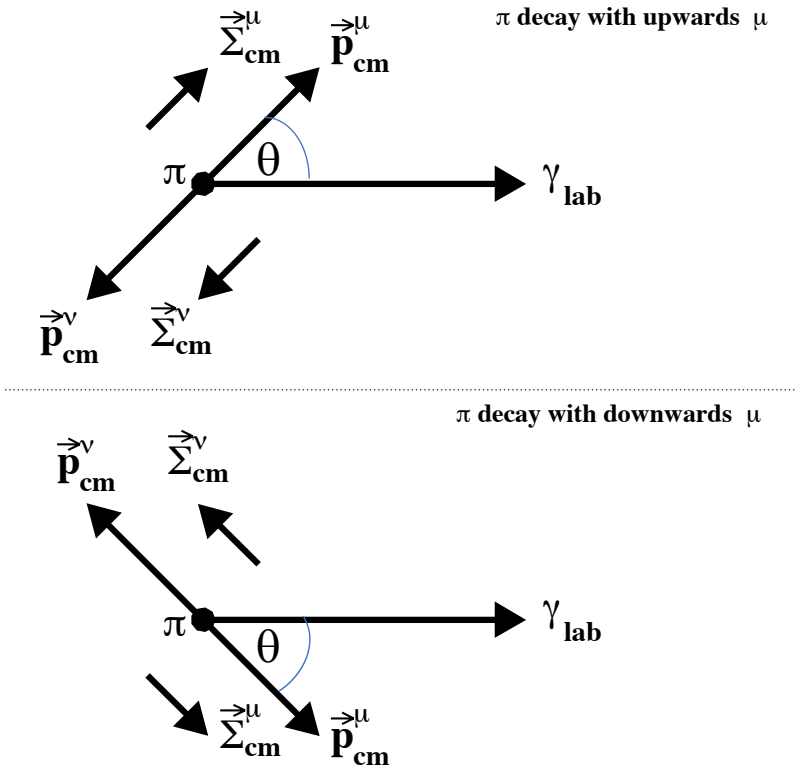
Δω/ω [ppb]
configuration
Diktys
Eremey
Early kick -30ns
B_kick=264G
B_kick=224G & -30ns
ΔB_inf = +1%, B_kick=264G
ΔB_inf = -1%, B_kick=264G
dg/dt SIM
Tue Jan 03 10:26:58 2023
plotting_scripts/harp_plot.gnu

Backup

Correlation between muon spin and momentum in muon rest frame



Spin angle lags for muon x' > 0

Spin angle leads for muon x' < 0

Doc-db 3841 Crnkovic, et al.
Doc-db 27609 Morse

Propagate distribution into ring

N_{ij} Is the number of muons stored with momentum δ_i and displacement x_j or x'_j

$$\chi^2 = \Sigma_i(\Sigma_j N_{ij}[x_j - (a + b\delta_i)])^2$$

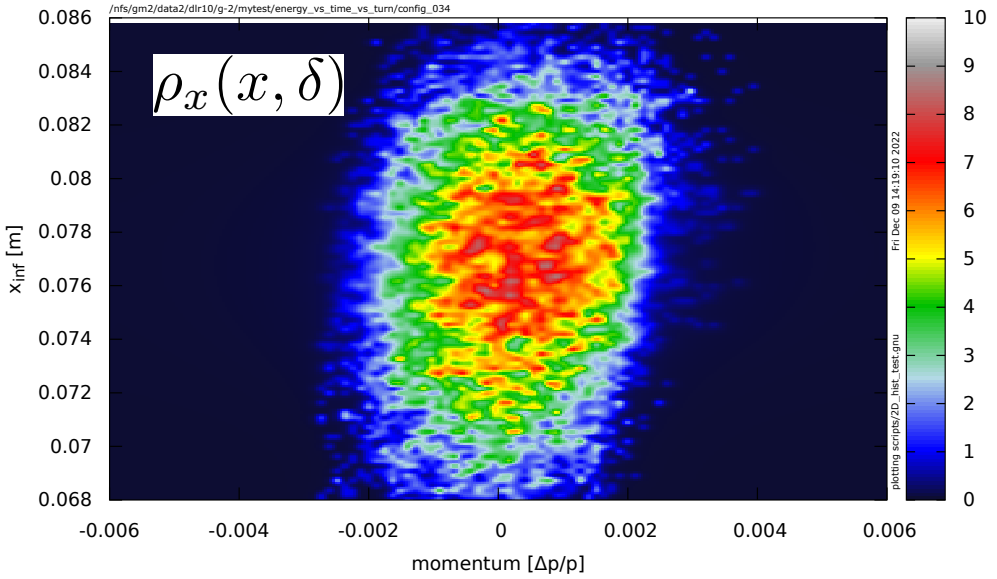
Minimize χ^2 with respect to *a*, and *b*

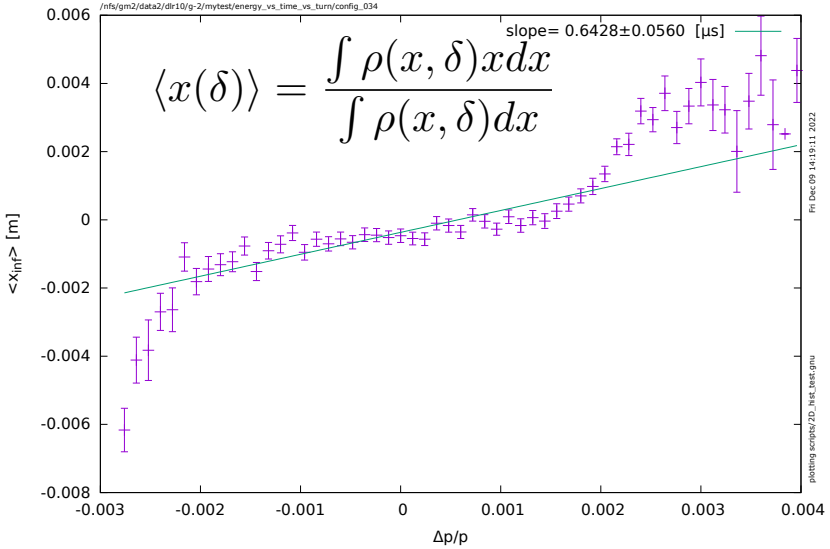
Slope = b

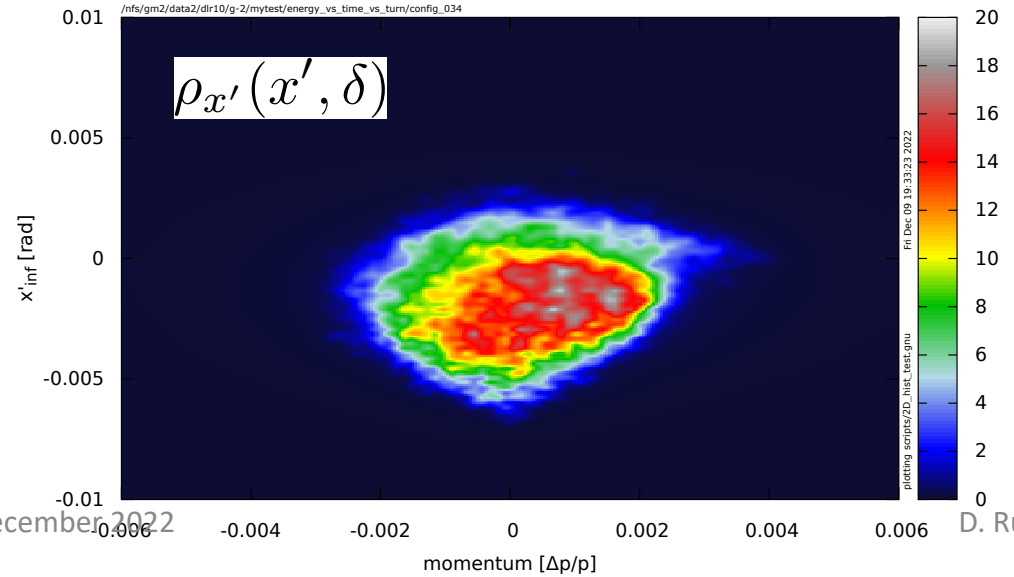
Track particles (Eremey) with temporal distribution as per measured T0 through the injection channel and into the ring

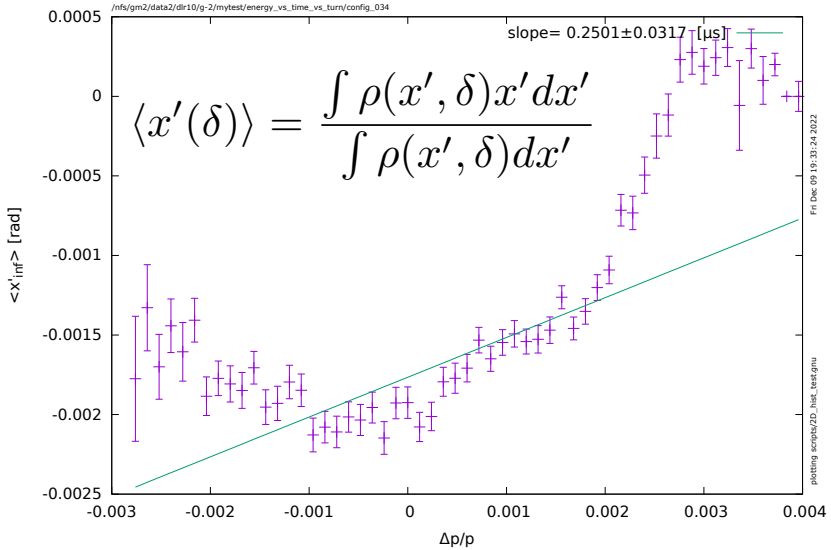
- Peak kicker field is 264 G (Run 3b-4), Measured kicker pulse shape
- Compute offset and angle at inflector vs fractional momentum offset for particles that survive at least 4 us

config_034

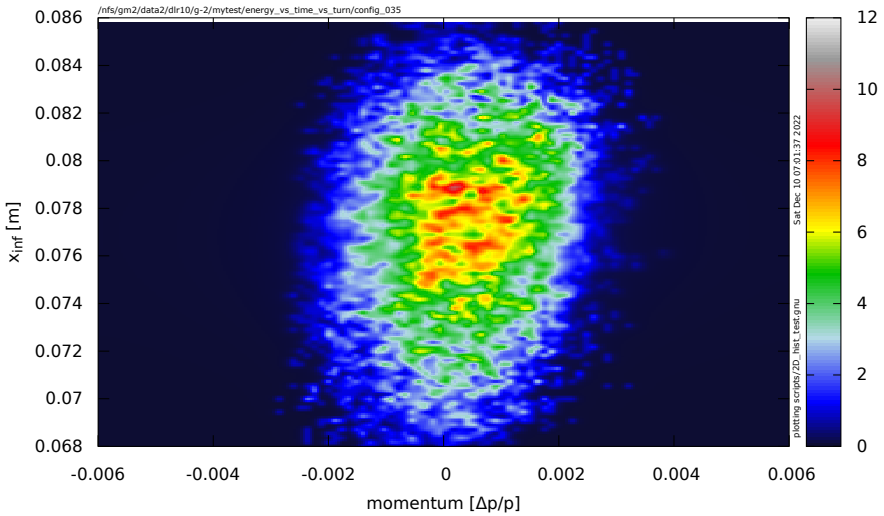


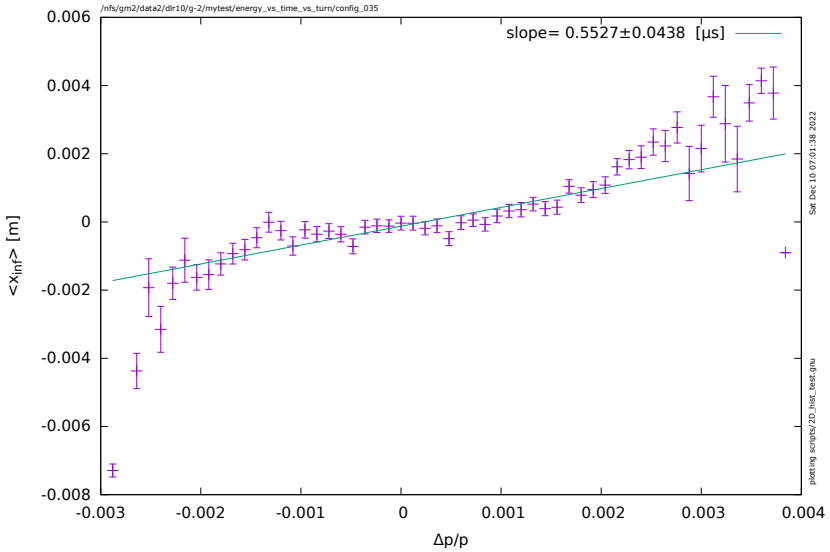


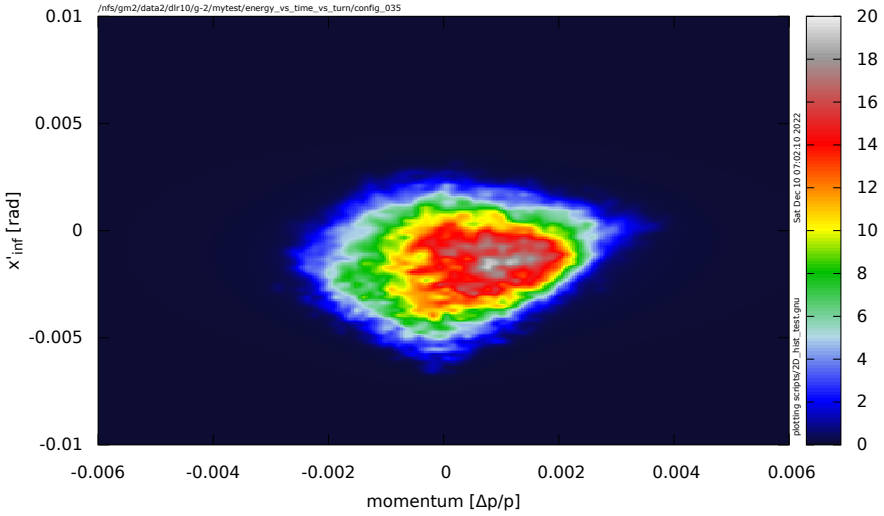


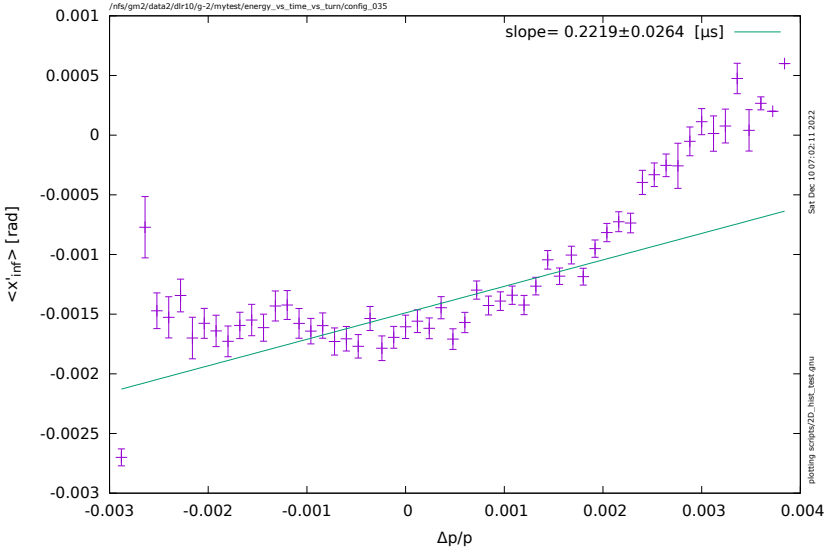


Shift kicker time 30ns earlier



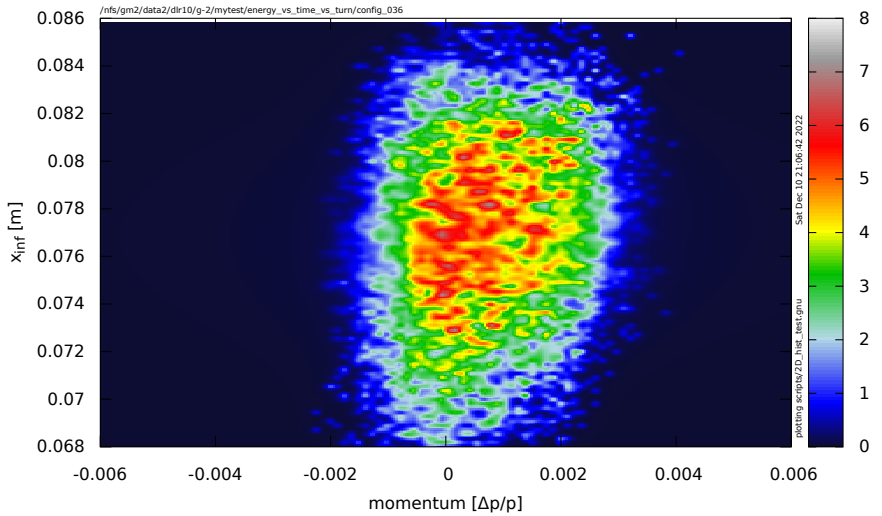


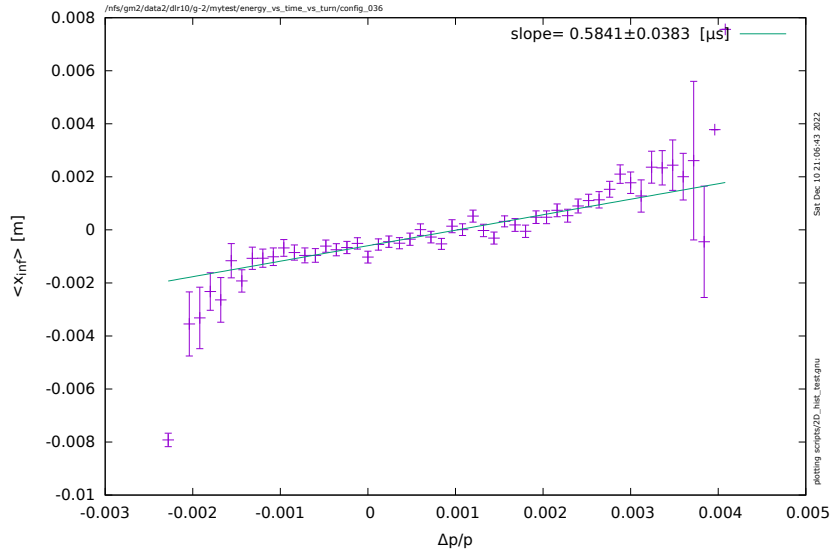


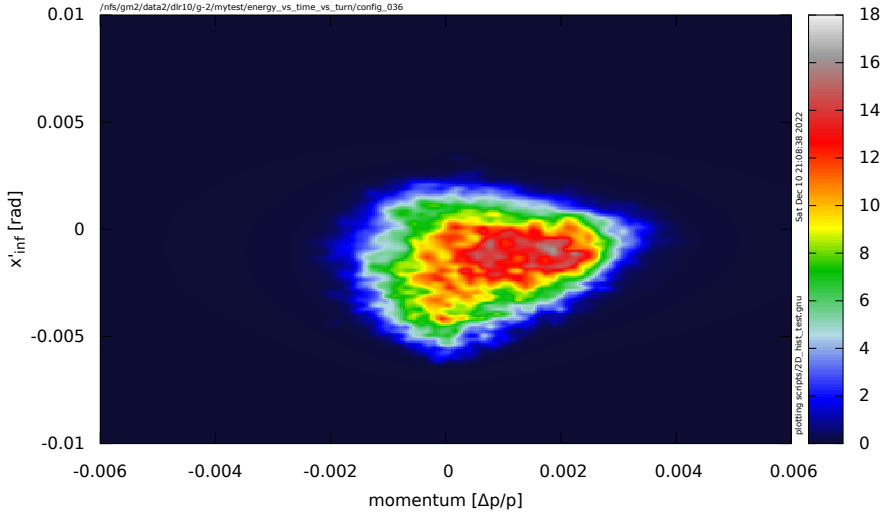


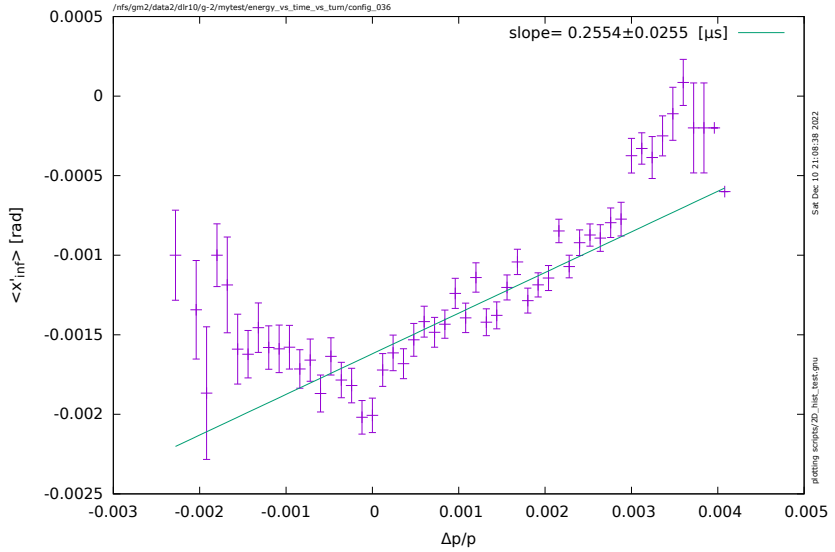
config_035

Kick start time 30ns earlier and B_{kick} = 224 G (vs 264 G)



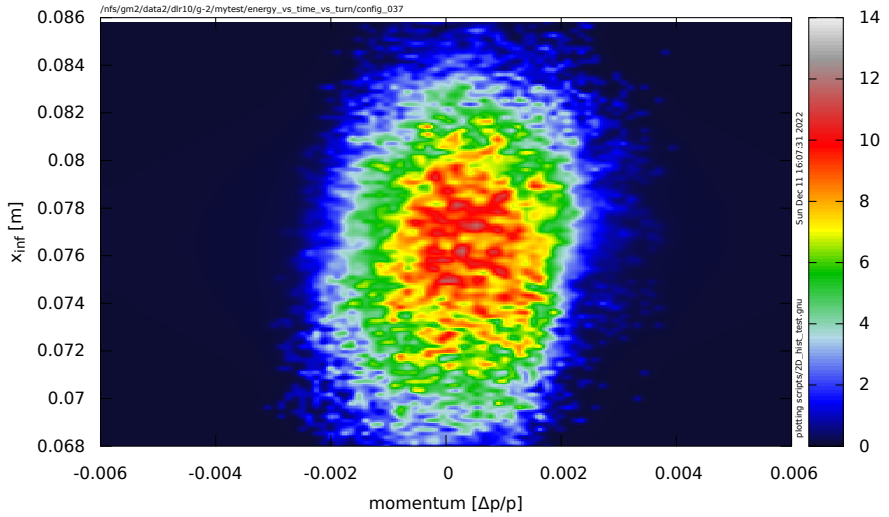


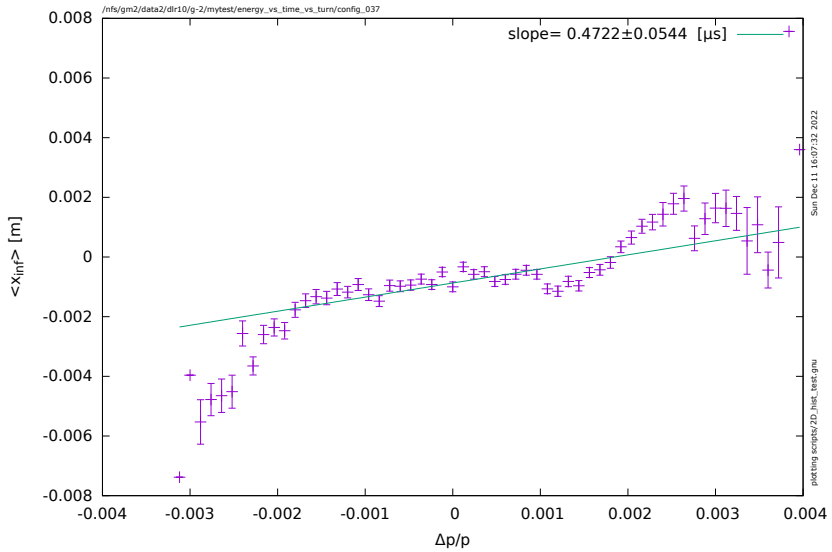


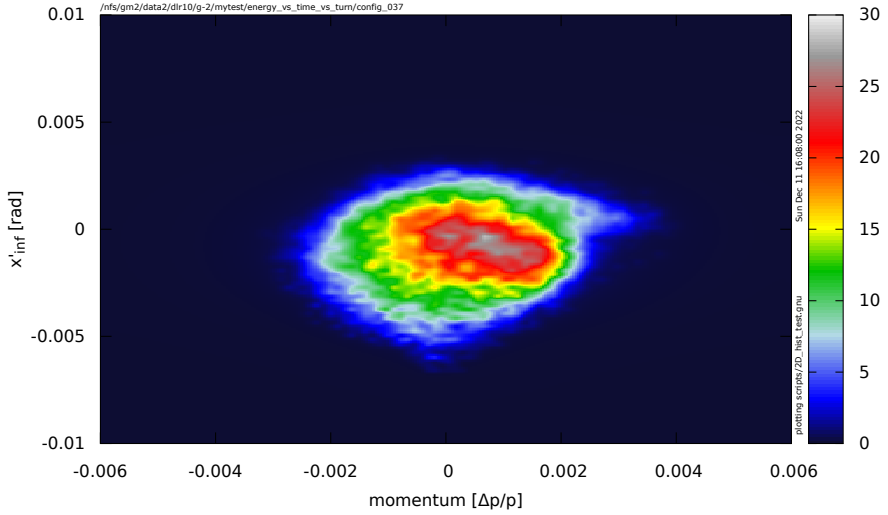


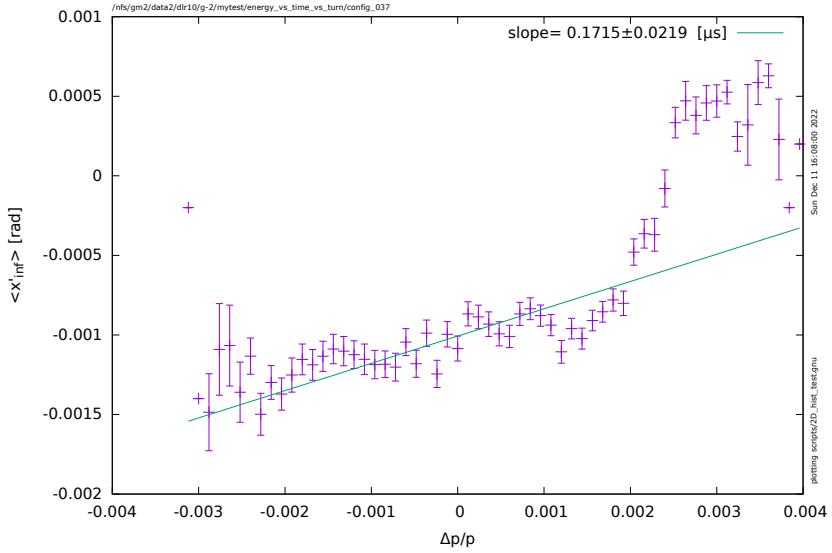
config_36

Increase inflector 1% (start time =210ns, B_{kick} =264G

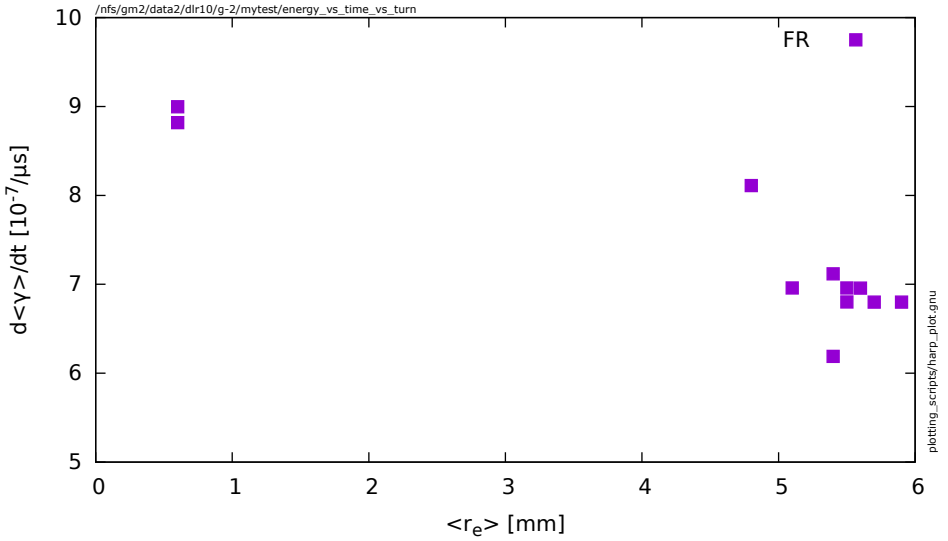








config_37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FR
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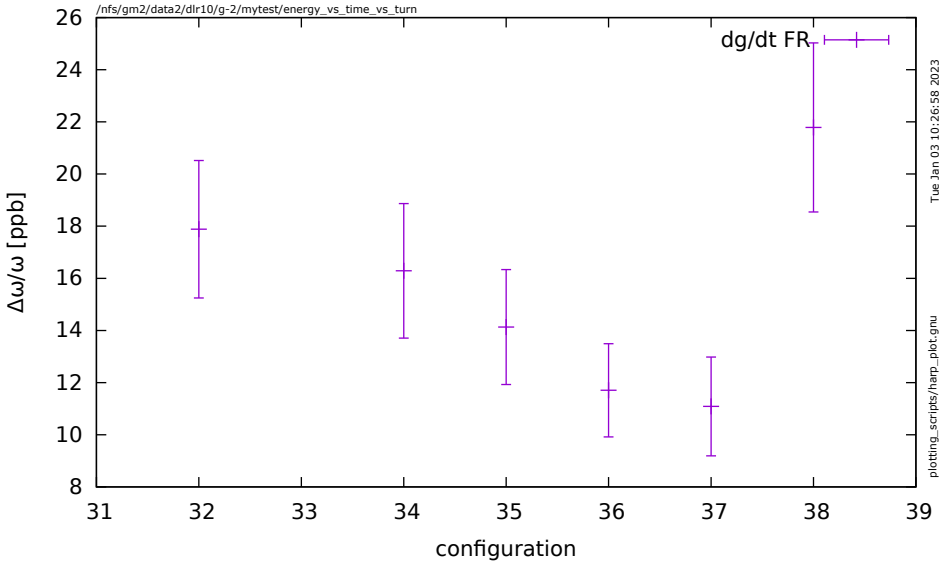
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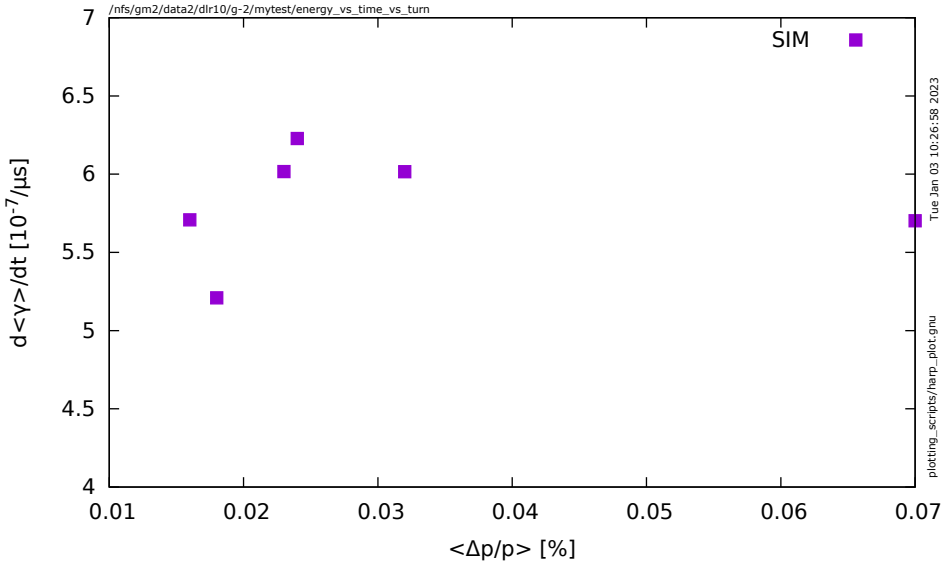
dg/dt FR
Δω/ω [ppb]
configuration
Tue Jan 03 10:26:58 2023
plotting_scripts/harp_plot.gnu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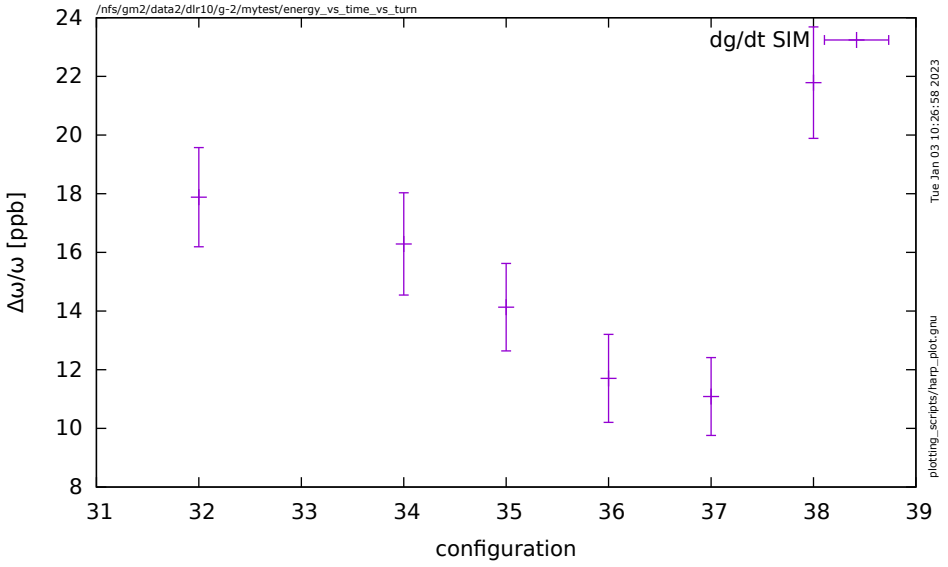
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