GPT simulations of the three-particle dynamics

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In this note, the results of GPT simulations of the dipole mode cavity from MircoWaveStdio (provided by John Power) are presented. The purpose is to confirm that the cavity field map are properly incorporated in GPT by comparing the simulation results with Ref. [1]. Thanks to John's suggestion of flipping the signs of the magnetic fields, the results finally come to agreements and the some emittance exchange happening.

The amplitude of cavity strength is calculated this way [2]: the field map is given at

From MWstudio outpout: $f_0 = 1.29997 \times 10^9$;

$Q_0 = 18871$; changed it into $Q_0 = 18871 \times 0.85$; the factor of 0.85 is based on the estimate of achievable.

$U_0 = 1$

The power is calculated as

$\Omega = 2 \times \pi \times f_0$;

$P_0 = \Omega \times U_0/Q_0 = 0.51$ MW;

As required power is 2.5 MW [1], therefore a factor of $\sqrt{2.5/0.51} = 2.21$ is used in GPT to re-scale the field strength.

The cavity phase is chosen such that the average transverse kick to the three particles are zero; see Fig. 1. The phase can be set to either 3.02 or -0.119 rad. Changing from one phase to the other switches the direction the particles are slightly bent towards (i.e., positive or negative x offset after the cavity).

The cavity is then inserted into two doglegs.

1 Three-particle dynamics: cavity only

In Figure 4, the three particles coordinates are shown in Table 1:

Table 1: Transverse three particle beam dynamics.

x	y	z	GBx	GBy	GBz
0.001	0	0	0	0	29.98
0	0	0	0	0	29.98
-0.001	0	0	0	0	29.98

In Figure 5, the three particles coordinates are shown in Table 2:

Figure 4 is to be compared with John Power's Fig 3, emittance exchange note EX-4 [1].

Figure 5 is to be compared with John Power's Fig 4, emittance exchange note EX-4 [1].

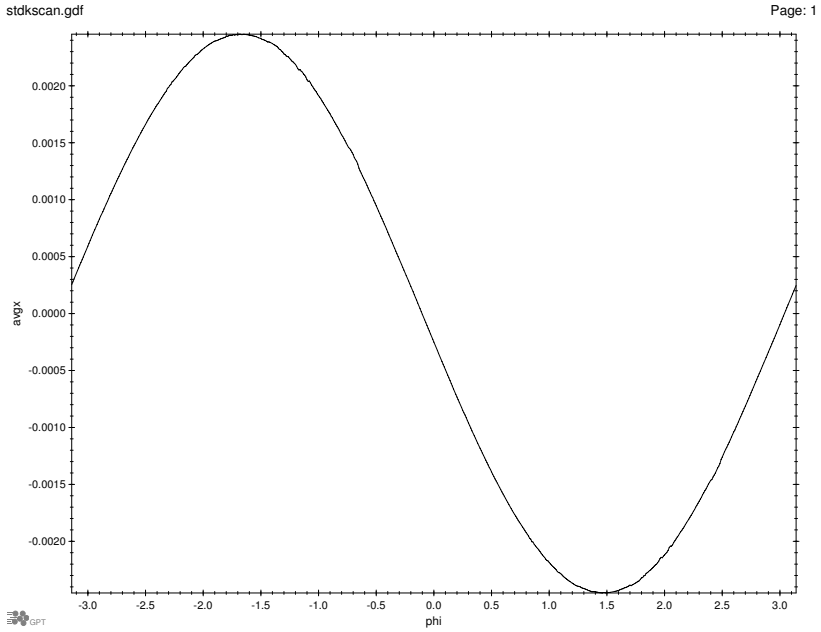

Figure 1: Phase scan of the dipole mode cavity.

Table 2: Longitudinal three particle beam dynamics.

x	y	z	GBx	GBy	GBz
0	0	0.001	0	0	29.98
0	0	0	0	0	29.98
0	0	-0.001	0	0	29.98

2 three-particle dynamics: cavity and double-dog-leg

References

[1] John Power, Emittance Exchange note EX-004, "Report on the 2 cell cavity simulations with the 1/2-full-1/2 geometry."

[2] John Power.

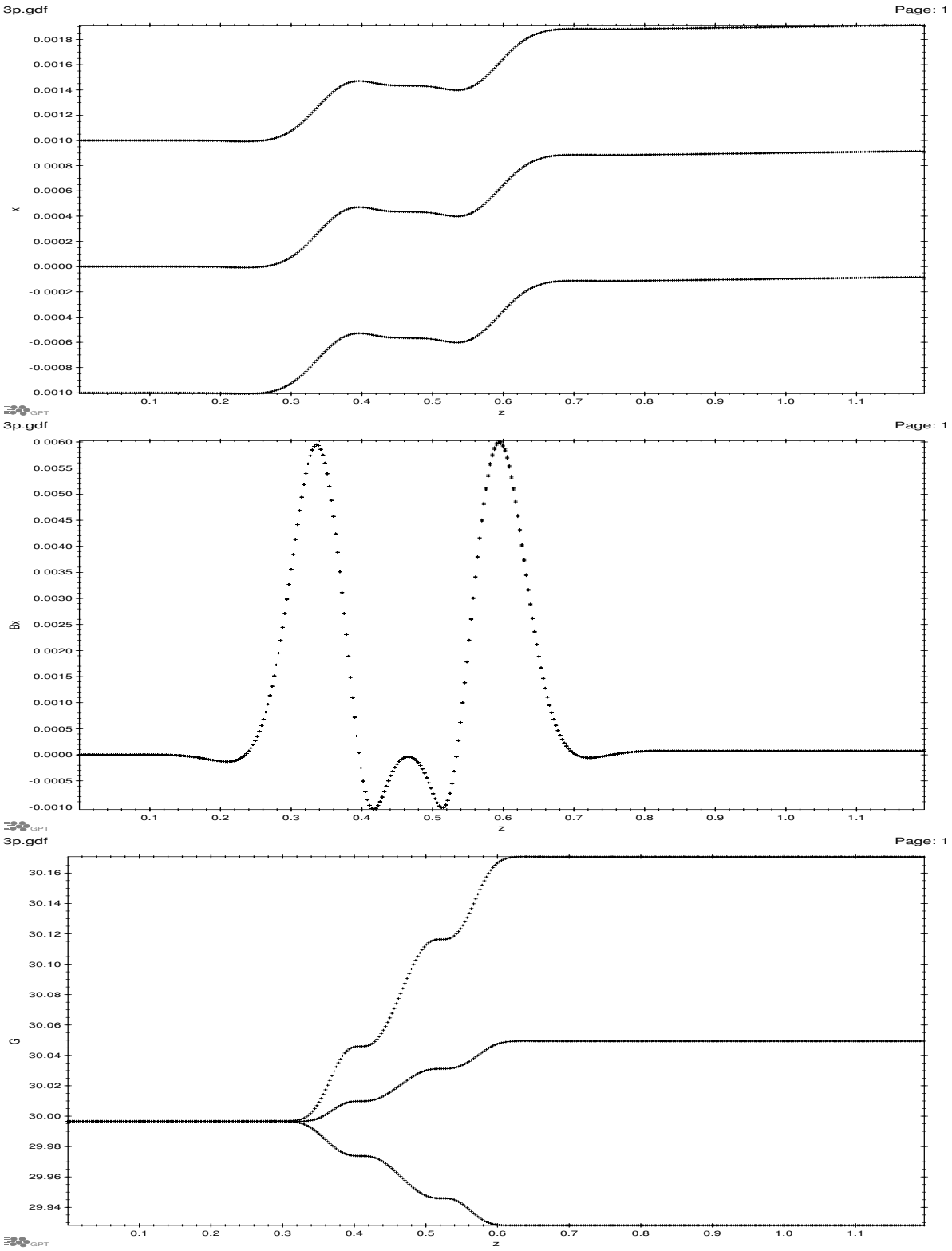

Figure 2: Cavity only: transverse three particle beam dynamics. Top: x vs z; middle: x' vs z; bottom: γ vs z.

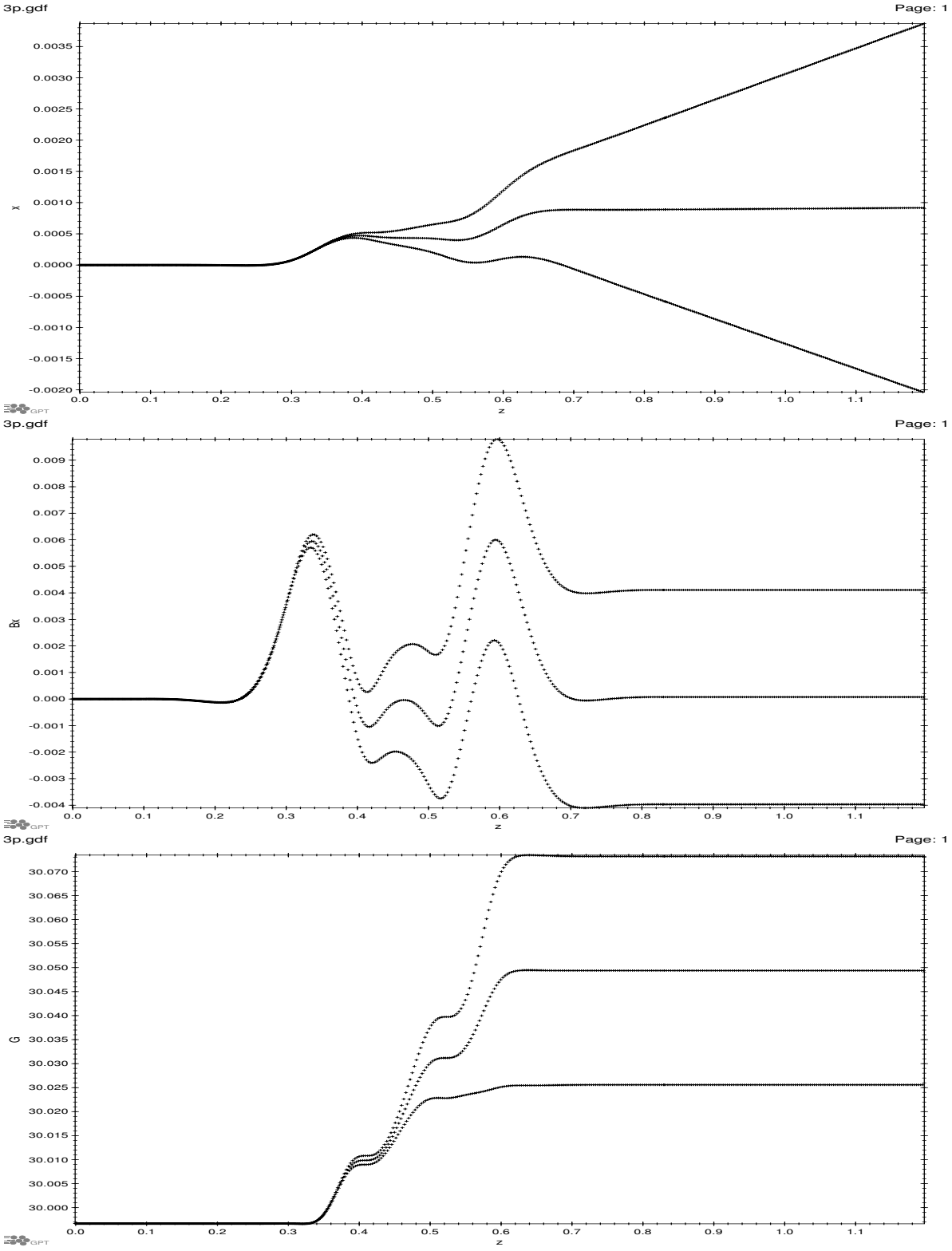

Figure 3: Cavity only: longitudinal three particle beam dynamics. Top: x vs z; middle: x' vs z; bottom: γ vs z.

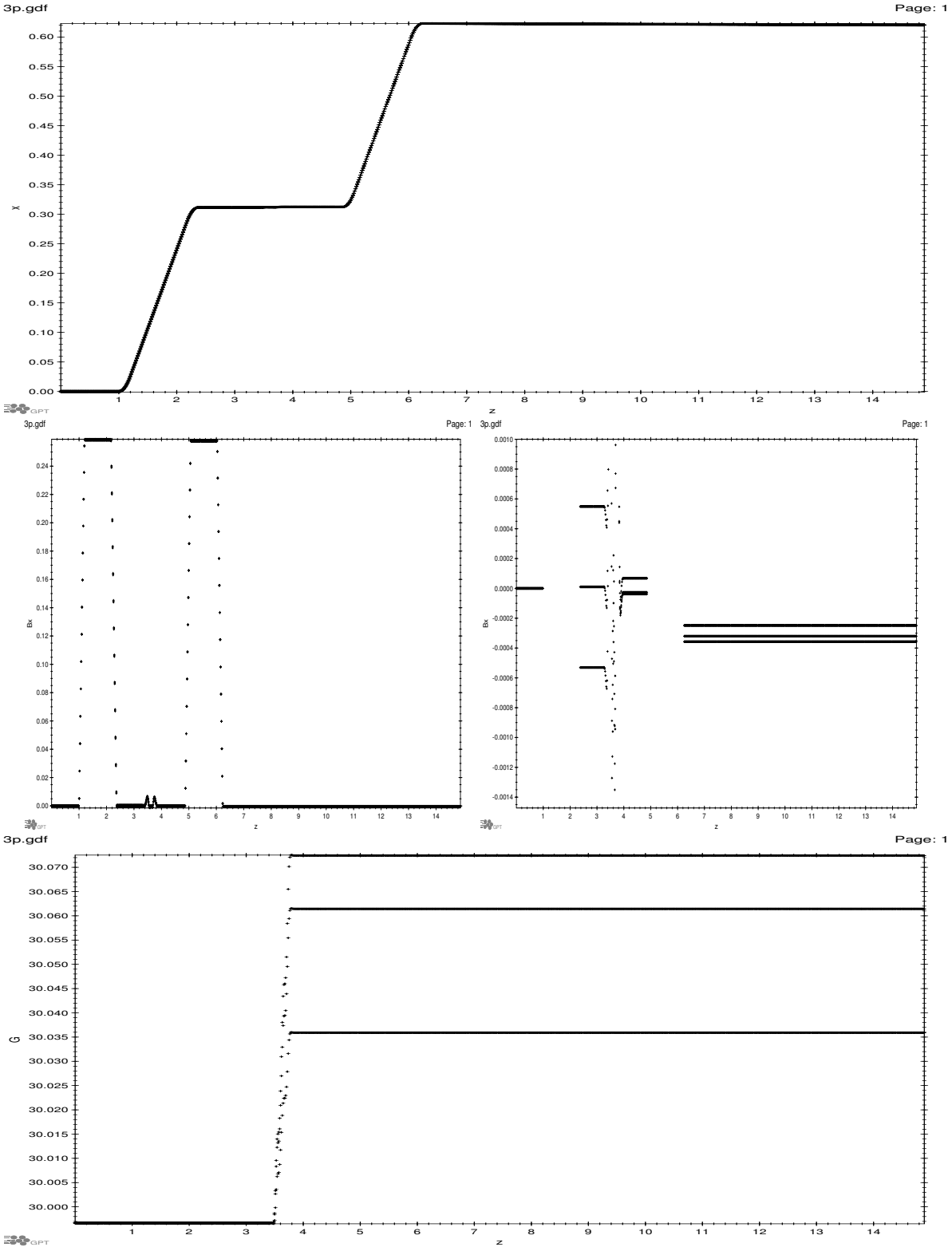

Figure 4: Cavity and double-dog-leg: transverse three particle beam dynamics. Top: x vs z; middle: x' vs z; bottom: γ vs z.

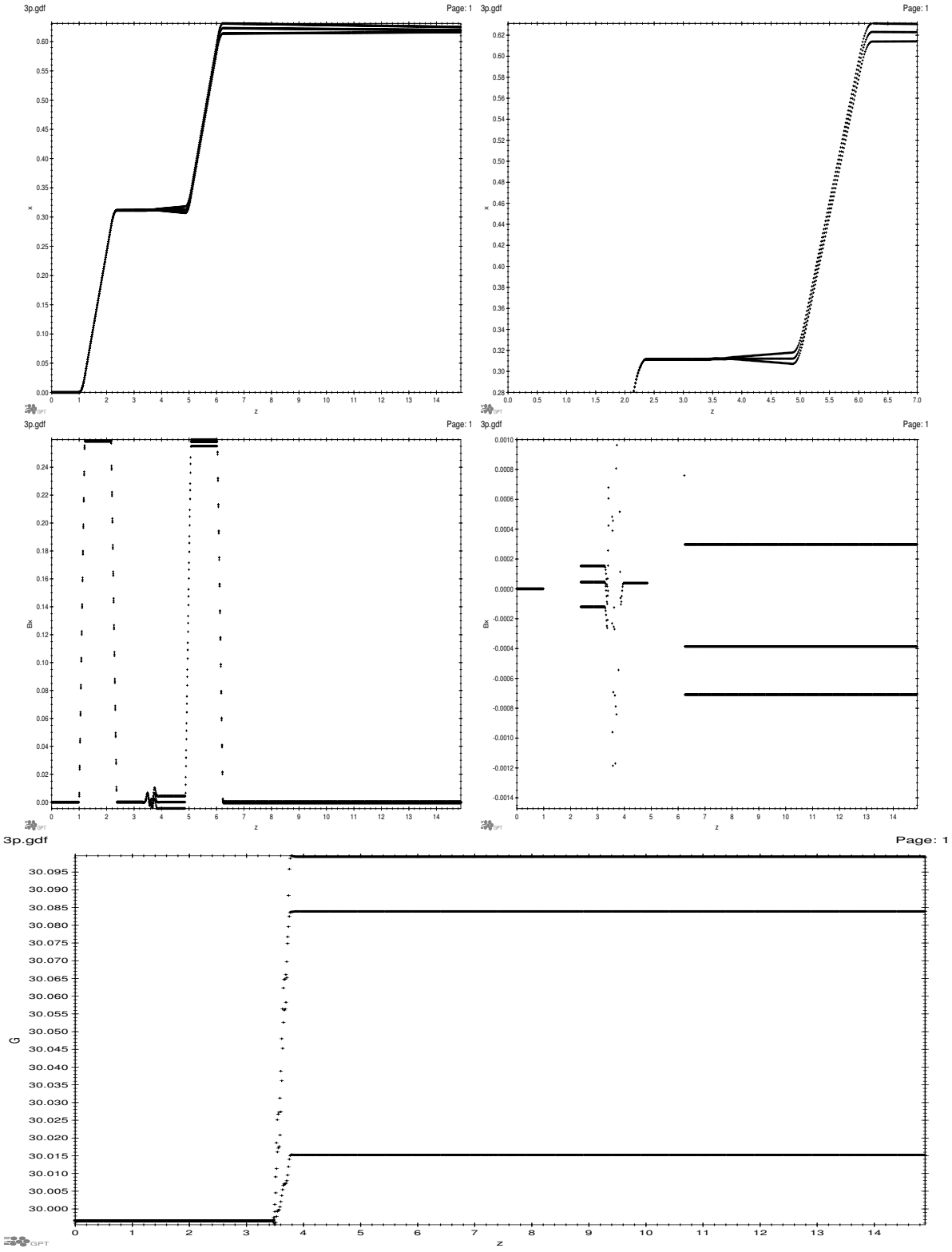

Figure 5: Cavity and double-dog-leg: longitudinal three particle beam dynamics. Top: x vs z; middle: x' vs z; bottom: γ vs z.