Model Unspecific Search for New Physics in pp Collisions @ √s = 7 TeV

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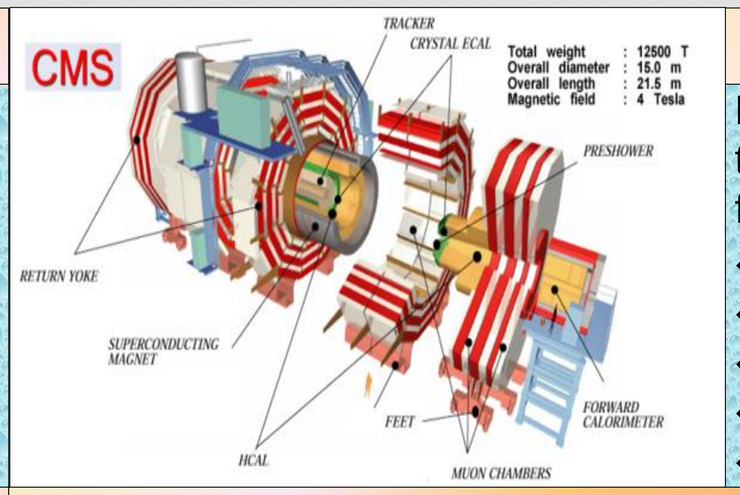
Abstract: We present the results of a model independent analysis, which systematically scans the data taken by CMS for deviations from the Standard Model predictions. Events with at least one electron or muon are classified according to their content of reconstructed objects (muons, electrons, photons, jets and missing transverse energy). A broad scan of three kinematic distributions in those classes is performed by identifying deviations from Standard Model expectations, accounting for systematic uncertainties. In this particular search no significant discrepancies have been observed in data taken by CMS in 2010 and corresponding to an integrated luminosity of 36.1/pb.

Reference: Model Unspecific Search for New Physics in pp Collisions at √s = 7 TeV, EXO-10-021, CMS Collaboration

Model Unspecific Search in CMS

➔ Looks for deficit as well as excess in data from the Standard Model (SM)
➔ Focus on well understood physics objects
➔ Covers a large phase space
➔ No optimization of selection cuts w.r.t. some expected signal
➔ Alarm system for new physics



Event Classes

Event classes group events according to their final state topology with the following physics objects:

- Muons (μ)
- Electrons (e)
- Photons (γ)
- Hadronic Jets (jet)
- Missing Transverse Energy (MET)

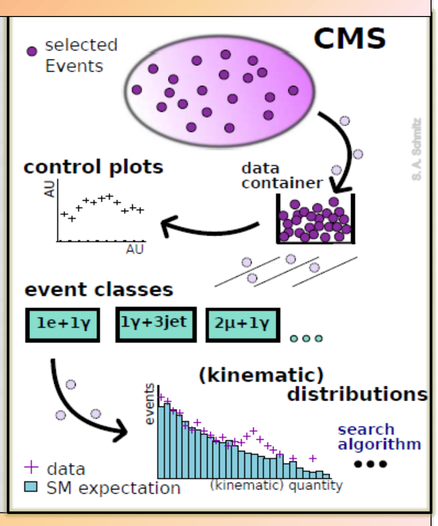
Search for Deviations

Distributions of following variables that should be sensitive to New Physics are considered:

➔ Σp_T : **Scalar sum of the transverse momentum** of all participating objects in an event class
➔ M_{inv} : **Invariant mass** of all physics objects in event class. For classes containing MET the transverse invariant mass M_T is used
➔ **MET : Missing transverse energy** in an event (only for classes with MET)

Search Algorithm

- **Skim** CMS Events with (soft) pre-selection cuts into data container
- Generate **control plots**
- Sort events into **event classes** depending on their object content: μ, e, γ, jet, MET
- Generate **kinematic distributions** of these classes: Σp_T, M_{inv} and MET
- Scan distributions for the most **significant region** of bins



Search Strategy & Probability Definition

Step I: Determining Region of Interest

The p-value is the probability of a discrepancy between data and Monte Carlo which is determined by adding up all the contributions of the distribution that are more extreme than the no. of observed data events N_{data}.

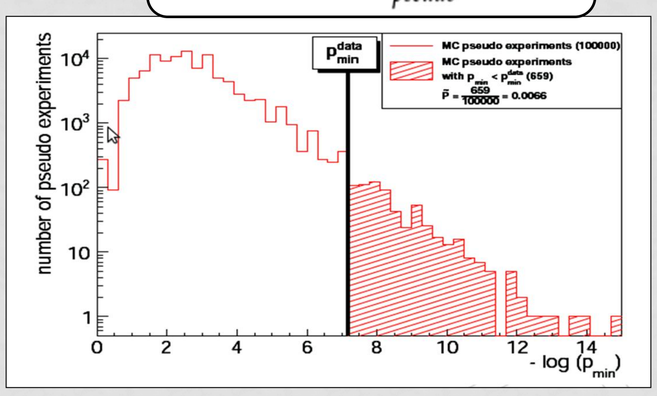
$$p = A \cdot \sum_i \int_0^{\infty} e^{\frac{-(\mu-B)^2}{2\sigma^2}} \cdot \frac{e^{-\mu}\mu^i}{i!} d\mu$$

where, A : normalization factor,
B : no. of expected events,
σ : total systematic uncertainity
The region with the smallest p is chosen as the *Region of Interest* (RoI).

Step II: Absolute p-value

The MUSiC algorithm uses pseudo experiments to determine the event class significance by applying penalty factor. A total class significance is then estimated by :

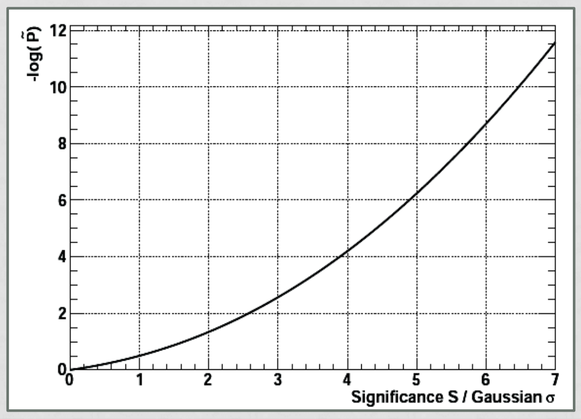
$$\tilde{p} = \frac{N_{pseudo}(p_{pseudo} < p_{data})}{N_{pseudo}}$$



Fraction of pseudo expts. being more significant than the data

Step III: Look elsewhere effect

A histogram of all $\tilde{p}$ -values can be compared to the expected $\tilde{p}$ -distributions. The $\tilde{p}$ can be translated to standard deviation of a Gaussian, comparable to the widely used CL as shown below:

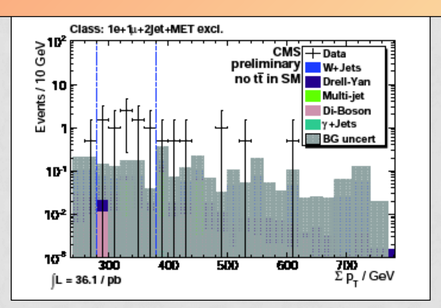


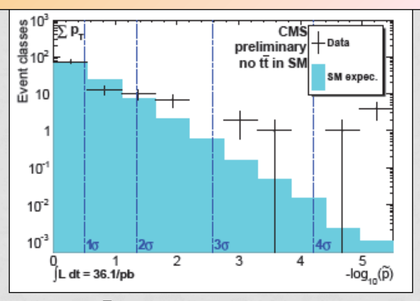
Sensitivity Tests

A number of tests scenarios has been studied to show that MUSiC would be able to successfully point out discrepancies. This was done by:

➢ Removing top-quark pair production process from the SM background
➢ Assuming a 500 GeV Z' as potential signal for New Physics
➢ Assuming SUSY benchmark point LM0 as potential signal

and discrepancy between data and SM was observed.

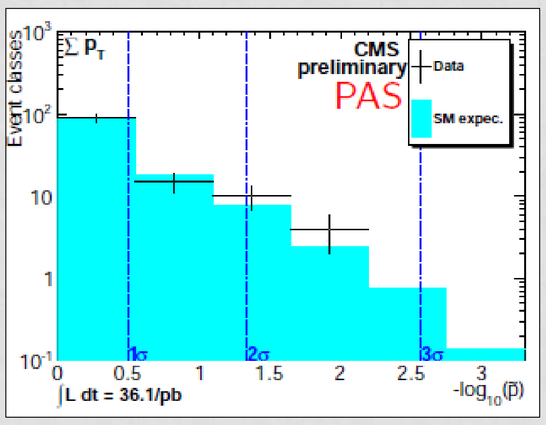


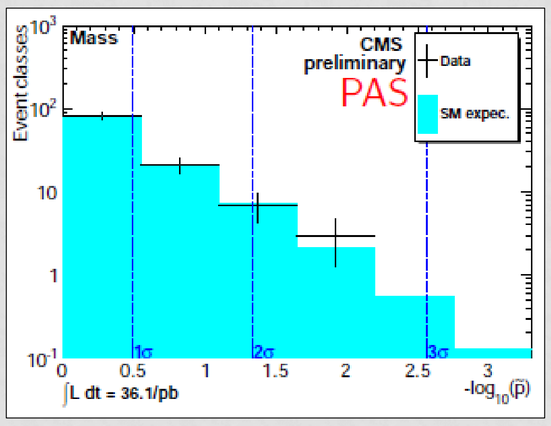


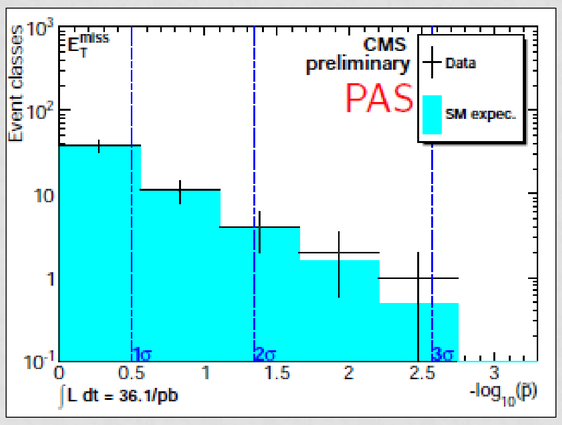
Σp_T and the $\tilde{p}$ of the most significant class, without $t\bar{t}$ in the list of SM backgrounds

Results

The distributions of the $\tilde{p}$ of all analyzed event classes, separated by kinematic distribution, are shown here. Overall 287 distributions in 118 classes have been analyzed. They include up to four leptons, two photons and eight jets, with at least one lepton in each event class.







Conclusions

The analysis has been applied to the data taken by CMS in 2010 and no significant deviations have been observed. Now working on 2011 data.

Poster Session, HCP Symposium, Nov 14 – 18, 2011, Paris, France