Status on X(3872) $\rightarrow$ DD decay

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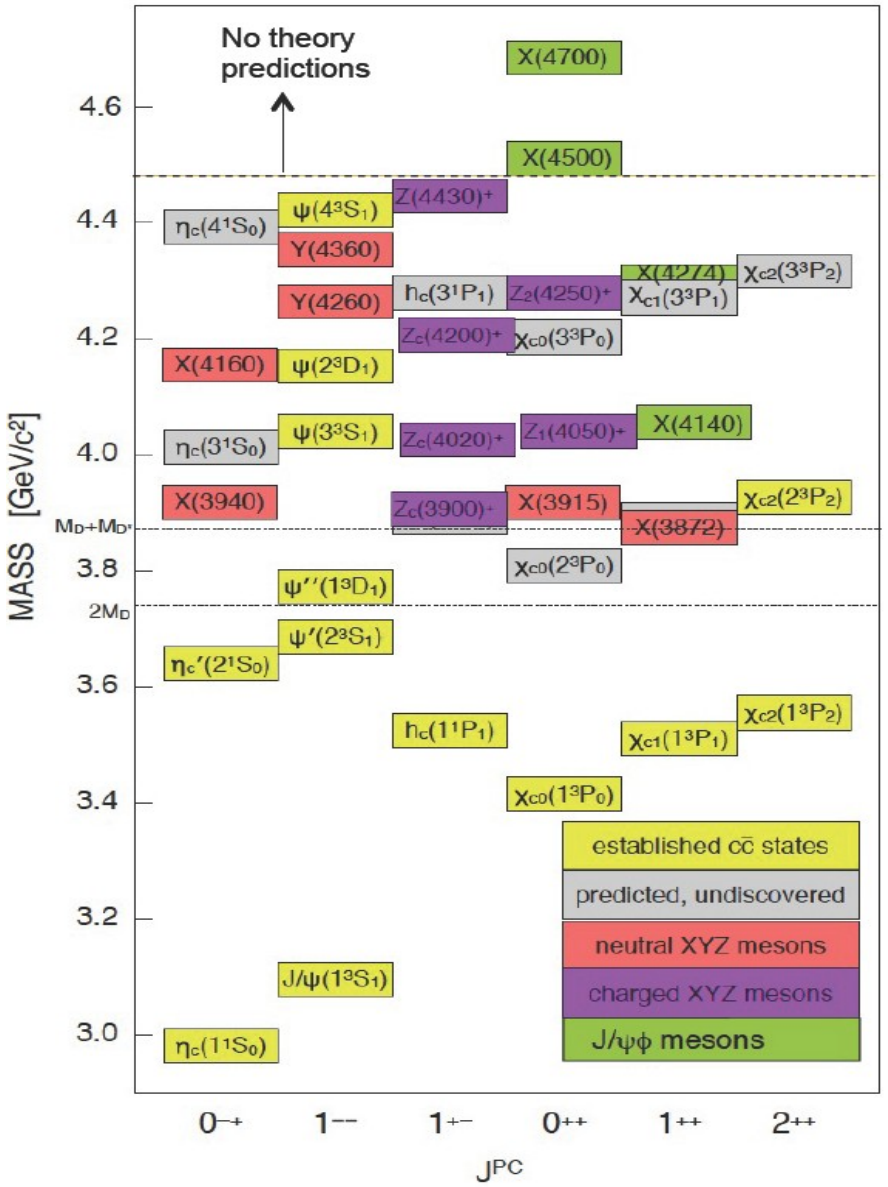
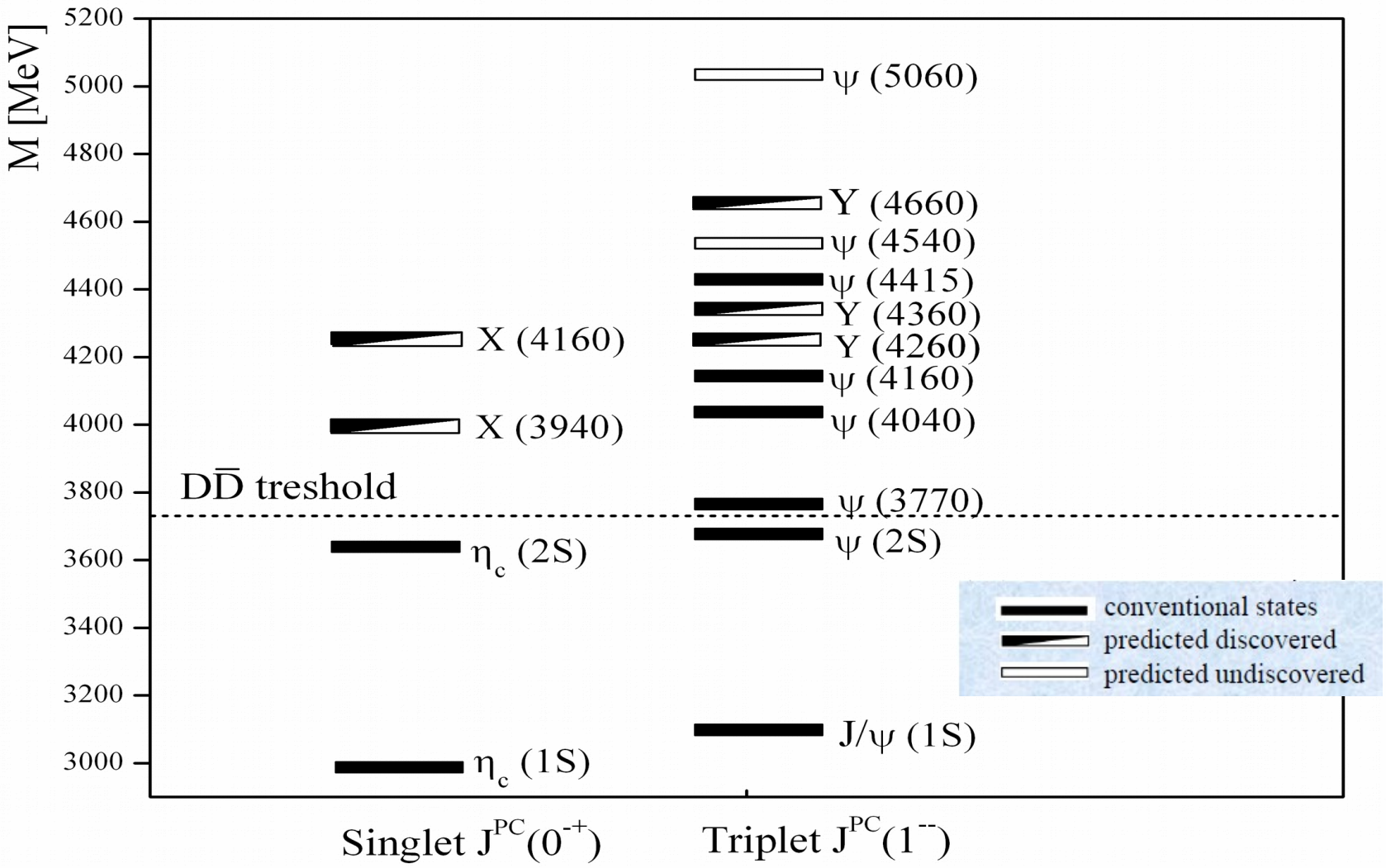
Motivation

- Predicted neutral charmonium states compared with found $c\bar{c}$ states, & both neutral & charged exotic candidates
- Based on Olsen [arXiv:1511.01589]
- Added 4 new J/ψϕ states



Motivation

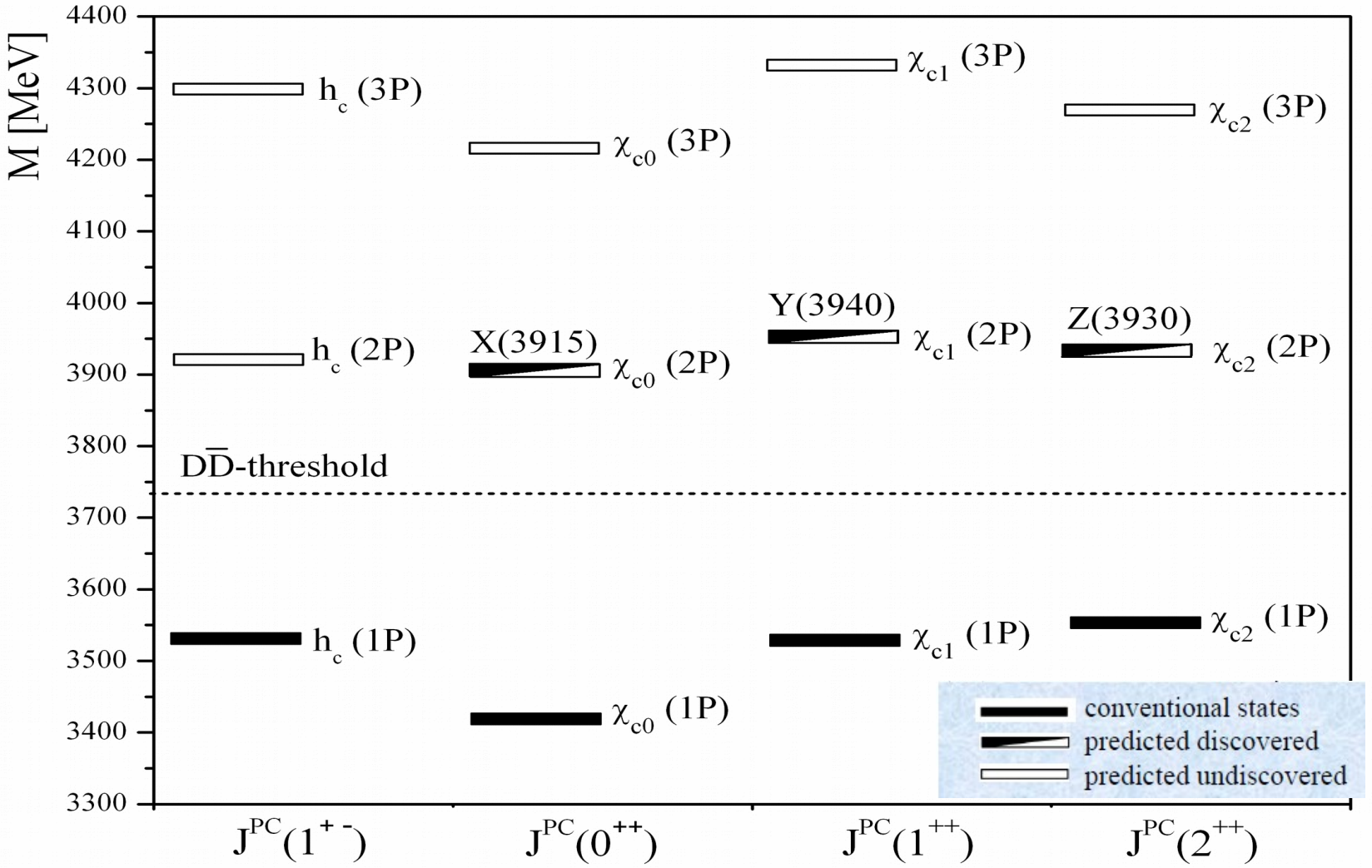
THE SPECTRUM OF SINGLET ($^1S_0$) AND TRIPLET ($^3S_1$) STATES OF CHARMONIUM



M.Yu. Barabanov, A.S. Vodopyanov, S.L. Olsen, Yadernaya Fizica, V.77, N.1, pp. 1 - 5 (2014) / Phys. At. Nucl., V.77, N.1, pp. 126 -130 (2014)

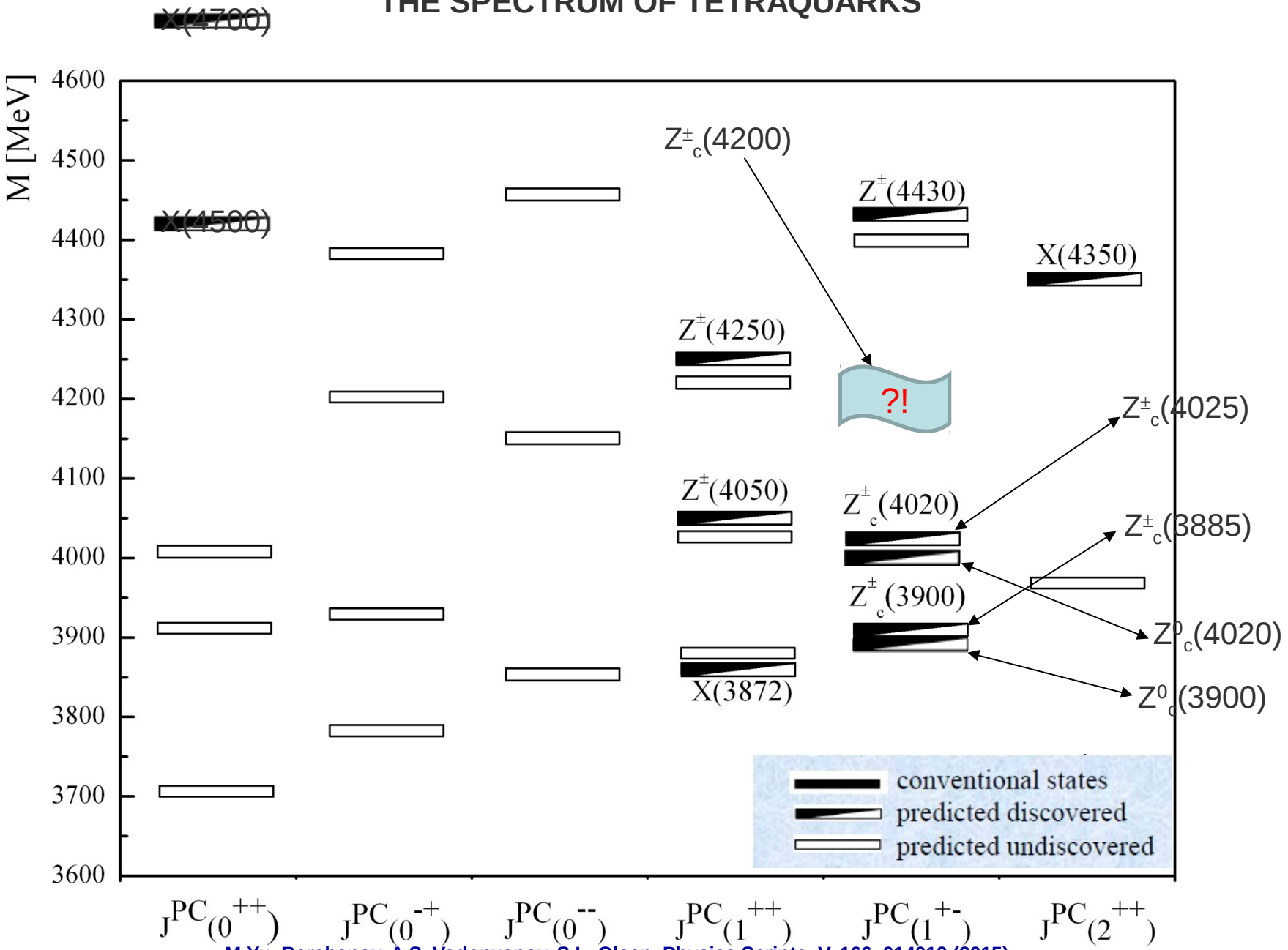
Motivation

THE SPECTRUM OF SINGLET ($^1P_1$) AND TRIPLET (^3P_J) STATES OF CHARMONIUM



M.Yu. Barabanov, A.S. Vodopyanov, S.L. Olsen , Yadernaya Fizica, V.77, N.1, pp. 1 - 5 (2014) / Phys. At. Nucl., V.77, N.1, pp. 126 -130 (2014)

THE SPECTRUM OF TETRAQUARKS



M.Yu. Barabanov, A.S. Vodopyanov, S.L. Olsen, Physica Scripta, V. 166, 014019 (2015)

M.Yu. Barabanov, S. L. Olsen, A.S. Vodopyanov, A.I. Zinchenko, Yad. Fiz., V.79, N.1, pp. 1-4 (2016) / Phys. At. Nucl., V.79, N.1, pp. 126 – 129 (2016)

Outline

1. Software used

2. Decay X(3872) $\rightarrow$ D+D- $\rightarrow$ $(K\pi\pi)^2$

*3. Decay X(3872) $\rightarrow$ D0antiD*0*

4. Yield considerations

5. Background estimates

6. Summary and outlook

Software used

- *FairSoft may16p1*
- *FairRoot v-16.06*
- *PandaRoot trunk 29531 (updated on 6/10/2016)*

1. EvtGen and DPM generators

2. prod/prod_sim.C, prod/prod_aod.C

3. Rho analysis package

Generated events

```
noPhotos

Decay pbarpSystem
  1.0       D+ D-           PHSP;
Enddecay

Decay D+
  1.0   K- pi+ pi+    D_DALITZ;
Enddecay

Decay D-
  1.0   K+ pi- pi-     D_DALITZ;
Enddecay

End
```

10k events

```
noPhotos

Decay pbarpSystem
  1.0  D0 anti-D*0        PHSP;
Enddecay

Decay D0
  1.0   K- pi+            PHSP;
Enddecay

Decay anti-D*0
  1.0   anti-D0 pi0       VSS;
Enddecay

Decay anti-D0
  1.0   K+ pi-            PHSP;
Enddecay

End
```

10k events

Generated events

```
noPhotos

Decay pbarpSystem
  1.0  D0 anti-D*0        PHSP;
Enddecay

Decay D0
  1.0   K- pi+ pi0        D_DALITZ;
Enddecay

Decay anti-D*0
  1.0   anti-D0 pi0       VSS;
Enddecay

Decay anti-D0
  1.0   K+ pi- pi0        D_DALITZ;
Enddecay

End
```

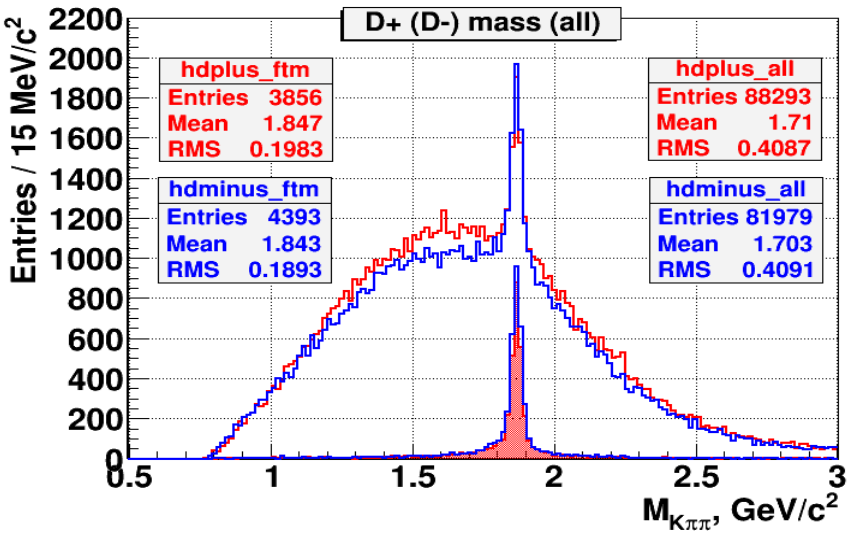
10k events

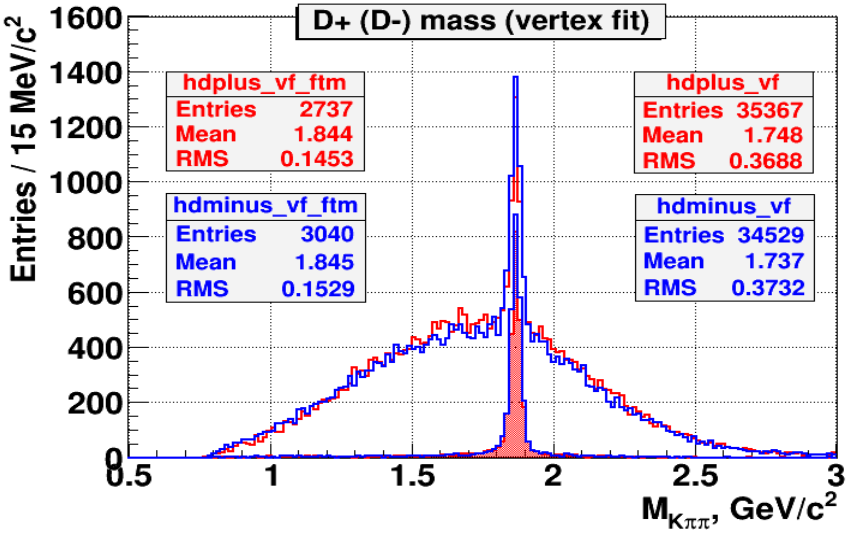
```
noPhotos

Decay pbarpSystem
  1.0  D0 anti-D*0        PHSP;
Enddecay

Decay D0
  1.0   K- pi+ pi+ pi-    PHSP;
Enddecay

Decay anti-D*0
  1.0   anti-D0 pi0       VSS;
Enddecay

Decay anti-D0
  1.0   K+ pi- pi- pi+    PHSP;
Enddecay

End
```

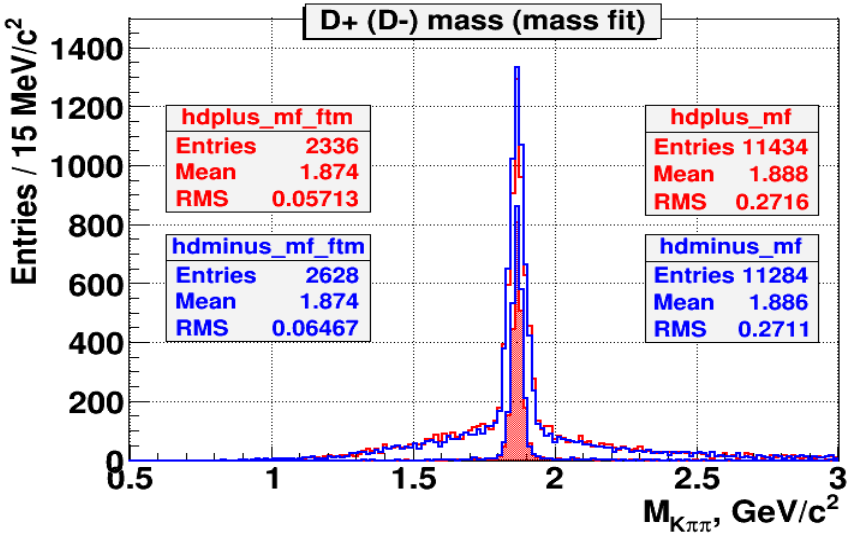
10k events

X(3872) → D+D-

D+ → K-π+π+ and D- → K+π-π- invariant mass



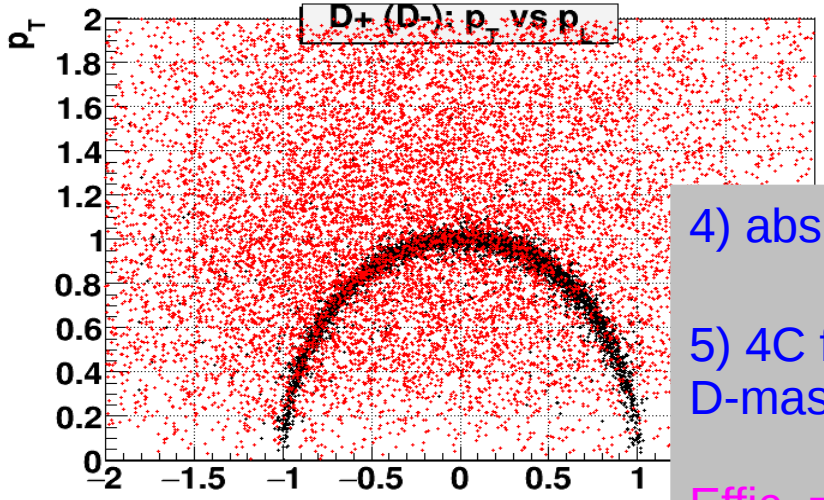


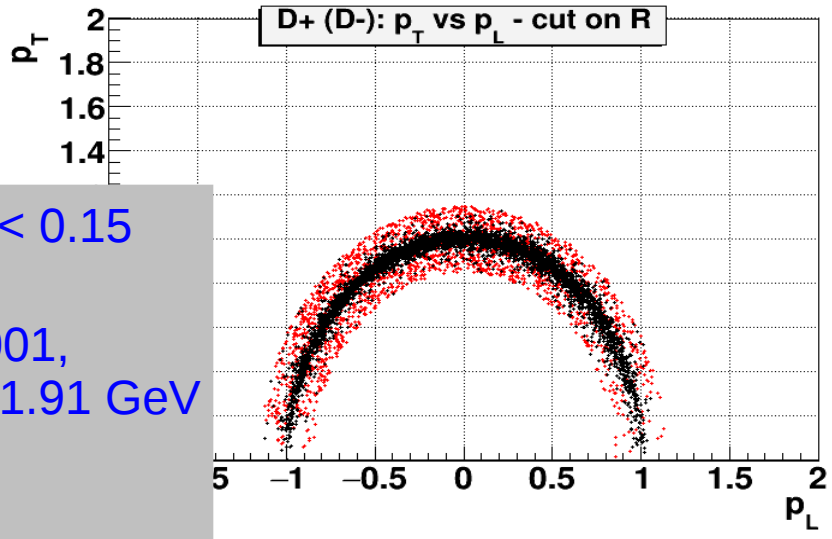


1) K all
2) P(vtx fit) > 0.001
3) P (D-mass fit) > 0.001

X(3872) → D+D-

D+ → K-π+π+ and D- → K+π-π-

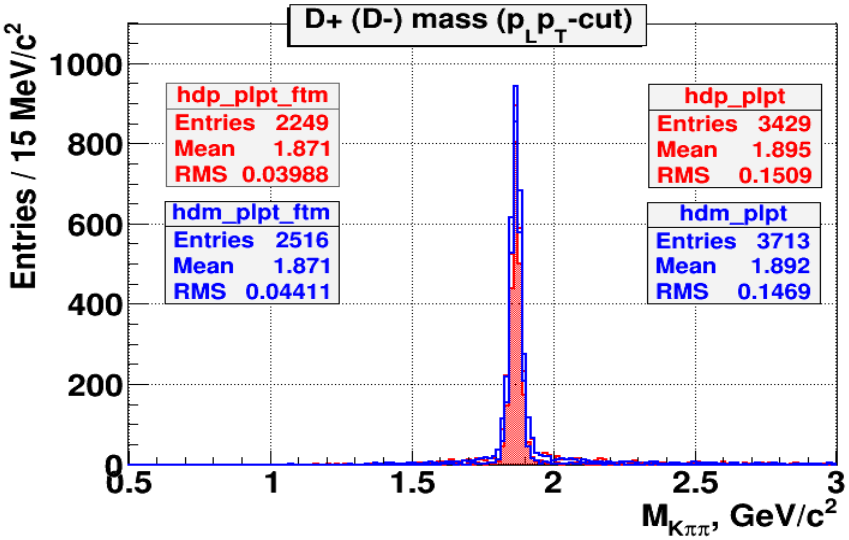


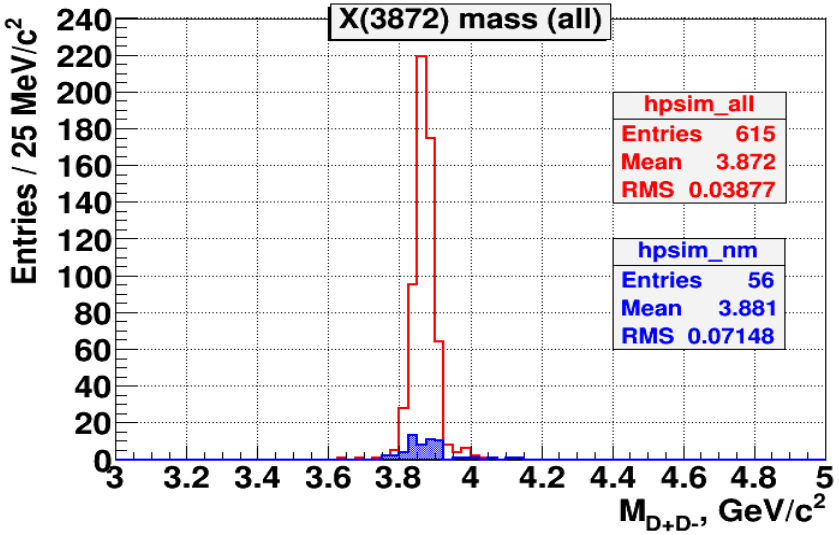


4) abs(Rp_Lp_T-1) < 0.15

5) 4C fit: P > 0.001,
D-mass = 1.83-1.91 GeV

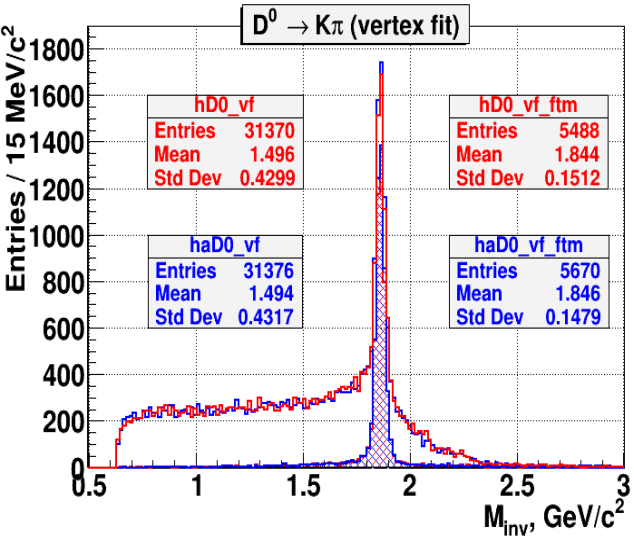
Effic. = 5.6%

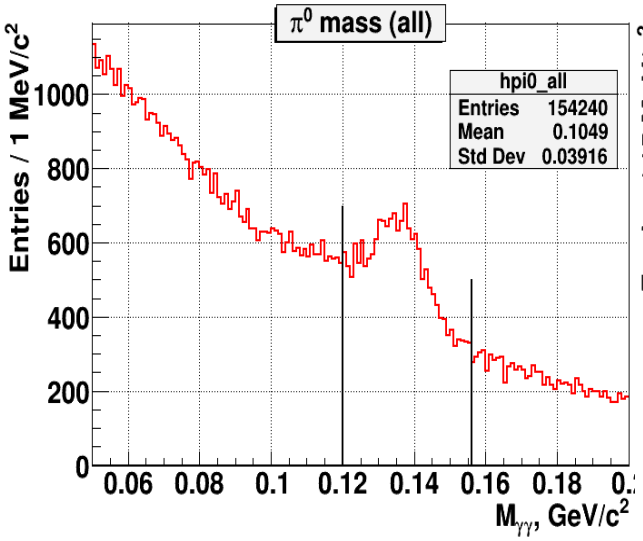


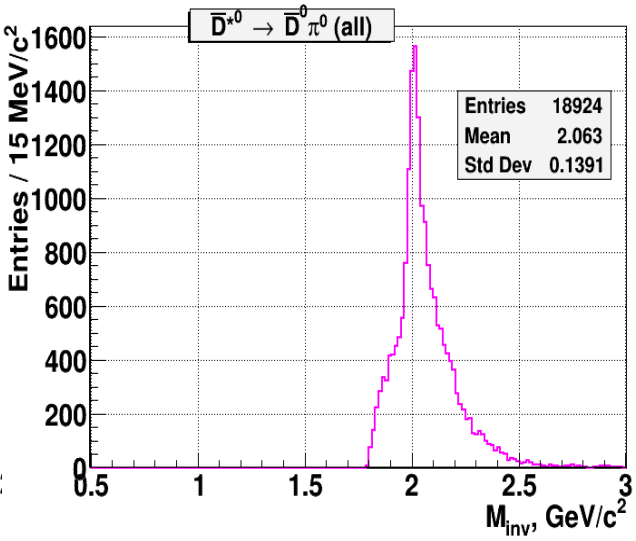


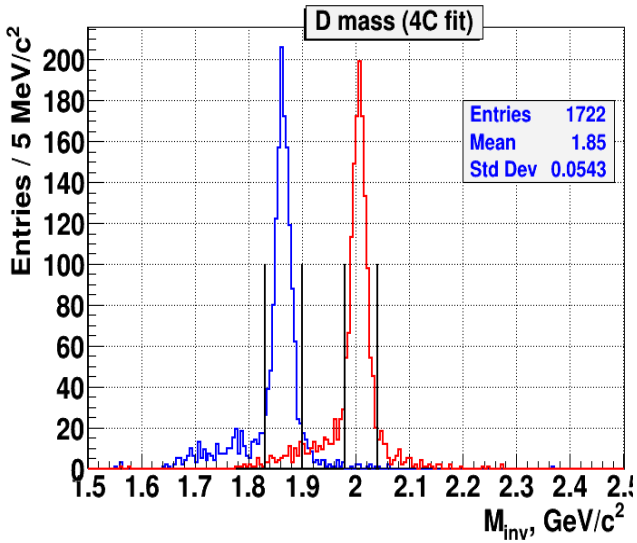
X(3872) → D0antiD0*

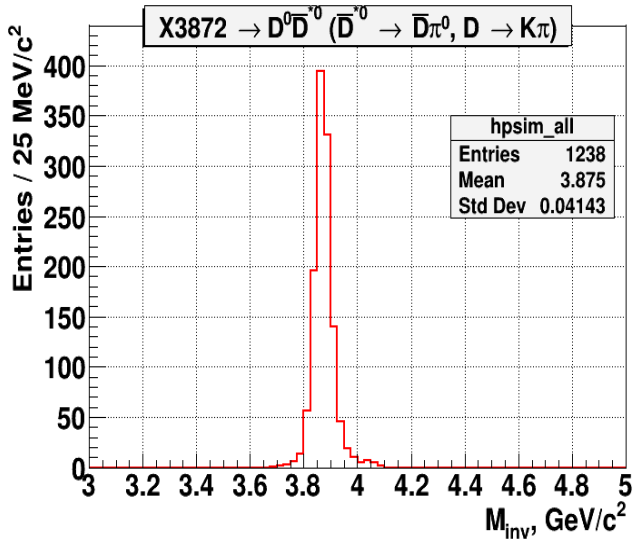
antiD0* → antiD0 π0, D0 → Kπ







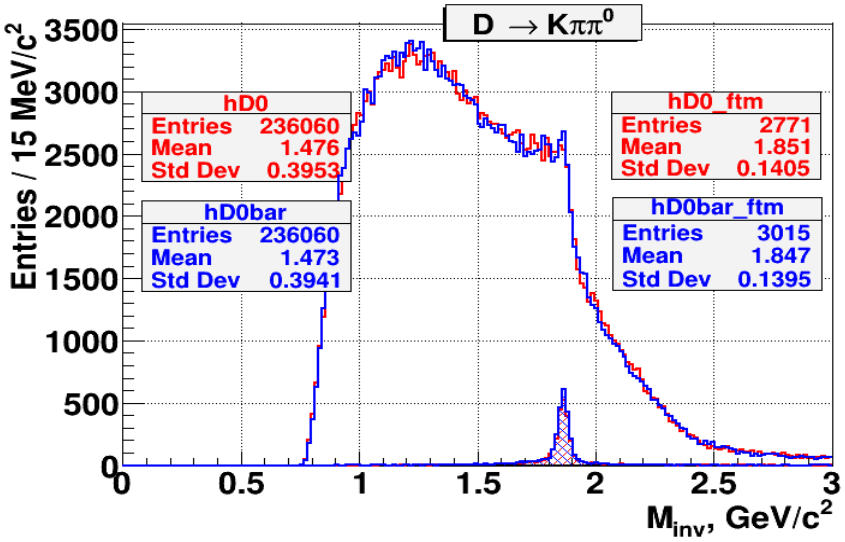


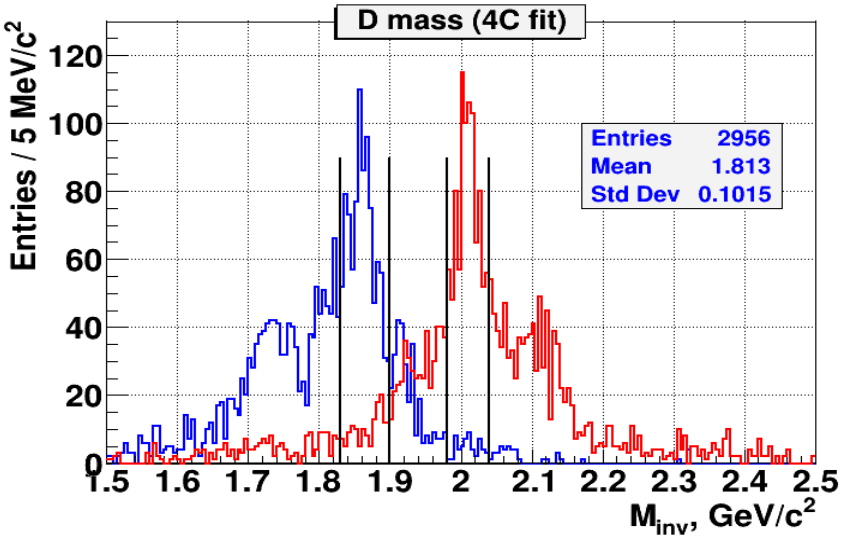


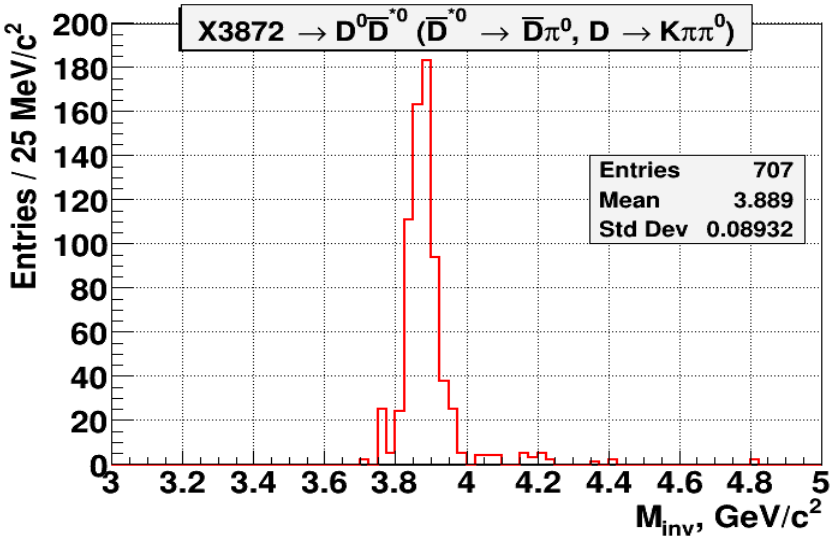
1) K all
2) RhoGoodPhotonSelector (loose)
3) P(vtx fit) > 0.001
4) P(4C fit) > 0.001
mass D0 = 1.83-1.90 GeV
mass D0* = 1.98-2.04 GeV

X(3872) → D0antiD0*

antiD0* → antiD0 π0, D0 → Kππ0



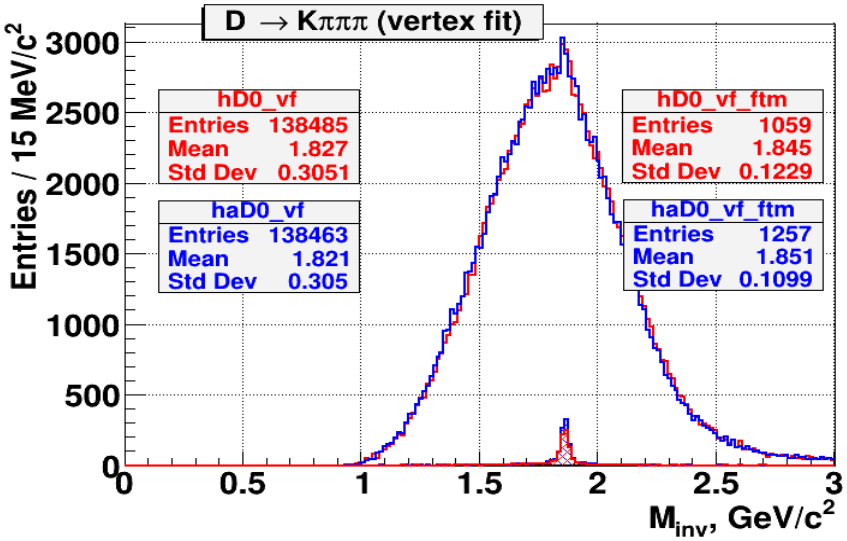


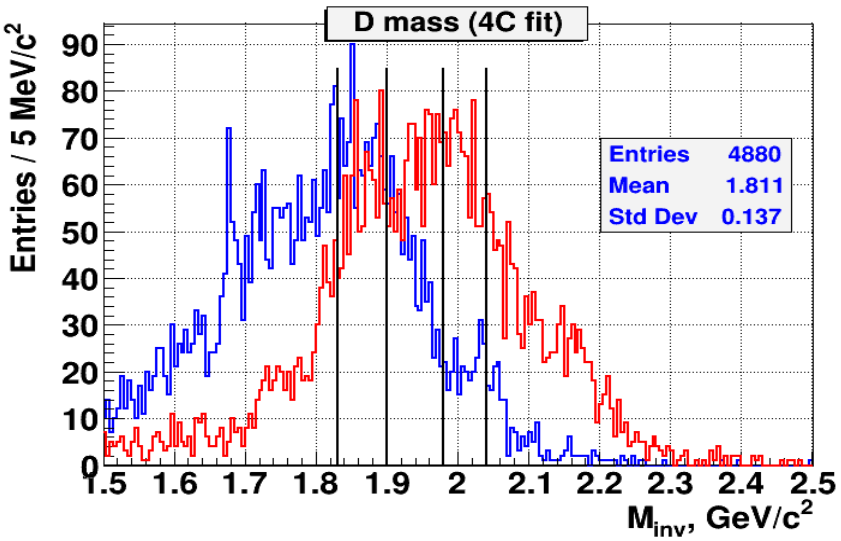


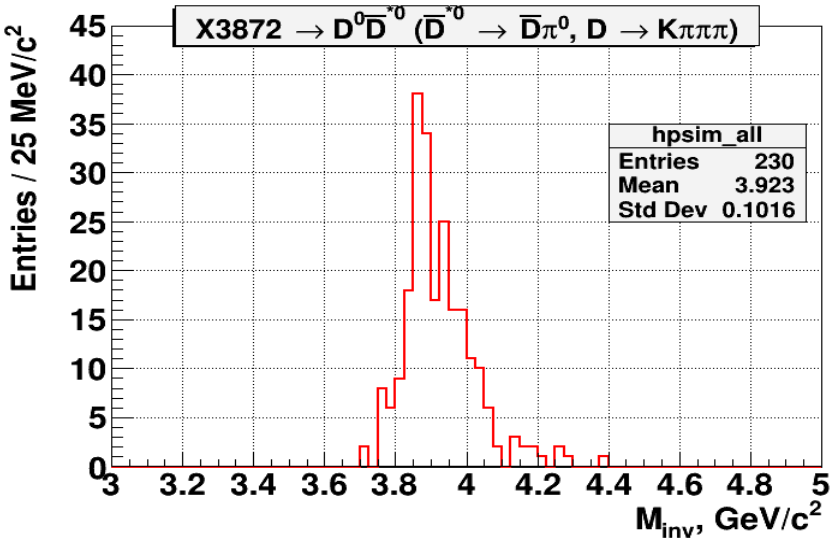
1) K all
2) P(vtx fit) > 0.001
3) P(4C fit) > 0.001
mass D0 = 1.83-1.90 GeV
mass D0* = 1.98-2.04 GeV

X(3872) → D0antiD0*

antiD0* → antiD0 π0, D0 → Kππ







1) K all
2) P(vtx fit) > 0.001
3) P(4C fit) > 0.001
mass D0 = 1.83-1.90 GeV
mass D0* = 1.98-2.04 GeV

X(3872) yield considerations

Cross-section X(3872) = 100 nb [1]

Br X(3872) → J/ψ π+π- : 5% [1] efficiency: ~10% [1]
Br X(3872) → D+D-: 40.45% efficiency: 5.6%
→ D0antiD0: 54.55%*

Br D+- → Kππ: 9.40%
1) Br D0 → Kπ: 3.90% efficiency: 12.4%
2) Br D0 → Kππ0: 13.90% efficiency: 7.1%
3) Br D0 → Kπππ: 8.10% efficiency: 2.3%

"Visible" cross-sections:
*X(3872) → J/ψ π+π- : 100 * 0.05 * 0.06 * 0.10 = 0.030 nb (1 decay mode)*
*X(3872) → D+D-: 100 * 0.4045 * 0.094 * 0.094 * 0.056 = 0.020 nb*
X(3872) → D0antiD0:*
*1) D0 → Kπ: 100 * 0.5455 * 0.039 * 0.039 * 0.124 = 0.010 nb*
*2) D0 → Kππ0: 100 * 0.5455 * 0.139 * 0.139 * 0.071 = 0.075 nb*
*3) D0 → Kπππ: 100 * 0.5455 * 0.081 * 0.081 * 0.023 = 0.008 nb*

[1] K.Goetzen et al, "Simulation Study of the Width and Line Shape of the X(3872)"

Background suppression

Cross-checks of D0antiD0* decays:

event samples for decay modes 1)-3) were fed to “wrong” reconstruction procedures, e.g. samples 2) and 3) to procedure for sample 1), etc. No candidates survived the cuts.

DPM background estimates

Generator-level filter of inelastic DPM:

D0antiD0*: 1) >= 4 charged particles; 2) K-pi+ inv. mass combinations (1.5-2.2 GeV) >= 1; 3) K+pi- inv. mass combinations (1.5-2.2 GeV) >= 1: rejection factor ~ 6.

No candidates for decay mode 1) survived the cuts.

170k filtered events - equivalent of ~1 mil.

Summary

X(3872) decays to DD-pairs have been looked at.

The decay D->K$\pi\pi^0$ seems to give the highest yield.