Status of $\overline{p}p \longrightarrow h_c \longrightarrow \eta_c + \gamma$ analysis

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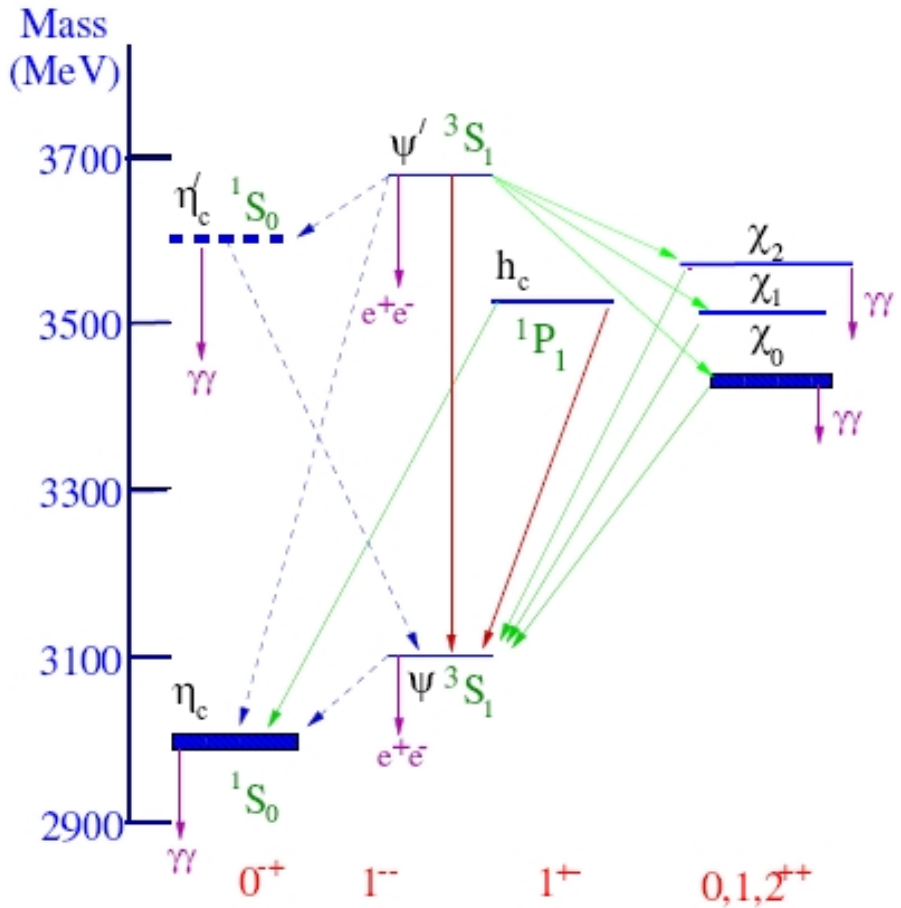
h_c among other charmonium states



h_c decay modes

$$\bar{p}p \rightarrow h_c \rightarrow \eta_c + \gamma$$

Neutral channel

$$h_c \rightarrow \gamma + \eta_c \rightarrow \gamma + \gamma + \gamma \quad (BR = 4.3 \cdot 10^{-4})$$

Channels with charged particles

$\eta_c \rightarrow K_S^0 K^{\pm}\pi^{\pm}$ $(BR = 1.9 \cdot 10^{-2})$

$\eta_c \rightarrow K_L^0 K^{\pm}\pi^{\pm}$ $(BR = 1.9 \cdot 10^{-2})$

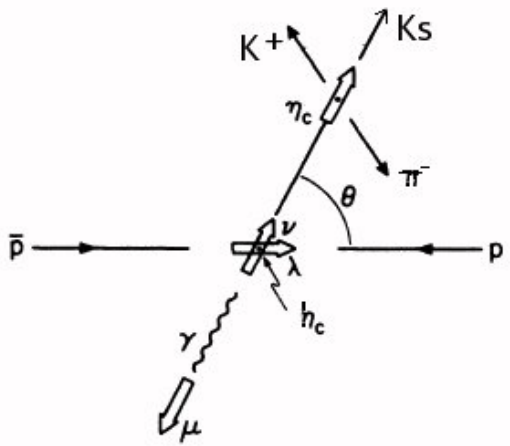
$\eta_c \rightarrow K^+K^-\pi^+\pi^-$ $(BR = 1.5 \cdot 10^{-2})$

$\eta_c \rightarrow \pi^+\pi^-\pi^+\pi^-$ $(BR = 1.2 \cdot 10^{-2})$

$\eta_c \rightarrow K^+K^-\pi^0$ $(BR = 1.5 \cdot 10^{-2})$

$\eta_c \rightarrow \pi^+\pi^-\eta(\gamma\gamma)$ $(BR = 1.3 \cdot 10^{-2})$

Description of the studied channel



$$p\bar{p} \rightarrow h_c \rightarrow \eta_c + \gamma \rightarrow K_s K^{\pm}\pi^{\mp}\gamma,$$

E_γ=503 MeV

$$\eta_c \rightarrow K^0_S K^{\pm}\pi^{\mp},\ BR = 1.9 \cdot 10^{-2}$$

E_{CM}=3526 MeV, p_z=5609 MeV

$$\sigma_{p\bar{p}\rightarrow h_c \rightarrow \eta_c + \gamma} = 40nb\ (E835)$$

Background

$$p\bar{p} \rightarrow K_s K^{\pm}\pi^{\mp}\pi^0$$

$\sigma_=$ 100 μb

Event selection

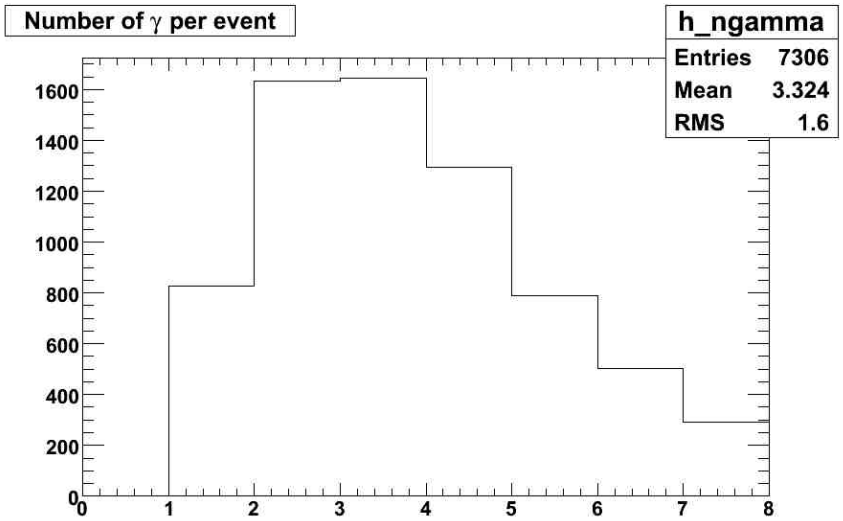
- 20 k events
  $p\bar{p} \to h_c \to \eta_c + \gamma, \eta_c \to K_s K^{\pm}\pi^{\mp} \quad (E_{CM} = 3526 MeV)$
- background
  100 k events $p\bar{p} \to K_s K^{\pm}\pi^{\mp}\pi^0$

Selection cuts:

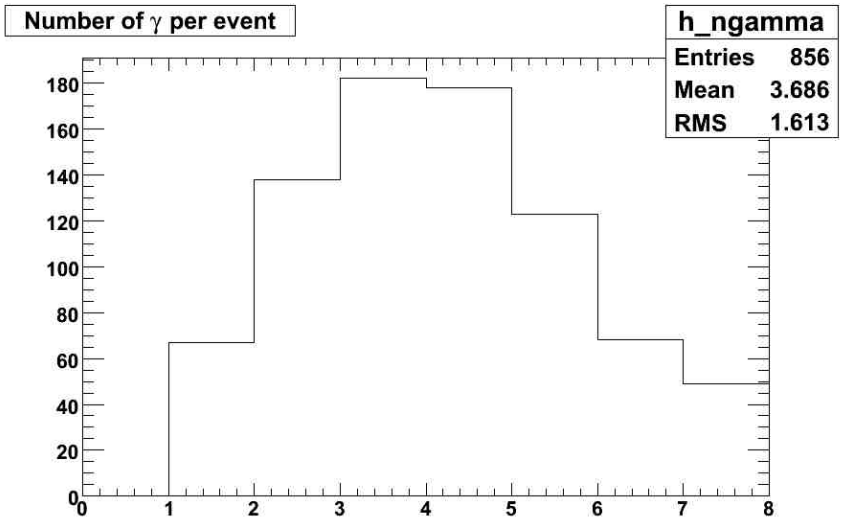
- 4C-fit to beam energy and momentum + additional constraint on K_s mass, CL> 0.1%
- η_c pre-fit selection [2.6:3.2] GeV
- η_c post-fit selection [2.9:3.1] GeV
- K_s common vertex constraint, with pre-fit mass selection [0.3:0.8] GeV
- using PID information for K/π separation.
- E_γ within [0.4:0.6] GeV

Multiplicity of γ

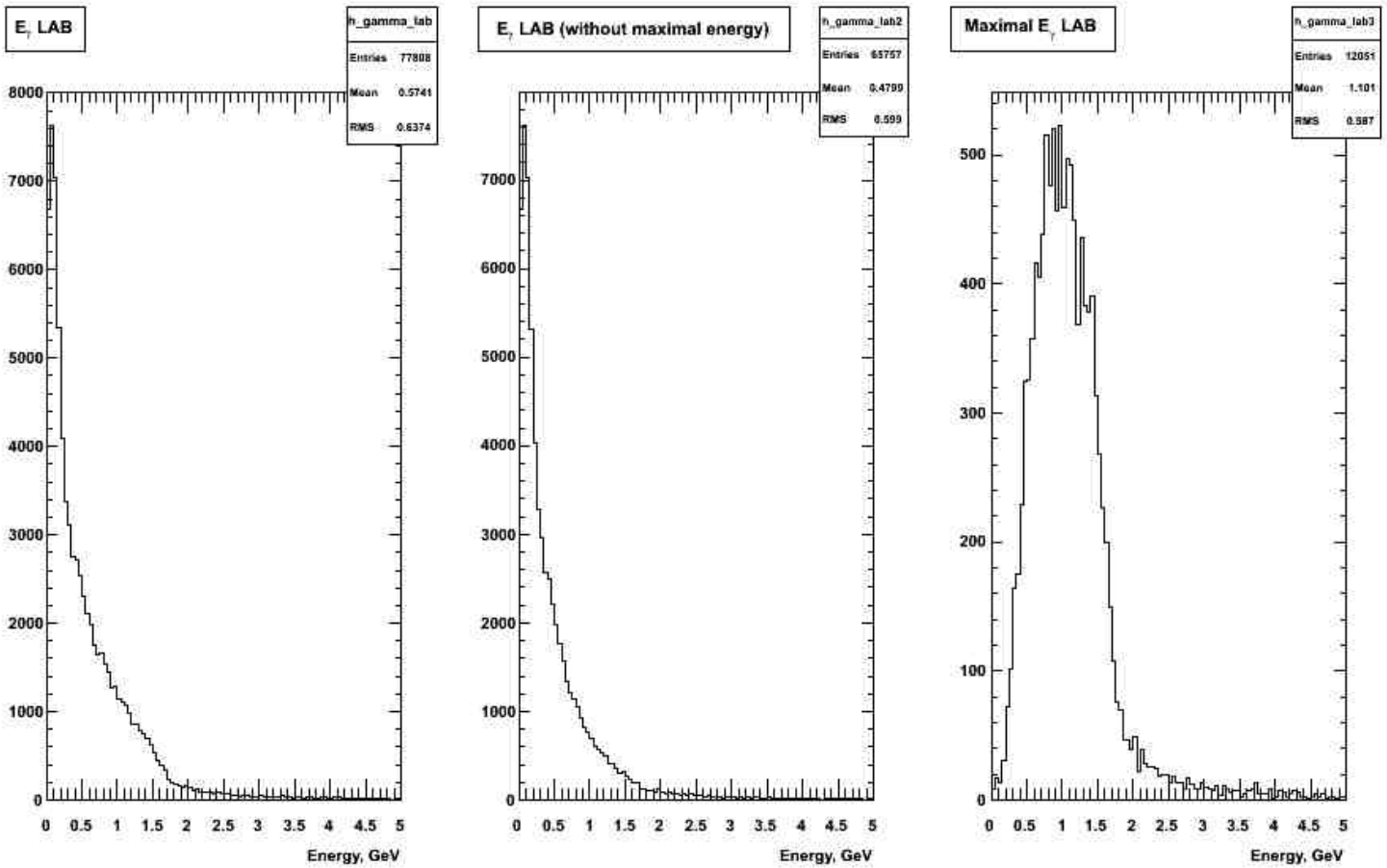
Signal



Background

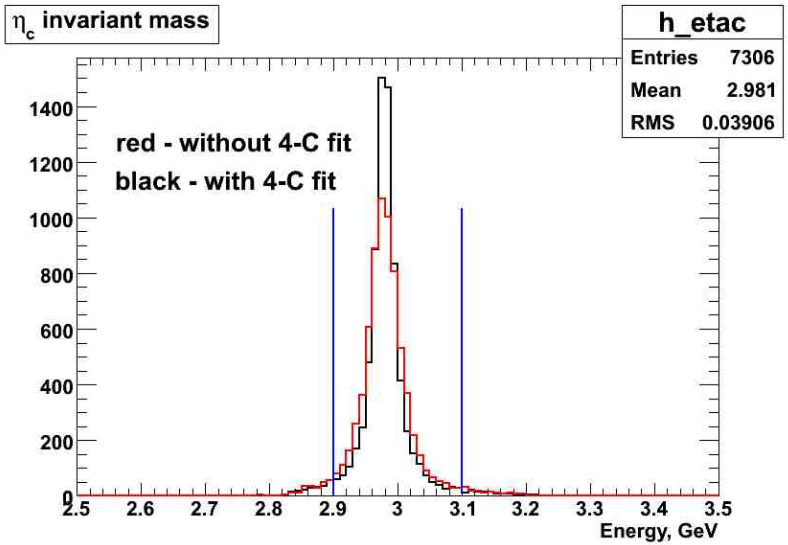


E_γ in Laboratory System

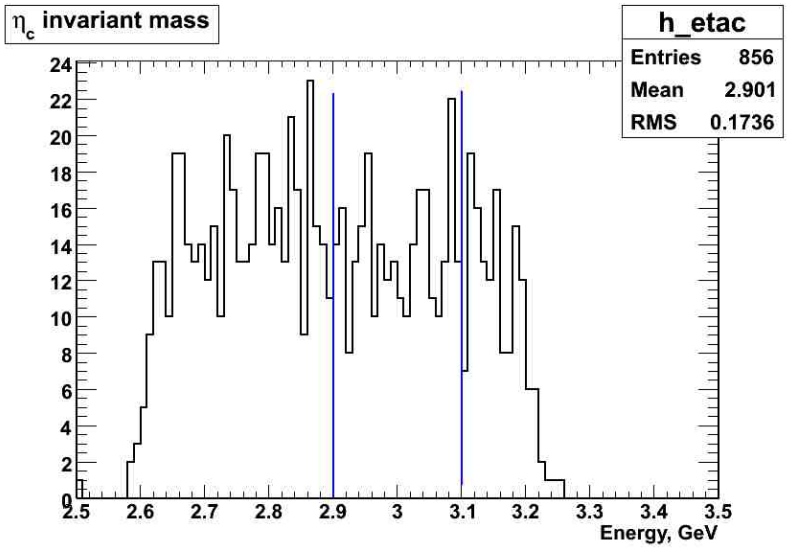


4C-fit effect (η_c invariant mass)

Signal

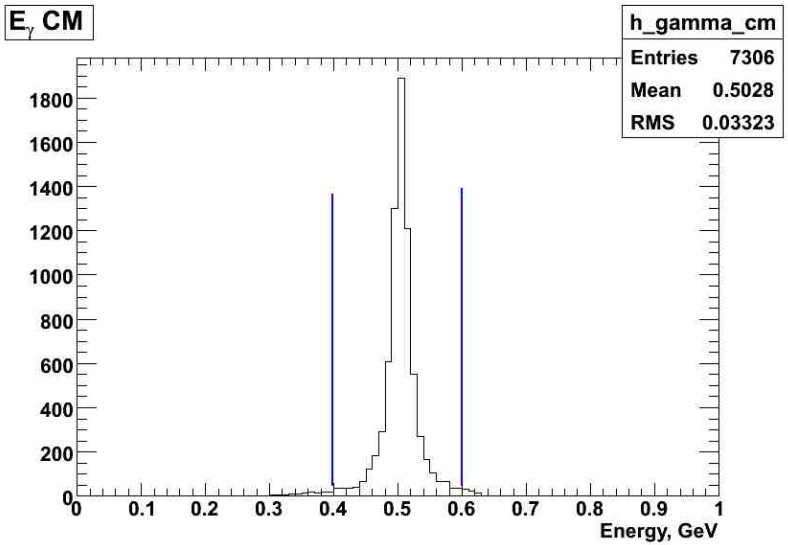


Background



E_γ distribution

Signal



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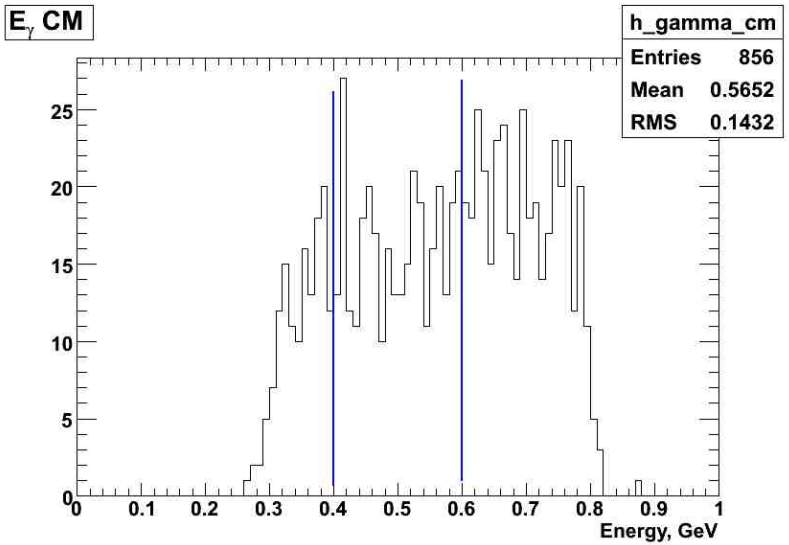
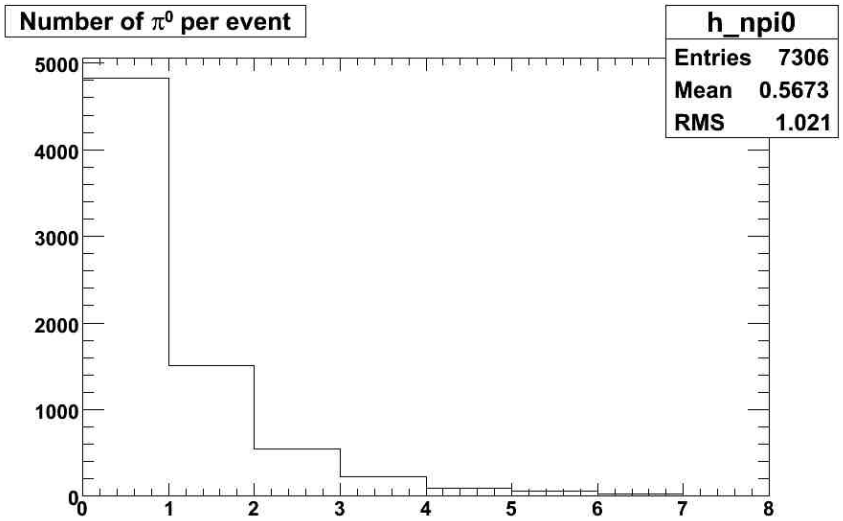
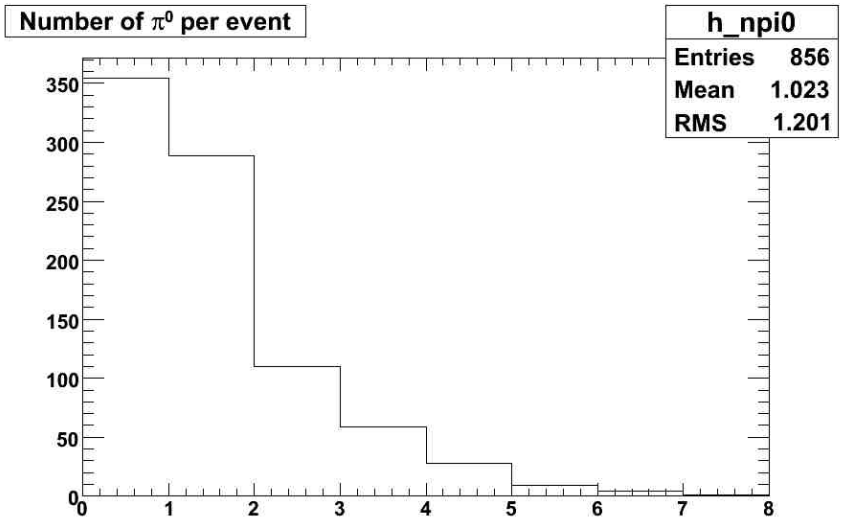


Number of π^0

Signal



Background



Summary of cut efficiency

	signal	background
η_c mass pre-fit, K_s mass prefit, PID	43.4%	3.2%
4C-fit CL>0.1 %	36.5 %	0.86%
E_γ [0.4;0.6] GeV	35.6%	0.32%
η_c mass post-fit	34.9 %	0.28%
no π^0	23.0%	0.12%

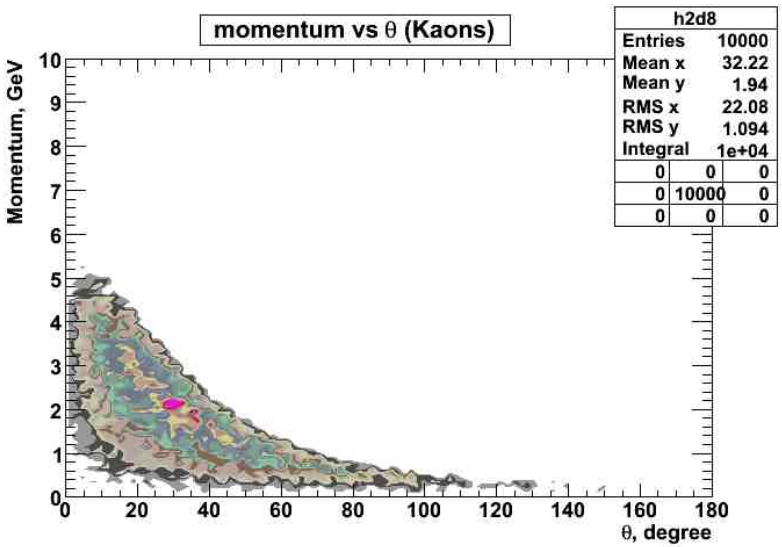
Summary

- With aplied cuts background supression is not sufficient, signal/background ratio = $1 : 700$.
- Continuation with higher statistic is foreseen.
- Other possible background channels should be investigated.

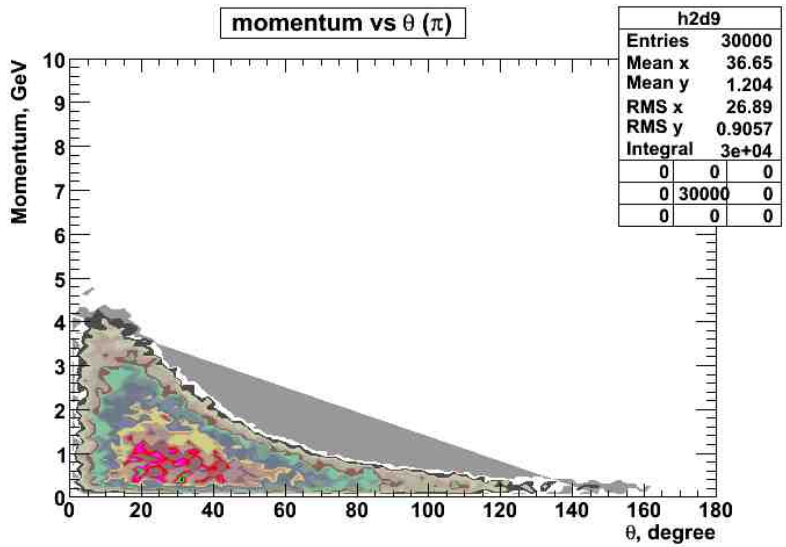
$$\bar{p}p \rightarrow \pi^+\pi^-\pi^+\pi^-\pi^0$$
$$\bar{p}p \rightarrow K^+K^-\pi^+\pi^-\pi^0$$

PID plots

K

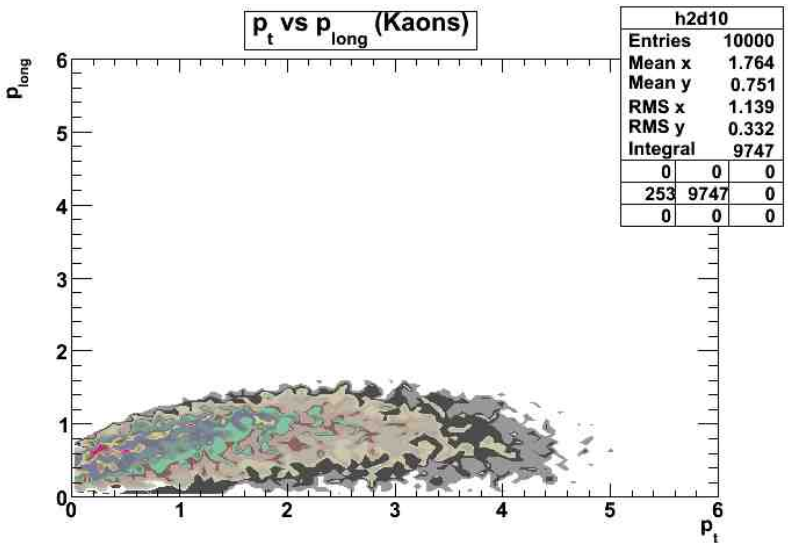

momentum vs θ (Kaons)
h2d8
Entries 10000
Mean x 32.22
Mean y 1.94
RMS x 22.08
RMS y 1.094
Integral 1e+04
Momentum, GeV
θ, degree

π

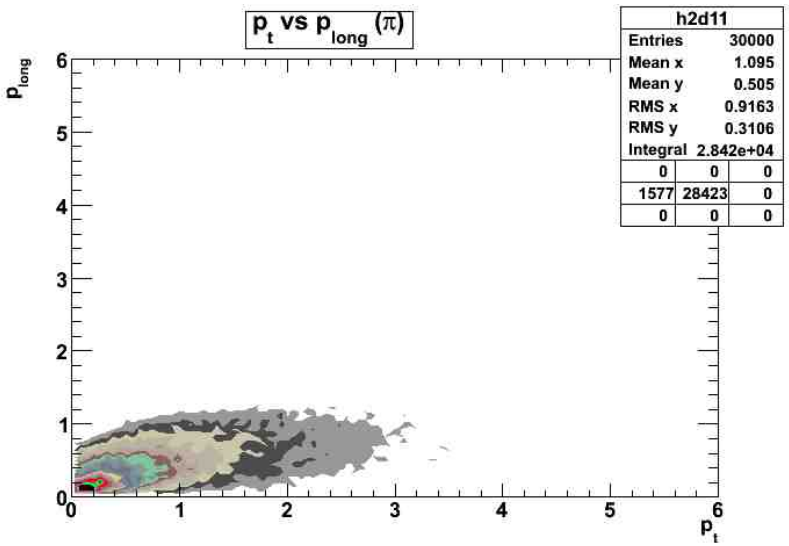

momentum vs θ (π)
h2d9
Entries 30000
Mean x 36.65
Mean y 1.204
RMS x 26.89
RMS y 0.9057
Integral 3e+04
Momentum, GeV
θ, degree

PID plots

K


p_t vs p_long (Kaons)
h2d10
Entries 10000
Mean x 1.764
Mean y 0.751
RMS x 1.139
RMS y 0.332
Integral 9747
0 0 0
253 9747 0
0 0 0
p_long
p_t

π


p_t vs p_long (π)
h2d11
Entries 30000
Mean x 1.095
Mean y 0.505
RMS x 0.9163
RMS y 0.3106
Integral 2.842e+04
0 0 0
1577 28423 0
0 0 0
p_long
p_t

```
mod talk KsList
   decayMode          set "K_S0 -> pi+ pi-"
   daughterListNames set  PionCombinedLHVeryLoose
   daughterListNames set  PionCombinedLHVeryLoose
   preFitSelectors   set "Mass 0.3:0.8"
   fittingAlgorithm  set "TreeFitter"
exit

mod talk EtacToKsKPi
  decayMode set "eta_c -> K_S0 K+ pi-"
  daughterListNames set KsListFit
  daughterListNames set KaonCombinedLHVeryLoose
  daughterListNames set PionCombinedLHVeryLoose
  preFitSelectors set "Mass 2.6:3.2"
exit
```

If ChargedTracks are used

- 77% cut in efficiency for signal
- 69% cut in efficiency for background