Background study for $p\bar{p} \rightarrow p\bar{p}$(el.)

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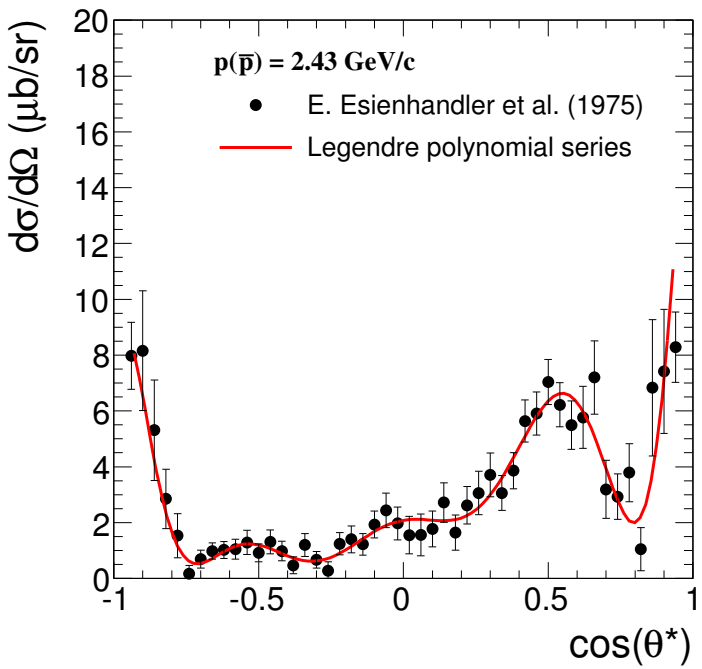
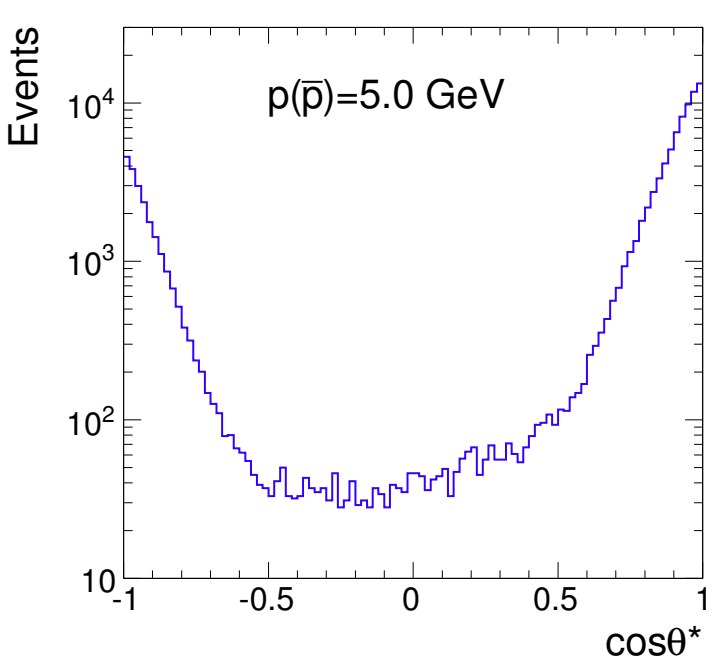
$p\bar{p} \to \pi^-\pi^+$ generator (by M.Zambrana and D.Khaneft)

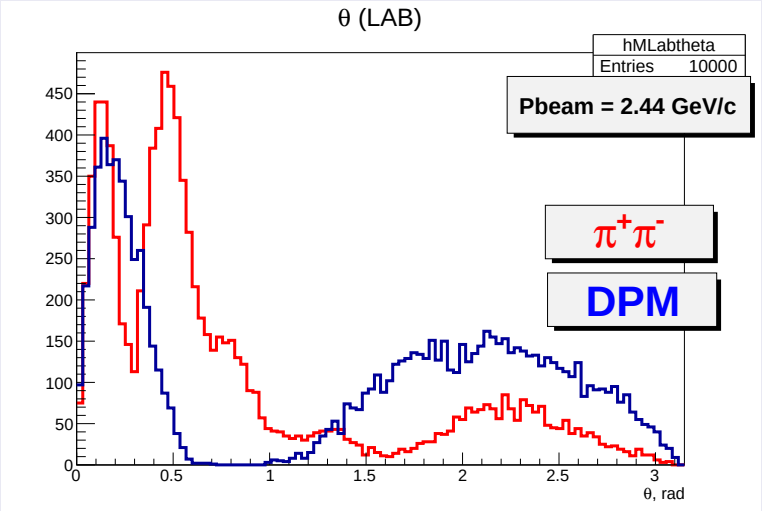
- $\bar{p}$ momentum range from 0.79 GeV to 12.0 GeV (LAB)
- Low energy regime (0.79 – 2.43 GeV) - experimental data
- High energy regime (5.0 – 12.0 GeV) - theory predictions

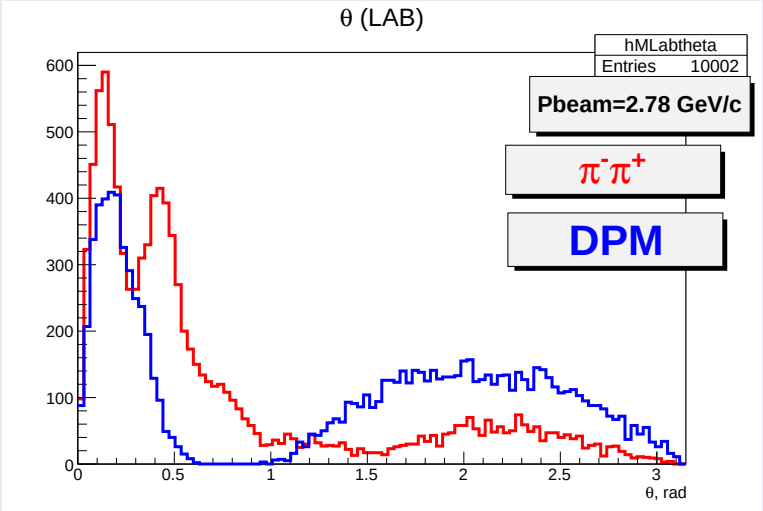


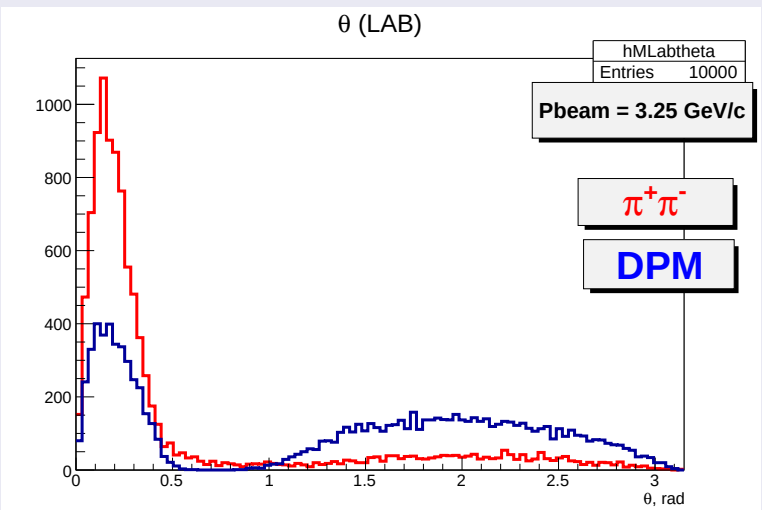


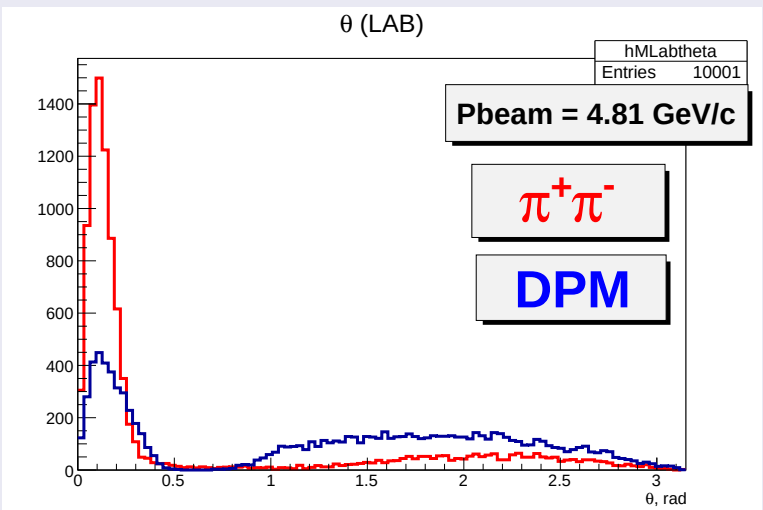
DPM vs. $p\bar{p} \to \pi^-\pi^+$ by M.Zambrana and D.Khaneft

Generators output

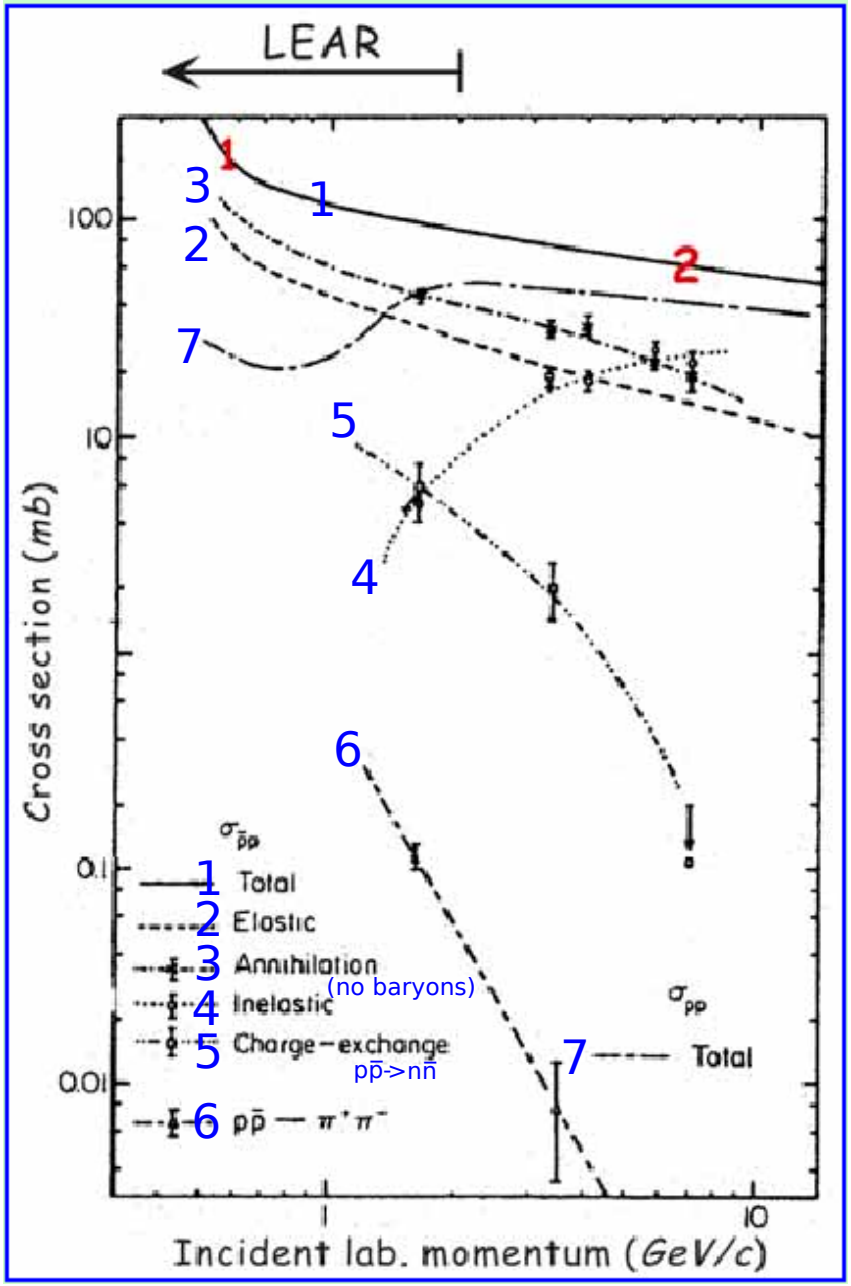








$p\bar{p}$ cross section



Background study with DPM

Strategy

- Generation of background with DPM:
  $\theta \subset (0, 2\pi)$, large statistic
- Reconstruction tracks in the luminosity monitor:
  anti-proton assumption
- Comparison reconstructed and MC information
  (+anti-proton and bkg signal)
- Cut(s) proposal for background suppression

Channels with reconstructed tracks (1e7 sim. events)

Beam Energy 1.5 GeV

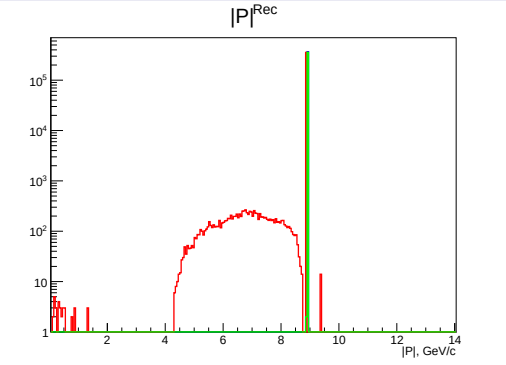
Num. of trks	Process
330	$\pi^-\pi^+\pi^0$
161	$2\pi^-2\pi^+$
151	$\pi^0 2\pi^-2\pi^+$
149	$2\pi^0\pi^-\pi^+$
116	$\pi^0 p\bar{p}$
65	$\pi^-\pi^+$
54	$4\pi^0\pi^-\pi^+$
47	$\pi^-\pi^+3\pi^0$
41	$2\pi^0 2\pi^-2\pi^+$
37	$2\gamma\pi^-\pi^+$
19	$2\gamma\pi^-\pi^+\pi^0$
19	$2\gamma 2\pi^-2\pi^+$

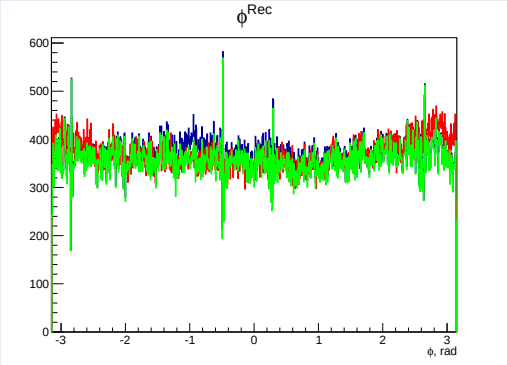
Beam Energy 4.06 GeV

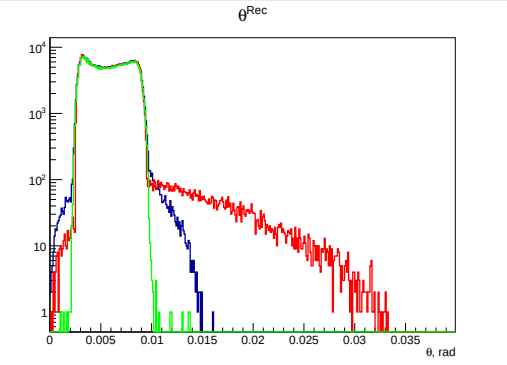
Num. of trks	Process
1020	$\pi^0 p\bar{p}$
272	$\pi^0 2\pi^-2\pi^+$
190	$\pi^-\pi^+ p\bar{p}$
180	$2\pi^-2\pi^+$
162	$\pi^-\pi^+ n\bar{n}$
156	$2\pi^0\pi^-\pi^+$
150	$2\pi^0 2\pi^-2\pi^+$
117	$\pi^-\pi^+\pi^0$
73	$\pi^-\pi^+3\pi^0$
47	$\pi^-2\pi^+ n\bar{p}$
46	$\gamma 2\pi^-2\pi^+$
34	$2\gamma\pi^-\pi^+\pi^0$

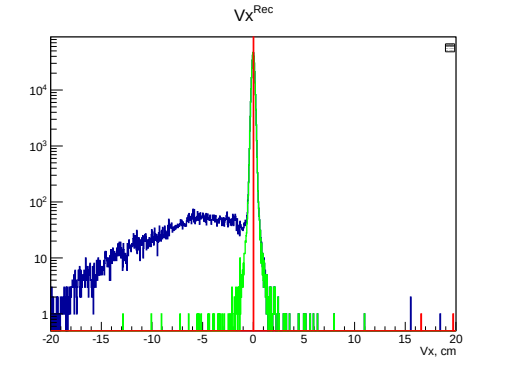
P, θ, ϕ and vertex for P_{beam}=8.9 GeV/c (θ_{min}=1.75mrad)

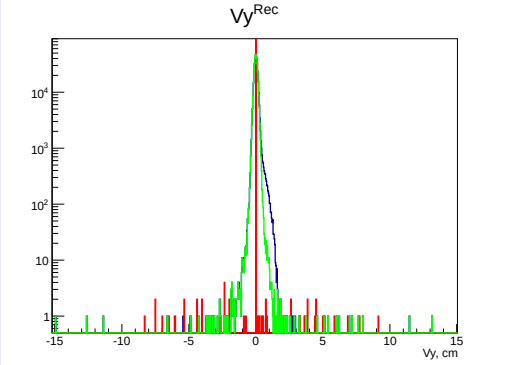
MC track, reconstructed track, reconstructed $\bar{p}$ track

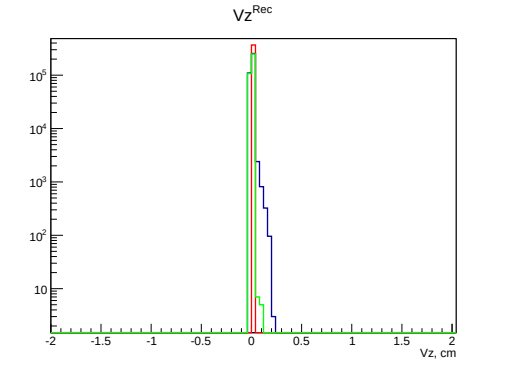












Background channels

Dominant bkg channels, Beam Energy 15 GeV, $2 \cdot 10^7$ events

Channel	# of rec. tracks	ratio to rec. $\bar{p}$, %
$p\bar{p}$	628333	100
$\bar{n}\pi^- p$	5111	0.813422
$\bar{n}\pi^- 2\gamma p$	384	0.0611141
$\bar{n}\pi^- \pi^0 p$	4017	0.639311
$\bar{p}2\pi^0\pi^+ \mathrm{n}$	1361	0.216605
$\bar{p}\pi^-\pi^+ p$	5275	0.839523
$\bar{p}\pi^-\gamma\pi^+ \mathrm{p}$	563	0.0896022
$\bar{n}2\pi^-\pi^+ \mathrm{p}$	6085	0.968436
$\bar{n}2\pi^-\gamma\pi^+ \mathrm{p}$	409	0.0650929
$\bar{n}K^-\pi^-\pi^+ \mathrm{p}$	372	0.0592043
$\bar{p}\pi^- 2\pi^0\pi^+ \mathrm{p}$	2660	0.423342
$\bar{p}\pi^- 2\pi^0 2\pi^+ \mathrm{n}$	723	0.115066
$\bar{p}2\pi^- 2\pi^+ \mathrm{p}$	518	0.0824404
$\bar{p}2\pi^-\gamma 2\pi^+ \mathrm{p}$	440	0.0700266
$\bar{p}2\pi^-\pi^0 2\pi^+ p$	657	0.104562
$\bar{n}3\pi^-\pi^0 2\pi^+ p$	314	0.0499735
$\bar{p}K^+\Lambda$	265	0.0421751

Background particles, Beam Energy 15 GeV, $2 \cdot 10^7$ events

Particle	# of rec. tracks
$\bar{p}$	661161
K^-	79
π^-	1931
e^-	5
e^+	4
π^+	21
p	18

$p\bar{p} \to p\bar{p}$ had 628333 events
$\to$ 32828(5%) $\bar{p}$ tracks came from different process!

A few words about generated statistic

$2 \cdot 10^7$ events with DPM were generated

$\frac{dN}{dt} = \sigma \cdot L \rightarrow \tilde{N} = \sigma \cdot \tilde{L} \cdot t$

$\tilde{L} = 2 \cdot 10^{32} \frac{1}{cm^2 s}$ (High lumi mode)

$\sigma = (100 - 51)$ mb

$t = \frac{2 \cdot 10^7}{2 \cdot 10^{32} (100-51) \cdot 10^{-27}} = (1 - 2)$ s

DPM normalization problem

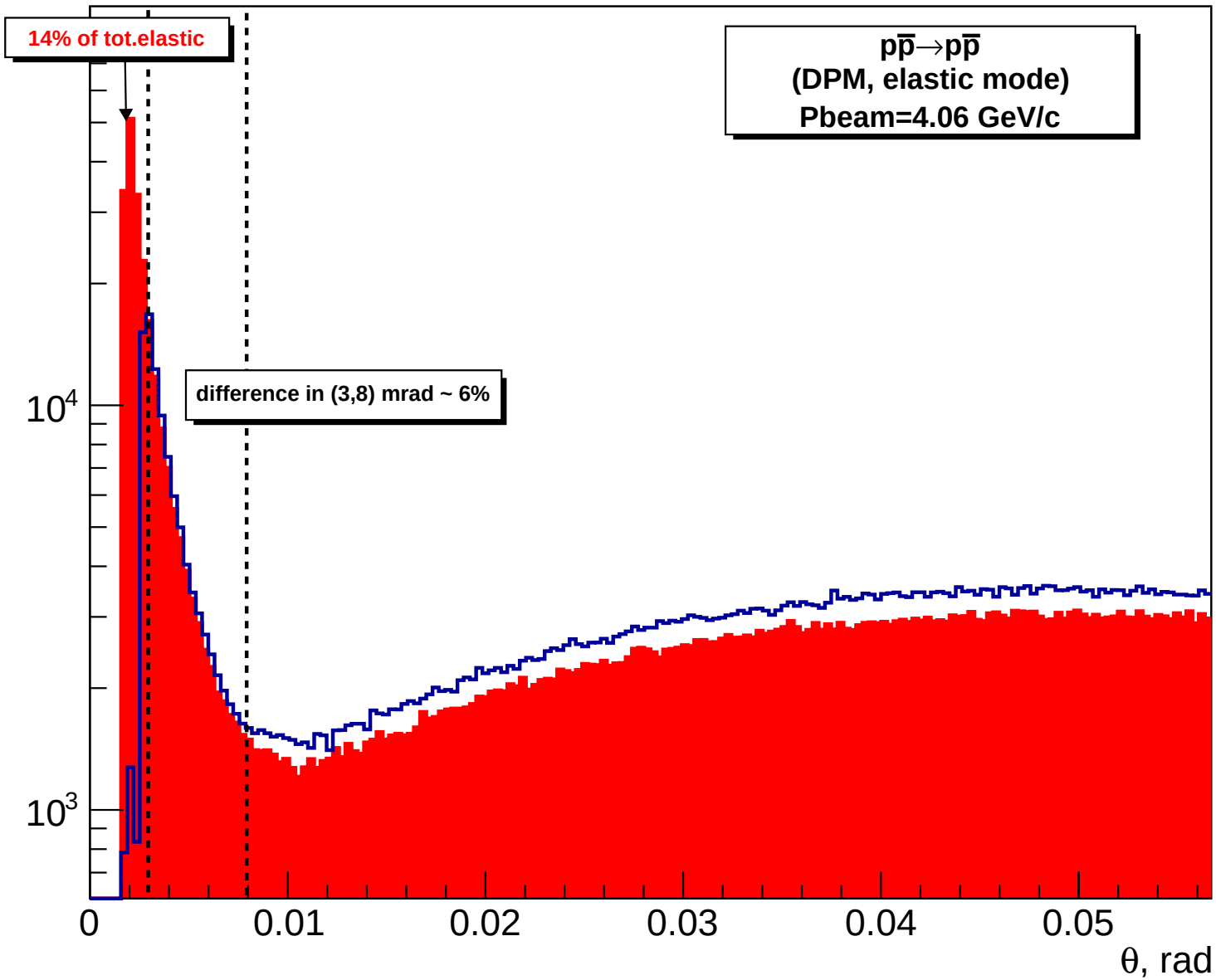
$\sigma_{el} = \sigma_{Col} + \sigma_{int} + \sigma_{had}$

Coloumb scaterring diverges for $\theta \to 0$ and one needs θ_{min} to fix it.
No measurements available in that theta range.

DMP uses ratio $\frac{\sigma_{el}}{\sigma_{tot}}$, which doesn't depend on θ_{min}
This mean that σ_{el} is always the same, but $\frac{\sigma_{Col}}{\sigma_{had}}$ depends on θ_{min}

On one hand σ_{had} shouldn't depend on θ_{min},
on the other hand from experiment only σ_{el} is known.

DPM normalization problem: Example



To be continued...

References

M.Zambrana, D.Khaneft (2011)

twoPionGen: a Monte Carlo event generator for $\pi^+\pi^-$ production on $p\bar{p}$ interactions

H.Koch (2004)

Hadron Physics

Varenna June 2004