

Search for a heavy bottom-like quark



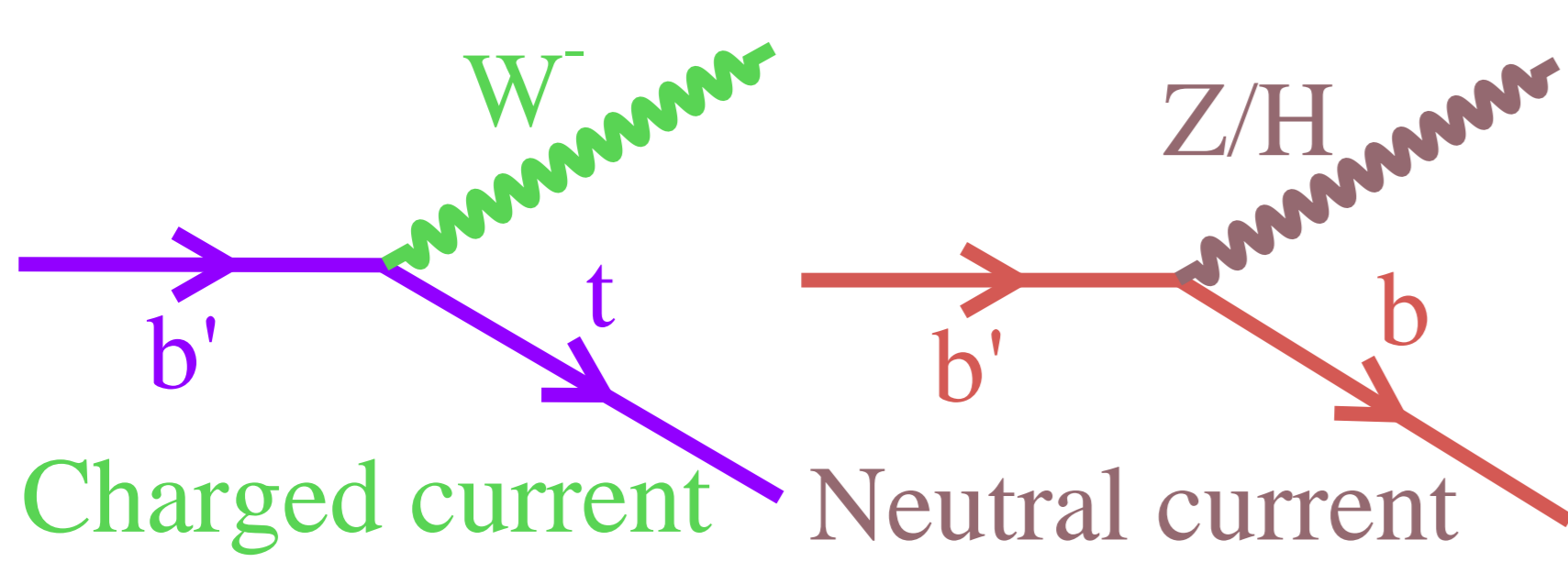
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b' : A vector-like charge $-1/3$ quark

- ▶ Predicted in BSM scenarios as top or bottom quark partner.
- ▶ Symmetric left- and right-handed couplings to SM vector bosons.
- ▶ Mostly pair-produced $pp \rightarrow b'\bar{b}'$ for mass $M(b') < 1 \text{ TeV}/c^2$.
- ▶ Decay processes:

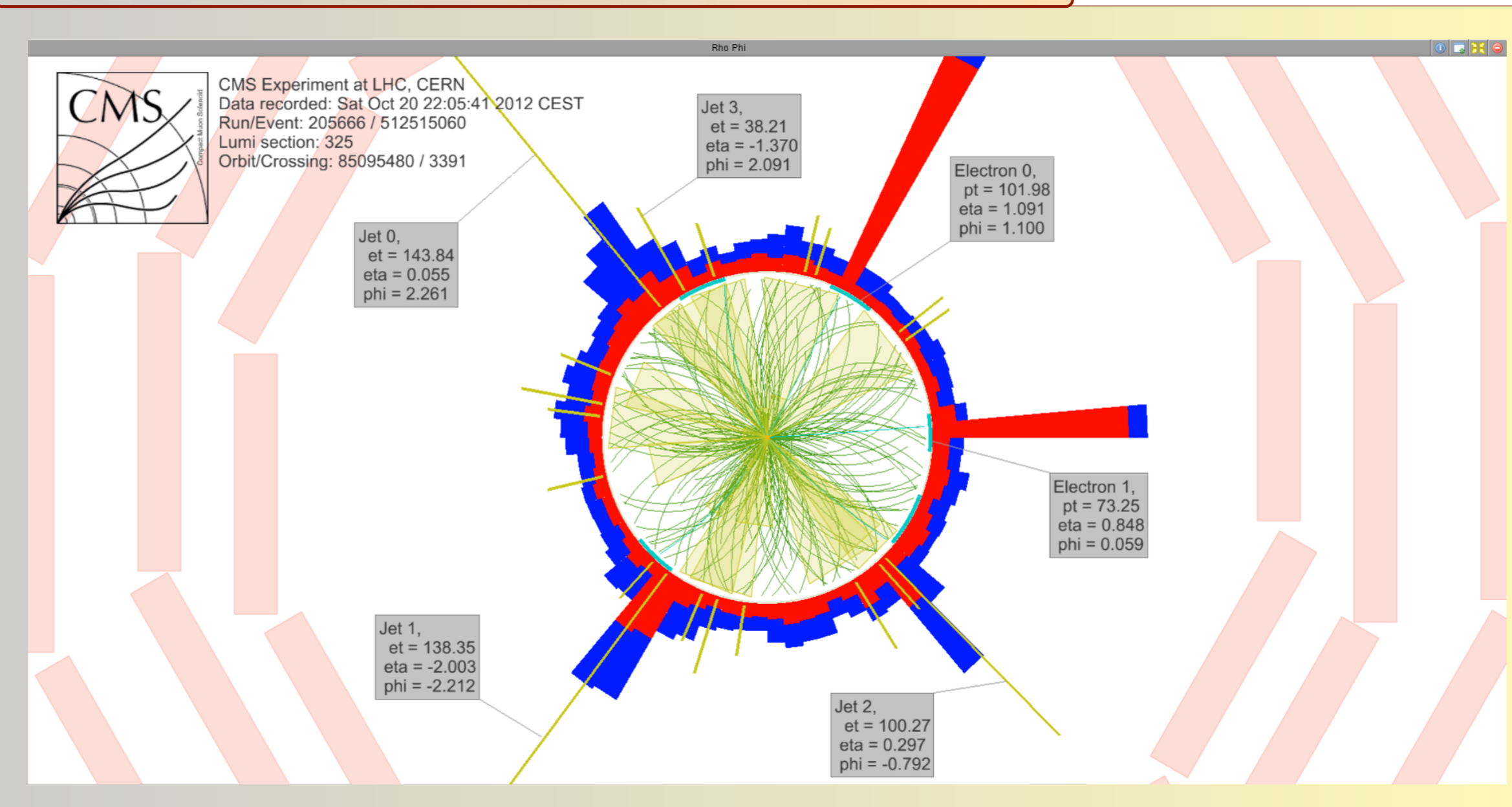


We search for the b' quark in the neutral current $b' \rightarrow bZ$ process.

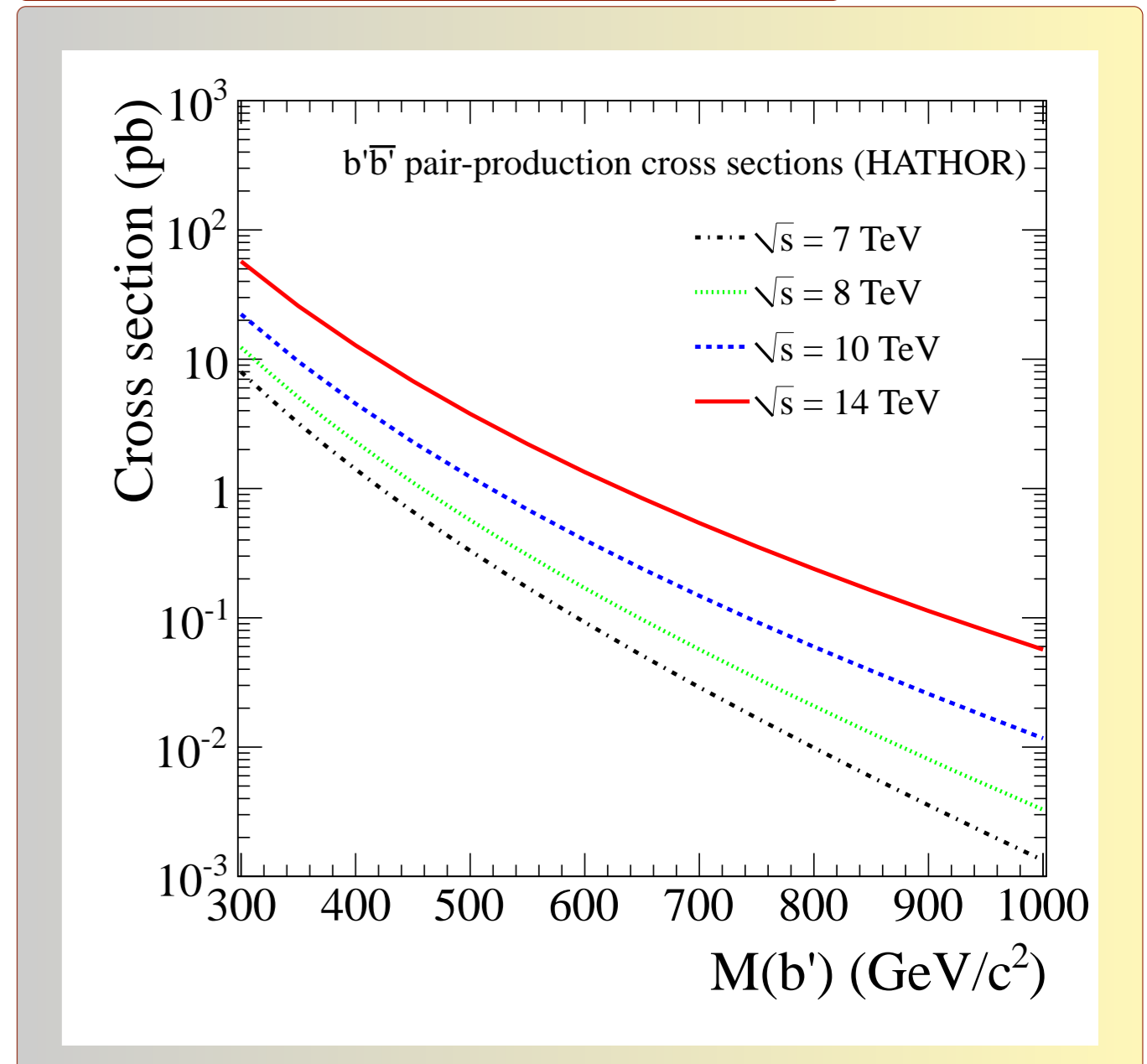
Search methodology

- ▶ Reconstruct b' candidates using high p_T $Z \rightarrow e^+e^-$ or $\mu^+\mu^-$ and b-tagged jets.
- ▶ Measure SM backgrounds: Z +jets, $t\bar{t}$ +jets, dibosons, using the data.
- ▶ Search for a bump in the invariant mass $M(bZ)$ of the Z boson and b jets.

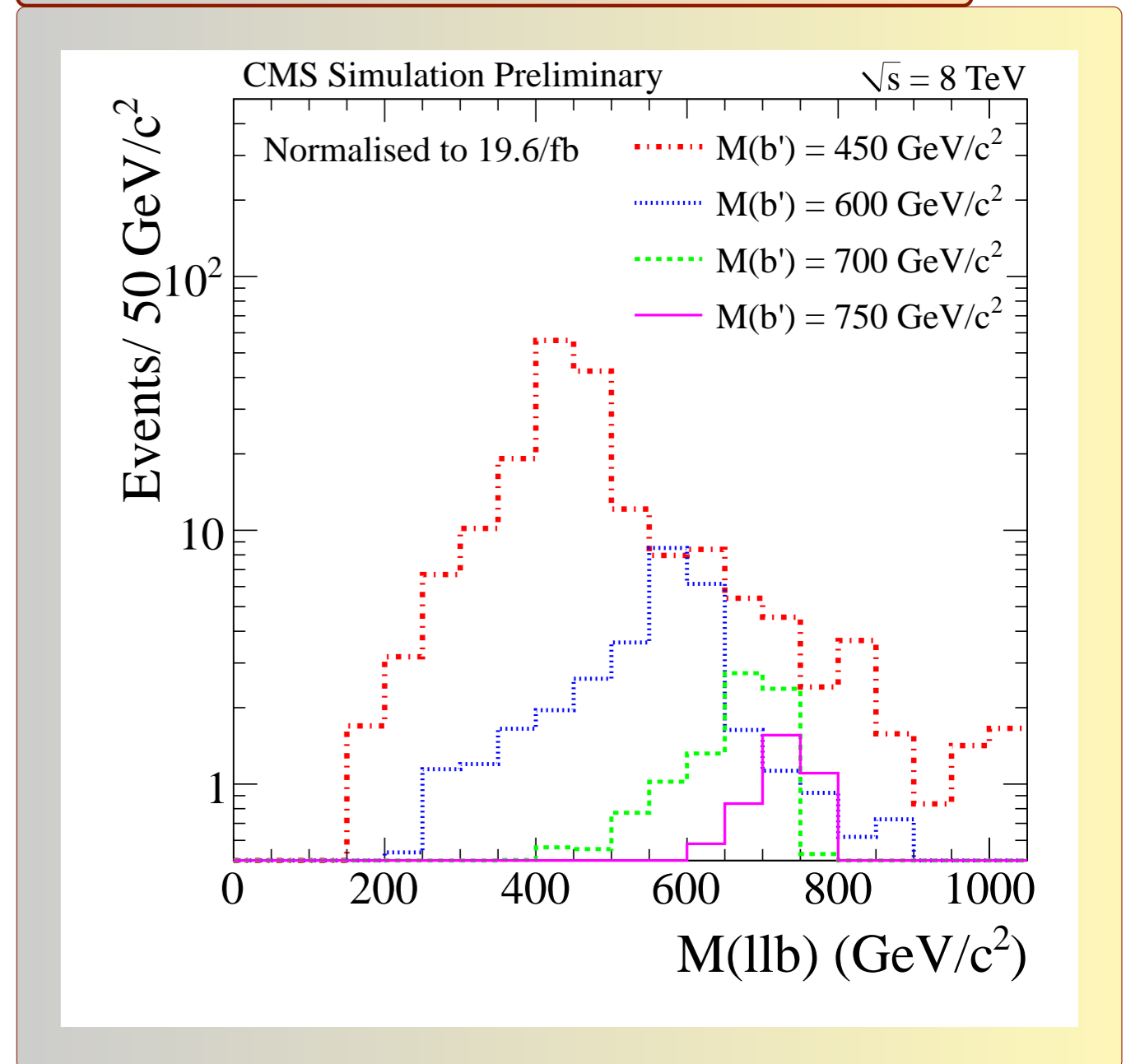
Event display of a b' quark candidate



Cross sections at the LHC



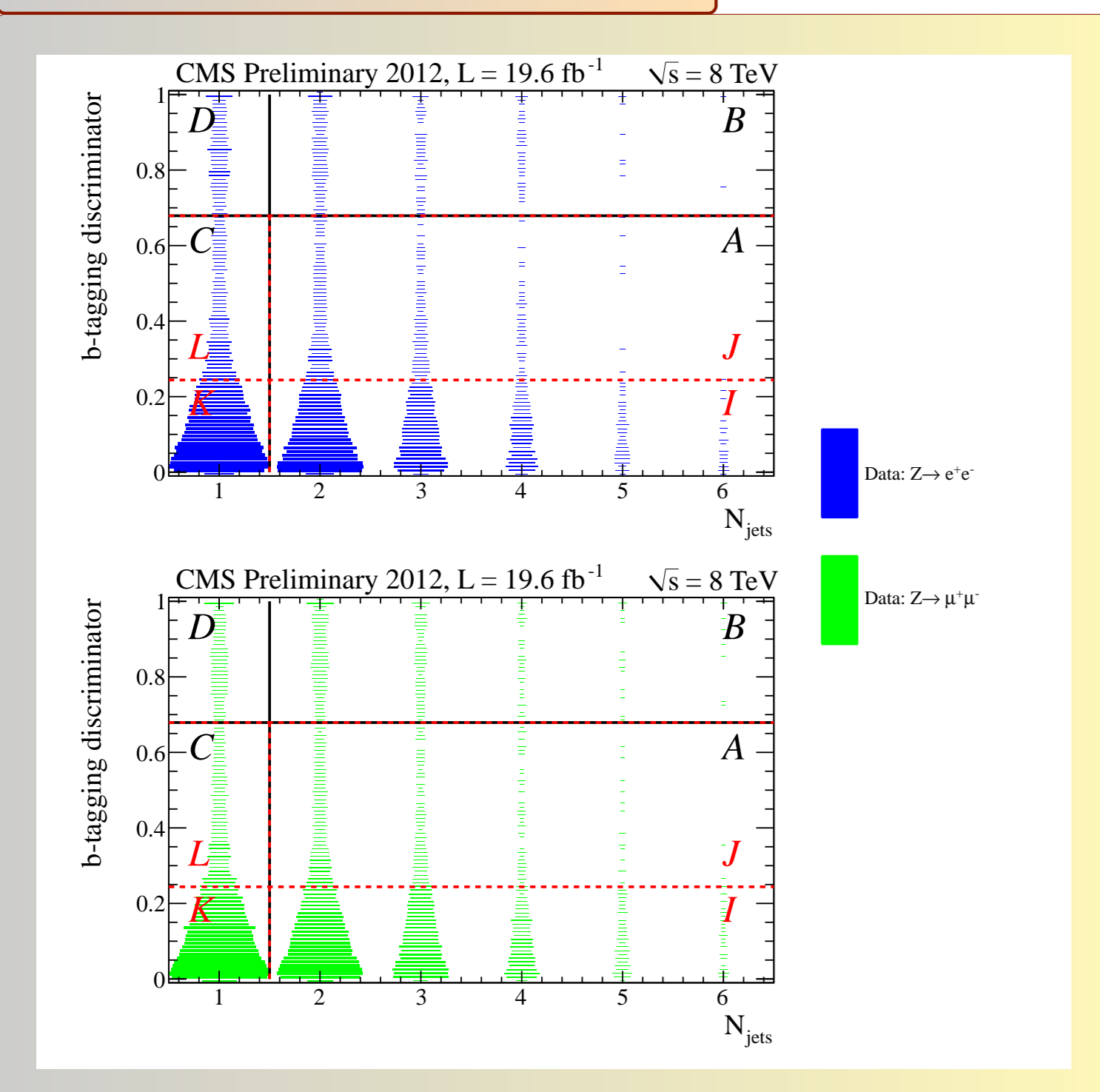
Simulated signal invariant mass



Background estimation

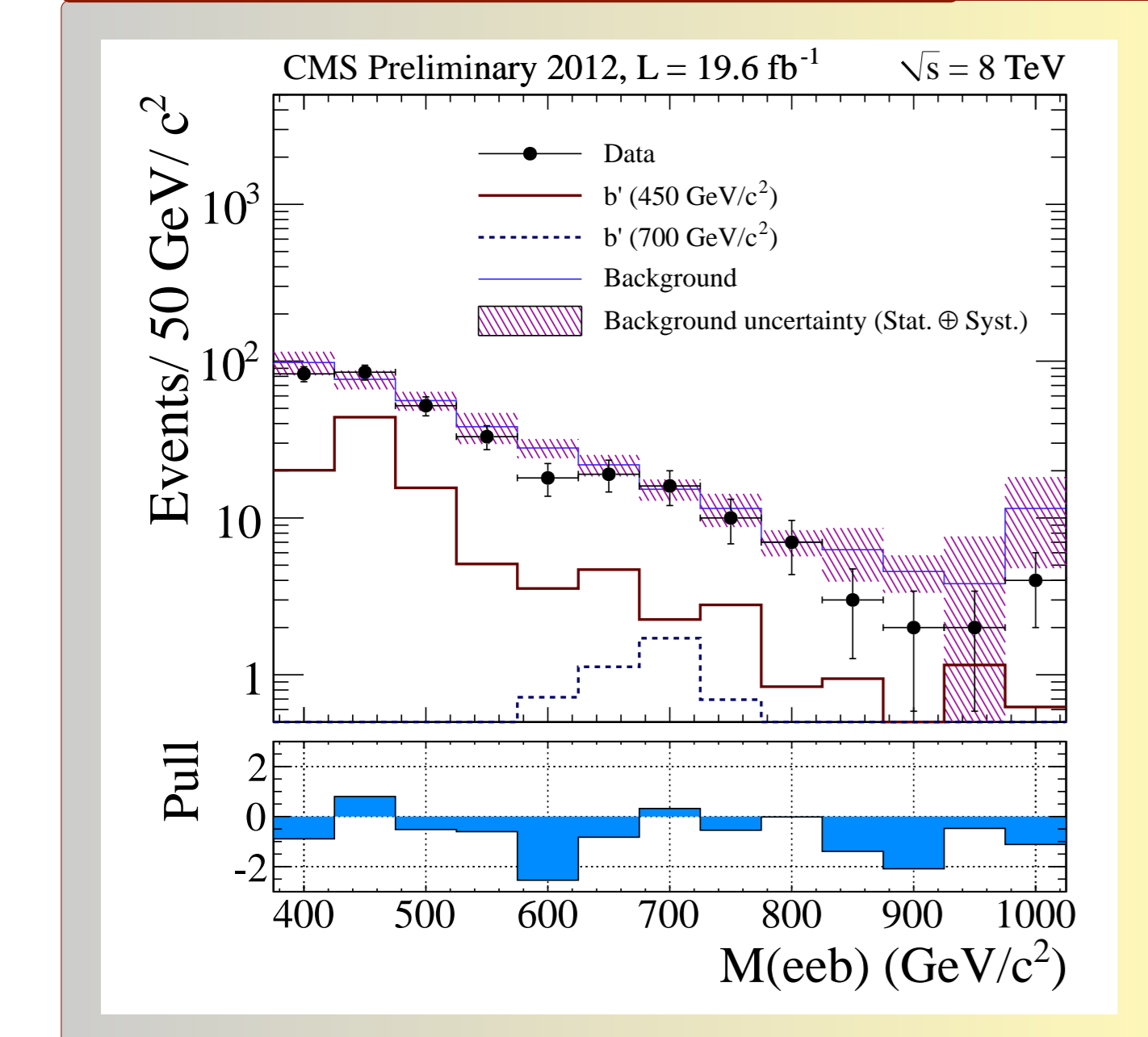
- ▶ $ABCD$ method used. Fully data-driven.
- ▶ $N_B = N_A \times N_D / N_C$. A, C, D are control regions.
- ▶ B = signal region with N_B background events.

Signal and control regions

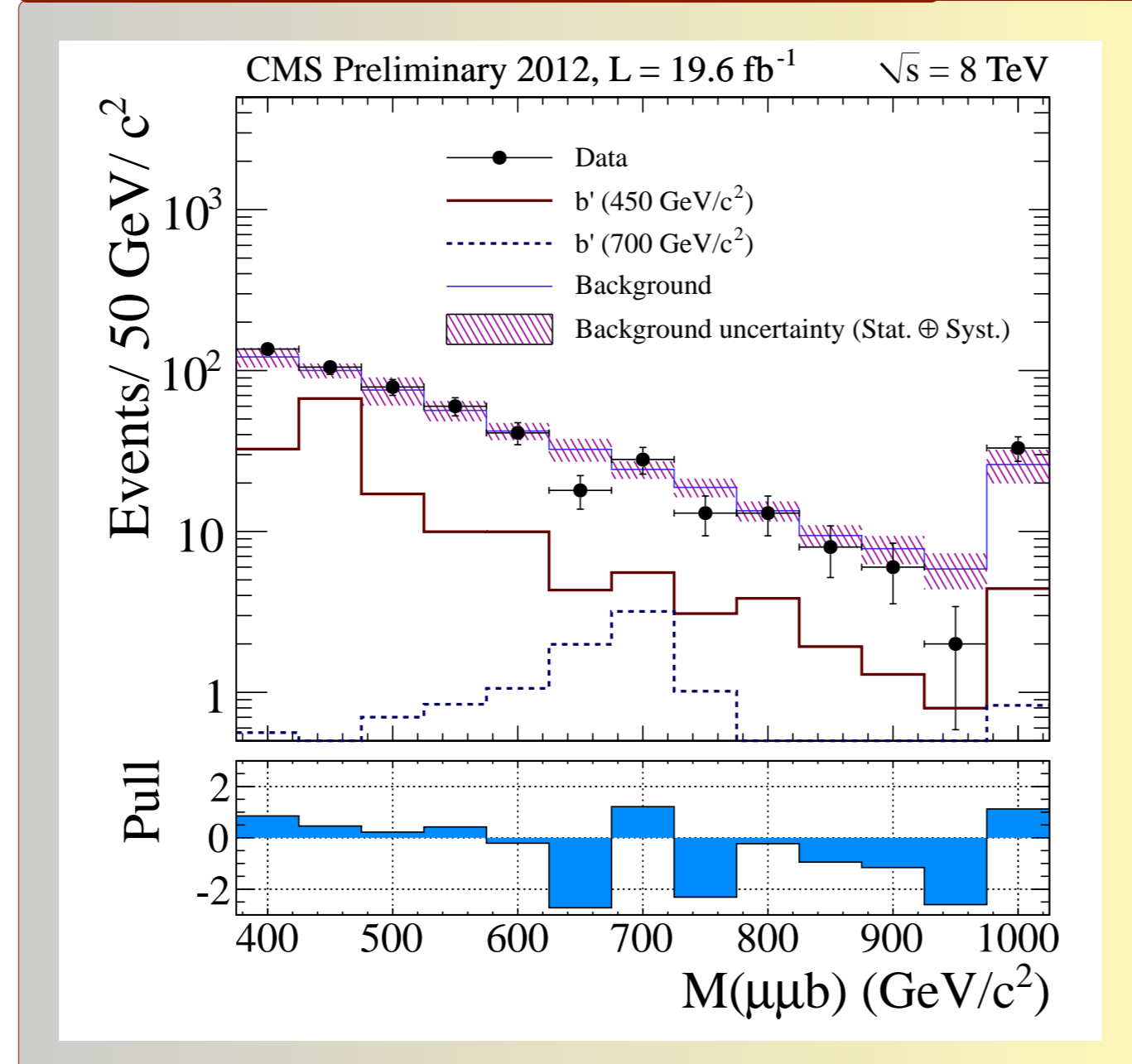


- ▶ $ABCD$ variables: N_{jets} and b-tagging discriminator value.
- ▶ Correlations between variables accounted for.

b' candidate mass spectrum: $Z \rightarrow ee$ channel



b' candidate mass spectrum: $Z \rightarrow \mu\mu$ channel

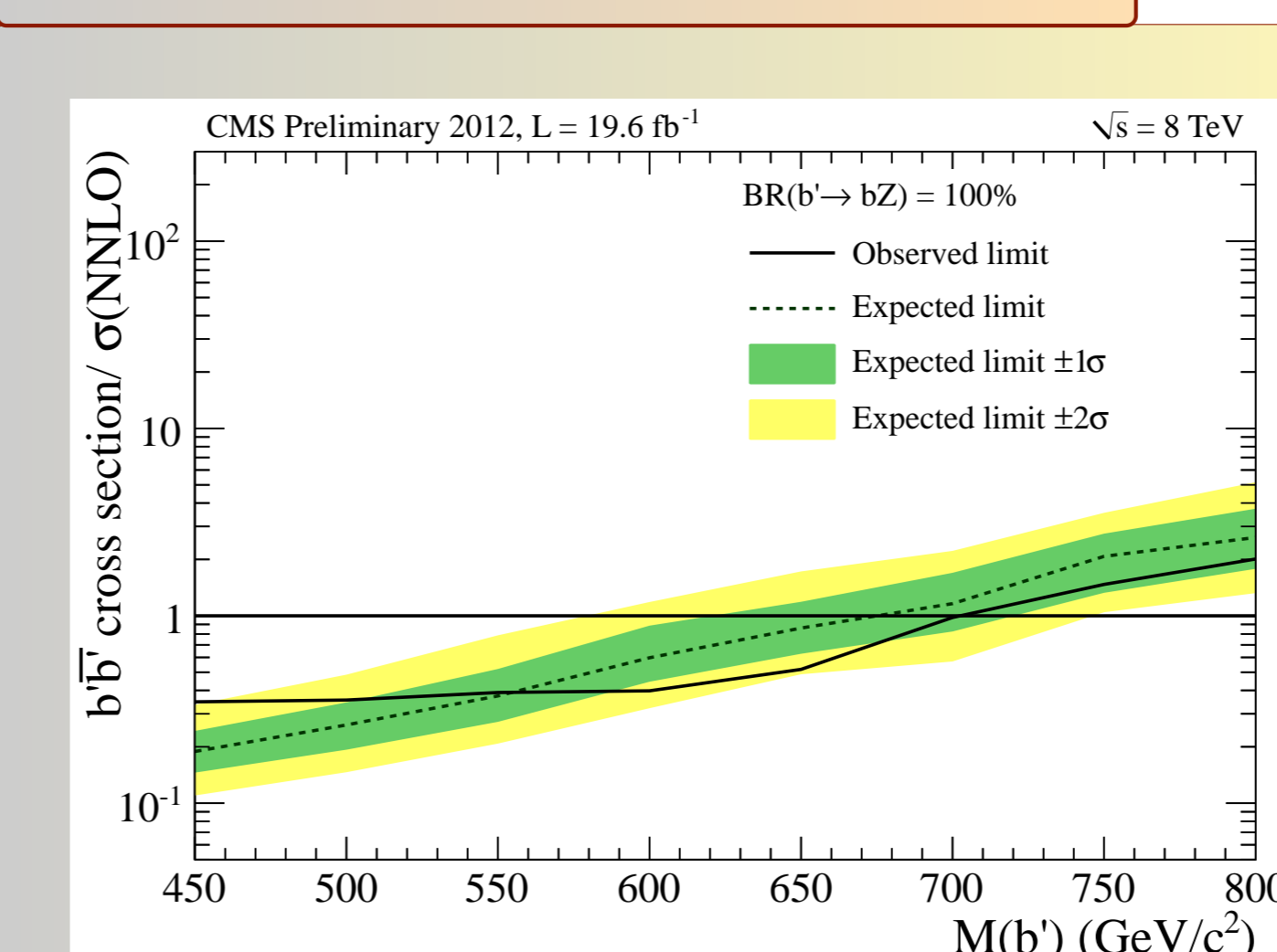


Good agreement between observation and estimated SM background events.

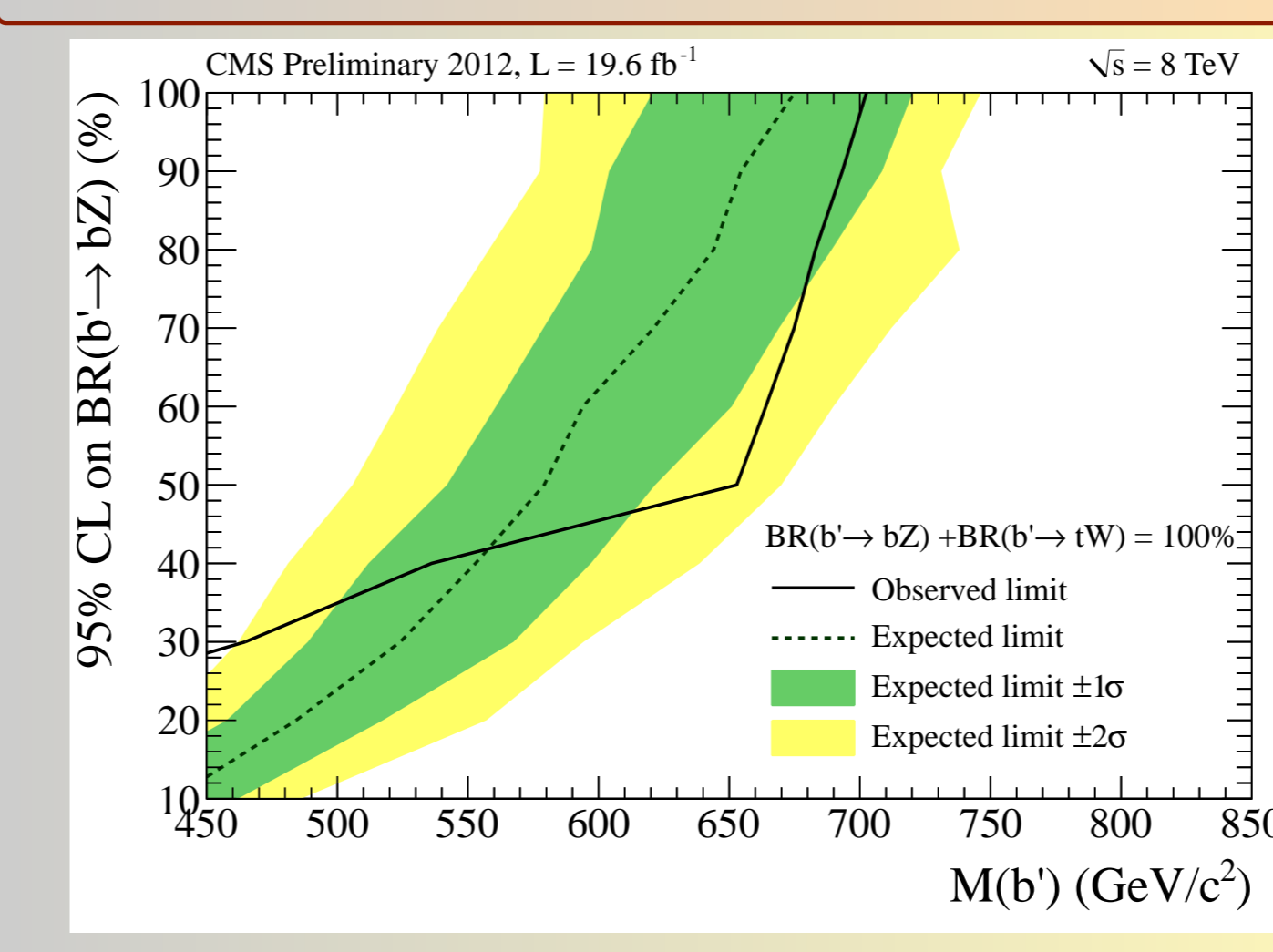
Results

Limit set on $\sigma(pp \rightarrow b'b')$ for $BR(b' \rightarrow bZ) = 100\%$ and on mass of the b' quark for mixed decays to the neutral current $b' \rightarrow bZ$ and the charged-current $b' \rightarrow tW$.

b' quark cross section limit



Mass limit when $BR(b' \rightarrow bZ) + BR(b' \rightarrow tW) = 1$



b' quarks of mass below $700 \text{ GeV}/c^2$ ruled out for $BR(b' \rightarrow bZ) = 100\%$.

Observed and expected background events

Channel	$Z \rightarrow ee$	$Z \rightarrow \mu\mu$
Expected background in data	379 ± 70	534 ± 79
Observed events	334	542

Expected signal yields

$BR(b' \rightarrow bZ)$	100%		50%	
	$Z \rightarrow e^+e^-$	$Z \rightarrow \mu^+\mu^-$	$Z \rightarrow e^+e^-$	$Z \rightarrow \mu^+\mu^-$
$M(b') = 450 \text{ GeV}/c^2$	214 ± 13	336 ± 16	102 ± 4	162 ± 5
$M(b') = 500 \text{ GeV}/c^2$	122 ± 7	209 ± 9	56 ± 2	94 ± 3
$M(b') = 550 \text{ GeV}/c^2$	76 ± 4	114 ± 5	33 ± 1	54 ± 2
$M(b') = 600 \text{ GeV}/c^2$	36 ± 2	66 ± 3	17.6 ± 0.7	30.8 ± 0.9
$M(b') = 650 \text{ GeV}/c^2$	23 ± 1	41 ± 2	11.0 ± 0.4	19.5 ± 0.6
$M(b') = 700 \text{ GeV}/c^2$	14.1 ± 0.7	25.9 ± 1.0	6.5 ± 0.2	12.0 ± 0.3
$M(b') = 750 \text{ GeV}/c^2$	7.6 ± 0.4	15.5 ± 0.6	3.6 ± 0.1	7.4 ± 0.2
$M(b') = 800 \text{ GeV}/c^2$	4.8 ± 0.3	9.9 ± 0.4	2.20 ± 0.10	4.6 ± 0.1

Sources of systematic uncertainties

Background estimation	$\sim 34\%$
Jet energy corrections	$\sim 23\%$
Integrated luminosity	4.4%
Others	$< 1\%$

Reference

B2G-12-021: <http://cds.cern.ch/record/1595039?ln=en>
TWiki: CMSPublic/PhysicsResultsB2G12021

