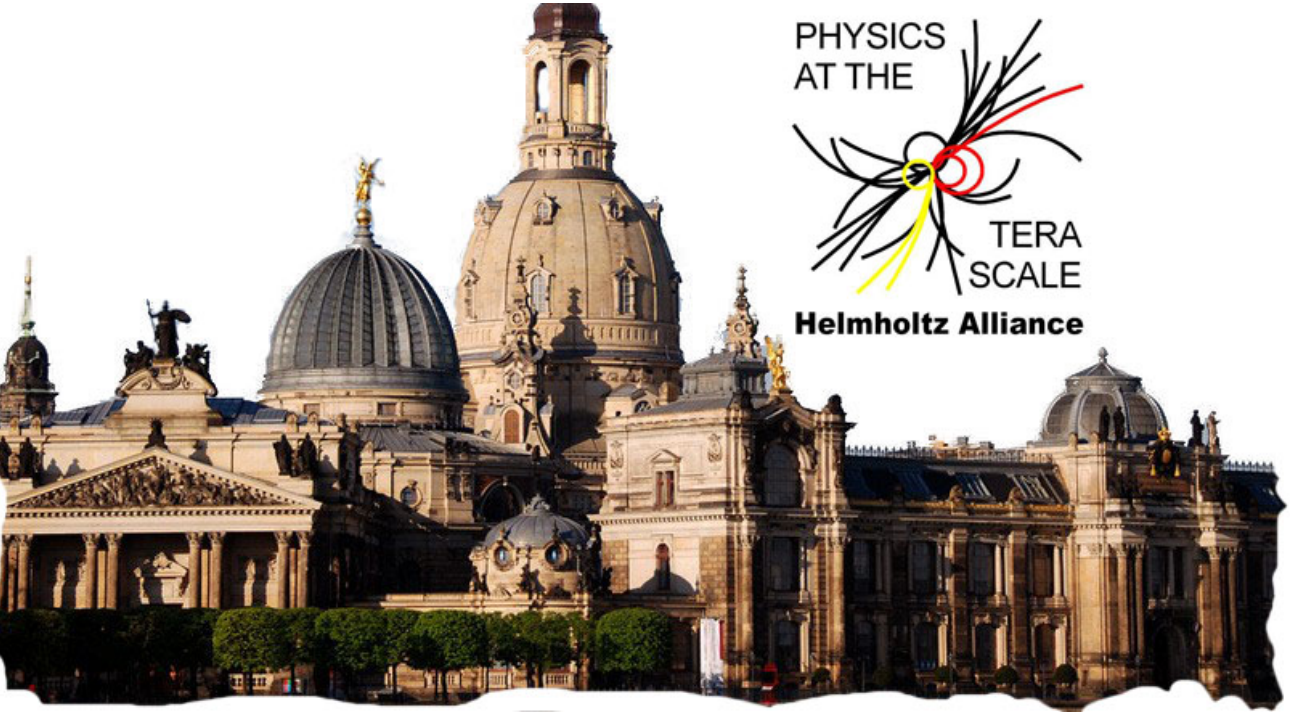
Search for Large Extra Dimensions (LED) in the di-muon final state with CMS



- **Metin Ata**
- Thomas Hebbeker
- Arnd Meyer
- Stefan A. Schmitz

4th Annual Workshop of the Helmholtz Alliance, Dresden

"Physics at the Terascale", December 2010

GEFÖRDERT VOM

Bundesministerium
für Bildung
und Forschung

III. Physikalisches Institut A, RWTH Aachen

CMS

Outline

Motivation

Why extra dimensions?

- Huge hierarchy between VEV of Higgs (M_{EW}) and characteristic energy scale of gravity (M_{Planck}) given by :

$$\left(\frac{M_{Planck}}{M_{EW}}\right)^2 = 10^{32}$$

- Closely related is the fine-tuning problem of the Higgs mass (e.g. contributions by lepton loops)
- Such hierarchies tend to collaps and are considered unnatural

Possible Solutions?

- In SUSY divergent loop corrections cancel due to super partners
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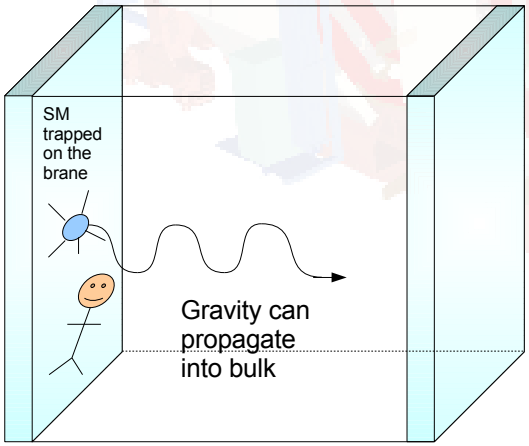
What are LED about?

- SM trapped on Brane, gravity escapes into extra dimensions (Bulk)
- Extra dimensions are compactified possibly at the mm-scale



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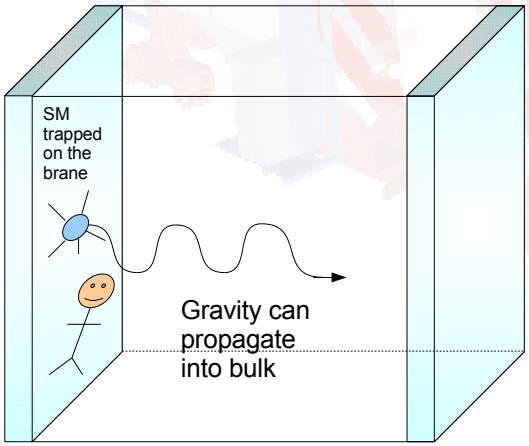

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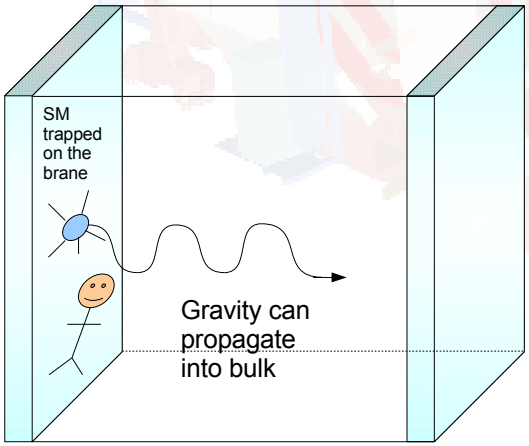

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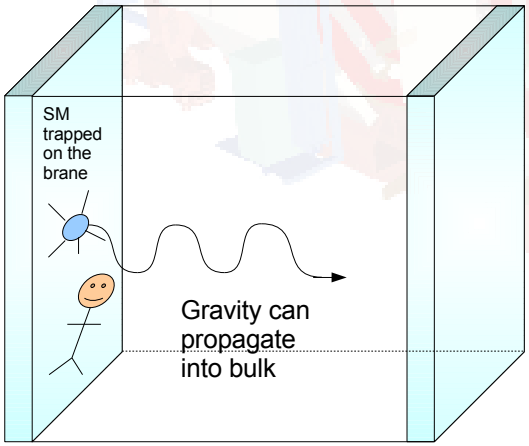

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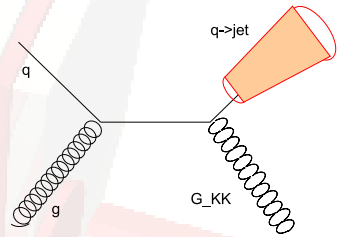

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Metin Ata, CMS TS-2010/021

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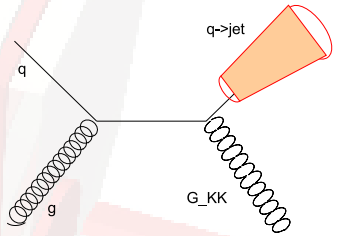

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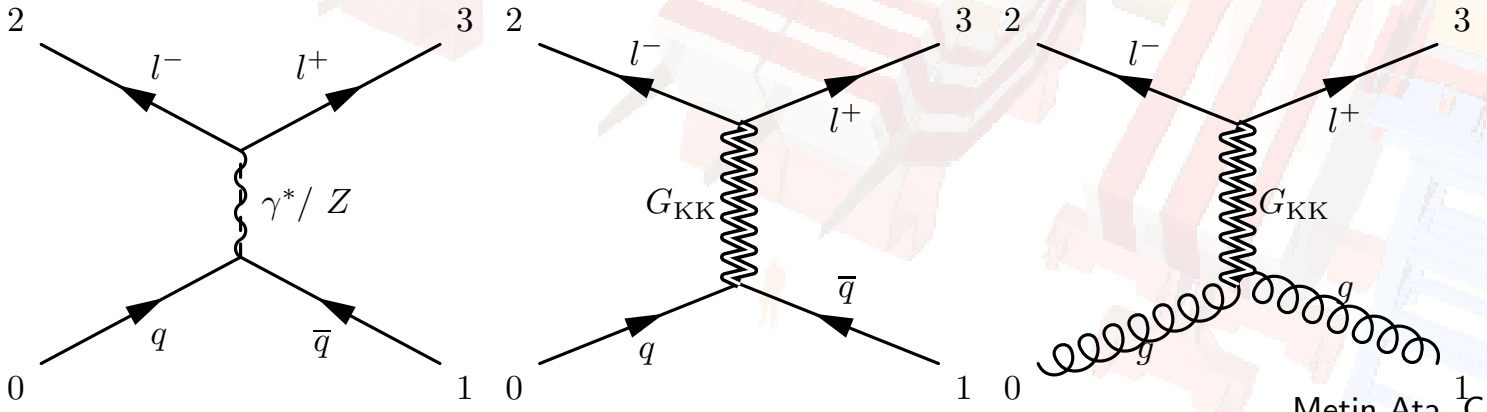

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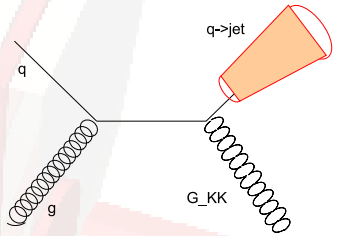

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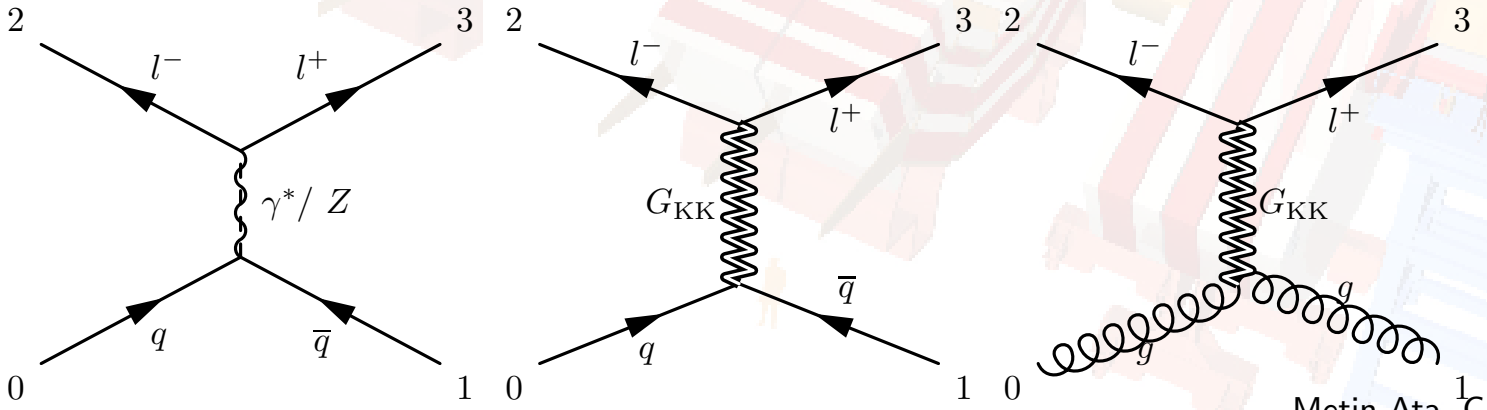

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Muon Selection

Analysis based on Exotica Muon cut recommendations :

- Single muon trigger required
- $|\eta| \leq 2.1$ (muon trigger)
- $p_t > 30$ GeV
- Tight Muon ID:
  - Criterion on goodness of track fit
  - Reconstructed in Muon System and Tracker
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- Isolation requirements for the track in the Silicon Tracker
- Transverse distance of the track fit to interaction point < 0.2 cm
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Also need to refit p_t, η, ϕ for high energy muons

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Signal Monte Carlos

- Currently using Pythia 8 package documented in arXiv:0912.4233v2
- Using GRW convention, only depending on reduced Planck scale M_S, not on number of extra dimensions, hep-ph/9811291
- Producing high invariant di-muon masses where signal becomes dominant $\sqrt{\hat{s}} > 300$ GeV
- Different values of M_S from 1200 GeV to 1800 GeV (DØ limits at $M_S \approx 1600$ GeV (GRW))

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Theory demands a cut-off scale to avoid divergences. Presently the cut-off scale set to COM energy but naivly at M_S in theory.

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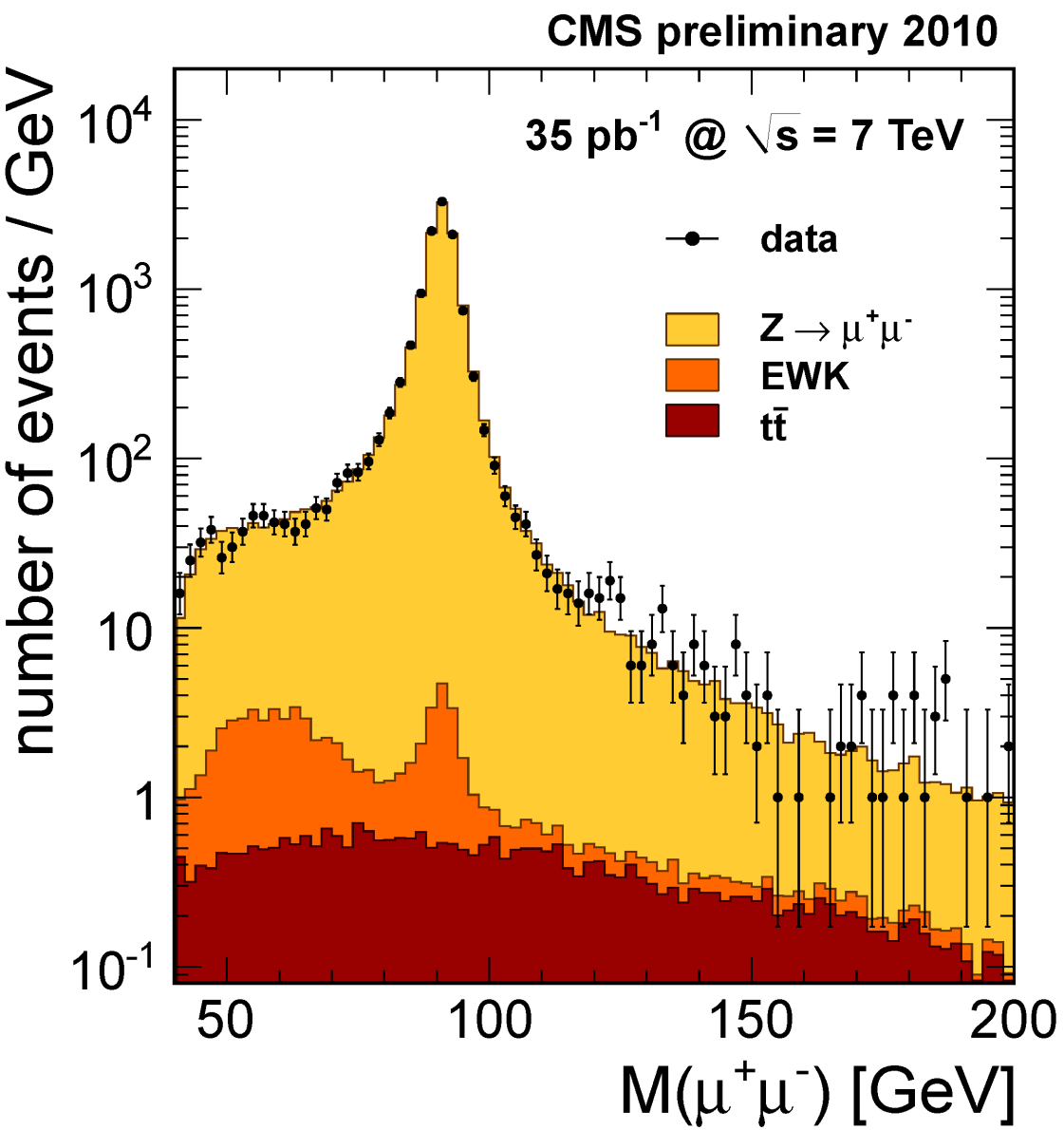

RWTH AACHEN
Phys. Inst. III A

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- Excellent muon momentum resolution of the CMS detector

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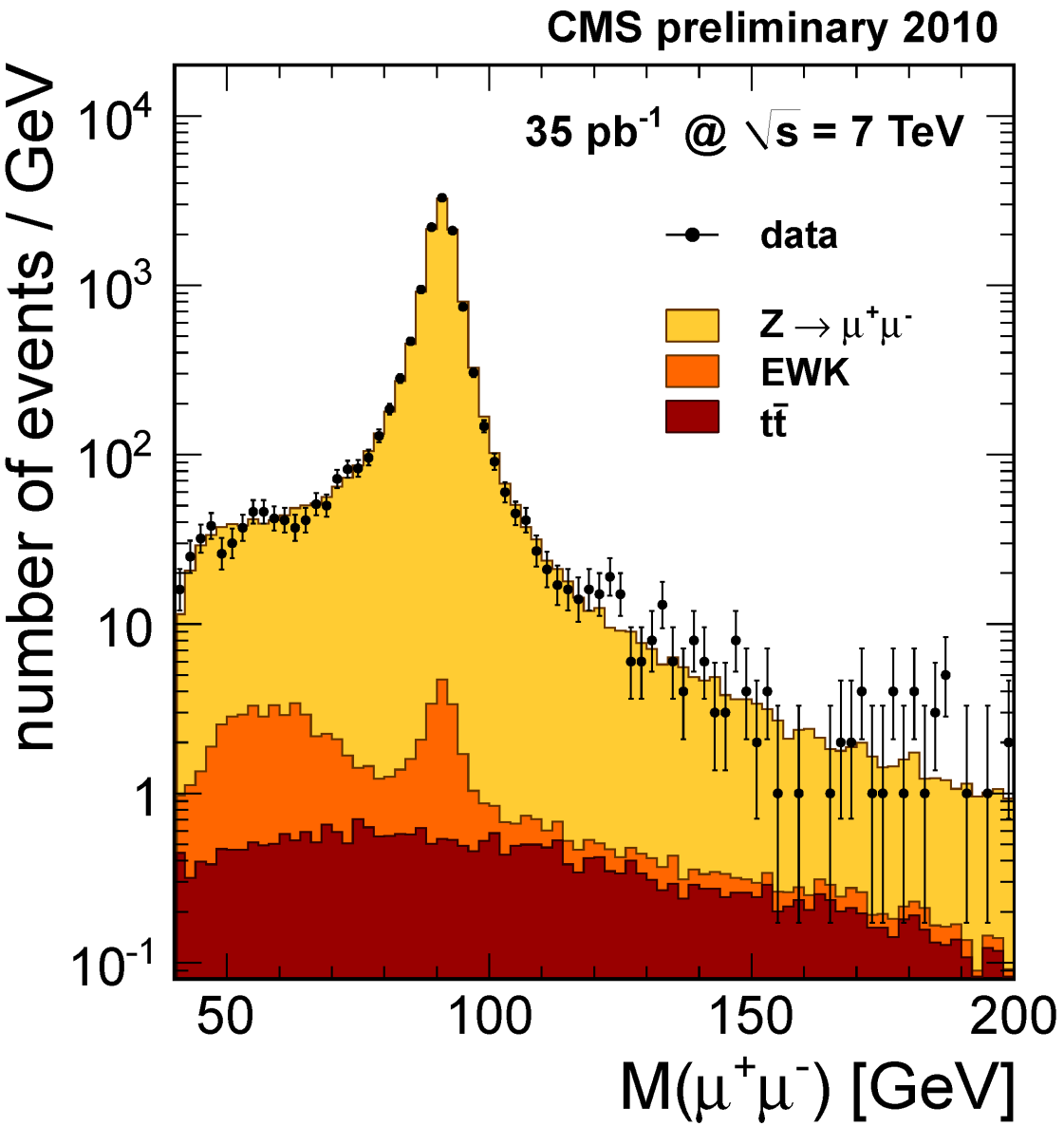

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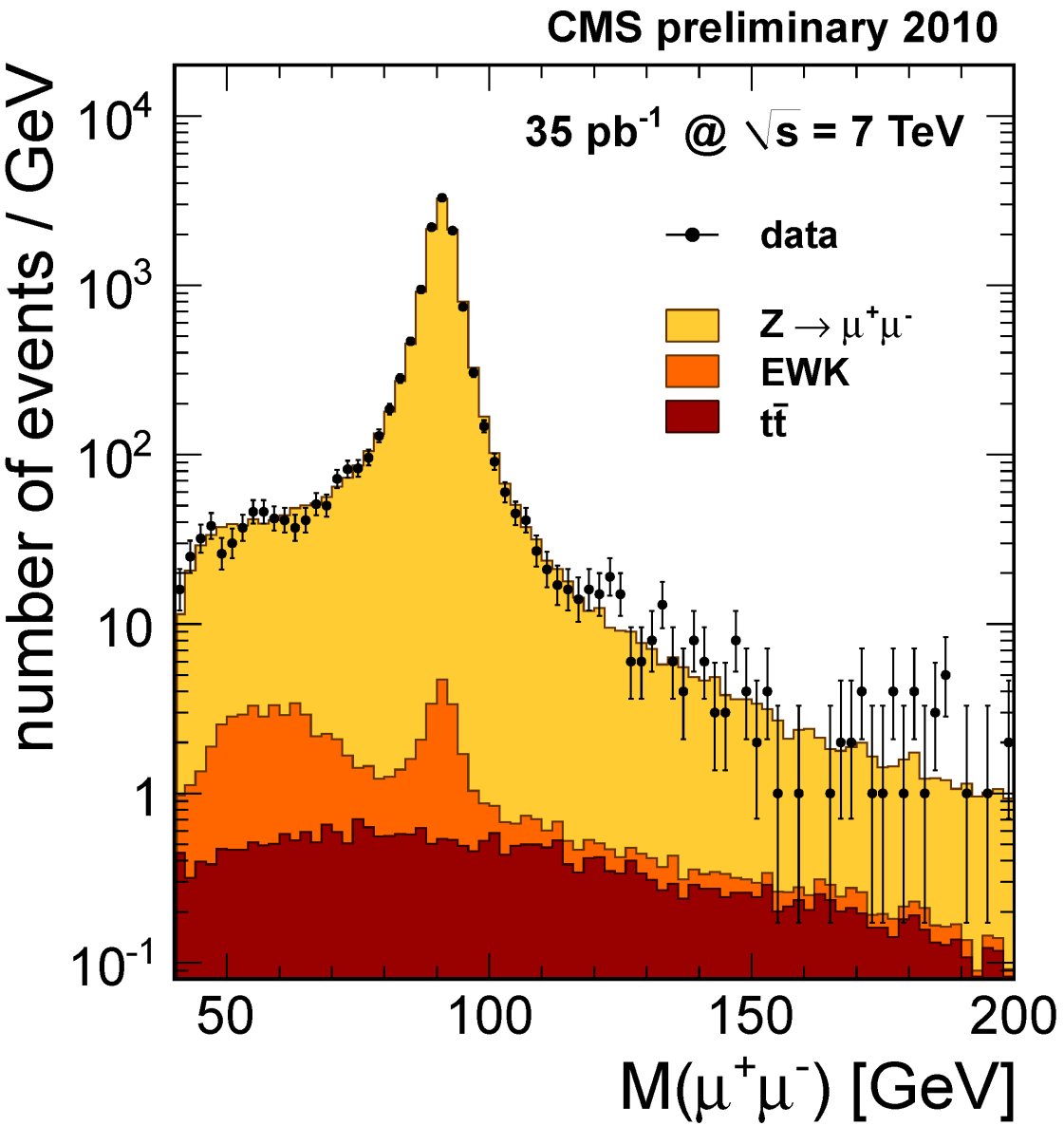

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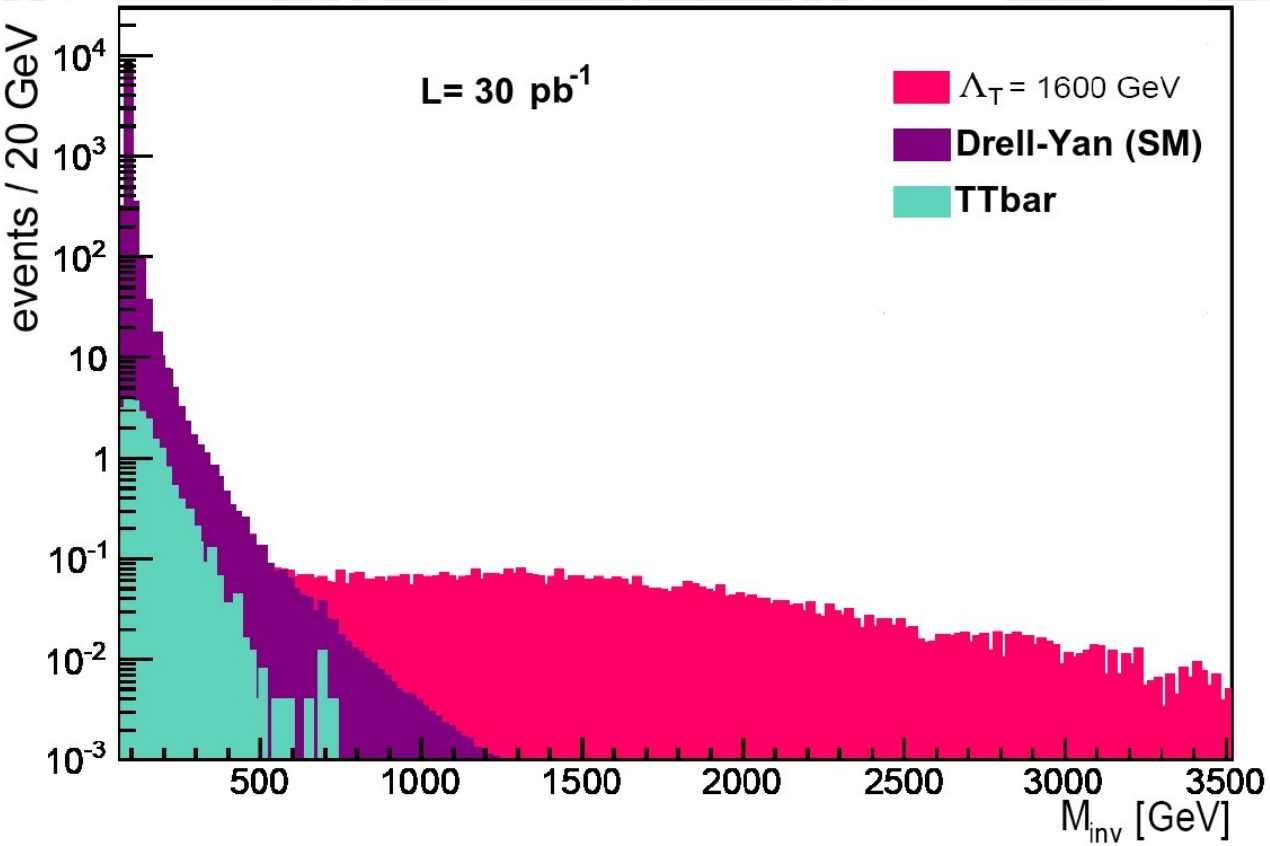

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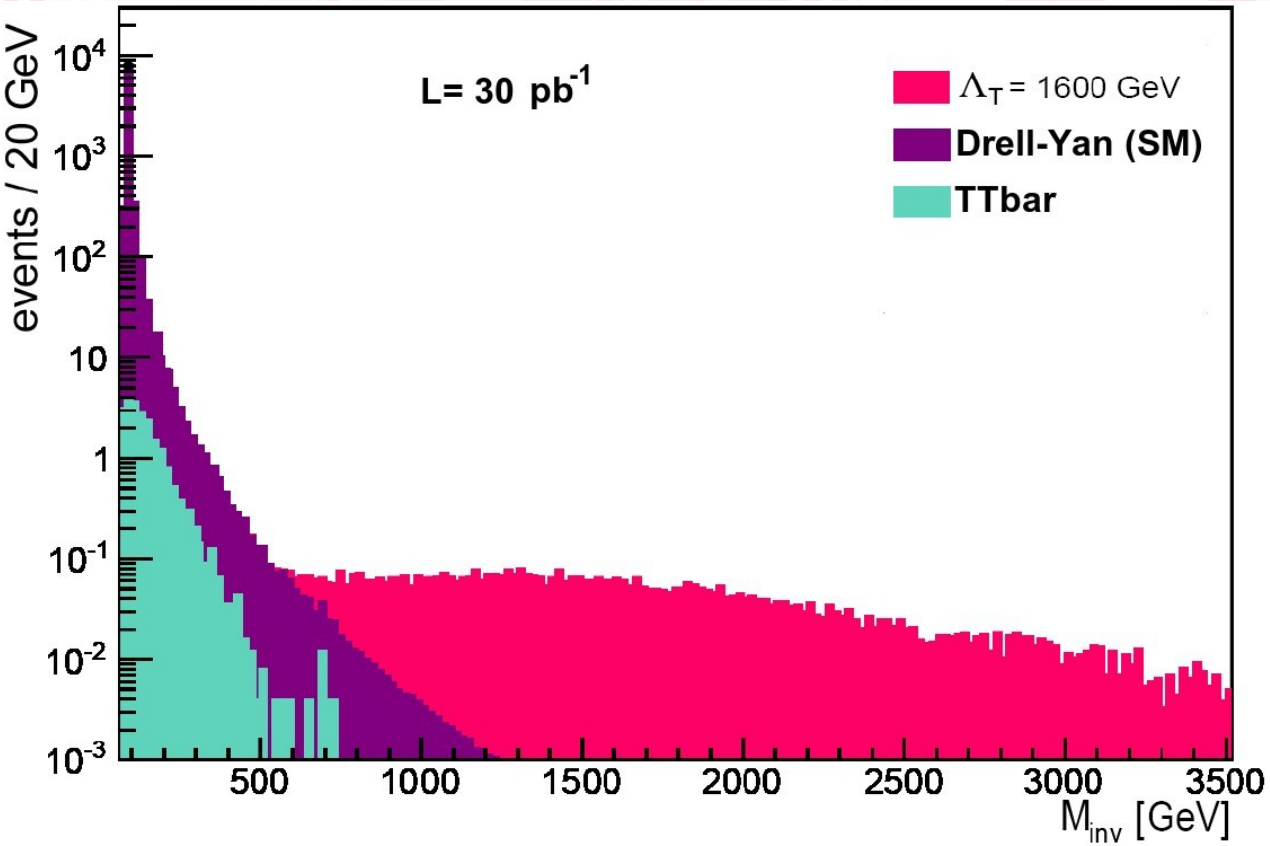

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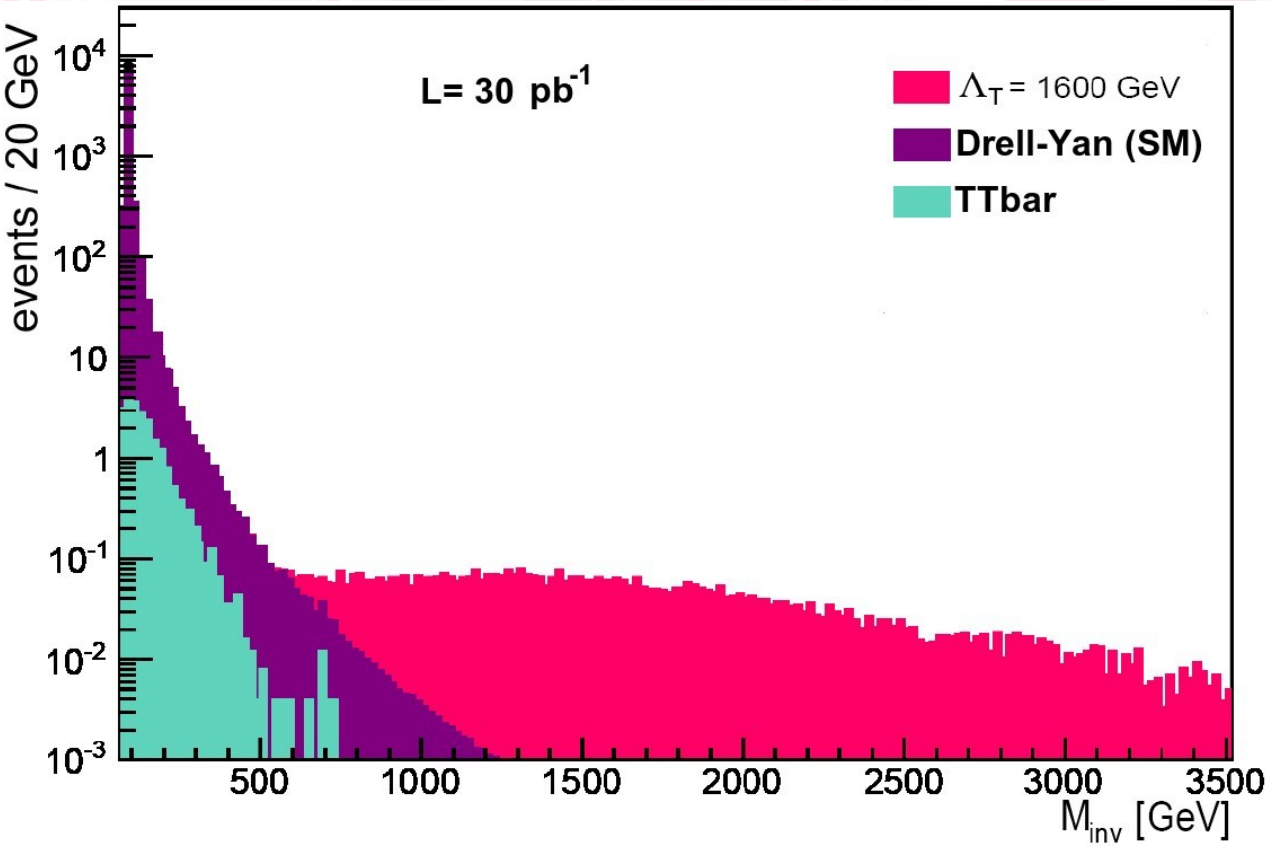

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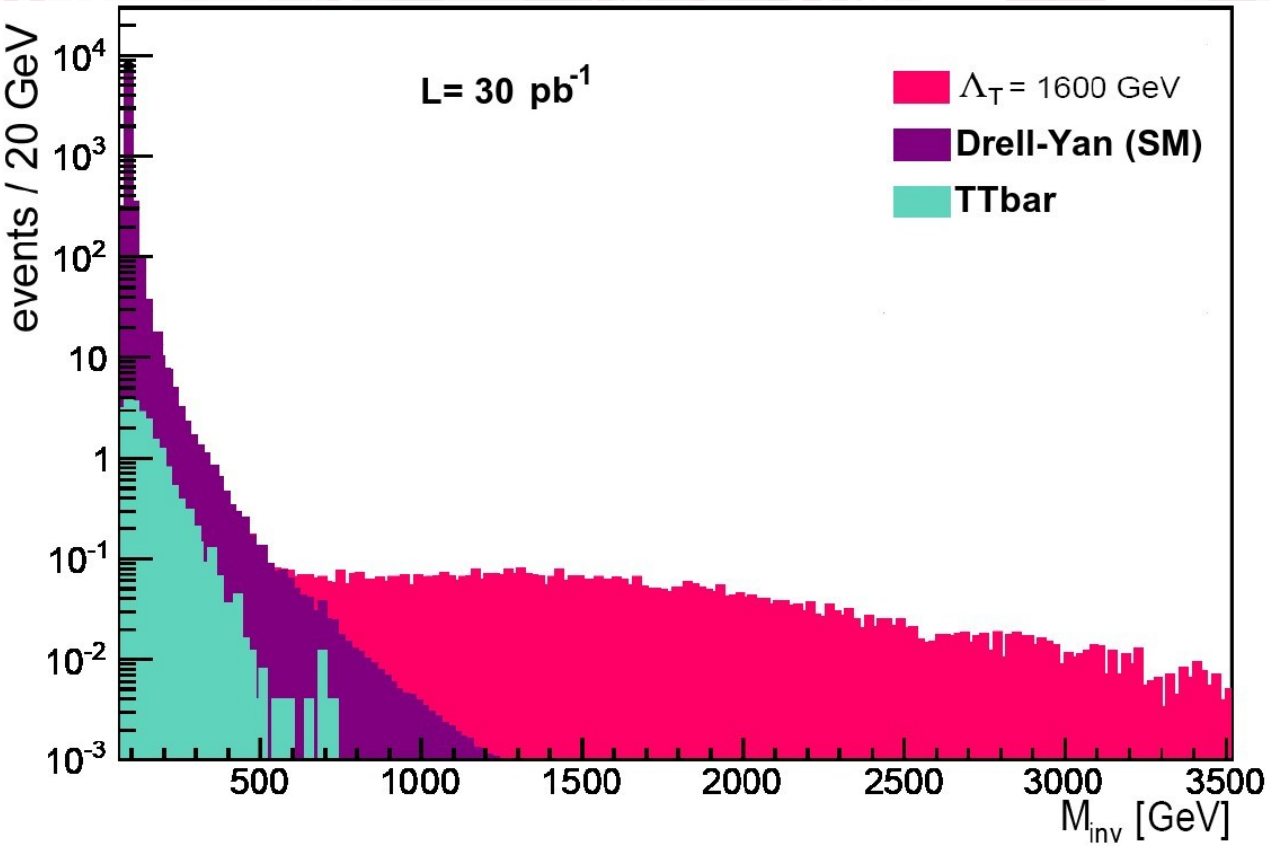

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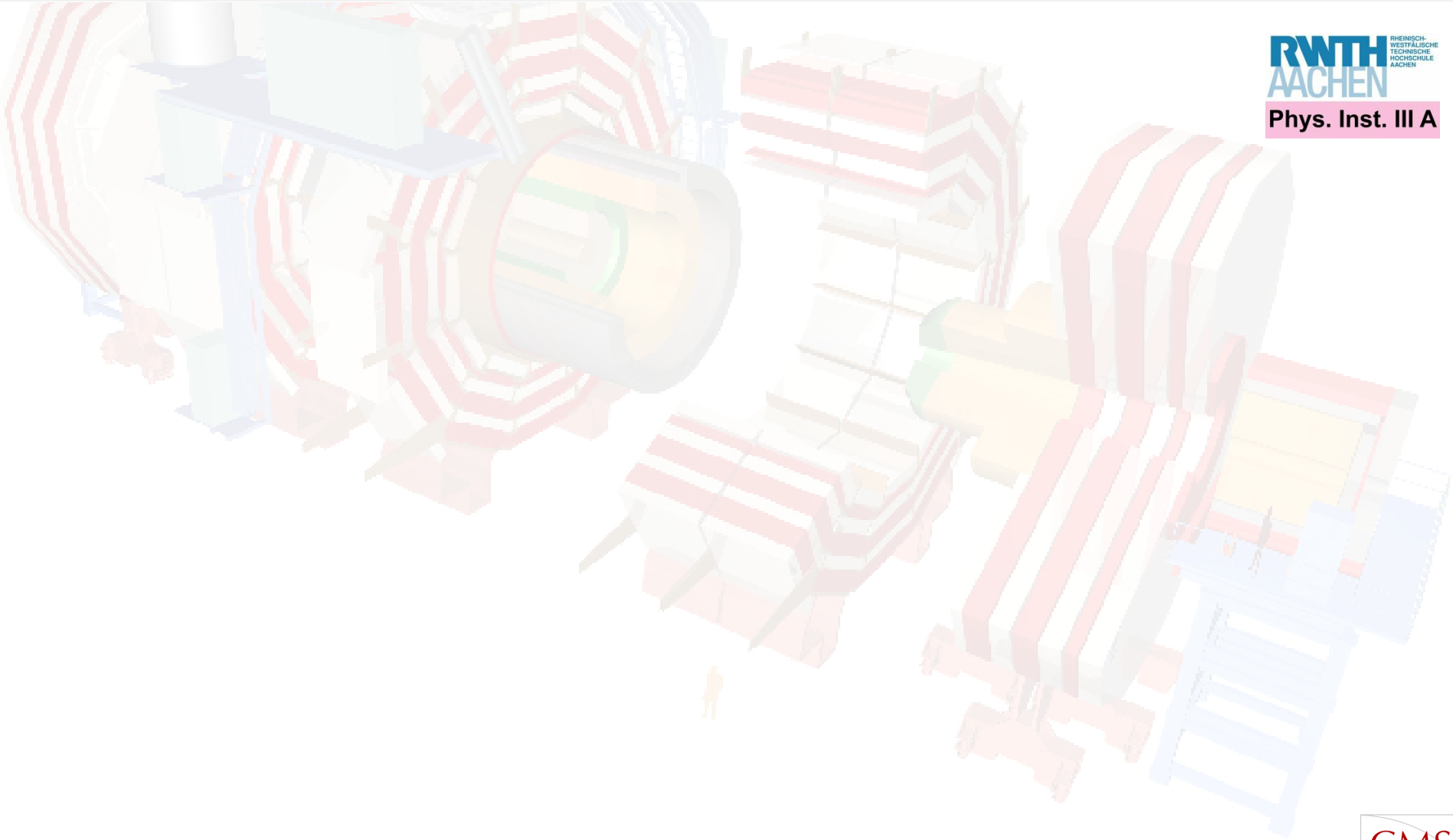
Interesting Event Displays



Bayesian Limit Calculations

Statistical model:

Calculate posterior probability by:

$$\Pi_{\text{posterior}}(\sigma_{\mu\mu}|N_{\text{obs}}) =$$

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- CMS detector is capable to detect experimental signatures of LED (here virtual gravitons)

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