A charming exploration of a t-channel model of dark matter

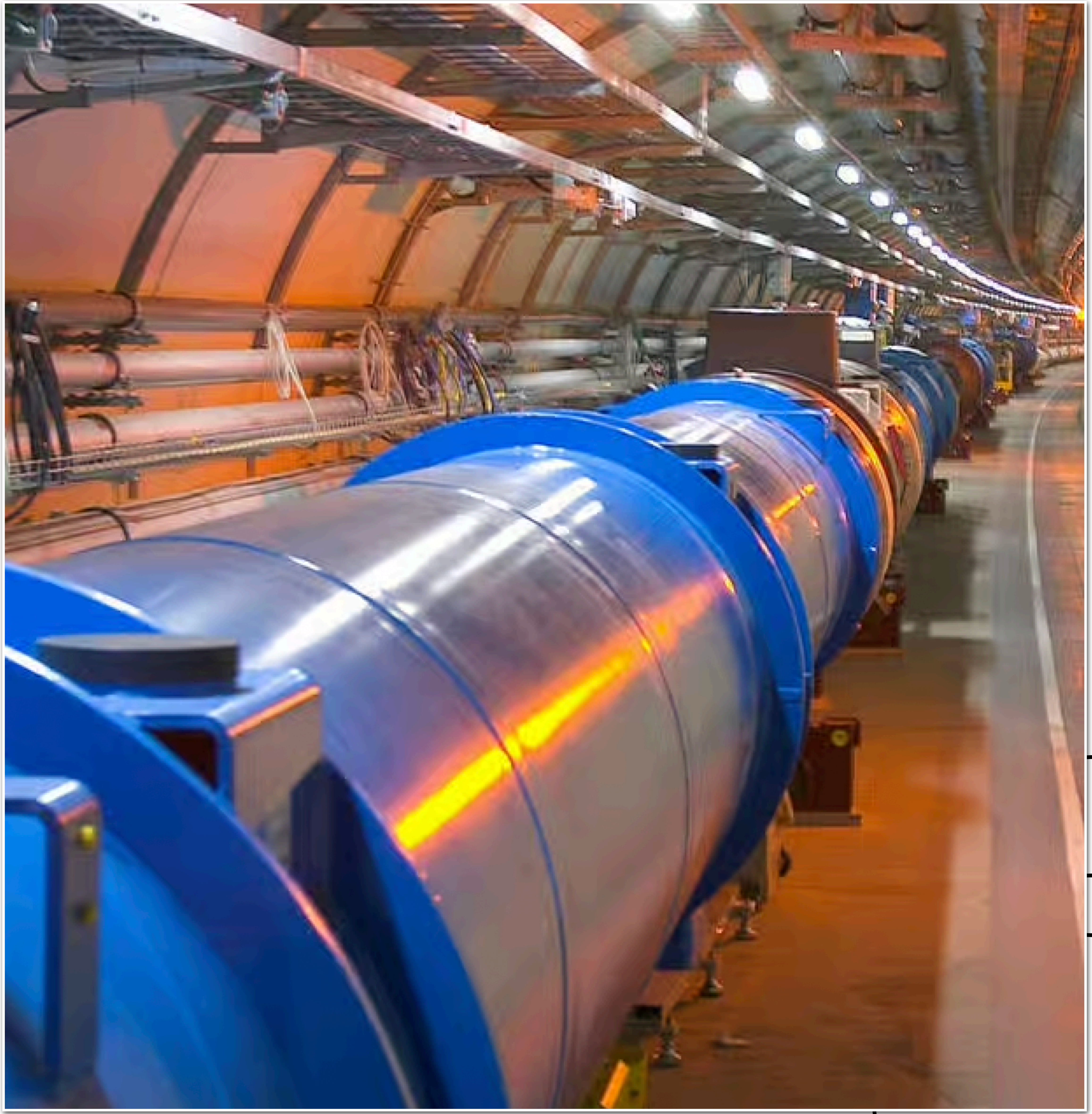
Internship supervisor : Benjamin Fuks

Léandre Munoz

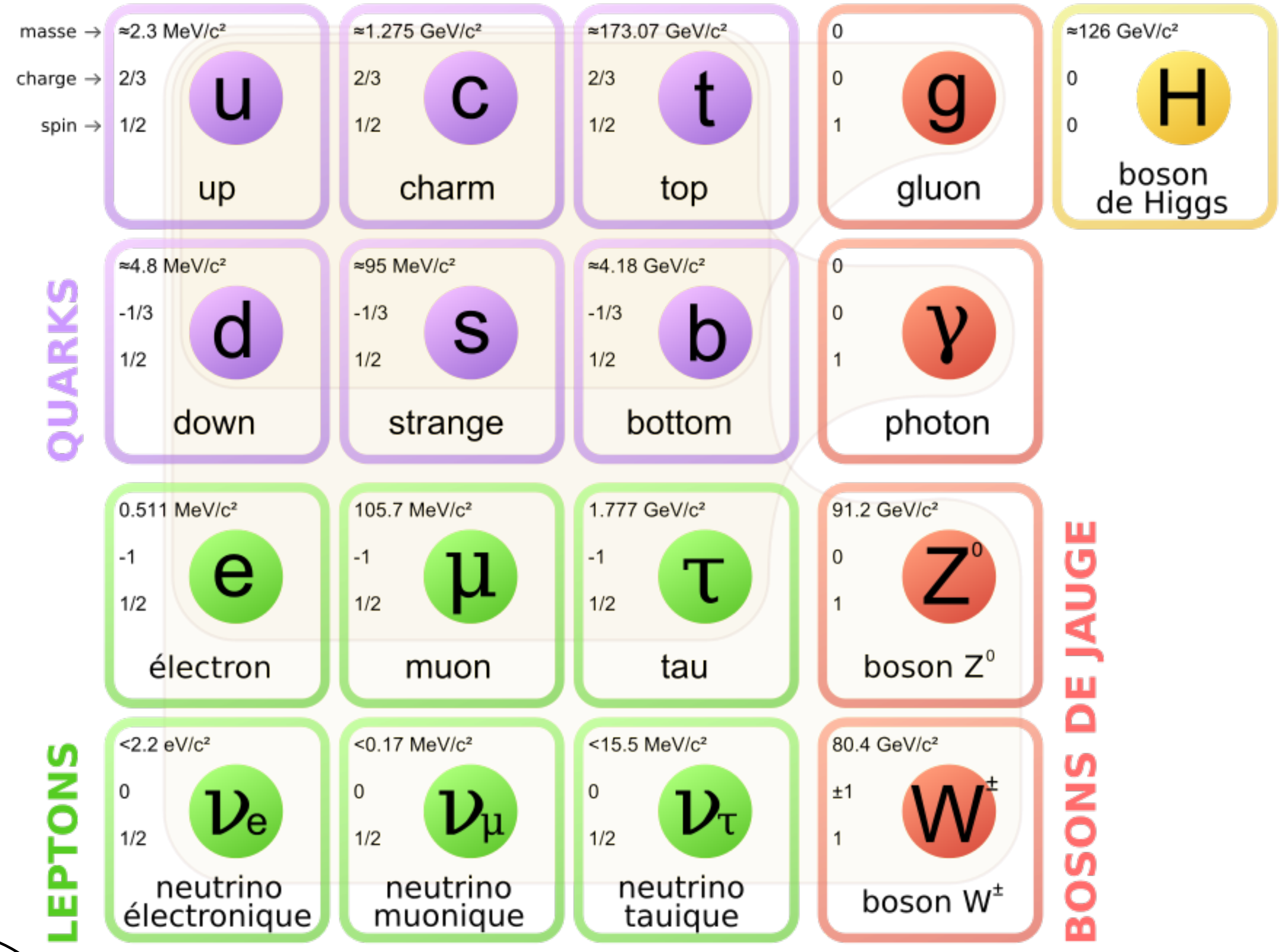
LPTHE
LABORATOIRE DE PHYSIQUE THEORIQUE ET HAUTES ENERGIES
SPRINT

Plan

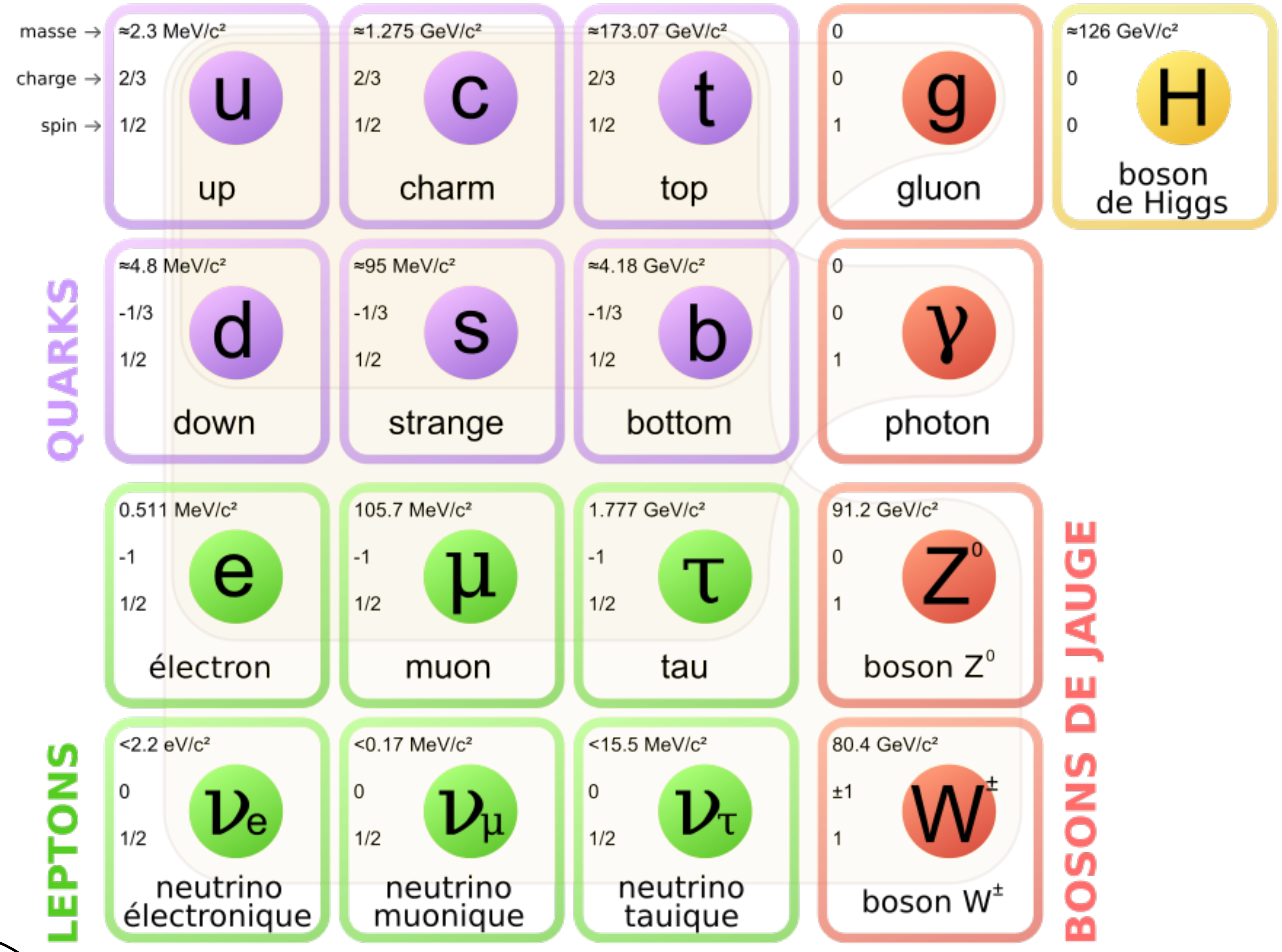
- Introduction
  - The standard model and beyond
  - Our model of study
  - The numerical tools
- Exclusion diagrams
- Observables and errorbars
- Conclusion



The standard model...



… and beyond ?

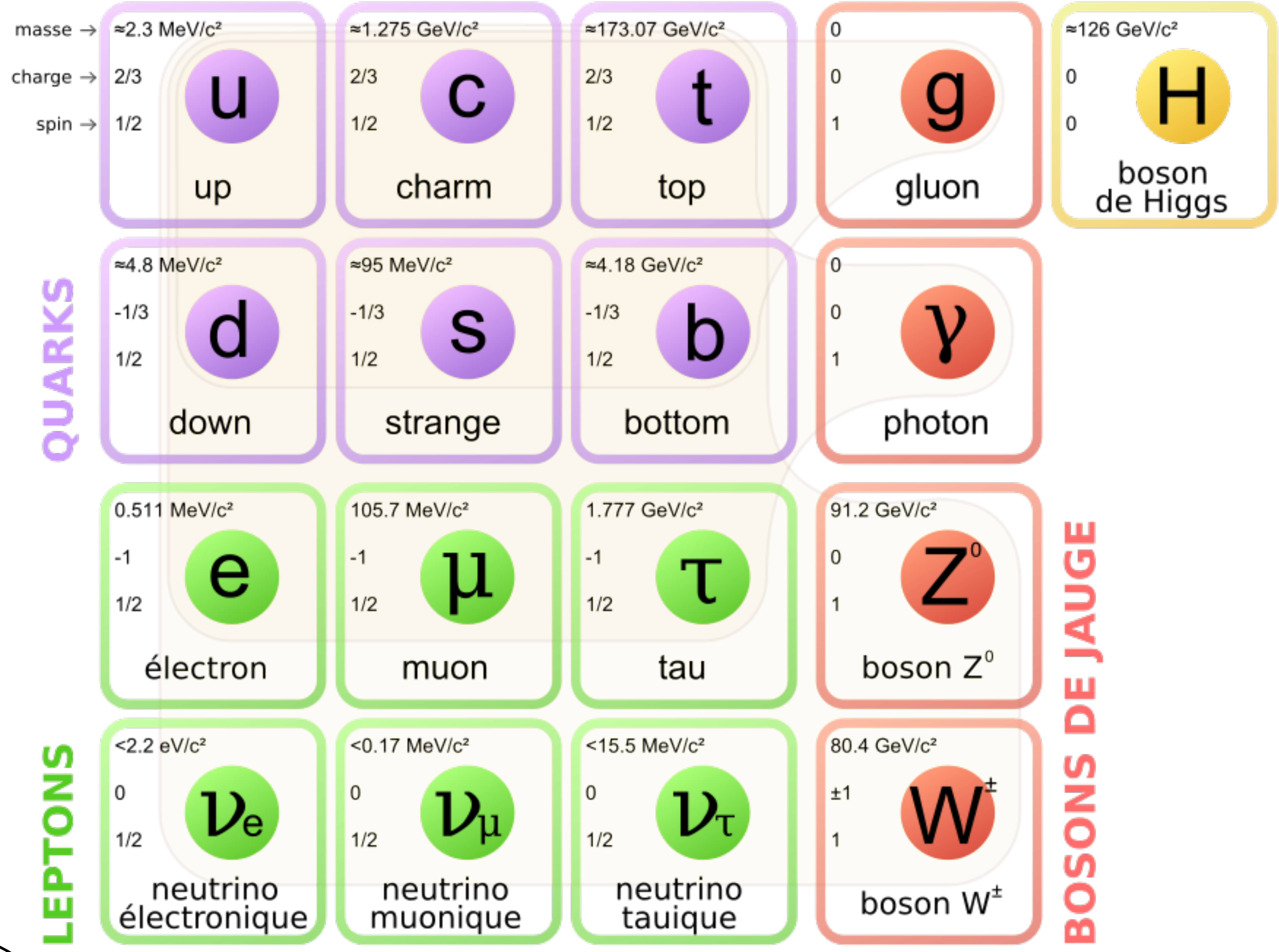


The succes

Discovery of W and Z bosons, gluons and top/bottom quarks

…

… and beyond ?



The succes

Discovery of W and Z bosons, gluons and top/bottom quarks

…

The problems :

Neutrino masses

Hierarchy problem

No DM in the standard model

…

The dark matter

The detection methods

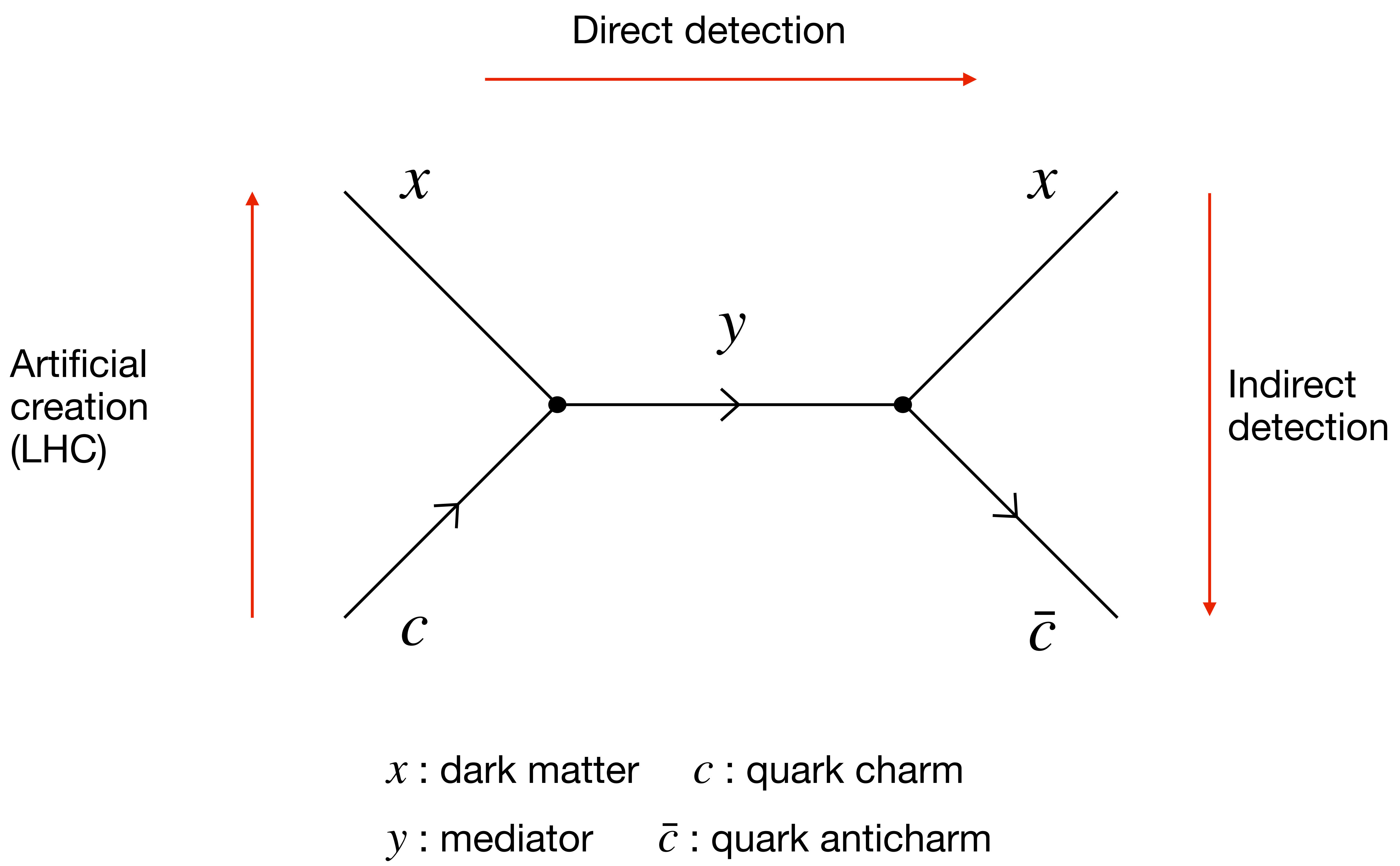
- Direct detection

- Indirect detection

⟶ *Cosmology*

- Artificial creation

⟶ *Accelerators / Collider*



Our model of dark matter

Model

SM + X + Y

DMSimpt_NLO_v1_2_UFO-F3S_cr

DM : Dark matter

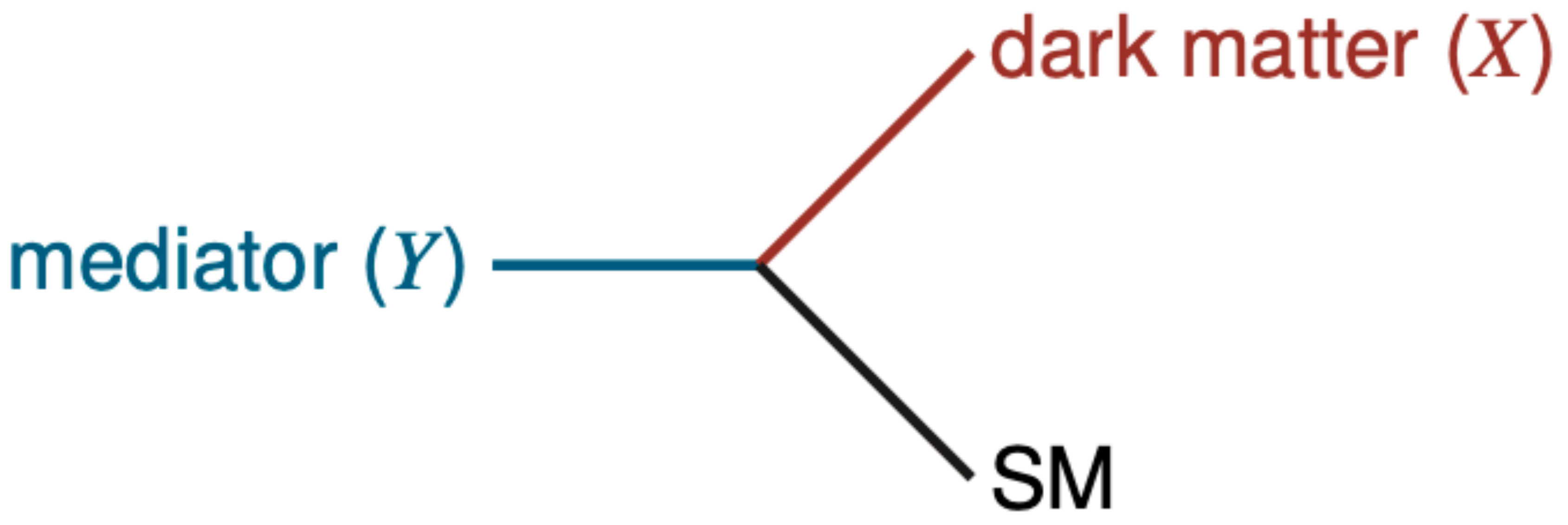
Simp : simplified

T : t-channel model

UFO : Universal Feynman Output

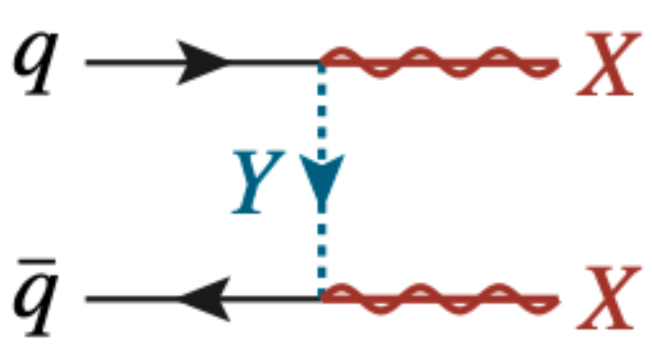
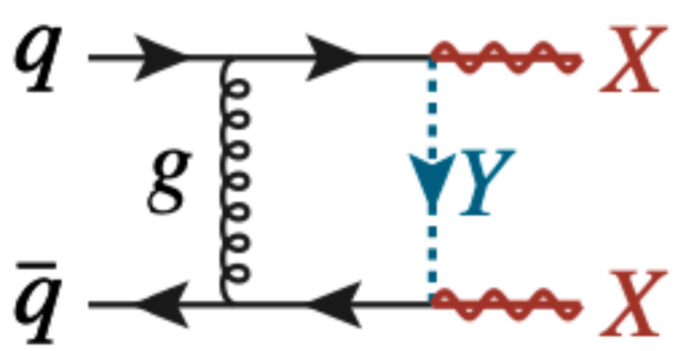
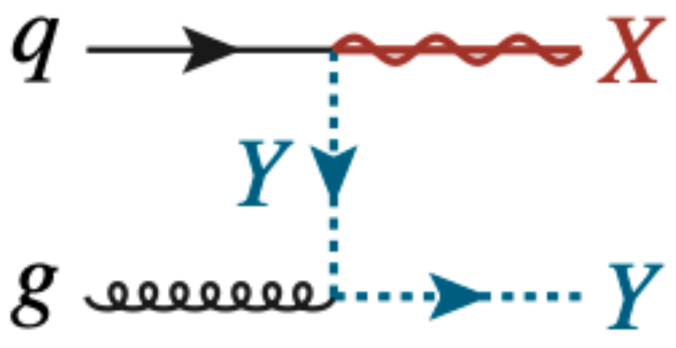
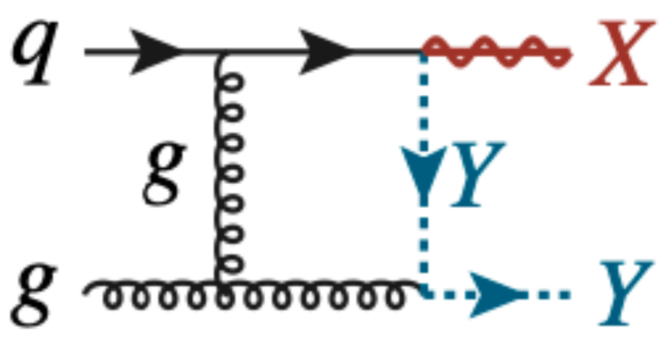
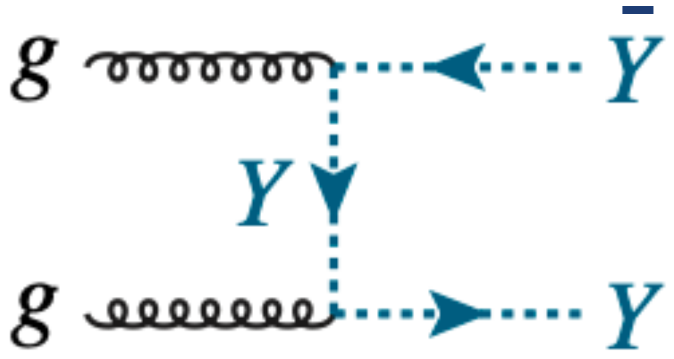
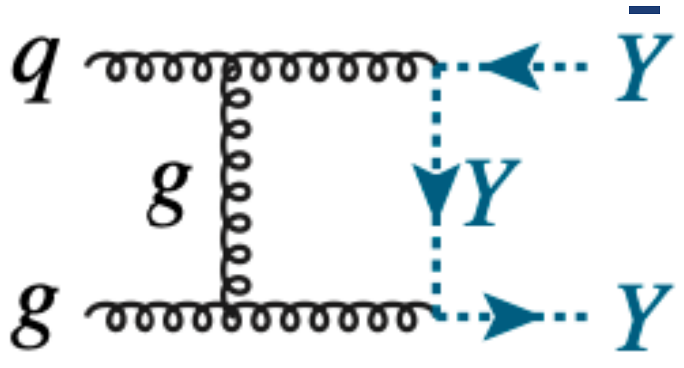
F3S : mediator is a fermion and dark matter a scalar

Cr : implies a charm quark



Our model of dark matter

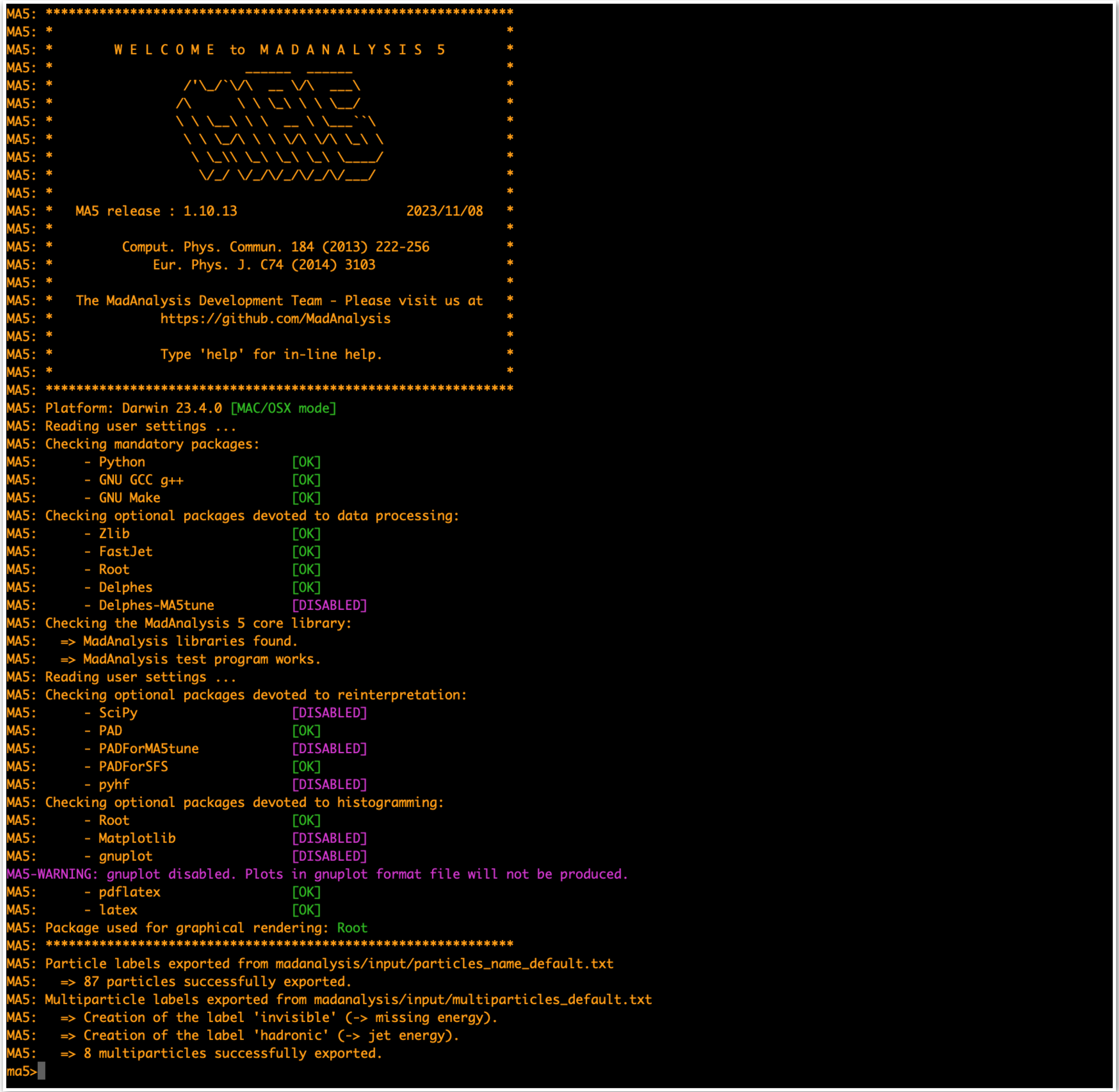
3 process :

		LO	NLO
XX :	$p\,p \longrightarrow x\,x$		
XY :	$p\,p \longrightarrow x\,y$ ou $p\,p \longrightarrow x\,\bar{y}$		
YY :	$p\,p \longrightarrow y\,\bar{y}$		

The tools

MADGRAPH5_aMC@NLO

MADANALYSIS 5



The tools

MADGRAPH5_aMC@NLO

- Simulation and production of dark matter at LHC

- Generation of simulated collisions to compare to theoretical data

MADANALYSIS 5

- Analysis of results

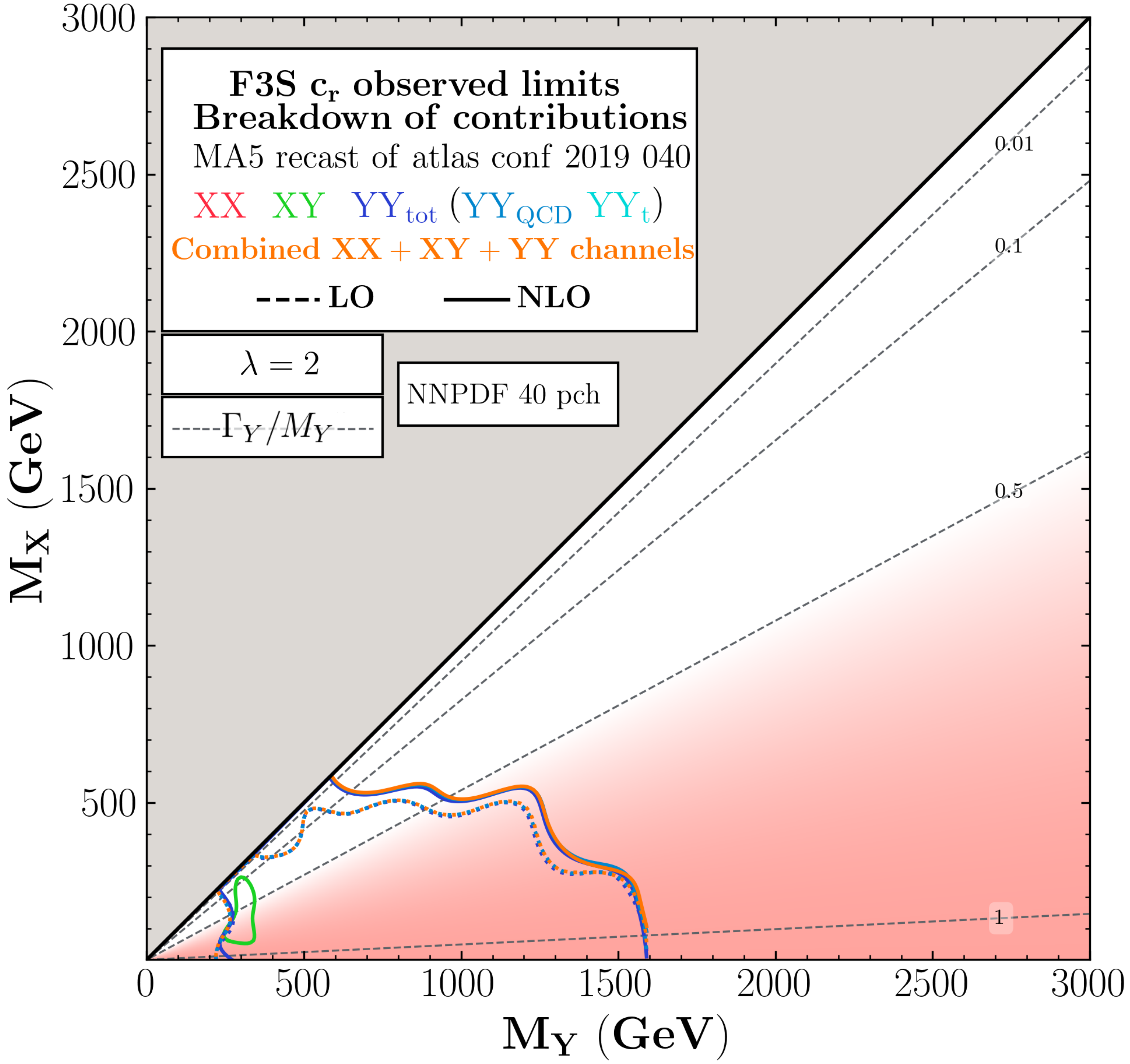
- Comparison with real experimental data from LHC

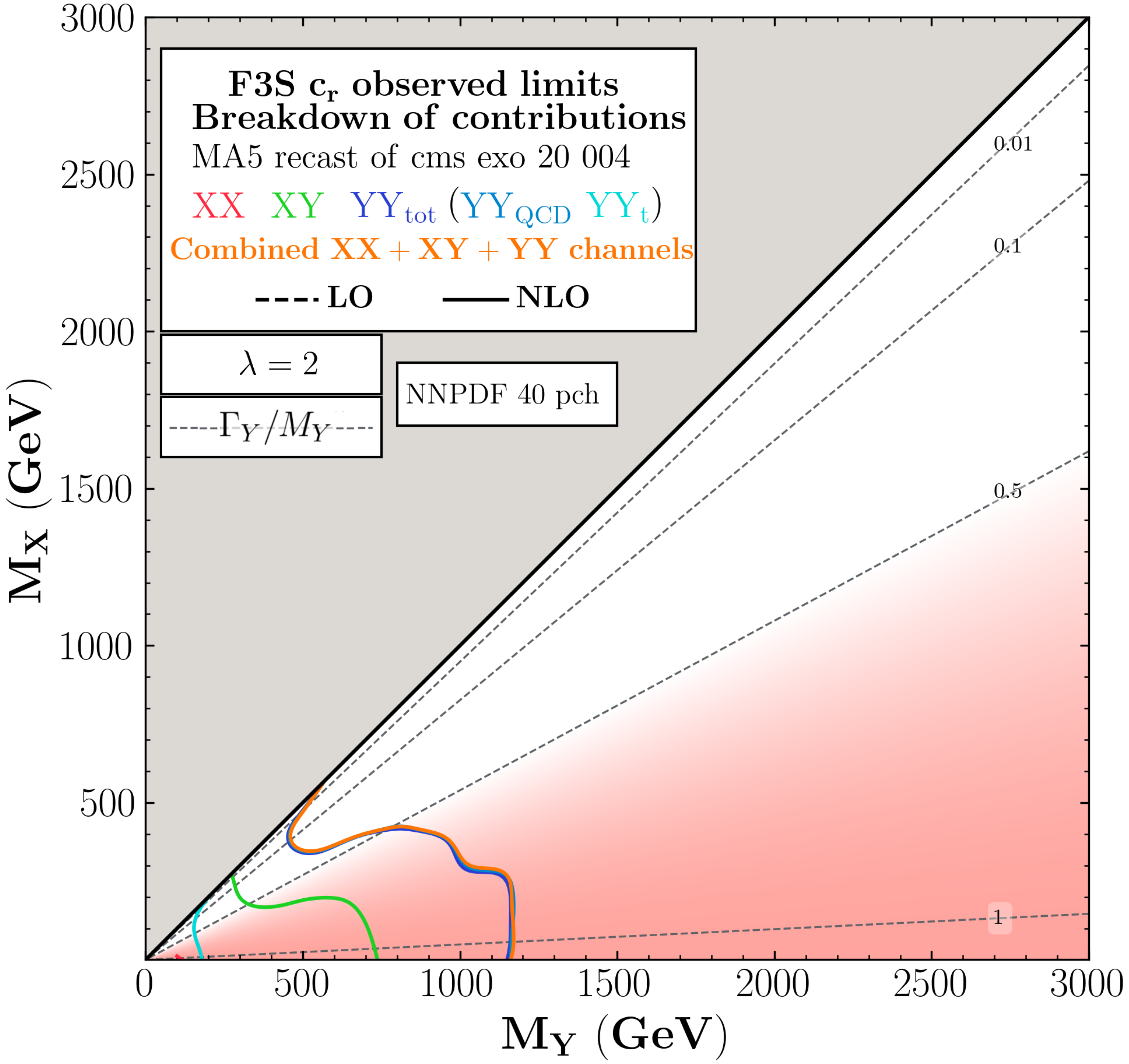
- Statistical analysis

Exclusion diagrams

→ Two free parameters : the masses m_X and m_Y

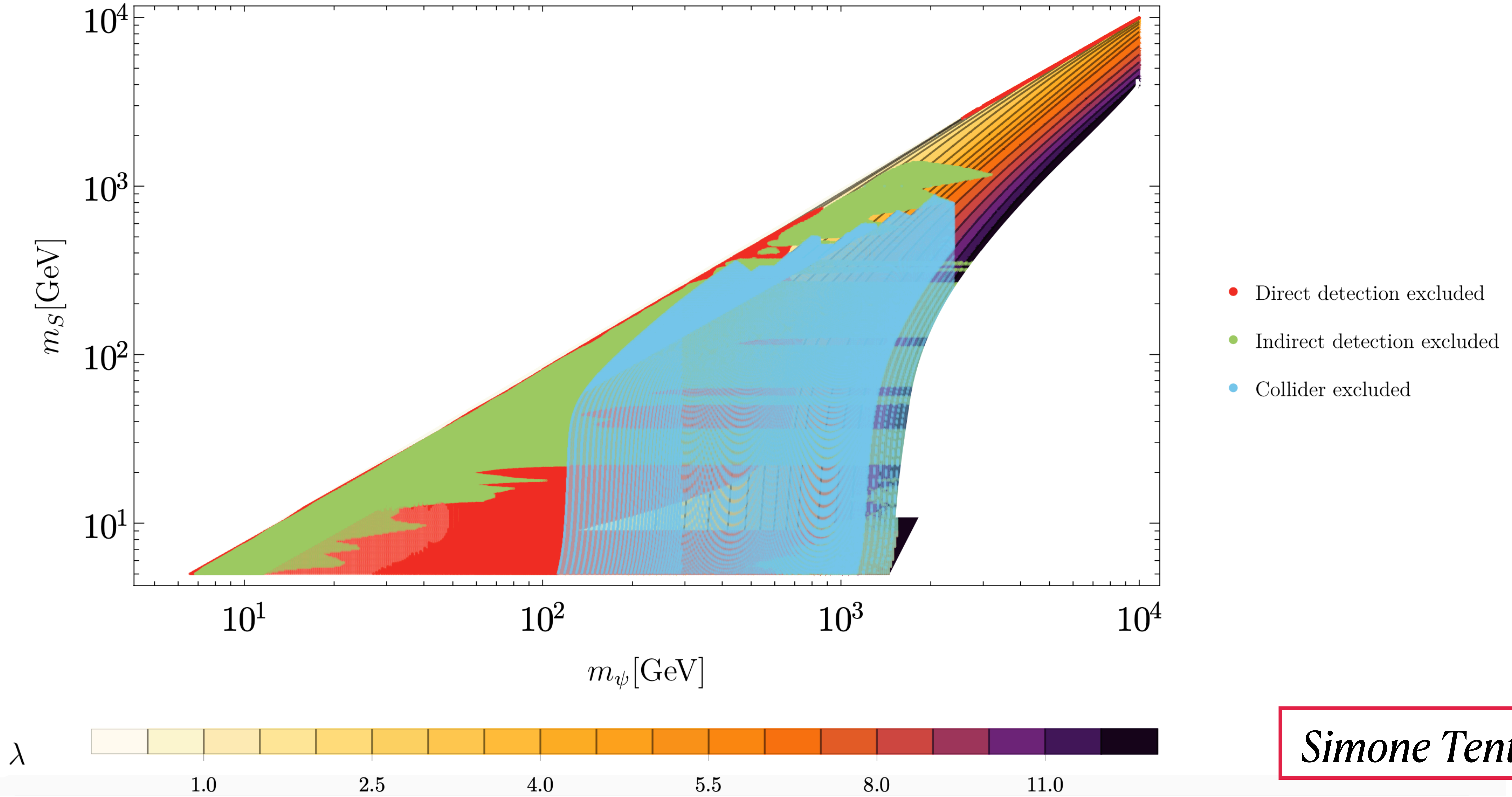
$0 \leq \mathrm{CLs}(m_X, m_Y) \leq 1$





Exclusion diagrams

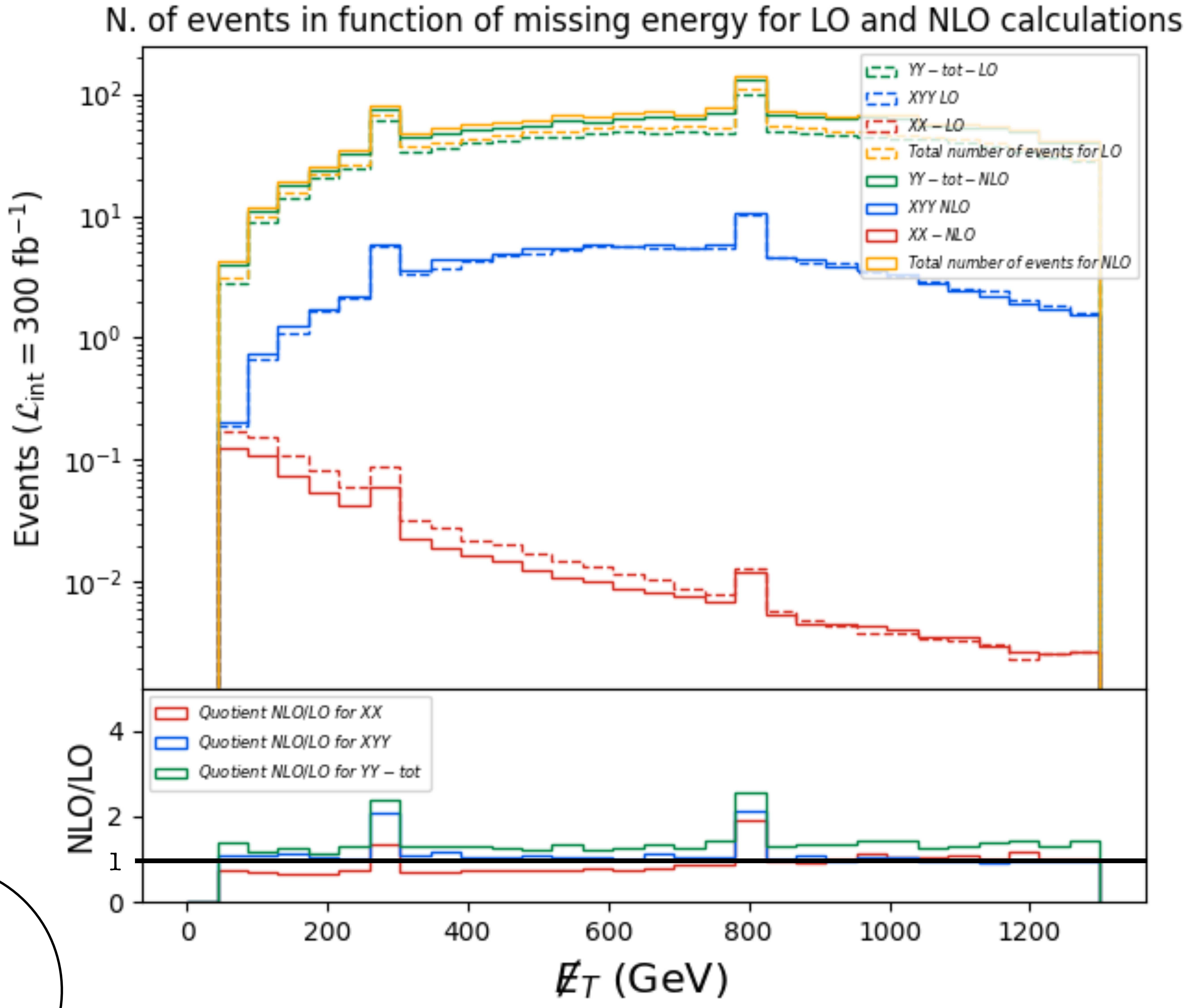
→ Sharing of results between accelerators and cosmology



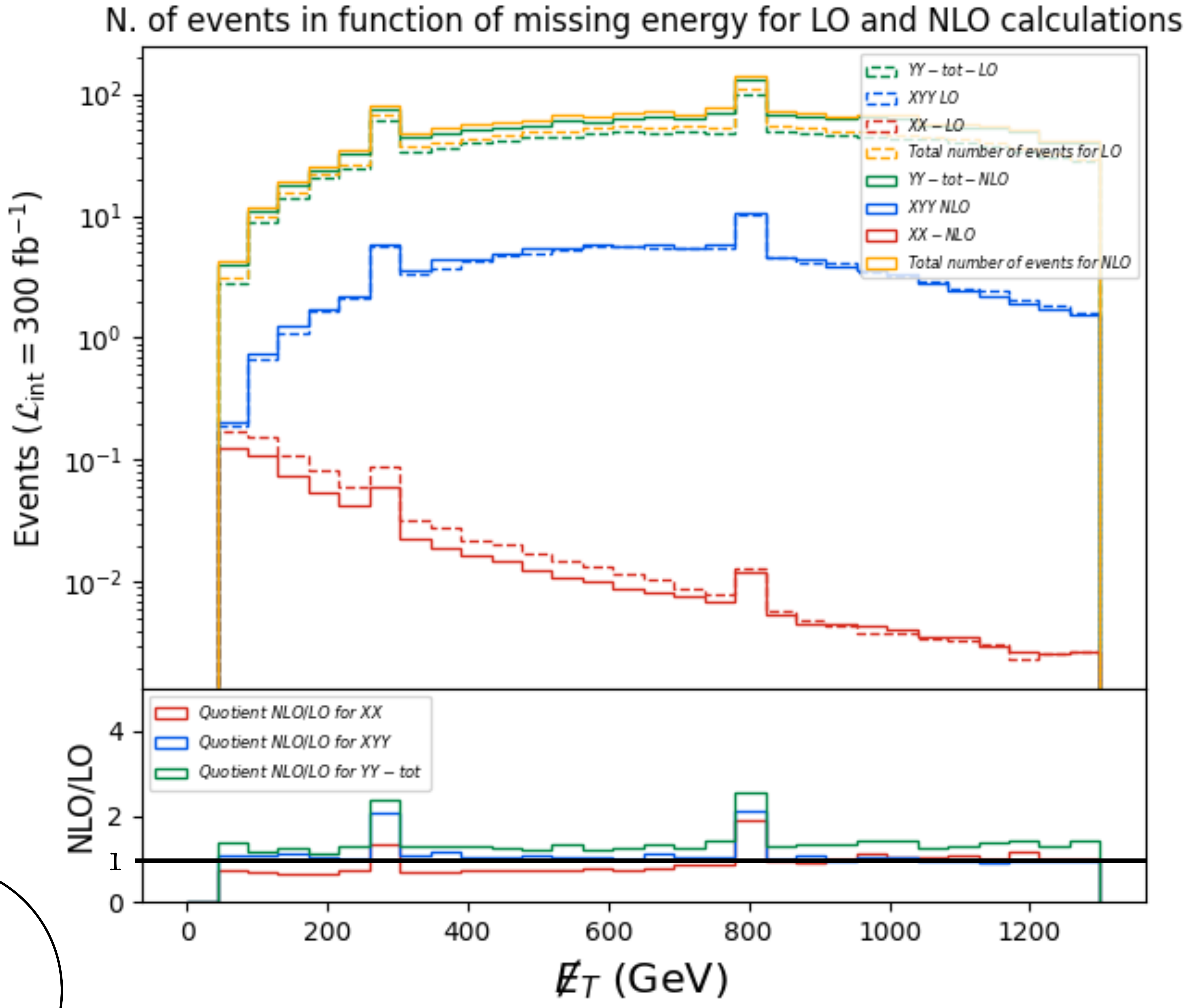
Simone Tentori

Observables and errorbars

Observables and errorbars



Observables and errorbars



→ $M_X = 900$ GeV

$M_Y = 1300$ GeV

→ Some contributions are negligible

→ Importance of NLO

Observables and errorbars

→ Errorbars ?

Observables and errorbars

→ Errorbars ?

PDF : Partonic Distribution Function

↓

Necessary to calculate analytically the cross section (Amount of production)

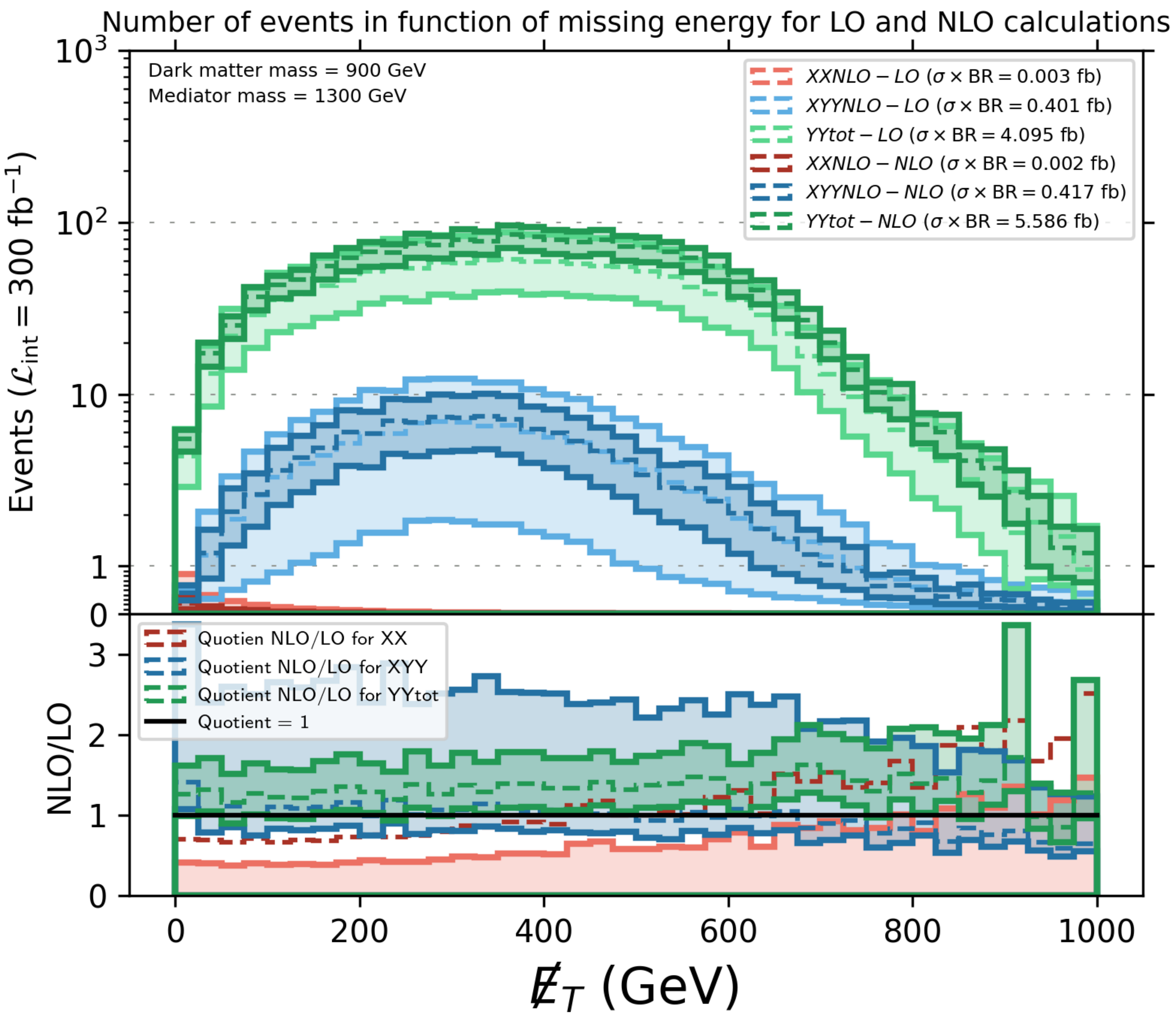
Observables and errorbars

→ Errorbars ?

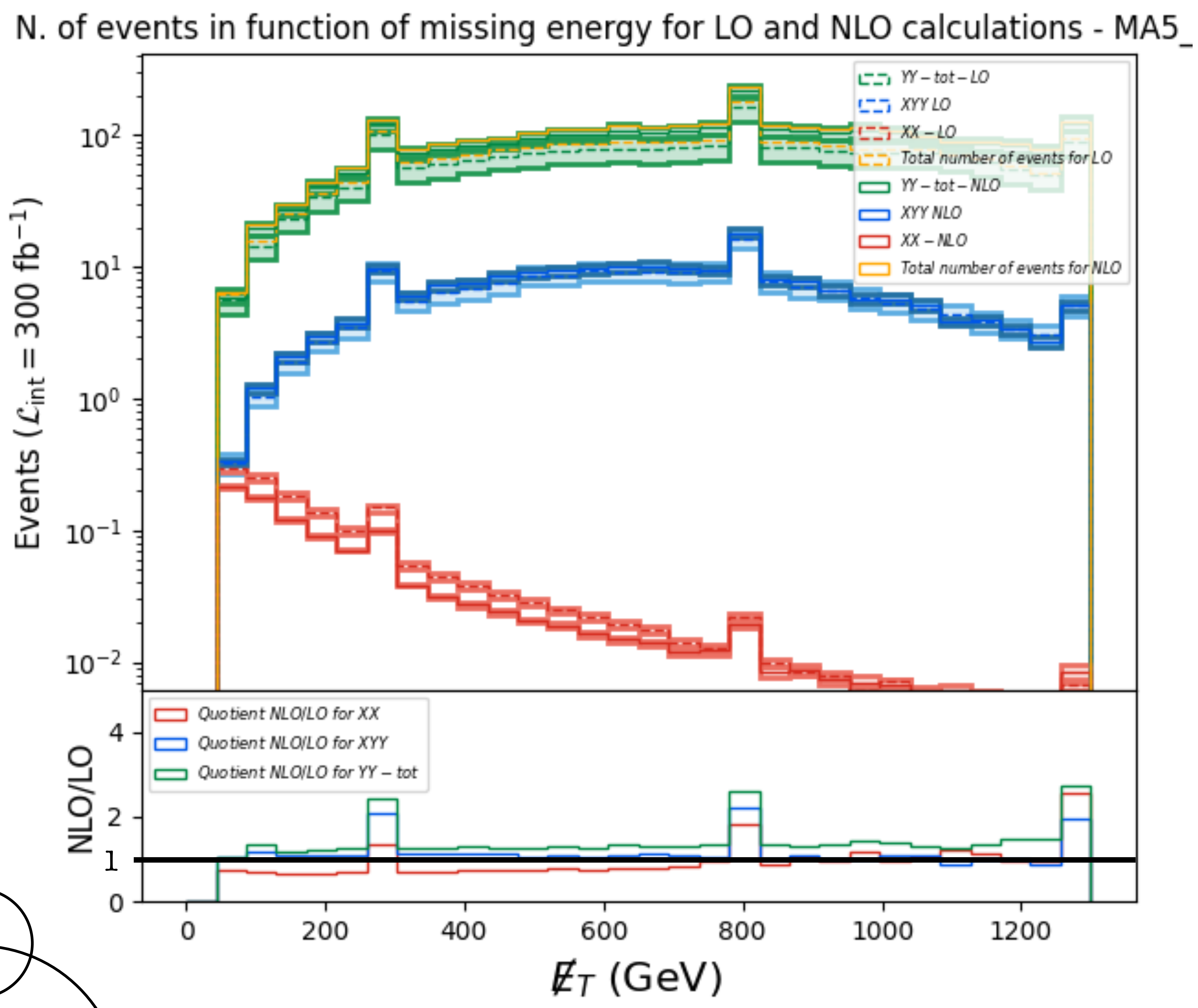
PDF : Partonic Distribution Function

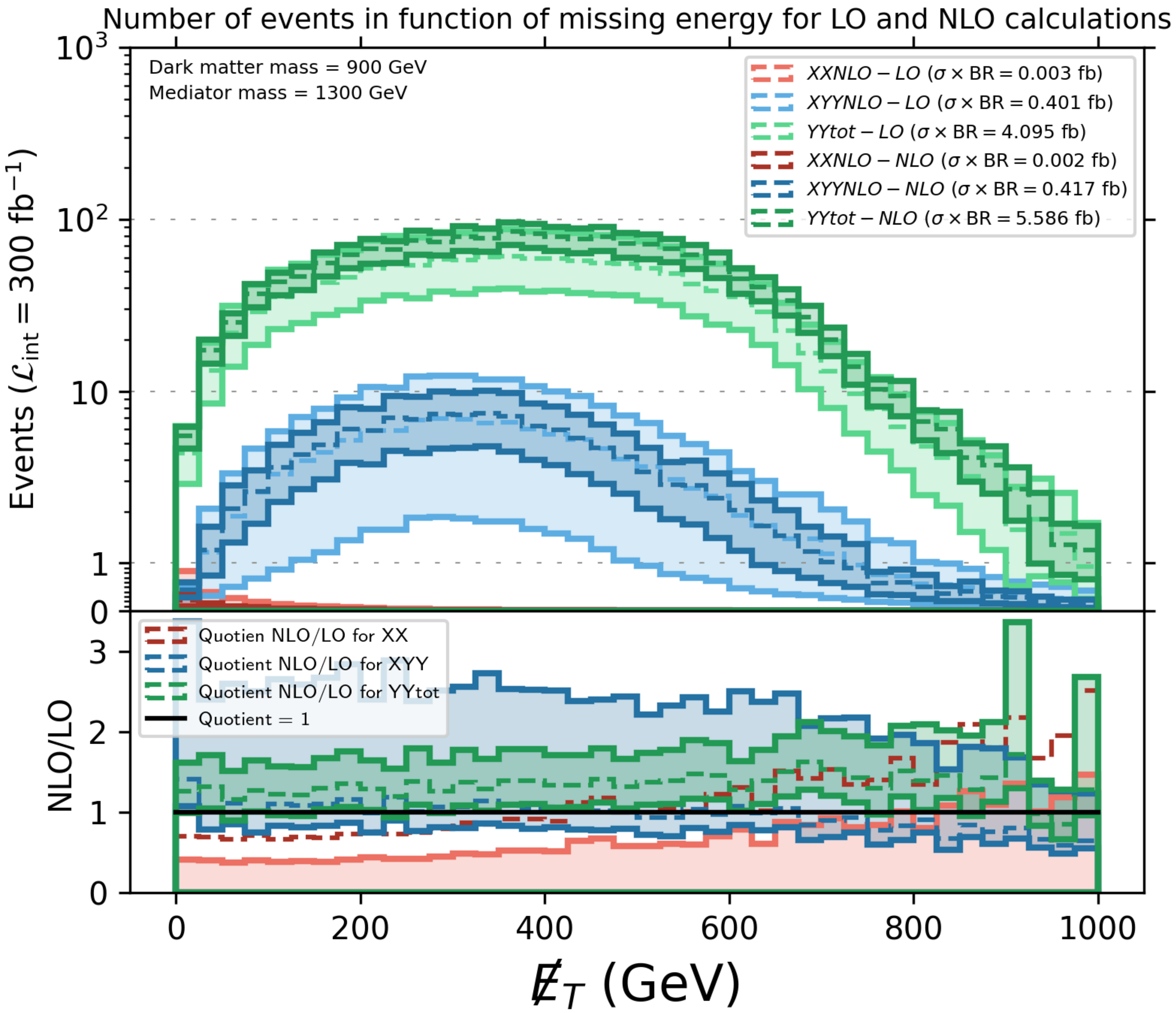
↓

Necessary to calculate analytically the cross section (Amount of production)

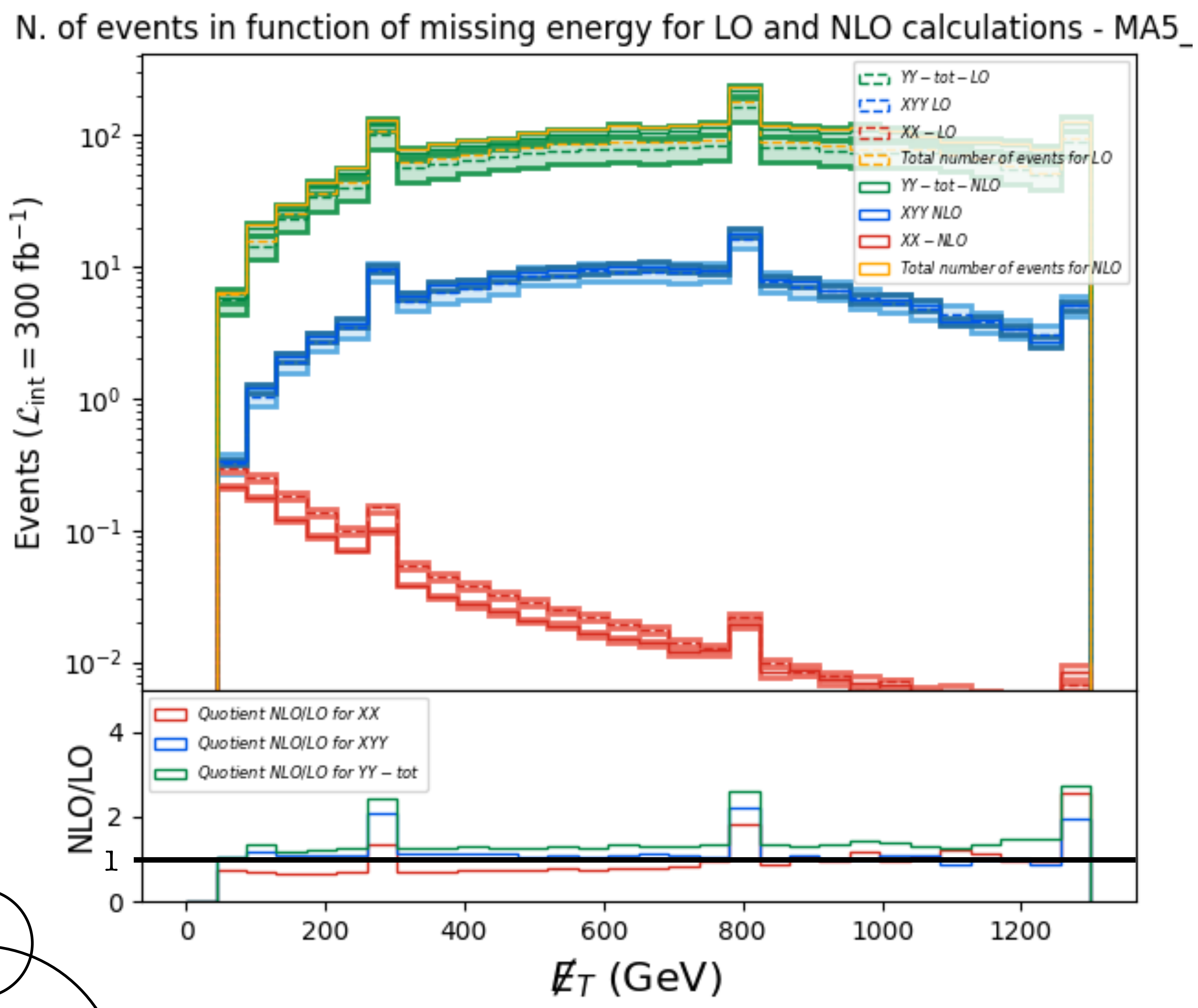


Observables and errorbars

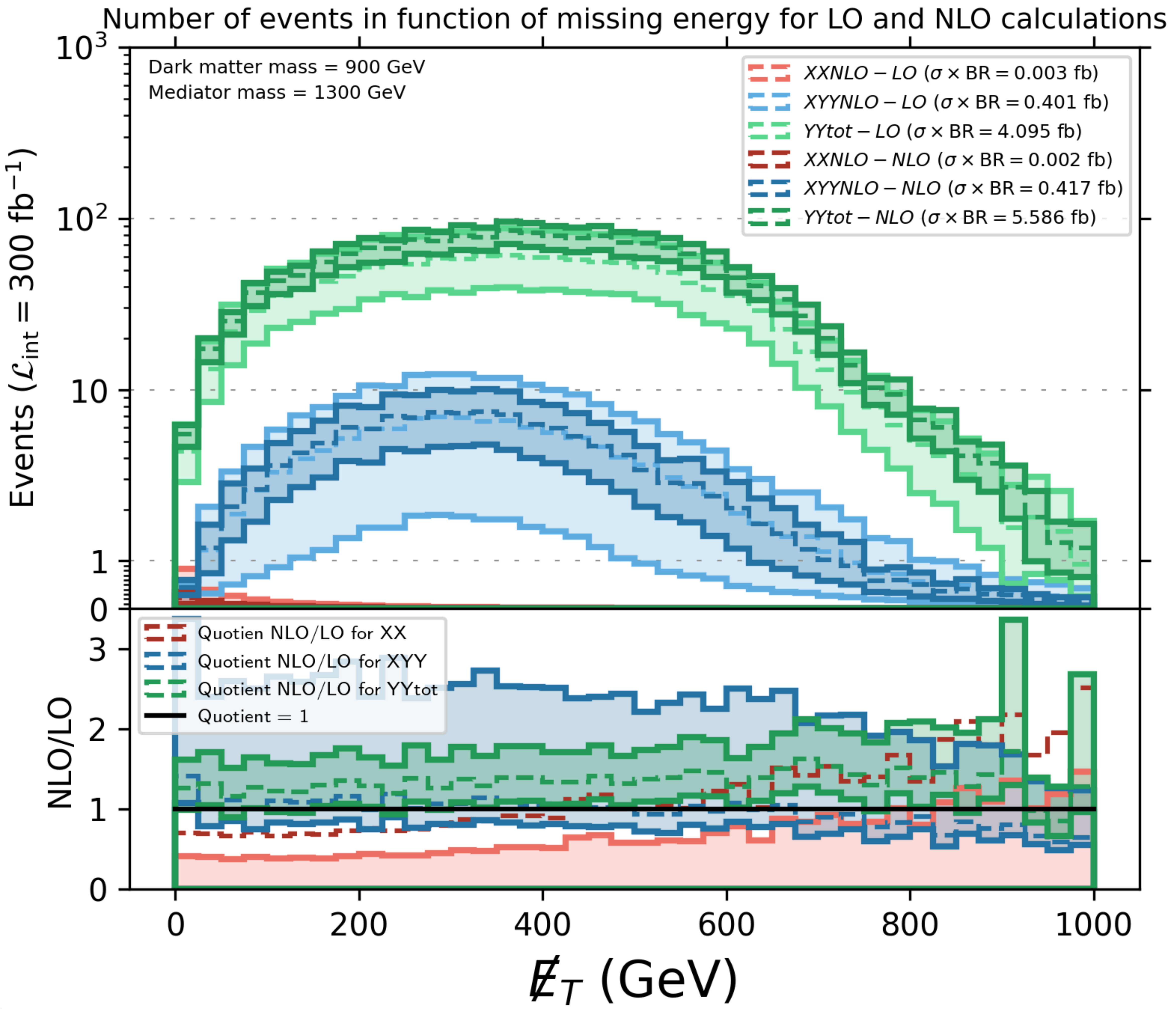




Observables and errorbars



?
=



Conclusion