

Search for heavy neutral leptons in events with three charged leptons with CMS detector at LHC

EPS-HEP 2019
Gent, Belgium



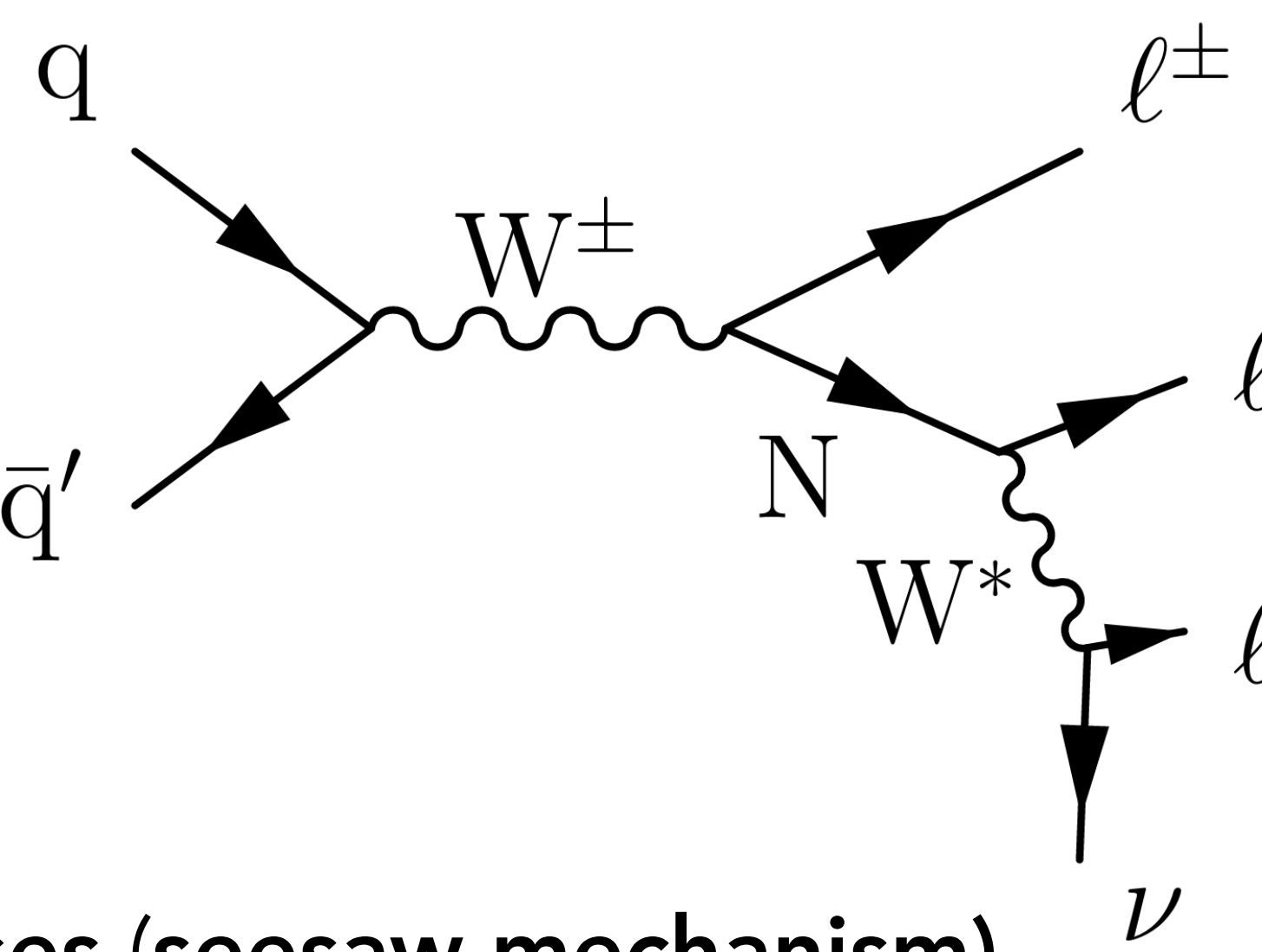
1. Introduction

A search for a **heavy neutrino** decaying into a charged lepton and a W boson $\rightarrow \ell \ell \nu$ is presented.

- ◆ The HNLs are sterile,
- ◆ mixing angles with ν_{SM} : V_{eN} , $V_{\mu N}$, and $V_{\tau N}$
- ◆ The production cross section and lifetime of N depend on $|V_{IN}|^2$ and its mass m_N .

Right-handed **HNL** as potential solution for:

- ◆ **Baryon asymmetry**;
- ◆ **dark matter candidate**;
- ◆ Smallness of **neutrino masses** (seesaw mechanism).

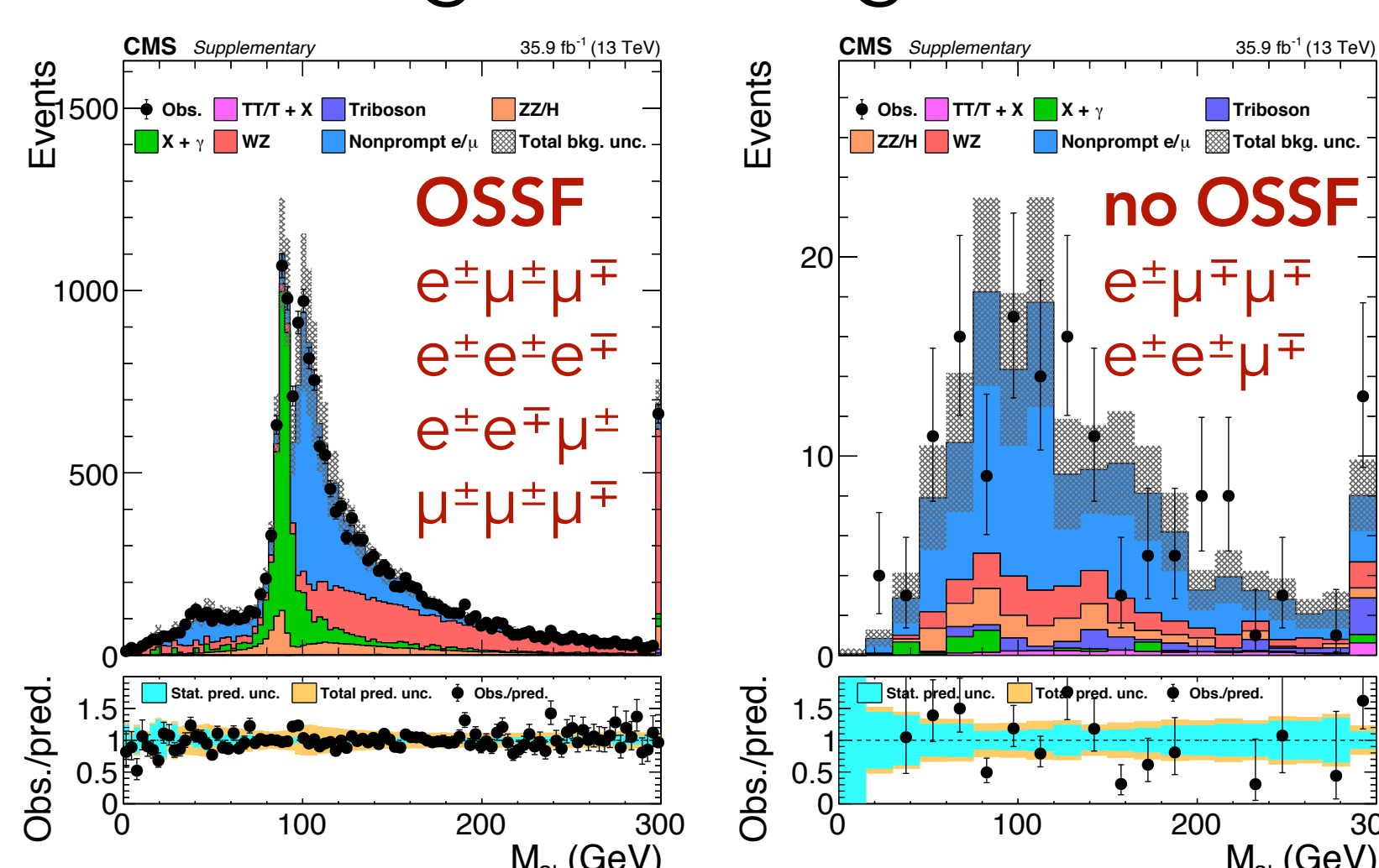


2. Background

Two categories: **with or without an OppositeSignSameFlavor pair**. Background two orders of magnitude higher in final state with an OSSF pair.

Main backgrounds:

- nonprompt leptons;
- WZ and ZZ;
- Conversion, $Z\gamma^*$ with $\gamma^* \rightarrow 2\ell$.



3. Event selection

Only prompt decays are considered.

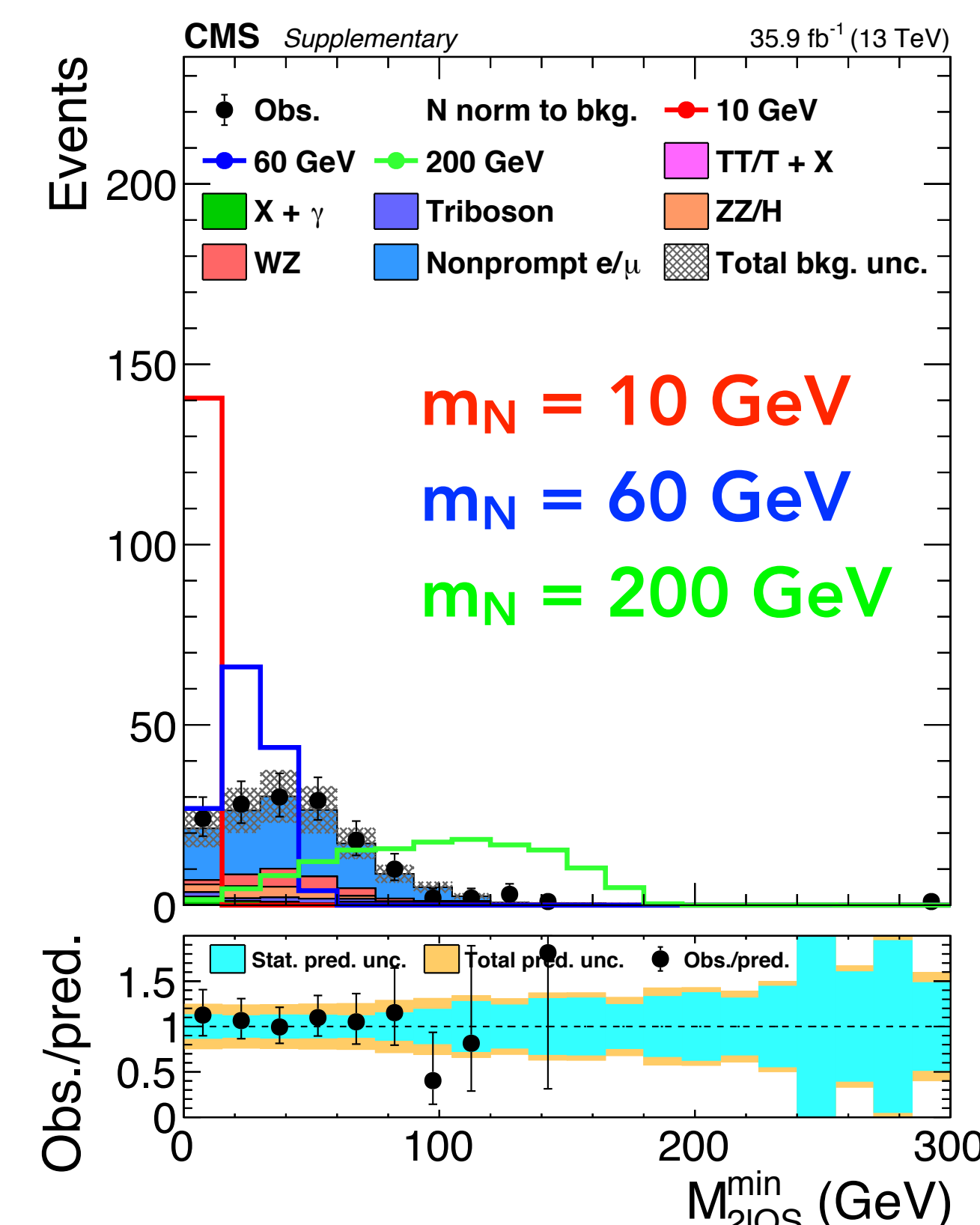
Kinematically distinct cases for N masses below and above that of the W boson, two search regions are defined.

Search variables:

- ◆ M_{3L} , for background rejection;
- ◆ M_T , very high for high m_N ;
- ◆ M_{2LOS}^{min} , proxy for m_N .

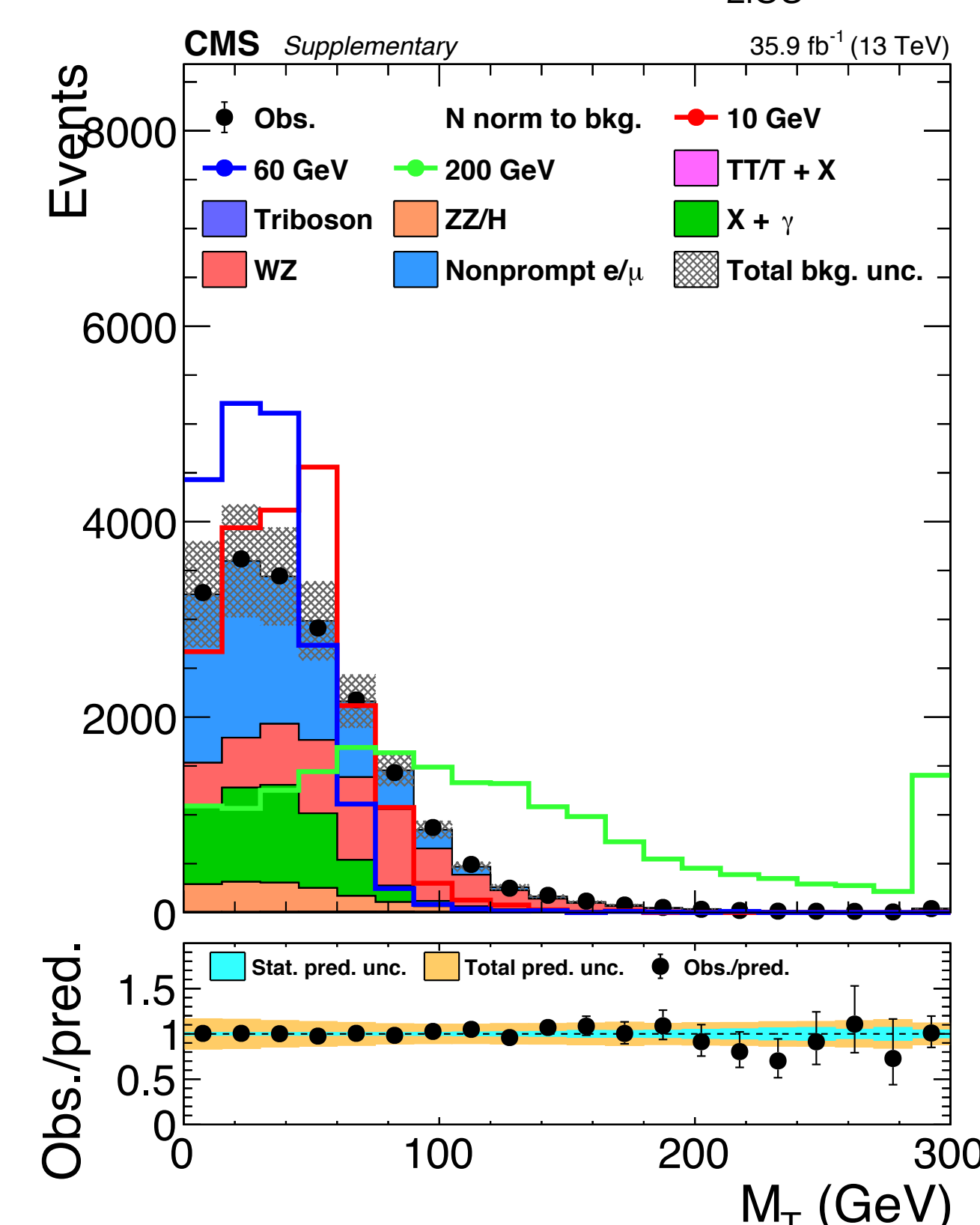
Low mass ($m_N < m_W$)

- ◆ Only use events without OSSF \rightarrow probing LNV, Majorana ν ;
- ◆ Compressed p_T spectra, low p_T thresholds;
- ◆ categorize according to P_T .

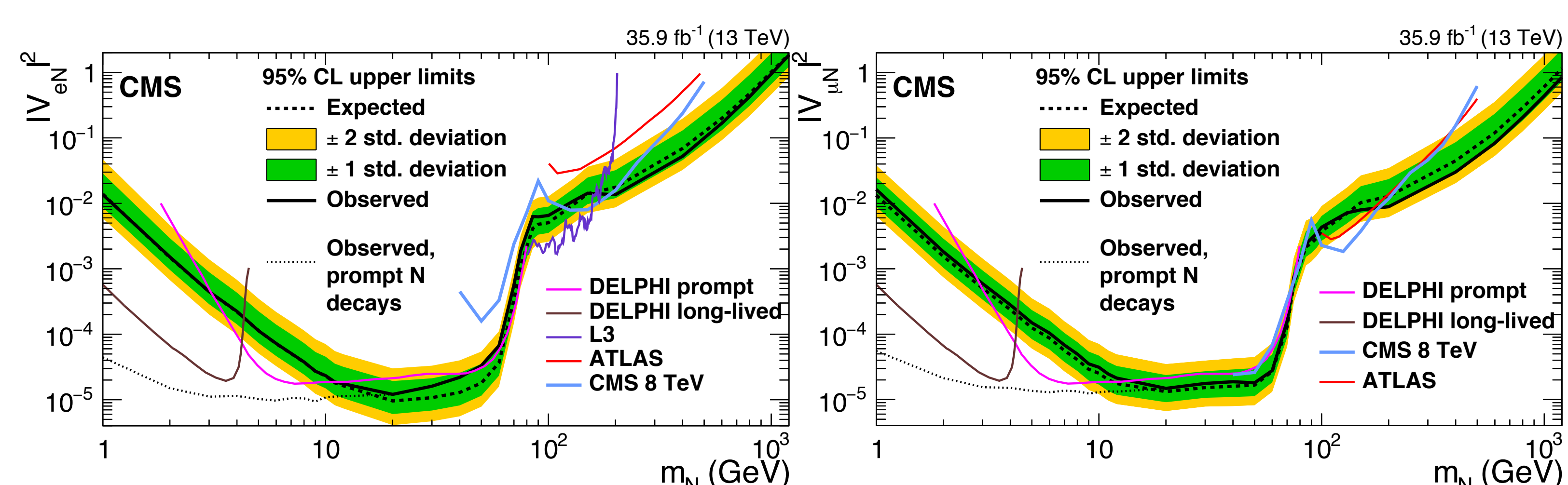
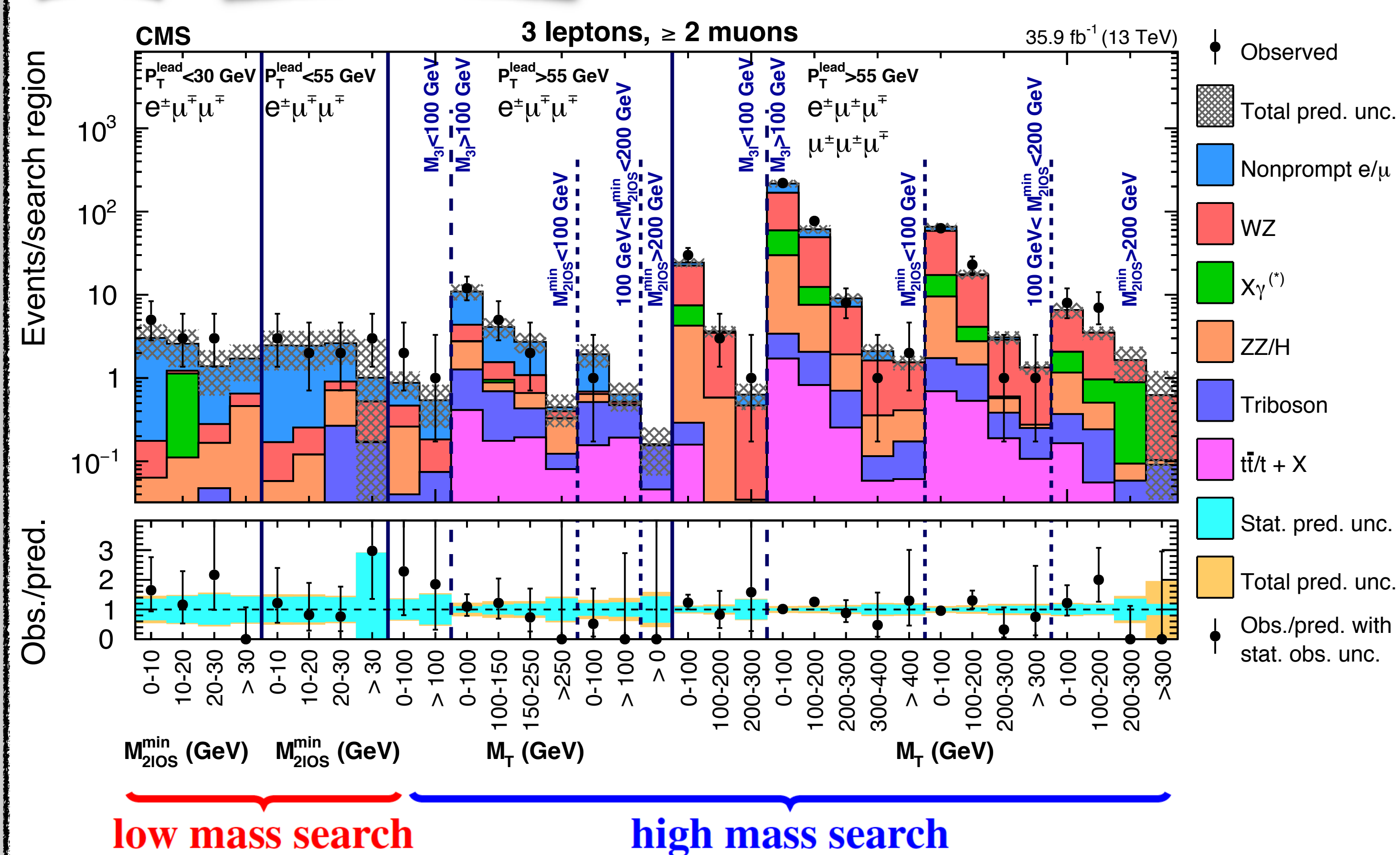


High mass ($m_N > m_W$)

- ◆ Both events with and without OSSF;
- ◆ high p_T thresholds;
- ◆ Relatively high E_T and very high M_{3L}



4. Results



Lifetime correction

- For **small N** mass and couplings, the **decay length** can be **significantly large** \rightarrow reduced acceptance for this specific search;
- a-posteriori correction applied to account for the finite lifetime \rightarrow sensitivity degrades with decreasing $|V_{IN}|^2$;
- effect is partially compensated by signal cross section growth $\propto |V_{eN}|^2$

No deviations from the SM are observed; upper limits set on $\nu_{SM}N$ coupling strengths V_{eN} and $V_{\mu N}$.

New sensitivity \rightarrow These are the **first direct limits** for N masses **above 500 GeV** and the **first limits** obtained at a **hadron collider** for **N masses below 40 GeV**.

