Status of $\overline{p}p \to \phi\phi\eta$ Analysis with FSIM

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Charmonium and Exotics Meeting
16.05.2014

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General Considerations

- Search for (heavy) glueballs in mass range $3 - 5$ GeV/c^2
- Explore mass range in production, followed by detailed investigation in formation
- Assume glueball production cross section of 1 nb (guided by f0(1500) results from CB@LEAR)
- Glueball width could be small (assume 10 MeV)
- Main background channels (cross section about 1 mb each):
  - $\overline{p}p \to \pi^+\pi^-\pi^+\pi^-\eta$
  - $\overline{p}p \to \pi^+\pi^-\pi^+\pi^-\pi^0$
  - $\overline{p}p \to \pi^+\pi^-\pi^+\pi^-\pi^0\pi^0$
- Figure of Merit: Signal >100 events, S/N>1

Overview

- Decay channels to be analyzed:
  $\overline{p}p \to G\eta$, $\overline{p}p \to G\pi^0$ with
  - $G \to \phi\phi$
  - $G \to \omega\omega$
  - $G \to \eta'\eta'$
  - $G \to KK\pi^0$
- Started with $\phi\phi\eta$ / $\phi\phi\pi^0$ channel at $p_{\overline{p}} = 15\,\mathrm{GeV}/c$
- For comparison: Full simulation of this channel has been performed in 2008 with the BaBar-like analysis software (diploma thesis B.Roth)
- Using `scrut14` release, revision #24893

- Generated signal events w/o Glueball resonance: $\overline{p}p \to \phi\phi\eta \to K^+K^-K^+K^-\gamma\gamma$

$\to$ 100.000 events, PHSP

- One of the main background channels: $\overline{p}p \to \pi^+\pi^-\pi^+\pi^-\eta$

$\to$ Generated $2 \cdot 10^7$ events (need 100 times more $\to$ disk space problematic)

- Choosing best candidate for each event:

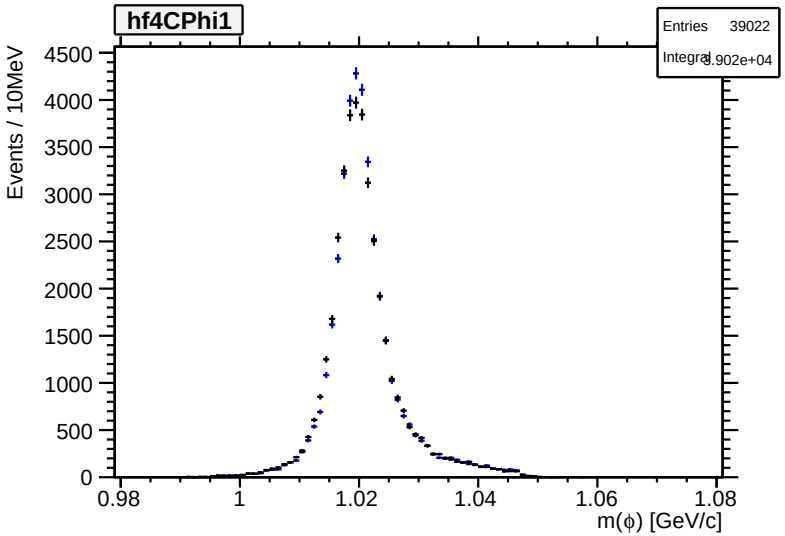
$\to$ candidate with minimal $r = \sqrt{(m(\phi_1) - m(\phi_{PDG}))^2 + (m(\phi_2) - m(\phi_{PDG}))^2}$ is selected to reduce combinatoric background

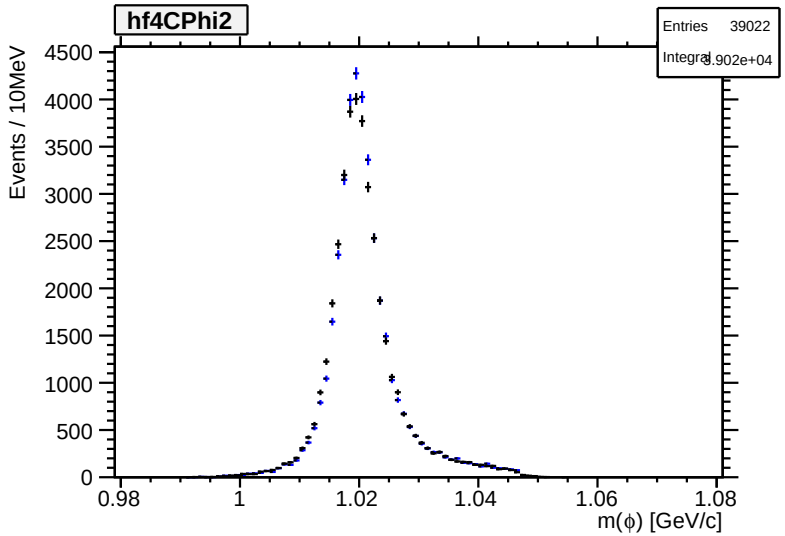
- Some struggles in the beginning, but now 4C kinematic fit works also with neutral particles in the final state

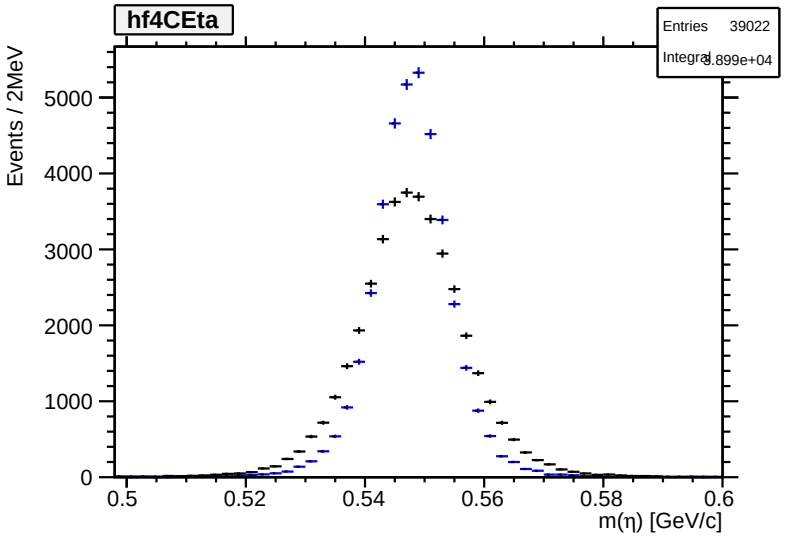
$\to$ Cut on probability of 4C-Fit: Prob$(\chi^2, 4) > 0.05$)

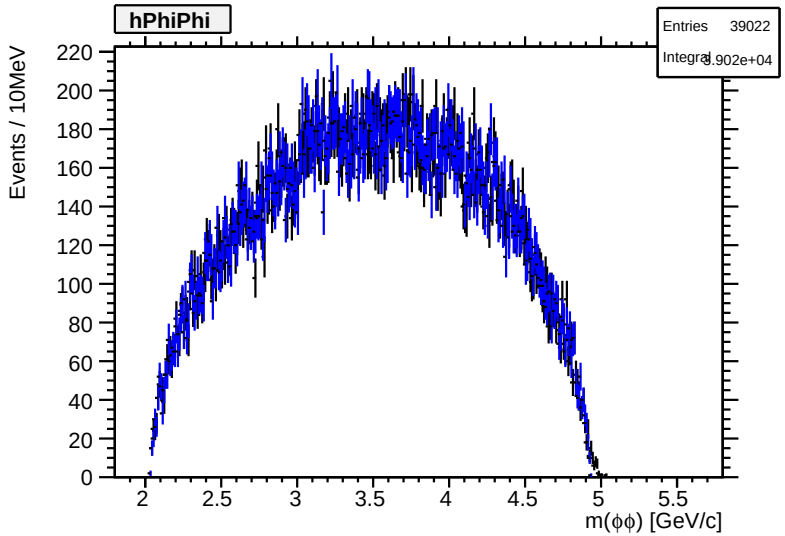
- So far using **full** detector setup and `PidChargedProbability:KaonAllPlus/Minus`

Mass spectra ($p_{\overline{p}} = 15\,\mathrm{GeV}/c$, blue: 4C-Fit, black: unfitted)

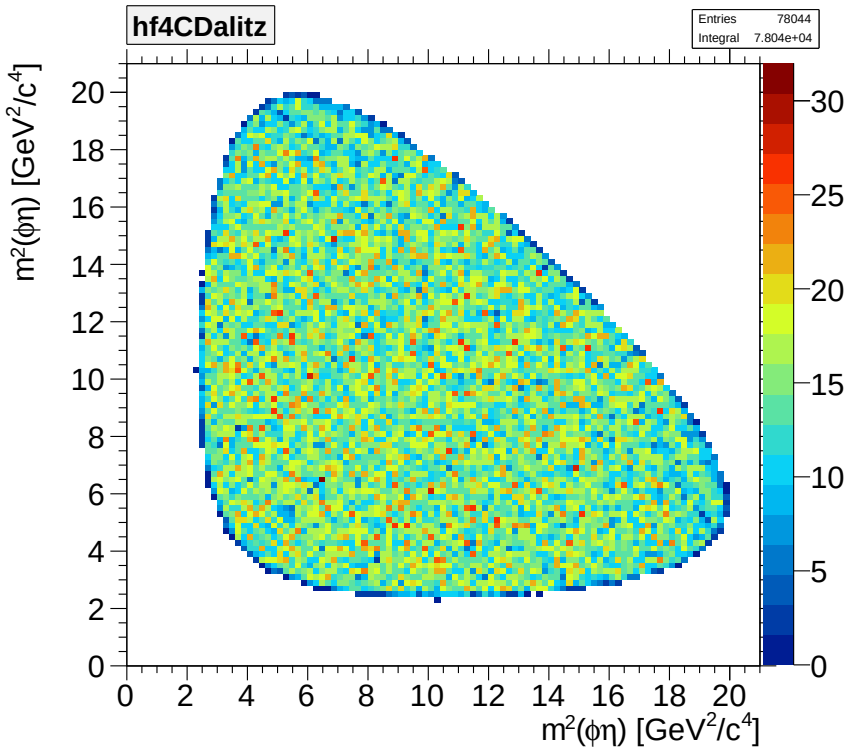




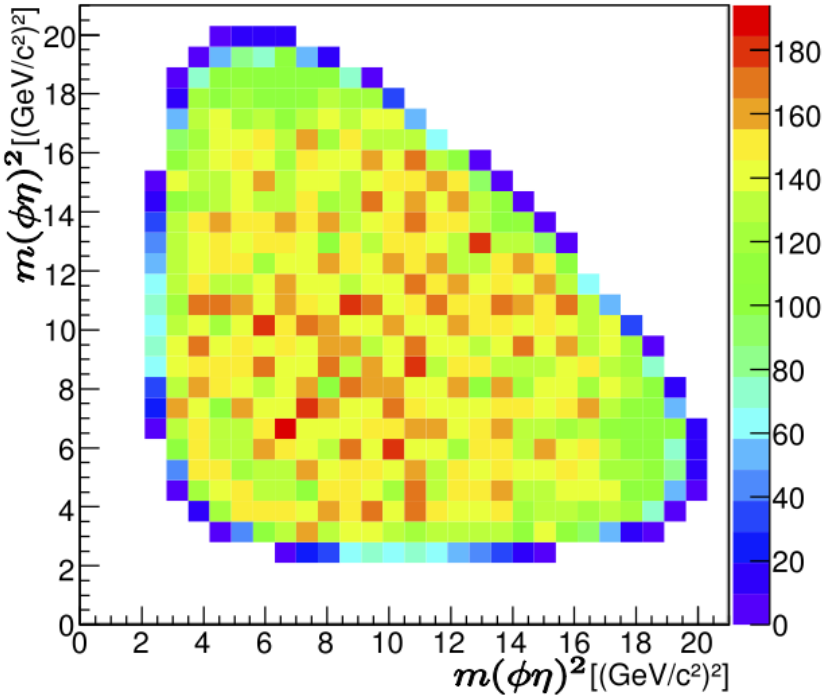




Dalitz Plot



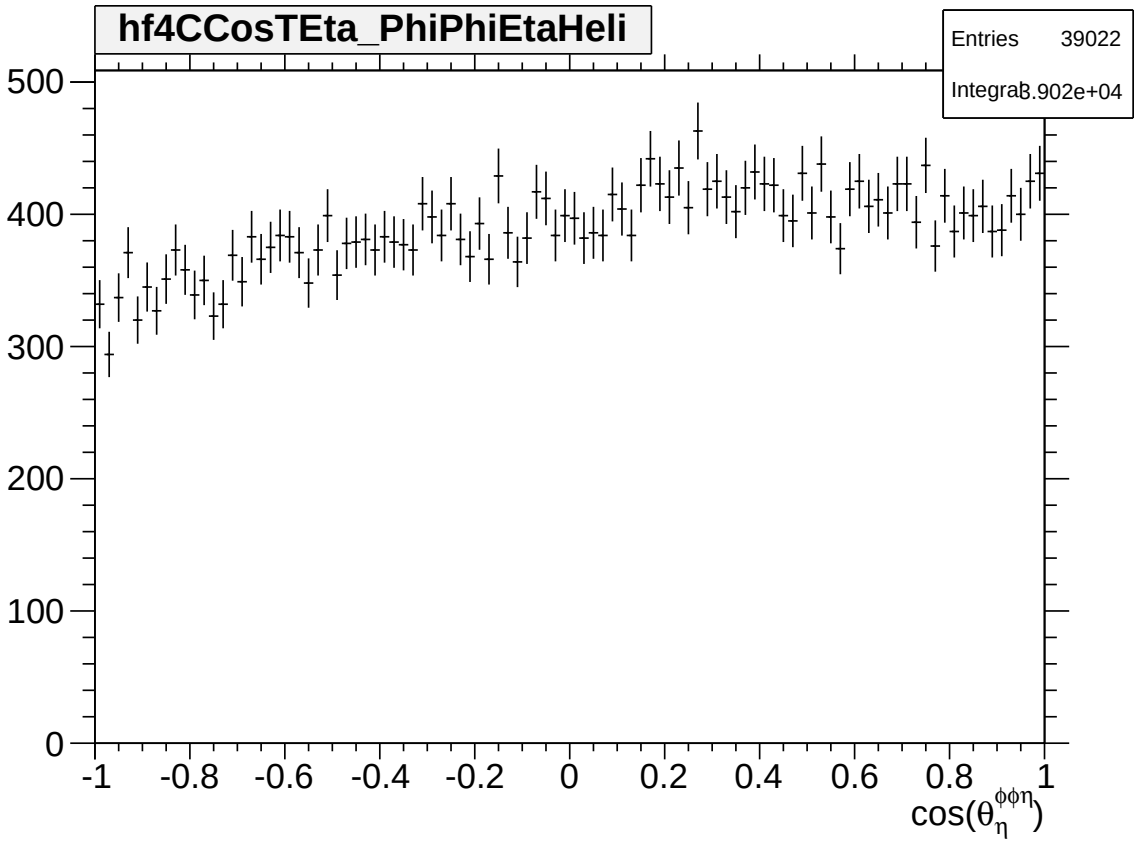
FastSim



Full simulation (diploma thesis B.Roth)

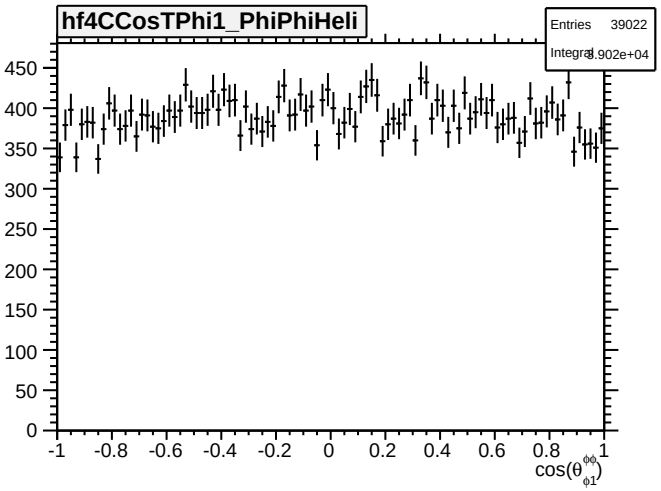
→ Homogeneous population of the dalitz plot also in FastSim

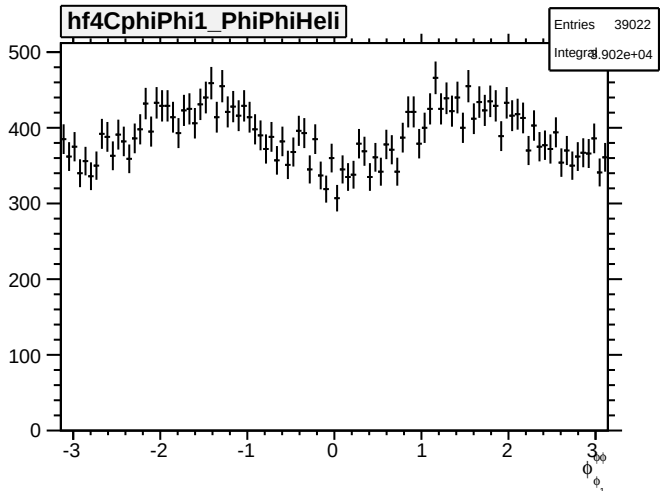
Angular distributions in FastSim

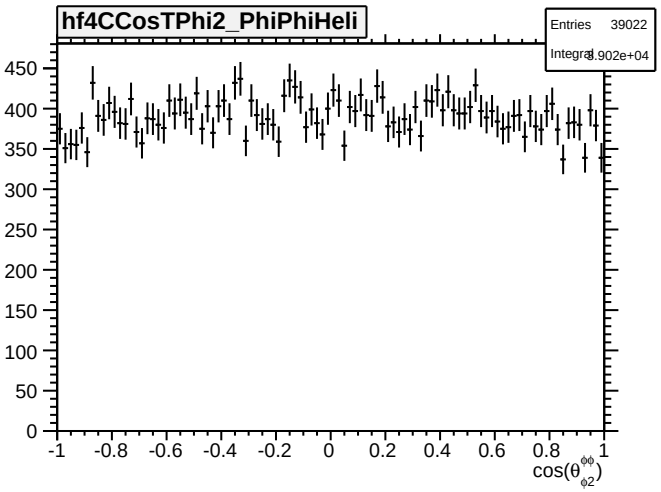


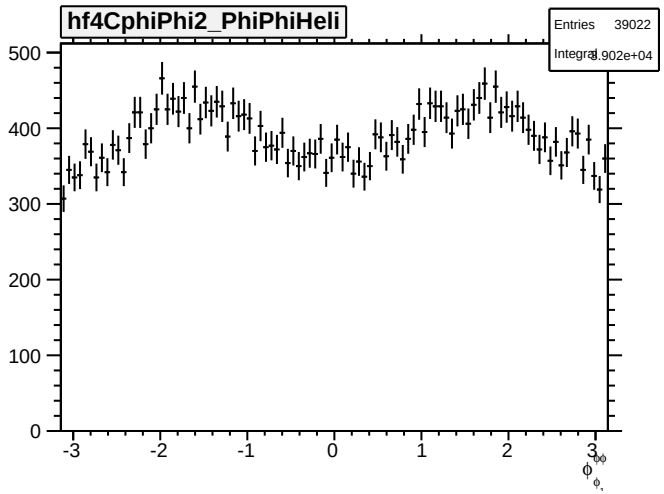
Production angle:
cos(θ) of η in center of mass system

Angular distributions in FastSim









cos(θ) and φ angles of ϕ's in the $\phi\phi$-helicity frame

Update - 16.05.2014

- Generated 400M background events ($\pi^+\pi^-\pi^+\pi^-\pi^0$) $\rightarrow$ still NO surviving event after 4C-fit (?!)
- Studied for 6 different detector options for:
  - Narrow Glueball resonance decaying to $\phi\phi$ with recoil π^0, Glueball with $M = 3900\,\mathrm{MeV}/c^2$, $\Gamma = 10\,\mathrm{MeV}$ at $p_{\overline{p}} = 15\,\mathrm{GeV}/c$ and $7.7\,\mathrm{GeV}/c$
  - Non-resonant $\phi\phi\pi^0$ events at $p_{\overline{p}} = 2.4\,\mathrm{GeV}/c$
- Require $S = 100$ for Glueball search, $S = 1000$ for spin-parity analysis
- Detector setups: 1=MvdGem, 2=EmcBarrel, 3=Drc, 4=Dsc, 5=FwdSpec

$M = 3900\,\mathrm{MeV}/c^2$, $\Gamma = 10\,\mathrm{MeV}$ Glueball at $p_{\bar{p}} = 15\,\mathrm{GeV}/c$

Detector Setup	ϵ_S [%]	$t(S=100)$ $L = 2 \cdot 10^3 2\mathrm{cm}^{-2}\mathrm{s}^{-1}$	$t(S=100)$ $L/10$	$t(S=100)$ $L/100$
12345	36.7	3.3 hr	1.4 d	14 d
2345	4.3	28 hr	12 d	120 d
1 345	16.5	7.2 hr	3 d	30 d
12 45	36.5	3.3 hr	1.4 d	14 d
123 5	36.7	3.3 hr	1.4 d	14 d
1234	24.0	5.0 hr	2.1 d	21 d

Detector setups: 1=MvdGem, 2=EmcBarrel, 3=Drc, 4=Dsc, 5=FwdSpec

$M = 3900\,\mathrm{MeV}/c^2$, $\Gamma = 10\,\mathrm{MeV}$ Glueball at $p_{\bar{p}} = 7.7\,\mathrm{GeV}/c$

Detector Setup	ϵ_S [%]	$t(S=100)$ $L = 2 \cdot 10^3 2\mathrm{cm}^{-2}\mathrm{s}^{-1}$	$t(S=100)$ $L/10$	$t(S=100)$ $L/100$
12345	45.6	2.6 hr	1.1 d	11 d
2345	8.0	15.0 hr	6.25 d	62.5 d
1 345	1.3	92.3 hr	38.5 d	385 d
12 45	45.6	2.6 hr	1.1 d	11 d
123 5	45.6	2.6 hr	1.1 d	11 d
1234	33.0	3.6 hr	1.5 d	15 d

Detector setups: 1=MvdGem, 2=EmcBarrel, 3=Drc, 4=Dsc, 5=FwdSpec

Todo

- Mass region for lighter glueball ($M \approx 2400\text{MeV}/c^2$) under investigation
- Background studies for minimum detector setup needed (!)

$\rightarrow$ PID not needed

- For final report: study of at least one more decay channel ($G \rightarrow \eta'\eta'$) needed