The $\tilde{\eta_{c1}}$ analysis using genetic algorithm

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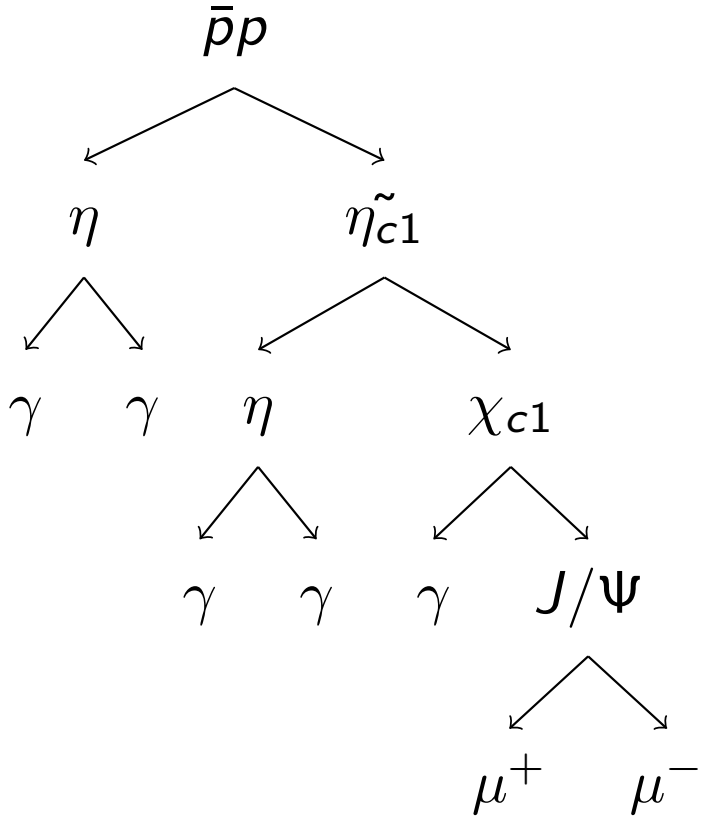
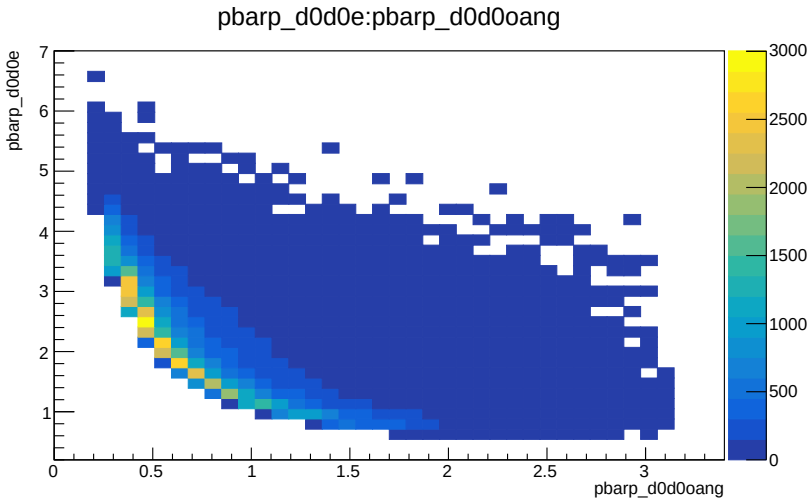
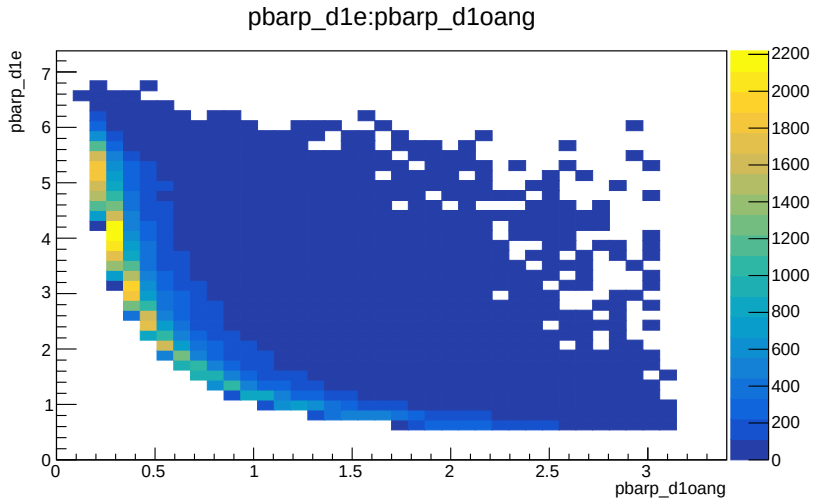
Decay channel



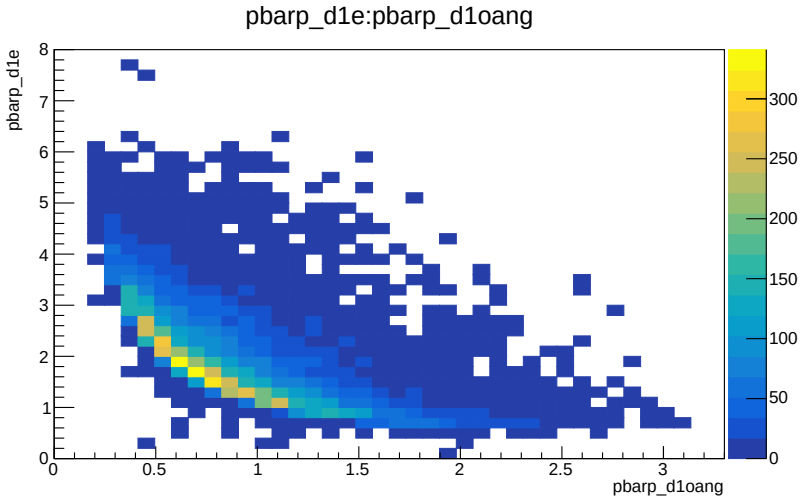
η distributions - energy - opening angle



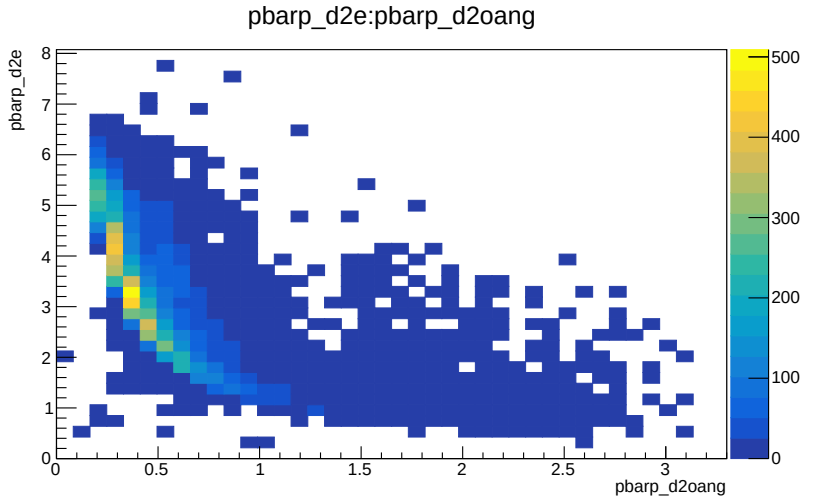
Generated from $\tilde{\eta_{c1}}$-decay



Generated from ppbar-decay

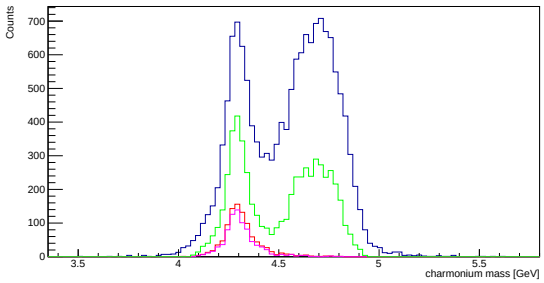


Reconstructed 1

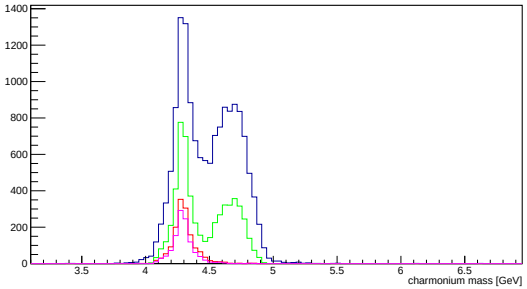


Reconstructed 2

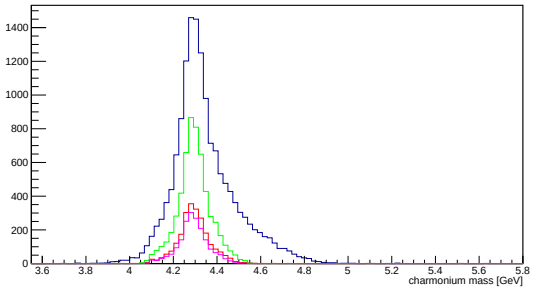
Best candidate



First combination

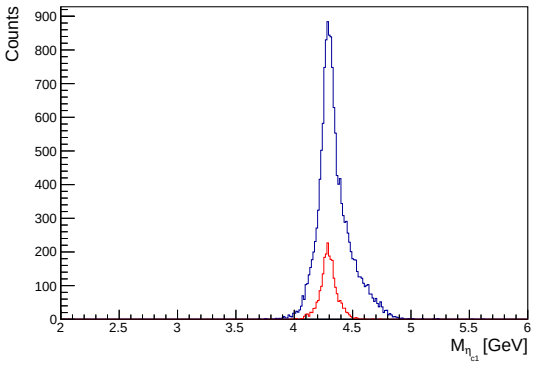


Other combination

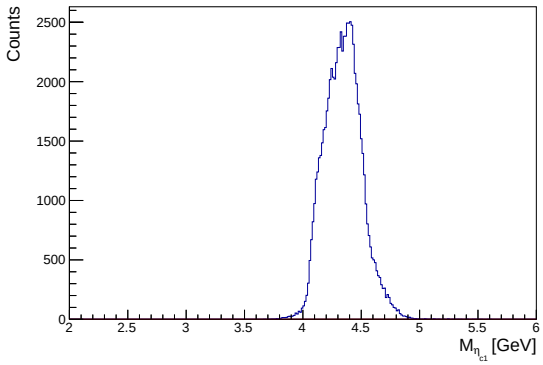


Best candidate

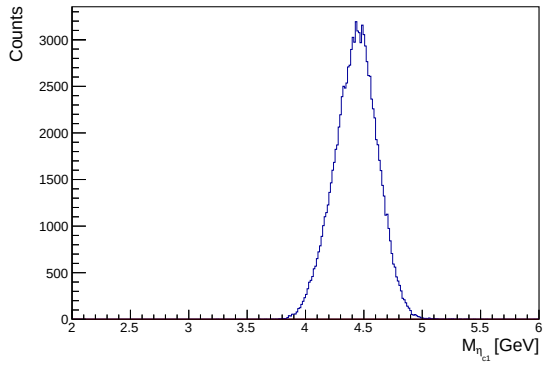
$\tilde{\eta_{c1}}$ invariant mass



Signal

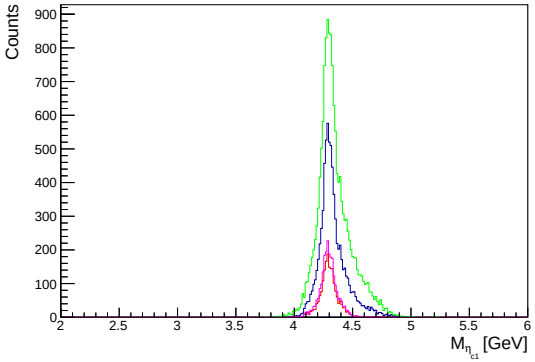


Background 1

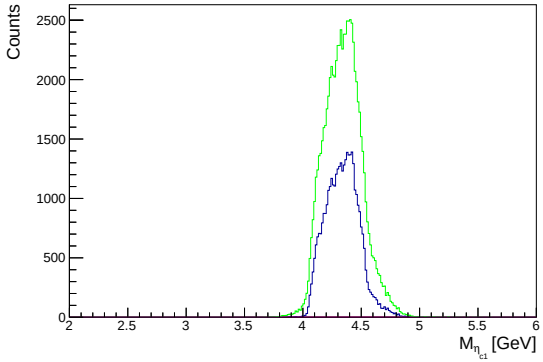


Background 2

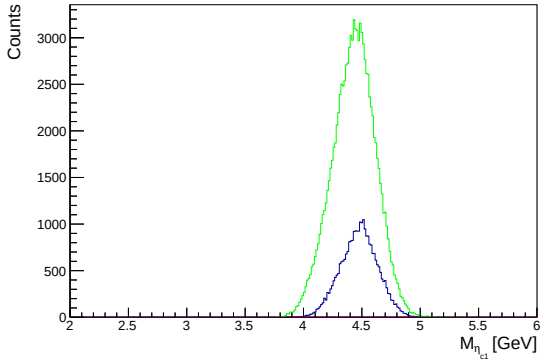
$\tilde{\eta_{c1}}$ invariant mass after the mass cuts



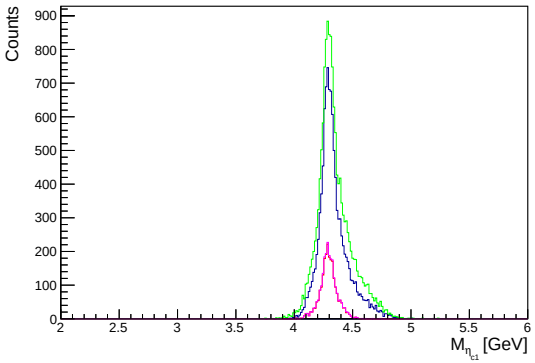
Signal



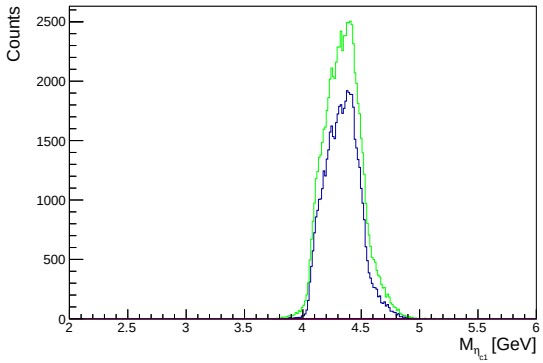
Background 1



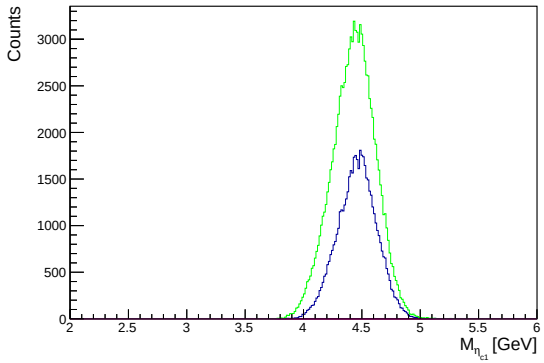
Background 2



Signal - Gen. cuts

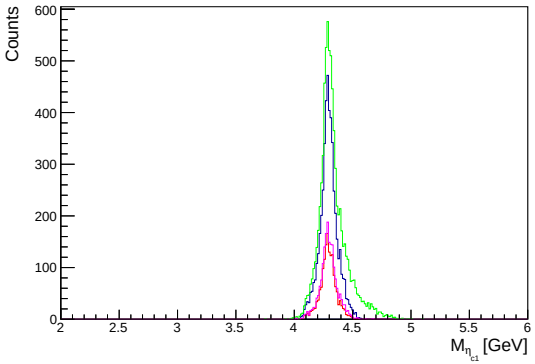


Background 1 - Gen. cuts

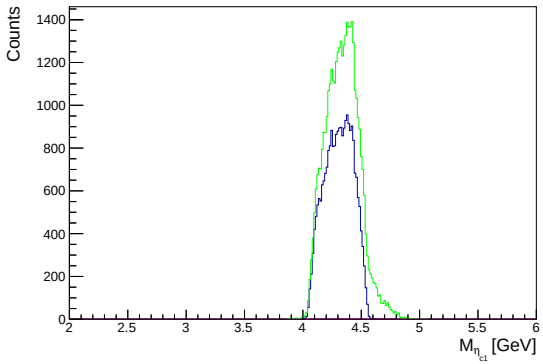


Background 2 - Gen. cuts

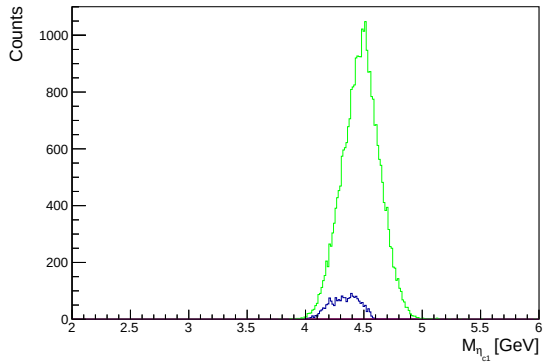
$\tilde{\eta_{c1}}$ invariant mass after the mass and all 6 prob. cuts



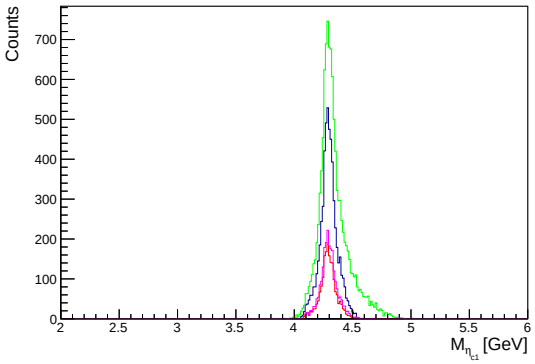
Signal



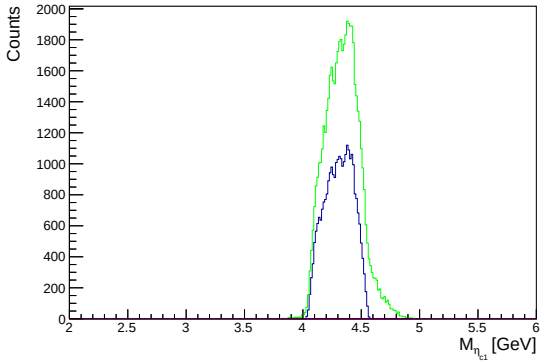
Background 1



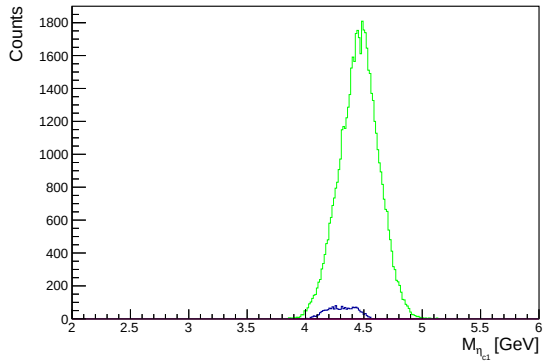
Background 2



Signal - Gen. cuts



Background 1 - Gen. cuts



Background 2 - Gen. cuts

Cuts

	Genetic	**Manual**
4C fit	0.000024	0.001
χ_{c1} mass fit	0.273	0.001
η mass fit	0.014	0.001
Other η mass fit	0.583325	0.001
Second 4C fit	0.6574	0.001
η mass cut	490-583 MeV	528-590 MeV
χ_{c1} mass cut	3.38-3.64 GeV	3.45-3.62 GeV

Results of the cuts

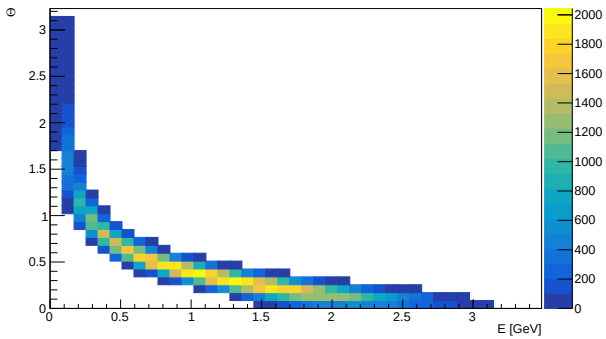
	Manual	Genetic	Generated
Bck. 1	24438	28286	500000
Bck. 2	2068	1876	500000
All bck.	29823	33968	1000000+comb.
Signal	1566	1846	100000
Significance	8.84	9.75	$\mathrm{FTM}/\sqrt{\mathrm{Reconst.}}$

More than 2 times better significance and efficiency

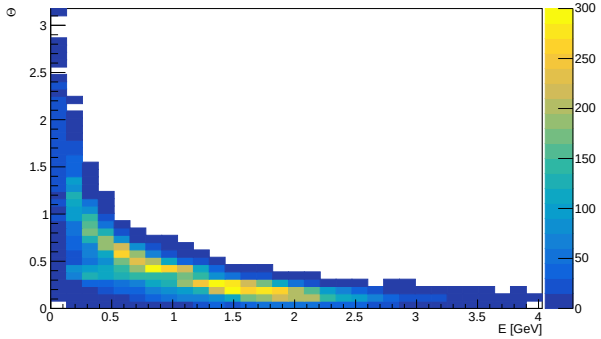
Efficiencies - mct

- 2 η: 40.2% ($\sim$ 80% for 1 photon)
- J/Ψ: 30.5%
- χ_{c1}: 17% ($\sim$ 57% for 5th photon)
- $\tilde{\eta_{c1}}$: 2.3%

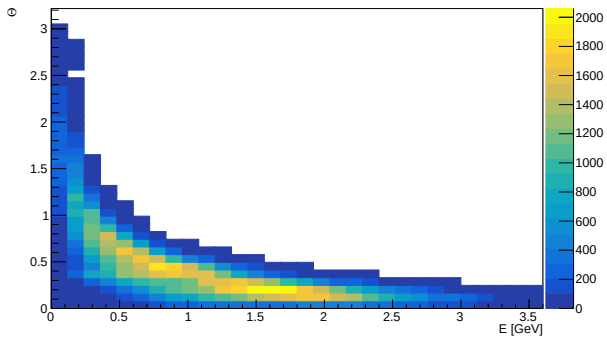
5th photon



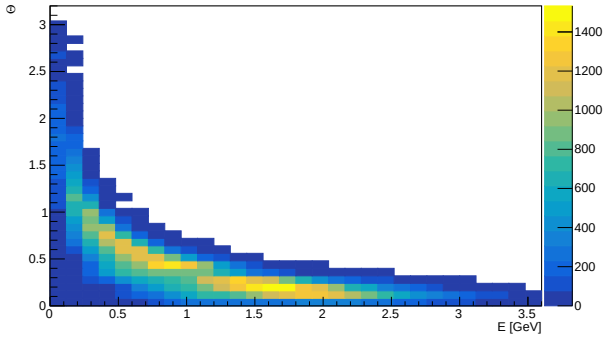
Generated



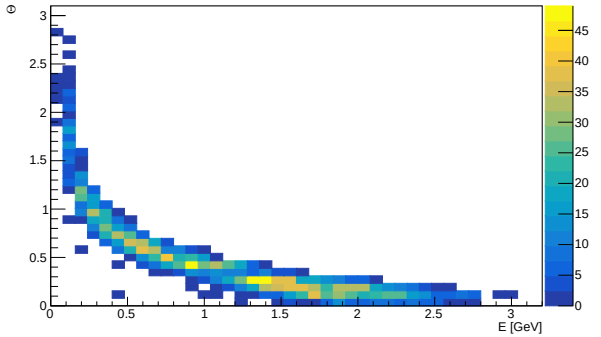
Reconstructed in an $\tilde{\eta_{c1}}$



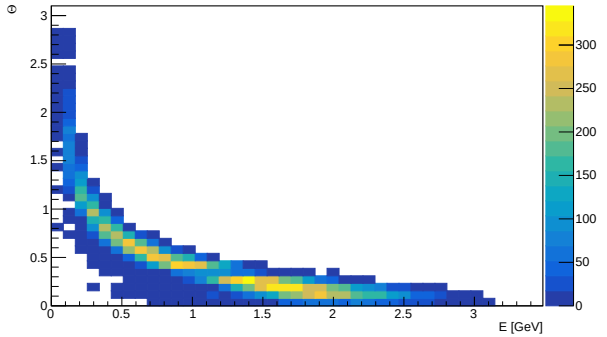
Reconstructed in a χ_{c1}



Reconstructed mct in a χ_{c1}



Reconstructed in an mct $\tilde{\eta_{c1}}$

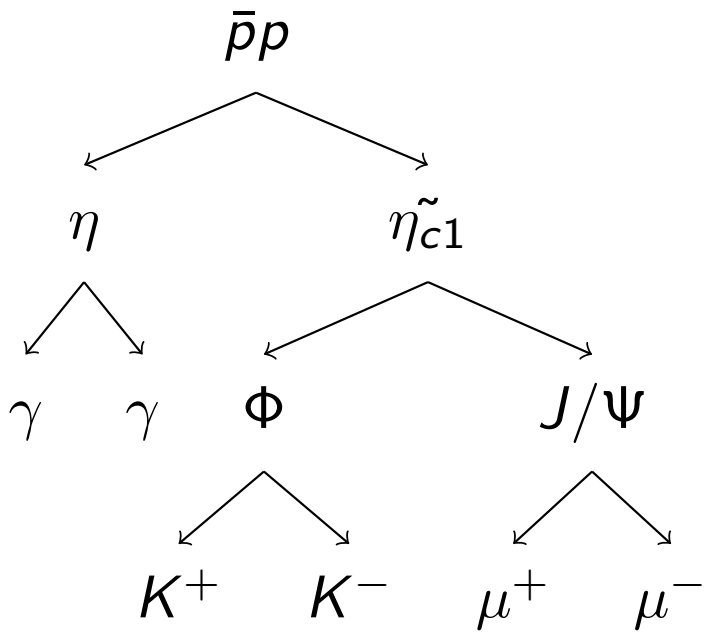


Reconstructed in an mct χ_{c1}

5th photon

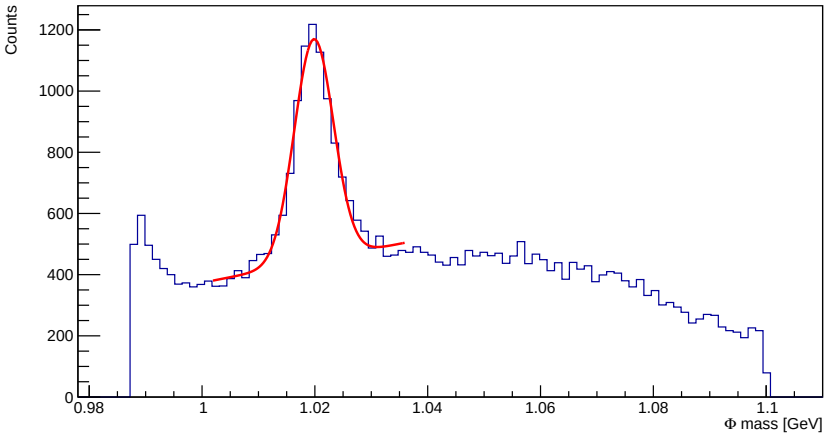
	Eff. with $\chi_{c1} mct$	Eff. with 30% J/Ψ	Events
$\theta < 0.2$	20.8%	69.3%	25%
$0.2 < \theta < 0.4$	13.7%	45.6%	32%
$\theta > 0.4$	18.4%	61.3%	43%

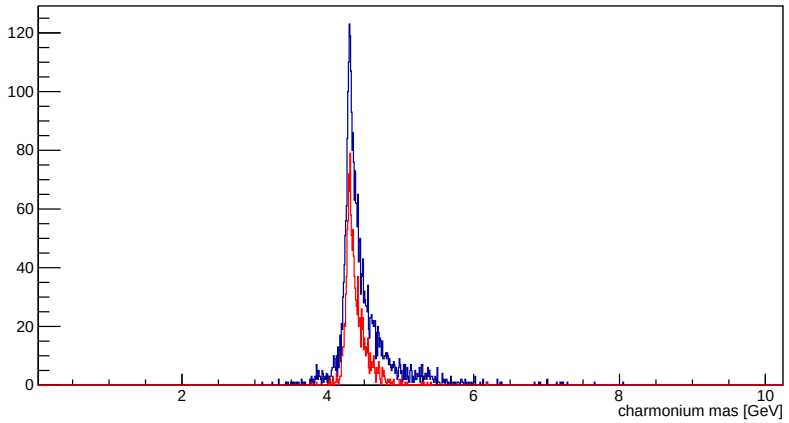
New decay channel

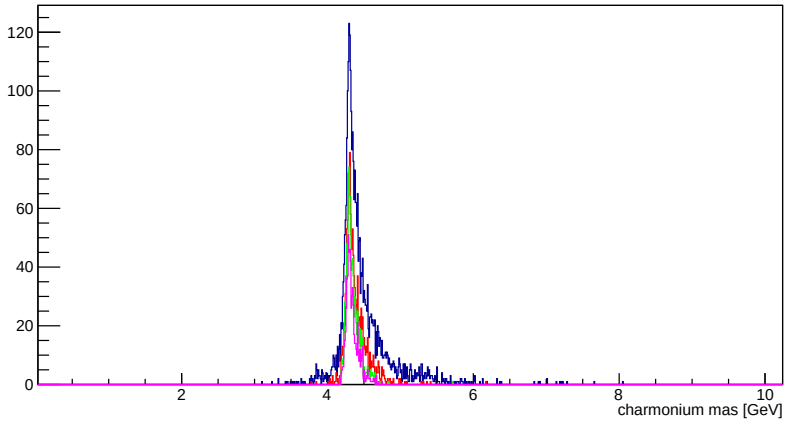


Φ efficiency: 10.3%
J/Ψ efficiency: 28%

Mass distributions



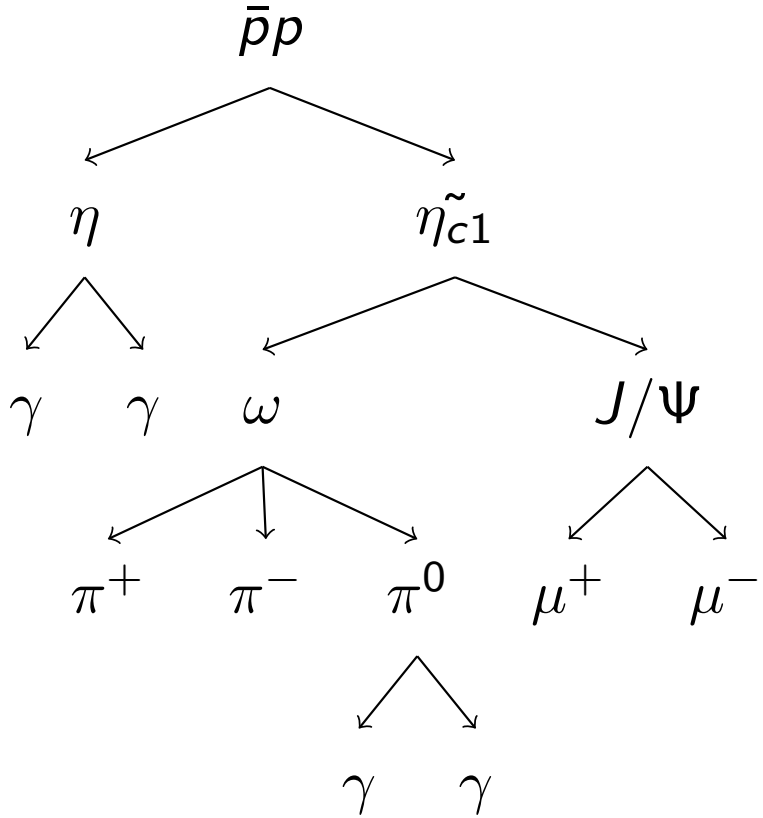




Efficiency: 1.32%

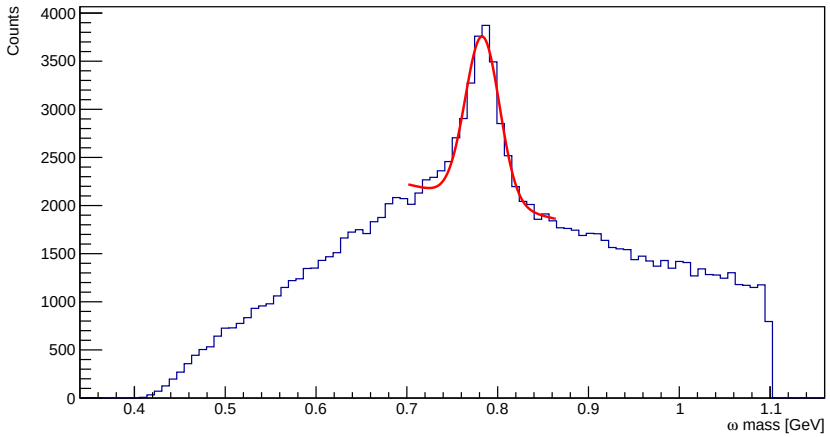
Efficiency with prob. cuts: 0.66%

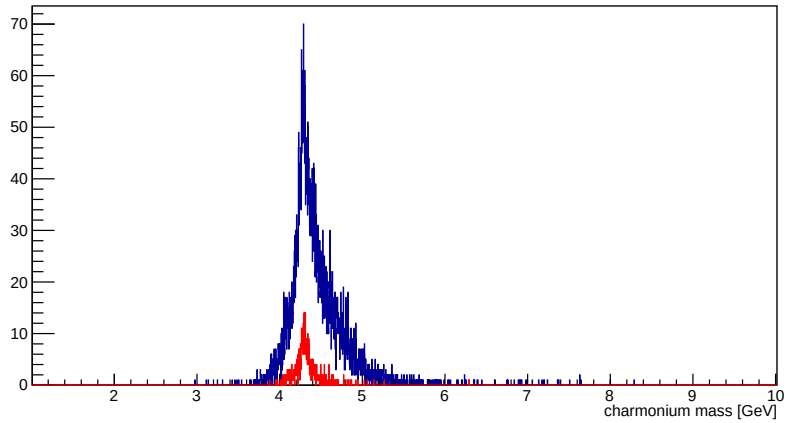
New decay channel

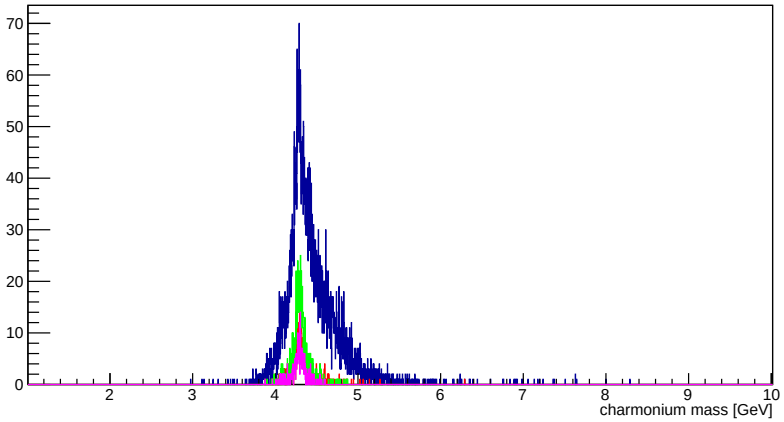


ω efficiency: 7.2%
J/Ψ efficiency: 25%

Mass distributions







Efficiency: 0.74%

Efficiency with prob. cuts: 0.41%