SEARCH FOR DARK MATTER AT LHC

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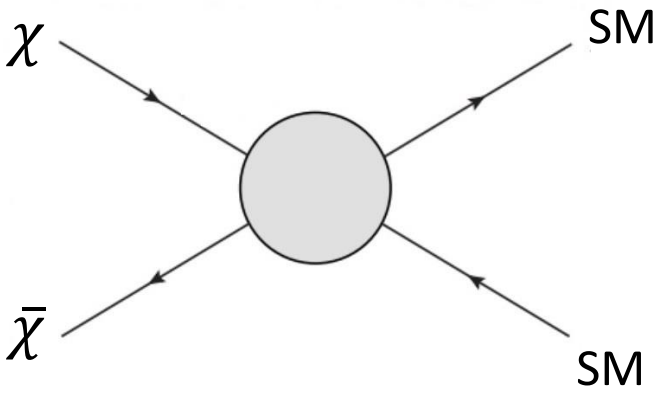
SHEDDING LIGHT ON DARK MATTER

- indirect search:

Dark matter (DM) **annihilation** into Standard Model (SM) particles



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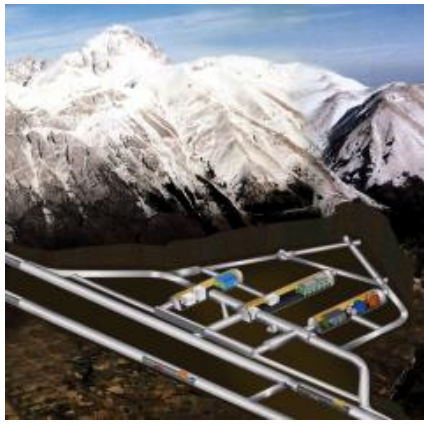
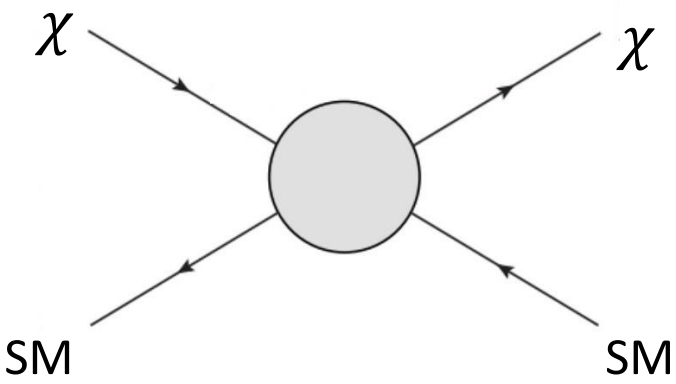


- direct search:

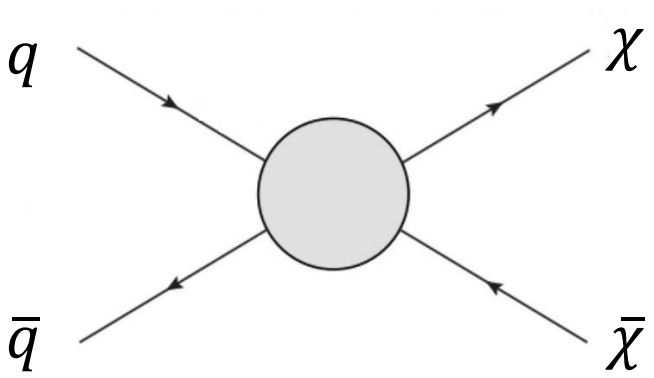
DM **scattering** on nucleons



SHEDDING LIGHT ON DARK MATTER

- search at colliders:

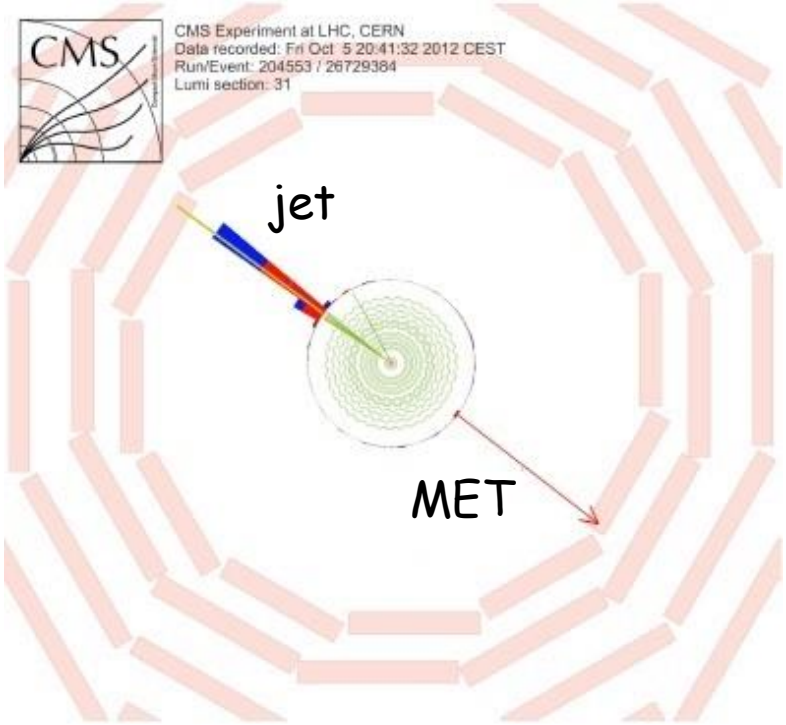
DM **production** from proton-proton collisions at LHC



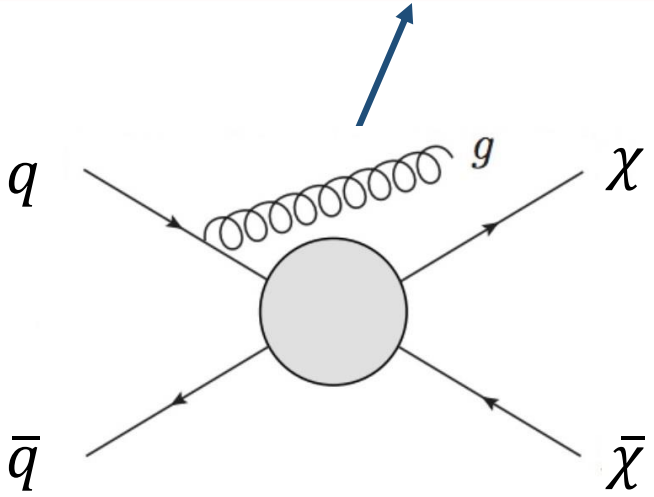
I will present CMS results

DARK MATTER SIGNAL AT LHC

MONOJET EVENT



exploit radiation from initial state as a trigger



look for events with high missing transverse energy (MET or $\vec{\not{E}}_T$)

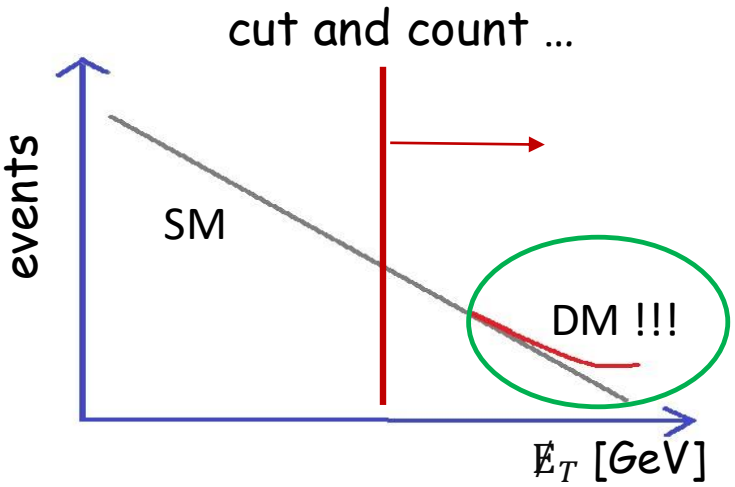
SIGNAL SELECTION

→ 1 high energy jet recoiling against $\not{E}_T$

- **MET** > 200 GeV
- **Njets** ≤ 2
- **noise cleaning** on leading jet
- **jet 1** p_T > 110 GeV;
- **second jet** allowed if:
  $\Delta\phi(jet1, jet2)$ < 2.5
- **photon veto**
- **lepton veto**

$$\vec{\not{E}}_T = -\sum_{\substack{all \\ particles}} \vec{p}_T$$

$\vec{p}_T$: momentum in transverse plane



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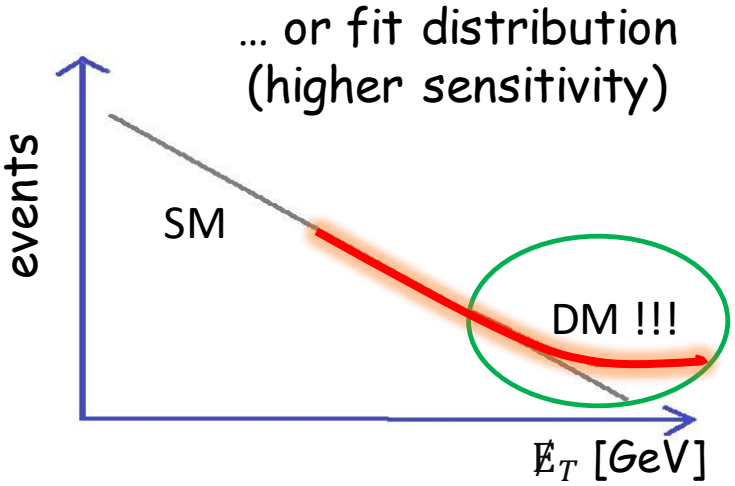
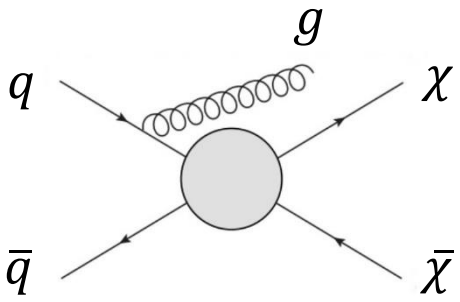
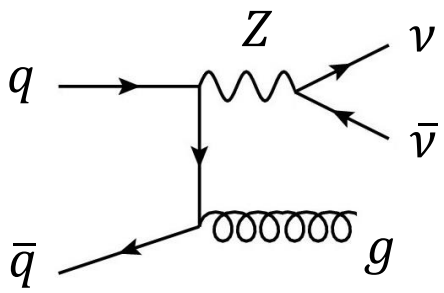


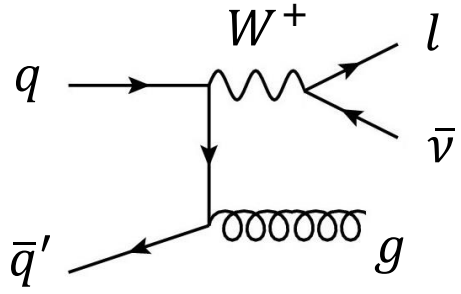
MONOJET BACKGROUNDS

everything in SM that produces jets and $\not{E}_T$



signal





backgrounds

main backgrounds

- $Z(\nu\nu) + jets$ (55%)
- $W(l\nu) + jets$ (40%) (if l is lost)

estimated from data using control samples

others:

- $t\bar{t}$, single top
- QCD multijet
- diboson

estimated from MC

DATA DRIVEN BACKGROUND ESTIMATE

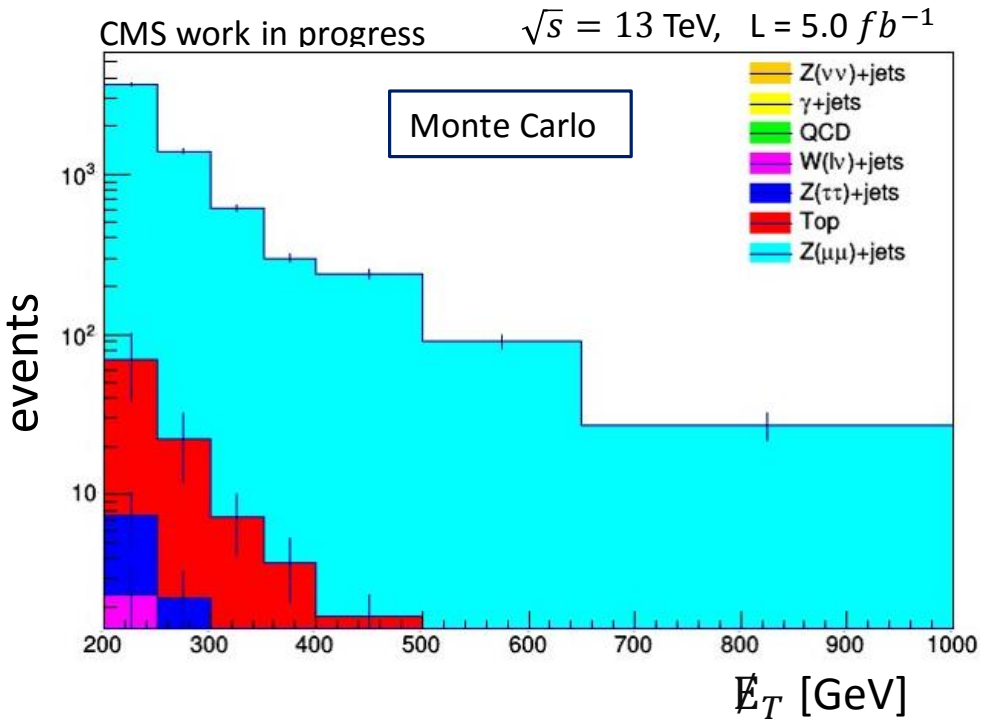
- select a control sample in data
- use MC to get transfer factors from control region (CR) to signal region (SR)

$$N_{SR}^{data} = N_{CR}^{data} \times \frac{N_{SR}^{MC}}{N_{CR}^{MC}}$$

my contribution

$Z(\mu\mu)$ + jets
$Z(ee)$ + jets
γ + jets

$\rightarrow Z(\nu\nu)$



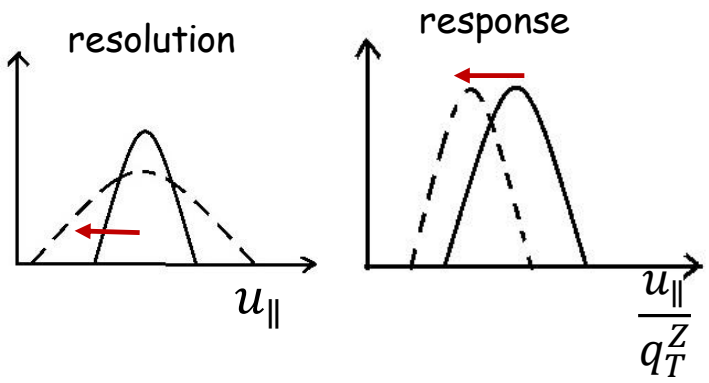
MET defined here excluding Z or γ p_T in the sum

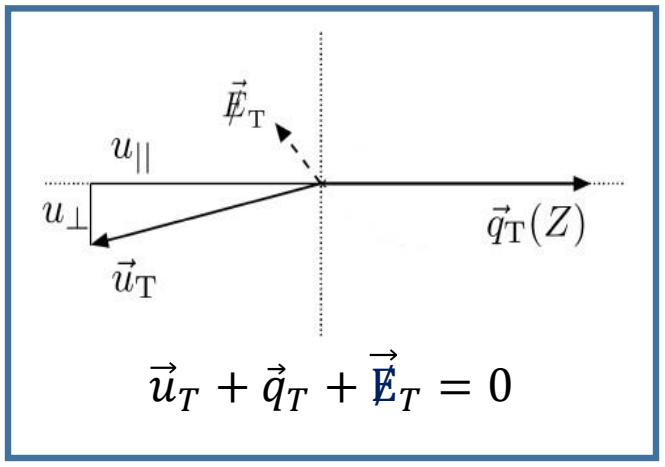
MET RESOLUTION AND RESPONSE

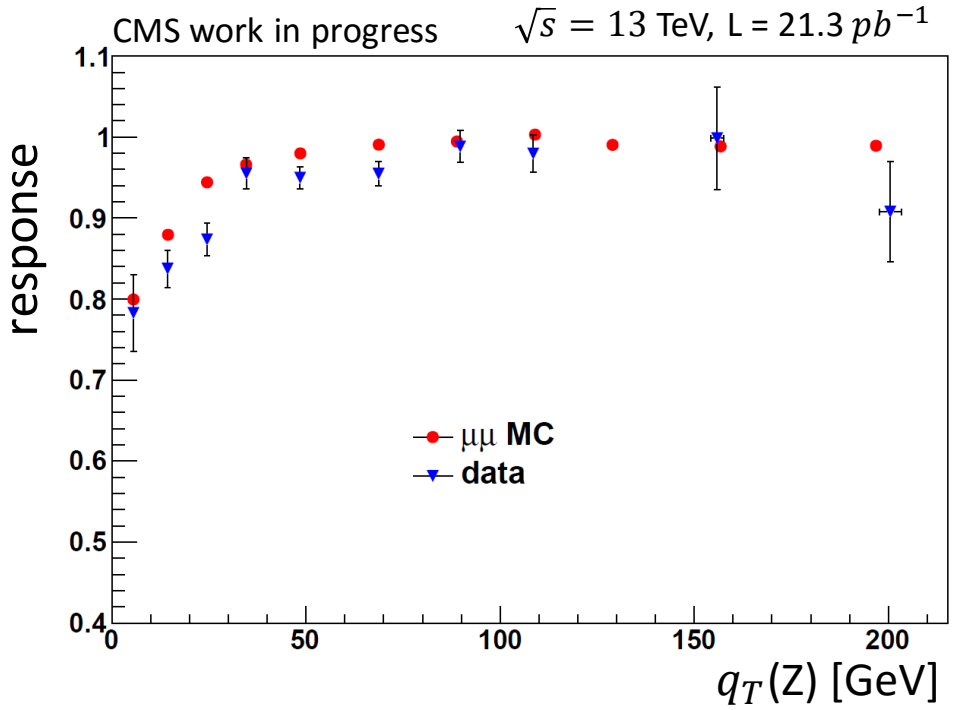
my contribution

- assess the performance of the hadronic recoil reconstruction

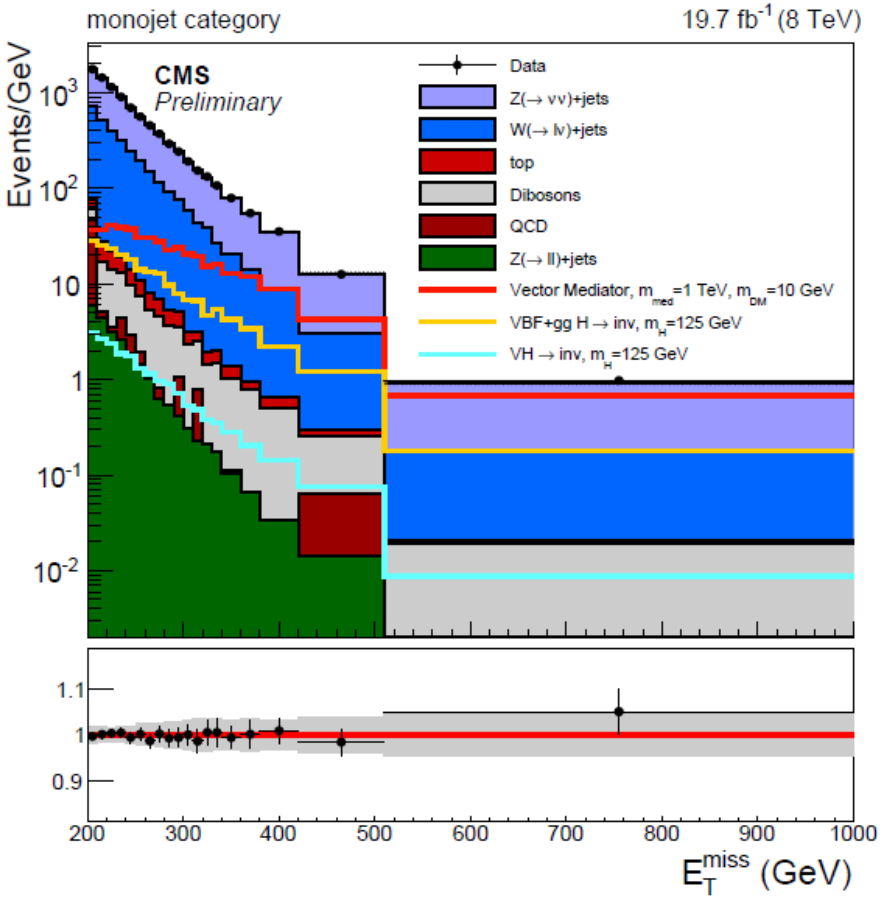
Use $Z(ll) + jets$ events: induce MET by removing the well-measured leptons



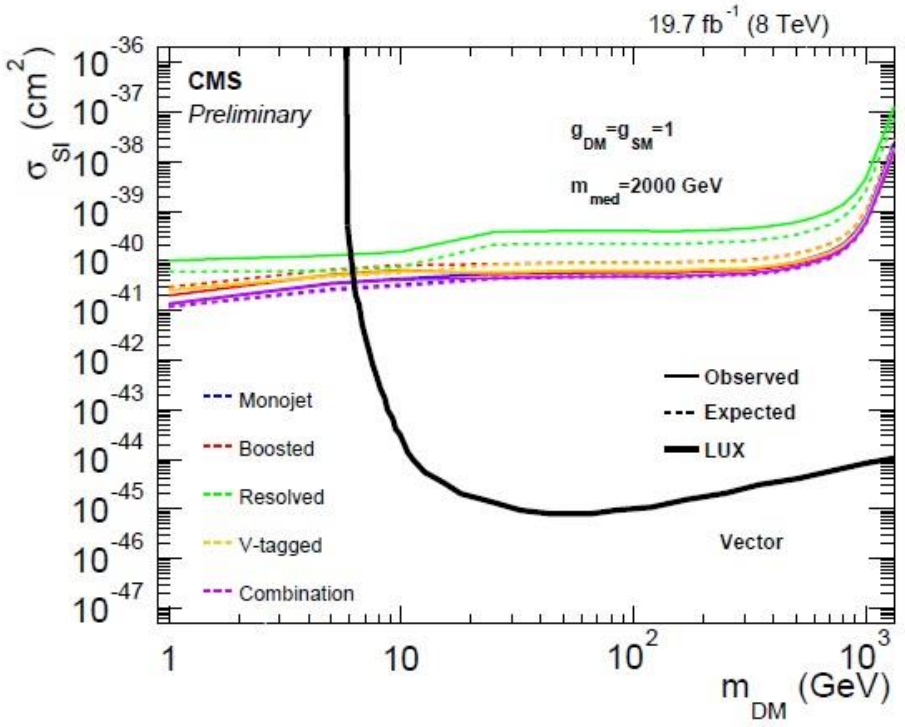




RUN 1 RESULTS



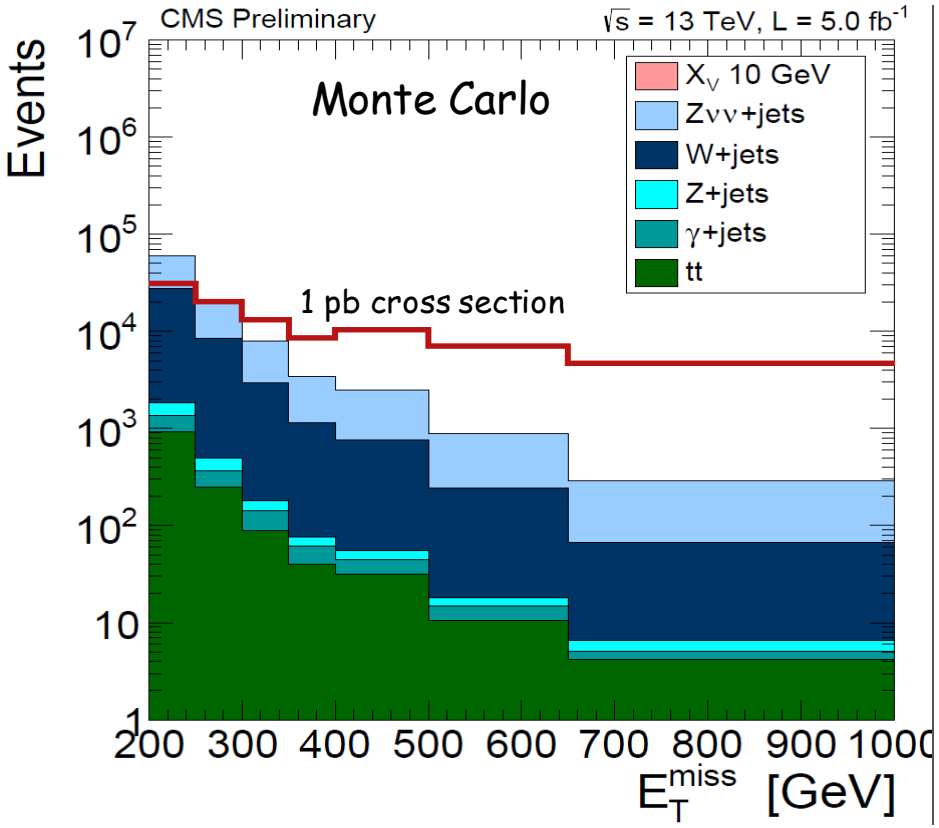
CMS-PAS-EXO-12-055



complementarity with respect to direct searches

collider searches are also sensitive to low DM mass

RUN 2 PERSPECTIVES



need 5 fb^{-1} at 13 TeV to be competitive with Run 1

- signal from fit to MET distribution: higher sensitivity than "cut&count"
- more control samples for background estimate

SUMMARY

✓ **monojet analysis for dark matter search at LHC presented**

- simple experimental signature: 1 jet and $\not{E}_T$

✓ **Run 2 and data taking at 13 TeV at LHC has begun**

- enhanced sensitivity thanks to higher energy collisions
- with $5fb^{-1}$ we are as sensitive as previous Run 1 ($\approx 20fb^{-1}$)

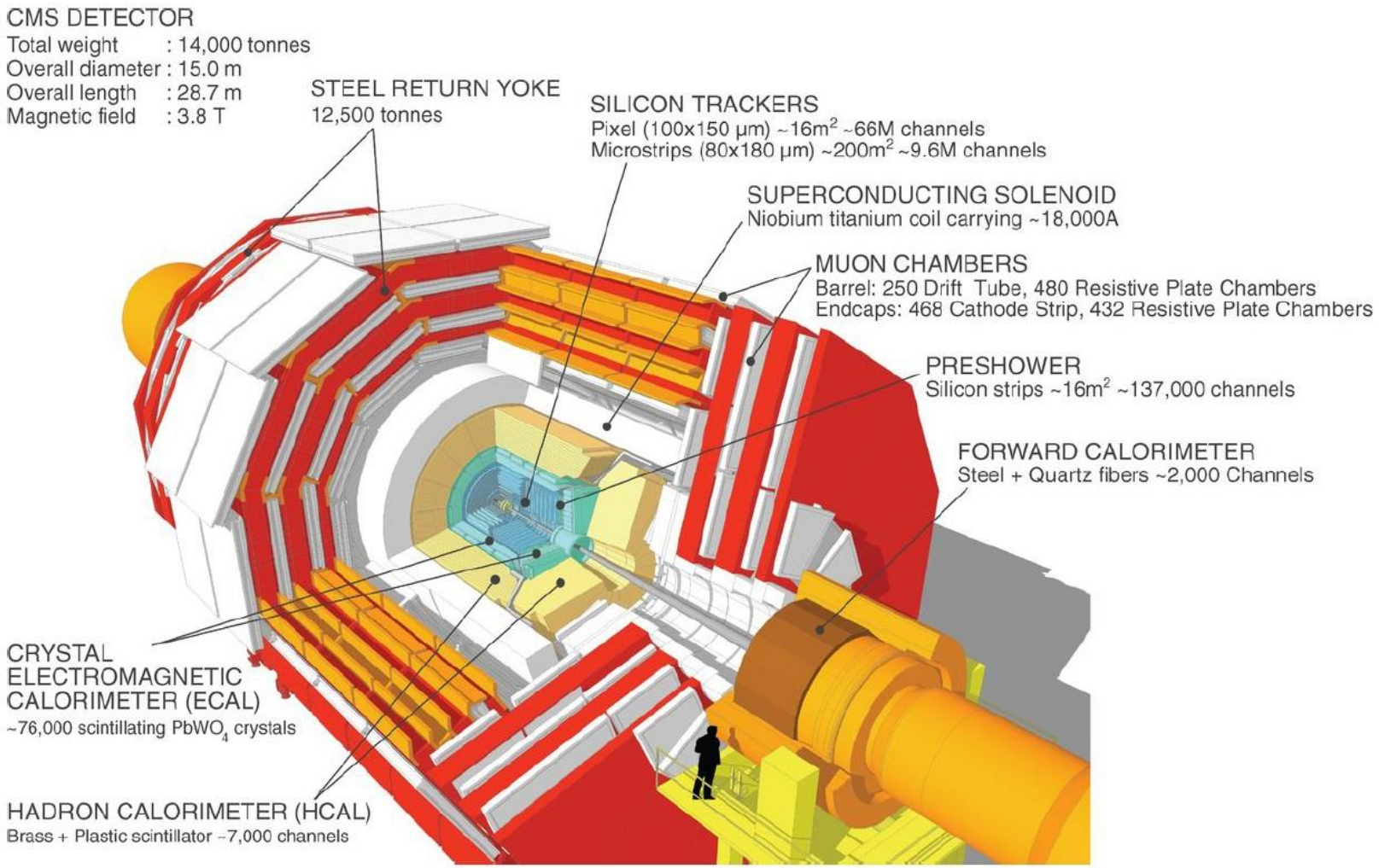
✓ **many improvements in the analysis during Run 2**

- more control samples to estimate the backgrounds

✓ **collider and direct searches complement each other**

BACKUP

COMPACT MUON SOLENOID



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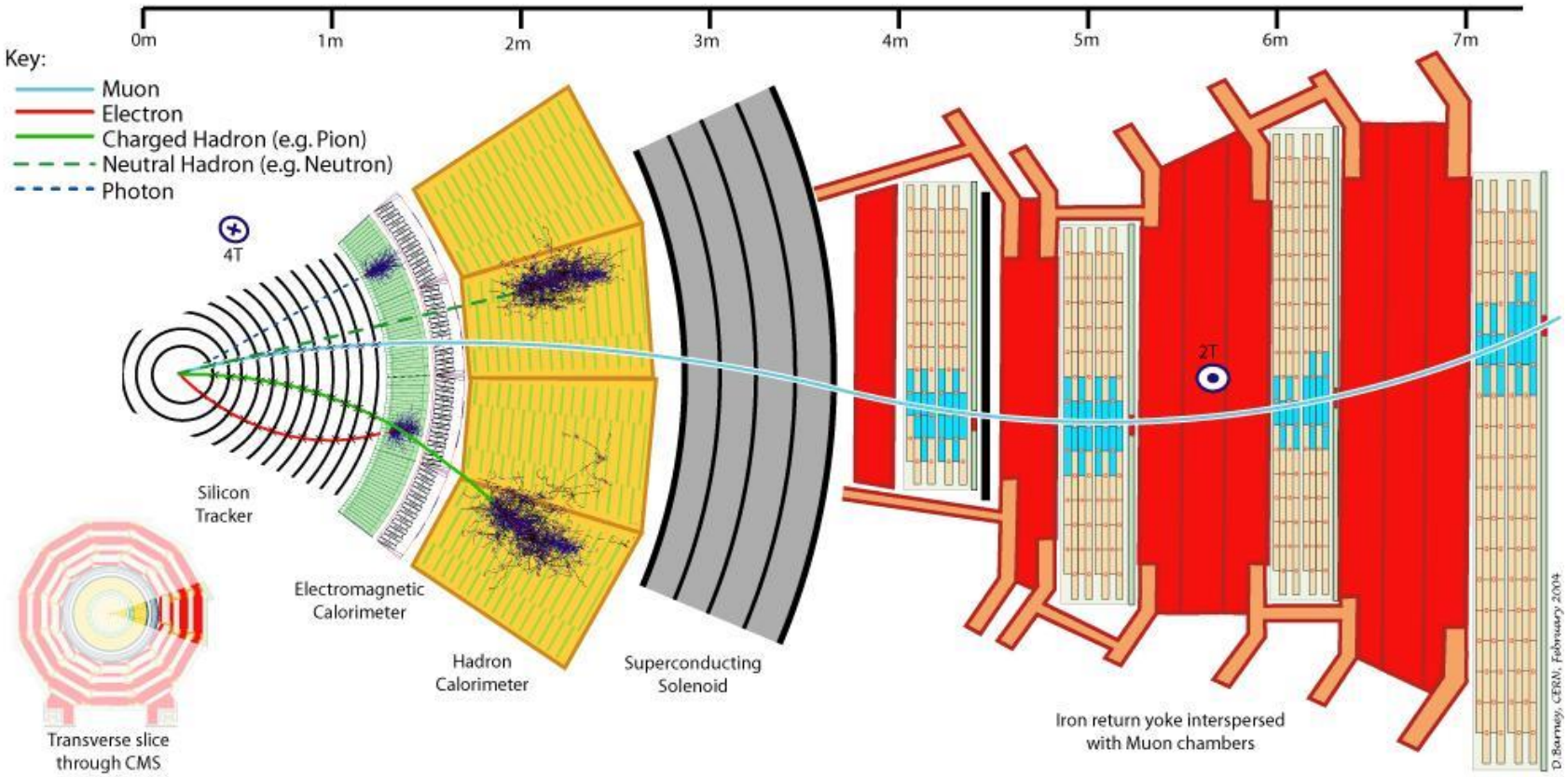

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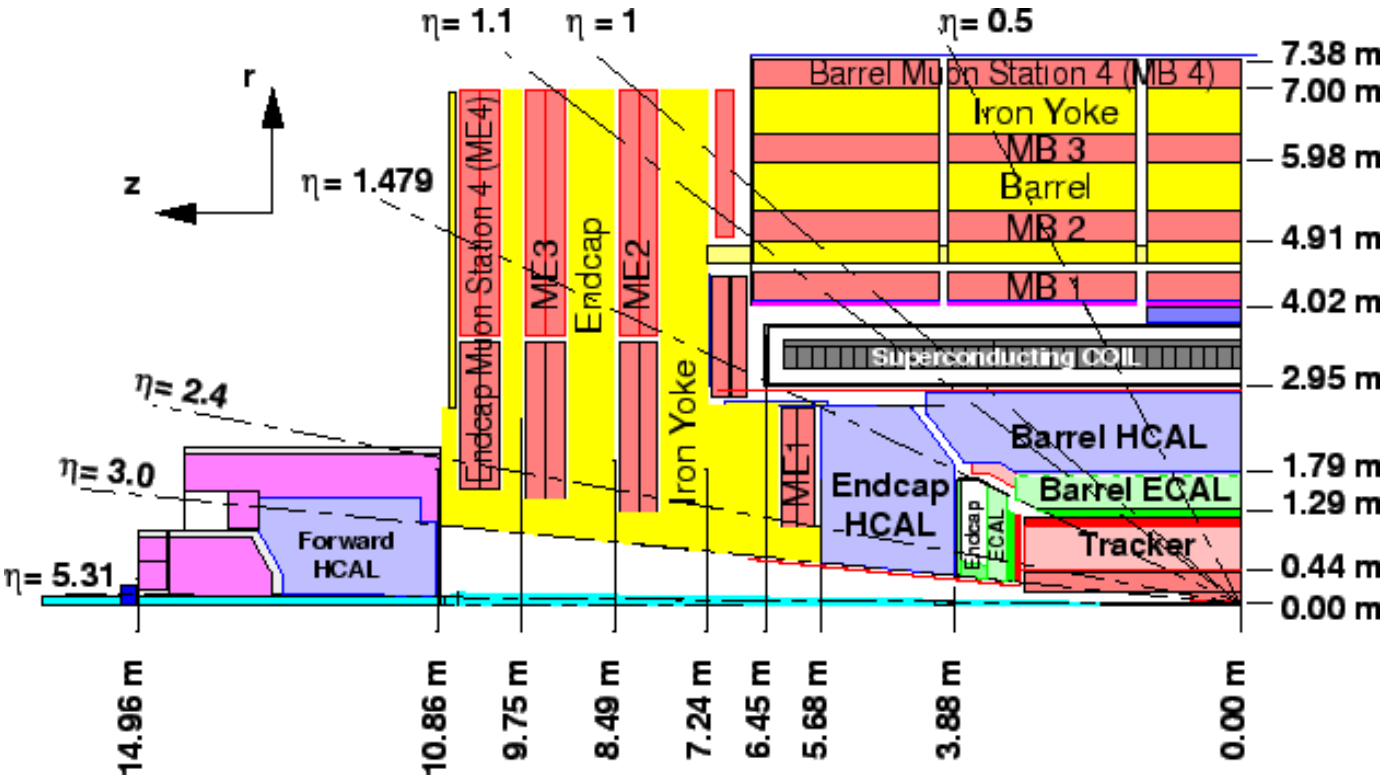

$$\eta = -\ln tg\frac{\theta}{2}$$

η differences are Lorentz invariant for high energy particles

INTERPRETATIONS OF RUN 1 RESULTS

observed limit on cross section depends on DM mass and interaction with SM

can be translated into limit on DM-nucleon scattering cross section

different sensitivity from various experiments can lead to controversial results