

Probing Standard-Model Higgs Substructures using Tops and Weak Gauge Bosons

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12th of July 2019
Ghent
Belgium



NAWI Graz
Natural Sciences

What's up?

Review: 1712.04721

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Subtle field theory creates new effects
in the standard model

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See review for background!

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 - Peaks in (experimental) cross-sections

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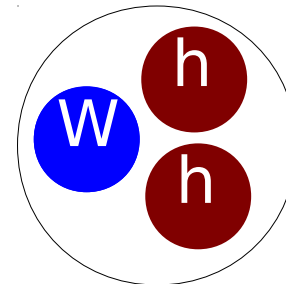
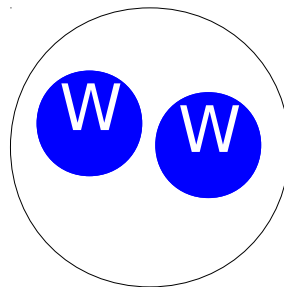
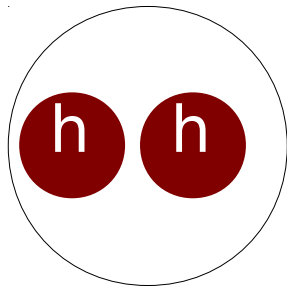
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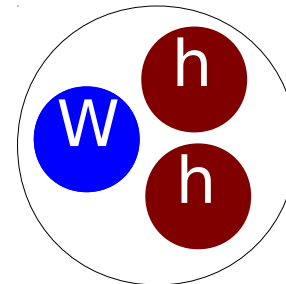
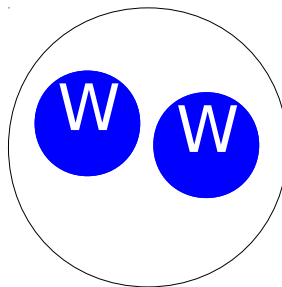
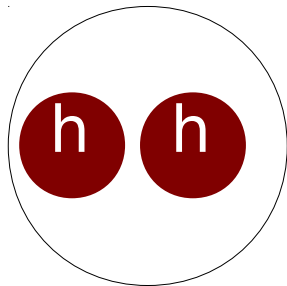
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- Why does perturbation theory work?
 - Fröhlich-Morchio-Strocchi mechanism

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[Fröhlich et al.'80,'81
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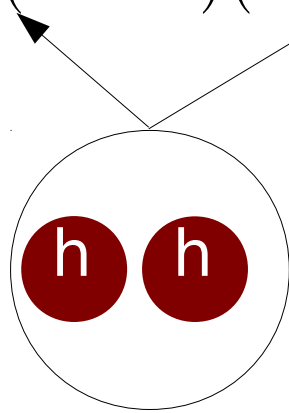


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Deviations

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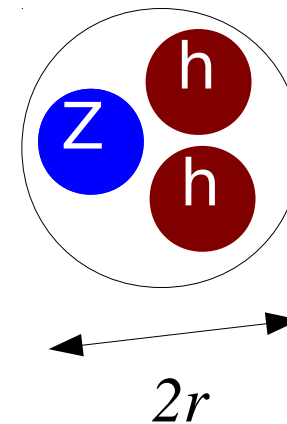
Bound states as extended objects

- Bound states have an extension
 - Can it be measured?

Bound states as extended objects

[Maas,Raubitzke,Törek'18]

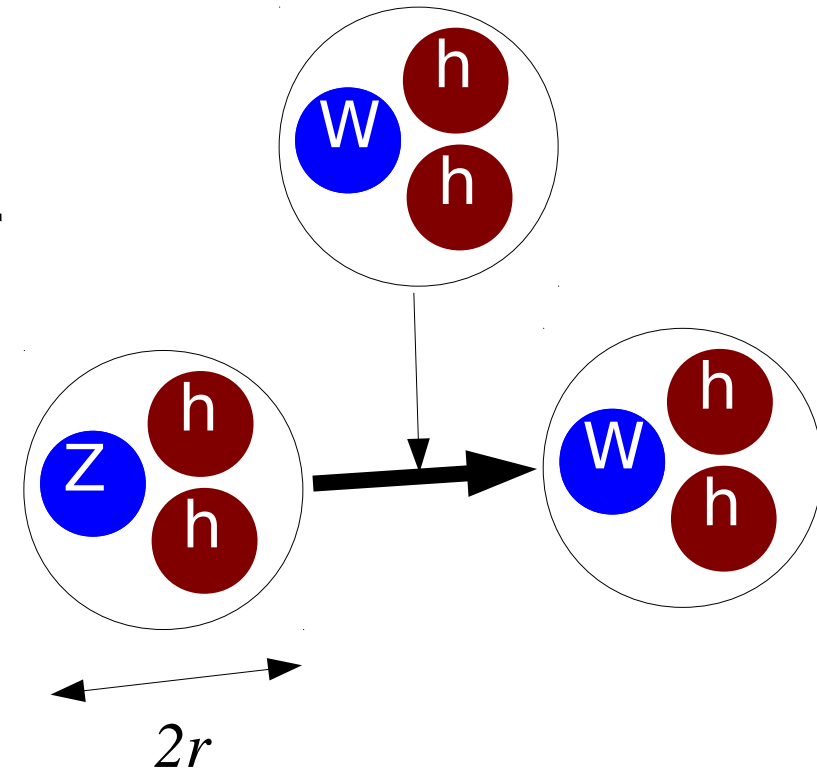
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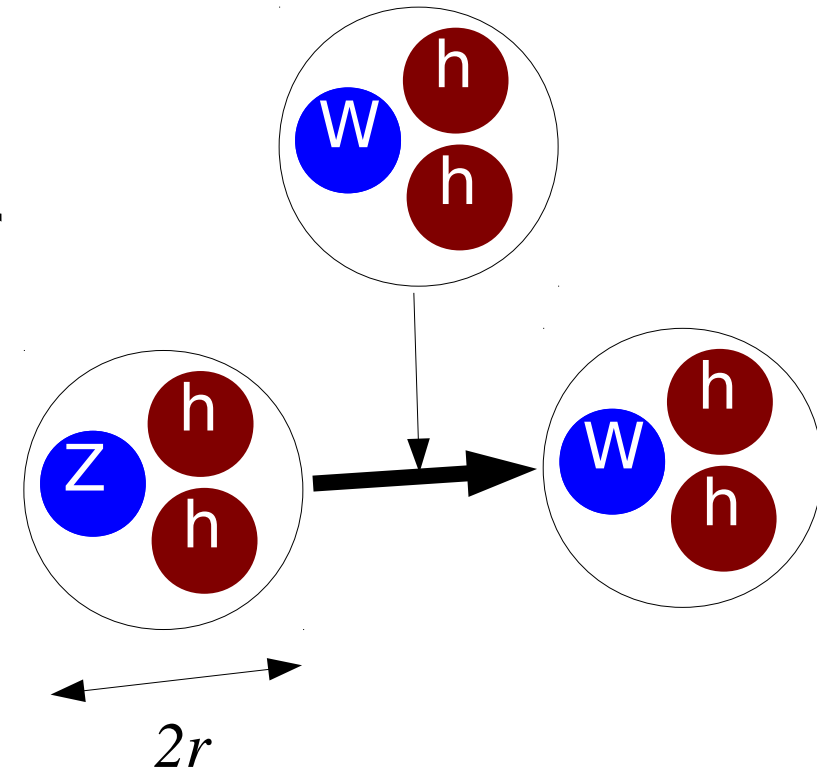


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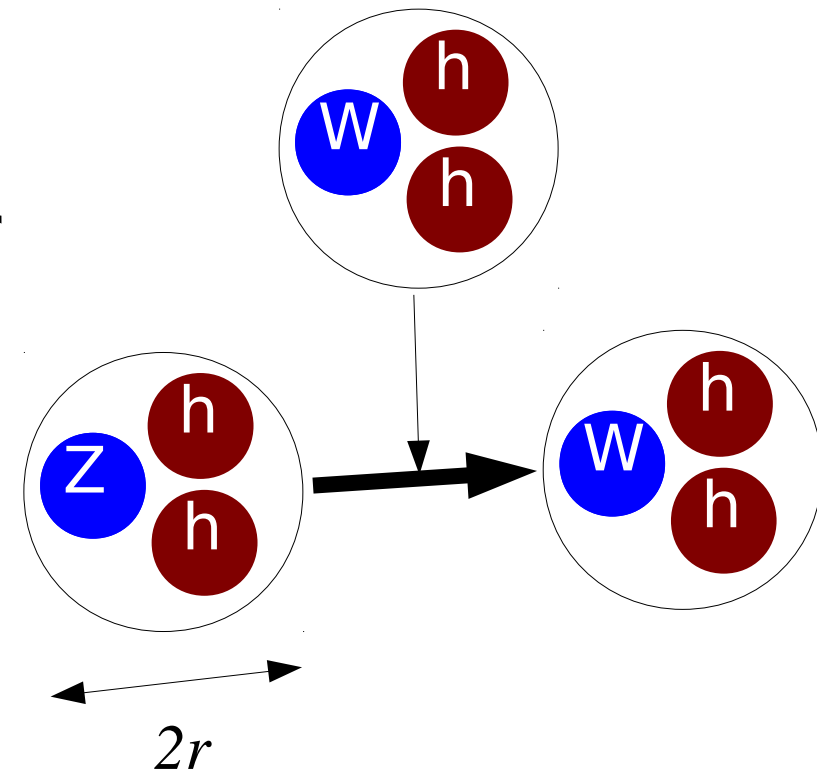
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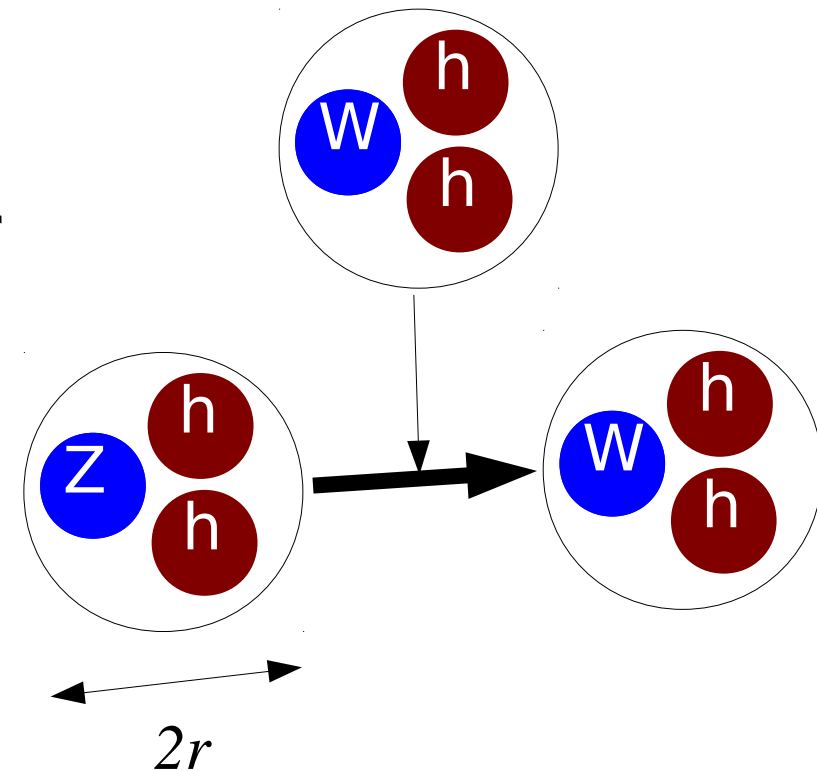
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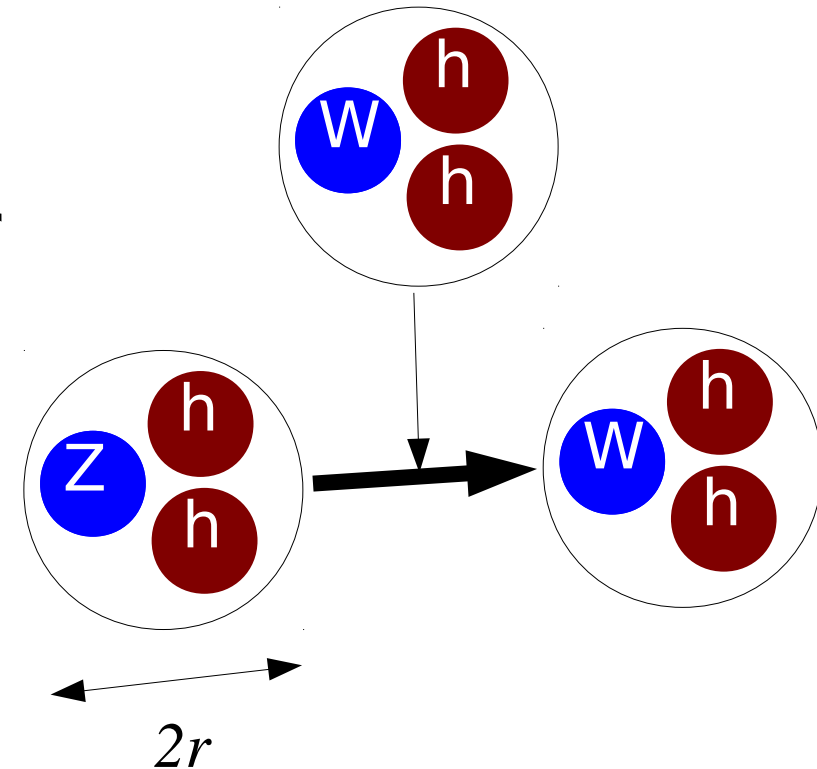
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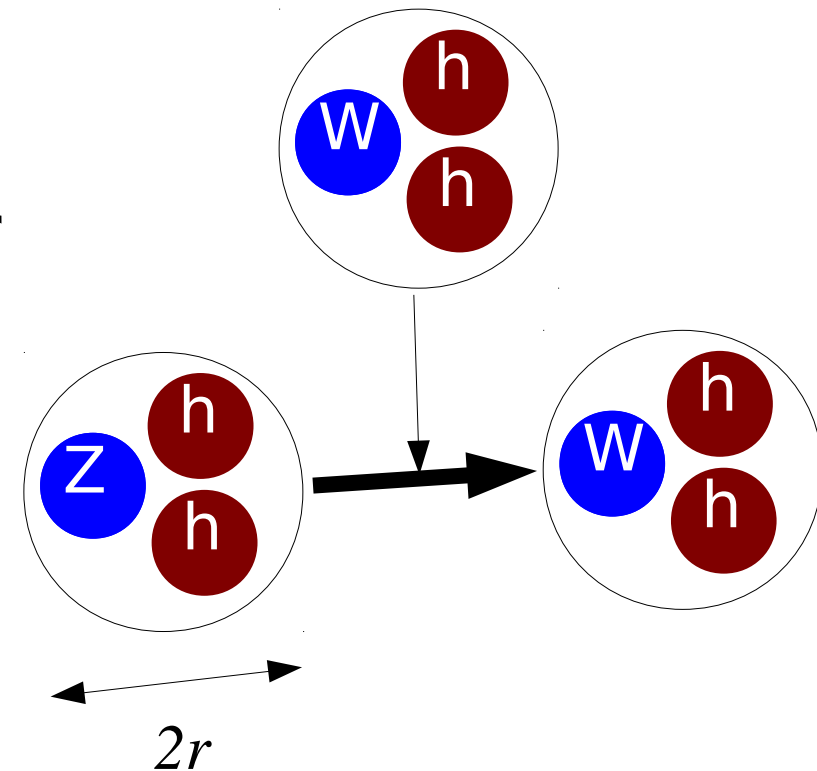
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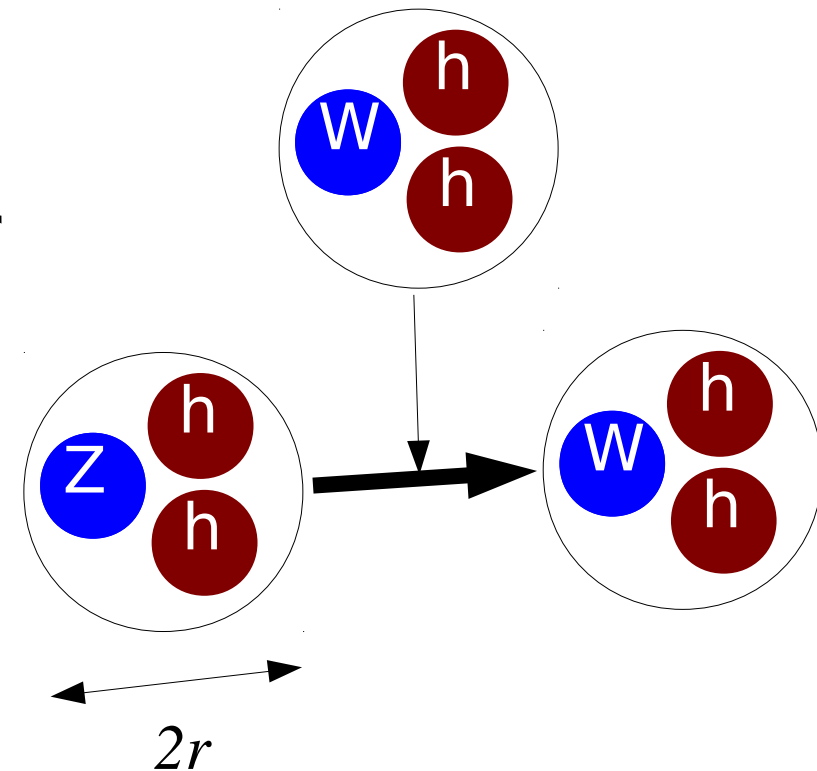
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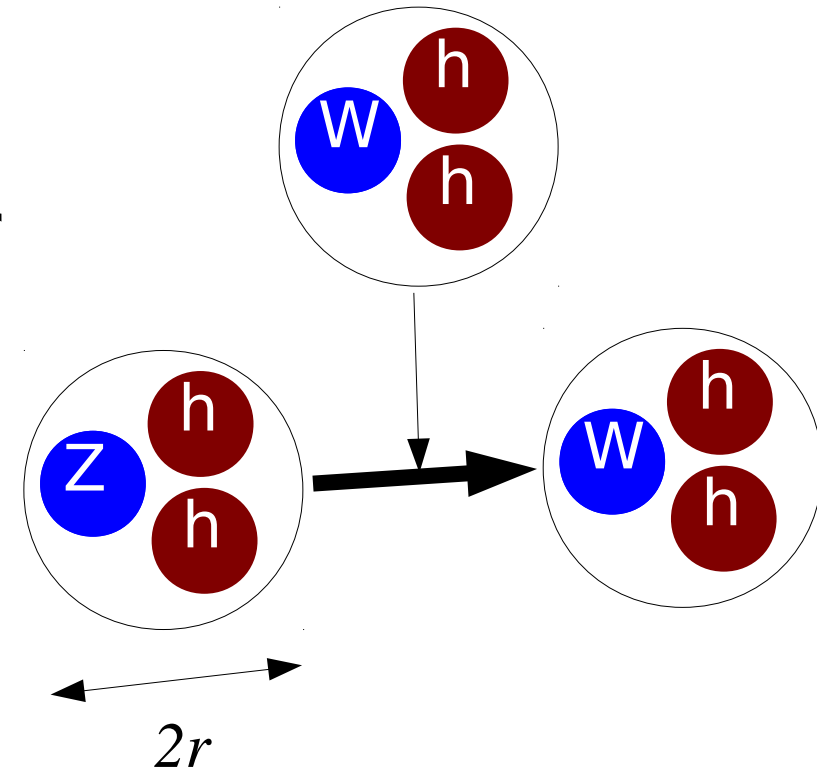
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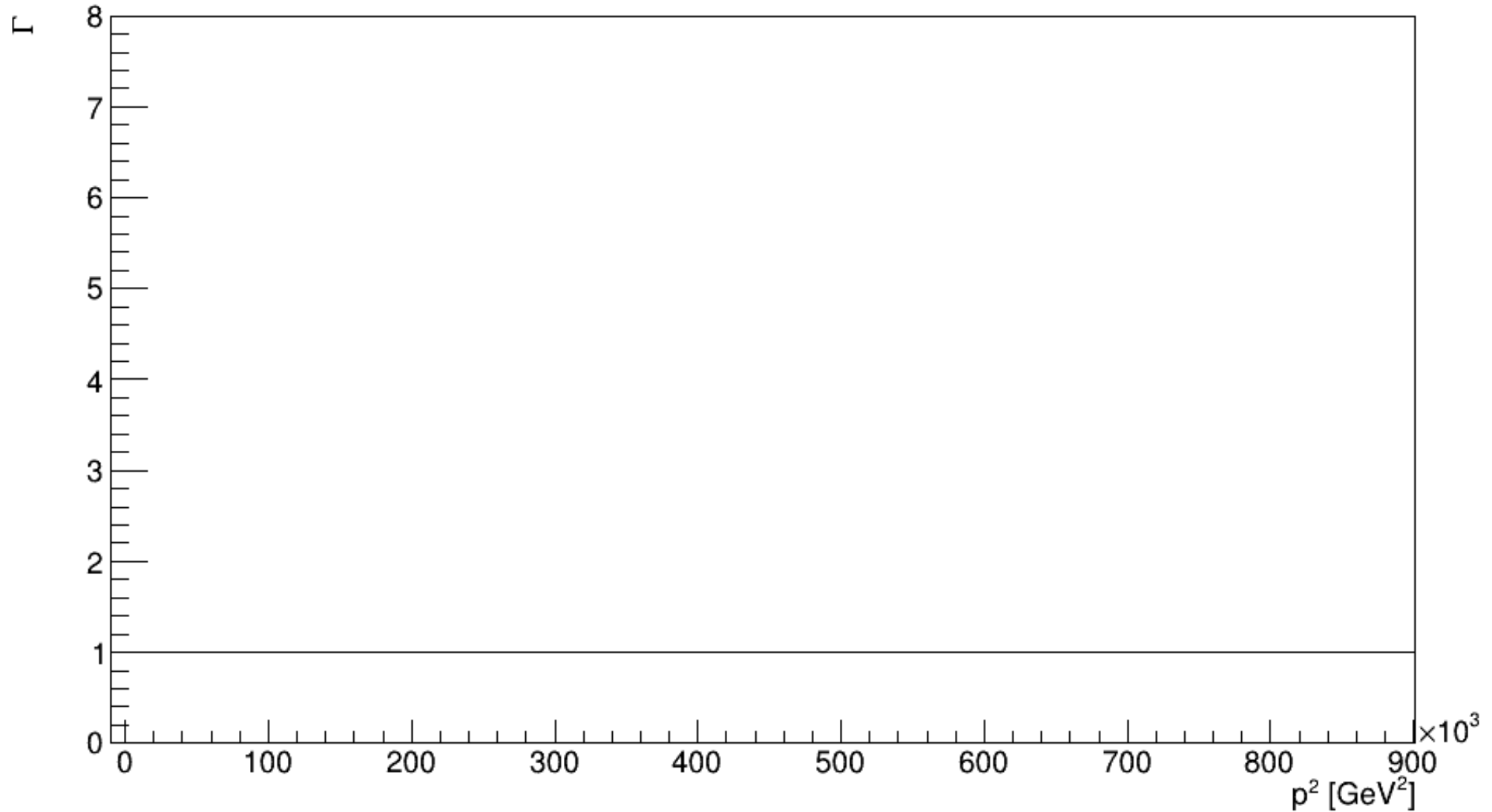
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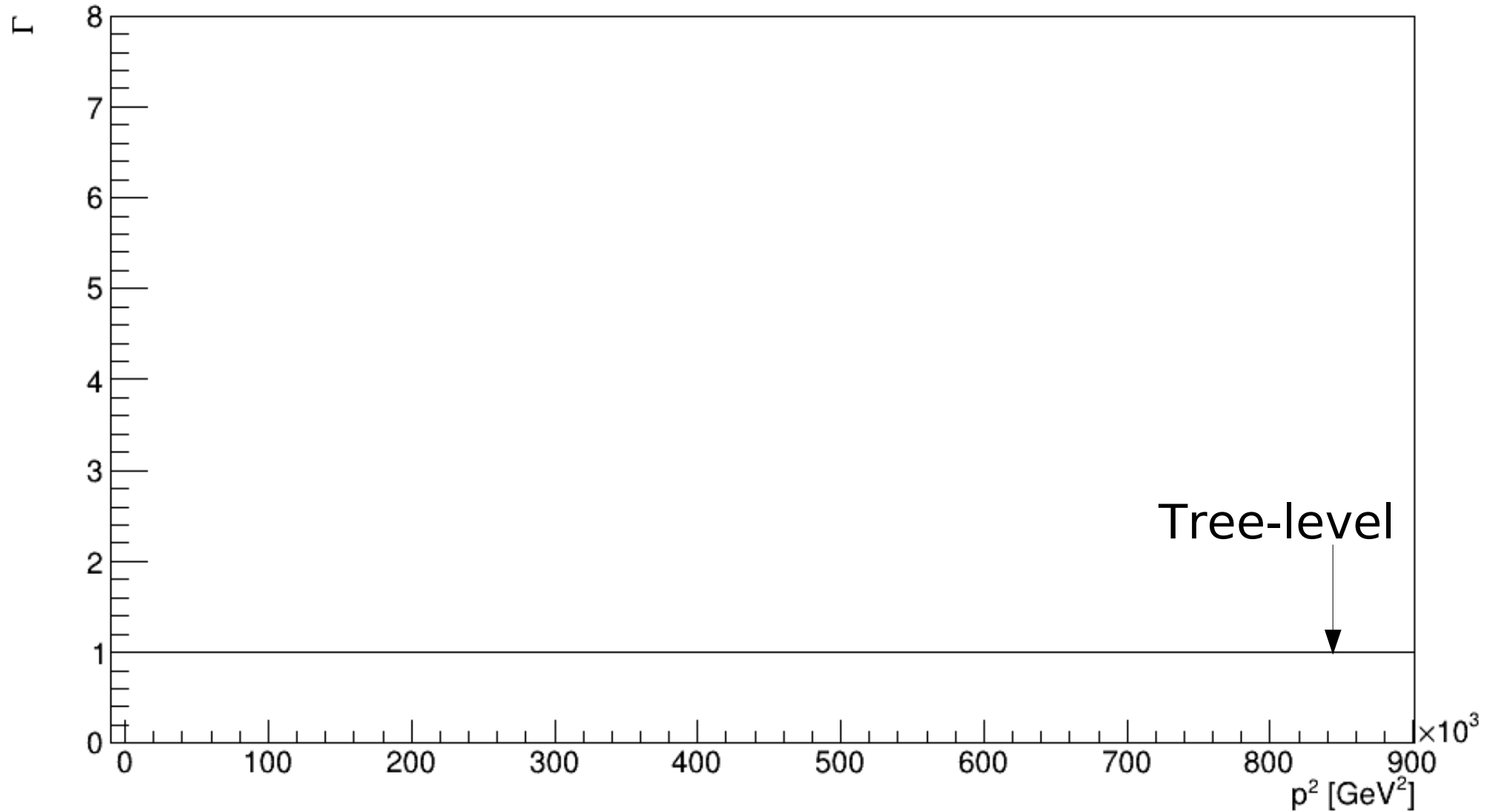
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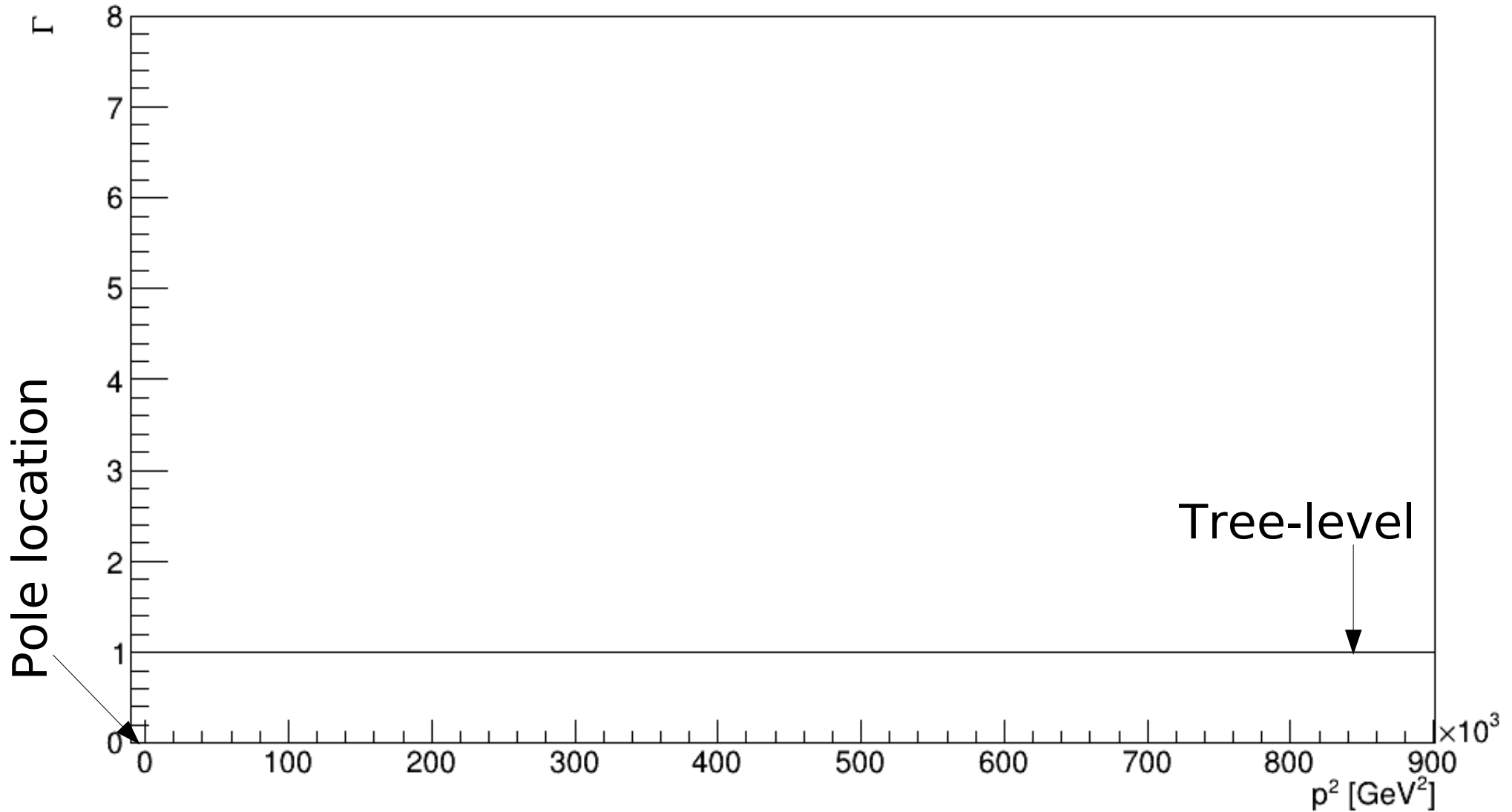
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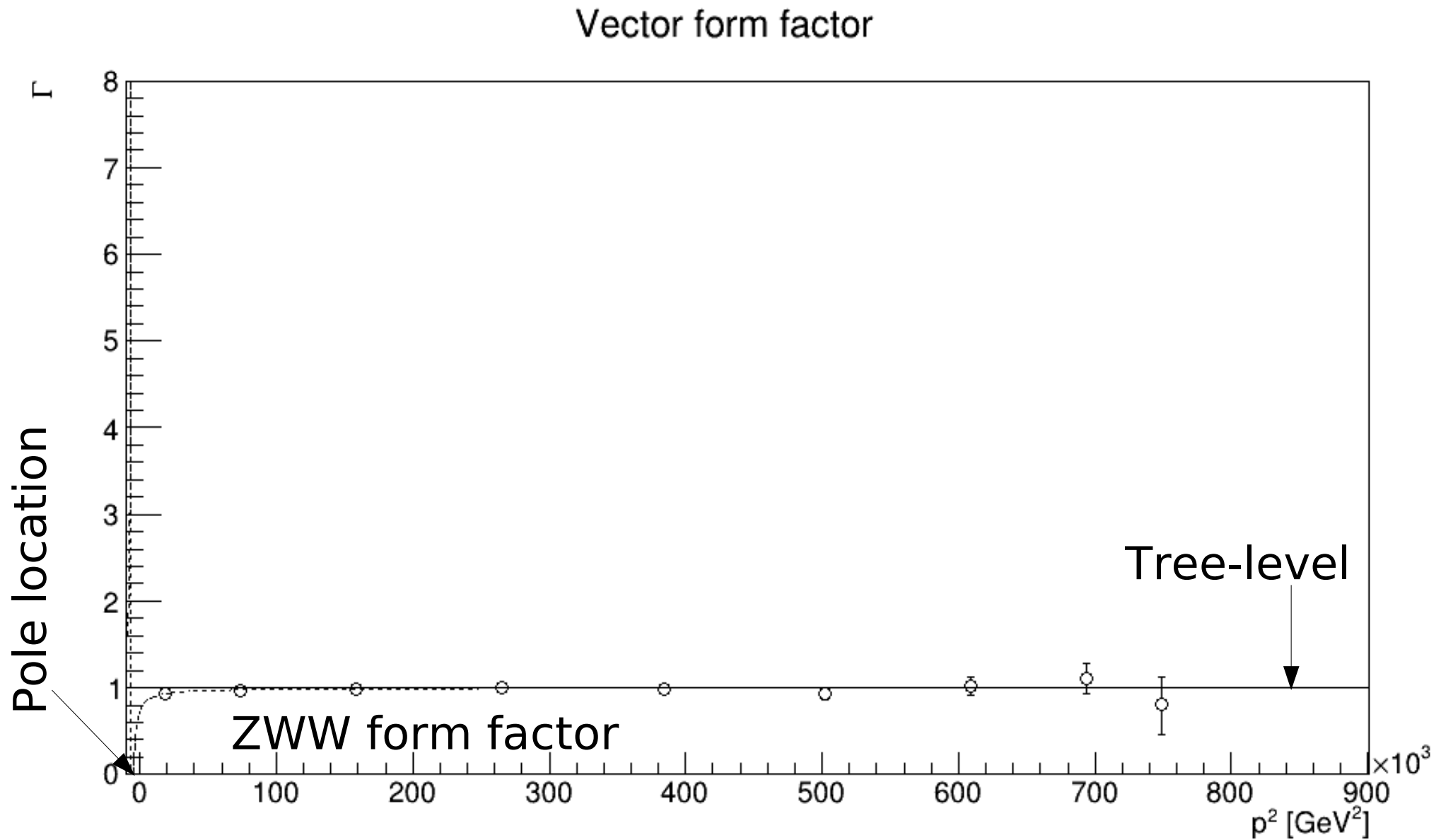
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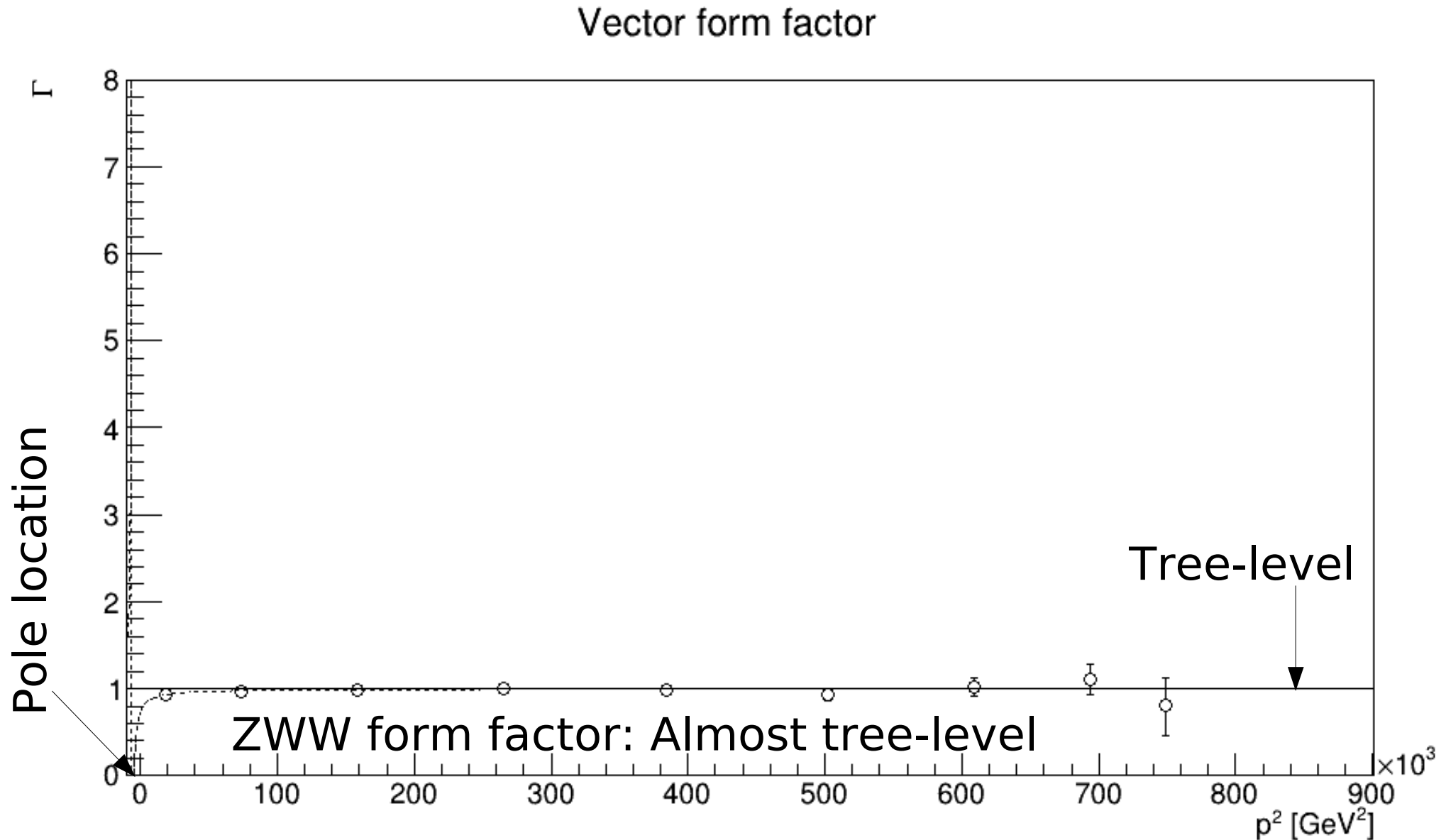
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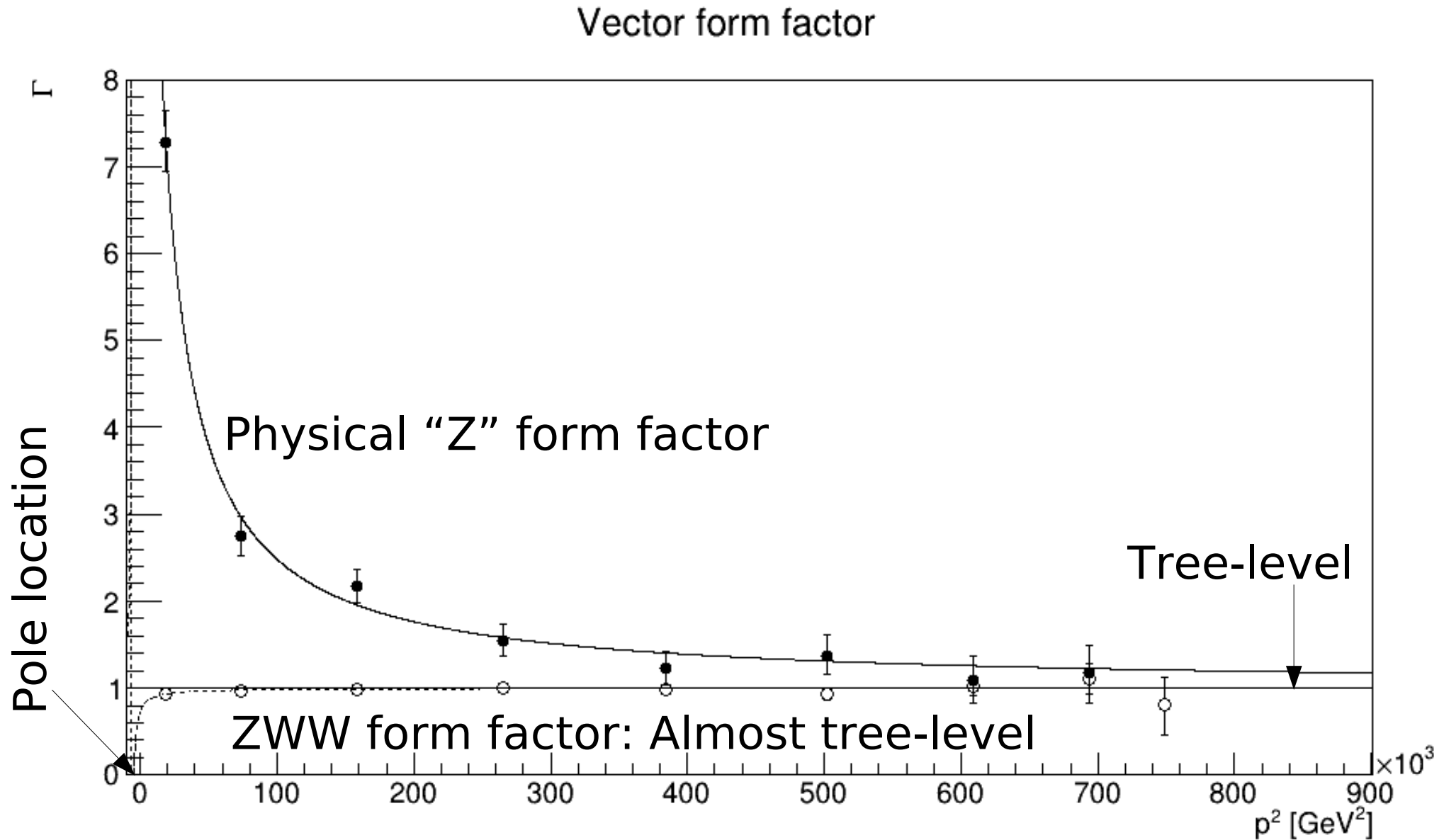
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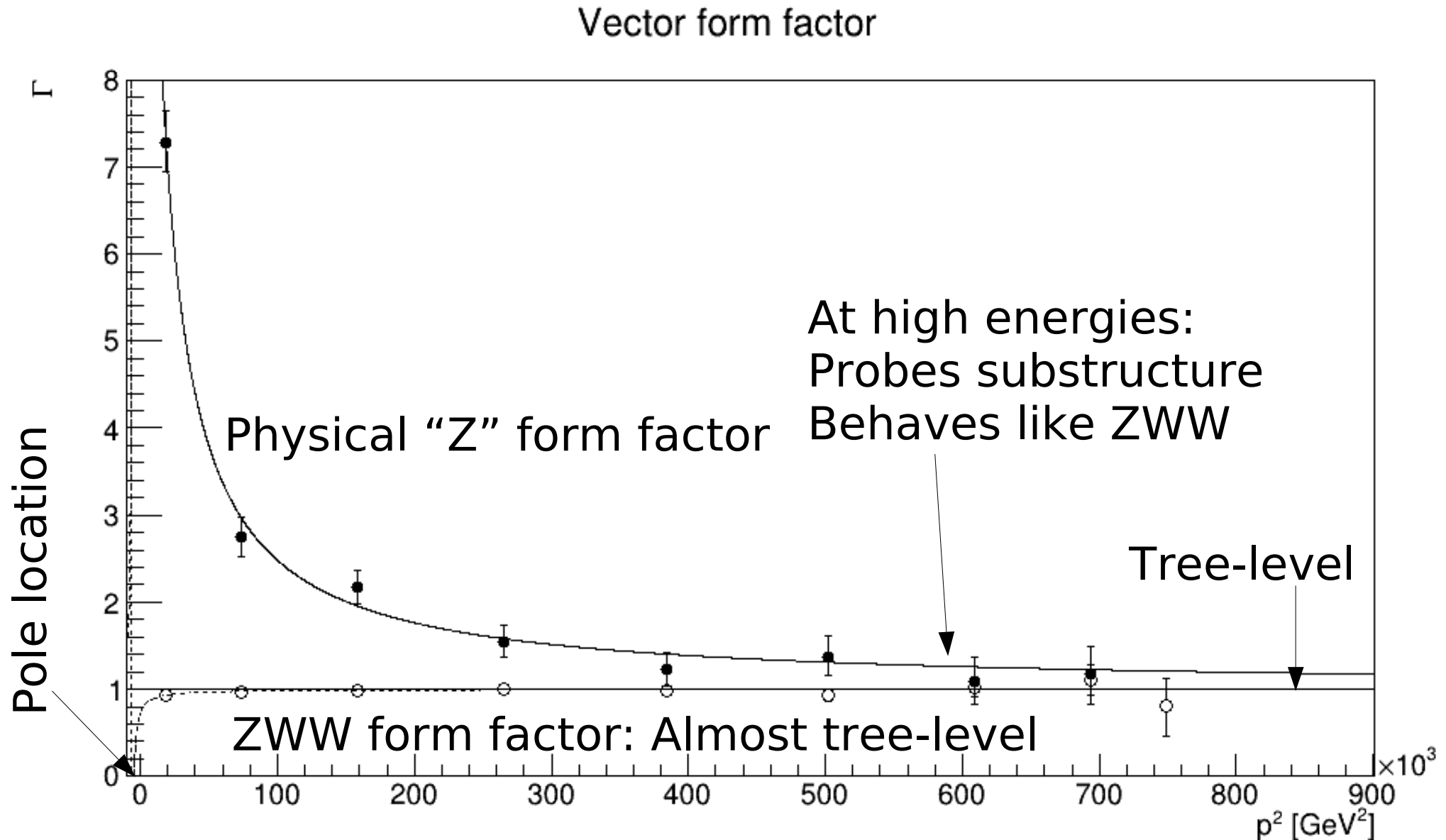
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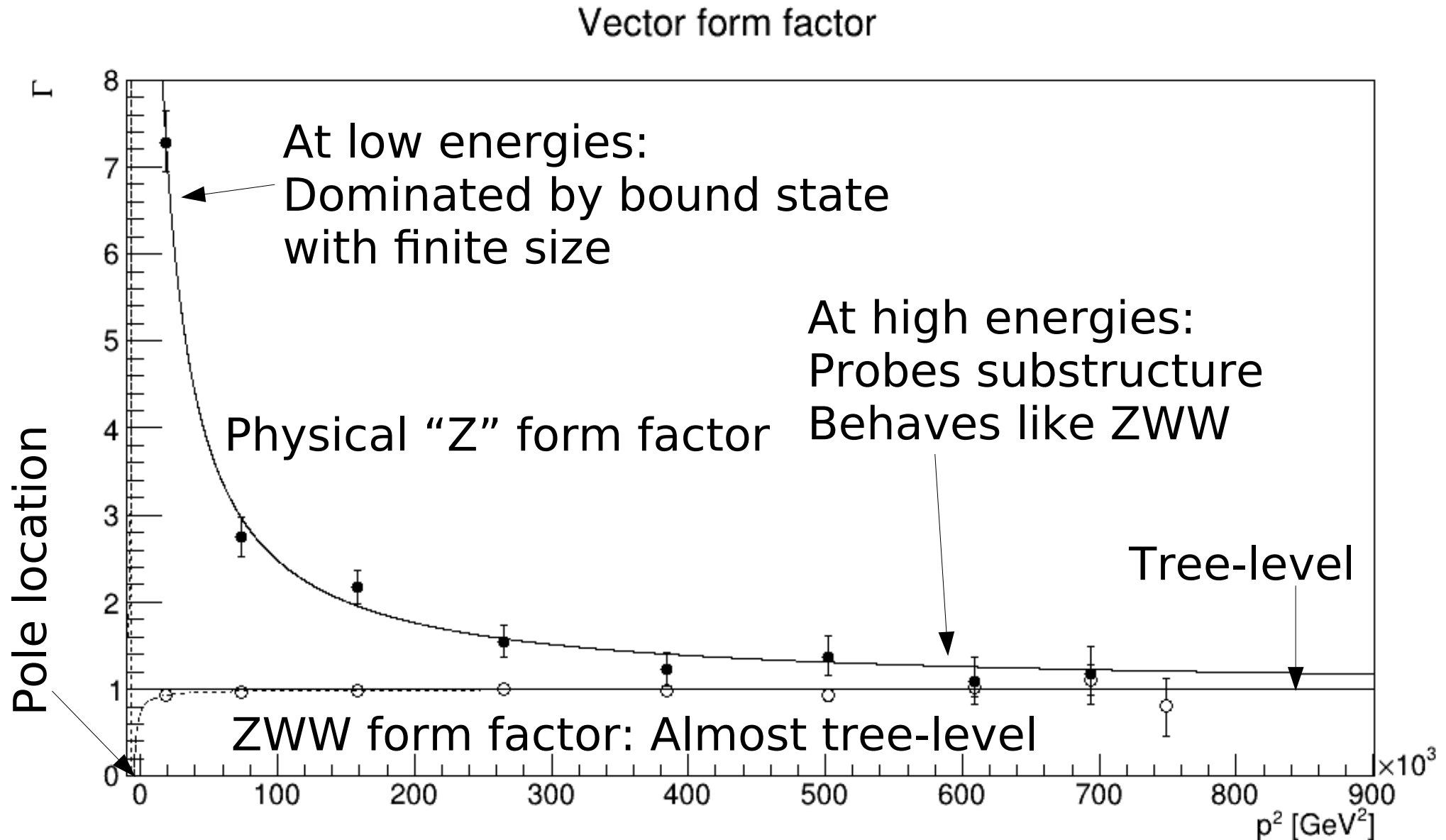
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- Physical "Z" $m r \sim 2$ while gauge-dependent Z has $m r \sim 0.5i$

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[Egger, Maas, Sondenheimer'17]

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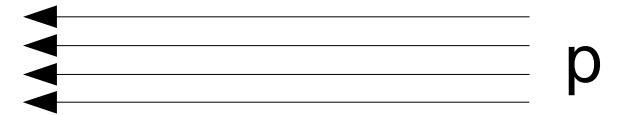
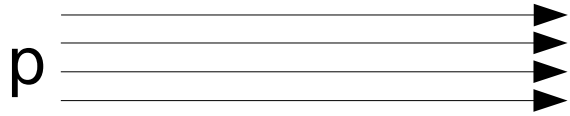
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- Valence Higgs detectable at LHC?
 - Strong couplings to Higgs: tops, weak gauge bosons

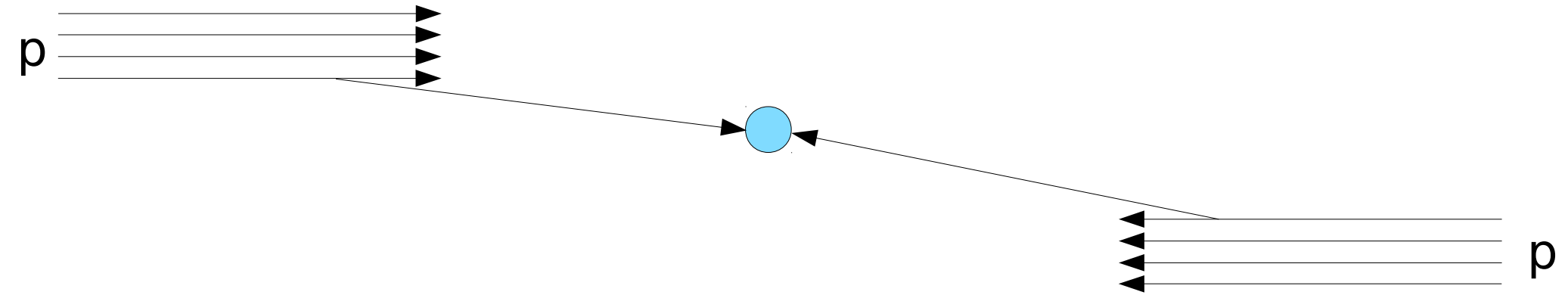
Constraining the valence Higgs

[Fernbach, Lechner, Maas,
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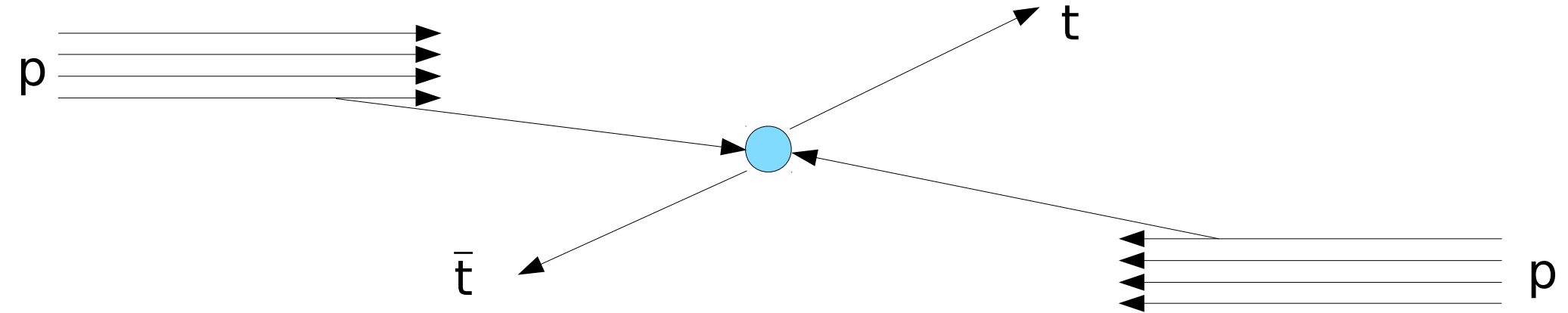
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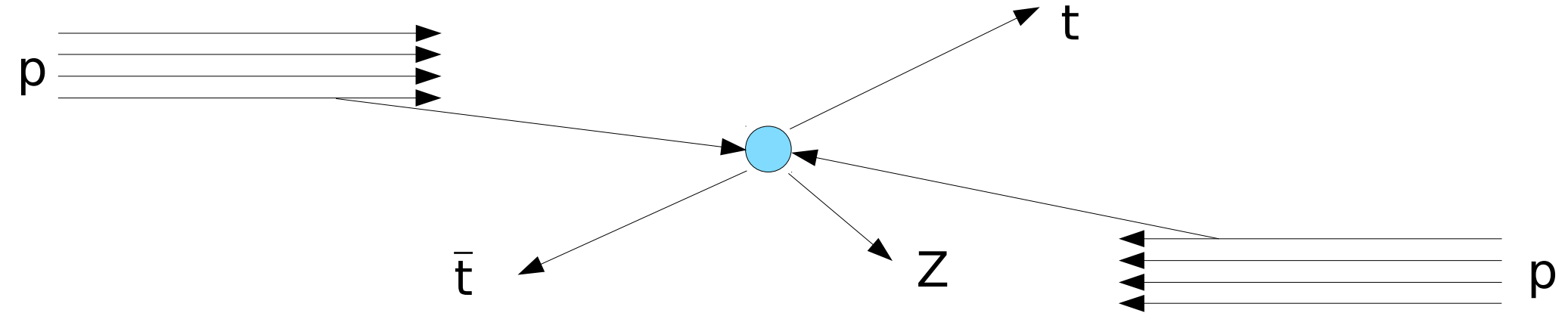
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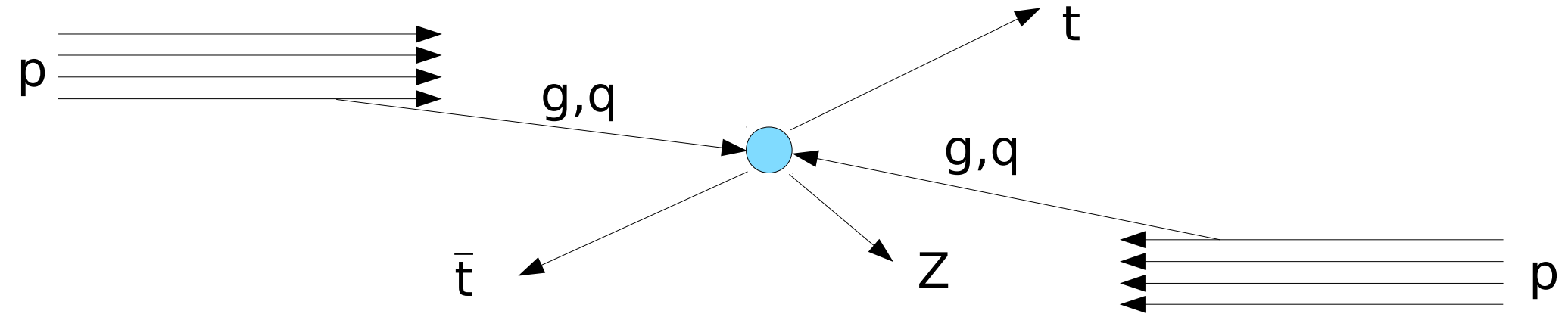
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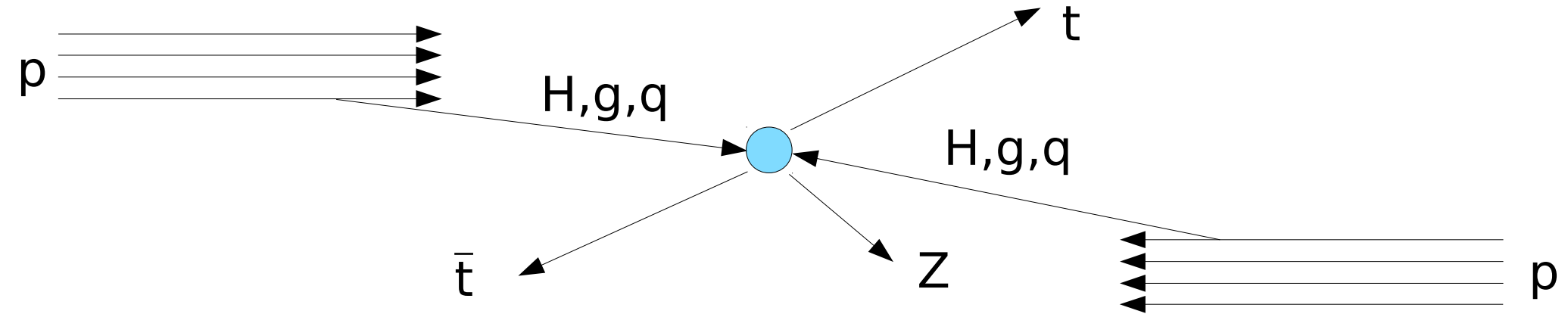
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- Hard process calculated by Herwig 7

Constraining the valence Higgs

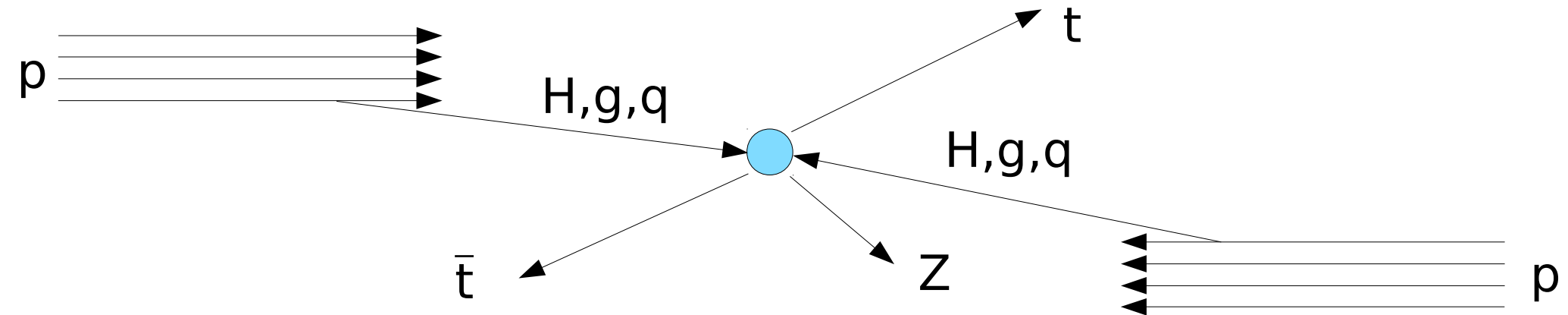
[Fernbach, Lechner, Maas,
Plätzer, Schöfbeck, unpublished]



- Hard process calculated by Herwig 7
- Modified version to include Higgs initial state

Constraining the valence Higgs

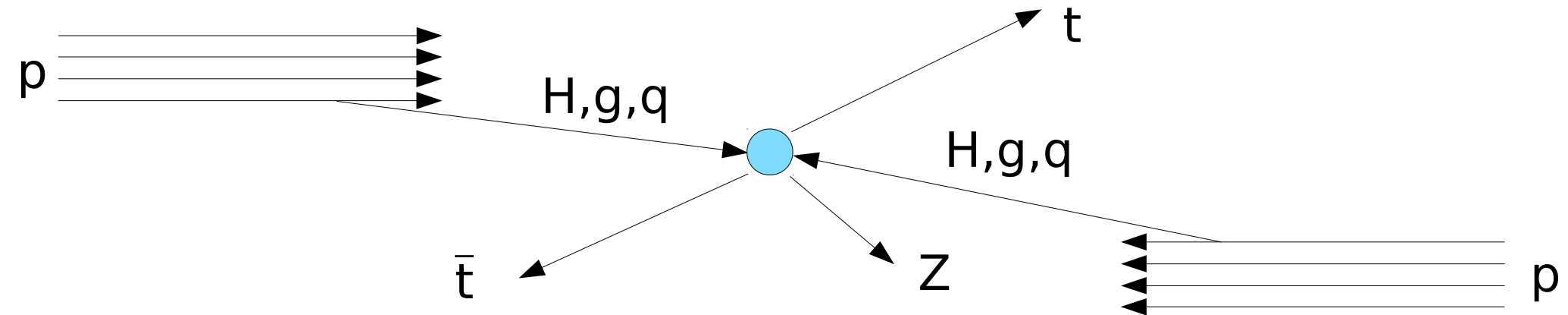
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 - Tree-level only
 - Standard-model dominated by gluons
 - Initial states $q\bar{q}$, gg , gH , HH

Constraining the valence Higgs

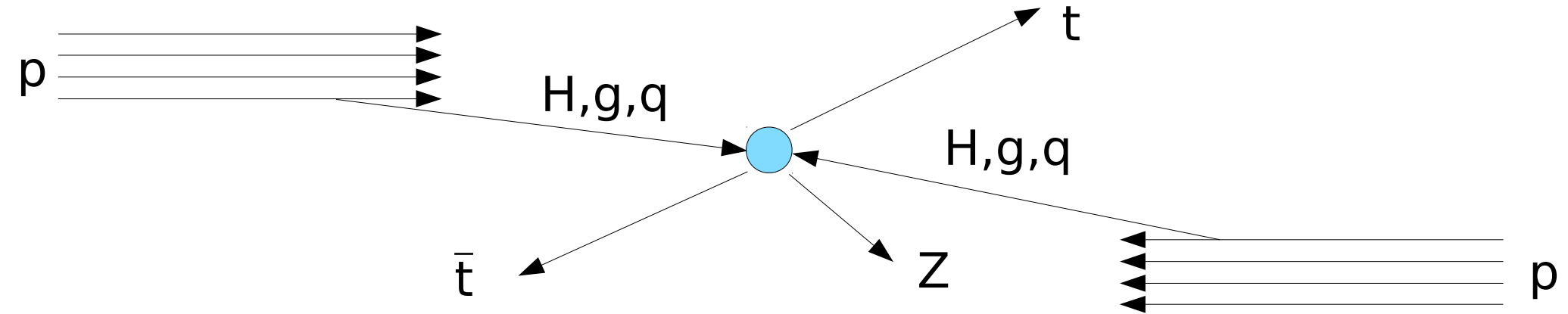
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- Hard process calculated by Herwig 7
- Modified version to include Higgs initial state
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 - Initial states $q\bar{q}$, gg , gH , HH
- PDF ansatz for valence Higgs

Constraining the valence Higgs

[Fernbach, Lechner, Maas, Plätzer, Schöfbeck, unpublished]

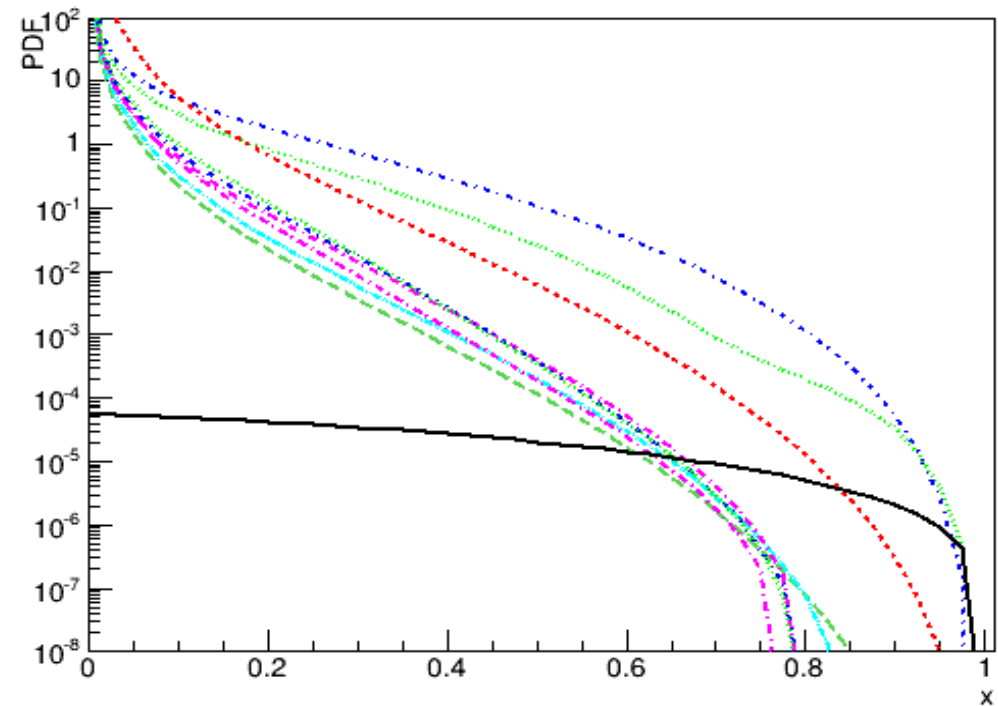
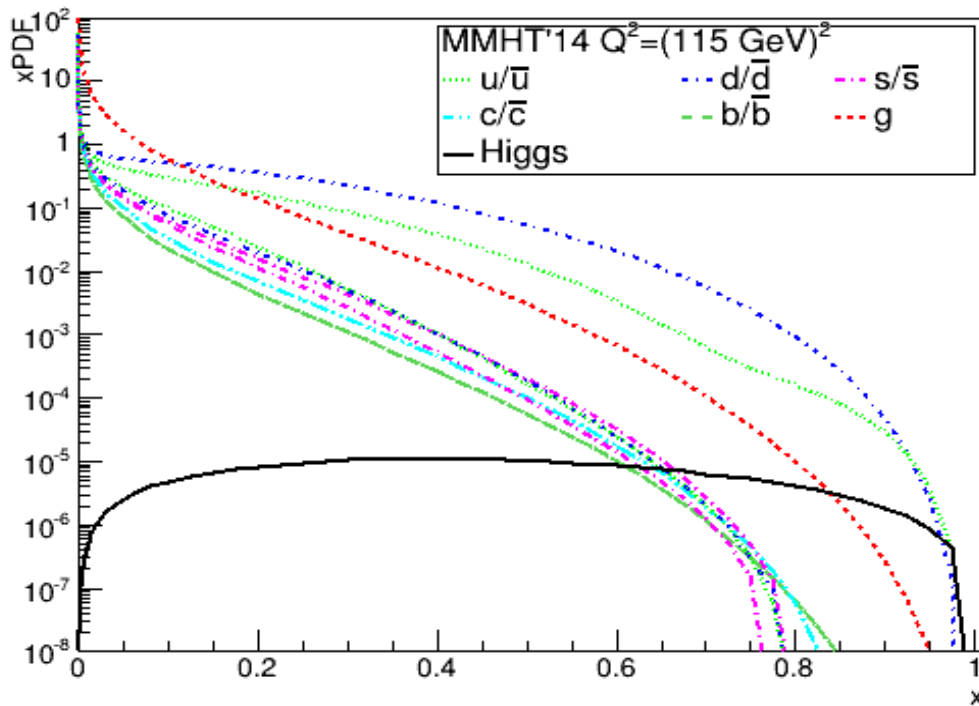


Starting guess: Higgs PDF still 'condensate'-like

xPDFs

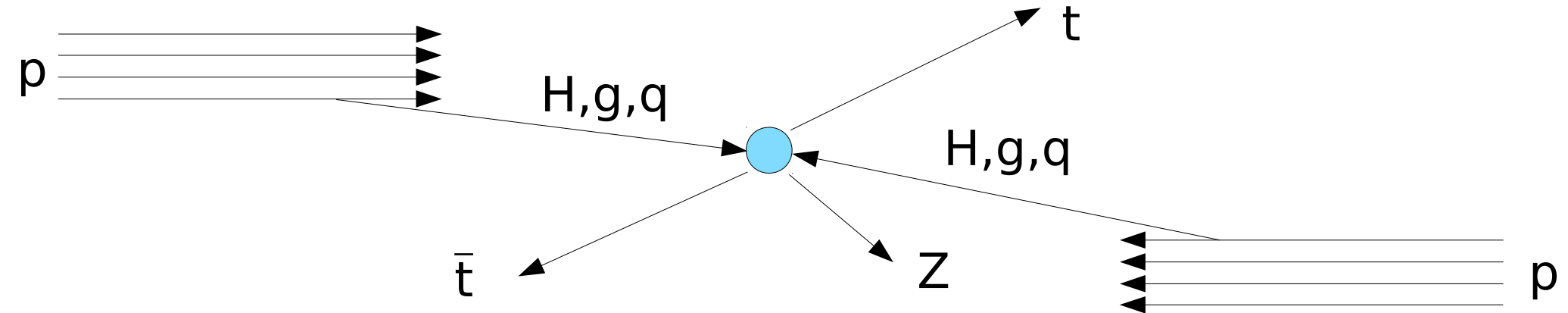
PRELIMINARY

PDFs



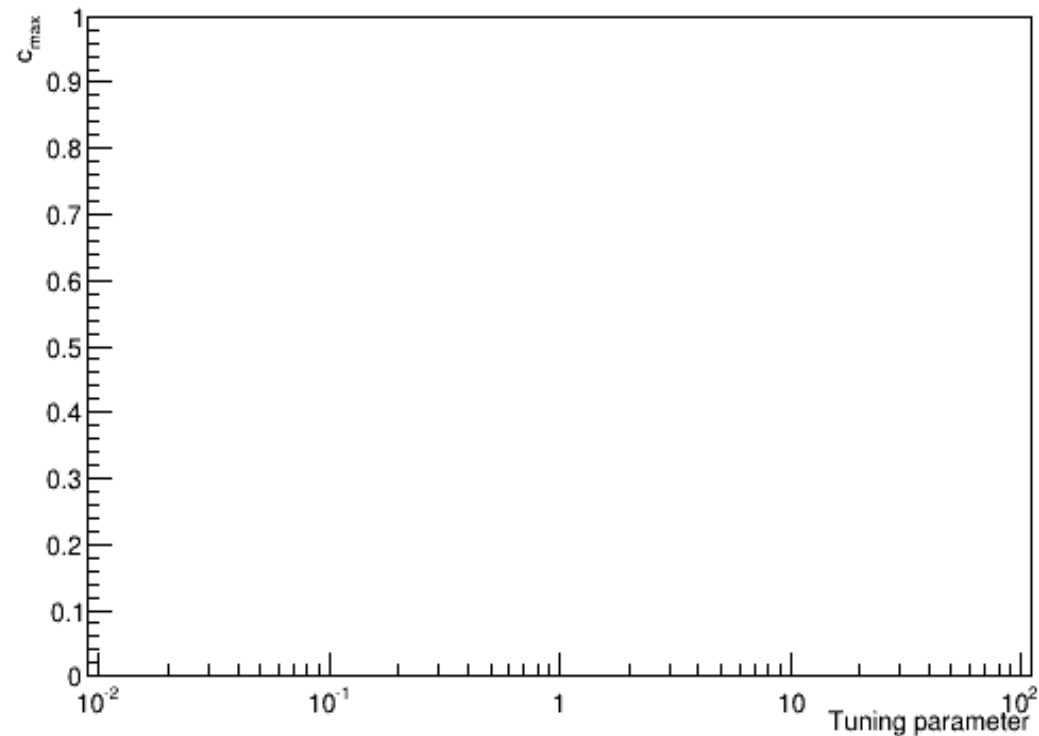
Constraining the valence Higgs

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Plätzer, Schöfbeck, unpublished]



Maximal Higgs content

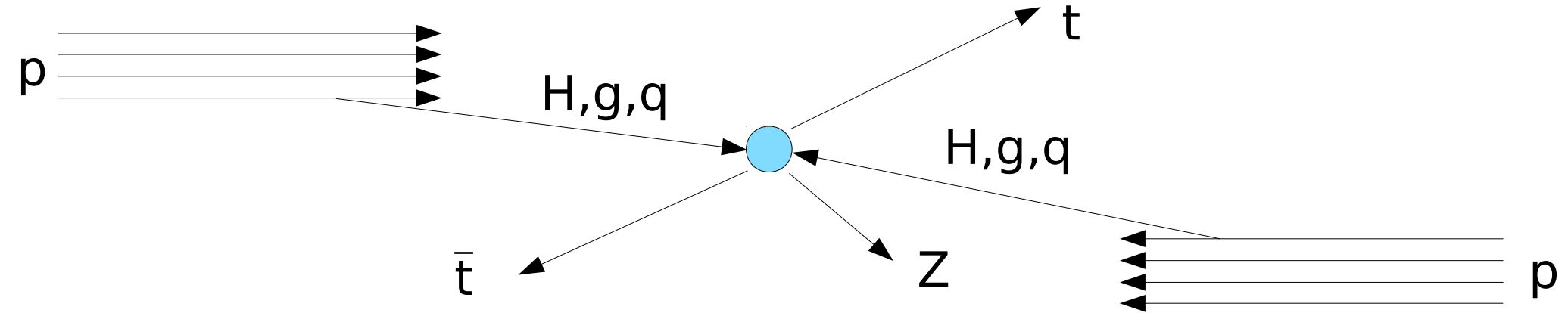
PRELIMINARY



PDF shape parameter

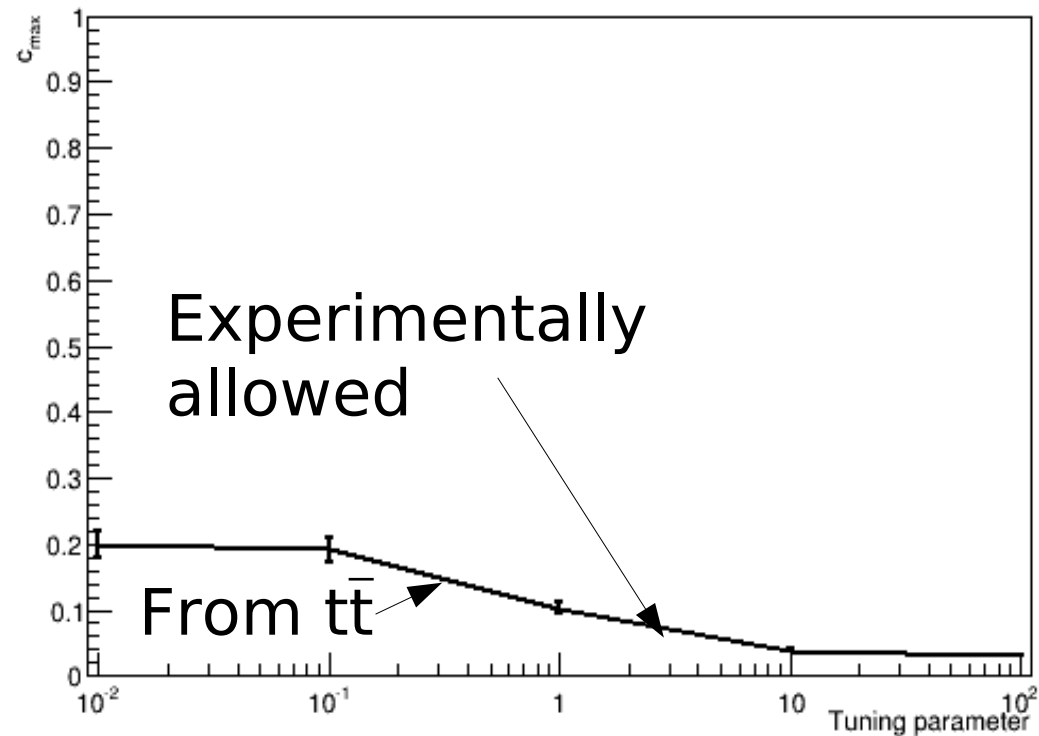
Constraining the valence Higgs

[Fernbach, Lechner, Maas,
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Maximal Higgs content

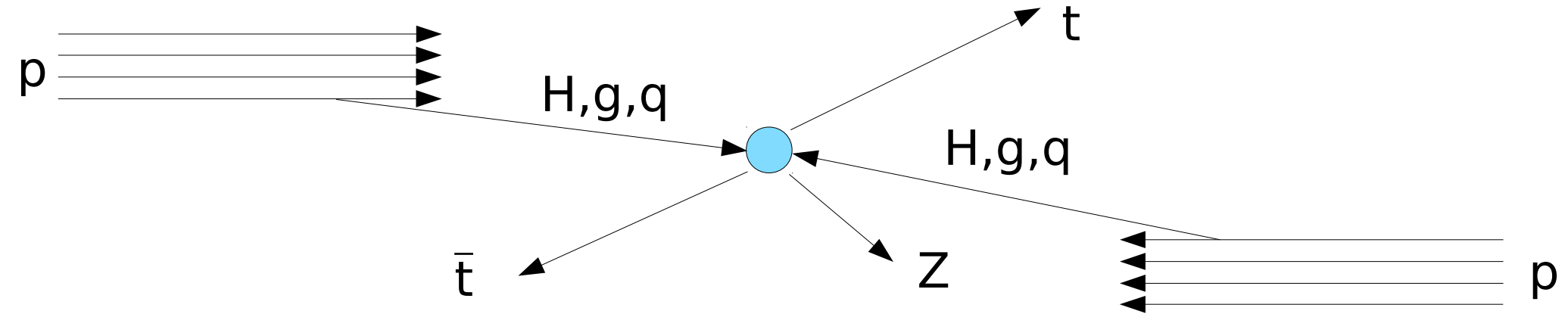
PRELIMINARY



PDF shape parameter

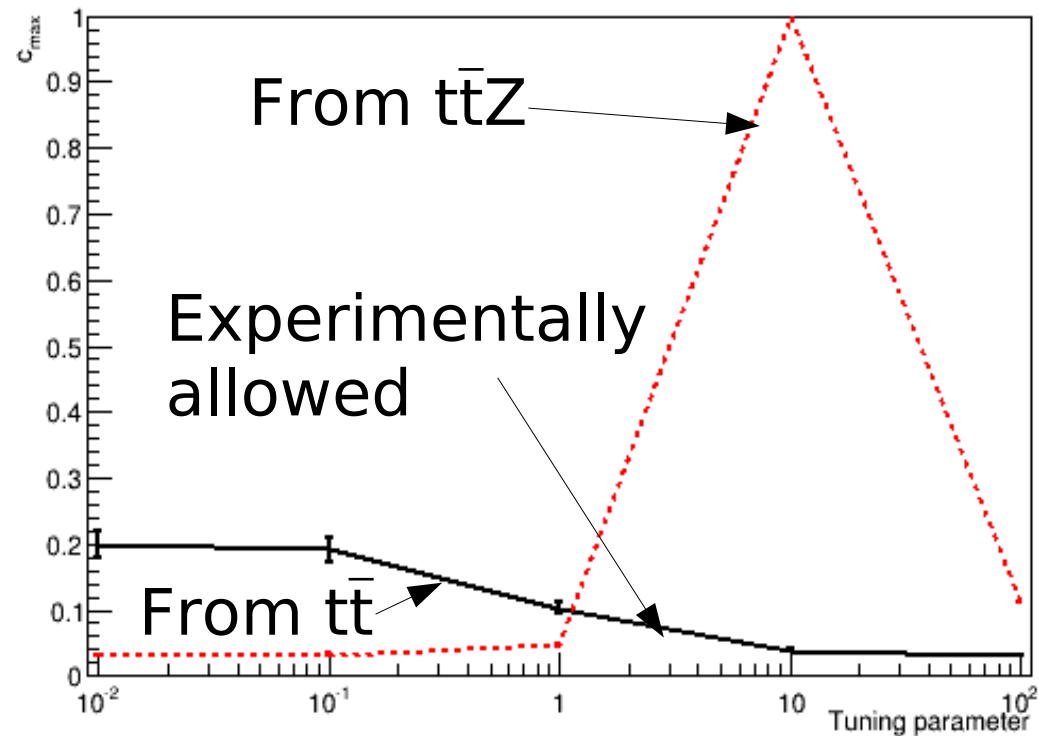
Constraining the valence Higgs

[Fernbach, Lechner, Maas, Plätzer, Schöfbeck, unpublished]



Maximal Higgs content

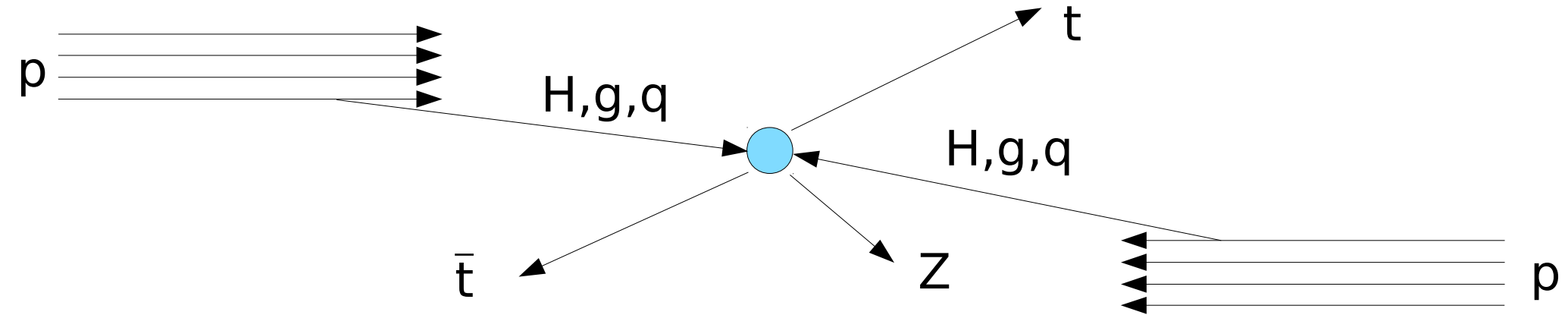
PRELIMINARY



PDF shape parameter

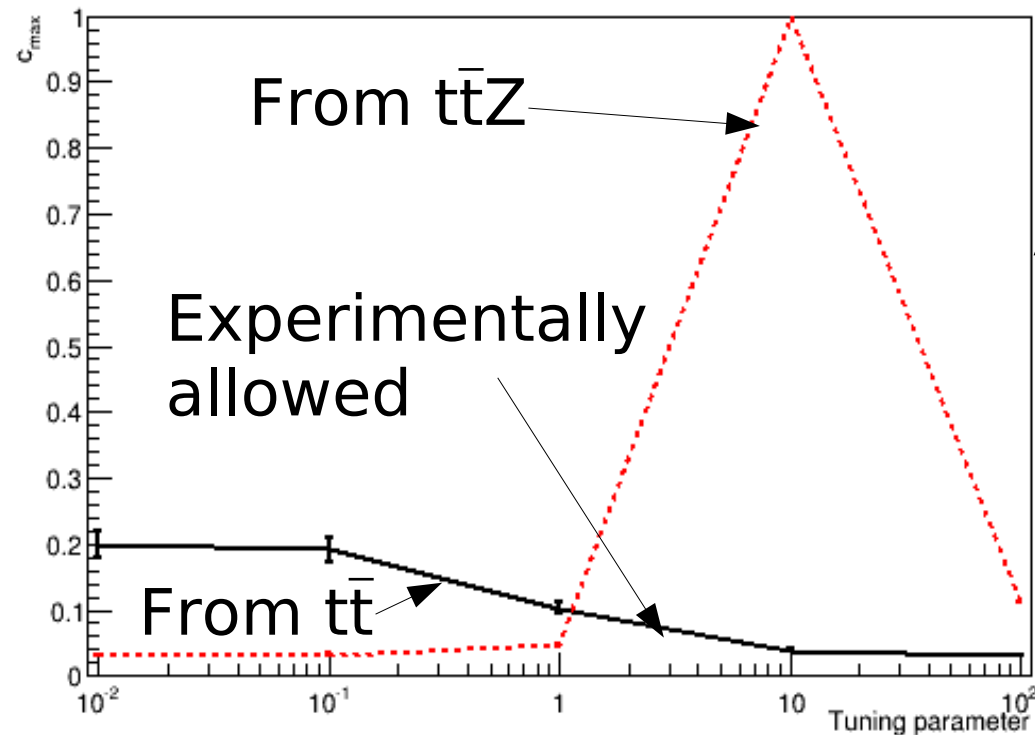
Constraining the valence Higgs

[Fernbach, Lechner, Maas, Plätzer, Schöfbeck, unpublished]



Maximal Higgs content

PRELIMINARY



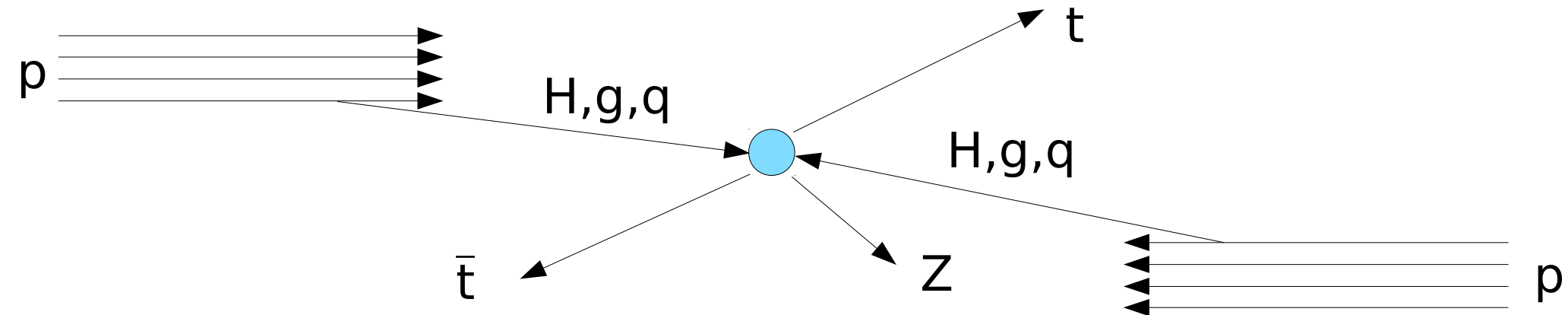
Add:

- Partial differential crosssections
- CMS detector simulation
- Full run II reach

PDF shape parameter

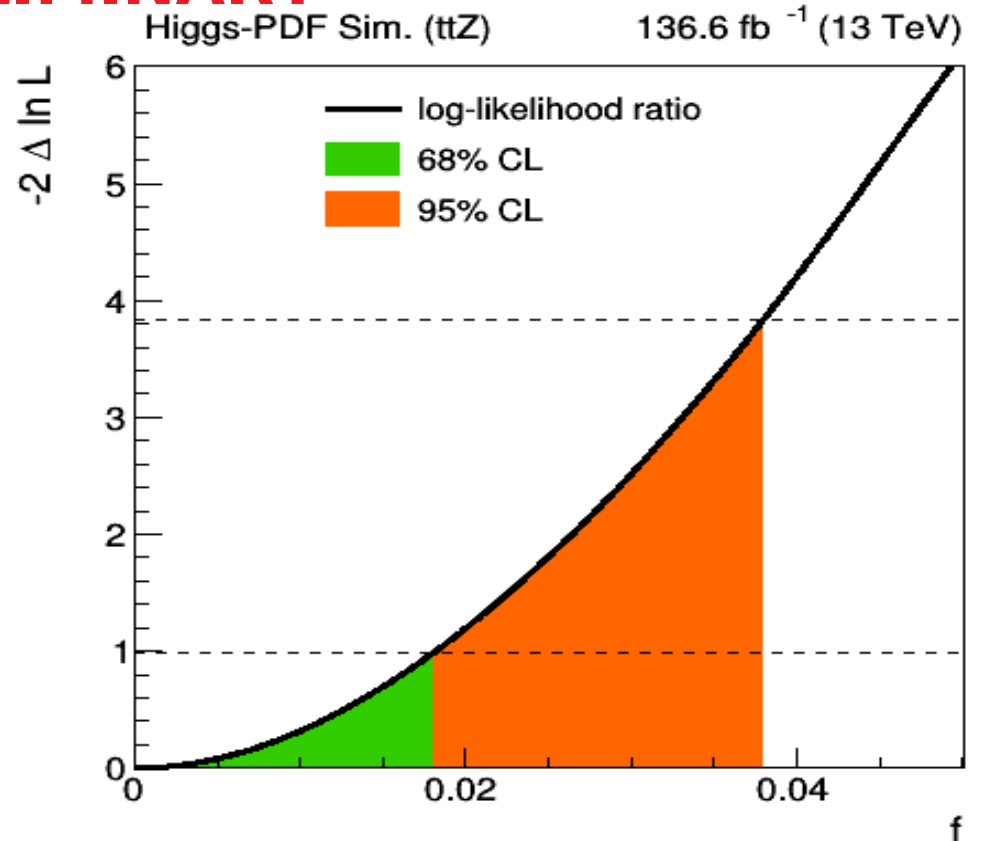
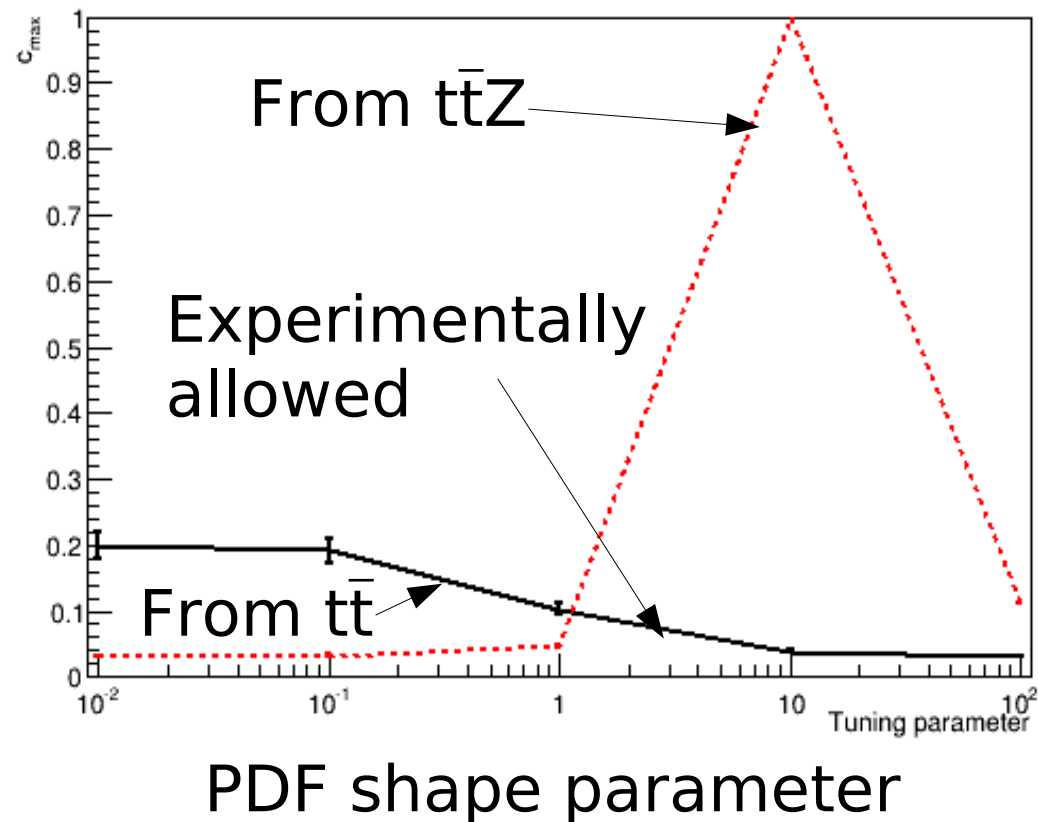
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Maximal Higgs content

PRELIMINARY



Up next

- In SM physics: Quantitative changes
 - Suppressed below Higgs threshold
 - Consistent with experimental bounds
 - Detectable

Up next

- In SM physics: Quantitative changes
 - Suppressed below Higgs threshold
 - Consistent with experimental bounds
 - Detectable
- In BSM physics: Qualitative changes
 - Different number of particles
 - Different masses
 - Different signatures