pp Çarpışmalarında Lepton-Kayıp Enerji oluşumu üzerinden W’ bozonu arayışı

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Gürsel KAZIL
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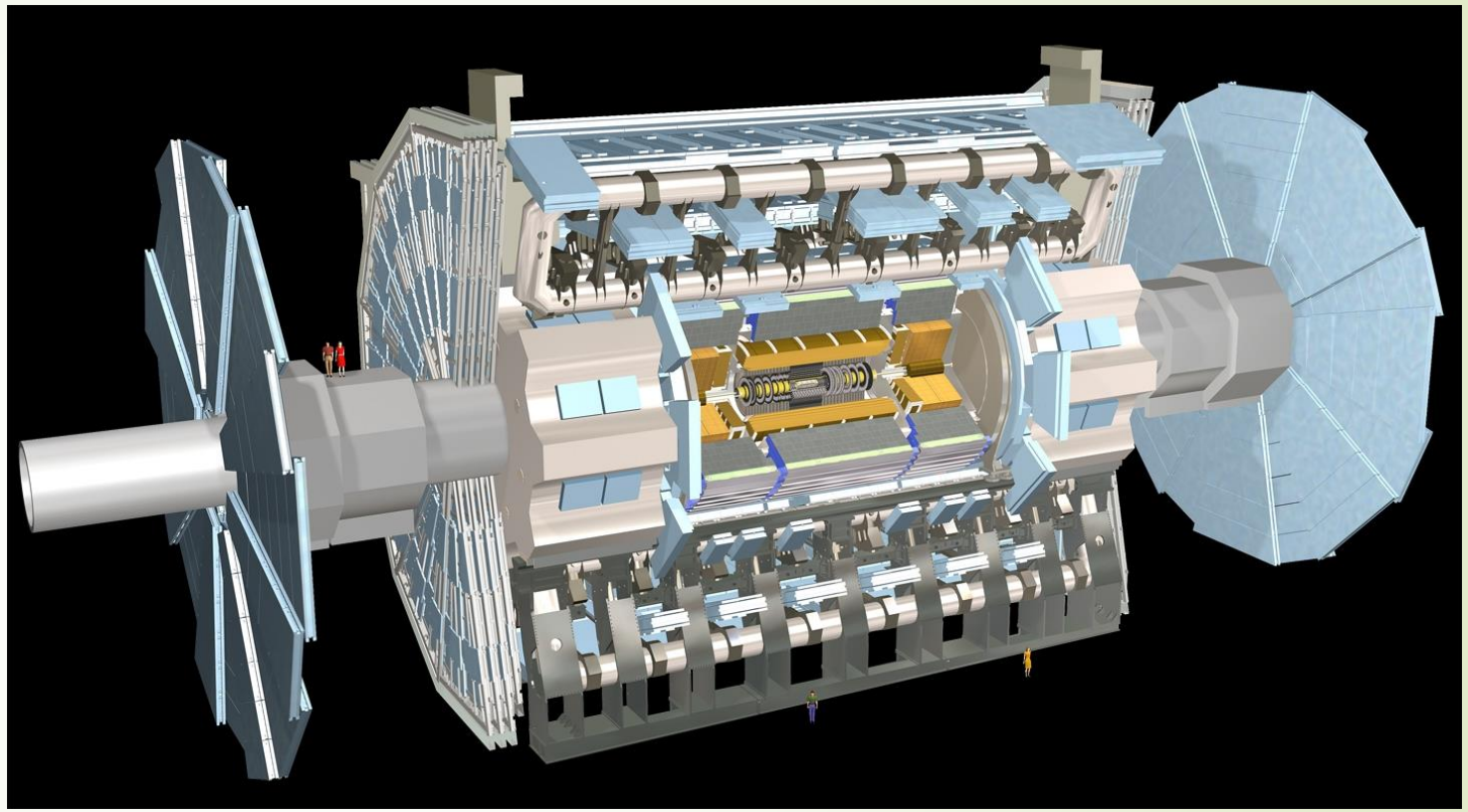
- Giriş
- ATLAS Dedektörü
- Kullanılan Monte Carlo Simulasyon örnekleri
- Olay yeniden yapılandırması
- Sinyal
- Ardalan
- Sonuç ve Yorum

Giriş

- W’ bozonu içeren birçok SM ötesi teori
- (Grand Unified Theory, Lef-Right symmetry models, Little Higgs models)
- Sequential Standard Model (SSM)?
- SM fermiyonlarıyla aynı etkileşim, SM bozonlarıyla zayıf etkileşim
- Neden lepton-nötrino çifti? En hassas sonuçlar

ATLAS Dedektörü

- Genel amaçlı bir dedektör
- İç dedektör: Yüklü parçacıkların yönü, momentum ve yükünü ölçer
- Kalorimetre: EM (elektron ve foton) ve hadronik (Muon ve nötrino HARİÇ)
- Muon Spektrometresi: Muon ölçümü yapar



KAYNAK: SLAC - Stanford Uni. (https://www6.slac.stanford.edu/sites/www6.slac.stanford.edu/files/styles/lightbox_large_image/public/Img1-ATLAS-Detector.jpg)

Simulasyon verileri

- Data ile İLGİLENİLMEDİ
- Sadece sinyal ve ardalan verileri üzerinde ayıklama yapıldı
- 139 fb^-1
- Tau leptona bozunum gözardı edildi

W bozonu ve bozulma şekilleri

- W bozonu -> Zayıf etkileşimin yüklü aracı parçacığı
- W bozonu -> m = 80.4 GeV/c^2

W^+ DECAY MODES

W^- modes are charge conjugates of the modes below.

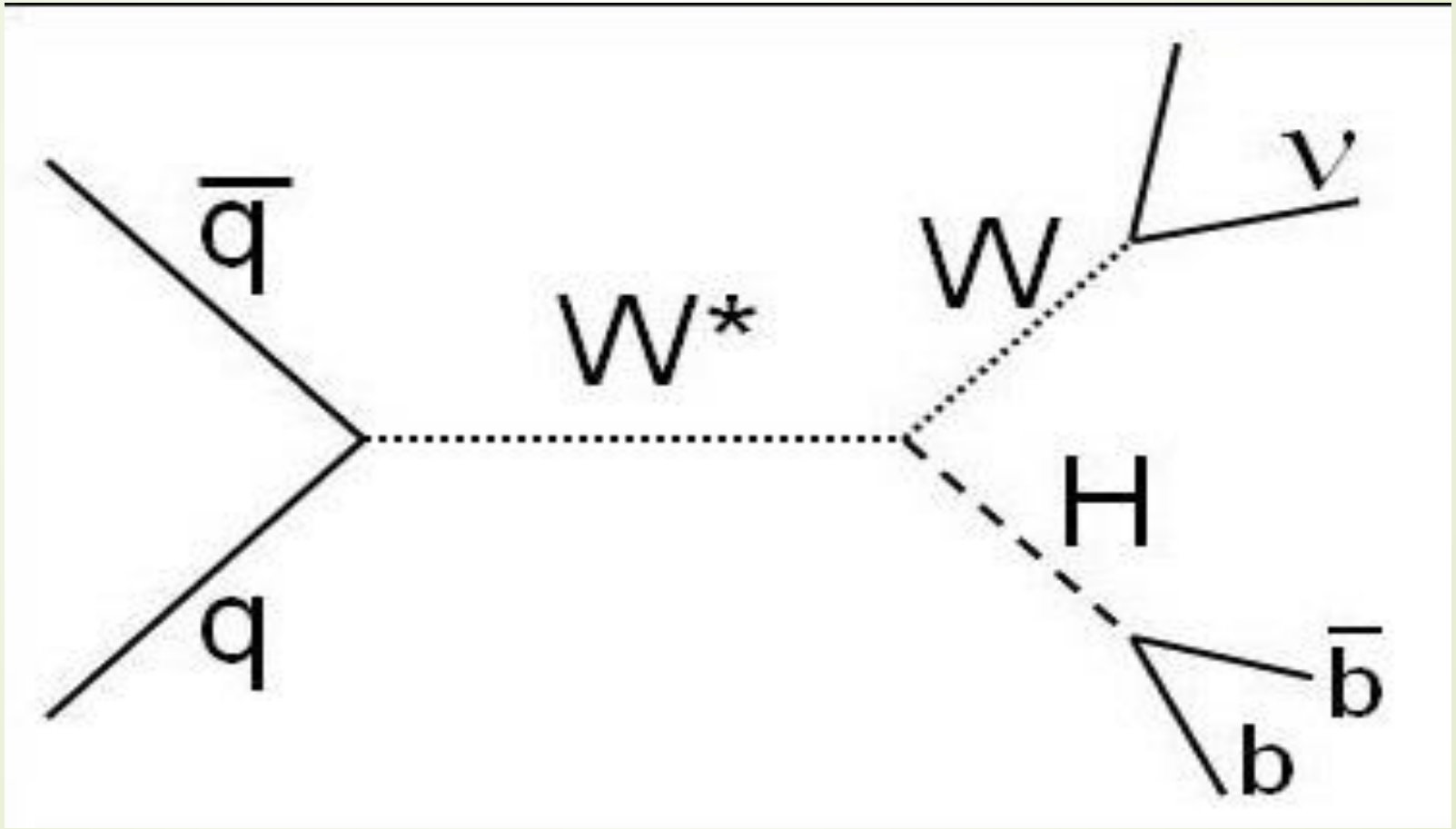
	Mode		Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\ell^+\nu$	[a]	(10.80 ± 0.09) %	
Γ_2	$e^+\nu$		(10.75 ± 0.13) %	
Γ_3	$\mu^+\nu$		(10.57 ± 0.15) %	
Γ_4	$\tau^+\nu$		(11.25 ± 0.20) %	
Γ_5	hadrons		(67.60 ± 0.27) %	
Γ_6	$\pi^+\gamma$		$< 8 \times 10^{-5}$	95%
Γ_7	$D_s^+\gamma$		$< 1.3 \times 10^{-3}$	95%
Γ_8	cX		(33.4 ± 2.6) %	
Γ_9	$c\bar{s}$		$(31\ ^{+13}_{-11}\ )$ %	
Γ_{10}	invisible	[b]	(1.4 ± 2.9) %	

[a] ℓ indicates each type of lepton (e, μ, and τ), not sum over them.

[b] This represents the width for the decay of the W boson into a charged particle with momentum below detectability, p< 200 MeV.

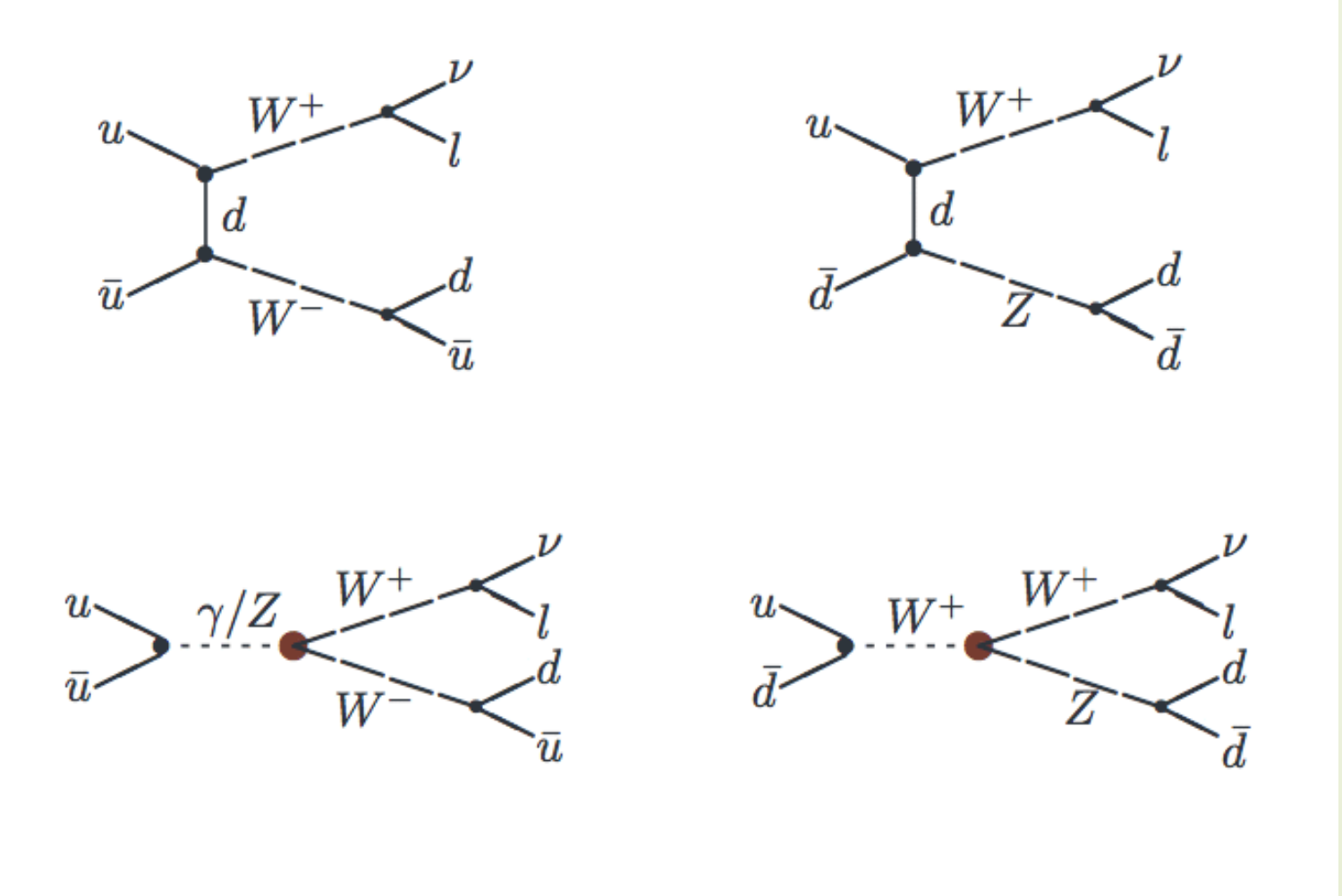
KAYNAK: Berkeley Lab (http://pdg.lbl.gov/2012/listings/rpp2012-list-w-boson.pdf)

Drell-Yan süreci



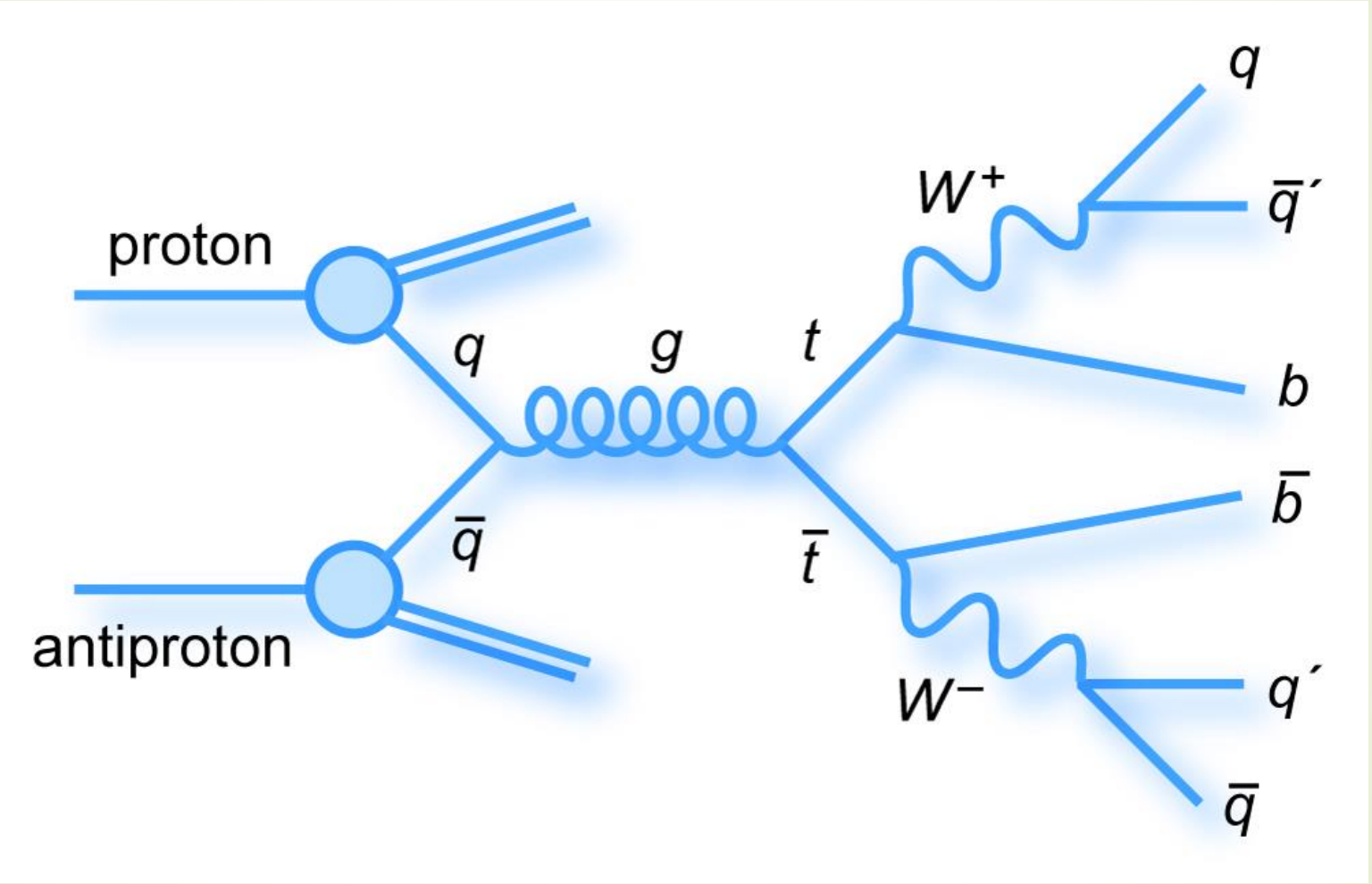
KAYNAK: Science 2.0
(https://www.science20.com/files/images/tevhiggsprod_diags.jpg)

Diboson Bozunum Süreci



KAYNAK: Fermilab (https://www-cdf.fnal.gov/physics/ewk/2008/wwwz/plots/WW_WZ_ALL.gif)

ttbar Bozunum Süreci



KAYNAK: Fermilab (https://www-d0.fnal.gov/Run2Physics/top/top_public_web_pages/feynman_diagrams/feynman_ttbar_alljets.png)

Elektron ayıklama

- $0<|\eta|<1.37$ ve $1.52<|\eta|<2.47$
- E(T) > 65 GeV
- p(T) > 200 GeV/c
- Tek elektronlu ya da daha fazla elektronlu olaylar
- Toplam W' kütlesi > 130 GeV/c^2
- Kayıp enerji > 65

- Saptama verimi > %80
- İzolasyon verimi > %99

Muon ayıklama

- İç dedektör izleriyle muon izlerinin eşleştirilmesi
- $0<|\eta|<2.5$
- p(T) > 200 GeV/c
- Tek Muonlu ya da daha fazla muonlu olaylar
- Toplam W' kütlesi > 110 GeV/c^2
- Kayıp enerji > 55

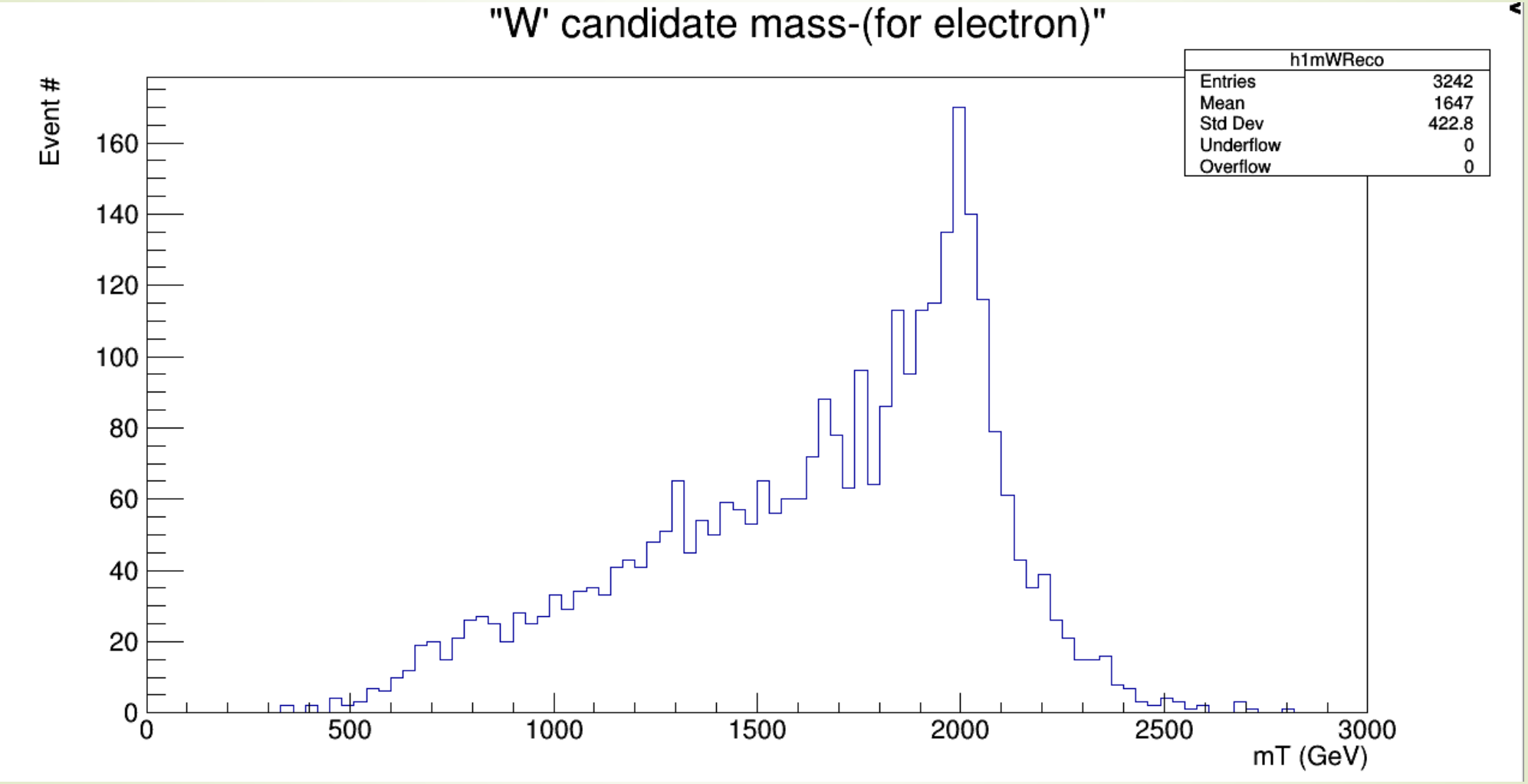
- Saptama verimi düşük

Sinyal

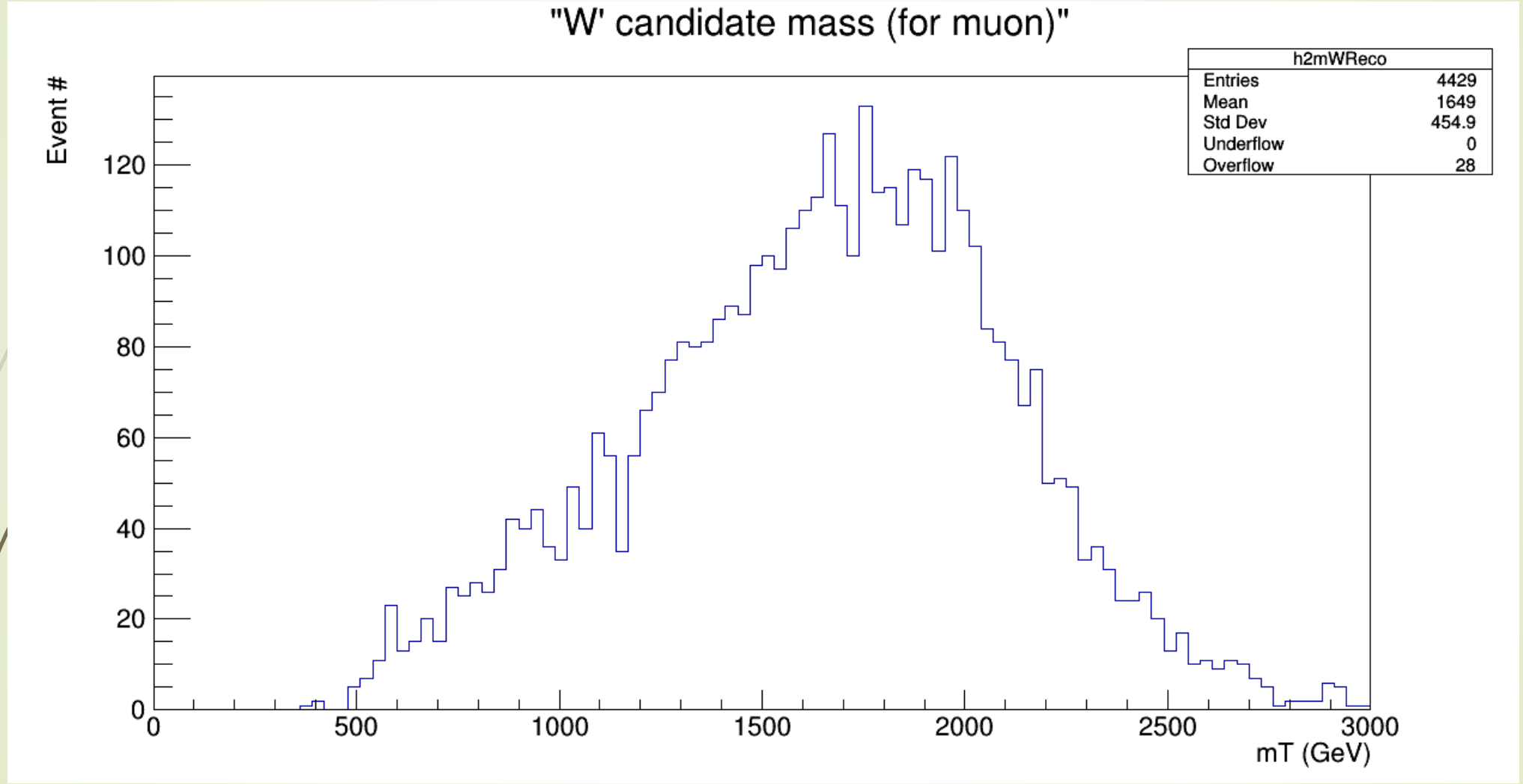
```
define WPLreco:ELE_0 METLV_0

region electron
select ALL
select Size(ELE)>=1
select {ELE}AbsEta<2.47 AND {ELE}AbsEta>1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0
select {ELE}E > 65
select {ELE}Pt>200
select m(WPLreco)>130
select MET>65
histo h1mWReco,"W' candidate mass (GeV)", 100,0,3000,{WPLreco}m



region muon
select ALL
select Size(MUO)>=1
select {MUO}AbsEta<2.5
select {MUO}Pt>200
select MET>55
select m(MUO_0 METLV_0)>110
histo h2mWReco, "W' candidate mass (GeV)", 100,0,3000, {MUO_0 METLV_0}m
```

```
              electron       Based on 10000 events:
                                    ALL :      1 +-         0 evt:    10000
                          Size(ELE)>=1 : 0.3451 +-   0.00475 evt:     3451
>1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0 : 0.9583 +-    0.0034 evt:     3307
                             {ELE}E > 65 : 0.9991 +-  0.000524 evt:     3304
                            {ELE}Pt>200 : 0.9812 +-   0.00236 evt:     3242
                         m(WPLreco)>130 :      1 +-         0 evt:     3242
                                 MET>65 :      1 +-         0 evt:     3242
   [Histo] W' candidate mass (GeV) :      1 +-         0 evt:     3242
         --> Overall efficiency  =   32.4 % +-  0.468 %


              muon    Based on 1e+04 events:
                                    ALL :      1 +-         0 evt:    10000
                          Size(MUO)>=1 : 0.4512 +-   0.00498 evt:     4512
                         {MUO}AbsEta<2.5 :      1 +-         0 evt:     4512
                            {MUO}Pt>200 : 0.9816 +-     0.002 evt:     4429
                                 MET>55 :      1 +-         0 evt:     4429
                    m(MUO_0 METLV_0)>110 :      1 +-         0 evt:     4429
   [Histo] W' candidate mass (GeV) :      1 +-         0 evt:     4429
         --> Overall efficiency  =   44.3 % +-  0.497 %
```

Sinyal


"W' candidate mass-(for electron)"
h1mWReco
Entries 3242
Mean 1647
Std Dev 422.8
Underflow 0
Overflow 0
Event #
0
20
40
60
80
100
120
140
160
0
500
1000
1500
2000
2500
3000
mT (GeV)

Sinyal


"W' candidate mass (for muon)"
h2mWReco
Entries 4429
Mean 1649
Std Dev 454.9
Underflow 0
Overflow 28
Event #
0
20
40
60
80
100
120
0
500
1000
1500
2000
2500
3000
mT (GeV)

Ardalan (DY)

```
define WPLreco:ELE_0 METLV_0

region electron
select ALL
select Size(ELE)>=1
select {ELE}AbsEta<2.47 AND {ELE}AbsEta>1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0
select {ELE}E > 65
select {ELE}Pt>200
select m(WPLreco)>130
select MET>65
histo h1mWReco,"W' candidate mass (GeV)", 100,0,3000,{WPLreco}m



region muon
select ALL
select Size(MUO)>=1
select {MUO}AbsEta<2.5
select {MUO}Pt>200
select MET>55
select m(MUO_0 METLV_0)>110
histo h2mWReco, "W' candidate mass (GeV)", 100,0,3000, {MUO_0 METLV_0}m
```

```
            electron       Based on 50000 events:
                                ALL :      1 +-         0 evt:    50000
                       Size(ELE)>=1 : 0.1475 +-   0.00159 evt:     7376
1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0 : 0.9256 +-   0.00306 evt:     6827
                        {ELE}E > 65 :  0.415 +-   0.00596 evt:     2833
                       {ELE}Pt>200 :      0 +-         0 evt:        0
                    m(WPLreco)>130 :   -nan +-      -nan evt:        0
                           MET>65 :   -nan +-      -nan evt:        0
 [Histo] W' candidate mass (GeV) :   -nan +-      -nan evt:        0
      --> Overall efficiency  =      0 % +-      0 %


            muon    Based on 5e+04 events:
                                ALL :      1 +-         0 evt:    50000
                       Size(MUO)>=1 : 0.1939 +-   0.00177 evt:     9693
                      {MUO}AbsEta<2.5 :      1 +-         0 evt:     9693
                       {MUO}Pt>200 : 0.0002063 +-  0.000146 evt:        2
                           MET>55 :    0.5 +-     0.354 evt:        1
                m(MUO_0 METLV_0)>110 :      1 +-         0 evt:        1
 [Histo] W' candidate mass (GeV) :      1 +-         0 evt:        1
      --> Overall efficiency  =  0.002 % +-  0.002 %
```

Ardalan (Diboson)

```
define WPLreco:ELE_0 METLV_0

region electron
select ALL
select Size(ELE)>=1
select {ELE}AbsEta<2.47 AND {ELE}AbsEta>1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0
select {ELE}E > 65
select {ELE}Pt>200
select m(WPLreco)>130
select MET>65
histo h1mWReco,"W' candidate mass (GeV)", 100,0,3000,{WPLreco}m



region muon
select ALL
select Size(MUO)>=1
select {MUO}AbsEta<2.5
select {MUO}Pt>200
select MET>55
select m(MUO_0 METLV_0)>110
histo h2mWReco, "W' candidate mass (GeV)", 100,0,3000, {MUO_0 METLV_0}m
```

```
            electron       Based on 20000 events:
                                 ALL :      1 +-         0 evt:    20000
                         Size(ELE)>=1 : 0.3866 +-   0.00344 evt:     7732
1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0 : 0.8853 +-   0.00362 evt:     6845
                          {ELE}E > 65 : 0.6476 +-   0.00577 evt:     4433
                         {ELE}Pt>200 : 0.01624 +-    0.0019 evt:       72
                      m(WPLreco)>130 : 0.7222 +-    0.0528 evt:       52
                             MET>65 :    0.5 +-    0.0693 evt:       26
  [Histo] W' candidate mass (GeV) :      1 +-         0 evt:       26
       --> Overall efficiency  =   0.13 % +- 0.0255 %


            muon    Based on 2e+04 events:
                                 ALL :      1 +-         0 evt:    20000
                         Size(MUO)>=1 : 0.4644 +-   0.00353 evt:     9289
                        {MUO}AbsEta<2.5 : 0.9419 +-   0.00243 evt:     8749
                         {MUO}Pt>200 : 0.01109 +-   0.00112 evt:       97
                             MET>55 : 0.5258 +-    0.0507 evt:       51
                  m(MUO_0 METLV_0)>110 : 0.9412 +-    0.0329 evt:       48
  [Histo] W' candidate mass (GeV) :      1 +-         0 evt:       48
       --> Overall efficiency  =   0.24 % +- 0.0346 %
```

Ardalan (t-tbar)

```
define WPLreco:ELE_0 METLV_0

region electron
select ALL
select Size(ELE)>=1
select {ELE}AbsEta<2.47 AND {ELE}AbsEta>1.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0
select {ELE}E > 65
select {ELE}Pt>200
select m(WPLreco)>130
select MET>65
histo h1mWReco,"W' candidate mass (GeV)", 100,0,3000,{WPLreco}m



region muon
select ALL
select Size(MUO)>=1
select {MUO}AbsEta<2.5
select {MUO}Pt>200
select MET>55
select m(MUO_0 METLV_0)>110
histo h2mWReco, "W' candidate mass (GeV)", 100,0,3000, {MUO_0 METLV_0}m
```

```
            electron        Based on 20000 events:
                                ALL :      1 +-         0 evt:    20000
                        Size(ELE)>=1 :  0.349 +-   0.00337 evt:     6980
.52 OR {ELE}AbsEta<1.37 AND {ELE}AbsEta>0 : 0.9285 +-   0.00308 evt:     6481
                          {ELE}E > 65 : 0.5897 +-   0.00611 evt:     3822
                        {ELE}Pt>200 : 0.01256 +-    0.0018 evt:       48
                     m(WPLreco)>130 : 0.8333 +-    0.0538 evt:       40
                           MET>65 :  0.875 +-    0.0523 evt:       35
 [Histo] W' candidate mass (GeV) :      1 +-         0 evt:       35
       --> Overall efficiency  =  0.175 % +- 0.0296 %


            muon    Based on 2e+04 events:
                                ALL :      1 +-         0 evt:    20000
                        Size(MUO)>=1 : 0.4371 +-   0.00351 evt:     8742
                      {MUO}AbsEta<2.5 :  0.986 +-   0.00125 evt:     8620
                        {MUO}Pt>200 : 0.006845 +-  0.000888 evt:       59
                           MET>55 : 0.8136 +-    0.0507 evt:       48
                 m(MUO_0 METLV_0)>110 : 0.9583 +-    0.0288 evt:       46
 [Histo] W' candidate mass (GeV) :      1 +-         0 evt:       46
       --> Overall efficiency  =   0.23 % +- 0.0339 %
```

mT		130-400	400-600	600-1000	1000-2000	2000-3000	3000-10000	
Drell-Yan	elektron	0	0	0	0	0	0	
	müon	1	0	0	0	0	0	
Diboson	elektron	16	4	2	0	0	0	
	müon	29	13	6	0	0	0	
ttbar	elektron	23	11	1	0	0	0	
	müon	29	14	3	0	0	0	
Sinyal	elektron	9	54	301	2229	703	0	w=18.8762
	Müon	15	88	397	2988	986	28	

Electron channel						
m_T [GeV]	130–400	400–600	600–1000	1000–2000	2000–3000	3000–10 000
Data	3 538 403	35 568	7358	818	17	0
Background	3 320 000 ± 250 000	34 800 ± 1500	7200 ± 400	830 ± 80	20.2 ± 3.1	1.3 ± 0.5
W' (2 TeV)	574 ± 22	720 ± 40	2190 ± 120	12200 ± 600	1130 ± 290	3.20 ± 0.25
W' (3 TeV)	68.4 ± 1.9	58.6 ± 2.6	127 ± 7	448 ± 22	860 ± 40	87 ± 23
W' (4 TeV)	19.6 ± 0.5	13.2 ± 0.5	22.1 ± 1.1	44.3 ± 2.2	49.2 ± 2.3	86 ± 4
W' (5 TeV)	7.85 ± 0.19	4.99 ± 0.18	7.26 ± 0.35	9.9 ± 0.5	5.82 ± 0.28	13.6 ± 0.7
W' (6 TeV)	3.76 ± 0.09	2.35 ± 0.08	3.28 ± 0.16	3.82 ± 0.18	1.41 ± 0.07	2.01 ± 0.10
Muon channel						
m_T [GeV]	110–400	400–600	600–1000	1000–2000	2000–3000	3000–10 000
Data	8 751 095	26 225	5393	622	22	2
Background	7 800 000 ± 700 000	25 800 ± 1400	5300 ± 400	570 ± 50	18 ± 4	2.3 ± 0.9
W' (2 TeV)	490 ± 14	594 ± 26	1680 ± 90	6700 ± 500	1520 ± 210	70 ± 50
W' (3 TeV)	58.1 ± 1.4	45.5 ± 1.9	102 ± 6	322 ± 31	380 ± 50	160 ± 40
W' (4 TeV)	16.3 ± 0.4	9.64 ± 0.34	15.9 ± 0.8	32.2 ± 3.4	34 ± 5	44 ± 13
W' (5 TeV)	6.50 ± 0.15	3.55 ± 0.12	4.98 ± 0.22	6.7 ± 0.6	3.9 ± 0.6	7.2 ± 2.3
W' (6 TeV)	3.11 ± 0.07	1.67 ± 0.06	2.22 ± 0.10	2.45 ± 0.17	0.88 ± 0.12	1.09 ± 0.35

Sonuç

- Data incelemesi YAPILMADI
- Sinyal incelemesinde elektron kanalı net
- Sinyal incelemesinde Muon kanalında netlik daha az
- Ardalandan kayıp çok yüksek
- $|d0|/\sigma(d0)$ (transverse impact parameter significance relative to the beam axis) ve $|z0|\sin\theta$ (longitudinal impact parameter significance relative to the primary vertex) ayıklamaya katılmadı
- Yapılan tablo ve makaledeki tablo uyumsuz

TEŞEKKÜRLER