Search for high-mass resonances decaying to leptons or photons

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DIS 2008
Heavy Resonances

**Come from:**

- Extra dimensions
- Extended gauge groups
- Technicolor
- Unthought of theories

**Go to:**

- Leptons
  - e
  - μ
  - τ
- Bosons
  - γ
  - W/Z
- Quarks
  - Top
  - B-tag
  - Jets
- Exotics
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- Leptons
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  - $\tau$
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  - $\gamma$
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  - $B$-tag
  - Jets
- Exotics

**Simple final states**

**Good for early searches**
CDF di-electron search:

- Events found up to ~500 GeV, compatible with SM
- => exclusion limit ≤ 900 GeV
- Similar results for other lepton/photon channels
- Similar results from DØ
Analysis

1) Identify particles
2) Reject background
3) Compute invariant mass
4) Discovery?
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Background cross section high -> little mis-id large problem

charge id at high \( p_t \) (straight tracks)

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Use isolation (in cone around lepton):

- No (additional) tracks
- No extra Calo deposits

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Definition of Significance?
=> need to fix method

4) Discovery?
Backgrounds

<table>
<thead>
<tr>
<th>e</th>
<th>γ</th>
<th>μ</th>
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<tr>
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<tr>
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<tr>
<td>DY</td>
<td>QED</td>
<td>DY</td>
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</tbody>
</table>
Example $\mu$

CMS PAS SBM_07_002

- Background from DY and sources with one real $\mu$
- Danger: MC may not represent reality
  - Efficiencies
  - Background
Example $\mu$

- Include realistic conditions
- Alignment/Calibration
- Determine efficiencies from data (tag & probe)
- Find background from data themselves ($tt\rightarrow e\mu$)

- Good potential even at low luminosities
Possible with few events

- Mass
- (relative) branching ratios
- Spin
- Cross section
- $A_{FB}$
- Width

Model sensitive i.e. $Z'\#\#\gamma\gamma$

From angular distribution graviton vs gauge boson

Depends on absolute lumi measurement, efficiency

Dilution from unknown quark direction

Limited by detector resolution

Large statistics
• Focused on long term prospects
• Wide range of physics studied
  • Angular distributions
  • Interference structure
  • Width
• Good prospects for discrimination at high lumi

Z' \chi (1.5\text{TeV})
100 \text{ fb}^{-1}

\chi^2 / \text{ndf} = 3.68 / 4
Prob = 0.4511
Afb = -0.1444 \pm 0.0246

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Summary

- Excellent prospects for heavy resonance searches at the LHC
- Early discovery possible even at low lumi
- Lots of interesting physics to be extracted from larger lumi
To Do

1. Take data
2. Find Signal
3. Party!