Another approach using the normalized emittance

Normalized emittance should be const

$$\varepsilon_n = \gamma\,\beta\,\varepsilon = const.$$

Emittance in different coordinates

$$\varepsilon = z\frac{\Delta p}{p} = (\gamma\,\beta^2)^{-1} z\,\Delta\gamma$$

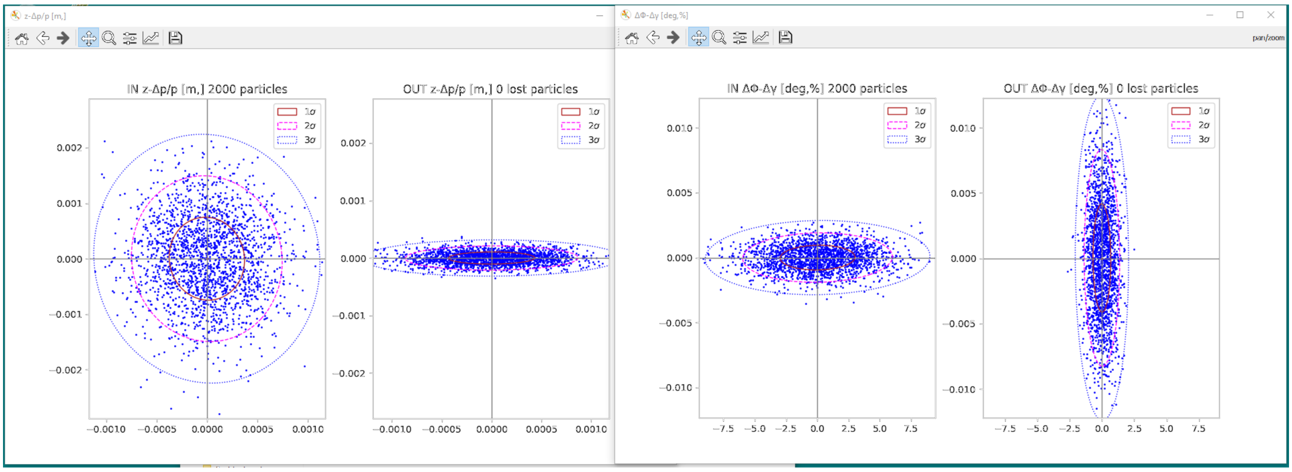
Normalized emittance then is

$$\varepsilon_n = (\gamma\,\beta)\,z\frac{\Delta p}{p} = \frac{1}{\beta} z\,\delta\gamma = \frac{1}{\beta} z\frac{\Delta T}{m_0 c^2} = const$$

Then

$$\frac{z_{[200]}}{z_{[6]}}\frac{\Delta\gamma_{[200]}}{\Delta\gamma_{[6]}} = \frac{\beta_{[200]}}{\beta_{[6]}} = 5.02$$ with $\frac{\Delta\gamma_{[200]}}{\Delta\gamma_{[6]}} \approx 4.3$ read from plot.

Therefore $\frac{z_{[200]}}{z_{[6]}} \approx \frac{5.02}{4.3} = 1.2$ should not vary much (what is confirmed on the plots).



Wolf-Dieter Klotz <wdklotz@gmail.com>

question about increase in energy spread with acceleration

Wolf-Dieter Klotz <wdklotz@gmail.com> 10 April 2023 at 23:03
To: Hunt Steve <hunt@alceli.com>

Hi Steve
I checked but for me everything is correct. You have to be careful with longitudinal units.
Explanation:
I added two plots of the same data. T energy IN = 6 MevV, T energy out = 200 MeV. The program internally works with z and delta-p/p. The plot with these two coordinates shows the reduction in impulse-spread with acceleration (physics is correct). The 2nd plot shows the same data with coordinates delta-phase and delta-gamma. Now delta-gamma is delta-T energy over rest-mass and the relation between it and relative impulse spread delta-p/p is:

$$\Delta\gamma=\frac{\Delta T}{E_0}=\frac{\Delta p}{p}(\gamma-1/\gamma)$$

Let's take numbers:

$$\frac{\Delta\gamma(200\,Mev)}{\Delta\gamma(6\,Mev)}\approx 30.5\frac{\Delta p/p(200\,Mev)}{\Delta p/p(6\,Mev)}$$

From the plots I read:

$$\frac{\Delta p/p(200\,Mev)}{\Delta p/p(6\,Mev)}\approx 0.146$$

therefore

$$\frac{\Delta\gamma(200\,Mev)}{\Delta\gamma(6\,Mev)}\approx 30.5\frac{\Delta p/p(200\,Mev)}{\Delta p/p(6\,Mev)}\approx 4.45$$

This corresponds well with the 2nd plot form which I read:

$$\frac{\Delta\gamma(200\,Mev)}{\Delta\gamma(6\,Mev)}\approx 4.3$$

Let's make another check using only the energy relation below. Input in tracker is:

$$\frac{\Delta T}{T}=\Delta\gamma*\frac{E_0}{T}=10^{-3}$$

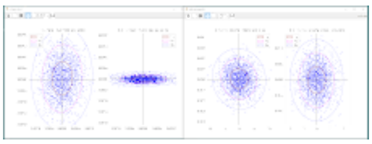
at 6 Mev. The 1-sigma from the plot at the output is approx 0.00408%. Then

$$\frac{\Delta T}{T}=0.00408*10^{-2}\frac{E_0}{T}=0.00408*10^{-2}*938/200\approx 0.19*10^{-3}$$

Again a reduction in relative energy spread at the output (approx factor 5 and same order as above)!

Conclusion: tracker shows correct data and physics!

cheers
Wolf-Dieter



Dgamma-Dp2p.png
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