Study of intermediate state of $\Lambda_c^+ \to p\, K_s\, \pi^0$

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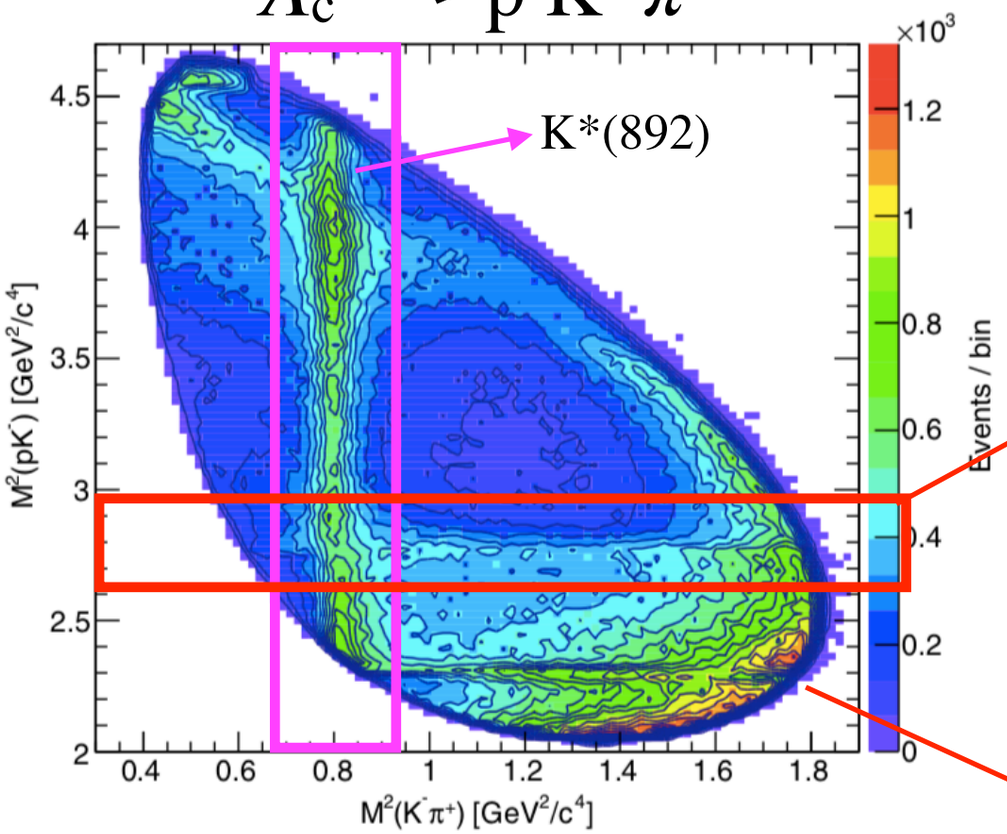
Outline

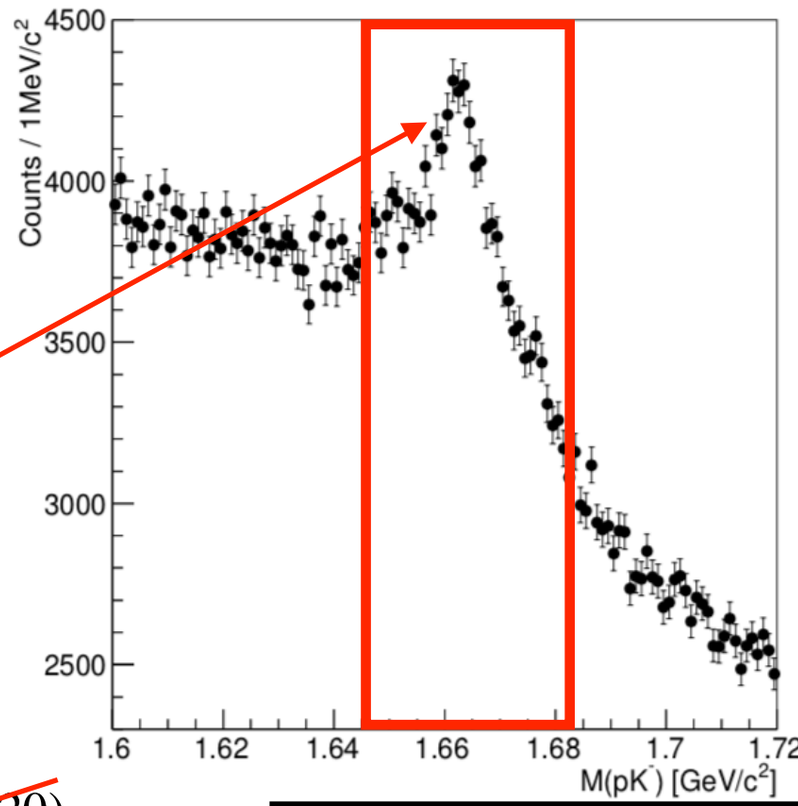
- Motivation
- Optimization
- Detection efficiency

Motivation

- Identification of new hyperon resonance
  - Excited state of Λ : Sharp peak would disappear in the $\Lambda_c^+ \rightarrow p\ K_s\ \pi^0$ mode
  - Excited state of Σ : Sharp peak would appear in the $\Lambda_c^+ \rightarrow p\ K_s\ \pi^0$ mode
- Measurement of branch ratio of the $\Lambda_c^+ \rightarrow p\ K_s\ \pi^0$ and resonances
- Mass shift of K(892) around M(pK) ≃ 1.67 GeV/c^2

$\Lambda_c^+ \rightarrow p\ K^-\ \pi^+$





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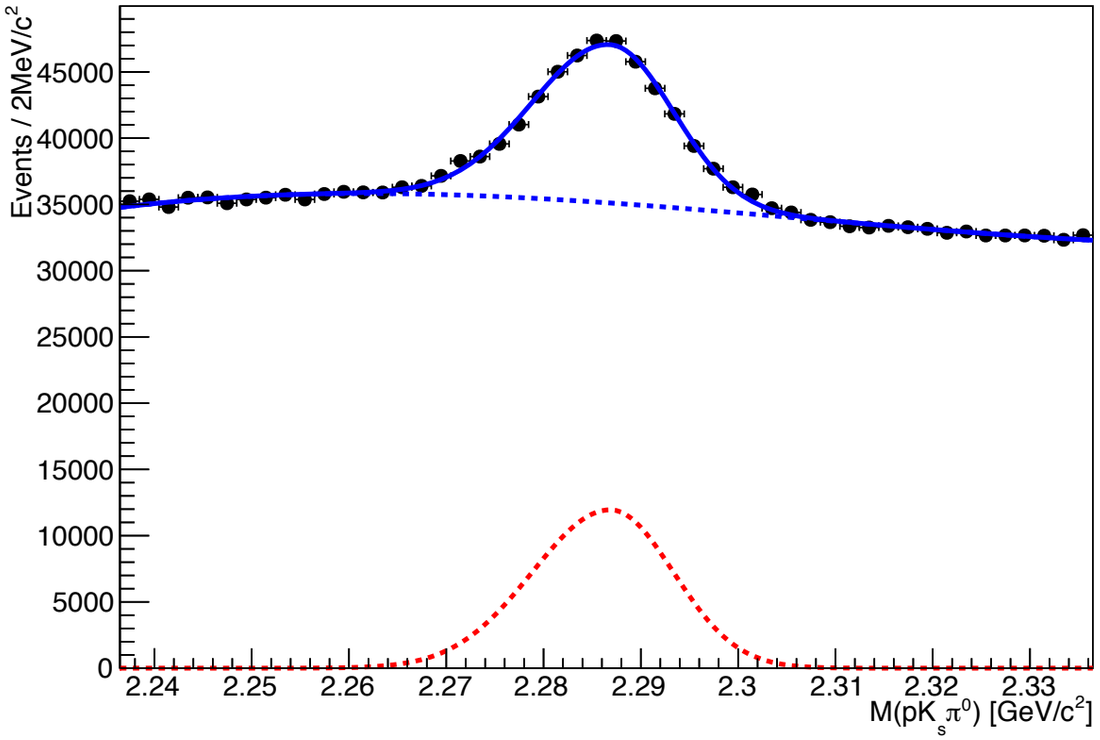
~~$\Lambda(1520)$~~

~~$\Lambda(1670)$~~, $\Sigma(1660)$, $\Sigma(1670)$, ~~Λ^*~~

Preselection

- Λ_c
  - $2.18646 < \text{mass} < 2.38646$
  - $x_p > 0.5$
- proton
  - $R(p \mid \pi) > 0.8$
  - $R(p \mid K) > 0.8$
  - $eid < 0.9$
  - $dr < 0.3$ cm
  - $dz < 3.0$ cm
  - Number of SVD hits
    - $r\varphi$-layer > 0
    - z-layer > 0
- π^0
  - $0.12 < \text{mass} < 0.15$
  - $E_\gamma < 50$MeV
- K_s
  - $0.487611 < \text{mass} < 0.507611$
  - $R(p \mid \pi) < 0.4$
  - $R(K \mid \pi) < 0.4$
- For Λ_c, π^0, K_s
  - kvertex fit $\chi 2 < 40$

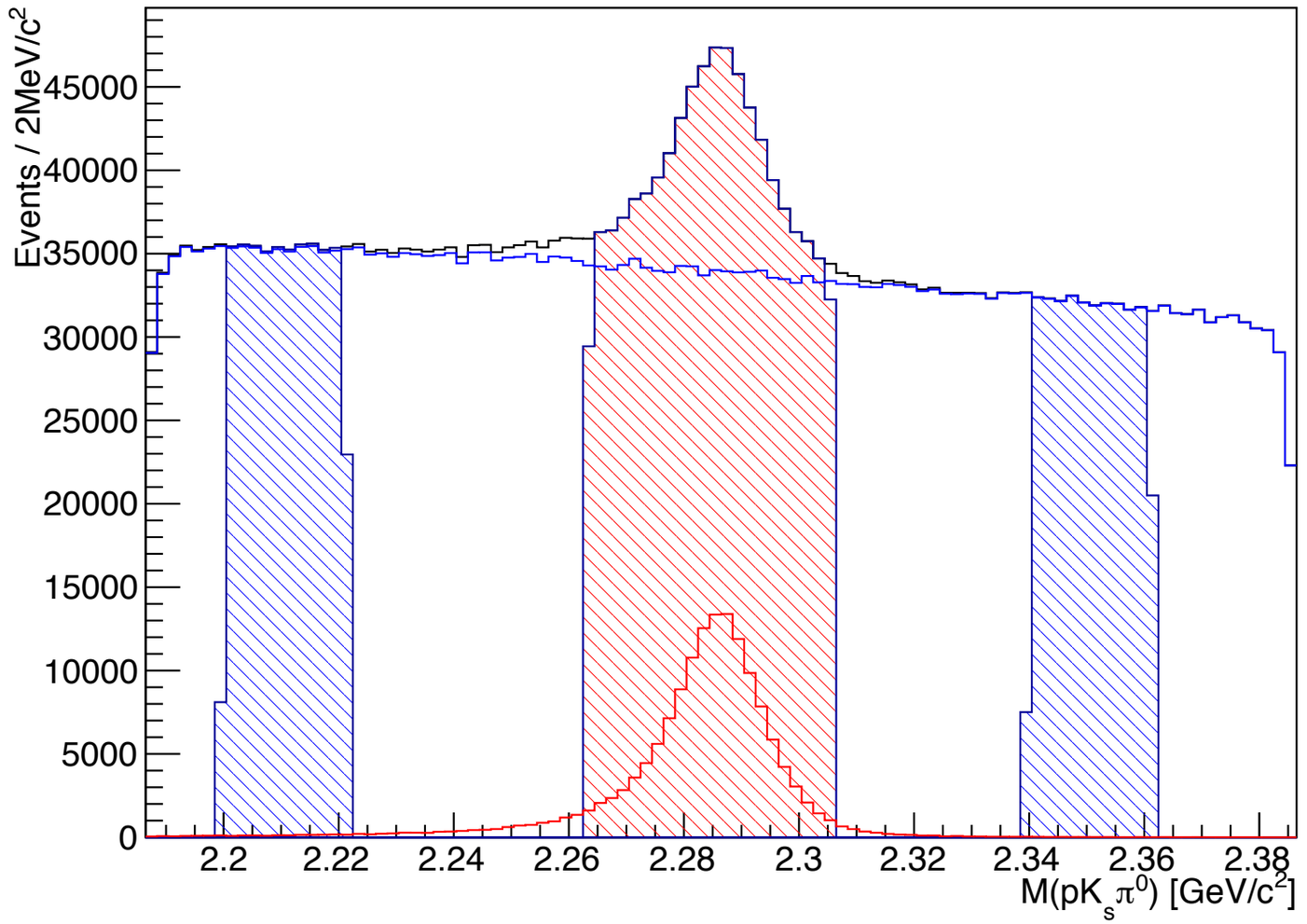
Λ_c^+ mass distribution with Preselection cuts



Bifurcated Gaussian (signal)
+ 3rd chebyshev pol (bkg)

σ_L = 0.08014

σ_R = 0.06488



Sideband1 (2.2, 2.22176)

Signal region (2.26828, 2.30633)

Sideband2 (2.34, 2.36176)

Optimization - FoM

$$\text{Figure of Merit (FoM)} = \frac{N(signal)}{\sqrt{N(generic\ MC)}}$$

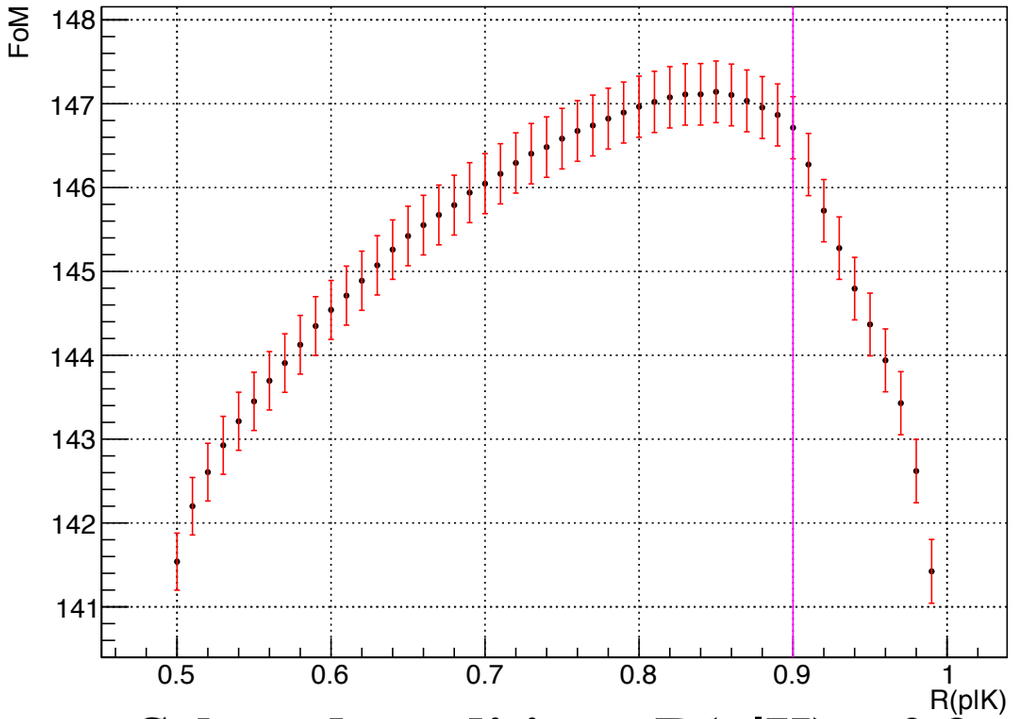
Quantity	Initial	Selected
Λ_c		
x_p	> 0.5	**> 0.54**
χ^2	< 40	< 40

Quantity	Initial	Selected
proton		
R(p|K)	> 0.8	**> 0.9**
R(p|π)	> 0.8	**> 0.9**
eid	< 0.9	< 0.9
|dr| (cm)	< 0.3	**< 0.05**
|dz| (cm)	< 3.0	**< 1.0**
SVD nhits rϕ-	> 0	-
SVD nhits z-layer	> 0	-

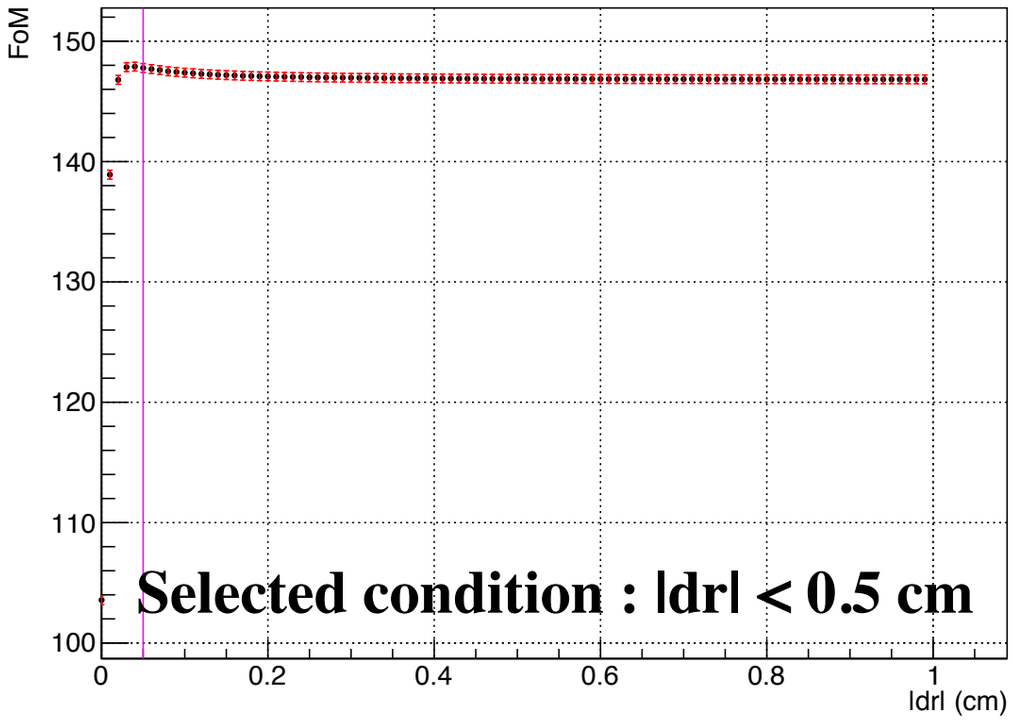
Quantity	Initial	Selected
K_s		
mass	$\pm 10 MeV/c^2$	$\pm 10 MeV/c^2$
R(K|π)	<0.4	-
R(p|π)	<0.4	**< 0.9**
χ^2	<40	<40

Quantity	Initial	Selected
π^0		
mass (GeV)	(0.12,0.15)	**(0.125, 0.142)**
E_γ	$> 50MeV$	**barrel 50MeV endcap 100MeV**
E9/E25	-	**> 0.9**
χ^2	<40	**< 50**
P(π^0)	-	**> 0.7**

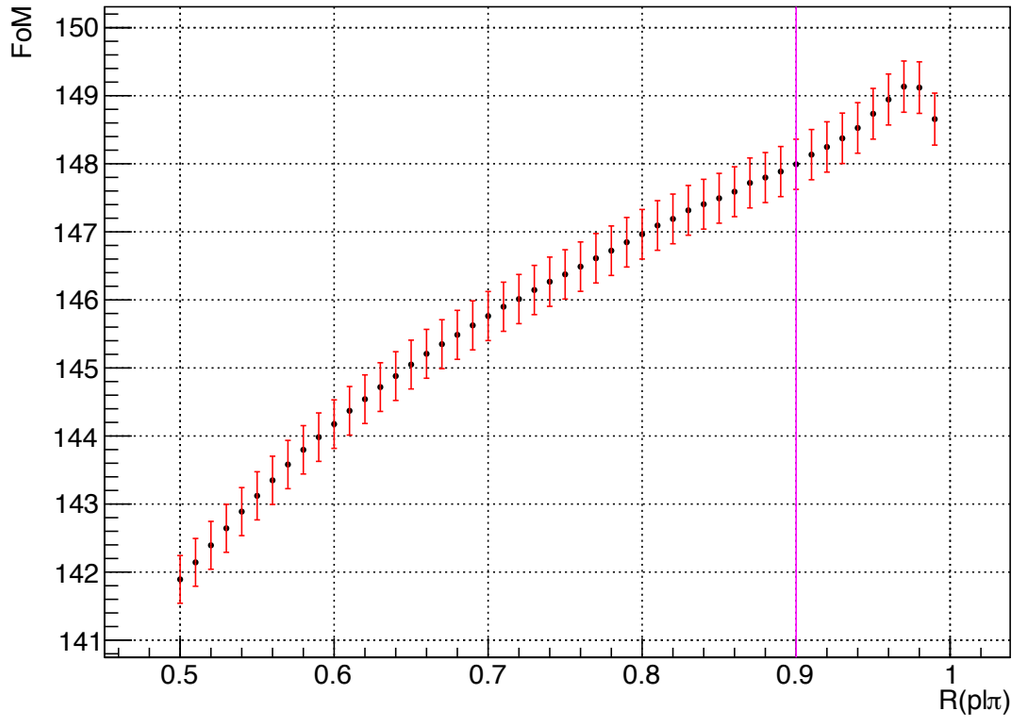
Optimization - proton



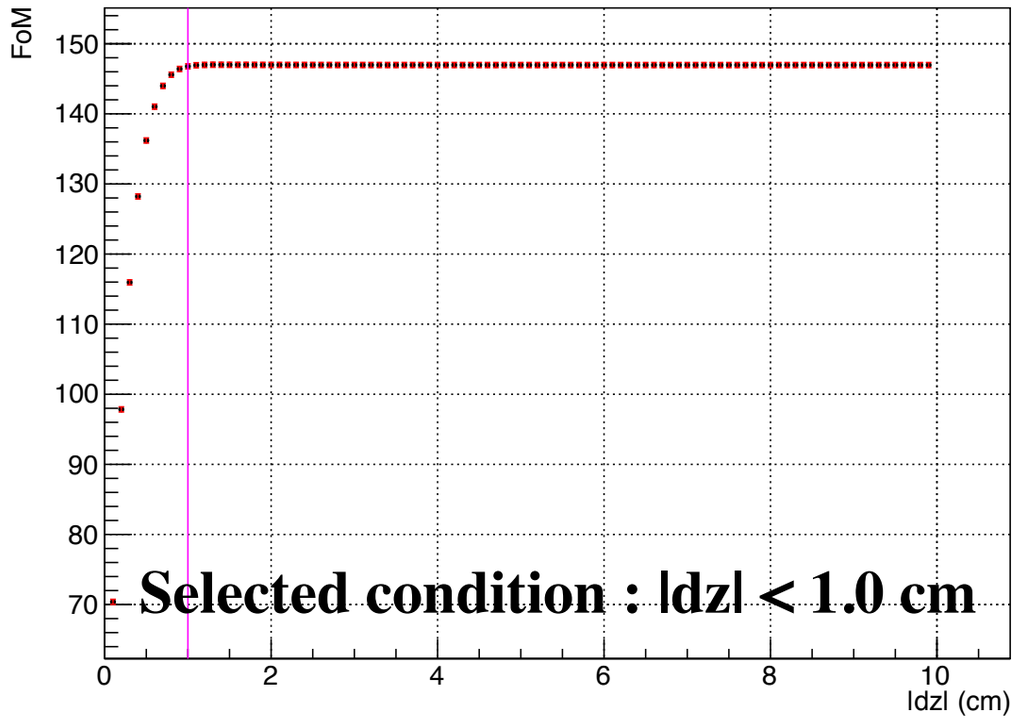
Selected condition : R(plK) > 0.9



Selected condition : |dr| < 0.5 cm

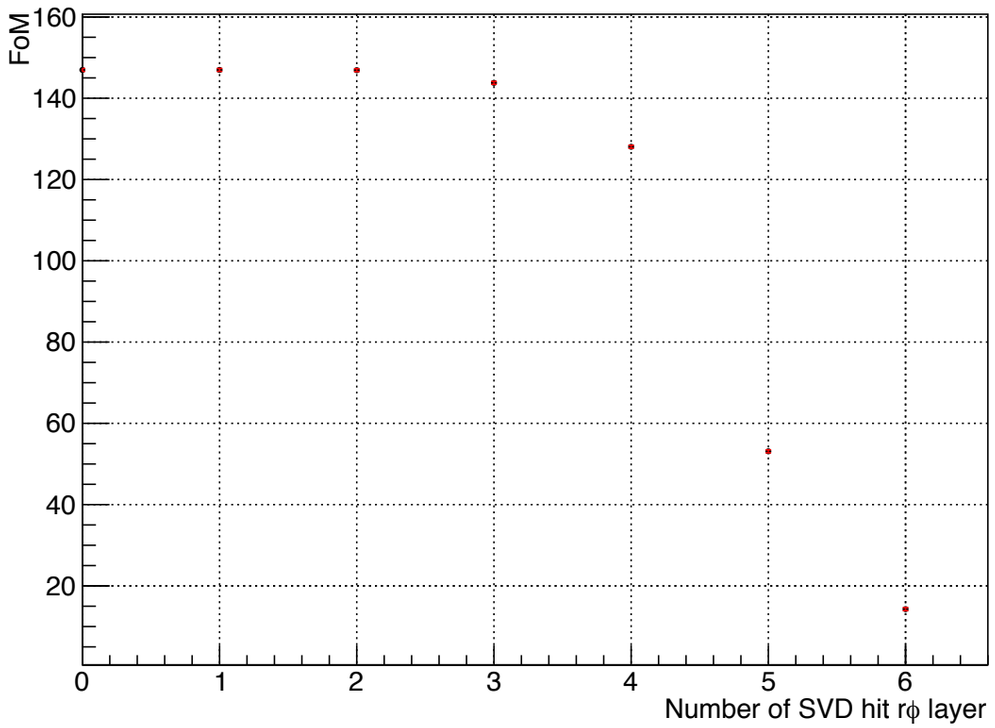


Selected condition : R(plπ) > 0.9

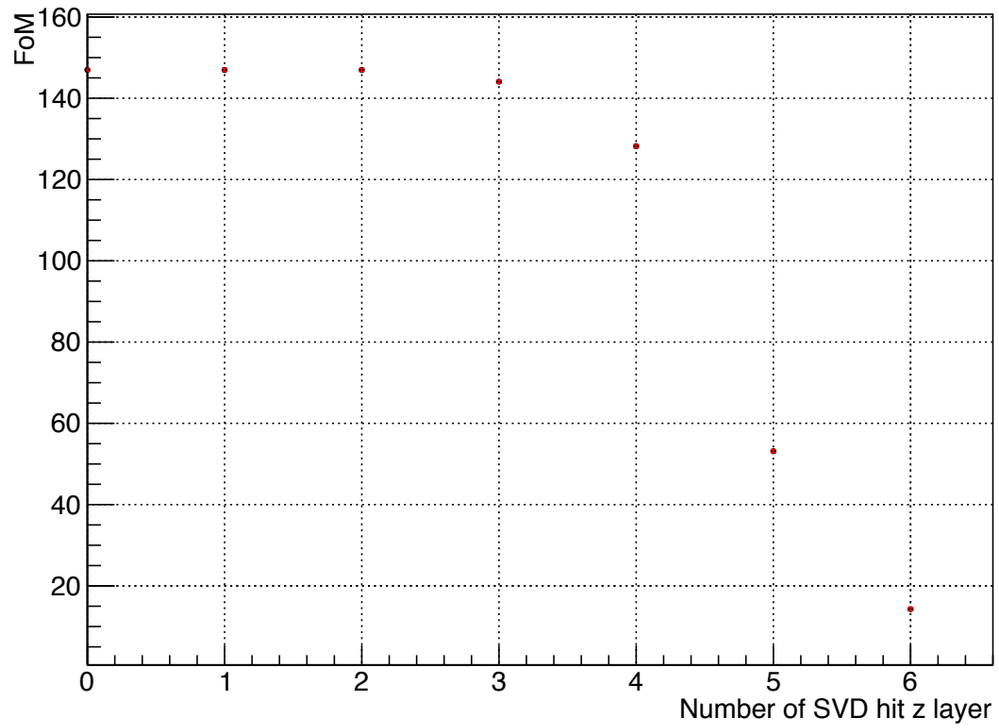


Selected condition : |dz| < 1.0 cm

Optimization - proton

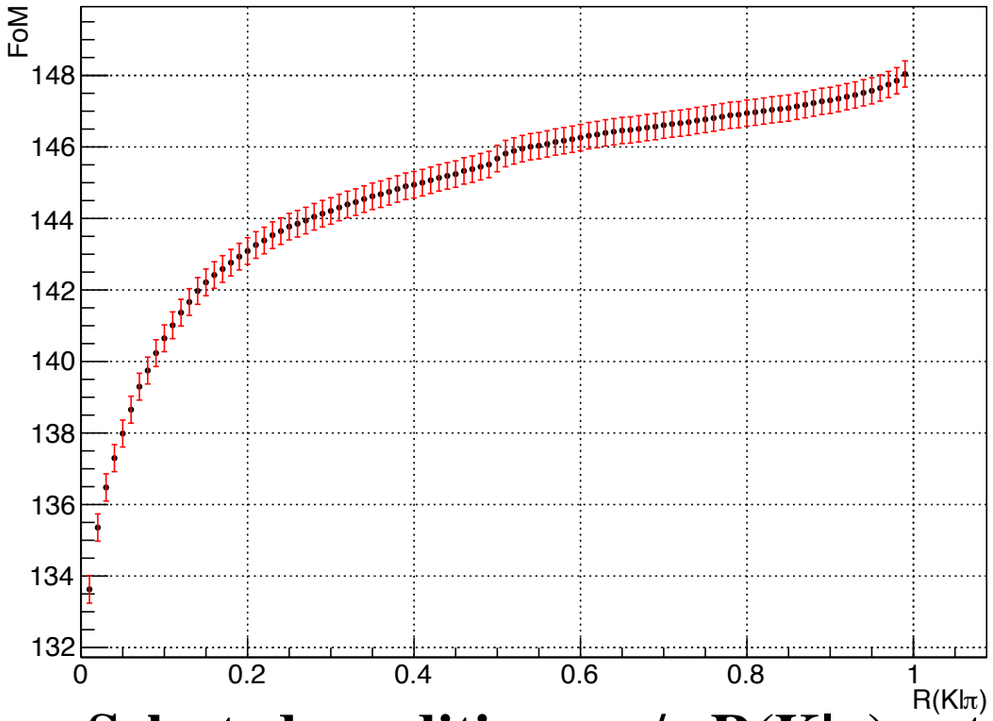


Selected condition : w/o nhits rϕ-layer cut

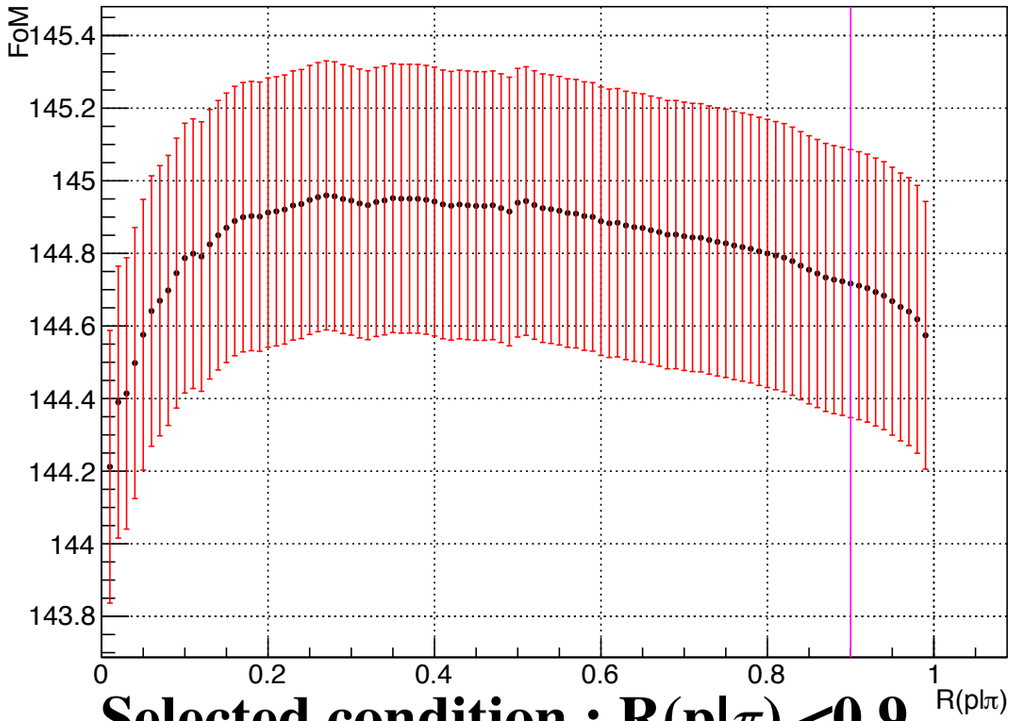


Selected condition : w/o nhits z-layer cut

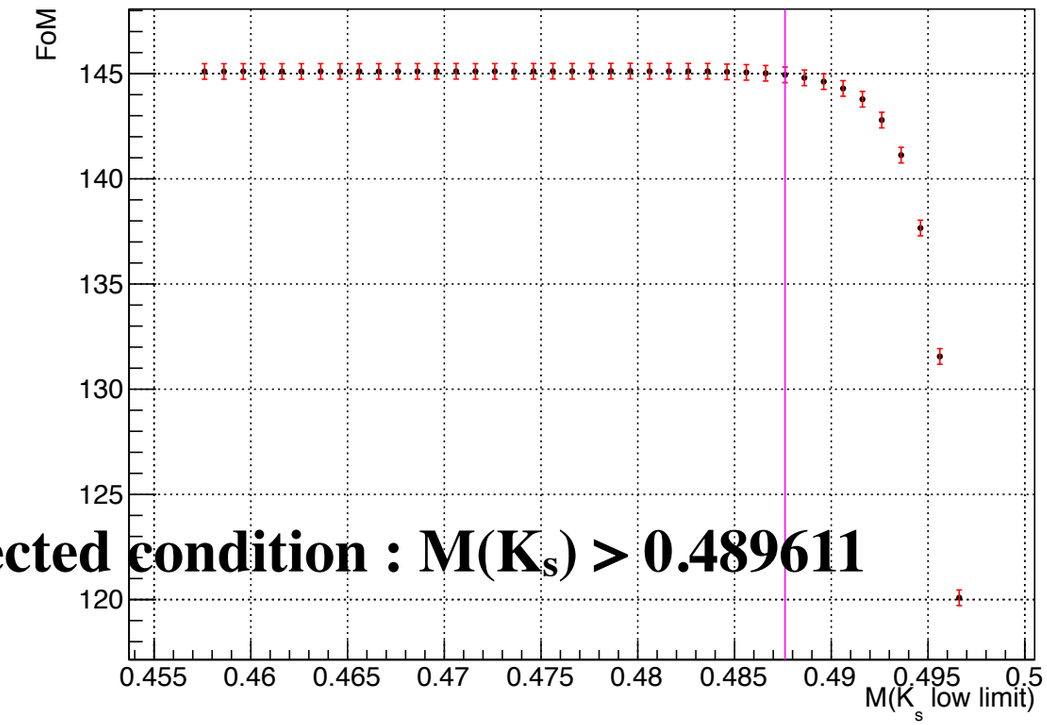
Optimization - K_s



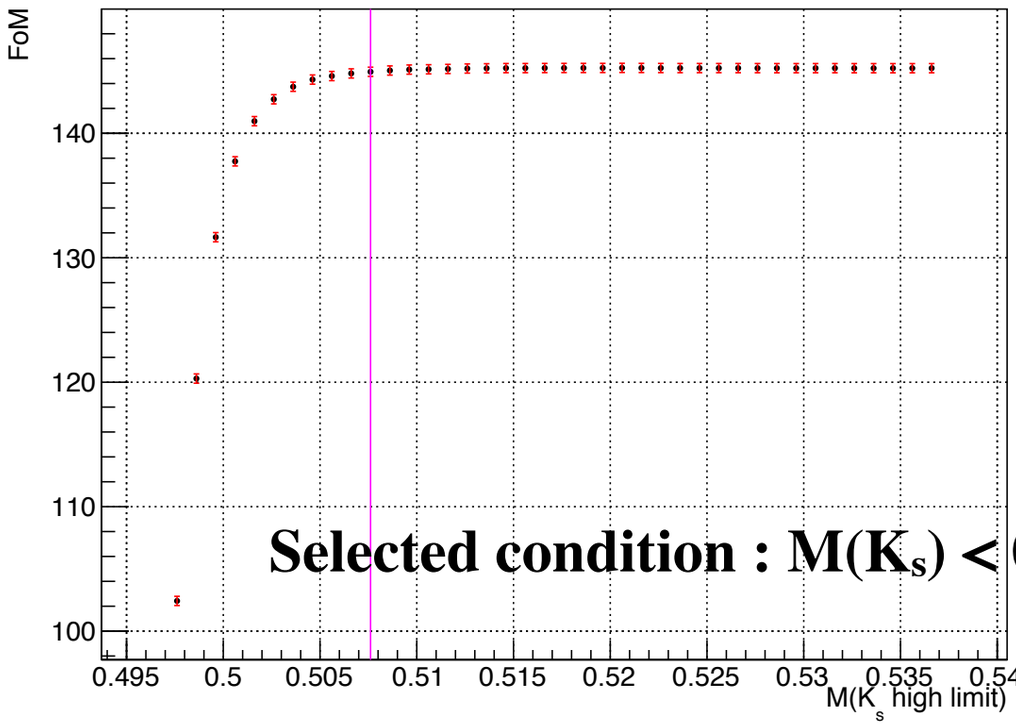
Selected condition : w/o R(Klπ) cut



Selected condition : R(plπ) <0.9

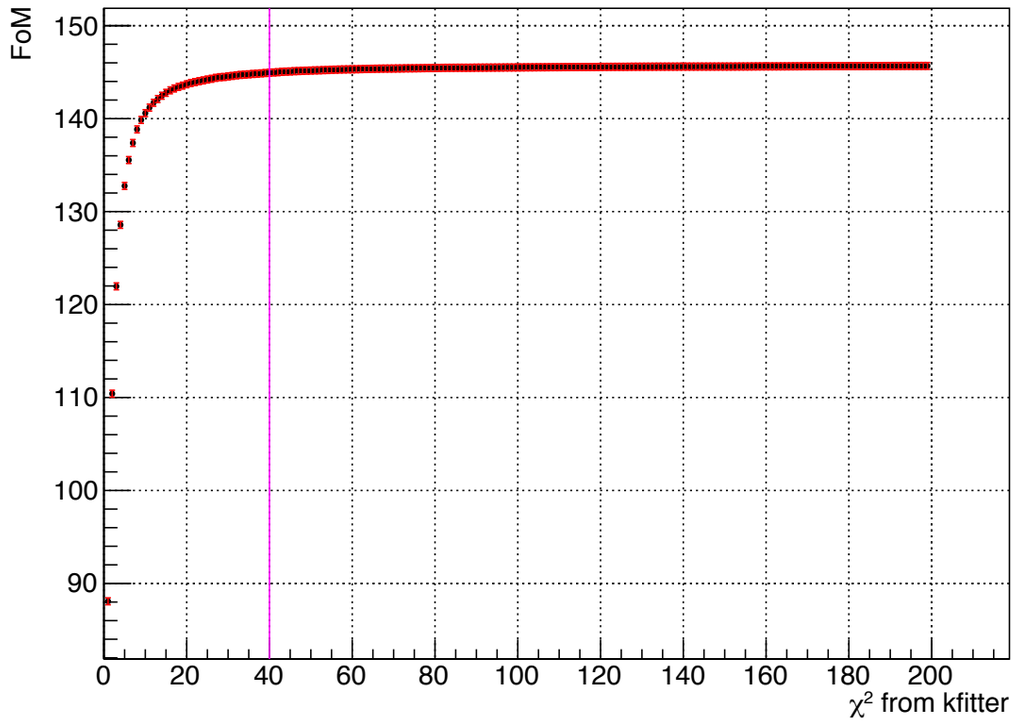


Selected condition : M(K_s) > 0.489611



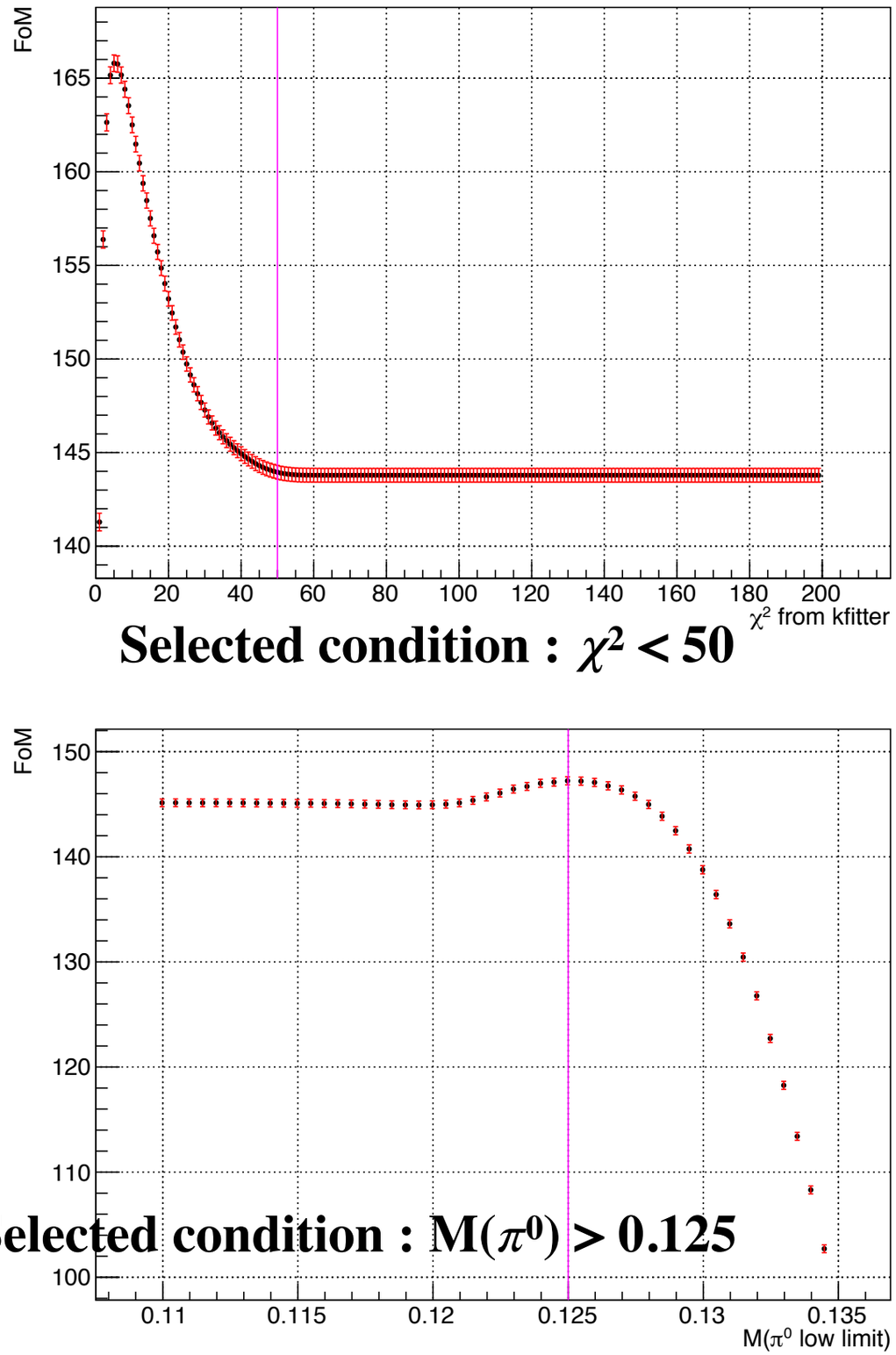
Selected condition : M(K_s) < 0.509611

Optimization - K_s



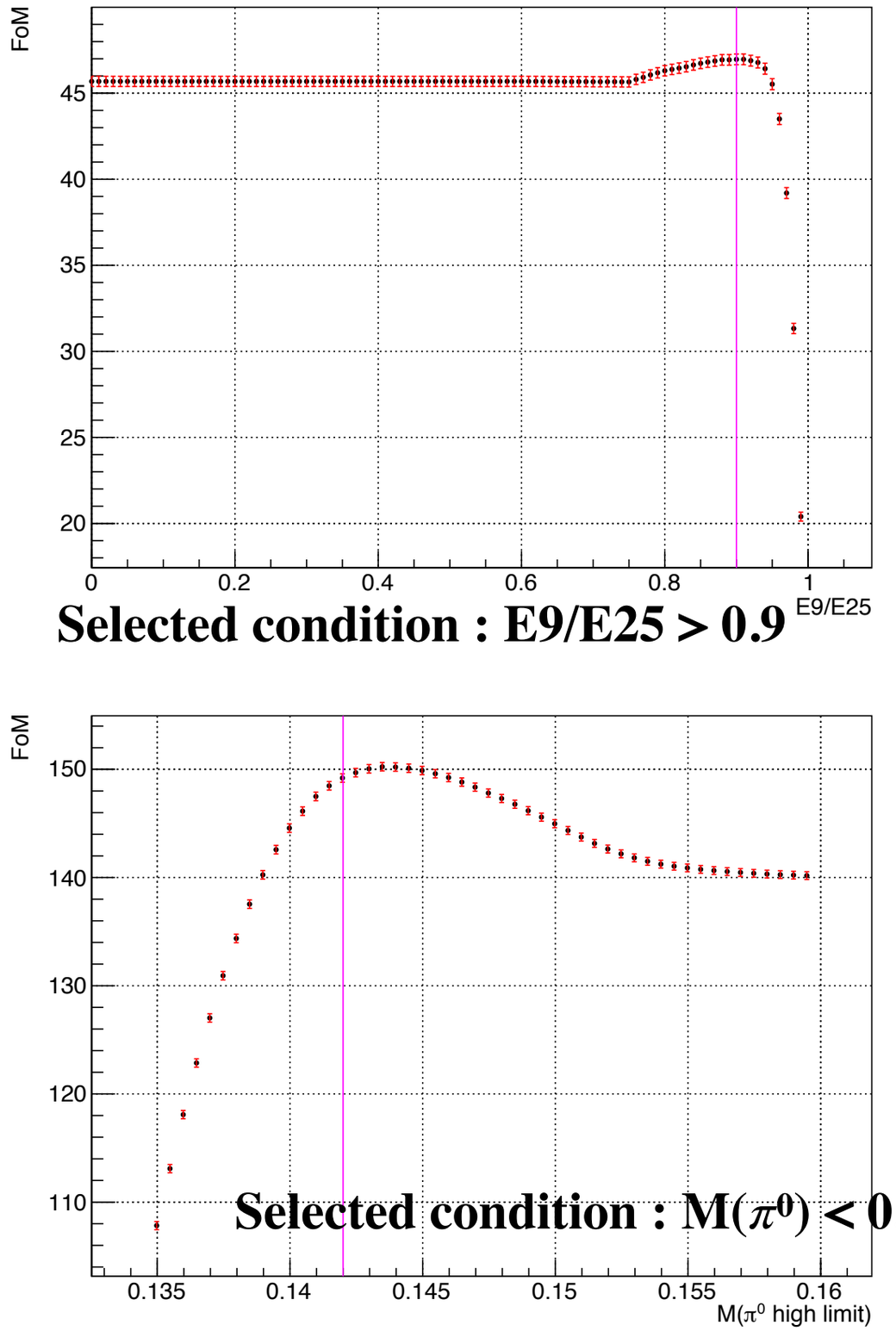
Selected condition : $\chi^2 < 40$

Optimization - π^0



Selected condition : $\chi^2 < 50$

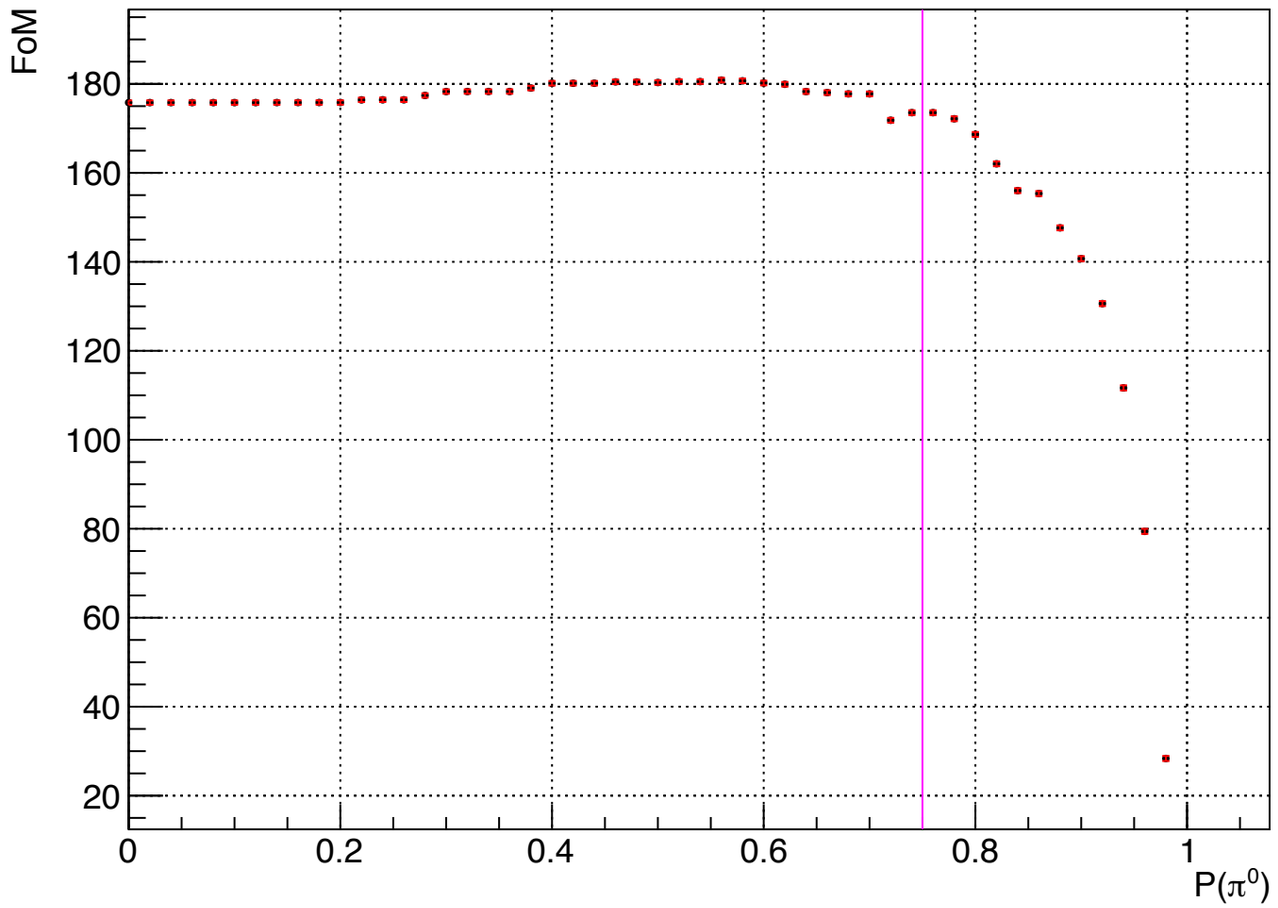
Selected condition : $M(\pi^0) > 0.125$

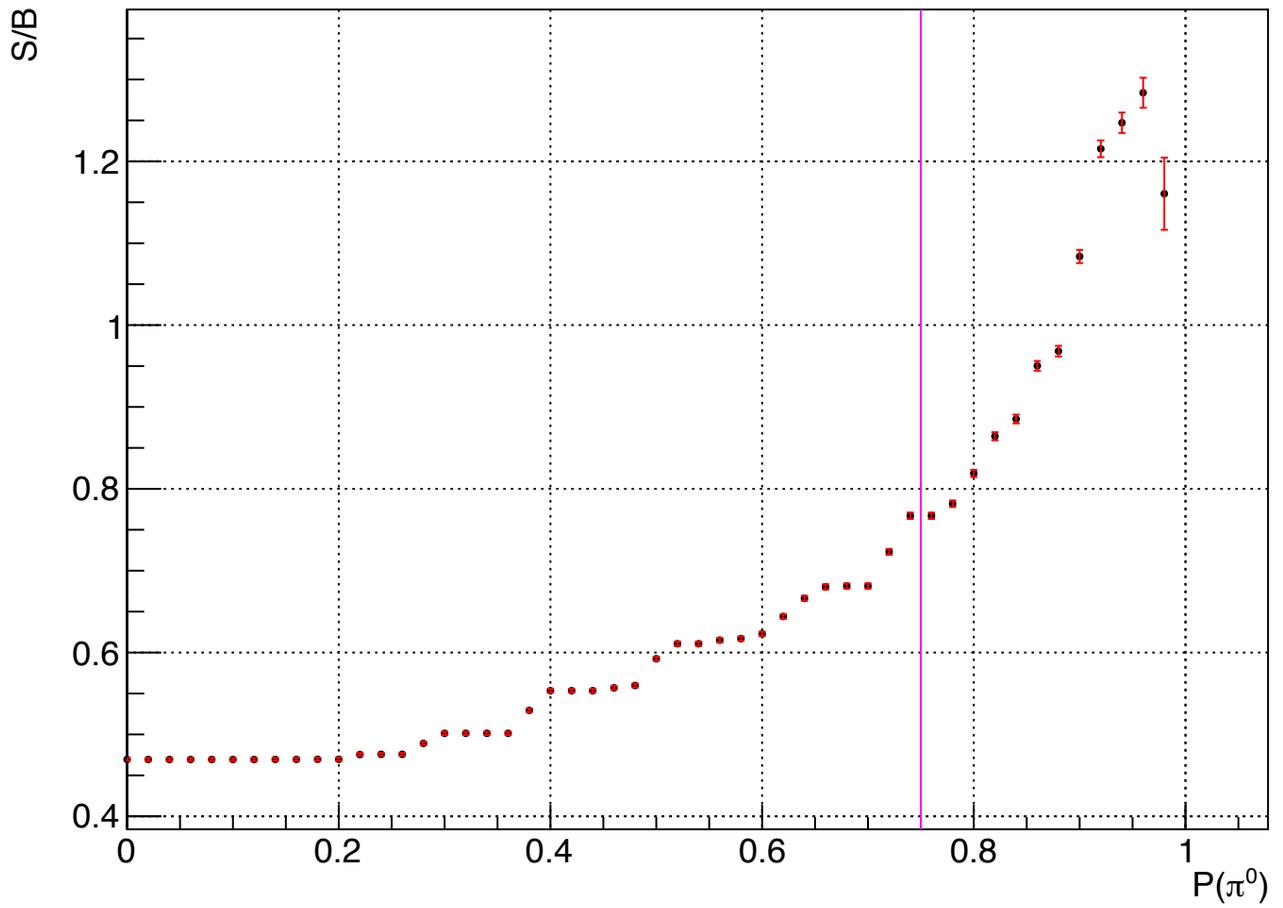


Selected condition : E9/E25 > 0.9

Selected condition : $M(\pi^0) < 0.142$

Optimization - π^0



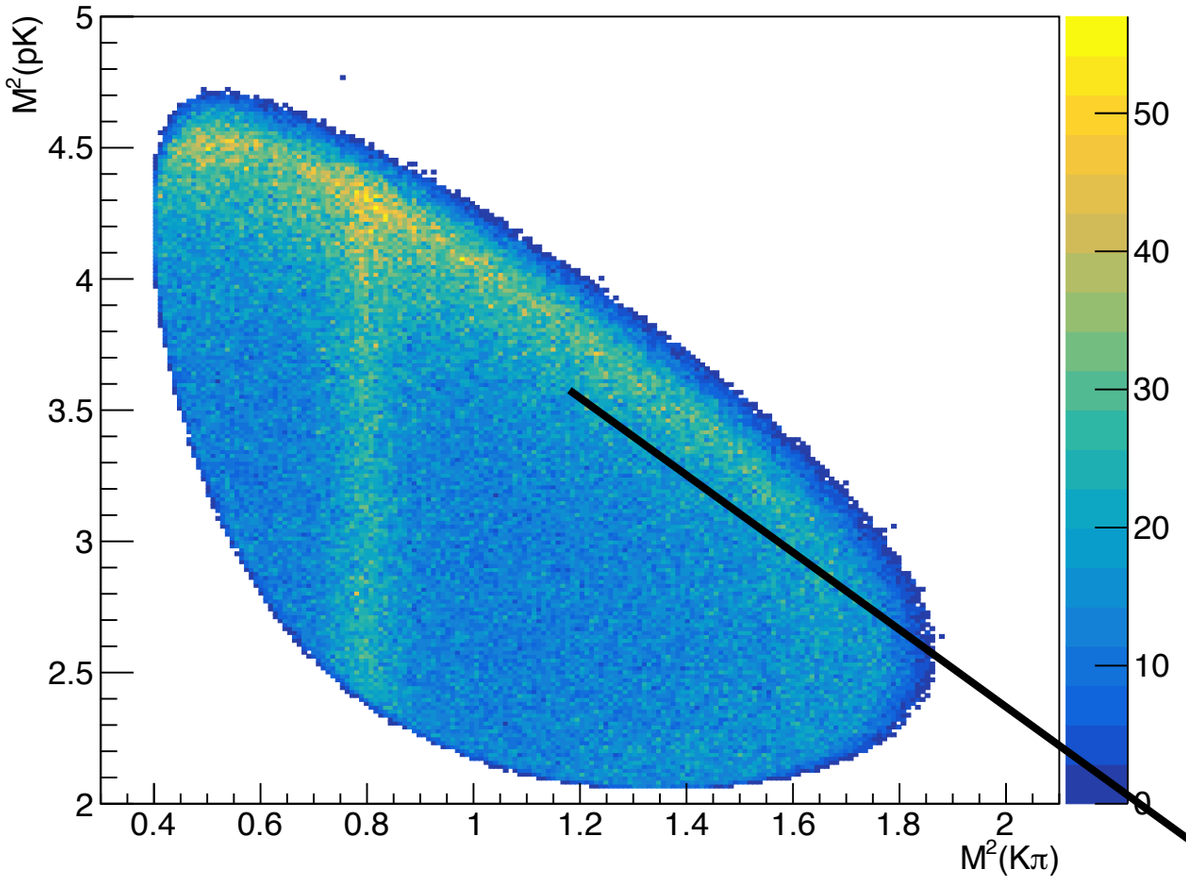


Selected condition : P(π^0) > 0.75

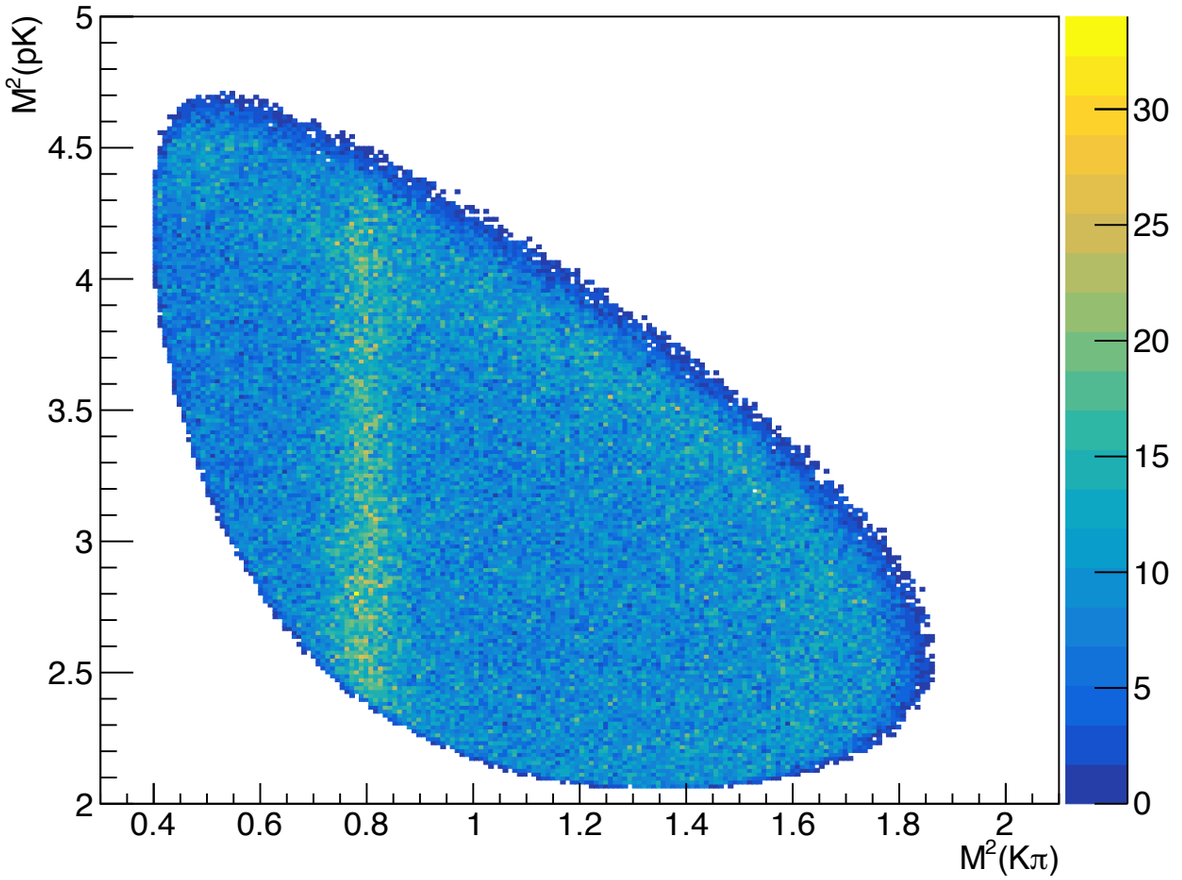
P(π^0) : Koppenburg's BN #665, #666

Optimization - P(π^0)

Selected condition : P(π^0) > 0



Selected condition : P(π^0) > 0.75

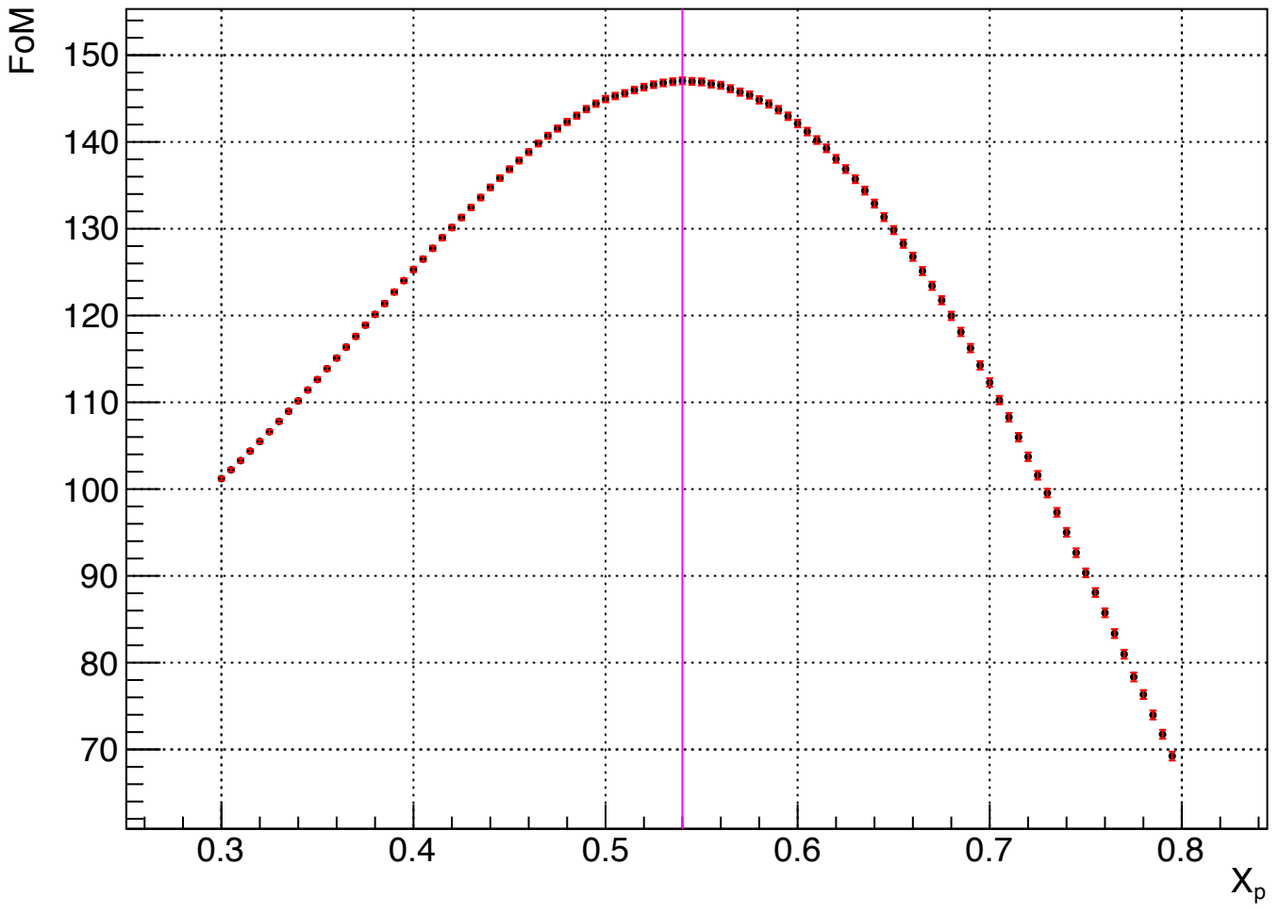


Selected condition : P(π^0) > 0.75

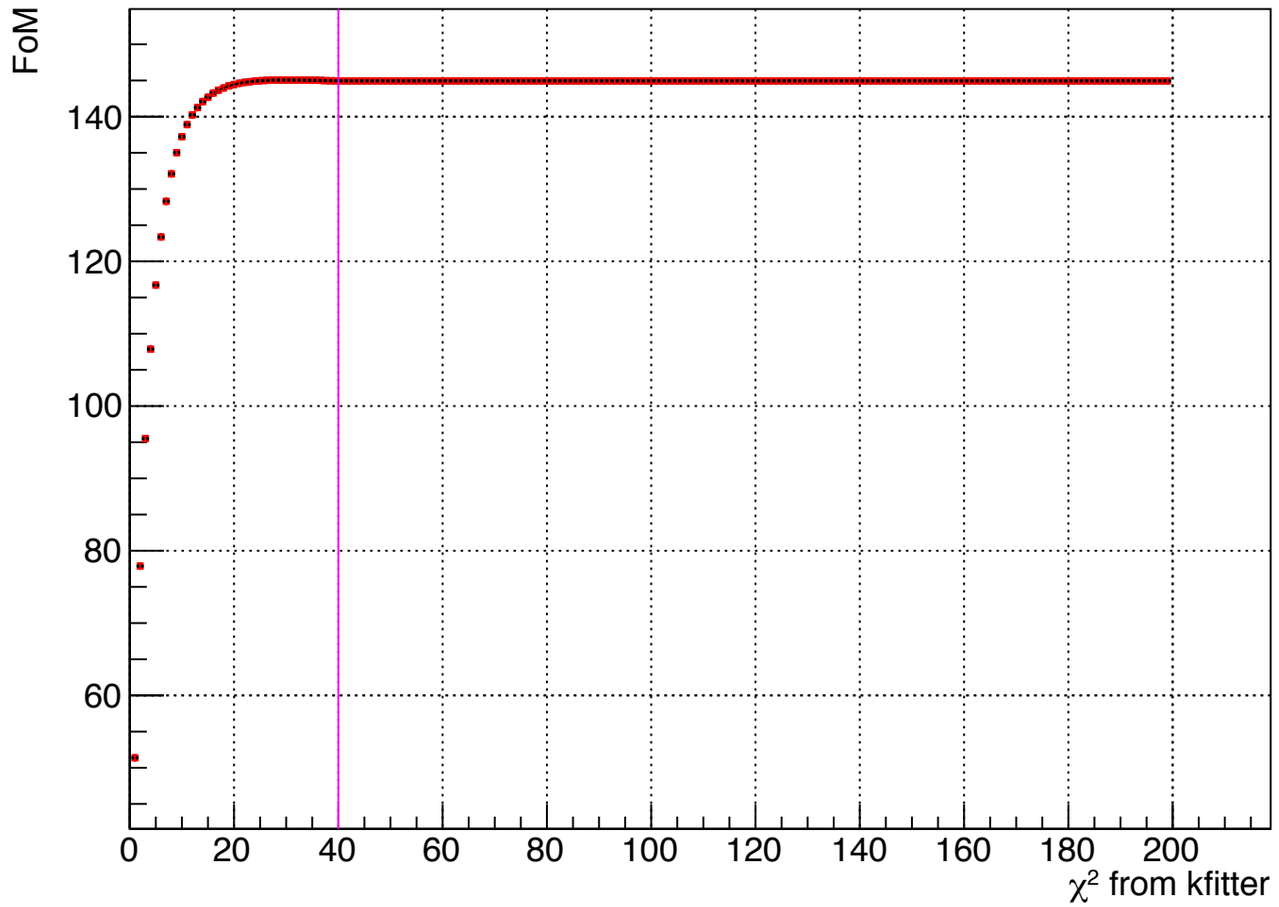
P(π^0) : Koppenburg's BN #665, #666

Background events from fake π^0 were reduced

Optimization - Λ_c^+



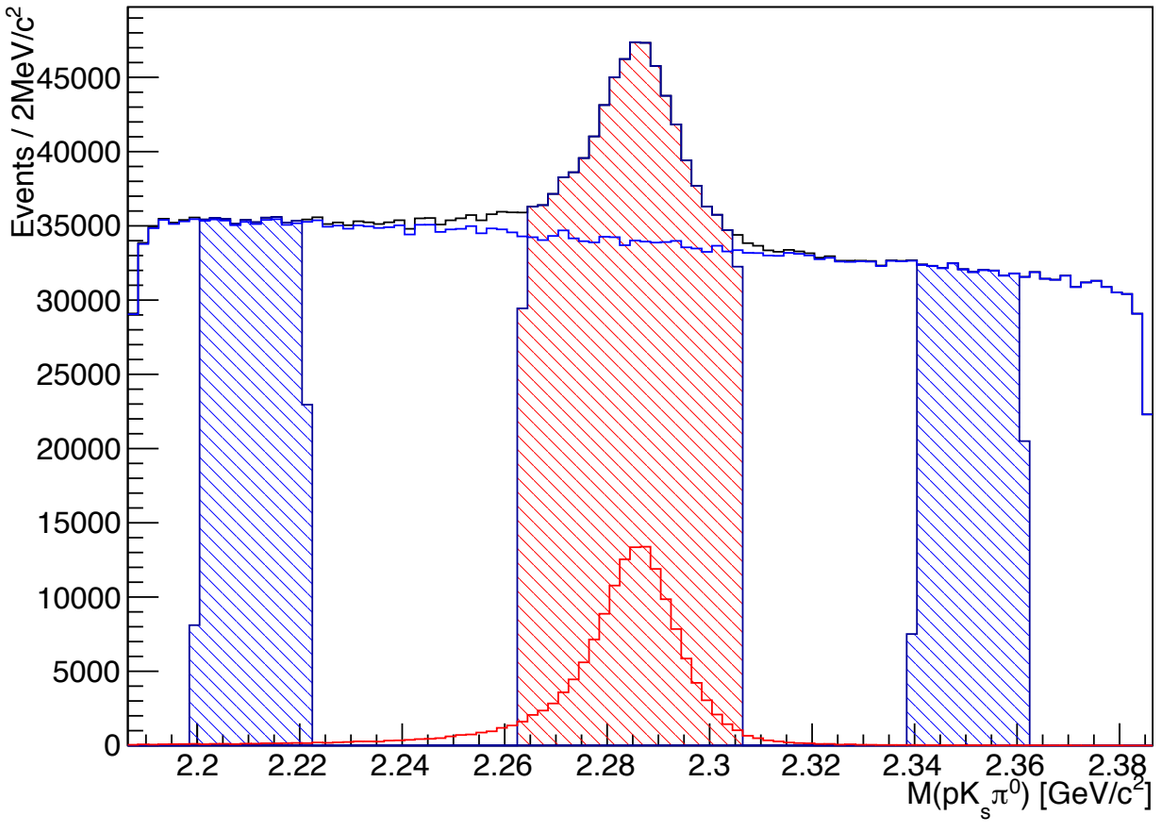
Selected condition : $X_p > 0.54$



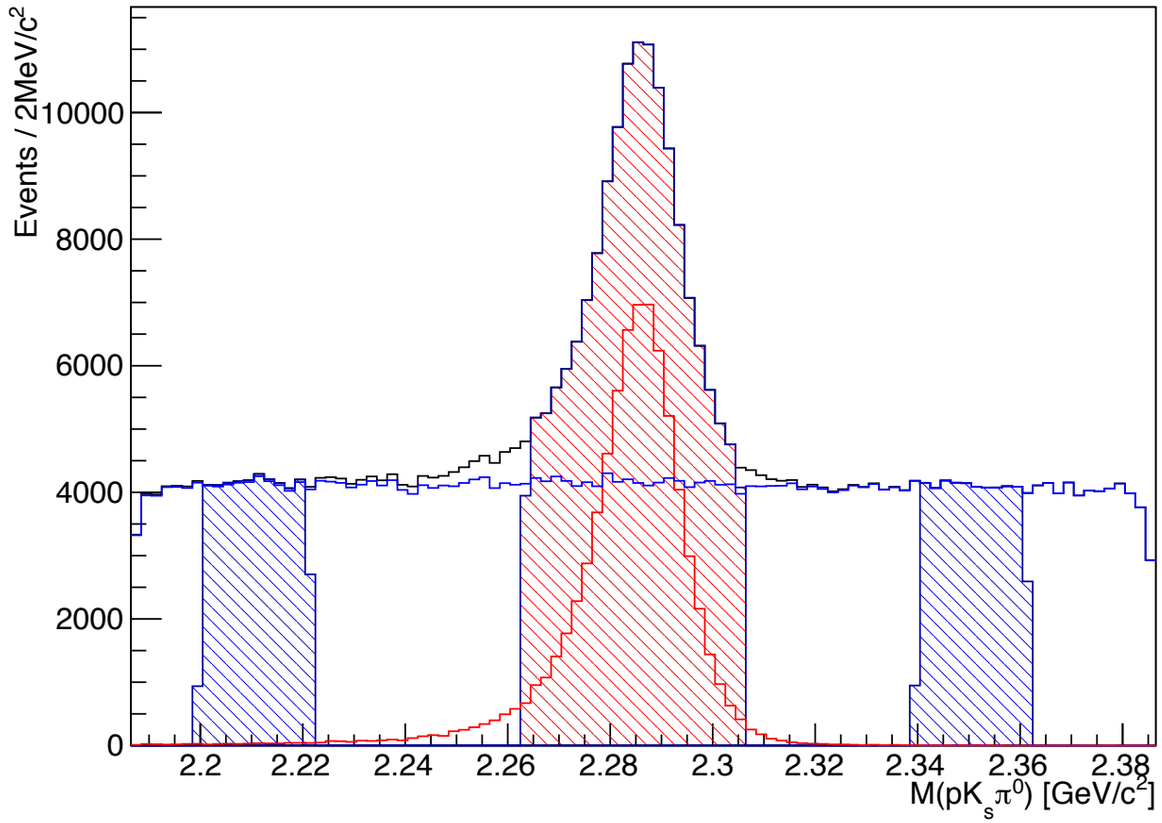
Selected condition : $\chi^2 < 40$

Optimization result - Λ_c^+ mass distribution

Preselection cut

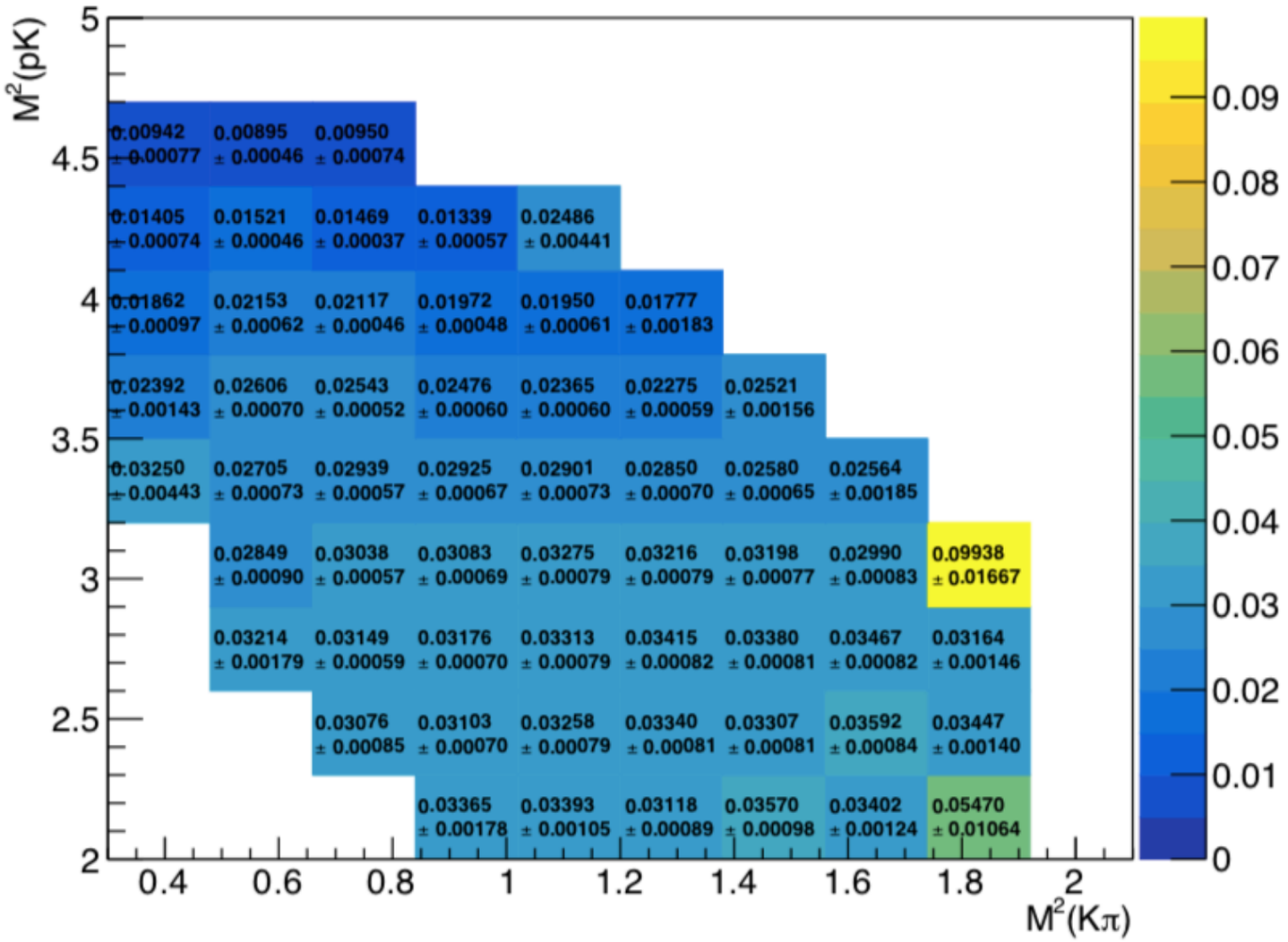


Optimized cut



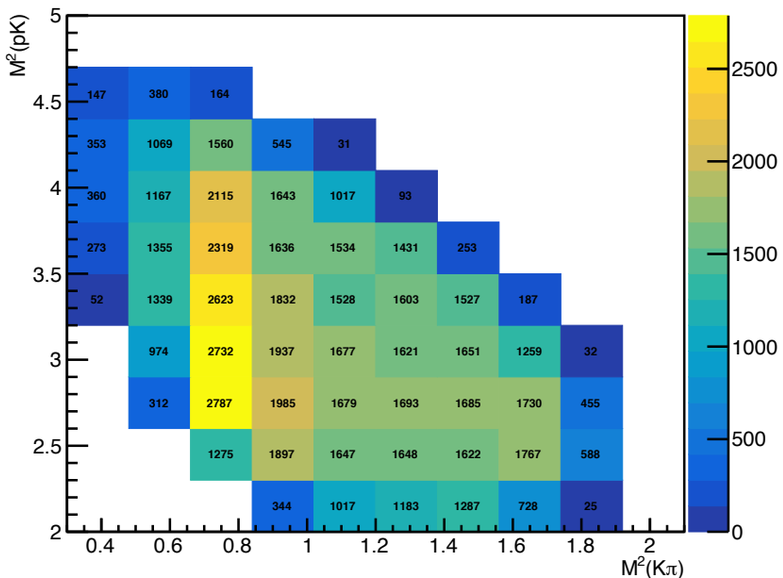
	Preselection	Selected
Nsig	151,540	74,692
Nbkg	3,364,626	411,036
Ntotal	3,516,166	485,728

Efficiency

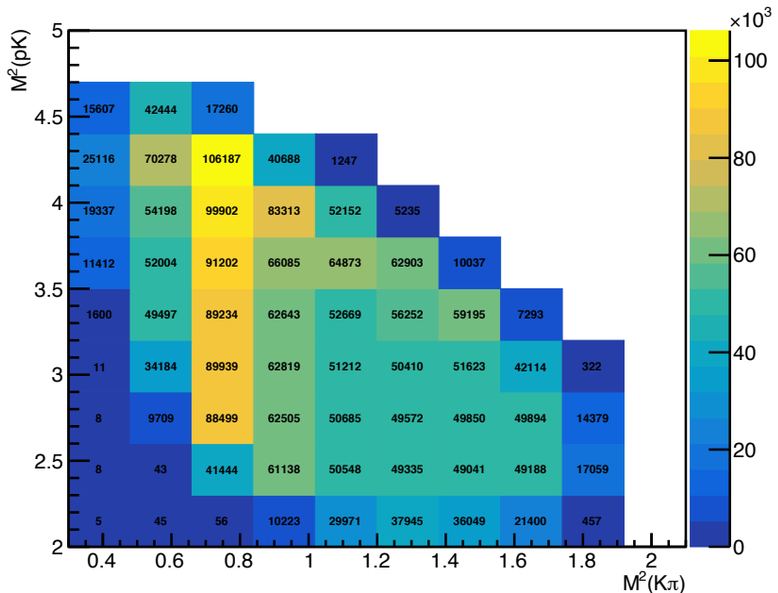


$$\text{Efficiency} = \frac{N(signal)}{N(Generated\ signal)}$$

True signals in the signal region



Generated Evts



back up

Plan

- Add $\Lambda_c^+ \rightarrow \Sigma(1670)^+ \pi^0$

  $\hookrightarrow$ p K_s