Search for new physics in events with same-sign isolated dileptons at CMS

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1 Experiment

2 Motivation

Events with same-sign isolated lepton pairs from hadron collisions are rare in the Standard Model but appear naturally in SUSY [1-3] and other new physics scenarios [4-7].

Two guiding principles:

- Astrophysical evidence for the dark matter [8] suggests us to search for the final states with **significant missing E_T**.
- Observable new physics signals are likely to be produced by strong interactions and we thus expect **significant hadronic activity** in association with the two same-sign leptons.

➡ **Search is signature-based, as independent from a particular model as possible**

3 Strategy

We identify four search regions and one baseline selection region:

① H_T > 400 GeV, miss. E_T > 120 GeV [cMSSM, low m0 region]

② H_T > 200 GeV, miss. E_T > 120 GeV [simplified model of squark-gluino production]

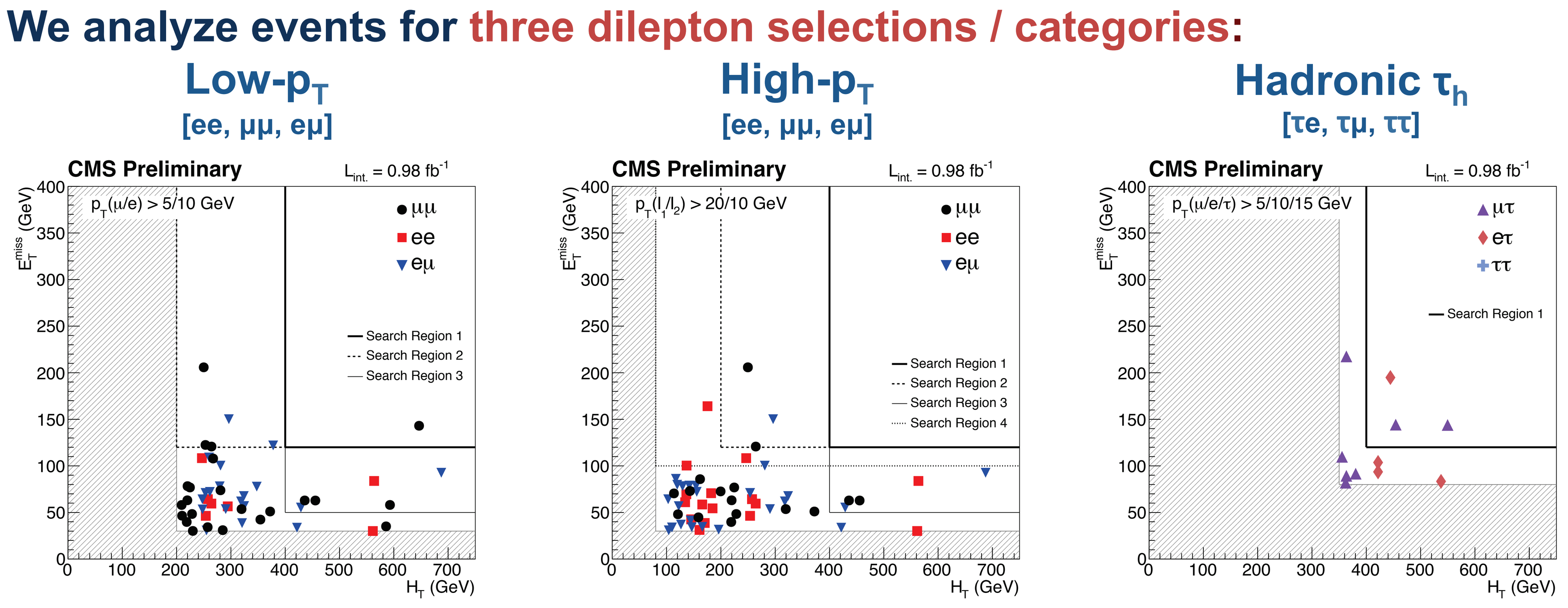
③ H_T > 400 GeV, miss. E_T > 50 GeV [cMSSM, high m0 region]

④ H_T > 80 GeV, miss. E_T > 100 GeV [pMSSM with sneutrino as the LSP]

Baseline H_T > 80 GeV, miss. E_T > 30 GeV [to asses the performance of the methods]

The four search regions are consistent with our search motivations and are chosen to maximize the sensitivity of the analysis to several new physics scenarios.

We analyze events for three dilepton selections / categories:



4 Backgrounds

Processes with prompt same-sign dileptons:

qq → WZ, qq → ZZ, qq → qqW±W±, 2 × (qq → W±), qq → ttW, qq → WWW

Evaluated using simulation, 10 - 40% contribution, assigned 50% systematic uncertainty

Processes with opposite-sign dileptons and charge mis-reconstruction:

Z + jets → l±l∓ + jets, top-pair → l±l∓ + jets

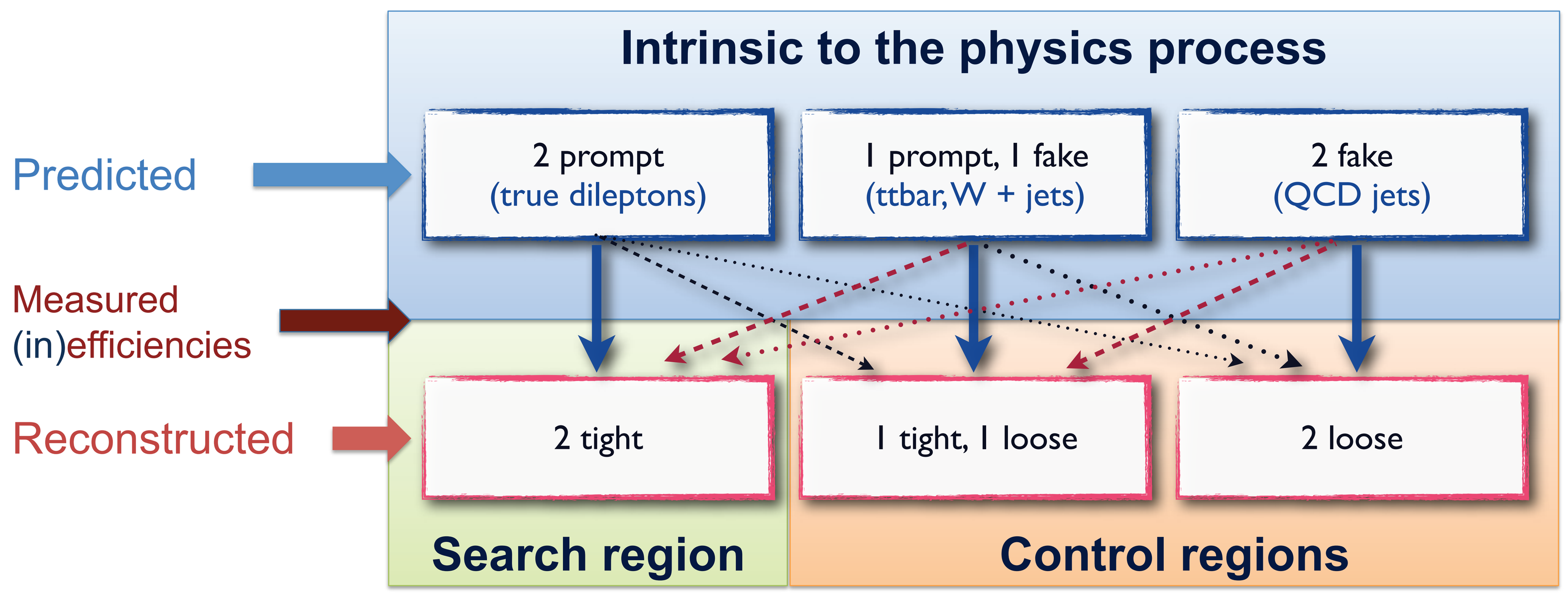
Evaluation completely based on data, < 10% contribution, 20% systematic uncertainty

Processes with one or two *fake* leptons:

top-pair → l± + jets, W + jets → l± + jets, single-top → l± + jets, QCD jets

Evaluation completely based on data, dominant, below 50% systematic uncertainty

fake leptons: leptons originating from heavy-flavor decays and misidentified light flavor jets



Tight leptons: leptons passing the final selection criteria;
Loose leptons: leptons passing loosened criteria, but not the final selection criteria;

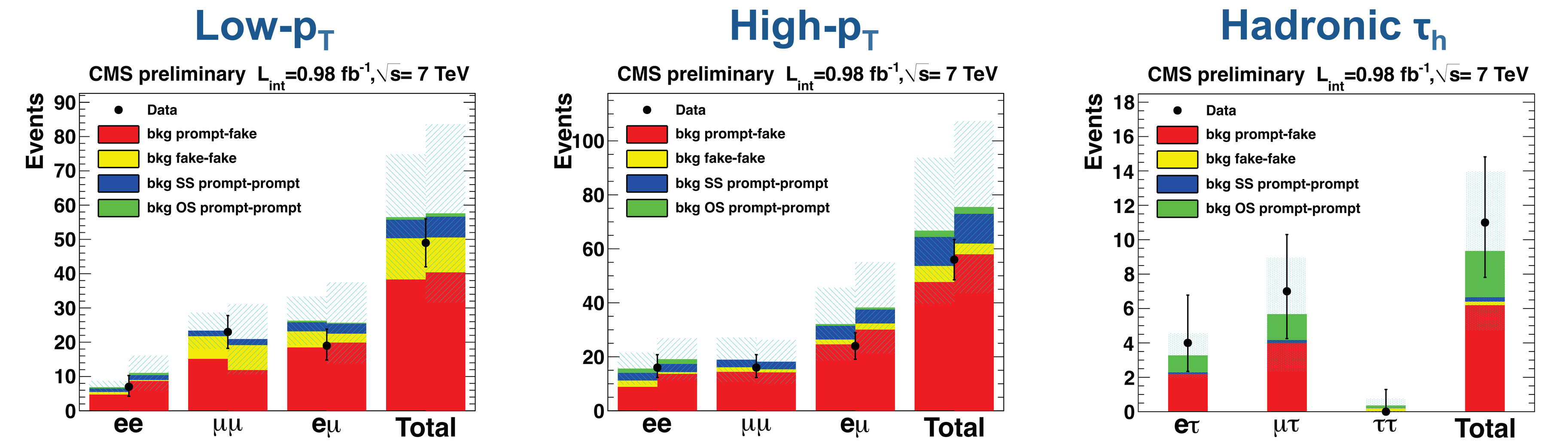
5 Predictions

Data-driven background prediction methods:

- **Two sets of complimentary methods** are used to measure the backgrounds for the *low-p_T* and *high-p_T* dilepton categories (two predictions are shown next to each other in plots below) [9,10]
- A similar method is used to measure the backgrounds for the *hadronic τ_h* dilepton category [9,10]

Predictions in the baseline selection region:

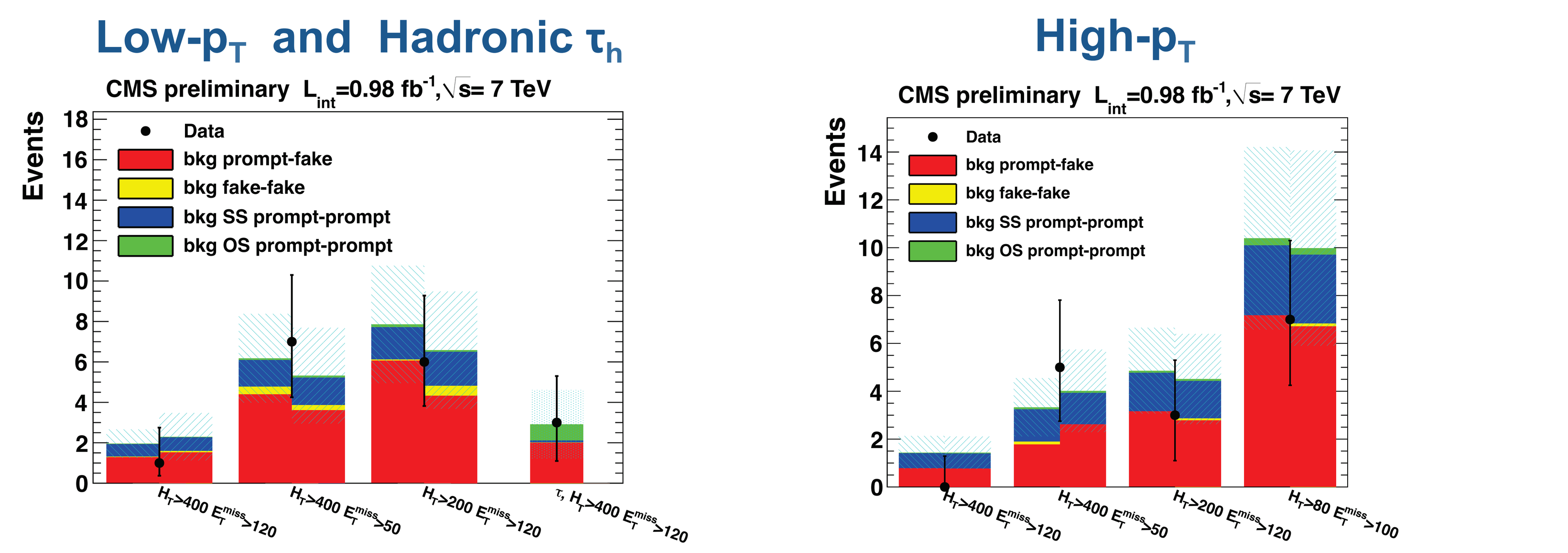
- Baseline selection region is expected to be largely **dominated by the background events**. It is used for each of the three dilepton categories in order to assess the performance of methods with a statistically meaningful sample.



➡ **A very good agreement between the predicted and observed number of events and between complementary background prediction methods.**

6 Results

Yields and predictions for each search region and the dilepton category:



- We observe **no evidence of an excess** over the background predictions and we set the 95% CL_S upper limits on the number of new physics events (using the modified frequentist method [11]):

Limits on the new physics events in 0.98 fb^{-1} of data

Dilepton category	Low-p_T			Had. τ_h	High-p_T			
H_T [GeV], ME_T [GeV]	400, 120	400, 50	200, 120	400, 120	400, 120	400, 50	200, 120	80, 100
predicted	2.3 ± 1.2	5.3 ± 2.4	6.6 ± 2.9	2.9 ± 1.7	1.4 ± 0.7	4.0 ± 1.7	4.5 ± 1.9	10 ± 4
observed	1	7	6	3	0	5	3	7
upper limit CL_S 95%	3.7	8.9	7.3	5.8	3.0	7.5	5.2	6.0

In case of lepton selections with complementary prediction methods, limits are set using the background estimate that provides the more conservative limit.

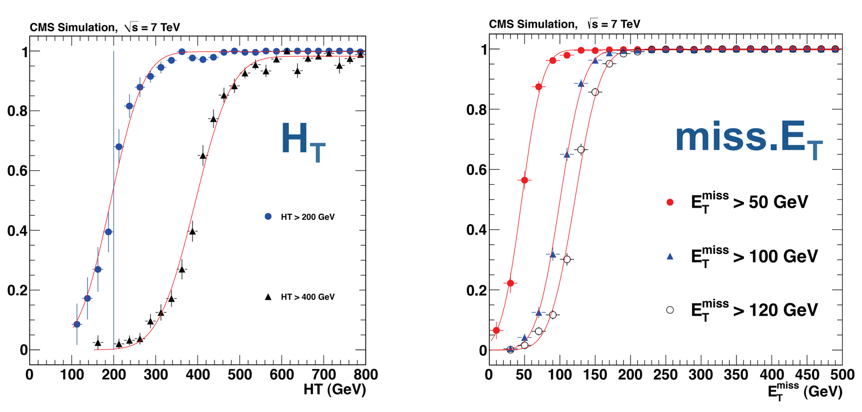
- The limits include uncertainties on the signal efficiency of 14%, 17%, and 20% for the low-p_T, high-p_T, and hadronic τ_h di-lepton categories respectively.

7 Interpretation

Model independent information:

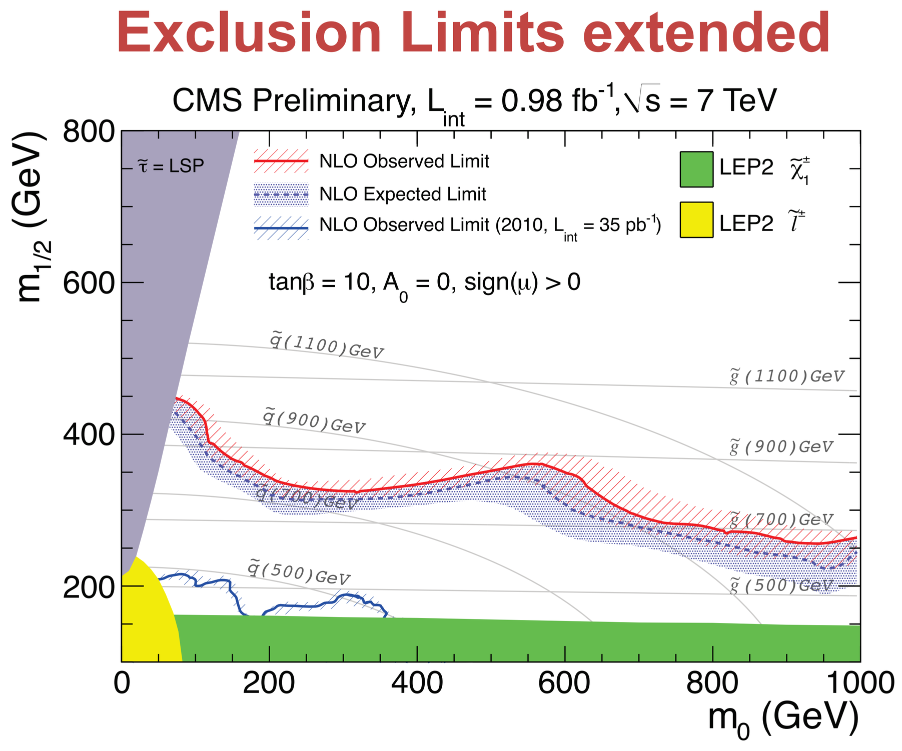
- We provide approximate efficiency models for the lepton, H_T and missing E_T selections in a parametric form that can be used to test a broad range of specific physics models.

Parameterized efficiencies for H_T and missing E_T:



Constrained MSSM model:

Exclusion Limits extended



8 Conclusions

✓ **Background estimates derived from data** for all major background sources

✓ **No evidence for new physics observed**

✓ **Set 95% CL_S upper limits** on the number of new physics events in 0.98 fb^{-1} of data

9 References

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