Spin Tune Shift Update

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Average energy & updated colormap

Average energy estimation

Only in perfectly aligned flat lattice

Instantaneous spin precession frequency

$$\Omega = \Omega_0(1 + a\gamma) \qquad \Omega_0 = eB_\perp/\gamma mc$$

Average spin precession frequency over one revolution

$$\langle\Omega\rangle = \Omega_0(1 + a\langle\gamma\rangle)$$

Closed orbit spin tune

$$\nu_0 = \frac{\langle\Omega\rangle}{\Omega_0} - 1 = a\langle\gamma\rangle$$

Average energy estimation

In real machine measurement

spin tune ν' measured by RDP = amplitude dependent spin tune (ADST)+δ_1

= closed orbit spin tune ν_0 + δ_2

= a<γ> + δ_3

Tao (Bmad)

what we want to measure

$$\nu' = a\langle\gamma\rangle + \Delta\nu$$

incorporates the contribution from systematic error

Average energy estimation

$$\nu_0 = \frac{\langle\Omega\rangle}{\Omega_0} - 1 = a\langle\gamma\rangle$$

Only in perfectly aligned flat lattice

$$a\langle\gamma\rangle = a\langle E_{ave}\rangle/m \approx \frac{a}{2\pi m}\int E(\theta)\mathrm{d}\theta$$

assume that dθ only happens in bending dipoles

Test:

E_{ref}=45.6GeV

E deduced from ν_0 = 45599.99309262228 MeV

estimated E_{ave} = 45599.9927957908 MeV less than 0.3keV difference

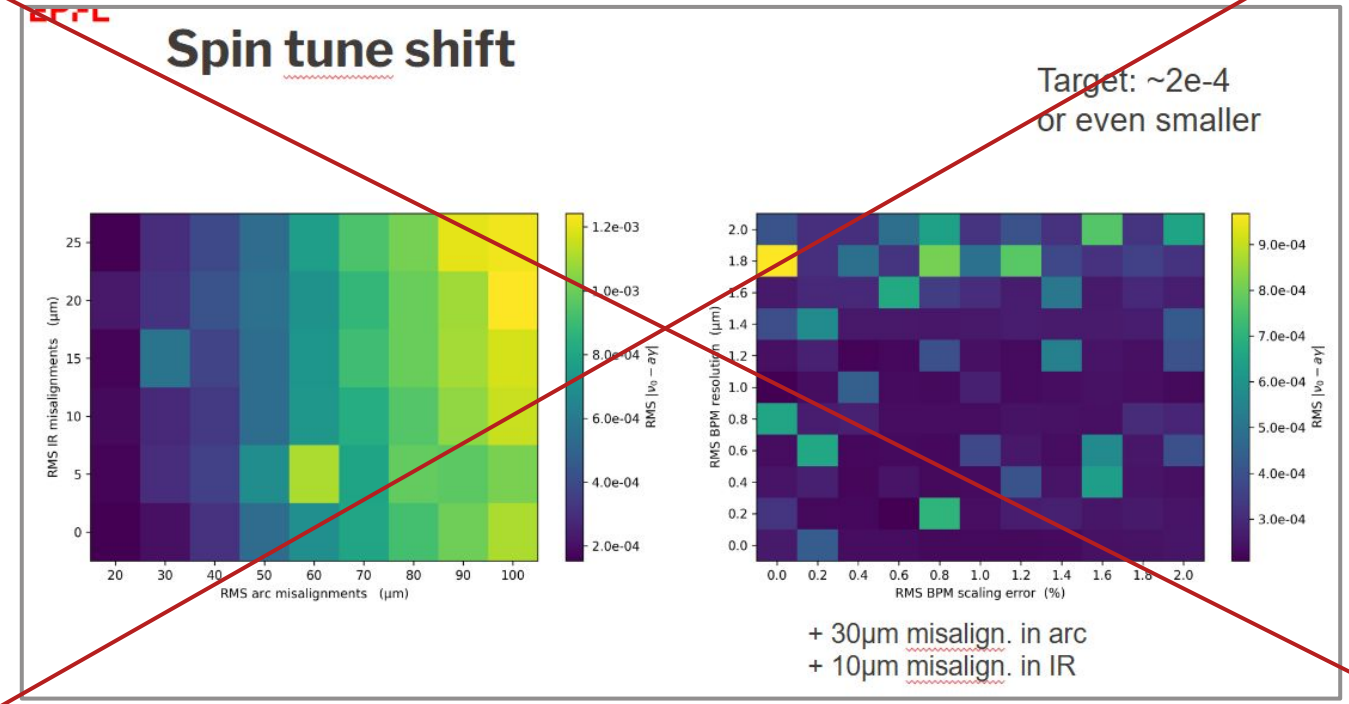
E_{ref}=43.85GeV

E deduced from ν_0 = 43849.994150256825 MeV

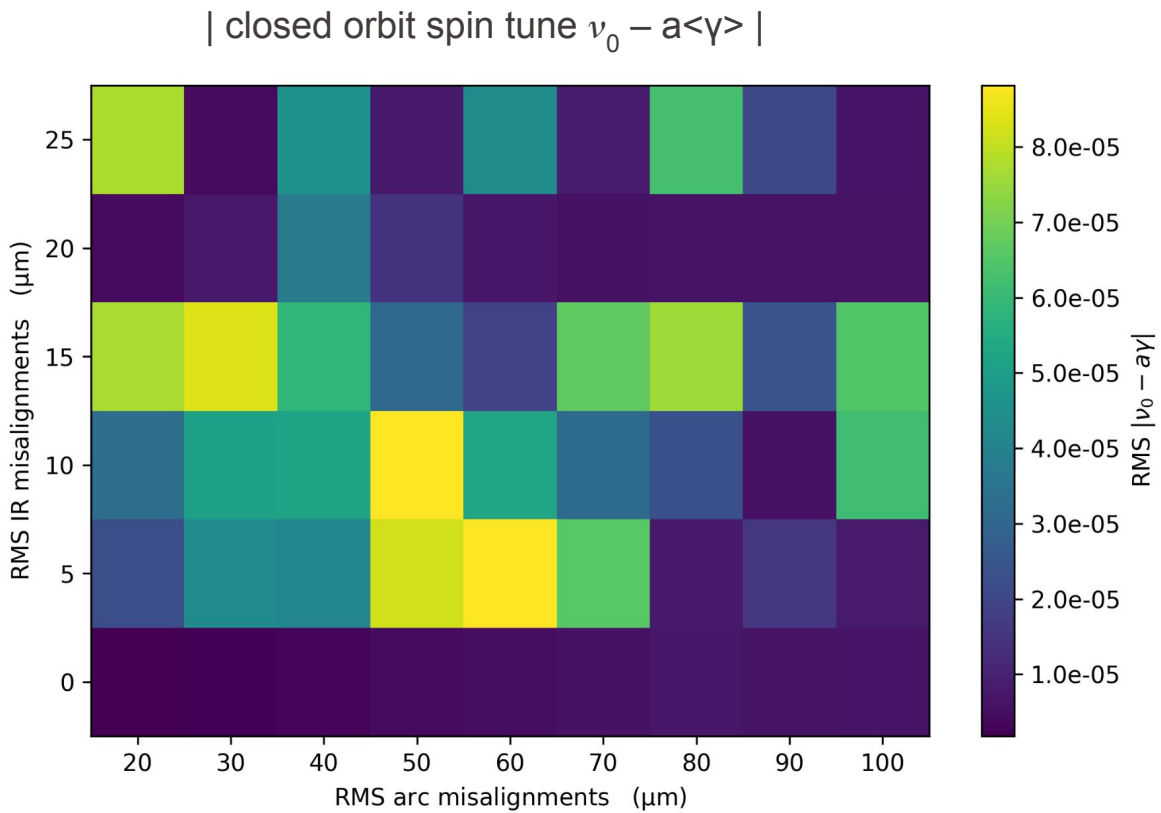
estimated E_{ave} = 43849.99385825588 MeV less than 0.3keV difference

Updated colormap

Old plot!



Updated colormap



- adding additional complex factors could easily push it beyond the precision target

Off Z pole scan

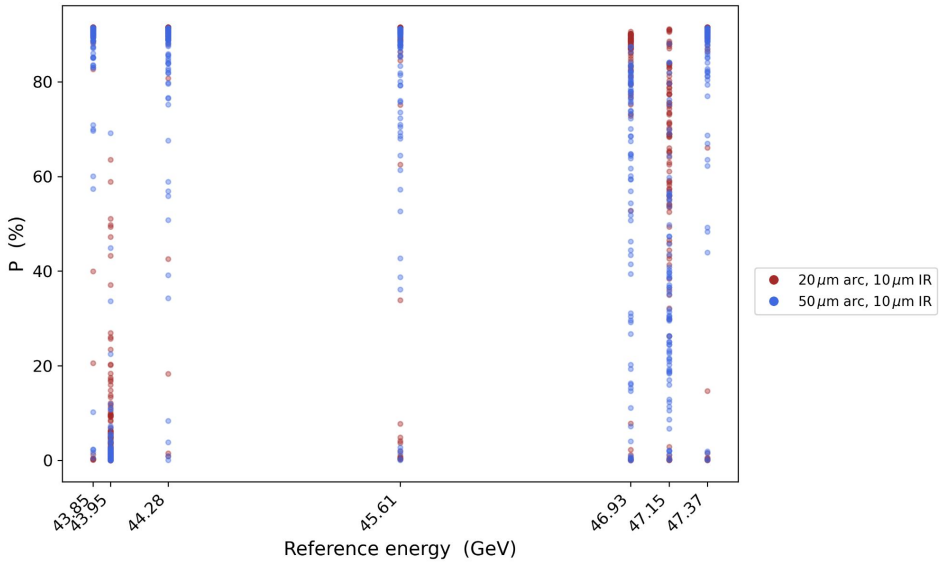
Off Z pole scan

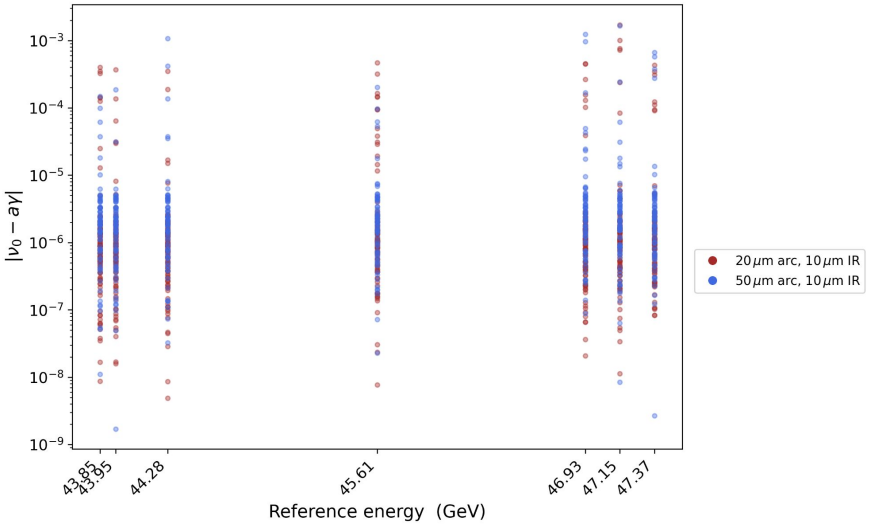
Scan point	$\sqrt{s}$ (GeV)	E_{b} (GeV)	Spin tune
$\sqrt{s_-}$ A	87.69	43.85	99.5
$\sqrt{s_-}$ Request	87.9	43.95	99.7
$\sqrt{s_-}$ B	88.57	44.28	100.5
$\sqrt{s_0}$	91.21	45.61	103.5
$\sqrt{s_+}$ A	93.86	46.93	106.5
$\sqrt{s_+}$ Request	94.3	47.15	107.0
$\sqrt{s_+}$ B	94.74	47.37	107.5

Centre-of-mass energies for the proposed Z scan. The points noted A and B are half integer spin tune points with energies closest to the requested energies.

Off Z pole scan

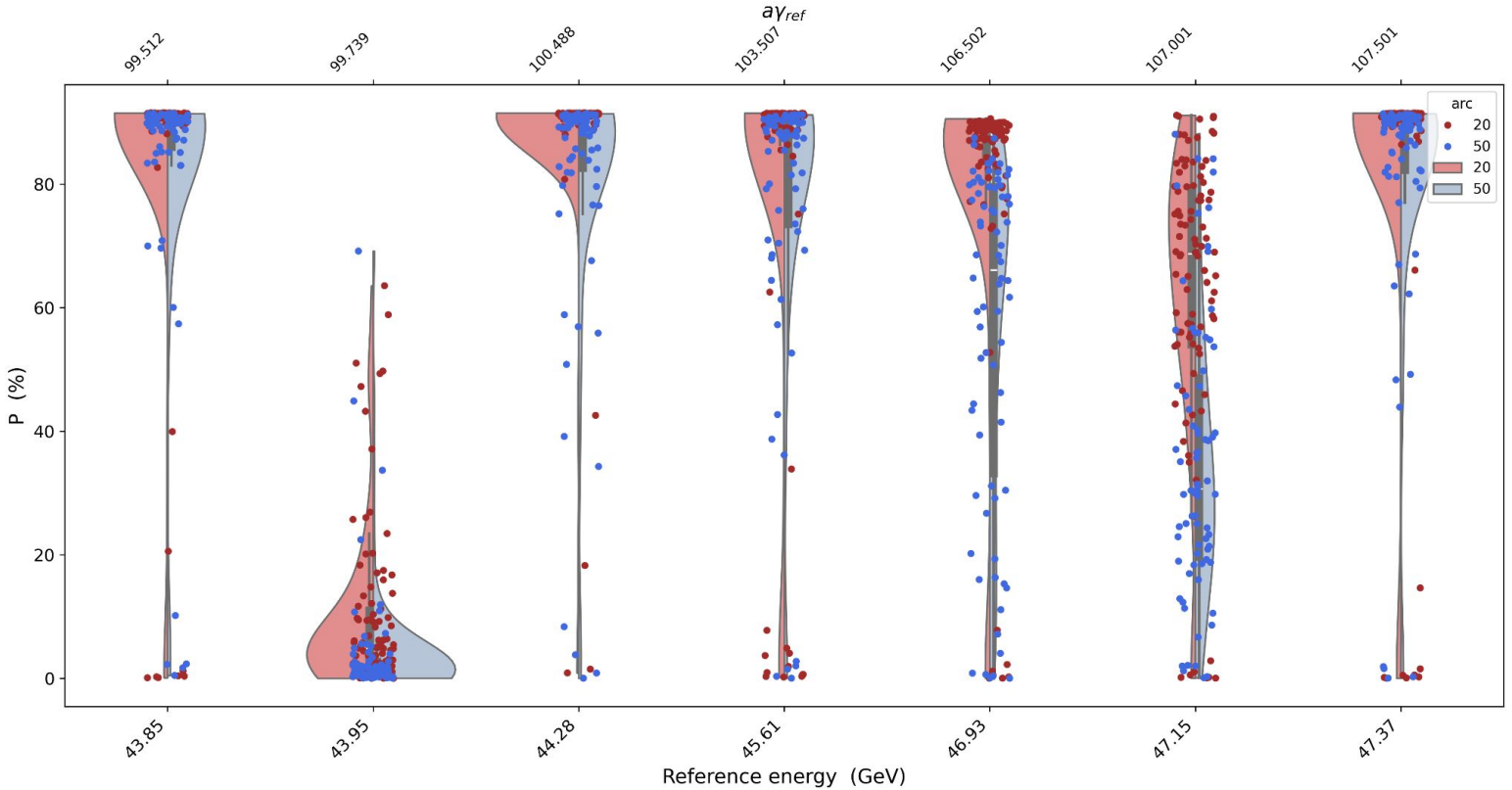
20/50μm in arc, 10μm in IR, the same 100 initial seeds





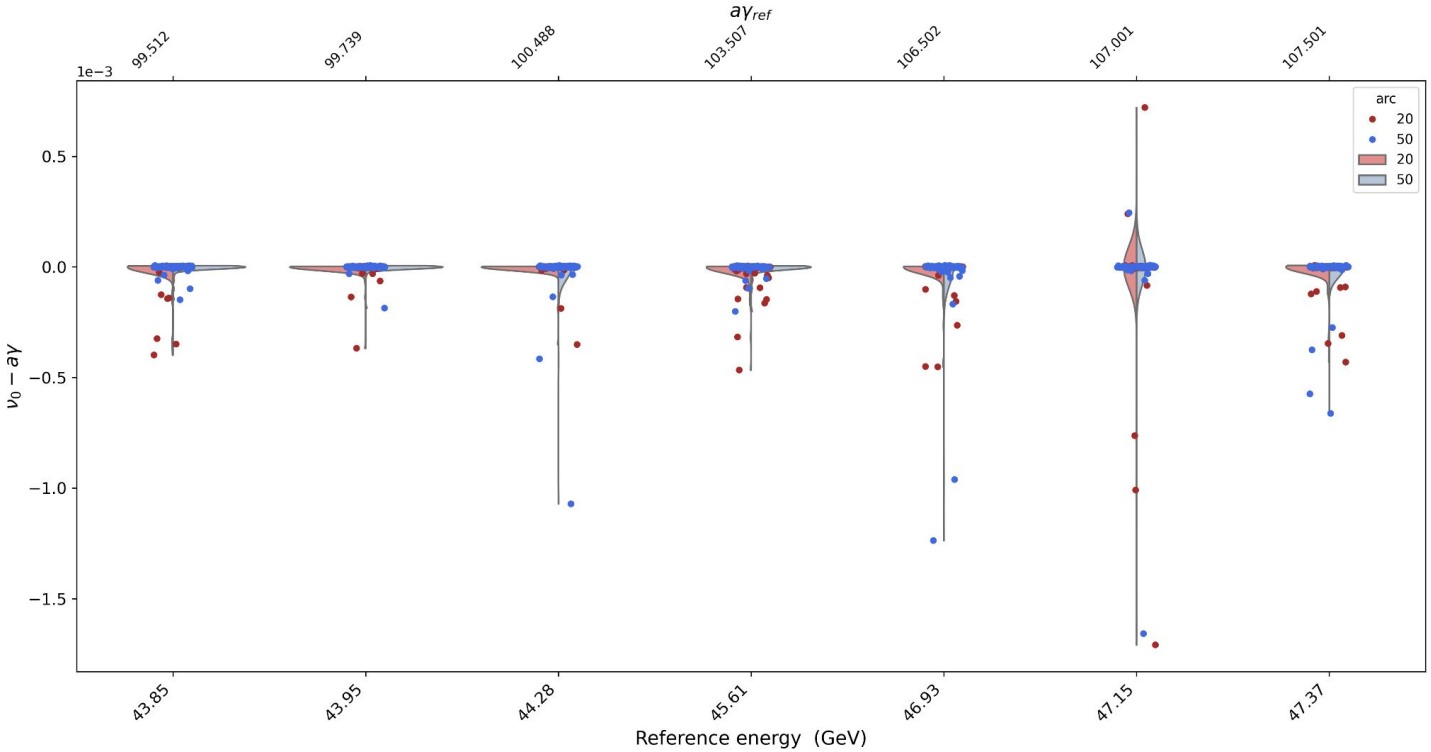
Off Z pole scan

20/50μm in arc
10μm in IR



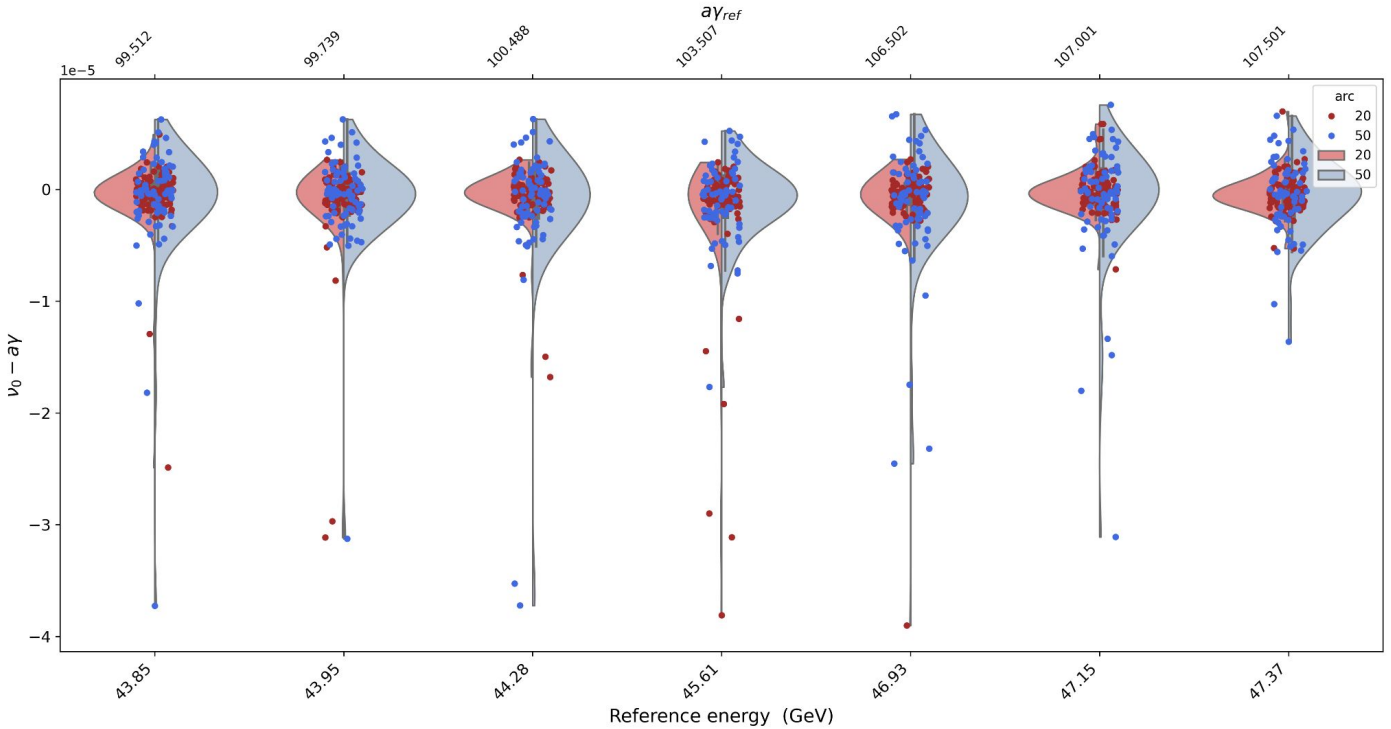
Off Z pole scan

20/50μm in arc
10μm in IR



Off Z pole scan

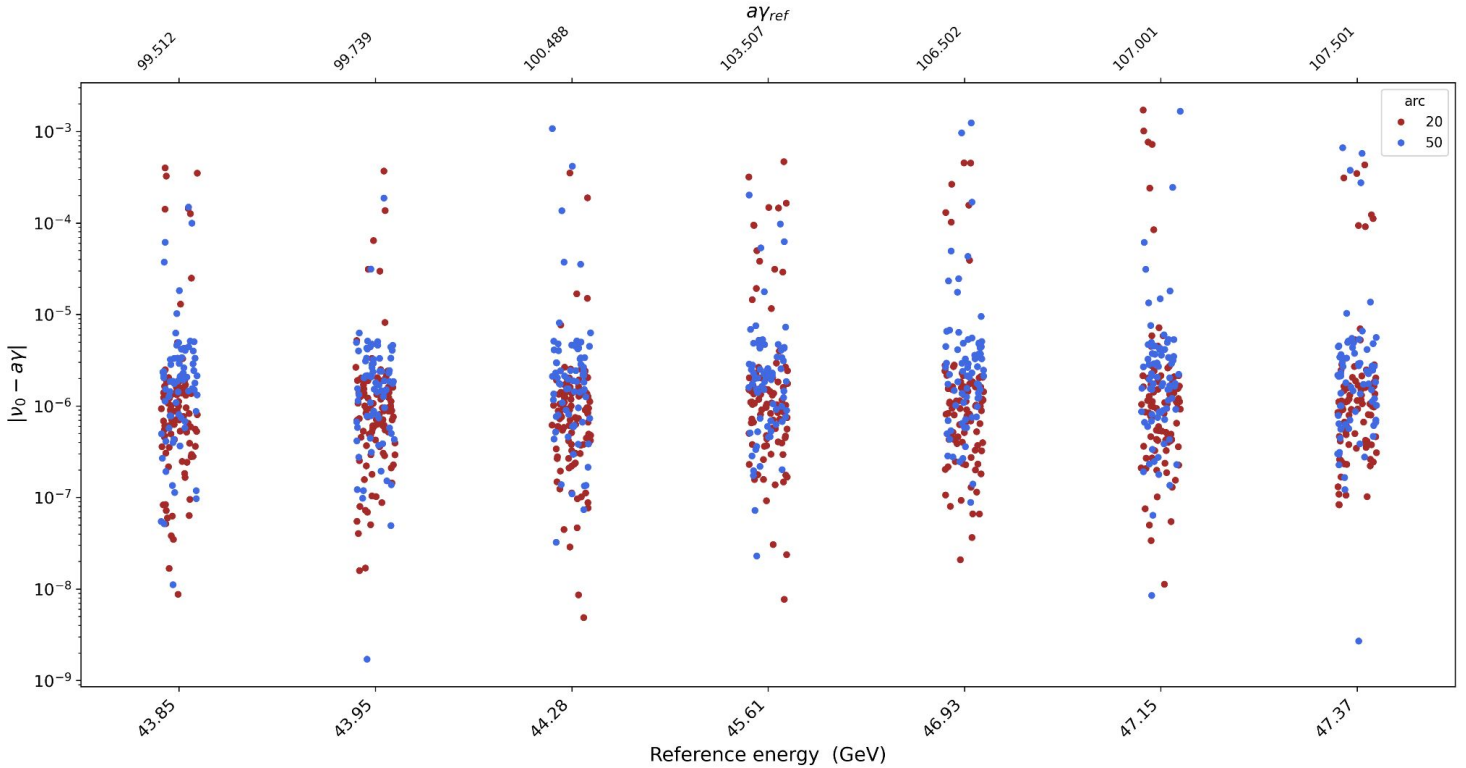
20/50μm in arc
10μm in IR



Points with abs value > 4e-5 were truncated to improve plot readability.

Off Z pole scan

20/50μm in arc
10μm in IR



Absolute value in log scale

Thank you!