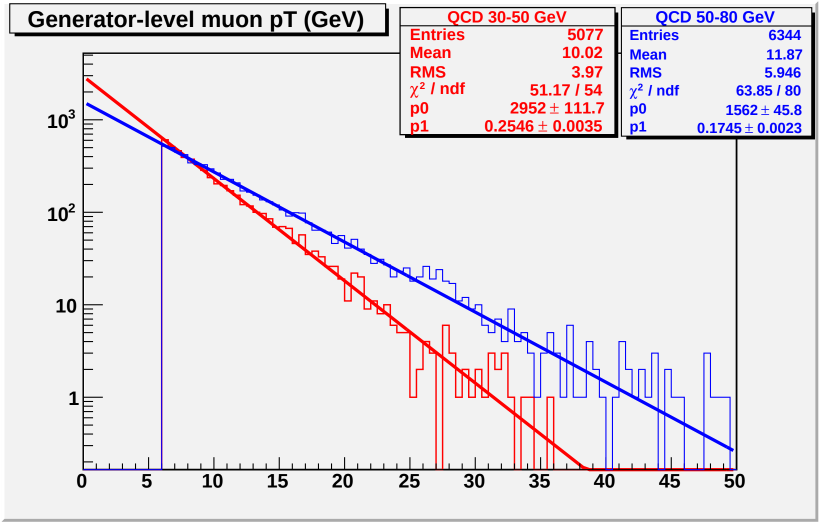
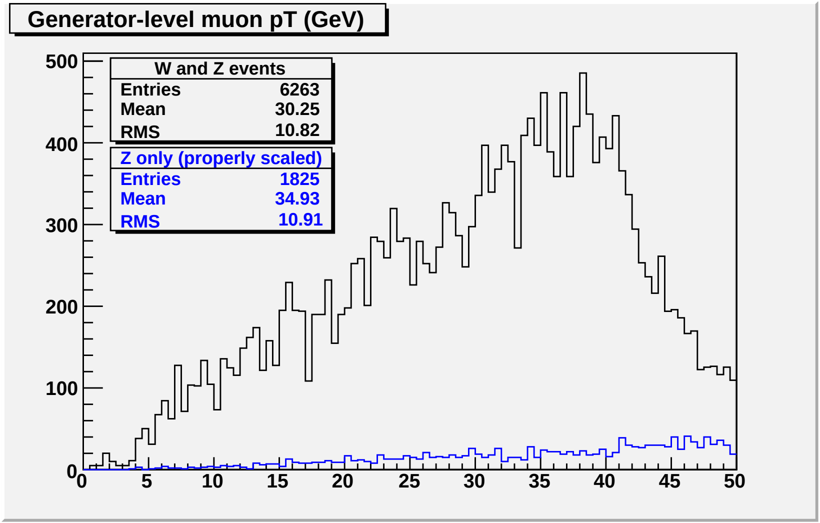
# How many QCD muons with a given $p_T$ cut?

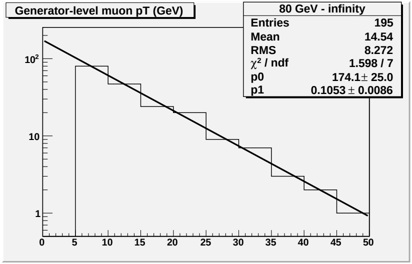


# Spectrum for "physics muons"



| Sample | cross-section | $k$ in $Ae^{-k\,pT}$ | $(A/k)e^{-k\,20\text{ GeV}}$ |
|---|---|---|---|
| QCD 0–30 GeV | 54.71 mb | 0.30/GeV? | 0.4520? |
| QCD 30–50 GeV | 0.1553 mb | 0.25/GeV | 0.0042 |
| QCD 50–80 GeV | 0.0216 mb | 0.17/GeV | 0.0042 |
| QCD 80 GeV–$\infty$ | 0.0037 mb | 0.11/GeV | 0.0037 |

30–50 GeV: 0.46% have muons
50–80 GeV: 1.1% have muons
80 GeV–$\infty$: 2% have muons




0–30 GeV: $<$ 0.01% have muons. Forget about that.

Fraction with $p_T > 20$ GeV

| | |
|---|---|
| QCD 30–50 GeV | 3% |
| QCD 50–80 GeV | 9% |
| QCD 80 GeV–$\infty$ | 21% |

$$\frac{\sigma_{\text{QCD}\mu}}{\sigma_{\text{“physics”}\,\mu}} = \frac{0.000058\text{ mb}}{7.1\text{ nb}} = 8.2$$

# Do that out more explicitly, for the record

$$\frac{\sigma_{\mathrm{QCD}\mu}}{\sigma_{\text{``physics''}\mu}} = (0.1553\text{ mb} \cdot 0.0046 \cdot 0.03 + 0.0216\text{ mb} \cdot 0.011 \cdot 0.09 + 0.0037\text{ mb} \cdot 0.02 \cdot 0.21)/(7.1\text{ nb}) = \frac{0.000058\text{ mb}}{7.1\text{ nb}} = 8.2$$

where each term in the numerator has three factors:

- cross-section of the QCD process
- fraction with $p_T > 6$ GeV muons
- $\frac{\int_{20\text{ GeV}}^{\infty} e^{-kp_T}\, dp_T}{\int_{6\text{ GeV}}^{\infty} e^{-kp_T}\, dp_T}$

- 100k "physics" muon events is 25 $\text{pb}^{-1}$ and quite enough for a good alignment (2.5 $\text{pb}^{-1}$ is barely enough).
- To get the same muons from a realistic soup with a 20 GeV cut, anticipate $(8.2 + 1)$ times as many $=$ 1 million
- 17kB per muon $\rightarrow$ 16GB? That's not very large.
- If we try to go down to a $p_T > 10$ GeV cut (redo all math), we find QCD sample is 61 $\times$ the "physics" sample $\rightarrow$ 6.1 million $\rightarrow$ 100GB... that's something.

| cut | events | disk space | alignment time/iteration |
|---|---|---|---|
| 10 GeV | 6.1 million | 100 GB | 76.3 hours |
| 15 GeV | 2.3 million | 37 GB | 28.7 hours |
| 20 GeV | 0.94 million | 16 GB | 11.8 hours |
| 25 GeV | 0.45 million | 7.3 GB | 5.6 hours |
| 30 GeV | 0.25 million | 4.0 GB | 3.1 hours |
| 35 GeV | 0.17 million | 2.8 GB | 2.1 hours |
| 40 GeV | 0.14 million | 2.3 GB | 1.8 hours |

We want realistic soups of the 15 GeV cut, 25 GeV, and 35 GeV. This will cost 50 GB. We want the following features:

- Statistically independent samples: *different* events
- Miscalibrated chambers (doesn't hurt: bring it on!)
- Realistically misaligned tracker (only ONE times the short-term scenario, or the 10 $pb^{-1}$ sample, whichever is most appropriate)
- Wheels/disks misaligned 3 mm and 1 mrad in all directions/angles
- Chambers misaligned 3 mm and 1 mrad in all directions/angles
- CSC layers misaligned 191 $\mu$m in $x$, 335 $\mu$m in $y$ and 0.04 mrad in $\phi_z$
- No DT layer/superlayer misalignment

The events can come from the "QCDmu_Pt_30_50", "QCDmu_Pt_50_80", "QCDmu_Pt_80_120", "QCDmu_Pt_120_170", "QCDmu_Pt_170_230" GEN-SIM samples.

# What will we do with them?

- Wheel/disk alignment in each of the three samples with a few thousand global muons: well under an hour.
- Global muon alignment on each sample (with deweighting). 1 iteration = 28.7 hours, 5.6 hours, 2.1 hours in parallel. Actually, break each of these samples into three parts: 90%, 9%, and 1% of the events, so you have 9 globalmuon jobs.
- Standalone muon alignment on 1/10th of the 15 GeV cut, half of the 25 GeV cut, all of the 35 GeV cut (NO deweighting). 7 iterations = 20.1 hours, 19.6 hours, 14.7 hours in parallel. Do the 90%/9%/1% thing, so you have 9 standalonemuon jobs running.
- Global muon alignment of layers with the three samples in parallel: 28.7 hours, 5.6 hours, 2.1 hours *after* the chamber alignment is done. 90%/9%/1% makes for 9 layer jobs. The clock is now at 2.5 days and we have been using 18 CPUs.
- When they are done, re-reconstruct $N$ events in each of the 27 conditions. NO APEs!!!