t-ϕ coverage simulations for Low Q^2 F_π

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Due to problems with the design of the Hall C beamline, it will not be possible for both the HMS and SHMS to access their smallest angle in the summer 2019 run. The spectrometers will be limited to $\theta_{HMS} \geq 10.92^o$, $\theta_{SHMS} \geq 5,55^o$, $\theta_{open} \geq 18.60^O$. Thus, instead of the originally proposed $Q^2 = 0.30$ GeV^2 for the low Q^2 F_π run, we will be limited to $Q^2 = 0.375$ GeV^2. To reduce the physics impact, the lab has agreed to give us three extra days, to enable additional $Q^2 = 0.425$ GeV^2 data to be taken, to improve the precision of the extrapolation of the electroproduction data to the CERN F_π data, as shown in Fig. 1.

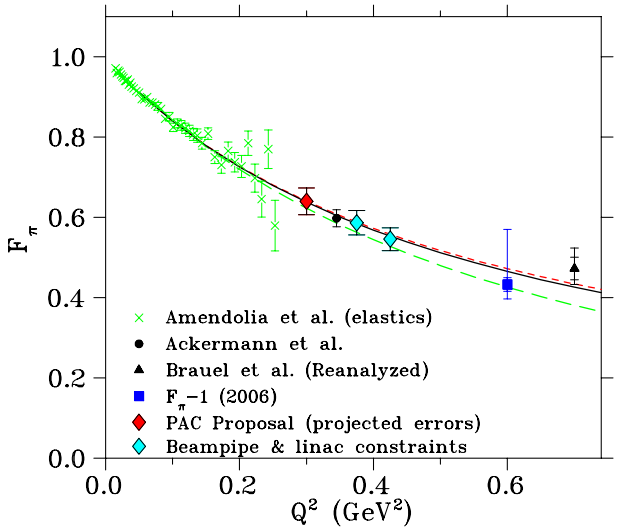

Figure 1: Projected data from this experiment at Q^2=0.375, 0.425 GeV^2, in comparison to the originally proposed point at Q^2=0.30 GeV^2, and world data.

1 Q^2=0.375 GeV^2 Simulations

SIMC simulations were run with the "Param_3000" exclusive π^+ production generator for the kinematics listed in Table 1. At each beam energy, multiple SHMS angles were run, within the allowable constraints, to investigate the experimental acceptance.

Table 1: $Q^2 = 0.375$ GeV^2, W=2.200 GeV kinematics.

E_e (MeV)	$p_{e'}$ (MeV/c)	$\theta_{e'}$ (deg)	ϵ	θ_q (deg)	q (MeV/c)
2758	448	31.97	0.286	-5.70	2300
3660	1350	15.83	0.629	-8.87	2300
4562	2252	10.96	0.781	-10.33	2300

The following nominal spectrometer acceptance cuts were applied to all data: $|hsdelta|$ <8.0%, $|hsxptar|$ <0.080 rad, $|hsyptar|$ <0.035 rad, $|ssdelta|$ <15.0%, $|ssxptar|$ <0.040 rad, $|ssyptar|$ <0.024 rad. In addition, diamond cuts were applied to equalize acceptance to that of the lowest ϵ setting, as shown in the top panels of Figs. 2, 3, 4.

Coverage over a wide range of t near $\phi = 0$ is a problem generally, due to SHMS forward angle restrictions. At high ϵ, it is suggested to acquire data at $\theta_{\pi q} = -2.69^o$ instead of -2^o. At medium ϵ, two SHMS settings at $\theta_{piq} = -2.0^o$, -3.32^o are proposed, as shown in Fig. 3. At low ϵ, a setting at $\theta_{\pi q} = +6.0^o$ was simulated and is shown in Fig. 2 for completeness, but isnot proposed.

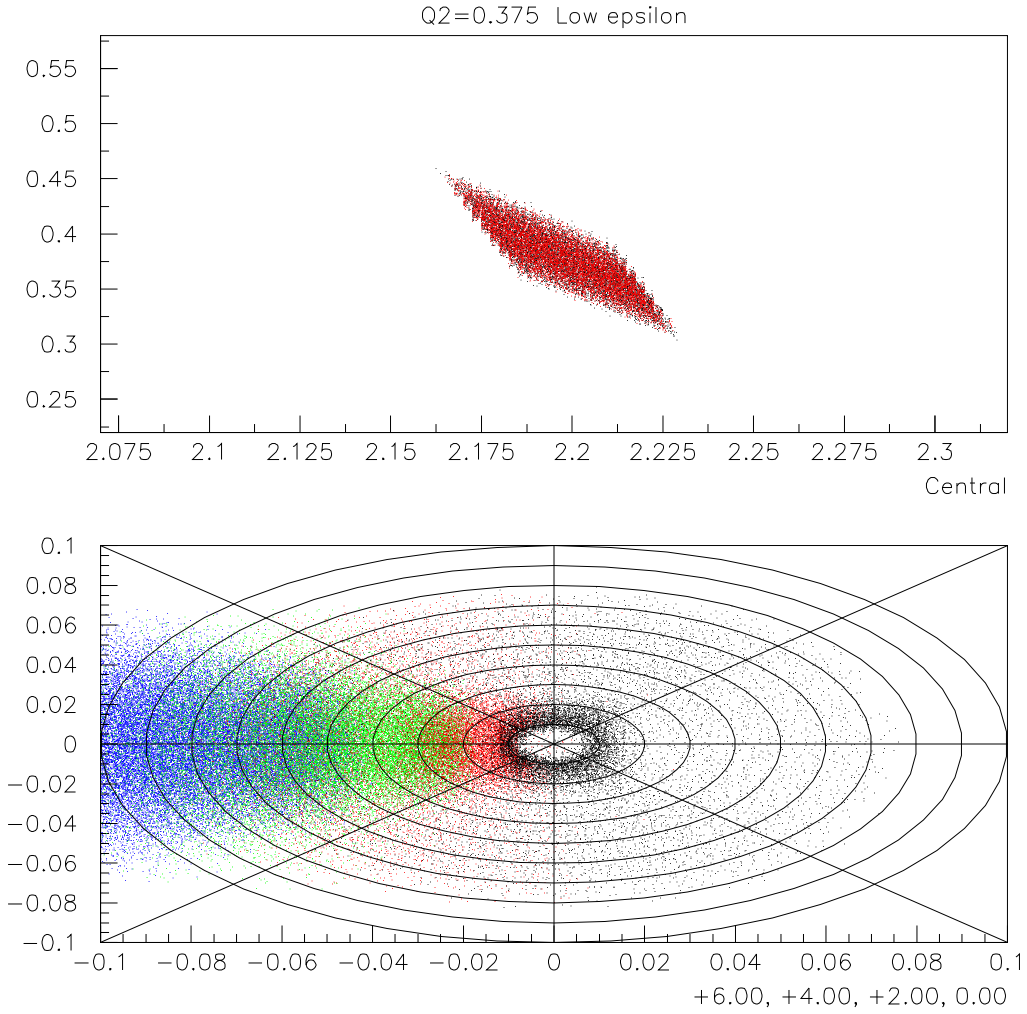

Figure 2: Simulated distributions for the 2.758 GeV beam setting. *Top:* Applied diamond cut is shown in red. *Bottom:* t-ϕ coverage for the applied diamond cut, for SHMS settings: $\theta_{SHMS} = 5.70^o$ (black), 7.70^o (red), 9.70^o (green), 11.70^o (blue). The black rings are spaced 0.01 GeV^2 in $-t$.

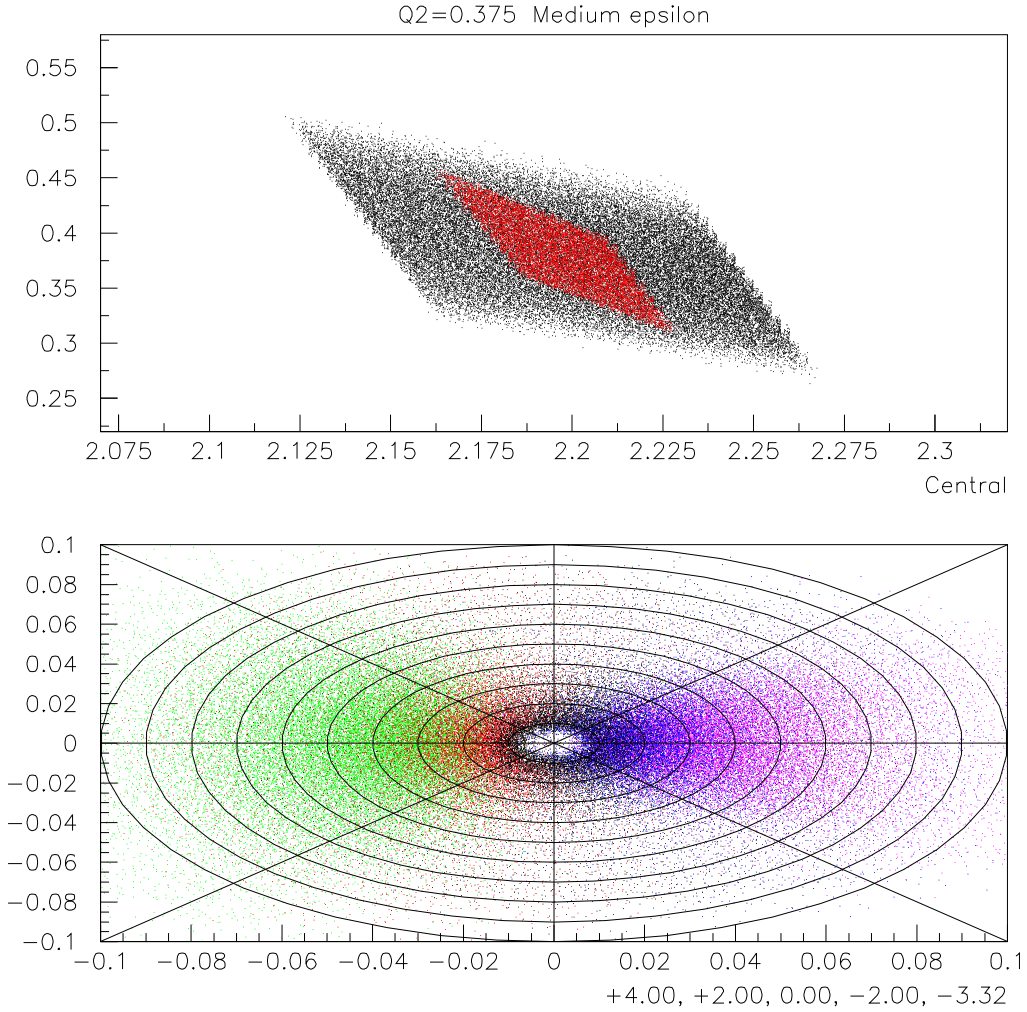

Figure 3: Simulated distributions for the 3.660 GeV beam setting. *Top:* Applied diamond cut is shown in red. *Bottom:* t-ϕ coverage for the applied diamond cut, for SHMS settings: $\theta_{SHMS} = 5.55^o$ (violet), 6.87^o (blue), 8.87^o (black), 10.87^o (red), 12.87^o (green). The black rings are spaced 0.01 GeV^2 in $-t$.

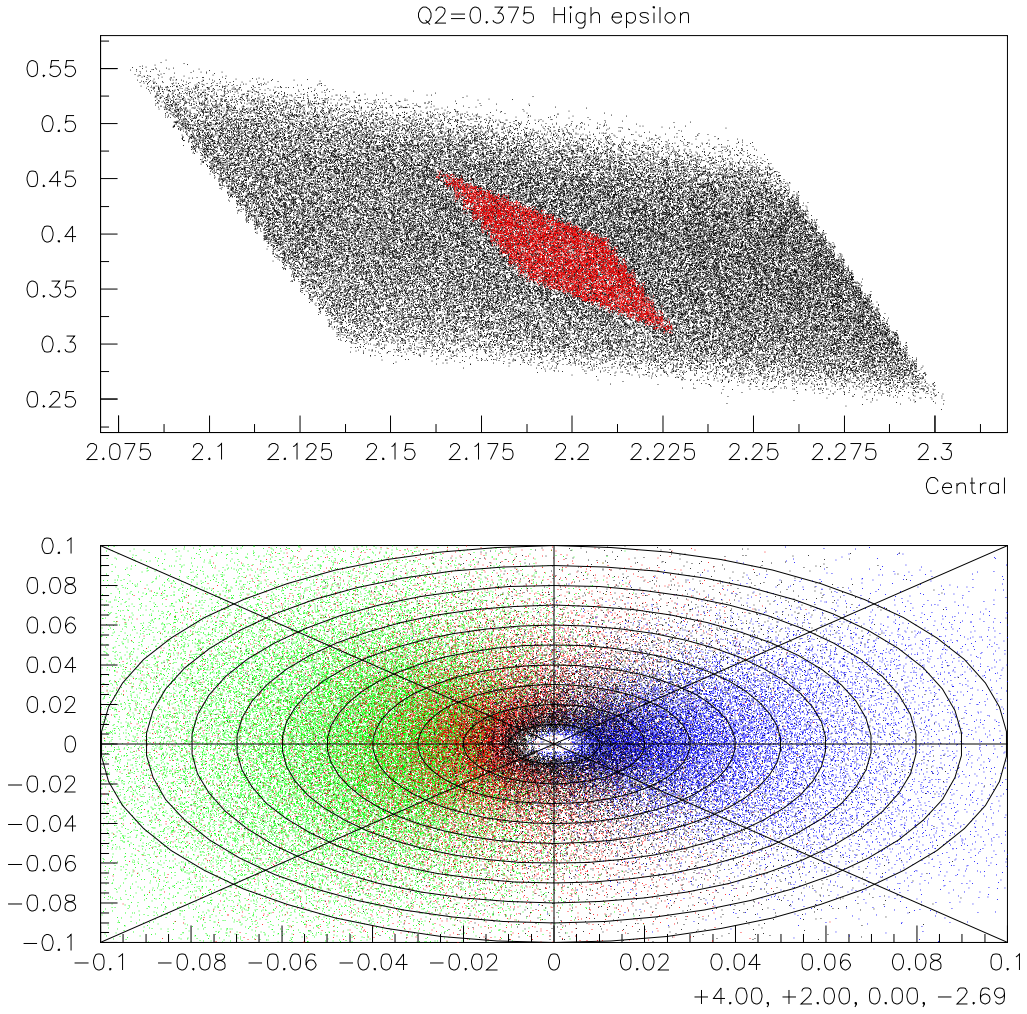

Figure 4: Simulated distributions for the 4.562 GeV beam setting. *Top:* Applied diamond cut is shown in red. *Bottom: t-ϕ* coverage for the applied diamond cut, for SHMS settings: $\theta_{SHMS} = 7.64^o$ (blue), 10.33^o (black), 12.33^o (red), 14.33^o (green). The black rings are spaced 0.01 GeV^2 in $-t$.

2 Q^2=0.425 GeV^2 Simulations

SIMC simulations were run for the kinematics listed in Table 2. The same spectrometer acceptance cuts were applied as for the Q^2 =0.375 GeV^2 simulations.

Table 2: Q^2 = 0.425 GeV^2, W=2.200 GeV kinematics.

E_e (MeV)	$p_{e'}$ (MeV/c)	$\theta_{e'}$ (deg)	ϵ	θ_q (deg)	q (MeV/c)
2758	421	35.19	0.264	-5.75	2326
3660	1323	17.03	0.617	-9.20	2326
4562	2226	11.74	0.774	-10.76	2326

The SHMS forward angle restrictions affect the settings slightly differently than at Q^2=0.375 GeV^2. At high ϵ, it is suggested to acquire data for two SHMS settings at $\theta_{piq} = -2.0^o$, -3.22^o, as shown in Fig. 7. At low ϵ, a setting at $\theta_{\pi q} = +6.0^o$ was simulated and is shown in Fig. 5 for completeness, but is not proposed.

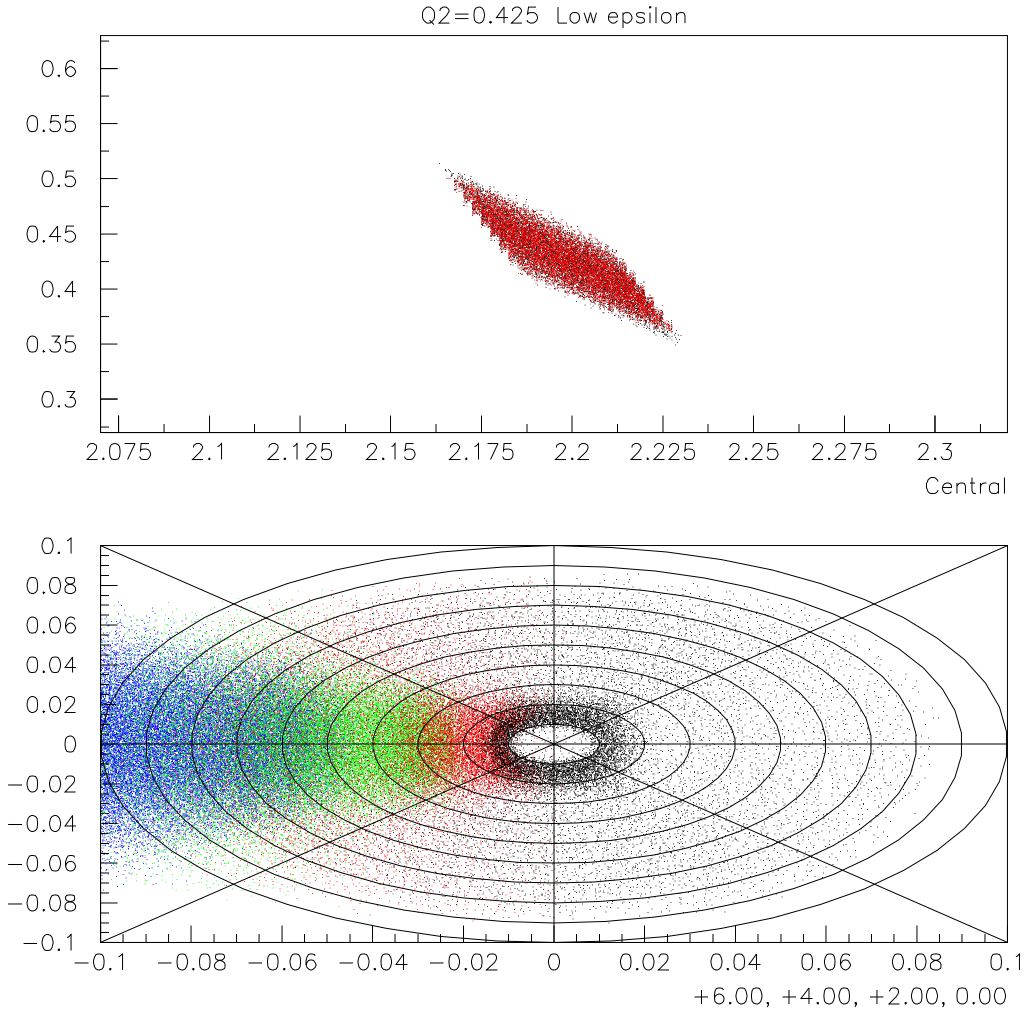

Figure 5: Simulated distributions for the 2.758 GeV beam setting. *Top:* Applied diamond cut is shown in red. *Bottom: t-ϕ* coverage for the applied diamond cut, for SHMS settings: $\theta_{SHMS} = 5.75^o$ (black), 7.75^o (red), 9.75^o (green), 11.75^o (blue). The black rings are spaced 0.01 GeV^2 in $-t$.

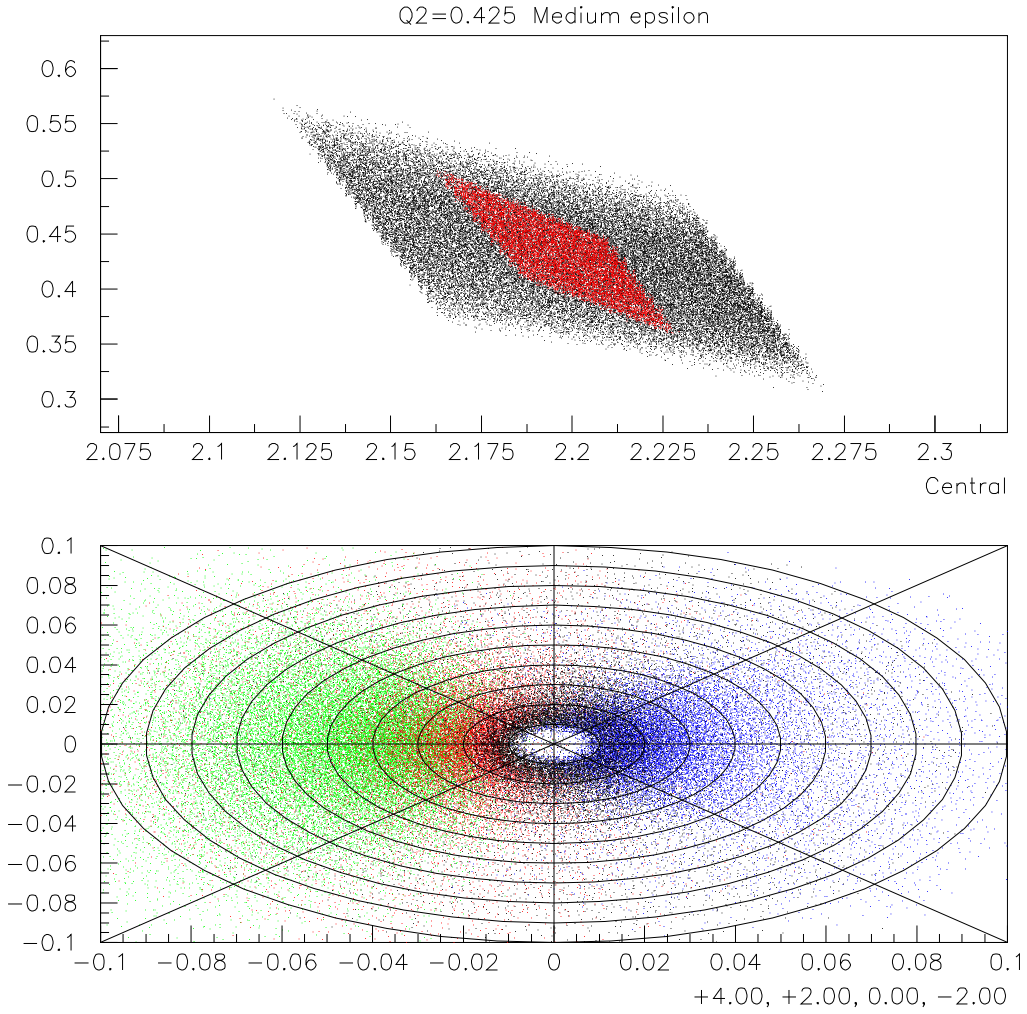

Figure 6: Simulated distributions for the 3.660 GeV beam setting. *Top:* Applied diamond cut is shown in red. *Bottom:* t-ϕ coverage for the applied diamond cut, for SHMS settings: $\theta_{SHMS} = 7.20^o$ (blue), 9.20^o (black), 11.20^o (red), 13.20^o (green). The black rings are spaced 0.01 GeV^2 in $-t$.

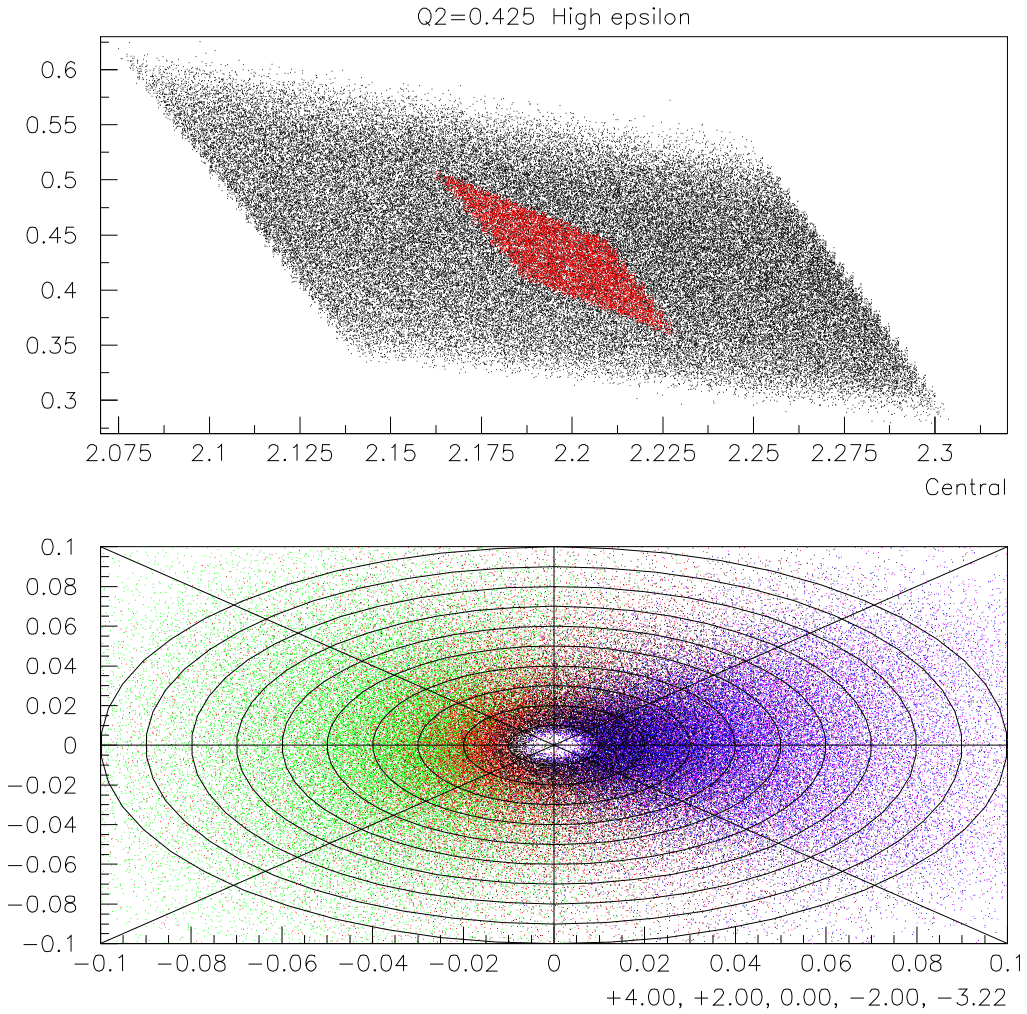

Figure 7: Simulated distributions for the 4.562 GeV beam setting. *Top:* Applied diamond cut is shown in red. *Bottom: t-ϕ* coverage for the applied diamond cut, for SHMS settings: $\theta_{SHMS} = 6.86^o$ (violet), 8.08^o (blue), 10.08^o (black), 12.08^o (red), 14.08^o (green). The black rings are spaced 0.01 GeV^2 in $-t$.